The Washington County Regional Medical Center

11116 Medical Campus Road
Hagerstown, Maryland 21742

Final Report

Scott Earley
Construction Management
Consultant: Dr. David Riley
4.7.2009

The Washington County Regional Medical Center

Scott Earley
Construction Management

11116 Medical Campus Road
Hagerstwon, MD 21742

Project Information

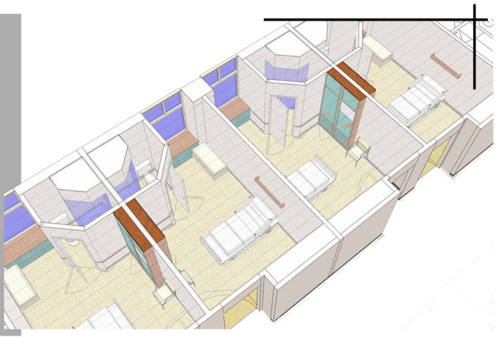
Size	500,000 sq. ft.
Height	5 levels
Project Cost	$150 million
Construction Dates	March 2008 - December 2010
Delivery Method	CM @ Risk

Project Team

Owner	Washington County Health Systems
Architect	Matthei & Colin Associates
CM	Gilbane Building Company
MEP Engineers	Leach Wallace Associates, Inc.
Structural Engineers	Abatangelo-Hason, Ltd.

Architectural Design

- Various facade types; brick, arch. precast, and glass
- Ballasted single ply roof membrane on rigid insulation
- (275) single bed rooms with private bathrooms
- (53) emergency treatment rooms
- (2) truma and 2 cardiac rooms



MEP Systems

- (5) AHU's totaling a maximum of 450,000 cfm.
- Central Utility Plant - (2) chillers & (2) cooling towers
- Electrical service feeds (3) substations each at 4,000 amps, 480Y/277, 13.2kV, 3 phase 4 wires.
- (2) emergency generators at 2,000 amps, 480Y/277
- Flourescent ceiling mounted light fixtyres typical

Structural System

- (150) deep foundation caissons under bed towers
- Spread footing foundation and grade beams under the other portions of building footprint
- Structural steel frame with 3-1/4" LWT concrete slab on 20 guage composite deck for the floors

http://www.engr.psu.edu/ae/thesis/portfolios/2009/sse112

Acknowledgements

Researching, executing, and compiling this report was a very challenging and rewarding experience for me. I have learned a wealth of knowledge and gained valuable experience through my thesis work. Although this is presented as my work, I could not have completed it without the help of the following people.

First and foremost, I would like to thank the Washington County Health System, notably Mr. Neal McKelvey, owner's representative, for allowing me to use The Washington County Regional Medical Center as a model for my thesis research. Without their consent or permission to use the project information, I could not have even started this work.

I would next like to thank the Gilbane project team at the Washington County Regional Medical Center for sponsoring me with this thesis. I would especially like to extend gratitude to Matt Sarver, a senior project engineer who became my main contact and continuously answered my questions and provided me valuable information whenever I needed it, Fred Neighoff, the senior general superintendent, and Gary Orton, the project executive.

I would like to thank my course instructors, faculty, and fellow classmates. I would like to especially thank Dr. David Riley, my thesis advisor, and Dr. Michael Horman who both provided insight and direction into my thesis topics and research. I would like to acknowledge Professor Bob Holland and Professor Kevin Parfitt for the job they have done organizing and administering the thesis course. Also, a special thanks to all my classmates who have provided assistance to me throughout my five years at Penn State.

Lastly, but perhaps most importantly, I would like to thank my friends and family for their continuous support and constant steadfastness throughout my life and education: my mother, Karen Borst; my father, Foster Earley; my brothers, Todd and Ryan; my grandparents, Bill and Dottie Borst; my girlfriend's parents, Tom and Julie Ramsey; my extended family, Thomas Chirdon, Christopher Conrad, Dominic Manno, and David Miller and Steve Lumpp '''Hawks 4 Life'''. Finally, I would like to thank my girlfriend, Megan Ramsey, who contributed to this report, my education, and my life in numerous amounts of ways that provided me the ability to grow and achieve success.

I would also like to acknowledge my grandparents, Gene and Jean Earley, who passed away before the completion of my education. I know they would be proud and I will forever be grateful for the knowledge and values they instilled in me.

Table of Contents

List of Visuals

Executive Summary

This report examines The Washington County Regional Medical Center, a new, replacement medical center in Washington County Maryland owned by the Washington County Health System. The medical center will serve as an acute medical care facility for the region’s continuously growing population. The report provides analyses focus on adding value to the project, reducing costs, and shortening the project schedule. Specifically, the report examines the development of the old facility, a redesign of the deep foundation system, and a composite precast panel wall implementation.

The financial issues facing the market today create an industry issue when considering the owners, their money, and their financing strategies. Primarily, this project was funded purely from bonds that will start to mature shortly after the completion of the new medical center. The owner may be concerned with the ability to repay these bonds. Through market and local research a solution to generate additional money was produced. Washington County Health System owns the old hospital; developing this facility would generate additional income. Four development options were assessed: Develop to Sell, Develop to Run, Partially Develop to Run, and Develop to Lease. The best solution was to Partially Develop to Run which produced an internal rate of return of 31%, a sale price of $74,264,614 in year 10, and a $50,865,041 return on the investment. These numbers prove a valuable investment in developing the old hospital.

The second analysis looked at the deep foundation system. The system chosen was an array of caissons under the three bed towers. This proved to be costly and time consuming. Alternate options were considered based on constructability, value engineering, and schedule enhancement. The research showed that a minipile deep foundation system under the bed towers was an appealing alternative. Depending on load, the design produced a range of two to eight minipiles under each footer. The minipile system saved $413,356 and, when compared to the caissons, a 48% schedule reduction was present. These numbers alone show that the minipile deep foundation system may have been a better option for the new medical center.

The third analysis examined the implementation of a composite precast wall panel. Through product research, a system called Metal Stud Crete® by Earl Corporation was chosen to perform the analysis. This system is comprised of a thin precast concrete exterior shell combined with exterior metal framing. The wall also contains insulation and options to create any exterior that the owner may want. The system was used to replace the brick on the new medical center. When analyzing the construction impacts, the composite precast system produced a 56% reduction in on-site construction time. The implementation also saved the project $334,683 in upfront costs. A mechanical analysis comparison between the brick cavity wall and the composite wall system was also performed. The results showed a reduction in annual energy costs and life cycle costs, but did not allow a reduction in the sizes of mechanical equipment. With these figures, implementation of this composite system appears to be a good fit with the Washington County Regional Medical Center.

1.0 Project Introduction

The Washington County Regional Medical Center is the construction of a new, replacement medical center in Washington County Maryland. The medical center will serve as an acute medical care facility for the region's continuously growing population. It is located just outside of Hagerstown, Maryland at 11116 Medical Campus Road. It will directly connect to an existing outpatient facility located at the site, Robinwood Medical Center.

The owner of the new medical center is Washington County Health Systems. Their intent is to have a state of the art medical center with the newest and most specialized equipment in the region while keeping patient safety a high priority. The medical center will also become a regional trauma unit with the expansion of their emergency services section of the building.

The size of the new medical center is about 500,000 square feet and features three five story bed towers for patient care. It also contains separate transportation corridors for patients and visitors. The medical center will "link" to Robinwood through administrative offices.

The architect for the new medical center is Matthei & Colin Associates (M&CA). The project delivery is Construction Manager at Risk (CM @ Risk) with the CM being Gilbane Building Company. The project is slated for completion in December of 2010 and the total project costs including land procurement, design fees, and other expenses to completely fund the entire project from start to finish is $282 million.

2.0 Project Team Overview

2.1 Client Information

The Washington County Regional Medical center is owned by Washington County Health Systems (WCHS), a non-profit organization, accredited by the Joint Commission on the Accreditation of Healthcare Organizations. WCHS is building the new medical center because the old hospital is becoming obsolete and the old site provides no room for expansion. The old technologies and facilities make it hard to keep up with the ever evolving healthcare world. Also the region that the hospital serves is rapidly expanding and the old hospital can not handle the growth without an expansion. The new medical center is allowing WCHS the opportunity to expand to a regional trauma unit, a goal that they look forward to achieving.

The medical center has always had a mission of delivering quality healthcare in a safe manor as demonstrated in the following quote from their website:

> "....offering spaces and amenities just for patients and their families, focusing on quality and safety, and bringing advanced medical technology to our region."
>
> *Source: http://www.washingtoncountyhospital.com/news/pdfdb/Case%20Statement.pdf*

WCHS expects to be occupying the new medical center in early 2011. They are excited to attain regional medical center status and are anxious to operate as a regional trauma center. The new medical center will also allow for an easy flow of inpatient and outpatient procedures between the existing Robinwood Medical Center and the medical center.

2.2 Project Delivery System and Contracts

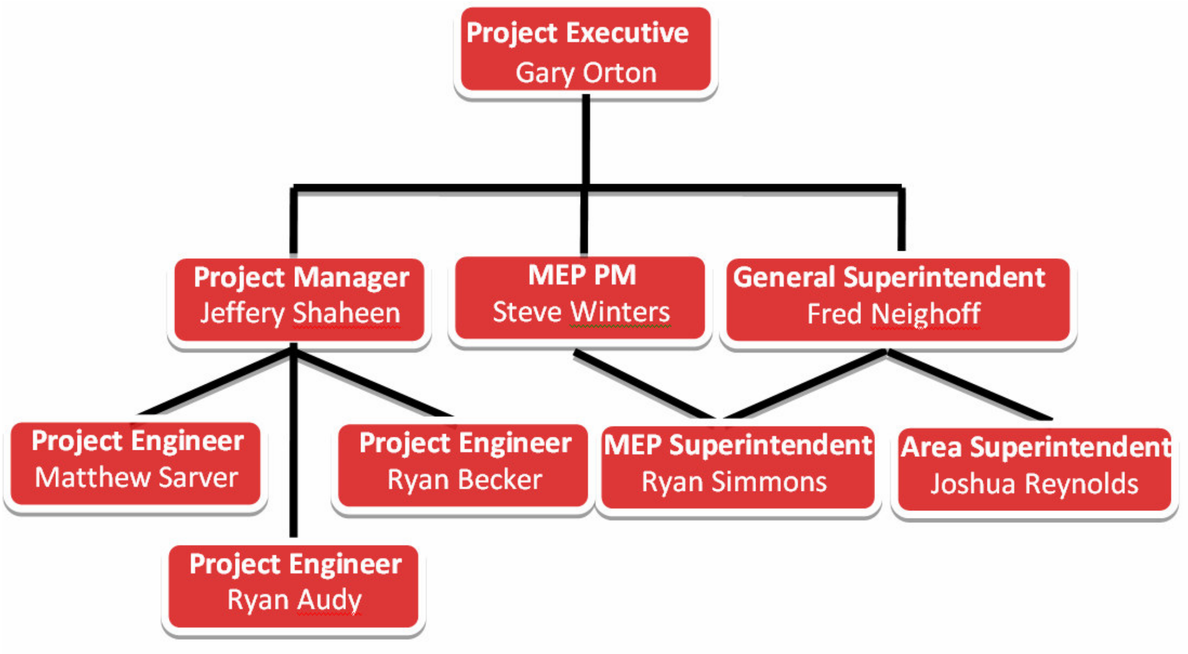
The delivery system chosen for The Washington County Regional Medical Center was a Construction Manager (CM) @ Risk approach. This approach was taken because of the nature of the relationship between Gilbane and WCHS. They began negotiating the contract as soon as the decision to build a new hospital in Hagerstown was made. The architect, M&CA, was also chosen very early on negotiated terms and conditions. M&CA was chosen because of their extensive work and expertise in the healthcare facility market. The contract between them and the owner is a percent fee type. This gives M&CA a percentage of the costs of the project. M&CA also has arrangements with several design consultants; however, the contract details could not be released. The CM @ Risk approach and the contract types between all parties is very appropriate for this type of job and this type of owner. These factors should allow for a smooth successful project.

A lump sum contract was chosen for the subcontracting roles. These were hard bid packages released to qualified subcontractors. The low bid was then used for the guaranteed maximum price (GMP) contract between the CM and the owner.

2.3 Project Team Organization Structure

The organizational structure, as shown below in Figure 2.1, establishes all the personnel that the CM has staffed on the project. All staff personnel are onsite. The project manager, general superintendent, and two of the project engineers will see the project form start to finish. The other project staff will spend their full time on the project when their specific contractors are completing their work.

Figure 2.1: CM Organizational Chart



3.0 Existing Conditions

3.1 Architectural Description

The site the new medical center will sit on is sloped creating the first level to be below grade on one side of the building and on grade on the opposite side. The second level adds the administrative wing, or the "link", to the building footprint (See Appendix A for footprint reference plan). The link will attach directly into the existing Robinwood building creating a flow between the two facilities. The second level also carries the main part of the building through it. The link and the patient bed towers continue to the third level where the link stops and the three bed towers continue two more levels creating the main vertical elements of the building.

The building consists of three different types of veneer; brick, precast architectural panels, and exterior glazing. The brick is mainly located on the link to the existing facility and various other lower levels of the medical center. The precast panels are primarily located on the patient bed towers with the exterior glazing spread throughout all sections of the building. A typical wall cavity is used behind these veneers. It consists of rigid steel framing supported by the steel structure.

The roof system throughout all areas of the medical center is fairly consistent. It is made up of a ballasted single ply roof membrane on rigid insulation, all of which sits on metal roof deck supported by the steel structure. The roof also contains a helipad for the transportation and reception of patients flown by helicopter. This particular section of the roof is a 4" concrete slab on rigid insulation with a reinforced hot applied membrane as the cover. Also, a small section of the building contains a standing seam metal roof on rigid insulation and oriented strand board. This is located over the religious services section of the building and provides a distinct difference in the appearance to create a visually separate space.

3.2 Zoning and Codes

Zoning:

- Hospital: Use Group I-2 (Institutional Hospital)
- Administration Wing: Group B (Business)
- Industrial (Power Plant, Laundry, and Waste Holding): Use Group F-1 (Industrial)

Applicable Codes:

- 2003 International Building Code (IBC) (For total building except seismic design)
- 2006 International Building Code (IBC) (For seismic design)
- 2003 International Mechanical Code
- 2003 International Plumbing Code
- 2005 National Electric Code

- Maryland Accessibility Code
- Maryland Energy Code
- COMAR (Codes of Maryland) 10.07.01 Acute General Hospitals & Special Hospitals
- NFPA 101 2000 Life Safety Code

3.3 Insurance and Bonding

This project, unlike many, had no requirements for subcontractors to be bonded. Instead, the CM replaced several subcontractor bonds with their own Contractor Default Insurance (CDI). This insurance covers all the subcontractors and protects the CM if a subcontractor defaults on their contract. The benefits of the CDI is, if a subcontractor defaults on a contract, then the CM does not have to fight with surety companies for the money to cover the default. The CDI that the CM carries will immediately pick this up and hopefully allow for a smoother and more efficient solution to the problem so the project can continue to completion. The CDI only covers defaulting subcontractors. Therefore, the subcontractors must carry their own builder's risk and general liability insurance. The CM also carries both of these as an umbrella over the subcontractors and, as a final precaution, the owner also has both insurances.

3.4 Building Systems Summary

The following table, Table 3.1, and written information describe the main building systems of the medical center. The information describes the key design and construction issues of the project.

Table 3.1: Building Systems Summary

Work Scope Questions	Medical Center	
	Yes	No
Is Demolition Required?	x	
Is there a Structural Steel Frame?	x	
Is there Cast in Place Concrete?	x	
Is Precast Concrete used?	x	
Describe Mechanical System	n/a	n/a
Describe Electrical System	n/a	n/a
Is Masonry used?	x	
Is there a Curtain Wall?	x	
What supports the Excavation?	n/a	n/a

3.4.1 Demolition

There is very little demolition for this building since it is new construction on an empty site. With the new construction, a new information technologies (IT) room must be built. The existing Robinwood Medical Center adjacent to the new hospital has a room in the basement that will be converted into an IT room for use by both the new medical center and the existing Robinwood complex. This room will need some interior partition demolition to convert it to an open IT room with an office and a bathroom.

3.4.2 Structural Steel Frame

The structural system is comprised of a steel frame of wide flange columns and beams. There are not too many typical sizes of steel because of the unique design; however, the bed towers are comprised mainly of three different sections. They are W21x44, W18x35, and W12x16. Some typical sizes throughout the other sections of building are W16x31, W14x22, and W16x26. There are also other areas of the building that use hollow steel sections for miscellaneous steel framing. There are two different primary bracing systems used in the steel frame. The first is a vertical chevron style brace. This style of bracing is used in the highest sections of the building that extend from the foundation through the vertical elements of the stair towers. The other type of bracing is a form of cross bracing. This type of brace has two elements. The first beam extends one full diagonal of the frame while a second only goes from one corner to the midpoint of the full diagonal piece.

The structural steel will be erected with two different cranes. A 300 ton crawler crane will erect the three bed towers in the first three sequences. For the next sequences a smaller, 150 ton crawler crane will be used. This will allow the steel erector to get rid of the larger, more expensive crane and switch to a smaller, less expensive crane to finish the erection.

3.4.3 Cast in Place Concrete

All the structural concrete on the project will be cast in place. These items include the foundation walls, footings, grade beams, and the slab on grade and slab on decks. A steel formwork system is used for foundation walls and a stick-built plywood forming system is used for the footings and grade beams. The decks are formed using the composite metal decking with shoring on the deck below. The edges and pour stops are formed with different sizes of lumber.

The concrete for the foundation work will be placed by a crane and bucket method. A 175 ton crawler crane will be used for the concrete and will only have to make one crucial move after the initial mobilization. The same crane used to erect the forms and place the rebar cages will be used to swing the concrete to the proper place.

3.4.4 Precast Architectural Concrete

The precast concrete on the project only consists of architectural panels used as a façade. These panels vary in size across the building and are located primarily on the bed towers. They will be supported by the steel frame and connected to the columns with steel angles or "C" channel. A 250 ton crawler crane will be used to erect the precast panels and will have to move to complete the erection.

3.4.5 Mechanical System

The mechanical system is comprised of three different elements and they are as follows:

- Central Utility Plant (CUP)
- Two Dedicated Mechanical Rooms
- Various Roof Top Units

The CUP is located in the service section of the building (first floor, plan south; see Appendix A for reference plan). It houses two, 1000 ton chillers and two, 3000 GPM cooling towers. The area also contains three high pressure steam boilers for hot water. The CUP has various pumps for the fire protection system as well as the mechanical system. The location of the CUP allows for ease of maintenance, service, and installation of the major systems.

The first, and larger, of two dedicated mechanical rooms is located on the third floor of the south bed tower. There are three Air Handling Units (AHUs) located in this room of sizes 90,000, 100,000, and 110,000 CFM. These units serve separate sections of the building from the second through the fifth floors.

The second of two dedicated mechanical rooms is located on the first floor, (plan) west side of the building. This room holds two more AHUs of 40,000 and 90,000 CFM. These AHUs serve various sections of the first floor departments.

There are three other smaller AHUs located on different sections of the roof that serve dedicated spaces.

3.4.6 Electrical System

The electrical system starts with service to the CUP where the main feed comes into the building. The electrical service feeds three separate electrical substations in the CUP. These substations are all 13.2 kV at 480Y/277V delivering 4,000 amps. The substations feed into different switchgear which then services separate sections of the building. The CUP location, as previously discussed, allows for easy maintenance and service for all the electrical switchgear and systems located there. There is redundancy built into the electrical system with two emergency generators, at 480Y/277 delivering 2,000 amps each, supplying key areas and emergency lighting in the medical center.

The luminaries throughout the main areas of the building are fluorescent luminaries. However, there are also many different types of unique lighting in the operating rooms and other special procedures areas.

3.4.7 Masonry

The masonry on the project consists of a brick veneer. This veneer is located on the lower levels of the building and the link. The brick will be supported by the steel frame with steel angles and will be erected with scaffolding moving around the building. It is also tied into the steel with masonry wall ties.

3.4.8 Curtain Wall

There is curtain wall on various lower portions of the building. It is an aluminum curtain wall system with ½" mullions and 1" insulated glass. Erection will start with the framing system of the curtain wall. After the frame is set, the windows are placed from the exterior of the building using an aerial platform lift. Any field modifications can then be made to the frame so the system works as a unit. The finishing caps are then placed over the framing.

3.4.9 Excavation Support

The excavation is supported by seven permanent retaining walls ranging from 1'-0" to 1'-7. The retaining walls are located at the loading docks in the service area and at an outdoor dining terrace outside the cafeteria. These walls contain no "tie-backs" into the soil. Other excavated earthwork is retained in stockpiles located on the site. Soil is retained from these other excavated areas using the slope set back tolerances specified by OSHA.

3.5 Local Conditions

3.5.1 Local Soil Conditions

The project is located just outside of the city of Hagerstown, MD. The large site allows for many freedoms when it comes to contractor parking, available lay-down areas, dumpster space, and other storage spaces. The site is underlain by the Conococheague Limestone formation and the site soil is primarily composed of silty clay, clayey silt, and silt with various amounts of sand and rock fragments. The soil located on the site takes an abnormally long time to dry out and becomes saturated easily. The subsurface testing concluded that there was no real concern with subsurface water condition because the test borings performed without rock coring were dry both during drilling and at the completion of the drilling operations.

3.5.2 Special Local Site Conditions

The site contains several sinkholes from previous construction projects including the existing Robinwood Medical Center. One significant sinkhole was noted and not remedied previously due to an abandoned project and the hole was subsequently filled. The sinkholes could cause problems if not handled properly; however, the sinkholes are not under the proposed building footprint and can easily be fixed. Therefore, no extra bearing foundation systems were developed to handle these areas.

As stated previously in the report, the new medical center will be joining an existing outpatient procedures building. This facility will continue to serve the community during construction.

Many considerations need to be taken when working this close to an active medical establishment.

3.5.3 Local Weather Conditions

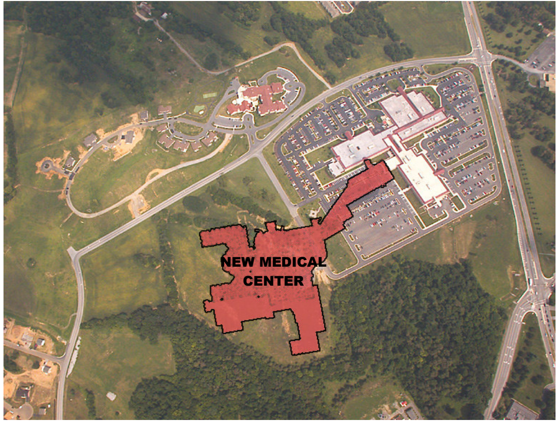
The weather conditions have a big impact on any construction project. Hagerstown Maryland is located in the northeast region of the United States and experiences hot and humid summers and moderately cold winters. Hagerstown averages 37.2 inches in rainfall and 21 inches of snowfall a year. The yearly average high is 64°F and the yearly average low is 43°F.

3.6 Site Plan of Existing Conditions

The new location for the Washington County Regional Medical Center has a site that is large and very open which will allow for adequate laydown area, storage, parking, and many other luxuries a tight, congested site can not have. The following two figures, Figure 3.1 and Figure 3.2, show aerial photographs of the existing site. Included are the Robinwood Medical Center and its existing parking lots. Figure 3.2 has a superimposed footprint of the new medical center on it to show the relationship of the site, the medical center, and the existing facility.

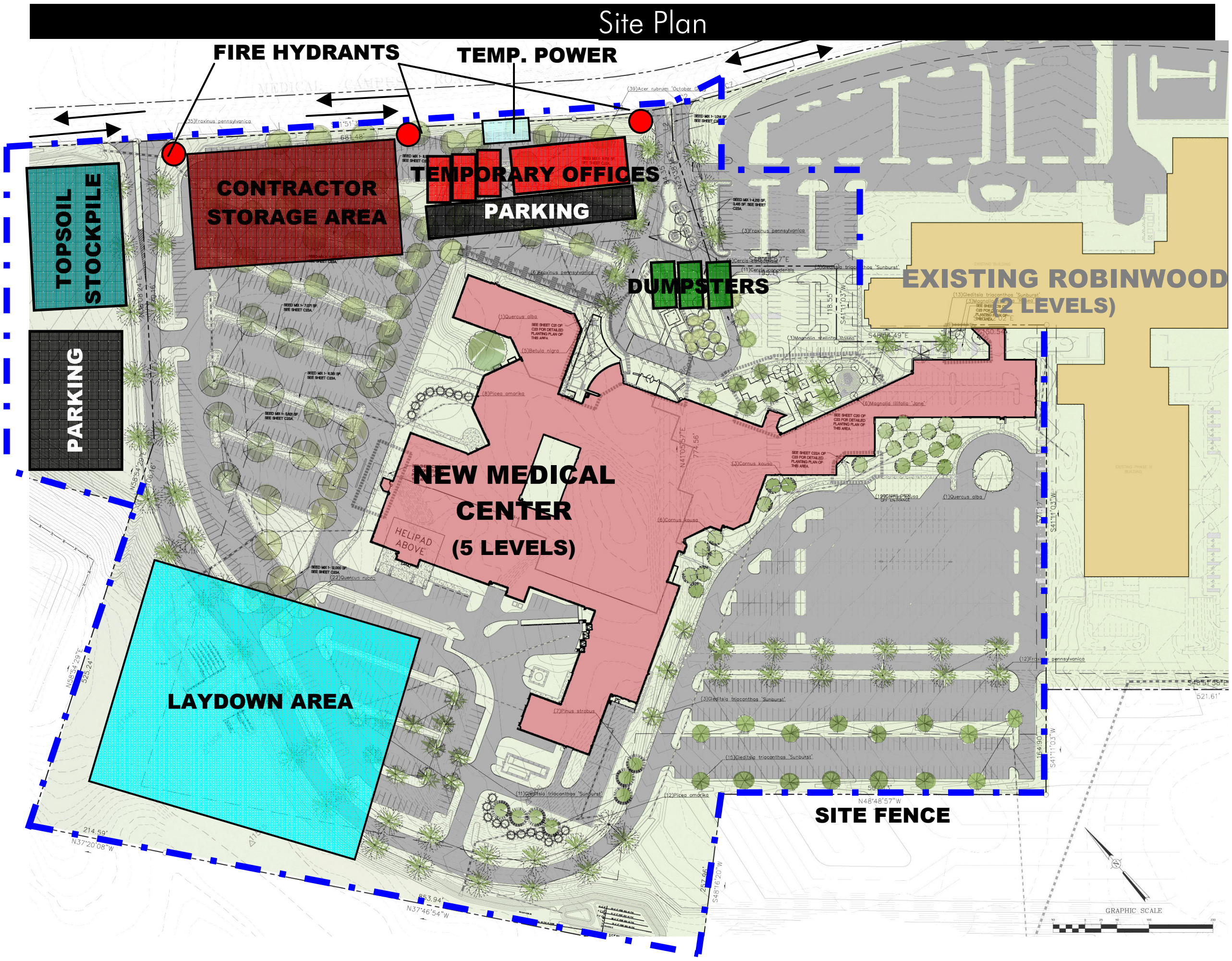
Figure 3.1: Existing Site

Figure 3.2: Existing Site with New Medical



The drawing over page, Figure 3.3, shows a site utilization plan, finished site plan, and an existing site plan all overlaid on each other. Temporary facilities, parking, and site waste are only a few of the things to consider when planning for construction on the site. Also make note of the existing Robinwood Medical Center and where the new medical center will tie into this outpatient facility.

