2011

TECHNICAL ASSIGNMENT 2

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Construction Management
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Executive Summary

The Biological Research Lab is an Animal Biological Safe Laboratory (ABSL-3) located on the Pennsylvania State University Campus. The laboratory's design of a modern barn captures the nature of the surrounding facilities. Making up the façade, the rusticated concrete masonry units, metal roof and unique windows fit with the agricultural part of campus while providing a high efficiency building envelope. The facility as seen in figure 1 is approximately 20, 330 square feet and has a scheduled cost of $23 million which is funded by the National Institutes of Health (NIH) along with Penn State.

Figure 1 - Courtesy of Payette Associates

The detailed project schedule for the project is laid out to show sequencing of trades by floor in the construction of the Biological Research laboratory. A detailed estimate of the structural system is provided, including both the foundations and superstructure for the BRL facility. The estimate of a typical bay analysis produced 50 CY of concrete, 2.50 tons of reinforcing rebar, and 30 tons of steel. Square foot costs were calculated based off of the typical bay with system estimates of $597,417.38 for cast-in-place and $909,645.52 for steel. The structural system estimates were 8.3% and 6.8% respectively higher than the anticipated costs by Torcon. A general conditions estimate also performed evaluated staff on site, temporary utilities, insurance and permitting, as well as other additional items amounting in a total cost of $1,012,379.87 differing 10% from Torcon's projected general conditions. An evaluation of LEED was implemented on the BRL facility, by assessing the 2002 scorecard value of silver and readjusting for a 2009 rating of LEED certified. The last piece discussed in the technical assignment are BIM uses on the BRL project, by examining and discussing the implemented processes and proposing other uses if viable.

After the first technical analysis and discoveries from this report, constructability challenges along with value engineering topics will be important in the following tech report. The PACE round table session will also be valuable because of industry professional's insight on schedule acceleration through the use of prefabricating laboratory spaces. Their ideas, knowledge, and actual experience in these areas could lead to some innovative ideas in which research, simply could not fulfill.

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Detailed Project Schedule

The Biological Research Laboratory was first presented to the Centre Region Planning Agency which reviewed the land development plan, designed by Sweetland Engineering, in December of 2008 and at this time presented to the public. The College Township later reviewed and proposed comments on the land development plan which needed to be changed before the project could proceed. The architect Payette Associates worked with Penn State as well as Sweetland Engineering to correct the changes proposed by the township. In the beginning of March 2009, the township approved the preliminary plan and allowed the BRL facility to proceed in the design process. Penn State Board of Trustees were notified in late March of 2010 that $15 million dollars in funding by National Center for Research Resources (NCRR) was approved for the project on top of the existing $8 million funded by Penn State. This allowed the laboratory to be redesigned yet again because of the additional funding and new design requirements with accepting the grant.

On July 27, 2011, The Pennsylvania State University, Office of Physical Plant, presented the notice to proceed to Torcon Inc. which began planning and initializing the procurement process for the Bioresearch Laboratory. The detailed project schedule presented several issues with developing a timetable because of the size of the structure. Also, phasing was not apparent on the project since the gross square footage totaled 20330 sq ft., all trades completed their scope of work sequentially. The detailed schedule which can be referenced in Appendix A, contains the breakdown of procurement, construction as well as the closeout for the project. In the procurement stage contract awards are listed based off the division of work as well as the date awarded. In order to keep the schedule close to 200 line items, Table 1 can be referenced for the division of work. Also in the procurement part of the schedule are the submittal and reviews for all of the divisions of work on the project.

Award	Division of Work	Duration	Start Date	End Date
1.01	Sitework	5	19-Aug-11	25-Aug-11
1.02	Concrete	5	19-Aug-11	25-Aug-11
1.03	Masonry	5	19-Aug-11	25-Aug-11
1.04	Structural Steel	5	19-Aug-11	25-Aug-11
1.05	Miscellaneous Metals	5	19-Aug-11	25-Aug-11
1.06	Roofing and Metal Panels	5	19-Aug-11	25-Aug-11
1.08	Plumbing	5	19-Aug-11	25-Aug-11
1.09	HVAC	5	19-Aug-11	25-Aug-11
1.11	Electrical	5	19-Aug-11	25-Aug-11
1.14	Carpentry (incl. 1.16-19)	5	19-Aug-11	25-Aug-11
1.25	Membrane Roofing	5	19-Aug-11	25-Aug-11
1.07	Glass & Glazing	10	19-Aug-11	01-Sep-11
1.12	Fire Protection	10	19-Aug-11	01-Sep-11
1.13	Doors, Frames and Hard	10	19-Aug-11	01-Sep-11
1.15	Special Flooring	10	19-Aug-11	01-Sep-11
1.22	EDS	10	19-Aug-11	01-Sep-11
1.10	Building Automation Syst	15	19-Aug-11	09-Sep-11
1.20	Lab Casework	15	19-Aug-11	09-Sep-11
1.21	Lab Equipment	15	19-Aug-11	09-Sep-11
1.23	Sprayed Fireproofing	20	19-Aug-11	16-Sep-11
1.24	Landscaping	20	19-Aug-11	16-Sep-11

Table 1: Award dates for each division of work

One issue involved with the detailed estimate because the project size was relatively small meant that the detail in the different trades was increased. Especially in the work dealing with the Mechanical, Electrical, Plumbing, Telecom and the Fire Alarm systems, work performed was denoted on the schedule by floor. Abbreviations on the schedule were used of for these areas of work which can be referenced in Table 2.

Floor	Abbreviations
Basement Level	BL
First Floor	FF
Penthouse Level	PH
Mezzanine Level	ML
Utility Yard	UY

Table 2 : Abbreviations for floor levels when sequencing work

The schedule also contains critical milestones in the project denoting the end of different sequences of work. The substructure because of the design of the building, the BRL contains a full basement where the mechanical equipment is stored along with the slab on grade foundations on the first floor. This structural design impacted the way the work was performed, the foundations for the Biological Research Laboratory was completed by floor along the additional site work such as backfilling. The superstructure was also completed in using a floor to floor method which is typical to most construction projects. The building systems as stated above were performed by floor along with the interior compartments and the finishes associated with each space.

The substantial completion for the project set by Torcon is scheduled to be December 19 of 2012 with only project closeout and punch list items before the scheduled turnover. Start up and testing for the Biological Research Lab is essential because of the complicated mechanical systems as well as the different bio containment labs and holding areas. One of the reasons why Penn State chose Torcon is because of their experience in previous work with vivariums. On the schedule, start-up and testing has a duration of 43 days to ensure the building systems and the lab equipment are operating correctly. After testing the Commissioning Agent, Cornerstone Commissioning Inc., would then perform a final review of the finished laboratory with the intention to completing turnover by the January 31, 2013.

Detailed Structural Estimate

The 20,330 SF facility, the Biological Research Laboratory, falls into the category of new construction with a steel framing and typical foundations. Consisting of approximately 5 typical bays along with two unique bays on each end of the building, the BRL facility was small and concise. The detailed estimate performed on the facility was intended to achieve conservative values which led to choose bay between, column line 5 and 6.

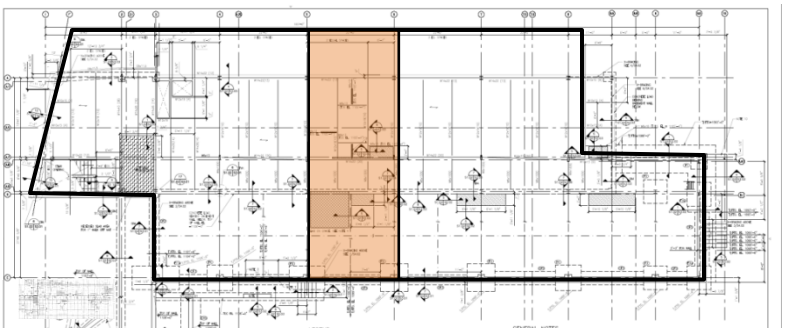


Figure 2: Location where typical bay was chosen

This section of the building was a typical bay but also had additional equipment pads as well as structural supports. Foundations along with the basement for the structure are also somewhat different because of the anticipated mechanical equipment placed in the basement.
Information regarding the footings, column piers, as well as the concrete walls was all gathered from the structural drawings created by Payette Associates. Elements such as fabrication details and sections were also used from the provided documents to determine elevations and quantity of materials used in this estimate. The general notes on each foundation plan along with the specifications for the project were used for any other required information needed in the approximation. Excel spreadsheets were created to organize both the quantity and measurements taken off in the project and can be referenced in Appendix B1-2 for further reference. Materials in total quantities for the takeoff are highlighted for visibility producing final values in cubic yards, formwork square feet as well as linear feet, and tonnage.

Structurally, half the building was designed with a full basement, accessed from the outside, and solely dedicated to the mechanical equipment for the labs. The entrance side of the building from a foundation perspective has basic spread and continuous footings with a slab on grade design. On the first floor of the lab 2" metal decking VLI20 was specified for installation along with 2" of lightweight concrete and welded wire fabric to structurally increase the strength of the system. Due to the design of the building the front half of the building which is slab on grade has a 6" slab with welded wire fabric and chair supports.

Estimating the mechanical penthouse along with the mezzanine was extremely typical because the design consisted of wide flange and hollow core structural steel beams and columns. The metal decking also remained the same as the first floor with light weight concrete and welded wire fabric. Architecturally, the roof had a large impact on the estimate as well as distinctive angles supported by joists and beams not common to an ordinary building. Multiple metal decks were also utilized on the roof, the first spanned between joists on the sloped sections while the second has to support extra equipment pads for the laboratory air handling units in the center of the roof.

Torcon, the construction manager, produced for the owner, The Pennsylvania State University, a detailed construction estimate for the project which breaks down the cost of work based on the major trades. These values are used to compare actual and the estimated cost per S.F. which can be seen in Table 3 on the next page. This table also provides the adjusted cost factor which will be further described.

Structural Estimate Breakdown		Estimated			Actual	
System	$/SF	Adjustment	TOTAL	System Cost	$/SF	System Cost
03 Concrete	$ 20.99	1.4	$ 29.39	$597,417.38	$ 27.13	$551,552.90
05 Steel	$ 31.96	1.4	$ 44.74	$909,645.52	$ 41.89	$851,623.70

Table 3: Compare the estimated cost per S.F. to the actual cost per S.F. projected by Torcon

Cost per square foot for both systems was determined by compiling the take offs which resulted in two total quantities that can be referenced in Appendix B1-2. The total area of the bay, between column lines 5 and 6, was calculated and divided by total cost which can be seen in Figure 4 and Figure 5. After the analysis of the two systems, the comparative cost per square foot seemed to be accurate based on the manipulation of the dependent factors. The first significant factor was appropriating inflation, location, and time factor to the middle of the construction period. All of the data was extracted from the 2009 R.S. Means Building Construction Cost Data which needed to be adjusted to the middle of the project.

$$Adjustment\ Factor = \left(\frac{BCI\ 2011\ (Sept)}{BCI\ (2009)}\right) + \left(\frac{month}{12\ months}\right)(Est.\ Inflation) + (Location\ Factor)$$

$$1.40 = \left(\frac{5097.80}{4764}\right) + \left(\frac{5}{12}\right)(1.03) + (.937)$$

Figure 3 : Calculates total adjustment factor

The Equations along with Table 3 above show how the adjustment factor was determined to update the R.S. Means cost values from 2009 to the approximate middle of the project. The square foot estimates for the structural analysis of the two values were determined to be very similar and in order to justify the values, the processes and methods need to be expressed. A large reason why the Cast-In-Place estimate was so close to the actually estimate was the detailed estimate, provided by Torcon, included many extra line items not related to the Cast-In -Place aspect of the structure. Factors of waste were also accounted involving rebar, formwork and concrete with a value of 10%. The Cast-In Place takeoff in Table 4 below was performed to adjust the cost of the Cast-In-Place to Table 3. Line Items on the takeoff consist of some parts of the excavation on the site, miscellaneous concrete items, waterproofing, drainage mat material, and rock excavation. The equation below in Figure 4 shows the adjusted cost of the new Cast-In-Place estimate with the irrelevant line items removed.

Figure 4 : Commutates the Cost per S.F. for Cast-In-Place

$$\frac{\$\ 106301.9}{3616.7\ S.F.} = \$29.39\ .S.F.$$

Foundations Additional takeoffs	Quanitity	Units	Unit Price	Amount
Excavation				
Building Excavation - Footing	541	CY	$ 20.00	$ 10,820.00
Trench Excavation for Footings	205	CY	$ 20.00	$ 4,100.00
Backfill	550	CY	$ 20.00	$ 10,998.00
Pumping - Rain Water	LS			$ 3,500.00
Cementitious Coating	2238	SF	$ 2.50	$ 5,595.00
Miscellaneous Concrete Items				
Layout	760	CY	$ 2.50	$ 1,900.00
Small Tools & Accessories	760	CY	$ 5.50	$ 4,180.00
Pump Mix & Additives	760	CY	$ 7.50	$ 5,700.00
Special Cleaning and Protection	LS			$ 2,500.00
Concrete Dry Well & Seat Wall	LS			$ 5,500.00
Loading Dock Pits / Exterior Stairs	1	ea	$ 3,500.00	$ 3,500.00
6" Exterior Equipment Pads	856	SF	$ 22.00	$ 18,827.00
Waterproofing				
Waterproofing at Foundation Walls	4167	SF	$ 2.50	$ 10,418.00
Below Slab on Grade	7635	SF	$ 3.75	$ 28,631.00
Drainage Mat Material				
2" Rigid Insulation W/ Drainboard	4167	SF	$ 3.25	$ 13.54
Interior Curbs	65	LF	$ 15.00	$ 975.00
Rock Excavation - Allowance				
Rock Excavation Allowance	200	CY	$ 125.00	$ 25,000.00
Addtl. Rock Excavation Allowance	LS			$ 20,000.00
TOTAL				$ 162,157.54
Actual Cost	$713680-($162157.54)	$ 551,522.46	$ 27.13	Cost/SF

Table 4 : Cast-In-Place adjustment takeoff

The superstructure estimate provided by Torcon had miscellaneous items that did not apply to the structure of the project. The estimate even though relatively close, was still above the actual cost raising a red flag because smaller items were not accounted for including connections, base plates, lintels, and bolts all would increase cost further. This suggests, the adjustment factor is not correct with cost but with construction trends at that period in time causing an inflated cost.

$$\frac{\$161{,}847.67}{3616.7\ S.F.} = \$44.74\ S.F.$$

Figure 5: Commutates the Cost per S.F. for Steel

The detailed breakdown of both the Cast-In-Place and Steel estimates can be referenced for further use in Appendix B3-4.

General Conditions

The cost of the Biological Research Laboratory was in part due to many general conditions established by Torcon, the construction manager, on the project. In the estimate below all figures are approximations and are not the actual contracted amounts between The Pennsylvania State University and Torcon Inc. Five categories make up the general conditions, outlined in Table 5, for the project which is the management and staff, Issuance and permits, temporary utilities, office trailer and supplies, and finally miscellaneous items.

General Conditions Breakdown	Cost	
Management and Staff	$	413,400.61
Insurance and Permits	$	308,297.03
Temporary Utilities	$	129,814.17
Office and Equipement	$	17,507.95
Miscellaneous	$	143,360.12
TOTAL	$	1,012,379.88

Table 5 : Breakdown of General Conditions

Full-time management and staff on the project consists of three members from Torcon, a Sr. Project Manager Scott Loureiro, a Project Superintendent Mike Beatrice, and a Project Engineer Victor Ziobro. On the CM team for the BRL facility is also the Project Executive John DeFazio who is not involved full time on the project as well as a BIM coordinator whose role is to lead the weekly 3-dimensional coordination meetings amongst the Subcontractors. Other part time staff includes a safety site manager who made visits once a week along with a desk clerk at Torcon's main office filing necessary paperwork. Hourly rates for the estimate were based off of Torcon's projections which are labeled under daily output in Appendix C-1.

Insurance and permitting under general conditions includes builders risk insurance, permits, and performance bonds. These values from RS Means were listed as a percentage of the total cost of the job alongwith including overhead and profit. When calculating the values of the insurance, permits and bonds, the bid cost of $23,000,000 was used to achieve the appropriate figure. Contractor's equipment, another item from RS Means placed insurance on rented equipment on the project. The only substantial equipment, incorporated into the General Conditions estimate was a 50'X12' trailer with air conditioning along with 3 portable bathrooms around the construction site.

