

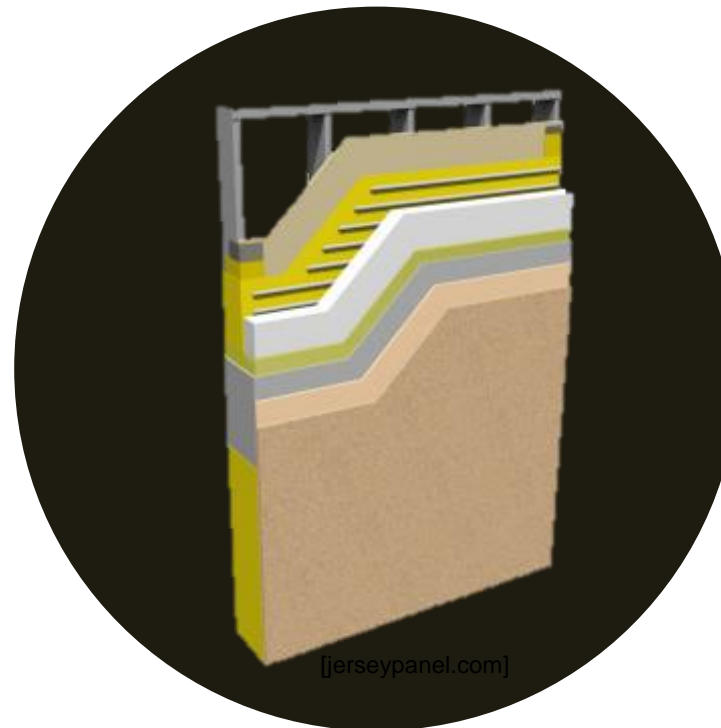
COMMUNITY HEALTHCARE

KENNA MARKEL
CONSTRUCTION MANAGEMENT

ADVISOR | DR. ROBERT LEIGHT
PENN STATE AE THESIS
APRIL 12, 2016



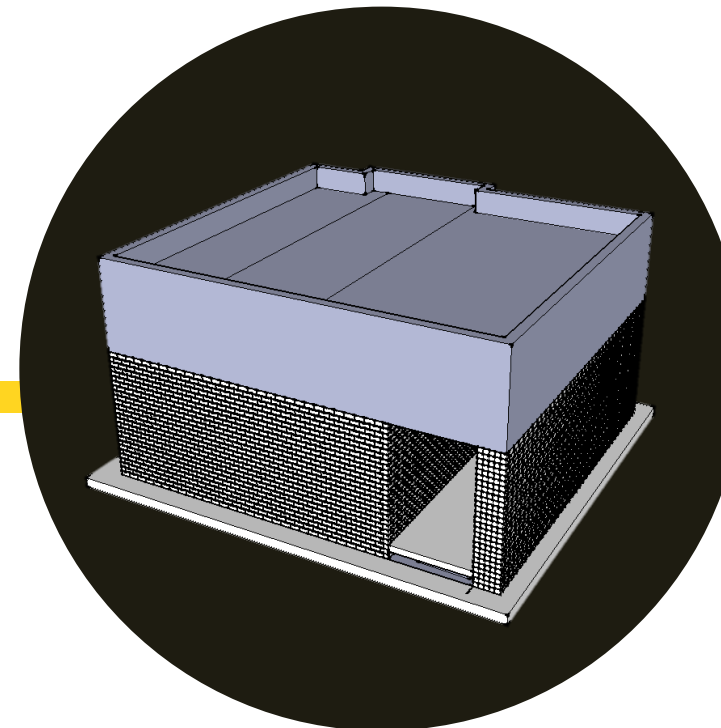
- PROJECT BACKGROUND
- ANALYSIS I: PREASSEMBLED PANELS
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- STRUCTURAL BREADTH
- ANALYSIS III: MASONRY LINAC VAULT
- ANALYSIS IV: VIRTUAL MOCKUPS
- CONCLUSIONS & RECOMMENDATIONS
- CLOSING REMARKS



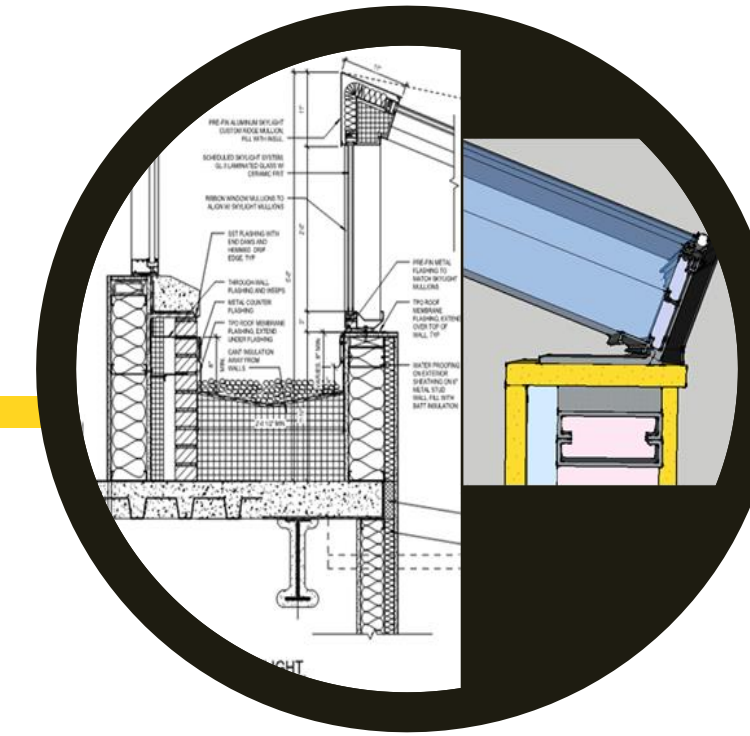
Analysis I | Prefabricated Panels



Analysis II | Precast Footings



Analysis III | HD Block LINAC Vault

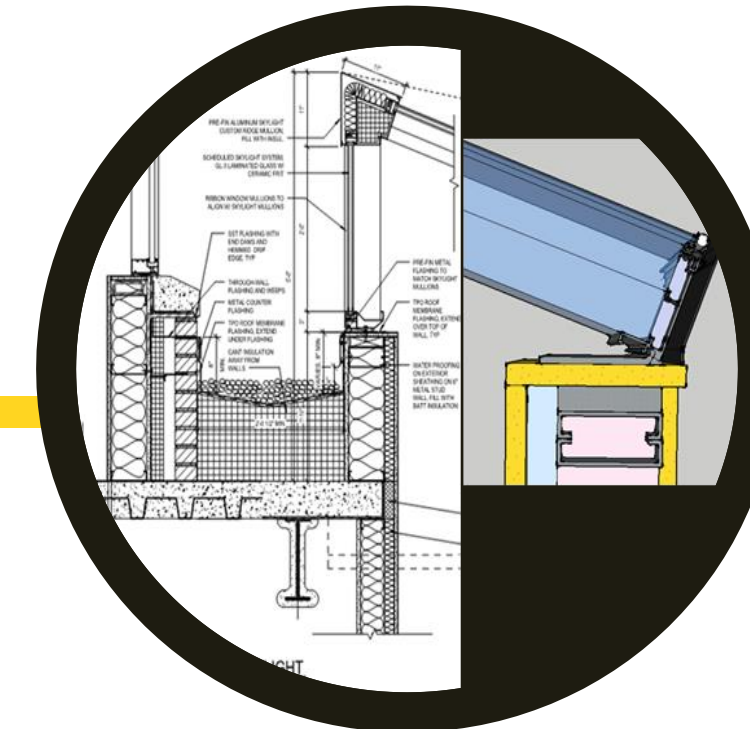
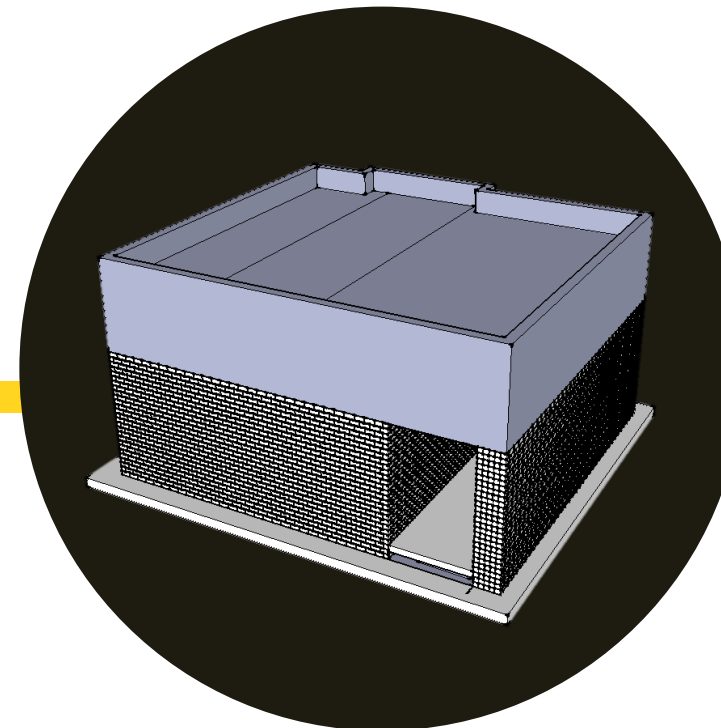


Analysis IV | Virtual Mockups

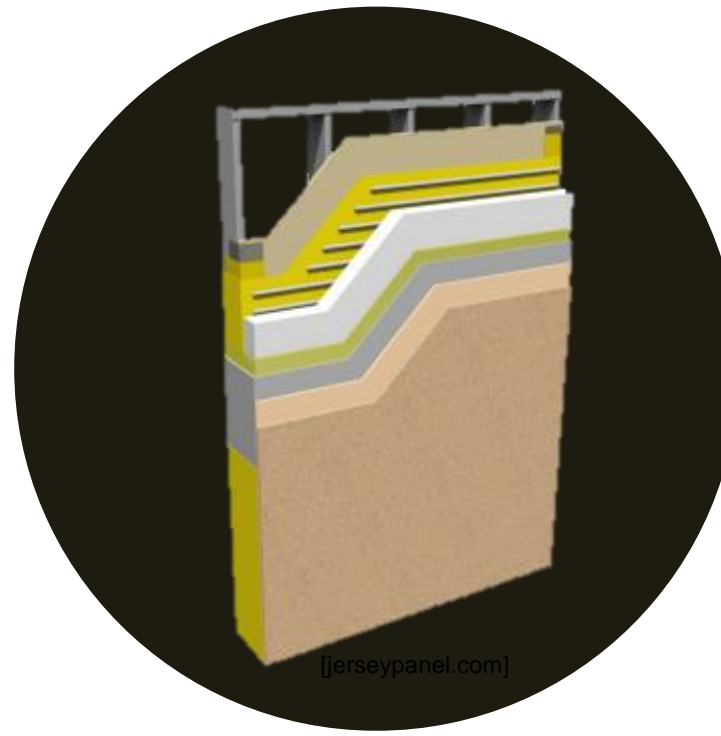
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Analysis I | Prefabricated Panels



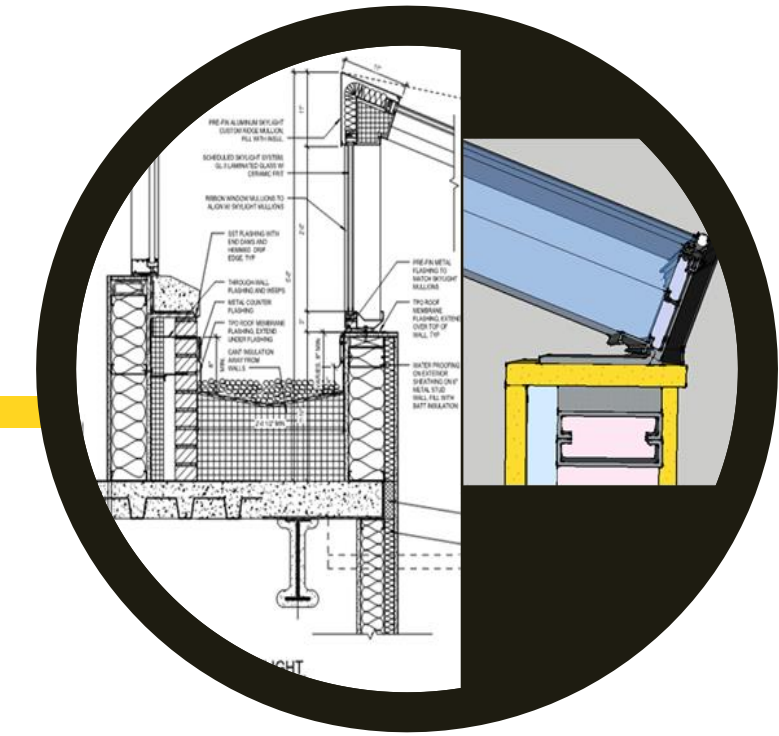
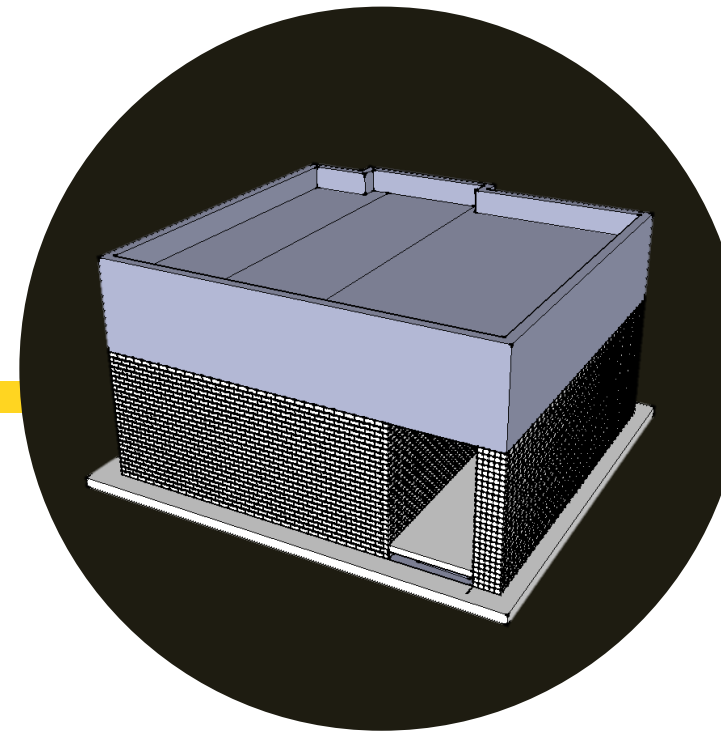
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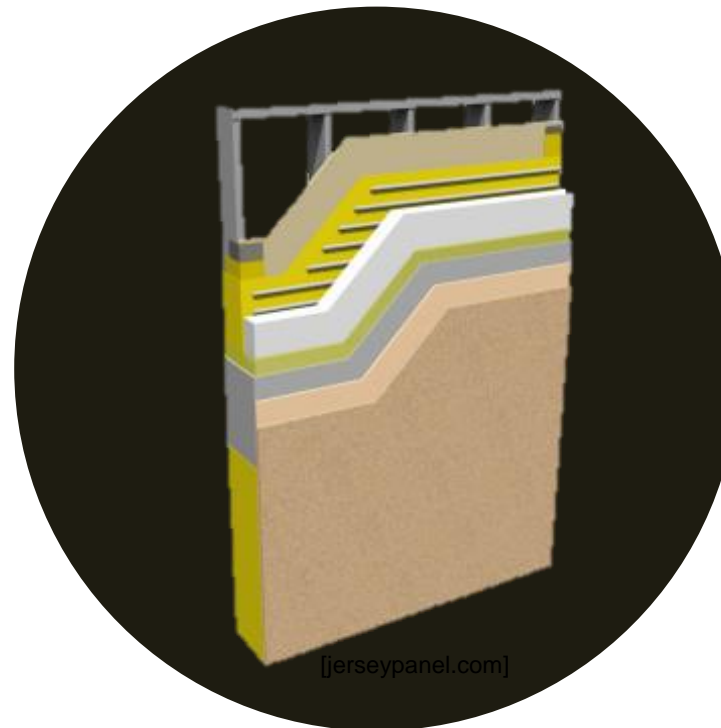
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Analysis II | Precast Footings



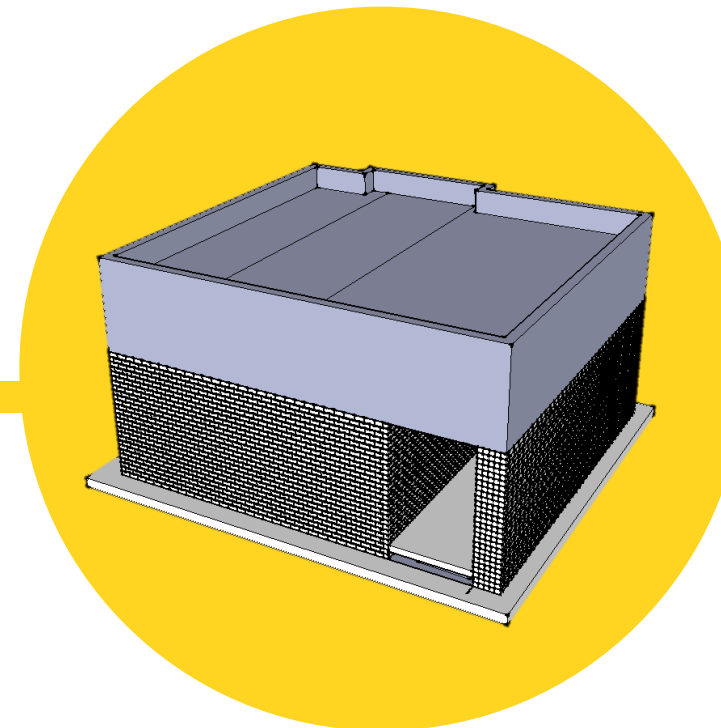
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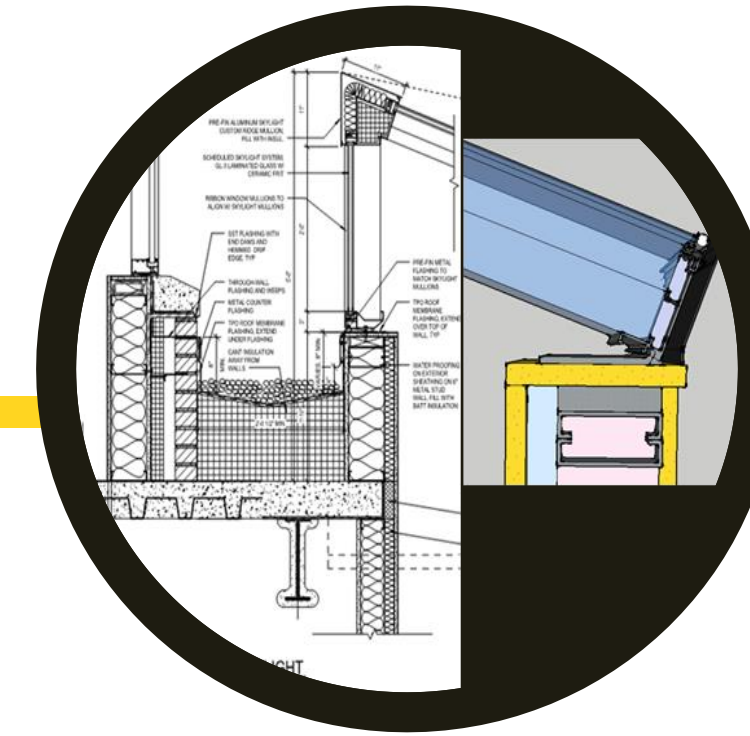
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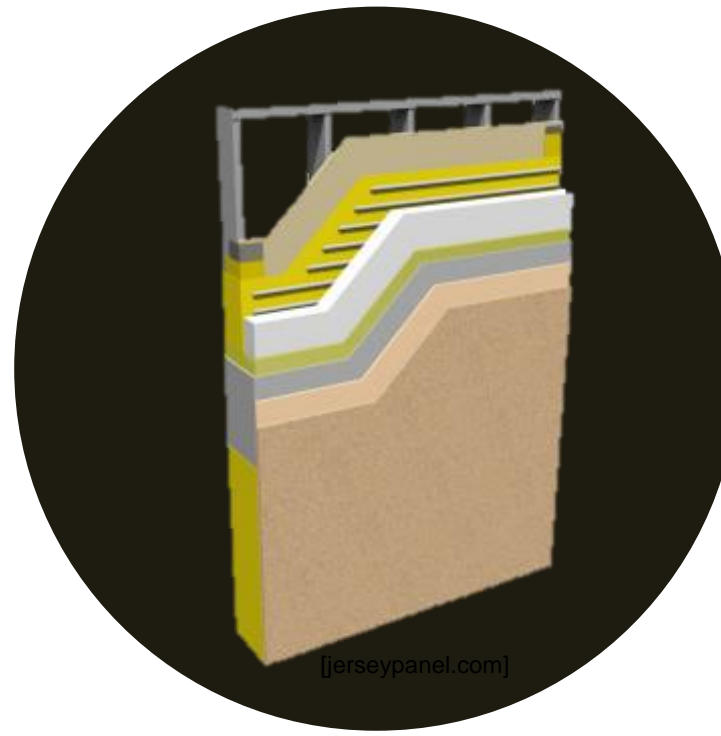
Analysis II | Precast Footings



Analysis III | HD Block LINAC Vault



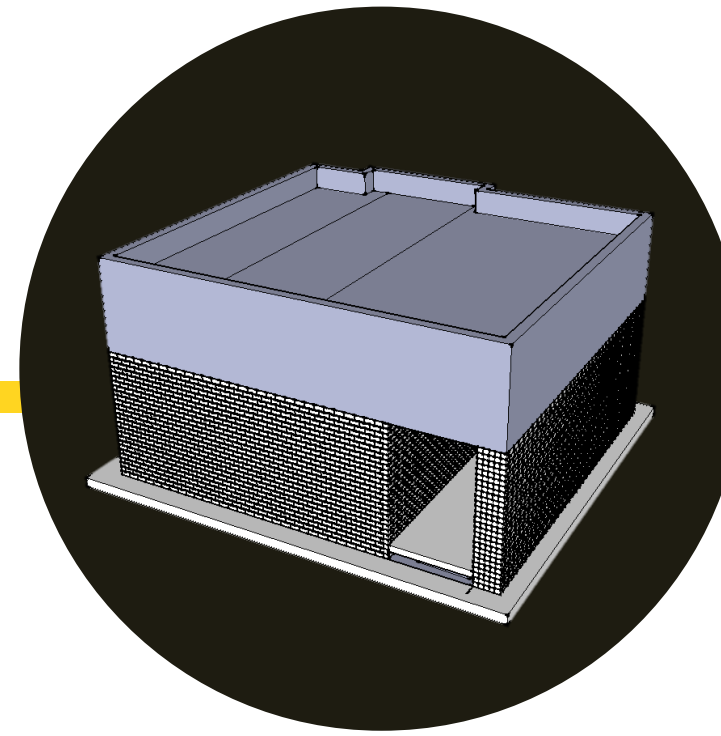
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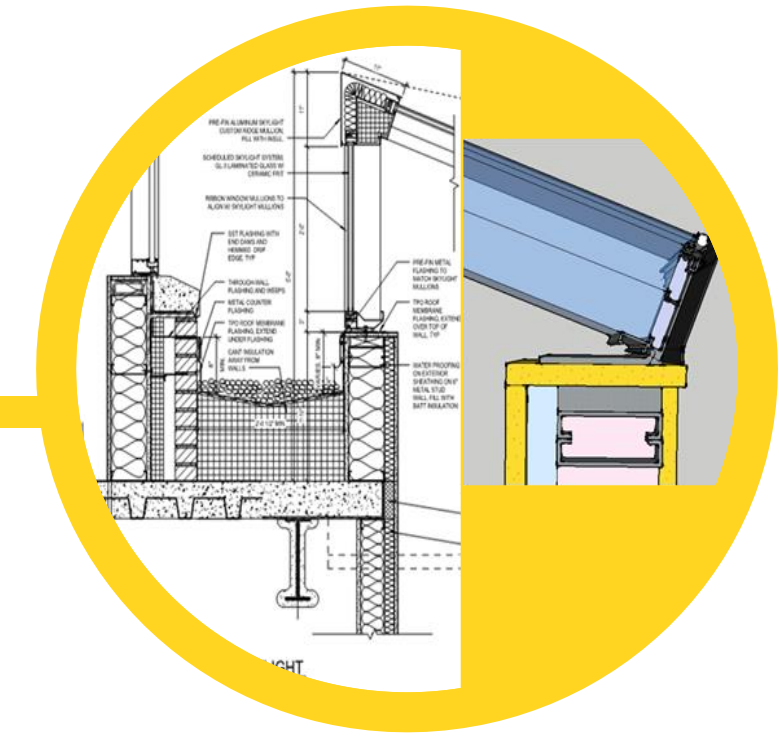
Analysis I | Prefabricated Panels



