# Monongalia General Hospital

Morgantown, WV

## Technical Assignment I

September 29, 2008
Dr. Riley


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Construction Management

# Table of Contents

## Executive Summary

This document illustrates the conditions under which the Monongalia General Hospital Addition and Renovation Project is constructed. This background information provides a building systems description, project schedule summary, and cost comparisons and evaluations. Additional to the building statistics, is an overview of the project teams including a more in depth look into the construction manager staffing plan and owner information. Also evaluated are the local conditions, with a site plan layout.

Located in Morgantown, West Virginia, the new addition to the existing Monongalia General Hospital is named the Hazel Ruby McQuain Tower after a wealthy business woman who donated millions of dollars to the Morgantown community. With an addition of 210,000 square feet, it more than doubles the size of the hospital and places privacy at the forefront. All of the 88 new patient rooms are designed to be 100 percent private. The new tower also features a Women's Imaging Center, a large Emergency Department, an expanded Imaging Department, and a state-of-the-art Intensive Care Unit. Upon completion of the tower, renovations in the existing building will commence, eventually providing the hospital with a total of 189 private patient rooms. When the expansion and renovation project is fully complete the project cost is expected to total $92 million.

## A. Project Schedule Summary

The new Hazel Ruby McQuain Tower required demolition to the pavement parking lot located where the tower now sits. Additional demolition to the southern part of the existing building required work in the early phases done directly by the Monongalia General Hospital, consisting of establishing new safety routing, signage, and construction barriers in the corridors. The remaining phases progress from in order from quadrant A to quadrant D following a parade of trades, type of sequencing. Figure A.1 illustrates the building layout in quadrants. A phase schedule demonstrates the number of phases and progression of work lengths throughout the project is located in Appendix A. Also provided is a key milestone schedule which clearly indicates important project dates, located in Appendix B.

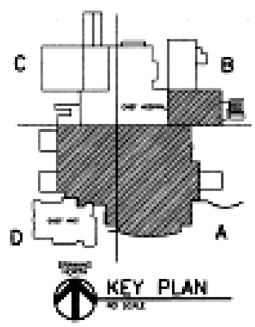



**Figure A.1 – Building Construction Quadrants**

## B. Building Systems Summary

| Yes | No | Work Scope |
|---|---|---|
| X | | Demolition |
| X | | Structural Steel |
| X | | Cast in Place Concrete |
| | X | Precast Concrete |
| X | | Mechanical System |
| X | | Electrical System |
| X | | Masonry |
| X | | Curtain Wall |
| X | | Support of Excavation |

### B.1 Demolition

The site in which the new tower building is located was previously a parking lot for the hospital. The blacktop parking lot was demolished and removed before further excavation continued. Slight demolition to the existing building and tunnel was needed before tying into the structures. Particular care was taken during the demolition phases as to not disturb the hospital's functioning.

### B.2 Structural Steel

Although the primary structure is concrete, steel members were used in two areas. The new central lobby uses W12x40 columns and a combination of 12"-18" deep wide flange steel beams. The ski-lighted roof system covering the drive up entrance area also uses a combination of W-flange beams and square tube columns. The new central plant incorporates three W10x33 columns to support the added weight of the two cooling towers on the plant's roof. The plant uses a combination of W-flange beams and k-series roof joist for the roofing system. Additional steel beams are used on top of the central plant roof as framing support for the cooling towers.

### B.3 Cast in Place Concrete

The Hazel Ruby McQuain Tower's structure is primarily cast-in-place concrete. The tower rests on shallow spread footings which support typical sized 24"x24" cast-in-place reinforced concrete columns. The first floor of the tower is partially underground and therefore requires a 14" cast-in-place exterior wall with #4 and #6 size rebars for horizontal and vertical reinforcing. The first floor system is a 5" thick slab-on-grade with 6x6 W.W.F. reinforcing. Floors two through six consist of an 8" thick concrete flat slab system with two-way reinforcing at the top and bottom of the slab, and drop panels at the interior columns. The common beam size is 24"x18" (width x depth), which are located on the exterior of the slabs, large penetrations, and areas of higher loads. The roof structure is the same as the floor systems which support the air handling units. The stair and elevator walls are 12" thick cast-in-place reinforced concrete and act as the structure's shear walls. In addition to the new hospital tower, the new central plant also uses cast-in-place concrete spread footings. The majority of all cast in place concrete was placed using pump trucks. The formwork consisted of a reusable Logik Crane Set Forming System provided by Patent Construction Systems.

### B.4 Mechanical System

In order to handle the large HVAC loads required in a 210,000 sq. ft. hospital building, a new central plant was built to house most of the mechanical equipment for the new tower. The large HVAC loads require the use of seven variable air volume roof-top units, each sized specifically to the type and sizes of the areas they serve. Located on the roof of the central plant are two 500 ton, 1,500 GPM (gallons per minute) cooling towers, with a reserved spot for a possible future third chiller. Inside the plant, are two 500 ton, 1,500 GPM water-cooled chillers and one 5,175 lb/hr, 100 psi steam boiler. For winter heating the system uses a combination of electric duct heaters and a terminal re-heat system. The building uses a dry-pipe sprinkler system for fire suppression.