Figure 3.3: Site Plan



3.7 Site Logistics Plans

The site logistics plans created, as shown in Appendix B, are a combination of a final site layout and a site logistics plan. This is useful to show the relationship of each item relative to the final landscaping and site plan.

3.7.1 Common Items

As previously stated, the site is very open; therefore, many temporary facilities, storage areas, and other items do not have to move through out construction. Traffic around the site will need to be maintained throughout construction for Robinwood employees; thus, traffic patterns will not change or be affected. The following is a list of such items that are common among all the logistics plans.

- All temporary offices
- Majority of site fencing
- Contractor parking
- Office parking
- Topsoil stockpile
- Dumpsters
- Contractor storage area
- Fire hydrants
- Toilets
- Entries
- Temporary power and sewer connections

3.7.2 Foundation Site Logistics Plan

The foundation site logistics plan shows many key features of the foundation construction. Included with the aforementioned common items, are components related to the crucial deep foundation and foundation wall work. These items are on site simultaneously, but are not performed by the same contractor. The plan shows a 175 ton crawler crane used by the concrete contractor as they begin their work on the foundation walls below the South Tower and progressing toward the Service Area. The deep foundation drilling rigs are also shown as they do work on the caissons that support the three large bed towers. There is also space shown for each contractor to store their materials to be used.

3.7.3 Superstructure Site Logistics Plan

The superstructure site logistics plan mainly shows the work of the steel contractor because the steel is vital to the project schedule at this point of construction. Two cranes are shown. The large crane, a 300 ton crawler crane, is shown twice since it will have to make a critical move during erection. A smaller, 150 ton crawler crane that will be used after the large steel of the towers is erected, is also shown. This will be used to erect the remaining parts of the building so the larger, more expensive crane, can be removed from the site. The other interesting feature of this site plan is the road that has been developed around the majority of the building. This allows for access to all parts of the erection sequence.

3.7.4 Interiors / Finishes Site Logistics Plan

The interiors/finishes site logistics plan has a few additions to help complete the building. A trash chute and material hoist have been added. Also, laydown area for the mechanical contractor and the temporary heating system has been sectioned off near the service area of the building. There is also extra storage space in the north end of the building as well as near the hoist and trash chute.

4.0 Project Schedule, Sequencing, and Budget Information

4.1 Detailed Project Schedule

The Washington County Regional Medical Center schedule, refer to Appendix C, is a detailed schedule that encompasses a wide, in depth range of tasks. The schedule includes many features comprising all the critical phases of construction progress such as the substructure, superstructure, MEP, and the detailed finishes required for hospital construction. The design process is also included with the schedule. As the schedule shows, a noticeable gap between the completion of the design and the release of the construction documents exists. This gap is attributed to the many phases of litigation the medical center project went through. The legal action was related to the location and zoning of the new hospital. It was a case being pursued by only a few members of the surrounding community. A Maryland Supreme Court judge eventually ruled in favor of the medical center allowing the work to begin in March of 2008. The medical center is scheduled for substantial completion in December of 2010.

4.1.1 Foundation Schedule Impacts

The medical center consists of three, five story bed towers. Supporting these bed towers are an array of one hundred fifty deep foundation caissons. These caissons are a crucial component of the sequencing because the bed towers lead each building construction sequence. The caissons must bear on rock with an allowable service load bearing pressure of 80,000 pounds per square foot. If finding adequate bearing rock, drilling and excavating each bore, and placing concrete for each caisson can maintain schedule, this will set a good precedence for the continuation of the sequences throughout the building. The other building foundation systems consist of the following:

- Spread and strip concrete footings
- Load bearing concrete foundation walls
- Concrete grade beams

Since the caissons and the other foundation elements are each part of their own package, the other concrete foundation systems can proceed simultaneously with the caissons. The only exceptions to this are that some of the grade beams are located on top of the caissons and therefore cannot be placed until the caissons are finished.

Another consideration to the foundation systems is cold weather. The schedule shows the foundation systems to end in February of 2009. This will mean cold weather concrete placement procedures will need to be practiced to ensure the quality of the foundations.

4.1.2 Structural Schedule Impacts

The structural system consists of steel beams and columns with composite concrete slab on metal decks. The steel will be set throughout the winter starting in early October and ending in early March. Although not as crucial as cold weather concrete, cold weather steel erection will need to be considered when it comes to planning the steel work. The sequencing will follow the caissons. This means the steel erection will start with the most critical parts of the building, the bed towers. Since the bed towers rise five stories, the steel columns at the base of these bed towers will be very large. Again, it is vital that the steel maintains a tight schedule because the architectural precast panels and building envelope will follow the same sequence. If the steel cannot maintain this schedule and the building envelope cannot start on time, the building enclosure milestone will not be met and as a result, will delay the interior work and push substantial completion back.

4.1.3 Finishing Schedule Sequence

The finishing sequencing will continue to follow the other sequences of the building. This means the bed towers will start with the finishing trades first. They will employ a top down method of finishing, starting on the fifth floor and working to the third floor of each tower. Below the third floor they will continue to move from the top down, however, they will finish more crucial departments within the hospital first because of the extensive owner furnished equipment in these areas. There are many constraints and intricate details when finishing a medical center. This attributes to a substantial time frame for the finishes that are vital for the completion and turn over of the building.

4.1.4 Schedule Assumptions

The schedule includes two extra sequences that have not been previously mentioned. These are sequences within one of the other sequences and were separated for some activities, such as the steel, and not separated for other activities. Therefore, I used the diagram to show general overall sequences and did not show the smaller “sub-“sequences.

Activity durations were carefully determined; however, with limited experience in developing schedules, some durations were educated, knowledge based assumptions. Also, being bound by activity limits, many activities were combined and may distort the actual duration of each detailed line item.

4.2 Sequencing

To be able to fully understand the medical center’s schedule, the sequencing process needs to be examined. Appendix D shows a diagram of the building’s footprint. It is labeled by each section of the building and a number that represents the sequence order. As this diagram shows, all the sequences start with the bed towers. These are the most crucial parts of the building, especially with respect to the substructure and superstructure. Table 4.1 is a summary of Appendix D and shows the order of sequencing.

Table 4.1: Building Sequencing Order

SEQUENCING ORDER	
#	**Area**
1	**South Tower**
2	**West Tower**
3	**East Tower**
4	**Service Building**
5	**Admin (or Link) North**
6	**Admin (or Link) South**
7	**Admitting**
8	**Ambulatory**
9	**Emergency**
10	**Surgery**

A top down method will be employed for the finishing sequences. However, this level of detail was not able to be captured in this schedule, but was considered when the schedule was being developed.

4.3 Cost Evaluation

4.3.1 Actual Building Construction Cost

The following is The Washington County Regional Medical Center's actual building construction cost based on figures released from the owner and construction manager:

Building Size:	500,000 sqft
Cost per Sqft:	$300
Total Cost:	$150 million

4.3.2 Total Project Costs

The following is The Washington County Regional Medical Center's total building cost based on figures released from the owner and construction manager. It includes land procurement, design fees, and other expenses to completely fund the entire project from start to finish:

Building Size:	500,000 sqft
Cost per Sqft:	$564
Total Cost:	$282 million

4.3.3 Major Building Systems Costs

Table 4.2: Major Building Systems Cost Summary

Building System	Total Cost	Size	Cost/SQ FT
Electrical	$20,830,000	500,000 sq ft	$41.66
Mechanical and Plumbing	$48,376,500	500,000 sq ft	$96.75
Fire Protection	$1,557,500	500,000 sq ft	$3.12
Structural[1]	$18,657,524	500,000 sq ft	$37.32

[1] Figues include all concrete and steel packages

4.3.4 Parametric Estimate using D4 Cost

Table 4.3, shown below, is an estimate using D4 Cost software. The D4 Cost program predicts the cost of a building based on historical data. The four buildings were chosen because they all represented some aspect of the Washington County Regional Medical Center. Choosing the most similar projects should produce a more accurate cost prediction.

Table 4.3: Parametric Estimate

Project	Size	Cost/SQ FT	Total Cost
Lawrence J. Ellison Ambulatory Care Center	369,777 sqft	$184.52	$68,231,228.00
Baylor Regional Medical Center	354,400 sqft	$261.54	$92,689,693.00
Utah Valley Regional Medical Center	218,213 sqft	$313.01	$68,303,492.00
Florida Flagler Hospital	294,898 sqft	$203.81	$60,102,526.00
Average	**309,322 sqft**	**$240.72**	**$72,331,734.75**

4.3.5 Square Foot Estimate using 2008 R.S. Means

Appendix E shows an estimate utilizing RS Means square foot building data. The highlighted data is information that had to be extrapolated because the data was not explicit for the size and specifics of The Washington County Regional Medical Center. RS Means also allows the choice of an exterior wall system. Since the medical center is comprised of both face brick and architectural precast panels, the median value between the two was chosen.

4.3.6 Cost Comparison

Table 4.4: Cost Comparison

COST COMPARISON	
Method	Total Construction Costs
D4 Cost Software	$72,331,735.00
RS Means Data	$115,160,600.00
Actual Costs	$150,000,000.00

An analysis of all three costs shows RS Means to be lower than the actual building cost and the D4 Cost estimate to be much lower.

A further examination of the D4 Cost data will show that the historical data for hospitals, though chosen with The Washington County Regional Medical Center in mind, cannot be used so easily. The range of systems, technology, and equitable projects varies tremendously. Historical data alone can not produce an accurate cost of such a diverse and constantly growing and changing market.

A look into the RS Means data produces one explanation for the lower figure. Technological advances in the medical field, also shown in the D4 Cost evaluation, can cause a tremendous amount of systems and equipment price fluctuations. RS Means can not control or account for these constant changes.

4.3.7 General Conditions Estimate

The general conditions estimate, refer to Appendix F, provides costs for the general items covered by the construction manager. The total length of the project used as the base of the calculations is thirty three months. Table 4.5 shows a summary of the three major categories from the general conditions estimate: field office, equipment, and expenses, project staffing, and temporary utilities. The table also includes the total general conditions estimate.

Table 4.5: General Conditions Estimate Summary

GENERAL CONDITIONS ESTIMATE SUMMARY	
Description	Total Costs
Field Office, Equipment, & Expenses	513,270
Temporary Utilities	249,150
Project staffing	5,192,480
Total General Conditions Estimate[1]	7,622,660

[1] This is not just a sum of the three values above it. It includes all the items shown on the general conditions estimate

As Table 4.5 and Appendix F show, the majority of the estimate is made up of the project staffing costs. This leaves approximately $2,400,000 for all the other items included in general conditions.

5.0 Thesis Introduction

The failing financial markets and unstable economy persuaded me to review ways the Washington County Health System could generate extra money to be able to repay the bonds issued for the construction of the new medical center. This was the basis behind the research done to develop the previous facility into a useful and prosperous investment. Developing in these times may seem odd, but the demand for nursing home facilities across the country is growing. The healthcare market in general is one area of construction that is not feeling the effects of the economy as bad as other sectors. The major issue with healthcare construction is the ability to find skilled workers. These are all analyzed and evaluated through the development options to produce a viable investment option for the Washington County Health System.

Washington County Health System is interested in providing the best service to the region they can through any means necessary. Providing the best care is what ultimately provoked the construction of a new medical center. At the heart of construction, the owners want to save money and time while always enhancing value. Through the owner's desire to achieve equitable or better systems while saving money became the main source from which the following two analyses were produced: the redesign of the deep foundation system and the implementation of a composite precast wall panel system. Both of these analyses cost savings also became a source for investing in the previous facilities development.

The deep foundation system used to replace the caissons is minipiles. The composite precast wall panel implementation researched was Metal Stud Crete® by Earl Corporation. Using the owner's interests, these analyses create enhanced value for the Washington County Regional Medical Center and its owner, the Washington County Health System.

6.0 Developing Previous Facilities

Construction Management Depth
MAE Requirement

6.1 Introduction

Developing land or existing facilities is a great way to earn a profitable return on an investment purchase. However, it can be risky and the margin for error can be slim. The development's success hinges on great planning, execution, and analysis of possible development explorations. Many newly constructed facilities leave behind an opportunity for a wise investment by the owner.

6.2 Problem Statement

With the construction of the new facility, The Washington County Regional Medical Center, the old facility will become vacant and unused. What to do with the old building becomes the main problem. Current financial times will make it hard to allow the facility to sit idle because of the money it will cost the owner. Additionally, the bonds used to fund the new medical center will soon begin their maturation and money will be needed to assist in the repayment of these bonds.

6.3 Goal

The goal of this analysis is to be able to generate additional income for the owner by developing the former facility with minimal expense. By developing the existing facility the owner is essentially investing in themselves and shouldering the risks. This should create a more secure investment for the owner. The additional income will hopefully be helpful in aiding the ability of the medical center to repay their bonds.

6.4 Methodology

The following steps will be taken to adequately research this topic:

1. Identify the need for an Extended Care / Nursing Home facility development with the current economic situation in mind.
2. Determine baseline cost and schedule information as would be used for development purposes.
3. Analyze different ways of developing the existing facility.
4. Use financial models to determine possible investment strategies.
5. Evaluate different development types and determine the best investment.
6. Explain the best development model o ensure security in the end result.
7. Analyze the site for possible constructability and logistical challenges.
8. Recommend the development for the former facility.

6.5 Tools and Resources

1. Washington County Regional Medical Center Construction Documents and Specifications
2. Gilbane Building Company
3. Penn State Architectural Engineering Faculty
4. R.S. Means 2008/2009
5. Financial Analysis Models
6. Regional Market and Tax Documents

6.6 Expectations

I expect the development model to be useful for implementation into the old facility. Since the existing facility is a hospital and the proposed development will be an extend care / nursing home facility, the cost to renovate should be minimal. I expect to be able to generate additional monies to help the owner pay off debt or use elsewhere in the healthcare facility.

6.7 Quick Background

The old hospital facility is a 550,000 square foot, seven floor facility located in the downtown area of Hagerstown, Maryland. It current serves as a 264 bed acute care facility and provides emergency services. For the purpose of this development, it will be utilized as a 264 bed nursing home facility, providing care to the elderly with various health issues. It has all the necessary zoning permits and contains all the additional spaces needed in a hospital for conversion to a nursing home such as the kitchen, laundry room, and CUP to name a few. The site contains two different parking decks and is connected to The Washington County Health Services' office building through a pedestrian bridge. The old hospital is located about 2.5 miles from the new facility. Figure 6.1 and Figure 6.2 show a satellite image of the old hospital's site and the proximity of the old hospital to the new medical center, respectively.

Figure 6.1: Satellite Image

Image courtesy of Google Earth

Figure 6.2: Proximity Map

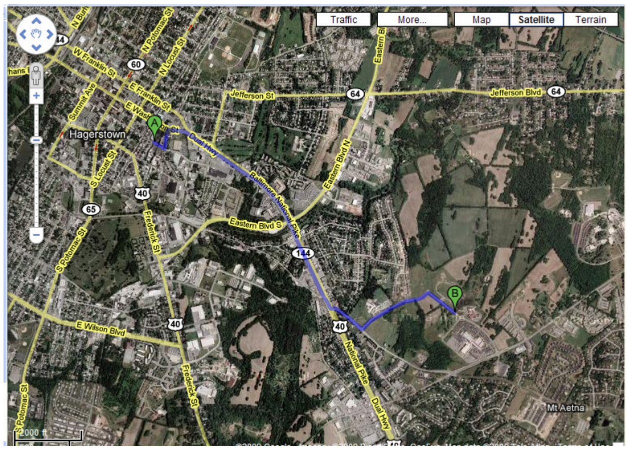


Image courtesy of Google Maps
(Top Left – Old Hospital
Bottom Right – New Medical Center)

6.8 Establishing the Need

6.8.1 Market Research

In an economic situation as the country is in now, it is hard to convince people to invest in construction projects. However, as stated before, this project is applying the owner's money into an investment that they can control. This may prove to be more secure than investing money into other projects where you cannot control the risk as much. Furthermore, the following table, Table 6.1, shows the construction market economic growth for the last quarter of 2008 and projected through 2009. The information is broken into specific market and the growth is analyzed by construction spending.

Table 6.1: Construction Market Study

MARKET ANALYSIS	
Market	Construction Spending
Retail and Office Construction	-20%
Hotel Market (Typically Resorts)	-10%
K through 12	-0.6%
Higher Education	17%
Healthcare	26%
Religious	-8%
Public Construction	13%

Data courtesy of the publication Consulting-Specifying Engineer titled 2009 Economic Outlook and was published January 1, 2009

As the table shows, a projected 26% growth can be expected in the healthcare field. This is higher than any other market shown including the broad, publicly funded construction market. However, the healthcare market projection includes public healthcare construction. Higher education is the only other market to show growth in 2009. This is mainly because of private funds expected to continue to flow in for the construction of new projects. Much of this information is also echoed by other publications. For example, according to FMI Management and Investment Banking for the Construction Industry, market segments such as office, commercial, religious, and amusement and recreation will see declines due to the economy. Conversely, healthcare, education, public safety, and Homeland Security construction should fare much better. Turner Construction Company, a leader in the construction industry, says that their construction activity in the education, healthcare, and public sectors continue to grow. These projects will see stimulus money to achieve this more stable environment. Also, new technology in the healthcare industry, which broadens constantly, increases the demand for upgraded and new facilities.

The healthcare market in the 2009 Economic Outlook article covered facilities such as hospitals, nursing homes, and assisted living facilities. A more detailed nursing home facilities study produced by MetLife shows a growth for nursing homes. Although the growth is lower than previous years, it shows the market demand to grow by almost 1.5%. This shows an increase in fragile economic times. Also, Plunkett Research, Ltd. estimated there are 77 million baby boomers in America that continue to age and require more medical care. These staggering numbers will surely create the demand to fill nursing home facilities as time progresses.

6.8.2 Local Conditions Research

There are only three other facilities such as this in the surrounding and they are much smaller. According to the United States Census Bureau, Washington County Maryland has an estimated population of 143,000 people. Of this total, 13.7% of these people are 65 years of age or older. The US average is only 12.5%. This data shows that the surrounding area has a higher population of older people than many places across the country. These reasons all illustrate the need for extra facilities to help and serve the elderly people of the community.

The Washington County Health System has the premier healthcare services in the region which includes West Virginia, Virginia, Pennsylvania, and Maryland. This constant influx of trusting people shows that the Washington County Health System does and will continue to generate income. The income will create the availability of funds to build the new nursing home.

Perhaps the most intriguing argument for having a nursing home is the integration of healthcare from one primary provider. Washington County Health Services are creating the new regional medical center for acute care and control Robinwood Medical Center for outpatient procedures. Adding a nursing home would complete the full realm of services and ultimately enhance the patient's spectrum of care.

6.9 Initial Budget Establishment

The initial budget establishment is a crucial factor to possible development opportunity. It needs to be fairly accurate for this early stage of planning, but also it needs to be slightly conservative because once the number is used a developer will not want to spend any more than originally calculated. Any overages will directly take away from the developer's profit margin.

Since Washington County Health Services will be the developer and the owner, they will need to have tight control over the budget. They will also have to resist varying from the initial design and budget for fear of change orders and schedule elongation. A crucial benefit to Washington County Health Services is that they currently own the property and the facilities on the property. They will have no additional purchase costs and no additional mortgage payments; a huge benefit when considering development returns. This also plays a factor in the development costs. Since the old facility was used as a hospital, renovations to a nursing home should be fairly easy: this includes renovation costs and schedule.

The type of demolition that will be utilized will be selective demolition. For reasons explained above, the renovations will include demolition of only selective areas and items. Selective demolition is selection of certain demolition areas to be removed with minimal harm to the adjacent areas. The old hospital will be brought up to date, but will use a lot of the features it currently contains. This will keep development costs low and returns high.

The following table, Table 6.2, shows how the budget for the development costs were established. Due to the early planning phase and for simplification purposes, all costs were calculated as total square foot costs. There were also relative percentages used because not the entire building will need complete work. All the mechanical, electrical, and plumbing items will be inspected for new use, cleaned, and upgraded as necessary.

Table 6.2: Initial Budget

BUDGET		
Demolition		
Item	Cost ($/SF)	Total Cost
Demolition (All)	$19.50	$10,725,000.00
Renovation		
Item	Cost ($/SF)	Total Cost
Replacement Windows		$300,000.00
New Roofing	$3.03	$238,070.13
Upgrades, Cleaning, Inspection		
Mechanical	$17.98	$5,735,620.00
Electrical	$8.06	$1,152,580.00
Plumbing	$4.96	$436,480.00
Elevator Inspections, Repairs, and Upgrades		$95,000.00
All Interior Work	$18.45	$10,147,500.00
Total Renovation Costs		$28,830,250.13

As the table shows, the total estimated renovations costs for the old hospital is just under $30 million. For development calculations, $30 million will be used.

6.10 Initial Schedule Development

The schedule development is formulated from the same basic princiles as the budget. As a developer, the schedule is crucial; if the project runs over schedule, these are days the developer is not making money or receiving a return on their investment. This risk may be cause for a developer to include a liquidated damages clause into the contract with the contractor. This will help midigate the profit losses for the developer if the project runs over schedule.

From a developer's standpoint, the schedule is just as critical to their success as it is to a contractor. Just like the budget, the schedule needs to be as acurate as possible for calculation purposes, but contain some buffer because of the early planning phase of the development project.

The following table , Table 6.3, shows an initial schedule for the renovations of the old hospital. The production numbers were gathered using the outputs for the crews currently working on the new medical center. Again, many of these are calculated on a rough daily output (SF/Day) then multiplied by the same relative percentages of square footage of the old hospital used in calculating the budget.

Table 6.3: Initial Schedule

SCHEDULE		
Demolition		
Item	Daily Output (SF/Day)	Total Duration
Demolition (All)	500	55
Renovation		
Item	Daily Output (SF/Day)	Total Duration
Replacement Windows	-----------	10
New Roofing	50	20
Upgrades, Cleaning, Inspection		
Mechanical	200	28
Electrical	250	22
Plumbing	415	13
Elevator Inspections, Repairs, and Upgrades	-----------	5
All Interior Work	610	90
Total Renovation Schedule		243

The table shows the renovation schedule to be 243 days. With a working week being 5 days a week and 52 weeks in a year, this is just under 1 full year. Therefore, 1 year will be the number used for the renovation schedule in the development calculations.

6.11 Constructability and Logistics

One of the final decisions that will affect the development decision is the constructability and logistics of the renovations. The old hospital site is unlike the new medical center site because space is very restricted. However, the good news is that major equipment should not be needed during renovations. That leaves space for parking and material storage area. As Figure 6.3 to the right shows, the parking deck across the street from the site should be adequate for contractor parking. There is also a parking lot beside the deck. This would be a good for contractor

Figure 6.3: Site Utilization Plan

trailor area. This leaves the parking deck and all the other area around the building for material stroage and other working space. The figure also shows the location of the CUP. If replacement equipment parts need to be hoisted into this area, a crane can operate from the road adjacent to the CUP. This is a very low traffic road; therefore, it should not affect traveling patterns around the hospital if it were to be shut down for work to proceed. Scaffolding will be needed to replace the windows. This can be fixed to the roof and suspended over the sides of the building.

The renovations should be able to be constructed fairly easily since no major adjustments to the structure or façade will be taking place. The only major issue will be the movement of supplies throughout the building. The elevators can be used, but capacity limits and damage will have to monitored closely.

6.12 Development Options

As the owner and developer of the facility, multiple options will be considered to provide different financial situations. The best choice for Washington County Health Systems can then be chosen. As presented earlier in this report, a nursing home development will be used for this facility. These options provide a broad look at development opportunities for the owner. There will be four different ways of development considered. They are:

- Develop to sell
- Develop to run
- Partially develop to run
- Develop to lease

The following is a list of assumptions that may or may not apply in all four different development situations, but were used uniformly across all options where they were applied. Additional individual option assumptions will be listed in their respective portion of the report.

- Preconstruction / Approvals = 6 months
- Construction time period = 12 months
- Construction cost escalation[1] = 4% per annum
- Sales cost escalation[1] = 1.1% per annum
- Capitalization Rate[2] = 12.75%
- Marketing / Advertising[3] = 1%
- Agent Commission[3] = 1.5%
- Legals[3] = 5%
- Holding charges[3] = 2%
- Real EstateTaxes[4] = 1.858%

---

[1] The MetLife Market Survey of Nursing Home and Assisted Living Costs
[2] National Investment Center for the Seniors Housing and Care Industry
[3] Estimated from previous examples
[4] Washington County Treasurer's Office – Tax Rate Schedule

6.12.1 Develop to Sell

This analysis looks into developing the property for immediate sale after development. The benefit of this would be a short term, lump sum return on the development investment. The sales value was found by performing a residual property value assessment. This complete assessment can be found in Appendix G. Table 6.4, shows a summary of the results.

