FINAL REPORT

April 9th, 2014

SOUTH HALLS RENOVATION: EWING-CROSS

UNIVERSITY PARK, PA

Quaid Spearing

Construction Option

Advisor: Dr. Anumba

South Halls Renovation: Ewing-Cross

University Park, PA

ARCHITECTURE

- One of four dormitory renovations
- Brick façade and limestone veneer enclosure
- New wrap around porches invite students to socialize

STRUCTURAL SYSTEM

- Original structure consists of HSS columns and lift slab construction
- The new structural system for the bathrooms consists of concrete slab on composite metal deck

MECHANICAL SYSTEM

- Heating and cooling is supplied via campus steam and chilled water
- The building utilizes a two-pipe and a four-pipe system to condition spaces
- (2) ERVs supply fresh outside air and utilize enthalpy wheels
- (2)1700CFM AHU condition the meeting rooms

ELECTRICAL SYSTEM

- 480/277V Main Electrical Service
- (2) 600A Panel boards
- 208/120V Emergency Feed
- One main electrical room on ground floor

PROJECT TEAM

Owner: Penn State

Design Builder: Barton Malow Company

Architect/MEP Engineer: Clark Nexsen

Civil Engineer: Sweetland Engineering

Electrical Contractor: The Farfield Company

Mechanical Contractor: McClure Company

PROJECT OVERVIEW

Size: 71,002 GSF

Stories: Four plus Basement

Function: Residential & Assembly

Construction Dates: May 2013 - Dec 2013

Delivery Method: Design-Build

SPECIAL THANKS

PENNSTATE 1855

Barton Malow

CLARK◆NEXSEN
Architecture & Engineering

Quaid Spearing | Construction Management Option

http://www.engr.psu.edu/ae/thesis/portfolios/2014/qws5007/index.html

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The Barton Malow Project Team

PACE Industry Members

My Friends and Family

SOUTH HALLS RENOVATION: EWING-CROSS

EXECUTIVE SUMMARY

The South Halls Renovation and New Construction project is a $94M construction project, which is located in University Park of the Pennsylvania State University. There are four identical dormitory buildings that are currently being consecutively renovated, with Ewing – Cross serving as the building primarily analyzed for previous technical reports and for this final report. This senior thesis report encompasses the findings of the four analyses that were performed for the South Halls Renovation. Through project team interviews, course knowledge, jobsite visits, and online research, the four analyses for this report were developed.

Analysis 1: Modularization of Bathroom Units

The first analysis focused on the construction of the bathroom pods due to the issues with the quality of the finish work, which caused delays in the turnover of these areas. Ewing – Cross has two stacks of bathroom cores, encompassing 40 individual bathrooms. In an effort to improve the quality of the bathrooms while also reducing the construction schedule, the bathrooms were modularized to be built offsite as individual bathroom pods. Modularizing the bathrooms resulted in $120,000 in savings, in addition to the bathroom construction being completed four weeks earlier than previously scheduled. Note that this analysis included an architectural breadth that looked at designing the bathrooms for modularization.

Analysis 2: SIPS Implementation for Student Rooms

The second analysis looked at implementing SIPS for the construction of student rooms. The punchlist for student rooms and turnover to the owner was critical at Ewing-Cross because the owner was receiving the building just as students were ready to return for the spring semester. The repetitive nature of the student room construction lent itself well to SIPS; there was a focus on creating equal sized zones, with all construction activities having an equal duration of 5 days. While implementing SIPS did not reduce the overall project schedule, the reorganization of activities and optimizing of crew sizes resulted in a schedule savings of 10 days, allowing the owner to begin their FF&E sooner.

Analysis 3: Prefabrication of Limestone Façade

Analysis 3 focused on the construction of the building enclosure; specifically, the limestone façade. The stone panel veneer was compared to a traditional 3 5/8” limestone panel façade to determine if any costs savings were achievable through changing materials. The increased structural requirements of the thicker limestone actually added about $1,000 per bumpout to the cost of the building, so this was ruled out as an alternative. Then, the limestone veneer wall system was analyzed to determine if prefabrication was feasible. Prefabricating the walls into modules allowed for a potential cost savings of $175,000, while reducing the enclosure schedule by 36 days. Note that this analysis also included a structural breadth.

Analysis 4: Resequencing of Renovation Phases

The final analysis dealt with resequencing the renovations in an attempt to deliver the project one semester earlier; this would allow the owner to start generating revenue earlier, upon completely opening the South Halls dormitories for the fall 2014 semester. By increasing the project management staff, it would be feasible to renovate two buildings at the same time to shorten the overall project schedule by 5 months. This would add approximately $31,000 in General Conditions costs, but would also allow the owner to generate $1.3M in revenue.

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PROJECT INTRODUCTION

Ewing – Cross is part of the South Halls Renovation and New Construction project, which is located in University Park of the Pennsylvania State University. Ewing – Cross is a 71,000 gross square foot four-story plus basement dormitory building that will house approximately 250 students. Also included in the South Halls Renovation is the addition of a new dormitory building, Chace Hall, as well as the renovation of three other dormitory buildings and the renovation and addition to Redifer Commons. Figure 1 below depicts the current sequencing of the renovation phases at South Halls.

Figure 1: **South Halls Phasing Schedule | Image Courtesy of Bing**

The project is delivered using a Design – Build delivery method. Barton Malow Company is serving as the construction manager for the project, along with Clark Nexsen fulfilling the role of the architect and MEP engineer. Barton Malow is contracted with Penn State on a $94.1M Guaranteed Maximum Price (GMP) contract, and Clark Nexsen is contracted with Barton Malow on a Lump Sum basis. The total cost for the Ewing – Cross renovation is approximately $15.2M; this equates to $214.15/SF.

The total project duration for the South Halls renovation is approximately 33 months, with the design phase beginning at the end of May in 2011. The notice to proceed was given on May 1st, 2012, with construction beginning on Chace and Haller-Lyons. Construction on Ewing-Cross began with the demolition and abatement of the interiors in May of 2013, and is expected to reach substantial completion at the end of December 2013, in anticipation of student move-in for the 2014 spring semester. In total, the construction of Ewing-Cross follows an aggressive seven month duration, with a unique phasing of the interior work.

CLIENT INFORMATION

Penn State University is a public university, which was founded in 1855, as one of the nation's first colleges of agricultural science. There are twenty-four campuses located throughout Pennsylvania. The main campus, University Park, is the largest Penn State campus, and is home to about 44,000 undergraduate students. There are approximately 13,700 students who live on campus, including all incoming freshman.

WHY RENOVATE?

There are several reasons why Penn State Housing decided to renovate the South Halls Dormitories. The original facilities were constructed in the 1950's, and over the last 60+ years, were well maintained. However, there were several issues with MEP systems: the mechanical equipment was past its useful life, and the sprinkler systems in place were temporarily installed, in anticipation of a future renovation. Most of the building systems did not meet current energy and building codes, including not being ADA compliant.

In addition to the overall deterioration of the South Halls complex, Penn State had a desire to relocate all sororities to South Halls. A large portion of the sororities on campus are located in Pollock and South Halls. By placing all sororities in South Halls, Penn State is able to allocate each sorority their own floor.

PROJECT EXPECTATIONS

Penn State considers safety the highest priority for the South Halls projects; not only during construction, but safe facilities for the students to reside in. Following safety, the project schedule is the most critical aspect. The first renovation, Haller-Lyons, took one year to complete. However the next three buildings have anticipated schedule durations of 7 months each, leaving little room for error in respect to delivery of the project. Students are anticipated to move into each dorm immediately after completion.

In terms of cost and quality, Penn State has high expectations. Housing and Food Services (HFS) are self-supporting; the students are their business. They wanted to create a great place for students to live, while still getting the best value for their dollar. Unlike most other owners who only make 15-20 year decisions, Penn State follows long term planning by making 50 year decisions. They wanted to make sure the renovation had durable spaces and quality equipment; Penn State's mentality is to renovate, not replace. Examples of what Penn State expects from projects can be seen all across the campus. There are several buildings that are greater than 100 years old.

SEQUENCING ISSUES OF INTEREST

The most notable sequencing issue is the overall phasing of the project. Much planning went into to determining the order in which the four buildings would be renovated. A big factor that played into the phasing of the buildings was which two Penn State would want to renovate if they could only complete half of the overall project.

KEYS TO OWNER SATISFACTION

Overall the keys to owner satisfaction are: safety, delivering the project on time, and budget. There is no flexibility in schedule for each phase of the project, and they expect the project to meet the budget, all without a loss in quality.

EXISTING CONDITIONS

Figure 2 below shows the existing conditions for the renovation of Ewing – Cross; the full detailed plan of the existing conditions can be found in Appendix D.

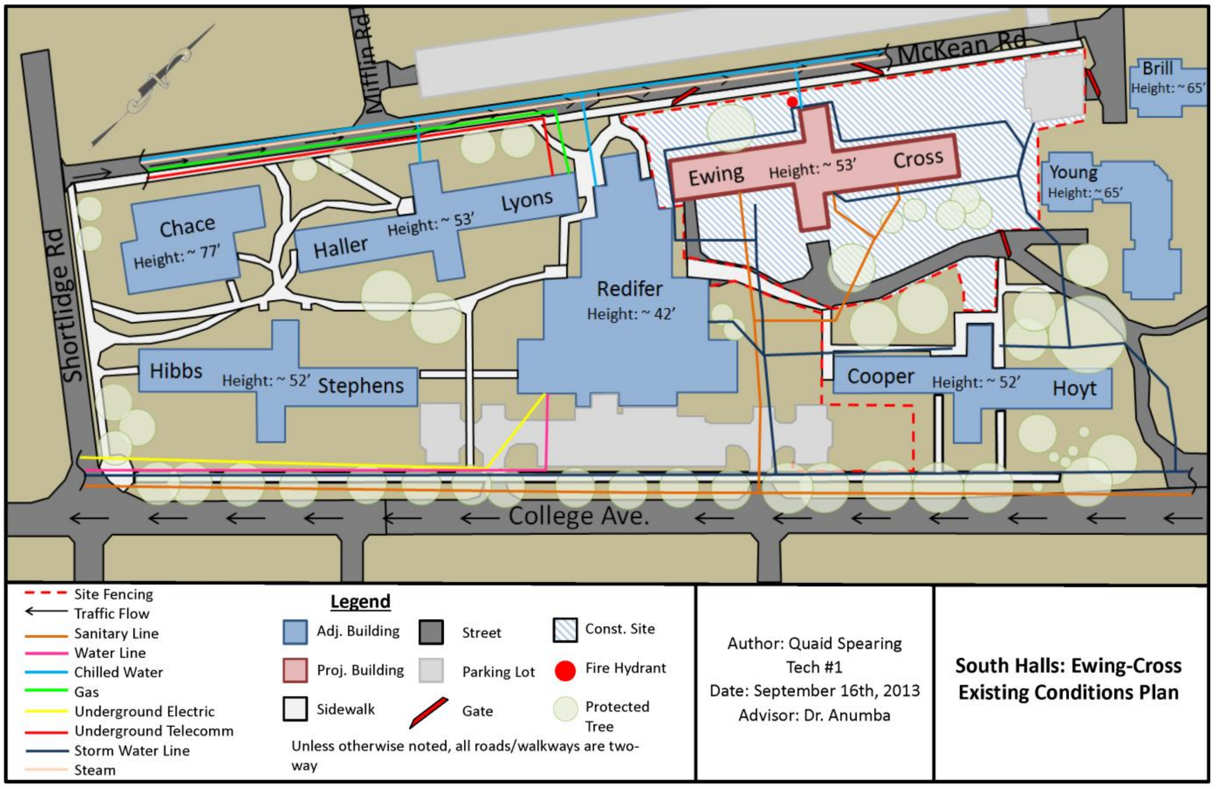


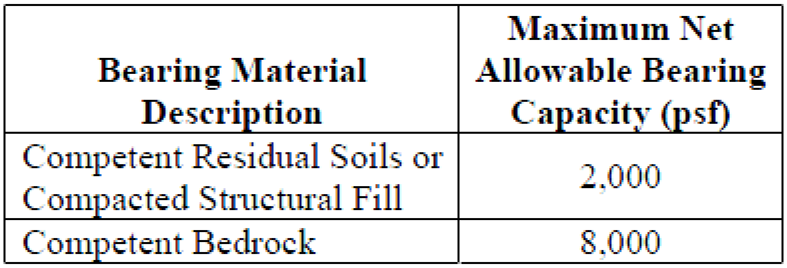
Figure 2: Existing Conditions Plan

LOCAL CONDITIONS

SOIL

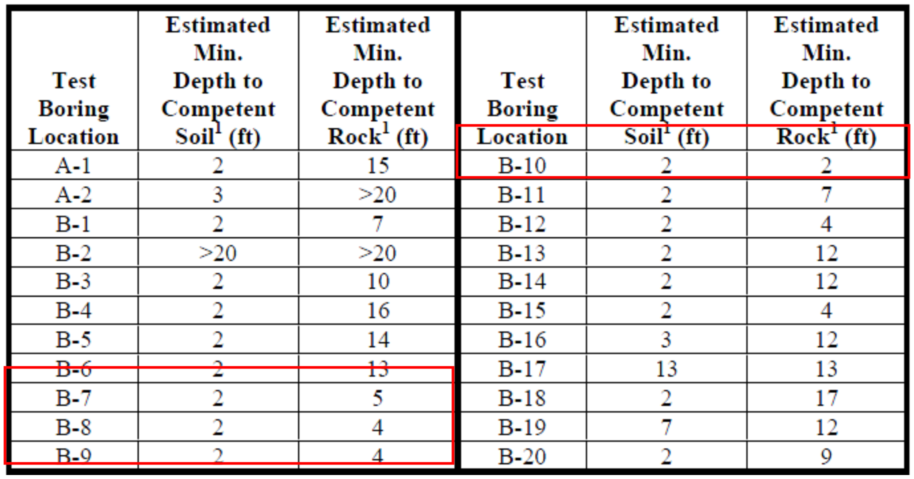
In total, there were 22 bore holes tested at South Halls. Of these twenty-two, four are relevant to Ewing-Cross: B-7, B-8, B-9, and B-10 (see figure 3). These four boring locations contain a layer of topsoil approximately 4 to 18 inches thick. Underlying the topsoil, the soils around Ewing-Cross consist of a layer of natural residual soils consisting primarily of clay and silt sized particles with varying amounts of sand sized particles and weathered dolomite fragments. These soils sit directly on dolomite bedrock, which resides between 1 and 13 feet below the existing surface grades.

Based upon the boring samples from CMT, it was determined the soils around the building would have suitable bearing capacity (see figures 3 and 4). Compacted PennDot 2A course was recommended for structural fill under footings and slabs. Groundwater testing was performed at each bore hole; there were several areas where ground water encountered during drilling activities. However, at the four locations surrounding Ewing-Cross, groundwater was not encountered.



Bearing Material Description	Maximum Net Allowable Bearing Capacity (psf)
Competent Residual Soils or Compacted Structural Fill	2,000
Competent Bedrock	8,000

Figure 3: Foundation Bearing Capacity | Courtesy of CMT



Test Boring Location	Estimated Min. Depth to Competent Soil[1] (ft)	Estimated Min. Depth to Competent Rock[1] (ft)	Test Boring Location	Estimated Min. Depth to Competent Soil[1] (ft)	Estimated Min. Depth to Competent Rock[1] (ft)
A-1	2	15	B-10	2	2
A-2	3	>20	B-11	2	7
B-1	2	7	B-12	2	4
B-2	>20	>20	B-13	2	12
B-3	2	10	B-14	2	12
B-4	2	16	B-15	2	4
B-5	2	14	B-16	3	12
B-6	2	13	B-17	13	13
B-7	2	5	B-18	2	17
B-8	2	4	B-19	7	12
B-9	2	4	B-20	2	9

Figure 4: Minimum Over excavation Depths | Courtesy of CMT

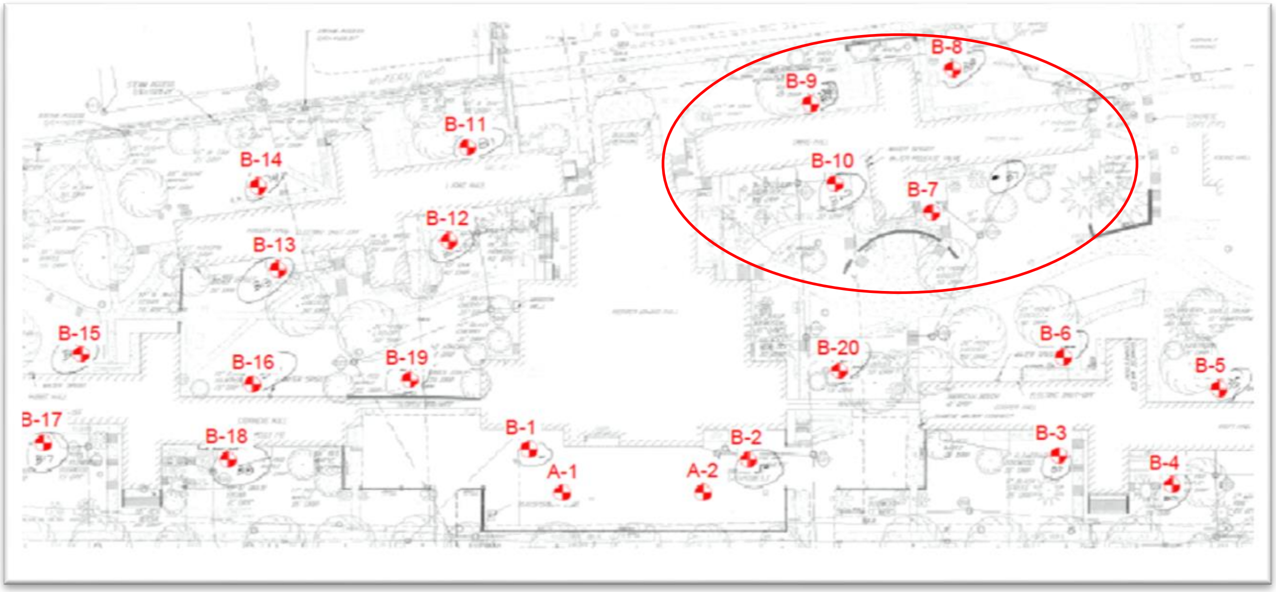


Figure 5: Bore Holes around Ewing - Cross | Courtesy of CMT

PARKING

Typical for most construction projects on campus, workers are required to park offsite at the commuter lots located near the Bryce Jordan Center and Beaver Stadium; from there, workers then ride the bus over to the jobsite at South Halls. Figure 6 shows the offsite parking locations.

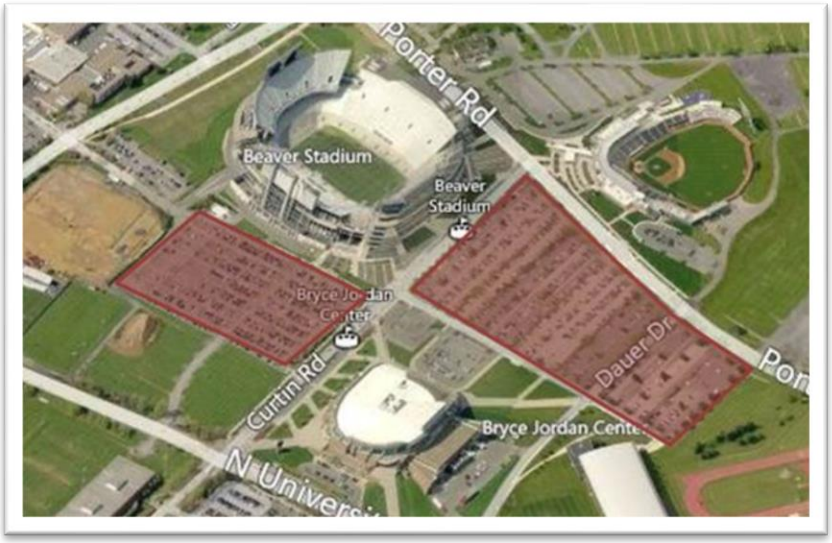


Figure 6: Offsite Construction Parking | Bing Maps

RECYCLING

Per PSU requirements, the contractor is required to recycle a minimum of 75% of construction waste; greater than minimum the requirements for LEED.

CONSTRUCTION PHASING

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. 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 is 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**

PROJECT DELIVERY SYSTEM

The South Halls Renovation and Construction utilizes a Design-Build delivery method, with Barton Malow Company acting as the Contractor and Clark Nexsen as the designer. In 2009, Penn State had a feasibility study performed to look into the potential construction activities that could be performed in the South Halls complex area. Based upon the findings of the study, Penn State requested proposals from several project teams, including Barton Malow/Clark Nexsen, who was eventually selected on a Best Value basis. Barton Malow is contracted with Penn State on a Guaranteed Maximum Price (GMP) contract, and Clark Nexsen is contracted with Barton Malow on a Lump Sum Basis. A GMP gives Penn State the flexibility to adjust the project, while still having a cap on the price; this works well with a design-build project, as there can be numerous change orders with fast tracked projects.

Clark Nexsen serves several functions on the project team: Design Architect, Mechanical Engineer, Electrical Engineer, Structural Engineer, and Fire Protection Engineer. Unlike most projects where work is bid on a Lump Sum low bid basis, the primary Design Assist Specialty Contractors were selected through a two stage proposal where each contractor was scored based on their proposals. The judges were comprised of the project management team as well as a Penn State Office of Physical Plant (OPP) project manager. The specialty contractor with the highest average score was awarded the work for their respective trade. Selecting DA specialty contractors through scoring allowed Penn State to select the contractors that would provide the best value and quality, not just the lowest bid.

On the next page is an organizational chart for the project that details all of the main parties involved and how they are contracted. As previously stated, Barton Malow is directly contracted with Penn State on a GMP contract. The specialty contractors and Clark Nexsen are contracted with Barton Malow on Lump Sum contracts. Sweetland Engineering and APA are contracted with Clark Nexsen on Lump Sum contracts.

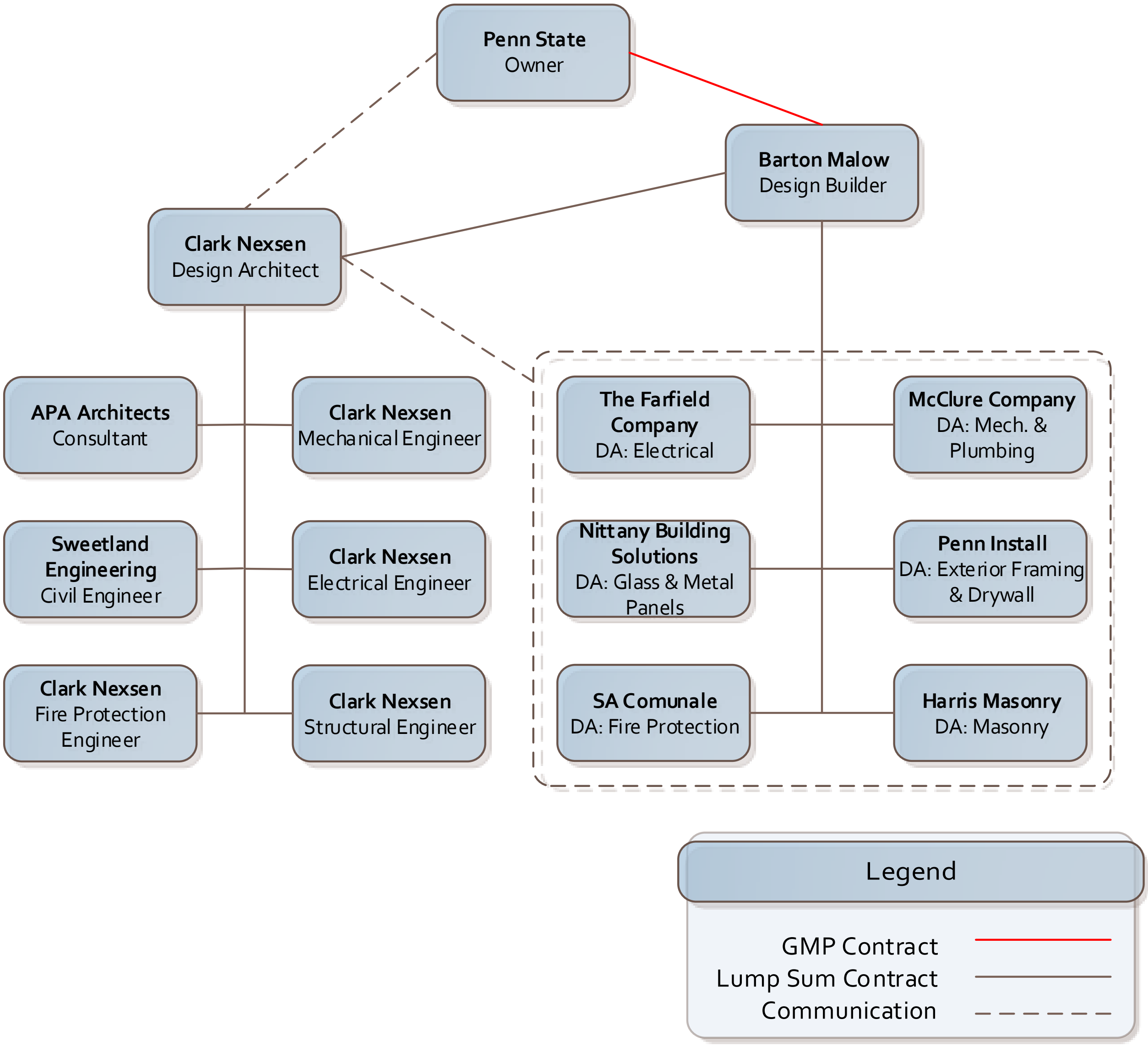


Figure 7: Project Organizational Chart

STAFFING PLAN

The project staff is located in the co-location office in Redifer Commons. The staffing chart shown below, details Barton Malow's project team for the South Halls renovation. Everybody in the staffing plan works out of the field office, except for the Senior Project Manager and Project Executive.

In looking at the staffing plan in detail, Bob Grottenhaler serves as the Project Executive, with Dan Buchta reporting directly to him. Heading the project management on site is handled by Ken Pagett. Reporting directly to him is the Senior Project Engineer, Nicholas Umosella, and the Project Technician, Jodie Evans. Lindsay Wirtz serves as the Project Engineer and reports to Nicholas. On the field side, Andy Lawless serves as the Field Superintendent and has two assistant superintendents who report to him; Keith Merrit and Mike Curtis.

The staffing plan represents the management staff for the Ewing-Cross Renovation, Phase 1B, and is adjusted accordingly for future phases as required. In addition to Barton Mallow's staff, all of the Design Assist specialty contractors are located in the co-location office, which promotes communication among trades.

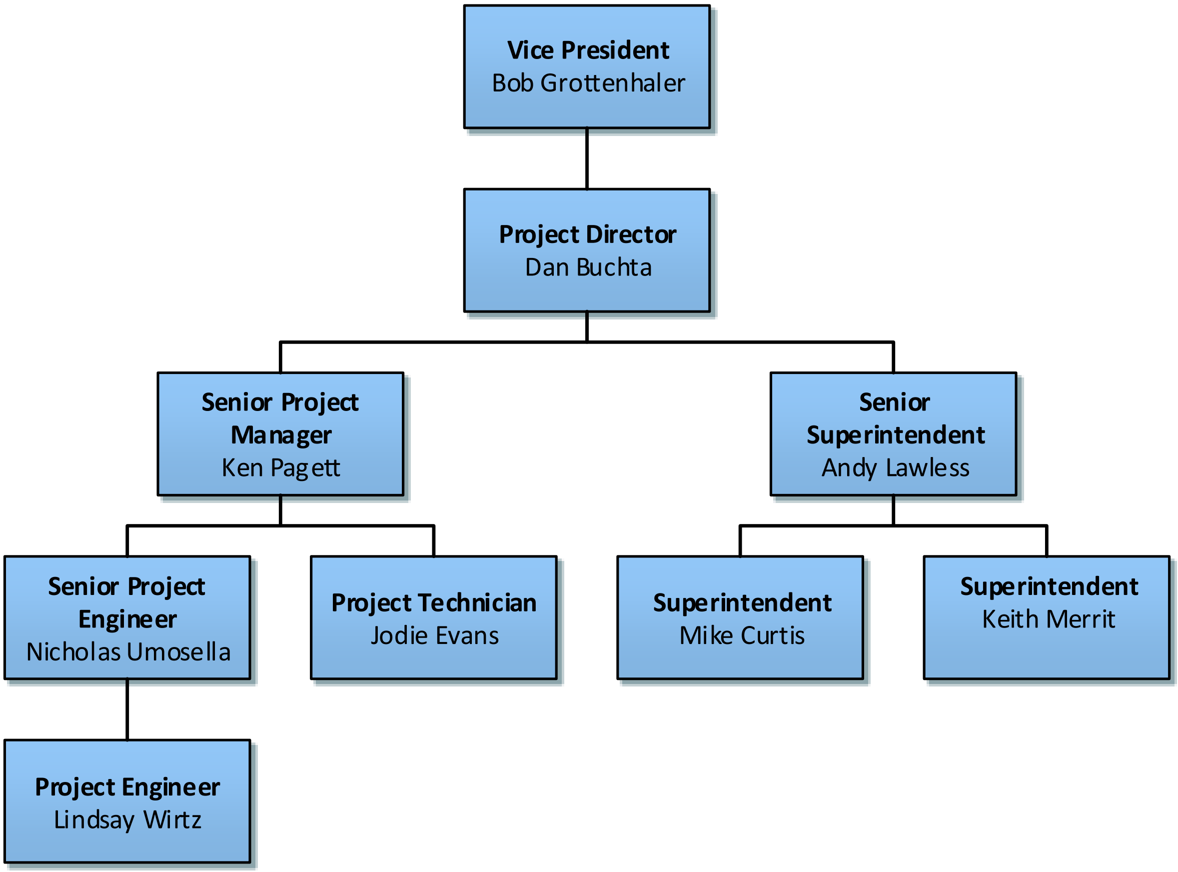


Figure 8: Project Staffing Plan

BUILDING SYSTEM SUMMARY

The building systems summary outline below shows the key aspects of the design and construction for Ewing-Cross. Following the checklist are short summaries that describe the design and construction for each relevant system.

Table 1: Building Systems Checklist

Yes	No	Work Scope	If Yes, Topics/Questions Addressed
X		Demolition Required	Types of materials, lead paint, or asbestos?
X		Structural Steel Frame	Type of bracing, composite slab, crane info.
X		Cast in Place Concrete	Formwork types, concrete placement methods
	X	Precast Concrete	Casting location, connection methods, crane info.
X		Mechanical System	Room locations, system type, fire suppression
X		Electrical System	Size/capacity, redundancy
X		Masonry	Load bearing/veneer, connection details, scaffolding
X		Curtain Wall	Materials, construction methods, design responsibility
X		Support of Excavation	Type of support system, detwatering system, permanent vs. temporary

DEMOLITION

Since this is a renovation project, demolition makes up a considerable portion of the project. There was a large amount of abatement work that included the removal of asbestos tiles and insulation. The abatement part of the project was not included in Barton Malow's contract. Other demolition includes the removal of all sorority and bedroom furniture; portions of the exterior storefront, exterior walls, and interior walls; the removal of the bathroom floor slabs; and the demolition of the existing mechanical, electrical, and plumbing systems.

STRUCTURE

Structural Steel Frame

Ewing-Cross was constructed in 1955 using mainly HSS steel members; columns range in size from HSS4 1/2x4 1/2 to HSS7x4. There are also W8x28 wide flange members, and the existing roof consists of mainly W8x13 wide flange members. It was determined that the alternations to the building increased the weight, and therefore the lateral load of the existing building structure by less than 5 percent. Therefore, additional lateral force resistance to the existing building was not required. The existing structural steel frame will remain in place.

The new bathroom floor construction for the bumpouts (1-4) consists of a 3 ¼" LW Concrete on 3" VLI composite metal deck, reinforced with 6x6 wwf. The composite slab-on-deck was designed as unshored composite construction.

A truck crane was utilized for the placement of the steel members. The crane was located on the south side of Ewing-Cross. On the north side, two (2) smaller crawler cranes were used for the placement of the metal stud framing for the stone panel projections.

Cast in Place Concrete

The replacement floor slabs in Ewing-Cross were designed as 7.5” thick Lift Concrete Structural Slab. The upper floors are supported at the ground floor by cast-in-place concrete beams that tie into cast-in-place concrete columns, ranging in size from 12”x12” to 16”x27”. These columns distribute the building loads to a 24” thick foundation slab. A majority of the existing structure will remain; will the exception of the bathroom floor slabs.

Since a majority of the existing structure is to remain, the only areas requiring cast-in-place concrete work are the bathroom floor slabs and bumpout slab on metal deck, the wraparound porch slab, columns, and the footers, which support both the porch and stone panel system bumpouts. The foundations consisted of spread and continuous footings and concrete walls to support the bumpouts and columns for the wraparound porch. The foundations were wood formed and placed using a concrete pump. The most unique cast-in-place concrete for the South Halls Renovation is the bathroom composite slab-on-deck. The bathroom slabs had to be demoed due to delamination. Figure 9 shows the detail of how the new slab ties into the existing structure. It was designed as shored construction and was placed with a concrete pump directly from the concrete truck. While the rest of the construction follows a top-down sequence, the bathroom slabs were constructed from the first floor up so that shoring could be placed quickly to support the above floor slab.

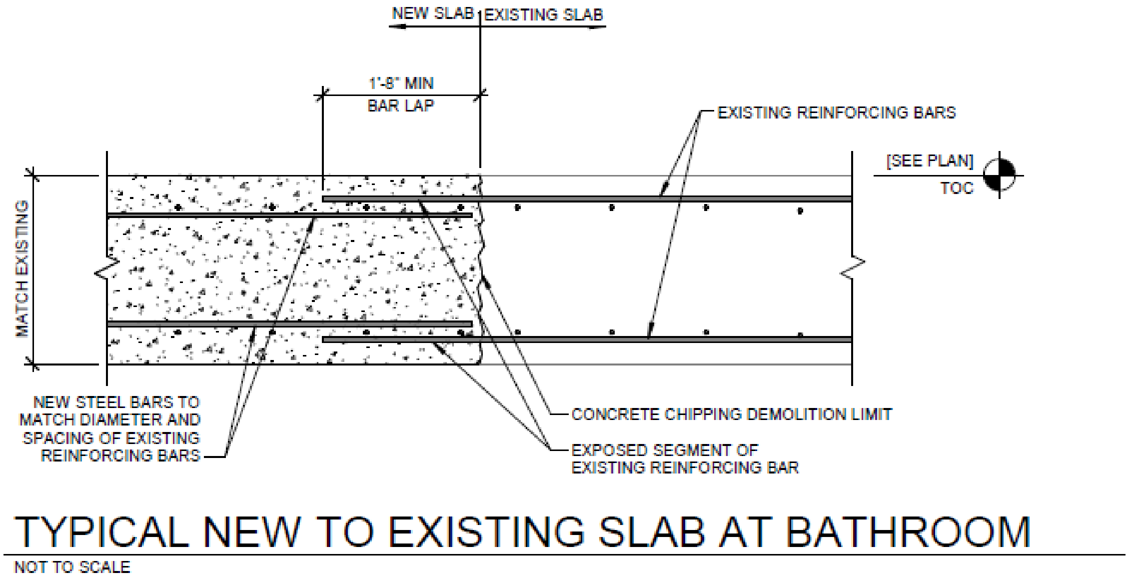


Figure 9: Existing Bathroom Slab

MECHANICAL

Hot and chilled water is supplied from Redifer Hall and is transferred to Ewing/Cross’s system through heat exchangers on the ground floor. There are three main mechanical systems that serve Ewing Cross. The first system is a dual temperature system which provides heating and cooling through 160 individual Fan Coil Units (FCU), which service student bedrooms, sorority suites and lobbies. The FCUs are on a dual pipe system, with a 1” copper supply and a 1” copper return. The second system consists of Two (2)

Air-to-Air Energy Recovery Ventilation (ERV) units which are used to supplement the Outside Air by recovering heating/cooling from Exhaust Air; ERV-3 supplies 3,830 CFM to Ewing and ERV-4 supplies 4,370 CFM to Cross. Duct chases from the ERV units at ground floor are ran through the four (4) stone panel bumpouts located in front of the bathroom stacks. From these chases, the ductwork branches out to each floor to distribute fresh to each room that runs on a two pipe system. The third system is a Four Pipe System which services the Ground and First Floors Common Areas, such as the lounge, loggia, entrance, and sorority storage. The four pipe system allows for greater flexibility in temperature control by allowing heating and cooling simultaneously. The fan coil units on the four pipe system are tied directly into the ductwork for the space which they service, eliminating runs of ductwork from the ERV to each respective room.

In addition to the three main mechanical systems, special accommodations were made to provide heating and cooling to the two (2) meetings rooms on the first floor; both are fed by separate 1700 CFM Air Handling Units (AHU). This was due to the lack of room for running additional ductwork to the meeting rooms, from the mechanical room on ground floor; the reduced runs of ductwork also provide cost savings.

FIRE PROTECTION

The building makes use of a wet pipe sprinkler system for all areas except for the attic, which will remain on the existing dry pipe sprinkler system. All areas are considered light hazard occupancies per NFPA 13, except the basement, mechanical and storage areas, which are considered ordinary hazard group 1 occupancies. All other building elements have fire-resistive ratings in accordance with IBC 2009 Table 601.

ELECTRICAL

Similar to the other buildings at South Halls, Ewing/Cross has a normal feeder and an emergency feeder from Redifer Hall. The system requires a demand service of 354.6 kVA. It is supplied via 480V utility feed that travels through a 600 amp main distribution panel (MDP). From the MDP, service is provided to the major mechanical equipment that requires 480Y/277 (ERV, CHWP, HWP, DTP, CHWP) are supplied. The MDP also supplies the 600 amp existing distribution panel (LDP), via a 150 kVA step-down transformer. The elevators and all of the smaller panel boards are directly supplied via the LDP panel and are rated at 208Y/120 and primarily service the power and lighting loads.

Ewing/Cross implements an emergency power system, which is fed from Redifer Hall. Emergency Power is supplied to an Emergency 3-phase medium voltage switch that feeds into a 75kVA emergency transformer. The transformer services an emergency distribution panel (EDP) which ties directly into the LDP via 208V utility feed, and can used to energize the necessary loads during a power outage.

LIGHTING

The lighting plan for Ewing/Cross consists of various sizes of T8 fluorescent troffer luminaires, recessed downlight and wall washers led fixtures, and several different compact fluorescent ceiling and wall mounted fixtures. The Common Lounges and Meeting Rooms utilize 2x4 Direct/Indirect fluorescent F28T8 luminaires with three (3) lamps on dimming ballast. A typical student room makes use of a 1x4 surface mounted fluorescent two (2) lamp F28T8 fixture with integral occupancy sensor. The sorority suites lighting consists of several 4" diameter led downlight fixtures, along with 24" diameter decorative flush ceiling mounted fluorescent FT36/2G11 fixtures. The typical lamp throughout the building is a F28T8.

MASONRY

Clark Nexsen implemented two different types of building facades for Ewing/Cross. The first type of building envelope is the existing brick veneer, which ties into a CMU wall; 1-1/2" rigid insulation along with 6" batt insulation was added to the interior of the CMU wall to improve the building's heating/cooling efficiency. The brick façade wall is accented by limestone wall sweeps at each floor level.

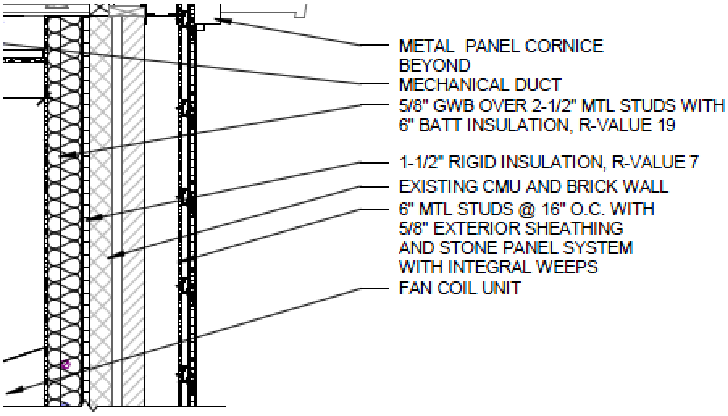


Figure 10: Small Project Wall Detail | AE 321

The second wall type is the stone panel system, which acts a veneer. There are two different types of stone panel bumpouts. The first is the stone panel system at the bathroom wetcores. The 1/4" stone panels are backed by metal furring strips which are attached to 5/8" sheathing, supported by 8" metal studs. These stone panel bumpouts contain mechanical chases.

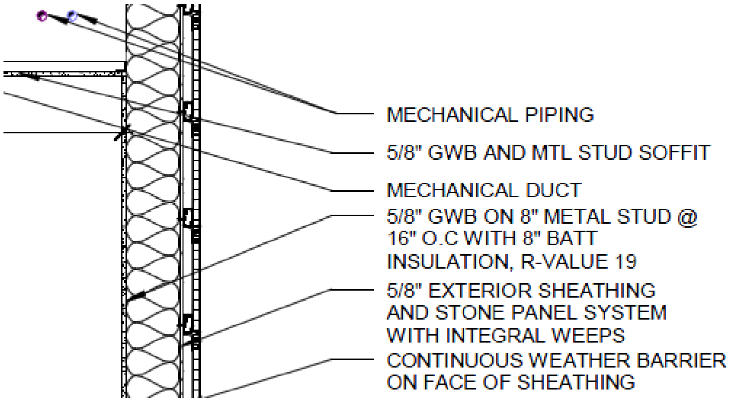


Figure 11: Large Projection Wall Detail | AE 322

The other type of stone panel system is the smaller aesthetic panel systems, meant to mimic the ones at the wetcores. Similar to the wetcore stone panel systems, the 1/4" panels tie into metal furring strips which are attached to 5/8" sheathing. This system then ties into 6" metal studs which attach directly to the existing brick veneer.

A hydraulic scaffolding system was implemented for the installation of all building facades and to effectively install the stone panel veneers. The system was placed on flats and could be picked up and moved around the building perimeter as needed. This type of scaffolding helps with the schedule because it cuts down on the time that would be required for assembly and removal of a traditional scaffolding system.

CURTAIN WALL

The curtain wall system designed for Ewing-Cross follows the same scheme as the existing curtain wall at the stairwells. The curtain wall works to allow natural light to penetrate the stairwells for both Ewing and Cross. Aluminum frame storefront and insulated low E glass are the two components of the curtain wall system. The aluminum framing and metal trim is designed to match the rest of the storefront and window trim. The low E glass will help to reduce the building heat loads as well as earn LEED credits.

SUPPORT OF EXCAVATION

Because a majority of the structure is to remain, very little excavation is needed for the renovation of Ewing-Cross. The majority of the excavation performed is for the foundations of the wraparound porch and stone panel bumpouts. The foundation backfill is to be compacted PennDot 2A stone.

TRANSPORTATION

There are two (2) traction elevators that service the building; one (1) for Ewing and one (1) for Cross, as required by code for handicap access to the upper floors of the building. In addition to the elevators, there is also a wheelchair lift located in stairwell #1, due to 4’-9 5/8” floor height difference between Ewing and Cross.

TELECOMMUNICATIONS

Ewing - Cross has the typical telecommunication systems: voice, data and catv cabling is ran to each room. Service Entrance Cabling is run from Redifer Hall through the Utility Tunnel to terminals located on the ground floor. From the ground floor terminals, cabling is distributed to each floor and then to the telecommunications device outlets. Ewing/Cross is also equipped with whole building Wi-Fi.

PROJECT COST EVALUATION

The cost data for Ewing – Cross was analyzed to gain a better understanding of the project. Previous technical reports looked at comparing the actual cost data to a square foot estimate. Costs were further evaluated by performing assemblies’ estimates for the major building systems.

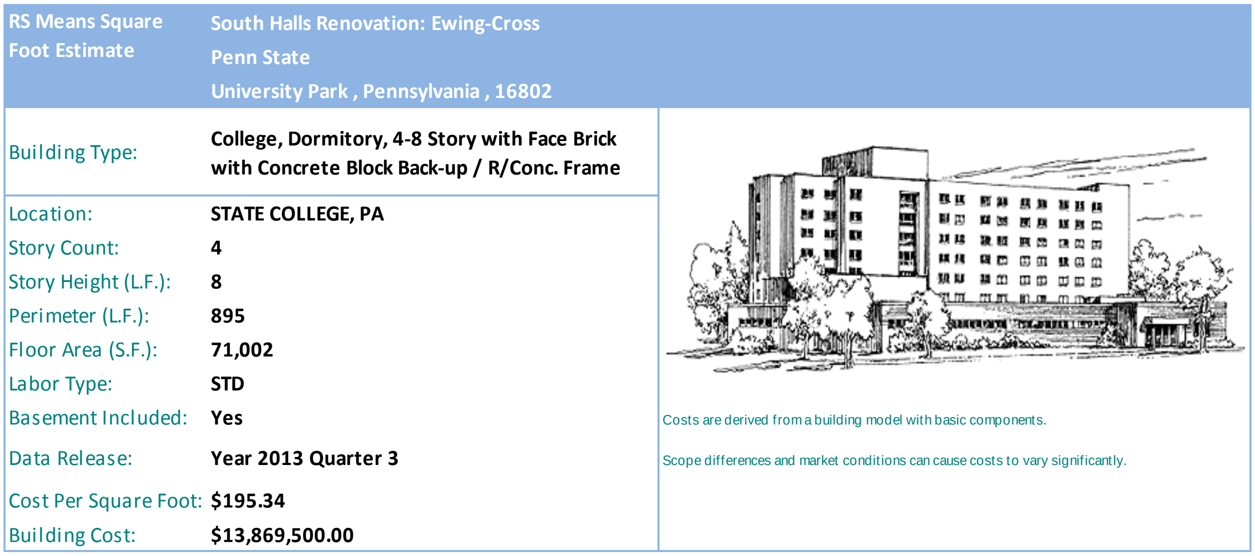
The construction cost for Ewing-Cross is approximately **$11,836,550**, at **$166.71/SF**; including the indirect costs such as General Conditions, Bonding & Insurance, and CM Fees, the Project Costs comes out to **$15,204,750**, at **$214.15/SF.** Since Ewing-Cross is nearly identical to Haller-Lyons, the other building included in the Phase 1 renovation, the cost of Phase 1 is $30,409,500. Table 2 shows a cost breakdown of the project’s various systems. Upon further analysis of the building systems costs, it is apparent that the two largest components are the mechanical and electrical systems. This is due to the fact that a majority of the structure is existing to remain, and the MEP systems were entirely replaced.

Table 2: Building Cost Summary | Information Courtesy of Barton Malow

South Halls: Ewing-Cross Actual Cost				
Description	**Total Cost**	**SF**	**Cost/SF**	**% of Total**
Demolition	$ 386,250.00	71,002	$ 5.44	3.26%
Concrete	$ 414,900.00	71,002	$ 5.84	3.51%
Masonry	$ 998,450.00	71,002	$ 14.06	8.44%
Metals	$ 413,950.00	71,002	$ 5.83	3.50%
Carpentry	$ 414,850.00	71,002	$ 5.84	3.50%
Roofing	$ 692,400.00	71,002	$ 9.75	5.85%
Doors & Hardware	$ 417,000.00	71,002	$ 5.87	3.52%
Glazing & Metal Panels	$ 817,800.00	71,002	$ 11.52	6.91%
Drywall & Ceilings	$ 1,017,600.00	71,002	$ 14.33	8.60%
Tile	$ 271,400.00	71,002	$ 3.82	2.29%
Flooring	$ 372,550.00	71,002	$ 5.25	3.15%
Painting	$ 181,200.00	71,002	$ 2.55	1.53%
Specialties	$ 90,750.00	71,002	$ 1.28	0.77%
Fire Protection	$ 130,350.00	71,002	$ 1.84	1.10%
Mechanical & Plumbing	$ 2,782,950.00	71,002	$ 39.20	23.51%
Electrical	$ 1,304,000.00	71,002	$ 18.37	11.02%
Total Building Construction Cost	**$ 11,836,550.00**	71,002	**$ 166.71**	100.00%
Total Project Costs	**$ 15,204,750.00**	71,002	**$ 214.15**	

SF COST

The RS Means Online, version 2013, was utilized for the Square Foot Estimate of Ewing-Cross. The building is 71,002 sf and has a building perimeter of 895 lf. Location, floor height, and time factors were used to arrive at the final square foot estimate. Figure 5 shows the details utilized for the square foot estimate.



RS Means Square Foot Estimate

South Halls Renovation: Ewing-Cross
Penn State
University Park , Pennsylvania , 16802

Building Type: College, Dormitory, 4-8 Story with Face Brick with Concrete Block Back-up / R/Conc. Frame

Location: STATE COLLEGE, PA
Story Count: 4
Story Height (L.F.): 8
Perimeter (L.F.): 895
Floor Area (S.F.): 71,002
Labor Type: STD
Basement Included: Yes
Data Release: Year 2013 Quarter 3
Cost Per Square Foot: $195.34
Building Cost: $13,869,500.00

Costs are derived from a building model with basic components.

Scope differences and market conditions can cause costs to vary significantly.

Figure 12: RS Mean Square Foot Estimate

There are several factors that influence the differences among the actual building cost and the square foot estimate. The main factor being that the square foot estimate assumes a new structure. Demolition costs are not taken into account with the square foot estimate. Another factor that makes the actual building cost higher than the square foot estimate is the low floor to floor heights. At 8’-0”, coordination of the MEP systems becomes more difficult, as there is less ‘real estate’ for each system above ceiling, creating a higher level of BIM coordination needed. Floor construction (concrete) costs are also significantly different; the square foot estimate is nearly $1,000,000 greater than the actual cost. This can be accounted to the fact that the existing slabs are remaining, except for the bathroom slabs.

Table 3: Building Cost Summary Comparison

South Halls: Ewing-Cross Actual Cost					Square Foot Estimate		
Description	**Total Cost**	**SF**	**Cost/SF**	**% of Total**	**Total Cost**	**Cost/SF**	**% of Total**
Demolition	$ 386,250.00	71002	$ 5.44	3.26%	-	-	-
Concrete	$ 414,900.00	71002	$ 5.84	3.51%	$ 1,787,500.00	$ 25.18	17.24%
Masonry	$ 998,450.00	71002	$ 14.06	8.44%	$ 377,500.00	$ 5.32	3.64%
Metals	$ 413,950.00	71002	$ 5.83	3.50%	-	-	
Roofing	$ 692,400.00	71002	$ 9.75	5.85%	$ 323,000.00	$ 4.55	3.11%
Doors & Hardware	$ 417,000.00	71002	$ 5.87	3.52%	$ 481,500.00	$ 6.78	4.64%
Glazing & Metal Panels	$ 817,800.00	71002	$ 11.52	6.91%	$ 110,000.00	$ 1.55	1.06%
Drywall & Ceilings	$ 1,017,600.00	71002	$ 14.33	8.60%	$ 793,500.00	$ 11.18	7.65%
Flooring	$ 372,550.00	71002	$ 5.25	3.15%	$ 687,500.00	$ 9.68	6.63%
Fire Protection	$ 130,350.00	71002	$ 1.84	1.10%	$ 230,500.00	$ 3.25	2.22%
Mechanical & Plumbing	$ 2,782,950.00	71002	$ 39.20	23.51%	$ 2,579,000.00	$ 36.32	24.87%
Electrical	$ 1,304,000.00	71002	$ 18.37	11.02%	$ 1,305,000.00	$ 18.38	12.58%
Total Building Construction Cost	**$ 11,836,550.00**	71002	**$166.71**	100.00%	**$ 10,369,500.00**	**$146.05**	100.00%
Total Project Costs	**$ 15,204,750.00**	71002	**$ 214.15**		**$ 13,869,500.00**	**$195.34**	

ASSEMBLIES ESTIMATE

Table 4: RS Means 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 cost 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 are $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.

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. 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 also 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.

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

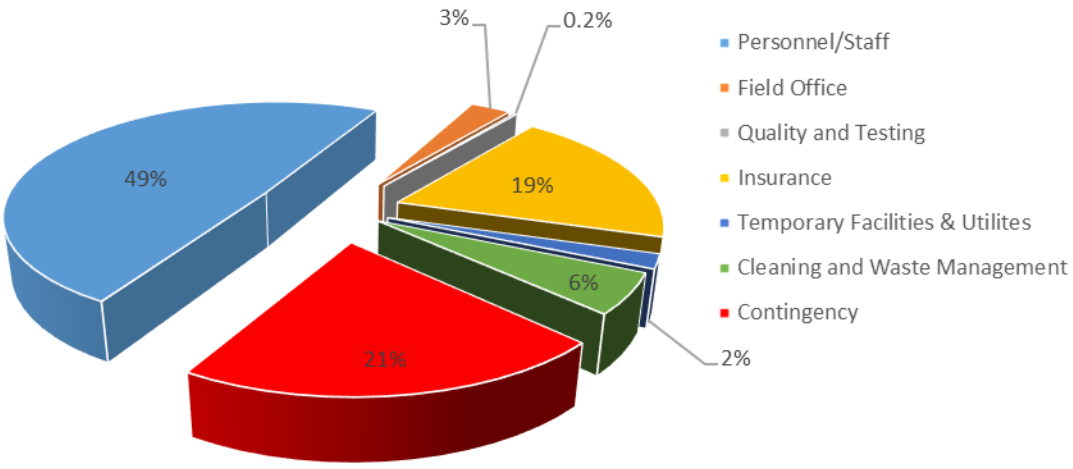


Figure 13: General Conditions Breakdown by Percentage

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 6: 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.

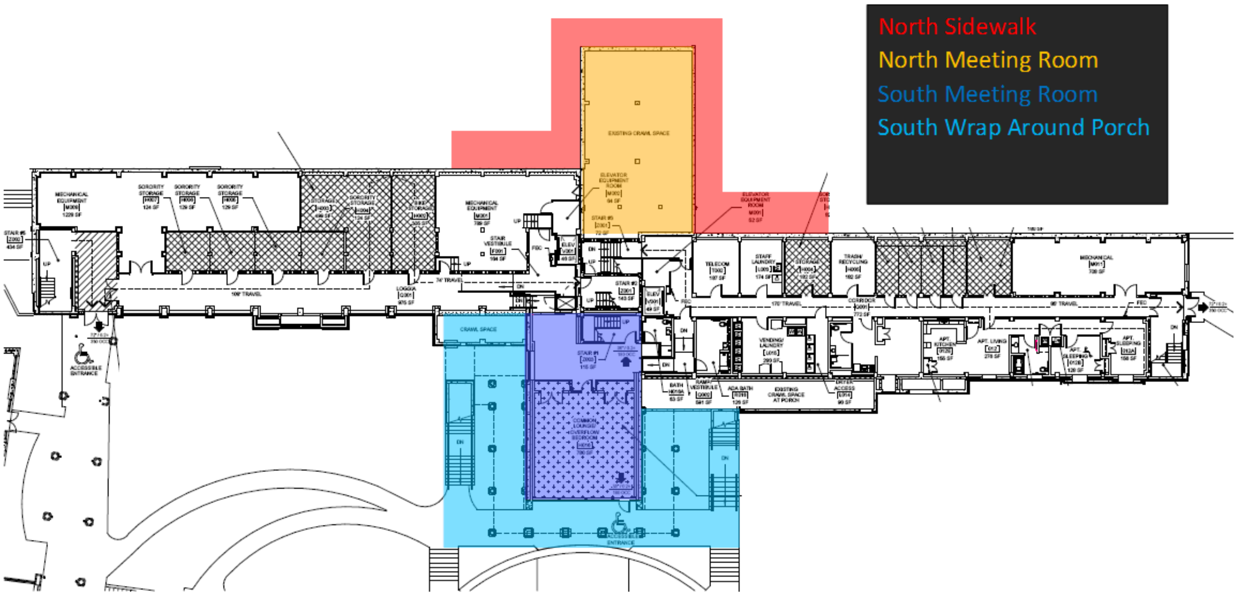


Figure 14: Site Work and Demo Plan | Quaid Spearing

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. 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.

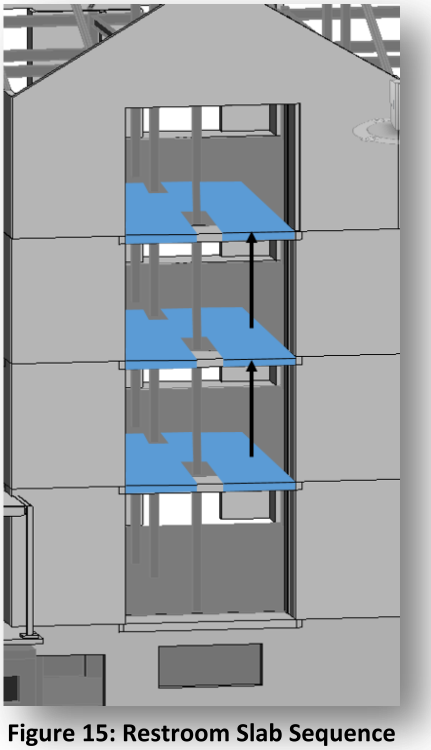


Figure 15: Restroom Slab Sequence

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.

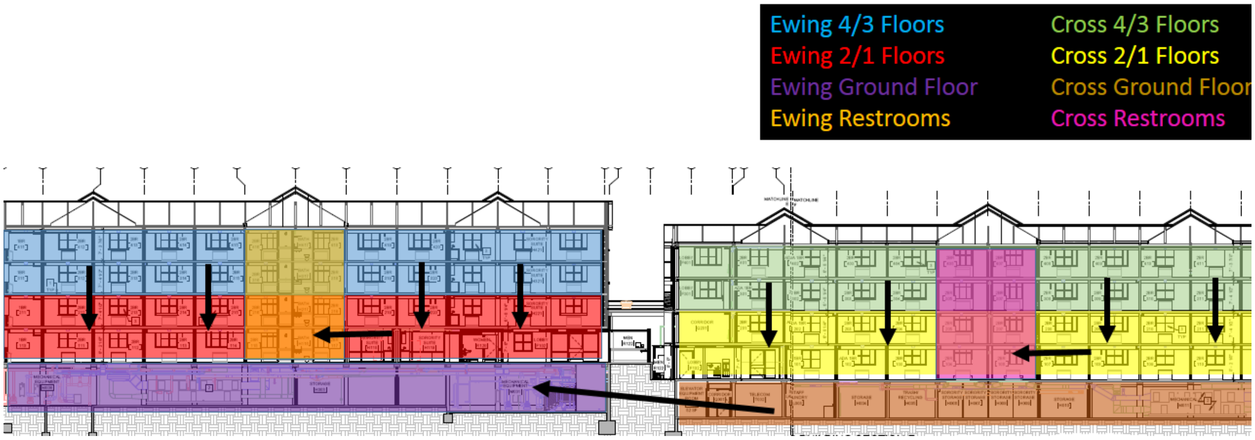


Figure 16: Interior Work Sequencing | Quaid Spearing

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 early January of 2014.

ANALYSIS 1 – MODULARIZATION OF BATHROOM UNITS

PROBLEM IDENTIFICATION

There have been numerous quality concerns with the bathrooms, especially with the finishes, such as the tile work. While the rest of Ewing – Cross follows a top-down construction method, all four floors of restrooms are working simultaneously. This makes it more difficult to track quality and ensure that all finish work, such as waterproofing the showers, is done properly and according to specification. Without proper coordination of all finish crews, it can become difficult to deliver a finished product that meets Penn State's standards, without the need for rework. In addition, Cooper – Hoyt and Hibbs – Stephens are essentially identical to Ewing – Cross, so any solutions identified could be implemented in those buildings as well.

ANALYSIS GOALS

The main goal of this analysis is to investigate the benefits of moving the construction of the bathrooms offsite. There will be a focus on analyzing the costs associated with modularization as well as the potential schedule savings. The benefits of modularization will be weighed against the cons, such as increased early planning and management, as well as sequencing and installation of the modules. The design of the bathroom modules will also be analyzed to optimize the layout of the bathrooms, while still maintaining ADA and other codes. Finally, a cost and schedule analysis will be performed to determine if this analysis will benefit the South Halls project.

BACKGROUND RESEARCH

The removal of the bathroom slabs in Ewing – Cross in turn required that the brick façade be removed in front of the bathrooms. While the rest of the brick façade on the building will remain, opening the façade at the bathrooms creates a unique opportunity to use modularization in the bathrooms. The bathroom units could be built offsite, in a factory, and then shipped to the jobsite. By removing the construction of the bathrooms from the jobsite and placing them in a factory setting, there is potential improve the quality of the finishes. The units could be built at a reasonable pace, and the construction manager can then better track quality of the finish work. Modularization of the bathrooms would allow for a finalized unit to be installed, which would help to alleviate some of the rush to finish the bathrooms. Removing portions of the construction off of the jobsite would reduce congestion on the jobsite, which would be beneficial for Analysis 4.

Modularization of the bathrooms would also alleviate some of the burden of field installing the intricate MEP systems in the bathrooms. Modularization allows for the construction of the bathrooms to occur at essentially any point in the project, even during non-normal construction hours. The units could be built ahead of time and waiting to be installed as soon as the new bathroom slabs are in place. The modular design of the units would need to take into account how they will be connected to the structural system; further research would need to be performed to determine if modular units would have an integral structural system or be slid into place and rest on a traditional concrete slab system. Another concern would be the productivity rates and schedule savings achievable; this will be supported by research performed using knowledge gained from AE 570: Production Management in Construction. Modularization was a key focus of the course, and information obtained from this course will help garner a strategy for modular implementation at South Halls.

CRITICAL INDUSTRY RESEARCH

Modularization has been a key topic of discussion throughout various AE courses at Penn State. A lot of projects incorporate prefabrication, but very few fully utilize modular units, whether it is the entire building, or even just the bathrooms. The goal of the research will be to explore the effectiveness of modularization as well as the limitations. It is easier to implement modularization in new construction because there are few preexisting limitations placed on the project team. However, as Ewing – Cross is a renovation, it will be important to fully research and understand how the existing structure could impact the use of modularization. Interviews will be conducted with project team members as well as industry professionals who have been on a project where modularization was used. The results of the research will benefit the project team as well as provide an understanding of how modularization can be implemented in renovation projects in the future.

MODULAR CONSTRUCTION

Modular construction is a type of prefabrication that involves assembling various building components off-site in the form of modules. These modules are typically complete units that are built in a factory and are comprised of walls, the floor, and roof of the individual space (Skanska). Modular construction is very different from the typical on-site, or stick built construction, in that the modules are assembled more in the fashion of a factory assembly line; whereas, on-site construction sees each individual trade move through a space, adding in their components. As with most types of construction, there are both advantages and disadvantages to utilizing modular construction.

ADVANTAGES

According to McGraw-Hill, the biggest drivers for modularization include: an improved project schedule, reduced cost and budgets, increased site safety, improved quality, and an eliminations of construction site waste. Many of these advantages are critical aspects on the South Halls Renovation.

SCHEDULE

The schedule for each dormitory renovation is one of the biggest risks to the construction manager, Barton Malow; modularization of the bathrooms has the potential to reduce some of the project’s critical path. The bathroom modules can be constructed in the factory, while other on-site work, such as the installation of the new bathroom slabs, can be performed simultaneously.

COST

By decreasing the amount of time it takes to construct a bathroom, the cost of labor would also decrease. On campus work at Penn State requires the use of Prevailing Wage rates; by moving construction off-site, the cost of labor can be further reduced.

QUALITY

In addition, there were quality concerns with the finish work in the bathrooms at Ewing – Cross. This was mostly due to the time constraint placed on the finish installers, as is typical on most construction projects. Moving the bathroom construction to a factory would allow the construction to move along at a more reasonable pace, while still improving the quality of the construction. Building the modules in a factory would allow the laborers to construct an entire mock-up and work out any details that could cause rework in the field.

SAFETY

Moving construction to a factory setting also improves the safety of the workers because workers now have better access to the work areas. It is much easier to work on the ground, as opposed to several stories up in the air.

DISADVANTAGES

While there are several advantages to utilizing modularization, there are also several disadvantages that could prohibit its use. A study by Skanska outlines the constraints of modularization to include: transportation, logistics, costs, permitting and inspections, and the architectural design.

TRANSPORTATION

The transportation of the bathroom modules would need to be weighed against the savings achieved through offsite construction. If the cost to transport the modules exceeds the savings, then it becomes difficult to justify the need for modularization. The industry generally recognizes 125 miles as the maximum practical distance for module transportation; anything in excess of 200 miles becomes cost prohibitive (Skanska). Figure 17 shows a map with a 150 mile radius surrounding State College; ideally a factory within this radius would want to be chosen to

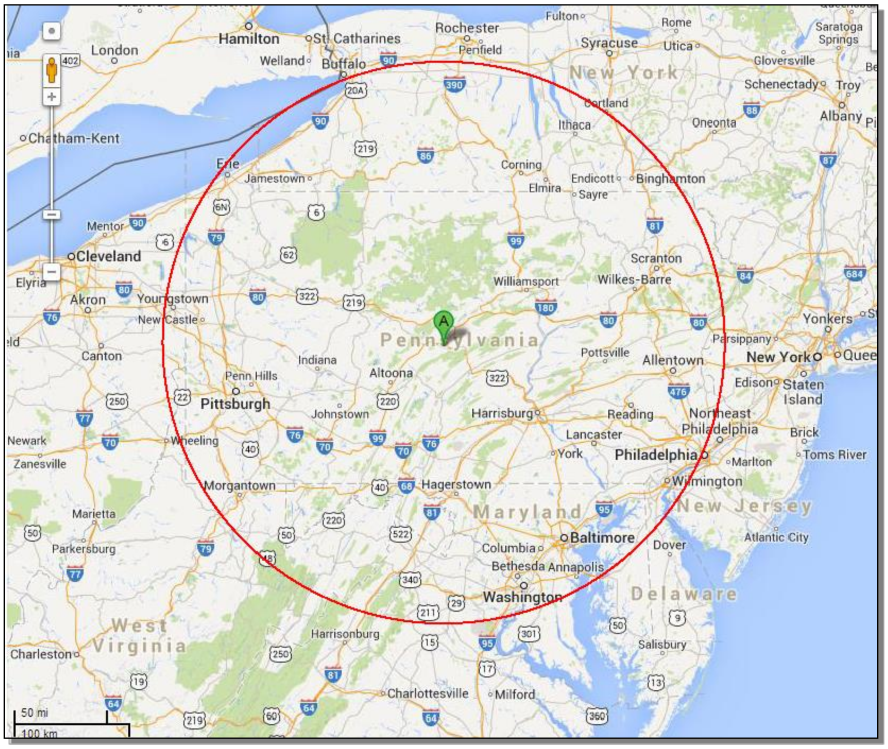


Figure 17: 150 Mile Radius around State College, PA | Google Maps

achieve the maximum amount of savings. In addition, the regulations, such as tractor trailer length and weight limitations would need to be taken into consideration.

LOGISTICS

The logistics involved with off-site construction can also pose a constraint on the project. Staging for the modules can become critical, especially if they are traveling great distances, and just in time deliveries are not practical. The crane and hoisting of the modules could also pose a constraint, especially because hoisting would place additional strain on the modules that could create cracking in the finishes.

COSTS

Although significant costs can be saved through the use of modularization, additional costs can actually be created by it. These costs come in the form of transportation of the modules, as well as redundant materials; if modules are to be installed directly next to each other, there would be redundant interior stud walls between two modules.

PERMITTING AND INSPECTIONS

Depending on where the modules are built, inspections can become difficult, especially if the modules are built outside of Pennsylvania and the local building codes differ. It will be crucial to work closely with the local building inspectors to ensure that they fully understand the modularization process, and that the modules are all built to code.

PLANNING AND PROCUREMENT

Implementing modularization on any project involves a lot of up front coordination among the key participants involved in the process. This involves the owner, construction manager, architect, engineers, and any necessary specialty contractors working together early enough in the project to ensure that modularization can be successfully implemented. For this reason, modular construction would be difficult to use on a typical design-bid-build project. However, the South Halls Renovation is a design-build project, and the entire project team has been working very closely from the early design phase. The way that the South Halls contract is set up actually lends itself to the introduction of modularization; there is a team atmosphere that creates collaboration and open communication to ensure timely project delivery. Early planning is essential to ensure that modularization can be successfully implemented; ideally, the bathrooms would need to be designed for modularization from the early stages of design.

MANUFACTURERS EVALUATION

Typically, prefabrication would involve the project team selecting an ideal offsite warehouse or factory to build the prefabricated assembly. However, modular bathroom construction is actually fairly common and there are several companies in the US that focus on constructing these bathroom pods. Acquiring the talents of a modular bathroom builder would be ideal for several reasons. For starters, a modular builder would already have a factory location in place with all the necessary equipment for construction bathrooms offsite. They would also have the necessary manpower and experience in coordinating the various trades that would typically be involved in constructing a bathroom. Through online research and contact with industry professionals, there are two companies that stand out as potential candidates for constructing the bathroom pods at South Halls: Eggrock Modular Solutions and Ameripod LLC.

The two modular builders will be compared alongside the stick-built bathrooms to determine which solution, if either, is a suitable alternative. This will involve looking at the costs associated with the modular process, and which modular builder would best fit with the South Halls project. Other important factors to consider when selecting a contractor would be the previously discussed advantages and disadvantages: schedule, distance from State College, and how inspections are handled will all play a role in selecting the best modular builder. Of course, one of the most important factors that will be considered is the quality associated with the modular construction.

