Project X

Mid-Atlantic Region, USA

Technical Report 1

Taylor M. Sweeney | 16 September 2015

Construction Management | Dr. John Messner

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Executive Summary

Project X, located in the Mid-Atlantic Region of the United States, broke ground June 2013. The building will be utilized as commercial real estate that the owners will lease out to tenants. Project X is a 4 story, 76.5 foot high building, and covering 285,000 square feet. The function of the building has been requested to remain undisclosed due to the nature of work being performed.

As with any construction project three of the most important concerns are time, cost, and safety, but not necessarily in that order. With the functionality of this building relying heavily on electricity, one major concern of the owners was the redundancy of supply of the electrical power supplied to the building. With the need to constantly have a supply of electricity to building, the team of architects, engineers, and contractors were able to address any issues that arose during the construction process. Another important goal during the construction process was energy efficiency that was achieved through obtaining a LEED Gold certification under the LEED rating system for Core and Shell Development as well as becoming Energy Star rated.

Project X was selected to be a project for the Pennsylvania State University Architectural Engineering Thesis project. The purpose of the thesis project is for students to gain a better understanding of the construction process for an entire building. For Project X, this report will focus on the construction of the building, and analyzing the conditions under which it was constructed. The following report will look into different aspects of the project but not limited to: project delivery system, staffing plan, project schedule, project budget, and conditions under which it was constructed.

Project Analysis

Client Information

For this project, the client wished to remain unnamed, as well as the purpose of the building. The owner commissioned Project X for the purpose of expanding their business to a new locations and having the ability to serve more customers. To ensure that the owner was satisfied with the construction of their new building, Forrester Construction Company (the CM on this project) needed to put an emphasis on the timeline and budget of the project, as well as energy efficiency and safety. One major concern of the owner's was the redundancy of electrical supply. It is important to the owner and their customers that the building never loses power, so the sequencing of the electrical supply was of upmost importance. Another key to successfully completing the project, in the owner's eyes, was ensuring that the building was energy efficient and received a LEED rating. Forrester Construction managed the project to ensure that the building was LEED certified. Entering into the project, the owners expected LEED Silver rating; when the project was complete the building was certified as a LEED Gold rating in Core and Shell Development.

Project Delivery System

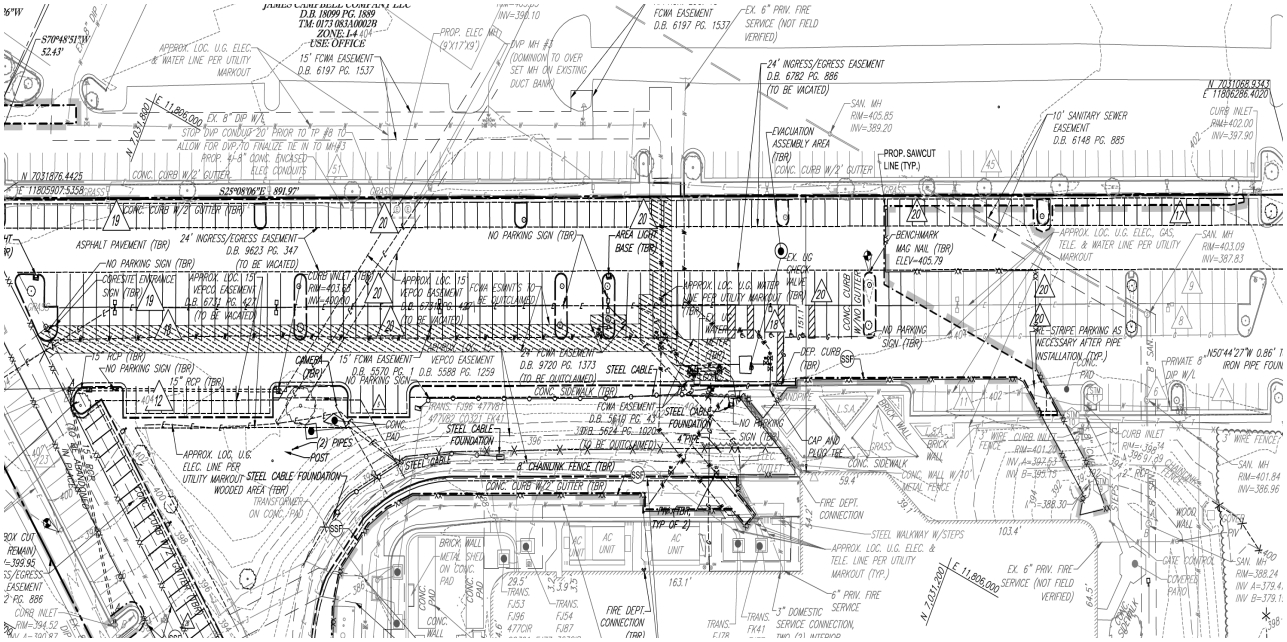
For Project X, the owner holds a Guaranteed Maximum Price (GMP) contract with Forrester Construction Company; this contract only covers the base building and the fit out of the first floor. Forrester was chosen as the General Contractor on this job based on a competitive bid, per the contract Forrester provides construction management services to the owner. Forrester Construction Company is not a self-performing general contractor, so all the work is contracted out to subcontractors. Forrester Construction holds lump sum contracts with the subcontractors as well as insurance bonds on work that results in a cost over $100,000.

