TECHNICAL ASSIGNMENT ONE

LancasterHistory.Org
Lancaster, PA

Eric R. Buckwalter
Chimay J. Anumba, Ph.D., D.Sc., P.E.
Comprehensive Architectural Engineering Senior Project I
Construction Management
9 October 2012

EXECUTIVE SUMMARY

This report details the LancasterHistory.Org construction projects preliminary management. Major findings include the specific requests by the owner, including protection of trees. Also, there is a lot of other site demolition to be done, so phasing for the project will include more detail for site construction than most projects. The construction phase of the project requires demolition as well, so construction and gutting of the existing building will be done simultaneously. The project is being delivered by Benchmark construction as a General Contractor, and their schedule and estimate are broken down and compared to RS Means, reaching similar results.

The site plans detail how the Wheatland residence can remain operational during construction via construction traffic logistics planning and strategic fencing. The project is being delivered with a good amount of responsibility on the owner's shoulders, in a design bid build fashion. Benchmark hires as many of its own employees as possible and subcontracts under prevailing wage requirements. The MEPF detailed estimate is still a work in progress.

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PROJECT SCHEDULE SUMMARY

The LancasterHistory.org project had a somewhat protracted schedule in order to accommodate private fundraising as well as state financing, as it is a cultural building. Benchmark Construction was awarded the LancasterHistory.org project and received notice to proceed on October 3, 2011. Their schedule breakdown consisted of four primary phases, Site construction I & II, Building Construction and Building Commissioning.

The foundation sequence requires approximately 45 days, including temporary shoring, underpinning and demolition of the existing building and construction of footers/piers and foundation walls. While shoring and underpinning the pre-existing continuous footer, existing conditions and dimensions were verified. After demolition is completed, column footers and piers go in, followed by underslab and foundation/shear walls. A foundation drain is then installed and waterproofing is installed before the foundation walls are backfilled.

The structural sequence takes about 60 days, and it includes the steel setting, exterior wall construction and glu-lam roof installation. During the slab below grade water proofing, the structural steel can be set, followed by precast plank installation. At this point, masonry walls are laid and grouted, while in-wall blocking and the concrete bond beam are installed. Glulam is put in place and secured then Laminated Veneer Lumber, exterior overhang and canopy framing as well. Roof Blocking and sheathing is completed during LVL installation.

Finishes in the building will take the longest time to complete, about 4 months of flooring, carpet and paint. This sequence begins with first level prime and first coat paint. Then casework, ceramic tile, prime and first coat paint on ground level, resilient flooring, wood panels and trim, concrete stained, carpet and paint (cut and roll final cut).

BUILDING SYSTEMS SUMMARY

Demolition

The existing building had lead-based paint and asbestos (despite an asbestos abatement prior to demo.). Asbestos was found in acoustical ceiling panels and discovered in piping. The lead was painted over with latex, and the asbestos contaminated materials were removed by specialty contractors and taken out of state and documented.

1988 Building

Part of the roof on the South West side is to be removed, and the existing truss must be temporarily supported. On the other part of the SW roof, dormers are to be removed & the roof filled and patched and the roof is to be stripped to plywood deck, receiving new underlayment, accessories & shingles.

The exterior wall on the South West side is to be removed down to the first floor slab, salvaging the oval window at its gable. Temporary building enclosure will be provided. The South East wall is to have a new wall opening. The slab on grade at building entrance and adjacent corners is to be removed. The water fountain on ground level is to be protected and retained.

The interior partitions, plumbing fixtures, and casework are to be removed from the ground level and lower level. Compact storage shelves and track on the lower level is to be protected and retained. (See D3.01)

1955 Building

The wall between the mechanical and selected equipment is to be removed from the lower level, and a new opening will be created at the South West exterior wall to connect to the addition. On the ground level, the millwork at door openings is to be salvaged for later use. Existing mechanical chase is to be removed and the floor and ceiling in-filled. Several interior walls are to be removed.

Structural Steel Frame

Renovations require structural steel under the concrete slab at an opening to be drilled in near the North side and by the East Stair opening, both will bear on the existing masonry walls. All beam to column connections are made with high strength bolts, and all connections must resist 50% of the maximum allowable uniform load capacity. The existing roof is to be shored during the demolition of the wall until new supports are in place. Steel lintels exposed to weather are to be hot tip galvanized.

In the roof, W12X16 beams connect the ’88 building’s W27X84 upturned girder to the addition’s W12X40 girders. The addition’s roof is comprised of HSS beams of various dimensions and thicknesses that are welded HSS columns as moment connections. The addition roof is comprised of arced glu lam structures that are bolted to the columns.

Bracing is required to support concrete, canopy roofing and structural steel until entire integrated supporting structures have been completed and permanent connections to framing are secured. Temporary bracing is needed in formwork for items that are built into concrete or masonry. These are then removed after permanent steel, connections and bracing are in place and secure.

Cast in Place Concrete

The addition required a typical shallow foundation with two long retaining walls. Typical components such as foundation footings, walls, retaining walls, piers, slabs and topping slabs were all cast in place. Exposed concrete retaining walls on the lower level are board-form finished formwork with exterior-grade plywood panels placed horizontally. Cylindrical columns are formed with paper tubes. Rough form finished concrete on footings and slab edges are formed with lumber (dressed on at least two edges and one side). Topping slabs are hydraulic based and are dyed for aesthetic appearance.

Precast Concrete

Hollow core plank is used on the ground level and is tied into the lower level masonry walls with #4 U Bars and grouted.

Mechanical System

There is one large mechanical room and three smaller mechanical rooms. All of the mechanical rooms are located on the lower level of the building.

The primary mechanical system of the building is a 30-35% glycol VAV system, consisting of a direct outside air processor with a mounted humidifier, an enthalpy wheel and a desiccant wheel. It has two primary pumps and two secondary pumps, all located in the second mechanical room. It also has an expansion tank and air separator which are both located in the second mechanical room. A make-up air fan is located in the fire pump room, also on the lower level. Two of the system’s three air conditioning units are all located in the large mechanical room and the third is in the third mechanical room. Each AC has its own mounted humidifier. The system’s natural-gas high efficiency condensing boiler is located in the second mechanical room.