The site needed the addition of temporary utilities including temporary heat, running an average 12 hours a day when needed and lighting including service lamps, wiring and outlets. The units for these quantities are presented in CSF which equates to every hundred square feet of building space. Other temporary utilities such as power for temporary lighting and power for construction over the duration of the job were calculated in the same fashion. Portable toilets, considered a temporary utility was rented and priced per unit per month during the duration of the 17 month project. A total projected cost for temporary utilities over the duration of the project amounted to $129,814.17.

General conditions on the project were also broken down into work space and materials. One line item which can be seen under office and storage trailer in Appendix C-1 is a 50 foot by 12 foot office trailer. The mobile workspace was rented by Torcon to house the project team as well as holding weekly contractor meetings about the progress of the BRL facility. The size of the trailer was estimated based on what actually was present in the field. In order to operate during construction, the construction manager incorporated office equipment, office supplies, a telephone for conference calls as well as lights and heating, ventilation and air conditioning. These takeoffs were referenced to RS Means and have a unit for price per month. The total projected cost for office and storage trailer takeoff on the general conditions estimate amounts to $17,507.95.

Miscellaneous items in general conditions such as vehicular access and parking, temporary fencing, signage on the project; cleaning and waste management and finally building commission were grouped together. In the beginning of construction access roads which led in and away from the site needed to be widened to allow room for the delivery of materials and equipment. The access routes were widened with crushed blue stone and through RS Means can be quantified as square yards of material, suggesting an 8" base layer. Project identification or signage fell under general conditions too, the CM provided safety and construction postings throughout the site to inform all necessary parties. Signage from R.S. Means quantified into total square feet of signs on a project. Clean sites are a necessity in construction; Torcon utilized a cleaning crew which through R.S Means can be calculated per thousand square feet of a structure. In the general condition estimate weekly cleaning crews were implemented as well as a dedicated crew before the turnover of the project. This section of general conditions also incorporated the building commissioning on the project which was a total percentage of the project. Miscellaneous line items in the general conditions estimate amounted to a total of $143,360.12.

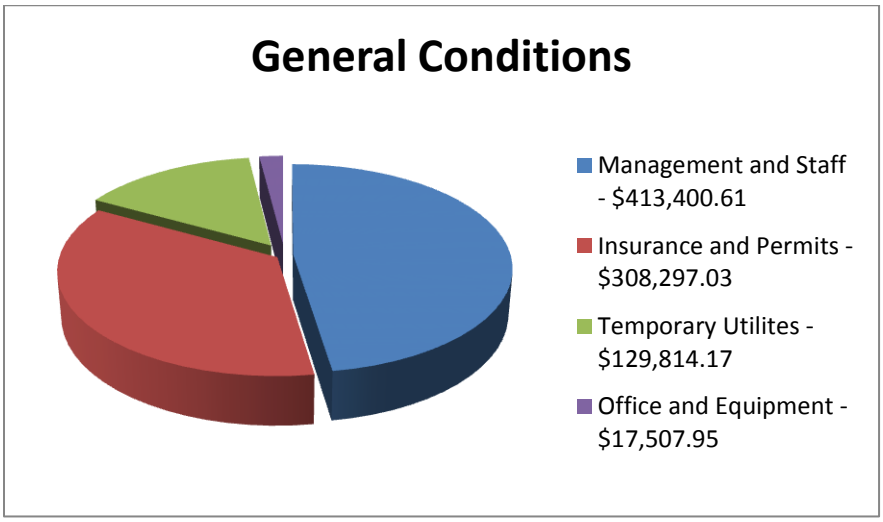


Table 6 : Breakdown of General Conditions in Percentages

The pie chart in Table 6 shows the breakdown of each of each section of general conditions which sums up to **$1,012,379.88**. An estimated projection for general conditions provided by Torcon totaled $1,131,950; this value should not be assumed to be the actual general conditions value submitted to

Penn State. Comparing the estimate to the project reveals a difference of 10.5%. This inaccuracy can be associated from numerous reasons but management and staff seemed to be part of the discrepancy. When calculating the rate of several employees, many of the personal could not be found in R.S. Means so they were interpolated. Another discrepancy found was the hourly wage rate. Through R.S. Means, a comparable person's hourly rate was significantly lower than what Torcon claimed on their staffing plan. Adjusting these values would significantly decrease the difference in error, producing a better general conditions estimate.

The General conditions data was gathered from R.S. Means Costworks online. This online program uses the latest quarterly values so inflation was not calculated on top of the values regarding all of the line items. Costworks also takes into account the location of the project being constructed, adjusting values to appropriate levels. One item on the general conditions estimate was signage which estimated based on the total number of square feet of signs on site. Since this value was extremely difficult to calculate an assumption was made based on the size of the project to use 500 total square feet.

LEED Evaluation

LEED 2009 evaluates Green Building Design and Construction on several different categories including sustainable sites, water efficiency, energy and atmosphere, materials and resources, indoor environmental quality, innovation and design process, and regional priority credits. The Pennsylvania State University seeks LEED certification as a minimum on every new construction and renovation project on all university campuses. Areas of focus for the University are energy conservation, natural resources conservation, prevention of environmental degradation, people's health (well-being), comfort, and finally total cost of ownership.

Sustainable Sites

A focus category for LEED is Sustainable Sites (SS) which place an emphasis on reducing environmental damage and pollution associated with the construction of buildings. The Penn State Master governing how the campus is to be developed presently in the future, many times will not comply with the first three credits under sustainable sites. The Biological Research Lab's location was pre-determined well before design and fails to achieve SS credit 1, SS credit 2, SS credit 3 in Appendix D-2. These three credits promote not building on green fields, constructing in an already developed area with a density of 60,000 square feet per net area, and using brown field or contaminated sites according to the 2009 LEED reference handbook[1]. Different forms of transportation are not critical to university policy; university officials are more focused on bicycle transportation, providing changing rooms and showers over offering alternate low energy vehicles with lowering parking costs for carpooling. Only one out of thirteen points has a possibility for being achieved in this area because of the needs of the university.

Site development along with storm water design is very important to Penn State due to its size and environmental impact from students to faculty. Land development on the University Park campus falls under the Penn State's master plan and the beautification process, keeping the campus's topography and vegetation very selective. Storm water Design is mandated by the university, the Office of Physical Plant design services complete a storm water plan and project for every new project on Penn State campuses.

The energy consumption in recent years nearly has placed a strain on the steam plants, chiller plants, and ever increasing electric bill for Penn State, so the SS credit 7 from the LEED check list in Appendix D-1 is important. The BRL laboratory is a high consuming facility because of the redundant mechanical systems, needed to run the laboratory rooms, so reducing energy is essential for this project. The heat island effect utilizes materials that have a high solar reflectance covering at least 75 percent of the roof surface in Figure 6.

$$\frac{\text{Area Roof Meeting Minimum SRI}}{\text{Total Roof Area}} \times \frac{\text{SRI of Installed Roof}}{\text{Required SRI}} \geq 75\%$$

Roof Type	Slope	SRI
Low-sloped roof	≤ 2:12	78
Steep-sloped roof	> 2:12	29

Figure 6 : table used to calculate the solar reflectance index from the 2009 LEED reference Handbook.

The Sustainable sites section in the LEED 2009 Checklist achieved 4 points with the possibility to achieve 8 more points through restructuring transportation and light pollution reduction.

Water Efficiency

The Biological Research Lab in order to reduce water consumption was landscaped with native plants that require no water. This design of the landscape allows the BRL facility to obtain four points in water efficiency, two points for reducing water by 50% and two points for eliminating irrigation to the site for plants. The project also incorporates water efficient fixtures throughout the building which allows the building to achieve a point under water use reduction. Water use is calculated based on the current baseline for fixtures, an estimate of occupancy usage, which can be correlated to a percentage of reduction using the Figure 7 below according to the 2009 LEED reference handbook[1].

Commercial Fixtures, Fittings, and Appliances	Current Baseline
Commercial toilets	1.6 gallons per flush (gpf)* Except blow-out fixtures: 3.5 (gpf)
Commercial urinals	1.0 (gpf)
Commercial lavatory (restroom) faucets	2.2 gallons per minute (gpm) at 60 pounds per square inch (psi), private applications only (hotel or motel guest rooms, hospital patient rooms) 0.5 (gpm) at 60 (psi)** all others except private applications 0.25 gallons per cycle for metering faucets
Commercial prerinse spray valves (for food service applications)	Flow rate ≤ 1.6 (gpm) (no pressure specified; no performance requirement)

Figure 7: Table used to calculate water reduction from the 2009 LEED reference Handbook.

Energy and Atmosphere

LEED for 2009 requirements has increased the standards from the previous checklist created in 2002. The optimized energy performance credit now for this year in 2009 must achieve points in this category unless a reason of design impedes the increased efficiency. The base standard for evaluating LEED energy performance comes from ANSI/ASHRAE/IENSA standard 90.1 90.1-2007, obtained from the 2009 handbook. The BRL scores eleven points in this field with an improvement in energy performance of 32 percent.

The implemented design of the ABSL-3 facility contained no features of on-site renewable energy which can earn a total of three points. The site where the laboratory is being constructed is surrounded by open and green space. One suggestion to achieve points in this field is to create a solar based car canopy system. The photovoltaic system would fulfill more requirements than just generating renewable resources by having the ability to charge alternative powered vehicles, as well as fulfilling the preferred parking requirement creating the potential for an additional 8 more points. Under Energy and Atmosphere the research facility complied with enhanced commissioning, enhanced refrigerant, and measure and verification for a total of three points.

The Energy and Atmosphere checklist, which can be seen in Appendix D-2, for the BRL obtained 14 points out of a total of 35 points for this section of the 2009 LEED checklist.

Materials and Resources

The Animal Research Lab composition is strictly a new construction project which lacks the reuse of any existing walls, floors, or roof forfeiting 3 points of materials and resource section of the checklist. However, the facility is on track to achieve the standard for recycling 75 percent of waste on the site with the coordination of, the construction manager, Torcon Inc. leading the initiative. Material reuse is also apparent inside the structure with 20 percent of material derived from post and pre consumers. The design team also made an initiative to incorporate regional materials on the project as well as use certified woods which implements environmental forest management. The Materials and Resources checklist, which can be seen in Appendix D-2, for the BRL obtained 7 points out of a total of 14 points for this section of the 2009 LEED checklist.

Indoor Environmental Quality

In order for the project to receive funding in the form of grants for over half of the project sum, the National Institutes of Health (NIH) required the mechanical systems to be enlarged and incorporate redundancy in the BRL facility. These requirements helped to achieve air quality LEED points in outdoor air delivery monitoring and increased ventilation of the space. Torcon was also responsible for adequate ventilation for construction laborers during construction and before occupancy. Appropriate levels of ventilation during and after construction achieve four points for the LEED scorecard in the indoor quality section. Low emitting materials which reduce air contaminants were used; these materials focus on reducing vulgar odors, irritating chemicals which can be dangerous to the laborers installing the materials[1]. Thermal comfort design and verification are also incorporated into the design of the building with individual controls in the laboratory and in the conference spaces for comfort. A verification and monitoring system has also been incorporated into the mechanical system so a thermal conduct survey can be performed 18-24 months after occupancy. The Indoor environmental quality, which can be seen in Appendix D-2, for the BRL obtained 11 points out of a total of 15 points for this section of the 2009 LEED checklist.

Innovation and Design Process / Regional Priority Credits

On the Project of the Biological Research Laboratory a Low Energy Headhouse was utilized in the design process. Implementation of a site excavation strategy on the laboratory was also used to achieve exceptional performance in the area of bulk soil removal. Regional Priority Credits were also captured in the BRL project. When analyzing regional credits by area, specifically State College Pennsylvania, water efficiency for landscaping involving reduction of water and the elimination of water are acceptable for the priority credits category.

LEED Evaluation Conclusion

The Biological Research Lab when evaluated according to the 2009 LEED scorecard achieves a rating of LEED certified with a total score of 47 points. LEED Certified has a range of 40-49 points according to USGBC while a rating of silver has a range of 50-59 points. When the project was designed, the LEED 2002 scorecard Appendix D-1 was in effect and has been grandfathered for the BRL facility. The 2002 evaluation rating of LEED Silver was achieved for the project and awarded once the project is completed in January of 2013. One important item about LEED checklists, they are projections and are not guaranteed. These projections if not successful completed at the end of the project will be removed from the final score, lowering the LEED rating.

Building Information Modeling (BIM) Use Evaluation

The Office of Physical Plant for the Pennsylvania State University's plan was always to implement BIM on the Biological Research Laboratory but depleted man power during the design phase left engineers and drafters unable to complete the model in Figure 8. The BRL, when completed would have become the Universities first project created through BIM and led by Penn State's design firm. Torcon, the construction manager, intent was to use the model created by design services within Penn State for 3-D coordination. The Animal Biological Safe Laboratory-3's intricate level of mechanical systems on different floors makes BIM modeling and coordination a priority resulting in Torcon creating their own model.

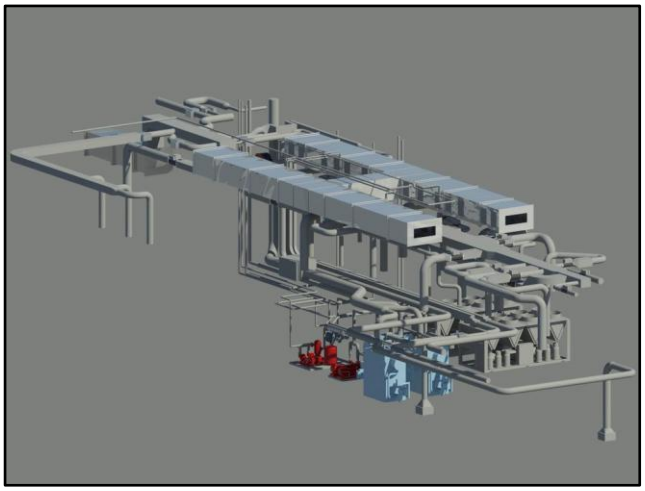


Figure 8: Unfinished MEP model, Courtesy of Robert Schreffler OPP

BIM Goals

Torcon lead the design initiative in creating the BIM model for the project so the goals are more focused on the CM for this project which can be referenced in Appendix E-1. The main goal for the Building Information Model used for the Biological Research Laboratory was for 3-D coordination between the Sub-Contractors. Scheduling and productivity was also a concern for Torcon and through the use of clash detection, the CM hoped to reduce RFI's regarding on site coordination issues. A secondary goal for the BIM model was to create and continually update a record model for the project. The record model was then to be turned over to the Penn State University after the completion of the project.

BIM Uses

Building Information Modeling was limited on the Biological Research Lab to record modeling and 3-dimensional coordination both in design as well as in construction noted in Appendix E-3. The BIM analysis worksheet which can be found in Appendix E-2 details the roles of each party involved in the implementation of BIM on the project. The spread sheet takes into account the contractor, owner, designer and sub-contractor while evaluating their resources, competence in the BIM use, and experience. This rating ultimately determines if the BIM use should be carried out on the project while looking at additional resources and how high the value is to the respective party involved.

Clash Detection

In an effort to use clash detection on the project Torcon will make the models available to all parties involved within the project. The design model of the structure contains basic architectural features defining the boundaries of floors, ceilings, chases, door openings, partitions, exterior wall surfaces,

window openings, roofs, and stairs. The structural elements of the building are also represented in the architectural model such as slabs, walls, steel framing, columns and beams for the subcontractors to visualize during their modeling process. The intent of the 3-D model is to be used as a visual representation, which is not intended to be associated with accuracy or the final construction design. A file sharing site was utilized on the project provided by Torcon where the standard for the file format on the site is a DWG/IFC/NWC.

Coordination Meetings on the project are held every week where the subcontractors would have their work progress along with their shop models uploaded to the FTP site within 24 hours of the meeting. Travis Johnson, the BIM coordinator from Torcon, would compile the shop models into a federated model before every coordination meeting. "A Federated Model is a model that aggregates the various Design and Shop Drawing Models provided by the project participants and allows delineating these Models from each other in the aggregate representation."[2] Navisworks Manage, an Autodesk Program, creates the combined model and runs the clash detection process between the design and the shop drawings. After the Navisworks has complied data, a clash report is created from the federated model which is available before every coordination meeting.