EGGROCK MODULAR SOLUTIONS

Eggrock Modular Solutions is a North American company that focuses on manufacturing prefabricated, factory-built bathrooms. They have various locations throughout the United States, with their East Coast modular bathroom factory based out of Orlando, Florida.

TRANSPORTATION FEES

As previously discussed, the bathrooms have a maximum width of 8 feet; this allows them to fit into a standard 53 foot box truck, which is Eggrock's preferred method of transportation. Eggrock's closest bathroom pod factory to State College is located in Orlando, FL; this distance is approximately 1,065 miles, as observed in Figure 18. Shipping fees are $2/mile, which means that one truck carrying 5 pods would cost approximately $2,130, or about $426 per pod. At first glance, this distance seems very excessive, especially when the acceptable range is in the 125 – 200 mile range.

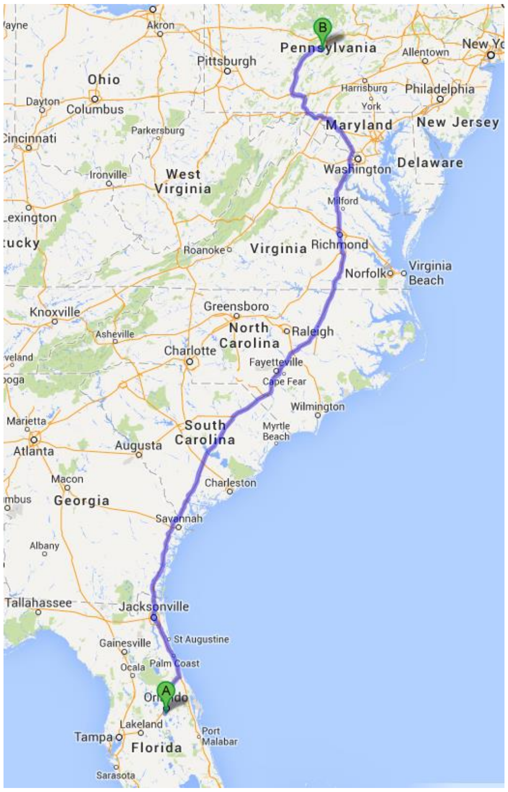


Figure 18: Distance from Eggrock Factory to State College, PA | Google Maps

WAGE RATES

Eggrock utilizes local prevailing wages for labor costs; however, the prevailing wage rates for Orlando, FL is significantly lower than those for State College, PA. As an example, the prevailing wage rate for a carpenter is $18/hour in Orlando, while the current prevailing wage rate for a carpenter in PA is $39.56/hour. This means that even if the South Halls bathrooms were constructed at a jobsite in Florida with all other things equal, the labor cost would be cut in half. This does not even factor in the increased efficiency from utilizing a factory for the construction.

OVERHEAD

While the labor cost is significantly lower for offsite construction, there is also an additional manufacturer overhead of 20%, which covers the cost of the factory, equipment, etc. This is a significant cost increase that often inhibits many contractors from implementing modular bathroom pods.

TOTAL COST

The total cost for a typical 8’ x 10’ bathroom pod with full wall height 12”x12” tiles, 2”x4” floor tile, and water resistant GWB ceiling would be approximately $16,000. This $16,000 would include the previously mentioned transportation fees, manufacturer overhead, labor, and material. Pulling out the overhead and transportation fees would put the total cost for labor and material at:

$16,000 - $426 – ($16,000*.2) = $12,370 per pod (material and labor cost only)

DESIGN FEES

In addition to the above mentioned $16,000, there is a design fee and engineering cost for each bathroom pod design. Eggrock charges $10,000 per design; with the current layout of eight different bathrooms at Ewing – Cross, the associated design fees would be $80,000. This additional cost would need to be considered in selecting a contractor for the modular bathrooms.

SCHEDULE

Eggrock’s factory built bathrooms typically require half of the labor hours needed, as compared to stick-built bathrooms. A typical dormitory bathroom takes about 5 work days to complete, and they can produce about 3 units a day, per production line. According to Eggrock’s website, they can install 25 – 30 bathroom units per day. They have five separate production lines that can be utilized for multiple jobs at once. Based on these numbers:

5 days per bathroom with 3 units per production line = 3 units per work week

40 South Halls Bathrooms/ 3 units per week = 14 weeks per dormitory hall

This 14 weeks could be scaled down by utilizing more than one production line, depending upon how long Eggrock can store the pods, and how soon they would be needed at South Halls. Assuming that 20 units can be installed per day, it would take two working days to install the 40 bathroom pods at Ewing – Cross, or at any of the South Halls renovations. This number does not include the final connection to MEP, which would be handled by the contractor.

AMERIPOD LLC

Ameripod LLC is another company that focuses on building prefabricated bathroom pods. They are based out of South Plainfield, New Jersey. Tom Caldwell provided information and a schematic design estimate for the cost of a typical dormitory bathroom pod job.

TRANSPORTATION

Ameripod’s factory is approximately 231 miles from State College, placing it about four times closer to the South Halls Renovation than Eggrock’s factory. The shipping fees for Ameripod can vary depending on the project’s location, but are typically included in the unit price of the bathroom pods.

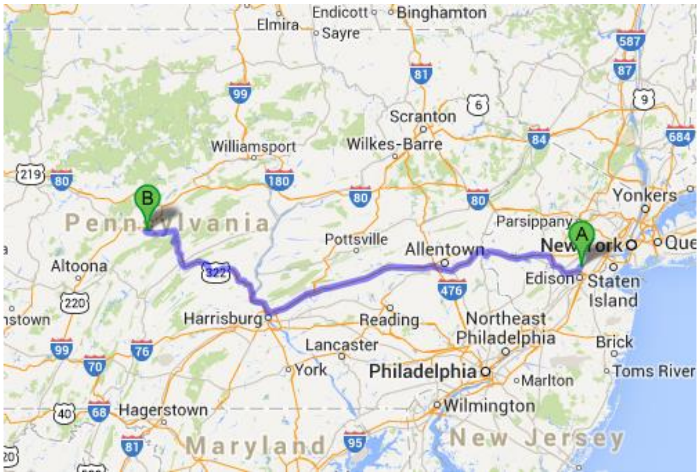


Figure 19: Distance from Ameripod Factory to State College, PA | Google Maps

WAGE RATES

Ameripod utilizes open shop labor, which helps to drive down the cost to build their bathroom pod by bidding out subcontractor work out to the lowest bidder. The base wage rate for a carpenter in Middlesex, NJ is $42.46/hr; this wage rate is comparable to State College labor, and over double the labor cost for Eggrock.

OVERHEAD

Ameripod’s overhead depends on how many different jobs are occurring in their factory at any given time. If the South Halls Renovation were the only project that pods were being built for, and the job was taking up all of the assembly lines, then the overhead would be significantly higher than if there were several different jobs to spread the overhead costs over. Similar to Eggrock, this cost is worked into the total price per pod estimate.

TOTAL COST

Similar to Eggrock, Ameripod includes the cost of transportation, labor, and factory overhead into the unit price of their bathrooms. For the typical 8’ x 10’ bathroom pod with full wall height 12”x12” tiles, 2”x4” floor tile, and water resistant GWB ceiling would be approximately $13,640.

DESIGN FEES

Ameripod’s design and engineering fees are in addition to the total cost per pod. For a typical project, the design fees range in the $5,000 - $10,000 range, depending on the complexity of the designs. The South Halls bathrooms have a fairly average layout, so it would be safe to assume an average design fee of $7,500 per pod design.

SCHEDULE

A typical bathroom pod takes approximately three weeks to complete, with assembly moving quicker towards the finishing phase. On average, Ameripod can produce about 30 bathrooms per week, if all of the assembly lines are running full force. They can install about twelve pods per day; making all of the connections to the building's MEP takes about one week for 10 bathrooms, on a typical construction project.

MANUFACTURER SELECTION

The following table summarizes the information gathered on cost and manufacturing time after speaking with representatives from both Ameripod and Eggrock. Ameripod holds the advantage in terms of cost, but Eggrock is capable of producing the pods at a quicker rate. To better understand the cost impacts, the costs/bathroom were extrapolated to get an idea of what the entire South Halls job would cost. This comparison can be seen in Table 8.

Table 7: Comparison of Modular Manufacturers

Bathroom Comparison		
Manufacturer	**Eggrock**	**Ameripod**
Cost Per Bathroom	$ 16,000.00	$ 13,460.00
Design Fees/Design	$ 10,000.00	$ 7,500.00
Manufacturing: Days/Pod	5	15
Manufacturing: Pods/Week	15*	30*
Installation Pods/Day	25	12
Distance from Jobsite (miles)	1065	231

*These numbers represent the full force of the factory, and would be assuming that the entire factory is being dedicated to South Halls.

Table 8: Cost Difference in Manufacturers

Total Project Cost Comparison			
Manufacturer	**Cost/Bathroom**	**Qty. Bathrooms**	**Total Cost**
Eggrock	$ 16,000.00	160	$ 2,560,000.00
Ameripod	$ 13,640.00	160	$ 2,182,400.00
		Cost Difference	$ (377,600.00)

Comparing the costs for construction of both companies shows that Ameripod would deliver the project for about $378,000 lower than Eggrock. Although Eggrock can produce and install the pods quicker, Ameripod was chosen as the ideal bathroom pod manufacturer. Although important, the time to produce the bathroom pods will not ultimately affect the construction schedule. Ameripod would be like any other specialty contractor on the project; the construction manager is going to pay the same cost per pod regardless of how long it takes to produce each pod. As long as the bathroom pods are able to show up at the jobsite for their scheduled installation, there should not be a problem. If the South Halls renovation were a design-bid-build project, then there would be concern for lead times, depending on how early the contractor and modular builder were brought onto the project. However, since South Halls utilizes a design-build delivery method, it is safe to assume that if modular bathrooms were to be implemented, the modular builder would be brought onto the project early, along with all of the other specialty contractors.

DESIGN EVALUATION: ARCHITECTURAL BREADTH

To implement modular bathrooms and take full advantage of the prefabrication process, it is important to look at the current bathroom design and layout. Any improved efficiencies in the design would help with design and construction costs.

TRANSPORTATION LIMITATIONS

The design of the bathroom pods is driven by several factors: the logistics of transportation, the height of the units and the weight of each unit. It is logical to first look at the limitations that transportation places on the bathroom design. As previously discussed, there are numerous ways to transport the bathroom modules; however, the most common and logical choice to use a tractor-trailer. Table 9 shows the typical limitations for tractor trailer sizes.

Table 9: Transportation Information for PA

Pennsylvania Truck Information	
Size Limitations	
Width	8 feet
Height	13 feet 6 inches
Length	53 feet trailer
Maximum Gross Weight	
Two-Axle Motor Vehicle	38,000 lbs

Based on transportation laws in Pennsylvania, the relevant dimensions are 8 feet and 53 feet. These size limitations will work with the current bathroom design, based on the dimensions in Figures 21 and 22; however it would be ideal to reduce the width of the units by a few inches to ensure that they safely fit inside a box delivery truck. The largest individual bathroom measures 8 feet by 10.7 feet. These layouts are typical on floors 2-4 of Ewing and on each floor of Cross respectively. The first floor of Ewing features one bathroom with a roll-in shower, as required by ADA code. The roll-in shower layout, highlighted in grey, causes the bathroom beside it to shrink in length. In total, there are ten different module layouts; due to the size of the smaller bathrooms adjacent to the custodial closets, it would be logical to build these as one unit.

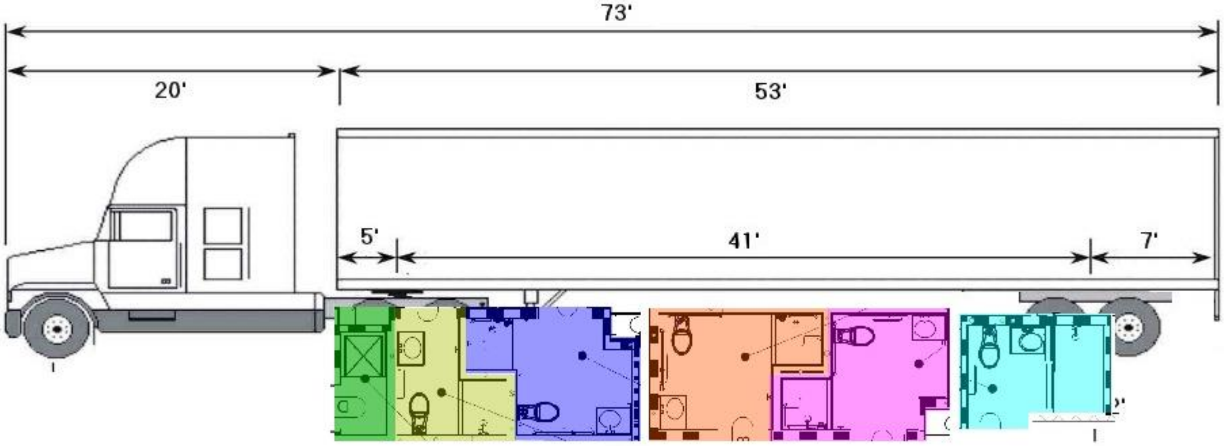


Figure 20: Typical Delivery of Bathroom Pods | Truck Image courtesy of Google

Based on the dimensions of the bathroom modules, five pods would fit on one trailer (see Figure 20). This means that each delivery would bring one floor's bathroom core. The typical 8x9 bathroom weighs approximately 2000 lbs; this would put the five pods in the 10,000 - 12,000lb range, well under the maximum weight capacity. Due to the height of the modules being approximately 8 feet, it would not be possible to stack the modules to reduce the number of deliveries required. In total, for Ewing and Cross, there needs to be 8 deliveries of bathroom pods.

BATHROOM MODULE DESIGN

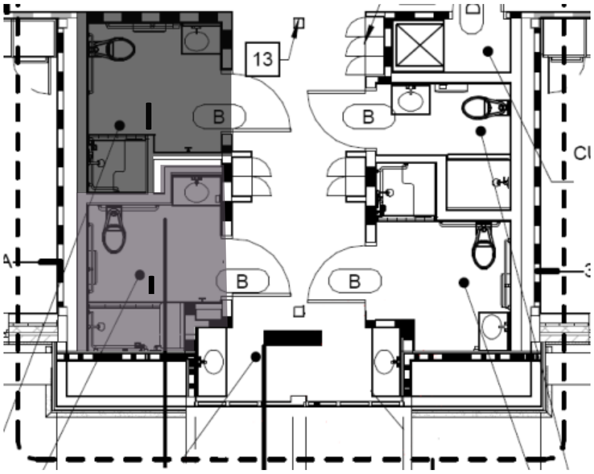


Figure 21: Roll-In Shower, Ewing First Floor | AE 111

After careful analysis of the modular process, it was determined that some redesign of the bathrooms is necessary to take full advantage of the modularization process. There are several reasons why redesigning the layout of the bathrooms is beneficial: reducing the number of bathroom layouts decreases the number of designs that the manufacturer needs to come up with, resulting in a lower design fee. Reducing the variation also allows the laborers to increase their productivity through repetition; there is an inherent learning curve in repeatable processes, and it is much easier to build 10 of the same layout, as opposed to 5 each of two different layouts.

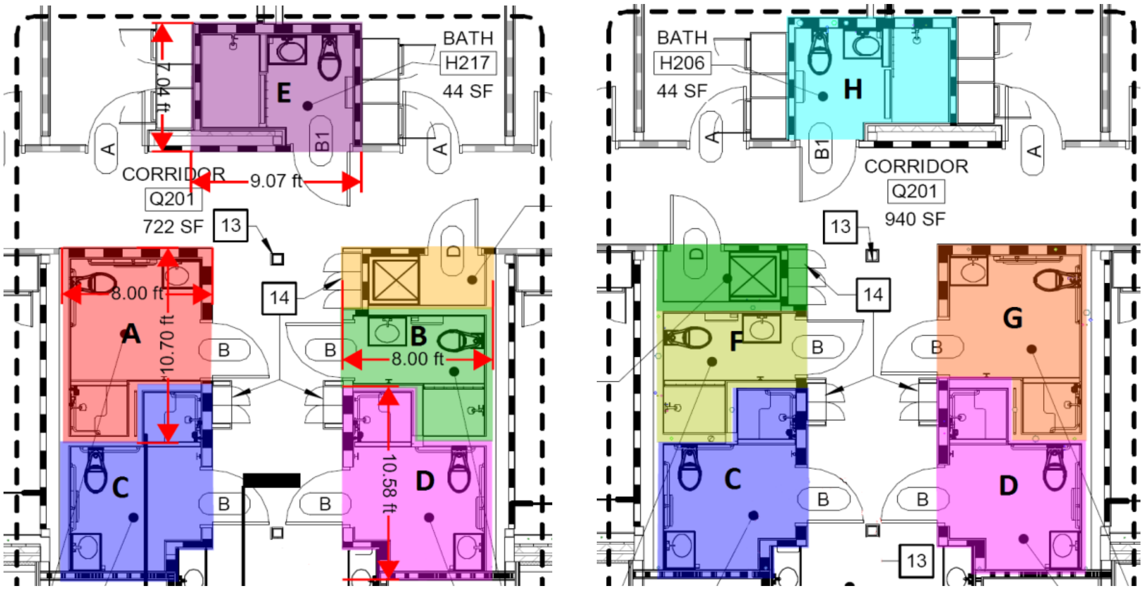


Figure 22: Current Bathroom Core Layouts of Ewing and Cross | AE 112

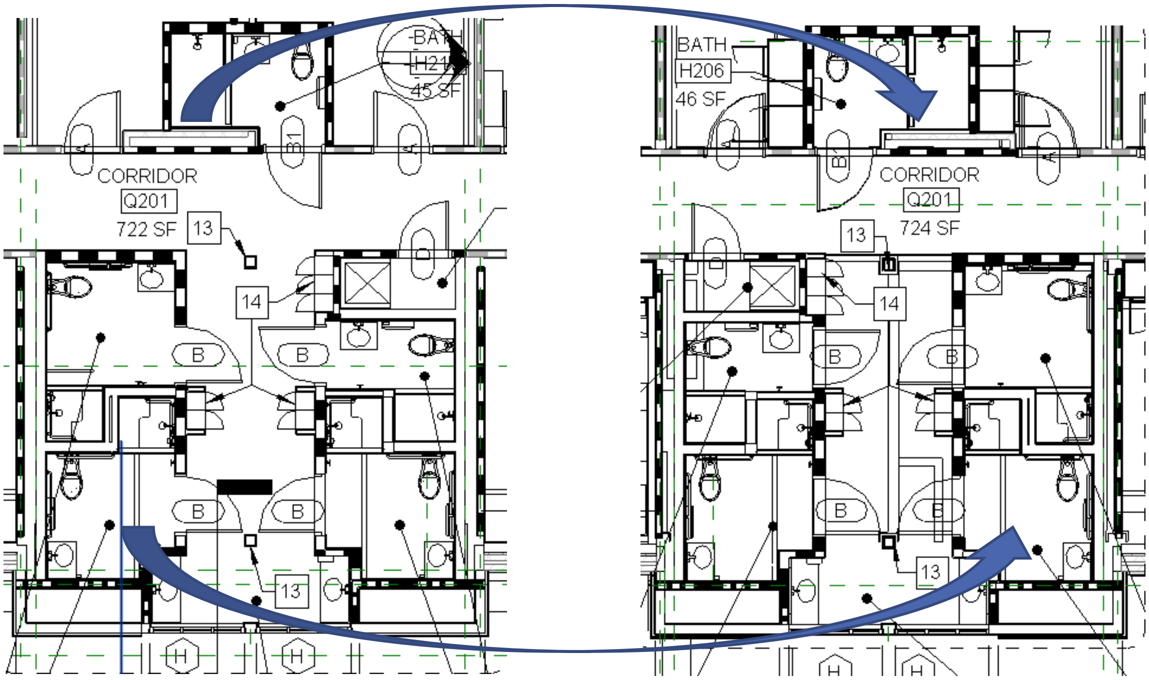


Figure 23: Current Layouts for Ewing and Cross

With the current layout, there are ten different bathroom design; ideally it would be efficient to reduce this to five or six layouts. A quick analysis of the bathroom layouts of Ewing were mirrored over to Cross, as seen below. This was mainly due to existing conditions; the design left the janitor's closets in their existing space to reuse some of the existing plumbing.

PROPOSED NEW LAYOUT

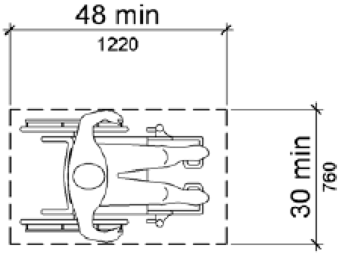


Figure 24: Clear Floor or Ground Space | 2010 ADA Code

To take full advantage of the modularization process, a better solution would be to copy the layout of Ewing over to Cross; this would reduce the number of different layouts from ten down to seven. Altering the layout of bathroom D to be identical to bathroom A would further reduce the number of layouts to six. Implementing this change requires several architectural features to be adjusted; ADA code must be maintained with every change as well.

Using layout A in place of layout D requires the shower layout to be shifted around for the bathroom on the right side of the plan. The figure to the right shows how the shower location of A and D differ once A is rotated. The sink that sits adjacent to bathroom D poses a challenge to using layout A. According to the 2010 ADA code 305.3 Size; the clear floor or ground space shall be 30 inches minimum by 48 inches minimum.

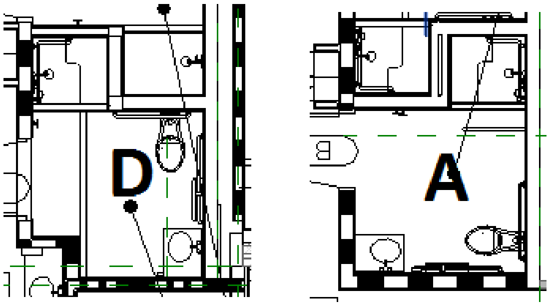


Figure 25: Comparison of Bathroom Layouts A & D

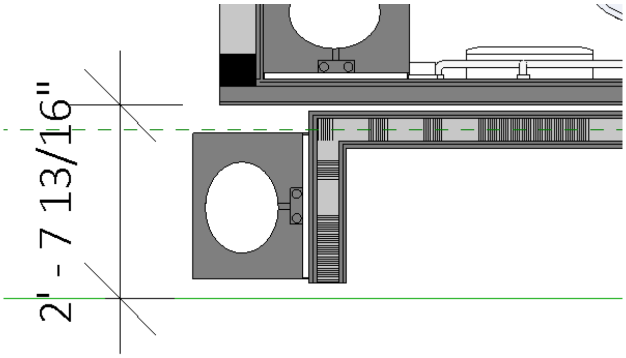


Figure 27: Proposed New Lavatory Layout

To accommodate the layout A, the 18” x 43” lavatory was removed in lieu of the smaller 18” x 24” fixture that is used in the bathrooms. Even with the smaller sink, the width of the area did not meet the 30 inch minimum for ADA. After analyzing the design of a typical modular bathroom and a stick built bathroom, it was concluded that the width of the metal stud framing would need to be reduced. After consulting with Tom Caldwell from Ameripod, it was determined that the bathrooms could be redesigned using 2 ½” metal studs with additional blocking and welds to strengthen the framing; the existing wider stud wall is still used for the wall which houses the door frame. Using this strategy as a basis for design, the South Halls bathroom pods were redesigned with 2 ½” metal studs.

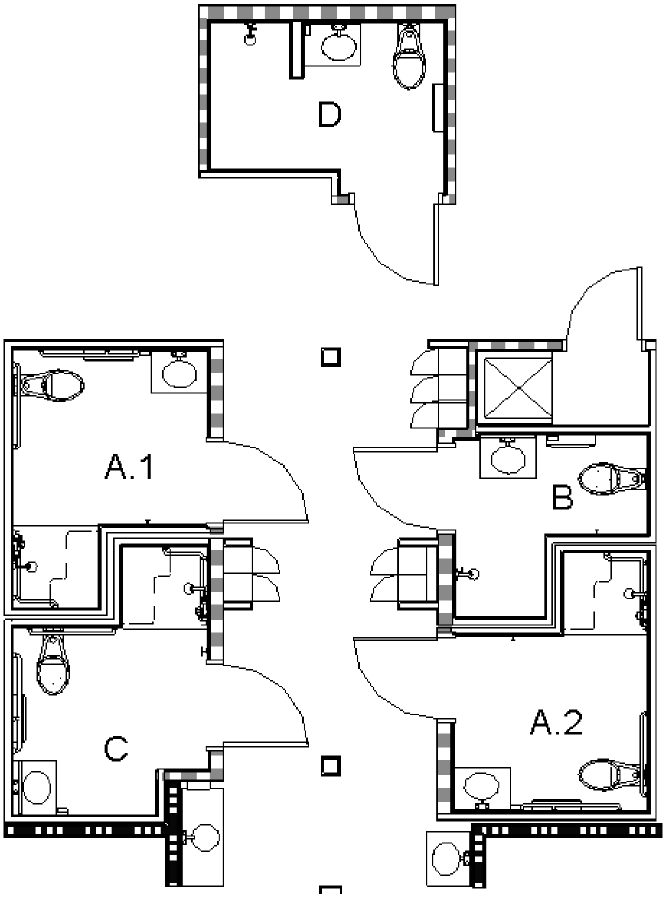


Figure 26: Proposed New Typical Bathroom Core Layout

Reducing the wall thickness allowed for approximately 32 inches of clear floor space at the lavatory, which exceeds the 30 inch minimum. Utilizing smaller metal stud framing also yielded another benefit. The original floor areas were maintained, while decreasing the exterior wall to exterior wall dimensions. The overall width of the units was decreased from 8 feet to 7 feet 9 7/16 inch, which makes the bathroom pods much easier to fit into a standard delivery truck without damage. In addition, delivery fees for a box truck typically run cheaper than those of a flat bed.

Figure 29 shows the layout with the required Roll-In type shower; Per ADA code, one Roll-In shower per building is required. Throughout Ewing and Cross with the new bathroom core layout, there are nine bathroom layouts that are typical, and one bathroom layout with a Roll-In shower, located on the first floor of Ewing. The dimensions for A.3 and E were reused from the existing design. Full Architectural plans of the proposed bathroom layout can be found in Appendix F.

MODULE HEIGHTS

According to the 2009 International Building Code, the minimum ceiling height for bathrooms is to be not less than 7 feet. This can be further reduced to 6 feet 8 inches, to allow for bulkheads, as in the case of the South Halls bathrooms. During the design of the bathroom modules, it was crucial to maintain the minimum ceiling height while also ensuring that there would be enough room to slide the modules into place.

The new module design maintains the 7’-0” minimum ceiling height; Figure 28 shows the typical ceiling height and total module height for the proposed bathroom pod design.

These ceiling height are achievable, even with the addition of subflooring for the bathroom pods. Ameripod uses a thin-set plastic composite honeycomb flooring system; even with a 3/8” porcelain tile, the total floor thickness is only 1-1/4”. Although the total bathroom pod height is 7’-3 1/4”, which is less than the 7’-4 1/2” available (top of slab to bottom of slab), this is still a very tight fit. This will be further discussed in detail in the Constructability Concerns section.

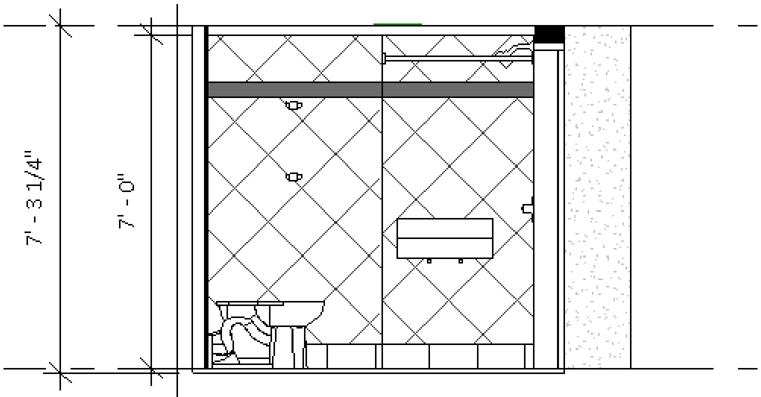


Figure 28: Typical Bathroom Pod Height

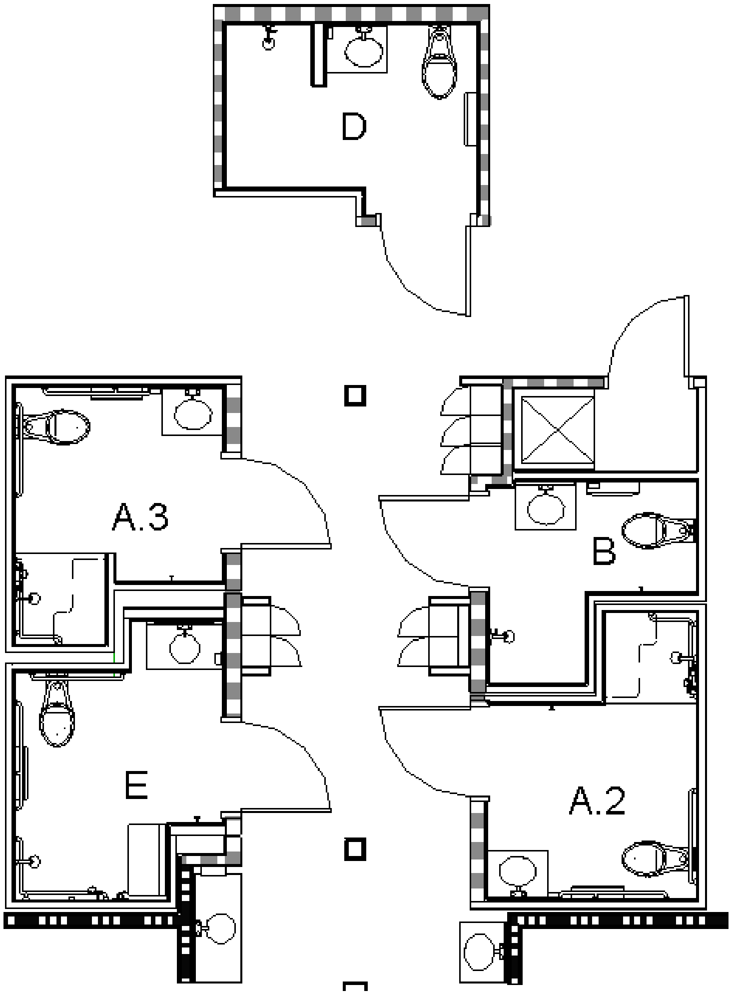


Figure 29: New Roll-In Shower Layout

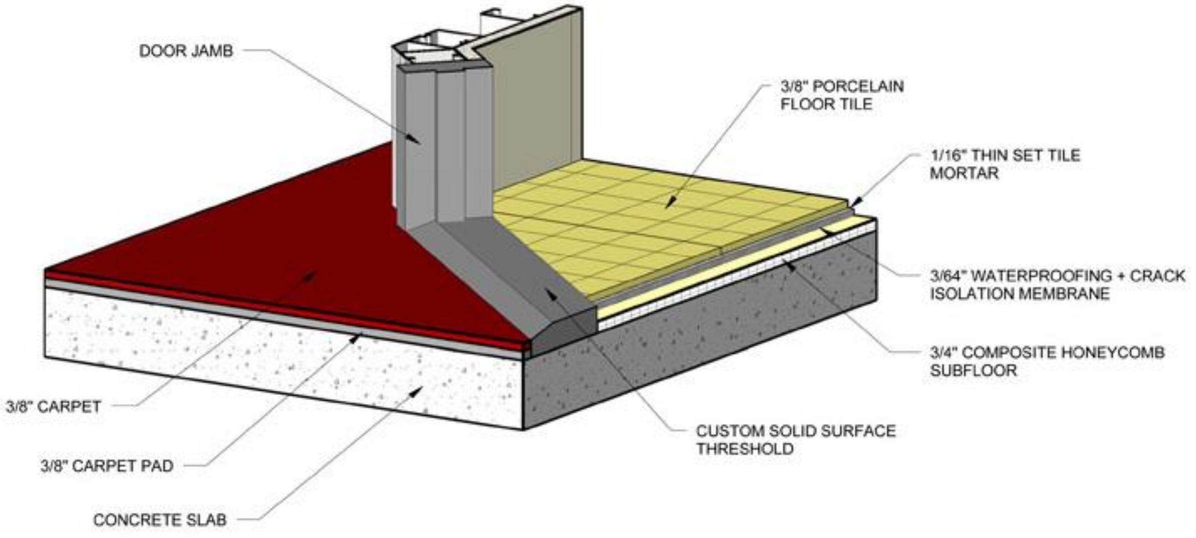


Figure 30: Floor Composition Detail | Courtesy of Ameripod Website

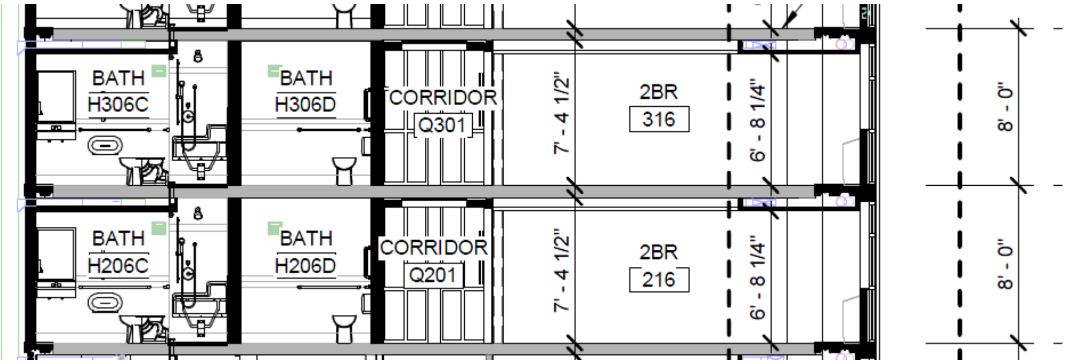


Figure 31: Floor to Floor Heights of Bathrooms | AE 333

Although layout D was replaced with layout A, a bulkhead is still required in layout D to allow for the ductwork. The two layouts can still be considered the same because of the way that the pods are manufactured; the ceiling is built separately and then lowered onto the wall frame and welded into place. Therefore it was assumed that the same design and layout could be used for these two modules, with the only variation being the ceiling bulkhead.

In total, the number of bathroom layouts was reduced from ten down to six. This translates to a savings in design fees of approximately $30,000.

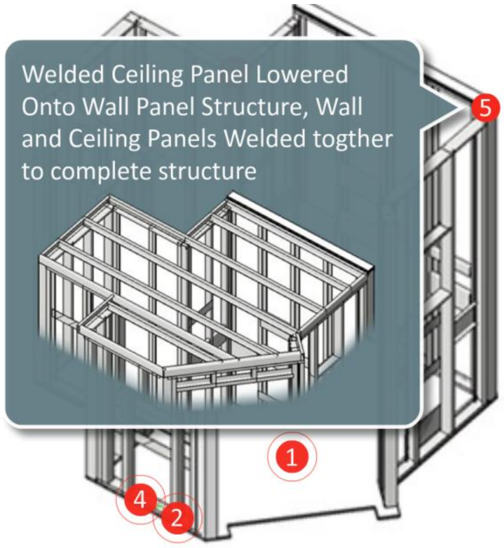


Figure 32: Ceiling Structure Detail | Courtesy of Ameripod Website

DESIGN SUMMARY

To sum up the design changes for the modularization of the bathroom pods, the number of bathroom layouts was reduced to six, from the original of ten. In total, there are forty modules for Ewing – Cross, and 160 for the entire South Halls Renovation. Table 10 below shows the breakdown of modules designs per building. ADA code was maintained throughout the design process; the codes that were designed to can be found in Appendix G.

Table 10: South Halls Bathroom Pod Type Summary

Bathroom Module Designs		
Module	**Qty/Bldg**	**Qty/Project**
A.1/A.2	15	60
A.3	1	4
B	8	32
C	7	28
D	8	32
E	1	4
Total	40	160

LOGISTICS AND INSTALLATION

With the bathroom module design in place, it is also important to look at the logistics of installation. This involves looking at the sequencing of construction, hoisting, final MEP connections, and any additional concerns that may arise during construction.

SEQUENCING

Both bathroom pod stacks are located on the South side of the building. The Cross bathrooms (the right stack in Figure 33) will be placed first, since the bathroom slab replacement finishes first on this side of the building.

Figure 33: Bathroom Stack Location | AE211

Sequencing will follow the flow set by the bathroom slabs, with the first floor bathrooms placed first. The bathrooms on the first and second floor will be set in one day, and the third and fourth floor bathrooms would be placed on the following day. The scheduling of this work will be discussed in detail in the Schedule Analysis.

Due to the size of the pods, the enclosure of the large bumpouts cannot begin until the pods are placed inside the building. Although there would be enough room to slide the pods in where the glazing will be installed, the columns at the center of the room make it impossible to effectively maneuver the pods into their final installation location.

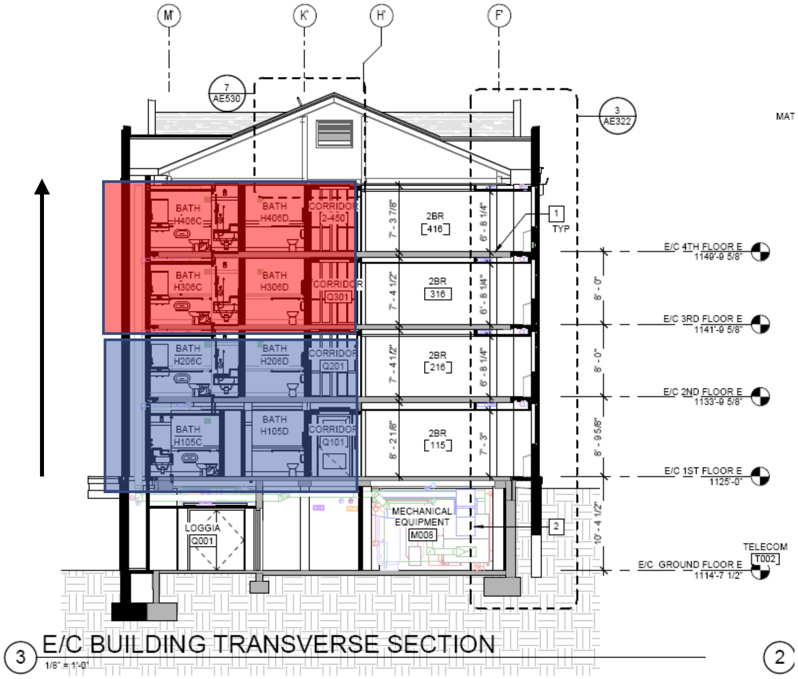


Figure 34: Sectional View of Typical Bathroom Stack | AE 311

HOISTING

There are several ways of hoisting the bathroom pods into the building; at South Halls, it was decided that easiest way would be with the use of a hydraulic truck mounted crane. This type of crane will sufficiently handle the lightweight modules, and is used for various other crane picks on the jobsite. Rather than directly connecting the

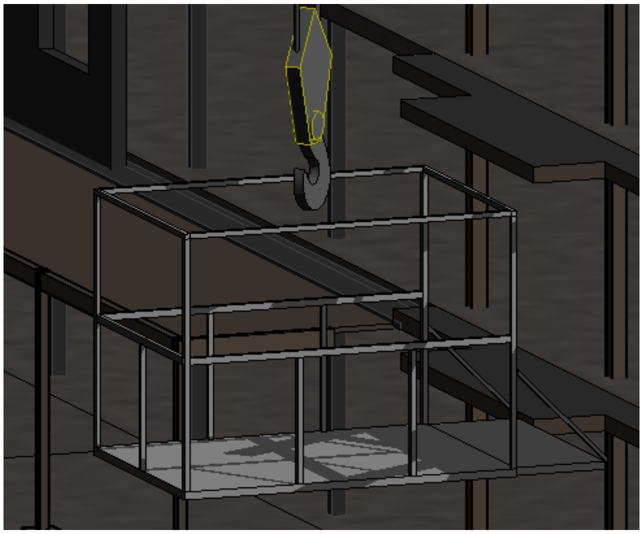


Figure 36: Bathroom Pod Hoist

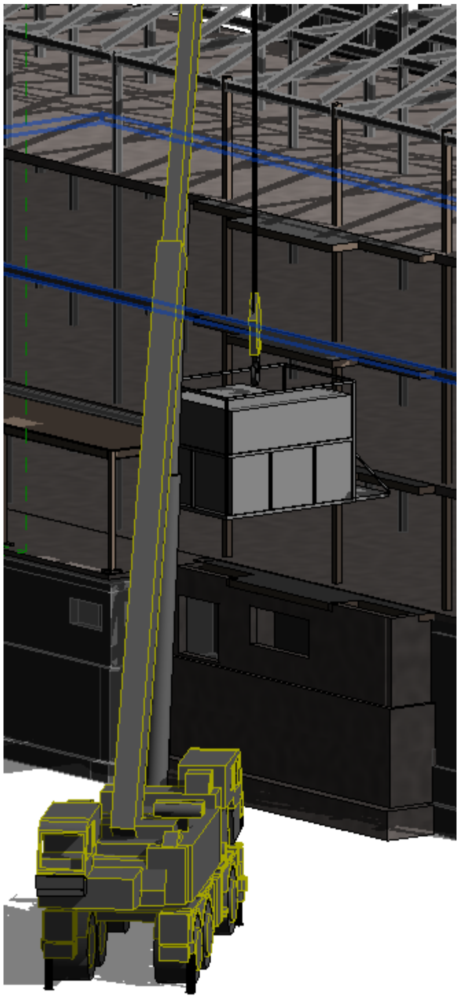


Figure 35: Crane Hoisting Bathroom Pod

pods to the crane hook and risk damaging the pods, a special platform hoist will be used. The platform would be supplied by the pod manufacturer, with the contractor supplying the crane. The platform hoist was modeled in Revit to show how the system would work. The bathrooms would be hoisted up, and then slid off of the platform and onto the bathroom slab.

Table 11: Proposed Hoist Sequence

		Hoisting Sequencing																	
		Day 1									Day 2								
Truck	# PODS	8AM	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	8AM	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM
A	5	🟦	🟦	🟦	🟦														
B	5						🟦	🟦	🟦	🟦									
C	5										🟥	🟥	🟥	🟥					
D	5															🟥	🟥	🟥	🟥

The table above shows the hoisting sequencing for one stack of bathroom pods. To cut down on crane rental costs, it would be best to place all twenty bathroom pods in a two day span; this would involve having two deliveries of five pods each day. This installation sequencing would then be repeated for the other stack of bathroom pods.

MEP CONNECTION

Once the modules have been hoisted and placed in their final locations, the connections to the building MEP can be made. This can arguably be the most difficult part of the entire modular process, if not properly planned for. Ameripod would provide custom templates for coring the necessary plumbing penetrations. The plumbing supply and returns lines will be fairly straight forward, because the connections can be made at waist height, in the wall chase behind the bathroom pods. As observed in figure 37, the wall chase behind the pods allows for sufficient room to place the risers. To make this final connection, the wall of the adjacent student room cannot be installed until after final MEP connections are made.

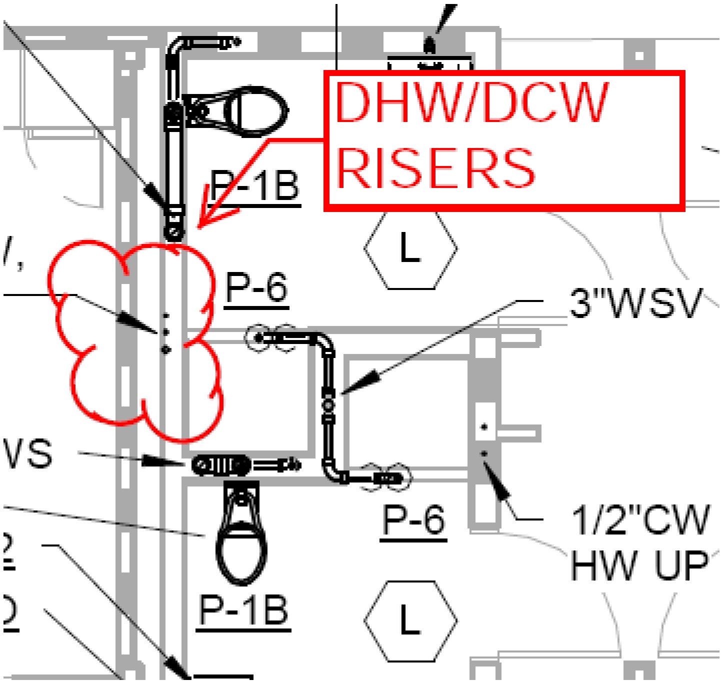


Figure 37: Location of Plumbing Risers

The waste water and vent stack risers would be connected between pods with pvc sleeves. Once the pods are in place, a sleeve would be prepped and slid over the riser above in the floor penetration, and then connected to the riser below.

Once the pods are installed and the risers have been connected, the ductwork behind the bathrooms can be installed. The ductwork that runs over the bathrooms near the exterior wall was designed into the pods; if this were to be field installed, it would be very difficult for the installers to place the duct if the 4” deep bulkhead was already in place. Instead the ductwork in the bulkhead will be installed offsite and terminate just at the pod wall, so that it can be connected the onsite ductwork.

Once the final MEP connections have been made, the bathroom pods are completed and the rest of the onsite work can continue as scheduled. There are several follow-on activities, including drywall, that will still need to be completed in the wetcores, and these items are addressed specifically in the Schedule Analysis.

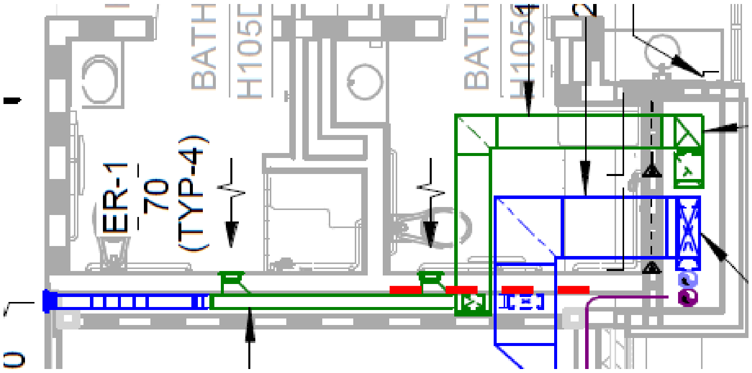


Figure 38: Ductwork in Bathroom Cores

CONSTRUCTABILIBITY CONCERNS

The implementation of modular bathrooms creates several constructability concerns. Clearly, implementing any type of offsite construction requires intense coordination from the entire project team; however, with South Halls being constructed as a design-build (IPD like) project, planning and coordination should not be a crucial problem. There would need to be a lot of upfront coordination with the pod manufacturer to ensure that the pod design and manufacturing does not delay the project. However, the heavy amount of upfront coordination would pay off in ease of construction and schedule savings later on.

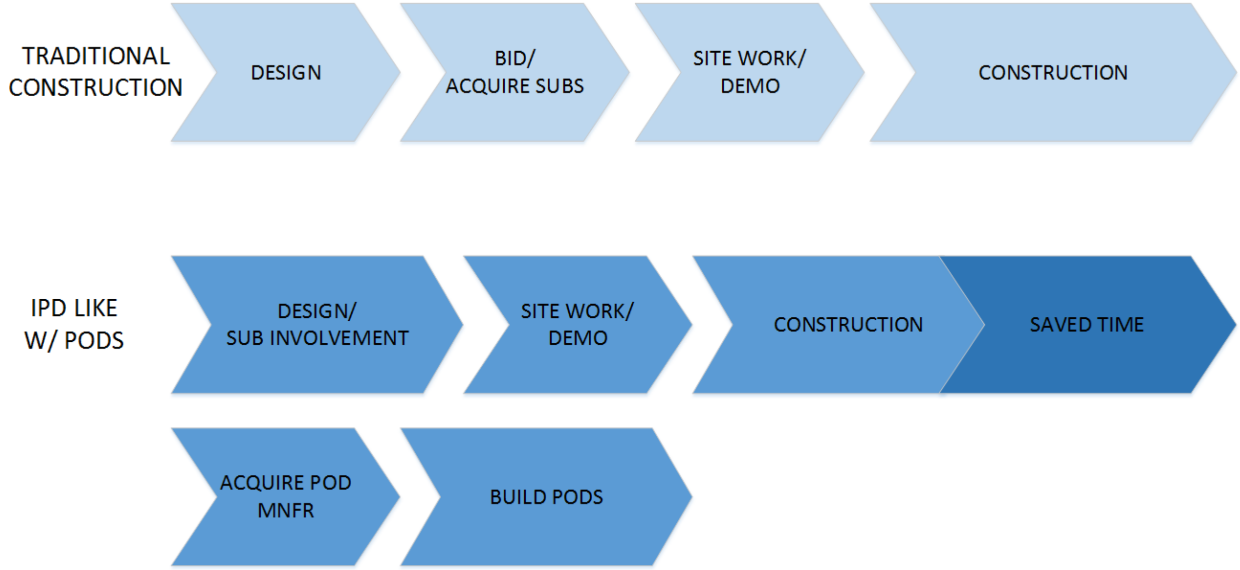


Figure 39: Example of IPD-Like projects and modularization saves time | Quaid Spearing

Another concern is the duct risers; originally, these were built from inside the building, prior to the framing of the bathroom walls. The duct risers cannot be installed until after the pods are in place, so these would either need to be installed prior to the finish of the enclosure or relocated. Further analysis may need to be performed to determine if the bathrooms would still be the ideal location for the risers.

The other concern involves actually getting the bathroom pods into the building. Although the pods were designed to a minimum ceiling height of 7'-0", the total height of each pod is 7'-3 1/4"; the floor to ceiling height at Ewing – Cross dips down to 7'-4 1/2" on floors two through four. This results in a tolerance 1.25 inches, and makes it very difficult to maneuver the pods once they in the building. Even if the pods were moved from the hoist platform into the building with a low profile dolly, the top of the pods may still scrape the bottom of the floor slab above.

SCHEDULE EVALUATION

To gain an understanding of the potential schedule savings with modularization, it is important to look at the original schedule. The typical duration for one floor of bathrooms (five) takes approximately 54 days, as detailed in Table 12 below. It is important to note that due to the slab replacement at the bathrooms, all four floors of bathroom rough-in and finishes could not begin with the rest of the building, and were all started simultaneously. The schedule and sequencing created for the modular installation will try and create a more linear flow to the bathroom installation.

Table 12: Original Bathroom Construction Schedule

Typical Bathroom Construction Schedule for One Floor (5 Bathrooms)	
Activity	**Duration (Days)**
Framing	5
Plumbing Rough In	15
Electrical Rough In	15
Duct Rough In	15
Sprinkler Rough In	15
Close In Inspection	1
Hang & Finish GWB	8
Install Shower Bases	3
Prime & First Coat Paint	2
Install Ceramic Tile	12
Plumbing Fixtures	2
Install Accessories	3
Mech/Electrical Trim Out	3
Total Duration	**54 Days**

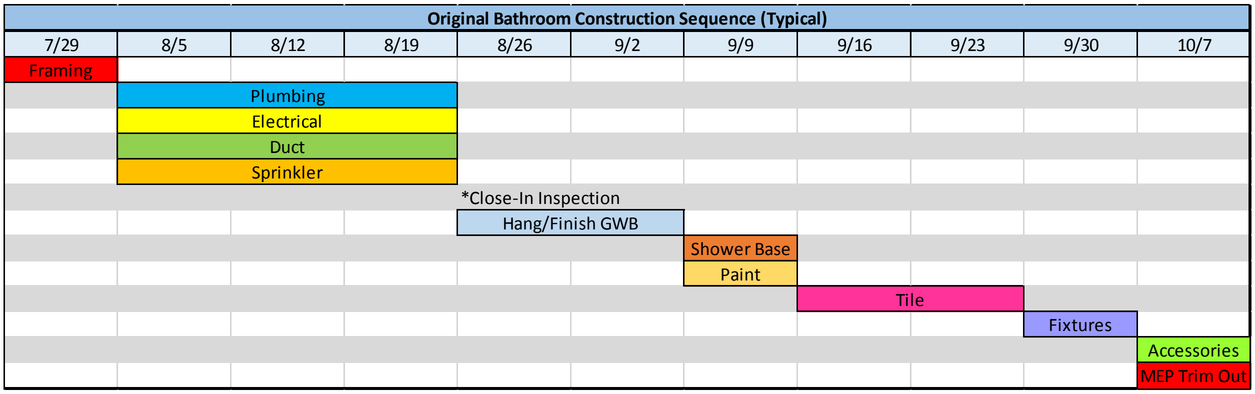


Figure 40: Typical Bathroom Schedule Sequence for one floor

The bathroom construction for Cross started on 08/01/2013; this followed the completion of the fourth floor slab structure. The bathroom construction for Ewing started on 08/27/2013, following the completion of the floor slab structure for Ewing. The sequencing for the bathroom slab pours had already been optimized from the Haller – Lyons renovation; Haller – Lyons followed top-down sequencing for slab replacement. Because the shoring is set onto the slab below, this resulted in extended waiting for the slabs to set before the shoring could be removed. Ewing – Cross reversed the sequencing and replaced the slabs from the ground-up. For this reason, it will be assumed that 08/01/2013 is the earliest that the bathrooms can be installed.

Table 13: Original Bathroom Schedule Summary

Current Schedule Summary				
Activity	Ewing		Cross	
	Start	Finish	Start	Finish
Bathroom Slab Replacement	5/28/2013	7/19/2013	6/7/2013	8/14/2013
L4 Restrooms	8/1/2013	10/9/2013	8/27/2013	11/4/2013
L3 Restrooms	8/1/2013	10/9/2013	8/27/2013	11/4/2013
L2 Restrooms	8/1/2013	10/9/2013	8/27/2013	11/4/2013
L1 Restrooms	8/1/2013	10/9/2013	8/27/2013	11/4/2013

As previously mentioned, Ameripod can install about twelve pods per day; for the purpose of scheduling and because each bathroom group has five pods, ten pods per day will be assumed. This would only involve hoisting the bathroom pods to their final location, and does not include making the final connections for MEP. Ten pods per day is actually an ideal number of installations per day because only five pods can fit on one delivery truck. This means that there would need to be two deliveries for the ten pods. To try and achieve just in time delivery, it would be best to only have as many pods delivered as can be installed.

Ameripod also said that it takes about one week to make the final connections for 10 bathroom pods. Assuming a typical work week of forty hours, this translates to about 4 hours per bathroom. There are two approaches to scheduling the installation of the bathroom pods. The first would involve having all of the pods ready for delivery, and placing all of them in their final location in four days. The second would involve spacing the installations out, and doing the final MEP connections in between. Because of the nature of the construction sequencing, the first method is not ideal because the Ewing restrooms can be installed on 08/01, while the Cross bathrooms would need to wait until 08/27 for installation. Therefore, it would be best to divide the bathroom pods into two sets of twenty pods each. In addition, this places fewer burdens on the Ameripod to utilize all of their assembly lines for one project. For crane rental purposes, it will be ideal to install the twenty pods in a two day span, and then come back and make the final connections.

Once the bathroom slabs are complete, there is some preparation work that needs to occur. This involves having the plumbing risers in place and ready to receive final connection to the bathroom pods. Since the durations for risers were lumped together with the rest of the MEP rough-in for the bathrooms, RS Means was utilized to determine typical installation duration for these items. The 3 Day duration for Risers, as seen in Table 14, represent the total time it takes for one full stack of bathrooms.

Table 14: Pre-Bathroom Pod Work

Pre-Bathroom Pod Work		
Bathroom Finish Activities	**Quantity**	**Duration**
2" Cold Water Riser	56 LF	1.4 Days
1-1/4" Hot Water Riser	32 LF	0.5 Days
1" Hot Water Riser	24 LF	0.4 Days
3/4" Hot Water Riser Return	56 LF	0.75 Days
Total Duration		**3 Days**

It is important to note that the total schedule for the installation of the bathroom modules does not include the exterior drywall on each pod; this will be included as a separate schedule item to be installed in field. The follow-on work that occurs after the pods are installed and final connections are made include: batt insulation and drywall on the relevant bathroom pod walls, finishing and painting drywall, building the mechanical chase walls near the exterior of the building, and installing the floor tiling located outside of the bathrooms. Durations for the follow-on work were calculated using RS Means; these durations can be seen in Table 15 below. Conservatively, there is about seven days' worth of finish work that must follow the installation of the bathroom pods.

Table 15: Bathroom Pod Follow On Work

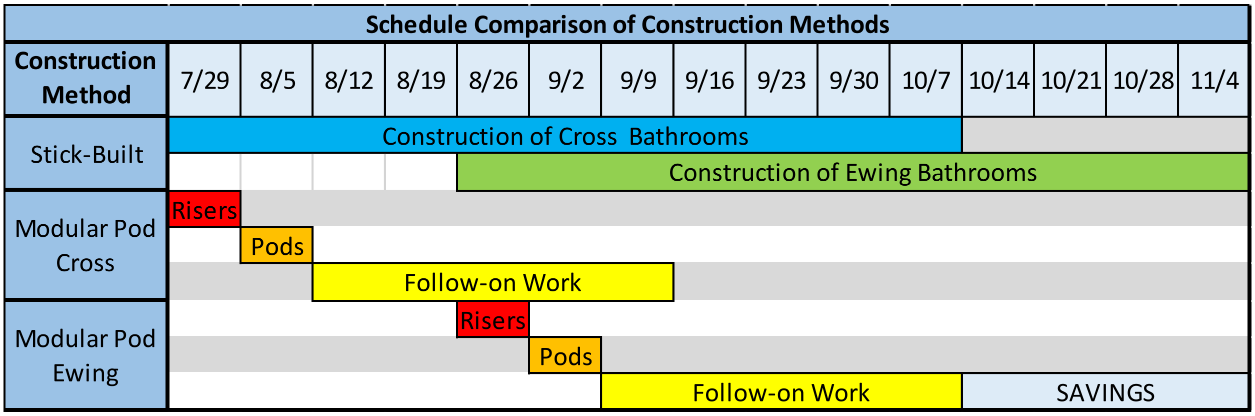
Bathroom Pod Follow-on Activities		
Bathroom Finish Activities	**Quantity**	**Duration**
Finished Interior Walls with Insulation	480 SF	3 Days
Mechanical Chase Walls	160 SF	1 Day
2"x4" Ceramic Tile	155 SF	2 Days
Ductwork	92.6 Lb	0.5 Day
Lavatories	2 EA	0.5 Day
Total Duration		**7 Days**

Table 16: Schedule Reduction Summary

Anticipated Schedule Reduction for a Typical Floor			
Activity	**Original Duration**	**New Duration**	**Total Days Saved/Added**
Framing	5	0	5
Plumbing Rough-In	15	0	15
Electrical Rough-In	15	0	15
Duct Rough-In	15	3	12
Sprinkler Rough-In	15	0	15
Close-In Inspection	1	0	0
Hang & Finish Drywall	8	4	4
Install Shower Bases	3	0	3
Prime & Coat First Paint	2	2	0
Install Ceramic Tile	12	2	10
Plumbing Fixtures	2	1	1
Accessories	3	1	2
Mech/Elec Trim Out	3	2	1
Place Bathroom Pods	0	1	1
Final MEP Connection	0	3	3
Total	**54**	**19**	**35**

Table 16 above summarizes the new durations for a typical floor of bathroom pods at Ewing - Cross. There is a potential to significantly reduce the schedule by thirty-five days per floor, through the use of modular bathrooms. The project schedule for the entire bathroom installation was recalculated, and can be seen in Appendix H. It was assumed that the bathroom pod installation would immediately follow the completion of the bathroom slabs, so the slab finish dates were used as a starting point for the schedule. The Ewing bathroom stack would begin on 08/01/2013, and would take approximately 28 days. Cross would begin on 08/27/2013 and would take 29 days total for all four floors of bathrooms. It is important to note that the original schedule saw all four floors of bathrooms working simultaneously, making it difficult to track and maintain the quality of the bathrooms. The new schedule was built by sequencing the work to follow one floor after another. This will help to reduce the number of workers needed to complete the follow on work, as well as reduce onsite congestion.

One item that isn't particularly called out in the schedule of the bathrooms is the punchlist. With multiple problems with the quality of the tile work, the punchlist proved to be one of the more challenging items of the bathrooms at South Halls. One of the advantages to building the bathrooms offsite is the fact that the punchlist of those spaces can be completed ahead of time, so that there is not a last minute push to fix major concerns, such as tile work.



Schedule Comparison of Construction Methods															
Construction Method	7/29	8/5	8/12	8/19	8/26	9/2	9/9	9/16	9/23	9/30	10/7	10/14	10/21	10/28	11/4
Stick-Built	Construction of Cross Bathrooms														
					Construction of Ewing Bathrooms										
Modular Pod Cross	Risers														
		Pods													
			Follow-on Work												
Modular Pod Ewing					Risers										
						Pods									
								Follow-on Work				SAVINGS			

Figure 41: Summary of Schedule Savings through Modular Pods | Quaid Spearing

Introducing modular bathrooms created two conflicts with the original project schedule; the enclosure work for the large bumpouts at the bathrooms, and the interior student room walls adjacent to the bathrooms. The large panel projection for the Cross bathrooms was scheduled to start on 07/15/2013; the earliest it could begin would be 09/04/2013, immediately following the fourth floor pod installation. The Ewing large projection wall panel was also scheduled to begin on 07/15/2013; the earliest it could begin is 08/13/2013. Although the enclosure installation would be delayed at these locations, the overall enclosure phase would not be delayed.

The interior student room walls that cannot finish until the bathroom pods are installed are indicated in Figure 41 below. Once the pods are placed, the final MEP connections would be made and the ductwork that runs behind the bathrooms can be installed. Clearly, the adjacent interior walls for student rooms 204 and 207 cannot be started until the final MEP connections are made. Each of these walls is about 16 feet long and would take about one day per wall to install. Delaying the installation of these walls is a minor item and the two walls per floor can still be installed before the final painting for each floor finishes.

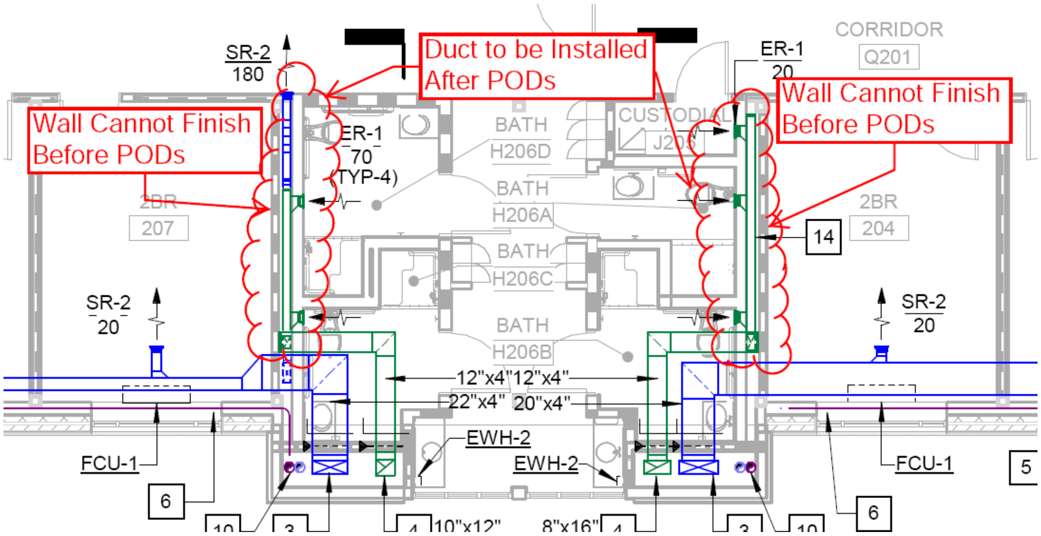


Figure 42: Duct Installation Overview

Overall, the baseline project schedule for the Cross restrooms was decreased by 32 days; the schedule for the Ewing restrooms was decreased by 21 days. It is important to note that even though the bathroom construction was decreased by a total of 21 working days, the overall project schedule cannot be reduced by 21 days. This is because of the nature of the work and the schedule; as stated in previous reports, the bathroom construction follows its own schedule, due mainly to the bathroom slabs needing replaced. For example, the student rooms and ground floor finishes are still working after the 11/04/2013 completion of the restrooms. Even if the total project schedule were to be reduced, the General Conditions costs would not decrease because the project team would still be onsite for the next two renovations.

The real benefits to reducing the bathroom construction schedule are not easily seen by simply looking at the project schedule. During the construction of the bathrooms, there were numerous problems with the quality of work, such as the tile installation. Although the bathrooms were scheduled for completion on 11/04/2013, due to the finish installation problems that arose, the bathrooms did not complete until 12/06/2013. This resulted in the turnover of student rooms essentially overlapping with the completion of the bathrooms. The student rooms were turned over earlier than the rest of the project to allow the owner to start moving in student items and furniture. Reducing the construction schedule of the bathrooms through modularization would help to relieve the pressure of having the building ready for turnover. Completing the bathrooms thirty-five days sooner than the baseline schedule would allow the entire floor to be turned over to the owner, rather than just student rooms.

COST EVALUATION

While it is hard to see any real savings in the overall project schedule, the costs of implementing modular bathrooms is more straight-forward. The cost per bathroom on a typical construction project is something that is not usually tracked. This is because there are so many different trades involved in constructing a bathroom, and the various costs are usually lumped into each subcontractor's pricing. For the purpose of comparison to the bathroom pod costs, RS Means was utilized to price a typical bathroom at South Halls. Ameripod provided a schematic design estimate, based on the typical bathroom layout at South Halls.

Table 17 below shows the cost summary associated with implementing modular bathrooms. As previously stated, the pricing provided by Ameripod includes the manufacturing, transportation, factory overhead fees, and the placement of the pods. The design fees are additional, and average about $7,500 per pod design. Looking at only Ewing – Cross, the implementation of pods actually cost an additional $3,000. The costs savings are not seen until the entire project has implemented modular pods. $122,000 is actually a sizeable savings for the implementation of a modular process, because offsite fabrication has a tendency to save schedule at the expense of increasing project costs.

Table 17: Bathroom Pod Cost Overview

Cost Analysis of Modular Bathrooms					
Item	**Cost/POD**	**Quantity /Building**	**Total Cost/Bldg**	**Quantity (Total Project)**	**Total Cost/Project**
Stick Built Bathroom	$ 15,240.00	40	$ 609,600.00	160	$ 2,438,400.00
Modular Bathroom					
Layout A.1/A.2	$ 14,222.00	15	$ 213,330.00	60	$ 853,320.00
Layout A.3	$ 14,222.00	1	$ 14,222.00	4	$ 56,888.00
Layout B	$ 14,801.00	8	$ 118,408.00	32	$ 473,632.00
Layout C	$ 14,801.00	7	$ 103,607.00	28	$ 414,428.00
Layout D	$ 12,134.00	8	$ 97,072.00	32	$ 388,288.00
Layout E	$ 13,907.00	1	$ 13,907.00	4	$ 55,628.00
Design Fees for Pods	$ 7,500.00	6	$ 45,000.00	6	$ 45,000.00
25 Ton Hydraulic Crane, Truck Mounted	$ 1,807.00	4	$ 7,228.00	16	$ 28,912.00
Total Costs/Savings			**$ (3,174.00)**		**$ 122,304.00**

CONCLUSION AND RECOMMENDATION

The schedule and cost analysis of implementing modular bathrooms for the South Halls Renovation show that it would be beneficial to both the project manager and the owner. Although the overall project schedule cannot be reduced, moving the bathroom construction offsite would result in numerous benefits. The quality of the construction would be improved, while still saving over $120,000. The bathroom construction would no longer be overlapping with the turnover to the owner, reducing onsite congestion. In addition, the onsite labor originally needed to construct the bathrooms could be utilized elsewhere on the jobsite, if the project needed to be accelerated.

In addition to saving money, improving the quality of finish work, and earlier owner turnover, the modular process create several benefits that are difficult to quantify, such as a reduction in construction waste. Although it would be difficult to place the pods in their final locations due to the low floor to floor heights at the South Halls dormitories, it is still recommended that modular bathrooms be implemented for all of the reasons stated above.

ANALYSIS 2 – SIPS IMPLEMENTATION FOR STUDENT ROOMS

PROBLEM IDENTIFICATION

Ewing – Cross is comprised of four floors of student housing, and a ground floor that primarily consists of the mechanical rooms. The top four floors are typical; however, the current schedule only divides the rough-in and finishes by floor. In addition, most of the activities per floor do not have typical durations; for example, Electrical Rough-In takes 5 days, while Hanging and Finishing Drywall takes 19 days. If activity durations can be made more consistent, then the overall construction will have a better flow. The punchlist for student rooms and turnover to the owner was critical at Ewing-Cross because the owner was receiving the building right when students were ready to return for the spring semester. This resulted in phasing the turnover of floors so that Penn State could start on owner FF&E. If the duration of construction for student rooms can be shortened, then the turnover of the building should happen earlier, allowing the owner more time to prepare for student arrival.

ANAYLSIS GOALS

The goal of this analysis is to determine if there are any schedule savings that can be achieved in the construction of the student rooms through the use of short interval production scheduling (SIPS). There will be a focus on optimizing crew sizes so that each construction activity, for the student rooms, has an equal duration. While the student rooms are not on the critical path of the project, any schedule acceleration in these areas will greatly benefit the owner, and allow them to begin their FF&E earlier. The schedule, constructability, and costs of implementing SIPS will all be analyzed. It is anticipated that implementing SIPS, at a minimum, will deliver the student rooms one week earlier.

