Technical Report 2

October 27th, 2010

Butler Health System

New Inpatient Tower
Addition and Renovation
Butler, PA

Christopher DiLorenzo
Construction Option
Advisor: Dr. Chimay Anumba

Penn State AE Senior Thesis

Executive Summary

For Technical Report 2, a more detailed analysis was performed for several aspects of the construction project. The key features of the project that affect project execution were thoroughly investigated. Most of these issues were addressed in Technical Report 1, but in much more depth for this second report.

The site layout for the project was something that was addressed early. Because of the limited space on the construction site, Turner established a nearby residence as its engineering office. Available on-site parking was minimal, and therefore additional parking spaces were located off site. A shuttle was utilized to move construction personnel to and from the jobsite. For this technical report, a more in depth analysis was performed for the steel erection phase of construction. With only one main location needed for crane access, planning allowed minimal construction congestion to exist. The staging area is also included in this small crane access area.

For the New Inpatient Tower at Butler Memorial Hospital, schedule was the driving factor throughout the entire construction project. With a set date for patients to be treated in the new facility, there was no room for error in terms of the schedule. This was a challenging process due to the complexities of a state-of-the-art hospital. This report includes a detailed project schedule, which is broken down into just over 150 activities. The schedule reflects the critical dates of construction, and the important overlapping of activities. Without these overlapping activities, it would have been impossible to complete the project in the tight time frame. The schedule also reflects the fact that the project was fast tracked. Several design releases were issued throughout the construction process. Because of this, the construction team was able to meet the deadlines set by Butler Health Systems.

Also included in this report, are the detailed structural systems estimate and the general conditions estimate for the project. The structural systems estimate, which includes all steel and concrete work, is approximately $3,279,250. The included estimate breaks down the several activities that go into this value. The section of the report also indicates any item that is not included in the detailed structural estimate. The general conditions estimate for this project comes in at about $5,395,896. This high value shows just how critical the schedule was for this project. With a large project staff, the monthly rates would drastically alter the costs in the case of a construction delay.

To conclude this report, the summary of critical industry issues discussed at the 2010 PACE Roundtable Meeting is included. At this meeting, several current industry topics were addressed. With the input of industry professionals and students, topics were thoroughly discussed and analyzed. This gave the students a new insight into the recent trends of the industry.

Technical Report 2 Table of Contents

Executive Summary……………………………………………………………………………….1

Table of Contents……………………………………………………………………………2

Detailed Project Schedule………………………………………………………………...3

Site Layout Planning…..……………………………………………………………………….5

Detailed Structural Systems Estimate……………………………………………………….7

General Conditions Estimate…………………………………………………………………….11

Critical Industry Issues……………………………………………………………………..13

Appendix A: Detailed Project Schedule

Appendix B: Site Layout Planning

Appendix C: Detailed Structural Systems Estimate

Appendix D: General Conditions Estimate

Detailed Project Schedule

The design process of the Butler Health System New Inpatient Tower began on February 4th, 2008. The design process continued throughout the majority of the construction. During this time period, several design releases were developed at specific times. The release dates of these portions of the projects were based on the planned dates of construction activities.

Before the design was completed, the GMP was developed by Turner Construction. Along with the actual construction activity, BIM Coordination and Procurement also began early on in the process. Construction of the New Inpatient Tower began on August 18th, 2008. Below are some of the critical dates of the construction process:

Structural Steel Erection:	2/17/2009 – 6/8/2009
Concrete Pouring:	1/26/2009 – 7/30/2009
Masonry Work:	6/23/2009 – 3/22/2009
Windows and Curtain Wall:	10/12/2009 – 3/1/2010
Vertical Work:	5/15/2009 – 5/27/2010
Ground Floor Work:	6/2/2009 – 1/7/2010
First Floor Work:	6/1/2009 – 1/20/2010
Second Floor Work:	6/16/2009 – 7/6/2010
Third Floor Work:	6/16/2009 – 6/9/2010
Fifth Floor Work:	7/24/2009 – 5/18/2010
Sixth Floor Work:	8/5/2009 – 6/10/2010
Seventh Floor Work:	8/20/2009 – 5/5/2010
Roofing:	6/9/2009 – 4/1/2010
Final Sitework:	12/18/2009 – 7/7/2010
Turnover/Commissioning:	1/8/2010 – 7/9/2010

All of these summary activities along with detailed activities are included in Appendix A: Detailed Project Schedule.

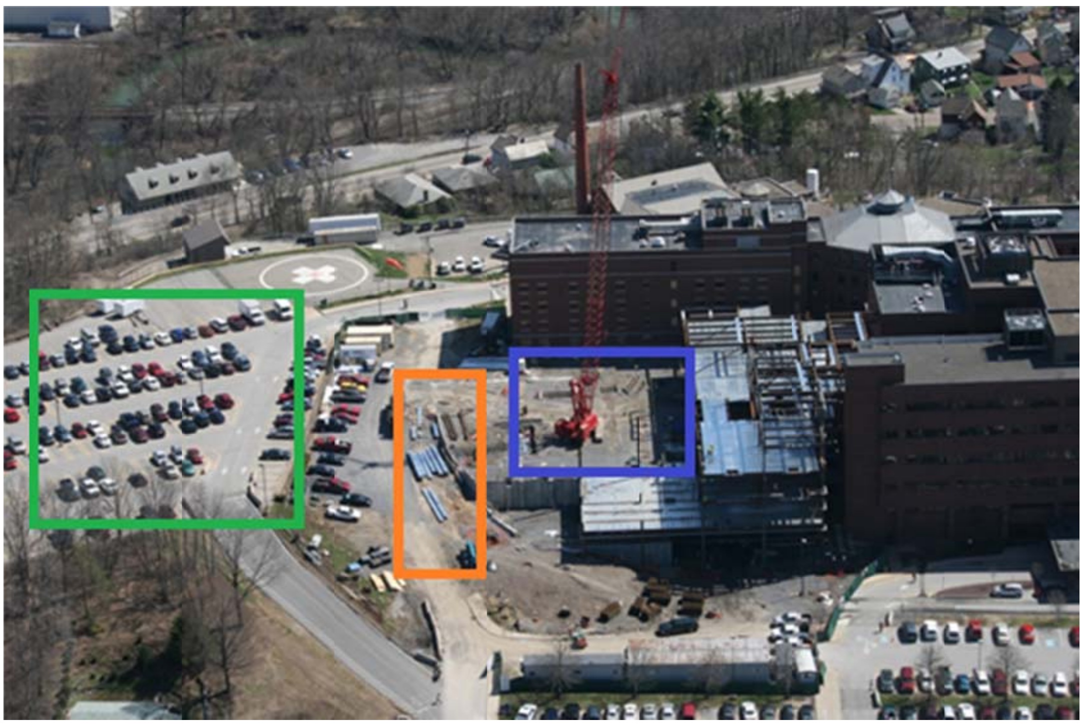
The procurement process of the project continued from the onset to the near completion of construction. The actual construction of the tower ran from May 29th, 2008 through July 7th, 2010. With a duration of this extent, it is necessary to break down the construction into activities by floor. It can be seen from the dates above that the work on each floor overlapped significantly. This was necessary because of the strict turnover dates. Butler Health Systems had already committed dates that patients were to be serviced in the new tower. With immovable deadlines such as these, serious attention to detail was needed for the project schedule.

The entire hospital was completely in the hand of the owner’s by the end of June 2010. While the tower was already turned over the owner, commissioning and sitework continued throughout July.

Site Layout Planning

For the steel erection phase of the New Inpatient Tower, one crane was used for the setting of all structural steel. The Manitowoc Model 777 is a lattice boom crawler crane. This crane was able to navigate within a small area in order to assemble the entire structure of the building. This limited site logistic complexities because only one area was needed for crane use. The steel beams and columns were also staged in nearby areas in order to minimize construction interference.

The site plan of the steel erection phase is included in Appendix B: Site Layout Planning. This site plan is referenced from the included photographs, taken during the steel erection phase:



View from Northwest: Manitowoc setting steel

It is seen in the above photograph that the site logistics did not change much for this phase. The on-site parking is still shown on the left side of the photograph. Also, the site trailers are shown in the foreground of the construction. This limited change to the site logistics minimized difficulties on the job site.

ORANGE: Steel Staging Area
BLUE: Area for Crane Use
GREEN: North Parking Lot

Image from Northwest: Manitowoc setting steel

The above photograph again shows the minimal disturbances to the site during steel erection. The staged steel is shown just to the right of the crawler crane. With the staging space so close to the erection, it again minimizes interference with the rest of the construction sites. As the steel erection progressed, the crane never had to move from the same general location.

The layout of the site, devised by Turner, seems to be the most effective way to utilize the site. As seen in the photographs, a confined space is designated as the space for crane movement. With minimal movement required by the crane, it also reduces potential safety hazards.

Refer to Appendix B: Site Layout Planning for the site plans. The site layout plans included in this appendix include an overall site plan, as well as an enlarged plan of the crane access area.

Detailed Structural Systems Estimate

In order to perform a detailed structural estimate, several different CSI Masterformat aspects need to be addressed. The structural system of the Butler Hospital New Inpatient Tower includes the following:

- Drilled Caissons
- Foundation Walls
- Slab on Grade
- Structural Steel Columns and Beams
- Concrete Floor Slabs

All estimates, provided in this report, include material, labor and equipment. Overhead and profit costs are not incorporated into these values. All values in this estimate are from *RS Means Building Construction Cost Data 2011*.

