

Introduction

South Halls Renovation and New Construction
The Pennsylvania State University
University Park, PA



Penn State Architectural Engineering Senior Capstone Project
Quaid Spearing | Construction Option
Advisor: Dr. Anumba
April 15, 2014

Project Overview

Analysis 1: Modular Bathrooms

Background Information
Planning & Procurement
Design Evaluation – Arch. Breadth
Results

Analysis 2: SIPS

Background Information
Approach
Results

Analysis 4: Phase Resequencing

Background Information
Process
Results

Final Recommendation

Acknowledgements

Project Overview

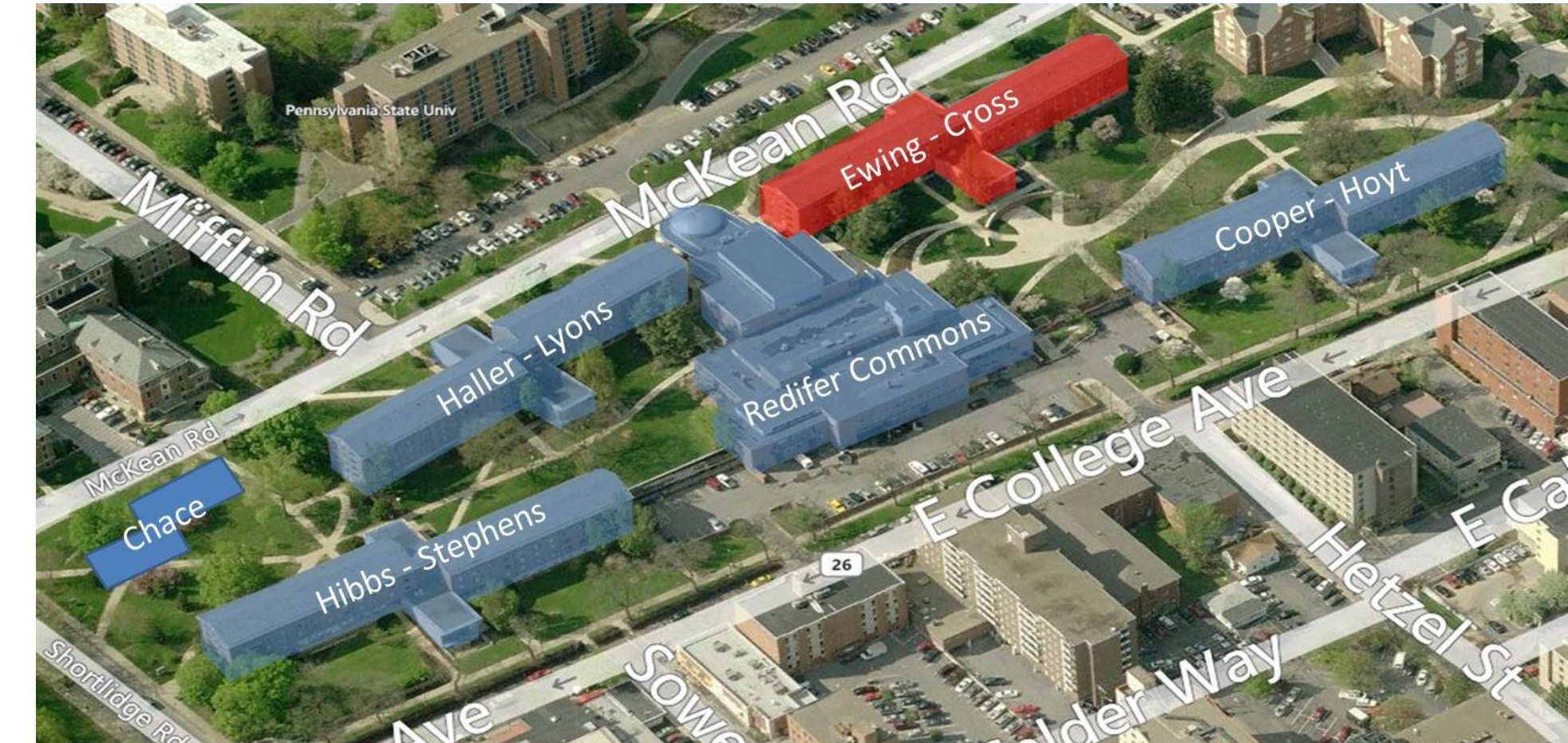
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Project Team