Analysis II | Precast Footings

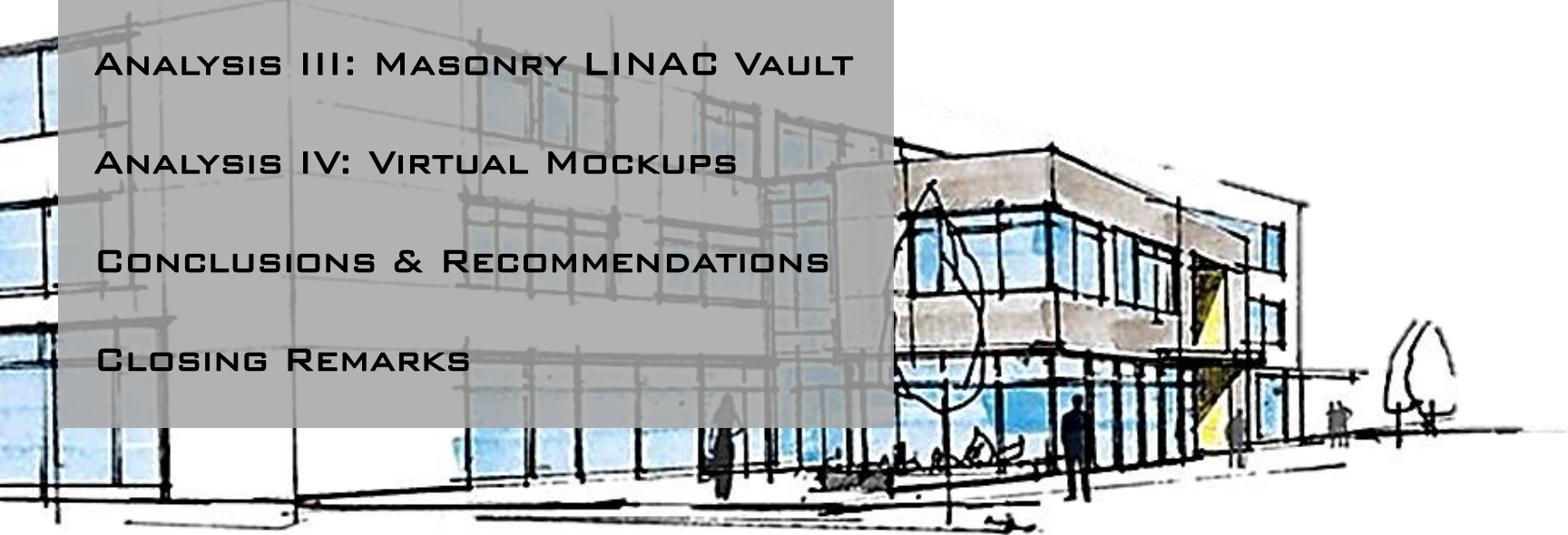


Analysis III | HD Block LINAC Vault



Analysis IV | Virtual Mockups

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Location | Mid-Atlantic Region

Cost | \$26.5 Million

Stories | 3 Floors

Construction Schedule | 17 Months

PROJECT BACKGROUND

ANALYSIS I: PREASSEMBLED PANELS

LIGHTING BREADTH

ANALYSIS II: PRECAST FOOTINGS

STRUCTURAL BREADTH

ANALYSIS III: MASONRY LINAC VAULT

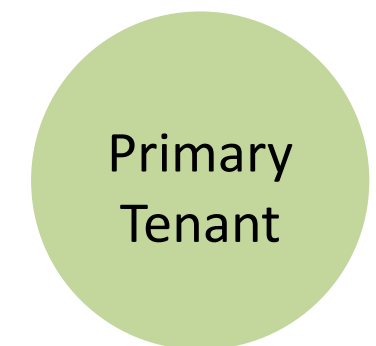
ANALYSIS IV: VIRTUAL MOCKUPS

CONCLUSIONS & RECOMMENDATIONS

CLOSING REMARKS



Core & Shell Package



Tenant Interiors Packages



PROJECT BACKGROUND

ANALYSIS I: PREASSEMBLED PANELS
LIGHTING BREADTH

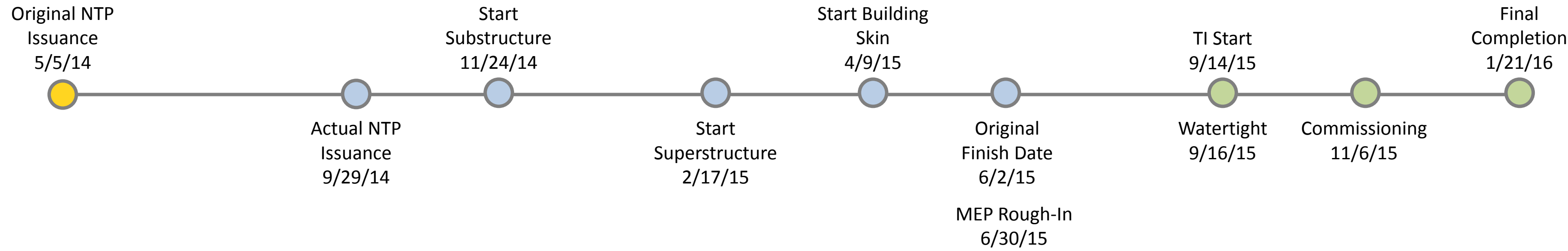
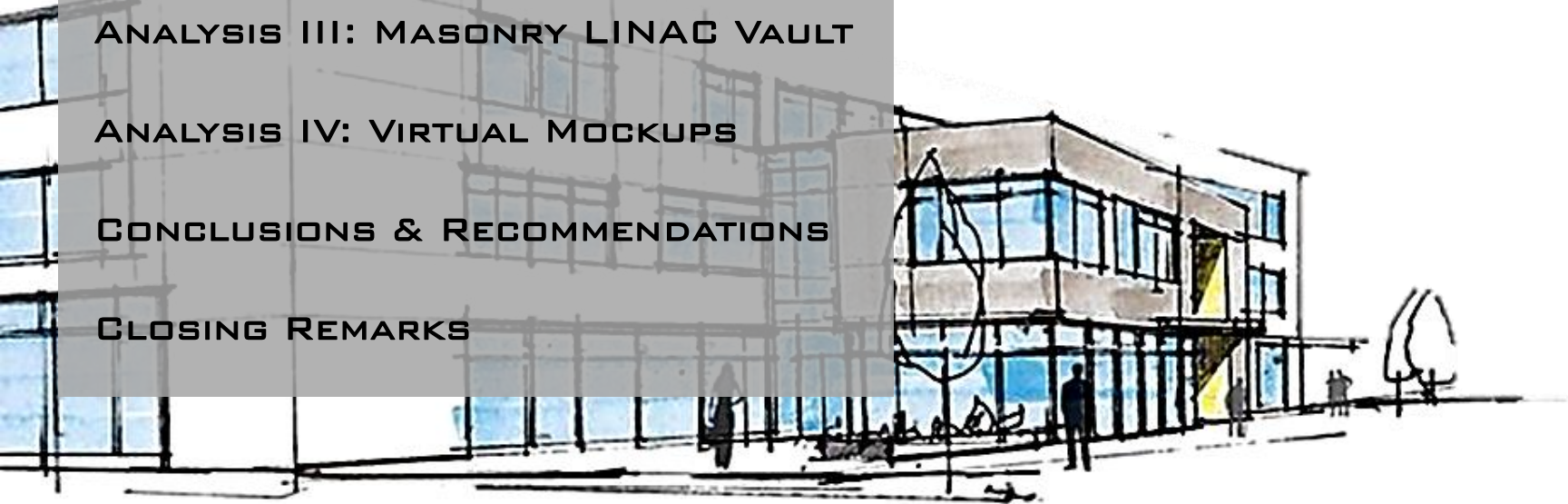
ANALYSIS II: PRECAST FOOTINGS
STRUCTURAL BREADTH

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CONCLUSIONS & RECOMMENDATIONS

CLOSING REMARKS



PROJECT BACKGROUND

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LIGHTING BREADTH

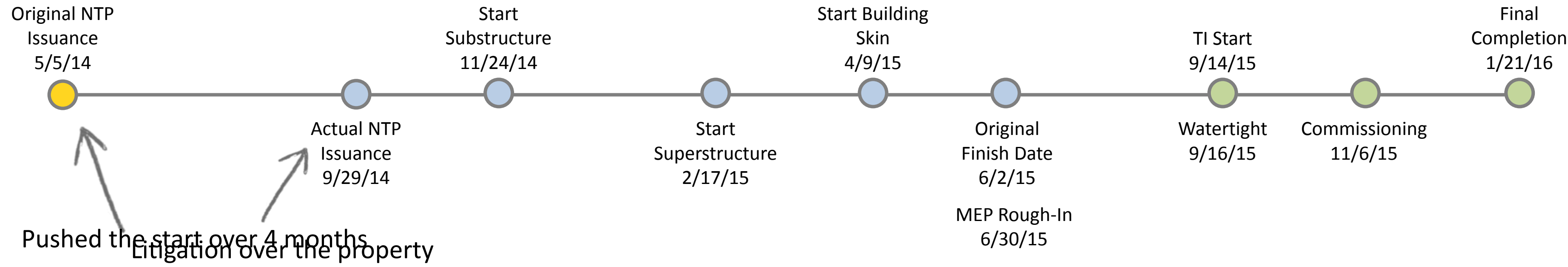
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CONCLUSIONS & RECOMMENDATIONS

CLOSING REMARKS



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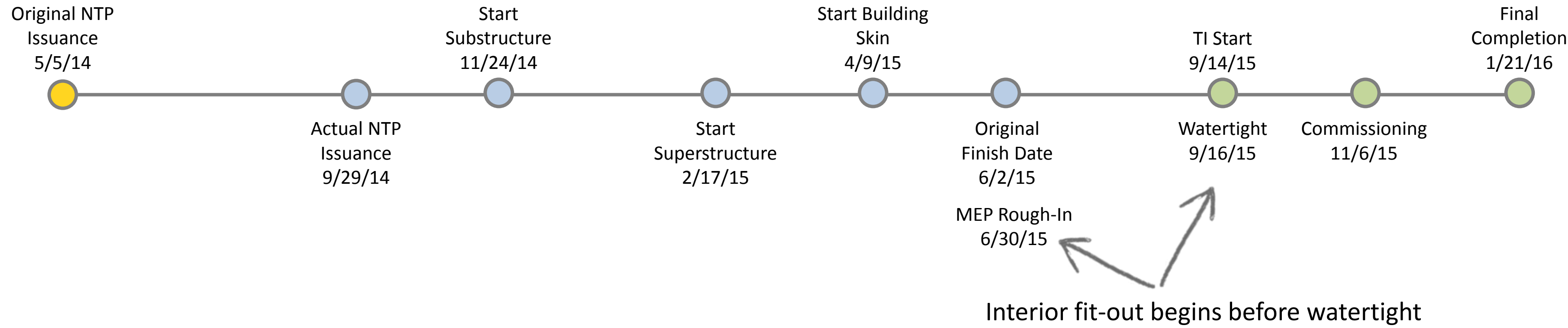
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CLOSING REMARKS



PROJECT BACKGROUND

ANALYSIS I: PREASSEMBLED PANELS
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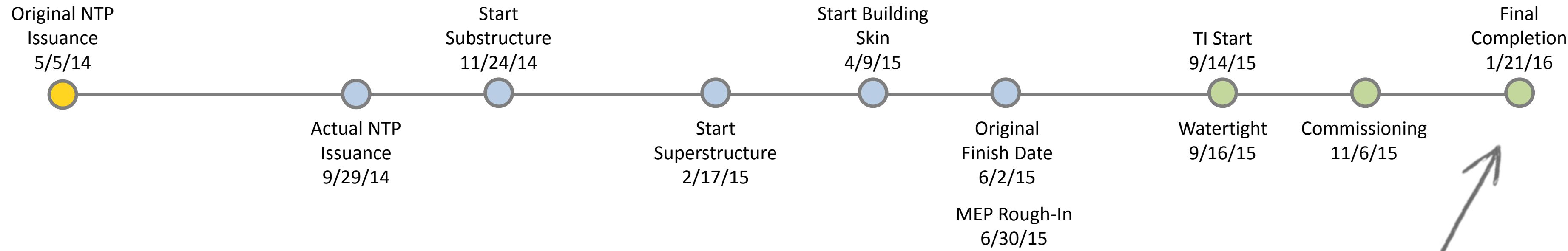
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CONCLUSIONS & RECOMMENDATIONS

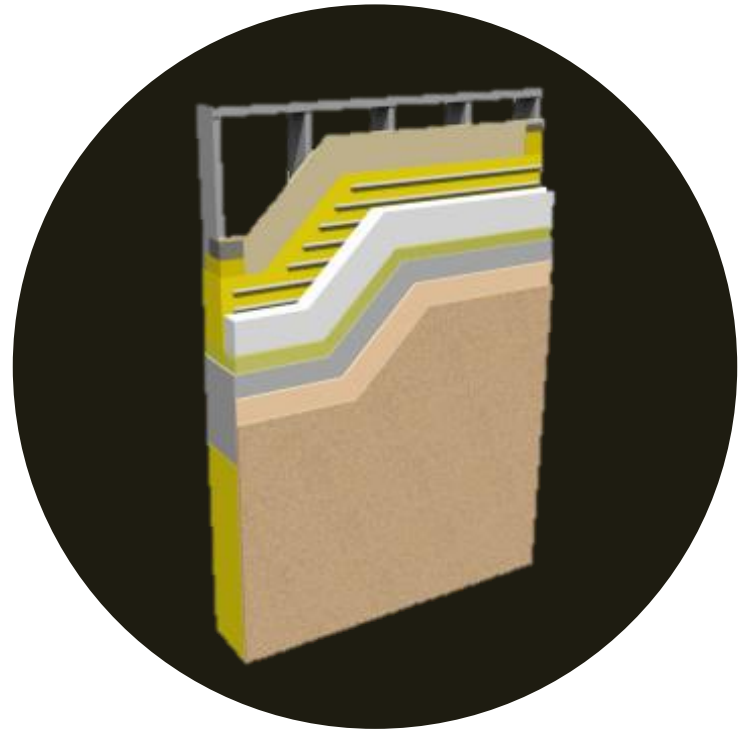
CLOSING REMARKS



7 month delay to Final Completion date

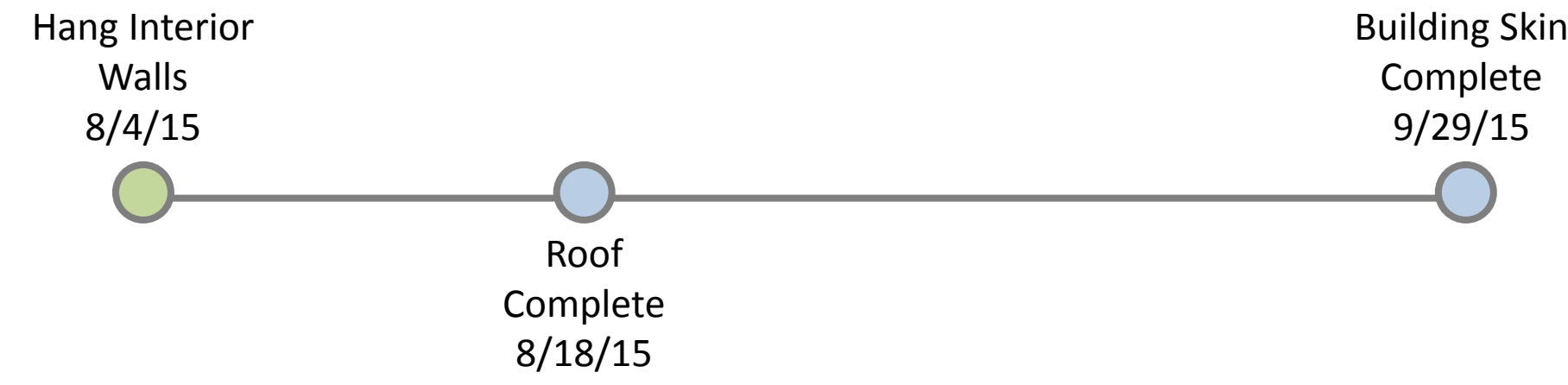


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Analysis I | Prefabricated Panels

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Percentage of Building Skin | 30% Temporary

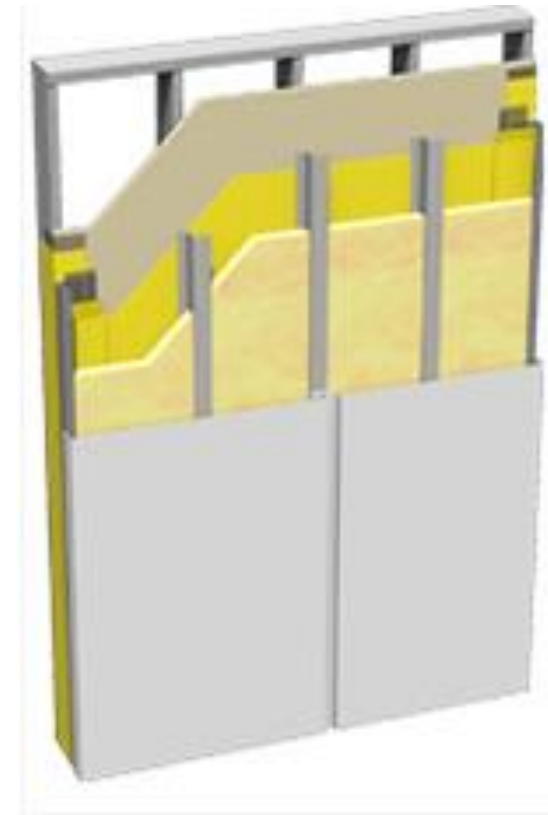
Cost | \$12,000 for Skin, \$6,000 for Skylight/Roof

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Prefabricated Wall Panel System

Purpose | Watertight before TI



Combines

Exterior Metal Framing

Insulation

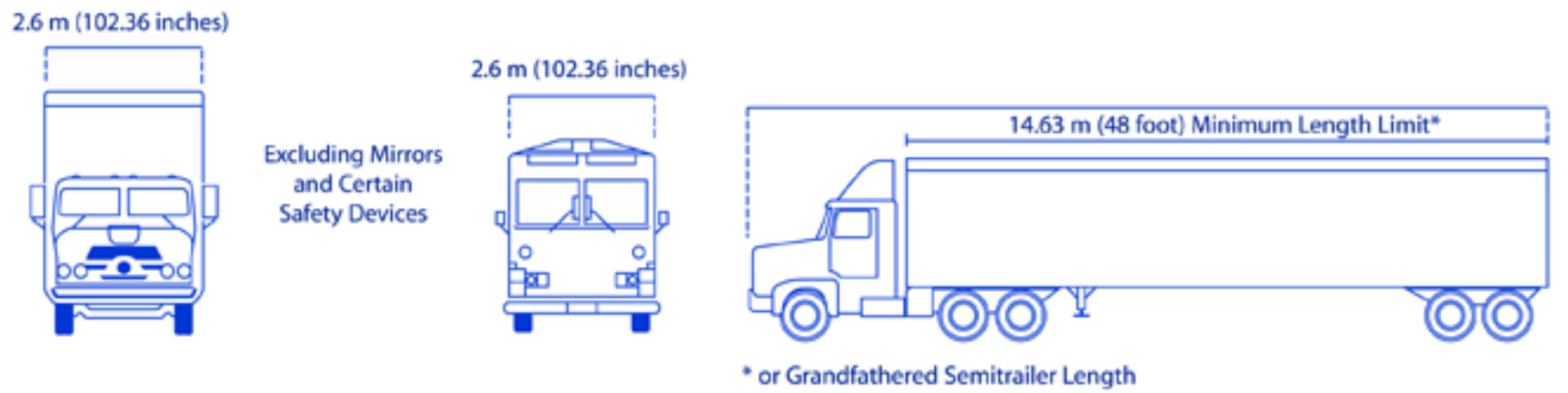
Sheathing

| Remaining façade elements installed onsite

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Road Constraints

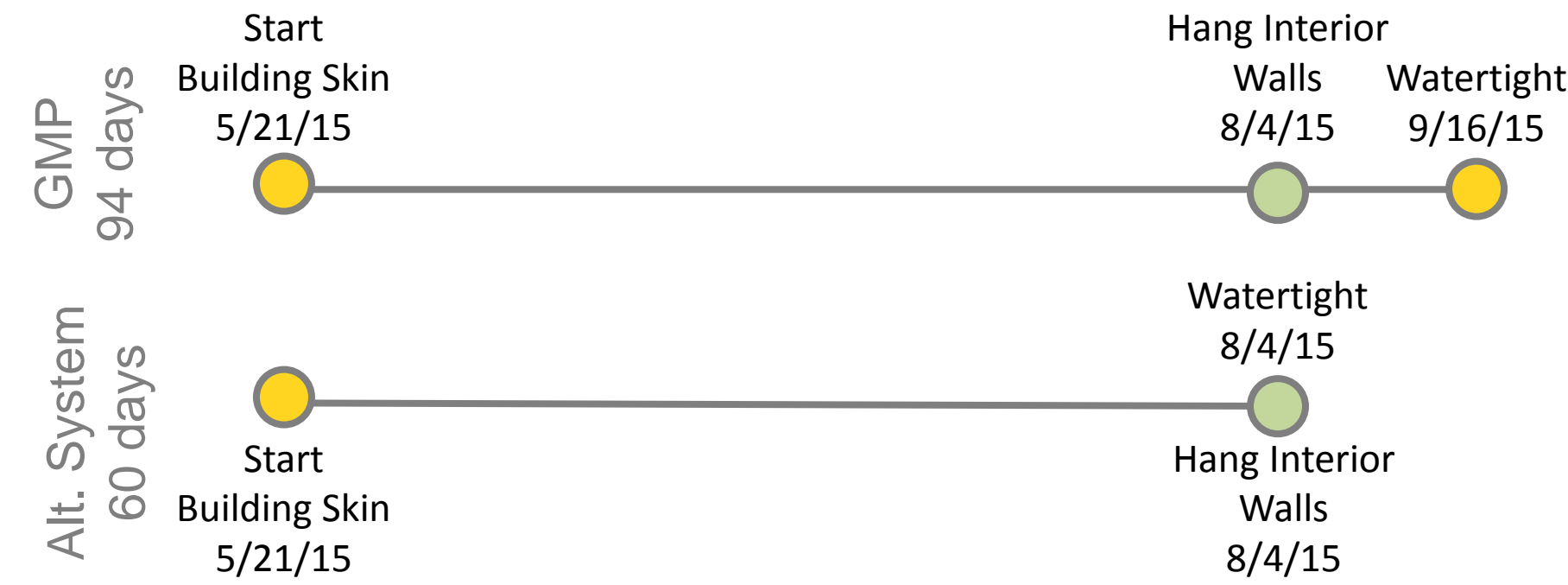


Maximum Panel Size |
 Width | 15' | largest 11'-9"
 Length | 53' | largest 46'-4"

Sequencing



- | 120 Panels Total
- | 5 Panels per day
- | 7 days W & E sides | 3 days N & S



Cost Variation

- PROJECT BACKGROUND
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Square Foot Cost Comparison

	Traditional Install	Preassembled Install
Metal Framing, Sheathing, & Insulation	\$7.18/SF	\$17.39/SF
Air Barrier	\$2.72/SF	\$2.72/SF
Total SF Cost	\$9.90/SF	\$20.11/SF