There is also closed-loop water to air geothermal condenser water system that serves the VAV DOAP and AC units, and its water solution is only 15% glycol. The system's well water loop has two pumps located on the site. It has 2 wells. The well water travels through the system's two heat exchangers, located in mechanical room four, heating or cooling condensed water circuits. The system has nine heat pumps, six in the first mechanical room, two in the third mechanical room and one that is ceiling-hung in the first stairwell. It also has a water-cooled CRC unit which is located in the server room (118). The condenser loop requires two pumps, an air separator and an expansion tank, all located in the second mechanical room.

Electrical System

The existing electrical system consisted of a 120/240, 3 Phase, 4 wire setup. All panels are removed and upgraded. The new system is 1600 Amperes 120/240 Delta, 3 phase, 4 wire, and it has an emergency diesel generator capable of 80kW/100KVA 600 Amperes.

All lighting, receptacles, switches panels, contactors, telephone outlets, data outlets, fire alarm devices and associated conduit wire is stripped from the existing building, except where noted in (DE1.0). Lighting in the lower level of the building consists of fluorescent tube down lighting. Some of the luminaires are hanging and some recessed. Many are motion activated. The ground level of the addition contains the same, but with light sensors that dim bulbs depending on natural ambient light.

Masonry

Masonry walls on the lower level consist of the walls surrounding stairwell one and its adjacent elevator shaft, the wall between the education room and the workroom and between the staff room and the large mechanical room. Masonry from the elevator shaft carries up to ground level where the only other masonry appears on the south, east and west facades as a load bearing shear wall.

Curtain wall

The main curtain wall system consists of a brick veneer to the CMU exterior walls of the building. Between these two walls is a fluid applied air barrier and rigid insulation. There is also a glass/mahogany curtain wall at addition entrances and at clerestory north elevations. Masonry veneer anchors are located at 16" O.C. vertically and at 24" O.C. horizontally. Angle connections secure the top and bottom of the brick walls and flashing and weep holes will allow breathability and prevent efflorescence.

LEED Gold Certification

The orientation of the building was one of the first steps taken by the architect in reaching Gold status. In addition, the north facing clerestory windows paired with heavily insulated walls allows for a highly efficient building envelope. Wall surface area was minimized by putting the storage and archive areas below grade. The aforementioned mechanical system incorporates ground source heat pumps and a heat recovery unit, which are particularly important since museum require more strict conditioning equipment. The electrical system also incorporates a photovoltaic roof system to reduce energy consumption. Building materials are recycled and sourced locally wherever possible. Also, artificial lights are almost exclusively LEDs or fluorescents.

Building Systems Summary

Yes	No	Work Scope	
X		Demolition	
X		Structural Steel Frame	
X		Cast in Place Concrete	
X		Precast Concrete	
X		Mechanical System	
X		Electrical System	
X		Masonry	
X		Curtain wall	
	X	Support of Excavation	

PROJECT COST EVALUATION

Systems Cost Breakdown		
	Cost	Cost/SF
HVAC	$ 1,282,972.00	$ 40.01
Electrical	$ 1,136,206.00	$ 35.43
Concrete	$ 678,564.00	$ 21.16
Wood, Plastics & Composites	$ 461,428.00	$ 14.39
Exterior Improvements	$ 408,325.00	$ 12.73
Finishes	$ 391,524.00	$ 12.21
Masonry	$ 386,225.00	$ 12.04
Metals	$ 297,500.00	$ 9.28
Thermal & Moisture Protection	$ 267,337.00	$ 8.34
Plumbing	$ 169,100.00	$ 5.27
Fire Suppression	$ 104,950.00	$ 3.27

Project Cost Overview		
	Cost	Cost/SF
Construction (CC)	$ 6,290,673.00	$ 196.17
Other	$ 1,610,641.00	$ 50.23
General Conditions	$ 401,566.00	$ 12.52
Existing Conditions	$ 48,525.00	$ 1.51
Utilities	$ 116,455.00	$ 3.63
Bond	$ 56,550.00	$ 1.76
Building Permit	$ 19,241.00	$ 0.60
Change Order s	$ 204,108.00	$ 6.36
Total (TC)	$ 7,901,314.00	$ 246.39

Building Data		
	Gross Area	Footprint Area
Existing Building	15,233 SF	7,435 SF
Demolition	- 1,112 SF	-217 SF
Addition	17,947 SF	9,314 SF
Total	32,068 SF	16,532 SF

Using RS means I was able to produce a square foot cost estimate for the LancasterHistory.org building. The design of this building is quite unique, so I combined the properties of several types of projects to get a reasonable estimate quickly. For the substructure, I used an

Auditorium type building, for the building shell, I used a Library, and for the interior and services I used a Computer Data Center.

The substructure estimate uses a 24 foot high auditorium as a model. This is because the high ceiling height and material properties are very similar, including the foundations, slab on grade, excavation and basement walls. The shell estimation is based off of a two story library's superstructure, enclosure and roofing. For these structural elements, I multiplied the cost per SF by the addition's gross area, since the renovation will be unchanged for these.

The interior of the building and the services estimates are based off of a computer data center, since the LancasterHistory.org project contains some serious MEPF equipment, including the heat exchanger, highly amped service panel and dry sprinkler system. Although there isn't as much computer equipment as a data center, there is a good amount of historical paintings and artifacts that can't get wet and must be stored under particular conditions. The renovation is gutted for MEPF, so I included its SF with the additions, minus the demo. In finding the SF cost estimate.

For my MEPF detailed estimate, I am currently acquiring cost data of the specific equipment detailed in the mechanical schedules. I am using quotes from the manufacturers, and I intend to compare this data to actual costs to show how construction companies can save money with good connections.

SITE PLANS

Existing Conditions

The Lancaster Historical Society building is located just off of President Ave in Lancaster, Pennsylvania. Combined with the Buchanan Wheatland properties, to encompass 10 acres of land, the site will pose no restrictions for space. However, there are many trees that are to be protected. This is covered in “Site Layout Planning.”