- Size: 71,002 GSF
- Stories: Four plus Basement
- Function: Residential & Assembly
- Construction Dates: 05/13 – 12/13
- Total Project Cost: \$94.1M GMP
- Phase Project Cost: \$15.2M
- Delivery Method: Design-Build



Source: Bing Maps

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- Design Evaluation – Arch. Breadth
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Analysis 2: SIPS

- Background Information
- Approach
- Results

Analysis 4: Phase Resequencing

- Background Information
- Process
- Results

Final Recommendation

Acknowledgements

Analysis 1: Modular Bathrooms

- Improve quality of bathrooms through modularization, while also reducing the construction schedule.

Architectural Breadth

- Decrease the number of bathroom layouts to improve design efficiency and increase offsite productivity

Analysis 2: SIPS

- Implement a new construction sequencing through the use of SIPS, with a goal to deliver the student rooms 1 week sooner.

Analysis 3: Prefabrication of Limestone Façade

- Fabricate stone panel wall system offsite to increase productivity and accelerate project schedule

Structural Breadth

- Analyze loads of traditional limestone façade on existing columns

Analysis 4: Phase Resequencing

- Develop an alternate master phasing plan to accelerate the completion of the project and allow generation of revenue sooner.

Project Overview

Analysis 1: Modular Bathrooms

- Background Information
- Planning & Procurement
- Design Evaluation – Arch. Breadth
- Results