Drilled Caissons:
The new tower's foundation system includes 117 drilled caissons, set at different depths. These piers have been designed for both end bearing and skin friction. For this project, the piers have been designed to bear on a limestone and siltstone layer of bedrock. The piers are socketed 36" into the competent bedrock. Some of the drilled piers, labeled as LDP, are laterally drilled piers. The concrete used for the piers has a 28-day strength of 4000 PSI.

Due to the large floor area of the tower, the geotechnical conditions change throughout the site. Because of this, the depths of the piers vary based on location. For this project, the depths were based on three different areas:

- Area A: 11'0" depth
- Area B: 25'0" depth
- Area C: 48'0" depth

The caissons for this project are open style, machine drilled. All information for the drilled caissons is included in Appendix C. Table 1 includes the take-off and pricing for all caissons.

Caisson Estimate = ***$328,844.90***

Foundation Walls:

As with the drilled caissons, the concrete used for foundation walls has a 28-day strength of 4000 PSI. Foundation walls are found on the ground and first floors of construction. The foundation walls have been estimated using the following criteria:

- Formwork: Wall, job-built plywood, 8-16' high
- Concrete: 12" thick walls, pumped

All detailed information, regarding the foundation wall construction, is included in Appendix C. Table 2.1 includes the information on the quantity and pricing for the formwork. Table 2.2 includes the take-off and pricing for the concrete placement.

Foundation Wall Formwork= ***$14,315.46***
Foundation Wall Concrete= ***$11,628.18***
Total Foundation Wall Cost = ***$25,493.64***

Concrete Work:

The concrete for the new tower is also 4000 PSI at 28 days. The total area for the slab on grade is 8,105 Square Feet. For the slab on grade, 6.5"(0.5416') edge forms have been used. The slab on grade cost has been estimated using the following criteria:

- Formwork: Edge forms, wood, 4 use, 7-12" high
- Concrete Placement: Includes finishing, 6" thick
- Welded Wire Fabric: 6x6-W2.1x2.1 (30 lbs. per CSF)

The elevated slabs concrete has been estimated using the following criteria:

- Formwork: Edge forms, to 6" high
- Concrete: 6-10" thick, pumped
- Metal Decking: 22 Gauge (Floor and Roof)
- Reinforcing Steel: Elevated Slabs (#4-#7)
- Welded Wire Fabric: 6x6-W2.1x2.1 (30 lbs. per CSF)

Welded Wire Fabric is used for each floor of the new tower. Also, the reinforcing steel on the elevated slabs is strictly around the perimeter of the slabs. All of the floors, except the seventh, have 4-#4 bars installed around the perimeter of the building. The seventh floor calls for 80#4 bars.

Appendix C includes in-depth information on the slab on grade construction:

- Table 3.1: Slab on Grade Formwork
- Table 3.2: Elevated Slabs Formwork
- Table 3.3: Welded Wire Fabric
- Table 3.4: Metal Decking
- Table 3.5: Reinforcing Steel
- Table 3.6: Slab on Grade Concrete Pouring
- Table 3.7: Elevated Slabs Concrete Pouring

The total cost of the concrete work, including all accessories, consists of the following:

- *Slab on Grade Formwork* = **$799.50**
- *Elevated Slabs Formwork* = **$9,007.05**
- *Welded Wire Fabric* = **$87,253.45**
- *Metal Decking* = **$379,711.50**
- *Reinforcing Steel* = **$12,849.58**
- *Slab on Grade Pouring* = **$22,207.70**
- *Elevated Slabs Pouring* = **$76,931.29**
- *Total Concrete Cost* **= $588,760.07**

Structural Steel:

Steel beams and columns are utilized throughout the new Inpatient Tower. The sizes of both columns and beams vary significantly throughout the project. Because of this, and the non-uniform shape of the building, it was not possible to estimate the structural steel based off of a typical bay. In order to estimate properly, a complete quantity take-off was necessary. In Appendix C, Table 4.1 shows the detailed quantification by floor.

The quantification of the beams was then used to provide an estimate. Table 4.2, in Appendix C, shows the detailed estimate of steel beams. The same process was used in order to calculate the cost of the structural steel columns. In Appendix C, Table 4.3 includes the quantities and cost breakdown of the structural steel columns.

The total cost of the structural steel work, consists of the following:

- *Structural Steel Beams* = **$1,916,673.61**
- *Structural Steel Columns* = **$391,505.96**
- *Total Steel Cost* = **$2,308,179.57**

The total estimated cost of the structural system comes out to be **$3,251,728.18.** For estimating purposes, this value will be set as **$3,250,000.** In order to apply this value to this particular project, a location factor must be used. The location factor for Pittsburgh, PA (closest city) is 100.9.

Cost due to Location = $3,250,000 x 100.9/100= **$3,279,250**

As stated earlier, this value does not incorporate overhead and profit. Therefore, this value would only represent the material, labor, and equipment costs. There are also some other issues that would alter the cost of this estimate:

- Steel connections are not included in this estimate. With the complexities of moment-frame connections, this would significantly alter the labor and material costs of the operation.

- While reinforcing steel was accounted for in the all of the slab work and the caissons, the actual labor and quantity needed for the project could alter the cost. The labor necessary to install complicated rebar systems may not be represented completely accurately.

- As in all construction activities, estimates can change quickly depending on site conditions. If installation is more time consuming or difficult than expected, the cost of the system will increase accordingly.

The final estimated cost breakdown is also included in Appendix C. Table 5 breaks down each construction activity, organized by CSI Masterformat Numbers.

General Conditions Estimate

The General Conditions estimate for the new Inpatient Tower is composed of several different elements. The elements included in the General Conditions estimate, provided by Turner Construction, are the following:

- Temporary Facilities
- Temporary Utilities
- Protection and Safety
- General Expenses
- Project Staff
- Fringes/Taxes/Insurance

The total General Conditions cost for the project is estimated at **$5,395,896.** This cost is in comparison with a direct construction cost of **$69,339,103.**

Along with the General Conditions, there are also contingencies allocated into the project. The contingencies include:

- Design/Development
- Construction

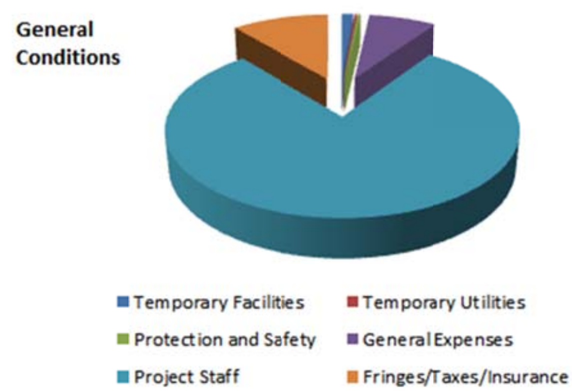
The total contingency costs for the projects comes out to be **$2,083,437.00**

All information on the General Conditions and Contingencies are included in Appendix D: General Conditions Estimate. The following tables are included in Appendix D:

- Table 1: General Conditions Estimate
- Table 2: Contingency Costs
- Table 3: Onsite Staff Rates

In the figure below, it is obvious that the Project Staff makes up a majority of the General Conditions Cost. Also in Appendix D, a table is included to show the base monthly and hourly billing rates of on-site employees. All home office employees are not included in this cost breakdown. Home office employees would include:

- Operations Manager
- Purchasing Department
- Estimating Department
- Project Executive
- Administration
- IT
- Accounting
- Cost Engineering Department



It is quite evident that a construction delay would drastically increase the cost of a construction project. By analyzing the tables in Appendix D, the following calculations depict the approximated monthly fees of the project:

- Temporary Utilities: **$560.00/month**
- Protection and Safety: **$840.00/month**
- General Expenses: **$16,300.00/month**
- Project Staff: **$169,150.00/month**
- Total Monthly Rate: **$186,850/month**

With a total monthly General Conditions rate in this cost range, it is obviously critical that the schedule must be closely monitored. Any delays in the project will lead to a major cost increase to some party in the construction process. The monthly cost for the project staff is the most critical factor in this cost.

Critical Industry Issues

The 2010 PACE Roundtable Meeting was held on October 27-28, at The Penn Stater Conference Center. The Roundtable Meeting is an open forum discussion, which focuses on several key topics in the construction field. To begin the event, a kick-off presentation was given by each of the key Construction professors. Dr. Riley, Dr. Messner, and Dr. Leicht each gave a brief presentation on their respective research topics. From there, the conference was divided into several break-out sessions. At the conclusion of these break-out sessions, an activity was held based on negotiations. The final part of the meeting was a panel discussion, with industry professionals and students, on the topic of obtaining a job in a poor economy.