Site Layout Planning

Demolition will encompass a large amount of the project, which is why the site construction makes up two whole phases, spanning more time than the actual construction itself. Fences are put up around the site with special netting on the fence where designated trees must be protected at the owner’s request. As many trees are kept intact as possible, but some lie directly where the building‘s addition is constructed and are relocated. This is done in an orderly fashion, as per request of the owner. A new electric line is brought in with lighting as shown in “Site Demolition” diagram in Appendix C. A new water meter and line are brought into the building to compensate the additions needs. For example, the water sprinkler system needed more pressure and a fire pump. All other utility lines are preexisting. Temporary offices are located catty-corner to the Buchanan carriage house so utilities can easily be tapped into from there.

A major constraint for this project is that the owner required the Wheatland House be operational for the duration of construction. This posed several issues for logistics, safety and productivity. A new ramp was built on the East side of the property for construction traffic to separate the project from the historical landmark. In addition, secondary fence and lock separates the project from the existing facility. Site construction around the carriage house is completed over the duration of building construction, such that it may be conducted at times which minimize facility disturbance. Signage is required to supplement fences and warm pedestrians.

The superstructure is sequenced from north to south during the erection of the steel framing and the masonry shear walls. The crane used for this phase is located on the west end of the project and does picks from trucks parked behind it. Equipment reaches the site from the south east entrance. Scaffolding is sequenced from north to south as well. In fact, the entirety of all tasks are sequenced from north to south as the addition stems out this way from the existing building.

The layout selected by the contractor is sufficient for addressing the projects constraints.

Another potential layout for the project would be for the main construction entrance to be in front of the existing building. As such, backfill would go to the south side of the property, and the Wheatland residence would have minimal disturbance, and equipment would be as far from people as possible. However, this is a less likely scenario as the route would go right over utility lines, potentially causing damage. Further, it would be more of an eyesore for traffic and residences along Marietta Pike. I agree with the layout selected by Benchmark.

LOCAL CONDITIONS

In Lancaster County, Pennsylvania, construction is completed usually by contractors. For this particular project, construction parking is widely available after demolition. Prior to demolition, a new entrance is paved to support the large loads of equipment. Recycling is done wherever possible, and as much wreckage is reused in the new building as possible. There is a recycling plant less than ten minutes away from the site, where all of the wreckage and waste may be disposed of.

According to the geotechnical report, there were two soil samples analyzed in a laboratory. These samples include Elastic Silt with Sand and Silty Sand with Gravel. Benchmark took out some soil samples to supplement the owner's records. However, a compressive strength couldn't be obtained due to moisture content. It came out to 70 PSI. Rock bins are decided upon to accommodate storm water.

CLIENT INFORMATION

The owner of the project is LancasterHistory.org, which is building the project due to expansion and adjoining of the Lancaster Historical Society and President James Buchanan's Wheatland for the Lancaster Campus of History. Cost expectations were originally $7.5 million for the entire project, which eventually grew to $13.5 million over time, requiring further donations. The quality of the project is expected to be of the highest quality, using the latest technology and finest materials. The schedule was originally slotted as November 1st but has since been delayed to mid-January. Safety expectations are high, as the project is pretty straight forward and only two stories.

PROJECT DELIVERY SYSTEM

This project is being delivered via a Design-Bid-Build method. However, the structure is actually more of a Design-Fundraising-Bid-Financing-Build structure. The LancasterHistory.org project used this approach because the building is a cultural one and is funded entirely by private donations and state grants.

The owner decided to hire the GC, Architect, Commissioning Agent and Geotechnical Engineer separately because LancasterHistory.org has many donors to answer to and design and the final product are of upmost importance. This method allows for the owner to have more control over the project, but had potential to go over budget and schedule, as it already has. The risk taken seems to be paying off for the most part though.

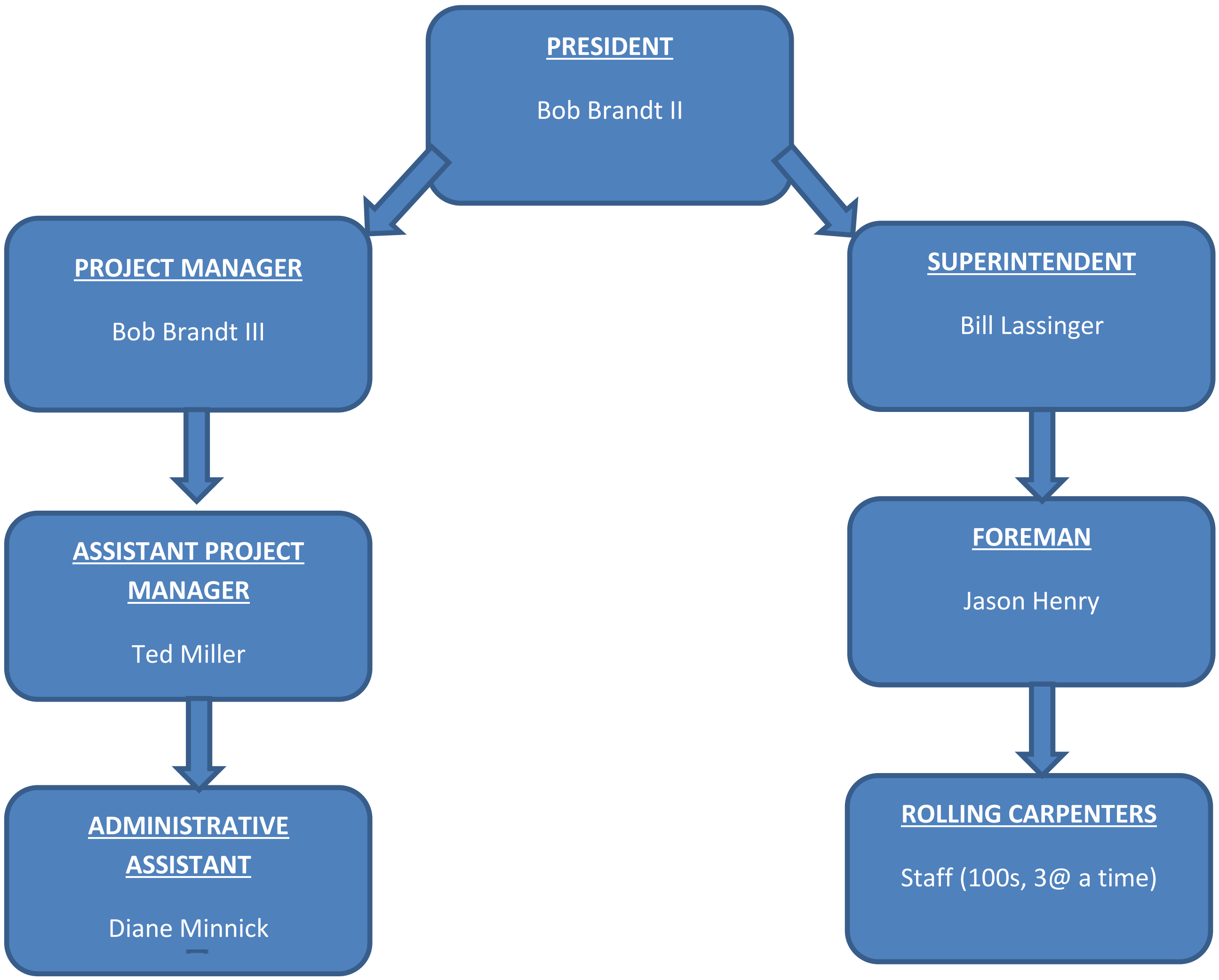
The General Contractor, Benchmark, has been in operation since 1985, and has established itself as the premier construction company in Lancaster, PA. As such, it has many of its own workers on staff but also a good reputation with many local contractors that it can pick from for various tasks. For this project, an Umbrella Bond is used for the company's protection, and subcontractors receive prevailing wage. LancasterHistory.org received public funding.

