Abe Vogel
Construction Management

Frederick Memorial Hospital,
Project 2000 Phase IV
Additions & Renovations
Frederick, MD

Spring 2006

Dr. Riley

Abe Vogel
Construction Management

Frederick Memorial Hospital, Additions & Renovations
Frederick, MD

Project Team

- **Owner:** Frederick Memorial Hospital
- **Owner's Rep:** ADAMS Management Services Corporation
- **CM:** Barton Malow Company
- **Architect:** Noelker and Hull Associates, Inc.
- **Structural Engineer:** ABEL Consulting Engineers
- **MEP Engineer:** TLC Engineering for Architecture

Project Features

- **Dates of Construction:** July 2005 - May 2006
- **Overall Project Cost:** $10.2 Million
- **Project Delivery Method:** Traditional, CM At-Risk
- **Occupancy or Function Types :** Institutional
- **Size :** 85,000 SF
- **Number of Stories Above Grade :** 3 and a mechanical penthouse

Construction

- Complete demolition of the interior space
- 1B noncombustible 2 hour rated construction
- New brick façade over existing brick façade

Mechanical, Lighting, & Electrical

- 3 existing AHUs serve the space, ranging from 7700 - 10300 CFM
- 2 new roof top AHUs installed, 19950 and 16680 CFM each
- 120V and 277V T8 fluorescent and compact fluorescent electronic ballast lighting
- Power distributed at 208/120V and 480/277V form existing electric room
- 36 208/120V and 16 480/277V panels serve the space

Structure

- Existing concrete structure to remain
- Courtyard infill is 9" cast-in-place concrete slabs
- Elevated slabs supported by 22"x22" cast-in-place concrete columns
- 10'x10' drop panels at each column/slab connection

FREDERICK MEMORIAL HEALTHCARE SYSTEM

ADAMS

Barton Malow

NOELKER AND HULL

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ACKNOWLEDGEMENTS

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- Dr. Linda Hanagan, Associate Professor – Structural, Pennsylvania State University
- Ralph Colarusso, Project Executive, Barton Malow Company
- Leaha Martynuska, Project Engineer, Barton Malow Company
- Mark Taylor, Vice President – Chief Operating Officer, Nitterhouse Concrete Products Inc.
- Chad Westall, Technician, Scott System Inc.

EXECUTIVE SUMMARY

The project discussed in this thesis is the Frederick Memorial Hospital Project 2000, Phase IV Additions and Renovations. Frederick Memorial Hospital is a private not for profit 298 bed hospital located in Frederick Maryland. Phase IV is the complete renovation of the G wing of the hospital. The existing interior courtyard of the G wing, previously a garden, will be infilled to create more usable square footage for each floor in the wing. The building envelope is brick façade. The existing façade is to remain and the new façade is placed in front of the existing exterior wall. A unique feature of the project is the fact that the wing is connected and integral with the rest of the hospital which still be functioning through construction. The construction and renovation of the G wing is a $10.2 Million, 85,000 SF project taking 10 months.

The existing design for the courtyard within the G wing is for a cast-in-place concrete structure. The design being proposed within this thesis is a structural steel with slab on metal deck system. All beams, columns, and footers to support the columns are design. The new steel system does have several implications to the design and construction of the hospital. The steel system results in a floor thickness 8" greater than the existing design. However, the steel system eliminates the need for columns within the courtyard infill, instead placing them on the exterior of the floor plan. The steel system is less expensive than the cast-in-place system due in part to less labor hours, as well as general conditions time saved. The implications to the schedule are all positive, as the steel system takes less time to construct than the cast-in-place system.

The existing façade design for Frederick Memorial Hospital calls for a brick veneer wall to be placed in front of the old façade. This thesis proposes the use of precast masonry and concrete panels instead. The heat and moisture transfer properties of these panels are analyzed in the German program WUFI and via a U value analysis. The precast panels are shown to provide the same level of moisture and heat resistance as a brick veneer wall. There are several implications of using the precast panels. The panels weigh twice as much as the brick veneer system. As a result the existing foundation will have to be upsized. The precast panels must be erected with a crane; as a result there is a significant impact upon the site planning. In addition, the precast panels are much more expensive than a brick veneer. Because brick veneer wall construction is very slow, the precast panels can be installed much faster comparatively. The schedule is positively impacted, allowing for less general conditions time and for the building to be dried in faster.

Careful care has to be made during construction and renovation at hospital facilities with respect to infection control. Bacteria and microorganisms introduced during construction pose a serious risk to those with lowered immune systems. There are several infection control guidelines published; two of which by the CDC and the Healthcare Infection Control Practices Advisory Committee, and the American Institute of Architects. Both guidelines strongly suggest the implementation of an infection control risk assessment, which is a process of looking at various project factors and determining what needs to be done to control infection during the life of the project. In this thesis an infection control risk assessment will be performed for Frederick Memorial Hospital. From the ICRA and other literature, suggestions for infection control on FMH will be recommended. Implications of these recommendations will be discussed, as well as a comparison between what is currently being done and what is being suggested.

At the 2005 PACE Roundtable a recurring theme within the healthcare discussions was the impact of the healthcare owners upon the contractors. Industry members lamented the fact that "owner" usually consists of some combination of the board of directors, head nurses, facilities management, maintenance, and head doctors, just to name a few. The thesis research will address this problem. To collect data, surveys were sent out to various general contractors and construction managers asking them a variety of questions. The survey consisted of questions about the four typical entities of an owner: president, chief financial officer, end user, and operator. Additional questions regarding the complex nature of the relationships between the entities and how this can affect the contractor are asked as well. The outcome of the research was that each owner entity is complex and must be dealt with differently. Some methods of dealing with the different entities are to build a solid relationship with the owner at the beginning of the project, get the owner groups involved early on, and foster a sense of honesty among all project participants. In the end, the burden is on the contractor to make sure that the owner is handled properly.

PROJECT INFORMATION & BACKGROUND

Project Information

The Phase IV addition and renovation is the last phase of construction to be done on the Frederick Memorial Hospital facility. After the completion of Phase III, Frederick Memorial Hospital is a 298 bed hospital dedicated to serving the areas residents providing a variety of healthcare services. Phase IV is the complete renovation of the G wing of the hospital. The renovated G wing will feature a new entry vestibule, an employee gym, medical exam rooms, physical therapy facility, and administrative offices. The interior courtyard of the G wing, previously a garden, will be infilled to create more usable square footage for each floor in the wing. The building envelope is brick façade. Red brick will be on the exterior of the partially exposed basement and first two floors, and yellow brick on the third floor. The existing façade is to remain and the new façade is placed in front of the existing exterior wall.

The most unique feature of the project is the fact that the wing is connected and integral with the rest of the hospital. Temporary partitions have to be constructed and maintained so that hospital workers and patients cannot enter the jobsite, and construction workers cannot enter the hospital. Special care has to be made so that no construction dust and debris infiltrates into the hospital. Infection control procedures are stringent for these reasons. Contractors are additionally required to notify the hospital when they will be using torches or other equipment, which will produce smoke or odor, to demolish existing systems. There are weekly construction utility interrupt request meetings in which the contractors outline where they are going to be working and what they are going to be doing.

Client Information

The owner of the project is Frederick Memorial Hospital. FMH, a private not for profit hospital, opened its doors in 1902 and has been providing cost-efficient healthcare to the residents of Frederick ever since. The hospital began a multi-phase project to improve the quality and size of the hospital in 2000. The most recently completed phase was the construction of the F wing which is adjacent to the G wing. The hospital has high expectations when it comes to the cost of the project. As it is the last phase of a six year project, their budget is tight, and it is essential that the project costs remain low. This has been evident in their insistence on thorough bid and scope reviews to make sure that nothing is bought twice. Imperative to the owner's satisfaction is running a safe and predictable job site.

Project Cost Evaluation

- Total Project Cost
    - $10,234,749
    - At 85,000 SF - $120.41/SF

- Major Building System Cost
    - Mechanical: $1,954,469 - $22.99/SF
    - Electrical: $1,036,900 - $12.20/SF
    - Structural: $717,974 - $8.45/SF
    - Sitework: $766,375 - $9.02/SF
- Square Foot Estimate From RS Means 2005
    - Total Estimate Cost = $15,916,414

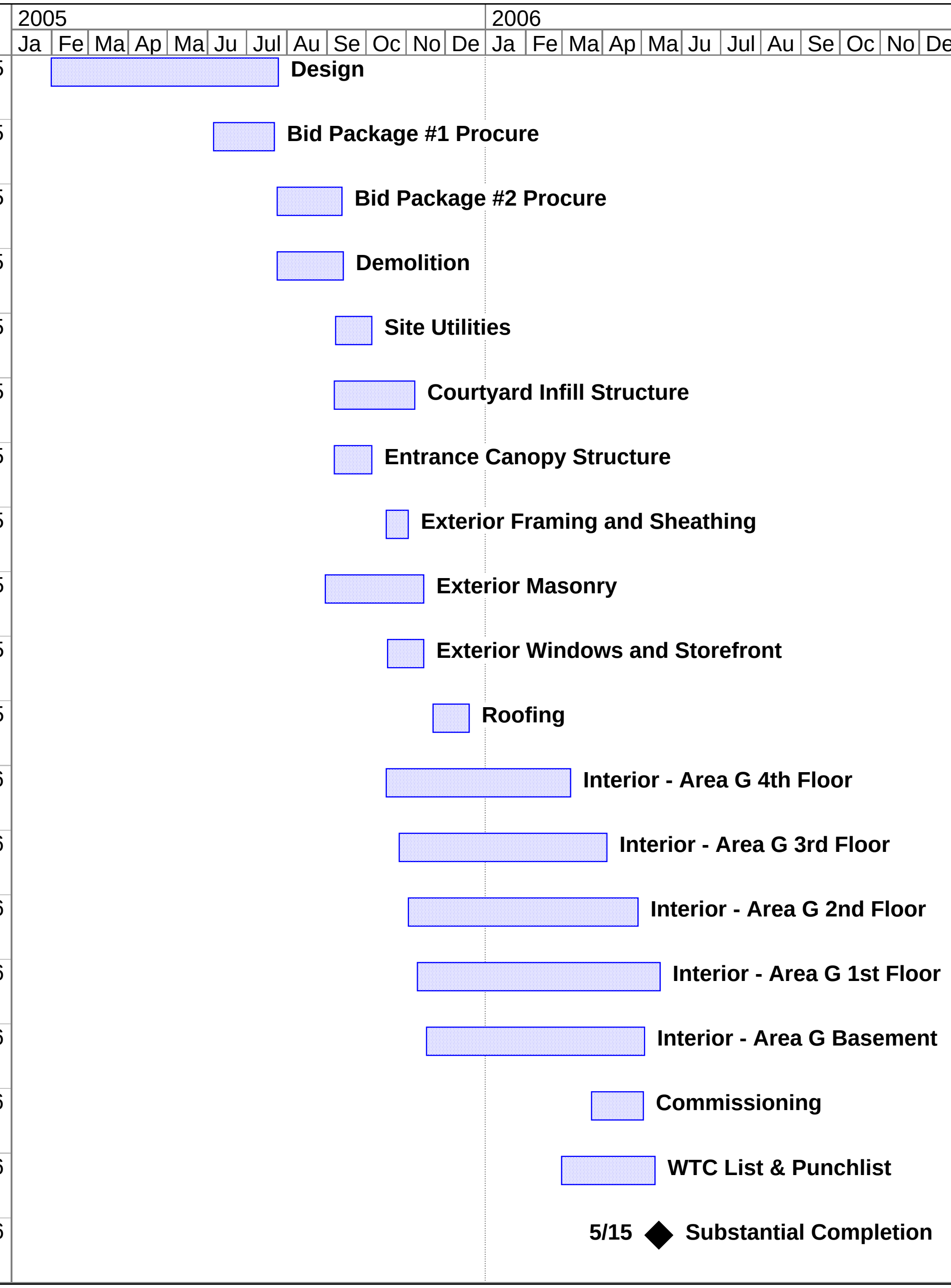
- D4 Cost Parametric Estimate
    - Total Estimate Cost = $11,048,366

Project Summary Schedule

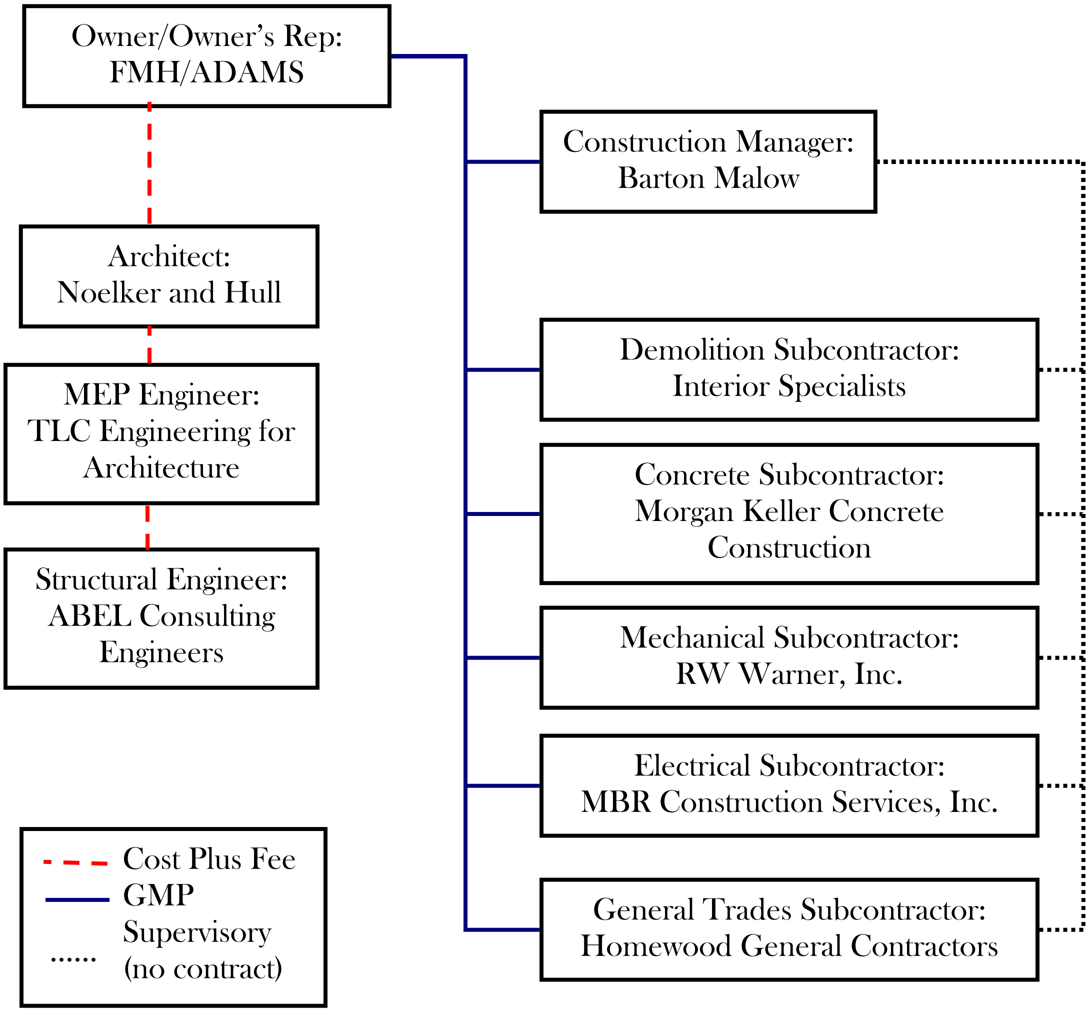
One key element of the schedule is that the foundation, structural, and exterior finishes are phased in order to finish before winter. The shell of the building is constructed first so that during the winter months the space inside can be conditioned. A unique feature of the finish sequence is that the interior finishing crews work from the top floor down. This is done in order to ensure that once floors are finished they are not walked through by the construction workers; this is essential for infection control. The summary schedule is shown on the next page. The full detailed project schedule is shown in appendix A.

Frederick Memorial Hospital, Phase 4 Additions and Renovations — Summary Schedule

ID	Task Name	Start	Finish
1	Design	Tue 2/1/05	Mon 7/25/05
2	Bid Package #1 Procure	Mon 6/6/05	Fri 7/22/05
3	Bid Package #2 Procure	Mon 7/25/05	Mon 9/12/05
4	Demolition	Mon 7/25/05	Tue 9/13/05
5	Site Utilities	Thu 9/8/05	Wed 10/5/05
6	Courtyard Infill Structure	Wed 9/7/05	Mon 11/7/05
7	Entrance Canopy Structure	Wed 9/7/05	Wed 10/5/05
8	Exterior Framing and Sheathing	Mon 10/17/05	Wed 11/2/05
9	Exterior Masonry	Wed 8/31/05	Mon 11/14/05
10	Exterior Windows and Storefront	Tue 10/18/05	Mon 11/14/05
11	Roofing	Tue 11/22/05	Mon 12/19/05
12	Interior - Area G 4th Floor	Mon 10/17/05	Tue 3/7/06
13	Interior - Area G 3rd Floor	Thu 10/27/05	Tue 4/4/06
14	Interior - Area G 2nd Floor	Thu 11/3/05	Fri 4/28/06
15	Interior - Area G 1st Floor	Thu 11/10/05	Mon 5/15/06
16	Interior - Area G Basement	Thu 11/17/05	Wed 5/3/06
17	Commissioning	Fri 3/24/06	Tue 5/2/06
18	WTC List & Punchlist	Wed 3/1/06	Thu 5/11/06
19	Substantial Completion	Mon 5/15/06	Mon 5/15/06



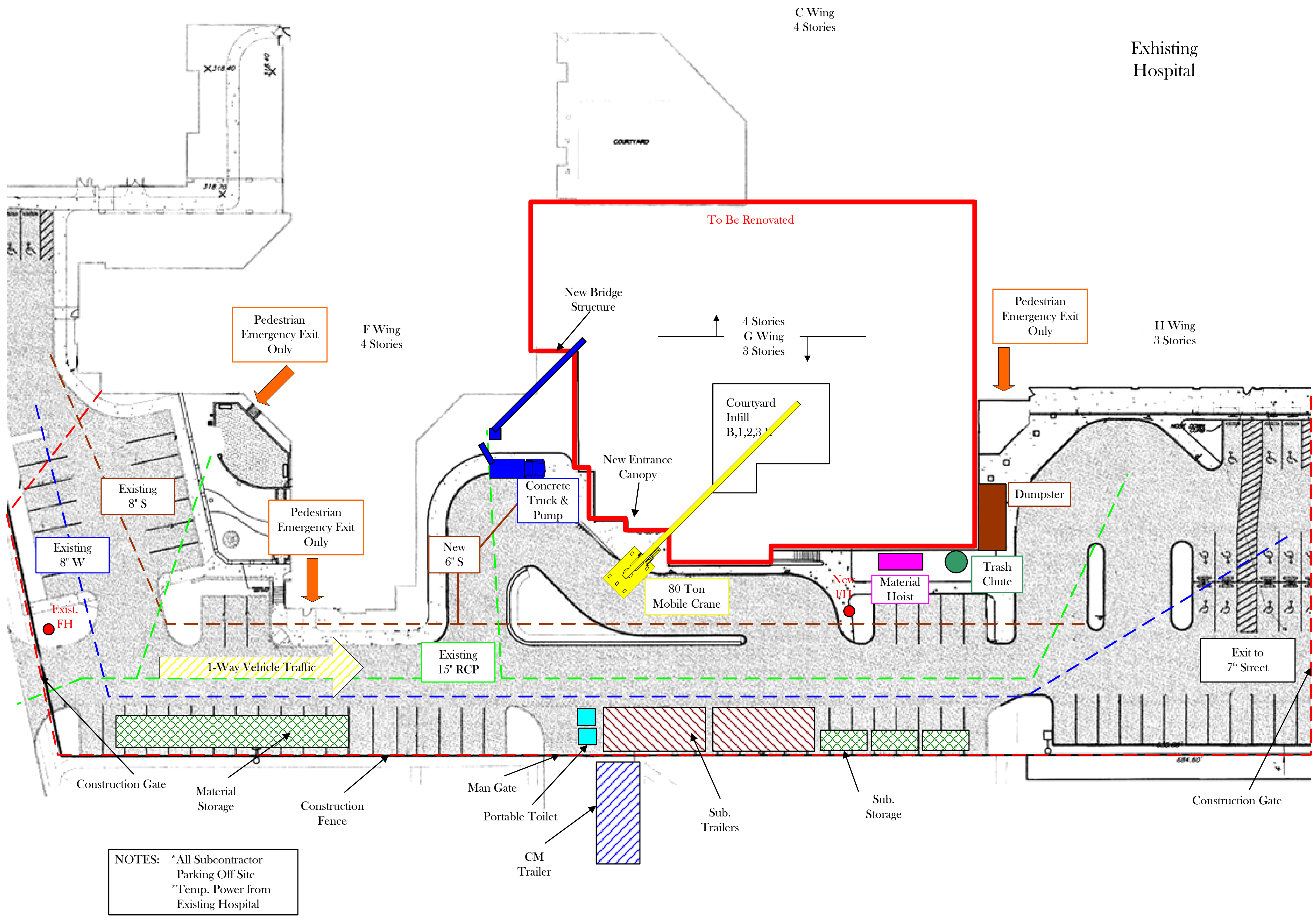
Project Delivery System



Site Layout Planning

The site plan during active construction is shown on the following page. The crane used is an 80 ton mobile crane. Concrete trucks and all other vehicles enter from the south and travel one-way through the site. There is limited on site parking for subcontractors; all crews must park in public parking off site because of an existing agreement between the neighborhood and the hospital regarding contractor parking. There is no need for temporary power as it is supplied through the existing hospital. The site plan is shown on the following page.

FREDERICK MEMORIAL HEALTHCARE SYSTEM



Frederick Memorial Hospital

Project 2000
Phase 4
Additions
&
Renovations

NAME

Abe Vogel

4.03.06

TITLE

SITE
PLAN

THESIS PROPOSAL
ANALYSIS 1 (BREADTH):
COURTYARD INFILL STRUCTURE DESIGN

This technical analysis will consist of analyzing the utilization of a steel structural system instead of a cast-in-place concrete system for the courtyard infill. To develop this analysis the following steps will take place:

- Consult with a structural option faculty for help designing a structural steel system. RAM structural system will be used to design beams, columns, and footers.
- Determine impact of using structural steel to the floor plan and floor to floor height.
- Determine the cost impact of using structural steel. This can be assessed by looking at the current cost of using cast-in-place concrete compared to that of a steel system. This will be done using MC^2 estimating software.
- Determine the cost impact on general conditions. There will most likely be a schedule savings from using steel; however there may be a cost increase due to the need for a crane to erect steel members.
- Determine the schedule impact of using structural steel. This can be assessed by looking at the current schedule using cast-in-place concrete compared to that of a steel system.

The cast-in-place courtyard infill structure at Frederick Memorial Hospital does not tie into the existing structure in anyway. The two structures are separated by an expansion joint. Therefore there are no constructability issues to worry about by going to a precast structure. A steel structure will most likely cost more money however there will be schedule savings which will result in the roof being able to be constructed sooner, meaning the building will be dried in sooner.

THESIS PROPOSAL
ANALYSIS 2 (BREADTH):
PRECAST BRICK VENEER FAÇADE

This technical analysis will consist of analyzing the value added from using a precast brick veneer façade instead of a mason laid brick façade. To develop this analysis the following steps will take place:

- Consult with a structural option faculty or an industry member to get help designing the precast panels. The panels must be designed for erection as well as other structural requirements.
- Consult with a mechanical option faculty to formulate a heat and moisture analysis of the two different façades.
- Perform a U value analysis, comparing the heat transfer properties of the existing system to the proposed system.
- Determine the impact to the existing structural system of using precast panels.
- Determine impact of the precast panels to the site layout plan. The site plan must be changed to allow for a staging area for the precast members. Another option would be erecting the members right off of the truck.
- Determine the cost impact of using a precast brick façade and a precast concrete structural system. Manufacturers will be contacted in order to determine the cost of using precast brick systems.
- Determine the schedule impact of using a precast brick façade by comparing the current schedule length of the masonry activity with the length of time it would take to erect precast panels.

There will be several benefits to using some sort of precast system. By saving time on the masonry the building will be able to be dried in faster. There is also a chance that glazing could be preinstalled into the panels, saving even more time. In addition to designing the members, the site plan must be analyzed so there is room for a staging area.

THESIS PROPOSAL
ANALYSIS 3:
INFECTION CONTROL RISK ASSESSMENT

Because of the importance of infection control, the last technical analyses will be an infection control risk assessment performed for the Frederick Memorial Hospital. To develop this analysis the following steps will take place:

- Do a literature review to determine what type of assessment to perform.
- Do a literature review to determine the various guidelines governing infection control.
- Perform the infection control risk assessment.
- From the assessment and the published guidelines, propose suggestions for infection control on the project.
- Compare the proposed suggestions to what is actually being done in terms of infection control at Frederick Memorial Hospital.

THESIS PROPOSAL
RESEARCH: GETTING TO KNOW THE OWNER

Getting to Know the Owner

At the 2005 PACE Roundtable a recurring theme within the healthcare discussions was the impact of the healthcare owners upon the contractors. Industry members lamented the fact that "owner" usually consists of some combination of the board of directors, head nurses, facilities management, maintenance, and head doctors, just t o name a few. Numerous communication problems arise because of this, slowing down construction and causing work stoppages. The critical issues research will address this problem.

Because the topic of research is somewhat new the goal is not to find some solution to the problem; that will be left to upcoming researchers. Instead, the main objective of this research is to develop a simple guide to learn how to address the different entities of the owner and how to better understand and deal with them.

The end result of this research will be a description of the different entities in an owner, describing what characterizes them and what is important to them. Additionally, an outcome of the research will be recommendations for dealing with the intricacies of having multiple entities as an owner.

To achieve these objectives contractors will be surveyed. The data collection will come from online surveys. The survey will consist of questions about the four typical entities of an owner: president, chief financial officer, end user, and operator. Additional questions regarding the complex nature of the relationships between the entities and how this can affect the contractor will be asked as well.

COURTYARD INFILL STRUCTURE DESIGN

Executive Summary

The existing design for the courtyard within the G wing is for a cast-in-place concrete structure. The design being proposed within this analysis is a structural steel with slab on metal deck system. All beams, columns, and footers to support the columns are design. The new steel system does have several implications to the design and construction of the hospital. The steel system results in a floor thickness 8” greater than the existing design. However, the steel system eliminates the need for columns within the courtyard infill, instead placing them on the exterior of the floor plan. The steel system is less expensive than the cast-in-place system due in part to less labor hours, as well as general conditions time saved. The implications to the schedule are all positive, as the steel system takes less time to construct than the cast-in-place system. Weighing the advantages and the disadvantages, the proposed structural steel design is the superior system when compared to the existing cast-in-place concrete design.

Existing Structural Design

The courtyard infill is a 42' (east-west) x 40' (north-south) cast-in-place concrete structure with four 22" x 22" columns. At the floor slabs, each column has a 10' x 10' 3 ½"-thick drop panel. The floor slabs are 9" thick concrete reinforced with #5's at 9" o.c. in the top of the slab and #4's at 8" o.c. in the bottom of the slab. Four columns support the 40' x 40' floor area. The columns are situated in a square at 20' o.c. in the middle of the infill, with the slabs cantilevering out 10' on each side.

Proposed Structural Design

The proposed structural redesign consists of a structural steel system with concrete slabs on metal deck. The design intent is to eliminate the need for columns in the middle of the infill without altering the floor plan too much. The new design places the columns at the exterior of the floor area minimizing the need for cantilevers. Constraining the design is the fact that the floor area is surrounded by corridors, making it impossible to simply place columns at the four corners of area. The design consists of 2 columns spaced 21' apart along the north and south side of the area, and 1 column in the middle of the 40' span in each the east and west sides. Three main girders span the 40' in the north-south direction. The only complexity in the design is at the corners of the floor area where beams do not have columns to bear on. A schematic of the design is shown below in figure 1.