Table 6.4: Summary Table of Residual Analysis

DEVELOP TO SELL SUMMARY	
Total Design and Construction Costs	$34,475,474
Net Development Return	$94,238,703
Gross Residual Value	$59,763,229
Sale Price	$126,799,059
Land Value[1]	$1,915,000
Return on Investment	$92,323,585

[1] Source: Maryland Department of Assesment and Taxation

An efficiency rate of 75% was used in these calculations because most nursing home facilities only range from 150 to 175 beds. This facilities capacity is 264 beds; it is not reasonable to assume the whole building will be filled. This summary table shows a $92 million return on the development investment. This return uses the maximum amount of money somebody should be willing to pay for the property. Therefore, a slightly lower sale value should be anticipated. Regardless, this could be a very valuable amount of money that could help Washington County Health Systems. It would also provide a large amount of money upfront and ultimately they would not have to worry about the ownership of the old facility.

6.12.2 Develop to Run

This analysis looks into developing the old facility and then having Washington County Health Systems run the facility for ten years. There will also be a look into the return with a sale of the facility at the end of the ten years. The major benefit to this type of development is a continuous flow of money from the development over a period of time. Over the ten years this may yield more than a direct sale too. The major risk is not knowing the stability of the markets; however, as established earlier, the need for medical assistance for the elderly care is always needed and projected to be on the rise. A discounted cash flow analysis was used to determine the viability of the development and is shown in Appendix H. The table shown over page, Table 6.5, is a summary of the analysis.

Table 6.5: Develop to Run Cash Flow Summary

DEVELOP TO RUN SUMMARY	
Sale Price @ 10th year	$144,325,571
Return on Investment	$99,850,097
Internal Rate of Return	32%

A revisionary capitalization rate of 13% was used because, according to the National Investment Center for the Seniors Housing and Care Industry, capitalization rates are on their way back up from previous quarters; however, they are not projected to continue this growth in the short term. It is only reasonable to use a number similar to the rates right now. Also, a 1.5% growth rate in price was used across all ten years because, according to The MetLife Market Survey of Nursing Home and Assisted Living Costs, the past year produced a growth of just under this amount. This is conservate across all ten years. A $10 million refurbishment cost in year five is also considered. This will be used to further improve the facilities as needed.

The most important number is the Internal Rate of Return (IRR). This analysis provides a considerable IRR at 32%. This can be attributed to the low contruction costs and the obsolete purchase price. It is important to notice the operations costs included in the summary. These costs include staffing, utilities, and operations and maintainance costs. They were calculated based on a percentage of the income. It also worth note that the sale price in ten years, assuming the market follows the assumptions made, is not too much higher than the immediate selling of the property. This can be attributed to the conservative capitalization rate. This model also takes work by Washington County Health Systems to keep it operational and sucessful.

6.12.3 Partially Develop to Run

As stated in the report, it is unreasonable to fill this larger than average facility. A third development consideration is to only partially develop the nursing home to run. This will cut down on upfront costs and vacancy rates; however, it will also reduce the IRR and sales price. This may help with starting the development in a fragile economy. The National Investment Center for the Seniors Housing and Care Industry lists the average number of beds in a facility at 125. This will be the partially developed facility size. Also the average occupancy is 85%. This will be the effeciency rate used.

Again, a discounted cash flow analysis will be used to evaluate this investment. For simplification purposes, new construction calculations will be used based on a proportional relationship between the cost and the reduction in size. This relationship is a 46% reduction in size which equates to construction costs of $18,747,612. Refurbishment costs will also be reduced in the same manner. New net proceeds were calculated with adjustments to the residual analysis. The full analysis is shown in Appendix I. Summary table, Table 6.6, is shown on the next page.

Table 6.6: Partially Develop to Run Cash Flow Summary

PARTIALLY DEVELOP TO RUN SUMMARY	
Sale Price @ 10th year	$74,264,614
Return on Investment	$50,117,002
Internal Rate of Return	31%

The table shows that the IRR at 31%. This is an intriguing factor to consider when evaluating this analysis. The sale price shows to be just under $75 million. This shows that partially developing can produce a considerable IRR, but have upfront construction costs and refurbishment cost tremendously reduced. Also, the lower sale price reflects the adage of lower risk, lower reward. However, during these financial times this may be just what Washington County Health System needs to start the development. It is worth note to point out that Washington County Health System needs to run the facility.

6.12.4 Develop to Lease

The final option will look at developing the old hospital and then leasing the facility to a company that manages and runs nursing homes. The major advantage to this type of development is Washington County Health Systems will not have to worry about operating the facility. They will not have to spend any time or resources after the nursing home is constructed. Washington County Health Systems can just collect a flat, stable monthly rental income from the operator.

This analysis was done differently than the others. Full development numbers were used to maximize the rental return. The gross rent that can be collected from the entire facility at the 75% efficiency rate, $16,166,880, was multiplied by the operations costs factor. Then a 15% profit margin was subtracted from this sum to receive $7,832,853. This provides the sum of money the lessee would owe to Washington County Health Systems per year. The monthly rent would then be $652,738.

The basis behind this math is that no management company would lease the facility at the revenue less the operating expenses. This is why a profit was subtracted out of the rental costs. The final number was formulated with this in mind. A cash flow analysis with a 1.5% growth rate was then explored. The full analysis can be found in Appendix J. Table 6.7, is a summary of the results.

Table 6.7: Develop to Lease Cash Flow Summary

DEVELOP TO LEASE SUMMARY	
Sale Price @ 10th year	$69,925,736
Return on Investment	$35,450,262
Internal Rate of Return	25%

This table shows a sale price of $69,925,736 with a return on the investment of $35,450,262. This investment equates to a 25% IRR. This is a decent IRR for this type of investment. The return is low, but the risk is much lower and Washington County Health Services does not have to run the facility.

6.13 Preferred Development Analysis

The preferred development should answer one major question: What is the best invesment, considering the financial times, for Washington County Health System to undertake with the best return? The development that best fits the owner at this point in time is the partially develop scenario.

The first development option considered was to develop for immediate sale. The information used to run the analysis was current and acurate; however, to think that the old facility would sell for $126 million in these financial times is unlikely. It should be an inticing purchase, but buyers are just not willing to sink this level of money into investments in the development industry. Also, the number itself is just to big and sounds like an extreme amount of money right now.

The second development option was to fully develop the building and running it for a period of ten years. It is unlikely that the entire facility would fill, so why waste the money renovating the entire building for less than impressive efficiency rates. The pure numbers are inticing, but risk is higher with this type of development in this financial situation. Also, as touched on earlier, the construction costs to renovate the entire facility may be too high to add to the cost of construction of the new medical center.

The fourth option evaluated was to develop the facility to lease. The main reason this option was analyzed was because the Washington County Health System would not have to operate or maintain the facility; they would only generate a monthly income from the renter. However, the return is much less than the other options and although helpful, the owners can do better.

The third development option was to partially develop the facility to run. This seems to be the best option for the hospital at this time. There are three distinctions that make this the best option:

- The construction costs are realitively low at just under $19 million especially considering the size of the new medical center.
- The return is very good with an IRR of 31%.
- If the economy regains its former strength, there is room to develop the rest of the facility.

The risk and reward are moderate, but the reward could potentially become much better in a more stable economy. This option allows the Washington County Health System to take this moderate risk now and expand in the future with less risk, but much higher reward. This option also considers selling the facility in ten years. This will produce a large return after ten years and also has the potential to be much higher because of the market. However, the owner could always continue to run the facility themselves. Operating the facility should be no problem for the owner. They have proved their ability to affectivly manage and control multiple different types of healthcare operations.

6.14 Conclusion and Recommendations

The financial burdens the market has created scare many owners and developers. Washington County Health System can take advatage of the healthcare construction market's vulnerability and the industries realitvly low costs. A new medical center leaves behind a building that can generate income to help repay the bonds taken for the new construction. Developing a building that is already owned by the Washington County Health System presnets tremendous benefits. The report showed great potential for the use of the building and the statistics to show that developing this type of facility in this market may still prove to be a good investment.

I would highly recommend the Washington County Health System to consider developing the old hospital into an extended care facility or nursing home. I think it would help them economically and establish an overall strong investment. I also think it would provide an additional medical service to the surrounding region and show that Washington County Health Service is commited to total patient care throughout life. The risks are present, but the rewards are great. I think considering development of the old hospital instead of some sort of demolition or appraisal sale would prove to be a valuable asset to the Washington County Health Service.

7.0 Redesign of Deep Foundation System

Structural Breadth

7.1 Introduction

The foundation of a building provides the building block for the successful completion of an entire project. As a critical phase in the big picture of a construction project, the foundation system operation needs to flow smoothly and cause minimal disruption to following activities to allow our healthcare facilities to open and serve communities faster. A deep foundation system only enhances the need for a reliable, cost efficient method.

7.2 Problem Statement

The current deep foundation system, 150 caissons under the three bed towers, has created multiple issues during construction because of the subsurface site conditions and lack of ability for the entire caisson to rest on adequate bearing rock where intended. This has created numerous schedule delays and cost implications.

7.3 Goals

The analysis will focus on determining a more appropriate system that meets or exceeds all the contract document specifications, greatly improves work flow related to schedule requirements, and maintains a suitable cost.

7.4 Methodology

The following steps will be taken to adequately research this topic:

1. Perform a quantity takeoff of the current deep foundation system
2. Consult industry professionals, research, and identify alternative deep foundation systems that meet the goal.
3. Compare and contrast each system based on initial reviews of constructability, value, and schedule enhancement.
4. Choose best system and design an alternate foundation system based on building loads and other structural variables.
5. Evaluate the alternative system's cost and schedule impacts.
6. Conduct a comparative analysis of the two systems with a primary focus on cost and schedule and a secondary focus on safety.
7. Recommend alternative solution as a viable deep foundation system.

7.5 Tools and Resources

1. Washington County Regional Medical Center Construction Documents and Specifications

2. Gilbane Building Company
3. Penn State Architectural Engineering Faculty
4. Industry Professionals
5. R.S. Means 2008/2009

7.6 Expectations

After conducting all the applicable research and calculations, I expect to have developed an alternative deep foundation system that meets or exceeds the requirements for the project. I also expect the new system to maintain a suitable cost and alleviate schedule concerns. Overall I expect the new system to be a better choice of deep foundation than the original caissons.

7.7 Current Foundation System

As discussed earlier in this report, the Washington County Regional Medical Center has three, five story bed towers that are supported by a deep foundation system. The system chosen for the project was drilled piers, or caissons. A deep foundation system must be utilized in the medical center's situation because of high column loads and deep zones of soft compressible clayey soils. These conditions would cause undesirable differential settlement under a simpler shallow foundation system. There are 150 caissons divided among the three bed towers. The depth varies from approximately six feet to about fifty feet; nevertheless, all of the caissons must reach an adequate rock surface with bearing pressure of 80,000 pounds per square foot. Figure 7.1, as seen on the right, shows the two main problems with the current system. The first problem is the severely sloping rock formation that measures approximately a forty-five degree angle. The second problem is the probe used to identify the location of adequate bearing rock is significantly smaller than the caissons. This caused the reports to show a higher elevation of rock. Consequently, when the much larger diameter caisson drill was used, adequate bearing rock was not reached until a much lower elevation.

Figure 7.1: Caisson Diagram

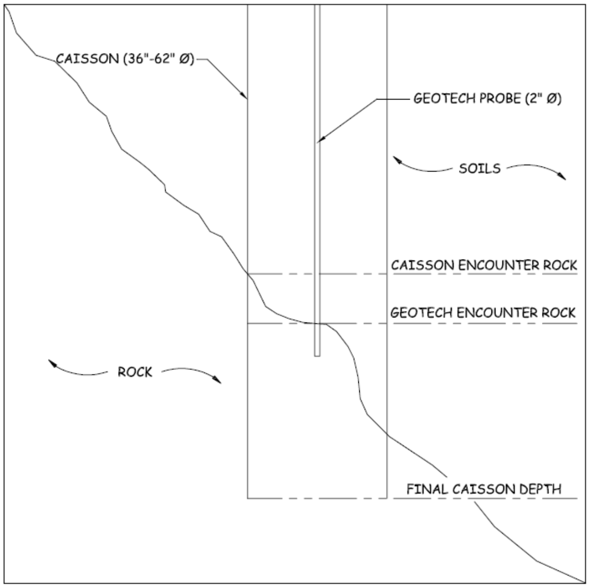


Figure 7.1 is for diagrammatic purposes only and was drawn by the author, not to scale.

7.8 Alternative Method Analysis

The following table, Table 7.1, shows an initial analysis of alternate deep foundation systems. Each system, through proper design, would be able to meet the minimum project requirements of the construction documents and specifications. The initial analysis will be based primarily on constructability with secondary emphasis on value engineering, and schedule enhancement. Each system is listed and includes the most significant project constraint associated with its construction.

Table 7.1: Initial Alternate Foundation Analysis

INITIAL ALTERNATE FOUNDATION ANALYSIS	
Alternate System	Major Project Constraint
Mat Foundation	Severely sloped rock on site would cause problems excavating a level surface for the mat. This would create a large additional expense on an already expensive system.
End Bearing Piles	End bearing piles need to be avoided because of vibrations from pounding. The outpatient facility on the same site will stay operational throughout construction and vibrations would cause procedural issues.
Friction Piles	Friction piles sound good, but the soil conditions would not provide adequate friction to meet requirements. They too would cause too much vibration.
*Geopiers	Geopiers are a soil enhancement method that would allow the soils to achieve greater bearing capacity. This would then allow a shallow foundation system to be used on top of them. However, vibrations become a major issue when crushing and driving the stone used.
Minipiles	No major constructability issues. May be expensive and time consuming, but hopefully cheaper and faster than drilled piers.

**Geopiers is a registered trade mark name by the Geopier Foundation Company*

Minipiles seem to be a very functional solution. They are a drilled system, contrary to what their name may imply. They could alleviate the troubles encountered by the caissons mainly because of the diameter of the shafts. Minipiles range from five to seven inches, which compares significantly better to the two inch probe utilized for subsurface exploration. They could also drill and manage the Karst terrain, as discussed earlier in this report, which lies under the surface of the site.

7.9 Redesign of Deep Foundation System

The minipile foundation design starts with determining the gravity loads of each of the columns that will bear on the minipiles. The drawings give the load of each column. The ultimate bearing capacity of the minipiles is the next key to design. The geotechnical reports propose that when a minipile foundation design is considered, the bearing capacity and size of the minipile should be 250 kips and 5 inches diameter, respectively. The load from the drawings is then divided by the 250 kips per minipile. This will provide the number of minipiles per column. There are five different groups of piles. They are the following:

- 2 minipiles
- 4 minipiles
- 5 minipiles
- 6 minipiles
- 8 minipiles

Odd numbered groupings were to be avoided because of the complicated form they present to cap. The exception is 5. Five minipiles can be grouped easily. The next step is to design the caps for the minipiles. The following is a sample calculation for the pile cap design:

Based on

Load transported through column = 392 kips
392 k / 250 kips per minipile = 2 minipiles
Actual capacity = 392 k / 2 = 196 kips
M_{max}=196 kips (3 ft)
M_{max}=588 'k

$$\rho = 0.85\beta_1(f'c/fy)(Eu/(Eu+0.005))$$
$$\rho = 0.85(0.85)(3/60)(0.003/(0.003+0.005))$$
$$\rho = 0.0135$$

Mu=ϕMn assume b=36"
588'k(12"/1') = 0.90 x ρ x 60 bd^2 x (1 – 0.59 ((ρfy)/ $f'c$))
7056 in-kips = 0.90 x 0.0135 x (60 bd^2) x (1 – 0.59 ((0.0135 x 60)/3))
bd^2 = 9326 in^3
d=16" OK

A_s= ρ bd
A_s=0.0135 x 36" x 16"
A_s=7.78 in^2
Use 8 #9's $\Rightarrow$ A_s=8 in^2 OK

h=16 + 2.5" (clear cover)
h=18.5" ≈20"
d=17.5"

A_s=7056/(0.90 x 60 (17.5 – 2.5))
A_s=8.71 in^2
Use 9 #9's $\Rightarrow$ A_s=9 in^2 OK – Bottom Reinforcement

Shear

$Vc=(2\sqrt{f'c}\,(b)(h))/1000$
$Vc=(2\sqrt{3000}\,(36)(17.5))/1000$
$Vc=69$ kips

$\phi Vn= 0.5(0.75)69$
$\phi Vn=25.9$ kips

$Vu/\phi - Vc = Vs = 196/0.75 - 69$
$Vs=192$ kips
$Vs\leq 8\sqrt{f'c}\,bwd$
$=8\sqrt{3000}\,(36)(17.5)$
$=276$ kips $<$ 192 kips OK

S_{min}=min (d/4 controls) = 17.5/4
$S_{min}=4.375'' \approx 4''$

Av_{min}= max((50(b)(s))/60 controls) = (50(36)(4))/60)
$Av_{min}=0.12\text{ in}^2$
Use #3 stirrups @ 4″ as minimum Shear Reinforcement

Figure 7.2: Elevation of Sample Minipile Cap

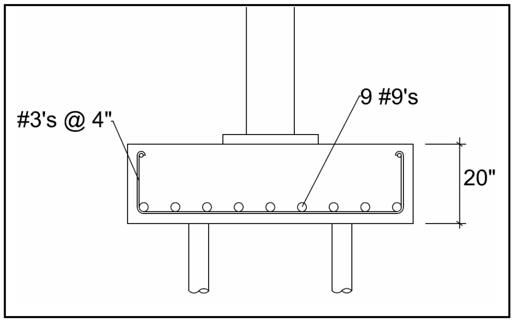
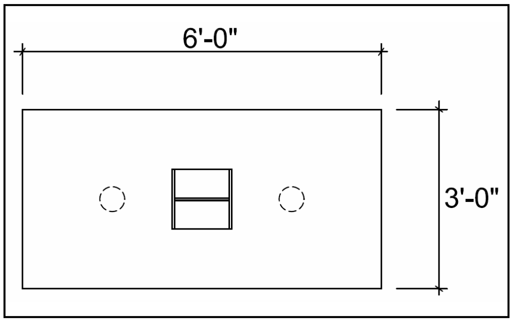


Figure 7.3: Plan of Sample Minipile



This design was calculated based on per pile width. This allowed for easy calculation of all five different load cases.

The lateral loads are currently being carried by grade beams over the caissons and cap. This system will still work with the minipile foundation system. Therefore, no design alterations were considered to address the lateral loads. Also, the uplift will be controlled with the rock socket. Each minipile is required to include a 10 foot rock socket.

7.10 Schedule Review

The following is a summary schedule comparison of the two deep foundation system durations.

Table 7.2: Schedule Comparison

SCHEDULE COMPARISON				
Construction Time				
System	Quantity	Unit	Output (Unit/Day)	Total (Days)
Caissons	150.0	Caissons	1.5	103.0
Minipiles	532.0	Minipiles	11.0	53.2
			Difference	49.8

The original duration of the caissons was to be 50 days. However, as explained previously, the underlying terrain and unforeseen rock slope conditions caused the schedule for the caissons to double. The final duration was 103 days.

Since the minipiles are significantly smaller in diameter the terrain and rock slope will not affect the minipile duration. Also, the probe will be able to determine the rock depth much more accurately because the diameter of the probe is very close to the diameter of the minipile. With these specific site conditions in mind, a 10% buffer will be added to cover some delays. This is the reason the total days on Table 7.2 does not equal the quantity divided by the output. The difference as shown in the table is 49.8 or 50 days. This equates to a 48% percent reduction in schedule time.

7.11 Budget Review

An in depth cost breakdown of each system is provided in Appendix K. The following table, Table 7.3, is a summary comparison of the two systems' costs. Again, a buffer of 10% was added into the costs because of the underground, unexpected conditions related to the project site.

Table 7.3: Cost Comparison Summary

COST COMPARISON				
System	Labor ($)	Material ($)	Equipment ($)	Total
Caissons	$759,826.61	$295,632.12	$798,114.90	$1,853,573.62
Mininpiles	$520,383.27	$203,568.88	$585,336.19	$1,440,217.16
			Difference	$413,356.46

The table shows a 22% reduction in cost. The two major costs differences are shown in the labor and equipment costs. The labor costs can be attributed to the rebar cages. The minipiles do not require rebar cages for reinforcement; they only need the special casings left in place after drilling. The caissons need rebar cages fabricated and lowered into the holes. This process is much more labor and time intensive.

7.12 Constructability and Logistics

7.12.1 Constructability

The construction of the minipile foundation system should pose less construction issues than the caisson foundation system. As mentioned in the sections preceding, the terrain and rock slope present major challenges with deep foundation work. The probe used to determine the elevation of the rock and the material that will be drilled through is 2 inches in diameter. The caissons range from 30 inches to 66 inches in diameter. The minipile rigs drill a 5 inch diameter hole. This means that predicting the exact elevation and material make-up of the underground conditions are much more accurate when using the closest diameter rig. Less uncertainties and risks are taken with the smaller hole. The caissons have a much higher degree of risk associated with them.

Figure 7.4: Drill Rig

The rigs used for drilling both size diameter holes are comparable machines. These machines, as shown in Figure 7.4 to the right, are drilling rigs. This machine can drill holes up to 80 inches in diameter. Therefore, the same rig is used when drilling small holes and large holes. The number of rigs will depend on the pace that is achieved during construction. If the minipile construction were to fall behind, more rigs may be brought on site to help make up time. This would pose area issues. However, since the drilling happens early on in construction, the few other activities that are being performed can work around these extra rigs. Again, there is plenty of room on the site if this situation were to present itself.

The schedule and budget both include minipile cap and caisson cap information in them. Another issue is the coordination that needs to occur between the two trades that install the minipiles and that cap the minipiles. The sizes have changed and the materials within the minipile caps have changed. Both were accounted for, but need to be strictly coordinated so that the critical deep foundation work can start the job off on a positive note.

7.12.2 Safety

Safety is always a concern on any jobsite. The minipile foundation system provides less safety risk during inspection and testing. The main aspect of safety is the inspecting of the holes. First, the caissons are tested by sending an engineer in each hole to inspect the drilling operation and to pick out any defects or imperfections. The minipile foundation, since it is much smaller, requires a different testing mechanism that does not involve sending an individual into the hole. A computer camera system may be used and may cost more, but the individual's safety is of primary importance.

7.13 Conclusion and Recommendations

The minipile deep foundation system provides a very constructible and economical solution for transferring the building's loads to bedrock. It provides significant schedule reduction. Since project start-up is very crucial to the overall project schedule, saving time may prove critical in the big picture. This may also allow other contractors to start earlier, thus compressing the project schedule. The cost of the minipiles is significantly less than the caisson costs. The main savings come from the constructability issues that should be able to be avoided with the minipile construction. The minipile foundation also lessens the risk of injury to an on site worker because no one has to be lowered into a large hole to inspect the inside.

I would highly recommend the minipile deep foundation system as a substitute to the caisson foundation. The main reasons lay in the budget and schedule. Both are greatly reduced from the caissons. There are no real constructability issues with the minipile foundation system and overall seems to be a much better fit with the constraints on the Washington County Regional Medical Center construction site.

8.0 Composite Precast Panel Unit Implementation

Mechanical Breadth

8.1 Introduction

Composite precast wall panel units are a composite wall system that typically contains an exterior cast concrete cladding that can have a variety of finishes, metal studs, and insulation integrated into one system. These provide many construction benefits and can offer energy efficiency due to the combination of all parts of a typical wall system. Precast is generally known for greater quality and quicker erection speeds allowing owners to save time on their schedule. Due to many industry issues, precast is becoming a more readily used system as an alternative to traditional façade systems.

8.2 Problem Statement

The masonry work on the project is mainly located on the link and other various lower levels of the medical center. The masonry work starts in the winter months and can be a long, labor intensive activity. This combined with rising energy costs and other material and labor costs to complete an exterior wall system provide for a precast wall panel investigation.

8.3 Goal

The analysis will focus on simplifying the construction on the exterior façade where the brick is located by reducing the amount of activities and laborers needed to complete the exterior wall system. By incorporating the composite precast panel system I intend to reduce the schedule and the cost of the overall wall system. I also aim to enhance the thermal properties of the wall system allowing a reduction in the mechanical load on the affected areas of the building permitting me to decrease the size on the mechanical units and provide initial and lifecycle cost savings.

8.4 Methodology

The following steps will be taken to adequately research this topic:

1. Identify a proper composite precast panel system that is most relevant for this project.
2. Determine cost and schedule impacts of the precast wall panel system compared to the current system.
3. Address logistical concerns including transportation and laydown area.
4. Determine the initial and life cycle costs associated with engineering, producing, and installing the precast wall panel unit.
5. Obtain thermal properties of the wall system and compare with the current system.
6. Calculate effect of reduced loads on mechanical system.
7. Resize mechanical system units serving the affected areas and comment on initial and lifecycle costs.

8. Recommend precast wall panel unit to replace the current wall cavity.

8.5 Tools and Resources

1. Washington County Regional Medical Center Construction Documents and Specifications
2. Gilbane Building Company
3. Penn State Architectural Engineering Faculty
4. Earl Corporation's Composite System: Metal Stud Crete®
5. R.S. Means 2008/2009
6. Energy-10 v1-8

8.6 Expectations

I expect the initial cost of the composite precast panel unit system to be higher than the traditional masonry wall cavity unit. However, when looking at all the affected trades and the potential general conditions savings due to schedule reduction, I expect the precast system to be cheaper. I also expect the thermal properties of the panel unit to resist more heat transfer thereby reducing the size of the air handling units. In turn, this will reduce the project's initial and lifecycle costs.

