Thesis Proposal

Marriott Hotel at Penn Square and
Lancaster County Convention Center

Trevor J. Sullivan

Construction Management
AE Faculty Consultant: Dr. Horman

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Executive Summary

The following proposal outlines issues and changes that will be analyzed to add value, decrease schedule and cost to the project. Three technical issues will be analyzed and one industry issue will be researched and applied towards the Marriott Hotel and Convention Center Project. All of the following issues will be addressing construction difficulties that arose in the lower levels of the project, in particularly the convention entry level of the project. These technical and industry issues include:

Breadth #1 - Structural Redesign

The structural system of the convention entry level will be redesigned from a cast in place concrete structure to a steel structure. The steel structure will allow for the super structure to be erected prior to all underground and unforeseen issues being complete in the museum and convention entry levels.

Breadth #2 - Mechanical Redesign

The ceiling will be redesigned from a hard ceiling to a balloon type ceiling. This redesign will yield a savings in smoke evacuation ductwork by utilizing the plenum space as means of smoke evacuation. The proposed change will also provide a savings in material costs, design costs and time, and schedule. Additionally, in switching from a concrete structure to steel structure the required ductwork will be evaluated for the potential in having the entire ductwork run through the joist openings and thus not losing floor to ceiling height.

Breadth #3 - Construction Sequencing

A micro-pile foundation system will be designed and evaluated as an alternative to decrease the schedule for the foundation work from the existing caisson foundation design. Additionally, the convention entry (south end of the site) will be evaluated and re-sequenced to implement all the proposed changes. With the implementation of all proposed changes the south end of the site will be a cleaner more efficient work area that will also reduce the schedule.

Research - BIM Implementation

The BIM processes that will be researched for this project will include the effectives and advantages of having a 3D electronic survey of existing conditions imported into a BIM model/3D model of the structure when an existing building is on the proposed building site. Additionally the use of BIM for the coordination of MEP systems and for the design and coordination of the structure will be evaluated for potential advantages with using BIM.

Analysis Descriptions

Introduction:

The convention entry level for The Marriott Hotel and Convention Center Project faced construction delays due to unforeseen site conditions and requirements in sequencing to place a reinforced concrete slab. The Analysis Description section of this report will focus primarily on the convention entry area of the convention center portion of the project, see figure 3 below for a visual representation of the area.

Problem Background:

- Dewatering System Redesign

During the excavation in the lowest part of the site, the museum level, a natural spring was discovered. This spring provided significantly larger water flows then what the current permanent dewatering system could handle. A delay in construction was encountered while a redesign was finalized for the dewatering system.

- Convention Entry Level

The convention entry level is the level above the museum level in the convention center. The museum level, as mentioned above, encountered unexpected delays with the discovery of a natural spring. The museum level also encountered issues and delays with the unearthing of historical artifacts and structures near the Kleiss Saloon (in particular a brick floor). The delays encountered in the museum level directly affect the ability to proceed with the convention entry level, as in concrete construction the slab below needs to be complete to enable the forming of the slab above.

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Proposed Solutions:

- **Structural System**

Problem Statement:

The convention entry level is a cast in place concrete structure; can the load requirements for this area be met with a structural steel system, specifically a composite metal joist system? With a structural steel frame, what sequencing delays and how much of a delay could have been avoided due the required sequential steps in placing an elevated concrete structural slab that could was not met due to unforeseen issues in the lowest level of the building (museum level)?

Proposed Solution:

A composite metal joist framing system will be designed to support the required loads of the exhibit level without changing the current column grid, see figure 2 below for a detail of a composite joist system. The majority of the convention center is already a steel structure and in designing the convention entry to be steel, schedule reduction can be achieved. See figure 1 Convention Entry below for a picture of the convention entry level concrete with the exhibit level steel being erecting above it. A cast-in-place concrete structure mandates a specific sequence of construction activities and any delay to a part of the sequence will delay the entire process. A steel structure offers more flexibility for the sequence of construction and most importantly does no rely on the museum level or under slab work to be totally complete. As mentioned previously, the museum level faced unforeseen issues and redesign issues creating delays in the completion of the underslab and slab work. Due to these issues in the museum level the entire convention center superstructure was delayed. A steel structure would have been very beneficaial to break the schedule ties between the museum level and the rest of the superstructure and significant time could be saved and construction sequencing would greatly improve. See Appendix A for floor plans of the Museum, Convention Entry and Exhibit Levels, the elevated structural concrete is highlighted in yellow. Based off preliminary estimates, an 18” deep composite joist system will adequately support the loads of the exhibit hall. In having a 30’x30’ column grid, live load reductions can be obtained and therefore deflection will be the controlling factor in the new structural system.

