Research Facility Core and Shell

2012

Technical Report 2

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Construction Management

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San Anto, California

Submitted: October 12, 2012

Executive Summary

Design for Research Facility Core and Shell (RFCS) began January 24th, 2012 after attaining the notice to proceed from the owner. RFCS scope includes the substructure, superstructure, enclosure, core components of the MEP system along with some minor interior finishes. The project was phased to follow a "bottom-up" approach in which the teams would follow one another in sequence from the basement to the roof. This means for example that while steel was being raised on level 3, welding and metal decking were being installed on the floor below. From design to completion the project spanned 20 months and substantial completion was attained on August 28th, 2012.

For purposes of future research into alternative structural systems as well as schedule change impacts, both a detailed structural system estimate and a General Condition estimate were assembled. The total cost of the structural system is estimated to be $5,047,615 or $39.60/SF. The cost came in about a million dollars shy of the estimate performed by DPR; possible explanations offered in this report could be due to a fluctuation in the steel market as well as unfamiliarity with the Southern California market. General Conditions costs at RFCS are quite low and competitive as the project team has been able to share the temporary facility and office needs with a DPR team performing work on a building next door. The cost for General Conditions is $11,832 per week including personnel.

BIM was a critical component to the success of RFCS. The design team used it to build virtual prototypes, perform 3-D coordination, and run engineered system analysis. The construction team used BIM tools to run clash detections between the models built by the subcontractors. A critical gap in the information flow occurred because the architect did not hand over their 3-D model to the contractor, DPR. Instead DPR and the subcontractors were forced to create a new model based on the 2-D construction documents that they were issued. The teams could see potential benefits by creating a BIM Execution plan early in the process to align goals through contractual ties and could also benefit by using information from the model for facilities management as well as estimating purposes.

Constructability issues will be detailed in the revised version of this report once appropriate information from the project team is attained. Based on the study of RFCS so far, it seems as though the team might have experienced problems with the intricate exterior envelope. Multiple connections exist between the curtain walls and metal stud walls around the entire exterior. This could prove to be critical for waterproofing as well as provide communication challenges for the various subcontractors responsible for the exterior skin.

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Detailed Project Schedule

From conception to completion, RFCS was built in 20 months. Design began January 24th, 2011 and the project attained substantial completion August 28th, 2012. Over this 20 month period the project underwent many different phases which were all heavily coordinated to ensure on-time completion. The following table gives a general breakdown of the phases and their associated time frames:

Table 1: Schedule Overview

Schedule Overview	
Phase	**Timeframe**
Notice to Proceed	January 24, 2011
Design/Preconstruction	January 24, 2011 – June 26, 2011
Substructure	June 27, 2011 – September 30, 2011
Superstructure	October 12, 2011 – November 30, 2011
Exterior Envelope	December 15, 2011 – June 29, 2012
Core MEP Rough-in	March 20th 2012 – April 30, 2012
Core Interior Finishes	May 1, 2012 – June 21, 2012
Commissioning	March 20, 2012 – August 27, 2012
Substantial Completion	August 28, 2012

Many of the phases of RFCS overlapped and often followed a logical pattern. Design was followed by BIM-clash detection which occurred simultaneously with procurement and fabrication. Once the team mobilized, the site work and basement excavation began which followed closely by foundations, slab on grade, and basement structures. The steel structure was then erected which was phased according to floor level. Levels 1 and 2 were raised first followed by 2 and 4 and then finally the roof level. Once a level was raised, crews began welding and metal decking the associated floor. The process followed vertically until the entire structure was raised, welded, and metal deck installed. Concrete crews followed, lagging slightly behind the steel detailers, pouring the slab on deck one level at a time from Level 1 to 4. Once all of the concrete pours were complete the exterior skin was built. The skin was raised from the ground up on all four major sides of the building concurrently. Lagging the exterior skin by a few months, the interior work began on all floors almost simultaneously. This is most likely due to the majority of the interior work being done on the main vertical chase of the building which runs through all levels. As systems were installed they were commissioned which saved the team time at the end from figuring each system out last minute. Final commissioning allowed for substantial completion which marked the end of the Core and Shell effort and signaled the beginning of the next contract- Tenant Improvement.

A more detailed version of the project schedule can be found in Appendix A. This researcher chose to go into greater detail on the substructure, superstructure, and facade than that of interior work. This decision is based on the uniquely minimal amount of MEP and interior work that lies within the scope of the Core and Shell when compared to the structure and exterior facades. The scheduling of the structure was the main key to success for DPR so this also gives merit to analyzing this portion more extensively.

Detailed Structural System Estimate

Structural systems are often major components of building costs and due to RFCS being only core and shell, these components contribute greatly to the overall cost. To better understand the breakdown and the costs associated with each component, this researcher performed a detailed estimate of the structural system. The overall estimated cost of the structural system is $5,047,615 ($39.60/SF) which was about a million dollars shy of the estimate performed by DPR. Reasons for this could include differences in steel market conditions as well as unique project location knowledge and associated costs that go with building in San Anto, CA.

The detailed estimate has been broken down into individual components and can be found in Appendix B. The main components found to contribute to cost were the structural steel members, concrete pours, and metal deck though all were expected from the onset to have major cost influence. Material costs accounted for a majority of the structural system cost which is reasonable based on the relatively high price of steel.

RS Means Cost Works 2012 was used for unit pricing and the proper location factor was applied to adjust conditions to that of Southern California. The estimate was completed in a straightforward manner in which all components of the structural system were accounted for, specifications noted, and then the components were matched to their appropriate unit prices in RS Means. To organize the information, the estimate was broken down in general by floor level; the only exception to this is the column section and that is because columns extend many floors in some instances. The following table shows a breakdown of the structural system by each grouping and gives a better picture of the structural system costs for RFCS.

Table 2: Structural System Costs

Structural System Costs					
Category	Material	Labor	Equipment	Total	Total Incl. O & P
Subgrade	$ 183,695	$ 82,321	$ 2,500	$ 266,667	**$ 336,942**
Columns	$ 170,341	$ 4,947	$ 2,717	$ 178,004	**$ 199,799**
Level 1	$ 624,900	$ 86,980	$ 25,481	$ 763,372	**$ 861,929**
Level 2	$ 630,283	$ 86,685	$ 25,274	$ 768,232	**$ 868,145**
Level 3	$ 630,283	$ 86,685	$ 25,274	$ 768,232	**$ 868,145**
Level 4	$ 630,283	$ 86,685	$ 25,274	$ 768,232	**$ 868,145**
Roof	$ 654,682	$ 88,134	$ 26,078	$ 794,851	**$ 897,492**
Location Adjust.	$ 105,734	$ 15,673	$ 3,978	$ 129,228	**$ 147,018**
Grand Total	$ 3,630,199	$ 538,110	$ 136,577	$ 4,436,817	**$5,047,615**

General Conditions Estimate

The General Conditions cost for Research Facility Core and Shell is estimated to be $754,705 over the 63 week schedule. This works out to cost $11,831.97 per week in General Conditions. These costs seem considerably low but unique factors come into play for this project allowing the DPR team to offer competitive prices.

DPR is in an advantageous position for keeping their General Conditions cost low and thus competitive on the RFCS project. The team has an established base on Faction's campus because another DPR team is working on the fitness center next to RFCS and started work at about the same time. Because of this, general requirement costs such as the cost of the office trailer can be distributed between the projects thus driving the cost down. The two projects also share some key supervision personnel which allows DPR to bill less for jobsite management. These factors contribute to a relatively low GC cost and help to explain why values are lower than industry averages.

Temporary utilities costs become an important factor when calculating General Condition's costs for projects. Fortunately on the RFCS project, temporary utilities costs were minimal because the team was immediately able to tie into the existing utilities made available by Faction from the central plant on campus. These tie-ins were covered in the MEP scopes because their contracts included running the underground utilities to the new RFCS as well as connection to the trailer.

The following tables give a detailed breakdown of the General Condition's costs mentioned above. By itemizing the individual costs, readers can see where DPR was able to keep costs low and therefore competitive for RFCS. These costs are essential for future studies that will analyze the effects of schedule increases and reductions on total project cost.

Table 3: General Conditions Summary

RFCS General Conditions Summary		
General Breakdown	**Cost/Week**	**Total Cost**
Management	$10,701	$674,133
Jobsite Requirements	$1131	$80,572
Total	**$11,832**	**$754,705**

Table 4: Jobsite Management

RFCS Jobsite Management					
Title	**Weeks**	**Total Hours**	**Rate ($/hr)**	**Cost/Week**	**Total Cost**
Project Executive	-	-	-	$1,032	$64,994
Project Manager	-	-	-	$1,237	$77,922
Project Superintendent	-	-	-	$4,150	$261,469
Project Engineer	-	-	-	$2,698	$169,955
Field Office Coordinator	-	-	-	$889	$56,029
Accounting	-	-	-	$250	$15,771
MEP Coordinator	-	-	-	$257	$16,165
Safety Engineer	-	-	-	$188	$11,828
Total	**63**	**7955**	**$84.74**	**$10,701**	**$674,133**

Table 5: General Requirements

RFCS Jobsite General Requirements		
Item	**Cost/Week**	**Total Cost**
Trailer Setup/Mobilization	(--)	$6,493
Trailer Demobilization	(--)	$2,828
Office Trailer Complex	$155.37	$9,788
ISP/IT Setup	$25.87	$1,630
Computers	$325.87	$20,530
Monthly Network & Server	$27.16	$1,711
Office Supplies	$54.32	$3,422
Printer/ Fax	$13.59	$856
Copy Machine	$59.76	$3,765
Janitorial Service	$43.46	$2,738
Postage	$16.30	$1,027
Office Drinking Water	$5.43	$342
Cell Phones	$130.35	$8,212
Trucks	$170.86	$10,764
Fuel	$102.63	$6,466
Total	**$1131**	**$80,572**

*(--) indicates that the item is a one-time cost and has been removed from the Cost/Week total for purposes of analyzing effects of scheduled increase/decrease in future reports.

Building Information Modeling Use Evaluation and Critical Evaluation

Evaluation Summary

Evaluating the BIM use on Research Facility Core and Shell is crucial to gaining full understanding of the building construction process. During the design phase, the owner made clear to the teams that the use of BIM would be limited for the Core and Shell to 3-D coordination, clash detection, and some system analysis applications. During the design development process the architect worked hand-in-hand with the engineers to develop the 3-D project model. The architect would design the architecture of the building and share this model with the engineers. The engineers would then use this model to design their systems and once complete would give to the architect to combine with the other engineered systems to detect clashes and inconsistencies. Thus the architecture influenced the engineered systems and once combined, the engineered systems influenced how the architecture might need changed for constructability. Engineers also used the 3-D model to analyze proper lighting levels and energy flow which influenced MEP system requirements.

Once the systems were integrated and the architecture complete, the contract documents were produced and handed over to the general contractor, DPR. A crucial gap in the information transfer exists here as the architect and engineers did not turn over a 3-D model to DPR but rather handed over the 2-D drawings that were made from their model. Since the 3-D model was not turned over to DPR, DPR was forced to create their own and require the subcontractors to model each of their respective systems. Once each subcontractor modeled their respective systems, they all met on site with DPR and conducted clash detection meetings. Meetings of this nature occurred multiple times throughout construction to continue to fix constructability issues.

Upon completion of RFCS, DPR plans to give the model to the owner. The model is simply a 3-D representation that resulted from the continued coordination meetings between the contractor and the subcontractors. The model will not carry with it important information needed for operation uses. It should be made clear that the model will be handed over as part of the record set but the 2-D project documents constitute the governing record set and will be used by the owner for legal reference and future construction needs.

