Executive Summary:

This assignment made me take a deeper look at the systems that go into the building and the time it takes to construct them. It also gave insight into the cost of the building compared to others like it and the factors that affect the building that are outside the control of the designer.

During the scheduling section I found the building to have very repeatable units. This is due to the repeating apartment throughout the building. Because of the very critical schedule on the project this looks like a good opportunity to look at using a SIPS schedule to cut the duration of both the structure and the interior trades as they make their way through the building.

From the building systems summary I noted that most of the systems are typical of the region and style of building with the exception of the mechanical system which uses geothermal heat pumps rather than typical air source heat pumps. This should give the building vastly improved efficiency and comfort. When discussing this system with those around me the first response that they have is to ask what the LEED rating for the project is. This project is not LEED rated. It seems that using this type of mechanical system would increase the chances of a building gaining at least a rating of LEED Certified. The building also has some other features such as bike racks that would gain it points. I intend to investigate how close this building is to being LEED Certified without even trying to be, and what costs would be incurred in the process of picking up any points that it would need to become certified.

The project cost evaluation showed that the actual building cost, the Means estimated s.f. cost, and the D4 estimate all came out relatively close. There was some deviation in the total project cost, mostly due to the well field required for the mechanical system that was not accounted for in the estimates. This shows the similarity in cost of buildings of this type. They are relatively simple structures mostly built very practically, with the intent of housing as many students comfortably as they are able to. The only really surprising thing was the location factor causing a 13.6% increase in the price. I expected the cost to be slightly above normal due to the location near a large city, but the amount of the increase was not expected. I believe this may be due to the high wages of the local union labor force and the pressure they exert on the market. I don't believe material prices would change that significantly because most of the materials are brought in from outside the city anyway.

The existing site, owner, and local conditions are all things that the designer and construction manager must keep in mind. The site may limit the ability for certain systems to be used, the owner may have special requirements, and the local conditions may dictate the practicality of certain methods of construction. On this project there is a wide open site, an experienced owner, and an experienced work force that is also more expensive than in most areas.

The most important part of this assignment is that it provided the opportunity to look for parts of the building that don't quite make sense or could use improvement. It is these areas that will make a good place to start when looking for topics to research. Although I expect the project to go well due to the highly experienced staff and the level of planning the construction manager is doing ahead of time, this does not mean there are not better ways of doing some things.

Existing Conditions

Project Schedule Summary:

See attached Figure 1, a general construction schedule for the project. The project is being delivered as a design-build project that began with a design competition. This creates some interesting challenges for everybody. The first is that the general shape of the building is set by the competition and can not be influenced during the typical design phase of the project. The next is that as a design-build project, the building will not be completely designed when construction begins. As shown on the schedule, all the geothermal wells are finished and the foundations are at 50% completion when the design is finalized. This is fine as long as the critical parts have been completed. These include the mechanical system because that is what the wells are for, and the structural system, which should be designed first in order to have the pre-cast concrete and steel ordered. After this early part of the project is completed, the schedule becomes repetitious as the building is built from the first floor to the roof. At the end of the schedule, when the building is under roof, the interior trades are able to move in and things become more complicated again due to the increase in trades on the project. For simplification all of the interior trades have been lumped together for this summary schedule.

The keys to making this a successful project will be to keep the crane busy at all times during the structural part of the project and avoiding conflicts among the interior trades. The reason these are the most important activities is that there is really no way to have problems in other areas. The foundation is a very simple shallow foundation system. The structural system is equally simple, using masonry walls and pre-cast floor planks. However, if the planks are not delivered as they are needed this process could easily fall behind. It will be critical that the project management staff keeps a close eye on this process. The last part of the project will also be important. There will be more people on the project, creating more opportunities for congestion, conflicts, and unsafe conditions than at other points in the project. Also, if an activity falls behind at this point in the project there is no time to recover. Any delays will directly influence the final completion of the project.

Building Systems Summary:

See Figure 2 for an overview of items to be covered in this section. The first item is Demolition. This site began as an open field so there is no demolition on this project.

Structural Steel Frame:

There is structural steel framing used in two places on this project. First is in the bridge section at the corner of the L-shaped building. The diagonal bracing used in this section is HSS 4x4x3/8” diagonal braces. These are not used to resist lateral loads, but to support a cantilevered section of the building. The lateral load is held by the CMU shear walls in the main part of the building. The steel for this building will require a crane with the capacity to lift approximately 1300 pounds at a range of 40 feet. This should be well within the limits of the crane that will need to be on site for placing the pre-cast hollow floor planks. The other place structural steel is used is in the clubhouse building around the atrium. The largest piece in this section will way about 550 pounds. This will not be a problem for the crane used for the rest of the building.

