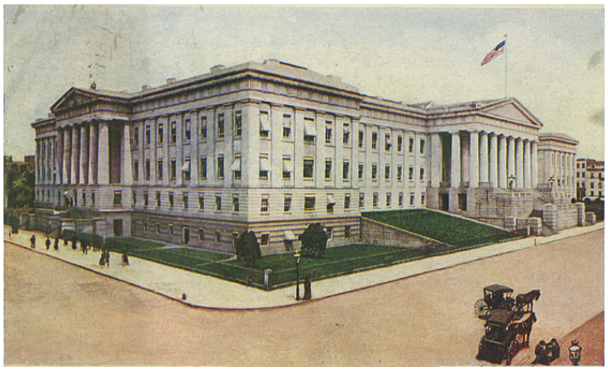


Robert M. Leicht
Construction Management Option
Advisor: Dr. John Messner
Bldg: Smithsonian Institution
Patent Office building
Washington, DC
10/4/04
Technical Assignment 1

Executive Summary:

The Smithsonian Institution Patent Office Building is a very unique project. Located in downtown DC, it takes up two square city blocks. The project was delivered as a traditional Design-Bid-Build project with a CM agency to help oversee construction. The method seemed very appropriate based on the owner's experience and the unique demands of the project.

The schedule depicts the long design time as well as the congestion the project will feel due to overlap of trades when construction gets into full swing. The site is very tight, being in the center of the city. Also, the courtyard poses several issues due to the lack of access through the building. The building has a wide variety of building systems, highlighted by its existing structurally arched masonry and the use of the chimneys as mechanical chases.

The estimates used to find cost information on the project appeared to be very inaccurate due to the unique constraints of the project. The actual cost per square foot was much higher than the estimates bore out. The local construction conditions in DC favor concrete construction, which will be used in the courtyard. Also, though the project does little recycling, many of the historical materials in the building will be restored and reused. Though the storage of the materials will lead to further congestion.

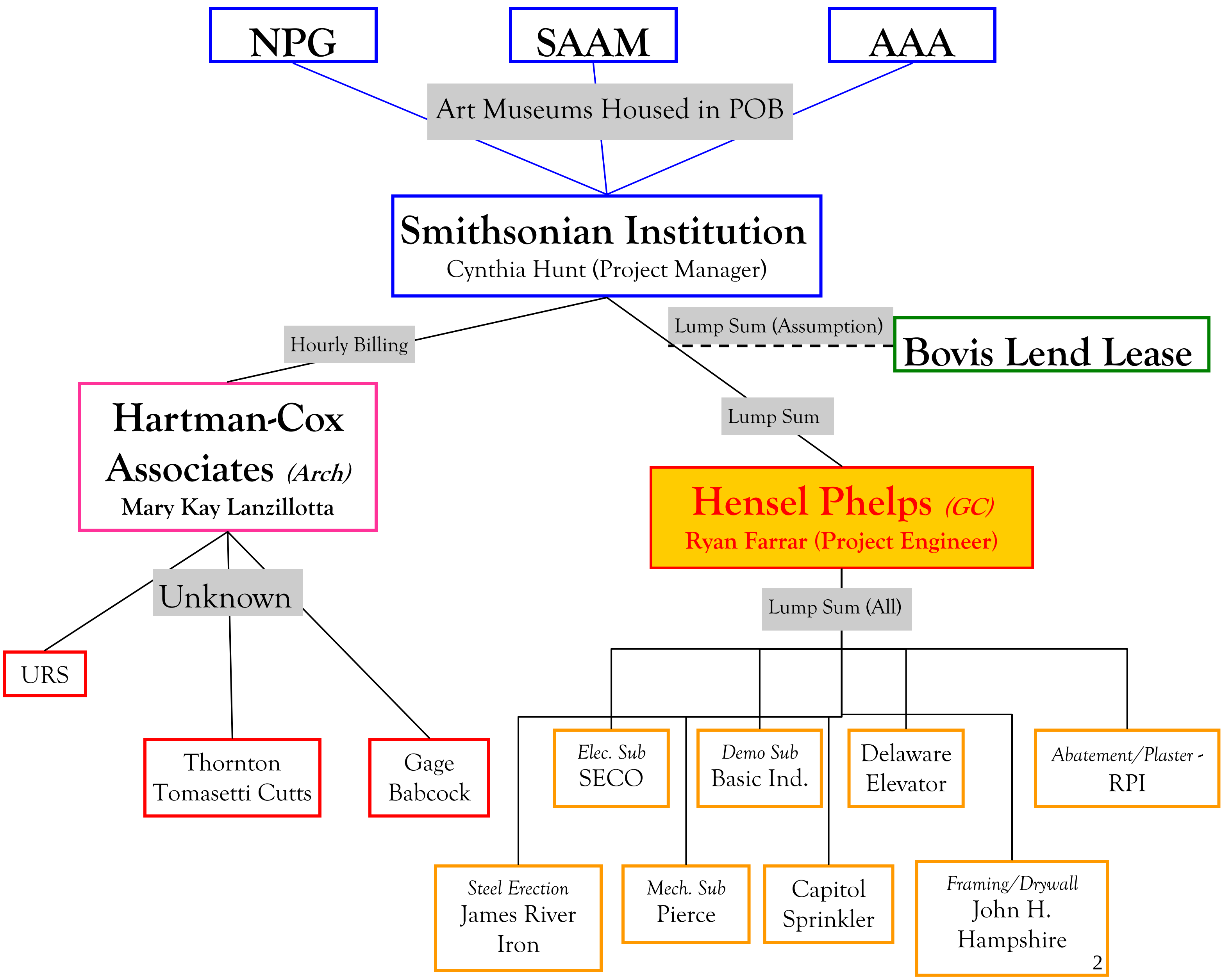
Smithsonian Institution is a unique client who has many attributes of a government agency, however they tend to favor higher end work and finishes. The historical nature of the building is of utmost importance to the owner, creating some unique situations and opportunities. The key interests of the owner lay in timely completion due to the significance of the opening date, the 170th birthday of the building and the 4th of July. Also, the level of quality expected is very high. All in all, the project is very complex and unique.

