

Replacement High School

Undisclosed Location | Maryland

Analysis Topics

Alternate Mechanical System

Solar Energy Conversion System (SECS)

Alternate Delivery Method

Façade Prefabrication



Breadth Topics

Mechanical System Redesign

Hybrid geothermal system w/ a cooling tower to supplement for peak load conditions

Structural Roof Redesign

To accommodate extra loads of the cooling tower

Project Background

Presentation Outline:

Project Background

- General Information
- Project Participants

Analysis 1: Mechanical System

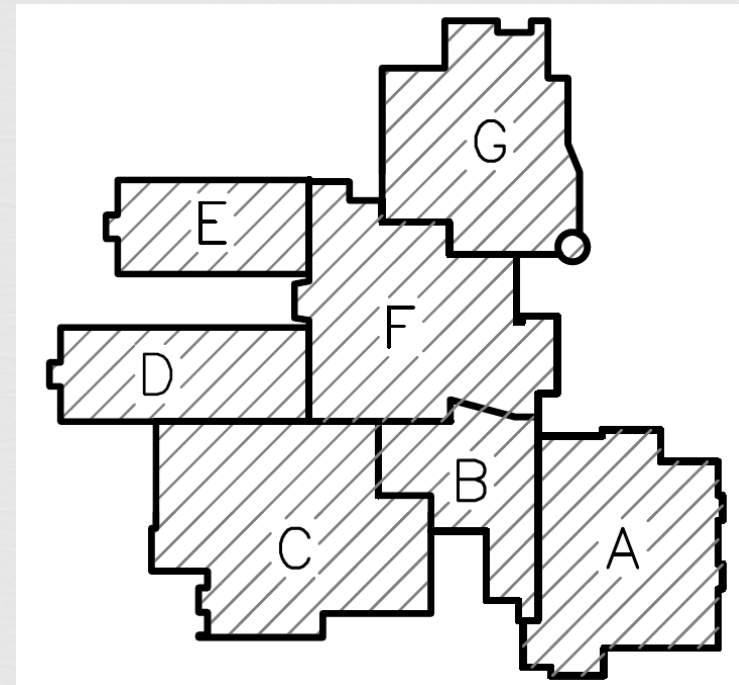
Analysis 2: Solar Energy Conversion

System (SECS)

Analysis 4: Façade Prefabrication

Conclusion

Acknowledgements



Location

- Southern Maryland below Washington DC

Building Size

- Area: 254,878 GSF
- Height: 3 Stories @ 70'

Project Parameters

- Cost: \$74,250,000
- Dates of Construction: Dec. 2011 – Aug. 2013
- Delivery method: CM at Risk, Cost + Fee w/ GMP

Purpose

- To replace the outdated existing school



INITIAL SITE LAYOUT



PROGRESS PHOTO

Project Background

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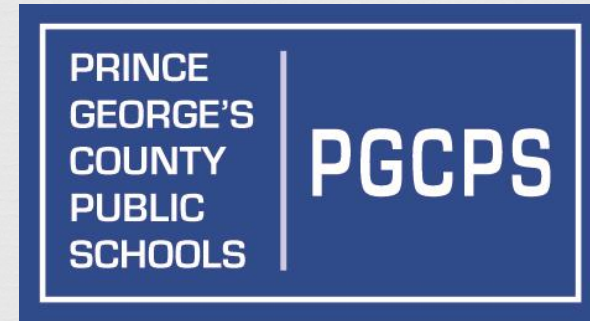
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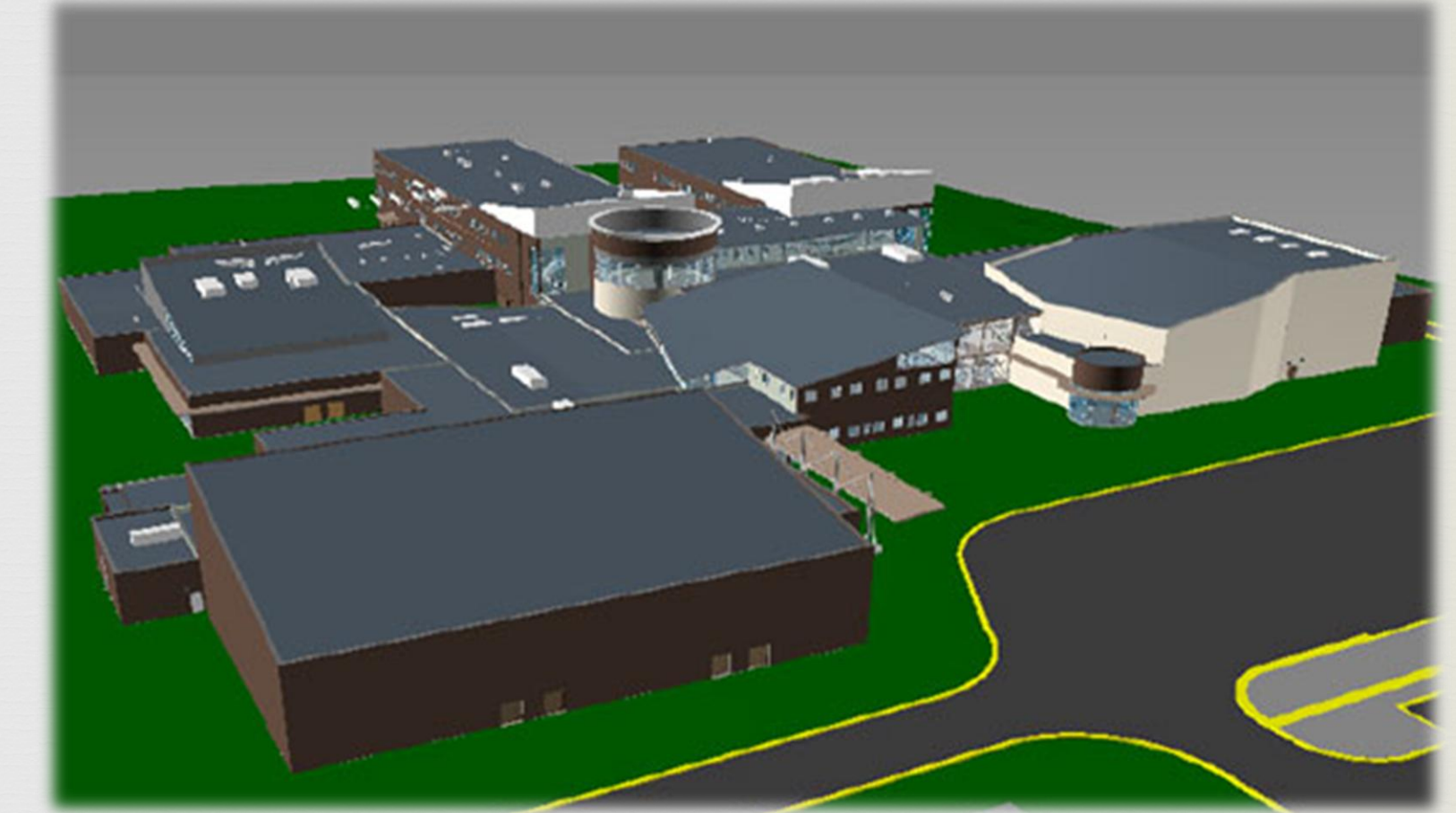


Project Participants

Owner: Prince George's County Public School (PGCPS)

Construction Manager: HESS Construction + Engineering Services

Architect: WMCRP



Analysis 1: Mechanical System

Presentation Outline:

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Analysis 1: Mechanical System

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Problem Background:

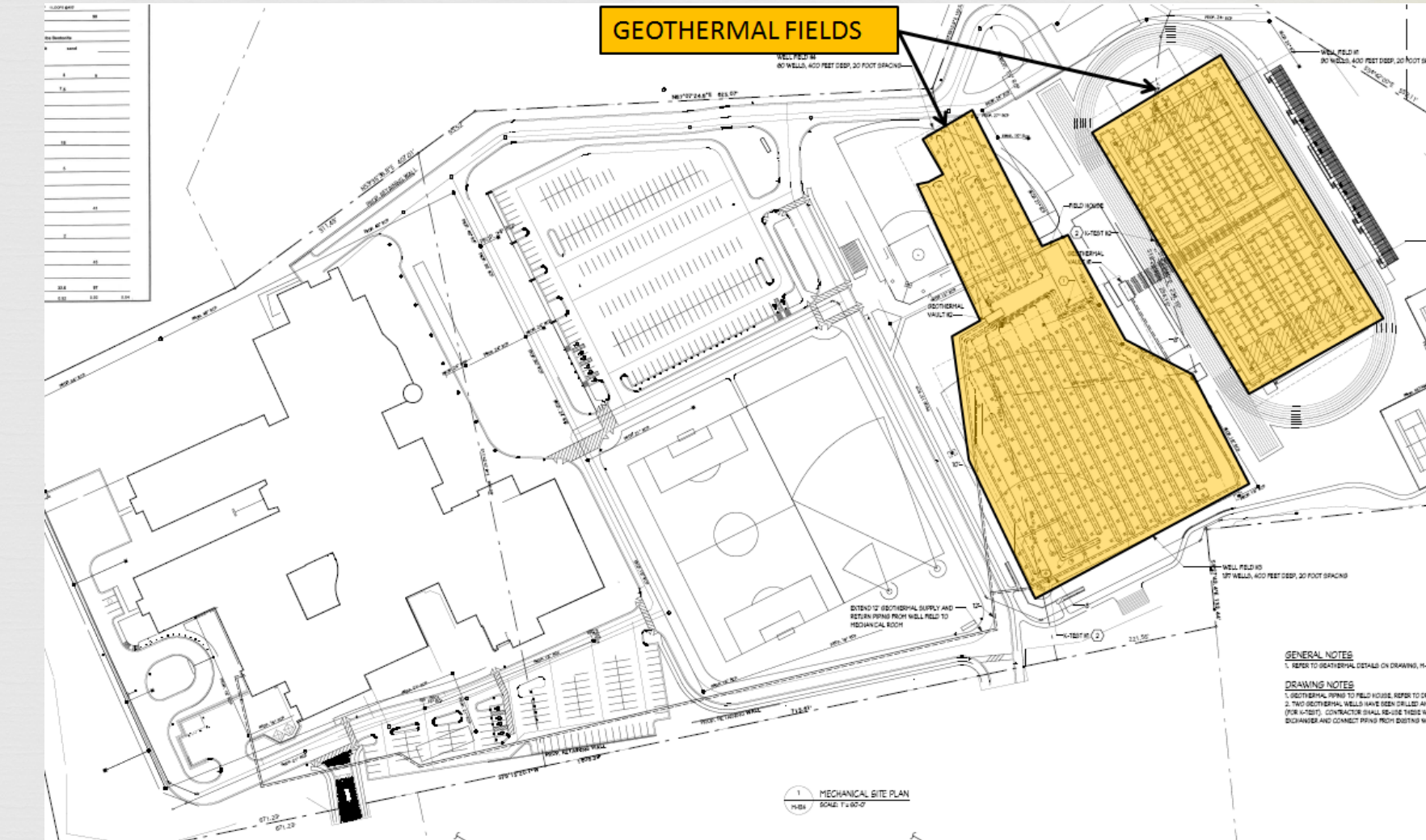
High upfront cost of the school correlated to a lot of VE

Current System:

Geothermal system w/ 400 wells all at a depth of 400' @ \$6,500/Well

Proposal

Hybrid Geothermal system

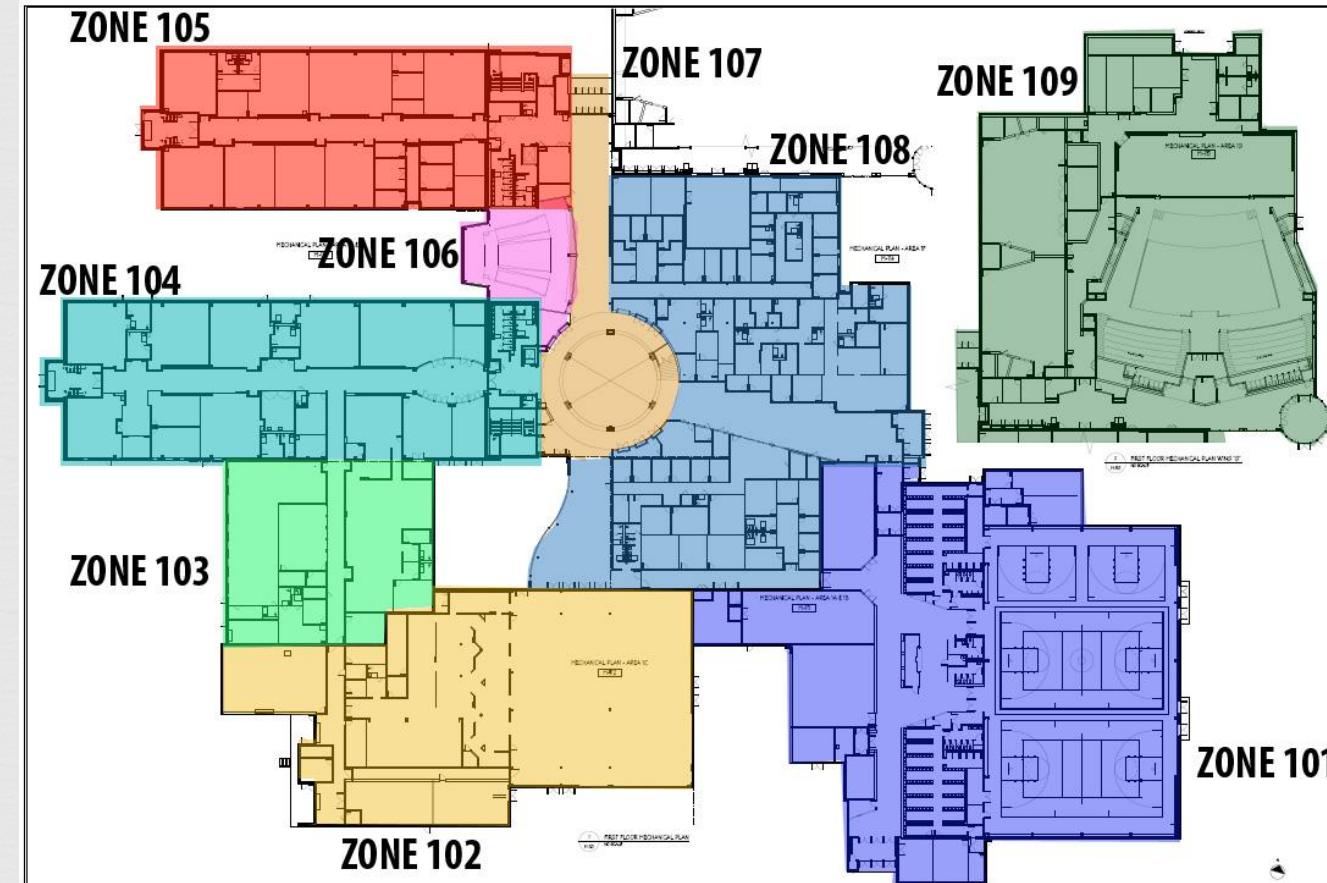


Analysis 1: Mechanical System

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- **Broke Building Into Zones**
- **Takeoffs**
- **Translated Building Info Into *Trane Trace 700* Energy Modeling Software**



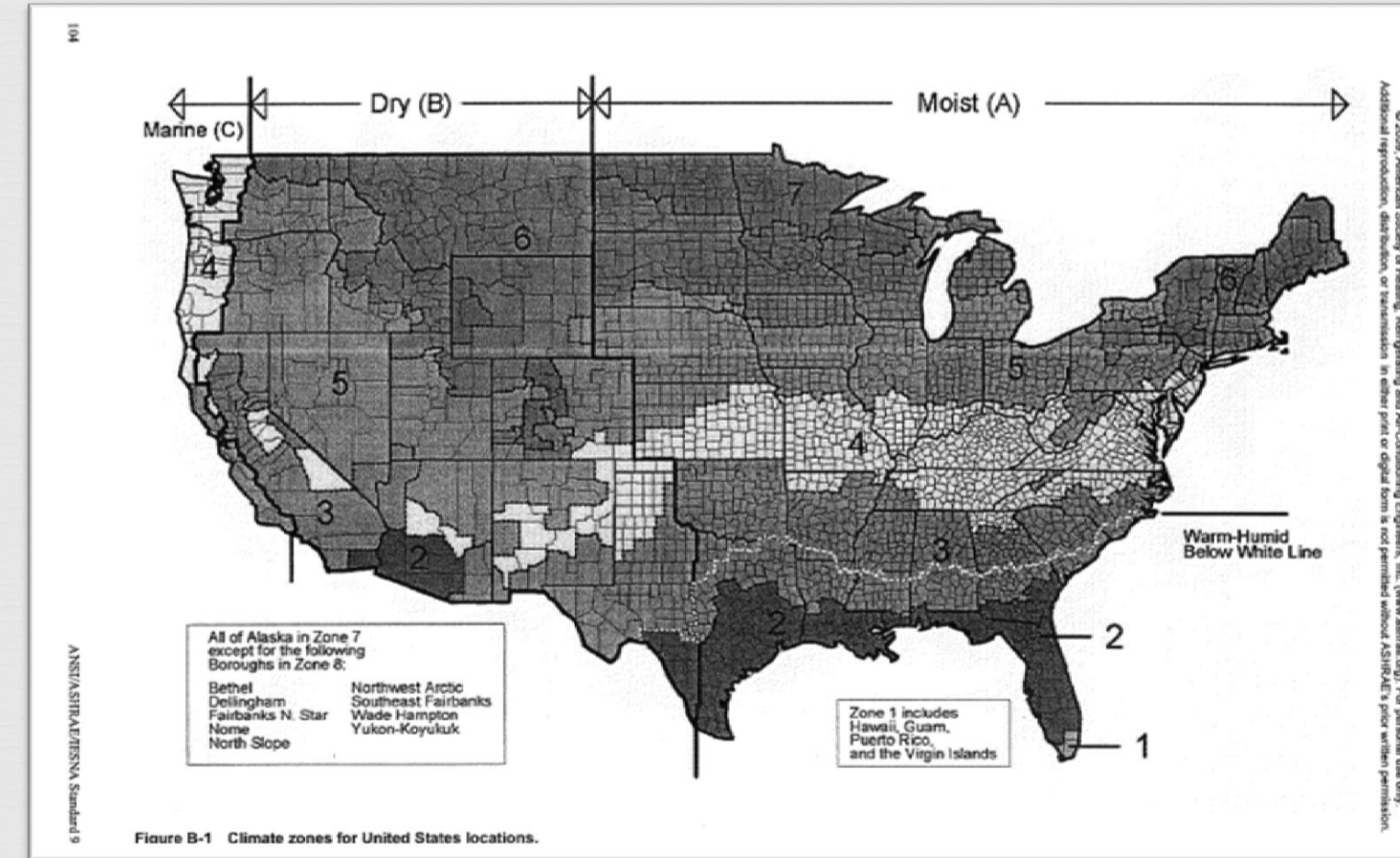
Takeoffs													
#	Zone Name	Building Pieces	Floor (sf)	N	E	S	W	Flat Roof	Roof	Height	Occ	# Extra Floors	Multi Story SF
101	Gym	I-A,B	37700	4972	6537	6076	10608	20593	17033	43.4			
102	Cafeteria	II-C	19355	4973	1227	13826	1582	12590	9870	16	1397		
103	Kitchen	III-C	10343	-	5095	-	1583	10343		16	127		
104	Classrooms	III-D	20657	10455	1814	10826	3747	20657	-	45.4	1134	2	41314
105	Classrooms	IV-E	15980	9360	2514	7601	3747	15980	-	45.4	918	2	31960
106	Lecture Hall	N/A	2815	-	-	-	2064	2815		45.4	230		
107	Transition	Centrla Core & Atrium	5746	1813	-	434	1537	5746		45.4	120	2	11492
108	Admin	V-B,F	26638	3368	8973	1790	-	22048	9291	35	385		
109	Auditorium	VI-G	31176	7336	7475	-	6271	7298	7856	51	1587		