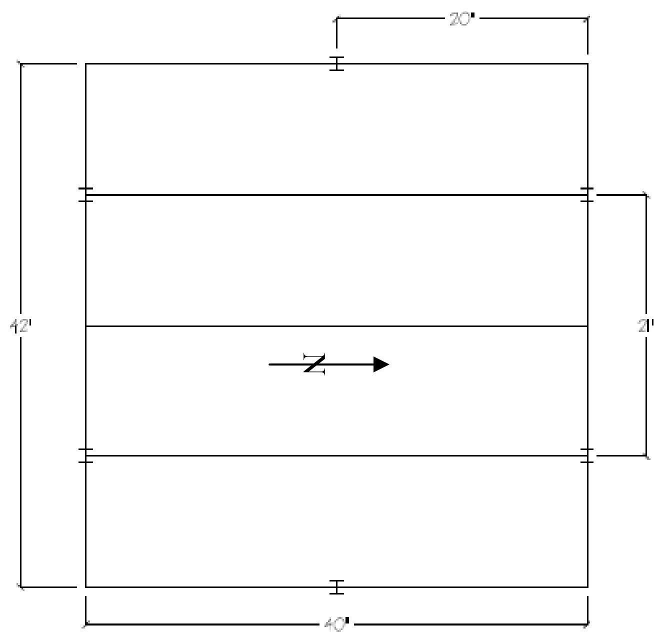


Figure 1: Schematic Layout

Design Calculations using RAM Structural System

The original design requirements for the courtyard infill were used for the RAM calculations. The following loads were used: 30 psf dead load, and 80 psf live load. The slab was designed as a 5" concrete slab on USD 2" Lok-floor with 6x6 W1.4/W1.4 Mesh. After the schematic geometry was inputted into the program, the beam and column sizes, the number of shear studs, as well as the footer sizes were calculated. The structure consists of the W10x33 columns with the following girder and beam sizes: W8x10, W16x26, and W16x31. Figure 2 below shows the members and sizes. Each column on the north and south side has a 5' x 5' x 1'6" thick footer that is reinforced on the bottom with 10 #4 bars each way. The columns on the east and west side have 3' x 3' x 1'6" thick footers that are reinforced on the bottom with 6 #4 bars each way. Figure three below shows the structure in three dimensions. All of the connections are simple shear connections except for the column to cantilever beam interfaces, which require moment connections to counteract the cantilevering action. Because the structure is in the interior of the building, lateral loads did not need to be taken into consideration, as the existing building resists the any lateral load. Output from RAM can be found in Appendix B.

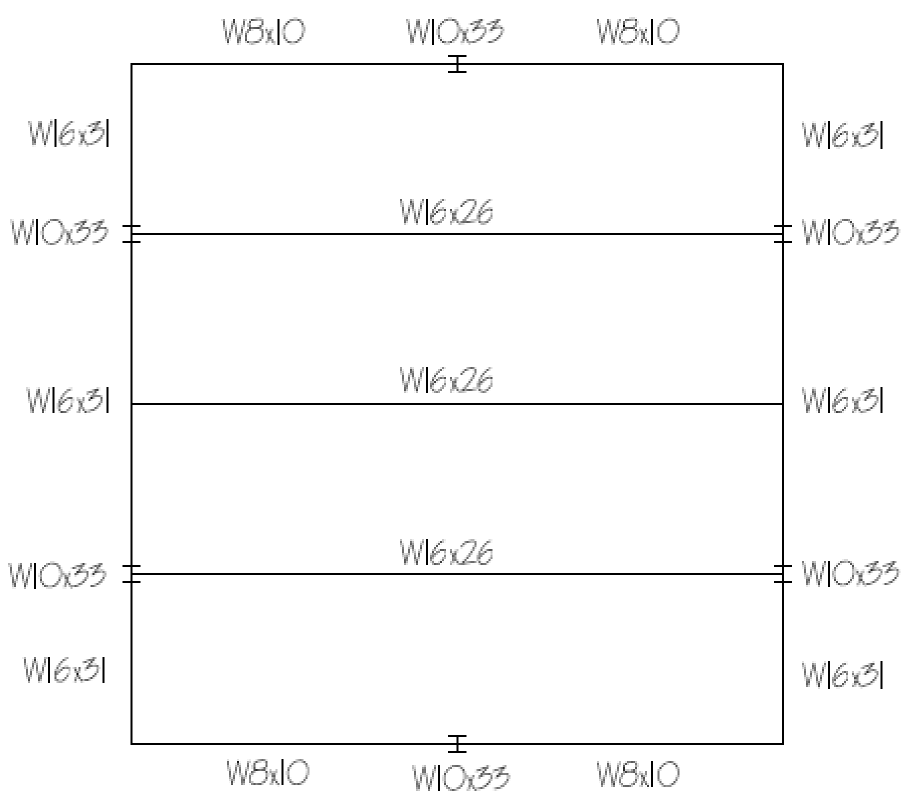


Figure 2: Designed Members

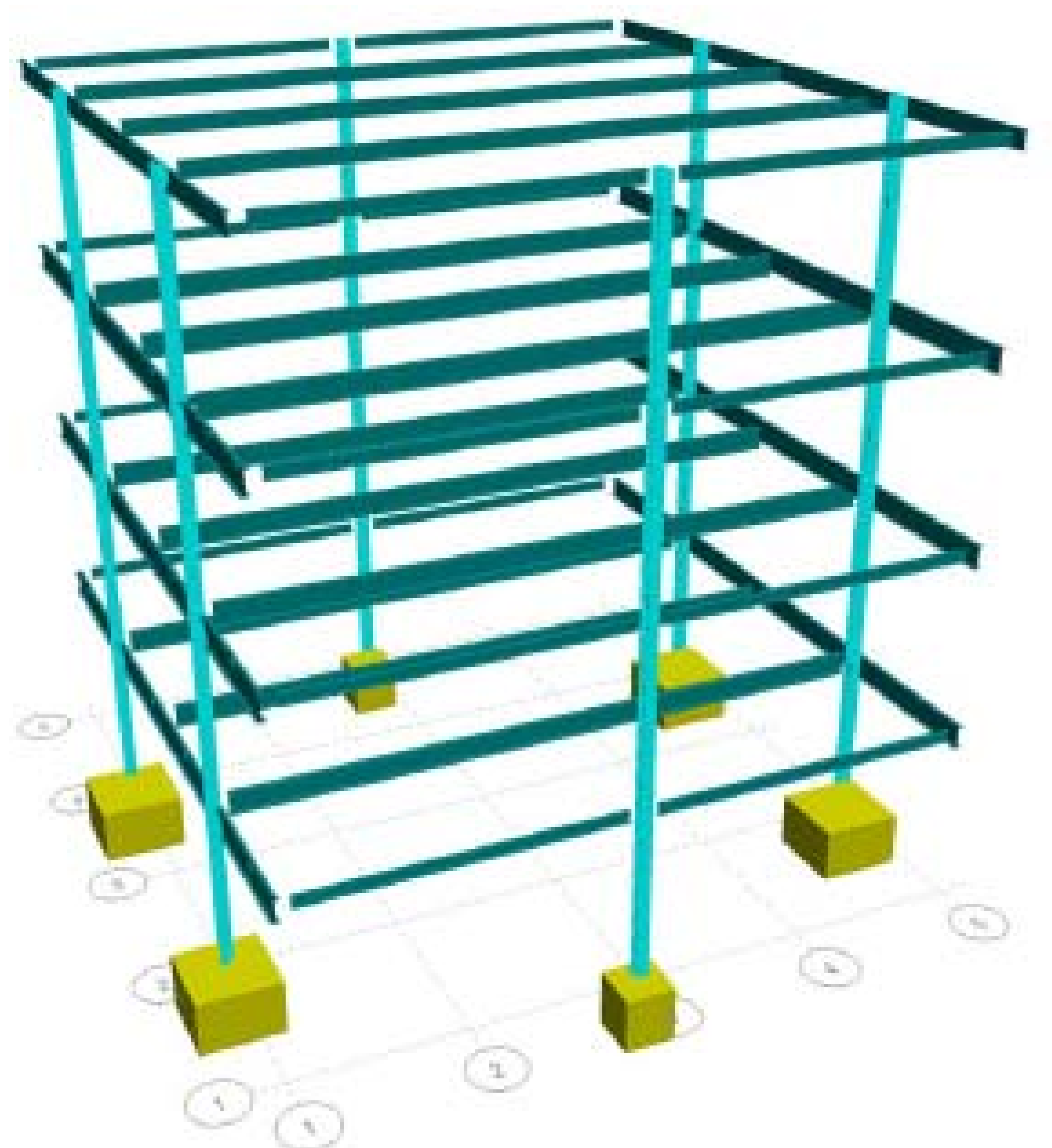


Figure 3: 3D Schematic of Design

Impact of Design

There are several impacts of the new steel structure design. One disadvantage of steel construction versus cast-in-place concrete is that the floor to floor height is reduced. In this case the steel structure results in a floor cross section of 8” thicker than with a concrete structure. This is not an issue for the G wing because there is not a complex HVAC or piping system because the majority of the spaces are offices. The height of the duct in the area is 10”, and the largest pipes are 1-1/2”. At the very worst, the ceiling can be lowered 8” to accommodate the increased thickness of the structure. Figure 4 shows the comparison between the proposed and existing design.

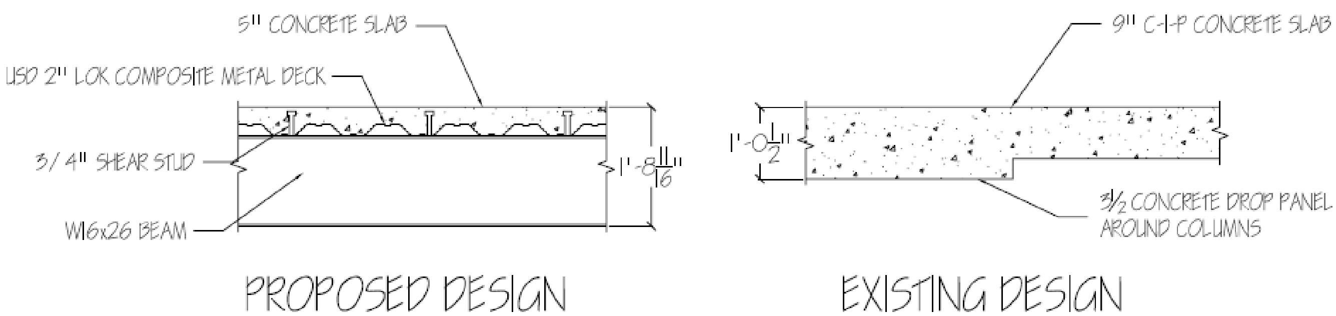


Figure 4: Proposed v. Existing Cross-Sections

Another impact of the design is in the architectural floor plan. Without the interior columns there is more flexibility allowed in the floor plan for the area. However, compromises must be made at the edges of the area where the proposed columns are to be placed. Figures 5 though 8 show the floor plans of the basement through the third floor respectively, with the locations of the proposed columns highlighted in red. In the basement floor plan the proposed design results in a completely open floor plan for the future employee gym (seen in figure 5). In the first floor plan, space can be saved where columns are no longer in the interior of the floor plan, however with the proposed columns situated at the edge of the infill area they now fall within the corridor, decreasing the corridor width at a few locations (seen in figures 6, 7 and 8). According to IBC 2003 section 1016.2 the minimum width must be at least 72” (6’) “in corridors serving surgical Group I, health care centers for ambulatory patients receiving outpatient medical care, which causes the patient to be not capable of self-preservation.” Despite having the proposed columns at the edge of the corridor, the hallway width still meets the minimum requirements. On the second floor the only other impact is a column that falls within the countertop of a kitchenette (figure 7). This would be easily remedied by moving the kitchenette over 2' or reducing the size of the countertop. On the fourth floor there are no other adverse impacts; the new layout eliminates the need for the columns in the center of the physical therapy room.

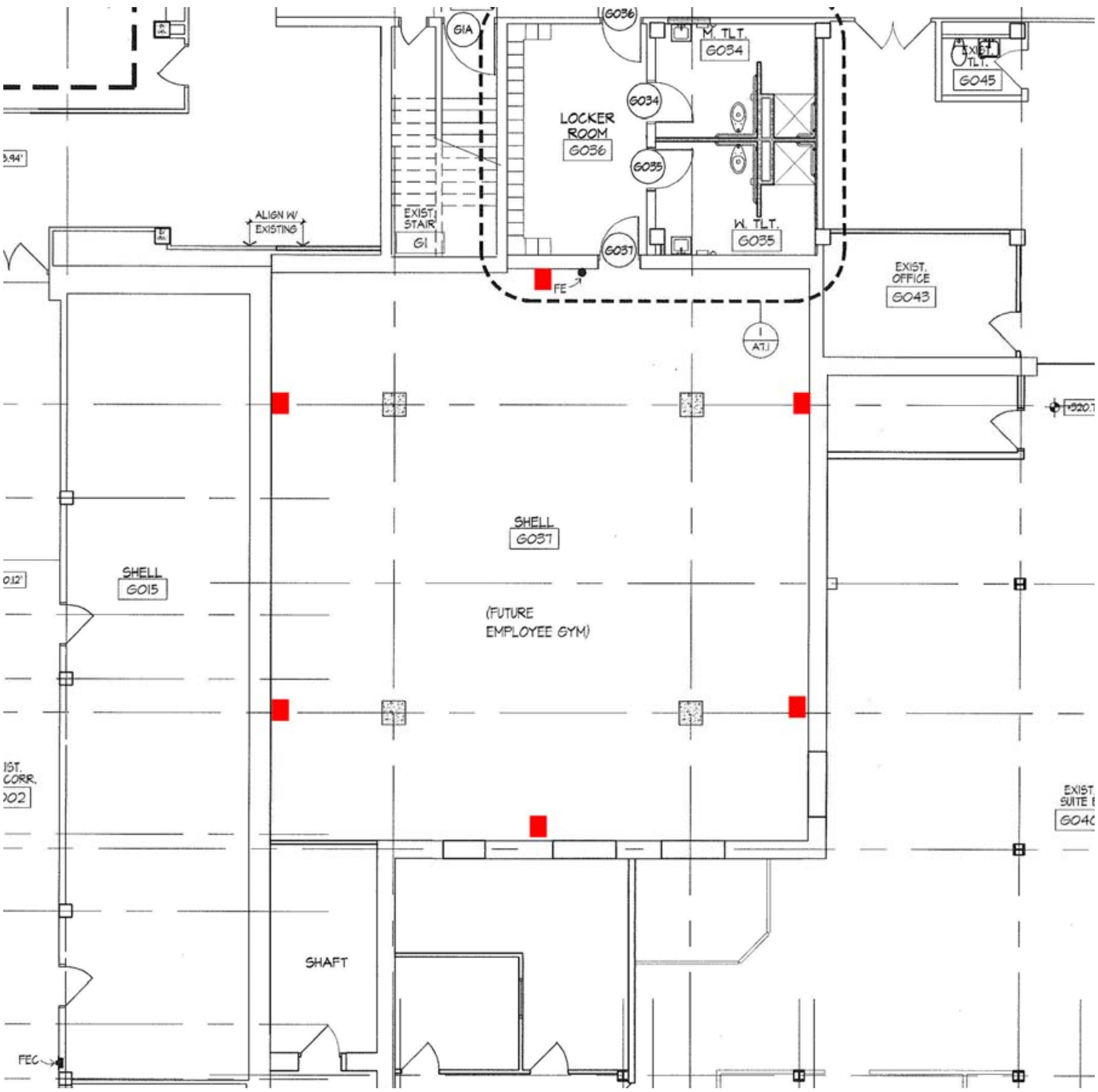


Figure 5: Basement

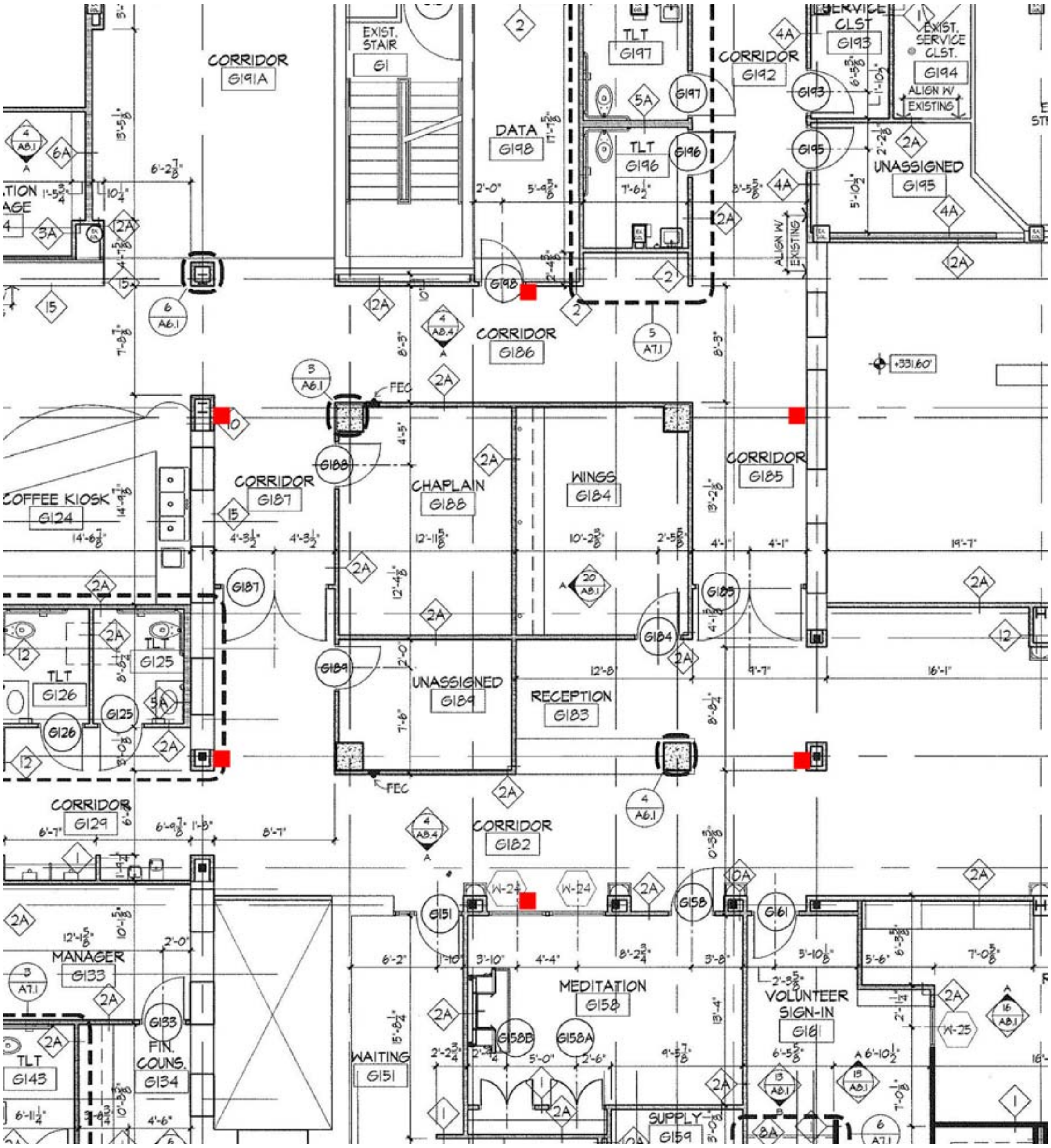


Figure 6: First Floor

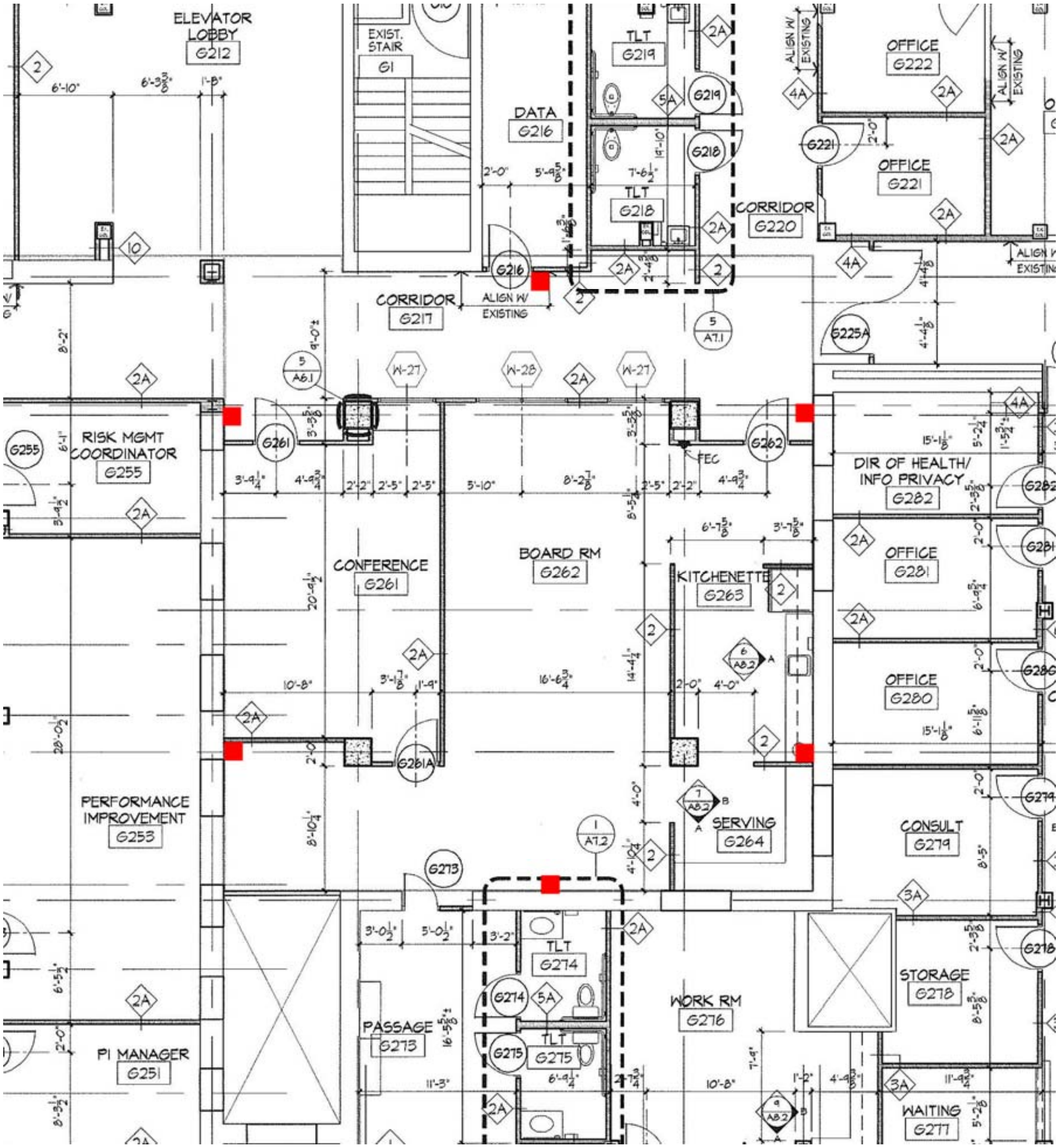


Figure 7: Second Floor

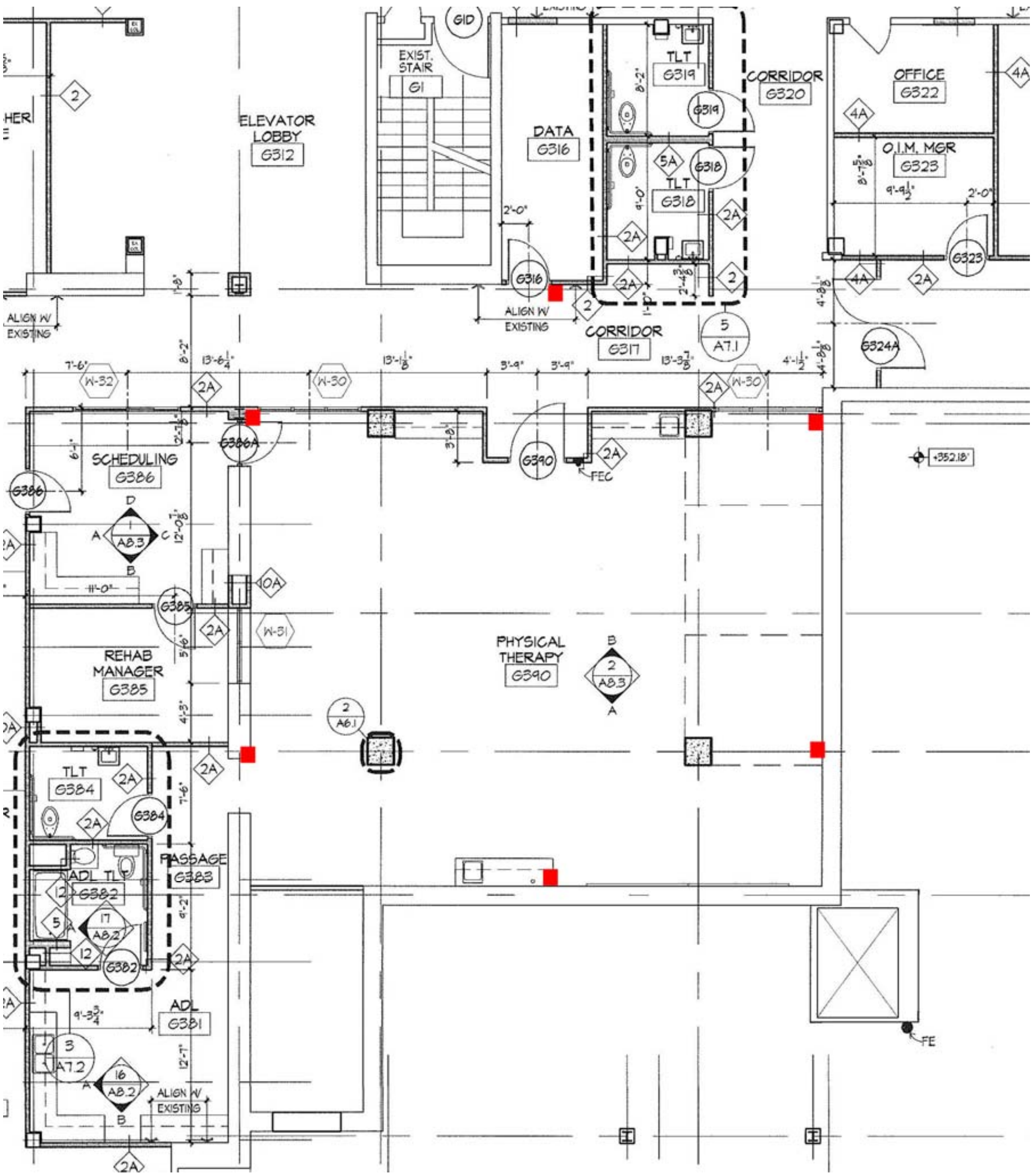


Figure 8: Third Floor Plan

Cost Implications

The cost of the proposed design is significantly different from the existing design. The proposed structural steel design is roughly half as much as the existing cast-in-place concrete design. There are various factors that contribute to this difference. Cast-in-place concrete is a very labor intensive form of construction, requiring a lot of man hours. Whereas, steel does not require as many workers so there is less labor cost. Additionally, a steel structure can be erected faster, resulting in savings from less crane time, as well as savings from less general conditions time. General conditions savings are based of the general conditions estimate and can be found in appendix C. There is the possibility that the steel structure will cost more because of the need for some moment connections, which cost more than simple shear connections. Table 1 below shows the cost breakdown for the cast-in-place concrete structure, derived from the initial structural estimate. Table 2 below shows the cost breakdown for the steel and concrete slab on metal deck, derived from the MC^2 estimate of the structural steel system found in appendix D.

