The Heartland Hotel

The Midwest

Final Report

Alexis Fons | Construction Management

4.08.2016

Advisor: Dr. Robert Leicht

The Heartland Hotel

Building Details

Location | The Midwest
Size | 129,416 Square Feet
Height | 9 Stories Above Grade
Primary Project Team
    Developer | Mortenson Development Inc. (MDI)
    Contractor | Mortenson Construction
    Architect | Elness Swenson Graham Architects
Cost | $40.05 Million
Duration | June 3, 2015 - October 13, 2016
Delivery System | Design-Build
Unique Attributes
    Turnkey Handover
    MDI will be a partial owner of the finished product

Mechanical

◊ Two rooftop units (with cooling and gas heating capabilities) located on the ninth-story roof supply the hallways of floors 2-9 with heated and cooled air
◊ The first floor has a return plenum ceiling and a second-story rooftop unit for air supply
◊ Guestrooms have individual Vertical Terminal Air Conditioning (VTAC) units
◊ Split A/C systems supply the elevator/electrical rooms

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https://www.engr.psu.edu/ae/thesis/

Architecture/Site

◊ Part of a 30-year city improvement plan
◊ Interior and architectural design is regulated by an international Spanish and European brand-type
◊ There is a historical building adjacent to the lot
◊ Two drive lanes cut underneath the building
◊ A pedestrian bridge connects the hotel to an existing parking garage
◊ Contaminated soil on-site required a 2’ subcut

Structural

◊ Steel columns and beams are used minimally on the first floor for the entrance, canopies, tower, bridge, stairs, and elevator
◊ The first floor is comprised of a 2-way concrete slab and grade beams, while remaining floors have 6.5-7” post-tensioned slabs
◊ A 212’ tall tower crane will be utilized

Electrical

◊ The utility transformer connects to the Main Switch Board at 2500A
◊ A 250kW generator is located outside of the main building footprint
◊ Transformers and panelboards are located every other floor to supply lighting, receptacles, and VTAC units above and below

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EXECUTIVE SUMMARY

The following document is a final report of three analyses and one research topic related to the construction industry and the Heartland Hotel. Throughout the 2015-2016 academic year, the Heartland Hotel and related construction techniques were analyzed to identify potential opportunities. Three specific analyses were chosen and goals for each were established. Detailed and specific research was performed for these analyses related to cost, schedule, and constructability. This thesis presents the findings of the research related specifically to the established goals and areas of opportunity. Research related to the general construction industry was also performed through a questionnaire sent to companies within the construction workforce. The findings of this research and how it relates to the industry is also presented. Overall, the four analysis areas presented focus on techniques to improve the construction and final product of the Heartland Hotel.

Analysis 1: 9th Story Design Change

The Heartland Hotel promotes a luxurious stay for guests by offering eight stories of state-of-the-art rooms. While 245 rooms are available for guests to stay, they are all standard rooms and no suites are offered. With a location near several points of interest and methods of public transportation, it is likely that the Heartland Hotel will serve a multitude of tourists. This type of consumer is more likely to rent suites than the standard business person – a market which the Heartland Hotel currently aims to serve. However, by changing the ninth floor from standard rooms into suites, nearly $34,000 can be saved from construction costs and an additional $20,000 annual revenue can be achieved.

Analysis 2: Link Bridge Redesign for Constructability

A 62' long link bridge connects the Heartland Hotel with a nearby parking garage. There have been constructability concerns within the project team about the link bridge through the entirety of the project. The limited space between the bridge and the garage poses concerns about workers, materials, and equipment fitting between. By prefabricating the link bridge as one module and lifting the finished component into its final place on site, the space constraints are eliminated. A prefabricated module with all but two finishes reduces the overall budget by nearly $30,000. Additionally, the overall schedule is reduced by 7 days and on-site work on the link bridge is nearly eliminated.

Analysis 3: Structural Lift System

Located on the corner of an intersection, the construction site space for the Heartland Hotel is extremely limited. The current process of constructing the structure of the building includes prefabrication, additional lot storage space, and storage on the top of the adjacent parking garage. Additionally, due to extreme weather conditions, there are concerns within the project team about installing stucco on the façade, as it is a temperature-dependent material. Upbrella Construction, a Canadian construction company, offers a way to mitigate these issues. By installing a structural lift system designed by Upbrella Construction, the building would be built with the roof attached at the top and the floors built and lifted underneath. This system allows almost all work to occur at man-height and provides a protection shell against weather and falls. As one floor structure is completed, the exterior enclosure can begin one floor below and interior construction can begin two floors below. The current structural design did not align with the structural uplift method, and was changed from elevated PT slabs to composite steel framing. While the structural uplift method directly addresses problems on-site and reduces the overall schedule by one and a half months, the cost to use this method increases the overall budget by $825,000. Therefore, this structural lift method is not recommended for this project.

Analysis 4: Field Labor Experience

Interviews and a questionnaire were used to address potential benefits that field labor experience provides for superintendents and how it impacts the role and success of a superintendent. Respondents were all current construction industry members, and revealed the importance of a having both education and field experience. Field experience is extremely beneficial to becoming a superintendent, yet is not required and is by no means the only form of education necessary to become successful. This research could lead to future areas of study on how to incorporate hands-on learning experiences for students interested in the superintendent and/or construction path.

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PROJECT INFORMATION

Project Background

Mortenson Development Incorporated (MDI) bought the plot of land where The Heartland Hotel will be located. After completing the construction of the hotel, MDI will become a partial owner with Heartland Hotel in order to benefit from future profits. Heartland Hotel requested a specific brand which details various interior and exterior architectural features. As the contractor appointed by MDI, Mortenson Construction hired the Architects and Engineers to complete the design and construction of this building with a Design-Build project delivery system. The Heartland Hotel will be built for $40.05 M in 17 months. The hotel will be completed in a "turnkey" fashion, where everything, including operating, supplies, and equipment, will be delivered and sold to the Heartland Hotel.

The building consists of nine stories, nine of which are post-tensioned (PT) concrete slabs (floors 2-roof). The finishes and architectural features are a major part of design and construction in order to comply with the brand requirements and to establish a high-end product. The Heartland Hotel is on the corner of two one-way streets, adjacent to a twelve-story historical brick building and a seven-story parking garage (of which hotel guests will be able to use). The building has a one-way drive-through lane passing underneath and behind the building, thereby creating a seemingly closed-off façade of glass and metal.

Key goals on this project are safety and quality. Both Mortenson Construction and MDI have these two points as top priorities, along with coming in under budget. Staying at the Heartland Hotel is meant to be an escape from the hectic world. With MDI, Mortenson Construction, and key players that have been brought onto the project team, the goal is to create a unique and timeless hotel that causes a shift in the culture of the city.

Architecture

As an international chain of hotels, Heartland Hotels are known for expressing hints of Spanish roots with a European design twist. Not only does the Heartland Hotel provide a place to stay for the night, it also offers guests a dining area, a bar and lounge, several meeting rooms, a library, and multimedia salons.

An "H" for Heartland Hotel is showcased atop a glass and metal panel tower – the tallest part of the building (Figure 0.1). The Heartland has an entrance and exit drive lane cutting underneath the building and connecting to an existing, adjacent parking garage. Courtyard-strung lights highlight the main, east entrance, but is hidden from street view (Figure 0.2).

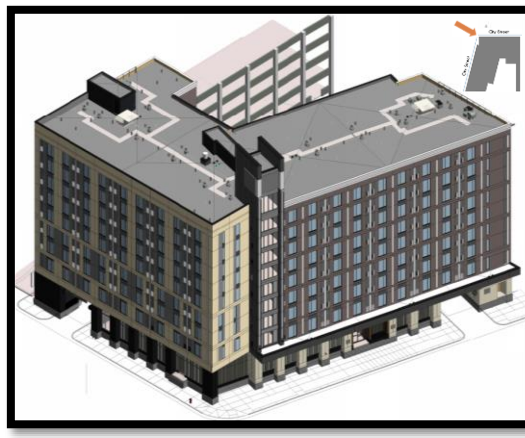


Figure 0.1: Northwest/street view of the Heartland Hotel

Building Enclosure

At the base of the Heartland Hotel, a single-story aluminum storefront system welcomes the guests while seemingly supporting the remainder of the building (Figure 0.3). Above this feature, narrow windows (largest W:H ratio of 2:5) alternate between narrow metal panels and stucco. The majority of the façade is composed of three different shades of stucco, while the metal panels break the wall into vertical sections. The exterior enclosure system is a metal stud cavity wall with varying insulation types, sheathing, and vapor retarders dependent upon the exterior façade material. Glazing types consist of tempered, non-tempered, wire, and spandrel glass.

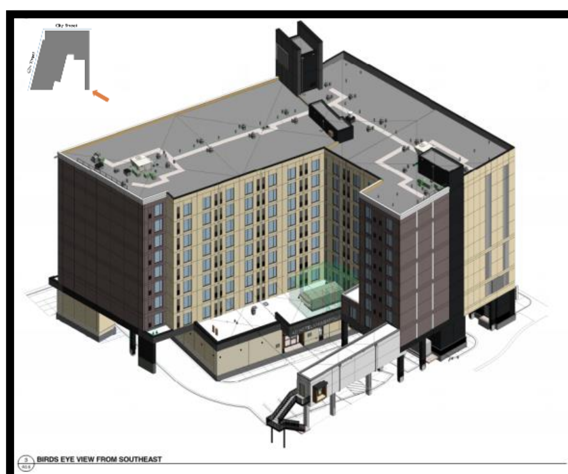


Figure 0.1: Southeast view of the Heartland Hotel's east entrance

Two main types of roofing systems are utilized: "Adhered membrane roof assembly on PT concrete" and

"Fully ballasted membrane roof assembly" (Construction Documents, A5.1 – Wall Sections). The first type of roofing is on the top floor of the building and contains an adhered EPDM roofing membrane, a minimum of 2" rigid insulation, and a vapor retarder. This roofing system has a fire resistance rating of 1 hour. The second type of roofing system is only above the first floor entrance canopies and the link bridge. This roofing contains the same features as the first but also includes ½" gypsum sheathing and 1 hour-rated, spray applied fireproofing.

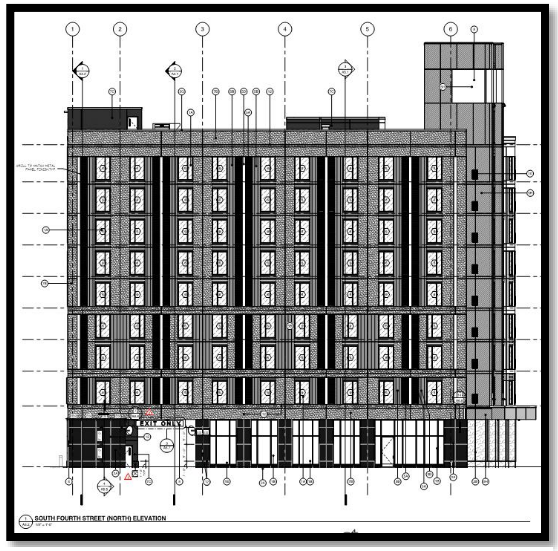


Figure 0.2: The north elevation reveals the aluminum storefront system as well as the vertical metal panels and windows surrounded by stucco.

Primary Engineering Systems

Demolition

In 1984, an existing hotel on the Heartland Hotel lot was demolished by explosives. The land was immediately put to use as a parking lot comprised of soot and leftover rock from a blast furnace as the base. Recently, as part of the geotechnical analysis of the site, the soil was deemed contaminated and needed to be deposited in a contaminated soil lot located off-site. Mortenson received a grant for the removal of contaminated soil and performed a 2' subcut to clear the site.

Demolition involved an existing parking lot with bollards and signs, as well as previous hotel foundations. Unexpected underground demolition resulted in a 3-week increase in schedule. Additional walls and minor changes in design were included at the start of the project in order to be cautious of nearby buildings.

Electrical

A utility transformer connects to the main switchboard, located in the northeast corner of the building, at 2500A. This is then connected to the main electrical systems room (which supports the elevator), the fire pump room, mechanical room, and kitchen. Electrical rooms with 112.5kVA transformers and panelboards are located on floors 3, 5, 7, and 9 to support the lighting, receptacles, and VTAC (Vertical Terminal Air Conditioning) units on that floor and the floor below. An additional electrical room is found on floor 8 and is connected to a supplementary 30kVA transformer on floor 9. A 250kW generator is located on the first floor near Stair B.

Lighting

LED strip lights (tape lights) and downlights are scattered throughout the guestrooms, along with lamps and portable light fixtures. Hallways leading to the guestrooms are lined with 4" recessed circular fluorescent lights. Fluorescent lighting is also utilized in the first floor workroom, kitchen, mechanical and electrical rooms, and the administrative area on the second floor. The underside of the canopies, drive-through lanes, and bridge contain 6" recessed LED downlights. Four strings of LED lights are strung across the courtyard.

Mechanical

The first floor is comprised of three main mechanical rooms: mechanical, fire pump, and fire command center. Two mechanical rooftop units (with cooling and gas heating capabilities) supply the hallways leading to the guestrooms of floors 2-9, with heated and cooled air. Exhaust fans are scattered throughout the roof. Each guestroom has an individual VTAC unit for supply and exhaust. The first floor has a return plenum ceiling and a second-story rooftop unit for air supply. Variable air volume terminal units are located throughout the first floor and in the administrative space located on the second floor. The elevator room and electrical room have split A/C systems.

Structural

The foundation system is composed of driven 7-5/8" diameter steel pipe piles filled with concrete. The first floor, a multifunction area for guests and employees, is comprised of a two-way concrete slab and grade beams 40" deep. Steel columns and beams are used only at the single-story entrance and canopies, as well as the tower, bridge, stairs, and elevator. The entrance and canopies are comprised mainly of W12x16 and W14x22 beams, while the bridge is primarily W12x26 beams. The few steel columns utilized on the first floor are W10x49, HSS4x4x1/4, and HSS6x6x3/8, while the remaining columns throughout the first floor are 18"x26" concrete columns. Guestroom floors 2-9 are 6.5"-7" PT slabs with prefabricated reinforced 12"x22" columns. The columns form a 24'5"x18'5" grid throughout the building, making the width of the hotel only four columns wide. This allows natural space for the hallways and does not necessitate columns interfering with the guestroom layouts.

Fire Protection

Extended coverage ¾" dry pendants line the exterior ceiling of the drive-through lanes. Standard and concealed ½" wet pendants are scattered throughout the administrative area, while ¾" extended coverage wet pendants line the public area of the first floor. ½" horizontal sidewall sprinklers and pendants are located in all guestrooms. Two 4" standpipes with 2 ½" fire hose valves are found on the south and northeast ends of the building.

Transportation

Guests may enter the Heartland Hotel through the west entry vestibule next to the street, through the east courtyard entry, or through either two stairs located at the northeast and southwest corners of the building. Three elevators are located in the center of the building, and two extend up to the ninth floor while the third extends up to the roof. A rooftop walkway is provided for maintenance. An approximately 62' long link bridge connects the second floor of the hotel to an existing parking garage, which can be utilized by guests.

Telecommunications

Six wireless access points are located on each guest floor. Hard phone lines and voice data cables are found primarily on the first and second floors. "Door Contact" sensors are located at every entrance to the building. 13 ceiling-mounted cameras are positioned on the first and second floors.

Construction Information

Client Information

Mortenson Development Incorporated (MDI) scouted out and eventually bought the property in hopes of selling it to a future buyer. The Heartland Hotel came to an agreement with MDI that MDI/Mortenson Construction would build the hotel and turn it over completely furnished and ready to open. After turnover, MDI would have partial ownership with Heartland Hotel, resulting in both companies benefiting from profits made by the hotel. Heartland Hotel wanted a specific "brand" for this particular hotel, and therefore provided design guides to match future and existing hotels with this brand. Other than those specific design rules, the design was released to designers chosen by Mortenson.

The specific project site was selected as part of a 30-year city improvement plan. The particular part of the city that the Heartland Hotel is being built in is heavily rundown, and the 30-year city improvement plan involves restoring this area and turning it into a high-end district. MDI selected this site in order to be one of the first, partial owners of a high-end hotel, to pursue a shift in culture, and to be a "billboard" entering into this new high-end nightlife region.

As of right now, MDI is technically the owner of the project. However, because the product is specifically intended for Heartland Hotels, they are included during the design and construction process. The top priorities of MDI and Mortenson are no injuries and zero rework. Because MDI is a section of Mortenson, the construction team and owner have similar goals. The schedule is not of extreme priority because Heartland Hotel isn't opening until November – approximately one month after the project construction and move-in is completed. However, because an earlier finish means that Mortenson can begin another job and the hotel could potentially begin making a profit earlier, schedule is still highly valued. Lowering costs on this project is also beneficial to MDI, Mortenson, and Heartland Hotel.

Project Delivery System

The project is being delivered as a type of Design-Build (Figure 0.4). Because of the unique client/owner, it is difficult to pinpoint exactly the type of project delivery system that is being used. MDI selected Mortenson because they are sister companies. Mortenson then proceeded to select the Architect, Interior Designer, Structural Engineer, and Civil/Landscape Professionals. These selections were based off of previous relationships (and therefore qualifications) and accounted for company workload. From here, the subcontractors were selected based off of past relationships as well as lowest bid. Many of the design consultants also performed their own work. Mortenson Construction self-performed work in several areas, including concrete. Primary Design Consultants were selected as quickly as possible while the remaining design consultants/subcontractors were selected later due to schedule flexibility. All companies were required to supply their own insurance and Mortenson supplied roll-over coverage.

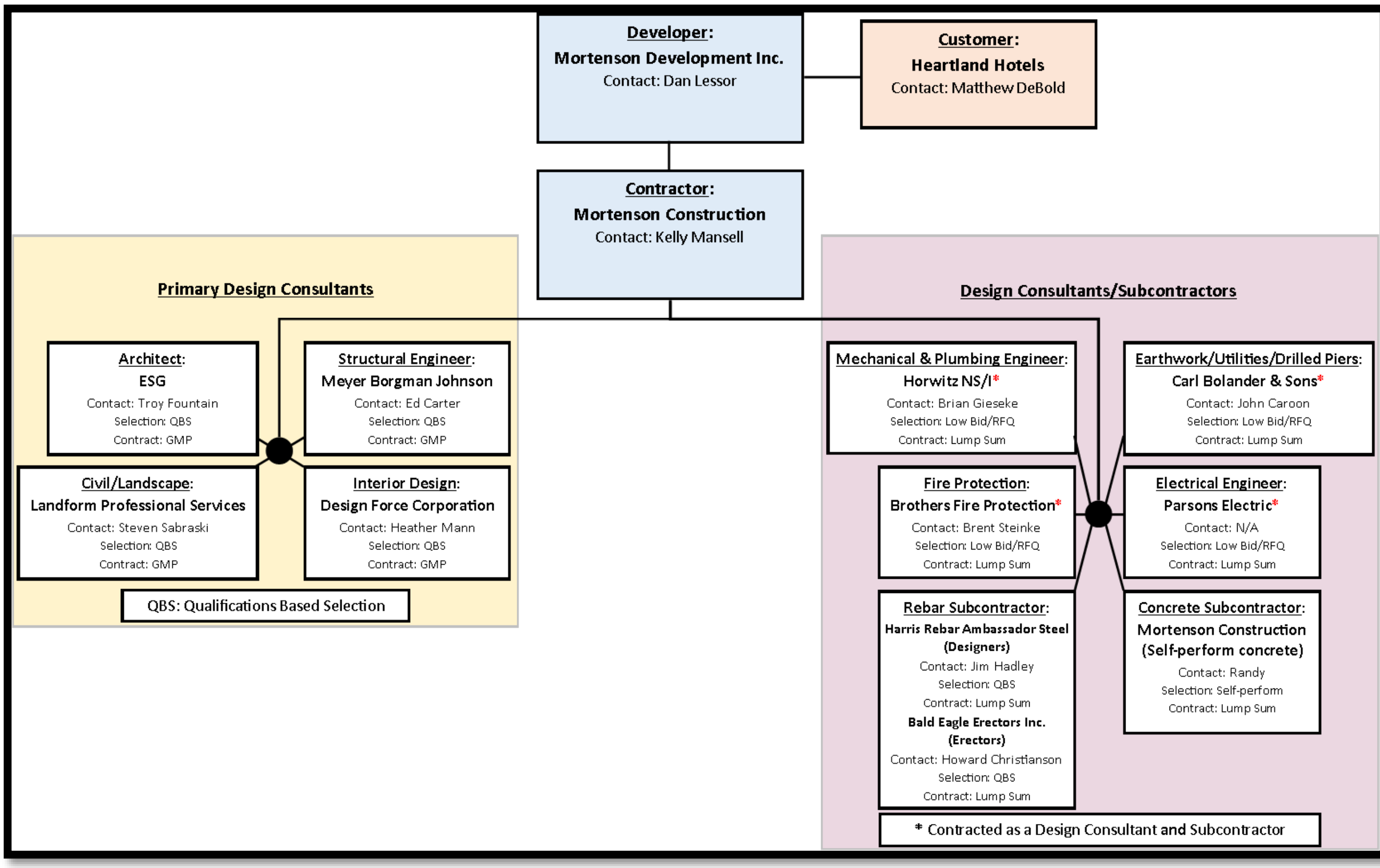


Figure 0.3: Project delivery layout

The organizational chart for Mortenson Construction is found in Figure 0.5. Employees Amundson, Orbeck, Hines, Zamorano, Hannack, and Pladson are all on-site daily. Amundson and Orbeck work together to manage activities on site, while Pladson works on document control and assists the Superintendent and Project Manager. Hines and Zamorano work together to account for budget, scope, and contracts. Hannack monitors the site daily to ensure safety and fix any potential issues. Wegener focuses on coordination and construction logistics. As the construction executive, Mansell oversees this project as well as several other projects.

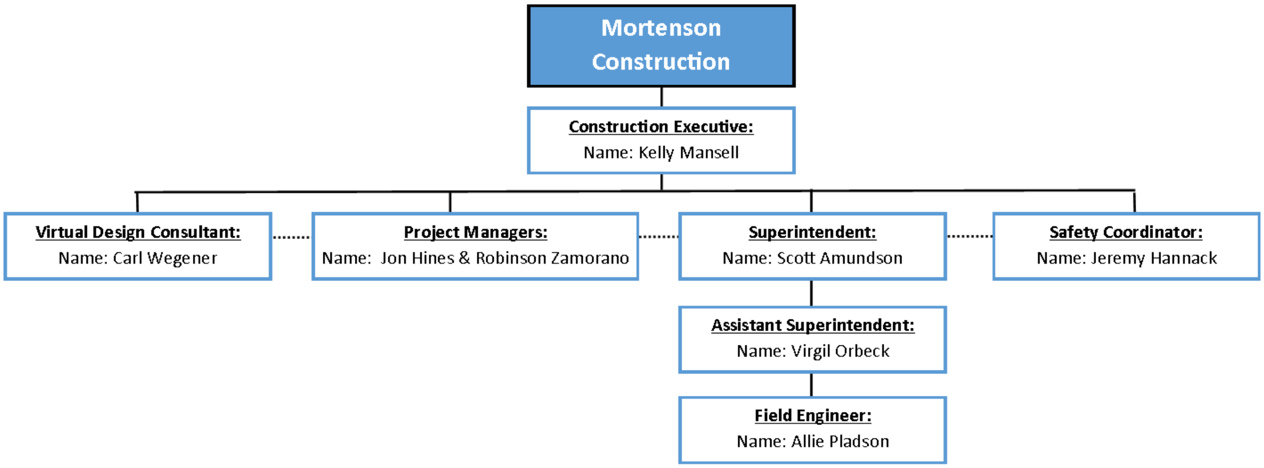


Figure 0.5: The organizational chart of Mortenson Construction.

Schedule

The schedule for the Heartland Hotel lasts from June 3rd, 2015 until October 13th, 2016 (Appendix 0.1). Overall construction will occur from June 3rd, 2015 until October 3rd, with a temporary Certificate of Occupancy granted on September 16th. The Final Completion Certificate of Occupancy will be granted on October 6th, while the remaining week will be devoted to completing the punch list and delivering the operating supplies and equipment (OS&E). The hotel will not welcome guests until November so that the Heartland Hotel has an adequate transition time to move in and train employees.

The schedule was fast-tracked because not all designs were 100% complete before construction began. The MEP system is typically critical due to the long lead time; therefore, the subcontractor proposals were solicited while the project team was still in the Schematic Design phase. Similarly, the enclosure is a complex portion of this building, so subcontractors were brought on early for input and acceleration of schedule.

Cost

The following information pertains to the *actual* budgeted cost for the Heartland Hotel and the *calculated* budgeted cost using estimating resources (Table 1). Appendix 0.2 contains detailed calculations and assumptions. The blue SFE/TC cells highlight considerable cost differences.

Building Construction Cost (**CC**): **$32.74 M**
Total Project Costs (**TC**): **$40.05 M**
Square Foot Estimate (**SFE**): **$39.34 M**

CC/SF: $252.99/sf
TC/SF: $309.47/sf
SFE/SF: $304.00/sf

Table 0.1: Actual and calculated budgeted cost

Major Building Systems Cost	Total Cost (TC)	TC/SF	Square Foot Estimate (SFE)	SFE/TC (%)
Superstructure	$4,474,147.48	$34.57	$4,865,627.78	109%
Exterior Enclosure	$2,341,547.31	$18.09	$3,522,133.54	*150%*
Interior Construction	$11,342,930.46	$87.65	$8,278,829.36	*73%*
Mechanical	$5,176,729.00	$40.00	$10,893,196.53	*210%*
Electrical	$2,081,009.59	$16.08	$3,304,269.61	116%
Furniture, Fixtures & Equipment (FF&E)	$3,411,740.28	$26.36	N/A	N/A
Operating Supplies & Equipment (OS&E)	$830,015.03	$6.41	N/A	N/A

The Square Foot Estimate calculated does not include all features found in the Heartland Hotel. For example, major components missing from this estimate are the Fitness Center, Media Centers, FF&E, OS&E, Site Work, Permits, Insurance, and General Conditions. Therefore, while the SFE and TC seem relatively close in amount, one must keep in mind that by adding these missing components with costs from the actual budget, the $39.34 M would increase by around $8.22 M, resulting in a SFE of $47.56 M. An additional $8.22 M puts the estimated budged at $7.51 M over the actual budget. This is likely due to Mortenson using past projects as their estimating tools, which is drastically more accurate than R.S. Means.

The three blue-highlighted areas in the table recognize considerably different costs between the two budgets. Potential reasons for these discrepancies are as follows:

Exterior Enclosure – The estimate is most likely high because the building is comprised mostly of materials other than glass (metal, stucco, limestone, etc.). Glazing systems can be more expensive than generic materials.

Interior Construction – The estimate is most likely low due to the high-end finishes required by the hotel brand.

Mechanical – The estimate is most likely high because individual mechanical units (VTACs) are used in every room. Additionally, besides the VTAC units, the mechanical equipment necessary for the hotel has minimum requirements because it is only supplying the hallways (vertical ductwork only) and first floor.

Site Logistics

The site logistics plan can be found in Appendix 0.3. The location of the Heartland Hotel is on the corner of two one-way streets. Its neighboring buildings include a 12-story historical brick building and a 7-story parking garage which will attach to the hotel. The job trailer is located approximately one block north and 2 blocks east of the jobsite (images cannot be included due to confidentiality). Construction must be wary of the historical brick building because it is only offset from the Heartland Hotel property by approximately 2'.

Parking for construction personnel is located off-site and most likely in nearby parking garages/lots in the city. The limited space that is available for materials is located at the back corner of the site (adjacent to the two neighboring buildings). Additionally, two drive lanes will pass underneath the building, making site-accessibility limited to a 17' wide one-way street. A drive lane and sidewalk/bike lane closure is necessary to provide delivery lanes and perform work on the Xcel Energy vault. The crane used will need to be able to clear the 12-story adjacent building, so the height will be 3 stories larger than the Heartland Hotel requires. Due to limited site space and schedule acceleration, the column rebar will be formed off-site and brought to the site only on the day that it will be installed.

MAE REQUIREMENTS

The information and knowledge gained from the coursework in the MAE program assisted with the research and analysis. Specifically, the first analysis of a redesigned 9th story incorporates a cash flow and business model investigation. Both of these areas of study were taught and discussed in AE 572 – Project Development and Delivery Planning. The second analysis, where the link bridge will be constructed as a prefabricated module, will integrate information learned from AE 570 – Production Management in Construction. Finally, the third analysis, a structural lift system, will include a 4D simulation. While this specific technology used was not taught, the thought process behind producing this simulation was discussed in AE 597F – Virtual Facility Prototyping.

ANALYSIS 1: 9TH STORY DESIGN CHANGE

Background Information

The Heartland Hotel is currently being constructed in a heavily rundown area, yet a 30-year city improvement plan involves restoring this area and turning it into a high-end district. Mortenson Development Incorporated (MDI) selected this site in order to be one of the first, partial owners of a high-end hotel, to pursue a shift in culture, and to be a "billboard" entering into this emerging nightlife region. One of the founding missions of Heartland Hotels across the world is to offer guests a luxurious escape from the hectic world.

Figure 1.1: Standard floorplan for floors 2-9.

Currently, the Heartland Hotel offers eight floors with 245 total rooms to guests. All rooms are standard layouts, containing either one king bed (174 rooms available), or two double beds (71 rooms available). Each floor is approximately 14,600 square-feet and has one central hallway through the middle of the floorplan, with rooms on either side (Figure 1.1). Room sizes vary slightly depending on the location within the building, but are for the most part similar in size (Figures 1.2 and 1.3).

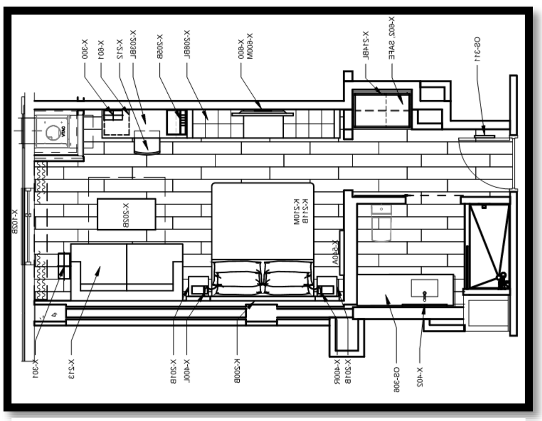


Figure 1.2: Standard king room layout

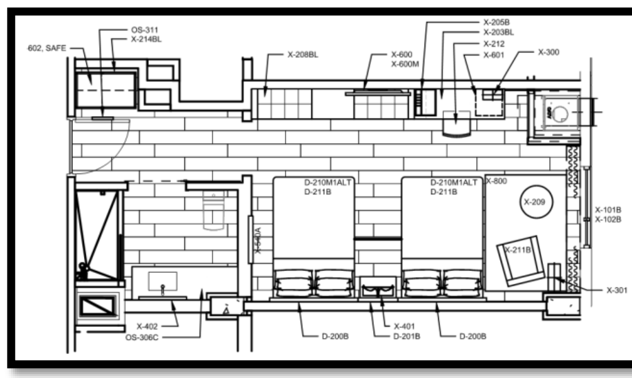


Figure 1.3: Standard double double room layout

Potential Opportunity

Because the Heartland Hotel aims to attract guests to a luxurious experience, an opportunity arises to provide guests with extra-luxurious rooms. There are currently zero exclusive rooms, or suites, available for guests to use. By redesigning the top, ninth floor of the hotel, rooms can be reconfigured for additional accommodations typically found in suites. The repetitive floorplan provides an opportunity to combine multiple rooms into one suite, thereby offering additional space for dining, conducting business meetings, cooking, and/or accommodating more guests than usual. By combining multiple rooms into one, the structure and façade would remain the same, while the interior design and architecture would be transformed. This opportunity to provide suites would offer a greater variety of room choices for guests, and could therefore reach a broader range of customers.

These room changes have the potential to impact the business model of both Heartland Hotel and MDI due to the partial ownership. The cost/room of the suites would be greater than standard rooms, thereby impacting overall potential revenue; however, the total number of available rooms would decrease. Additionally, the suites would require changes with interior construction and fixtures, furnishings, and equipment (FF&E).

Analysis Goals

The following list includes the steps that will be taken in order to perform this analysis:

1. Interview an MDI employee to gain background information on the decision to not include suites
2. Research nearby attractions and public transportation
3. Research nearby hotels, accommodations, prices, and sizes of suites
4. Determine an appropriate number and price of suites
5. Redesign the ninth-story layout to include the suites
    a. Include brand requirements and specifications
6. Calculate interior construction and FF&E costs
7. Analyze the change in the construction schedule

The success of a hotel greatly depends on the location and surrounding areas. By researching nearby tourist attractions and public transportation, the appeal of the hotel location can be qualitatively assessed. Nearby hotel prices, layouts, and accommodations will also reveal what guests expect in that area of the city. Through this research, standard square-footages and prices can be determined.

By defining the price and square-foot range, as well as standard occupancy rates for the area, an occupancy vs. revenue chart of various numbers of suites will reveal the optimum price range and amount of suites. Pairing the ideal number of suites with a new floorplan, the study will analyze the suites' impact on the potential revenue for the hotel and MDI, the changed interior construction and FF&E cost, and the overall schedule for the ninth floor.

Through the research, calculations, and redesign, a final recommendation to include or not include suites will be made based off of the qualitative and quantitative information received and produced.

Execution

Considerations

In order to more fully understand the reasoning behind not including suites, an MDI executive involved in the Heartland Hotel project was interviewed. The transcript from this interview can be found in Appendix 1.1. The following considerations are based off of the interview as well as additional research done on advantages and disadvantages of suites (Table 1.1).

MDI has a minority interest in the property, meaning that the better the hotel profit, the more money MDI makes. Therefore, when considering the room design, MDI had invested interest in the profitability of the hotel. Many of the decisions made concerning the layout of the hotel were front-end decisions. The initial guideline was the height of the building, which dictated the programming. Then, it was decided that 240-250 total keys (or rooms) was desired. By looking at the surrounding areas, it was noted that the primary business that the hotel would receive was from weekday, business personnel traffic. This type of customer desires a nice stay for a relatively cheap price.

With this, the net operating income/cost of the asset, or cap rate, was the return standpoint which needed significant consideration. Hotels have a higher cap rate that other residential buildings like apartments. This means that the hotel needs X% more in cash flow and return in order to compensate for the nightly risk that is incurred with running a hotel. Because hotels are reflective of the economy with nightly leases, the profitability is always uncertain. By including suites in a design, the MDI representative stated that it would make the profitability riskier.

Table 1.1: Advantages and Disadvantages of Suites

Potential Advantages	Potential Disadvantages
Increased beverage/food revenue	Fewer rooms available
Decreased cost of cleaning/square foot	"Riskier" cap rate
Potentially higher occupancy rate	Higher gross square-footage/key, so greater construction cost/key
Wider range of consumers (larger groups and parties)	Public uninterested in additional cost
More room features available	

Nearby Points of Interest and Public Transportation

In order to assess the type of consumer interested in staying at the Heartland Hotel, local points of interest and available public transportation were mapped in relation to the hotel (Figure 1.4). Table 1.2 is a key for the different markers from Figure 1.4.

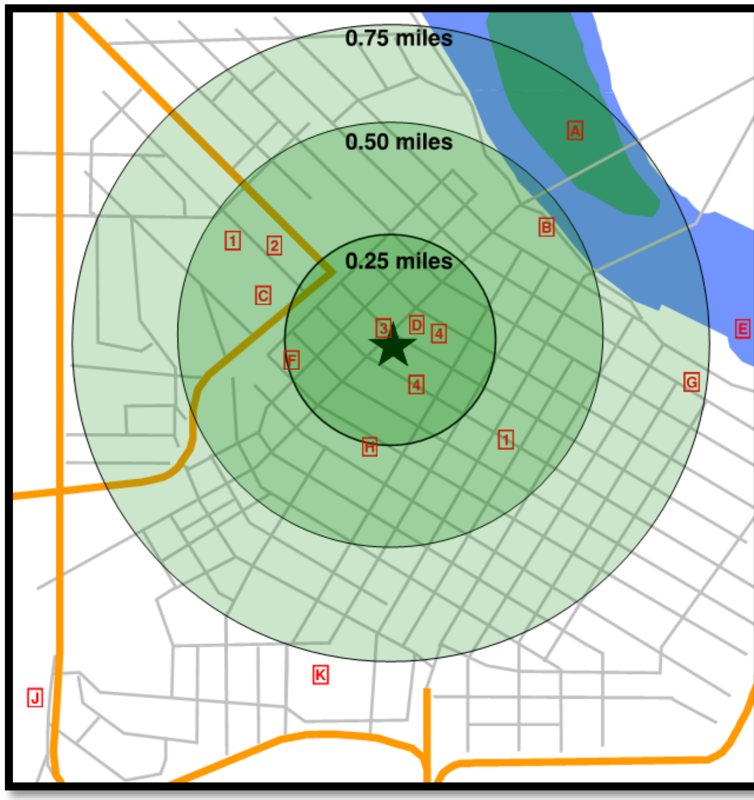


Figure 1.4: Nearby points of interest and public transportation

Within one mile of the Heartland Hotel, nine local attractions and points of interest are available for tourists to visit. Two of these places are sporting event fields/arenas, which attracts large amounts of people – both natives and tourists. Additionally, the convention center, which serves as a gathering place for large amounts of people, is only one mile away. Between these three locations where many people gather at one time, as well as the seven other historical and/or interesting places, the Heartland Hotel is located in the middle of an area which would likely see consistent streams of tourists.

Additionally, four very different methods of public transportation are available. The light rail station, with two different routes, allows people to travel between this city, another major city, and one of the most well-known tourist attractions in the Midwest. Additionally, the first rail platform for the train is located 0.4 miles away from the Heartland Hotel, and travels northbound with six stops over 40 miles. Across the street is one of many bus stops that run within and outside of the city. It is estimated that nearly 225,000 people board this bussing system daily. Finally, this Midwestern city has a bike-sharing option available, with two stations located within 400 feet of the hotel. Because bike stations are located throughout the city, the Heartland Hotel offers a great nearby location for tourists to explore the city via bike.

Table 1.2: Key for points of interest and public transportation map

Point Label	Points of Interest	Distance from Heartland Hotel (as the crow flies)
A	Historic Island	0.8 miles
B	River Parkway	0.5 miles
C	MLB Field	0.5 miles
D	Library	Across the street
E	Historical Bridge	1.0 mile
F	Multi-purpose Arena	0.3 miles
G	Historical Society museum	0.9 miles
H	Twelve-block Outdoor Mall	0.3 miles
J	Art Center	1.4 miles
K	Convention Center	1.0 mile
Point Label	**Public Transportation**	**Distance from Heartland Hotel (as the crow flies)**
1	Light Rail Station	0.1 miles
2	Train Station	0.4 miles
3	Bus Stop	Across the street
4	Public Bike Sharing Stations	Two located within 400 feet

With the significant amount of nearby points of interest as well as public transportation, the Heartland Hotel is located in an area which would likely attract tourists. There are enough major points of interest to attract large amounts of visitors at one time, as well as smaller points of interest to attract casual tourists who are interested in exploring and learning more about the city. Additionally, the public transportation serves as a connection between various parts of this city, as well as other major cities. The range of public transportation would allow guests to reasonably stay at the Heartland Hotel and see the city, as well as justify remaining at the Heartland Hotel when they travel to other cities/locations.

Through this study of the surrounding areas of the Heartland Hotel, it is reasonable to assume that the Heartland Hotel will see more than just weekday, business personnel traffic, and will in fact, see a significant amount of tourists. This high probability that the Heartland Hotel will serve many tourists impacts the types of rooms offered, the percent occupancy rates, and the cost per room.

Nearby Hotel Amenities

The success of a hotel depends on making a profit via guests purchasing rooms for one or more nights. Because of the size of the city, 28 competing hotels are located within 0.75 miles of the Heartland Hotel. Therefore, the price, room square-footage, and accommodations of the Heartland Hotel must be compared to nearby hotels in order to ensure that guests are receiving an equal, if not better, experience at the Heartland Hotel. Figure 1.5 shows the locations of the 28 hotels within the 0.75 mile range. 24 of the 28 hotels are located south of the Heartland Hotel, which suggests that more downtown activities take place in that area of the city; however, Figure 1.4 shows that many of the local points of interest seem to be in all directions from the Heartland Hotel. Therefore, while it may appear that the Heartland Hotel is located too far north to be considered a tourist-attracting hotel, points of interest and public transportation show otherwise.

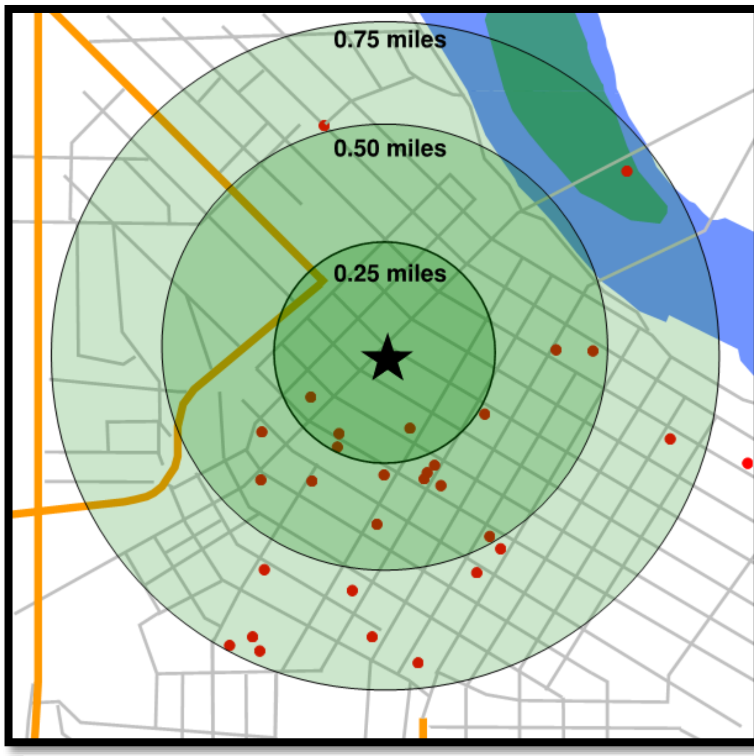


Figure 1.5: Nearby hotels, as seen with red circles

Of the nearby hotels which offer suites, common amenities found in the suites are listed below:

Sofa bed	Seating area	Living room	Multiple beds	Adjoining rooms	Privacy walls
Dining area	Equipped kitchen	Wet bar	Loft	Parlor area	Media den
Work area	Conference table	Walk-in closet	Jacuzzi	1-2 bathrooms	

While all of these accommodations will not be included in the suite redesign, many will be considered and weighed against what is offered by Heartland Hotel.

Nearby Hotel Prices

Heartland Hotel will not welcome guests until November; therefore, the costs of standard rooms and suites for a November 1st-2nd occupancy at nearby hotels was collected for comparison. Through this data collection, multiple price ranges were calculated.

The Heartland Hotel is owned by an international hospitality company (Company X) with multiple different "brands." Because of the large size of Company X, many of its brands are located throughout this city. Due to similar business practices and proceeding on the assumption that suites will be included in Heartland Hotel, all Company X hotel suites within 0.75 miles of the Heartland Hotel were gathered to compare price vs. square-footage (Figure 1.6). While there is no definite linear correlation between price and square-footage of Company X hotels, the price range is between $190 and $460, while the typical square-footage is between 309 and 950 square feet.

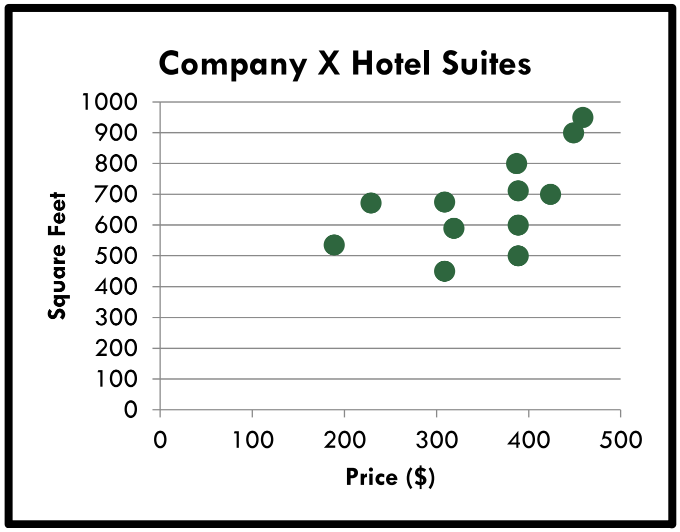


Figure 1.6: Company X hotel suite prices vs. square feet

Heartland Hotel will be a 3-star hotel that will not only be in competition with other Company X hotels, but also with surrounding hotels of similar status. Figure 1.7 depicts all nearby 3-star hotel suites and Company X hotel suites to compare price per square-foot differences between the two categories of hotels. Again, while there is no linear correlation, there is a grouping of data which ranges from $190 to $460 and 362 to 950 square-feet. From the data, it can be assumed that there is minimal, if any, difference between price per square-foot for suites for Company X and 3-Star hotels.

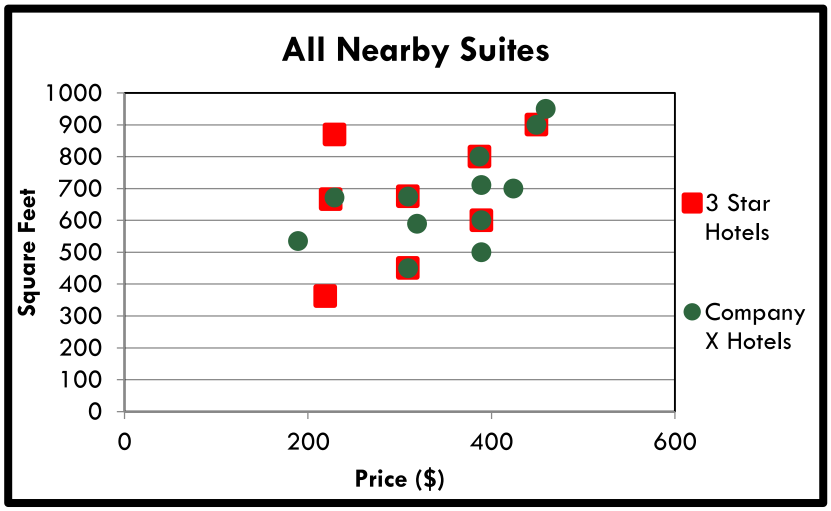


Figure 1.7: Company X hotel suites vs. all nearby 3-star suites

Determining the price of a suite must take into account the cost of a standard room. If the gap between the two rooms is too small or too great, occupancy rates can become skewed and the added cost for maintainence will likely impact profit. Hotel star-ratings are a common way for travelers to choose a hotel. Figure 1.8 compares the price per room of both standard rooms and suites vs. the star-rating of the hotel.

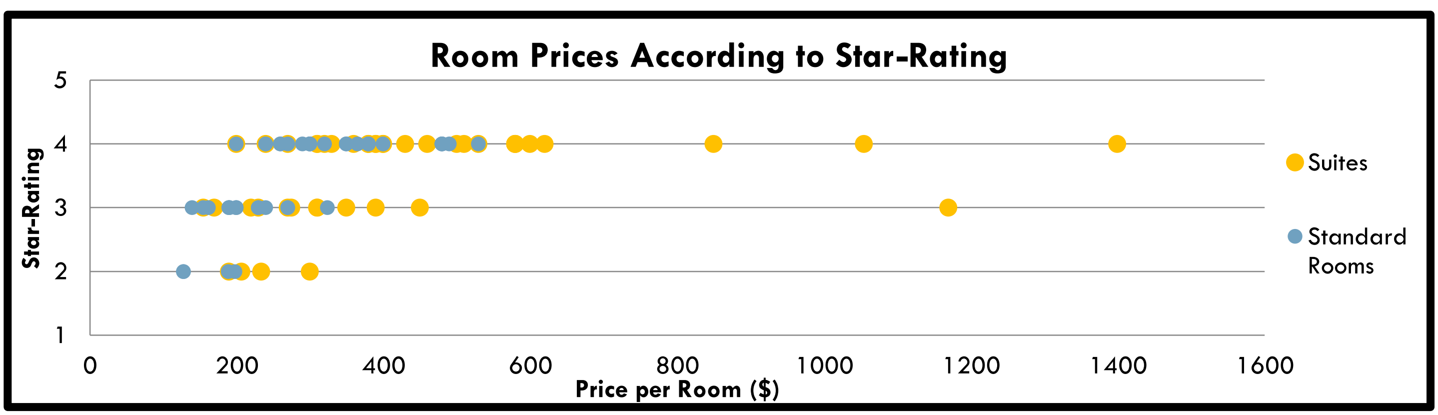


Figure 1.8: Price per room vs. star-rating

While there are several anomolies in the data (suites costing greater than $800), it is safe to assume that all suites, no matter the star-rating, tend to be slightly more expensive and have a greater price range than standard rooms. Additionally, the better the star-rating, the more expensive the room.

Table 1.3: Cost estimate for hotels based off star-ratings

Star Rating	2	3	4
Average Cost/Standard	$ 159.75	**$ 212.71**	$ 342.80
Average Cost/Suite	$ 231.75	**$ 357.33**	$ 494.37

The information thus far has been able to provide ranges for suite and standard prices, yet a definitive cost cannot be established solely off these ranges. Therefore, the average cost per room of 3-star hotels can begin a base cost per room estimate (Table 1.3). Additionally, the average cost per square-foot of 3-star and Company X hotels, as well as the cost per square-foot of all nearby hotels can establish a second base cost and reasonable range (Table 1.4). With current standard room sizes in the Heartland Hotel at approximately 320 square-feet, it is assumed that a suite will merge two rooms, resulting in a 640 square-foot suite.

Table 1.4: Cost Estimate from Average Cost per Square-Foot

	3-Star + Company X	All Nearby Hotels
Average $/SF	0.5088	0.6626
Cost for Standard Room Size (320 SF)	**$ 162.82**	**$ 212.03**
Cost for Suite (640 SF)	**$ 325.63**	**$ 424.06**

The range from Table 1.4 certifies the accuracy of the cost estimate in Table 1.3. Therefore, it is likely that the standard room will cost around $212 while the suite will cost around $360.

Special consideration must be given for what the cost of a room depends on. Not only is it based off of competing prices, but additional guest statistics and costs for cleaning must be considered. The occupancy rate of the city is one of the higher rates in the nation, at aroud 72%. This means that on average, 72% of available hotel rooms will be rented for the night. Additionally, rooms incur costs to clean. The larger the square-footage of the room, the more it costs to clean. However, most of the cleaning cost arises from bathroom supplies. If a suite has double the square-footage but still contains only one bathroom, it is assumed that the cleaning cost for a suite is not double that of a standard room. The cost to clean a standard room will be priced at $10 per room while the cost to clean a suite will be priced at $15 per room (or 1.5x that of a standard room).

Suites Occupancy

There are currently six other Heartland Hotels throughout the nation, five of which have suites. To accurately gauge the profitability of their suites, brief interviews were held (Table 1.5).

Table 1.3: Heartland Hotels around the nation on suites

Heartland Hotel	Number of Suites	Number of Standard Rooms	Typical Price of Suites	Typical Price of Standard Rooms	Do the suites fill up quickly?
#1	2	224	$100 more than standard rooms	$79-$499 (summer)	"Not really"
#2	2	121	Same price range as standard rooms	N/A	"Business and parties use the suites often. I wish we had more"
#3	4	150	$70-$100 more than standard rooms	N/A	N/A
#4	7	192	$399-499	$249-399	"Yes, they get filled up very quickly"
#5	4	49	$169-$189	$109-$129	"They typically fill up, or we upgrade guests into them"

Of the four hotels which commented on the occupancy rates of the suites, three stated that the number of suites the hotel had filled up quickly. This leads to the assumption that a higher occupancy rate than standard rooms could potentially be associated with suites.

To quantify the profitability of including suites, the profit will depend on the price of suites and standard rooms, occupancy rates, specified cleaning rates, and the number of suites and standard rooms. Because most Heartland Hotel representatives stated that their suites fill up quickly (averaged at 4.33 suites per hotel), for this project, between one and five suites will have the same occupancy rates and prices. From the cost estimates, the baseline for a suite will be $360 with a $15 cleaning fee, and the baseline for a standard room will be $212 with a $10 cleaning fee.

Five Suites Study

The following is an analysis of prices and occupancy rates for five suites. Corresponding numbers and graphs can be found in Tables 1.6 and 1.7, and Figure 1.9.

Table 1.4: 5 suites occupancy and price study

5 Suites	
Occupancy Rate	**Cost per Suite**
100%	$220
87%	$325
82%	$360
72%	$424
0%	$950

For five suites at $360, it is estimated that the occupancy rate will be slightly higher than average, at 82%. Again, this is due to the response for generally needing more suites. With standard rooms costing $212, an $8 jump to $220 for suites would likely cause 100% occupancy rate due to the extremely low prices. The lowest value for a 3-star and Company X suite is $325. Being on the lower spectrum of prices, this rate for a hotel room would likely see a 5% increase from base occupancy of %82, at 87% - or 15% above the normal occupancy rate. On the more expensive side of the spectrum, $424 is the average cost per square foot of all nearby hotel suites. Therefore, this would likely reach a normal occupancy rate of 72% because of the luxurious appeal of the Heartland Hotel. The middle value between the second and third highest 4-star prices was around $950. Therefore, it is safe to assume that if the price per suite at the Heartland Hotel was $950, occupancy would be 0% because guests would take their business to higher-rated hotels. 0% occupancy needs to be a higher, definitive number because this is guaranteeing that nobody will ever purchase this room. If this price is too low, this will skew numbers and skew the overall revenue.

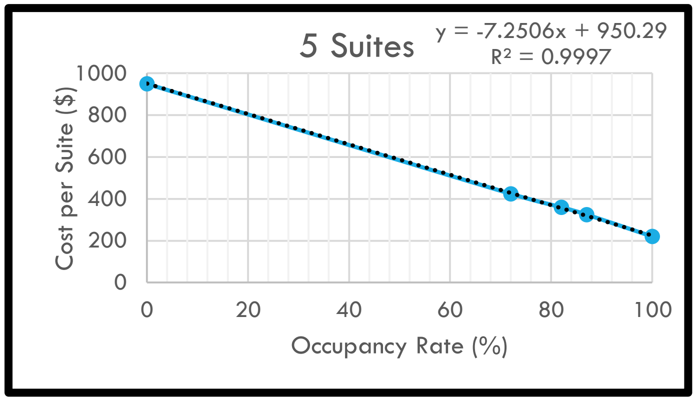


Figure 1.9: 5 suites occupancy rate vs. cost trend line

From here, the price and occupancy rates were graphed and a trend line was drawn to gather prices at 10% incremental occupancy rates (Figure 1.9 and Table 1.7). An R^2=0.9997 represents an accurate linear trend line fit. The revenues were calculated as follows:

$$\textit{Revenue from Suites} = (OR)(C - SF)(NS)$$

$$\textit{Revenue from Suites and Standard Rooms} = (NT - NS * 2)(CT - TF)(72\%) + \textit{Profit from Suites}$$

Where OR = Occupancy Rate (%)
C = Cost per Suite ($)
SF = Suite Cleaning Fee ($15)
NS = Number of Suites.
NT = Number of Standard Rooms (245)
CT = Cost of Standard Rooms.
TF = Standard Cleaning Fee ($10)

Standard rooms have a typical occupancy rate of 72%, and every suite replaces two standard rooms.

Table 1.5: Extrapolated suite costs and profit for 5 suites

5 Suite Trend line		Revenue from Suites	Revenue from Suites and Standard Rooms
Occupancy Rate (%)	Cost per Suite ($)		
100%	$225.23	$ 1,156.27	$ 35,334.67
90%	$297.74	$ 1,399.54	$ 35,577.94
80%	$370.24	$ 1,563.06	$ 35,741.46
70%	$442.75	$ 1,646.83	$ 35,825.23
60%	**$515.25**	**$ 1,650.84**	**$ 35,829.24**
50%	$587.76	$ 1,575.09	$ 35,753.49
40%	$660.27	$ 1,419.59	$ 35,597.99
30%	$732.77	$ 1,184.32	$ 35,362.72
20%	$805.28	$ 869.31	$ 35,047.71
10%	$877.78	$ 474.53	$ 34,652.93
0%	$950.29	$ -	$ 34,178.40

Ten Suites Study

To calculate a range for the optimum number of suites, the same process carried out for five suites was carried out for ten suites. The same prices per suite were kept due to the calculated averages from which they originated. Corresponding numbers and graphs can be found in Tables 1.8 and 1.9, and Figure 1.10.

Table 1.6: 10 suites occupancy and price study

10 Suites	
Occupancy Rate	Cost per Suite
100%	$220
62%	$325
52%	$360
42%	$424
0%	$950

For consistency, a price of $220 and $950 remained paired with 100% and 0% occupancy rates respectively. With the lowest average price for a suite at $325, this would likely result in an occupancy rate 10% below the normal rate of 72%, or 62%. This is due to the increase in availability and therefore decrease in demand. The next rate used was $360. With the increase in number of suites, the demand for the suites at this price decreases by about 10% from $325, or 52%. Increase in supply decreases demand; yet, offering more suites also reaches a wider range of consumers like large parties and groups of people interested in renting multiple suites together. Therefore, the demand slightly increases as well. With five-suite occupancy normally decreasing 5% and 10% between $325 to $360 and $360 to $424 respectively, the demand due to higher supply decreases 10% with each, resulting in 15% and 20% respectively. However, by reaching a larger range of consumers, demand also increases because of this variety. Therefore, a 5% and 10% increase from variety leads to a resulting 10% and 10% decrease in occupancy rates respective to price and 5-suite occupancy rates.

From here, the price and occupancy rates were graphed and a trend line was drawn to gather prices at 10% incremental occupancy rates (Figure 1.10 and Table 1.9). An R^2=0.9975 represents an accurate polynomial trend line fit. The revenues were calculated the same as five-suite revenues were calculated.

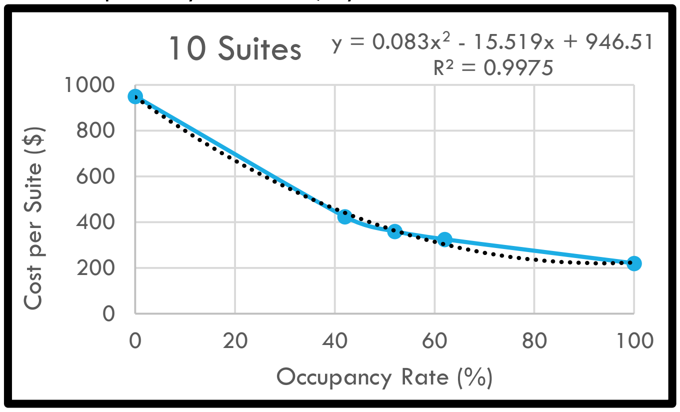


Figure 1.10: 10 suites occupancy rate vs. cost trend line

Suite Profitability

With the five and ten suite ranges set, six, seven, eight, and nine suite layouts were calculated with the set prices ($220, $325, $360, $424, and $950) and average occupancy rates between the five and ten suite occupancy rates. From here, graphs similar to Figures 1.9 and 1.10 were created to calculate trend lines. The trend lines of occupancy rate vs. calculated costs per suite for five to ten suites is found in Figure 1.11. While 5 suites tends to have a linear relationship between cost per suite and occupancy rate, this gradually turns into a decreasing polynomial relationship as the number of available suites increases.