Staffing Plan

This structure is typical of any construction project with the utilization of both staff from the operational side and support side of the staff. During construction the Project Executive, Jeffrey Frengel, and Michael Barnhart, the Construction Executive lead the team. Under Jeff the project managers David Brookes and Steven McRea handled the business side of the project. Mike Barnhart led a team of 3 superintendents to ensure the project was on time and completed to the standard expected by the owner.

Existing Conditions

Before construction started, on the site of the new building there was a large parking lot area. It was a standard parking lot, with concrete curbs along the perimeter and the some curbs in the center, as well as some vegetation in mulch beds. Along with the parking lot there were light poles and sidewalks as well. All of these needed to be removed for the new building to be constructed. There was also an existing waterline that need to be tapped and removed, as well as a 15" reinforced concrete pipe. You can see the existing conditions on the site plan below in Figure 1.



Project Schedule

The project team first began construction in June 2013 and completed in December 2015; spanning 18 months. This schedule was just for the construction of the building itself and the fit out of only the first floor; the rest of the floors are now currently being fit out under a different contract with the owner. Besides the start of construction the other major milestones include building structure complete June 2014, site work complete October 2014, and final completion December 2014. [Please refer to Appendix A for further schedule detail]

Project Budget

Using values from *RS Means* database a square foot estimate was performed. These results were compared to actual project costs in terms of both total cost and the cost per square foot. Comparatively the actual cost per square foot is smaller

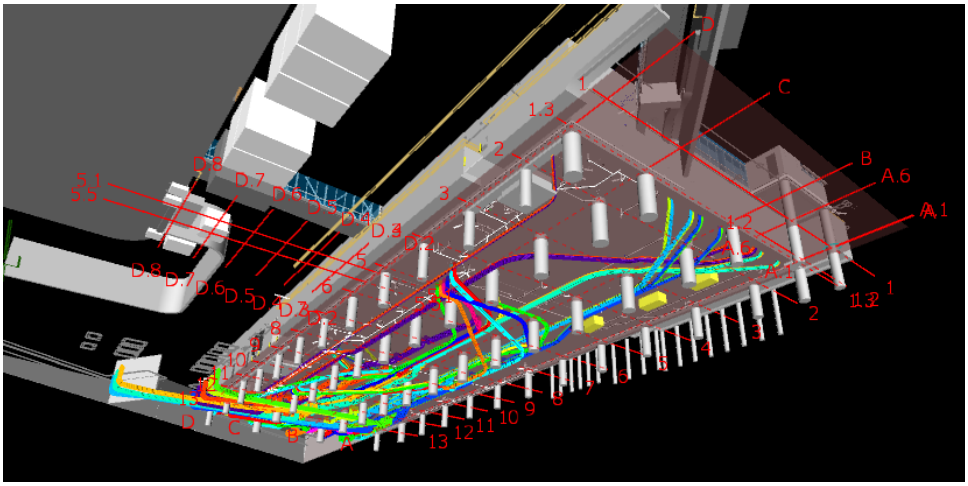
than the cost per square foot for *RS Means* , this could be for a number of reasons. Project X GMP budget just accounts for the base building and the fit out of the first floor, floors 2 through 4 were not completed under this contract. Also the size of Project X is significantly larger than the data collected in *RS Means*. [Please refer to Appendix B for further budget detail]

Building Systems

Demolition

For this project there was not a need for demolition.

Structural System



The structural system for Project X is comprised of structural steel and cast-in-place concrete. Caissons and footings are used as the foundation system for the building, and are constructed with concrete and steel reinforcement; with the concrete have a strength of 3000 PSI. Each floor has a steel frame and bracing system with concrete slabs for the floors. The floors are slabs on metal decking and have a strength of 3500 PSI, and the deck is 3" 20 gauge composite deck. The structure for this building is unique in the sense that building is only 4 floors about ground with a cellar below, but it actually stand the height of an 8 story building. For the bridges between this building and the existing building on site are constructed from steel, with an architectural grade steel finish, that is fully welded and ground smooth. In Figure 2 above you can see the foundation for the cellar along with some of the electrical conduit.

Mechanical System

The mechanical load for this building is very high. It is important to the owner and the owner's tenants that the building be kept a consistent temperature so none of the equipment is overheated. To maintain temperatures throughout, the building utilizes multiple 550-ton centrifugal chillers and multiple 617-ton cooling towers. The building was built for a capacity of 8 chillers and towers, but only 3 where installed during this contract. The cooling towers and air-handling units are located on the roof, while the centrifugal chillers are located in the

chiller room in the cellar. Each floor will have 8 computer room air handling units (CRAH) as well; there is also a 36,000 CFM air handler dedicated to support areas and computer room make-up air throughout the building.