### B.5 Electrical System

In addition to housing the mechanical equipment, the new central plant also holds most of the electrical equipment with three rooms designated specifically for normal power, emergency power, and generators. The normal operating electrical system uses a 480V, 5000A switchboard unit. Backup power is supplied by two 1500 kW generators through a 480V, 8000A switchgear.

### B.6 Masonry

Most of the masonry on the new tower is on exterior façade consisting of a red brick veneer to match the existing building. Some additional ground faced masonry units are used horizontally around the façade to accent the floor levels. The light brown colored ground faced masonry units are also used as the primary masonry type at specific parts of the building to add to the aesthetics of the building façade. Additionally, concrete masonry units (CMU) are used throughout the building for partition walls. The scaffolding used for the masonry construction was a walk-through pipe scaffolding system.

### B.7 Curtain Wall

Much of the 2nd and 3rd floors of the new tower contain large curtain wall windows. The northeast stair and elevator lobby use a four story height curved curtain wall, creating an open feel and allowing morning sunlight into light the space. The southeast corner has a full curtain wall as well, spanning two stories from the 2nd to 3rd floors. Five large curtain wall windows open the southern part of the 3rd floor to sunlight and a beautiful view. The dark pained glazing adds a modern look to the simple red brick exterior façade. The curtain wall system uses 7" aluminum framing and two types of glass. The 1" clear insulated tempered glass is used from floor to ceiling, while a similar 1" insulated tempered spandrel glass is used in areas to conceal the structure behind while continuing with the glazing from floor to floor.

**B.8 Support of Excavation**

The new Hazel Ruby McQuain Tower sits directly adjacent to the existing hospital building. With the new tower's foundations being so close to the foundations of the existing building, the excavation process required a soil nailing support system. The systems consisted of three, 5' lifts made of 4" thick shotcrete with 2 layers of wire-mesh reinforcing. Each 5' section uses #10 size bars tensioned to 150 kips. The excavation and soil nailing process required 6-7 days in between lifts in order to insure proper curing time for the shotcrete retaining wall. Most of the soil nailing walls were only temporarily installed and removed upon completion of the new tower's foundation. In some locations the soil nailing remained permanent, in which the bars were epoxy coated for corrosion protection. In these areas, gravel was placed in between the retention wall and foundation wall to enable water drainage.

# C. Project Cost Evaluation

Addition Size: 210,000 SF

Renovation Size: 95,000 SF

Total Construction Size: 305,000 SF

| CSI Divisions | | Total Project Costs ($) | Total Construction Costs ($) | Costs/Square Foot ($) |
|---|---|---|---|---|
| Division 1 | General Requirements | 628,200 | ~ | 2.06 |
| Division 2 | Site Construction | 5,072,862 | ~ | 16.63 |
| Division 3 | Concrete | 7,833,806 | 7,833,806 | 25.68 |
| Division 4 | Masonry | 1,590,515 | 1,590,515 | 5.21 |
| Division 5 | Metals | 1,905,170 | 1,905,170 | 6.25 |
| Division 6 | Wood and Plastics | 2,379,075 | 2,379,075 | 7.80 |
| Division 7 | Thermal and Moisture Protection | 837,000 | 837,000 | 2.74 |
| Division 8 | Doors and Windows | 2,168,575 | 2,168,575 | 7.11 |
| Division 9 | Finishes | 8,927,785 | 8,927,785 | 29.27 |
| Division 10 | Specialties | 75,600 | 75,600 | 0.25 |
| Division 11 | Equipment | 65,444 | 65,444 | 0.21 |
| Division 12 | Furnishings | 0 | 0 | 0.00 |
| Division 13 | Special Construction | 0 | 0 | 0.00 |
| Division 14 | Conveying Systems | 1,428,115 | 1,428,115 | 4.68 |
| Division 15 | Mechanical | 14,753,595 | 14,753,595 | 48.37 |
| Division 16 | Electrical | 9,425,035 | 9,425,035 | 30.90 |
| | Totals | 57,090,777 | 51,389,715 | |
| | Cost/SF | 187.18 | 168.49 | |

**Table C.1 – Project Cost Breakdown**

## C.1 Actual Construction Costs

Construction Cost (CC): $ 51,389,715

Construction Cost per Square Foot: $ 168.49 / SF

## C.2 Total Project Costs

Total Project Cost (TC): $ 57,090,777

Total Project Cost per Square Foot: $ 187.18 / SF

## C.3 Major Building Systems

See table C.1 on page 8 for each of the building systems broken up into CSI divisions.