Phase	CSI	Description	Quantity		Unit Price		Cost
Foundation	3110	Formwork for Spread Footings	623	SF	7.15	/SF	$4,454
	3210	Rebar for Spread Footings	2	Tons	1800	/Tons	$3,600
	3310	Concrete for Spread Footings, 5000 PSI	87	CY	123.5	/CY	$10,745
Superstructure	3110	Plywood Forming System for Columns	1330	SF	7.7	/SF	$10,241
	3110	Plywood Forming System for 2-Way Flat Plate with Drops	8712	SF	10.45	/SF	$91,040
	3150	Shoring System for 2-Way Flat Plate with Drops	7480	SF	1.02	/SF	$7,630
	3210	Reinforcing Steel for 2-Way Flat Plate with Drops	25	Tons	1625	/Tons	$40,625
	3210	Reinforcing Steel for Columns	4	Tons	2200	/Tons	$8,800
	3310	5000 PSI Placed with Crane, for Flat Plates and Columns	252	CY	137.5	/CY	$34,650
	3350	Machine Trowel Finish 2-Way Flat Plates	7480	SF	0.7	/SF	$5,236
		Location Modifier - Hagerstown			0.89		-$23,872
		Estimate Total					$193,149

Table 1: C-I-P Cost Breakdown

Phase	CSI	Description	Quantity		Unit Price		Cost
Foundation	3210	Rebar for Column Footings	4.14	CWT	58.5	/CWT	$242
	3310	Concrete for Column Footings, 3000 PSI	8.33	CY	68.1	/CY	$568
Superstructure	3320	6x6 W1.4/W1.4 Mesh in SOD	73.92	SQS	27.1	/SQS	$2,001
	3311	Concrete for SOD	82.96	CY	72.9	/CY	$6,046
	3350	Machine Trowel Finish	6720	SF	0.33	/SF	$2,220
	5129	3/4" Shear Studs	522	EA	1.56	/EA	$814
	5129	Steel I Beams	140	CWT	68.73	/CWT	$9,622
	5129	Steel I Girders	94.1	CWT	68.73	/CWT	$6,466
	5129	Steel I Columns	87.1	CWT	68.73	/CWT	$5,988
	5310	2" USD Lok Floor Deck	6720	SF	1.3	/SF	$8,836
	7810	Cementitious Fireproofing	2606	BDFT	45	/BDFT	$118,143
		Decrease in Crane Time (15 days per schedule)	15	DAY	1513	/DAY	-$22,695
		Less General Conditions	2	WK	12837	/WK	-$25,674
		Location Modifier - Hagerstown			0.89		-$15,208
		Estimate Total					$97,369

Table 2: Structural Steel Cost Breakdown

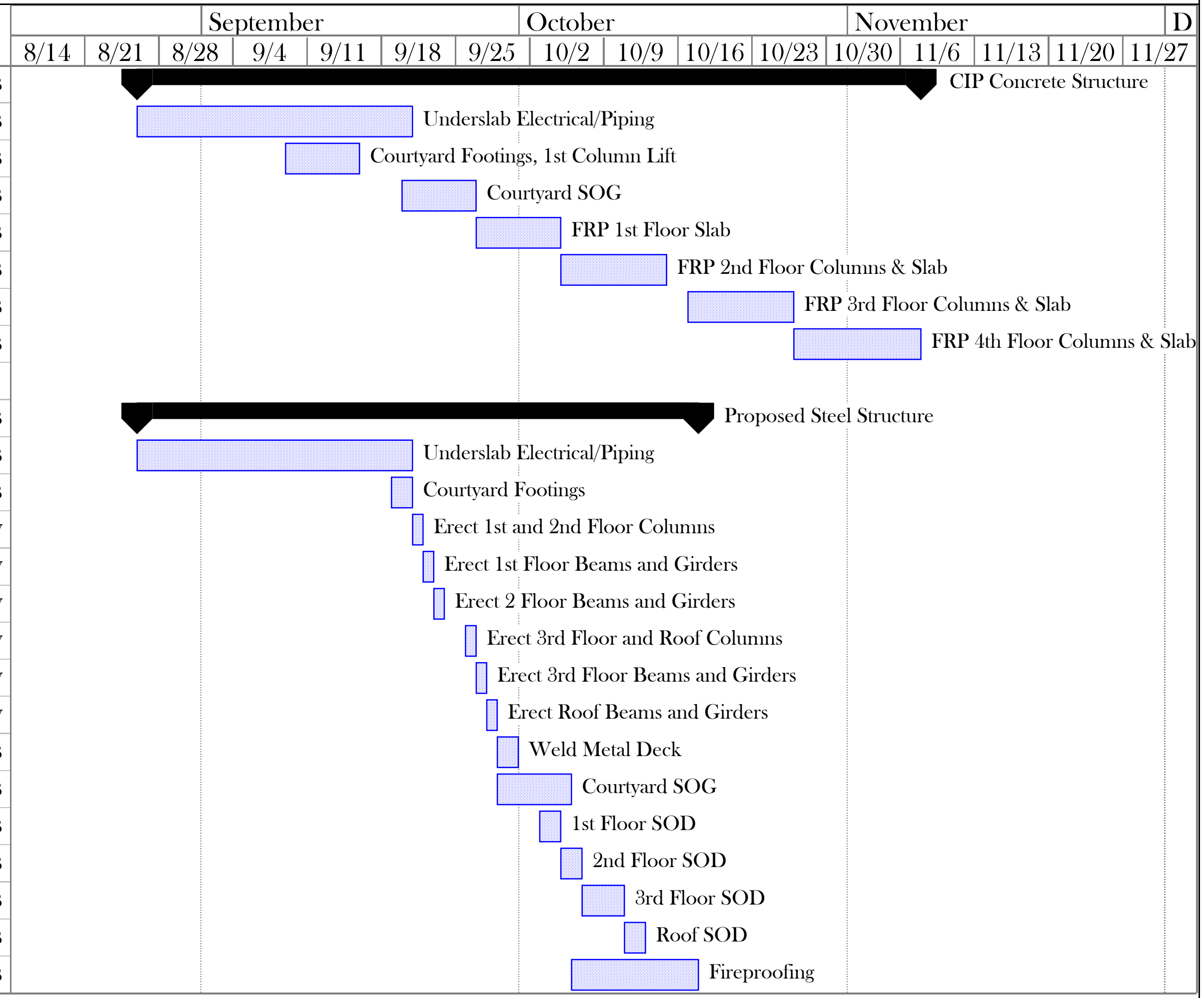
Schedule Implications

There is a significant difference in the schedule for the existing cast-in-place concrete structure design, and the proposed steel structure design. The courtyard infill structure takes 3 weeks (15 days) less to construct as structural steel with slab on metal deck rather than cast-in-place concrete. The main reason for this difference in construction times is because of the discrepancy in production rates between cast-in-place and structural steel. Steel can be erected very rapidly, whereas it takes a lot of time to erect formwork and shore concrete slabs. Because of the need for moment connections which take longer to construct, the schedule could possibly be increased with the steel structure. The schedule for the steel structure would be even faster if it were not for the need to fireproof the steel. This activity is very time consuming, and is not needed for a concrete structure. The schedule on the following page shows a schedule comparing the construction of the cast-in-place structure construction with the proposed structural steel courtyard infill.

Frederick Memorial Hospital, Phase 4 Additions and Renovations

Courtyard Infill Structure Schedule

ID	Task Name	Duration
1	CIP Concrete Structure	52 days
2	Underslab Electrical/Piping	18 days
3	Courtyard Footings, 1st Column Lift	5 days
4	Courtyard SOG	5 days
5	FRP 1st Floor Slab	6 days
6	FRP 2nd Floor Columns & Slab	8 days
7	FRP 3rd Floor Columns & Slab	8 days
8	FRP 4th Floor Columns & Slab	8 days
9		
10	Proposed Steel Structure	37 days
11	Underslab Electrical/Piping	18 days
12	Courtyard Footings	2 days
13	Erect 1st and 2nd Floor Columns	1 day
14	Erect 1st Floor Beams and Girders	1 day
15	Erect 2 Floor Beams and Girders	1 day
16	Erect 3rd Floor and Roof Columns	1 day
17	Erect 3rd Floor Beams and Girders	1 day
18	Erect Roof Beams and Girders	1 day
19	Weld Metal Deck	2 days
20	Courtyard SOG	5 days
21	1st Floor SOD	2 days
22	2nd Floor SOD	2 days
23	3rd Floor SOD	2 days
24	Roof SOD	2 days
25	Fireproofing	8 days



Conclusion

The proposed structural steel courtyard infill construction provides a lot of advantages and disadvantages over the existing design of cast-in-place concrete. In terms of cost and schedule the structural steel is cheaper and faster than cast-in-place concrete. Unfortunately, the structural steel floor construction is 8” thicker than the existing floor design. Additionally the structural steel requires fireproofing whereas the concrete does not. A last advantage is that the structural steel design eliminates the need for columns in the interior of the courtyard infill, although some of the corridors are narrowed at spots. Weighing the advantages and the disadvantages, the proposed structural steel design is the superior system when compared to the existing cast-in-place concrete design.

BUILDING FAÇADE DESIGN

Executive Summary

The existing façade design for Frederick Memorial Hospital calls for a brick veneer wall to be placed in front of the old façade. This analysis proposes the use of precast masonry panels instead. The panels will utilize the Brick Snap© system patented by Scott System, Inc. This system consists of thin brick veneers that are attached to a concrete panel. The heat and moisture transfer properties of these panels are analyzed in the German program WUFI and via a U value analysis. The precast panels are shown to provide the same level of moisture and heat resistance as a brick veneer wall. There are several implications of using the precast panels. The panels weigh twice as much as the brick veneer system. As a result the existing foundation will have to be upsized. The precast panels must be erected with a crane; as a result there is a significant impact upon the site planning. In addition, the precast panels are much more expensive than a brick veneer. Contributing to the extra cost is the fact that a crane is needed for erection. Even with general conditions savings from the decreased construction time, the panels are more expensive. Because brick veneer wall construction is very slow, the precast panels can be installed much faster comparatively. The schedule is positively impacted, allowing for less general conditions time and for the building to be dried in faster. Weighing the advantages and disadvantages, the precast panel construction is better than the standard brick veneer façade method.

Façade Design

The current construction of the G wing at Frederick Memorial Hospital is cast-in-place concrete slabs and columns with brick masonry walls constructed over 50 years ago. The walls are just 2 layers of brick separated by a layer of grout. The existing façade design entails constructing a brick veneer wall in front of the old façade. The designed façade consists of standard 3-5/8" brick, a 2" airspace, 2" of rigid insulation, and damproofing sprayed on the exterior of the old façade.

The proposed design for the façade consists of manufactured precast masonry panels instead of hand laid brick veneer. The panels are 5 ¼" thick concrete with ¾" thick thin bricks attached to the concrete. The panels being used are Scott System Inc. Brick Snap© panels. With this system the thin bricks are placed on a flat concrete surface in a running bond and each brick is "snapped" together. An example of this procedure is shown in figures 1 and 2. Formwork is then placed around the edges and reinforcing is situated on chairs on top of the brick in the form. Concrete is then poured and vibrated as it would be in any typical form. After the concrete has cured, the panel is lifted and placed upright exposing the brick. The brick snaps are then removed by hand. The snaps are designed so that when the concrete is poured a tooled joint shape forms at the snap connections. Therefore, when the snaps are removed there appears to be a tooled joint between the courses exactly how a hand laid masonry wall would look. The end result is a panel that appears to be a very carefully handcrafted masonry wall.


Figure 1: Laying the thin bricks

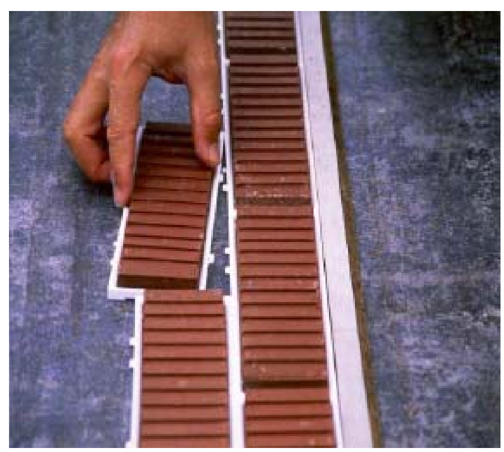


Figure 2: Snapping the bricks together

For Frederick Memorial Hospital the panels have been designed to each be one story high, by 20' long. This will match the existing column to column spacing of the wing. The panels will stack directly on top of each other from the basement to the roof.[4]

panels will span this vertical distance. Each panel will be 6" thick and reinforced in both the long and short direction. To transfer lateral load, each panel will tie into the existing structure at the existing floor level. On each side the panels connect to each other with a plate bolted to each panel. On the top and bottom the panels bear on each other. Sealant is caulked around all of the edges to minimize water infiltration. Figure 3 below shows a comparison between the cross section of the existing design, and the proposed design.

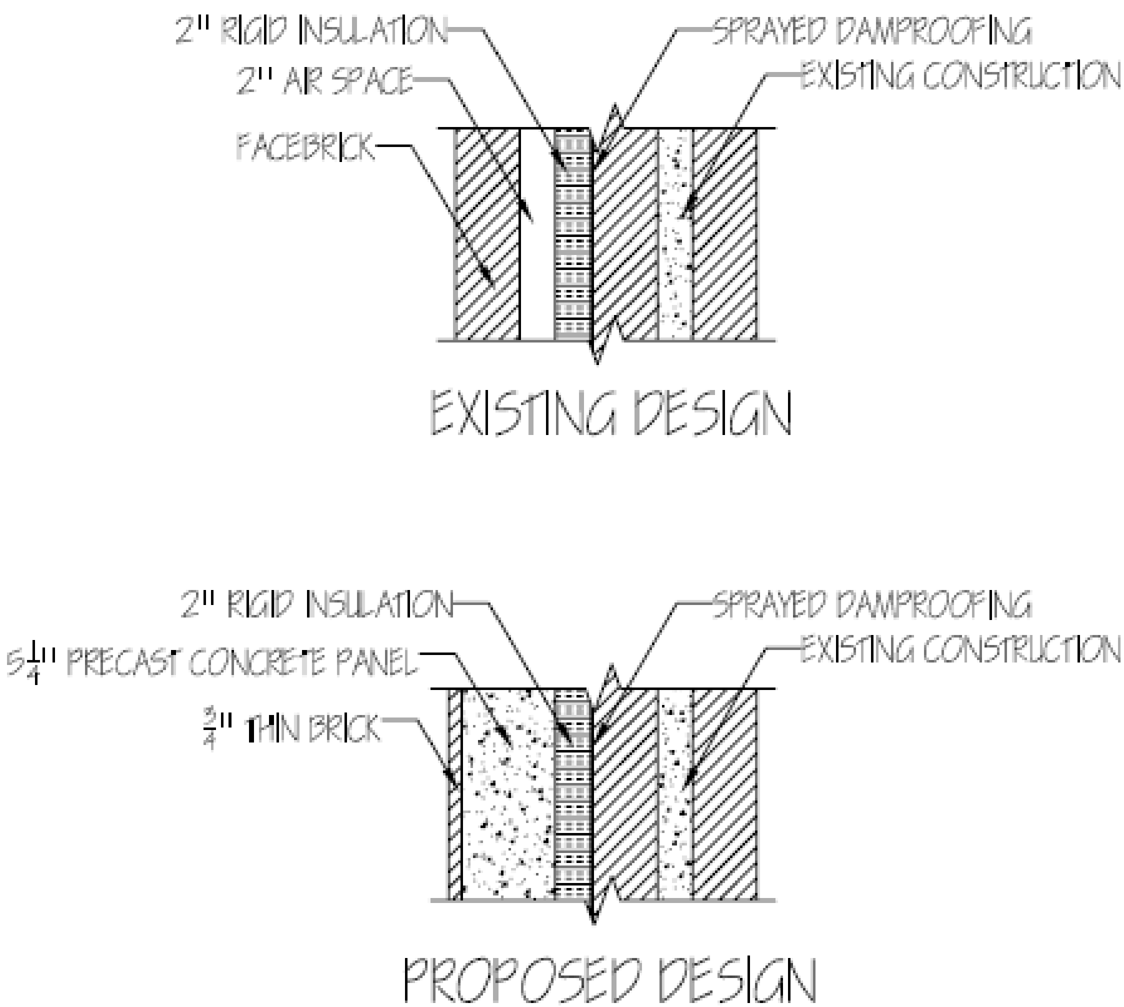


Figure 3: Proposed v. Existing Cross-Sections

Introduction to WUFI

The existing hand laid masonry design and the proposed precast concrete and masonry panel design were both tested for heat and moisture transfer in a program titled WUFI. WUFI is the acronym for Wärme- und Feuchtetransport Instationär, which translates from German to transient heat and moisture transport in English. The program calculates simultaneous heat and moisture transport through building envelopes. WUFI takes the following into account for the calculations:

- thermal conduction
- enthalpy flows through moisture movement with phase change
- short-wave solar radiation
- nighttime long-wave radiation cooling
- vapor diffusion
- solution diffusion
- capillary conduction
- surface diffusion

The first step in the analysis is inputting the envelope materials and thicknesses. WUFI has an extensive database of construction materials that contains all of the thermal and moisture properties necessary for the analysis. For each case to be analyzed the cross section of the envelope is created with the associated materials from the WUFI database. Three primary cases were analyzed through WUFI:

1. The old G wing façade
2. The brick veneer existing design
3. The precast panel proposed design

Besides those cases, 4 additional cases for the precast panel were analyzed to determine the impact of the insulation, airspace, and dampproofing membrane on the thermal and moisture properties of the wall:

1. Airspace instead of insulation, with dampproofing
2. Airspace instead of insulation without dampproofing
3. No airspace, no insulation, with dampproofing
4. No airspace, no insulation, without dampproofing

The following pages contain graphical data from the tests in figures 4 through 8.

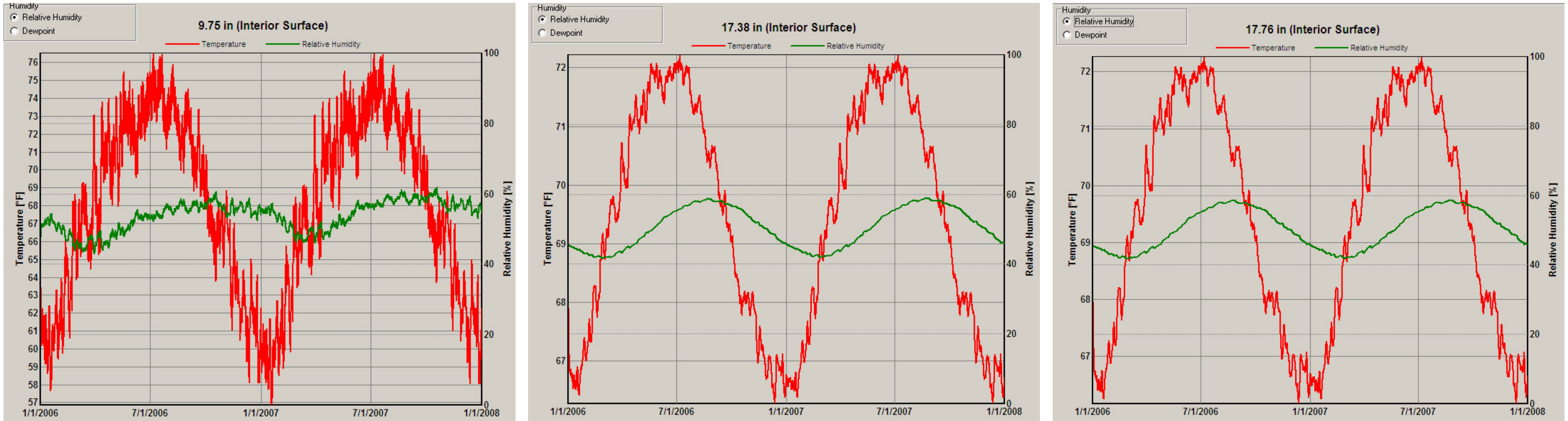


Figure 4: Temperature on interior wall during 2 year period for old façade, existing veneer design, and proposed panel design

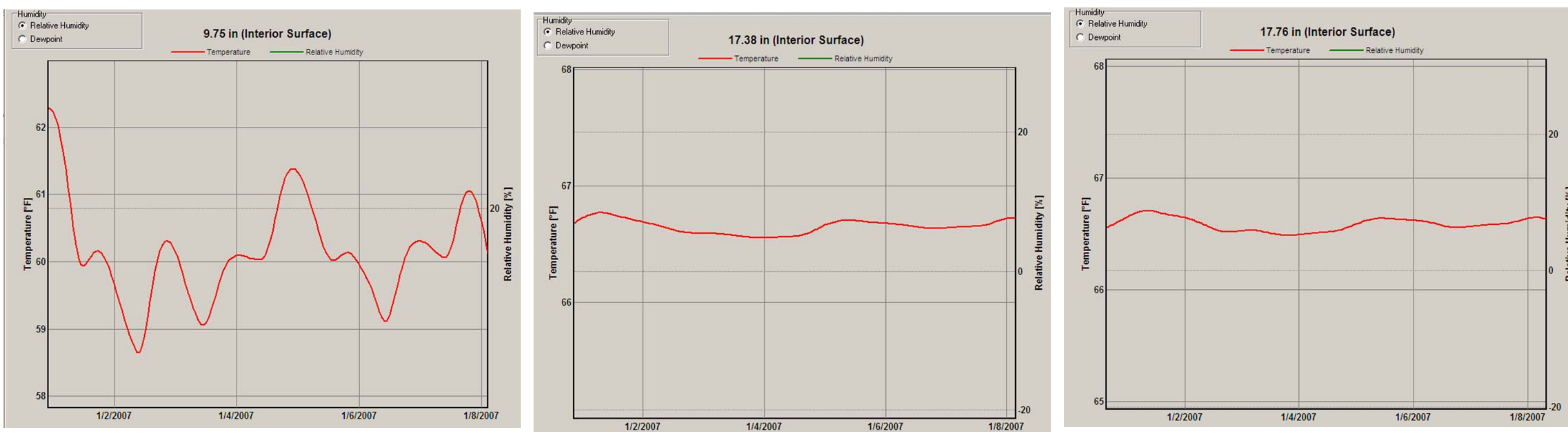


Figure 5: Temperature on interior wall during 1 week period in January for old façade, existing veneer design, and proposed panel design

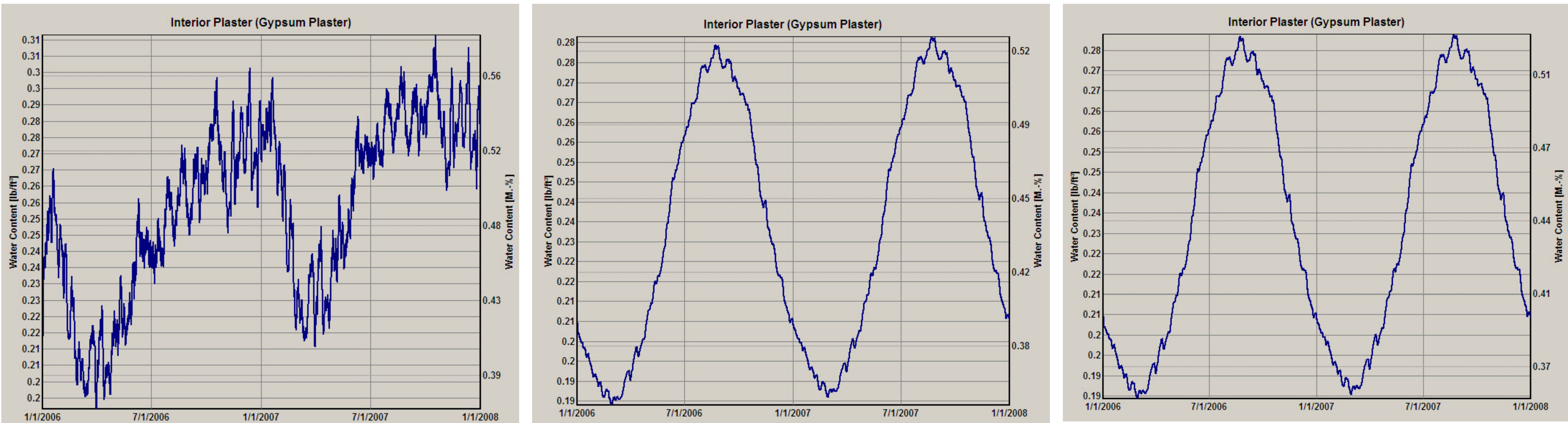


Figure 6: Water content of the interior during a 2 year period surface for old façade, existing veneer design, and proposed panel design

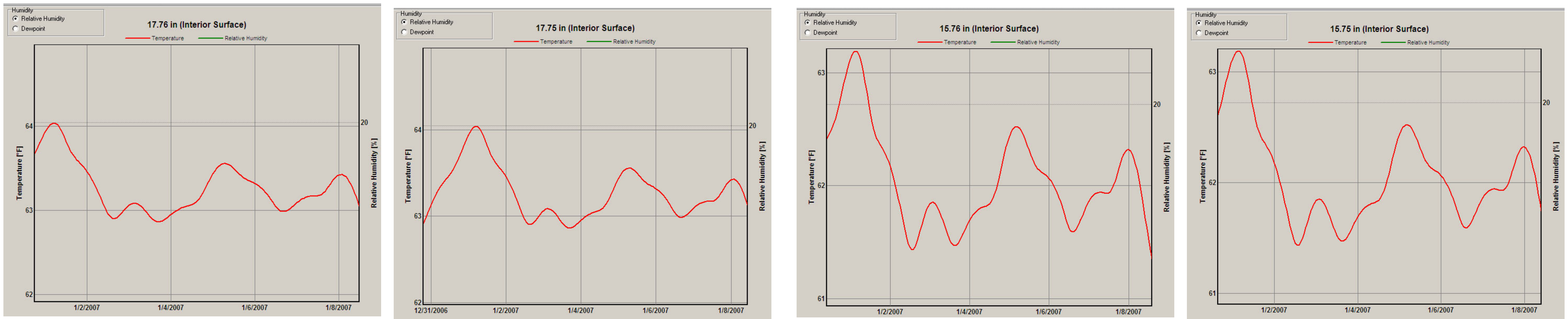


Figure 7: Temperature on interior wall during 1 week period in January for panel with airspace with dampproofing, panel with airspace without dampproofing, panel without airspace with dampproofing, panel without airspace without dampproofing

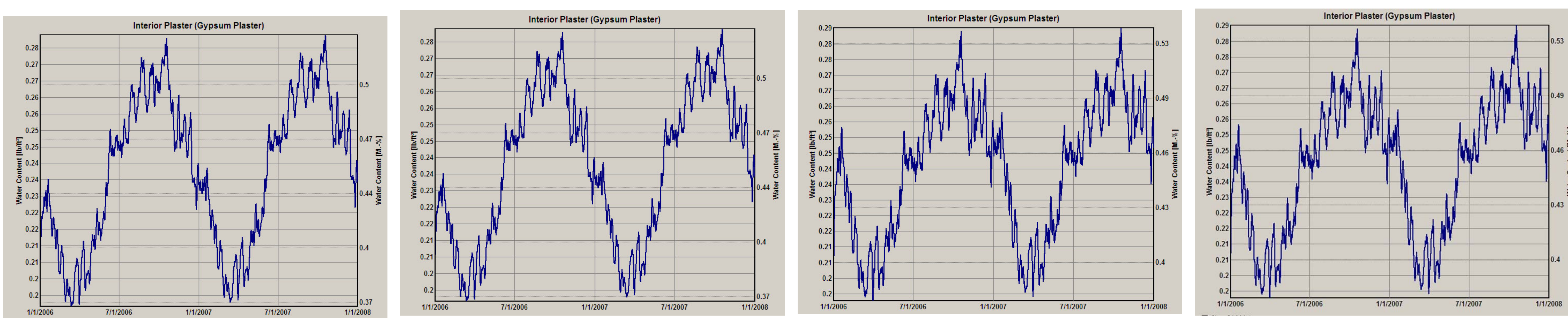


Figure 8: Water content of the interior surface during a 2 year period for panel with airspace with dampproofing, panel with airspace without dampproofing, panel without airspace with dampproofing, panel without airspace without dampproofing