BACKGROUND RESEARCH

The repetitive layout of student rooms creates the opportunity to implement Short Interval Production Scheduling (SIPS). Utilizing SIPS will give a better understanding of the crews performing each construction activity. By understanding this information, the crew sizes can be optimized to eliminate the need for crews to overlap. The quality of work should also increase because SIPS will create a linear flow to the construction activities, where each crew has a designated work area that belongs to them for a given period of time. Better matching each construction activity to have similar durations would allow the project team to quickly identify if one particular activity is holding up other trades.

Currently, the construction is zoned by floor, making it difficult to understand how the work flows on each floor. It will be important to investigate if rezoning the construction will create a better flow for the activities. Dormitory buildings lend themselves well to the implementation of SIPS, and with there being four identical buildings in the South Halls renovation, any schedule savings achieved at Ewing – Cross could be applied to the other buildings. Implementing SIPS may not decrease the overall project schedule, but would allow for the turnover of critical spaces earlier, which would ease the burden of move-in on both the project team and the owner.

SIPS CASE STUDY: PENTAGON RENOVATION AND CONSTRUCTION

Short Interval Production Schedule (SIPS) is a method of scheduling that is utilized on projects that have highly repeatable activities, such as high rise office buildings, apartment complexes, hotels, or even dormitory buildings. The idea behind a SIPS is to try and create equal durations for each activity in a construction sequence. A greater level of detail is required to build a SIPS to ensure that a continuous flow of work is achieved.

There are numerous examples of projects that have successfully implemented SIPS; one of the most famous being the Pentagon renovation. The project involved the renovation of four wedges, with each wedge divided into areas of 10,000 square feet. Each area was scheduled to take 26 weeks to complete, with each activity taking one week. For this type of schedule, it is ideal to break the building into portions that can be completed in multiples of full work weeks because it becomes more difficult to track work progress if activities are carrying over into the following week, even if only for a day.

As can be observed in the figure below, the SIPS schedule for the Pentagon renovation sought to achieve a continuous flow of work. As each trade finished their respective task, they move onto the next area. This continued for the entirety of the project, with the entire project taking only 63 weeks. Much like any successful SIPS implementation, the Pentagon renovation followed the basic steps for developing a SIPS (Burkhart 1989):

1. Break the operation down into specific activities
2. Quantify each activity
3. Assign production rates to each activity
4. Calculate extensions and set goals
5. Develop a time-scaled resources-loaded bar chart

These steps will be followed in developing the new schedule for the Ewing – Cross student rooms.

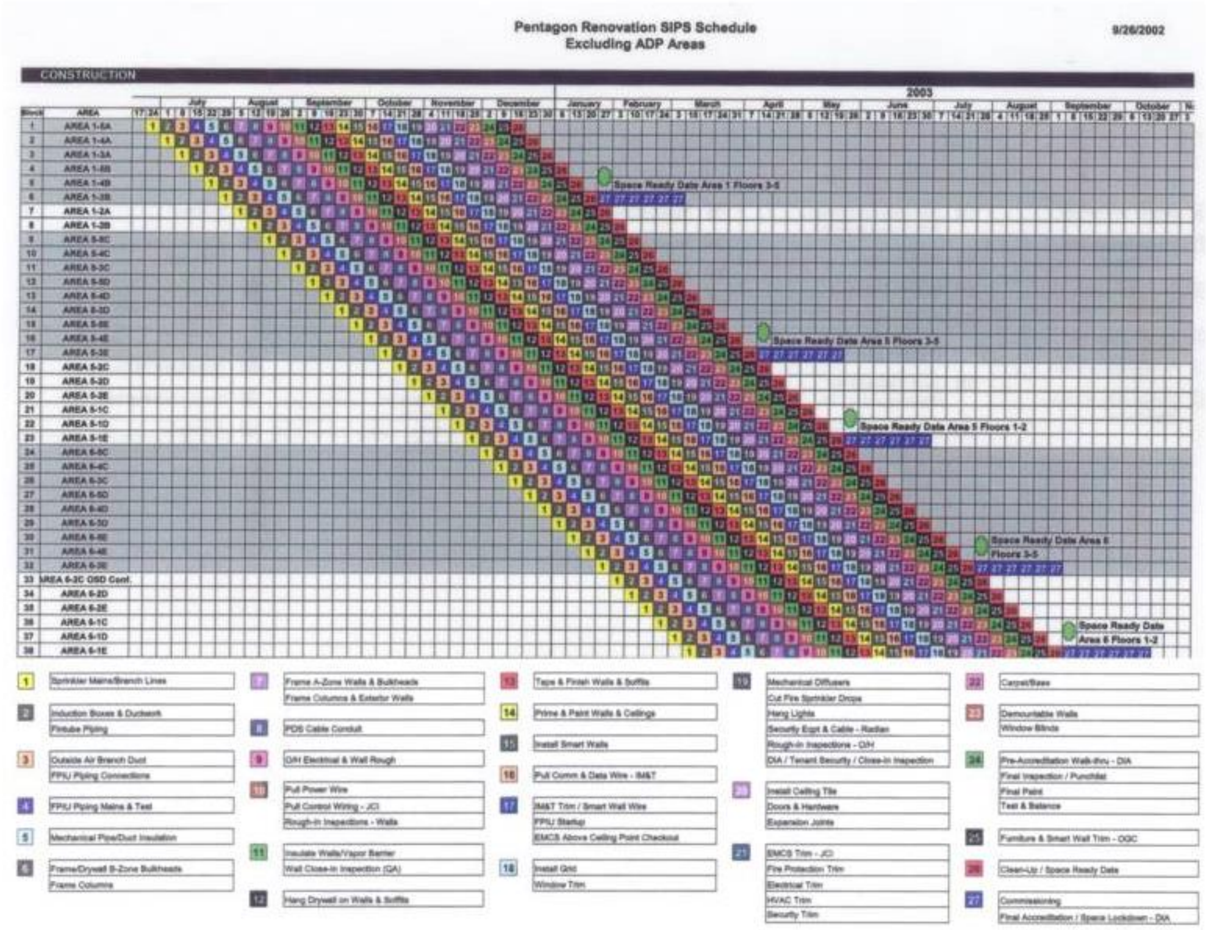


Figure 43: SIPS for the Pentagon Renovation | **http://renovation.pentagon.mil/wedge2-5/sips.htm**

CONSTRUCTION ACTIVITIES

The SIPS analysis will focus on the construction of the student rooms on floors 1 through 4; these areas of the project are all very similar and will lend themselves well to the SIPS process. It is important to note that the Ground floor will not be considered in the SIPS analysis because this floor is mainly comprised of the mechanical rooms and staff apartments, and differs greatly from the above floors.

The final schedule with actual durations was obtained to fully understand how long activities will take to construct with the current resources. Table 18 below summarizes the durations of activities for a typical floor. One activity to make note of is the Framing & Door Frames; this activity was shown in the schedule as having a ten day duration. After speaking with the South Halls project team, it was discovered that this activity was actually taking closer to only 5 days to complete. Therefore, a five day duration will be assumed for this activity.

Table 18: Actual Activity Durations for Typical Floor

Activity Durations for Fourth Floor (Typical)					
Activitity	**Current Duration**	**Baseline Start**	**Baseline Finish**	**Start Date**	**Finish Date**
Layout & Top Track	5	6/20/2014	6/27/2013	6/6/2013	6/11/2013
Perimeter Insulation	3	7/3/2014	7/8/2014	6/10/2013	8/2/2013
Ductwork	5	7/1/2014	7/9/2014	6/11/2013	6/17/2013
MEP Coring	5	6/26/2014	7/3/2014	6/11/2013	6/14/2013
Perimeter Bedroom Framing	5	7/5/2014	7/12/2014	6/11/2013	7/31/2013
Electrical Rough In	5	7/11/2014	7/18/2014	6/13/2013	7/31/2013
Perimeter Bedroom Piping	5	7/12/2014	7/19/2014	6/13/2013	7/31/2013
Framing & Door Frames	10	6/24/2014	7/9/2014	6/21/2013	7/31/2013
Ceiling/Bulkhead Framing	7	6/28/2014	7/10/2014	7/1/2013	7/31/2013
Perimeter Bedroom Tela-Data/Elec	5	7/16/2014	7/23/2014	7/8/2013	7/31/2013
Sprinkler Rough In	3	7/15/2014	7/17/2014	7/10/2013	7/18/2013
Plumbing Rough In	5	7/16/2014	7/22/2014	7/15/2013	7/31/2013
Hang GWB	8	7/23/2014	8/1/2014	7/22/2013	9/25/2013
Finish GWB	8	8/2/2014	8/13/2014	7/22/2013	10/16/2013
Windows	3	7/15/2014	7/18/2014	7/22/2013	8/20/2013
Prime & Paint	4	8/12/2014	8/16/2014	8/12/2014	10/16/2014
Pull Tela-Data	2	8/12/2014	8/14/2014	8/14/2014	10/16/2014
Install Lighting	5	8/16/2014	8/23/2014	8/20/2014	11/1/2014
Install Flooring	5	9/3/2014	9/10/2014	9/13/2014	11/1/2014
Intsall FCU	5	8/27/2014	9/3/2014	9/13/2014	9/20/2014
Mech. Trim Out	3	9/11/2014	9/13/2014	9/13/2014	11/1/2014
Doors & Hardware	3	9/17/2014	9/19/2014	9/16/2014	11/1/2014
Adjust Sprinkler Heads	4	9/17/2014	9/23/2014	9/23/2014	10/11/2014
Elec/Tele/Fire Alarm Trim Out	3	9/18/2014	9/23/2014	9/23/2014	11/1/2014
Suite/Lobby Casework	3	10/15/2014	10/18/2014	10/17/2014	11/15/2014
Window Treatment	2	10/15/2014	10/17/2014	10/18/2014	11/1/2014
Apply Final Paint	5	11/7/2014	11/14/2014	11/4/2014	11/6/2014
Floor Install/Carpet Base	2	10/23/2014	10/25/2014	11/4/2014	11/7/2014
Final Clean	2	11/18/2014	11/20/2014	12/2/2014	12/6/2014

As you can see, a lot of the activities start and completion dates differ from the baseline schedule; this can be accounted to other work occurring on each floor besides the student rooms, such as the construction of the bathroom slabs and bathrooms. The net duration of actual construction time remained the same, even though many of the activities were delayed. It can also be observed that for many of the activities, several trades are occupying the same floor at one time; this can make the construction more difficult because the various trades can easily get in one another's way. Implementing SIPS will help to distinguish which area belongs to which trade, which should create a better flow to the construction.

The table below displays the durations and scheduled time of construction for electrical rough-in on each floor. You can see that the electrical work often overlapped on several floors, with the overall duration starting on 06/13/2013 and finishing on 10/07/2013. Implementing SIPS will seek to eliminate work overlapping onto multiple floors, in an effort to assign an area to one particular trade at a time.

Table 19: Electrical Rough-In for Ewing - Cross

Electrical Rough In All Floors						
Floor	**Activity**	**Duration**	**Baseline Start**	**Baseline Finish**	**Actual Start**	**Actual Finish**
C4	Electrical Rough In	5	11-Jul	18-Jul	13-Jun	31-Jul
C3	Electrical Rough In	5	8-Jul	15-Jul	20-Jun	31-Jul
C2	Electrical Rough In	5	17-Jul	24-Jul	1-Jul	9-Aug
C1	Electrical Rough In	10	19-Aug	30-Aug	5-Aug	7-Oct
E4	Electrical Rough In	5	15-Jul	22-Jul	13-Jun	26-Jul
E3	Electrical Rough In	5	8-Jul	15-Jul	19-Jun	26-Jul
E2	Electrical Rough In	5	29-Jul	5-Aug	1-Jul	9-Aug
E1	Electrical Rough In	10	15-Aug	28-Aug	5-Aug	7-Oct

BUILDING ZONES

The next step is to identify the different zones for the SIPS. Floors 2 through 4 have very similar layouts; floor 1 also houses two meeting rooms. As can be seen in the tables below, the top three floors (Zones 1 -6) are fairly consistent in layout in size. Dividing the zones by wing is logical because it gives a clear divide to the work areas. The first floor was broken into three areas to keep the work zones to a manageable size; the first floor also took longer to complete than the other three floors, further necessitating the need to create three zones for this floor.

Table 20: Zone Breakdown

Area Per Zone		
Zone	**Floor**	**Square Footage**
1	4th	5600
2	4th	5600
3	3rd	5600
4	3rd	5600
5	2nd	5600
6	2nd	5600
7	1st	4650
8	1st	4260
9	1st	5650

The average duration of each activity is in the 5 – 10 day range; the goal will be to have each activity per zone be completed in one work week, or five days. Five days per activity is ideal because this means that each activity would be completed Monday through Friday; Saturday can be left as a make-up day, if any particular trade is behind. With the building square footage evenly distributed amongst the nine zones, the construction activities for each zone will have similar durations, allowing for a smooth flow of work.

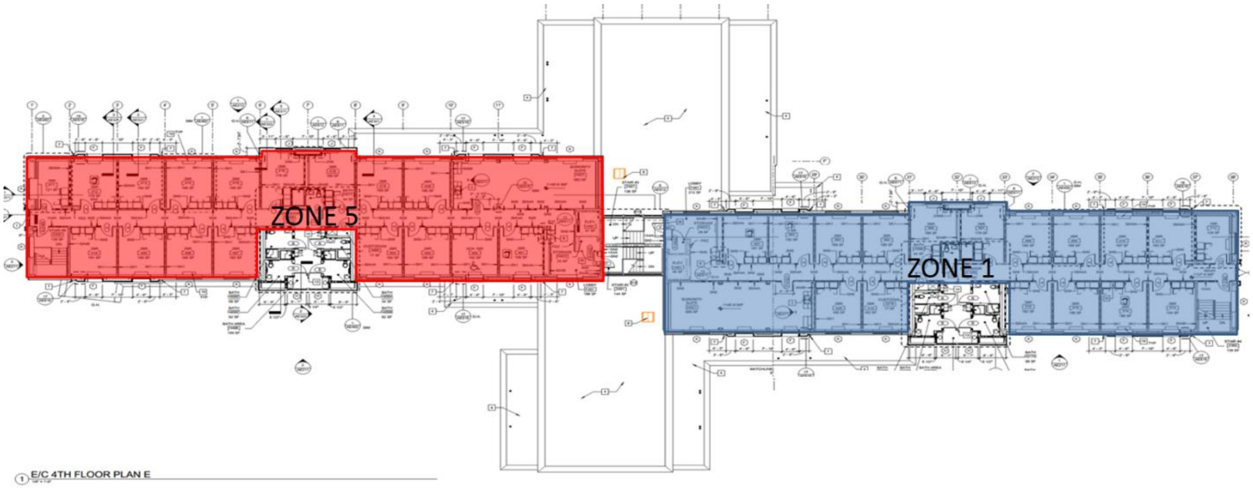


Figure 44: Fourth Floor Zones

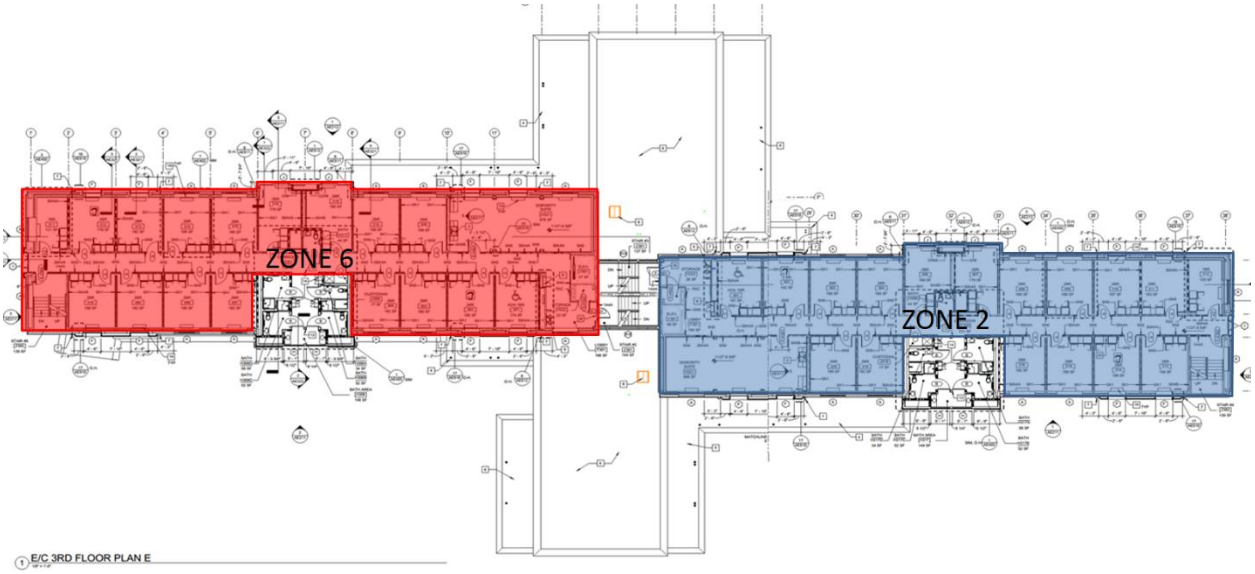


Figure 45: Third Floor Zones

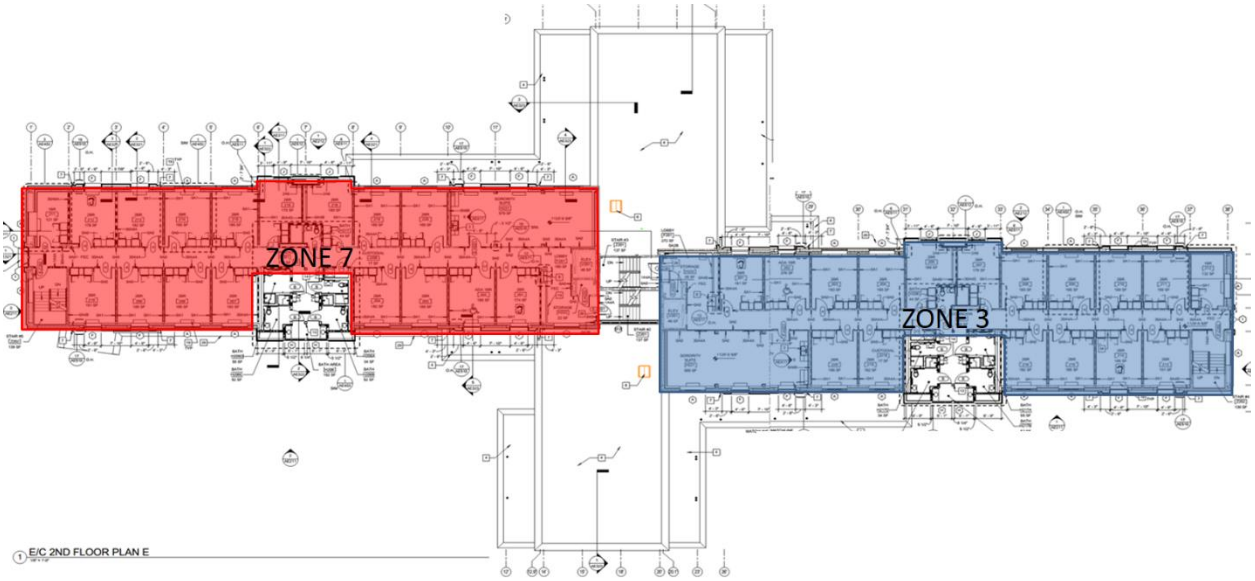


Figure 46: Second Floor Zones

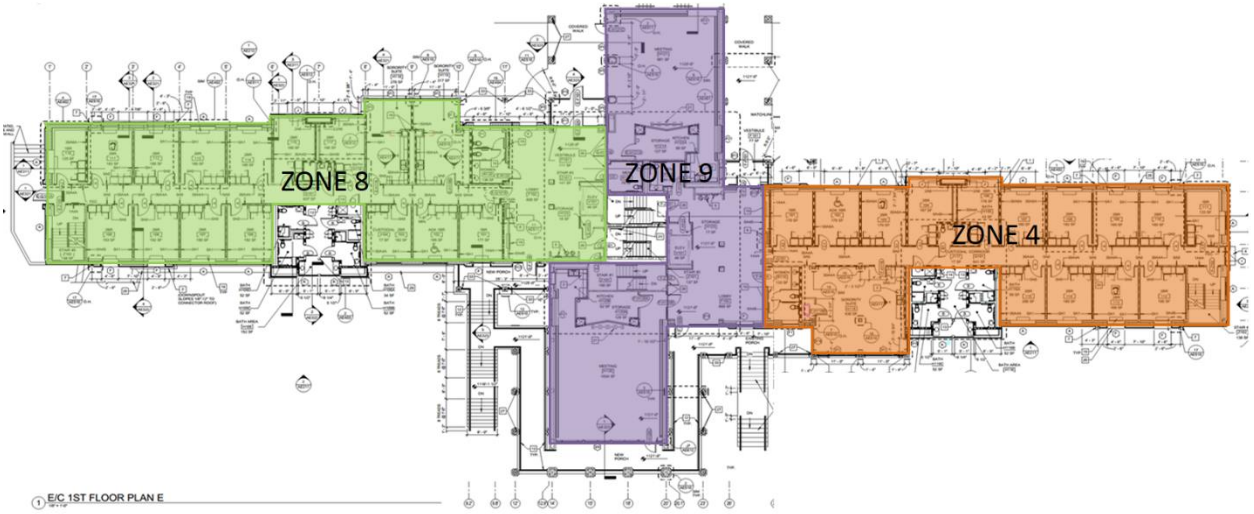


Figure 47: First Floor Zones

ADJUSTED CREW SIZES

Now that the SIPS zones have been identified, the crew sizes for each activity need to be adjusted to try and achieve the 5 day duration for each activity. The original schedule was sequenced per wing, just like Zones 1 through 6; using crew sizes provided by Barton Malow and assuming a work area of 5600 square feet, Table 21 below summarizes the original production rates per worker. For example, the Layout and Top Track activity has a five day duration and a crew size of five:

5600SF /5 Workers = 1120 SF/Worker

(1120SF/Worker) / 5 Days = **224 SF/Day**

With production rates per worker for each activity known, the ideal crew size can be calculated. Looking at the Hang GWB activity, which has an eight day duration:

5600 SF = 117 SF/Day x 5 Days x Y Workers

Y = **10 Workers**

Using this thought process, Table 22 shows the new crew sizes and adjusted activity durations.

Table 21: Original Production Rates

Original Duration and Production Rates				
Activity	**Current Duration**	**Subcontractor**	**Crew Size**	**Production/Wrkr (SF/Day)**
Layout & Top Track	5	Penn Install	5	224
Perimeter Insulation	3	Penn Install	3	622
Ductwork	5	McClure	5	224
MEP Coring	5	McClure & FE	2	560
Perimeter Bedroom Framing	5	Penn Install	6	187
Electrical Rough In	5	FE	5	224
Perimeter Bedroom Piping	5	McClure	5	224
Framing & Door Frames	5	Penn Install	7	160
Ceiling/Bulkhead Framing	7	Penn Install	3	267
Perimeter Bedroom Tele-Data/Elec	5	FE	3	373
Sprinkler Rough In	3	SAC	4	467
Plumbing Rough In	5	McClure	5	224
Hang GWB	8	Penn Install	6	117
Finish GWB	8	Penn Install	5	140
Windows	3	NBS	3	622
Prime & Paint	4	PAT	3	467
Pull Tele-Data	2	FE	3	933
Install Lighting	5	FE	3	373
Install Flooring	5	NBS	4	280
Install FCU	5	McClure	2	560
Mech. Trim Out	3	McClure	2	933
Doors & Hardware	3	Hood Co	4	467
Adjust Sprinkler Heads	4	SAC	2	700
Elec/Tele/Fire Alarm Trim Out	3	FE	2	933
Suite/Lobby Casework	5	Penn Install	4	280
Window Treatment	2	Penn Install	1	2800
Apply Final Paint	5	PAT	3	373
Floor Install/Carpet Base	2	NBS	3	933
Final Clean	2	BMC	5	560

Currently, there are 29 different activities for each zone; assuming five day durations, the total construction of student rooms would take about 33 weeks. Starting with a baseline of June 6th, the final zone would be completed sometime around January 17th, 2014. Clearly some of the activities will need to be combined to achieve any schedule savings. Some of the activities were also resequenced to create a better flow of trades; looking at the typical start and finish durations from Table 18, it can be seen that a lot of the activities were simultaneously being completed. Therefore, it was assumed that certain activities could be moved around, depending on which subcontractor owned the activity. Several activities were also combined because they were performed by the same subcontractor and were back to back in sequencing. Major changes to the schedule activities include:

- Perimeter Bedroom Framing and Perimeter Insulation were combined into one activity; both are performed by Penn Install and it makes sense that the crew would place insulation as they are framing the student room walls.
- The majority of the Bedroom Telecom and Data wires are pulled at the same time as the Electrical Rough-In. The two activities were combined to create an activity with a five day duration and a crew size of eight. It will be important that the electrical subcontractor solely own each zone for their activities because their work flow is different than other trades. While most trades flow towards the center of the building, the electrical work flows from the center of each wing because the panel boards are located at the center of each wing.
- Penn Install also handles both the Door Frames and Ceiling & Bulkhead Framing; therefore, the two will be combined, with a total crew size of 11 workers.
- The electrical contractor handles both the final Tele-Data Pull and the Light Fixture Install; these two were combined to have a total crew size of 4.
- The mechanical trim out was combined with the installation of the fan coil units, because the mechanical subcontractor owns both activities. The combined activity will take 5 days with a crew of three workers.
- Penn Install performs both the Suite/Lobby Casework and the Window Treatment; these activities will be combined for a total duration of 5 days with a crew of 5 workers.

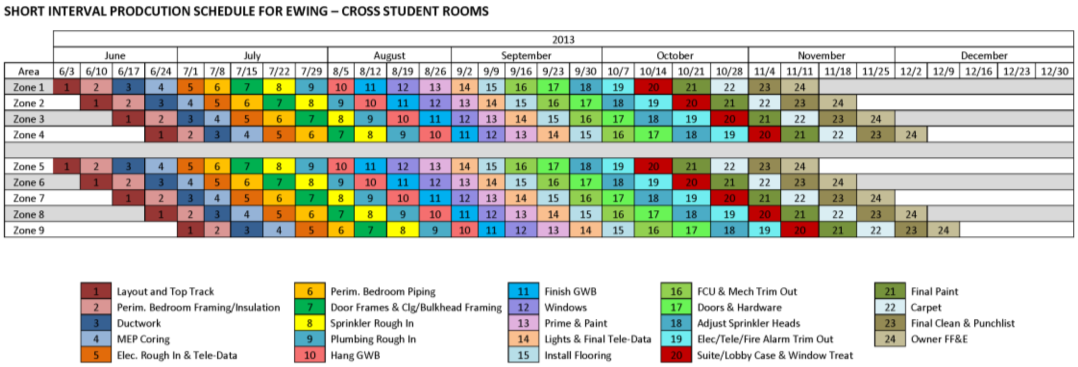
The adjusted schedule was reduced to a total of 23 activities, which will total 23 weeks per floor. The final two activities, Floor Install/Carpet Base and Final Clean were not adjusted; a week will be allotted to each activity, but with each actually having a three day buffer in case any of the previous activities are delayed by more than a day. In addition, the Architect and Engineers will be performing the Punchlist concurrent to the Final Cleaning activity.

Table 22: New Production Rates

New Duration and Production Rates					
No.	**Activity**	**New Duration**	**Subcontractor**	**Crew Size**	**Production/Wrkr (SF/Day)**
1	Layout & Top Track	5	Penn Install	5	224
2	Perimeter Bedroom Framing & Insulation	5	Penn Install	6	187
3	Ductwork	5	McClure	2	224
4	MEP Coring	5	McClure & FE	6	560
5	Electrical Rough In & Tele-Data	5	FE	8	140
6	Perimeter Bedroom Piping	5	McClure	5	224
7	Door Frames & Clg/Bulkhead Framing	5	Penn Install	11	160
8	Sprinkler Rough In	5	SAC	2	467
9	Plumbing Rough In	5	McClure	5	224
10	Hang GWB	5	Penn Install	10	117
11	Finish GWB	5	Penn Install	8	140
12	Windows	5	NBS	2	622
13	Prime & Paint	5	PAT	2	467
14	Install Lighting and Final Tele-Data Pull	5	FE	4	373
15	Install Flooring	5	NBS	4	280
16	Install FCU & Mech. Trim Out	5	McClure	3	560
17	Doors & Hardware	5	Hood Co	2	467
18	Adjust Sprinkler Heads	5	SAC	2	700
19	Elec/Tele/Fire Alarm Trim Out	3	FE	2	933
20	Suite/Lobby Casework & Window Treatment	5	Penn Install	5	280
21	Apply Final Paint	5	PAT	3	373
22	Floor Install/Carpet Base	2	NBS	2	933
23	Final Clean	2	BMC	5	560

NEW SCHEDULE

The Figure below shows the SIPS created for the Ewing – Cross student room construction; the schedule was produced using Microsoft Excel. The full sized schedule can be found in Appendix K.



SHORT INTERVAL PRODCUTION SCHEDULE FOR EWING – CROSS STUDENT ROOMS

	2013																														
	June				July					August				September					October				November				December				
Area	6/3	6/10	6/17	6/24	7/1	7/8	7/15	7/22	7/29	8/5	8/12	8/19	8/26	9/2	9/9	9/16	9/23	9/30	10/7	10/14	10/21	10/28	11/4	11/11	11/18	11/25	12/2	12/9	12/16	12/23	12/30
Zone 1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24							
Zone 2		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24						
Zone 3			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24					
Zone 4				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24				
Zone 5	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24							
Zone 6		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24						
Zone 7			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24					
Zone 8				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24				
Zone 9					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24			

1	Layout and Top Track
2	Perim. Bedroom Framing/Insulation
3	Ductwork
4	MEP Coring
5	Elec. Rough In & Tele-Data
6	Perim. Bedroom Piping
7	Door Frames & Clg/Bulkhead Framing
8	Sprinkler Rough In
9	Plumbing Rough In
10	Hang GWB
11	Finish GWB
12	Windows
13	Prime & Paint
14	Lights & Final Tele-Data
15	Install Flooring
16	FCU & Mech Trim Out
17	Doors & Hardware
18	Adjust Sprinkler Heads
19	Elec/Tele/Fire Alarm Trim Out
20	Suite/Lobby Case & Window Treat
21	Final Paint
22	Carpet
23	Final Clean & Punchlist
24	Owner FF&E

Figure 48: Student Room SIPS Schedule

The SIPS created for Ewing – Cross follows the same thought process as the schedule for the Pentagon renovation, except for the simultaneous sequencing of the two wings. The original schedule saw both Ewing and Cross constructed at the same time, and it was deemed that this was still necessary. If there was only one crew per activity, the overall duration of the student room construction would increase by about 5 weeks, resulting in a finish date of January 10th, 2014. This would not be feasible because the spring semester begins on January 13th, with many students arriving earlier than this.

A SIPS follows the same thought pattern as linear scheduling; a linear schedule seeks to break the project into sections and introduce uniform workflow and production rates. There are three models for making a linear schedule: Sequence Production, Parallel Production, and Flowline Production. The Pentagon SIPS followed the idea of the sequence production, because it finished each zone activity before the next is started. The Ewing – Cross schedule follows the ideas of parallel production because there are the two wings are constructed simultaneously. Parallel production allows for the shortest construction duration, but can also become more demanding and difficult to manage. However, it is necessary to make use of parallel production because the entire project only has a seven month window for the construction to be completed. The project team would be able to handle a parallel production schedule, because it is basically the same scheduling methodology that is already implemented, but the SIPS will better streamline the process.

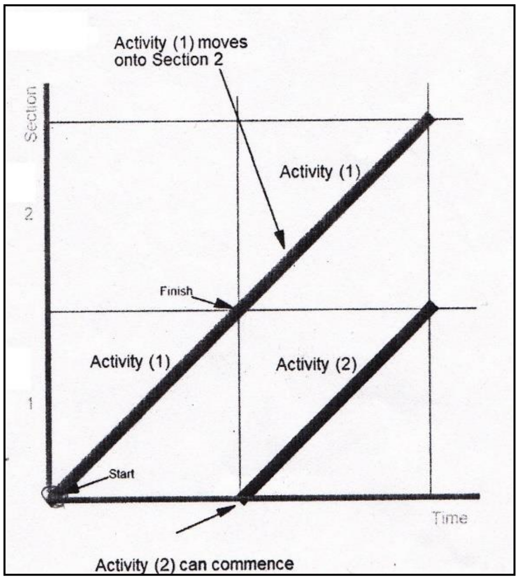


Figure 49: Example of Linear Schedule | AE 476 Notes

In addition to the activities already called out, the owner furniture, fixtures, and equipment (FF&E) was added as the final task to occur on each floor. There are various deliveries that will occur for the mattresses, bed frames, student room desks, wardrobe closets, etc. The original schedule saw each of these activities taking one day each for all four floors; for example, it was easier for Penn State to get all of the mattresses in one delivery, as opposed to having each floor delivered separate. Material availability and lead times often drive a construction schedule, and the owner FF&E is no different. It can become more difficult and costly to have four or more separate deliveries for furniture coming from several hundred miles away, especially if it would be feasible to only have one delivery. A week for owner FF&E was added to each zone, which essentially allots the owner a five week period to coordinate deliveries necessary.

Table 23: Schedule Summary of Work in each Zone

Schedule Summary					
Area	**Original Start**	**Original Finish**	**SIPS Start**	**SIPS Finish**	**Total Duration (weeks)**
Zone 1	6/6/2013	12/6/2013	6/3/2013	11/15/2013	24
Zone 2	6/5/2013	12/6/2013	6/10/2013	11/22/2013	24
Zone 3	6/5/2013	12/6/2013	6/17/2013	11/29/2013	24
Zone 4	7/5/2013	12/27/2013	6/24/2013	12/6/2013	24
Zone 5	6/11/2013	12/6/2013	6/3/2013	11/15/2013	24
Zone 6	6/14/2013	12/6/2013	6/10/2013	11/22/2013	24
Zone 7	6/26/2013	12/6/2013	6/17/2013	11/29/2013	24
Zone 8	7/17/2013	12/20/2013	6/24/2013	12/6/2013	24
Zone 9	N/A	N/A	7/1/2013	12/13/2013	24
Total	**6/6/2013**	**12/27/2013**	**6/3/2013**	**12/13/2013**	**28**

Overall, the new SIPS was found to reduce the overall schedule for the student rooms by about two weeks, or 10 working days. This does not sound like a huge savings, but when the turnover and final owner activities are considered, this schedule reduction is invaluable. There was an immense amount of coordination for owner FF&E deliveries with the original schedule; finishing the construction two weeks earlier provides the owner more time to get the rooms ready for student arrival.

The two week schedule savings was mainly achieved through adjusting the crew sizes and combining certain tasks together to ensure that each activity has a five day duration per zone. While the original schedule had the same activities often being performed on multiples floors at the same time, the new SIPS creates a smoother flow to the work to help in reducing jobsite congestion.

Similar to Analysis 1, the reduction in schedule of the student room construction does not reduce the overall construction schedule because there are other independent activities, including: the ground floor, mechanical rooms, exterior work, building enclosure, and the bathroom cores. Even if these activities were able to be reduced, it really wouldn't result in any quantifiable savings, such as General Conditions. Construction schedules for university work are often dictated by the school semester schedules. Even if Ewing – Cross were to finish early, the earliest that students would move in would still be the beginning of January. The entire phasing and scheduling for South Halls has been built around the idea of completing each building so that it is ready at the start of the following semester. As previously stated, the real benefit of implementing SIPS is trying to ease the turnover of the building provide the owner more time for their FF&E in the critical areas.

COST ANALYSIS

The implementation of SIPS for the construction of the student rooms did not add any additional costs to the project. The nature of a SIPS in scaling manpower to reach a desirable activity duration; the same amount of manhours are going into both the original schedule and the SIPS, so the subcontractors are not incurring any additional costs. The SIPS allows for more predictable activity durations, because the schedule is built directly on the idea that each worker can produce a given amount of work (SF) per day. By looking at production rates at the start of a project, each subcontractor is able to accurately provide enough labor, rather than being understaffed, falling behind, and then using overtime to get the project back on track. There may be increased management costs in coordinating the SIPS at the start of the project, but this would eventually be offset by the fact that the schedule has become more predictable.

Although there are no additional costs incurred through the use of SIPS, there aren’t really any costs savings achieved either. As previously stated, Ewing – Cross is one building in a multi-phase project; the project team will be on site for the entirety of the project, and future phases cannot be started earlier if the other phases finish sooner.

CONSTRUCTABILITY

Collaboration of the entire project team and subcontractors will be necessary to ensure that the implementation of SIPS is successful. Any delays will compound because the activities are sequenced one after the other. To help alleviate this concern, the activities were scheduled to be completed in 5 working days, with Saturday serving as a possible catchup day. The original schedule saw a lot of activities overlapping with multiple subcontractors occupying zones at the same time. The SIPS now dictates which areas belong to each subcontractor at any given time; this will help to reduce congestion in each work zone.

Timely deliveries will be critical in maintaining the project schedule; delays in material acquisition would no doubt impact the entire SIPS. Extra planning will need to be performed by each subcontractor to ensure that enough materials are readily available for each zone. In addition, each trade will need to make sure that each zone is properly prepared for the next trade; it becomes more difficult for trades to work if they are trying to work around other trades material, tools, and waste.

SIPS requires buy-in from the entire project team; each subcontractor will need to make sure that each zone is ready for the follow-on trade. Any hostility among the trades could result in the SIPS unraveling. With the project being delivered as a design-build delivery method, there is an increased amount of collaboration among all subcontractors. Furthermore, having a collocated jobsite office helps in increasing the collaboration and transparency of the project team.

Other activities could cause delays in the timely completion of the student room construction activities. The construction of the bathrooms is of particular concern because each zone wraps around the bathroom cores, meaning that these areas are intricately connected. Analysis 1 sought to improve the construction of the bathrooms by implementing modular pods, which reduced the overall construction schedule of the bathroom cores; the proposed shorter construction schedule of the bathrooms would reduce the impact they have on surrounding construction areas, such as the student rooms.

The SIPS was sequenced top-down because portions of the first floor are used as storage space, particularly zone 9. The zone 9 area needs to be completed last because a lot of the activities that occur in this area cannot be completed until the meeting rooms are enclosed. Delays in the enclosure activities could result in delaying the completion of the first floor interior construction.

CONCLUSION AND RECOMMENDATION

Implementing SIPS for the construction of the student rooms will accelerate the project schedule by two weeks. This will ease the turnover process by allowing the owner to begin their FF&E sooner, reducing the number of activities that run right up against student arrival. While there are no perceived cost savings through SIPS, there are also no additional costs incurred to the project team. The SIPS will allow for a continuous flow of work, and help in reducing work zone congestion. For all of these reasons, it is recommended that SIPS be implemented for the construction of the student rooms.

ANALYSIS 3 – PREFABRICATION OF LIMESTONE FACADE

PROBLEM IDENTIFICATION

As previously mentioned, maintaining the project schedule is of particular concern. In addition, the site at Ewing – Cross is very tight, by State College standards. Often construction activities overlap and any minor delay can offset several different activities from being completed on time. During the enclosure of Ewing – Cross, there was a delay in material acquisition; the limestone panels were delayed by two weeks, and the façade completion was delayed because of this. The delays caused by the limestone panels required Barton Malow to shift several other exterior activities around to maintain the schedule. Because eight of the twelve limestone bumpouts are attached to the existing brick veneer, there is an opportunity to utilize prefabrication.

ANALYSIS GOALS

The goal is this analysis will involve looking at using traditional limestone panels as an alternative façade to the limestone veneer panels. Cost will be the driving factor in this comparison, and will require analyzing the structural requirements for potentially implementing a heavier façade. The second part of this analysis will focus on prefabricating the more cost effective wall system. Similar to Analysis 1, the benefits of moving construction offsite, such as schedule acceleration and increased productivity, will be weighed against the cons, which include: transportation and warehouse costs, and onsite installation coordination. A schedule and cost analysis will then be performed to determine if prefabricating the limestone façade will benefit the South Halls project. It is believed that offsite prefabrication will reduce the schedule of the building enclosure, without increasing the overall project cost.

WALL ASSEMBLIES

There are two systems that will be analyzed for potential use as a prefabricated wall assembly: a prefabricated full thickness limestone façade, and the currently used limestone veneer panels.

EXISTING FAÇADE

The existing limestone panel system is comprised of different wall assemblies. The limestone veneer at the large panel projections houses the mechanical chases and is comprised of 8” metal studs @ 16” o.c. with 5/8” sheathing and vapor barrier. The stone panels are secured directly into the sheathing with anchors and the metal studs carry the load. The small panel projections are built in a similar fashion, with 6” metal studs and 5/8” sheathing and vapor barrier. The metal studs are attached directly to the existing brick veneer.

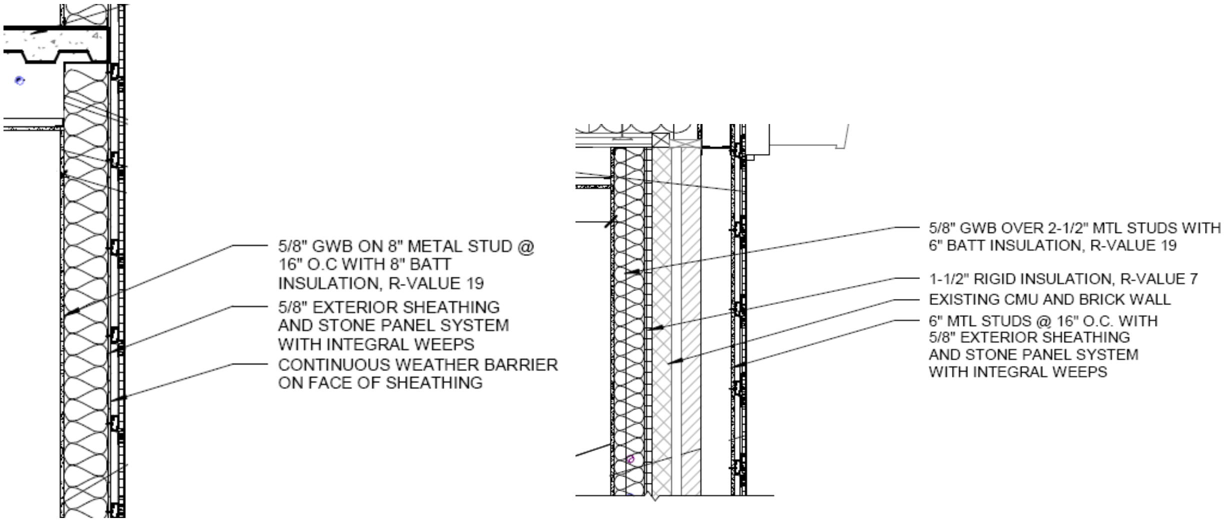


Figure 50: Typical Large Limestone Bumpout (left), and Small Limestone Bumpout connected to existing brick veneer (right)

TRADITIONAL LIMESTONE

The new dormitory building, Chace Hall, made use of a more traditional limestone façade, which can be seen in the figure below. For the purpose of this analysis, the thicker limestone façade design follows the same design as Chace. The typical thickness for a limestone panel is 3 5/8"; this thickness is typically used because it gives enough width for bearing onto a shelf angle. Much like the existing limestone panel system, the thicker limestone panels are tied back into the sheathing; however, the shelf angle carries the load from the limestone. The thicker limestone is typically a lower cost/sf than the thin Stonepanel system, but would take significantly longer to install because of its weight. Analyzing the possibility of prefabricating sections of limestone would potentially lead to saving significant amounts of onsite construction time in setting the limestone panels.

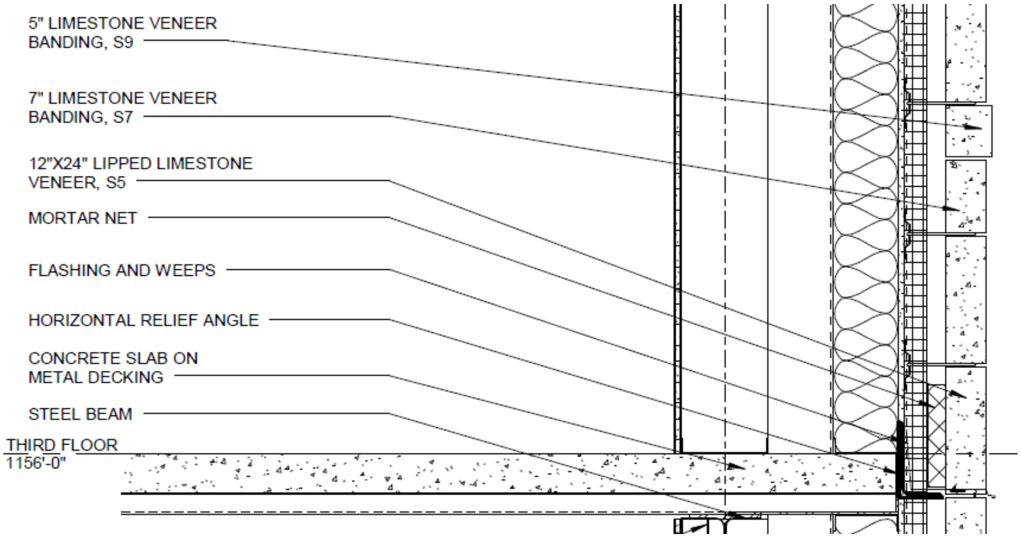


Figure 51: Limestone Facade used at Chace Hall

STRUCTURAL IMPACT & DESIGN: STRUCTURAL BREADTH

Utilizing a thicker limestone panel would have several implications with regards to the structural systems. In addition, understanding the cost associated with increasing the structure will help in choosing which system to prefabricate. The current structural system at the large panel projections cantilevers a 3VLI composite metal deck with 3 ¼" lightweight concrete from the existing slab. The load of the existing limestone panel system is carried only by the 8" metal studs, which is then transferred to the foundation mat slab.

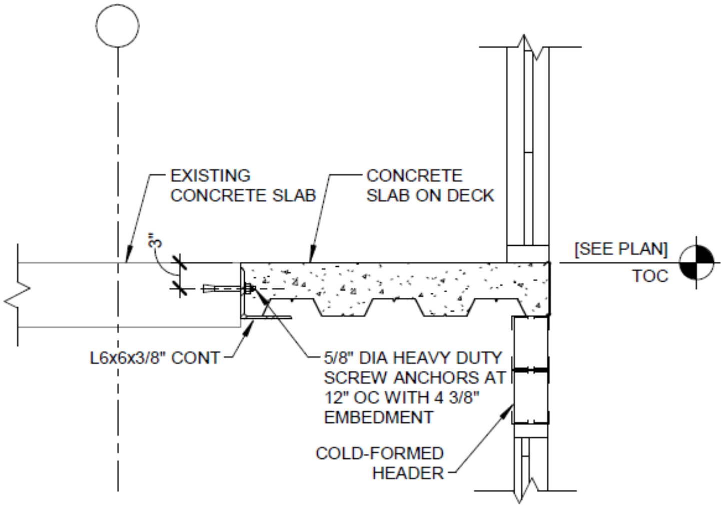


Figure 52: Connection to Existing Slab

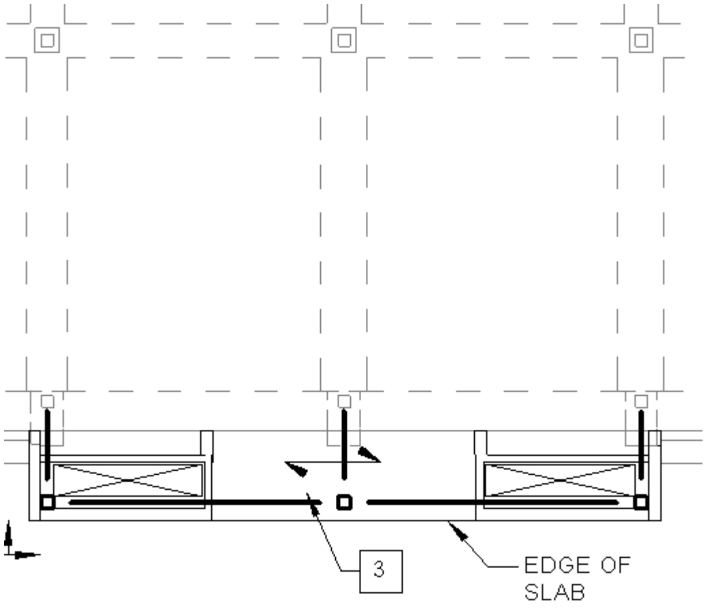


Figure 53: Proposed structural design to carry thicker limestone | Quaid Spearing

After some initial research into how a traditional limestone wall assembly is constructed, it was determined that the 8" metal studs are not capable of carrying the wall load. The Indiana Limestone Institute of America, Inc. (ILI) states that a metal stud backup system is acceptable provided that no gravity loads are transferred to the stud system. Therefore, a structural system will need to be designed that is capable of carrying the heavier wall loads. A preliminary design concept was formed using HSS columns and beams, as is typical for the South Halls construction. Sticking with the existing column layout, three columns were added at the new exterior wall; these columns are then tied back into the existing columns with HSS beams. The proposed layout can be seen in Figure 53. It was also determined that the layout of the composite deck and slab would need to be slightly altered to accommodate the limestone wall. The slab was extended 1'-0" in each external direction so that the metal stud wall can be attached. It would not be feasible to put the metal stud wall in line with the columns because this does not allow the stud walls to fully enclose the columns, creating unnecessary thermal breaks in the building enclosure.

The new wall load was calculated to be 56.3 lb/ft^2; for structural design purposes, the whole wall is conservatively assumed to be limestone. Using the existing composite deck and LW concrete at 46 psf and various other dead and live loads, the load experienced by a corner column was found to be 80.15k. A HSS 6x6x5/16 column was designated for the three new columns.

Following methods learned in AE 404 and the HSS LRFD Beam Load Tables, the shorter beams that tie into the existing structure were designed as HSS 3 1/2x 3 1/2x 3/16. The longer beams at the face of the façade were designed as HSS 6x6x3/16.

A quick check of the geotechnical reports for South Halls revealed that the allowable loads for the soils were at 8,000 psf; most of the site is bedrock, resulting in significant bearing capacity. At 8,000 psf, the existing 4'-0" by 27'-8" footing is capable of carrying 885.4k, which is more than enough to carry the 260.2k wall load for a typical large projection bumpout.

Table 24: Wall Loads

Proposed Wall System	
Item	Weight (psf)
8" Metal Studs	2
8" Batt Insulation	0.5
5/8" Sheathing	2.1
3 5/8" Limestone	51.7
Total	**56.3**

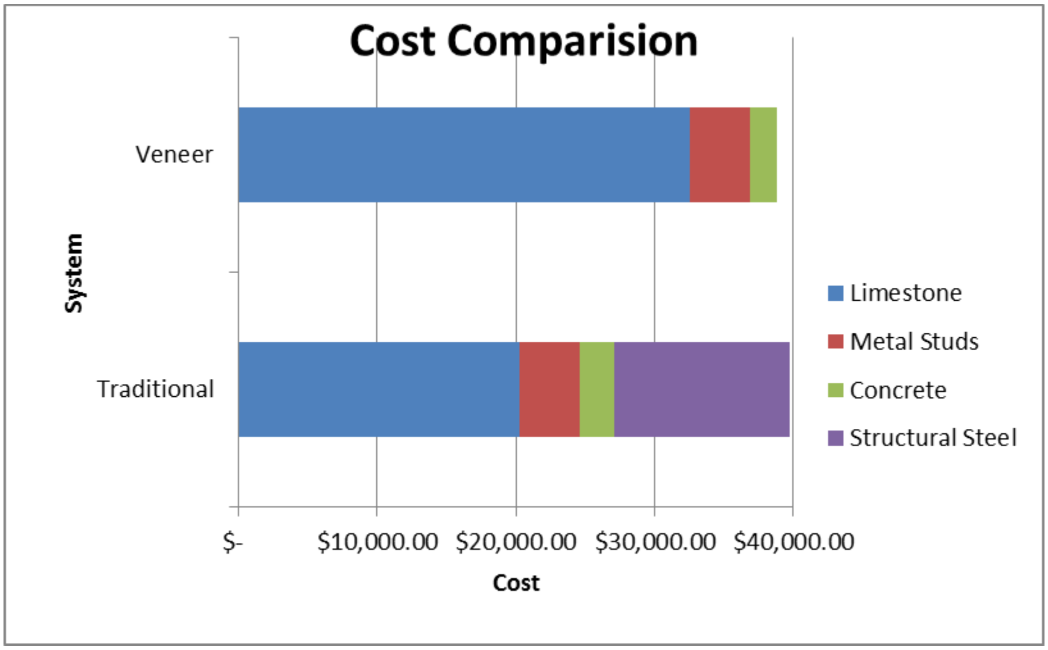
Although the mat slab seemed more than capable of carrying the heavier wall load, it was still necessary to check the design conditions and shear for a column footing. It was assumed that the mat slab could be divided at the halfway point between columns as a representative column footing. Analyzing the footing design yielded that the existing mat slab is capable of the proposed wall design. Detailed calculations for the structural loads can be found in Appendix L.

WALL SYSTEM SELECTION

To truly and fully understand which wall assembly is the most economical, it makes sense to compare the two from a cost standpoint for onsite construction. Both systems would receive construction schedule savings from offsite prefabrication, so this will not be analyzed until a system is chosen. In addition to the cost aspect, there are also other factors to consider, such as the productivity rates for installation, as well as weight of the modules; clearly the thicker limestone weighs significantly more, meaning that a larger crane may be needed, as well as increased difficulty in handling the heavier modules.

Table 25: Wall Assemblies Cost Comparison (Typical for One Bumpout)

Stone Panel Veneer System	
Item	**Total Cost**
1/4" Limestone and Aluminum Honeycomb Backing	$ 32,580.00
Metal Studs, Sheathing & Vapor Barrier	$ 4,317.51
LW Concrete & Composite Deck	$ 1,925.21
Total System	**$ 38,822.72**
Traditional Limestone System	
Item	**Total Cost**
3 5/8" Limestone Panels	$ 20,244.85
Metal Studs, Sheathing & Vapor Barrier	$ 4,317.51
Structral Steel	$ 12,678.61
LW Concrete & Composite Deck	$ 2,502.04
Total System	**$ 39,743.00**
Cost Difference	$ (920.29)



A combination of actual cost data supplied by Barton Malow was supplemented with RS Means cost data and supplier quotes for materials to come up with cost comparison in Table 25. Significant cost savings of over $12,000 were obtained on the limestone panels by switching from the Stonepanel veneer to a 3 5/8" traditional limestone panel. However, the structural system necessary to sustain the increased building loads also added costs. When comparing the two systems as a whole, the traditional limestone panel wall assembly would actually cost $920/bumpout more than the currently used system.

Besides the cost factors, there are several other variables that play into which wall system will be best for implementation of prefabrication. The 3 5/8" limestone panels weigh approximately 51.7psf, whereas the stone panel veneer weighs about 4.3psf. Even if the thicker limestone façade were prefabricated, a typical 16" x 32" panel would weigh over 180lbs, while the stone panel veneer weighs in at 15.3lbs. Clearly, it is much easier for the workers to handle a 15lb panel, while the 180lb may need to be hoisted into place. In addition, the stone panel veneer is caulked at the joints, while the traditional limestone would still need to be grouted; caulking is less labor intensive than grouting. Even is the construction is moved offsite, it is still ideal to choose the system that requires less manhours. The Stonepanel veneer system appears advantageous from both the cost and schedule angle. For these reasons, it was determined that the currently used Stonepanel veneer system is the ideal choice to design for prefabrication.

PREFABRICATED DESIGN

In approaching how to prefabricate the limestone façade, it was decided that it would be most advantageous to move as much construction offsite as possible. This would involve having the limestone façade connecting to the sheathing and metal studs as an all-in-one unit. This approach would be ideal for speed of installation, but also makes it very difficult to achieve a consistent vapor barrier, particularly at the joints between sheathing. Although the vapor barrier presents a challenge, moving more labor offsite will help reduce costs and jobsite congestion.

PREFABRICATION BENEFITS

It will also be beneficial to move the assembly of the limestone façade offsite to increase the productivity of the workers. During a project for the AE 570 Course: Production Management, the limestone façade installation was observed for inefficiencies and to come up with ways that productivity could be improved. During the research of the installation, it was determine that the inefficiencies of the limestone installation stemmed from the way the jobsite was laid out; as observed in the figure below, the limestone material for the entire job was located on the North side of Cross. This meant for the installation on the North side of Ewing, a forklift had to pick up the pallets of limestone panels and move them across the jobsite. Moving the construction offsite would help in allowing the limestone installation crew better lay out the jobsite to decrease muda (waste) created by handling material multiple times.

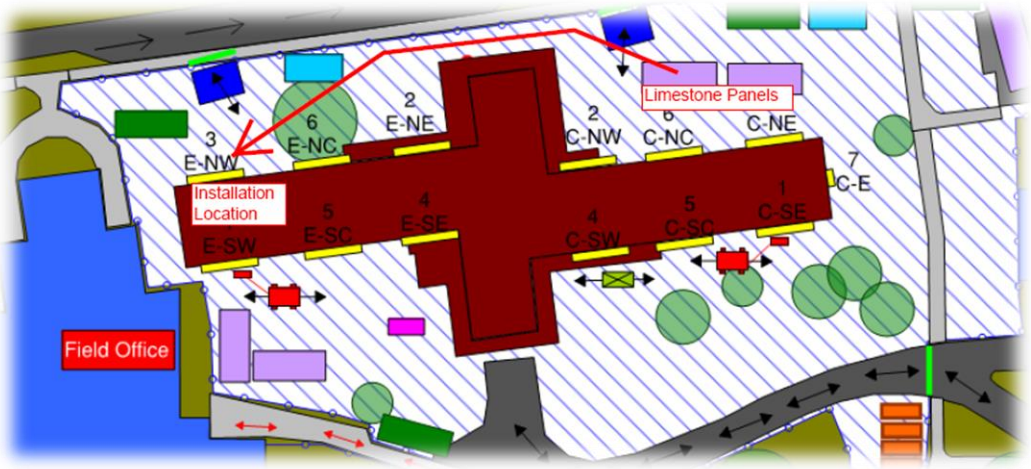


Figure 54: Site Logistics for Limestone Installation

Figure 55: Installation of Limestone Panels

Another issue that was observed during the installation of the panels was the amount of time it took the installers to travel up and down on the manlift. The installation of the limestone panels is actually fairly quick, but the lift takes well over a minute to travel up and down. By moving the construction offsite, the need to use a manlift is eliminated, because the modules can be built in 8 foot high increments. This will help to eliminate non-contributory time workers spend in traveling. In addition, the work will also become safer because the laborers are now working from ground level, as opposed to 20 – 30 feet in the air. The amount of time saved through offsite construction will be addressed in detail in the schedule section of this analysis.

CONNECTION TO EXISTING FAÇADE

The large bumpouts lend themselves fairly well to prefabrication because they will be installed where there is no existing façade. This means that the wall assembly can be lifted into place and then secured to the building structure from inside the building. The large bumpout assemblies will be connected in the same fashion as they were when they were built onsite.

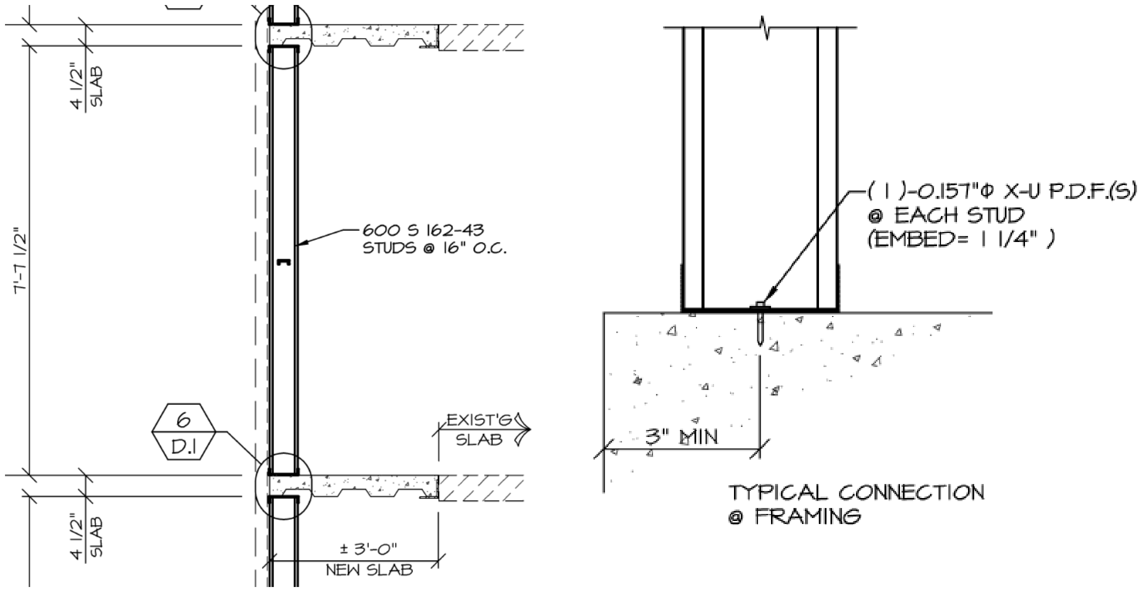


Figure 56: Large Bumpout Facade Connection Details | South Halls Shop Drawings

However, the small bumpouts present a challenge because they are to connect to the existing brick veneer. When the limestone façade was stick-built onsite at Haller – Lyons, the metal studs and sheathing were originally intended to be a prefabricated unit. However, it was difficult to make the connections between the metal studs and brick veneer, which resulted in tearing off portions of the sheathing to make the connections. For Ewing – Cross, the metal studs were installed first and secured directly to the brick, using Verti-Clips to allow for vertical deflection.

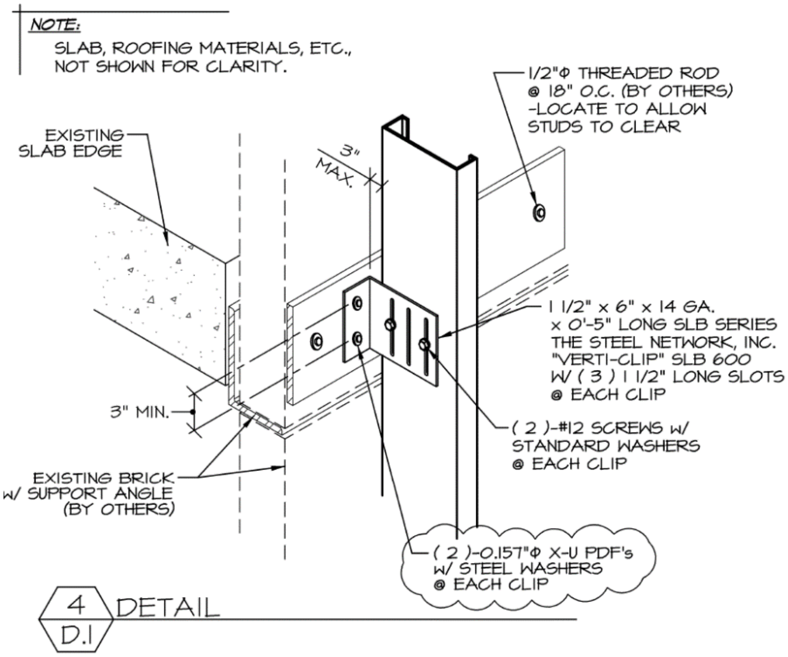


Figure 57: Verti-Clip Detail for Small Bumpouts | South Halls Shop Drawings

The prefabricated wall assemblies will need to factor in the previous challenges already encountered by the project team at South Halls. This will involve leaving portions of sheathing and limestone panels off so that the wall assemblies can be properly connected to the existing façade. This will also be necessary so that the weather barrier can be overlapped at the point where wall panels meet. One row of limestone panels will be left off at floor slab height of each level to allow for weather barrier and flashing to overlap, as well as to allow for the wall assemblies to be connected to the building.

It is important to ensure the wall assembly has enough room to move vertically so that there are no vertical forces transferred into the framing. Figure 57 shows how the metal walls panels are currently connected to the brick veneer. The Verti-Clip system will work well with prefabrication, there will just need to be proper planning to ensure that the top and bottom tracks meet at the correct building elevation.

The connection detail was modeled in CAD, and the full drawings can be found in Appendix M. As can be seen in Figure 58 below, a 16” section of sheathing and stone panels would need to be left off to connect the wall panels to the building. The Verti-Clip system would connect the metal stud walls to the steel plate just below the top track; the top track would be level with the top of each respective slab. Figure 59 below shows how horizontal movement will be dealt with; connecting the walls track to track will make the wall assemblies act as one continuous system. Since the 1/2” diameter rods @ 18” o.c. were already found to sufficiently transfer the wall load to the slab, these were reused for the new design. Once the wall panels are hung, the weather barrier and flashing of the above panel would be lapped over the weather barrier/flashing of the panel below. Placing the intermediate sheathing and row of stone panels would tie the entire system together.

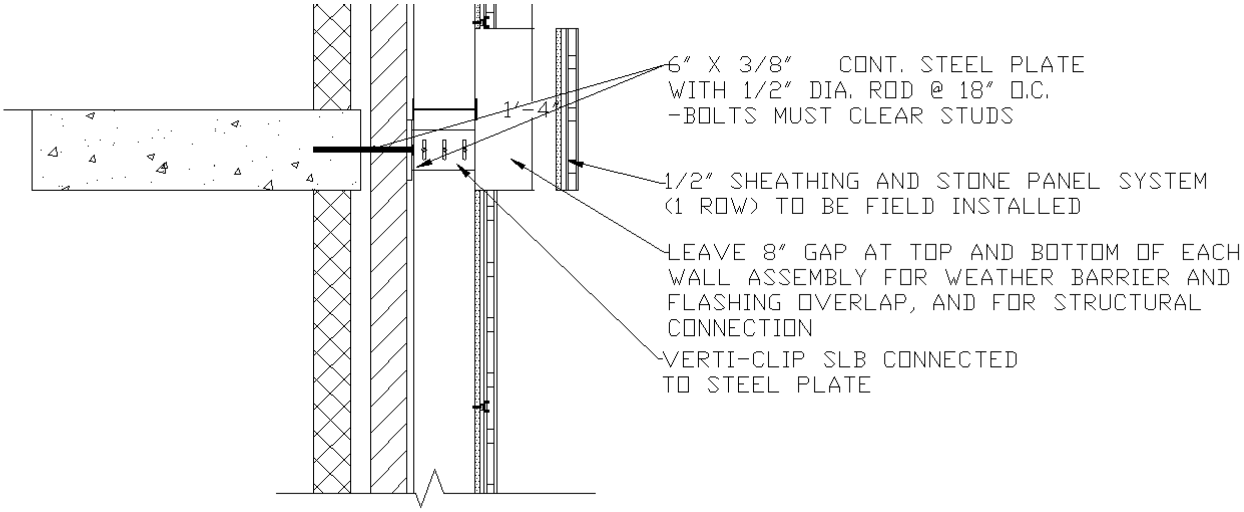


Figure 58: Prefabricated Wall Assembly Connection Detail | Quaid Spearing

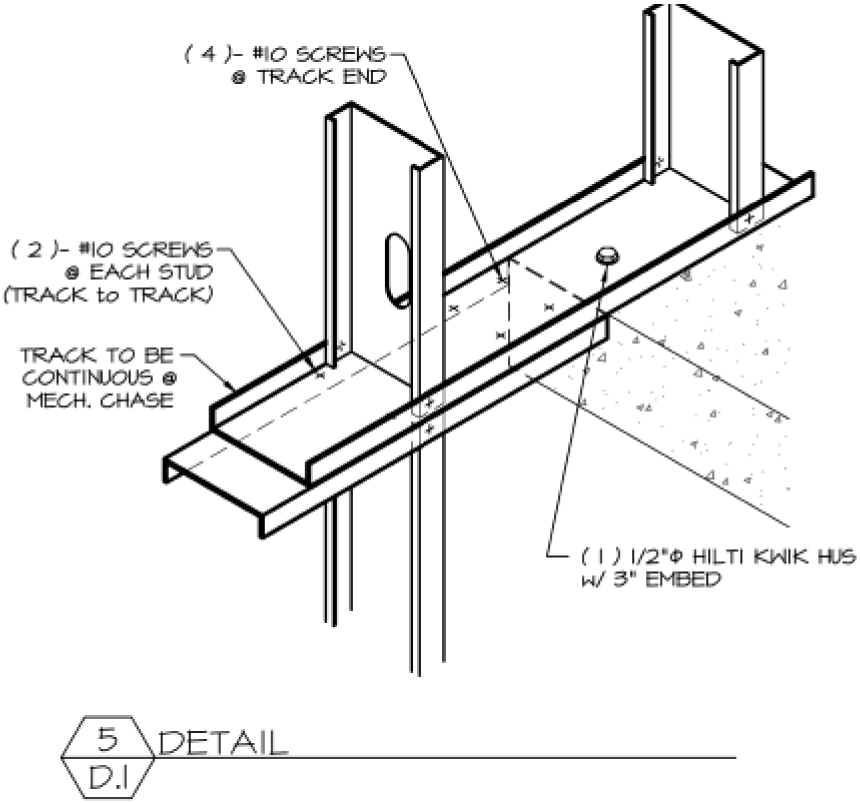


Figure 59: Track Connection Detail | South Halls Shop Drawings

MODULE LAYOUT

The layout of the modules can be seen in Figure 60. In total there are 10 different module patterns. The modules were based on floor height for two reasons: to allow for workers to safely fabricate the modules from ground level, and because the floor to floor height of 8 feet creates a good break in the limestone façade, with each panel at 16" (8 feet = 6 courses of limestone). The module layout was based on the existing design for the metal stud wall panels.

