Technical Report 1

October 4th, 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 1, there were several aspects of the construction project analyzed. This report explains the conditions under which the building was constructed. It familiarizes the reader with the background of the project, opportunities, and constraints that can affect the construction process.

The construction of the new Inpatient Tower at Butler Memorial Hospital is an addition to the existing, functional hospital. This presents some construction difficulties due to logistics and operations. The project team needed to be aware of everything on-site in order to safely and properly construct the new tower. Because of the complexities of a hospital project, and the added difficulty of tying into an existing hospital, the project was heavily staffed by the General Contractor, Turner Construction. While the size of the on-site team may seem relatively large compared to projects of the same size and cost, it allowed the project to be completed successfully.

The schedule of the project was critical throughout the duration of construction. With the hospital already scheduling patients for the new tower, there was no room for error in terms of turning over the building. Cost was important, as in all projects, but it was not the driving factor in the construction of this facility. Because of a hospital's reliance on medical care and equipment usage, the MEP system of the building was very complex. Due to this, the MEP system has a much higher cost than the structural system, or the interior finishes. This is typical of all medical facility construction.

Butler Health System is an extensive medical services provider north of Pittsburgh. With about 1,700 employees and 189,000 residents relying on this hospital, it was evident that an expansion project was necessary. The new tower is a state-of-the-art facility with new operating rooms, medical surgical units, intensive care unit, individual patient spaces, and an extravagant entry level floor. This entry level floor includes a chapel, coffee shop, training classrooms, and auditorium. Because of the desire for a high-tech facility, the project team had to be one that was able to deliver this. Butler Health System hired Turner Construction as the General Contractor with a negotiated GMP of approximately $80 million. Turner then formed a list of pre-qualified subcontractors in order to put together the finest project team possible.

Technical Report 1 Table of Contents

Project Schedule Summary

The project schedule summary lists all of the broad, key activities throughout the project. While it is not very detailed, it lays out the activities in a sequential order. The full project schedule summary can be found in Appendix A. It also indicates key milestone dates, such as topping out and turning over different parts of the building. The schedule is divided into the three main phases of the project:

- Preconstruction/Procurement
- Construction
- Turnover/Commissioning

The schedule also shows the importance of overlapping major activities. It is this type of overlapping that pushes the project along and allows it to keep up to the schedule.

Foundation:
For the foundation construction of the project, there are a few different activities that go into it. After the excavation has produced enough workable space, the foundation work is started with installing caissons, grade beams, and foundation walls. The foundation work also includes setting up crane access for the beginning of structural work.

Structure:
The structural system for the new Inpatient Tower is composed of steel columns and beams. The structure of the building is made up of several key activities, which are included in a few summary tasks in the summary schedule. The structural activities include steel erection, detailing and shear studs, and also the pouring of concrete for the slabs. Spray-on fireproofing is also included in Turner's structural schedule. These are all tasks that will be shown in more detail in a detailed schedule.

Enclosure:
The exterior of the new Inpatient Tower is composed of face brick masonry and curtain wall. These activities, along with door and window installation, are included in the summary schedule as part of "Construct Enclosure." In more detail, this consists of all construction activity that deals with sealing the building. Roofing would also be considered part of the building enclosure.

Finishes:
The finishes for the building are included in the "Interiors" task in the summary schedule. In reality, finishes would encompass many activities. This would include drywall, painting, casework, flooring, trim work, etc. This is a longer duration activity due to the detail necessary for finished products.

Building Systems Summary

Yes	No	Work Scope
✓		Demolition Required?
✓		Structural Steel Frame
✓		Cast-in-Place Concrete
	✓	Precast Concrete
✓		Mechanical System
✓		Electrical System
✓		Masonry
✓		Curtain Wall
	✓	Support of Excavation

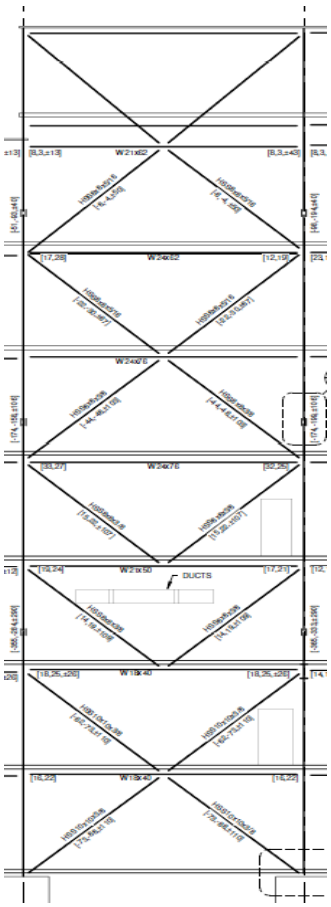
Details on each of the building systems follows.

Demolition

The new tower is constructed where the original Nixon Sarver Building was located. This building was demolished prior to construction. In the contract, there was some selective demolition that was performed prior to foundation work. Where the new tower meets the existing hospital, some demolition was necessary in order to properly construct the caissons. In this demolition, there was no lead or asbestos encountered.

Structural Steel Frame:

The majority of the structure of the new Inpatient Tower is composed of structural steel. The structural columns are mainly W12's and W14's. The steel beams in this building are mainly W16's and W18's. The W shaped beams and columns are ASTM A992, with a yield strength of 50ksi. For the lateral loads on the tower, K-frame braces are utilized. This bracing system is made up of HSS sections. The HSS sections vary based on the floor level. The lower floors are mainly HSS 10x10 and the upper floors are mainly HSS 8x8. These HSS sections are ASTM A500, Grade B, with a yield strength of 36ksi. The lateral bracing for the building is shown below:



Drawing S300: Lateral Bracing

The structural steel frame supports a load that is distributed over composite metal decking, which supports composite concrete slabs. The slabs are a total thickness of 6 ½", with a total topping of 3 ½". The structural drawings indicate that the floor slabs shall have a strength of 3500 PSI at 28 days. The structural steel was erected using a crawler crane, which navigated throughout the site depending on the location of the pick. The crane was a Manitowoc Model 777. The specifications include the following:

- 200 Ton Capacity
- 4,830 ft-kips Maximum Load Moment
- 300' Boom Length
- 29,500 lb Clamshell Capacity
- 20,000 lb Dragline Capacity
- 340 HP Engine Standard

Manitowoc Setting Steel

Cast-in-Place Concrete:
Cast-in-place concrete was used on several parts of the project. It was used for the drilled piers in the foundation system. It was also used for the lightweight concrete on metal decking. All concrete on this project was cast-in-place. All formwork is designed, constructed, and maintained to insure completed work within tolerance limits specified in ACI 301 and ACI 347. The formwork varies depending on if the concrete is exposed or unexposed. For exposed concrete surfaces, panels must be used that will provide continuous, true, and smooth surfaces. For unexposed surfaces, plywood, lumber, or metal can be used. For all cast-in-place concrete, it must be shored until 75% of the required compressive strength is reached. The cast-in-place concrete was all placed using a concrete truck and pump.