Electrical System

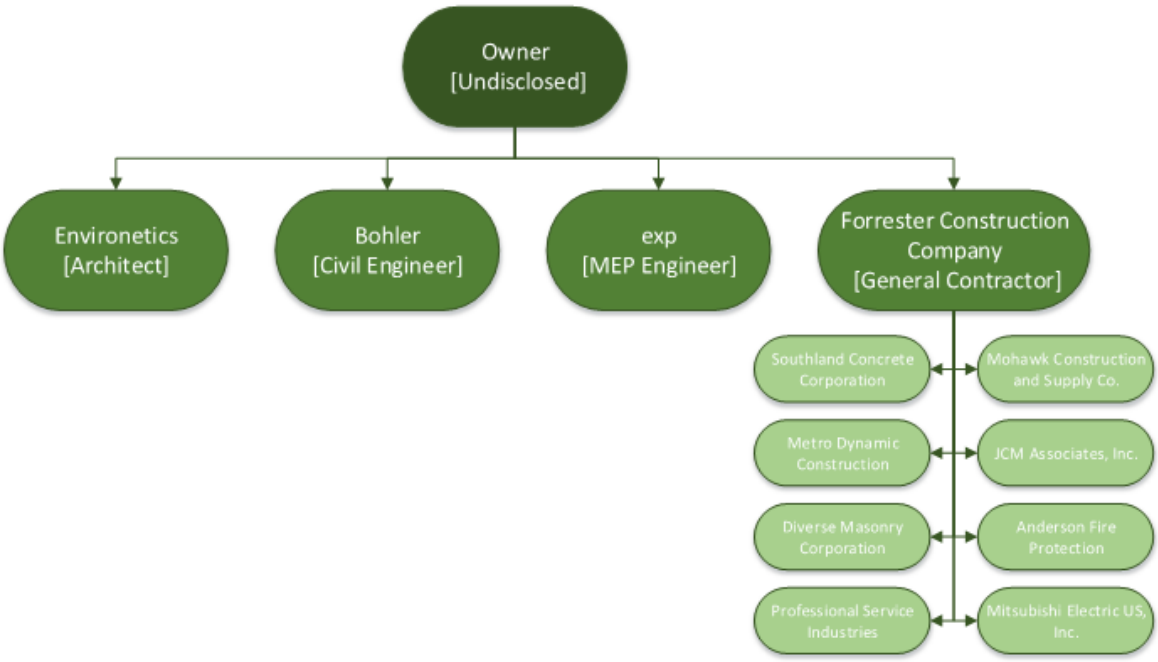
Project X utilizes an uninterruptable power source system (UPS system) on top of the power supply. A UPS system is a battery that provides emergency power to the building should the main power input fail and generators are needed to supply the power to the building. The UPS system provides the needed power in the interim of the power failing and the generators starting up. The building has an incoming service of 18 megawatts, enough to power 18,000 homes, and 40,000 amps into the building. Underneath and throughout the entire building there is 26 miles worth of conduit use to transport electricity throughout the building. Located just outside of the building are 5 double-stacked generators that supply electricity to the building should the power fail for a significant amount of time.

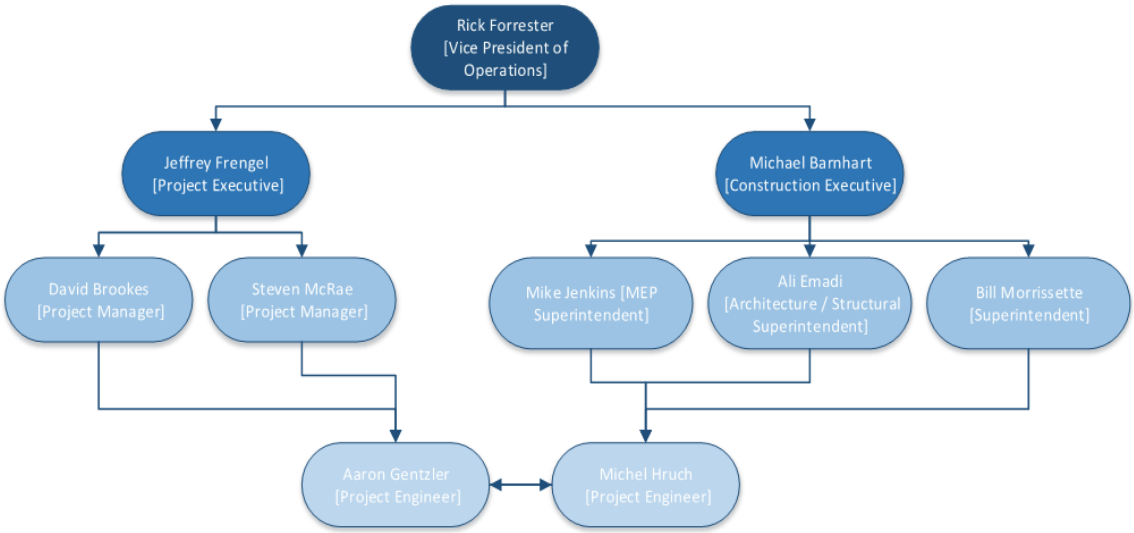
Wall (Masonry) System

The façade of Project X is comprised of metal paneling and storefront curtain walls. The metal panel façade system consists of 3" insulated metal wall panels on metal studs. The storefront glass is comprised of 1" insulated opaque spandrel glazing units as well as 1" clear insulated glazing units, held together by an aluminum curtain wall system.