Submission Contents: **Page(s)**

Submission Contents:	Page(s)
♦ Project Delivery Method w/ Organizational Chart	2
♦ Project Schedule Narrative	3
♦ Project CPM Schedule	4
♦ Building Systems Summary	5-6
♦ Project Cost Evaluation	7-8
♦ Local Construction Conditions	9
♦ Client Information	10
♦ Existing Conditions Site Plan (11x17)	11

Project Delivery System

The project is being delivered using a Traditional Design-Bid-Build method with a CM agent. The owner, Smithsonian Institution (SI), is experienced in construction. They have three separate museums being housed within the Patent Office Building and each has very specific requirements for the space they will occupy. SI has spent a great deal of time in design tailoring the design to accommodate each museum. The traditional method is advantageous when the owner is experienced and has very set ideas about the design of the building. Also, time was not a critical issue when the project began, having several years to develop the design and revise it before sending it out for bid. SI also chose to use a CM agent to assist in the construction process. The CM agent assists in the preconstruction phases to bring out constructability issues. With the considerable size and high quality finishes required SI was glad to have someone else helping to monitor the project, looking for problems and other areas of concern.



Project Schedule Summary

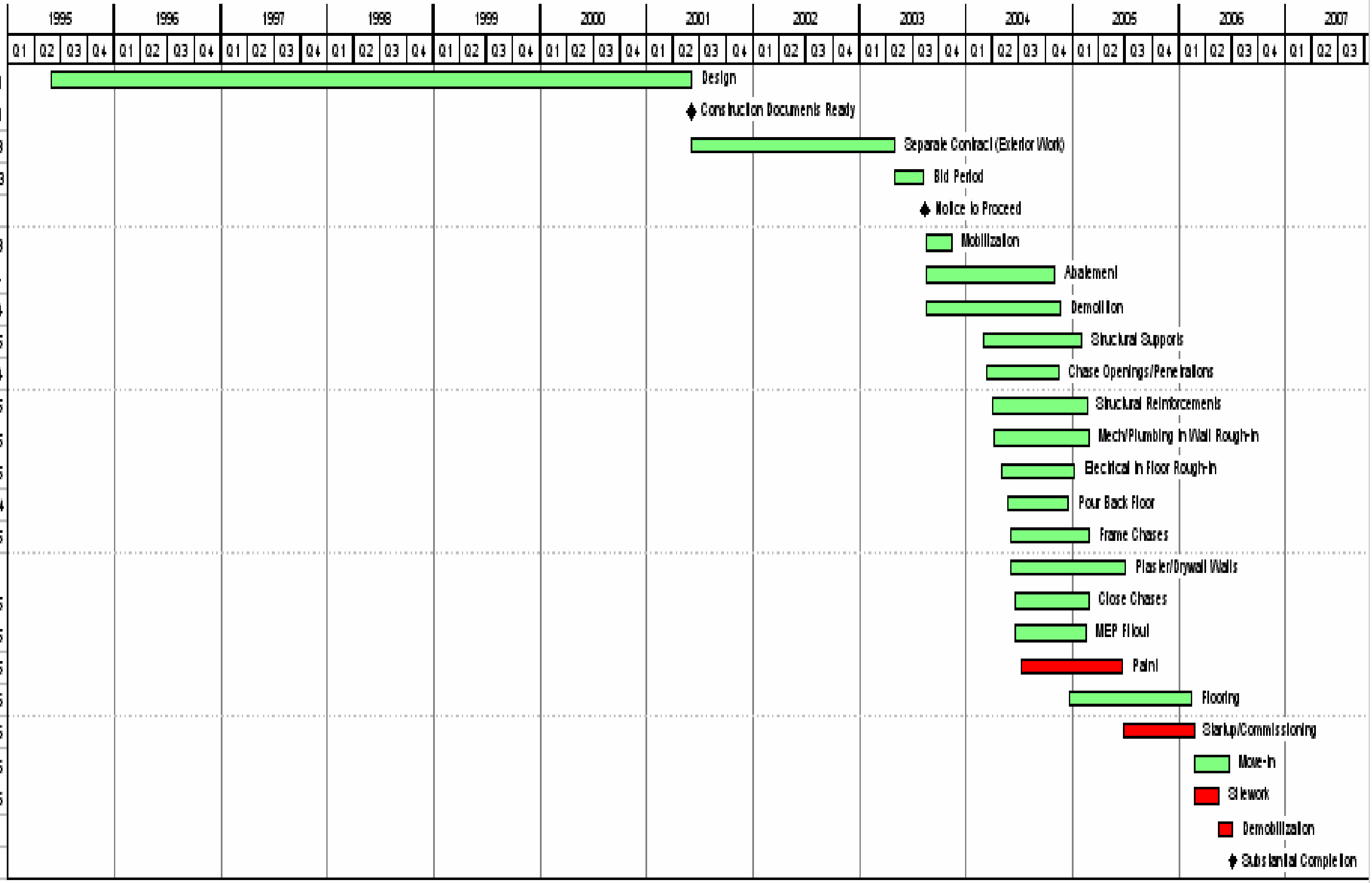
It is pretty obvious, when looking at the CPM schedule below, the project had a very long design period. The design period includes the schematic design, design development, and the creation of the construction documents. When the documents were completed there was a separate contract to perform the original demolition work as well as cleaning and repointing the façade of the building. There was also a new roof, and new windows put on the building. Once the first contract was finished, the bid documents for the current project went out, and the project was bid over a three year period.

Once the contract was awarded to Hensel Phelps to renovate the building, the first steps were the mobilization, then demolition and abatement of the building. Due to the sheer size of the building, there is excessive overlap of activities. Once areas have been abated of all hazardous materials the work on the chases can begin. First structural supports are put in where necessary to support upper floors while cutting the chase openings. Next the structural reinforcements are installed in the chases to make up for the structural brick that was removed. Then the mechanical and plumbing systems run their risers through the chases. Once all of the mechanical work is in place the chases can be framed. Occurring concurrently is the demolition of the floor slabs to run the electrical conduit within the floors. Once the conduit is roughed in the floor can be poured using concrete.

Once all of the basic MEP work is roughed in the chases can be closed, followed closely by drywall and plaster. When all of the necessary coats of plaster are in place the painter can come through and paint the walls and ceilings. When the painter is through with certain space, the area can be fitted with lights, louvers, fixtures, etc. The flooring is then installed, whether it is marble, tile, carpet, or wood. Once the MEP fitout is well under way, the commissioning of the various systems can begin. When an area has all of its finishes, the museums can begin to move in and take them over. Lastly, there is some sitework that needs to be accomplished as well as the demobilization of all of the trailers, equipment, etc.