Figure 1 Convention Entry

Research Steps:

1. Gather loading requirements for the floor systems in the spaces of interest.
2. Determine the best steel alternative for the space allotted (composite joists)
3. Design the steel structure to maintain the current column grid and evaluate to determine if modification to the grid would be beneficial
4. Design a complete structural system for the area
5. Calculate a detailed costs for the structural system and compare to the cast-in place concrete structure
6. Develop a schedule for the erection of the steel and compare to the schedule for concrete

Sources of Information:

1. Baker Ingram & Associates
2. Providence Engineering Corporation
3. Uzun and Case Engineers
4. 1st Ed. CJ Series Standard Specifications for Composite Joists; Weight table and bridging tables code of standard practice by SJI (Steel Joist Institute)

- **Mechanical System**

Problem Statement:

In the convention entry level can the smoke evacuation ductwork be reduced with the change in ceiling requirements? With a change in the ceiling from a hard type (total acoustic tile coverage) to a balloon system (partial coverage) can the smoke evacuation system be reduced, or eliminated? See Appendix B for a plan of the smoke evacuation system in the convention entry level.

The smoke evacuation ductwork is the largest in the convention entry area and any reduction or elimination of this ductwork would save time and money in design, coordination drawings, fabrication and installation on site. The convention entry level is not an architectural focal point in the building thus a change in the ceiling would not be a major concern to the overall esthetics of the design.

Proposed Solution:

A change in the ceiling design can yield a savings in smoke evacuation ductwork. In utilizing a balloon type ceiling system the plenum space can be used as means of smoke evacuation and provide a savings in material, design, and schedule. Additionally, in switching from a concrete structure to steel structure any required ductwork can be laid out through the joist openings and thus not increasing the plenum space, see Figure 2 below.

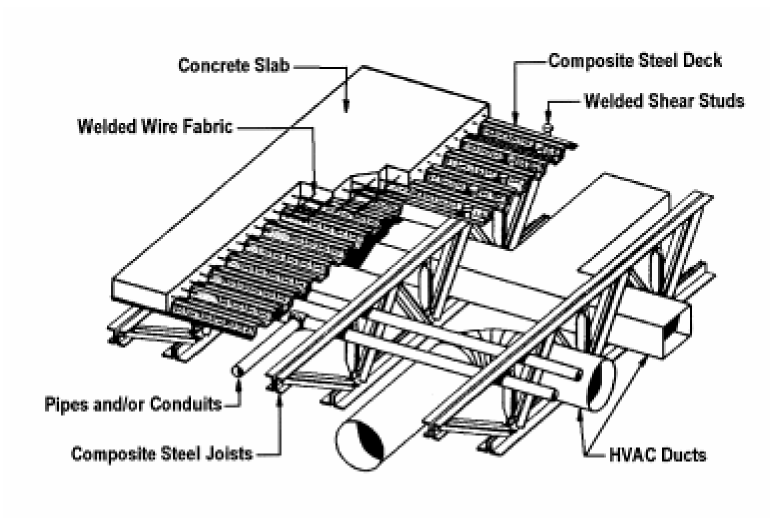

Figure 2 Joists and Mechanical Equipment Detail

Research Steps:

1. Research Marriott's standards for smoke evacuation
2. Analyze the spaces requirement for smoke evacuation
3. Research ceiling type requirements for a plenum space to be incorporated into the smoke evacuation system
4. Reevaluate the ductwork sizes and quantities for the change in plenum space
5. Propose a new ductwork layout for the area
6. Calculate the possible reduction in ductwork quantity
7. Calculate possible cost and schedule savings

Sources of Information

1. Rado Enterprises the mechanical contractor
2. Jordan and Skala Engineers the mechanical engineers
3. 1st Ed. CJ Series Standard Specifications for Composite Joists; Weight table and bridging tables code of standard practice by SJI (Steel Joist Institute)
4. Heating, Ventilating and Air Conditioning by McQuston, Parker and Spitler, 6th Ed.
5. Mechanical and Electrical Equipment for Building by Stein and Reynolds, 9th Ed.
6. Architectural Acoustics Principles and Design by Mehta, Johnson, Rocafort

- **Construction Sequencing/Planning**

Problem Statement:

In using mini-piles for the foundation system instead of caissons will there be cost savings and schedule reduction? In switching the convention entry structure to a steel frame can the construction sequence be reworked to accelerate work in this area, and what will be the schedule savings?