Appendix A

Project Breakdown

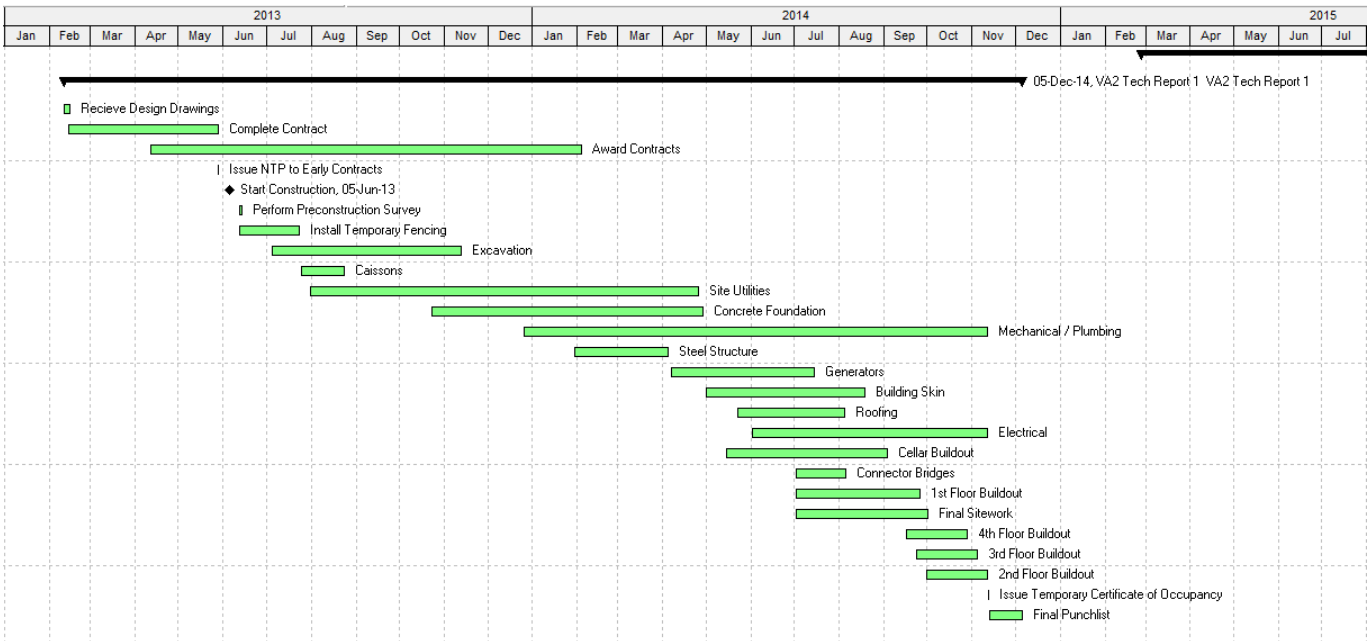

Owner
[Undisclosed]
Environetics
[Architect]
Bohler
[Civil Engineer]
exp
[MEP Engineer]
Forrester Construction Company
[General Contractor]
Southland Concrete Corporation
Mohawk Construction and Supply Co.
Metro Dynamic Construction
JCM Associates, Inc.
Diverse Masonry Corporation
Anderson Fire Protection
Professional Service Industries
Mitsubishi Electric US, Inc.


Rick Forrester
[Vice President of Operations]
Jeffrey Frengel
[Project Executive]
Michael Barnhart
[Construction Executive]
David Brookes
[Project Manager]
Steven McRae
[Project Manager]
Mike Jenkins [MEP Superintendent]
Ali Emadi
[Architecture / Structural Superintendent]
Bill Morrissette
[Superintendent]
Aaron Gentzler
[Project Engineer]
Michel Hruch
[Project Engineer]

Appendix B

Project Schedule

VA2 Tech Report 1 VA2 Tech Report 1		11-Feb-13	05-Dec-14
10	Recieve Design Drawings	11-Feb-13	14-Feb-13
11	Complete Contract	14-Feb-13	28-May-13
12	Award Contracts	12-Apr-13	03-Feb-14
13	Issue NTP to Early Contracts	28-May-13	28-May-13
14	Start Construction	05-Jun-13	
15	Perform Preconstruction Survey	12-Jun-13	13-Jun-13
16	Install Temporary Fencing	12-Jun-13	23-Jul-13
17	Excavation	05-Jul-13	12-Nov-13
18	Caissons	25-Jul-13	23-Aug-13
19	Site Utilities	31-Jul-13	25-Apr-14
20	Concrete Foundation	23-Oct-13	28-Apr-14
21	Mechanical / Plumbing	26-Dec-13	11-Nov-14
22	Steel Structure	30-Jan-14	04-Apr-14
23	Generators	07-Apr-14	14-Jul-14
24	Building Skin	01-May-14	18-Aug-14
25	Roofing	23-May-14	04-Aug-14
26	Electrical	02-Jun-14	11-Nov-14
27	Cellar Buildout	15-May-14	03-Sep-14
28	Connector Bridges	02-Jul-14	05-Aug-14
29	1st Floor Buildout	02-Jul-14	25-Sep-14
30	Final Sitework	02-Jul-14	01-Oct-14
31	4th Floor Buildout	16-Sep-14	28-Oct-14
32	3rd Floor Buildout	23-Sep-14	04-Nov-14
33	2nd Floor Buildout	30-Sep-14	11-Nov-14
34	Issue Temporary Certificate of Occupancy	12-Nov-14	12-Nov-14
35	Final Punchlist	13-Nov-14	05-Dec-14



