

Eric R. Buckwalter – CM Option
Chimay J. Anumba, Ph. D., D.Sc., P.E.
Comprehensive AE Senior Project II
3 April 2013

LancasterHistory.org Building

230 N. President Ave.
Lancaster, PA 17603



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130 N. President Ave.
Lancaster, PA

PRESENTATION OUTLINE



Eric R. Burkholder – CM, Oglethorpe
Chinay J. Anumba, Ph.D., D.Sc., P.E.
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Presentation Outline:

- Project Overview
- Analysis I – Soil Remediation Engineering
 - Off-Site Replacement
 - Stockpile Protection & On-Site Repurposing
- Analysis II – Mechanical re-Design
 - Open Loop Geothermal
 - Closed Loop Cooling Tower (Breadth)
- Analysis III – Electrical Assembly Construction
 - Field-Built
 - Prefabricated
- Analysis IV – Greater Use of BIM
- Conclusions & Recommendations
- Acknowledgements



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PROJECT OVERVIEW

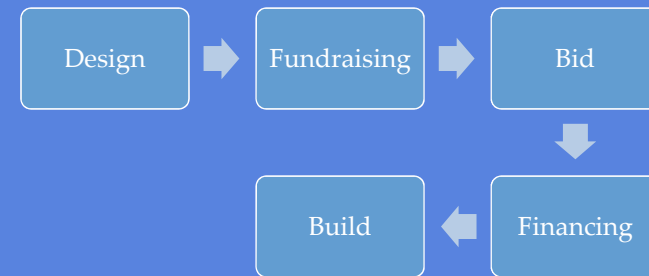


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PROJECT OVERVIEW

Owner:	LancasterHistory.org
General Contractor:	Benchmark Construction
Architect:	Centerbook Architects
Structural Engineer:	Gibble Norden Champion Brown
Civil Engineer:	David Miller & Associates
MEPF Engineer:	Alteri Sebor Wiebar
Project Cost:	\$13.5 Million
Size & Height:	32,068 SF 34 Feet

Project Delivery Method



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SOIL REMEDIATION ENGINEERING

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Problem Areas

- Rock Bin 3
- Building
- Rock Bin 2
- Pervious Paving

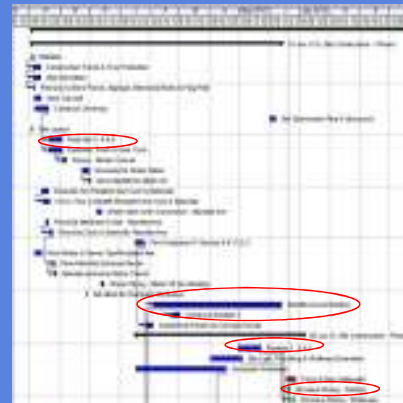




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Implemented Schedule



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SOIL REMEDIATION ENGINEERING



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Excavation Logistics

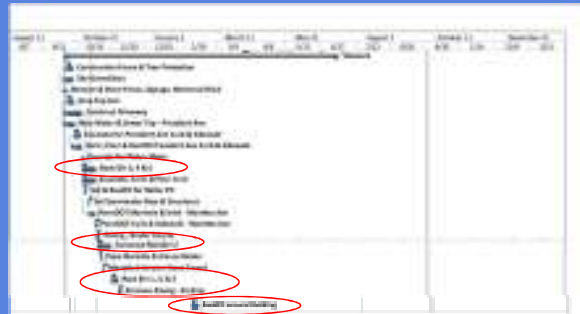




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Alternate Schedule





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Alternate Remediation Method is RECOMMENDED

Pros –

- **Better Soil Compactability**
- **Overall Cost & Schedule Savings**
- **Green**

Con –

- **Front Loading Expenses**

Weighted Matrix – Soil Remediation

	Schedule	Safety	Site Congestion	Cost	Mean value
Implement Method	5	5	5	5	5.0
Alternative Analysis	1	1	1	4	1.25
Assigned Weight	100%	100%	100%	20%	100%
Weighted Implementation	4.3	3.5	5	1.25	3.31
Weighted Alternative	100	100	1	1	100

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MECHANICAL REDESIGN

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System Initial Costs

Geothermal System – \$184,432

Closed Circuit Cooling Tower - \$97,172



MECHANICAL REDESIGN



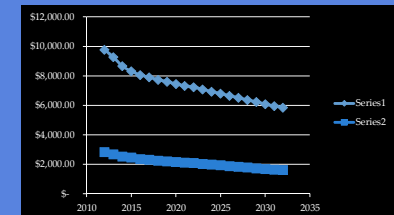
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Energy Consumption

System	Value
Upper Level/Refrigeration	
Electricity	100,000 kWh
Gas	100,000 kWh
Water	1,000,000 gal
Value	\$100,000
Cooling Tower	
Electricity	100,000 kWh
Gas	100,000 kWh
Water	1,000,000 gal
Value	\$100,000

Future Annual Energy



MECHANICAL REDESIGN



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Alternate System is NOT RECOMMENDED