Table 1.7: Extrapolated suite costs and revenue for 10 suites

5 Suite Trend line		Revenue from Suites	Revenue from Suites and Standard Rooms
Occupancy Rate (%)	Cost per Suite ($)		
100%	$ 224.61	$ 2,096.10	$ 34,820.10
90%	$ 222.10	$ 1,863.90	$ 34,587.90
80%	$ 236.19	$ 1,769.52	$ 34,493.52
70%	$ 266.88	$ 1,763.16	$ 34,487.16
60%	$ 314.17	$ 1,795.02	$ 34,519.02
50%	**$ 378.06**	**$ 1,815.30**	**$ 34,539.30**
40%	$ 458.55	$ 1,774.20	$ 34,498.20
30%	$ 555.64	$ 1,621.92	$ 34,345.92
20%	$ 669.33	$ 1,308.66	$ 34,032.66
10%	$ 799.62	$ 784.62	$ 33,508.62
0%	$ 946.51	$ -	$ 32,724.00

The calculated revenue from suites alone is found in Figure 1.12. Between nine and ten suites tend to make the most revenue, yet because of the linear relationship of five suites and occupancy rates, five suites makes a larger revenue than six suites in every situation.

Finally, Figure 1.13 shows the total revenue made from the suites and standard rooms. The black "0 Suites" line shows the potential nightly revenue with the current design of zero suites.

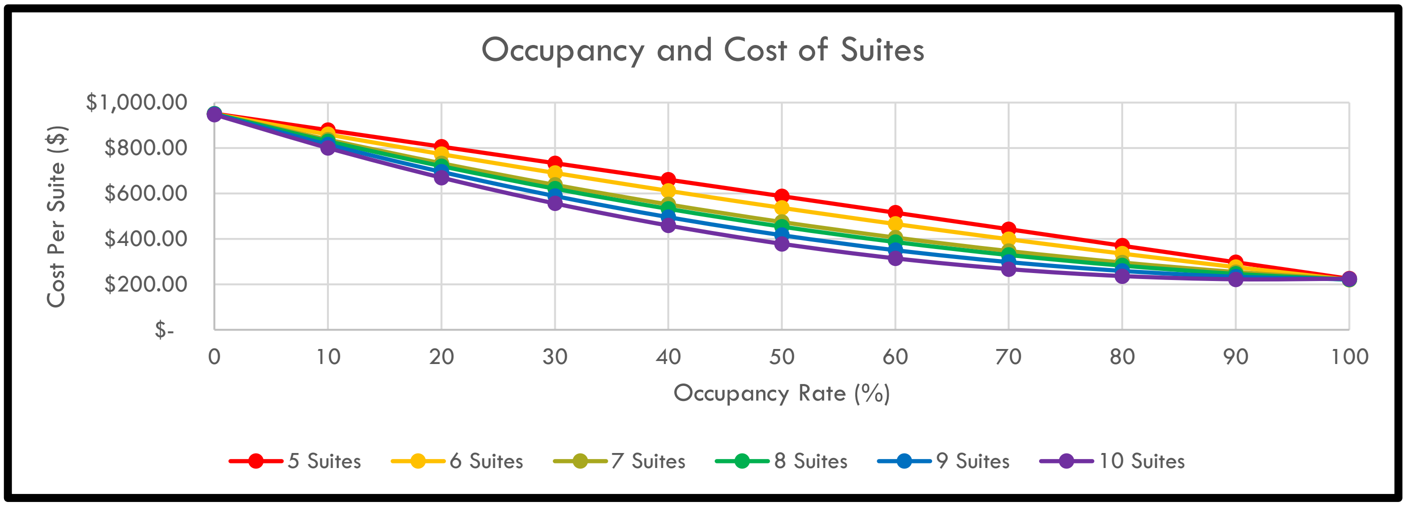


Figure 4: Occupancy and cost of suites 5-10

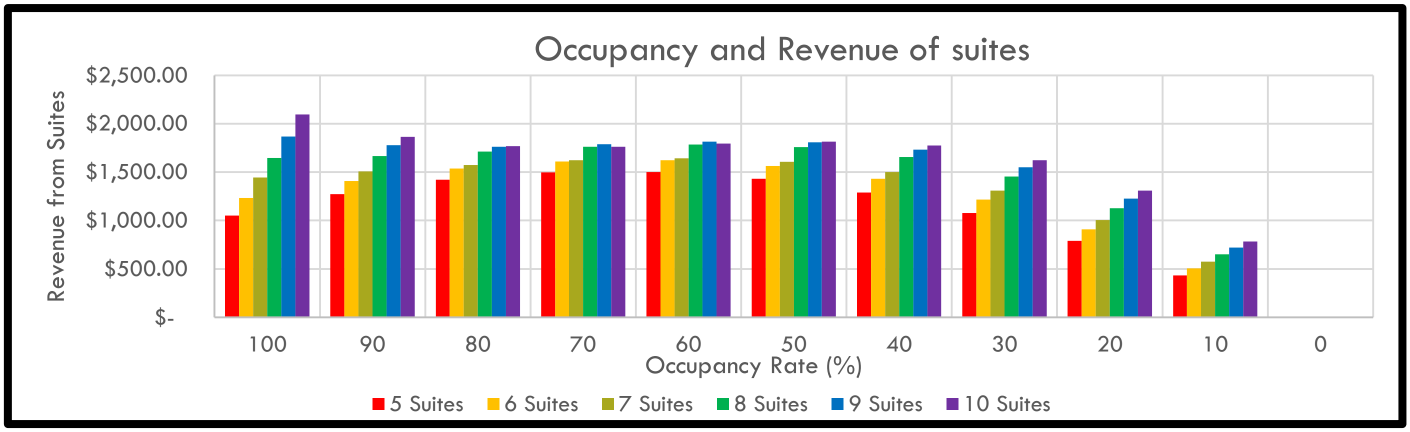


Figure 1.12: Occupancy and revenue of suites 5-10

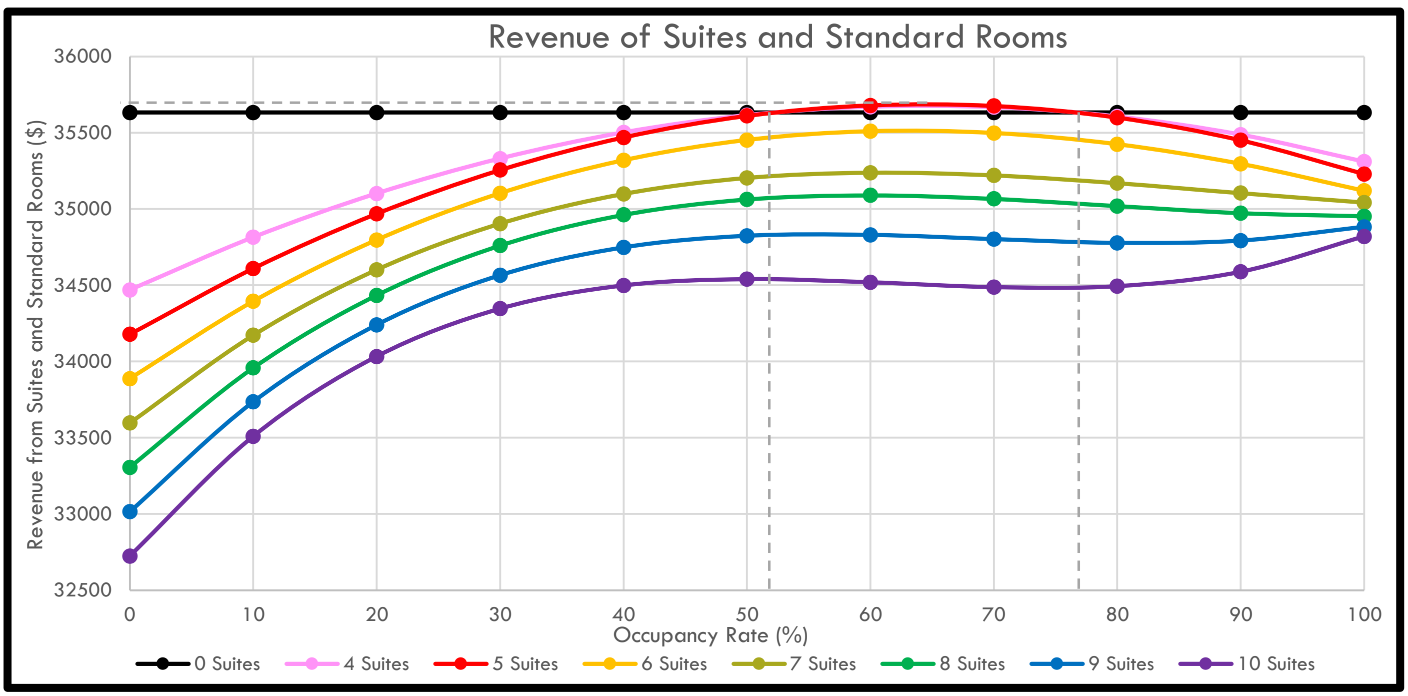


Figure 1.13: Total revenue of suites and standard rooms

By including suites, five suites produces the most overall available revenue between 52% and 77% occupancy rates (as seen by the grey dashed lines). The costs associated with these occupancy rates are $573 and $392 respectively. At these occupancy rates, the same revenue would be made as with only standard rooms, or around $35,630. However, if the occupancy rate for these suites is between 52% and 77%, which is likely given the standard occupancy rate of 72% as well as the local attractions and public transportation, the suites would increase potential revenue for the hotel, reaching a maximum of around $35,686 at 65% occupancy, or $56 more per night. 65% occupancy correlates with a nightly rate of $479.

Designing a layout with more than five suites would decrease profitability due to decreasing the number of standard rooms. Four suites has the same price and occupancy rates as five suites, and therefore would not make as high of a revenue increase between 52% and 77% occupancy rates as five suites.

Suite Profitability at 90% and 110%

The numbers and calculations were based off of research and assumptions. In order to provide a comprehensive analysis of the profitability potential of including suites, the occupancy rates will be observed at 90% of the initial rate and 110% of the initial rate. Appendix 1.2 contains the total revenue of suites and standard room graphs at 90% and 110%. A 10% decrease in occupancy rates would make any number of suites less profitable than all standard rooms by a minimum of $19 per night with one suite and $101 per night with five suites, while a 10% increase in occupancy rates would make five suites more profitable by nearly $250 per night.

Floorplan Redesign

From the suite profitability study, it was determined that five suites is the optimal number for the Heartland Hotel. The floorplan of the building has a string of ten king rooms on the west exterior side of the building. These ten rooms were chosen to be converted into suites because of the view that they provide for guests as well as to make the interior hallways look architecturally more continuous. The brand specifications that apply to the Heartland Hotel were followed for changes in FF&E, but they did not apply to the room size and use changes. The brand specifications callout the design standards and intent; therefore, by changing the room layout without changing the FF&E, these brand specifications are followed.

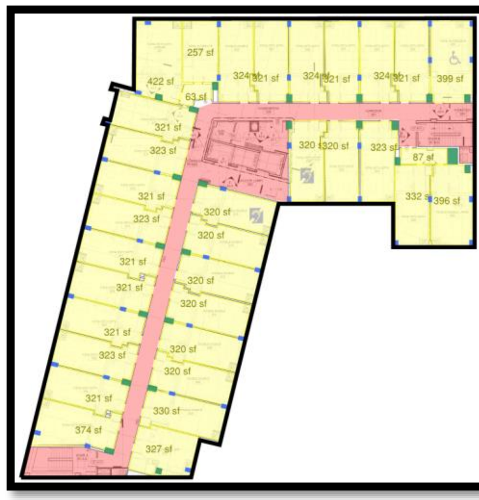


Figure 1.14: 9th story layout
Red=hallway, Yellow=rooms

The current layout has a central hallway with columns and plumbing shafts located on a grid system between every two rooms (Figure 1.14 and 1.15). These "unchangeable elements" were accounted for in the final redesign of the suites so that the structure, mechanical system, and means of egress did not change. Two types of suites were detailed. Table 1.10 lists the features found in each type of suite designed.

Figure 1.15: 9th story layout
Green=mechanical shaft, Blue=columns

Table 1.8: Features of the suites

Amenities in Both Designs	
King bedroom with an extra-large closet	
Double Double bedroom with a TV	
Extended bathroom with extra sink and mirror	
Suite with a Dining Area	**Suite with a Living Room**
Refrigerator	Sleeper-Sofa
Stove and Oven	Extra sofa and Individual Chair
Kitchen Sink	Rectangular Cocktail Table
Island Counter	Additional TV
Dining table – seats 6	Two Side Tables

Figures 1.16 and 1.17 contain the final five-suite layout design.

One additional note with the suite layout is that the VTAC (Vertical Terminal Air Conditioning units) remain in the same location as the original design. They are therefore in the two bedrooms but not in the dining area or living room. If it is deemed necessary to have an air-exchange system between the three rooms, there is 1'6.5" high open space between the ceiling and the bottom of the floor above, which could house the duct to remedy this issue.

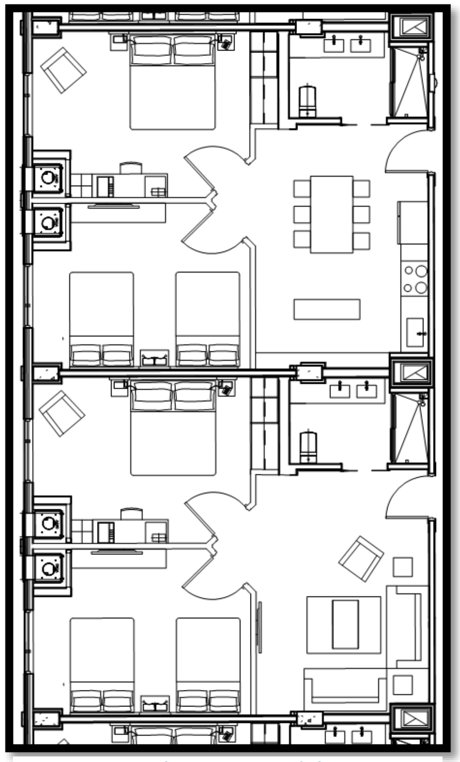


Figure 1.16: Close-up view of the two types of suites

Figure 1.17: Overview of the five suites

Suite Construction Cost Analysis

A detailed take-off was performed on both the redesigned floorplan and the original floor plan. Three separate areas were impacted by the redesign: finishes, furnishings, and construction (Appendix 1.3).

The suites maintained typical finishes, furnishings, and construction details, but the amount of each was modified to account for the design change. When comparing costs between the suites and the standard rooms, there are ten standard rooms and five suites within the same area. Therefore, the cost of the standard construction will be multiplied by ten and the cost of the suite construction will be multiplied by five.

The finishes for the suites, which included paints, flooring, baseboards, and tile, was $6,078 less expensive than the standard rooms. This is mainly because the suites have only one bathroom and each standard room has one bathroom, totaling five total suite bathrooms and ten standard bathrooms. To perform a take-off for the suite furnishings, both types of suites were analyzed and multiplied by 2.5 to equal five rooms. While the suite floorplan currently shows three kitchen layouts and two living room layouts, for cost calculation purposes, there will be 2.5 kitchen layouts and 2.5 living room layouts. Therefore, the furnishings, which included standard furniture as well as the added suite amenities, cost $8,187 less than the standard rooms. Finally, the construction, which consisted of wall construction (studs, insulation, furring channels, gypsum board, etc.), cost $19,454 less than the standard rooms. In total, the suite finishes, furnishings, and construction cost $33,719 less to build than the standard rooms.

This decreased cost is mainly due to the types of walls within the suites. Standard-to-standard room walls have 3-5/8" studs at 16" o.c., insulation, ½" resilient furring channels at 24" o.c., and three layers of gypsum wall board. This is for privacy between guest rooms. However, suites do not require this extensive of a wall between the king and double double rooms because guests are part of the same group. By not including this thick wall, nearly $13,000 is saved. Additionally, the suites only contain one bathroom instead of two. This impacts the tile finishing in the bathroom, as well as greatly impacts overall construction costs. The walls between the bathroom and bedroom are thick for privacy and plumbing. The bathroom door is also an extensive sliding glass barn door. By halving the required bathroom doors and bathroom walls, an additional $10,000 is saved.

Construction Schedule Impacts

Similar to the construction cost analysis, the construction schedule decreases by nearly 274 man-hours by replacing ten standard rooms with five suites. The reduction of the total number of bathrooms from ten to five greatly impacts the schedule by decreasing the time spent installing bathroom wall tile, a shower pan, and thick, waterproof walls.

The finishes are reduced by 89 total man-hours. This reduction includes a 20 hour increase due to 1.13 times as much engineered wood laminate flooring. However, the majority of the schedule reduction comes from the wall tile and wall vinyl installation time.

A majority of the furnishings did not include additional man-hours because the furniture was simply placed in the rooms and not "installed." The furnishings schedule did have an 8 hour increase in man-hours, mainly due to the cabinets and countertops found in the kitchen floorplan.

Along the same lines as the construction cost decrease, the schedule decreased by nearly 194 man-hours because of the different wall construction types. With half as much room-to-room construction, less material and man-hours are required to make thinner walls. Therefore, by replacing these thick walls with thinner, suite bedroom-to-bedroom walls, the construction duration was reduced greatly.

In total, the original layout was calculated to take 989 man-hours for ten standard rooms, while the five-suite layout was calculated to take 715 man-hours – a 274 man-hour reduction, or 28% reduction. By redesigning 10 of the 32 rooms on the 9th floor, approximately 1/3 of the ninth floor schedule is reduced by 28%. By reducing 1/3 of the construction by 28%, the total ninth-floor duration is reduced by 8.7%, or will take only 91.3% of the original time allotted. With a 38-day duration, the suite construction duration will be reduced to 34.7 days. 274 man-hours less than normal construction, or 3.3 days, adds up to about 10 workers at 8 hours per day, for three days. Therefore, this time reduction logically fits the overall construction schedule. Because this decreased duration is approximately 3 days, it will likely not impact the project schedule enough to produce an earlier turn-over date. Therefore, any additional profit from opening early will not be included.

Final Recommendation

The surrounding attractions, public transportation, and nearby hotel accommodations all point to an opportunity to provide Heartland Hotel guests with suites. By analyzing the revenue implications of replacing ten standard rooms with five suites, a potential $56 increase in revenue per night could be achieved. For a hotel which serves guests 365 days per year, this could increase the total hotel revenue by over $20,000. Not only does this added profit go to Heartland Hotel, but MDI, a partial owner, would also see this profit increase.

Redesigning the floorplan to account for the changes in finishes, furnishings, and construction, the total cost of the five suites cost $33,719 less than the construction of the ten standard rooms. Additionally, 3.3 days is reduced from the overall construction schedule.

While there is always a risk in the hotel industry with providing more expensive rooms than cheaper, more standard rooms, the surrounding area research proves that this change would be supported by the tourism industry and overall beneficial to both Heartland Hotel and MDI.

ANALYSIS 2: LINK BRIDGE REDESIGN FOR CONSTRUCTABILITY

Background Information

The Heartland Hotel offers guests parking spaces at the neighboring seven-story parking garage. For ease of accessibility, a 62' long link bridge connecting the second floor to the parking garage is provided for guest use (Figure 2.1). 27'8" feet of the link bridge is a ramp to account for the level differences between the two buildings. The interior dimension of the bridge is 7'9" wide while the exterior dimension is 9'4" wide.

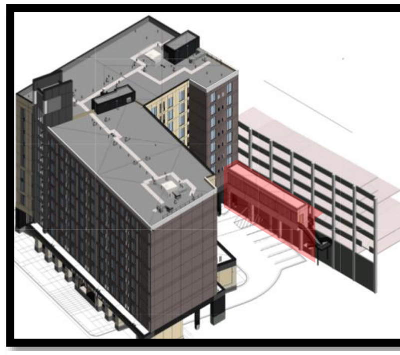


Figure 2.1: The link bridge, highlighted in red is located on the northeast side of the Heartland Hotel, adjacent to the parking garage.

The Heartland Hotel is built on the edge of the site in order to maximize the courtyard space. Because of this, the space between the link bridge and the existing concrete parking garage ranges between 1'4" and 2'6" wide. This minimal gap does not provide enough space for people, machinery, and/or tools to fit between for installation (Figure 2.2).

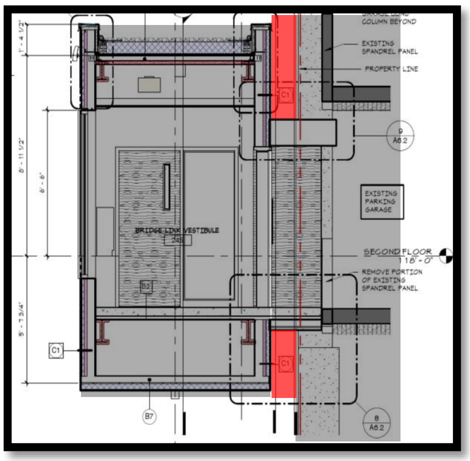


Figure 2.2: The red area in the image indicates the minimal space between the link bridge and the parking garage.

The floor of the bridge is comprised of six W12x26s running the length, and three W14x38 beams running the width. Two unspecified steel braces also support the raised floor. HSS 6x6x3/8 columns are attached to the beams in order to support the roof structure, which is comprised of six W12x26 beams and three W12x35 beams. All beams have 1-hour fireproofing protection applied. The flooring is comprised of 2" 18 GA VLI composite decking with 4 ½" normal weight concrete topping. The entire structure is supported above the first floor by 26"x20" concrete piers ranging between 15'8 and 18' tall.

A supply air duct runs below the raised floor system, with the largest dimension reaching 24"x8". This duct is connected to four 12"x4" diffusers located throughout the link bridge. A 480V, 4.0 kVA motor is located in the vestibule at the end of the bridge. Nine 6" rounded recessed LED downlights are on the bottom of the structure to light the path beneath the link bridge. Inside the bridge, six 4" circular recessed fluorescent downlights light the hallway. Additionally, the canopy lights for the courtyard are attached to the exterior façade of the bridge. The following list details the exterior sections of the bridge:

Slab on Link ***(Floor)***	**Fully Ballasted Membrane** ***(Roof)***	**Exterior Soffit Metal Stud with Stucco Finish** ***(Finish Below Bridge)***	**Metal Stud with Metal Panel Finish** ***(Sides of Bridge)***
• 4 ½" cast-in-place concrete • 2" 18 GA VLI composite decking	• Ballasted EPDM membrane • R-24 average insulation • Vapor retarder • ½" gypsum deck sheathing • Metal deck	• 3 5/8" light gauge framing • 5/8" exterior sheathing • Vapor retarder • 3" insulation • Building wrap • 7/8" stucco finish	• 5/8" gypsum sheathing • 6" metal stud framing • 1 ½" closed cell spray foam in stud cavity • 5/8" exterior sheathing • 1 ½" rigid insulation • Horizontal metal strapping • Building wrap • Metal panel system

The exterior metal panel has three types of panels: flat (at the bottom and top portions of the side of the bridge), 8" vertical ribbed (at the middle section), and horizontal ribbed (between the flat and vertical ribbed sections). Aluminum windows with tinted glass are located throughout the bridge.

The flooring is made of carpet tiles and 9" wood base. The wall is covered in vinyl, and the exit from the bridge has two wood doors and one hollow metal door connecting the vestibule to the staircase.

Potential Opportunity

With the information provided by the drawings and project team, any potential solution would need to allow for easy installation while still accounting for vast amount of materials and differing finishes required. Two potential options are prefabricated siding and modularization. Both of these options would require that the concrete piers are installed on-site.

A prefabricated siding system for both sides of the link bridge would allow workers to utilize machinery to place the siding in panels connecting to the bridge. While this would still require some sort of manual connection, it would significantly decrease the amount of time spent between the bridge and the parking garage. This method would also allow a portion of the work to be completed off-site, which would mitigate site congestion.

Creating modularized portions of the link bridge is a second option of prefabrication. With this method, the bridge would be sectioned into manageable pieces and manually attached or brought on site as one large piece. This method would also decrease site congestion and on-site construction. Additionally, modularized sections would provide closed and watertight units, allowing for finishes and fixtures to be installed within the section.

Both potential solutions will be analyzed for constructability, schedule, budget and quality, and compared with the planned site logistics layout.

Analysis Goals

The following list includes the steps that will be taken in order to perform this analysis:

1. Research the benefits of prefabricated panels and modularized units
    a. Evaluate different types and methods of prefabrication
2. Speak with the Mortenson project team about plans of action and constructability concerns
3. Analyze advantages and disadvantages of the original installation method, prefabricated panels, and modular units
    a. Choose the system which is most feasible and advantageous for the project
4. Interview a prefabrication industry professional to understand the process, cost, schedule, and logistics
5. Perform an in-depth cost, schedule, and logistical analysis of the chosen system
    a. The cost analysis will focus on the set-up costs for the alternative system vs. the labor cost for trades impacted by the limited accessibility

This analysis is expected to provide an alternate system which mitigates the problems associated with the minimal space between the link bridge and the parking garage. Potential areas of concern would be prefabricating the stucco finish on the bottom of the bridge, as this requires additional design and likely a change in material composition. While the cost and off-site construction time for prefabrication might increase, the improvement of constructability and time spent on-site is expected to overcome these probable drawbacks.

Prefabrication is becoming more advantageous and feasible in the construction industry. By looking at the link bridge, a unique extension of the building, an opportunity arises to use this construction method. The exact method for constructing this bridge is still unknown within the project team. Analyzing and potentially recommending prefabrication would not be feasible for the project in its current state, as there would likely be too much lead time. However, the research and findings associated with this analysis could benefit the Mortenson team for future projects.

Through the link bridge redesign analysis, a final recommendation to of how to proceed with the construction of the link bridge will be based off of the qualitative and quantitative information received and produced.

Execution

Research

Prefabrication is still a relatively new concept to the construction industry; however, research and case studies related to prefabrication and the advantages/opportunities that it provides are widely available. Issa J. Ramaji, a PhD Candidate at Penn State, has published a relevant article related to prefabrication: "Identification of Structural Issues in Design and Construction of Multi-Story Modular Buildings". According to his publication, it has been established that there are six major types of modular prefabrication ("Ramaji"):

1. **2D Systems** – the wall, floor, and/or ceiling are prefabricated separately and pieced together to build a room
2. **3D Systems –** a 3D volume enclosed within one prefabricated unit
3. **Open Building System –** combining and structurally attaching framing and modules
4. **Hybrid Cored-Modular Systems –** modular units which are connected by a core
5. **Hybrid Podium-Modular Systems –** modular construction above long bay spans which form a podium underneath
6. **Framing Unit Systems –** the module is inserted into a structurally framed system

Because the link bridge is the only part being analyzed for prefabrication, the hybrid cored-modular system, hybrid podium-modular system, and framing unit system are not applicable to the Heartland Hotel. Additionally, the open building system would likely be more beneficial on a project with repetitive spaces and which large enough to support the various connections. Therefore, the open building system is also deemed unsuitable for the link bridge. This leaves the 2D and 3D systems for comparison and analysis.

Table 1: Illustration of various levels of building technologies in the context of MMC (adapted from Gibb in the PrOSPa programme)

Level	Components	Description of technology
0	Materials	Basic materials for site intensive construction e.g. concrete, brickwork
1	Components	Components that are used as part of site-intensive building processes
2	Elemental systems	Linear or 2D components in the form of assemblies of structural frames and wall panels
3	Volumetric systems	3D components in the form of modules used to create major parts of buildings, which may be combined with elemental systems
4	Complete building systems	Complete building systems, which comprise modular components, and are essentially fully finished before delivery to site

Figure 2.3: Methods of construction ("Lawson")

A second conference paper, "Developments in pre-fabricated systems in light steel and modular construction" ("Lawson") describes the levels of modern methods of construction, or MMC (Figure 2.3). The current method of construction for the link bridge utilizes levels 0, 1, and 2. The only level 2 element used is the metal panel siding – the remainder of the bridge uses levels 0 and 1. By analyzing 2D and 3D systems, this would move the method of construction to levels 2, 3, and/or 4.

From a cost standpoint, this article also provided a graph detailing potential savings and losses of off-site manufacturing, or OSM (Figure 2.4).

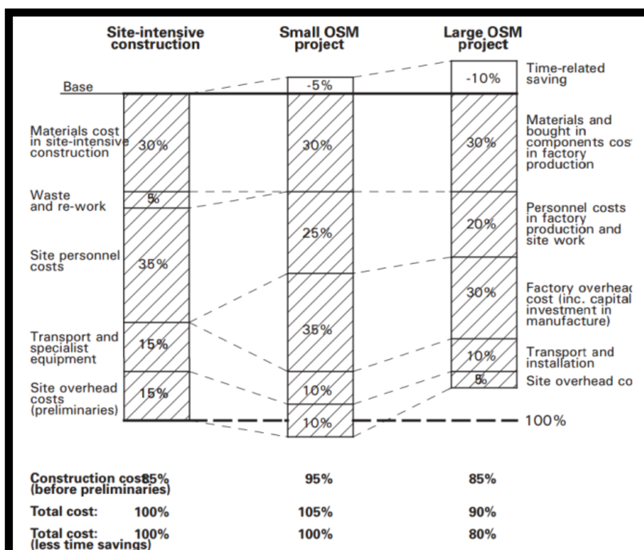


Figure 2.4: Potential cost impacts of construction with and without off-site manufacturing. ("Lawson")

Another team of researchers sent a survey to 200 parties about prefabrication. After receiving responses, Figures 2.5 and 2.6 reveal the advantages and disadvantages of prefabrication on a scale from 1-5 (1=least significant, 5=extremely significant).

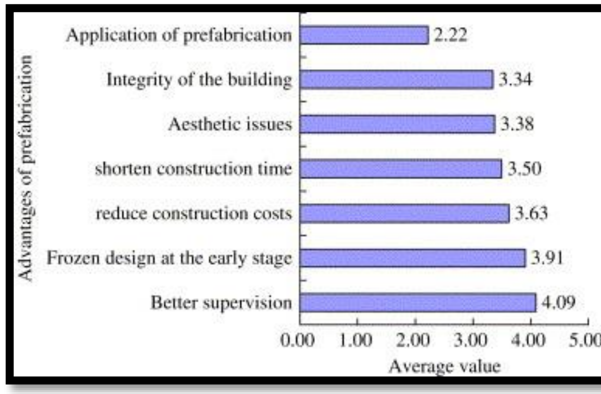


Figure 2.5: Survey responses about advantages of prefabrication ("Tam")

SteelConstruction.info, an online encyclopedia for the UK, listed technical issues/considerations which are common with prefabrication and which need to be addressed before proceeding ("Modular"):

- Dimensional Planning
    - Dimensions of spaces/areas to accommodate for typical building material sizes
    - Standard dimensions (wall heights, grid systems, etc.)
    - Transportation requirements and site accessibility
- Stability and structural integrity
    - Between units and in case of failure
- Service interfaces
    - Easy accessibility for final connections on-site
- Acoustic performance
    - Additional methods available to improve sound performance
- Fire safety
    - The cavities between modules serves as a fire barriers

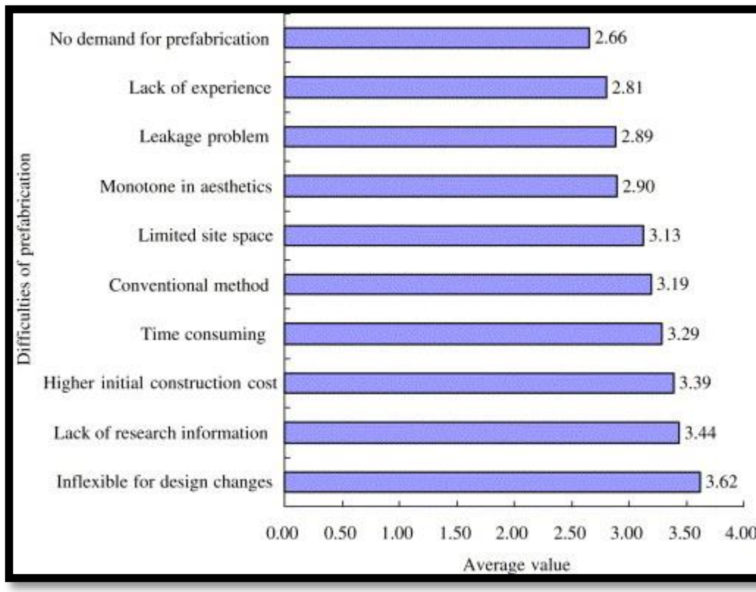


Figure 2.6: Survey responses about disadvantages of prefabrication ("Tam")

Through the research of different methods of prefabrication, advantages and disadvantages, considerations, and case studies, a more thorough understanding of what needs to be designed and considered for prefabricating the link bridge has been established.

Mortenson Process and Concerns

The Mortenson project team plans to install the link bridge with a crawler crane during the third week of March. The week before this, the removal of the tower crane is scheduled to occur. The link bridge was not planned to be built with the second level because it was thought that the additional space without the link would be required for the tower crane removal; however, when interviewed about the process, it was stated that this space was actually not needed for the tower crane removal. Additionally, it was believed that the link bridge would deduct the space on site for material storage.

With the plan in place to install the bridge at the end of March, the scaffolding on this side of the bridge must be removed for the final connection of the bridge to the building. In order to eliminate any additional remobilization time, Mortenson required that the bridge was built during the same time as the other steel installations on the building.

The plan for construction in the limited area between the bridge and the parking garage is to work "very carefully" and establish a plan when the foreman arrives on site. It is likely that a worker will tie off and climb or drop down from the parking garage as needed to install the exterior siding. A prefabrication discussion meeting about the link bridge was held in December, 2015. While the exact discussion was not recorded, when asked about the reasoning behind using traditional construction methods instead of prefabrication, the project team responded that site logistics would be an issue as well as the metal panels are 2'x6', making the installation not as difficult as initially anticipated.

Advantages and Disadvantages

As mentioned in the *Research* section, the two main types of prefabrication possible for the link bridge are 2D panels and 3D modular units. In order to more specifically analyze these methods for the link bridge, two tables of pros and cons are found in Tables 2.1 and 2.2.

Table 2.1: Traditional construction vs. prefabrication

	Original Method	**Prefabrication**	
	On-Site Construction	**2D Panels**	**3D Modular**
Pros	Later design possible Standard method	Quality control No confinement restriction Resource efficiency Schedule savings	
Cons	1'6-2'6 gap - doesn't fit men/equipment Construction takes up site space Safety hazards Weather delays Wasted materials	Weight considerations Must fit into the schedule Transportation Connection design Early decisions required Structural integrity Available manufacturers Prefabrication fee	

Table 2.2: 2D prefabricated panels vs. 3D prefabricated modular unit(s)

	2D Panels	**3D Modular**
Pros	Smaller truck with stacked panels Lighter crane pick Easier problem management because smaller pieces to fix if issues arise	Can use guiderails (if necessary) Faster on-site schedule Q.C. total unit No additional site time Watertight interior Design already created Crane pick points established at pier points
Cons	Limited access is still a problem Increase potential gaps - integrity of seams Q.C. needed for connections More site time (could increase schedule) Interior finishes not possible Change structure/attachment methods	Larger truck Larger pick Complicated lift and placement Site accessibility for unit and truck

From comparison Tables 2.1 and 2.2, prefabrication of the link bridge has noticeable advantages concerning the space limitations. Between the 2D and 3D comparison, the 2D panels still require that workers fit between the bridge and the garage, thereby not solving the space issues, but only slightly mitigating them. Rather, the 3D modular option would allow the entire bridge, including the interiors, to be prefabricated and delivered on-site as a completed unit. The 3D modular unit poses issues concerning the size, weight, and site accessibility. These potential issues will be addressed in the *Size and Restrictions*, *Crane Logistics*, and *Site Logistics* sections. The 3D modular unit was decided as most advantageous for the link bridge, and the research and analysis will continue with this method.

Satellite Shelters, Inc. Interview

After deciding on a 3D prefabricated module, more information about the process, cost, schedule, and installation method needed to be researched. Satellite Shelters, Inc. graciously provided more information through various emails and a phone interview. While the numbers are not exact for this project, as they did not have the specific plans of the bridge, it is assumed that the information given can be utilized on the link bridge.

Instead of splitting the link bridge into two 3D modules, prefabricating it into one piece is more feasible and practical because modular manufacturers are used to making buildings of this size and magnitude (roughly 62'x9'x15'6). Wheels can be added to the bottom of the bridge so that it will act as a trailer pulled by a truck cab during transportation. Pieces up to 76' long can be hauled, so a 62' bridge is within the realm for typical modular transportation. The standard cost for transportation of a 12'x60' modular unit is $2,500. Due to similar sizes, this additional transportation fee will be included in the cost analysis.

The link bridge will be built fully within the factory, with the exception of stucco and ballasted stone installation. These will be installed on-site due to the fragility of the stucco and the weight of the ballasted stone. Because the bridge is designed and engineered already, minimal work will need to be done from the prefabricator's engineers. The materials will be ordered and sent to the prefabricating factory instead of the site, making the delivery cost of materials essentially equal for both methods. Labor and material prices will be similar to that of on-site construction, yet an overhead cost for the modular company would be built in as well.

A single unit mobile office (12'x60') takes about one day for the line to construct the entire unit. Because the link bridge is a customized product, it is estimated that this would take around two to three days. Essentially, the bridge would go through a "line," not unlike an assembly line. The frame is installed, followed by the concrete floor, walls, roof, electrical and plumbing rough-in, and the interior and exterior finishes. With the construction occurring in a controlled, enclosed environment which is not impacted by weather, labor issues, security, or height safety concerns, the construction time is significantly reduced. The estimated lead time for gathering materials and constructing the unit once the plans are approved, is 8-12 weeks. This leaves more than enough time to procure the materials after permitted documents and before installation is required. By turning a standard construction process into manufacturing, between 60 and 100 men are typically found on a line. Each person is performing a different task which they are trained and specialized in. This allows them to produce the final unit rapidly.

If there are concerns or issues regarding attachment methods of the bridge to the concrete piers, depending on the loads and structure of the bridge and the piers, steel can be placed on top of the piers so that when the bridge is lifted into place, the frame of the bridge is welded directly to the steel.

Size and Restrictions

As stated in the *Satellite Shelters, Inc. Interview* section, units up to 76' long can be transported easily. When the unit arrives at the site, there are multiple ways to transfer it to the final location. The typical interstate semitrailer has a turning radius of 46.4'. This is a large amount of room to be able to fit into the Heartland Hotel project site. Additionally, the drive through lane underneath the hotel is 71' long, 21'9 wide, and 14' tall. This tunnel is too small to fit the link bridge, as the bridge is 15'6 tall. Therefore, the bridge must be brought in before the second level is framed if the truck is going to transport it into the site. If the truck is to stay outside of the site, for lifting safety reasons, the second level should not be framed.

Due to the truck turning radius, small site, and narrow entry, the truck will simply pull up next to the building instead of entering the project site. This will mitigate any transportation issues and will take less time for delivery.

Crane Logistics

The tower crane on-site could provide an opportunity to lift the link bridge from the truck to the final location; however, when the weights of all materials that would be included in the prefabricated modular unit were added together, the overall weight totaled around 38,000lbs, or 19 tons (Appendix 2.1). The crane currently in use on site is a 213' tall Liebherr 281 HC (Appendix 2.2). The truck drop-off location would be outside of the site, making the farthest pick nearly 130' from the center of the crane. With a 213' tall crane reaching 130', the maximum pick that it can perform is 14,319 lbs. – less than half of the total load of the link bridge. Therefore, the tower crane alone cannot be used to pick the link bridge.

LARGE CRANES				
Crane Classes	Boom	Jib	Total	Quantity Available
40 Ton Hydraulic Truck Crane	95'	45'	140'	9
60 Ton Hydraulic Truck Crane	110'	56'	166'	17
80 Ton Hydraulic Truck Crane	128'	56'	184'	2
100 Ton Hydraulic Truck Crane Hydraulic Lifting Jib	142'	89'	231'	20
150 Ton Hydraulic Truck Crane	161'	141'	302'	11
200 Ton Hydraulic Truck Crane	203'	141'	317'	7

Figure 2.7: Joyce Crane types of cranes ("Equipment")

Instead, if a truck crane were to be utilized, it would be on the outside of the project site (due to site size restrictions), and would need to complete a pick nearly 182' long. A 100 ton hydraulic truck crane with a hydraulic lifting jib from Joyce Crane has a 142' boom and an 89' jib, totaling to a reach of 213' (Figure 2.7). The closest option reached a total of 184', but this was ultimately deemed too close to the maximum dimension, so the crane reach of the next size was used.

This heavy duty crane is able to pick up the link bridge completely. Ultimately, the hydraulic truck crane will be used alone so that additional coordination between the tower crane and the truck crane lifting together is not necessary. Additionally, this will allow the tower crane to continue work on-site without being interrupted by the link bridge. The hydraulic truck crane will cost around $3,400 per day, and will only be necessary for one day.

Site Logistics

A full site plan and logistics of transferring the link bridge from the road to the final location can be found in Appendix 2.3. By turning the bridge clockwise instead of counter-clockwise, the furthest movement is reduced from 177' to 168'. While both options would be possible, the site plan depicts how a clockwise rotation can be done without extending outside of the project site lines. For the installation, the truck will drive along the one-way road and simply pull up next to the sidewalk. From here, the hydraulic truck crane will lift the bridge to the final location 182' away. For safety, three lanes of traffic will be temporarily closed and a fourth will be opened up to vehicles. The lift does not extend outside of the project lines, and is only transferred over one traffic lane.

Because the bridge is designed to be supported by three piers and likely a temporary pier (see *Connections and Temporary Bracing*), the truck crane pick points will be directly over these pier locations. This will ensure structural stability as the bridge is transferred. While the truck crane is moving the bridge, normal work can continue on the southwest side of the project site.

The overall site is extremely limited for space. However, installing the link bridge earlier with prefabrication instead of the original method would lift the extra bridge materials off the ground, thereby creating more space on the ground level for material laydown.

Schedule Opportunity

Mortenson has released several schedule updates since the beginning of the project. The oldest and newest are compared to see how the schedule has developed over time (Table 2.3).

Table 2.3: Released schedule comparisons for the link bridge

Activity Specifically for the Link Bridge	October 2015 Schedule Update	February 2016 Schedule Update
Erect Steel Framing/Decking	12/23/15-1/07/16	3/18/16-3/31/16
SOMD Floor Slab	1/08/16-1/12/16	4/01/16-4/05-16
Fireproofing	1/08/16-1/14/16	4/01/16-4/07/16
Roof Systems	2/05/16-2/15/16	4/08/16-4/18/16

These schedule changes can signify two things: the construction technique for installing the link bridge is still under discussion and/or the link bridge structure is not on the critical path. Therefore, when installing the module, in order to not interrupt the schedule, the delivery and installation should also not be on the critical path.

Table 2.4: Key activities and dates for the link bridge installation

Activity	Date
Tower Crane In Use	August 27, 2015
Foundations *Completed*	September 30, 2015
FRP Columns Level 1 *Completed*	October 7, 2015
Level 1 Slab on Grade *Completed*	October 9, 2015
FRP Level 2 Deck *Begins*	October 12, 2015

Because the bridge will be lifted over the footprint of the building, it would be easiest, safest, and less interruptive if the bridge were installed before the second floor framing was in place. Table 2.4 lists important dates during which the link could be delivered and installed. There is a two-day weekend gap between the completion of level 1 slab on grade and the beginning of forming, reinforcing, and pouring the level 2 deck. The link bridge can either be installed over the weekend or on October 9th. It is possible to install the bridge during the slab on grade activity because work on the southwest end can still continue during the bridge installation. The first floor columns need to be installed before the link bridge can go in because the piers supporting the bridge are on the first level. Therefore, the link bridge needs to go in after October 7th and when the concrete has reached the proper curing strength. Because the team is using 8,000psi concrete, it is possible that the piers would be strong enough to hold the link bridge two days after being installed. However, if this is not the case, either the piers can be installed earlier or the link bridge will need to be lifted over the second floor framing. While this is not ideal, it is possible to install the bridge while not interrupting the schedule.

While the structural portion of the link bridge is not on the critical path of the schedule, all other activities necessary for completing the bridge is blended into the overall schedule (exterior framing, interior framing, exterior enclosure, electrical rough-in, drywall, and wall, ceiling, floor, mechanical, and electrical finishes). It is likely that these activities play a role in the overall schedule duration, and therefore the critical path.

The average durations of each of the aforementioned activities for one floor were calculated. These numbers were then multiplied by the percentage of bridge square footage compared to the overall floor square footage (ex: floor area percentage = 581sf/14,596sf = 3.98%). Table 2.5 details these calculations.

Table 2.5: Non-structural link bridge activities and durations

Activity	Original Duration (days)	Bridge Duration (days)	Critical Path?
Infill Framing	10	2.3	Yes
Exterior Enclosure	30	2.5	Yes
Interior Wall Framing	15	0.6	Overlap
Electrical Rough-In	15	~~0.6~~	
Drywall	15	0.6	Overlap
Ceiling Finishes	10	~~0.4~~	
Wall Finishes	10	0.4	Yes
Mechanical and Electrical Finishes	10	0.4	Yes
Floor Finishes	15	0.6	Yes
Total Duration	-	**7.4**	Yes

By looking at the dates, two sets of two activities overlapped. So as to not double count durations which were not on the critical path, the longest duration was kept and the smallest removed. The total duration for the non-structural construction of the link bridge components totaled roughly 7.4 days, which is on the critical path. In addition to this, as recorded in Table 2.3, the structural duration would last 22 days, but is likely not on the critical path.

By prefabricating the link bridge, both the 7.4 and 22 day durations would be eliminated; however, only the 7.4 days for the non-structural components would impact the schedule because it is on the critical path. By eliminating nearly one and a half weeks' worth of interior construction, the Heartland Hotel could potentially open up one and a half weeks earlier. The cost associated with this early completion date will be discussed in the *Cost Impact* section.

The ballasted stone and stucco will not be prefabricated. However, the ballasted stone and stucco will most likely not take a significant portion of time, and could probably be installed on the same day that the link bridge is installed. Therefore, these durations are not included.

Duration and Productivity

Prefabrication greatly impacts the productivity of construction. According to the article "Marginal Productivity Gained through Prefabrication: Case Studies of Building Projects in Auckland" ("Shahzad"), productivity is 8.8% higher for prefabrication than standard construction. This would impact the labor cost because fewer hours would be required of the workers in prefabrication than with traditional construction methods. Appendix 2.4 details the man-hours calculated for on-site construction and prefabrication construction with an 8.8% increase in productivity[1]. Additionally, the limited space between the bridge and the garage would increase the construction time in those areas. By doubling the man-hours of materials within that area, the total man-hours required for on-site production equaled 564 hours, which equates to roughly $25,800 for labor. Through prefabrication, the total man-hours are reduced to 421 (a 143 man-hour reduction), which equates to $19,200 in labor (a $6,600 reduction).

Cost Impact

All of the same materials are used by both methods of construction. By prefabricating the bridge, five additional line items are included (Appendix 2.4).

7 Day Schedule Reduction: Through prefabrication, the hotel could potentially open seven days earlier. With 245 rooms at $202 ($212-$10=$202 – taken from *Analysis 1: 9th Story Design Change) and* an occupancy rate of 85.9% for 7 days, the hotel could see a potential revenue of $297,583. According to the MDI executive interviewed (Appendix 1.1), the hotel needs a 9% cap rate to survive. Therefore, if 9% of this income is profit, the hotel would gain an additional $26,782 from opening 7 days earlier.

Transportation Fee: It was estimated in the *Satellite Shelters, Inc. Interview* section that transporting the modular unit would cost around $2,500.

Prefabrication Company Fee: An overhead fee of 3% of all materials and manpower would go towards the prefabrication company, totaling to $2,000.

100 Ton Hydraulic Truck Crane: An additional $3,400 for a one day rental of this crane would be included in the total budget for prefabrication.

Temporary Pier for Bracing: As discussed in the *Connections and Temporary Bracing* section, a temporary W12x26 column for the end of the link bridge would be installed. This would cost around $800.

In total, by prefabricating the link bridge and accounting for productivity duration differences, the original method would cost $79,000 whereas the prefabrication would cost $49,500. Prefabrication reduces the total cost of the bridge by 37%. For the overall project budget of $40.05 million, prefabrication would have a 0.07% impact.

Connections and Temporary Bracing

The floor of the link bridge connects to the second floor slab, as seen in the section diagram in Figure 2.8. An embedded 3/8" plate, studs, angle, and rebar connect the two floors together. The initial construction method doesn't connect these two floors until well after the second floor has been poured. However, it is possible to reverse this order. With the link bridge installed before the second floor is formed, these connection pieces can simply be attached to the bridge first, instead of the other way around. With form saver dowels, the reinforcing bars can be inserted in the link bridge floor

[1] R.S. Means 2014 was used for the man-hour calculations. The numbers provided assumed a 62.5% productivity.

slab, and then later inserted into the second floor slab. Likewise, the angle and plate can be attached to the bridge and a dowel inserted just before the second floor is poured.

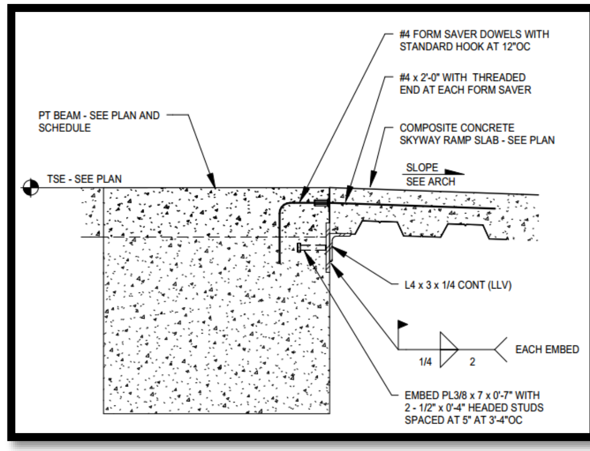


Figure 2.8: A section through the link bridge floor connection detail to the second floor

The link bridge roof is connected to a steel W10x22 beam, which spans columns extending from the first floor to the roof (Figure 2.9). There is a gap between the steel beam and the concrete floor above, which is made up by light gauge metal framing studs. This steel beam cannot be installed until after the second to third floor columns are installed. This steel beam likely supports the end of the bridge, as the nearest concrete pier is 18'8 away. Therefore, the bridge must be able to support itself without this steel beam, and will then later be connected to the rest of the building. Roof support is possible because the two walls on either end of the bridge will be constructed. But this creates a cantilevered bridge without the connection to the building. To mitigate this, a temporary bracing pier can be inserted until the bridge is fully connected. While the structural calculations have not been performed to size this temporary bracing, for the purpose of a cost analysis, it will be assumed that a W12x26 column can be used to support the end of the bridge.

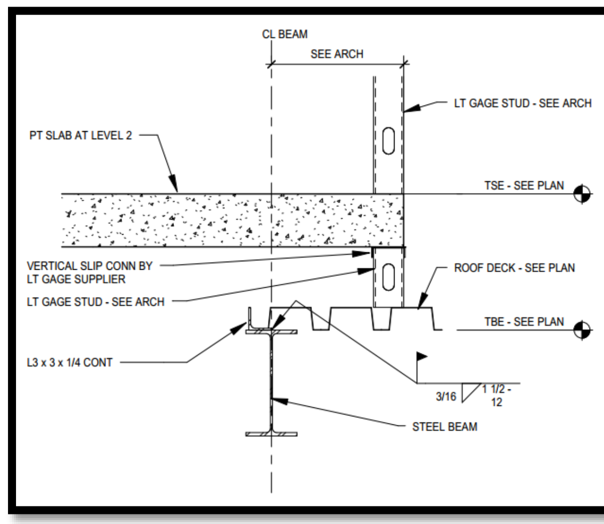


Figure 2.9: A section through the link bridge roof connection detail to the third floor

Final Recommendation

There have been constructability concerns about the link bridge through the entirety of the project. The limited space between the bridge and the garage pose difficulties with construction men, materials, and equipment fitting. However, prefabrication offers a method to eliminate these size constraints, decrease the schedule, reduce the cost, and increase constructability. By creating a prefabricated modular unit with all finishes installed except the stucco and ballasted stone, the overall budget is reduced by nearly $30,000, the schedule is reduced by 7 days, and work on-site for the link bridge is virtually eliminated. The site plans make for a relatively easy lift with a hydraulic truck crane while minimally disturbing other work occurring on-site.

While prefabrication might be new to the industry, this analysis has proven that prefabricating the link bridge into a modular unit instead of constructing it on-site would be extremely beneficial to Heartland Hotel and Mortenson Construction.

ANALYSIS 3: STRUCTURAL LIFT SYSTEM

Background Information

The Heartland Hotel is located on the corner of two one-way streets (Figure 3.1). The plan-southwest blackened area is taken up by a 12-story historical brick building and the plan-southeast blackened area is taken up by a 7-story parking garage. Two drive-through lanes are located on the plan east and west sides of the building for material drop-off and future customer use. A 213' tall tower crane is used throughout the structural construction process. Because of the close proximity of the adjacent buildings and city streets, the site is extremely limited. Materials are being stored on the roof of the parking garage and off-site, and the contractor is stationed several blocks away.

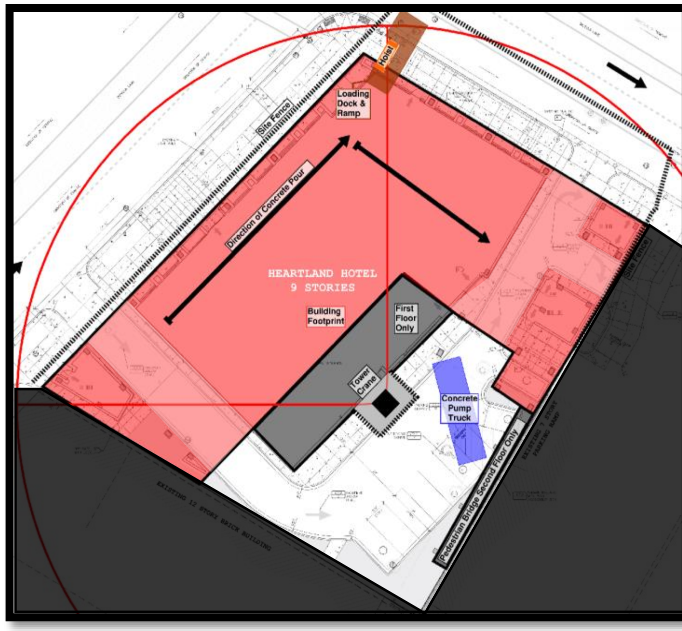


Figure 3.1: The site logistics plan for the PT slab construction process.
***Blue** = Concrete Pump Truck; **Black Square** = Tower Crane;*
***Red Area**= building footprint; **Black Area** = adjacent buildings*

The hotel consists of nine stories composed of mainly post-tensioned (PT) concrete (Figure 3.2). The first and second floor have unique layouts, but floors three through nine are identical except for slab thickness (6.5"-7"). Because the concrete structure is a critical component of the overall building, the means and methods, schedule, cost, and logistics have been developed by Mortenson to expedite the process while maintaining high quality.

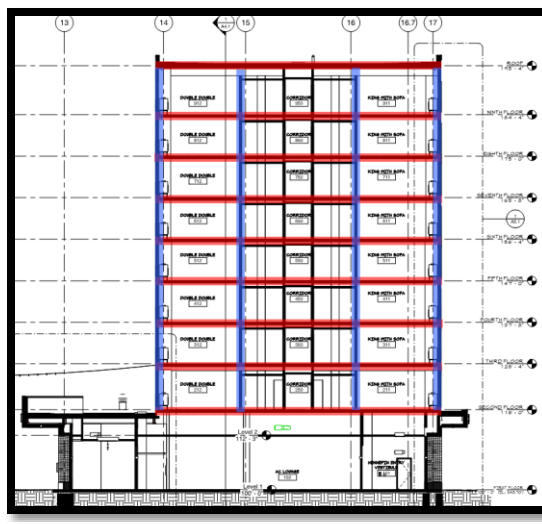


Figure 3.2: PT slab and columns in the Heartland Hotel.

Construction for this system completes one entire floor before moving on to the next. In order to decrease schedule time for this structure, each floor is finished within five working days (Figure 3.3). 8,000psi concrete is utilized for both the columns and the slab. Although the construction specifications only call for a 6,000psi concrete slab, the construction team decided to use 8,000psi concrete for both systems to avoid puddling with the columns and so that the slab strength is equal to the column strength. The reinforcing for the columns is prefabricated off-site and delivered to the site on the day it is needed. One level of shoring will support the most recent concrete pour, while two

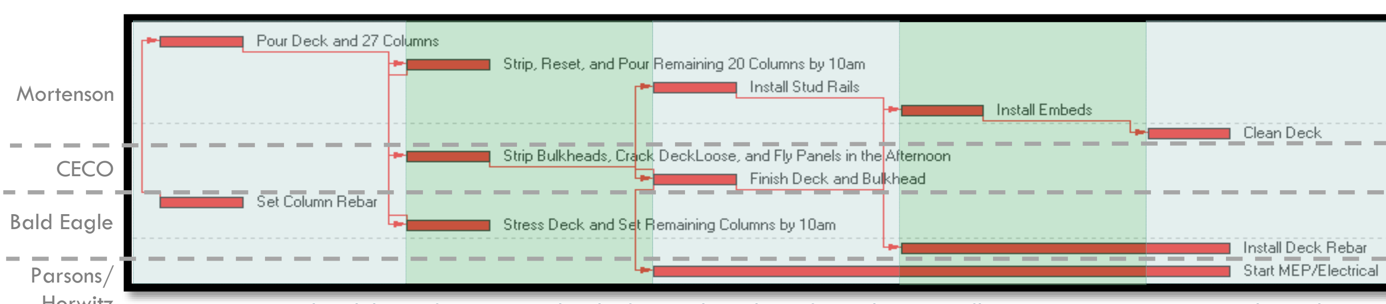


Figure 3.3: A breakdown of activities within the five working days of completing one floor. Companies in grey are the trades responsible for the tasks.

levels of re-shoring will support the two floors below. Once the re-shoring has been removed from the first floor, the façade construction will begin.

Because of the location and schedule of the Heartland Hotel, there is concern with constructing the façade in the middle of a severe winter. The façade contains stucco – an element which is very temperature dependent during installation. Furthermore, when building a 9-story building, safety is always a concern.

Potential Solution

A construction technique established by Upbrella Construction (http://www.upbrella.com/en/home) approaches the structure of high-rise buildings in a way which takes up less site space, allows for quicker façade installation, and is safer. Through Upbrella Construction's approach, the permanent roof is installed after the ground level and first two floors have been constructed. This roof is only one floor above the third floor structure, and can protect the floors below. Construction of the fourth floor structure then begins on the third floor and is attached to the roof and roof lift system. Once all elements are ready for the concrete pour, the fourth floor and roof are lifted to just above the fourth level height. The columns below the floor are installed and the floor and roof are lowered onto the columns. The concrete floor is then poured and this process is repeated, with construction work occurring on the most recently poured slab. In this way, the floors are always built at man's height and are connected to the roof and structural lift system.