8.7 Current Brick Cavity Wall System

The current brick cavity wall system, as shown in Appendix L, consists of the typical construction of such a wall. The drawing shows 4" face brick backed with an air space, 1" rigid insulation, an air infiltration barrier, and 16 gauge metal studs. The insulation is 6" batt insulation with a k value of 0.27. Although there is no inherent faults with the construction of the wall as designed, it can be enhanced to contain better attributes such as energy savings, less weight, and smaller cavity if another system can be utilized. The masonry is also schedule to begin work in the winter months. The cold can adversely affect the masonry crews and the rate at which they perform work. Ultimately this will affect the close-in process and the critical path of the entire medical center schedule.

The brick cavity is not completely the wrong system for the project; it does have some good features. The transportation of the brick and other components can have a much smaller impact on the budget of the project. The lead time to produce the product to be installed can also be shorter. The components of the brick cavity wall, the equipment, and crews combined need less on-site space than other systems. These issues will be addressed when choosing the alternate precast panel wall unit.

8.8 Alternative Method Analysis: Metal Stud Crete®[1]

One of the goals of The Washington County Regional Medical Center is to create a semi appealing exterior facade that flows well with the existing Robinwood Medical Center ecspecially at the connection of the two facilities. Robinwood's exterior is comprised of two different brick patterns that will be mimicked in the connection of the new facility. However, the new facility will not be a complete copy of the existing medical center, rather it will have its own identity by using a third brick pattern mainly used on the vertical elements of the stair towers. These constraints leave only one logical change to the exterior façade: precast. Precast architectural panels are currently being utilized for the three bed towers. This proves that the owner does not have any preconcieved negative notions about precast. It also helps with logistics and the need to find a contractor.

While researching different types of precast systems, one system appeared to be much better than alternative products. This is a composite wall panel system produced by Earl Corporation and termed Metal Stud Crete®. This system appears to be ideal for the Washington County Regional Medical Center in many ways.

8.8.1 Achieving the Brick Look

Metal Stud Crete® in conjunction with Scott System Inc. can cast a flat brick panel into the composite panel unit. They can do this using any brick that the owner chooses. This means that the current brick choices for the new medical center can still be utilized and reproduced by Scott System Inc. as a flat brick. This will give the exact same appearance the facility is currently going to employ in a precast panel unit. The two figures to the right, Figure 8.1 and 8.2 respectively, show the flat brick and how it is used to be integrated into the panel, and the finished look it can produce. As the final panel picture shows the precast unit can be implemented to create a finish that is identical to traditional masonry units.

Figure 8.1 (left): Flat Brick Casting
Figure 8.2 (right): Final Panel Look

Figures 8.1and 8.2 are courtesy of Scott System, Inc. website: www.scottsystem.com. Note: NTS

8.8.2 Green Construction

Although it is not a priority to achieve any LEED credits, Metal Stud Crete® provides numerous environmental benefits. The steel studs, Metal Stud Crete® connectors, and the wire mesh used in this panel contain between 30.47% and 80% recycled content, 23.5% to 30% post consumer scrap, and 6.4 to 70% pre consumer scrap. Metal Stud Crete® also claims they can use locally extracted materials from within 500 miles of any project site. The carbon footprint through shipping is also reduced because the panel is much lighter than traditional panels and can be shipped in a fewer amount of loads. The panels can also optimize energy performance. This will be discussed in much greater detail when this report shows thermal characteristics and compares reduced loads to the current system.

---

[1] Metal Stud Crete® is a registered trademark of Earl Corporation and will contain the ® emblem throughout this report. All information is courtesy of Metal Stud Crete®

8.8.3 Technical Aspects

Metal Stud Crete® is a structural composite wall panel system combining hardrock concrete, approximately 2" thick, insulation, and light gauge framing. Metal Stud Crete® also has a patented structural, composite shear connecter that bonds the framing and concrete. This allows the panel to carry wind loads, frame movement, expansion, and contraction throughout the life of the panel. Figure 8.3 to the right and Figure 8.4 below, shows a detail of both track and web connectors, respectively.

Figure 8.3: Web Connector

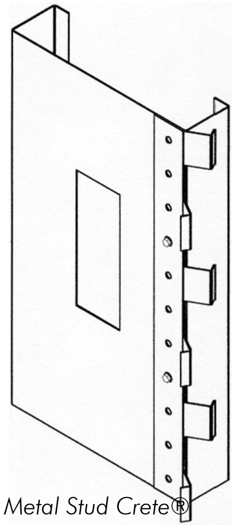
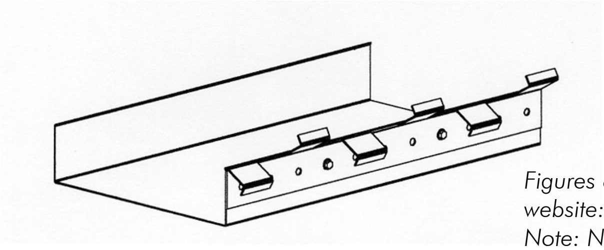


Figure 8.4: Track



Figures 8.3 and 8.4 are courtesy of Metal Stud Crete® website: www.metalcrete.com/tech_typical_details.html. Note: NTS

Metal Stud Crete® is also lighter and thinner than the traditional brick cavity wall system. This will reduce loads and produce more square feet of usable space for the owner. The panel does not need any extra furring on the interior to accept interior finishes. This is included in the panel system. The panels can also be made into any shippable shape and size to fit project needs.

The system has many ways of connection; however, only one fits the needs of The Washington County Regional Medical Center because the others contain reveals, a feature that will not relate to the clean brick look. The panel to panel connection, as shown in Figure 8.5, below, provides a smooth finish to the exterior and creates a great moisture and infiltration barrier. As seen in Figure 8.5, the exterior is sealed with backer rod and sealant. Enhancing the moisture and infiltration barrier is the bitumen that can be placed throughout the rest of the joint. Vapor barriers can also be incorporated for additional moisture protection.

Figure 8.5: Panel to Panel Connection

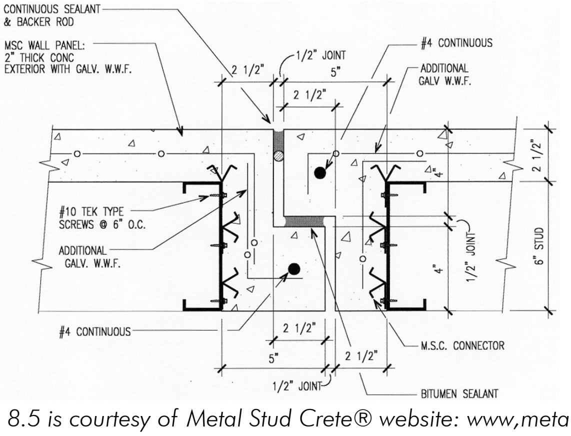


Figure 8.5 is courtesy of Metal Stud Crete® website: www,metalcrete.com/tech_typical_details.html. Note: NTS

8.9 Schedule Review

When considering the schedule review, a thourough examination of the actual construction activites and their effect on the overall progress of the contruction is crucial. In addition, evaluating leadtime for the materials is also very important and although it may not have a direct construction schedule impact, it will affect procurement planning. Table 8.1, as follows, shows a comparison of the two systems lead times and construction durations.

Table 8.1: Schedule Comparison

SCHEDULE COMPARISON				
Lead Times				
System	Quantity	Unit	Output (Unit/Day)	Total (Days)
Brick	12927.0	SF	--------	70.0
*Metal Stud Crete®	12927.0	SF	--------	103.3
			Difference	33.3
Construction Time				
System	Quantity	Unit	Output (Unit/Day)	Total (Days)
Brick	12927.0	SF	190.0	68.0
Exterior Framing	6093.0	LF	450.0	13.5
Metal Stud Crete®	12927.0	SF	853.0	15.2
			Difference	66.4

*Transportation included

The information for Metal Stud Crete® said that the panels, based on square footage, can be erected and fully connected and complete in forty-five minutes. However, the precast contractor on site can only erect one panel in about an hour. Since the system proposes using the existing contractor to for erection purposes, one hour was used. The exterior framing was also used when calculating the adjusted schedule because Metal Stud Crete® incorporates the framing into the panel. The production times for the brick were calculated using an average number of outputs for winter and summer construction since the brick façade erection begins in the winter and proceeds to the spring. Neither the brick nor the Metal Stud Crete® durations include interior drywall. The lead time for the panels works out to be just over 33 days. The bulk of this lead time comes from the special finishes required to achieve the brick look. If this panel were to have a sandblasted finish the lead time would be dramatically reduced. The difference of on site construction time worked out to about 66 days. This is 56% reduction in on site construction time. The façade is a crucial element to drying in the building. This difference helps interior trades start earlier in the building. Since the interior trades are critical to the completion of a hospital, this difference is a considerable help to the project.

8.10 Budget Review

The Washington County Regional Medical Center, like all construction projects, is concerned with maintaining a cost effective budget. Table 8.2, below, shows the cost comparison between the two systems less the activities and items included with the masonry wall. It includes the composite precast wall extra crane usage and transportaion cost comparisons.

Table 8.2: Systems Cost Comparison

COST COMPARISON				
Bare Costs				
System	Quantity	Unit	Cost ($/SF)	Total Cost
Brick	12927.0	SF	$35.00	$452,445.00
*Metal Stud Crete®	12927.0	SF	$45.00	$581,715.00
			Difference	$129,270.00
Related Costs				
Item	Quantity	Unit	Cost ($/Unit)	Total Cost
Add:				
Crane (15 Days)	120.0	hrs.	$350.00	$42,000.00
			Sub-Total	$171,270.00
Less:				
Scaffold	1500.0	SFCA	$252.00	$378,000.00
Exterior Framing	6093.0	LF	$21.00	$127,953.00
			Total Savings	$334,683.00

The main cost savings, as the table shows, comes from the the exclusion of the scaffold. In addition to the scaffold, eliminating the exterior framing also makes a significant contribution. This cost savings may be a little conservative because the current precast contractor will be performing the work. Therefore, the unit costs may be slightly lower. Overall a 29% reduction in cost was achieved.

8.11 Constructability and Logistics

The biggest constructability issue pertaining to the precast erection is the crane useage. Again, as previously stated, the current precast erector will be performing the work. This means that the same crane they used in other places of the building can be used when erecting the Metal Stud Crete®. The Metal Stud Crete® panels weigh less per square foot of panel and the current architectural precast panels will be larger. This means that the crane will have sufficient capacity to erect the Metal Stud Crete® panels. The manufacturer recommends a 70 ton crane to erect Metal Stud Crete® panels. The current crane is 250 tons. The crane will be used for about a half hour per 240 square foot panel. To replace the brick system 12,927 square feet of panel must be erected. This provides the following:

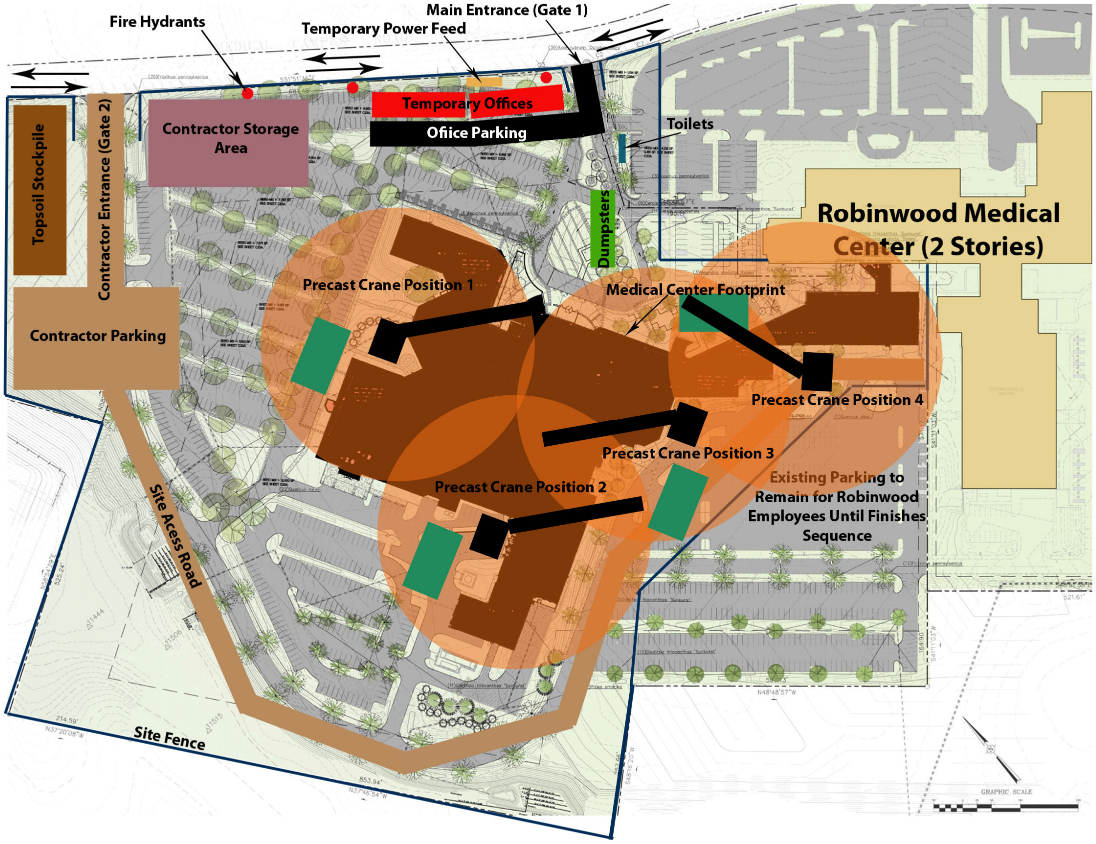
(0.5 hours / 240 square feet) x (12,927 square feet) = 27 hours
or
27 hours / 15.2 days = 1.8 hours of crane operation per day

Other issues relate to logistics and sequencing. Logistically, the laydown area may be of concern. However, the Washington County Regional Medical Center has a very large and open site. In fact, the entire precast shipment could be contained on the site at once if needed. Sequencing provides different issues. Since the critical path relies heavily on the bed towers, these should remain the primary focus of the façade erection. The sequencing should then be based off the location of the crane to minimize movement. The following table, Table 8.3, and figure, Figure 8.6 (over page), shows a suggested façade erection sequence and a site layout plan.

Table 8.3: Sequencing Order for Façade

SEQUENCING ORDER	
#	Area
1	South Tower
2	West Tower
3	East Tower
4	Emergency
5	Service Building
6	Surgery
7	Ambulatory
8	Admitting
9	Admin (or Link) North
10	Admin (or Link) South

Figure 8.6: Logistics Plan for Façade



With this sequence the façade erection now has three critical crane moves. This is the least amount of moves possible. These moves can take place at the end of each section because of the downtime that will happen.

8.12 Thermal and Mechanical Analysis

8.12.1 Thermal Analysis

Another deciding factor to chose the Metal Stud Crete® system is its thermal advantages. Table 8.4, on the following page, shows a comparison of the thermal principles of each system. It shows the R value, resistance to heat transfer, and the U value, how well a material allows heat to pass through. It is also worthy to point out the extra three inch gain in space between the two systems.

Table 8.4: Thermal Wall Analysis Comparison

THERMAL ANALYSIS				
Current System - Brick Cavity Wall Unit				
Component	Thickness (inches)	Unit R-Value	Units	Total R-Value
Outside Air Layer	N/A	0.17	ea	0.17
Face Brick	4.0	0.44	ea	0.44
Air Space	1.0	1.00	ea	1.00
Rigid Insulation	1.0	5.00	ea	5.00
Sheathing	0.5	0.63	ea	0.63
Insulation (k-value = .27)	6.0	3.70	in	22.2
Vapor Barrier	N/A	0.10	ea	0.10
Gypsum Board	0.625	0.56	ea	0.56
Inside Air Layer	N/A	0.68	ea	0.68
Total Thickness (in)	13	Total R-Value (hr-sf-°F/BTU)		30.78
		Total U-Value (BTU/hr-sf-°F)		0.0325
Proposed System - Metal Stud Crete® Precast Composite Unit				
Component	Thickness (inches)	Unit R-Value	Units	Total R-Value
Outside Air Layer	N/A	0.17	ea	0.2
Concrete	2.0	1.00	in	2.0
Foam Insulation	0.75	6.50	in	4.9
Air Space	0.5	1.00	ea	1.0
Insulation (k-value = .25)	6.0	4.00	in	24.0
Vapor Barrier	N/A	0.10	ea	0.10
Gypsum Board	0.625	0.56	ea	0.56
Inside Air Layer	N/A	0.68	ea	0.68
Total Thickness (in)	10	Total R-Value (hr-sf-°F/BTU)		33.39
		Total U-Value (BTU/hr-sf-°F)		0.0300

Further thermal analysis is provided in the next table, Table 8.5. The overall heat gain and heat loss is calculated in this table. The summer and winter design temperatures are taken from a comparable area. The inside temperatures are taken from the mean radiant temperature of the average person.

Table 8.5: Summer and Winter Thermal Comparison

THERMAL ANALYSIS				
Summer Heat Gain ($T_o = 89$, $T_i = 72$)				
System	Area (SF)	U-Value	ΔT (^oF)	Heat Gain (BTU/Hr)
Brick Cavity Wall	12927.0	0.325	17	71421.68
Metal Stud Crete®	12927.0	0.300	17	65927.70
			Difference	137349.38
			Reduction in Heat Gain	7.69%
Winter Heat Loss ($T_o = 11$, $T_i = 69$)				
System	Area (SF)	U-Value	ΔT (^oF)	Heat Gain (BTU/Hr)
Brick Cavity Wall	12927.0	0.325	58	243673.95
Metal Stud Crete®	12927.0	0.300	58	224929.80
			Difference	468603.75
			Reduction in Heat Loss	7.69%

This thermal analysis shows an overal reduction in both the heat loss in the winter and the heat gain in the summer by 7.69%.

8.12.2 Energy-10 Analysis

The previous thermal analysis based on the wall composition was then used in the energy simulation software Energy-10. Energy-10 is a comprehensive building software that analyzes the impact of different materials on a structures overall energy consumption. Two simulations were compared; one with the brick cavity wall system and one with the composite precast wall panels. No other parameters were changed so the simulation would be a true comparison of the wall systems. Since the brick is used primarily in the administration wing, the simulation was developed only on that portion of the medical center. Additionally, the following assumptions were used when inputing data into the simulation:

- The location used was Sterling, VA. This was the closest location to Hagerstown, MD.
- Office use was used because the administration wing is primarily composed of offices.
- Utility rates were gathered from Allegheny Power, the local utlity company.
- The brick cavity wall composition and the composite precast panels used inputs from the library. However, they did not exactly match the properties of the material used. Therefore, the R-Value was then adjusted based on the calculations from section 8.12.1 of this document.
- The HVAC system used was the closest representative of the actual HVAC system.
- All results are presented in percentages because it is not a representative of all the brick changing to precast.

- Inside temperture used for summer cooling was 72°F. Inside temperature used for winter heating was 69°F
- Life cycle was calculated on a 60 year life and all other parameter given in simulation.
- The life cycle cost summary page can only be used to determine utility life cycle cost because other parameter were not changed to show a true reflection of the project.

After completing all entry fields in both situations, the simulation was performed and the energy analysis was produced. The following is a summary results produced. To see complete graphical results, please refer to Appendix M. These values are shown as percent reduction.

- Annual Energy Use (kBTU/ft^2)
    - Heating – 34%
    - Cooling – 42%
    - Other – 6.2%
- Annual Energy Costs ($/ft^2)
    - Fuel – 76%
    - kWh – 20%
    - Demand – 25%
- HVAC Capacities (kBTU/h)
    - Heating – 0%
    - Cooling – 0%
- Life Cycle Cost – Utilities ($)
    - 24%

The precast performed significantly better in energy use, cost, and utilities life cycle costs. However, as the HVAC capacities show, the difference is wall system is not significant to warrant new air handling units. These chages show that the composite precast system outperforms the tradtional brick cavity wall system as it relates to energy consumption and costs.

8.13 Conclusion and Recommendations

The composite precst panel wall system is a viable choice for the Washington County Regional Medical Center. It provides significant construction schedule improvments which will help the overal schedule. Similar to the expectations, the intial bare cost of the composite precast system is higher than the brick cavity wall. However, when considering the elimination of the exterior framing contract and the scaffold the composite precast system shows a sizeable cost savings to the project. Logistically, the project is affected by new crane movements. The construction team needs to be prepared to handle crane movements and extra crane time on site. However, a useable plan is shown in the report. Laydown area is not affected because of the available space at the construction site.

The compostion of the composite precast panel system provides thermal atvantages over the brick cavity wall. The R-Value difference shows better resistance to heat transfer. Sizeable energy savings is also shown in the Energy-10 analysis. This showed that the mechanical system will use less energy and utility costs will be greatly reduced. Contrary to initial expectations, the thermal atvantages did not prove to be enough to resize the units. However, less stress will be placed on the current units and hopefully this will cause a longer life.

I would highly recommend the replacement of the brick with the composite precast system because of the major schedule and cost savings. Also, the technical aspects of the system match or exceed all the goals of the medical center. The introduction of the precast system would prove to be a good endevor for the medical center both now and in the future.

9.0 Completing the Picture

9.1 Introduction

To complete the big picture and adequately justify the thesis work that has been completed thus far, a final analysis will be run with the savings accrued from the construction of the new medical center. This will show where this savings money can be used and how it can be invested to gain a good return.

9.2 Brief Analysis

A fairly brief analysis will be used to complete this thesis. To adequately show these results two major assumptions must be applied. They are as follows:

- First cost savings from the new medical center can be applied to the development of the old facility.
- Annual energy costs will be estimated and linearly related to be used in the yearly cash flow. 1.5% growth assumed with facility growth.

The partially developed facility model, as chosen through previous analysis, will be used to show how the development could be enhanced with the construction savings from the new medical center. The same model was used; therefore, all assumptions made and numbers used apply except for the following savings.

- $413,356 applied to the renovation cost from upfront cost savings of the minipile deep foundation system.
- $334,683 applied to the renovation cost from upfront cost savings of the precast panel wall implementation.
- Annual energy costs from the precast panel wall implementation.

The following table, Table 9.1, shows a summary of the complete analysis that can be found in Appendix N.

Table 9.1: Partially Develop to Run w/ Savings Cash Flow Summary

PARTIALLY DEVELOP TO RUN W/ SAVINGS SUMMARY	
Sale Price @ 10th year	$74,264,614
Return on Investment	$50,865,041
Internal Rate of Return	34%

Table 9.2, below, shows a comparison of the best development option, Partially Develop to Run (PDTR), versus the best development option with the construction savings, Partially Develop to Run with Savings (PDTRwS).

Table 9.2: Comparison Summary

COMPARISON		
	PDTR	PDTRwS
Sale Price @ 10th year	$74,264,614	$74,264,614
Return on Investment	$50,117,002	$50,865,041
Internal Rate of Return	31%	34%

The most significant change is the IRR. It rises 3% over the period of analysis meaning the hospital will be generating more yearly income from this investment. The sale price stays the same because the capitalization rates did not change and the return on investment is up slightly.

9.3 Conclusion

This analysis shows that the costs savings from new medical center could be used in developing the old facility and yield a better return on the investment. Therefore, this cost savings would not only produce a direct cost savings for the project, it could be invested and grown into substantial cost savings.

Again, this analysis was done because it tied the whole report together. It is known that this may be an unrealistic analysis mainly because of the application of the annual costs. This will more than likely not be physical money, just less expenditures for the owner. However, it was interesting to show the results.

10.0 Conclusion

As an owner, the Washington County Health System is constantly looking for ways to enhance the construction of their project. This can be done in several ways such as cost savings, schedule enhancement, and constructability and logistics as shown throughout this report. The constant management of project success depends heavily on these factors too. This report provided alternate was of adding value to the project to help the Washington County Health System achieve their goals.

As reported in the first analysis, the ability for the owner to develop the old facility could prove to create a worthy investment. The analysis examined different development options and showed the best fit for the owner. This partially development of the old facility would generate additional revenue for the owner to apply to the repayment of bonds. The most beneficial factor of the development was that the Washington County Health System does not have to purchase the land or building; they already own it. This was a big consideration in this analysis.

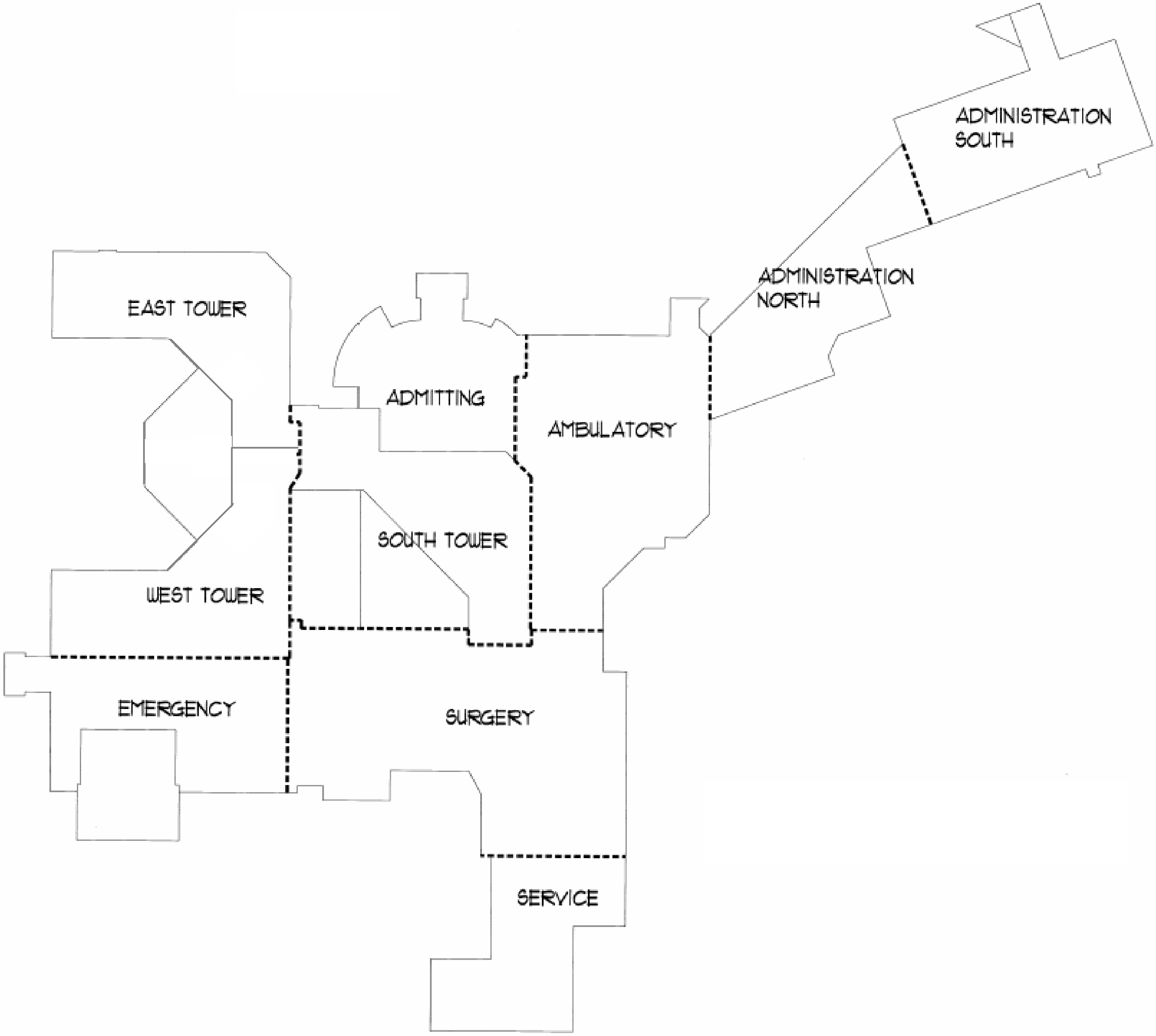
The second analysis looked into a redesign of the deep foundation system. As reported, a minipile deep foundation system was researched to replace the caissons. To highlight a few conclusions from this analysis, a substantial amount of money, 29%, was saved and the schedule was reduced by 52%. Overall the minipile deep foundation system proved to be a more complete system and a better fit for the owner.