Pros –

- Initial Cost is Lower
- Minimize Schedule Delays

Cons –

- Utility Costs are Higher
- Less Green



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ELEC. ASSEMBLY CONSTRUCTION

Government Funded Project

Prevailing Wage Labor Rates

Minimize Construction Schedule



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ELEC. ASSEMBLY CONSTRUCTION



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Receptacle & Light-switch Estimate: Prefab vs. Field-Built

Cost Code	Unit Price	Material	Tax	Mat Total	Lab Hrs	Lab Rate	Lab Total	Prime Cost	Tools	Tools(\$)	Exp	Exp(\$)	Mkp	Mkp(\$)	Total	Qty	Unit Price	# Units	Ext. Total
1	(508) Prefab 5-20R DRec. w/ 20' MC Tail	\$ 44.00	6%	\$ 46.64	0.20	\$ 54.99	\$ 11.00	\$ 57.64	2%	\$ 0.22	10%	\$ 5.79	10%	\$ 6.37	\$ 70.02	1	\$ 70.02	3	\$ 210.06
2	(508) Prefab 5-20R Quadruplex w/ 20' MC Tail	\$ 48.00	6%	\$ 50.88	0.20	\$ 54.99	\$ 11.00	\$ 61.88	2%	\$ 0.22	10%	\$ 6.21	10%	\$ 6.83	\$ 75.14	1	\$ 75.14	92	\$ 6,912.88
3	(508) Prefab 5-20R GFI Drec. w/ 20' MC Tail	\$ 58.00	6%	\$ 61.48	0.20	\$ 54.99	\$ 11.00	\$ 72.48	2%	\$ 0.22	10%	\$ 7.27	10%	\$ 8.00	\$ 87.97	1	\$ 87.97	21	\$ 1,847.37
4	(508) Prefab 1P Switch w/ 20' MC Tail	\$ 50.00	6%	\$ 53.00	0.20	\$ 54.99	\$ 11.00	\$ 64.00	2%	\$ 0.22	10%	\$ 6.42	10%	\$ 7.06	\$ 77.70	1	\$ 77.70	44	\$ 3,418.80
5	(508) Prefab 3W Switch w/ 20' MC Tail	\$ 53.00	6%	\$ 56.18	0.25	\$ 54.99	\$ 13.75	\$ 69.93	2%	\$ 0.28	10%	\$ 7.02	10%	\$ 7.72	\$ 84.95	1	\$ 84.95	7	\$ 594.65
6	(508) Prefab Single Gang Telecom Box w/ 10' EMT	\$ 18.00	6%	\$ 19.08	0.15	\$ 54.99	\$ 8.25	\$ 27.33	2%	\$ 0.17	10%	\$ 2.75	10%	\$ 3.03	\$ 33.28	1	\$ 33.28	20	\$ 665.60
7	02/70) Prefab 1.5" EII	\$ 6.00	6%	\$ 6.36	0.13	\$ 54.99	\$ 7.15	\$ 13.51	2%	\$ 0.14	10%	\$ 1.37	10%	\$ 1.50	\$ 16.52	1	\$ 16.52	18	\$ 297.36
8	02/70) Prefab 2" EII	\$ 8.00	6%	\$ 8.48	0.17	\$ 54.99	\$ 9.35	\$ 17.83	2%	\$ 0.19	10%	\$ 1.80	10%	\$ 1.98	\$ 21.80	1	\$ 21.80	27	\$ 588.60
9	02/70) Prefab 3" EII	\$ 30.00	6%	\$ 31.80	0.19	\$ 54.99	\$ 10.45	\$ 42.25	2%	\$ 0.21	10%	\$ 4.25	10%	\$ 4.67	\$ 51.38	1	\$ 51.38	23	\$ 1,181.74
10	02/70) Prefab 4" EII	\$ 48.00	6%	\$ 50.88	0.31	\$ 54.99	\$ 17.05	\$ 67.93	2%	\$ 0.34	10%	\$ 6.83	10%	\$ 7.51	\$ 82.61	1	\$ 82.61	27	\$ 2,340.47
11	Prefab 225A Panelboard w/ (2) 2" EMT Risers & J-Box	\$ 46.00	6%	\$ 48.76	6.40	\$ 54.99	\$ 351.94	\$ 400.70	2%	\$ 7.04	10%	\$ 40.77	10%	\$ 44.85	\$ 493.36	1	\$ 493.36	17	\$ 8,387.12
12	Field-Built Duplex Receptacle w/ 20' MC Cable	\$ 22.00	6%	\$ 23.32	1.01	\$ 54.99	\$ 55.54	\$ 78.86	2%	\$ 1.11	10%	\$ 8.00	10%	\$ 8.80	\$ 96.77	1	\$ 96.77	3	\$ 290.31
13	Field-Built Quadruplex Receptacle w/ 20' MC Cable	\$ 24.00	6%	\$ 25.44	1.18	\$ 54.99	\$ 64.89	\$ 90.33	2%	\$ 1.30	10%	\$ 9.16	10%	\$ 10.08	\$ 110.87	1	\$ 110.87	92	\$ 10,200.04
14	Field-Built GFI Receptacle w/ 20' MC Cable	\$ 29.00	6%	\$ 30.74	1.05	\$ 54.99	\$ 57.74	\$ 88.48	2%	\$ 1.15	10%	\$ 8.96	10%	\$ 9.86	\$ 108.45	1	\$ 108.45	21	\$ 2,277.45
15	Field-Built 1P Switch w/ 20' MC Cable	\$ 25.00	6%	\$ 26.50	1.04	\$ 54.99	\$ 57.19	\$ 83.69	2%	\$ 1.14	10%	\$ 8.48	10%	\$ 9.33	\$ 102.64	1	\$ 102.64	44	\$ 4,516.16
16	Field-Built 3W Switch w/ 20' MC Cable	\$ 26.50	6%	\$ 28.09	1.20	\$ 54.99	\$ 65.99	\$ 94.08	2%	\$ 1.32	10%	\$ 9.54	10%	\$ 10.49	\$ 115.43	1	\$ 115.43	7	\$ 808.01
17	Field-Built 1-Gang Telecom Box w/ 10' EMT & Pull String	\$ 9.00	6%	\$ 9.54	1.18	\$ 54.99	\$ 64.89	\$ 74.43	2%	\$ 1.30	10%	\$ 7.57	10%	\$ 8.33	\$ 91.63	1	\$ 91.63	20	\$ 1,832.60
18	Field Bend 1-1/2" EMT 90 Degrees	\$ 3.00	6%	\$ 3.18	0.80	\$ 54.99	\$ 43.99	\$ 47.17	2%	\$ 0.88	10%	\$ 4.81	10%	\$ 5.29	\$ 58.15	1	\$ 58.15	18	\$ 1,046.70
19	Field Bend 2" EMT 90 Degrees	\$ 4.00	6%	\$ 4.24	1.00	\$ 54.99	\$ 54.99	\$ 59.23	2%	\$ 1.10	10%	\$ 6.03	10%	\$ 6.64	\$ 73.00	1	\$ 73.00	27	\$ 1,971.00
20	Field Bend 3" EMT 90 Degrees	\$ 15.00	6%	\$ 15.90	1.40	\$ 54.99	\$ 76.99	\$ 92.89	2%	\$ 1.54	10%	\$ 9.44	10%	\$ 10.39	\$ 114.26	1	\$ 114.26	23	\$ 2,627.98
21	Field Bend 4" EMT 90 Degrees	\$ 24.00	6%	\$ 25.44	2.00	\$ 54.99	\$ 109.98	\$ 135.42	2%	\$ 2.20	10%	\$ 13.76	10%	\$ 15.14	\$ 166.52	1	\$ 166.52	27	\$ 4,496.04
22	Field-Built 225A Panelboard w/ (2) 2" EMT Risers & J-Box	\$ 23.00	6%	\$ 24.38	7.60	\$ 62.38	\$ 474.09	\$ 498.47	2%	\$ 9.48	10%	\$ 50.80	10%	\$ 55.88	\$ 614.63	1	\$ 614.63	17	\$ 10,448.71