The following tables show the desired BIM uses that the project team for RFCS followed as well as the actual implementation that occurred on the project. A Level 1 process map showing how BIM was executed on RFCS can be found in Appendix C and gives a clear visual representation of the workflow the project followed.

Table 6: Major BIM Goals and Objectives

PRIORITY	GOAL DESCRIPTION	POTENTIAL BIM USES
High	Initial planning and constructability challenges.	3-D Coordination/ Clash Detection
High	To minimize system clashes in the field to prevent schedule delays and cost overruns.	3-D Coordination/ Clash Detection
High	Assign responsibility for system relocation to parties during the planning process.	3-D Coordination/ Clash Detection
Moderate	Perform engineering analysis on building systems to influence design	Engineering Analysis

Table 7: BIM Uses

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

Critical Evaluation

The Building Information Modeling that was executed on RFCS exemplifies various areas of strength but also proves to be lacking in particular areas. As far as the flow of the model is concerned, there is a crucial information gap between design and construction. The architect did not turn over the designed and engineered model to DPR which forced DPR and the subcontractors to develop an entirely new model and re-coordinate the systems within the building. This allows for error through misinterpretation as well as adds additional costs and time requirements to the modeling budget. A flaw in information transfer of this nature is often seen within the industry and has been attributed most commonly to risk management practices. If the contract could be restructured to enable the 3-D model to be passed from the architect to the contractor and assign risk to the appropriate partner, the team could see considerable savings and avoid potential interpretation errors.

In regards to BIM implementation throughout the project, a few additional key uses could have benefited the team greatly. From project start to finish, the team missed a value opportunity to use BIM as a tool for estimating costs. Current software allows estimators to export the information from the model into itemized reports essentially eliminating the majority of the "hand" takeoff process. By using the model to do takeoffs, a step in the estimating process can be reduced thus saving time and cost for the project. The project is sure to change throughout design and construction which also allows for fast and easy cost estimate adjustments along the way.

Another key BIM tool that would have benefited the project had it been incorporated is model based digital fabrication. Industry facts and figures have consistently shown that prefabrication provides safer, cheaper, and more exact construction. Fabricating system components based on the model reduces the work of the subcontractors who currently redraw the systems based on the 2-D drawings. Again, this will save the project time and money.

The last major BIM tool that the project could have benefited from greatly falls under the category of Operations. Under the actual project conditions BIM gives minor contributions to the project after the contractor turns over the model to the owner. If some time is spent during construction inputting system information it can pay dividends in reducing facility management cost. The search for information on systems as well as the repetitive accounting process that facility managers undertake constitutes large portions of their time. If the information is passed on to facility management then considerable costs can be saved in the long term.

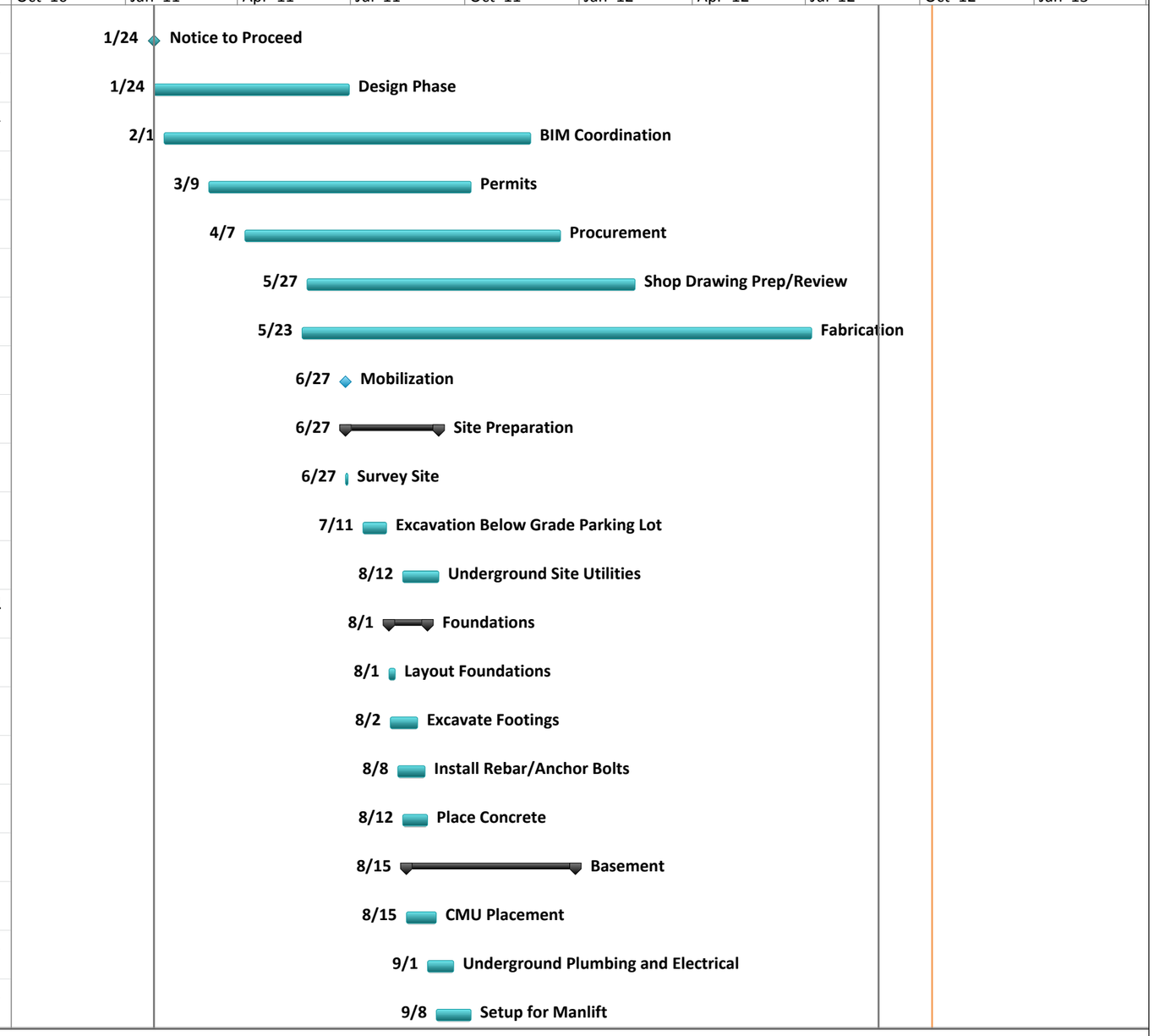
Of all the missed opportunities for BIM implementation a recurring theme is shared between them: Information is lost or must be duplicated due to the party's involved not sharing information. Whether this is due to contractual arrangements or lack of early planning, the problems could be reduced by implementing a well thought out BIM Execution plan. A BIM Execution plan would allow the teams to figure out early in the process the desired flow of information and would then allow them to line the contracts up to enable proper implementation. Proper BIM planning early on as well as a continued attention to the guidelines could benefit RFCS greatly both during construction and after.

Constructability Challenges

Note: Constructability Challenges will be added to this report as soon as information can be obtained from the project team.

Appendix A- Detailed Project Schedule

ID	Task	Task Name	Duration	Start	Finish
1		Notice to Proceed	0 days	Mon 1/24/11	Mon 1/24/11
2		Design Phase	113 days	Mon 1/24/11	Wed 6/29/11
3		BIM Coordination	211 days	Tue 2/1/11	Tue 11/22/11
4		Permits	151 days	Wed 3/9/11	Wed 10/5/11
5		Procurement	182 days	Thu 4/7/11	Fri 12/16/11
6		Shop Drawing Prep/Review	188 days	Fri 5/27/11	Tue 2/14/12
7		Fabrication	294 days	Mon 5/23/11	Thu 7/5/12
8		Mobilization	0 days	Mon 6/27/11	Mon 6/27/11
9		**Site Preparation**	**55 days**	**Mon 6/27/11**	**Fri 9/9/11**
10		Survey Site	2 days	Mon 6/27/11	Tue 6/28/11
11		Excavation Below Grade Parking Lot	15 days	Mon 7/11/11	Fri 7/29/11
12		Underground Site Utilities	21 days	Fri 8/12/11	Fri 9/9/11
13		**Foundations**	**23 days**	**Mon 8/1/11**	**Wed 8/31/11**
14		Layout Foundations	5 days	Mon 8/1/11	Fri 8/5/11
15		Excavate Footings	16 days	Tue 8/2/11	Tue 8/23/11
16		Install Rebar/Anchor Bolts	16 days	Mon 8/8/11	Mon 8/29/11
17		Place Concrete	14 days	Fri 8/12/11	Wed 8/31/11
18		**Basement**	**98 days**	**Mon 8/15/11**	**Wed 12/28/11**
19		CMU Placement	18 days	Mon 8/15/11	Wed 9/7/11
20		Underground Plumbing and Electrical	15 days	Thu 9/1/11	Wed 9/21/11
21		Setup for Manlift	20 days	Thu 9/8/11	Wed 10/5/11



Project: Detailed Schedule
Date: Thu 10/11/12

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				

ID	Task	Task Name	Duration	Start	Finish
22		Backfill Below Grade Parking Structure	59 days	Fri 10/7/11	Wed 12/28/11
23		Waterproofing	12 days	Mon 12/5/11	Tue 12/20/11
24		**Slab on Grade**	**10 days**	**Mon 9/19/11**	**Fri 9/30/11**
25		Place Sand	7 days	Mon 9/19/11	Tue 9/27/11
26		Install Rebar	4 days	Mon 9/26/11	Thu 9/29/11
27		Place Concrete	1 day	Fri 9/30/11	Fri 9/30/11
28		Complete Substructure	0 days	Fri 9/30/11	Fri 9/30/11
29		**Steel Erection**	**36 days**	**Wed 10/12/11**	**Wed 11/30/11**
30		Steel Erection Sequence 1 (Level 1 & 2)	6 days	Wed 10/12/11	Wed 10/19/11
31		Metal Decking/Welding- Level 1	10 days	Fri 10/14/11	Thu 10/27/11
32		Steel Erection Sequence 2 (Level 3 & 4)	7 days	Fri 10/21/11	Mon 10/31/11
33		Install Manlift	3 days	Fri 10/21/11	Tue 10/25/11
34		Metal Decking/Welding- Level 2	3 days	Fri 10/28/11	Tue 11/1/11
35		Steel Erection Sequence 3 (Roof)	4 days	Tue 11/1/11	Fri 11/4/11
36		Metal Decking/Welding- Level 3	4 days	Wed 11/2/11	Mon 11/7/11
37		Steel Erection Sequence 4 (Roof Screen)	2 days	Mon 11/7/11	Tue 11/8/11
38		Metal Decking/Welding- Level 4	10 days	Wed 11/9/11	Tue 11/22/11
39		Metal Decking/Welding- Roof	6 days	Wed 11/23/11	Wed 11/30/11
40		Superstructure Top-Out	0 days	Wed 11/30/11	Wed 11/30/11
41		**Slab on Metal Deck**	**33 days**	**Tue 11/1/11**	**Thu 12/15/11**
42		**Level 1**	**16 days**	**Tue 11/1/11**	**Tue 11/22/11**