Figure 60: Module Types

The small end bumpouts will not be prefabricated because they are only 1-2 panels wide and mostly glazing; they do not take full advantage of maximizing the amount of construction moved offsite. It was decided that the modules would be the full width of the bumpout, since the stone panels are installed in a running bond; it would be difficult to break the modules into smaller assemblies and still achieve the desired aesthetics.

In each projection, there is a row of panels left out between modules. As stated earlier, this is to allow for the small bumpouts to be structurally connected to the brick veneer, and also to allow the weather barrier and flashing to lapped on all bumpouts. The connection details and sequencing will be discussed in detail in the Logistics section.

Table 26: Summary of Limestone Modules

Limestone Modules						
Area	Number of Locations/Building	Types of Module/Bumpout	Total Number Modules/Bumpout	Modules /Building	Average Length of Module	Average Height of Module
Small Projection	8	3	5	40	21 ft	8 ft
Large Projection Bathroom	2	5	9	18	7 ft	8 ft
Large Projection Student Room	2	3	5	10	25 ft	8 ft

PREFABRICATION PROCESS

The cost of the material would remain the same, regardless of where the limestone walls are assembled. For this reason, the cost analysis of prefabrication will focus on the savings achievable through increased labor productivity and also the added costs associated with warehouse rental and module transportation.

LABOR

Labor makes up approximately 50% of the building cost for a typical construction project. Any opportunity to reduce the cost of labor can quickly generate overall project savings. Prefabrication introduces two main ways that savings in labor can be achieved: increased productivity and reduction of labor rates. In AE 570, productivity was defined as the output divided by the input; in the case of construction, the output is a building or assemblies, and the input is manhours. This increased productivity can be translated to a percentage of construction schedule reduction, which directly translates to manhour savings. According to a report by McGraw Hill *Prefabrication and Modularization: Increasing Productivity in the Construction Industry*, two-thirds of the firms surveyed reported a reduced project schedule through the use of prefabrication/modularization, with 35% of those two-thirds seeing savings of four weeks or more. The survey also states that 65% of firms surveyed experienced labor savings between 5 and 20%. It would be safe to assume that the productivity of the offsite labor would be improved by 15% because the travel time on the hydraulic scaffolding will be eliminated by all work occurring on the ground and the time spent handling materials will be reduced.

The labor associated with the limestone walls can be divided into two main categories: offsite labor and the labor needed to place the panels and install the final row(s) of limestone. As previously stated, the installation of the limestone was studied in detail in AE 570; the productivity rates observed during that time will be used for this analysis.

OFFSITE CONSTRUCTION

The original duration, per bumpout, saw the metal wall panels, sheathing, and weather barrier taking five days for installation. The metal wall panels come already prefabricated from FrameCo Inc., so there will be very little offsite fabrication time associated with the metal wall panels. Figure 61 shows how the small bumpout metal wall panels are divided; offsite fabrication at the warehouse will involve connecting the two panels, for each level, to form the longer 20’ – 8” length panels.

Productivity Rates for the prefabricated wall assembly were calculated using field observations and RS means. Using these rates, plus factoring in the increased productivity for offsite fabrication, the cost and time to assemble the wall panels can be found.

The original installation of limestone panels took five workers: two workers installing panels from the scaffolding, and three material handlers. It is believed that by moving the construction offsite and making it so that all work is completed at ground level, these workers can be better utilized. Three material handlers were necessary because the location of the panels was not directly near the installation location. In a factory setting, material can be better laid out to improve the flow of work. Seeing as the limestone panels are the longest duration in the wall assembly, it would make sense to better utilize this five man crew by creating 2 pairs of limestone installers, and one material handler. This would effectively double the daily output of the limestone installers.

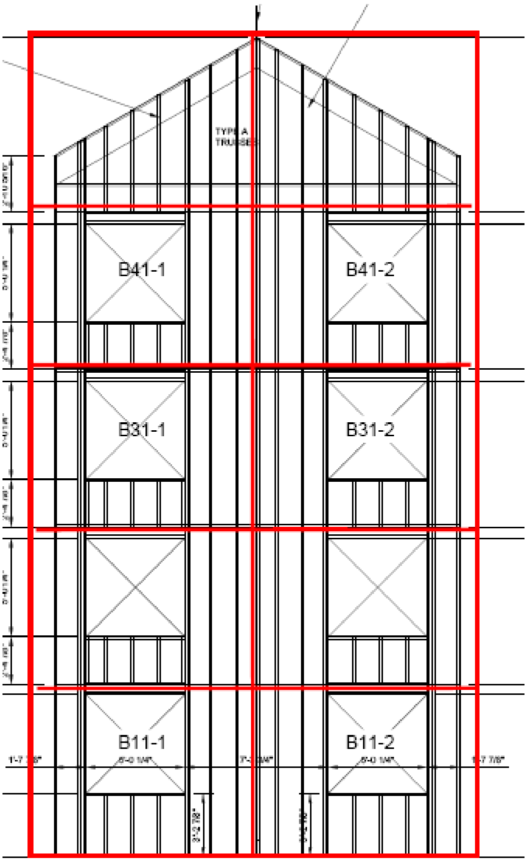


Figure 61: Metal Wall Panels

Table 27: Production Rates of Laborers

Original Productivity Rates			
Item	**Crew**	**Daily Output**	**Labor Hours**
Sheathing	2 Carp	1050	0.015
Vapor Barrier	1 Carp	4000	0
Limestone Veneer	2 Carp	180	0.09
Windows	2 Carp	2	8.00

Table 28: Production Rates of Offsite Labor

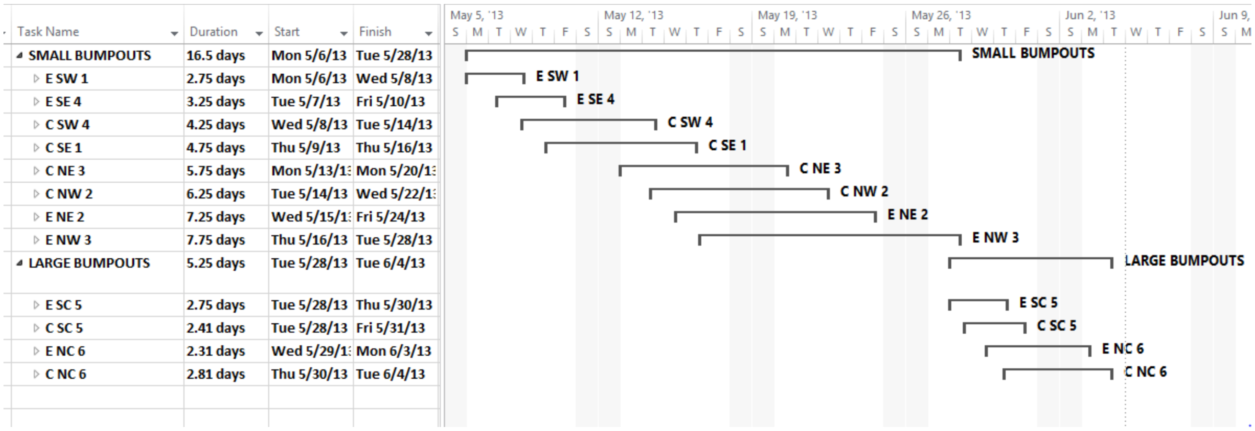
Offsite Productivity Rates			
Item	**Crew**	**Daily Output**	**Labor Hours**
Sheathing	2 Carp	1200	0.013
Vapor Barrier	1 Carp	4600	0
Limestone Veneer	2 Carp	210	0.08
Windows	2 Carp	2	8.00

The 400 SF/Day for limestone veneer installation includes caulking the joints between the limestone panels. After factoring out the limestone and sheathing that will need to be installed in the field, the total square footage of wall panels that will be assembled offsite is summarized in the table below. The prefabrication process will effectively move 84% of the limestone enclosure construction offsite.

Table 29: Summary of Offsite and Onsite Wall Assembly Work

	Material to be Installed in the Field		Material Installed at Warehouse	
Small Bumpout Modules				
Type	Area/Bumpout SF	Area/Building SF	Area/Bumpout SF	Area/Building SF
A	27.5	219.9	167.5	1340.1
B	27.5	659.8	148.5	3564.2
C	27.5	219.9	162.5	1300.1
Large Bumpout Module Bathrooms				
D	13.5	27.1	76.1	152.1
E	13.5	27.1	76.1	152.1
F	13.5	81.2	67.9	407.2
G	13.5	81.2	67.9	407.2
H	33.8	67.6	196.2	392.4
Large Bumpout Module Student Rooms				
I	39.9	79.8	224.1	448.2
J	39.9	239.4	200.1	1200.6
H	39.9	79.8	196.2	392.4
Totals	290.1	1782.8	1583.0	9756.6

With productiviy rates and quanities known, the durations for offsite construction were calculated. Below is a summary of the offsite construction; the work was divided between large and small bumpouts. The total offsite construciton will take about 22 days. The full schedule for offsite construction can be found in Appendix N.



Task Name	Duration	Start	Finish
SMALL BUMPOUTS	16.5 days	Mon 5/6/13	Tue 5/28/13
E SW 1	2.75 days	Mon 5/6/13	Wed 5/8/13
E SE 4	3.25 days	Tue 5/7/13	Fri 5/10/13
C SW 4	4.25 days	Wed 5/8/13	Tue 5/14/13
C SE 1	4.75 days	Thu 5/9/13	Thu 5/16/13
C NE 3	5.75 days	Mon 5/13/1:	Mon 5/20/1:
C NW 2	6.25 days	Tue 5/14/13	Wed 5/22/1:
E NE 2	7.25 days	Wed 5/15/1:	Fri 5/24/13
E NW 3	7.75 days	Thu 5/16/13	Tue 5/28/13
LARGE BUMPOUTS	5.25 days	Tue 5/28/13	Tue 6/4/13
E SC 5	2.75 days	Tue 5/28/13	Thu 5/30/13
C SC 5	2.41 days	Tue 5/28/13	Fri 5/31/13
E NC 6	2.31 days	Wed 5/29/1:	Mon 6/3/13
C NC 6	2.81 days	Thu 5/30/13	Tue 6/4/13

Figure 62: Schedule summary for offsite construction

Table 30: Offsite Construction Wage Rates

Offsite Labor				
Sources	Description	Hourly Rate	Fringe Benefits	Total
PA Wage Rates	Carpenter	$ 25.85	$ 10.61	$ 36.46

The Prevailing Wage Rates for the offsite construction were taken from www.portal.state.pa.us for the South Halls Renovation. It was assumed that carpenter rates would be used for the sheathing, weather barrier, and also the limestone panels, since they are not actually grouted. For a typical sequence, taking seven days with ten workers, labor would cost approximately $6,200.

Table 31: Summary of Offsite Labor Costs

Offsite Labor Costs					
Activity	Crew	Labor/Hour	Crew $/Day	Total Duration	Total Labor
Sheathing/Weather Barrier	2 Carp	$ 36.46	$ 583.36	22	$ 12,833.92
Limestone Installation	5 Carp	$ 36.46	$ 1,458.40	22	$ 32,084.80
Total					**$ 44,918.72**

WAREHOUSE

Moving the construction of the limestone façade away from the jobsite requires having a predetermined location for the fabrication to take place. Finding a suitable factory location involves analyzing several variables, which include: distance from the jobsite, minimum size requirements of the factory, and rental fees. The minimum factory size is based upon the amount of square footage needed for laydown area for materials, area for assembling the walls, and storage for the finished modules. It would be ideal to have enough area to store all the modules for one building. Based on the pallet sizes that modules will be shipped on, the total storage area for modules needs to be at least 2200sf. In addition, it would be ideal to have that amount for assembly and at least another 2000sf for material laydown. In total the ideal factory size would be in the 6000 -7000sf range.

Considering all of the above factors, the warehouse shown in Figure 63 was chosen as a suitable site for the wall module fabrication. This warehouse was found listed on www.showcase.com; the space is 6,000SF and a rental price of $3,500/month ($42,021/year). It is located just outside of Altoona, PA right off of I-99 which is a straight shot back to State College and approximately 50 miles from the South Halls jobsite.

Although the monthly rent for the warehouse is reasonably low, the rental costs can significantly add up when considering its use for the entire renovation of all four dormitories. Haller – Lyons, the first renovation, began work in May of 2013. Currently, the final building, Hibbs – Stephens, is scheduled for stone panel installation to finish in September, 2014. This equates to a total of 17 months needed for the entire project, which would cost approximately $59,500 in rental fees for the entire South Halls project.

Figure 63: Warehouse selected for offsite construction

Table 32: Summary of Warehouse Costs

Warehouse Lease			
Area SF	Cost/Month	Rental Time (mos)	Total Cost
6,900	$3,500.00	17	**$59,500**

TRANSPORTATION

Based on the size of the modules and the transportation limitations for a delivery truck, the number of modules per delivery can be calculated. Assuming a 53 foot flatbed with an 8 foot width, the following module transportation layout was developed. Modules built offsite would be constructed on pallets so that they could then be directly forklifted onto the back of a delivery truck. In total there are 69 modules per building. The following delivery schedule was devised based on the dimensions of each wall assembly.

Table 33: Limestone Wall Assembly Delivery Sequence

Panel Delivery Schedule		
Truck No.	Number of Panels	Bumpout(s)
1	10	E1, E4
2	10	C1, C4
3	10	C2, C3
4	11	E2, E3
5	10	E5
6	10	C5
7	4	C6
8	4	E6

In total, 8 deliveries are needed; the typical delivery truck plan and bumpout sequencing can be seen in Appendix O. To find the cost for shipping from the warehouse to the South Halls jobsite, the website www.freightquote.com was used. Freight Quote calculates shipping fees based on the estimated size of pallets and the zip codes for the To and From locations. Using an average pallet size of 8’ x 4’, the estimated cost per truck came to approximately $350, which extrapolates to $2,800 for the entire building.

A crane will be needed to get the modules onto the back of the flatbed trucks for delivery. RS Means was used to price the cost for loading the modules. Assuming that one bumpout can be installed per day, the crane will need to be rented for at least twelve days. Because the Ewing – Cross site has limited laydown area, the modules will be delivered on a just-in-time basis. The total cost for a 3 ton truck crane and crew to load the wall modules will be approximately $4,950.

In addition to the cost of truck deliveries, there is also an additional cost associated with the pallets needed to ship the units. Building the wall modules on pallets is the most economical solution because this allows for the use of a pallet truck to load the modules onto the delivery truck as well as move the modules around the factory. Since most of the modules are larger than the standard pallet size of 40” x

48”, custom pallets will need to be made or ordered. A quick online search found Uline, a company that makes custom sized pallets. Uline makes a 48” x 96” pallets, which will be ideal for the bumpouts that are the 7’ x 4’ L shape. These same pallets can be strung together to support the 20 -25 foot wall assemblies; the walls can be built on 3 consecutive pallets and strapped down to the pallet so that they can be lifted with a crane onto the back of the flat bed delivery truck. In addition to the cost of the pallets, there is also the cost for pallet trucks to move the modules around and onto the truck. Two pallet trucks would be used in tandem to move the larger modules around. The pallet trucks were chosen because the modules are relatively lightweight, and a pallet truck is significantly cheaper than a forklift. The total cost for the pallets and pallet trucks came out to $8,100. These pallets are enough to take care of all of the limestone modules for Ewing – Cross, and would be reused for the other three dormitory renovations to help cut down on costs.

Table 34: Summary of pallet costs

Pallets Needed		
Size	**Quantity**	**Total Cost**
48" x 96"	172	$ 7,224.00
Pallet Truck	3	$ 897.00
Total Cost	-	$ 8,121.00

ONSITE INSTALLATION

The original sequencing for the installation of the prefabricated wall panels had to be sequenced around the other construction activities that were occurring. Sequence 6 bumpouts are used as access points for brining material into the building. The Sequence 5 bumpouts are at the location where the restroom slabs are replaced. To work around the other activities onsite, the sequencing for bumpout installation for both buildings was originally:

1 → 4 → 2 → 3 → 5 → 6

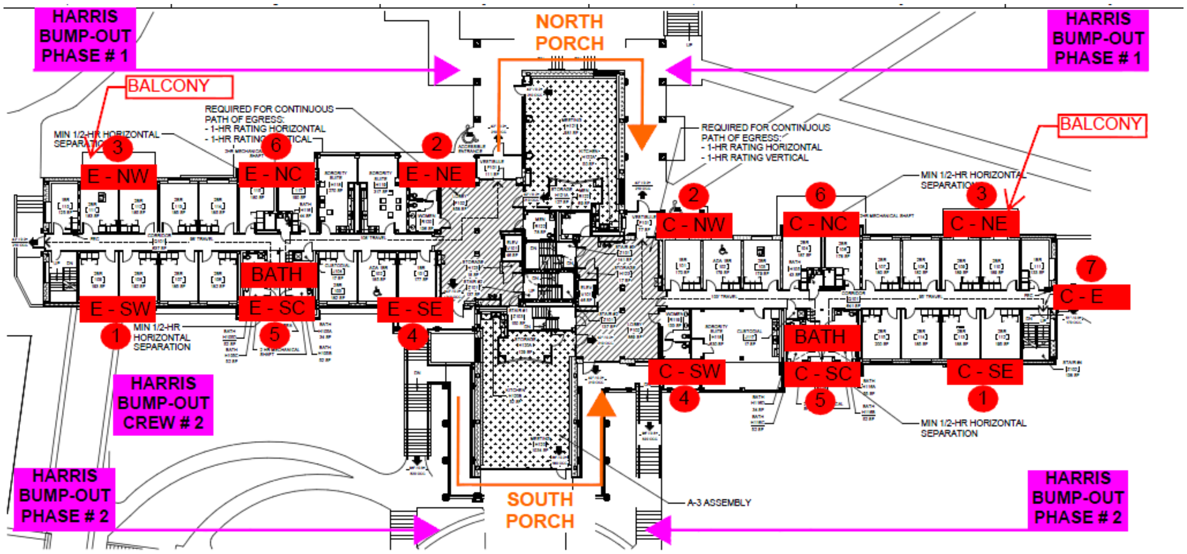


Figure 64: Original bumpout sequence

This would essentially phase the bumpout installation by small and large bumpouts. You can see in the figure above that both Ewing and Cross bumpouts were installed simultaneously by two crews. Bumpouts 5 and 6 on both wings will be installed last; a better workflow can be achieved by installing all of the small bumpouts, and then installing the large bumpouts. The new sequence will be:

E1 → E4 → C4 → C1 → C3 → C2 → E2 → E3 →E5 → C5 → C6 → E6

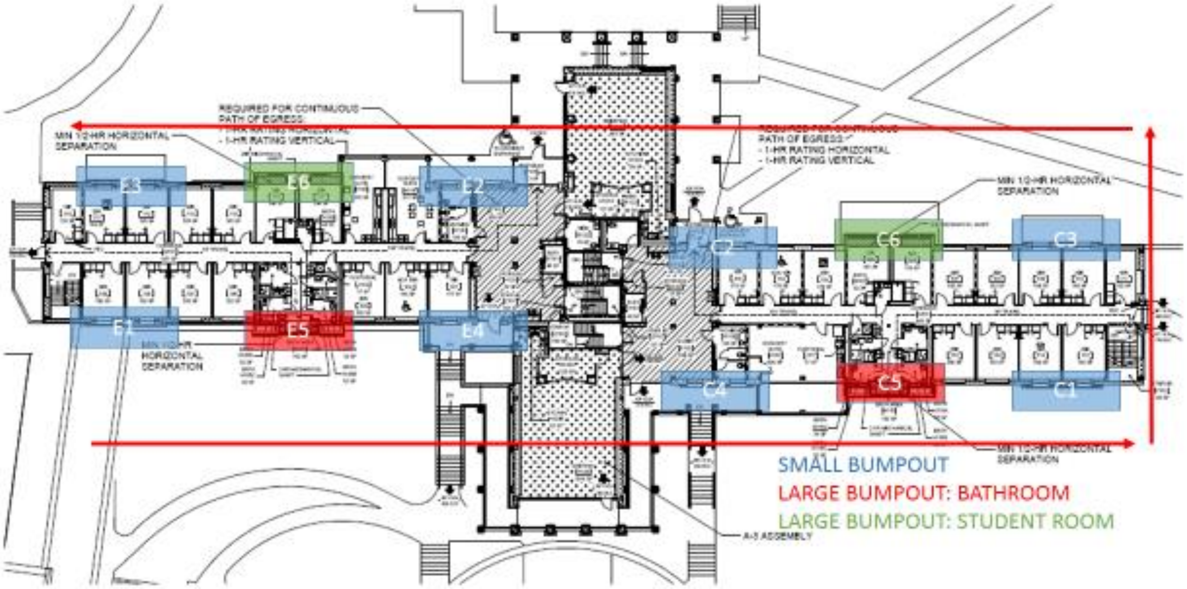
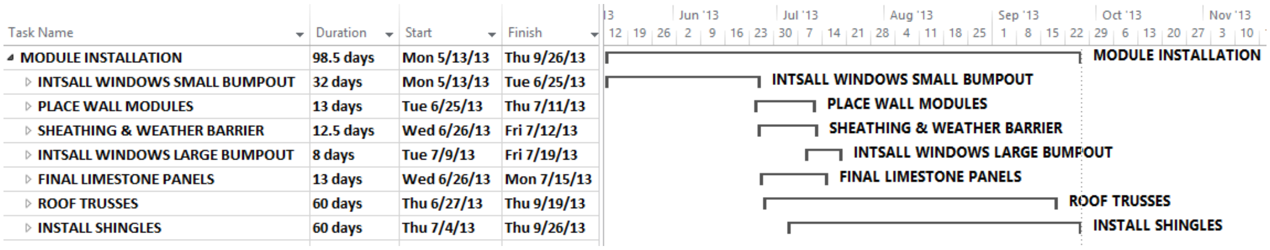


Figure 65: New proposed bumpout sequence

As previously stated, there will also need to be onsite work to make the module connections and put the final sheathing and limestone on. To understand the costs associated with installing the wall modules, the sequencing and schedule for the onsite installation needs to be calculated. RS Means productivity rates for installation of precast wall panels were assumed to be equivalent for installing the limestone panel modules. At 1024SF/Day, it was assumed one bumpout can be completed per day.

Before the small bumpouts can be installed, the windows need to be in place. While the modules are being prefabricated offsite, the windows will be installed in all of the small bumpouts. A summary of the new enclosure schedule can be seen below. The window installation will finish in time for the small bumpout modules to show up on site. While these are being installed, the bathroom slabs will be finishing; once the slabs have finished curing and shoring is removed, the wall modules will be installed on E5 and C5, and then C6 and E6 will be installed. The rest of the onsite enclosure activities will remain the same, but can now occur earlier, since the prefabricated limestone modules will be installed sooner.



Task Name	Duration	Start	Finish
MODULE INSTALLATION	98.5 days	Mon 5/13/13	Thu 9/26/13
INTSALL WINDOWS SMALL BUMPOUT	32 days	Mon 5/13/13	Tue 6/25/13
PLACE WALL MODULES	13 days	Tue 6/25/13	Thu 7/11/13
SHEATHING & WEATHER BARRIER	12.5 days	Wed 6/26/13	Fri 7/12/13
INTSALL WINDOWS LARGE BUMPOUT	8 days	Tue 7/9/13	Fri 7/19/13
FINAL LIMESTONE PANELS	13 days	Wed 6/26/13	Mon 7/15/13
ROOF TRUSSES	60 days	Thu 6/27/13	Thu 9/19/13
INSTALL SHINGLES	60 days	Thu 7/4/13	Thu 9/26/13

Figure 66: Onsite Schedule for Enclosure

Once the modules arrive on site, they will be lifted into place using a truck mounted crane. A 12-ton truck-mounted crane was assumed for the installation of the modules. For a 12 day period, the installation of the modules will cost approximately $15,300. This includes the rental fees for the crane and crane operator. This will be additional to any other crane costs associated with the building enclosure because no cranes were previously used for bumpouts.

After all of the modules have been installed for a wall, the final sheathing and weather barrier tie-ins can be made. During the prefabrication process, excess building wrap will be installed at the top and bottom of each module; this will allow for them to overlap and create a consistent barrier. Using the onsite installation productivity rates, it was estimated that making the final weather barrier tie-ins and sheathing will take 4 hours per bumpout.

Following the sheathing installation at the gaps between the modules, the final row of limestone between each module will be installed. Again, utilizing the stick-built production numbers, this work is estimated to take about 1 day per bumpout.

Once the final limestone panels have been installed onsite, the rest of the onsite enclosure activities can be completed. This will include installing the roof trusses for the bumpouts and installing the shingles. Both of these activities take 5 days per bumpout.

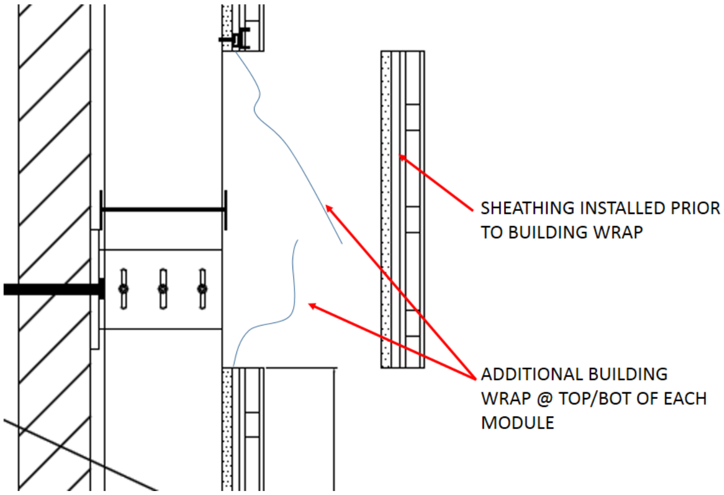


Figure 67: Weather Barrier Detail | Quaid Spearing

CONSTRUCTABILITY CONCERNS

Besides the concerns already addressed, there are several other constructability concerns that come with implementing prefabrication. For starters, there will need to be an increase in coordination among the subcontractors involved in the prefabrication process.

There were problems with the limestone panels arriving on time for the scheduled installations; this resulted in delays of the building enclosure being completed. If there were to be delays of limestone panels to the offsite warehouse, there could be a significant impact on the overall schedule. With the entire prefabrication process planned on Short Interval Production Schedule, any delays at any point in the assembly could halt the whole process. This would result in a delay of the just-in-time delivery of the modules to the jobsite. Delays in the installation would obviously result in idle workers, and increased labor and equipment rental costs.

Another concern has to deal with which subcontractor would own the wall modules. With stick-built construction, there is usually a clear cut line as to when liability of damage is transferred to another subcontractor. It will need to be defined who is responsible for the wall modules, if there were to be any damage during transportation and installation. This can become hazy because there are multiple contractors involved in assembling the modules, and it is likely that no particular subcontractor will want bear the burden of liability. The fragility of the limestone veneer is of particular concern, and could prove troublesome during transportation if proper care is not taken.

SCHEDULE ANALYSIS

Although previous technical reports were based on the original project schedule, the new sequencing plan will follow the updated final schedule; the updated schedule has an improved sequencing of activities, with the actual durations for activities surrounding the façade installation. The original schedule for the bathroom slab replacement saw the final slabs being finished on 08/27 for Ewing and 08/01 for Cross, while the actual slab replacement was completed on 07/05 for Ewing and 07/02 for Cross. It is much easier to create a linear sequence for the façade installation based on the actual schedule.

Table 35: Building Enclosure Schedule Summary

Schedule Summary				
Location	**Activity**	**Total Working Days**	**New Working Days**	**Difference**
Ewing	Erect Wall Panels	33	6	27
	Install Windows	22	22	0
	Install Roof Truss	30	30	0
	Install Stone Panels	30	6	24
	Install Shingles	30	30	0
	Sequence 7	10	10	0
	Final Sheathing/Weather Barrier	0	6	6
Cross	Erect Wall Panels	36	6	30
	Install Windows	22	22	0
	Install Roof Truss	30	30	0
	Install Stone Panels	30	6	24
	Install Shingles	30	30	0
	Sequence 7	12	12	0
	Final Sheathing/Weather Barrier	0	6	6
Other	Gutter & Downspout	10	10	0
	Total	135	109	**26**

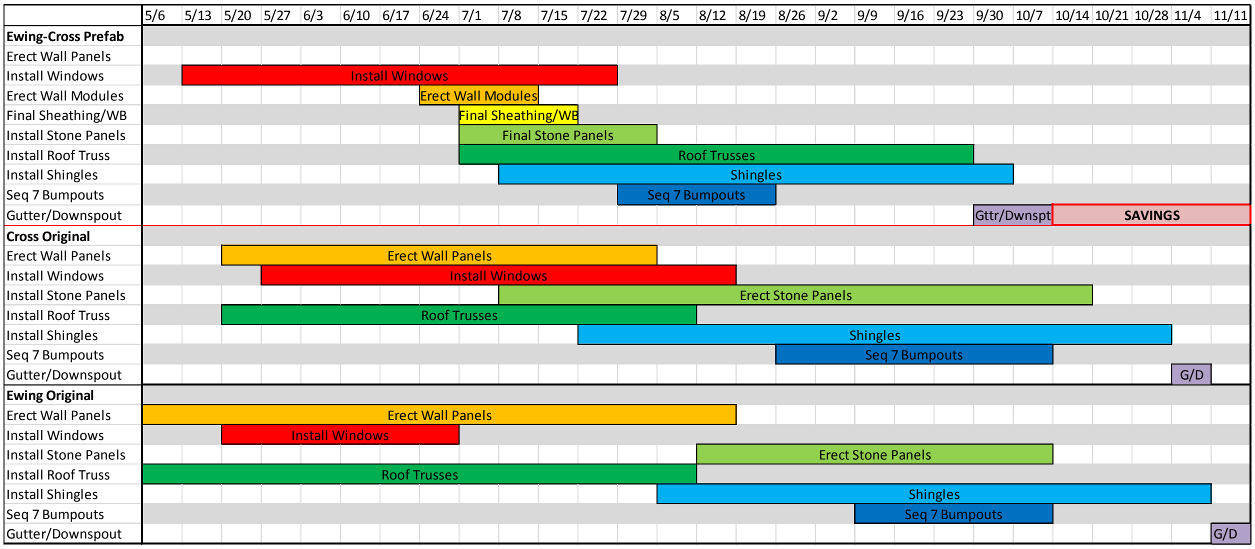


Figure 68: Schedule Savings Summary; full size in Appendix N

The new schedule was based on the actual durations for the other onsite activities that directly correlate to the façade installation. Based on the new sequence, the total enclosure will take approximately 109 days; originally, the enclosure took 135 days to complete. While 26 days is a significant savings, it is important to note that the new sequencing assumed a single linear work flow; the original schedule had the bumpouts for Ewing and Cross working simultaneously. Nearly every enclosure activity was simultaneously performed on both Ewing and Cross to deliver the project within the seven month timeframe. The new sequencing for the prefabricated walls has effectively cut the onsite labor needed for the enclosure in half. While it would be feasible to still utilize multiple crews for simultaneous installation for the two wings, further reducing the schedule would not be beneficial because the overall project schedule would not be reduced further.

Although the enclosure schedule is reduced significantly, there are several other independent activities that continue past the enclosure, such as the interior fit out of student rooms. The real benefits of prefabricating the limestone façade are not realized in reducing the overall schedule, but in simplifying the sequencing of the construction and reducing the needed onsite labor.

COST ANALYSIS

While the prefabrication does not necessarily reduce the project schedule, there is still a potential to achieve cost savings. However, there are also several additional costs added due to prefabrication, including: warehouse rental fees, transportation, and additional crane usage. The benefits include increased productivity of offsite labor, resulting in fewer labor hours, and reduced onsite labor for the enclosure installation.

It is first important to determine the manhours needed for both the original install and the prefabricated wall assemblies. The activities that need to be analyzed are the metal wall panels, sheathing and weather barrier, and the limestone panels. Other enclosure activities, such as the roof trusses, shingles, and windows did not change and therefore will not be considered for cost savings. The pricing for the façade installation was based upon the scheduled durations for both the original and the prefabricated wall installation.

Table 36: Cost comparison summary

	Installation Costs	
Area	**Activity**	**Cost**
Ewing Original	Wall Panel/Sheathing/Weather Barrier	$ 22,626.00
	Limestone Panels	$ 65,127.00
Cross Original	Wall Panel/Sheathing/Weather Barrier	$ 24,375.00
	Limestone Panels	$ 65,127.00
Ewing New	Prefab Wall Assemblies	$ 4,175.00
	Sheathing/Weather Barrier	$ 3,500.00
	Final Limestone Panels	$ 16,625.00
Ewing New	Prefab Wall Assemblies	$ 4,175.00
	Sheathing/Weather Barrier	$ 3,500.00
	Final Limestone Panels	$ 16,625.00

Using a combination of RS Means cost data and the prevailing wage rates for the South Halls job, the following table was developed, comparing the cost of the original install to the prefabricated route. Overall, the prefabrication process would add about $6,400 to the enclosure costs for Ewing – Cross. However, Ewing – Cross cannot be considered only on its own, as there are three other renovations.

Furthermore, the rental of the warehouse was considered for the entirety of the project, so this cost will not be carried over to the other three renovations. Also, the plan is to reuse the pallets for all four buildings, so this will save additional costs.

Table 37: Cost Estimate Summary for Prefabricated Wall Assemblies

Prefabrication Costs for Ewing - Cross		
Item	**Activity**	**Cost**
Stick Built		
	Labor/Equipment for Metal Wall Panels/Sheathing/Weather Barrier	$ 177,255.00
Prefab System		
Prefabrication		
	17 Lease for 6,900SF Warehouse	$ 59,000.00
	Labor for Sheathing/Weather Barrier & Limestone Panels	$ 44,920.00
Transportation		
	172 48"x96" Pallets and 3 Pallet Trucks	$ 8,120.00
	(8) Truck Deliveries from Warehouse to Jobsite	$ 2,800.00
	3 Ton Crane to Load Modules at Warehouse	$ 4,950.00
Onsite Installation		
	Onsite Labor/Equipment to Install Modules and Install Final Façade	$ 48,600.00
	12 Ton Crane to Install Wall Modules	$ 15,300.00
Total		$ (6,435.00)

Extrapolating the above costs to consider all four renovations, the cost associated with prefabrication was found to be $533,400; this cost only looks at the labor and equipment of the prefabrication, because the material will cost the same, regardless of where it is assembled. A $175,000 savings in labor and equipment rental is possible across the entire South Halls job.

Table 38: Cost Savings of Prefabricated Wall Assemblies for all Four Buildings

Prefabrication Costs for all Four Renovations		
Item	**Activity**	**Cost**
Stick Built		
	Labor/Equipment for Metal Wall Panels/Sheathing/Weather Barrier	$ 709,020.00
Prefab System		
Prefabrication		
	17 Lease for 6,900SF Warehouse	$ 59,000.00
	Labor for Sheathing/Weather Barrier & Limestone Panels	$ 179,680.00
Transportation		
	172 48"x96" Pallets and 3 Pallet Trucks	$ 8,120.00
	(8) Truck Deliveries from Warehouse to Jobsite	$ 11,200.00
	3 Ton Crane to Load Modules at Warehouse	$ 19,800.00
Onsite Installation		
	Onsite Labor/Equipment to Install Modules and Install Final Façade	$ 194,400.00
	12 Ton Crane to Install Wall Modules	$ 61,200.00
Total		$ 175,620.00

These significant savings are mainly attributed to the setup of the prefabrication process. Moving the construction offsite allows the workers to build the walls more efficiently at ground level. Breaking each bumpout into smaller modules created a sort of Short Interval Production Schedule for the offsite fabrication. Rather than having the activities have durations of days, breaking the sequences down into hours eliminated a lot of waste in waiting. The limestone installers are able to start placing panels a lot quicker, because they are only waiting for a module to have sheathing and be wrapped, not the entire bumpout.

CONCLUSION AND RECOMMENDATIONS

Similar to Analysis 1, the benefits of moving the construction offsite are only achieved by considering the entire South Halls Renovation, and not just Ewing – Cross. While the overall project schedule cannot be reduced through prefabrication, reducing the enclosure schedule by 36 days is still beneficial; this will help to reduce onsite congestion and provide more time and room for the other exterior site activities that need to occur. Realistically, it is difficult to reduce the overall project schedule by any more than it already has been; Haller – Lyons had taken twelve months, and for Ewing – Cross, this was reduced to seven months.

The sequencing of the enclosure was made more linear thanks to prefabrication, resulting in a reduction of onsite labor. Reducing onsite congestion is of particular importance because there were several delays in the original enclosure schedule due to other site activities. The reduction in labor and equipment rental would result in an overall savings of $175,000. In addition to the cost savings, the jobsite will also become safer, because there is a significant reduction in the amount of work being performed from atop scissor lifts. For all of these reasons, it is recommended that the prefabrication of the limestone façade be implemented.

ANALYSIS 4 – RESEQUENCING OF RENOVATION PHASES

PROBLEM IDENTIFICATION

The current phasing of the South Halls project sees the first renovation, Haller-Lyons, taking twelve months to complete, with the remaining three buildings taking seven months each to complete. This puts the total construction duration at approximately 33 months, from May 2012 to January 2015. Each of the renovated dormitories will house approximately 248 students. As such, the sooner that Penn State can have each dormitory back online, the more revenue they stand to generate. Having the project completed even one semester quicker would allow them to start their payback period that much sooner.

ANALYSIS GOALS

The goal of this analysis is to identify any possibilities to renovate multiple buildings at the same time, in an effort to reduce the overall project schedule. There will be a focus on determining if the owner, Penn State, has the capacity to have multiple buildings unoccupied, and the implications that multiple renovations would have on the construction manager. The General Conditions for the project will be analyzed to determine if decreasing the overall project schedule will save or add to the project cost. Along with the general conditions, the potential revenue of having the South Halls project finish early will also be examined. At a minimum, the analysis will seek to reduce the schedule by one full semester, or seven months. It is believed that it will be feasible to implement renovating multiple buildings at once in order to shorten the total project schedule. Doing so will require increasing the project management staff and their fees, but should be offset by the owner being able to generate revenue one semester sooner, ultimately saving Penn State money.

BACKGROUND RESEARCH

This analysis will focus on the phasing of the South Halls renovation to determine how multiple buildings could be renovated at once to accelerate the schedule and turn the project over to Penn State quicker. The goal will be to renovating two buildings at the same time, allowing the project to finish seven months ahead of schedule, or a semester earlier. Renovating the final two buildings simultaneously is initially thought to be ideal because there is an inherent learning curve from having already renovated Haller – Lyons and Ewing – Cross.

Attempting to deliver a project seven months sooner raises several concerns; it would create an aggressive schedule as well as increase the jobsite congestion. This will tie into the other three analyses, which focus on prefabrication and moving construction offsite. If several areas of the project can be effectively constructed offsite and then quickly installed onsite, renovating multiple buildings at once becomes more feasible.

It would also need to be determined if Penn State has the capability to house twice as many students elsewhere on campus. After speaking with the project manager for the Office of Physical Plant, it was determined that taking multiple buildings offline is more feasible during the spring semester because student enrollment is typically lower during the spring, when compared to the fall semester. There are also renovations occurring in Redifer, as well as the east and west connectors from Redifer to Cooper – Hoyt and Hibbs – Stephens respectively. The Redifer work could pose a challenge to completing Cooper – Hoyt and Hibbs – Stephens together, so the entire sequencing of the South Halls project will be analyzed to determine the best sequence for the renovations.

PROCESS

PSU CAPACITY

The first step in analyzing the project phasing is to determine if Penn State has the capabilities and housing capacity to take two buildings down at once. This will involve looking at the historical data for on-campus housing, during both the fall and spring semesters. Based upon the data obtained and interviews with Housing and the Office of Physical Plant (OPP), it was determined that there are typically less students living on campus during the spring semester than there are during the fall semester. This can be accounted to the fact that many students graduate in the fall, study abroad, obtain internships, or leave the Penn State main campus for other reasons. Based on these findings, it was concluded that the spring semester is the best opportunity for renovating two buildings at once.

After speaking with the Director of Housing, Conal Carr, it was determined that there would be enough room to relocate the displaced students. Looking at the historical data for on-campus capacity, on-campus housing is typically over the maximum capacity of 13,721 by about 3%. However, there are on average 1500 less students during the spring semester; the South Halls dorm buildings house, on average, 250 students. Therefore, there will be more than enough room to relocate students at South Halls to renovate two buildings at once.

INCREASING STAFF

Renovating multiple buildings at the same time initially sounds difficult and rather intensive for the South Halls project team; however, during the first phase of the project, Chace Hall was built and Haller – Lyons was renovated. During this time, the project management team was larger than the team utilized for the Ewing – Cross and other two renovations. Over the summer of 2013, after Haller – Lyons and Chace finished construction, the project management team was downsized because the next phases only involved renovating one building at time. It is therefore same to assume that Barton Malow and all of the subcontractors would have the capabilities of increasing the manpower on the jobsite to handle renovating two buildings at the same time.

Table 39: Project Management Staffing Comparison

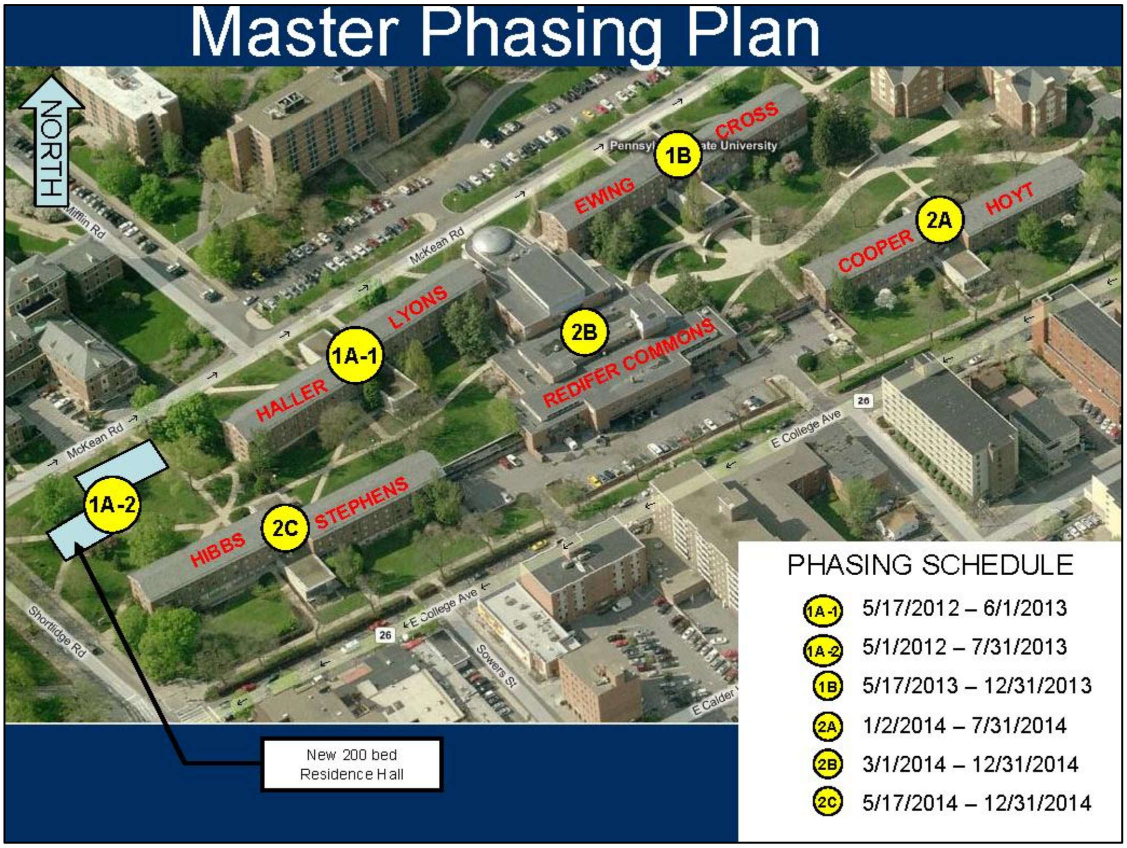
Current Phase 2 Staffing	Proposed Phase 2 Staffing
Project Director	Project Director
Project Manager	Project Manager
Project Engineer	Senior Project Engineer
Senior Superintendent	Project Engineer
Project Technician	Senior Superintendent
Intern	Field Superintendent
-	Field Superintendent
-	Project Technician
-	Intern
-	Intern

The proposed staffing plan for renovating multiple buildings is identical to the project management team for the first phase of the South Halls project. This staff size was proven capable of handling the construction of multiple buildings already, and will be sufficient to renovate two buildings at once.

NEW SEQUENCING

As can be seen in Figure 69 below, the current phasing plan follows a clockwise direction, with Hibbs – Stephens renovated last. After consulting the Barton Malow project team and studying the nature of the work, a new sequencing plan was developed. The new plan has an overall west to east flow, with the new dormitory building being constructed with Hibbs – Stephens, followed by Ewing – Cross, and then the other two dormitory buildings together. The Redifer Commons additions and renovation will still happen concurrent to the dorm renovations; however, this work was moved up in the master schedule. This accurately reflects the actual schedule because the Redifer Commons work was moved forward in the schedule and start during the 2013 summer. Therefore, as Hibbs – Stephens is finishing, the west Redifer connector will begin and so on.

Renovating Ewing – Cross and Cooper – Hoyt is the most logical choice because this would group the construction to the right side of South Halls. This means that permanent landscaping and sidewalks can be installed around the south of Haller – Lyons and Hibbs – Stephens; the clockwise flow of the current master plan makes it so that site between Haller – Lyons and Hibbs – Stephens is disturbed twice during construction. Resequencing the master plan to have a left to right flow will eliminate the need to disturb certain portions of the site multiple times, and ultimately allow permanent landscaping and sidewalks to be installed sooner. Overall, with Phase 2 construction only occupying the right side of the site, Redifer Commons can serve as a buffer to isolate the renovated dormitories from the construction site and create a better environment for students living in South Halls during construction.



Master Phasing Plan

PHASING SCHEDULE

1A-1	5/17/2012 – 6/1/2013
1A-2	5/1/2012 – 7/31/2013
1B	5/17/2013 – 12/31/2013
2A	1/2/2014 – 7/31/2014
2B	3/1/2014 – 12/31/2014
2C	5/17/2014 – 12/31/2014

Figure 69: Original Master Phasing Plan

PROPOSED MASTER PHASING PLAN

PROPOSED PHASING SCHEDULE
1A-1: HIBBS-STEPHENS 5/17/2012 – 6/1/2013
1A-2: CHACE 5/1/2012 – 7/31/2013
1B: HALLER – LYONS 5/17/2013 – 12/31/2013
2A: REDIFER COMMONS 8/1/2013 – 5/31/2014
2B-1: EWING – CROSS 1/2/2014 – 7/31/2014
2B-2: COOPER – HOYT 1/2/2014 – 7/31/2014

Figure 70: Proposed Phasing Plan

SCHEDULE ANALYSIS

Overall, renovating Ewing – Cross and Cooper – Hoyt simultaneously will allow the overall project schedule to be reduced by 5 months, allowing for both buildings to be opened to students for the fall 2014 semester. The figure below shows a summary of the potential schedule savings.

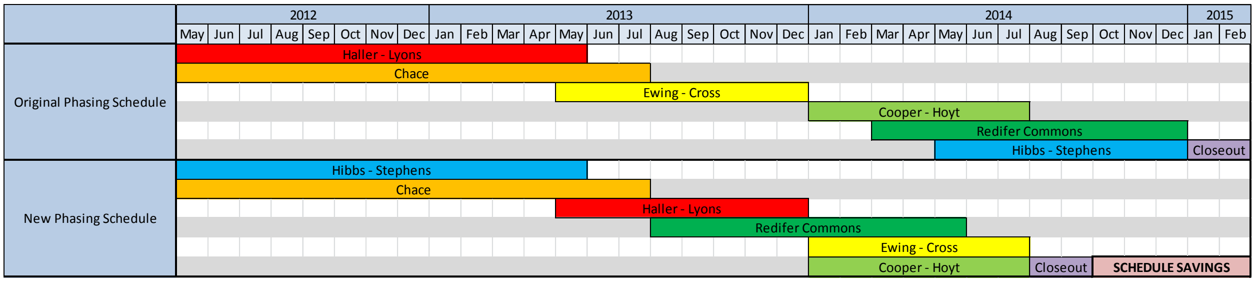


Figure 71: Summary of Schedule Savings | full plan in Appendix T

The fall semester will be the ideal time to open the dorm buildings because the number of on-campus residents typically peaks during the fall. Usually, students will reside in the same dorm room for both the fall and spring semester; having both buildings ready for the fall will reduce the number of students that need to be shuffled around during construction and also alleviate some of the burden on Penn State Housing to move student items around in between building renovations.

The order of the renovations is not necessarily a critical item because all four buildings are essentially identical; as previously stated, the new sequencing gives a better flow to the construction, as opposed to the original clockwise sequencing.

CONSTRUCTABILITY

Figure 72: Phase 2 Site Area of Concern

Renovating two buildings at the same time could prove to be challenging in terms of managing the site logistics. For a period of five months, construction would be occurring on Redifer Commons, Ewing – Cross, and Cooper – Hoyt, all at the same time. The area highlighted in red in the figure to the right will be a hotspot for jobsite congestion. However, the construction should be manageable with proper planning; Chace hall and Haller – Lyons were in close proximity during phase 1, and there were very few issues. Form a management standpoint, the project team would have already renovated two buildings and would have the working experience to properly prepare for potential issues. However, further analysis may be required to fully understand how the site logistics would need to be coordinated during the proposed phase 2 construction.

The other analyses that were performed in this thesis could provide insight into areas that were critical schedule concerns. Analyses 1 and 3 looked at moving construction offsite to help with schedule acceleration and jobsite congestion. Analysis 3 looked at prefabricating the exterior limestone walls; this would be particularly helpful because the main concern with site congestion during phase 2 would mainly deal with exterior and enclosure activities. The prefabrication accelerated the enclosure schedule and could also help in coordinating enclosure work occurring on Ewing – Cross and Cooper – Hoyt. However, the façade prefabrication analysis only looked at constructing the wall modules for one building at a time; the project team would need to ensure that the offsite fabrication can keep pace with simultaneous renovations.

The SIPS analysis could also prove beneficial in attempting to renovate two dormitories at the same time. SIPS could be implemented on both buildings to help the subcontractors ensure that the construction stays on schedule, while easily tracking manpower.

COST ANALYSIS

GENERAL CONDITIONS COST COMPARISON

To gain an understanding of the potential cost savings through the master plan resequence, the General Conditions for the project need to be analyzed. Resequencing the project would not change the overall cost for material and labor, because the scope of work and manhours needed for the project will not change. The staffing costs were analyzed first, based on the current staffing plan and the proposed staffing plan for renovating Ewing – Cross and Cooper – Hoyt at the same time. The staffing for the phase 1 renovations and Chace hall would not change, and therefore, the costs would remain the same for that portion of the project.

Table 40: Original Staffing Costs; Estimated Using RS Means

Phase 2 Original Staffing					
Cost Code	Description	Quantity	Unit	Labor/Unit	Labor Total
013113200220	Project Executive	12	Weeks	3825	$ 45,900.00
013113200200	Project Director	30	Weeks	3350	$ 100,500.00
013113200180	Project Manager	60	Weeks	2900	$ 174,000.00
013113200100	Senior Project Engineer	60	Weeks	2050	$ 123,000.00
013113200260	Senior Superintendent	60	Weeks	3100	$ 186,000.00
013113200020	Project Technician	60	Weeks	570	$ 34,200.00
013113200010	Intern	13	Weeks	1040	$ 13,520.00
				Subtotal	**$ 677,120.00**

Table 41: New Staffing Costs; Estimated Using RS Means

Phase 2 New Staffing					
Cost Code	Description	Quantity	Unit	Labor/Unit	Labor Total
013113200220	Project Executive	8	Weeks	3825	$ 29,835.00
013113200200	Project Director	20	Weeks	3350	$ 65,325.00
013113200180	Project Manager	39	Weeks	2900	$ 113,100.00
013113200120	Senior Project Engineer	39	Weeks	2050	$ 79,950.00
013113200100	Project Engineer	39	Weeks	1575	$ 61,425.00
013113200260	Senior Superintendent	39	Weeks	3100	$ 120,900.00
013113200240	Field Superintendent	39	Weeks	2825	$ 110,175.00
013113200240	Field Superintendent	39	Weeks	2825	$ 110,175.00
013113200020	Project Technician	39	Weeks	570	$ 22,230.00
013113200010	Intern	13	Weeks	1040	$ 13,520.00
013113200010	Intern	13	Weeks	1040	$ 13,520.00
				Subtotal	**$ 740,155.00**

As can be seen in the two tables above, the new phasing would actually add $63,000 in staffing costs. While reducing the total schedule for phase 2 by 21 weeks saved on the cost per staff member, adding additional project team members increases the overall cost. The table below shows a summary for the general conditions on the entire project. While the staffing added $63,000 to the project, reducing the overall project schedule by 5 months saved $32,000 in other areas such as: field office upholding, porta-johns, and dumpsters. Overall, renovating two buildings at the same time added approximately $31,000 in general conditions cost.

Table 42: South Halls General Conditions Summary

General Conditions Summary			
Description	Original $	New $	Cost Difference
Phase 1 Staffing	$ 1,617,835.00	$ 1,617,835.00	$ -
Phase 2 Staffing	$ 677,120.00	$ 740,155.00	$ 63,035.00
Phase 1 Gen Cond.	$ 361,763.42	$ 361,763.42	$ -
Phase 1 Chace Gen Cond.	$ 238,515.66	$ 238,515.66	$ -
Phase 2 Gen Cond.	$ 323,598.94	$ 291,458.54	$ (32,140.40)
Total	$ 3,218,833.02	$ 3,249,727.62	**$ 30,894.60**

The full General Conditions Estimate can be found in Appendix U.

POTENTIAL REVENUE PSU

Finishing the project 5 months earlier would allow for the final dormitory building to be opened one semester earlier. Therefore, it is important to understand the revenue that Penn State would stand to generate by having the South Halls renovation completed for the beginning of the fall 2014 semester. Ewing – Cross was used as the dorm building that would be finished 5 months early. Ewing – Cross can house approximately 248 students; the potential revenue is outlined in the table below. Housing and meal plan rates for the fall 2014 semester were obtained from the Penn State Housing and Food

Services website: http://www.hfs.psu.edu/hfs/rates/index.cfm. Mean plans are required for all students who live on campus, and the potential revenue for these was averaged to be $554,280.

Table 43: Potential Revenue through Early Project Completion

Potential Revenue for Ewing - Cross				
Housing Rates				
Room	**Rate**	**Standard Occupancy**	**Number of Rooms**	**Revenue**
Standard Double	$ 2,730.00	2	0	$ -
Standard Double w/ AC	$ 2,955.00	2	112	$ 661,920.00
Small Double	$ 2,045.00	2	0	$ -
Supplemental	$ 2,185.00	4 to 8	0	$ -
Supplemental w/ Bath	$ 2,455.00	6	1	$ 14,730.00
Standard Single	$ 3,715.00	1	18	$ 66,870.00
			Total Revenue	**$ 743,520.00**
Meal Plans				
Meal Plan	**Rate**	**Per Person**	**Number of Students**	**Total Revenue**
Level 1	$ 2,005.00	1	248	$ 497,240.00
Level 2	$ 2,095.00	1	248	$ 519,560.00
Level 3	$ 2,155.00	1	248	*$ 534,440.00*
Level 4	$ 2,270.00	1	248	*$ 562,960.00*
Level 5	$ 2,355.00	1	248	$ 584,040.00
Level 6	$ 2,530.00	1	248	$ 627,440.00
			Average Revenue	**$ 554,280.00**
			Total Potential Revenue	**$ 1,297,800.00**

CONCLUSIONS AND RECOMMENDATIONS

Renovating the final two dormitory buildings would accelerate the overall construction schedule by five months, allowing for South Halls to be fully opened for the fall 2014 semester. While this would add nearly $31,000 in General Conditions costs, this is a small price to pay when the owner stands to generate $1.3M in revenue. Although renovating multiple buildings would prove to be challenging, the South Halls project team proved they were more than capable during phase 1, with both Haller – Lyons and Chace hall under construction. By maintaining the project management staff of phase 1 for the phase 2 work, the implementation of this analysis would be feasible. For all of the above reasons, it is recommended that the resequencing of the South Halls Renovation be implemented.

MAE REQUIREMENTS

The MAE requirements for this thesis report were met by integrating topics learned in various courses into this report.

AE 570: PRODUCTION MANAGEMENT IN CONSTRUCTION

This course dealt with increasing productivity and efficiency on jobsites. One of the topics discussed dealt with Short Interval Production Scheduling (SIPS). This scheduling tool was discussed using case studies and in class examples. Analysis 3 deals with implementing SIPS for the student rooms of the South Halls renovation. Knowledge gained from AE 570 was applied in the implementation of the South Halls SIPS analysis. A SIPS was created for a typical construction zone, and then applied to all nine zones within Ewing – Cross.

Knowledge gained from AE 570 was also implemented in Analysis 3. Analysis 3 deals with moving construction offsite, through the use of prefabrication. One of topics discussed dealt with productivity of workers and how offsite construction can improve production rates. Analysis 3 examined the potential increased productivity of construction limestone wall modules offsite, while better utilizing the crews to decrease the overall construction time. Factory logistics and transportation schedules were developed to fully understand the more complex areas of implementing prefabrication. Therefore, knowledge gained from AE 570 about prefabrication and SIPS was applied to Analysis 3 and Analysis 1 respectively.

FINAL RECOMMENDATIONS

The South Halls Renovation and New Construction project is a $94M construction project, which is located in University Park of the Pennsylvania State University. There are four identical dormitory buildings that are currently being consecutively renovated, with Ewing – Cross serving as the building primarily analyzed for previous technical reports and for this final report. This senior thesis report encompasses the findings of the four analyses that were performed for the South Halls Renovation. Through project team interviews, course knowledge, jobsite visits, and online research, the four analyses for this report were developed.

Analysis 1: Modularization of Bathroom Units

The first analysis focused on the construction of the bathroom pods due to the issues with the quality of the finish work, which caused delays in the turnover of these areas. Ewing – Cross has two stacks of bathroom cores, encompassing 40 individual bathrooms. In an effort to improve the quality of the bathrooms while also reducing the construction schedule, the bathrooms were modularized to be built offsite as individual bathroom pods. Modularizing the bathrooms resulted in $120,000 in savings, in addition to the bathroom construction being completed four weeks earlier than previously scheduled. Note that this analysis included an architectural breadth that looked at designing the bathrooms for modularization.

Analysis 2: SIPS Implementation for Student Rooms

The second analysis looked at implementing SIPS for the construction of student rooms. The punchlist for student rooms and turnover to the owner was critical at Ewing-Cross because the owner was receiving the building right when students were ready to return for the spring semester. The repetitive nature of the student room construction lent itself well to SIPS; there was a focus on creating equal sized zones, with all construction activities having an equal duration of 5 days. While implementing SIPS did not reduce the overall project schedule, the reorganization of activities and optimizing of crew sizes resulted in a schedule savings of 10 days, allowing the owner to begin their FF&E sooner.

Analysis 3: Prefabrication of Limestone Façade

Analysis 3 focused on the construction of the building enclosure; specifically, the limestone façade. The stone panel veneer was compared to a traditional 3 5/8” limestone panel façade to determine if any costs savings were achievable through changing materials. The increased structural requirements of the thicker limestone actually added about $1,000 per bumpout to the cost of the building, so this was ruled out as an alternative. Then, the limestone veneer wall system was analyzed to determine if prefabrication was feasible. Prefabricating the walls into modules allowed for a potential cost savings of $175,000, while reducing the enclosure schedule by 36 days. Note that this analysis also included a structural breadth.

Analysis 4: Resequencing of Renovation Phases

The final analysis dealt with resequencing the renovations in an attempt to deliver the project one semester earlier; this would allow the owner to start generating revenue earlier, upon completely opening the South Halls dormitories for the fall 2014 semester. By increasing the project management staff, it would be feasible to renovate two buildings at the same time to shorten the overall project schedule by 5 months. This would add approximately $31,000 in General Conditions costs, but would also allow the owner to generate $1.3M in revenue.

Conclusion

In conclusion, it is recommended that all four analyses be incorporated into the South Halls Renovation project. Combined, the four alternatives yield an overall project schedule savings of five months. From a cost perspective, the four analyses would result in $264,000 in project savings, which would amount to 0.28% of the total project cost; this does not include the $1.3M in revenue the owner could generate as a result of resequencing the renovations. Therefore, all four analyses are recommended as it is believed that the South Halls Renovation can benefit from them.

REFERENCES

2010 ADA Standards for Accessible Design. N.p., n.d. Web. Jan. 2014. <http://www.ada.gov/regs2010/2010ADAStandards/2010ADAStandards_prt.pdf>

AmeriPOD. N.p., n.d. Web. 17 Mar. 2014. <http://ameripod.com/>

Burkhart, A. F. (1989). "The Use of SIPS as a Productivity Improvement Tool." *Construction Congress I*. Web. Feb. 2014.

HSS LRFD Column Load Tables. N.p., n.d. Web. Jan. 2014. <http://www.pirate4x4.com/tech/billavista/PDFs/Hollow%20Structural%20Sections%20lrfd%20column%20load%20tables.pdf>

Prevailing Wage Rates. N.p., n.d. Web. Feb. 2014. <http://www.portal.state.pa.us/portal/server.pt/community/prevailing_wage/10519>

Indiana Limestone Handbook. N.p., n.d. Web. Jan. 2014. <http://www.bybeestone.com/pdf/ili/22nd_Edition_Handbook.pdf>

"Modular Prefabricated Residential Construction." University of Washington | Skanska Innovation Grant, 2012. Web. Jan. 2014.

"Stone Veneer Products." *Stonepanels*. N.p., n.d. Web. 17 Mar. 2014. <http://www.stonepanels.com/stone-veneer/>

Pennsylvania Highways: Pennsylvania Truck Information. N.p., n.d. Web. Jan. 2014. <http://www.pahighways.com/truckinfo.html>

"Prefabrication and Modularization: Increasing Productivity in the Construction Industry | McGraw-Hill Construction." *Prefabrication and Modularization: Increasing Productivity in the Construction Industry | McGraw-Hill Construction*. McGraw Hill Construction, n.d. Web. 17 Mar. 2014.

"Press Release." *Eggrock: Eggrock Enters the Student Housing Market with 700 Bathrooms for Florida Atlantic University*. N.p., 2012. Web. 17 Mar. 2014.