23%

| Increase to the Exterior Skin Package

3.8%

| Increase to the Core & Shell Package

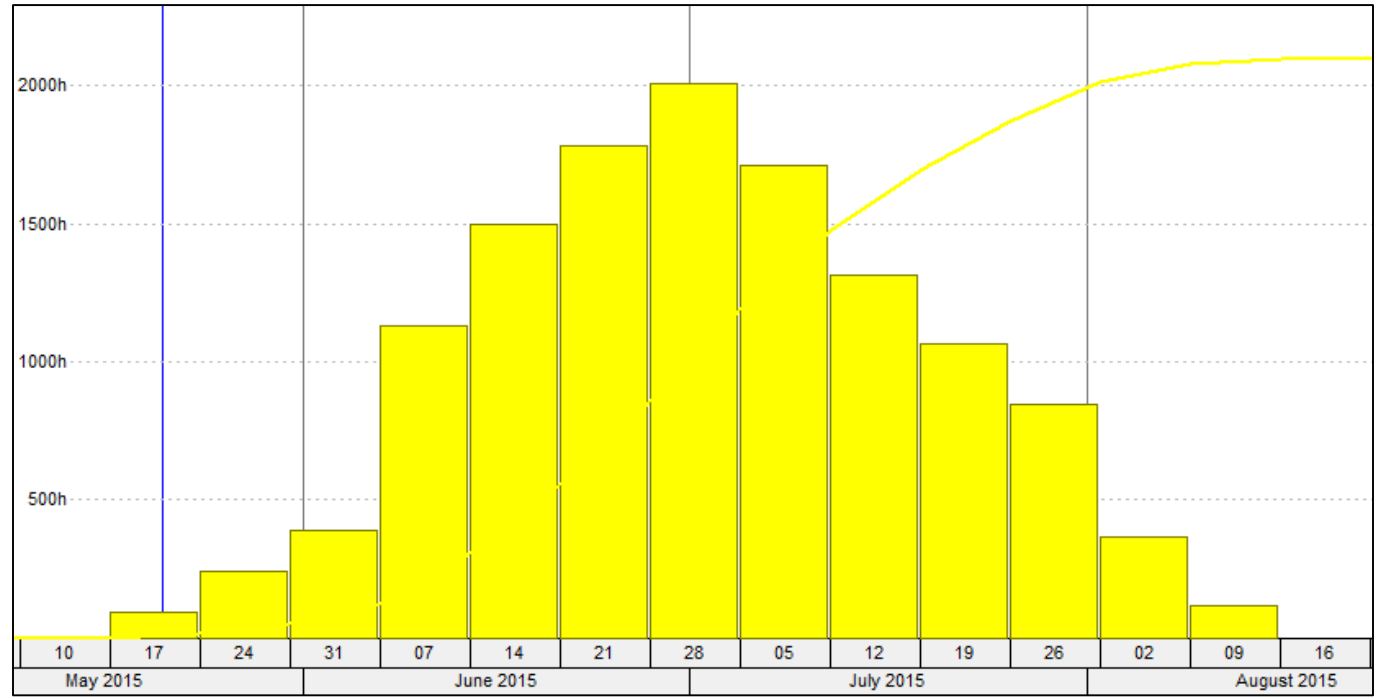
Crane Cost \$50,000 additional |

Total Cost \$700,000 additional |

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Manpower Shift



23%

| Increase to the Exterior Skin Package

3.8%

| Increase to the Core & Shell Package

| Decrease in Labor Cost

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Final Results

- | Accelerates Schedule
- | Removes risk of Temporary Enclosure
- | Shifts Manpower | Reduces Labor
- | Improved Quality & Reduce Waste
- | Added 3.8% to Core & Shell Package

 Recommended

- PROJECT BACKGROUND
- ANALYSIS I: PREASSEMBLED PANELS
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West Façade

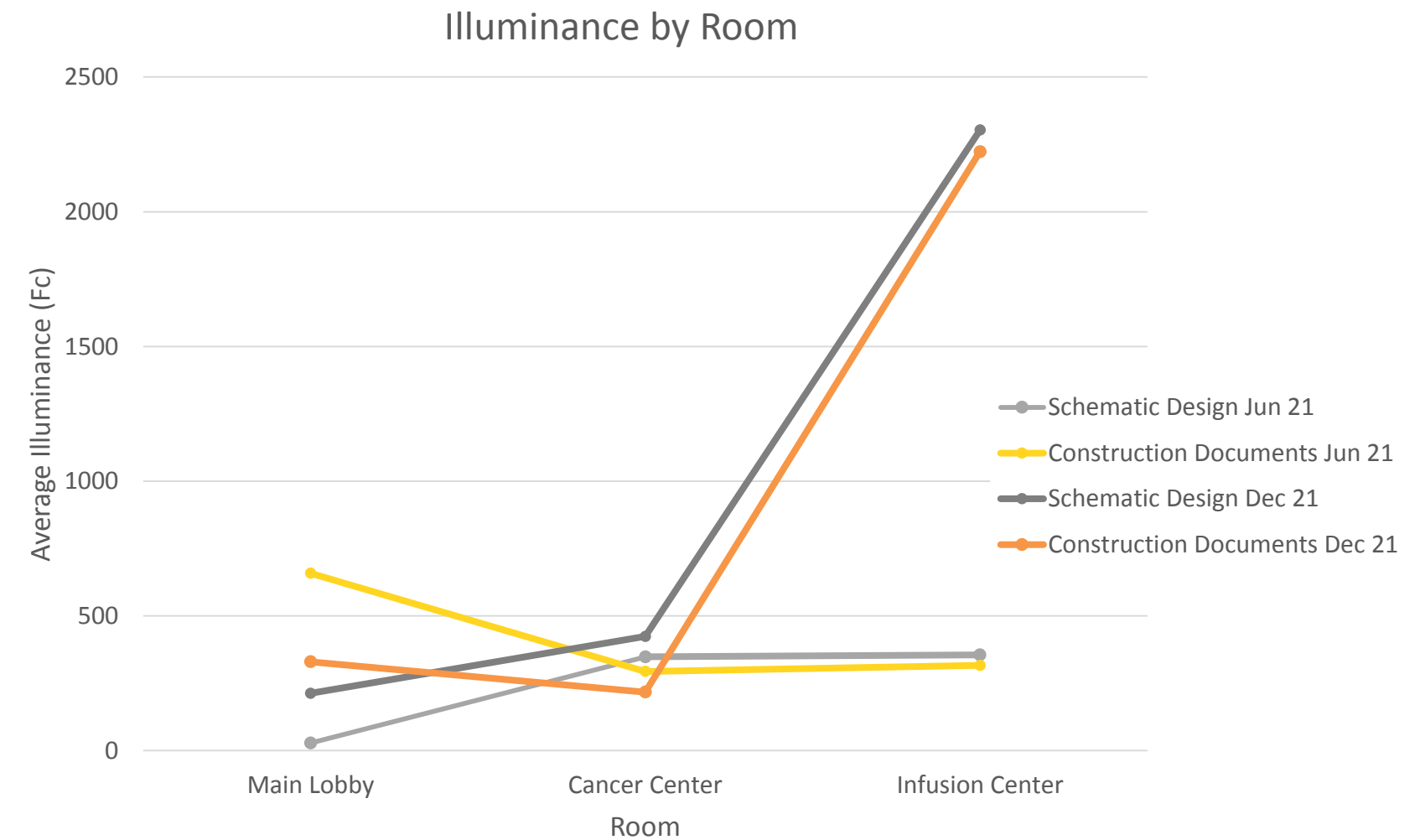


East Façade



| Schematic Design (above), Construction Documents Façade (below)

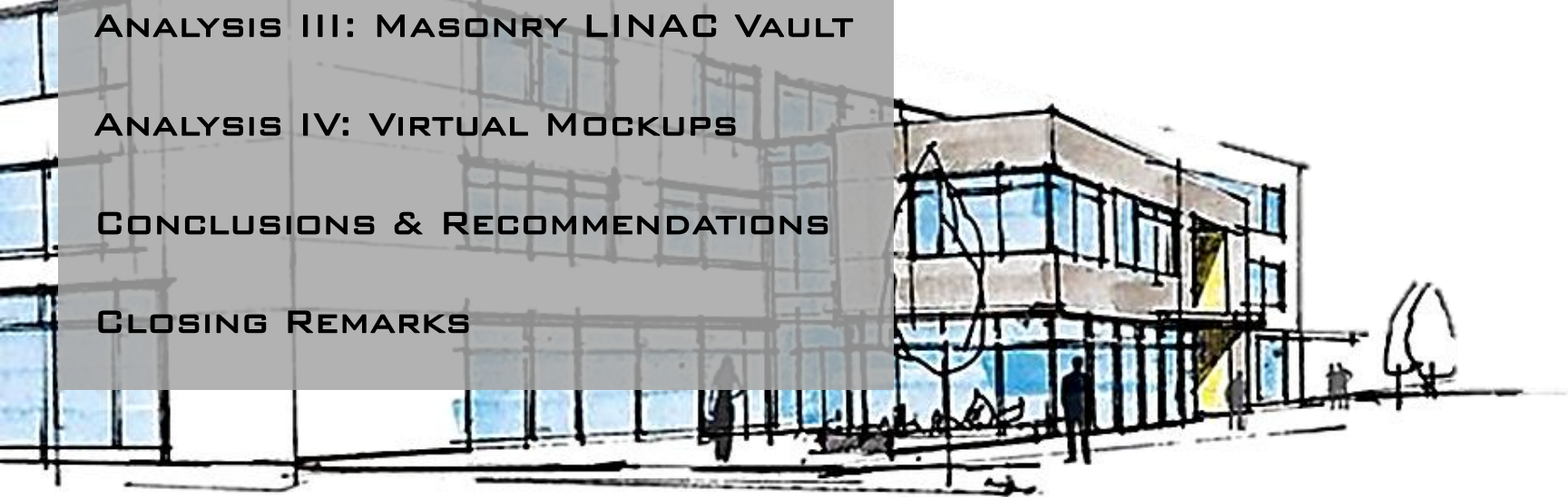
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Final Results

- | Project saved 0.7% of the Core & Shell Package
- | Project saved 4.5% of the Skin Package
- | Redesign provided typically less light, but still sufficient for daylighting

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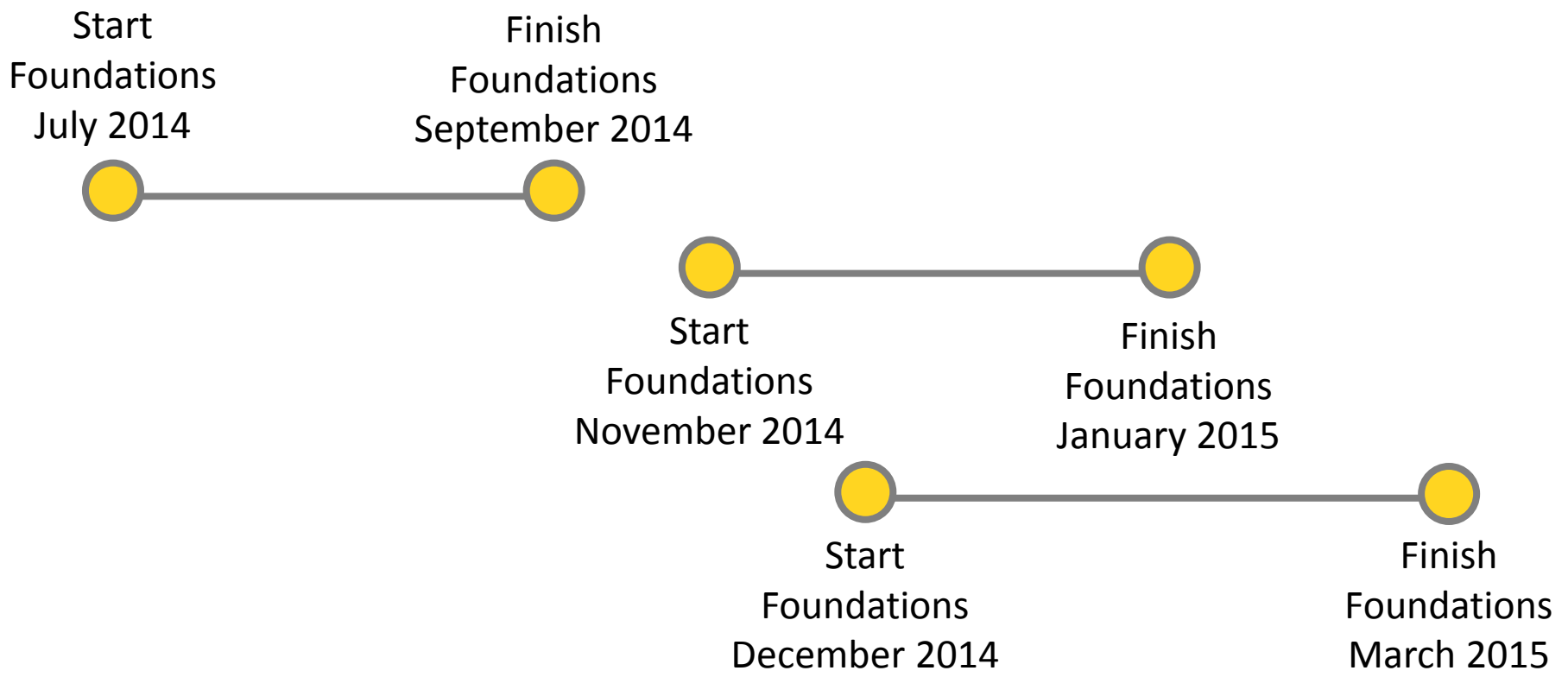


Analysis II | Precast Footings

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Foundation Schedule



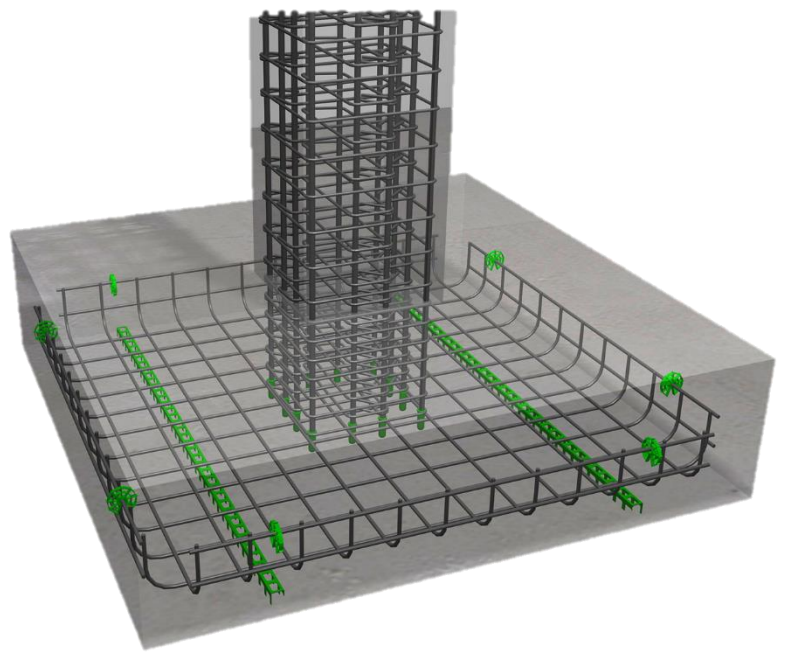
| Original GMP | 39 days
 | Revised GMP | 39 days
 | Actual Duration | 54 days

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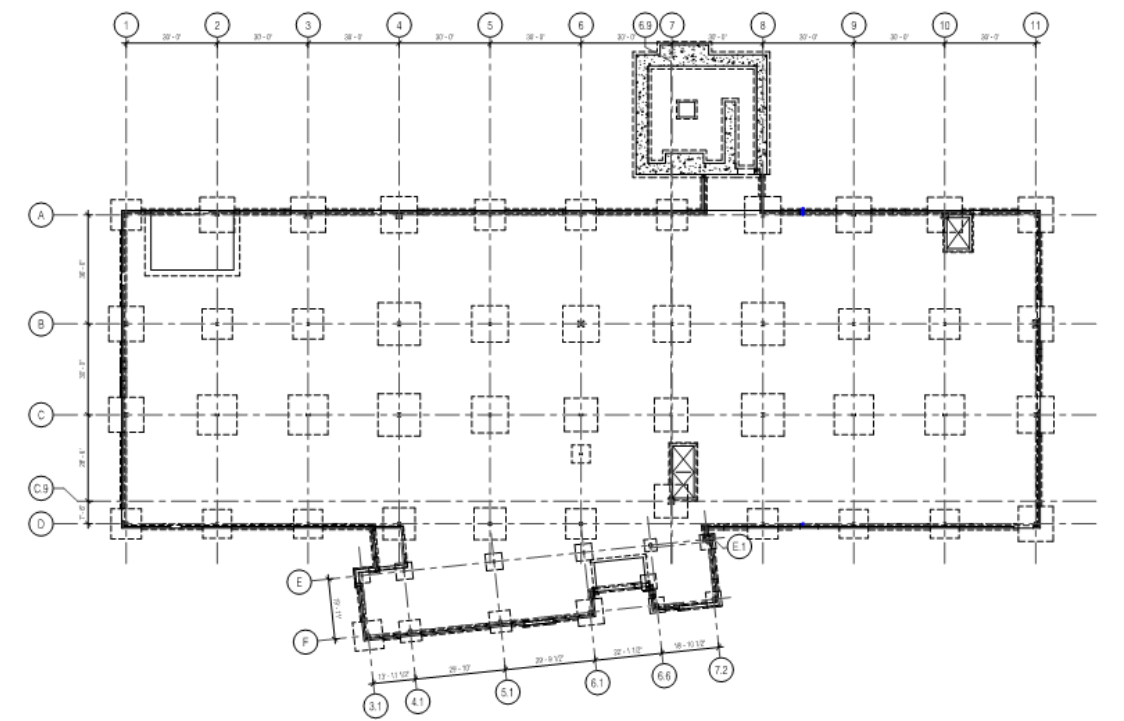
Precast Footings

Purpose | Accelerate Foundation Schedule



Current Foundation System

- | Square Spread Footings with Foundation Wall
- | Borings showed no substantial rock
- | Soil Remediation to bring bearing up to 2 ksi



Miller, Long & Arnold Yard | 4701 Washington Blvd, Halethorpe, MD 21227

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Road Constraints

- | All footings over 11'-0" had to be redesigned
- | Footings over that size were heavy
- | Deliveries over 80,000 lbs had to pay permit

Redesign Options

- | Make footings in three sections and assemble onsite
- | Increase soil bearing capacity



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Procedure

Calculate column load |
 Change bearing capacity until all footings |
 under 11'-0" in length & width |
 Redesign footings |

Summary of Redesigned Footings

	L x W	Depth	Bar #	Spacing
A/2	8'x8'	1.5'	#6	9.5"
A/4	8'x8'	1.5'	#6	9.5"
A/8	8'x8'	1.5'	#6	9.5"
A/11	6'x6'	1'	#5	6.5"
B/1	8'x8'	1.5'	#6	9.5"
B/4	10'x10'	2'	#7	12"
B/5	10'x10'	2'	#7	12"
C/1	7.5'x7.5'	1.25'	#6	9.5"
C/2	9.5'x9.5'	2'	#6	9.5"
C/4	9.5'x9.5'	2'	#6	9.5"
C/5	9.5'x9.5'	2'	#6	9.5"
C/11	7.5'x7.5'	1.25'	#6	9.5"

| Bearing capacity increased to 5 ksi
 | All remaining footing were reduced by the average 64%

PROJECT BACKGROUND

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STRUCTURAL BREADTH

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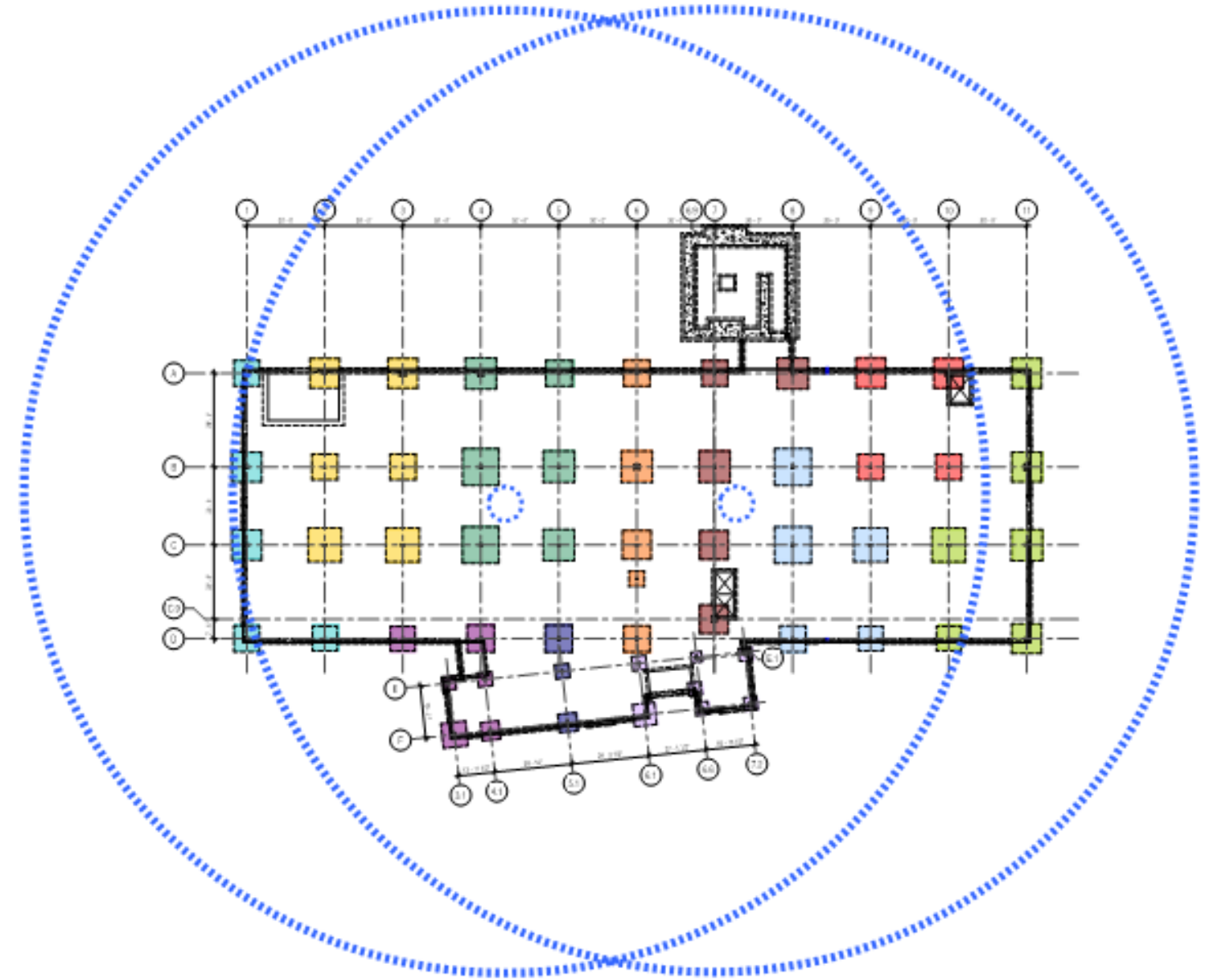
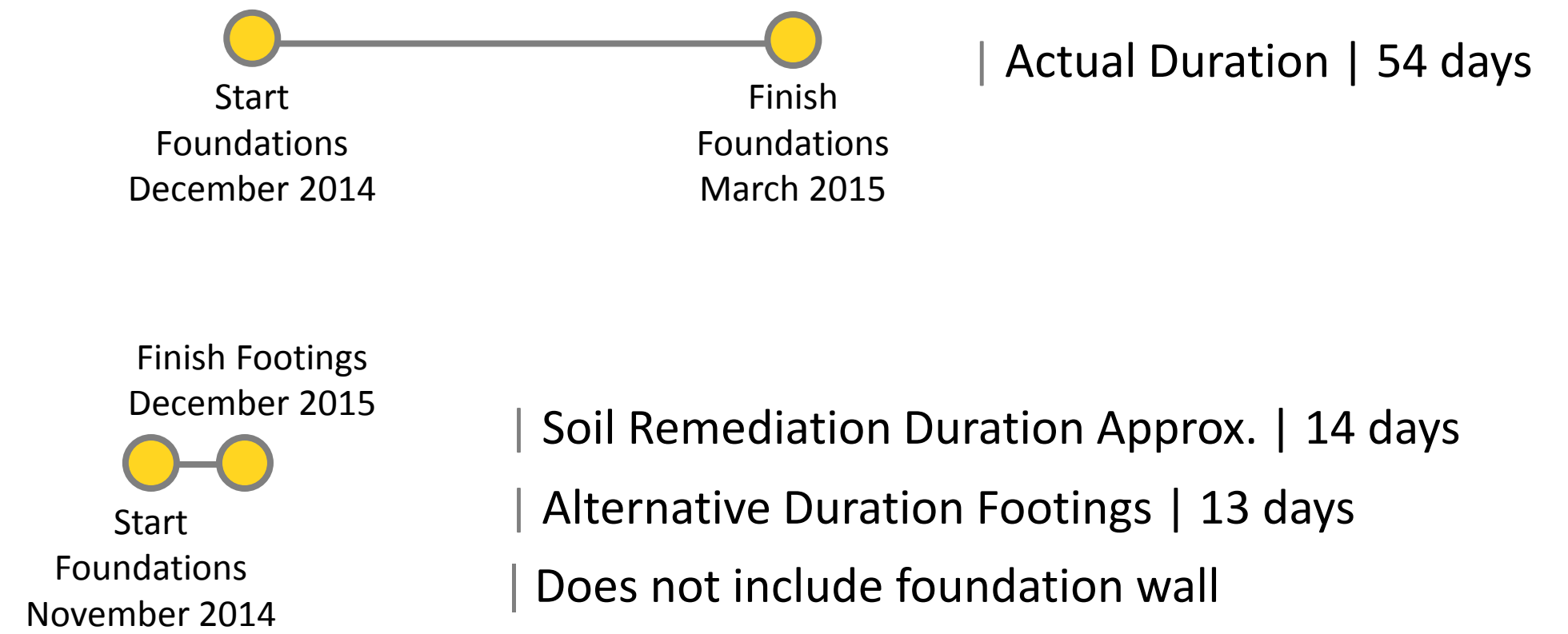
ANALYSIS IV: VIRTUAL MOCKUPS