Appendix C

Project Budget

Project X	
Location:	[Undisclosed]
Story Count:	4
Story Height (LF):	~15
Floor Area (SF):	157,492
Basement:	Yes
Actual Cost Per Square Foot:	$242.94
Building Cost:	$38,261,270.44

RS Means	
Total Project Cost	$49,798,970
Project Cost / SF	$316.20
Total Construction Cost	$ 54,778,867.00
Construction Cost / SF	$ 347.82

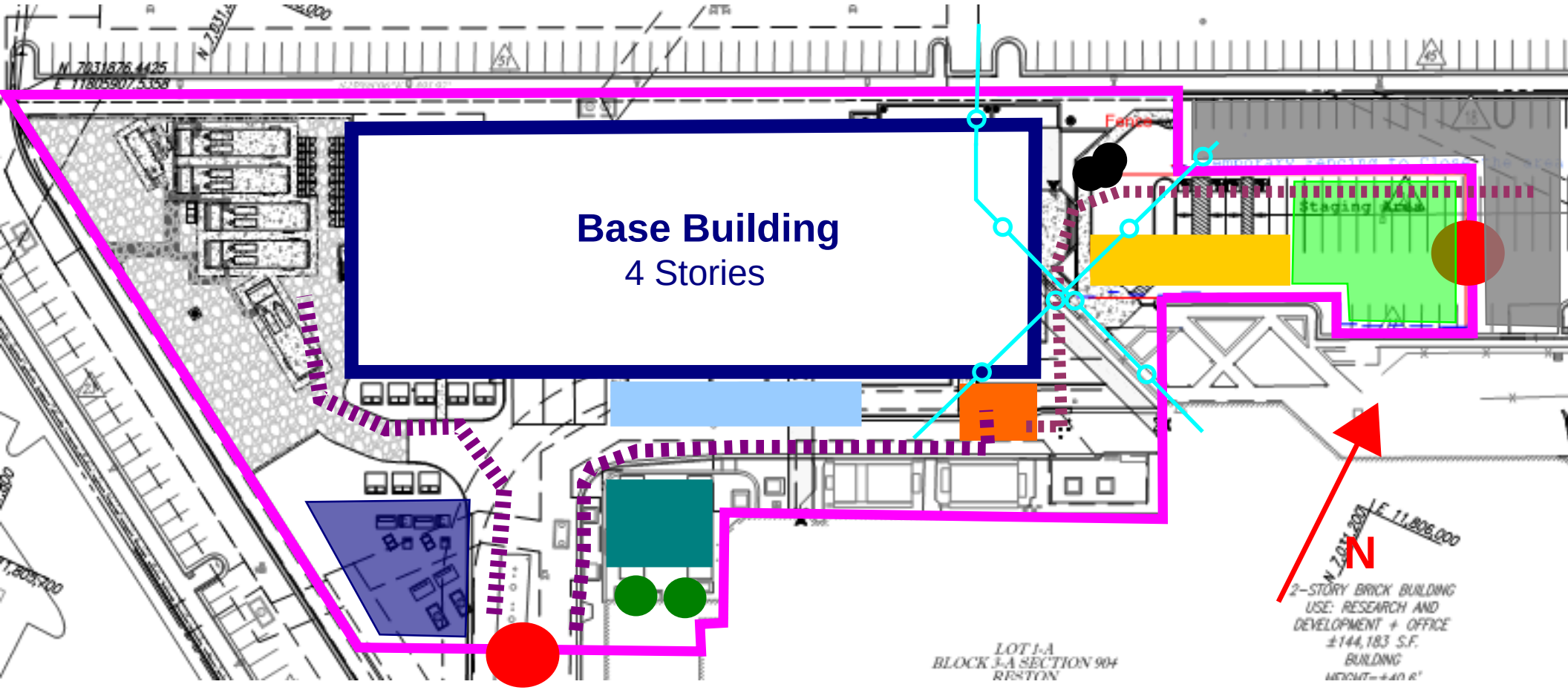
Actual Construction Cost	
Total Project Cost	$38,261,270.44
Project Cost / SF	$242.94
Total Construction Cost	$34,053,681.00
Construction Cost / SF	$119.50