Analysis 2: SIPS

- Background Information
- Approach
- Results

Analysis 4: Phase Resequencing

- Background Information
- Process
- Results

Final Recommendation

Acknowledgements

Analysis 1

Modular Bathrooms

Background Information

Analysis 1: Modular Bathrooms

Project Overview

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Background Information

Planning & Procurement
Design Evaluation – Arch. Breadth
Results

Analysis 2: SIPS

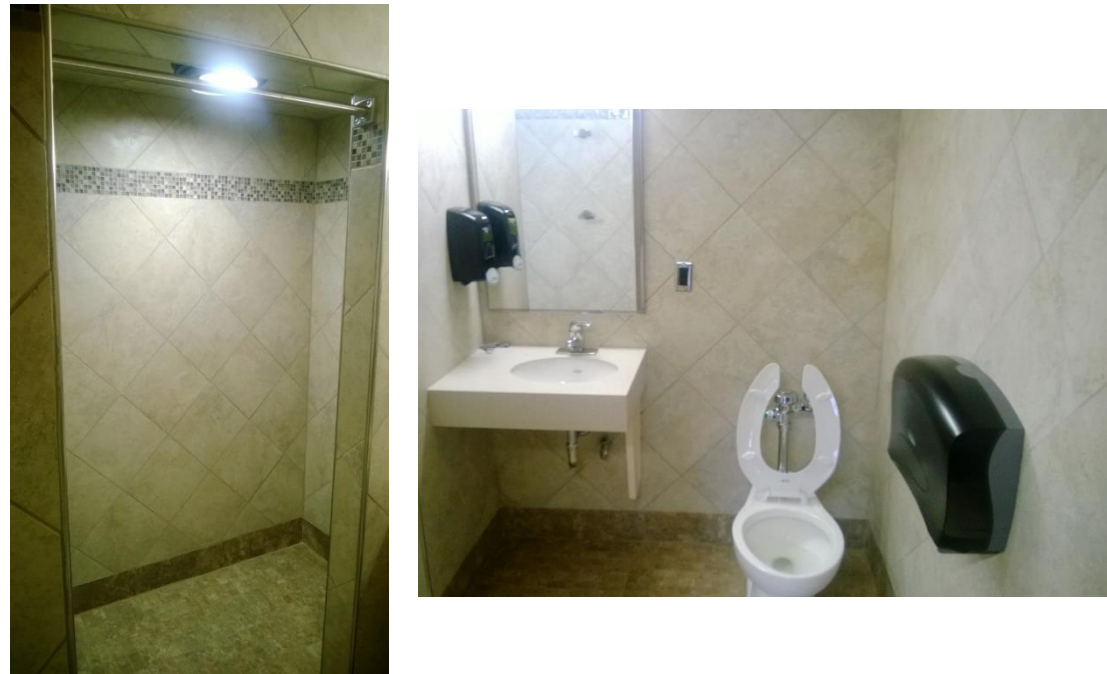
Background Information
Approach
Results

Analysis 4: Phase Resequencing

Background Information
Process
Results

Final Recommendation

Acknowledgements



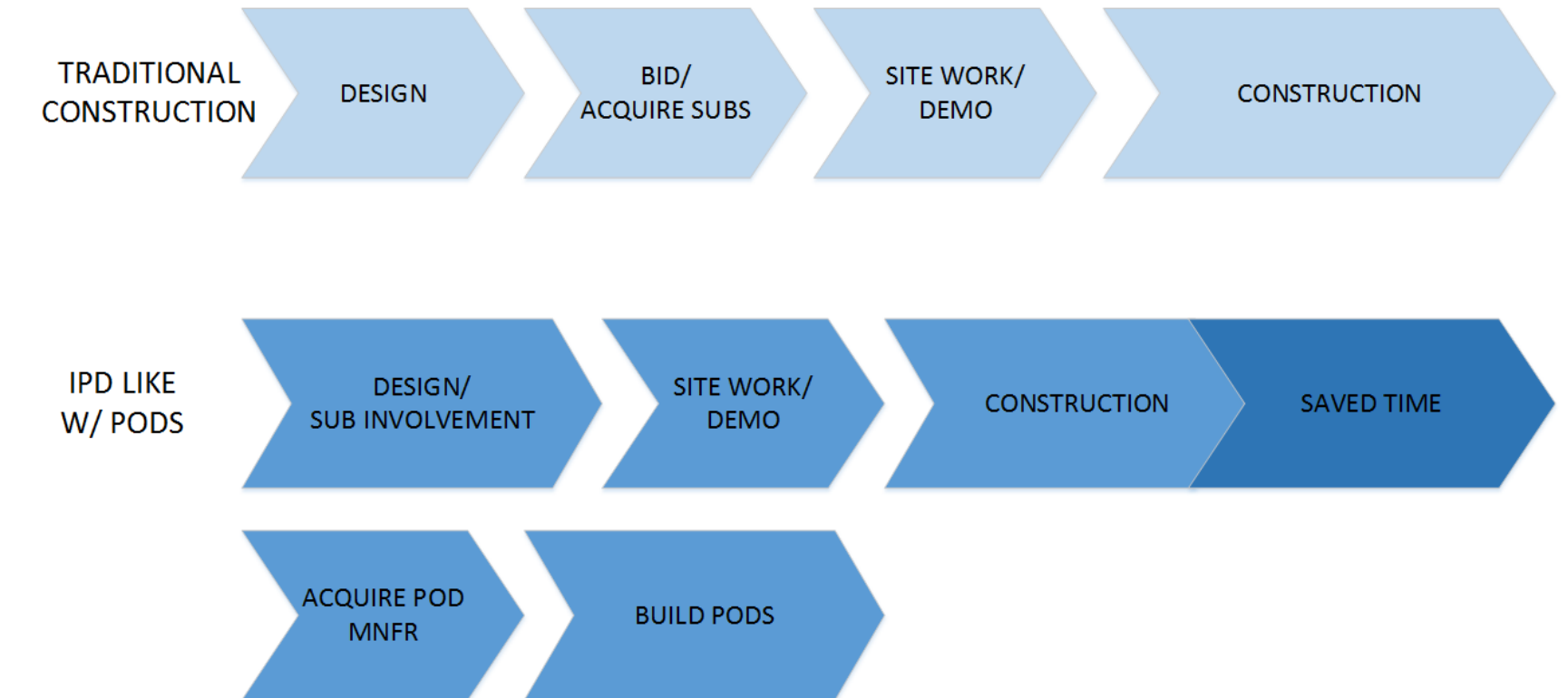
Images taken by Quaid Spearing

Problem

- Quality of finish work and in Bathrooms
 - Bathroom finishes accelerated to maintain schedule
 - Rework of Tile