The clash report generated from the combined model in Navisworks Manage, focuses on resolving and creating solutions to the clashes that all parties can agree on. During each weekly meeting, Torcon mandated that each subcontractor bring their computers with specified software to fix small coordination issues during the conference. Larger clashes discovered from the report are designed with a conceptual solution and fixed outside the coordination meeting. Clashes that cannot be corrected during the meeting are to be submitted to the architect for arbitration and ultimately their decision would be the solution.

Record Modeling Process

Each Sub-Contractor has a specific area in the model to install their systems, allowing the model completed after construction to be signed-off as an As-Built model. When design changes are proposed, the model must be changed and it becomes the responsibility of the Sub-Contractor to update the model. These changes in design need to be represented in the shop drawing model, updated to the site and combined with the federated model. Torcon would use Navisworks to check for constructability as well as clashes before implementing the changed design in the field. In the process for achieving a record model Sub-Contractors must incorporate all RFI's, change orders, bulletins or any other design materials that have altered the shop drawings. The final documents should follow a specific set of tolerances set by Torcon and can be seen in figure 9 below.

PHASE	DISCIPLINE	TOLERANCE
Design Documents	M/E/P/FP	1/8" size & location
Design Documents	Architectural	1/8" size & location
Coordination / Shop Drawings	Structural	1/8" size & location
As-Builts	M/E/P/FP	1/8" size & ¼" location

Figure 9 : Courtesy of OPP and Torcon : Tolerances within the model

BIM Process Design

Together many elements translate into a fully functioning BIM model, including organization, proper programing, and collaboration between the owner and designers. The Biological Research Laboratory like many other projects requires BIM on new construction projects at the Penn State University. Initial meetings while the project is still in design; include the CM, Torcon, as well as the owner, The Pennsylvania State University, collaborate on what the model should accomplish. Software tends to be one item that is discussed in order to start designing the model. There are various bases of design but the University has chosen to use Autodesk programs when incorporating BIM onto a project. Nomenclature or how the file names will be formatted or structure is critical in any BIM project and for the BRL was mandated to have a standard naming system. This aspect is extremely important in the BIM process design because if every Sub-Contractor had a different standard for naming files the model would be worthless if a modification was needed after construction.
The level one process map which can viewed in detail through appendix E-4 incorporates all of the items listed in depth above throughout Schematic Design, Design Development, and the construction documents. The process model integrates 3-D coordination, author design and virtual prototypes at every stage of design and construction; creating a smooth flow throughout the project. The end process results in a compiled record model by the CM who can later turn over the as-built model to the University for their later uses.

BIM Evaluation

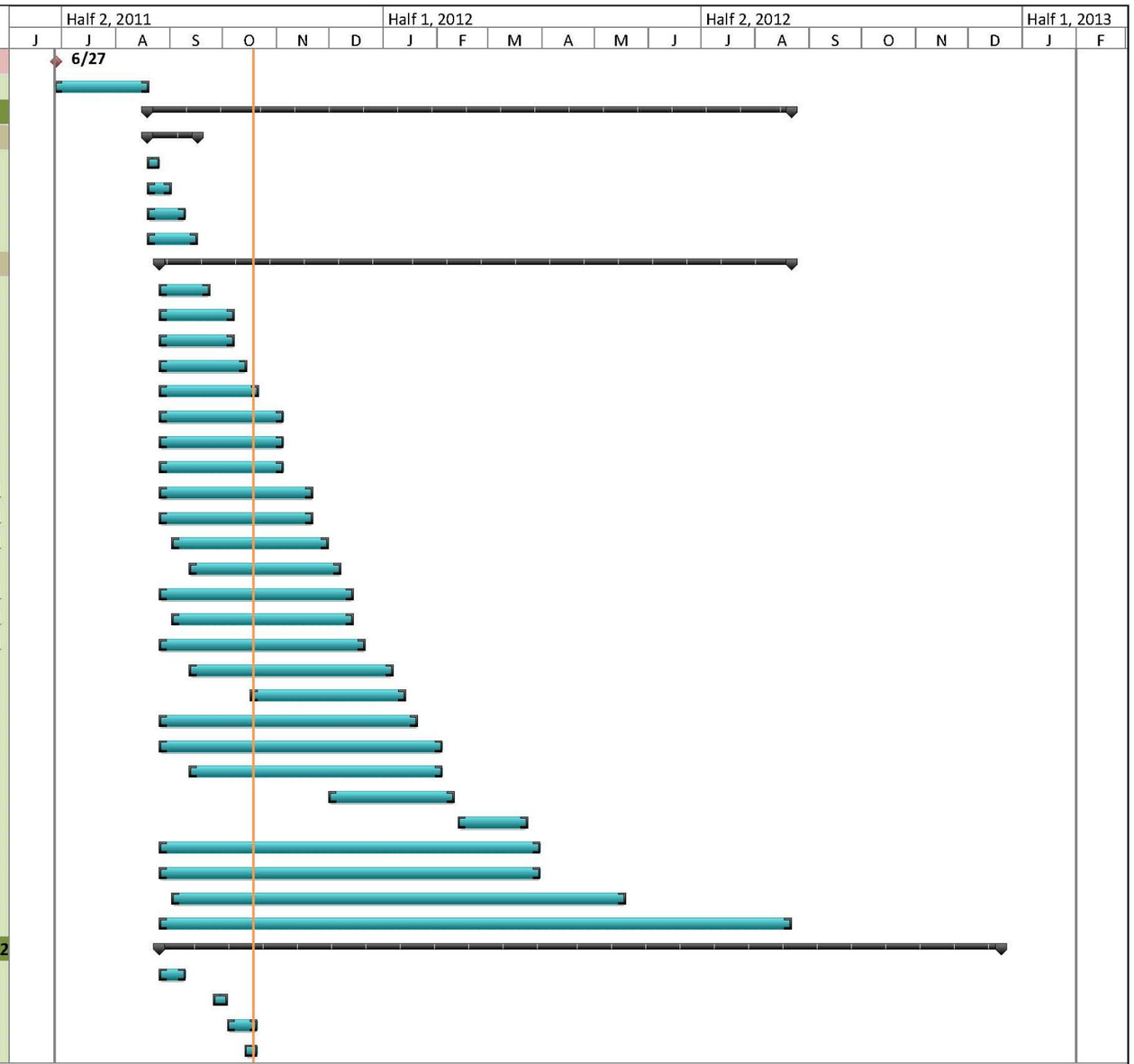
The lack of communication between Torcon and Penn State's design services translated to fewer uses of BIM on the Biological Research Laboratory. The model's design intent was purely for 3-D coordination as well as to produce a record model for the university to use after the project is complete. A cost estimation on the BRL facility would have not been valuable for construction because of the specific requirements and design standards for an ABSL-3. Implementation of a redesign to save money based on BIM would not only have to conform to NIH guidelines but also the commissioning agent as well as the end users for the building. The use of 4D modeling on the project would also have very limited value because of the size of the project and abundance of construction space around laboratory. Linking the schedule to the model in Navisworks Manage would only show the sequencing of mechanical, electrical and plumbing trades per floor.

The Pennsylvania State University in the schematic and design development phases of BIM could have potentially utilized engineering analyses for the Biological Research Laboratory. The highest value adding analysis would be energy monitoring and consumption of the building systems. The BRL due to NIH standards after receiving a large grant has many redundant systems which consume high amounts of energy. An attempt to use BIM to reduce the consumption of energy while in design could have potentially saved the university a significant amount in utility bills. A potential reason why this analysis was not implemented even when Torcon led the initiative on the model would be cost. The BRL is a relatively small project in regards to building footprint which has a large economic effect on the uses of BIM.

[APPENDIX A]

PROJECT SUMMARY SCHEDULE

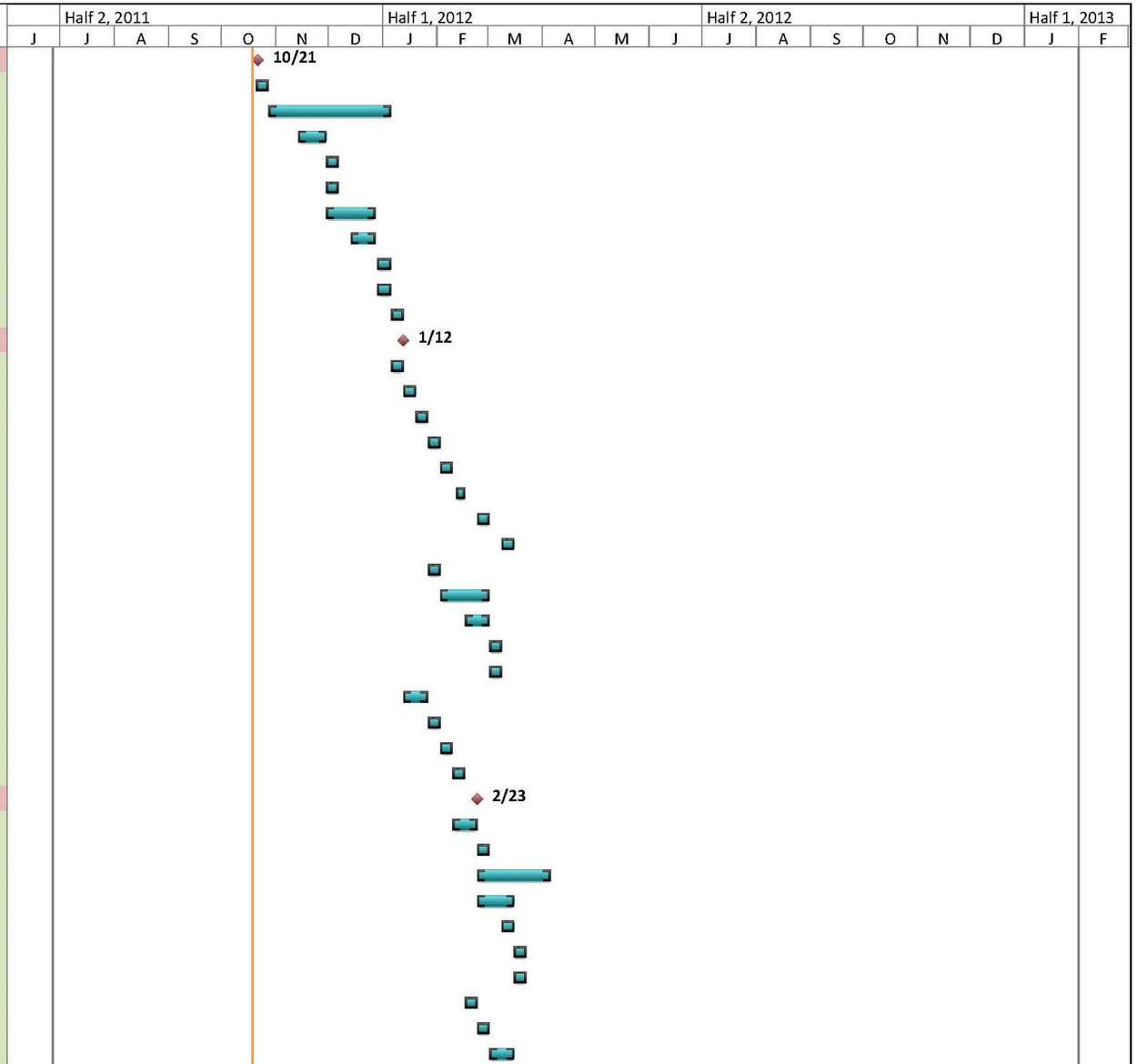
ID	Task Name	Duration	Start	Finish
1	**CM Mobilize**	0 days	Mon 6/27/11	Mon 6/27/11
2	Notice to Proceed	40 days	Mon 6/27/11	Fri 8/19/11
3	**PROCUREMENT**	**263 days**	**Fri 8/19/11**	**Tue 8/21/12**
4	**Contract Purchasing**	**21 days**	**Fri 8/19/11**	**Fri 9/16/11**
5	Contract Award (1.01-1.09,1.11,1.14,1.25)	5 days	Fri 8/19/11	Thu 8/25/11
6	Contract Award 2 (1.07,1.12,1.13,1.15,1.22)	10 days	Fri 8/19/11	Thu 9/1/11
7	Contract Award 3 (1.10, 1.20, 1.21)	16 days	Fri 8/19/11	Fri 9/9/11
8	Contract Award 4 (1.23-1.24)	21 days	Fri 8/19/11	Fri 9/16/11
9	**Submittal and Review**	**258 days**	**Fri 8/26/11**	**Tue 8/21/12**
10	Division 31 -Earthwork	21 days	Fri 8/26/11	Fri 9/23/11
11	Division 6 -Wood, Plastics, and Composites	31 days	Fri 8/26/11	Fri 10/7/11
12	Division 33 -Utilities	31 days	Fri 8/26/11	Fri 10/7/11
13	Division 3 -Concrete	36 days	Fri 8/26/11	Fri 10/14/11
14	Division 4 -Masonry	41 days	Fri 8/26/11	Fri 10/21/11
15	Division 7 -Thermal and Moisture Protection	51 days	Fri 8/26/11	Fri 11/4/11
16	Division 27 -Communications	51 days	Fri 8/26/11	Fri 11/4/11
17	Division 28 -Electronic Safety and Security	51 days	Fri 8/26/11	Fri 11/4/11
18	Division 22 -Plumbing	62 days	Fri 8/26/11	Mon 11/21/11
19	Division 24 -Electrical	62 days	Fri 8/26/11	Mon 11/21/11
20	Division 21 -Fire Suppression	64 days	Fri 9/2/11	Wed 11/30/11
21	Division 23 -HVAC	63 days	Mon 9/12/11	Wed 12/7/11
22	Division 5 -Metals	79 days	Fri 8/26/11	Wed 12/14/11
23	Division 8 -Openings	74 days	Fri 9/2/11	Wed 12/14/11
24	Division 7 -{Metal Roof & Wall Panels}	84 days	Fri 8/26/11	Wed 12/21/11
25	Division 12 -Furnishings	85 days	Mon 9/12/11	Fri 1/6/12
26	Division 10 -Specialtieis	65 days	Mon 10/17/11	Fri 1/13/12
27	Division 24 -{Main Transformer}	106 days	Fri 8/26/11	Fri 1/20/12
28	Division 24 -{Electrical Gear}	116 days	Fri 8/26/11	Fri 2/3/12
29	Division 11 -Equipment	105 days	Mon 9/12/11	Fri 2/3/12
30	Division 9 -Finishes	52 days	Thu 12/1/11	Fri 2/10/12
31	Division 32 -Exterior Improvements	30 days	Mon 2/13/12	Fri 3/23/12
32	Division 23 -{AHU's}	156 days	Fri 8/26/11	Fri 3/30/12
33	Division 23 -{Chillers}	156 days	Fri 8/26/11	Fri 3/30/12
34	Division 22 -{EDS}	186 days	Fri 9/2/11	Fri 5/18/12
35	Division 24 -{Generator}	258 days	Fri 8/26/11	Tue 8/21/12
36	**CONSTRUCTION**	**344 days**	**Fri 8/26/11**	**Wed 12/19/12**
37	Erosion Controls	11 days	Fri 8/26/11	Fri 9/9/11
38	Strip Topsoil to Stockpile	6 days	Mon 9/26/11	Mon 10/3/11
39	Site Storm Sewerage	13 days	Tue 10/4/11	Thu 10/20/11
40	Bulk Excavation	5 days	Fri 10/14/11	Thu 10/20/11