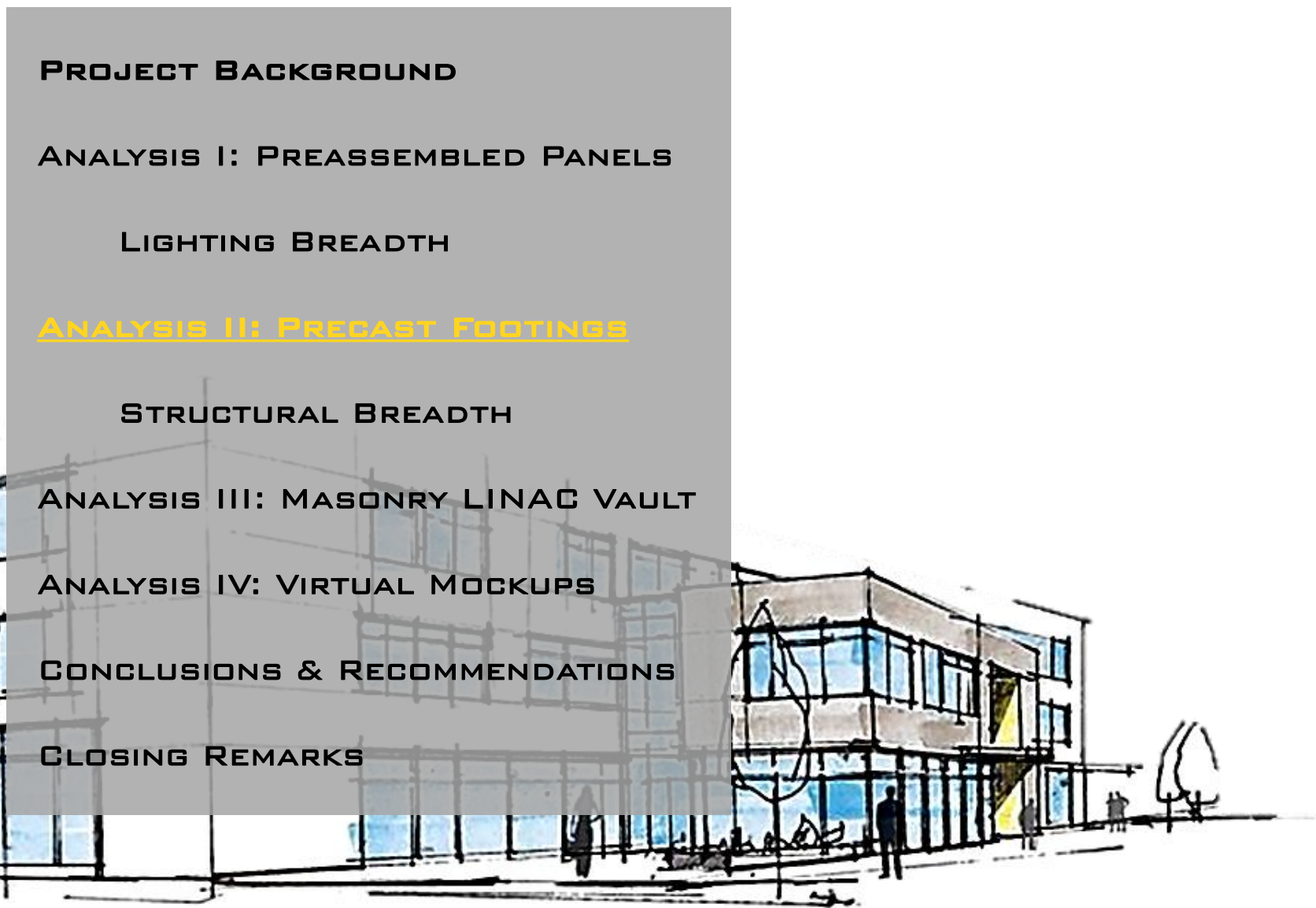
CONCLUSIONS & RECOMMENDATIONS

CLOSING REMARKS

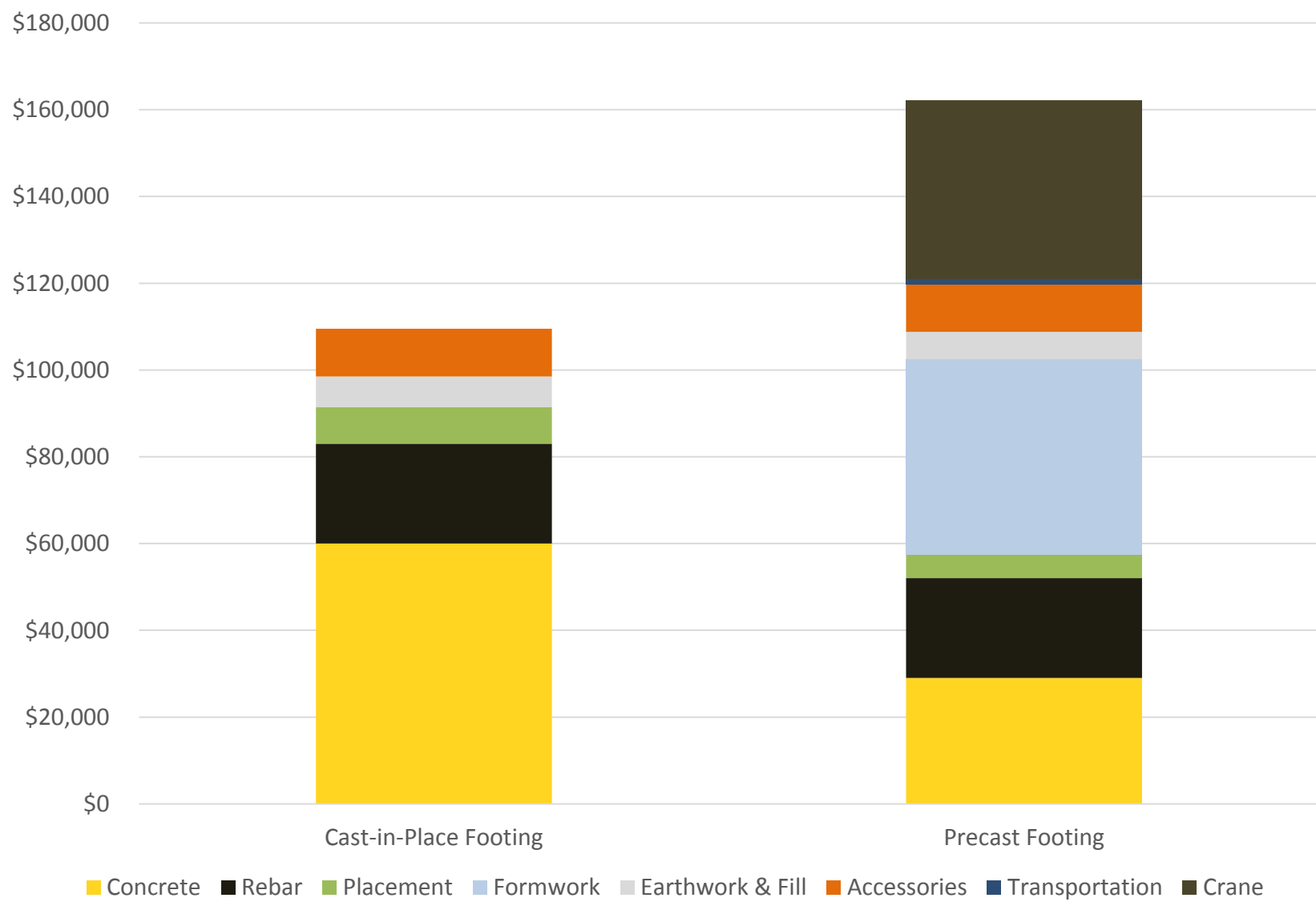


Schedule Summary





Comparison Based on Footing Type



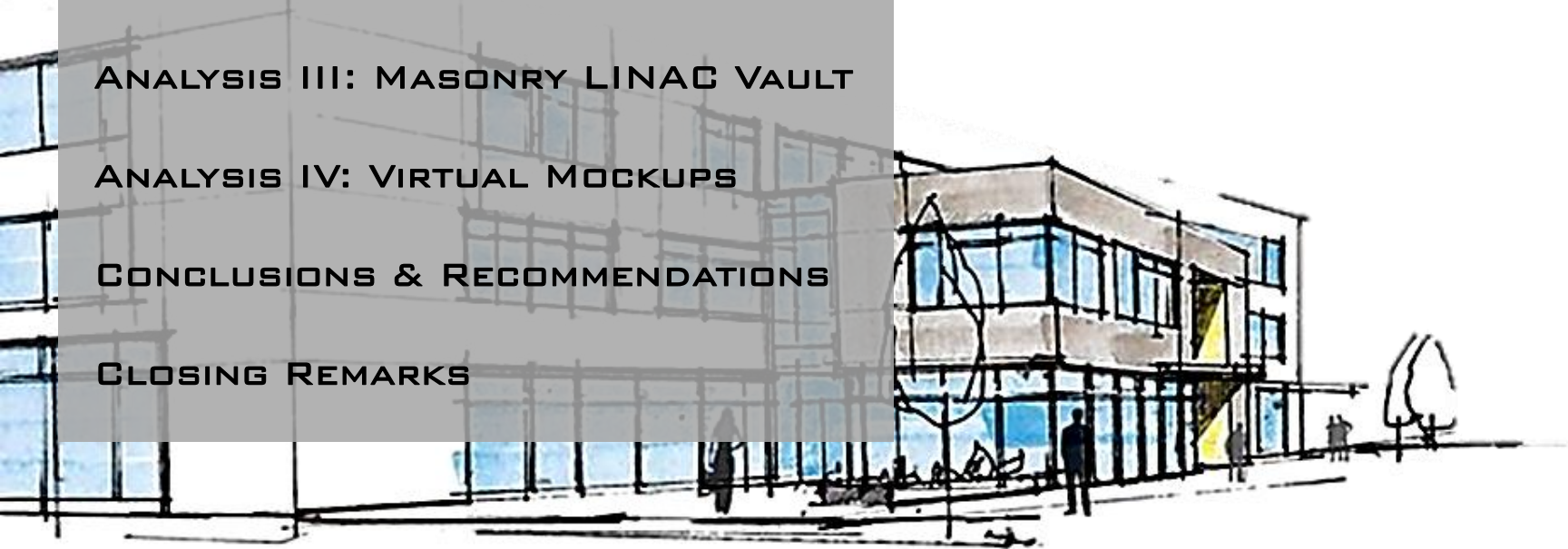
| Crane cost based on \$2,600 per day & \$10,000 for relocation

| Cost for soil remediation not included

0.3%

| Increase to the Core & Shell Package

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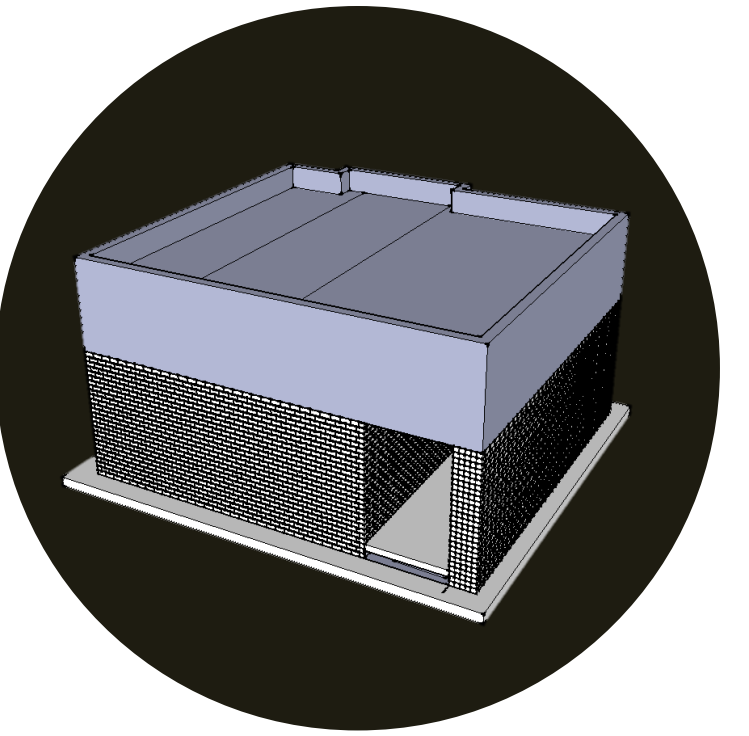
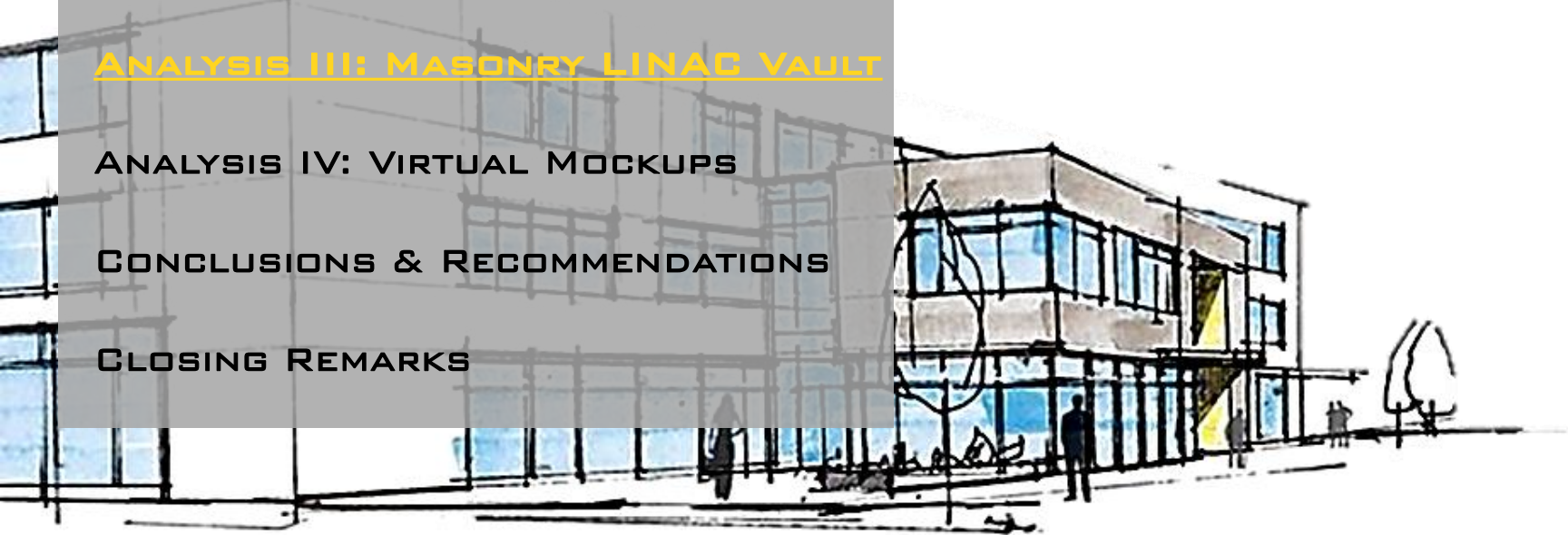


Final Results

- | Accelerates Schedule
- | Alternative System is less inhibited by bad weather
- | Shifts Manpower | Reduces Labor
- | Added 0.3% to Core & Shell Package

 **Not Recommended** | Does not align with Owner's goals

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Analysis III | HD Block LINAC Vault

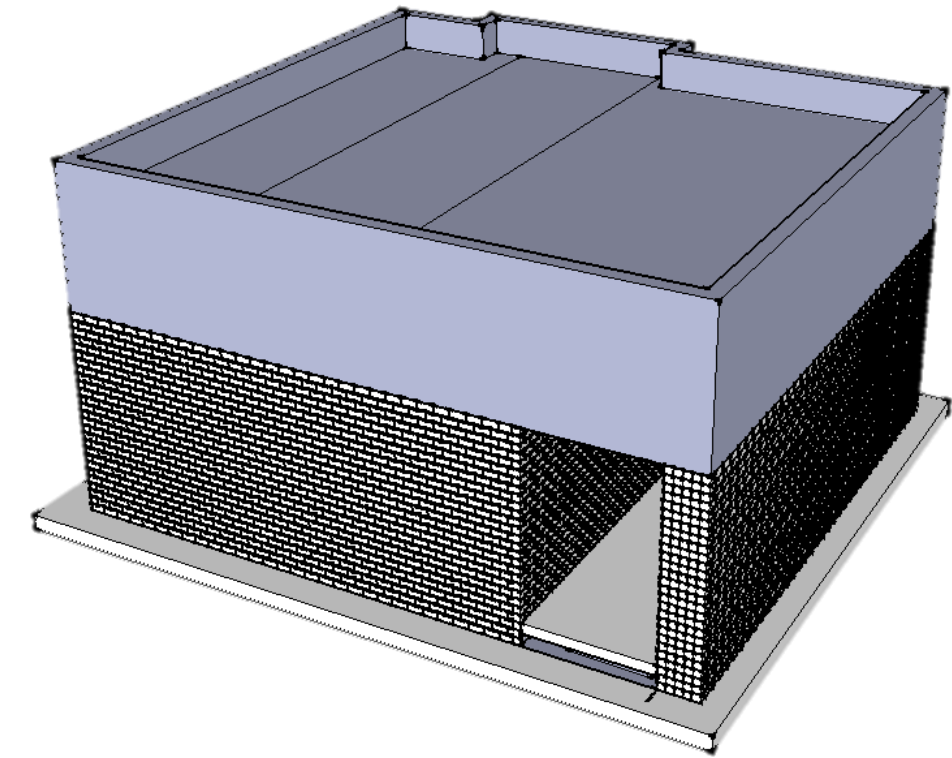
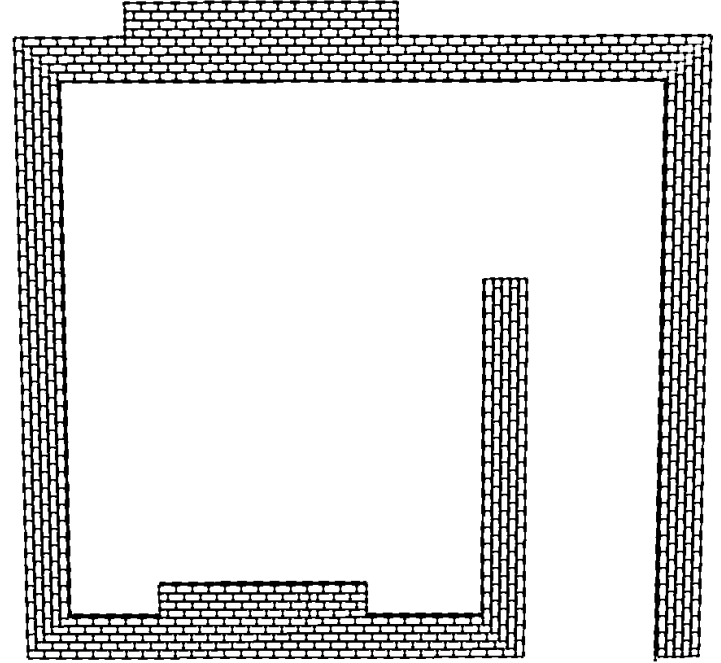
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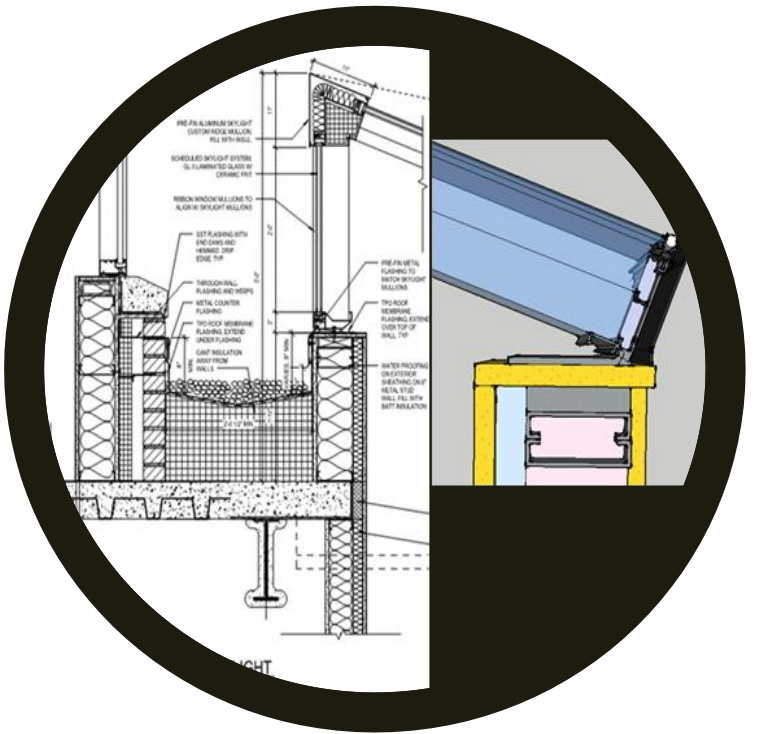
Final Results

- | Reduces wall thickness from 4' to 2'-6" and from 7' to 4'
- | Increased installation duration of 2 months
- | Added 2.4% to the Core & Shell Package

 Not Recommended



- PROJECT BACKGROUND
- ANALYSIS I: PREASSEMBLED PANELS
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- ANALYSIS III: MASONRY LINAC VAULT
- ANALYSIS IV: VIRTUAL MOCKUPS**
- CONCLUSIONS & RECOMMENDATIONS
- CLOSING REMARKS

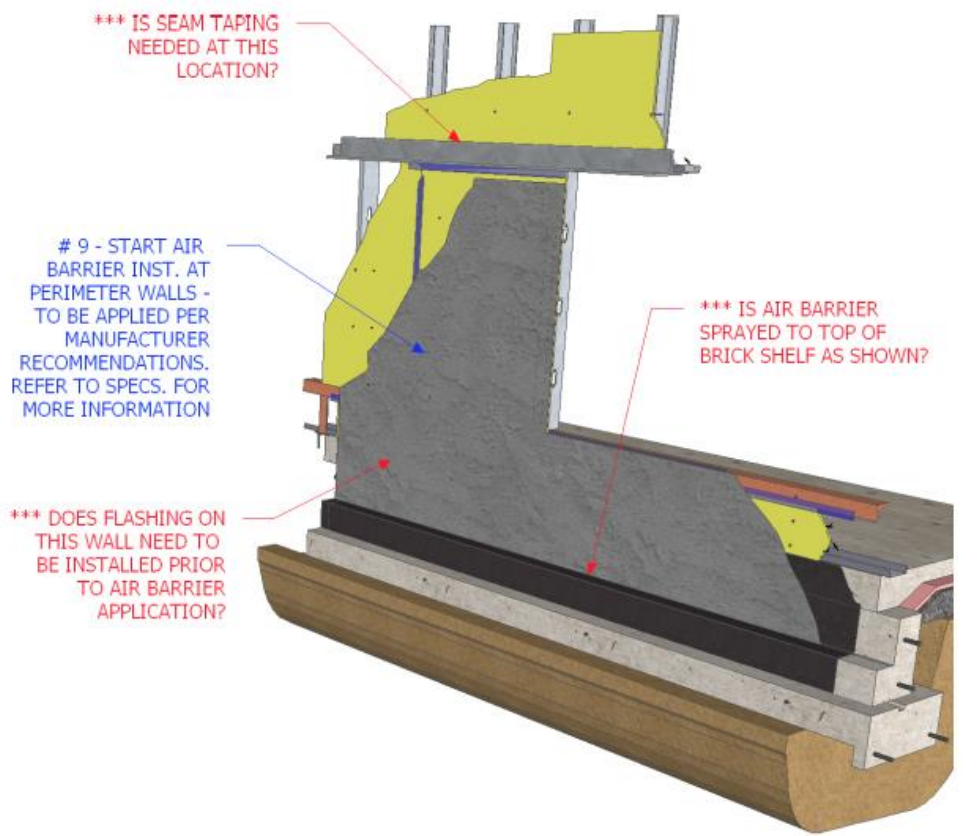


Analysis IV | Virtual Mockups

Virtual Mockup Technologies

Purpose | Evaluate the technologies on the market & when to implement

- PROJECT BACKGROUND
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PROJECT BACKGROUND