RS Means Building Systems Cost			
System	% of Project	Amount / SF	Total
Sturcture	11.0%	$34.78	$5,477,886.74
Exterior Enclosure	5.4%	$17.07	$2,689,144.40
Interior	10.3%	$32.57	$5,129,293.95
Plumbing / Mechanical	42.7%	$135.02	$21,264,160.36
Electrical	27.6%	$87.27	$13,744,515.83
Fire Protection	2.1%	$6.64	$1,045,778.38
Special Construction & Demolition	1.0%	$3.16	$497,989.70
		Total	**$49,848,769.37**

Actual Building Systems Cost					
System	% of Project		Amount/ SF		Total
Structure	27%	$	65.34	$	9,158,787.00
Exterior Enclosure	16%	$	39.51	$	5,538,011.00
Interior	8%	$	19.81	$	2,776,153.00
Plumbing / Mechanical	23%	$	56.79	$	7,960,822.00
Electrical	14%	$	34.85	$	4,885,000.00
Fire Protection	3%	$	6.25	$	875,510.00
Special Construction & Demolition	1%	$	3.31	$	463,991.00
Site Work	7%	$	17.72	$	2,483,612.00
			Total	**$**	**34,141,886.00**

Appendix D

Project Site Plan



- Crane
- Construction Enterance
- Temporary Trailers
- Perimeter Fence
- Dumpster
- Existing Waterline
- Temporary Staging
- Temporary Stairs
- Parking
- Extra Parking
- Worker's Path
- Existing Standpipe

Appendix E

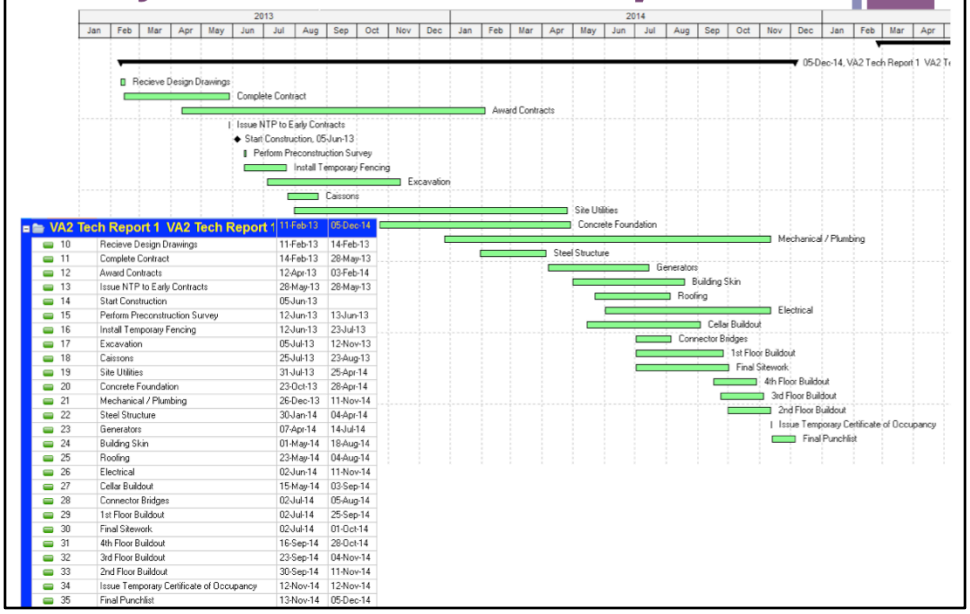
Presentation Slides

Project X

Technical Report #1

Taylor Sweeney

Project Schedule Summary



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Original Contract: 11.5 month duration
Started June 5 2013
Concrete Began October 22 2013
Steel Erection began February 2014, building structure complete April 2014
Temporary CoO 12 November 2014

Longer duration than original thought because of permit delays

Building Systems

- Structural
  - 4 Story building
  - Steel frame and bracing
  - Cast in place concrete slabs for floor
  - Foundation: Caissons

- Mechanical
  - 8 550-ton centrifugal chillers
  - 8 617-ton cooling tours
  - 8 CRAH units per floor

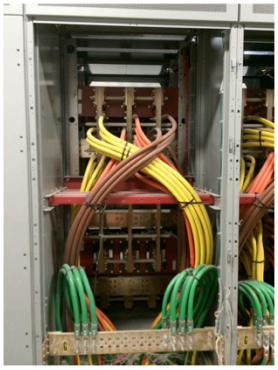
Structural System:

The building is a steel frame building, cast in place slabs for floors
4 stories tall, but actually stands the height of an 8 story building
Cellar serves as part of the foundation system, utilizing caissons for support
Concrete ranges from 3KSI to 3.5KSI

Mechanical System

Building Systems

- Electrical
  - 18 MW
  - 40,000 amps
  - 26 miles of conduit
  - 5 double stacked generators
  - UPS system



- Wall (Masonry) System
  - Metal Panel Façade
  - Storefront curtain Wall

Electrical System

UPS System- uninterruptable power source system- kicks on when the permanent power fails giving the generators time to warm up and take over the electrical load

18 Megawatts=enough power to power 18,000 homes

26 miles of conduit

Wall System

metal panel- aluminum panels, insulated on metal studs

curtain wall- some opaque and some clear glazing, held together through aluminum curtain wall system

curtain wall also contains aluminum sun shades to help with the energy load. These shades contain solar panels on them as well that produce 15 watts of power at peak performance