A semi-temporary wall surrounds the floor under construction and the floor below. This provides a set construction area and completely encloses both floors. Because the floor below is enclosed and watertight, construction of the façade and interior finishes can begin. Additionally, a man lift is installed to transport materials and workers. A sample of construction sequence snapshots can be found in Figure 3.4. A more complete video is available through Upbrella Construction and 3L Innogenie (https://www.youtube.com/watch?v=q9bKap4FdCc).

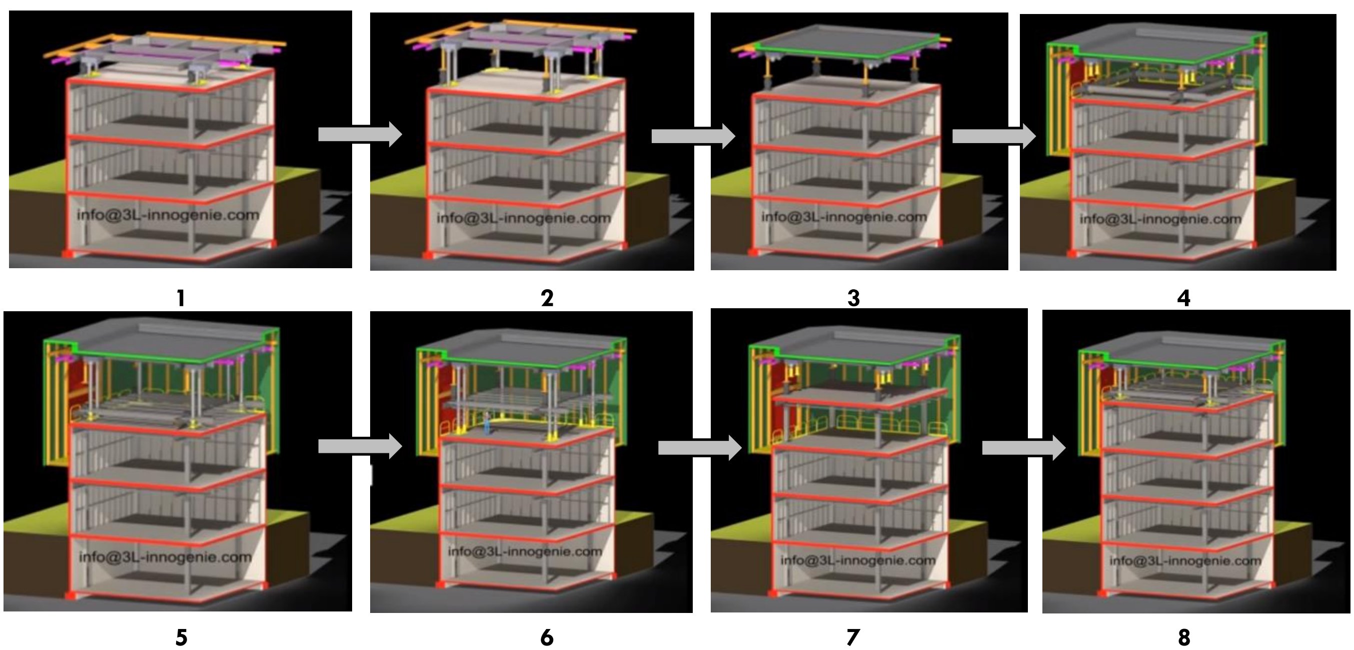


Figure 3.4: This patent pending sequence is courtesy of Upbrella Construction (http://www.3l-innogenie.com/en/upbrella).

1. The roof structure is built with additional supports for the temporary wall
2. The roof system is lifted to a standard floor-to-floor height
3. The final roof system is installed
4. The semi-temporary wall is constructed while the structure for the 4th floor begins
5. The structure for the 4th floor is complete, and the roof is lifted to a standard floor-to-floor height above the 4th floor structure
6. The 4th floor structure is attached to the roof system and lifted to the appropriate height above the 3rd floor

7. The columns between the 3rd and 4th floor have been installed and the 4th floor structure is finalized. Meanwhile, work begins on the enclosure system for the 3rd floor
8. The 3rd floor enclosure system is being finished while the structure for the 5th floor is being installed. This process repeats beginning at step 5.

This structural lift system offers unique opportunities to address the concerns of a constrained site and the winter schedule for the exterior enclosure system. Through this method, the schedule can potentially be accelerated and a tower crane would be unnecessary. With different equipment requirements as well as a different structural system, the cost for the construction will be impacted. The semi-temporary wall enclosure and method for building the floors would allow workers to work in an enclosed environment at man-height. This would improve productivity due to the increased safety and by eliminating weather impacts.

Analysis Goals

The following list includes the steps that will be taken in order to perform this analysis:

1. Contact Upbrella Construction and gather information pertaining to methods, design considerations, cost, schedule, and requirements
2. Based off of the information received, analyze the feasibility of this structural lift method while considering:
    a. Roof and floor structural design
    b. Site restrictions and access
    c. Building size and layout
3. Redesign a portion of the structural system to accommodate for this alternate method (*Structural Breadth*)
4. Analyze the use of temporary heat for the installation of the concrete floors and stucco façade (*Mechanical Breadth)*
    a. Compare the current and proposed temporary enclosures and their impact on the temporary heat required
5. Perform an in-depth cost, schedule, and constructability analysis of the chosen system
6. Create a 4D comparative simulation of the original and alternative construction methods

The Mortenson project team has scheduled a project with an extremely efficient structural schedule, even with the site constraints and weather concerns. The five-day cycle has already been used on a nearby project and is therefore extremely feasible and realistic for this project.

3L Innogenie and Upbrella were connected in 2011 to begin working on the Upbrella Construction technique together. One project, The Rubic, will be used as a case study for applying this construction method to the Heartland Hotel. Since allowing visitors on The Rubic project, there have been over 300 inquiries/visits. While this method is innovative, unique, and clearly desirable, it is still relatively new and has yet to reach all construction firms in the United States. Because of this, Mortenson Construction has not completed a project with this type of construction method. Therefore, this new method has potential to improve the overall structural construction process for the Heartland Hotel. With a refined five-day cycle construction method already in place, a distinct and innovative process needs to be proposed in order to compete with cost, schedule, and constructability of the project.

Through the structural uplift analysis, it will be determined if this method can outperform the current method. By comparing cost, schedule, and constructability of this system, a final recommendation for the Upbrella structural lift system will be made based off of the qualitative and quantitative information received and produced.

Execution

Upbrella Construction

In order to more fully understand the process and requirements for Upbrella Construction's technique, Joey Larouche, the owner of Upbrella Construction, graciously explained the current process for The Rubic. The following list details the equipment and techniques for the Rubic:

- Vertical lift system: Telescopic hydraulic cylinders are used to lift the entire system

- Vertical and horizontal handling system: mast climbing platform
- Interior horizontal handling system: bridge crane inside the building
- Protection shell: aluminum or wood studs with heavy duty tarp or polycarbonate panels
- Work platform: one at the bottom of the shell
- Elevators: expandable elevator for occupants and a separate one for construction use

Upbrella provides many advantages compared to typical construction methods. For buildings which would benefit from opening early, Upbrella allows occupants/guests to move into floors which are four floors under the current construction. In other words, once construction reaches level five, building occupants may move into level one. Because of the height difference and the building materials between the construction and tenants, the construction noise would be dampened enough to mitigate noise and risk of occupants. This provides developers with new financing tools so that construction speed can change according to the market, yet the building can still be occupied.

The building site landscaping can be completed after the lift system has begun. Without a tower crane and with all of the building lift systems attached to the building, the project site is opened up and the landscape work can begin quicker. This also allows for a clean site for early occupants to move in.

With the protection shell weather issues are mitigated, as work will be occurring only within an enclosed and watertight space. This not only provides a better and more productive work environment, but it also increases safety. By working on an enclosed platform as well as constructing the floor structure at man-height, risk for objects and people falling is almost completely eliminated. With an increase in productivity and safety through working in an enclosed environment, quality also improves.

For The Rubic, a ten day cycle was used for the construction of the structural components (interior video of The Rubic: https://www.youtube.com/watch?v=GJuG6wCCN5o). The following is a breakdown of the days:

- Days 1-4: Down position – set up beams and decking
- Day 5: Lift and install columns
- Day 6-9: Up position – complete the structure (stairs, elevator shafts, rebar, inspection, etc.)
- Day 10: Concrete pour

Upbrella is extremely beneficial for tall, thin towers. The Rubic fits this tower standard and all of the information received is unique to The Rubic project. Despite the differences between The Rubic and the Heartland Hotel, The Rubic will be used as a baseline for designing a structural lift system for the Heartland Hotel. Adaptations and changes will be made to both the Heartland Hotel and the Upbrella approach to fully combine these two subjects.

Structural Breadth: Structural Bay Redesign

With a PT slab for levels 2-9 and the roof, the current structure creates some issues when trying to pair it with the Upbrella structural lift system (Table 3.1). However, a steel structure with a composite deck offers advantages which would be beneficial when using the structural lift system.

While a PT slab might still be possible with great modifications and likely a three-level exterior protection shell, it is much more feasible with a composite steel structure. Therefore, the floors will be redesigned to include a steel structure. However, the roof will remain the same as originally designed – a PT elevated slab. While it is also more likely and beneficial to perform this structural uplift system with a steel-structured roof, the PT roof was left so as to not change too many elements. Additionally, in the *Hydraulic Cylinders* section, it will be shown that a PT roof is still feasible with Upbrella Construction's method due to the construction timeline of the roof.

Table 3.1: PT vs. steel structure for structural lift method

PT Floor Structure				
System	**Attributes**		**Aligns with Upbrella?**	**Reasoning**
PT Formwork	Either/Or	Flying forms	No	Cannot bring forms outside of the building because of the protection shell
		Formwork every floor	No	Extremely expensive and time consuming
	One level of shoring and two levels of re-shoring		No	Floor space is needed for interior and exterior rough-in construction
Tendon Stressing	Platform for workers to stress tendons outside of the building footprint		Maybe	This additional space would need to be accounted for in the protection shell
	Tendons will extend well beyond the building footprint		Maybe	This additional space would need to be accounted for in the protection shell
	Extra time needed to stress the tendons		Yes	This will modify the schedule
Concrete Columns	Rebar cages are prefabricated and brought on site		No	Cages need to be lifted into place with a crane
	Additional time needed to pour and cure all of the columns		Maybe	This will modify the schedule
Floor-to-floor height	Shorter overall building height		Yes	Less exterior enclosure materials needed

Steel Floor Structure			
System	**Attributes**	**Aligns with Upbrella?**	**Reasoning**
Steel Deck	Composite steel deck attached to joists and girders	Yes	Acts as "formwork"
	Unshored system	Yes	Can begin interior and exterior rough-in construction below
Beams and Girders	Beams and girders are to support the steel decking and concrete	Maybe	Likely a longer erection timeline
	Column lines intersect with vertical plumbing chases	Yes	Joists can be moved to be located around these locations
	Bay sizes are small	Yes	Likely an overdesigned steel structure
Rebar	WWF needed	Yes	Placed quickly
Columns	Steel columns are in the same locations as the original design	Yes	Floor structure can immediately be placed on top of the columns
Floor-to-floor height	Taller overall building height	Yes	More exterior enclosure materials are needed

The structural breadth for this report will design the deck, joists, girders, and columns for one bay of the building. This design will then be extruded throughout the rest of the floor areas and levels. A center bay in the southern portion of the building was redesigned because of the large size and the repetition of this size of bay (Figure 3.5). The exterior bays were not chosen because they are smaller and because it is assumed that the added wall load to these small bays will be accounted for in the redesign of the larger bay. After the bay is redesigned, it will be extruded by square footage throughout the remainder of the building and on all floors except the roof.

The plumbing chases pose as an issue because they directly intersect with the gridlines between columns. Therefore, the structural bay will be designed with girders spanning north to south between columns, but the joists will be equally spaced within the bay and will not directly tie into the columns (Figure 3.6). The following section mathematically describes the process taken to structurally redesign the bay.

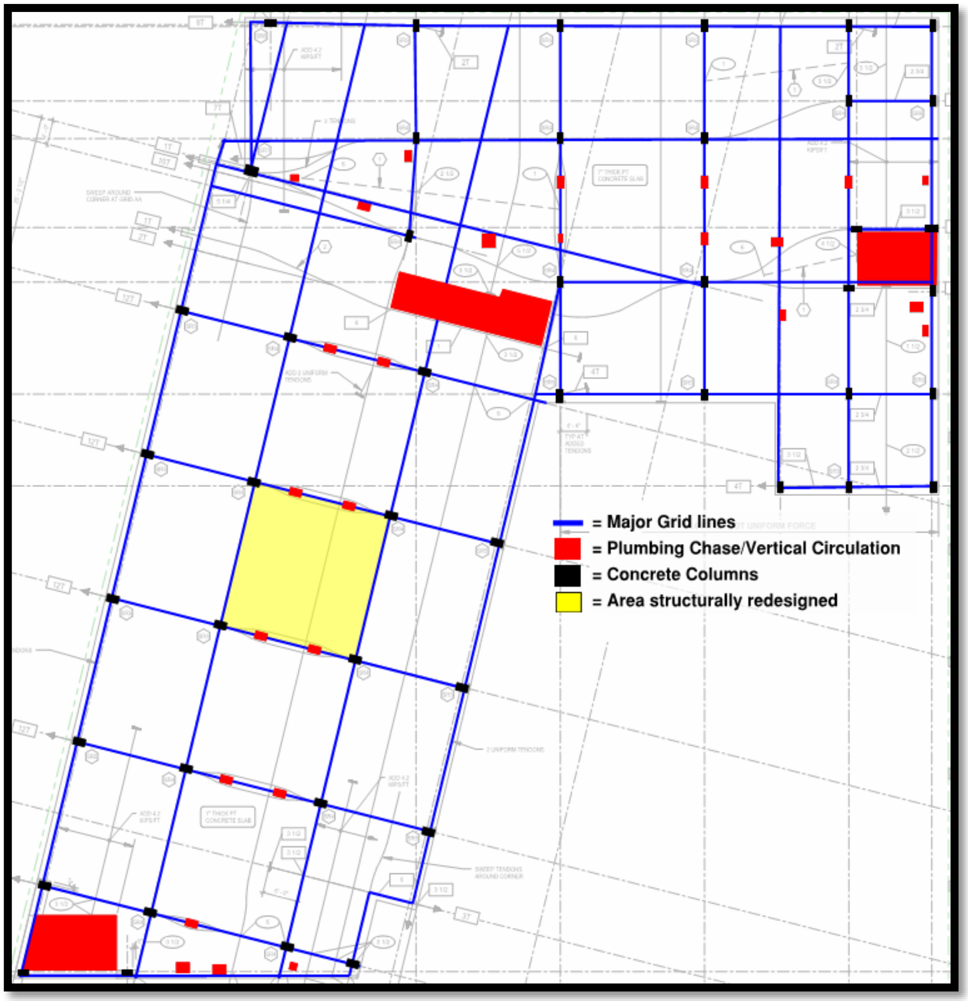


Figure 3.5: The bay chosen to be structurally redesigned

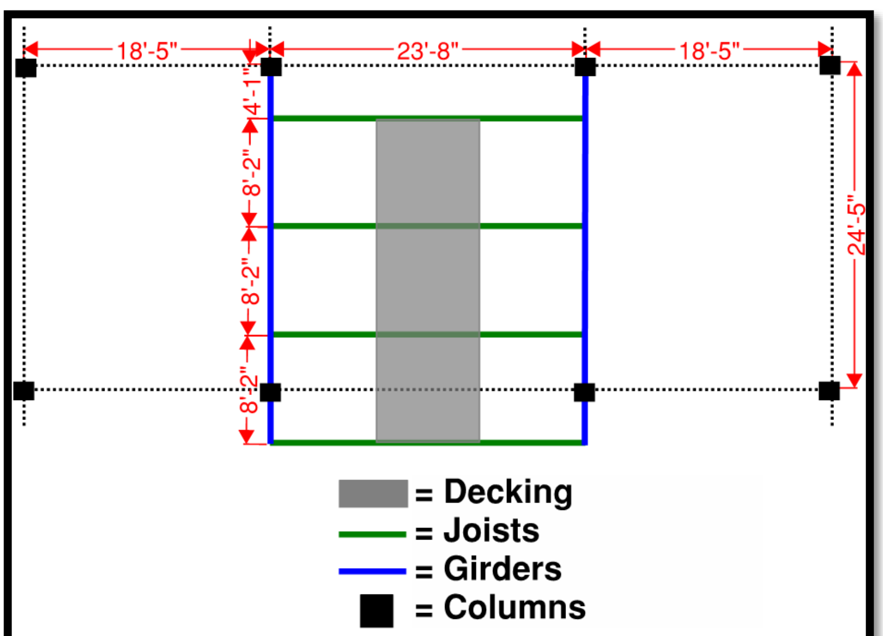


Figure 3.6: The redesign of the bay

Decking

Requirements:

- Composite decking because:
  - Thinner
  - More economic use of materials
  - Efficient
- 3-1/4" topping for fireproofing for lightweight concrete
- 3-spans
- 8'2 spacing
- Unshored

Loads taken from the structural drawings:

- Live Load – 40psf for rooms and corridors above the 2nd floor
- Wind Load – N/A
- Dead Load – assumed 10pst

$Total\ Load = Dead + Live$

$\mathbf{50}\boldsymbol{psf} = 10 + 40$

Decking chosen from Vulcraft Steel Roof and Floor Deck catalog:

1.5VL20 with lightweight concrete

4.75" deep

t=3.25" (for fireproofing)

37psf = concrete + deck self-weight

Recommended Welded Wire Fabric: **6x6 – W1.4xW1.4**

Maximum superimposed load with a 8'6 clearspan: 200psf ✓

Joist

Loads:

- Deck and Concrete load = 37psf
- Joists = Assumed 5psf
- Superimposed dead load = 10psf
- Live load = 40psf
  - Live Load reduction: $K_{LL}A_T$ = 8'2*2*23'8 = 387 < 400 – *not reducible*

Load Combinations:

- Dead: 37+5+10=**52psf**
- Live: **40psf**

1.4D = 75.6psf

1.2D+1.6L = **126.4psf** – *controls*

Check Decking:

126.4psf < 200psf limit ✓

Weight:

$$W_u = 126.4psf * \frac{8'2}{1000\frac{lb}{kip}} = 1.03\ klf$$

Moment:

$$M_U = \frac{wl^2}{8} = \frac{(1.03klf)(23'8)^2}{8} = 72.11 ft \cdot kips$$ →**W12x16**[2]

$$M_U = 72.11 \leq 75.4 = \phi M_n$$ ✓

Shear:

$$V_U = \frac{wl}{2} = \frac{(1.03klf)(23'8)^2}{2} = 12.19 kips$$

$$V_U = 12.19 \leq 79.2 = \phi V_n$$ ✓

Check Self Weight Assumption:

Assumed $5psf > \frac{16lbs}{8'2} = 1.96$ ✓

Final Design:

W12x16

[2] According to Table 3-2 of AISC Steel Construction Manual, 14th ed.

Girder

Spacing:

$\frac{18'5+23'8}{2} = 21.04'$

Span = 24'5

Loads:

- Deck and Concrete load = 37psf
- Joists = 5psf
- Superimposed dead load = 10psf
- Girders = *Assumed* 2psf
- Live load = 40psf

Live Load reduction

$L = 0.4L_0$ -or-

$L = L_0 * \left(0.25 + \frac{15}{\sqrt{K_{LL}A_T}}\right) = L_0 * \left(0.25 + \frac{15}{\sqrt{(24'5*21.04*2)}}\right) = 0.72L_0$ – *controls*

Live Load = 40*0.72 = **28.72psf**

Dead Load = 37+5+10+2 = **54psf**

Load Combinations:

1.4D = 75.6psf

1.2D+1.6L = 110.75psf – *controls*

Weight:

$W_u = 110.75psf * \frac{21.04'}{1000\frac{lb}{kip}} = 2.33klf$

Moment:

$M_U = \frac{wl^2}{8} = \frac{(2.33klf)(24'5)^2}{8} = 173.64ft \cdot kips$ →**W14x30**[2]

$M_U = 173.64 \leq 177 = \phi M_n$ ✓

Shear:

$V_U = \frac{wl}{2} = \frac{(2.33klf)(24'5)^2}{2} = 28.45kips$

$V_U = 28.45 \leq 112 = \phi V_n$ ✓

Check Self Weight Assumption:

Assumed $2psf > \frac{30lbs}{21.04'} = 1.43$ ✓

Final Design:

W14x30

Columns

Area:

$A_T = 24'5 * \frac{23'8+18'5}{2} = \mathbf{513.73\ sf}$

Loads:

- Deck and Concrete load = 37psf
- Joists = 5psf
- Superimposed dead load = 10psf
- Girders = 2psf
- Snow Load = 16psf
- Live load = 40psf
- Number of stories: 1 through 9 and the roof = 8 + roof

Live Load reduction

$L = 0.5L_0$ - *controls*

$L = L_0 * \left(0.25 + \frac{15}{\sqrt{K_{LL}A_T}}\right) = L_0 * \left(0.25 + \frac{15}{\sqrt{(8*4*513.73)}}\right) = 0.37L_0$

Live Load = 40*0.5 = **20psf**

Dead Load = 37+5+10+2 = **54psf**

Load Combinations for the Roof:

1.2D + 1.6L + 0.5S = **128.8psf** – *controls*

128.8psf * 513.73 sf = 66,168 lbs = **66.17kips** – *for the roof*

Load Combinations for the Floors:

1.2D + 1.6L = **90.4psf** – *controls*

128.8psf * 513.73 sf = 66,168 lbs = **66.17kips** – *for the roof*

$$\frac{(Number\ of\ Stories)*(90.4psf)*(513.73sf)}{1000} + 66.17 = Total\ Load$$

Columns for Floors	Number of Stories	Total Load (Kips)	Column Design Size	P_{ult}[3]
1-2	8	438	**W10x49**	532 kips ✓
2-3	7	392		
3-4	6	345		
4-5	5	299		
5-6	4	252		
6-7	3	206		
7-8	2	160		
8-9	1	113		
9-Roof	0	66.17	**W10x33**	311 kips ✓

Minimum Column Size: W10x33 ✓

[3] According to Table 4-1 of AISC Steel Construction Manual, 14th ed.

After performing the calculations for designing the decking, girders, joists, and columns, the results for the calculated bay and the two smaller bays adjacent to it are as follows:

- 9 Joists (W12x16)
- 4 Girders (W14x30).

These amounts of joists and girders are for 1,477 sf. Therefore, this must be multiplied by approximately 9.88 in order to cover the entire floor area (14596sf/1477sf=9.88). The floor to ceiling height needs to remain at 8'9 for the comfort of the guests. The original design had a floor-to-floor height of 9'4; however, by changing the structure from PT concrete to composite steel, additional space was required for the beams. Therefore, with an 8'9 floor to ceiling height, the floor-to-floor height was increased to 10'4. This will impact the amount of exterior enclosure necessary for the building. Overall, there will be 47 columns (W10x49) per floor which are 10'4 tall, and 47 columns (W10x33) 11' tall for the roof.

Hydraulic Cylinders

With the composite steel floors to replace the PT concrete slab, the lifting mechanism, a double acting telescopic hydraulic cylinder, must be sized to lift the roof, the protection shell, and the framing for the floor to be lifted. The double action allows the cylinder to generate a high amount of force in both directions as well as is necessary when the piston needs to be retracted upwards. The telescoping action shortens the overall size of the cylinder when not in use, but also provides a long extension range. A weight calculation revealed that this system would weight roughly 703 tons (Table 3.2).

Table 3.2: Weights of materials

Area	Description	Amount	Unit	Width	CY	Weight of Material	Unit	Total Weight (lbs)	Total Weight (tons)
Roof	Concrete (6000psi)	14,596.00	sf	6.50	292.82	150.00	lbs/ft^3	1,185,925.00	593
	Rebar tendons	103.00	ea	-	-	9,075.00	lbs	9,075.00	5
	Rebar Bars	0.43	tons	-	-	-	-	0.43	0
	EPDM Roofing (B4)	14,596.00	sf	0.06		2.00	lbs/ft^2	29,192.00	15
	R-24 Rigid Insulation (2" min at drain)	Included Above	-	-	-	-	-	-	-
								Total:	613
Area	Description	Amount	Unit	Width	CY	Weight of Material	Unit	Total Weight (lbs)	Total Weight (tons)
Floor	Joists	1,793.00	lf	-	-	16.00	psf	28,688.00	14
	Girders	965.00	lf	-	-	30.00	psf	28,950.00	14
	Decking	14,596.00	sf	-	-	2.14		31,235.44	16
								Total:	44
Area	Description	Amount	Unit	Width	CY	Weight of Material	Unit	Total Weight (lbs)	Total Weight (tons)
Protection Shell	Polycarbonate Panels	17,079.00	lf	-	-	0.35	psf	5,943.49	3
	Steel Columns	2,310.00	lf	-	-	33.00	psf	76,230.00	38
	7' Aluminum with plywood planks	88.60	sf	-	-	28.00	lbs	2,480.80	1
								Total:	42
Cylinder	Hydraulic Cylinder	8.00	ea			999.00	lbs	7,992.00	4
								Total Weight	703

The hydraulic cylinders therefore need to be able to lift 703 tons at least 22' high, which accounts for the floor-to-floor height (10'4), the floor-to-roof height (11'), and the added space needed to install the columns. After contacting Prince Manufacturing Corporation, a hydraulic cylinder manufacturing company, and describing the task, it was suggested that a SAE56-1500-TGFL double acting hydraulic cylinder be used on the Heartland Hotel (Appendix 3.1). This cylinder has a maximum extended load of 225,000 lbs., or 112.5 tons, and has an estimated weight of 999lbs. With this load capability, 6.2, or 7 cylinders are needed for the Upbrella Construction method. While the exact layout would need to be structurally engineered, it is likely that the layout in Figure 3.7 would be feasible due to the overdesign of the hydraulic cylinders. Extra materials and equipment on the roof and/or structure can be included in this total weight calculation, but would still fit within the range of 7 cylinders. For 3-5 cylinders, the estimated price was $12,417.50 per cylinder. Therefore, the total cost of the hydraulic cylinders will be $86,922.50.

Polycarbonate Panels

The protection shell needs to be watertight and provide structural safety for the workers. Similar to standard scaffolding, the floor of the shell will be 5' wide and made of 7' aluminum with plywood planks. These will be braced by structural steel, which is attached to the entire protection shell system. According to Upbrella Construction, the walls are typically made out of heavy duty tarp or polycarbonate panels. Due to the structural stability, transparency, sound reduction, and R-value of the polycarbonate panels for temporary heating, polycarbonate panels will be used for the walls and ceiling of the protection shell.

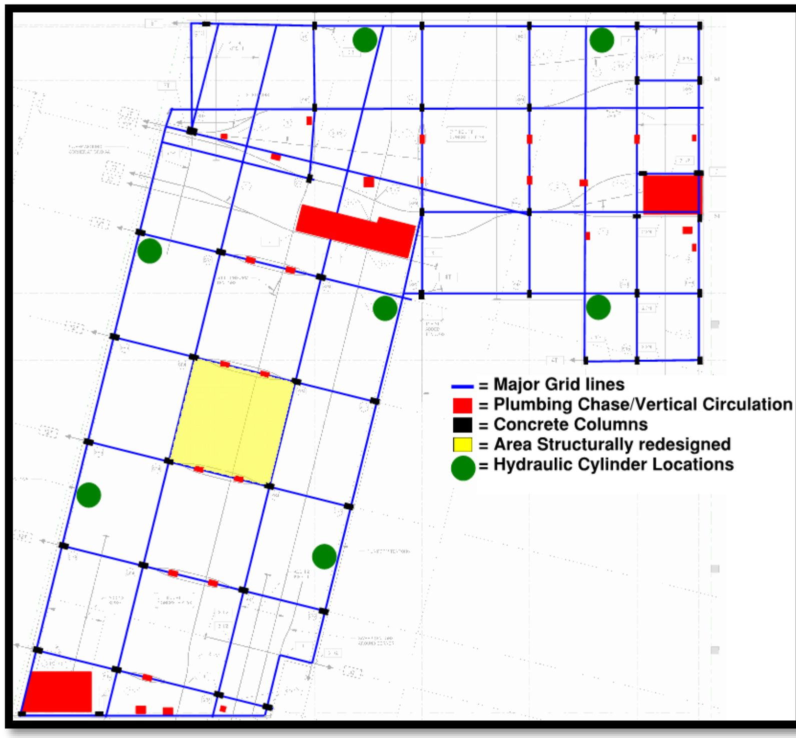


Figure 3.7: Hydraulic Cylinder estimated layout

Polygal Plastics Industries Ltd., a leader in manufacturing polycarbonate panels, offers several types of panels. Because the panels will be used as structural walls for the workers, the panels need to satisfy the OSHA standards for guardrails – the ability to withstand 200 lbs. or 890 N of force. The strongest and thinnest panel possible was a Triple Clear 8mm panel (Appendix 3.2). This panel has a clear tint, an R-value of 2.0 ft²·°F·h/Btu, a maximum width of 6.9', a light transmission of 77%, and weighs 0.35psf. A simplified illustration of the protection shell set up can be seen in Figure 3.8.

In order to support these panels, steel or aluminum beams will be spaced every 6' around the extruded perimeter of the building. While the design loads were not calculated, for the purpose of this analysis, it will be assumed that the steel beams supporting the polycarbonate panels and planks are W10x33s.

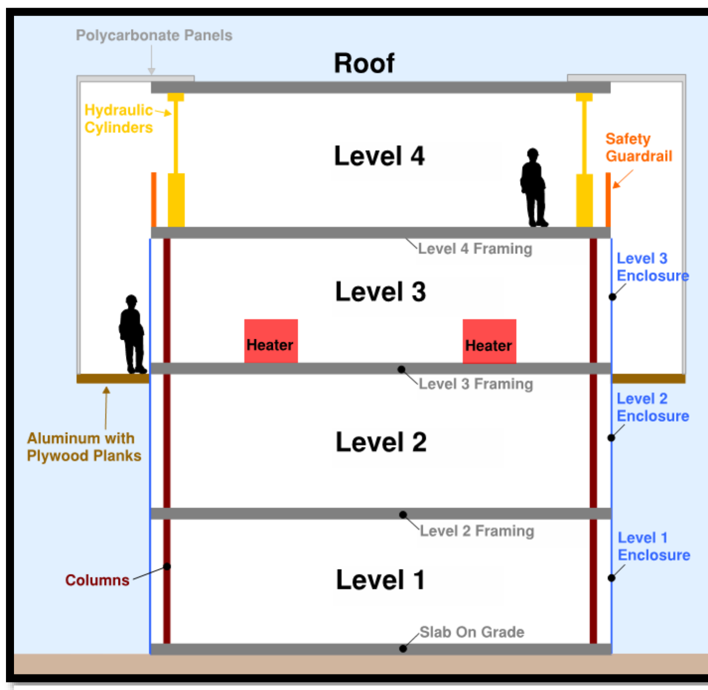
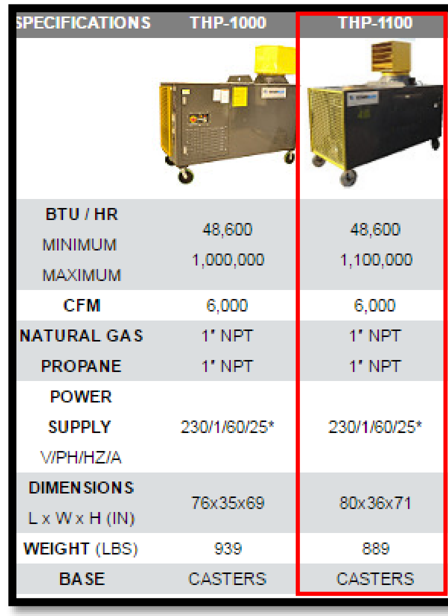


Figure 3.8: Simplified figure demonstrating the protection shell for the Upbrella Construction technique

Mechanical Breadth: Temporary Heat

The final redesign necessary to use the Upbrella method is the temporary heating system. According to ACI – 306R_10 Guide to Cold Weather Concreting, the minimum concrete temperature as placed and maintained for a slab less than 12" is 55°F. This concrete temperature then must be protected for two days, according to Table 7.1 of the guide. To combat this with the current method, the project team begins the heaters the day before a concrete pour on the deck below and tarps the deck above. This heater remains on all night, and the tarp is removed the morning of the pour. Because the temperature needs to be maintained, it will be assumed that the project team will keep these heaters on for 2.5 total days per floor.

The stucco on the exterior enclosure also requires certain temperature conditions. According to the product data, the brown coat process requires a placement temperature of above 40°F. To handle this requirement, the project team heats the scaffolding area, which is enclosed by a tarp. According to the schedule, the brown coat process will take approximately 30 days.



SPECIFICATIONS	THP-1000	THP-1100
BTU / HR MINIMUM MAXIMUM	48,600 1,000,000	48,600 1,100,000
CFM	6,000	6,000
NATURAL GAS	1" NPT	1" NPT
PROPANE	1" NPT	1" NPT
POWER SUPPLY V/PH/HZ/A	230/1/60/25*	230/1/60/25*
DIMENSIONS L x W x H (IN)	76x35x69	80x36x71
WEIGHT (LBS)	939	889
BASE	CASTERS	CASTERS

Figure 3.9: Heaters used for temporary heat

With the new construction method and exterior materials, the temporary heating system for the structural uplift method will be compared to the original design. The calculations will determine the number of "days requiring heat" and compare the cost of renting the same heaters in each situation. The current heaters used by the project team are THP1100 by Temp-Air (Figure 3.9).

Table 3.3: Temperature range during construction

Month	Temperature Range (°F)	Average Temperature (°F)
November	26-41	33.5
December	12-27	19.5
January	8-24	16
February	13-29	21
March	24-41	32.5
April	37-58	47.5

The first step in determining the required heating was finding the average temperature of the area (Table 3.3). The duration of the concrete slab construction lasted throughout November and December; therefore, the average temperature used in the calculations was 26.5°F. The stucco installation lasted for one week in February and three in March; therefore, the average temperature used was 29.6°F.

Table 3.4: Heating calculations for the original concrete placement method

Original Design: Concrete - 55°F					
Material	**Square Footage**	**R-Value (ft^2·°F·h/Btu)**	**U-Value (1/R)**	**Temperature Change (°F)**	**Total (Btu/hr)**
Tarp	6,240	0.071	14.11	28.5	2,509,322
Formwork (3/4" plywood)	14,596	0.94	1.06	28.5	442,538
Concrete (NW 6.57" thick)	14,596	0.47	2.13	28.5	885,077
Total Btu/hr for total construction:					**3,836,937**
This is equivalent to 4 heaters					

The heater used is capable of a maximum output of 1,100,000 Btu/hr. Most likely these heaters should not be used with a maximum output at all times; however, in order to compare similar systems, it will be assumed that 1,100,000 Btu/hr is acceptable.

Additionally, the concrete construction occurs well before the stucco installation; therefore, the total Btu/hr sums for the original method of construction cannot be added together because they occur at different times. Hence, the concrete requires four heaters at 87% maximum output, and the stucco requires two heaters at 87% maximum output (Tables 3.4 and 3.5).

With the 2.5 days of required heat for the concrete and 8 floors (floors 3-9 and the roof [4]), this equates to 20 days of heat with four heaters, or 80 days requiring heat. The stucco lasts for 30 days and requires 2 heaters, totaling to 60 days requiring heat. In total, the original construction method needs 140 days requiring heat.

Table 3.5: Heating calculations for the original stucco placement method

Original Design: Stucco Installation - 40°F					
Material	**Square Footage**	**R-Value (ft²·°F·h/Btu)**	**U-Value (1/R)**	**Temperature Change (°F)**	**Total (Btu/hr)**
Tarp (between scaffolding and building)	6,240	0.071	14.11	10.4	915,683
Tarp (exterior)	6,600	0.071	14.11	10.4	968,510
Scaffolding Wood Planks (1.5" thick)	6,438	1.88	0.53	10.4	35,614
Total Btu/hr for total construction:					**1,919,807**
This is equivalent to 2 heaters					

Table 3.6: Heating calculations for the structural uplift system

Structural Uplift System - 55°F					
Material	**Square Footage**	**R-Value (ft²·°F·h/Btu)**	**U-Value (1/R)**	**Temperature Change (°F)**	**Total (Btu/hr)**
Polycarbonate Panels	17,079	2.00	0.50	27.5	234,836
Plywood Planks (1.5")	3,219	1.88	0.53	27.5	47,086
Concrete (3.25")	14,596	0.260	3.85	27.5	1,543,808
Roof	14,596	24	0.04	27.5	16,725
Metal Deck	14,596	0	N/A	27.5	-
Solar Heat Gain	N/A	N/A	N/A	N/A	(63,749)
Total Btu/hr for total construction:					1,778,706
This is equivalent to 2 heaters					

The structural uplift schedule constructs both the concrete floors and stucco façade at the same time. For this reason, the temperature of the entire enclosure will be held at 55°F. This timeline lasts from the end of December to the end of April. Therefore, the temperature change average is lower at 27.5°F. Polycarbonate panels are advantageous not only for their structural stability and thermal insulation, but also because they have a clear tint. With a Solar Heat Gain Coefficient (SHGC) of 0.69, the clear material can translate directly into solar heat gain, thereby reducing the amount of temporary heat needed to ensure a temperature of 55°F. Sustainable by Design, a consulting firm, provides an internet tool to determine monthly solar heat gain dependent upon orientation, location, ground, and SHGC. By using this tool, the solar heat gain through the northwest and southwest facing panels totaled 63,749 Btu/hr. The northeast and southeast facing panels were not included in the calculations because they are shaded by adjacent buildings. The total structural uplift system requires two heaters (Table 3.6).

The structural uplift system allots nine days for stucco installation and one day for concrete pours per floor. The concrete pour, and therefore heating before and after, occurs within the nine days of the stucco installation. Therefore, heat is only required for nine days per floor, or 63 days for floors 3-9. Additionally, the roof will require heating, which will likely add 2.5 days with four heaters because it remains as per the original design. With 2 heaters for 63 days and 4 heaters for 2.5 days, the structural lift system has 136 days requiring heat at 81%.

[4] The first and second floors were not included in this calculation because both construction methods will likely need to use scaffolding and tarp, as the uplift system will build the first and second floors outside of the protection shell.

The percentage of maximum output for the proposed structural uplift system is significantly less than that of the original design, as well as four fewer heating days are required. While the structural uplift system is likely an overestimate of heating requirements because 6.5 of the 9 days need only be heated to 40°F instead of 55°F, this increased temperature will also impact productivity, as discussed in the *Schedule Impact* section.

The cost for renting the heaters (approximately $1,300/month) and the cost of propane ($1.873/gallon), with a heater that consumes approximately 8.25 gallons per hour, results in the total cost for the original method to be $21,123 and the Upbrella Construction method to be $19,511. This new polycarbonate wall system saves around $1,600 and provides the workers with natural daylighting.

Site Plan

Site plans of the original and structural uplift systems are located in Appendix 0.3 and 3.3. The original method requires a site plan with a tower crane and nine stories of scaffolding. This scaffolding extended beyond the building site limits, resulting in a covered sidewalk on the northwest side of the building. Additionally, in order to drop off and transfer materials to the material hoist, one road lane had to be closed permanently and a second was closed from 9am to 3pm. There was an extremely small amount of material laydown space due to the drive lanes and crane, so the project stored materials on top of the seven story parking garage on the northeast side of the building.

The structural uplift system changes a majority of the site plan. The site fence now extends out to the northwest edge of the sidewalk to protect pedestrians from walking underneath the protection shell. The two lane closures are no longer necessary, as the protection shell extends only 5' outside of the building footprint. Instead, this opened space on the sidewalk can be used for additional material laydown. The back courtyard (southeast end of the building) has a drive through lane which is no longer hindered by the tower crane, clearing up space for increased material laydown area. This will make the additional material area on the top of the seven story parking garage unnecessary, which saves money on the rental fee associated with renting the top parking spaces. A second material hoist has been added for ease of construction by allowing materials to be transported up from the inside and outside of the building. Two mast-climbing platforms have been added on the northeast and northwest ends so that the building is split in half and productivity is doubled. Forklifts with crane hooks will be used throughout the site to transport the steel members.

The site plan requirements for the structural lift system is not constraining, as opposed to the original method. Instead, there is a plethora of material laydown room and money can be saved by keeping roads open and not renting parking spaces. Additionally, traffic coming into and out of the site is much easier and straightforward, as it does not need to bend around a tower crane.

The project team is currently off-site due to the site constraints. With the structural uplift system, it is entirely possible for the project team to be located on site. Their area could be in the southern corner of the site or even in the first floor of the building, as it will be finished much earlier than the original schedule would allow. By moving the project team to the site, time and money can be saved and communication between the project team, construction workforce, and design professionals could be drastically improved.

Schedule Impact

To most accurately compare the schedules between the original construction method and the Upbrella Construction technique, only the activities which were changed or impacted will be compared. This then means that both schedules will directly address the timelines for installing heavy equipment/machinery, all levels of the structure (including the roof), floor-to-floor exterior infill framing, exterior façade finishes, glazing systems, and landscaping. Through the schedule arrangement, interior, plumbing, HVAC, fire protection, and electrical rough-ins, as well as drywall, finishes, doors and windows, furnishings, FF&E, clean-up, and punch list will be impacted. While it is likely that more systems could be impacted by the two construction methods, these activities were singled out as important for comparison between the two methods.

The original schedule (Appendix 3.4) begins with erecting the tower crane and material hoist. From here, 67 days are spent on the structure, 156 days are spent on the wall enclosure systems, 31 days are spent on the roof, 129 days are spent on the interior rough-ins, and 46 days are spent on the site landscaping. In total, the entire schedule for the selected activities lasts from August 8th, 2015 to October 13th, 2016, or 303 days. However, the tower crane is erected and in use for 17 days before the structure begins. Therefore, while it is important to note the duration of these machines from a cost standpoint, the actual duration for schedule comparison shall not include the days in which the tower crane and/or material hoist were not directly used for the structure.

To produce an accurate schedule comparison, only the number of days of construction will be considered. The duration used for the original schedule will therefore be 279 (construction of the structure and activities to follow) + 12 (construction for the tower crane foundation, and erection time for the tower crane and material hoist) = **291 days**.

The Upbrella Construction method rearranged the schedule of the structure and the wall enclosure systems, which includes exterior infill framing, exterior façade finishes, and glazing systems (Appendix 3.4). The roof was also shifted from the end of the schedule to the beginning of the schedule to account for the new construction method. Hardscapes and landscaping can begin immediately after the fourth floor structure is lifted and installed in place because the protection shell will be lifted well above the ground level. Additionally, all rough-ins, drywall, finishes, doors and windows, furnishings, FF&E, clean-up, and punch list can begin on a level as soon as that level's wall enclosure system is complete. Therefore, the 3rd floor rough-in begins while the 5th floor structure is being constructed two levels above.

The structural lift method allows interior construction to occur while floors are still being constructed, so there is a large amount of overlap. While this schedule was being created, it was noticed that some activities, if begun immediately after the 3rd floor wall enclosure system was complete, would finish either before or too soon after the 9th floor wall enclosure was completed. Therefore, all interior activities were given a predecessor of the 9th floor wall enclosure system plus the number of days needed to complete the work per activity. For example, the fire protection rough-in took approximately 9 days per floor to complete; therefore, the fire protection rough-in finished exactly 9 days after the 9th floor wall enclosure system was complete. This limitation impacted some, but not all interior activities. When it did impact an activity, the activity duration was lengthened to accommodate this, but additional activities were scheduled during the same time, or overlapped, to make-up for this loss of productivity. It was assumed that if the same amount of work was done over a longer time period, fewer workers would be needed per area. Therefore, more trades could be working in the same areas and not negatively impact the newly set productivity.

As noted earlier in the *Upbrella Construction* section, The Rubic used a ten day cycle per floor. The Heartland Hotel is likely 3-4 times larger than The Rubic. By using two to three times as much manpower per floor, the Heartland Hotel duration will be somewhere between 1 to 2 times as long as The Rubic duration. By utilizing the man-hours needed per activity (*Cost Impact* section) as well dividing the original time allotted for the wall enclosure systems per the number of floors, the durations were calculated (Table 3.7).

Table 3.7: Structural uplift system activity durations

Task Name	Duration
Floor Structure	**11 days**
Construct Floor Framing (Joists and Girders)	5 days
Lift and Install Columns	1 day
Lower System onto Columns	1 day
Finalize Structure (Stairs, Elevator Framing, Rebar, Inspection)	5 days
Pour Floor Concrete	1 day
Wall Enclosure Systems	**11 days**
Exterior Infill Framing	8 days
Install Stucco	9 days
Install Metal Panels	9 days
Install Glazing Systems	9 days

One final note about the durations and scheduling is that the temperature of the work environment impacts worker productivity. According to "Enclosures Keep Workers Warm and More Productive in Cold Weather" by Anne Smith, "Workers are 100% more productive only at air temperatures between 50°F and 80°F when relative humidity is less than 80%. At temperatures from 0°F to 32°F, productivity ranges from 70% to 98%" ("Smith").

To accommodate for the productivity gain through the Upbrella Construction method, the average temperatures were utilized and a linear relationship between temperature and productivity was developed. The average percent productivity for the original method was calculated by finding the productivity of each month with activities in cold weather. This calculation resulted in a 92% productivity rate. To account for this 8% increase in productivity for the structural lift method, the durations of activities which were typically done before proper heating was installed were decreased by 92%. Especially for long-duration activities, like HVAC and Fire Protection rough-in, these activities were positively impacted by this reduction. However, activities like drywall and finishes were not impacted by this productivity reduction because it was assumed that at that point, the temperature of the building would be adequate for the workers through either temporary heat or other means.

With all of the above calculations and considerations, the final schedule for the proposed construction method lasts **258 days**. This proposed method reduces the schedule by **33 working days**, or 6.6 weeks. The Heartland Hotel would see a turnover date just over one and a half months earlier than the original method. This means that instead of handing over the finished hotel in mid-October, with the Upbrella Construction method, the hotel could be finished by the end of August.

It was stated by the project team that the hotel would not open its doors until November, likely to allow time for staff training and move-in. By reducing the schedule by 1.5 months, the hotel would be able to open by mid-September, which is still during peak-tourism season. According to the 2015 *Monthly Occupancy and ADR Statistics* from Central Business District, the occupancy rate in September is 8.4% greater than the occupancy rate in November (Figure 3.9). This demonstrates that by welcoming guests 1.5 months earlier, there is a high chance for the hotel to gain 1.5 months' worth of additional profit. With 245 rooms at $202 ($212-$10=$202 – taken from *Analysis 1: 9th Story Design Change*), an occupancy rate of 82.9% for 0.5 months and 85.9% for one month, the hotel could see a potential revenue of $1,890,765.45. According to the MDI executive interviewed (Appendix 1.1), the hotel needs a 9% cap rate to survive. Therefore, if 9% of this income is profit, the hotel would gain an additional $170,169 from opening 1.5 months earlier.

Month	ADR	Occupancy (%)
January	$139.29	51.0
February	$141.01	57.1
March	$171.48	71.7
April	$200.49	79.2
May	$254.93	86.1
June	$247.50	87.5
July	$226.19	88.3
August	$203.53	84.8
September	$231.44	82.9
October	$243.35	85.9
November	$208.06	74.5
December	$161.47	60.0

Figure 3.9: Average occupancy rates by month ("Monthly")

Cost Impact

Including all of the cost impacts mentioned in previous sections, the different construction requirements were priced by materials, labor, and equipment from R.S. Means 2014, various company contacts, and online sources. A more detailed cost analysis can be found in Appendix 3.5. Due to the structural changes (*Structural Bay Redesign*), heating requirements (*Temporary Heat*), and differing equipment requirements, the cost breakdown between the structural uplift system and the original method varies in six different categories (Table 3.8). The red areas in Table 3.8 demonstrate in which major categories the original method would cost less, and the green categories show when the structural uplift method would cost less.

As mentioned in both the *Temporary Heat* and *Schedule Impact* sections, the structural uplift system would cost less and/or increase the potential profit of the hotel in these two categories. Overall, the structural uplift construction method costs around $825,000 more than the original construction method. This is a 54% cost increase for the sections directly impacted by this change in construction method. The overall budget for the Heartland Hotel was $40.05 million, so the structural lift system would increase the overall budged by 2.1%, totaling to $40.88 million.

The largest impact is the change in structure, by 76%. Not only do the small bay sizes mean that there will be a large number of steel members (which are oversized for the given loads), but it also means that the building height increases by 7'. This additional exterior enclosure necessary accounts for 21% of the cost increase. While a tower crane is no

Table 3.8: Cost comparison between the structural uplift system and the original construction method

Category	Structural Uplift Method	Original Method	Cost Change (Proposed – Original)
Construction Enclosure System	$224,233.26	$148,644.67	**$75,588.59**
Heating System	$19,592.80	$21,213.68	**$ (1,620.88)**
Structure	$1,834,730.94	$1,205,195.30	**$629,535.65**
Equipment	$264,680.39	$144,864.00	**$119,816.39**
Exterior Enclosure	$171,937.81	$0	**$171,937.81**
Profit	$(170,169.00)	$0	**$(170,169.00)**
Total	**$2,556,279.89**	**$1,519,917.64**	**$825,088.55**

longer necessary for the proposed construction method, this cost is quickly offset by the need for two double girder bridge cranes, hydraulic cylinders, and, because of the large size and perimeter of the building, two mast-climbing platforms and two material hoists. While The Rubic only utilizes one material hoist, mast-climbing platform, and bridge crane, the Heartland Hotel is shaped like an "L." Therefore, in order to have a realistic productivity so that workers don't receive all materials from one end, two material hoists and mast-climbing platforms were needed. This essentially splits the Heartland Hotel into two sections – which then necessitates two bridge cranes as well.

The construction enclosure system, which includes the polycarbonate panels, increases safety and productivity and decreases the amount of heat necessary. This change directly impacts the heating system profit of $1,600, as well as the profit of $170,000 from opening the hotel early. However, this changed system also costs $75,600 more to use than standard scaffolding.

Along with the quantifiable costs, there are additional costs and profits which cannot be quantified. By using the Upbrella Construction method, a new construction technique would be brought to the United States and would make a statement for Mortenson Construction. This would increase their publicity, broaden their scope of work and skills, and provide new challenges to a somewhat stagnant industry. However, with these benefits, using this new method also has downfalls. The structural uplift system would have a large learning curve, taken either a significant amount of time to plan or the cost to bring Upbrella Construction on the team, and could increase skepticism due to the newness of the method. While it was thought that insurance rates would decrease because of the added safety of the protection wall, this cost was not included in either budget because this method would be new to the United States.

4D Simulation

A 4D simulation comparing the structural uplift construction method and the original method can be found at the following link: https://www.youtube.com/watch?v=vsnbKCPHESc

Final Recommendation

The three main drivers for proposing a structural uplift system are the site constraints, the façade installation in cold weather, and the opportunity for Mortenson to try a new and innovative construction method. While Upbrella Construction's technique has worked extremely well on past and current projects, it is most beneficial when used on tall, thin, tower projects. The Heartland Hotel, therefore, adds additional constraints and requirements due to the "L" shape of the building and shorter height with respect to width. However, this does not completely exclude the structural uplift system from succeeding.

The current structural design does not align with the structural uplift method, thereby requiring a redesign of the structural system to composite steel. While this decreases the amount of time needed per floor, it also increases the cost by $630,000.

Mortenson has perfected their structural construction system with a five day per floor cycle. Because of this, Upbrella has a slower structural construction start, but makes up for the time with the accelerated façade and interior construction. Overall, the structural uplift system saves 1.5 months on the overall project duration. This translates directly into $170,000 profit by opening the hotel earlier.

The protection shell included in the structural uplift system increases safety, daylighting, and productivity while decreasing heating requirements,; however, this increases project cost by $74,000.

The site constraints are eliminated by opening up the project site without the need for a tower crane. With this open site plan, material storage on the roof is no longer necessary and the project team could potentially be located on site.

Using the Upbrella Construction method on the Heartland Hotel directly addresses the original drivers – the site no longer has size constraints, the façade installation schedule and productivity is improved, and a new technique can be undertaken by Mortenson. However, even with these initial goals achieved, the cost to use this method increases the overall budget by $825,000 – a 54% increase on sections directly impacted by this change in construction method. The added cost due to structure, equipment, and a building height increase of 7'causes this proposed construction method to have a large impact on budget.

This structural uplift system is new and innovative, and should be utilized on more projects; but, the Heartland Hotel is not one of these projects. The size and shape of the building fit better with the current construction method. If the Heartland Hotel was taller, thinner, or designed as a steel building initially, then the Upbrella Construction method would likely work much better. However, due to the original design and Mortenson's construction technique, the structural uplift system is not recommended.

ANALYSIS 4: FIELD LABOR EXPERIENCE

Problem Statement

As a position of authority on the project site, superintendents need a vast array of knowledge and experience. There are two typical paths that most construction superintendents have followed to reach their current position. Some have gone through the "office" side, where drawings were analyzed, problems were solved, and decisions were made within an office or trailer. Typical office positions for knowledge development prior to becoming a superintendent could include being a project engineer, field engineer, estimator, scheduler, or worker in specific areas of study with trades, preconstruction, or managerial staff[5]. The second path to becoming a superintendent is through performing work in the field. This path involves field labor experience through one or several trades.

As students work through Architectural Engineering, Construction Management, and Civil Engineering programs, they are taught information pertaining to work sites and construction methods. However, through internship opportunities, many students are taught things that they could never learn in a classroom. Internships offer immersive environments where students can see firsthand how their education can assist with their role as an employee.

As a superintendent, it is expected that you understand construction methods, are able to coordinate trades, and take control of the jobsite. But just as internships provide different opportunities for learning than academic education, performing field work offers different opportunities than office work. Therefore, the questions that arise are:

What benefits does field labor experience provide for a career as a superintendent?

How does field labor impact the role and success of a superintendent?

Research Goals

Research about the differences between field labor and office work will address benefits and drawbacks of each route. This can benefit many individuals and companies within the construction industry. For individuals with an interest in the construction industry, this research can provide additional information about opportunities to become a successful superintendent. Companies can gain from this research through recognizing pros and cons about offering different job paths, as well as opportunities and attributes which contribute to having a successful superintendent as an employee.

Approach

The following list includes the steps that will be taken in order to perform this analysis:

1. Review current research and articles related to success as a superintendent and field labor experience
2. Interview 4 current Superintendents with 10+ years of experience in the construction industry to gather feedback about job history and experience as a superintendent
3. Develop a questionnaire based off of the literature reviews and superintendent interviews
4. Distribute the questionnaire to multiple companies in order to gather feedback from superintendents, project managers, and other willing participants in the industry
5. Analyze the questionnaire responses for trends and/or correlations

The interview is intended to develop accurate questions for the questionnaire in order to gather a broader range of information. The responses received will help determine potential correlations between success and satisfaction and job paths, education, trade, location, and previous experiences. Additional areas of interest for potential factors in decision making and path choices are personality, family history, and people of influence/reasoning behind decisions.

Success can be due to various things, including skills and attributes, experiences, and choices. This analysis is expected to produce results which rank different ways to become successful as a superintendent. With an anticipated broad

[5] This list is not all-inclusive of job positions prior to becoming a superintendent.

range of responses due to varying backgrounds, positions, and years of experience, it is the hope that the results of the questionnaire will provide a sufficient starting point for those interested in becoming a superintendent. Additionally, as this research is part of the Penn State Architectural Engineering, Construction Management Senior Thesis, there is potential that the questionnaire addresses advantages and disadvantages of the courses offered and required at Penn State.

Execution

Literature Reviews

The first and second articles in a series of articles related to superintendent skills were reviewed before creating interview questions. The two articles provided interview responses regarding skills and competencies related to the superintendent role as well as how this role has changed/developed over time.

Part I: "Construction Superintendent Skill Sets" ("Gunderson")

The first article documents the results of seven interviews with construction superintendents. The interview questions from this article provided a general basis for the field labor experience interview questions.

From the seven interviews, five main skill sets were identified as important for being a construction superintendent:

- People skills
- Understanding the work and sequencing
- Scheduling, estimating, cost control
- Work ethic
- Learning from other people

Additionally, the interviewees identified how the superintendent position has changed over time:

- More paperwork
- More managerial responsibilities
- Must be computer literate
- Increased emphasis on safety
- Increased reliance on foreman
- Source of construction personnel (more college graduates)

The final section detailed the preparation necessary to become a superintendent:

- Education
- Construction experience

While these results were preliminary and did not provide any quantitative information, they did provide insight into important skills and traits necessary to becoming a superintendent. It is also important to understand how the superintendent position has changed over time. A changing position might require new skills and attributes that were not initially necessary. Therefore, by surveying important skills and attributes for superintendents in this current day and age, one can see how certain personality and/or knowledge requirements have developed or changed over time. This can then impact how one approaches the superintendent position and what path they choose to take.

Part II: "Ranking Construction Superintendent Competencies and Attributes Required for Success" ("Gunderson")

The second article documents the results of 14 interviews with construction superintendents. The questions posed required that the superintendents quantitatively rank competencies and attributes that are necessary for being a successful superintendent. The superintendents were provided with a list of skill sets, and were to rank the top ten (Figure 4.1).

Interestingly, the five main skill sets identified from part one do not exactly correspond with the ranked attributes. Specifically, the researchers found it curious that estimating was ranked last, but was identified in Part I as one of the top attributes.

Nevertheless, these interviews have identified important attributes to becoming a successful superintendent. In order to more quantitatively grasp the importance of certain skills for future superintendents, many of these competencies and attributes will be included in the questionnaire.

Superintendent Competencies or Attributes Ranking

Rank	***Competency or Attribute Description***	***Rank***	***Competency or Attribute Description***
1	Oral Communication	16	Trust Building
2	Leadership	17	Time Management
3	Scheduling	17	Written Communication
4	Strong Values and Ethics	19	Ability to "Keep your Cool"
5	Ability to Plan Ahead	20	Reinforcing Behaviors
6	Detailed Knowledge of Construction	21	Strong Work Ethic
7	Team Building	22	Collaboration
8	Broad Knowledge of Construction	23	Understand Materials
9	Computer Skills	23	Good with Numbers
10	Listening Skills	25	Conceptualization
10	Cost Control	26	Get Along with People
12	Ability to Work with Different Kinds of People	27	Estimating
13	Understand Subcontractors' Work	27	Typing Skills
14	Ability to Teach	27	Ability to Sketch
15	Ability to Learn from Others		

Figure 4.1: Literature review Part II - superintendent interview results ("Gunderson")

Application of the Literature Reviews

Part I of the series of articles identified skill sets and how the superintendent position has changed over time. Part II had 14 superintendents rank these skill sets. Both articles provided insight into skill sets which are important to becoming a superintendent, and the interviews and research associated with this analysis will further look into a ranking/rating system to more quantitatively identify how to become successful as a superintendent.

Interview Results

Four superintendents were interviewed via phone in order to more fully understand their position, background, opinions on success as a superintendent, and office vs. field opportunities. The interview questions can be found in Appendix 4.1. The full sentence interview responses can be found in Appendix 4.2.

The reasons for three of the four interviewees entering the construction workforce was because it was a natural progression and/or they were passionate about it. All four superintendents had dads which were involved in the construction industry. This family history could play a large role in their choice to enter the construction industry, and will be examined further to see if it has an impact on entering the construction industry via physical labor (eg. union, apprenticeship, trade) or via a college/university.