Analysis 1: Mechanical System

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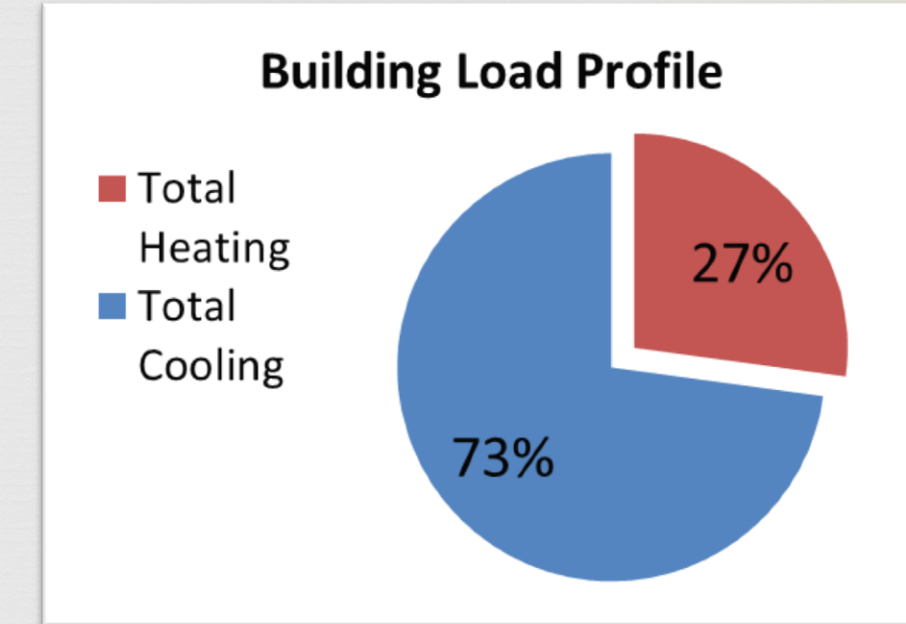
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- **Broke Building Into Zones**
- **Takeoffs**
- **Translated Building Info Into *Trane Trace 700* Energy Modeling Software**
- **Determined Geographic Zone Type**
- **Ran Model to Generate Basic Load Calculations**



Total Peak Heating Load: **275 tons**

Total Peak Cooling Load: **738 tons**



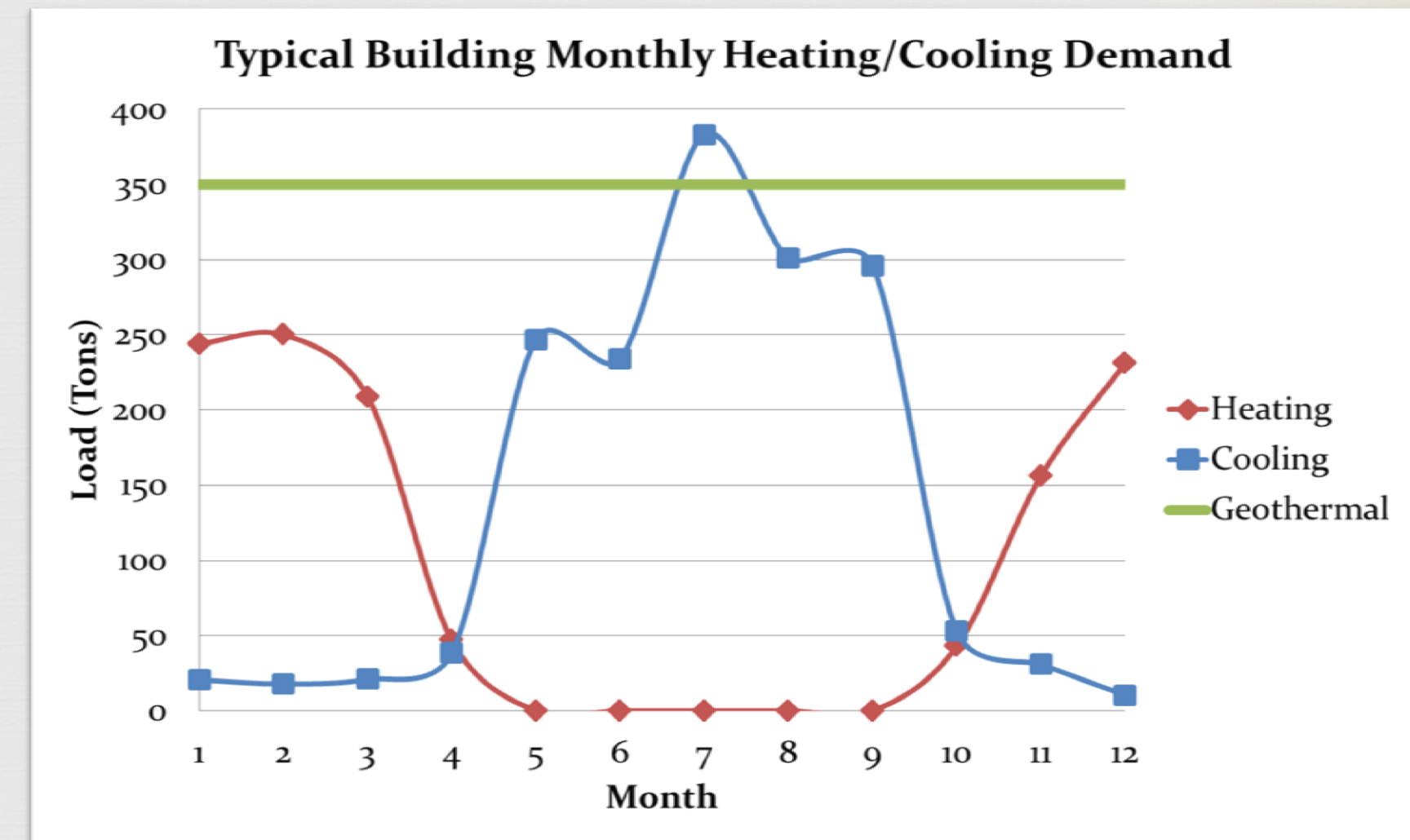
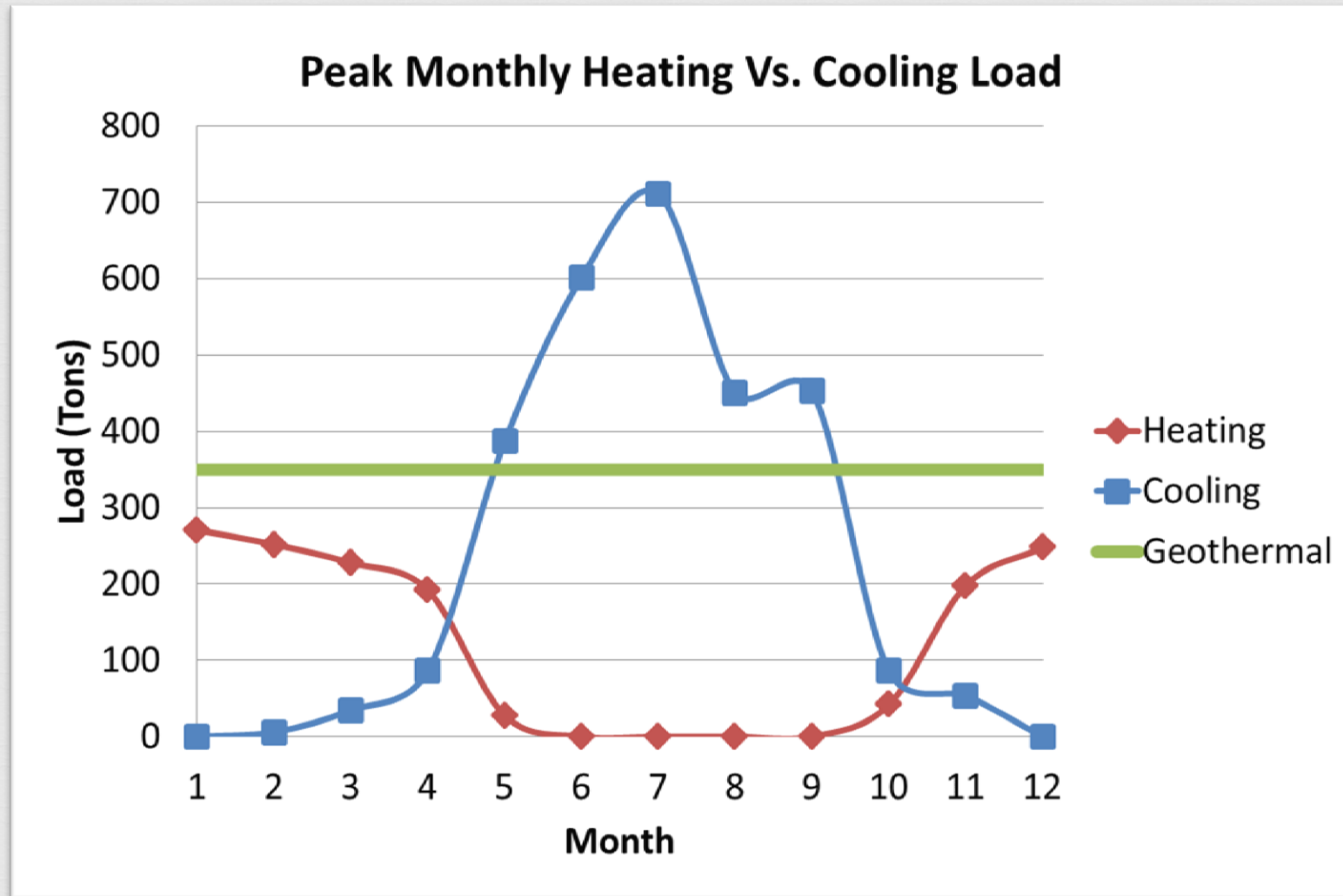
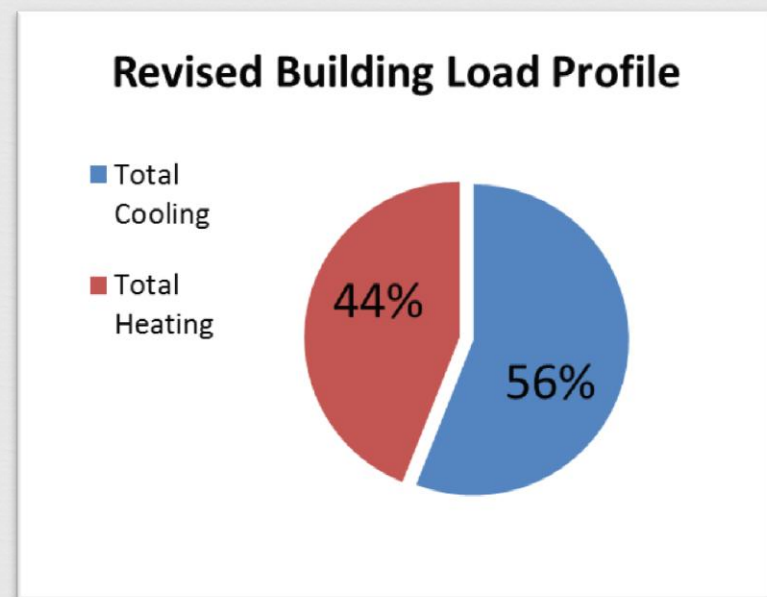
Total Cooling Capacity Installed(Geothermal+Equipment)	718.47
Trace700 Building Cooling Load Profile	738
% Deviation	2.72

