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Tech Report 2
10/12/12
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CityCenterDC | Parcel 1

Washington, D.C.

Executive Summary

The ensuing technical report focuses on key features affecting the project execution. Analyses of a project schedule, electrical and general conditions estimate, Building Information Modeling use, and constructability challenges outline the considerations the project team encountered throughout the construction of Office Building 1.

Five years after the initial design of CityCenterDC began, construction broke ground. A detailed schedule of Office Building 1 was produced to analyze the challenges and strategies utilized on the job. Findings revealed that the repetitive nature of the core and shell office floors allowed for the use of production techniques. A work plan was developed for a typical floor and implemented on the rest of the structure.

CityCenterDC was broken down into four bid packages. Office Building 1 & 2 were grouped together to form one such package. Upon further investigation it was found that a joint electrical system was utilized between the two buildings. A detailed electrical estimate broke down the electrical cost for Office Building 1, yielding an estimated cost of $3.1 million.

The separation of the project into the previously mentioned packages also meant that the general conditions costs would be distributed accordingly. Taking into consideration the costs shared between all four packages, the general conditions estimate for Office Building 1 was estimated at $5 million.

Due to the unique and lengthy development of the CityCenterDC project, Building Information Modeling was never implemented in the design stage. BIM use costs were not included in the original bid, but the project team decided to adopt them on their own in an effort to increase the efficiency of the project. The willful addition of BIM proved to be a huge success among the contractors, who were able to use 3D coordination to resolve many clash problems and enhance communication.

Among the many constructability challenges encountered during the construction of the office building, three unique circumstances stood out. Through collaboration between all trades, an engineered ramp was designed to speed up the process of the subgrade structure, a prefabrication technique was applied for construction of the connection bridges, and a strategic crane placement strategy was implemented. The innovative solutions demonstrated the perseverance of the project team. The following report focuses on the thorough description of the preceding features of the project.

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Project Schedule

Overview

The idea for CityCenterDC started over a decade ago when the mayor of D.C. decided to redevelop the site of the old convention center. Approximately 9 years later, the project broke ground. Three city blocks were excavated for the garage, the foundation for all 6 buildings of the development. After the shared garage was complete, all 6 buildings' above grade structures started simultaneously. The detailed project schedule created focuses on the construction of office building 1.

Table 1: Schedule Phases

Phase	Start Date	End Date	Duration
Design & Pre-Construction	9/1/2002	3/22/2011	3124
Excavation & Below Grade Structure	3/22/2011	2/18/2012	333
Above Grade Structure	2/21/2012	7/5/2012	135
Building Envelope	5/14/2012	10/31/2012	170
Core Rough In	4/12/2012	7/5/2012	84
Framing & Wall Rough In	5/10/2012	8/27/2012	109
Finishes	9/10/2012	5/31/2013	263
Penthouse/Roof	6/11/2012	5/31/2013	354

Design & Preconstruction

In 2002, the District of Columbia released an RFP to potential developers. The District sought to develop the three city-block space created from the demolition of the old convention center. Approximately one year later, after many presentations from various parties, a developer was chosen. Soon thereafter, the architect started developing a design. For the next couple of years, the developers struggled to come to terms on the details of the project. Due in part to the financial crisis, the project was put on hold towards the end of the decade. It wasn't until March, 2011 that the project finally broke ground.

Excavation & Below Grade Structure

All six buildings in the CityCenterDC development share the same excavation and foundation. The entire site was excavated at once, footings for cranes were poured, and the cranes were set in place. Following was the foundation for all six buildings, which consists of a four story parking garage. With the cranes and an engineered ramp in place, described in the Constructability Challenges section of this report, the cast-in-place concrete foundations were poured. Once the entire subgrade structure was complete, each building's above grade structure was ready to begin.

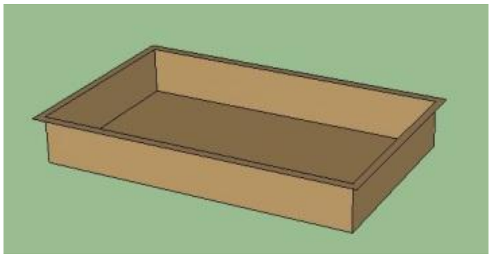

Figure 4: Excavation

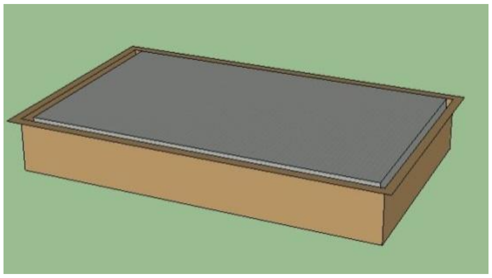

Figure 4: Subgrade Structure

Above Grade Structure

Due to the similarity of the floor-to-floor structure of the office building, the above grade structure erection process was very efficient. In fact, the average duration for construction of one floor slab was one week.

First, the formwork and temporary shoring was erected. Post-tensioned cables along with rebar were arranged on stools to create a grid. Following, the slab was poured, starting from the west side of the building towards the east. This process was repeated for all of the floors of the office building.

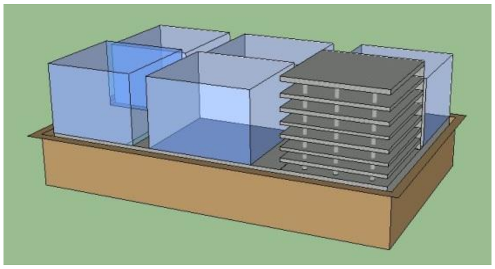

Figure 4: Above Grade Structure

Building Enclosure

Just around the time the last floor was being poured, the construction of the curtain wall began on the second floor. The curtain wall system used special embeds in the slabs to attach to the structure. Every floor was enclosed in approximately 12 working days. With the climate in mind, the curtain wall enclosure was started at the beginning of May with the intent to finish before the harsh winter months.

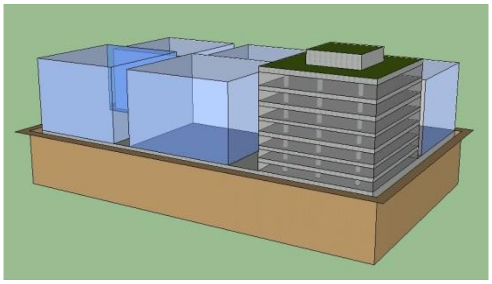

Figure 4: Enclosure

Rough In

Feeders for various building systems run through chases located at the core of the building. As each floor is constructed, these risers are installed and connected to the previous sections. Duct and other MEP rough in are delivered to each floor prior to its placement, as seen in Figure 5. This strategy was to not only keep the remaining site uncongested, but to also have the material readily available for the crews. This way when a crew was ready to install the duct or VAV boxes, all of their material was close by. With this tactic, each major rough in per floor took approximately one week to complete.

Figure 5: Duct Stored on Floor

Finishes

From the initial development phases of the project it was clear that the office building, along with the remaining five buildings, would be geared towards the luxury market. This meant that finishes would have to be of the highest quality. The special care required for these types of finishes resulted in longer than usual installation and planning durations. As an example, the marble walls and floors seen in Figure 6, were custom ordered from Italy, and required long times. As such, the planning around these finishes was always a top priority to the construction team.

Figure 6: Marble Walls | Photo: Hines-Archstone

Penthouse/Roof

Located at the penthouse level is the mechanical room. It houses the cooling towers as well as some additional mechanical equipment. Surrounding the mechanical penthouse are various types of green roofs. The most important scheduling aspect to this area was the delivery and set up of the mechanical equipment. Large mechanical equipment requires long lead times. As such, it must be ordered well in advance to ensure it is ready for its scheduled installation.

Typical Floor

Repetitive floors allowed the construction team to implement a SIPS-like (Short Interval Production) schedule. Most of the mechanical, electrical, plumbing, and wall configurations were identical on a floor-to-floor basis. To maximize productivity, crews with specific tasks were assigned to a floor for a given amount of time. When that crew finished their work, they would move to the next floor and repeat it. A crew performing a different task would take the place of the old crew and follow a similar schedule. The work the succeeding crews perform usually builds off what is already in place. Due to this dependency, if one crew falls behind, the others cannot continue to their next destination, resulting schedule delays.

In the office building, this system was incorporated with a time interval of approximately 6 days for each crew. The size of the project allowed for one or two day gaps between crews if necessary. If there was an instance that one crew would have to wait for an additional day until they could start the next floor, they would be assigned to a different building for the day. Most projects have only one building and could not afford to do this without accruing some type of labor costs or schedule delays. The unique situation at CityCenterDC therefore created this alternative to the textbook SIPS definition.

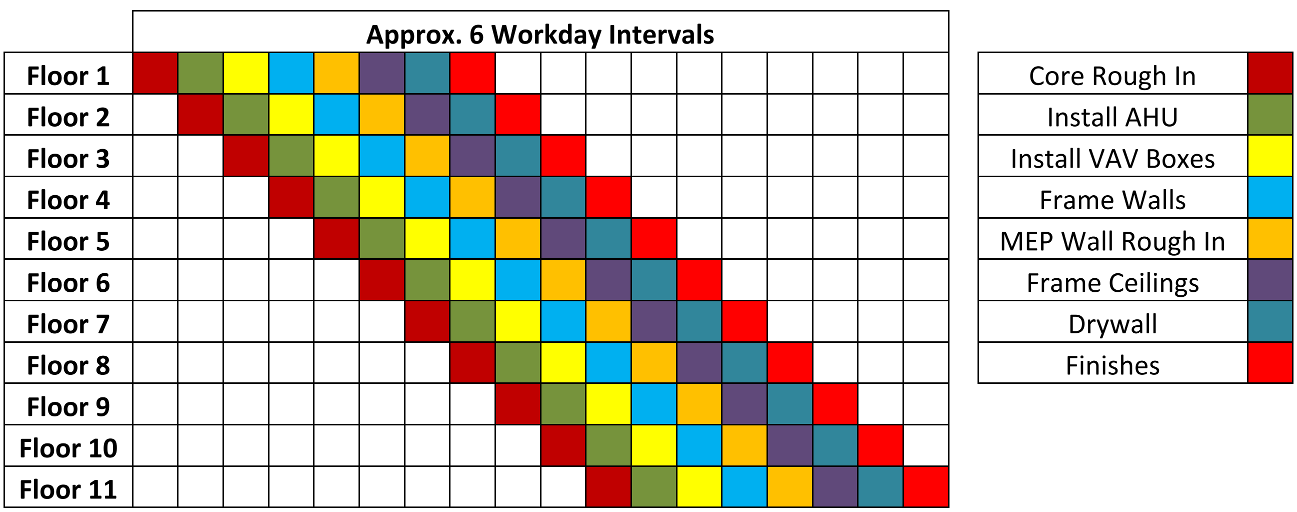

Figure 7: Schedule For A Typical Floor

Detailed Electrical Systems Estimate

Overview

A 480/277V electrical distribution system provides power to Office Building 1 of the CityCenterDC project. The main electrical room, shared by both office buildings and located in the garage structure, is supplied 480/277V service by PEPCO. Four switchboards feed the various distribution panels and electrical closets throughout the two buildings. Step-down transformers are located next to the panels or equipment requiring lower voltage. The electrical drawings provide one riser and distribution diagram for both office buildings. In order to perform a detailed electrical estimate, each building's systems had to be separated. The ensuing descriptions outline the processes and assumptions taken during the detailed takeoff.

Gear & Equipment

A joint riser and distribution diagram was provided for both office buildings. Consequently, the initial step in the takeoff process was to separate the distribution gear and equipment for each office building. The nomenclature for each piece of equipment indicated to which building it belonged. A count for all of the switchboards, panels, transformers, circuit breakers, safety switches, a generator, and variable frequency drives was taken. While the switchboards are shared in between buildings, the loads for each building are almost identical. Therefore, (1) 3000A and (1) 4000A switchboard was assigned to each building. All of the sizing for the equipment was noted and respective pricing for material and labor was applied.

Feeders

Following the distribution gear and equipment was the feeder takeoff. This proved to be the most challenging takeoff due to the shared electrical system. As mentioned earlier, switchboards were not designated to specific buildings. As a result, some feeds to Office Building 1 came from the switchboards assigned to Office Building 2, and vice versa. Another dilemma occurred when a distribution panel fed from a switchboard fed multiple panels. These panels were located in both buildings. At that point, it was necessary to assign the appropriate feeders and equipment to Office Building 1 and not takeoff the rest.

A 4000A bus feeder runs vertically through the chase in the core of the building. The electrical closets on each floor, each in the same location, tap into this busway. With the electrical closets on every floor in the same location, it made vertical feeder length takeoff straight-forward. Horizontal lengths from the main electrical room were taken to the electrical chase at the core of the building and then rolled up. Additional horizontal lengths were added for feeders on the penthouse level. Once again, they followed the same path through the core chase until they reach the penthouse.