PSU Room & Board Rates Fall 2013/Spring 2014. N.p., n.d. Web. Mar. 2014. <http://www.hfs.psu.edu/HFS/Rates/fall13-spring14.cfm>

"Short Interval Production Schedule (SIPS)." *Pentagon Renovation Program*. N.p., n.d. Web. Feb. 2014. <http://renovation.pentagon.mil/wedge2-5/sips.htm>

"TSN Product: VertiClip® SLB." *TSN Product: VertiClip® SLB*. N.p., n.d. Web. Feb. 2014. <http://www.steelnetwork.com/Product/verticlipslb>

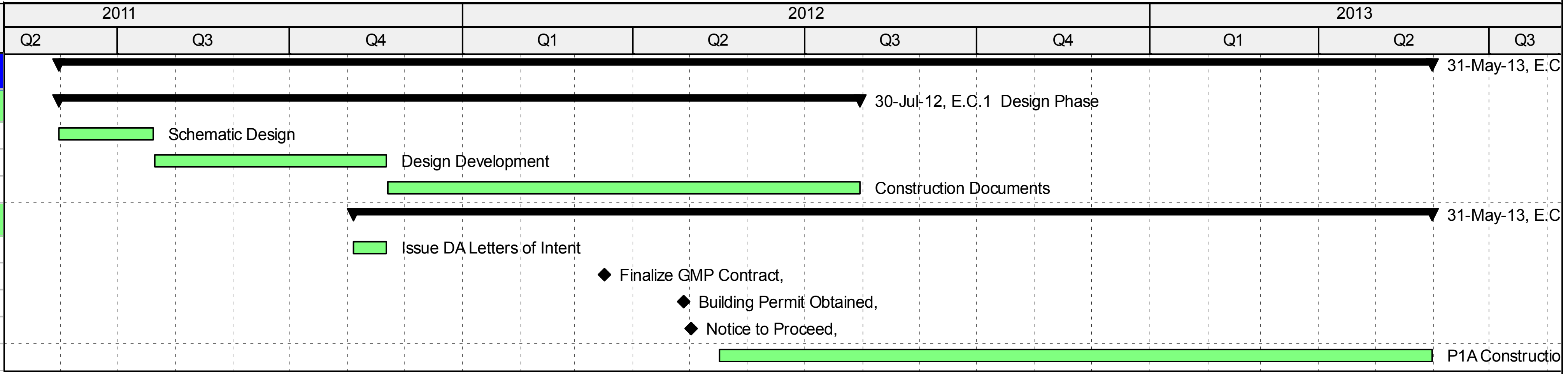
APPENDIX A: ORIGINAL PROJECT SCHEDULE

Quaid Spearing, Construction Management

Ewing Cross Detailed Schedule

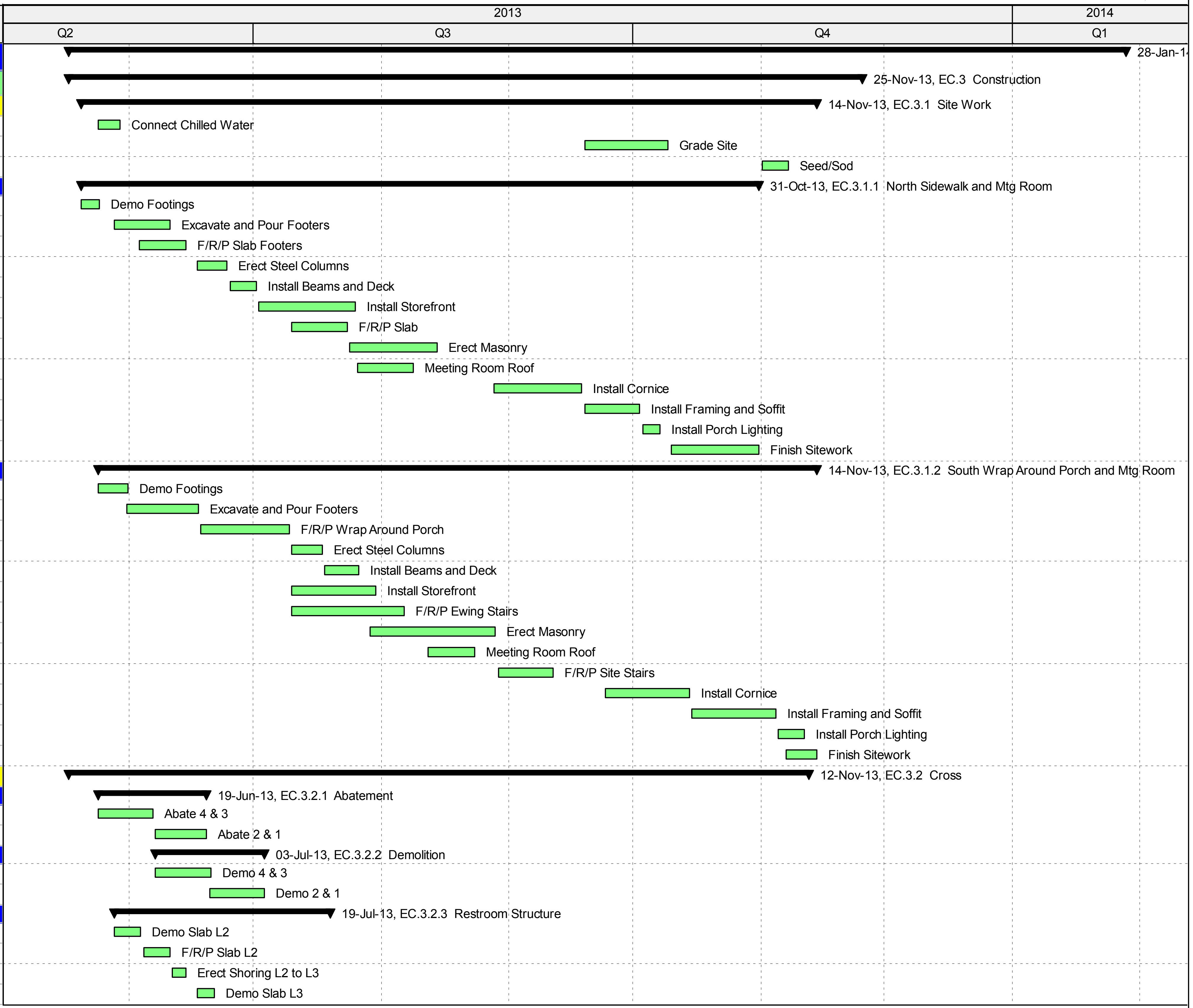
October 16th, 2013

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



▬	Actual Level of Effort	🟩	Remaining Work	◆ ◆	Milestone
▬	Actual Work	🟥	Critical Remaining Work	▼▬▼	summary

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 M		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

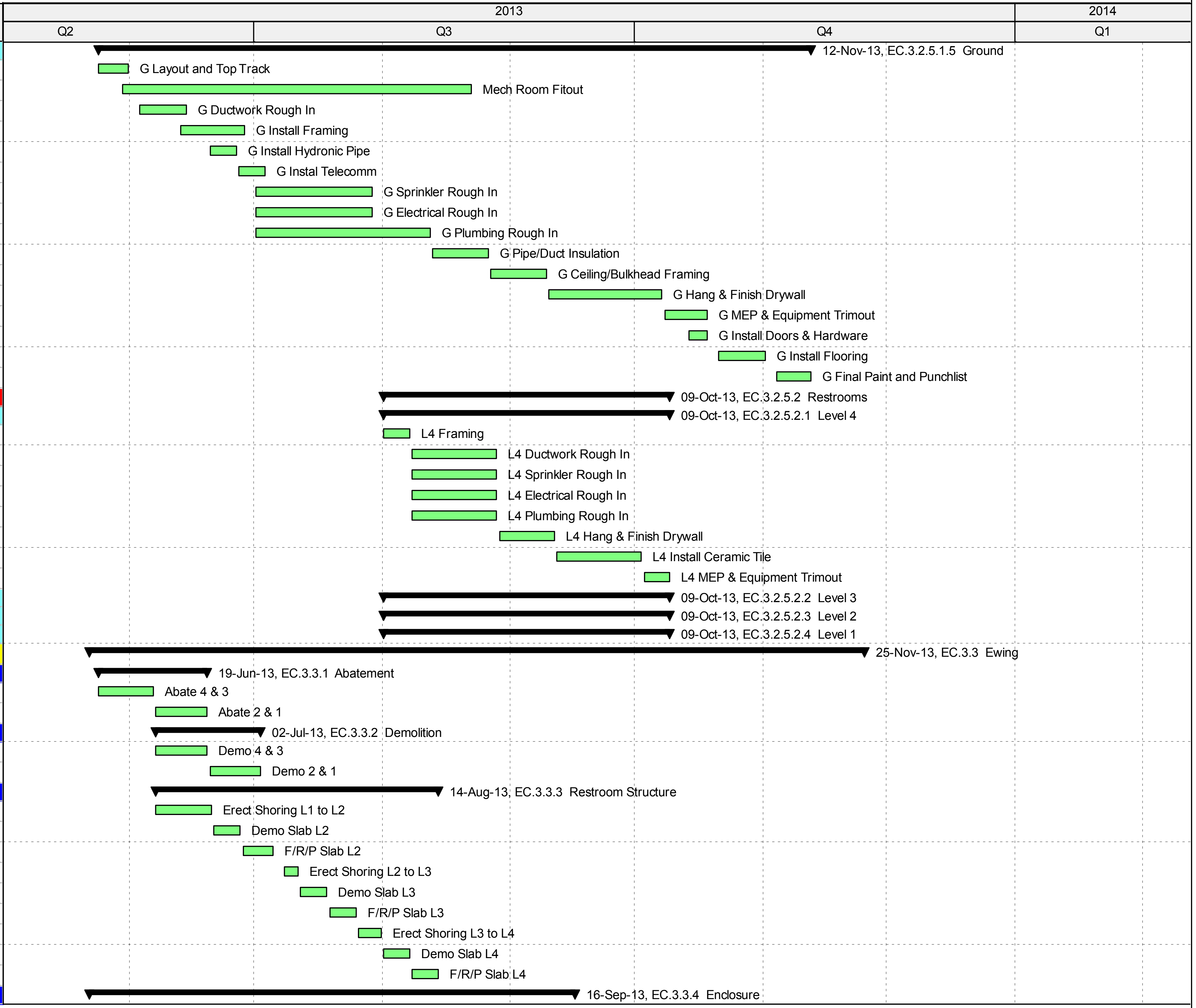


▬ Actual Level of Effort	🟩 Remaining Work	◆ ◆ Milestone	
▬ Actual Work	🟥 Critical Remaining Work	▼▬▼ summary	

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 Trim	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 Trim	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 Trim	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



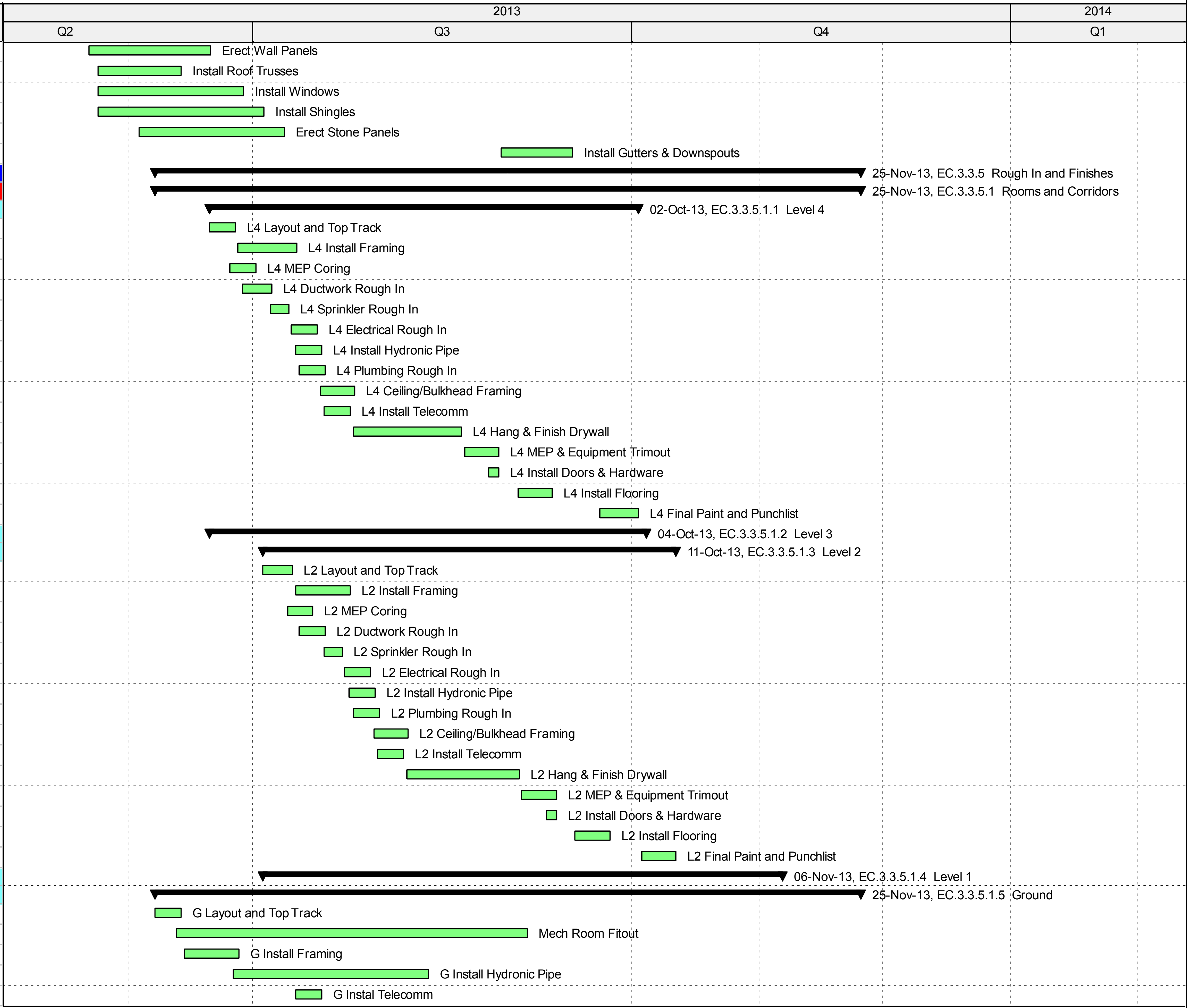
▬ Actual Level of Effort	🟩 Remaining Work	◆ ◆ Milestone
▬ Actual Work	🟥 Critical Remaining Work	▼▬▼ summary

Quaid Spearing, Construction Management

Ewing Cross Detailed Schedule

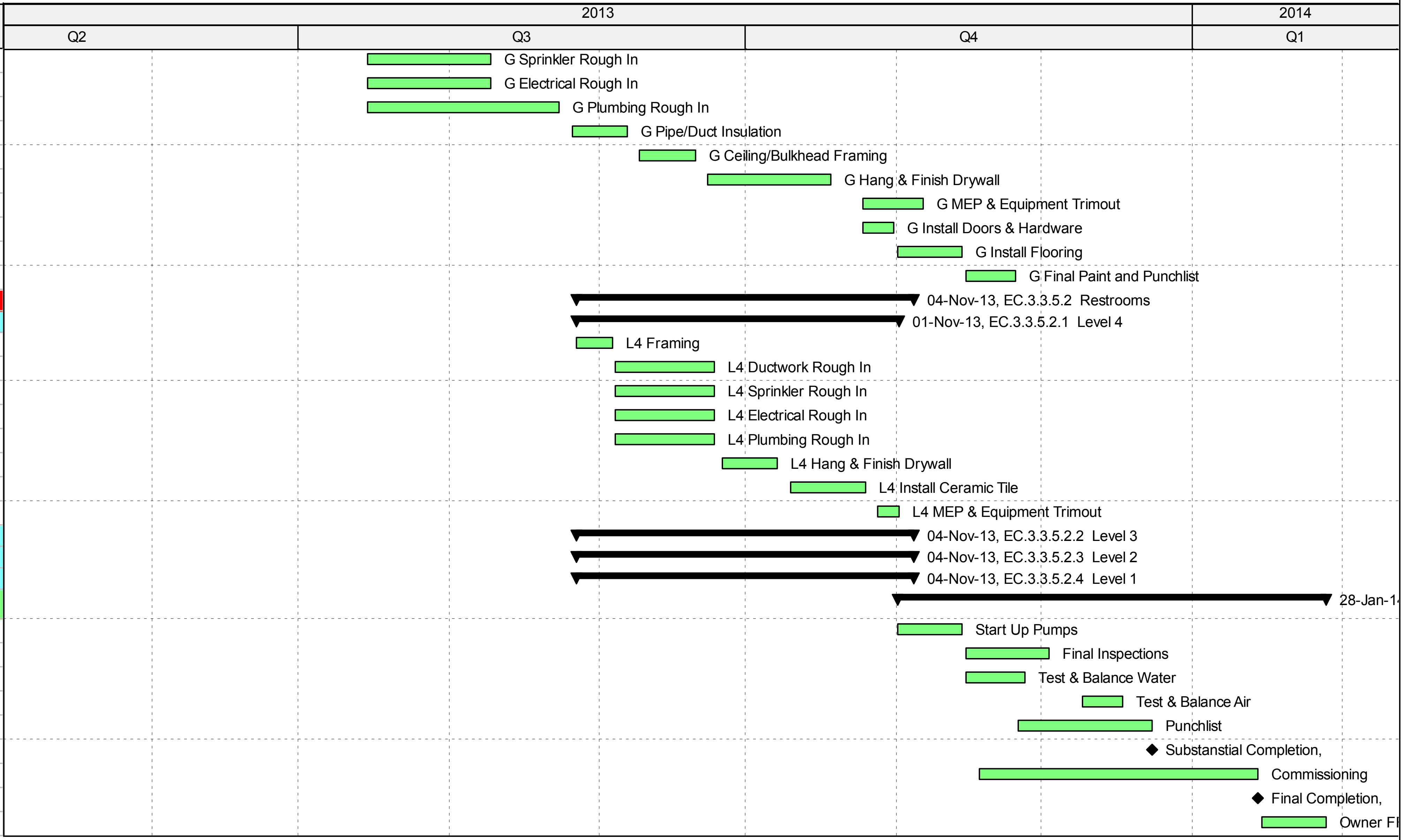
October 16th, 2013

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 Trim	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 Trim	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	🟩 Remaining Work	◆ ◆ Milestone
🟦 Actual Work	🟥 Critical Remaining Work	▼▬▼ 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 Framin	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 Trim	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



▬ Actual Level of Effort	🟩 Remaining Work	◆ ◆ Milestone
🟦 Actual Work	🟥 Critical Remaining Work	▼▬▼ summary

APPENDIX B: COST ESTIMATES

Reed Construction Data®

Cost Estimate Report
RSMeansOnline

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	✎	T	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**

Reed Construction Data®

Cost Estimate Report
RSMeans Online

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	✎	T	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: 07-Sep-13

Ewing-Cross Plumbing
Year 2013 Quarter 3
Assembly Detail Report

Prepared By:
quaid spearing
penn state

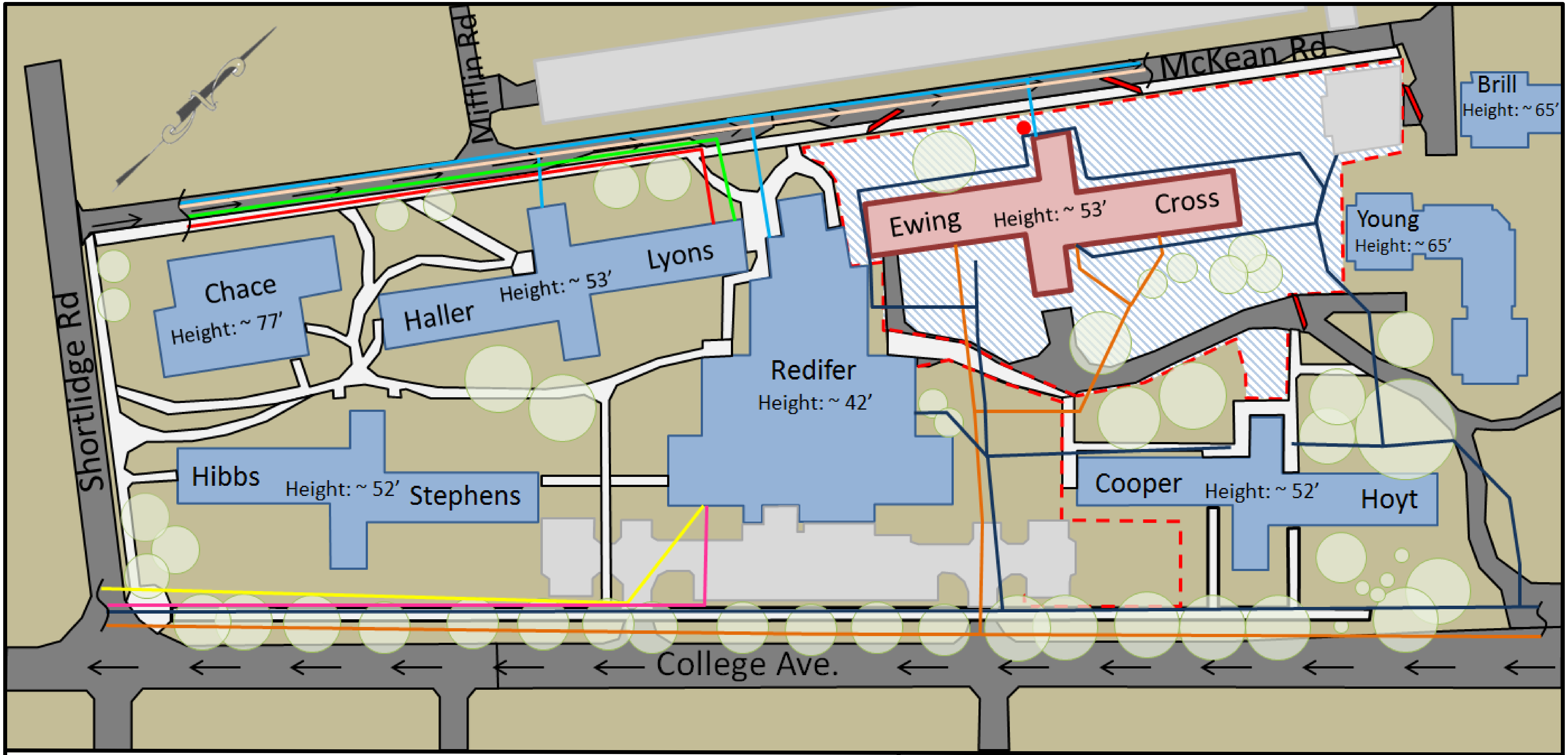
Assembly Number	✎	T	Description	Quantity	Unit	Total Incl. O&P	Ext. Total Incl. O&P
D Services							
D20103102300		■	Lavatory w/trim, wall hung, vitreous china, 20" x 27", handicap	22.00	Ea.	$1,735.97	$38,191.34
D20104101960		■	Kitchen sink w/trim, countertop, stainless steel, 33" x 22" double bowl	11.00	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**

APPENDIX C: ORIGINAL 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 D: EXISTING CONDITIONS



Legend

- - - Site Fencing
← Traffic Flow
— Sanitary Line
— Water Line
— Chilled Water
— Gas
— Underground Electric
— Underground Telecomm
— Storm Water Line
— Steam

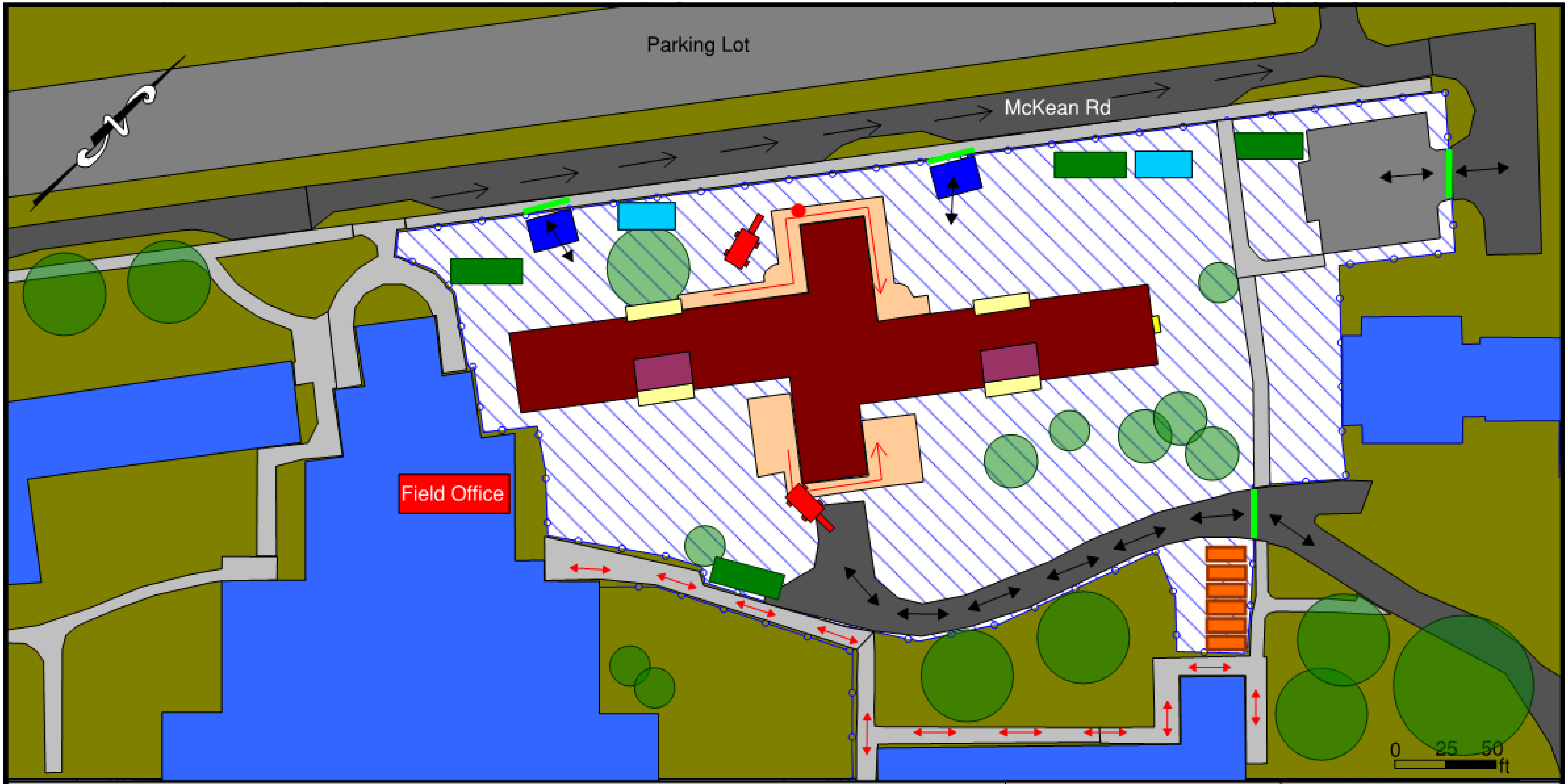
■ Adj. Building
■ Proj. Building
□ Sidewalk
■ Street
■ Parking Lot
/ Gate
▨ Const. Site
● Fire Hydrant
○ Protected Tree

Unless otherwise noted, all roads/walkways are two-way

Author: Quaid Spearing
Tech #1
Date: September 16th, 2013
Advisor: Dr. Anumba

South Halls: Ewing-Cross Existing Conditions Plan

APPENDIX E: CONSTRUCTION SITE PLANS

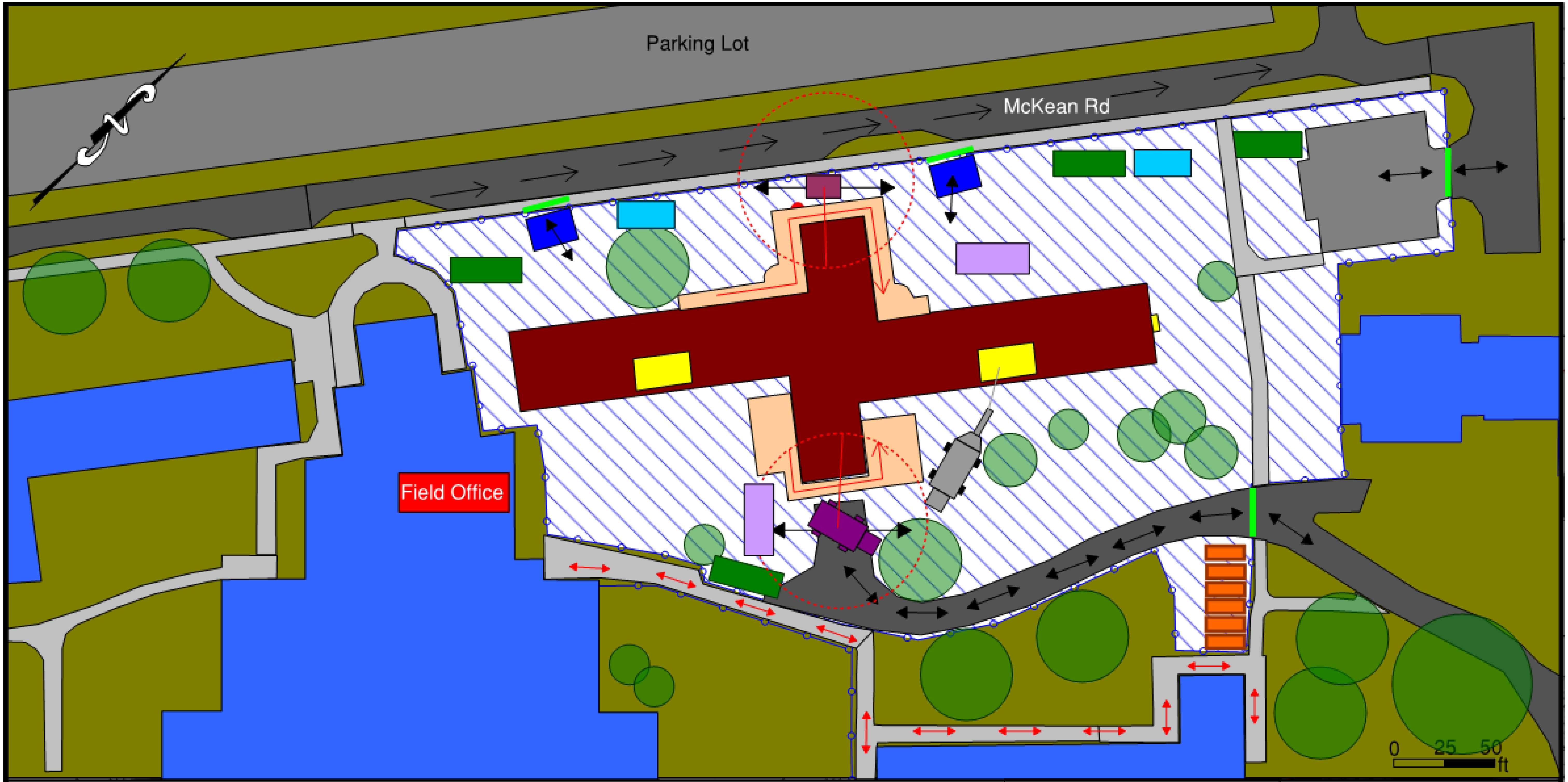


LEGEND

- ↔ 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

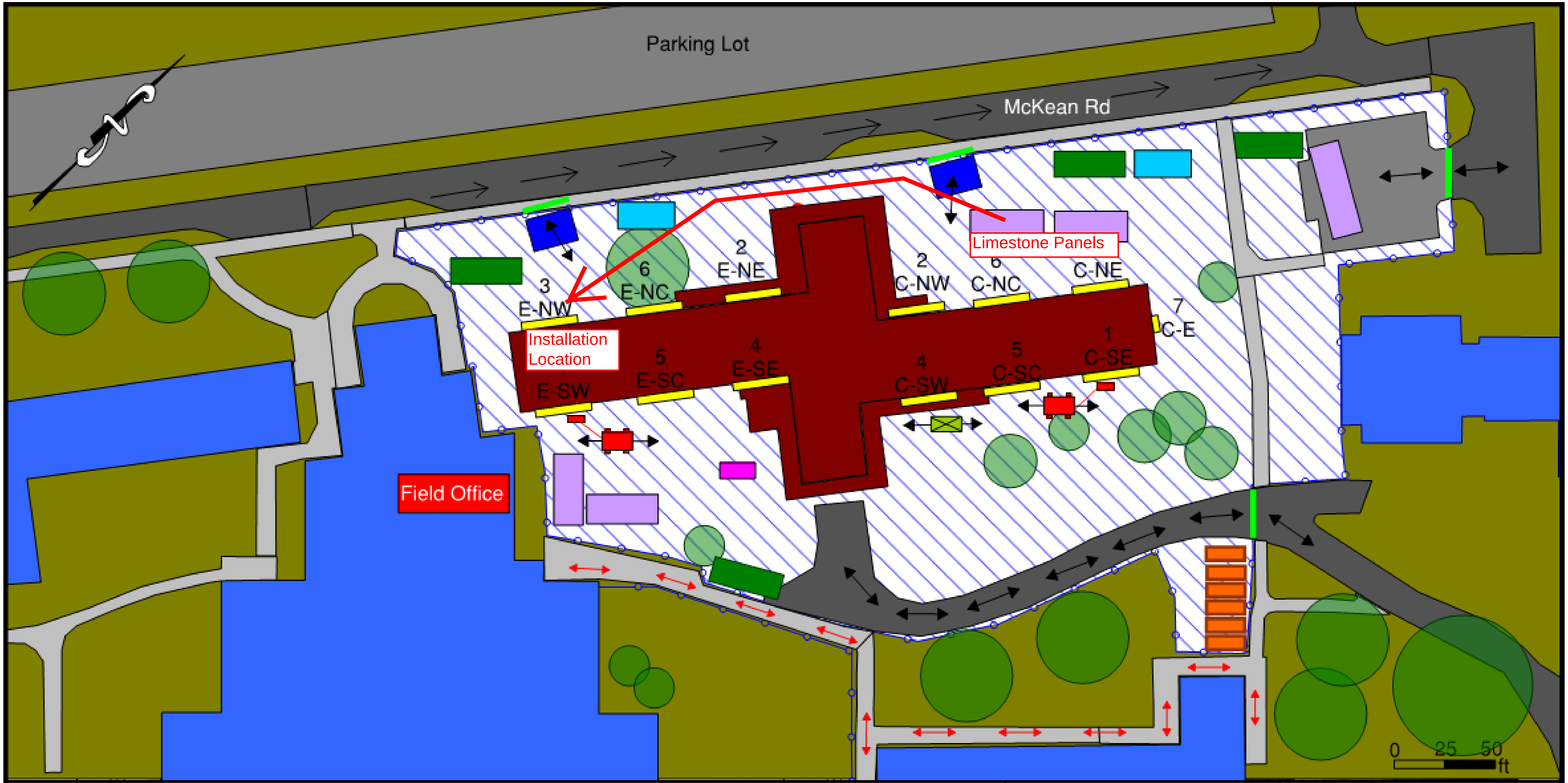


LEGEND

- ↔ 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



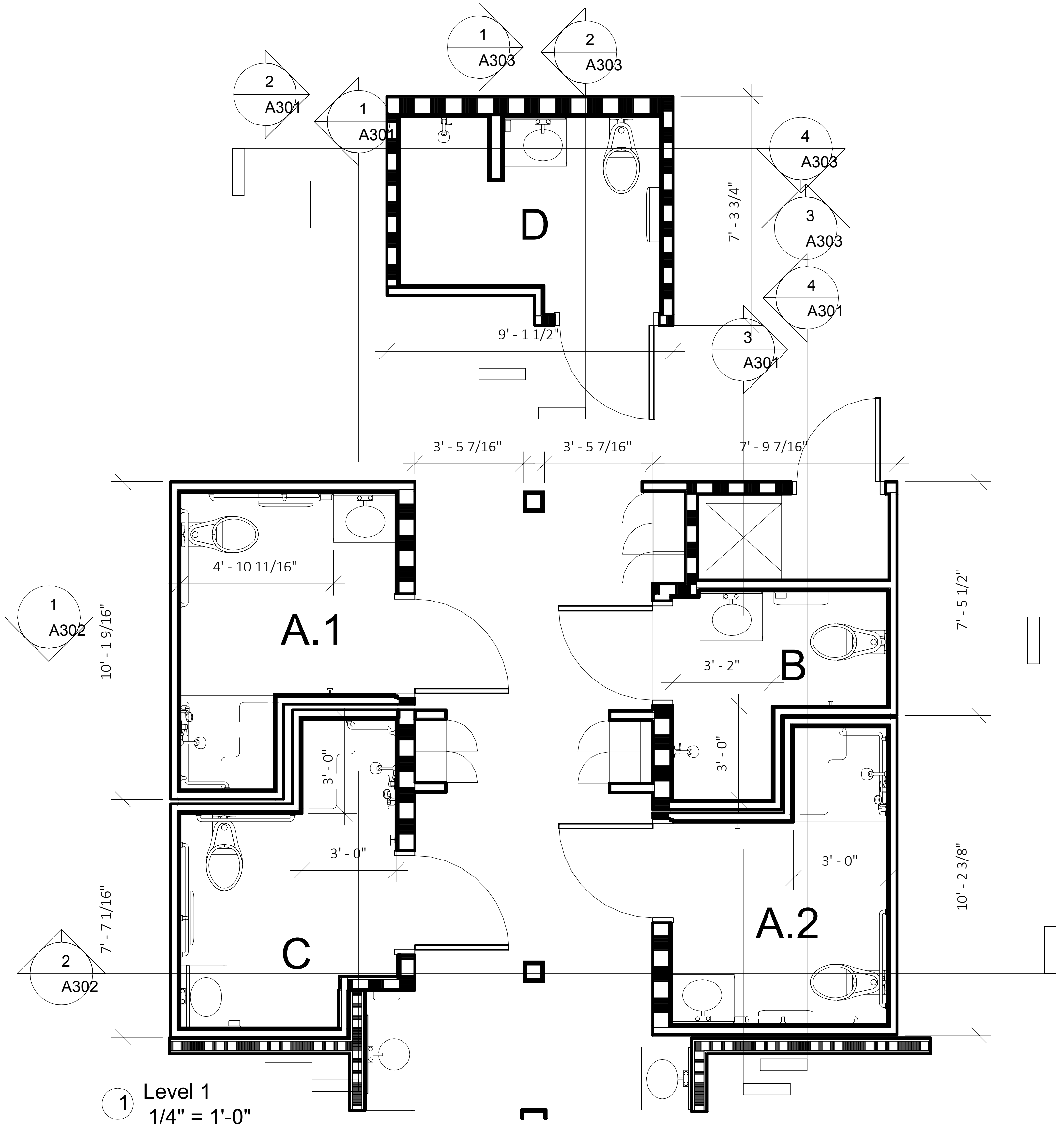
LEGEND

- ↔ 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

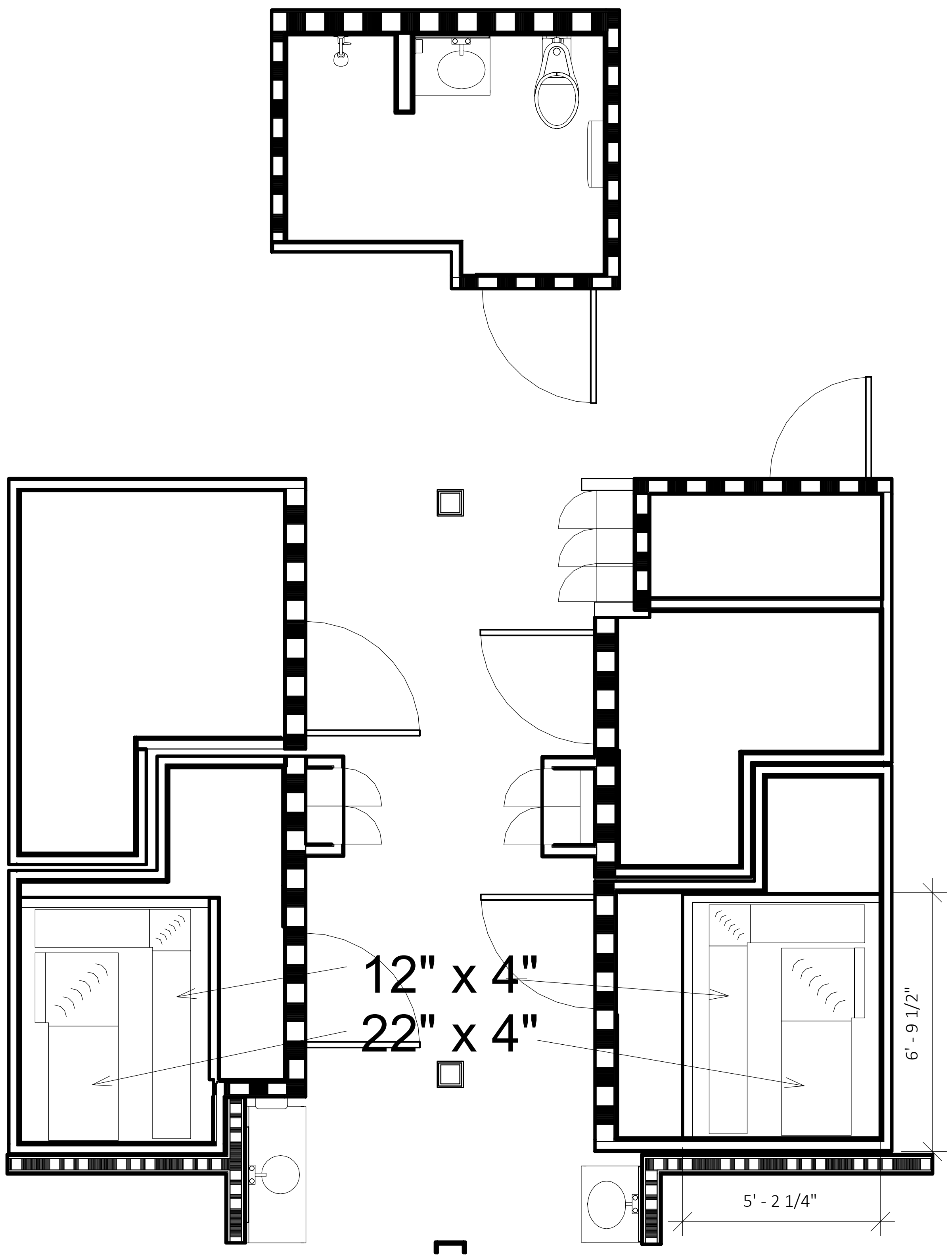
Author: Quaid Spearing
Tech #2
Date: October 16th, 2013
Advisor: Dr. Anumba

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

APPENDIX F: POD DRAWINGS



1 Level 1
1/4" = 1'-0"



2 Level 1 Ceiling
1/4" = 1'-0"

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Penn State

South Halls Renovation

No.	Description	Date

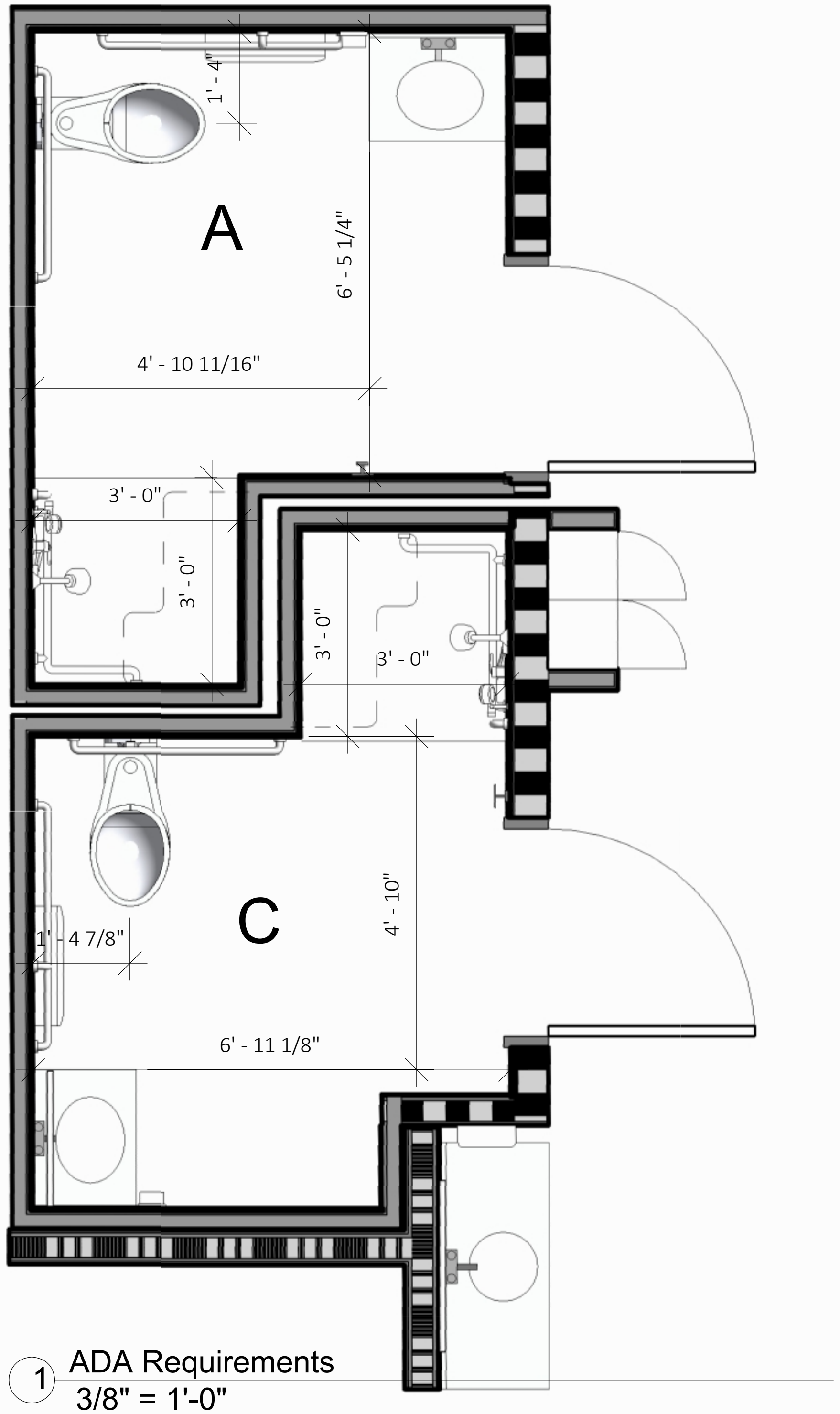
Bathroom Pod Typical Layout

Project number	Project Number
Date	01/26/2014
Drawn by	QWS
Checked by	Checker

A101

Scale 1/4" = 1'-0"

2/15/2014 5:49:44 PM



1 ADA Requirements
3/8" = 1'-0"

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Penn State

South Halls Renovation

No.	Description	Date

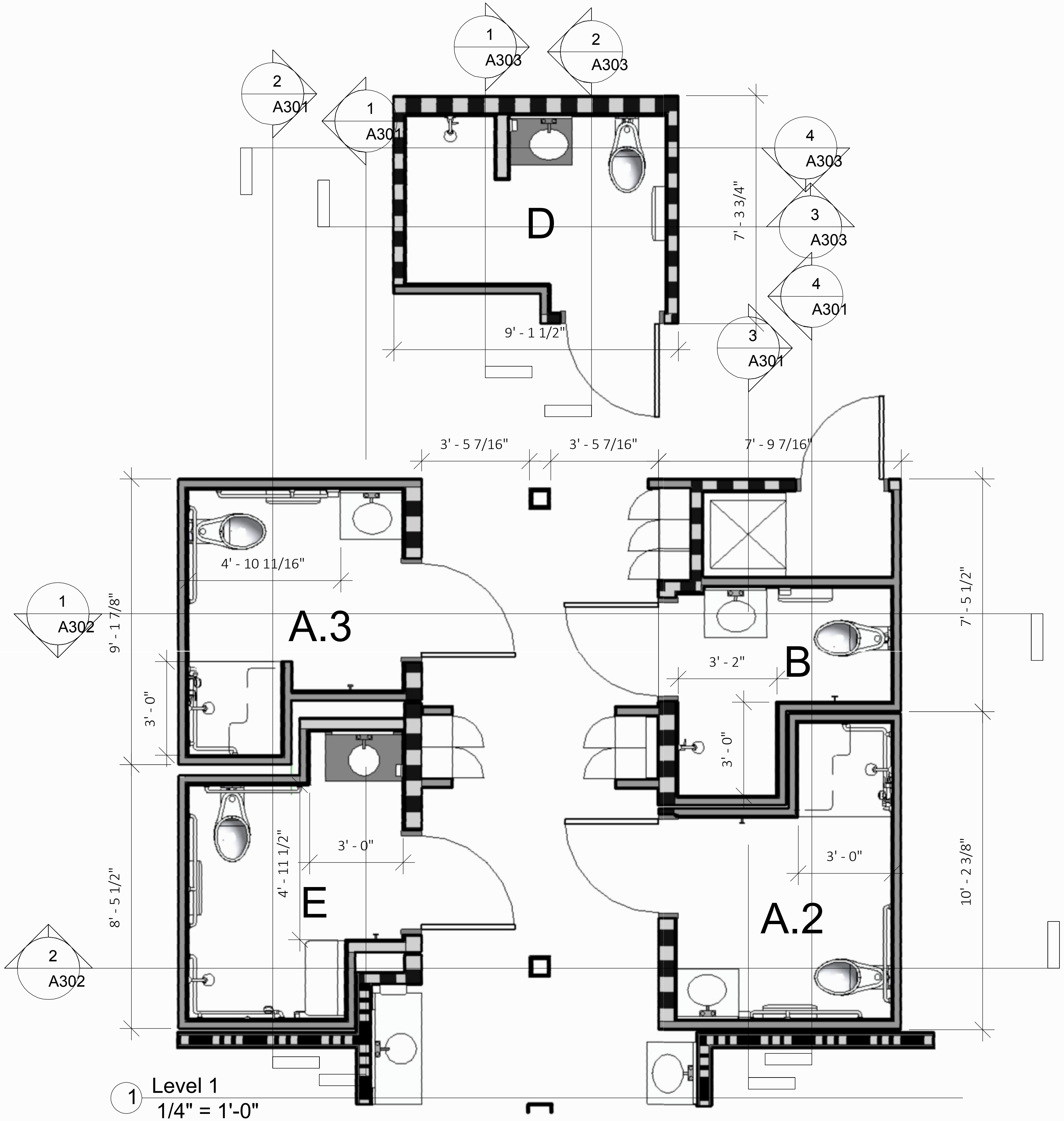
ADA Requirements

Project number Project Number
Date 01/26/2014
Drawn by QWS
Checked by Checker

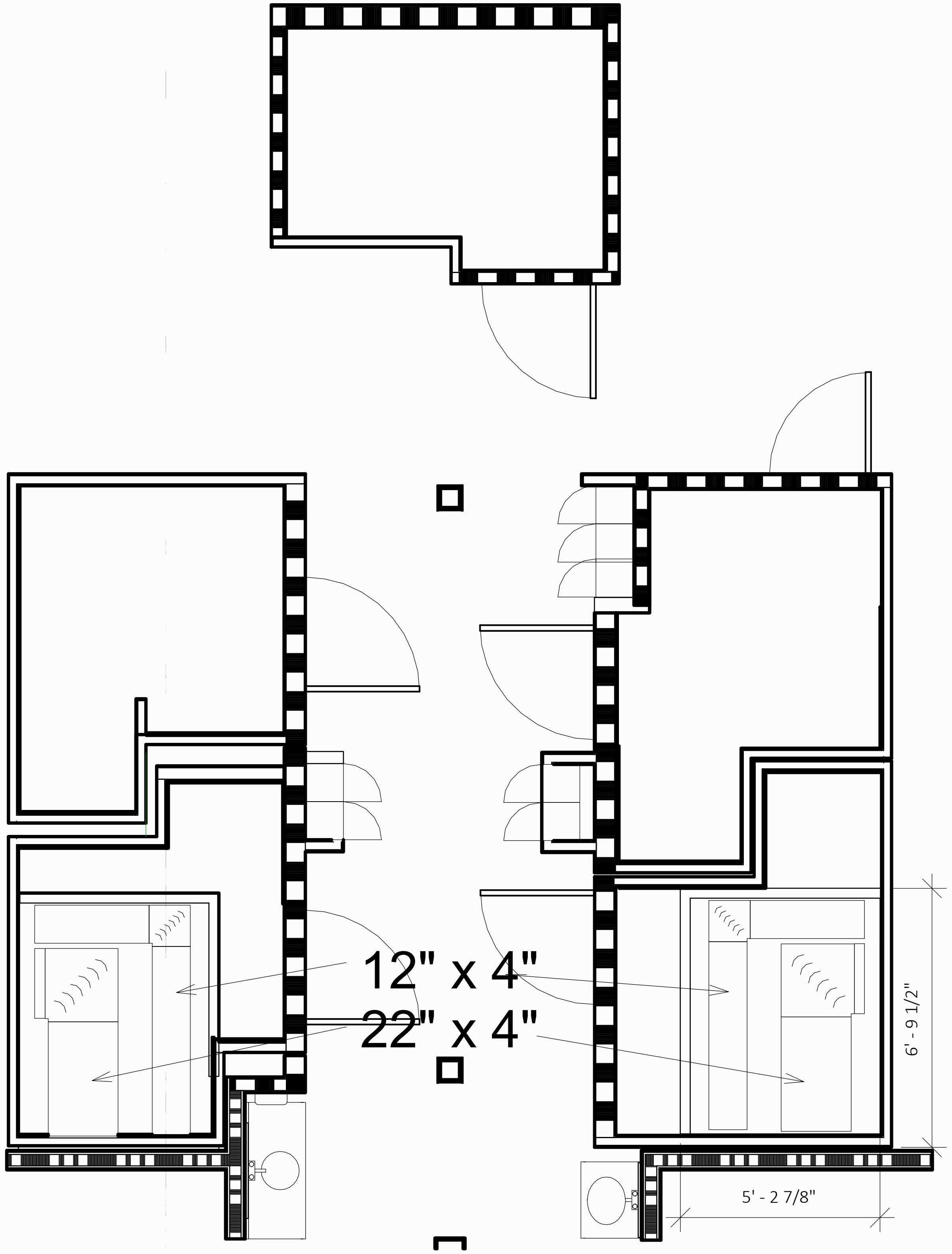
A102

Scale 3/8" = 1'-0"

2/15/2014 5:49:45 PM



① Level 1
1/4" = 1'-0"



② Level 1 Ceiling
1/4" = 1'-0"

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Penn State

South Halls Renovation

No.	Description	Date

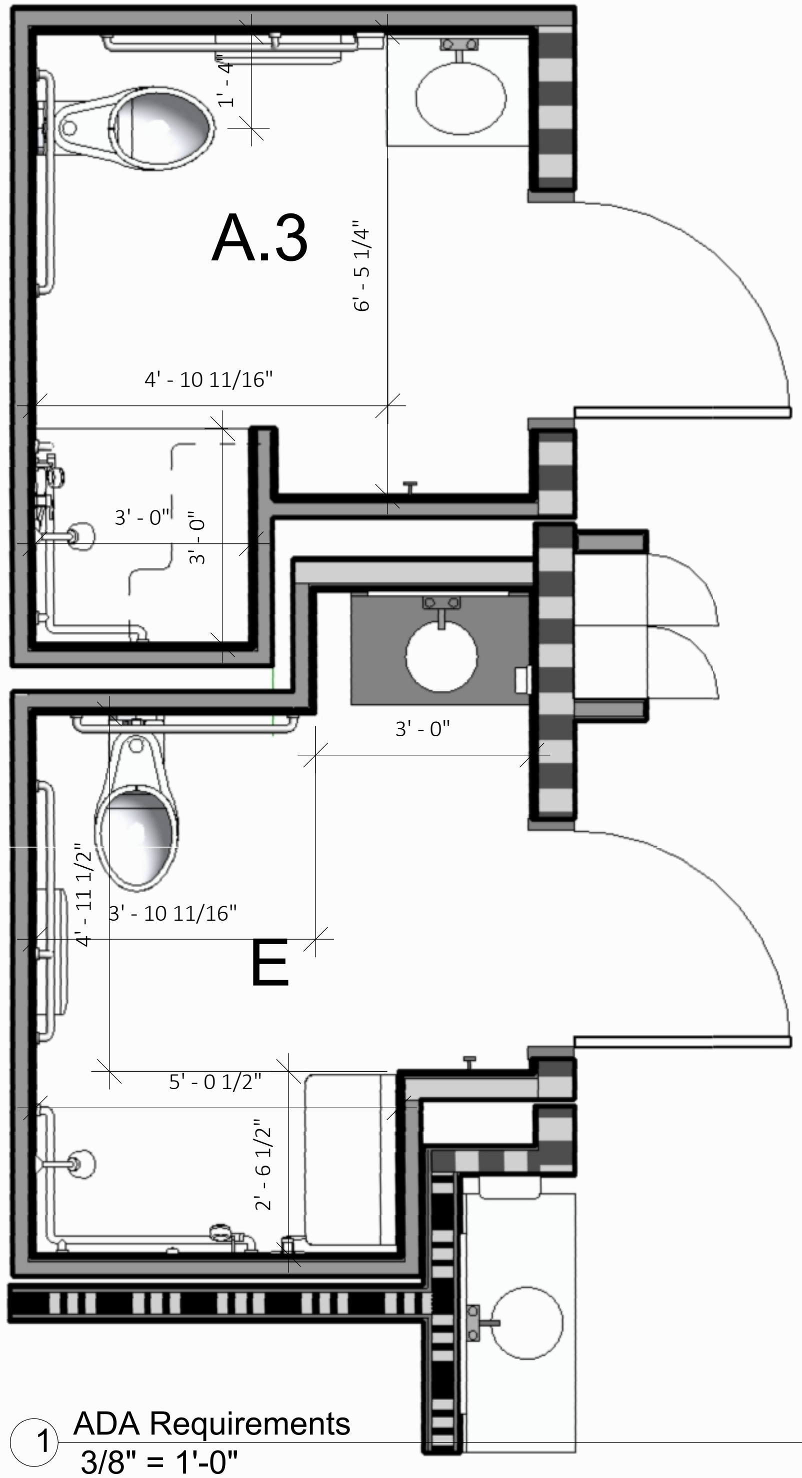
Pod Roll-In Shower Layout

Project number	Project Number
Date	01/26/2014
Drawn by	QWS
Checked by	Checker

A103

Scale 1/4" = 1'-0"

2/4/2014 9:27:42 PM



① ADA Requirements
3/8" = 1'-0"

Autodesk® Revit®

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Penn State

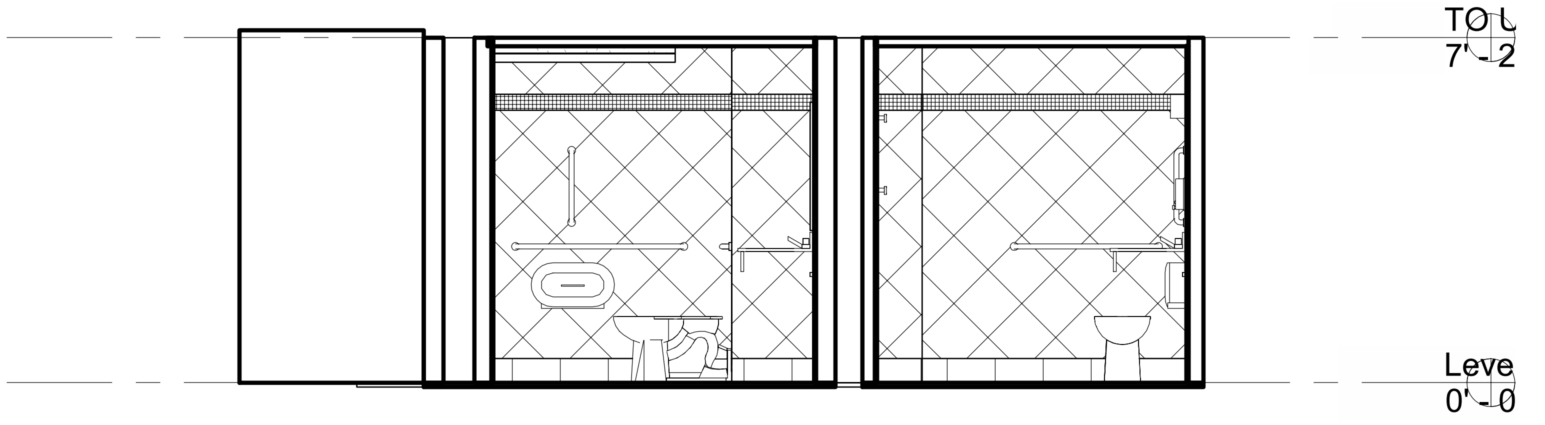
South Halls Renovation

No.	Description	Date

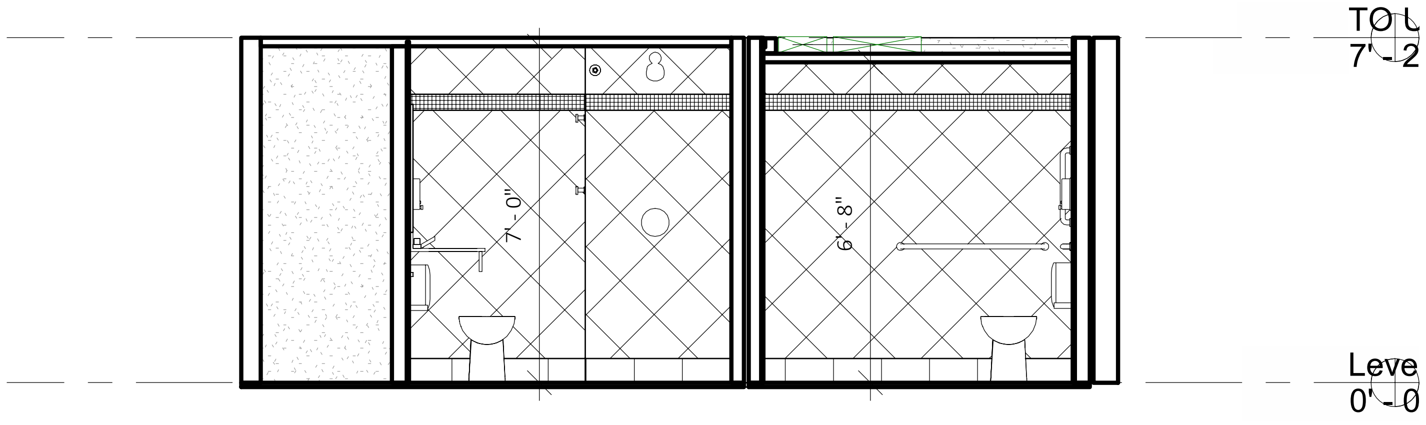
ADA Requirements Roll-In Shower

Project number	Project Number	A104
Date	01/26/2014	
Drawn by	QWS	
Checked by	Checker	Scale 3/8" = 1'-0"

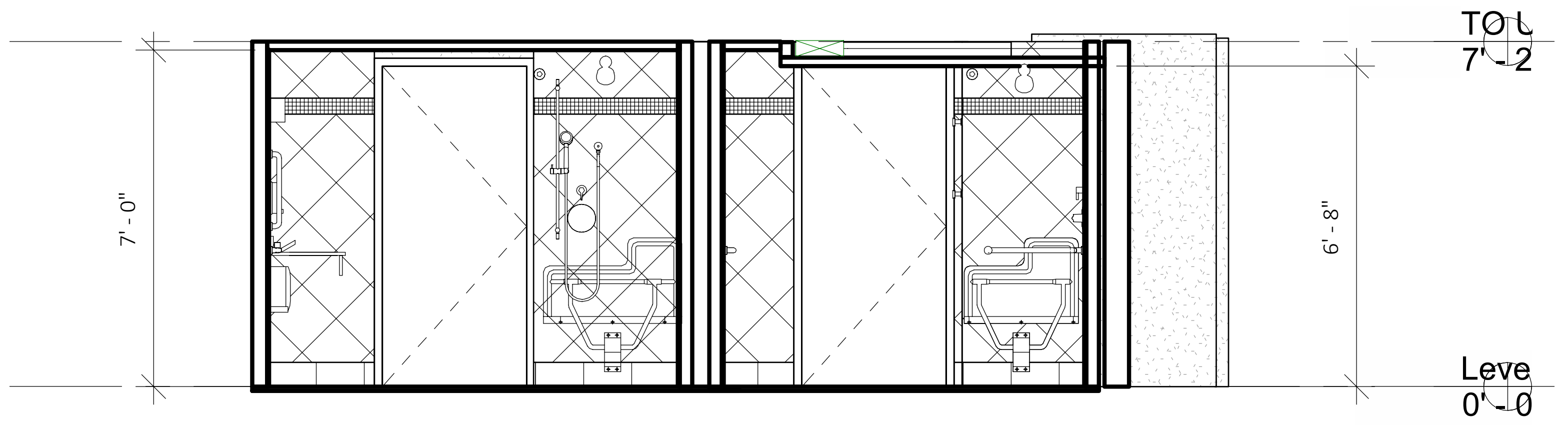
2/4/2014 9:27:43 PM



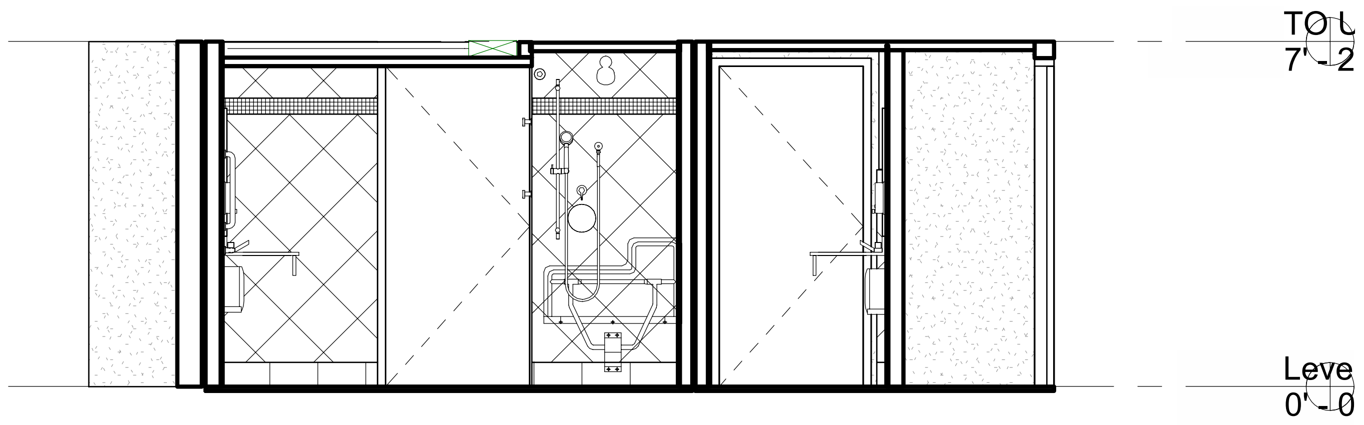
1 Pod C & A.1 West
1/4" = 1'-0"



3 Pod B & A.2 East
1/4" = 1'-0"



2 Pod A.1 & C East
1/4" = 1'-0"



4 Pod B & A.2 West
1/4" = 1'-0"

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Penn State
South Halls Renovation

No.	Description	Date

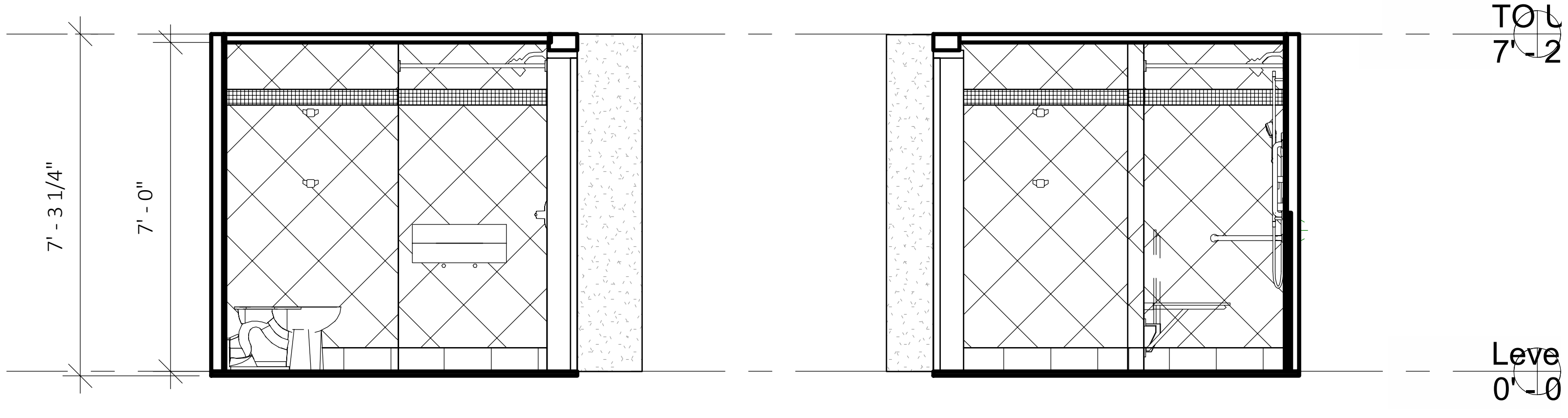
Pod Sections

Project number	Project Number
Date	01/26/2014
Drawn by	QWS
Checked by	Checker

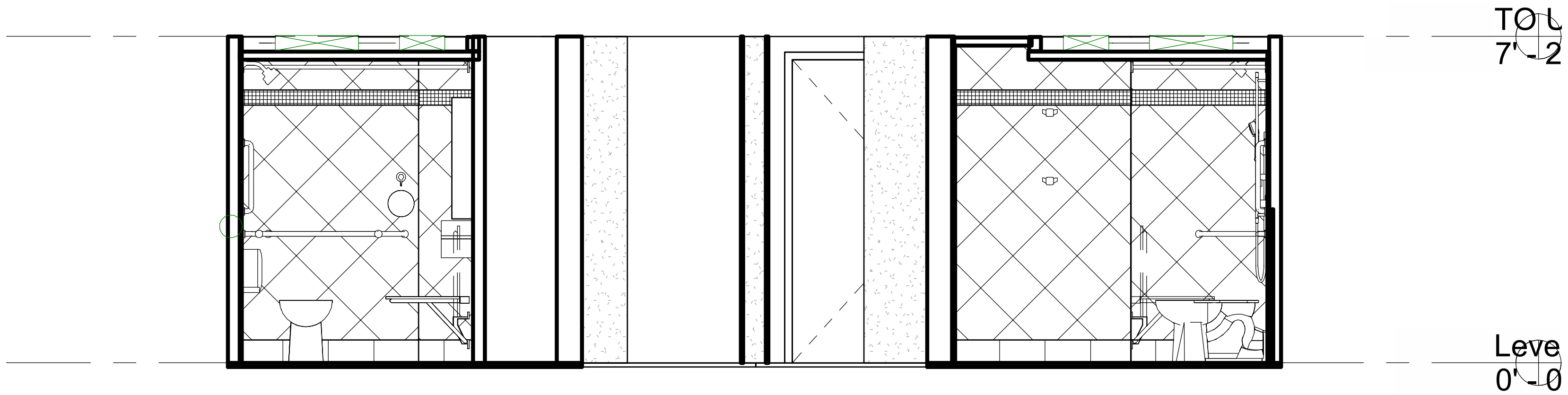
A301

Scale 1/4" = 1'-0"

2/4/2014 9:27:45 PM



1 Pod A.1 & B
1/4" = 1'-0"



2 Pod C & A.2
1/4" = 1'-0"

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Penn State

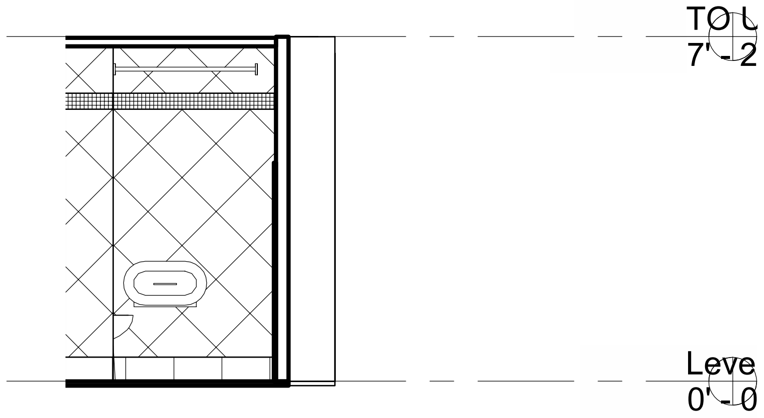
South Halls Renovation

No.	Description	Date

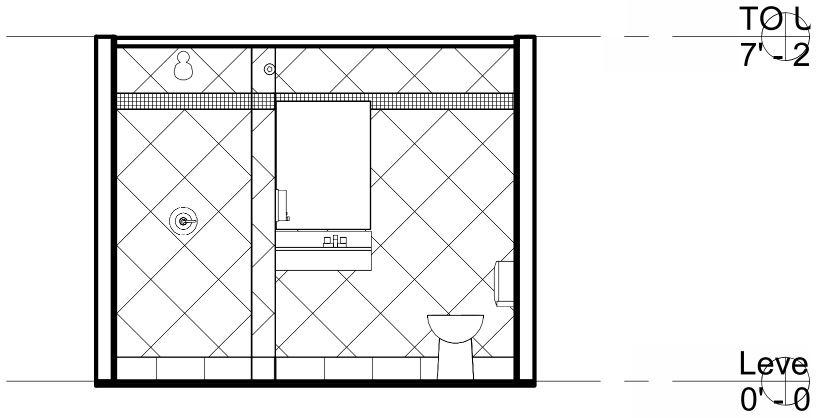
Pod Sections

Project number	Project Number	A302
Date	01/26/2014	
Drawn by	QWS	
Checked by	Checker	Scale 1/4" = 1'-0"

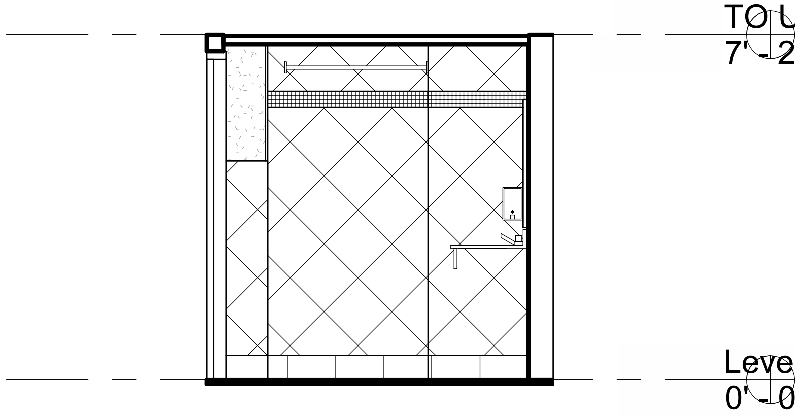
2/4/2014 9:27:46 PM



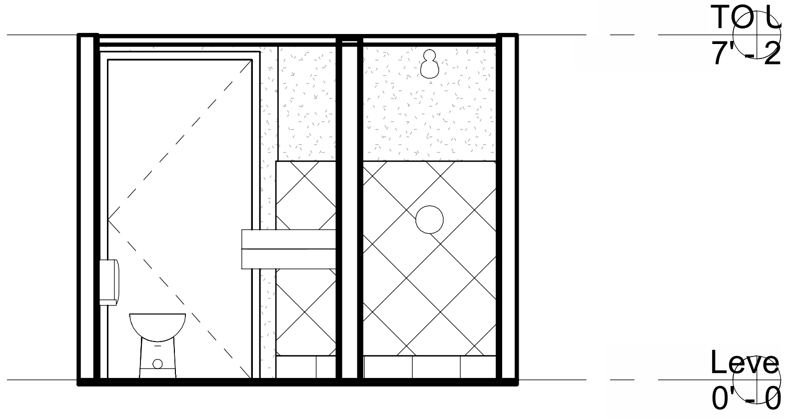
① Pod D East
1/4" = 1'-0"