Analysis 1: Mechanical System

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- Monthly Load Profiles**
- Redesign for 350 Tons**

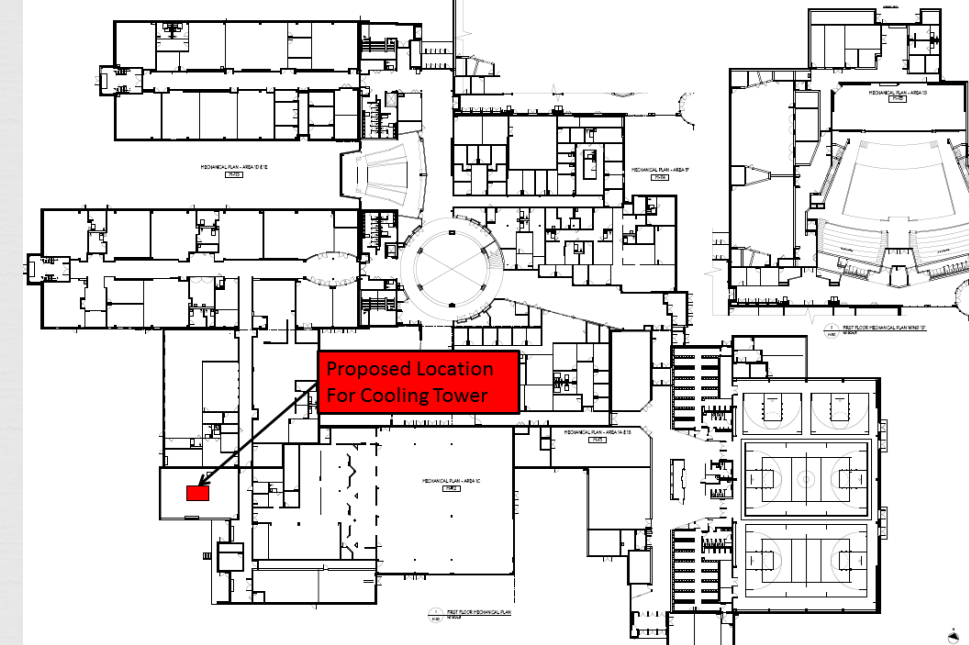


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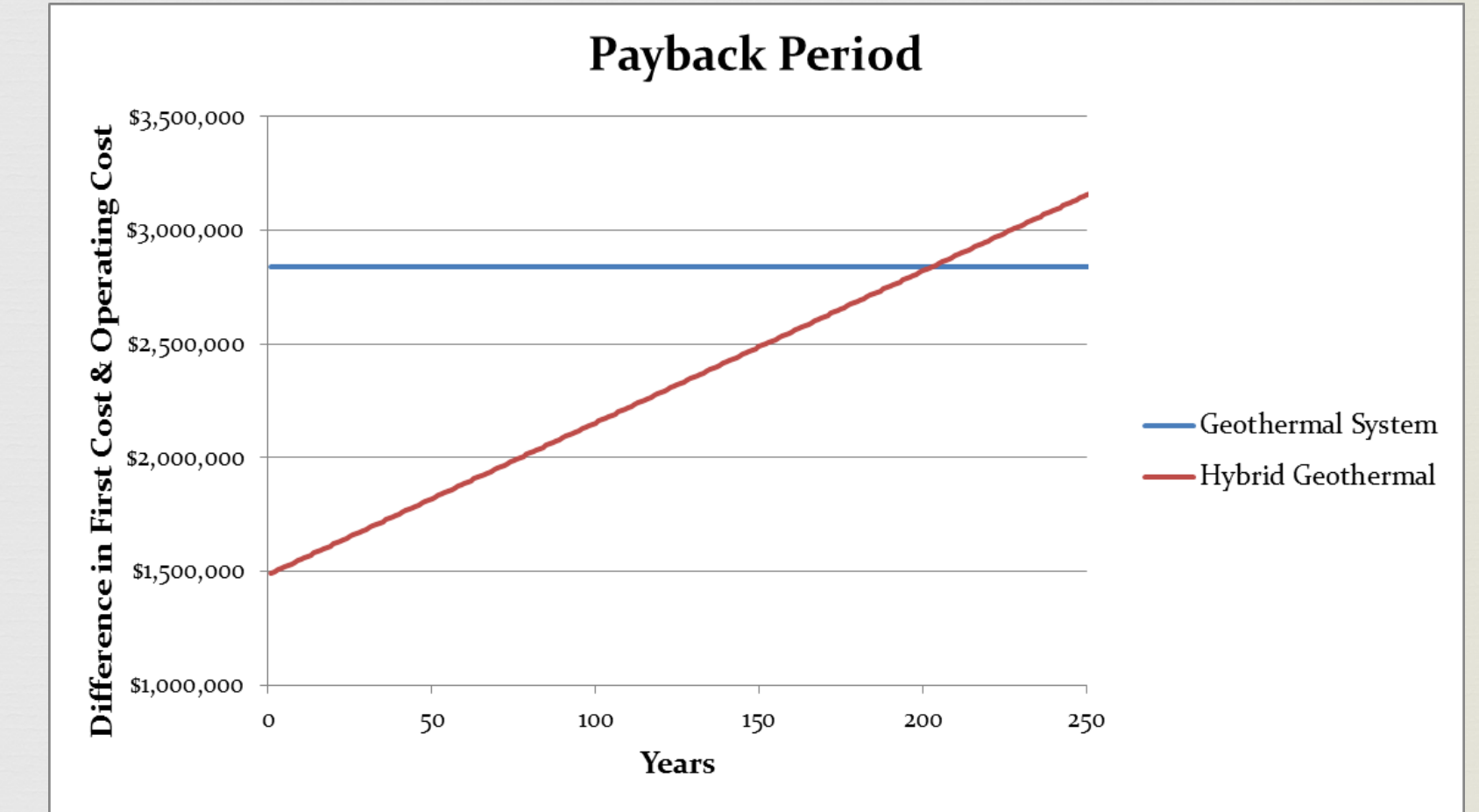
- **Monthly Load Profiles**
- **Redesign for 350 Tons**
- **Select a Cooling Tower and Location**
- **Payback Period**