Project: Project1
Date: Wed 10/19/11

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

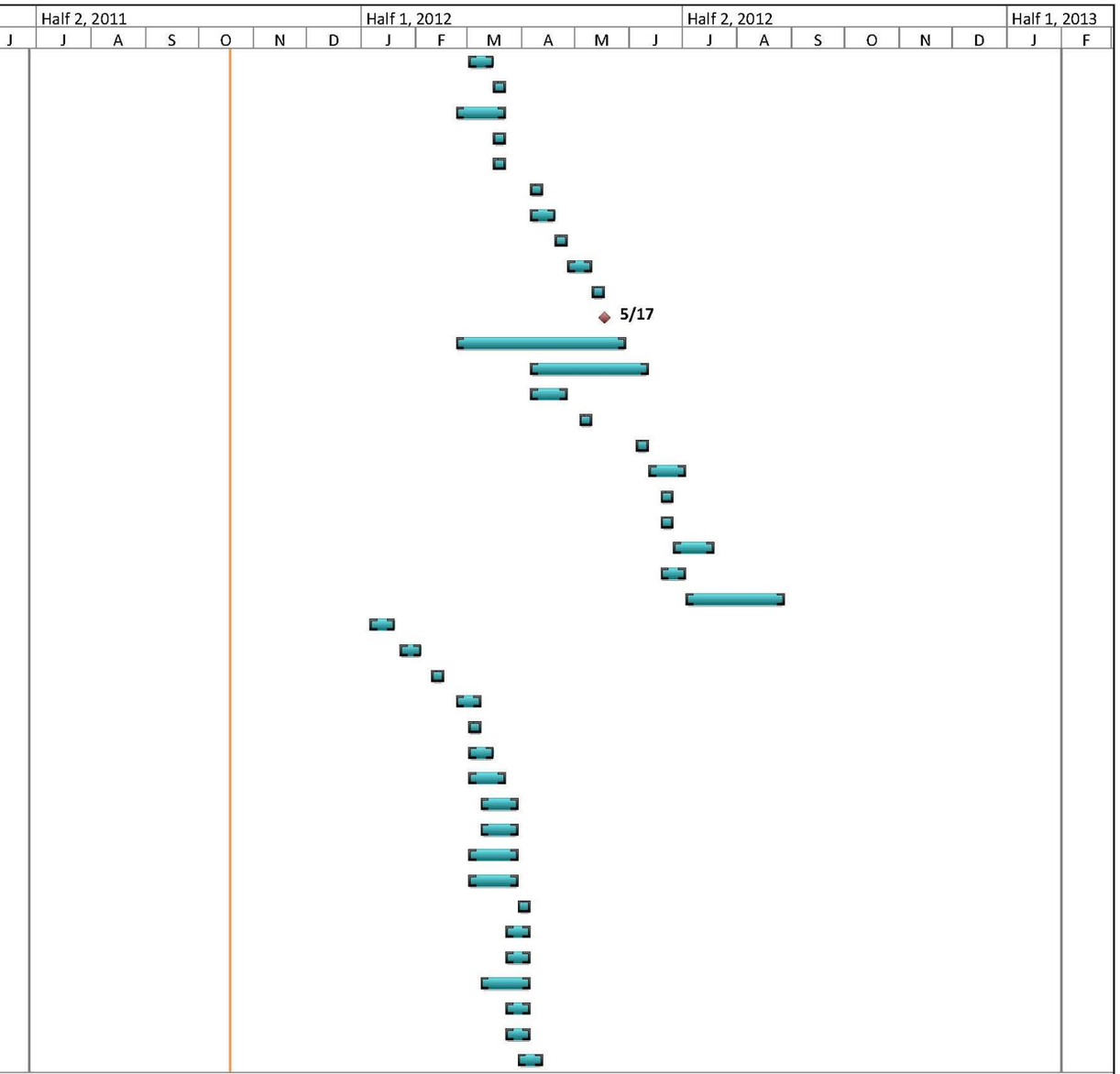
ID	Task Name	Duration	Start	Finish
41	**Foundations Commence**	0 days	Fri 10/21/11	Fri 10/21/11
42	Excavate Foundations [BL]	5 days	Fri 10/21/11	Thu 10/27/11
43	FRP Foundations (West & South) [BL]	50 days	Fri 10/28/11	Thu 1/5/12
44	FRP Foundation Walls (West & South)	12 days	Mon 11/14/11	Tue 11/29/11
45	Shore Foundation Walls	5 days	Wed 11/30/11	Tue 12/6/11
46	Excavate Foundations [FF]	5 days	Wed 11/30/11	Tue 12/6/11
47	FRP Foundation Walls (North & East)	20 days	Wed 11/30/11	Tue 12/27/11
48	Foundation Waterproofing	10 days	Wed 12/14/11	Tue 12/27/11
49	FRP Equipment Pads	6 days	Thu 12/29/11	Thu 1/5/12
50	Backfill Foundations for SOG [BL]	6 days	Thu 12/29/11	Thu 1/5/12
51	Backfill Foundation for SOG [FF]	5 days	Fri 1/6/12	Thu 1/12/12
52	**Substructure Complete**	0 days	Thu 1/12/12	Thu 1/12/12
53	FRP Loading Dock Foundations	5 days	Fri 1/6/12	Thu 1/12/12
54	FRP Loading Dock Walls	5 days	Fri 1/13/12	Thu 1/19/12
55	FRP Loading Dock SOG	5 days	Fri 1/20/12	Thu 1/26/12
56	FRP East Stairs	5 days	Fri 1/27/12	Thu 2/2/12
57	FRP Hardscape Foundations	5 days	Fri 2/3/12	Thu 2/9/12
58	FRP Hardscape Walls	5 days	Sun 2/12/12	Thu 2/16/12
59	Rub/Finish Foundation Walls	5 days	Fri 2/24/12	Thu 3/1/12
60	Under Slab Waterproofing/Insulation	5 days	Fri 3/9/12	Thu 3/15/12
61	Backfill Exterior Foundation	5 days	Fri 1/27/12	Thu 2/2/12
62	Site Duct Banks	20 days	Fri 2/3/12	Thu 3/1/12
63	Rough Grade Site	10 days	Fri 2/17/12	Thu 3/1/12
64	Site Gas	5 days	Fri 3/2/12	Thu 3/8/12
65	Site Lighting	5 days	Fri 3/2/12	Thu 3/8/12
66	Structural Steel Framing	10 days	Fri 1/13/12	Thu 1/26/12
67	First Floor Steel Deck	5 days	Fri 1/27/12	Thu 2/2/12
68	Penthouse Steel Deck	5 days	Fri 2/3/12	Thu 2/9/12
69	Steel Decking	5 days	Fri 2/10/12	Thu 2/16/12
70	**Superstructure Complete**	0 days	Thu 2/23/12	Thu 2/23/12
71	FRP Elevated Deck	10 days	Fri 2/10/12	Thu 2/23/12
72	FRP SOG	5 days	Fri 2/24/12	Thu 3/1/12
73	FRP Equipment Pads	30 days	Fri 2/24/12	Thu 4/5/12
74	Metal Stairs & Railings (Basement to Mezzanine)	15 days	Fri 2/24/12	Thu 3/15/12
75	Infill at Metal Stairs	5 days	Fri 3/9/12	Thu 3/15/12
76	FRP SOG	5 days	Fri 3/16/12	Thu 3/22/12
77	Ships Ladders	5 days	Fri 3/16/12	Thu 3/22/12
78	Roof Sheathing	5 days	Fri 2/17/12	Thu 2/23/12
79	Exterior Wall Framing/Sheathing	5 days	Fri 2/24/12	Thu 3/1/12
80	Exterior Wall Masonry/Insulation	10 days	Fri 3/2/12	Thu 3/15/12



Project: Project1
Date: Wed 10/19/11

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 Name	Duration	Start	Finish
81	Exterior Wall Framing/Sheathing/Insulation	10 days	Fri 3/2/12	Thu 3/15/12
82	Exterior Overhead Doors	5 days	Fri 3/16/12	Thu 3/22/12
83	Standing Seam Metal Roofing	20 days	Fri 2/24/12	Thu 3/22/12
84	EPDM Roofing Exterior Wall Metal Panels/Soffits	5 days	Fri 3/16/12	Thu 3/22/12
85	Wall Metal Panels/Soffits	5 days	Fri 3/16/12	Thu 3/22/12
86	Exterior Metal Doors & Frames	5 days	Fri 4/6/12	Thu 4/12/12
87	Aluminum Framing Storefronts/Curtainwalls	10 days	Fri 4/6/12	Thu 4/19/12
88	Glazing Storefronts/Curtainwalls	5 days	Fri 4/20/12	Thu 4/26/12
89	Louvers	10 days	Fri 4/27/12	Thu 5/10/12
90	Exterior Caulking and Sealants	5 days	Fri 5/11/12	Thu 5/17/12
91	**Building Envelope Complete**	0 days	Thu 5/17/12	Thu 5/17/12
92	Partition Layout & Top Track	68 days	Fri 2/24/12	Tue 5/29/12
93	Partition Framing	47 days	Fri 4/6/12	Mon 6/11/12
94	HM Door Frames	15 days	Fri 4/6/12	Thu 4/26/12
95	Partition Grouting	5 days	Fri 5/4/12	Thu 5/10/12
96	HM Door Frames	5 days	Tue 6/5/12	Mon 6/11/12
97	Partition GWB	15 days	Tue 6/12/12	Mon 7/2/12
98	Ceiling Framing	5 days	Tue 6/19/12	Mon 6/25/12
99	Roll-up Doors	5 days	Tue 6/19/12	Mon 6/25/12
100	Ceiling GWB	17 days	Tue 6/26/12	Wed 7/18/12
101	Ceiling Framing	10 days	Tue 6/19/12	Mon 7/2/12
102	Tape & Finish	40 days	Tue 7/3/12	Mon 8/27/12
103	Basement Under Slab Duct Banks	10 days	Fri 1/6/12	Thu 1/19/12
104	Set/Connect Transformer [UY]	10 days	Mon 1/23/12	Fri 2/3/12
105	Under Slab Sanitary Piping [FF]	5 days	Fri 2/10/12	Thu 2/16/12
106	Under Slab Utilities	10 days	Fri 2/24/12	Thu 3/8/12
107	Vent RI [PH]	5 days	Fri 3/2/12	Thu 3/8/12
108	Storm Sewerage RI [PH]	10 days	Fri 3/2/12	Thu 3/15/12
109	Plumbing RI [PH]	15 days	Fri 3/2/12	Thu 3/22/12
110	MPS/R RI [FF]	15 days	Fri 3/9/12	Thu 3/29/12
111	HWS/R RI [FF]	15 days	Fri 3/9/12	Thu 3/29/12
112	HWS/R RI [PH]	20 days	Fri 3/2/12	Thu 3/29/12
113	CHWS/R RI [PH]	20 days	Fri 3/2/12	Thu 3/29/12
114	Gas RI [BL]	5 days	Fri 3/30/12	Thu 4/5/12
115	Set/Connect ACF's [BL]	10 days	Fri 3/23/12	Thu 4/5/12
116	Plumbing Insulation [PH]	10 days	Fri 3/23/12	Thu 4/5/12
117	Ductwork [FF]	20 days	Fri 3/9/12	Thu 4/5/12
118	Set/Connect STS Generators [PH]	10 days	Fri 3/23/12	Thu 4/5/12
119	Set/Connect ACF's [PH]	10 days	Fri 3/23/12	Thu 4/5/12
120	Domestic Water RI [BL]	10 days	Fri 3/30/12	Thu 4/12/12



Project: Project1
Date: Wed 10/19/11

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

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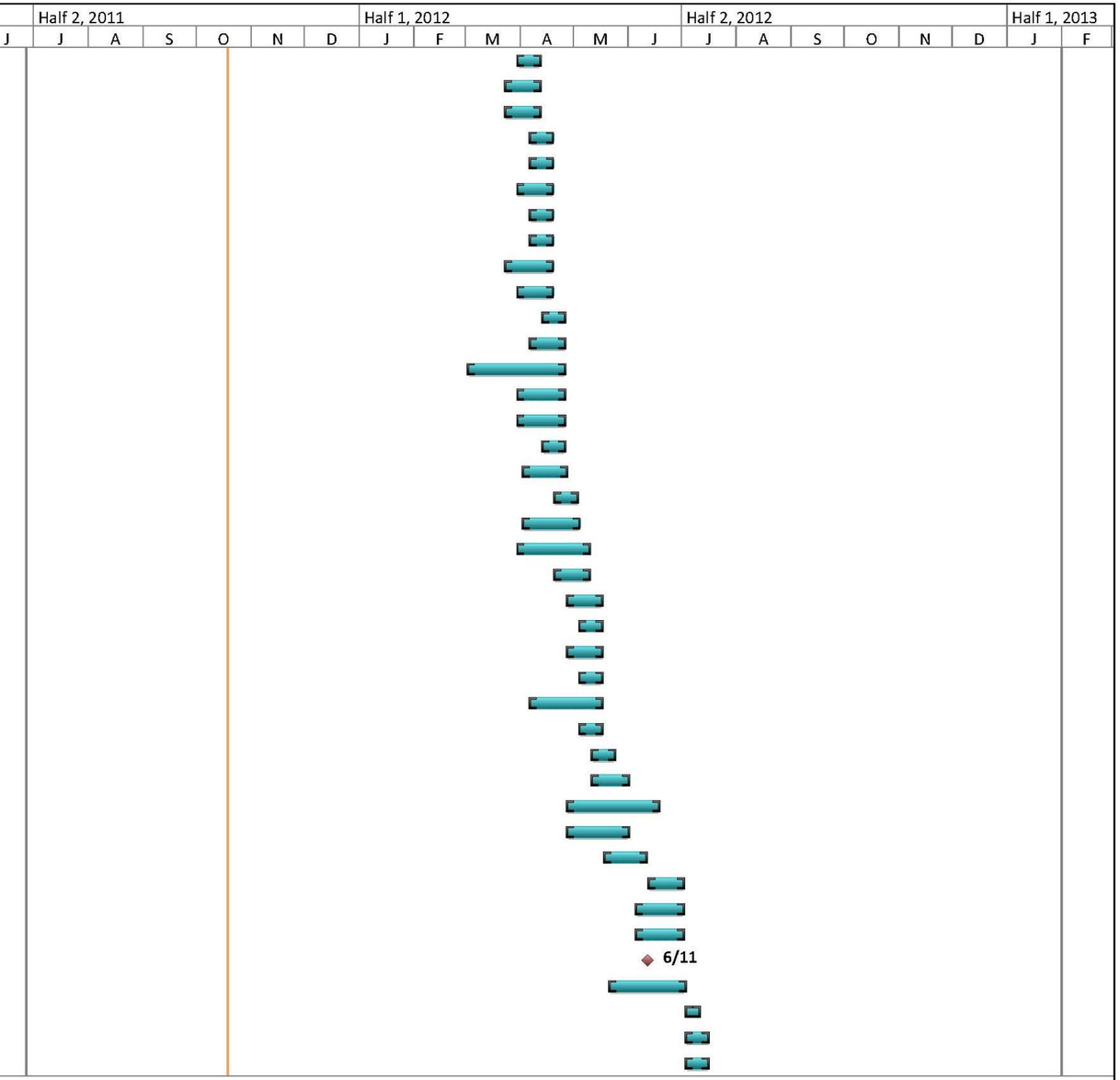
ID	Task Name	Duration	Start	Finish
121	MPS/R HWS/R Insulation	10 days	Fri 3/30/12	Thu 4/12/12
122	Set/Connect Heat Recovery Equipment	15 days	Fri 3/23/12	Thu 4/12/12
123	Roof Set/Connect Exhaust Fans	15 days	Fri 3/23/12	Thu 4/12/12
124	Set/Connect Steam Equipment [BL]	10 days	Fri 4/6/12	Thu 4/19/12
125	Set/Connect Heating Hot Water Equip	10 days	Fri 4/6/12	Thu 4/19/12
126	Boiler Stack [BL]	15 days	Fri 3/30/12	Thu 4/19/12
127	Plumbing Above Ceiling RI [FF]	10 days	Fri 4/6/12	Thu 4/19/12
128	HWS/R Insulation [PH]	10 days	Fri 4/6/12	Thu 4/19/12
129	Set/Connect In-Line Fans [PH]	20 days	Fri 3/23/12	Thu 4/19/12
130	CHWS/R Insulation [PH]	15 days	Fri 3/30/12	Thu 4/19/12
131	Compressed Air RI [BL]	10 days	Fri 4/13/12	Thu 4/26/12
132	Set/Connect Water Softener Equipment	15 days	Fri 4/6/12	Thu 4/26/12
133	Ductwork RI [PH]	40 days	Fri 3/2/12	Thu 4/26/12
134	LPS/R RI [PH]	20 days	Fri 3/30/12	Thu 4/26/12
135	ERS/R RI [PH]	20 days	Fri 3/30/12	Thu 4/26/12
136	Ductwork Insulation [FF]	10 days	Fri 4/13/12	Thu 4/26/12
137	Set/Connect Chillers [UY]	20 days	Mon 4/2/12	Fri 4/27/12
138	Set/Connect Chilled Water Equipment	10 days	Fri 4/20/12	Thu 5/3/12
139	Set/Connect AHU's [PH]	25 days	Mon 4/2/12	Fri 5/4/12
140	HPS/R HWS/R CHWS/R RI	30 days	Fri 3/30/12	Thu 5/10/12
141	EDS Exhaust Ductwork	15 days	Fri 4/20/12	Thu 5/10/12
142	Set/Connect Domestic Water Heater	15 days	Fri 4/27/12	Thu 5/17/12
143	Humidification Piping Insulation [PH]	10 days	Fri 5/4/12	Thu 5/17/12
144	LPS/R ERS/R Insulation	15 days	Fri 4/27/12	Thu 5/17/12
145	Roof Snow-Melt Mats	10 days	Fri 5/4/12	Thu 5/17/12
146	BAS Raceways	30 days	Fri 4/6/12	Thu 5/17/12
147	Plumbing Insulation	10 days	Fri 5/4/12	Thu 5/17/12
148	HPS/R HWS/R CHWS/R Insulation	10 days	Fri 5/11/12	Thu 5/24/12
149	Ductwork	16 days	Fri 5/11/12	Fri 6/1/12
150	Ductwork Insulation	37 days	Fri 4/27/12	Mon 6/18/12
151	BAS Raceways	26 days	Fri 4/27/12	Fri 6/1/12
152	Set/Connect Compressed Air Equipment	17 days	Fri 5/18/12	Mon 6/11/12
153	Set/Connect Water Booster Pumps	15 days	Tue 6/12/12	Mon 7/2/12
154	Sprinkler Mains & Branches RI	20 days	Tue 6/5/12	Mon 7/2/12
155	BAS Raceways [BL] Set/Connect EDS	20 days	Tue 6/5/12	Mon 7/2/12
156	**Permanent Power**	0 days	Mon 6/11/12	Mon 6/11/12
157	Set/Connect EDS	32 days	Mon 5/21/12	Tue 7/3/12
158	Terminal Units [FF]	7 days	Tue 7/3/12	Wed 7/11/12
159	Domestic Water Insulation [BL]	10 days	Tue 7/3/12	Mon 7/16/12
160	Sprinkler Drops/Heads [BL]	10 days	Tue 7/3/12	Mon 7/16/12