Two of the four superintendents were involved in the carpentry industry. Questionnaire results will examine whether certain trades are more common backgrounds for superintendents.

All four superintendents answered that they were satisfied with their role as a Superintendent, yet quantitative responses were not gathered as to their level of satisfaction. Therefore, the questionnaire will involve a quantitative response to satisfaction. Additionally, any potential correlation between amount of time spent in the industry and satisfaction with their role will be analyzed.

Interview responses about traits for being successful as a superintendent were as follows:

Understanding Others' Work	The Ability to Listen	Willingness to Learn	Relationship Building	Works Well with Others	Identifying Road Blocks
Understanding People	Strategic Thought Process	Communication	Collaborative	Experience	Confidence
Management	Integrity	Assertiveness	Being Respectful	Leadership	Intentional
	Fair	Hard Working	Scheduler	Organized	

These traits, along with key attributes from the *Literature Review* section, will be included in the questionnaire in order to rank the importance of each. Additionally, responses about what is gained from field labor vs. office work will be included in the questionnaire in order to quantitatively rank important opportunities.

It was observed that the questions about the "next step" for becoming a superintendent after college and after high school was slightly confusing, as some of the interviewees thought that this implied that college was not an option for high school students. Therefore, in order to gather qualitative data about path options for future superintendents, options about next steps will be provided.

The final question about beginning a career again as a superintendent was interesting because it revealed opportunities that were thought to have been missed and provided advice for future superintendents. Therefore, this question will be kept in the questionnaire as an open-ended question because of the interesting and unique responses.

Questionnaire Results

The questionnaire prepared was sent to several different construction management firms. The contacts at these firms were asked to distribute the questionnaire to superintendents, project managers, and people in similar positions via email or physical pdf handout. The respondents then emailed their responses back for further analysis. Because company contacts were asked to distribute the responses personally, it is unknown how many were questionnaires were sent; however, 69 total responses were received. The questionnaire pdf can be found in Appendix 4.3. Figure 4.2 shows the positions held by the 69 respondents.

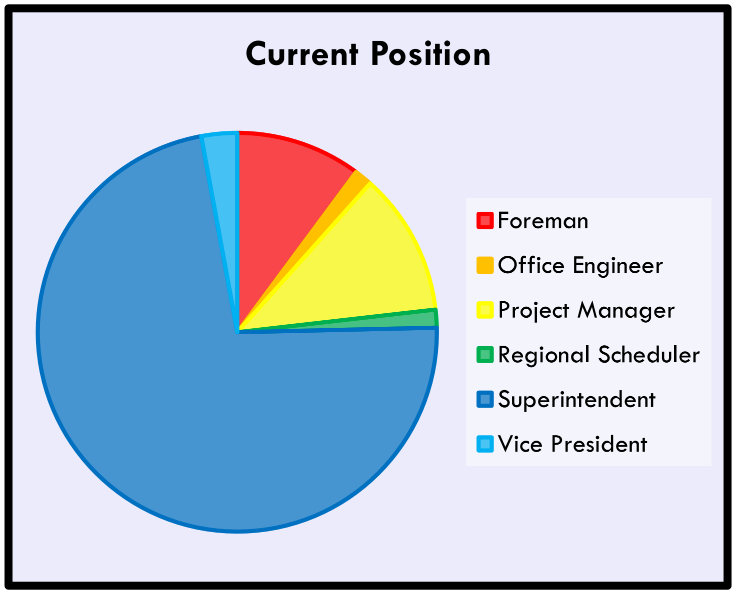


Figure 4.2: Positions held by respondents

Figure 4.3 compares the amount of time the respondents have spent in their current position and the amount of time that they have spent in construction. Over 40% have spent between 0 and 5 years in their current position, which could lead one to think that fairly young people responded to the questionnaire. However, over 50% of all respondents have spent over 20 years in the construction industry. Therefore, the results of the upcoming questions are likely a good representation of the construction industry, as there is plenty of experience within the respondent pool.

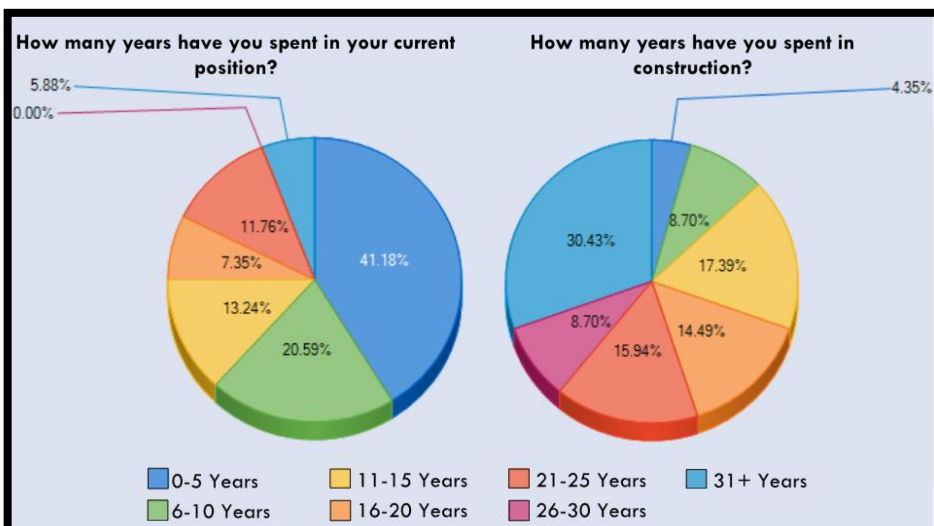


Figure 4.3: Amount of time spend in their current position vs. amount of time spent in construction

As mentioned in the *Interview Results* section, satisfaction with a current position is quantified in Figure 4.4. When the satisfaction responses were separated by amount of time spent in the construction industry, the results revealed that responders with 0-20 years of experience averaged a 4.29 satisfaction rate, while those with 21-30+ years of experience averaged a 4.27 satisfaction rate. Therefore, no results can be drawn correlating satisfaction and amount of time spend in the construction industry. Similar results were found when split by position, with a satisfaction of 4.19 for superintendents and foreman, and 4.33 for office positions.

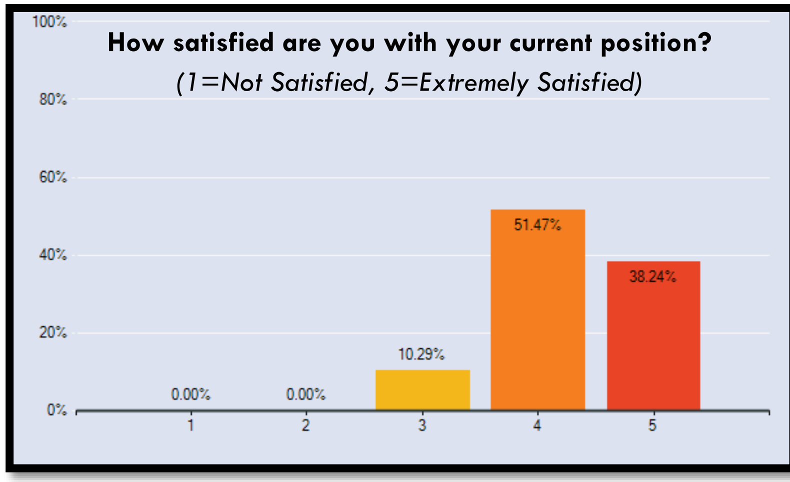


Figure 4.4: Satisfaction with current position

Figure 4.5 details the highest level of education that survey respondents have completed. Some respondents answered with multiple options selected, so all responses were included. Approximately 31% of respondents received some sort of degree and 67% of respondents went directly into the field without attending an educational institute beyond high school. Surprisingly, of the respondents who are currently superintendents, 48% received some sort of collegiate degree. Typically, the superintendent position is filled with people who have come up through the trades, but the respondents reveal that this pool of superintendents is just as likely to have gone to college as they are to have come up through the trades. Areas of study to obtain a degree included accounting, agriculture, architectural engineering, architecture, business, civil engineering, computer programming, construction management, liberal arts, medicine, robotic engineering, structural engineering, and wildlife management, with construction management and civil engineering being the most common answer. Superintendents who had field labor experience were involved with one of the following trades: carpentry, concrete, drywall, electrical, laborer, manufacturing, masonry, mechanical, plumbing, steam fitting, surveying, and/or underground utilities. Of all the trades which superintendents stated that they were involved in, 48% were involved in carpentry. This leads to a potential correlation between carpentry and becoming a superintendent.

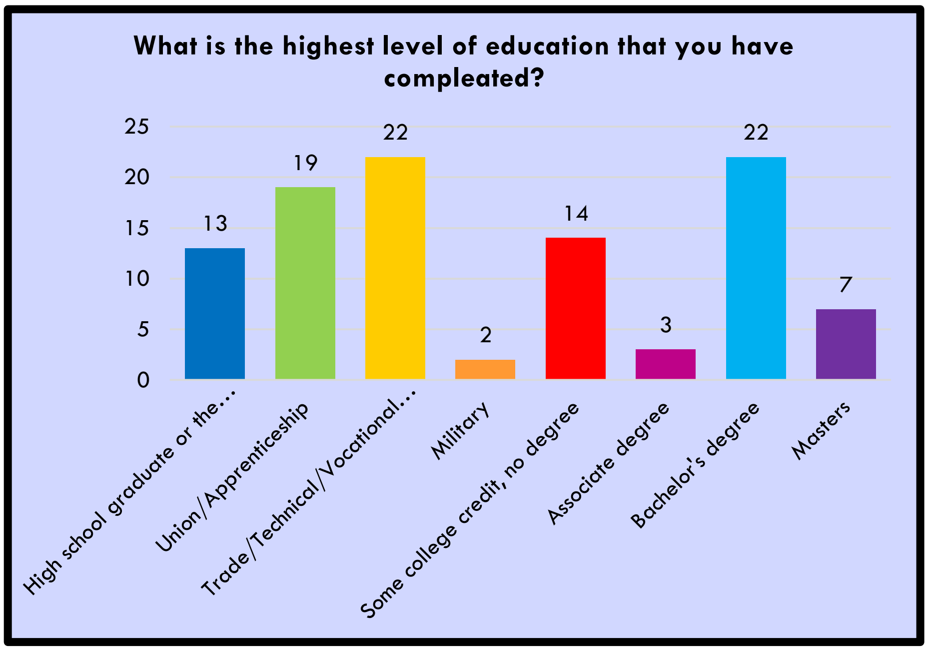


Figure 4.5: Highest level of education

The questionnaire responses revealed that 41% of respondents had one or two parents who were involved in the construction industry (Figure 4.6). Additionally, 55% of respondents had an older figure in their life (parent, grandparent, or uncle) who might have impacted their decision to join the construction industry. From this point, all positions besides the superintendent were filtered out to reveal if an older figure in construction impacted the route taken to becoming a superintendent. 55% of respondents with an older figure in construction received some sort of higher education degree. This leads to the conclusion that, while entering the construction industry may be passed down from generation to generation (55%), this does not necessarily promote either entering the field labor force or receiving a degree.

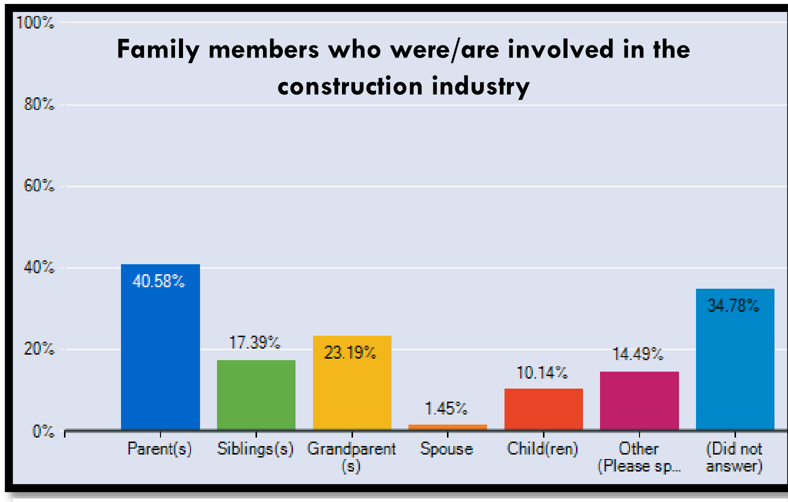


Figure 4.6: Family members involved in the construction industry

The second section of the questionnaire addressed success as a superintendent. Respondents were asked to rate potential experiences to becoming a superintendent on a scale from 1-5 (1=not beneficial, 5=extremely beneficial). Figure 4.7 details the responses. The results revealed that experience working with drawings and specifications was extremely important, with an average rating of 4.9. All other experiences, besides taking accounting classes, received an average rating at or above 3.3. This reveals that most respondents felt that these experiences, while not required, would still be beneficial to those pursuing a superintendent path.

Penn State offers a Construction Management path within Architectural Engineering. Of the students pursuing this degree, most aim to become a project manager; however, some will become superintendents. Of the top three experiences to becoming a successful superintendent, only one course is required within the AE, CM degree (blue bars in Figure 4.7 represent courses required at Penn State; red bars signify courses not required). While Penn State AE students receive a handful of experience working with drawings and specifications, they do not receive any formal leadership classes or experience physically building. Data was not collected to determine if these experiences were beneficial to becoming a project manager, but it is unfortunate that students pursuing a career as a superintendent are not exposed to these classes as a part of their collegiate education.

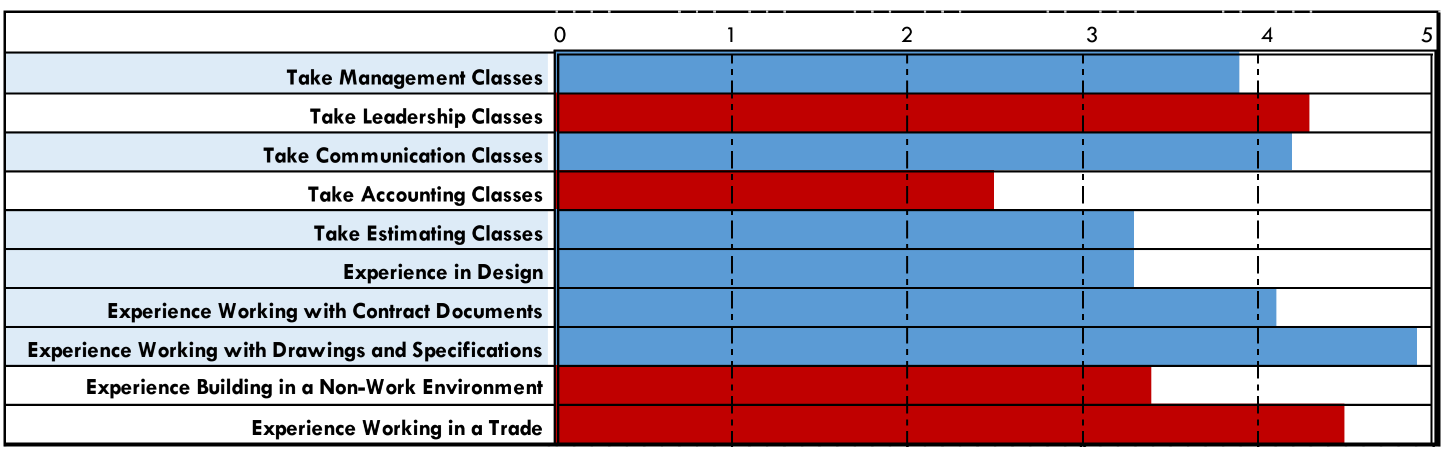


Figure 4.7: Potential experiences to become a successful superintendent

As mentioned in the *Interview Results* section, the "next step" question for those pursuing a career as a superintendent was worded differently in the questionnaire than the interview. Respondents were asked to rank several next-step options for a college graduate and for a high school graduate. Results for each are in Tables 4.1 and 4.2. The results were obtained by a weighted score (#1=6 points, #2=5 points, etc.). The points are included solely for ranking purposes, but reveal if the final ranks were close.

For the recent college graduate, the top ranked option was to work on-site as a project engineer/field engineer; however, physically working in the field closely followed this, and was ranked second. Working on-site received 26 #1 choices, while physically working in the field received a close 24 #1 choices.

Table 4.9: Next-step options for a recent college graduate pursuing a superintendent

Rank	Recent College Graduate Options	Weighted Score
1	Work **on-site** as a Project Engineer/Field Engineer (or the equivalent)	174 points
2	Physically work in the field (e.g. Union, laborer, trade)	159 points
3	Work in the **office** (e.g. estimating, pre-construction, scheduling)	110 points
4	Work with a specialty group (e.g. BIM, LEED, safety)	87 points

For the recent high school graduate, the top ranked option was to enter the construction workforce, with going to a college/university, joining a union/apprenticeship program, and getting trade/technical/vocational training following closely behind as second, third, and fourth choices. Entering the construction workforce received 21 #1 choices, while going to a college/university received 15 #1 choices. The results for the high school graduate are interesting in that respondents leaned towards students entering the construction workforce as opposed to furthering their education through a college, apprenticeship, or technical training. However, the interviews held revealed that formal education is not for everyone, and that getting hands-on experience can be equally, if not more, beneficial.

Table 4.2 Next-step options for a recent high school graduate pursuing a superintendent position

Rank	Recent High School Graduate Options	Weighted Score
1	Enter the construction workforce (labor/trade)	238 points
2	Go to a college/university to get a degree in construction or a related field	198 points
3	Join a Union/Apprenticeship Program	192 points
4	Get Trade/Technical/Vocational Training	191 points
5	Join the military to learn a trade/skill or become an engineer	137 points
6	Get certified/training (OSHA, ABC, or similar)	115 points

The final question regarding success as a superintendent asked the respondents to mark the skill/attribute which is more important to becoming a successful superintendent (Figure 4.8). Of the options, verbal communication, field experience, field credibility, and the ability to work with a team were consistently highly ranked, with average scores of 2.30, 2.70, 2.46, and 2.66 respectively. The questions were intended to see if there was a strong pull towards office or field work and towards relationship building. Questions 3, 5, and 9 looked specifically at office vs. field experience. Both question 3 and 5 rated the importance of field experience and credibility highly. Similarly, questions 2, 4, 6, 8, 9, and 10 looked specifically at the importance of relationships and understanding people. However, only questions 2 and 10 rated the importance of these interactions as important.

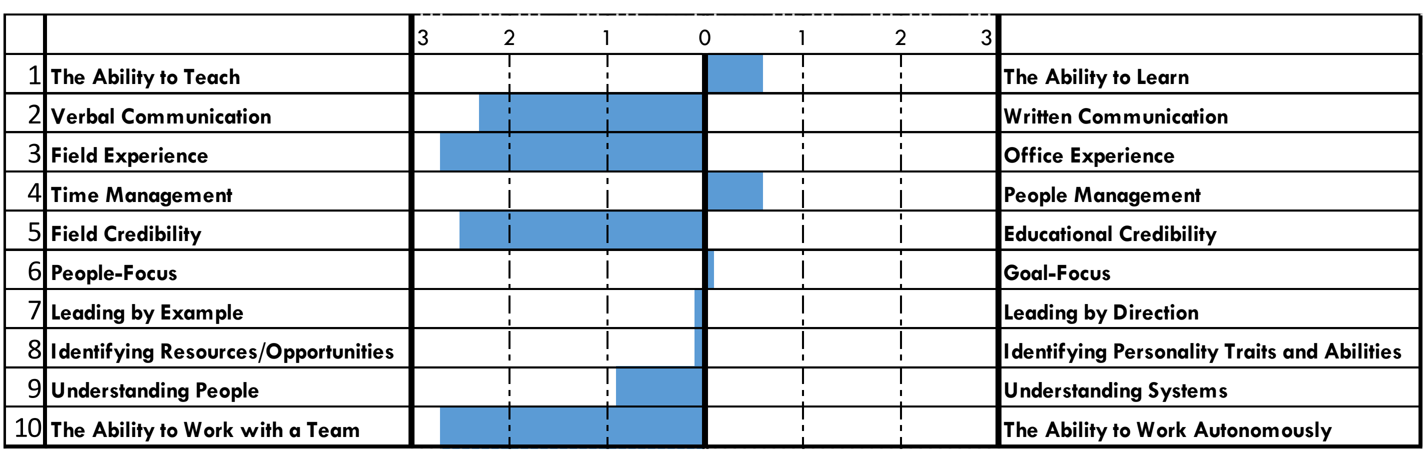


Figure 4.8: Skills/attributes which are important to becoming a successful superintendent

Open Ended Questions

The questionnaire concluded with three open ended questions. With 69 returned questionnaires, the responses had a wide range of answers. However, there were also trends of answers within each question. Full responses can be found in Appendix 4.4.

In your opinion, what experience (e.g. field labor, project management) best prepares someone to be a Superintendent? Please explain.

The answers for this question typically leaned towards field labor experience. Many responses were adamant about learning how to perform the work, instead of simply watching or reading about it. However, some responses also gave a more "well-rounded" view and encouraged both an educational and a hands-on track. Specifically, one respondent stated that while going through the trades is the traditional track taken to becoming a superintendent, one can achieve this same role quicker with a college degree.

"The best superintendent's I've worked with are the ones who worked their way up through the trade, specifically carpentry"

"The best superintendents have project management experience. The best project managers have field experience"

"Being a PSU AE Alum, you can better apply the principles learned in an education program. I mean this in that we can acclimate better with the office - technology, document control, finances, communication, problem solving, organization, coordination of BIM. However, once this acclimation occurs we can have a better feel for the field. This 'adjustment time' helps us choose which way to go, office or field. Guys who grow and progress through the trades will more than likely be field guys, and the same for college and office people. We are beginning to blur that line"

Overall, the responses to this question were eye opening. It is obvious through the responses that many skills are needed in order to become a successful superintendent. No single experience best prepares someone for this role, but rather, getting a mix of different experiences and education can lead you towards developing into a leader.

In your experience, how has the superintendent role changed over time.

The responses to this question ranged from "no change" to "nearly everything has changed." However, as with the first question, there were trends of answers throughout the responses. Technology use has greatly increased and because of this, more people feel that superintendents need to be able to adapt to this new technology or bring in people who can. For many respondents, this technology was associated with a college education.

Additionally, the role has changed in two ways on a relationship level. Many respondents stated that nothing was done with a handshake anymore and that instead, everyone was worried about protecting themselves. However, while this form of agreement and relationship has diminished, more people feel that superintendents need to be able to form relationships with tradesmen and lead instead of dictate.

Overall, it seems as though the superintendent role has changed in a way which requires a broader range of knowledge. This opens up the position to people of different backgrounds and experiences, thereby creating a more diverse and unique superintendent position.

"The Senior Superintendents can provide insight based on their practical work experience, while the junior superintendents can provide insight into the newer construction technology tools. Together that is a powerful team"

"Technology has become so critical to our daily lives that a good trade school or college education has almost become a prerequisite to being a superintendent"

"This role has gone from a position of dictating on site to a position of team(s) leadership at all levels and phases of the project"

"I would hate to see the super track one day require a college degree. It's about finding the right types of people and developing them into field-based leaders"

If you had to begin your career again to become a superintendent, what would you have done differently and why?

The answers to this final question depended on the respondent's background. Several stated that they wished they had taken more classes or completed more school. Others stated that they wished they had joined the industry sooner or paid more attention to how things went together. Many even said that they would not have changed anything, as they are happy where they are today and how they got there.

Each respondent had a different path to get to where they are today. Many wish that they had done something differently. So while these responses cannot be used to direct a path, they can be used to recognize opportunities to take when available, like education, mentors, and field experience.

Recommendations

The industry norm up until now has typically taken superintendents who have come up through the trades. This path has provided these superintendents with a plethora of field labor experience which translates directly into their knowledge as a superintendent. According to the questionnaire respondents, however, the superintendent role is slowly emerging to incorporate those with a higher education background. 48% of the respondents who are superintendents have received some sort of formal higher education beyond high school.

As students are graduating and entering the construction work force, they have a scholarly background but typically minimal experience performing field labor. So while the industry is changing to include these students as superintendents, a question arises as to whether this lack of field labor experience might impact their success as a superintendent.

From the questionnaire, respondents stated that leadership classes, experience working with drawings and specifications, and experience working in a trade were the top three practices that are beneficial to becoming a successful superintendent. Additionally, the top "next-step" options for high school graduates and college graduates both included physical, on-site experience. Field experience, field credibility, and the ability to work with a team were the top attributes to becoming a successful superintendent.

It is obvious through the responses that field labor experience greatly impacts success as a superintendent. But how, then, can people who are obtaining a degree in higher education also receive this type of field experience? Typically, internships provide on-site work but don't include physical labor. The only physical field labor experience available for students is if they personally seek it out through hobbies, clubs, and/or jobs. While it is not the sole responsibility of the educational program to provide every opportunity possible, it is their responsibility to encourage learning experiences that can further the education of students and help them to be more successful in the working world.

Specifically looking at the Penn State Architectural Engineering program, many classes are required which align with important experiences for superintendents. However, physically building is not in the curriculum. As Architectural Engineers, we are taught the fundamentals of engineering and why certain things work/go together. But unfortunately, we are never asked to physically put these pieces together. This means that two of three main learning styles are addressed – auditory and visual. But the kinesthetic learners, those who need to physically touch and experience something in order to learn, have no required courses.

Understanding a construction process can be daunting and confusing. But, as one of the respondents stated, "…field experience will show that nothing works exactly as taught in books." I recognize that including hands-on experience might be difficult and near-impossible. So while that would be the optimal solution, at the very least, hands-on experience needs to be emphasized and promoted.

As an industry, we cannot be satisfied with simply teaching thoughts and ideas. We need to ready students to enter the construction workforce – an industry based on the physical labor of others. By getting involved and doing physical work, a broader range of knowledge and opportunities are possible.

CONCLUSIONS

Through the four analyses of this thesis, the intention was to further develop potential opportunities and determine the feasibility and practicality of implementing the ideas on the Heartland Hotel project. The first three analyses developed plans which related the building components and improving upon construction goals of schedule, budget, and constructability. The final analysis was intended to research an industry-related topic to further understand and improve the construction industry as a whole. The mechanical and structural depth were meant to further develop and demonstrate the education of various options received at Penn State. By integrating these ideas together, this thesis presents an overall demonstration of the education and knowledge received through the Penn State Architectural Engineering, Construction Management program.

Analysis 1 seized a potential business opportunity by incorporating suites on the top level of the Heartland Hotel. By redesigning the floorplans to include these suites, the construction cost decreased by nearly $34,000. Additionally, these suites provide a potential $20,000 additional annual revenue for the Heartland Hotel and MDI. Although the profitability projection is based off of estimates and assumptions, this analysis is recommended due to the increased cost-effectiveness and the variability in rooms offered by the Heartland Hotel.

Analysis 2 exploited constructability concerns with the link bridge. Prefabricating the link bridge as one module and transporting it to site eliminated these constructability issues. Additionally, nearly $30,000 would be saved through prefabrication and the schedule would be reduced by 7 days. Although prefabrication can be an unfamiliar construction method to some, this link bridge provides a significant opportunity to utilize new construction techniques to improve the project budget, schedule, and safety.

Analysis 3 sought to mitigate concerns about installing stucco during a harsh winter and constructing within a small site. With the help of Upbrella Construction, this analysis replaced traditional construction methods with a structural lift system. A structural breadth was included in this analysis, as the PT floor was redesigned to include a composite steel framing system in order to mitigate the hydraulic lifting weight as well as increase constructability and productivity. The structural lift system also included an exterior protection shell so that exterior enclosure work could safely be completed at the same time as the structure. The protection shell involved polycarbonate panels, which required a mechanical breadth analysis for temporary heating requirements. Although this structural lift system provided Mortenson with an opportunity to expand its knowledge and experience, as well as sped up the schedule by 1.5 months, the overall system would cost an additional $825,000. This system was therefore not recommended for the Heartland Hotel, but would be more beneficial with a taller, less irregularly-shaped building.

Analysis 4 researched the importance of field labor experience for becoming a superintendent. Interviews and a questionnaire were used to address these benefits, and many industry members provided insightful responses. It was concluded that both education and field experience are extremely beneficial. Neither experience is replaceable by the other. Both provide different and unique opportunities, and both are beneficial and encouraged for future superintendents. An emphasis on encouraging students to gain both of these types of experiences should be embraced through academic and construction settings.

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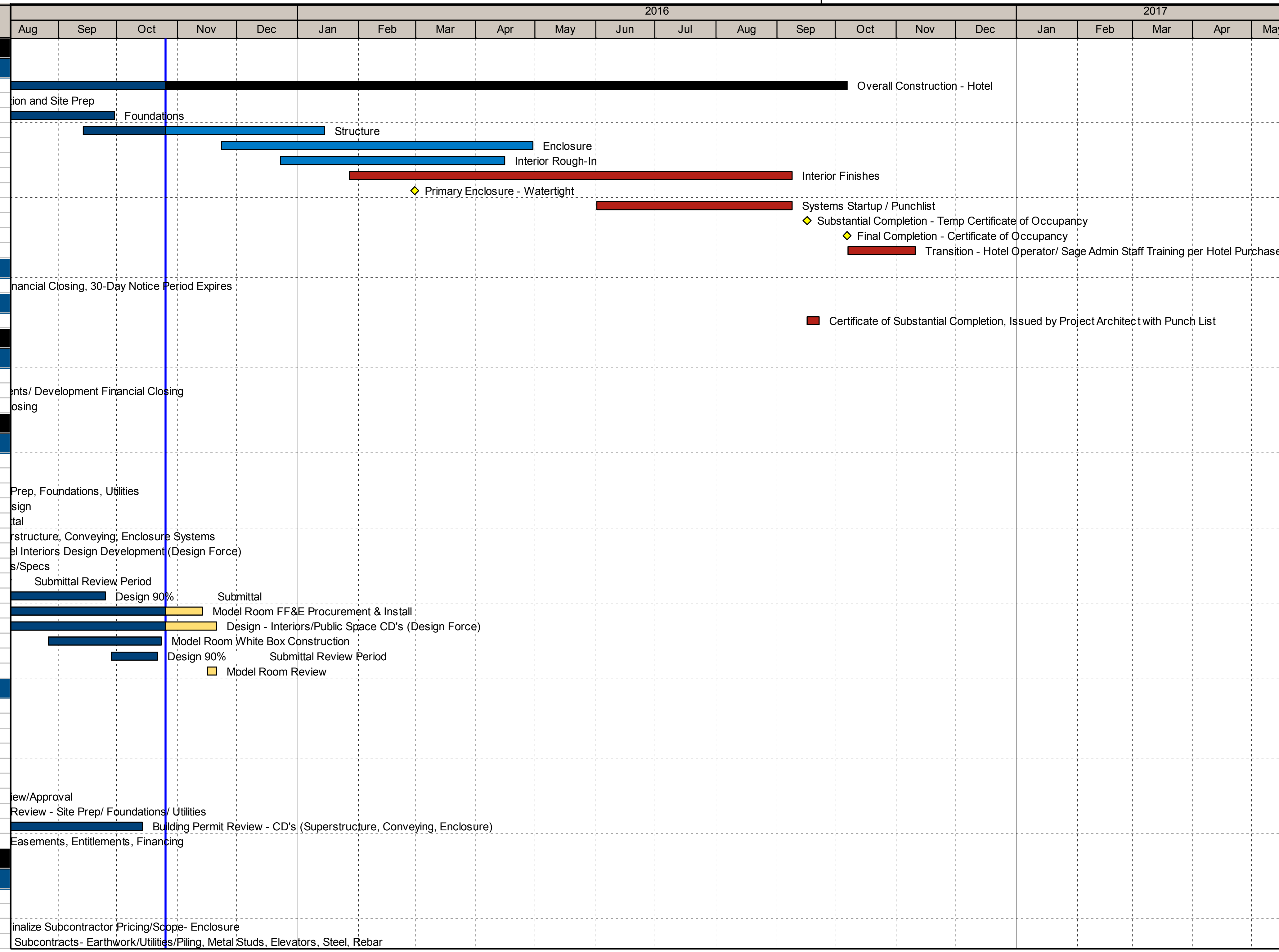
Project Information

0.1 - Project Schedule

Mortenson construction — Building what's next.[SM]

Activity Name	Orig. Dur'n	Start	Finish
Summary and Milestones			
Project Summary			
Overall Construction - Hotel	301	Jun/03/15 A	Oct/06/16
Mobilization and Site Prep	25	Jun/08/15 A	Jul/13/15 A
Foundations	30	Jul/13/15 A	Sep/30/15 A
Structure	60	Sep/14/15 A	Jan/14/16
Enclosure	111	Nov/23/15*	Apr/29/16
Interior Rough-In	81	Dec/23/15*	Apr/15/16
Interior Finishes	159	Jan/27/16*	Sep/08/16
Primary Enclosure - Watertight	0		Feb/29/16*
Systems Startup / Punchlist	70	Jun/01/16*	Sep/08/16
Substantial Completion - Temp Certificate of Occupancy	0		Sep/16/16*
Final Completion - Certificate of Occupancy	0		Oct/06/16
Transition - Hotel Operator/ Sage Admin Staff Training per Hotel Purchase A(	25	Oct/07/16	Nov/10/16
Temporary Facilities			
Parking Operator- MDI Financial Closing, 30-Day Notice Period Expires	22	Apr/29/15 A	Jun/01/15 A
Systems Testing and Start-Up			
Certificate of Substantial Completion, Issued by Project Architect with Punch	5	Sep/16/16	Sep/22/16
Planning and Development			
Customer / Developer Agreement			
Development Agreements - AIG/MDI JV Termsheet	0		Dec/08/14 A
Final Exhibits for Agreements/ Development Financial Closing	80	Jan/09/15 A	Jun/01/15 A
Development Financial Closing	0		Jun/01/15 A
Design and Pre-Construction			
Prepare Drawings			
Design - Schematic Design (ESG) - 30% Submittal	23	Dec/29/14 A	Jan/21/15 A
Design 30% Submittal Review Period	20	Jan/21/15 A	Feb/27/15 A
Design - Permit Set/ CD's - Demo, Site Prep, Foundations, Utilities	35	Jan/22/15 A	Apr/28/15 A
Design - Contract Set - Arch/Interior Design	40	Mar/09/15 A	Apr/28/15 A
Design 60% Submittal	41	Apr/10/15 A	May/26/15 A
Design- Permit Set/ CD's - Superstructure, Conveying, Enclosure Systems	27	Apr/29/15 A	May/15/15 A
Design - Hotel Interiors Design Development (Design Force)	45	May/11/15 A	Jul/02/15 A
Model Room Drawings/Specs	17	May/18/15 A	Jun/10/15 A
Design 60% Submittal Review Period	20	May/27/15 A	Jun/23/15 A
Design 90% Submittal	40	Jul/20/15 A	Sep/25/15 A
Model Room FF&E Procurement & Install	45	Jul/27/15 A	Nov/13/15
Design - Interiors/Public Space CD's (Design Force)	40	Jul/27/15 A	Nov/20/15
Model Room White Box Construction	10	Aug/27/15 A	Oct/23/15 A
Design 90% Submittal Review Period	20	Sep/28/15 A	Oct/21/15 A
Model Room Review	5	Nov/16/15*	Nov/20/15
Design Decisions, Reviews & Approvals			
City of Minneapolis CoW Approval	1	Oct/31/14 A	Nov/13/14 A
City of Mpls- Planning Commission- Review/Approval	24	Dec/05/14 A	Jan/12/15 A
City of Mpls - Preliminary Development Review (PDR)	30	Dec/30/14 A	Jan/09/15 A
MPCA - RAP Plan Review/Approval	30	Feb/02/15 A	Feb/24/15 A
City of Mpls - PDR Resubmittal	10	Mar/27/15 A	Apr/17/15 A
Building Permit Review - Demolition	10	Mar/27/15 A	Apr/28/15 A
SAC Determination - Review/Approval	20	May/06/15 A	Jun/01/15 A
Building Permit Review - Site Prep/ Foundations/ Utilities	20	May/07/15 A	Jun/26/15 A
Building Permit Review - CD's (Superstructure, Conveying, Enclosure)	30	May/28/15 A	Oct/14/15 A
Development Approvals- Easements, Entitlements, Financing	0		Jun/01/15 A
Assemble Construction Team			
Bid and Award Contracts			
Solicit Subcontractor Bids - MEP	10	Jan/05/15 A	Feb/12/15 A
Award Design-Build MEP Subcontracts	15	Feb/13/15 A	Mar/20/15 A
Finalize Subcontractor Pricing/Scope- Enclosure	15	May/18/15 A	Jul/31/15 A
Award Critical Subcontracts- Earthwork/Utilities/Piling, Metal Studs, Elevators	10	May/26/15 A	Jun/30/15 A



Legend: Planned Work; Procurement; Project Summary; Critical Work; Milestone; Progressed Work; Pre-Construction

October 2015 Update

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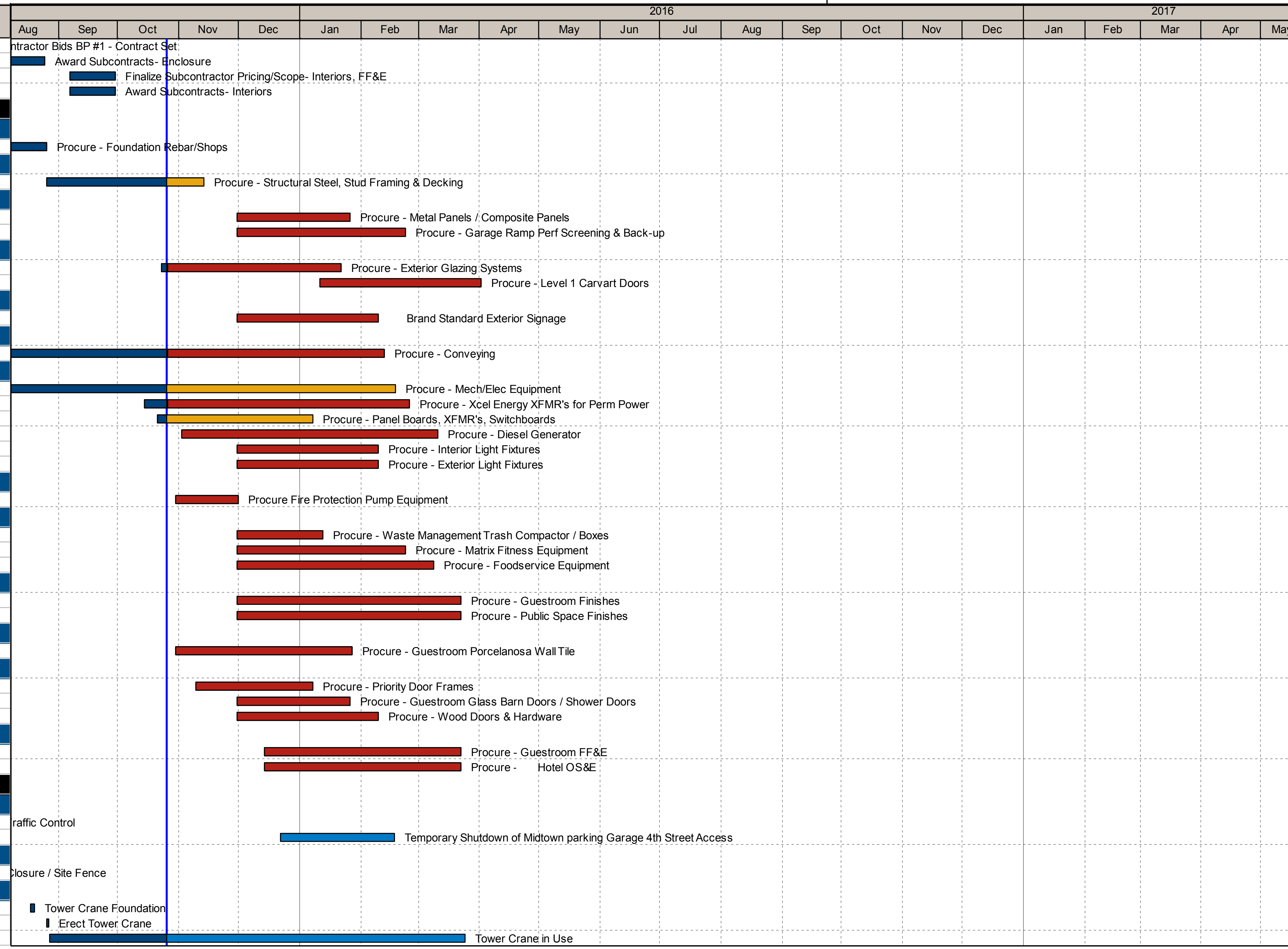
Oct/22/15	October 2015 Schedule Update	JH	JH

Mortenson construction — Building what's next.℠

Activity Name	Orig. Dur'n	Start	Finish
Solicit Subcontractor Bids BP #1 - Contract Set	10	Jun/01/15 A	Jul/02/15 A
Award Subcontracts- Enclosure	15	Jun/15/15 A	Aug/25/15 A
Finalize Subcontractor Pricing/Scope- Interiors, FF&E	15	Sep/07/15 A	Sep/30/15 A
Award Subcontracts- Interiors	15	Sep/07/15 A	Sep/30/15 A
Procurement			
Foundations			
Procure - Foundation Rebar/Shops	25	Jun/29/15 A	Aug/26/15 A
Steel Structure			
Procure - Structural Steel, Stud Framing & Decking	60	Aug/26/15 A	Nov/13/15
Wall Enclosure Systems			
Procure - Metal Panels / Composite Panels	40	Nov/30/15*	Jan/26/16
Procure - Garage Ramp Perf Screening & Back-up	60	Nov/30/15*	Feb/23/16
Glazing Systems			
Procure - Exterior Glazing Systems	60	Oct/23/15 A	Jan/21/16
Procure - Level 1 Carvart Doors	60	Jan/11/16*	Apr/01/16
Misc. Enclosure Items			
Brand Standard Exterior Signage	50	Nov/30/15*	Feb/09/16
Elevators			
Procure - Conveying	150	Aug/03/15 A	Feb/12/16
Equipment			
Procure - Mech/Elec Equipment	80	Jul/27/15 A	Feb/18/16
Procure - Xcel Energy XFMR's for Perm Power	90	Oct/14/15 A	Feb/25/16
Procure - Panel Boards, XFMR's, Switchboards	50	Oct/21/15 A	Jan/07/16
Procure - Diesel Generator	90	Nov/02/15*	Mar/10/16
Procure - Interior Light Fixtures	50	Nov/30/15*	Feb/09/16
Procure - Exterior Light Fixtures	50	Nov/30/15*	Feb/09/16
Fire Protection Equipment			
Procure Fire Protection Pump Equipment	20	Oct/30/15*	Nov/30/15
Specialty Equipment			
Procure - Waste Management Trash Compactor / Boxes	30	Nov/30/15*	Jan/12/16
Procure - Matrix Fitness Equipment	60	Nov/30/15*	Feb/23/16
Procure - Foodservice Equipment	70	Nov/30/15*	Mar/08/16
Drywall and Interior Finishes			
Procure - Guestroom Finishes	80	Nov/30/15*	Mar/22/16
Procure - Public Space Finishes	80	Nov/30/15*	Mar/22/16
Wall Finishes			
Procure - Guestroom Porcelanosa Wall Tile	60	Oct/30/15*	Jan/27/16
Interior Doors & Windows			
Procure - Priority Door Frames	40	Nov/09/15*	Jan/07/16
Procure - Guestroom Glass Barn Doors / Shower Doors	40	Nov/30/15*	Jan/26/16
Procure - Wood Doors & Hardware	50	Nov/30/15*	Feb/09/16
Furniture, Fixtures, & Equipment			
Procure - Guestroom FF&E	70	Dec/14/15*	Mar/22/16
Procure - Hotel OS&E	70	Dec/14/15*	Mar/22/16
Construction			
Temporary Facilities			
Mobilize / Temporary Traffic Control	5	Jun/03/15 A	Jun/09/15 A
Temporary Shutdown of Midtown parking Garage 4th Street Access	40	Dec/22/15	Feb/17/16
Mobilization			
Street / Sidewalk Closure / Site Fence	5	Jun/12/15 A	Jun/18/15 A
Tower Crane			
Tower Crane Foundation	5	Aug/18/15 A	Aug/20/15 A
Erect Tower Crane	2	Aug/26/15 A	Aug/27/15 A
Tower Crane in Use	116	Aug/27/15 A	Mar/24/16



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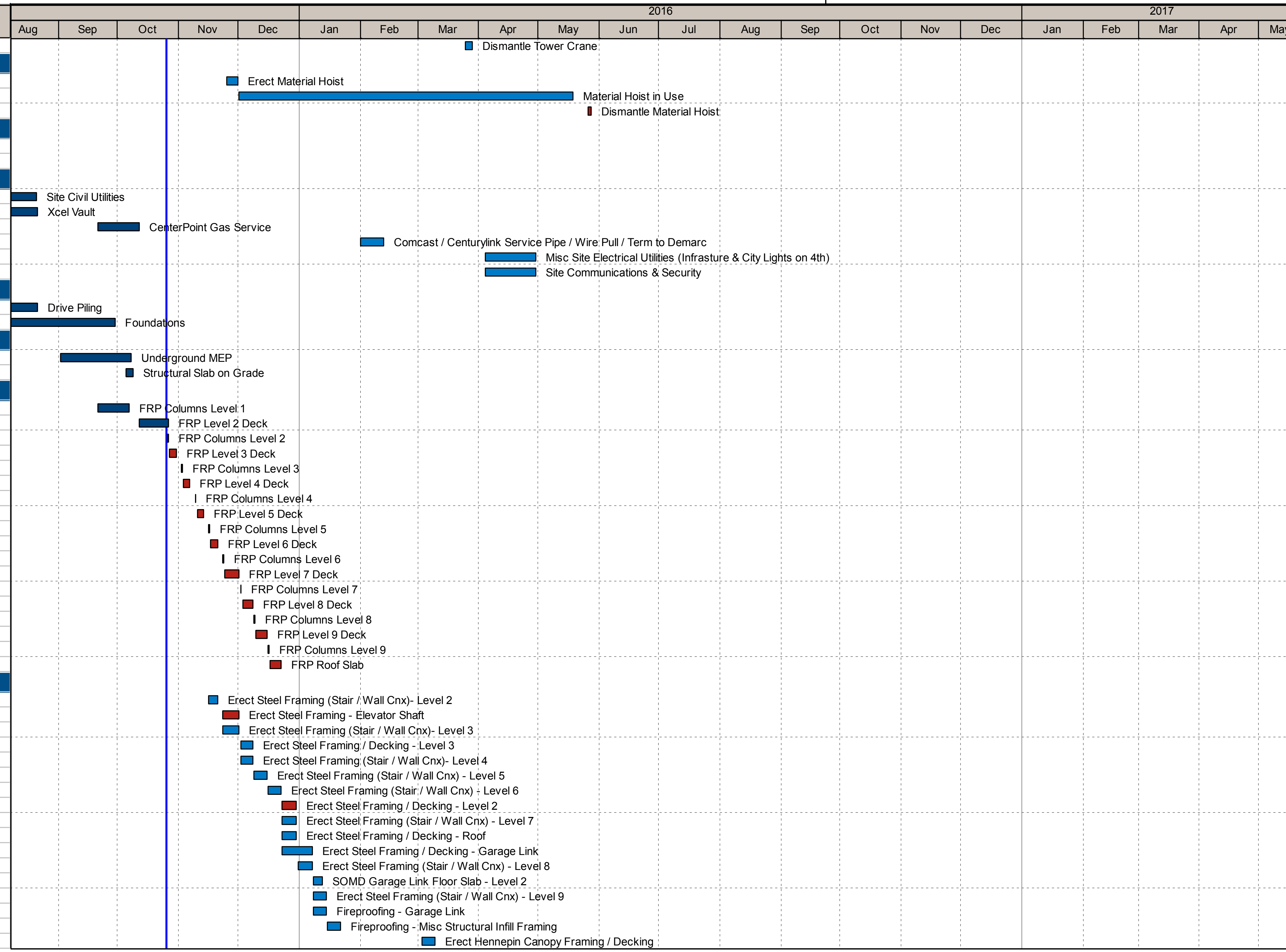
Activity Name	Orig. Dur'n	Start	Finish
Dismantle Tower Crane	2	Mar/25/16	Mar/28/16
Personnel/Material Hoist			
Erect Material Hoist	2	Nov/25/15	Nov/30/15
Material Hoist in Use	120	Dec/01/15	May/18/16
Dismantle Material Hoist	2	May/26/16	May/27/16*
Excavation			
Site Clearing	10	Jun/09/15 A	Jun/22/15 A
Excavation	10	Jun/16/15 A	Jun/29/15 A
Site Utilities			
Site Civil Utilities	10	Aug/03/15 A	Aug/21/15 A
Xcel Vault	15	Aug/03/15 A	Aug/21/15 A
CenterPoint Gas Service	10	Sep/21/15 A	Oct/12/15 A
Comcast / Centurylink Service Pipe / Wire Pull / Term to Demarc	10	Feb/01/16*	Feb/12/16
Misc Site Electrical Utilities (Infrasture & City Lights on 4th)	20	Apr/04/16*	Apr/29/16
Site Communications & Security	20	Apr/04/16*	Apr/29/16
Foundations			
Drive Piling	10	Jul/13/15 A	Aug/21/15 A
Foundations	20	Aug/03/15 A	Sep/30/15 A
UG M/E and Slab on Grade			
Underground MEP	20	Sep/02/15 A	Oct/08/15 A
Structural Slab on Grade	7	Oct/05/15 A	Oct/09/15 A
Concrete Structure			
FRP Columns Level 1	5	Sep/21/15 A	Oct/07/15 A
FRP Level 2 Deck	5	Oct/12/15 A	Oct/26/15 A
FRP Columns Level 2	1	Oct/26/15	Oct/26/15
FRP Level 3 Deck	4	Oct/27/15	Oct/30/15
FRP Columns Level 3	1	Nov/02/15	Nov/02/15
FRP Level 4 Deck	4	Nov/03/15	Nov/06/15
FRP Columns Level 4	1	Nov/09/15	Nov/09/15
FRP Level 5 Deck	4	Nov/10/15	Nov/13/15
FRP Columns Level 5	1	Nov/16/15	Nov/16/15
FRP Level 6 Deck	4	Nov/17/15	Nov/20/15
FRP Columns Level 6	1	Nov/23/15	Nov/23/15
FRP Level 7 Deck	4	Nov/24/15	Dec/01/15
FRP Columns Level 7	1	Dec/02/15	Dec/02/15
FRP Level 8 Deck	4	Dec/03/15	Dec/08/15
FRP Columns Level 8	1	Dec/09/15	Dec/09/15
FRP Level 9 Deck	4	Dec/10/15	Dec/15/15
FRP Columns Level 9	1	Dec/16/15	Dec/16/15
FRP Roof Slab	4	Dec/17/15	Dec/22/15
Steel Structure			
Erect Steel Framing (Stair / Wall Cnx)- Level 2	5	Nov/16/15	Nov/20/15
Erect Steel Framing - Elevator Shaft	5	Nov/23/15*	Dec/01/15
Erect Steel Framing (Stair / Wall Cnx)- Level 3	5	Nov/23/15	Dec/01/15
Erect Steel Framing / Decking - Level 3	5	Dec/02/15	Dec/08/15
Erect Steel Framing (Stair / Wall Cnx)- Level 4	5	Dec/02/15	Dec/08/15
Erect Steel Framing (Stair / Wall Cnx) - Level 5	5	Dec/09/15	Dec/15/15
Erect Steel Framing (Stair / Wall Cnx) - Level 6	5	Dec/16/15	Dec/22/15
Erect Steel Framing / Decking - Level 2	5	Dec/23/15	Dec/30/15
Erect Steel Framing (Stair / Wall Cnx) - Level 7	5	Dec/23/15	Dec/30/15
Erect Steel Framing / Decking - Roof	5	Dec/23/15	Dec/30/15
Erect Steel Framing / Decking - Garage Link	10	Dec/23/15	Jan/07/16
Erect Steel Framing (Stair / Wall Cnx) - Level 8	5	Dec/31/15	Jan/07/16
SOMD Garage Link Floor Slab - Level 2	3	Jan/08/16	Jan/12/16
Erect Steel Framing (Stair / Wall Cnx) - Level 9	5	Jan/08/16	Jan/14/16
Fireproofing - Garage Link	5	Jan/08/16	Jan/14/16
Fireproofing - Misc Structural Infill Framing	5	Jan/15/16	Jan/21/16
Erect Hennepin Canopy Framing / Decking	5	Mar/03/16*	Mar/09/16



Planned Work
Project Summary
Milestone
Pre-Construction
Procurement
Critical Work
Progressed Work

October 2015 Update

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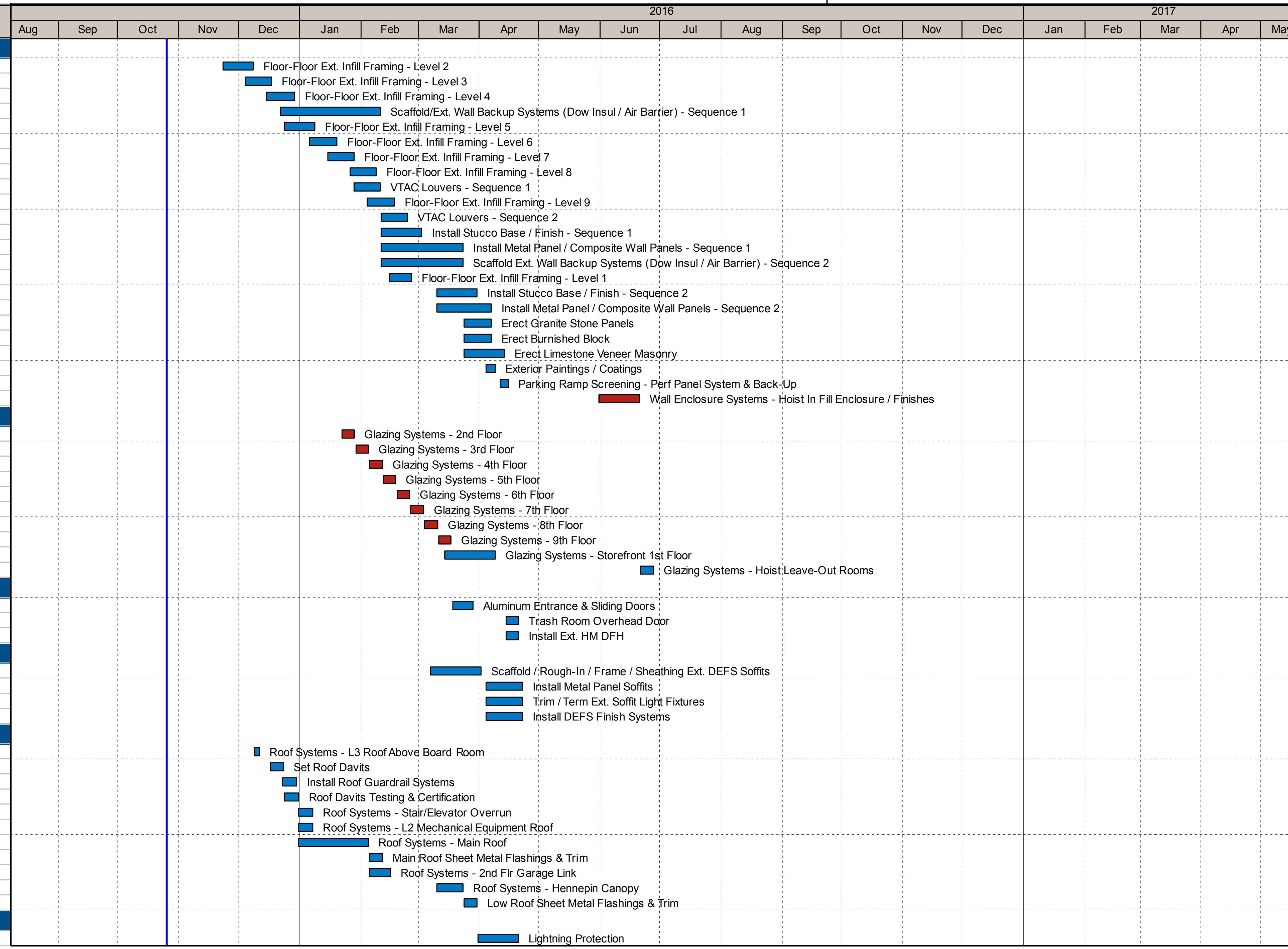
Mortenson construction

Building what's next.SM

Mortenson construction

Building what's next.[SM]

Activity Name	Orig. Dur'n	Start	Finish
Wall Enclosure Systems			
Floor-Floor Ext. Infill Framing - Level 2	10	Nov/23/15	Dec/08/15
Floor-Floor Ext. Infill Framing - Level 3	10	Dec/04/15	Dec/17/15
Floor-Floor Ext. Infill Framing - Level 4	10	Dec/15/15	Dec/29/15
Scaffold/Ext. Wall Backup Systems (Dow Insul / Air Barrier) - Sequence 1	35	Dec/22/15	Feb/10/16
Floor-Floor Ext. Infill Framing - Level 5	10	Dec/24/15	Jan/08/16
Floor-Floor Ext. Infill Framing - Level 6	10	Jan/06/16	Jan/19/16
Floor-Floor Ext. Infill Framing - Level 7	10	Jan/15/16	Jan/28/16
Floor-Floor Ext. Infill Framing - Level 8	10	Jan/26/16	Feb/08/16
VTAC Louvers - Sequence 1	10	Jan/28/16	Feb/10/16
Floor-Floor Ext. Infill Framing - Level 9	10	Feb/04/16	Feb/17/16
VTAC Louvers - Sequence 2	10	Feb/11/16	Feb/24/16
Install Stucco Base / Finish - Sequence 1	15	Feb/11/16	Mar/02/16
Install Metal Panel / Composite Wall Panels - Sequence 1	30	Feb/11/16	Mar/23/16
Scaffold Ext. Wall Backup Systems (Dow Insul / Air Barrier) - Sequence 2	30	Feb/11/16	Mar/23/16
Floor-Floor Ext. Infill Framing - Level 1	10	Feb/15/16	Feb/26/16
Install Stucco Base / Finish - Sequence 2	15	Mar/10/16	Mar/30/16
Install Metal Panel / Composite Wall Panels - Sequence 2	20	Mar/10/16	Apr/06/16
Erect Granite Stone Panels	10	Mar/24/16	Apr/06/16
Erect Burnished Block	10	Mar/24/16	Apr/06/16
Erect Limestone Veneer Masonry	15	Mar/24/16	Apr/13/16
Exterior Paintings / Coatings	5	Apr/04/16*	Apr/08/16
Parking Ramp Screening - Perf Panel System & Back-Up	5	Apr/11/16*	Apr/15/16
Wall Enclosure Systems - Hoist In Fill Enclosure / Finishes	15	May/31/16	Jun/20/16
Glazing Systems			
Glazing Systems - 2nd Floor	5	Jan/22/16	Jan/28/16
Glazing Systems - 3rd Floor	5	Jan/29/16	Feb/04/16
Glazing Systems - 4th Floor	5	Feb/05/16	Feb/11/16
Glazing Systems - 5th Floor	5	Feb/12/16	Feb/18/16
Glazing Systems - 6th Floor	5	Feb/19/16	Feb/25/16
Glazing Systems - 7th Floor	5	Feb/26/16	Mar/03/16
Glazing Systems - 8th Floor	5	Mar/04/16	Mar/10/16
Glazing Systems - 9th Floor	5	Mar/11/16	Mar/17/16
Glazing Systems - Storefront 1st Floor	20	Mar/14/16	Apr/08/16
Glazing Systems - Hoist Leave-Out Rooms	5	Jun/21/16	Jun/27/16
Entrances			
Aluminum Entrance & Sliding Doors	7	Mar/18/16	Mar/28/16
Trash Room Overhead Door	5	Apr/14/16	Apr/20/16
Install Ext. HM DFH	5	Apr/14/16	Apr/20/16
Soffit Enclosure			
Scaffold / Rough-In / Frame / Sheathing Ext. DEFS Soffits	20	Mar/07/16*	Apr/01/16
Install Metal Panel Soffits	15	Apr/04/16	Apr/22/16
Trim / Term Ext. Soffit Light Fixtures	15	Apr/04/16	Apr/22/16
Install DEFS Finish Systems	15	Apr/04/16	Apr/22/16
Roof Systems			
Roof Systems - L3 Roof Above Board Room	3	Dec/09/15	Dec/11/15
Set Roof Davits	5	Dec/17/15	Dec/23/15
Install Roof Guardrail Systems	5	Dec/23/15	Dec/30/15
Roof Davits Testing & Certification	5	Dec/24/15	Dec/31/15
Roof Systems - Stair/Elevator Overrun	5	Dec/31/15	Jan/07/16
Roof Systems - L2 Mechanical Equipment Roof	5	Dec/31/15	Jan/07/16
Roof Systems - Main Roof	25	Dec/31/15	Feb/04/16
Main Roof Sheet Metal Flashings & Trim	5	Feb/05/16	Feb/11/16
Roof Systems - 2nd Flr Garage Link	7	Feb/05/16	Feb/15/16
Roof Systems - Hennepin Canopy	10	Mar/10/16	Mar/23/16
Low Roof Sheet Metal Flashings & Trim	5	Mar/24/16	Mar/30/16
Misc. Enclosure Items			
Lightning Protection	15	Mar/31/16	Apr/20/16