For the morning break-out session, the topics included the following:

1. Educating a Future Workforce for Delivering High Performance Buildings
2. What are the innovations that will transform our industry?
3. Exploring the drivers behind highly integrated delivery of projects

For this session, I attended the discussion on the innovations in the industry. For this session, several different topics were addressed for current advances in the industry. Some of the ideas that were touched upon include prefabricated mechanical spaces, BIM field implementation, bar coding of construction materials, intelligent models, laser scanning, and document control. All of these topics are currently revolutionizing the industry. Also in this break-out session, the concept of several different BIM uses was discussed. Although many industry players have used BIM for a few purposes, such as 3D coordination and clash detection, there are many uses that are not being utilized to their fullest potential. With the BIM Project Execution Plan, developed by Penn State, several companies are using it as a resource and looking further into the multiple BIM uses. This is a topic that I have been very interested in, due to Dr. Messner's class on BIM Execution. In this class, as well as in this break-out session, the implementation of the variety of uses is described in depth.

For the afternoon break-out session, the topics included the following:

1. The Smart Grid: Energy impacts in the building industry
2. Carrying BIM to the field- new responsibilities, new roles, new competencies
3. Operations & Maintenance Process Integration

For the afternoon session, I attended the discussion on carrying BIM to the field. While this topic was addressed briefly in the morning session, it was reviewed in more depth for this conversation. BIM has transformed the field side of the construction industry also. With the use of intelligently developed models and programs such as Latista, contractors and construction managers are able to employ this technology to maximize benefits. BIM has been incorporated into all levels of field operations. Some of the main benefits discussed included the use of BIM for close-out and commissioning. By using the available technology, the project team is able to save time that was typically spent during close-out operations. Systems like Latista are being used for punch-list reviews and commissioning. These systems involve the use of tablet PCs on the jobsite. This improves the efficiency of jobsite personnel. With constant access to technology, there is no time lost in traveling to and from the construction trailers. Along with these procedures, BIM is also being used for 4D planning throughout the entire construction process.

After the break-out sessions, an activity on negotiations was held. During this time, the attendees were divided into small groups to take part in a game, which was only possible to complete through negotiation. After my group was given a specific amount of time to devise a plan for the success of both parties, all groups discussed their actions. In the end, it was seen that the group that put together a scheme to forfeit all benefits to one side ended up benefiting the most overall. This is a plan of attack that was discussed by several of the groups, but only performed by one. In the end, it showed that negotiating can be a very complicated process, and one that can be looked at in several different ways. It also allowed the teams to view different levels of creativity that may not have been discussed by their group.

To conclude the 2010 Roundtable, a panel discussion took place between the students and professionals. The discussion was based on finding a job in a poor economy. This conversation allowed students and professionals to see how the other viewed the job search in tough economic times. Although the economy is known to be in a recession, it seems as if both the employers and students are optimistic about the near future. Employers made it evident that hiring is something that will always take place, despite the economic times. The employer's need to prevent a gap in the age of employees explains just why hiring still takes place. Students also provided the fact that the career fair left many of them optimistic. This is due to the overwhelming interest that construction companies seem to have towards graduating seniors. In the end, it appears as if the economy is headed in a positive direction. Although work is more difficult to obtain, the market seems to be shifting towards a recovery. While employers do believe that it will take a long time before the industry is completely recovered, it is headed that way.

Throughout these discussions and activities, I was able to understand the positions of several different members of the construction industry. There were a few particular topics that I considered as the most interesting. First, the idea of prefabricated mechanical spaces was an attractive topic. While the idea of prefabrication is a concept that has been presented to me before, the subject of prefabricating ceiling mechanical work was one that was not brought to my attention. It was also interesting because the use of these prefabricated systems was discussed for a hospital project. With my thesis project being based on a hospital addition, it seems as if this is something that could be implemented for the Butler Health System New Inpatient Tower. This method of assembling the mechanical spaces would save significant time on a hospital project if implemented correctly. This is due to the high complexities of hospital mechanical systems.

Another interesting topic was the idea of a project employing several different BIM uses. For the Butler Hospital project, BIM was used as a 3D coordination tool. While this was a detailed process, it is apparent that other uses could have been used for this project. BIM could have been used for existing conditions modeling, cost estimation, site planning, engineering analysis, and space management among others. It is clear that BIM can be used for many more uses other than 3D coordination. Because of this, I may look into this for Butler Hospital. If the process is thoroughly implemented, the benefits can be extraordinary.

Because of these discussions, I was able to observe the viewpoint of several members of the industry. With these differing viewpoints on varying sectors of technology, I was able to gain several potential topics for my thesis project. Some of the contacts that would benefit my research include:

1. Chuck Tomasco- Truland Systems
2. Jim Salvino- Clark Construction
3. Bill Moyer- Davis Construction
4. Bob Grottenthaler- Barton Malow

For the topics that were of the most interest for my thesis project, these seem to be the top contacts. It is also clear that almost every industry professional in attendance would be a beneficial person to discuss issues with.

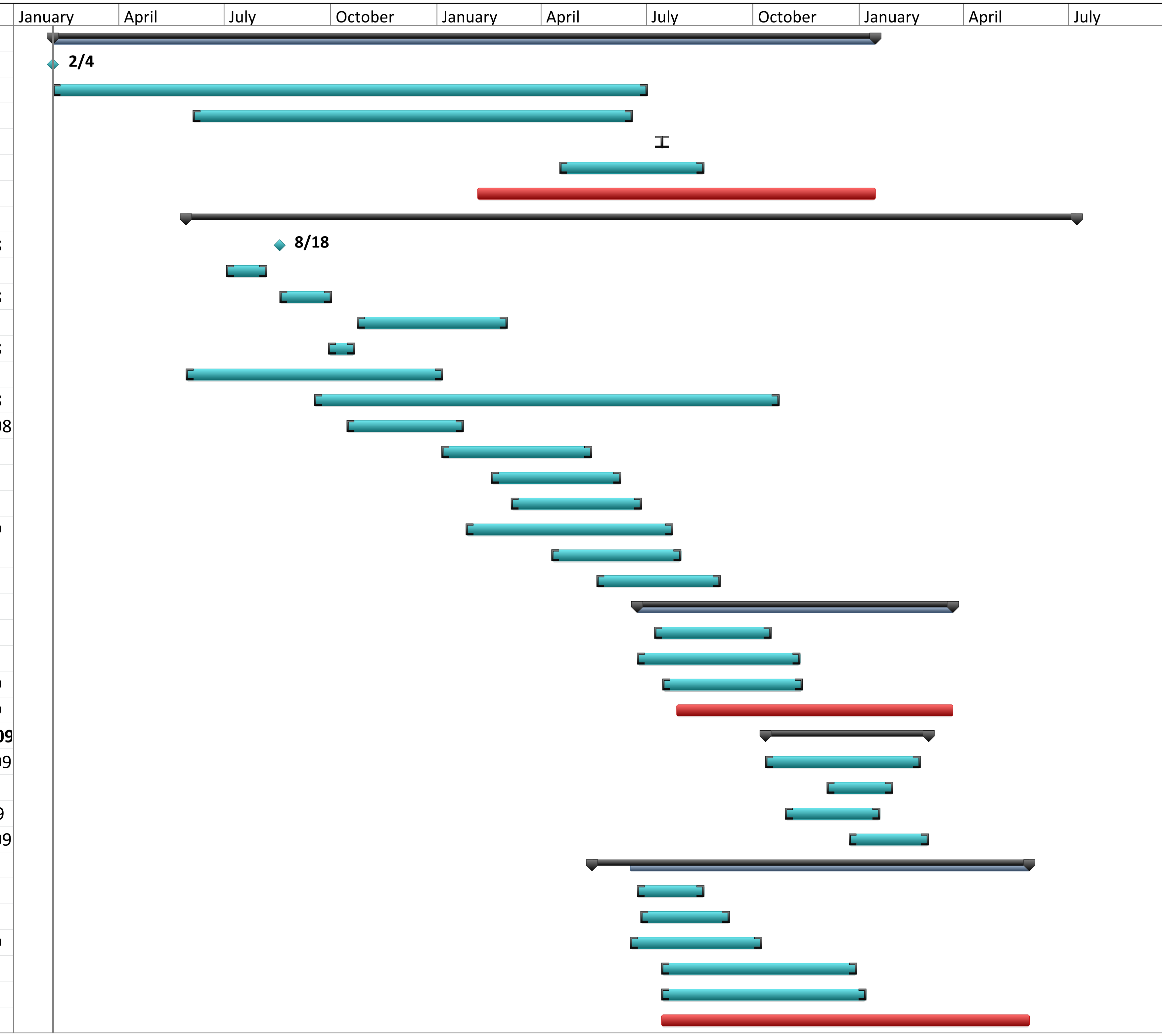
In the end, the entire conference was a very beneficial experience. By interacting with professionals in the industry, it allowed the students to gain a point of view that is not typically given to them. While current technologies are constantly discussed in the classroom, the implementation in real world applications is interesting. Also, the industry professionals are able to provide information from both sides of the table. While these new technologies are usually spoke about in high regard, it is interesting to see where glitches still exist. If not for this crucial interaction with these professionals, students would not be able to fully understand the current issues in the construction industry.