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ANALYSIS II: PRECAST FOOTINGS

STRUCTURAL BREADTH

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ANALYSIS IV: VIRTUAL MOCKUPS

CONCLUSIONS & RECOMMENDATIONS

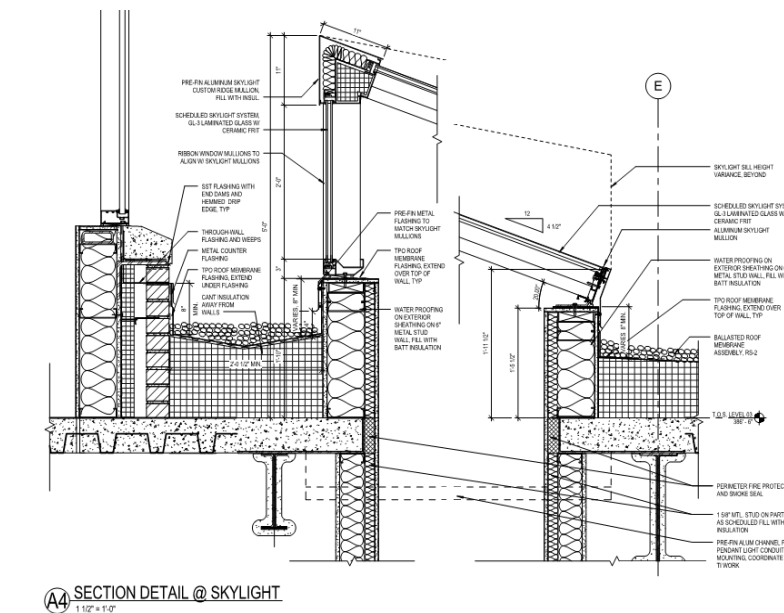
CLOSING REMARKS



Change Order Identification

Owner Driven	C & S	008, 009, 010
	TI	002, 003, 004, 005, 006, 007
Constructability	C & S	006, 007, 008, 009, 010
	TI	003, 006
Delayed NTP	C & S	001, 002, 003, 004
	TI	001

Specific Areas of Interest



| Skylight Detail

Exterior Wall Assembly |



PROJECT BACKGROUND

ANALYSIS I: PREASSEMBLED PANELS

LIGHTING BREADTH

ANALYSIS II: PRECAST FOOTINGS

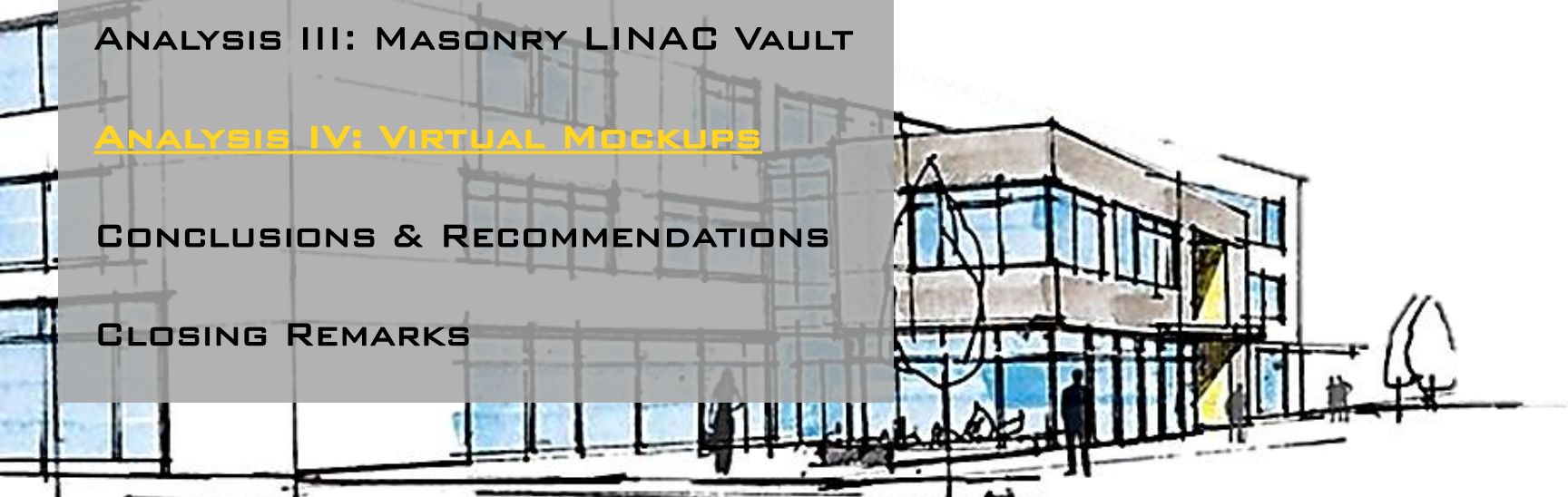
STRUCTURAL BREADTH

ANALYSIS III: MASONRY LINAC VAULT

ANALYSIS IV: VIRTUAL MOCKUPS

CONCLUSIONS & RECOMMENDATIONS

CLOSING REMARKS



Industry Interviews



James G. Davis Construction | Julien Bartolo & Christopher Scanlon



DPR Construction | Tim Conroy



Barton Malow | Bill Gamble



Mortenson | Lucas Manos

Interview Summary

| Sketchup is the preferred modeling software

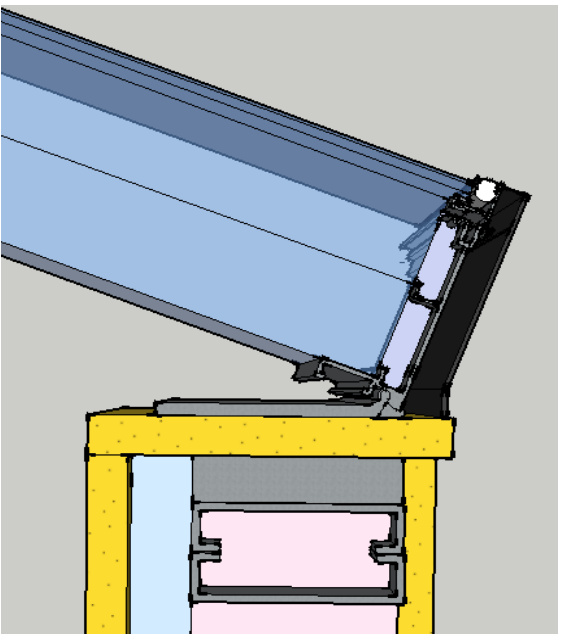
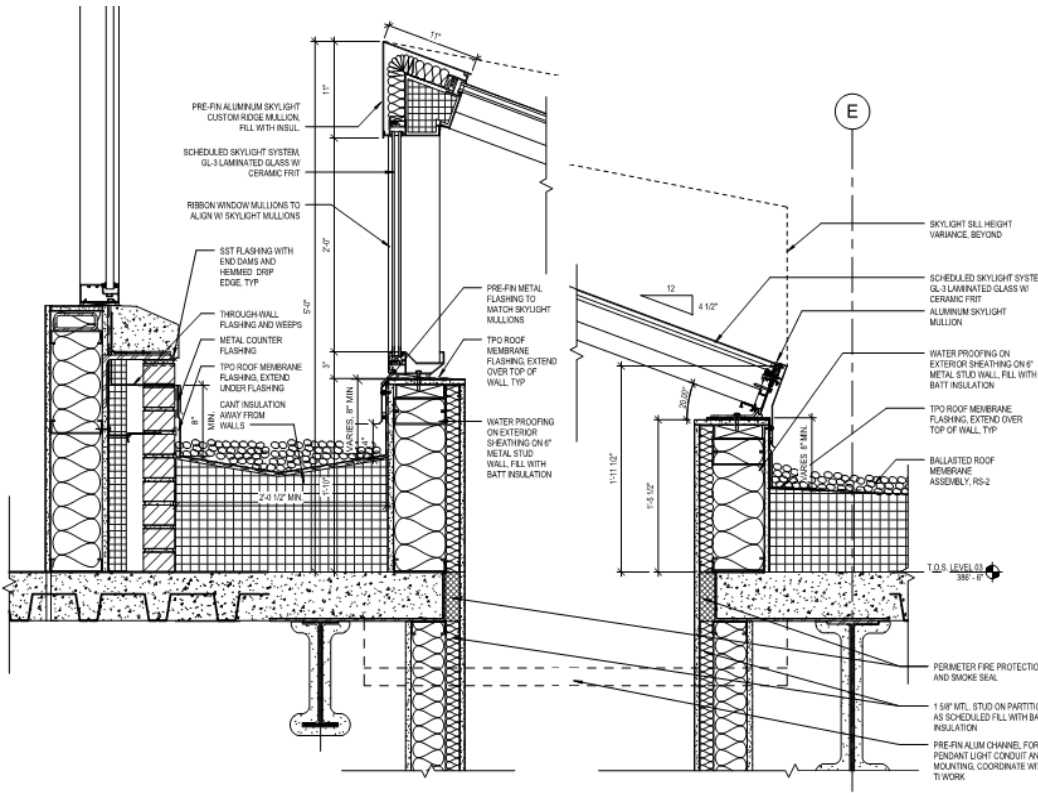
| Uses | Details, coordination, construction means & methods
design reviews, work sequence, alternative systems

| Non-immersive reviews can be as beneficial if not more beneficial

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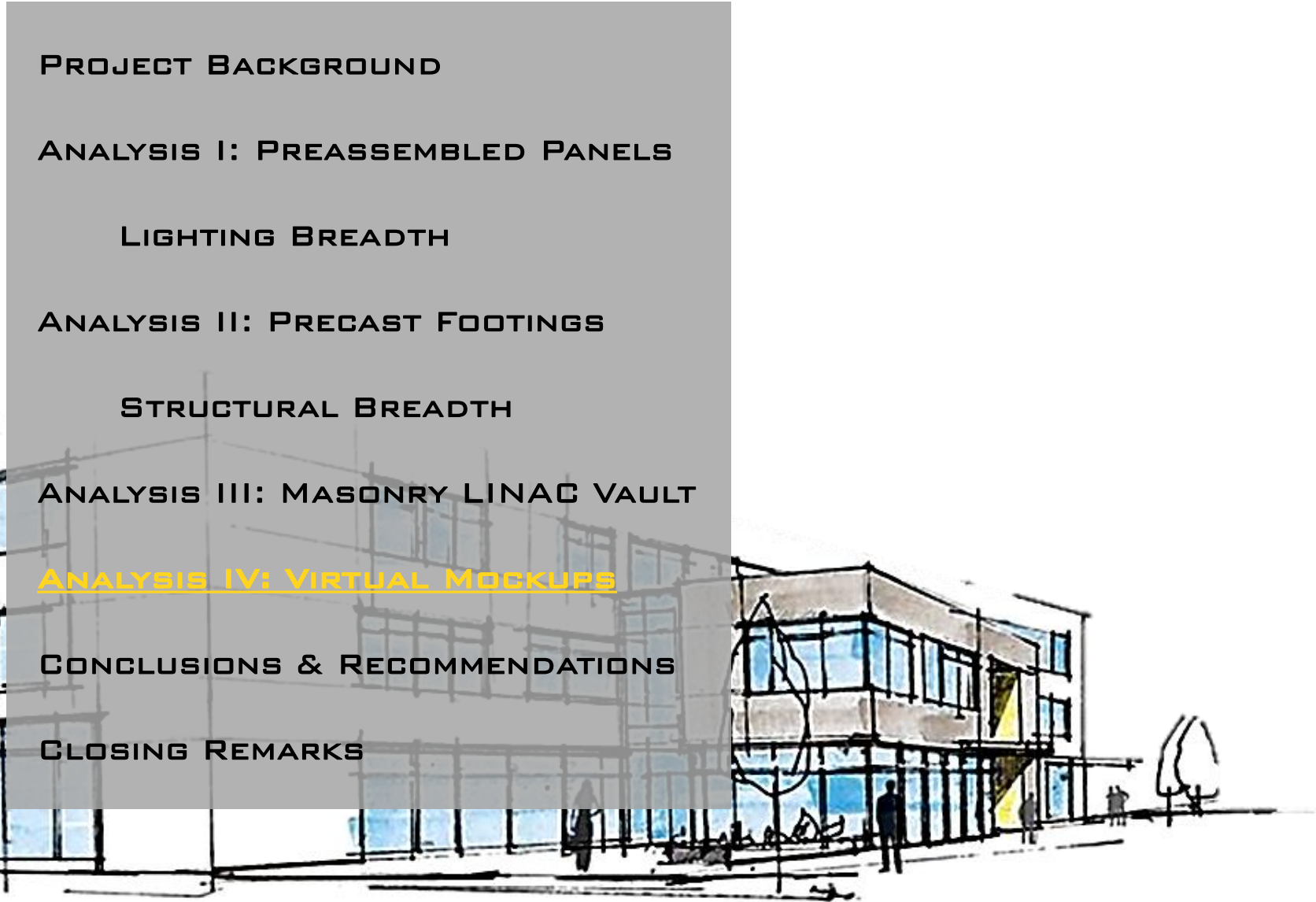


Implementation Guide



Skylight Detail Virtual Mockup

- | Skylight detail recognized as a area of concern
- | Sketchup used for minimal cost and schedule commitment
- | 3 hours to create

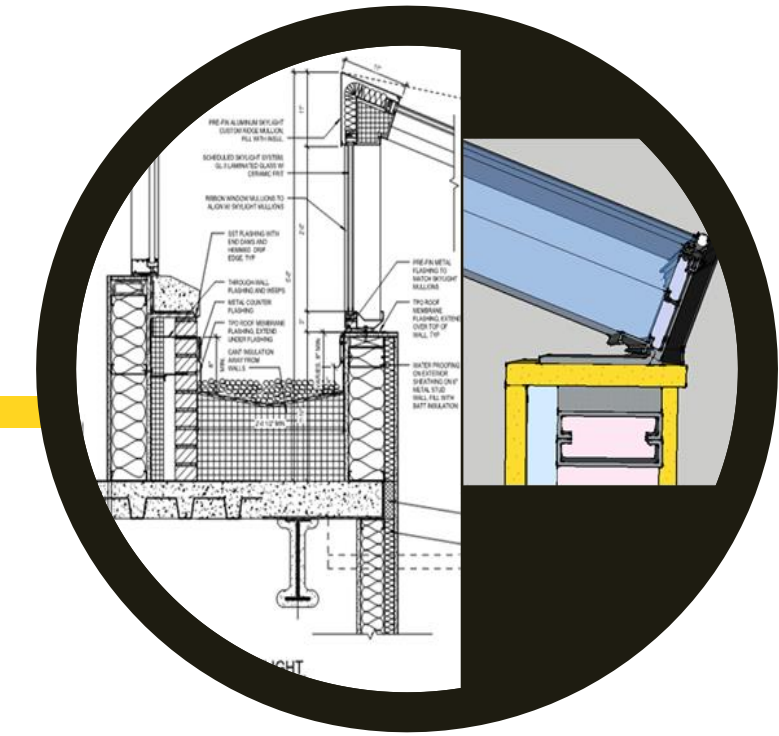
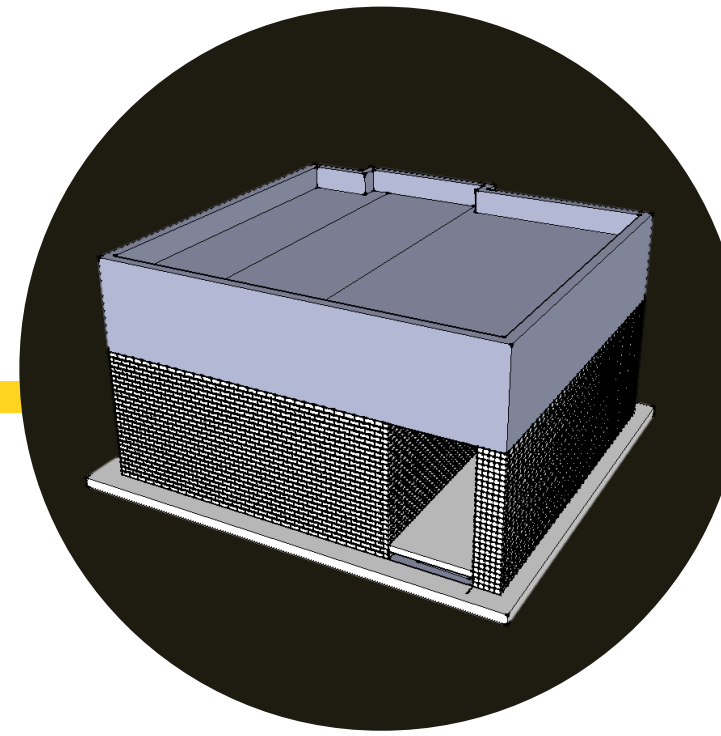


Final Results

- | Most projects can benefit from some form of virtual mockups
- | Expected to become more affordable with increased usage
- | Team & end user is buyin is critical to successful virtual mockups
- | Success is also measured by the conversations created

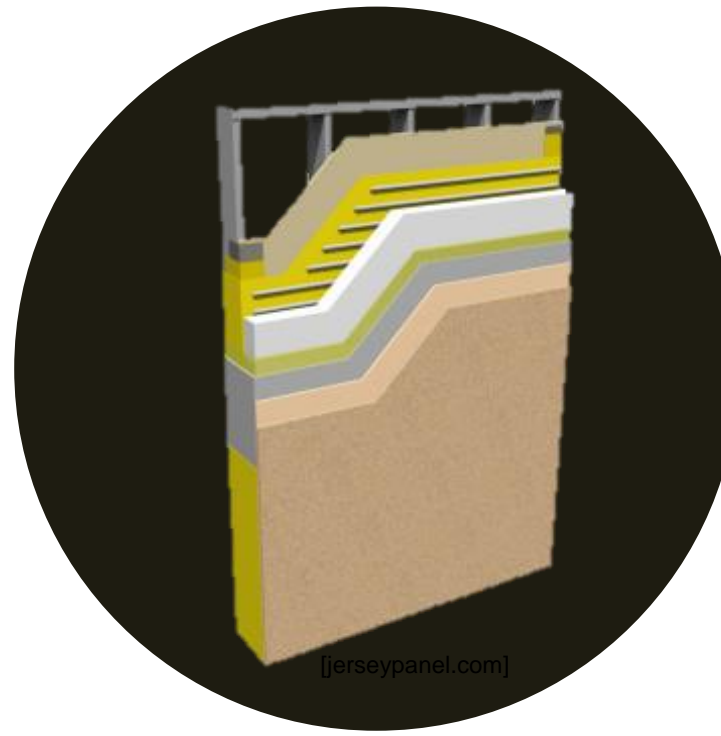
 Recommended

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Analysis I | Prefabricated Panels
 Recommended

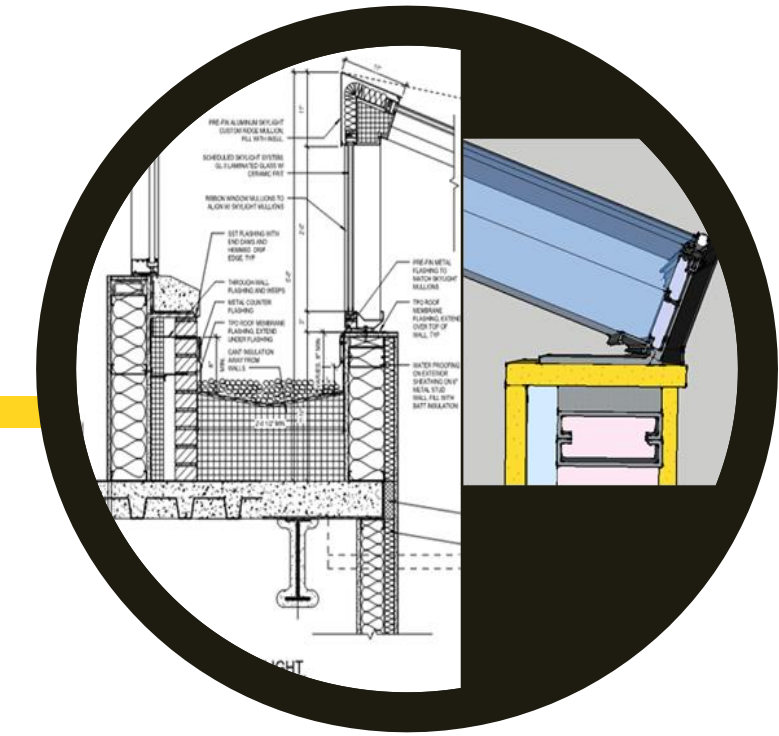
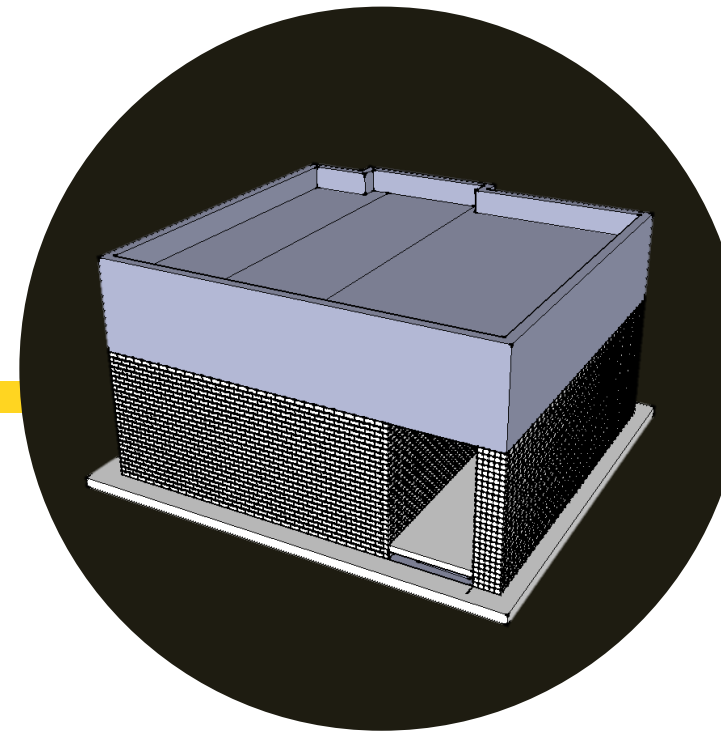
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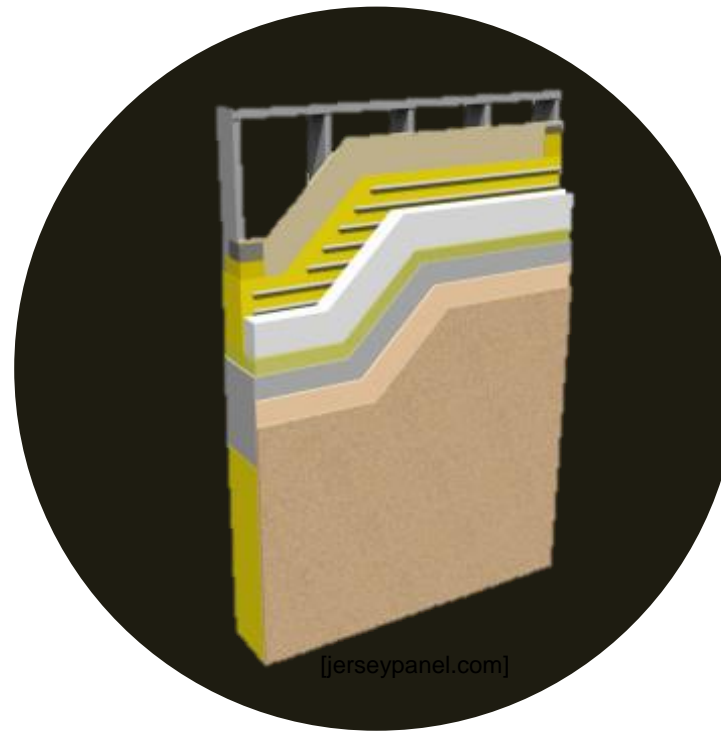
Analysis I | Prefabricated Panels
 Recommended