Please see Appendix D for a project delivery system chart & diagram.

STAFFING PLAN

The president of Benchmark construction is Bob Brandt II. Below is the project's CM and Super, who are both involved on several projects at a time. The APM is Ted Miller, who is a PSU AE graduate. He has an AA for documenting and other help.

Bill, the Superintendent monitors the Foreman's progress. Jason, the Foreman, manages the carpenters for any given task completed by Benchmark.

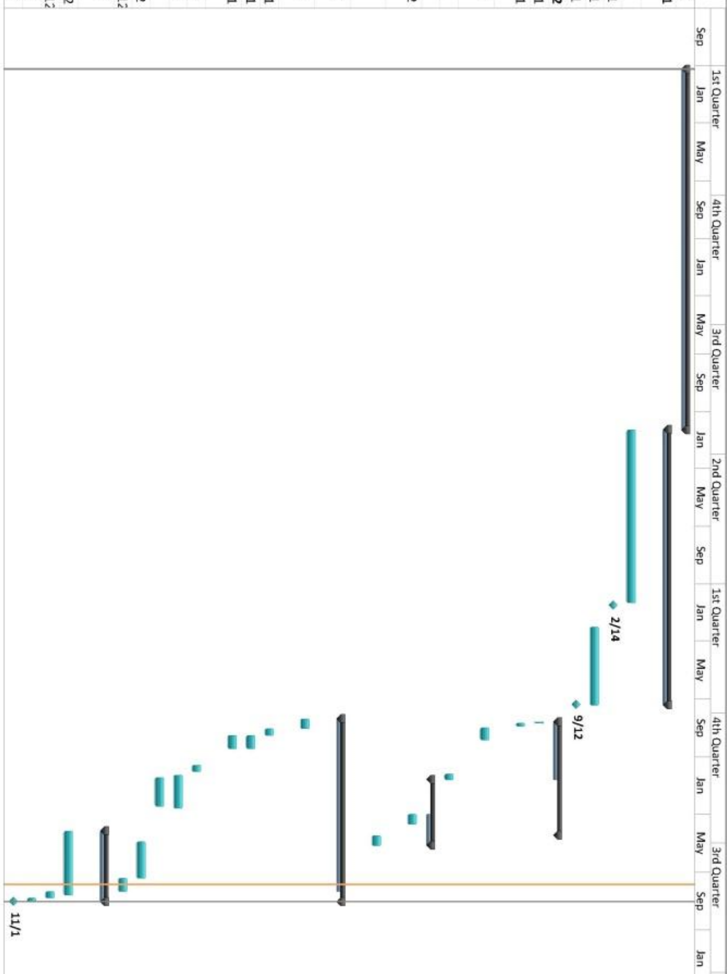


WORKS CITED

RS Means, Square Foot Costs 2012

APPENDIX A: PROJECT SUMMARY SCHEDULE

ID	Task Name	Duration	Start	Finish
1	**Design Phase**	**545 days**	**Tue 1/8/08**	**Mon 2/8/10**
3	**Submittals/Procurement Phase**	**416 days**	**Mon 2/8/10**	**Mon 9/12/11**
4	Private Fundraising	262 days	Mon 2/8/10	Tue 2/8/11
5	Bid	0 days	Mon 2/14/11	Mon 2/14/11
6	State Financing	117 days	Fri 4/1/11	Mon 9/12/11
7	Permit Set	0 days	Mon 9/12/11	Mon 9/12/11
8	**Site Construction - Phase 1**	**171 days**	**Wed 10/19/1**	**Wed 6/13/12**
9	Mobilize	2 days	Wed 10/19/11	Thu 10/20/11
10	Construct Fences & Demo. Site	5 days	Fri 10/21/11	Thu 10/27/11
11	Construct Driveway & Curb	20 days	Mon 10/31/11	Fri 11/25/11
12	Backfill Around Building	10 days	Mon 2/6/12	Fri 2/17/12
13	**Site Construction - Phase 2**	**100 days**	**Fri 2/17/12**	**Thu 7/5/12**
14	Site Light Trenching and Walkway Excavation	15 days	Tue 5/1/12	Mon 5/21/12
15	Form and Pour Sidewalks	15 days	Fri 6/15/12	Thu 7/5/12
16	**Building Construction Phase**	**277 days**	**Wed 10/12/11**	**Thu 11/1/12**
17	Temporary Shoring and Underpinning	15 days	Wed 10/12/11	Tue 11/1/11
18	Building Demo.	10 days	Wed 11/2/11	Tue 11/15/11
19	Footers & Piers	20 days	Wed 11/16/11	Tue 12/13/11
20	Foundation and Shear Walls	20 days	Wed 11/16/11	Tue 12/13/11
21	Set Steel	10 days	Wed 1/18/12	Tue 1/31/12
22	Exterior Walls	50 days	Wed 2/8/12	Tue 4/17/12
23	MEP Rough In	45 days	Mon 2/13/12	Fri 4/13/12
24	Flooring	55 days	Thu 6/28/12	Wed 9/12/12
25	Carpet and Paint	20 days	Thu 9/13/12	Wed 10/10/12
26	**Commisioning & Closeout Phase**	**108 days**	**Tue 6/5/12**	**Thu 11/1/12**
27	Commissioning	98 days	Tue 6/5/12	Thu 10/18/12
28	Punchlist	10 days	Thu 10/11/12	Wed 10/24/12
29	Final Inspections	6 days	Thu 10/25/12	Thu 11/1/12
30	Final Completion	0 days	Thu 11/1/12	Thu 11/1/12