Appendix A

Detailed Project Schedule

Butler Health System- New Inpatient Tower

ID	Task Name	Duration	Start
1	**Preconstruction/Procurement**	**509 days**	**Mon 2/4/08**
2	Design Start	0 days	**Mon 2/4/08**
3	Schematic Design & Design Development	368 days	Mon 2/4/08
4	Construction Documents	272 days	Wed 6/4/08
5	GMP Development	1 day	Tue 7/14/09
6	BIM Coordination	89 days	Thu 4/16/09
7	Submittals and Procurement	246 days	Thu 2/5/09
8	**Construction**	**550 days**	**Thu 5/29/08**
9	Start Construction	0 days	Mon 8/18/08
10	Access Drive Design and Construction	25 days	Thu 7/3/08
11	Mass Excavation	33 days	Mon 8/18/08
12	Construct Foundations	92 days	Fri 10/24/08
13	Sanitary and Storm Line Installation	17 days	Mon 9/29/08
14	Site Electrical Relocation	158 days	Thu 5/29/08
15	Water/Gas/Oxygen Relocations	288 days	Wed 9/17/08
16	Install Caissons	73 days	Wed 10/15/08
17	Structural Steel Fabrication	94 days	Mon 1/5/09
18	Structural Steel Erection	80 days	Tue 2/17/09
19	Decking, Detailing, and Shear Stud Work	81 days	Fri 3/6/09
20	Concrete Slab on Grade	129 days	Mon 1/26/09
21	Concrete on Metal Deck	80 days	Fri 4/10/09
22	Spray on Fire Proofing	77 days	Tue 5/19/09
23	**Masonry Work**	**195 days**	**Tue 6/23/09**
24	Entire Floor Masonry	73 days	Wed 7/8/09
25	West Elevation Masonry	101 days	Tue 6/23/09
26	East and South Elevation Levels 5-8	87 days	Wed 7/15/09
27	North Elevation Masonry	171 days	Mon 7/27/09
28	**Windows and Curtain Wall Installation**	**101 days**	**Mon 10/12/09**
29	West Elevation	96 days	Mon 10/12/09
30	Northeast Elevation	41 days	Fri 12/4/09
31	North Elevation	58 days	Thu 10/29/09
32	South Elevation	49 days	Wed 12/23/09
33	**Vertical Work**	**270 days**	**Fri 5/15/09**
34	Service Elevators 8	42 days	Tue 6/23/09
35	Service Elevator 9	55 days	Fri 6/26/09
36	Service Elevator 10	82 days	Wed 6/17/09
37	Service Elevators 4&5	121 days	Tue 7/14/09
38	Trauma Elevator 3	127 days	Tue 7/14/09
39	Passenger Elevators 6 & 7	228 days	Tue 7/14/09

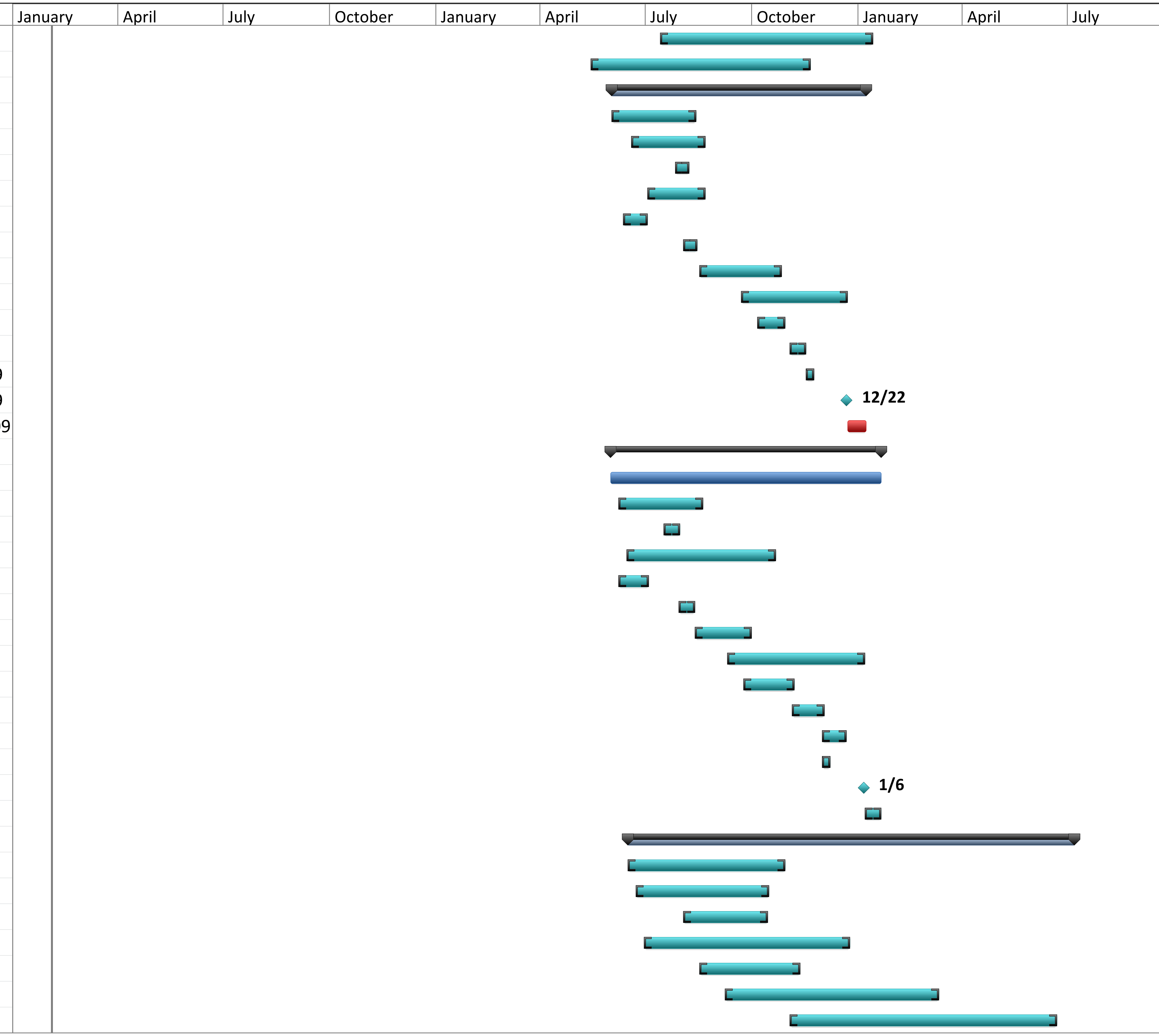


Project: Butler Hospital Inpatient
Date: October 27th, 2010

Task	Project Summary	Inactive Milestone	Manual Summary Rollup	Deadline
Split	External Tasks	Inactive Summary	Manual Summary	Critical
Milestone	External Milestone	Manual Task	Start-only	Critical Split
Summary	Inactive Task	Duration-only	Finish-only	Progress

Butler Health System- New Inpatient Tower

ID	Info	Task	Task Name	Duration	Start
40		Manual	Passenger elevators 1 & 2	132 days	Tue 7/14/09
41		Manual	Stair Installation	136 days	Fri 5/15/09
42		Manual	**Ground Floor Work**	**158 days**	**Tue 6/2/09**
43		Manual	Mechanical Rough-In	53 days	Tue 6/2/09
44		Manual	Plumbing Rough-In	46 days	Fri 6/19/09
45		Manual	Fire Protection Rough-In	10 days	Mon 7/27/09
46		Manual	Electrical Rough-In	36 days	Fri 7/3/09
47		Manual	Construct Masonry Walls	15 days	Fri 6/12/09
48		Manual	Interior Studs and Door Frames	10 days	Mon 8/3/09
49		Manual	Ceilings and Drywall Installation	51 days	Mon 8/17/09
50		Manual	Prime and Paint Walls/Ceilings	66 days	Tue 9/22/09
51		Manual	Finish System Trim	18 days	Tue 10/6/09
52		Manual	Flooring Installation	10 days	Tue 11/3/09
53		Manual	Doors and Hardware	5 days	Tue 11/17/09
54		Manual	Substantial Completion Ground Floor	0 days	Tue 12/22/09
55		Manual	Balancing and Life Safety Testing	12 days	Wed 12/23/09
56		Auto	**First Floor Work**	**168 days**	**Mon 6/1/09**
57	Table	Auto	Mechanical Rough-In and Mechanical Room	168 days	Mon 6/1/09
58		Manual	Plumbing Rough-In	53 days	Mon 6/8/09
59		Manual	Fire Protection Rough-In	10 days	Fri 7/17/09
60		Manual	Electrical Rough-In and Electrical Room	93 days	Mon 6/15/09
61		Manual	Construct Masonry Walls	20 days	Mon 6/8/09
62		Manual	Interior Studs and Door Frames	10 days	Thu 7/30/09
63		Manual	Ceilings and Drywall Installation	35 days	Thu 8/13/09
64		Manual	Prime and Paint Walls/Ceilings	85 days	Thu 9/10/09
65		Manual	Finish System Trim and Casework	32 days	Thu 9/24/09
66		Manual	Flooring Installation	20 days	Thu 11/5/09
67		Manual	Wall Protection and Misc. Specialties	15 days	Tue 12/1/09
68		Manual	Doors and Hardware	5 days	Tue 12/1/09
69		Manual	Substantial Completion Ground Floor	0 days	Wed 1/6/10
70		Manual	Balancing and Life Safety Testing	10 days	Thu 1/7/10
71		Manual	**Second Floor Work**	**276 days**	**Tue 6/16/09**
72		Manual	Mechanical Rough-In	98 days	Tue 6/16/09
73		Manual	Plumbing Rough-In	83 days	Tue 6/23/09
74		Manual	Fire Protection Rough-In	53 days	Mon 8/3/09
75		Manual	Electrical Rough-In	128 days	Tue 6/30/09
76		Manual	Interior Studs and Door Frames	63 days	Mon 8/17/09
77		Manual	Ceilings and Drywall Installation	133 days	Tue 9/8/09
78		Manual	Prime and Paint Walls/Ceilings	165 days	Tue 11/3/09