Patent Office Building Summary Schedule

Activity Name	Original Duration	Start	Finish
Design	1567	01-Jun-95*	01-Jun-01
Construction Documents Ready	0		01-Jun-01
Separate Contract (Exterior Work)	500	04-Jun-01*	02-May-03
Bid Period	71	05-May-03*	11-Aug-03
Notice to Proceed	0	12-Aug-0...	
Mobilization	65	19-Aug-0...	17-Nov-03
Abatement	314	19-Aug-0...	29-Oct-04
Demolition	329	19-Aug-0...	19-Nov-04
Structural Supports	243	02-Mar-04*	03-Feb-05
Chase Openings/Penetrations	181	09-Mar-04*	16-Nov-04
Structural Reinforcements	235	30-Mar-04*	21-Feb-05
Mech/Plumbing in Wall Rough-in	235	06-Apr-04*	28-Feb-05
Electrical in Floor Rough-in	176	04-May-04*	04-Jan-05
Pour Back Floor	149	25-May-04*	17-Dec-04
Frame Chases	195	01-Jun-04*	28-Feb-05
Plaster/Drywall Walls	285	01-Jun-04*	04-Jul-05
Close Chases	185	15-Jun-04*	28-Feb-05
MEP Fitout	178	15-Jun-04	17-Feb-05
Paint	253	06-Jul-04*	23-Jun-05
Flooring	300	22-Dec-0...	14-Feb-06
Startup/Commissioning	173	24-Jun-05	21-Feb-06
Move-in	89	22-Feb-06	26-Jun-06
Sitework	60	22-Feb-06	16-May-06
Demobilization	35	17-May-06	04-Jul-06
Substantial Completion	0		04-Jul-06



Building Systems Summary

Demolition

- Abatement - There is abatement requirements for both asbestos and lead. The lead is existent in the current paint on the walls. The paint has not been removed ever since the original construction of the building, and has undergone several renovations and remodeling efforts. There was limited asbestos since the building was complete before asbestos was popular and therefore was only used in a limited capacity during the last major renovation in the 1950's.
- Demolition – The major area of demolition for the project relates to the expansion of the existing chimneys to make room for the pipe chases. Throughout the project there are over 500 chases that need to be located and opened, typically from floor to ceiling. Then they need to be expanded, often both wider and deeper, to accommodate the duct or pipe running vertically through the space. There is also some demolition required for through wall penetrations for the duct and pipe as well. Also, there are an extensive number of through floor penetrations for electrical conduit since it is run in the floor in all of the gallery spaces.

Structural Steel Frame

- There is steel reinforcement, steel angles, needed for the existing granite slab throughout the North and West wings of the third, third mezzanine, and fourth floors.
- In the mechanical chases, often steel C channel is bolted into the masonry walls for support if the chase is expanded from its original size.
- In the courtyard there is structural steel spanning the auditorium area. The connections are mostly bolted, though at the beam splices there are full penetration welds as well.
- The erection of the steel requires a 500 ton mobile crane with an extension to reach over the building into the courtyard. The locations to set up the crane were limited due to the downtown location. G Street between 7th and 8th Streets needed to be closed for two weeks to erect the steel in the courtyard.

Cast in Place Concrete

- The formwork for the concrete for the vertical placements was all built in place from wood, or used the soldier beams and lagging that were in place for the excavation.
- The formwork for the piers and pile caps consisted of some gang forms and wood forms for some of the unique shapes required.

Mechanical System

- The mechanical system is split into two separate parts, one running up from the basement through the second floor, the other starting at the top floor and feeding down to the third floor.
- The mechanical rooms for the lower floors is are located in the basement of the West wing. The mechanical and electrical equipment take up almost the entire basement of the West wing.
- The mechanical rooms for the upper floors are in the North wing and the north half of the West wing.
- The mechanical system is an all air system with vertical distribution using duct through existing chimneys.
- The fire suppression system is an all water system. Due to the historical nature of the building there are some spaces that do not have sprinklers so as not to take away from the historical nature of the space, such as the Lincoln Ballroom.

Building Systems Summary Continued

Electrical System

- The electrical system feeds the building with two 13.8 KVA lines coming into the basement at two separate points.
- The building, besides having two separate feeds, has an UPS system with a diesel generator to maintain power.