Branch

Floors 3-11 of Office Building 1 have identical layouts in regard to branch power. Therefore, a detailed takeoff of a typical floor was performed, and the quantities were multiplied by the number of floors. Each floor contained wire for lighting and HVAC equipment. Receptacle layouts were not included in the drawings. These will be added on later per the requested layout of the tenant. This will also add additional costs in the form of wire, conduit, receptacles, boxes, and fittings. These costs are not included in this estimate. The first two floors of the office building, also known as the retail space, have different configurations in regard to lighting and power. These two floors were taken off separately. Refer to Figure 8 for typical floor electrical power plan.

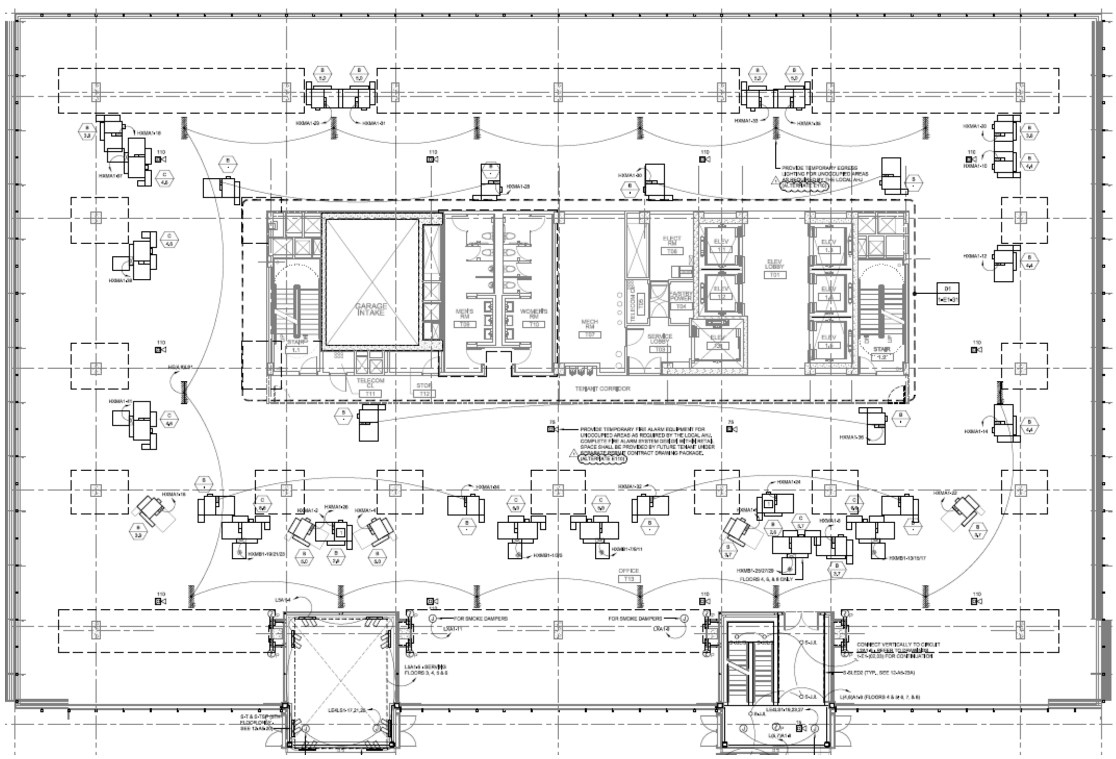

Figure 8: Typical Floor Plan | Clark

Conduit

Both the feeders and branch wiring were housed in EMT conduit. Elbows, couplings, box connections, hangers, riser clamps, and junction boxes were included in the takeoff. Additional conduit was added for communication feeds on the first level. Communication branch layouts were not yet designed, and as a result, not taken off. These will also add cost in the future.

Lighting & Sensors

While a lighting layout does exist for every floor, it will most likely be redone once a tenant purchases or leases the space. The tenant will have the option to reconfigure and choose different fixtures to match their floor plan layout. The fixtures chosen for the takeoff are generic models at an average price. This price will most likely increase once a tenant redesigns it, but the additional cost will be paid for by the tenant.

Table 2: Detailed Electrical Estimate Breakdown

Category	Material Cost	Labor/Equipment Cost	Total Cost
Gear and Equipment	$687,710.84	$220,893.08	$908,603.92
Wire	$662,378.73	$266,020.22	$928,398.94
Conduit	$322,604.17	$351,025.48	$673,629.65
Lighting & Sensors	$131,969.47	$92,952.31	$224,921.87

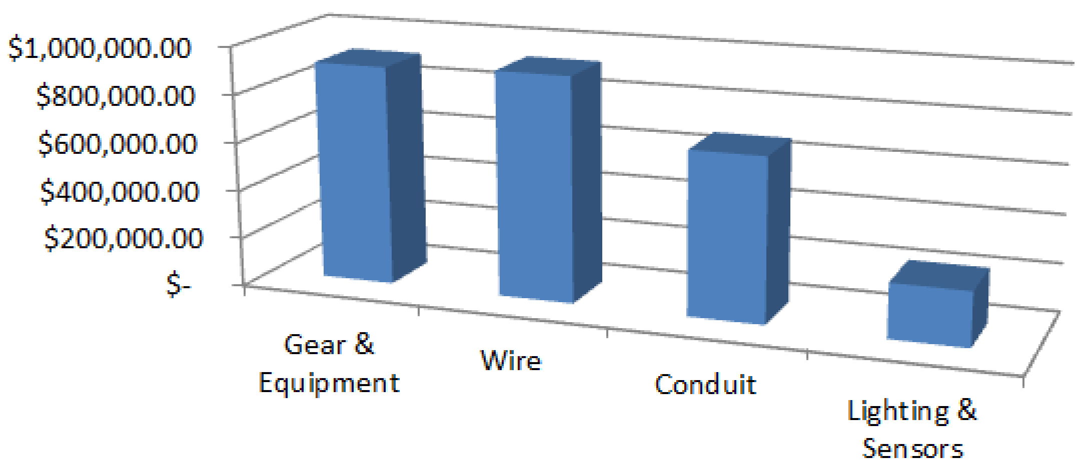

Figure 9: Electrical Cost Breakdown

A breakdown of the electrical systems estimate is shown in Table 2 and Figure 9. The reason the wire category is the highest is due to the large amount of feeders. Once the tenant adds in their communication and receptacle layouts, the conduit and wire prices will increase. Compared to the actual cost, this estimate is about $300,000 lower. This price difference is due to the factors listed in this section, including the shared electrical system. A complete takeoff of the entire electrical system would yield a cost closer to the actual.

General Conditions Estimate

When CityCenterDC was bid, it was separated into four packages. Office Buildings 1 and 2 were grouped together into one of these packages. As a result, the actual general conditions estimate was calculated for both buildings. Additional general conditions costs are dispersed throughout the remaining packages. These costs are for equipment, services, etc. that are shared between all six buildings. The following general conditions estimate for Office Building 1 takes these factors into account. Pricing is a combination of actual job cost data and RSMeans.

Notable Expenses

Winter Protection = $205,200

The office building will endure two winters throughout its construction. It is necessary to provide the appropriate protection from the cold during these months to ensure the quality of the product.

Temporary Power = $121,800

In addition to the power required for the twelve stories and subgrade structure, the crane adds a significant cost to the temporary power.

Office Trailers = $37,625

A total of eight trailers were utilized by the contractor for the entire CItyCenterDC project. Two trailers were used in the general conditions estimate for the office building.

Tower Crane = $226,733

In addition to the 22 ton crane embedded in the middle of the office building, neighboring tower and crawler cranes were used to assist with picks for the office building. As such, the monthly cost for the tower crane in the general conditions estimate was increased by 30%.

Contingency = $841,735

2% contingency was added to the general conditions cost. As mentioned earlier, there are many general conditions costs distributed through the bid prices of all four packages. For example, a concrete batch plant was mobilized on-site in order to supply the large demand from all six buildings. This cost was not directly applied to a specific building. Many of the costs associated with the excavation and foundation phase of the project were assigned to the parking garage package. Cleaning stations and parking were among some other costs that could not be directly quantified for a specific building. Consequently, this 2% contingency provides for many of these expenses.

Table 3: General Conditions Estimate Breakdown

Item	Cost
Staffing	$1,797,225
Bonding & Insurance	$946,952
Temporary Facilities & Utilities	$309,125
Remaining Site Expenses	$1,041,551
Contingency	$841,735

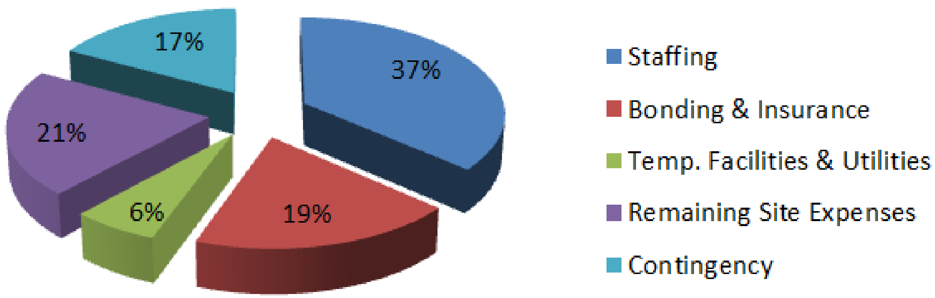

Figure 10: General Conditions Breakdown

Table 3 and Figure 10 outline the major categories of the general conditions costs. Staffing costs comprised the highest percentage due to the heavy supervision and management requirements. The staffing plans created in Technical Report 1, for both office buildings, included 2 project managers, 3 office engineers, 1 project engineer, 2 superintendents, 1 QC Manager. For the general conditions estimate for Office Building 1, only 1 PM, 1 office engineer, 1 project engineer, 2 superintendents, and 1 quality control manager was used. This was done in order to differentiate the staff between the two office buildings. One project executive was also included in the estimate. The "Contingency" category includes the costs that were not directly assigned to Office Building 1, as explained above.

Schedule changes could occur from both the work on the office building and the surrounding buildings. Any such delays could result in the appreciation of some general conditions costs. Any of the services or equipment that is rented would certainly be affected by a significant change in schedule. Also, because the remaining five buildings are being constructed simultaneously, and in most cases sharing the same work force, any major delay in another building could result in one for Office Building 1. In addition to the shared work force, cranes are used across multiple buildings. A schedule delay of another building requiring the office building's crane would mean additional costs for the office building's crane. Such factors are incorporated into the contingency costs.

Building Information Modeling Use

When design for CityCenterDC began in 2005, BIM was still a relevantly new concept. Few individuals in companies had the knowledge and capabilities necessary to implement BIM on a project from the get-go. Consequently, it was not widely adopted in the industry, as was the case with this project. The architects ensued to produce a set of 2D drawings for the design. For the next couple of years, with the development procedures and paperwork still in swing, the design was revisited and adjusted accordingly. By the time the project was set out to bid, years after the initial design, BIM had become a proven tool in the construction industry. Implementation of BIM on large scale projects, such as CityCenterDC, was a given. The project team was anxious to begin construction of CityCenterDC though, and as a result, the developer did not want to spend extra money and time creating a model for the job. Consequently, the job was bid without the use of BIM as a requirement.

This was worrisome in the eyes of the contractors. The complexity and size of the project was overwhelming. They would not be able to perform their duties in the given schedule, much less avoid coordination problems with the various trades. The general consensus was that this project would be extremely difficult without the aid of Building Information Modeling. The MEP subcontractors were the most adamant about the importance of BIM for CityCenterDC.

Figure 11: Pipe Coordination

It was at that point that the mechanical contractor decided to take the lead and make a model. They first created a very rough structural model, outlining the walls, floors, columns, etc. Once that was complete, they could begin modeling their systems. Duct, FPTUs, AHUs, and other gear were the first objects to go into the model. Soon, many of the other contractors joined in the effort.

The electrical contractor worked closely with the mechanical contractor to properly model the electrical and mechanical closets on each floor of the office building. The model turned out extremely helpful in coordinating systems in these tight spaces. The subgrade level, which houses the main electrical and mechanical feeders, is also a very MEP intensive coordination area that required the mechanical, electrical, and plumbing contractors to model their systems prior to beginning their work. As seen in Figure 15, the extensive amount of piping from each trade had to be planned out and modeled to ensure no major clashes occurred.