Concrete Slabs being Pumped

Mechanical System:
The majority of the new tower is served by three air handling units on the highest roof. These three units (AHU-1,2,3) are served by two water-cooled chillers on the first floor. Each of these rooftop units supplies 62,000 CFM, which serve every floor of the building. The Operating Rooms are controlled by two separate air handling units (AHU-4,5), which reside on the 5th floor penthouse. Each of these units supply 18,500 CFM to the Operating Rooms. All five of these units are variable air volume units. There are also three other air handling units in the building. AHU-6 supplies the first floor chiller room with 4,700 CFM. AHU-7 supplies the first floor electrical room with 4,000 CFM. The elevator penthouse is supplied with 4,700 CFM from AHU-8. The last three air handling units are constant volume units.

The heating for the building is controlled through two boilers, located on the first floor. These 215 HP Boilers supply the hot water to each of the air handling units in the tower. The new tower utilizes a Variable Air Volume (VAV) system throughout. The air from the air handling units is supplied to the VAV boxes. These boxes adjust the volume of the air that passes into each space in order to keep the space at the desired temperature. In addition to these aspects of the

mechanical system, radiant ceiling panels are also employed. These panels exist at the perimeter of the building, on the upper three floors.

The building also is completely covered by a wet pipe sprinkler system, with a fire pump room being located on the first floor of the building. Additionally, the building contains fire rated walls (1-3 hours) and smoke barrier walls. Along with these systems, smoke and fire dampers are installed in the ductwork in order to control the spread of a fire.

Electrical System:
Due to the fact that the inpatient tower is an addition to the existing hospital, the power for the addition comes from the existing facility. The power enters into the electrical room on the west side of the tower. It is here that the power encounters the 2500 kVa transformer, which then supplies the power to the upper floors. This main electrical room is located on the first floor of the building. Power is also then to electrical rooms throughout the upper floors. Each of the upper floors has at least two additional electrical rooms. Inside of these electrical rooms, both 120/208 and 277/480 volt panels are utilized for the distribution to the respective floors.

On the ground floor, two emergency generators are installed in order to combat any power failure. A UPS system is employed to minimize problems in the event of a failure. In the OR and IT rooms, a flywheel system is used. With this system, there is no blip when switching over to emergency power. This system is used due to the critical activities in these spaces that cannot afford to be affected by power loss.

Masonry:
Masonry is used for both the building enclosure and also as some wall construction on the ground and 1st floors. The mechanical and electrical rooms on the bottom floors are enclosed by 8” CMU walls. These walls are used as fire rated walls, due to the nature of the equipment in these spaces. The CMU walls are a standard 8”x16”. The load bearing type complies with ASTM C 90 and an average compressive strength of 2,000 psi. Also, all reinforcing steel for grouted concrete masonry walls, bond beams, concrete masonry lintels, and other similar work shall conform to ASTM A 615 or A616, Grade 60.

The masonry used for the building enclosure is a face brick veneer. This assembly includes an air cavity and rigid 2” polyisocyanurate rigid insulation. This is attached to 6” structural steel stud framing. The face brick on this project must comply with ASTM C 216 and have a compressive strength of 3,000 psi. The framing is concealed by sheathing and gypsum wall board.

For the construction of the masonry, free-standing scaffolding and hydraulic scaffolding were used. The scaffolding was assembled based on efficiency in order to reduce wasting any valuable construction time. The anchoring for the masonry depends on the use. For brick veneer over

concrete, dovetail anchors are used. Veneer anchors are used over metal stud and gypsum sheathing.

Curtain Wall:

The glazing system used is an aluminum curtain wall system. There are several different glass types used throughout the project. This includes 1" tinted insulating glass, 1" spandrel glass, 1" insulating glass, and ¼" clear float glass. These different glass types have a low "E" coating and a ½" air space for insulation purposes. All glass and glazing has been fabricated and installed to withstand normal thermal movement, wind loading, and sometimes impact loading.

Masonry and Curtain Wall

Support of Excavation:

When the excavation took place for the new tower, benching was used as support of the excavation. This benching was sloped at adequate levels to meet OSHA requirements. Once the foundations were constructed, these excavated areas were backfilled. The slope between excavations was not to exceed one vertical for every two horizontal.

Project Cost Evaluation

Construction Cost

To report the actual building construction cost, the following line items have been excluded:

- Fringes/Taxes/Insurance
- Site Work
- Contingency
- General Conditions
- Fee

All cost per square foot information is based on a total addition project size of 208,076 square feet. These costs are based on the final estimated values produced by Turner Construction.

Total Building Construction Cost = **$67,173,679**
Building Cost per Square Foot= **$323**

Total Project Cost

All line items have been included for the total project cost.

Total Project Cost = **$79,750,974**
Project Cost per Square Foot = **$383**

Building Systems Costs

System	Total Cost	Cost per Square Foot
Mechanical System	$9,949,569	$48
Electrical System	$12,296,394	$59
Structural System	$5,844,805	$28
Plumbing System	$5,152,886	$25

D4Cost Parametric Estimate

In order to properly produce a parametric estimate using D4Cost Estimating Software, several pieces of information were needed. The included information consists of the following:

- Comparable Project: Baylor Regional Medical Center
  - 8 Stories
  - 342,956 SF

The following information was used to adjust the project to provide results for this estimate:

- Comparable City: Pittsburgh, PA
- Target Date: August, 2010 (Finish Date)
- Size: 208,076 SF

Also, all other project information was imported, such as number of floors, floor height, floor size, etc. Also, modifications were made based on the square foot costs estimated for each of the building systems above.

The D4 Cost Estimate produced the following results:

Total Building Construction Cost = **$60,957,229**
Building Construction Cost per Square Foot = **$293**

See Appendix B for the complete D4 Cost Estimate.

RS Means Square Foot Estimate

To determine the RS Means Square Foot Estimate, RS Means CostWorks software was utilized. The following information was needed to calculate this estimate:

- Building Type: Hospital, 4-8 Story with Face Brick with Steel Frame
- Area: 208,076 SF
- Perimeter: 550 LF
- Stories: 7
- Story Height: 14’8”

The RS Means Cost Estimate produced the following results:

Total Building Construction Cost = **$55,843,500**
Building Construction Cost per Square Foot = **$268**

See Appendix C for the complete RS Means Square Foot Estimate.

Comparison of Costs

The total construction costs were compared using each type of cost analysis. Total project costs were not compared due to varying indirect costs. These vary due to specifications for the project.

Type of Estimate	Total Construction Cost	Construction Cost per SF
Actual Building Construction	$67,173,679	$323
D4 Cost Estimating	$60,957,229	$293
RS Means	$55,843,500	$268

The D4 Cost Estimating analysis produced a total construction cost about $7 million lower than the actual building construction. The numbers are relatively close because the major system square footage costs were incorporated. The difference in the numbers most likely lies in the costs of interior work. This interior work includes items such as woods, plastics, doors and windows, finishes, specialties, etc. Also, for a hospital project, the equipment costs can vary from one hospital to another.

The estimate produced with RS Means Costworks came in even lower than the D4 Cost Estimate. By comparing the results of the produced report and the known GMP values given by Turner, some key differences can be seen. In particular, the foundations and structure are significantly underestimated in the RS Means Estimate. This can due to project intricacies. The equipment and interior work can also vary slightly.

Site Plan of Existing Conditions

The original site at Butler Memorial Hospital included the Nixon Sarver Building. This building is located at the North Side of the Hospital, and was demolished prior to construction. The location of this building became the site of the new Inpatient Tower. The aerial photograph below, provided by *Bing Maps*, shows the site prior to the demolition. The Nixon Sarver Building is outlined in ORANGE.

