The Heartland Hotel

The Midwest

Alexis Fons | Construction Management

Technical Report II | 10.22.2015

Dr. Leicht

Photo courtesy of the Construction Documents and Mortenson Construction.

TABLE OF CONTENTS

Executive Summary 2

Production Plan 3

Production Analysis 7

Field Supervisor Interview 9

Appendix A – Overall Project Schedule 10

Appendix B – Site Logistics Plans 11

Appendix C – Superintendent Interview Transcript – Scott Amundson 15

EXECUTIVE SUMMARY

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 14 months. The hotel will be completed in a "turnkey" fashion, where everything, including operating, supplies, and equipment, will be delivered and sold to Heartland Hotel.

The building consists of nine stories, nine of which are post-tensioned 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, 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. The turnover date is not of great importance because there is a 3-month float between handoff and hotel opening day. 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.

The system analyzed in this Technical Report II is the Post-Tensioned (PT) concrete slab and prefabricated column reinforcing. Specifically, the second floor through the roof are examined for the construction methodology, production schedule, cost, and logistics. An analysis is then performed in each of these areas, and the Superintendent on site is interviewed for input and feedback on the chosen system.

The construction methods for this system is a five-day cycle per floor. Within the five days, the forms will be set, stud rails, embeds, rebar, MEP sleeves, and PT cables will be installed, the deck and columns will be poured (with the prefabricated column reinforcing delivered to site the day it is installed), and the PT cables will be stressed. This cycle, while demanding, allows the enclosure construction to begin as soon as possible. Five main subcontractors will be on-site performing this work weekly to ensure that each deck is finalized before the concrete is placed and stressed. A key component to this construction method is communication. Mortenson has coordinated through virtual design with the MEP and architectural layouts to ensure quick installation. Additionally, a phased schedule for all trades has been developed to coordinate trade responsibilities and handoffs. This type of cyclical PT slab process has been completed by Mortenson before, so they have experience to ensure that the construction goes smoothly. Both the Superintendent and I believe that this method of construction is efficient and effective.

Key equipment necessary for this system are a tower crane, concrete pump, and tendon stressors. If any one of these pieces of equipment breaks down, the entire project will come to a halt. Therefore, Mortenson has made arrangements to have three tendon stressors on-site for backup, and has performed tests to ensure that the concrete pump and tower crane do not interfere with one another.

Because of the tight site and requirement for on-time delivery, strict site regulation and plans have been put in place. Limitations due to neighboring buildings and city restrictions do not allow for much movement outside of the site. Key workflow changes will occur when the first floor slab-on-grade is cleared of shoring (once the fifth level slab is poured). This will allow for additional storage space on-site. Suggestions for improvement and an increase in material storage space can be found in the *Logistical Analysis* section.

The cost estimate obtained through the extrapolation of a detailed cost analysis of a smaller portion of the building resulted in a total of $2.2M for this system. While this is under the project team's budget, exclusions of the first floor and steel, as well as assumptions made and program limitations lead to this reasonable result.

The site Superintendent was interviewed regarding schedule acceleration scenarios and constructability and logistical challenges. While he was able to provide potential minor improvements, his feedback suggested that the current system in place has been Value Engineered to provide the most economical and fastest method of construction and design.

PRODUCTION PLAN

The critically engineered system chosen for the following Technical Report II was the post-tensioned (PT) slabs and concrete columns with prefabricated reinforcing. The Heartland Hotel consists of nine stories composed of mainly PT concrete. The first level is a slab-on-grade and therefore is not included in this report. All other levels (2-roof) have PT slabs. Because this system is a critical component to the overall building, the means and methods, schedule, cost, and logistics have been developed and are detailed below. Images detailing the areas analyzed can be found in Figures 1 and 2.

Figure 1: PT slab and columns analyzed in this technical report (A4.1 – Building Sections)

System Construction Means and Methods

Construction for this system will complete an entire floor before moving on to the next. In order to decrease schedule time for this structure, each floor will be finished within five working days. The reinforcing for the columns will be prefabricated off-site and delivered to the site on the day it is needed. A three-level shoring system will support the system until the concrete cures to the appropriate strength. 8,000psi concrete will be utilized for both the columns and the slab. Although the construction specifications only call for a 6,000psi concrete slab, the construction team has decided to use 8,000psi concrete for both systems to avoid puddling with the columns, and so that the slab is equal to the column strength.

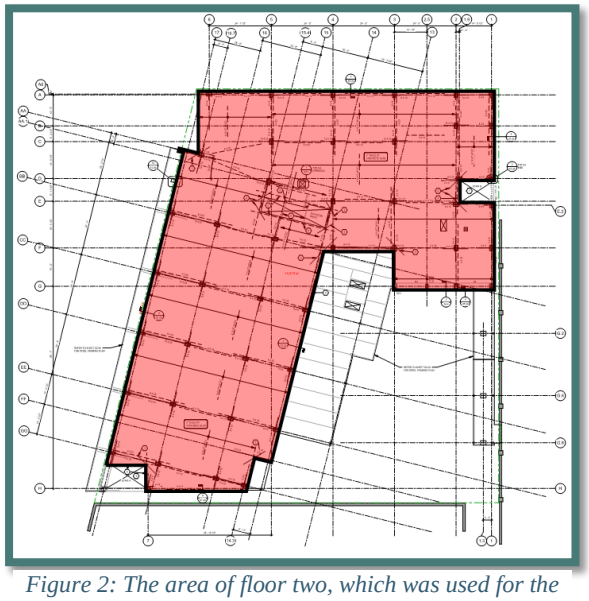


Figure 2: The area of floor two, which was used for the analysis of the PT slab (S2.2R - Second Floor Reinforcing Plan)

Critical subcontractors and their respective responsibilities for the construction of this system can be found in Table 1.

The project team chose to prefabricate the rebar cages of the columns off-site at a steel yard only 3.5 miles away. The steel yard will ship the columns to the site on the day of installation in order to increase site accessibility. The post-tensioning cables have been stored at Mortenson's yard, and will be delivered on the day of installation as well. More details regarding the methods of construction can be found in the *Production Schedule* analysis.

While the detailed design standards for this system can be found in the specifications, Mortenson chose to go beyond what was required. The field engineer will perform all quality inspections of material delivered to site, and after the material has been installed. Before the deck has been poured, Braun Intertec, a third-party inspector, and an Ed Carter (Meyer Borgman Johnson - structural engineer) will walk the deck to check the rebar, tendons, layout, etc. Once all parties have signed off on the inspection (Braun Intertec, Parsons Electric, Bald Eagle, CECO, Mortenson, Horwitz, and MBJ), the pour can commence.

Table 1: Key subcontractors and their responsibilities.