Project: Project1
Date: Wed 10/19/11

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

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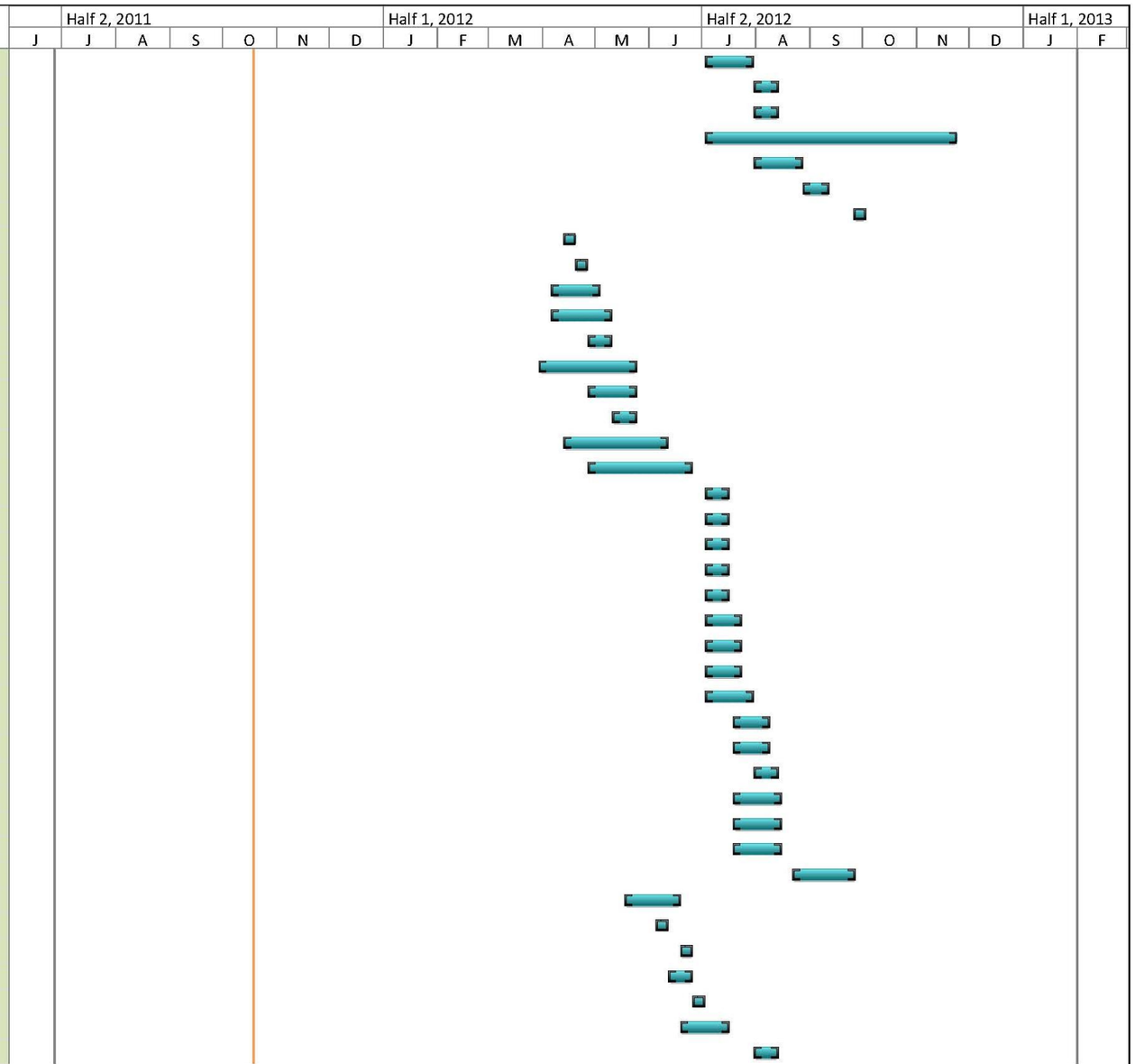
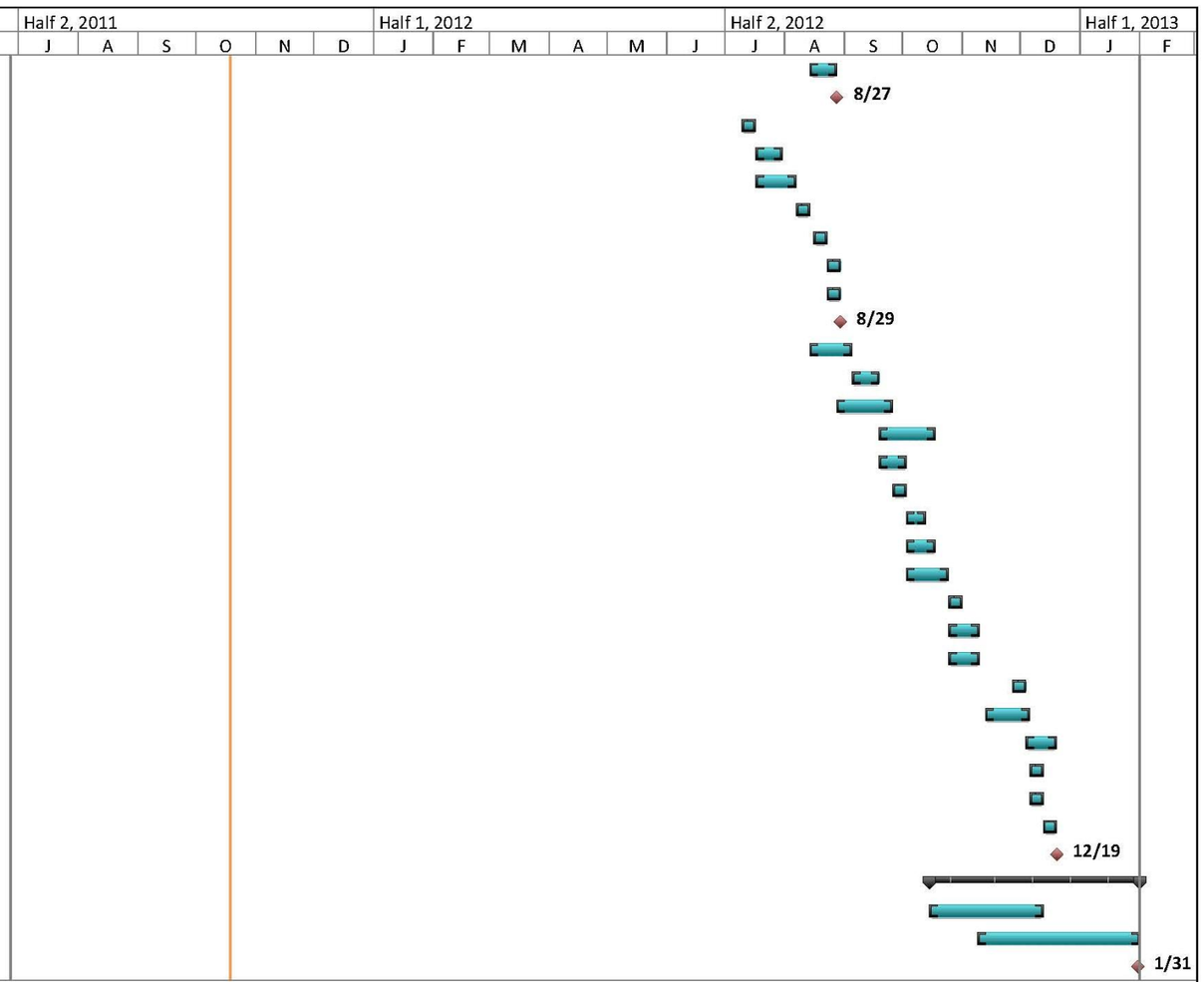
ID	Task Name	Duration	Start	Finish
161	Sprinkler Mains & Branches RI [FF]	20 days	Tue 7/3/12	Mon 7/30/12
162	Plumbing Fixtures [BL]	10 days	Tue 7/31/12	Mon 8/13/12
163	Sprinkler Drops [FF]	10 days	Tue 7/31/12	Mon 8/13/12
164	BAS Wiring & Devices [BL]	104 days	Tue 7/3/12	Fri 11/23/12
165	Sprinkler Mains & Branches RI [PH]	20 days	Tue 7/31/12	Mon 8/27/12
166	Sprinkler Drops/Heads [PH]	11 days	Tue 8/28/12	Tue 9/11/12
167	Plumbing Fixtures [FF]	5 days	Wed 9/26/12	Tue 10/2/12
168	Roof Set/Connect Disconnects	5 days	Fri 4/13/12	Thu 4/19/12
169	Roof Raceways	5 days	Fri 4/20/12	Thu 4/26/12
170	Set/Connect Panels & Disconnects [BL]	20 days	Fri 4/6/12	Thu 5/3/12
171	Set/Connect Main Switchgear [BL]	25 days	Fri 4/6/12	Thu 5/10/12
172	Roof Power Wiring and Devices	10 days	Fri 4/27/12	Thu 5/10/12
173	Raceways [BL]	40 days	Fri 3/30/12	Thu 5/24/12
174	Set/Connect Panels & Disconnects	20 days	Fri 4/27/12	Thu 5/24/12
175	Roof Lighting Wiring and Devices	10 days	Fri 5/11/12	Thu 5/24/12
176	Raceways [FF]	42 days	Fri 4/13/12	Mon 6/11/12
177	Raceways [PH]	42 days	Fri 4/27/12	Mon 6/25/12
178	Tel/Com Wiring and Devices [BL]	10 days	Tue 7/3/12	Mon 7/16/12
179	Fire Alarm Wiring and Devices [BL]	10 days	Tue 7/3/12	Mon 7/16/12
180	CCTV/AC Wiring and Devices [BL]	10 days	Tue 7/3/12	Mon 7/16/12
181	Fire Alarm Wiring and Devices [PH]	10 days	Tue 7/3/12	Mon 7/16/12
182	CCTV/AC Wiring and Devices [PH]	10 days	Tue 7/3/12	Mon 7/16/12
183	Lighting Wiring and Devices [BL]	15 days	Tue 7/3/12	Mon 7/23/12
184	Power Wiring and Devices [BL]	15 days	Tue 7/3/12	Mon 7/23/12
185	Lighting Wiring and Devices [PH]	15 days	Tue 7/3/12	Mon 7/23/12
186	Power Wiring and Devices [PH]	20 days	Tue 7/3/12	Mon 7/30/12
187	Tel/Com Wiring and Devices [FF]	15 days	Thu 7/19/12	Wed 8/8/12
188	Fire Alarm Wiring and Devices [FF]	15 days	Thu 7/19/12	Wed 8/8/12
189	Tel/Com Wiring and Devices [PH]	10 days	Tue 7/31/12	Mon 8/13/12
190	Lighting Wiring and Devices [FF]	20 days	Thu 7/19/12	Wed 8/15/12
191	Power Wiring and Devices [FF]	20 days	Thu 7/19/12	Wed 8/15/12
192	CCTV/AC Wiring and Devices [FF]	20 days	Thu 7/19/12	Wed 8/15/12
193	Set/Connect Generator [UY]	26 days	Wed 8/22/12	Wed 9/26/12
194	Road Work / Paving	22 days	Fri 5/18/12	Mon 6/18/12
195	FRP Sidewalks	5 days	Tue 6/5/12	Mon 6/11/12
196	Gravel Shoulders	5 days	Tue 6/19/12	Mon 6/25/12
197	Exterior Stair Railings	10 days	Tue 6/12/12	Mon 6/25/12
198	Parking Striping, Stops, Signage	5 days	Tue 6/26/12	Mon 7/2/12
199	Security Fencing	20 days	Tue 6/19/12	Mon 7/16/12
200	Spread Topsoil Stockpile	10 days	Tue 7/31/12	Mon 8/13/12



Project: Project1
Date: Wed 10/19/11

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 Name	Duration	Start	Finish
201	Landscaping	10 days	Tue 8/14/12	Mon 8/27/12
202	**Sitework Complete**	0 days	Mon 8/27/12	Mon 8/27/12
203	Prime Paint & Coat [PH]	5 days	Tue 7/10/12	Mon 7/16/12
204	Prime Paint & 1st Coat [BL]	10 days	Tue 7/17/12	Mon 7/30/12
205	Resinous Flooring [PH]	15 days	Tue 7/17/12	Mon 8/6/12
206	Doors & Hardware [PH]	5 days	Tue 8/7/12	Mon 8/13/12
207	Prime Paint & First Coat [FF]	5 days	Thu 8/16/12	Wed 8/22/12
208	Ceramic Tile [FF]	5 days	Thu 8/23/12	Wed 8/29/12
209	Polished Floors [FF]	5 days	Thu 8/23/12	Wed 8/29/12
210	**Interior Compartments Complete**	0 days	Wed 8/29/12	Wed 8/29/12
211	Seal Concrete Floors [BL]	16 days	Tue 8/14/12	Tue 9/4/12
212	Doors & Hardware [BL]	10 days	Wed 9/5/12	Tue 9/18/12
213	Wall Coatings Prime & Intermediate Coating	21 days	Tue 8/28/12	Tue 9/25/12
214	Set/Connect Lab Equipement	21 days	Wed 9/19/12	Wed 10/17/12
215	Touch Up & Finish Paint [BL]	10 days	Wed 9/19/12	Tue 10/2/12
216	Entrance Mat [FF]	5 days	Wed 9/26/12	Tue 10/2/12
217	Touch-up and Finish Paint [FF]	8 days	Wed 10/3/12	Fri 10/12/12
218	Misc. Trim-out [BL]	11 days	Wed 10/3/12	Wed 10/17/12
219	Resinous Flooring [FF]	16 days	Wed 10/3/12	Wed 10/24/12
220	Fiberglass Grating [FF]	5 days	Thu 10/25/12	Wed 10/31/12
221	Lab Casework [FF]	12 days	Thu 10/25/12	Fri 11/9/12
222	Doors & Hardware [FF]	12 days	Thu 10/25/12	Fri 11/9/12
223	Touch Up & Finish Paint [PH]	5 days	Tue 11/27/12	Mon 12/3/12
224	Wall Coatings Topcoat [FF]	17 days	Tue 11/13/12	Wed 12/5/12
225	Misc. Trim-out [PH]	12 days	Tue 12/4/12	Wed 12/19/12
226	Hepa Filters [FF]	5 days	Thu 12/6/12	Wed 12/12/12
227	Wall Protection [FF]	5 days	Thu 12/6/12	Wed 12/12/12
228	Joint Sealants [FF]	5 days	Thu 12/13/12	Wed 12/19/12
229	**Substancial Completion**	0 days	Wed 12/19/12	Wed 12/19/12
230	**PROJECT CLOSEOUT**	**79 days**	**Mon 10/15/12**	**Thu 1/31/13**
231	Start-Up & Testing	43 days	Mon 10/15/12	Wed 12/12/12
232	Commisioning	60 days	Fri 11/9/12	Thu 1/31/13
233	**Commisioning Complete**	0 days	Thu 1/31/13	Thu 1/31/13