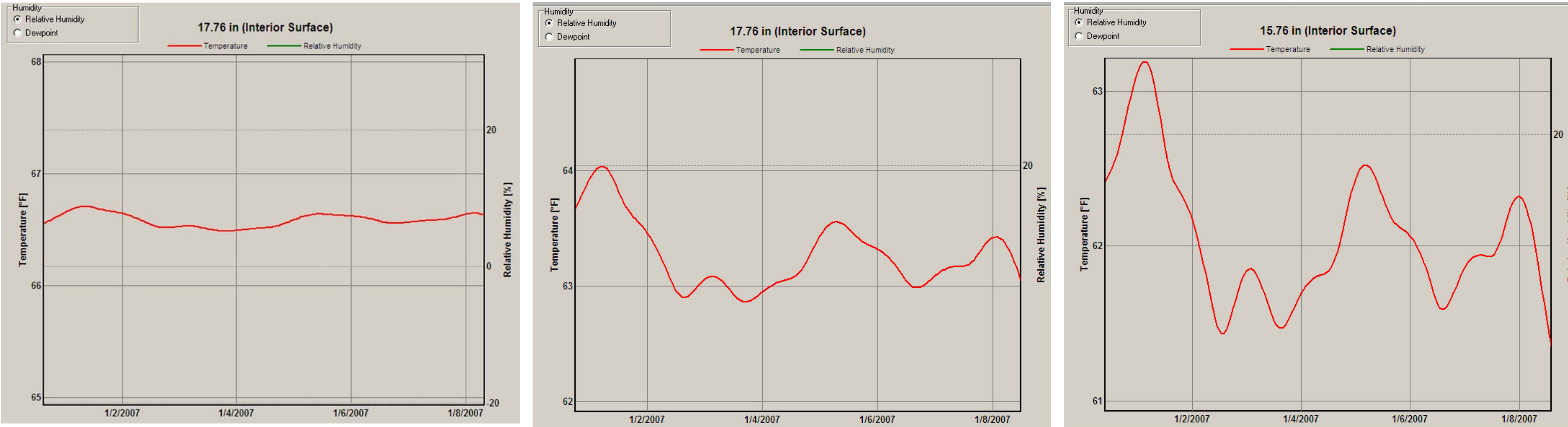


Figure 9: Temperature on interior wall during 1 week period in January for panel with insulation, panel without insulation with airspace, panel without insulation without airspace

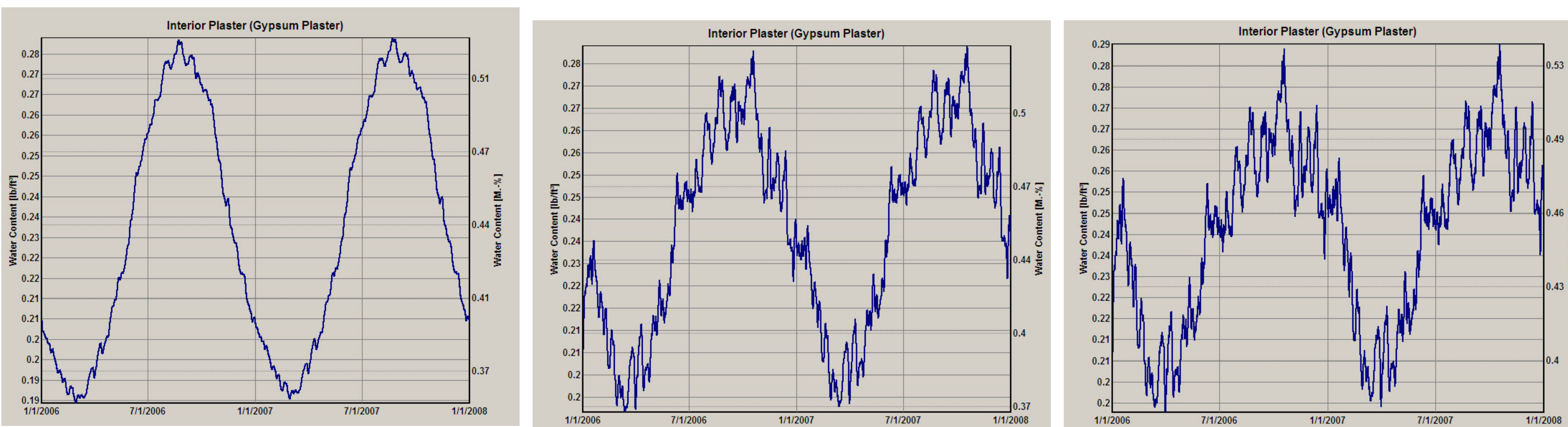


Figure 10: Water content of the interior surface during a 2 year period for panel with insulation, panel without insulation with airspace, panel without insulation without airspace

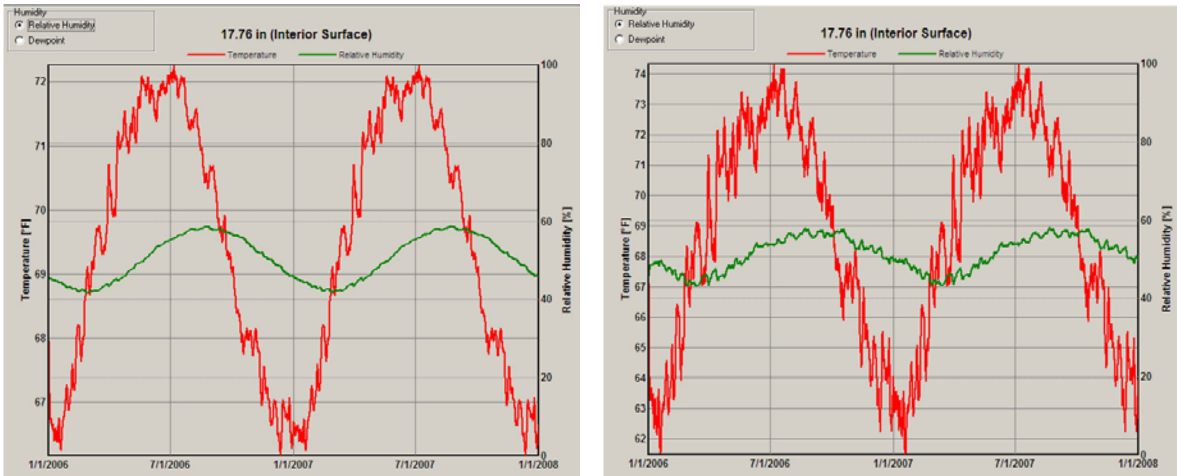


Figure 11: Relative humidity shown in green of precast panel with and without insulation

Transient Heat & Moisture Transport Analysis

The goal of this analysis was to determine if the precast Brick Snap© panels would perform the same or better when compared to the hand laid brick veneer. In terms of the temperature on the inside surface of the building the precast panel performed essentially exactly the same as the brick veneer. Both the veneer and the panel were marked a marked improvement over the existing construction. The inside temperature for the veneer and the panel virtually did not vary from day to day, whereas in the existing condition the temperature fluctuated around 3 degrees daily. In terms of moisture content on the inner surface the panel performed almost identically as the brick veneer. And again both the panel and the veneer showed visible improvement over the existing construction. In terms of fluctuation range the panel, veneer and existing construction varied the same; however the existing construction had moisture content variation on a daily and weekly basis, whereas the panel and the veneer fluctuated from season to season because of the increased humidity during the warm months, but barely fluctuated on a daily or weekly basis. Additionally, the existing construction showed a significant trend of the moisture content increasing each year. This trend could result in failure of the building materials if a certain critical water content level was reached, or could result in moisture appearing on the inside surface of the building. The brick veneer and the precast panel both did not exhibit any increasing water content trend.

When looking at just the precast panel to see impact of the insulation, airspace, and dampproofing membrane there were some consistent trends visible. First, it appeared to make no difference if there was damproofing present or not. The panel with an airspace showed no discrepancy in interior surface temperature and moisture content whether or not there was damproofing. The panel with no airspace had the same results. This can most likely be attributed to the fact that brick is about 20 times more permeable than concrete. Typical brick veneer construction dictates having damproofing, but since concrete allows much less water through it becomes unnecessary. There only a slight difference between the panel with and airspace and the one without an airspace, but there seemed to be a fairly significant difference between those two and the panel with insulation. The panel with insulation barely fluctuated inside temperature, where as the other two panels fluctuated about 2 degrees a day, and the average was about 4 degrees colder with the non insulated panels during the winter. Additionally, whereas the panel with insulation did not fluctuate daily and weekly with respect to moisture content, the panels without insulation did. The interior moisture content can be correlated to the insulation because as seen above in figure 11, the relative humidity varies much more with the panel without insulation. As a result of the relative humidity being more variable, the moisture content is more variable.

U Value Analysis

Another good metric to determine the heat transfer properties of a wall is the U value. The U value defines the number of BTUs flowing through an assembly per square foot per hour per temperature degree difference. A lower U value is preferred because it means that less heat is being lost through the wall during the winter, and less heat is transmitted through the wall into the building during the summer. Tables 1 through 4 show the U values for the various wall assemblies. The U value including windows is calculated as 25% of wall area containing double glazed windows.

Existing Construction	
	R value
air film	0.17
brick	0.385
grout	0.2
brick	0.385
plaster	0.32
inside air	0.68
sum (R Value)	2.14
U Value	0.4673
U incl. windows	0.4755

Hand Laid Brick Veneer	
	R value
air film	0.17
brick	0.385
2" air space	0.9
2" rigid ins.	10
brick	0.385
grout	0.2
brick	0.385
plaster	0.32
inside air	0.68
sum (R Value)	13.425
U Value	0.0745
U incl. windows	0.1809

Table 1: U values for Existing Construction and Brick Veneer

Precast Panels, no insulation	
	R value
air film	0.17
brick	0.385
concrete	0.6
air space	0.9
brick	0.385
grout	0.2
brick	0.385
plaster	0.32
inside air	0.68
sum (R Value)	4.025
U value	0.248447
U incl. windows	0.311335

Precast Panels with insulation	
	R value
air film	0.17
brick	0.385
concrete	0.6
rigid ins.	10
brick	0.385
grout	0.2
brick	0.385
plaster	0.32
inside air	0.68
sum (R Value)	13.125
U Value	0.07619
U incl. windows	0.182143

Table 2: U values for Precast Panel without insulation and Panel with insulation

For Frederick Maryland, with 5000 heating degree days, ASHRAE standards dictate that a non-residential facility should have a minimum 0.3 U value for the exterior walls. The existing construction of the walls is definitely inadequate. The brick veneer and the precast panel with insulation are both meet the standards and are more than adequate. However the precast panel without insulation does not meet ASHRAE standards. This is evidence that in order to use the precast masonry panels there must be insulation in the wall assembly.

Structural Implications

By changing the new façade from a brick veneer system to a precast concrete and masonry system there are several impacts. The precast panels are significantly heavier than typical brick veneer. The following table 3 shows the calculated weight difference of the two construction systems.

Brick Veneer	
120	lb/cf
0.30208	ft
11	ft
398.75	lb/ft

Precast Panel			
Brick		Concrete	
120	lb/cf	150	lb/cf
0.0625	ft	0.4375	ft
11	ft	11	ft
82.5	lb/ft	721.875	lb/ft
Total		804.38	lb/ft

Equivalent 20' wide by 11' high area	
Brick Veneer	Precast Panel
7975 lbs	16088 lbs

Table 3: Weight Comparison of Brick Veneer v. Precast Panels

Because of the panels weighing twice as much as the brick veneer changes must be made to the foundation so that it can bear the weight of the panels. The existing design of the brick veneer façade calls for the brick to bear on the existing foundation built over 50 years ago. This is no longer acceptable, and the foundation must be retrofitted. Figure 12 below shows a schematic design of the retrofitted foundation. As well as the additional bearing requirements, connections between the panels and the existing façade must be designed to be able to transfer the lateral load of the panels to the existing structure. However, because the panels bear on top of each other, the bearing angles that supported the brick can be eliminated.

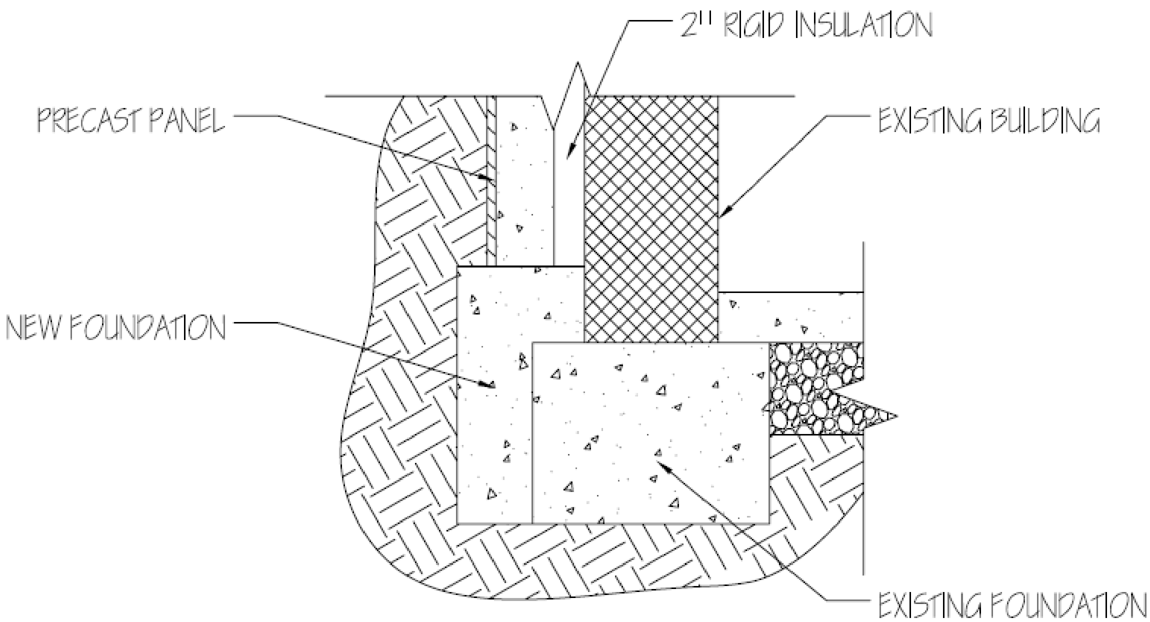
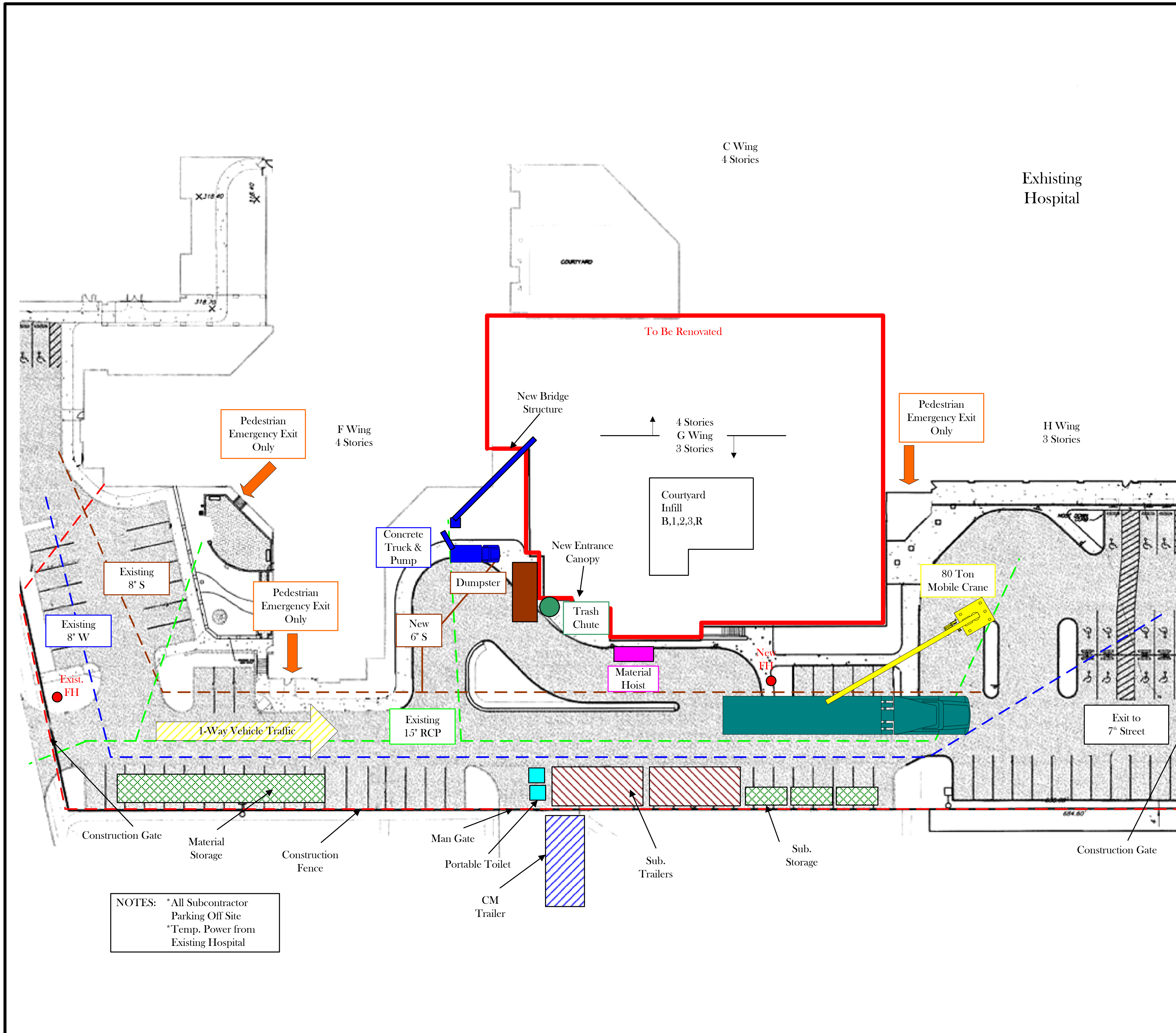


Figure 12: Schematic Design of New Foundation

Site Planning Implications

The construction of a brick veneer façade is very different from the construction of a precast concrete façade; as a result there are some site planning implications from using precast. Masonry construction requires a lot of scaffolding which can clog up the site; by using precast this eliminates the need for scaffolding. However, precast members must be erected with a crane, so the scaffolding has been eliminated but there is a crane on site instead. Additionally, there is very little to no lay down area on the site, therefore the precast panels must be trucked in and lifted right off of the truck. This adds more congestion to the site. Two site plans are shown on the following pages for the construction of the precast panel façade.



FREDERICK MEMORIAL HEALTHCARE SYSTEM

Frederick Memorial Hospital

Project 2000
Phase 4
Additions
&
Renovations

N

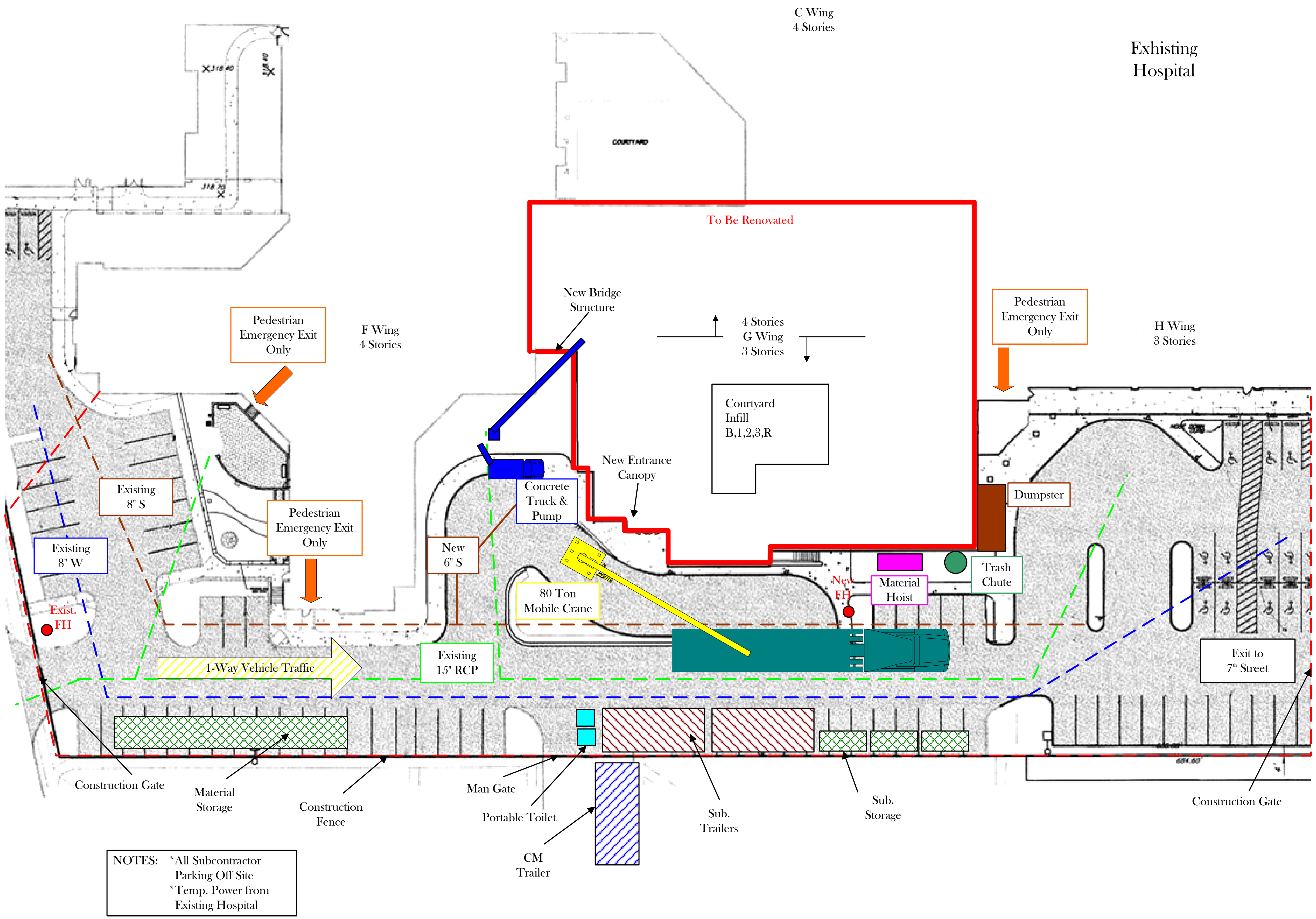
NAME

Abe Vogel

4.03.06

TITLE

NE PANEL ERECTION



FREDERICK MEMORIAL
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Hospital

Project 2000
Phase 4
Additions
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Renovations

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Cost Implications

Being two very different systems there is a cost difference between brick veneer and precast panel construction. The following table shows the estimate of each method.

Description	Quantity	Unit Price	Cost
Brick Veneer, 4" standard brick with polystyrene cavity insulation	15,772 SF	26.8 /SF	$422,690
Location Modifier – Hagerstown		0.89	-$58,304
Estimate Total			$364,386

Description	Quantity	Unit Price	Cost
Manufacture and Deliver Precast Panels	15772 SF	35 /SF	$552,020
Crane for Panel Erection	20 DAY	1513 /DAY	$30,260
Less General Conditions	4 WK	12837 /WK	-$51,348
Location Modifier - Hagerstown		0.89	-$64,051
Estimate Total			$466,881

Table 4: Cost Comparison of Brick Veneer v. Precast Panels

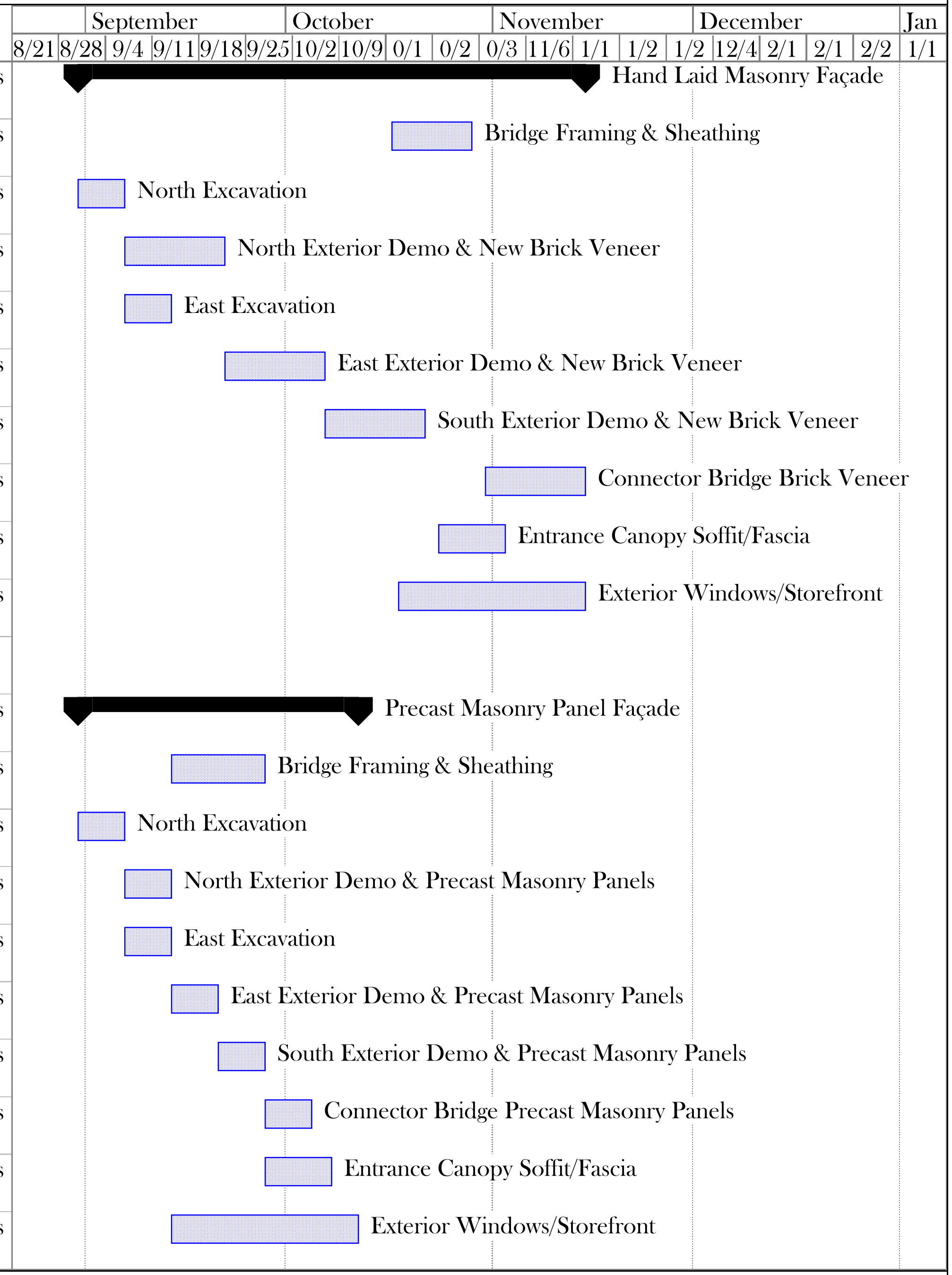
Cost for the manufacture and deliver precast panels activity was quoted from Mark Taylor of Nitterhouse Concrete Products Inc. Precast panel erection is less labor intensive than masonry construction; however the labor hours required to manufacture the panels must be taken into consideration. A major cost difference is that the precast panels require a crane to be rented. A somewhat equalizing factor is that the precast panels can be erected much more rapidly than brick veneer walls can be built. This saves a significant amount of time on general conditions.