## C.4 Parametric Estimate – Using D4Cost 2002 Estimating Software

D4 Cost Estimate

| Code | Division Name | % | Sq. Cost | Projected |
|---|---|---|---|---|
| 01 | General Requirements | 3.71 | 7.09 | 2,162,778 |
| 02 | Site Work | 3.58 | 6.85 | 2,087,764 |
| 03 | Concrete | 12.16 | 23.24 | 7,089,062 |
| 04 | Masonry | 0.26 | 0.50 | 151,883 |
| 05 | Metals | 6.64 | 12.69 | 3,871,816 |
| 06 | Wood & Plastics | 4.68 | 8.95 | 2,729,821 |
| 07 | Thermal & Moisture Protection | 7.53 | 14.40 | 4,391,750 |
| 08 | Doors & Windows | 6.64 | 12.69 | 3,869,701 |
| 09 | Finishes | 8.09 | 15.47 | 4,718,807 |
| 10 | Specialties | 0.80 | 1.54 | 468,627 |
| 11 | Equipment | 0.45 | 0.87 | 264,086 |
| 12 | Furnishings | 0.23 | 0.45 | 136,913 |
| 14 | Conveying Systems | 3.59 | 6.86 | 2,091,848 |
| 15 | Mechanical | 23.15 | 44.26 | 13,500,138 |
| 16 | Electrical | 18.49 | 35.36 | 10,786,309 |
| | Total Building Costs | 100.00 | 191.22 | 58,321,302 |

**Table C.2 – Parametric Estimate using D4 Cost Estimating Software**

### D4 Cost Estimating Project Costs

Total Project Cost (TC): $ 58,321,302

Total Project Cost per Square Foot: $ 191.22 / SF

### C.5 Square Foot Estimate – Using R. S. Means Data

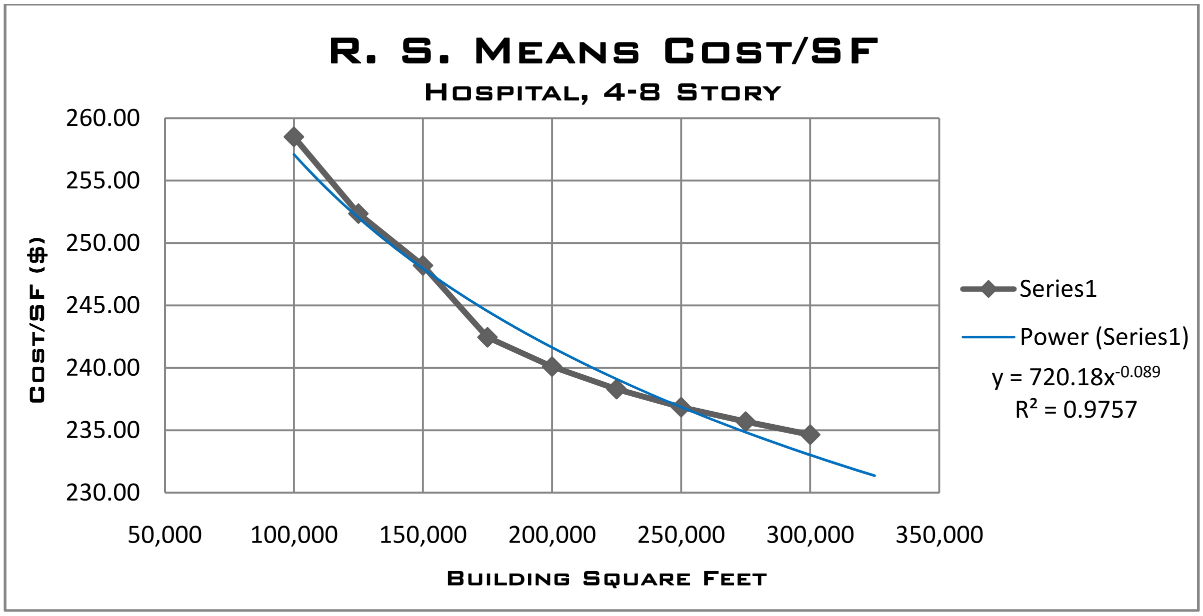



**Chart C.1 – R.S. Means Cost per SF Graph**

Chart C.1 is made from data taken from the 2008 R. S. Means Square Foot Cost book. From the graph, the approximate cost per square foot estimate using 305,000 SF is obtained. A factor of 0.92 is multiplied to the estimate to adjust for the project location.