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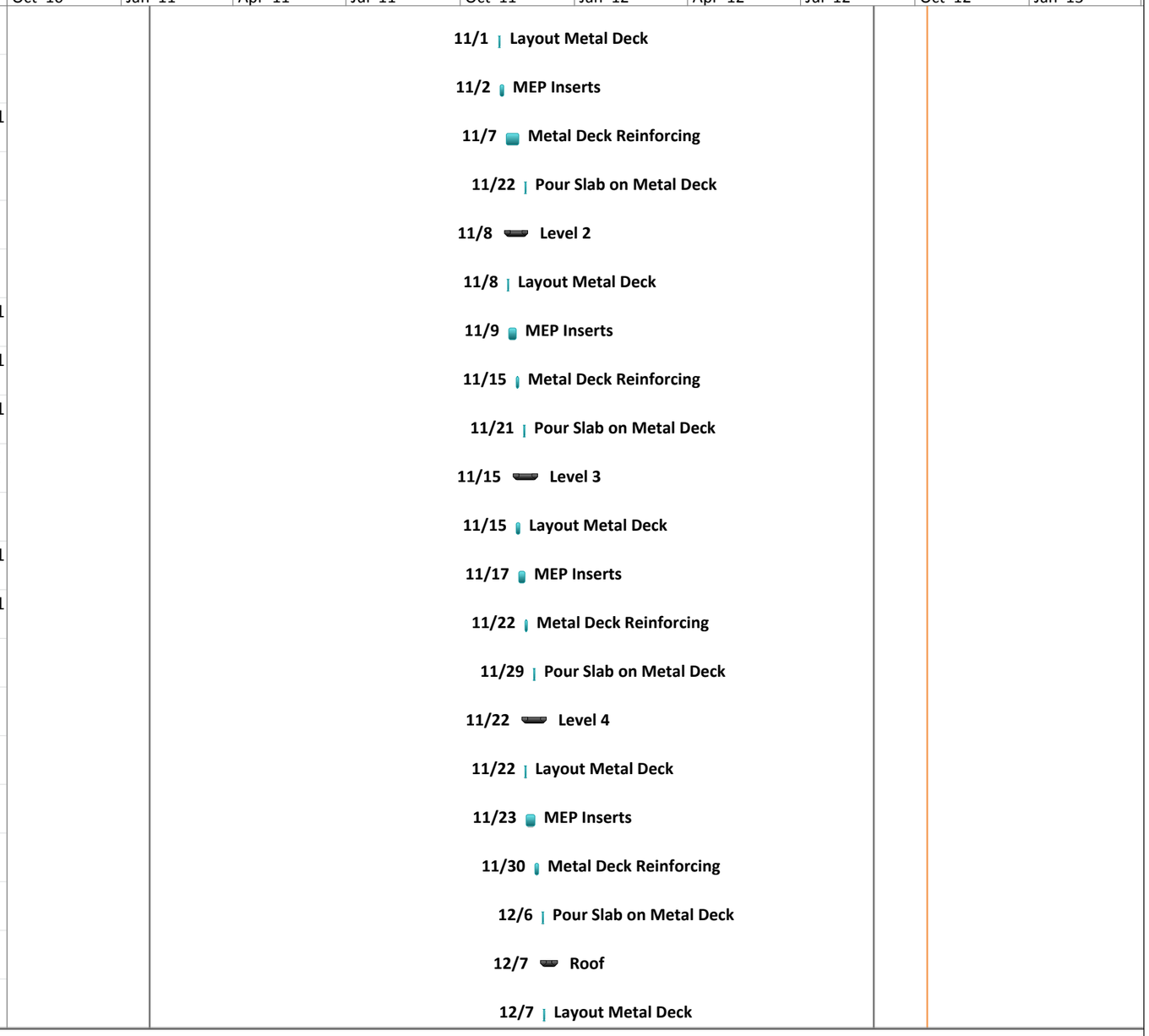
Date: Thu 10/11/12

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				

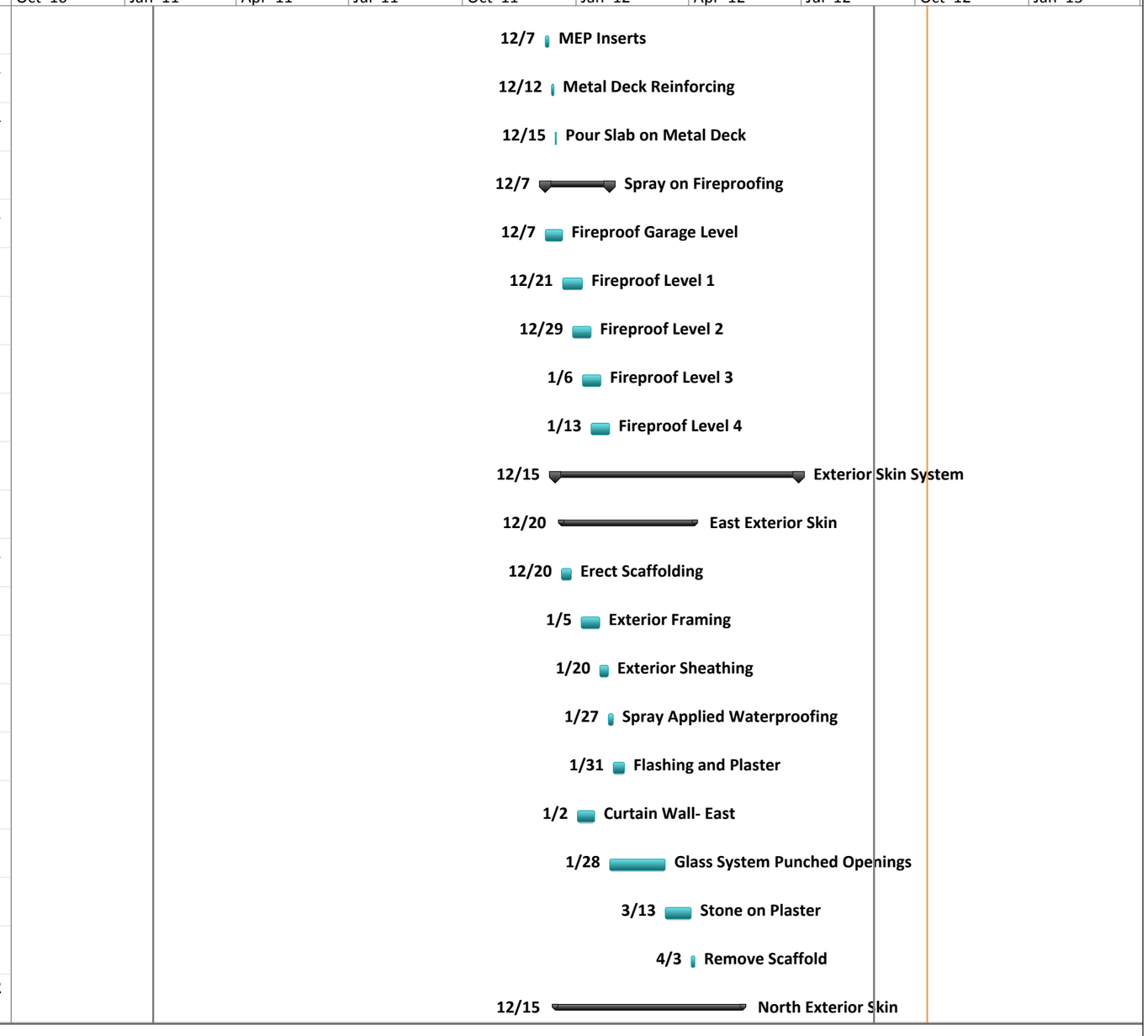
ID	Task	Task Name	Duration	Start	Finish
43		Layout Metal Deck	1 day	Tue 11/1/11	Tue 11/1/11
44		MEP Inserts	3 days	Wed 11/2/11	Fri 11/4/11
45		Metal Deck Reinforcing	8 days	Mon 11/7/11	Wed 11/16/11
46		Pour Slab on Metal Deck	1 day	Tue 11/22/11	Tue 11/22/11
47		**Level 2**	**10 days**	**Tue 11/8/11**	**Mon 11/21/11**
48		Layout Metal Deck	1 day	Tue 11/8/11	Tue 11/8/11
49		MEP Inserts	4 days	Wed 11/9/11	Mon 11/14/11
50		Metal Deck Reinforcing	2 days	Tue 11/15/11	Wed 11/16/11
51		Pour Slab on Metal Deck	1 day	Mon 11/21/11	Mon 11/21/11
52		**Level 3**	**11 days**	**Tue 11/15/11**	**Tue 11/29/11**
53		Layout Metal Deck	3 days	Tue 11/15/11	Thu 11/17/11
54		MEP Inserts	3 days	Thu 11/17/11	Mon 11/21/11
55		Metal Deck Reinforcing	2 days	Tue 11/22/11	Wed 11/23/11
56		Pour Slab on Metal Deck	1 day	Tue 11/29/11	Tue 11/29/11
57		**Level 4**	**11 days**	**Tue 11/22/11**	**Tue 12/6/11**
58		Layout Metal Deck	1 day	Tue 11/22/11	Tue 11/22/11
59		MEP Inserts	5 days	Wed 11/23/11	Tue 11/29/11
60		Metal Deck Reinforcing	3 days	Wed 11/30/11	Fri 12/2/11
61		Pour Slab on Metal Deck	1 day	Tue 12/6/11	Tue 12/6/11
62		**Roof**	**7 days**	**Wed 12/7/11**	**Thu 12/15/11**
63		Layout Metal Deck	1 day	Wed 12/7/11	Wed 12/7/11



Project: Detailed Schedule
Date: Thu 10/11/12

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	

ID	Task	Task Name	Duration	Start	Finish
64		MEP Inserts	3 days	Wed 12/7/11	Fri 12/9/11
65		Metal Deck Reinforcing	2 days	Mon 12/12/11	Tue 12/13/11
66		Pour Slab on Metal Deck	1 day	Thu 12/15/11	Thu 12/15/11
67		**Spray on Fireproofing**	**38 days**	**Wed 12/7/11**	**Fri 1/27/12**
68		Fireproof Garage Level	10 days	Wed 12/7/11	Tue 12/20/11
69		Fireproof Level 1	12 days	Wed 12/21/11	Thu 1/5/12
70		Fireproof Level 2	11 days	Thu 12/29/11	Thu 1/12/12
71		Fireproof Level 3	11 days	Fri 1/6/12	Fri 1/20/12
72		Fireproof Level 4	11 days	Fri 1/13/12	Fri 1/27/12
73		**Exterior Skin System**	**141 days**	**Thu 12/15/11**	**Fri 6/29/12**
74		**East Exterior Skin**	**78 days**	**Tue 12/20/11**	**Thu 4/5/12**
75		Erect Scaffolding	6 days	Tue 12/20/11	Tue 12/27/11
76		Exterior Framing	11 days	Thu 1/5/12	Thu 1/19/12
77		Exterior Sheathing	5 days	Fri 1/20/12	Thu 1/26/12
78		Spray Applied Waterproofing	2 days	Fri 1/27/12	Mon 1/30/12
79		Flashing and Plaster	7 days	Tue 1/31/12	Wed 2/8/12
80		Curtain Wall- East	11 days	Mon 1/2/12	Sun 1/15/12
81		Glass System Punched Openings	32 days	Sat 1/28/12	Mon 3/12/12
82		Stone on Plaster	15 days	Tue 3/13/12	Mon 4/2/12
83		Remove Scaffold	3 days	Tue 4/3/12	Thu 4/5/12
84		**North Exterior Skin**	**108 days**	**Thu 12/15/11**	**Mon 5/14/12**