Proposed Solution:

Mini-piles require more holes to be drilled then caissons but the holes are much smaller and can be drilled considerably faster. The mini-piles also use less material then caissons and can provide cost savings also. The load requirements for the area can be met with a mini-pile system.

In redesigning the convention entry level to be a steel structure there will no longer be a need for shoring and reshoring in the area and the flow of materials and workers will be improved.

The steel structure can be erected in this area regardless of the unforeseen conditions in the museum level, and can be independent of the progress in that area to a certain extent. Overall, a steel structural system for the convention entry level will save time and provide a less crowded work site. See figure 3 below for an aerial view of the museum, convention entry and exhibit levels.

Research Steps:

1. Determine the load requirements for the foundations in this area
2. Calculate an equivalent micropile system to support these loads
3. Calculate the cost for the mini-pile system and compare to the caisson cost
4. Evaluate the sequence of construction activities in this area
5. Develop a new sequence of activities to include activities related around the excavation, micropile construction thru steel erection
6. Compare the cost, schedule and site access to that of the existing design.

Sources of Information:

1. Shelley Drilling for micropile and caisson information
2. Contact Walter Schneider (PSU foundation professor) about information on the design of micro-piles
3. Reynolds Construction Management for scheduling and sequencing information
4. Mechanical and Electrical Building Construction by Hettema

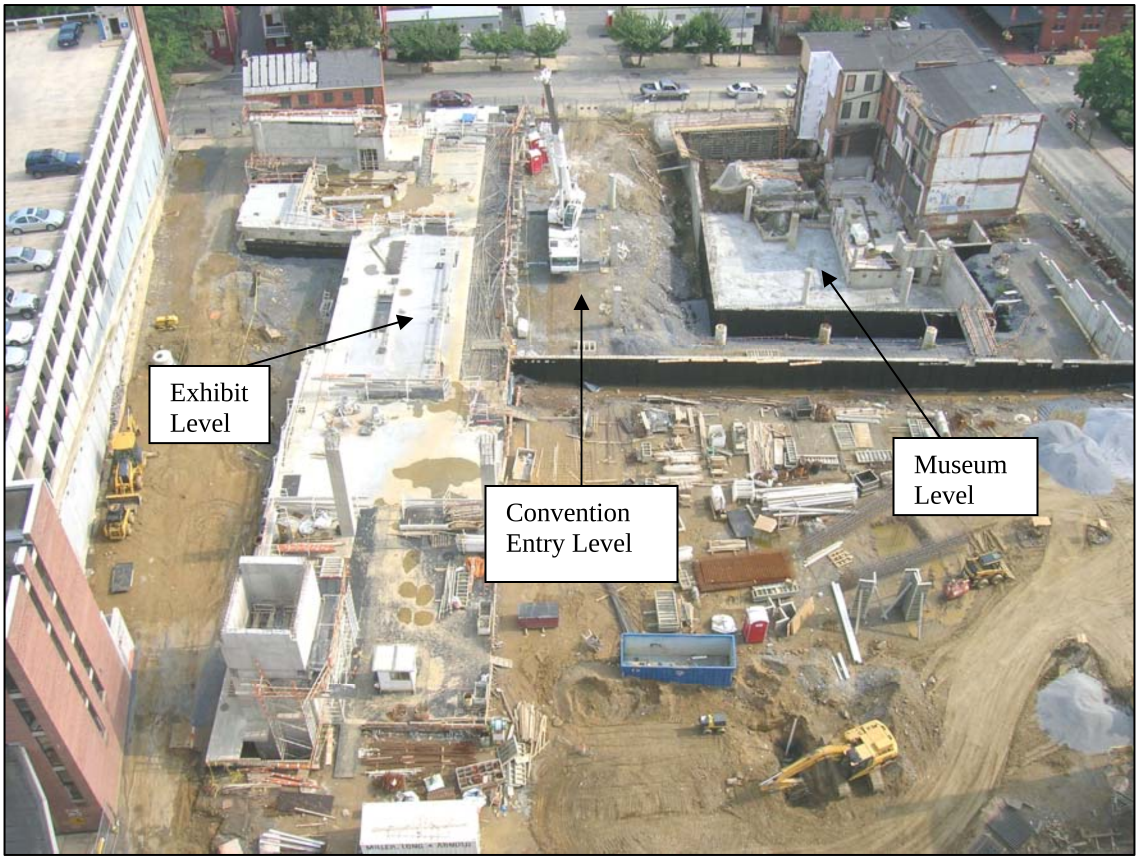

Figure 3 View from Tower Crane of Southern Half of Site

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Construction Management
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Critical Issues Research Method

Writers note: This section of the report is considered a rough draft and will be revised and resubmitted by January 17, 2008. Technical Assignment #3 feedback was received on December 15, 2007 rejecting the initial idea of researching micro-pile construction advantages, thus there was insufficient time to gather information about BIM and to formulate a new and more complete research topic at this time. Once more feedback and information is learned about BIM a more accurate and focused research method will be applied to the project and resubmitted under separate cover.