Cast in Place Concrete:

The only concrete that will be cast in place is the foundations and the topping for the floors. The foundations will not be formed. The walls of the excavation will be made the correct size for the footers and no forming is necessary unless there is over excavation in an area. The openness of the site lends itself to placing the concrete in the forms directly out of the chute from the truck. This is the most economical way to place concrete in shallow foundations.

Yes	No	Work Scope	If yes, address these questions/issues
	X	Demolition required?	Types of materials, lead paint, or asbestos?
X		Structural Steel Frame	Type of bracing, composite slab?, crane size/type/location
X		Cast in Place Concrete	Horiz. And Vert. Formwork types, concrete placement methods
X		Precast Concrete	Casting location, connection methods, crane size/type/location
X		Mechanical System	Mech. Room locations, system type, types of distribution systems, types of fire suppression
X		Electrical System	Size/ capacity, redundancy
X		Masonry	Load bearing or veneer, connection details, scaffolding
X		Curtain Wall	Materials included, construction methods, design responsibility
	X	Support of Excavation	Type of excavation support system, dewatering system, permanent vs. Temporary

Figure 2. List of general topics to be covered in this section.

Precast Concrete:

Precast concrete is being used on this building as the structural floor system. Hollow core planks are being used for all elevated floor systems as well as the roof. The precast members are 8” hollow core concrete planks between 23’ and 30’ long. The crane required for the placement of the planks will need to be able to carry the weight of the planks at a maximum distance of 70’. The planks will be cast at the Morrisville, PA plant of Old Castle Precast and trucked to site as needed to be placed directly off of the trailer.

Mechanical:

The air intake and discharge for the building is on the roof in the form of 4 Greenheck ERV-521H heat recovery units. The units send the air to geothermal heat pumps located in the mechanical closet of each apartment unit. The heat pumps are part of a loop that receives water from 72 – 500 foot deep wells located in the rear of the building. From the heat pumps the air is ducted into the bedrooms and hallway of the building. Then the air travels through the living areas and is returned through the bathroom exhaust system into a vertical chase that takes it back to the rooftop heat recovery units and out of the building. There is also a large mechanical room on the ground floor of the building on the South end. This houses systems such as water heaters, fire protection pumps, electrical switchgear, and electrical and plumbing feeds into the building.

Electrical:

Power will come from a feed connected at an existing transformer at nearby Moll Hall. The feeder will run underground in a 4" conduit at 13.2 kV. This will be carried by 3 #2/0, Type 133% EPR conductors with the capability of handling 15 kV. It will be reduced to a 208/120V, 3 phase, 4 wire power supply by a transformer at the entrance to the building; inside the mechanical room. This power will then be distributed by a switchboard to a fire pump, jockey pump, TVSS, and other distribution switchboards that will send power to the individual panelboards. The emergency system will be a generator capable of producing 1000kW at 125kVA. This power will be distributed in the form of 3 phase, 60 Hz, 208/120V power to the life safety systems panel and the elevator.

Masonry:

The masonry system in Widener University's new residence is the primary vertical structure. This building uses load bearing CMU walls to support nearly all loads. The exterior walls and one of the hallway walls in the middle of the building support the precast plank floors. These walls are solid grouted on the first level, but are only reinforced at the corners on the second through fourth floors. There are also CMU shear walls between each apartment to support lateral loadings due to wind. The building also makes use of brick veneer exterior which is attached to the masonry walls by the standard masonry anchors.

Curtain Wall:

The last system to be covered for this building is the curtain wall and storefront systems. These use insulated metal panels to break up the massive brick walls. These 2 inch thick panels are locked into place and secured to the wall using screws that become hidden by the panel above them. The storefront system uses aluminum mullions between sections of glazing. This system is used at the entrances to the building.

Excavation Support:

Because this system uses a shallow foundation system, the excavation is very simple. The foundations are small enough to dig out with an excavator at surface level. There will be no support needed for the foundations except in the deepest area where the side walls of the excavation will be stepped to provide protection and access for the concreters placing the footers. The shallow depth also means that there will be no problem with the water table and dewatering will not be necessary.

Project Cost Evaluation:

Actual building construction cost is $14.5 million. The total building size is 87340 s.f. This gives a building cost of $166.02 per square foot. The total project cost is $18 million giving a total cost per square foot of $206.09.