Planned Work | Procurement
Project Summary | Critical Work
Milestone | Progressed Work
Pre-Construction

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Activity Name	Orig. Dur'n	Start	Finish
Exterior Brand Signage	15	Apr/07/16*	Apr/27/16
Building Lighting	20	Apr/07/16*	May/04/16
Exterior Brand Signage - Electrical Terminations / Testing	5	Apr/28/16	May/04/16
Building Lighting - Electrical Terminations / Testing	5	May/05/16	May/11/16
Elevators			
Elevator Rails - Hotel	15	Feb/15/16*	Mar/04/16
Service Elevator - Hotel	70	Feb/15/16	May/20/16
Passenger Elevators - Hotel	50	Mar/07/16	May/13/16
Permit Temp Use for Service Elevator - Hotel	0		May/20/16
Special Conveying Systems			
Install Linen Chute L1-L9	15	Jan/27/16	Feb/16/16
Misc. Conveying Systems			
Permanent Power to Elevators	0		Feb/08/16*
Interior Rough-In			
Interior Priority Wall Framing, Top-Out & Risers - Hotel 2nd Lvl	10	Dec/02/15	Dec/15/15
Shaftwalls / Elevator Support - Hotel	15	Dec/09/15	Dec/30/15
Interior Partition Framing - Hotel Lvl 2	5	Dec/16/15	Dec/22/15
Interior Priority Wall Framing, Top-Out & Risers - Hotel 3rd Lvl	10	Dec/18/15	Jan/04/16
Interior Partition Framing - Hotel Lvl 3	5	Jan/05/16	Jan/11/16
Interior Priority Wall Framing, Top-Out & Risers - Hotel 4th Lvl	10	Jan/05/16	Jan/18/16
Interior Partition Framing - Hotel Lvl 4	5	Jan/19/16	Jan/25/16
Interior Priority Wall Framing, Top-Out & Risers - Hotel 5th Lvl	10	Jan/19/16	Feb/01/16
Interior Partition Framing - Hotel Lvl 5	5	Feb/02/16	Feb/08/16
Interior Priority Wall Framing, Top-Out & Risers - Hotel 6th Lvl	10	Feb/02/16	Feb/15/16
Interior Partition Framing - Hotel Lvl 6	5	Feb/16/16	Feb/22/16
Interior Priority Wall Framing, Top-Out & Risers - Hotel 7th Lvl	10	Feb/16/16	Feb/29/16
Interior Priority Wall Framing & Top-Out - Hotel 1st Lvl	10	Feb/29/16	Mar/11/16
Interior Partition Framing - Hotel Lvl 7	5	Mar/01/16	Mar/07/16
Interior Priority Wall Framing, Top-Out & Risers - Hotel 8th Lvl	10	Mar/01/16	Mar/14/16
Interior Partition Framing - Hotel Lvl 1	5	Mar/14/16	Mar/18/16
Interior Partition Framing - Hotel Lvl 8	5	Mar/15/16	Mar/21/16
Interior Priority Wall Framing, Top-Out & Risers - Hotel 9th Lvl	10	Mar/15/16	Mar/28/16
Interior Partition Framing - Hotel Lvl 9	5	Mar/29/16	Apr/04/16
Interior Partition Framing - Hoist Leave-Out Rooms	5	May/31/16	Jun/06/16
Stairs			
Erect Stair A (Southwest)	9	Nov/09/15*	Nov/19/15
Erect Stair B (Northeast)	10	Nov/23/15*	Dec/08/15
Erect Stair C (Link Stair)	5	Apr/04/16*	Apr/08/16
Plumbing Rough-In			
Set Guestroom Shower Pans / Tubs - Hotel Lvl 2	5	Dec/23/15	Dec/30/15
Plumbing R/I - Level 2	7	Dec/23/15	Jan/04/16
Set Guestroom Shower Pans / Tubs - Hotel Lvl 3	5	Jan/12/16	Jan/18/16
Plumbing R/I - Level 3	7	Jan/12/16	Jan/20/16
Set Guestroom Shower Pans / Tubs - Hotel Lvl 4	5	Jan/26/16	Feb/01/16
Plumbing R/I - Level 4	7	Jan/26/16	Feb/03/16
Set Guestroom Shower Pans / Tubs - Hotel Lvl 5	5	Feb/09/16	Feb/15/16
Plumbing R/I - Level 5	15	Feb/09/16	Feb/29/16
Set Guestroom Shower Pans / Tubs - Hotel Lvl 6	5	Feb/23/16	Feb/29/16
Plumbing R/I - Level 6	7	Feb/23/16	Mar/02/16
Set Guestroom Shower Pans / Tubs - Hotel Lvl 7	5	Mar/08/16	Mar/14/16
Plumbing R/I - Level 7	7	Mar/08/16	Mar/16/16
Plumbing R/I - Level 1	7	Mar/14/16	Mar/22/16
Set Guestroom Shower Pans / Tubs - Hotel Lvl 8	5	Mar/22/16	Mar/28/16
Plumbing R/I - Level 8	7	Mar/22/16	Mar/30/16
Plumbing R/I - Roof / Roof Drains	5	Apr/05/16	Apr/11/16
Set Guestroom Shower Pans / Tubs - Hotel Lvl 9	5	Apr/05/16	Apr/11/16
Plumbing R/I - Level 9	7	Apr/05/16	Apr/13/16
Plumbing R/I - Hoist Leave-Out Rooms	5	Jun/07/16	Jun/13/16

Planned Work
Project Summary
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October 2015 Update

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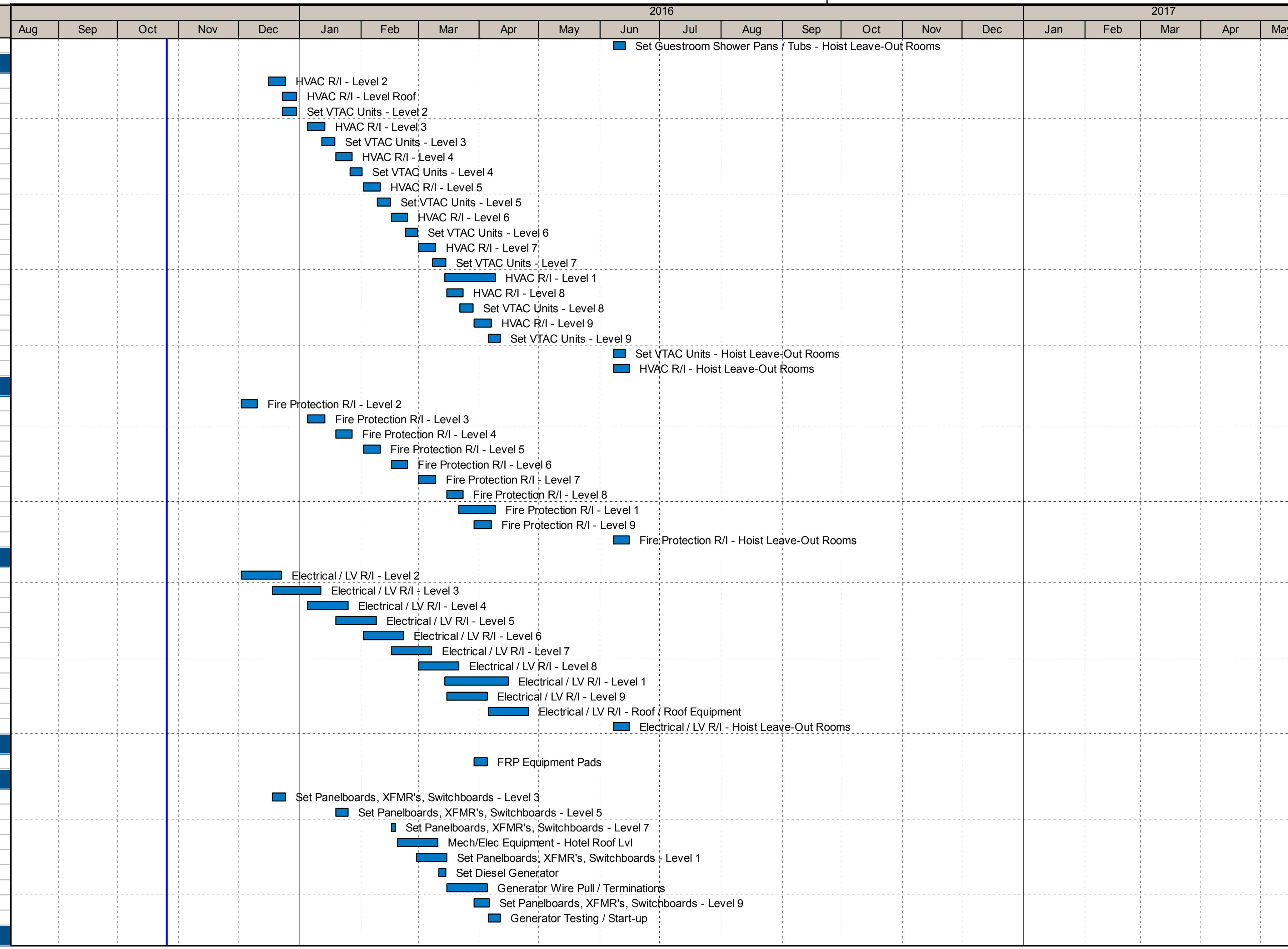
Oct/22/15	October 2015 Schedule Update	JH	JH

Mortenson construction — Building what's next.[SM]

Activity Name	Orig. Dur'n	Start	Finish
Set Guestroom Shower Pans / Tubs - Hoist Leave-Out Rooms	5	Jun/07/16	Jun/13/16
HVAC Rough-In			
HVAC R/I - Level 2	7	Dec/16/15	Dec/24/15
HVAC R/I - Level Roof	5	Dec/23/15	Dec/30/15
Set VTAC Units - Level 2	5	Dec/23/15	Dec/30/15
HVAC R/I - Level 3	7	Jan/05/16	Jan/13/16
Set VTAC Units - Level 3	5	Jan/12/16	Jan/18/16
HVAC R/I - Level 4	7	Jan/19/16	Jan/27/16
Set VTAC Units - Level 4	5	Jan/26/16	Feb/01/16
HVAC R/I - Level 5	7	Feb/02/16	Feb/10/16
Set VTAC Units - Level 5	5	Feb/09/16	Feb/15/16
HVAC R/I - Level 6	7	Feb/16/16	Feb/24/16
Set VTAC Units - Level 6	5	Feb/23/16	Feb/29/16
HVAC R/I - Level 7	7	Mar/01/16	Mar/09/16
Set VTAC Units - Level 7	5	Mar/08/16	Mar/14/16
HVAC R/I - Level 1	20	Mar/14/16	Apr/08/16
HVAC R/I - Level 8	7	Mar/15/16	Mar/23/16
Set VTAC Units - Level 8	5	Mar/22/16	Mar/28/16
HVAC R/I - Level 9	7	Mar/29/16	Apr/06/16
Set VTAC Units - Level 9	5	Apr/05/16	Apr/11/16
Set VTAC Units - Hoist Leave-Out Rooms	5	Jun/07/16	Jun/13/16
HVAC R/I - Hoist Leave-Out Rooms	7	Jun/07/16	Jun/15/16
Fire Protection Rough-In			
Fire Protection R/I - Level 2	7	Dec/02/15	Dec/10/15
Fire Protection R/I - Level 3	7	Jan/05/16	Jan/13/16
Fire Protection R/I - Level 4	7	Jan/19/16	Jan/27/16
Fire Protection R/I - Level 5	7	Feb/02/16	Feb/10/16
Fire Protection R/I - Level 6	7	Feb/16/16	Feb/24/16
Fire Protection R/I - Level 7	7	Mar/01/16	Mar/09/16
Fire Protection R/I - Level 8	7	Mar/15/16	Mar/23/16
Fire Protection R/I - Level 1	15	Mar/21/16	Apr/08/16
Fire Protection R/I - Level 9	7	Mar/29/16	Apr/06/16
Fire Protection R/I - Hoist Leave-Out Rooms	7	Jun/07/16	Jun/15/16
Electrical Rough-In			
Electrical / LV R/I - Level 2	15	Dec/02/15	Dec/22/15
Electrical / LV R/I - Level 3	15	Dec/18/15	Jan/11/16
Electrical / LV R/I - Level 4	15	Jan/05/16	Jan/25/16
Electrical / LV R/I - Level 5	15	Jan/19/16	Feb/08/16
Electrical / LV R/I - Level 6	15	Feb/02/16	Feb/22/16
Electrical / LV R/I - Level 7	15	Feb/16/16	Mar/07/16
Electrical / LV R/I - Level 8	15	Mar/01/16	Mar/21/16
Electrical / LV R/I - Level 1	25	Mar/14/16	Apr/15/16
Electrical / LV R/I - Level 9	15	Mar/15/16	Apr/04/16
Electrical / LV R/I - Roof / Roof Equipment	15	Apr/05/16	Apr/25/16
Electrical / LV R/I - Hoist Leave-Out Rooms	7	Jun/07/16	Jun/15/16
Architectural Rough-In			
FRP Equipment Pads	5	Mar/29/16	Apr/04/16
Equipment			
Set Panelboards, XFMR's, Switchboards - Level 3	5	Dec/18/15	Dec/24/15
Set Panelboards, XFMR's, Switchboards - Level 5	5	Jan/19/16	Jan/25/16
Set Panelboards, XFMR's, Switchboards - Level 7	3	Feb/16/16	Feb/18/16
Mech/Elec Equipment - Hotel Roof Lvl	15	Feb/19/16	Mar/10/16
Set Panelboards, XFMR's, Switchboards - Level 1	12	Feb/29/16	Mar/15/16
Set Diesel Generator	2	Mar/11/16	Mar/14/16
Generator Wire Pull / Terminations	15	Mar/15/16	Apr/04/16
Set Panelboards, XFMR's, Switchboards - Level 9	6	Mar/29/16	Apr/05/16
Generator Testing / Start-up	5	Apr/05/16	Apr/11/16
Mechanical Equipment			



Legend: Planned Work; Project Summary; Milestone; Pre-Construction; Procurement; Critical Work; Progressed Work

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Activity Name	Orig. Dur'n	Start	Finish
Set Roof Top Units (Main)	5	Feb/19/16	Feb/25/16
Set Roof Top Units (RTU-3) (3rd South)	5	Feb/19/16	Feb/25/16
Specialty Equipment			
Deliver / Set Security Equipment	10	Feb/19/16	Mar/03/16
Parking Control Equipment Relocates at Midtown 4th Street Access	15	Feb/19/16	Mar/10/16
Audio-Visual Equipment	35	Feb/19/16	Apr/07/16
Xcel Vault XFMR Equipment Set / Trim / Term	10	Feb/26/16	Mar/10/16
Deliver / Set Trash Compactor & Boxes	5	Apr/14/16	Apr/20/16
Matrix Fitness Equipment	5	May/10/16	May/16/16
Deliver / Set Foodservice Equipment	10	Jul/06/16	Jul/19/16
Drywall			
RTS - Stair Shaft A	15	Dec/31/15	Jan/21/16
RTS - Stair Shaft B	15	Jan/13/16	Feb/02/16
RTS - Hotel 2nd Lvl	15	Jan/27/16	Feb/16/16
RTS - Hotel 3rd Lvl	15	Feb/10/16	Mar/01/16
RTS - Hotel 2nd Lvl - VTAC Comeback	5	Feb/17/16	Feb/23/16
RTS - Hotel 4th Lvl	15	Feb/24/16	Mar/15/16
RTS - Hotel 3rd Lvl - VTAC Comeback	5	Mar/02/16	Mar/08/16
RTS - Hotel 5th Lvl	15	Mar/09/16	Mar/29/16
RTS - Hotel 4th Lvl - VTAC Comeback	5	Mar/16/16	Mar/22/16
RTS - Hotel 6th Lvl	15	Mar/23/16	Apr/12/16
RTS - Hotel 5th Lvl - VTAC Comeback	5	Mar/30/16	Apr/05/16
RTS - Hotel 7th Lvl	15	Apr/06/16	Apr/26/16
RTS - Hotel 6th Lvl - VTAC Comeback	5	Apr/13/16	Apr/19/16
RTS - Hotel 1st Lvl	35	Apr/18/16	Jun/06/16
RTS - Hotel 8th Lvl	15	Apr/20/16	May/10/16
RTS - Hotel 7th Lvl - VTAC Comeback	5	Apr/27/16	May/03/16
RTS - Hotel 9th Lvl	15	May/04/16	May/24/16
RTS - Hotel 8th Lvl - VTAC Comeback	5	May/11/16	May/17/16
RTS - Hotel 9th Lvl - VTAC Comeback	5	May/25/16	Jun/01/16
RTS - Hotel Hoist Leave-Out Rooms	15	Jun/21/16	Jul/12/16
Wall Finishes			
Guestroom Wall Tile / Surrounds - Hotel Lvl 2	10	Feb/17/16	Mar/01/16
Guestroom Wall Tile / Surrounds - Hotel Lvl 3	10	Mar/02/16	Mar/15/16
Guestroom Paint / Vinyl Wallcovering - Hotel Lvl 2	15	Mar/02/16	Mar/22/16
Guestroom Wall Tile / Surrounds - Hotel Lvl 4	10	Mar/16/16	Mar/29/16
Guestroom Paint / Vinyl Wallcovering - Hotel Lvl 3	15	Mar/23/16	Apr/12/16
Guestroom Wall Tile / Surrounds - Hotel Lvl 5	10	Mar/30/16	Apr/12/16
Guestroom Wall Tile / Surrounds - Hotel Lvl 6	10	Apr/13/16	Apr/26/16
Guestroom Paint / Vinyl Wallcovering - Hotel Lvl 4	15	Apr/13/16	May/03/16
Corridor Paint / Vinyl Wallcovering - Hotel Lvl 2	10	Apr/19/16	May/02/16
Guestroom Wall Tile / Surrounds - Hotel Lvl 7	10	Apr/27/16	May/10/16
Corridor Paint / Vinyl Wallcovering - Hotel Lvl 3	10	May/03/16	May/16/16
Guestroom Paint / Vinyl Wallcovering - Hotel Lvl 5	15	May/04/16	May/24/16
Guestroom Wall Tile / Surrounds - Hotel Lvl 8	10	May/11/16	May/24/16
Guestroom Wall Tile / Surrounds - Hotel Lvl 9	10	May/25/16	Jun/08/16
Guestroom Paint / Vinyl Wallcovering - Hotel Lvl 6	15	May/25/16	Jun/15/16
Guestroom Wall Tile / Surrounds - Hoist Leave-Out Rooms	10	May/31/16	Jun/13/16
Corridor Paint / Vinyl Wallcovering - Hotel Lvl 4	10	Jun/01/16	Jun/14/16
Public Area Paint / Vinyl Wallcovering - Hotel Lvl 1 and Lvl 2	35	Jun/07/16	Jul/26/16
Guestroom Paint / Vinyl Wallcovering - Hotel Lvl 7	15	Jun/16/16	Jul/07/16
Corridor Paint / Vinyl Wallcovering - Hotel Lvl 5	10	Jun/29/16	Jul/13/16
Guestroom Paint / Vinyl Wallcovering - Hotel Lvl 8	15	Jul/08/16	Jul/28/16
Guestroom Paint / Vinyl Wallcovering - Hoist Leave-Out Rooms	15	Jul/13/16	Aug/02/16
Corridor Paint / Vinyl Wallcovering - Hotel Lvl 6	10	Jul/14/16	Jul/27/16
Corridor Paint / Vinyl Wallcovering - Hotel Lvl 7	10	Jul/28/16	Aug/10/16
Guestroom Paint / Vinyl Wallcovering - Hotel Lvl 9	15	Jul/29/16	Aug/18/16
Corridor Paint / Vinyl Wallcovering - Hotel Lvl 8	10	Aug/11/16	Aug/24/16
Corridor Paint / Vinyl Wallcovering - Hotel Lvl 9	10	Aug/25/16	Sep/08/16

Timeline: 2016 / 2017 — Aug, Sep, Oct, Nov, Dec, Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, Oct, Nov, Dec, Jan, Feb, Mar, Apr, May

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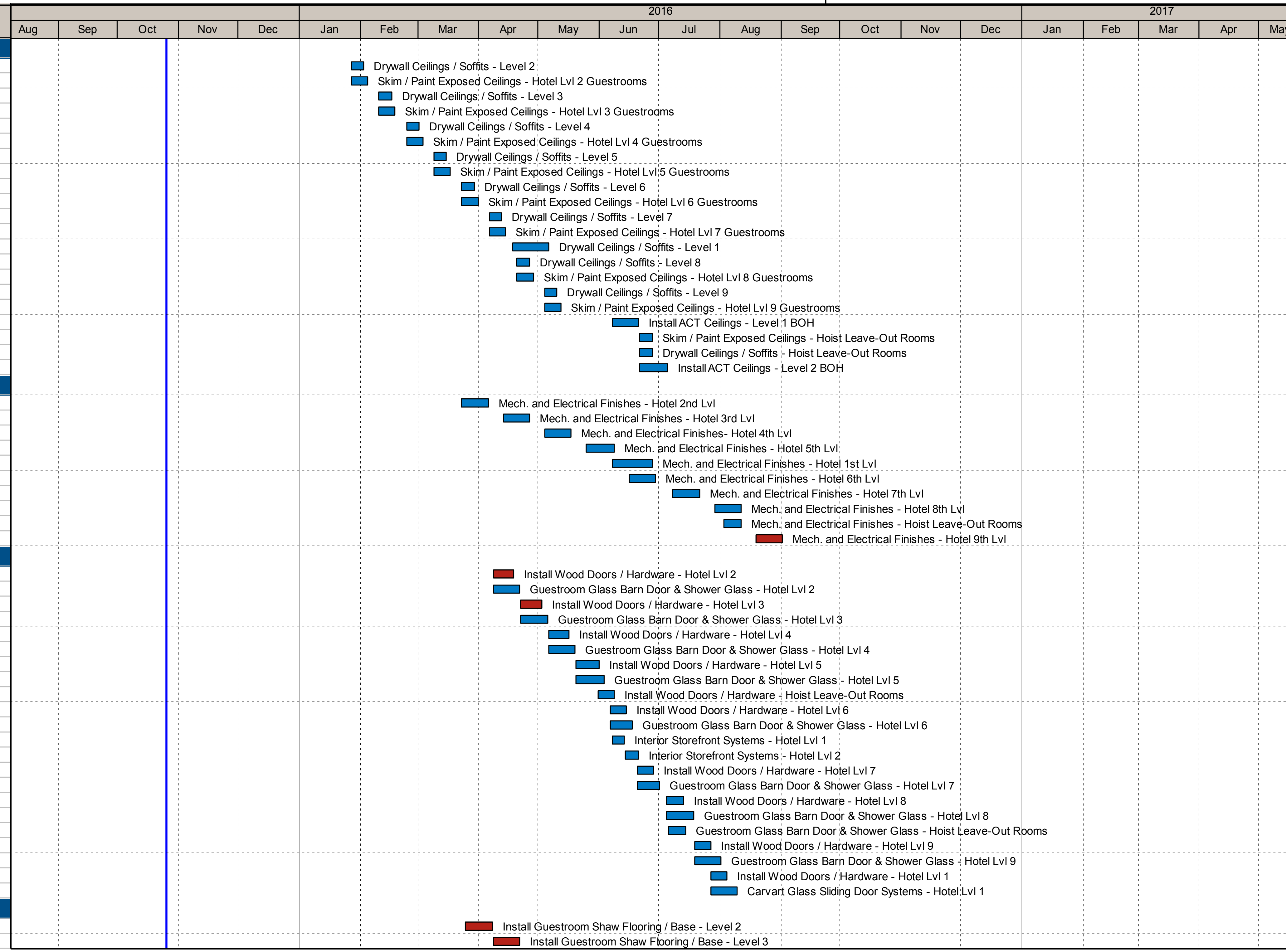
Ceiling Finishes			
Drywall Ceilings / Soffits - Level 2	5	Jan/27/16	Feb/02/16
Skim / Paint Exposed Ceilings - Hotel Lvl 2 Guestrooms	7	Jan/27/16	Feb/04/16
Drywall Ceilings / Soffits - Level 3	5	Feb/10/16	Feb/16/16
Skim / Paint Exposed Ceilings - Hotel Lvl 3 Guestrooms	7	Feb/10/16	Feb/18/16
Drywall Ceilings / Soffits - Level 4	5	Feb/24/16	Mar/01/16
Skim / Paint Exposed Ceilings - Hotel Lvl 4 Guestrooms	7	Feb/24/16	Mar/03/16
Drywall Ceilings / Soffits - Level 5	5	Mar/09/16	Mar/15/16
Skim / Paint Exposed Ceilings - Hotel Lvl 5 Guestrooms	7	Mar/09/16	Mar/17/16
Drywall Ceilings / Soffits - Level 6	5	Mar/23/16	Mar/29/16
Skim / Paint Exposed Ceilings - Hotel Lvl 6 Guestrooms	7	Mar/23/16	Mar/31/16
Drywall Ceilings / Soffits - Level 7	5	Apr/06/16	Apr/12/16
Skim / Paint Exposed Ceilings - Hotel Lvl 7 Guestrooms	7	Apr/06/16	Apr/14/16
Drywall Ceilings / Soffits - Level 1	15	Apr/18/16	May/06/16
Drywall Ceilings / Soffits - Level 8	5	Apr/20/16	Apr/26/16
Skim / Paint Exposed Ceilings - Hotel Lvl 8 Guestrooms	7	Apr/20/16	Apr/28/16
Drywall Ceilings / Soffits - Level 9	5	May/04/16	May/10/16
Skim / Paint Exposed Ceilings - Hotel Lvl 9 Guestrooms	7	May/04/16	May/12/16
Install ACT Ceilings - Level 1 BOH	10	Jun/07/16	Jun/20/16
Skim / Paint Exposed Ceilings - Hoist Leave-Out Rooms	5	Jun/21/16	Jun/27/16
Drywall Ceilings / Soffits - Hoist Leave-Out Rooms	5	Jun/21/16	Jun/27/16
Install ACT Ceilings - Level 2 BOH	10	Jun/21/16	Jul/05/16
Mech. and Elec. Finishes			
Mech. and Electrical Finishes - Hotel 2nd Lvl	10	Mar/23/16	Apr/05/16
Mech. and Electrical Finishes - Hotel 3rd Lvl	10	Apr/13/16	Apr/26/16
Mech. and Electrical Finishes- Hotel 4th Lvl	10	May/04/16	May/17/16
Mech. and Electrical Finishes - Hotel 5th Lvl	10	May/25/16	Jun/08/16
Mech. and Electrical Finishes - Hotel 1st Lvl	15	Jun/07/16	Jun/27/16
Mech. and Electrical Finishes - Hotel 6th Lvl	10	Jun/16/16	Jun/29/16
Mech. and Electrical Finishes - Hotel 7th Lvl	10	Jul/08/16	Jul/21/16
Mech. and Electrical Finishes - Hotel 8th Lvl	10	Jul/29/16	Aug/11/16
Mech. and Electrical Finishes - Hoist Leave-Out Rooms	7	Aug/03/16	Aug/11/16
Mech. and Electrical Finishes - Hotel 9th Lvl	10	Aug/19/16	Sep/01/16
Interior Doors & Windows			
Install Wood Doors / Hardware - Hotel Lvl 2	7	Apr/08/16	Apr/18/16
Guestroom Glass Barn Door & Shower Glass - Hotel Lvl 2	10	Apr/08/16	Apr/21/16
Install Wood Doors / Hardware - Hotel Lvl 3	7	Apr/22/16	May/02/16
Guestroom Glass Barn Door & Shower Glass - Hotel Lvl 3	10	Apr/22/16	May/05/16
Install Wood Doors / Hardware - Hotel Lvl 4	7	May/06/16	May/16/16
Guestroom Glass Barn Door & Shower Glass - Hotel Lvl 4	10	May/06/16	May/19/16
Install Wood Doors / Hardware - Hotel Lvl 5	7	May/20/16	May/31/16
Guestroom Glass Barn Door & Shower Glass - Hotel Lvl 5	10	May/20/16	Jun/03/16
Install Wood Doors / Hardware - Hoist Leave-Out Rooms	7	May/31/16	Jun/08/16
Install Wood Doors / Hardware - Hotel Lvl 6	7	Jun/06/16	Jun/14/16
Guestroom Glass Barn Door & Shower Glass - Hotel Lvl 6	10	Jun/06/16	Jun/17/16
Interior Storefront Systems - Hotel Lvl 1	5	Jun/07/16	Jun/13/16
Interior Storefront Systems - Hotel Lvl 2	5	Jun/14/16	Jun/20/16
Install Wood Doors / Hardware - Hotel Lvl 7	7	Jun/20/16	Jun/28/16
Guestroom Glass Barn Door & Shower Glass - Hotel Lvl 7	10	Jun/20/16	Jul/01/16
Install Wood Doors / Hardware - Hotel Lvl 8	7	Jul/05/16	Jul/13/16
Guestroom Glass Barn Door & Shower Glass - Hotel Lvl 8	10	Jul/05/16	Jul/18/16
Guestroom Glass Barn Door & Shower Glass - Hoist Leave-Out Rooms	7	Jul/06/16	Jul/14/16
Install Wood Doors / Hardware - Hotel Lvl 9	7	Jul/19/16	Jul/27/16
Guestroom Glass Barn Door & Shower Glass - Hotel Lvl 9	10	Jul/19/16	Aug/01/16
Install Wood Doors / Hardware - Hotel Lvl 1	7	Jul/27/16	Aug/04/16
Carvart Glass Sliding Door Systems - Hotel Lvl 1	10	Jul/27/16	Aug/09/16
Floor Finishes			
Install Guestroom Shaw Flooring / Base - Level 2	10	Mar/25/16	Apr/07/16
Install Guestroom Shaw Flooring / Base - Level 3	10	Apr/08/16	Apr/21/16



Planned Work
Project Summary
Milestone
Pre-Construction
Procurement
Critical Work
Progressed Work

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Activity Name	Orig. Dur'n	Start	Finish
Install Guestroom Shaw Flooring / Base - Level 4	10	Apr/22/16	May/05/16
Install Corridor Carpet - Hotel Lvl 2	5	May/03/16	May/09/16
Install Guestroom Shaw Flooring / Base - Level 5	10	May/06/16	May/19/16
Install Corridor Carpet - Hotel Lvl 3	5	May/17/16	May/23/16
Install Guestroom Shaw Flooring / Base - Level 6	10	May/20/16	Jun/03/16
Install Guestroom Shaw Flooring / Base - Level 7	10	Jun/06/16	Jun/17/16
Install Corridor Carpet - Hotel Lvl 4	5	Jun/15/16	Jun/21/16
Install Guestroom Shaw Flooring / Base - Level 8	10	Jun/20/16	Jul/01/16
Quarry Floor Tile - Level 1	10	Jun/21/16	Jul/05/16
Install Guestroom Shaw Flooring / Base - Hoist Leave-Out Rooms	5	Jun/28/16	Jul/05/16
Install Guestroom Shaw Flooring / Base - Level 9	10	Jul/05/16	Jul/18/16
Large Format Floor Tile - Level 1	15	Jul/06/16	Jul/26/16
Install Corridor Carpet - Hotel Lvl 5	5	Jul/14/16	Jul/20/16
Install Epoxy Flooring - Hotel Lvl 1	10	Jul/27/16	Aug/09/16
Install Corridor Carpet - Hotel Lvl 6	5	Jul/28/16	Aug/03/16
Install Corridor Carpet - Hotel Lvl 7	5	Aug/11/16	Aug/17/16
Install Corridor Carpet - Hotel Lvl 8	5	Aug/25/16	Aug/31/16
Install Corridor Carpet - Hotel Lvl 9	5	Sep/09/16	Sep/15/16
Stair Finishes			
Install Stair Handrails / Guardrails - Stair A	10	Nov/20/15	Dec/07/15
Paint Stairs & Railings - Stair A	10	Dec/08/15	Dec/21/15
Install Stair Handrails / Guardrails - Stair B	10	Dec/09/15	Dec/22/15
Paint Stairs & Railings - Stair B	10	Dec/23/15	Jan/07/16
Specialties			
Set Belstone Tops - Hotel Lvl 2	10	Mar/02/16	Mar/15/16
Install Millwork Pieces / Finishes - Hotel Lvl 2	7	Mar/16/16	Mar/24/16
Install Toilet Accessories - Hotel Lvl 2	7	Mar/16/16	Mar/24/16
Set Belstone Tops - Hotel Lvl 3	10	Mar/16/16	Mar/29/16
Install Millwork Pieces / Finishes - Hotel Lvl 3	7	Mar/30/16	Apr/07/16
Install Toilet Accessories - Hotel Lvl 3	7	Mar/30/16	Apr/07/16
Set Belstone Tops - Hotel Lvl 4	10	Mar/30/16	Apr/12/16
Install Millwork Pieces / Finishes - Hotel Lvl 4	7	Apr/13/16	Apr/21/16
Install Toilet Accessories - Hotel Lvl 4	7	Apr/13/16	Apr/21/16
Set Belstone Tops - Hotel Lvl 5	10	Apr/13/16	Apr/26/16
Install Millwork Pieces / Finishes - Hotel Lvl 5	7	Apr/27/16	May/05/16
Install Toilet Accessories - Hotel Lvl 5	7	Apr/27/16	May/05/16
Set Belstone Tops - Hotel Lvl 6	10	Apr/27/16	May/10/16
Install Millwork Pieces / Finishes - Hotel Lvl 6	7	May/11/16	May/19/16
Install Toilet Accessories - Hotel Lvl 6	7	May/11/16	May/19/16
Set Belstone Tops - Hotel Lvl 7	10	May/11/16	May/24/16
Install Millwork Pieces / Finishes - Hotel Lvl 7	7	May/25/16	Jun/03/16
Install Toilet Accessories - Hotel Lvl 7	7	May/25/16	Jun/03/16
Set Belstone Tops - Hotel Lvl 8	10	May/25/16	Jun/08/16
Install Toilet Accessories - Hoist Leave-Out Rooms	3	May/31/16	Jun/02/16
Install Millwork Pieces / Finishes - Hotel Lvl 8	7	Jun/09/16	Jun/17/16
Install Toilet Accessories - Hotel Lvl 8	7	Jun/09/16	Jun/17/16
Set Belstone Tops - Hotel Lvl 9	10	Jun/09/16	Jun/22/16
Set Belstone Tops - Hoist Leave-Out Rooms	2	Jun/14/16	Jun/15/16
Install Millwork Pieces / Finishes - Hoist Leave-Out Rooms	5	Jun/16/16	Jun/22/16
Install FEC Cabinets / FE's	5	Jun/21/16	Jun/27/16
Install Millwork Pieces / Finishes - Hotel Lvl 9	7	Jun/23/16	Jul/01/16
Install Toilet Accessories - Hotel Lvl 9	7	Jun/23/16	Jul/01/16
Install Millwork Pieces / Finishes - Hotel Lvl 1	30	Jun/28/16	Aug/09/16
Install Toilet Accessories - Hotel Lvl 1	5	Jul/06/16	Jul/12/16
Install Toilet Partitions - Hotel Lvl 1	5	Jul/27/16	Aug/02/16
Install Interior Signage Package	15	Aug/25/16	Sep/15/16
Furnishings			
Install Lockers - Hotel Lvl 2	5	Mar/16/16	Mar/22/16
Install Guestroom Valences & Window Treatments - Hotel Lvl 2	10	Apr/08/16	Apr/21/16

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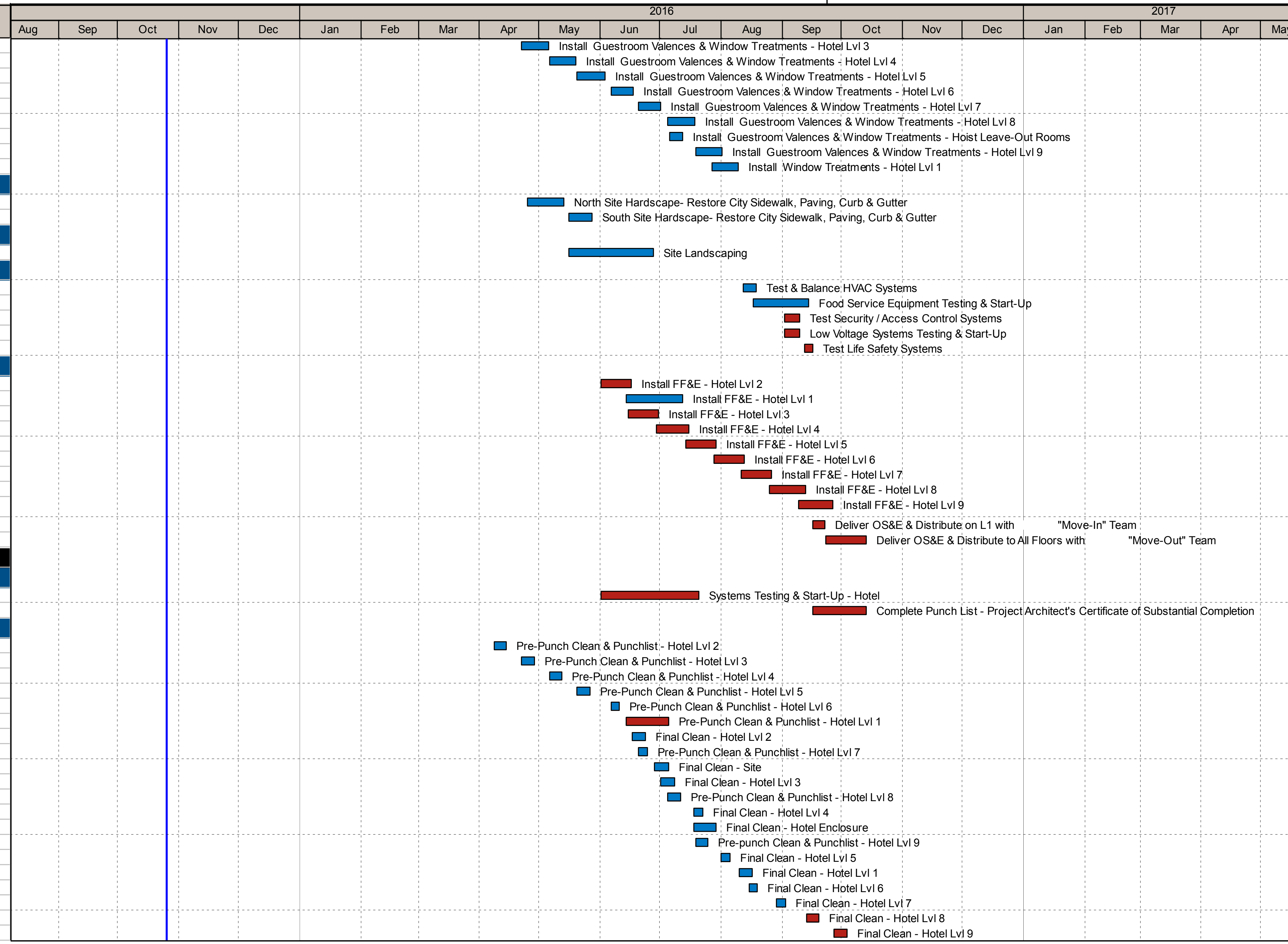
Install Guestroom Valences & Window Treatments - Hotel Lvl 3	10	Apr/22/16	May/05/16
Install Guestroom Valences & Window Treatments - Hotel Lvl 4	10	May/06/16	May/19/16
Install Guestroom Valences & Window Treatments - Hotel Lvl 5	10	May/20/16	Jun/03/16
Install Guestroom Valences & Window Treatments - Hotel Lvl 6	10	Jun/06/16	Jun/17/16
Install Guestroom Valences & Window Treatments - Hotel Lvl 7	10	Jun/20/16	Jul/01/16
Install Guestroom Valences & Window Treatments - Hotel Lvl 8	10	Jul/05/16	Jul/18/16
Install Guestroom Valences & Window Treatments - Hoist Leave-Out Rooms	5	Jul/06/16	Jul/12/16
Install Guestroom Valences & Window Treatments - Hotel Lvl 9	10	Jul/19/16	Aug/01/16
Install Window Treatments - Hotel Lvl 1	10	Jul/27/16	Aug/09/16
Hardscape			
North Site Hardscape- Restore City Sidewalk, Paving, Curb & Gutter	15	Apr/25/16*	May/13/16
South Site Hardscape- Restore City Sidewalk, Paving, Curb & Gutter	10	May/16/16	May/27/16
Landscape			
Site Landscaping	30	May/16/16*	Jun/27/16
Systems Testing and Start-Up			
Test & Balance HVAC Systems	5	Aug/12/16	Aug/18/16
Food Service Equipment Testing & Start-Up	20	Aug/17/16*	Sep/14/16
Test Security / Access Control Systems	5	Sep/02/16	Sep/09/16
Low Voltage Systems Testing & Start-Up	5	Sep/02/16	Sep/09/16
Test Life Safety Systems	5	Sep/12/16	Sep/16/16
Furniture, Fixtures, & Equipment			
Install FF&E - Hotel Lvl 2	12	Jun/01/16*	Jun/16/16
Install FF&E - Hotel Lvl 1	20	Jun/14/16	Jul/12/16
Install FF&E - Hotel Lvl 3	12	Jun/15/16	Jun/30/16
Install FF&E - Hotel Lvl 4	12	Jun/29/16	Jul/15/16
Install FF&E - Hotel Lvl 5	12	Jul/14/16	Jul/29/16
Install FF&E - Hotel Lvl 6	12	Jul/28/16	Aug/12/16
Install FF&E - Hotel Lvl 7	12	Aug/11/16	Aug/26/16
Install FF&E - Hotel Lvl 8	12	Aug/25/16	Sep/12/16
Install FF&E - Hotel Lvl 9	12	Sep/09/16	Sep/26/16
Deliver OS&E & Distribute on L1 with "Move-In" Team	5	Sep/16/16	Sep/22/16
Deliver OS&E & Distribute to All Floors with "Move-Out" Team	15	Sep/23/16	Oct/13/16
Project Close-Out			
Systems Testing and Start-Up			
Systems Testing & Start-Up - Hotel	35	Jun/01/16*	Jul/20/16
Complete Punch List - Project Architect's Certificate of Substantial Completion	20	Sep/16/16	Oct/13/16
Clean-Up and Punchlist			
Pre-Punch Clean & Punchlist - Hotel Lvl 2	5	Apr/08/16	Apr/14/16
Pre-Punch Clean & Punchlist - Hotel Lvl 3	5	Apr/22/16	Apr/28/16
Pre-Punch Clean & Punchlist - Hotel Lvl 4	5	May/06/16	May/12/16
Pre-Punch Clean & Punchlist - Hotel Lvl 5	5	May/20/16	May/26/16
Pre-Punch Clean & Punchlist - Hotel Lvl 6	5	Jun/06/16	Jun/10/16
Pre-Punch Clean & Punchlist - Hotel Lvl 1	15	Jun/14/16	Jul/05/16
Final Clean - Hotel Lvl 2	5	Jun/17/16	Jun/23/16
Pre-Punch Clean & Punchlist - Hotel Lvl 7	5	Jun/20/16	Jun/24/16
Final Clean - Site	5	Jun/28/16	Jul/05/16
Final Clean - Hotel Lvl 3	5	Jul/01/16	Jul/08/16
Pre-Punch Clean & Punchlist - Hotel Lvl 8	5	Jul/05/16	Jul/11/16
Final Clean - Hotel Lvl 4	5	Jul/18/16	Jul/22/16
Final Clean - Hotel Enclosure	10	Jul/18/16*	Jul/29/16
Pre-punch Clean & Punchlist - Hotel Lvl 9	5	Jul/19/16	Jul/25/16
Final Clean - Hotel Lvl 5	5	Aug/01/16	Aug/05/16
Final Clean - Hotel Lvl 1	5	Aug/10/16	Aug/16/16
Final Clean - Hotel Lvl 6	5	Aug/15/16	Aug/19/16
Final Clean - Hotel Lvl 7	5	Aug/29/16	Sep/02/16
Final Clean - Hotel Lvl 8	5	Sep/13/16	Sep/19/16
Final Clean - Hotel Lvl 9	5	Sep/27/16	Oct/03/16



Legend: Planned Work; Project Summary; Milestone; Pre-Construction; Procurement; Critical Work; Progressed Work

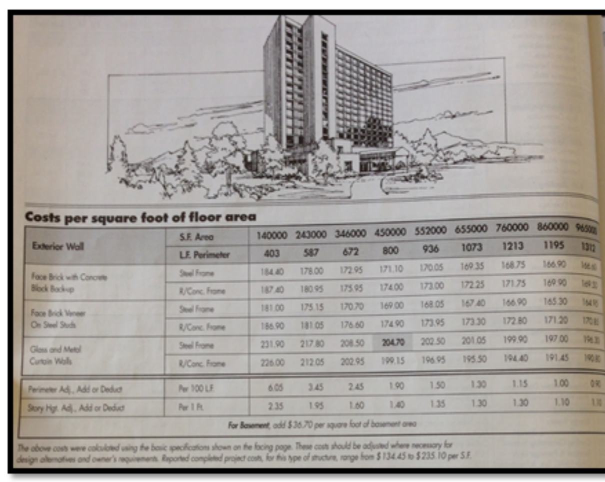
October 2015 Update

Date	Revision	Checked	Approved
Oct/22/15	October 2015 Schedule Update	JH	JH

0.2 - Cost Evaluation

Actual Project Budget Cost for The Heartland Hotel		
Building System	**Building Systems Cost**	**Cost/SF**
Foundations	$713,268.10	$5.51
Superstructure	**$4,474,147.48**	**$34.57**
Exterior Enclosure	**$2,341,547.31**	**$18.09**
Roofing	$400,820.83	$3.10
Interior Construction	**$8,111,096.92**	**$62.67**
Interior Finishes	**$3,231,833.54**	**$24.97**
Conveying & Chutes	$807,362.00	$6.24
Mechanical	**$ 5,176,729.00**	**$40.00**
Fire Protection	$296,887.50	$2.29
Electrical	**$2,081,009.59**	**$16.08**
Low Voltage	$757,500.00	$5.85
Equipment	$25,500.00	$0.20
Building Demolition	$7,167.73	$0.06
Site Preparation	$466,617.23	$3.61
Site Improvements	$147,464.00	$1.14
Site Electrical Utilities	$81,950.00	$0.63
Site Services	$541,870.30	$4.19
Furniture, Fixtures & Equipment (FF&E)	**$3,411,740.28**	**$26.36**
Operating Supplies & Equipment (OS&E)	**$830,015.03**	**$6.41**
General Conditions/Staff	$1,732,638.90	$13.39
Permits & Street/Sidewalk Closure Fees	$573,166.00	$4.43
Third Party Inspections/Testing	$160,000.00	$1.24
Design Fees	$950,000.00	$7.34
Insurance	$351,558.00	$2.72
Design Builders Fee	$1,071,898.00	$8.28
Estimating & Construction Contingency	$1,306,212.00	$10.09
Total Cost (TC)	**$40,049,999.74**	**$309.47**
Blue rows signify major building systems.		

Calculated Square Foot Take-Off				
Building System		**% of Sub-Total**	**Sub-Total Cost**	**Cost/SF**
Substructure		5.40%	$ 1,798,876.49	$13.90
Shell	Superstructure	13.40%	$ 4,463,878.70	$34.49
	Exterior Enclosure	9.70%	$ 3,231,315.18	$24.97
	Roofing	0.30%	$ 99,937.58	$0.77
	Interiors	22.80%	$ 7,595,256.29	$58.69
Services	Conveying	4.40%	$ 1,465,751.21	$11.33
	Plumbing	19.40%	$ 6,462,630.35	$49.94
	HVAC	10.60%	$ 3,531,127.93	$27.29
	Fire Protection	4.90%	$ 1,632,313.85	$12.61
	Electrical	9.10%	$ 3,031,440.01	$23.42
Equipment and Furnishings		0.00%	$ -	$ -
Special Construction		0.00%	$ -	$ -
Building Site work		0.00%	$ -	$ -
Sub-Total		100.00%	$ 33,312,527.60	$257.41
Location Multiplier		109.00%	$ 36,310,655.08	$280.57
Contractor Fee		6.50%	$ 2,165,314.29	$16.73
Architect Fee		2.60%	$ 866,125.72	$6.69
	Total Building Cost		**$ 39,342,095.10**	**$304.00**



Costs per square foot of floor area

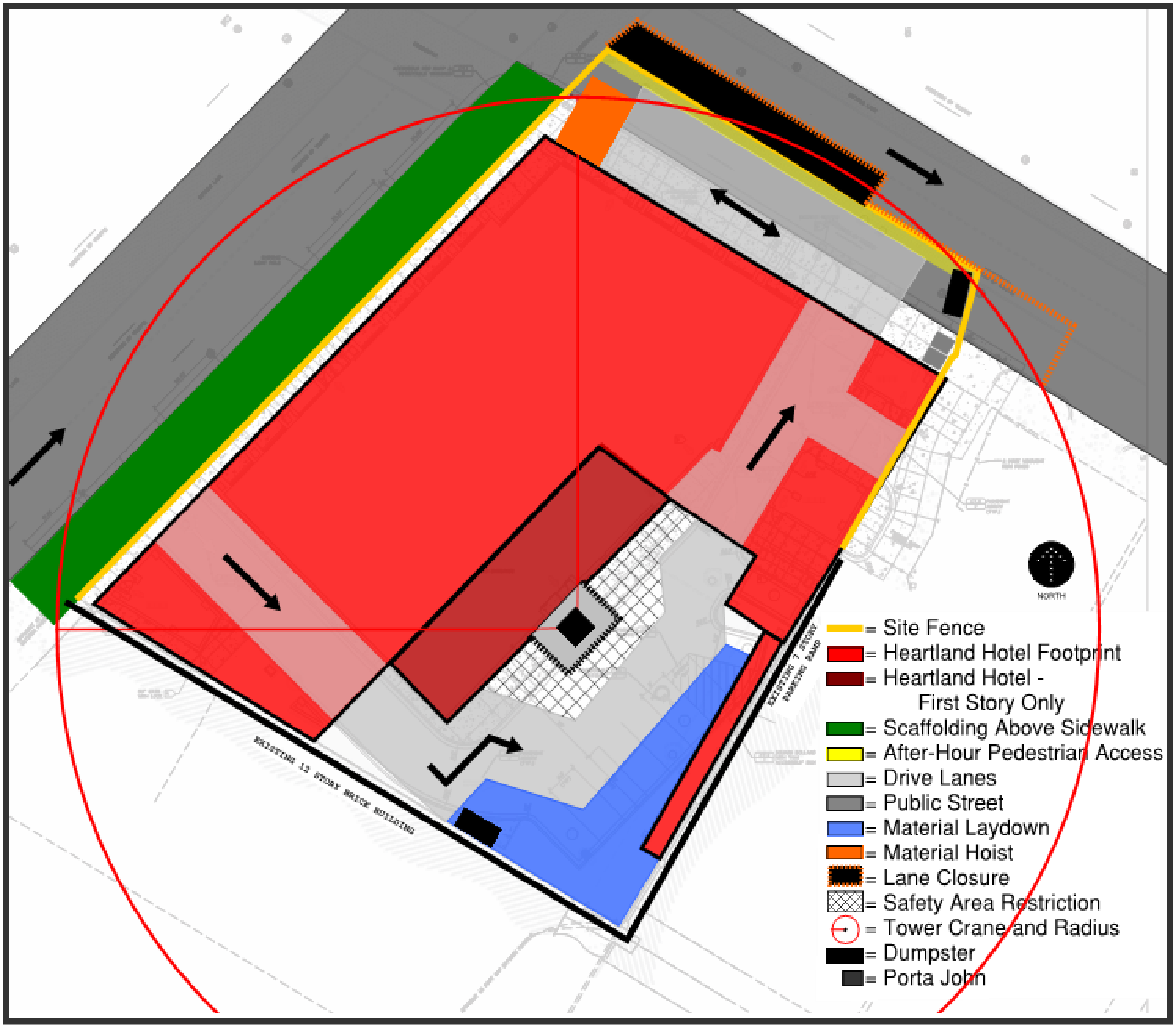
Exterior Wall	S.F. Area	140000	243000	346000	450000	552000	655000	760000	860000
	L.F. Perimeter	403	587	672	800	936	1073	1213	1195
Face Brick with Concrete Block Backup	Steel Frame	184.40	178.00	172.95	171.10	170.05	169.35	168.75	166.90
	R/Conc. Frame	187.40	180.95	175.95	174.00	173.00	172.25	171.75	169.90
Face Brick Veneer On Steel Studs	Steel Frame	181.00	175.15	170.70	169.00	168.05	167.40	166.90	165.30
	R/Conc. Frame	186.90	181.05	176.60	174.90	173.95	173.30	172.80	171.20
Glass and Metal Curtain Walls	Steel Frame	231.90	217.80	208.50	204.70	202.50	201.05	199.90	197.00
	R/Conc. Frame	226.00	212.05	202.95	199.15	196.95	195.50	194.40	191.45
Perimeter Adj., Add or Deduct	Per 100 L.F.	6.05	3.45	2.45	1.90	1.50	1.30	1.15	1.00
Story Hgt. Adj., Add or Deduct	Per 1 Ft.	2.35	1.95	1.60	1.40	1.35	1.30	1.30	1.10
For Basement, add $36.70 per square foot of basement area									

The above costs were calculated using the basic specifications shown on the facing page. These costs should be adjusted where necessary for design alternatives and owner's requirements. Reported completed project costs, for this type of structure, range from $134.45 to $235.10 per S.F.

Calculations for the Square Foot Take-Off were completed using RS Means Square Foot Costs 2014. Specifically, the image depicts the numbers used for S.F. Area and L.F. Perimeter to calculate the Cost/SF. The information was taken from a Commercial/ Industrial/ Institutional, M3.60 | Hotel, 8-24 Story. The percentages of Sub-Total numbers were taken from the subsequent pages in RS Means Square Foot Costs 2014.

Project Information

0.3 - Site Logistics Plan


EXISTING 12 STORY BRICK BUILDING
EXISTING 7 STORY PARKING RAMP
NORTH
= Site Fence
= Heartland Hotel Footprint
= Heartland Hotel - First Story Only
= Scaffolding Above Sidewalk
= After-Hour Pedestrian Access
= Drive Lanes
= Public Street
= Material Laydown
= Material Hoist
= Lane Closure
= Safety Area Restriction
= Tower Crane and Radius
= Dumpster
= Porta John

1.1 - Mortenson Development Incorporated Executive Interview

As Allie mentioned, Mortenson has allowed me to use the Heartland Hotel project in Minneapolis for my Senior Thesis. As part of my thesis, I have decided to look deeper into the room type/layout and incorporating suites into the 9th story of the hotel. The goal of this analysis is to propose a 9th story with suites included, and present on how incorporating these types of rooms can impact the cash flow, new present values, and overall business model.

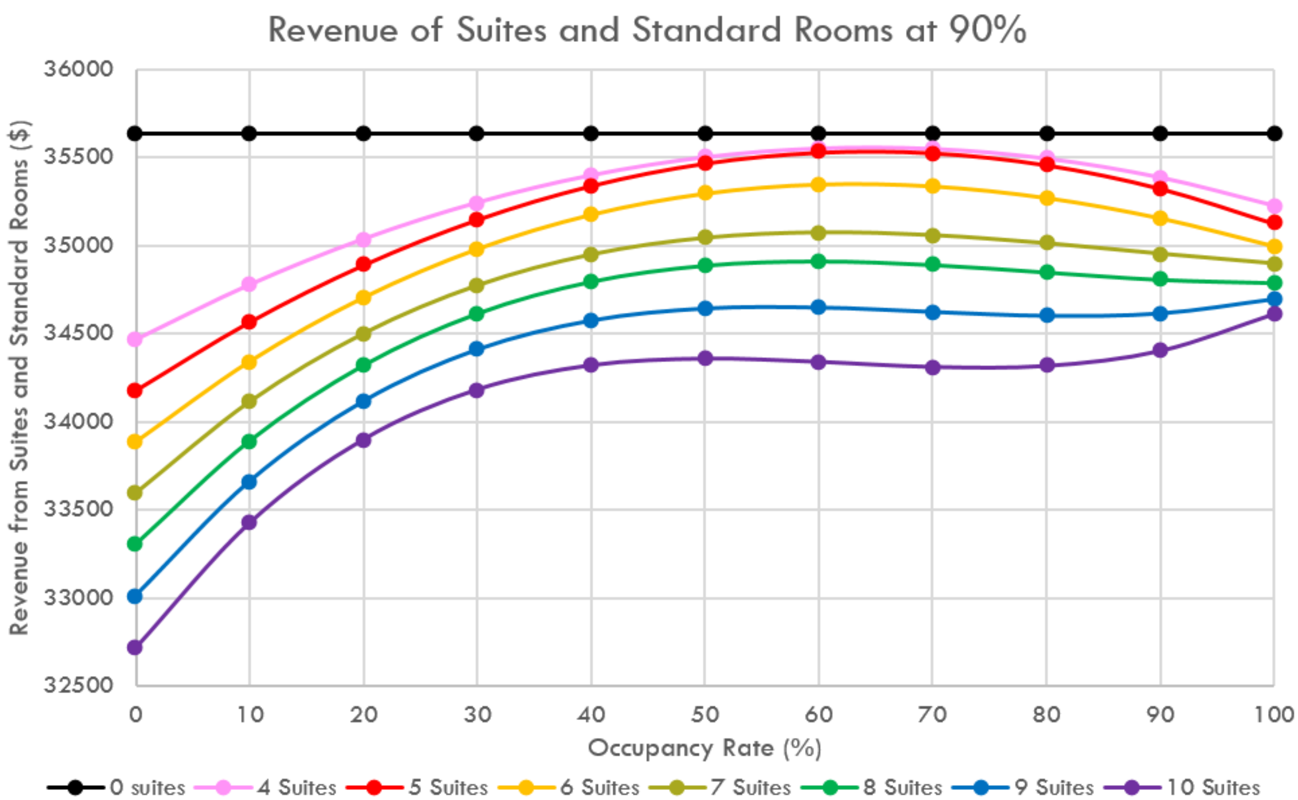
With that said, I asked Allie to reach out to you in hopes of discussing benefits and drawbacks, prices, considerations and requirements, and the decision making process for all of this.