Approximate Cost per Square Foot: $ 235.00 / SF (without location factor)

Approximate Cost per Square Foot: $ 216.20 / SF

Estimated Building Cost: $ 82,250,000 (without location factor)

Estimated Building Cost: $ 75,670,000

### C.6 Cost and Estimate Comparisons

| | PROJECT COST ($) | COST/SF | % DIFF. |
|---|---|---|---|
| ACTUAL | 57,090,777 | 197.18 | - |
| D4 COST SOFTWARE | 58,321,302 | 191.22 | 2.2 |
| R. S. MEANS | 75,670,000 | 216.20 | 32.5 |

When comparing the actual project cost to the two estimates it is clear which of the two is more accurate. The D4 Cost estimate came within 2.2% of the actual project cost, while R. S. Means fell shy with a 32.5% difference. By using historical data from a project similar to the Monongalia General Hospital and adjusting for the differences, D4 proved to be very accurate. R. S. Means on the other hand highly overestimated the cost of the project. This is partly due to the lack of flexibility in different building designs with R. S. Means estimating. This may also be due to the fact that the R. S. Means estimate is determined mainly on square feet of floor area and 95,000 SF of the 305,000 SF is renovation construction and not new building construction. When looking at only the new construction square footage (210,000 SF) for the estimate in R. S. Means, the total comes to $46,368,000 after the location adjustment. This estimate is significantly lower than the project cost, but does not take into consideration the renovation costs.

# D. Site Plan of Existing Conditions

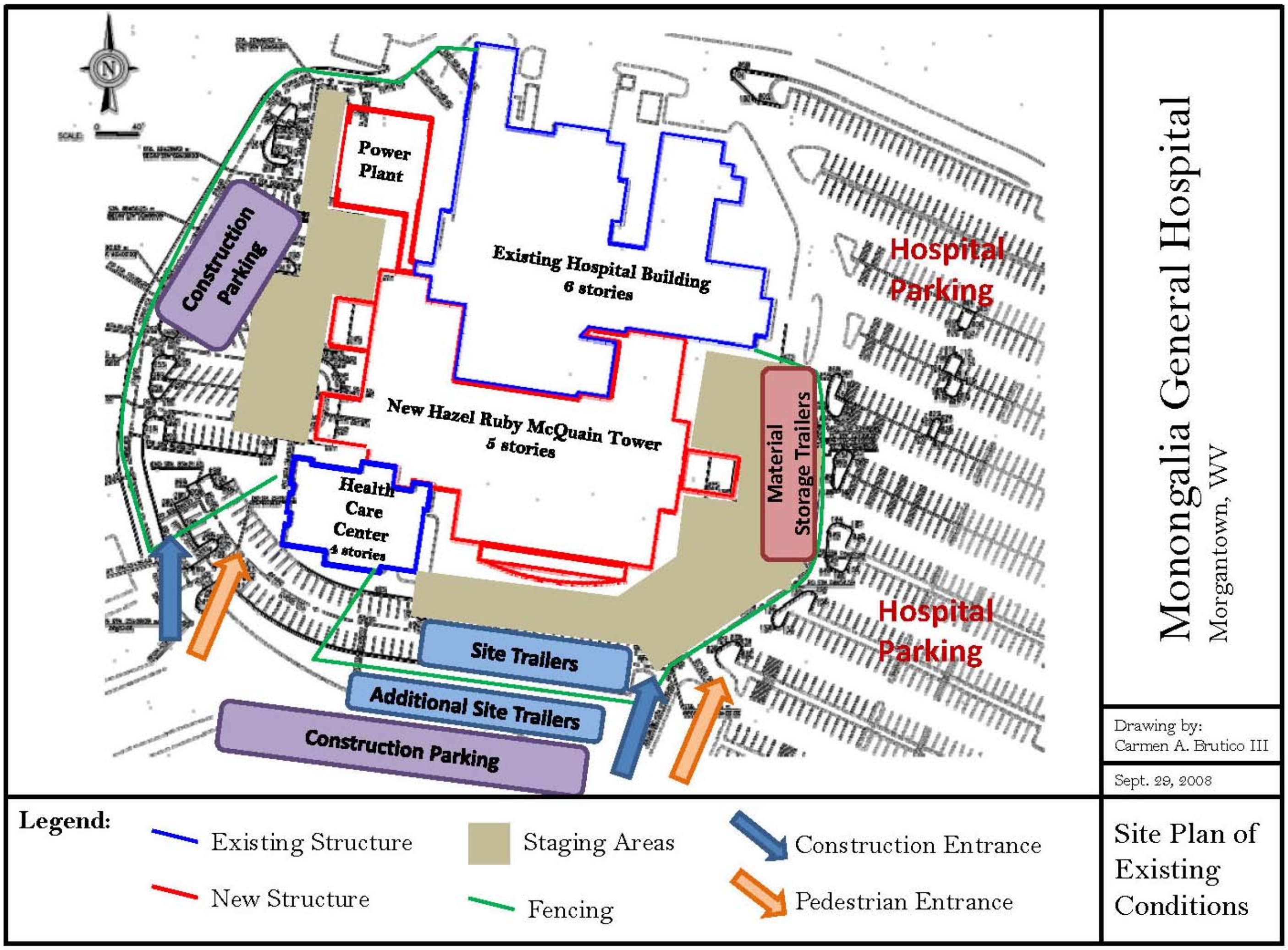



**Figure D.1 - Site Plan of Existing Conditions for the Monongalia General Hospital Renovation and Addition Project**


**Figure D.2 - Arial Photo of the existing Monongalia General Hospital**

## E. Local Conditions

The existing hospital building in which the new tower connects into is a concrete structure. When designing the addition the choice to use cast in place concrete for the structure was necessary to match the same floor to floor heights of the existing building. There is also an underground tunnel connecting the existing hospital to the health care center. Additional precautions while excavating around and connecting into the tunnel were required.