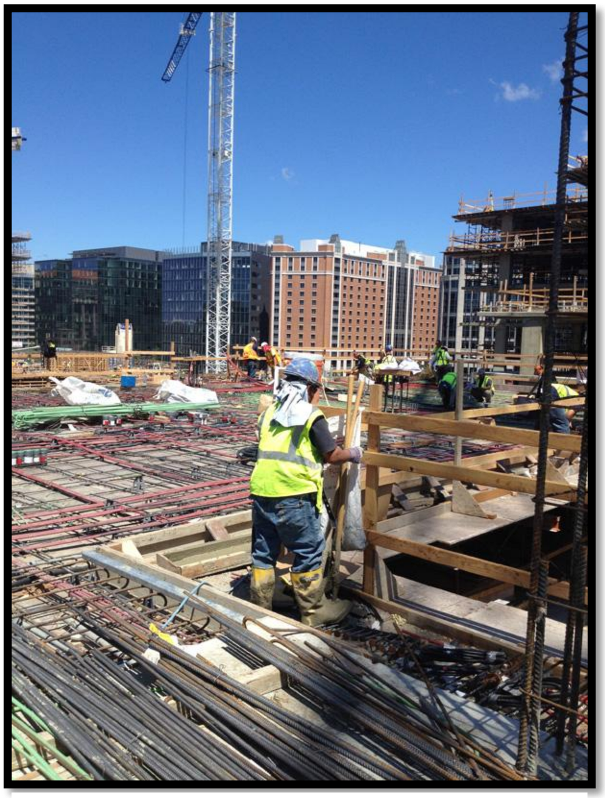

Figure 12: Slab Layout

Another very important coordination issue for this job was the location of the cores and embeds. Before the concrete was poured, the precise location for coring, chases, embeds, etc. had to be found. Traditionally, this would require having a point of reference and measuring out coordinates to the exact spot. This is a very slow and sometimes unreliable method whose risks could not be afforded. Once a post-tensioned slab was poured and stressed, any rework on it would threaten its structural integrity. Therefore, if the location of the core and chases was not correct the first time around, the rework that would have to follow would mean completely redoing the slab. This would cause detrimental delays to the schedule. Consequently, the project team decided to use Trimble equipment, in conjunction with the BIM model, to accurately locate these precise points. As seen in Figure 16 & 17, the total station communicates with the BIM model and transmits the location of the cores to the user. The user then locates the spot and marks it. This process is extremely quick, and as long as the model is correct, also extremely accurate.

Figure 13: Trimble Total Station

Evaluation of BIM Use

The voluntary application of BIM on this project proved to be a large success. The project team was satisfied with the clash detection and coordination. They used it extensively and admit to having avoided many problems. The model was also used to produce 2D drawings for the field. The ability to edit and make revisions on the model was very convenient for the contractors. Contractors worked together very effectively and helped each other on a day to day basis. Without the BIM model, the coordination and communication would not have been as effective.

Table 4: BIM Uses | PennState

X	PLAN	X	DESIGN	X	CONSTRUCT	X	OPERATE
	PROGRAMMING	X	DESIGN AUTHORING	X	SITE UTILIZATION PLANNING		BUILDING MAINTENANCE SCHEDULING
	SITE ANALYSIS	X	DESIGN REVIEWS	X	CONSTRUCTION SYSTEM DESIGN		BUILDING SYSTEM ANALYSIS
		X	3D COORDINATION	X	3D COORDINATION		ASSET MANAGEMENT
			STRUCTURAL ANALYSIS		DIGITAL FABRICATION		SPACE MANAGEMENT / TRACKING
			LIGHTING ANALYSIS		3D CONTROL AND PLANNING		DISASTER PLANNING
			ENERGY ANALYSIS		RECORD MODELING		RECORD MODELING
			MECHANICAL ANALYSIS				
			OTHER ENG. ANALYSIS				
			SUSTAINABLITY (LEED) EVALUATION				
			CODE VALIDATION				
	PHASE PLANNING (4D MODELING)	X	PHASE PLANNING (4D MODELING)	X	PHASE PLANNING (4D MODELING)		PHASE PLANNING (4D MODELING)
	COST ESTIMATION		COST ESTIMATION		COST ESTIMATION		COST ESTIMATION
	EXISTING CONDITIONS MODELING		EXISTING CONDITIONS MODELING		EXISTING CONDITIONS MODELING		EXISTING CONDITIONS MODELING

Table 4 shows the actual and proposed BIM use for the CityCenterDC project. The black marks indicate the BIM uses actually used on the project. Due to its late introduction into the project, the construction team was only able to apply it for 3D coordination and design editing. The red marks, along with the existing black marks, indicate the proposed use. The addition of BIM in the design phase would have helped in the design authoring and phase planning of the project. With a detailed model from the beginning, the team would have been able to resolve issues early on. The complexity and size of the project would have benefited from additional planning that could have been shared with all of the contractors. During the preconstruction phase, the team would have been able to resolve issues prior to the start of construction. A more accurate schedule would have been produced based on these results. Given the repetitive work on many of the office building floors, a 4D model could have been created to show the sequence of work to contractors and allow them to plan accordingly.

The constructability challenge concerning the bridges mentioned earlier could also have been modeled using BIM. The prefabrication and logistics behind the placement could have been modeled in a way to show every contractor their involvement in the process. Linked in with the schedule, it would show each contractor's role and path. The contractors could then use this to link it to their personal schedules and manage their workers.

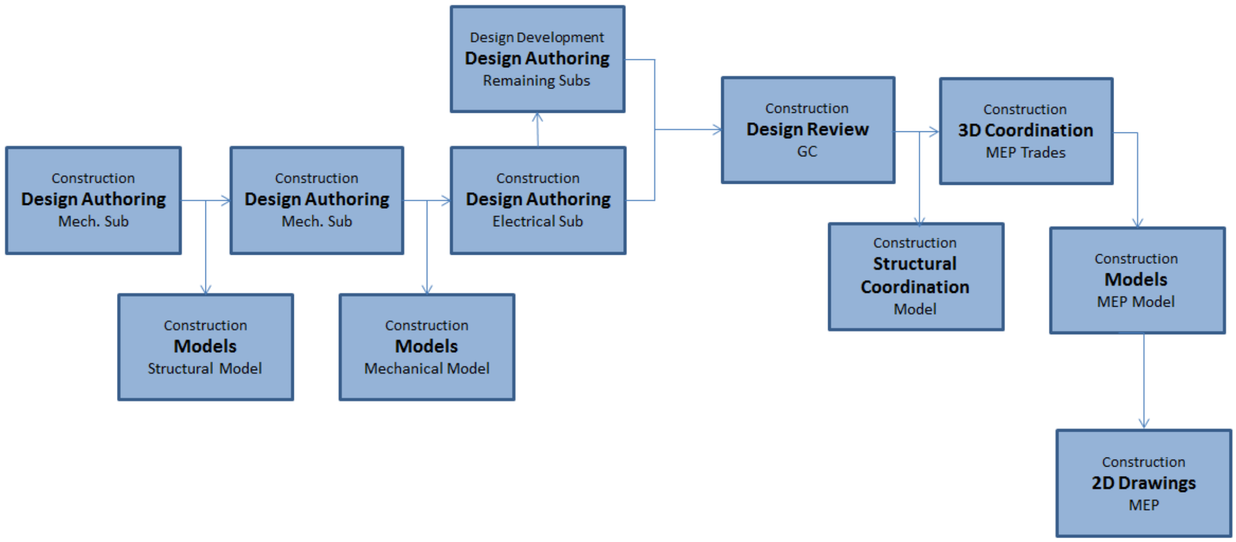

Figure 14: BIM Process Map

Figure 18 demonstrates the actual BIM process taken by the construction team. The mechanical contractor first created a rough structural model, followed by their mechanical systems. The remaining contractors then joined in and added their systems. The GC reviewed the model to ensure no clashes with the structure were present. Following, 3D coordination and clash detection were performed. The final model was produced, from which the 2D drawings were distributed to the field.

Constructability Challenges

Bridges

Spanning in between the two office buildings are five structural steel bridges. These bridges serve as tie-in corridors between office floors of the two buildings. They are connected on either end to a structural steel frame, shown in Figure 11, and enclosed in glass curtain wall.

Figure 15: Structural Steel Frame for Bridges

In planning their construction approach for the bridges, the contractors concentrated on safety as their top priority. At first, the thought was to build them on-spot. This raised many tie-off concerns, as workers would have to hang several stories in the air. Every trade would have to be trained to work at those heights. All work around and below the bridges would also have to stop, and any poor weather conditions would impede progress. All of these issues would translate into additional costs and schedule delays.

With these concerns in mind, an alternative solution to prefabricate the bridges was proposed, and eventually implemented. The bridges would be constructed off-site, in a controlled warehouse environment. Workers would be able to concentrate on building the bridges rather than worrying about their safety. The iron workers would construct the steel structure, followed by the various other trades, including mechanical, electrical, and curtain wall. The trades would alternate on each of the five bridges, creating a production line process. This process would in turn yield a high quality product, as the workers would not be exposed to external factors that could hinder their performance.

The logistics behind placing these prefabricated bridges in their final destination was the most challenging aspect of this tactic. The completed structures would have to be swung in via tower crane. Not only would the crane have to lift the heavy bridge structure over the existing office building, but also maneuver it in the constricted space between the buildings. Once the crane positions the bridge in place, workers would attach each end to the structural steel frame. The remaining work would then be completed on a solid structure, ensuring the safety of the workers. This process would be repeated for all of the bridges.

Cranes

The size and location of the CityCenterDC project called for a unique crane placement layout. Swing radiuses were restricted by the surrounding government buildings, and the project's footprint spanned three city blocks. Space in between the six buildings was not sufficient to place a crane. Regardless, the cranes had to be placed to reach every point of the site.

In general, when deciding on crane placement, the contractor must take into account several factors. First, the crane needs to be close to the pick point. Picks over work areas are not safe, and require more time and effort to perform. Blind picks are also not recommended, as they increase the difficulty and risk associated with the process. If a crane must be placed inside a building, it ought to be positioned so that it does not interrupt any of the main MEP lines. That is, it should not get in the way of any other substantial and critical work, as the crane will be in place for the majority of the project.

In the case of the office building for CityCenterDC, it was determined that the crane would have to be placed inside the building. As mentioned above, it had to be positioned so that the crane operator had a clear line of sight, and the structure of the crane did not interfere with any MEP lines. It is common in these circumstances to place the crane in the mechanical shaft, but due to the large crane size, the tight mechanical shaft would not allow it. As a result, the crane was placed in the northern wing of the office building, as marked in blue in Figure 12. Once the building was enclosed, the crane would be needled out of the hole using a crawler crane. Since the slabs on each floor were poured around the crane, they would have to be patched up. From that point forward, the crawler crane and adjacent cranes would be used for picks necessary for the office building.

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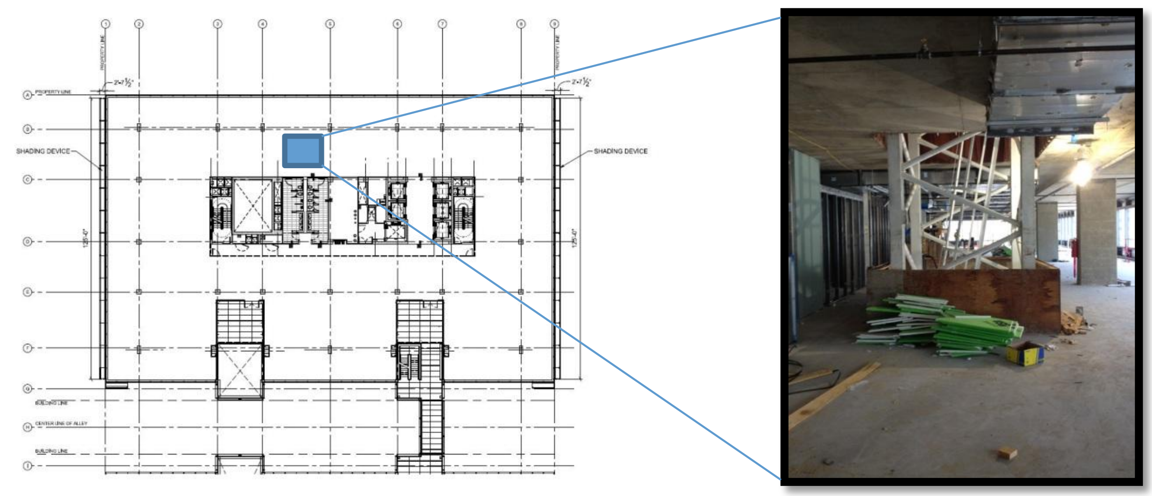


Figure 16: Crane Location

Excavation

One of the earlier challenges for the team came during the excavation phase of the project. Upon performing a geotechnical report, it was found that the site contained contaminated soil, a common occurrence in the area. This called for stringent measures to ship the soil off to a suitable location. Before that could be done though, the team encountered an even larger challenge.