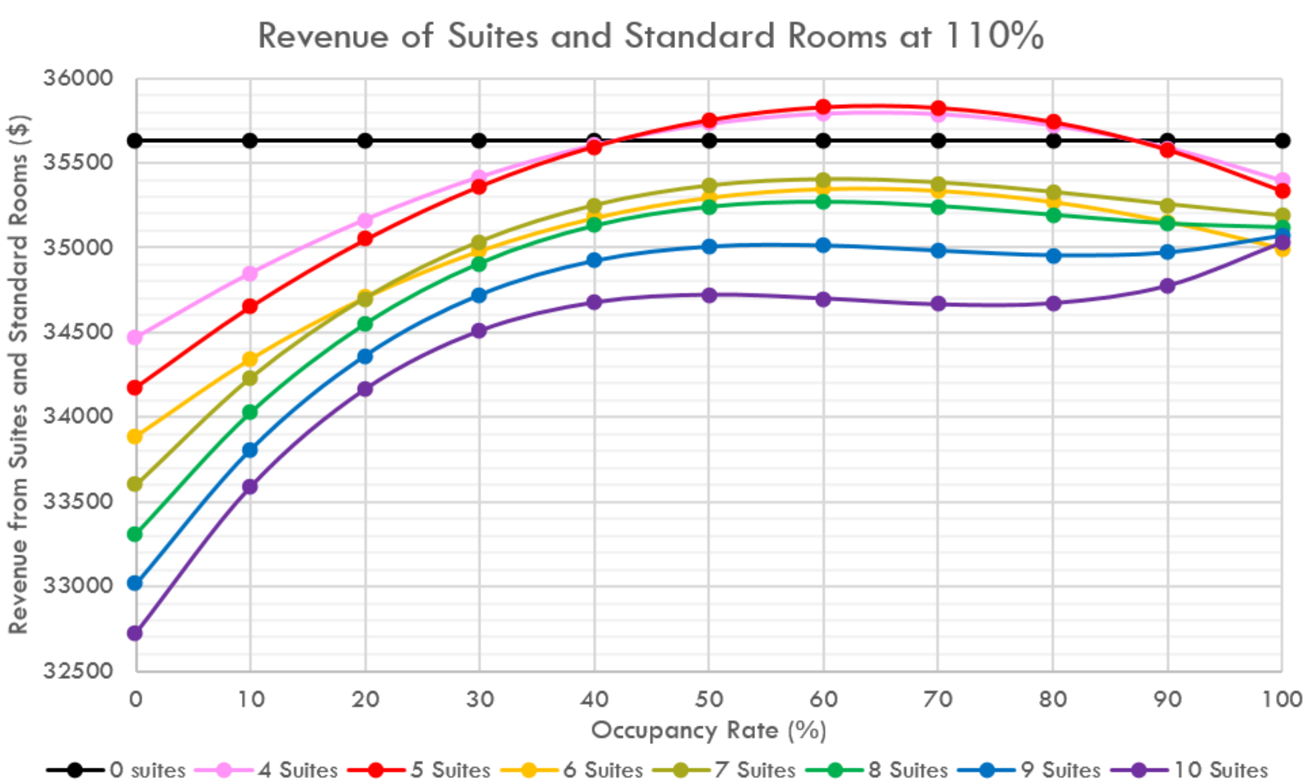
Below you will find questions to guide this interview, but please feel free to address anything not included, but that you feel important.

1. **What is your position at Mortenson Development?**
    a. I am a Development Executive.
2. **How does Mortenson Development benefit from the Heartland Hotel after construction is complete?**
    a. We have an agreement with the Heartland Hotel. We are partial owners, so we have a minority interest in the property. So for example, they would receive 90% of the profits and we would receive 10%. Essentially, the better the hotel, the more money MDI makes.
3. **How does the programming and decision making process for a hotel take place?**
    a. A lot of the decisions made are front end decisions. So for the Heartland, the question was how tall we could build. This dictated the programming. Our biggest impact was that we wanted 240-250 keys on site. A standard king is bigger, so the larger the room, the less total rooms we are able to have.
4. **What are key considerations and requirements in the development stages for a hotel, and how does this relate to the decision of whether to include suites?**
    a. Well first off, the programming needs to be approved by Heartland. Then you need to consider the site constraints and size, and height requirements and restrictions. We were only allowed to go up so high. There are king suites in the brand standards. Specifically to the Heartland, at first the company usually did renovations for buildings. But now, they are doing ground-up projects. Because the Heartland is located downtown, the business that the hotel would receive is from weekday traffic. This is business people looking for cheap prices, but nice stays. Typically, suites would be used for leisure travel – so if a hotel is by a stadium, for example, you could probably get away with more suites. Travelers and tourists would want that extra room. But with business travelers, suites aren't always the best idea.
5. **Can you touch on the cash flow, specifically for Mortenson Development, when dealing with a hotel?**
    a. From a return standpoint:

        The *Net operating income/cost of asset* is a *cap rate*. So it is some form of a return. Typically, for example, apartments have the lowest cap rate, at say 6%. This means that they have a net income which is 106% more than the cost of the asset. It is less risky of a business because there are typically year-long leases, so the acceptable apartment cap rate is lower. Hotels, however, have a higher cap rate, at say 9%. This means you need 9% more in cash flow and return in order to compensate for the nightly risk that is incurred with a hotel. Hotels are very reflective of the economy because it is only nightly leases. So if the economy tanks, the hotel will easily reflect this.
6. **How would including suites impact this cash flow/value?**
    a. Including suites would make it riskier. In the downtown area, most customers are there just for business, so they are looking for a good rate and high quality room without needing an excess of space.
7. **How are the decisions made in terms of suites?**
    a. Heartland depicts how many suites they want and then MDI can say more or less. In this case, MDI said that we wanted less.
8. **Can you give me any advice as I look into incorporating suites?**
    a. Location matters the most for renting suites or not. Also, the actual construction cost is a huge consideration. Gross sf/key is the largest metric. With each additional suite, that number goes up. If the typical cost for a hotel is $250/sf, for every suite you add, there is more sf/room. So you would be paying $250/sf additional for those rooms. At the end, if you have 250 suites vs. 250 standard rooms, the hotel with suites would be 10-15% larger. And if you're not getting paid extra for building those suites, you're essentially not getting paid to build that extra area. Overall, I would look at cost and location. In a suburban area with lots of families or local attractions, suites make a lot of sense. But when the traveler is mostly there for business, it doesn't necessarily make sense.

1.2 - Total Revenue of Suites and Standard Rooms at 90% and 110%


Revenue of Suites and Standard Rooms at 90%
Revenue from Suites and Standard Rooms ($)
36000
35500
35000
34500
34000
33500
33000
32500
0
10
20
30
40
50
60
70
80
90
100
Occupancy Rate (%)
0 suites
4 Suites
5 Suites
6 Suites
7 Suites
8 Suites
9 Suites
10 Suites


Revenue of Suites and Standard Rooms at 110%
Revenue from Suites and Standard Rooms ($)
36000
35500
35000
34500
34000
33500
33000
32500
0
10
20
30
40
50
60
70
80
90
100
Occupancy Rate (%)
0 suites
4 Suites
5 Suites
6 Suites
7 Suites
8 Suites
9 Suites
10 Suites

1.3 - Materials Cost

	Area	King Room			RS Means Data				King With Sofa Costs/Man-Hours						Suites Cost/Man-Hours						Comparison		
		Code	Material	Description	Unit	Labor-Hours	Material ($)	Labor ($)	Amount	Unit	Labor-Hours	Material ($)	Labor ($)	Total ($)	Amount	Unit	Labor-Hours	Material ($)	Labor ($)	Total ($)	Labor-Hours Comparison	Cost Comparison	**Total Cost/Category**
Finishes - 8'3 to Ceiling	**Ceilings**	OS-400	Extra White paint, flat	Painting ceiling, complete (surface prep, primer, and 2 coats finish), 399	sf	0.025	0.2	1.213	239.0	sf	5.98	$ 48.09	$ 347.46	$ 406.02	558.0	sf	14.0	$ 112.27	$ 811.21	$ 947.96	10.0	$ 679.54	
		OS-401	Extra white paint, semi-gloss	Painting ceiling, complete (surface prep, primer, and 2 coats finish), 399	sf	0.025	0.2	1.213	49.0	sf	1.23	$ 9.86	$ 71.24	$ 83.24	56.0	sf	1.4	$ 11.27	$ 81.41	$ 95.14	-5.3	$ (356.76)	
	Flooring	PG-217B	Resilient rubber base, 4"	1/8" rubber base, 4" high - 375	lf	0.025	1.26	1.07	84.3	lf	2.11	$ 106.90	$ 108.19	$ 219.64	129.3	lf	3.2	$ 163.84	$ 165.83	$ 336.63	-4.9	$ (513.21)	
		OS-100	Engineered Wood laminate flooring	Wood composition, thin set, on concrete, no finish, p 374	sf	0.064	5.5	2.41	240.0	sf	15.36	$ 1,327.92	$ 693.50	$ 2,059.64	543.0	sf	34.8	$ 3,004.42	$ 1,569.05	$ 4,659.95	20.2	$ 2,703.28	
		OS-200	Stainless Steel base at Bathroom	1/8" rubber base, 4" high - 375 - steel N/A	lf	0.025	1.26	1.07	24.8	lf	0.62	$ 31.48	$ 31.86	$ 64.68	26.8	lf	0.7	$ 34.01	$ 34.42	$ 69.88	-2.9	$ (297.37)	**$ (6,077.51)**
		OS-101	Waterproof engineered wood laminate flooring	Wood composition, thin set, on concrete, no finish, p 374	sf	0.064	5.5	2.41	37.0	sf	2.37	$ 204.72	$ 106.91	$ 317.53	44.0	sf	2.8	$ 243.45	$ 127.14	$ 377.60	-9.6	$ (1,287.28)	
		PL-10	shower pan, 32x60"	Shower pan, bituminous membrane, 7oz, p266	sf	0.52	1.62	2.02	11.0	sf	5.72	$ 17.93	$ 26.64	$ 50.85	11.0	sf	5.7	$ 17.93	$ 26.64	$ 50.85	-28.6	$ (254.27)	
	Walls	V-300B	wall vinyl	Vinyl wall covering, fabric-backed, lightweight type - 383	sf	0.013	0.93	0.5	797.5	sf	10.37	$ 746.13	$ 478.10	$ 1,248.46	1293.2	sf	16.8	$ 1,209.92	$ 775.29	$ 2,024.49	-19.6	$ (2,362.09)	
		OS-301	Wall tile	Walls, interior, thin set, 16"x16" tile, p367	sf	0.107	4.77	4.01	89.4	sf	9.56	$ 428.86	$ 429.70	$ 877.87	89.4	sf	9.6	$ 428.86	$ 429.70	$ 877.87	-47.8	$ (4,389.36)	
Furnishings	**Standard/King Furniture**	X-101B	Operable sheers						1		0.00	$ -	$ -	$ -	1.0	ea.	0.0	$ -	$ -	$ -	0.0	$ -	
		X-102B	Operable Over-drapes, black out						1		0.00	$ -	$ -	$ -	1.0	ea.	0.0	$ -	$ -	$ -	0.0	$ -	
		X-300	Desk lamp	LED, interior, shape A60	ea.	0.05	22	2.67	1		0.05	$ 22.13	$ 3.20	$ 25.67	0.5	ea.	0.0	$ 11.07	$ 1.60	$ 12.83	-0.4	$ (192.51)	
		X-601	Mini-fridge, glass door, Eco smart		ea.	0	148		1		0.00	$ 148.89	$ -	$ 150.56	0.5	ea.	0.0	$ 74.44	$ -	$ 75.28	0.0	$ (1,129.19)	
		X-212	Desk chair	standard office chair, exec, min	ea.	0	320	0	1		0.00	$ 321.92	$ -	$ 325.53	0.5	ea.	0.0	$ 160.96	$ -	$ 162.77	0.0	$ (2,441.50)	
		X-203BL	Desk		ea.				1		0.00	$ -	$ -	$ -	1.0	ea.	0.0	$ -	$ -	$ -	0.0	$ -	
		X-205B	Coffee tray		ea.		100		1		0.00	$ 100.60	$ -	$ 101.73	0.5	ea.	0.0	$ 50.30	$ -	$ 50.86	0.0	$ (762.97)	
		X-208BL	Luggage bench		ea.		40		1		0.00	$ 40.24	$ -	$ 40.69	0.5	ea.	0.0	$ 20.12	$ -	$ 20.35	0.0	$ (305.19)	
		X-600	TV - 47" LG LED Flat Panel		ea.		448		1		0.00	$ 450.69	$ -	$ 455.75	1.3	ea.	0.0	$ 563.36	$ -	$ 569.68	0.0	$ (1,709.05)	
		X-600M	TV Wall mounting bracket		ea.		23		1		0.00	$ 23.14	$ -	$ 23.40	1.3	ea.	0.0	$ 28.92	$ -	$ 29.25	0.0	$ (87.74)	
		X-214BL	Closet		ea.				1		0.00	$ -	$ -	$ -	1.0	ea.	0.0	$ -	$ -	$ -	0.0	$ -	
		X-602, SAFE	Safe - smart box laptop		ea.		100		1		0.00	$ 100.60	$ -	$ 101.73	0.5	ea.	0.0	$ 50.30	$ -	$ 50.86	0.0	$ (762.97)	
		OS-311	Mirror for back of entry door, 12x44"		ea.				1		0.00	$ -	$ -	$ -	1.0	ea.	0.0	$ -	$ -	$ -	0.0	$ -	
		X-402	LED Vanity mirror		ea.				1		0.00	$ -	$ -	$ -	1.0	ea.	0.0	$ -	$ -	$ -	0.0	$ -	
		OC-306C	Vanity top, sink and towel bar, 67"x21.75"x3.25"		ea.				1		0.00	$ -	$ -	$ -	1.0	ea.	0.0	$ -	$ -	$ -	0.0	$ -	
		X-201B	King Nightstand		ea.		35		2		0.00	$ 70.42	$ -	$ 71.21	1.5	ea.	0.0	$ 52.82	$ -	$ 53.41	0.0	$ (445.07)	
		X-400R	Headboard Wall Sconce		ea.				2		0.00	$ -	$ -	$ -	2.0	ea.	0.0	$ -	$ -	$ -	0.0	$ -	
		X-540A	Artwork		ea.		30		1		0.00	$ 30.18	$ -	$ 30.52	1.3	ea.	0.0	$ 37.73	$ -	$ 38.15	0.0	$ (114.45)	**$ (8,187.32)**
		K-201M	King Mattress - Serta		ea.		400		1		0.00	$ 402.40	$ -	$ 406.92	0.5	ea.	0.0	$ 201.20	$ -	$ 203.46	0.0	$ (3,051.88)	
		K-211B	King Platform Bed Base		ea.		239		1		0.00	$ 240.43	$ -	$ 243.13	0.5	ea.	0.0	$ 120.22	$ -	$ 121.57	0.0	$ (1,823.50)	
		K-200B	King Headboard		ea.		159		1		0.00	$ 159.95	$ -	$ 161.75	0.5	ea.	0.0	$ 79.98	$ -	$ 80.87	0.0	$ (1,213.12)	
		X-202B	Cocktail table - rectangular		ea.		164		1		0.00	$ 164.98	$ -	$ 166.84	0.3	ea.	0.0	$ 41.25	$ -	$ 41.71	0.0	$ (1,459.81)	
		X-400L	Sleeper Sofa		ea.		160		1		0.00	$ 160.96	$ -	$ 162.77	0.5	ea.	0.0	$ 80.48	$ -	$ 81.38	0.0	$ (1,220.75)	
		X-201B	Floor lamp		ea.		20		1		0.00	$ 20.12	$ -	$ 20.35	1.5	ea.	0.0	$ 30.18	$ -	$ 30.52	0.0	$ (50.86)	
		X-213	End Table - Circular		ea.		35		0		0.00	$ -	$ -	$ -	0.5	ea.	0.0	$ 17.61	$ -	$ 17.80	0.0	$ 89.01	
		X-301	Lounge Chair		ea.		149		0		0.00	$ -	$ -	$ -	0.8	ea.	0.0	$ 112.42	$ -	$ 113.68	0.0	$ 568.41	
			Double Double Mattress		ea.		319		0		0.00	$ -	$ -	$ -	1.0	ea.	0.0	$ 320.91	$ -	$ 324.52	0.0	$ 1,622.58	
			Double Double Platform Base		ea.		127		0		0.00	$ -	$ -	$ -	1.0	ea.	0.0	$ 127.76	$ -	$ 129.20	0.0	$ 645.98	
			Double Double Headboard		ea.		119		0		0.00	$ -	$ -	$ -	1.0	ea.	0.0	$ 119.71	$ -	$ 121.06	0.0	$ 605.29	
			Area Rug		ea.		30		0		0.00	$ -	$ -	$ -	0.3	ea.	0.0	$ 7.55	$ -	$ 7.63	0.0	$ 38.15	
	ional Suite rnishings		Dining Table		ea.		334		0		0.00	$ -	$ -	$ -	0.3	ea.	0.0	$ 84.00	$ -	$ 84.94	0.0	$ 424.72	
			Dining Chairs	Cost included with table	ea.		0		0		0.00	$ -	$ -	$ -	1.5	ea.	0.0	$ -	$ -	$ -	0.0	$ -	
			Cabinets	+ Manufactured wood casework, two top drawers, two doors below, 33" wide	ea.	0.766	420	35			0.00	$ -	$ -	$ -	1.0	ea.	0.8	$ 422.52	$ 41.97	$ 470.47	3.8	$ 2,352.37	

Addi Fu			Countertop	plastic laminate countertop, avg.	lf	0.333	7.05	15.3	0		0.00	$ -	$ -	$ -	2.6	lf	0.9	$ 18.62	$ 48.15	$ 68.41	4.4	$ 342.03	
			Fridge				1000		0		0.00	$ -	$ -	$ -	0.3	ea.	0.0	$ 251.50	$ -	$ 254.32	0.0	$ 1,271.62	
			Stove/Oven				490		0		0.00	$ -	$ -	$ -	0.3	ea.	0.0	$ 123.24	$ -	$ 124.62	0.0	$ 623.09	
Construction - 11' to Structure	Doors	GR-1	Entry - 3'x6'8x1.75" stained wood, core wood	walnut face, 3x6'8, p292	ea.	0.941	197	43	1.0	ea.	0.94	$ 198.18	$ 51.56	$ 253.49	3.0	ea.	2.8	$ 594.55	$ 154.67	$ 760.48	4.7	$ 1,267.47	
		GR-3	Bathroom - 3'4x7'6x1.75" sliding glass barn door	aluminum, 5/8" tempered insulated glass, 6' wide, economy, p302	ea.	4	905	813	1.0	ea.	4.00	$ 910.43	$ 974.79	$ 1,910.42	1.0	ea.	4.0	$ 910.43	$ 974.79	$ 1,910.42	-20.0	$ (9,552.12)	
	Room-to-Room Walls	Bathroom-to-Room: 7-3/4", 6" stud width, UL #U465, 16 o.c.	width: 7-3/4", 6" stud width, UL #U465, 16oc, p357																				
			wall studs	10' high, 25 ga, 6", 16" o.c.	sf	0.017	0.5	0.78	26.1	sf	0.44	$ 13.14	$ 24.43	$ 38.44	52.3	sf	0.9	$ 26.28	$ 48.87	$ 76.89	0.0	$ -	
			insulation	Unfaced R-13, 15" wide, p244	sf	0.006	0.32	0.27	26.1	sf	0.16	$ 8.41	$ 8.46	$ 17.22	52.3	sf	0.3	$ 16.82	$ 16.91	$ 34.43	0.0	$ -	
			1/2" resilient furring channel @ 24" o.c. - 5 channels high	Furring channel, galv. Steel, 7/8" deep, resilient, p366	clf	3.137	29	144	0.2	clf	0.75	$ 6.93	$ 41.01	$ 49.23	0.5	clf	1.5	$ 13.86	$ 82.01	$ 98.45	0.0	$ -	
			gyp, bottom layers (already multiplied)	5/8" thick, on walls, standard, no finish, p363	sf	0.016	0.64	0.74	26.1	sf	0.42	$ 16.82	$ 23.18	$ 40.87	52.3	sf	0.8	$ 33.64	$ 46.36	$ 81.74	0.0	$ -	
			gyp, final layer	5/8" thick, on walls, standard, w/compound skim coat (level 5 finish), p363	sf	0.021	0.43	0.95	26.1	sf	0.55	$ 11.30	$ 29.76	$ 42.07	52.3	sf	1.1	$ 22.60	$ 59.52	$ 84.15	0.0	$ -	
		Room-to-Room	width: 5-3/8", 3-5/8" stud width, UL #U465, 16oc, p357																				
			wall studs	10' high, 25 ga, 3-5/8", 16" o.c.	sf	0.017	0.36	0.76	275.0	sf	4.68	$ 99.59	$ 250.59	$ 358.84	181.1	sf	3.1	$ 65.57	$ 164.99	$ 236.26	-31.4	$ (2,407.12)	
			insulation	Unfaced R-13, 15" wide, p244	sf	0.006	0.32	0.27	275.0	sf	1.65	$ 88.53	$ 89.03	$ 181.22	181.1	sf	1.1	$ 58.29	$ 58.61	$ 119.31	-11.1	$ (1,215.59)	
			1/2" resilient furring channel @ 24" o.c. - 5 channels high	Furring channel, galv. Steel, 7/8" deep, resilient, p366	clf	3.137	29	144	2.5	clf	7.84	$ 72.94	$ 431.64	$ 518.17	1.6	clf	5.2	$ 48.02	$ 284.19	$ 341.16	-52.6	$ (3,475.88)	
			gyp, bottom layers (already multiplied)	5/8" thick, on walls, standard, no finish, p363	sf	0.016	0.64	0.74	275.0	sf	4.40	$ 177.06	$ 244.00	$ 430.23	181.1	sf	2.9	$ 116.57	$ 160.65	$ 283.26	-29.5	$ (2,885.97)	
			gyp, final layer	5/8" thick, on walls, standard, w/compound skim coat (level 5 finish), p363	sf	0.021	0.43	0.95	275.0	sf	5.78	$ 118.96	$ 313.24	$ 442.89	181.1	sf	3.8	$ 78.32	$ 206.24	$ 291.60	-38.7	$ (2,970.90)	$ (19,454.31)
	Interior Walls	Edge of Bathroom-to-Bedroom	width: 4-7/8", 3-5/8" stud width, UL #U419, 16oc, p357																				
			wall studs	10' high, 25 ga, 3-5/8", 16" o.c.	sf	0.017	0.36	0.76	33.0	sf	0.56	$ 11.95	$ 30.07	$ 43.06	33.0	sf	0.6	$ 11.95	$ 30.07	$ 43.06	-2.8	$ (215.31)	
			insulation	Unfaced R-13, 15" wide, p244	sf	0.006	0.32	0.27	33.0	sf	0.20	$ 10.62	$ 10.68	$ 21.75	33.0	sf	0.2	$ 10.62	$ 10.68	$ 21.75	-1.0	$ (108.73)	
			gyp, bottom layers (already multiplied)	5/8" thick, on walls, standard, no finish, p363	sf	0.008	0.32	0.37	33.0	sf	0.26	$ 10.62	$ 14.64	$ 25.81	33.0	sf	0.3	$ 10.62	$ 14.64	$ 25.81	-1.3	$ (129.07)	
			gyp, final layer	5/8" thick, on walls, standard, w/compound skim coat (level 5 finish), p363	sf	0.021	0.43	0.95	33.0	sf	0.69	$ 14.28	$ 37.59	$ 53.15	33.0	sf	0.7	$ 14.28	$ 37.59	$ 53.15	-3.5	$ (265.73)	
		Bathroom-to-Bedroom	width: 9-7/8", 8" stud width, GA WP 1052, 24oc, p357																				
			wall studs	10' high, 25 ga, 8", 24" o.c. - N/A, used 6" at 24oc	sf	0.11	0.37	0.51	76.1	sf	8.37	$ 28.32	$ 46.53	$ 84.15	76.1	sf	8.4	$ 28.32	$ 46.53	$ 84.15	-41.8	$ (420.76)	
			insulation	Unfaced R-13, 23" wide, p244	sf	0.005	0.32	0.23	76.1	sf	0.38	$ 24.49	$ 20.98	$ 46.37	76.1	sf	0.4	$ 24.49	$ 20.98	$ 46.37	-1.9	$ (231.86)	
			gyp, bottom layers (already multiplied)	5/8" thick, water resistant, no finish, p363	sf	0.008	0.45	0.37	76.1	sf	0.61	$ 34.44	$ 33.75	$ 69.58	76.1	sf	0.6	$ 34.44	$ 33.75	$ 69.58	-3.0	$ (347.90)	
			gyp ** waterproof, final layer	5/8" thick, on walls, standard, water resistant, w/compound skim coat (level 5 finish), p363	sf	0.021	0.56	0.95	76.1	sf	1.60	$ 42.86	$ 86.67	$ 132.60	76.1	sf	1.6	$ 42.86	$ 86.67	$ 132.60	-8.0	$ (663.01)	
		Additional Interior Walls	Width: 4-1/4", 3-5/8" stud, 16oc, p357																				
			wall studs	8' high, 25 ga, 3-5/8", 16" o.c.	sf	0.013	0.39	0.61	32.1	sf	0.42	$ 12.59	$ 23.47	$ 36.88	308.0	sf	4.0	$ 120.84	$ 225.27	$ 354.04	15.8	$ 1,401.38	
			insulation	Unfaced R-13, 15" wide, p244	sf	0.006	0.32	0.27	32.1	sf	0.19	$ 10.33	$ 10.39	$ 21.14	308.0	sf	1.8	$ 99.15	$ 99.71	$ 202.96	7.3	$ 803.36	
			gyp	5/8" thick, on walls, standard, w/compound skim coat (level 5 finish), p363	sf	0.021	0.43	0.95	32.1	sf	0.67	$ 13.88	$ 36.55	$ 51.68	308.0	sf	6.5	$ 133.23	$ 350.83	$ 496.04	25.6	$ 1,963.42	
Total											**98.91**	$ 7,316.22	$ 5,129.79	**$ 12,685.74**			**143.0**	$10,950.89	$ 7,326.94	**$18,627.65**			
Total * Number of Rooms (10 Standard , 5 Suites)											**989.1**	$ 73,162.19	$51,297.93	**$ 126,857.38**			**715.2**	$54,754.45	$36,634.68	**$93,138.24**			

2.1 - Weights of Materials

Material					Weight			Calculated Weight
Section	Material	Description	Amount	Unit	Material Weight	Unit	Notes	Total Weight (lbs.)
Underneath	6" rounded recessed LED downlights		9	ea.	0	psf		-
	3-5/8" light gauge framing		527	sf	0.37	psf		194.99
	5/8" ext. sheathing		527	sf	2.1	psf		1,106.70
	vapor retarder		527	sf	0	psf		-
	3" rigid insulation, foil faced w/joints taped		527	sf	1.77	psf		932.79
	7/8" furring channels		527	sf	0.432	psf		227.66
	building wrap/slip sheet		527	sf	0	psf		-
	7/8" stucco		527	sf	10	psf	Will not be prefabricated	-
Ceiling	Hung gab		477	sf	2.75	psf		1,311.75
	4" circular recessed fluorescent downlights	120v, 50w	6	ea.	0	psf		-
Roof	Ballasted EPDM		581	sf	2	psf	Will not be prefabricated	1,162.00
	R-24 insulation		581	sf	0	psf	Included in the Roof	-
	Vapor Retarder		581	sf	0	psf		-
	1/2" gyp deck sheathing		581	sf	2.2	psf		1,278.20
	Metal deck 3" 18 ga galvanized		581	sf	3	psf		1,743.00
	5/8" exterior gyp		581	sf	2.75	psf		1,597.75
	3-5/8" metal stud framing		10	ea.	0.37	psf		214.97
Exterior	2 Downspouts		31	lf	0			-
	5 windows (5, 1A)	7x1'8, 1" tempered insulated	5	ea.	8	psf		93.52
	Door - 245A	3x7, hollow metal, painted	1	ea.	5	psf		105.00
	Door - 245B	3x7, wood, narrow light	1	ea.	2.5	psf		52.50
	Door - 245C	3x7, wood, narrow light	1	ea.	2.5	psf		52.50
	5/8" gyp sheathing		1926	sf	1.95	psf		3,755.70
	4" metal stud framing		1926	sf	0.37	psf		712.62
	1-1/2" closed cell spray foam insulation		1926	sf	0.21	psf		404.46
	5/8" exterior sheathing		1926	sf	2.1	psf		4,044.60
	1-1/2" rigid insulation, foil faced w/joints taped		1926	sf	1.6	psf		3,081.60
	building wrap/slip sheet		1926	sf	0	psf		-
	Pre-fin metal panel, flat, C1		459	sf	1.46	psf		670.14
	Pre-fin metal panel, flat, C1		894	sf	1.46	psf		1,305.41
	Pre-fin metal panel, flat, C1		124	sf	1.46	psf		180.48
	Pre-fin metal panel, ribbed vertical 8"		364	sf	1.46	psf		531.44
	Pre-fin metal panel, ribbed horizontal 4"		85	sf	1.46	psf		124.10
Mechanical	12"x4" SA	x4, assumed raised 10' to supply	11.37	lf	56	lbs.		56.00
	14"x8" SA duct		24.83	lf	44	lbs.		44.00
	24"x8" SA duct		21.41	lf	53	lbs.		53.00
	12/4 SA Dn	Diffuser	4	ea.	16	lbs.		16.00
	480V, 4.0 kVA motor		1	ea.	0			-
Interior Finishes	Walnut stained wood base, 9" height		142	lf				-
	Carpet tile, 19"x19"		477	sf	2	psf		954.00
	Wall vinyl		477	sf				-
	W12x26		122.34	lf	26	plf		3,180.84
Structure	W14x38		23.25	lf	38	plf		883.50
	HSS 6x6x3/8		93	lf	27.48	plf		2,555.64
	W10x22		72.84	lf	22	plf		1,602.48
	W12x26		49.5	lf	26	plf		1,287.00
	W12x35		23.25	lf	35	plf		813.75
	2" 18 GA VLI composite decking		477	sf	3	psf		1,431.00
	4.5" NW concrete		6.625	cy	56.25	psf		372.66
							Total Weight (lbs.)	**38,133.75**
							Weight (Tons)	**19.07**
							Weight (lbs.)/sf	**73.62**

****Tower crane can hold 14319 lbs. at 213' height, 130' away --> 7.16 tons**

****100 ton hydraulic truck crane, hydraulic lifting jib; 142' boom, 89' jib = 231' reach - cost $3,400/day**

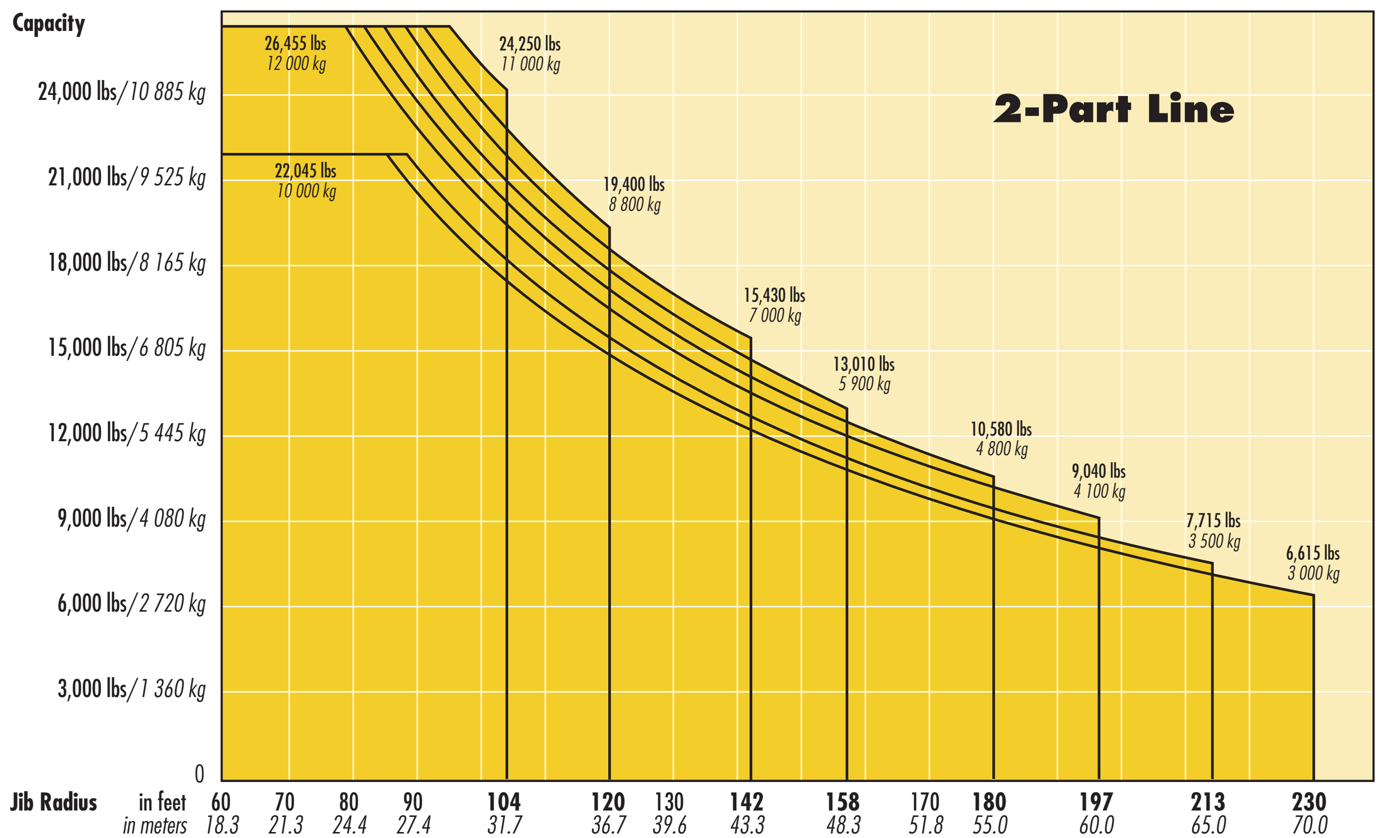
2.2 - Tower Crane Specifications

Radius and Capacities

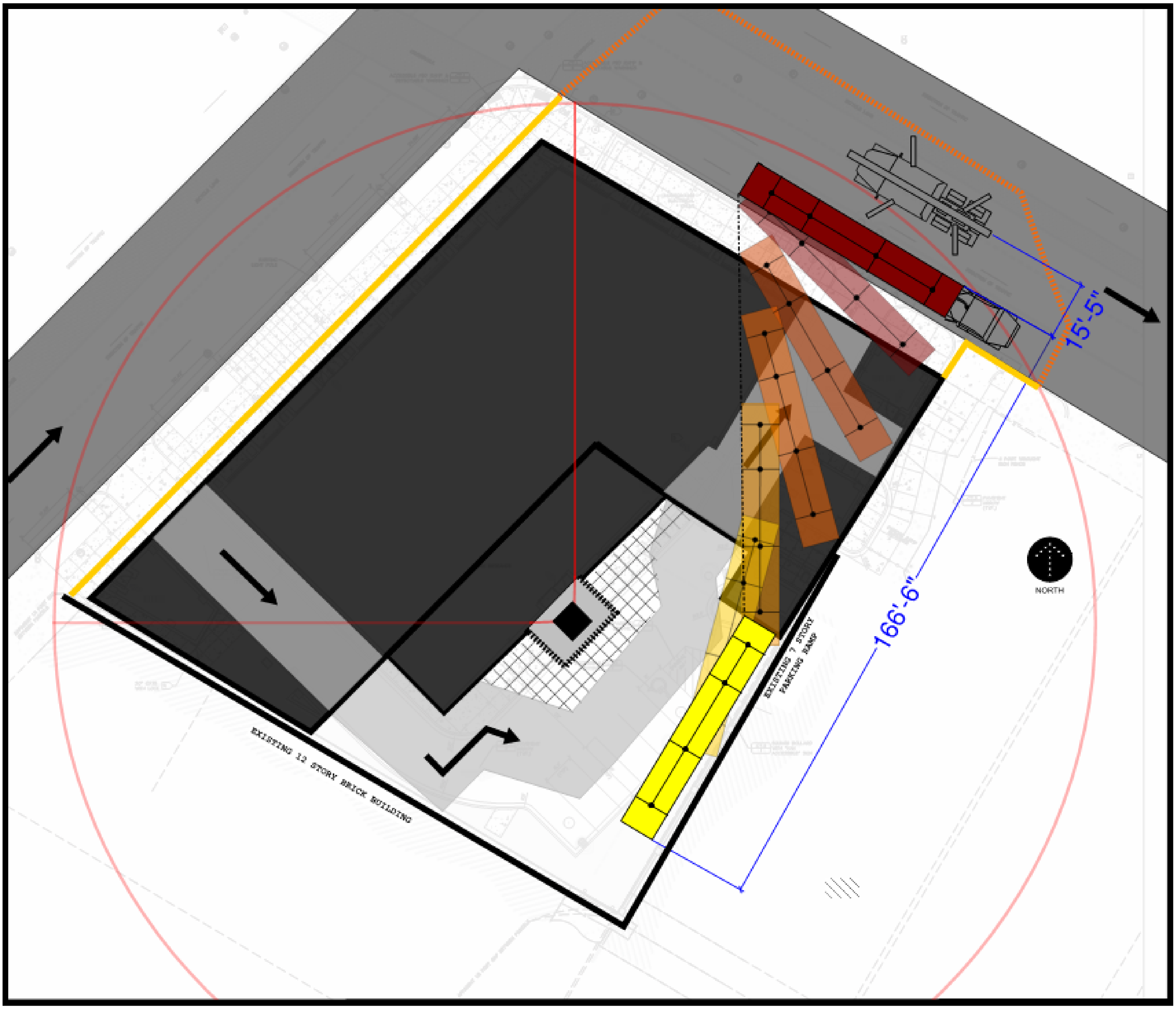
LIEBHERR Tower Crane Model 281 HC

2-Part Line

Hook Radius	2-Part Line Max Capacity – Radius	ft m	60 18.3	70 21.3	80 24.4	90 27.4	**104 31.7**	110 33.5	**120 36.7**	130 39.6	**142 43.3**	150 45.7	**158 48.3**	170 51.8	**180 55.0**	190 58.0	**197 60.0**	**213 65.0**	**230 70.0**
230 ft	22,045 lbs – 86 ft	lbs	22,045	22,045	22,045	20,955	17,747	16,643	14,958	13,672	12,280	11,495	10,737	9,833	9,105	8,534	8,135	7,319	**6,615**
70.0m	*10 000 kg – 26.2m*	kg	*10 000*	*10 000*	*10 000*	*9 505*	*8 050*	*7 549*	*6 785*	*6 201*	*5 570*	*5 214*	*4 870*	*4 460*	*4 130*	*3 871*	*3 690*	*3 320*	***3 000***
213 ft	22,045 lbs – 89 ft	lbs	22,045	22,045	22,045	21,922	18,563	17,424	15,675	14,319	12,875	12,067	11,266	10,340	9,590	8,975	8,576	**7,715**	
65.0m	*10 000 kg – 27.3m*	kg	*10 000*	*10 000*	*10 000*	*9 943*	*8 420*	*7 903*	*7 110*	*6 495*	*5 840*	*5 474*	*5 110*	*4 690*	*4 350*	*4 071*	*3 890*	***3 500***	
197 ft	26,455 lbs – 79 ft	lbs	26,455	26,455	26,132	22,897	19,445	18,253	16,424	15,033	13,514	12,688	11,861	10,882	10,097	9,469	**9,040**		
60.0m	*12 000 kg – 24.1m*	kg	*12 000*	*12 000*	*11 853*	*10 386*	*8 820*	*8 280*	*7 450*	*6 819*	*6 130*	*5 755*	*5 380*	*4 936*	*4 580*	*4 295*	***4 100***		
180 ft	26,455 lbs – 82 ft	lbs	26,455	26,455	26,455	23,944	20,305	19,061	17,174	15,712	14,154	13,274	12,412	11,402	**10,580**				
55.0m	*12 000 kg – 25.0m*	kg	*12 000*	*12 000*	*12 000*	*10 861*	*9 210*	*8 646*	*7 790*	*7 127*	*6 420*	*6 021*	*5 630*	*5 172*	***4 800***				
158 ft	26,455 lbs – 85 ft	lbs	26,455	26,455	26,455	24,987	21,219	19,932	17,957	16,435	14,815	13,904	**13,010**						
48.3m	*12 000 kg – 26.0m*	kg	*12 000*	*12 000*	*12 000*	*11 334*	*9 625*	*9 041*	*8 145*	*7 455*	*6 720*	*6 307*	***5 900***						
142 ft	26,455 lbs – 88 ft	lbs	26,455	26,455	26,455	25,979	22,068	20,737	18,695	17,124	**15,430**								
43.3m	*12 000 kg – 26.9m*	kg	*12 000*	*12 000*	*12 000*	*11 784*	*10 010*	*9 406*	*8 480*	*7 767*	***7 000***								
120 ft	26,455 lbs – 91 ft	lbs	26,455	26,455	26,455	26,455	22,906	21,522	**19,400**										
36.7m	*12 000 kg – 27.8m*	kg	*12 000*	*12 000*	*12 000*	*12 000*	*10 390*	*9 762*	***8 800***										
104 ft	26,455 lbs – 96 ft	lbs	26,455	26,455	26,455	26,455	**24,250**												
31.7m	*12 000 kg – 29.3m*	kg	*12 000*	*12 000*	*12 000*	*12 000*	***11 000***												



2.3 - Prefabrication Installation Site Logistics Plan



= Site Fence
= Lane Closure
= Heartland Hotel Footprint
= Drive Lanes
= Public Street
= Tower Crane
= Safety Area Restriction
= Hydraulic Truck Crane
= Prefabricated Link Bridge Delivery Position
= Prefabricated Link Bridge Final Position
= Crane Pick Points/Future Pier Locations
= Corner to Corner Limit

2.4 - Man-Hour and Cost Analysis

Traditional Man-Hour and Cost Analysis

Link Bridge Components				R.S. Means Data						Calculated Cost for Traditional Construction Method						
Section	Notes	Material	Amount	pg.	Labor	Unit	Material	Labor	Equipment	Hours	Hours w/Difficult Spaces	Material	Labor	Labor w/Difficult Spaces	Equipment	Total
Underneath		6" rounded recessed LED downlights	9.0	1046	0.8	ea.	$ 495.00	$ 42.50		7.20	7.20	$ 4,455.00	$ 382.50	$ 382.50	$ -	$ 4,837.50
		3-5/8" light gauge framing	527.0	357	0.017	sf	$ 0.36	$ 0.76		8.96	8.96	$ 189.72	$ 400.52	$ 400.52	$ -	$ 590.24
		5/8" ext. sheathing	527.0	212	0.012	sf	$ 0.74	$ 0.56		6.32	6.32	$ 389.98	$ 295.12	$ 295.12	$ -	$ 685.10
		vapor retarder	5.3	249	0.216	100 sf	$ 1.50	$ 9.90		1.14	1.14	$ 7.91	$ 52.17	$ 52.17	$ -	$ 60.08
		3" rigid insulation, foil faced w/joints taped	527.0	242	0.01	sf	$ 2.18	$ 0.46		5.27	5.27	$ 1,148.86	$ 242.42	$ 242.42	$ -	$ 1,391.28
		7/8" furring channels	527.0	356	0.08	sf	$ 1.29	$ 3.25		42.16	42.16	$ 679.83	$ 1,712.75	$ 1,712.75	$ -	$ 2,392.58
		building wrap/slip sheet	527.0	248	0.002	sf	$ 0.14	$ 0.09		1.05	1.05	$ 73.78	$ 47.43	$ 47.43	$ -	$ 121.21
		7/8" stucco	58.6	361	0.222	sy	$ 3.58	$ 8.90		13.00	13.00	$ 209.63	$ 521.14	$ 521.14	$ -	$ 730.77
Ceiling		Hung gab	477.0	364	0.026	sf	$ 0.43	$ 1.19		12.40	12.40	$ 205.11	$ 567.63	$ 567.63	$ -	$ 772.74
		4" circular recessed fluorescent downlights	6.0	1038	1	ea.	$ 146.00	$ 53.50		6.00	6.00	$ 876.00	$ 321.00	$ 321.00	$ -	$ 1,197.00
Roof		Ballasted EPDM	5.8	262	0.784	100 sf	$ 97.50	$ 28.00		4.56	4.56	$ 566.48	$ 162.68	$ 162.68	$ -	$ 729.16
		R-24 insulation	581.0	246	0.008	sf	$ 1.06	$ 0.30		4.65	4.65	$ 615.86	$ 174.30	$ 174.30	$ -	$ 790.16
		Vapor Retarder	5.8	249	0.216	100 sf	$ 1.50	$ 9.90		1.25	1.25	$ 8.72	$ 57.52	$ 57.52	$ -	$ 66.23
		1/2" gyp deck sheathing	581.0	213	0.014	sf	$ 0.44	$ 0.65		8.13	8.13	$ 255.64	$ 377.65	$ 377.65	$ -	$ 633.29
		Metal deck 3" 18 ga. galvanized	581.0	168	0.009	sf	$ 2.90	$ 0.46		5.23	5.23	$ 1,684.90	$ 267.26	$ 267.26	$ -	$ 1,952.16
		5/8" exterior gyp	581.0	213	0.014	sf	$ 0.44	$ 0.65		8.13	8.13	$ 255.64	$ 377.65	$ 377.65	$ -	$ 633.29
		3-5/8" metal stud framing	581.0	357	0.017	sf	$ 0.36	$ 0.76		9.88	9.88	$ 209.16	$ 441.56	$ 441.56	$ -	$ 650.72
Exterior	*All	2 Downspouts	31.0	269	0.055	lf	$ 3.06	$ 3.02		1.71	3.41	$ 94.86	$ 93.62	$ 187.24	$ -	$ 282.10
		5 windows (5, 1A)	5.0	315	2	ea.	$ 360.00	$ 102.00		10.00	10.00	$ 1,800.00	$ 510.00	$ 510.00	$ -	$ 2,310.00
		Door - 245A	1.0	288	0.941	ea.	$ 435.00	$ 43.00		0.94	0.94	$ 435.00	$ 43.00	$ 43.00	$ -	$ 478.00
		Door - 245B	1.0	292	1	ea.	$ 313.00	$ 46.00		1.00	1.00	$ 313.00	$ 46.00	$ 46.00	$ -	$ 359.00
		Door - 245C	1.0	292	1	ea.	$ 313.00	$ 46.00		1.00	1.00	$ 313.00	$ 46.00	$ 46.00	$ -	$ 359.00
		5/8" gyp sheathing	1926.0	213	0.014	sf	$ 0.44	$ 0.65		26.96	26.96	$ 847.44	$ 1,251.90	$ 1,251.90	$ -	$ 2,099.34
		4" metal stud framing	134.0	172	0.516	lf	$ 29.00	$ 23.50		69.14	69.14	$ 3,886.00	$ 3,149.00	$ 3,149.00	$ -	$ 7,035.00
		1-1/2" closed cell spray foam insulation	1926.0	246	0.006	sf	$ 0.71	$ 0.21		11.56	11.56	$ 1,367.46	$ 404.46	$ 404.46	$ -	$ 1,771.92
	*R-side	5/8" exterior sheathing	1926.0	212	0.012	sf	$ 0.74	$ 0.56		23.11	33.86	$ 1,425.24	$ 1,078.56	1580.09	$ -	$ 3,005.33
	*R-side	1-1/2" rigid insulation, foil faced w/joints taped	1926.0	242	0.008	sf	$ 1.35	$ 0.37		15.41	22.57	$ 2,600.10	$ 712.62	1043.99	$ -	$ 3,644.09
	*R-side	building wrap/slip sheet	1926.0	248	0.002	sf	$ 0.14	$ 0.09		3.85	5.64	$ 269.64	$ 173.34	253.94	$ -	$ 523.58
		Pre-fin metal panel, flat, C1	459.0	255	0.04	sf	$ 2.04	$ 1.83		18.36	18.36	$ 936.36	$ 839.97	$ 839.97	$ -	$ 1,776.33
	*All	Pre-fin metal panel, flat, C1	894.1	255	0.04	sf	$ 2.04	$ 1.83		35.76	71.53	$ 1,823.99	$ 1,636.23	$ 3,272.46	$ -	$ 5,096.46
		Pre-fin metal panel, flat, C1	123.6	255	0.04	sf	$ 2.04	$ 1.83		4.94	4.94	$ 252.17	$ 226.22	$ 226.22	$ -	$ 478.39
		Pre-fin metal panel, ribbed vertical 8"	364.0	255	0.04	sf	$ 2.04	$ 1.83		14.56	14.56	$ 742.56	$ 666.12	$ 666.12	$ -	$ 1,408.68
		Pre-fin metal panel, ribbed horizontal 4"	85.0	255	0.04	sf	$ 2.04	$ 1.83		3.40	3.40	$ 173.40	$ 155.55	$ 155.55	$ -	$ 328.95
Mechanical		12"x4" SA	56.0	755	0.102	lb.	$ 0.66	$ 5.20		5.71	5.71	$ 36.96	$ 291.20	$ 291.20	$ -	$ 328.16
		14"x8" SA duct	44.0	755	0.102	lb.	$ 0.66	$ 5.20		4.49	4.49	$ 29.04	$ 228.80	$ 228.80	$ -	$ 257.84
		24"x8" SA duct	53.0	755	0.102	lb.	$ 0.66	$ 5.20		5.41	5.41	$ 34.98	$ 275.60	$ 275.60	$ -	$ 310.58
		12/4 SA Dn	4.0	781	0.533	ea.	$ 71.50	$ 29.00		2.13	2.13	$ 286.00	$ 116.00	$ 116.00	$ -	$ 402.00
		480V, 4.0 kVA motor								0.00	0.00	$ -	$ -	$ -	$ -	$ -
Interior Finishes		Walnut stained wood base, 9" height	142.0	215	0.036	lf	$ 3.12	$ 1.67		5.11	5.11	$ 443.04	$ 237.14	$ 237.14	$ -	$ 680.18
		Carpet tile, 19"x19"	53.0	381	0.1	sy	$ 22.50	$ 4.20		5.30	5.30	$ 1,192.50	$ 222.60	$ 222.60	$ -	$ 1,415.10
		Wall vinyl	477.0		0.013	sf	$ 0.93	$ 0.50		6.20	6.20	$ 443.61	$ 238.50	$ 238.50	$ -	$ 682.11
Structure	*Half	W12x26	122.3	158	0.064	lf	$ 38.00	$ 3.19	$ 1.74	7.83	15.66	$ 4,648.92	$ 390.26	$ 780.53	$ 212.87	$ 5,642.32
	*Half	W14x38	23.3	158	0.069	lf	$ 49.50	$ 3.47	$ 1.89	1.60	3.21	$ 1,150.88	$ 80.68	$ 161.36	$ 43.94	$ 1,356.17
	*Half	HSS 6x6x3/8	6.0	155	1.037	ea.	$ 360.00	$ 52.00	$ 28.50	6.22	12.44	$ 2,160.00	$ 312.00	$ 624.00	$ 171.00	$ 2,955.00
	*Half	W10x22	72.8	158	0.093	lf	$ 32.00	$ 4.68	$ 2.55	6.77	13.55	$ 2,330.88	$ 340.89	$ 681.78	$ 185.74	$ 3,198.40
	*Half	W12x26	49.5	158	0.064	lf	$ 38.00	$ 3.19	$ 1.74	3.17	6.34	$ 1,881.00	$ 157.91	$ 315.81	$ 86.13	$ 2,282.94
	*Half	W12x35	23.3	158	0.064	lf	$ 38.00	$ 3.19	$ 1.74	1.49	2.98	$ 883.50	$ 74.17	$ 148.34	$ 40.46	$ 1,072.29
		2" 18 GA VLI composite decking	477.0	167	0.009	sf	$ 2.62	$ 0.49		4.29	4.29	$ 1,249.74	$ 233.73	$ 233.73	$ -	$ 1,483.47
		4.5" NW concrete	6.6	97	4.079	cy	$ 273.00	$ 187.00	$ 14.55	27.02	27.02	$ 1,808.63	$ 1,238.88	$ 1,238.88	$ 96.39	$ 3,143.89
Equipment		Crawler Crane	1.5			weeks	$ -	$ -	$ 3,195.00	0.00	0.00	$ -	$ -	$ -	$ 4,792.50	$ 4,792.50
									Total:	480	564	$ 47,692.10	$ 21,872.24	$ 25,871.50	$ 5,629.03	$ 79,192.64
									Difference:		84			$ 3,999.26		

Indicates that this was the initial calculation before productivity in the limited space was accounted for

* Indicates that productivity would be impacted on this amount of the material

** The labor-hours expressed in this publication are based on Avg. Installation time, using an efficiency level of approximately 60%-65%, which has been found reasonable and acceptable by many contractors.