One locality condition which required added planning from the construction team is the winter weather conditions susceptible to the Morgantown, West Virginia area. The winter weather posed temperature problems when placing the cast in place concrete. This impacts the concrete placing during the winter season which was necessarily adjusted for in the project scheduling.

## F. Client Information

The pre-existing Monongalia General Hospital opened in October 1977. Now 28 years old, the renovation and addition project is designed to bring Monongalia General Hospital, from a facilities standpoint, into the 21st century. Healthcare has changed dramatically from 1977, from being predominantly inpatient medical care to care being rendered on an outpatient bases. In addition, most of the medical technologies that we now have today didn't exist in 1977; as a result, the building was not designed to adequately meet the requirements of today's workplace. Furthermore, it was rare in 1977 for a patient to have a private room. Most patient rooms in the existing hospital are semi-private with two patients sharing a room using a curtain as a divider. Today's typical patient expects a private room and federal Health Insurance Portability and Accountability Act (HIPAA) privacy requirements almost mandate it. Overall, the goal of the expansion is to enhance the quality of care, provide the privacy and comfort that today's patients have come to expect, and modernize the facilities to accommodate new healthcare technologies.

A project of this magnitude in a moderately sized city attracted a lot of publicity from the community. While this is generally excellent publicity for the parties involved, it comes at a cost. As with most projects the construction manager on the project was continuously pressured to maintain schedule. With a watchful eye from the public, patiently waiting for the finishing and unveiling of the new hospital tower, the CM's main concern was hitting the schedule. As the project progressed and changes were made increasing the cost of the project, the budget became the prevailing issue. Since the project owner is a hospital, increased costs over the budget can become problems very quickly due to the way hospitals obtain their funding.

Most of the existing hospital remained in full function throughout the construction of the new tower. The exterior rooms, to which the new tower connects to the existing building, were vacated prior to demolition of the exterior. The hospital provided its own barriers for penetrations into the building near construction, to protect the occupants from any airborne construction debris. Upon the completion, the hospital transferred many of the departments into their new location in the new addition and so that the renovation phases could begin in the existing building.

## G. Project Delivery System

The delivery method for this project is unique in that it is defined as a design-build delivery method but essentially utilized a competitive bidding process to select the construction manager, instead of the usual design-build or joint venture firms. The project began as the owner brought an architect (FreemanWhite) on board early in the design phase to then plan and design the project. The architect holds a Guaranteed Max Price (GMP) contract with the owner. The at-risk construction manager (Turner) for the project also holds a GMP contract but with the architect and not with the owner (Monongalia General Hospital), as in most cases. This is also where the combination of delivery methods comes in to play. The selection for the CM on the project was declared using 70% document completion, justifying a design-build delivery. The construction team was permitted to break ground under contract of the 70% complete documents. As mentioned, the selection of the CM was done through a competitive bidding process often used in design-bid-build delivery methods, making the delivery method on this project a unique combination of delivery methods.

The architect performed most of the design elements such as architecture, MEP, interiors, and fire and sprinklers. The structural and civil design work, were contracted out by the architect, to third parties engineering companies. The two firms are illustrated on Figure G.1 with their contracts most likely being lump sums.

The CM holds all the contracts with the performing construction companies. The five major subcontractors are shown in Figure G.1. All of the subcontractors hold lump sum contracts with the CM. The requirement for subcontractor selection was a minimum of three bidders per scope package. Each of the subcontractors was required to provide their own performance bond and insurance. Additionally the CM held its own general liability insurance.