Potential Solution

- Modularize the bathroom units to be constructed offsite
 - Improve finish quality
 - Accelerate bathroom schedule



Analysis 1: Modular Bathrooms

Planning & Procurement

Project Overview

Analysis 1: Modular Bathrooms

Background Information

Planning & Procurement

Design Evaluation – Arch. Breadth

Results

Analysis 2: SIPS

Background Information

Approach

Results

Analysis 4: Phase Resequencing

Background Information

Process

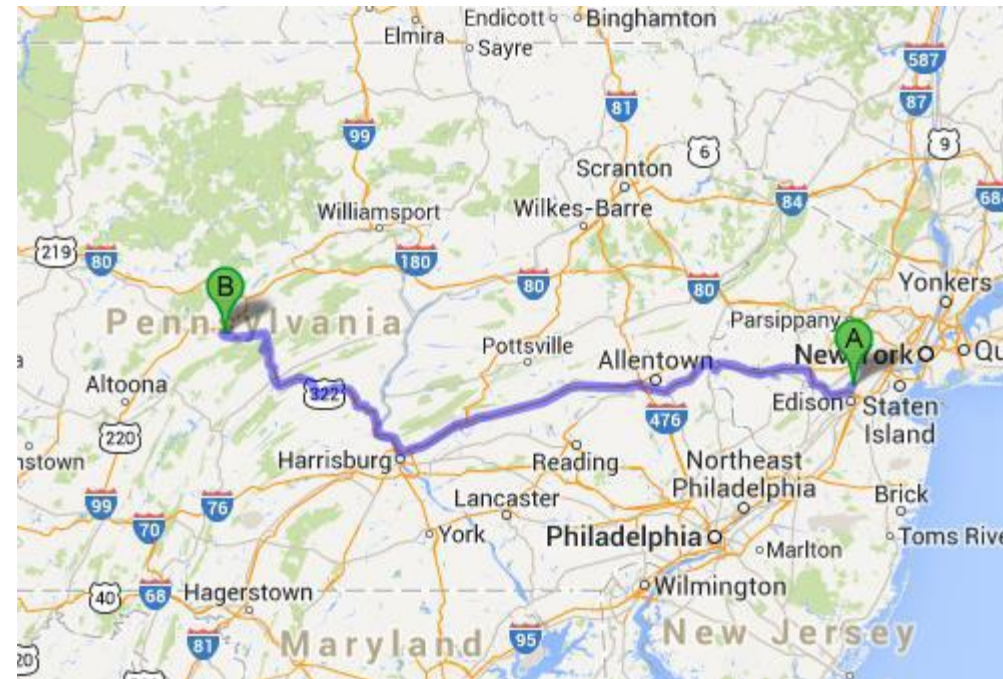
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Final Recommendation

Acknowledgements

Bathroom Pod Manufacturer

- Ameripod LLC



Source: Google Maps

Bathroom Pod Summary

Manufacturer	Ameripod
Cost Per Bathroom	\$ 13,460.00
Design Fees/Design	\$ 7,500.00
Manufacturing: Days/Pod	15
Manufacturing: Pods/Week	30
Installation Pods/Day	12
Distance from Jobsite (miles)	231