For the square foot estimate of the building, I used R.S. Means 2005. For a typical college dormitory with 85,000 s.f. of space with exterior walls of face brick on concrete block back-up and a reinforced concrete frame the building should cost $125.75 per square foot. Because this building is in the Philadelphia area and the area code for the building is 19013 there is an adjustment increasing the price by 13.6%. This increases the price to $142.85 per s.f. The next thing to consider is the linear feet of exterior wall. Because this building is made up of two long narrow wings there is 1115 l.f. of perimeter wall, compared to the 500 l.f. of wall included in Means. To adjust for this 3.15 must be added for each additional 100 l.f. of exterior wall. This brings the square foot cost to $162.24 per square foot. After multiplying by 87,340 s.f. the Means estimated price for this building is $14.17 million. This price should include all structure, shell, and services for the building. It also includes built in dormitory furnishings but not kitchen equipment or furniture that is not built in to the building. The price also excludes building site work and commercial, institutional, and vehicular equipment.

The final price of nearly 14.2 million is $300,000 lower than the building cost for this project. This is most likely due to having a kitchen in each apartment. Another thing that may have increased the cost of the building is the layout. The building layout is more like an apartment building than the standard rows of rooms found in a dormitory.

I also used Means to find the expected Electrical and Mechanical costs for the building. I have been unable to locate the actual costs on the project, but because the square foot estimate for the building was very close to the actual cost, I feel that it is a valid assumption to believe that the estimated costs will fall very near the actual cost for the various systems as well. The mechanical costs for a building in the upper quarter of expenses is $27.80 per square foot. Adjusted for the area of this building this becomes $31.58 per square foot, or $2.76 million for this project. The electrical cost for a building in the upper quarter of expenses is $14.20 per s.f. Adjusted for the area this results in a cost of $16.13 per s.f. or $1.41 million. If the quality of the building were to be reduced to median quality the costs would be brought down to $1.93 million for the mechanical system and $1.25 million for the electrical system.

Another way to check the estimate was to use D4 Cost. I tried 3 different cases within D4. The first came out very low with a price of just under $12 million. Because this was well below both the actual cost and the Means cost, I tried another case. The second case gave an estimate of $15.8 million with a total project cost of $17 million. This is very close to the price range of Means and the actual project costs. Next I ran D4 a third time to see which result it would be closest to and received an estimate of $15.3 million with a total project cost of $15.8 million. This falls near the upper end of the estimates, but is very close to the second D4 case. It appears that D4 will generally give a conservative result for the building cost but this building has extra site work that can not be taken into account through D4. This results in the project cost given by D4 to be lower than the actual project cost for this building.

Tech 1

Site Plan of Existing Conditions:

See attached Figure 3, the site plan for the layout of the space during construction. As you can see the building sits on the corner of 17'th Street and Melrose Avenue. Public utilities are all easily accessible, as they run under and alongside the roads. There is a large site with plenty of room on the inside of the L-shaped building for all temporary requirements. The nearest buildings are across an existing driveway to the South of the new residence hall.

A mobile crane will need to be used for this project to lift the pre-cast planks into place. This crane is shown with a 70 foot reach inside a circle. I have defined 4 set-up locations for the crane. You will notice that these locations do not cover the entire building. This is because covering the entire building is not necessary due to the exterior walls being masonry walls. The crane only needs to reach to the center of the planks for the far side of the building. As shown this requirement will be met.

You may also notice that the well field boundary has objects on top of it. This is because the entire geothermal well system is buried a minimum of 4'6" from the surface. This amount of cover will protect the system from all surface loads. However, I would still not recommend placing a crane on top of it because this may be a load the designers have not considered due to its unusual nature.

Local Conditions:

In the Philadelphia nearly all new apartment buildings, regardless of size are being constructed of cast in place concrete. This is mostly due to the sharp increase in the cost of steel in recent years. Because of the proximity to the city a union labor force must be employed to avoid confrontations with union officials. There is a large site for this project so parking is not an issue and there should not be any problems with site congestion. The building uses a shallow foundation system so the water table level is not an issue. The soil for the site is typical for the area. There is an organic topsoil region approximately a foot deep and a mix of clay and silt below that.

Client Information:

Widener University is building the residence hall as a way of keeping up with their commitment to house all of their students. The university is gradually expanding and has filled all of their other living spaces. This hall will be the closest to apartment living of their residence halls and is expected to house mostly upperclassmen. As a university project the building is expected to have a longer than average life cycle, this means that the quality of the building is to be above standard. Construction will be closely monitored to ensure this goal is achieved.