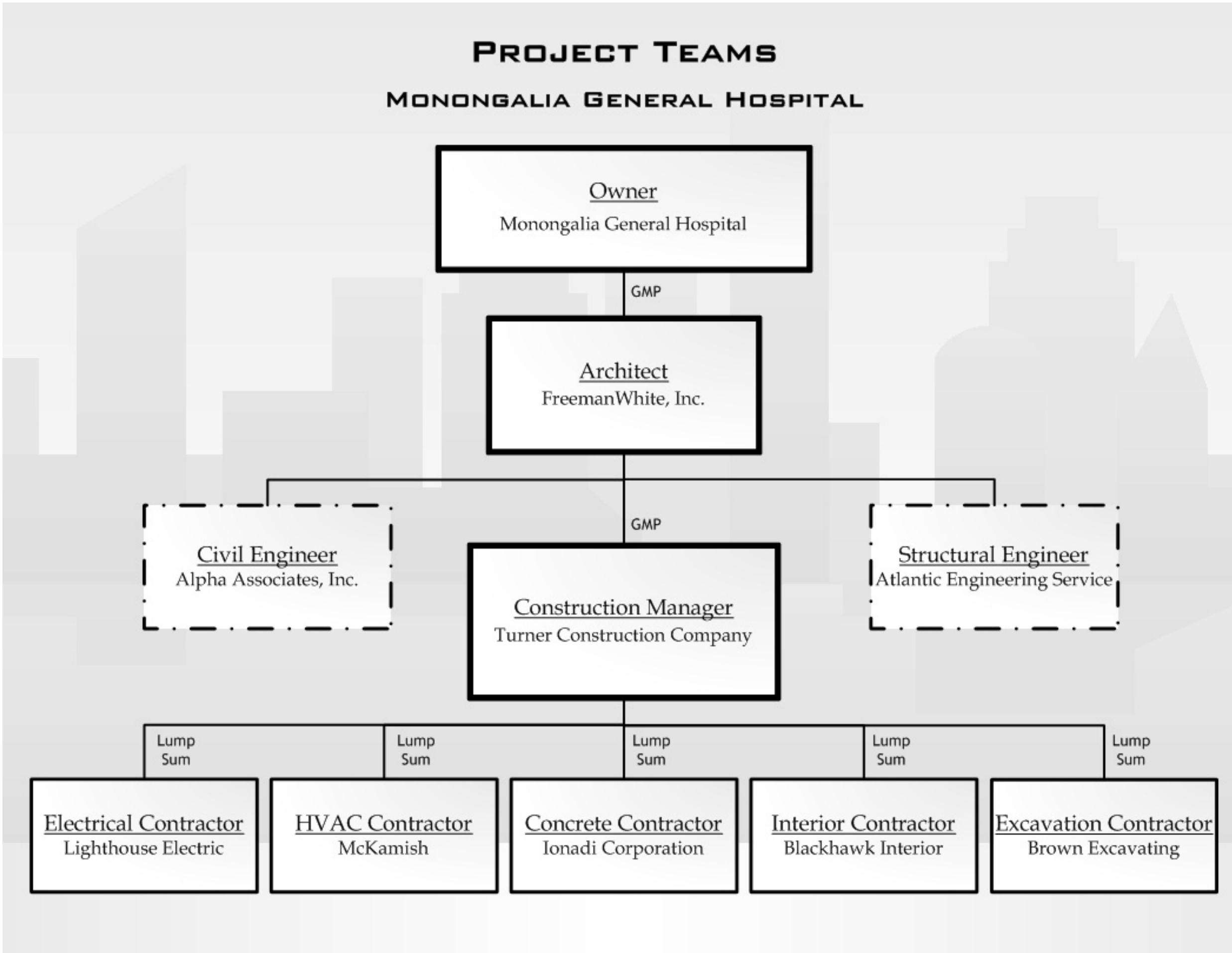



**Figure G.1 - Project Delivery Team Organizational Chart**

## H. Staffing Plan

The Turner construction team on the Monongalia General Hospital Project is split into a field team and an engineering team, both of which are located onsite. Also onsite is a field secretary. The secretary manages the site office on both the field and engineering side. The engineering team is led by a project engineer who has an additional assistant project engineer positioned below him to assist in the field engineering duties. The field team is made up of two superintendents and four field engineers. The construction supervision consists of a full time field superintendent and an MEP superintendent. The addition of the MEP superintendent was essential to handling the additional field coordination due to the hospital's intricate MEP systems. One of the four field engineers was designated as a safety engineer to handle all the safety items on the project. Directly overseeing the entire project is the project manager, who reports to the project executive. Topping out the administrative personnel is an operations manager positioned above the project executive. Additional to the field personnel, a cost engineer located offsite in a regional office is designated to handle project cost information.