Subcontractor	Responsibilities/Assemblies Needed
CECO	Place elevated deck, formwork, and shoring
Bald Eagle	Place slab and prefabricated column rebar Install and stress post-tensioning cables
Mortenson	Shoot layout elevations Install stud rails and embeds Form, pour, and strip concrete
Parsons Electric	Electrical layout and embeds
Horwitz	Plumbing and mechanical layout and embeds

The biggest factor in testing and quality control is ensuring that the deck has reached the minimum strength of 3,000psi before the tendons are stressed. Typically, this is not an issue, especially with an 8,000psi concrete mix. If, however, there is any pause/delay in the schedule, the Saturday is reserved to make up time. The only thing that cannot be performed on a Saturday is a pour. It is likely that as the construction team moves up the building, the efficiency of this process will increase.

When asked what the key component to a successful installation of this system is, Mortenson replied with "communication." In order to coordinate the fast-paced installation of the PT slab and columns, Mortenson has focused on three key methods of communication.

1. Virtual Design and Coordination – A Mortenson employee, Carl Wegener, performed upfront work in order to coordinate the MEP and architectural layout. Carl provided Mortenson carpenters with detailed formwork layouts and elevations to lessen the possibility for mistakes and to decrease the overall duration of installation. Additionally, Carl coordinated all of the MEP openings and provided this documentation to CECO so that CECO could create their own deck profile drawings. This coordination increased communication while minimizing errors and schedule.
2. A phased schedule – All parties mentioned above sent their foreman to attend a pre-pour deck meeting in order to coordinate the operation of the five-day cycle. The subcontractors communicated their crew sizes, sequencing, busiest days, and other critical information. This ensured that the five-day cycle was manageable by all trades.
3. Competent foreman chosen for the job – Competent foreman were requested, when possible, in order to convey appropriate messages to the project team and to their own crews. This increases the likelihood of success for the construction of this system because of past experience and knowledge.

Table 2 lists the critical equipment necessary for the construction of the PT slab and columns. If at any point any one of these pieces of equipment shuts down, the entire project will shut down until it is repaired. In order to prevent this, three PT stressors will be delivered to the site along with the first tendon shipment. The crane and concrete pump have also been coordinated to ensure that they both can fit and operate on site.

Table 2: Key equipment necessary for the installation of PT slabs and columns.

Equipment	Responsibilities
Tower Crane	Hoisting all materials to the appropriate location and level
Concrete Pump	Placing concrete for the deck and columns (needed for 2 days)
Tendon Stressor	Stress the tendons after the concrete has cured to 3,000psi (three will be available on-site).

Production Schedule

The production schedule of one floor can be found in Figures 3 and 4. Figures 3 and 4 breakdown the activities necessary to fully complete one floor, by trade and by day/time required. The tasks are completely dependent upon each other, with multiple links per task in many cases. Every aspect of this schedule is part of the critical path, and the subcontractors who are a part of this production have previously met to discuss needs, requirements, plans, and production schedules. This five-day cycle considers Saturday a "buffer day," but also expects the efficiency to increase as construction moves forward.

Activity ID	Activity Name	Original Duration	Remaining Duration	Start	Finish
PT Slab Heartland	PT Slab Heartland	5	5	12-Oct-15	16-Oct-15
A1000	Pour Deck and 27 Columns	1	1	12-Oct-15	12-Oct-15
A1010	Strip, Reset, and Pour Remaining 20 Columns by 10am	1	1	13-Oct-15	13-Oct-15
A1020	Install Stud Rails	1	1	14-Oct-15	14-Oct-15
A1030	Install Embeds	1	1	15-Oct-15	15-Oct-15
A1040	Clean Deck	1	1	16-Oct-15	16-Oct-15
A1050	Strip Bulkheads, Crack DeckLoose, and Fly Panels in the Afternoon	1	1	13-Oct-15	13-Oct-15
A1060	Finish Deck and Bulkhead	1	1	14-Oct-15	14-Oct-15
A1070	Set Column Rebar	1	1	12-Oct-15	12-Oct-15
A1080	Stress Deck and Set Remaining Columns by 10am	1	1	13-Oct-15	13-Oct-15
A1090	Install Deck Rebar	2	2	15-Oct-15	16-Oct-15
A1110	Start MEP/Electrical	3	3	14-Oct-15	16-Oct-15

Figure 3: PT Slab and column schedule summary

This five-day cycle also fits into the overall project schedule after the slab-on-grade has been poured and during the "enclosure" phase (Appendix A). The second floor cycle will begin on the Monday after the slab-on-grade has been completed, on October 12th. With a five-day cycle and 9 floors needed (2-9, roof), the total process for this activity

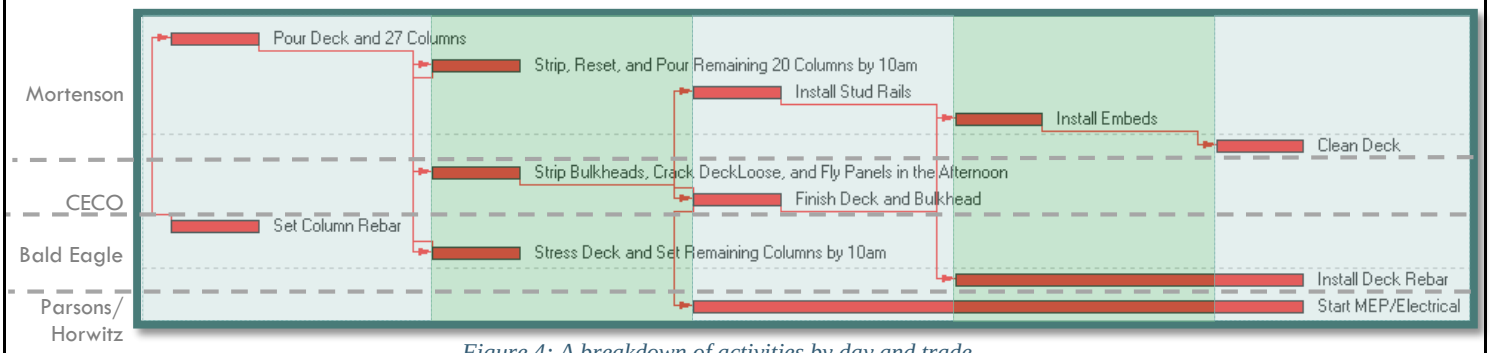


Figure 4: A breakdown of activities by day and trade

should take 45 working days and finish on December 11th. In the original schedule, however, the project team has this system finishing on December 28th. Looking closer into their detailed schedule, extra days have been added to the schedule, making it longer than a five-day cycle in many cases. As of right now, the plan for the project team is to stay on track with the projected five-day schedule.

One of the critical factors for completion of The Heartland Hotel is the enclosure. With the harsh winter approaching, the aim of the project team is to begin and complete this work as quickly as possible. With that said, the façade will begin as soon as the shoring has been removed off of the first floor – or once the fifth floor cycle begins. Completing the PT slab and columns in a quick manner is therefore critical to the façade and overall enclosure of the building. Additional critical activities and milestones include material coordination, the submittal review process, finalizing the virtual design coordination, and hiring the subcontractors and executing contracts in order to coordinate plans.