Aerial Photograph Prior to Construction

With the demolition of the Nixon Sarver Building, the new tower is constructed in its place and connected with the existing hospital. All other sections of the hospital, shown in the photograph, will remain after construction. The existing parking areas were partially used for construction staging. Also, Turner Construction occupied one of the neighboring homes as an on-site office. The Site Plan during construction is included in Appendix D.

Local Conditions

Butler Memorial Hospital is located in Butler, PA at 911 East Brady Street. The complex is set on a 23-acre location in the city of Butler. Butler Health System owns not only the hospital structure, but also several residences around the perimeter of the hospital. The reason that these homes are owned is due to possible expansion. BHS did not need to tap into these land resources for this expansion project. The demolition of the existing Nixon Sarver Building gave the proper space for the addition of the new Inpatient Tower.

Due to the fact that the project was based in the center of a city, parking was limited for construction personnel. Due to this, additional parking was available in a parking lot about ½ miles from the jobsite. In order to limit the inconvenience for construction employees, a bus service was provided, which ran from the lot to the jobsite. Also, due to the limited site space and large Turner staff, more provisions were made. Among the local residences, Turner was able to use a house (owned by the hospital) to perform some of its operations. A site trailer was used for on-site work, and the house provided Turner an engineering office. The following picture shows the site during the excavation process:

RED: Turner's Engineering Office
BLUE: Turner's Field Office
YELLOW: Limited Construction Parking
ORANGE: Route to Additional Construction Parking

In Butler, as in many areas, it is typical for steel construction to be used for larger buildings of this sort. Butler Memorial Hospital followed suit, and a steel structural system was utilized. Due to the fact that it was a renovation, masonry was used for a majority of the exterior, to tie into the existing building. The new Inpatient Tower uses a brick color that is very close to the masonry used on the existing hospital.

According to the geotechnical report, provided by Pennsylvania Soil and Rock Incorporated, the subsurface exploration showed a variety of substances. The excavation encountered fill, decomposed rock and readily excavatable bedrock. This bedrock included shale, claystone, and weathered sandstone. As stated in the geotechnical report, the decomposed rock and overburdened materials could be removed with conventional earthwork practices.

No recycling or tipping fees existed for this project. All waste removal was coordinated by Turner Construction. The location of site dumpsters changed throughout the project. For the majority of the project, dumpsters were located in the North Parking Lot, which is shown above.

Client Information

Butler Health System (BHS) is a community health system that serves Western Pennsylvania. The system includes doctors, nurses, and other healthcare professionals. These healthcare professionals provide individualized care to all patients. Because Butler Health System is considered a community health system, it conducts Community Health Assessment Surveys. In order to better the healthcare provided to the community, new services and education programs are constantly introduced. The cornerstone of BHS is Butler Memorial Hospital, which is the focus of this thesis project. Butler Memorial Hospital came to existence in 1898. Overall, there are currently about 1,700 employees employed by BHS.

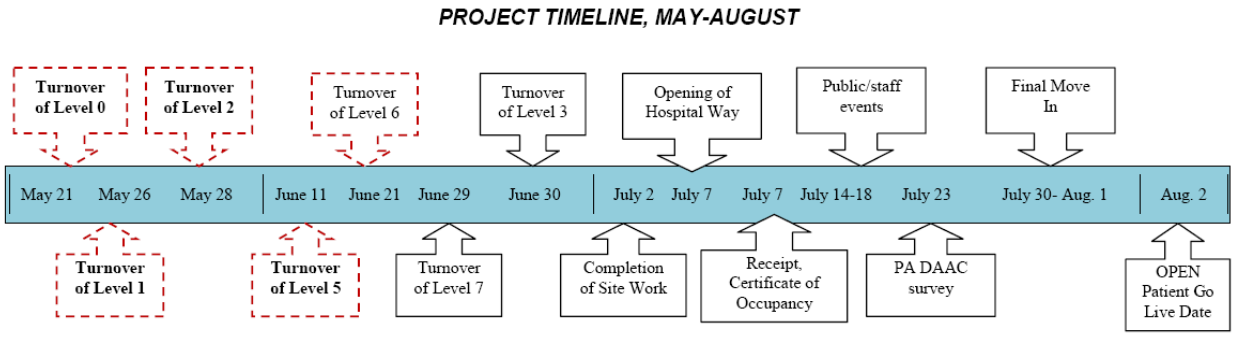
The Addition and Renovation Project at Butler Memorial Hospital is a project that will help to serve the 189,000 residents of Butler County and several surrounding counties. The existing hospital includes a 259-bed acute-care hospital on a 23-acre campus in the city of Butler. The facility was aged and included a strained emergency department. Also, the size of the facility was not able to effectively serve the growing demand for healthcare services in this area.

Because of the growing demand, the new Inpatient Tower was constructed, along with a renovation of some of the existing facilities. The new tower includes:

- New nurses' stations outside each new patient room
- 10 state-of-the-art Operating Rooms
- Two floors of Medical Surgical Units with 26 rooms each
- A new Intensive Care Unit with 24 beds and support area
- Individual rooms for each patient with spaces for families to stay the night
- Austin's Play Area (Mario Lemieux Foundation) for children
- Patient-tracking monitors for families located throughout
- 43,000-square-foot lobby with a chapel, coffee shop, training classrooms, and auditorium

Cost is not a driving factor for this project, but a detailed budget is necessary in order to ensure that the project meets the needs of Butler Health System. Because of this, budget meetings were continually monitored in order to verify that the cost was on track. **Schedule** was the driving factor because it is crucial that all spaces were turned over to the owner, due to patient

scheduling. For example, the Operating Rooms had a set date that surgery was to begin. Because of this, Turner was pressed to complete all work in the Operating Room area prior to this date. There was no way to modify this date because surgeries had been scheduled. The need for precise scheduling is shown by Butler Health System's Expansion Updates provided on its website. In each update, a turnover schedule was shown:



Butlerhealthsystem.org

Sequencing was a major issue in the turnover of the project. This was due to the fact that the Hospital had set dates to move patients into each floor. If the spaces were not turned over at the proper time, there would be no space for these scheduled patients. The importance of scheduling can also be seen from the above figure.

The new Inpatient Tower at Butler Memorial Hospital was always determined to be a state-of-art facility for healthcare. During its design and construction, quality was something that was focused on in extraordinary amounts. This quality is demonstrated in the new Operating Rooms, Patient Rooms, and support areas among others.