③ Pod D North
1/4" = 1'-0"



② Pod D West
1/4" = 1'-0"



④ Pod D South
1/4" = 1'-0"

Autodesk® Revit®

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Penn State

South Halls Renovation

No.	Description	Date

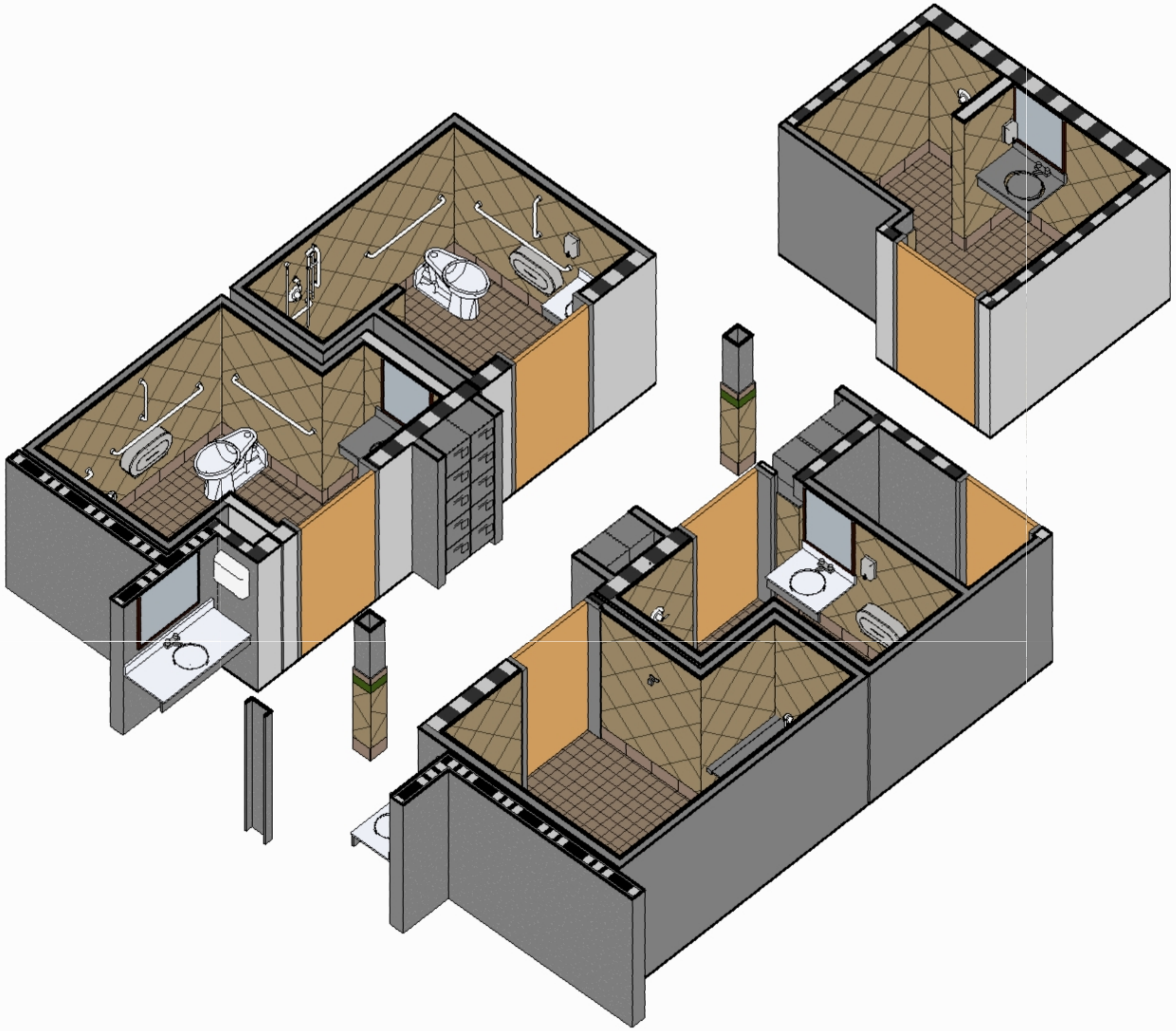
Pod Sections D

Project number Project Number
Date 01/26/2014
Drawn by QWS
Checked by Checker

A303

Scale 1/4" = 1'-0"

2/4/2014 9:27:46 PM



1 Iso Section Cut

Autodesk® Revit®

www.autodesk.com/revit

Penn State

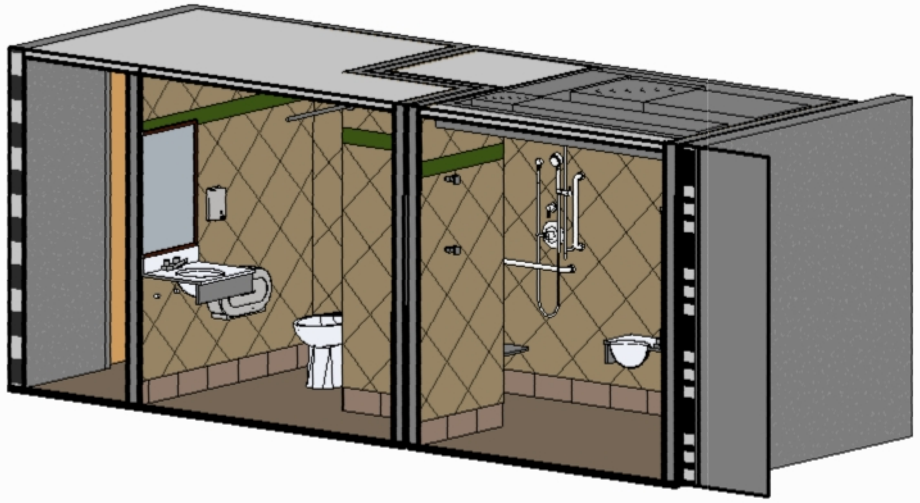
South Halls Renovation

No.	Description	Date

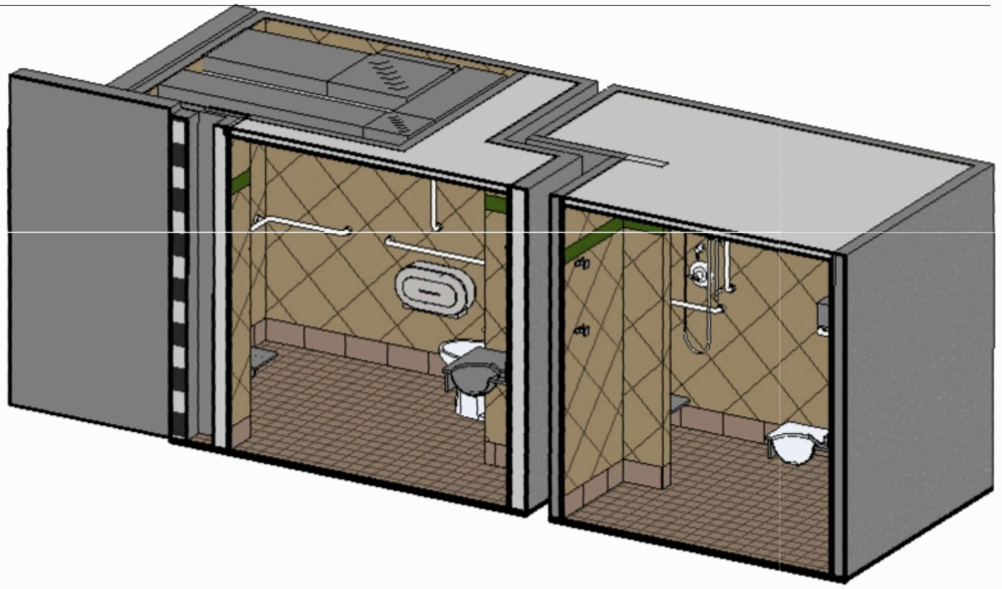
Iso Section Cut Roll-In Shower

Project number	Project Number	A901
Date	01/26/2014	
Drawn by	Author	
Checked by	Checker	Scale

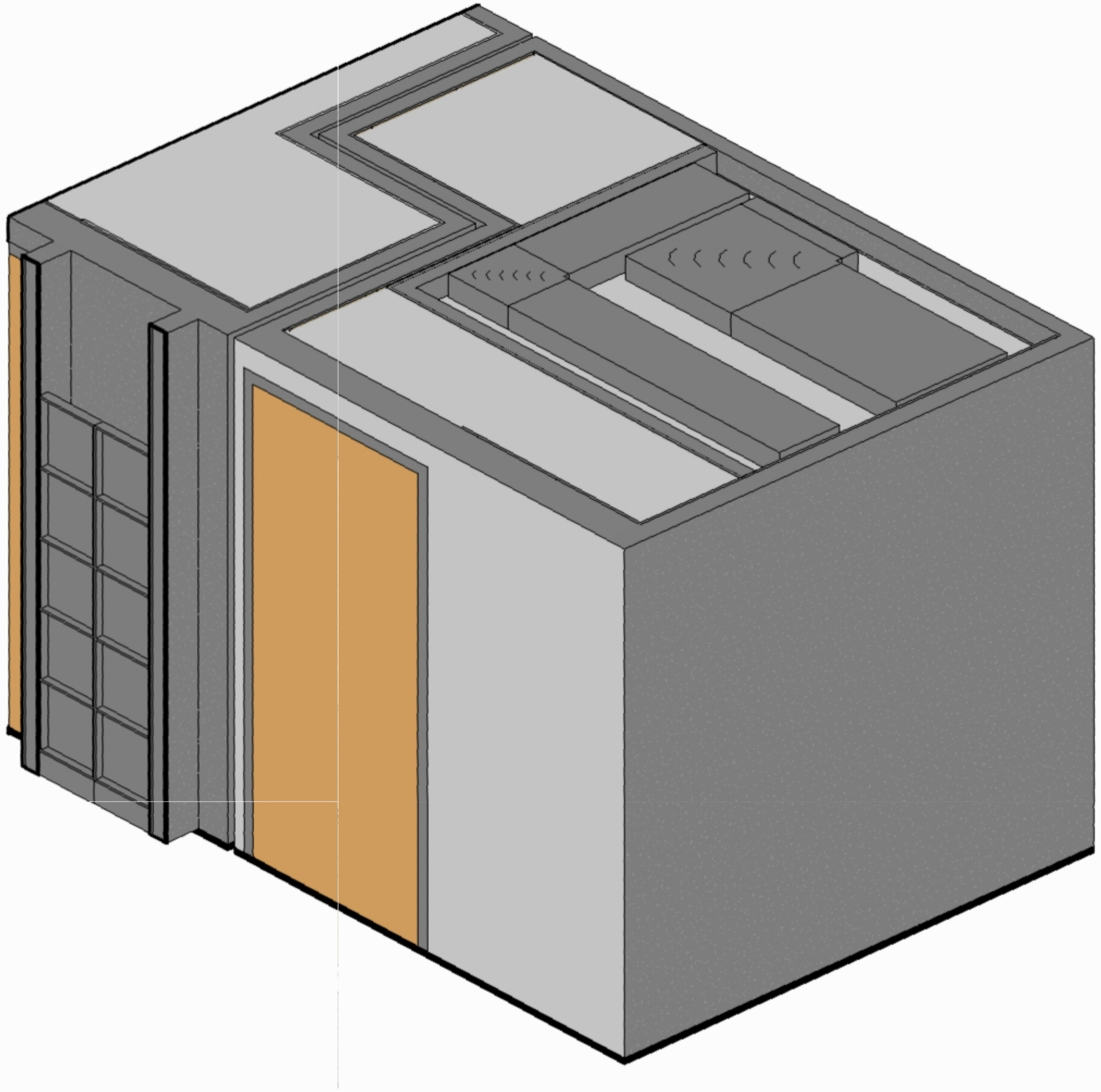
2/4/2014 9:27:47 PM



1 Iso Cut A.2 and B



2 Iso Cut E and A.3



3 Typical Pod

Autodesk® Revit®

www.autodesk.com/revit

Penn State

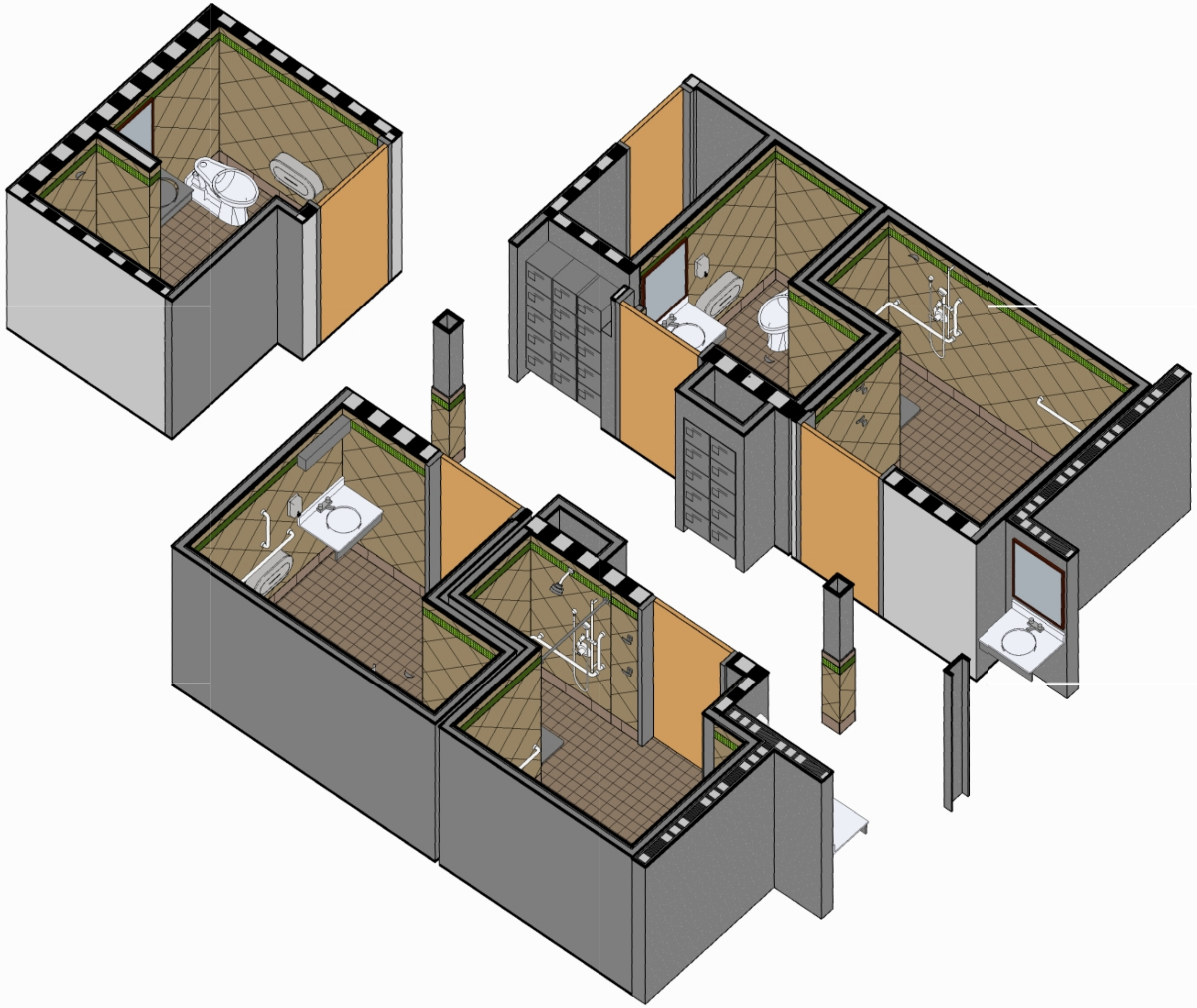
South Halls Renovation

No.	Description	Date

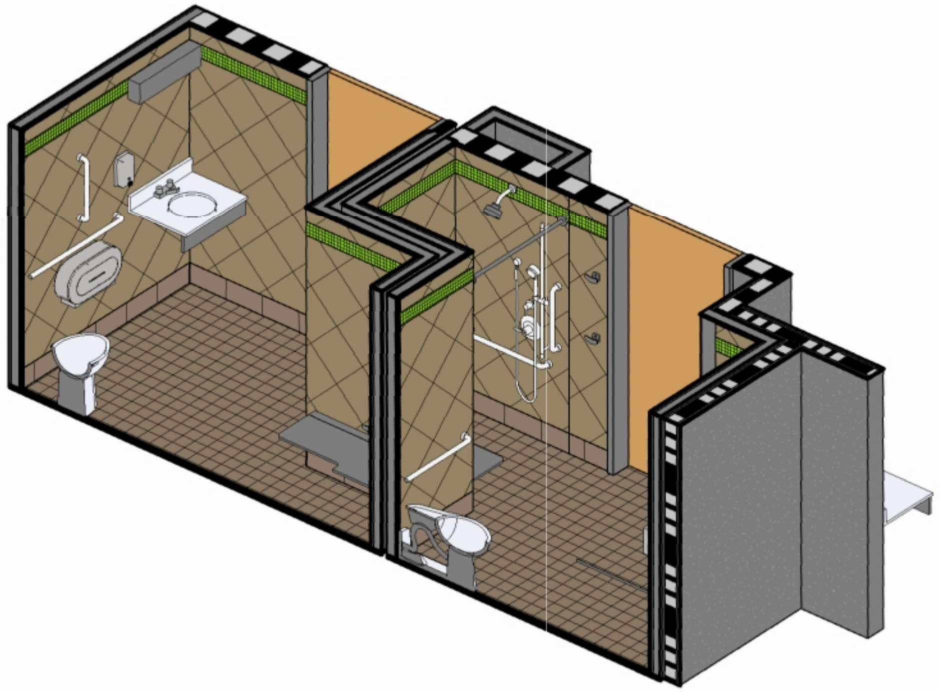
Iso Sections

Project number	Project Number	A902
Date	01/26/2014	
Drawn by	Author	
Checked by	Checker	Scale

2/4/2014 9:27:48 PM



① Iso Section Typical



② Bathrooms A.1 and C Typical

Autodesk® Revit®

www.autodesk.com/revit

Penn State

South Halls Renovation

No.	Description	Date

Iso Section Typical

Project number	Project Number
Date	01/26/2014
Drawn by	Author
Checked by	Checker

A903

Scale

2/15/2014 5:49:47 PM

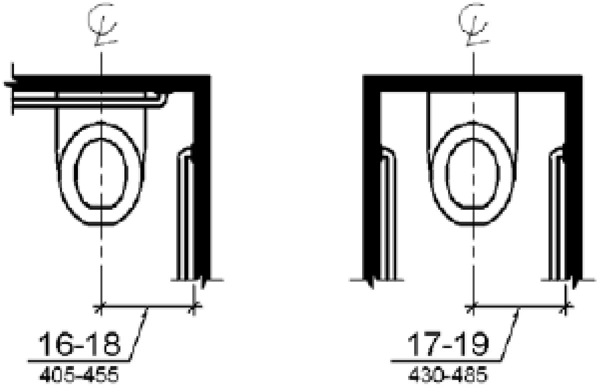
APPENDIX G: ADA CODE

Excerpts From 2010 ADA Standards for Accessible Design

213.2 Toilet Rooms and Bathing Rooms. Where toilet rooms are provided, each toilet room shall comply with 603. Where bathing rooms are provided, each bathing room shall comply with 603.

> **4.** Where multiple single user toilet rooms are clustered at a single location, no more than 50 percent of the single user toilet rooms for each use at each cluster shall be required to comply with 603.

604.2 Location. The water closet shall be positioned with a wall or partition to the rear and to one side. The centerline of the water closet shall be 16 inches (405 mm) minimum to 18 inches (455 mm) maximum from the side wall or partition, except that the water closet shall be 17 inches (430 mm) minimum and 19 inches (485 mm) maximum from the side wall or partition in the ambulatory *accessible* toilet compartment specified in 604.8.2. Water closets shall be arranged for a left-hand or right-hand approach.



(a)
wheelchair
accessible
water closets

(b)
ambulatory
accessible water
closets

Figure 604.2
Water Closet Location

604.3 Clearance. Clearances around water closets and in toilet compartments shall comply with 604.3.

604.3.1 Size. Clearance around a water closet shall be 60 inches (1525 mm) minimum measured perpendicular from the side wall and 56 inches (1420 mm) minimum measured perpendicular from the rear wall.

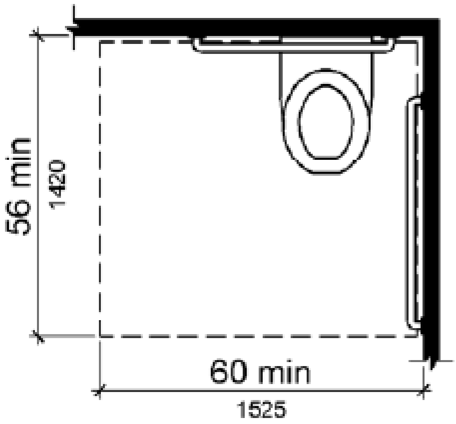
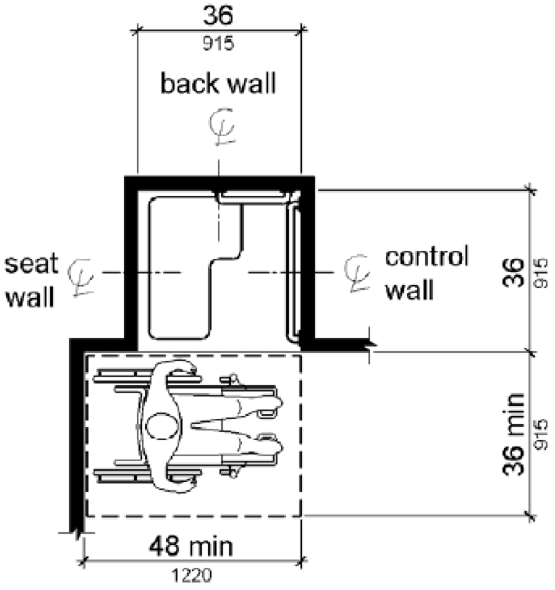


Figure 604.3.1
Size of Clearance at Water Closets

608.2 Size and Clearances for Shower Compartments. Shower compartments shall have sizes and clearances complying with 608.2.

608.2.1 Transfer Type Shower Compartments. Transfer type shower compartments shall be 36 inches (915 mm) by 36 inches (915 mm) clear inside dimensions measured at the center points of opposing sides and shall have a 36 inch (915 mm) wide minimum entry on the face of the shower compartment. Clearance of 36 inches (915 mm) wide minimum by 48 inches (1220 mm) long minimum measured from the control wall shall be provided.



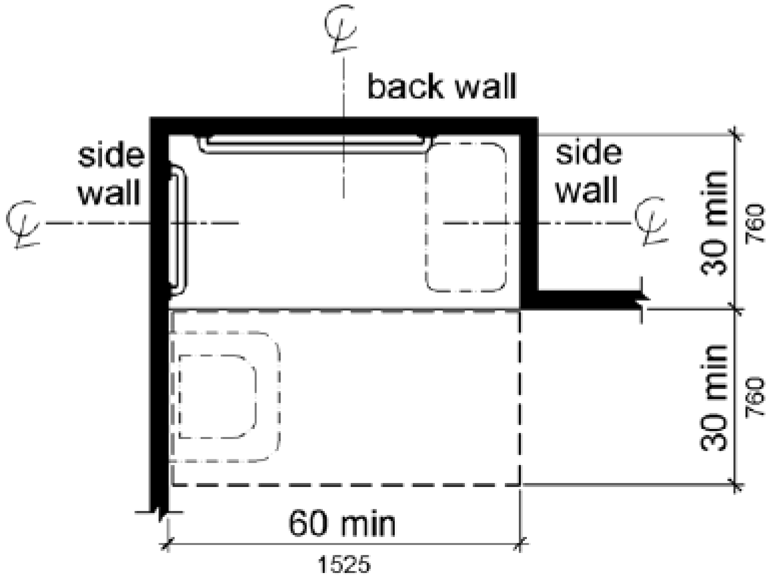
Note: inside finished dimensions measured at the center points of opposing sides

Figure 608.2.1
Transfer Type Shower Compartment Size and Clearance

608.2.2 Standard Roll-In Type Shower Compartments. Standard roll-in type shower compartments shall be 30 inches (760 mm) wide minimum by 60 inches (1525 mm) deep minimum clear inside dimensions measured at center points of opposing sides and shall have a 60 inches (1525 mm) wide minimum entry on the face of the shower compartment.

608.2.2.1 Clearance. A 30 inch (760 mm) wide minimum by 60 inch (1525 mm) long minimum clearance shall be provided adjacent to the open face of the shower compartment.

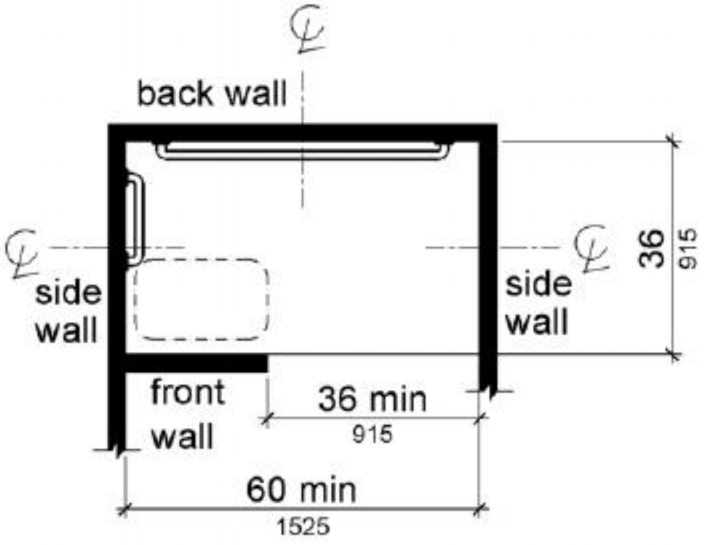
EXCEPTION: A lavatory complying with 606 shall be permitted on one 30 inch (760 mm) wide minimum side of the clearance provided that it is not on the side of the clearance adjacent to the controls or, where provided, not on the side of the clearance adjacent to the shower seat.



Note: inside finished dimensions measured at the center points of opposing sides

Figure 608.2.2
Standard Roll-In Type Shower Compartment Size and Clearance

608.2.3 Alternate Roll-In Type Shower Compartments. Alternate roll-in type shower compartments shall be 36 inches (915 mm) wide and 60 inches (1525 mm) deep minimum clear inside dimensions measured at center points of opposing sides. A 36 inch (915 mm) wide minimum entry shall be provided at one end of the long side of the compartment.



Note: inside finished dimensions measured at the center points of opposing sides

Figure 608.2.3
Alternate Roll-In Type Shower Compartment Size and Clearance

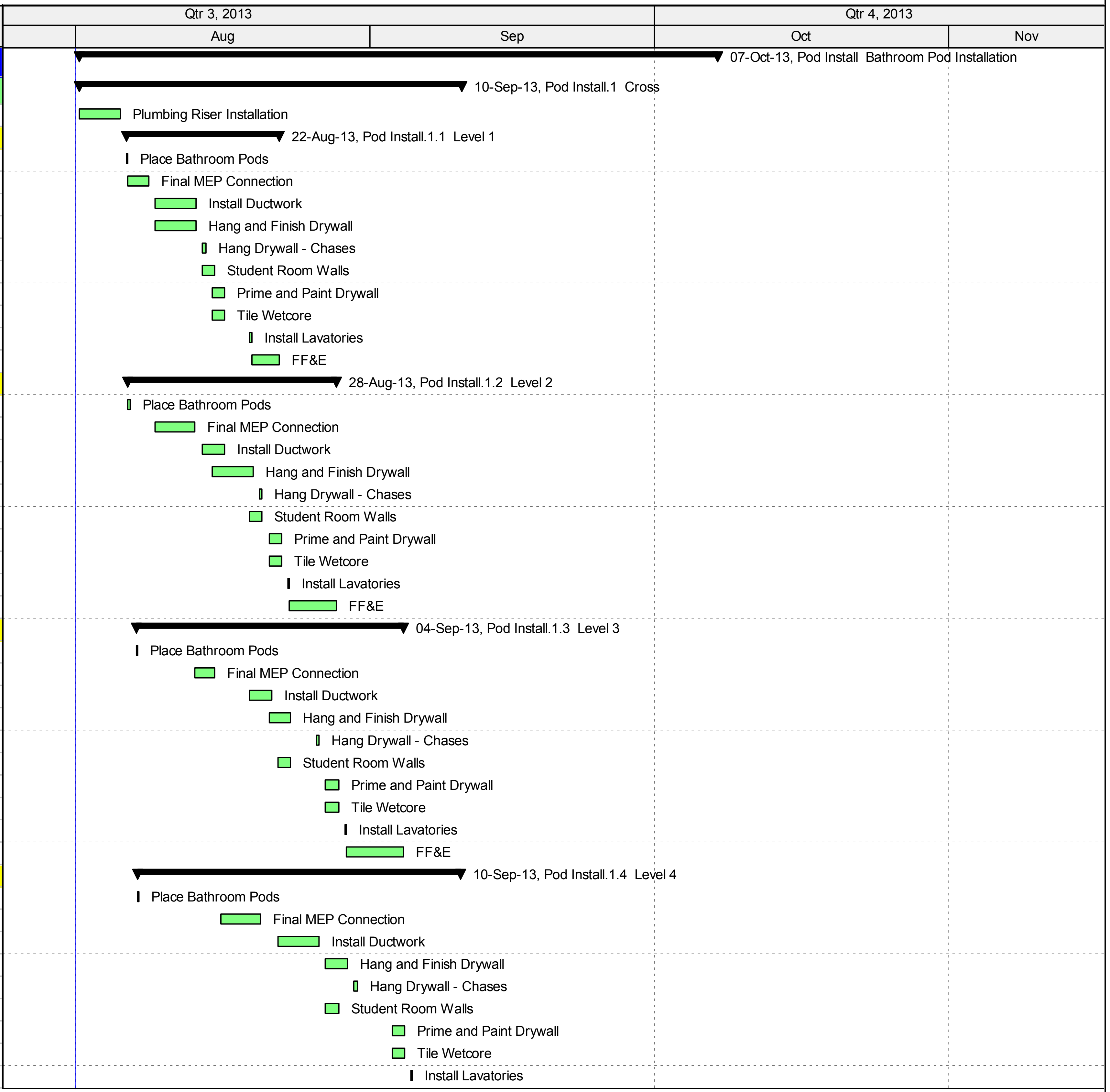
Excerpt from 2009 International Building Code

1208.2 Minimum ceiling heights.

Occupiable spaces, habitable spaces and corridors shall have a ceiling height of not less than 7 feet 6 inches (2286 mm). Bathrooms, toilet rooms, kitchens, storage rooms and laundry rooms shall be permitted to have a ceiling height of not less than 7 feet (2134 mm).

APPENDIX H: BATHROOM POD SCHEDULE

Activity ID	Activity Name	Original Duration	Start	Finish	Predecessors
Pod Install Bathroom Pod Installatio		47	01-Aug-13	07-Oct-13	
Pod Install.1 Cross		28	01-Aug-13	10-Sep-13	
A1000	Plumbing Riser Installation	3	01-Aug-13	05-Aug-13	
Pod Install.1.1 Level 1		13	06-Aug-13	22-Aug-13	
A1340	Place Bathroom Pods	1	06-Aug-13	06-Aug-13	A1000
A1350	Final MEP Connection	3	06-Aug-13	08-Aug-13	A1340
A1360	Install Ductwork	3	09-Aug-13	13-Aug-13	A1350
A1370	Hang and Finish Drywall	3	09-Aug-13	13-Aug-13	A1350
A1380	Hang Drywall - Chases	1	14-Aug-13	14-Aug-13	A1370
A1381	Student Room Walls	2	14-Aug-13	15-Aug-13	A1360
A1385	Prime and Paint Drywall	2	15-Aug-13	16-Aug-13	A1380
A1390	Tile Wetcore	2	15-Aug-13	16-Aug-13	A1380
A1400	Install Lavatories	1	19-Aug-13	19-Aug-13	A1390
A1410	FF&E	3	19-Aug-13	22-Aug-13	A1400
Pod Install.1.2 Level 2		16	06-Aug-13	28-Aug-13	
A1420	Place Bathroom Pods	1	06-Aug-13	06-Aug-13	A1340
A1430	Final MEP Connection	3	09-Aug-13	13-Aug-13	A1420, A1350
A1440	Install Ductwork	3	14-Aug-13	16-Aug-13	A1430, A1360
A1450	Hang and Finish Drywall	3	15-Aug-13	19-Aug-13	A1430, A1380
A1460	Hang Drywall - Chases	1	20-Aug-13	20-Aug-13	A1450
A1461	Student Room Walls	2	19-Aug-13	20-Aug-13	A1440
A1465	Prime and Paint Drywall	2	21-Aug-13	22-Aug-13	A1460, A1385
A1470	Tile Wetcore	2	21-Aug-13	22-Aug-13	A1460, A1390
A1480	Install Lavatories	1	23-Aug-13	23-Aug-13	A1470, A1410
A1490	FF&E	3	23-Aug-13	28-Aug-13	A1480
Pod Install.1.3 Level 3		20	07-Aug-13	04-Sep-13	
A1500	Place Bathroom Pods	1	07-Aug-13	07-Aug-13	A1420
A1510	Final MEP Connection	3	13-Aug-13	15-Aug-13	A1500, A1430
A1520	Install Ductwork	3	19-Aug-13	21-Aug-13	A1510, A1440
A1530	Hang and Finish Drywall	3	21-Aug-13	23-Aug-13	A1510, A1460
A1540	Hang Drywall - Chases	1	26-Aug-13	26-Aug-13	A1530
A1541	Student Room Walls	2	22-Aug-13	23-Aug-13	A1520
A1545	Prime and Paint Drywall	2	27-Aug-13	28-Aug-13	A1540, A1465
A1550	Tile Wetcore	2	27-Aug-13	28-Aug-13	A1540, A1470
A1560	Install Lavatories	1	29-Aug-13	29-Aug-13	A1550, A1490
A1570	FF&E	3	29-Aug-13	04-Sep-13	A1560
Pod Install.1.4 Level 4		23	07-Aug-13	10-Sep-13	
A1580	Place Bathroom Pods	1	07-Aug-13	07-Aug-13	A1500
A1590	Final MEP Connection	3	16-Aug-13	20-Aug-13	A1580, A1510
A1600	Install Ductwork	3	22-Aug-13	26-Aug-13	A1590, A1520
A1610	Hang and Finish Drywall	3	27-Aug-13	29-Aug-13	A1590, A1540
A1620	Hang Drywall - Chases	1	30-Aug-13	30-Aug-13	A1610
A1621	Student Room Walls	2	27-Aug-13	28-Aug-13	A1600
A1625	Prime and Paint Drywall	2	03-Sep-13	04-Sep-13	A1620
A1630	Tile Wetcore	2	03-Sep-13	04-Sep-13	A1620, A1550
A1640	Install Lavatories	1	05-Sep-13	05-Sep-13	A1630, A1570



▬ Actual Level of Effort	🟩 Remaining Work	◆ ◆ Milestone
▬ Actual Work	🟥 Critical Remaining Work	▬ summary

Project Schedule Penn State University Ewing Cross Renovation

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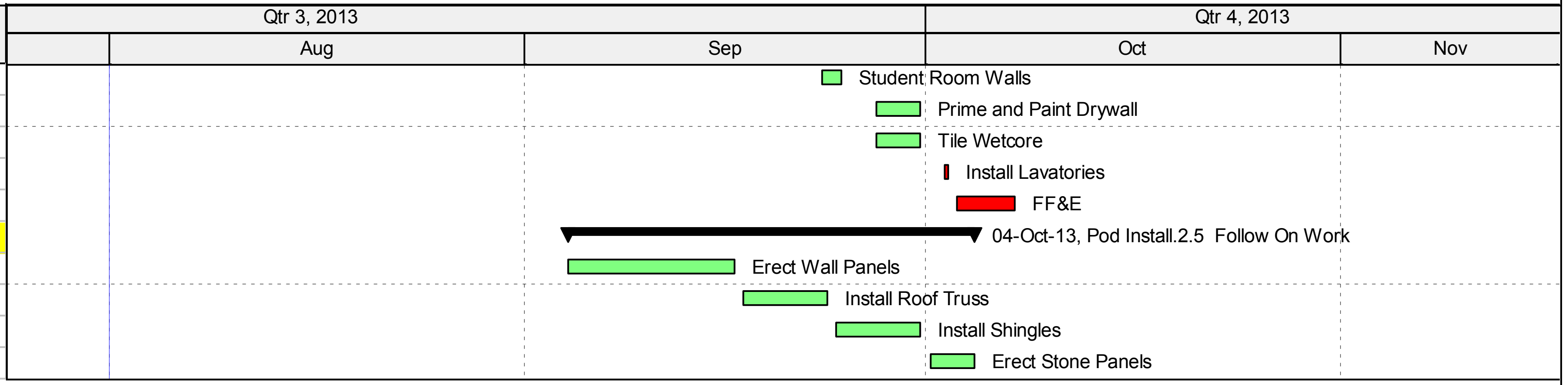
Activity ID	Activity Name	Original Duration	Start	Finish	Predecessors
A1650	FF&E	3	05-Sep-13	10-Sep-13	A1640
Pod Install.1.5 Follow On Work		**23**	**08-Aug-13**	**10-Sep-13**	
A1700	Erect Wall Panels	9	08-Aug-13	20-Aug-13	A1580
A1710	Install Roof Truss	5	21-Aug-13	27-Aug-13	A1700
A1720	Install Shingles	5	28-Aug-13	04-Sep-13	A1710
A1730	Erect Stone Panels	4	05-Sep-13	10-Sep-13	A1720
Pod Install.2 Ewing		29	27-Aug-13	07-Oct-13	
A1090	Plumbing Riser Install	3	27-Aug-13*	29-Aug-13	
Pod Install.2.1 Level 1		**15**	**30-Aug-13**	**20-Sep-13**	
A1010	Place Bathroom Pods	1	30-Aug-13	30-Aug-13	A1090
A1020	Final MEP Connection	3	30-Aug-13	04-Sep-13	A1010
A1030	Install Ductwork	3	05-Sep-13	09-Sep-13	A1020
A1040	Hang and Finish Drywall	3	05-Sep-13	09-Sep-13	A1020
A1050	Hang Drywall - Chases	1	10-Sep-13	10-Sep-13	A1040
A1051	Student Room Walls	2	10-Sep-13	11-Sep-13	A1030
A1055	Prime and Paint Drywall	2	11-Sep-13	12-Sep-13	A1050
A1060	Tile Wetcore	2	13-Sep-13	16-Sep-13	A1050, A1055
A1070	Install Lavatories	1	17-Sep-13	17-Sep-13	A1060
A1080	FF&E	3	17-Sep-13	20-Sep-13	A1070
Pod Install.2.2 Level 2		**18**	**30-Aug-13**	**26-Sep-13**	
A1100	Place Bathroom Pods	1	30-Aug-13	30-Aug-13	A1010
A1110	Final MEP Connection	3	05-Sep-13	09-Sep-13	A1100, A1020
A1120	Install Ductwork	3	10-Sep-13	12-Sep-13	A1110, A1030
A1130	Hang and Finish Drywall	3	11-Sep-13	13-Sep-13	A1110, A1050
A1140	Hang Drywall - Chases	1	16-Sep-13	16-Sep-13	A1130
A1141	Student Room Walls	2	13-Sep-13	16-Sep-13	A1120
A1145	Prime and Paint Drywall	2	17-Sep-13	18-Sep-13	A1140, A1055
A1150	Tile Wetcore	2	19-Sep-13	20-Sep-13	A1140, A1060, A11
A1160	Install Lavatories	1	23-Sep-13	23-Sep-13	A1150, A1080
A1170	FF&E	3	23-Sep-13	26-Sep-13	A1160
Pod Install.2.3 Level 3		**22**	**03-Sep-13**	**02-Oct-13**	
A1180	Place Bathroom Pods	1	03-Sep-13	03-Sep-13	A1100
A1190	Final MEP Connection	3	09-Sep-13	11-Sep-13	A1180, A1110
A1200	Install Ductwork	3	13-Sep-13	17-Sep-13	A1190, A1120
A1210	Hang and Finish Drywall	3	17-Sep-13	19-Sep-13	A1190, A1140
A1220	Hang Drywall - Chases	1	20-Sep-13	20-Sep-13	A1210
A1221	Student Room Walls	2	18-Sep-13	19-Sep-13	A1200
A1225	Prime and Paint Drywall	2	23-Sep-13	24-Sep-13	A1220, A1145
A1230	Tile Wetcore	2	25-Sep-13	26-Sep-13	A1220, A1150, A12
A1240	Install Lavatories	1	27-Sep-13	27-Sep-13	A1230, A1170
A1250	FF&E	3	27-Sep-13	02-Oct-13	A1240
Pod Install.2.4 Level 4		**25**	**03-Sep-13**	**07-Oct-13**	
A1260	Place Bathroom Pods	1	03-Sep-13	03-Sep-13	A1180
A1270	Final MEP Connection	3	12-Sep-13	16-Sep-13	A1260, A1190
A1280	Install Ductwork	3	18-Sep-13	20-Sep-13	A1270, A1200
A1290	Hang and Finish Drywall	3	23-Sep-13	25-Sep-13	A1270, A1220
A1300	Hang Drywall - Chases	1	26-Sep-13	26-Sep-13	A1290

▬ Actual Level of Effort	🟩 Remaining Work	◆ ◆ Milestone
▬ Actual Work	🟥 Critical Remaining Work	▬ summary

Project Schedule Penn State University Ewing Cross Renovation

Activity ID	Activity Name	Original Duration	Start	Finish	Predecessors
A1301	Student Room Walls	2	23-Sep-13	24-Sep-13	A1280
A1305	Prime and Paint Drywall	2	27-Sep-13	30-Sep-13	A1225, A1300
A1310	Tile Wetcore	2	27-Sep-13	30-Sep-13	A1300, A1230
A1320	Install Lavatories	1	02-Oct-13	02-Oct-13	A1310, A1250
A1330	FF&E	3	03-Oct-13	07-Oct-13	A1320
Pod Install.2.5 Follow On Work		**23**	**04-Sep-13**	**04-Oct-13**	
A1660	Erect Wall Panels	9	04-Sep-13	16-Sep-13	A1260
A1670	Install Roof Truss	5	17-Sep-13	23-Sep-13	A1660
A1680	Install Shingles	5	24-Sep-13	30-Sep-13	A1670
A1690	Erect Stone Panels	4	01-Oct-13	04-Oct-13	A1680



▬ Actual Level of Effort
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🟩 Remaining Work
🟥 Critical Remaining Work
◆ ◆ Milestone
▼▼ summary

Project Schedule Penn State University Ewing Cross Renovation

APPENDIX I: BATHROOM COST ESTIMATE

Crane Estimate for Bathroom Pod Installation

Source	Description	Crew	Daily Output	Labor Hours	Unit	Quantity	Labor $/Unit	Equip $/Unit	Labor Total	Equip Total	Grand Total
015419500200	25 Ton Crane and Crew	A3I	1	8	Day	4	$ 567.00	$ 1,240.00	$ 2,268.00	$ 4,960.00	**$ 7,228.00** *

*Pricing is per building, extrapolated for the entire South Halls Renovation, crane rental fees will be $28,912

Typical Bathroom Takeoff

RS Means Code	Description		Quantity	Unit	Daily Output	Labor Hours	Mat. $/Unit	Mat. Total	Labor $/Unit	Labor Total	Grand Total
	Flooring										
093013103310	PRC6	2" x 4" Mosaic Tile	57	SF	190	0.08	$ 5.49	$ 311.28	$ 2.50	$ 141.75	$ 453.03
093413100030		Waterproofing Membrane	74	SF	250	0.06	$ 2.06	$ 151.41	$ 1.90	$ 139.65	$ 291.06
	Ceiling							$ -		$ -	$ -
092910303250		5/8" WR GWB	57	SF	765	0.02	$ 0.47	$ 26.65	$ 0.79	$ 44.79	$ 71.44
	Wall Assemblies							$ -			$ -
054113304200	30A6S	6" MTL STUD @ 16" O.C.	15	LF	73	0.22	$ 10.49	$ 161.80	$ 11.96	$ 184.48	$ 346.28
072116200020		3-1/2" BATT INSUL.	123	SF	1350	0.01	$ 0.27	$ 33.32	$ 0.25	$ 30.85	$ 64.17
092813100200		CEMENTITIOUS BACKERBOARD	123	SF	350	0.05	$ 0.89	$ 109.82	$ 1.72	$ 212.24	$ 322.06
054113304200	0A6S	6" MTL STUD @ 16" O.C.	7	LF	73	0.22	$ 10.49	$ 75.45	$ 11.96	$ 86.02	$ 161.47
072116200160		5-1/2" BATT INSUL.	58	SF	1350	0.01	$ 0.44	$ 25.32	$ 0.25	$ 14.39	$ 39.70
092813100200		CEMENTITIOUS BACKERBOARD	58	SF	350	0.05	$ 0.89	$ 51.21	$ 1.72	$ 98.97	$ 150.18
054113304140	0A4B	3-5/8" MTL STUD @ 16" O.C.	3	LF	76	0.21	$ 7.86	$ 23.58	$ 11.48	$ 34.44	$ 58.02
092813100200		CEMENTITIOUS BACKERBOARD	24	SF	350	0.05	$ 0.89	$ 21.36	$ 1.72	$ 41.28	$ 62.64
054113304200	0A6B	6" MTL STUD @ 16" O.C.	7	LF	73	0.22	$ 10.49	$ 73.43	$ 11.96	$ 83.72	$ 157.15
092813100200		CEMENTITIOUS BACKERBOARD	56	SF	350	0.05	$ 0.89	$ 49.84	$ 1.72	$ 96.32	$ 146.16
	Wall Tile							$ -			$ -
093013105820	PRC1	12" X 12" TILE	235	SF	80	0.2	$ 4.02	$ 945.50	$ 5.94	$ 1,397.09	$ 2,342.59
093013100050	PRC4	6" X 12" TILE BASE	34	LF	82	0.2	$ 5.45	$ 183.12	$ 5.80	$ 194.88	$ 378.00
093023100450	GT2	1/2" X 1/2 MOSAIC TILE	11	SF	73	0.22	$ 25.38	$ 281.41	$ 6.51	$ 72.18	$ 353.60
093013102700	PRC5	3" X 12" BULLNOSE	34	LF	84	0.19	$ 3.94	$ 132.38	$ 5.64	$ 189.50	$ 321.89
	Electrical							$ -			$ -
260923100150		OS Switch	1	EA	24	0.333	$ 58.57	$ 58.57	$ 19.78	$ 19.78	$ 78.35
265113502310	A1	FIXTURE 6X24 WALL MNT; BRONZE; 2 F17T8	1	EA	8	1	$ 200.00	$ 200.00	$ 59.44	$ 59.44	$ 259.44
265113501100	C1	FIXTURE 6X24 CLG MNT 2 F17T8; SHOWER	1	EA	7	1.14	$ 150.00	$ 150.00	$ 67.77	$ 67.77	$ 217.77
266113300150		FIXTURE WHIP	4	EA	28	0.29	$ 8.26	$ 33.04	$ 16.94	$ 67.76	$ 100.80
260505101720		JUNCTION BOX	2	EA	80	0.1	$ -	$ -	$ 5.94	$ 11.88	$ 11.88
260590104320		GFI Rec.	1	EA	10.67	0.75	$ 53.12	$ 53.12	$ 44.44	$ 44.44	$ 97.56
	Plumbing - Waste							$ -			$ -
221113741140	Sink	3" Waste Line	8	LF	50	0.32	$ 27.49	$ 219.92	$ 13.76	$ 110.08	$ 330.00
221113762470		3" T	1	EA	13.9	1.15	$ 40.76	$ 40.76	$ 49.33	$ 49.33	$ 90.09
221113741110		1-1/2" Waste Line	4	LF	34	0.23	$ 10.43	$ 41.72	$ 11.23	$ 44.92	$ 86.64
221113762160		1-1/2" 90 Elbow	1	EA	18.2	0.44	$ 6.92	$ 6.92	$ 21.14	$ 21.14	$ 28.06
221316606733		1-1/2" P-Trap	1	EA	18	0.44	$ 11.33	$ 11.33	$ 21.14	$ 21.14	$ 32.47
221113741150	Water Closet	4" Waste Line	12	LF	46	0.35	$ 38.87	$ 466.44	$ 14.92	$ 179.04	$ 645.48
221113762480		4" T	2	EA	11	1.46	$ 46.93	$ 93.86	$ 62.59	$ 125.18	$ 219.04
221113762190		4" 90 Elbow	1	EA	16.5	0.97	$ 33.65	$ 33.65	$ 41.45	$ 41.45	$ 75.10
221113765287		4"-2" Reducer	1	EA	12.2	1.31	$ 36.50	$ 36.50	$ 56.37	$ 56.37	$ 92.87
221113741120		2" Vent Pipe	12	LF	55	0.29	$ 13.51	$ 162.12	$ 12.48	$ 149.76	$ 311.88

221113762170		2" 90 Elbow	1	EA	33.1	0.48	$ 8.39	$ 8.39	$ 20.73	$ 20.73	$ 29.12
221113762460		2" T	1	EA	20	0.8	$ 29.86	$ 29.86	$ 34.40	$ 34.40	$ 64.26
221113741140	Shower	3" Waste Line	8	LF	50	0.32	$ 27.49	$ 219.92	$ 13.76	$ 110.08	$ 330.00
221113764942		3" to 1-1/2" Wye	1	EA	10.6	1.51	$ 62.57	$ 62.57	$ 64.66	$ 64.66	$ 127.23
221113741110		1-1/2" Waste Line	4	LF	34	0.23	$ 10.43	$ 41.72	$ 11.23	$ 44.92	$ 86.64
221113762160		1-1/2" 90 Elbow	1	EA	18.2	0.44	$ 6.92	$ 6.92	$ 21.14	$ 21.14	$ 28.06
221316606733		1-1/2" P-Trap	1	EA	18	0.44	$ 11.33	$ 11.33	$ 21.14	$ 21.14	$ 32.47
	Plumbing - Water							$ -			$ -
221113231140		1/2" Copper Line	49	LF	78	0.1	$ 4.24	$ 209.24	$ 4.89	$ 241.32	$ 450.57
221113231180		3/4" Copper Line	8	LF	74	0.11	$ 7.39	$ 62.08	$ 5.14	$ 43.18	$ 105.25
221113231200		1" Copper Line	8	LF	66	0.12	$ 10.05	$ 84.42	$ 5.80	$ 48.72	$ 133.14
221113231260		2" Copper Line	8	LF	40	0.2	$ 25.12	$ 211.01	$ 9.53	$ 80.05	$ 291.06
221113250100		1/2" Copper Elbow	4	EA	20	0.4	$ 2.92	$ 11.68	$ 19.07	$ 76.28	$ 87.96
221113250480		1/2" T Copper	4	EA	13	0.61	$ 4.98	$ 19.92	$ 29.43	$ 117.72	$ 137.64
221113250510		1" T Copper	1	EA	10	0.8	$ 37.45	$ 37.45	$ 38.13	$ 38.13	$ 75.58
221113250130		1" Copper Elbow	1	EA	16	0.5	$ 16.12	$ 16.12	$ 24.04	$ 24.04	$ 40.16
220719101016		1/2" Fiberglass	74	LF	230	0.07	$ 1.57	$ 116.42	$ 2.71	$ 200.95	$ 317.36
220719101026		1" Fiberglass	8	LF	205	0.08	$ 1.81	$ 15.20	$ 3.04	$ 25.54	$ 40.74
	FF&E							$ -			$ -
123661170015	7	Vanity Countertop	1	EA	12	0.67	$ 186.00	$ 186.00	$ 28.00	$ 28.00	$ 214.00
102813133200	TA6	42" H Mirror	1	EA	10	0.8	$ 139.00	$ 139.00	$ 33.51	$ 33.51	$ 172.51
102813131105	TA1	42" SS Grab Bar	1	EA	20	0.4	$ 46.00	$ 46.00	$ 16.85	$ 16.85	$ 62.85
102813130800	TA19	18" Vertical SS Grab Bar	1	EA	24	0.33	$ 29.00	$ 29.00	$ 14.05	$ 14.05	$ 43.05
102813131300	TA2	36" SS Grab Bar	1	EA	20	0.4	$ 33.50	$ 33.50	$ 16.85	$ 16.85	$ 50.35
102813131120	TA17	18" x 30" L-Shape SS Grab Bar	1	EA	20	0.4	$ 85.50	$ 85.50	$ 16.85	$ 16.85	$ 102.35
102813130350	TA12	36" Heavy Duty Shower Rod	1	EA	13	0.61	$ 32.50	$ 32.50	$ 25.70	$ 25.70	$ 58.20
102813134300	TA21	Robe Hook	2	EA	36	0.22	$ 18.10	$ 36.20	$ 9.36	$ 18.72	$ 54.92
224116106000	P-3	15" x 12" ADA Lavatory	1	EA	7	2.29	$ 218.99	$ 218.99	$ 97.82	$ 97.82	$ 316.81
224113401110	P-1B	ADA WC 16-1/2" Hgt	1	EA	5.3	3.02	$ 283.45	$ 283.45	$ 129.32	$ 129.32	$ 412.77
224123405200	P-6	Shower; Head/Handset; Single Lever	1	EA	3.6	2.22	$ 241.74	$ 241.74	$ 106.11	$ 106.11	$ 347.85
081416090210	2	3' x 6'-8" x 1-3/4" Wood	1	EA	16	1	$ 97.01	$ 97.01	$ 45.59	$ 45.59	$ 142.60
081213130025		HM Door Frame	1	EA	16	1	$ 129.05	$ 129.05	$ 45.59	$ 45.59	$ 174.64
233713301000	12	6" X 4" Mech Grille EA	1	EA	26	0.31	$ 18.68	$ 18.68	$ 13.16	$ 13.16	$ 31.84
083113101350		42" x 36" Access Panel	1	EA	7.5	1.07	$ 440.55	$ 440.55	$ 48.56	$ 48.56	$ 489.11
Subtotal								$ 7,446.26		$ 6,001.70	$ 13,447.96
Tax								$ 446.78		$ 360.10	$ 806.88
Overhead and Profit								$ 744.63		$ 600.17	$ 1,344.80
Grand Total								$ 8,637.66		$ 6,961.98	**$ 15,599.64**

Quotation

AmeriPOD
150 Maple Avenue #295
South Plainfield, New Jersey 07080
Phone: 732-752-4120
Fax: 732-968-4777

Client Information

Name: ______________________________

Address: ______________________________
____

Phone: ______________ Fax: ______________

Proposal Information

Quotation No: XXXX
Author: Tom Caldwell
Date: 2/4/2014

Item	Description	QTY	Unit Price	Total
1	Penn State South Halls Renovation - Modular Bathroom Type A Layout	64	$12,134	$776,576
2	Penn State South Halls Renovation - Modular Bathroom Type B Layout (w/ Rough-In For Bath Area Sink)	32	$14,801	$473,632
3	Penn State South Halls Renovation - Modular Bathroom Type C Layout (w/ Rough-In For Bath Area Sink)	28	$14,801	$414,428
4	Penn State South Halls Renovation - Modular Bathroom Type D Layout	32	$14,422	$461,504
5	Penn State South Halls Renovation - Modular Bathroom Type E Layout (w/ Accessible Roll-In Tiled Shower)	4	$13,907	$55,628

***POD Fabrication, Delivery, Staging, & Installation Subtotal:** **$2,181,768**

6	POD Transportation - 53' Enclosed Trailer Deliveries From South Plainfield, NJ to State College, PA	34	-	**Included In POD Unit Prices**
7	**PSU South Halls Renovation Bathroom POD Staging & Installation	160	-	**Included In POD Unit Prices**

8	Penn State South Halls Modular Bathroom Prototype (Dedicated Throw Away Unit, Delivered To Penn State For Project Team Review)	LS	$22,822	**$22,822**

Tax: **Excluded**

Penn State South Halls Renovation POD Scope of Work Grand Total: **$2,204,590**

Notes:

*All POD types identified above were developed from the Penn State South Halls Phase 1 architectural drawing AE014 without deviation to interior layouts. An 7'-0" bathroom interior ceiling height was assumed for all units to allow installation into the current designed building structure. Further review of MEP & building structure is required to assure POD installation is accessible based on current slab-to-slab height. Bathroom POD walls do not carry a fire rating due to modular construction technique, bathroom modules to be installed against field built rated partitions. Modules include all framing, fixtures, finishes, door, hardware, & accessories as detailed in the accompanying POD specifications. Specifications developed from architectural layout of units and AmeriPOD's previous dormitory experience. Full height tile finish provided for all wall applications, possible project savings can be achieved through less tiled surfaces in unnecessary areas. Any deviations or desired changes to the specifications can be made in future proposals.

****Bathroom POD Staging and Installation Includes**: Off-loading modules from coordinated delivery vehicles and staging them into the building. PODs will be staged near their final location to await future installation. AmeriPOD will provide installation team with flagmen for coordination of incoming delivery vehicles. AmeriPOD currently anticipates coordinating use of site crane with GC for hositing PODs up and into the building. AmeriPOD will provide all loading platforms and spreader bars for lifting PODs into the building. Adjustable casters and extended pallet jacks will also be provided for moving PODs around the building floor into final location. GC is to provide an open, level floor surface for movement of the POD into coordinated installation locations. Once necessary framing and MEP connections are prepared and building is weather-tight, installation team will return to complete POD setting. Any leveling, if necessary will be performed by AmeriPOD installation team. Once slab is ready, PODs will be lowered off of the adjustable casters and mechanically fastened to the floor. MEP tie-ins to be performed by others.

APPENDIX J: BATHROOM POD INFORMATION

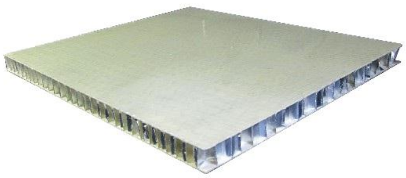
Specifications

Framing, Subflooring, & Drywall Assemblies

Assembly: Bathroom POD Framing
Manufacturer: Marino/WARE
Description: Welded 18 GA Cold Formed Steel Framing w/ Welded Blocking & Reinforcement For Increased Structural Rigidity
Notes:
* 3-5/8" Track & Stud Framing Typical For Bathroom Wet Wall & Door Wall Panels, 1-5/8" Framing Utilized For All Remaining Locations To Allow w/ Integration To Surrounding Bathrooms
* 7'-0" Interior Ceiling Height Provided For All Bathrooms As Standard Based On Structure

Assembly: Interior Gypsum
Manufacturer: USG
Model: Aqua-Tough
Description: 5/8" Fiberock Tile Backer Interior Wall Panels
Notes:
* Suitable For Paint & Tile Finishes
* Highest Rating For Mold Resistance In ASTM D 3273 Testing

Assembly: Bathroom Subflooring
Description: 3/4" Lightweight Composite Honeycomb Panel
Notes:
* Mechanically Fastened & Glued To Welded Wall & Ceiling Panels To Complete Bathroom Structure
* Subflooring Prepared For Rough Plumbing & Drain Stub-Outs For Field Installation



Bathroom Finishes

Assembly:	Porcelain Floor Tile
Manufacturer:	Royal Mosa
Series:	Global Floor Collection
Tile Size:	6" x 6"
Color:	76010V (Plain White) & 75030V (Plain Grey Beige)
Notes:	* Complete Tile Floor Finish For All Areas Outside Walk-In Shower Pan

Assembly:	Glazed Wall Tile
Manufacturer:	Royal Mosa
Series:	Mosa Matte Collection
Tile Size:	6" x 12"
Color:	15810 (Porcelain White) & 15840 (Plain Grey Beige)
Notes:	* Full Height Tile Finish Provided For All Bathroom Walls

Assembly:	Transition Tile Pieces
Manufacturer:	Royal Mosa
Series:	Global Cove & Wall Bullnose Tile
Tile Size:	6" x 6" Cove & Bullnose Cuts
Color:	76010V (Plain White) & 75030V (Plain Grey Beige)
Notes:	* 6" x 6" Cove Base Tile Around Perimeter of Bathroom At Base of Each Wall Panel

Assembly:	Epoxy Grout
Manufacturer:	Mapei
Brand:	Kerapoxy
Description:	Premium-Grade, Water-Cleanable, 100%-Solids, High-Strength Epoxy Grout
Notes:	* Resilient For POD Transport, Final Color Selection TBD

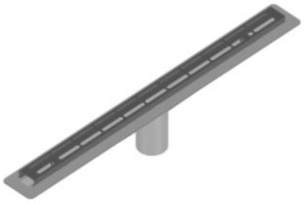
Bathroom Finishes

Assembly: Waterproofing Membrane
Manufacturer: Quickdrain
Brand: Quickdrain TS
Description: Single Sheet Membrane Providing Waterproofing & Crack Isolation For Thin-Set Tile Installations
Notes: * Complete Waterproofing Provided Underneath All Floor Tile Applications, 4" Flashing Provided On All Bathroom POD Wall Panels

Assembly: Ceiling Finish
Manufacturer: Sherwin Williams
Brand: Pro-Industrial Zero VOC Waterborne Catalyzed Epoxy Paint
Color: TBD
Description: Washable, Chemical Resistant, Impact-Resistant Finish, Improved Maintenance
Notes: * Typical Ceiling Finish For All Bathroom Units

Assembly: Soap Dishes
Manufacturer: Daltile
Description: Ceramic Wall Mounted Shower Soap Dish, Arctic White
Notes: * (2) Dishes Included In Shower Tile Surround, Final Color To Match Finish Specs

Assembly: Accessible Shower Drain
Manufacturer: Quickdrain
Models: 60" Custom Low Profile Drain Body w/ Grid Cover & Spacers, Single Male NPT Outlet Connection
Notes: * Drain Assembly Includes Dot Strainer Grid Cover
* Tile Floor Finish Single Directional Sloped Towards Linear Drain @ Back Wall of Shower



Plumbing Fixtures

Assembly:		Bathroom Sink
Manufacturer:		American Standard
Model:		0356.012
Description:		Lucerne 20-1/2" Wall Mounted VC Sinks, White, 4" Center Cutouts
Notes:	*	POD Assembly Includes Watts TCA-411 Concealed Arm Carrier

Assembly:		Bathroom Faucet
Manufacturer:		Moen
Model:		L64625
Description:		Chateau WaterSense Faucet, 4" Centerset Design, Polished Chrome
Notes:	*	ADA Compliant For All Lavatory Sink Applications

Assembly:		Rough Plumbing & Lavatory Fittings
Manufacturer:		Proflo
Model:		PFPTB401, 2048PCLK
Description:		1-1/4" x 1-1/2" Semi-Cast P-Trap & 1/2" FIP x 3/8" OD Loose Key Ball Valve & Supply Kit, Polished Chrome
Notes:	*	Rough Plumbing For Each Bathroom POD Unit Estimated As Pro-Press Copper Fittings For All Supply Piping & No-Hub Cast Iron w/ Heavy Duty Couplings For Waste/Vent Piping
	*	All Fixture Supply Piping Brought To Single Points of Connection For Field Tie-In (HW/CW)

Plumbing Fixtures

Assembly: Shower Fixtures
Manufacturer: Moen
Model: TL183
Description: Chateau Chrome Single Lever, Shower Trim
Notes: * Includes Moen 62370 Posi-Temp Pressure Balancing Shower Valve w/ Stops

Assembly: Water Closets
Manufacturer: Kohler
Model: K-3999
Description: Highline Comfort Height Two-Piece Elongated 1.28 GPF Toilet w/ Class Five Flush Technology
Notes: * Assembly Includes Kohler Plastic Closed Front Toilet Seat w/ Cover & Supply Trim For Cold Water Plumbing

Assembly: Shower Base
Manufacturer: Sterling By Kohler
Model: 72161100-0
Description: Ensemble 36" x 36" Square Vikrell Alcove Shower Receptor, Centerset Drain, White
Notes:

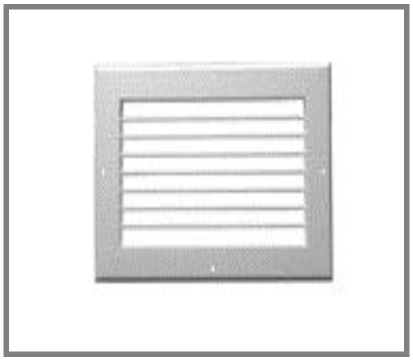
Assembly: Shower Drain
Manufacturer: American Brass
Model: 6520
Description: 2" Brass Shower Drain (Non Caulk), Complete w/ Stainless Steel Grill, Brass Caulking Ring, Neoprene Sealing Joint and Locking Key
Notes:

Electrical / Exhaust Assemblies

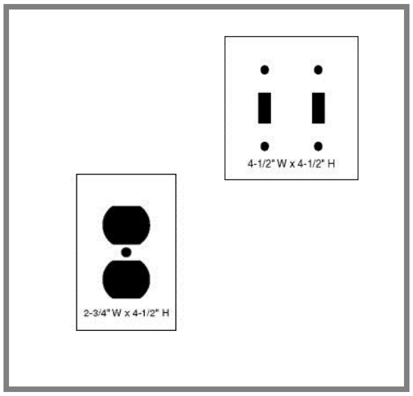
Assembly:	Overhead Light Fixtures
Manufacturer:	Cooper Lighting
Model:	Halo - H470ICAT-955PS
Description:	4" Compact Fluorescent Recessed Ceiling Fixture, AirTite Aluminum Housing, White Trim Ring, Flat Lens, Rated For Wet Locations
Notes:	* (2) Recessed Fixtures Included For Each Bathroom Unit, One Located Over Shower & One At Bathroom Entrance

Assembly:	Vanity Light Fixture
Manufacturer:	Philips Forecast
Model:	F340280ED
Description:	27.5" Clouds Wall Mounted Vanity Fixture, Energy Star Rated, 2 Lamp, 25 W T8 Fluorescent, White
Notes:	* Wall Mounted Centered Above Bathroom Mirror & Lavatory Sink

Assembly:	Exhaust Grille
Manufacturer:	Carnes
Model:	RAMHD0600 6011-NX
Description:	6" x 6" Exhaust Air Grille, Baked Enameled Finish , White
Notes:	* Includes Drywall Mounting Brackets, Finished To Match Bathroom Ceiling Color Scheme



Assembly:	Lighting Controls
Description:	4-1/2" x 4-1/2" Double Gang Light Switch, White Plastic Face Plate, Decora
Assembly:	GFCI Receptacles (@ Vanities)
Description:	2-3/4" x 4-1/2" Single Gang GFCI Receptacle, White Plastic Face Plate, Decora
Notes:	* All Electrical Rough-In Work Performed w MC Cable & Routed To Junction Boxes Above POD Ceiling For Field Tie-Ins



Bathroom Door, Frame, & Hardware

Assembly: Hollow Metal Bathroom Doors
Manufacturer: Ingersoll Rand
Description: 2'-10" x 6'-8" Graintech Flush Hollow Metal Doors w/ Standard Wood Finish
Notes: * Oak Style Flush L-Series Bathroom Doors Standard Finish For Bathroom Door Units

Assembly: Door Frames
Manufacturer: MDI
Description: 3'-2" x 6'-10" Continuously Welded Door Frame, 16 GA, Primed
Notes: * Door Frames Primed, To Be Finished In Field By Others After Installation

Assembly: Door Hardware
Manufacturer: Hager
Models:
- * Hager 2510 WTN Grade II Privacy Set with Lever Handle US26D
- * Hager EC1100 4-1/2" x 4-1/2" Plain Bearing, Steel Hinges, US26D
- * Hager 236W Wall Stop, US26D

Notes:

Assembly: Door Threshold
Manufacturer: Custom
Description: 4-7/8" x 36" Marble Door Saddle, Eased Edges, White Finish
Notes: * Furnished By AmeriPOD, Installed By Finished Floor Contractor At Edge of POD Flooring Finish To Create Transition To Exterior Flooring Surface

Bathroom Accessories

Assembly: Toilet Tissue Holder
Manufacturer: Bobrick
Model: B-685
Description: Surface Mounted Bright-Polished Stainless Steel Toilet Tissue Holder w/ Chrome-Plated Plastic Spindle Roll
Notes:

Assembly: Robe Hooks
Manufacturer: Bobrick
Model: B-672
Description: Classic Series Surface-Mounted Double Robe Hook, Bright-Polished Stainless Steel Finish
Notes: * (2) Robe Hooks Typically Included For Each Bathroom POD Unit

Assembly: Bathroom Mirrors
Size: 30" x 42"
Description: Frameless 30" x 42" Surface Mounted Bathroom Mirror w/ Stainless Steel Mounting Brackets
Notes:

Assembly: Curtain Rods
Manufacturer: Bobrick
Model: B-6047x36
Description: Satin Stainless Steel 36" Classic Series Extra-Heavy-Duty Shower Curtain Rod
Notes: * Shower Curtain & Hooks To Be Provided By Others In FF&E Package

Bathroom Accessories

Assembly: Bathroom Shelf
Manufacturer: ASI
Model: 0692-616
Description: 16" Stainless Steel Surface Mounted Shelf, 6" Depth
Notes: * Wall Mounted Above Bathroom Lavatory Sink

Assembly: Shower Seat
Manufacturer: Bobrick
Model: B-5181
Description: Reversible Solid Phenolic Folding Shower Seat, Ivory
Notes: * Wall Mounted In Walk-In Shower Area As Indicated On Architectural Drawings