The steel columns and beams for the entrance, canopies, and bridge will be installed before and during the construction of the second through fourth floor PT slabs. The majority of steel can be found on the first and second floors, with minimal steel in other locations.

The manpower on site for this portion of construction is largely dependent upon which task is being performed at the time. Keeping in mind Figure 4, Figure 5 maps the manpower/day by trade. These numbers were given to the project team by each trade. The maximum number of workers on-site working on the PT slab and columns is 38, while the minimum is 26. Because the majority of the pour is taking place on Monday, it is more efficient for the concrete workers to have fewer other trades on-site for logistical, safety, and spatial reasons. Likewise, on Wednesday, most trades need to begin work on the next deck so that everything is in place for a pour to begin the following Monday.

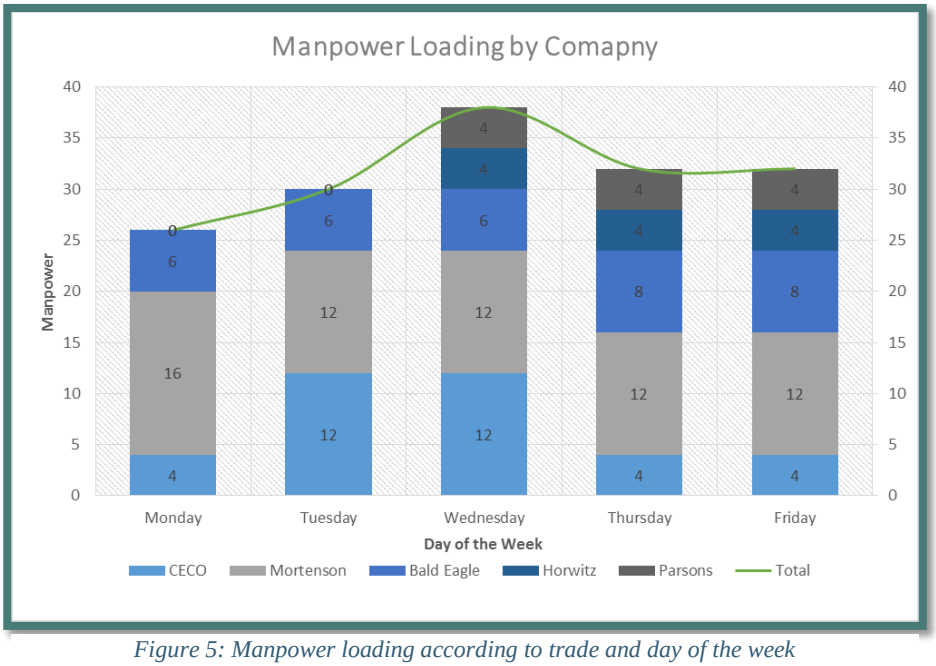


Figure 5: Manpower loading according to trade and day of the week

Detailed Costs

Figure 6 shows the Timberline cost estimate for the PT slab and column system. The total cost for this system equaled around $2.2M. Newest superstructure cost information from the project team reveals their cost totaled nearly $3.6M. While these values are about $1.4M off, the following items were excluded and can account for the discrepancies:

- The first floor slab-on-grade and columns
- Any potential scaffolding
- Steel (columns and beams for the entrance, canopies, tower, bridge, stairs, and elevator)
- Bridge concrete and reinforcing
- Concrete Masonry Units
- Framing system

Due to program limitations, slight modifications to the Timberline estimate are as follows:

- 8,000psi concrete is used for the slab and columns – Timberline only offered 7,000psi
- Shoring options were limited to 4x4 fir (unreasonably expensive) and unknown "shoring forms" – "Shoring forms" was chosen due to the more reasonable cost. It is unknown whether this Timberline shoring is wood or metal

Phase	Description	Takeoff Quantity	Labor Cost/Unit	Labor Price	Labor Amount	Material Price	Material Amount	Total Cost/Unit	Total Amount
	CONCRETE								
3110.200	Forms: Columns								
	Column Forms - Patent System	20,597.15 sf	9.39 /sf	46.95 /hr	193,407	0.78 /sf	16,548	10.19 /sf	209,955
	Column Clamps	4,136.00 ea	-	-	-	1.20 /ea	5,112	1.24 /ea	5,112
3110.350	Forms: Suspended Slab								
	Suspended Slab Forms (Lab and Mat.)	127,804.20 sf	4.70 /sf	46.95 /hr	600,041	1.20 /sf	157,966	5.93 /sf	758,007
3110.500	Forms: Beams								
	Beam Bottom Form	561.08 sf	9.39 /sf	46.95 /hr	5,269	0.82 /sf	472	10.23 /sf	5,740
	Beam Sides - 1/2" Plywood	729.57 sf	9.39 /sf	46.95 /hr	6,851	0.24 /sf	180	9.64 /sf	7,031
3111.050	Forms: EdgeFm Suspnd Slab								
	EdgeForm (Any Depth, LF)	5,801.00 lf	4.70 /lf	46.95 /hr	27,236	0.78 /lf	4,661	5.50 /lf	31,896
3111.450	Forms: Screeds								
	Screeds	127,804.20 sf	0.14 /sf	46.95 /hr	18,001	0.02 /sf	3,159	0.17 /sf	21,161
3111.500	Forms: Strip & Oil								
	Strip/Oil Forms-Columns	20,597.15 sf	1.41 /sf	46.95 /hr	29,011	15.00 /gal	1,591	1.49 /sf	30,602
	Strip/Oil Forms-All other	1,290.65 sf	1.17 /sf	46.95 /hr	1,515	15.00 /gal	100	1.25 /sf	1,615
	Strip/Oil Forms-All other	127,804.20 sf	1.17 /sf	46.95 /hr	150,010	15.00 /gal	9,873	1.25 /sf	159,883
3111.600	Forms: Shoring								
	Shoring	150.14 mbf	1,173.75 /mbf	46.95 /hr	176,222	300.00 /mbf	46,392	1,482.75 /mbf	222,614
3230.100	Rebar: At Tendons								
	Tendon Rebar (tons)	36.24 ton	1,313.75 /ton	52.55 /hr	47,604	504.00 /ton	18,810	1,832.87 /ton	66,414
3230.150	Rebar: Stressing Tendons								
	Stressing Tendons (each)	927.00 ea	10.51 /ea	52.55 /hr	9,743	120.00 /ea	114,577	134.11 /ea	124,320
	Pull Tendons (each)	927.00 ea	15.77 /ea	52.55 /hr	14,614	-	-	15.77 /ea	14,614
3310.180	Conc: Columns								
	Column Conc 7000 psi	246.81 cy	37.56 /cy	46.95 /hr	9,270	65.34 /cy	16,610	104.86 /cy	25,880
3310.260	Conc: Suspended Slab								
	Susp Slab Conc 7000 psi	2,630.20 cy	16.43 /cy	46.95 /hr	43,221	65.34 /cy	177,013	83.73 /cy	220,234
3310.340	Conc: Beams								
	Beam Conc 7000 psi	27.31 cy	39.91 /cy	46.95 /hr	1,090	65.34 /cy	1,838	107.21 /cy	2,928
3350.100	Finish: General								
	Trowel Finish	127,804.20 sf	1.13 /sf	45.00 /hr	143,780	0.01 /sf	790	1.13 /sf	144,570
	Rub, Cut, & Patch	1,290.65 sf	0.90 /sf	45.00 /hr	1,162	0.01 /sf	16	0.91 /sf	1,178
	Rub, Cut, & Patch	20,597.15 sf	0.90 /sf	45.00 /hr	18,537	0.01 /sf	255	0.91 /sf	18,792
	Rub, Cut, & Patch	127,804.20 sf	0.90 /sf	45.00 /hr	115,024	0.01 /sf	1,580	0.91 /sf	116,603
3350.300	Finish: Protect & Cure								
	CS 309 Curing Compound	127,804.20 sf	0.11 /sf	45.00 /hr	14,378	0.02 /sf	3,159	0.14 /sf	17,537