Schedule Implications

Because masonry construction is very slow and requires a lot of man hours, the precast panel erection saves a significant amount of time on the schedule. The brick veneer will take 54 work days, whereas the precast panels will take 30 work days. One aspect that must be considered is the lead time on the precast panels. The design of the façade must be 100% complete before the manufacturer can begin constructing the panels. Because once the panel is made, there is not possible way to change a window size or window placement without making another panel. However, the biggest positive impact in saving a month on the schedule is that the building is dried in faster. This is extremely important from an infection control standpoint. As long as the building is opened up the risk for bacteria infiltrating the building is extremely high. With this project being a hospital project infection risks must be minimized. The shortened schedule for the building envelope is a big help towards this goal. The comparison schedule is shown on the next page.

Frederick Memorial Hospital, Phase 4 Additions and Renovations — Precast Panel Schedule

ID	Task Name	Duration
1	Hand Laid Masonry Façade	54 days
2	Bridge Framing & Sheathing	10 days
3	North Excavation	5 days
4	North Exterior Demo & New Brick Veneer	11 days
5	East Excavation	5 days
6	East Exterior Demo & New Brick Veneer	11 days
7	South Exterior Demo & New Brick Veneer	11 days
8	Connector Bridge Brick Veneer	11 days
9	Entrance Canopy Soffit/Fascia	8 days
10	Exterior Windows/Storefront	20 days
11		
12	Precast Masonry Panel Façade	30 days
13	Bridge Framing & Sheathing	10 days
14	North Excavation	5 days
15	North Exterior Demo & Precast Masonry Panels	5 days
16	East Excavation	5 days
17	East Exterior Demo & Precast Masonry Panels	5 days
18	South Exterior Demo & Precast Masonry Panels	5 days
19	Connector Bridge Precast Masonry Panels	5 days
20	Entrance Canopy Soffit/Fascia	8 days
21	Exterior Windows/Storefront	20 days



Conclusion

The Brick Snap© panels provide an effective alternative to hand laid masonry for Frederick Memorial Hospital. In terms of heat and moisture transport a system of precast panels with rigid insulation performs just as well as a brick veneer façade. The precast panels are also shown to be just as good as masonry veneer when it comes to thermal transmission. However it was apparent that the panels need the rigid insulation in order to meet ASHRAE standards. The precast panels do have some significant implications, both positive and negative, on the project. Structurally, the panels require a new foundation to be constructed to support the extra weight that the panels have versus the brick veneer, as well as connections to the structure to transfer the lateral load from the panels. The panels do affect the site plan. Although there no longer needs to be scaffolding set up, a crane must be used to erect the panels and truck deliveries must be scheduled to bring in the panels. And due to the tight sight, the panels must be lifted right off the trucks because there is no laydown area. The precast panel system is more expensive than a brick veneer system. However, one month is saved on the schedule by going to a precast panel façade allowing the building to be dried in faster greatly reducing infection risk. Weighing the advantages and disadvantages, the precast panel construction is better than the standard brick veneer façade method.

INFECTION CONTROL RISK ASSESSMENT

Executive Summary

Careful care has to be made during construction and renovation at hospital facilities with respect to infection control. Bacteria and microorganisms introduced during construction pose a serious risk to those with lowered immune systems. There are several infection control guidelines published; two of which are the CDC and the Healthcare Infection Control Practices Advisory Committee's *Guidelines for Environmental Infection Control in Health-Care Facilities*, and the *Guidelines for Design and Construction of Hospitals and Health Care Facilities* issued by the American Institute of Architects. Both guidelines strongly suggest the implementation of an infection control risk assessment, which is a process of looking at various project factors and determining what needs to be done to control infection during the life of the project. In this analysis an infection control risk assessment will be performed for Frederick Memorial Hospital. From the ICRA and other literature, suggestions for infection control on FMH will be recommended. Implications of these recommendations will be discussed, as well as a comparison between what is currently being done and what is being suggested. When comparing the results of the assessment to what is actually being done at Frederick Memorial Hospital it is apparent that all necessary precautions are being made at the hospital during the construction process.

Background Information & Literature Review

The risk of infection during renovation and construction is a serious concern in the healthcare industry. The Centers for Disease Control and Prevention estimates healthcare associated infections account for an estimated 2 million infections, 90,000 deaths, and $4.5 billion in excess health care costs annually. Not all of these deaths can be attributed to poor construction practices, but many bacteria and microorganism can be introduced during construction resulting in infection or death among future patients. The following table is taken from the Association for Professionals in Infection Control and Epidemiology's 2000 report on "the role of infection control during construction in health care facilities". Table 1 shows different examples where "environmental dispersal of microorganisms during construction, resulting in nosocomial infections, has been described previously". This is proof that the risk of infection from construction and renovation procedures is real.

Year, author	Organism	Population	Epidemiologic factors
Airborne			
1976 Aisner et al[1]	*Aspergillus* spp	Acute leukemia	Fireproofing insulation
1982 Lentino et al[2]	*Aspergillus* spp	BMT; renal	Road construction; window air conditioners
1985 Krasinski et al[3]	*Rhizopus; Aspergillus*	Neonatal	False ceiling
1987 Streifel et al[4]	*Penicillium* spp	BMT	Rotted wood cabinet
1987 Weems et al[5]	*Rhizopus; Mucor* sp;	Hematologic BMT	Construction activity
1990 Fox et al[6]	*Penicillium* sp; *Cladosporium* sp	OR	Ventilation duct fiberglass insulation
1991 Arnow et al[7]	*Aspergillus* sp	Cancer-melanoma	Tiles; humidified cell incubators; air filters
1993 Flynn et al[8]	*Aspergillus terreus*	ICU	ICU renovation; elevators
1994 Gerson et al[9]	*Aspergillus* sp	General	Carpeting
1995 Alvarez et al[10]	*Scedosporium prolificans* (*inflatum*)	Neutropenic hematology	Construction, presumed environmental
1996 Pittet et al[11]	*Aspergillus* sp	COPD	Air filter replacement
Waterborne			
1976 Haley et al[12]	*Legionella* spp	Immunosuppressed	Soil; water
1980 Dondero et al[13]	*Legionella* spp	Adults, employees	Cooling towers
1980 Crane et al[14]	*Pseudomonas paucimobilis*	ICU	Potable water used to fill flush water bottles
1985 Claesson et al[15]	Group A *Streptococcus*	Maternity	Shower head
1993 Sniadeck et al[16]	*Mycobacterium xenopi*	Endoscopy-pseudo	Potable water; scopes
1997 Dearborn et al[17]	*Stachybotrys atra*	Infants	Water-damaged homes
1997 Fridkin et al[18]	*Acremonium kiliense*	Ambulatory surgery	Vent system humidifier

BMT, Bone marrow transplant; *OR*, operating room; *ICU*, intensive care unit; *COPD*, chronic obstructive pulmonary disease.

Table 1: Selected events of nosocomial infection associated with the dispersal of microorganisms during construction

One current guideline for infection control is the *Guidelines for Design and Construction of Hospitals and Health Care Facilities* issued by the American Institute of Architects. The CDC and the Healthcare Infection Control Practices Advisory Committee have also published the *Guidelines for Environmental Infection Control in Health-Care Facilities* which include a section on "Construction, Renovation, Remediation, Repair, and Demolition". Both of these organizations strongly support the implementation of an Infection Control Risk Assessment (ICRA). Premiere Inc., a hospital consulting company, defines ICRA as "a multidisciplinary, organizational, documented process that focuses on reduction of risk from infection; acts through phases of facility planning, design, construction, renovation, facility maintenance, and coordinates and weighs knowledge about infection, infectious agents, and care environment, permitting the organization to anticipate potential impact." In the case of Frederick Memorial Hospital an ICRA will be implemented to determine the different infection risks on the project and how to properly manage them.

Infection Control Risk Assessment Analysis

There are many different forms and checklists used as Infection Control Risk Assessments. For this analysis the "Infection Control Risk Assessment Matrix of Precautions for Construction & Renovation" distributed by the Association for Professionals in Infection Control and Epidemiology will be used as the assessment tool. The following 4 pages show the ICRA matrix filled out for the G wing renovation.

Infection Control Risk Assessment
Matrix of Precautions for Construction & Renovation

Step One:

Using the following table, *identify* the Type of Construction Project Activity (Type A-D)

TYPE A	**Inspection and Non-Invasive Activities**. Includes, but is not limited to: ▪ removal of ceiling tiles for visual inspection limited to 1 tile per 50 square feet ▪ painting (but not sanding) ▪ wallcovering, electrical trim work, minor plumbing, and activities which do not generate dust or require cutting of walls or access to ceilings other than for visual inspection.
TYPE B	**Small scale, short duration activities which create minimal dust** Includes, but is not limited to: ▪ installation of telephone and computer cabling ▪ access to chase spaces ▪ cutting of walls or ceiling where dust migration can be controlled.
TYPE C	**Work that generates a moderate to high level of dust or requires demolition or removal of any fixed building components or assemblies** Includes, but is not limited to: ▪ sanding of walls for painting or wall covering ▪ removal of floorcoverings, ceiling tiles and casework ▪ new wall construction ▪ minor duct work or electrical work above ceilings ▪ major cabling activities ▪ any activity which cannot be completed within a single workshift.
TYPE D	**Major demolition and construction projects** Includes, but is not limited to: ▪ activities which require consecutive work shifts ▪ requires heavy demolition or removal of a complete cabling system ▪ new construction.

Step 1: D

Step Two:

Using the following table, ***identify* the Patient Risk Groups** that will be affected.
If more than one risk group will be affected, select the higher risk group:

Low Risk	Medium Risk	High Risk	Highest Risk
▪ Office areas	▪ Cardiology ▪ Echocardiography ▪ Endoscopy ▪ Nuclear Medicine ▪ Physical Therapy ▪ Radiology/MRI ▪ Respiratory Therapy	▪ CCU ▪ Emergency Room ▪ Labor & Delivery ▪ Laboratories (specimen) ▪ Newborn Nursery ▪ Outpatient Surgery ▪ Pediatrics ▪ Pharmacy ▪ Post Anesthesia Care Unit ▪ Surgical Units	▪ Any area caring for immunocompromised patients ▪ Burn Unit ▪ Cardiac Cath Lab ▪ Central Sterile Supply ▪ Intensive Care Units ▪ Medical Unit ▪ Negative pressure isolation rooms ▪ Oncology ▪ Operating rooms including C-section rooms

Step 2 Low Risk

Step Three: *Match* the

Patient Risk Group (***Low, Medium, High, Highest***) with the planned **…**
Construction Project Type (***A, B, C, D***) on the following matrix, to find the **…**
Class of Precautions (***I, II, III or IV***) or level of infection control activities required.

Class I-IV or Color-Coded Precautions are delineated on the following page.

IC Matrix - Class of Precautions: Construction Project by Patient Risk

Construction Project Type

Patient Risk Group	TYPE A	TYPE B	TYPE C	TYPE D
LOW Risk Group	I	II	II	III/IV
MEDIUM Risk Group	I	II	III	IV
HIGH Risk Group	I	II	III/IV	IV
HIGHEST Risk Group	II	III/IV	III/IV	IV

Note: Infection Control approval will be required when the Construction Activity and Risk Level indicate that **Class III** or **Class IV** control procedures are necessary.

Step 3 Class III/IV

Description of Required Infection Control Precautions by Class

	During Construction Project	Upon Completion of Project
CLASS I	1. Execute work by methods to minimize raising dust from construction operations. 2. Immediately replace a ceiling tile displaced for visual inspection	1. Clean work area upon completion of task.
CLASS II	1. Provide active means to prevent airborne dust from dispersing into atmosphere. 2. Water mist work surfaces to control dust while cutting. 3. Seal unused doors with duct tape. 4. Block off and seal air vents. 5. Place dust mat at entrance and exit of work area 6. Remove or isolate HVAC system in areas where work is being performed.	1. Wipe work surfaces with disinfectant. 2. Contain construction waste before transport in tightly covered containers. 3. Wet mop and/or vacuum with HEPA filtered vacuum before leaving work area. 4. Remove isolation of HVAC system in areas where work is being performed.
CLASS III	1. Remove or Isolate HVAC system in area where work is being done to prevent contamination of duct system. 2. Complete all critical barriers i.e. sheetrock, plywood, plastic, to seal area from non work area or implement control cube method (cart with plastic covering and sealed connection to work site with HEPA vacuum for vacuuming prior to exit) before construction begins. 3. Maintain negative air pressure within work site utilizing HEPA equipped air filtration units. 4. Contain construction waste before transport in tightly covered containers. 5. Cover transport receptacles or carts. Tape covering unless solid lid.	1. Do not remove barriers from work area until completed project is inspected by the owner's Safety Department and Infection Control Department and thoroughly cleaned by the owner's Environmental Services Department. 2. Remove barrier materials carefully to minimize spreading of dirt and debris associated with construction. 3. Vacuum work area with HEPA filtered vacuums. 4. Wet mop area with disinfectant. 5. Remove isolation of HVAC system in areas where work is being performed.
CLASS IV	1. Isolate HVAC system in area where work is being done to prevent contamination of duct system. 2. Complete all critical barriers i.e. sheetrock, plywood, plastic, to seal area from non work area or implement control cube method (cart with plastic covering and sealed connection to work site with HEPA vacuum for vacuuming prior to exit) before construction begins. 3. Maintain negative air pressure within work site utilizing HEPA equipped air filtration units. 4. Seal holes, pipes, conduits, and punctures. 5. Construct anteroom and require all personnel to pass through this room so they can be vacuumed using a HEPA vacuum cleaner before leaving work site or they can wear cloth or paper coveralls that are removed each time they leave work site. 6. All personnel entering work site are required to wear shoe covers. Shoe covers must be changed each time the worker exits the work area. 7. Do not remove barriers from work area until completed project is inspected by the owner's Safety Department and Infection Control Department and thoroughly cleaned by the owner's Environmental Services Dept	1. Remove barrier material carefully to minimize spreading of dirt and debris associated with construction. 2. Contain construction waste before transport in tightly covered containers. 3. Cover transport receptacles or carts. Tape covering unless solid lid 4. Vacuum work area with HEPA filtered vacuums. 5. Wet mop area with disinfectant. 6. Remove isolation of HVAC system in areas where work is being performed.

Step 4. **Identify the areas surrounding the project area, assessing potential impact**

Unit Below	Unit Above	Lateral	Lateral	Behind	Front
		High	High		
Risk Group	Risk Group	Risk Group	Risk Group	Risk Group	Risk Group

Step 5. **Identify specific site of activity eg, patient rooms, medication room, etc.**

Patient rooms, Nursery, Labor & Delivery, Radiology, Cardiology

Step 6. **Identify issues related to: ventilation, plumbing, electrical in terms of the occurrence of probable outages.**

Outages must be planned in advance, construction utility interrupt requests

Step 7. **Identify containment measures, using prior assessment. What types of barriers? (Eg, solids wall barriers); Will HEPA filtration be required?**

Solid wall barriers, yes HEPA filtration

(Note: Renovation/construction area shall be isolated from the occupied areas during construction and shall be negative with respect to surrounding areas)

Step 8. **Consider potential risk of water damage. Is there a risk due to compromising structural integrity? (eg, wall, ceiling, roof)** No

Step 9. **Work hours: Can or will the work be done during non-patient care hours?** No

Step 10. **Do plans allow for adequate number of isolation/negative airflow rooms?** Yes

Step 11. **Do the plans allow for the required number & type of handwashing sinks?** N/A

Step 12. **Does the infection control staff agree with the minimum number of sinks for this project?** (Verify against AIA Guidelines for types and area) N/A

Step 13. **Does the infection control staff agree with the plans relative to clean and soiled utility rooms?** Yes

Step 14. **Plan to discuss the following containment issues with the project team. Eg, traffic flow, housekeeping, debris removal (how and when),**

Finishes work from top floor down

temporary trash chute constructed for debris removal

Appendix: Identify and communicate the responsibility for project monitoring that includes infection control concerns and risks. The ICRA may be modified throughout the project. Revisions must be communicated to the Project Manager.

Steps 1-3 Adapted with permission V Kennedy, B Barnard, St Luke Episcopal Hospital, Houston TX; C Fine, CA
Steps 4-14 Adapted with permission Fairview University Medical Center, Minneapolis MN
Forms modified and provided courtesy of Judene Bartley, ECSI Inc. Beverly Hills MI 2002 Reviewed 2005

Suggested Infection Control Actions

The results of the ICRA show that the project is in between the class III and class IV precaution level. This is a result of the patient groups in the construction area being low risk, like offices and reception areas, but the surrounding wings are all high risk patient groups, like labor & delivery and the nursery. Taking into account the results of the ICRA, other published guidelines, and the project specifics of Frederick Memorial Hospital the following precautions should be taken:

- All HVAC returns in the construction spaces should be completely sealed off with plastic.
- Temporary wall partitions that are completely sealed around the edges should be constructed separating the construction area from the hospital.
- Negative pressure utilizing HEPA filtration should be maintained in the zones adjacent to the hospital to prevent air and particulate in the construction area from flowing into the hospital.
- Testing should be performed daily to ensure that the area around the temporary barriers is indeed in negative pressure when compared to the hospital on the other side of the barrier.
- All above ceiling penetrations from the construction area into the hospital should be completely sealed.
- Place sticky mats at all construction entrances into the building. This will prevent excess dust and dirt from being tracked inside.
- Construction debris should be wrapped in plastic, sealed, and HEPA-filter vacuumed before removal from the construction area.
- Debris and construction tools should be cleaned daily to prevent build up of dust and microorganisms.
- Seal the window openings with plastic until the windows can be put in to minimize infiltration.
- Workers should be HEPA-filter vacuumed before they enter the construction zone.

Implications of ICRA

There are several different implications that arise from an ICRA. The party with by far the largest impact on the success of infection control is the contractor. It is imperative that all contractors involved in the demolition and construction of the hospital understand the importance of infection control to the project. This is the job of the construction manager to lead by example and stress how essential infection control is. Before a subcontractor begins any work, the infection control procedures must be explained to him/her, and they must understand the role they play in minimizing potential infection risks. The construction manager must also hold the subcontractors accountable to the infection control plan and punish any misdeeds. An effective way of stressing the importance of infection control would be to have it be a topic regularly discussed in the weekly superintendents meeting. The contractors on the project are not hospital specific contractors, they do projects in all industry sectors, therefore the mistake must not be made of assuming that the contractors know what infection control precautions to take.

Another implication that arises from the ICRA is cost. It can begin to get expensive to build multiple temporary barriers, have continuous negative pressure in the construction space, and to use HEPA-filtered vacuums numerous times daily. The owner must understand that money needs to be budgeted for infection control. Additionally, the owner must understand that the there can be no value engineering when it comes to infection control, if the budget needs to be cut it has to come from other areas of the project.

Comparison to FMH Methods

Although there was no official infection control risk assessment performed, Frederick Memorial Hospital does have some mandated infection control precautions that are being followed during construction. These prescribed precautions are mostly all from the various published guidelines. There is no area of infection control that is not being covered at the hospital, and in some cases more stringent provisions are being made. For example: interim air-tight reinforced plastic dust abatement curtains are being installed before the prescribed temporary barriers are built, that way no dust or debris enters the building during the construction of the temporary barrier. Also site construction activities are not permitted within 25 feet of existing fresh air intakes, and materials or supplies may not be placed near intake louvers. Compressed air may not be used to clean away dust and dirt.

Conclusion

Infection control is very important on hospital construction projects. There are several resources available to determine what level of precaution needs to be taken with the facility in question. After performing in infection control risk assessment for Frederick Memorial Hospital several specific methods for minimizing infection risk were identified. Two implications of the infection control procedures were discussed: the need for getting contractors to understand the importance of minimizing infection risks, and the need for maintaining the infection control budget if money starts to becomes tight on the project. Finally, when comparing the results of the assessment to what is actually being done at Frederick Memorial Hospital it is apparent that all necessary precautions are being made at the hospital during the construction process.

RESEARCH: GETTING TO KNOW THE OWNER

Executive Summary

At the 2005 PACE Roundtable a recurring theme within the healthcare discussions was the impact of the healthcare owners upon the contractors. Industry members lamented the fact that "owner" usually consists of some combination of the board of directors, head nurses, facilities management, maintenance, and head doctors, just to name a few. The critical issues research will address this problem. To collect data, surveys were sent out to various general contractors and construction managers asking them a variety of questions. The survey consisted of questions about the four typical entities of an owner: president, chief financial officer, end user, and operator. Additional questions regarding the complex nature of the relationships between the entities and how this can affect the contractor are asked as well. The outcome of the research was that each owner entity is complex and must be dealt with differently. Some methods of dealing with the different entities are to build a solid relationship with the owner at the beginning of the project, get the owner groups involved early on, and foster a sense of honesty among all project participants. In the end, the burden is on the contractor to make sure that the owner is handled properly.

Background

At the 2005 PACE Roundtable a recurring theme within the healthcare discussions was the impact of the healthcare owners upon the contractors. Industry members lamented the fact that “owner” usually consists of some combination of the board of directors, head nurses, facilities management, maintenance, and head doctors, just t o name a few. Numerous communication problems arise because of this, slowing down construction and causing work stoppages. The critical issues research will address this problem.

Because the topic of research is somewhat new the goal is not to find some solution to the problem; that will be left to upcoming researchers. Instead, the main objective of this research is to develop a simple guide to learn how to address the different entities of the owner and how to better understand and deal with them.

The end result of this research will be a description of the different entities in an owner, describing what characterizes them and what is important to them. Additionally, an outcome of the research will be recommendations for dealing with the intricacies of having multiple entities as an owner.

To achieve these objectives contractors will be surveyed. The data collection will come from online surveys. The survey will consist of questions about the four typical entities of an owner: president, chief financial officer, end user, and operator. Additional questions regarding the complex nature of the relationships between the entities and how this can affect the contractor will be asked as well.

The following two pages contain the survey that was sent out.

RESEARCH SURVEY:
GETTING TO KNOW THE "OWNER"

The relationship between contractor and owner is critical to the success of any construction project. This relationship can become even more strained due to the fact that the "owner" is rarely ever one person. The goal of this survey is to learn how to address the different entities of the owner and how to better understand and deal with them.

For this survey I am assuming that the 4 major entities of an owner usually are: president, chief financial officer, end user, maintenance/operators.

Please write as much or as little as you want. Responses can be based on past or present projects. Thank you in advance for taking the time out of you busy schedule to participate in this research.

What is important to the President? What does she/he like and dislike?

What is the best way to get to know and communicate with the President?

What is important to the Chief Financial Officer? What does she/he like and dislike?

What is the best way to get to know and communicate with the Chief Financial Officer?

What is important to the End User? What does she/he like and dislike?

What is the best way to get to know and communicate with the End User?

What is important to the Operator? What does she/he like and dislike?

What is the best way to get to know and communicate with the Operator?

How can it be beneficial to have various entities to the owner? Can this be used to your Advantage?

How can differences of opinion between the entities create problems for the project?

What other complexities are caused by having multiple entities for an owner?

How often do you have to play peacekeeper between the entities?
Never Rarely Occasionally Often Very Often

Who is usually the easiest to get on your side? Why?

Who is usually the hardest to get on your side? Why?

Are there other entities regularly involved in the business decisions of the project aside from these 4?

Any other comments?

Your Name:
Your Position:
Your Company:

Thank you for participating in this survey. Please click the submit via email button or print out and fax response to (814) 863-4789 Attention: Abe Vogel.

Summary of Results

After analyzing the surveys returned by the industry members, the results of each question are summarized below:

What is important to the President? What does she/he like and dislike?

- President just wants to be satisfied with the project
- President looks at macro big picture issues
- Concerned about money and the schedule

What is the best way to get to know and communicate with the President?

- Face to face interaction is the only way
- Must be verbal communication

What is important to the Chief Financial Officer? What does she/he like and dislike?

- Cash flow on project is most important
- Slightly more specific interests that president

What is the best way to get to know and communicate with the Chief Financial Officer?

- Face to face interaction is preferred
- Monthly reports good way of communicating money status

What is important to the End User? What does she/he like and dislike?

- Quality of building, does it function properly
- End user wants to be involved in design

What is the best way to get to know and communicate with the End User?

- More involved at project level; job site meetings
- Communication acceptable over phone/email, face to face better

What is important to the Operator? What does she/he like and dislike?

- Performance of building, O&M manuals most important

What is the best way to get to know and communicate with the Operator?

- Involved on project level; jobsite meetings

How can it be beneficial to have various entities to the owner? Can this be used to your advantage?

- There are more eyes to see things and catch mistakes
- Creates more accountability

How can differences of opinion between the entities create problems for the project?

- Creates schedule issues with delays and slow downs
- So many players create problems in direction of project
- Everybody wants something different which causes conflicts

What other complexities are caused by having multiple entities for an owner?

- There is too much communication, too many meetings
- Hard to figure out who is in charge, who to involve in certain issues

How often do you have to play peacekeeper between the entities?

- 0% - Never
- 27% - Rarely
- 55% - Occasionally
- 18% - Often
- 0% - Very often

Who is usually the easiest to get on your side? Why?

- Many times end user because no contractual arrangement between them and CM
- Operator because values usually align with contractors; level of trust there

Who is usually the hardest to get on your side? Why?

- President and CFO because they tend to have a short term view
- Lack of construction experience dictates who is hardest to get on your side

Are there other entities regularly involved in the business decisions of the project aside from these 4?

- Depends on type of project
- Owner's representative, which causes different complexities

Any other comments?

- Every project is different
- Assessment of the situation is key

Recommendation for Getting to Know the Owner

Getting to know the owner is all about trust, and it has to start at the top. The project executive and/or the project manager need to develop a rapport with the president that will continue throughout the life of the project. This can only be done with a face to face meeting before the project has even started. The purpose of the meeting is team building. The goal for the contractor is to create a partnership with the president; so that the president understands that the contractor has his/her best interests at heart, and that they both have the same goals for the project. For this reason it is vital that the meeting is in person. It is nearly impossible to create a bond through email or telephone. The non-verbal signals from the contractor will play an important role in how much trust is created. Once the project is underway, less communication is necessary, but effort still needs to be made to maintain the relationship. Meetings occasionally should be had, especially when the project is not running as smoothly as anticipated. When the project is in turmoil the president will be hearing about the problems through the grapevine of the people underneath him/her. Information and subtleties can get lost through this chain because it is human nature to deflect blame for problems to try to look good for your superior. Meeting directly with the president will eliminate these problems, and the project can be talked about directly instead of through various channels. If a solid, honest relationship is established with the president there will be a trickle-down effect throughout the rest of the "owner" groups.

Another key to successfully dealing with the owner is early involvement. The end user and the operator should be brought on boards as soon as possible. As a result they will feel more like the project is "theirs" and not like they have to guard their backs from the contractor. Early involvement will also reduce the chances of late changes on the project, which will save everyone money. Handling of the end user and the operator does not necessarily have to be done with meetings with the project manager and the project executive, they can be dealt with by the assistant project managers and the project engineers to eliminate meeting overload on the project manager.

A final important piece is honesty. The contractor should take the lead in fostering an honest environment among all the project participants. The contractor needs to take the initiative to show their honesty and have the job site open to the owners. This will make sure that the owner groups with little construction expertise feel more comfortable about the project. Additionally, this will avoid them thinking that the contractor is trying to hide something from them, or pull the wool over their eyes.