Assembly: Grab Bars
Manufacturer: Bobrick
Description: 6806 Series, 1-1/2" Diameter Satin Stainless Steel Grab Bars w/ Concealed Mounting Flanges
Notes: * Toilet & Shower Grab Bars Included As Per Architectural Layout

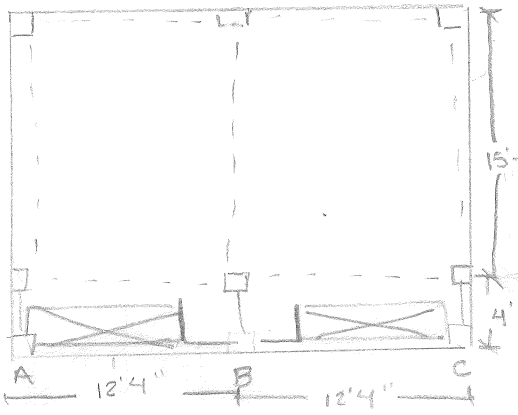
APPENDIX K: SIPS SCHEDULE FOR STUDENT ROOMS

SHORT INTERVAL PRODCUTION SCHEDULE FOR EWING – CROSS STUDENT ROOMS

	2013																														
	June				July					August				September					October				November				December				
Area	6/3	6/10	6/17	6/24	7/1	7/8	7/15	7/22	7/29	8/5	8/12	8/19	8/26	9/2	9/9	9/16	9/23	9/30	10/7	10/14	10/21	10/28	11/4	11/11	11/18	11/25	12/2	12/9	12/16	12/23	12/30
Zone 1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24							
Zone 2		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24						
Zone 3			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24					
Zone 4				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24				
Zone 5	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24							
Zone 6		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24						
Zone 7			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24					
Zone 8				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24				
Zone 9					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24			

1	Layout and Top Track
2	Perim. Bedroom Framing/Insulation
3	Ductwork
4	MEP Coring
5	Elec. Rough In & Tele-Data
6	Perim. Bedroom Piping
7	Door Frames & Clg/Bulkhead Framing
8	Sprinkler Rough In
9	Plumbing Rough In
10	Hang GWB
11	Finish GWB
12	Windows
13	Prime & Paint
14	Lights & Final Tele-Data
15	Install Flooring
16	FCU & Mech Trim Out
17	Doors & Hardware
18	Adjust Sprinkler Heads
19	Elec/Tele/Fire Alarm Trim Out
20	Suite/Lobby Case & Window Treat
21	Final Paint
22	Carpet
23	Final Clean & Punchlist
24	Owner FF&E

APPENDIX L: STRUCTURAL CALCULATIONS



Columns - Grade 46 HSS Columns

Floor to Floor Hgt 8'-0"

Exterior Wall Load 56.3 psf

Allowances: 5 psf beams
2 psf Girders
1 psf columns

SDL = 10 psf

Slab: 3 1/4" LW Concrete on 3" VLI → 46 psf
Composite deck

Snow Load = 30psf

Assume LL = 100 → Res. Area Public Space

WALL

6" metal stud @ 16" OC	2.5
5/8" sheathing	2.1 psf
3 5/8" Limestone	51.7 psf
↳ Assume whole wall	56.3

Load Cases

$P_U = 1.2D + 1.6L + 0.5(S \text{ or } L_R)$ ⇐ Controls

$P_U = 1.2D + 0.5L + 1.6(S \text{ or } L_R)$

Column A (and C)

Roof: $\left[1.2(20 + 2.1 + 2 + 8 + 5) + 0.5(30)\right] \times \frac{61}{1000} = 3.63^K$

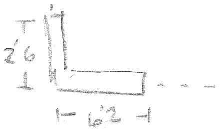
$$\text{Floors: } 1.2(\overset{\text{slab+deck}}{46} + \overset{\text{SDL}}{10} + \overset{\text{steel}}{8}) \times \frac{61}{1000} = 4.68^K/\text{Floor}$$

Walls: $1.2(69.4)(56.3) = 4.69^K/\text{Floor}$

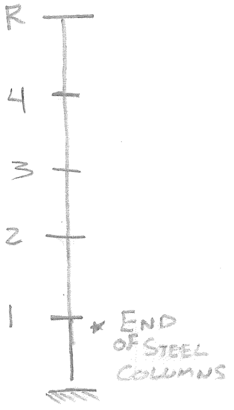
$K_{LL}A_T = (12'4")(4'\text{-}11\tfrac{3}{8}") = 61\text{ sf} < 400\text{ sf}$

* No LL Reduction Permitted

WALLS



$8.67 \times 8 = 69.36\text{ SF}/\text{FLR}$



Roof: 3.63

$4: \underbrace{3.63 + 4.68 + 4.69}_{DL} + 1.6(100)(61)/1000 = 22.96^K$

$3: 3.63 + 2(4.68 + 4.69) + 1.6(100)(61 \times 2)/1000 = 41.89^K$

$2: 3.63 + 3(9.37) + 1.6(100)(61 \times 3)/1000 = 61.02^K$

$1: 3.63 + 4(9.37) + 1.6(100)(61 \times 4)/1000 = 80.15^K$

Assume KL = 15 (conservatively)

HSS 6x6x5/16 capacity = 167^K

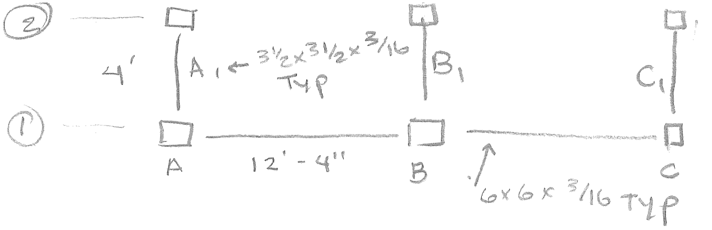
* It is assumed that this column will work @ B b/c B only carries ≈8" of limestone and the rest is glazing (which is only ≈15 psf (<1/4 that of stone)

→ Middle column $K_{LL}A_T = 122\text{ SF}$ →

@ 1st Floor: $3.63 + 4(9.37) + 1.6(100)(122 \times 4) = 119.83 < 167^K$ ✓

↖ assuming <u>all</u> limestone — use HSS 6x6x5/16

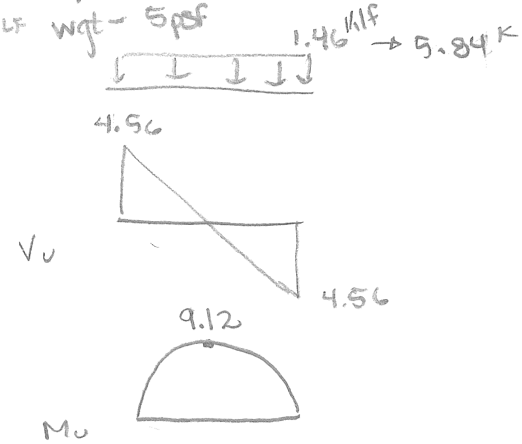
BEAM DESIGN



3" VLI comp. deck w/ 3'4" LW CONC. -46psf

MISC. SDL = 10psf

BEAM SELF wgt - 5psf



$L_o = 100$

$D = 46 + 10 + 5 = 61$ psf

BEAM A₁/C₁ ⌐ tributary width

$w_u = W_u \times 6.25$

$W_u = 1.2(61) + 1.6(100) = 233.2$

$w_u = 233.2 \times 6.25 = 1457.5$ plf → 1.46 KlF

BASED ON LRFD For Square HSS Beams

$\boxed{3\tfrac{1}{2} \times 3\tfrac{1}{2} \times \tfrac{3}{16}} = 19^K > 5.84$

BEAM B₁

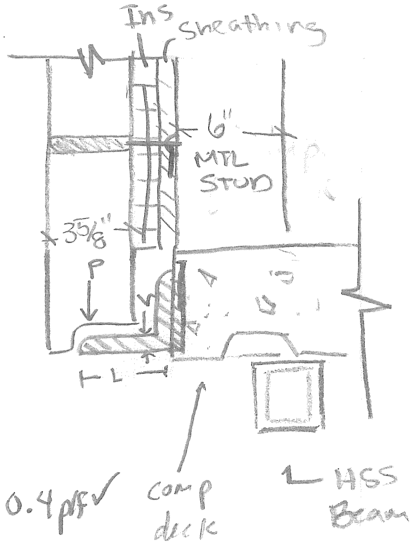
$w_u = W_u \times 12.33 = 233.2 \times 12.33 = 2.88$ KlF → 11.5^K

$\therefore\ 3\tfrac{1}{2} \times 3\tfrac{1}{2} \times \tfrac{3}{16} = 19^K > 11.5^K$

Beam A-B + ~~B~~-C

$W_u = 233.2 \times 2 = 466.4 \rightarrow 0.47$ KlF → 5.8^K

@13ft → $6 \times 6 \times \tfrac{3}{16} = 17^K > 5.8^K$



ANGLE PLATE DESIGN

WALL = 56.3psf

Assume each angle carries 8'-0" of wall

(56.3psf)(8ft) = 450.4plf

↙ Stone bearing on angle

ASSUME That 2" + 5/8" + 2½" = 5.125 → 5½" angle

↖ Ins. ↖ Sheathing

A 3/8" ANGLE @ 3½" will support 76.7#/in = 920.4plf✓

IDEAL STONE HEIGHT

TOTAL ALLOWABLE LOAD

* GEOTEECH REPORT → $q_u = 8{,}000$ psf

$P = q_a A = (8{,}000)(4'\text{-}0'' \times 27'8'') = 885{,}440^{\#}$

LOADS APPLIED: COL A + B + C → conservatively assume each has 80.15^K load
+ FOUNDATION WALL
$(106.17 + 12.82 + 12.82)\,CF \times 150\,pcf = 19.78^K$

TOTAL LOAD ON FOUNDATION $= (80.15 \times 3) + 19.78 = 260.23^K$

$$\frac{P_{ALLOWED}}{P_{LOAD}} = \frac{885.44}{260.23} \Rightarrow FOS = 3.40 \checkmark$$

∴ The currently designed foundation will handle the increased load of the thicker limestone facade

PUNCHING SHEAR FOR TYP COLUMN

HSS column applies load to base plate to FOUNDATION FOOTING

4000 psi FOOTING

8000 psf bearing capacity

base plate → assume 12" x 8"

$P = P_D + P_L$

ROOF FLOOR WALL

$P_D = 3.63 + 4(3.9) + 4(3.91) = 34.87$

$P_L = 100 \times 61 \times 4 = 24.4K$

ASSUME RECT. FTG $L = 1.5B$

$$q_a > \frac{P}{A}$$

$8KSF \geq \frac{59.3^K}{1.5B^2} \rightarrow B \geq 2.22'$ ✓ → current design @ 4'

use 4ft = B

$8KSF > \frac{59.3}{4L} \rightarrow L > 1.85$ ✓ → current Footing alots >8' to this col.

$P_U = 1.2D + 1.6L = 1.2(34.87) + 1.6(24.4) = 80.15^K$

$q = \frac{P_u}{A} = \frac{80.15}{4 \times 8} = 2.5\ KSF = 17.39\,psi$

$v_c = \phi 4\sqrt{f'_c} = 0.75(4)\sqrt{4000} = 189.74\,psi \rightarrow 190$

THIS EQUATION CONTROLS FOR SHEAR:

$$d^2(4v_c + q) + d(2v_c + q)(b + c) = q(BL - bc)$$

$d^2(4(190psi) + 17.39psi) + d(2(190) + 17.4)(12" + 8") = 17.4((48)(96) - (12)(8))$

$777.4d^2 + 7948d = 78{,}508.8$

$d = 6.16"$

$h = d + 3" + d_b = 6.16 + 3 + 0.625 = 9.785"$ → current design = 24"

use $h = 24"$

$d_L = 24'' - 3'' - 0.5(0.625'') = 20.69''$

$d_g = 24'' - 3'' - 1.5(0.625'') = 20.06''$

CHECK WIDE BEAM SHEAR

$$V_{uL} = 2.5\text{KSF}\left[\frac{8'-1'}{2} - 1.72'\right] = 4.45^K$$

$$V_{ug} = 2.5\text{Ksf}\left[\frac{4-0.67}{2} - 1.67'\right] \approx 0^K$$

$$\phi V_n = \phi 2\sqrt{f'c}\, bd$$

$$= 0.75(2)\sqrt{4000}(12'')(20.06'') = 22.84^K$$

$$\phi V_n = 22.84^K \geq V_u = 4.45^K \checkmark$$

LONG SIDE

$$L = \frac{96''-12''}{2} = 42'' \rightarrow 3.5'$$

$$M_u = \frac{qL^2}{2} = \frac{2.5(3.5)^2}{2} = 15.31'K$$

$$a = \frac{A_s f_y}{0.85f'cb} \Rightarrow 1.96A_s$$

$$M_u = \phi M_n = \phi A_s F_y(d - a/2)$$
$$15.31(12) = 0.9A_s 60(20.69 - 0.98A_s)$$
$$183.72 = 1117.3A_s - 52.92A_s^2$$
$$A_s = 0.166\,\text{in}^2$$

Current DESIGN $<$ 7 #6 @ 6" OC $\rightarrow$ 0.88 in²
5 #5 @ 10" OC $\rightarrow$ 0.37 in²

$$\rho = \frac{A_s}{bh} = \frac{1.25}{(12')(24'')} = 0.00434 \geq 0.0018$$

$$a = 1.96A_s = 1.96(1.25\,\text{in}^2) = 2.45''$$
$$c = a/.85 = 2.88''$$

$$\varepsilon_s = \frac{.003}{c}(d-c) = \frac{.003}{2.88}(20.69 - 2.88) = 0.0185 > 0.005$$

$\therefore \phi = 0.9$

∴ Current design OK by inspection

SHORT SIDE

$L = \frac{48-8}{2} = 20" \rightarrow 1.67'$

$M_u = \frac{2.5(1.67)^2}{2} = 3.49'K$

$3.49(12) = 54A_s(20.06 - 0.98A_s)$

$41.88 = 1083.24\overset{A_s}{} - 52.92A_s^2$

$A_s = 0.038 \text{ in}^2$

CURRENT DESIGN < &
$\#5 @ 9" OC \; 0.41 \text{ in}^2$
$\#5 @ 16" OC \; 0.23 \text{ in}^2$ $\rightarrow 0.64 \text{ in}^2$

$\rho = \frac{A_s}{bh} = \frac{0.64}{12(24)} = 0.0022 > 0.0018$ ✓

$a = 1.96(0.64) = 1.25"$

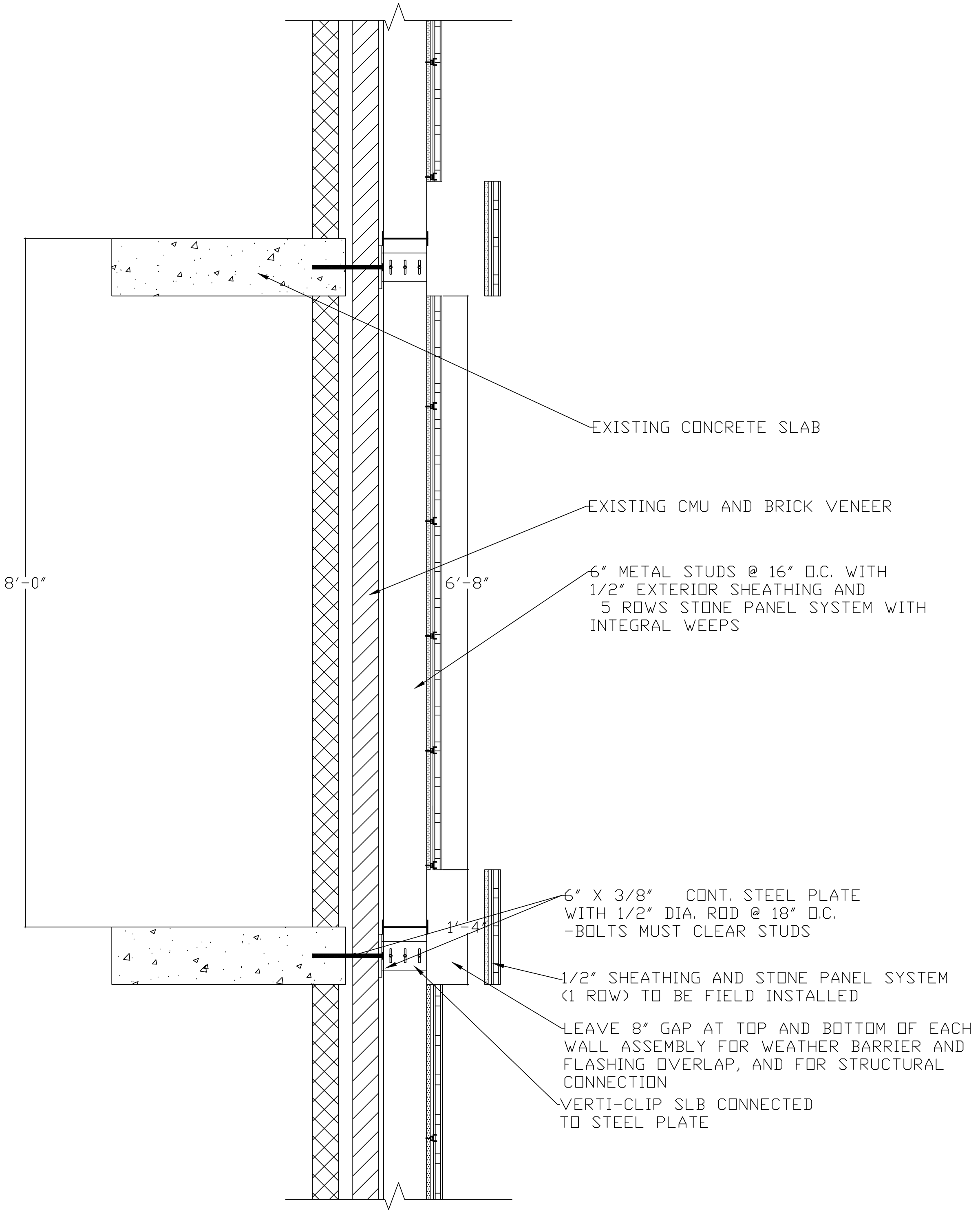
$c = 1.25/0.85 = 1.47"$

$\varepsilon_s = \frac{0.003}{1.47}(20.06 - 1.47) = 0.038 > 0.005$ ✓

$\therefore \phi = 0.9$

THE EXISTING FOOTING IS CAPABLE OF CARRYING THE LOADS OF THE HSS COLUMNS AND THE THICKER LIMESTONE FACADE

APPENDIX M: SMALL BUMPOUT CONNECTION DETAILS



General Notes

No.	Revision/Issue	Date

Firm Name and Address

Project Name and Address
SOUTH HALLS RENOVATION
PREFABRICATED WALL ASSEMBLY

Project
EWING-CROSS
Date
02/09/2014
Scale
1/8" = 1' 0"
Sheet
S.1

VertiClip® SLB

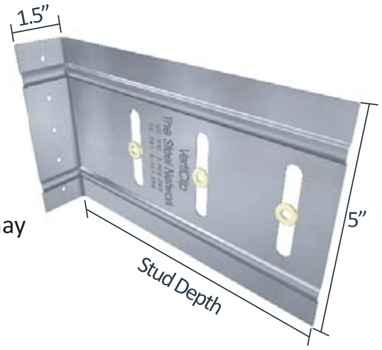
Bypass Slab

The Steel Network, Inc.
www.steelnetwork.com
1-888-474-4876

Material Composition

ASTM A1003/A1003M Structural Grade 50 (340) Type H, ST50H (ST340H): 50ksi (340MPa) minimum yield strength, 65ksi (450MPa) minimum tensile strength, 68mil minimum thickness (14 gauge, 0.0713” design thickness) with ASTM A653/A653M G90 (Z275) hot dipped galvanized coating.

The attachment of VertiClip to the primary structure may be made with PAFs, screw/bolt anchors or weld and is dependent upon the base material (steel or concrete) and the design configuration.



US Patents #5,467,566 & #5,906,080

VertiClip SLB Allowable (Unfactored) Loads[1]

VertiClip® SLB, Recommended Allowable Load (lbs): F1 & F2								
Stud		F1 Load Direction			F2 Load Direction			
		SLB362	SLB600	SLB800	SLB 362/400, 600, 800		SLBxxx-10, SLBxxx-12, SLB1000 & SLB1200	
Thickness Mils (ga)	Yield Strength (ksi)	w/2 #12 Screws	w/2-3 #12 Screws	w/2-3 #12 Screws	w/2 #12 Screws	w/3 #12 Screws	w/2 #12 Screws	w/3 #12 Screws
33 (20)	33	95	95	95	376	564	376	564
33 (20)	50	138	138	118	544	817	544	817
43 (18)	33	124	124	118	560	840	560	840
43 (18)	50	179	179	118	810	1,215	810	933
54 (16)	33	156	156	118	788	1,182	788	933
54 (16)	50	225	225	118	1,140	1,600	933	933
68 (14)	50	227	227	118	1,600	1,600	933	933
97 (12)	50	227	227	118	1,600	1,600	933	933
Maximum Allowable Clip Load		**227**	**227**	**118**	**1,600**	**1,600**	**933**	**933**

Notes:

- Allowable load tables incorporate eccentric loading of fasteners. Values with welded connection may increase.
- Fasten within ¾” from the angle heel (centerline of the 1½” leg) to minimize eccentric load transfer.
- Fasteners attaching clip to structure should be installed symmetrically around the center line of the clip. The allowable load of the clip may be reduced if fasteners are not installed symmetrically.
- Guide holes in the 1½” leg measure 0.172” in diameter for SLB362, 0.141" in diameter for SLB600 and SLB800.
- Total vertical deflection of up to 2” (1” up and 1” down). Deflection requirements greater than 1” up and down are available.
- VertiClip SLB series is designed to support horizontal loads and should not be used in axial-load-bearing wall construction.
- Allowable loads have not been increased for wind, seismic, or other factors.
- #12 screws are provided with each step bushing. Load requirements don't always justify use of a third screw.
- Three slots are standard in 6” and higher web depths to accommodate construction tolerances. Use of a 3rd screw and bushing is dependent upon load configuration. 250 and 362/400 sizes have only 2 slots and 2 screws.
- Use of strengthening ribs and return bends varies with each clip.

Load Direction

[1] For LRFD Design Strengths refer to ICC-ESR-1903.

Nomenclature

VertiClip SLB is designated by multiplying stud depth by 100.

> ***Example:*** *6” stud.*
> ***Designate:*** *VertiClip® SLB600*

** Use of strengthening ribs and return bends varies with each clip.*
*** The VertiClip SLB600-10 and 600-12 accommodate an even greater construction tolerance of studs from structure.*
The VertiClip SLB600-10 is 10” in depth and the VertiClip SLB600-12 is 12” in depth with slot spacings designed for a 6” stud

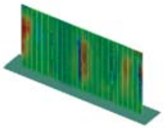
Example Details

Step Bushings and Screws may be installed in the middle and outer slots of SLB600 or 800 to accommodate greater building tolerances. Note that this may affect the F1 and F2 allowable load capacity and may require a row of bridging at a maximum distance of 12" of the connection to resist stud torsional effects. Call TSN Tech Support for test data and recommendations.

The VertiClip SLB600-10 and 600-12 accommodate an even greater construction tolerance of studs from structure and are now standard products. The VertiClip SLB600-10 is 10” in depth with slot spacing designed for a 6” stud, and the VertiClip SLB600-12 is 12” in depth with slot spacing designed for a 6” stud.

VertiClip SLB600
ICC-ESR-1903
www.icc-es.org

VertiClip SLB Series
LARR #25631
www.ladbs.org



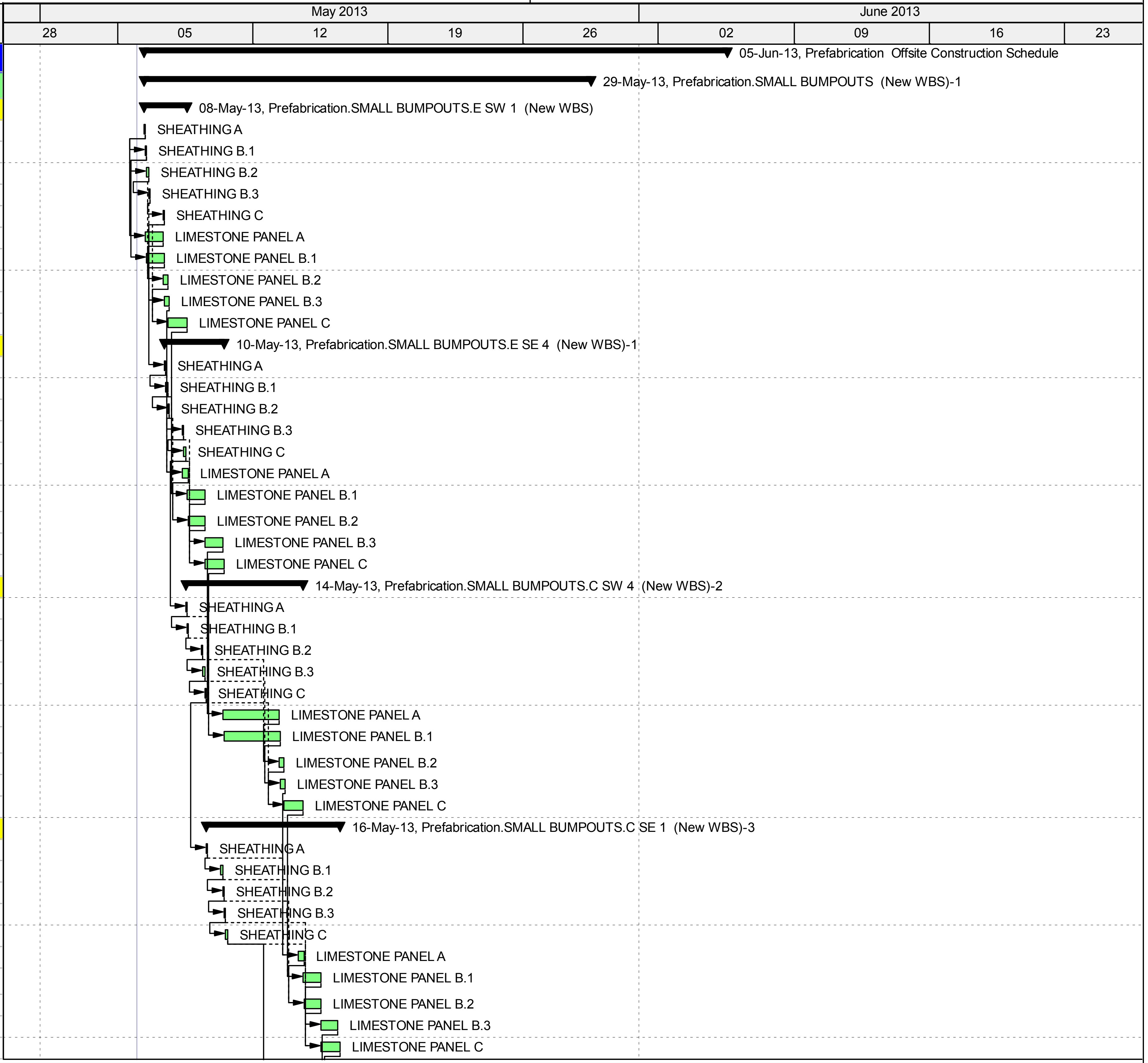
VertiClip SLB Series
Blast and Seismic Design data
www.steelnetwork.com

** For more information or to review a copy of each of these reports, please visit our website at http://www.steelnetwork.com/Site/TechnicalData

APPENDIX N: BUILDING ENCLOSURE SCHEDULES

Quaid Spearing | Offsite Construction Schedule | 17-Feb-14 13:20

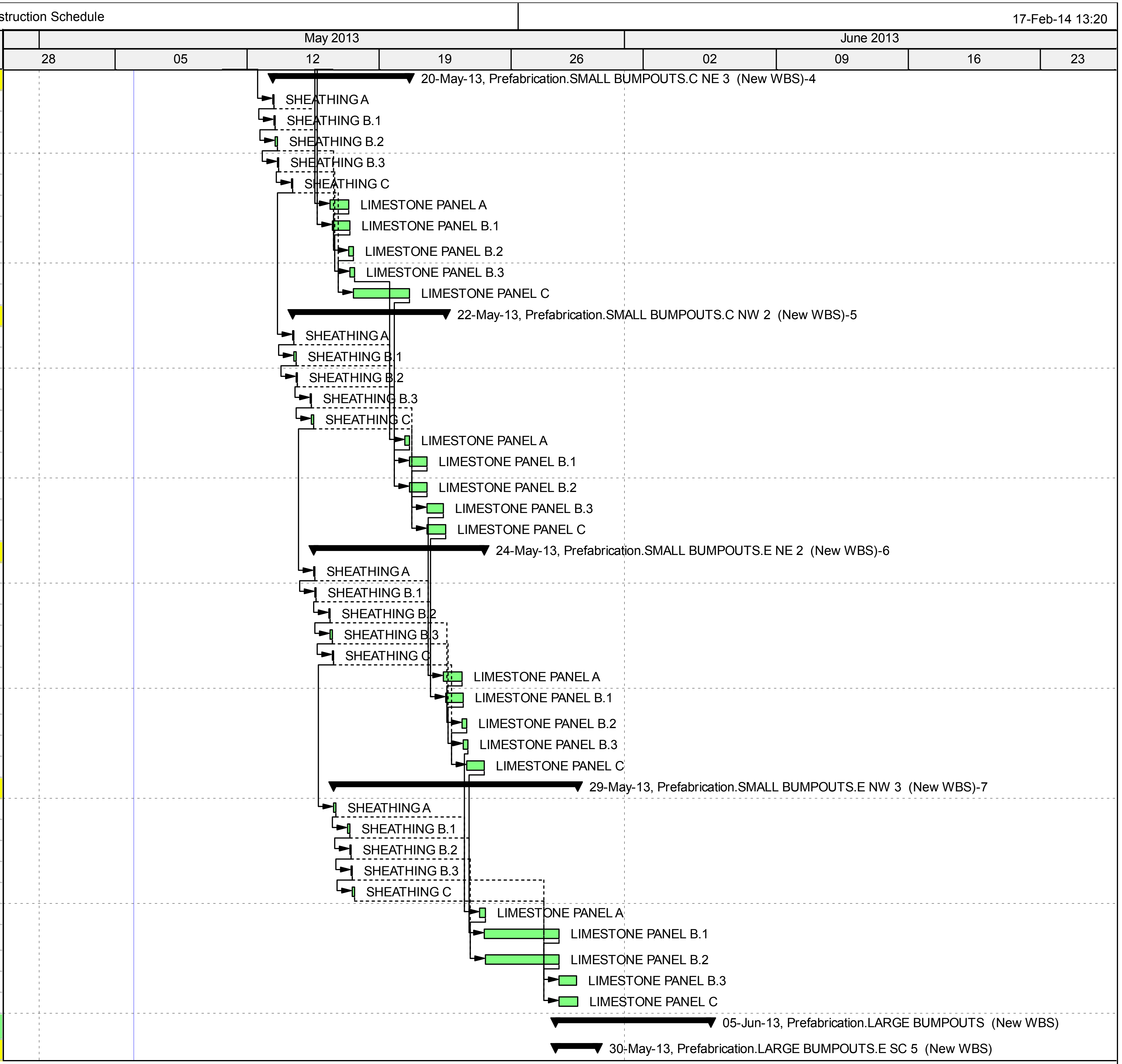
Activity ID	Activity Name	Original Duration	Start	Finish	Predecessors
Prefabrication Offsite Construction		174	06-May-13	05-Jun-13	
Prefabrication.SMALL BUMPOUTS (		132	06-May-13	29-May-13	
Prefabrication.SMALL BUMPOUTS.E SW 1		22	06-May-13	08-May-13	
A1000	SHEATHING A	2	06-May-13	06-May-13	
A1010	SHEATHING B.1	2	06-May-13	06-May-13	A1000
A1020	SHEATHING B.2	2	06-May-13	06-May-13	A1010
A1030	SHEATHING B.3	2	06-May-13	06-May-13	A1020
A1040	SHEATHING C	2	07-May-13	07-May-13	A1030
A1050	LIMESTONE PANEL A	7	06-May-13	07-May-13	A1000
A1060	LIMESTONE PANEL B.1	6	06-May-13	07-May-13	A1010
A1070	LIMESTONE PANEL B.2	6	07-May-13	07-May-13	A1020, A1050
A1080	LIMESTONE PANEL B.3	6	07-May-13	07-May-13	A1030, A1060
A1090	LIMESTONE PANEL C	7	07-May-13	08-May-13	A1040, A1070
Prefabrication.SMALL BUMPOUTS.E SE 4		26	07-May-13	10-May-13	
A1100	SHEATHING A	2	07-May-13	07-May-13	A1040
A1110	SHEATHING B.1	2	07-May-13	07-May-13	A1100
A1120	SHEATHING B.2	2	07-May-13	07-May-13	A1110
A1130	SHEATHING B.3	2	08-May-13	08-May-13	A1120
A1140	SHEATHING C	2	08-May-13	08-May-13	A1130
A1150	LIMESTONE PANEL A	7	08-May-13	08-May-13	A1100, A1080
A1160	LIMESTONE PANEL B.1	6	08-May-13	09-May-13	A1110, A1090
A1170	LIMESTONE PANEL B.2	6	08-May-13	09-May-13	A1120, A1150
A1180	LIMESTONE PANEL B.3	6	09-May-13	10-May-13	A1130, A1160
A1190	LIMESTONE PANEL C	7	09-May-13	10-May-13	A1140, A1170
Prefabrication.SMALL BUMPOUTS.C SW 4		34	08-May-13	14-May-13	
A1200	SHEATHING A	2	08-May-13	08-May-13	A1140
A1210	SHEATHING B.1	2	08-May-13	08-May-13	A1200
A1220	SHEATHING B.2	2	09-May-13	09-May-13	A1210
A1230	SHEATHING B.3	2	09-May-13	09-May-13	A1220
A1240	SHEATHING C	2	09-May-13	09-May-13	A1230
A1250	LIMESTONE PANEL A	7	10-May-13	13-May-13	A1200, A1180
A1260	LIMESTONE PANEL B.1	6	10-May-13	13-May-13	A1210, A1190
A1270	LIMESTONE PANEL B.2	6	13-May-13	13-May-13	A1220, A1250
A1280	LIMESTONE PANEL B.3	6	13-May-13	13-May-13	A1230, A1260
A1290	LIMESTONE PANEL C	7	13-May-13	14-May-13	A1240, A1270
Prefabrication.SMALL BUMPOUTS.C SE 1		38	09-May-13	16-May-13	
A1300	SHEATHING A	2	09-May-13	09-May-13	A1240
A1310	SHEATHING B.1	2	10-May-13	10-May-13	A1300
A1320	SHEATHING B.2	2	10-May-13	10-May-13	A1310
A1330	SHEATHING B.3	2	10-May-13	10-May-13	A1320
A1340	SHEATHING C	2	10-May-13	10-May-13	A1330
A1350	LIMESTONE PANEL A	7	14-May-13	14-May-13	A1300, A1280
A1360	LIMESTONE PANEL B.1	6	14-May-13	15-May-13	A1310, A1290
A1370	LIMESTONE PANEL B.2	6	14-May-13	15-May-13	A1320, A1350
A1380	LIMESTONE PANEL B.3	6	15-May-13	16-May-13	A1330, A1360
A1390	LIMESTONE PANEL C	7	15-May-13	16-May-13	A1340, A1370



▬ Actual Level of Effort	🟩 Remaining Work	◆ ◆ Milestone	
🟦 Actual Work	🟥 Critical Remaining Work	▼▬▼ summary	

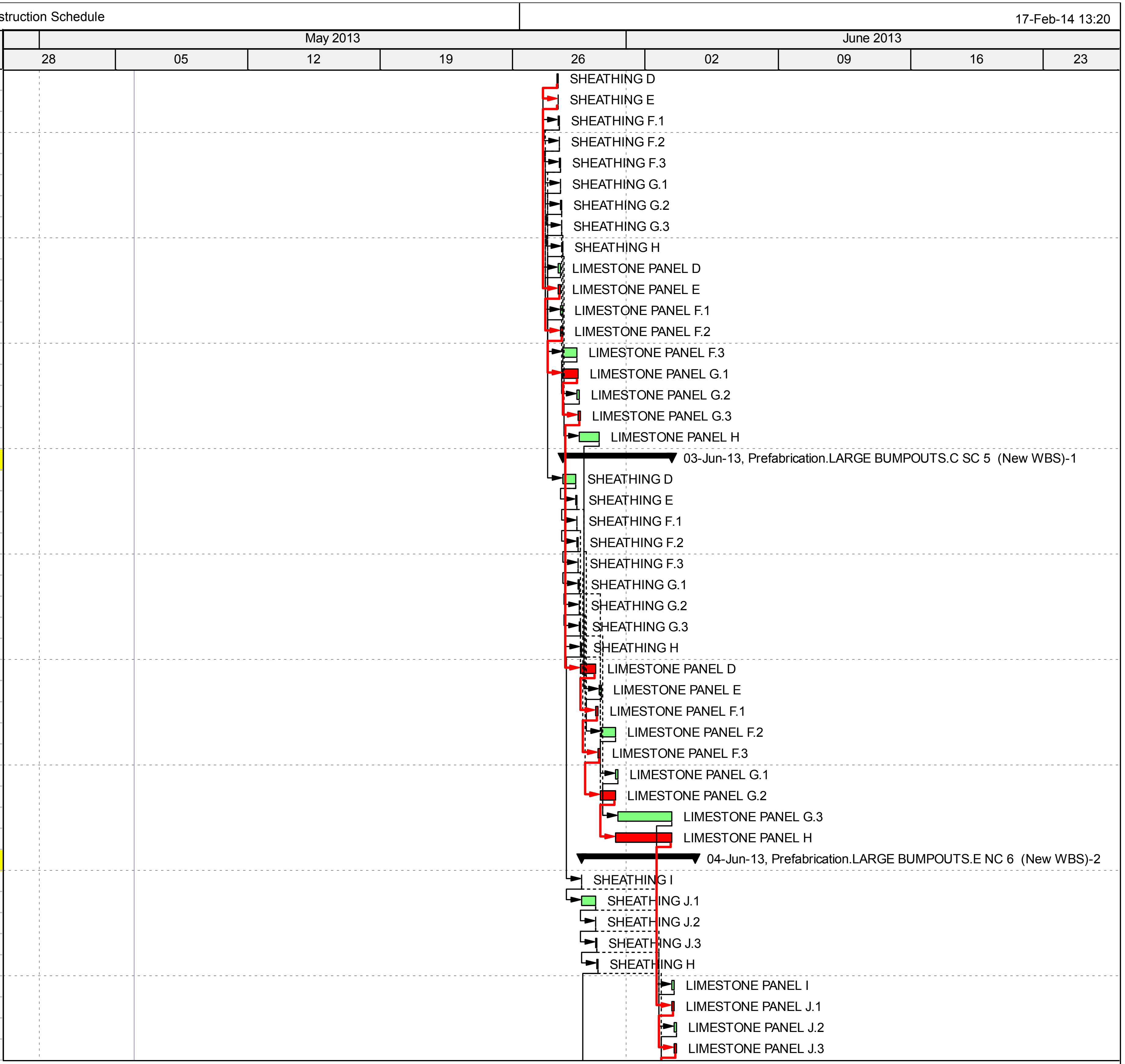
Ewing-Cross Renovation

Activity ID	Activity Name	Original Duration	Start	Finish	Predecessors
Prefabrication.SMALL BUMPOUTS.C NE 3		46	13-May-13	20-May-13	
A1400	SHEATHING A	2	13-May-13	13-May-13	A1340
A1410	SHEATHING B.1	2	13-May-13	13-May-13	A1400
A1420	SHEATHING B.2	2	13-May-13	13-May-13	A1410
A1430	SHEATHING B.3	2	13-May-13	13-May-13	A1420
A1440	SHEATHING C	2	14-May-13	14-May-13	A1430
A1450	LIMESTONE PANEL A	7	16-May-13	17-May-13	A1400, A1380
A1460	LIMESTONE PANEL B.1	6	16-May-13	17-May-13	A1410, A1390
A1470	LIMESTONE PANEL B.2	6	17-May-13	17-May-13	A1420, A1450
A1480	LIMESTONE PANEL B.3	6	17-May-13	17-May-13	A1430, A1460
A1490	LIMESTONE PANEL C	7	17-May-13	20-May-13	A1440, A1470
Prefabrication.SMALL BUMPOUTS.C NW 2		50	14-May-13	22-May-13	
A1500	SHEATHING A	2	14-May-13	14-May-13	A1440
A1510	SHEATHING B.1	2	14-May-13	14-May-13	A1500
A1520	SHEATHING B.2	2	14-May-13	14-May-13	A1510
A1530	SHEATHING B.3	2	15-May-13	15-May-13	A1520
A1540	SHEATHING C	2	15-May-13	15-May-13	A1530
A1550	LIMESTONE PANEL A	7	20-May-13	20-May-13	A1500, A1480
A1560	LIMESTONE PANEL B.1	6	20-May-13	21-May-13	A1510, A1490
A1570	LIMESTONE PANEL B.2	6	20-May-13	21-May-13	A1520, A1550
A1580	LIMESTONE PANEL B.3	6	21-May-13	22-May-13	A1530, A1560
A1590	LIMESTONE PANEL C	7	21-May-13	22-May-13	A1540, A1570
Prefabrication.SMALL BUMPOUTS.E NE 2		58	15-May-13	24-May-13	
A1600	SHEATHING A	2	15-May-13	15-May-13	A1540
A1610	SHEATHING B.1	2	15-May-13	15-May-13	A1600
A1620	SHEATHING B.2	2	16-May-13	16-May-13	A1610
A1630	SHEATHING B.3	2	16-May-13	16-May-13	A1620
A1640	SHEATHING C	2	16-May-13	16-May-13	A1630
A1650	LIMESTONE PANEL A	7	22-May-13	23-May-13	A1600, A1580
A1660	LIMESTONE PANEL B.1	6	22-May-13	23-May-13	A1610, A1590
A1670	LIMESTONE PANEL B.2	6	23-May-13	23-May-13	A1620, A1650
A1680	LIMESTONE PANEL B.3	6	23-May-13	23-May-13	A1630, A1660
A1690	LIMESTONE PANEL C	7	23-May-13	24-May-13	A1640, A1670
Prefabrication.SMALL BUMPOUTS.E NW 3		62	16-May-13	29-May-13	
A1700	SHEATHING A	2	16-May-13	16-May-13	A1640
A1710	SHEATHING B.1	2	17-May-13	17-May-13	A1700
A1720	SHEATHING B.2	2	17-May-13	17-May-13	A1710
A1730	SHEATHING B.3	2	17-May-13	17-May-13	A1720
A1740	SHEATHING C	2	17-May-13	17-May-13	A1730
A1750	LIMESTONE PANEL A	7	24-May-13	24-May-13	A1700, A1680
A1760	LIMESTONE PANEL B.1	6	24-May-13	28-May-13	A1710, A1690
A1770	LIMESTONE PANEL B.2	6	24-May-13	28-May-13	A1720, A1750
A1780	LIMESTONE PANEL B.3	6	28-May-13	29-May-13	A1730, A1760
A1790	LIMESTONE PANEL C	7	28-May-13	29-May-13	A1740, A1770
Prefabrication.LARGE BUMPOUTS		54	28-May-13	05-Jun-13	
Prefabrication.LARGE BUMPOUTS.E SC 5		21	28-May-13	30-May-13	



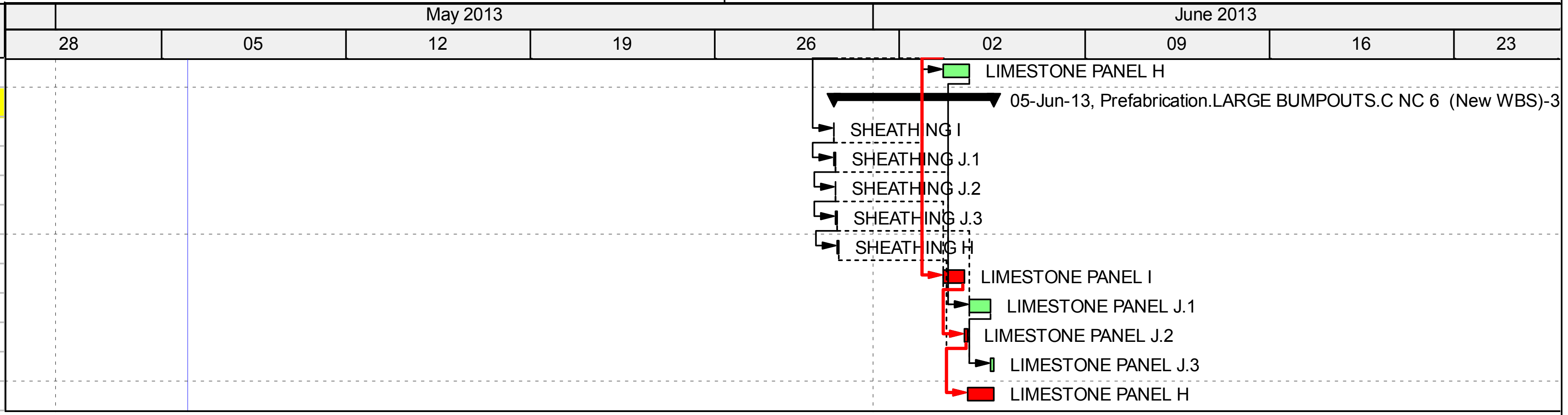
▬ Actual Level of Effort
🟦 Actual Work
🟩 Remaining Work
🟥 Critical Remaining Work
◆ ◆ Milestone
▬ summary

Activity ID	Activity Name	Original Duration	Start	Finish	Predecessors
A1800	SHEATHING D	1	28-May-13*	28-May-13	
A1810	SHEATHING E	1	28-May-13	28-May-13	A1800
A1820	SHEATHING F.1	1	28-May-13	28-May-13	A1810
A1830	SHEATHING F.2	1	28-May-13	28-May-13	A1820
A1840	SHEATHING F.3	1	28-May-13	28-May-13	A1830
A1850	SHEATHING G.1	1	28-May-13	28-May-13	A1840
A1860	SHEATHING G.2	1	28-May-13	28-May-13	A1850
A1870	SHEATHING G.3	1	28-May-13	28-May-13	A1860
A1880	SHEATHING H	2	28-May-13	28-May-13	A1870
A1890	LIMESTONE PANEL D	3	28-May-13	28-May-13	A1800
A1900	LIMESTONE PANEL E	3	28-May-13	28-May-13	A1810
A1910	LIMESTONE PANEL F.1	3	28-May-13	28-May-13	A1820, A1890
A1920	LIMESTONE PANEL F.2	3	28-May-13	28-May-13	A1830, A1900
A1930	LIMESTONE PANEL F.3	3	28-May-13	29-May-13	A1840, A1910
A1940	LIMESTONE PANEL G.1	3	28-May-13	29-May-13	A1850, A1920
A1950	LIMESTONE PANEL G.2	3	29-May-13	29-May-13	A1860, A1930
A1960	LIMESTONE PANEL G.3	3	29-May-13	29-May-13	A1870, A1940
A1970	LIMESTONE PANEL H	8	29-May-13	30-May-13	A1880, A1950
Prefabrication.LARGE BUMPOUTS.C SC 5		**26**	**28-May-13**	**03-Jun-13**	
A1980	SHEATHING D	1	28-May-13*	29-May-13	A1880
A1990	SHEATHING E	1	29-May-13	29-May-13	A1980
A2000	SHEATHING F.1	1	29-May-13	29-May-13	A1990
A2010	SHEATHING F.2	1	29-May-13	29-May-13	A2000
A2020	SHEATHING F.3	1	29-May-13	29-May-13	A2010
A2030	SHEATHING G.1	1	29-May-13	29-May-13	A2020
A2040	SHEATHING G.2	1	29-May-13	29-May-13	A2030
A2050	SHEATHING G.3	1	29-May-13	29-May-13	A2040
A2060	SHEATHING H	2	29-May-13	29-May-13	A2050
A2070	LIMESTONE PANEL D	3	29-May-13	30-May-13	A1980, A1960
A2080	LIMESTONE PANEL E	3	30-May-13	30-May-13	A1990, A1970
A2090	LIMESTONE PANEL F.1	3	30-May-13	30-May-13	A2000, A2070
A2100	LIMESTONE PANEL F.2	3	30-May-13	31-May-13	A2010, A2080
A2110	LIMESTONE PANEL F.3	3	30-May-13	30-May-13	A2020, A2090
A2120	LIMESTONE PANEL G.1	3	31-May-13	31-May-13	A2030, A2100
A2130	LIMESTONE PANEL G.2	3	30-May-13	31-May-13	A2040, A2110
A2140	LIMESTONE PANEL G.3	3	31-May-13	03-Jun-13	A2050, A2120
A2150	LIMESTONE PANEL H	8	31-May-13	03-Jun-13	A2060, A2130
Prefabrication.LARGE BUMPOUTS.E NC 6		**32**	**29-May-13**	**04-Jun-13**	
A2160	SHEATHING I	1	29-May-13	29-May-13	A2060
A2170	SHEATHING J.1	1	29-May-13	30-May-13	A2160
A2180	SHEATHING J.2	1	30-May-13	30-May-13	A2170
A2190	SHEATHING J.3	1	30-May-13	30-May-13	A2180
A2200	SHEATHING H	2	30-May-13	30-May-13	A2190
A2210	LIMESTONE PANEL I	3	03-Jun-13	03-Jun-13	A2160, A2140
A2220	LIMESTONE PANEL J.1	3	03-Jun-13	03-Jun-13	A2170, A2150
A2230	LIMESTONE PANEL J.2	3	03-Jun-13	03-Jun-13	A2180, A2210
A2240	LIMESTONE PANEL J.3	3	03-Jun-13	03-Jun-13	A2190, A2220



▬ Actual Level of Effort
🟦 Actual Work
🟩 Remaining Work
🟥 Critical Remaining Work
◆ ◆ Milestone
▼▬▼ summary

Activity ID	Activity Name	Original Duration	Start	Finish	Predecessors
A2250	LIMESTONE PANEL H	8	03-Jun-13	04-Jun-13	A2200, A2230
	Prefabrication.LARGE BUMPOUTS.C NC 6	**34**	**30-May-13**	**05-Jun-13**	
A2260	SHEATHING I	1	30-May-13	30-May-13	A2200
A2270	SHEATHING J.1	1	30-May-13	30-May-13	A2260
A2280	SHEATHING J.2	1	30-May-13	30-May-13	A2270
A2290	SHEATHING J.3	1	30-May-13	30-May-13	A2280
A2300	SHEATHING H	2	30-May-13	30-May-13	A2290
A2310	LIMESTONE PANEL I	3	03-Jun-13	04-Jun-13	A2260, A2240
A2320	LIMESTONE PANEL J.1	3	04-Jun-13	05-Jun-13	A2270, A2250
A2330	LIMESTONE PANEL J.2	3	04-Jun-13	04-Jun-13	A2280, A2310
A2340	LIMESTONE PANEL J.3	3	05-Jun-13	05-Jun-13	A2290, A2320
A2350	LIMESTONE PANEL H	8	04-Jun-13	05-Jun-13	A2300, A2330



▬ Actual Level of Effort
🟦 Actual Work
🟩 Remaining Work
🟥 Critical Remaining Work
◆ ◆ Milestone
▼▼ summary

Quaid Spearing

Ewing-Cross Installation Schedule

17-Feb-14 14:06

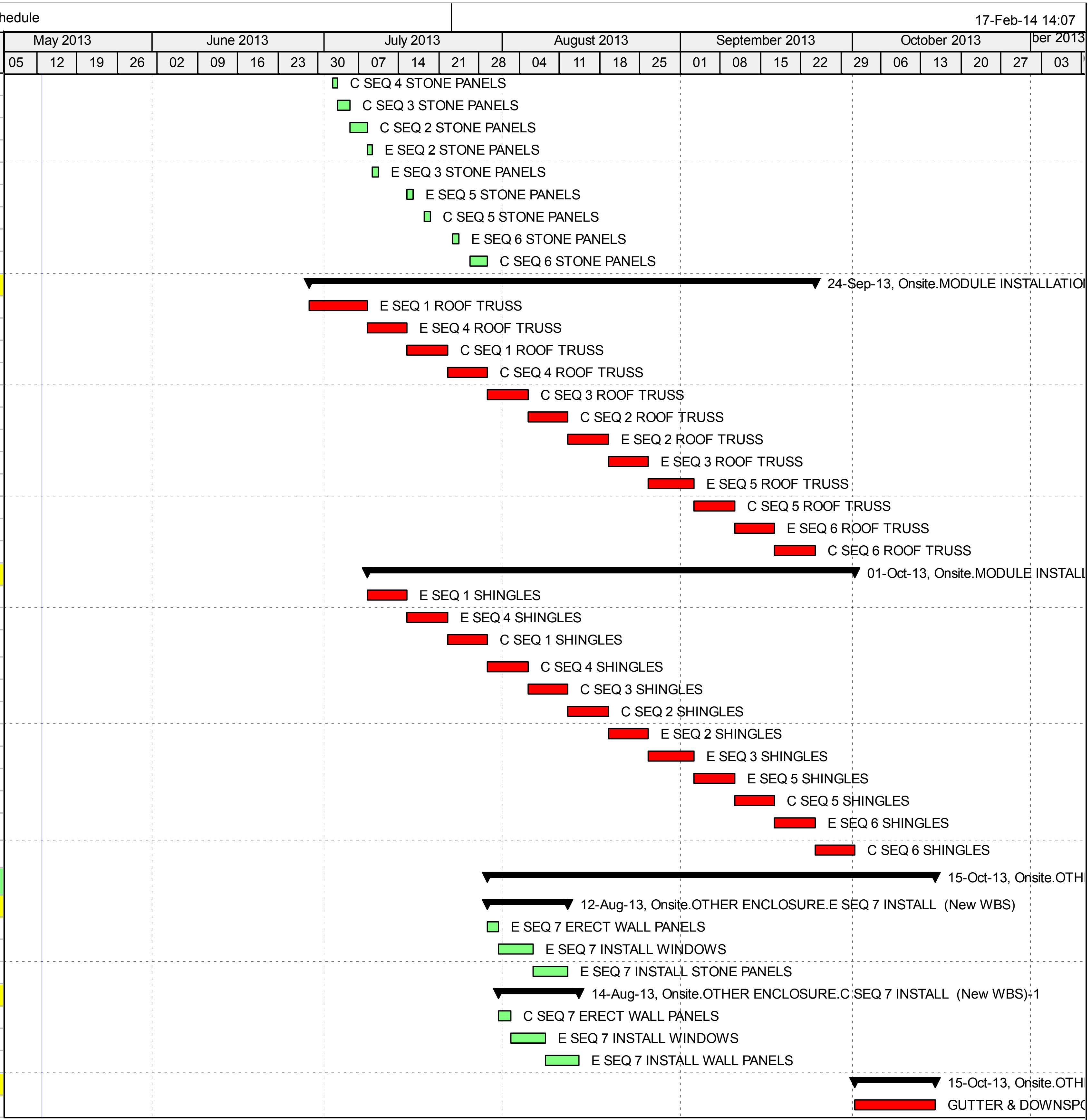
Activity ID	Activity Name	Original Duration	Start	Finish	Predecessors
Onsite Ewing-Cross Installation Schedule		109	13-May-13	15-Oct-13	
Onsite.MODULE INSTALLATION (New WBS)-1		99	13-May-13	01-Oct-13	
Onsite.MODULE INSTALLATION.SMALL BUMPOUT WIND		32	13-May-13	26-Jun-13	
A1000	E SEQ 1 WINDOWS	4	13-May-13*	16-May-13	
A1010	E SEQ 4 WINDOWS	4	17-May-13	22-May-13	A1000
A1020	C SEQ 1 WINDOWS	4	23-May-13	29-May-13	A1010
A1030	C SEQ 4 WINDOWS	4	30-May-13	04-Jun-13	A1020
A1040	C SEQ 3 WINDOWS	4	05-Jun-13	10-Jun-13	A1030
A1050	C SEQ 2 WINDOWS	4	11-Jun-13	14-Jun-13	A1040
A1060	E SEQ 2 WINDOWS	4	17-Jun-13	20-Jun-13	A1050
A1070	E SEQ 3 WINDOWS	4	21-Jun-13	26-Jun-13	A1060
Onsite.MODULE INSTALLATION.PLACE WALL MODULES		12	26-Jun-13	12-Jul-13	
A1080	E SEQ 1 WALL MODULES	1	26-Jun-13*	26-Jun-13	
A1090	E SEQ 4 WALL MODULES	1	27-Jun-13	27-Jun-13	A1080
A1100	C SEQ 1 WALL MODULES	1	28-Jun-13	28-Jun-13	A1090
A1110	C SEQ 4 WALL MODULES	1	01-Jul-13	01-Jul-13	A1100
A1120	C SEQ 3 WALL MODULES	1	02-Jul-13	02-Jul-13	A1110
A1130	C SEQ 2 WALL MODULES	1	03-Jul-13	03-Jul-13	A1120
A1140	E SEQ 2 WALL MODULES	1	05-Jul-13	05-Jul-13	A1130
A1150	E SEQ 3 WALL MODULES	1	08-Jul-13	08-Jul-13	A1140
A1160	E SEQ 5 WALL MODULES	1	09-Jul-13	09-Jul-13	A1150
A1170	C SEQ 5 WALL MODULES	1	10-Jul-13	10-Jul-13	A1160
A1180	E SEQ 6 WALL MODULES	1	11-Jul-13	11-Jul-13	A1170
A1190	C SEQ 6 WALL MODULES	1	12-Jul-13	12-Jul-13	A1180
Onsite.MODULE INSTALLATION.SHEATHING & WTHR BR		12	27-Jun-13	15-Jul-13	
A1200	E SEQ 1 SHEATHING & WB	1	27-Jun-13	27-Jun-13	A1080
A1210	E SEQ 4 SHEATHING & WB	1	28-Jun-13	28-Jun-13	A1090, A1200
A1220	C SEQ 1 SHEATHING & WB	1	01-Jul-13	01-Jul-13	A1100, A1210
A1230	C SEQ 4 SHEATHING & WB	1	02-Jul-13	02-Jul-13	A1110, A1220
A1240	C SEQ 3 SHEATHING & WB	1	03-Jul-13	03-Jul-13	A1120, A1230
A1250	C SEQ 2 SHEATHING & WB	1	05-Jul-13	05-Jul-13	A1130, A1240
A1260	E SEQ 2 SHEATHING & WB	1	08-Jul-13	08-Jul-13	A1140, A1250
A1270	E SEQ 3 SHEATHING & WB	1	09-Jul-13	09-Jul-13	A1150, A1260
A1280	E SEQ 5 SHEATHING & WB	1	10-Jul-13	10-Jul-13	A1160, A1270
A1290	C SEQ 5 SHEATHING & WB	1	11-Jul-13	11-Jul-13	A1170, A1280
A1300	E SEQ 6 SHEATHING & WB	1	12-Jul-13	12-Jul-13	A1180, A1290
A1310	C SEQ 6 SHEATHING & WB	1	15-Jul-13	15-Jul-13	A1190, A1300
Onsite.MODULE INSTALLATION.LARGE BUMPOUT WIND		12	10-Jul-13	26-Jul-13	
A1320	E SEQ 5 WINDOWS	3	10-Jul-13	15-Jul-13	A1280
A1330	C SEQ 5 WINDOWS	3	15-Jul-13	18-Jul-13	A1320, A1290
A1340	E SEQ 6 WINDOWS	3	18-Jul-13	23-Jul-13	A1330, A1300
A1350	C SEQ 6 WINDOWS	3	23-Jul-13	26-Jul-13	A1340, A1310
Onsite.MODULE INSTALLATION.FINAL STONE PANEL (N		21	27-Jun-13	29-Jul-13	
A1360	E SEQ 1 STONE PANELS	1	27-Jun-13	28-Jun-13	A1200
A1370	E SEQ 4 STONE PANELS	1	28-Jun-13	01-Jul-13	A1360, A1210
A1380	C SEQ 1 STONE PANELS	1	01-Jul-13	02-Jul-13	A1370, A1220

▬ Actual Level of Effort	🟩 Remaining Work	◆ ◆ Milestone
🟦 Actual Work	🟥 Critical Remaining Work	▼▬▼ summary

Page 1 of 2

Ewing-Cross Renovation

Activity ID	Activity Name	Original Duration	Start	Finish	Predecessors
A1390	C SEQ 4 STONE PANELS	1	02-Jul-13	03-Jul-13	A1380, A1230
A1400	C SEQ 3 STONE PANELS	1	03-Jul-13	05-Jul-13	A1390, A1240
A1410	C SEQ 2 STONE PANELS	1	05-Jul-13	08-Jul-13	A1400, A1250
A1420	E SEQ 2 STONE PANELS	1	08-Jul-13	09-Jul-13	A1410, A1260
A1430	E SEQ 3 STONE PANELS	1	09-Jul-13	10-Jul-13	A1420, A1270
A1440	E SEQ 5 STONE PANELS	1	15-Jul-13	16-Jul-13	A1430, A1280,
A1450	C SEQ 5 STONE PANELS	1	18-Jul-13	19-Jul-13	A1440, A1290,
A1460	E SEQ 6 STONE PANELS	1	23-Jul-13	24-Jul-13	A1450, A1300,
A1470	C SEQ 6 STONE PANELS	1	26-Jul-13	29-Jul-13	A1460, A1310,
Onsite.MODULE INSTALLATION.ROOF TRUSSES (New W		60	28-Jun-13	24-Sep-13	
A1480	E SEQ 1 ROOF TRUSS	5	28-Jun-13	08-Jul-13	A1360
A1490	E SEQ 4 ROOF TRUSS	5	08-Jul-13	15-Jul-13	A1480, A1370
A1500	C SEQ 1 ROOF TRUSS	5	15-Jul-13	22-Jul-13	A1490, A1380
A1510	C SEQ 4 ROOF TRUSS	5	22-Jul-13	29-Jul-13	A1500, A1390
A1520	C SEQ 3 ROOF TRUSS	5	29-Jul-13	05-Aug-13	A1510, A1400
A1530	C SEQ 2 ROOF TRUSS	5	05-Aug-13	12-Aug-13	A1520, A1410
A1540	E SEQ 2 ROOF TRUSS	5	12-Aug-13	19-Aug-13	A1530, A1420
A1550	E SEQ 3 ROOF TRUSS	5	19-Aug-13	26-Aug-13	A1540, A1430
A1560	E SEQ 5 ROOF TRUSS	5	26-Aug-13	03-Sep-13	A1550, A1440
A1570	C SEQ 5 ROOF TRUSS	5	03-Sep-13	10-Sep-13	A1560, A1450
A1580	E SEQ 6 ROOF TRUSS	5	10-Sep-13	17-Sep-13	A1570, A1460
A1590	C SEQ 6 ROOF TRUSS	5	17-Sep-13	24-Sep-13	A1580, A1470
Onsite.MODULE INSTALLATION.INSTALL SHINGLES (Ne		60	08-Jul-13	01-Oct-13	
A1600	E SEQ 1 SHINGLES	5	08-Jul-13	15-Jul-13	A1480
A1610	E SEQ 4 SHINGLES	5	15-Jul-13	22-Jul-13	A1600, A1490
A1620	C SEQ 1 SHINGLES	5	22-Jul-13	29-Jul-13	A1610, A1500
A1630	C SEQ 4 SHINGLES	5	29-Jul-13	05-Aug-13	A1620, A1510
A1640	C SEQ 3 SHINGLES	5	05-Aug-13	12-Aug-13	A1630, A1520
A1650	C SEQ 2 SHINGLES	5	12-Aug-13	19-Aug-13	A1640, A1530
A1660	E SEQ 2 SHINGLES	5	19-Aug-13	26-Aug-13	A1650, A1540
A1670	E SEQ 3 SHINGLES	5	26-Aug-13	03-Sep-13	A1660, A1550
A1680	E SEQ 5 SHINGLES	5	03-Sep-13	10-Sep-13	A1670, A1560
A1690	C SEQ 5 SHINGLES	5	10-Sep-13	17-Sep-13	A1680, A1570
A1700	E SEQ 6 SHINGLES	5	17-Sep-13	24-Sep-13	A1690, A1580
A1710	C SEQ 6 SHINGLES	5	24-Sep-13	01-Oct-13	A1700, A1590
Onsite.OTHER ENCLOSURE (New WBS)		55	29-Jul-13	15-Oct-13	
Onsite.OTHER ENCLOSURE.E SEQ 7 INSTALL (New WB		10	29-Jul-13	12-Aug-13	
A1720	E SEQ 7 ERECT WALL PANELS	2	29-Jul-13	31-Jul-13	A1470
A1730	E SEQ 7 INSTALL WINDOWS	4	31-Jul-13	06-Aug-13	A1720
A1740	E SEQ 7 INSTALL STONE PANELS	4	06-Aug-13	12-Aug-13	A1730
Onsite.OTHER ENCLOSURE.C SEQ 7 INSTALL (New WB		10	31-Jul-13	14-Aug-13	
A1750	C SEQ 7 ERECT WALL PANELS	2	31-Jul-13	02-Aug-13	A1720
A1760	E SEQ 7 INSTALL WINDOWS	4	02-Aug-13	08-Aug-13	A1750
A1770	E SEQ 7 INSTALL WALL PANELS	4	08-Aug-13	14-Aug-13	A1760
Onsite.OTHER ENCLOSURE.GUTTER & DOWNSPOUT (N		10	01-Oct-13	15-Oct-13	
A1780	GUTTER & DOWNSPOUT	10	01-Oct-13	15-Oct-13	A1710



▬ Actual Level of Effort	🟩 Remaining Work	◆	◆ Milestone	
▬ Actual Work	🟥 Critical Remaining Work	▼	summary	

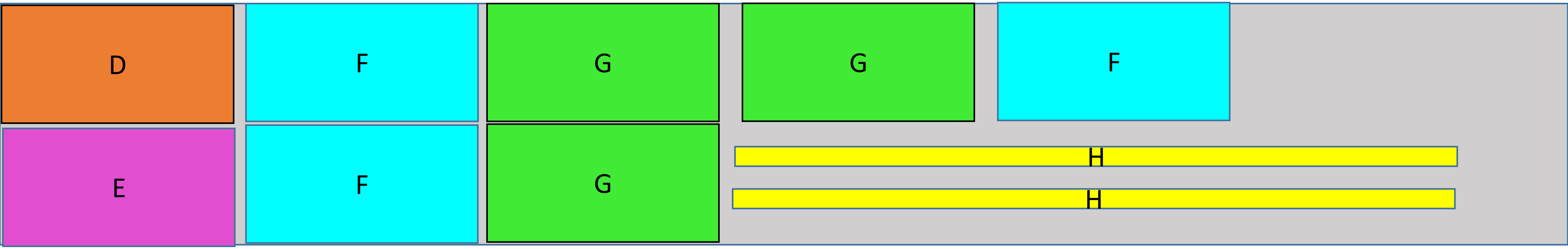
APPENDIX O: LIMESTONE WALL ASSEMBLY TRANSPORTATION

TRUCK 1: (2) SMALL BUMPOUTS; TOTAL WEIGHT 16,214#

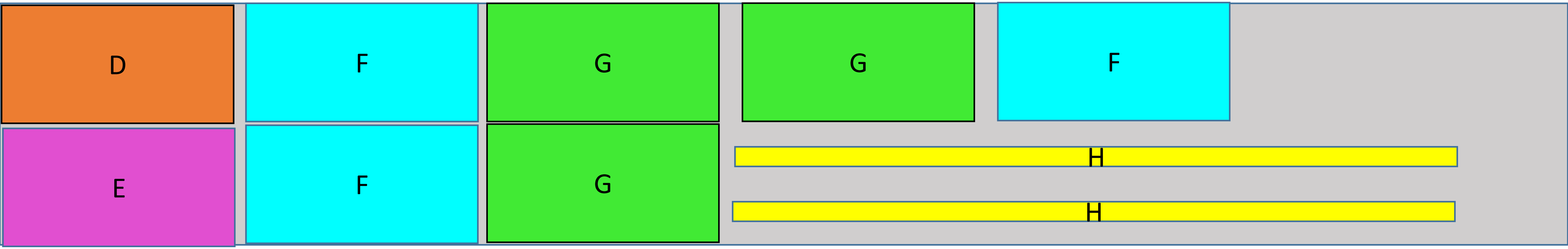
TRUCK 2: (2) SMALL BUMPOUTS; TOTAL WEIGHT 16,214#

TRUCK 3: (2) SMALL BUMPOUTS; TOTAL WEIGHT 16,214#

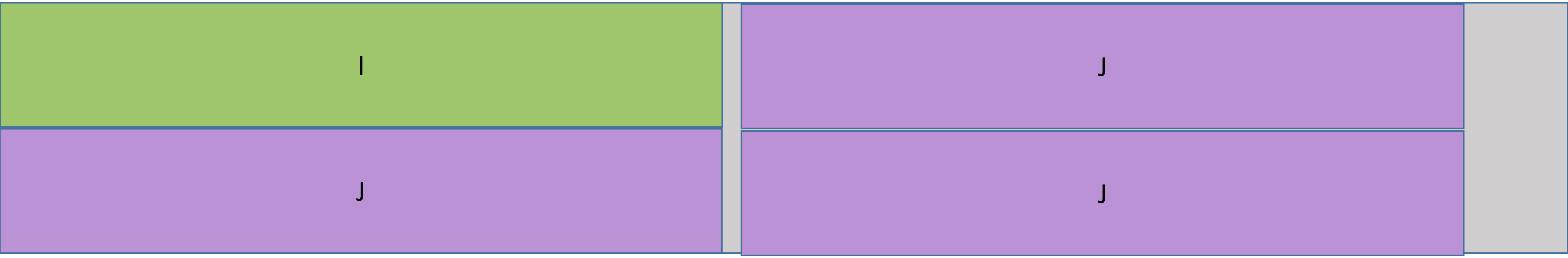
TRUCK 4: (2) SMALL BUMPOUTS; TOTAL WEIGHT 16,214#