New Operating Room

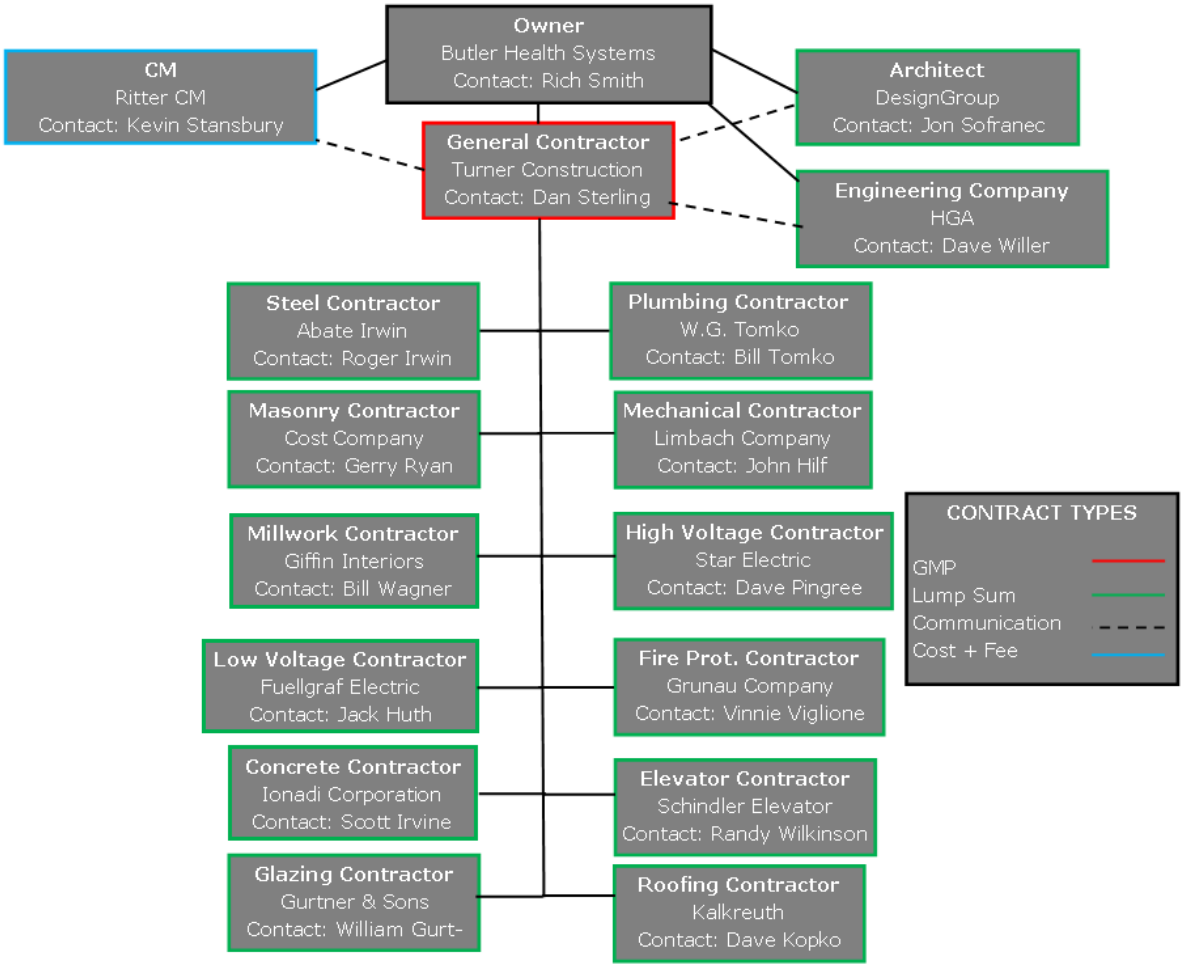
New Private Patient Room

It is evident that schedule and quality were the most important factors in satisfying the owner. Because of this, these two factors were the ones seen as most critical for the project team.

Project Delivery System

The addition of the new Inpatient Tower at Butler Memorial Hospital was completed using a Design-Bid-Build delivery system. Turner was selected as the General Contractor by utilizing a negotiated GMP. Turner was added to a short list of contractors devised by Butler Health System. When it came to determining the appropriate General Contractor, Turner was awarded the contract for several key reasons. Butler Health System decided that Turner should receive the contract due to the ability of using BIM, the General Conditions, proposed fee, and the competency of the interviewed Turner personnel. The interviewed personnel included the Project Executive, Project Manager, and Project Engineer.

Once awarded the project, Turner developed a list of qualified subcontractors for each of the composed bid packages. From this point, bids were requested, and the lowest qualified bidder was awarded the subcontract. Each of these awarded subcontracts are lump sum contracts.



Project Delivery Method

Turner maintains All-Risk Builder's Risk Insurance for these subcontracts. Turner's CCIP Program requires that several documents be submitted by each subcontractor. Turner requires that all subcontractors hold the following insurances from the start of work until final completion:

- Workers' Compensation and Employers' Liability Insurance
- Commercial General Liability Insurance
- Commercial Automobile Liability Insurance

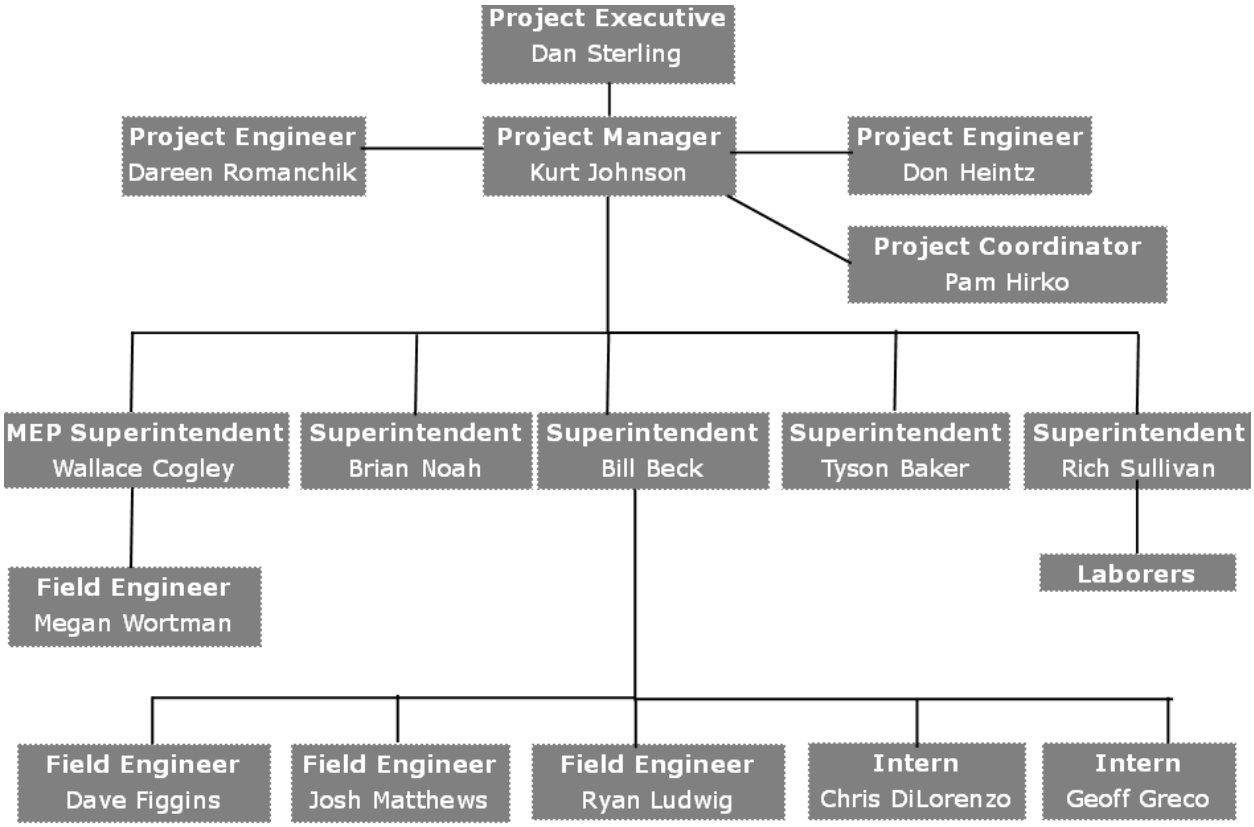
If the subcontractor fails to hold the specified insurances, Turner reserves the right to procure and maintain those insurances. The subcontractor would then be responsible for paying the cost of this service.