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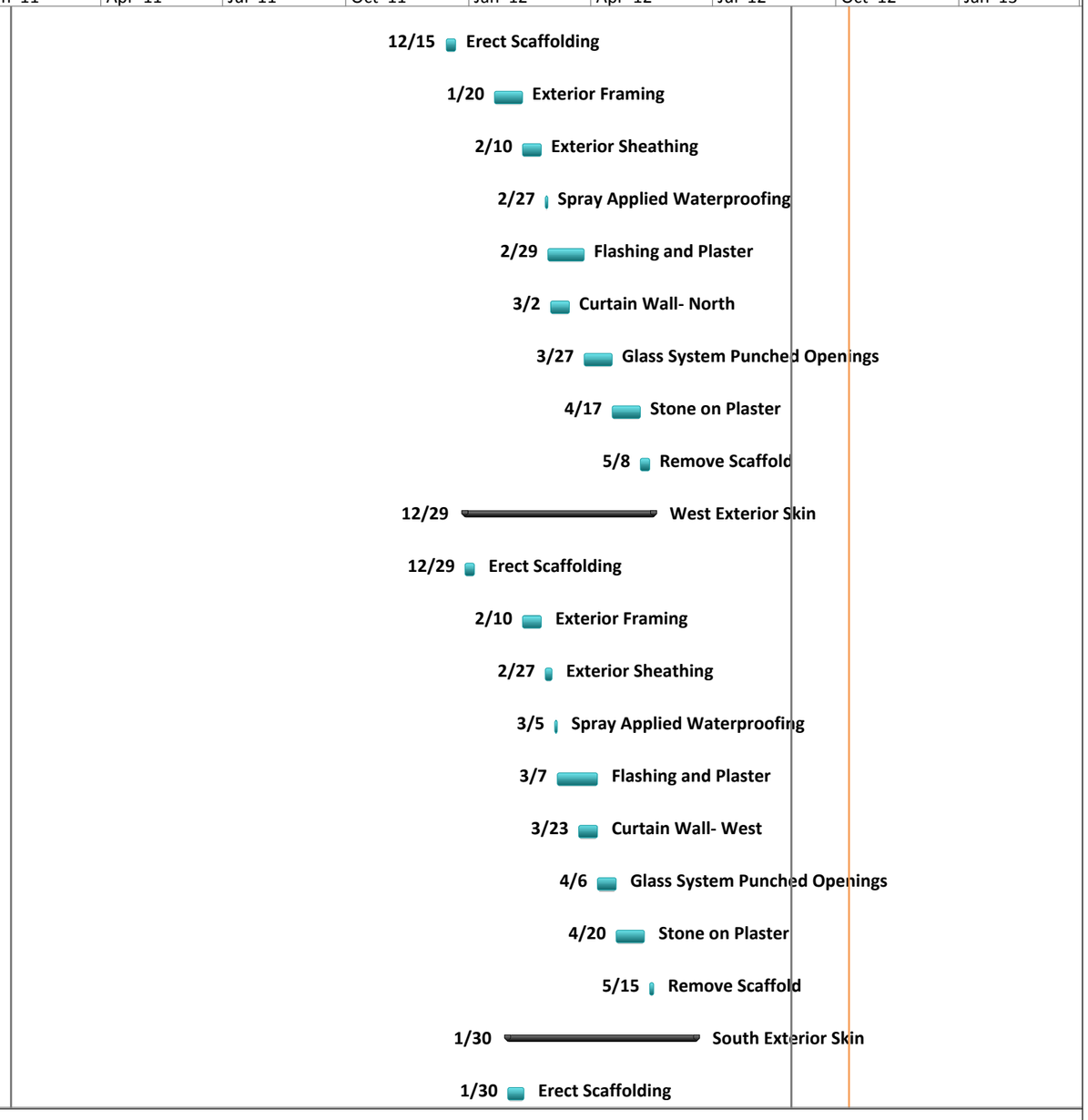
Task	Project Summary	Inactive Milestone	Manual Summary Rollup	Deadline			
Split	External Tasks	Inactive Summary	Manual Summary	Progress			
Milestone	External Milestone	Manual Task	Start-only				
Summary	Inactive Task	Duration-only	Finish-only				

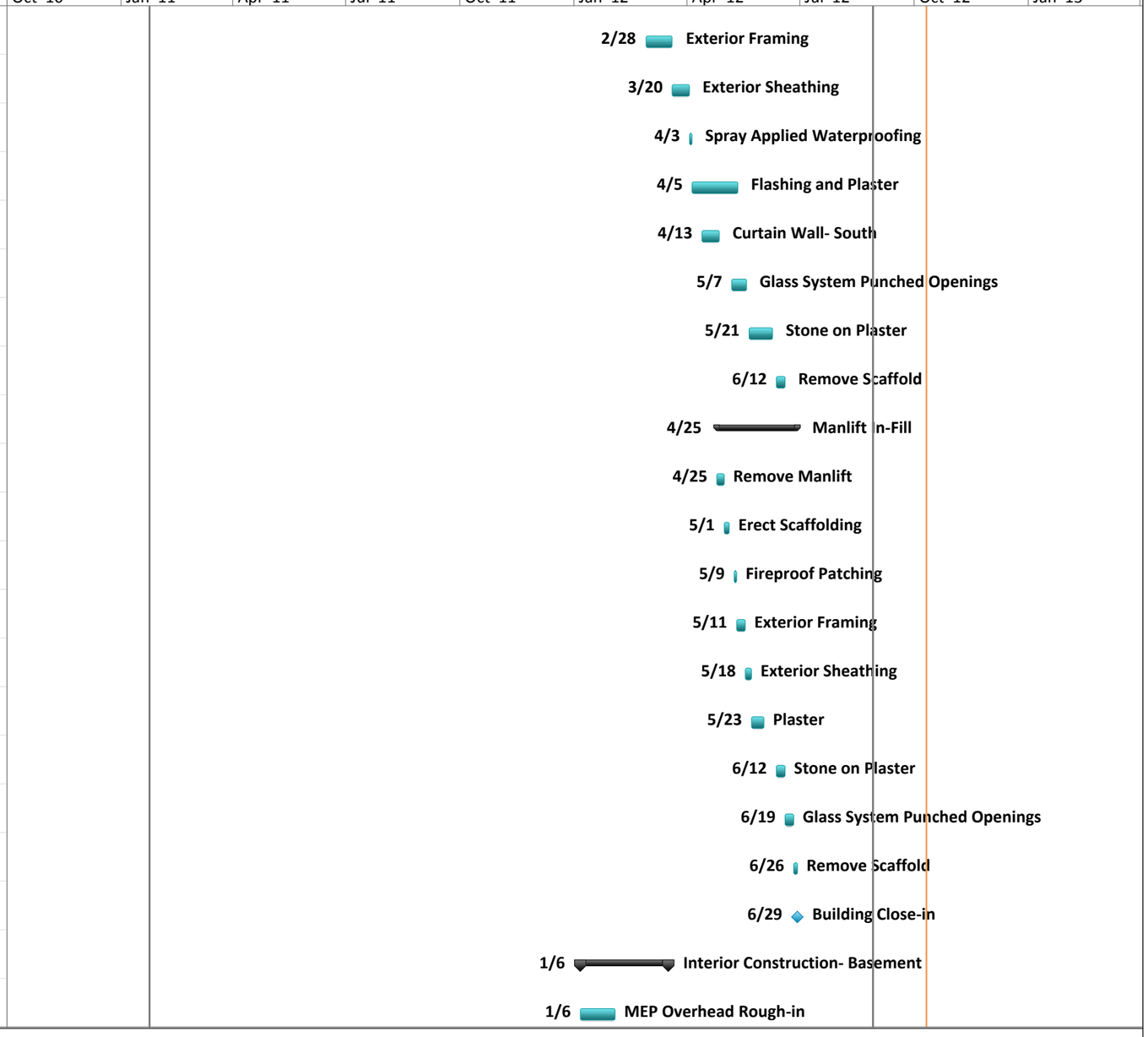
ID	Task	Task Name	Duration	Start	Finish
85		Erect Scaffolding	5 days	Thu 12/15/11	Wed 12/21/11
86		Exterior Framing	15 days	Fri 1/20/12	Thu 2/9/12
87		Exterior Sheathing	10 days	Fri 2/10/12	Thu 2/23/12
88		Spray Applied Waterproofing	2 days	Mon 2/27/12	Tue 2/28/12
89		Flashing and Plaster	19 days	Wed 2/29/12	Mon 3/26/12
90		Curtain Wall- North	10 days	Fri 3/2/12	Thu 3/15/12
91		Glass System Punched Openings	15 days	Tue 3/27/12	Mon 4/16/12
92		Stone on Plaster	15 days	Tue 4/17/12	Mon 5/7/12
93		Remove Scaffold	5 days	Tue 5/8/12	Mon 5/14/12
94		**West Exterior Skin**	**101 days**	**Thu 12/29/11**	**Thu 5/17/12**
95		Erect Scaffolding	5 days	Thu 12/29/11	Wed 1/4/12
96		Exterior Framing	10 days	Fri 2/10/12	Thu 2/23/12
97		Exterior Sheathing	5 days	Mon 2/27/12	Fri 3/2/12
98		Spray Applied Waterproofing	2 days	Mon 3/5/12	Tue 3/6/12
99		Flashing and Plaster	22 days	Wed 3/7/12	Thu 4/5/12
100		Curtain Wall- West	10 days	Fri 3/23/12	Thu 4/5/12
101		Glass System Punched Openings	10 days	Fri 4/6/12	Thu 4/19/12
102		Stone on Plaster	15 days	Fri 4/20/12	Thu 5/10/12
103		Remove Scaffold	3 days	Tue 5/15/12	Thu 5/17/12
104		**South Exterior Skin**	**101 days**	**Mon 1/30/12**	**Mon 6/18/12**
105		Erect Scaffolding	10 days	Mon 1/30/12	Fri 2/10/12



Project: Detailed Schedule
Date: Thu 10/11/12

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		

ID	Task	Task Name	Duration	Start	Finish
106		Exterior Framing	15 days	Tue 2/28/12	Mon 3/19/12
107		Exterior Sheathing	10 days	Tue 3/20/12	Mon 4/2/12
108		Spray Applied Waterproofing	2 days	Tue 4/3/12	Wed 4/4/12
109		Flashing and Plaster	27 days	Thu 4/5/12	Fri 5/11/12
110		Curtain Wall- South	10 days	Fri 4/13/12	Thu 4/26/12
111		Glass System Punched Openings	10 days	Mon 5/7/12	Fri 5/18/12
112		Stone on Plaster	15 days	Mon 5/21/12	Fri 6/8/12
113		Remove Scaffold	5 days	Tue 6/12/12	Mon 6/18/12
114		**Manlift In-Fill**	**47 days**	**Wed 4/25/12**	**Fri 6/29/12**
115		Remove Manlift	4 days	Wed 4/25/12	Mon 4/30/12
116		Erect Scaffolding	4 days	Tue 5/1/12	Fri 5/4/12
117		Fireproof Patching	2 days	Wed 5/9/12	Thu 5/10/12
118		Exterior Framing	5 days	Fri 5/11/12	Thu 5/17/12
119		Exterior Sheathing	3 days	Fri 5/18/12	Tue 5/22/12
120		Plaster	8 days	Wed 5/23/12	Fri 6/1/12
121		Stone on Plaster	5 days	Tue 6/12/12	Mon 6/18/12
122		Glass System Punched Openings	5 days	Tue 6/19/12	Mon 6/25/12
123		Remove Scaffold	3 days	Tue 6/26/12	Thu 6/28/12
124		Building Close-in	0 days	Fri 6/29/12	Fri 6/29/12
125		**Interior Construction- Basement**	**51 days**	**Fri 1/6/12**	**Fri 3/16/12**
126		MEP Overhead Rough-in	20 days	Fri 1/6/12	Thu 2/2/12