Conclusion

Ultimately, the onus falls on the contractor. Managing the owners is almost as important as managing the subcontractors. Therefore, the contractor should be as proactive with handling the owners as they are with the subs. At the very beginning of the project, before construction has even started, the contractor should assess the situation. Because each project is different each “owner” is different, and every new project will have to be administered differently. The contractor should plan on how they are going to tackle the issue of managing the owner. But in the end it will come down to time and money. If the project is delivered on time and on budget, the owners will be happy and very little management will be needed. However, more than likely not everything will run smoothly on every project, and the contractor needs to understand the intricacies of the owner and how to deal with them.

CONCLUSION

In this thesis several proposed changes were made and fully analyzed. The analysis of the use of a structural steel system in the place of cast-in-place concrete showed the feasibility of the structural steel. The steel system resulted in a floor thickness 8" greater than the existing design. However, the steel system eliminated the need for columns within the courtyard infill, instead placing them on the exterior of the floor plan. The steel system was less expensive than the cast-in-place system and the implications to the schedule were all positive, as the steel system took less time to construct than the cast-in-place system.

In the façade analysis it was shown that precast masonry/concrete panels were and acceptable alternative to laid brick veneer from a heat and moisture transfer perspective. However, the panels did weigh twice as much as the brick veneer system, and as a result the existing foundation had to be upsized. The precast panels affected the site plan because of the need for a crane, and were more expensive than the brick veneer. Nevertheless, the schedule is positively impacted, allowing for less general conditions time and for the building to be dried in faster.

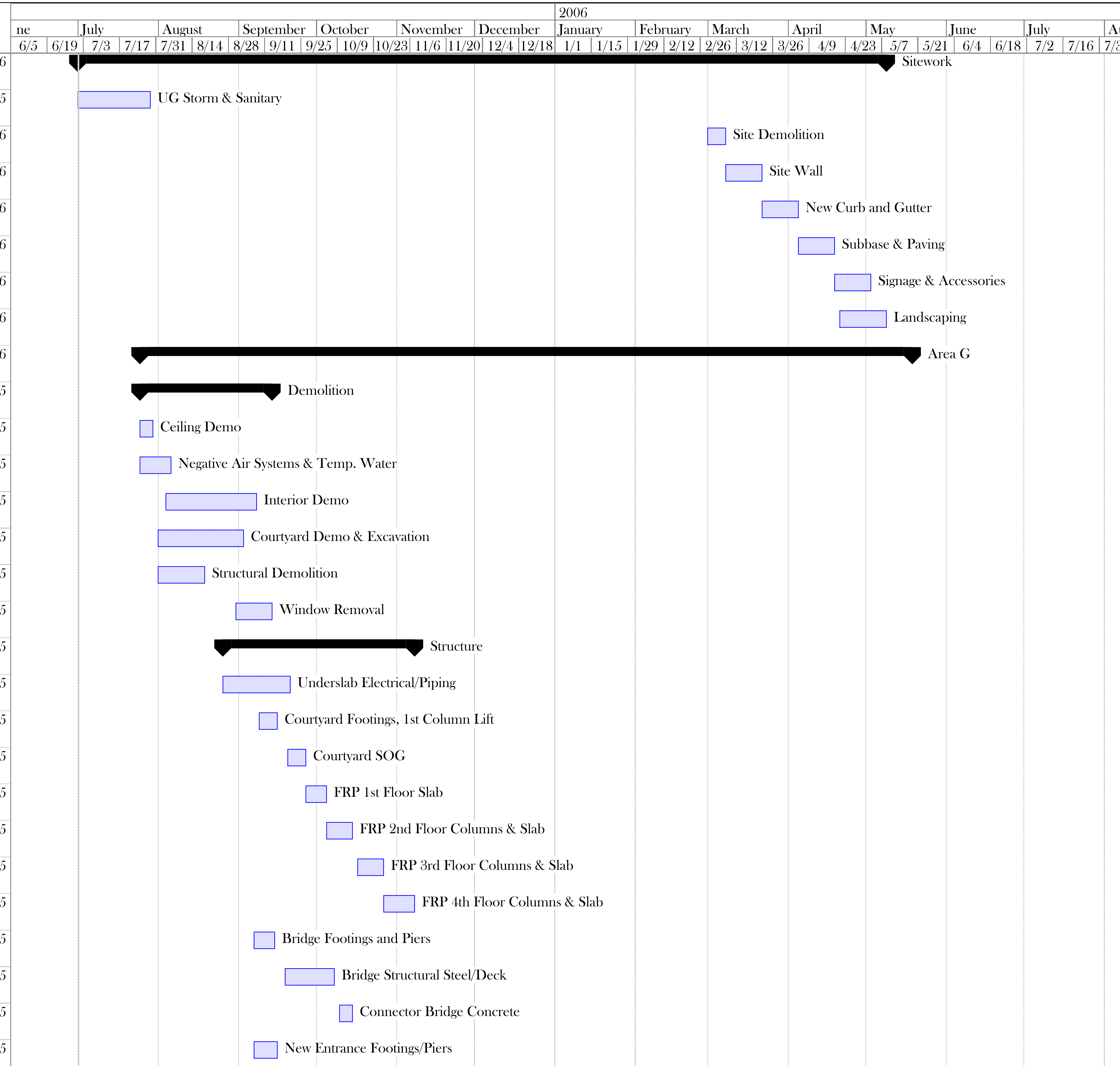
In this thesis an infection control risk assessment was performed for Frederick Memorial Hospital. From the ICRA and other literature, suggestions for infection control on FMH were recommended. Implications of these recommendations were discussed, as well as a comparison between what is currently being done and what was suggested.

The research component of this thesis addressed the problem "owners" consisting of multiple entities. To collect data, surveys were sent out to various general contractors and construction managers asking them a variety of questions. The outcome of the research was that each owner entity is complex and must be dealt with differently. Several methods of dealing with the different owner groups were identified.

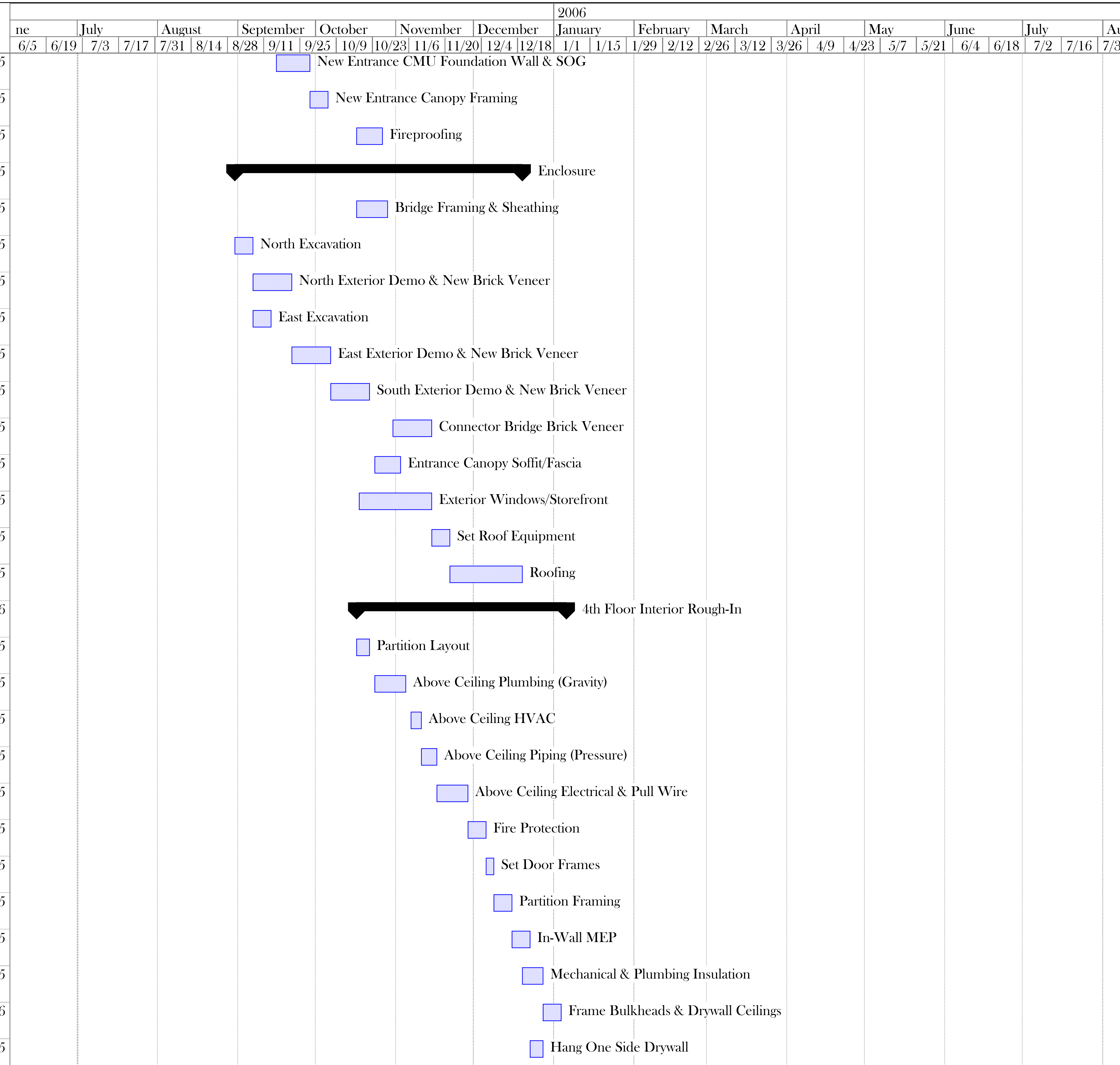
APPENDICES

Appendix A – Detailed Project Schedule

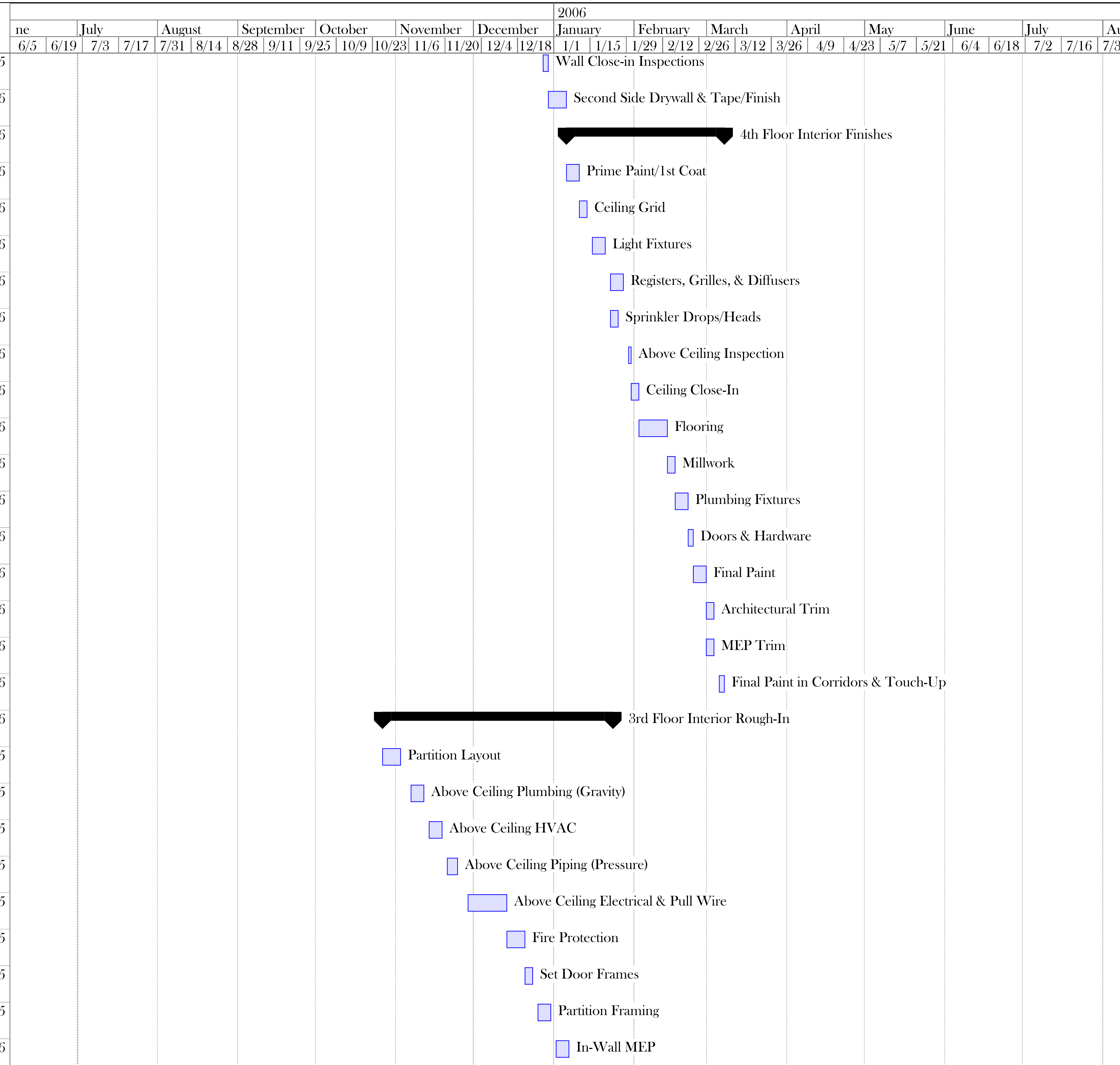
ID	Task Name	Duration	Start	Finish
	Sitework	222 days	7/1/05	5/8/06
1	UG Storm & Sanitary	20 days	7/1/05	7/28/05
2	Site Demolition	5 days	3/1/06	3/7/06
3	Site Wall	10 days	3/8/06	3/21/06
4	New Curb and Gutter	10 days	3/22/06	4/4/06
5	Subbase & Paving	10 days	4/5/06	4/18/06
6	Signage & Accessories	10 days	4/19/06	5/2/06
7	Landscaping	12 days	4/21/06	5/8/06
	Area G	214 days	7/25/05	5/18/06
	Demolition	37 days	7/25/05	9/13/05
8	Ceiling Demo	5 days	7/25/05	7/29/05
9	Negative Air Systems & Temp. Water	10 days	7/25/05	8/5/05
10	Interior Demo	25 days	8/4/05	9/7/05
11	Courtyard Demo & Excavation	25 days	8/1/05	9/2/05
12	Structural Demolition	14 days	8/1/05	8/18/05
13	Window Removal	10 days	8/31/05	9/13/05
	Structure	52 days	8/26/05	11/7/05
14	Underslab Electrical/Piping	18 days	8/26/05	9/20/05
15	Courtyard Footings, 1st Column Lift	5 days	9/9/05	9/15/05
16	Courtyard SOG	5 days	9/20/05	9/26/05
17	FRP 1st Floor Slab	6 days	9/27/05	10/4/05
18	FRP 2nd Floor Columns & Slab	8 days	10/5/05	10/14/05
19	FRP 3rd Floor Columns & Slab	8 days	10/17/05	10/26/05
20	FRP 4th Floor Columns & Slab	8 days	10/27/05	11/7/05
21	Bridge Footings and Piers	6 days	9/7/05	9/14/05
22	Bridge Structural Steel/Deck	15 days	9/19/05	10/7/05
23	Connector Bridge Concrete	5 days	10/10/05	10/14/05
24	New Entrance Footings/Piers	7 days	9/7/05	9/15/05



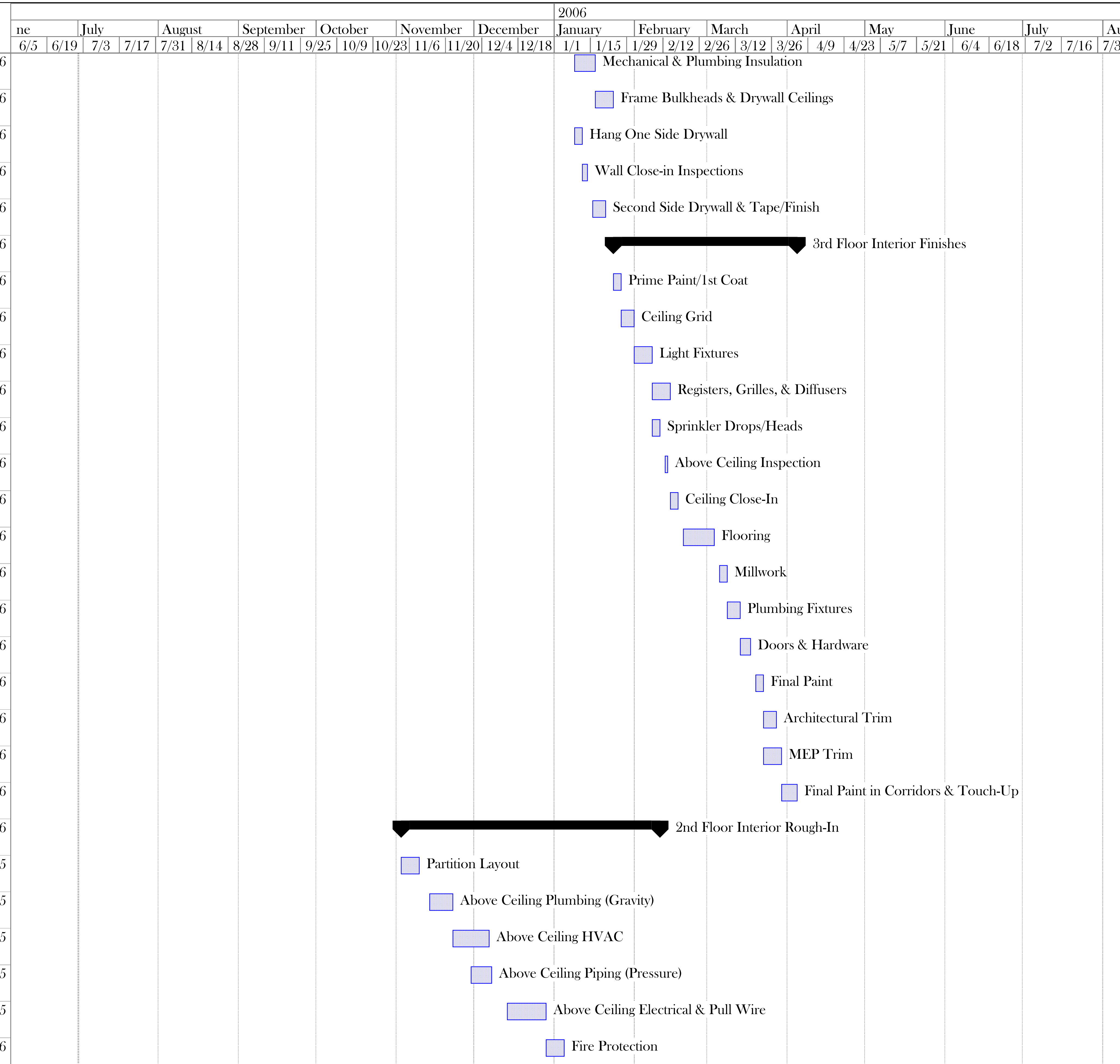
ID	Task Name	Duration	Start	Finish
25	New Entrance CMU Foundation Wall & SOG	9 days	9/16/05	9/28/05
26	New Entrance Canopy Framing	5 days	9/29/05	10/5/05
27	Fireproofing	8 days	10/17/05	10/26/05
	Enclosure	79 days	8/31/05	12/19/05
28	Bridge Framing & Sheathing	10 days	10/17/05	10/28/05
29	North Excavation	5 days	8/31/05	9/6/05
30	North Exterior Demo & New Brick Veneer	11 days	9/7/05	9/21/05
31	East Excavation	5 days	9/7/05	9/13/05
32	East Exterior Demo & New Brick Veneer	11 days	9/22/05	10/6/05
33	South Exterior Demo & New Brick Veneer	11 days	10/7/05	10/21/05
34	Connector Bridge Brick Veneer	11 days	10/31/05	11/14/05
35	Entrance Canopy Soffit/Fascia	8 days	10/24/05	11/2/05
36	Exterior Windows/Storefront	20 days	10/18/05	11/14/05
37	Set Roof Equipment	5 days	11/15/05	11/21/05
38	Roofing	20 days	11/22/05	12/19/05
	4th Floor Interior Rough-In	59 days	10/17/05	1/5/06
39	Partition Layout	5 days	10/17/05	10/21/05
40	Above Ceiling Plumbing (Gravity)	10 days	10/24/05	11/4/05
41	Above Ceiling HVAC	4 days	11/7/05	11/10/05
42	Above Ceiling Piping (Pressure)	4 days	11/11/05	11/16/05
43	Above Ceiling Electrical & Pull Wire	8 days	11/17/05	11/28/05
44	Fire Protection	5 days	11/29/05	12/5/05
45	Set Door Frames	3 days	12/6/05	12/8/05
46	Partition Framing	5 days	12/9/05	12/15/05
47	In-Wall MEP	5 days	12/16/05	12/22/05
48	Mechanical & Plumbing Insulation	6 days	12/20/05	12/27/05
49	Frame Bulkheads & Drywall Ceilings	5 days	12/28/05	1/3/06
50	Hang One Side Drywall	3 days	12/23/05	12/27/05



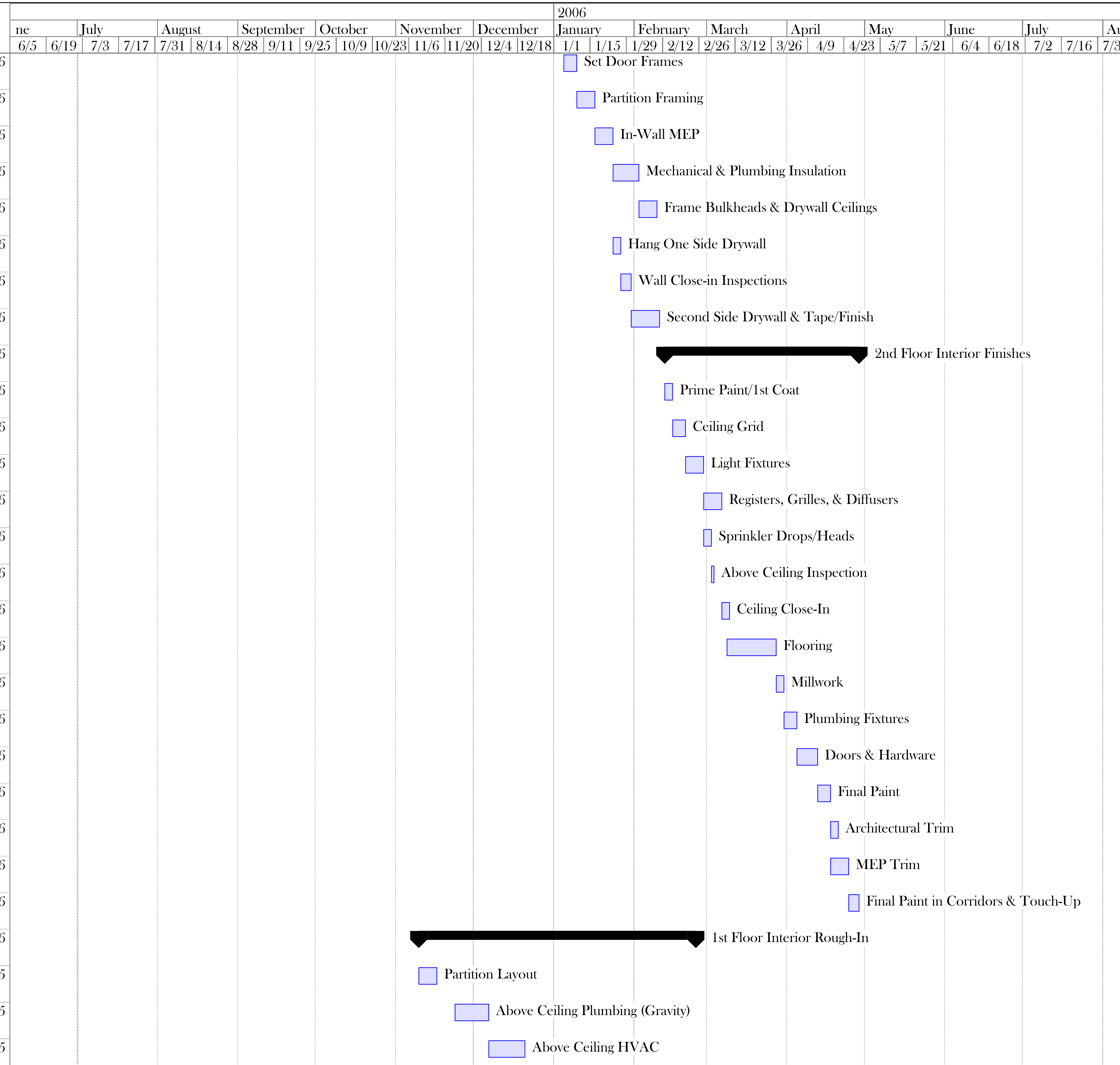
ID	Task Name	Duration	Start	Finish
51	Wall Close-in Inspections	2 days	12/28/05	12/29/05
52	Second Side Drywall & Tape/Finish	5 days	12/30/05	1/5/06
	4th Floor Interior Finishes	43 days	1/6/06	3/7/06
53	Prime Paint/1st Coat	3 days	1/6/06	1/10/06
54	Ceiling Grid	3 days	1/11/06	1/13/06
55	Light Fixtures	5 days	1/16/06	1/20/06
56	Registers, Grilles, & Diffusers	5 days	1/23/06	1/27/06
57	Sprinkler Drops/Heads	3 days	1/23/06	1/25/06
58	Above Ceiling Inspection	1 day	1/30/06	1/30/06
59	Ceiling Close-In	3 days	1/31/06	2/2/06
60	Flooring	7 days	2/3/06	2/13/06
61	Millwork	3 days	2/14/06	2/16/06
62	Plumbing Fixtures	3 days	2/17/06	2/21/06
63	Doors & Hardware	2 days	2/22/06	2/23/06
64	Final Paint	3 days	2/24/06	2/28/06
65	Architectural Trim	3 days	3/1/06	3/3/06
66	MEP Trim	3 days	3/1/06	3/3/06
67	Final Paint in Corridors & Touch-Up	2 days	3/6/06	3/7/06
	3rd Floor Interior Rough-In	63 days	10/27/05	1/23/06
68	Partition Layout	5 days	10/27/05	11/2/05
69	Above Ceiling Plumbing (Gravity)	5 days	11/7/05	11/11/05
70	Above Ceiling HVAC	5 days	11/14/05	11/18/05
71	Above Ceiling Piping (Pressure)	4 days	11/21/05	11/24/05
72	Above Ceiling Electrical & Pull Wire	11 days	11/29/05	12/13/05
73	Fire Protection	5 days	12/14/05	12/20/05
74	Set Door Frames	3 days	12/21/05	12/23/05
75	Partition Framing	5 days	12/26/05	12/30/05
76	In-Wall MEP	5 days	1/2/06	1/6/06