Masonry

- The building is an existing load bearing masonry building. Near the foundation the walls are several feet thick.
- The majority of the building is brick; however there are granite and marble columns, and the façade is made up of sandstone, granite, and marble.
- Where there has been demolition the building is, as much as possible, to be built back with brick and block. The use of similar materials lowers the risk of structural issues related to uneven expansion and contraction.
- A unique note for the masonry is when new brick is put into place; the brick used must be uniquely different from the existing brick. The specifications require the unique brick to ensure that in the future it is easier to identify which was original and which was installed in the renovation for historical purposes. The contractor therefore used both blonde and concrete bricks for the new construction.
- Scaffolding was required in the interior of the building when doing work on the chases. The scaffolding was used for two reasons:
    - To support the existing structure when demolition undermined supports for the floor above
    - When doing work at some of the higher elevations. Some of the grand spaces have ceiling heights approximately 40 feet above the existing floor.

Support of Excavation

- The support system for the excavation of the courtyard consists of soldier beams and lagging.
- The support system remained in place and served as the rear form for the cast in place concrete walls in the courtyard.
- Since the excavation had portions of existing building along the west, north, and east faces dewatering was only an issue due to rain. When necessary a pump was brought in to dewater the courtyard.

Project Cost Evaluation

Actual Cost

- Total Building Renovation Cost per Square Foot (per base bid): $261.78/SF
- MEP System Cost per Square Foot (Mechanical, Electrical, Plumbing, Fire Protection): $94.24/SF

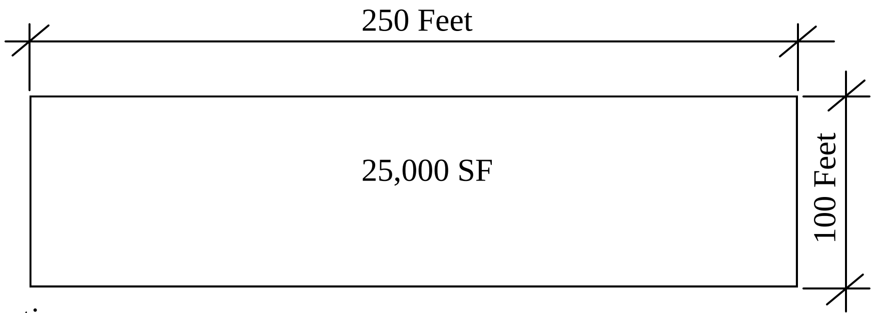
D4 Cost Estimate

- What is D4? - D4 is software for estimating projects based on historical project costs. The program has a database of projects and the database can be searched by a list of criteria to find projects similar to the project being estimated. Once a list of similar projects is put together, the user chooses the projects best most like their project and using the software can “Smart Average” them. The software weighs the different buildings to account for number of floors, floor heights, etc. The outcome is an estimate split up into the 16 CSI divisions. The user then has a base estimate to work from and can make adjustments for the unique characteristics of their actual project.

D4 Original Estimate	**Adjustment**	**New Amount**	**Reason for Adjustment**
$5,298,710	$6,000,000	$11,298,710	Multiple trailers, staff of 20+, 3 year job, 5 trucks, parking $,
$5,496,093	$5,000,000	$10,496,093	extensive lead & asbestos abatement, demolition work, CY work
$10,924,196	$0	$10,924,196	repouring all of the floors, CY foundations & floor
$2,109,917	$1,000,000	$3,109,917	all masonry bldg, lots of repair work
$4,910,729	$0	$4,910,729	
$1,030,431	$2,000,000	$3,030,431	repairing historical wood, lots of exposed wood
$1,754,023		$1,754,023	CY
$1,942,231	$0	$1,942,231	
$4,763,065	$3,000,000	$7,763,065	high end finishes, hand made, from overseas
$3,573,145	$0	$3,573,145	
$1,776,191	$0	$1,776,191	
$1,348,894	$1,000,000	$2,348,894	casework, auditorium seating
$1,136,200	$2,000,000	$3,136,200	blast resistance, measurement/control instrumentation
$1,847,123	$2,000,000	$3,847,123	installing multiple elevators
$7,791,697	$10,000,000	$17,791,697	two systems, extensive ductwork, new sprinkler system
$6,723,695	$10,000,000	$16,723,695	high end security system, new data lines, UPS system
$62,426,340	$42,000,000	$104,426,340	**Totals**

RS Means SF Cost Estimate

Dimensions: Courtyard - the new construction portion of the project.