Project Overview

Analysis 1: Modular Bathrooms

Background Information

Planning & Procurement

Design Evaluation – Arch. Breadth

Results

Analysis 2: SIPS

Background Information

Approach

Results

Analysis 4: Phase Resequencing

Background Information

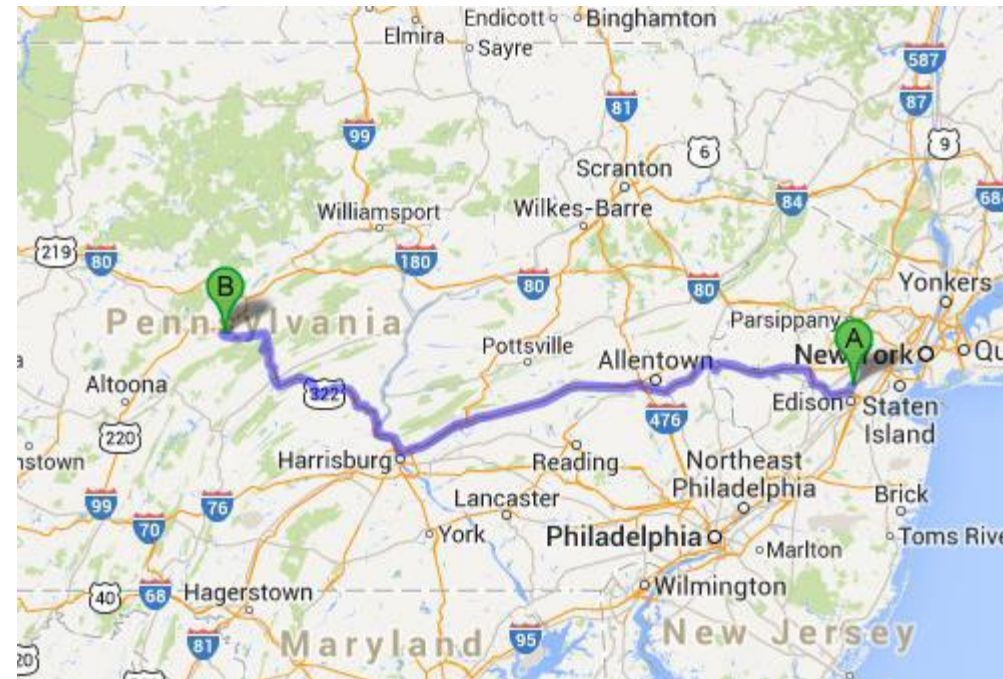
Process

Results

Final Recommendation

Acknowledgements

Analysis 1: Modular Bathrooms



Source: Google Maps

Planning & Procurement

Bathroom Pod Manufacturer

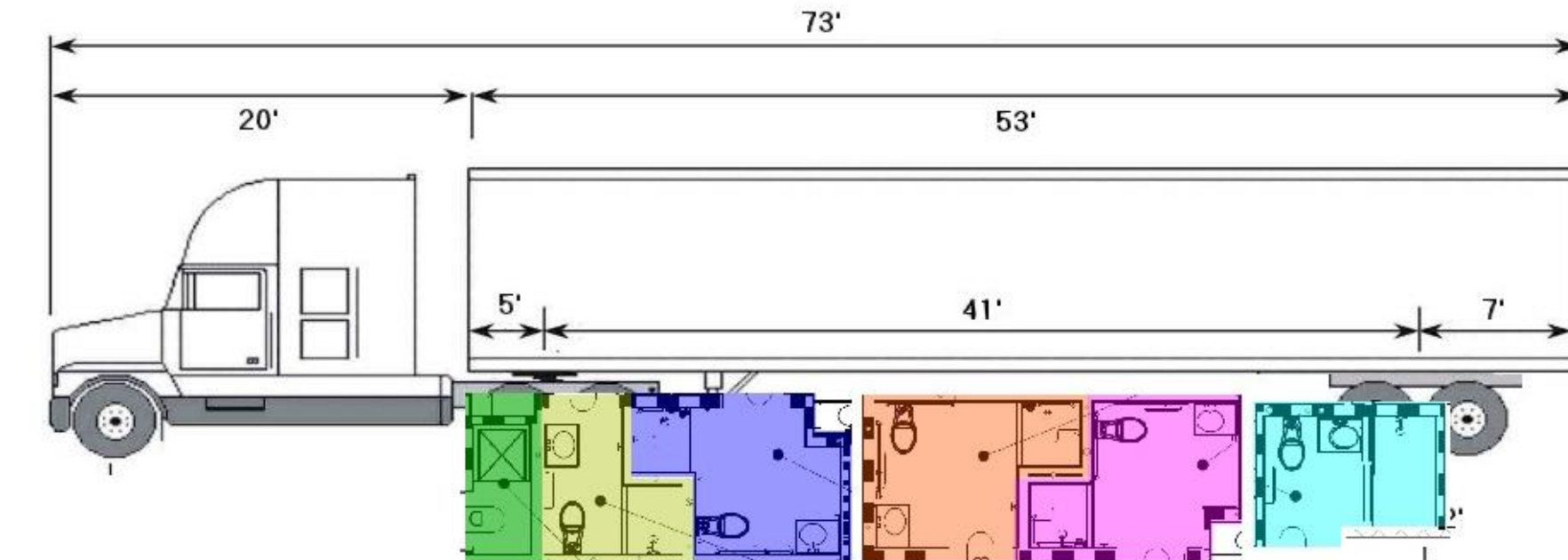
- Ameripod LLC

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Transportation