Background

By Definition:

> Building Information Modeling (BIM) is a building design and documentation methodology characterized by the creation and use of coordinated, internally consistent computable information about a building project in design and construction. – Autodesk

Building Information Modeling is a new tool to the construction industry. BIM is much more then a 3D model of the project, it is a model with scheduling, cost and specification information built into it. The information that can be contained in a BIM model can be used to save time and money on a project. A BIM model can be developed so that the information from the model can serve multiple productive purposes; the 3D model itself can be utilized for marketability for a project; the design information can be send directly to a fabricator for fabrication; MEP systems can be designed, coordinated and signed-off on in a 3D model; constructability issues can be recognized and dealt with before construction begins; maintenance data and facilities management information can be obtained in the model; along with other benefits. There is no code or requirement for a BIM model, thus every project can utilize BIM as much or as little, as the team sees fit. Currently the key uses of a BIM model in the construction industry lie with clash detection of MEP and structural systems along with estimating for the project.

As mentioned above, BIM is a tool, it is used to help involve decision making earlier on in the process requiring an integrated project delivery. BIM will only work with design-build delivery methods not design-bid-build for two main reasons. First, there are insurance liability issues in transforming 2D drawings from the architect and engineer and creating a 3D and 4D model. Secondly, with design-bid-build, it is not an integrated project delivery. Similar to obtaining early contractor input for prefabrication, early contractor input is critical to the success of using BIM as a successful tool for the project. In obtaining early contractor input and designing for BIM it changes the fee structure for the project to accommodate the higher upfront costs. It is believed in the industry that as more projects are delivered using BIM that more case studies will be available to analyze benefit in a numerical amount to justify the cost of implementing BIM.

The largest challenge preventing BIM from advancing is the implementation of the system in the industry. It is also believed that it is not the software requirements or the learning curve required for the industry to begin utilizing the tool but that the owner is simply not requiring BIM to be used on the project.

Some lessons learned about BIM is that with the proper delivery method utilized for a project and the use of BIM, prefabrication and fabrication can be done directly from BIM, coordination issues can be worked out faster and in 3D, better schedules can be created with the visualization of a 3D and 4D models, and estimates can be more accurate with the quantities calculated directly from the BIM software.

The Marriott Hotel and Convention Center could benefit from the abilities of BIM to coordinate MEP systems, prefabrication of smart walls or MEP risers, the fabrication of the steel to be done directly from the model, and the schedule better understood with the use of 3D and 4D animations. Additionally, industry members believe BIM will promote better flow of information for a project once the industry becomes more familiar with the software available to create BIM projects.

Problem Identification

Structural Redesign

The locations of the interior concrete columns were designed too close to the existing façade to allow the caisson rig to drill the caissons in the required location. A major structural redesign took place to move the concrete columns in from the façade so they would all line up on top of each other. In moving the columns through the height of the structure, it changed dimensions on almost every page of the architectural and structural drawings. A few of the conflict caissons were also redesigned into large spread footings. Significant time was spent by the architect and structural engineer to complete the required redesign.

Architectural Redesign

The neighboring office building to the north of the side was discovered to be out of square and encroach on the Hotel and Convention Centers footprint during the layout of the buildings' superstructure. Again a redesign needed to take place to move the exterior wall a few inches to avoid the conflict.

Flow of Information

For each redesign or RFI response or response to a constructability review comment, the architect issues new drawings to be rectify the issue. These new drawings are identified as bulletins, addendums, or RFI responses. With hundreds of new drawings being issued in the first few months of construction it is clear to see that there exists confusion in the field as to who is constructing off the most current set of prints. The architect and most of the engineers for the project are located in Atlanta, Georgia. The architect has experience with designing Marriotts and similar sized projects while the structural engineer specializes in post-tension high rises. Their experience and expertise is needed to design a state of the art facility though being in Georgia significant travel is required to view the site. The internet is a great tool; it enables instant transferring of electronic files, particularly pdf files of the drawings and photos of construction issues. Even with the internet and digital photos, it is always beneficial to see a project first hand. The travel required for the architect and engineers to meet on site to view an issue and hold a meeting is a significant portion of time, and cost. Even with the internet and instant access to view updated pdf files of the drawings on the computer, the contractors in the field are not receiving the drawings until the construction manager sends the documents to the printers to get printed, logs the documents for tracking and receiving purposes, and then gets them into the hands of the contractor. Significant time is spent transferring information through the proper channels to get from the engineer to the architect to the construction manager to the printers and back then to the contractors in the field. With the schedule required by the Owner for the completion of the project, the time spend relaying information from one party to another is significant.