Project: Project Schedule
Date: Thu 9/27/12

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

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APPENDIX B: COST ESTIMATE DATA

Model costs calculated for a 1 story building with 24′ story height and 24,000 square feet of floor area

Auditorium

			Unit	Unit Cost	Cost Per S.F.	% Of Sub-Total
A. SUBSTRUCTURE						
1010	Standard Foundations	Poured concrete; strip and spread footings	S.F. Ground	1.42	1.42	
1020	Special Foundations	N/A	—	—	—	
1030	Slab on Grade	6″ reinforced concrete with vapor barrier and granular base	S.F. Slab	6.16	6.16	7.2%
2010	Basement Excavation	Site preparation for slab and trench for foundation wall and footing	S.F. Ground	.18	.18	
2020	Basement Walls	4′ foundation wall	L.F. Wall	89	2.36	

Model costs calculated for a 2 story building with 14′ story height and 22,000 square feet of floor area

Library

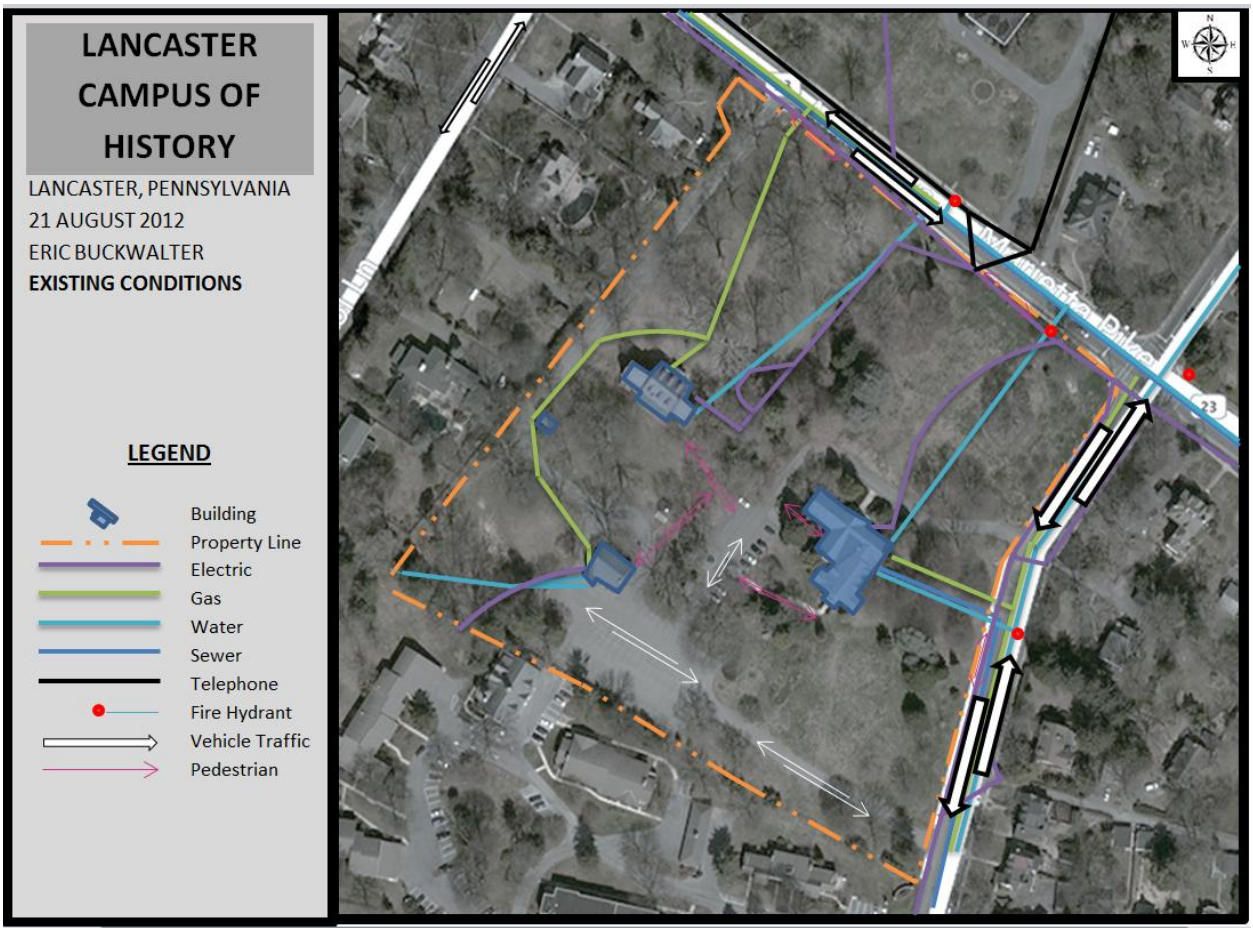
			Unit	Unit Cost	Cost Per S.F.	% Of Sub-Total
B. SHELL						
	B10 Superstructure					
1010	Floor Construction	Concrete waffle slab	S.F. Floor	25.76	12.88	18.7%
1020	Roof Construction	Concrete waffle slab	S.F. Roof	18.36	9.18	
	B20 Exterior Enclosure					
2010	Exterior Walls	Face brick with concrete block backup *90% of wall*	S.F. Wall	31.25	15.57	16.0%
2020	Exterior Windows	Window wall *10% of wall*	Each	51	2.81	
2030	Exterior Doors	Double aluminum and glass, single leaf hollow metal	Each	5575	.50	
	B30 Roofing					
3010	Roof Coverings	Single ply membrane, EPDM, fully adhered; perlite/EPS composite insulation	S.F. Roof	4.98	2.49	2.1%
3020	Roof Openings	Roof hatches	S.F. Roof	.08	.04	