Estimate Totals

Description	Amount	Totals	Rate	Cost Basis	Cost per Unit	Percent of Total	
Labor	1,625,984					73.68%	
Material	580,701					26.32%	
Subcontract							
Equipment							
Other							
	2,206,685	2,206,685				100.00	100.00%
Total		*2,206,685*					

Figure 6: Detailed cost estimate using Timberline

- Off-site prefabricated column rebar was not available in Timberline – Manpower and material for assembling the rebar on-site was used and assumed to be similar enough
- Labor prices provided by timberline were all $20.00/hr – Prices used were taken from RS Means 2015 Facilities Construction Cost Data (Carpenter: $46.95; Cement Finisher: $45.00; Rodman: $52.55)

Site Plans and Logistics

Images found in Appendix B show various site plans for the Heartland Hotel. During the deck and column pours, the concrete pump truck will remain in the site. Testing to ensure that the hose radius does not conflict with the tower crane must be performed. Key changes in workflow are when the slab-on-grade has been completed and work can commence on the PT elevated decks, as well as when shoring has moved off the first floor (when level five is being poured). Moving the shoring from the first floor will allow for the enclosure phase to begin, and will provide a new material storage area on the first floor. Due to the tight site, materials such as the column rebar and PT tendons will be delivered on the day they are needed. Other materials such as reinforcing bars, will be brought to site weekly.

The workflow of the building goes from South to North, and West to East. Columns that are being poured on the second day will be in the North-East portion of the building.

Deliveries can be made to either street entrance, depending on the time of day. The western street cannot be closed between 9am and 3pm. The concrete trucks will most likely enter the site from the northern street and exit the western street. On pour days between 9am-3pm, remaining deliveries will most likely enter the site through the northern entrance, because it will have a lane closure during that time.

PRODUCTION ANALYSIS

Production

Given the crews, resources, site constraints, and interrelated schedule activities, the PT slab and prefabricated column reinforcing is very efficient. The five-day cycle allows subcontractors to work at an efficient and loaded pace, but does not require overworking their workers. As the Superintendent, Scott Amundson mentioned (see *Field Supervisor Interview* section and Appendix C), the cycle can be shortened to a four-day or a four-and-a-half day cycle, but this wouldn't change the schedule drastically enough, and instead, would tire out the workers quickly. Additionally, the five-day cycle allows for Saturday as a buffer day, in case anything goes awry.

The workflow has clear handoffs between trades, and designates specific days for specific types of work. This limits confusion and sets expectations immediately. The time requirements (pour columns by 10am, fly panels in the afternoon, etc.) also provide more details to the subcontractors, for additional coordination.

The virtual design coordination provided by Mortenson also has a huge impact on schedule acceleration. These additions help with coordination between design and subcontractors, and allow for quicker overall installation.

One concern, however, with such expedited work on one floor, is that subcontractors could get in the way of each other. While they do have an entire day (or two) to complete their work, the schedule is strict, and falling behind directly impacts every other trade on site. Furthermore, what happens when there is a weather delay? If no work is done on Friday, will there be work done on Saturday, or will the work that was halted instead occur on Monday? This then brings up choosing between overtime on Saturday, or a complete shift in manpower and schedule rearrangements for Monday.

Overall, the production for the PT slab and prefabricated column reinforcing is effective and well though-out. Because this type of construction has previously been performed by Mortenson, the project team has the ability and resources to ensure that this system is constructed with high-quality and on-time.

Cost Analysis

Comparison between the cost alignment using Timberline software and the actual budget provided by Mortenson can be found in the *Detailed Costs* section. The total cost of $2.2M results in an approximate cost/square-foot of $17.31/SF. While this is drastically different from the original superstructure cost/square-foot of $34.57/SF, factors mentioned in the *Detailed Costs* section can account for most of these discrepancies.

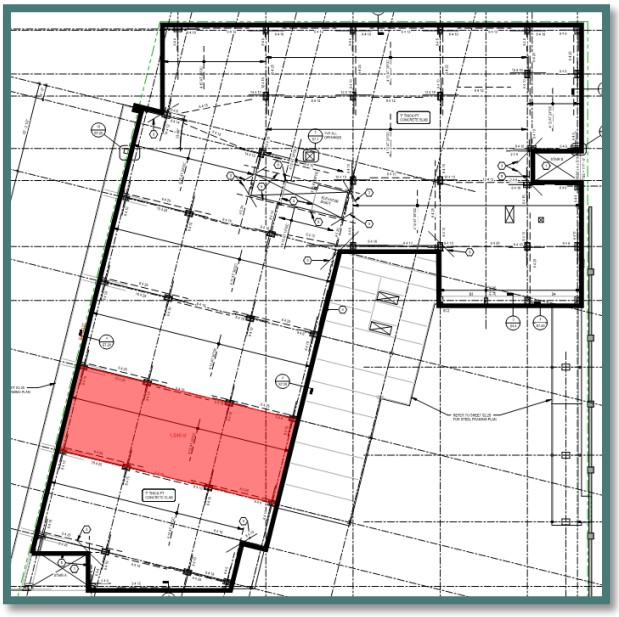


Figure 7: PT slab cost estimate takeoff (S2.2R – Second Floor Reinforcing Plan)

The method for this cost analysis was performed by taking-off two portions of the building, and using that data to extrapolate throughout the rest of the building. Figure 7 depicts the take-off that was performed on the second floor. This method collected information pertaining to the tendon count, rebar tons, square footage, linear footage, and shoring height. A second take-off in this same area on the third floor was performed and extrapolated for floors 3-roof. This additional take-off was performed because of the differing heights of the floors, amount of rebar, and area compared to the second floor. Floors 3-roof are consistent enough that extrapolation was logical. The columns and beams were then taken-off apart from the floors. Because the second floor through the roof are all hotel living spaces and rooms, it was reasonable to assume that the extrapolation from two average spaces would produce an adequate estimate.