Analysis II | Precast Footings
 Not Recommended



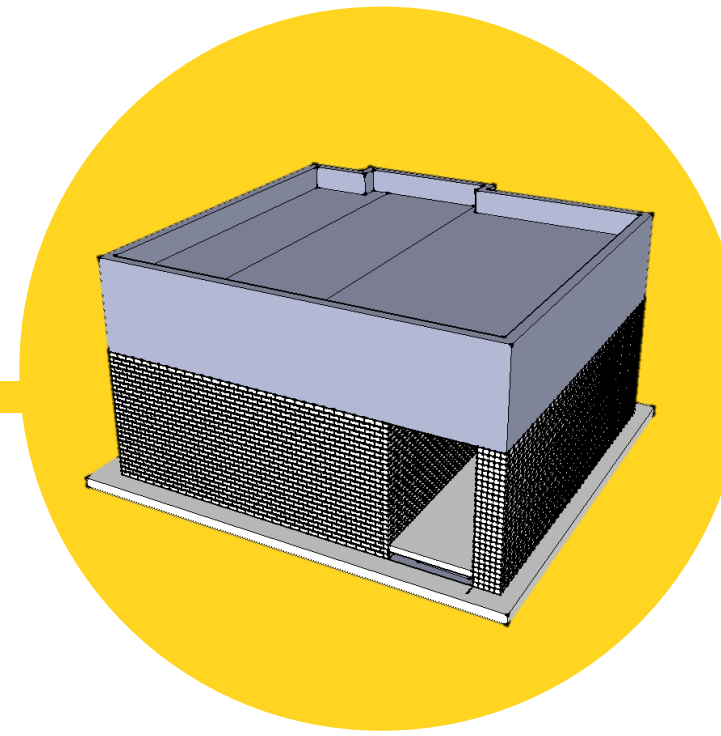
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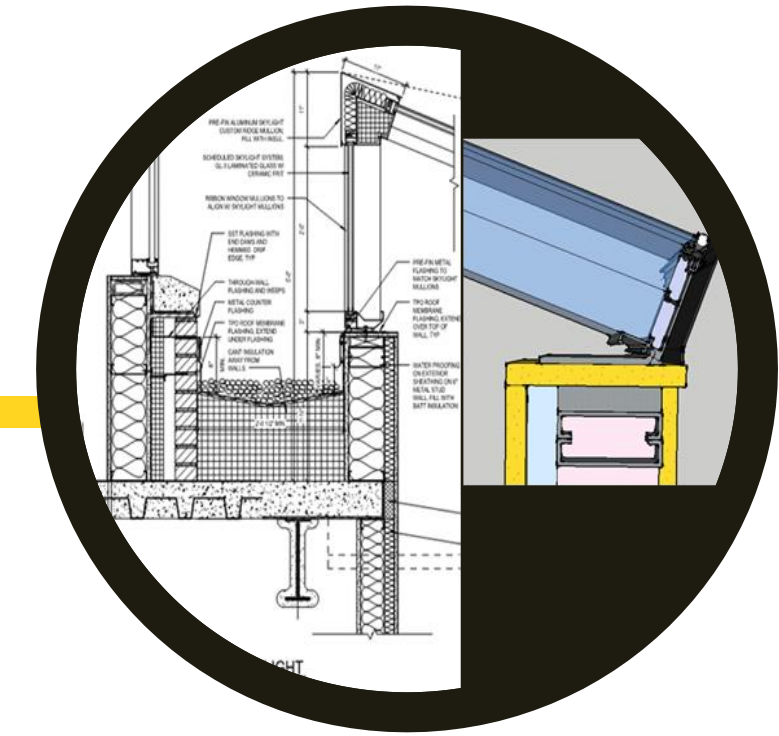
Analysis I | Prefabricated Panels
 ✓ Recommended



Analysis II | Precast Footings
 ✗ Not Recommended

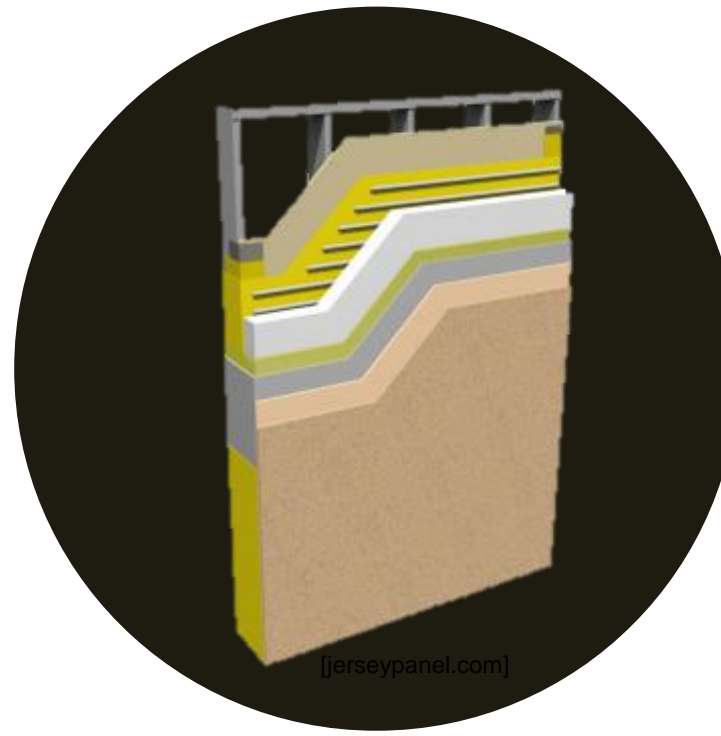


Analysis III | HD Block LINAC Vault
 ✗ Not Recommended



Analysis IV | Masonry Linac Vault
 ✗ Not Recommended

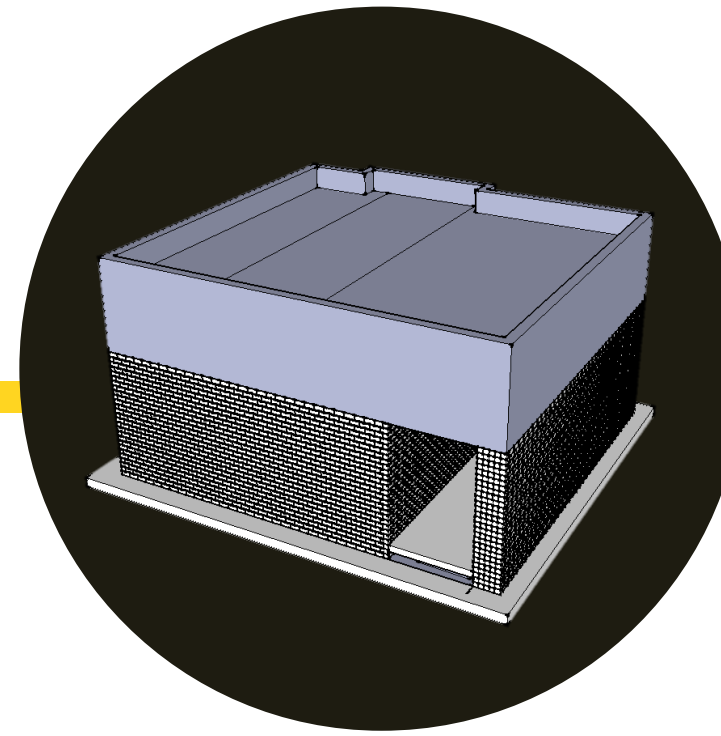
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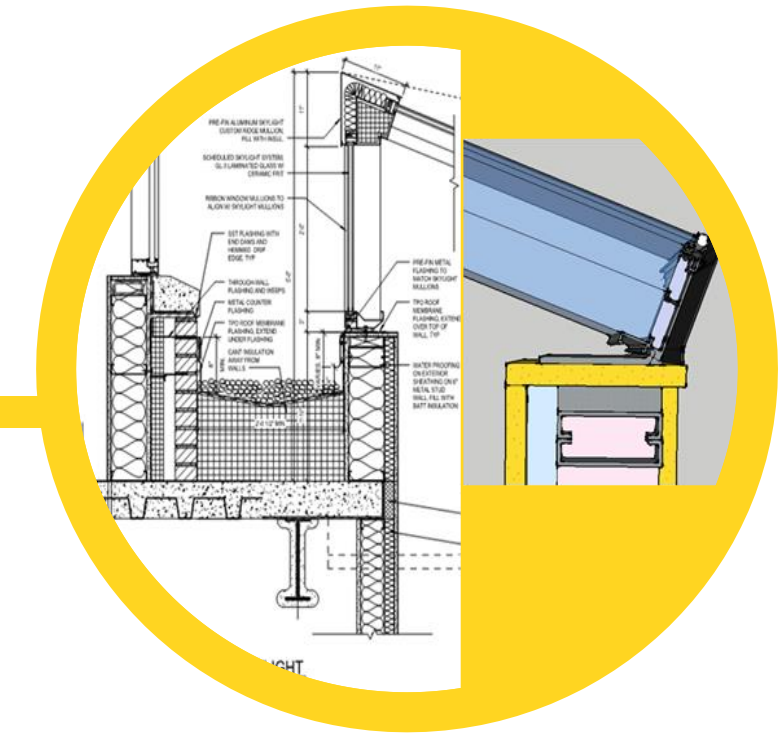
Analysis I | Prefabricated Panels
 Recommended



Analysis II | Precast Footings
 Not Recommended



Analysis III | HD Block LINAC Vault
 Not Recommended



Analysis IV | Virtual Mockups
 Recommended

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Industry



Special Thanks

Construction Advisor | Robert Leicht, PhD.
 Penn State Architectural Engineering Faculty and Staff
 My Friends & Family
 Ladies of 623 S. Allen Street

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Questions?

PROJECT BACKGROUND

ANALYSIS I: PREASSEMBLED PANELS

LIGHTING BREADTH

ANALYSIS II: PRECAST FOOTINGS

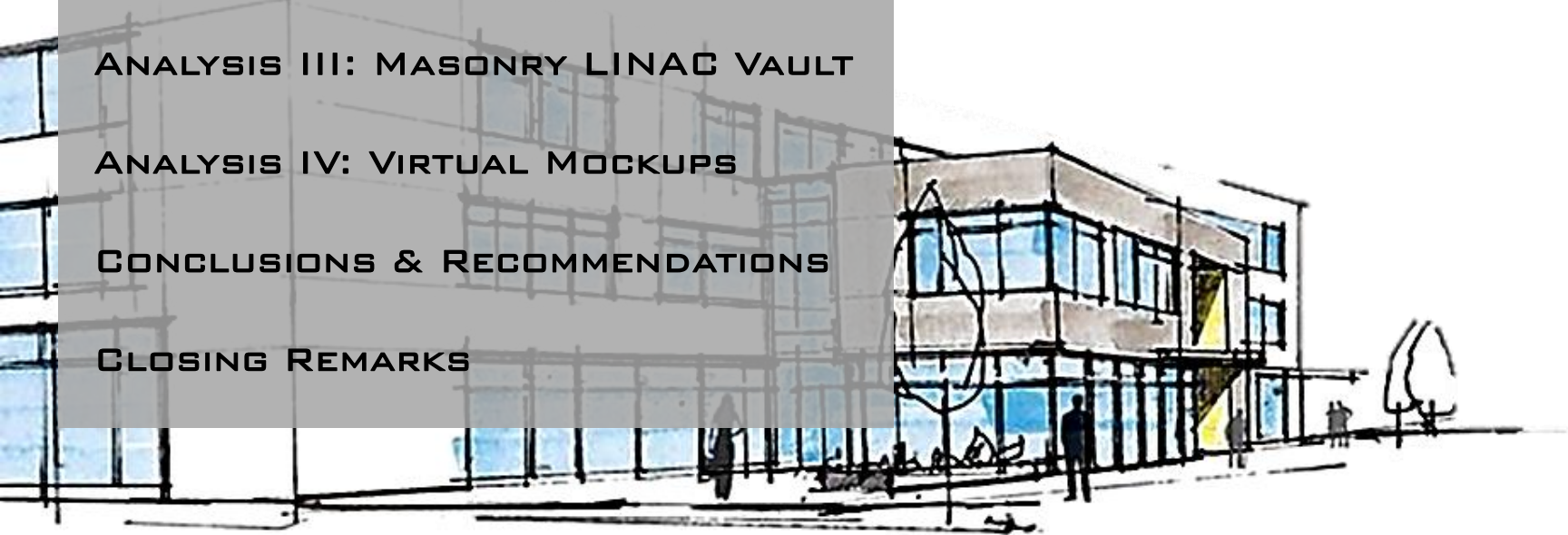
STRUCTURAL BREADTH

ANALYSIS III: MASONRY LINAC VAULT

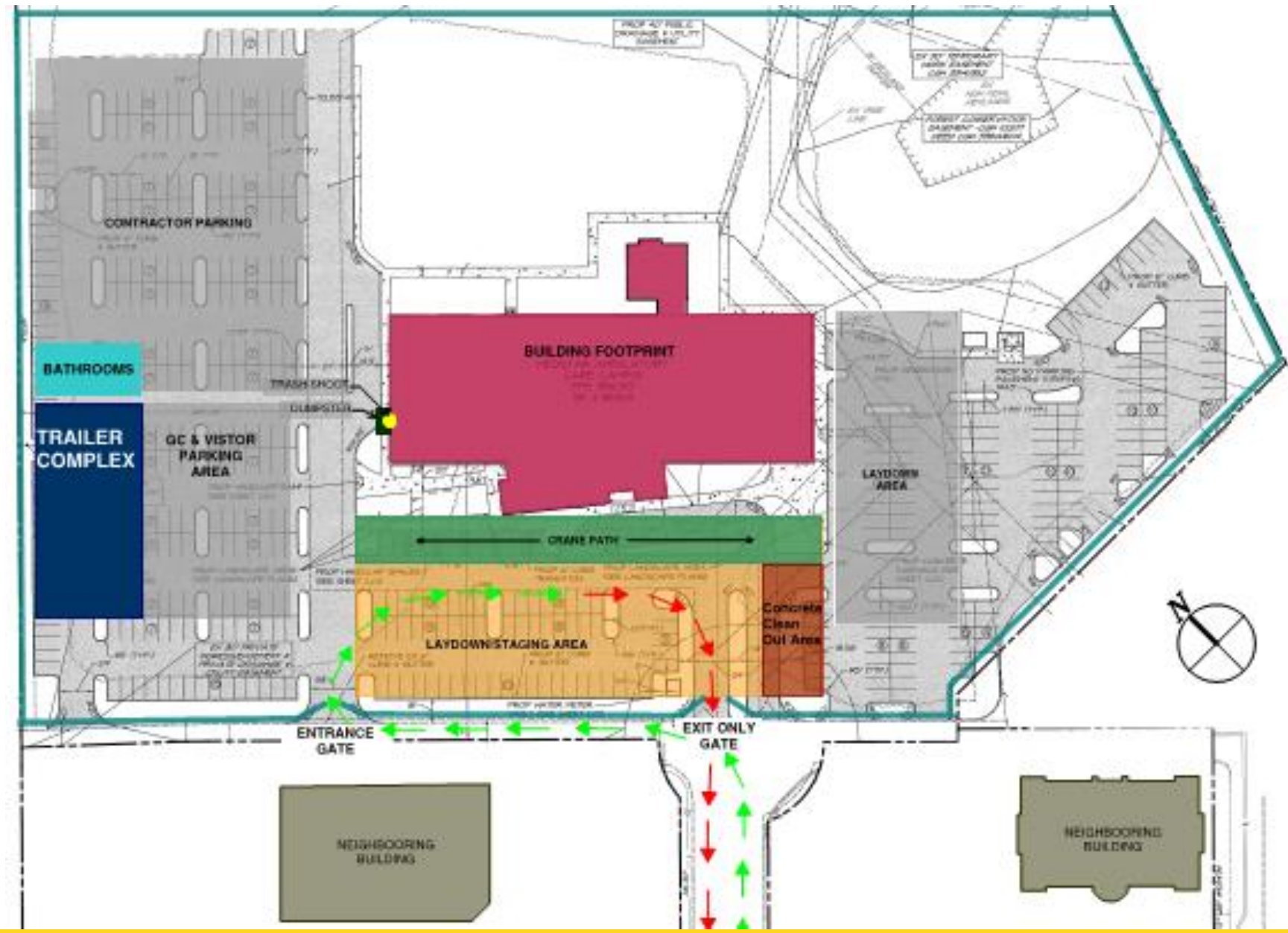
ANALYSIS IV: VIRTUAL MOCKUPS

CONCLUSIONS & RECOMMENDATIONS

CLOSING REMARKS



Site Logistics



PROJECT BACKGROUND

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ANALYSIS IV: VIRTUAL MOCKUPS

CONCLUSIONS & RECOMMENDATIONS

CLOSING REMARKS



Footing Schedule

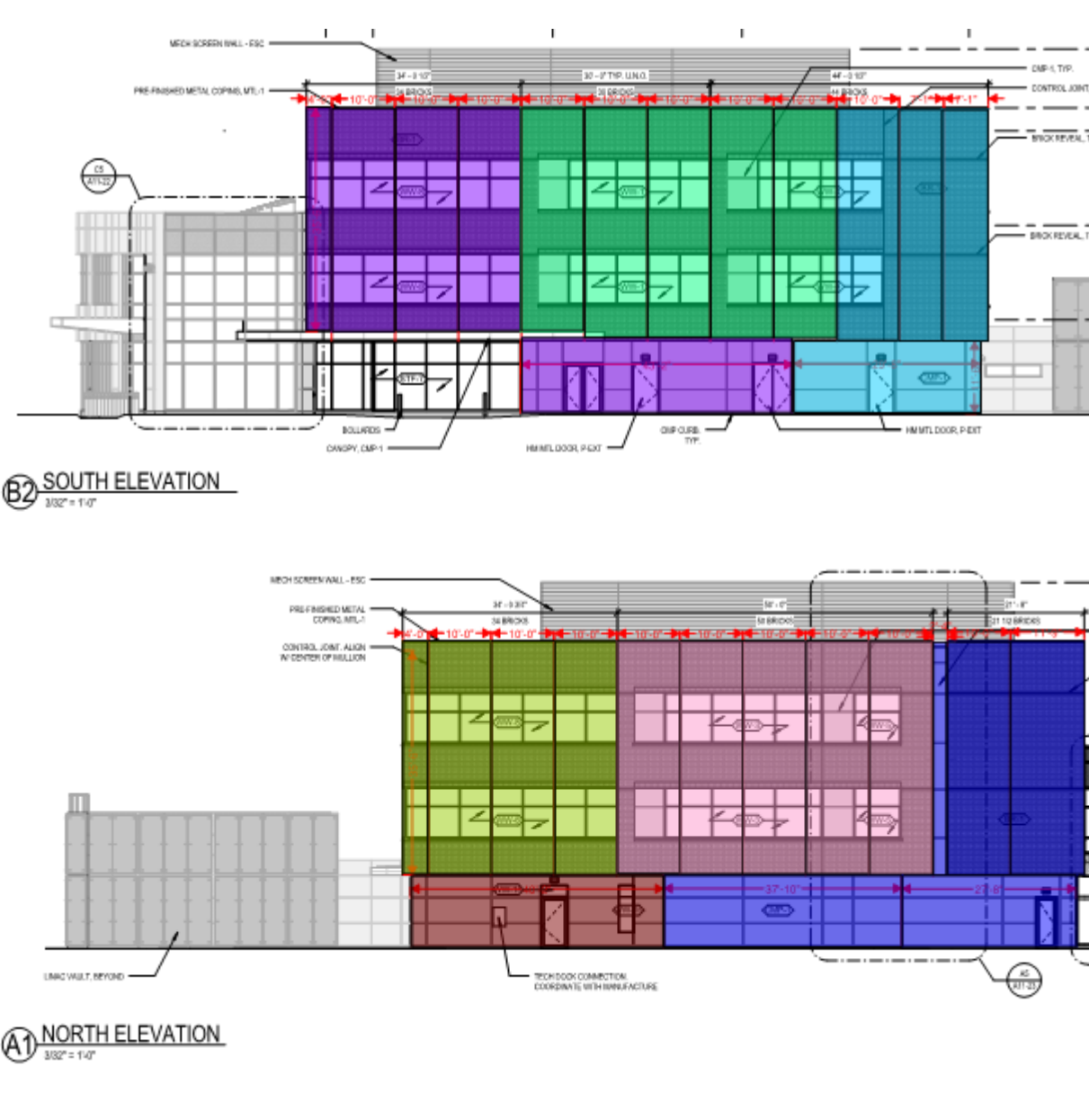
Delivery Schedule			
	Footings	Load Weight	Delivery Date
Truck 1	A/1, B/1, C/1, D/1, D/2, C/2	85000 lbs	11/25/14
Truck 2	B/2, A/2, A/3, B/3, C/3	73000 lbs	11/26/14
Truck 3	D/3, F/3.1, E/3.1, F/4.1, E/4.1, D/4, C/4	74000 lbs	11/29/14
Truck 4	B/4, A/4, A/5, B/5	86000 lbs	12/1/14
Truck 5	C/5, D/5, E/5.1, F/5.1, A/6	63000 lbs	12/1/14
Truck 6	B/6, C/6, C.4/6, D/6, E/6.1, F/6.1, F/6.6, E.7/6.6, E/6.6, F/7.2, E/7.2	81000 lbs	12/2/14
Truck 7	C.9/7, C/7, B/7, A/7, A/8	78000 lbs	12/4/14
Truck 8	B/8, C/8, D/8, D/9	79000 lbs	12/5/14
Truck 9	C/9, B/9, A/9, A/10, B/10	73000 lbs	12/5/14
Truck 10	C/10, D/10, D/11, C/11, B/11, A/11	77000 lbs	12/6/14

COMMHEALTH Footing Foundat		24-Nov-14	09-Dec-14	Duration	Duration
A1000	Excavation/Gravel Fill (Grid. 1	24-Nov-14	25-Nov-14	2	0
A1010	Set Footings (A1-D2)	25-Nov-14	26-Nov-14	1	0
A1020	Place Piers (A1-D2)	26-Nov-14	29-Nov-14	1	0
A1030	Excavation/Gravel Fill (Grid. 1	25-Nov-14	29-Nov-14	2	0
A1040	Set Footings (C2-C3)	26-Nov-14	29-Nov-14	1	0
A1050	Place Piers (C2-C3)	29-Nov-14	29-Nov-14	1	0
A1060	Excavation/Gravel Fill (Grid. 1	29-Nov-14	01-Dec-14	2	0
A1070	Set Footings (D3-D4)	29-Nov-14	29-Nov-14	1	0
A1080	Place Piers (D3-D4)	01-Dec-14	01-Dec-14	1	0
A1090	Set Footings (C4-C5)	01-Dec-14	01-Dec-14	1	0
A1100	Place Piers (C4-C5)	01-Dec-14	02-Dec-14	1	0
A1110	Set Footings (D5-F5.1)	01-Dec-14	02-Dec-14	1	0
A1120	Place Piers (D5-F5.1)	02-Dec-14	03-Dec-14	1	0
A1130	Set Footings (A6-D6)	02-Dec-14	03-Dec-14	1	0
A1140	Place Piers (A6-D6)	03-Dec-14	04-Dec-14	1	0
A1150	Set Footings (E6.1-E7.2)	03-Dec-14	04-Dec-14	1	0
A1160	Place Piers (E6.1-E7.2)	04-Dec-14	04-Dec-14	1	0
A1170	Set Footings (C.9-A8)	04-Dec-14	04-Dec-14	1	0
A1180	Place Piers (C.9-A8)	05-Dec-14	05-Dec-14	1	0
A1190	Set Footings (B8-C9)	05-Dec-14	05-Dec-14	1	0
A1200	Place Piers (B8-C9)	05-Dec-14	06-Dec-14	1	0
A1210	Set Footings (B9-B10)	05-Dec-14	06-Dec-14	1	0
A1220	Place Piers (B9-B10)	06-Dec-14	08-Dec-14	1	0
A1230	Set Footings (C10-A11)	06-Dec-14	08-Dec-14	1	0
A1240	Place Piers (C10-A11)	08-Dec-14	09-Dec-14	1	0