Project: Project1
Date: Wed 10/19/11

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	

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[APPENDIX B-1]

2011 Detailed Cast-In-Place Concrete Takeoff

Basement Cast-In-Place Concrete Takeoff

Cast-In-Place										
	Tag	Depth (Ft)	Area (SF)	Reinforcing	Concrete (CF)	WWF Total (SF)	Rebar Total (Ft)	Formwork (Ft)	Rebar wt.	Rebar tons
Basement Plan Spead Footings										
	F11	1.75	43.5	#7	76.125	N/A	76		155.344	
	F11/12	1.75	65.25	#7	114.1875	N/A	89.25		182.427	
	F12	1.75	50.75	#7	88.8125	N/A	123.75		252.945	
	F6	1.5	28.125	#6	42.1875	N/A	56		84.1568	
Continuous Footings	CF2	1.167	36.25	#5	42.3038	N/A	73.5		76.6605	
	F6.1	1.5	28.125	#6	42.1875	N/A	56		84.112	
	F13	1.75	49	#4	85.75	N/A	92.5		61.79	
	F13.1	1.75	49	#4	85.75	N/A	92.5		61.79	0.47961265
Basement Equipement Pads	Cpad1	0.33	35.625	#4	11.75625	N/A	42.25	24.5	28.223	
	Cpad2	0.33	35.625	#4	11.75625	N/A	42.25	24.5	28.223	
	Cpad3	0.33	35.625	#4	11.75625	N/A	42.25	24.5	28.223	
	Cpad4	0.33	45	#4	14.85	N/A	52.5	28	35.07	0.0598695
Basement Slab	Slab1	0.5	660	N/A	330	660	N/A			
Concrete Piers	FP6	1.167	3.36	N/A	1.96056	N/A	N/A	13.25		
				#4	N/A	N/A	9.813		6.555084	
				#9	N/A	N/A	10.98		37.332	
	FP6.1	1.167	3.36	N/A	1.96056	N/A	N/A	13.25		
				#4	N/A	N/A	9.813		6.555084	0.006555084
				#9	N/A	N/A	10.98		37.332	0.037332
Concrete Load Bearing Walls										
	S 9(1.01/S3.03)	1.167	317.625		370.668375	N/A		1270.5		
				#4	N/A	N/A	616		411.488	
				#5	N/A	N/A	514.75		536.88425	
				#8	N/A	N/A	514.75		1374.3825	0.68719125
	S 1(1.01/S3.03)	1.167	317.625		370.668375	N/A		1270.5		
				#5	N/A	N/A	616		642.488	
				#5	N/A	N/A	390.5		407.2915	
				#5	N/A	N/A	390.5		407.2915	0.677831875

1St Floor Cast-In-Place Concrete Takeoff

Cast-In-Place										
	Tag	Depth (Ft)	Area (SF)	Reinforcing	Concrete (CF)	WWF Total (SF)	Rebar Total (Ft)	Formwork (Ft)	Rebar wt.	Rebar tons
First Floor Spread Footings										
	F9	1.75	54	#7	47.25	N/A	50.25		102.711	
	F5	1.75	49	#6	42.875	N/A	45.5		68.3774	
Continuous Footing										
	CF2	1.167	55	#5	64.185	N/A	108.5		113.1655	0.14212695
Concrete Piers 1st floor										
	S 8(1.02/S3.01	1.167	3.36		1.96056	N/A	N/A	13.25		
				#4		N/A	22.895		15.29386	
				#9		N/A	10.98		37.332	
	S 8(1.02/S3.01	1.167	3.36		1.96056	N/A	N/A	13.25		
				#4		N/A	22.895		15.29386	0.01529386
				#9		N/A	10.98		37.332	0.037332
Concrete 1st Floor										
	Slab 2	0.5	475.75	N/A	237.875	475.75	N/A	87.25		
Concrete Wall 1st										
	CF3	1.167	132	#4	154.044	N/A	382.25	264	255.343	0.1276715
					83.4382					

[APPENDIX B-2]

2011 Detailed Superstructure Takeoff

First Floor Framing Takeoff

BRL Structural Estimate					
	Size	Type	Unit	Length (ft)	Quantity
First Framing Plan					
	W8X13	Wide Flange		8.625	
	W8X13	Wide Flange		8.625	
	W8X13	Wide Flange		8.625	
	W8X13	Wide Flange		8.625	
	W8X13	Wide Flange		6.583	
	W8X13	Wide Flange		6.583	
	W8X13	Wide Flange		6.583	
	W8X13	Wide Flange		6.33	
TOTAL	W8X13	Wide Flange		60.579	
	W12X19	Wide Flange		19.98	
	W12X19	Wide Flange		19.98	
	W12X19	Wide Flange		19.98	
	W12X19	Wide Flange		19.98	
TOTAL	W12X19	Wide Flange		79.92	
	W14X22	Wide Flange		22	
	W14X22	Wide Flange		22	
TOTAL	W14X22	Wide Flange		44	
	W8X18	Wide Flange		6.33	
TOTAL	W8X18	Wide Flange		6.33	
2" 20 gage Steel deck		2VLI20	Sq ft.		616.91
Lightweight Concrete	2"		Cu ft.		102.818333
WWF	6X6	W1.4XW1.4	Sq ft.		616.91

Penthouse Floor Framing Takeoff

BRL Structural Estimate					
	Size	Type	Unit	Length (ft)	Quantity
Penthouse Framing Plan	W8X13	Wide Flange		8.625	
	W8X13	Wide Flange		8.625	
	W8X13	Wide Flange		8.625	
	W8X13	Wide Flange		8.625	
TOTAL	W8X18	Wide Flange		34.5	
	W12X19	Wide Flange		19.98	
	W12X19	Wide Flange		19.98	
	W12X19	Wide Flange		21.625	
	W12X19	Wide Flange		21.625	
TOTAL	W12X19	Wide Flange		83.21	
	W14X61	Wide Flange		21.625	
	W14X61	Wide Flange		21.625	
	W14X61	Wide Flange		19.98	
	W14X61	Wide Flange		19.98	
TOTAL	W14X61	Wide Flange		83.21	
	W14X26	Wide Flange		22	
	W14X26	Wide Flange		22	
TOTAL	W14X26	Wide Flange		44	
	W14X22	Wide Flange		22	
	W14X22	Wide Flange		22	
TOTAL	W14X22	Wide Flange		44	
2" 20 gage Steel deck		2VLI20	Sq ft.		1127.06
Lightweight Concrete	2"		Cu ft.		187.843333
WWF	6X6	W1.4XW1.4	Sq ft.		1127.06

Mezzanine Floor Framing Takeoff

BRL Structural Estimate					
	Size	Type	Unit	Length (ft)	Quantity
Mezzanine Framing Plan	W10X15	Wide Flange		22	
	W10X15	Wide Flange		22	
	W10X15	Wide Flange		7.45	
	W10X15	Wide Flange		7.45	
	W10X15	Wide Flange		7.48	
	W10X15	Wide Flange		7.48	
	W10X15	Wide Flange		9.28	
	W10X15	Wide Flange		9.28	
TOTAL	W10X15	Wide Flange		92.42	
	W10X22	Wide Flange		22	
	W10X22	Wide Flange		22	
TOTAL	W10X22	Wide Flange		44	
	W10X19	Wide Flange		22	
TOTAL	W10X19	Wide Flange		22	
2" 20 gage Steel deck		2VLI20	Sq ft.		532.62
Lightweight Concrete	2"		Cu ft.		88.77
WWF	6X6	W1.4XW1.4	Sq ft.		532.62

Roof Framing Takeoff

BRL Structural Estimate					
	Size	Type	Unit	Length (ft)	Quantity
Roof Framing Plan					
	16K4	K joist		22	
	16K4	K joist		22	
	16K4	K joist		22	
TOTAL	16K4	K joist		66	
	16K7	K joist		20	
	16K7	K joist		20	
	16K7	K joist		20	
	16K7	K joist		20	
	16K7	K joist		20	
TOTAL	16K7	K joist		100	
	W8X18	Wide Flange		9.29	
	W8X18	Wide Flange		9.29	
	W8X18	Wide Flange		9.29	
	W8X18	Wide Flange		9.29	
TOTAL	W8X18	Wide Flange		37.16	
	W12X40	Wide Flange		22	
	W12X40	Wide Flange		22	
TOTAL	W12X40	Wide Flange		44	
	W14X43	Wide Flange		32.79	
	W14X43	Wide Flange		32.79	
TOTAL	W14X43	Wide Flange		65.58	
	W12X35	Wide Flange		22	
	W12X35	Wide Flange		22	
	W12X35	Wide Flange		22	
TOTAL	W12X35	Wide Flange		66	
	HSS8X6X1/4	Box Beam		22	
TOTAL	HSS8X6X1/4	Box Beam		22	
	HSS6X6X5/16	Box Beam		22	
TOTAL	HSS6X6X5/16	Box Beam		22	
2" 20 gage Steel Deck		2VLI20	Sq ft.		204.38
Lightweight Concrete	2"		Cu ft.		34.0633333
WWF	6X6	W1.4XW1.4	Sq ft.		204.38
1.5" 20 gage Wide Rib Steel Deck	Type B	B-C	Sq ft.		643.94
1.5" 20 gage Wide Rib Steel Deck	Type B	A-B	Sq ft.		721.38

Column Framing Takeoff

BRL Structural Estimate					
	Size	Type	Unit	Length (ft)	Quantity
Column Framing Plan					
Starts at Basement					
A/5	W8X31	Wide Flange		31.396	
A/6	W8X31	Wide Flange		31.396	
TOTAL	W8X31	Wide Flange		62.792	
A.8/5	HSS10X6X1/2	Box Beam		26.5	
TOTAL	HSS10X6X1/2	Box Beam		26.5	
A.8/6	HSS10X4X5/8	Box Beam		26.5	
TOTAL	HSS10X4X5/8	Box Beam		26.5	
	Size	Type	Unit	Length (ft)	Quantity
Column Framing Plan					
Starts at First Floor					
A.9/5	W8X31	Wide Flange		13.167	
A.9/6	W8X31	Wide Flange		13.167	
TOTAL	W8X31	Wide Flange		26.334	
C/5	W8X31	Wide Flange		17.33	
C/6	W8X31	Wide Flange		17.33	
TOTAL	W8X31	Wide Flange		34.66	
	Size	Type	Unit	Length (ft)	Quantity
Starts at Penthouse					
B/5	W8X48	Wide Flange		26.23	
B/6	W8X48	Wide Flange		26.23	
TOTAL	W8X48	Wide Flange		52.46	
A.7/5	W8X48	Wide Flange		26.23	
A.7/6	W8X48	Wide Flange		26.23	
TOTAL	W8X48	Wide Flange		52.46	
Mezzanine Post	W8X31	Wide Flange		8.98	
	W8X31	Wide Flange		8.98	
	W8X31	Wide Flange		8.98	
	W8X31	Wide Flange		8.98	
TOTAL	W8X31	Wide Flange		35.92	

[APPENDIX B-3]

Cast-In Place Structural Estimate

Cast-In Place Structural Estimate

CSI	Description	Crew	Daily Output	Labor-Hours	Unit	Quantity	Material	Labor	Equipment	Total	Total Incl O&P	Cost	Cost w O & P
FORMS													
31113.4	**Forms In Place, Equipment Foundations** - 4 use	C-2	205	0.234	SFCA	55.825	$ 0.87	$ 9.80		$ 10.67	$ 16.00	$ 595.65	**$ 893.20**
31113.45	**Forms In Place, Footings** - Pile Cap, square or rectangle, job-built plywood - 4 use	C-1	383	0.084	SFCA	58.3	$ 0.76	$ 3.42		$ 4.18	$ 6.10	$ 243.69	**$ 355.63**
31113.45	**Forms In Place, Footings - Spread Footings**, Job-built lumber, 4 use	C-1	414	0.077	SFCA	0	$ 0.58	$ 3.16		$ 3.74	$ 5.50		
31113.65	**Forms In Place, Slab on Grade** - wood, 4 use, on grade, to 6" high	C-1	600	0.053	L.F.	96.25	$ 0.27	$ 2.18		$ 2.45	$ 3.64	$ 235.81	**$ 350.35**
31113.85	**Forms In Place, Walls - Below Grade**, Job-Built Plywood, 4 use	C-2	225	0.213	SFCA	3092.1	$ 0.73	$ 8.95		$ 9.68	$ 14.50	$ 29,931.53	**$ 44,835.45**
REBAR													
32110.6	**Footings**, #4-#7	4-Rodm	2.1	15.238	Ton	0.682	$ 1,475.00	$ 475.00		$ 2,155.00	$ 2,725.00	$ 1,469.71	**$ 1,858.45**
	Elevated slabs, #4-#7	4-Rodm	2.9	11.034	Ton	0.066	$ 1,650.00	$ 490.00		$ 2,140.00	$ 2,600.00	$ 141.24	**$ 171.60**
	Columns,#3-#7	4-Rodm	1.5	21.333	Ton	0.0231	$ 1,550.00	$ 950.00		$ 2,500.00	$ 3,250.00	$ 57.75	**$ 75.08**
	Cloumns, #8-#18	4-Rodm	2.3	13.913	Ton	0.0814	$ 1,550.00	$ 620.00		$ 2,170.00	$ 2,725.00	$ 176.64	**$ 221.82**
	Walls, #3-#7	4-Rodm	3	10.667	Ton	0.891	$ 1,475.00	$ 475.00		$ 1,950.00	$ 2,400.00	$ 1,737.45	**$ 2,138.40**
	Walls, #8-#18	4-Rodm	4	8	Ton	0.759	$ 1,475.00	$ 355.00		$ 1,830.00	$ 2,200.00	$ 1,388.97	**$ 1,669.80**
WWF													
32205.5	**Welded Wire Fabric** - ASTM A185												
	6X6 - W1.4 X W1.4 (10X10) 21lb. Per C.S.F.	2 Rodm	35	0.457	C.S.F	34.30823	$ 12.50	$ 22.00		$ 34.50	$ 49.50	$ 1,183.63	**$ 1,698.26**
	6X6 - W4 X W4 (10X10) 21lb. Per C.S.F.	2 Rodm	27	0.593	C.S.F	5.093	$ 29.50	$ 28.50		$ 58.00	$ 78.50	$ 295.39	**$ 399.80**

Cast-In Place Structural Estimate

Description	Crew	Daily Output	Labor-Hours	Unit	Quantity	Material	Labor	Equipment	Total	Total Incl O&P	Cost	Cost w O & P
Normal Weight Concrete - 3000psi				C.Y.	91.7752	$ 98.50			$ 98.50	$ 108.00	$ 9,039.86	**$ 9,911.72**
Light Weight Concrete - 3000psi				C.Y.	16.874	$ 123.13			$ 123.13	$ 135.00	$ 2,077.61	**$ 2,277.99**
Placing Concrete - Elevated slabs, 6" to 10" thick, pumped	C-20	160	0.4	C.Y.	2.046		$ 13.55	$ 4.94	$ 18.49	$ 26.50	$ 37.83	**$ 54.22**
Placing Concrete - Footings,continuous deep pumped	C-20	160	0.4	C.Y.	13.046		$ 13.55	$ 4.94	$ 18.49	$ 26.50	$ 241.22	**$ 345.72**
Placing Concrete - Footings, spread, over 5 C.Y. Pumped	C-20	150	0.427	C.Y.	16.764		$ 14.45	$ 5.25	$ 19.70	$ 28.00	$ 330.25	**$ 469.39**
Placing Concrete - Pile caps, under 5 C.Y., Pumped	C-20	110	0.582	C.Y.	0.319		$ 19.75	$ 7.20	$ 26.95	$ 38.00	$ 8.60	**$ 12.12**
Placing Concrete - Slab on Grade, up to 6" thick, pumped	C-20	185	0.346	C.Y.	36.13		$ 11.75	$ 4.27	$ 16.02	$ 22.50	$ 578.80	**$ 812.93**
Placing Concrete - Walls, 15" thick, Pumped	C-20	120	0.533	C.Y.	36.476		$ 18.10	$ 6.60	$ 24.70	$ 35.00	$ 900.96	**$ 1,276.66**
Floor Finsihes - (Manual screed, bull float, manual float, manual steel trowel)	C-10	1265	0.019	S.F.	3616.72		$ 0.68		$ 0.68	$ 1.02	$ 2,459.37	**$ 3,689.05**
Finishing Walls - Break Ties and patch voids	1 Cefi	540	0.015	S.F.	2805	$ 0.03	$ 0.57		$ 0.60	$ 0.86	$ 1,683.00	**$ 2,412.30**
											$ 54,814.97	**$ 75,929.93**
											Cost/s.f.	**$ 29.39**