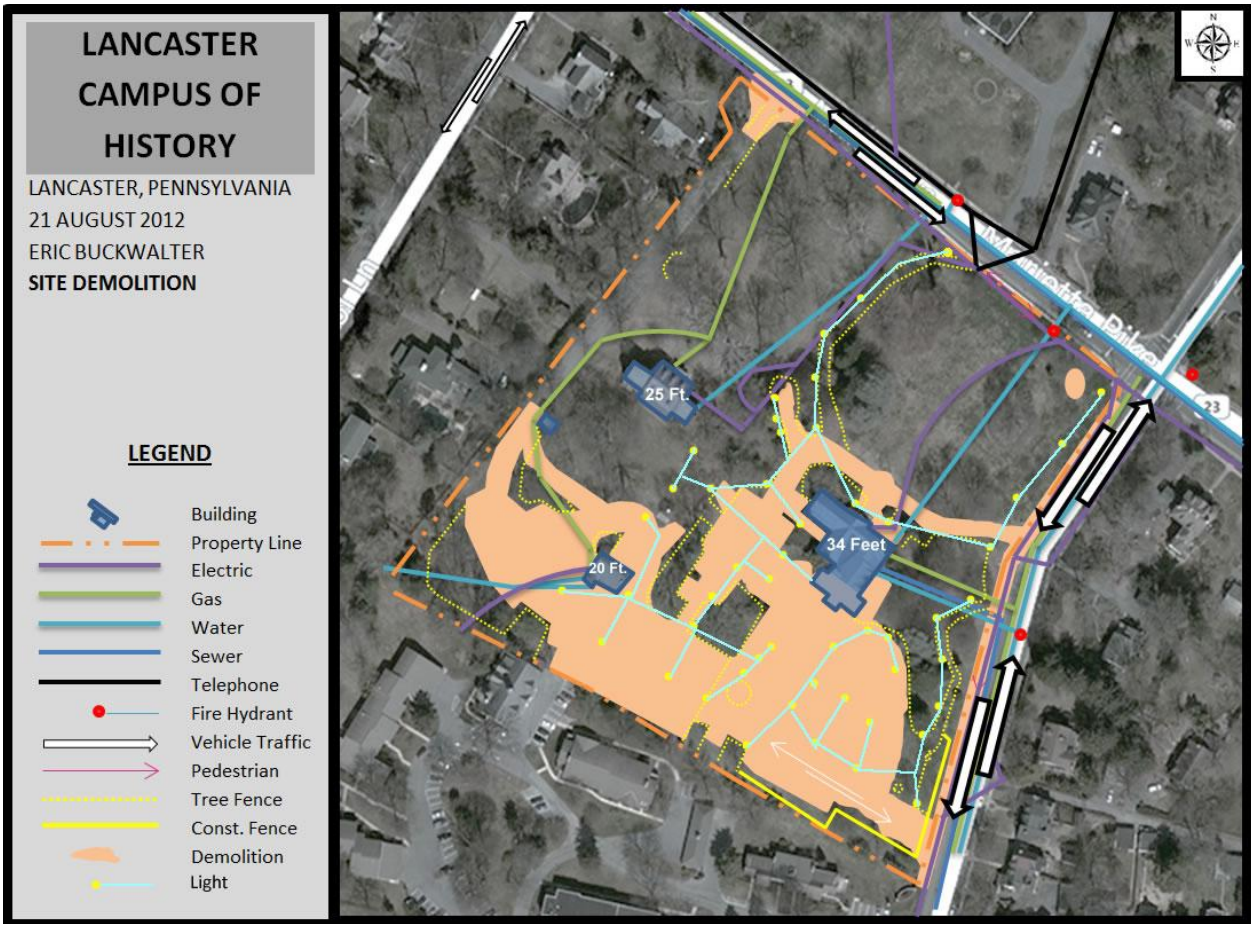
Model costs calculated for a 1 story building with 16′-6″ story height and 22,500 square feet of floor area