The subcontractor is also responsible for furnishing Turner a performance and payment bond. The subcontractor and its surety agree to promptly pay all lawful claims during the project. Turner is therefore relieved of fault for any liability loss, damage and expense, including interests, costs, and attorney fees.

The contract types and delivery system appears to be appropriate for the project at hand. Because it is a large-scale project involving complexities typical of a hospital, it is necessary to have a competent General Contractor. Due to Turner's exceptional record on healthcare projects, it gave BHS a great opportunity to produce a quality project. Also, because of Turner's experience, it was possible to devise a list of qualified subcontractors. With Turner's decision on subcontractors, it would be evident to the owner that the project team is a competent one.

Staffing Plan

Prior to the project, Turner looked into the most efficient way to staff this project. Because of the size and complexity of the project, the on-site team is relatively large. Also, there was significant support being provided by personnel in Turner's Pittsburgh Office. The diagram below shows the staffing plan for Turner on-site:



Turner Staffing Chart

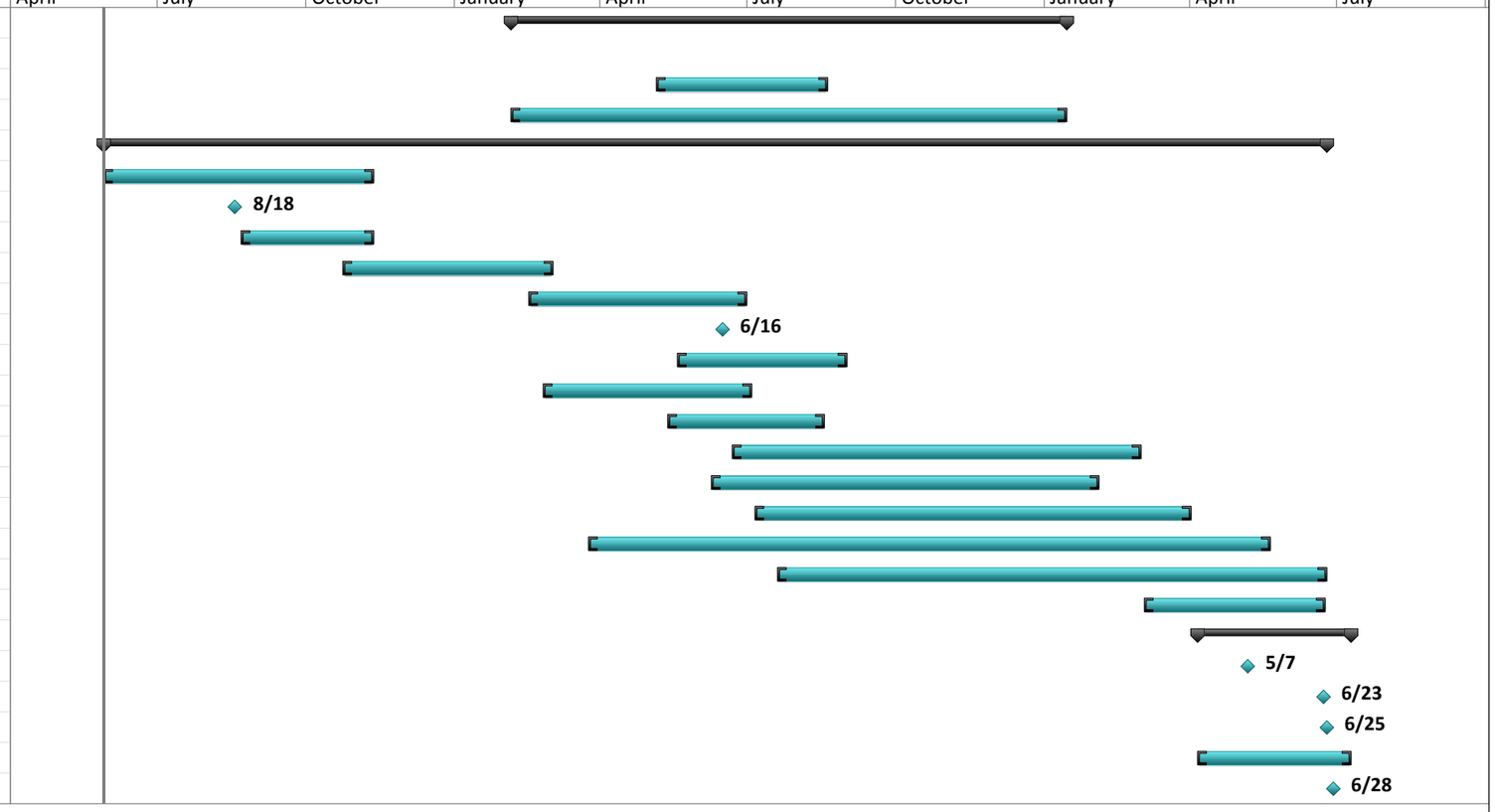
For this project, Dan Sterling was the Project Executive. His main contact was Kurt Johnson, the on-site Project Manager. Everyone on site indirectly reported to Kurt Johnson, as shown above. This structure worked efficiently for this project due to its intricacies and size. While this staff made minor changes through the duration of the 2-year project, the layout of the chart only varied slightly throughout. Not included in this chart, is the office personnel. This includes departments such as estimating, purchasing, and IT.

Appendix A

Summary Schedule

Butler Health System- New Inpatient Tower

ID	Task	Task Name	Duration	Start	Finish
1		**Preconstruction/Procurement**	**246 days**	**Thu 2/5/09**	**Thu 1/14/10**
2		Design			
3		BIM Coordination	76 days	Wed 5/6/09	Wed 8/19/09
4		Submittals and Procurement	246 days	Thu 2/5/09	Thu 1/14/10
5		**Construction**	**541 days**	**Thu 5/29/08**	**Thu 6/24/10**
6		Preliminary Sitework	119 days	Thu 5/29/08	Tue 11/11/08
7		Start Construction	0 days	Mon 8/18/08	Mon 8/18/08
8		Excavation and Utilities	58 days	Fri 8/22/08	Tue 11/11/08
9		Construct Foundations	92 days	Fri 10/24/08	Mon 3/2/09
10		Erect Structural Steel	97 days	Mon 2/16/09	Tue 6/30/09
11		Topping Out	0 days	Tue 6/16/09	Tue 6/16/09
12		Fireproofing	75 days	Tue 5/19/09	Mon 8/31/09
13		Set Steel Decking	93 days	Wed 2/25/09	Fri 7/3/09
14		Pour Concrete Slabs	69 days	Wed 5/13/09	Mon 8/17/09
15		Construct Enclosure	181 days	Mon 6/22/09	Mon 3/1/10
16		Install Elevators	172 days	Tue 6/9/09	Wed 2/3/10
17		Roofing	194 days	Mon 7/6/09	Thu 4/1/10
18		MEP Work	302 days	Wed 3/25/09	Thu 5/20/10
19		Interiors	244 days	Mon 7/20/09	Thu 6/24/10
20		Final Sitework	80 days	Thu 3/4/10	Wed 6/23/10
21		**Turnover/Commissioning**	**69 days**	**Tue 4/6/10**	**Fri 7/9/10**
22		Turnover Ground-2nd Floors	0 days	Fri 5/7/10	Fri 5/7/10
23		Turnover 3rd-5th Floors	0 days	Wed 6/23/10	Wed 6/23/10
24		Turnover 6th-7th Floors	0 days	Fri 6/25/10	Fri 6/25/10
25		Commissioning	69 days	Tue 4/6/10	Fri 7/9/10
26		Patient Go Live Date	0 days	Mon 6/28/10	Mon 6/28/10