With the assumptions and differences noted in the *Detailed Costs* section, it seems fairly reasonable that the price for the PT slab and prefabricated column reinforcing was around $2.2M. Because the main take-off was performed at a straight portion of the building, the varying edges, bridges, openings, and turns in the buildings may have also impacted the overall price, making it lower than actual cost.

The cost breakdown states that the labor cost about 74% of the total price. This seems unusually high for this type of system. Although the schedule is demanding and there is a constant flow of work (both on-site and off-site), it was surprising that materials such as the tendons and concrete did not cost more. This might also be an error due to take-offs, extrapolation, and/or Timberline program limitations.

Logistical Analysis

The total available space on the project site is very constricted. With neighboring buildings forming tight boundaries, and strict city road restrictions, there aren't many opportunities for spatial rearrangement. The project trailer is located off-site, which makes sense due to limitations, yet it provides an additional challenge for supervision and communication. The material staging area is in a good location for the crane picks, but it doesn't seem reasonable for the entrance and exit of vehicles. Unless site access is closed-off at the western entrance, this seems like an area that would be congested and difficult to coordinate. Once the slab-on-grade and upper floors are available for storage, more room will be available for use. An alternative option for the material staging is to place it along the perimeter of the site, and allow the drive lane to run directly through the middle of the site. One benefit of the current location of the drive lane is that the deliveries and vehicles are compacting the soil in the location where the future drive lane will be. This is a natural compaction and will help with future construction.

The PT slab and column stage in construction necessitates only the crane, concrete trucks, and pumps as major equipment. Until the scaffolding for the exterior façade is erected, these will be the largest and most important features of the site.

One area of concern is the tower crane. The goal of Mortenson is to never allow the tower crane to be idle; yet how will the tower crane be utilized on pour days? When the façade phase of construction begins, will the crane need to

reach over the workers on the deck to bring materials for the façade installation on the North or West sides? How will safety be a priority for workers and nearby buildings, while at the same time, fully utilizing the crane time?

FIELD SUPERVISOR INTERVIEW

The Mortenson Site Superintendent, Scott Amundson, agreed to an interview on Monday, October 12th, 2015. The following information is regarding the interview held with him over the phone. The full transcript of this interview can be found in Appendix C. Additional information and explanations not found in the *Schedule Acceleration Scenarios* and *Constructability and Logistical Challenges* can be found in the transcript.

Schedule Acceleration Scenarios

The schedule relates to the critical path of the overall project schedule in that it is the key component before the enclosure can begin. The sooner the structure is up, the sooner the enclosure can begin. The project schedule puts the enclosure construction in the middle of winter, which causes difficulties relating to some of the materials being installed, like stucco. In general, weather is an unpredictable factor, especially during the winter, and has the ability to do a lot of damage to the project schedule. Therefore, building the superstructure is critical to move forward with the enclosure and therefore the overall schedule. The building system and availability of equipment, manpower, and materials is easily controlled and something that Mortenson has experience with.

In terms of schedule acceleration, Scott was unable to pinpoint a specific area for acceleration that seemed reasonable. The system chosen has been thoroughly Value Engineered and deemed the most economical and quickest method for construction. The PT slab allows for a shorter building and a quicker construction time – both of which save money. Previous Mortenson projects have used four-day cycles, and while this is a possibility, it seems unnecessary for this project because the potential improvement isn't worth the additional manpower cost. Likewise, an admixture is a possibility to set the concrete quicker, but this also isn't necessary to only save a couple of hours. This admixture would likely cost around $10/yard.

Constructability and Logistical Challenges

The largest challenge for the Mortenson project team is the site logistics. Because the Mortenson Development team focused on maximizing the real estate dollar through land purchase and maximizing the amount of hotel space, the land available for construction is very tight. Additionally, the city put restrictions on how many traffic lanes could be disrupted by construction. These site plans can be found in Appendix B.

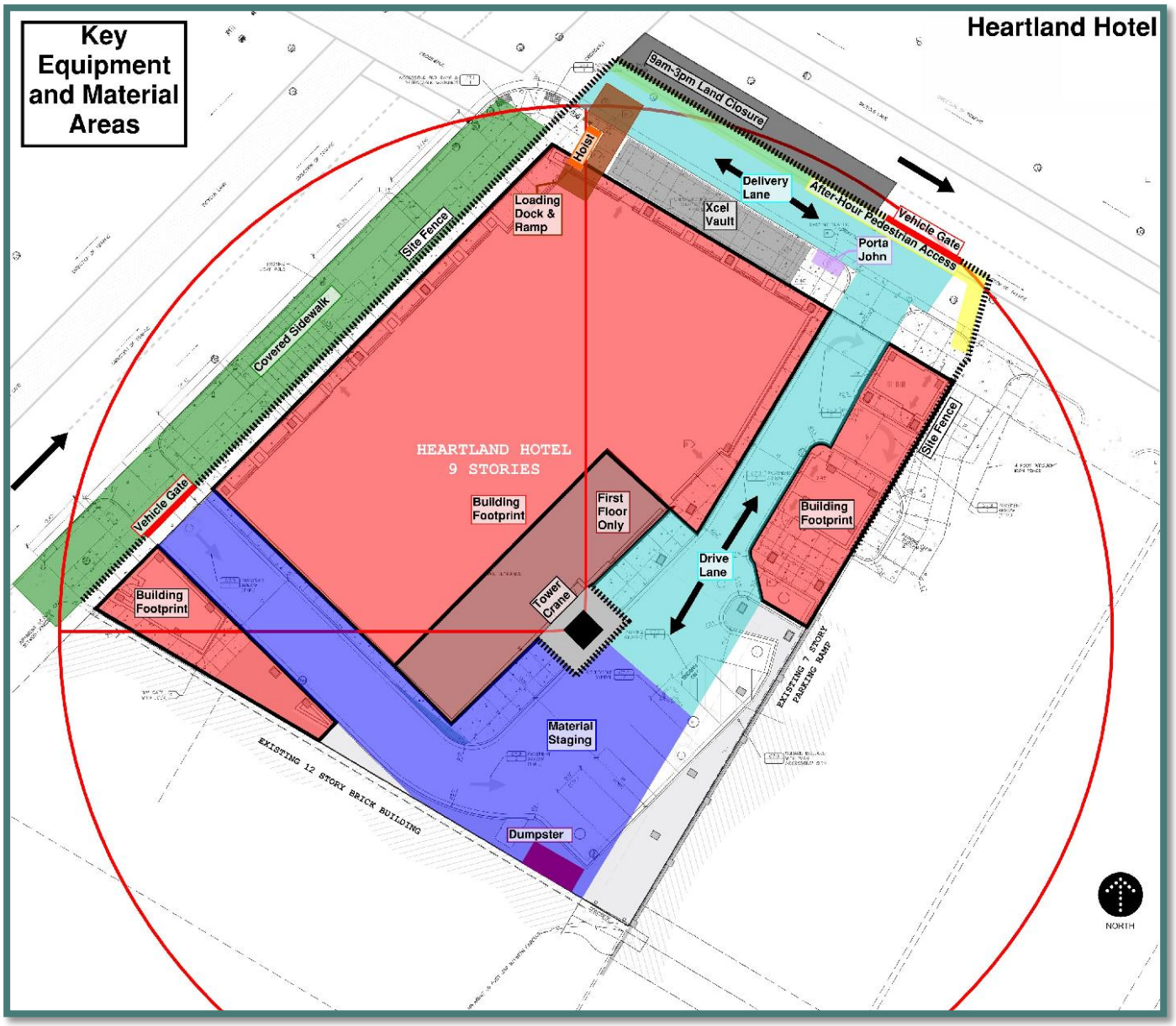
In terms of the PT slab and columns, this process is something that Mortenson has previous experience building. Once the major players are on board and virtual design is established, everyone is able to coordinate locations for quick installation. There is a lot of up-front worker-coordination, but this results in less time spent constructing in the field. Communication is key with this system, and has been established as a priority within the project team.