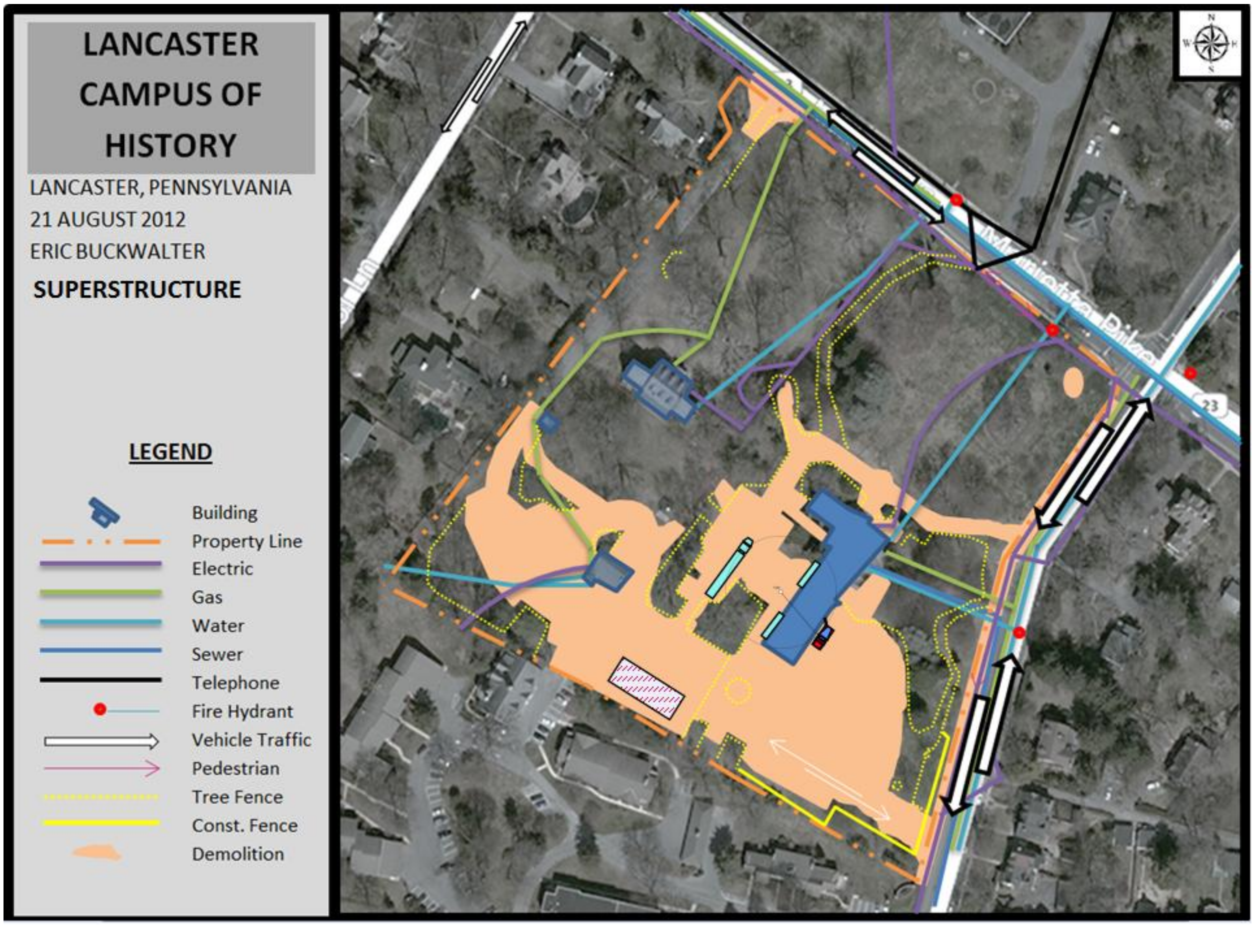
Computer Data Center

			Unit	Unit Cost	Cost Per S.F.	% Of Sub-Total
C. INTERIORS						
1010	Partitions	Gypsum board on metal studs *13 S.F. Floor/L.F. Partition*	S.F. Partition	4.57	4.22	
1020	Interior Doors	Solid core wood, metal frame *370 S.F. Floor/Door*	Each	751	2.03	
1030	Fittings	Toilet partitions	S.F. Floor	.49	.49	
2010	Stair Construction	N/A	—	—	—	10.3%
3010	Wall Finishes	90% paint, 10% ceramic tile	S.F. Surface	1.97	3.63	
3020	Floor Finishes	65% carpet tile, 10% ceramic tile, 10% quarry tile	S.F. Floor	5.87	5.87	
3030	Ceiling Finishes	Mineral fiber tile on concealed zee bars	S.F. Ceiling	6.86	6.86	
D. SERVICES						
	D10 Conveying					
1010	Elevators & Lifts	N/A	—	—	—	0.0 %
1020	Escalators & Moving Walks	N/A	—	—	—	
	D20 Plumbing					
2010	Plumbing Fixtures	Toilet and service fixtures, supply and drainage *1 fixture/1180 S.F. Floor*	Each	4708	3.99	
2020	Domestic Water Distribution	Gas fired water heater	S.F. Floor	.66	.66	2.5%
2040	Rain Water Drainage	Roof drains	S.F. Floor	1.04	1.04	
	D30 HVAC					
3010	Energy Supply	Hot water reheat	S.F. Floor	7.00	7.00	
3020	Heat Generating Systems	Boiler, oil fired hot water	Each	44,500	8.60	
3030	Cooling Generating Systems	Cooling tower	S.F. Floor	9.00	9.00	38.1%
3050	Terminal & Package Units	N/A	—	—	—	
3090	Other HVAC Sys. & Equipment	Heat exchanger, ductwork, air handling units, VAV terminals	S.F. Floor	61	60.88	
	D40 Fire Protection					
4010	Sprinklers	85% wet pipe sprinkler system, 15% preaction sprinkler system	S.F. Floor	4.25	4.25	2.2%
4020	Standpipes	Standpipes and hose systems	S.F. Floor	.61	.61	
	D50 Electrical					
5010	Electrical Service/Distribution	1200 ampere service, panel board and feeders	S.F. Floor	4.61	4.61	
5020	Lighting & Branch Wiring	High efficiency fluorescent fixtures, receptacles, A.C. and misc. power	S.F. Floor	16.44	16.44	29.7%
5030	Communications & Security	Addressable alarm & telephone systems, internet wiring and emergency lighting	S.F. Floor	31.55	31.55	
5090	Other Electrical Systems	Emergency generator, 350 kW; UPS system	S.F. Floor	14	14	