It is not only the time lost in the issuance of new drawings, but a question of are the contractors actually reviewing the changes to the drawings and annotating their drawings and specifications to reflect the changes. The architect tries to outline the changes made to drawings, though sometimes it is not practical to do so or they may miss an outline – it still does not make it acceptable for the contractor to be constructing off old/incorrect drawings. If a small change is made to a drawing it is not practical to reissue a new full size sheet – just an 8.5x11 of the area on the drawing. Once several changes are made to a drawing the sheet becomes cluttered with reissued 8.5x11 and very difficult to read. Large sheets that are used to reflect changes are cleaner and easier to read though are much more expensive. The flow of information and the reassurance that contractors are constructing off the most current set of construction documents are critical issues for any construction project, though become immensely critical when the project requires extensive redesign work and the architect and engineer are not local.

Proposed Solution

The Marriott Hotel and Lancaster Country Convention Center project is a strong candidate for BIM requirements. The CM for the project has been involved very early on in the design phases and could contribute to/lead the process. Additionally the Architect and Engineers for the project are located in Georgia while the project is in Pennsylvania.

The BIM processes that will be researched for this project will include the effectives and advantages of having a 3D electronic survey of existing conditions imported into a BIM model/3D model of the structure and foundation design when an exitisting building is on the proposed building site. Additionally the use of BIM for the coordination of MEP systems and for the design and coordination of the structure will be evaluated for potential advantages with using BIM. Research will be completed on the comparison of the upfront cost and coordination required for a 3D electronic survey of existing conditions and the importing of the survey into a BIM model to reduce the later costs and time of redesign work for conflicts. The electronic survey information would also benefit the design of the concrete superstructure as to more accurately locate the edge of slabs and column locations against the existing façade. Additionally research will be done to provide findings on potential time and money savings by utilizing a BIM model for MEP design/coordination.

Research Steps

The following steps will be followed to complete the research for the implementation of BIM modeling on the Marriott Hotel and Lancaster County Convention Center project:

1. Further discuss and fine-tune this research topic with Dr. Messner and Dr. Riley.
2. Interview Tom Smithgall at High Associates (the developer) to see if any requirements for BIM implementation were discussed for this project.
3. Review literature about BIM and 3D electronic surveys.
4. Interview the Reynolds Construction Management to obtain data about the delays encountered on this project due to lack of known existing conditions, structural coordination and MEP coordination.
5. Interview the Structural and MEP engineers about their thoughts and experience with BIM. Obtain data about what their perceived cost would be to implement there models into a BIM system and what/if any learning curve would need to be accomplished.
6. Compile an analysis detailing the costs of and learning time required to implement a BIM system compared to the potential schedule and costs savings if had utilized a BIM model.

Concluding Remarks

This proposal outlines issues and changes that will be analyzed to add value, decrease schedule and cost to the project. The museum level of the project encountered several unforeseen conditions including a freshwater spring that created water issues and redesign issues, along with the discovery of a historic floor that is to be preserved and incorporated into the new building along with other issues. The issues encountered in the museum level directly effected the progress on the entire project due to the required sequence of activities to form and place a concrete structure. Incorporating the new structural system for the convention entry level it would mitigate the delays of the unforeseen issues in the museum level by being able to erect steel without a slab placed beneath it. The smoke evacuation system and ductwork can also be reduced in the convention entry area with a change in the ceiling type, reducing cost, time to construct and time to coordinate between other MEP trades. Additionally, micro-piles will be explored as a potential schedule reducing option to the existing foundation system of caissons. Lastly, the implementation of BIM modeling will also be researched into the effectiveness and advantages in incorporating a 3D electronic survey of existing conditions into the original design to alleviate several unknowns due to an existing building on the project site. Construction sequencing, scheduling and cost will all be analyzed for the proposed changes to quantify potential advantages in using the new systems.