[APPENDIX B-4]

Steel Structural Estimate

CSI	Description	Crew	Daily Output	Labor-Hours	Unit	Quantity	Material	Labor	Equipment	Total	Total Incl O&P	Cost	Cost w O&P
Structural Beams													
51223.75	W8X13 / W8X15	E-2	600	0.093	L.F.	60.58	$ 25.00	$ 4.06	$ 2.90	$ 31.96	$ 37.00	$ 1,936.14	**$ 2,241.46**
	W8X18 / W8X21	E-2	600	0.093	L.F.	78	$ 34.50	$ 4.06	$ 2.90	$ 41.46	$ 48.00	$ 3,233.88	**$ 3,744.00**
	W8X31	E-2	550	0.102	L.F.	98.71	$ 51.00	$ 4.43	$ 3.17	$ 58.60	$ 67.50	$ 5,784.41	**$ 6,662.93**
	W10X15	E-2	600	0.093	L.F.	92.42	$ 25.00	$ 4.06	$ 2.90	$ 31.96	$ 37.00	$ 2,953.74	**$ 3,419.54**
	W10X19 / W10X 22	E-2	600	0.093	L.F.	22	$ 36.50	$ 4.06	$ 2.90	$ 43.46	$ 50.00	$ 956.12	**$ 1,100.00**
	W10X22	E-2	600	0.093	L.F.	44	$ 36.50	$ 4.06	$ 2.90	$ 43.46	$ 50.00	$ 1,912.24	**$ 2,200.00**
	W12X19 / W12X22	E-2	880	0.064	L.F.	162.41	$ 36.50	$ 2.77	$ 1.98	$ 41.25	$ 47.00	$ 6,699.41	**$ 7,633.27**
	W12X35	E-2	810	0.069	L.F.	66	$ 58.00	$ 3.01	$ 2.15	$ 63.16	$ 71.00	$ 4,168.56	**$ 4,686.00**
	W12X40 / W12X35	E-2	810	0.069	L.F.	44	$ 58.00	$ 3.01	$ 2.15	$ 63.16	$ 71.00	$ 2,779.04	**$ 3,124.00**
	W14X22 / W14X26	E-2	990	0.057	L.F.	88	$ 43.00	$ 2.46	$ 1.76	$ 47.22	$ 53.00	$ 4,155.36	**$ 4,664.00**
	W14X26	E-2	990	0.057	L.F.	44	$ 43.00	$ 2.46	$ 1.76	$ 47.22	$ 53.00	$ 2,077.68	**$ 2,332.00**
	W14X43	E-2	810	0.069	L.F.	65.58	$ 71.00	$ 3.01	$ 2.15	$ 76.16	$ 85.50	$ 4,994.57	**$ 5,607.09**
	W14X61 / W14X53	E-2	800	0.07	L.F.	83.21	$ 87.50	$ 3.05	$ 2.18	$ 92.73	$ 104.00	$ 7,716.06	**$ 8,653.84**
Open Web Steel Joists Framing													
52119.1	16K4 / 16K3	E-7	1800	0.044	L.F.		$ 6.40	$ 1.96	$ 1.12	$ 9.48	$ 11.65		
	16K7 / 16K6	E-7	1800	0.044	L.F.		$ 8.25	$ 1.96	$ 1.12	$ 11.33	$ 13.70		
Hollow Structural Steel													
51223.17	HSS8X6X1/4 HSS8X4X3/8"X12'-0"	E-2	54	1.037	Ea.	2	$ 550.00	$ 45.00	$ 32.00	$ 627.00	$ 715.00	$ 1,254.00	**$ 1,430.00**
	HSS6X6X5/16 HSS6"X6"X1/4"X12'-0"	E-2	54	1.037	Ea.	2	$ 405.00	$ 45.00	$ 32.00	$ 482.00	$ 560.00	$ 964.00	**$ 1,120.00**
	Assumption :	Rounded up for pieces that contained each for units if the piece count was not a whole number											
Structural Columns													
51223.75	W8X31	E-2	1080	0.052	L.F.	61	$ 39.50	$ 2.26	$ 1.61	$ 43.37	$ 49.00	$ 2,645.57	**$ 2,989.00**
	W8X48	E-2	1080	0.052	L.F.	112.92	$ 51.00	$ 2.26	$ 1.61	$ 54.87	$ 62.00	$ 6,195.92	**$ 7,001.04**
51223.17	HSS10X6X1/2	E-2	50	1.12	Ea.	3	$ 880.00	$ 49.00	$ 35.00	$ 964.00	$ 1,075.00	$ 2,892.00	**$ 3,225.00**
	HSS10X4X5/8	E-3	50	1.12	Ea.	3	$ 880.00	$ 49.00	$ 35.00	$ 964.00	$ 1,075.00	$ 2,892.00	**$ 3,225.00**
	Assumption :	Used a HSS10X6X3/8X14'-0" to replace both HSS box beams used on the project											
Steel Floor Decking													
53113.5	Non Cellular composite Deck, 2", 20 gauge	E-4	3600	0.009	S.F.	$ 2,481.00	$ 2.71	$ 0.37	$ 0.03	$ 2.84	$ 3.39	$ 7,046.04	**$ 8,410.59**
Roof Decking													
53113.5	Open Type 1-1/2" deep wide rib, 20 gauge	E-4	4300	0.007	S.F.	$ 1,365.32	$ 2.18	$ 0.34	$ 0.03	$ 2.55	$ 3.03	$ 3,481.57	**$ 4,136.92**
Metal Stairs													
55113.5	Cement fill metal pan, picket rail 3'-6"	E-4	35	0.914	Riser	$ 40.00	$ 560.00	$ 41.50	$ 3.83	$ 605.33	$ 700.00	$ 24,213.20	**$ 28,000.00**
												$ 100,951.51	**$ 115,605.67**
							Cost per S.F.	$ 31.96					

[APPENDIX C-1]

General Conditions Estimate

General Conditions Estimate

Line Number	Description	Unit	Crew	Daily Output	Labor Hours	Bare Material	Bare Labor	Bare Equipment	Bare Total	Total O&P	COST	Cost/ Category
Personal												**$ 413,400.61**
13113200200	Project Manager Average	Per hour		2591			$ 51.88		$ 51.88	$ 79.38	$ 205,660.63	
13113200240	Superintendant Average	Per hour		121.11			$ 48.13		$ 48.13	$ 73.75	$ 8,931.86	
	Project Executive	Per hour		272			$ 55.00		$ 55.00	$ 84.38	$ 22,950.00	
	Commsioning Manager	Per hour		216			$ 48.13		$ 48.13	$ 73.75	$ 15,930.00	
	Field Engineer	Per hour		2591			$ 31.63		$ 31.63	$ 48.75	$ 126,311.25	
	Bim Coordinator	Per hour		471			$ 36.25		$ 36.25	$ 55.63	$ 26,199.38	
	Site Safety Manager	Per hour		136			$ 31.63		$ 31.63	$ 48.75	$ 6,630.00	
13113200020	Clerk	Per hour		50			$ 10.25		$ 10.25	$ 15.75	$ 787.50	
Issurance and Permitting												**$ 308,297.03**
13113300020	Builders Risk insurance standard	Job								0.24%	$ 55,200.00	
13113300400	contractor's equipment	Value								0.50%	$ 97.03	
14126500010	Permits	Job								0.50%	$ 115,000.00	
13113900020	Performance Bond buildings	Job								0.60%	$ 138,000.00	
Temporary Utilities	Utilities											**$ 129,814.17**
15113800100	Heat incl. fuel and operation 12hr/day	CSF Flr	1 Skwk	100	0.08	$ 27.53	$ 3.35		$ 30.88	$ 35.67	$ 24,172.37	
15113800350	Lighting incl. service lamps, wiring and outlets	CSF Flr	1 elec	34	0.235	$ 2.73	$ 11.17		$ 13.90	$ 19.55	$ 13,248.38	
15113800400	Power for Temporary Lighting 11.8 cents/kwh	CSF Flr							$ 0.90	$ 0.98	$ 664.11	
15113800600	Power for Job duration in	CSF Flr							$ 107.25	$ 117.98	$ 79,951.11	
15433406410	Toilet	Ea/ month					$ 15.25	$ 211.69	$ 226.94		$ 11,778.19	
Office and storage Trailer												**$ 17,507.95**
15213200550	50'X12' rent	Month		17.3		$ 401.90			$ 401.90	$ 440.95	$ 7,628.44	
15213400100	Office Equipment Rental	Month		17.3		$ 200.20			$ 200.20	$ 220.22	$ 3,809.81	
15213400120	Office Supplies Average	Month		17.3		$ 86.09			$ 86.09	$ 94.59	$ 1,636.41	
15213400140	Telephone bill avg.	Month		17.3		$ 81.08			$ 81.08	$ 89.09	$ 1,541.26	
15213400160	Lights and HVAC	Month		17.3		$ 152.15			$ 152.15	$ 167.17	$ 2,892.04	
Miscellaneous / Additional												**$ 143,360.12**
Vehicular Access and Parking												
15523500100	8" gravel depth	S.Y.	B14	615	0.078	$ 8.01	$ 2.67	$ 0.62	$ 11.30	$ 13.55	$ 2,439.00	
Temporary Fensing												
15626500100	6' High Chain Link Fense	L.F.	2 Clab	300	0.053	$ 5.31	$ 1.73		$ 7.04	$ 8.51	$ 9,667.36	
Project identification												
15813500020	High intensity reflectorized signs	S.F.				$ 26.53			$ 26.53	$ 29.53	$ 14,765.00	
Cleaning and Waste Management												
17413200050	Cleanup of floor are, continuous during constr. p	M.S.F.	A5	24	0.75	$ 1.70	$ 24.05	$ 2.14	$ 27.89	$ 41.48	$ 57,258.99	
17413200100	Final by GC at end of constr.	M.S.F.	A5	11.5	1.565	$ 2.71	$ 50.45	$ 4.46	$ 57.62	$ 85.21	$ 1,729.76	
Building Commissioning												
19113500100	Basic building commissioning	%								0.0025	$ 57,500.00	
TOTAL												**$ 1,012,379.87**

[APPENDIX D-1]

LEED for New Constrution v2.2
Checklist

LEED for New Construction v2.2
Registered Project Checklist

Project Name:
Project Address:

Yes	?	No			
4	6	4	**Sustainable Sites**		14 Points
Y			Prereq 1	**Construction Activity Pollution Prevention**	Required
		1	Credit 1	**Site Selection**	1
		1	Credit 2	**Development Density & Community Connectivity**	1
		1	Credit 3	**Brownfield Redevelopment**	1
		1	Credit 4.1	**Alternative Transportation**, Public Transportation Access	1
	1		Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	1
	1		Credit 4.3	**Alternative Transportation**, Low-Emitting & Fuel-Efficient Vehicles	1
	1		Credit 4.4	**Alternative Transportation**, Parking Capacity	1
	1		Credit 5.1	**Site Development,** Protect or Restore Habitat	1
1			Credit 5.2	**Site Development,** Maximize Open Space	1
1			Credit 6.1	**Stormwater Design,** Quantity Control	1
1			Credit 6.2	**Stormwater Design,** Quality Control	1
	1		Credit 7.1	**Heat Island Effect,** Non-Roof	1
1			Credit 7.2	**Heat Island Effect,** Roof	1
	1		Credit 8	**Light Pollution Reduction**	1

Yes	?	No			
3	1	1	**Water Efficiency**		5 Points
1			Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	1
1			Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	1
		1	Credit 2	**Innovative Wastewater Technologies**	1
1			Credit 3.1	**Water Use Reduction**, 20% Reduction	1
	1		Credit 3.2	**Water Use Reduction**, 30% Reduction	1

10		7	**Energy & Atmosphere**		17 Points
Y			Prereq 1	**Fundamental Commissioning of the Building Energy Systems**	Required
Y			Prereq 2	**Minimum Energy Performance**	Required
Y			Prereq 3	**Fundamental Refrigerant Management**	Required
				*Note for EAc1: All LEED for New Construction projects registered after June 26th, 2007 are required to achieve at least two (2) points under EAc1.	
7		3	Credit 1	**Optimize Energy Performance**	1 to 10
				10.5% New Buildings or 3.5% Existing Building Renovations	1
				14% New Buildings or 7% Existing Building Renovations	2
				17.5% New Buildings or 10.5% Existing Building Renovations	3
				21% New Buildings or 14% Existing Building Renovations	4
				24.5% New Buildings or 17.5% Existing Building Renovations	5
				28% New Buildings or 21% Existing Building Renovations	6
				7 31.5% New Buildings or 24.5% Existing Building Renovations	7
				35% New Buildings or 28% Existing Building Renovations	8
				38.5% New Buildings or 31.5% Existing Building Renovations	9
				42% New Buildings or 35% Existing Building Renovations	10
		3	Credit 2	**On-Site Renewable Energy**	1 to 3
				2.5% Renewable Energy	1
				7.5% Renewable Energy	2
				12.5% Renewable Energy	3
1			Credit 3	**Enhanced Commissioning**	1
1			Credit 4	**Enhanced Refrigerant Management**	1
1			Credit 5	**Measurement & Verification**	1
		1	Credit 6	**Green Power**	1

continued…

Yes	?	No			
7		6	**Materials & Resources**		13 Points
Y			Prereq 1	**Storage & Collection of Recyclables**	Required
		1	Credit 1.1	**Building Reuse**, Maintain 75% of Existing Walls, Floors & Roof	1
		1	Credit 1.2	**Building Reuse**, Maintain 100% of Existing Walls, Floors & Roof	1
		1	Credit 1.3	**Building Reuse**, Maintain 50% of Interior Non-Structural Elements	1
1			Credit 2.1	**Construction Waste Management**, Divert 50% from Disposal	1
1			Credit 2.2	**Construction Waste Management**, Divert 75% from Disposal	1
		1	Credit 3.1	**Materials Reuse**, 5%	1
		1	Credit 3.2	**Materials Reuse**,10%	1
1			Credit 4.1	**Recycled Content**, 10% (post-consumer + ½ pre-consumer)	1
1			Credit 4.2	**Recycled Content**, 20% (post-consumer + ½ pre-consumer)	1
1			Credit 5.1	**Regional Materials**, 10% Extracted, Processed & Manufactured Regio	1
1			Credit 5.2	**Regional Materials**, 20% Extracted, Processed & Manufactured Regio	1
		1	Credit 6	**Rapidly Renewable Materials**	1
1			Credit 7	**Certified Wood**	1
Yes	?	No			
11	3	1	**Indoor Environmental Quality**		15 Points
Y			Prereq 1	**Minimum IAQ Performance**	Required
Y			Prereq 2	**Environmental Tobacco Smoke** (ETS) **Control**	Required
1			Credit 1	**Outdoor Air Delivery Monitoring**	1
1			Credit 2	**Increased Ventilation**	1
1			Credit 3.1	**Construction IAQ Management Plan**, During Construction	1
1			Credit 3.2	**Construction IAQ Management Plan**, Before Occupancy	1
1			Credit 4.1	**Low-Emitting Materials**, Adhesives & Sealants	1
1			Credit 4.2	**Low-Emitting Materials**, Paints & Coatings	1
		1	Credit 4.3	**Low-Emitting Materials**, Carpet Systems	1
1			Credit 4.4	**Low-Emitting Materials**, Composite Wood & Agrifiber Products	1
1			Credit 5	**Indoor Chemical & Pollutant Source Control**	1
	1		Credit 6.1	**Controllability of Systems**, Lighting	1
	1		Credit 6.2	**Controllability of Systems**, Thermal Comfort	1
1			Credit 7.1	**Thermal Comfort**, Design	1
1			Credit 7.2	**Thermal Comfort**, Verification	1
1			Credit 8.1	**Daylight & Views**, Daylight 75% of Spaces	1
	1		Credit 8.2	**Daylight & Views**, Views for 90% of Spaces	1
Yes	?	No			
3		2	**Innovation & Design Process**		5 Points
1			Credit 1.1	**Innovation in Design**: Low-Energy Headhouse (Zoning)	1
1			Credit 1.2	**Innovation in Design**: Site Excavation Strategy	1
		1	Credit 1.3	**Innovation in Design**: Provide Specific Title	1
		1	Credit 1.4	**Innovation in Design**: Provide Specific Title	1
1			Credit 2	**LEED® Accredited Professional**	1
Yes	?	No			
38	10	21	**Project Totals** (pre-certification estimates)		69 Points