In a typical excavation, an earth ramp is used to transport soil out of the work area. This ramp is built from the existing soil and must be made considerably wide for structural integrity. During the early phases of excavation, such a ramp was present at the CityCenterDC site, as seen in Figure 13.

Figure 17: Earth Ramp at CityCenterDC | OxBlue

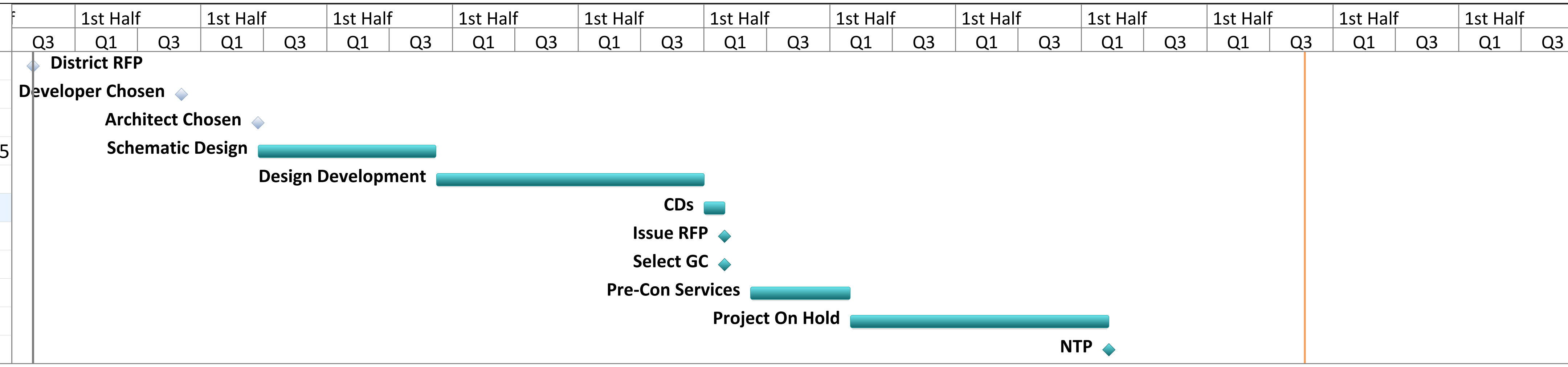
Once the excavation progressed though, the team was faced with a dilemma. The footings and foundations of the garage spanned the entire footprint of the excavation. With a ramp in the middle of the site, they could not begin to set them. They could not simply remove the ramp because they needed a way to transport material and contaminated soil out of the excavation. To solve the problem, an engineered ramp was designed. This ramp, as seen in Figure 14, sat in between two future buildings, thus not interfering with the footings. The piles and supports of the engineered ramp allowed it to be considerably skinnier than the previous, clearing out enough space for the work to continue.

Figure 18: Engineered Ramp

Appendix A

Project Schedule

ID	Task Name	Duration	Start	Finish
1	District RFP	0 days	Sun 9/1/02	NA
2	Developer Chosen	0 days	Thu 11/6/03	NA
3	Architect Chosen	0 days	Tue 6/15/04	NA
4	Schematic Design	370 days	Tue 6/15/04	Mon 11/14/05
5	Design Development	557 days	Tue 11/15/05	Tue 1/1/08
6	CDs	45 days	Tue 1/1/08	Sat 3/1/08
7	Issue RFP	0 days	Sat 3/1/08	Sat 3/1/08
8	Select GC	0 days	Sat 3/1/08	Sat 3/1/08
9	Pre-Con Services	208 days	Thu 5/15/08	Sun 3/1/09
10	Project On Hold	538 days	Sun 3/1/09	Tue 3/22/11
11	NTP	0 days	Tue 3/22/11	Tue 3/22/11



Project: Tech 2 Schedule
Date: 10/12/12
Name: Andy Penev

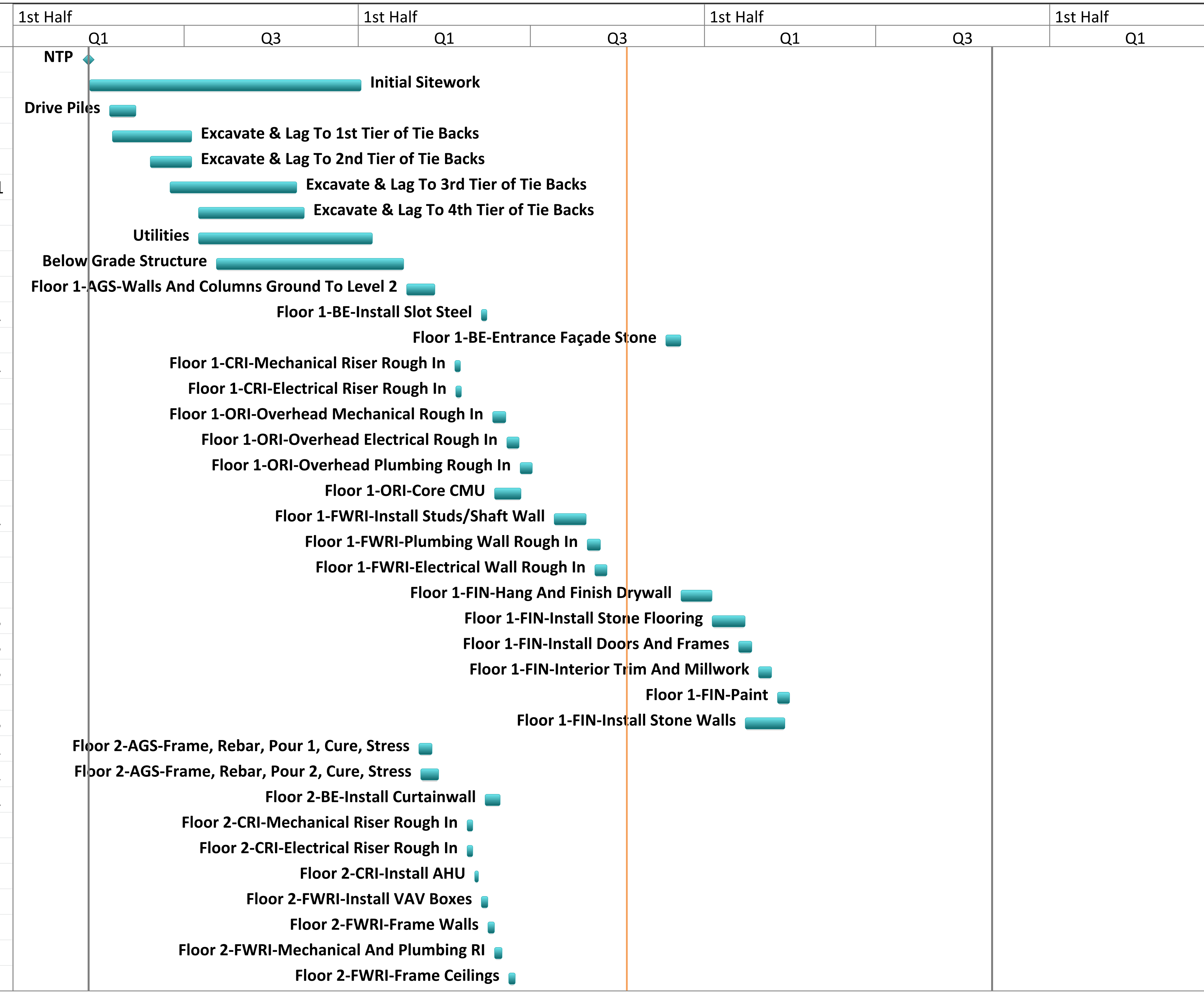
Task	Project Summary	Inactive Milestone	Manual Summary Rollup	Deadline
Split	External Tasks	Inactive Summary	Manual Summary	Progress
Milestone	External Milestone	Manual Task	Start-only	
Summary	Inactive Task	Duration-only	Finish-only	

Construction Schedule

AGS - Above Grade Structure
BE - Building Envelope
CRI - Core Rough In

ORI - Overhead Rough In
FWRI - Framing and Wall Rough In
FIN - Finishes

ID	Task Name	Duration	Start	Finish
1	NTP	0 days	Tue 3/22/11	Tue 3/22/11
2	Initial Sitework	205 days	Wed 3/23/11	Tue 1/3/12
3	Drive Piles	20 days	Wed 4/13/11	Tue 5/10/11
4	Excavate & Lag To 1st Tier of Tie Backs	61 days	Sat 4/16/11	Fri 7/8/11
5	Excavate & Lag To 2nd Tier of Tie Backs	32 days	Thu 5/26/11	Fri 7/8/11
6	Excavate & Lag To 3rd Tier of Tie Backs	96 days	Thu 6/16/11	Thu 10/27/11
7	Excavate & Lag To 4th Tier of Tie Backs	81 days	Sat 7/16/11	Fri 11/4/11
8	Utilities	132 days	Sat 7/16/11	Sun 1/15/12
9	Below Grade Structure	143 days	Thu 8/4/11	Sat 2/18/12
10	Floor 1-AGS-Walls And Columns Ground To Level 2	23 days	Tue 2/21/12	Thu 3/22/12
11	Floor 1-BE-Install Slot Steel	5 days	Thu 5/10/12	Wed 5/16/12
12	Floor 1-BE-Entrance Façade Stone	13 days	Wed 11/21/12	Fri 12/7/12
13	Floor 1-CRI-Mechanical Riser Rough In	5 days	Thu 4/12/12	Wed 4/18/12
14	Floor 1-CRI-Electrical Riser Rough In	5 days	Fri 4/13/12	Thu 4/19/12
15	Floor 1-ORI-Overhead Mechanical Rough In	11 days	Tue 5/22/12	Tue 6/5/12
16	Floor 1-ORI-Overhead Electrical Rough In	10 days	Wed 6/6/12	Tue 6/19/12
17	Floor 1-ORI-Overhead Plumbing Rough In	10 days	Wed 6/20/12	Tue 7/3/12
18	Floor 1-ORI-Core CMU	21 days	Thu 5/24/12	Thu 6/21/12
19	Floor 1-FWRI-Install Studs/Shaft Wall	25 days	Thu 7/26/12	Wed 8/29/12
20	Floor 1-FWRI-Plumbing Wall Rough In	11 days	Thu 8/30/12	Thu 9/13/12
21	Floor 1-FWRI-Electrical Wall Rough In	10 days	Fri 9/7/12	Thu 9/20/12
22	Floor 1-FIN-Hang And Finish Drywall	24 days	Fri 12/7/12	Wed 1/9/13
23	Floor 1-FIN-Install Stone Flooring	26 days	Wed 1/9/13	Wed 2/13/13
24	Floor 1-FIN-Install Doors And Frames	11 days	Wed 2/6/13	Wed 2/20/13
25	Floor 1-FIN-Interior Trim And Millwork	11 days	Wed 2/27/13	Wed 3/13/13
26	Floor 1-FIN-Paint	10 days	Tue 3/19/13	Mon 4/1/13
27	Floor 1-FIN-Install Stone Walls	31 days	Wed 2/13/13	Wed 3/27/13
28	Floor 2-AGS-Frame, Rebar, Pour 1, Cure, Stress	11 days	Mon 3/5/12	Mon 3/19/12
29	Floor 2-AGS-Frame, Rebar, Pour 2, Cure, Stress	14 days	Wed 3/7/12	Mon 3/26/12
30	Floor 2-BE-Install Curtainwall	13 days	Mon 5/14/12	Wed 5/30/12
31	Floor 2-CRI-Mechanical Riser Rough In	5 days	Wed 4/25/12	Tue 5/1/12
32	Floor 2-CRI-Electrical Riser Rough In	5 days	Wed 4/25/12	Tue 5/1/12
33	Floor 2-CRI-Install AHU	3 days	Thu 5/3/12	Mon 5/7/12
34	Floor 2-FWRI-Install VAV Boxes	6 days	Thu 5/10/12	Thu 5/17/12
35	Floor 2-FWRI-Frame Walls	6 days	Thu 5/17/12	Thu 5/24/12
36	Floor 2-FWRI-Mechanical And Plumbing RI	7 days	Thu 5/24/12	Fri 6/1/12
37	Floor 2-FWRI-Frame Ceilings	6 days	Fri 6/8/12	Fri 6/15/12