Project: Butler Hospital Inpatient
Date: October 4th, 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

D4 Parametric Estimate

Statement of Probable Cost

BHS New Inpatient Tower - Aug 2010 - PA - Pittsburgh

Division		Percent	Sq. Cost	Amount
01	**General Requirements**	**10.24**	**29.99**	**6,240,634**
	General Requirements	10.24	29.99	6,240,634
03	**Concrete**	**2.73**	**8.00**	**1,664,608**
	Concrete	2.73	8.00	1,664,608
04	**Masonry**	**2.40**	**7.02**	**1,461,727**
	Masonry	2.40	7.02	1,461,727
05	**Metals**	**6.83**	**20.00**	**4,161,520**
	Metals	6.83	20.00	4,161,520
06	**Wood & Plastics**	**3.76**	**11.02**	**2,292,353**
	Finish Carpentry	3.66	10.73	2,232,993
	Rough Carpentry	0.10	0.29	59,360
07	**Thermal & Moisture Protection**	**3.94**	**11.54**	**2,402,199**
	Dampproofing & Waterproofing	1.26	3.70	769,314
	Membrane Roofing	0.91	2.67	556,283
	Roof & Wall Specialties & Acces.	0.12	0.35	72,824
	Roofing & Siding Panels	1.65	4.82	1,003,777
08	**Doors & Windows**	**6.58**	**19.28**	**4,011,777**
	Doors & Frames	1.90	5.57	1,158,826
	Glazing	4.01	11.74	2,442,902
	Hardware	0.29	0.85	176,260
	Specialty Doors & Frames	0.38	1.12	233,789
09	**Finishes**	**11.10**	**32.51**	**6,763,704**
	Finishes	11.10	32.51	6,763,704
10	**Specialties**	**1.88**	**5.49**	**1,143,243**
	Fire & Smoke Protection	0.54	1.59	330,651
	Specialties	1.33	3.91	812,592
11	**Equipment**	**0.99**	**2.90**	**603,233**
	Equipment	0.99	2.90	603,233
12	**Furnishings**	**0.40**	**1.17**	**242,736**
	Furnishings	0.40	1.17	242,736
13	**Special Construction**	**0.24**	**0.69**	**144,382**
	Special Construction	0.24	0.69	144,382
14	**Conveying Systems**	**2.45**	**7.18**	**1,493,091**
	Conveying Equipment	2.45	7.18	1,493,091
15	**Mechanical**	**26.34**	**77.16**	**16,055,539**
	Fire Suppression	1.42	4.16	865,991
	HVAC & Plumbing	24.92	73.00	15,189,548
16	**Electrical**	**20.14**	**59.00**	**12,276,484**
	Electrical	20.14	59.00	12,276,484
Total Building Costs		**100.00**	**292.96**	**60,957,229**

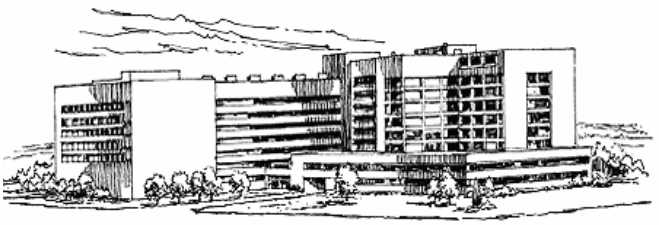
Appendix C

RS Means Square Foot Estimate

Square Foot Cost Estimate Report

Estimate Name: **Butler Inpatient Tower**

Building Type:	**Hospital, 4-8 Story with Face Brick with Structural Facing Tile / Steel Frame**
Location:	National Average
Stories Count (L.F.):	**7.00**
Stories Height	**14.66**
Floor Area (S.F.):	**208,076.00**
LaborType	**Union**
Basement Included:	Yes
Data Release:	**Year 2010 Quarter 2**
Cost Per Square Foot	**$268.38**
Total Building Cost	**$55,843,500**



Costs are derived from a building model with basic components. Scope differences and market conditions can cause costs to vary significantly.

		% of Total	Cost Per SF	Cost
A Substructure		**1.4%**	**2.78**	**$578,500**
A1010	**Standard Foundations**		**0.94**	**$195,500**
	Strip footing, concrete, reinforced, load 14.8 KLF, soil bearing capacity 6 KSF, 12" deep x 32" wide			
	Spread footings, 3000 PSI concrete, load 400K, soil bearing capacity 6 KSF, 8' - 6" square x 27" deep			
A1030	**Slab on Grade**		**0.68**	**$142,000**
	Slab on grade, 4" thick, non industrial, reinforced			
A2010	**Basement Excavation**		**0.51**	**$106,000**
	Excavate and fill, 10,000 SF, 8' deep, sand, gravel, or common earth, on site storage			
A2020	**Basement Walls**		**0.65**	**$135,000**
	Foundation wall, CIP, 12' wall height, pumped, .52 CY/LF, 24.29 PLF, 14" thick			
B Shell		**16.5%**	**32.47**	**$6,756,500**
B1010	**Floor Construction**		**18.52**	**$3,853,000**
	Cast-in-place concrete column, 16" square, tied, 400K load, 12' story height, 251 lbs/LF, 4000PSI			
	Steel column, W10, 200 KIPS, 10' unsupported height, 45 PLF			
	Flat slab, concrete, with drop panels, 6" slab/2.5" panel, 12" column, 15'x15' bay, 75 PSF superimposed load, 153 P			
	Floor, composite metal deck, shear connectors, 5.5" slab, 30'x30' bay, 26.5" total depth, 75 PSF superimposed load,			
	Fireproofing, gypsum board, fire rated, 2 layer, 1" thick, 10" steel column, 3 hour rating, 17 PLF			
B1020	**Roof Construction**		**1.03**	**$214,500**
	Floor, steel joists, beams, 1.5" 22 ga metal deck, on columns, 30'x30' bay, 28" deep, 40 PSF superimposed load, 62			
B2010	**Exterior Walls**		**8.18**	**$1,703,000**
	Brick wall, cavity, standard face, 4" glazed tile back-up, 10" thick, styrofoam cavity fill			
B2020	**Exterior Windows**		**3.02**	**$629,000**
	Windows, aluminum, sliding, insulated glass, 5' x 3'			
B2030	**Exterior Doors**		**0.74**	**$154,000**
	Door, aluminum & glass, with transom, full vision, double door, hardware, 6'-0" x 10'-0" opening			
	Door, aluminum & glass, with transom, non-standard, double door, hardware, 6'-0" x 10'-0" opening			
	Door, steel 18 gauge, hollow metal, 1 door with frame, no label, 3'-0" x 7'-0" opening			
B3010	**Roof Coverings**		**0.95**	**$197,500**