Project: Detailed Schedule
Date: Thu 10/11/12

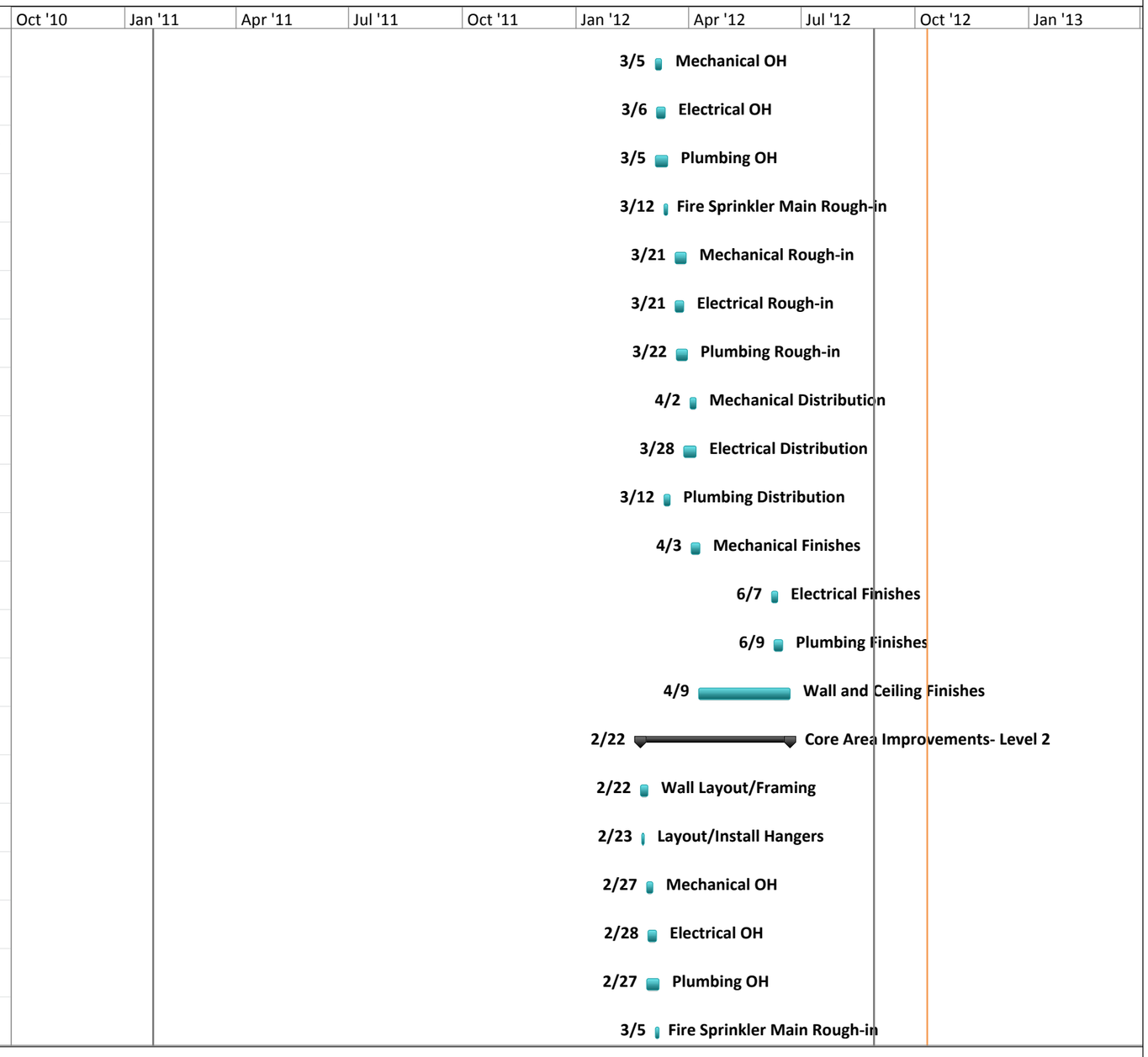
Task	Project Summary	Inactive Milestone	Manual Summary Rollup	Deadline
Split	External Tasks	Inactive Summary	Manual Summary	Progress
Milestone	External Milestone	Manual Task	Start-only	
Summary	Inactive Task	Duration-only	Finish-only	

ID	Task	Task Name	Duration	Start	Finish
127		Set Main Electrical Equipment	30 days	Mon 2/6/12	Fri 3/16/12
128		**Core Area Improvements- Level 4**	**68 days**	**Tue 3/20/12**	**Thu 6/21/12**
129		Wall Layout/Framing	4 days	Tue 3/20/12	Fri 3/23/12
130		Layout/Install Hangers	2 days	Wed 3/21/12	Thu 3/22/12
131		Mechanical OH	5 days	Fri 3/23/12	Thu 3/29/12
132		Electrical OH	5 days	Mon 3/26/12	Fri 3/30/12
133		Plumbing OH	8 days	Fri 3/23/12	Tue 4/3/12
134		Fire Sprinkler Main Rough-in	3 days	Fri 3/30/12	Tue 4/3/12
135		Mechanical Rough-in	7 days	Tue 4/10/12	Wed 4/18/12
136		Electrical Rough-in	5 days	Tue 4/10/12	Mon 4/16/12
137		Plumbing Rough-in	7 days	Wed 4/11/12	Thu 4/19/12
138		Mechanical Distribution	5 days	Mon 4/23/12	Fri 4/27/12
139		Electrical Distribution	8 days	Tue 4/17/12	Thu 4/26/12
140		Plumbing Distribution	5 days	Fri 3/30/12	Thu 4/5/12
141		Mechanical Finishes	5 days	Mon 4/23/12	Fri 4/27/12
142		Electrical Finishes	3 days	Thu 6/7/12	Mon 6/11/12
143		Plumbing Finishes	6 days	Wed 6/6/12	Wed 6/13/12
144		Wall and Ceiling Finishes	40 days	Fri 4/27/12	Thu 6/21/12
145		**Core Area Improvements- Level 3**	**82 days**	**Wed 2/29/12**	**Thu 6/21/12**
146		Wall Layout/Framing	2 days	Wed 2/29/12	Thu 3/1/12
147		Layout/Install Hangers	2 days	Thu 3/1/12	Fri 3/2/12

Project: Detailed Schedule
Date: Thu 10/11/12

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				

ID	Task	Task Name	Duration	Start	Finish
148		Mechanical OH	5 days	Mon 3/5/12	Fri 3/9/12
149		Electrical OH	5 days	Tue 3/6/12	Mon 3/12/12
150		Plumbing OH	8 days	Mon 3/5/12	Wed 3/14/12
151		Fire Sprinkler Main Rough-in	3 days	Mon 3/12/12	Wed 3/14/12
152		Mechanical Rough-in	7 days	Wed 3/21/12	Thu 3/29/12
153		Electrical Rough-in	5 days	Wed 3/21/12	Tue 3/27/12
154		Plumbing Rough-in	7 days	Thu 3/22/12	Fri 3/30/12
155		Mechanical Distribution	5 days	Mon 4/2/12	Fri 4/6/12
156		Electrical Distribution	8 days	Wed 3/28/12	Fri 4/6/12
157		Plumbing Distribution	5 days	Mon 3/12/12	Fri 3/16/12
158		Mechanical Finishes	5 days	Tue 4/3/12	Mon 4/9/12
159		Electrical Finishes	3 days	Thu 6/7/12	Mon 6/11/12
160		Plumbing Finishes	6 days	Sat 6/9/12	Fri 6/15/12
161		Wall and Ceiling Finishes	54 days	Mon 4/9/12	Thu 6/21/12
162		**Core Area Improvements- Level 2**	**87 days**	**Wed 2/22/12**	**Thu 6/21/12**
163		Wall Layout/Framing	4 days	Wed 2/22/12	Mon 2/27/12
164		Layout/Install Hangers	2 days	Thu 2/23/12	Fri 2/24/12
165		Mechanical OH	5 days	Mon 2/27/12	Fri 3/2/12
166		Electrical OH	5 days	Tue 2/28/12	Mon 3/5/12
167		Plumbing OH	8 days	Mon 2/27/12	Wed 3/7/12
168		Fire Sprinkler Main Rough-in	3 days	Mon 3/5/12	Wed 3/7/12



Project: Detailed Schedule
Date: Thu 10/11/12

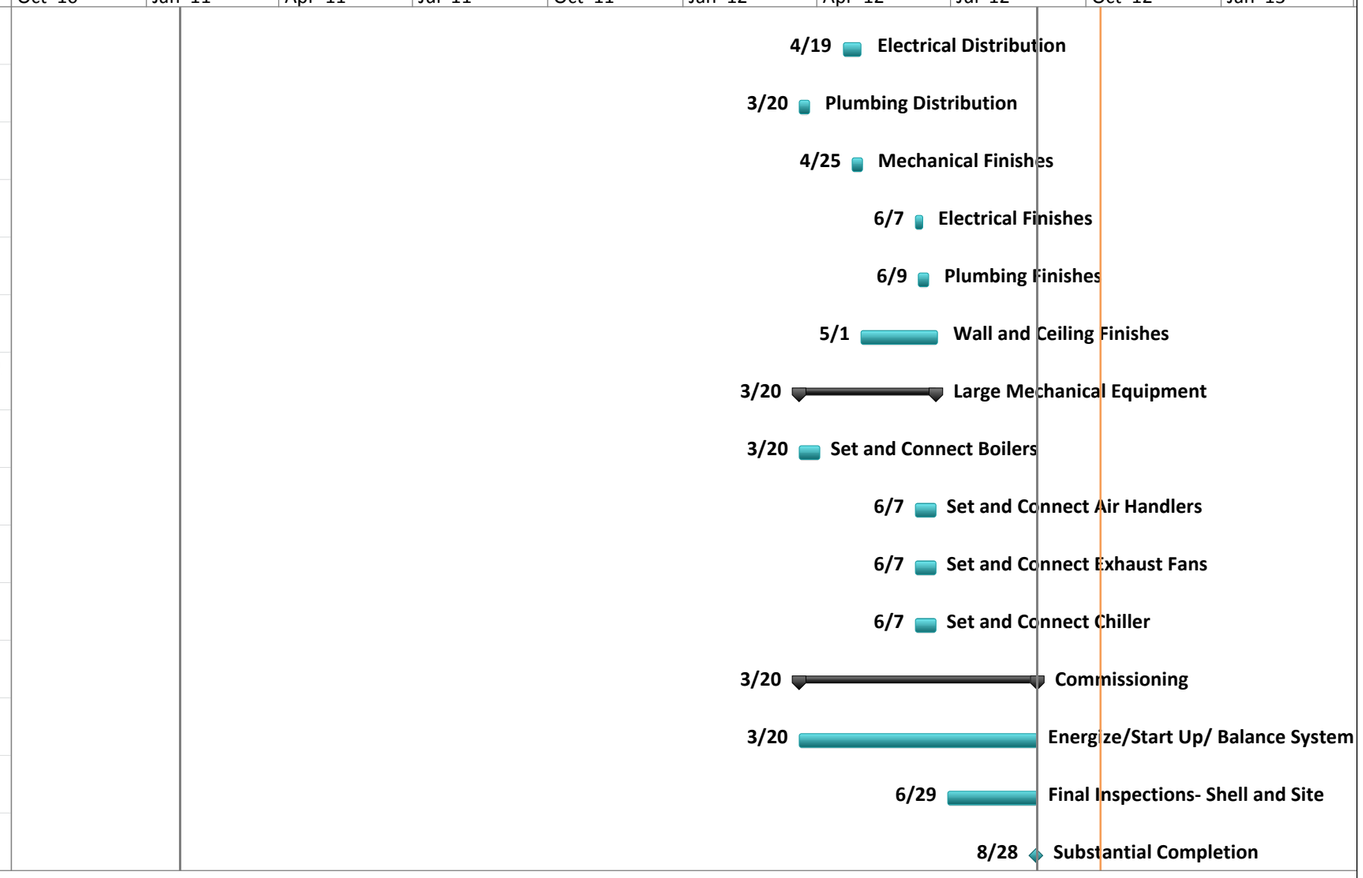
Task | Split | Milestone | Summary | Project Summary | External Tasks | External Milestone | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | Deadline | Progress