The third analysis looked into a composite precast panel wall implementation in place of the brick cavity wall. This system was chosen based on its thermal properties, but proved to be a cost reducer and a schedule enhancer. The cost savings returned 22% and the schedule was reduced by 56%. This analysis also established a better fit with the Washington County Health System.

Ultimately, the report provided two critical analyses that were able to help the construction of the new medical center and one analysis that considered the previous hospital. With these analyses, the owner can consider the results for enhancement to the project and the financial strength of their investments.

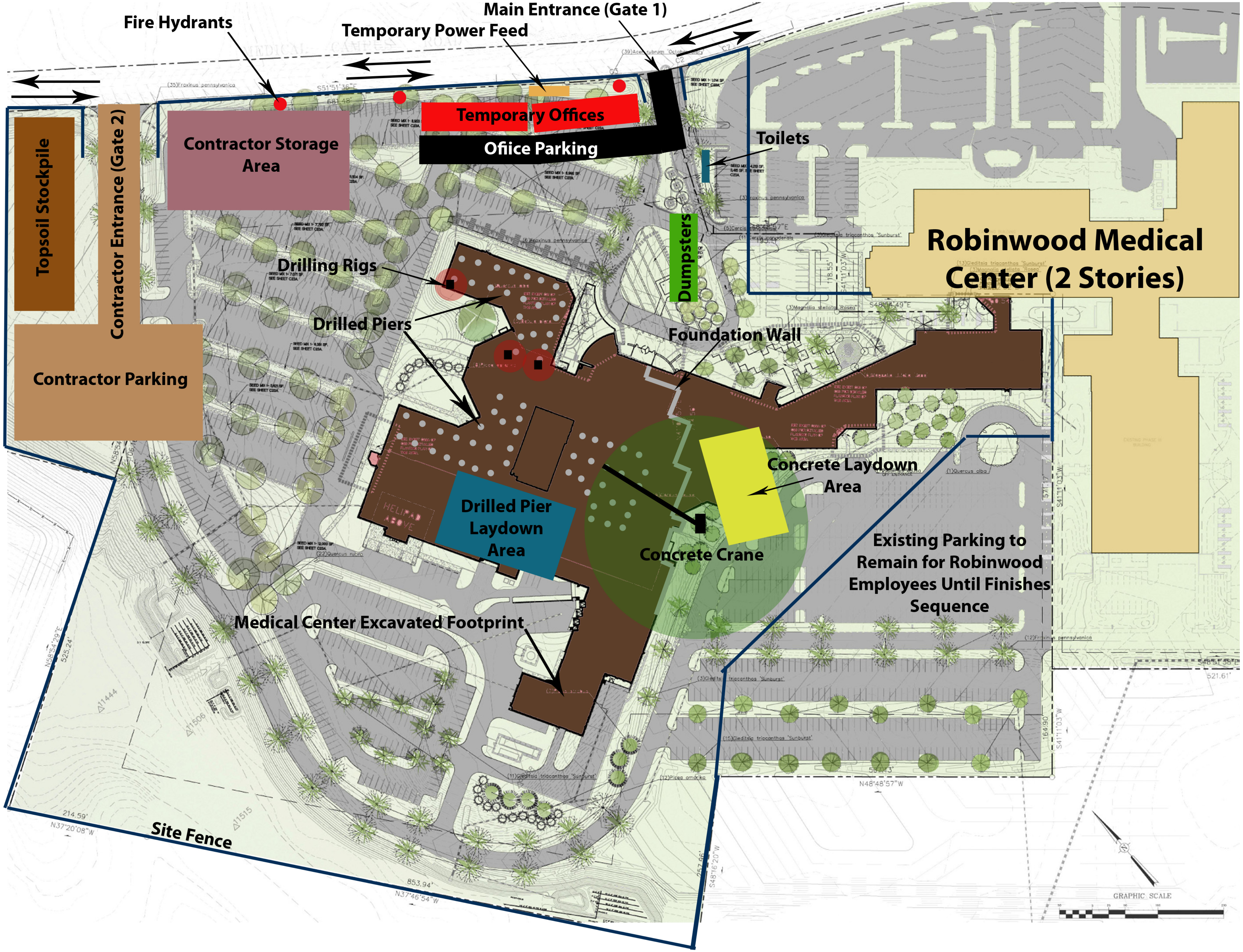
Appendix A:

Reference Plan


ADMINISTRATION SOUTH
ADMINISTRATION NORTH
EAST TOWER
ADMITTING
AMBULATORY
SOUTH TOWER
WEST TOWER
EMERGENCY
SURGERY
SERVICE

Appendix B:

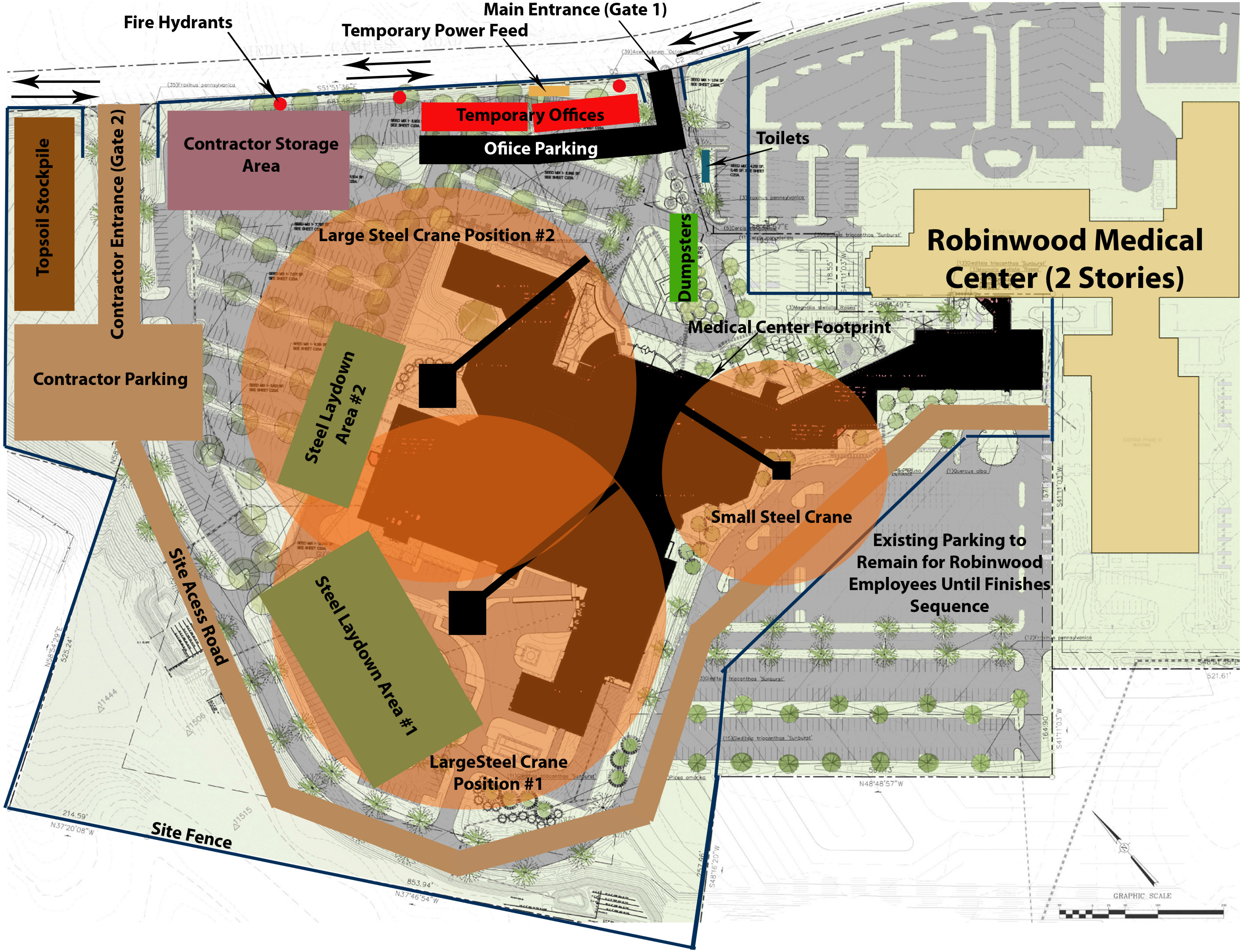
Site Logistics Plans



Washington County Regional Medical Center

Foundation Site Logistics Plan

Scott Earley
Final Report



Washington County Regional Medical Center

Superstructure Site Logistics Plan

Scott Earley
Final Report

Washington County Regional Medical Center

Interiors/Finishes Site Logistics Plan

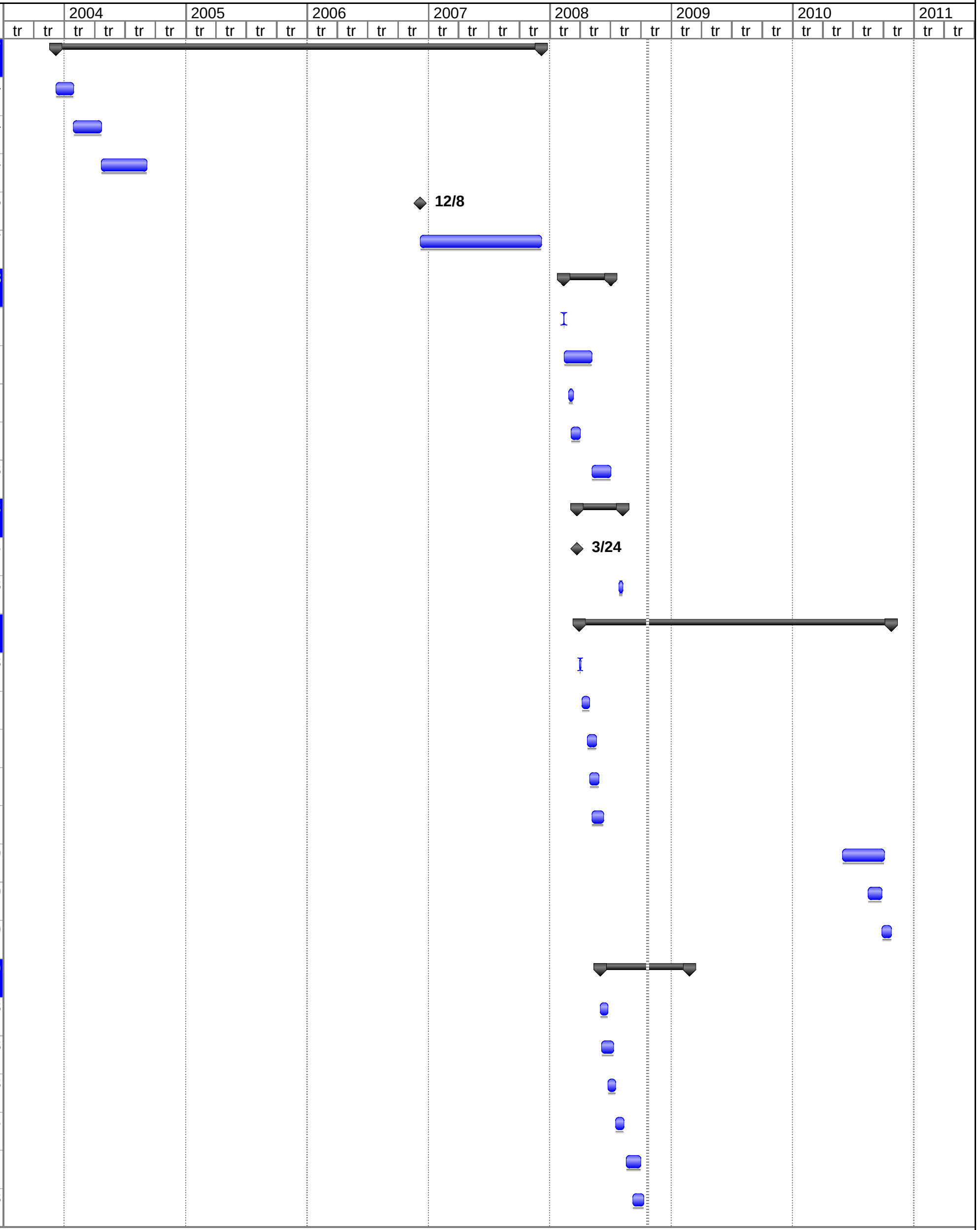
Scott Earley
Final Report

Appendix C:

Project Schedule

The Washington County Regional Medical Center Detailed Schedule

ID	Task Name	Duration	Start	Finish
1	**Design and Preconstruction**	**1045 days**	**Mon 12/8/03**	**Fri 12/7/07**
2	Schematic Design	39 days	Mon 12/8/03	Thu 1/29/04
3	Design Development	61 days	Thu 1/29/04	Thu 4/22/04
4	Construction Documents	98 days	Thu 4/22/04	Mon 9/6/04
5	Construction Documents Issued	0 days	Fri 12/8/06	Fri 12/8/06
6	Preconstruction Activities	261 days	Fri 12/8/06	Fri 12/7/07
7	**Procurement and Contracting**	**102 days**	**Wed 2/13/08**	**Thu 7/3/08**
8	Notice to Proceed	1 day	Wed 2/13/08	Wed 2/13/08
9	Award Contracts	60 days	Thu 2/14/08	Wed 5/7/08
10	Early Site Submittals	10 days	Thu 2/28/08	Wed 3/12/08
11	Fab and Deliver Underground Material	20 days	Thu 3/6/08	Wed 4/2/08
12	Underground Coordination	41 days	Thu 5/8/08	Thu 7/3/08
13	**Mobilization**	**100 days**	**Mon 3/24/08**	**Fri 8/8/08**
14	Begin Work on Site	0 days	Mon 3/24/08	Mon 3/24/08
15	Install Temp. Office Trailers	10 days	Mon 7/28/08	Fri 8/8/08
16	**Site Work**	**671 days**	**Mon 3/31/08**	**Mon 10/25/10**
17	Install Forrest Protection and LOD	5 days	Mon 3/31/08	Fri 4/4/08
21	Install Silt Fences, Sediment Traps, and Dikes	17 days	Tue 4/8/08	Wed 4/30/08
18	Drill and Blast for Building Pad	20 days	Thu 4/24/08	Wed 5/21/08
19	Clear and Grub Site	20 days	Thu 5/1/08	Wed 5/28/08
20	Excavate Building Pad (Cut and Fill Site)	25 days	Thu 5/8/08	Wed 6/11/08
22	Sidewalks	90 days	Tue 6/1/10	Mon 10/4/10
23	Landscaping	30 days	Tue 8/17/10	Mon 9/27/10
24	Final Paving	20 days	Tue 9/28/10	Mon 10/25/10
25	**Foundations**	**193 days**	**Mon 6/2/08**	**Wed 2/25/09**
26	Install Caissons South Tower	17 days	Mon 6/2/08	Tue 6/24/08
40	Install Spread Ftgs. Admitting / Ambulatory	26 days	Fri 6/6/08	Fri 7/11/08
29	Install Caissons West Tower	17 days	Wed 6/25/08	Thu 7/17/08
32	Install Caissons East Tower	17 days	Fri 7/18/08	Mon 8/11/08
27	Underground Utilites South Tower	32 days	Tue 8/19/08	Wed 10/1/08
30	Underground Utilities West Tower	25 days	Mon 9/8/08	Fri 10/10/08

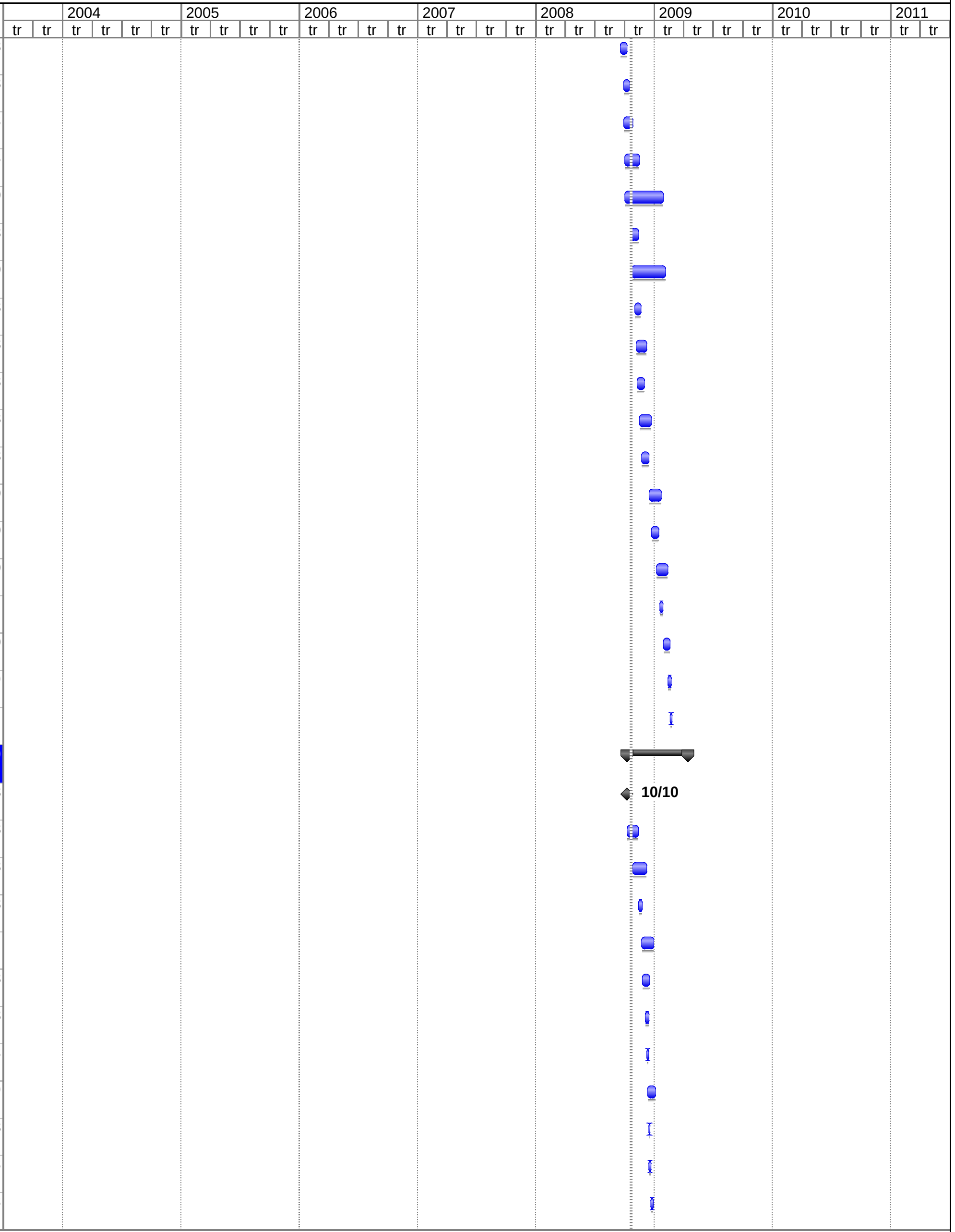


Project: Detailed Schedule.mpp
Date: Sun 10/19/08

Task	▬	Progress	▬	Summary	▬	External Tasks	▬	Deadline	⇩
Split	┈	Milestone	◆	Project Summary	▬	External Milestone	◆		

The Washington County Regional Medical Center Detailed Schedule

ID	Task Name	Duration	Start	Finish
28	SOG South Tower	15 days	Fri 9/19/08	Thu 10/9/08
31	SOG West Tower	15 days	Mon 9/29/08	Fri 10/17/08
37	Install Foundations Admin Link	20 days	Tue 9/30/08	Mon 10/27/08
35	Underground Utilities Service Building	32 days	Fri 10/3/08	Mon 11/17/08
47	Underground Utilities Surgery	85 days	Fri 10/3/08	Thu 1/29/09
33	Underground Utilities East Tower	20 days	Mon 10/20/08	Fri 11/14/08
48	SOG Surgery	75 days	Fri 10/24/08	Thu 2/5/09
34	SOG East Tower	15 days	Mon 11/3/08	Fri 11/21/08
38	Underground Utilities Admin Link	23 days	Fri 11/7/08	Tue 12/9/08
36	SOG Service Building	17 days	Mon 11/10/08	Tue 12/2/08
41	Underground Utilities Admitting / Ambulatory	27 days	Mon 11/17/08	Tue 12/23/08
39	SOG Admin Link	17 days	Mon 11/24/08	Tue 12/16/08
43	Underground Utilities Sequence 9-10	28 days	Wed 12/17/08	Fri 1/23/09
42	SOG Admitting / Ambulatory	17 days	Wed 12/24/08	Thu 1/15/09
45	Underground Utilities Emergency	25 days	Fri 1/9/09	Thu 2/12/09
44	SOG Sequence 9-10	8 days	Mon 1/19/09	Wed 1/28/09
46	SOG Emergency	15 days	Fri 1/30/09	Thu 2/19/09
49	Underground Utilities Sequence 13	7 days	Fri 2/13/09	Mon 2/23/09
50	SOG Sequence 13	4 days	Fri 2/20/09	Wed 2/25/09
51	**Superstructure**	**134 days**	**Fri 10/10/08**	**Wed 4/15/09**
52	Start Structural Steel Erection	0 days	Fri 10/10/08	Fri 10/10/08
53	Erect Steel South Tower	25 days	Fri 10/10/08	Thu 11/13/08
57	Erect Steel West Tower	32 days	Mon 10/27/08	Tue 12/9/08
54	Detail Steel South Tower	8 days	Fri 11/14/08	Tue 11/25/08
61	Erect Steel East Tower	28 days	Mon 11/24/08	Wed 12/31/08
55	Concrete on Metal Deck South Tower	17 days	Wed 11/26/08	Thu 12/18/08
58	Detail Steel West Tower	8 days	Fri 12/5/08	Tue 12/16/08
83	Erect Steel Surgery 1	4 days	Wed 12/10/08	Mon 12/15/08
59	Concrete on Metal Deck West Tower	17 days	Fri 12/12/08	Mon 1/5/09
65	Erect Steel Service Building	4 days	Tue 12/16/08	Fri 12/19/08
84	Detail Steel Surgery 1	5 days	Tue 12/16/08	Mon 12/22/08
66	Detail Steel Service Building	6 days	Mon 12/22/08	Mon 12/29/08