Assumptions:

- 1 Story Building
- 24’ Story Height
- Precast Concrete w/ Steel Frame

Revisions to Standard Data:

- Interpolation between 24,000 SF and 27000 SF to get numbers
  {Formula = 24,000 + (25,000-24,000)/(27,000-24,000)}
- Modification from 640 LF of Perimeter to 700 LF of perimeter (4.70 / 100LF)
  → $2.82/SF = (60 LF * 4.70 / 100)
- Change to Padded Seats costs $207 EA for 300 seats
  $207 * 300 = $62,100

RS Means Estimate:

$111.81 / SF
+ $2.82 / SF

$114.63 / SF X 25,000 SF = $2,865,750 + $62,100 = $2,927,850

Comparisons:

- D4: The D4 Estimate was considerably lower than expected. The projects used to “Smart-Average” in order to come up with an estimated project cost were not very similar to the Smithsonian Institution Patent Office Building. The projects used ranged for a arts center, to the National Archive II bldg. The trouble lies in the unique nature of the Patent Office Building. Also, estimating for a renovation changes significantly from building to building because of each buildings different history.

- RS Means: The RS Means estimate appears to below what the courtyard should probably cost. The Smithsonian Institution is sparing no expense for their project, and the high end finishes they are using is not apparent in the SF cost of the courtyard. The SF cost is less than half of what the SF cost for the entire building is for the base contract. Since the courtyard is basically a new project within the renovation, the cost per SF should probably be a little less than the rest of the building, since there is limited demolition and no abatement. The estimate also cannot show the lack of access to the courtyard that will raise costs of doing any work requiring equipment in the area.

Local Conditions

Preferred Methods of Construction

- Washington, DC is well known for its concrete construction due to the height limitations on buildings within the city and the ability to have smaller space between floors with a cast in place concrete building rather than a steel structure.
- Since the site is downtown, there is limited space within the construction boundaries. Nonessential uses of space are, when possible, moved off-site. For example, parking is off-site at local parking decks and other available locations.
- Since the building takes up two entire city blocks, there is obviously very little space around the site.

Recycling/Dumping

- Recycling is being done for the office paper used on site.
- There are several materials in the building that are being restored and reused. There are existing tile and marble floors that have been taken up to be cleaned and put back in place.
- Tipping fees in the Washington area run $350 to get a 30 yd dumpster pulled and dumped.