Project Cost

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Actual Cost

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Total	$242.94	$38,261,270.44

Percentage Break Down

System	RS Means	Actual
Structure	11.0%	27.0%
Plumbing / Mechanical	42.7%	23.0%
Electrical	27.6%	14.0%
Interior	10.3%	8.0%
Exterior Enclosure	5.5%	16.0%

Actual Cost of building was $38.2 million, RS Means predicted that the building would cost $49.8 million

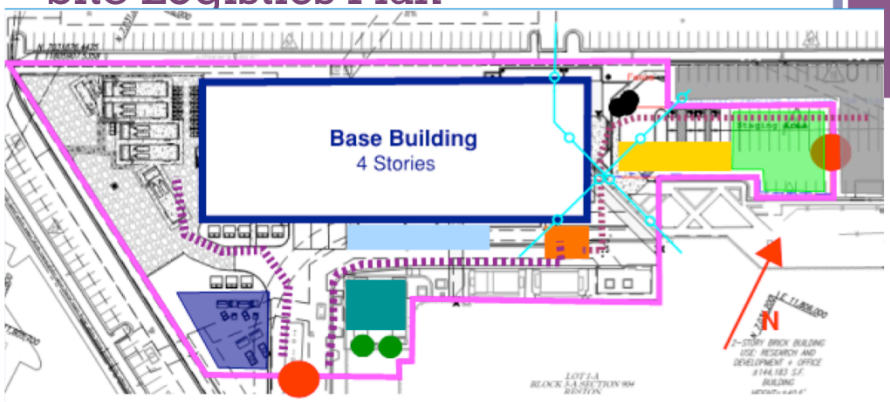
RS vs Actual %

Structural was considerable higher, while plumbing / mechanical and electrical were considerably lower

RS means expects for entire building to be built and fit out, Project X: GMP accounted only for base building and for the first floor to be fit out

Cost could also be higher from RS Means because RS means did not have data related to the size of Project X, so when using the numbers from RS Means I had to use the highest numbers available, which were significantly under. RS Means accounted for 40,000 SQFT my building was ~160,000 SQFT

Site Logistics Plan



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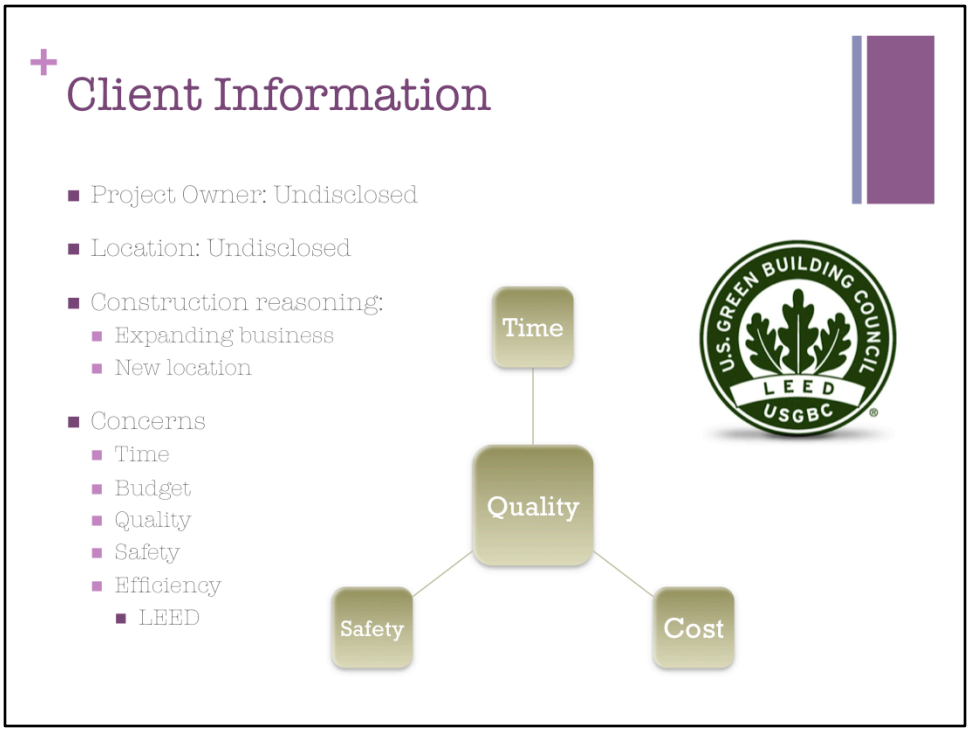


Construction Reasoning:

opening in the market where there was a need

good opportunity for costs (low electric costs)

Concerns

Time: the original timeline was 11.5 months, ended up taking 18 mos due to permit issues