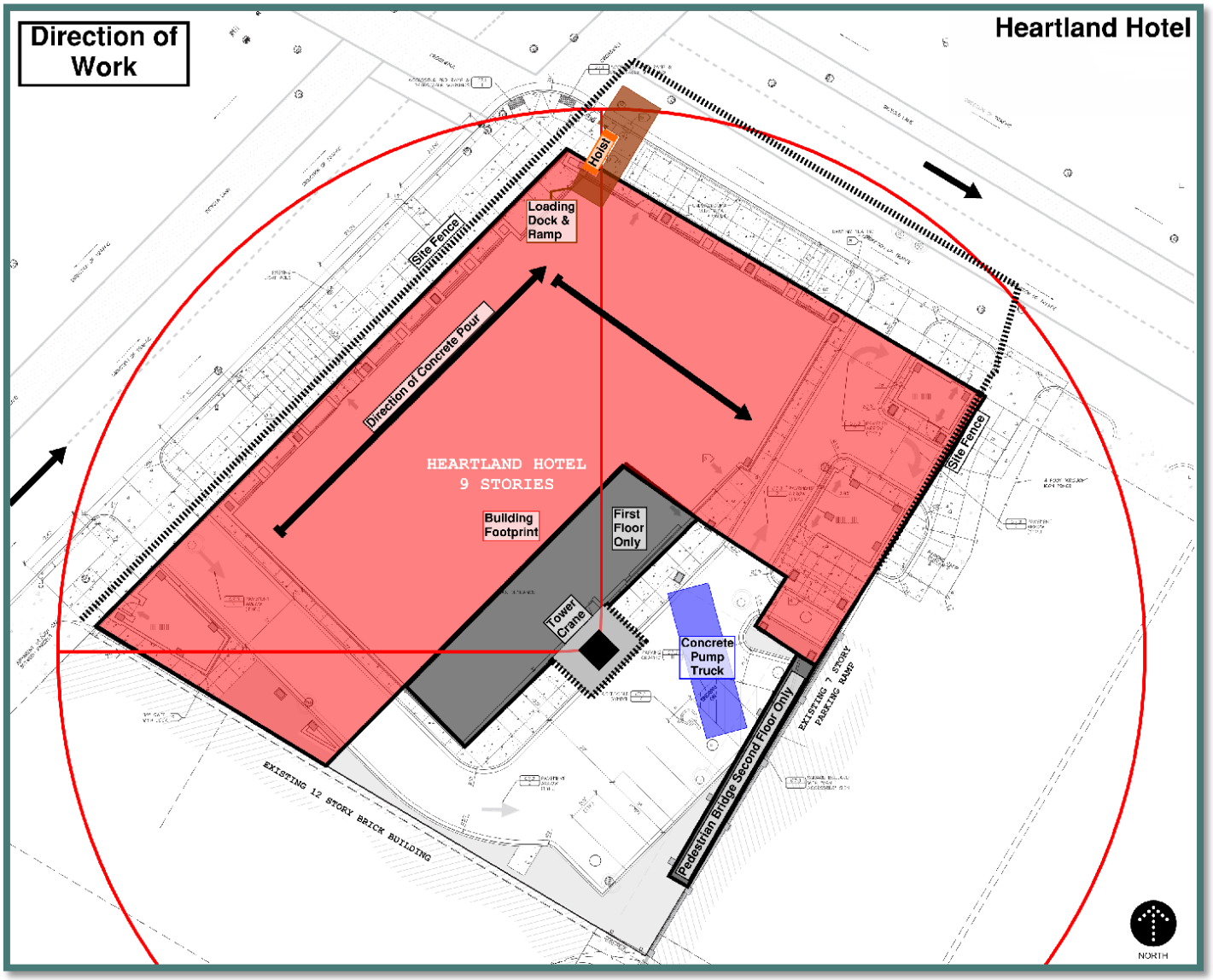
The PT slab, prefabricated column reinforcing, and schedule methods are efficient and logical; however, it took some persuasion to get all of the subcontractors on board. Because it is a newer system and idea, overcoming the typical mindset seemed to be a slight issue for the team.