Project: Tech 2 Schedule
Date: 10/12/12
Name: Andy Penev

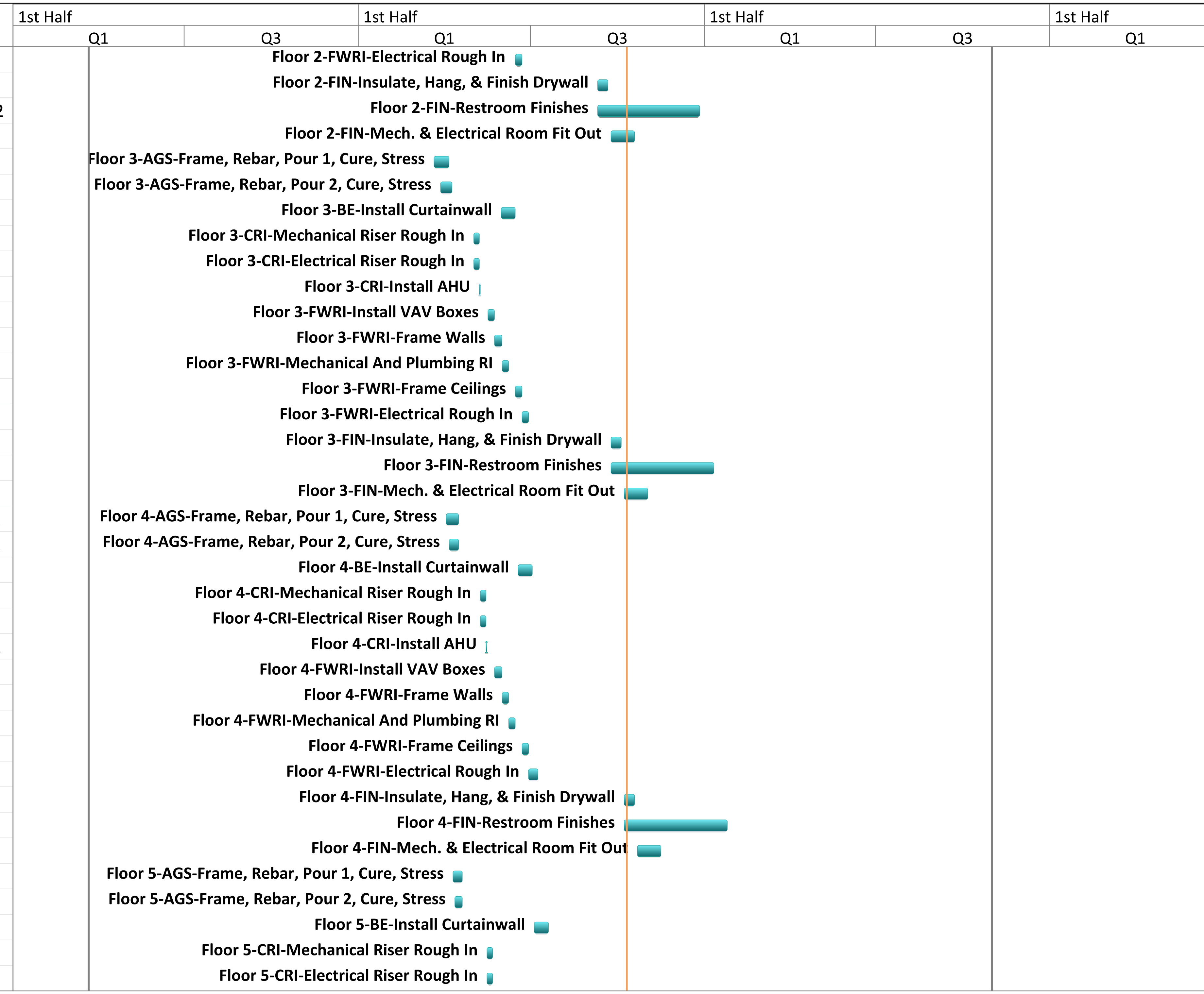
Task	Project Summary	Inactive Milestone	Manual Summary Rollup	Deadline
Split	External Tasks	Inactive Summary	Manual Summary	Progress
Milestone	External Milestone	Manual Task	Start-only	
Summary	Inactive Task	Duration-only	Finish-only	

Construction Schedule

AGS - Above Grade Structure
BE - Building Envelope
CRI - Core Rough In

ORI - Overhead Rough In
FWRI - Framing and Wall Rough In
FIN - Finishes

ID	Task Name	Duration	Start	Finish
38	Floor 2-FWRI-Electrical Rough In	6 days	Fri 6/15/12	Fri 6/22/12
39	Floor 2-FIN-Insulate, Hang, & Finish Drywall	10 days	Mon 9/10/12	Fri 9/21/12
40	Floor 2-FIN-Restroom Finishes	79 days	Mon 9/10/12	Thu 12/27/12
41	Floor 2-FIN-Mech. & Electrical Room Fit Out	20 days	Mon 9/24/12	Fri 10/19/12
42	Floor 3-AGS-Frame, Rebar, Pour 1, Cure, Stress	13 days	Wed 3/21/12	Fri 4/6/12
43	Floor 3-AGS-Frame, Rebar, Pour 2, Cure, Stress	9 days	Wed 3/28/12	Mon 4/9/12
44	Floor 3-BE-Install Curtainwall	12 days	Thu 5/31/12	Fri 6/15/12
45	Floor 3-CRI-Mechanical Riser Rough In	5 days	Wed 5/2/12	Tue 5/8/12
46	Floor 3-CRI-Electrical Riser Rough In	5 days	Wed 5/2/12	Tue 5/8/12
47	Floor 3-CRI-Install AHU	2 days	Tue 5/8/12	Wed 5/9/12
48	Floor 3-FWRI-Install VAV Boxes	6 days	Thu 5/17/12	Thu 5/24/12
49	Floor 3-FWRI-Frame Walls	7 days	Thu 5/24/12	Fri 6/1/12
50	Floor 3-FWRI-Mechanical And Plumbing RI	6 days	Fri 6/1/12	Fri 6/8/12
51	Floor 3-FWRI-Frame Ceilings	6 days	Fri 6/15/12	Fri 6/22/12
52	Floor 3-FWRI-Electrical Rough In	6 days	Fri 6/22/12	Fri 6/29/12
53	Floor 3-FIN-Insulate, Hang, & Finish Drywall	10 days	Mon 9/24/12	Fri 10/5/12
54	Floor 3-FIN-Restroom Finishes	80 days	Mon 9/24/12	Fri 1/11/13
55	Floor 3-FIN-Mech. & Electrical Room Fit Out	20 days	Mon 10/8/12	Fri 11/2/12
56	Floor 4-AGS-Frame, Rebar, Pour 1, Cure, Stress	10 days	Tue 4/3/12	Mon 4/16/12
57	Floor 4-AGS-Frame, Rebar, Pour 2, Cure, Stress	7 days	Fri 4/6/12	Mon 4/16/12
58	Floor 4-BE-Install Curtainwall	12 days	Mon 6/18/12	Tue 7/3/12
59	Floor 4-CRI-Mechanical Riser Rough In	5 days	Wed 5/9/12	Tue 5/15/12
60	Floor 4-CRI-Electrical Riser Rough In	5 days	Wed 5/9/12	Tue 5/15/12
61	Floor 4-CRI-Install AHU	2 days	Tue 5/15/12	Wed 5/16/12
62	Floor 4-FWRI-Install VAV Boxes	7 days	Thu 5/24/12	Fri 6/1/12
63	Floor 4-FWRI-Frame Walls	6 days	Fri 6/1/12	Fri 6/8/12
64	Floor 4-FWRI-Mechanical And Plumbing RI	6 days	Fri 6/8/12	Fri 6/15/12
65	Floor 4-FWRI-Frame Ceilings	6 days	Fri 6/22/12	Fri 6/29/12
66	Floor 4-FWRI-Electrical Rough In	7 days	Fri 6/29/12	Mon 7/9/12
67	Floor 4-FIN-Insulate, Hang, & Finish Drywall	10 days	Mon 10/8/12	Fri 10/19/12
68	Floor 4-FIN-Restroom Finishes	80 days	Mon 10/8/12	Fri 1/25/13
69	Floor 4-FIN-Mech. & Electrical Room Fit Out	20 days	Mon 10/22/12	Fri 11/16/12
70	Floor 5-AGS-Frame, Rebar, Pour 1, Cure, Stress	9 days	Tue 4/10/12	Fri 4/20/12
71	Floor 5-AGS-Frame, Rebar, Pour 2, Cure, Stress	7 days	Thu 4/12/12	Fri 4/20/12
72	Floor 5-BE-Install Curtainwall	12 days	Thu 7/5/12	Fri 7/20/12
73	Floor 5-CRI-Mechanical Riser Rough In	5 days	Wed 5/16/12	Tue 5/22/12
74	Floor 5-CRI-Electrical Riser Rough In	5 days	Wed 5/16/12	Tue 5/22/12



Project: Tech 2 Schedule
Date: 10/12/12
Name: Andy Penev

Task	Project Summary	Inactive Milestone	Manual Summary Rollup	Deadline
Split	External Tasks	Inactive Summary	Manual Summary	Progress
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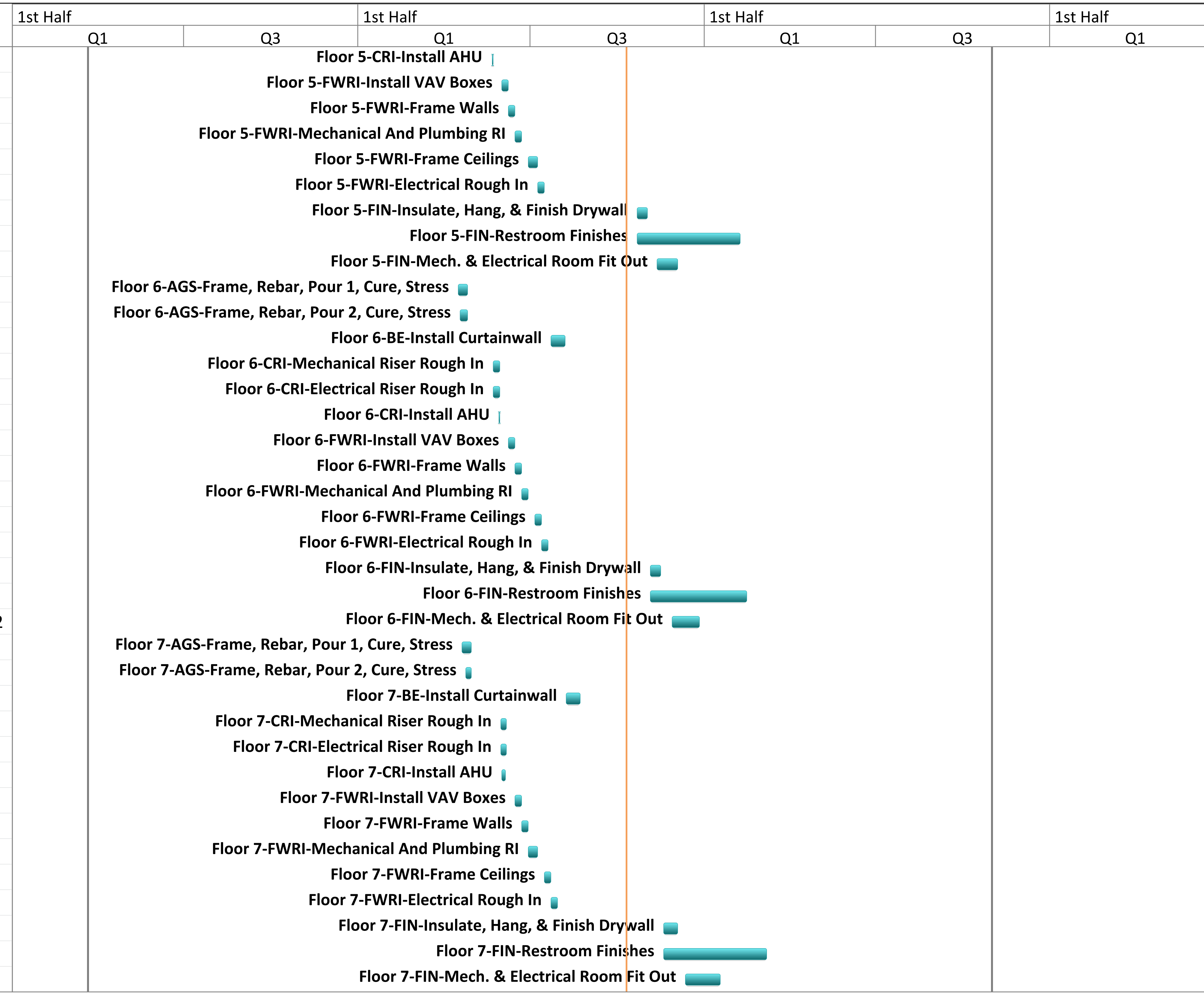
Construction Schedule