Weight Matrix

Description	Research	Value Eng.	Const. Rev.	Sched. Red.	Total
Analysis 1 - Structural Redesign		5	10	15	30
Analysis 2 - Mechanical - Smoke Evacuation Redesign		10	5	5	20
Analysis 3 - Construction Sequencing	5		15	10	30
Analysis 4 - BIM Research	10		5	5	20
Total	15	15	35	35	100

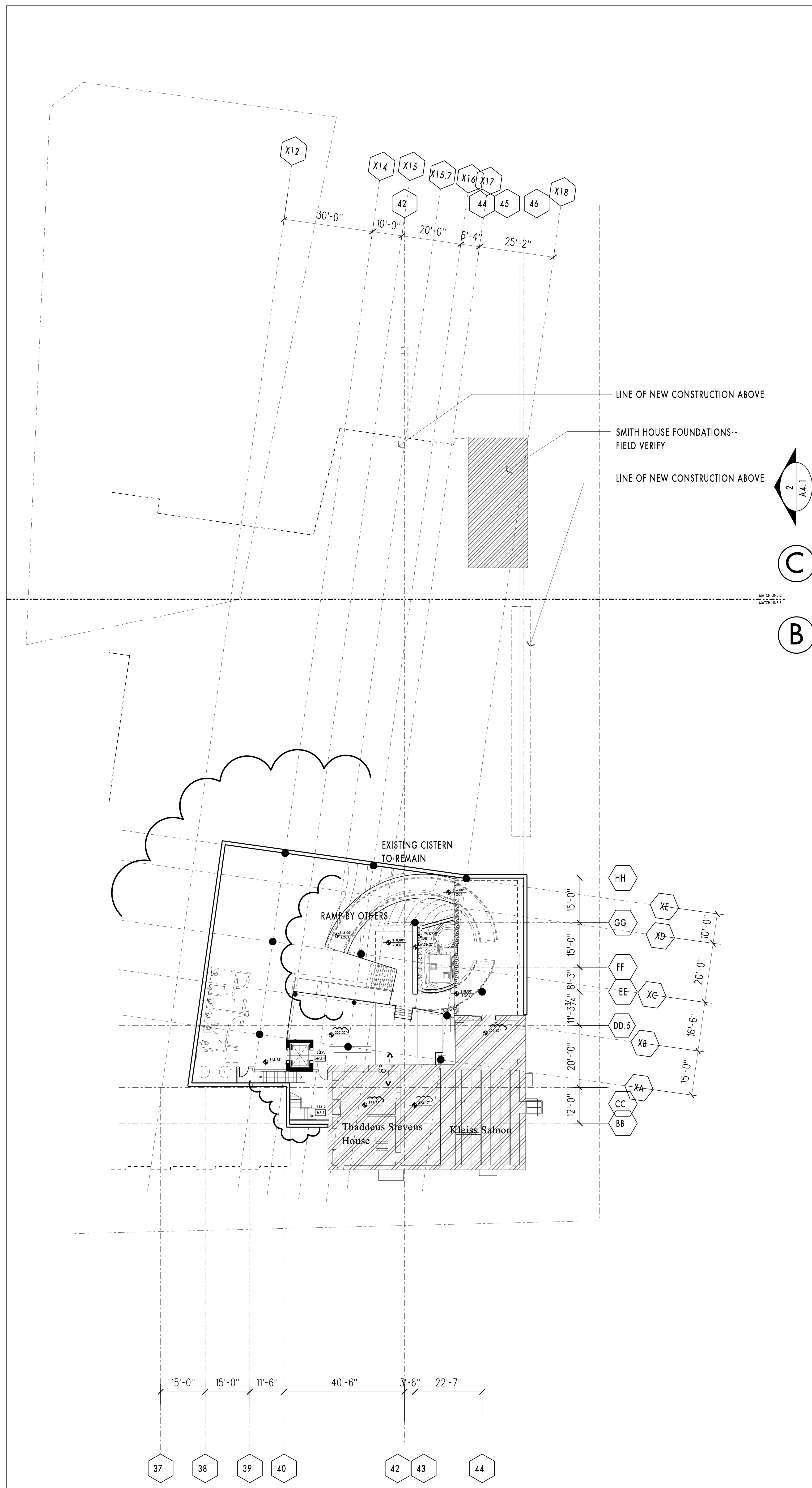
Schedule

The following schedule will be followed to complete the proposed work during the spring semester.