Project Overview

Analysis 1: Modular Bathrooms

Background Information

Planning & Procurement

Design Evaluation – Arch. Breadth

Results

Analysis 2: SIPS

Background Information

Approach

Results

Analysis 4: Phase Resequencing

Background Information

Process

Results

Final Recommendation

Acknowledgements

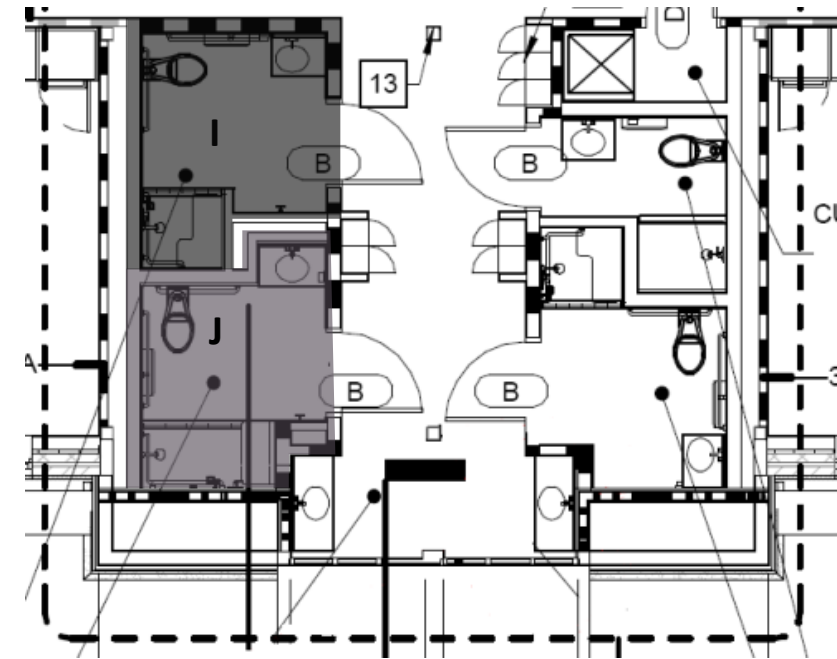
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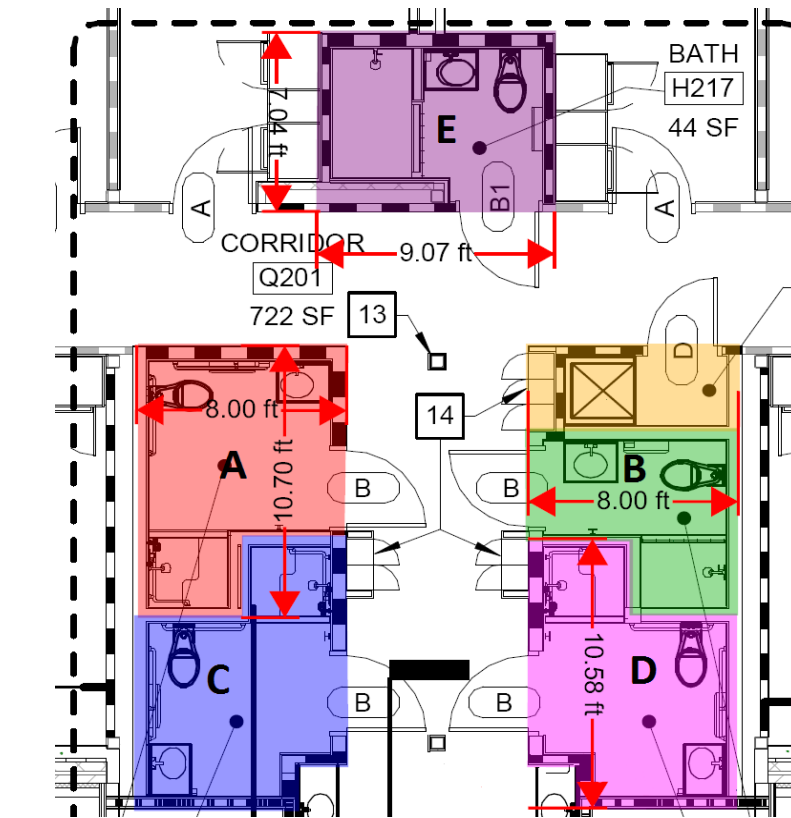
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Original Bathroom Layout