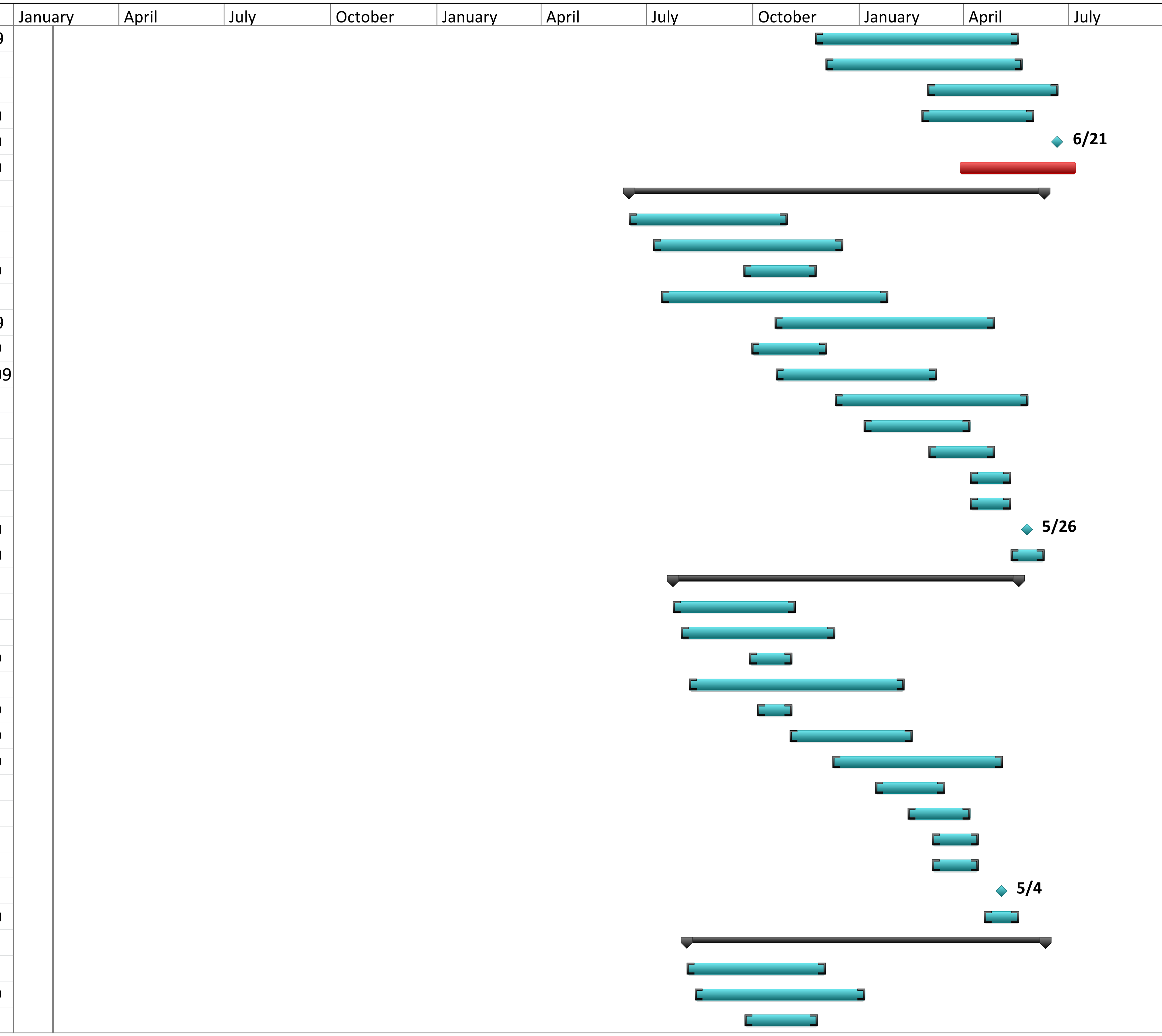


Project: Butler Hospital Inpatient
Date: October 27th, 2010

Task		Project Summary		Inactive Milestone		Manual Summary Rollup		Deadline	
Split		External Tasks		Inactive Summary		Manual Summary		Critical	
Milestone		External Milestone		Manual Task		Start-only		Critical Split	
Summary		Inactive Task		Duration-only		Finish-only		Progress	

Butler Health System- New Inpatient Tower

ID	Task Mode	Task Name	Duration	Start
79		Finish System Trim and Casework	126 days	Tue 11/24/09
80		Flooring Installation	122 days	Thu 12/3/09
81		Wall Protection and Misc. Specialties	81 days	Mon 3/1/10
82		Doors and Hardware	69 days	Wed 2/24/10
83		Substantial Completion Ground Floor	0 days	Mon 6/21/10
84		Balancing and Life Safety Testing	72 days	Mon 3/29/10
85		**Third Floor Work**	**257 days**	**Tue 6/16/09**
86		Mechanical Rough-In	99 days	Tue 6/16/09
87		Plumbing Rough-In	118 days	Tue 7/7/09
88		Fire Protection Rough-In	45 days	Wed 9/23/09
89		Electrical Rough-In	140 days	Tue 7/14/09
90		Build Out Operating Rooms	136 days	Tue 10/20/09
91		Interior Studs and Door Frames	47 days	Wed 9/30/09
92		Ceilings and Drywall Installation	99 days	Wed 10/21/09
93		Prime and Paint Walls/Ceilings	119 days	Fri 12/11/09
94		Finish System Trim and Casework	66 days	Tue 1/5/10
95		Flooring Installation	41 days	Tue 3/2/10
96		Wall Protection and Misc. Specialties	25 days	Wed 4/7/10
97		Doors and Hardware	25 days	Wed 4/7/10
98		Substantial Completion Ground Floor	0 days	Wed 5/26/10
99		Balancing and Life Safety Testing	21 days	Wed 5/12/10
100		**Fifth Floor Work**	**213 days**	**Fri 7/24/09**
101		Mechanical Rough-In and Mechanical Room	76 days	Fri 7/24/09
102		Plumbing Rough-In	95 days	Fri 7/31/09
103		Fire Protection Rough-In	27 days	Mon 9/28/09
104		Electrical Rough-In	132 days	Fri 8/7/09
105		Interior Studs and Door Frames	22 days	Mon 10/5/09
106		Ceilings and Drywall Installation	76 days	Mon 11/2/09
107		Prime and Paint Walls/Ceilings	105 days	Wed 12/9/09
108		Finish System Trim and Casework	42 days	Fri 1/15/10
109		Flooring Installation	38 days	Fri 2/12/10
110		Wall Protection and Misc. Specialties	28 days	Fri 3/5/10
111		Doors and Hardware	28 days	Fri 3/5/10
112		Substantial Completion Ground Floor	0 days	Tue 5/4/10
113		Balancing and Life Safety Testing	22 days	Mon 4/19/10
114		**Sixth Floor Work**	**222 days**	**Wed 8/5/09**
115		Mechanical Rough-In	86 days	Wed 8/5/09
116		Plumbing Rough-In	105 days	Wed 8/12/09
117		Fire Protection Rough-In	45 days	Thu 9/24/09