AGS - Above Grade Structure
BE - Building Envelope
CRI - Core Rough In

ORI - Overhead Rough In
FWRI - Framing and Wall Rough In
FIN - Finishes

ID	Task Name	Duration	Start	Finish
75	Floor 5-CRI-Install AHU	2 days	Tue 5/22/12	Wed 5/23/12
76	Floor 5-FWRI-Install VAV Boxes	6 days	Fri 6/1/12	Fri 6/8/12
77	Floor 5-FWRI-Frame Walls	6 days	Fri 6/8/12	Fri 6/15/12
78	Floor 5-FWRI-Mechanical And Plumbing RI	6 days	Fri 6/15/12	Fri 6/22/12
79	Floor 5-FWRI-Frame Ceilings	7 days	Fri 6/29/12	Mon 7/9/12
80	Floor 5-FWRI-Electrical Rough In	6 days	Mon 7/9/12	Mon 7/16/12
81	Floor 5-FIN-Insulate, Hang, & Finish Drywall	10 days	Mon 10/22/12	Fri 11/2/12
82	Floor 5-FIN-Restroom Finishes	80 days	Mon 10/22/12	Fri 2/8/13
83	Floor 5-FIN-Mech. & Electrical Room Fit Out	17 days	Mon 11/12/12	Tue 12/4/12
84	Floor 6-AGS-Frame, Rebar, Pour 1, Cure, Stress	9 days	Mon 4/16/12	Thu 4/26/12
85	Floor 6-AGS-Frame, Rebar, Pour 2, Cure, Stress	7 days	Wed 4/18/12	Thu 4/26/12
86	Floor 6-BE-Install Curtainwall	12 days	Mon 7/23/12	Tue 8/7/12
87	Floor 6-CRI-Mechanical Riser Rough In	6 days	Wed 5/23/12	Wed 5/30/12
88	Floor 6-CRI-Electrical Riser Rough In	6 days	Wed 5/23/12	Wed 5/30/12
89	Floor 6-CRI-Install AHU	2 days	Tue 5/29/12	Wed 5/30/12
90	Floor 6-FWRI-Install VAV Boxes	6 days	Fri 6/8/12	Fri 6/15/12
91	Floor 6-FWRI-Frame Walls	6 days	Fri 6/15/12	Fri 6/22/12
92	Floor 6-FWRI-Mechanical And Plumbing RI	6 days	Fri 6/22/12	Fri 6/29/12
93	Floor 6-FWRI-Frame Ceilings	6 days	Fri 7/6/12	Fri 7/13/12
94	Floor 6-FWRI-Electrical Rough In	6 days	Fri 7/13/12	Fri 7/20/12
95	Floor 6-FIN-Insulate, Hang, & Finish Drywall	10 days	Mon 11/5/12	Fri 11/16/12
96	Floor 6-FIN-Restroom Finishes	75 days	Mon 11/5/12	Fri 2/15/13
97	Floor 6-FIN-Mech. & Electrical Room Fit Out	22 days	Wed 11/28/12	Thu 12/27/12
98	Floor 7-AGS-Frame, Rebar, Pour 1, Cure, Stress	7 days	Fri 4/20/12	Mon 4/30/12
99	Floor 7-AGS-Frame, Rebar, Pour 2, Cure, Stress	5 days	Tue 4/24/12	Mon 4/30/12
100	Floor 7-BE-Install Curtainwall	12 days	Wed 8/8/12	Thu 8/23/12
101	Floor 7-CRI-Mechanical Riser Rough In	5 days	Thu 5/31/12	Wed 6/6/12
102	Floor 7-CRI-Electrical Riser Rough In	5 days	Thu 5/31/12	Wed 6/6/12
103	Floor 7-CRI-Install AHU	3 days	Fri 6/1/12	Tue 6/5/12
104	Floor 7-FWRI-Install VAV Boxes	6 days	Fri 6/15/12	Fri 6/22/12
105	Floor 7-FWRI-Frame Walls	6 days	Fri 6/22/12	Fri 6/29/12
106	Floor 7-FWRI-Mechanical And Plumbing RI	7 days	Fri 6/29/12	Mon 7/9/12
107	Floor 7-FWRI-Frame Ceilings	6 days	Mon 7/16/12	Mon 7/23/12
108	Floor 7-FWRI-Electrical Rough In	6 days	Mon 7/23/12	Mon 7/30/12
109	Floor 7-FIN-Insulate, Hang, & Finish Drywall	12 days	Mon 11/19/12	Tue 12/4/12
110	Floor 7-FIN-Restroom Finishes	80 days	Mon 11/19/12	Fri 3/8/13
111	Floor 7-FIN-Mech. & Electrical Room Fit Out	28 days	Wed 12/12/12	Fri 1/18/13



Project: Tech 2 Schedule
Date: 10/12/12
Name: Andy Penev

Task | Split | Milestone | Summary | Project Summary | External Tasks | External Milestone | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | Deadline | Progress

Construction Schedule

AGS - Above Grade Structure
BE - Building Envelope
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ORI - Overhead Rough In
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FIN - Finishes

ID	Task Name	Duration	Start	Finish
112	Floor 8-AGS-Frame, Rebar, Pour 1, Cure, Stress	8 days	Thu 4/26/12	Mon 5/7/12
113	Floor 8-AGS-Frame, Rebar, Pour 2, Cure, Stress	6 days	Mon 4/30/12	Mon 5/7/12
114	Floor 8-BE-Install Curtainwall	13 days	Fri 8/24/12	Tue 9/11/12
115	Floor 8-CRI-Mechanical Riser Rough In	5 days	Thu 6/7/12	Wed 6/13/12
116	Floor 8-CRI-Electrical Riser Rough In	5 days	Thu 6/7/12	Wed 6/13/12
117	Floor 8-CRI-Install AHU	2 days	Thu 6/14/12	Fri 6/15/12
118	Floor 8-FWRI-Install VAV Boxes	6 days	Fri 6/22/12	Fri 6/29/12
119	Floor 8-FWRI-Frame Walls	7 days	Fri 6/29/12	Mon 7/9/12
120	Floor 8-FWRI-Mechanical And Plumbing RI	6 days	Mon 7/9/12	Mon 7/16/12
121	Floor 8-FWRI-Frame Ceilings	6 days	Mon 7/23/12	Mon 7/30/12
122	Floor 8-FWRI-Electrical Rough In	6 days	Mon 7/30/12	Mon 8/6/12
123	Floor 8-FIN-Insulate, Hang, & Finish Drywall	10 days	Wed 12/5/12	Tue 12/18/12
124	Floor 8-FIN-Restroom Finishes	78 days	Wed 12/5/12	Fri 3/22/13
125	Floor 8-FIN-Mech. & Electrical Room Fit Out	31 days	Fri 12/28/12	Fri 2/8/13
126	Floor 9-AGS-Frame, Rebar, Pour 1, Cure, Stress	9 days	Wed 5/2/12	Mon 5/14/12
127	Floor 9-AGS-Frame, Rebar, Pour 2, Cure, Stress	7 days	Fri 5/4/12	Mon 5/14/12
128	Floor 9-BE-Install Curtainwall	12 days	Wed 9/12/12	Thu 9/27/12
129	Floor 9-CRI-Mechanical Riser Rough In	5 days	Thu 6/14/12	Wed 6/20/12
130	Floor 9-CRI-Electrical Riser Rough In	5 days	Wed 6/13/12	Tue 6/19/12
131	Floor 9-CRI-Install AHU	2 days	Tue 6/19/12	Wed 6/20/12
132	Floor 9-FWRI-Install VAV Boxes	7 days	Fri 6/29/12	Mon 7/9/12
133	Floor 9-FWRI-Frame Walls	6 days	Mon 7/9/12	Mon 7/16/12
134	Floor 9-FWRI-Mechanical And Plumbing RI	6 days	Mon 7/16/12	Mon 7/23/12
135	Floor 9-FWRI-Frame Ceilings	6 days	Mon 7/30/12	Mon 8/6/12
136	Floor 9-FWRI-Electrical Rough In	6 days	Mon 8/6/12	Mon 8/13/12
137	Floor 9-FIN-Insulate, Hang, & Finish Drywall	13 days	Wed 12/19/12	Fri 1/4/13
138	Floor 9-FIN-Restroom Finishes	78 days	Wed 12/19/12	Fri 4/5/13
139	Floor 9-FIN-Mech. & Electrical Room Fit Out	35 days	Mon 1/14/13	Fri 3/1/13
140	Floor 10-AGS-Frame, Rebar, Pour 1, Cure, Stress	9 days	Tue 5/8/12	Fri 5/18/12
141	Floor 10-AGS-Frame, Rebar, Pour 2, Cure, Stress	8 days	Wed 5/9/12	Fri 5/18/12
142	Floor 10-BE-Install Curtainwall	12 days	Fri 9/28/12	Mon 10/15/12
143	Floor 10-CRI-Mechanical Riser Rough In	5 days	Thu 6/21/12	Wed 6/27/12
144	Floor 10-CRI-Electrical Riser Rough In	5 days	Thu 6/21/12	Wed 6/27/12
145	Floor 10-CRI-Install AHU	2 days	Fri 6/22/12	Mon 6/25/12
146	Floor 10-FWRI-Install VAV Boxes	6 days	Mon 7/9/12	Mon 7/16/12
147	Floor 10-FWRI-Frame Walls	6 days	Mon 7/16/12	Mon 7/23/12
148	Floor 10-FWRI-Mechanical And Plumbing RI	6 days	Mon 7/23/12	Mon 7/30/12

Project: Tech 2 Schedule
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Construction Schedule