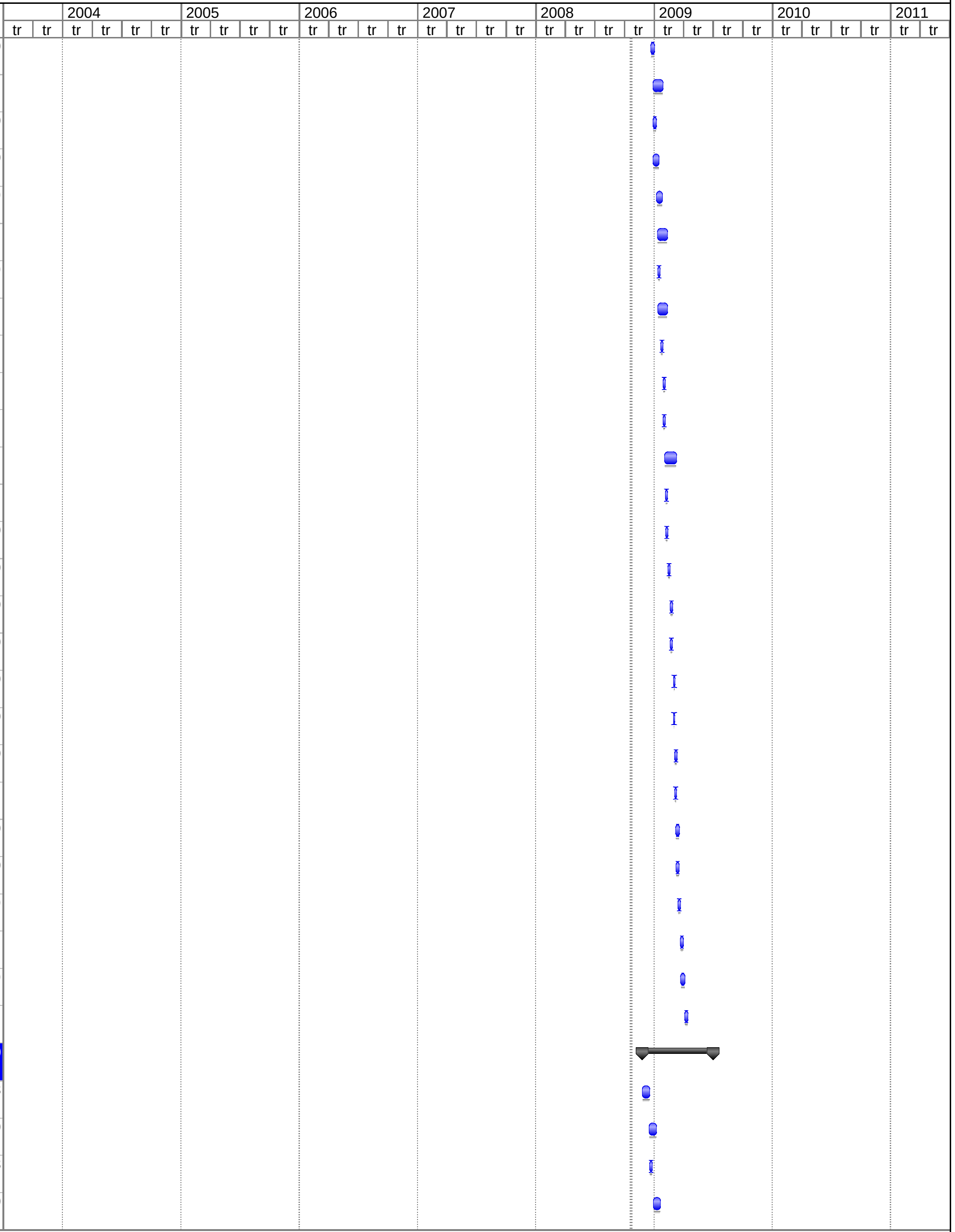


Project: Detailed Schedule.mpp
Date: Sun 10/19/08

Task	▬	Progress	▬	Summary	▬	External Tasks	▬	Deadline	⇩
Split	┈	Milestone	◆	Project Summary	▬	External Milestone	◆		

The Washington County Regional Medical Center Detailed Schedule

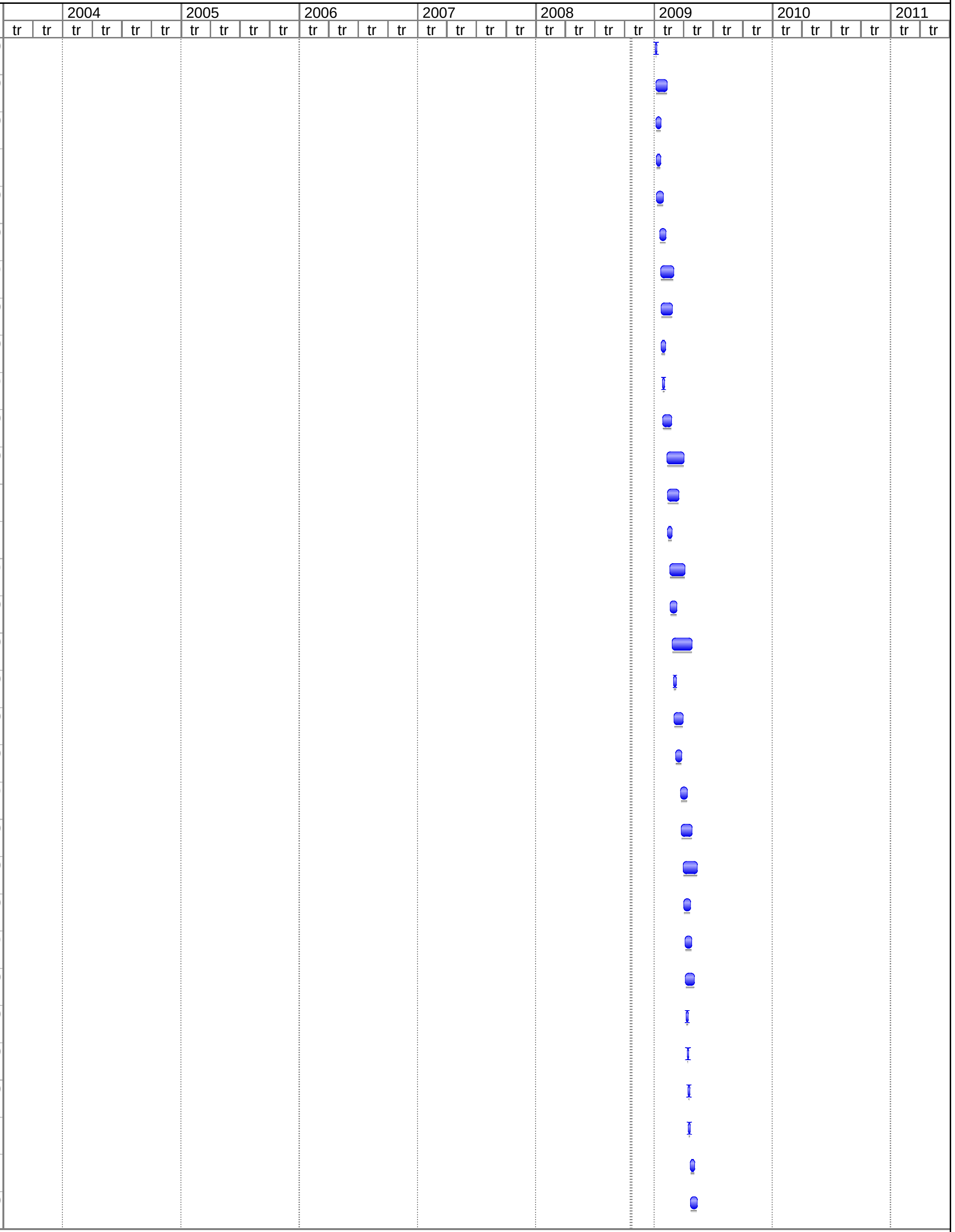
ID	Task Name	Duration	Start	Finish
68	Erect Steel Link North and South	10 days	Mon 12/22/08	Fri 1/2/09
56	Fireproof South Tower	23 days	Mon 12/29/08	Wed 1/28/09
62	Detail Steel East Tower	9 days	Mon 12/29/08	Thu 1/8/09
69	Detail Steel Link North and South	15 days	Mon 12/29/08	Fri 1/16/09
63	Concrete on Metal Deck East Tower	12 days	Fri 1/9/09	Mon 1/26/09
60	Fireproof West Tower	23 days	Mon 1/12/09	Wed 2/11/09
70	Concrete on Metal Deck Link South	5 days	Tue 1/13/09	Mon 1/19/09
71	Fireproof Link North and South	22 days	Tue 1/13/09	Wed 2/11/09
72	Erect Steel Admitting	5 days	Thu 1/22/09	Wed 1/28/09
73	Detail Steel Admitting	5 days	Thu 1/29/09	Wed 2/4/09
77	Erect Steel Sequence 9-10	5 days	Thu 1/29/09	Wed 2/4/09
64	Fireproof East Tower	27 days	Tue 2/3/09	Wed 3/11/09
78	Detail Steel Sequence 9-10	5 days	Thu 2/5/09	Wed 2/11/09
85	Erect Steel Surgery 2	5 days	Fri 2/6/09	Thu 2/12/09
86	Detail Steel Surgery 2	5 days	Fri 2/13/09	Thu 2/19/09
79	Erect Steel Emergency	6 days	Fri 2/20/09	Fri 2/27/09
87	Concrete on Metal Deck Surgery	5 days	Fri 2/20/09	Thu 2/26/09
80	Detail Steel Emergency	5 days	Mon 3/2/09	Fri 3/6/09
89	Erect Steel Sequence 13	4 days	Mon 3/2/09	Thu 3/5/09
74	Erect Steel Ambulatory	6 days	Fri 3/6/09	Fri 3/13/09
90	Detail Steel Sequence 13	4 days	Fri 3/6/09	Wed 3/11/09
81	Concrete on Metal Deck Emergency	10 days	Mon 3/9/09	Fri 3/20/09
67	Fireproof Service Building	8 days	Tue 3/10/09	Thu 3/19/09
75	Detail Steel Ambulatory	6 days	Mon 3/16/09	Mon 3/23/09
82	Fireproof Emergency	8 days	Mon 3/23/09	Wed 4/1/09
76	Fireproof Admitting / Ambulatory	10 days	Tue 3/24/09	Mon 4/6/09
88	Fireproof Surgery	8 days	Mon 4/6/09	Wed 4/15/09
91	**Façade / Roof**	**157 days**	**Wed 11/26/08**	**Thu 7/2/09**
92	Roof Curbs and Penetrations South Tower	17 days	Wed 11/26/08	Thu 12/18/08
99	Roof Curbs and Penetrations West Tower	17 days	Wed 12/17/08	Thu 1/8/09
93	Install Precast Support South Tower	6 days	Fri 12/19/08	Fri 12/26/08
115	Roof Curbs and Penetrations Service Building	16 days	Tue 12/30/08	Tue 1/20/09



Project: Detailed Schedule.mpp Date: Sun 10/19/08	Task	▬	Progress	▬	Summary	▬	External Tasks	▬	Deadline ⇩
	Split	┈	Milestone	◆	Project Summary	▬	External Milestone ◆		

The Washington County Regional Medical Center Detailed Schedule

ID	Task Name	Duration	Start	Finish
100	Install Precast Support West Tower	5 days	Mon 1/5/09	Fri 1/9/09
94	Install Exterior Studs South Tower	25 days	Wed 1/7/09	Tue 2/10/09
116	Install Exterior Studs Service Building	12 days	Wed 1/7/09	Thu 1/22/09
95	Erect Precast South Tower	10 days	Thu 1/8/09	Wed 1/21/09
107	Roof Curbs and Penetrations East Tower	15 days	Fri 1/9/09	Thu 1/29/09
119	Roof Curbs and Penetrations Admin. Link	15 days	Mon 1/19/09	Fri 2/6/09
117	Install Masonry Service Building	28 days	Thu 1/22/09	Mon 3/2/09
101	Install Exterior Studs West Tower	25 days	Fri 1/23/09	Thu 2/26/09
102	Erect Precast West Tower	10 days	Fri 1/23/09	Thu 2/5/09
108	Install Precast Support East Tower	5 days	Tue 1/27/09	Mon 2/2/09
120	Install Exterior Studs Admin. Link	20 days	Wed 1/28/09	Tue 2/24/09
96	Install Masonry South Tower	39 days	Tue 2/10/09	Fri 4/3/09
109	Install Exterior Studs East Tower	25 days	Thu 2/12/09	Wed 3/18/09
110	Erect Precast East Tower	10 days	Thu 2/12/09	Wed 2/25/09
103	Install Masonry West Tower	33 days	Thu 2/19/09	Mon 4/6/09
135	Roof Curbs and Penetrations Surgery 1 and 2	15 days	Fri 2/20/09	Thu 3/12/09
111	Install Masonry East Tower	44 days	Thu 2/26/09	Tue 4/28/09
118	Install Overhead Doors Service Building	7 days	Mon 3/2/09	Tue 3/10/09
136	Install Exterior Studs Surgery 1 and 2	20 days	Wed 3/4/09	Tue 3/31/09
129	Roof Curbs and Penetrations Emergency	15 days	Mon 3/9/09	Fri 3/27/09
124	Roof Curbs and Penetrations Admitting / Ambulatory	15 days	Tue 3/24/09	Mon 4/13/09
130	Install Exterior Studs Emergency	24 days	Thu 3/26/09	Tue 4/28/09
137	Install Masonry Surgery 1 and 2	32 days	Wed 4/1/09	Thu 5/14/09
97	Install Roofing South Tower	15 days	Fri 4/3/09	Thu 4/23/09
104	Curtainwall West Tower	15 days	Tue 4/7/09	Mon 4/27/09
139	Install Roofing Surgery 1 and 2	20 days	Wed 4/8/09	Tue 5/5/09
125	Install Exterior Studs Admitting / Ambulatory	5 days	Fri 4/10/09	Thu 4/16/09
98	Windows South Tower	4 days	Tue 4/14/09	Fri 4/17/09
105	Windows West Tower	4 days	Thu 4/16/09	Tue 4/21/09
138	Glaze Windows Surgery 1 and 2	4 days	Fri 4/17/09	Wed 4/22/09
121	Install Masonry Admin. Link	10 days	Thu 4/23/09	Wed 5/6/09
106	Install Roofing West Tower	15 days	Fri 4/24/09	Thu 5/14/09

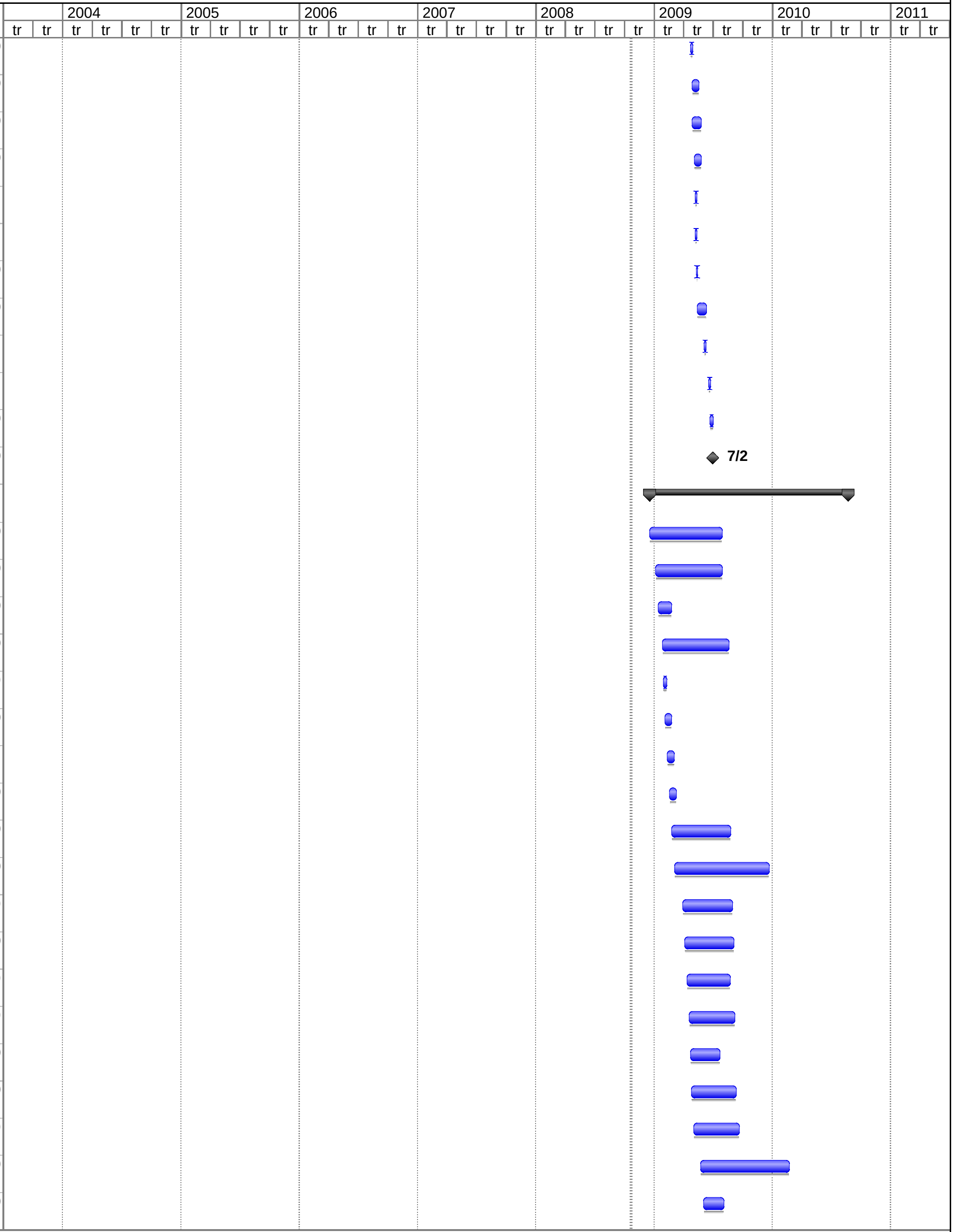


Project: Detailed Schedule.mpp
Date: Sun 10/19/08

Task	▬	Progress	▬	Summary	▬	External Tasks	▬	Deadline	⇩
Split	┈	Milestone	◆	Project Summary	▬	External Milestone	◆		

The Washington County Regional Medical Center Detailed Schedule

ID	Task Name	Duration	Start	Finish
126	Install Masonry Admitting / Ambulatory	5 days	Fri 4/24/09	Thu 4/30/09
112	Curtainwall East Tower	15 days	Wed 4/29/09	Tue 5/19/09
131	Install Masonry Emergency	20 days	Wed 4/29/09	Tue 5/26/09
113	Install Roofing East Tower	15 days	Wed 5/6/09	Tue 5/26/09
114	Windows East Tower	4 days	Fri 5/8/09	Wed 5/13/09
122	Windows Admin. Link	4 days	Fri 5/8/09	Wed 5/13/09
127	Windows Admitting / Ambulatory	4 days	Tue 5/12/09	Fri 5/15/09
128	Install Roofing Admitting / Ambulatory	20 days	Fri 5/15/09	Thu 6/11/09
132	Windows Emergency	4 days	Fri 6/5/09	Wed 6/10/09
123	Install Roofing Admin. Link	4 days	Fri 6/19/09	Wed 6/24/09
133	Install Roofing Emergency	8 days	Tue 6/23/09	Thu 7/2/09
134	Building Enclosure	0 days	Thu 7/2/09	Thu 7/2/09
140	**Interiors**	**437 days**	**Fri 12/19/08**	**Mon 8/23/10**
144	Erect Partitions South Tower	160 days	Fri 12/19/08	Thu 7/30/09
148	Erect Partitions West Tower	148 days	Tue 1/6/09	Thu 7/30/09
160	Set Equipment Service Building	30 days	Wed 1/14/09	Tue 2/24/09
154	Erect Partitions East Tower	148 days	Tue 1/27/09	Thu 8/20/09
164	Erect Partitions Link	7 days	Fri 1/30/09	Mon 2/9/09
170	Erect Partitions Emergency	15 days	Wed 2/4/09	Tue 2/24/09
177	Erect Partitions Admitting / Ambulatory	16 days	Wed 2/11/09	Wed 3/4/09
184	Erect Partitions Surgery	15 days	Wed 2/18/09	Tue 3/10/09
161	Rough-In Mechanical Piping and Duct Service Building	130 days	Wed 2/25/09	Tue 8/25/09
143	Rough-In Mechanical Piping and Duct South Tower	208 days	Fri 3/6/09	Tue 12/22/09
149	Rough-In Mechanical Piping and Duct West Tower	110 days	Tue 3/31/09	Mon 8/31/09
155	Rough-In Mechanical Piping and Duct East Tower	110 days	Mon 4/6/09	Fri 9/4/09
165	Rough-In Mechanical Piping and Duct Link	96 days	Mon 4/13/09	Mon 8/24/09
171	Rough-In Mechanical Piping and Duct Emergency	101 days	Mon 4/20/09	Mon 9/7/09
141	Install Bus Riser, Conduit, and Elec. Panels South Tower	65 days	Fri 4/24/09	Thu 7/23/09
178	Rough-In Mechanical Piping and Duct Admitting / Ambulatory	100 days	Mon 4/27/09	Fri 9/11/09
185	Rough-In Mechanical Piping and Duct Surgery	101 days	Mon 5/4/09	Mon 9/21/09
142	Install Elevators Core	196 days	Mon 5/25/09	Mon 2/22/10
162	Install Feeders, Conduit, and Elec. Panels Service Building	45 days	Wed 6/3/09	Tue 8/4/09

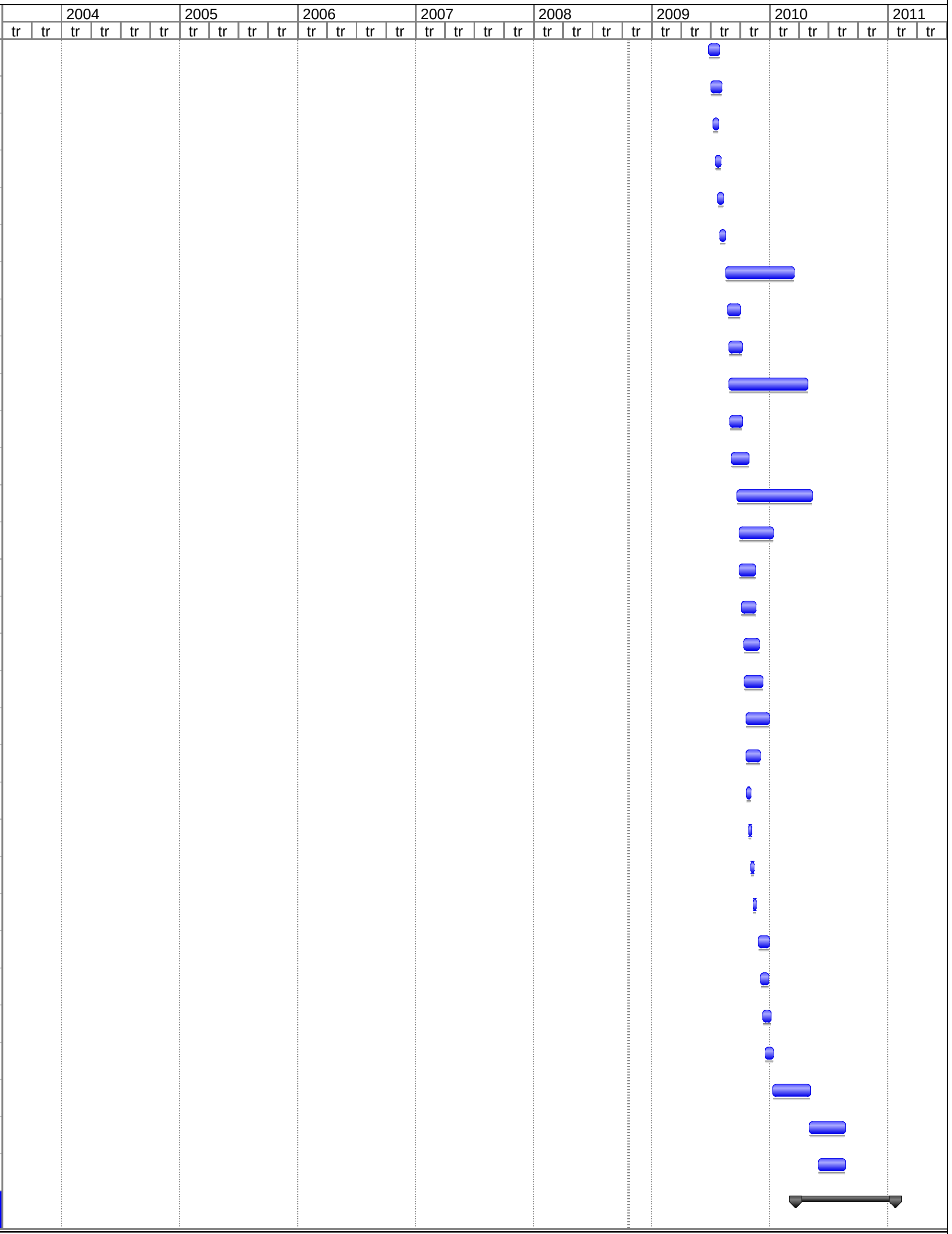


Project: Detailed Schedule.mpp
Date: Sun 10/19/08

Task	▬	Progress	▬	Summary	▬	External Tasks	▬	Deadline	⇩
Split	┅	Milestone	◆	Project Summary	▬	External Milestone	◆		

The Washington County Regional Medical Center Detailed Schedule

ID	Task Name	Duration	Start	Finish
150	Install Feeders, Conduit, and Elec. Panels West Tower	25 days	Fri 6/26/09	Thu 7/30/09
156	Install Feeders, Conduit, and Elec. Panels East Tower	25 days	Fri 7/3/09	Thu 8/6/09
166	Install Feeders, Conduit, and Elec. Panels Link	12 days	Fri 7/10/09	Mon 7/27/09
172	Install Feeders, Conduit, and Elec. Panels Emergency	12 days	Fri 7/17/09	Mon 8/3/09
179	Install Feeders, Conduit, and Elec. Panels Admitting / Ambulatory	13 days	Fri 7/24/09	Tue 8/11/09
186	Install Feeders, Conduit, and Elec. Panels Surgery	12 days	Fri 7/31/09	Mon 8/17/09
147	Ceilings, Floor, Paint South Tower	153 days	Tue 8/18/09	Thu 3/18/10
146	Lighting South Tower	30 days	Mon 8/24/09	Fri 10/2/09
145	GRD South Tower	30 days	Fri 8/28/09	Thu 10/8/09
151	Ceilings, Floor, Paint West Tower	175 days	Fri 8/28/09	Thu 4/29/10
152	Lighting West Tower	30 days	Mon 8/31/09	Fri 10/9/09
153	GRD West Tower	40 days	Fri 9/4/09	Thu 10/29/09
157	Ceilings, Floor, Paint East Tower	168 days	Tue 9/22/09	Thu 5/13/10
163	Ceilings, Floor, Paint Service Building	76 days	Tue 9/29/09	Tue 1/12/10
167	Ceilings, Floor, Paint Link	37 days	Tue 9/29/09	Wed 11/18/09
173	Ceilings, Floor, Paint Emergency	33 days	Tue 10/6/09	Thu 11/19/09
180	Ceilings, Floor, Paint Admitting / Ambulatory	35 days	Tue 10/13/09	Mon 11/30/09
158	Lighting East Tower	43 days	Wed 10/14/09	Fri 12/11/09
159	GRD East Tower	53 days	Tue 10/20/09	Thu 12/31/09
187	Ceilings, Floor, Paint Surgery	33 days	Tue 10/20/09	Thu 12/3/09
168	Lighting Link	11 days	Wed 10/21/09	Wed 11/4/09
174	Lighting Emergency	8 days	Wed 10/28/09	Fri 11/6/09
181	Lighting Admitting / Ambulatory	8 days	Wed 11/4/09	Fri 11/13/09
188	Lighting Surgery	8 days	Wed 11/11/09	Fri 11/20/09
169	GRD Link	25 days	Fri 11/27/09	Thu 12/31/09
175	GRD Emergency	18 days	Fri 12/4/09	Tue 12/29/09
182	GRD Admitting / Ambulatory	18 days	Fri 12/11/09	Tue 1/5/10
189	GRD Surgery	18 days	Fri 12/18/09	Tue 1/12/10
176	Specialty Finishes Emergency	85 days	Mon 1/11/10	Fri 5/7/10
183	Specialty Finishes Admitting / Ambulatory	80 days	Tue 5/4/10	Mon 8/23/10
190	Specialty Finishes Surgery	60 days	Tue 6/1/10	Mon 8/23/10
191	**Commissioning**	**221 days**	**Tue 3/23/10**	**Tue 1/25/11**