ID	Task	Task Name	Duration	Start	Finish
169		Mechanical Rough-in	7 days	Mon 3/5/12	Tue 3/13/12
170		Electrical Rough-in	5 days	Wed 3/14/12	Tue 3/20/12
171		Plumbing Rough-in	7 days	Thu 3/15/12	Fri 3/23/12
172		Mechanical Distribution	5 days	Wed 3/14/12	Tue 3/20/12
173		Electrical Distribution	8 days	Wed 3/21/12	Fri 3/30/12
174		Plumbing Distribution	5 days	Mon 3/5/12	Fri 3/9/12
175		Mechanical Finishes	5 days	Tue 3/27/12	Mon 4/2/12
176		Electrical Finishes	3 days	Thu 6/7/12	Mon 6/11/12
177		Plumbing Finishes	6 days	Sat 6/9/12	Fri 6/15/12
178		Wall and Ceiling Finishes	59 days	Mon 4/2/12	Thu 6/21/12
179		**Core Area Improvements- Level 1**	**71 days**	**Thu 3/15/12**	**Thu 6/21/12**
180		Wall Layout/Framing	2 days	Thu 3/15/12	Fri 3/16/12
181		Layout/Install Hangers	2 days	Fri 3/16/12	Mon 3/19/12
182		Mechanical OH	5 days	Tue 3/20/12	Mon 3/26/12
183		Electrical OH	8 days	Wed 3/21/12	Fri 3/30/12
184		Plumbing OH	5 days	Tue 3/20/12	Mon 3/26/12
185		Fire Sprinkler Main Rough-in	3 days	Tue 3/27/12	Thu 3/29/12
186		Mechanical Rough-in	7 days	Tue 3/27/12	Wed 4/4/12
187		Electrical Rough-in	5 days	Thu 4/12/12	Wed 4/18/12
188		Plumbing Rough-in	7 days	Fri 4/13/12	Mon 4/23/12
189		Mechanical Distribution	5 days	Thu 4/5/12	Wed 4/11/12

Project: Detailed Schedule
Date: Thu 10/11/12

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				

ID	Task	Task Name	Duration	Start	Finish
190		Electrical Distribution	8 days	Thu 4/19/12	Mon 4/30/12
191		Plumbing Distribution	5 days	Tue 3/20/12	Mon 3/26/12
192		Mechanical Finishes	5 days	Wed 4/25/12	Tue 5/1/12
193		Electrical Finishes	3 days	Thu 6/7/12	Mon 6/11/12
194		Plumbing Finishes	6 days	Sat 6/9/12	Fri 6/15/12
195		Wall and Ceiling Finishes	38 days	Tue 5/1/12	Thu 6/21/12
196		**Large Mechanical Equipment**	**67 days**	**Tue 3/20/12**	**Wed 6/20/12**
197		Set and Connect Boilers	10 days	Tue 3/20/12	Mon 4/2/12
198		Set and Connect Air Handlers	10 days	Thu 6/7/12	Wed 6/20/12
199		Set and Connect Exhaust Fans	10 days	Thu 6/7/12	Wed 6/20/12
200		Set and Connect Chiller	10 days	Thu 6/7/12	Wed 6/20/12
201		**Commissioning**	**116 days**	**Tue 3/20/12**	**Tue 8/28/12**
202		Energize/Start Up/ Balance System	116 days	Tue 3/20/12	Tue 8/28/12
203		Final Inspections- Shell and Site	43 days	Fri 6/29/12	Tue 8/28/12
204		Substantial Completion	0 days	Tue 8/28/12	Tue 8/28/12



Project: Detailed Schedule
Date: Thu 10/11/12

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				

Appendix B- Detailed Structural Systems Estimate

Subgrade

Category	CSI Division	Item	Unit	Unit Costs					Quantity	Total Costs				
				Material	Labor	Equipment	Total	Total Including O & P		Material	Labor	Equipment	Total	Total Including O & P
Footings														
Reinforcing Bar	321100502	Footings, #4 to #7	Lb	$ 0.51	$ 0.37	$ -	$ 0.88	$ 1.18	1054.8	$ 538	$ 390	$ -	$ 928	$ 1,245
	321100552	Footings, #8 to #18	Lb	$ 0.51	$ 0.22	$ -	$ 0.73	$ 0.92	41068.4	$ 20,945	$ 9,035	$ -	$ 29,980	$ 37,783
Formwork	311135050	Spread footings, job-built lumber, 2 use	SFCA	$ 1.06	$ 3.61	$ -	$ 4.67	$ 7.05	5442.0	$ 5,769	$ 19,646	$ -	$ 25,414	$ 38,366
	311130020	Grade Beam, plywood 1 use	SFCA	$ 2.68	$ 3.89	$ -	$ 6.57	$ 9.30	1024.0	$ 2,744	$ 3,983	$ -	$ 6,728	$ 9,523
Concrete Placement	331050300	4000 psi structural concrete	CY	$ 103.00	$ 14.65	$ 0.46	$ 118.11	$ 137.50	720.9	$ 74,257	$ 10,562	$ 332	$ 85,150	$ 99,129
Slab on Grade										$ -	$ -	$ -	$ -	$ -
Reinforcing Bar	321100602	Slab on Grade, #4	Lb	$ 0.49	$ 0.37	$ -	$ 0.86	$ 1.16	26860.9	$ 13,162	$ 9,939	$ -	$ 23,100	$ 31,159
Formwork	311133000	Edge form, wood 6" to 12"	LF	$ 0.29	$ 2.23	$ -	$ 2.52	$ 3.98	734.0	$ 213	$ 1,637	$ 1,850	$ 1,850	$ 2,921
Concrete Placement	330535010	Up to 6" thick, cast in place	SF	$ 2.07	$ 0.85	$ 0.01	$ 2.93	$ 3.66	31917.0	$ 66,068	$ 27,129	$ 319	$ 93,517	$ 116,816
Subgrade Total										$ 183,695	$ 82,321	$ 2,500	$ 266,667	**$ 336,942**

Columns

Category	CSI Division	Item	Unit	Unit Costs					Quantity	Total Costs				
				Material	Labor	Equipment	Total	Total Including O & P		Material	Labor	Equipment	Total	Total Including O & P
Columns														
Structural Steel Members	512237000	W10x39, bolted connections	LF	$ 62.00	$ 2.62	$ 1.45	$ 66.07	$ 74.50	64	$ 3,968	$ 168	$ 93	$ 4,228	$ 4,768
	512237000	W10x45, bolted connections	LF	$ 62.00	$ 2.62	$ 1.45	$ 66.07	$ 74.50	64	$ 3,968	$ 168	$ 93	$ 4,228	$ 4,768
	512237200	W12x96, bolted connections	LF	$ 120.00	$ 2.75	$ 1.52	$ 124.27	$ 139.00	156.0	$ 18,720	$ 429	$ 237	$ 19,386	$ 21,684
	512237200	W12x65, bolted connections	LF	$ 120.00	$ 2.75	$ 1.52	$ 124.27	$ 139.00	176.0	$ 21,120	$ 484	$ 268	$ 21,872	$ 24,464
	512237250	W12x120, bolted connections	LF	$ 165.00	$ 2.82	$ 1.56	$ 169.38	$ 189.00	260.0	$ 42,900	$ 733	$ 406	$ 44,039	$ 49,140
	512237200	W12x72, bolted connections	LF	$ 120.00	$ 2.75	$ 1.52	$ 124.27	$ 139.00	192.0	$ 23,040	$ 528	$ 292	$ 23,860	$ 26,688
	512237200	W12x79, bolted connections	LF	$ 120.00	$ 2.75	$ 1.52	$ 124.27	$ 139.00	104.0	$ 12,480	$ 286	$ 158	$ 12,924	$ 14,456
	512237150	W12x53, bolted connections	LF	$ 69.00	$ 2.62	$ 1.45	$ 73.07	$ 82.00	64.0	$ 4,416	$ 168	$ 93	$ 4,676	$ 5,248
	512237250	W12x136, bolted connections	LF	$ 165.00	$ 2.82	$ 1.56	$ 169.38	$ 189.00	104.0	$ 17,160	$ 293	$ 162	$ 17,616	$ 19,656
	512233302	W18x31, bolted connections	LF	$ 48.00	$ 4.07	$ 1.69	$ 53.76	$ 62.00	40.0	$ 1,920	$ 163	$ 68	$ 2,150	$ 2,480
	512234600	HSS 8x8x3/8 x 14', sq structural tubing	Ea	$ 730.00	$ 54.00	$ 30.00	$ 814.00	$ 935.00	28.3	$ 20,649	$ 1,527	$ 849	$ 23,025	$ 26,447
Column Total										$ 170,341	$ 4,947	$ 2,717	$ 178,004	**$ 199,799**

Level 1

Category	CSI Division	Item	Unit	Unit Costs					Quantity	Total Costs				
				Material	Labor	Equipment	Total	Total Including O & P		Material	Labor	Equipment	Total	Total Including O & P
Steel Beams	512235502	W24x76, bolted connections	LF	$ 105.00	$ 3.52	$ 1.46	$ 109.98	$ 123.00	297	$ 31,185	$ 1,045	$ 434	$ 32,664	$ 36,531
	512235302	W24x68, bolted connections	LF	$ 93.50	$ 3.52	$ 1.46	$ 98.48	$ 111.00	165	$ 15,428	$ 581	$ 241	$ 16,249	$ 18,315
	512234302	W24x62, bolted connections	LF	$ 85.50	$ 3.77	$ 1.56	$ 90.83	$ 103.00	33	$ 2,822	$ 124	$ 51	$ 2,997	$ 3,399
	512234902	W24x55, bolted connections	LF	$ 75.50	$ 3.52	$ 1.46	$ 80.48	$ 91.00	642	$ 48,471	$ 2,260	$ 937	$ 51,668	$ 58,422
	512234702	W21x73, bolted connections	LF	$ 93.50	$ 3.77	$ 1.56	$ 98.83	$ 103.00	165	$ 15,428	$ 622	$ 257	$ 16,307	$ 16,995
	512234102	W21x44, bolted connections	LF	$ 60.55	$ 3.67	$ 1.52	$ 65.69	$ 75.00	1337	$ 80,955	$ 4,907	$ 2,032	$ 87,828	$ 100,275
	512233502	W18x40, bolted connections	LF	$ 55.00	$ 4.07	$ 1.69	$ 60.76	$ 69.50	210	$ 11,550	$ 855	$ 355	$ 12,760	$ 14,595
	512233302	W18x35, bolted connections	LF	$ 48.00	$ 4.07	$ 1.69	$ 53.76	$ 62.00	817	$ 39,216	$ 3,325	$ 1,381	$ 43,922	$ 50,654
	512233102	W16x40, bolted connections	LF	$ 55.00	$ 3.38	$ 1.87	$ 60.25	$ 68.50	245	$ 13,475	$ 828	$ 458	$ 14,761	$ 16,783
	512232702	W16x26, bolted connections	LF	$ 36.00	$ 2.70	$ 1.50	$ 40.20	$ 46.00	245	$ 8,820	$ 662	$ 368	$ 9,849	$ 11,270
	512231102	W12x14, bolted connections	LF	$ 22.00	$ 3.07	$ 1.70	$ 26.77	$ 31.50	32	$ 704	$ 98	$ 54	$ 857	$ 1,008
	512231330	L5x5x3/8, angle	LF	$ 1.50	$ 0.43	$ 0.04	$ 1.97	$ 2.50	64	$ 96	$ 28	$ 3	$ 126	$ 160
	512234600	HSS8x6x1/2, sq structural tubing	Ea	$ 730.00	$ 54.00	$ 30.00	$ 814.00	$ 935.00	9.43	$ 6,883	$ 509	$ 283	$ 7,675	$ 8,816
Shear Studs	505230100	Weld Studs 3/8" diameter, 4-1/8" long	Ea.	$ 0.31	$ 0.75	$ 0.36	$ 1.42	$ 2.12	3046	$ 944	$ 2,285	$ 1,097	$ 4,325	$ 6,458
Metal Deck	531135900	Floor decking, 3" deep, 18 gauge	SF	$ 2.46	$ 0.56	$ 0.04	$ 3.09	$ 3.83	31917	$ 78,516	$ 17,874	$ 1,277	$ 98,624	$ 122,242
Concrete Placement	331051400	Elevated slab, less than 6", pumped	CY	$ 91.50	$ 17.25	$ 5.50	$ 122.75	$ 134.00	2955.28	$ 270,408	$ 50,979	$ 16,254	$ 362,761	$ 396,008
Level 1 Total										$ 624,900	$ 86,980	$ 25,481	$ 763,372	**$ 861,929**