Marley NC8407M-1 Steel Cooling Tower



System	Cost of Wells	Cost of Cooling Tower	Difference in Yearly Running Costs	Difference in Maintenance Costs	Difference in Structural Cost
Fully Geothermal	\$2,840,500.00	-	-	-	-
Hybrid Geothermal	\$1,420,250.00	\$68,005.00	\$5,846.70	\$823.00	\$4,896.60



Analysis 1: Mechanical System

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Analysis 2: Solar Energy Conversion

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Results

Upfront Savings: \$1,347,348.40

Potential implications:

- Purchase custom casework
- Nicer Finishes
- Telecom Package

Recommendations:

Current geothermal system at the site is not the most practical design should use a hybrid geothermal system.



Analysis 2: SECS

Presentation Outline:

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Analysis 4: Façade Prefabrication

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Owners Goal:

To create a state-of-the-art educational facility particularly in the field of science and technology

Proposal:

To determine whether or not a photovoltaic array would prove to be advantageous for the client

Intent:

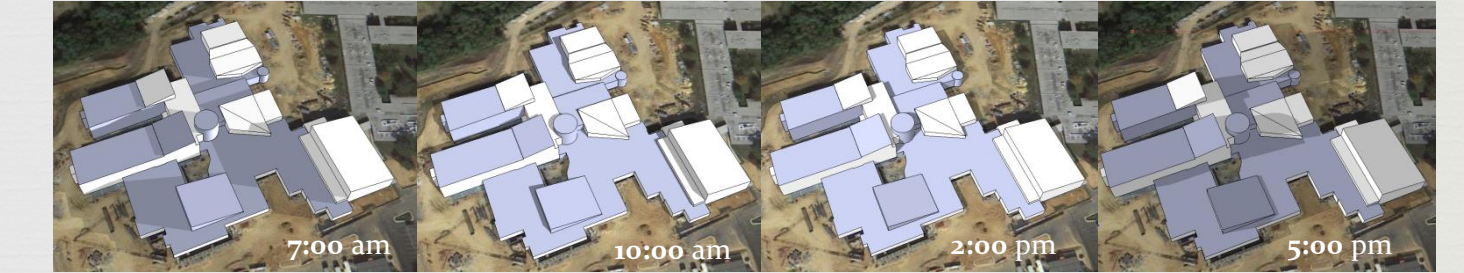
Prove that a PV array would be a beneficial investment for the owner.

Analysis 2: SECS

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• Building Analysis



Solar Shading on the Equinoxes



Solar Shading on the Winter Solstice



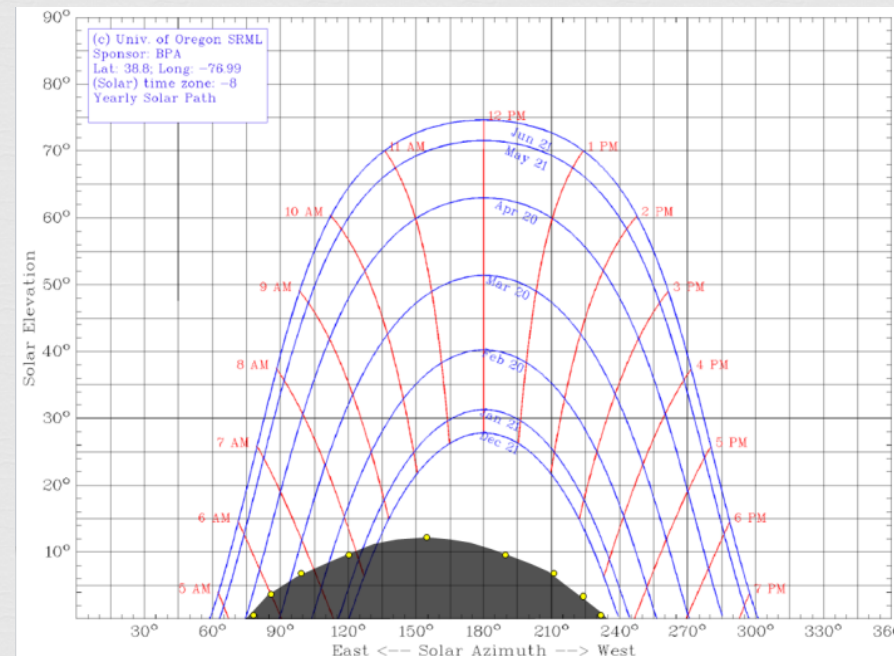
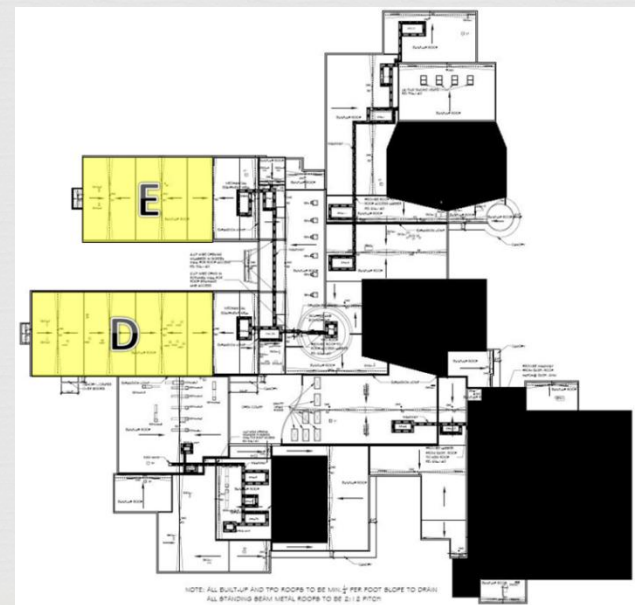
Solar Shading on the Summer Solstice

Analysis 2: SECS

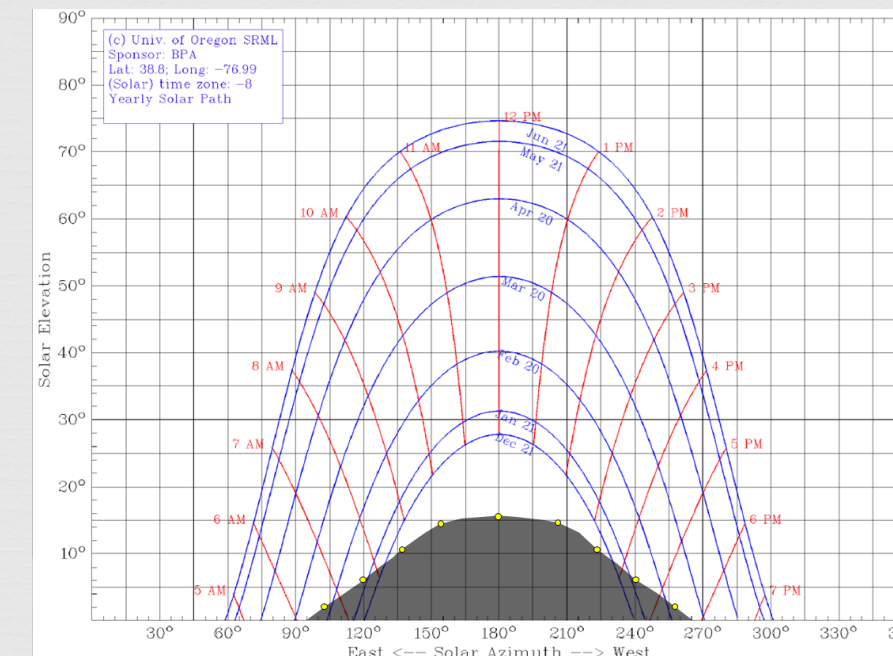
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- **Building Analysis**
- **Shading Concerns**
 - Parapet Wall
 - Module Spacing