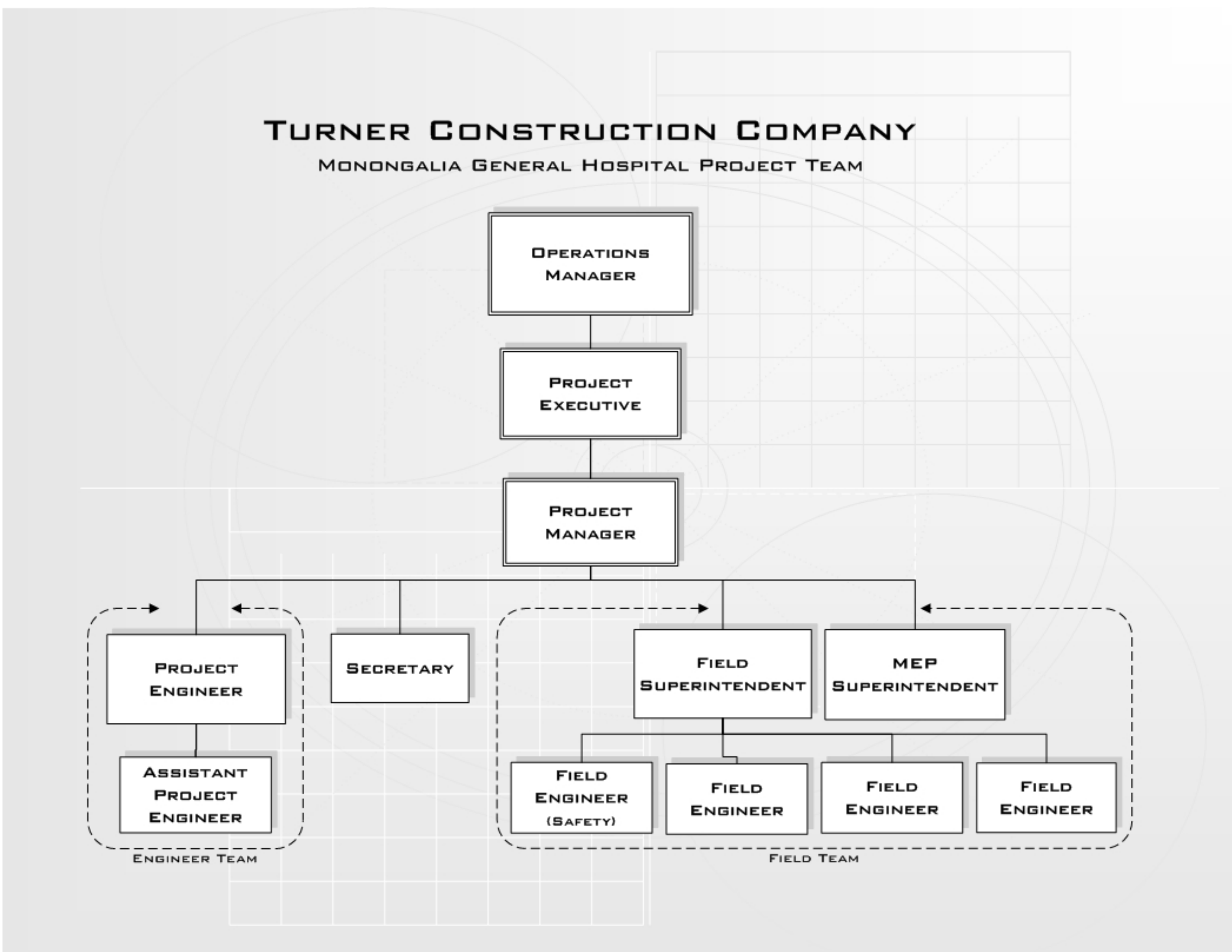
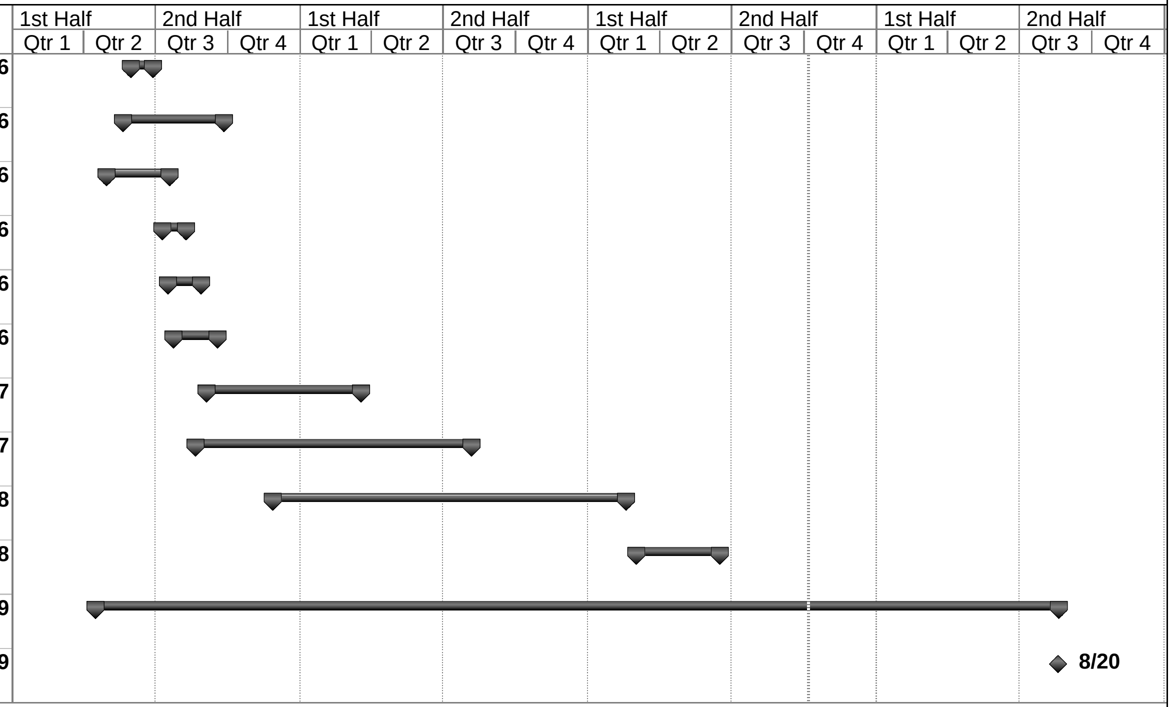