The schedule is the most critical aspect of this project. The building must be ready for full occupation in September of 2006. If this goal is not met there are heavy liquidated damages in the contract to compensate Widener for needing to find alternative housing for the students who are scheduled to occupy the building. Even though the university will receive money for liquidated damages for a late delivery, this is something that they would consider a disaster. Finding alternative housing for 300 students would create a huge headache for the administrative staff of the school.

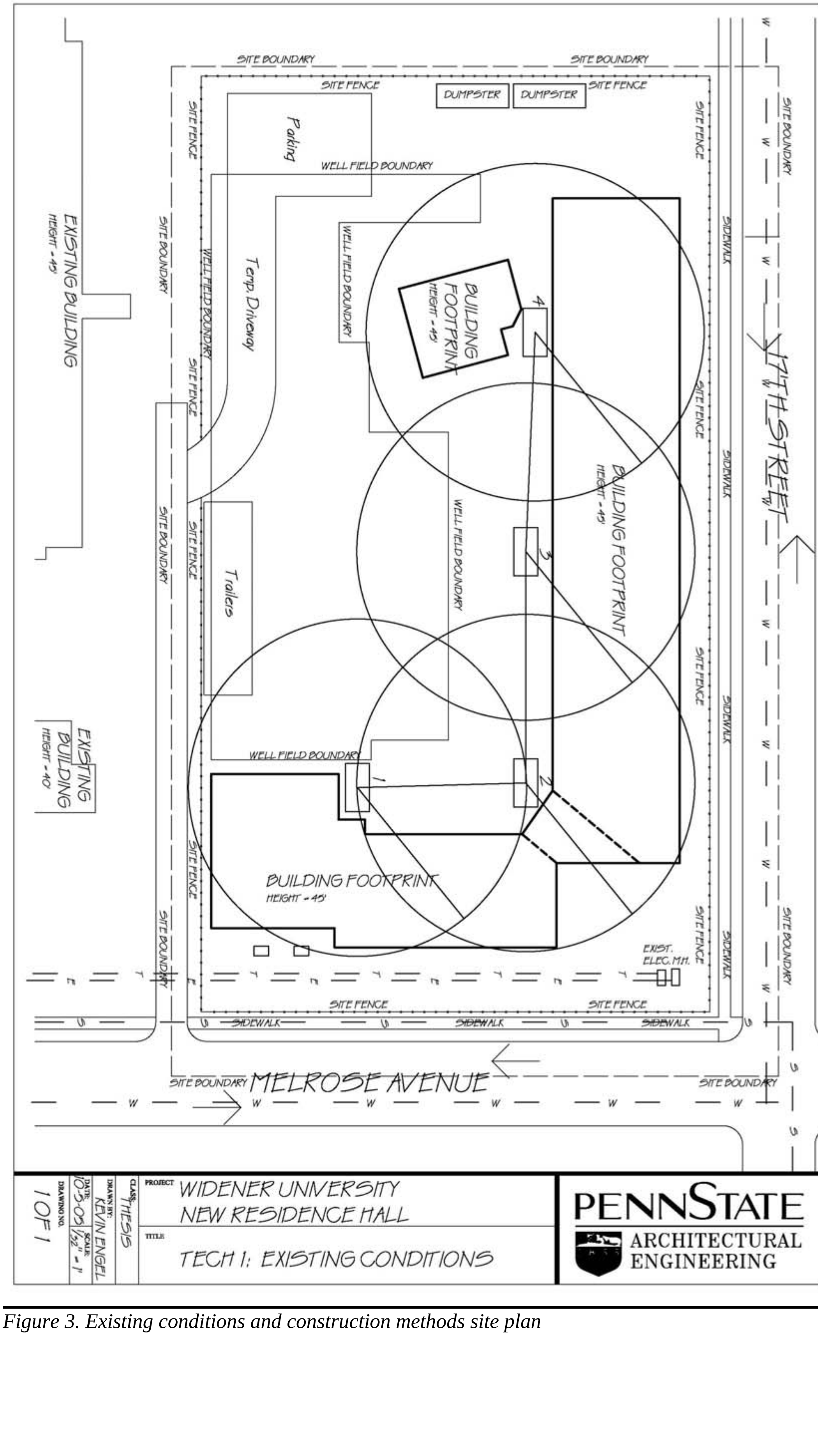

Figure 3. Existing conditions and construction methods site plan

Project Delivery System:

The project procurement process was a design-build competition. There were 6 entries by various design teams. The architectural firm Wallace, Roberts, & Todd(WRT) won the competition. WRT teamed with Cueto Kearney Design to complete the building design and HSC Builders was selected to be the construction manager. The building is being delivered as a design-build GMP project. This provides a price that can not be exceeded while giving the CM the ability to give input during the design phase of the project. For a graphic of the contract arrangements, see Figure 4.