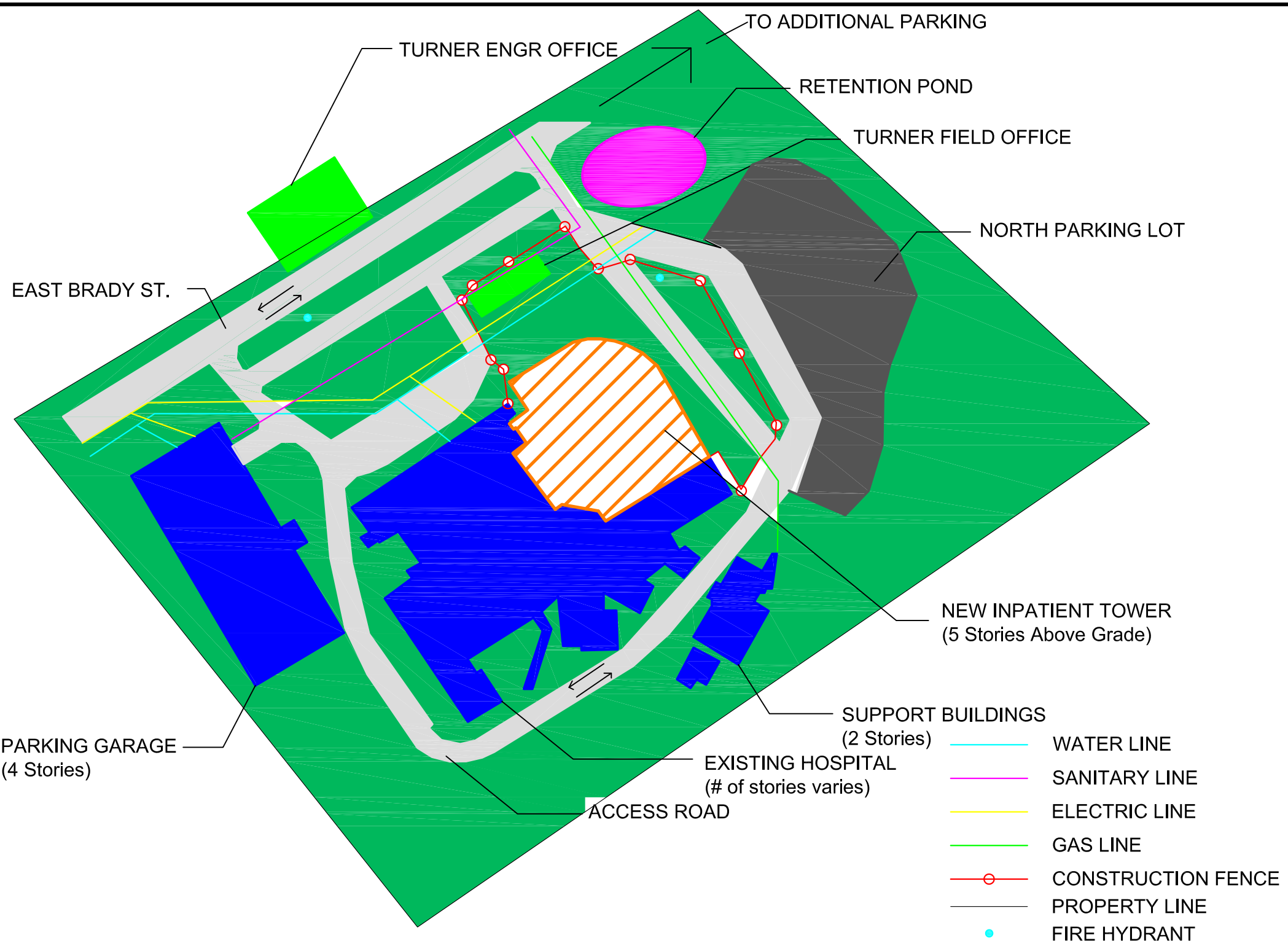
		% of Total	Cost Per SF	Cost
	Roofing, single ply membrane, reinforced, PVC, 48 mils, fully adhered, adhesive			
	Insulation, rigid, roof deck, composite with 2" EPS, 1" perlite			
	Roof edges, aluminum, duranodic, .050" thick, 6" face			
	Flashing, copper, no backing, 16 oz, < 500 lbs			
B3020	**Roof Openings**		**0.03**	**$5,500**
	Roof hatch, with curb, 1" fiberglass insulation, 2'-6" x 3'-0", galvanized steel, 165 lbs			
C Interiors		**23.5%**	**46.34**	**$9,642,500**
C1010	**Partitions**		**7.58**	**$1,578,000**
	Metal partition, 5/8" vinyl faced gypsum board face, 5/8"fire rated gypsum board base, 3-5/8" @ 24",s ame opposite			
	Gypsum board, 1 face only, 5/8" with 1/16" lead			
C1020	**Interior Doors**		**11.24**	**$2,339,000**
	Door, single leaf, kd steel frame, hollow metal, commercial quality, flush, 3'-0" x 7'-0" x 1-3/8"			
	Door, single leaf, kd steel frame, metal fire, commercial quality, 3'-0" x 7'-0" x 1-3/8"			
C1030	**Fittings**		**0.98**	**$204,500**
	Partitions, hospital curtain, ceiling hung, poly oxford cloth			
C2010	**Stair Construction**		**1.28**	**$266,000**
	Stairs, steel, cement filled metal pan & picket rail, 12 risers, with landing			
C3010	**Wall Finishes**		**7.51**	**$1,562,500**
	Glazed coating			
	Painting, interior on plaster and drywall, walls & ceilings, roller work, primer & 2 coats			
	Vinyl wall covering, fabric back, medium weight			
	Ceramic tile, thin set, 4-1/4" x 4-1/4"			
C3020	**Floor Finishes**		**10.15**	**$2,113,000**
	Composition flooring, epoxy terrazzo, maximum			
	Terrazzo, maximum			
	Vinyl, composition tile, maximum			
	Tile, ceramic natural clay			
C3030	**Ceiling Finishes**		**7.59**	**$1,579,500**
	Plaster ceilings, 3 coat prl, 3.4# metal lath, 3/4" crc, 12"OC furring, 1-1/2" crc, 36" OC support			
	Acoustic ceilings, 3/4"mineral fiber, 12" x 12" tile, concealed 2" bar & channel grid, suspended support			
D Services		**49.8%**	**98.00**	**$20,392,000**
D1010	**Elevators and Lifts**		**6.44**	**$1,339,000**
	Traction, geared hospital, 6000 lb, 6 floors, 12' story height, 2 car group, 200 FPM			
D2010	**Plumbing Fixtures**		**11.94**	**$2,484,000**
	Water closet, vitreous china, bowl only with flush valve, wall hung			
	Urinal, vitreous china, wall hung			
	Lavatory w/trim, wall hung, PE on CI, 19" x 17"			
	Kitchen sink w/trim, raised deck, PE on CI, 42" x 21" dual level, triple bowl			
	Laundry sink w/trim, PE on CI, black iron frame, 48" x 21" double compartment			
	Service sink w/trim, PE on CI,wall hung w/rim guard, 22" x 18"			
	Bathtub, recessed, PE on CI, mat bottom, 5'-6" long			
	Shower, stall, baked enamel, terrazzo receptor, 36" square			
	Water cooler, electric, wall hung, wheelchair type, 7.5 GPH			
D2020	**Domestic Water Distribution**		**6.91**	**$1,437,000**
	Electric water heater, commercial, 100< F rise, 1000 gal, 480 KW 1970 GPH			
D2040	**Rain Water Drainage**		**0.54**	**$112,000**
	Roof drain, CI, soil,single hub, 5" diam, 10' high			
	Roof drain, CI, soil,single hub, 5" diam, for each additional foot add			
D3010	**Energy Supply**		**3.55**	**$738,500**
	Hot water reheat system for 200,000 SF hospital			