**Figure H.1 - Turner Project Team**

# Appendix A:

## Phase Schedule

| ID | Task Name | Duration | Start | Finish |
|---|---|---|---|---|
| 1 | **Phase 1** | **20 days?** | **Thu 6/1/06** | **Wed 6/28/06** |
| 4 | **Phase 2** | **92 days?** | **Mon 5/22/06** | **Tue 9/26/06** |
| 28 | **Phase 3** | **58 days?** | **Mon 5/1/06** | **Wed 7/19/06** |
| 30 | **Phase 4** | **22 days?** | **Tue 7/11/06** | **Wed 8/9/06** |
| 32 | **Phase 5** | **30 days?** | **Tue 7/18/06** | **Mon 8/28/06** |
| 34 | **Phase 6** | **40 days?** | **Tue 7/25/06** | **Mon 9/18/06** |
| 36 | **Phase 7** | **140 days?** | **Tue 9/5/06** | **Mon 3/19/07** |
| 38 | **Phase 8** | **250 days?** | **Tue 8/22/06** | **Mon 8/6/07** |
| 40 | **Phase 9** | **320 days?** | **Tue 11/28/06** | **Mon 2/18/08** |
| 42 | **Phase 10** | **76 days?** | **Mon 3/3/08** | **Mon 6/16/08** |
| 44 | **Phase 11** | **874 days?** | **Mon 4/17/06** | **Thu 8/20/09** |
| 46 | **Project Complete** | **0 days** | **Thu 8/20/09** | **Thu 8/20/09** |




Project: Phase Schedule.mpp
Date: Mon 10/6/08

| | | | | | |
|---|---|---|---|---|---|
| Task | | Milestone | | External Tasks | |
| Split | | Summary | | External Milestone | |
| Progress | | Project Summary | | Deadline | |

# Appendix B:

## Milestone Schedule

Monongalia General Hospital Addition and Renovation | Milestone Schedule | Mon 10/6/08

| ID | Task Name | Start | Milestone |
|---|---|---|---|
| 2 | **Start of Excavation & Soil Nailing** | Wed 6/14/06 | 6/14 |
| 3 | **Start of Central Plant & Tunnel Extension** | Wed 6/21/06 | 6/21 |
| 5 | **Start Foundations** | Fri 7/7/06 | 7/7 |
| 6 | **Start of Structure - Building Concrete** | Mon 8/14/06 | 8/14 |
| 1 | **Early Site Package** | Tue 12/12/06 | 12/12 |
| 7 | **Start of Structural Steel** | Wed 12/20/06 | 12/20 |
| 8 | **Start of Exterior Studs and Insulation** | Tue 1/2/07 | 1/2 |
| 16 | **Start of Mechanical Systems** | Tue 1/2/07 | 1/2 |
| 9 | **Start of Masonry** | Mon 3/5/07 | 3/5 |
| 15 | **Start of Vertical Transportation** | Mon 3/5/07 | 3/5 |
| 10 | **Start of Curtainall & Windows** | Mon 4/16/07 | 4/16 |
| 11 | **Completion of Structure - Building Concrete** | Fri 4/20/07 | 4/20 |
| 14 | **Start of Interiors** | Tue 5/1/07 | 5/1 |
| 12 | **Start of Roofing** | Mon 5/7/07 | 5/7 |
| 4 | **Central Plant Complete** | Fri 6/8/07 | 6/8 |
| 20 | **Start of Renovations** | Mon 9/17/07 | 9/17 |
| 13 | **Buidling Enclosed (Skin & Roof)** | Fri 12/7/07 | 12/7 |
| 17 | **Start of Commissioning** | Tue 1/29/08 | 1/29 |
| 18 | **Start of State & Local Inspections** | Tue 3/11/08 | 3/11 |
| 19 | **Beneficial Occupancy - Addition** | Tue 4/22/08 | 4/22 |
| 22 | **Start 2nd Floor West Renovations** | Mon 6/16/08 | 6/16 |
| 23 | **Start 3rd Floor Renovations** | Mon 6/23/08 | 6/23 |
| 25 | **Start Patient Floor Renovations** | Tue 7/1/08 | 7/1 |
| 21 | **Construction Complete** | Thu 4/30/09 | 4/30 |
| 24 | **Project Closeout Complete** | Thu 8/20/09 | 8/20 |
| 26 | **Closeout Payment** | Thu 8/20/09 | 8/20 |

Project: Milestone Schedule.mpp
Date: Mon 10/6/08

| | | |
|---|---|---|
| Task | Milestone | External Tasks |
| Split | Summary | External Milestone |
| Progress | Project Summary | Deadline |