Prefabrication Man-Hour and Cost Analysis

Link Bridge Components			R.S. Means Data						Calculated Cost						
Section	Material	Amount	pg.	Labor	Unit	Material	Labor	Equipment	Hours	Hours w/increased productivity	Material	Labor	Labor w/increased productivity	Equipment	Total
Underneath	6" rounded recessed LED downlights	9.0	1046	0.8	ea.	$ 495.00	$ 42.50		7.20	6.31	$ 4,455.00	$ 335.07	$ 293.52	$ -	$ 4,748.52
	3-5/8" light gauge framing	527.0	357	0.017	sf	$ 0.36	$ 0.76		8.96	7.85	$ 189.72	$ 400.52	$ 350.86	$ -	$ 540.58
	5/8" ext. sheathing	527.0	212	0.012	sf	$ 0.74	$ 0.56		6.32	5.54	$ 389.98	$ 295.12	$ 258.53	$ -	$ 648.51
	vapor retarder	5.3	249	0.216	100 sf	$ 1.50	$ 9.90		1.14	1.00	$ 7.91	$ 52.17	$ 45.70	$ -	$ 53.61
	3" rigid insulation, foil faced w/joints taped	527.0	242	0.01	sf	$ 2.18	$ 0.46		5.27	4.62	$ 1,148.86	$ 242.42	$ 212.36	$ -	$ 1,361.22
	7/8" furring channels	527.0	356	0.08	sf	$ 1.29	$ 3.25		42.16	36.93	$ 679.83	$ 1,712.75	$ 1,500.37	$ -	$ 2,180.20
	building wrap/slip sheet	527.0	248	0.002	sf	$ 0.14	$ 0.09		1.05	0.92	$ 73.78	$ 47.43	$ 41.55	$ -	$ 115.33
	7/8" stucco	58.6	361	0.222	sy	$ 3.58	$ 8.90		13.00	11.39	$ 209.63	$ 521.14	$ 456.52	$ -	$ 666.15
Ceiling	Hung gab	477.0	364	0.026	sf	$ 0.43	$ 1.19		12.40	10.86	$ 205.11	$ 567.63	$ 497.24	$ -	$ 702.35
	4" circular recessed fluorescent downlights	6.0	1038	1	ea.	$ 146.00	$ 53.50		6.00	5.26	$ 876.00	$ 321.00	$ 281.20	$ -	$ 1,157.20
Roof	Ballasted EPDM	5.8	262	0.784	100 sf	$ 97.50	$ 28.00		4.56	3.99	$ 566.48	$ 162.68	$ 142.51	$ -	$ 708.98
	R-24 insulation	581.0	246	0.008	sf	$ 1.06	$ 0.30		4.65	4.07	$ 615.86	$ 174.30	$ 152.69	$ -	$ 768.55
	Vapor Retarder	5.8	249	0.216	100 sf	$ 1.50	$ 9.90		1.25	1.10	$ 8.72	$ 57.52	$ 50.39	$ -	$ 59.10
	1/2" gyp deck sheathing	581.0	213	0.014	sf	$ 0.44	$ 0.65		8.13	7.13	$ 255.64	$ 377.65	$ 330.82	$ -	$ 586.46
	Metal deck 3" 18 ga. galvanized	581.0	168	0.009	sf	$ 2.90	$ 0.46		5.23	4.58	$ 1,684.90	$ 267.26	$ 234.12	$ -	$ 1,919.02
	5/8" exterior gyp	581.0	213	0.014	sf	$ 0.44	$ 0.65		8.13	7.13	$ 255.64	$ 377.65	$ 330.82	$ -	$ 586.46
	3-5/8" metal stud framing	581.0	357	0.017	sf	$ 0.36	$ 0.76		9.88	8.65	$ 209.16	$ 441.56	$ 386.81	$ -	$ 595.97
Exterior	2 Downspouts	31.0	269	0.055	lf	$ 3.06	$ 3.02		1.71	1.49	$ 94.86	$ 93.62	$ 82.01	$ -	$ 176.87
	5 windows (5, 1A)	5.0	315	2	ea.	$ 360.00	$ 102.00		10.00	8.76	$ 1,800.00	$ 510.00	$ 446.76	$ -	$ 2,246.76
	Door - 245A	1.0	288	0.941	ea.	$ 435.00	$ 43.00		0.94	0.82	$ 435.00	$ 43.00	$ 37.67	$ -	$ 472.67
	Door - 245B	1.0	292	1	ea.	$ 313.00	$ 46.00		1.00	0.88	$ 313.00	$ 46.00	$ 40.30	$ -	$ 353.30
	Door - 245C	1.0	292	1	ea.	$ 313.00	$ 46.00		1.00	0.88	$ 313.00	$ 46.00	$ 40.30	$ -	$ 353.30
	5/8" gyp sheathing	1926.0	213	0.014	sf	$ 0.44	$ 0.65		26.96	23.62	$ 847.44	$ 1,251.90	$ 1,096.66	$ -	$ 1,944.10
	4" metal stud framing	134.0	172	0.516	lf	$ 29.00	$ 23.50		69.14	60.57	$ 3,886.00	$ 3,149.00	$ 2,758.52	$ -	$ 6,644.52
	1-1/2" closed cell spray foam insulation	1926.0	246	0.006	sf	$ 0.71	$ 0.21		11.56	10.12	$ 1,367.46	$ 404.46	$ 354.31	$ -	$ 1,721.77
	5/8" exterior sheathing	1926.0	212	0.012	sf	$ 0.74	$ 0.56		23.11	20.25	$ 1,425.24	$ 1,078.56	$ 944.82	$ -	$ 2,370.06
	1-1/2" rigid insulation, foil faced w/joints taped	1926.0	242	0.008	sf	$ 1.35	$ 0.37		15.41	13.50	$ 2,600.10	$ 712.62	$ 624.26	$ -	$ 3,224.36
	building wrap/slip sheet	1926.0	248	0.002	sf	$ 0.14	$ 0.09		3.85	3.37	$ 269.64	$ 173.34	$ 151.85	$ -	$ 421.49
	Pre-fin metal panel, flat, C1	459.0	255	0.04	sf	$ 2.04	$ 1.83		18.36	16.08	$ 936.36	$ 839.97	$ 735.81	$ -	$ 1,672.17
	Pre-fin metal panel, flat, C1	894.1	255	0.04	sf	$ 2.04	$ 1.83		35.76	31.33	$ 1,823.99	$ 1,636.23	$ 1,433.34	$ -	$ 3,257.33
	Pre-fin metal panel, flat, C1	123.6	255	0.04	sf	$ 2.04	$ 1.83		4.94	4.33	$ 252.17	$ 226.22	$ 198.16	$ -	$ 450.34
	Pre-fin metal panel, ribbed vertical 8"	364.0	255	0.04	sf	$ 2.04	$ 1.83		14.56	12.75	$ 742.56	$ 666.12	$ 583.52	$ -	$ 1,326.08
	Pre-fin metal panel, ribbed horizontal 4"	85.0	255	0.04	sf	$ 2.04	$ 1.83		3.40	2.98	$ 173.40	$ 155.55	$ 136.26	$ -	$ 309.66
Mechanical	12"x4" SA	56.0	755	0.102	lb.	$ 0.66	$ 5.20		5.71	5.00	$ 36.96	$ 291.20	$ 255.09	$ -	$ 292.05
	14"x8" SA duct	44.0	755	0.102	lb.	$ 0.66	$ 5.20		4.49	3.93	$ 29.04	$ 228.80	$ 200.43	$ -	$ 229.47
	24"x8" SA duct	53.0	755	0.102	lb.	$ 0.66	$ 5.20		5.41	4.74	$ 34.98	$ 275.60	$ 241.43	$ -	$ 276.41
	12/4 SA Dn	4.0	781	0.533	ea.	$ 71.50	$ 29.00		2.13	1.87	$ 286.00	$ 116.00	$ 101.62	$ -	$ 387.62
	480V, 4.0 kVA motor								0.00	0.00	$ -	$ -	$ -	$ -	$ -
Interior Finishes	Walnut stained wood base, 9" height	142.0	215	0.036	lf	$ 3.12	$ 1.67		5.11	4.48	$ 443.04	$ 237.14	$ 207.73	$ -	$ 650.77
	Carpet tile, 19"x19"	53.0	381	0.1	sy	$ 22.50	$ 4.20		5.30	4.64	$ 1,192.50	$ 222.60	$ 195.00	$ -	$ 1,387.50
	Wall vinyl	477.0		0.013	sf	$ 0.93	$ 0.50		6.20	5.43	$ 443.61	$ 238.50	$ 208.93	$ -	$ 652.54
Structure	W12x26	122.3	158	0.064	lf	$ 38.00	$ 3.19	$ 1.74	7.83	6.86	$ 4,648.92	$ 390.26	$ 341.87	$ 212.87	$ 5,203.66
	W14x38	23.3	158	0.069	lf	$ 49.50	$ 3.47	$ 1.89	1.60	1.41	$ 1,150.88	$ 80.68	$ 70.67	$ 43.94	$ 1,265.49
	HSS 6x6x3/8	6.0	155	1.037	ea.	$ 360.00	$ 52.00	$ 28.50	6.22	5.45	$ 2,160.00	$ 312.00	$ 273.31	$ 171.00	$ 2,604.31
	W10x22	72.8	158	0.093	lf	$ 32.00	$ 4.68	$ 2.55	6.77	5.93	$ 2,330.88	$ 340.89	$ 298.62	$ 185.74	$ 2,815.24
	W12x26	49.5	158	0.064	lf	$ 38.00	$ 3.19	$ 1.74	3.17	2.78	$ 1,881.00	$ 157.91	$ 138.32	$ 86.13	$ 2,105.45
	W12x35	23.3	158	0.064	lf	$ 38.00	$ 3.19	$ 1.74	1.49	1.30	$ 883.50	$ 74.17	$ 64.97	$ 40.46	$ 988.93
	2" 18 GA VLI composite decking	477.0	167	0.009	sf	$ 2.62	$ 0.49		4.29	3.76	$ 1,249.74	$ 233.73	$ 204.75	$ -	$ 1,454.49
	4.5" NW concrete	6.6	97	4.079	cy	$ 273.00	$ 187.00	$ 14.55	27.02	23.67	$ 1,808.63	$ 1,238.88	$ 1,085.25	$ 96.39	$ 2,990.27
Additional Costs	Profit from Opening 7 days early	0.0							0.00	0.00	$ -	$ -	$ -	$ -	$ (26,782.50)
	Transportation Fee	0.0							0.00	0.00	$ -	$ -	$ -	$ -	$ 2,500.00
	Fee from Prefabricated Company	0.0							0.00	0.00	$ -	$ -	$ -	$ -	$ 2,029.42
	100 ton hydraulic truck crane	1.0			day	$ -	$ -	$ 3,400.00	0.00	0.00	$ -	$ -	$ -	$ 3,400.00	$ 3,400.00
	Temporary Pier for Bracing (W12x26)	18.0	158	0.064	lf	$ 38.00	$ 3.19	$ 1.74	1.15	1.01	$ 684.00	$ 57.42	$ 50.30	$ 31.32	$ 765.62
								Total:	481	421	$ 48,376.10	$ 21,882.23	$ 19,168.84	$ 4,267.85	$ 49,559.71

Indicates that this was the initial calculation before productivity in the limited space was accounted for

* Indicates that productivity would be impacted on this amount of the material

** The labor-hours expressed in this publication are based on Avg. Installation time, using an efficiency level of approximately 60%-65%, which has been found reasonable and acceptable by many contractors.

***Prefabrication increased by 8.8% - or multiplied labor hours by .876

Structural Lift System

3.1 - Hydraulic Cylinder Catalog

STANDARD DOUBLE ACTING TELESCOPIC CYLINDER SPECIFICATIONS

BASE END FITTING OPTIONS

CODE NO.	D.DIA.	L	T	W	MAX PIN LOAD (SEE NOTE 6 & 9)
CT-1	1.015	.75	4.50	.25	30,000 lbs
CT2	1.265	.94	5.50	.31	50,000 lbs
CT-3	1.515	1.13	6.5	.38	71,000 lbs
CT-4	2.015	1.38	8	.38	110,000 lbs
CT-5	2.515	1.75	10	.50	161,000 lbs
CT-6	3.031	2.00	123	.50	225,000 lbs

CODE NO.	D.DIA.	L	T	R	MAX PIN LOAD (SEE NOTE 6 & 9)
TG-1	1.015	1.75	1.00	1.00	30,000 lbs
TG-2	1.265	2.00	1.50	1.25	50,000 lbs
TG-3	1.515	2.25	1.75	1.50	71,000 lbs
TG-4	2.015	2.75	2.00	2.00	110,000 lbs
TG-5	2.515	3.00	2.50	2.25	161,000 lbs
TG-6	3.031	3.25	3.00	2.50	225,000 lbs

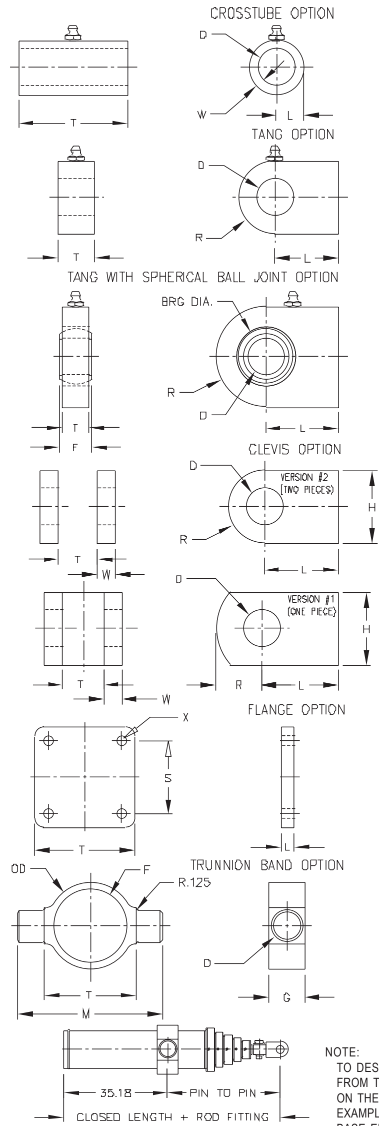
CODE NO	D DIA.	L	T	F	R	BRG. DIA.	MAX PIN LOAD (SEE NOTE 6 & 9)
BJ-1	1.00	2.00	.75	.88	1.38	1.625	30,000 lbs
BJ-2	1.25	2.50	1.00	1.09	1.88	2.000	50,000 lbs
BJ-3	1.50	3.00	1.125	1.31	2.38	2.437	71,000 lbs
BJ-4	2.00	3.50	1.50	1.75	2.88	3.187	110,000 lbs
BJ-5	2.50	4.25	1.875	2.19	3.31	3.937	161,000 lbs
BJ-6	3.00	4.50	2.250	2.63	3.75	4.751	225,000 lbs

CODE NO.	D.DIA.	L	T	W	R	H	VERSION	MAX PIN LOAD (SEE NOTE 6 & 9)
CL-1	1.015	2.38	1.13	.50	1.25	2.00	VER. 1	30,000 lbs
CL-2	1.265	2.50	1.38	.63	1.25	2.50	VER. 1	50,000 lbs
CL-3	1.515	2.75	1.63	.75	1.50	3.00	VER. 2	71,000 lbs
CL-4	2.015	3.00	2.13	1.00	2.00	4.00	VER. 2	110,000 lbs
CL-5	2.515	3.25	2.38	1.25	2.25	4.50	VER. 2	161,000 lbs
CL-6	3.031	3.50	2.63	1.50	2.50	5.00	VER. 2	225,000 lbs

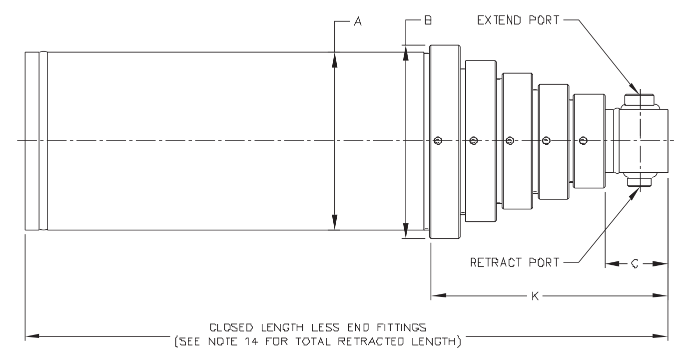
NOTE:
FLANGE OPTION TO BE WELDED DIRECTLY TO CYLINDER BASE END, IN PLACE OF THE STANDARD BUTT PLATE.

CODE NO.	X.DIA.	L	T SQ.	S SQ.	MAX PIN LOAD (SEE NOTE 6 & 9)
FL-1	.53	.75	5.50	4.00	30,000 lbs
FL-2	.66	1.00	7.00	5.25	50,000 lbs
FL-3	.78	1.25	8.00	6.00	71,000 lbs
FL-4	1.03	1.50	9.50	7.25	110,000 lbs
FL-5	1.28	1.75	11.25	8.50	161,000 lbs
FL-6	1.53	2.00	13.50	10.00	225,000 lbs

CODE NO.	MAT'L	D DIA.	G	T	M	F	0D	MAX PIN LOAD (SEE NOTE 6 & 9)
TR-1-(*)	A-36	1.75	2.00	5.00	8.00	4.00	4.75	30,000 lbs
TR-2-(*)	A-36	2.25	2.50	6.00	10.00	5.00	5.75	50,000 lbs
TR-3-(*)	A-36	2.50	3.00	7.00	11.00	6.00	6.75	71,000 lbs
TR-4-(*)	A-36	3.00	3.50	9.00	14.00	7.50	8.50	110,000 lbs
TR-5-(*)	T-1	3.00	3.50	10.50	15.50	9.00	10.00	161,000 lbs
TR-6-(*)	T-1	3.50	4.00	12.50	18.50	10.75	12.00	225,000 lbs



NOTE:
TO DESIGNATE THE TRUNNION LOCATION, ENTER THE DISTANCE, IN INCHES, FROM THE BASE END OF THE CYLINDER TO THE CENTER LINE OF THE PIN ON THE TRUNNION BAND.
EXAMPLE: TR03518 THIS TRUNNION WILL BE 35.18 INCHES FROM THE BASE END OF THE CYLINDER.



* MODEL NUMBER STEM

TO SPECIFY YOUR CYLINDER CHOOSE THE SIZES AND NUMBER OF STAGES REQUIRED, THEN ADD THE STROKE AND END FITTING OPTIONS. EXAMPLE:

PMC 72 - 0753 TG TR 03518

PORT
- PMC - NPTF PORTS
- SAE - O-RING PORTS

MODEL NUMBER
- INDENTIFIES STAGE SIZES

STROKE
- FIRST THREE DIGITS ARE INCHES
- LAST DIGIT IS 1/8'S OF AN INCH
- EXAMPLE: 0753 IS 75 3/8 INCHES

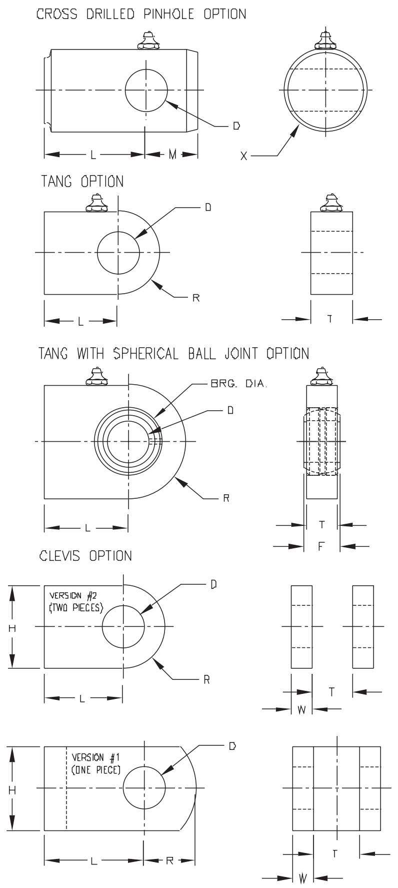
ROD END FITTING OPTION
- BL - BLANK
- PH - PINHOLE
- TG - TANG
- BJ - TANG WITH BALL JOINT
- CL - CLEVIS

BASE END FITTING OPTION
- BL - BLANK
- CT - CROSSTUBE
- TG - TANG
- BJ - TANG WITH BALL JOINT
- CL - CLEVIS
- FL - FLANGE
- TR - TRUNNION

TRUNNION LOCATION
(SEE TRUNNION OPTION TO DERIVE LOCATION)

THIS IS A 4 STAGE CYLINDER WITH 6.75 X 5.5 X 4.5 X 3.5 BORES 75 3/8 INCHES TOTAL STROKE, TANG OPTION ON ROD END TRUNNION OPTION 35.18 INCHES FROM BASE END.

ROD END FITTING OPTIONS



CODE NO.	D.DIA.	L	M	X DIA.	MAX PIN LOAD (SEE NOTE 6 & 9)
PH-1	1.015	.50	1.25	2	30,000 lbs
PH-2	1.265	.75	1.38	3	50,000 lbs
PH-3	1.515	1.25	1.50	4	71,000 lbs
PH-4	2.015	2.00	1.75	5	110,000 lbs
PH-5	2.515	2.75	2.00	6	161,000 lbs
PH-6	3.031	3.00	2.50	7.5	225,000 lbs

CODE NO.	D.DIA.	L	T	R	MAX PIN LOAD (SEE NOTE 6 & 9)
TG-1	1.015	1.75	1.00	1.00	30,000 lbs
TG-2	1.265	2.00	1.50	1.25	50,000 lbs
TG-3	1.515	2.25	1.75	1.50	71,000 lbs
TG-4	2.015	2.75	2.00	2.00	110,000 lbs
TG-5	2.515	3.00	2.50	2.25	161,000 lbs
TG-6	3.031	3.25	3.00	2.50	225,000 lbs

CODE NO.	D DIA.	L	T	F	R	BRG. DIA.	MAX PIN LOAD (SEE NOTE 6 7 9)
BJ-1	1.00	2.00	.75	.88	1.38	1.625	30,000 lbs
BJ-2	1.25	2.50	1.00	1.09	1.88	2.000	50,000 lbs
BJ-3	1.50	3.00	1.13	1.31	2.38	2.437	71,000 lbs
BJ-4	2.00	3.50	1.50	1.75	2.88	3.187	110,000 lbs
BJ-5	2.50	4.25	1.88	2.19	3.31	3.937	161,000 lbs
BJ-6	3.00	4.50	2.25	2.63	3.75	4.751	225,000 lbs

CODE NO.	D.DIA.	L	T	W	R	H	VERSION	MAX PIN LOAD (SEE NOTE 6 & 9)
CL-1	1.015	2.38	1.13	.50	1.25	2.00	VER. 1	130,000 lbs
CL-2	1.265	2.50	1.38	.63	1.25	2.50	VER. 1	50,000 lbs
CL-3	1.515	2.75	1.63	.75	1.50	3.00	VER. 2	71,000 lbs
CL-4	2.015	3.00	2.13	1.00	2.00	4.00	VER. 2	110,000 lbs
CL-5	2.515	3.25	2.38	1.25	2.25	4.50	VER. 2	161,000 lbs
CL-6	3.031	3.50	2.63	1.50	2.50	5.00	VER. 2	225,000 lbs

NOTES:
1. MAXIMUM DESIGN AND TEST PRESSURE: 3000 P.S.I.
2. NORMAL OPERATING PRESSURE: 3000 P.S.I. (EXCEPT AS NOTED IN SPECIFICATIONS)
3. PAINT INSTRUCTIONS: PRIME PER: PMS-00120
4. MOVING STAGES ARE HARD CHROME PLATED .0010 MIN.
5. MAXIMUM FLOW RATE IS BASED ON THE MAXIMUM ALLOWABLE FLOW INTO THE RETRACT PORT, LIMITED BY BACK PRESSURE ON FLOW EXITING THE EXTEND PORT.
6. PIN SIZE IS BASED ON PIN MATERIAL OF 120,000 P.S.I. MIN. TENSILE STRENGTH, RATING CAN BE INCREASED BY USING CORRESPONDINGLY STRONGER MATERIAL.
7. IF QUICK DISCONNECTS ARE USED ON THE PORTS, FAILURE TO COMPLETELY FASTEN THE DISCONNECT ON THE RETRACT PORT MAY RESULT IN INTERNAL FAILURE WHEN THE CYLINDER IS EXTENDED.
8. MAXIMUM STROKE LENGTHS ARE BASED ON A SAFETY FACTOR OF 2 TO 1 RELATIVE TO LOAD FOR LONG COLUMNS SUBJECT TO BUCKLING. CONTACT STRESS ON THE PISTON WEAR RINGS ALSO LIMITS MAXIMUM LENGTH IN SOME CASES.

NOTES:
9. MAXIMUM LOAD SHOULD NOT EXCEED THE RATING FOR THE ROD END PIN. (IN SOME CASES IT IS SMALLER THAN THE BASE END PIN. - REF: LOAD LIMITS ON END FITTINGS.)
10. MAXIMUM EXTEND LOADS ARE BASED ON MAXIMUM PIN LOADS FOR THE ROD END FITTINGS. SEE ALSO COLUMN DATA.
11. THIS PRODUCT IS DESIGNED WITH A MINIMUM FACTOR OF SAFETY OF 2:1 BASED ON THE YIELD STRENGTH OF THE MATERIALS.
12. UNLESS OTHERWISE SPECIFIED THIS PRODUCT IS DESIGNED FOR USE WITH A GOOD QUALITY PETROLEUM BASE HYDRAULIC FLUID.
13. THIS DRAWING IS THE PROPERTY OF PRINCE MFG. CORP. AND USE IN ANY MANNER DETRIMENTAL TO THE INTEREST OF PRINCE MFG. CORP. IS PROHIBITED.
14. TOTAL RETRACT EQUALS CLOSED+/- LENGTH PLUS DIMENSION +/- OF THE END BOXES FITTINGS WITH A TOLERANCE OF ? 1/8 FOR EACH STAGE.

MODEL NO.*	SPECIFICATIONS								COLUMN DATA					LARGEST STAGE		
									MAX STROKE AT OPER. P.S.I.							
2-STAGE	BORE SIZES	ROD SIZES	MAX EXTEND LOAD (SEE NOTES 6 & 10)	CLOSED LENGTH	A	B	C	K	3000	2500	2000	1500	1000	EXTEND AREA	EFFECTIVE RETRACT AREA FOR ALL STAGES	VOLUME OR AREA RATIO
PMC/SAE-51	3.5 X 2.5	3 X 2	30,000 lbs.	(STROKE ÷ 2) + 13.38	4	4.5	3.00	6.25	55 in.	61 in.	70 in.	84 in.	106 in.	9.62 SQ.IN.	1.77 SQ. IN.	3.77
PMC/SAE-52	4.5 X 3.5	4 X 3	50,000 lbs.	(STROKE ÷ 2) + 14.38	5	5.5	3.75	7.00	74 in.	83 in.	95 in.	113 in.	140 in.	15.90 SQ.IN.	2.55 SQ. IN.	4.77
PMC/SAE-53	5.5 X 4.5	5 X 4	71,000 lbs.	(STROKE ÷ 2) + 14.88	6	6.75	4.25	7.50	86 in.	98 in.	113 in.	133 in.	167 in.	23.76 SQ.IN.	3.34 SQ. IN.	5.76
PMC/SAE-54	6.75 X 5.5	6 X 5	110,000 lbs.	(STROKE ÷ 2) + 15.38	7.5	8.25	4.50	7.75	100 in.	114 in.	131 in.	154 in.	192 in.	35.79 SQ.IN.	4.12 SQ. IN.	4.77
PMC/SAE-55	8.25 X 6.75	7.5 X 6	161,000 lbs.	(STROKE ÷ 2) + 15.63	9	9.75	4.50	7.75	90 in.	132 in.	155 in.	184 in.	210 in.	53.46 SQ.IN.	7.51 SQ. IN.	5.76
PMC/SAE-56	9.75 X 8.25	9 X 7.5	225,000 lbs.	(STROKE ÷ 2) + 15.88	10.75	11.38	4.50	7.75	128 in.	168 in.	190 in.	190 in.	190 in.	74.66 SQ.IN.	9.28 SQ. IN.	6.76
									MAX STROKE AT OPER. P.S.I.							
3-STAGE	BORE SIZES	ROD SIZES	MAX EXTEND LOAD (SEE NOTES 6 & 10)	CLOSED LENGTH	A	B	C	K	3000	2500	2000	1500	1000	EXTEND AREA	EFFECTIVE RETRACT AREA FOR ALL STAGES	VOLUME OR AREA RATIO
PMC/SAE-61	4.5 X 3.5 X 2.5	4 X 3 X 2	30,000 lbs.	(STROKE ÷ 3) + 14.50	5	5.5	3.00	8.00	84 in.	93 in.	106 in.	126 in.	157 in.	15.90 SQ.IN.	1.77 SQ. IN.	4.77
PMC/SAE-62	5.5 X 4.5 X 3.5	5 X 4 X 3	50,000 lbs.	(STROKE ÷ 3) + 15.25	6	6.75	3.75	8.75	93 in.	105 in.	121 in.	143 in.	179 in.	23.76 SQ.IN.	2.55 SQ. IN.	5.76
PMC/SAE-63	6.75 X 5.5 X 4.5	6 X 5 X 4	161,000 lbs.	(STROKE ÷ 3) + 16.00	7.5	8.25	4.25	9.25	106 in.	122 in.	142 in.	167 in.	208 in.	35.79 SQ.IN.	3.34 SQ. IN.	4.77
PMC/SAE-64	8.25 X 6.75 X 5.5	7.5 X 6 X 5	110,000 lbs.	(STROKE ÷ 3) + 16.50	9	9.75	4.50	9.50	125 in.	144 in.	165 in.	195 in.	225 in.	53.46 SQ.IN.	4.12 SQ. IN.	5.76
PMC/SAE-65	9.75 X 8.25 X 6.75	9 X 7.5 X 6	161,000 lbs.	(STROKE ÷ 3) + 16.75	10.75	11.38	4.50	9.50	108 in.	165 in.	196 in.	215 in.	215 in.	74.66 SQ.IN.	7.51 SQ. IN.	6.76
									MAX STROKE AT OPER. P.S.I.							
4-STAGE	BORE SIZES	ROD SIZES	MAX EXTEND LOAD (SEE NOTES 6 & 10)	CLOSED LENGTH	A	B	C	K	3000	2500	2000	1500	1000	EXTEND AREA	EFFECTIVE RETRACT AREA FOR ALL STAGES	VOLUME OR AREA RATIO
PMC/SAE-71	5.5 X 4.5 X 3.5 X 2.5	5 X 4 X 3 X 2	30,000 lbs.	(STROKE ÷ 4) + 15.38	6	6.75	3.00	9.75	82 in.	94 in.	108 in.	130 in.	164 in.	23.76 SQ.IN.	1.77 SQ. IN.	5.76
PMC/SAE-72	6.75 X 5.5 X 4.5 X 3.5	6 X 5 X 4 X 3	50,000 lbs.	(STROKE ÷ 4) + 16.38	7.5	8.25	3.75	10.5	108 in.	123 in.	142 in.	168 in.	205 in.	35.79 SQ.IN.	2.55 SQ. IN.	4.77
PMC/SAE-73	8.25 X 6.75 X 5.5 X 4.5	7.5 X 6 X 5 X 4	71,000 lbs.	(STROKE ÷ 4) + 17.13	9	9.75	4.25	11.00	123 in.	142 in.	164 in.	194 in.	225 in.	53.46 SQ.IN.	3.34 SQ. IN.	5.76
PMC/SAE-74	9.75 X 8.25 X 6.75 X 5.5	9 X 7.5 X 6 X 5	110,000 lbs.	(STROKE ÷ 4) + 17.63	10.75	11.38	4.50	11.25	148 in.	168 in.	195 in.	225 in.	225 in.	74.66 SQ.IN.	4.12 SQ. IN.	6.76
									MAX STROKE AT OPER. P.S.I.							
5-STAGE	BORE SIZES	ROD SIZES	MAX EXTEND LOAD (SEE NOTES 6 & 10)	CLOSED LENGTH	A	B	C	K	3000	2500	2000	1500	1000	EXTEND AREA	EFFECTIVE RETRACT AREA FOR ALL STAGES	VOLUME OR AREA RATIO
PMC/SAE-81	6.75 X 5.5 X 4.5 X 3.5 X 2.5	6 X 5 X 4 X 3 X 2	30,000 lbs.	(STROKE ÷ 5) + 16.50	7.5	8.25	3.00	11.50	92 in.	104 in.	121 in.	147 in.	170 in.	35.79 SQ.IN.	1.77 SQ. IN.	4.77
PMC/SAE-82	8.25 X 6.75 X 5.5 X 4.5 X 3.5	7.5 X 6 X 5 X 4 X 3	50,000 lbs.	(STROKE ÷ 5) + 17.50	9	9.75	3.75	12.25	116 in.	138 in.	158 in.	188 in.	200 in.	53.46 SQ.IN.	2.55 SQ. IN.	5.76
PMC/SAE-83	9.75 X 8.25 X 6.75 X 5.5 X 4.5	9 X 7.5 X 6 X 5 X 4	71,000 lbs.	(STROKE ÷ 5) + 18.25	10.75	11.38	4.25	12.75	135 in.	160 in.	185 in.	220 in.	225 in.	74.66 SQ.IN.	3.34 SQ. IN.	6.76

MODEL NO.*	PORTING INFORMATION				ROD END FITTING OPTIONS (SEE NOTE 9)					BASE END FITTING OPTIONS (SEE NOTE 9)						
2-STAGE	RETRACT PORT	EXTEND PORT	MANIFOLD I.D.	MAX FLOW RATE (SEE NOTE 5)	BLANK	PH	TG	BJ	CL	BLANK	CT	TG	BJ	CL	FL	TR
PMC/SAE-51	3/8 NPTF-3/4 SAE	1/2 NPTF-7/8 SAE	.50	17 G.P.M.	BL	PH-1	TG-1	BJ-1	CL-1	BL	CT-1	TG-1	BJ-1	CL-1	FL-1	TR-1-(_)
PMC/SAE-52	3/4 NPTF-1 1/16 SAE	1 NPTF-1 5/16 SAE	.75	31 G.P.M.	BL	PH-2	TG-2	BJ-2	CL-2	BL	CT-2	TG-2	BJ-2	CL-2	FL-2	TR-2-(_)
PMC/SAE-53	1 NPTF-1 5/16 SAE	1 1/4 NPTF-1 5/8 SAE	1.25	38 G.P.M.	BL	PH-3	TG-3	BJ-3	CL-3	BL	CT-3	TG-3	BJ-2	CL-3	FL-3	TR-3-(_)
PMC/SAE-54	1 1/4 NPTF-1 5/8 SAE	1 1/2 NPTF-1 7/8 SAE	1.50	41 G.P.M.	BL	PH-4	TG-4	BJ-4	CL-4	BL	CT-4	TG-4	BJ-4	CL-4	FL-4	TR-4-( )
PMC/SAE-55	1 1/4 NPTF-1 5/8 SAE	1 1/2 NPTF-1 7/8 SAE	1.50	41 G.P.M.	BL	PH-5	TG-5	BJ-5	CL-5	BL	CT-5	TG-5	BJ-5	CL-5	FL-5	TR-5-( )
PMC/SAE-56	1/1/4 NPTF-1 5/8 SAE	1 1/2 NPTF-1 7/8 SAE	1.50	41 G.P.M	BL	PH-6	TG-6	BJ-6	CL-6	BL	CT-6	TG-6	BJ-6	CL-6	FL-6	TR-6-(_)
3-STAGE	RETRACT PORT	EXTEND PORT	MANIFOLD I.D.	MAX FLOW RATE (SEE NOTE 5)	BLANK	PH	TG	BJ	CL	BLANK	CT	TG	BJ	CL	FL	TR
PMC/SAE-61	3/8 NPTF-3/4 SAE	1/2 NPTF-7/8 SAE	.50	13 G.P.M.	BL	PH-1	TG-1	BJ-1	CL-1	BL	CT-2	TG-2	BJ-2	CL-2	FL-2	TR-2(_)
PMC/SAE-62	3/4 NPTF-1 1/6 SAE	1 NPTF-1 5/16 SAE	.75	26 G.P.M	BL	PH-2	TG-2	BJ-2	CL-2	BL	CT-3	TG-3	BJ-3	CL-3	FL-3	TR-3-(_)
PMC/SAE-63	NPTF-1 5/16 SAE	1 1/4 NPTF-1 5/8 SAE	1.25	38 G.P.M	BL	PH-3	TG-3	BJ-3	CL-3	BL	CT-4	TG-4	BJ-4	CL-4	FL-4	TR-4-(_)
PMC/SAE-64	1 1/4 NPTF-1 5/8 SAE	1 1/2 NPTF-1 7/8 SAE	1.50	41 G.P.M.	BL	PH-4	TG-4	BJ-4	CL-4	BL	CT-5	TG-5	BJ-5	CL-5	FL-5	TR-5-(_)
PMC/SAE-65	1 1/4 NPTF-1 5/8 SAE	1 1/2 NPTF-1 7/8 SAE	1.50	41 G.P.M.	BL	PH-5	TG-5	BJ-5	CL-5	BL	CT-6	TG-6	BJ-6	CL-6	FL-6	TR-6-(_)
4-STAGE	RETRACT PORT	EXTEND PORT	MANIFOLD I.D.	MAX FLOW RATE (SEE NOTE 5)	BLANK	PH	TG	BJ	CL	BLANK	CT	TG	BJ	CL	FL	TR
PMC/SAE-71	3/8 NPTF-3/4 SAE	1/2 NPTF-7/8 SAE	.50	13 G.P.M.	BL	PH-1	TG-1	BJ-1	CL-1	BL	CT-3	TG-3	BJ-3	CL-3	FL-3	TR-3(_)
PMC/SAE-72	3/4 NPTF-1 1/16 SAE	1 NPTF-1 5/16 SAE	.75	31 G.P.M.	BL	PH-2	TG-2	BJ-2	CL-2	BL	CT-4	TG-4	BJ-4	CL-4	FL-4	TR-4-( )
PMC/SAE-73	1 NPTF-1 5/16 SAE	1 1/4 NPTF-1 5/8 SAE	1.25	38 G.P.M.	BL	PH-3	TG-3	BJ-3	CL-3	BL	CT-5	TG-5	BJ-5	CL-5	FL-5	TR-5-(_)
PMC/SAE-74	1 1/4 NPTF-1 5/8 SAE	1 1/2 NPTF-1 7/8 SAE	1.50	41 G.P.M.	BL	PH-4	TG-4	BJ-4	CL-4	BL	CT-6	TG-6	BJ-6	CL-6	FL-6	TR-6-( )
5-STAGE	RETRACT PORT	EXTEND PORT	MANIFOLD I.D.	MAX FLOW RATE (SEE NOTE 5)	BLANK	PH	TG	BJ	CL	BLANK	CT	TG	BJ	CL	FL	TR
PMC/SAE-81	3/8 NPTF-3/4 SAE	1/2 NPTF-7/8 SAE	.50	13 G.P.M.	BL	PH-1	TG-1	BJ-1	CL-1	BL	CT-4	TG-4	BJ-4	CL-4	FL-4	TR-4-(_)
PMC/SAE-82	3/4 NPTF-1 1/16 SAE	1 NPTF-1 5/16 SAE	.75	26 G.P.M.	BL	PH-2	TG-2	BJ-2	CL-2	BL	CT-5	TG-5	BJ-5	CL-5	FL-5	TR-5-( )
PMC/SAE-83	1 NPTF-1 5/16 SAE	1 1/4 NPTF-1 5/8 SAE	1.25	33 G.P.M.	BL	PH-3	TG-3	BJ-3	CL-3	BL	CT-6	TG-6	BJ-6	CL-6	FL-6	TR-6-(_)

CATC 28-10-11-01

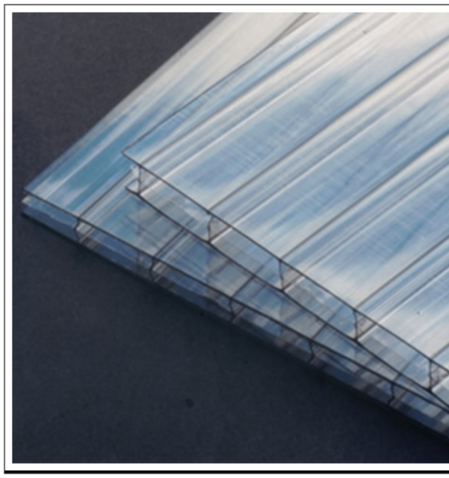
SEE PAGE 8, 9 & 10 OF THE STANDARD PRODUCT PRICE LIST FOR PRICING

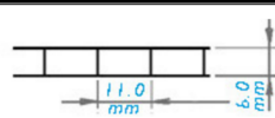
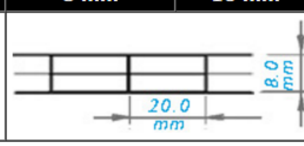
PRINCE MANUFACTURING CORPORATION/WORLD HEADQUARTERS • P.O. BOX 7000 • NORTH SIOUX CITY, SOUTH DAKOTA 57049-7000
URL: www.princehyd.com • E-MAIL: prince@princehyd.com
O.E.M. CUSTOMER SERVICE: (605) 235-1220 • FAX (712) 233-2181 DISTRIBUTOR CUSTOMER SERVICE: PHONE (605) 235-1220 • FAX (712) 233-2181

3.2 - Polygal Triple Clear 8mm Specifications

Triple Clear - 6, 8 and 10mm | Multiwall | Polycarbonate | Anti-Fog System

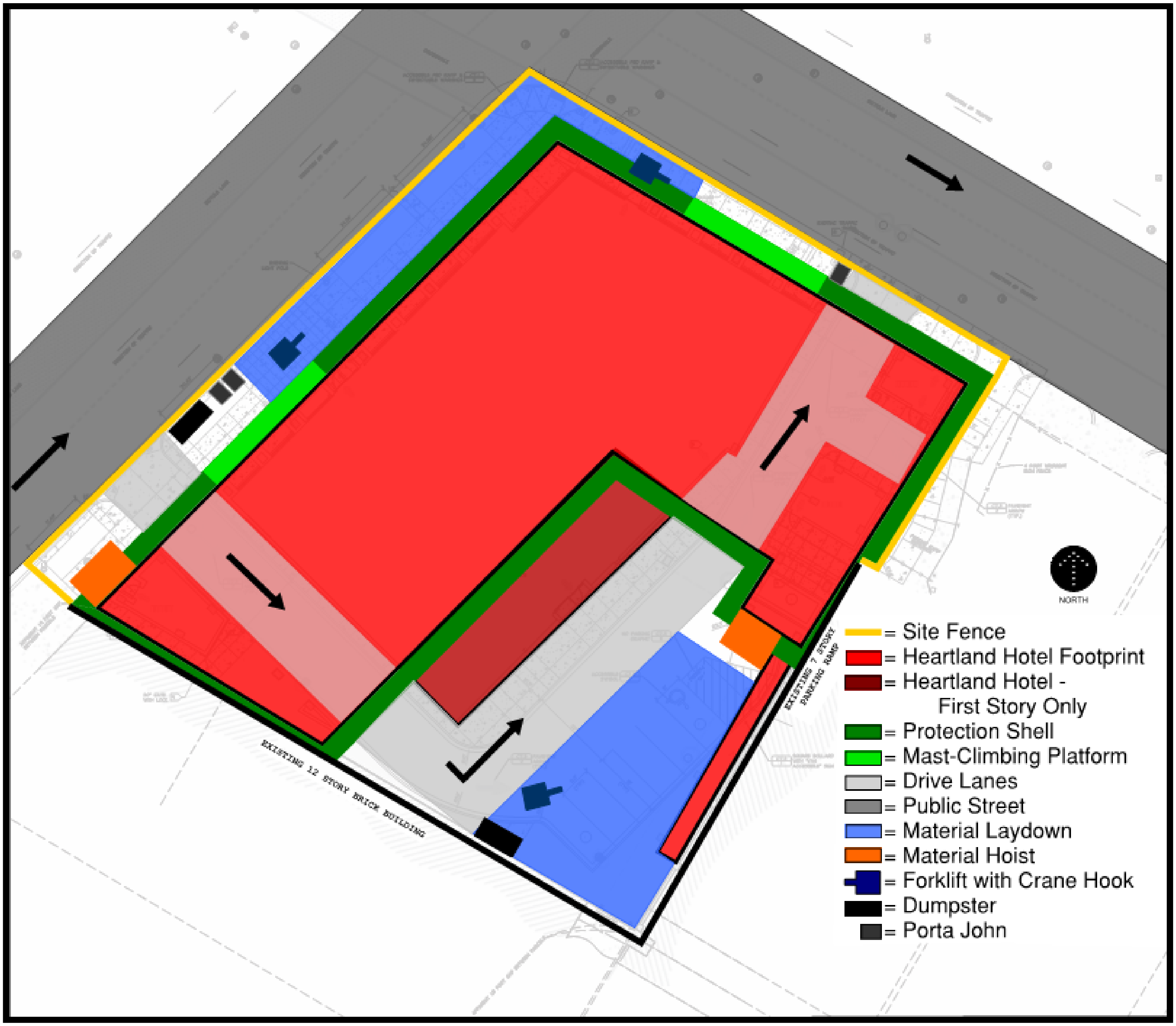
- Specially manufactured with a clear tint appearance
- Excellent thermal insulation
- Highly flexible, yet virtually unbreakable
- Anti-Fog system that prevents condensation build up, and falling droplets
- Rigid sheet structure provides extra strength under wind and snow loads
- Lightweight and easy to install
- Advanced UV-protective coating safeguards sheet transparency and mechanical properties, even with exposure to extreme weather conditions
- 10 Year warranty provided.
- Specially manufactured with a clear tint appearance



Sheet Thickness	6 mm	8 mm	10 mm
Structure			
Max. Width (mm)	2100		
Weight (g/m2)	1300	1700	2000
U-Value (W/m2 • OC)	3.6	2.85	2.6
Light Transmission, % (by ASTM-D1003)	80	77	76

3.3 - Structural Lift Site Logistics Plan

Structural Lift Site Logistics Plan

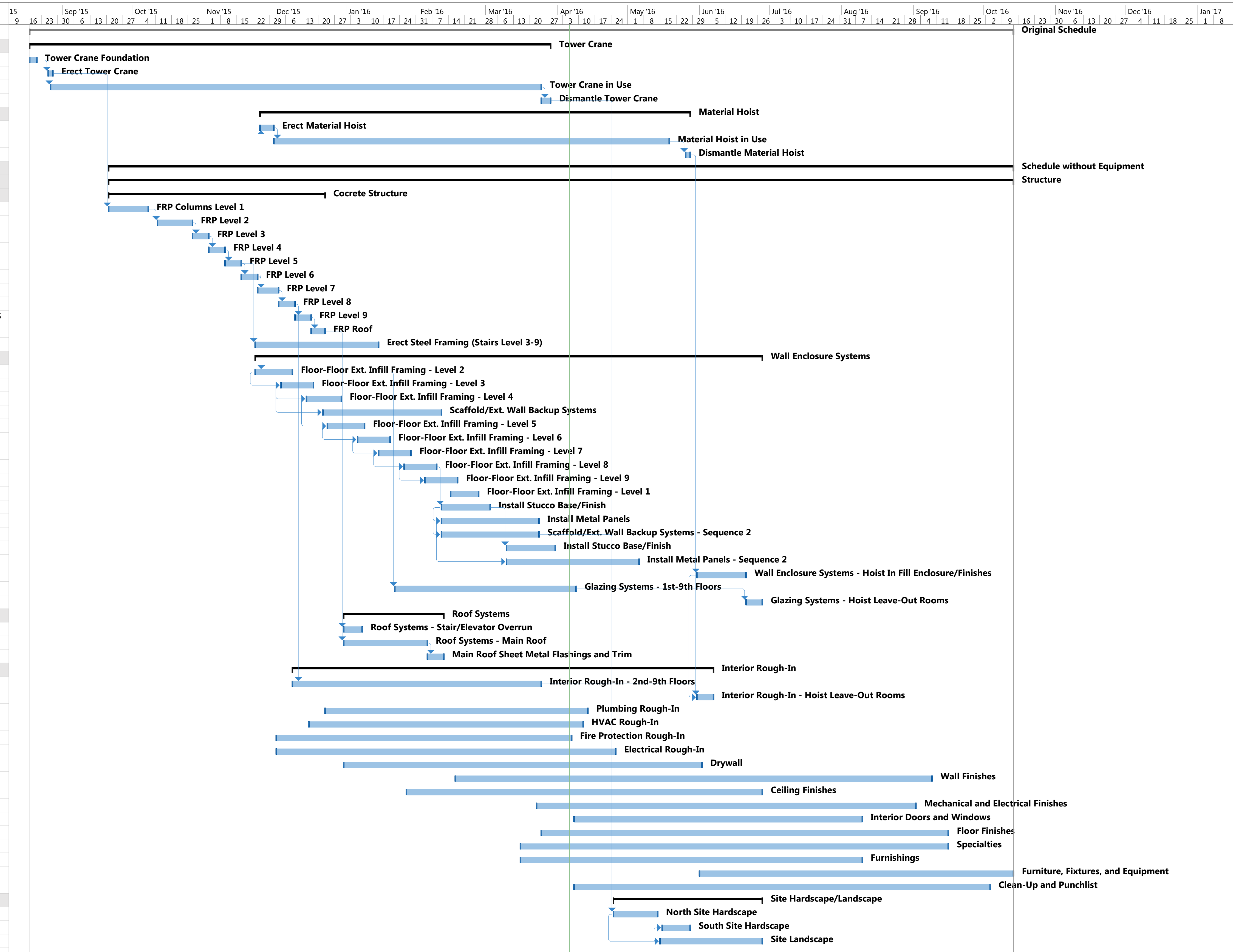


Structural Lift System

3.4 - Structural Lift Schedule Comparison

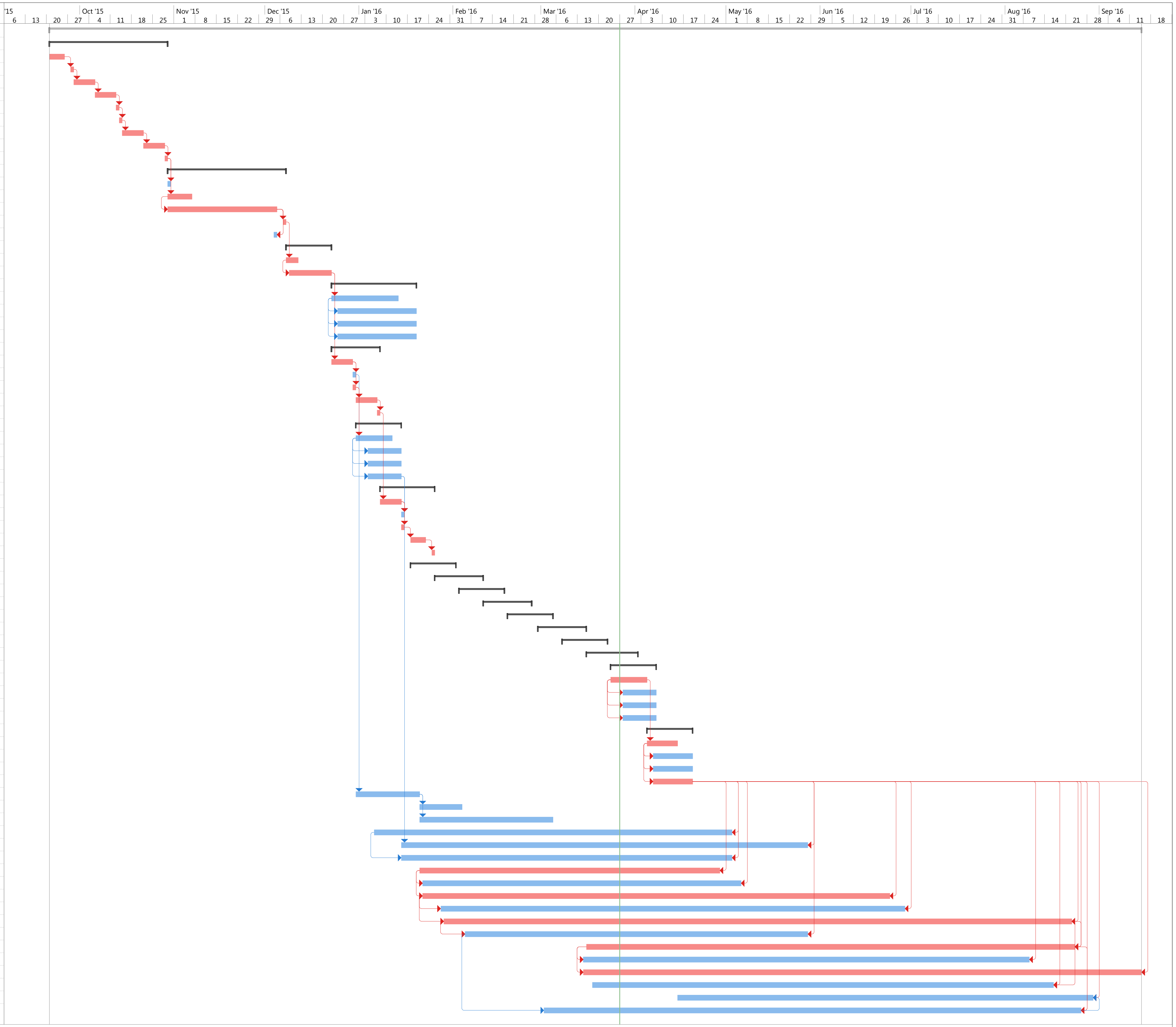
Original Schedule (Condensed)

ID	Task Name	Duration	Start	Finish
0	**Original Schedule**	**303 days?**	**Tue 8/18/15**	**Thu 10/13/16**
1	**Tower Crane**	**160 days**	**Tue 8/18/15**	**Mon 3/28/16**
2	Tower Crane Foundation	3 days	Tue 8/18/15	Thu 8/20/15
3	Erect Tower Crane	2 days	Wed 8/26/15	Thu 8/27/15
4	Tower Crane in Use	151 days	Thu 8/27/15	Thu 3/24/16
5	Dismantle Tower Crane	2 days	Fri 3/25/16	Mon 3/28/16
6	**Material Hoist**	**133 days**	**Wed 11/25/15**	**Fri 5/27/16**
7	Erect Material Hoist	4 days	Wed 11/25/15	Mon 11/30/15
8	Material Hoist in Use	122 days	Tue 12/1/15	Wed 5/18/16
9	Dismantle Material Hoist	2 days	Thu 5/26/16	Fri 5/27/16
10	**Schedule without Equipment**	**279 days?**	**Mon 9/21/15**	**Thu 10/13/16**
11	**Structure**	**279 days?**	**Mon 9/21/15**	**Thu 10/13/16**
12	**Cocrete Structure**	**67 days**	**Mon 9/21/15**	**Tue 12/22/15**
13	FRP Columns Level 1	13 days	Mon 9/21/15	Wed 10/7/15
14	FRP Level 2	11 days	Mon 10/12/15	Mon 10/26/15
15	FRP Level 3	5 days	Tue 10/27/15	Mon 11/2/15
16	FRP Level 4	5 days	Tue 11/3/15	Mon 11/9/15
17	FRP Level 5	5 days	Tue 11/10/15	Mon 11/16/15
18	FRP Level 6	5 days	Tue 11/17/15	Mon 11/23/15
19	FRP Level 7	7 days	Tue 11/24/15	Wed 12/2/15
20	FRP Level 8	5 days	Thu 12/3/15	Wed 12/9/15
21	FRP Level 9	5 days	Thu 12/10/15	Wed 12/16/15
22	FRP Roof	4 days	Thu 12/17/15	Tue 12/22/15
23	Erect Steel Framing (Stairs Level 3-9)	39 days	Mon 11/23/15	Thu 1/14/16
24	**Wall Enclosure Systems**	**156 days**	**Mon 11/23/15**	**Mon 6/27/16**
25	Floor-Floor Ext. Infill Framing - Level 2	12 days	Mon 11/23/15	Tue 12/8/15
26	Floor-Floor Ext. Infill Framing - Level 3	10 days	Fri 12/4/15	Thu 12/17/15
27	Floor-Floor Ext. Infill Framing - Level 4	11 days	Tue 12/15/15	Tue 12/29/15
28	Scaffold/Ext. Wall Backup Systems	37 days	Tue 12/22/15	Wed 2/10/16
29	Floor-Floor Ext. Infill Framing - Level 5	12 days	Thu 12/24/15	Fri 1/8/16
30	Floor-Floor Ext. Infill Framing - Level 6	10 days	Wed 1/6/16	Tue 1/19/16
31	Floor-Floor Ext. Infill Framing - Level 7	10 days	Fri 1/15/16	Thu 1/28/16
32	Floor-Floor Ext. Infill Framing - Level 8	10 days	Tue 1/26/16	Mon 2/8/16
33	Floor-Floor Ext. Infill Framing - Level 9	10 days	Thu 2/4/16	Wed 2/17/16
34	Floor-Floor Ext. Infill Framing - Level 1	10 days	Mon 2/15/16	Fri 2/26/16
35	Install Stucco Base/Finish	15 days	Thu 2/11/16	Wed 3/2/16
36	Install Metal Panels	30 days	Thu 2/11/16	Wed 3/23/16
37	Scaffold/Ext. Wall Backup Systems - Sequence 2	30 days	Thu 2/11/16	Wed 3/23/16
38	Install Stucco Base/Finish	15 days	Thu 3/10/16	Wed 3/30/16
39	Install Metal Panels - Sequence 2	41 days	Thu 3/10/16	Thu 5/5/16
40	Wall Enclosure Systems - Hoist In Fill Enclosure/Finish	15 days	Tue 5/31/16	Mon 6/20/16
41	Glazing Systems - 1st-9th Floors	56 days	Fri 1/22/16	Fri 4/8/16
42	Glazing Systems - Hoist Leave-Out Rooms	5 days	Tue 6/21/16	Mon 6/27/16
43	**Roof Systems**	**31 days**	**Thu 12/31/15**	**Thu 2/11/16**
44	Roof Systems - Stair/Elevator Overrun	6 days	Thu 12/31/15	Thu 1/7/16
45	Roof Systems - Main Roof	26 days	Thu 12/31/15	Thu 2/4/16
46	Main Roof Sheet Metal Flashings and Trim	5 days	Fri 2/5/16	Thu 2/11/16
47	**Interior Rough-In**	**129 days**	**Wed 12/9/15**	**Mon 6/6/16**
48	Interior Rough-In - 2nd-9th Floors	77 days	Wed 12/9/15	Thu 3/24/16
49	Interior Rough-In - Hoist Leave-Out Rooms	5 days	Tue 5/31/16	Mon 6/6/16
50	Plumbing Rough-In	81 days	Wed 12/23/15	Wed 4/13/16
51	HVAC Rough-In	84 days	Wed 12/16/15	Mon 4/11/16
52	Fire Protection Rough-In	91 days	Wed 12/2/15	Wed 4/6/16
53	Electrical Rough-In	104 days	Wed 12/2/15	Mon 4/25/16
54	Drywall	110 days	Thu 12/31/15	Wed 6/1/16
55	Wall Finishes	147 days	Wed 2/17/16	Thu 9/8/16
56	Ceiling Finishes	109 days	Wed 1/27/16	Mon 6/27/16
57	Mechanical and Electrical Finishes	117 days	Wed 3/23/16	Thu 9/1/16
58	Interior Doors and Windows	88 days	Fri 4/8/16	Tue 8/9/16
59	Floor Finishes	125 days	Fri 3/25/16	Thu 9/15/16
60	Specialties	132 days	Wed 3/16/16	Thu 9/15/16
61	Furnishings	105 days	Wed 3/16/16	Tue 8/9/16
62	Furniture, Fixtures, and Equipment	97 days	Wed 6/1/16	Thu 10/13/16
63	Clean-Up and Punchlist	127 days	Fri 4/8/16	Mon 10/3/16
64	**Site Hardscape/Landscape**	**46 days?**	**Mon 4/25/16**	**Mon 6/27/16**
65	North Site Hardscape	15 days	Mon 4/25/16	Fri 5/13/16
66	South Site Hardscape	10 days	Mon 5/16/16	Fri 5/27/16
67	Site Landscape	32 days	Sun 5/15/16	Mon 6/27/16
68				



Structural Lift Schedule

ID	Task Name	Duration	Start	Finish
0	**Upbrella Schedule Final v.2**	**258 days**	**Mon 9/21/15**	**Wed 9/14/16**
1	**1st, 2nd, 3rd Floor Structure - No Lift System**	**29 days**	**Mon 9/21/15**	**Thu 10/29/15**
2	Structural Slab on Grade	5 days	Mon 9/21/15	Fri 9/25/15
3	Install First Floor Columns	1 day	Mon 9/28/15	Mon 9/28/15
4	Construct 2nd Floor Framing (Joists and Girders)	5 days	Tue 9/29/15	Mon 10/5/15
5	Finalize Structure (Stairs, Elevator Framing, Rebar, Inspection)	5 days	Tue 10/6/15	Mon 10/12/15
6	Pour 2nd Floor Concrete	1 day	Tue 10/13/15	Tue 10/13/15
7	Install 2nd Floor Columns	1 day	Wed 10/14/15	Wed 10/14/15
8	Construct 3rd Floor Framing (Joists and Girders)	5 days	Thu 10/15/15	Wed 10/21/15
9	Finalize Structure (Stairs, Elevator Framing, Rebar, Inspection)	5 days	Thu 10/22/15	Wed 10/28/15
10	Pour 3rd Floor Concrete	1 day	Thu 10/29/15	Thu 10/29/15
11	**Roof**	**27 days**	**Fri 10/30/15**	**Mon 12/7/15**
12	Install Temporary Columns and Roof Attachment	1 day	Fri 10/30/15	Fri 10/30/15
13	Roof Systems - Stair/Elevator Overrun	6 days	Fri 10/30/15	Fri 11/6/15
14	Roof Systems - Main Roof	26 days	Fri 10/30/15	Fri 12/4/15
15	Main Roof Sheet Metal Flashings and Trim	1 day	Mon 12/7/15	Mon 12/7/15
16	Install Hydraulic Cylinders	1 day	Fri 12/4/15	Fri 12/4/15
17	**Shell**	**11 days**	**Tue 12/8/15**	**Tue 12/22/15**
18	Attach Aluminum Framing	4 days	Tue 12/8/15	Fri 12/11/15
19	Install Polycarbonate Panels	10 days	Wed 12/9/15	Tue 12/22/15
20	**1st and 2nd Floor Wall Enclosure Systems**	**20 days**	**Wed 12/23/15**	**Tue 1/19/16**
21	Exterior Infill Framing	16 days	Wed 12/23/15	Wed 1/13/16
22	Install Stucco	18 days	Fri 12/25/15	Tue 1/19/16
23	Install Metal Panels	18 days	Fri 12/25/15	Tue 1/19/16
24	Install Glazing Systems	18 days	Fri 12/25/15	Tue 1/19/16
25	**4th Floor Structure**	**12 days**	**Wed 12/23/15**	**Thu 1/7/16**
26	Construct 4th Floor Framing (Joists and Girders)	5 days	Wed 12/23/15	Tue 12/29/15
27	Lift and Install Columns	1 day	Wed 12/30/15	Wed 12/30/15
28	Lower System onto Columns	1 day	Wed 12/30/15	Wed 12/30/15
29	Finalize Structure (Stairs, Elevator Framing, Rebar, Inspection)	5 days	Thu 12/31/15	Wed 1/6/16
30	Pour 4th Floor Concrete	1 day	Thu 1/7/16	Thu 1/7/16
31	**3rd Floor Wall Enclosure Systems**	**11 days**	**Thu 12/31/15**	**Thu 1/14/16**
32	Exterior Infill Framing	8 days	Thu 12/31/15	Mon 1/11/16
33	Install Stucco	9 days	Mon 1/4/16	Thu 1/14/16
34	Install Metal Panels	9 days	Mon 1/4/16	Thu 1/14/16
35	Install Glazing Systems	9 days	Mon 1/4/16	Thu 1/14/16
36	**5th Floor Structure**	**12 days**	**Fri 1/8/16**	**Mon 1/25/16**
37	Construct 5th Floor Framing (Joists and Girders)	5 days	Fri 1/8/16	Thu 1/14/16
38	Lift and Install Columns	1 day	Fri 1/15/16	Fri 1/15/16
39	Lower System onto Columns	1 day	Fri 1/15/16	Fri 1/15/16
40	Finalize Structure (Stairs, Elevator Framing, Rebar, Inspection)	5 days	Mon 1/18/16	Fri 1/22/16
41	Pour 5th Floor Concrete	1 day	Mon 1/25/16	Mon 1/25/16
42	**4th Floor Wall Enclosure Systems**	**11 days**	**Mon 1/18/16**	**Mon 2/1/16**
47	**6th Floor Structure**	**12 days**	**Tue 1/26/16**	**Wed 2/10/16**
53	**5th Floor Wall Enclosure Systems**	**11 days**	**Wed 2/3/16**	**Wed 2/17/16**
58	**7th Floor Structure**	**12 days**	**Thu 2/11/16**	**Fri 2/26/16**
64	**6th Floor Wall Enclosure Systems**	**11 days**	**Fri 2/19/16**	**Fri 3/4/16**
69	**8th Floor Structure**	**12 days**	**Mon 2/29/16**	**Tue 3/15/16**
75	**7th Floor Wall Enclosure Systems**	**11 days**	**Tue 3/8/16**	**Tue 3/22/16**
80	**9th Floor Structure**	**13 days**	**Wed 3/16/16**	**Fri 4/1/16**
87	**8th Floor Wall Enclosure Systems**	**11 days**	**Thu 3/24/16**	**Thu 4/7/16**
88	Exterior Infill Framing	8 days	Thu 3/24/16	Mon 4/4/16
89	Install Stucco	9 days	Mon 3/28/16	Thu 4/7/16
90	Install Metal Panels	9 days	Mon 3/28/16	Thu 4/7/16
91	Install Glazing Systems	9 days	Mon 3/28/16	Thu 4/7/16
92	**9th Floor Wall Enclosure Systems**	**11 days**	**Tue 4/5/16**	**Tue 4/19/16**
93	Exterior Infill Framing	8 days	Tue 4/5/16	Thu 4/14/16
94	Install Stucco	9 days	Thu 4/7/16	Tue 4/19/16
95	Install Metal Panels	9 days	Thu 4/7/16	Tue 4/19/16
96	Install Glazing Systems	9 days	Thu 4/7/16	Tue 4/19/16
97	North Site Hardscape	15 days	Thu 12/31/15	Wed 1/20/16
98	South Site Hardscape	10 days	Thu 1/21/16	Wed 2/3/16
99	Site Landscape	32 days	Thu 1/21/16	Fri 3/4/16
100	Fire Protection Rough-In	84 days	Wed 1/6/16	Mon 5/2/16
101	Electrical Rough-In	96 days	Fri 1/15/16	Fri 5/27/16
102	HVAC Rough-In	77 days	Fri 1/15/16	Mon 5/2/16
103	Interior Rough-In	71 days	Thu 1/21/16	Thu 4/28/16
104	Plumbing Rough-In	75 days	Fri 1/22/16	Thu 5/5/16
105	Drywall	110 days	Fri 1/22/16	Thu 6/23/16
106	Ceiling Finishes	109 days	Thu 1/28/16	Tue 6/28/16
107	Wall Finishes	147 days	Fri 1/29/16	Mon 8/22/16
108	Interior Doors and Windows	81 days	Fri 2/5/16	Fri 5/27/16
109	Floor Finishes	115 days	Wed 3/16/16	Tue 8/23/16
110	Furnishings	105 days	Tue 3/15/16	Mon 8/8/16
111	Specialties	132 days	Tue 3/15/16	Wed 9/14/16
112	Mechanical and Electrical Finishes	108 days	Fri 3/18/16	Tue 8/16/16
113	Furniture, Fixtures, and Equipment	97 days	Fri 4/15/16	Mon 8/29/16
114	Clean-Up and Punchlist	127 days	Wed 3/2/16	Thu 8/25/16