ID	Task Name	Duration	Start	Finish
77	Mechanical & Plumbing Insulation	6 days	1/9/06	1/16/06
78	Frame Bulkheads & Drywall Ceilings	5 days	1/17/06	1/23/06
79	Hang One Side Drywall	3 days	1/9/06	1/11/06
80	Wall Close-in Inspections	2 days	1/12/06	1/13/06
81	Second Side Drywall & Tape/Finish	5 days	1/16/06	1/20/06
	3rd Floor Interior Finishes	51 days	1/24/06	4/4/06
82	Prime Paint/1st Coat	3 days	1/24/06	1/26/06
83	Ceiling Grid	3 days	1/27/06	1/31/06
84	Light Fixtures	5 days	2/1/06	2/7/06
85	Registers, Grilles, & Diffusers	5 days	2/8/06	2/14/06
86	Sprinkler Drops/Heads	3 days	2/8/06	2/10/06
87	Above Ceiling Inspection	1 day	2/13/06	2/13/06
88	Ceiling Close-In	3 days	2/15/06	2/17/06
89	Flooring	10 days	2/20/06	3/3/06
90	Millwork	3 days	3/6/06	3/8/06
91	Plumbing Fixtures	3 days	3/9/06	3/13/06
92	Doors & Hardware	4 days	3/14/06	3/17/06
93	Final Paint	3 days	3/20/06	3/22/06
94	Architectural Trim	3 days	3/23/06	3/27/06
95	MEP Trim	5 days	3/23/06	3/29/06
96	Final Paint in Corridors & Touch-Up	4 days	3/30/06	4/4/06
	2nd Floor Interior Rough-In	72 days	11/3/05	2/10/06
97	Partition Layout	5 days	11/3/05	11/9/05
98	Above Ceiling Plumbing (Gravity)	7 days	11/14/05	11/22/05
99	Above Ceiling HVAC	10 days	11/23/05	12/6/05
100	Above Ceiling Piping (Pressure)	6 days	11/30/05	12/7/05
101	Above Ceiling Electrical & Pull Wire	11 days	12/14/05	12/28/05
102	Fire Protection	5 days	12/29/05	1/4/06

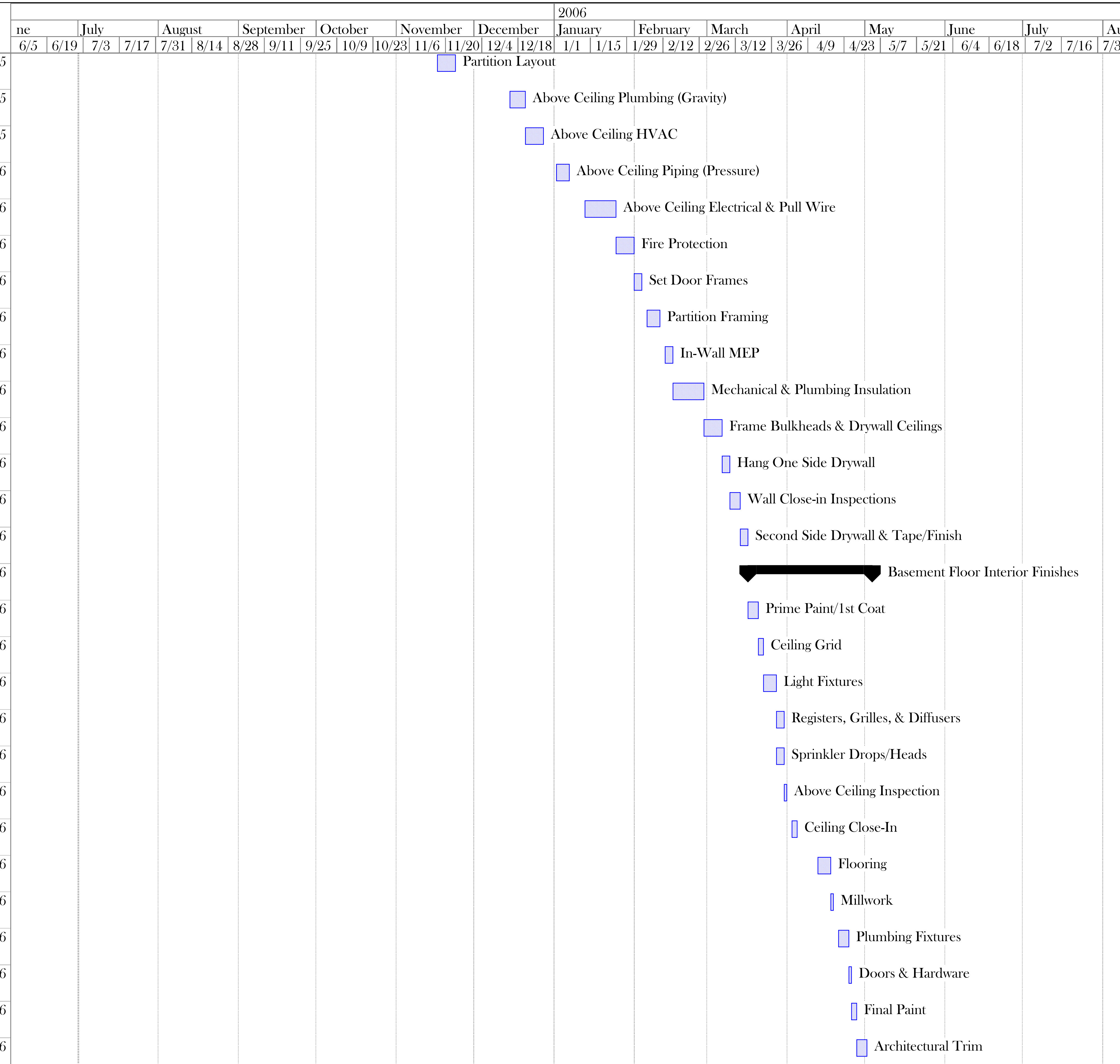


ID	Task Name	Duration	Start	Finish
103	Set Door Frames	3 days	1/5/06	1/9/06
104	Partition Framing	5 days	1/10/06	1/16/06
105	In-Wall MEP	5 days	1/17/06	1/23/06
106	Mechanical & Plumbing Insulation	8 days	1/24/06	2/2/06
107	Frame Bulkheads & Drywall Ceilings	5 days	2/3/06	2/9/06
108	Hang One Side Drywall	3 days	1/24/06	1/26/06
109	Wall Close-in Inspections	2 days	1/27/06	1/30/06
110	Second Side Drywall & Tape/Finish	9 days	1/31/06	2/10/06
	2nd Floor Interior Finishes	55 days	2/13/06	4/28/06
111	Prime Paint/1st Coat	3 days	2/13/06	2/15/06
112	Ceiling Grid	3 days	2/16/06	2/20/06
113	Light Fixtures	5 days	2/21/06	2/27/06
114	Registers, Grilles, & Diffusers	5 days	2/28/06	3/6/06
115	Sprinkler Drops/Heads	3 days	2/28/06	3/2/06
116	Above Ceiling Inspection	1 day	3/3/06	3/3/06
117	Ceiling Close-In	3 days	3/7/06	3/9/06
118	Flooring	13 days	3/9/06	3/27/06
119	Millwork	3 days	3/28/06	3/30/06
120	Plumbing Fixtures	3 days	3/31/06	4/4/06
121	Doors & Hardware	6 days	4/5/06	4/12/06
122	Final Paint	3 days	4/13/06	4/17/06
123	Architectural Trim	3 days	4/18/06	4/20/06
124	MEP Trim	5 days	4/18/06	4/24/06
125	Final Paint in Corridors & Touch-Up	4 days	4/25/06	4/28/06
	1st Floor Interior Rough-In	77 days	11/10/05	2/24/06
126	Partition Layout	5 days	11/10/05	11/16/05
127	Above Ceiling Plumbing (Gravity)	9 days	11/24/05	12/6/05
128	Above Ceiling HVAC	10 days	12/7/05	12/20/05

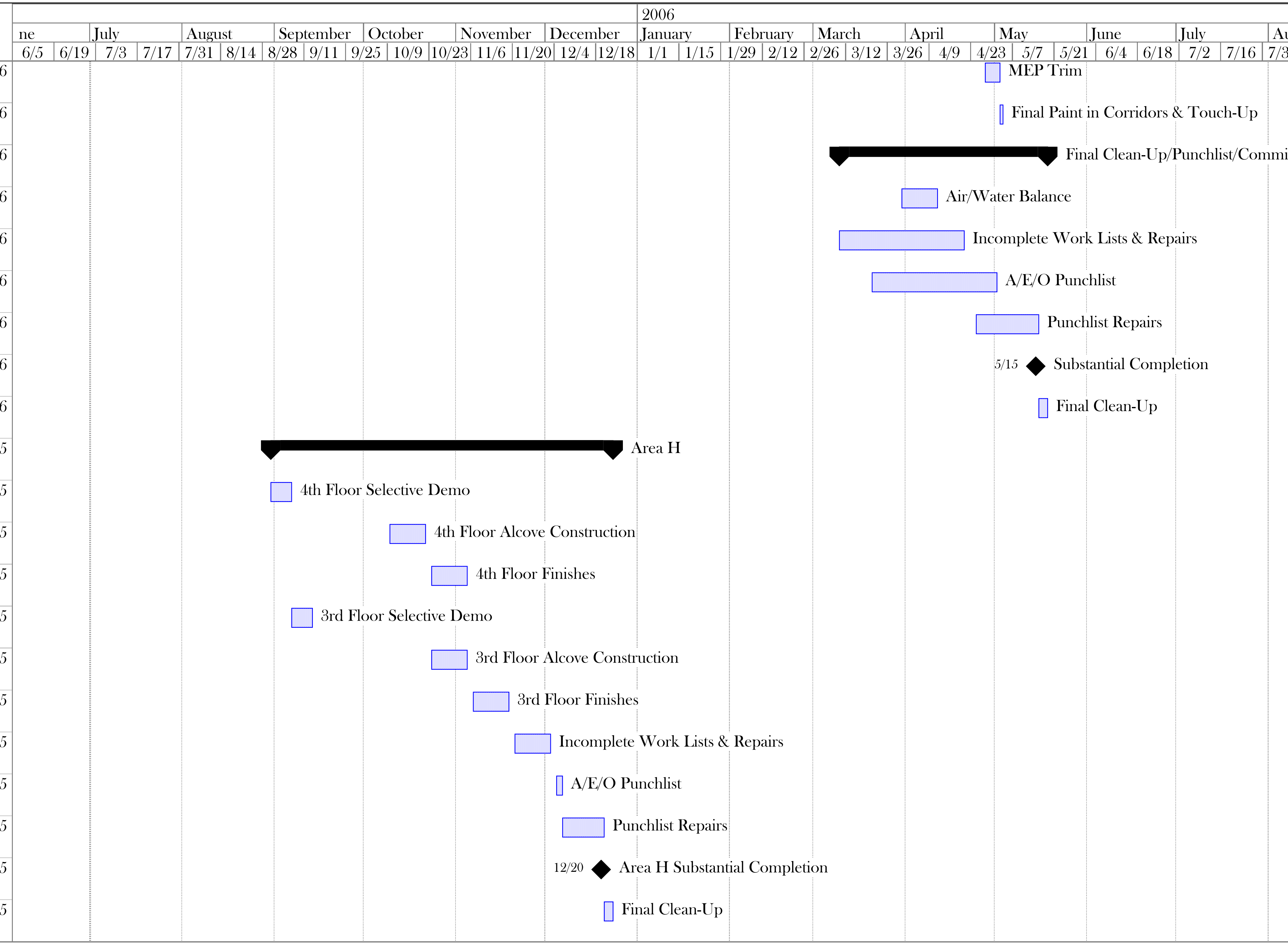


ID	Task Name	Duration	Start	Finish
129	Above Ceiling Piping (Pressure)	8 days	12/21/05	12/30/05
130	Above Ceiling Electrical & Pull Wire	11 days	12/29/05	1/12/06
131	Fire Protection	5 days	1/5/06	1/11/06
132	Set Door Frames	3 days	1/12/06	1/16/06
133	Partition Framing	5 days	1/17/06	1/23/06
134	In-Wall MEP	5 days	1/24/06	1/30/06
135	Mechanical & Plumbing Insulation	8 days	2/3/06	2/14/06
136	Frame Bulkheads & Drywall Ceilings	5 days	2/15/06	2/21/06
137	Hang One Side Drywall	3 days	1/31/06	2/2/06
138	Wall Close-in Inspections	2 days	2/3/06	2/6/06
139	Second Side Drywall & Tape/Finish	10 days	2/13/06	2/24/06
	1st Floor Interior Finishes	56 days	2/27/06	5/15/06
140	Prime Paint/1st Coat	3 days	2/27/06	3/1/06
141	Ceiling Grid	3 days	3/2/06	3/6/06
142	Light Fixtures	5 days	3/7/06	3/13/06
143	Registers, Grilles, & Diffusers	5 days	3/14/06	3/20/06
144	Sprinkler Drops/Heads	3 days	3/14/06	3/16/06
145	Above Ceiling Inspection	1 day	3/21/06	3/21/06
146	Ceiling Close-In	3 days	3/22/06	3/24/06
147	Flooring	12 days	3/28/06	4/12/06
148	Millwork	3 days	4/13/06	4/17/06
149	Plumbing Fixtures	3 days	4/18/06	4/20/06
150	Doors & Hardware	6 days	4/21/06	4/28/06
151	Final Paint	3 days	5/1/06	5/3/06
152	Architectural Trim	3 days	5/4/06	5/8/06
153	MEP Trim	5 days	5/4/06	5/10/06
154	Final Paint in Corridors & Touch-Up	3 days	5/11/06	5/15/06
	Basement Interior Rough-In	86 days	11/17/05	3/16/06

ID	Task Name	Duration	Start	Finish
155	Partition Layout	5 days	11/17/05	11/23/05
156	Above Ceiling Plumbing (Gravity)	4 days	12/15/05	12/20/05
157	Above Ceiling HVAC	5 days	12/21/05	12/27/05
158	Above Ceiling Piping (Pressure)	5 days	1/2/06	1/6/06
159	Above Ceiling Electrical & Pull Wire	8 days	1/13/06	1/24/06
160	Fire Protection	5 days	1/25/06	1/31/06
161	Set Door Frames	3 days	2/1/06	2/3/06
162	Partition Framing	5 days	2/6/06	2/10/06
163	In-Wall MEP	3 days	2/13/06	2/15/06
164	Mechanical & Plumbing Insulation	8 days	2/16/06	2/27/06
165	Frame Bulkheads & Drywall Ceilings	5 days	2/28/06	3/6/06
166	Hang One Side Drywall	3 days	3/7/06	3/9/06
167	Wall Close-in Inspections	2 days	3/10/06	3/13/06
168	Second Side Drywall & Tape/Finish	3 days	3/14/06	3/16/06
	Basement Floor Interior Finishes	34 days	3/17/06	5/3/06
169	Prime Paint/1st Coat	2 days	3/17/06	3/20/06
170	Ceiling Grid	2 days	3/21/06	3/22/06
171	Light Fixtures	3 days	3/23/06	3/27/06
172	Registers, Grilles, & Diffusers	3 days	3/28/06	3/30/06
173	Sprinkler Drops/Heads	3 days	3/28/06	3/30/06
174	Above Ceiling Inspection	1 day	3/31/06	3/31/06
175	Ceiling Close-In	2 days	4/3/06	4/4/06
176	Flooring	3 days	4/13/06	4/17/06
177	Millwork	1 day	4/18/06	4/18/06
178	Plumbing Fixtures	2 days	4/21/06	4/24/06
179	Doors & Hardware	1 day	4/25/06	4/25/06
180	Final Paint	2 days	4/26/06	4/27/06
181	Architectural Trim	2 days	4/28/06	5/1/06



ID	Task Name	Duration	Start	Finish
182	MEP Trim	3 days	4/28/06	5/2/06
183	Final Paint in Corridors & Touch-Up	1 day	5/3/06	5/3/06
	Final Clean-Up/Punchlist/Commissioning	50 days	3/10/06	5/18/06
184	Air/Water Balance	8 days	3/31/06	4/11/06
185	Incomplete Work Lists & Repairs	30 days	3/10/06	4/20/06
186	A/E/O Punchlist	30 days	3/21/06	5/1/06
187	Punchlist Repairs	15 days	4/25/06	5/15/06
188	Substantial Completion	0 days	5/15/06	5/15/06
189	Final Clean-Up	3 days	5/16/06	5/18/06
	Area H	83 days	8/31/05	12/23/05
190	4th Floor Selective Demo	5 days	8/31/05	9/6/05
191	4th Floor Alcove Construction	10 days	10/10/05	10/21/05
192	4th Floor Finishes	10 days	10/24/05	11/4/05
193	3rd Floor Selective Demo	5 days	9/7/05	9/13/05
194	3rd Floor Alcove Construction	10 days	10/24/05	11/4/05
195	3rd Floor Finishes	10 days	11/7/05	11/18/05
196	Incomplete Work Lists & Repairs	10 days	11/21/05	12/2/05
197	A/E/O Punchlist	2 days	12/5/05	12/6/05
198	Punchlist Repairs	10 days	12/7/05	12/20/05
199	Area H Substantial Completion	0 days	12/20/05	12/20/05
200	Final Clean-Up	3 days	12/21/05	12/23/05



Appendix B – RAM Output

Echo of Input Data

RAM Manager v8.1
DataBase: reactions
Building Code: IBC

03/02/06 23:46:29

Layout Types:

typical
roof

Tables Selected:

Deck Table:	ramdecks
Master Steel Table:	ramaisc
Default Steel Table:	ramaisc
Alternate Steel Table:	ramaisc
Column Steel Table:	ramaisc
Reinforcement Table:	RAMASTM
Pan Form Table:	RamCECO

Story Data:

Level	Story Label	Layout Type	Height (ft)
4	roof	roof	11.000
3	3	typical	11.000
2	3	typical	11.000
1	3	typical	11.000

Composite Deck Properties:

ID	Thick in	Unit Wt pcf	f'c ksi	Stud in	Diam in	Shoring	Deck Type
1	5.00	115.00	3.00	4.00	0.75	No	USD 2" Lok-Floor

ID	Hr in	Rib Spacing in	Wr in	AcRib in	YBar in
1	2.00	12.00	6.000	12.000	1.056

Load Properties:

Surface:

ID	DL psf	Constr DL psf	LL psf	Reduction Type	Constr LL psf	Mass DL psf
Load	30.0	0.0	80.0	Reducible	0.0	0.0
roof	8.0	0.0	25.0	Reducible	0.0	0.0

Grid Systems:

System Label	Type	X Offset ft	Y Offset ft	Rotation
grid1	Orthogonal	0.000	0.000	0.00

Grids:

System: grid1

X Grids	Label	X ft	Min Y ft	Max Y ft
	1	0.0000	----	----
	2	10.0000	----	----

X Grids	Label	X	Min Y	Max Y
	3	20.0000	----	----
	4	30.0000	----	----
	5	40.0000	----	----

Y Grids	Label	Y ft	Min X ft	Max X ft
	1	0.0000	----	----
	2	10.5000	----	----
	3	21.0000	----	----
	4	31.5000	----	----
	5	42.0000	----	----

DATA FOR FLOOR TYPE: typical

Grid Systems:
grid1

Columns:

ID	X ft	Y ft	Shape	Orientation Angle	Param* ksi	Max% LLRed	Frame Type
2	0.000	31.500	W	90.00	50.0	None	Gravity
3	40.000	31.500	W	90.00	50.0	None	Gravity
4	40.000	10.500	W	90.00	50.0	None	Gravity
5	0.000	10.500	W	90.00	50.0	None	Gravity
6	20.000	0.000	W	90.00	50.0	None	Gravity
7	20.000	42.000	W	90.00	50.0	None	Gravity

* Parameter: Steel - Fy
Concrete - f'c
Other - E

Beams:

ID	Xi ft	Yi ft	Xj ft	Yj ft	Param* ksi	Max% LLRed	Type	Frame Type	User Size
1	0.000	10.500	40.000	10.500	50.0	None	Comp	Gravity	None
2	0.000	31.500	40.000	31.500	50.0	None	Comp	Gravity	None
3	0.000	0.000	0.000	42.000	50.0	None	Comp	Gravity	None
4	40.000	0.000	40.000	42.000	50.0	None	Comp	Gravity	None
5	0.000	21.000	40.000	21.000	50.0	None	Comp	Gravity	None
6	0.000	42.000	20.000	42.000	50.0	None	Comp	Gravity	None
7	20.000	42.000	40.000	42.000	50.0	None	Comp	Gravity	None
8	20.000	0.000	40.000	0.000	50.0	None	Comp	Gravity	None
9	0.000	0.000	20.000	0.000	50.0	None	Comp	Gravity	None

* Parameter: Steel - Fy
Concrete - f'c

Other - E

Steel Beam Properties:

ID	Max Depth in	Min Depth in	Min Width in	Steel Table	Defl Criteria
1	None	0.00	0.00	Def.	Def.
2	None	0.00	0.00	Def.	Def.
3	None	0.00	0.00	Def.	Def.
4	None	0.00	0.00	Def.	Def.
5	None	0.00	0.00	Def.	Def.
6	None	0.00	0.00	Def.	Def.
7	None	0.00	0.00	Def.	Def.
8	None	0.00	0.00	Def.	Def.
9	None	0.00	0.00	Def.	Def.

Slab Edges:

Xi ft	Yi ft	Xj ft	Yj ft	Edge Dist in
0.000	31.500	0.000	42.000	1.0
0.000	42.000	20.000	42.000	1.0
20.000	42.000	40.000	42.000	1.0
40.000	31.500	40.000	42.000	1.0
40.000	10.500	40.000	31.500	1.0
40.000	0.000	40.000	10.500	1.0
20.000	0.000	40.000	0.000	1.0
0.000	0.000	20.000	0.000	1.0
0.000	0.000	0.000	10.500	1.0
0.000	10.500	0.000	31.500	1.0

Deck Polygons:

Deck Prop ID	Angle	X-Coord ft	Y-Coord ft
1	90.00	-5.00	47.00
		45.00	47.00
		45.00	-5.00
		-5.00	-5.00
		-5.00	47.00

Load Polygons:

Load Properties ID	X-Coord ft	Y-Coord ft
Load	-5.00	47.00
	45.00	47.00
	45.00	-5.00
	-5.00	-5.00
	-5.00	47.00

DATA FOR FLOOR TYPE: roof

Grid Systems:
grid1

Columns:

ID	X ft	Y ft	Shape	Orientation Angle	Param* ksi	Max% LLRed	Frame Type
1	0.000	31.500	W	90.00	50.0	None	Gravity
2	40.000	31.500	W	90.00	50.0	None	Gravity
3	0.000	10.500	W	90.00	50.0	None	Gravity
4	40.000	10.500	W	90.00	50.0	None	Gravity
5	20.000	0.000	W	90.00	50.0	None	Gravity
6	20.000	42.000	W	90.00	50.0	None	Gravity

* Parameter: Steel - Fy
Concrete - f'c
Other - E

Beams:

ID	Xi ft	Yi ft	Xj ft	Yj ft	Param* ksi	Max% LLRed	Type	Frame Type	User Size
1	0.000	31.500	40.000	31.500	50.0	None	Comp	Gravity	None
2	0.000	10.500	40.000	10.500	50.0	None	Comp	Gravity	None
3	40.000	0.000	40.000	42.000	50.0	None	Comp	Gravity	None
4	0.000	0.000	0.000	42.000	50.0	None	Comp	Gravity	None
5	0.000	21.000	40.000	21.000	50.0	None	Comp	Gravity	None
6	20.000	42.000	40.000	42.000	50.0	None	Comp	Gravity	None
7	0.000	42.000	20.000	42.000	50.0	None	Comp	Gravity	None
8	20.000	0.000	40.000	0.000	50.0	None	Comp	Gravity	None
9	0.000	0.000	20.000	0.000	50.0	None	Comp	Gravity	None

* Parameter: Steel - Fy
Concrete - f'c
Other - E

Steel Beam Properties:

ID	Max Depth in	Min Depth in	Min Width in	Steel Table	Defl Criteria
1	None	0.00	0.00	Def.	Def.
2	None	0.00	0.00	Def.	Def.
3	None	0.00	0.00	Def.	Def.
4	None	0.00	0.00	Def.	Def.
5	None	0.00	0.00	Def.	Def.
6	None	0.00	0.00	Def.	Def.

ID	Max	Min	Min	Steel	Defl
7	None	0.00	0.00	Def.	Def.
8	None	0.00	0.00	Def.	Def.
9	None	0.00	0.00	Def.	Def.

Slab Edges:

Xi ft	Yi ft	Xj ft	Yj ft	Edge Dist in
0.000	31.500	0.000	42.000	1.0
0.000	42.000	20.000	42.000	1.0
20.000	42.000	40.000	42.000	1.0
40.000	31.500	40.000	42.000	1.0
40.000	10.500	40.000	31.500	1.0
40.000	0.000	40.000	10.500	1.0
20.000	0.000	40.000	0.000	1.0
0.000	0.000	20.000	0.000	1.0
0.000	0.000	0.000	10.500	1.0
0.000	10.500	0.000	31.500	1.0

Deck Polygons:

Deck Prop ID	Angle	X-Coord ft	Y-Coord ft
1	90.00	-5.00	47.00
		45.00	47.00
		45.00	-5.00
		-5.00	-5.00
		-5.00	47.00

Load Polygons:

Load Properties ID	X-Coord ft	Y-Coord ft
roof	-5.00	47.00
	45.00	47.00
	45.00	-5.00
	-5.00	-5.00
	-5.00	47.00
roof	-5.00	47.00
	45.00	47.00
	45.00	-5.00
	-5.00	-5.00
	-5.00	47.00

Beam Summary

RAM Steel v10.0
DataBase: FMH
Building Code: IBC

04/02/06 16:59:39
Steel Code: AISC LRFD

STEEL BEAM DESIGN SUMMARY:

Floor Type: roof

Bm #	Length ft	+Mu kip-ft	-Mu kip-ft	Mn kip-ft	Fy ksi	Beam Size	Studs
8	20.00	14.2	0.0	68.6	50.0	W8X10	7
3	10.50	0.0	-31.8				
	21.00	48.7	-31.8	169.1	50.0	W12X19	10
	10.50	0.0	-31.8				
2	40.00	87.5	0.0	140.1	50.0	W10X12	18
5	40.00	87.5	0.0	140.1	50.0	W10X12	18
1	40.00	87.5	0.0	140.1	50.0	W10X12	18
6	20.00	14.2	0.0	68.6	50.0	W8X10	7
9	20.00	14.2	0.0	68.6	50.0	W8X10	7
7	20.00	14.2	0.0	68.6	50.0	W8X10	7
4	10.50	0.0	-31.8				
	21.00	48.7	-31.8	169.1	50.0	W12X19	10
	10.50	0.0	-31.8				

Floor Type: typical

Bm #	Length ft	+Mu kip-ft	-Mu kip-ft	Mn kip-ft	Fy ksi	Beam Size	Studs
8	20.00	45.7	0.0	68.6	50.0	W8X10	7
3	10.50	0.0	-100.3				
	21.00	159.9	-100.3	349.4	50.0	W16X31	17
	10.50	0.0	-100.3				
2	40.00	288.2	0.0	351.9	50.0	W16X26	28
5	40.00	288.2	0.0	351.9	50.0	W16X26	28
1	40.00	288.2	0.0	351.9	50.0	W16X26	28
6	20.00	45.7	0.0	68.6	50.0	W8X10	7
9	20.00	45.7	0.0	68.6	50.0	W8X10	7
7	20.00	45.7	0.0	68.6	50.0	W8X10	7
4	10.50	0.0	-100.3				
	21.00	159.9	-100.3	349.4	50.0	W16X31	17
	10.50	0.0	-100.3				

* after Size denotes beam failed stress/capacity criteria.
# after Size denotes beam failed deflection criteria.
u after Size denotes this size has been assigned by the User.