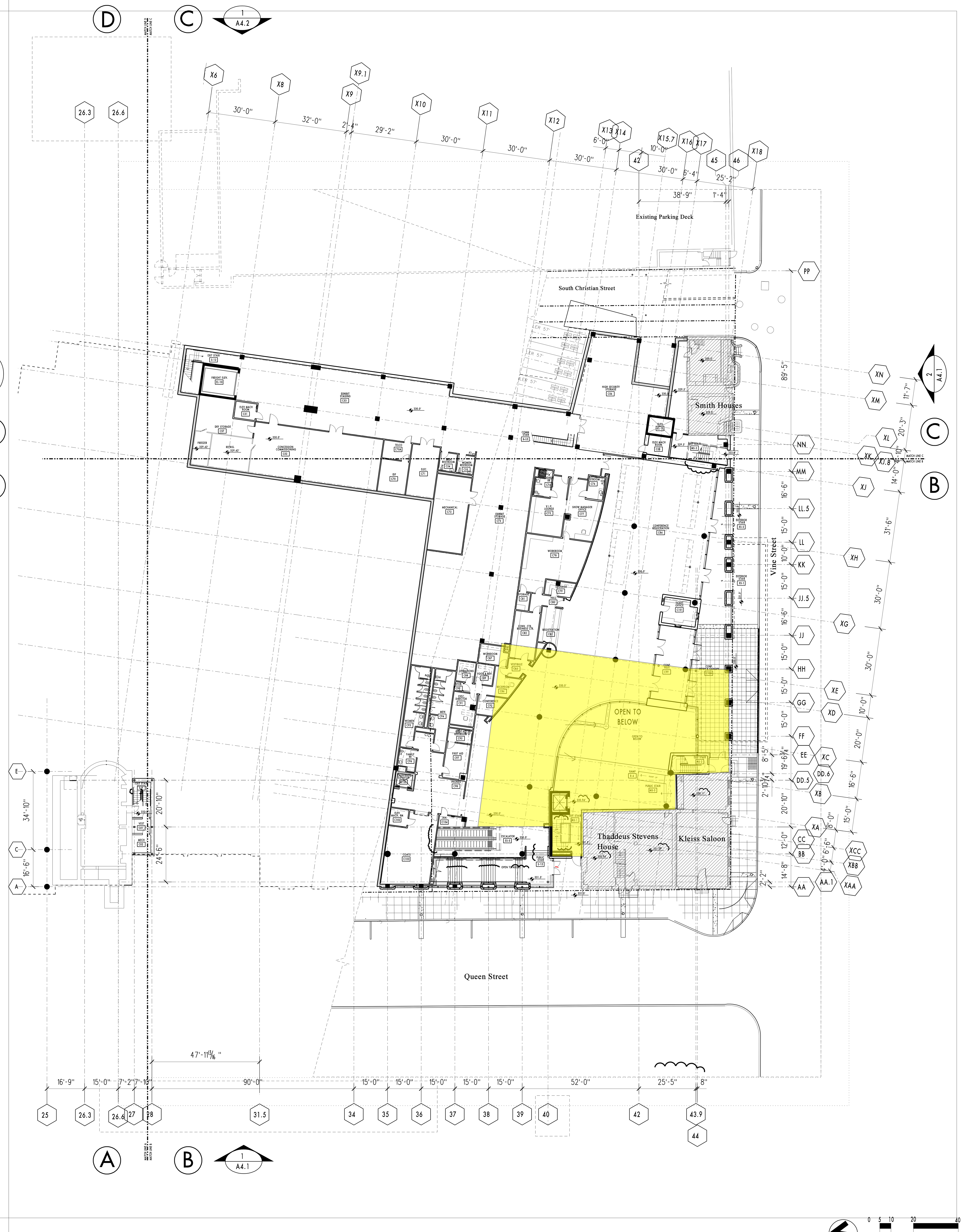
		Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Activity	**Start**	**Finish**	1/14	1/21	1/28	2/4	2/11	2/18	2/25	3/3	3/10	3/17	3/24	3/31	4/7	4/14
BIM Research	1/14/2008	2/22/2008									Spring Break					Presentation
Structural Breadth	1/14/2008	2/8/2008														
Mechanical Breadth	1/28/2008	2/22/2008														
CM Breadth	2/25/2008	3/30/2008														
Presentation	3/31/2008	4/10/2008														

Appendix A

See the following pages for highlighted floor plans of the museum, convention entry and exhibit levels showing the elevated structural concrete areas.