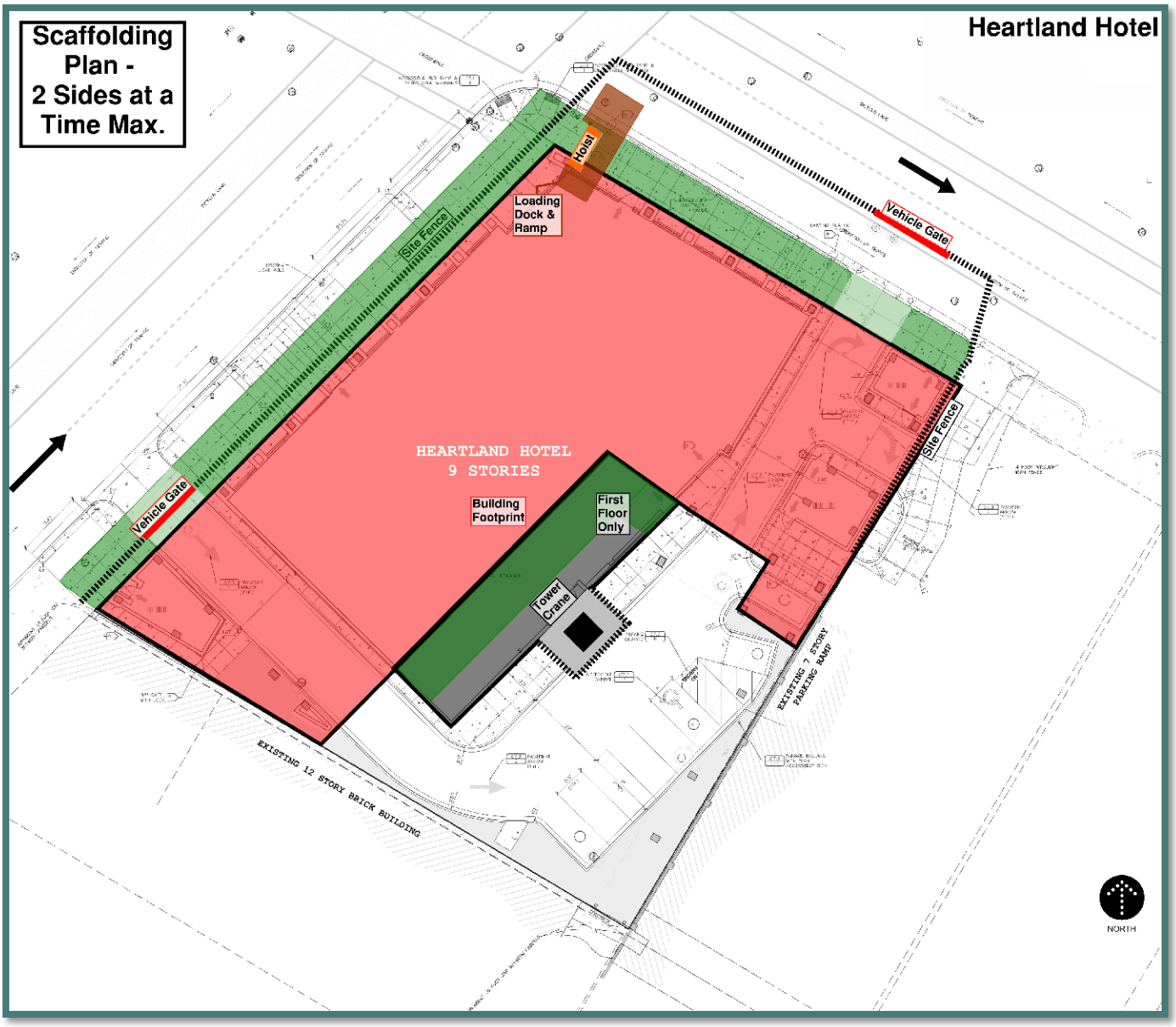
When asked what he would change about the system, were the building to be built again, Scott said that he wouldn't change anything relating to the PT slabs and columns. He would, however, change the façade of the building. Because the two are so closely related, the schedule of one impacts the other. Yet, because of the design standards of The Heartland Hotel, this design change is not an option.

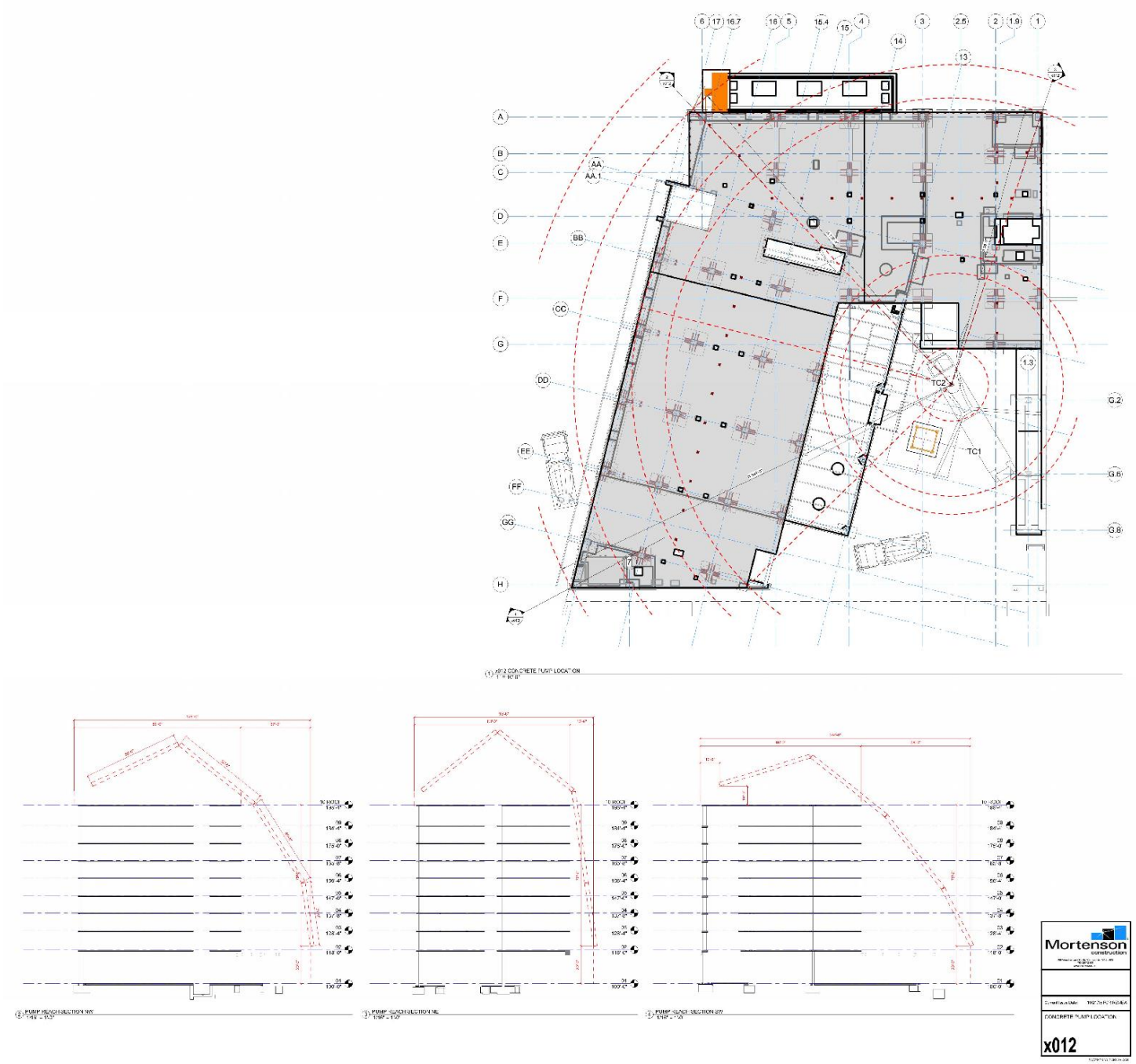
APPENDIX A – OVERALL PROJECT SCHEDULE

APPENDIX B – SITE LOGISTICS PLANS




Direction of Work
Heartland Hotel
Hoist
Loading Dock & Ramp
Site Fence
Direction of Concrete Pour
HEARTLAND HOTEL
9 STORIES
Building Footprint
First Floor Only
Tower Crane
Concrete Pump Truck
Site Fence
EXISTING 12 STORY BRICK BUILDING
Pedestrian Bridge Second Floor Only
EXISTING 7 STORY PARKING RAMP
NORTH


Scaffolding Plan - 2 Sides at a Time Max.
Heartland Hotel
Hotel
Loading Dock & Ramp
Site Fence
Vehicle Gate
Vehicle Gate
Site Fence
HEARTLAND HOTEL
9 STORIES
Building Footprint
First Floor Only
Tower Crane
EXISTING 12 STORY BRICK BUILDING
EXISTING 7 STORY PARKING RAMP
NORTH



Concrete Pump Location and Plan Courtesy of Mortenson Construction

APPENDIX C – SUPERINTENDENT INTERVIEW TRANSCRIPT – SCOTT AMUNDSON

**Note: Questions were sent out to the Superintendent before the interview took place so that he was able to read over and think about his answers.*

Schedule Acceleration Scenarios

What are the biggest risks to the project completion date?