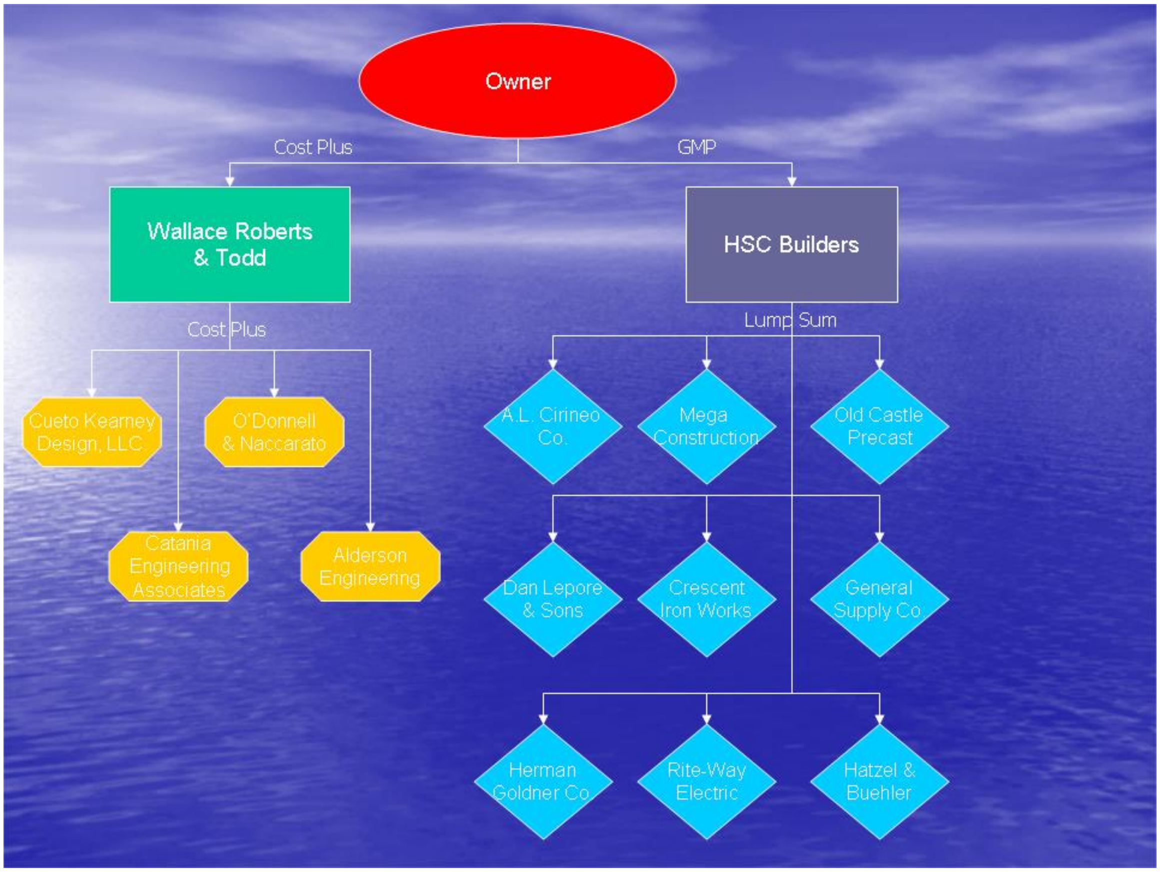

Figure 4. Project participants and contract types.

Staffing Plan :

See attached Figure 5 for a diagram of the construction manager's staffing plan for the project. The company is run by Mark Heim, the CEO. It is his job to keep the company pointed in the right direction and choose which projects to pursue. Within the company there are 3 groups that take part in the project. First is the Preconstruction/Estimating department. This is headed by Jim Viner, the Director of Preconstruction. On this project Brad Springer worked under Mr. Viner to estimate the project. Mr. Springer spent several weeks working on this project full time. Mr. Viner is responsible for the entire preconstruction department and only spent about a quarter of his time on this project during those weeks.