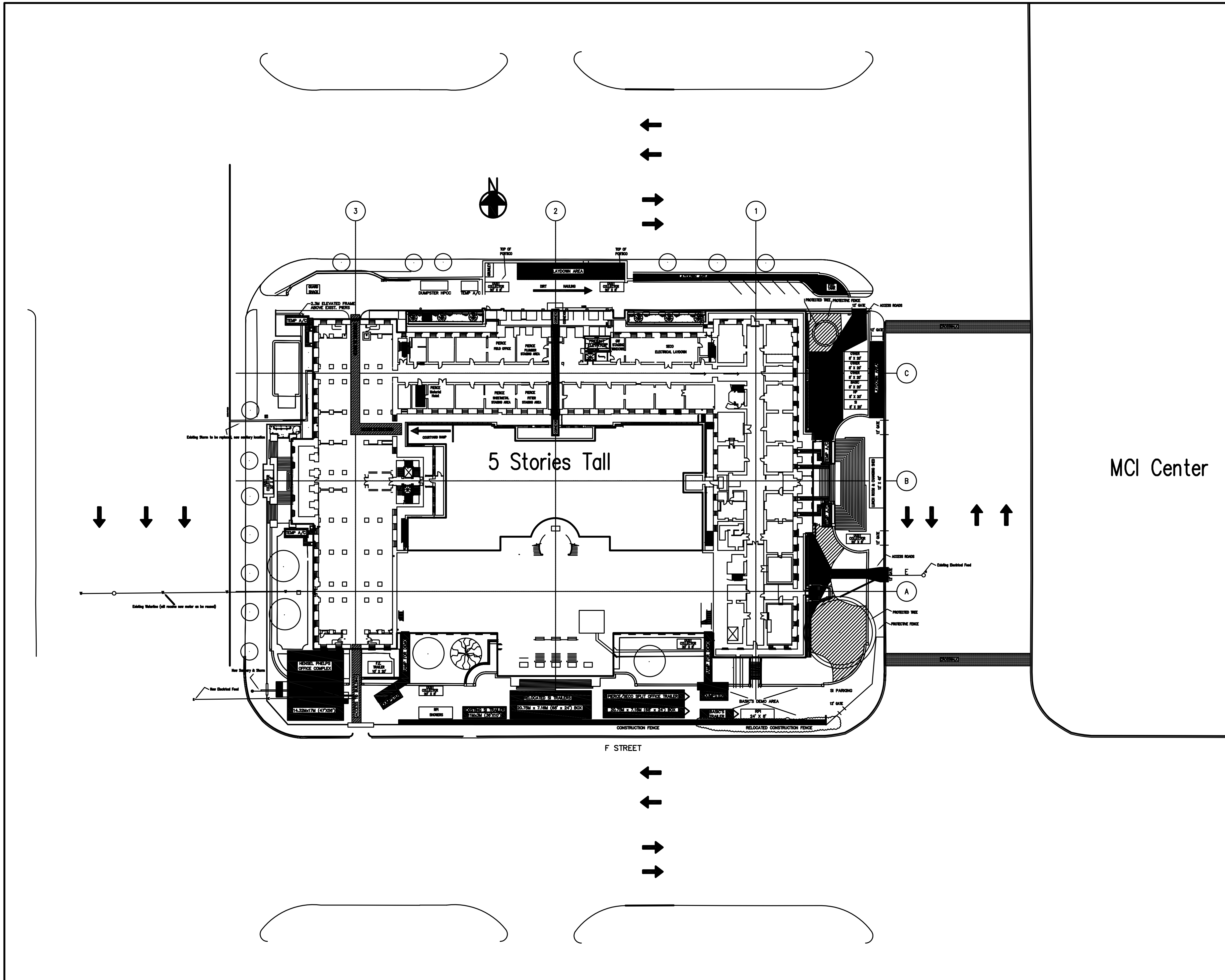
Soil & Subsurface Water Conditions

- The soil found when excavating in the courtyard …(soil report is being sent)
- Since the courtyard is within the building footprint, there were minimal problems with onsite water. The only time it was an issue was due to inclement weather.

Client Information

Smithsonian Institution

- "The Smithsonian, as an independent trust instrumentality of the United States, conducts scientific and scholarly research, administers the national collections and performs educational public service functions, supported by its trust endowments and revenues, gifts, grants, contracts and funds appropriated by the Congress." (Taken directly from http://newsdesk.si.edu/)
- The Patent Office Building is going to house three distinct art museums: The National Portrait Gallery, The Smithsonian American Art Museum, and The American Art Archives. The building is being renovated because of a number of issues related to the age of the building. When a building reaches a certain age the mechanical, electrical and plumbing systems become outdated. There is significant wasted energy, and there are a number of hazards related to the asbestos and lead in the building.
- The total cost of the building, including previous work to clean the façade, fix the roof, and replace the windows, combined with design and development costs and some planned future work, will be approximately $210 Million.
- The quality expected in the building is extremely high. The level of finishes required in the interior spaces are the highest possible on their respective scales. Many items are hand made, or made to resemble the buildings original makeup, as well as restoration of existing materials that have undergone 170 years of wear. The evidence of the strong interest is very clear in the specifications for the building through the quality control measures and the very specific nature of the specifications for finish materials. Also, the