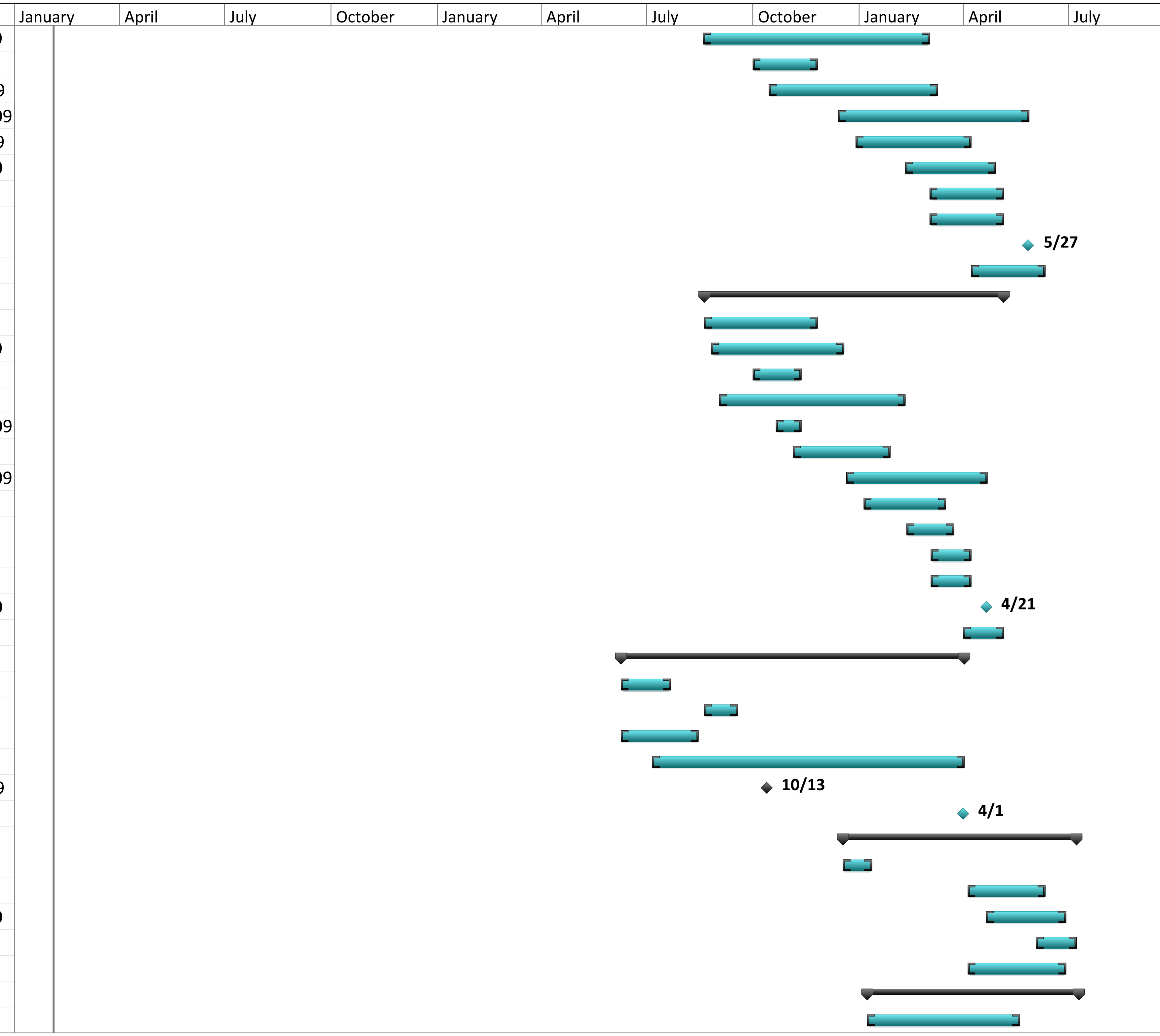


Project: Butler Hospital Inpatient
Date: October 27th, 2010

Task	Project Summary	Inactive Milestone	Manual Summary Rollup	Deadline
Split	External Tasks	Inactive Summary	Manual Summary	Critical
Milestone	External Milestone	Manual Task	Start-only	Critical Split
Summary	Inactive Task	Duration-only	Finish-only	Progress

Butler Health System- New Inpatient Tower

ID		Task	Task Name	Duration	Start
118			Electrical Rough-In	140 days	Wed 8/19/09
119			Interior Studs and Door Frames	40 days	Thu 10/1/09
120			Ceilings and Drywall Installation	104 days	Thu 10/15/09
121			Prime and Paint Walls/Ceilings	119 days	Mon 12/14/09
122			Finish System Trim and Casework	72 days	Tue 12/29/09
123			Flooring Installation	56 days	Wed 2/10/10
124			Wall Protection and Misc. Specialties	46 days	Wed 3/3/10
125			Doors and Hardware	46 days	Wed 3/3/10
126			Substantial Completion Ground Floor	0 days	Thu 5/27/10
127			Balancing and Life Safety Testing	46 days	Thu 4/8/10
128			**Seventh Floor Work**	**185 days**	**Thu 8/20/09**
129			Mechanical Rough-In and Penthouse Mains	70 days	Thu 8/20/09
130			Plumbing Rough-In	83 days	Wed 8/26/09
131			Fire Protection Rough-In	30 days	Thu 10/1/09
132			Electrical Rough-In	115 days	Wed 9/2/09
133			Interior Studs and Door Frames	16 days	Wed 10/21/09
134			Ceilings and Drywall Installation	60 days	Thu 11/5/09
135			Prime and Paint Walls/Ceilings	88 days	Mon 12/21/09
136			Finish System Trim and Casework	51 days	Tue 1/5/10
137			Flooring Installation	29 days	Thu 2/11/10
138			Wall Protection and Misc. Specialties	25 days	Thu 3/4/10
139			Doors and Hardware	25 days	Thu 3/4/10
140			Substantial Completion Ground Floor	0 days	Wed 4/21/10
141			Balancing and Life Safety Testing	25 days	Thu 4/1/10
142			**Roofing**	**213 days**	**Tue 6/9/09**
143			Studs and Sheathing	31 days	Tue 6/9/09
144			Metal Paneling	21 days	Thu 8/20/09
145			Complete Temporary Roofing	49 days	Tue 6/9/09
146			Complete Permanent Roofing	194 days	Mon 7/6/09
147			Building Dry-In	0 days	Tue 10/13/09
148			Building Watertight	0 days	Thu 4/1/10
149			**Final Sitework**	**144 days**	**Fri 12/18/09**
150			Exterior and Site Lighting	17 days	Fri 12/18/09
151			Seating Garden Area	49 days	Mon 4/5/10
152			North Parking Lot	49 days	Wed 4/21/10
153			ER Entry	25 days	Thu 6/3/10
154			Site Concrete and Paving	61 days	Mon 4/5/10
155			**Turnover/Commissioning**	**131 days**	**Fri 1/8/10**
156			Complete Punchlist	94 days	Fri 1/8/10

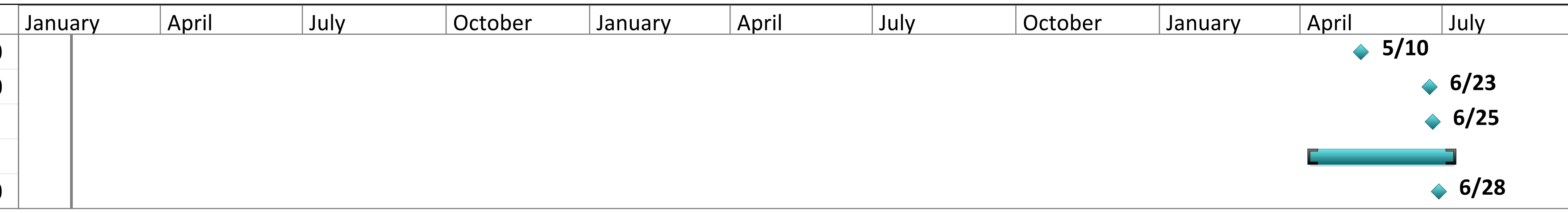


Project: Butler Hospital Inpatient
Date: October 27th, 2010

Task		Project Summary		Inactive Milestone		Manual Summary Rollup		Deadline	
Split		External Tasks		Inactive Summary		Manual Summary		Critical	
Milestone		External Milestone		Manual Task		Start-only		Critical Split	
Summary		Inactive Task		Duration-only		Finish-only		Progress	

Butler Health System- New Inpatient Tower

ID	Task Mode	Task Name	Duration	Start
157		Turnover Ground-2nd Floors	0 days	Mon 5/10/10
158		Turnover 3rd-5th Floors	0 days	Wed 6/23/10
159		Turnover 6th-7th Floors	0 days	Fri 6/25/10
160		Commissioning	69 days	Tue 4/6/10
161		Patient Go Live Date	0 days	Mon 6/28/10