Beam Deflection Summary

RAM Steel v8.1
DataBase: reactions
Building Code: IBC

03/02/06 23:26:32
Steel Code: AISC LRFD

STEEL BEAM DEFLECTION SUMMARY:

Floor Type: typical

Composite / Unshored

Bm #	Beam Size	Initial in	PostLive in	PostTotal in	NetTotal in	Camber in
9	W8X10	0.041	0.403	0.554	0.595	
3		0.018	0.633	0.734	0.753	
	W16X31	0.004	0.237	0.258	0.263	
		0.018	0.633	0.734	0.753	
1	W16X26	0.172	1.201	1.788	1.961	
5	W16X26	0.172	1.201	1.788	1.961	
2	W16X26	0.172	1.201	1.788	1.961	
6	W8X10	0.041	0.403	0.554	0.595	
8	W8X10	0.041	0.403	0.554	0.595	
7	W8X10	0.041	0.403	0.554	0.595	
4		0.018	0.633	0.734	0.753	
	W16X31	0.004	0.237	0.258	0.263	
		0.018	0.633	0.734	0.753	

Floor Type: roof

Composite / Unshored

Bm #	Beam Size	Initial in	PostLive in	PostTotal in	NetTotal in	Camber in
9	W8X10	0.041	0.124	0.164	0.204	
4		0.070	0.483	0.557	0.627	
	W12X19	0.010	0.164	0.177	0.168	
		0.070	0.483	0.557	0.627	
2	W10X12	0.445	1.073	1.520	1.965	
5	W10X12	0.445	1.073	1.520	1.965	
1	W10X12	0.445	1.073	1.520	1.965	
7	W8X10	0.041	0.124	0.164	0.204	
8	W8X10	0.041	0.124	0.164	0.204	
6	W8X10	0.041	0.124	0.164	0.204	
3		0.070	0.483	0.557	0.627	
	W12X19	0.010	0.164	0.177	0.168	
		0.070	0.483	0.557	0.627	

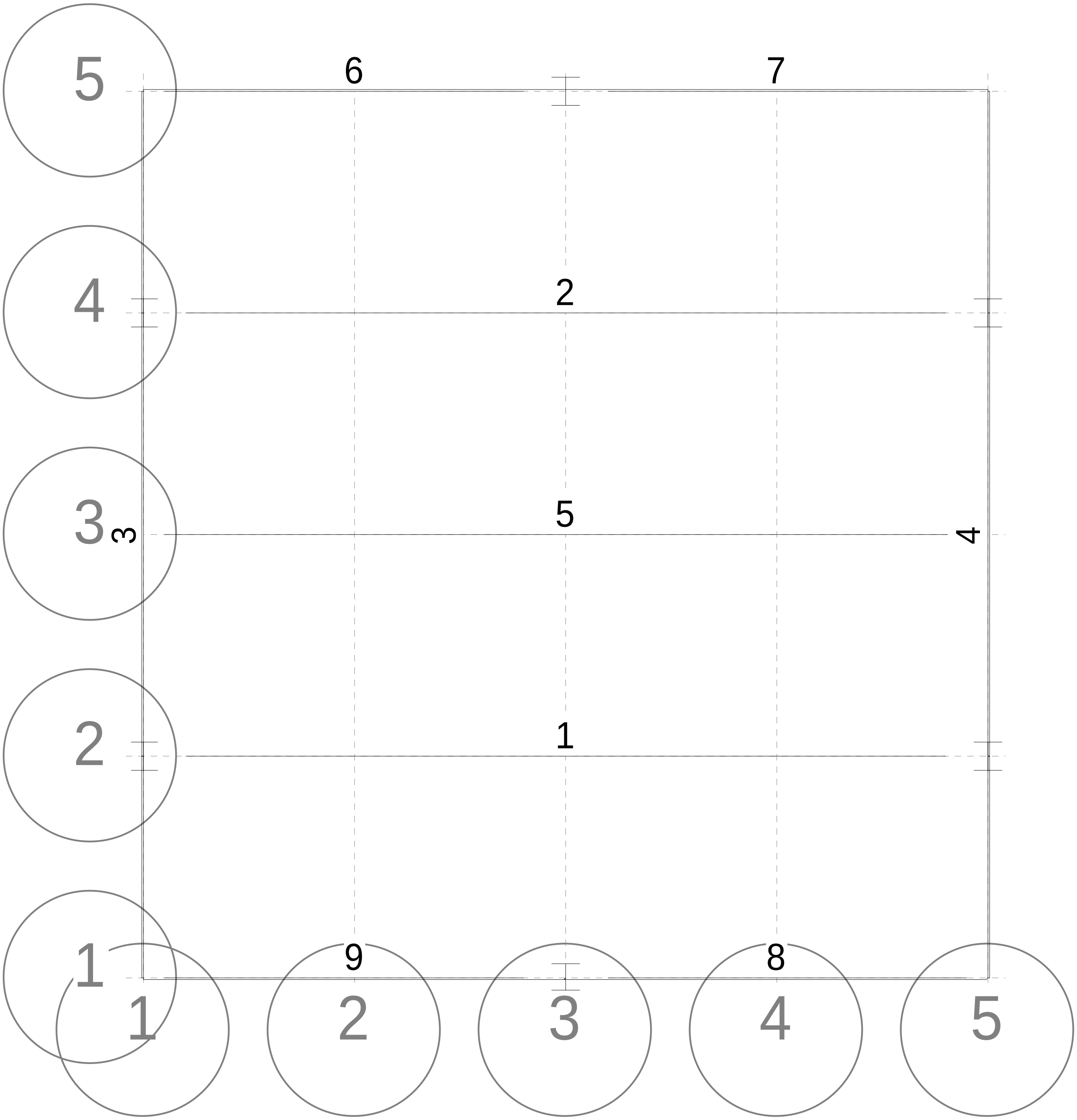
Percent of Dead Load Used for Camber Calculation = 80.00%
(Constr Dead Load for Unshored)
Camber Increment (in) = 0.250
Minimum Camber (in) = 0.750

Floor Map

RAM Steel v8.1
DataBase: reactions
Building Code: IBC

03/02/06 23:26:32

Floor Type: typical

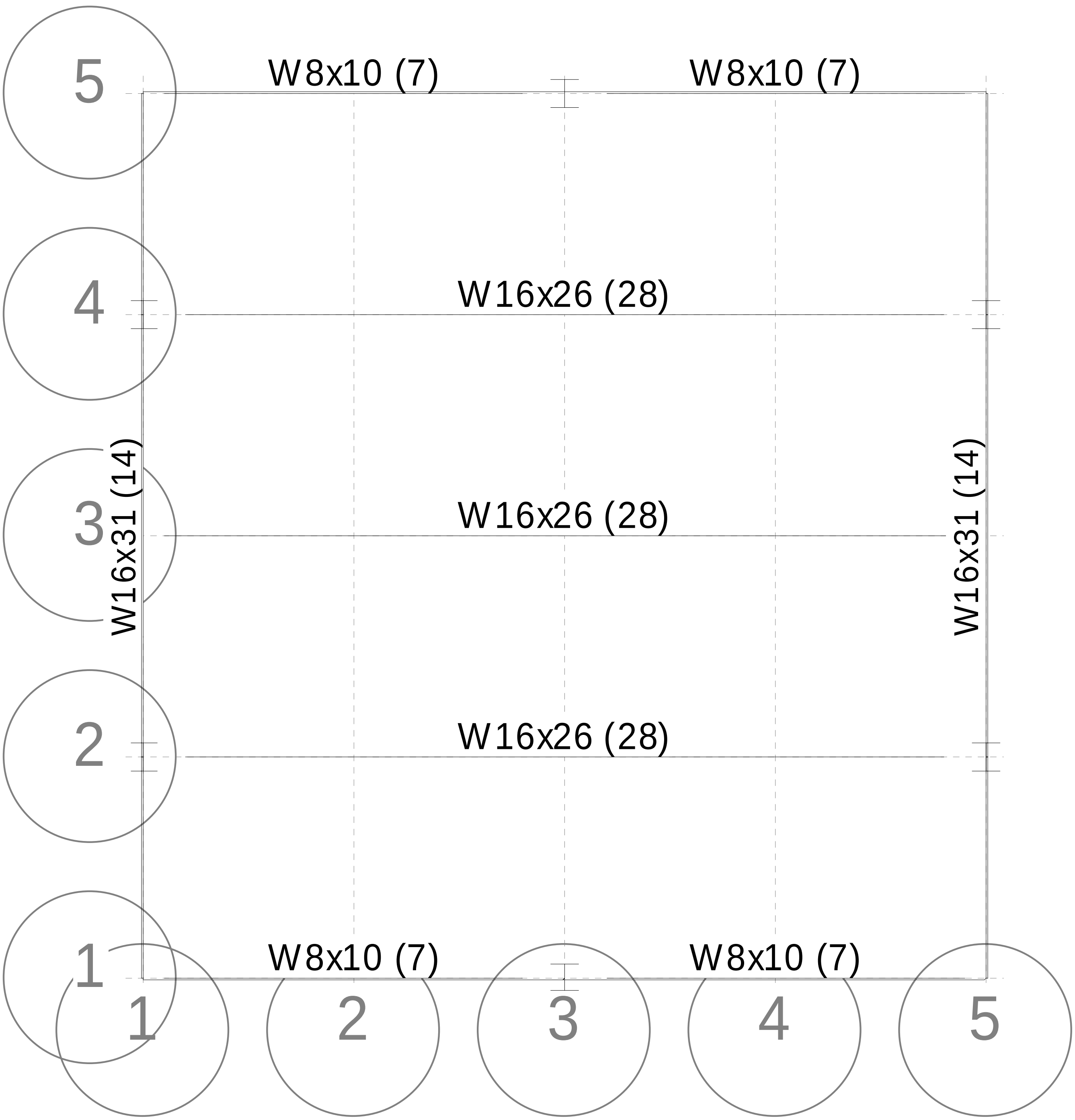


Floor Map

RAM Steel v8.1
DataBase: reactions
Building Code: IBC

03/02/06 23:26:32

Floor Type: typical

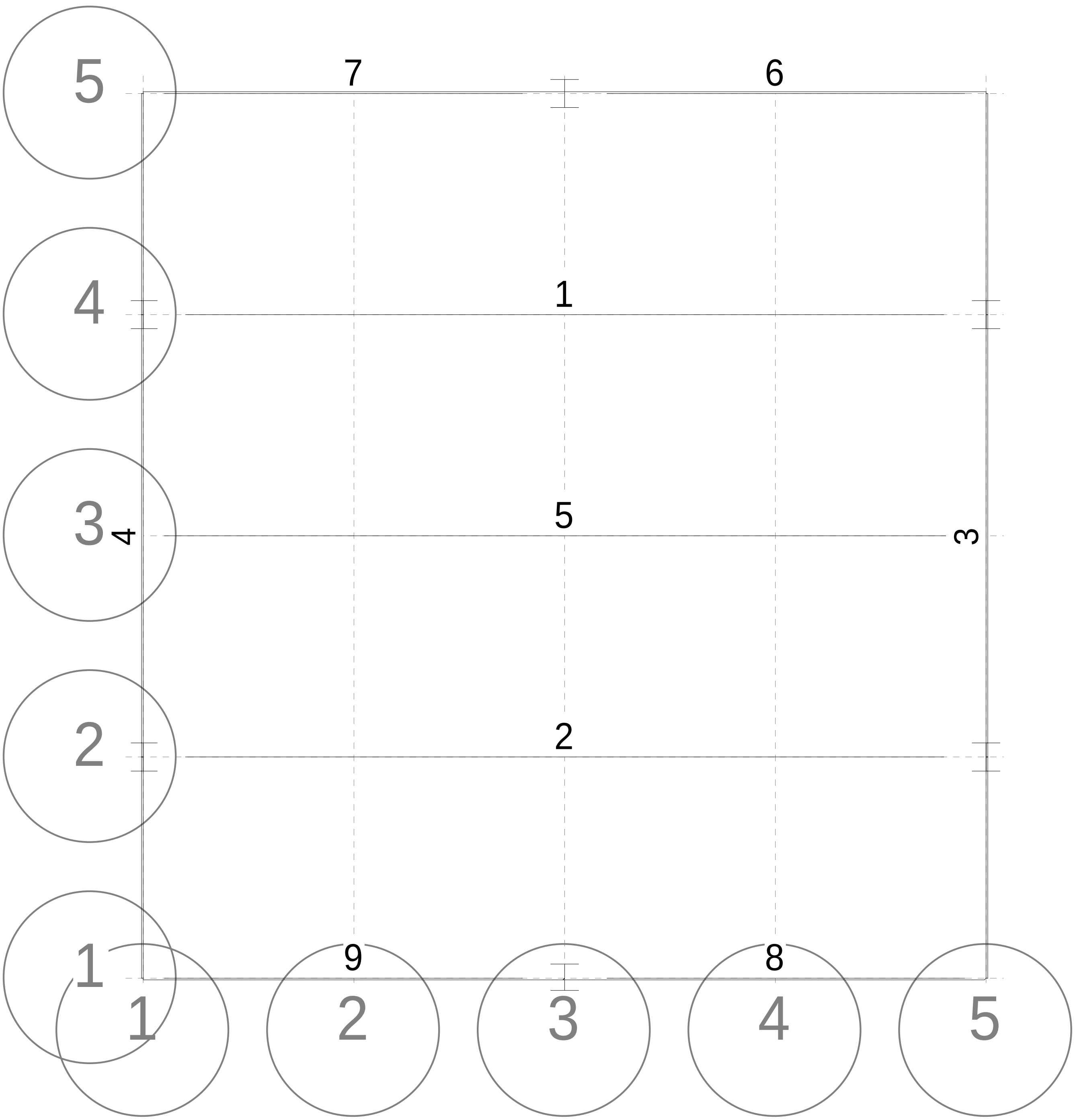


Floor Map

RAM Steel v8.1
DataBase: reactions
Building Code: IBC

03/02/06 23:26:32

Floor Type: roof

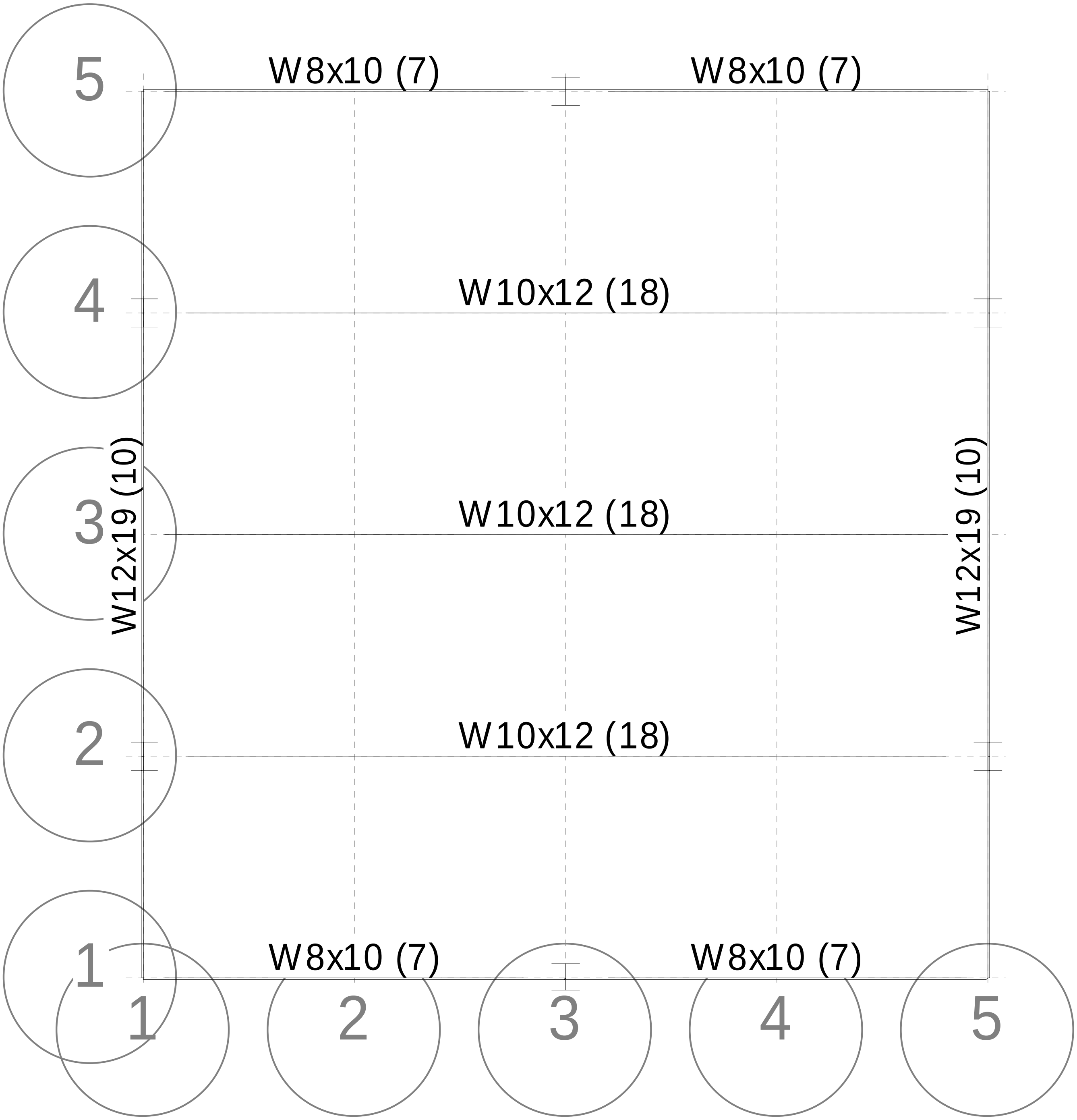


Floor Map

RAM Steel v8.1
DataBase: reactions
Building Code: IBC

03/02/06 23:26:32

Floor Type: roof



Gravity Column Design Summary

RAM Steel v8.1
DataBase: reactions
Building Code: IBC

03/02/06 23:40:54
Steel Code: AISC LRFD

Column Line 1 - 2

Level	Pu	Mux	Muy	LC	Interaction Eq.	Angle	Fy	Size
roof	16.0	0.0	0.0	1	0.05 Eq H1-1b	90.0	50	W10X33
3	58.5	0.0	0.0	1	0.20 Eq H1-1b	90.0	50	W10X33
3	96.1	0.0	0.0	1	0.33 Eq H1-1a	90.0	50	W10X33
3	131.7	0.0	0.0	1	0.45 Eq H1-1a	90.0	50	W10X33

Column Line 1 - 4

Level	Pu	Mux	Muy	LC	Interaction Eq.	Angle	Fy	Size
roof	16.0	0.0	0.0	1	0.05 Eq H1-1b	90.0	50	W10X33
3	58.5	0.0	0.0	1	0.20 Eq H1-1b	90.0	50	W10X33
3	96.1	0.0	0.0	1	0.33 Eq H1-1a	90.0	50	W10X33
3	131.7	0.0	0.0	1	0.45 Eq H1-1a	90.0	50	W10X33

Column Line 3 - 1

Level	Pu	Mux	Muy	LC	Interaction Eq.	Angle	Fy	Size
roof	5.8	0.0	1.8	2	0.04 Eq H1-1b	90.0	50	W10X33
3	19.9	0.0	0.0	1	0.07 Eq H1-1b	90.0	50	W10X33
3	31.8	0.0	0.0	1	0.11 Eq H1-1b	90.0	50	W10X33
3	43.0	0.0	0.0	1	0.15 Eq H1-1b	90.0	50	W10X33

Column Line 3 - 5

Level	Pu	Mux	Muy	LC	Interaction Eq.	Angle	Fy	Size
roof	5.8	0.0	1.8	2	0.04 Eq H1-1b	90.0	50	W10X33
3	19.9	0.0	0.0	1	0.07 Eq H1-1b	90.0	50	W10X33
3	31.8	0.0	0.0	1	0.11 Eq H1-1b	90.0	50	W10X33
3	43.0	0.0	0.0	1	0.15 Eq H1-1b	90.0	50	W10X33

Column Line 5 - 2

Level	Pu	Mux	Muy	LC	Interaction Eq.	Angle	Fy	Size
roof	16.0	0.0	0.0	1	0.05 Eq H1-1b	90.0	50	W10X33
3	58.5	0.0	0.0	1	0.20 Eq H1-1b	90.0	50	W10X33
3	96.1	0.0	0.0	1	0.33 Eq H1-1a	90.0	50	W10X33
3	131.7	0.0	0.0	1	0.45 Eq H1-1a	90.0	50	W10X33

Column Line 5 - 4

Level	Pu	Mux	Muy	LC	Interaction Eq.	Angle	Fy	Size
roof	16.0	0.0	0.0	1	0.05 Eq H1-1b	90.0	50	W10X33
3	58.5	0.0	0.0	1	0.20 Eq H1-1b	90.0	50	W10X33
3	96.1	0.0	0.0	1	0.33 Eq H1-1a	90.0	50	W10X33
3	131.7	0.0	0.0	1	0.45 Eq H1-1a	90.0	50	W10X33

Spread Footing Design Summary

RAM Foundation v8.1
DataBase: reactions

Design Code: ACI318-95

Grid	Orientation Col/Foot	Dimensions (ft) Length	Width	Thick	f'c/fy ksi	Bottom Reinforcement Parallel to Length	Parallel to Width	Top Reinforcement Parallel to Length	Parallel to Width
(1 - 2)	90.00/90.00	5.00	5.00	1.50	3.00/60.00	10-#4	10-#4	None	None
(1 - 4)	90.00/90.00	5.00	5.00	1.50	3.00/60.00	10-#4	10-#4	None	None
(3 - 1)	90.00/90.00	3.00	3.00	1.50	3.00/60.00	6-#4	6-#4	None	None
(3 - 5)	90.00/90.00	3.00	3.00	1.50	3.00/60.00	6-#4	6-#4	None	None
(5 - 2)	90.00/90.00	5.00	5.00	1.50	3.00/60.00	10-#4	10-#4	None	None
(5 - 4)	90.00/90.00	5.00	5.00	1.50	3.00/60.00	10-#4	10-#4	None	None

* - Number between () in reinforcement is quantity of bars in center strip of rectangular footing

Appendix C – General Conditions Estimate

Item	Unit Cost/Hr	Time (Hrs)	Cost
Project Manager	$52	1852	$96,304
Project Engineer	$36	2046	$73,656
Superintendent	$65	2210	$143,650
MEP Coordinator	$89	330	$29,370
Office Manager	$21	1780	$37,380
Safety Director	$50	62	$3,100
	Unit Cost/Wk	Time (Wks)	Cost
Trailer Setup	$3,000	LS	$3,000
Trailer Rental	$175	44	$7,700
Final Clean-Up	$225	44	$9,900
Rubbish Removal	$450	44	$19,800
Temporary Fence	$175	44	$7,700
Job Signs	$3,000	LS	$3,000
Telephone	$90	44	$3,960
Office Supplies	$250	44	$11,000
Safety Supplies	$4,000	LS	$4,000
Bond Premiums	$26,000	LS	$26,000
Liability Insurance	$17,500	LS	$17,500
Computers	$10,500	LS	$10,500
Hoist Set-Up	$10,000	LS	$10,000
Hoist Rental	$500	44	$22,000
Travel Expenses	$400	44	$17,600
Temporary Utilities	$175	44	$7,700
Estimate Total			$564,820

- Cost per week - $12,837

Appendix D – MC² Estimate Summary

Estimate Detail - Frederick Memorial Hospital Courtyard Infill Structure

Detail - Without Taxes and Insurance

Estimator : Abe Vogel
Project Size : sqft

ItemCode	Description	Quantity	UM	Lab.Unit	Mat.Unit	Eqp.Unit	Sub.Unit	Eqp.Rent.Unit	Temp.Mat.Unit	Other Unit	Tot.UnitCost	TotalCost
03111.800		656.00	EACH									
03150.650	SCREEDS FOR SLAB	806.40	LNFT	0.9219	0.320						1.242	1,001.47
03210.210	COLUMN FOOTING REBAR	4.14	CWT	31.7857	26.750						58.536	242.43
03220.010	6x6 W1.4/W1.4 MESH	73.92	SQS	18.8640	8.200						27.064	2,000.57
03310.200	**CONC IN COLUMN FOOTING**		****									
03310.203	3000 PSI W/CART	8.33	CUYD	13.1475	55.000						68.148	567.90
03315.972	* NO. OF COLUMN FOOTINGS *	6.00	EACH									
03311.700	**CONC IN SLAB OVER MTL DECK**		****									
03311.706	3000 PSI W/PUMP	82.96	CUYD	12.5997	55.000	5.280					72.880	6,046.32
03315.991	* SLAB OVER METAL DECK AREA *	6,720.00	SQFT									
03350.130	MACHINE TROWEL FINISH	6,720.00	SQFT	0.3304							0.330	2,220.29
03390.010	PROTECT & CURE	6,720.00	SQFT	0.1102	0.019						0.129	869.57
05129.404	SHEAR STUD, 3/4"	522.00	EACH	0.5434	0.717	0.300					1.560	814.42
05129.101	STEEL BEAMS		****									
05129.102	I BEAMS	140.00	CWT	28.7300	35.000	5.000					68.730	9,622.20
05129.121	STEEL COLUMNS		****									
05129.122	I SHAPES	87.12	CWT	28.7300	35.000	5.000					68.730	5,987.76
05129.141	GIRDERS		****									
05129.142	I BEAMS	94.08	CWT	28.7300	35.000	5.000					68.730	6,466.12
05129.990	* STRUCTURAL STEEL WEIGHT *	16.06	TONS									
05310.018	2" METAL DECK	6,720.00	SQFT	0.4445	0.870						1.315	8,836.13
07810.031	CEMENTITIOUS FIREPROOFING	2,606.02	BDFT	44.8066	0.448	0.080					45.335	118,142.87
	Total Estimate											$162,818

Estimate Detail - Production - Frederick Memorial Hospital Courtyard Infill Structure

Detail - Without Taxes and Insurance

Estimator : Abe Vogel
Project Size : sqft

ItemCode	Description	Quantity	UM	Crew	Production	Prod.UM	Lab.Unit	Mat.Unit	Eqp.Unit	Sub.Unit	Eqp.Rent.Unit	Temp.Mat.Unit	Other Unit	Tot.UnitCost	TotalCost
03111.800		656.00	EACH												
03150.650	SCREEDS FOR SLAB	806.40	LNFT	C311	1,250.00	DAY	0.9219	0.320						1.242	1,001.47
03210.210	COLUMN FOOTING REBAR	4.14	CWT	C321	56.00	DAY	31.7857	26.750						58.536	242.43
03220.010	6x6 W1.4/W1.4 MESH	73.92	SQS	C320	70.00	DAY	18.8640	8.200						27.064	2,000.57
03310.200	**CONC IN COLUMN FOOTING**		****												
03310.203	3000 PSI W/CART	8.33	CUYD	C220	115.00	DAY	13.1475	55.000						68.148	567.90
03315.972	* NO. OF COLUMN FOOTINGS *	6.00	EACH												
03311.700	**CONC IN SLAB OVER MTL DECK**		****												
03311.706	3000 PSI W/PUMP	82.96	CUYD	C235	120.00	DAY	12.5997	55.000	5.280					72.880	6,046.32
03315.991	* SLAB OVER METAL DECK AREA *	6,720.00	SQFT												
03350.130	MACHINE TROWEL FINISH	6,720.00	SQFT	C276	2,500.00	DAY	0.3304							0.330	2,220.29
03390.010	PROTECT & CURE	6,720.00	SQFT	C276	7,500.00	DAY	0.1102	0.019						0.129	869.57
05129.404	SHEAR STUD, 3/4"	522.00	EACH	C509	1,400.00	DAY	0.5434	0.717	0.300					1.560	814.42
05129.101	STEEL BEAMS		****												
05129.102	I BEAMS	140.00	CWT	C510	80.00	DAY	28.7300	35.000	5.000					68.730	9,622.20
05129.121	STEEL COLUMNS		****												
05129.122	I SHAPES	87.12	CWT	C510	80.00	DAY	28.7300	35.000	5.000					68.730	5,987.76
05129.141	GIRDERS		****												
05129.142	I BEAMS	94.08	CWT	C510	80.00	DAY	28.7300	35.000	5.000					68.730	6,466.12
05129.990	* STRUCTURAL STEEL WEIGHT *	16.06	TONS												
05310.018	2" METAL DECK	6,720.00	SQFT	C510	5,170.00	DAY	0.4445	0.870						1.315	8,836.13
07810.031	CEMENTITIOUS FIREPROOFING	2,606.02	BDFT	C207	36.13	DAY	44.8066	0.448	0.080					45.335	118,142.87
	Total Estimate														$162,818