Total Cost Prefab
\$ 26,334.65

Total Cost Field-Built
\$ 40,515.00



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Alternate System is RECOMMENDED

Pros –

- **Reduced Schedule**
- **Constructability Improvements**

Cons –

- **Greater Communication Required**

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GREATER USE OF B.I.M.

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PLAN	DESIGN	CONSTRUCT	OPERATE
4D Model	4D Model	4D Model	4D Model
3D Coordination	3D Coordination	3D Coordination	
Building System Analysis	Building System Analysis	Building System Analysis	Building System Analysis
	Virtual Mockup	Virtual Mockup	Virtual Mockup
	Site Utilization Planning	Site Utilization Planning	
Space Management	Space Management	Space Management	Space Management



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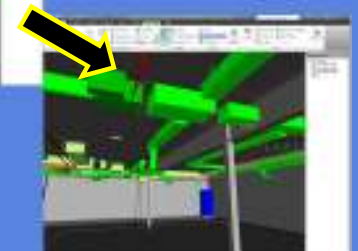
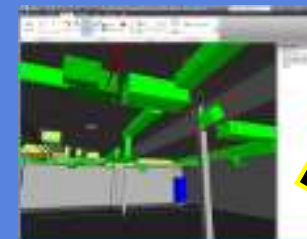
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It would cost \$770 to do more extensive clash detection, and the change order cost $(.85-.55)(\$20,847)=\$6,254$ more than had the cost been accounted for during the bidding phase.



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Greater 3D Coordination is RECOMMENDED

Pros –

- **Minimize Change Order Costs**

Cons –

- **Greater Communication Required**

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CONCLUSIONS & RECOMMENDATIONS



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Analysis I – RECOMMENDED

Analysis II – NOT RECOMMENDED

Analysis III – RECOMMENDED

Analysis IV – RECOMMENDED

ACKNOWLEDGEMENTS



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I would like to thank the Penn State Faculty, my peers, and all of the construction companies involved in the LancasterHistory.org project.