1 A1.1 FLOOR PLAN - MUSEUM LEVEL
1" = 20'-0"
PL-01.DGN



2 A1.1 FLOOR PLAN - CONVENTION ENTRY LEVEL
1" = 20'-0"
PL-01.DGN

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GEORGIA
30305 - 1595

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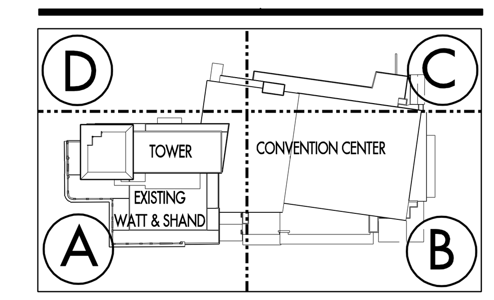
No.	Drawing Issue Description	Date
	BULLETIN 04	01/29/07
	ISSUED FOR BID	03/21/06

PENN SQUARE CENTER MARRIOTT HOTEL AND LANCASTER COUNTY CONVENTION CENTER

Lancaster, Pennsylvania

●

PENN SQUARE PARTNERS
LANCASTER COUNTY CONVENTION CENTER AUTHORITY



COMPOSITE PLAN MUSEUM LEVEL AND CONVENTION ENTRY LEVEL

Bullock Principal-in-Charge	204030 Project No.
Neal Project Director	As Noted Scale
Chapman Project Manager	March 21, 2006 Date
Chapman Project Architect	
Crittenden Project Designer	
File Path	
File Plot Date	A1.1

COMPOSITE PLAN - EXHIBIT HALL LEVEL

1 A1.3

1" = 20'-0"

PL-01.DGN

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No.	Drawing Issue Description	Date
	BULLETIN 04	01/29/07
	RFI 9.4	11/21/06
	RFI 9.5	11/21/06
	ISSUED FOR BID	03/21/06

PENN SQUARE CENTER MARRIOTT HOTEL AND LANCASTER COUNTY CONVENTION CENTER

Lancaster, Pennsylvania

PENN SQUARE PARTNERS
LANCASTER COUNTY CONVENTION CENTER AUTHORITY

D C A B
TOWER
CONVENTION CENTER
EXISTING WATT & SHAND

COMPOSITE PLAN EXHIBIT HALL LEVEL

Bullock — Principal-in-Charge
Neal — Project Director
Chapman — Project Manager
Chapman — Project Architect
Crittenden — Project Designer
204030 — Project No.
As Noted — Scale
March 21, 2006 — Date
File Path
File Plot Date

A1.3

Appendix B

See the following page for a plan of the mechanical system in the convention entry area; the smoke evacuation ductwork is highlighted.

ENLARGED PLAN - MONTGOMERY HOUSE LOWER LEVEL (2/M2.2B)
1/8" = 1'-0"

ENLARGED PLAN - CONVENTION ENTRY LEVEL PART B - MECHANICAL (1/M2.2B)
1/8" = 1'-0"

GENERAL NOTE (THIS SHEET ONLY)

FOR BRANCH SUPPLY AIR DUCTS AT CONFERENCE REGISTRATION, COORDINATE LENGTH OF SHEET METAL DUCT ATTACHED TO SLOT WITH THE SPACE BETWEEN CEILING PANELS. LENGTH OF SHEET METAL IS TO BE LONG ENOUGH TO CONCEAL SECTION OF FLEXIBLE DUCTWORK IN EACH BRANCH.

KEY NOTES (THIS SHEET ONLY)

1. CURVATURE OF SLOT DIFFUSER SHALL MATCH CURVATURE OF WALL.
2. SHEET METAL SA DUCT SERVING THE CONFERENCE REGISTRATION SHALL BE LINED
3. FIRE DAMPER SHOWN AT RATED, CURVED WALL SHALL BE INSTALLED IN STRAIGHT SECTION OF WALL ABV THE CLG (SEE ARCH DWGS FOR WALL DETAILS)
4. INSTALL DUCTWORK SO AS TO PROVIDE MIN. 3'-0" ACCESS TO PIU.

JSE

JORDAN & SKALA ENGINEERS, INC.

5365 OAKBROOK PARKWAY
NORCROSS, GEORGIA 30093
770/447-5547 FAX 770/448-0262
JSE Number - 0410326

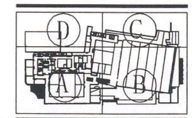
COMMONWEALTH OF PENNSYLVANIA — G.M. SKALA — PROFESSIONAL ENGINEER

No	Drawing Issue Description	Date
	ISSUED FOR BID	03/21/06

PENN SQUARE CENTER
MARRIOTT HOTEL AND
LANCASTER COUNTY
CONVENTION CENTER

Lancaster, Pennsylvania

PENN SQUARE PARTNERS
LANCASTER COUNTY CONVENTION CENTER AUTHORITY



ENLARGED PLAN
CONVENTION ENTRY LEVEL
PART B
MECHANICAL

Skala	204030
Principal-in-Charge	Project No.
Haefell	As Noted
Project Director	Scale
Haefell	3/21/06
Project Manager	Date
Moody	
Project Engineer	
File Path	
File Plot Date	M2.2B