Certified: 26-32 points, **Silver:** 33-38 points, **Gold:** 39-51 points, **Platinum:** 52-69 pc

[APPENDIX D-2]

LEED for New Constrution v2009
Checklist

LEED 2009 for New Construction and Major Renovations

Project Checklist

Y	?	N	d/C			
4	9	13		**Sustainable Sites**	Possible Points:	**26**
Y			C	Prereq 1	Construction Activity Pollution Prevention	
		1	d	Credit 1	Site Selection	1
		5	d	Credit 2	Development Density and Community Connectivity	5
		1	d	Credit 3	Brownfield Redevelopment	1
		6	d	Credit 4.1	Alternative Transportation—Public Transportation Access	6
	1		d	Credit 4.2	Alternative Transportation—Bicycle Storage and Changing Rooms	1
	3		d	Credit 4.3	Alternative Transportation—Low-Emitting and Fuel-Efficient Vehicles	3
	2		d	Credit 4.4	Alternative Transportation—Parking Capacity	2
	1		C	Credit 5.1	Site Development—Protect or Restore Habitat	1
1			d	Credit 5.2	Site Development—Maximize Open Space	1
1			d	Credit 6.1	Stormwater Design—Quantity Control	1
1			d	Credit 6.2	Stormwater Design—Quality Control	1
	1		C	Credit 7.1	Heat Island Effect—Non-roof	1
1			d	Credit 7.2	Heat Island Effect—Roof	1
	1		d	Credit 8	Light Pollution Reduction	1

Y	?	N				
6	1	3		**Water Efficiency**	Possible Points:	**10**
Y			d	Prereq 1	Water Use Reduction—20% Reduction	
4		0	d	Credit 1	Water Efficient Landscaping	2 to 4
				x	Reduce by 50%	2
				x	No Potable Water Use or Irrigation	4
0		2	d	Credit 2	Innovative Wastewater Technologies	2
2	1	1	d	Credit 3	Water Use Reduction	2 to 4
				x	Reduce by 30%	2
					Reduce by 35%	3
					Reduce by 40%	4

Y	?	N				
14	0	16		**Energy and Atmosphere**	Possible Points:	**35**
Y			c	Prereq 1	Fundamental Commissioning of Building Energy Systems	
Y			d	Prereq 2	Minimum Energy Performance	
Y			d	Prereq 3	Fundamental Refrigerant Management	
11		8	d	Credit 1	Optimize Energy Performance	1 to 19
					Improve by 12% for New Buildings or 8% for Existing Building Renovations	1
					Improve by 14% for New Buildings or 10% for Existing Building Renovations	2
					Improve by 16% for New Buildings or 12% for Existing Building Renovations	3
					Improve by 18% for New Buildings or 14% for Existing Building Renovations	4
					Improve by 20% for New Buildings or 16% for Existing Building Renovations	5
					Improve by 22% for New Buildings or 18% for Existing Building Renovations	6
					Improve by 24% for New Buildings or 20% for Existing Building Renovations	7
					Improve by 26% for New Buildings or 22% for Existing Building Renovations	8
					Improve by 28% for New Buildings or 24% for Existing Building Renovations	9
					Improve by 30% for New Buildings or 26% for Existing Building Renovations	10
				X	Improve by 32% for New Buildings or 28% for Existing Building Renovations	11
					Improve by 34% for New Buildings or 30% for Existing Building Renovations	12
					Improve by 36% for New Buildings or 32% for Existing Building Renovations	13
					Improve by 38% for New Buildings or 34% for Existing Building Renovations	14
					Improve by 40% for New Buildings or 36% for Existing Building Renovations	15
					Improve by 42% for New Buildings or 38% for Existing Building Renovations	16
					Improve by 44% for New Buildings or 40% for Existing Building Renovations	17
					Improve by 46% for New Buildings or 42% for Existing Building Renovations	18
					Improve by 48%+ for New Buildings or 44%+ for Existing Building Renovations	19
0		7	d	Credit 2	On-Site Renewable Energy	1 to 7
					1% Renewable Energy	1
					3% Renewable Energy	2
					5% Renewable Energy	3
					7% Renewable Energy	4
					9% Renewable Energy	5
					11% Renewable Energy	6
					13% Renewable Energy	7
1			c	Credit 3	Enhanced Commissioning	2
1			d	Credit 4	Enhanced Refrigerant Management	2
1			c	Credit 5	Measurement and Verification	3
		1	c	Credit 6	Green Power	2

Y	?	N			Materials and Resources	Possible Points: 14
Y			d	Prereq 1	Storage and Collection of Recyclables	
0		3	c	Credit 1.1	Building Reuse—Maintain Existing Walls, Floors, and Roof	1 to 3
					Reuse 55%	1
					Reuse 75%	2
					Reuse 95%	3
0		1	c	Credit 1.2	Building Reuse—Maintain 50% of Interior Non-Structural Elements	1
2		0	c	Credit 2	Construction Waste Management	1 to 2
					x 50% Recycled or Salvaged	1
					x 75% Recycled or Salvaged	2
0		2	c	Credit 3	Materials Reuse	1 to 2
					Reuse 5%	1
					Reuse 10%	2
2		0	c	Credit 4	Recycled Content	1 to 2
					x 10% of Content	1
					x 20% of Content	2
2		0	c	Credit 5	Regional Materials	1 to 2
					x 10% of Materials	1
					x 20% of Materials	2
0		1	c	Credit 6	Rapidly Renewable Materials	1
1		0	c	Credit 7	Certified Wood	1

Y	?	N				
11	3	1		**Indoor Environmental Quality**	Possible Points:	**15**
Y			d	Prereq 1	Minimum Indoor Air Quality Performance	
Y			d	Prereq 2	Environmental Tobacco Smoke (ETS) Control	
1			d	Credit 1	Outdoor Air Delivery Monitoring	1
1			d	Credit 2	Increased Ventilation	1
1			c	Credit 3.1	Construction IAQ Management Plan—During Construction	1
1			c	Credit 3.2	Construction IAQ Management Plan—Before Occupancy	1
1			c	Credit 4.1	Low-Emitting Materials—Adhesives and Sealants	1
1			c	Credit 4.2	Low-Emitting Materials—Paints and Coatings	1
		1	c	Credit 4.3	Low-Emitting Materials—Flooring Systems	1
1			c	Credit 4.4	Low-Emitting Materials—Composite Wood and Agrifiber Products	1
1			d	Credit 5	Indoor Chemical and Pollutant Source Control	1
	1		d	Credit 6.1	Controllability of Systems—Lighting	1
	1		d	Credit 6.2	Controllability of Systems—Thermal Comfort	1
1			d	Credit 7.1	Thermal Comfort—Design	1
1			d	Credit 7.2	Thermal Comfort—Verification	1
1			d	Credit 8.1	Daylight and Views—Daylight	1
	1		d	Credit 8.2	Daylight and Views—Views	1

Y	?	N				
3	0	0		**Innovation and Design Process**	Possible Points:	**6**
1			d/c	Credit 1.1	Innovation in Design: Low-Energy Headhouse	1
1			d/c	Credit 1.2	Innovation in Design: Site Excavation Strategy	1
0		0	d/c	Credit 1.3	Innovation in Design: Specific Title	1
0		0	d/c	Credit 1.4	Innovation in Design: Specific Title	1
0		0	d/c	Credit 1.5	Innovation in Design: Specific Title	1
1			d/c	Credit 2	LEED Accredited Professional	1

Y	?	N				
2	0	0		**Regional Priority Credits**	Possible Points:	**4**
1			d/c	Credit 1.1	Regional Priority: (Water Efficient Landscaping) Reduce by 50%	1
1			d/c	Credit 1.2	Regional Priority: (Water Efficient Landscaping) No Potable Water Use	1
		0	d/c	Credit 1.3	Regional Priority: Specific Credit	1
		0	d/c	Credit 1.4	Regional Priority: Specific Credit	1

47	13	40	**Total**	Possible Points: **110**

Certified 40 to 49 points Silver 50 to 59 points Gold 60 to 79 points Platinum 80 to 110

[APPENDIX E-1]

BIM Goals*

PRIORITY (High/Med/ Low)	GOAL DESCRIPTION	POTENTIAL BIM USES
HIGH	Increase construction timing and productivity	3D Coordination
HIGH	Produce record model for owner	Record Modeling / Design Updates
HIGH	Reduce RFI's regarding on-site coordination issues	3D, Coordination

***Chart temple obtained from bim.psu.edu**

[APPENDIX E-2]

BIM Use Analysis Worksheet*

Top Chart: Torcon's Actual uses on the project

Bottom Chart: Owner's uses if they were applied + (Engineering Analysis)

BIM Use*	Value to Project	Responsible Party	Value to Resp Party	Capability Rating			Additional Resources / Competencies Required to Implement	Notes	Proceed with Use
	High / Med / Low		High / Med / Low	Scale 1-3 (1 = Low)					YES / NO / MAYBE
				Resources	Competency	Experience			
Record Modeling	HIGH	Torcon Inc.	MED	2	3	2	Requires training and software		**YES**
		Facility Manager (OPP)	HIGH	1	2	1	Requires training and software		
		Cadnetics	MED	3	3	3			
3D Coordination (Construction)	HIGH	Torcon Inc. (CM)	HIGH	3	3	3			**YES**
		Subcontractors	HIGH	1	2	1	conversion to Digital Fab required	Modeling learning curve possible	
		Cadnetics	MED	2	3	3			
3D Coordination (Design)	HIGH	Payette Associates	HIGH	2	2	2	Coordination software required	Contractor to facilitate Coord.	**YES**
		Merrick and Co. (MEP)	MED	2	2	1			

BIM Use*	Value to Project	Responsible Party	Value to Resp	Capability Rating			Additional Resources / Competencies Required to	Notes	Proceed with Use
	High / Med / Low		High / Med / Low	Scale 1-3 (1 = Low)					YES / NO / MAYBE
				Resources	Competency	Experience			
Record Modeling	HIGH	Torcon Inc.	MED	2	3	2	Requires training and software		**YES**
		Facility Manager (OPP)	HIGH	1	2	1	Requires training and software		
		Cadnetics	MED	3	3	3			
3D Coordination (Construction)	HIGH	Torcon Inc. (CM)	HIGH	3	3	3			**YES**
		Subcontractors	HIGH	1	2	1	conversion to Digital Fab required	Modeling learning curve possible	
		Cadnetics	MED	2	3	3			
3D Coordination (Design)	HIGH	Payette Associates	HIGH	2	2	2	Coordination software required	Contractor to facilitate Coord.	**YES**
		Merrick and Co. (MEP)	MED	2	2	1			
Engineering Analysis	HIGH	Merrick and Co. (MEP)	HIGH	2	2	1			**MAYBE**
		Payette Associates	MED	2	2	2			
Design Authoring	HIGH	Architect	HIGH	3	3	3			**YES**
		Merrick and Co. (MEP)	MED	3	3	3			
		Sweetland Civil Engineers	LOW	2	1	1	Large learning curve	Civil not required	

***Chart temple obtained from bim.psu.edu**

[APPENDIX E-3]

BIM Uses

X	OPERATE	X	CONSTRUCT	X	DESIGN	X	PLAN
	Building Maintenance Scheduling		site utilization planning		design authoring		programming
	Building System Analysis	x	constructability reviews		design reviews		site analysis
	Asset Management	x	3d coordination	x	3d Coordination		
	Space Management/ Tracking		Pre Construction Coordination		Pre Construction Coordination		
	Disaster Planning		construction system design		structural analysis		
x	Record Modeling		digital fabrication		lighting analysis		
			3d control and planning		energy analysis		
					mechanical analysis		
					other eng. analysis		
					leed evaluation		
					code validation		
	4d modeling		4d modeling		4d modeling		4d modeling
	cost estimation		cost estimation		cost estimation		cost estimation
	existing conditions modeling		existing conditions modeling		existing conditions modeling		existing conditions modeling

[APPENDIX E-4]

Level One Process Overview Map*

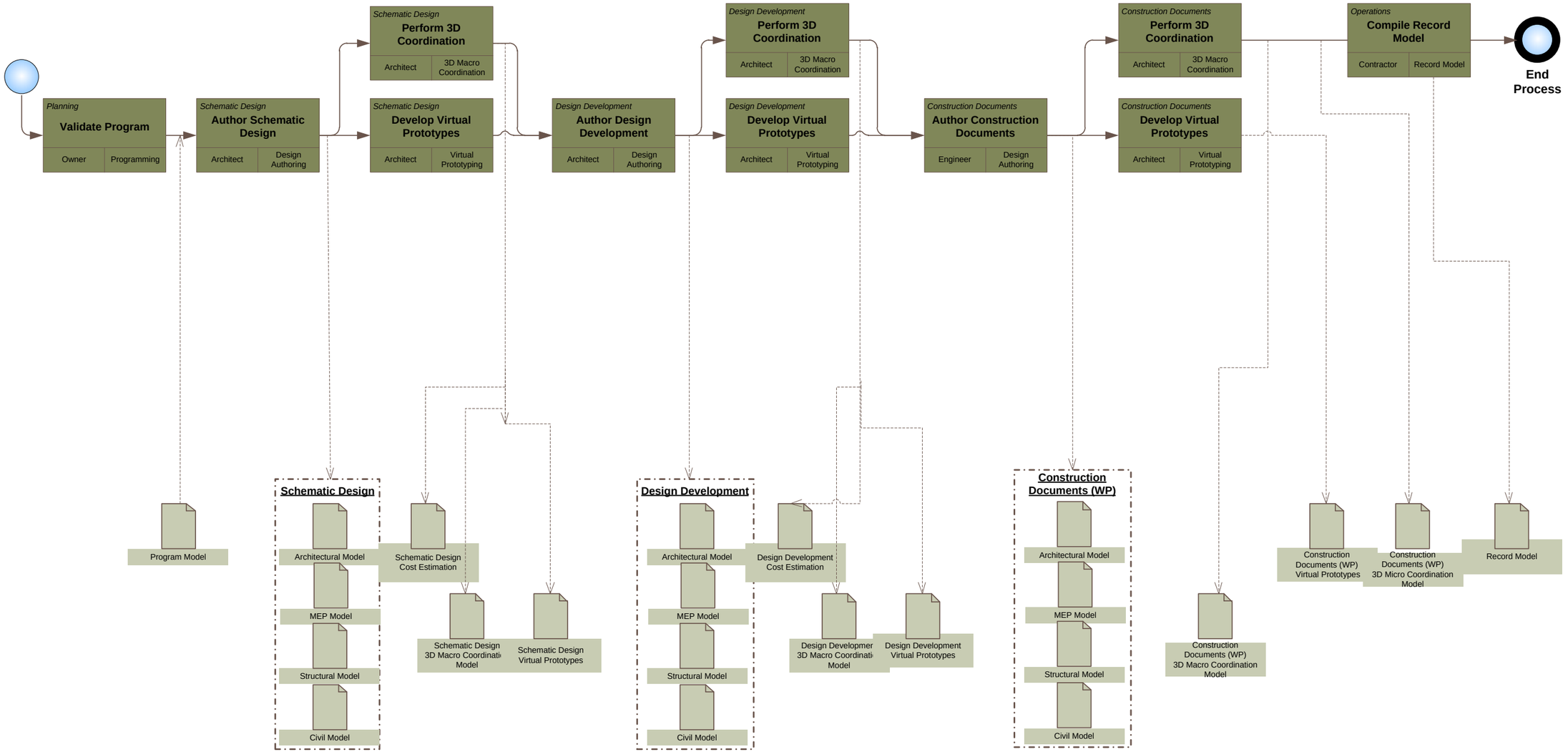

***Chart temple obtained from bim.psu.edu**

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