Level 2

Category	CSI Division	Item	Unit	Unit Costs					Quantity	Total Costs				
				Material	Labor	Equipment	Total	Total Including O & P		Material	Labor	Equipment	Total	Total Including O & P
Steel Beams	512235502	W24x76, bolted connections	LF	$ 105.00	$ 3.52	$ 1.46	$ 109.98	$ 123.00	1005	$ 105,525	$ 3,538	$ 1,467	$ 110,530	$ 123,615
	512234902	W24x55, bolted connections	LF	$ 75.50	$ 3.52	$ 1.46	$ 80.48	$ 91.00	99	$ 7,475	$ 348	$ 145	$ 7,968	$ 9,009
	512234102	W21x50, bolted connecitons	LF	$ 60.55	$ 3.67	$ 1.52	$ 65.69	$ 75.00	88	$ 5,328	$ 323	$ 134	$ 5,781	$ 6,600
	512234102	W21x44, bolted connecitons	LF	$ 60.55	$ 3.67	$ 1.52	$ 65.69	$ 75.00	1658	$ 100,392	$ 6,085	$ 2,520	$ 108,914	$ 124,350
	512233502	W18x40, bolted connecitons	LF	$ 55.00	$ 4.07	$ 1.69	$ 60.76	$ 69.50	385	$ 21,175	$ 1,567	$ 651	$ 23,393	$ 26,758
	512233302	W18x35, bolted connecitons	LF	$ 48.00	$ 4.07	$ 1.69	$ 53.76	$ 62.00	560	$ 26,880	$ 2,279	$ 946	$ 30,106	$ 34,720
	512231102	W12x14, bolted connecitons	LF	$ 22.00	$ 3.07	$ 1.70	$ 26.77	$ 31.50	308	$ 6,776	$ 946	$ 524	$ 8,245	$ 9,702
	512234600	HSS8x6x1/2, sq structural tubing	Ea	$ 730.00	$ 54.00	$ 30.00	$ 814.00	$ 935.00	9.43	$ 6,883	$ 509	$ 283	$ 7,675	$ 8,816
Shear Studs	505230100	Weld Studs 3/8" diameter, 4-1/8" long	Ea.	$ 0.31	$ 0.75	$ 0.36	$ 1.42	$ 2.12	2984	$ 925	$ 2,238	$ 1,074	$ 4,237	$ 6,326
Metal Deck	531135900	Floor decking, 3" deep, 18 gauge	SF	$ 2.46	$ 0.56	$ 0.04	$ 3.09	$ 3.83	31917	$ 78,516	$ 17,874	$ 1,277	$ 98,624	$ 122,242
Concrete Placement	331051400	Elevated slab, less than 6", pumped	CY	$ 91.50	$ 17.25	$ 5.50	$ 122.75	$ 134.00	2955.28	$ 270,408	$ 50,979	$ 16,254	$ 362,761	$ 396,008
Level 2 Total										$ 630,283	$ 86,685	$ 25,274	$ 768,232	**$ 868,145**

Level 3

Category	CSI Division	Item	Unit	Unit Costs					Quantity	Total Costs				
				Material	Labor	Equipment	Total	Total Including O & P		Material	Labor	Equipment	Total	Total Including O & P
Steel Beams	512235502	W24x76, bolted connections	LF	$ 105.00	$ 3.52	$ 1.46	$ 109.98	$ 123.00	1005	$ 105,525	$ 3,538	$ 1,467	$ 110,530	$ 123,615
	512234902	W24x55, bolted connections	LF	$ 75.50	$ 3.52	$ 1.46	$ 80.48	$ 91.00	99	$ 7,475	$ 348	$ 145	$ 7,968	$ 9,009
	512234102	W21x50, bolted connecitons	LF	$ 60.55	$ 3.67	$ 1.52	$ 65.69	$ 75.00	88	$ 5,328	$ 323	$ 134	$ 5,781	$ 6,600
	512234102	W21x44, bolted connecitons	LF	$ 60.55	$ 3.67	$ 1.52	$ 65.69	$ 75.00	1658	$ 100,392	$ 6,085	$ 2,520	$ 108,914	$ 124,350
	512233502	W18x40, bolted connecitons	LF	$ 55.00	$ 4.07	$ 1.69	$ 60.76	$ 69.50	385	$ 21,175	$ 1,567	$ 651	$ 23,393	$ 26,758
	512233302	W18x35, bolted connecitons	LF	$ 48.00	$ 4.07	$ 1.69	$ 53.76	$ 62.00	560	$ 26,880	$ 2,279	$ 946	$ 30,106	$ 34,720
	512231102	W12x14, bolted connecitons	LF	$ 22.00	$ 3.07	$ 1.70	$ 26.77	$ 31.50	308	$ 6,776	$ 946	$ 524	$ 8,245	$ 9,702
	512234600	HSS8x6x1/2, sq structural tubing	Ea	$ 730.00	$ 54.00	$ 30.00	$ 814.00	$ 935.00	9.43	$ 6,883	$ 509	$ 283	$ 7,675	$ 8,816
Shear Studs	505230100	Weld Studs 3/8" diameter, 4-1/8" long	Ea.	$ 0.31	$ 0.75	$ 0.36	$ 1.42	$ 2.12	2984	$ 925	$ 2,238	$ 1,074	$ 4,237	$ 6,326
Metal Deck	531135900	Floor decking, 3" deep, 18 gauge	SF	$ 2.46	$ 0.56	$ 0.04	$ 3.09	$ 3.83	31917	$ 78,516	$ 17,874	$ 1,277	$ 98,624	$ 122,242
Concrete Placement	331051400	Elevated slab, less than 6", pumped	CY	$ 91.50	$ 17.25	$ 5.50	$ 122.75	$ 134.00	2955.28	$ 270,408	$ 50,979	$ 16,254	$ 362,761	$ 396,008
Level 3 Total										$ 630,283	$ 86,685	$ 25,274	$ 768,232	**$ 868,145**

Level 4

Category	CSI Division	Item	Unit	Unit Costs					Quantity	Total Costs				
				Material	Labor	Equipment	Total	Total Including O & P		Material	Labor	Equipment	Total	Total Including O & P
Steel Beams	512235502	W24x76, bolted connections	LF	$ 105.00	$ 3.52	$ 1.46	$ 109.98	$ 123.00	1005	$ 105,525	$ 3,538	$ 1,467	$ 110,530	$ 123,615
	512234902	W24x55, bolted connections	LF	$ 75.50	$ 3.52	$ 1.46	$ 80.48	$ 91.00	99	$ 7,475	$ 348	$ 145	$ 7,968	$ 9,009
	512234102	W21x50, bolted connecitons	LF	$ 60.55	$ 3.67	$ 1.52	$ 65.69	$ 75.00	88	$ 5,328	$ 323	$ 134	$ 5,781	$ 6,600
	512234102	W21x44, bolted connecitons	LF	$ 60.55	$ 3.67	$ 1.52	$ 65.69	$ 75.00	1658	$ 100,392	$ 6,085	$ 2,520	$ 108,914	$ 124,350
	512233502	W18x40, bolted connecitons	LF	$ 55.00	$ 4.07	$ 1.69	$ 60.76	$ 69.50	385	$ 21,175	$ 1,567	$ 651	$ 23,393	$ 26,758
	512233302	W18x35, bolted connecitons	LF	$ 48.00	$ 4.07	$ 1.69	$ 53.76	$ 62.00	560	$ 26,880	$ 2,279	$ 946	$ 30,106	$ 34,720
	512231102	W12x14, bolted connecitons	LF	$ 22.00	$ 3.07	$ 1.70	$ 26.77	$ 31.50	308	$ 6,776	$ 946	$ 524	$ 8,245	$ 9,702
	512234600	HSS8x6x1/2, sq structural tubing	Ea	$ 730.00	$ 54.00	$ 30.00	$ 814.00	$ 935.00	9.43	$ 6,883	$ 509	$ 283	$ 7,675	$ 8,816
Shear Studs	505230100	Weld Studs 3/8" diameter, 4-1/8" long	Ea.	$ 0.31	$ 0.75	$ 0.36	$ 1.42	$ 2.12	2984	$ 925	$ 2,238	$ 1,074	$ 4,237	$ 6,326
Metal Deck	531135900	Floor decking, 3" deep, 18 gauge	SF	$ 2.46	$ 0.56	$ 0.04	$ 3.09	$ 3.83	31917	$ 78,516	$ 17,874	$ 1,277	$ 98,624	$ 122,242
Concrete Placement	331051400	Elevated slab, less than 6", pumped	CY	$ 91.50	$ 17.25	$ 5.50	$ 122.75	$ 134.00	2955.28	$ 270,408	$ 50,979	$ 16,254	$ 362,761	$ 396,008
Level 4 Total										$ 630,283	$ 86,685	$ 25,274	$ 768,232	**$ 868,145**