Weather. Weather is the one factor that we can't control. In terms of the building system and availability of materials, manpower, and equipment, it is easy to control and stay ahead of the game in that area. So shops, fabrication, delivery, and whatnot is something that we are used to and plan for. Site logistics are a bit of a challenge, but we have been working with the prefabricators and storing materials offsite to compensate for this. We purposely accelerated our schedule so that we had the ability to dictate when and where these things were delivered. Getting the concrete frame up and finished are on our critical path, because this directly impacts the enclosure schedule. Starting construction of the building this late in the fall means that the enclosure will be built during the winter, which is a pain.

What are key areas that have potential to accelerate the PT slab (excluding increased manpower or shifts)?

Nothing really. That's why we did prefabrication and early deliveries. We are on a five-day deck cycle. If we want to, we can pull out another day from our schedule. Right now there are 47 columns per deck, and we are pouring 27 out of 47 in one day. If we wat to pull a half day out, we can pour more columns in one day. But that isn't necessary really. When we planned this out we made sure that the five-day schedule was doable with all of our subs and schedule. We are using a concrete material that we are very familiar with and one which we can play around with. We can add admixtures to get a faster set and cure, because we need 50% strength minimum before stressing the PT. The admixtures would allow the concrete to finish faster. Traditionally, we have done a six-day cycle, where all of the columns are poured the entire second day, but our mix design allows us to strip the bulkheads in the afternoon of the first day. The ironworkers then prepare the PT tendons for the next morning. This process is as efficient as possible and allows us to minimize our working window, so in case there are weather issues, we have time to accommodate for it. We pour every Monday so that Saturday is the "hold card" in case something goes wrong. Once we get into this five-day cycle, there shouldn't be any problems. The biggest factors are the prefab columns and the mix to keep the schedule. So I guess changing these could get you further ahead and help you go faster.

What would be required (as in resources, costs, and/or techniques) to accomplish these alternative sequences or means and methods for acceleration?

We could pay a little more money for an admixture. This would be probably around $10 per yard, which would total to around $3,000. This would get people two to three hours off work earlier, but it's not really favorable because it's not necessary. Eventually, or if you take this to the extreme, you would take a day out of the pour cycle, which would help in the long term.

Constructability and Logistical Challenges

Can you describe any unique and/or challenging constructability issues for the PT slab?

The sits logistics is definitely a challenge. The site was an existing surface parking lot. The development folks at Mortenson were trying to maximize their real estate dollar, so they chose this rougher site. They wanted to put in as much hotel as possible in a smaller space, so the site is very restrictive. We were limited by the city on how many traffic lanes we could impact, especially by the city's "rush hour" times of 6-9am. So the tower crane and pumps all need to be accommodated for during those times. The owner crane layout and access is huge, and we needed to shuffle a lot of people around to get everyone in and set.

For the deck, it's not really rocket science. We got all the major players on board. We had VD (virtual design) and a 3D model, where we could overlay the penetrations through the slab. We also are using form saving devices for the sleeves in penetrations. Traditionally, we would block out the area with cast-in-place sleeves, and then later cut these

sleeve protrusions out. But when we are trying to place and finish the concrete, we can't have these sleeves sticking out, so it's a pain. So there are aftermarket products that we encourage our subs to use. They nail the products to the formwork, and have an adjustable height so that the product is flush with the top of concrete. That way, when they come back to do the rough-in, the subs just need to locate the cap. This means, though, that there is a lot of worker-design coordination up front so that the actual rough-in doesn't take too much time. We have a robotic total station as well to easily shoot points on the deck.

How have you overcome these challenges (either in design or planning, since they have yet to be built)?

Virtual design, pre-planning, and extensive pre-pour meetings where we discussed roles, made sure that everyone was on the same page, what different responsibilities were, and how we never wanted the crane to be idle were all part of the process. Overall, just communication.

Have you done this type of system before? *(Follow-up question not originally planned for)*

A typical job with this system, we would do a six-day cycle. We did a 30 story building with a four-day cycle which was about two blocks away. For that one, the enclosure completely drove the schedule.

This all depends on the job and what the relevant scopes of work needed are. You see this more, where there is the same day pour, than you used to. We have had the chance to play around with the mix design and time it well, so it all works out. It took more effort to overcome the mindset of the subcontractors, because they weren't used to this method, than it did to see the practicality of it all. But time is money, so it works out.

What would you change (in terms of the design materials, means and methods, equipment/resources, and relevant system decisions) to address these difficulties, were this building to be built again?

I wouldn't change anything. Right now, we are trying to convince them to use a different enclosure system because of the time of year that the schedule has us building it. There's a lot of stucco on the building, and it's very temperature dependent. So trying to maintain a constant temperature in an enclosed scaffolding system is tough, but required by The Heartland Hotel standards. We would rather do a PT deck than anything else because other ways are more labor-intensive and there is no way that we could get it done as fast.

How has site logistics influenced the design and/or planning for this system?

It influenced it by how tall the building could be. For the thickness of the slabs, conventional steel would make the building 15-20% higher per floor because the plenum and rough-in space is larger. It was originally designed to be framed lightweight deck system with lightweight framing walls, but we looked into it and saw that it would be faster with PT. PT is the fastest and most efficient and economical way to do it. Once everyone was on board, the site logistics didn't change much because the crane and concrete placement methods remained, but it influenced the height of the building. Everyone works for Mortenson, so we either had to convince them, or if we didn't, we told them how we were doing it. Typically, PT is the best way. With the hotel, we didn't need to worry about dividing the columns and walls. The longest span is the corridor, so the PT is easily used.

Just out of curiosity, because I was told that there weren't any restrictions given by the city, how tall was this building allowed to be? *(Follow-up question not originally planned for)*

The building next door has upper offices on floors 11-14. Because we had a tower crane, they weren't happy with us blocking their view. They said that it would limit their leasing opportunities from the 9th floor and up. We worked with Heartland and the development folks to decide the optimum floors for the square-footage and the cost/square-foot. We initially started at twelve floors, then went to eight, and then finished on nine. This made the most sense for the budget and purchase price of the property.

<u>Planned questions which were answered in responses to other questions, and therefore not asked:</u>

How does the PT slab schedule relate to the critical path of the project schedule?