project is an historical building as well as an art museum, both of which are of an extremely public, visible nature and the visitors coming into the building will have high expectations, therefore the owners want to meet the expectations coming in. Also, there is a whole section of the specification related to the historic nature of the building.
- The schedule is designed to have the building substantially complete and open to visitors on July 4th of 2006, 170 years after its original construction on a significant American holiday. The schedule includes some phased occupancy to allow the museums to all have some space within the building before the grand opening, as well as working out the commissioning of the systems and the move-in of the significant amount of art to be displayed.
- The safety is of utmost importance due to the hazardous contents and the age of the building creating the potential for very dangerous situations. The owners' emphasis on safety can be clearly seen through their hiring of a general contractor with a track record for safety, and their requirement of a full-time safety manager on site throughout the entire project.
- There is, as mentioned above, phased occupancy for the building. The entire West wing of the building is turned over to the owner more than a year in advance of the substantial completion of the project.
- The keys to completing the project to the owner's satisfaction lay in:
    - Completing the project in a timely manner, due to the significance of the grand opening date.
    - Providing a project up to the quality expectations of the representatives of the multiple museums who will be occupying the space.
    - Completing the project within a reasonable range of the budget.
    - Having no major injury throughout the construction.



Robert M. Leicht
5th Year AE – CM Option
Adviser – Dr. John Messner

Smithsonian Institution
Patent Office Building
801 F Street, NW
Washington, DC 20004

Site Plan
9/26/04