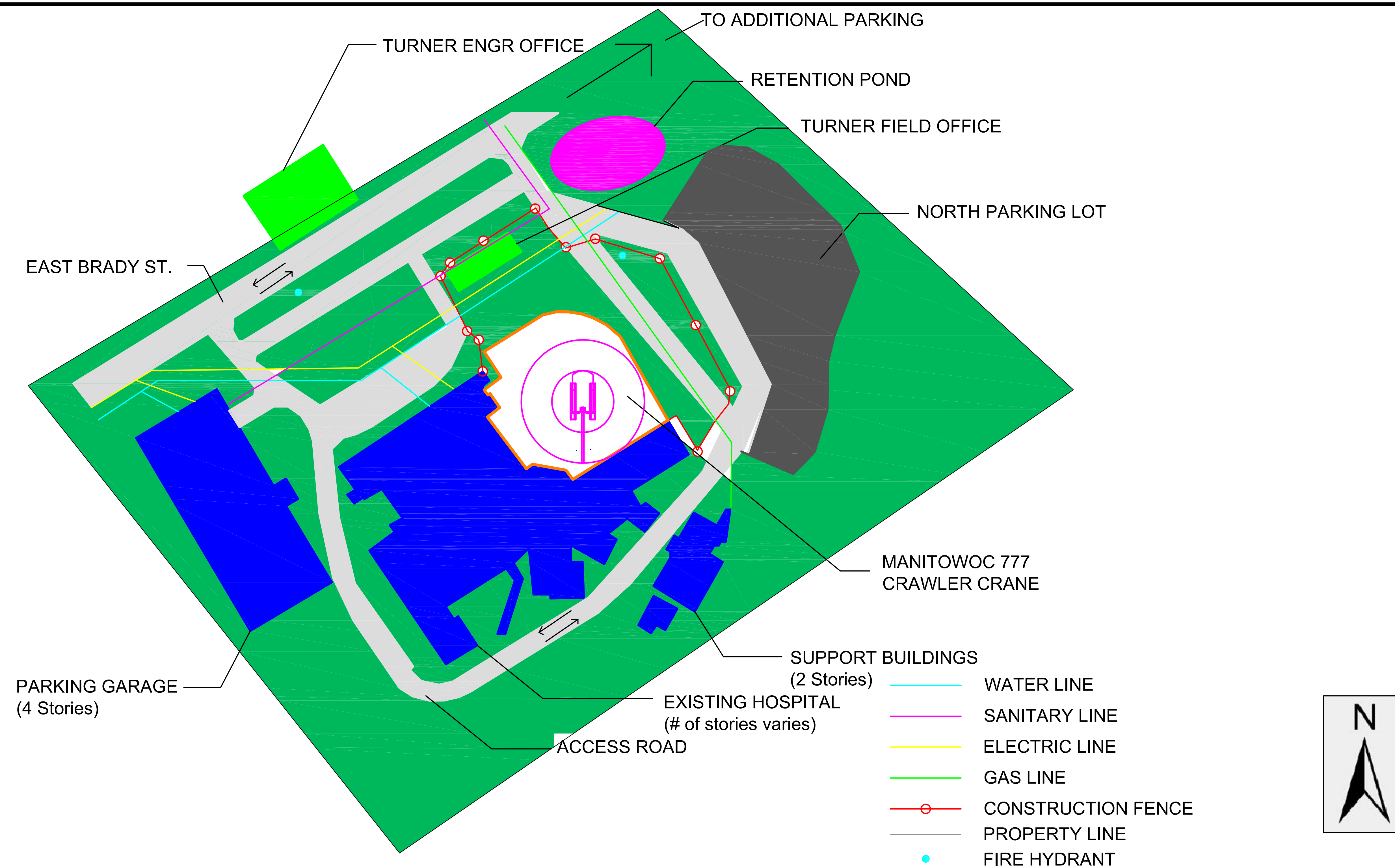


Project: Butler Hospital Inpatient
Date: October 27th, 2010

Task	Project Summary	Inactive Milestone	Manual Summary Rollup	Deadline
Split	External Tasks	Inactive Summary	Manual Summary	Critical
Milestone	External Milestone	Manual Task	Start-only	Critical Split
Summary	Inactive Task	Duration-only	Finish-only	Progress

Appendix B

Site Layout Planning



PROJECT: BUTLER HOSPITAL INPATIENT TOWER	TITLE: STEEL ERECTION SITEPLAN		SHEET: 1
LOCATION: BUTLER, PA	DATE: 10/27/2010	REVISIONS: 1 2 3	
YOUR NAME: CHRIS DILORENZO	SCALE: NTS		
AE SENIOR THESIS			

Appendix C

Detailed Structural Systems Estimate

Drilled Caissons

CSI Masterformat 31 63 26.13

Drilled Pier	Diameter	Number of Piers	Depth	Cost/Linear Foot	Total Cost
Area A					
DP30	30	2	11	$29.40	$646.80
DP42	42	3	11	$83.00	$2,739.00
DP48	48	4	11	$99.60	$4,382.40
DP54	54	10	11	$117.80	$12,958.00
DP60	60	1	11	$136.00	$1,496.00
DP66	66	1	11	$158.75	$1,746.25
LDP66	66	1	11	$158.75	$1,746.25
LDP72	72	10	11	$181.50	$19,965.00
LDP78	78	1	11	$206.25	$2,268.75
Area B					
DP36	36	9	25	$66.40	$14,940.00
DP42	42	9	25	$83.00	$18,675.00
DP48	48	5	25	$99.60	$12,450.00
LDP60	60	18	25	$136.00	$61,200.00
LDP78	78	1	25	$206.25	$5,156.25
Area C					
DP30	30	5	48	$29.40	$7,056.00
DP36	36	16	48	$66.40	$50,995.20
DP42	42	8	48	$83.00	$31,872.00
DP48	48	5	48	$99.60	$23,904.00
DP72	72	1	48	$181.50	$8,712.00
LDP72	78	3	48	$181.50	$26,136.00
LDP78	78	2	48	$206.25	$19,800.00
					$328,844.90

Table 1- Drilled Caisson Estimate

Foundation Walls

Formwork: CSI Masterformat 03 11 13.85

Formwork	Length (ft)	Height (ft)	SFCA	Cost/SFCA	Total Cost
Ground Floor					
East Wall-1	101.25	1.333	269.9325	$9.58	$2,585.95
East Wall-2	15	1.833	54.99	$9.58	$526.80
North Wall-1	39	1.833	142.974	$9.58	$1,369.69
North Wall-2	45	1.333	119.97	$9.58	$1,149.31
1st Floor					
Total Walls	340	1.333	906.44	$9.58	$8,683.70
					$14,315.46

Table 2.1: Foundation Walls Formwork

Concrete Placement: CSI Masterformat03 31 05.70

Pouring	Length (ft)	Thickness (ft)	Height (ft)	Volume(CY)	Cost/CY	Total Cost
Ground Floor						
East Wall-1	101.25	1.333	14.667	73.3166663	$28.65	$2,100.52
East Wall-2	15	1.833	14.667	14.935895	$28.65	$427.91
North Wall-1	39	1.833	14.667	38.833327	$28.65	$1,112.57
North Wall-2	45	1.333	14.667	32.585185	$28.65	$933.57
1st Floor						
Total Walls	340	1.333	14.667	246.199176	$28.65	$7,053.61
						$11,628.18

Table 2.2: Foundation Walls Concrete Placement

Concrete Slab Work

Slab on Grade Formwork: CSI Masterformat 03 11 13.65

Formwork					
Floor	**Perimeter(LF)**	**Height(LF)**	**SFCA (SF)**	**Cost/SFCA**	**Total Cost**
Slab on Grade					
Ground Floor	410	0.541666667	222.0833333	$3.60	**$799.50**

Table 3.1: Slab on Grade Formwork

Elevated Slabs Formwork: CSI Masterformat 03 11 13.35

Formwork					
Elevated Slabs	**Perimeter(LF)**	**Height(LF)**	**Total SFCA**	**Cost/SFCA**	**Total Cost**
First Floor	945	0.541666667	511.875	$2.79	$1,428.13
Second Floor	890	0.541666667	482.083333	$2.79	$1,345.01
Third Floor	900	0.541666667	487.5	$2.79	$1,360.13
Fifth Floor	930	0.541666667	503.75	$2.79	$1,405.46
Fifth Floor Penthouse	270	0.541666667	146.25	$2.79	$408.04
Sixth Floor	930	0.541666667	503.75	$2.79	$1,405.46
Seventh Floor	930	0.541666667	503.75	$2.79	$1,405.46
Roof	165	0.541666667	89.375	$2.79	$249.36
					$9,007.05

Table 3.2: Elevated Slabs Formwork

Welded Wire Fabric: CSI Masterformat 03 22 05.50

Welded Wire Fabric			
Floor	**Area (CSF)**	**Cost/CSF**	**Total Cost**
Ground Floor	81.05	$43.90	$3,558.10
First Floor	221	$43.90	$9,701.90
Second Floor	449	$43.90	$19,711.10
Third Floor	435.5	$43.90	$19,118.45
Fifth Floor	267	$43.90	$11,721.30
Sixth Floor	267	$43.90	$11,721.30
Seventh Floor	267	$43.90	$11,721.30
			$87,253.45

Table 3.3: Welded Wire Fabric

Metal Decking: CSI Masterformat 05 31 13

Metal Decking			
Floor	**Area(SF)**	**Cost/SF**	**Total Cost**
First Floor	22100	$1.79	$39,559.00
Second Floor	44900	$1.79	$80,371.00
Third Floor	43550	$1.79	$77,954.50
Fifth Floor	26700	$1.79	$47,793.00
Sixth Floor	26700	$1.79	$47,793.00
Seventh Floor	26700	$1.79	$47,793.00
Roof	26700	$1.44	$38,448.00
			$379,711.50

Table 3.4: Metal Decking

Reinforcing Steel: CSI Masterformat 03 21 10.60

Reinforcing Steel							
Floor	**Perimeter**	**Bars**	**Total Bar Length (LF)**	**Lbs./LF**	**Total Weight (tons)**	**Cost/Ton**	**Total Cost**
First Floor	945	(4)-#4	3780	0.668	1.26252	$1,490.00	$1,881.15
Second Floor	890	(4)-#4	3560	0.668	1.18904	$1,490.00	$1,771.67
Third Floor	900	(4)-#4	3600	0.668	1.2024	$1,490.00	$1,791.58
Fifth Floor	930	(4)-#4	3720	0.668	1.24248	$1,490.00	$1,851.30
Sixth Floor	930	(4)-#4	3720	0.668	1.24248	$1,490.00	$1,851.30
Seventh Floor	930	(8)-#4	7440	0.668	2.48496	$1,490.00	$3,702.59
							$12,849.58