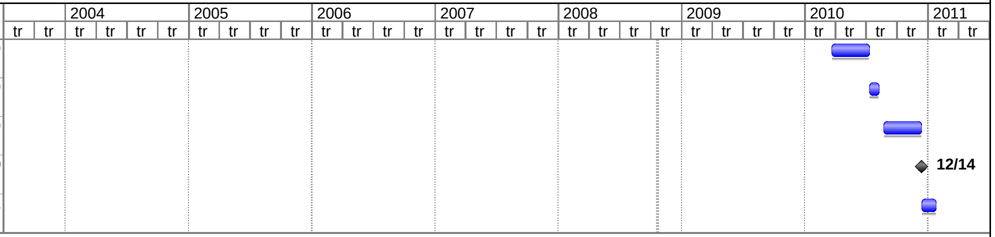


Project: Detailed Schedule.mpp
Date: Sun 10/19/08

Task	▬	Progress	▬	Summary	▬	External Tasks	▬	Deadline	⇩
Split	┈	Milestone	◆	Project Summary	▬	External Milestone	◆		

The Washington County Regional Medical Center Detailed Schedule

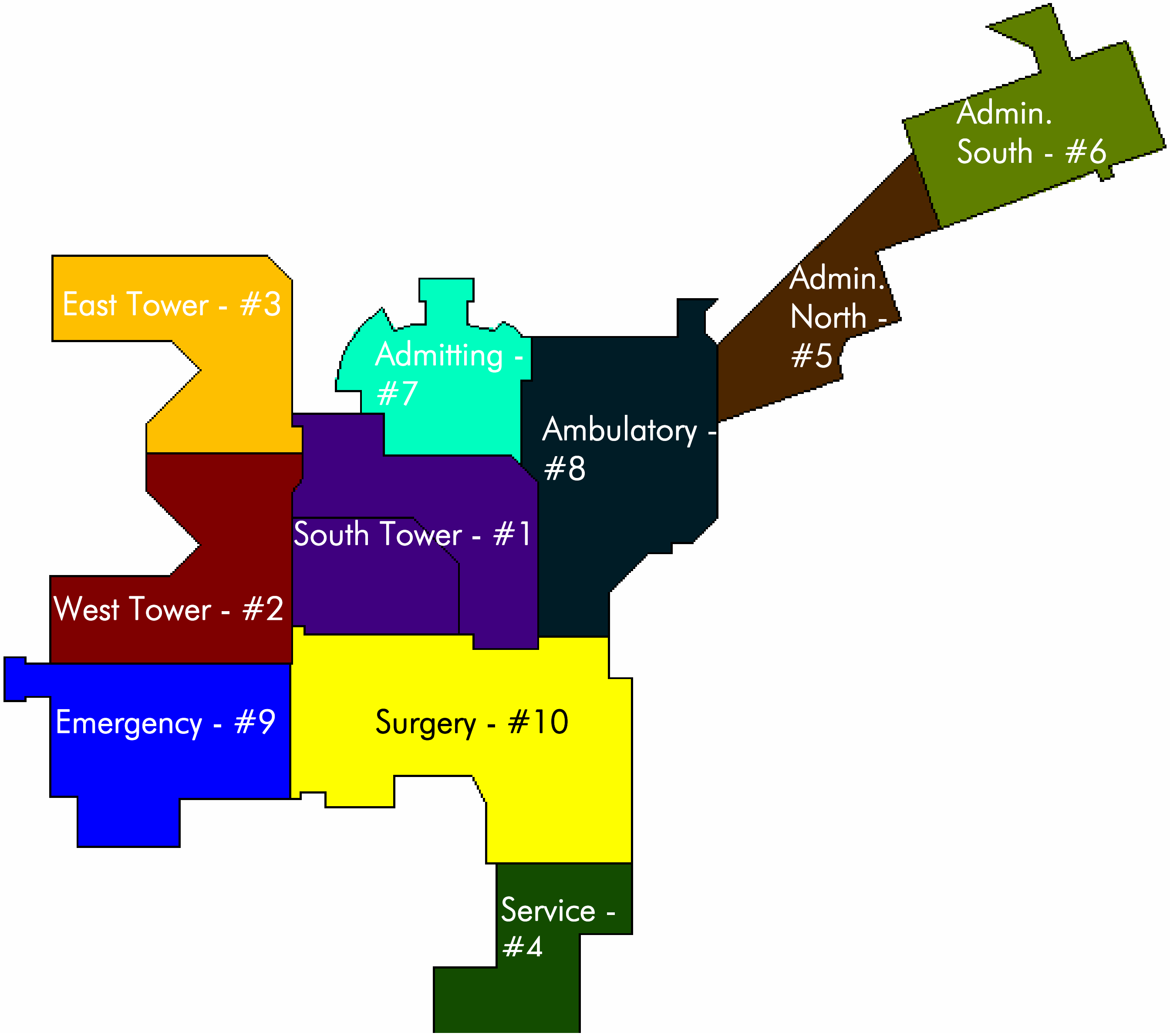
ID	Task Name	Duration	Start	Finish
192	Pre-Commissioning	80 days	Tue 3/23/10	Mon 7/12/10
193	Start Up	20 days	Tue 7/13/10	Mon 8/9/10
194	Testing / Balancing and Commissioning	80 days	Tue 8/24/10	Mon 12/13/10
195	Substantial Completion	0 days	Tue 12/14/10	Tue 12/14/10
196	Owner Move-In	30 days	Wed 12/15/10	Tue 1/25/11



Task
Split
Progress
Milestone ◆
Summary
Project Summary
External Tasks
External Milestone ◆
Deadline ⇩

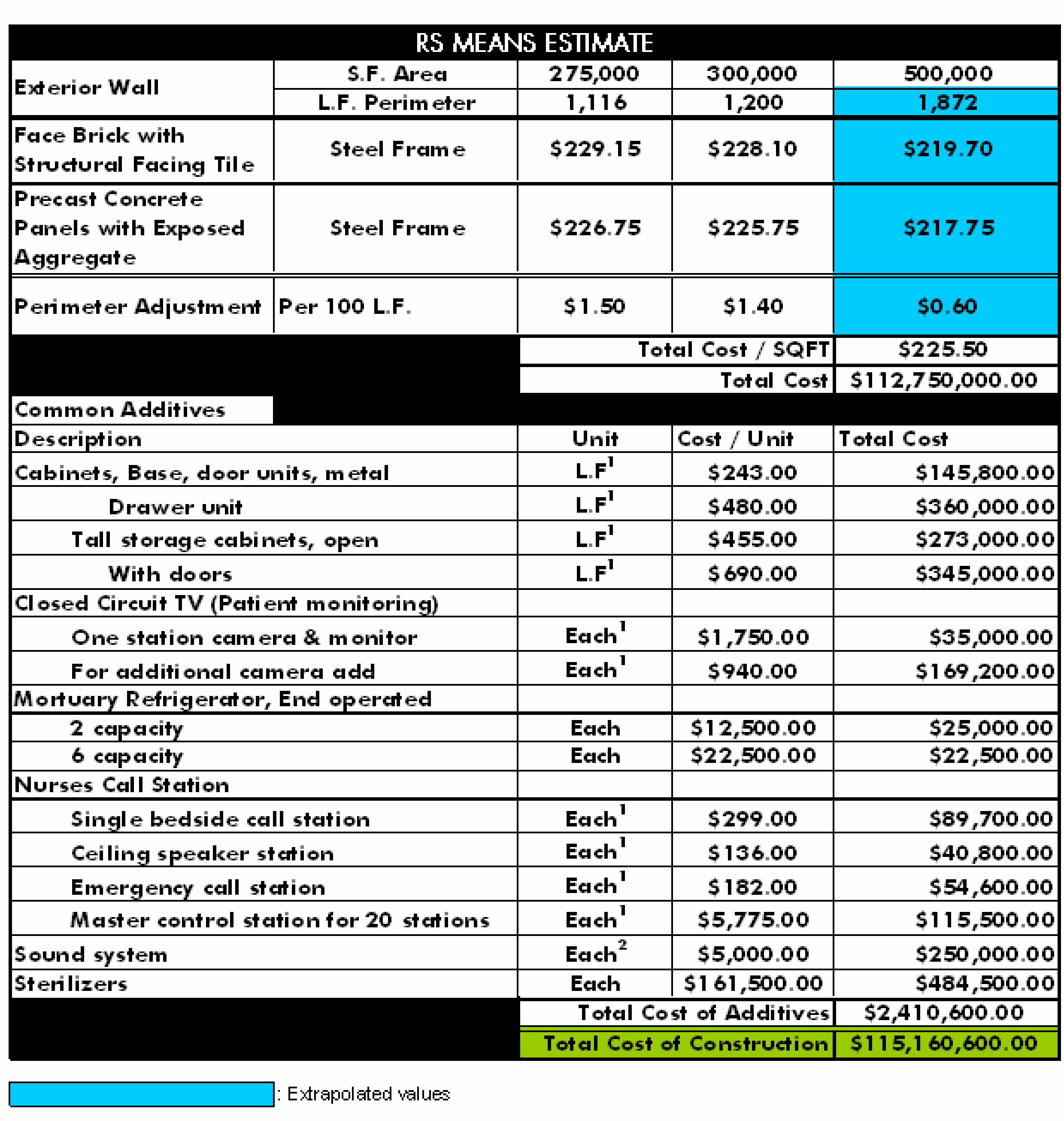
Appendix D:

Sequencing Diagram


Admin.
South - #6
Admin.
North -
#5
East Tower - #3
Admitting -
#7
Ambulatory -
#8
South Tower - #1
West Tower - #2
Emergency - #9
Surgery - #10
Service -
#4

Appendix E:

R.S. Means Square Foot Cost Estimate



RS MEANS ESTIMATE				
Exterior Wall	S.F. Area	275,000	300,000	500,000
	L.F. Perimeter	1,116	1,200	1,872
Face Brick with Structural Facing Tile	Steel Frame	$229.15	$228.10	$219.70
Precast Concrete Panels with Exposed Aggregate	Steel Frame	$226.75	$225.75	$217.75
Perimeter Adjustment	Per 100 L.F.	$1.50	$1.40	$0.60
			Total Cost / SQFT	$225.50
			Total Cost	$112,750,000.00
Common Additives				
Description		Unit	Cost / Unit	Total Cost
Cabinets, Base, door units, metal		L.F[1]	$243.00	$145,800.00
Drawer unit		L.F[1]	$480.00	$360,000.00
Tall storage cabinets, open		L.F[1]	$455.00	$273,000.00
With doors		L.F[1]	$690.00	$345,000.00
Closed Circuit TV (Patient monitoring)				
One station camera & monitor		Each[1]	$1,750.00	$35,000.00
For additional camera add		Each[1]	$940.00	$169,200.00
Mortuary Refrigerator, End operated				
2 capacity		Each	$12,500.00	$25,000.00
6 capacity		Each	$22,500.00	$22,500.00
Nurses Call Station				
Single bedside call station		Each[1]	$299.00	$89,700.00
Ceiling speaker station		Each[1]	$136.00	$40,800.00
Emergency call station		Each[1]	$182.00	$54,600.00
Master control station for 20 stations		Each[1]	$5,775.00	$115,500.00
Sound system		Each[2]	$5,000.00	$250,000.00
Sterilizers		Each	$161,500.00	$484,500.00
			Total Cost of Additives	$2,410,600.00
			Total Cost of Construction	$115,160,600.00

🟦 : Extrapolated values

---

[1] Estimated Quantities

[2] Sound system was not comparable; used other information to calculate

Appendix F:

General Conditions Estimate

Washington County Regional Medical Center

General Conditions Estimate

Description	Quantity	Unit	Rate	Total
Drawings				
Bid Set Reproduction and Distribution	1	Est.	50,000	50,000
Field Office				
Trailer Complex	33	Mo.	5,200	171,600
Trailer Complex Set-Up and Removal	1	Est.	40,000	40,000
Electric, Water, Sewer Connection Cost	1	Est.	10,000	10,000
Water and Sewer Charges	33	Mo.	3,000	99,000
Electric Consumption	33	Mo.	750	24,750
Security System	1	LS	2,000	2,000
Fire Extinguisher	8	Ea.	100	800
Janitorial Service	33	Mo.	800	26,400
Maintenance and Repair	33	Mo.	250	8,250
Field Office Equipment				
Copy Machine	33	Mo.	1,000	33,000
Digital Camera & Software	1	Ea.	600	600
Fax Machine	2	Ea.	400	800
Furniture	15	Start	1,000	15,000
Mailing	33	Mo.	75	2,480
PC/Printers	33	Mo.	1,236	40,800
Computer Network Server and Wiring	1	Ea.	12,000	12,000
Telephone System	17	Start	1,200	20,400
TV, DVD, & DVD's	1	Ea.	700	700
Field Office Expenses				
Construction Signage	1	Est.	600	600
Software	40	Ea.	650	26,000
Internet	33	Mo.	1,000	33,000
First Aid Supplies	2	LS	1,500	3,000
Miscellaneous Blueprinting	33	Mo.	750	24,750
Shipping & Express	33	Mo.	750	24,750
Stationary, Paper, & Supplies	33	Mo.	1,540	50,820
Cell Phones	33	Mo.	1,240	40,920
Job Travel Expense				
Travel	33	Mo.	3,000	99,000
Vehicles	214	Mo.	500	107,000
Vehicles Fuel & Maintenance	214	Mo.	450	96,300
Temporary Facilities / Chemical Toilets				

Chemical Toilets - Avg. 8 for entire length of job - @20 each = 160 avg. daily	290	Mo.	125	36,250
Storage Trailers and Tool Rooms	24	Mo.	335	8,040
Project Signage	1	Est.	20,000	20,000
Layout / Engineering				
Layout and Engineering - 15 days	120	Hr.	116	13,920
Line and Grade Updates - 60 days	480	Hr.	116	55,680
Temporary Construction / Safety				
First Aid Kits	3	Ea.	1,200	3,600
Material Hoist	15	Mo.	6,500	97,500
Fire Extinguishers	22	Est.	150	3,300
Safety Incentives	3	Est.	5,000	15,000
Temporary Dust Partitions	1	Est.	20,000	20,000
Temporary Elevator Operator	3,248	Hr.	26	84,440
Trash Chutes	45	Mo.	2,800	126,000
Temporary Fencing				
Removable Fence	5,000	Lf.	12	60,000
Double Gate	2	Ea.	300	600
Personnel Gate	2	Ea.	250	500
Project Clean-Up				
Dumpster Service	810	Ea.	500	405,000
Dumpster Pulls	33	Mo.	350	11,550
Rough Clean-Up	8,330	MnHr.	26	216,580
Final Clean-Up	510,000	S.F.	0.15	76,500
Clean Exterior Windows	50,000	S.F.	0.35	17,500
Snow Removal	3	Ea.	3,500	10,500
Miscellaneous Tools				
Small Tools and Supplies	33	Mo.	1,000	33,000
Temporary Power and Sewer				
Temporary Power	By Owner			
Temporary Sewer	By Owner			
Temporary Heat	5	Est.	10,000	50,000
Project Staffing				
Site Personnel				
Project Executive	4,840	Hr.	115	556,600
Project Manager	6,080	Hr.	90	547,200
General Superintendent	5,440	Hr.	125	680,000
Site Superintendent	5,280	Hr.	75	396,000
Structural Superintendent	5,120	Hr.	90	460,800
MEP Superintendent	3,200	Hr.	85	272,000
MEP Superintendent	4,800	Hr.	95	456,000

Interiors Superintendent	3,040	Hr.	85	258,400
Project Engineer - Structural	6,240	Hr.	60	374,400
Project Engineer - MEP	5,120	Hr.	75	384,000
Project Engineer - Interiors	4,160	Hr.	55	228,800
Administrative Assistant	5,440	Hr.	30	163,200
Office Personnel				
Project Principal	64	Hr.	200	12,800
Safety Engineer	296	Hr.	100	29,600
Estimating Department	64	Hr.	115	7,360
Scheduling Manager	428	Hr.	175	74,900
Purchasing Department	572	Hr.	115	65,780
Cost / Accounting Department	1,768	Hr.	110	194,480
Manager of Quality / Engineering	232	Hr.	130	30,160
	Total General Conditions Costs			**7,622,660**

Appendix G:

Develop to Sell Residual Analysis

DEVELOP TO SELL RESIDUAL ANALYSIS

Development Costs			
Development Period:			
Approvals / Preconstruction	6 months		
Construciton	12 months		
Construction Cost Escalation	4% per annum		
Building Costs			
	# of Beds	Rate	Cost
Nursing Home	274	$109,489	$29,999,986
Construction Costs at April 2009			$29,999,986
Cost Escalation Prior to Construction			$450,000
	Sub-Total		$30,449,986
Cost Escalation During Construction			$609,000
Total Construction Costs at Completion			$31,058,986
Consultants' Fees @ 11%			$3,416,488
Total Design and Construction Costs			**$34,475,474**
Development Returns			
Efficiency Rate	75%		
	# of Beds	Rent	Cost
Nursing Home	206	$78,480	$16,166,880
	Gross Rent		$16,166,880
	Capitalization Rate		12.75%
Gross Returns / Sale Price			**$126,799,059**
Less the Following:			
Marketing/Advertising		1%	$1,255,436
			$125,543,623

	Agents Commission	1.50%	$1,855,324
			$123,688,298
	Legals	5%	$5,889,919
			$117,798,379
	Vacancies	25%	$23,559,676
			$94,238,703
		Net Proceeds	**$94,238,703**
		Gross Residual Value	**$59,763,229**
	Less Interest Holding Charges	2%	$1,171,828
			$58,591,401
	Less Taxes	1.858%	$1,068,770
			$57,522,631
		Net Residual Value is:	**$57,522,631**

Appendix H:

Develop to Run Discounted Cash Flow

DEVELOP TO RUN DISCOUNTED CASH FLOW

Construciton Costs	$34,475,474
Initial Net Income	$16,166,880
Initial Cap. Rate	12.75%
Reversionary Cap Rate	13%
Growth	1.5%
Market Reviews	2 yearly
Refurbishment Cost	$10,000,000
Effeciency Rate	75%

Year	Construction Costs	Growth (%)	Income	Room Rate	Refurb Cost	Growth (%)	Operating Costs	Sale Price	Net Cash Flow	PV Factor	Discounted Cash Flow	PV Factor	Discounted Cash Flow
										30%		35%	
0	-$34,475,474	0							-$34,475,474	1	-$34,475,474	1	-$34,475,474
1		1.5%	$16,166,880	$16,166,880		0	6,951,758		$9,215,122	0.7693	$7,089,193	0.7408	$6,826,562
2		1.5%	$16,409,383	$16,166,880		1.5%	6,951,758		$9,215,122	0.5918	$5,453,509	0.5487	$5,056,337
3		1.5%	$16,655,524	$16,655,524		1.5%	7,056,035		$9,599,489	0.4552	$4,369,687	0.4065	$3,902,192
4		1.5%	$16,905,357	$16,655,524		1.5%	7,161,875		$9,493,649	0.3502	$3,324,676	0.3011	$2,858,538
5		1.5%	$17,158,937	$17,158,937	$10,000,000	1.5%	7,269,303		-$110,366	0.2694	-$29,733	0.2231	-$24,623
6		1.5%	$17,416,321	$17,158,937		1.5%	7,378,343		$9,780,594	0.2072	$2,026,539	0.1652	$1,615,754
7		1.5%	$17,677,566	$17,677,566		1.5%	7,489,018		$10,188,548	0.1594	$1,624,055	0.1224	$1,247,078
8		1.5%	$17,942,730	$17,677,566		1.5%	7,601,353		$10,076,213	0.1226	$1,235,344	0.0907	$913,912
9		1.5%	$18,211,870	$18,211,870		1.5%	7,715,374		$10,496,497	0.0943	$989,820	0.0672	$705,365
10		1.5%	$18,485,049	$18,211,870		1.5%	7,831,104	$144,325,571	$154,706,337	0.0726	$11,231,680	0.0498	$7,704,376
11			$18,762,324										
										NPV	$2,839,296		-$3,669,982
									IRR	**32%**			

Appendix I:

Partially Develop to Run Discounted Cash Flow

PARTIALLY DEVELOP TO RUN DISCOUNTED CASH FLOW

Construciton Costs	$18,747,612
Initial Net Income	$8,318,880
Initial Cap. Rate	12.75%
Reversionary Cap Rate	13%
Growth	1.5%
Market Reviews	2 yearly
Refurbishment Cost	$5,400,000
Effeciency Rate	85%

Year	Construction Costs	Growth (%)	Market Rent	Lease Rent	Refurb Cost	Growth (%)	Operating Costs	Sale Price	Net Cash Flow	PV Factor	Discounted Cash Flow	PV Factor	Discounted Cash Flow
										30%		35%	
0	-$18,747,612	0							-$18,747,612	1	-$18,747,612	1	-$18,747,612
1		1.5%	$8,318,880	$8,318,880		0	3,577,118		$4,741,762	0.7693	$3,647,837	0.7408	$3,512,697
2		1.5%	$8,443,663	$8,318,880		1.5%	3,577,118		$4,741,762	0.5918	$2,806,175	0.5487	$2,601,805
3		1.5%	$8,570,318	$8,570,318		1.5%	3,630,775		$4,939,543	0.4552	$2,248,480	0.4065	$2,007,924
4		1.5%	$8,698,873	$8,570,318		1.5%	3,685,237		$4,885,081	0.3502	$1,710,755	0.3011	$1,470,898
5		1.5%	$8,829,356	$8,829,356	$5,400,000	1.5%	3,740,515		-$311,159	0.2694	-$83,826	0.2231	-$69,420
6		1.5%	$8,961,796	$8,829,356		1.5%	3,796,623		$5,032,733	0.2072	$1,042,782	0.1652	$831,407
7		1.5%	$9,096,223	$9,096,223		1.5%	3,853,572		$5,242,651	0.1594	$835,679	0.1224	$641,700
8		1.5%	$9,232,667	$9,096,223		1.5%	3,911,376		$5,184,847	0.1226	$635,662	0.0907	$470,266
9		1.5%	$9,371,157	$9,371,157		1.5%	3,970,047		$5,401,110	0.0943	$509,325	0.0672	$362,955
10		1.5%	$9,511,724	$9,371,157		1.5%	4,029,597	$74,264,614	$79,606,174	0.0726	$5,779,408	0.0498	$3,964,387
11			$9,654,400										
										NPV	$384,665		-$2,952,992
									IRR	**31%**			

Appendix J:

Develop to Lease

DEVELOP TO LEASE DISCOUNTED CASH FLOW

Year	Construction Price	Growth (%)	Income	Room Rate	Refurb Cost	Sale Price	Net Cash Flow	PV Factor	Discounted Cash Flow	PV Factor	Discounted Cash Flow
								20%		30%	
0	-$34,475,474	0					-$34,475,474	1	-$34,475,474	1	-$34,475,474
1		1.5%	$7,832,853	$7,832,853			$7,832,853	0.8334	$6,527,900	0.7693	$6,025,814
2		1.5%	$7,950,346	$7,832,853			$7,832,853	0.6945	$5,439,916	0.5918	$4,635,482
3		1.5%	$8,069,601	$8,069,601			$8,069,601	0.5788	$4,670,685	0.4552	$3,673,282
4		1.5%	$8,190,645	$8,069,601			$8,069,601	0.4823	$3,891,969	0.3502	$2,825,974
5		1.5%	$8,313,505	$8,313,505	$10,000,000		-$1,686,495	0.4019	-$677,802	0.2694	-$454,342
6		1.5%	$8,438,207	$8,313,505			$8,313,505	0.3349	$2,784,193	0.2072	$1,722,558
7		1.5%	$8,564,780	$8,564,780			$8,564,780	0.2791	$2,390,430	0.1594	$1,365,226
8		1.5%	$8,693,252	$8,564,780			$8,564,780	0.2326	$1,992,168	0.1226	$1,050,042
9		1.5%	$8,823,651	$8,823,651			$8,823,651	0.1939	$1,710,906	0.0943	$832,070
10		1.5%	$8,956,006	$8,823,651		$69,925,736	$78,749,387	0.1616	$12,725,901	0.0726	$5,717,205
11			$9,090,346								
								NPV	$6,980,791		-$7,082,161
							IRR	25%			

Appendix K:

Detailed Cost Comparison:

Minipiles vs. Caissons

CAISSONS

Drilling and Excavating

Item	Quantity (CY)	Labor ($)	Material ($)	Equipment ($)	Total
Caissons					
Earth Auger	232.33	$15,758.67	$2,675.13	$17,810.05	$36,243.84
Rock Auger	3.06	$1,106.97	$187.91	$1,251.07	$2,545.95
Rock Core	842.11	$685,431.73	$116,356.29	$774,657.66	$1,576,445.68
Pier Caps	165.15	$627.57	———	$369.94	$997.51
Total	1242.65	$702,924.93	$119,219.34	$794,088.71	$1,616,232.98