		% of Total	Cost Per SF	Cost
D3020	**Heat Generating Systems**		**0.38**	**$80,000**
	Boiler, electric, steel, steam, 510 KW, 1,740 MBH			
D3030	**Cooling Generating Systems**		**2.75**	**$571,500**
	Chiller, reciprocating, water cooled, standard controls, 100 ton			
	Chiller, reciprocating, water cooled, standard controls, 150 ton			
	Chiller, reciprocating, water cooled, standard controls, 200 ton			
D3090	**Other HVAC Systems/Equip**		**33.13**	**$6,893,500**
	Ductwork for 200,000 SF hospital model			
	Boiler, cast iron, gas, hot water, 2856 MBH			
	Boiler, cast iron, gas, hot water, 320 MBH			
	AHU, rooftop, cool/heat coils, VAV, filters, 5,000 CFM			
	AHU, rooftop, cool/heat coils, VAV, filters, 10,000 CFM			
	AHU, rooftop, cool/heat coils, VAV, filters, 20,000 CFM			
	VAV terminal, cooling, hot water reheat, with actuator / controls, 200 CFM			
	AHU, rooftop, cool/heat coils, VAV, filters, 30,000 CFM			
	Roof vent. system, power, centrifugal, aluminum, galvanized curb, back draft damper, 1500 CFM			
	Roof vent. system, power, centrifugal, aluminum, galvanized curb, back draft damper, 2750 CFM			
	Commercial kitchen exhaust/make-up air system, rooftop, gas, 5000 CFM			
	Plate heat exchanger, 400 GPM			
D4010	**Sprinklers**		**2.68**	**$558,000**
	Wet pipe sprinkler systems, steel, light hazard, 1 floor, 10,000 SF			
	Wet pipe sprinkler systems, steel, light hazard, each additional floor, 10,000 SF			
	Standard High Rise Accessory Package 8 story			
D4020	**Standpipes**		**0.45**	**$94,000**
	Wet standpipe risers, class III, steel, black, sch 40, 4" diam pipe, 1 floor			
	Wet standpipe risers, class III, steel, black, sch 40, 4" diam pipe, additional floors			
	Cabs, hose rack assembly, & extinguisher, 2-1/2" x 1-1/2" valve & hose, steel door & frame			
	Alarm, electric pressure switch (circuit closer)			
	Escutcheon plate, for angle valves, polished brass, 2-1/2"			
	Fire pump, electric, with controller, 5" pump, 100 HP, 1000 GPM			
	Fire pump, electric, for jockey pump system, add			
	Siamese, with plugs & chains, polished brass, sidewalk, 4" x 2-1/2" x 2-1/2"			
	Valves, angle, wheel handle, 300 lb, 2-1/2"			
	Cabinet assembly, includes. adapter, rack, hose, and nozzle			
D5010	**Electrical Service/Distribution**		**3.88**	**$807,500**
	Service installation, includes breakers, metering, 20' conduit & wire, 3 phase, 4 wire, 120/208 V, 2000 A			
	Feeder installation 600 V, including RGS conduit and XHHW wire, 2000 A			
	Switchgear installation, incl switchboard, panels & circuit breaker, 2000 A			
D5020	**Lighting and Branch Wiring**		**18.66**	**$3,883,500**
	Receptacles incl plate, box, conduit, wire, 20 per 1000 SF,2.4 W per SF, with transformer			
	Wall switches, 5.0 per 1000 SF			
	Miscellaneous power, 1.2 watts			
	Central air conditioning power, 4 watts			
	Motor installation, three phase, 460 V, 15 HP motor size			
	Motor feeder systems, three phase, feed to 200 V 5 HP, 230 V 7.5 HP, 460 V 15 HP, 575 V 20 HP			
	Fluorescent fixtures recess mounted in ceiling, 0.8 watt per SF, 20 FC, 5 fixtures @32 watt per 1000 SF			
D5030	**Communications and Security**		**2.39**	**$496,500**
	Communication and alarm systems, fire detection, addressable, 100 detectors, includes outlets, boxes, conduit and			
	Fire alarm command center, addressable with voice, excl. wire & conduit			
	Internet wiring, 8 data/voice outlets per 1000 S.F.			

		% of Total	Cost Per SF	Cost
D5090	**Other Electrical Systems**		**4.31**	**$897,000**
	Generator sets, w/battery, charger, muffler and transfer switch, diesel engine with fuel tank, 100 kW			
	Generator sets, w/battery, charger, muffler and transfer switch, diesel engine with fuel tank, 400 kW			
	Uninterruptible power supply with standard battery pack, 15 kVA/12.75 kW			
E Equipment & Furnishings		**8.8%**	**17.38**	**$3,616,500**
E1020	**Institutional Equipment**		**13.42**	**$2,792,500**
	Architectural equipment, laboratory equipment glassware washer, distilled water, economy			
	Architectural equipment, sink, epoxy resin, 25" x 16" x 10"			
	Architectural equipment, laboratory equipment eye wash, hand held			
	Fume hood, complex, including fixtures and ductwork			
	Architectural equipment, medical equipment sterilizers, floor loading, double door, 28"x67"x52"			
	Architectural equipment, medical equipment, medical gas system for large hospital			
	Architectural equipment, kitchen equipment, commercial dish washer, semiautomatic, 50 racks/hr			
	Architectural equipment, kitchen equipment, food warmer, counter, 1.65 KW			
	Architectural equipment, kitchen equipment, kettles, steam jacketed, 20 gallons			
	Architectural equipment, kitchen equipment, range, restaurant type, burners, 2 ovens & 24" griddle			
	Architectural equipment, kitchen equipment, range hood, including CO2 system, economy			
	Special construction, refrigerators, prefabricated, walk-in, 7'-6" high, 6' x 6'			
	Architectural equipment, darkroom equipment combination, tray & tank sinks, washers & dry tables			
E1090	**Other Equipment**		**0.00**	**$0**
E2020	**Moveable Furnishings**		**3.96**	**$824,000**
	Furnishings, hospital furniture, patient wall system, no utilities, deluxe , per room			
F Special Construction		**0.0%**	**0.00**	**$0**
G Building Sitework		**0.0%**	**0.00**	**$0**
Sub Total		**100%**	**$196.98**	**$40,986,000**
Contractor's Overhead & Profit		**25.0%**	**$49.24**	**$10,246,500**
Architectural Fees		**9.0%**	**$22.16**	**$4,611,000**
User Fees		**0.0%**	**$0.00**	**$0**
Total Building Cost			**$268.38**	**$55,843,500**

Appendix D

Site Plan of Existing Conditions



PROJECT: BUTLER HOSPITAL INPATIENT TOWER	TITLE: SITEPLAN		SHEET: 1
LOCATION: BUTLER, PA	DATE: 10/4/2010	REVISIONS: 1 2 3	
YOUR NAME: CHRIS DILORENZO	SCALE: NTS		
AE SENIOR THESIS			