The second group is the project management group which is headed by Jim Faust, the Vice President of Project Management. Working for Mr. Faust are Senior Project Manager Jonathan Huggins, Project Manager Jeff Kasaczun, and Assistant Project Manager Renee Previte. Mr. Faust will spend about a tenth of his time on this project during the construction phase. Jonathan Huggins may spend up to half of his time on the project. Jeff Kasaczun and Rennee Previte will work on this project full time during construction.

The third group of people involved in a project is the superintendents. This group is run by Pete Garzia, the Vice President of Operations. Pete will probably not spend much time on this project, as he has assigned one of his best superintendents to it. Ray Messa will be working as the Superintendent on this project and will be working full time at the site.

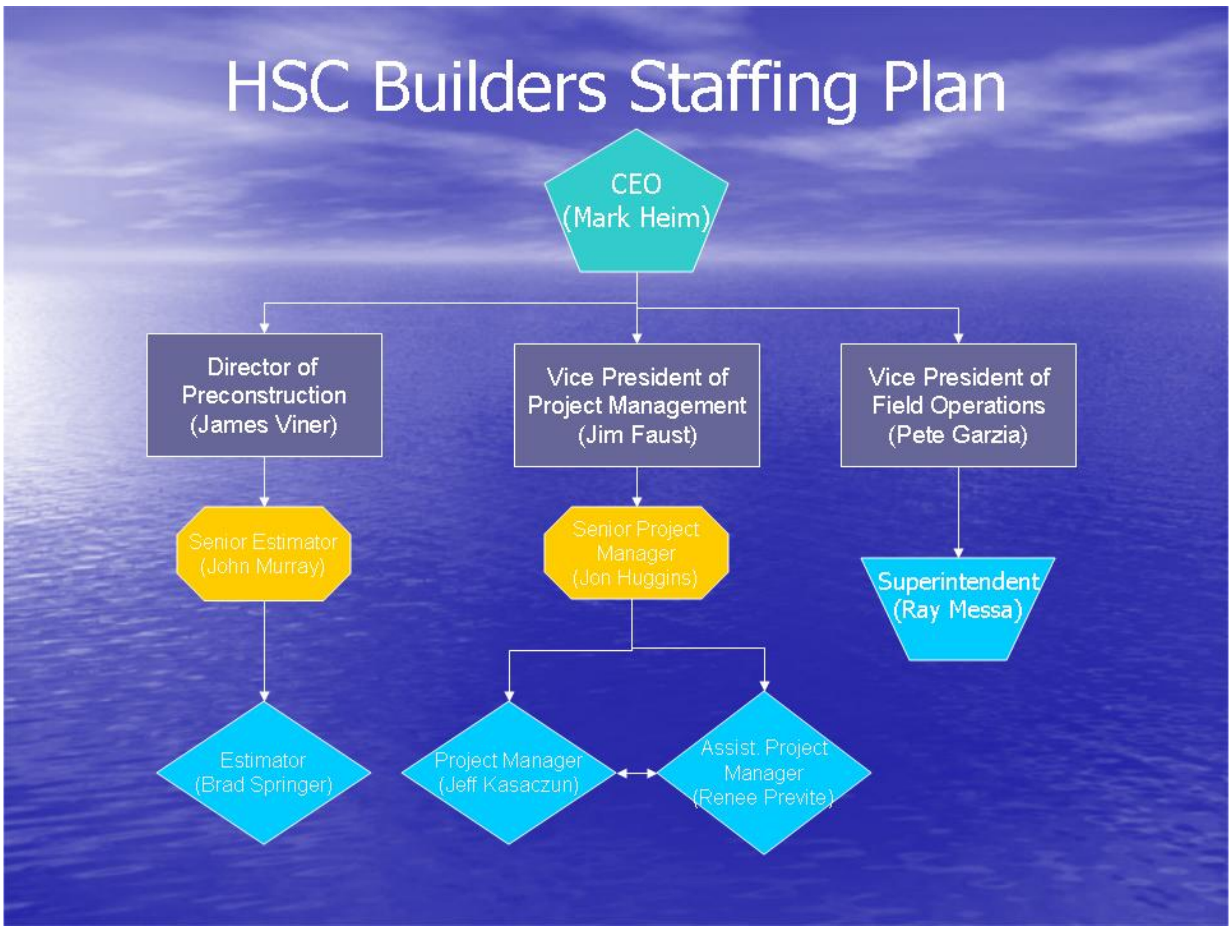

Figure 5. Construction Manager's Staffing Plan.