Table 3.5 Reinforcing Steel

Slab on Grade Concrete Pouring: CSI Masterformat 03 31 05.40

Concrete Pouring	Area (SF)	Cost/SF	Total Cost
Ground-SOG	8105	$2.74	$22,207.70

Table 3.6: Slab on Grade Concrete Pouring

Elevated Slabs Concrete Pouring: CSI Masterformat 03 31 05.70

Concrete Pouring	**Area (SF)**	**Depth (Feet)**	**Volume (CY)**	**Cost/CY**	**Total Cost**
First Floor	22100	0.541666667	443.3641975	$19.62	$8,698.81
Second Floor	44900	0.541666667	900.7716049	$19.62	$17,673.14
Third Floor	43550	0.541666667	873.6882716	$19.62	$17,141.76
Fifth Floor	26700	0.541666667	535.6481481	$19.62	$10,509.42
Fifth Floor Penthouse	3560	0.541666667	71.41975309	$19.62	$1,401.26
Sixth Floor	26700	0.541666667	535.6481481	$19.62	$10,509.42
Seventh Floor	26700	0.541666667	535.6481481	$19.62	$10,509.42
Roof	1240	0.541666667	24.87654321	$19.62	$488.08
					$76,931.29

Table 3.7: Elevated Slabs Concrete Pouring

Structural Steel: CSI Masterformat 05 12 23

Steel Member Size	First Floor	Second Floor	Third Floor	Fifth Floor	Sixth Floor	Seventh Floor(LF)	Roof	Rooftop (AHUs)	Total
W8x15	0	10	28	28	0	0	30	0	96
W8x18	0	0	0	20	0	0	0	0	20
W10x17	0	22	26	0	60	60	0	0	168
W12x16	0	0	150	0	75	0	326	0	551
W12x19	262	657	494	595	801	801	371	0	3981
W12x22	0	0	20	18	0	0	0	0	38
W12x26	0	0	378	0	0	0	40	472	890
W12x40	0	0	60	0	0	0	0	0	60
W14x22	108	122	250	150	145	145	97	0	1017
W14x30	0	0	0	0	0	0	65	0	65
W14x90	0	0	0	120	0	0	0	0	120
W16x26	336	1323	1264	1285	931	541	127	33	5840
W16x31	0	30	536	26	566	566	65	0	1789
W16x36	0	0	0	0	0	0	60	0	60
W16x40	0	0	0	0	0	0	20	504	524
W16x50	0	0	40	0	0	0	0	0	40
W16x67	0	0	0	0	0	0	0	40	40
W18x35	116	272	284	255	472	289	15	0	1703
W18x40	28	28	1818	2016	166	166	1766	0	5988
W21x44	150	663	780	959	728	728	264	0	4272
W21x50	30	0	290	214	176	176	494	0	1380
W21x57	0	0	28	0	0	0	0	0	28
W21x62	0	0	0	0	0	0	60	0	60
W24x55	100	263	276	362	250	250	398	0	1899
W24x62	0	118	228	110	60	60	108	0	684
W24x66	30	0	0	0	0	0	0	0	30
W24x68	44	144	134	240	0	0	114	0	676
W24x76	0	30	90	286	260	260	136	0	1062
W24x84	0	0	0	86	0	0	0	0	86
W27x84	60	95	245	65	65	65	294	0	889
W30x90	30	0	30	0	30	30	241	0	361
W30x99	0	0	0	0	0	0	60	0	60
W30x108	0	0	0	0	0	380	0	0	380
W30x116	30	0	0	0	0	0	0	0	30
W33x118	30	0	0	0	0	0	0	0	30
W33x130	0	0	0	0	0	0	30	0	30
C12x20.7	0	0	0	0	0	0	0	475	475

Table 4.1: Steel Beam Takeoff- All lengths are in Linear Feet

Steel Beams Costs			
Steel Member Size	**Total Linear Feet**	**Total Costs/LF**	**Total Costs**
W8x15	96	$25.67	$2,464.32
W8x18	20	$28.00	$560.00
W10x17	168	$25.67	$4,312.56
W12x16	551	$24.65	$13,582.15
W12x19	3981	$24.65	$98,131.65
W12x22	38	$31.85	$1,210.30
W12x26	890	$36.85	$32,796.50
W12x40	60	$53.00	$3,180.00
W14x22	1017	$36.32	$36,937.44
W14x30	65	$41.75	$2,713.75
W14x90	120	$116.77	$14,012.40
W16x26	5840	$36.27	$211,816.80
W16x31	1789	$43.25	$77,374.25
W16x36	60	$57.00	$3,420.00
W16x40	524	$62.50	$32,750.00
W16x50	40	$67.35	$2,694.00
W16x67	40	$88.62	$3,544.80
W18x35	1703	$49.29	$83,940.87
W18x40	5988	$55.29	$331,076.52
W21x44	4272	$59.73	$255,166.56
W21x50	1380	$67.23	$92,777.40
W21x57	28	$76.00	$2,128.00
W21x62	60	$81.87	$4,912.20
W24x55	1899	$73.01	$138,645.99
W24x62	684	$81.51	$55,752.84
W24x66	30	$87.00	$2,610.00
W24x68	676	$89.01	$60,170.76
W24x76	1062	$99.01	$105,148.62
W24x84	86	$109.15	$9,386.90
W27x84	889	$108.67	$96,607.63
W30x90	361	$120.00	$43,320.00
W30x99	60	$127.63	$7,657.80
W30x108	380	$138.63	$52,679.40
W30x116	30	$148.80	$4,464.00
W33x118	30	$150.73	$4,521.90
W33x130	30	$165.91	$4,977.30
C12x20.7	475	$40.48	$19,228.00
			$1,916,673.61

Table 4.2: Steel Beams Cost

Steel Column Costs			
Steel Member Size	**Total Linear Feet**	**Total Costs/LF**	**Total Costs**
W8x40	58.667	$58.00	$3,402.69
W12x40	101.667	$60.00	$6,100.02
W12x45	58.667	$63.00	$3,696.02
W12x50	101.667	$66.14	$6,724.26
W12x53	132	$75.00	$9,900.00
W12x58	44	$77.70	$3,418.80
W12x65	58.667	$90.00	$5,280.03
W12x72	43	$95.67	$4,113.81
W12x87	29.333	$112.35	$3,295.56
W12x96	57.667	$120.00	$6,920.04
W14x43	141.4166	$58.27	$8,240.35
W14x61	747.25	$85.00	$63,516.25
W14x68	441.833	$90.00	$39,764.97
W14x74	146.666	$95.85	$14,057.94
W14x82	281.5	$105.85	$29,796.78
W14x90	803.583	$111.00	$89,197.71
W14x99	29.333	$120.00	$3,519.96
W14x109	351	$140.00	$49,140.00
W14x120	102.667	$153.45	$15,754.25
W14x132	58.667	$160.00	$9,386.72
W14x145	29.333	$170.00	$4,986.61
W14x159	29.333	$185.00	$5,426.61
W14x176	29.333	$200.00	$5,866.60
			$391,505.96

Table 4.3: Steel Columns Costs

Complete Structural System Estimate

CSI Number	Activity	Description	Total Cost
03 11 13.35	Formwork-Elevated Slabs	Edge forms, to 6" high	$9,007.05
03 11 13.65	Formwork-Slab on Grade	Edge forms, wood, 4 use,7-12" high	$799.50
03 11 13.85	Foundation Wall Formwork	Wall, job-built plywood, 8-16' high	$14,315.46
03 21 10.60	Uncoated Reinforcing Steel	Elevated Slabs (#4-#7)	$12,849.58
03 22 05.50	Welded Wire Fabric	6x6-W2.1x2.1 30 lb per CSF	$87,253.45
03 30 53.40	Concrete Pouring-Slab on Grade	3500 PSI, including finish, 6" thick	$22,207.70
03 31 05.70	Concrete Pouring-Elevated Slabs	6-10" thick, pumped	$76,931.29
03 31 05.70	Placing Concrete-Foundation Walls	12" thick, pumped	$11,628.18
05 12 23	Structural Steel Beams	Varying Sizes	$1,916,673.61
05 12 23	Structural Steel Columns	Varying Sizes	$391,505.96
05 31 13	Metal Decking	22 Gauge (Floor and Roof)	$379,711.50
31 63 26.13	Fixed End Caisson Piles	Open style, machine drilled	$328,844.90
			$3,251,728.18

Table 5: Structural System Breakdown Estimate

Appendix D

General Conditions Estimate

General Conditions Estimate

General Conditions Estimate				
Line Item	**Unit Rate**	**Unit**	**Quantity**	**Total Cost**
Temporary Facilities	$68,717.00	Each	1	$68,717.00
Temporary Utilities	$111.89	Weeks	114	$12,755.00
Protection and Safety	$168.15	Weeks	114	$19,169.00
General Expenses	$3,626.18	Weeks	114	$413,385.00
Project Staff	$37,590.80	Weeks	114	$4,285,351.00
Fringes/Taxes/Insurance	-	-	-	$596,519.00
			Total GC Cost	**$5,395,896.00**

Table 1: General Conditions Estimate

Contingency Costs	
Contingency	**Cost**
Design/Development	$416,865.00
Construction	$1,666,572.00
Total Contingency Cost	**$2,083,437.00**

Table 2: Contingency Costs

Onsite Staff Positions and Rates		
Staff Position	**Base Monthly**	**Hourly Billing Rate**
Project Manager	$9,448.00	$81.71
Project Engineer	$8,117.00	$70.20
MEP Superintendent	$5,800.00	$50.16
Senior Engineer	$8,494.00	$73.46
Assistant Engineer	$4,200.00	$36.32
Onsite Safety Engineer	$6,574.00	$56.85

Table 3: Onsite Staff Rates