APPENDIX C: SITE PLANS




LANCASTER CAMPUS OF HISTORY
LANCASTER, PENNSYLVANIA
21 AUGUST 2012
ERIC BUCKWALTER
SITE DEMOLITION
LEGEND
Building
Property Line
Electric
Gas
Water
Sewer
Telephone
Fire Hydrant
Vehicle Traffic
Pedestrian
Tree Fence
Const. Fence
Demolition
Light
25 Ft.
34 Feet
20 Ft.
23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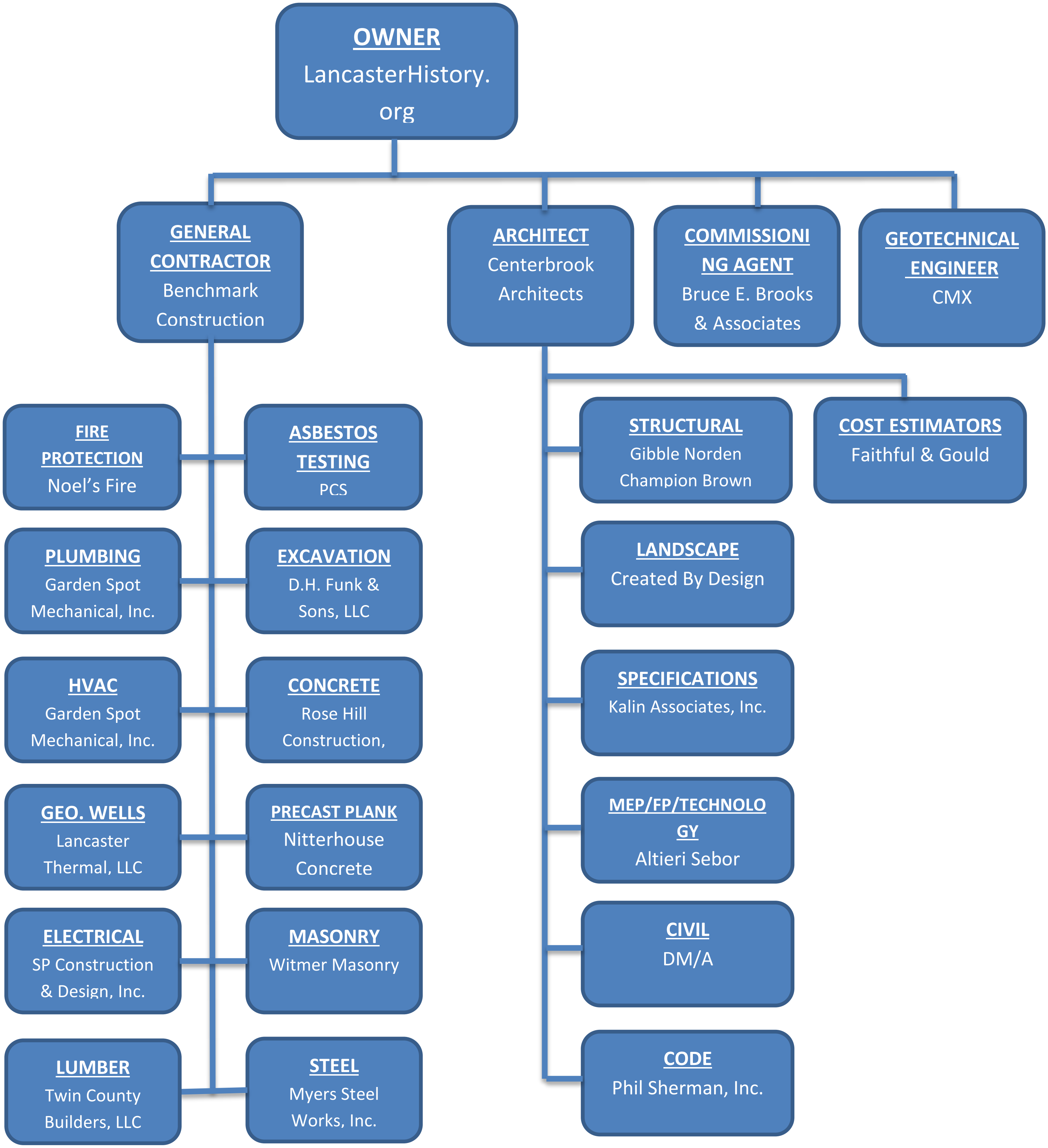
Water
Sewer
Telephone
Fire Hydrant
Vehicle Traffic
Pedestrian
Tree Fence
Const. Fence
Demolition

APPENDIX D: PROJECT DELIVERY SYSTEM



Company	Contact Name	Contact Number	Contact E-mail
Altieri Sebor	Andrew Sebor	203-866-5243	ajsebor@altierisw.com
Benchmark Construction	Ted Miller	717-278-4664	tmiller@benchmargc.com
Bruce E. Brooks & Associates	Brad Randall	215-569-0400	Brad.randall@brucebrooks.com
Centerbrook Architects	Peter Cornell	860-581-2696	cornell@centerbrook.com
CMX	David Harmanos	717-458-0800	dharmanos@cmxengineering.com
Created By Design	Mary Dresser	717-687-8614	cbdmhd@aol.com
D.H. Funk & Sons, LLC	Phillip Funk	717-475-0874	pfunk@dhfunk.com
DM/A	Bill Swiernik	717-898-3402	bswiernik@dmai.com
Faithful & Gould	Paul Male	617-423-5548	Paul.male@fgould.com
Garden Spot Mechanical, Inc.	Dean Eberly	717.665.0270	deberly@gardenspotmechanical.com
Gibble Norden Champion Brown	Charlie C. Brown	860.388.1224	brown@gncbengineers.com
Kalin Associates, Inc.	Mark Kalin	617.964.5477 x22	mkalin@kalinassociates.com
LancasterHistory.org	Tom Ryan	717-392-4633	tom.ryan@lancasterhistory.org
Lancaster Thermal, LLC	Jesse Wurtz	717.490.4043	jdwwurtz@gmail.com
Myers Steel Works, Inc.	John Fadenrecht	717.502.0266	jfadenrecht@myerssteelworks.com
Nitterhouse Concrete	Daryl Wenger	717.264.6154	dwenger@nitterhouse.com
Noel’s Fire	Hobie Hann	240.366.8287	hhann@noelsfp.com
PCS	Harry Wanner	717.939.8226	wannergroup@hotmail.com
Phil Sherman, Inc.	Phil Sherman	603.526.6190	sherman@prsherman.com
Rose Hill Construction	Tom Briggs	717.859.1216	rhctom@ptd.net
SP Construction & Design, Inc.	Sam Sterkenberg	717.656.3373	spconstructiondesign@comcast.net
Twin County Builders, LLC	John Lapp	717.587.7927	N/A
Witmer Masonry	Wayne Furman	717.653.1428	waynef@thewitmergroup.com