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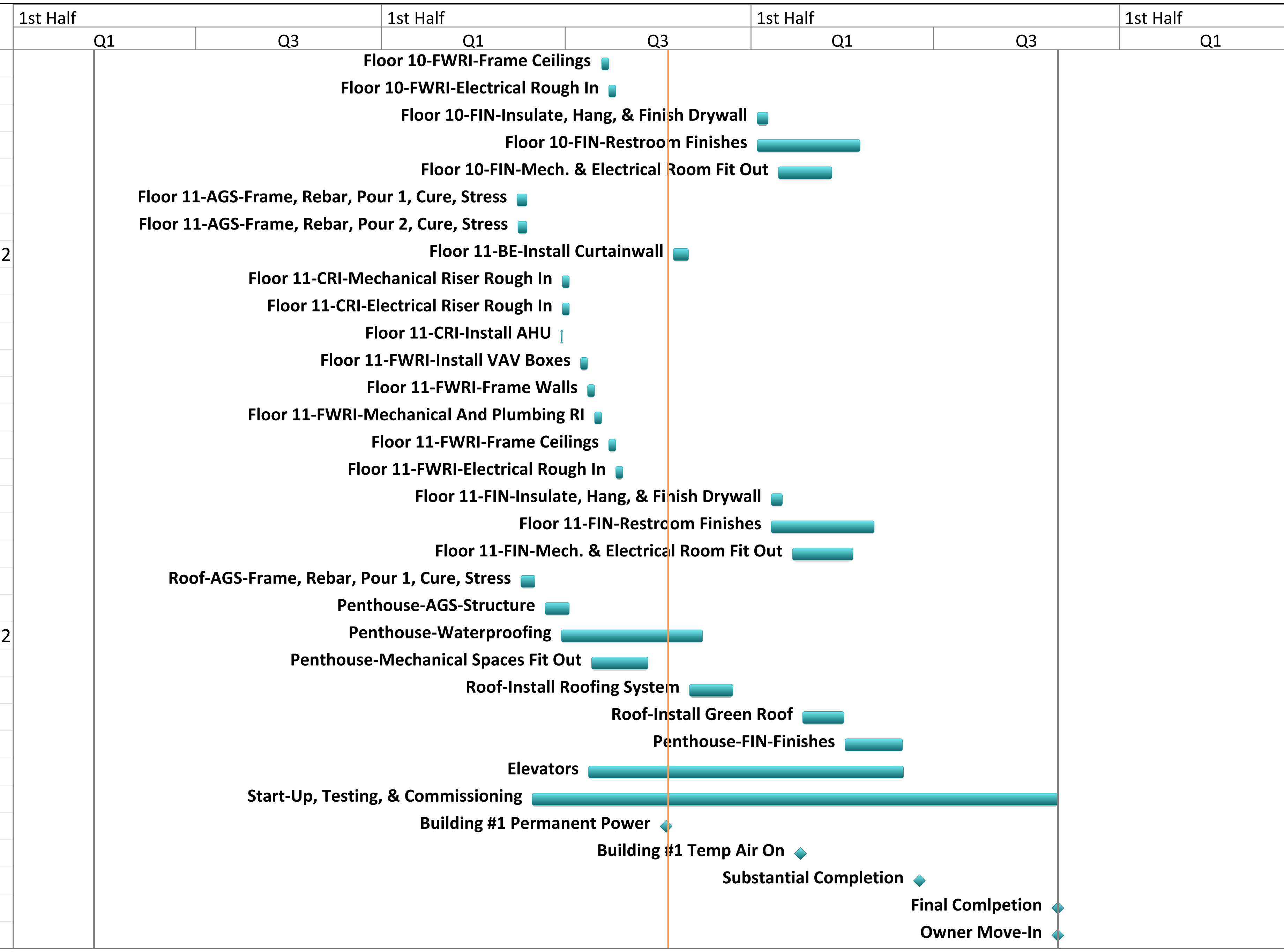
ID	Task Name	Duration	Start	Finish
149	Floor 10-FWRI-Frame Ceilings	6 days	Mon 8/6/12	Mon 8/13/12
150	Floor 10-FWRI-Electrical Rough In	6 days	Mon 8/13/12	Mon 8/20/12
151	Floor 10-FIN-Insulate, Hang, & Finish Drywall	10 days	Mon 1/7/13	Fri 1/18/13
152	Floor 10-FIN-Restroom Finishes	75 days	Mon 1/7/13	Fri 4/19/13
153	Floor 10-FIN-Mech. & Electrical Room Fit Out	40 days	Mon 1/28/13	Fri 3/22/13
154	Floor 11-AGS-Frame, Rebar, Pour 1, Cure, Stress	9 days	Mon 5/14/12	Thu 5/24/12
155	Floor 11-AGS-Frame, Rebar, Pour 2, Cure, Stress	8 days	Tue 5/15/12	Thu 5/24/12
156	Floor 11-BE-Install Curtainwall	12 days	Tue 10/16/12	Wed 10/31/12
157	Floor 11-CRI-Mechanical Riser Rough In	6 days	Thu 6/28/12	Thu 7/5/12
158	Floor 11-CRI-Electrical Riser Rough In	6 days	Thu 6/28/12	Thu 7/5/12
159	Floor 11-CRI-Install AHU	2 days	Wed 6/27/12	Thu 6/28/12
160	Floor 11-FWRI-Install VAV Boxes	6 days	Mon 7/16/12	Mon 7/23/12
161	Floor 11-FWRI-Frame Walls	6 days	Mon 7/23/12	Mon 7/30/12
162	Floor 11-FWRI-Mechanical And Plumbing RI	6 days	Mon 7/30/12	Mon 8/6/12
163	Floor 11-FWRI-Frame Ceilings	6 days	Mon 8/13/12	Mon 8/20/12
164	Floor 11-FWRI-Electrical Rough In	6 days	Mon 8/20/12	Mon 8/27/12
165	Floor 11-FIN-Insulate, Hang, & Finish Drywall	10 days	Mon 1/21/13	Fri 2/1/13
166	Floor 11-FIN-Restroom Finishes	75 days	Mon 1/21/13	Fri 5/3/13
167	Floor 11-FIN-Mech. & Electrical Room Fit Out	45 days	Mon 2/11/13	Fri 4/12/13
168	Roof-AGS-Frame, Rebar, Pour 1, Cure, Stress	11 days	Fri 5/18/12	Fri 6/1/12
169	Penthouse-AGS-Structure	19 days	Mon 6/11/12	Thu 7/5/12
170	Penthouse-Waterproofing	101 days	Wed 6/27/12	Wed 11/14/12
171	Penthouse-Mechanical Spaces Fit Out	41 days	Fri 7/27/12	Fri 9/21/12
172	Roof-Install Roofing System	32 days	Thu 11/1/12	Fri 12/14/12
173	Roof-Install Green Roof	30 days	Thu 2/21/13	Wed 4/3/13
174	Penthouse-FIN-Finishes	42 days	Thu 4/4/13	Fri 5/31/13
175	Elevators	225 days	Tue 7/24/12	Sat 6/1/13
176	Start-Up, Testing, & Commissioning	374 days	Tue 5/29/12	Fri 11/1/13
177	Building #1 Permanent Power	0 days	Tue 10/9/12	Tue 10/9/12
178	Building #1 Temp Air On	0 days	Tue 2/19/13	Tue 2/19/13
179	Substantial Completion	0 days	Mon 6/17/13	Mon 6/17/13
180	Final Comlpetion	0 days	Fri 11/1/13	Fri 11/1/13
181	Owner Move-In	0 days	Fri 11/1/13	Fri 11/1/13



Project: Tech 2 Schedule
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Task · Split · Milestone · Summary · Project Summary · External Tasks · External Milestone · Inactive Task · Inactive Milestone · Inactive Summary · Manual Task · Duration-only · Manual Summary Rollup · Manual Summary · Start-only · Finish-only · Deadline · Progress

Appendix B

Detailed Electrical Estimate

Summary

Category	Material Cost	Labor/Equipment Cost	Total Cost
Gear & Equipment	$ 687,710.84	$ 220,893.08	$ 908,603.92
Wire	$ 662,378.73	$ 266,020.22	$ 928,398.94
Conduit	$ 322,604.17	$ 351,025.48	$ 673,629.65
Lighting & Sensors	$ 131,969.47	$ 92,952.31	$ 224,921.78

Subtotals (loc., yr, adj. applied)	$ 1,804,663.21	$ 930,891.09	$ 2,735,554.29
Misc. Material (5%)	$ 90,233.16		$ 90,233.16
O&P (10%)	$ 189,489.64	$ 93,089.11	$ 282,578.75
Total			**$ 3,108,366.20**

Gear & Equipment

Cost Code	Item	Unit	Quantity	Mat. Unit. Price	Mat. Cost	Bare Labor	Labor/Equip. Cost	Total Cost
262213103100	XFMR, dry-type, 480V pri., 120/208 sec., 15kVA	EA	7	$ 1,259.70	$ 8,817.90	$ 795.00	$ 5,565.00	$ 14,382.90
262213103300	XFMR, dry-type, 480V pri., 120/208 sec., 30kVA	EA	3	$ 1,284.40	$ 3,853.20	$ 969.00	$ 2,907.00	$ 6,760.20
262213103500	XFMR, dry-type, 480V pri., 120/208 sec., 45kVA	EA	1	$ 1,531.40	$ 1,531.40	$ 1,086.50	$ 1,086.50	$ 2,617.90
262213103700	XFMR, dry-type, 480V pri., 120/208 sec., 75kVA	EA	2	$ 2,321.80	$ 4,643.60	$ 1,245.50	$ 2,491.00	$ 7,134.60
262213103900	XFMR, dry-type, 480V pri., 120/208 sec., 112.5kVA	EA	11	$ 3,062.80	$ 33,690.80	$ 1,344.20	$ 14,786.20	$ 48,477.00
262816200400	Safety Switch, 200A	EA	23	$ 736.00	$ 16,928.00	$ 333.90	$ 7,679.70	$ 24,607.70
262816200500	Safety Switch, 400A	EA	1	$ 1,852.50	$ 1,852.50	$ 487.60	$ 487.60	$ 2,340.10
262816102060	Circuit Breaker, Disconnect, NEMA 1, 20HP	EA	10	$ 503.88	$ 5,038.80	$ 189.74	$ 1,897.40	$ 6,936.20
262816101400	Circuit Breaker, NEMA 1, 1200A w/ ground fault	EA	1	$ 12,844.00	$ 12,844.00	$ 1,086.50	$ 1,086.50	$ 13,930.50
263213133240	Diesel-Engine Generator, 750kW	EA	1	$ 191,672.00	$ 191,672.00	$ 5,803.50	$ 5,803.50	$ 197,475.50
262416302300	Panelboard, 120/208V, 400A	EA	20	$ 3,112.20	$ 62,244.00	$ 1,828.50	$ 36,570.00	$ 98,814.00
262416302250	Panelboard, 120/208V, 225A	EA	4	$ 2,321.80	$ 9,287.20	$ 1,563.50	$ 6,254.00	$ 15,541.20
262416301000	Panelboard, 120/208V, 200A	EA	31	$ 1,358.50	$ 42,113.50	$ 1,298.50	$ 40,253.50	$ 82,367.00
262416300800	Panelboard, 120/208V, 100A	EA	18	$ 1,037.40	$ 18,673.20	$ 826.80	$ 14,882.40	$ 33,555.60
262416303360	Panelboard, 120/208V, 50A	EA	6	$ 790.40	$ 4,742.40	$ 218.36	$ 1,310.16	$ 6,052.56
262416302700	Panelboard, 277/480V, 400A	EA	5	$ 4,964.70	$ 24,823.50	$ 1,908.00	$ 9,540.00	$ 34,363.50
262416302750	Panelboard, 277/480V, 600A	EA	2	$ 6,792.50	$ 13,585.00	$ 2,305.50	$ 4,611.00	$ 18,196.00
262416301500	Panelboard, 277/480V, 200A	EA	7	$ 3,136.90	$ 21,958.30	$ 1,457.50	$ 10,202.50	$ 32,160.80
262416303210	Panelboard, 277/480V, 150A	EA	1	$ 1,086.80	$ 1,086.80	$ 218.36	$ 218.36	$ 1,305.16
262416303460	Panelboard, 277/480V, 100A	EA	4	$ 711.36	$ 2,845.44	$ 189.74	$ 758.96	$ 3,604.40
263623100800	ATS, 480V, 600A	EA	1	$ 8,373.30	$ 8,373.30	$ 1,086.50	$ 1,086.50	$ 9,459.80
263623100700	ATS, 480V, 400A	EA	2	$ 6,051.50	$ 12,103.00	$ 874.50	$ 1,749.00	$ 13,852.00
263623100500	ATS, 480V, 200A	EA	1	$ 4,001.40	$ 4,001.40	$ 434.60	$ 434.60	$ 4,436.00
262413300900	Switchboard-1, 3000A	EA	1	$ 6,594.90	$ 6,594.90	$ 1,563.50	$ 1,563.50	$ 8,158.40
262413300950	Switchboard-2, 4000A	EA	1	$ 9,633.00	$ 9,633.00	$ 1,669.50	$ 1,669.50	$ 11,302.50
262816101800	MCB-2, 2000A	EA	3	$ 18,080.40	$ 54,241.20	$ 1,378.00	$ 4,134.00	$ 58,375.20
262816101200	MCB-1, 1000A	EA	1	$ 6,347.90	$ 6,347.90	$ 1,038.80	$ 1,038.80	$ 7,386.70
262413200250	Distribution Switchboard, 200A	EA	5	$ 1,086.80	$ 5,434.00	$ 726.10	$ 3,630.50	$ 9,064.50
262413200260	Distribution Switchboard, 400A	EA	4	$ 1,259.70	$ 5,038.80	$ 726.10	$ 2,904.40	$ 7,943.20
262413200270	Distribution Switchboard, 600A	EA	1	$ 1,383.20	$ 1,383.20	$ 726.10	$ 726.10	$ 2,109.30
262413200290	Distribution Switchboard, 1200A	EA	1	$ 1,852.50	$ 1,852.50	$ 948.70	$ 948.70	$ 2,801.20
262816100600	Circuit Breaker, 200A	EA	5	$ 1,556.10	$ 7,780.50	$ 291.50	$ 1,457.50	$ 9,238.00
262816100700	Circuit Breaker, 400A	EA	4	$ 2,667.60	$ 10,670.40	$ 545.90	$ 2,183.60	$ 12,854.00
262816100800	Circuit Breaker, 600A	EA	1	$ 3,853.20	$ 3,853.20	$ 726.10	$ 726.10	$ 4,579.30
262816101220	Circuit Breaker, 1200A	EA	1	$ 8,126.30	$ 8,126.30	$ 1,086.50	$ 1,086.50	$ 9,212.80
262923100150	Variable Frequency Drives, 20HP	EA	11	$ 2,494.70	$ 27,441.70	$ 980.50	$ 10,785.50	$ 38,227.20
262923100100	Variable Frequency Drives, 1HP	EA	30	$ 1,086.80	$ 32,604.00	$ 545.90	$ 16,377.00	$ 48,981.00