Roof

Category	CSI Division	Item	Unit	Unit Costs					Quantity	Total Costs				
				Material	Labor	Equipment	Total	Total Including O & P		Material	Labor	Equipment	Total	Total Including O & P
Steel Beams														
	512235502	W24x76, bolted connections	LF	$ 105.00	$ 3.52	$ 1.46	$ 109.98	$ 123.00	533	$ 55,965	$ 1,876	$ 778	$ 58,619	$ 65,559
	512235902	W27x84, bolted connections	LF	$ 129.00	$ 3.28	$ 1.36	$ 133.64	$ 146.00	396	$ 51,084	$ 1,299	$ 539	$ 52,921	$ 57,816
	512234902	W24x55, bolted connections	LF	$ 75.50	$ 3.52	$ 1.46	$ 80.48	$ 91.00	165	$ 12,458	$ 581	$ 241	$ 13,279	$ 15,015
	512234102	W21x55, bolted connections	LF	$ 60.55	$ 3.67	$ 1.52	$ 65.69	$ 75.00	805	$ 48,743	$ 2,954	$ 1,224	$ 52,880	$ 60,375
	512234102	W21x44, bolted connecitons	LF	$ 60.55	$ 3.67	$ 1.52	$ 65.69	$ 75.00	1591	$ 96,335	$ 5,839	$ 2,418	$ 104,513	$ 119,325
	512233302	W18x35, bolted connecitons	LF	$ 48.00	$ 4.07	$ 1.69	$ 53.76	$ 62.00	350	$ 16,800	$ 1,425	$ 592	$ 18,816	$ 21,700
	512231102	W12x14, bolted connecitons	LF	$ 22.00	$ 3.07	$ 1.70	$ 26.77	$ 31.50	748	$ 16,456	$ 2,296	$ 1,272	$ 20,024	$ 23,562
	512234600	HSS8x6x1/2, sq structural tubing	Ea	$ 730.00	$ 54.00	$ 30.00	$ 814.00	$ 935.00	9.43	$ 6,883	$ 509	$ 283	$ 7,675	$ 8,816
Shear Studs	505230100	Weld Studs 3/8" diameter, 4-1/8" long	Ea.	$ 0.31	$ 0.75	$ 0.36	$ 1.42	$ 2.12	3337	$ 1,034	$ 2,503	$ 1,201	$ 4,739	$ 7,074
Metal Deck	531135900	Floor decking, 3" deep, 18 gauge	SF	$ 2.46	$ 0.56	$ 0.04	$ 3.09	$ 3.83	31917	$ 78,516	$ 17,874	$ 1,277	$ 98,624	$ 122,242
Concrete Placement	331051400	Elevated slab, less than 6", pumped	CY	$ 91.50	$ 17.25	$ 5.50	$ 122.75	$ 134.00	2955.28	$ 270,408	$ 50,979	$ 16,254	$ 362,761	$ 396,008
Roof Total										$ 654,682	$ 88,134	$ 26,078	$ 794,851	**$ 897,492**

Grand Total

Category	CSI Division	Item	Unit	Unit Costs					Quantity	Total Costs				
				Material	Labor	Equipment	Total	Total Including O & P		Material	Labor	Equipment	Total	Total Including O & P
Subgrade										$ 183,695	$ 82,321	$ 2,500	$ 266,667	**$ 336,942**
Columns										$ 170,341	$ 4,947	$ 2,717	$ 178,004	**$ 199,799**
Level 1										$ 624,900	$ 86,980	$ 25,481	$ 763,372	**$ 861,929**
Level 2										$ 630,283	$ 86,685	$ 25,274	$ 768,232	**$ 868,145**
Level 3										$ 630,283	$ 86,685	$ 25,274	$ 768,232	**$ 868,145**
Level 4										$ 630,283	$ 86,685	$ 25,274	$ 768,232	**$ 868,145**
Roof										$ 654,682	$ 88,134	$ 26,078	$ 794,851	**$ 897,492**
Sub Total										$ 3,524,465	$ 522,437	$ 132,599	$ 4,307,590	**$ 4,900,597**
Location Factor (1.03)										$ 105,734	$ 15,673	$ 3,978	$ 129,228	**$ 147,018**
Grand Total										$ 3,630,199	$ 538,110	$ 136,577	$ 4,436,817	**$ 5,047,615**

Take-offs

Table 8: Foundations- Concrete and Formwork

Foundations								
Type	Size (ft)			Volume (CY)	Form/Fting (SF)	Quantity	Volume Total (CY)	Form Total (SF)
4000psi with varrying depths	W	L	D					
F5	5	5	2	1.85	40	1	1.85	40
F6	6	6	2	2.67	48	5	13.33	240
F7	7	7	2	3.63	56	1	3.63	56
F8	8	8	2.5	5.93	80	1	5.93	80
F9	9	9	2.5	7.50	90	4	30.00	360
F10	10	10	3	11.11	120	4	44.44	480
F11	11	11	3.5	15.69	154	9	141.17	1386
F12	12	12	3.5	18.67	168	5	93.33	840
F13	13	13	4	25.04	208	7	175.26	1456
F14	14	14	4.5	32.67	252	2	65.33	504
Grade Beam	9	55	4	73.33	512	2	146.67	1024
Total							720.94	6466

Table 9: Foundations- Reinforcing

Foundations						
Type	Reinforcement	Reinf. (LF)	Reinf. (lb/LF)	Reinforcement lb/ Footing	Quantity	Reinf. Total (lb)
F5	(5)-#5 Ea. Way Bott.	50	1.043	52.15	1	52.15
F6	(6)-#6 Ea. Way Bott.	72	1.502	108.144	5	540.72
F7	(7)-#7 Ea. Way Bott.	98	2.044	200.312	1	200.312
F8	(8)-#7 Ea. Way Bott.	128	2.044	261.632	1	261.632
F9	(9)-#8 Ea. Way Bott.	162	2.67	432.54	4	1730.16
F10	(10)-#8 Ea. Way Bott.	200	2.67	534	4	2136
F11	(11)-#9 Ea. Way Bott.	222	3.4	754.8	9	6793.2
F12	(12)-#9 Ea. Way Bott.	288	3.4	979.2	5	4896
F13	(13)-#10 Ea. Way Bott.	338	4.3	1453.4	7	10173.8
F14	(14)-#10 Ea. Way Bott.	392	4.3	1685.6	2	3371.2
Grade Beam	(8) - #9 Cont. Top/ (14) - #9 Cont.	1760	3.4	5984	2	11968
Total						42123.174

Table 10: Slab-On-Grade- Concrete, Formwork, and Reinforcing

Slab On Grade	Size (SF)	Volume (CF)				
5" Conc. w/ #4 @ 18" Ea way	31917	13298.75				
	Edge Length (ft)	Height (ft)		Total (SF)		
Formwork	734	0.5		367		
	Type	Spacing	W-E Rebar (LF)	N-S Rebar (LF)	Total Rebar (LF)	Total Rebar (Lb)
Reinforcing	#4	18" ea/way	20086	20125	40211	26860.9

Table 11: Steel Columns

Structural Steel			
Columns	Length (ft)	Quantity	Total Length
W12x96	52	3	156
W12x65	32	3	96
W12x120	52	4	208
W12x72	32	4	128
W12x79	52	2	104
W12x53	32	2	64
W12x136	52	2	104
W12x72	32	2	64
W12x120	52	1	52
W12x65	32	1	32
W12x65	48	1	48
W18x31	20	2	40
W10x39	16	4	64
W10x45	16	4	64
HSS 8x8x3/8	54	4	216
HSS 8x8x3/8	42	2	84
HSS 8x8x3/8	28	2	56
HSS 8x8x3/8	20	2	40

Table 12: Steel Beams First Floor

Beams					
First Floor					
Beam Size	LF/ Beam	Quantity	Total LF	Shear Studs/Beam	Total Shear Studs
"Frame"	43	4	172	31	125
"Frame"	35	4	140	25	102
"Frame"	33	8	264	24	192
W24x76	33	9	297	24	216
W24x68	33	5	165	24	120
W24x62	33	1	33	24	24
W24x55	33	2	66	24	48
W21x73	33	5	165	24	120
W21x44	43	27	1161	31	844
W21x44	22	8	176	16	128
W18x40	35	6	210	25	153
W18x35	43	19	817	31	594
W16x40	35	7	245	25	178
W16x26	35	7	245	25	178
W12x14	8	4	32	6	23
L5x5x3/8	8	4	32		
L5x3x3/8	8	4	32		
HSS8x6x1/2	22	6	132		
Total					3046

Table 13: Steel Beams Second Floor

Beams					
Second Floor	LF/ Beam	Quantity	Total LF	Shear Studs/Beam	Total Shear Studs
"Frame"	43	4	172	31	125
"Frame"	35	4	140	25	102
"Frame"	33	8	264	24	192
W24x76	33	13	429	24	312
W24x55	33	3	99	24	72
W21x50	22	4	88	16	64
W21x44	43	36	1548	31	1126
W21x44	22	5	110	16	80
W18x40	35	11	385	25	280
W18x35	35	16	560	25	407
W12x14	11	28	308	8	224
HSS8x6x1/2	22	6	132		
Total					2984

Table 14: Steel Beams Third Floor

Beams					
Third Floor	LF/ Beam	Quantity	Total LF	Shear Studs/Beam	Total Shear Studs
"Frame"	43	4	172	31	125
"Frame"	35	4	140	25	102
"Frame"	33	8	264	24	192
W24x76	33	13	429	24	312
W24x55	33	3	99	24	72
W21x50	22	4	88	16	64
W21x44	43	36	1548	31	1126
W21x44	22	5	110	16	80
W18x40	35	11	385	25	280
W18x35	35	16	560	25	407
W12x14	11	28	308	8	224
HSS8x6x1/2	22	6	132		
Total					2984

Table 15: Steel Beams Fourth Floor

Beams					
Fourth Floor	LF/ Beam	Quantity	Total LF	Shear Studs/Beam	Total Shear Studs
"Frame"	43	4	172	31	125
"Frame"	35	4	140	25	102
"Frame"	33	8	264	24	192
W24x76	33	13	429	24	312
W24x55	33	3	99	24	72
W21x50	22	4	88	16	64
W21x44	43	36	1548	31	1126
W21x44	22	5	110	16	80
W18x40	35	11	385	25	280
W18x35	35	16	560	25	407
W12x14	11	28	308	8	224
HSS8x6x1/2	22	6	132		
Total					2984

Table 16: Steel Beams Roof

Beams					
Roof	LF/ Beam	Quantity	Total LF	Shear Studs/Beam	Total Shear Studs
"Frame"	43	3	129	31	94
"Frame"	35	4	140	25	102
"Frame"	33	8	264	24	192
W27x84	33	12	396	24	288
W24x55	33	5	165	24	120
W21x55	35	23	805	25	585
W21x44	43	37	1591	31	1157
W18x35	35	10	350	25	255
W12x14	11	68	748	8	544
HSS8x6x1/2	22	6	132		
Total					3337

Table 17: Metal Deck

Metal Deck	Size (SF)
First Floor	
3" 18 gauge Vented and Galvanized	31917
Second Floor	
3" 18 gauge Vented and Galvanized	31917
Third Floor	
3" 18 gauge Vented and Galvanized	31917
Fourth Floor	
3" 18 gauge Vented and Galvanized	31917
Roof	
3" 18 gauge Vented and Galvanized	31917

Table 18: Slab-On-Deck

Concrete Topping	Size (SF)	Volume (CY)
First Floor		
2 1/2" Normal Weight Concrete	31917	2955.28
Second Floor		
2 1/2" Normal Weight Concrete	31917	2955.28
Third Floor		
2 1/2" Normal Weight Concrete	31917	2955.28
Fourth Floor		
2 1/2" Normal Weight Concrete	31917	2955.28
Roof		
2 1/2" Normal Weight Concrete	31917	2955.28

Assumptions

The following assumptions were made when performing the detailed structural system estimate.

- Columns are grouped separately because they extend multiple floors
- Assumed beams labeled "frame" in drawings matched those that supported similar weight- W24x76
- Shear studs spaced every 1.5' on beams according to specs
- Assume concrete placement method was pump for elevated slabs
- Level 2, 3, and 4 are redundant schemes per contract docs

Appendix C- Level 1 Process Map for BIM Execution Plan

Developed with the BIM Project Execution Planning Procedure by the Penn State CIC Research Team.
http://www.engr/psu.edu/ae/cic/bimex

Level 1 Process Map- Research Facility Core and Shell Existing BIM Execution Plan