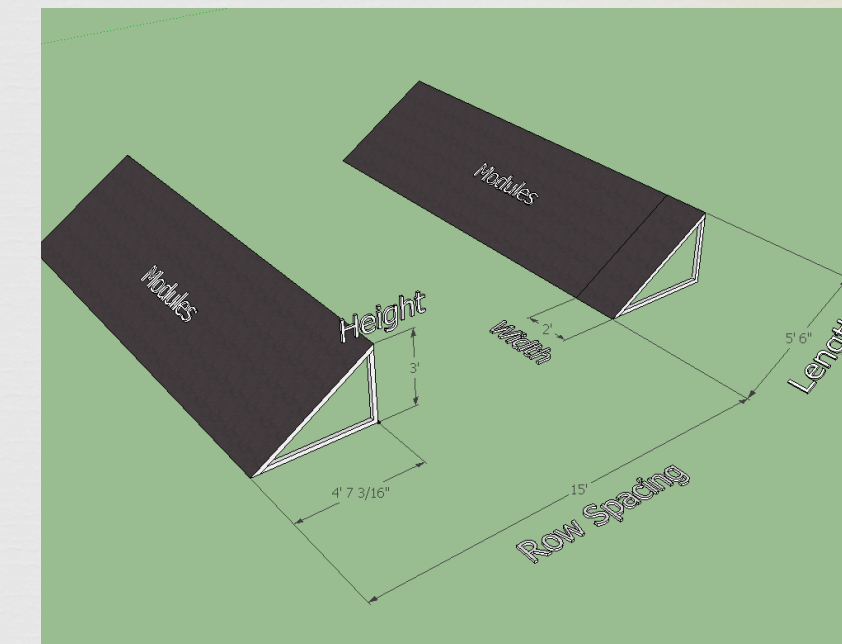
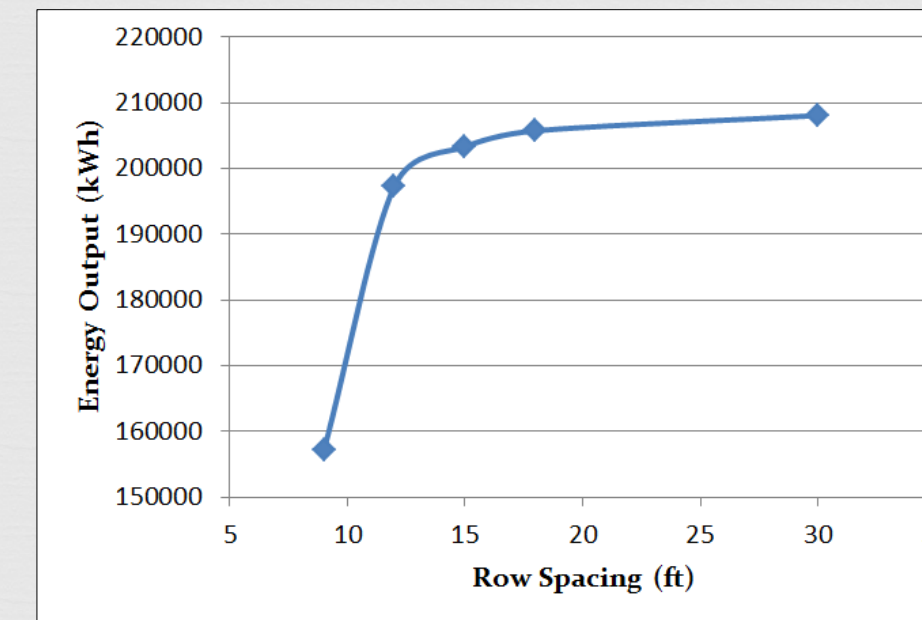


Shading Due to Parapet Wall



Shading Due to Modules

Row Spacing (ft)	Annual Energy (kWh)	System Performance Factor
9	157116	58%
12	197313	72%
15	203286	75%
18	205719	76%
30	208048	76%



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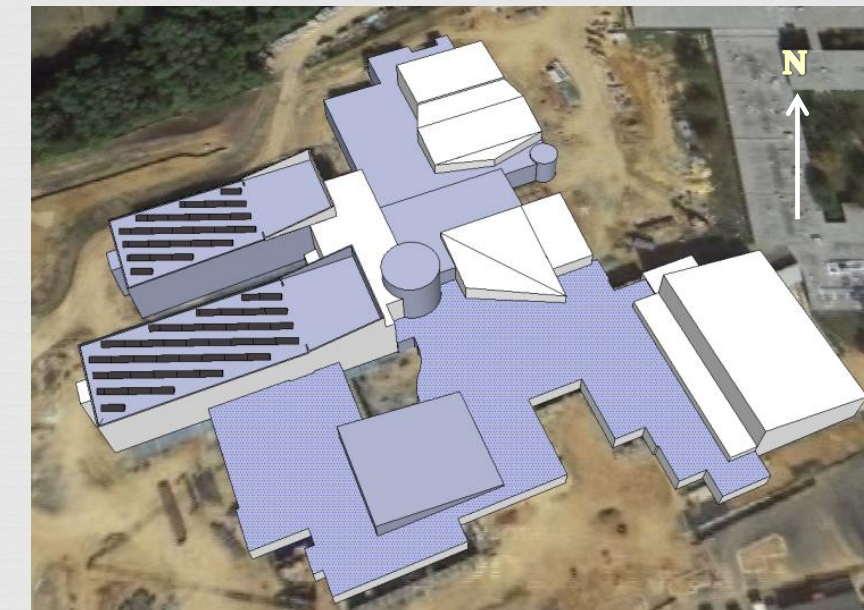
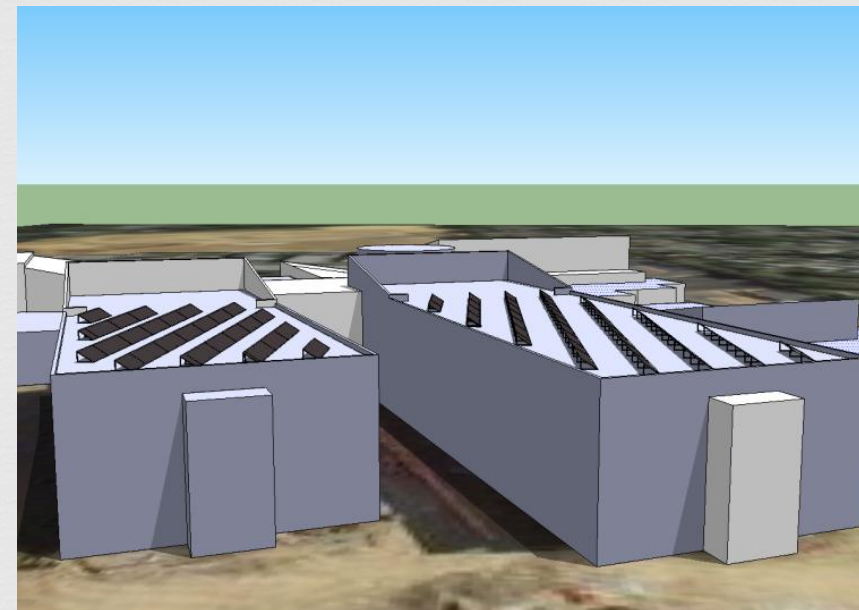
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- **Module Selection & Layout**
- **Cost & Incentives**

With Row Spacing @ 15'

Roof Section	Item	Quantity	Output	Duration (days)
D	Module	370	8/day/electrician	46.25
	Mounting Rack	37	4/day/roofer	9.25
	Inverter	3	3/day/electrician	1
E	Module	260	8/day/electrician	32.5
	Mounting Rack	26	4/day/roofer	6.5
	Inverter	2	2/day/electrician	1



Project Cost

Direct Capital Costs								
Module	630	units	0.2	kWdc/unit	151,304	kWdc	2.05 \$/Wdc	\$310,173.20
Inverter	5	units	30	KkWac/unit	149.85	kWac	0.37 \$/Wac	\$55,444.50
Balancing of System, equipment							0.43 \$/Wdc	\$65,060.72
Installation labor							0.48 \$/Wdc	\$72,625.92
Installer margin and overhead							0.81 \$/Wdc	\$122,556.24
Total Direct Cost								\$625,860.58
Indirect Capital Costs								
Permitting, Environmental Studies							0.23 \$/Wdc	\$34,799.92
Grid interconnection							0.01 \$/Wdc	\$1,513.04
Sales Tax							0%	\$0.00
Total Indirect Cost								\$36,312.96
Total Installed Cost								
Total Installed Cost:								\$662,173.54
Cost/Capacity:								\$4.38

Analysis 2: SECS

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Incentives

Property Tax Exemption For Wind and Solar
 Provides 100% real tax exemption in Maryland