3.5 - Cost Analysis

	Category	Material	Description	Amount	Floor Multiplier	Unit	R.S. Means page	Labor-Hour	Material	Labor	Equipment	Total	Areas Totaled	Man-Hours
Structural Uplift System (Proposed Method)	Construction Enclosure System	Polycarbonate Panels	Walls and ceiling	17079.0	1	sf		0.107	$ 1.26	$ 5.64		$ 117,722.13	$ 224,233.26	1,827.45
		7' Aluminum with plywood planks	Floor	88.6	1	ea.		0.33	$ 115.69	$ -		$ 10,250.13		29.24
		Steel Columns (W10x33)		2310.0	1	lf	310	0.093	$ 32.19	$ 5.61	$ 2.78	$ 93,747.47		214.83
		Guardrails	Portable metal with base pads	624.0	1	lf		0.027	$ 2.57	$ 1.46		$ 2,513.52		16.85
	Heating System	Heaters	136 days of heat	4.5	1	month		0	$ -	$ -	$ 1,300.00	$ 5,893.33	$ 19,592.80	-
		Propane for Heaters	8.25 GPH at 81%	7270.6	1	Gallons		0	$ 1.88	$ -	$ -	$ 13,699.47		-
	Structure	1.5VL20 decking	22 ga., 2" galvanized	14596.0	8	sf	168	0.009	$ 2.46	$ 0.55		$ 352,200.31	$ 1,834,730.94	1,050.91
		Concrete topping (3.25")	Lightweight	14596.0	8	sf	97	0.022	$ 1.25	$ 1.06	$ 0.27	$ 300,392.69		2,568.90
		WWF (6x6, W1.4xW1.4)		146.0	8	csf	95	0.457	$ 14.59	$ 27.58		$ 49,234.06		533.63
		Joists (W12x16)		1793.0	8	lf	158	0.064	$ 23.64	$ 3.82	$ 1.74	$ 418,928.14		918.02
		Girders (W14x30)		965.0	8	lf	158	0.062	$ 43.76	$ 3.74	$ 1.70	$ 379,838.51		478.64
		Columns (W10x33 - roof)		517.0	1	lf	158	0.093	$ 32.19	$ 5.61	$ 2.78	$ 20,981.58		48.08
		Columns (W10x49 - all other levels)		485.7	8	lf	158	0.102	$ 71.93	$ 6.11	$ 2.55	$ 313,155.66		396.33
	Equipment	Double Girder Bridge Crane	2 Girder, 50' span, 3 ton	2.0	1	ea.	1200	72	$ 46,753.00	$ 4,766.03	$ 355.00	$ 103,748.05	$ 264,680.39	144.00
		Hydraulic Cylinders		7.0	1	ea.		0	$ 12,492.01	$ -		$ 87,444.04		-
		Material Hoist	2 for 5 months	10.0	1	month	1335	0	$ 2,892.25	$ -	$ -	$ 28,922.50		-
		Mast-Climbing Platform	2 for 4 months, 50' wide, less than 100' tall, rent	8.0	1	mast*month	21	0	$ 3,118.60	$ -	$ -	$ 24,948.80		-
		Street Cranes	Truck mounted, 150 tons, 18' radius	10.0	1	days		0	$ 1,961.70	$ -	$ -	$ 19,617.00		-
	Façade	Additional Exterior Enclosure Installation	7' taller building w/624' perimeter; added price is a multiple of the original exterior enclosure cost	4368.0	1	sf		0.28	$ -	$ -	$ -	$ 171,937.81	$ 171,937.81	1,223.04
	Profit	Profit from Opening	Opens 1.5 months earlier	0.0	0			0	$ -	$ -	$ -	$ (170,169.00)	$ (170,169.00)	-
											Total:	$ 2,345,006.19	$ 2,345,006.19	9,449.91
Original Construction Method	Construction Enclosure System	Scaffolding Framing Erection	6-12 stories, 6'4x5	32.9	10.6	100sf	19	3.6	$ 35.21	$ 196.28		$ 80,728.53	$ 148,644.67	1,255.46
		Scaffolding planks 2"x10"x16'	Average cost of below and above 50'	241.0	10.6	ea.	20	0.333	$ 6.04	$ 18.34		$ 62,282.94		850.68
		Scaffolding Tarp	Polyethylene sheet	59.7	7	100sf	23	0.216	$ 4.00	$ 9.47		$ 5,633.20		90.29
	Heating System	Heaters	140 days of heat at 87%	4.7	1	month		0	$ -	$ -	$ 1,300.00	$ 6,066.67	$ 21,213.68	-
		Propane for Heaters	8.25 GPH at 87%	8038.8	1	Gallons		0	$ 1.88	$ -	$ -	$ 15,147.01		-
	Structure	Concrete Slab	6" elevated	14596.0	8	sf	98	0.022	$ 2.04	$ 1.06	$ 0.27	$ 393,192.89	$ 1,205,195.30	2,568.90
		PT Formwork	Multiple by number of forms - 4 uses, so 2x floor	14596.0	3	sf	76	0.086	$ 1.19	$ 4.59		$ 253,061.80		3,765.77
		PT Tendons		9075.0	8	lb.	95	0.027	$ 0.61	$ 1.63	$ 0.03	$ 165,114.18		1,960.20
		Slab Rebar	Elevated slabs, #4-#7	860.0	8	lb.	93	0.006	$ 0.50	$ 0.34	$ -	$ 5,770.39		41.28
		Column Concrete	16x16, less than 2% reinf, 9.57'	30.5	9	cy	97	0	$ 283.69	$ 677.44	$ 46.00	$ 276,818.93		-
		Column Rebar	#3-7 Column Rebar	19936.5	1	lb.		0.011	$ 0.50	$ 0.65	$ -	$ 22,936.10		219.30
		Column Rebar	#8=18 Column Rebar	95703.7	1	lb.		0.007	$ 0.50	$ 0.42	$ -	$ 88,301.01		669.93
	Equipment	Tower Crane		7.5	1	month	1334	0	$ 17,001.40	$ -	$ -	$ 127,510.50	$ 144,864.00	-
		Material Hoist	6 months	6.0	1	month	1335	0	$ 2,892.25	$ -	$ -	$ 17,353.50		-
											Total:	$ 1,519,917.64	$ 1,519,917.64	11,421.81
											Comparative Total (Proposed - Original):	$ 825,088.55	$ 825,088.55	(1,971.89)

Field Labor Experience

4.1 - Superintendent Interview Questions

Superintendent Interview Questions

General Information

1. Briefly describe your current position.
2. Please describe your educational background.
3. How many years have you been involved in the construction industry?
4. How many years have you been a Superintendent?
5. In which area of the country have you worked the longest?

Background Information

1. Why did you decide to enter the construction industry?
   a. Did you have a family member who worked in construction?
2. What did your career path look like on your way to becoming a Superintendent?
   a. If you worked in a trade, which trade did you work with and why?

Success as a Superintendent

1. Are you satisfied with your role as a Superintendent?
2. In your opinion, what are the top three most important traits of a Superintendent?
3. As a Superintendent, how did you become successful?
4. In general, how does one become a successful Superintendent?

Office vs. Field

1. As a Superintendent, what might you have been able to gain from experience performing field labor, which you wouldn't have gained from the office/trailer side of construction?
2. As a Superintendent, what might you have been able to gain from years of experience on the office/trailer side of construction, which you wouldn't have gained from field labor?
3. If a recent college graduate wants to become a Superintendent, what do you recommend they do?
4. If a recent high school graduate wants to become a Superintendent, what do you recommend they do?
5. If you had to begin your career again to become a Superintendent, would you have done anything differently?

Field Labor Experience

4.2 - Interview Transcripts

General Information

1. **Briefly describe your current position.**
    a. I am a Senior Superintendent.
2. **Please describe your educational background.**
    a. I got a Bachelor's degree in Civil and Environmental Engineering with an emphasis in Construction Management. Before that, I went into the Military when I was 18, into construction engineering, which is essentially equivalent to a tradesman. I did demolition, road building, and more. I served for ten-plus years in the military. Then I went to Wisconsin for college. I worked as a carpenter while in college. I also did surveying. I intended to be a Project Manager. I also went to Afghanistan in 2001 right after 9/11.
3. **How many years have you been involved in the construction industry?**
    a. For 32 years.
4. **How many years have you been a Superintendent?**
    a. I was a Project Engineer for five years, and then went to Afghanistan. Then after, I was a Project Manager for seven years. Then a Senior Project Manager. I've been a Superintendent for about five years now.
5. **In which area of the country have you worked the longest?**
    a. While with my current company, I've worked in the Midwest. When I was with the Military, I did lots of traveling around.

Background Information

1. **Why did you decide to enter the construction industry?**
    a. It was part of a natural progression. There wasn't anything definite that I was interested in, so it was natural to go into construction for college. I was familiar with it. The Military was an extension to construction. Construction has a single mind and a set purpose, which is what I like about it. My personality also fits. I want to accomplish something tangible for society while being collaborative. Being part of a performance-based industry, you can't hide the shortcomings.
    b. Did you have a family member who worked in construction?
        i. My dad worked as a "shack" builder. But then he got to a point where he was tired of being in the field and wanted to be in management. So he did the opposite, where he came up through the trades and then went to the office **side.**
2. **What did your career path look like on your way to becoming a Superintendent?**
    a. *Answered in previous question – Military, Bachelor's degree in Civil Engineering, served in Afghanistan, Project Engineer, Project Manager, Senior Project Manager, Superintendent*
    b. If you worked in a trade, which trade did you work with and why?
        i. *Answered in previous question – worked with carpentry and surveying*

Success as a Superintendent

1. **Are you satisfied with your role as a Superintendent?**
    a. Yes, absolutely. I'm not sure I would have been satisfied in the older days of being a Superintendent because it was very traditional, limited, and there were fewer interactions with the drawings. But the role now is very challenging and satisfying. The new expectation is that the Superintendent is involved early with making decisions. This is a lot more involved than it was historically.
2. **In your opinion, what are the top three most important traits of a Superintendent?**
    a. *Answered in following question – Communication, Collaboration, Experience*
3. **As a Superintendent, how did you become successful?**
    a. Communication. You need to be able to talk with the lowest tradesman and with the architect and owners. I understand collaboration. Decisions need to be made by getting buy-in from everyone there. It's not "my way or the highway." I learned a lot in the military. You might not like some

personalities, but they're the right guys to have there. Finally, experience. The more experience you have, the better.

4. **In general, how does one become a successful Superintendent?**
    a. *Answered in previous question – Communication, Collaboration, Experience*

<u>Office vs. Field</u>

1. **As a Superintendent, what might you have been able to gain from experience performing field labor, which you wouldn't have gained from the office/trailer side of construction?**
    a. An appreciation for what it physically takes to do a productive and safe installation and scope of work. You get to understand what is actually happening when you look at a schedule because you can relate it to the field work. You can understand the detailing and necessary elements, as well as the cost associated. By performing work, you get a better understanding of capabilities of yourself and of others. In the field, it's all about production. You have a quantifiable measurement of what you're trying to accomplish. So you gain an appreciation for all of the players.
2. **As a Superintendent, what might you have been able to gain from years of experience on the office/trailer side of construction, which you wouldn't have gained from field labor?**
    a. Scheduling, estimating, how to read drawings, and how to do all that sort of work. You learn how to manage a project. You have to look at blueprints – you aren't just told what to do. Some people are ignorant when it comes to reading drawings out in the field. The office teaches you about all the players involved. You gain a better understanding of cost as well as the challenges associated with information management.
3. **If a recent college graduate wants to become a Superintendent, what do you recommend they do?**
    a. If they have relevant field experience, they need to find a company that will hire them with the intention of allowing them to be a work in progress. So field or project engineers can get an understanding of the office. If you get a degree, you need to understand the business side. So take the opportunity to be a sort of "hybrid" and work in the office for some time to get that understanding. Those opportunities don't present themselves. Take business classes, and learn how to account for money and cash flow. Tae as many project electives as possible. Everyone with an engineering degree is smart. College gets you a degree, but your education starts in the field. The role is changing into needing to understand all side of the process. So this will set you up for better success.
4. **If a recent high school graduate wants to become a Superintendent, what do you recommend they do?**
    a. Technical schools are available and your best bet because it gets to the gist. It provides hands-on experience, technical training, drafting, scheduling, and more. That sort of relevant experience is good. Otherwise, our society as a whole promotes the four-year education without thinking that it's not a one-size-fits-all. There are some good programs through trade unions that allow you to explore that path. You want hands-on experience right away, and plenty of it. You can also go into the Military to get a diverse and realistic level of experience.
5. **If you had to begin your career again to become a Superintendent, would you have done anything differently?**
    a. No I wouldn't have. I have been in the industry long enough to understand my options. It was a natural progression for me to get away from project management and into a Superintendent role. I didn't want to spend all my time doing projections, evaluations, and business development because I like to be a part of the construction project. So my first thought was "would I have gone into the Military?" At eighteen, I didn't have a clue, so I chose to get relevant experience. I had grown up, so when I went to college, I had a better experience and understanding.

General Information

1. **Briefly describe your current position.**
    a. I am Superintendent 2. Typically, it goes: Assistant Superintendent, Superintendent 1, Superintendent 2, Senior Superintendent.
2. **Please describe your educational background.**
    a. I graduated high school.
3. **How many years have you been involved in the construction industry?**
    a. 12 years, but I've been in the construction industry since I was 12 years old. But starting with union work, 12 years.
4. **How many years have you been a Superintendent?**
    a. 4 years.
5. **In which area of the country have you worked the longest?**
    a. Minnesota.

Background Information

1. **Why did you decide to enter the construction industry?**
    a. I got into it at a young age, when I was 12, with my family. Also because of money and not needing further education to get into it.
    b. **Did you have a family member who worked in construction?**
        i. Yes, my dad. He was a field operations manager for a CM firm. He came up by trade from a laborer to a Superintendent.
2. **What did your career path look like on your way to becoming a Superintendent?**
    a. I started as a laborer doing primarily concrete work. I moved up to a labor foreman, which put me in charge of placing concrete, concrete work, helping organize the jobsite, and stuff like that. Then I went to a general labor foreman – or more like the key field guy out on the job site, helping, and being the right hand of the Superintendent that I was under. From there, I became the Assistant Superintendent, which was kind of a lot of the same things, but less physical work and more involvement in the bigger picture. I was in more of a management role. Then I was a Superintendent 1 and then a Superintendent 2.
    b. **If you worked in a trade, which trade did you work with and why?**
        i. I did concrete and other things. As a general contractor, we self-perform all of our concrete structure and all of our concrete work. We were overseeing self-performed carpentry work and managing subs. I did a wide range of things, not just concrete. You get to see a job from start to finish, and that's the biggest way to learn. I got in as a laborer, so as a GC, the trades that we have are laborers, carpenters, brick layers, cement masons, and operators. Those are the five trades that we carry that we physically self-perform. Laborer is easier to get into, and was more interesting. 90% or more of Superintendents that come up through the field start as a carpenter. Especially because a lot of times, laborers don't get a wide variety and range of work that's required to learn every aspect of the job from. You need to learn how to truly build things, so like a carpenter would do. Carpenters work more with details, prints, layouts, and actually build stuff. There's more of a benefit of growing in that area as opposed to labor. It just depends on what you want to learn and what you want to do. We do our own layout, so a lot of the GC's do that – have a layout carpenter. So layout is a big thing with the buildings that we do. Layout guys always come from carpentry because they're most in tune with that type of work. Lots of Superintendents were layout guys because of the experience and knowing why and where everything is. So it's a big benefit to come up from that side.

Success as a Superintendent

1. **Are you satisfied with your role as a Superintendent?**

  a. Yes. You get a lot of say and have a big part in setting up and managing the overall project. You're a key factor in the success, or in a bad case, the failure of a job. You have a lot of control.

2. **In your opinion, what are the top three most important traits of a Superintendent?**
    a. Confidence. And experience really. Very few of our Superintendents come up from the office side. We do have a small handful that's just in their nature, from the management side. Your capability to manage and handle stress make and make the right decision are another. So overall, management, experience, and confidence, if I had to pick three.
3. **As a Superintendent, how did you become successful?**
    a. By asserting myself to all the different parts of construction. And by not just focusing on my trade that I got into. I wanted to grow. And the biggest thing was the good people that I got to work with and learn from. You pick up a little piece of how they do stuff from everybody, if you want to. The biggest factor would be the good people that I got to work with.
4. **In general, how does one become a successful Superintendent?**
    a. Obviously, by putting in a lot of hard work. You're basically always involved, day and night. It becomes part of your life – it's more than just 8 hours a day. Understanding other people's work as well helps. The GC is just a small percentage of what happens on the job. You need to be able to understand people's work. You need to be able to manage and be organized and keep control and order. You also need to be able to schedule. And you need to look ahead and make sure everything will wind up the way it's supposed to be.

<u>**Office vs. Field**</u>

1. **As a Superintendent, what might you have been able to gain from experience performing field labor, which you wouldn't have gained from the office/trailer side of construction?**
    a. The physical building. Actually having the field experience, which you cannot recreate by working in the office. You just physically can't. You also get credibility, which is a big thing when dealing with tradesmen. They need to know that you know what you're talking about. They can tell right away if you understand their type of work.
2. **As a Superintendent, what might you have been able to gain from years of experience on the office/trailer side of construction, which you wouldn't have gained from field labor**?
    a. The biggest benefit to coming up in the office initially would be that you're already working with blueprints more than a field guy is, other than a very select few field guys that work with them in depth. You have a little bit more of the "big picture" knowledge. When you start managing the subs on the first day, and as the job progresses, you're taking on new subs when others finish. So you're more likely to be on the job from start to finish and see a little bit more of the whole job, not just a portion like most subs see. You manage subs as a field engineer to some extent. You get a little more of that management, and you dig into their details and their type of work a little bit further than a field guy. There are some benefits, but overall realistically, when it comes to a field Superintendent, it is probably 90-10, where 90% come up through the field. That reflects to what you see and who Superintendents are. It used to be 100%, but things are changing. Obviously as a field guy, I favor Superintendents coming up through the trades. It takes longer because as a field engineer, you go to a project engineer, and then you either stay there or you go to an Assistant Project Manager or Superintendent route. It takes longer to get there as a field guy, and you have that much more experience. What you need to learn on the office side, you can start to learn fairly quickly when you make that transition.
3. **If a recent college graduate wants to become a Superintendent, what do you recommend they do?**
    a. Obviously start out as a field engineer, and I would suggest that you try to get into, or try to start out, managing concrete. Start out right away with the foundations and managing the earthwork contractor. Manage steel and rebar. It's huge to get a couple jobs under your belt. You really start to understand what's what, why it's there, and why it's needed. You see what's formed up, why it's poured, etc. I would say that that is a big benefit right away. Then pick up the bigger scope subs to manage throughout the rest of the project – whether that's sheetrock with the framing

as well. You basically get to learn how every piece of the building is built. You need that field experience. Getting out on the site and meeting the supers and foreman is important. Talk with them and understand how they do things. Understand why things happen. Once you understand it, it makes your job that much easier.

4. **If a recent high school graduate wants to become a Superintendent, what do you recommend they do?**
    a. Get in as a carpenter or a laborer. It's a longer path. More realistically, for most people, it is at least a 15-year deal before you're at that stage. It depends on the company and size. There are a lot of factors. I would put in more in your mind to learn your specific trade first. That's step one, and then go from there.
5. **If you had to begin your career again to become a Superintendent, would you have done anything differently?**
    a. Me personally, no. I would have gone in the same trade and done it the same way.

General Information

1. **Briefly describe your current position.**
    a. I am the General Superintendent for an advanced tech group in the Mid-Atlantic Region. I have worked on lots of data centers previously. I have enough of a "big-picture view" ability that I found I was able to look at more than one project at a time. So with working on multiple jobs, I mentor people and go around ensuring that jobs are clean, on schedule, and that the project teams are doing what is desired by the owner. You could say that I "sniff the rats out of the wood pile," or have the ability to see a problem long before it becomes irreversible. Along with that, I also hire people and am part of the leadership team. I've been doing this for about six years.
2. **Please describe your educational background.**
    a. I went to one year of a Junior College with no particular focus or specified degree in mind, but paying for school was all out of my own pocket. Then a friend of mine had heard of another program, so we both enrolled in an electrical apprenticeship school. From there I worked two-and-a-half years in a residential program and then four years in a commercial application program. Afterwards, I worked for a large company for sixteen years. Then a construction firm approached me, and I worked for them for three years – the first of which I was an assistant superintendent, and the remaining two I was a superintendent. We did everything from office buildings, to parking garages, to many more projects. But I typically focused only on the electrical side. I wasn't getting exposure to other sides of construction, so I forced myself to learn those other areas while working. Then in 2001, I heard of my current company and went to work for them. In 2005, data centers were becoming huge in the industry, so I began working those, which is great because of the amount of electrical work. I've been with this company since.
3. **How many years have you been involved in the construction industry?**
    a. *Answered in previous question – 42 years*
4. **How many years have you been a Superintendent?**
    a. *Answered in previous question – 1 year Assistant Superintendent, 17 Superintendent*
5. **In which area of the country have you worked the longest?**
    a. I have worked in the Mid-Atlantic region for 42 years.

Background Information

1. **Why did you decide to enter the construction industry?**
    a. I needed to do something. Back then I could learn the trade and make good money – which was definitely an incentive. People in that industry were making a fortune. Specifically, I chose electrical because they seemed to be a cut above most other trades. My passion was sort of carpentry, but electrical teaches you about everything.
    b. Did you have a family member who worked in construction?
        i. My dad was a carpenter. He actually began working for the telephone company, which is electrical. But he eventually started his own construction company and built custom homes. My two brothers are also in construction – they are in the millwork business.
2. **What did your career path look like on your way to becoming a Superintendent?**
    a. *Answered in previous question – Junior College, Electrical Apprenticeship, worked in electrical for a large company, Superintendent (focus on electrical), Superintendent for his current company*
    b. If you worked in a trade, which trade did you work with and why?
        i. *Answered in previous question – electrical.*

Success as a Superintendent

1. **Are you satisfied with your role as a Superintendent?**
    a. Oh yes. Not everybody can do this job. It's one of the toughest, most underpaid jobs there is. It's a very tough job. But there's not enough people doing this. But it's very satisfying and very rewarding. And repeat business is the ultimate satisfaction – when someone specifically asks for you because they know you've done a great job.

2. **In your opinion, what are the top three most important traits of a Superintendent?**
    a. Integrity, fairness, and assertiveness. If I can add one final one, it would be the ability to develop relationships.
3. **As a Superintendent, how did you become successful?**
    a. I'm driven. I have a passion to succeed, and I'm very competitive. I like challenges, and I like to be able to succeed.
4. **In general, how does one become a successful Superintendent?**
    a. You have to be comfortable communicating. You can't be intimidated. Subs can sniff out a weak leader in a heartbeat, even if they don't know they're doing it. But they want to know that they're working for someone who is leading, who understands the process, and who respects that each trade is important and needs their time. You have to be able to communicate and respect those guys. The most important thing is to have a plan. It needs to be well thought out, but you also need to get the subs' opinions and listen to them. Even if you don't choose their way, they need to know that you listened and considered what they had to say. You need confidence, not cockiness. And you need to be fair. You don't need to know everything, but you need to have a good understanding and a plan. You need to be respectful and understand that subs' work is important.

<u>Office vs. Field</u>

1. **As a Superintendent, what might you have been able to gain from experience performing field labor, which you wouldn't have gained from the office/trailer side of construction?**
    a. Exposure to the physical work. You see how things are actually going together. Instead of just looking at documents, you take the plans, submittals, RFI's, and go out and apply it. You need to be comfortable to ask questions. The field is fun. If you go the field route, you'll be so much better. You have to know stuff when you're out in the field because you have to physically do that stuff. The exposure you get is important. And the questions you ask are important.
2. **As a Superintendent, what might you have been able to gain from years of experience on the office/trailer side of construction, which you wouldn't have gained from field labor?**
    a. You get a better understanding of the financial picture. You understand where you can and can't get away from something. You get more exposure to quality control, meetings, owners, change orders, and things like that. It took me a while to learn about this, but it's called opportunity. I never cared about the money. But through the office you understand about changes and working with owners. You have more time to look at submittals and the like, and study them. You also get better exposure to training.
3. **If a recent college graduate wants to become a Superintendent, what do you recommend they do?**
    a. Let it be known! Superintendents have a different schedule. They're the first ones there in the morning and they typically lock up. So if you come in at 7am and they've been there since 5am, they're already working. So you two will be on different schedules. So make sure you're willing to get to the jobsite when the Superintendent is there. Shadow them. Assist them. Be prepared for morning meetings. Get into the problems out in the field. Plus through that, you will gain instant respect out in the field and by everyone. It's very rewarding, and you can make just as much money, if not more, as a Project Manager.
4. **If a recent high school graduate wants to become a Superintendent, what do you recommend they do?**
    a. Go into the trades. Figure out what you want to do. Work with the trades for five to six years. It's said it takes about 10,000 hours of work for the trades. Be noticeable and be involved. Go to the GC; go into the trailer and ask questions.
5. **If you had to begin your career again to become a Superintendent, would you have done anything differently?**
    a. That's a tough question because for the longest time I thought I should have done something different. But I don't think I could have scripted it any better. In my earlier years, I probably would have taken evening classes in construction management. And I would have tried to get a

couple mentors to see what they saw in me. I wished someone would have seen my ability and talent.

Follow –Up Questions

6. **How does the future look in the field?**
   a. I'm excited to find young engineers who want to do this. They are definitely going to be needed in about five to ten years. It's a good path to be on. But take your time, hone your skills, and enjoy the time spent working. Just have a good attitude.
7. **Can you tell me a little more about the timing? How long would it take someone in the field and someone with a degree in Construction Management to become a Superintendent?**
   a. Going through the trades, you need to understand the skills required. So after about five years in the program, you'll probably need eight to ten years to be a Superintendent. Going through the same time of five years in school to get a CM degree, you'll probably need around eight to ten years to be an Assistant Superintendent. So about ten to twelve years to be a Superintendent.

General Information

1. **Briefly describe your current position.**
    a. I am a business consultant. I teach very large construction companies how to plan and schedule their work while being supported by tools like BIM 360. I've been a Lean Advocate since 2000, so I encouraged the Last Planner system. This translated into production planning platforms in software like the BIM 360 plan. I was recruited last year to share my expertise.
2. **Please describe your educational background.**
    a. I went to one year of college for business. Then I left to go into a carpenter apprenticeship in Baltimore.
3. **How many years have you been involved in the construction industry?**
    a. 33 years since 1982. I started when I was 17 years old.
4. **How many years have you been a Superintendent?**
    a. I was a Superintendent for 17 years. I was a Senior Superintendent at one company, and then with another I migrated to a General Superintendent. Then I went on to be with the National Operations folks, as well as a Project Executive. I had different roles – not titles, but roles. I helped to set the course of the business for project pursuit in my region and helped win work. I also help with the Lean culture.
5. **In which area of the country have you worked the longest?**
    a. The Mid-Atlantic region. I've been on the East coast for my entire career, primarily. I did travel nationally for meetings and job visits.

Background Information

1. **Why did you decide to enter the construction industry?**
    a. To make sure that my father didn't kill me for quitting college. If I was going to not go to school, I knew I had better figure out what I was going to do. I came home very happy that I was no longer going to go to school because I was bored. Instead, I wanted to go into the trades.
    b. **Did you have a family member who worked in construction?**
        i. My uncles were union members and my dad was a union operator.
2. **What did your career path look like on your way to becoming a Superintendent?**
    a. I was in the carpentry union, then a foreman (for a short period of time), and then an Assistant Superintendent.
    b. **If you worked in a trade, which trade did you work with and why?**
        i. I took a carpenter apprenticeship in Baltimore. It interested me. I was closest with one of my five uncles, who was a manager at some level in the carpenters union. It was a huge opportunity in the early 1980s, when we were just coming out of a recession. You had to apply and be accepted then, so you had to know somebody to get a chance of getting in. It was more about immediate employment for me than it was about the trade.

Success as a Superintendent

1. **Are you satisfied with your role as a Superintendent?**
    a. Yes, I am passionate about it. There's a lot of satisfaction derived from putting people in a position to get things done. You get a strong sense of accomplishment.
2. **In your opinion, what are the top three most important traits of a Superintendent?**
    a. You need to be forceful, or willing to get out in front of people to lead them. You have to have the ability to identify road blocks or pitfalls along the way to make subtle course corrections. You have to have an ability to understand the types of people that you are dealing with. A strength is identifying resources from a people standpoint – what are they capable of and what are they not capable of? Once you do that, then you can support or buttress their deficiencies and enhance their proficiencies. You need to identify traits and characteristics of people you're leading. Stand out in front of a team and lead. You also have to have some arrogance and ego, and a strategic thought process.

3. **As a Superintendent, how did you become successful?**
    a. First, it was that I have an innate ability to remember things. I can look at drawings once, and I can remember them. My memory has been a very strong attribute. I'm unafraid of leadership and gravitated toward it. Even as a Superintendent, I didn't just want to lead projects, I wanted to lead the Superintendents. And then I wanted to lead organizations. That was my mindset. So if I could build a successful project, then I could build successful people, a successful team, etc. And I wanted to learn everything about every other trade discipline. I'm a knowledge seeker. You're the expert, so tell me how it gets done, and I'll set a plan in motion to help the team understand how each piece goes with each other piece. I am also a conscious listener.
4. **In general, how does one become a successful Superintendent?**
    a. The first thing is learning from people who know things (*see previous answer*). You need to be willing to learn. Be willing to make sure that those people feel like they're providing something important, and don't just assume that they owe it. Those people are the ones that make you successful, so make them feel like contributors. Also, be intentional in everything you do. As a young person, don't be complacent. Always strive to look and learn, and go through the drawings dozens of times. Try to understand what the design intent was. Talk to the design team about their intent. Dive deep into what the goals of the project are. Get involved with as much as you can, and talk with your Project Manager, Project Executive, Project Engineer, or whoever, about the scope, previous pitfalls, values of general conditions, etc. It is bandwidth – it's not very deep now, but it can be wide. The other part is not letting technology get in the way of common sense. Young people want to expose themselves to anything that will help them get their job done in a proficient way. But the pitfall is that 90% of everything is nothing. Make a plan for what you want to use, in terms of technology, along with "why" and what outcomes you expect. Benchmark your success. Make a log of what the current state is. Develop that log to create the history of what you were successful and unsuccessful at. History is what actually happened. But historians are us telling about what actually happened. So when we try to go back and remember, it's never going to be as it actually was. So be intentional about benchmarking so that we can go back and see what happened, and improve in the future based on that result. Function with intention. When you stretch your legs, go look at the site and check the quality of the work. We waste motion when we have opportunity. Put that motion to good use. Make everything you do intentional. The more intentional, the faster you grown and the more you understand the why's of construction.

<u>Office vs. Field</u>

1. **As a Superintendent, what might you have been able to gain from experience performing field labor, which you wouldn't have gained from the office/trailer side of construction?**
    a. A real sense of how things actually go together, or how the parts and pieces are interconnected. When there's a problem, we take it back to get to the root cause and see what potential implications are results of decisions made. You can make decisions which are in the best interest of the project.
2. **As a Superintendent, what might you have been able to gain from years of experience on the office/trailer side of construction, which you wouldn't have gained from field labor?**
    a. I don't know. I think I gained so much from that field experience. Maybe it took me a few minutes longer to get the routine of the process of documenting funds and contracting methods, and those kinds of things. I learned those as an afterthought to my learning experience. But that's not necessarily a negative thing. Maybe that contracting and cost methodology would have helped, but I'm not sure. It's the chicken or the egg. It's really about people and behavior. Structuring your behavior around contract requirements is critical. You can continue to do the same things and expect different results. You do need to know contracting methods. If I had that experience it might have been helpful, but I'm not sure if it needed to be. It was much more important to understand how things were built and how hard the trades really worked at their craft, so that I could get a sense of how to get the most out of them.
3. **If a recent college graduate wants to become a Superintendent, what do you recommend they do?**

   a. They need to apply and be intentional in how they approach potential employers. Spell that out clearly that you want to be a Superintendent. You want to develop hybrid skills, but there's always this "let's get them in; let's let them work in different areas of the business, and then 2-3 years in, we will see what they want to do" thought process. I don't believe that for some that works or helps. It may stunt your growth depending on who you are and what you want to do. If you can declare your intention earlier, you can grow much quicker. But you have to know that you want that path. If you are personally aware of yourself and you feel good about knowing what path you want to initially explore, your growth potential is much quicker.

4. **If a recent high school graduate wants to become a Superintendent, what do you recommend they do?**
   a. With the mindset of management within construction firms these days, it would be difficult to make a direct application to start in some program, because they just don't exist. I would say that the first thought I have is to get into a trade school. The second is an apprenticeship program in one of the major trades: carpentry, electrical, mechanical, and plumbing. This would give them that kind of opportunity. Though they could come through the non-union ranks, the firms tend to gravitate more towards someone who came through apprenticeships, and accredited-type trades as the next-level Superintendents. Ascend to a foreman and get yourself noticed. Make sure that the GC or CM is noticing what you've done. Document what you do and develop a history of accountability and success. The other is to learn. If you don't go to a four-year institution, you better get an ABC, ATM, LCI, or OSHA100 certification. Go certify yourself in any aspect of construction that you can pick up and accredit yourself that way.
      i. ***The answer above was based off the assumption that they decided not to go to college. The following answer does not have that assumption.***
      ii. Go to college is my first piece of advice if they want to. You definitely should go. But some people just aren't cut out for it.

5. **If you had to begin your career again to become a Superintendent, would you have done anything differently?**
   a. Back when I initially started, I wouldn't have done anything differently because I aspired to a level I didn't think I could get to. Early in my career, I wouldn't have been as Type A as I was. But everything that I did and learned created value and experience. If I was starting in 2016, I would have made many different choices. One is that I would have finished college because the industry doesn't accept anything less from a management standpoint.

4.3 - Questionnaire

Field Labor Experience Questionnaire

Superintendents are an integral part of every construction project. Many Superintendents have come from one of two backgrounds: performing field labor work or gaining knowledge and experience in an office-like setting.

This area of research is aimed to determine the benefits that field labor provides and how it impacts the role and success of a project Superintendent. Please help further this research by completing the following questionnaire. The questionnaire should take no more than 10 minutes. The results of the questionnaire will be included in Alexis Fons' Senior Architectural Engineering Thesis, as part of The Pennsylvania State University requirements.

Section 1: Background Information

What is your current position? ____

How many years have you spent in your current position? _______________

How many years have you spent in construction? _______________________

On a scale of 1-5, how satisfied are you with your current position?

Not Satisfied — *Extremely Satisfied*

1 2 3 4 5

What is the highest level of education that you have completed?

- ☐ Up to 8th grade
- ☐ Military
- ☐ Some high school, no diploma
- ☐ Some college credit, no degree
- ☐ High school graduate or the equivalent
- ☐ Associate degree
- ☐ Union/Apprenticeship
- ☐ Bachelor's degree
- ☐ Trade/Technical/Vocational training
- ☐ Other:____________________

What was your area of study/focus?___________________________________

What trade(s) did you work in?_______________________________________

Check all family members who were/are involved in the construction industry, and list their position or trade.

- ☐ Parent(s)______________________
- ☐ Spouse____________________
- ☐ Sibling(s) ______________________
- ☐ Child(ren) _________________
- ☐ Grandparent(s) _________________
- ☐ Other_____________________

Section 2: Success as a Superintendent

Please indicate which potential experiences are beneficial to becoming a Superintendent (*1=not beneficial, 5=extremely beneficial*).

	Not beneficial 1	2	3	4	*Extremely beneficial* 5
Take management classes	☐	☐	☐	☐	☐
Take leadership classes	☐	☐	☐	☐	☐
Take communication classes	☐	☐	☐	☐	☐
Take accounting classes	☐	☐	☐	☐	☐
Take estimating classes	☐	☐	☐	☐	☐
Experience in design	☐	☐	☐	☐	☐
Experience working with contract documents	☐	☐	☐	☐	☐
Experience working with drawings and specifications	☐	☐	☐	☐	☐
Experience building in a non-work environment (home improvement, hobby, volunteer, etc.)	☐	☐	☐	☐	☐
Experience working in a trade	☐	☐	☐	☐	☐

If a recent college graduate wants to become a Superintendent, please rank the options according to which would be most beneficial (*1=most beneficial, 4=least beneficial*).

_____ Work **on-site** as a Project Engineer/Field Engineer (or the equivalent)

_____ Work in the **office** (e.g. estimating, pre-construction, scheduling)

_____ Work with a specialty group (e.g. BIM, LEED, safety); please describe which group:____________________________

_____ Physically work in the field (e.g. Union, laborer, trade)

If a *recent high school graduate* wants to become a Superintendent, please rank the options according to which would be most beneficial (*1=most beneficial, 6=least beneficial*).

___ Enter the construction workforce (labor/trade)

___ Get certified/training (OSHA, ABC, or similar)

___ Join a Union/Apprenticeship Program

___ Get Trade/Technical/Vocational Training

___ Go to a college/university to get a degree in construction or a related field

___ Join the military to learn a trade/skill or become an engineer

Please mark the skill/attribute which is more important to becoming a successful Superintendent:

The Ability to Teach	☐	☐	☐	☐	☐	☐	The Ability to Learn
Verbal Communication	☐	☐	☐	☐	☐	☐	Written Communication
Field Experience	☐	☐	☐	☐	☐	☐	Office Experience
Time Management	☐	☐	☐	☐	☐	☐	People Management
Field Credibility	☐	☐	☐	☐	☐	☐	Educational Credibility
People-focus	☐	☐	☐	☐	☐	☐	Goal-focus
Leading by Example	☐	☐	☐	☐	☐	☐	Leading by Direction
Identifying Resources/Opportunities	☐	☐	☐	☐	☐	☐	Identifying Personality Traits and Abilities
Understanding People	☐	☐	☐	☐	☐	☐	Understanding Systems
The Ability to Work with a Team	☐	☐	☐	☐	☐	☐	The Ability to Work Autonomously

Section 3: Open-Ended Questions

In your opinion, what experience (e.g. field labor, project management) best prepares someone to be a Superintendent? Please explain.

In your experience, how has the Superintendent role changed over time?

If you had to begin your career again to become a Superintendent, what would you have done differently and why?

Completed questionnaires may be returned by mail or email to:

Alexis Fons
131 North Sparks Street, Apt. 2, State College, PA 16801
AlexisLFons@gmail.com

If you are willing to clarify your answers will follow-up questions, please provide your contact information here:

____

Field Labor Experience

4.4 - Open Ended Question Responses

In your opinion, what experience (e.g. field labor, project management) best prepares someone to be a Superintendent? Please explain.	In your experience, how has the Superintendent role changed over time?	If you had to begin your career again to become a Superintendent, what would you have done differently and why?
I believe that it's a mix of both physical labor and project management. You have to have the education to understand all of the designs and how to physically piece everything together but at the same time you need to be out in the field getting your hands dirty to fully understand everything. It's very difficult to understand why your schedule is not going to plan if you are behind a desk every day.	Not enough experience to answer this question.	Would have spent more time physically working with the systems/trades to fully understand how each part works. This will allow for a more in depth understanding and will allow you to better solve problems.
Field labor, better understanding of the day to day problems, needs, and expectations.	We seem to be dealing more intimately with people on a personal level. Also seems to be a lot more overall responsibility, ex. safety, time line expectations	Would have listened to my father more. He was my biggest resource of knowledge I wasted
Actual W.I.P.	This role has gone from a position of dictating on site to a position of team(s) leadership at all levels and phases of the project. The position has moved from a personal to a project/owner requirement of what is best of W.I.P. The position has moved in intellect as well - Superintendents are expected to know the "deal" and are relied upon as QC navigator	Would have found a way to enhance my clairvoyance. Not even kidding future forecasting of weather, constructability, time constraints, level of expertise and Murphy's law to name a few are key to successful Project Completion. Time - no double work; On time - meet or beat schedule; in time - meat or beat estimate.
Field. The importance of the proper sequence of work can't be overstated.	Quality of work force has diminished	Attend a local community college and taken construction management classes sooner
Field engineering (layout). Get exposure to how things are built, exposed to drawings, and get to work in the trenches.	It's more of a "cover your ass" world than it used to be. Handshake agreements no longer work. The "drill sergeant" approach no longer works, everybody is more touchy feely.	Started younger. I messed around in junior college and dead end jobs until I was around 25. I'd been better off getting in the industry right after high school.
Being able to work with people and always make the decisions that are best for the project you are working on	When I started it was all about productivity screaming and yelling. Now it is about safety and collaboration with customer experience being important. I think it has changed for the better	The Superintendent of the future will be better with computers and written communication than I was or am.
Field Experience is the most important. A superintendent has to be able to understand not only each individual component, but also how those components interface to work as a complete system. You also need to be able to relate to what it takes to physically install these items so that you can better schedule, then manage the project resources. Anyone can be book smart, however in the field experience will show that nothing works exactly as taught in books.	Understanding the new emerging software technologies now used during construction like drawing management tools (Plan Grid), scheduling tools (Primavera P6 and BIM360Plan), Virtual Mock-ups, etc. The Senior Superintendents can provide insight based on their practical work experience, while the junior superintendents can provide insight into the newer construction technology tools. Together that is a powerful team.	Take as many classes as you can on construction related technologies (Primavera P6), so that you at least have a basic understanding of their capabilities. I would also have joined a trade so that I had actual field experience so when I became a Superintendent I understood what the trades needed in order to perform their work, from the perspective of managing them.
Actually doing the work	Adopting to the different building techniques as times change	Start earlier, take more classes attributed to becoming a Super
Understanding civil and structural aspects of a project, whether able to do internships on a concrete phase project or classroom studies and then work under a veteran superintendent on a project.	Basically hasn't changes. You develop a schedule and then implement that schedule, always trying to keep progressions toward the finish date. Advances in technology also is a plus as now you can carry all the info with you in the field.	Request to be involved in the pure cm, working on scopes with the team, sharing burdens. Knowing early on - that coupled with technology has been the game changer. Also a superintendent needs to work on the budged and the contractual language.
Lots of field experience. The best superintendent's I've worked with are the ones who worked their way up through the trade, specifically carpentry.	No	Payed more attention to systems and detail. Why things are done the way they are done and how.

On the job training. Work closely with a Superintendent that is respected, pick up his best practices and learn how you can improve on his weakness. Learn people, each individual is different and be successful you need to be able to get the most out of each of these individuals.	It used to be a position you received after working your way up through a trade. Technology has moved into the field, the days of carrying paper plans into the field are behind us, all of this can now be access on a tablet in the palm of your hand.	Pay closer attention to the processes and details of how the work goes together. Being able to draw from past experiences is very helpful. At times the project is moving so fast you don't take the time to slow down and understand the process and details which doesn't allow for you to truly draw from them in the future.
Work in the field prepares you to understand issues which don't show up on paper. This gives you the experience to see problems and solutions before it actually becomes a real problem.	In this world of technology and instant gratification...nobody takes the time to plan ahead! We used to make up a material list and manpower needs weeks ahead. Now it's a phone call at 10pm the night before!	Nothing. I am very confident in my abilities and do not regret any of the choices I made to get where I am in life. More money isn't as important as being happy with what I do for a living...of course I'd like more money!
Surveying/field engineering helps the technical comprehension. Subcontractor/trade management in detail along with project management help paints the whole picture.	It has become more technology related with all of the project management and scheduling programming. You need to be able to communicate in person but also in writing.	Nothing! I have enjoyed every role and project and each one has been different and has taught me different skills and lessons
Leadership in the field	There are many more requirements for reporting, schedule, meetings, training, writing, IT knowledge, teaching	Nothing - except learned to control all of my emotions at an earlier age
Field engineering. Teaches the individual the basics of construction. Control lines, elevations, and understanding how to layout, locate, and check installed work.	From what I've heard, yes.	Nothing
Labor, carpenter, carpenter foreman, superintendent	There is a big requirement to have IT skills and communication skills	Nothing
Field experience because no job is the same and construction is always changing. The more experience you have adapting to the changing industry will make a better super		none
Any on the job experience related to problem solving	Much more technology driven	More field focused internships
It's like a recipe. You need bits or lots of different things: math skills, people skills, good communication, and collaboration.	More technically ahead and this will continue. IPads on-site, electronic documents, communication.	Might have done more MEP related courses
To have a calm temperament and the ability to work with different personalities. Work in the trade and you will be able to work through difficult situations by past experiences.	Everything now seems to have to be done with a paper trail. No one can do business by a handshake anymore.	Made sure that the company would have provided me with training.
Field labor. This provides the background and knowledge of how a project comes together in the field and how important communication is to achieving a successful outcome.	More collaborative than in the past. The days of "barking orders" and not considering different approaches and perspectives are over if a Superintendent wants to be truly successful.	If I knew I would become a Superintendent, I probably would have entered a trade and perhaps gone to college later.
I would say the field experience is more beneficial. You are seeing and living it every day.	I would say so. More attached to the field people. More involved with developing relationships. Seemed more detached from the field people back in the day.	I wouldn't do anything different. I spent 36 years in electrical trade before retiring and going to work for DPR.
Field experience will best prepare a person looking to become a superintendent as this will expose this person to responsibilities and challenges of being a "Builder"	This role has become less of a hands on constructor and more of a coordinator and manager	I would start the Superintendent track earlier in my career. I spent the first fourteen years of my career in the Industrial Field.
Field labor experience that leads to foreman position, then to assistant superintendent, then to superintendent	Need to be much more client friendly, excellent people skills, and much more use of computer software like P6 and blue beam	I would not have changed a thing regarding how I got here. I believe my carpenter experience led me to pursue architecture and engineering disciplines (B.Arch. and MCE) in college which led me to work for very large GCs
Field experience. It's hard to explain to people how to do something if you have not been in their shoes.	I think it has.	I would not change much. Try to understand all other things that it takes to build a complete building.
The best superintendents have project management experience. The best project	It has changed tremendously with technology and more superintendents now than before	I would not change anything. I have been given so many opportunities

managers have field experience. You can't beat on the job training and that experience. I believe the best preparation for younger folks is being on a project start to finish.	are college educated. Older superintendents came up through the trades! That is not as common anymore. The role has a lot more responsibility than before with financials, schedule, safety, training.	with great people teaching me that my career this far has been blessed. I would say for any person wanting this career start and be a field engineer. It is the foundation for construction that will lead you to the best career path
Performing trades work including planning, organizing and being responsible for the costs of the work and comparing costs and production rates to the estimate or baseline	The role of superintendent now includes managing and supervising the work in a manner that includes Safety and Quality as well as production and costs. This requires a complete knowledge of the trade and discipline performing the work and an ability to recognize when consultants are needed to supplement the superintendent	I would have spent more time using internal and external resources to perform the duties of the superintendent as opposed to doing all the work myself.
1. Need to get an education. 2. Utilize education and become proficient in a trade. 3. On job management and supplemental leadership	Much more administrative and technology intensive	I would have spent more effort in English class to improve written communication
Field labor experience is very valuable because it helps a super relate to the people he or she is trying to lead. It also gives them an opportunity to be a part of building something.	The superintendent has to be more involved in the budgets and selling work.	I would have liked to have worked for a surveying firm doing building layout and control for a few years.
Scheduling different activities on site because it forces someone to consider the details of the activity and what/who it is going to take to get it done	I don't have a lot of experience but I would say it comes down to the use of technology	I would have gotten more field experience while still in college
Definitely field experience. Being able to relate to the rank and file and what they do daily is critical. You can now empathize and understand what is involved in specific activities.	The entire industry has changed - dealing with subs and individuals is much different than it was 30 years ago. We need to communicate better both orally and in writing, have more patience, and understand safety requirements thoroughly.	I would have entered the carpenter program sooner and gotten a college degree afterward.
I personally think there is nothing that can compare to hands on field experience.	More technical, more digital, more time on the computer, more reports, more covering your ass, pictures, etc. The job is changing with technology some things are getting easier some require quite a bit more time behind the desk.	I would have chosen a different trade path and tried to become a Superintendent earlier than later in life than I did.
I feel that the best superintendents start as a craft worker and work their way up. This allows years of experience in the field and working hand in hand with all trades. This is the best way to understand how to physically build all aspects of the job.	Now days, things are faster paced and there are more opportunities to excel more quickly. If someone is motivated and a fast learner. There are also more supts commonly from office background for the fact that more (big picture) part of construction can sometimes be learned more quickly.	I would do things the same except I would maybe take some blue print reading classes just to help excel in the transition from field worker to superintendent.
Working in the field from bottom-up; learning as you go	More work with technical/computer. More meetings for every little thing	I would do the same.
I took the unique track of being a PE and then moving to the supt role. I would recommend this as our education leads us in this way. Being a PSU AE Alum, you can better apply the principles learned in education program. I mean this in that we can acclimate better with the office - technology, document control, finances, communication, problem solving, organization, coordination of BIM. However, once this acclimation occurs we can have a better feel for the field. This "adjustment time" helps us choose which way to go, office or field. Guys who grow and progress through the trades will more than likely be field guys, and the same for college and office people. WE are beginning to blur that line. The role I am in is doing that exactly. PE to Assist Supt. I've been an advocate for this for a while.	It has morphed into a hybrid role as I said above. It's not that carpenter who was in the trades for ten years as a foreman and supt and now a general supt for a CM/GC. I have witnessed peers of my age waned the field path more and more. It's great to witness because it was always the other way around. Skilled trade was field and college was office. The difference now is the ability to acknowledge for each role to recognize the other. A college kid may actually be suited for the field, and the personality and communication can aid and bridge the gap to the "stubborn" old ways of the past. The same goes for a field guy going into the management. Multiple peers of mine, VPs, PMs, have come from Ironworker or carpenter trades.	I would actually choose to start as the PE. Like I said it gives you great background to understand the office. It makes your educational background connect. If you were to go straight from college to the "field side" you would often feel like a fish out of water. Our educational background prepares us more so for the office. But there is always the opportunity to go the other way. In my experience, I felt having the office side prior to sorely let me engage myself better and have more understanding of the jobsite.

In order to become a superintendent you need to understand all concepts of building. Field labor is the best because you will need to understand what the workers are telling you.	The role has stayed the same.	I never planned on being a superintendent. It's not something you can really plan for. The main skills are really not teachable in a class - you need to have the ability to treat the laborer in the ditch and the wealthy owner with the same respect. The workers are what make or break a leader.
In my opinion, field labor is more prevalent because it gives you the background knowledge to know why a construction site functions the way it does. You have more of a view of what is feasible to be accomplished on site.	From what I remember, the superintendent used to have the role of the Project Manager, where he made all the decisions and set things in motion plus managed the every task on site. These days, the Superintendent is more managing the on-site task and a day to day safety coordinator.	I believe I would have gone to college and achieved a degree in Construction Management before getting into the field labor just to have the knowledge of the office side of things
Field labor - it prepares the person to learn the trade and attributes of a project.	It has gone from a working superintendent role to a managing superintendent role due to the amount of paperwork and processing that is now required	I attended Vo-Tech and vocational school after graduation. Working the carpentry trade at the same time. Went to college and worked as a field engineer out of college. I would not change anything.
I believe that a good superintendent has some field experience and understands the building process. Not to say that the office side - safety/scheduling/contract administration/etc. aren't important because they are. But having a strong understanding of the field operations is very important.	It used to be that you started in the trades i.e.: carpentry/pipe fitter/etc. and could work your way up through the ranks and eventually become a superintendent. Technology has become so critical to our daily lives that a good trade school or college education has almost become a prerequisite to being a superintendent.	I am not sure I would do anything differently. I spent summers and winters during college as a concrete laborer/finisher and assisted carpenters with from work. After graduating college I spent time as a field/office engineer. My first 15-20 years was spent in the field on numerous types of projects learning the building process/checking productivity rates/etc. I feel that the more rounded experience an individual receives it all helps with whatever path one chooses.
Learning from a current superintendent	From what I noticed less hands on work. More challenges mentally	Higher education. It is something that I didn't do the first time around.
Field labor because as a superintendent you will have the knowledge of how processes work, the work flows, communications and schedule of a project. You will see firsthand how issues arise and are solved when they are NOT shown on paper (contract drawings)	The old way was a superintendent yelling and screaming and driving the schedule down the subs throat. Now it's truly a well-planned effort INCLUDING the subs to come up with a realistic schedule AND we build the project as a TEAM	Go directly in the field and learn one or more trades and then move into management.
I appreciate this study. Working for a GC, I answer in terms of a GC super, not a sub super. Trade experience is extremely beneficial for anyone in the construction industry. However, it is limiting and it takes a long time for someone to progress up through the trade ranks, maybe 5-10 years. By then they are experts in that trade, but lack well-rounded skills. The traditional track has been through the field, making a jump from trade foreman to assistant super, gain the broader experience and then to a super. You can get to that assistant super/area super role much faster with a college degree.	With technical tools (iPads, the way we run job sites and planning meetings): supers need a new set of skills not necessary 20 years ago. Also, the complexity of buildings as systems, client expectations, leadership skills, etc. require a certain set of skills. It's not black and white - I would hate to see the super track one day require a college degree. It's about finding the right types of people and developing them into field-based leaders.	Get a degree so that at age 22-23, you can enter a company as a Field Engineer. Hone super skills as an FE, assistant, area super under strong, older, well-experienced super to learn the best from them all.
Field labor, need to understand how systems go together that aren't clearly identified on paper	Depends on the market and owner, how they want the project to be run	Finished college degree, becoming more prudent no matter what industry
Field training and/or exposure	There's a lot more documentation today vs 10 years ago. Technology is constantly changing how we do things, building, safety, documentation.	Exposed myself to a wider variety of things earlier in my career
Field labor evokes you to see firsthand the path in which to create a successful project.	Need more "people skills" than previously	Experienced all types of construction. i.e. residential, different types of

		commercial construction at an earlier stage of my career
Field	Technology	Complete business management classes
Laborer then Foreman then Superintendent. Laborer - gives you an appreciation for how difficult it is to put work in place. Foreman - gives you experience leading people and coordinating with other trades. Superintendent - brings together all innate talents and learned skills to reach the goal	The role is becoming more technologically driven. Computer and phone/tablet skills are a must have. Communication is becoming more important every day. Being able to effectively communicate in a timely manner on site and via email is critical to success.	As a new hire out of college, I would spend more time learning the fundamentals of construction in the field. I would put more effort into understanding the MEP and CSA systems as a whole. This would help understand the "whys" behind the design and this knowledge would help with decision making on site.
My opinion might be skewed because when I graduated I did not have the option. I got my degree and started working for Hensel Phelps where they put you right in the field for a few years to get experience. At the time I hated it but I now see that this experience was invaluable to my career. I am light years ahead of my peers due to my experience in the field and would do it all over again if I could.	I have only seen the industry for 7 years but I can tell that the super role is evolving to being much more technical savvy. You used to see supers that came from the field and that is all they knew. Now you have supers like myself who have a degree, who is a registered surveyor, who has been a MEP BIM coordinator, who can bring up AutoCAD in the field to pull dimensions and work out conflicts in the field	Absolutely nothing. I might be in the 1% who was in the field for years before going to the office now back out in the field. I truly believe that you need to learn how to build it before you can move up to management and sell it.
I believe working on self-performed activities such as concrete or support of excavation helps to provide the leadership and organization needed to run work and understand the challenges all subcontractors face	The work force is less skilled and there are more language barriers	1. Focused on safety earlier in my career. 2. Participated in more self-performed work
Working with an experienced superintendent, who can relate to all the various trades that are on the job	There is a great deal more preplanning and scheduling involved than there was before.	
Working in the trades for at least some period of time is best in my opinion. The field experience helps understand the "nuts and bolts" challenges. It helps gain credibility with the trades and also gives a superintendent a more fully developed understanding of field work	The role has become more "professional." The days of the crusty old builder are over. Communication skills have become more critical to engage people and get them to want to do the right thing - dictating "how it's going to be" is less important than developing consensus among the trades and owner and being able to lead a team to a goal.	
Work in the field and do physical labor	Have learned to be more experienced with computers and be tech savvy	