Reinforcement

Item	Quantity (lbs)	Labor ($)	Material ($)	Equipment ($)	Total
Caissons	95384.27	$43,876.76	$46,738.29	———	$90,615.06
Pier Caps	895.69	$412.02	$438.89	———	$850.91
Total	96279.96	$44,288.78	$47,177.18	———	$91,465.96

Cast-In-Place Concrete

Item	Quantity (CY)	Labor ($)	Material ($)	Equipment ($)	Total
Caissons	1077.50	$10,936.63	$112,060.00	$3,491.10	$126,487.73
Pier Caps	165.15	$1,676.27	$17,175.60	$535.09	$19,386.96
Total	1242.65	$12,612.90	$129,235.60	$4,026.19	$145,874.68
	Grand Totals	**$759,826.61**	**$295,632.12**	**$798,114.90**	**$1,853,573.62**

MININPILES

Drilling and Excavating

Item	Quantity (CY)	Labor ($)	Material ($)	Equipment ($)	Total
Mininpiles					
Earth Auger	63.06	$4,112.77	$698.17	$4,648.15	$9,459.09
Rock Auger	1.00	$283.92	$48.20	$320.88	$653.01
Rock Core	725.4	$512,531.37	$87,005.38	$579,250.04	$1,178,786.79
Caps	166.67	$633.35	———	$373.34	$1,006.69
Total	956.13	$517,561.41	$87,751.75	$584,592.41	$1,189,905.58

Reinforcement

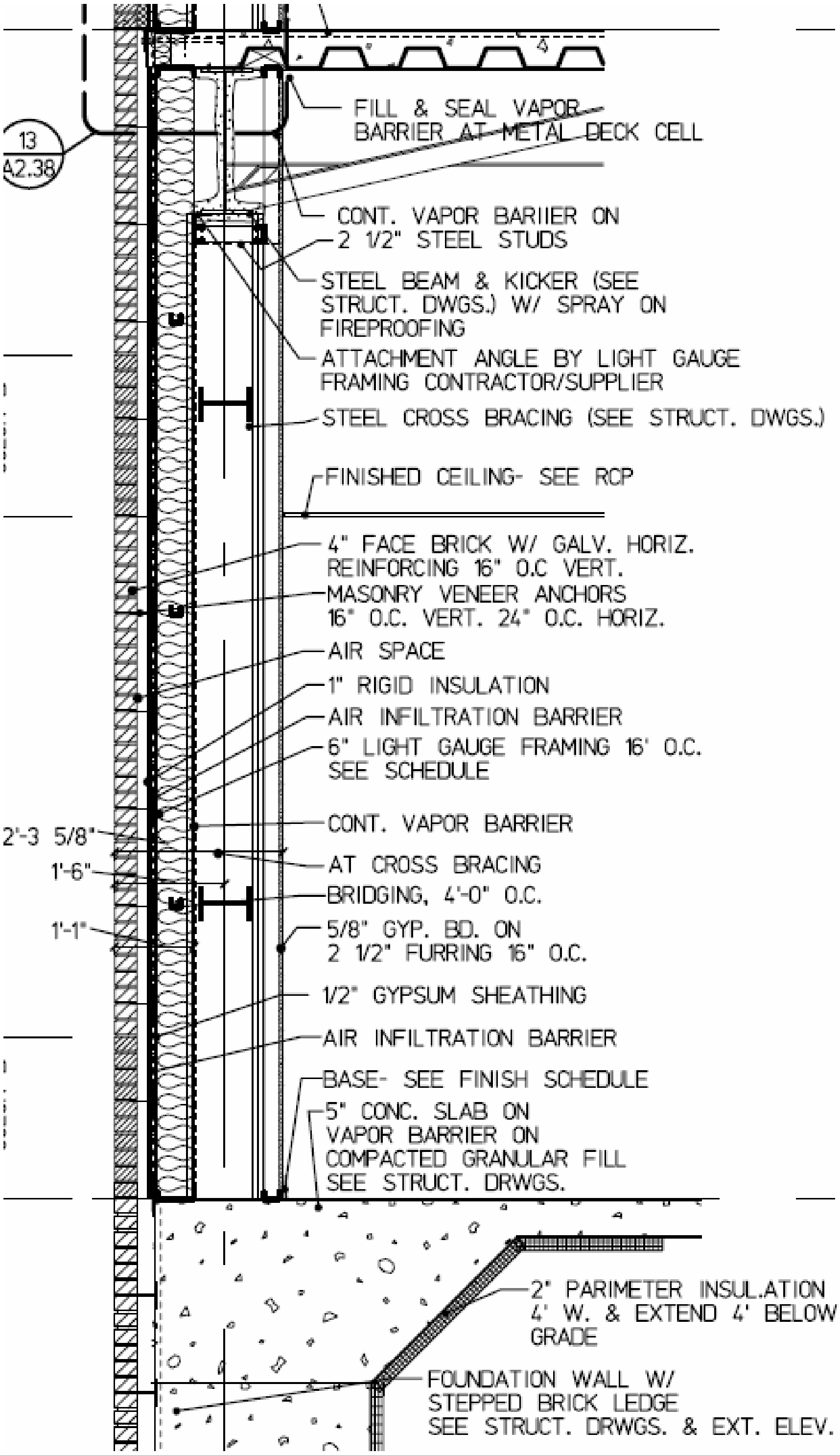
Item	Quantity	Labor ($)	Material ($)	Equipment ($)	Total
Casings (#)	532	$79.80	$91,504.00	———	$91,583.80
Caps (lbs)	895.69	$412.02	$438.89	———	$850.91
Total	1427.69	$491.82	$91,942.89	———	$92,434.71

Cast-In-Place Concrete

Item	Quantity (CY)	Labor ($)	Material ($)	Equipment ($)	Total
Mininpiles	62.89	$638.33	$6,540.56	$203.76	$7,382.66
Caps	166.67	$1,691.70	$17,333.68	$540.01	$19,565.39
Total	229.56	$2,330.03	$23,874.24	$743.77	$26,948.05
	Grand Totals	**$520,383.27**	**$203,568.88**	**$585,336.19**	**$1,309,288.33**

Appendix L:

Brick Cavity Wall Section

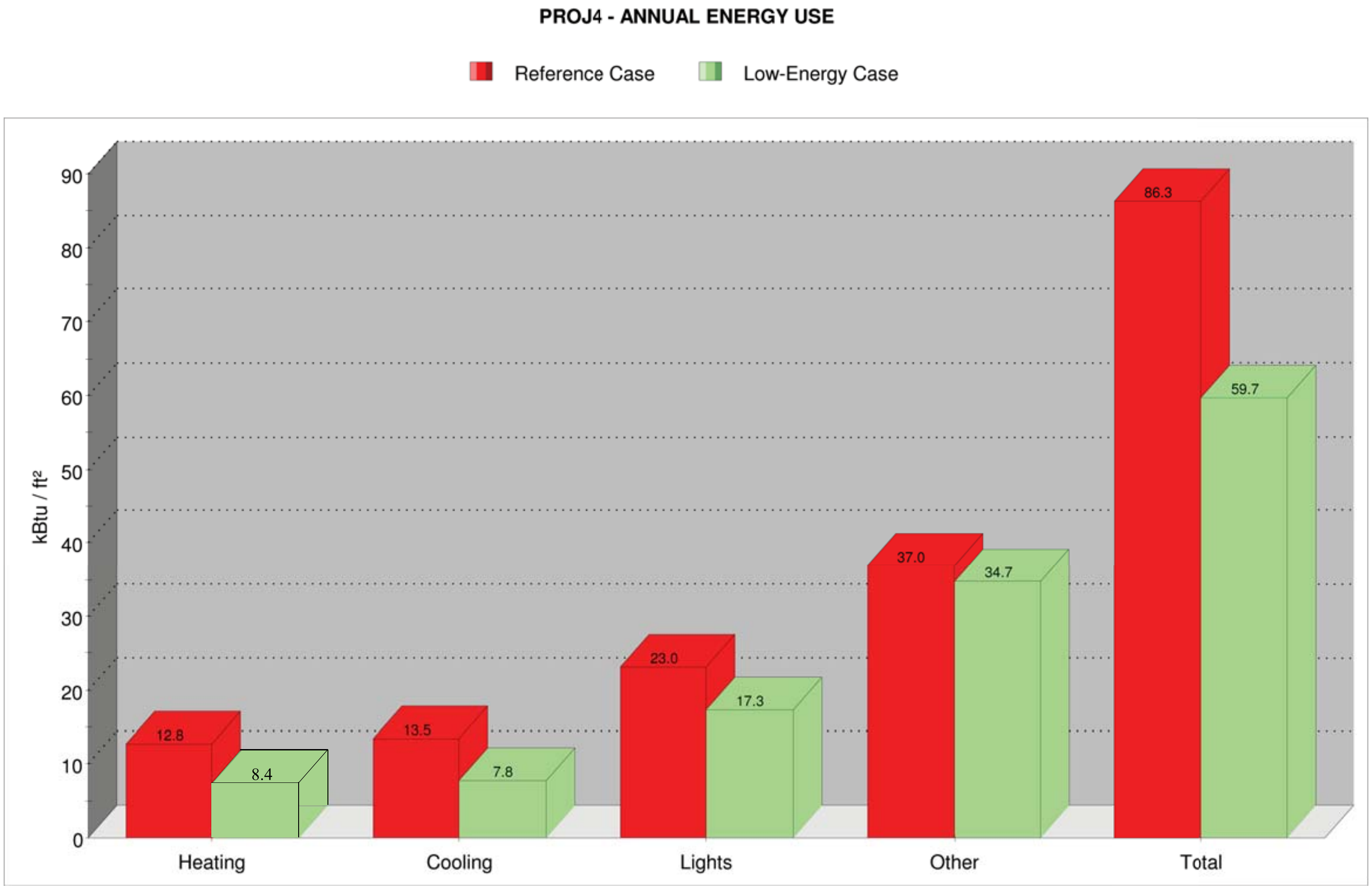


Source: The Washington County Regional Medical Center Drawings.
Note: NTS

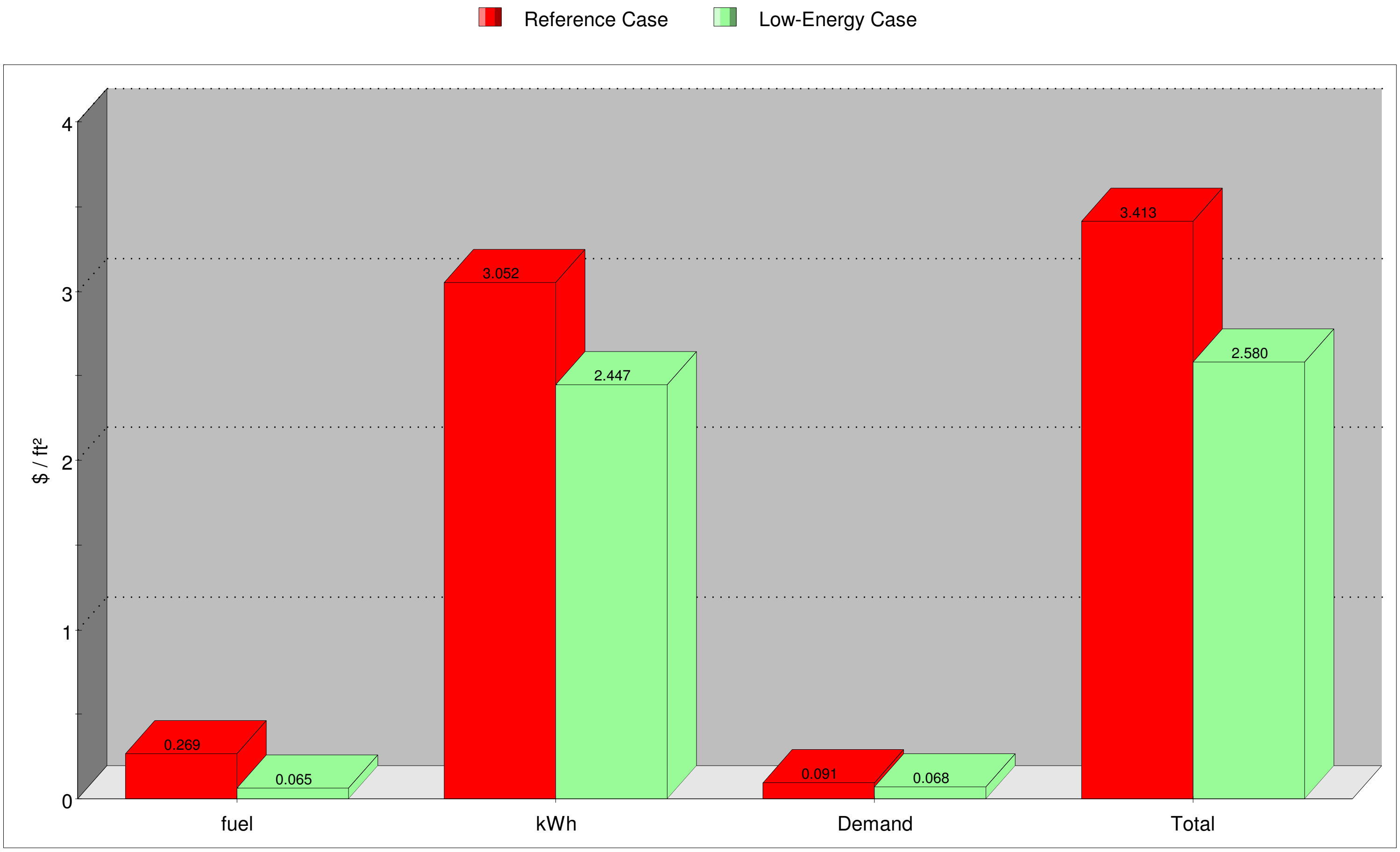
Appendix M:

Energy 10 Analysis Graphs:

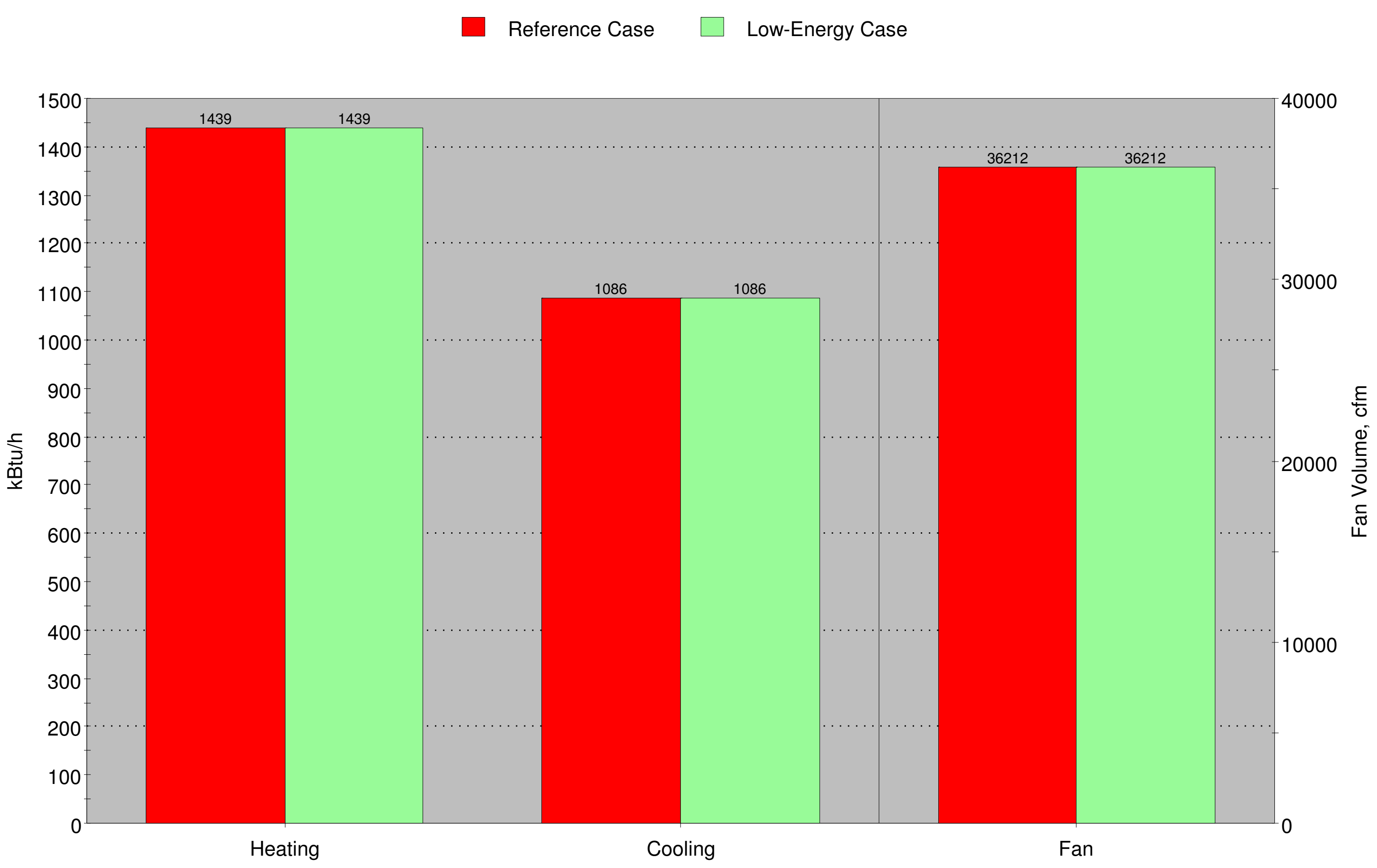
Annual Energy Use
Annual Energy Costs
HVAC Capacities
Life Cycle Costs


PROJ4 - ANNUAL ENERGY USE
Reference Case
Low-Energy Case
kBtu / ft²
0
10
20
30
40
50
60
70
80
90
12.8
8.4
13.5
7.8
23.0
17.3
37.0
34.7
86.3
59.7
Heating
Cooling
Lights
Other
Total

PROJ4 - ANNUAL ENERGY COST



HVAC Rated Capacities



```
   Cost Summary Report

   Scheme Name:                  Reference Case Low-Energy Case   Difference
   Construction                  5742299.81     6718411.28   -976111.46
    fixed                        5431800.00     5431800.00         0.00
    EE strategies                      0.00      910477.21   -910477.21
    HVAC installation             310499.81      376134.06    -65634.25
   Mortgage payment               526814.00      616364.00    -89550.00
   HVAC replacement               232874.86      282100.55    -49225.69
   Annual fuel                      9749.22        2350.53      7398.69
   Annual electric                113837.26       91064.70     22772.56
   Annual maintenance              18106.00       18106.00         0.00

   Life Cycle Cost Results       Reference Case Low-Energy Case   NetPresentValue
    capital                         1121147        1311726      -190579
    property taxes                   414577         485050       -70473
    mortgage                        5423537        6345463      -921926
    utilities                       5629950        4282459      1347491
    maintenance                      653600         653600            0
    HVAC replacement                 405328         491008       -85680
    tax deductions                 -3834202       -3742325       -91877
   Life-Cycle Cost                  9813937        9826981       -13044

   Internal Rate of Return, IRR,                           5.927%
   Simple Payback, years                                    0.00

   Benefit / Cost Ratio                                     0.99


Financial Parameters
   Year of Construction                                2005
   Building life, yr                                     60
   Salvage value, % of original                       10.00
   Annual property tax,  % of value                    0.20
   Property tax escalation rate, %                     4.00
   Fuel cost escalation rate, %                        4.50
   Electric cost escalation rate, %                    5.00
   Maintenance cost escalation rate, %                 4.00
   Building resale escalation rate, %                  4.00
   HVAC replacement cost escalation rate, %            4.00
   HVAC replacement cycle                                15
   Discount rate, %                                    6.00
   Mortgage?                                            yes
    mortgage term, yr                                    15
    mortgage interest, %                               8.00
    down payment, %                                   20.00
   Tax deductible?
    property taxes                                      yes
    loan interest                                       yes
    utilities                                           yes
    maintenance                                         yes
    HVAC upgrade                                        yes
    depreciation                                        yes
    straight line depreciation period, yr                31
    incremental tax bracket, %                        31.00
```

Appendix N:

Partially Develop to Run Discounted Cash Flow with Savings

PARTIALLY DEVELOP TO RUN DISCOUNTED CASH FLOW WITH SAVINGS

Construciton Costs	$17,999,573
Initial Net Income	$8,318,880
Initial Cap. Rate	12.75%
Reversionary Cap Rate	13%
Growth	1.5%
Market Reviews	2 yearly
Refurbishment Cost	$5,400,000
Effeciency Rate	85%

Year	Construction Costs	Growth (%)	Market Rent	Lease Rent	Refurb Cost	Growth (%)	Operating Costs	Annual Energy Savings	Sale Price	Net Cash Flow	PV Factor	Discounted Cash Flow	PV Factor	Discounted Cash Flow
											30%		35%	
0	-$17,999,573	0								-$17,999,573	1	-$17,999,573	1	-$17,999,573
1		1.5%	$8,318,880	$8,318,880		0	3,577,118	465,025		$5,206,787	0.7693	$4,005,581	0.7408	$3,857,188
2		1.5%	$8,443,663	$8,318,880		1.5%	3,577,118	465,025		$5,206,787	0.5918	$3,081,377	0.5487	$2,856,964
3		1.5%	$8,570,318	$8,570,318		1.5%	3,630,775	472,001		$5,411,544	0.4552	$2,463,335	0.4065	$2,199,793
4		1.5%	$8,698,873	$8,570,318		1.5%	3,685,237	479,081		$5,364,162	0.3502	$1,878,530	0.3011	$1,615,149
5		1.5%	$8,829,356	$8,829,356	$5,400,000	1.5%	3,740,515	486,267		$175,108	0.2694	$47,174	0.2231	$39,067
6		1.5%	$8,961,796	$8,829,356		1.5%	3,796,623	493,561		$5,526,294	0.2072	$1,145,048	0.1652	$912,944
7		1.5%	$9,096,223	$9,096,223		1.5%	3,853,572	500,964		$5,743,615	0.1594	$915,532	0.1224	$703,019
8		1.5%	$9,232,667	$9,096,223		1.5%	3,911,376	508,479		$5,693,326	0.1226	$698,002	0.0907	$516,385
9		1.5%	$9,371,157	$9,371,157		1.5%	3,970,047	516,106		$5,917,216	0.0943	$557,993	0.0672	$397,637
10		1.5%	$9,511,724	$9,371,157		1.5%	4,029,597	523,848	$74,264,614	$80,130,021	0.0726	$5,817,440	0.0498	$3,990,475
11			$9,654,400											
											NPV	$2,610,438		-$910,954
										IRR	**34%**			

11.0 References

Composite Wall Panel System by Metal Stud Crete. 2008. Earl Corporation. 26 Feb. 2009 <http://www.metalcrete.com/msc_system.html>.

Construction Market Forcast. Mar.. 28 Mar. 2009 <http://www.healthcaredesignmagazine.com>.

Das, Braja M. Principles of Foundation Engineering. 6th ed. Toronto, Canada: Thomson, 2007.

Dube, Nicole. Medicade Nursing Home Payment System. 28 Jan. 2009. 19 Mar. 2009 <http://www.cga.ct.gov/2009/rpt/2009-R-0041.htm>.

Freight Trucking Companies and Freight Companies. 2009. 23 Feb. 2009 <http://www.freightcenter.com/QuickQuote.aspx>.

"Fundamentals of Engineering Supplied-Reference Handbook." National Council of Examiners for Engineering and Surveying. Oct. 2008. NCEES. 26 Feb. 2009 <http://www.ncees.org/exams/study_materials/fe_handbook/fe_reference_handbook.pdf>

Gould, Frederick E. Managing the Construction Process: Estimating, Scheduling, and Project Control. 3rd ed. Upper Saddle River, NJ: Pearson Education, Inc, 2005.

Haughey, Jim. "2009 Economic Outlook." Consulting-Specifying Engineer 1 Jan. 2009.

Martin, Randy L. R-Value Tables. 29 July 2008. Colorodo Energy. 25 Feb. 2009 <http://www.coloradoenergy.org/procorner/stuff/r-values.htm>.

McQuiston, Faye C., Jerald D. Parker, and Jeffrey D. Spitler. Heating, Ventilation, and Air Conditioning Analysis and Design. 6th ed. Hoboken, NJ: John Wiley & Sons, Inc, 2005.

Morrell, Michael P. "Electric P. S. C. Md. No. 53." Allegheny Power. 20 June 2000. The Potomac Edison Company. 25 Feb. 2009 <http://www.alleghenypower.com>.

National Investment Center for the Seniors Housing and Care Industry. 2009. 20 Mar. 2009 <http://www.nic.org/>.

Nilson, Arthur H., David Darwin, and Charles W. Dolan. Design of Concrete Structures. 13th ed. New York: McGraw-Hill, 2004.

Real Estate and Construction Trends. 2009. Plunkett Research, Ltd. 23 Mar. 2009 <http://www.plunkettresearch.com/Industries/RealEstateConstruction/RealEstateConstructionTrends/tabid/279/Default.aspx.>

"Real Property Data Search." Real Property Search. 2007. Maryland Department of Assessments and Taxation. 17 Mar. 2009 <http://sdatcert3.resiusa.org/rp_rewrite/searchtype.aspx?County=22&SearchType=street>.

Scott System. 2009. 2 Mar. 2009 <http://www.scottsystem.com/>.

"The MetLife Market Survey of Nursing Home and Assisted Living Costs." MetLife Mature Market Institute. Oct. 2008. MetLife Institute. 19 Mar. 2009 <http://www.metlife.com/assets/cao/mmi/publications/studies/mmi-studies-2008-nhal-costs.pdf>.

Turner Construction Company. 2009. 23 Mar. 2009 <http://www.turnerconstruction.com/corporate/content.asp?d=6626&p=6567>.

Washington County Maryland Fact Sheet. 2007. United States Census Bureau. 22 Mar. 2009 <http://factfinder.census.gov>.

Washington County Maryland Homepage. 2009. 17 Mar. 2009 <http://www.washco-md.net/>.