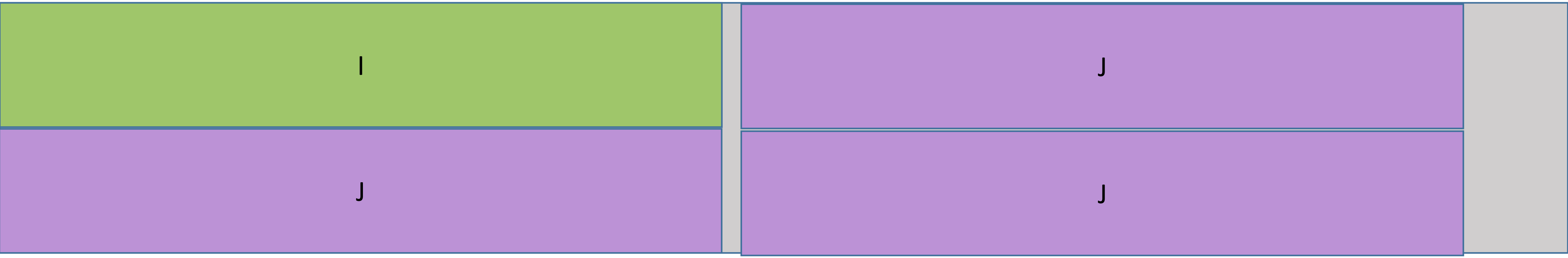
TRUCK 5: LARGE BUMPOUT BATHROOM; TOTAL WEIGHT 11,150#



TRUCK 6: LARGE BUMPOUT BATHROOM; TOTAL WEIGHT 11,150#

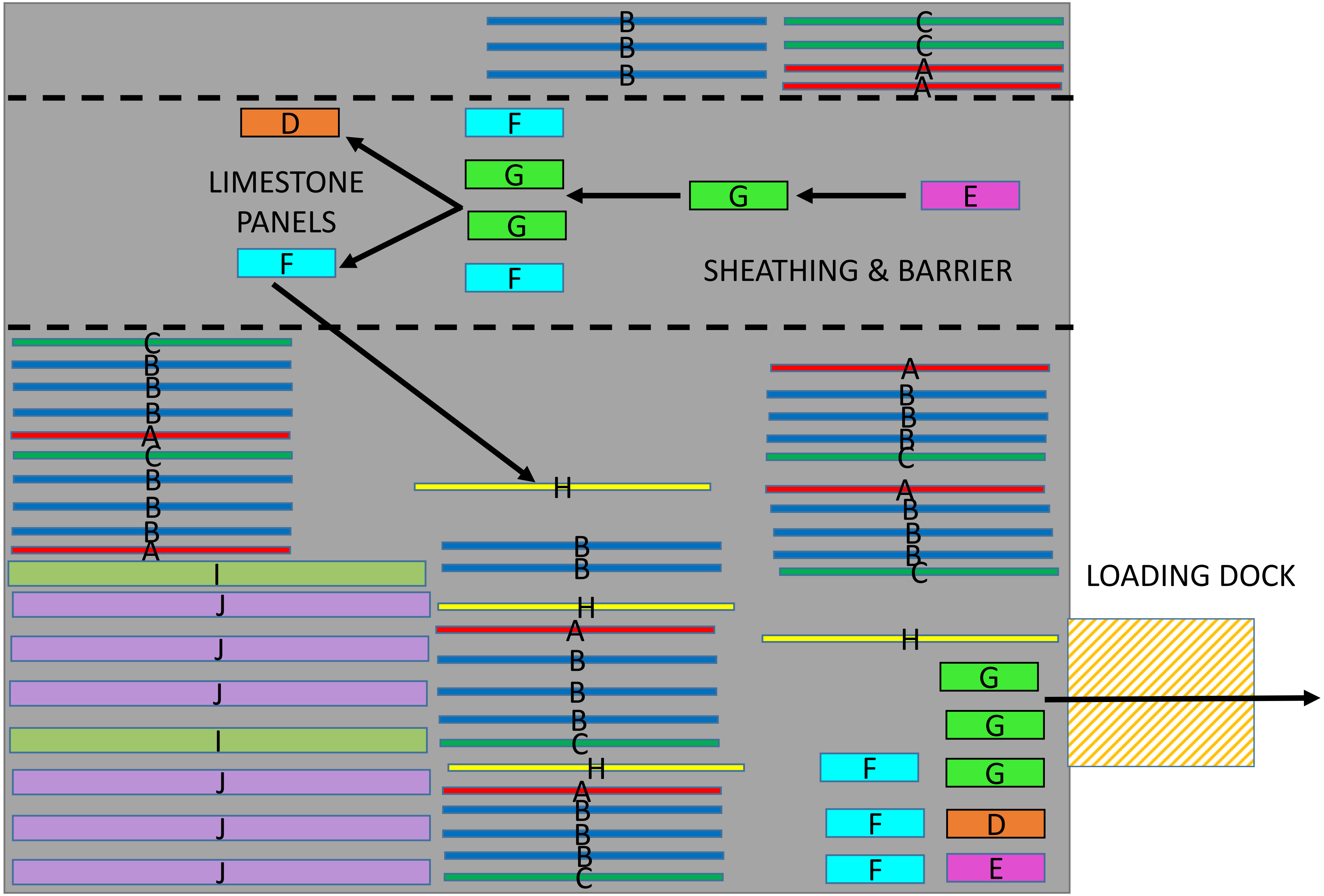


TRUCK 7: LARGE BUMPOUT STUDENT ROOM; TOTAL WEIGHT 10,824#



TRUCK 8: LARGE BUMPOUT STUDENT ROOM; TOTAL WEIGHT 10,824#

MATERIAL STORAGE



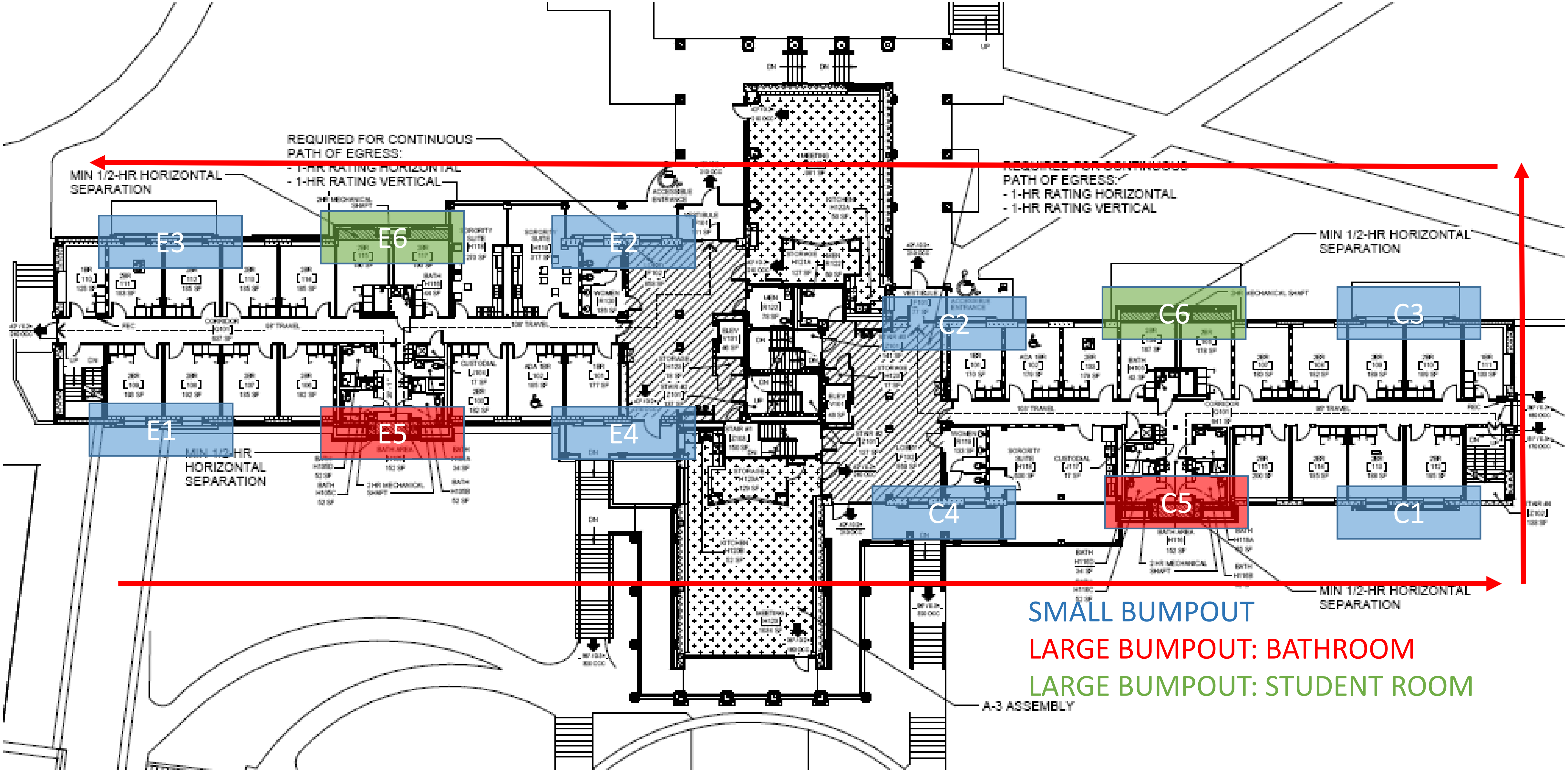
LIMESTONE PANELS

SHEATHING & BARRIER

LOADING DOCK

FINISHED ASSEMBLY STORAGE

NEXT SHIPMENT

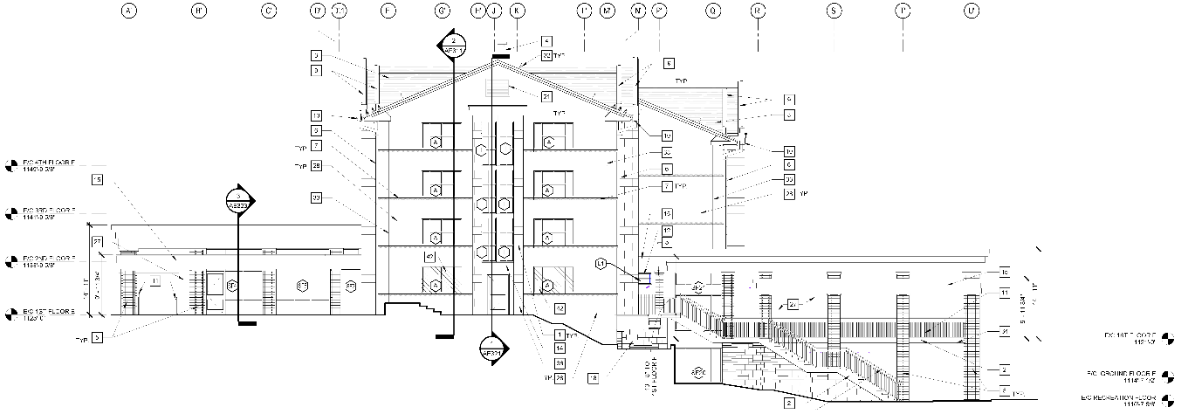


SMALL BUMPOUT

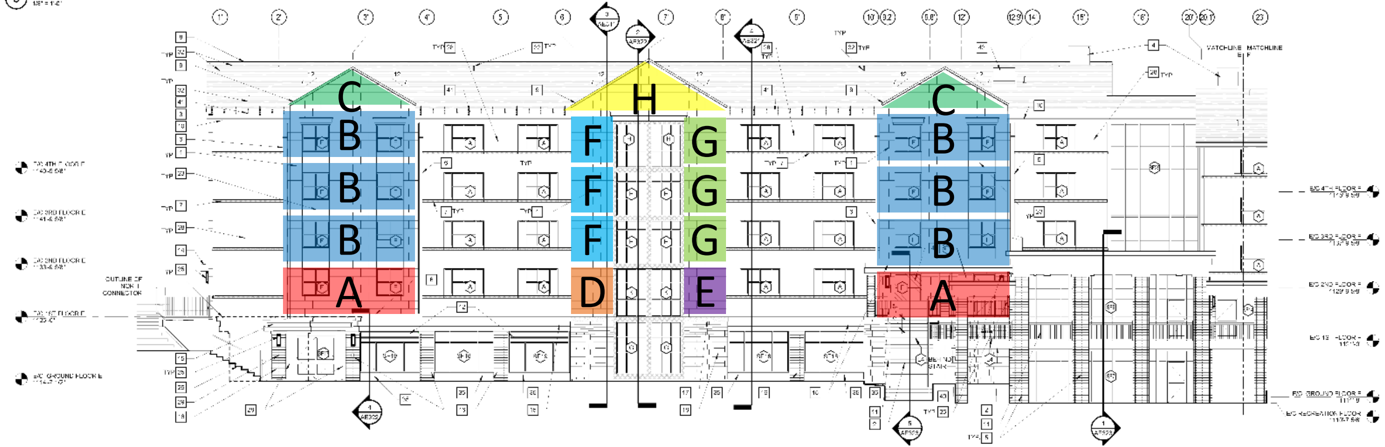
LARGE BUMPOUT: BATHROOM

LARGE BUMPOUT: STUDENT ROOM

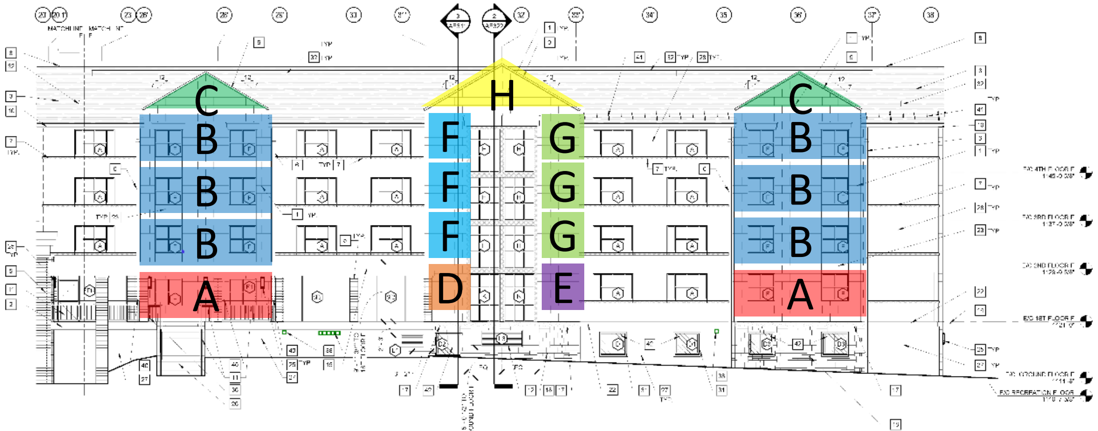
APPENDIX P: MODULE TYPES



3 EWING/CROSS WEST ELEVATION



2 EWING/CROSS SOUTH ELEVATION E



1 EWING/CROSS SOUTH ELEVATION F

GENERAL ELEVATION NOTES

A. SEE WALL SECTIONS AND BUILDING SECTIONS FOR ADDITIONAL INFORMATION.

B. A MATERIAL HATCH PATTERN ON THE ELEVATIONS INDICATES AN AREA OF NEW WORK. EXISTING WALLS ARE SHOWN AS UNHATCHED, EXCEPT WHERE INDICATED.

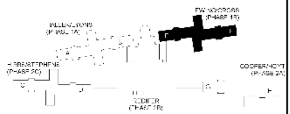
C. BEDROOM WINDOWS THAT ARE LOCATED 10' OR LESS FROM GRADE SHALL HAVE A SECURITY SCREEN INSTALLED.

D. OPERABLE WINDOWS SHALL HAVE AN INSECT SCREEN INSTALLED OVER THE OPERABLE PORTION.

ELEVATION KEYNOTES: A

1 18"X32" STONE PANEL VENEER SYSTEM ON EXTERIOR BAY.
2 EXTERIOR WALKWAY/STAIRS.
3 EXISTING ROOF RE-SHINGLED WITH RUBBER TILES.
4 EXISTING CHIMNEY.
5 MASONRY COLUMN WRAP.
6 6" SQUARE DOWNSPOUT; REFER TO DETAIL 9/AE500.
7 METAL ACCENT BAND.
8 RIDGE VENT.
9 METAL COPING.
10 METAL GUTTER.
11 METAL HANDRAIL AND GUARDRAIL SYSTEM; REFER TO TYPICAL ELEVATION/SECTION 1/AE400.
12 PRE-FINISHED ALUMINUM LOUVER.
13 LIGHT FIXTURE.
14 SLOPED CANOPY OVER BUILDING ENTRANCE.
15 METAL CANOPY ABOVE EXTERIOR WALKWAY/STAIRS.
16 BRICK WRAP OVER EXISTING CONCRETE. USE SALVAGED BRICK FROM SAVE BUILDING.
17 LIMESTONE WATER TABLE, COLOR AND FINISH TO MATCH EXISTING.
18 LIMESTONE MASONRY IN ASHLAR PATTERN. COLOR AND FINISH TO MATCH EXISTING.
20 INFILL WALL WHERE CONCRETE SLAB WAS REMOVED OR WHERE EXTERIOR INFILL WALL IS PROVIDED WITH SALVAGED BRICK FROM SAVE BUILDING.
21 EXISTING LOUVER.
22 EXISTING LIMESTONE WATERTABLE.
23 STONE PANEL VENEER SYSTEM BETWEEN WINDOWS.
25 WALL SCONCE.
26 EXISTING CONCRETE STAIR.
27 EXISTING LIMESTONE.
28 EXISTING BRICK.
29 CARD READER.
30 STRUCTURAL BEAM.
31 EXISTING LIMESTONE TRIM.
32 CONTINUOUS FALL ARREST SYSTEM.
33 EXISTING CONTROL JOINT.
34 SECURITY CAMERA.
35 EXISTING CONCRETE.
36 ELECTRICAL OUTLET.
37 SANITARY PIPE.
38 DRYER VENTS.
39 EXISTING RAILING.
40 2" ROUND DOWNSPOUT. REFER TO DETAIL 3/AE500.
41 SNOWGUARDS.
42 SECURITY SCREENS INSTALLED AT OPERABLE WINDOWS 10' OR LESS FROM GRADE, TYP.
43 ROOF HATCH.
44 ALUMINUM COLUMN WRAP. COLOR TO MATCH CANOPY. FLASH WRAP AT CANOPY PENETRATIONS.

BUILDING KEYPLAN



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CHARLOTTE, NC 28204
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Barton Malow

300 West Pratt Street, Suite 310
Baltimore, MD 21201
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Fax: 443.757.1011
www.bartonmalow.com

APA

3939 South Atherton Street
State College, PA 16801
Phone: 814.466.6675
Fax: 814.466.6676
www.aparchitects.com

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600 Science Park Road
State College, PA 16803
Phone: 814.237.6518
Fax: 814.237.1480
www.sweetland-eng.com

PENN STATE SOUTH HALLS PHASE 1
PENN STATE UNIVERSITY
UNIVERSITY PARK, PA 16802

PSU NO: 07-91210
CN NO: 3852
DATE: 06/08/2012
DESIGN: RTG
DRAWN: ASL
REVIEW: ERH, NGH

REVISIONS

No.	Date	Description

1B EWING/CROSS
EXTERIOR
ELEVATIONS

AE211

SHEET OF

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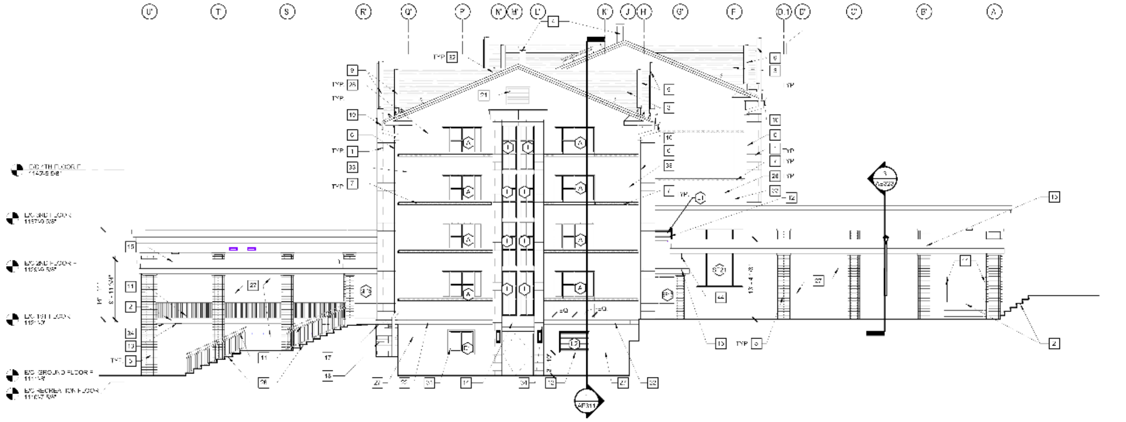
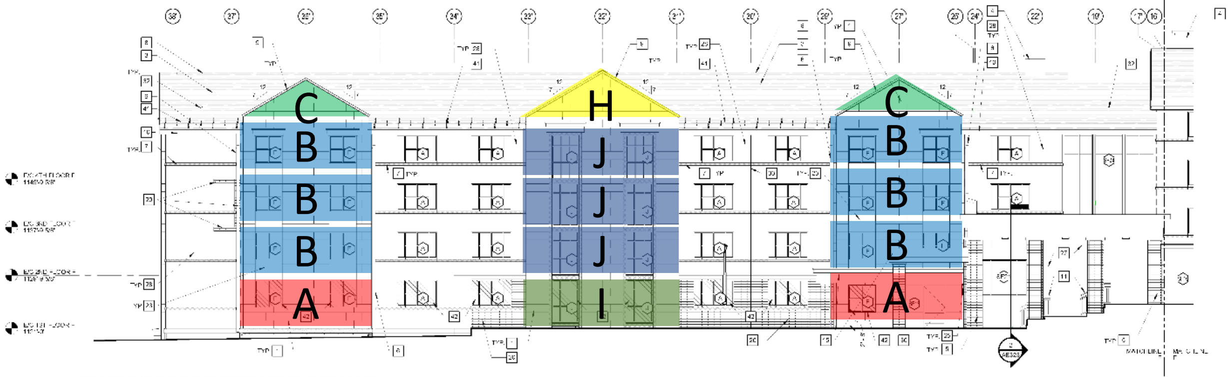
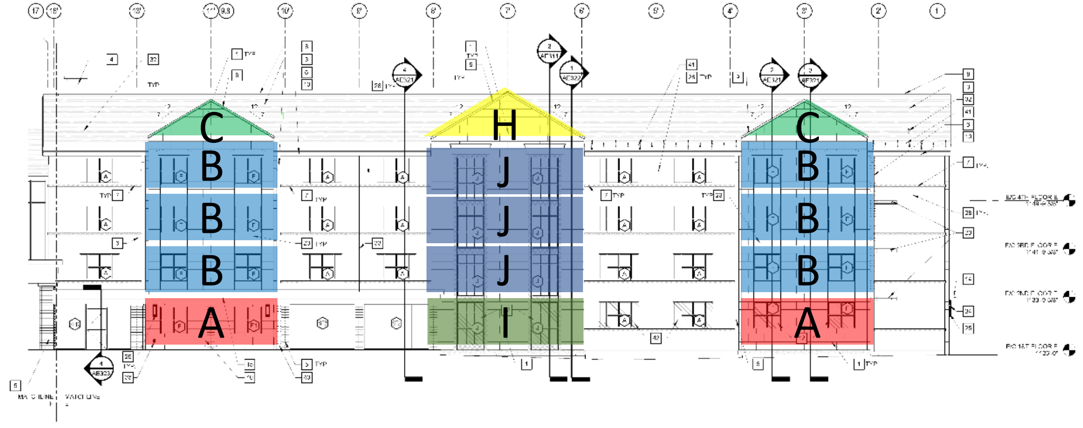


3 EWING/CROSS EAST ELEVATION



2 EWING/CROSS NORTH ELEVATION F



1 EWING/CROSS NORTH ELEVATION E

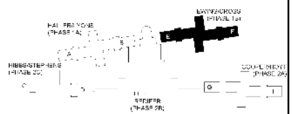
GENERAL ELEVATION NOTES

A. SEE WALL SECTIONS AND BUILDING SECTIONS FOR ADDITIONAL INFORMATION
B. A MATERIAL HATCH PATTERN ON THE ELEVATIONS INDICATES AN AREA OF NEW WORK. EXISTING WALLS ARE SHOWN AS UNHATCHED, EXCEPT WHERE INDICATED.
C. BEDROOM WINDOWS THAT ARE LOCATED 10' OR LESS FROM GRADE SHALL HAVE A SECURITY SCREEN INSTALLED.
D. OPERABLE WINDOWS SHALL HAVE AN INSECT SCREEN INSTALLED OVER THE OPERABLE PORTION.

ELEVATION KEYNOTES:

1	18"x36" STONE PANEL VENEER SYSTEM ON EXTERIOR BAY
2	EXTERIOR WALKWAY/STAIRS.
3	EXISTING ROOF RE-SHINGLED WITH RUBBER TILES.
4	EXISTING CHIMNEY.
5	MASONRY COLUMN WRAP
6	3" SQUARE DOWNSPOUT; REFER TO DETAIL 9/AE503.
7	METAL ACCENT BAND
8	RIDGE VENT
9	METAL COPING
10	METAL GUTTER.
11	METAL HANDRAIL AND GUARDRAIL SYSTEM; REFER TO TYPICAL ELEVATION/SECTION 1/AE430
12	PRE-FINISHED ALUMINUM LOUVER
13	LIGHT FIXTURE.
14	SLOPED CANOPY OVER BUILDING ENTRANCE
15	METAL CANOPY ABOVE EXTERIOR WALKWAY/STAIRS.
16	BRICK WRAP OVER EXISTING CONCRETE. USE SALVAGED BRICK FROM SAME BUILDING.
17	LIMESTONE WATER TABLE, COLOR AND FINISH TO MATCH EXISTING
18	LIMESTONE MASONRY IN ASHLAR PATTERN. COLOR AND FINISH TO MATCH EXISTING.
20	INFILL WALL WHERE CONCRETE SLAB WAS REMOVED OR WHERE EXTERIOR INFILL WALL IS PROVIDED WITH SALVAGED BRICK FROM SAME BUILDING.
21	EXISTING LOUVER.
22	EXISTING LIMESTONE WATERTABLE
23	STONE PANEL VENEER SYSTEM BETWEEN WINDOWS.
25	WALL SCONCE.
26	EXISTING CONCRETE STAIR
27	EXISTING LIMESTONE.
28	EXISTING BRICK.
29	CARD READER.
30	STRUCTURAL BEAM.
31	EXISTING LIMESTONE TRIM
32	CONTINUOUS FALL ARREST SYSTEM.
33	EXISTING CONTROL JOINT
34	SECURITY CAMERA.
35	EXISTING CONCRETE
36	ELECTRICAL OUTLET.
37	SANITARY PIPE
38	DRYER VENTS
39	EXISTING RAILING
40	3" ROUND DOWNSPOUT. REFER TO DETAIL 9/AE503
41	SNOWGUARDS
42	SECURITY SCREENS INSTALLED AT OPERABLE WINDOWS 10' OR LESS FROM GRADE, TYP.
43	ROOF HATCH
44	ALUMINUM COLUMN WRAP. COLOR TO MATCH CANOPY. FLASH WRAP AT CANOPY PENETRATIONS.

BUILDING KEYPLAN



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300 West Pratt Street, Suite 310
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PENN STATE SOUTH HALLS PHASE 1
PENN STATE UNIVERSITY
UNIVERSITY PARK, PA 16802

PSU NO: 07-91210
CN NO: 3852
DATE: 06/08/2012
DESIGN: RTG
DRAWN: ASL
REVIEW: ERH, NGH

REVISIONS

No	Date	Description

1B EWING/CROSS
EXTERIOR
ELEVATIONS

AE212
SHEET OF

APPENDIX Q: FACTORY INFORMATION

3431 Colonial Drive

Duncansville, PA 16635-8026

Powered by **SHOWCASE.COM**

Property Type:	Industrial
Sub Type:	-
Status:	Existing
Year Built:	-
Building Size:	6,900 SF
Land Area:	.74 AC (32,365 SF)
Ceiling Height:	-
Loading Docks:	-
Rail:	-
Power:	-
Smallest Space:	6,900 SF
Largest Space:	6,900 SF
Total Space Avail:	6,900 SF
Rent/SF/Yr:	$6.09
Zoning:	-
Sprinklers:	-
Drive Ins:	-
Cranes:	-

Space Available:

Floor	SF Avail	Rent/SF/Yr	Occupancy	Lease Term	Space Use
GRND	6,900 SF	$6.09/SF/Yr	30 Days	Negotiable	Industrial

3431 Colonial Drive

Duncansville, PA 16635-8026

Powered by **SHOWCASE.COM**

GRND Floor Space Detail

Available:	6,900 SF of Industrial, will not divide
Largest Space:	6,900 SF
Rent/SF/Yr:	$6.09 / mg
Rent/Yr:	$42,021
Exec Suite:	No
Occupancy:	30 Days
Type:	Direct
Term:	Negotiable
Space Notes:	$3,500/month

For more information:
Howard Hanna Johnston Realty Inc.
Richard Johnston 🗎 (814) 946-8682 ✉

APPENDIX R: PREFABRICATION COSTS

3 5/8" Limestone Panel System

Source	Item	Crew	Daily Output	Labor Hours	Quantity	Unit	Mat $/Unit	Labor $/Unit	Equip $/Unit	Mat $	Labor $	Equip $	Total Cost
Evans Limestone Company	Limestone	D10	275	0.12	905	SF	$ 12.64	$ 7.76	$ 1.97	$ 11,439.20	$ 7,022.80	$ 1,782.85	$ 20,244.85
RS Means Online	Sheathing	2 Carp	1050	0.01	905	SF	$ 0.60	$ 0.58	$ -	$ 543.00	$ 524.90	$ -	$ 1,067.90
RS Means Online	Metal Studs	2 carp	72	0.222	122	LF	$ 12.79	$ 12.14	$ -	$ 1,560.38	$ 1,481.08	$ -	$ 3,041.46
RS Means Online	Vapor Barrier	1 Carp	4000	0	905	SF	$ 0.15	$ 0.08	$ -	$ 135.75	$ 72.40	$ -	$ 208.15
RS Means Online	HSS Columns 6x6x5/16	E2	11270	0.01	3360	Lb	$ 1.18	$ 0.30	$ 0.16	$ 3,964.80	$ 1,008.00	$ 537.60	$ 5,510.40
RS Means Online	HSS 6x6x3/16	E2	11270	0.01	1800	Lb	$ 1.18	$ -	$ -	$ 2,124.00	$ -	$ -	$ 2,124.00
RS Means Online	HSS 3 1/2x3 1/2x3/16		-	-	489	Lb	$ 1.18	$ -	$ -	$ 577.02	$ -	$ -	$ 577.02
RS Means Online	HSS Beam(s) L&E	E2	600	0.09	183.3	LF	-	$ 5.52	$ 2.87	$ -	$ 1,011.82	$ 526.07	$ 1,537.89
RS Means Online	Horizontal Relief Angle 6"x4"	E4	250	0.128	110	LF	$ 18.20	$ 7.79	$ 0.64	$ 2,002.00	$ 856.90	$ 70.40	$ 2,929.30
RS Means Online	LW Composite Decking												
RS Means Online	LW 3 1/3" Concrete		-	-	6.3	CY	$ 124.98	$ -	$ -	$ 787.37	$ -	$ -	$ 787.37
RS Means Online	3" VLI Deck	E4	2850	0.011	328	SF	$ 3.00	$ 0.70	$ 0.06	$ 984.00	$ 229.60	$ 19.68	$ 1,233.28
RS Means Online	Placement, Pumped 6"-10"	C20	160	0.4	6.3	CY	$ -	$ 16.75	$ 5.54	$ -	$ 105.53	$ 34.90	$ 140.43
RS Means Online	WWF W2.5xW2.5	2 Rodm	29	0.55	3.28	CSF	$ 21.11	$ 29.84	$ -	$ 69.24	$ 97.88	$ -	$ 167.12
RS Means Online	Finish, bull float and manual float	C10	1265	0.02	328	SF	$ -	$ 0.53	$ -	$ -	$ 173.84	$ -	$ 173.84

1/4" Limestone Veneer System

	Item	Crew	Daily Output	Labor Hours	Quantity	Unit	Mat $/Unit	Labor $/Unit	Equip $/Unit	Mat $	Labor $	Equip $	Total Cost
Barton Malow	Limestone Veneer	2 Carp	230	0.09	905	SF	$ 36.00	-	-	$ 32,580.00	-	-	$ 32,580.00
RS Means Online	Sheathing	2 Carp	1050	0.01	905	SF	$ 0.60	$ 0.58	$ -	$ 543.00	$ 524.90	$ -	$ 1,067.90
RS Means Online	Metal Studs	2 carp	72	0.222	122	LF	$ 12.79	$ 12.14		$ 1,560.38	$ 1,481.08	$ -	$ 3,041.46
RS Means Online	Vapor Barrier	1 Carp	4000	0	905	SF	$ 0.15	$ 0.08	$ -	$ 135.75	$ 72.40	$ -	$ 208.15
RS Means Online	LW Composite Decking												
RS Means Online	LW 3 1/3" Concrete				4.86	CY	$ 124.98			$ 607.40			$ 607.40
RS Means Online	3" VLI Deck	E4	2850	0.011	252	SF	$ 3.00	$ 0.70	$ 0.06	$ 756.00	$ 176.40	$ 15.12	$ 947.52
RS Means Online	Placement, Pumped 6"-10"	C20	160	0.4	4.86	CY		$ 16.75	$ 5.54		$ 81.41	$ 26.92	$ 108.33
RS Means Online	WWF W2.5xW2.5	2 Rodm	29	0.55	2.52	CSF	$ 21.11	$ 29.84		$ 53.20	$ 75.20		$ 128.39
RS Means Online	Finish, bull float and manual float	C10	1265	0.02	252	SF		$ 0.53			$ 133.56		$ 133.56

Stone Panel Veneer System	
Item	**Total Cost**
1/4" Limestone and Aluminum Honeycomb Backing	$ 32,580.00
Metal Studs, Sheathing & Vapor Barrier	$ 4,317.51
LW Concrete & Composite Deck	$ 1,925.21
Total System	**$ 38,822.72**
Traditional Limestone System	
Item	**Total Cost**
3 5/8" Limestone Panels	$ 20,244.85
Metal Studs, Sheathing & Vapor Barrier	$ 4,317.51
Structral Steel	$ 12,678.61
LW Concrete & Composite Deck	$ 2,502.04
Total System	**$ 39,743.00**
Cost Difference	$ (920.29)

PREFABRICATION COSTS

PA Wage Rates

Sources	Description	Hourly Rate	Fringe Benefits	Total
PA Wage Rates	Carpenter	$ 25.85	$ 10.61	$ 36.46

Offsite Labor Costs

Source	Activity	Crew	Labor/Hour	Crew $/Day	Total Duration	Total Labor
PA Wage Rates	Sheathing/Weather Barrier	2 Carp	$ 36.46	$ 583.36	22	$ 12,833.92
PA Wage Rates	Limestone Installation	5 Carp	$ 36.46	$ 1,458.40	22	$ 32,084.80
					Grand Total	**$ 44,918.72**

Warehouse Lease

Source	Description	Unit	Quantity	Crew	Cost/Month	Total
Showcase	6,900 SF Warehouse Rental	Month	17	-	$ 3,500.00	$ 59,500.00
					Grand Total	**$ 59,500.00**

TRANSPORTATION COSTS

Costs for Loading Modules at Warehouse

Source	Description	Unit	Quantity	Crew	Labor/Unit	Equip/Unit	Total
015433600150	Flatbed Mounted Crane, 3 ton capacity	Month	1	-	$ -	$ 1,750.00	$ 1,750.00
015419500100	Crane Crew	Daily	8	A3N	$ 400.00	$ -	$ 3,200.00
						Grand Total	**$ 4,950.00**

Pallet Costs

Source	Description	Unit	Quantity	Crew	Mat/Unit	Mat Total
Uline	96" x 48" New Wood Pallet	Ea	172	-	$ 42.00	$ 7,224.00
Uline	Pallet Truck	Ea	3	-	$ 299.00	$ 897.00
					Grand Total	**$ 8,121.00**

Transportation Fees

Source	Description	Unit	Quantity	Crew	Cost/Delivery	Total
FreightQuote	Delivery from Duncansville to State College, 50 miles	Ea	8	-	$ 350.00	$ 2,800.00
					Grand Total	**$ 2,800.00**

ONSITE INSTALLATION COSTS

Crane Fees

Source	Description	Unit	Quantity	Crew	Cost/Unit	Total
RS Means Online	12 Ton Crane and Crew Rental	Day	12	A3H	$ 1,275.00	$ 15,300.00
					Grand Total	**$ 15,300.00**

ONSITE INSTALLATION COST COMPARISON

Ewing Original Installation

Source	Activity	Crew	Unit	Quantity	$/Unit	Equip Total	Labor Total
RS Means Online	Metal Wall Panel/Sheathing/Weather Barrier	2 Carp	Day	33	$ 583.36	$ -	$ 19,250.88
RS Means Online		Scissor Lift	Month	5	$ 675.00	$ 3,375.00	$ -
RS Means Online	Limestone Panels	5 Carp	Day	30	$ 1,458.40	$ -	$ 43,752.00
RS Means Online		Scissor Lift	Month	5	$ 675.00	$ 3,375.00	$ -
RS Means Online		Manlift	Month	5	$ 3,600.00	$ 18,000.00	$ -
					Total	**$ 24,750.00**	**$ 63,002.88**

Cross Original Installation

Source	Activity	Crew	Unit	Quantity	$/Unit	Equip Total	Labor Total
RS Means Online	Metal Wall Panel/Sheathing/Weather Barrier	2 Carp	Day	36	$ 583.36	$ -	$ 21,000.96
RS Means Online		Scissor Lift	Month	5	$ 675.00	$ 3,375.00	$ -
RS Means Online	Limestone Panels	5 Carp	Day	30	$ 1,458.40	$ -	$ 43,752.00
RS Means Online		Scissor Lift	Month	5	$ 675.00	$ 3,375.00	$ -
RS Means Online		Manlift	Month	5	$ 3,600.00	$ 18,000.00	$ -
					Total	**$ 24,750.00**	**$ 64,752.96**

Ewing Prefab Installation

Source	Activity	Crew	Unit	Quantity	$/Unit	Equip Total	Labor Total
RS Means Online	Install Wall Assemblies	2 Carp	Day	6	$ 583.36	$ -	$ 3,500.16
RS Means Online	Sheathing/Weather Barrier	2 Carp	Day	6	$ 583.36	$ -	$ 3,500.16
RS Means Online	Final Limestone Panels	5 Carp	Day	6	$ 1,458.40	$ -	$ 8,750.40
RS Means Online	Equipment	Scissor Lift	Month	2	$ 675.00	$ 1,350.00	$ -
RS Means Online		Manlift	Month	2	$ 3,600.00	$ 7,200.00	$ -
					Total	**$ 8,550.00**	**$ 15,750.72**

Cross Prefab Installation

Source	Activity	Crew	Unit	Quantity	$/Unit	Equip Total	Labor Total
RS Means Online	Install Wall Assemblies	2 Carp	Day	6	$ 583.36	$ -	$ 3,500.16
RS Means Online	Sheathing/Weather Barrier	2 Carp	Day	6	$ 583.36	$ -	$ 3,500.16
RS Means Online	Final Limestone Panels	5 Carp	Day	6	$ 1,458.40	$ -	$ 8,750.40
RS Means Online	Equipment	Scissor Lift	Month	2	$ 675.00	$ 1,350.00	$ -
RS Means Online		Manlift	Month	2	$ 3,600.00	$ 7,200.00	$ -
					Total	**$ 8,550.00**	**$ 15,750.72**

COST COMPARISON SUMMARY

	Installation Costs	
Area	Activity	Cost
Ewing Original	Wall Panel/Sheathing/Weather Barrier	$ 22,626.00
	Limestone Panels	$ 65,127.00
Cross Original	Wall Panel/Sheathing/Weather Barrier	$ 24,375.00
	Limestone Panels	$ 65,127.00
Ewing New	Prefab Wall Assemblies	$ 4,175.00
	Sheathing/Weather Barrier	$ 3,500.00
	Final Limestone Panels	$ 16,625.00
Ewing New	Prefab Wall Assemblies	$ 4,175.00
	Sheathing/Weather Barrier	$ 3,500.00
	Final Limestone Panels	$ 16,625.00

TOTAL PREFABRICATION COSTS FOR EWING – CROSS

	Prefabrication Costs for Ewing - Cross	
Item	**Activity**	**Cost**
Stick Built		
	Labor/Equipment for Metal Wall Panels/Sheathing/Weather Barrier	$ 177,255.00
Prefab System		
Prefabrication		
	17 Lease for 6,900SF Warehouse	$ 59,000.00
	Labor for Sheathing/Weather Barrier & Limestone Panels	$ 44,920.00
Transportation		
	172 48"x96" Pallets and 3 Pallet Trucks	$ 8,120.00
	(8) Truck Deliveries from Warehouse to Jobsite	$ 2,800.00
	3 Ton Crane to Load Modules at Warehouse	$ 4,950.00
Onsite Installation		
	Onsite Labor/Equipment to Install Modules and Install Final Façade	$ 48,600.00
	12 Ton Crane to Install Wall Modules	$ 15,300.00
Total		$ (6,435.00)

TOTAL PREFABRICATION COSTS FOR SOUTH HALLS

Prefabrication Costs for all Four Renovations		
Item	**Activity**	**Cost**
Stick Built		
	Labor/Equipment for Metal Wall Panels/Sheathing/Weather Barrier	$ 709,020.00
Prefab System		
Prefabrication		
	17 Lease for 6,900SF Warehouse	$ 59,000.00
	Labor for Sheathing/Weather Barrier & Limestone Panels	$ 179,680.00
Transportation		
	172 48"x96" Pallets and 3 Pallet Trucks	$ 8,120.00
	(8) Truck Deliveries from Warehouse to Jobsite	$ 11,200.00
	3 Ton Crane to Load Modules at Warehouse	$ 19,800.00
Onsite Installation		
	Onsite Labor/Equipment to Install Modules and Install Final Façade	$ 194,400.00
	12 Ton Crane to Install Wall Modules	$ 61,200.00
Total		$ 175,620.00

Home > Material Handling > Pallets > New Wood Pallets

96 x 48" New Wood Pallet

This economical alternative is the workhorse of the industry.

- Tough, durable wood.
- Stackable, reusable.
- **4-way forklift access.**
- Larger quantity quotes available.

Enlarge

MODEL NO.	WOOD TYPE	SIZE L x W	WEIGHT CAPACITY	SHPG. WEIGHT	PRICE EACH (MIN. 5)			ADD TO CART	
					5	10	20+		
H-1627	New Wood	96 x 48"	10,000 lbs.	104 lbs.	$47.50	$45.00	$42.00	5	ADD

SHIPS VIA MOTOR FREIGHT

⊟ Additional Info   Email Page

CONSTRUCTION:
- Stringers: (4) 1 1/4 x 3 1/2 x 96"
- Deck Lead Boards: (2) 5/8 x 4 x 48"
- Deck Boards: (11) 5/8 x 4 x 48"
- Bottom Lead Boards: (2) 5/8 x 4 x 48"
- Bottom Boards: (5) 5/8 x 4 x 48"

CAPACITY:
- Dynamic: 10,000 lbs (moving)
- Static: 23,283 lbs (standing still)

CERTIFICATIONS:
- Not heat treated for international shipments. H-2329 is recommended for international shipping.
- Not fumigated.

MISCELLANEOUS:
- Fork openings are on the width side.

Ships Via Motor Freight

Availability: In Stock
Unit Weight: 107 lbs.

Instructions

Catalog Page 36

Country of Origin: USA

GO

ULINE PRODUCTS
SHOP ULINE
SPECIAL OFFERS
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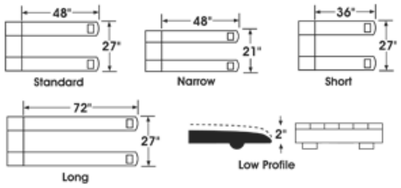
⊕ Larger Text

More Images & Video

Uline Pallet Trucks

Dependable pallet trucks at an affordable price.

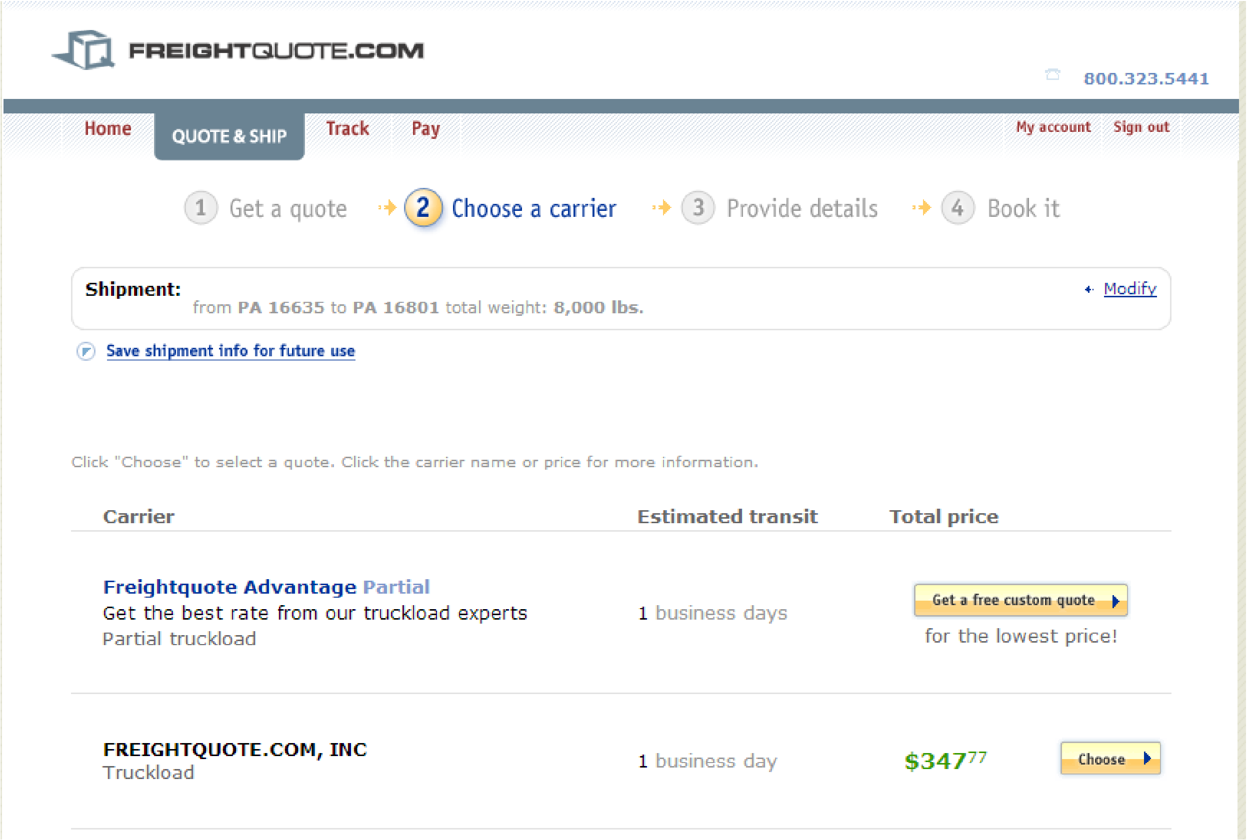
- 3-position hand control - Raise, lower, neutral.
- 7" polyurethane wheels. 210° steering arc.
- **Narrow** - Fits into narrow pallets.
- **Short** - Handles pallets up to 36" with ease.
- **Long** - Reaches under longer specialty pallets.
- **Low-Profile** - Slides into pallet openings only 2" high. 2" lowered and 5.6" raised height.



- Use with Pallet Truck Stop.
- View product video.

SHIPS ASSEMBLED VIA MOTOR FREIGHT

MODEL NO.	DESCRIPTION	FORK SIZE L x W	LOAD CAPACITY	WT. (LBS.)	PRICE EACH		ADD TO CART
					1	3+	
H-1043	Standard	48 x 27"	5,500 lbs.	153	$299	$279	1 ADD
H-1193	Narrow	48 x 21"		137			1 ADD
H-1484	Short	36 x 27"		136			1 ADD
H-1366	Short/Narrow	36 x 21"		130			1 ADD
H-1779	Long	72 x 27"	3,300 lbs.	205	489	459	1 ADD
H-2640	Long/Narrow	72 x 21"		200			1 ADD
H-1365	Low Profile	48 x 27"	3,300 lbs.	182	329	309	1 ADD
H-1780	Low Profile/Narrow	48 x 21"		173	329	309	1 ADD
H-1781	Low Profile/4 Way	48 x 33"		212	519	489	1 ADD



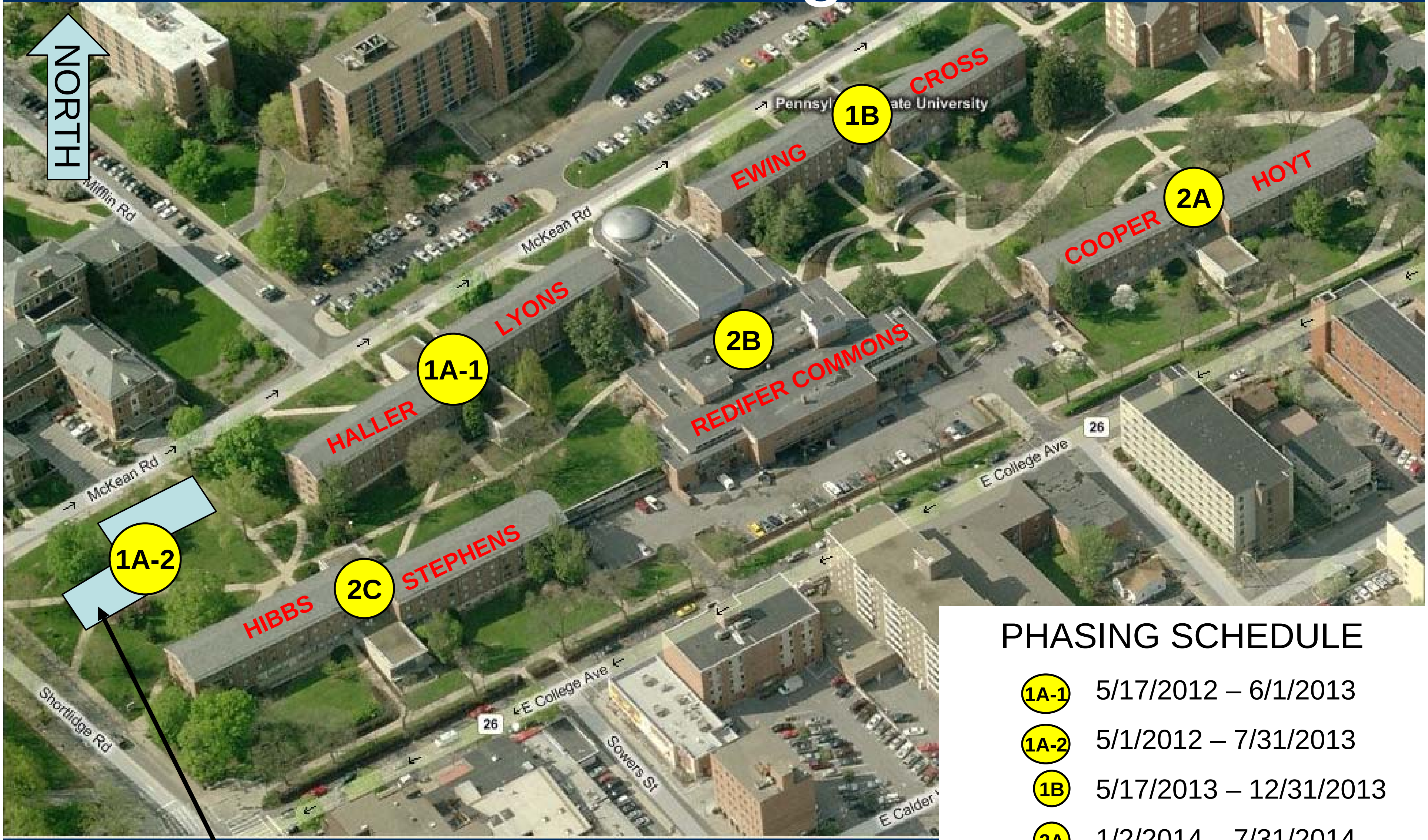
Shipment: from **PA 16635** to **PA 16801** total weight: **8,000 lbs.**

Click "Choose" to select a quote. Click the carrier name or price for more information.

Carrier	Estimated transit	Total price
Freightquote Advantage Partial Get the best rate from our truckload experts Partial truckload	1 business days	Get a free custom quote for the lowest price!
FREIGHTQUOTE.COM, INC Truckload	1 business day	$347.77

APPENDIX S: MASTER PHASING PLANS

Master Phasing Plan

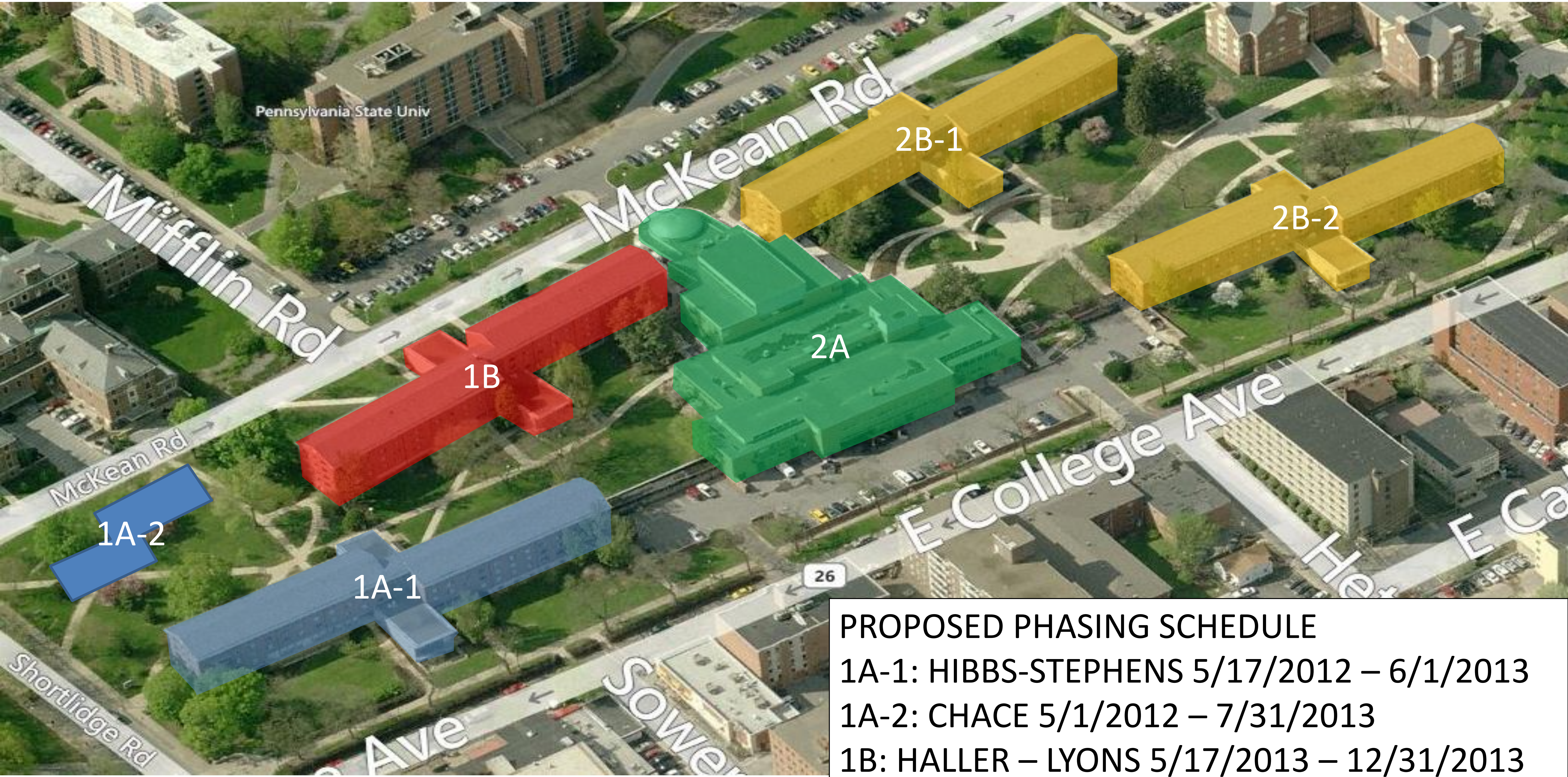


New 200 bed
Residence Hall

PHASING SCHEDULE

1A-1	5/17/2012 – 6/1/2013
1A-2	5/1/2012 – 7/31/2013
1B	5/17/2013 – 12/31/2013
2A	1/2/2014 – 7/31/2014
2B	3/1/2014 – 12/31/2014
2C	5/17/2014 – 12/31/2014

PROPOSED MASTER PHASING PLAN



PROPOSED PHASING SCHEDULE

1A-1: HIBBS-STEPHENS 5/17/2012 – 6/1/2013

1A-2: CHACE 5/1/2012 – 7/31/2013

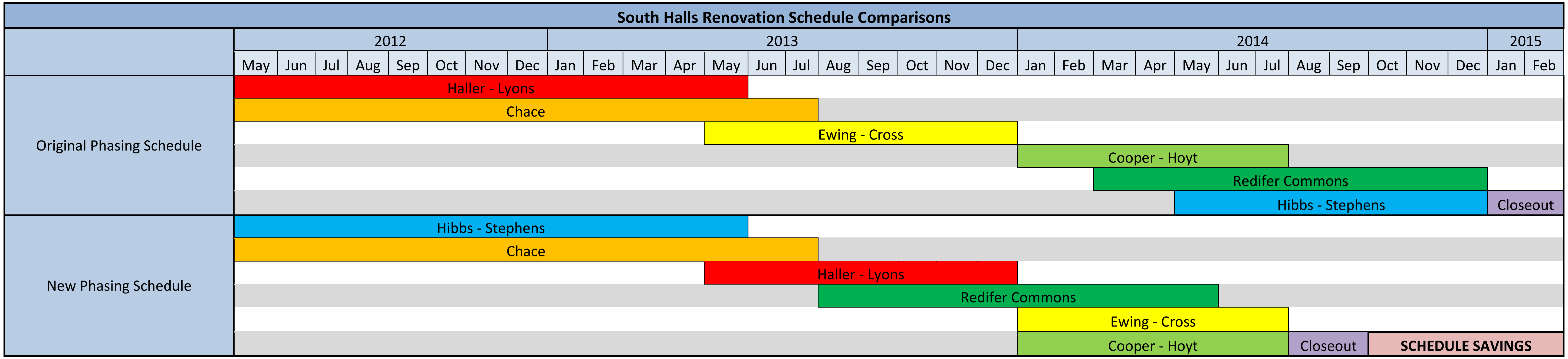
1B: HALLER – LYONS 5/17/2013 – 12/31/2013

2A: REDIFER COMMONS 8/1/2014 – 5/31/2014

2B-1: EWING – CROSS 1/2/2014 – 7/31/2014

2B-2: COOPER – HOYT 1/2/2014 – 7/31/2014

APPENDIX T: MASTER SCHEDULE SUMMARY


South Halls Renovation Schedule Comparisons
2012
2013
2014
2015
May
Jun
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May
Jun
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Sep
Oct
Nov
Dec
Jan
Feb
Original Phasing Schedule
Haller - Lyons
Chace
Ewing - Cross
Cooper - Hoyt
Redifer Commons
Hibbs - Stephens
Closeout
New Phasing Schedule
Hibbs - Stephens
Chace
Haller - Lyons
Redifer Commons
Ewing - Cross
Cooper - Hoyt
Closeout
SCHEDULE SAVINGS

APPENDIX U: GENERAL CONDITIONS

Phase 1 Original Staffing

Cost Code	Description	Quantity	Unit	Labor/Unit	Labor Total
013113200220	Project Executive	17	Weeks	3825	$ 66,555.00
013113200200	Project Director	44	Weeks	3350	$ 145,725.00
013113200180	Project Manager	87	Weeks	2900	$ 252,300.00
013113200120	Senior Project Engineer	87	Weeks	2050	$ 178,350.00
013113200100	Project Engineer	87	Weeks	1575	$ 137,025.00
013113200260	Senior Superintendent	87	Weeks	3100	$ 269,700.00
013113200240	Field Superintendent	87	Weeks	2825	$ 245,775.00
013113200240	Field Superintendent	87	Weeks	2825	$ 245,775.00
013113200020	Project Technician	87	Weeks	570	$ 49,590.00
013113200010	Intern	13	Weeks	1040	$ 13,520.00
013113200010	Intern	13	Weeks	1040	$ 13,520.00
					$ 1,617,835.00

Phase 2 Original Staffing

Cost Code	Description	Quantity	Unit	Labor/Unit	Labor Total
013113200220	Project Executive	12	Weeks	3825	$ 45,900.00
013113200200	Project Director	30	Weeks	3350	$ 100,500.00
013113200180	Project Manager	60	Weeks	2900	$ 174,000.00
013113200100	Senior Project Engineer	60	Weeks	2050	$ 123,000.00
013113200260	Senior Superintendent	60	Weeks	3100	$ 186,000.00
013113200020	Project Technician	60	Weeks	570	$ 34,200.00
013113200010	Intern	13	Weeks	1040	$ 13,520.00
				Subtotal	**$ 677,120.00**

Phase 2 New Staffing

Cost Code	Description	Quantity	Unit	Labor/Unit	Labor Total
013113200220	Project Executive	8	Weeks	3825	$ 29,835.00
013113200200	Project Director	20	Weeks	3350	$ 65,325.00
013113200180	Project Manager	39	Weeks	2900	$ 113,100.00
013113200120	Senior Project Engineer	39	Weeks	2050	$ 79,950.00
013113200100	Project Engineer	39	Weeks	1575	$ 61,425.00
013113200260	Senior Superintendent	39	Weeks	3100	$ 120,900.00
013113200240	Field Superintendent	39	Weeks	2825	$ 110,175.00
013113200240	Field Superintendent	39	Weeks	2825	$ 110,175.00
013113200020	Project Technician	39	Weeks	570	$ 22,230.00
013113200010	Intern	13	Weeks	1040	$ 13,520.00
013113200010	Intern	13	Weeks	1040	$ 13,520.00
				Subtotal	**$ 740,155.00**

Phase 1 General Conditions

	Field Office				
015213400100	Equipment	20	Month	217.8	$ 4,356.00
015213400120	Supplies	20	Month	100	$ 2,000.00
015213400140	Telephone	20	Month	88.11	$ 1,762.20
015213400160	Lights and HVAC	20	Month	165.33	$ 3,306.60
01521340010	Computer Equipment/Software	1	LPSM	50000	$ 50,000.00
01521340010	Furniture	1	LPSM	10000	$ 10,000.00
01521340010	Postage/Packaging	20	Month	200	$ 4,000.00
	Safety & Security				
Misc.	Subtotal Safety/Security	1	LPSM	10000	$ 10,000.00
	Quality & Testing				
014523505570	Testing (1/month)	20	Each	301.32	$ 6,026.40
	Temporary Utilities				
015113500140	Temporary Electrical Power	1	LPSM	3268	$ 3,268.00
	Temporary Facilities				
015626500250	Site Fencing	2700	LF	7.43	$ 20,061.00
015813500020	Signage	200	SF	37.13	$ 7,426.00
015433406410	Temporary Toilets (4)	80	Month	227.88	$ 18,230.40
	Small Tools				
015433400010	Small Tools/Equipment	1	LPSM	5000	$ 5,000.00
	Cleaning and Waste Management				
024119190600	Dumpsters (2)	174	Weeks	505	$ 87,870.00
017413200010	Final Cleaning	1420.04	MSF	90.46	$ 128,456.82
					$ 361,763.42

Phase 1 Chace General Conditions

	Field Office				
015213400100	Equipment	15	Month	217.8	$ 3,267.00
015213400120	Supplies	15	Month	100	$ 1,500.00
015213400140	Telephone	15	Month	88.11	$ 1,321.65
015213400160	Lights and HVAC	15	Month	165.33	$ 2,479.95
01521340010	Computer Equipment/Software	1	LPSM	50000	$ 50,000.00
01521340010	Furniture	1	LPSM	10000	$ 10,000.00
01521340010	Postage/Packaging	15	Month	200	$ 3,000.00
	Safety & Security				
Misc.	Subtotal Safety/Security	1	LPSM	10000	$ 10,000.00
	Quality & Testing				
014523505570	Testing (1/month)	15	Each	301.32	$ 4,519.80
	Temporary Utilities				
015113500140	Temporary Electrical Power	1	LPSM	3268	$ 5,500.00
	Temporary Facilities				
015626500250	Site Fencing	3000	LF	7.43	$ 22,290.00
015813500020	Signage	100	SF	37.13	$ 3,713.00
015433406410	Temporary Toilets (4)	60	Month	227.88	$ 13,672.80
	Small Tools				
015433400010	Small Tools/Equipment	1	LPSM	5000	$ 5,000.00
	Cleaning and Waste Management				
024119190600	Dumpsters (2)	128	Weeks	505	$ 64,640.00
017413200010	Final Cleaning	415.78	MSF	90.46	$ 37,611.46
					$ 238,515.66

Phase 2 Original General Conditions					
	Field Office				
015213400100	Equipment	14	Month	217.8	$ 3,049.20
015213400120	Supplies	14	Month	100	$ 1,400.00
015213400140	Telephone	14	Month	88.11	$ 1,233.54
015213400160	Lights and HVAC	14	Month	165.33	$ 2,314.62
01521340010	Computer Equipment/Software	1	LPSM	50000	$ 50,000.00
01521340010	Furniture	1	LPSM	10000	$ 10,000.00
01521340010	Postage/Packaging	14	Month	200	$ 2,800.00
	Safety & Security				
Misc.	Subtotal Safety/Security	1	LPSM	10000	$ 10,000.00
	Quality & Testing				
014523505570	Testing (1/month)	14	Each	301.32	$ 4,218.48
	Temporary Utilities				
015113500140	Temporary Electrical Power	1	LPSM	3268	$ 3,268.00
	Temporary Facilities				
015626500250	Site Fencing	2700	LF	7.43	$ 20,061.00
015813500020	Signage	200	SF	37.13	$ 7,426.00
015433406410	Temporary Toilets (4)	56	Month	227.88	$ 12,761.28
	Small Tools				
015433400010	Small Tools/Equipment	1	LPSM	5000	$ 5,000.00
	Cleaning and Waste Management				
024119190600	Dumpsters (2)	122	Weeks	505	$ 61,610.00
017413200010	Final Cleaning	1420.04	MSF	90.46	$ 128,456.82
					$ 323,598.94

Phase 2 New General Conditions

	Field Office				
015213400100	Equipment	9	Month	217.8	$ 1,960.20
015213400120	Supplies	9	Month	100	$ 900.00
015213400140	Telephone	9	Month	88.11	$ 792.99
015213400160	Lights and HVAC	9	Month	165.33	$ 1,487.97
01521340010	Computer Equipment/Software	1	LPSM	50000	$ 50,000.00
01521340010	Furniture	1	LPSM	10000	$ 10,000.00
01521340010	Postage/Packaging	9	Month	200	$ 1,800.00
	Safety & Security				
Misc.	Subtotal Safety/Security	1	LPSM	10000	$ 10,000.00
	Quality & Testing				
014523505570	Testing (1/month)	9	Each	301.32	$ 2,711.88
	Temporary Utilities				
015113500140	Temporary Electrical Power	1	LPSM	3268	$ 3,268.00
	Temporary Facilities				
015626500250	Site Fencing	2700	LF	7.43	$ 20,061.00
015813500020	Signage	200	SF	37.13	$ 7,426.00
015433406410	Temporary Toilets (4)	36	Month	227.88	$ 8,203.68
	Small Tools				
015433400010	Small Tools/Equipment	1	LPSM	5000	$ 5,000.00
	Cleaning and Waste Management				
024119190600	Dumpsters (2)	78	Weeks	505	$ 39,390.00
017413200010	Final Cleaning	1420.04	MSF	90.46	$ 128,456.82
					$ 291,458.54

General Conditions Summary

Description	Original $	New $	Cost Difference
Phase 1 Staffing	$ 1,617,835.00	$ 1,617,835.00	$ -
Phase 2 Staffing	$ 677,120.00	$ 740,155.00	$ 63,035.00
Phase 1 Gen Cond.	$ 361,763.42	$ 361,763.42	$ -
Phase 1 Chace Gen Cond.	$ 238,515.66	$ 238,515.66	$ -
Phase 2 Gen Cond.	$ 323,598.94	$ 291,458.54	$ (32,140.40)
Total	$ 3,218,833.02	$ 3,249,727.62	**$ 30,894.60**