Federal Tax Credit
 30%

State Tax Credit
 25%

SREC's
 \$120 deescalating at 10% over a 10 year period

Project Cost

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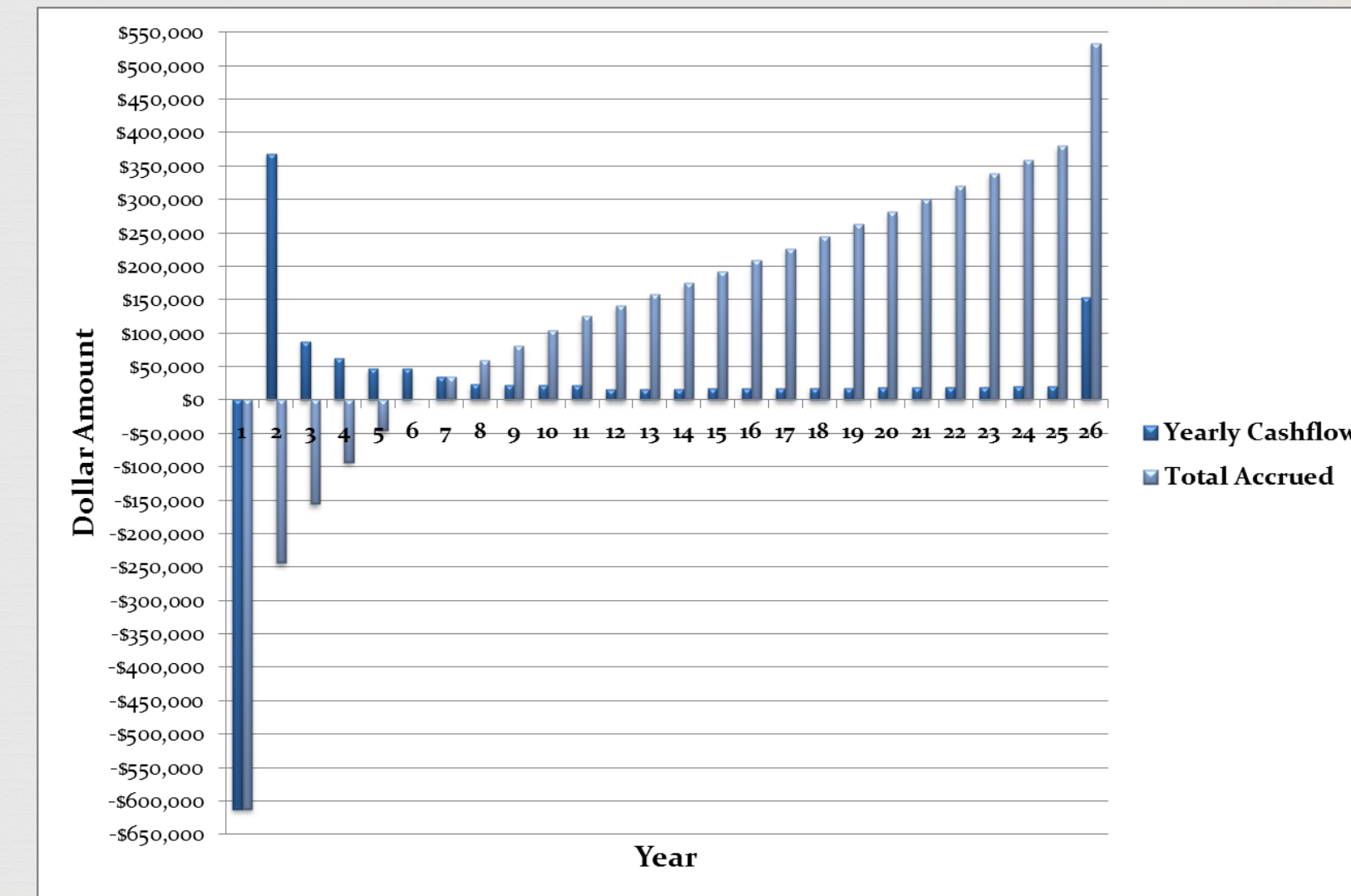
30%

State Tax Credit

25%

SREC's

\$120 deescalating at 10% over a 10 year period



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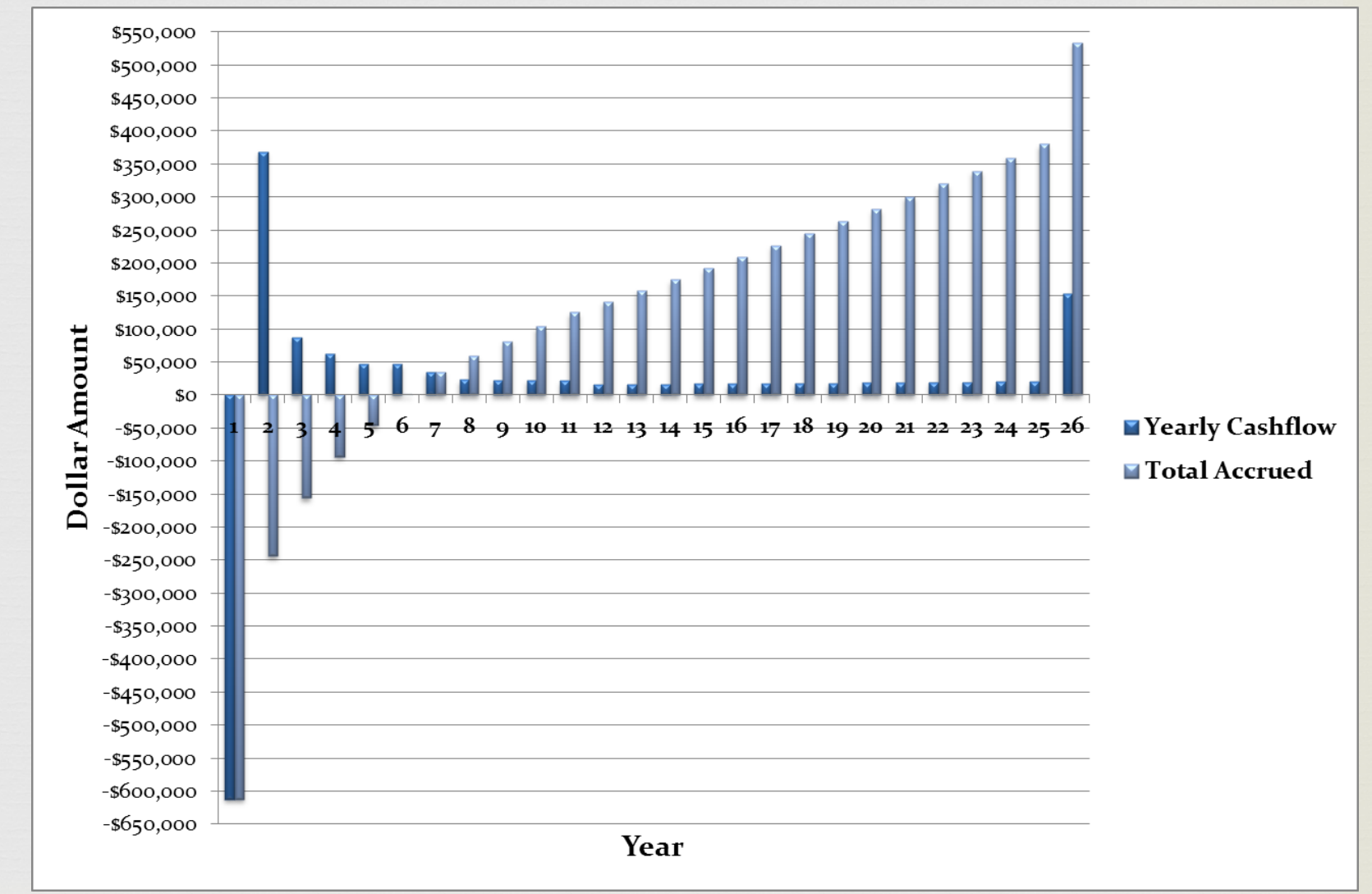
Results

Payback Period
4.99 years

Installation Time
17 days given 4 roofers and 7 electricians

Impact to schedule
Minimal: activities don't occur on the critical path

Recommendations
PGCPS should consider implementing PV system based off of the potential reduction in utility bills and the short payback period.



Analysis 4: Façade Prefabrication

Presentation Outline:

Project Background

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Analysis 4: Façade Prefabrication

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Problem Background:

A two month delay on the notice-to-proceed reduced an already tight schedule to 18 months

Current Facade:

69,000 SF of hand laid ground-face-CMU on a metal stud and masonry substrate.

Proposal

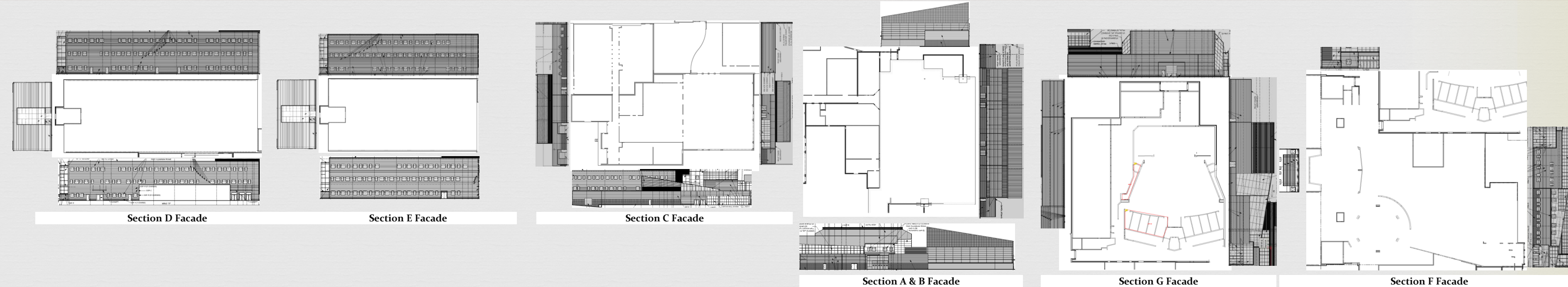
Accelerate the schedule by utilizing a precast architectural façade.