Wire

Cost Code	Item	Unit	Quantity	Mat. Unit. Price	Mat. Cost	Bare Labor	Labor/Equip. Cost	Total Cost
260519901200	Wire, Copper, THWN-THHN, #12	CLF	912.46	$ 14.18	$ 12,938.68	$ 39.75	$ 36,270.29	$ 49,208.97
260519901250	Wire, Copper, THWN-THHN, #10	CLF	1546.49	$ 21.74	$ 33,620.69	$ 43.46	$ 67,210.46	$ 100,831.15
2600519901300	Wire, Copper, THWN-THHN, #8	CLF	32.85	$ 33.10	$ 1,087.34	$ 54.59	$ 1,793.28	$ 2,880.62
260519901350	Wire, Copper, THWN-THHN, #6	CLF	66.52	$ 56.81	$ 3,779.00	$ 67.31	$ 4,477.46	$ 8,256.46
260519901400	Wire, Copper, THWN-THHN, #4	CLF	3.55	$ 88.92	$ 315.67	$ 82.68	$ 293.51	$ 609.18
260519901450	Wire, Copper, THWN-THHN, #3	CLF	15.15	$ 112.63	$ 1,706.34	$ 87.45	$ 1,324.87	$ 3,031.21
260519901550	Wire, Copper, THWN-THHN, #1	CLF	20.42	$ 184.76	$ 3,772.80	$ 109.18	$ 2,229.46	$ 6,002.25
260519901600	Wire, Copper, THWN-THHN, #1/0	CLF	43.5	$ 223.29	$ 9,713.12	$ 132.50	$ 5,763.75	$ 15,476.87
260519901650	Wire, Copper, THWN-THHN, #2/0	CLF	8.25	$ 279.60	$ 2,306.70	$ 150.52	$ 1,241.79	$ 3,548.49
260519901700	Wire, Copper, THWN-THHN, #3/0	CLF	89.8	$ 350.74	$ 31,496.45	$ 174.90	$ 15,706.02	$ 47,202.47
260519902000	Wire, Copper, THWN-THHN, #4/0	CLF	14.2	$ 439.66	$ 6,243.17	$ 198.22	$ 2,814.72	$ 9,057.90
260519902400	Wire, Copper, THWN-THHN, #300MCM	CLF	9	$ 622.44	$ 5,601.96	$ 230.02	$ 2,070.18	$ 7,672.14
260519902600	Wire, Copper, THWN-THHN, #350MCM	CLF	28.8	$ 731.12	$ 21,056.26	$ 242.74	$ 6,990.91	$ 28,047.17
260519902800	Wire, Copper, THWN-THHN, #500MCM	CLF	107.65	$ 1,037.40	$ 111,676.11	$ 273.48	$ 29,440.12	$ 141,116.23
262513403030	Busway, 4000A	LF	400	$ 1,037.40	$ 414,960.00	$ 218.36	$ 87,344.00	$ 502,304.00
260526803810	Insulated Ground, Copper, 3/0	CLF	6	$ 350.74	$ 2,104.44	$ 174.90	$ 1,049.40	$ 3,153.84

Conduit

Cost Code	Item	Unit	Quantity	Mat. Unit. Price	Mat. Cost	Bare Labor	Labor/Equip. Cost	Total Cost
260533135020	EMT, 3/4"	LF	54750	$ 1.11	$ 60,772.50	$ 3.36	$ 183,960.00	$ 244,732.50
260533135040	EMT, 1"	LF	970	$ 1.92	$ 1,862.40	$ 3.81	$ 3,695.70	$ 5,558.10
260533135080	EMT, 1 1/2"	LF	1300	$ 4.16	$ 5,408.00	$ 4.85	$ 6,305.00	$ 11,713.00
260533135100	EMT, 2"	LF	1078	$ 5.38	$ 5,799.64	$ 5.46	$ 5,885.88	$ 11,685.52
260533135120	EMT, 2 1/2"	LF	5420	$ 12.89	$ 69,863.80	$ 7.26	$ 39,349.20	$ 109,213.00
260533135160	EMT, 3 1/2"	LF	1260	$ 19.46	$ 24,519.60	$ 9.70	$ 12,222.00	$ 36,741.60
260533135180	EMT, 4"	LF	2500	$ 21.24	$ 53,100.00	$ 10.92	$ 27,300.00	$ 80,400.00
260533135700	Elbows, 1" diameter	EA	20	$ 8.65	$ 173.00	$ 10.92	$ 218.40	$ 391.40
260533135740	Elbows, 1 1/2" diameter	EA	6	$ 12.45	$ 74.70	$ 18.23	$ 109.38	$ 184.08
260533135760	Elbows, 2" diameter	EA	101	$ 18.33	$ 1,851.33	$ 21.73	$ 2,194.73	$ 4,046.06
260533135780	Elbows, 2 1/2" diameter	EA	185	$ 44.46	$ 8,225.10	$ 36.57	$ 6,765.45	$ 14,990.55
260533135820	Elbows, 3 1/2" diameter	EA	88	$ 88.92	$ 7,824.96	$ 62.54	$ 5,503.52	$ 13,328.48
260533135840	Elbows, 4" diameter	EA	20	$ 104.73	$ 2,094.60	$ 72.61	$ 1,452.20	$ 3,546.80
260533136220	Couplings, 3/4" diameter	EA	209	$ 3.13	$ 654.17		$ -	$ 654.17
260533136240	Couplings, 1" diameter	EA	31	$ 5.09	$ 157.79		$ -	$ 157.79
260533136280	Couplings, 1 1/2" diameter	EA	5	$ 15.41	$ 77.05		$ -	$ 77.05
260533136300	Couplings, 2" diameter	EA	110	$ 20.75	$ 2,282.50		$ -	$ 2,282.50
260533136320	Couplings, 2 1/2" diameter	EA	309	$ 59.77	$ 18,468.93		$ -	$ 18,468.93
260533136360	Couplings, 3 1/2" diameter	EA	131	$ 73.61	$ 9,642.91		$ -	$ 9,642.91
260533136380	Couplings, 4" diameter	EA	80	$ 81.02	$ 6,481.60		$ -	$ 6,481.60
260533138810	Box Connectors, 3/4" diameter	EA	654	$ 5.78	$ 3,780.12	$ 3.98	$ 2,602.92	$ 6,383.04
260533138820	Box Connectors, 1" diameter	EA	18	$ 8.60	$ 154.80	$ 4.85	$ 87.30	$ 242.10
260533138840	Box Connectors, 1 1/2" diameter	EA	4	$ 25.69	$ 102.76	$ 7.26	$ 29.04	$ 131.80
260533138850	Box Connectors, 2" diameter	EA	62	$ 37.05	$ 2,297.10	$ 8.75	$ 542.50	$ 2,839.60
260533138860	Box Connectors, 2 1/2" diameter	EA	113	$ 91.88	$ 10,382.44	$ 12.14	$ 1,371.82	$ 11,754.26
260533138880	Box Connectors, 3 1/2" diameter	EA	36	$ 190.68	$ 6,864.48	$ 20.83	$ 749.88	$ 7,614.36
260533138890	Box Connectors, 4" diameter	EA	20	$ 195.62	$ 3,912.40	$ 27.56	$ 551.20	$ 4,463.60
260529201450	Hanger, 3/4" diameter	EA	169.8	$ 0.88	$ 149.42	$ 2.30	$ 390.54	$ 539.96
260529201500	Hanger, 1" diameter	EA	26.5	$ 1.44	$ 38.16	$ 2.48	$ 65.72	$ 103.88
260529211600	Hanger, 1 1/2" diameter	EA	5	$ 2.52	$ 12.60	$ 3.13	$ 15.65	$ 28.25
260529201650	Hanger, 2" diameter	EA	107.8	$ 2.97	$ 320.17	$ 3.36	$ 362.21	$ 682.37
260529201700	Hanger, 2 1/2" diameter	EA	342.5	$ 3.42	$ 1,171.35	$ 4.37	$ 1,496.73	$ 2,668.08
260529201800	Hanger, 3 1/2" diameter	EA	126	$ 5.88	$ 740.88	$ 8.75	$ 1,102.50	$ 1,843.38
260529201850	Hanger, 4" diameter	EA	75	$ 13.49	$ 1,011.75	$ 10.92	$ 819.00	$ 1,830.75
260529201950	Riser Clamp, 3/4"	EA	57	$ 13.83	$ 782.78	$ 12.14	$ 687.12	$ 1,469.90
260529202000	Riser Clamp, 1"	EA	9	$ 13.93	$ 123.05	$ 14.58	$ 128.79	$ 251.84
260529202150	Riser Clamp, 1 1/2"	EA	2	$ 17.88	$ 29.80	$ 16.17	$ 26.95	$ 56.75
260529202200	Riser Clamp, 2"	EA	36	$ 18.67	$ 670.88	$ 21.73	$ 780.83	$ 1,451.71
260529202250	Riser Clamp, 2 1/2"	EA	114	$ 19.76	$ 2,255.93	$ 21.73	$ 2,480.84	$ 4,736.78
260529202350	Riser Clamp, 3 1/2"	EA	42	$ 24.21	$ 1,016.82	$ 24.38	$ 1,023.96	$ 2,040.78
260529202400	Riser Clamp, 4"	EA	25	$ 29.15	$ 728.75	$ 31.27	$ 781.75	$ 1,510.50
260533160150	Square, 4", Junction Box	EA	672	$ 2.87	$ 1,928.64	$ 21.73	$ 14,602.56	$ 16,531.20
260580100020	Motor Termination, 1 HP or less	EA	450	$ 10.18	$ 4,581.00	$ 54.59	$ 24,565.50	$ 29,146.50
260580101530	Motor Termination, 20 HP	EA	11	$ 19.41	$ 213.51	$ 72.61	$ 798.71	$ 1,012.22

Lighting & Sensors

Cost Code	Item	Unit	Quantity	Mat. Unit. Price	Mat. Cost	Bare Labor	Labor/Equip. Cost	Total Cost
265113502310	Strip Fixture, Fluor. 4' long, 2 lamp	EA	40	$ 67.68	$ 2,707.20	$ 54.59	$ 2,183.60	$ 4,890.80
265113503535	Downlight, Recessed, Fluor. Fixture	EA	60	$ 108.68	$ 6,520.80	$ 54.59	$ 3,275.40	$ 9,796.20
265113503525	Troffer, Parabolic, Fixture Fluor. 2x2	EA	80	$ 111.64	$ 8,931.20	$ 76.85	$ 6,148.00	$ 15,079.20
265113503510	Troffer, Parabolic, Fixture Fluor. 1x4	EA	219	$ 110.66	$ 24,234.54	$ 76.85	$ 16,830.15	$ 41,064.69
265113500210	Fluor., Recessed Ceiling, 1x4	EA	89	$ 64.75	$ 5,762.75	$ 81.09	$ 7,217.01	$ 12,979.76
265313100150	Exit lighting, fluor., single face	EA	120	$ 64.22	$ 7,706.40	$ 54.59	$ 6,550.80	$ 14,257.20
265313100160	Exit lighting, fluor., double face	EA	70	$ 72.12	$ 5,048.40	$ 65.19	$ 4,563.30	$ 9,611.70
266113100120	Occupancy Sensors, Ceiling Mounted	EA	45	$ 174.88	$ 7,869.60	$ 67.31	$ 3,028.95	$ 10,898.55
272123102040	Data Communications Network Equipment	EA	11	$ 2,247.70	$ 24,724.70	$ 1,987.50	$ 21,862.50	$ 46,587.20
265213103000	Emergency Lights, solid state battery	EA	22	$ 1,012.70	$ 22,279.40	$ 530.00	$ 11,660.00	$ 33,939.40
266113100170	Daylight Sensor	EA	44	$ 199.58	$ 8,781.52	$ 67.31	$ 2,961.64	$ 11,743.16
266113300360	Fixture Whips, 6' long, THHN	EA	488	$ 15.17	$ 7,402.96	$ 13.67	$ 6,670.96	$ 14,073.92

Appendix C

General Conditions Estimate

Item	Unit	Quantit	Cost/Unit	Total Cost
Field Personnel, Project Engineer	Week	117	$1,300.00	$152,100.00
Field Personnel, Field Engineer	Week	117	$1,100.00	$128,700.00
Field Personnel, Project Manager	Week	117	$2,425.00	$283,725.00
Field Personnel, Intern	Week	24	$550.00	$13,200.00
Field Personnel, QC Manager	Week	90	$1,200.00	$108,000.00
Project Executive	Week	117	$5,500.00	$643,500.00
Field Personnel, Assistant Superintendent	Week	117	$1,750.00	$204,750.00
Field Personnel, Superintendent	Week	117	$2,250.00	$263,250.00
Signs	SF	500	$26.50	$13,250.00
Winter Protection	SF	180,000	$1.14	$205,200.00
Temporary Power	Month	29	$4,200.00	$121,800.00
Office Trailer (x2)	Month	29	$648.71	$37,625.18
Waste Removal	Week	234	$375.00	$175,500.00
Tower Cranes, 22 Ton	Month	29	$7,818.40	$226,733.60
Temporary Water	Month	29	$2,400.00	$69,600.00
Office Equipment	Month	29	$250.00	$7,250.00
Office Supplies	Month	29	$150.00	$4,350.00
Temporary Fencing	LF	3000	$22.40	$67,200.00
Temporary Toilets	EA	5	$2,000.00	$10,000.00
Building Commissioning	%	0.25%	$42,086,750	$105,216.88
Small Tools	%	0.4%	$42,086,750	$168,347.00
Insurance, Builder's Risk	%	0.5%	$42,086,750	$210,433.75
Insurance, General Liability	%	0.75%	$42,086,750	$315,650.63
Payment & Performance Bond	%	1%	$42,086,750	$420,867.50
Scheduling	%	0.05%	$42,086,750	$21,043.38
Job Cleanup	%	0.3%	$42,086,750	$126,260.25
Contingency (Allowances for travel, phone, dwgs, etc.)	%	2%	$42,086,750	$841,735.00
Total				**$4,957,288.16**