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Panel Layout



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Detailed Footings

Delivery Sequence											
Delivery Day	Footing	Length (LF)	Width (LF)	Depth (LF)	Total (CF)	Reduced (64%)	Reduced L & W	Rounded L & W (LF)	Weight (lbs)	Weight (kips)	
1	A/1	10.0	10.0	2	200	72	6	6	10800	10.8	
1	B/1	8.0	8.0	1.5	96	-	-	8	14400	14.4	
1	C/1	7.5	7.5	1.25	70.3125	-	-	7.5	10546.88	10.54688	
1	D/1	10.0	10.0	2	200	72	6	6	10800	10.8	
1	D/2	9.5	9.5	2	180.5	64.98	5.7	6	10800	10.8	
1	C/2	9.5	9.5	2	180.5	-	-	9.5	27075	27.075	
									Delivery Weight	84421.88	84.42188
2	B/2	10.0	10.0	2	200	72	6	6	10800	10.8	
2	A/2	8.0	8.0	1.25	80	-	-	8.0	12000	12	
2	A/3	8.0	8.0	1.25	80	-	-	8.0	12000	12	
2	B/3	10.0	10.0	2	200	72	6	6	10800	10.8	
2	C/3	9.5	9.5	2	180.5	-	-	9.5	27075	27.075	
									Delivery Weight	72675	72.675
3	D/3	9.5	9.5	2	180.5	64.98	5.7	6	10800	10.8	
3	F/3.1	9.5	9.5	2	180.5	64.98	5.7	6	10800	10.8	
3	E/3.1	5.0	5.0	1.17	29.25	10.53	3	4	2808	2.808	
3	F/4.1	7.0	7.0	1.5	73.5	26.46	4.2	4	3600	3.6	
3	E/4.1	5.5	5.5	1.17	35.3925	12.7413	3.3	4	2808	2.808	
3	D/4	10.5	10.5	2.17	239.2425	86.1273	6.3	7	15949.5	15.9495	
4	C/4	9.5	9.5	2	180.5	-	-	9.5	27075	27.075	
									Delivery Weight	73840.5	73.8405
4	B/4	10.0	10.0	2.17	217	-	-	10.0	32550	32.55	
4	A/4	8.0	8.0	1.25	80	-	-	8.0	12000	12	
4	A/5	10.0	10.0	2	200	72	6	6	10800	10.8	
4	B/5	10.0	10.0	2	200	-	-	10.0	30000	30	
									Delivery Weight	85350	85.35
4	C/5	9.5	9.5	2	180.5	-	-	9.5	27075	27.075	
5	D/5	10.5	10.5	2.17	239.2425	86.1273	6.3	7	15949.5	15.9495	
5	E/5.1	5.5	5.5	1.17	35.3925	12.7413	3.3	4	2808	2.808	
5	F/5.1	7.0	7.0	1.5	73.5	26.46	4.2	5	5625	5.625	
6	A/6	10.0	10.0	2	200	72	6	6	10800	10.8	
									Delivery Weight	62257.5	62.2575

MOVE CRANE											
5											
6	B/6	10.0	10.0	2	200	-	-	10.0	30000	30	
6	C/6	11.0	11.0	1.5	181.5	65.34	6.6	7	11025	11.025	
6	C.4/6	6.0	6.0	1.25	45	16.2	3.6	4	3000	3	
6	D/6	10.0	10.0	2	200	72	6	6	10800	10.8	
7	E/6.1	5.5	5.5	1.17	35.3925	12.7413	3.3	4	2808	2.808	
7	F/6.1	8.5	8.5	1.75	126.4375	45.5175	5.1	6	9450	9.45	
7	F/6.6	5.0	5.0	1.17	29.25	10.53	3	4	2808	2.808	
7	E.7/6.6	5.0	5.0	1.17	29.25	10.53	3	4	2808	2.808	
7	E/6.6	4.0	4.0	1	16	5.76	2.4	4	2400	2.4	
7	F/7.2	5.0	5.0	1.17	29.25	10.53	3	4	2808	2.808	
7	E/7.2	5.0	5.0	1.17	29.25	10.53	3	4	2808	2.808	
									Delivery Weight	80715	80.715
8	C.9/7	10.0	10.0	2	200	72	6	6	10800	10.8	
8	C/7	11.0	11.0	1.5	181.5	65.34	6.6	7	11025	11.025	
8	B/7	10.0	10.0	2.17	217	-	-	10.0	32550	32.55	
8	A/7	10.0	10.0	2	200	72	6	6	10800	10.8	
8	A/8	8.0	8.0	1.25	80	-	-	8.0	12000	12	
									Delivery Weight	77175	77.175
9	B/8	10.0	10.0	2	200	-	-	10.0	30000	30	
9	C/8	9.5	9.5	2	180.5	-	-	9.5	27075	27.075	
9	D/8	10.0	10.0	2	200	72	6	6	10800	10.8	
9	D/9	9.5	9.5	2	180.5	64.98	5.7	6	10800	10.8	
									Delivery Weight	78675	78.675
10	C/9	9.5	9.5	2	180.5	-	-	9.5	27075	27.075	
10	B/9	10.0	10.0	2	200	72	6	6	10800	10.8	
10	A/9	8.0	8.0	1.25	80	-	-	8.0	12000	12	
10	A/10	8.0	8.0	1.25	80	-	-	8.0	12000	12	
10	B/10	10.0	10.0	2	200	72	6	6	10800	10.8	
									Delivery Weight	72675	72.675
11	C/10	10.0	10.0	2	200	-	-	10.0	30000	30	
11	D/10	9.5	9.5	2	180.5	64.98	5.7	6	10800	10.8	
11	D/11	6.0	6.0	1.25	45	-	-	6.0	6750	6.75	
11	C/11	7.5	7.5	1.25	70.3125	-	-	7.5	10546.88	10.54688	
11	B/11	8.0	8.0	1.25	80	-	-	8.0	12000	12	
11	A/11	6.0	6.0	1.25	45	-	-	6.0	6750	6.75	
									Delivery Weight	76846.88	76.84688

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Detailed Cost

Cast-in-Place Footings Estimate														
Cost Code	Item	Units	Crew	Daily Output	Labor Hours	Quantity	Mat'l Unit Cost	Mat'l Cost	Labor Unit Cost	Labor Cost	Equip Unit Cost	Equip Cost	Total	
Concrete														
03 31 13.35	0350 Heavyweight Concrete, Ready Mix, delivered	4500 psi	CY	C-30	135	0.059	522	\$ 116.00	\$ 60,552.00	\$ -	\$ -	\$ -	\$ 60,552.00	
Rebar														
03 21 11.60	0500 Reinforcing in Place	Footings, #4 to #7	Ton	4 Rodm.	2.1	15.238	13	\$ 960.00	\$ 12,480.00	\$ 810.00	\$ 10,530.00	\$ -	\$ 23,010.00	
Placement														
03 31 13.70	2600 Placing Concrete	Footings, spread, over 5 C.Y., direct chute	CY	C-6	120	0.4	522	\$ -	\$ -	\$ 15.80	\$ 8,247.60	\$ 0.53	\$ 276.66	\$ 8,524.26
Anchor Bolts														
03 015 19.1	0130 Anchor Bolts	3/4" diameter x 8" long	Set	1 Carp	20	0.4	31	\$ 10.81	\$ 335.11	\$ 19.40	\$ 601.40	\$ -	\$ 936.51	
03 15 19.1	0420 Anchor Bolts	1-1/4" diameter x 18" long	Set	1 Carp	18	0.444	27	\$ 30.00	\$ 810.00	\$ 21.50	\$ 580.50	\$ -	\$ 1,390.50	
Base Plates														
05 12 23.65	0500 Plates	1" thick (40.8 lb/S.F.)	SF	E-4			158	\$ 54.00	\$ 8,532.00	\$ -	\$ -	\$ -	\$ 8,532.00	
Excavation														
31 23 16.42	0200 Excavating, Bulk Bank Measure	Excavator, hydraulic, crawler mtd., 1 C.Y. cap. = 100 C.Y/hr.	BCY	B-12A	800	0.02	930	\$ -	\$ -	\$ 0.90	\$ 837.00	\$ 1.92	\$ 1,785.60	\$ 2,622.60
Fill														
31 23 23.17	0500 General Fill	Gravil fill, compacted, under floor slab, 4"	SF	B-37	10000	0.005	7,000	\$ 0.44	\$ 3,080.00	\$ 0.19	\$ 1,330.00	\$ 0.02	\$ 140.00	\$ 4,550.00
Total								\$ 85,789.11		\$ 22,126.50		\$ 2,202.26	\$ 110,117.87	

PROJECT BACKGROUND

ANALYSIS I: PREASSEMBLED PANELS

LIGHTING BREADTH

ANALYSIS II: PRECAST FOOTINGS

STRUCTURAL BREADTH

ANALYSIS III: MASONRY LINAC VAULT

ANALYSIS IV: VIRTUAL MOCKUPS

CONCLUSIONS & RECOMMENDATIONS

CLOSING REMARKS



Detailed Cost

Precast Footings Estimate													
Cost Code	Item	Units	Crew	Daily Output	Labor Hours	Quantity	Mat'l Unit Cost	Mat'l Cost	Labor Unit Cost	Labor Cost	Equip Unit Cost	Equip Cost	Total
Concrete													
03 31 13.35	0350 Heavyweight Concrete, Ready Mix, delivered 4500 psi	CY				250	\$ 116.00	\$ 29,000.00	\$ -	\$ -		\$ -	\$ 29,000.00
							\$ -	\$ -	\$ -	\$ -		\$ -	\$ -
Rebar													
03 21 11.60	0500 Reinforcing in Place Footings, #4 to #7	Ton	4 Rodm.	2.1	15.238	13	\$ 960.00	\$ 12,480.00	\$ 810.00	\$ 10,530.00		\$ -	\$ 23,010.00
							\$ -	\$ -	\$ -	\$ -		\$ -	\$ -
Formwork													
03 11 13.45	0050 Forms in Place, Footings Plywood, 2 use	SFCA	C-1	440	0.073	6,340	\$ 3.74	\$ 23,711.60	\$ 3.33	\$ 21,112.20		\$ -	\$ 44,823.80
							\$ -	\$ -	\$ -	\$ -		\$ -	\$ -
Placement													
03 31 13.70	2600 Placing Concrete Footings, spread, over 5 C.Y., direct chute	CY	C-6	120	0.4	329	\$ -	\$ -	\$ 15.80	\$ 5,195.31	\$ 0.53	\$ 174.27	\$ 5,369.58
							\$ -	\$ -	\$ -	\$ -		\$ -	\$ -
Anchor Bolts													
03 015 19.1	0130 Anchor Bolts 3/4" diameter x 8" long	Set	1 Carp	20	0.4	31	\$ 10.81	\$ 335.11	\$ 19.40	\$ 601.40		\$ -	\$ 936.51
03 15 19.1	0420 Anchor Bolts 1-1/4" diameter x 18" long	Set	1 Carp	18	0.444	27	\$ 30.00	\$ 810.00	\$ 21.50	\$ 580.50		\$ -	\$ 1,390.50
							\$ -	\$ -	\$ -	\$ -		\$ -	\$ -
Base Plates													
05 12 23.65	0500 Plates 1" thick (40.8 lb/S.F.)	SF	E-4			158	\$ 54.00	\$ 8,532.00	\$ -	\$ -		\$ -	\$ 8,532.00
Excavation													
31 23 16.42	0200 Excavating, Bulk Bank Measure Excavator, hydraulic, crawler mtd., 1 C.Y. cap. = 10' BCY	BCY	B-12A	800	0.02	730	\$ -	\$ -	\$ 0.90	\$ 657.00	\$ 1.92	\$ 1,401.60	\$ 2,058.60
Fill													
31 23 23.17	0500 General Fill Gravel fill, compacted, under floor slab, 4"	SF	B-37	10000	0.005	6,500	\$ 0.44	\$ 2,860.00	\$ 0.19	\$ 1,235.00	\$ 0.02	\$ 130.00	\$ 4,225.00
Transportation													
	Truck Costs	Mile				650	\$ -	\$ -	\$ 0.62	\$ 403.00	\$ 1.09	\$ 708.50	\$ 1,111.50
	Permit Fees 92,000 lbs					0	\$ 35.00	\$ -	\$ -	\$ -		\$ -	\$ -
	Permit Fees 90,000 lbs					3	\$ 30.00	\$ 90.00	\$ -	\$ -		\$ -	\$ 90.00
Crane													
	Mobile Crane Rental Liebherr-LTM1150-6.1	Day				12	\$ -	\$ -	\$ -	\$ -	\$ 2,600.00	\$ 31,200.00	\$ 31,200.00
	Mobile Crane Move Charges Liebherr-LTM1150-6.1	1 Way				1	\$ -	\$ -	\$ -	\$ -	\$ 10,000.00	\$ 10,000.00	\$ 10,000.00
Total								\$ 77,818.71		\$ 40,314.41		\$ 43,614.37	\$ 161,747.49

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- CONCLUSIONS & RECOMMENDATIONS
- CLOSING REMARKS



Detailed Footings

Delivery Sequence											
Delivery Day	Footing	Length (LF)	Width (LF)	Depth (LF)	Total (CF)	Reduced (64%)	Reduced L & W	Rounded L & W (LF)	Weight (lbs)	Weight (kips)	
1	A/1	10.0	10.0	2	200	72	6	6	10800	10.8	
1	B/1	8.0	8.0	1.5	96	-	-	8	14400	14.4	
1	C/1	7.5	7.5	1.25	70.3125	-	-	7.5	10546.88	10.54688	
1	D/1	10.0	10.0	2	200	72	6	6	10800	10.8	
1	D/2	9.5	9.5	2	180.5	64.98	5.7	6	10800	10.8	
1	C/2	9.5	9.5	2	180.5	-	-	9.5	27075	27.075	
									Delivery Weight	84421.88	84.42188
2	B/2	10.0	10.0	2	200	72	6	6	10800	10.8	
2	A/2	8.0	8.0	1.25	80	-	-	8.0	12000	12	
2	A/3	8.0	8.0	1.25	80	-	-	8.0	12000	12	
2	B/3	10.0	10.0	2	200	72	6	6	10800	10.8	
2	C/3	9.5	9.5	2	180.5	-	-	9.5	27075	27.075	
									Delivery Weight	72675	72.675
3	D/3	9.5	9.5	2	180.5	64.98	5.7	6	10800	10.8	
3	F/3.1	9.5	9.5	2	180.5	64.98	5.7	6	10800	10.8	
3	E/3.1	5.0	5.0	1.17	29.25	10.53	3	4	2808	2.808	
3	F/4.1	7.0	7.0	1.5	73.5	26.46	4.2	4	3600	3.6	
3	E/4.1	5.5	5.5	1.17	35.3925	12.7413	3.3	4	2808	2.808	
3	D/4	10.5	10.5	2.17	239.2425	86.1273	6.3	7	15949.5	15.9495	
4	C/4	9.5	9.5	2	180.5	-	-	9.5	27075	27.075	
									Delivery Weight	73840.5	73.8405
4	B/4	10.0	10.0	2.17	217	-	-	10.0	32550	32.55	
4	A/4	8.0	8.0	1.25	80	-	-	8.0	12000	12	
4	A/5	10.0	10.0	2	200	72	6	6	10800	10.8	
4	B/5	10.0	10.0	2	200	-	-	10.0	30000	30	
									Delivery Weight	85350	85.35
4	C/5	9.5	9.5	2	180.5	-	-	9.5	27075	27.075	
5	D/5	10.5	10.5	2.17	239.2425	86.1273	6.3	7	15949.5	15.9495	
5	E/5.1	5.5	5.5	1.17	35.3925	12.7413	3.3	4	2808	2.808	
5	F/5.1	7.0	7.0	1.5	73.5	26.46	4.2	5	5625	5.625	
6	A/6	10.0	10.0	2	200	72	6	6	10800	10.8	
									Delivery Weight	62257.5	62.2575

MOVE CRANE											
5											
6	B/6	10.0	10.0	2	200	-	-	10.0	30000	30	
6	C/6	11.0	11.0	1.5	181.5	65.34	6.6	7	11025	11.025	
6	C.4/6	6.0	6.0	1.25	45	16.2	3.6	4	3000	3	
6	D/6	10.0	10.0	2	200	72	6	6	10800	10.8	
7	E/6.1	5.5	5.5	1.17	35.3925	12.7413	3.3	4	2808	2.808	
7	F/6.1	8.5	8.5	1.75	126.4375	45.5175	5.1	6	9450	9.45	
7	F/6.6	5.0	5.0	1.17	29.25	10.53	3	4	2808	2.808	
7	E.7/6.6	5.0	5.0	1.17	29.25	10.53	3	4	2808	2.808	
7	E/6.6	4.0	4.0	1	16	5.76	2.4	4	2400	2.4	
7	F/7.2	5.0	5.0	1.17	29.25	10.53	3	4	2808	2.808	
7	E/7.2	5.0	5.0	1.17	29.25	10.53	3	4	2808	2.808	
									Delivery Weight	80715	80.715
8	C.9/7	10.0	10.0	2	200	72	6	6	10800	10.8	
8	C/7	11.0	11.0	1.5	181.5	65.34	6.6	7	11025	11.025	
8	B/7	10.0	10.0	2.17	217	-	-	10.0	32550	32.55	
8	A/7	10.0	10.0	2	200	72	6	6	10800	10.8	
8	A/8	8.0	8.0	1.25	80	-	-	8.0	12000	12	
									Delivery Weight	77175	77.175
9	B/8	10.0	10.0	2	200	-	-	10.0	30000	30	
9	C/8	9.5	9.5	2	180.5	-	-	9.5	27075	27.075	
9	D/8	10.0	10.0	2	200	72	6	6	10800	10.8	
9	D/9	9.5	9.5	2	180.5	64.98	5.7	6	10800	10.8	
									Delivery Weight	78675	78.675
10	C/9	9.5	9.5	2	180.5	-	-	9.5	27075	27.075	
10	B/9	10.0	10.0	2	200	72	6	6	10800	10.8	
10	A/9	8.0	8.0	1.25	80	-	-	8.0	12000	12	
10	A/10	8.0	8.0	1.25	80	-	-	8.0	12000	12	
10	B/10	10.0	10.0	2	200	72	6	6	10800	10.8	
									Delivery Weight	72675	72.675
11	C/10	10.0	10.0	2	200	-	-	10.0	30000	30	
11	D/10	9.5	9.5	2	180.5	64.98	5.7	6	10800	10.8	
11	D/11	6.0	6.0	1.25	45	-	-	6.0	6750	6.75	
11	C/11	7.5	7.5	1.25	70.3125	-	-	7.5	10546.88	10.54688	
11	B/11	8.0	8.0	1.25	80	-	-	8.0	12000	12	
11	A/11	6.0	6.0	1.25	45	-	-	6.0	6750	6.75	
									Delivery Weight	76846.88	76.84688

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Loading Calcs

Loading Calculation for A2																	
Start Level	End Level	DL factor	DL	LL factor	LL Reducing Coefficient	LL Reduced	At	n (floors supported)	DL Floor Load on Column (k)	LL Floor Load on Column (k)	DL Roof on Column (k)	LL Roof on Column (k)	Wall Load	Wall At	Wall Load on Column	Pu (DL)	Pu (LL)
3	R	1.2	34	1.6		30	540	0	0	0	18.36	16.2	15	560.1	4.20075	22.56075	16.2
2	3	1.2	56	1.6	0.57274861	45.81989	540	1	30.24	24.74274	18.36	16.2	15	450	10.125	58.725	40.94274
1	2	1.2	56	1.6	0.47821773	38.25742	540	2	60.48	41.31801	18.36	16.2	15	450	16.875	95.715	57.51801
															Total	177.0008	114.6608

Loading Calculation for A4																	
Start Level	End Level	DL factor	DL	LL factor	LL Reducing Coefficient	LL Reduced	At	n (floors supported)	DL Floor Load on Column (k)	LL Floor Load on Column (k)	DL Roof on Column (k)	LL Roof on Column (k)	Wall Load	Wall At	Wall Load on Column	Pu (DL)	Pu (LL)
3	R	1.2	34	1.6		30	540	0	0	0	18.36	16.2	15	560.1	4.20075	22.56075	16.2
2	3	1.2	56	1.6	0.57274861	45.81989	540	1	30.24	24.74274	18.36	16.2	15	450	10.125	58.725	40.94274
1	2	1.2	56	1.6	0.47821773	38.25742	540	2	60.48	41.31801	18.36	16.2	15	450	16.875	95.715	57.51801
															Total	177.0008	114.6608

Loading Calculation for A8																	
Start Level	End Level	DL factor	DL	LL factor	LL Reducing Coefficient	LL Reduced	At	n (floors supported)	DL Floor Load on Column (k)	LL Floor Load on Column (k)	DL Roof on Column (k)	LL Roof on Column (k)	Wall Load	Wall At	Wall Load on Column	Pu (DL)	Pu (LL)
3	R	1.2	34	1.6		30	540	0	0	0	18.36	16.2	15	560.1	4.20075	22.56075	16.2
2	3	1.2	56	1.6	0.57274861	45.81989	540	1	30.24	24.74274	18.36	16.2	15	450	10.125	58.725	40.94274
1	2	1.2	56	1.6	0.47821773	38.25742	540	2	60.48	41.31801	18.36	16.2	15	450	16.875	95.715	57.51801
															Total	177.0008	114.6608

Loading Calculation for A11																	
Start Level	End Level	DL factor	DL	LL factor	LL Reducing Coefficient	LL Reduced	At	n (floors supported)	DL Floor Load on Column (k)	LL Floor Load on Column (k)	DL Roof on Column (k)	LL Roof on Column (k)	Wall Load	Wall At	Wall Load on Column	Pu (DL)	Pu (LL)
3	R	1.2	34	1.6		30	270	0	0	0	9.18	8.1	15	616.11	4.620825	13.80083	8.1
2	3	1.2	56	1.6	0.7064355	56.51484	270	1	15.12	15.25901	9.18	8.1	15	495	11.1375	35.4375	23.35901
1	2	1.2	56	1.6	0.5727486	45.81989	270	2	30.24	24.74274	9.18	8.1	15	495	18.5625	57.9825	32.84274
															Total	107.2208	64.30175

Loading Calculation for B1																	
Start Level	End Level	DL factor	DL	LL factor	LL Reducing Coefficient	LL Reduced	At	n (floors supported)	DL Floor Load on Column (k)	LL Floor Load on Column (k)	DL Roof on Column (k)	LL Roof on Column (k)	Wall Load	Wall At	Wall Load on Column	Pu (DL)	Pu (LL)
3	R	1.2	34	1.6		30	495	0	0	0	16.83	14.85	15	616.11	4.620825	21.45083	14.85
2	3	1.2	56	1.6	0.58709993	46.96799	495	1	27.72	23.24916	16.83	14.85	15	495	11.1375	55.6875	38.09916
1	2	1.2	56	1.6	0.48836565	39.06925	495	2	55.44	38.67856	16.83	14.85	15	495	18.5625	90.8325	53.52856
															Total	167.9708	106.4777

Loading Calculation for B4																	
Start Level	End Level	DL factor	DL	LL factor	LL Reducing Coefficient	LL Reduced	At	n (floors supported)	DL Floor Load on Column (k)	LL Floor Load on Column (k)	DL Roof on Column (k)	LL Roof on Column (k)	Wall Load	Wall At	Wall Load on Column	Pu (DL)	Pu (LL)
3	R	1.2	34	1.6		30	990	0	0	0	33.66	29.7	15	0	0	33.66	29.7
2	3	1.2	56	1.6	0.48836565	39.06925	990	1	55.44	38.67856	33.66	29.7	15	0	0	89.1	68.37856
1	2	1.2	56	1.6	0.41854997	33.484	990	2	110.88	66.29831	33.66	29.7	15	0	0	144.54	95.99831
															Total	267.3	194.0769