Budget: GMP between Owner and FCC, keep it under $39 mil

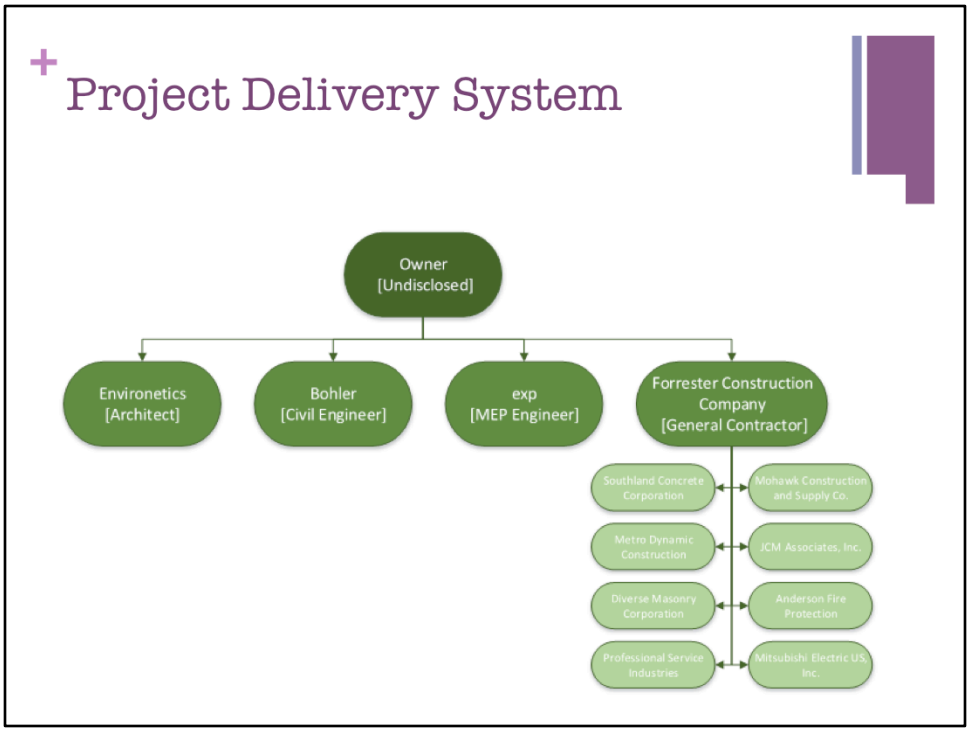
Quality: with potential tenants looking to lease property it was important that the job have the upmost quality

Safety

Efficiency: with high electrical use it was important to the owner that the building was energy efficient

Originally started off as LEED Silver, certified LEED Gold under Core and Development Shell

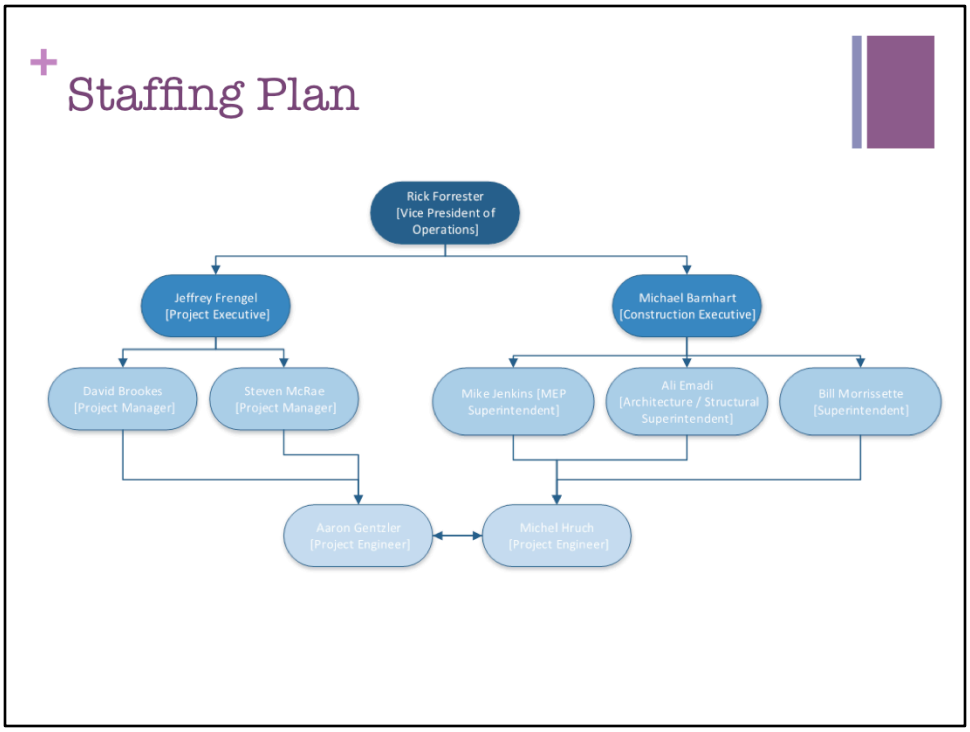
Energy Start Efficiency



Project Delivery:

GMP contact between Owner and Forrester Construction, GC contingency of 4% and fee of 2%

Forrester Construction has typical contract with subcontractor



Staffing Plan:

2 groups: Project Management Side and Superintendent side

Everyone reported to Rick Forrester

Project Executive: oversaw the entire project, works closely with project management

Construction Executive: oversaw the construction of the project: 3 different superintendents working together

Field Engineers: did whatever they could do to help, mostly project management side of work