Analysis 4: Façade Prefabrication

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- **Panel Quantity Calculations**



Total Panels: 342

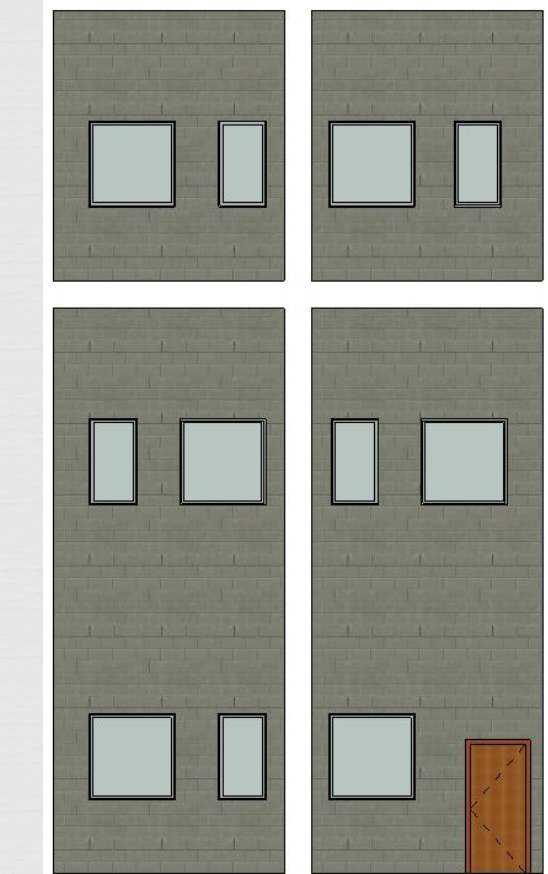
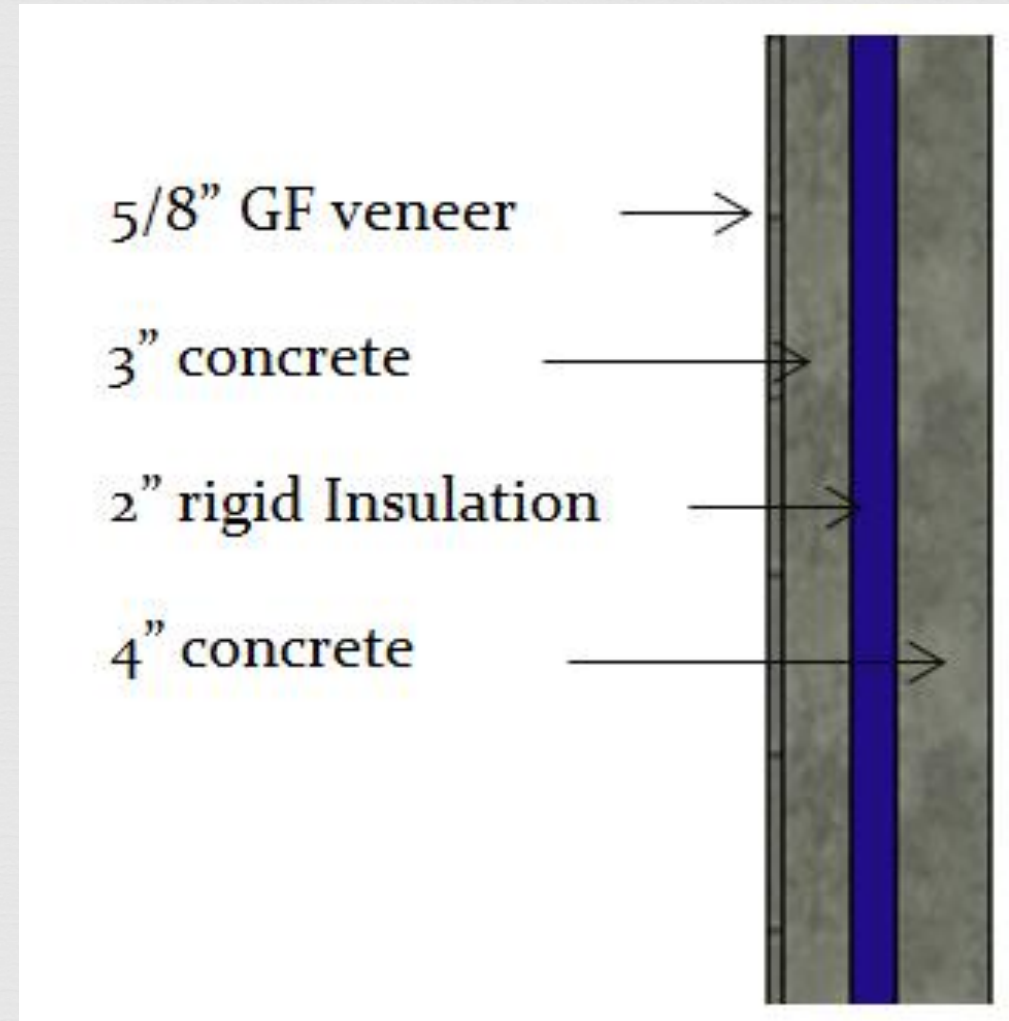
Panel Requirements: Height < 13'6"

Analysis 4: Façade Prefabrication

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- **Panel Quantity Calculations**
- **Typical Panel Design For Sections D & E**



Analysis 4: Façade Prefabrication

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- **Panel Quantity Calculations**
- **Typical Panel Design For Sections D & E**
- **Cost Impacts**

Current Cost of Façade: \$2,233,500

Cost of prefabricated Panels: \$35/SF

Cost of Prefabricated Façade: \$2,415,000

Additional Crane Costs: \$17,800

GC Cost Savings: \$22,700

Total Cost of Prefabricated Façade: \$2,410,100

Difference: **(\$176,600)**



Analysis 4: Façade Prefabrication

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- **Panel Quantity Calculations**
- **Typical Panel Design For Sections D & E**
- **Cost Impacts**
- **Schedule Impacts**

Section	# of Panels	Avg. Time/Panel	Total Time (min)	Total Time (Work Days)
D	89	24 min	2136	4.45
E	83	24 min	1992	4.15
F	33	24 min	792	1.65
G	48	24 min	1152	2.4
C	57	24 min	1368	2.85
A&B	32	24 min	768	1.6
Total Days Spent:				17.1

Section	Original Duration (8 Hr. Days)	Adjusted Duration (8 Hr. Days)	Reduction In Schedule (8 Hr. Days)
D:	60	4.45	55.55
E:	46	4.15	41.85
F:	19	1.65	17.35
G:	32	2.4	29.6
C:	41	2.85	38.15
A&B:	27	1.6	25.4

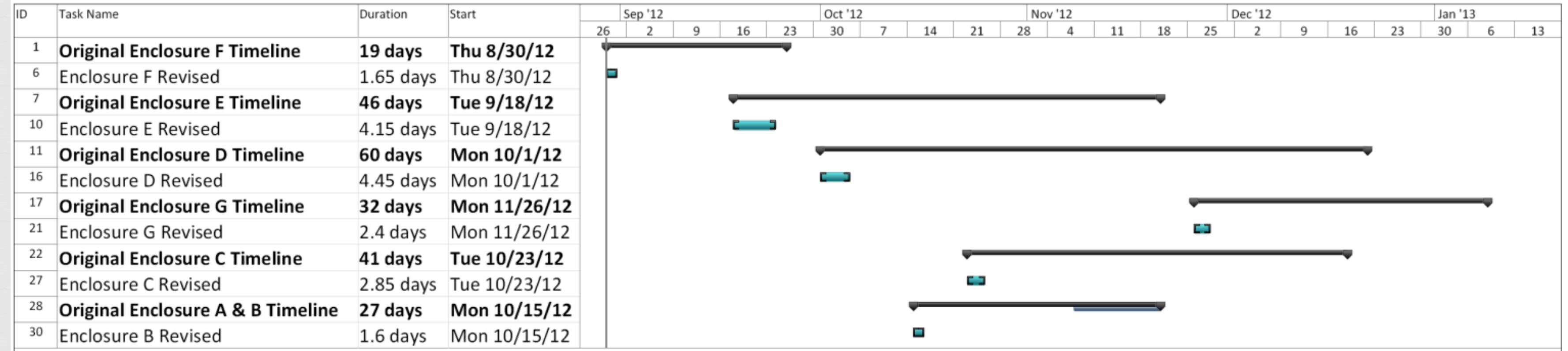


Analysis 4: Façade Prefabrication

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Analysis 4: Façade Prefabrication

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- Panel Quantity Calculations**
- Typical Panel Design For Sections D & E**
- Cost Impacts**
- Schedule Impacts**

Results

Cost Implication

\$176,600 More expensive (8% more)

Installation Time

Greatly reduces installation time which allows other trades to start sooner

Impact to schedule

Reduction of the critical path by 6 weeks

Recommendations

Hess Construction should consider switching the installation method of the facade. Ultimately this decision lies with the design team.



Conclusions

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- Analysis 3: Alternate Delivery Method
- Analysis 4: Façade Prefabrication
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Analysis 1: Hybrid Geothermal System

- Reduce first cost of system
- More efficient system
- Payback period validates change



Implement

Analysis 2: SECS

- Minimal to no impact on schedule
- Short payback period
- Reduction in utility bills
- Minimal maintenance and repairs



Implement

Analysis 4: Façade Prefabrication

- 6 week reduction in schedule
- 8% more expensive
- Safer site



Implement

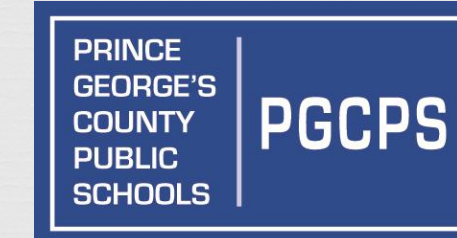
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Acknowledgements

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 Angie Veintimilla, AE Undergraduate
 Michael Palmer, AE Undergraduate

Thank you!

Questions?

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