Loading Calculation for B5																	
Start Level	End Level	DL factor	DL	LL factor	LL Reducing Coefficient	LL Reduced	At	n (floors supported)	DL Floor Load on Column (k)	LL Floor Load on Column (k)	DL Roof on Column (k)	LL Roof on Column (k)	Wall Load	Wall At	Wall Load on Column	Pu (DL)	Pu (LL)
3	R	1.2	34	1.6		30	990	0	0	0	33.66	29.7	15	0	0	33.66	29.7
2	3	1.2	56	1.6	0.48836565	39.06925	990	1	55.44	38.67856	33.66	29.7	15	0	0	89.1	68.37856
1	2	1.2	56	1.6	0.41854997	33.484	990	2	110.88	66.29831	33.66	29.7	15	0	0	144.54	95.99831
															Total	267.3	194.0769

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Loading Calcs

Loading Calculation for C1

Start Level	End Level	DL factor	DL	LL factor	LL Reducing Coefficient	LL Reduced	At	n (floors supported)	DL Floor Load on Column (k)	LL Floor Load on Column (k)	DL Roof on Column (k)	LL Roof on Column (k)	Wall Load	Wall At	Wall Load on Column	Pu (DL)	Pu (LL)
3	R	1.2	34	1.6		30	438.75	0	0	0	14.9175	13.1625	15	546.0975	4.095731	19.01323	13.1625
2	3	1.2	56	1.6	0.60805744	48.64459	438.75	1	24.57	21.34282	14.9175	13.1625	15	438.75	9.871875	49.35938	34.50532
1	2	1.2	56	1.6	0.50318484	40.25479	438.75	2	49.14	35.32358	14.9175	13.1625	15	438.75	16.45313	80.51063	48.48608
Total															148.8832	96.15389	

Loading Calculation for C2

Start Level	End Level	DL factor	DL	LL factor	LL Reducing Coefficient	LL Reduced	At	n (floors supported)	DL Floor Load on Column (k)	LL Floor Load on Column (k)	DL Roof on Column (k)	LL Roof on Column (k)	Wall Load	Wall At	Wall Load on Column	Pu (DL)	Pu (LL)
3	R	1.2	34	1.6		30	877.5	0	0	0	29.835	26.325	15	0	0	29.835	26.325
2	3	1.2	56	1.6	0.50318484	40.25479	877.5	1	49.14	35.32358	29.835	26.325	15	0	0	78.975	61.64858
1	2	1.2	56	1.6	0.42902872	34.3223	877.5	2	98.28	60.23563	29.835	26.325	15	0	0	128.115	86.56063
Total															236.925	174.5342	

Loading Calculation for C4

Start Level	End Level	DL factor	DL	LL factor	LL Reducing Coefficient	LL Reduced	At	n (floors supported)	DL Floor Load on Column (k)	LL Floor Load on Column (k)	DL Roof on Column (k)	LL Roof on Column (k)	Wall Load	Wall At	Wall Load on Column	Pu (DL)	Pu (LL)
3	R	1.2	34	1.6		30	877.5	0	0	0	29.835	26.325	15	0	0	29.835	26.325
2	3	1.2	56	1.6	0.50318484	40.25479	877.5	1	49.14	35.32358	29.835	26.325	15	0	0	78.975	61.64858
1	2	1.2	56	1.6	0.42902872	34.3223	877.5	2	98.28	60.23563	29.835	26.325	15	0	0	128.115	86.56063
Total															236.925	174.5342	

Loading Calculation for C5

Start Level	End Level	DL factor	DL	LL factor	LL Reducing Coefficient	LL Reduced	At	n (floors supported)	DL Floor Load on Column (k)	LL Floor Load on Column (k)	DL Roof on Column (k)	LL Roof on Column (k)	Wall Load	Wall At	Wall Load on Column	Pu (DL)	Pu (LL)
3	R	1.2	34	1.6		30	877.5	0	0	0	29.835	26.325	15	0	0	29.835	26.325
2	3	1.2	56	1.6	0.50318484	40.25479	877.5	1	49.14	35.32358	29.835	26.325	15	0	0	78.975	61.64858
1	2	1.2	56	1.6	0.42902872	34.3223	877.5	2	98.28	60.23563	29.835	26.325	15	0	0	128.115	86.56063
Total															236.925	174.5342	

Loading Calculation for C11

Start Level	End Level	DL factor	DL	LL factor	LL Reducing Coefficient	LL Reduced	At	n (floors supported)	DL Floor Load on Column (k)	LL Floor Load on Column (k)	DL Roof on Column (k)	LL Roof on Column (k)	Wall Load	Wall At	Wall Load on Column	Pu (DL)	Pu (LL)
3	R	1.2	34	1.6		30	438.75	0	0	0	14.9175	13.1625	15	546.0975	4.095731	19.01323	13.1625
2	3	1.2	56	1.6	0.60805744	48.64459	438.75	1	24.57	21.34282	14.9175	13.1625	15	438.75	9.871875	49.35938	34.50532
1	2	1.2	56	1.6	0.50318484	40.25479	438.75	2	49.14	35.32358	14.9175	13.1625	15	438.75	16.45313	80.51063	48.48608
Total															148.8832	96.15389	

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Loading Calcs

Loading Calculation for C1

Start Level	End Level	DL factor	DL	LL factor	LL Reducing Coefficient	LL Reduced	At	n (floors supported)	DL Floor Load on Column (k)	LL Floor Load on Column (k)	DL Roof on Column (k)	LL Roof on Column (k)	Wall Load	Wall At	Wall Load on Column	Pu (DL)	Pu (LL)
3	R	1.2	34	1.6		30	438.75	0	0	0	14.9175	13.1625	15	546.0975	4.095731	19.01323	13.1625
2	3	1.2	56	1.6	0.60805744	48.64459	438.75	1	24.57	21.34282	14.9175	13.1625	15	438.75	9.871875	49.35938	34.50532
1	2	1.2	56	1.6	0.50318484	40.25479	438.75	2	49.14	35.32358	14.9175	13.1625	15	438.75	16.45313	80.51063	48.48608
Total															148.8832	96.15389	

Loading Calculation for C2

Start Level	End Level	DL factor	DL	LL factor	LL Reducing Coefficient	LL Reduced	At	n (floors supported)	DL Floor Load on Column (k)	LL Floor Load on Column (k)	DL Roof on Column (k)	LL Roof on Column (k)	Wall Load	Wall At	Wall Load on Column	Pu (DL)	Pu (LL)
3	R	1.2	34	1.6		30	877.5	0	0	0	29.835	26.325	15	0	0	29.835	26.325
2	3	1.2	56	1.6	0.50318484	40.25479	877.5	1	49.14	35.32358	29.835	26.325	15	0	0	78.975	61.64858
1	2	1.2	56	1.6	0.42902872	34.3223	877.5	2	98.28	60.23563	29.835	26.325	15	0	0	128.115	86.56063
Total															236.925	174.5342	

Loading Calculation for C4

Start Level	End Level	DL factor	DL	LL factor	LL Reducing Coefficient	LL Reduced	At	n (floors supported)	DL Floor Load on Column (k)	LL Floor Load on Column (k)	DL Roof on Column (k)	LL Roof on Column (k)	Wall Load	Wall At	Wall Load on Column	Pu (DL)	Pu (LL)
3	R	1.2	34	1.6		30	877.5	0	0	0	29.835	26.325	15	0	0	29.835	26.325
2	3	1.2	56	1.6	0.50318484	40.25479	877.5	1	49.14	35.32358	29.835	26.325	15	0	0	78.975	61.64858
1	2	1.2	56	1.6	0.42902872	34.3223	877.5	2	98.28	60.23563	29.835	26.325	15	0	0	128.115	86.56063
Total															236.925	174.5342	

Loading Calculation for C5

Start Level	End Level	DL factor	DL	LL factor	LL Reducing Coefficient	LL Reduced	At	n (floors supported)	DL Floor Load on Column (k)	LL Floor Load on Column (k)	DL Roof on Column (k)	LL Roof on Column (k)	Wall Load	Wall At	Wall Load on Column	Pu (DL)	Pu (LL)
3	R	1.2	34	1.6		30	877.5	0	0	0	29.835	26.325	15	0	0	29.835	26.325
2	3	1.2	56	1.6	0.50318484	40.25479	877.5	1	49.14	35.32358	29.835	26.325	15	0	0	78.975	61.64858
1	2	1.2	56	1.6	0.42902872	34.3223	877.5	2	98.28	60.23563	29.835	26.325	15	0	0	128.115	86.56063
Total															236.925	174.5342	

Loading Calculation for C11

Start Level	End Level	DL factor	DL	LL factor	LL Reducing Coefficient	LL Reduced	At	n (floors supported)	DL Floor Load on Column (k)	LL Floor Load on Column (k)	DL Roof on Column (k)	LL Roof on Column (k)	Wall Load	Wall At	Wall Load on Column	Pu (DL)	Pu (LL)
3	R	1.2	34	1.6		30	438.75	0	0	0	14.9175	13.1625	15	546.0975	4.095731	19.01323	13.1625
2	3	1.2	56	1.6	0.60805744	48.64459	438.75	1	24.57	21.34282	14.9175	13.1625	15	438.75	9.871875	49.35938	34.50532
1	2	1.2	56	1.6	0.50318484	40.25479	438.75	2	49.14	35.32358	14.9175	13.1625	15	438.75	16.45313	80.51063	48.48608
Total															148.8832	96.15389	

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Loading Calcs

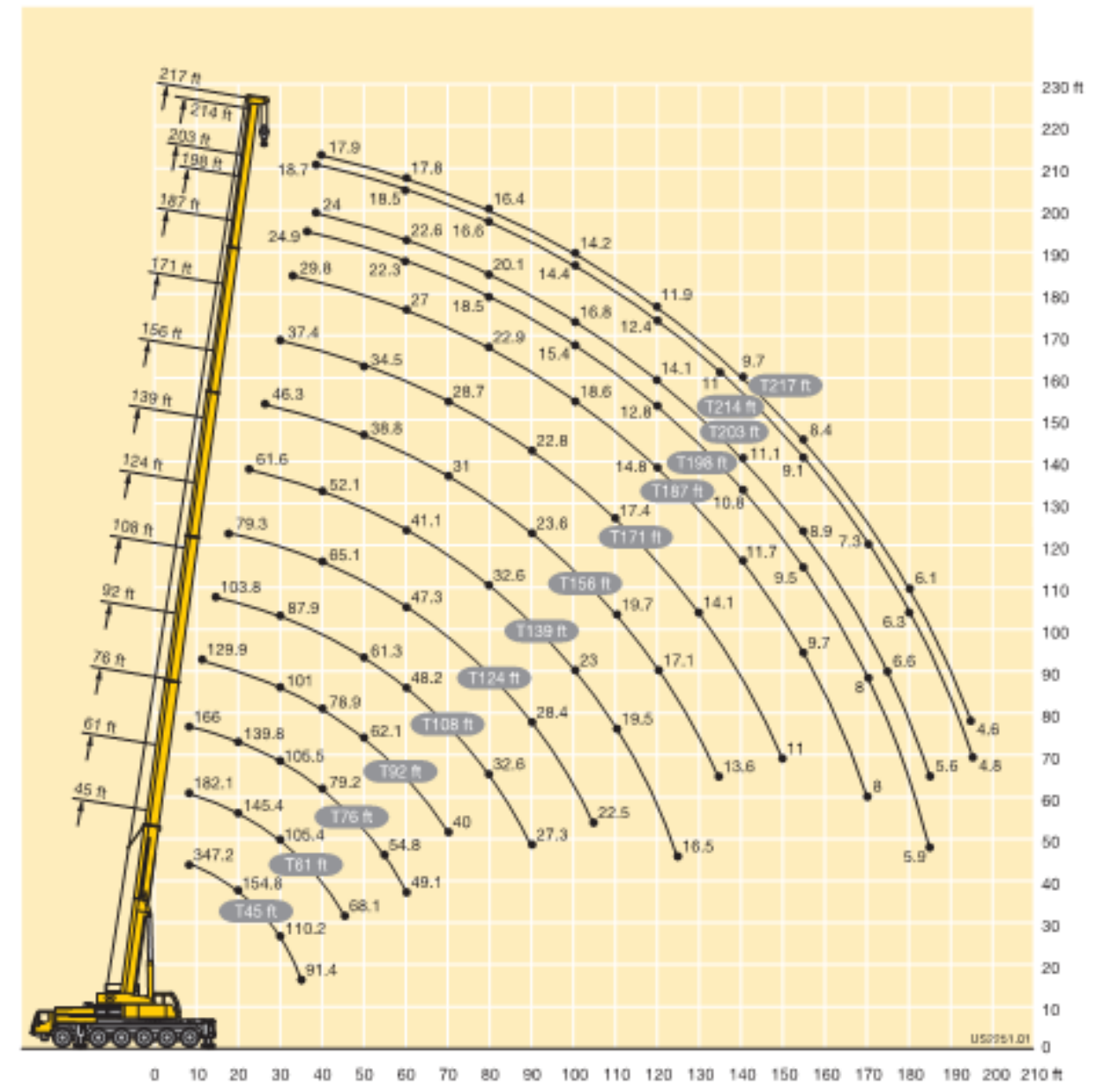
Footing Redesign Calculations																														
Footing	PD (K)	PL (K)	L+D (K)	Bearing capacity (qa) (ksf)	B	B	Size	Load Comb.	q (ksf)	q (psi)	Fc (psi)	vc	vc	vc (controls)	d	h	h (in)	h (ft)	d	l	Mn	a	As	Bar #	As	Spacing (in)	p(s+1)	a	c	%
A2	177.0008	114.6608	291.6615	5	7.64	8.00	8'x8'	395.8581	6.19	42.95	4500	402.4922	2146.625	201.25	11.82	19.57	18	1.5	14.25	36	27.83	1.31	0.44	#6	0.56	9.5	0.001944	0.73	0.86	0.046533
A4	177.0008	114.6608	291.6615	5	7.64	8.00	8'x8'	395.8581	6.19	42.95	4500	402.4922	2146.625	201.25	11.82	19.57	18	1.5	14.25	36	27.83	1.31	0.44	#6	0.56	9.5	0.001944	0.73	0.86	0.046533
A8	177.0008	114.6608	291.6615	5	7.64	8.00	8'x8'	395.8581	6.19	42.95	4500	402.4922	2146.625	201.25	11.82	19.57	18	1.5	14.25	36	27.83	1.31	0.44	#6	0.56	9.5	0.001944	0.73	0.86	0.046533
A11	107.2208	64.30175	171.5226	5	5.86	6.00	6'x6'	231.5478	6.43	44.67	4500	402.4922	1475.805	201.25	7.41	11.035	12	1	8.375	24	12.86	1.31	0.35	#5	0.57	6.5	0.001979	0.75	0.88	0.025601
B1	167.9708	106.4777	274.4485	5	7.41	8.00	8'x8'	371.9293	5.81	40.36	4500	402.4922	2146.625	201.25	11.31	15.06	18	1.5	14.25	36	26.15	1.31	0.42	#6	0.56	9.5	0.0019	0.73	0.86	0.046533
B4	267.3	194.0769	461.3769	5	9.61	10.00	10'x10'	631.283	6.31	43.84	3000	328.6335	2300.435	164.32	19.3	23.175	24	2	20.125	48	50.50	1.96	0.57	#7	0.60	12	0.002083	1.18	1.38	0.040638
B5	267.3	194.0769	461.3769	5	9.61	10.00	10'x10'	631.283	6.31	43.84	3000	328.6335	2300.435	164.32	19.3	23.175	24	2	20.125	48	50.50	1.96	0.57	#7	0.60	12	0.002083	1.18	1.38	0.040638
C1	148.8832	96.15389	245.0371	5	7.00	7.50	7.5'x7.5'	332.5061	5.91	41.05	4500	402.4922	2146.625	201.25	10.3	14.05	15	1.25	11.25	33	22.35	1.31	0.45	#6	0.56	9.5	0.001944	0.73	0.86	0.036105
C2	236.925	174.5342	411.4592	5	9.07	9.50	9.5'x9.5'	563.5647	6.24	43.36	3000	328.6335	2300.435	164.32	17.77	21.645	24	2	20.125	45	43.91	1.96	0.50	#6	0.56	9.5	0.001944	1.10	1.29	0.043755
C4	236.925	174.5342	411.4592	5	9.07	9.50	9.5'x9.5'	563.5647	6.24	43.36	3000	328.6335	2300.435	164.32	17.77	21.645	24	2	20.125	45	43.91	1.96	0.50	#6	0.56	9.5	0.001944	1.10	1.29	0.043755
C5	236.925	174.5342	411.4592	5	9.07	9.50	9.5'x9.5'	563.5647	6.24	43.36	3000	328.6335	2300.435	164.32	17.77	21.645	24	2	20.125	45	43.91	1.96	0.50	#6	0.56	9.5	0.001944	1.10	1.29	0.043755
C11	148.8832	96.15389	245.0371	5	7.00	7.50	7.5'x7.5'	332.5061	5.91	41.05	4500	402.4922	2146.625	201.25	10.3	14.05	15	1.25	11.25	33	22.35	1.31	0.45	#6	0.56	9.5	0.001944	0.73	0.86	0.036105

Average Reduction Percentage									
Footing	Bearing capacity (qa) (ksf)	Length/W idth @ qa = 2 ksf	Depth @ qa = 2 ksf	CF @ qa = 2 ksf	Bearing capacity (qa) (ksf)	Length/W idth @ qa = 5 ksf	Depth @ qa = 5 ksf	CF @ qa = 5 ksf	Reduced
A2	2	11.5	2.17	286.54	5	8.00	1.5	96	66%
A4	2	12	2.33	336.00	5	8.00	1.5	96	71%
A8	2	12	2.33	336.00	5	8.00	1.5	96	71%
A11	2	11.5	2.17	286.54	5	6.00	1	36	87%
B1	2	11.5	2.17	286.54	5	8.00	1.5	96	66%
B4	2	14	2.50	490.00	5	10.00	2	200	59%
B5	2	12	2.33	336.00	5	10.00	2	200	40%
C1	2	11.5	2.17	286.54	5	7.50	1.25	70.3125	75%
C2	2	12	2.33	336.00	5	9.50	2	180.5	46%
C4	2	14	2.50	490.00	5	9.50	2	180.5	63%
C5	2	12	2.33	336.00	5	9.50	2	180.5	46%
C11	2	12	2.33	336.00	5	7.50	1.25	70.3125	79%
Average									64%

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Footings Schedule



PROJECT BACKGROUND

ANALYSIS I: PREASSEMBLED PANELS

LIGHTING BREADTH

ANALYSIS II: PRECAST FOOTINGS

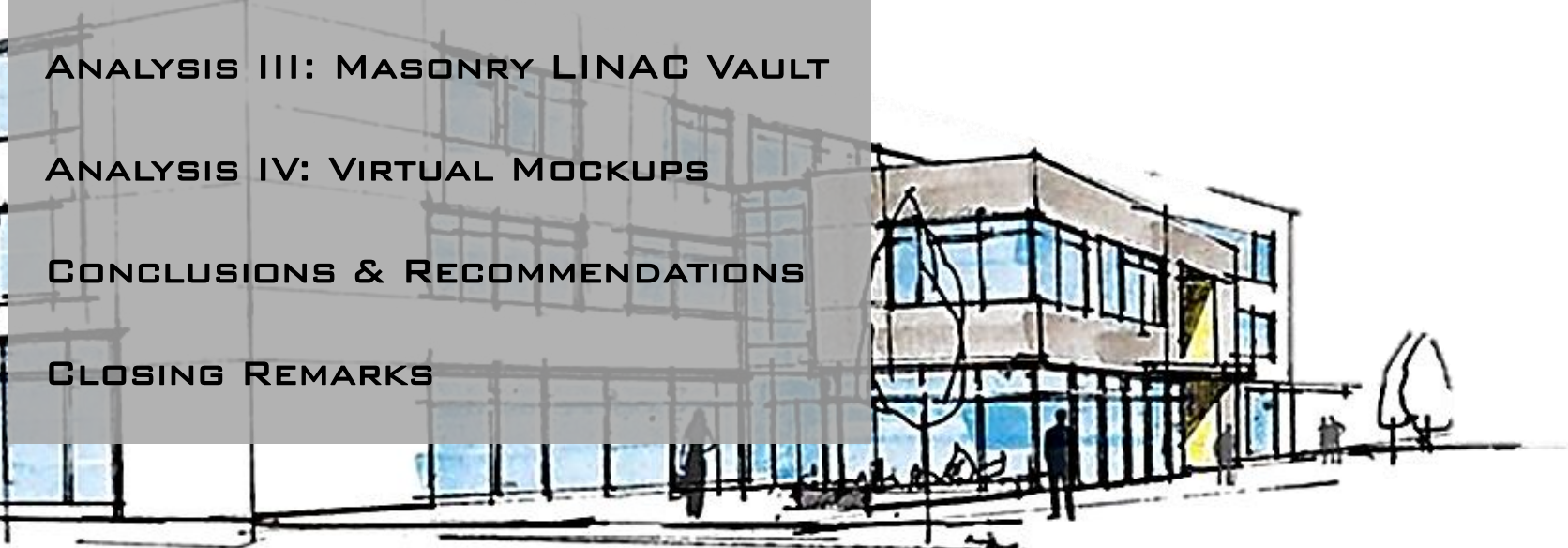
STRUCTURAL BREADTH

ANALYSIS III: MASONRY LINAC VAULT

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Cost Comparison

Summary of Cost Comparison for Analysis I		
	Cast-in-Place Footing	Precast Footing
Concrete	\$60,000	\$29,000
Rebar	\$23,000	\$23,000
Placement	\$8,500	\$5,500
Formwork	\$0	\$45,000
Earthwork & Fill	\$7,000	\$6,300
Miscellaneous Costs	\$11,000	\$11,000
Transportation	\$0	\$1,200
Crane	\$0	\$41,000
Total System Cost	\$110,200	\$161,800

PROJECT BACKGROUND

ANALYSIS I: PREASSEMBLED PANELS

LIGHTING BREADTH

ANALYSIS II: PRECAST FOOTINGS

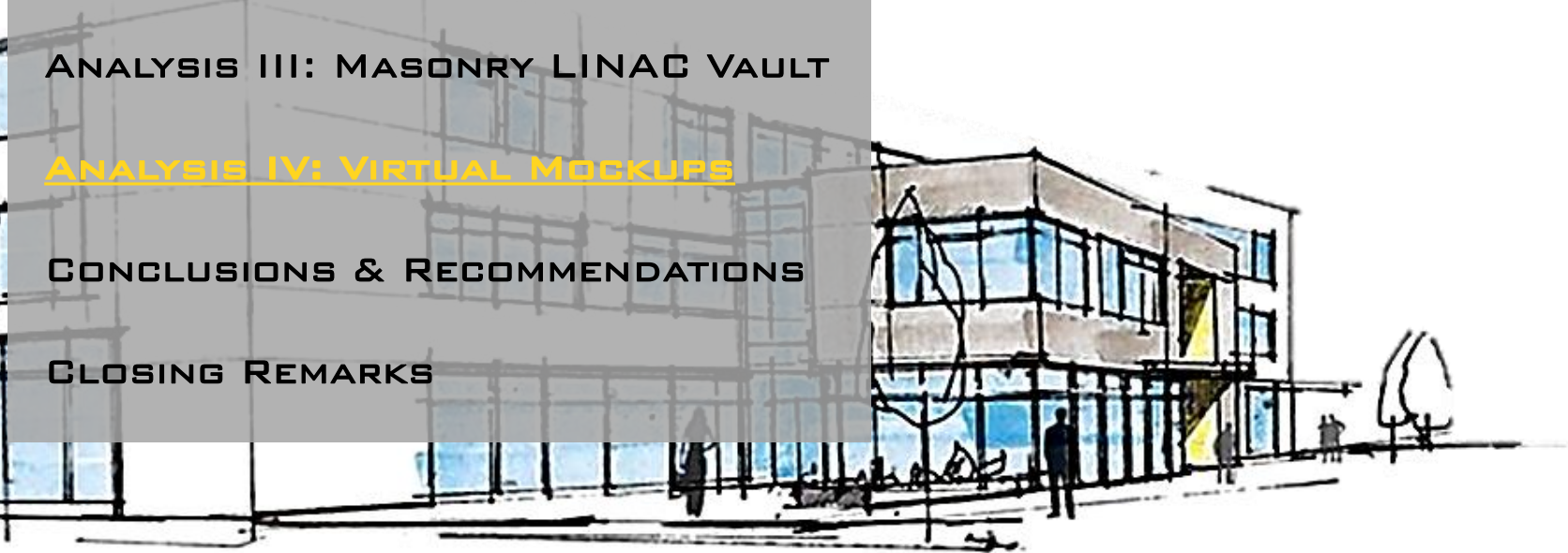
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