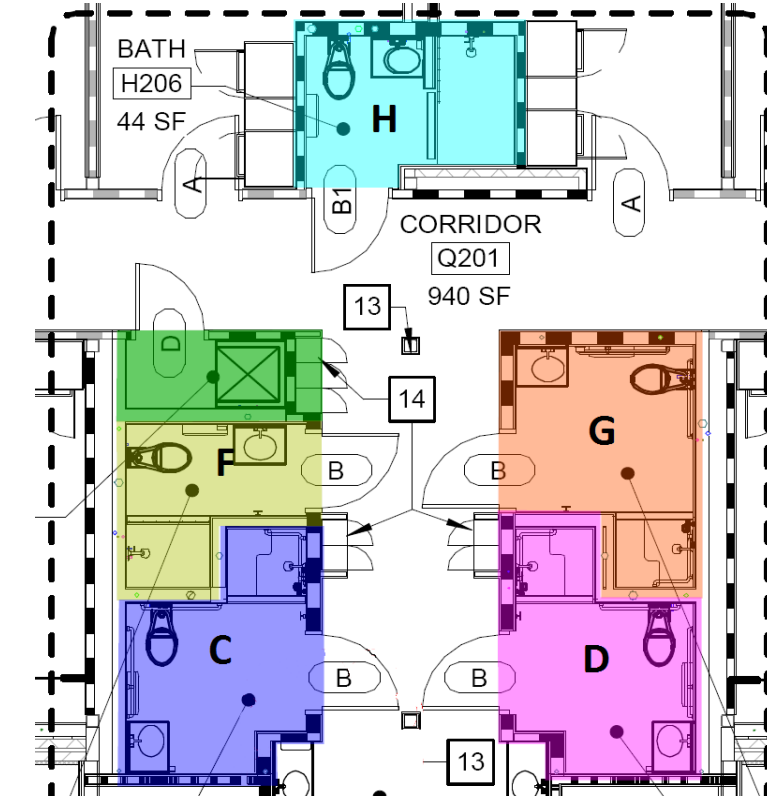
- 10 different unit types
 - Followed existing layout
- Goal: reduce number of layouts for modularization
 - Increase fabrication productivity



Original Roll-In Shower Layout



Original Ewing Layout



Original Cross Layout

Project Overview

Analysis 1: Modular Bathrooms

- Background Information
- Planning & Procurement
- Design Evaluation – Arch. Breadth**
- Results

Analysis 2: SIPS

- Background Information
- Approach
- Results

Analysis 4: Phase Resequencing

- Background Information
- Process
- Results

Final Recommendation

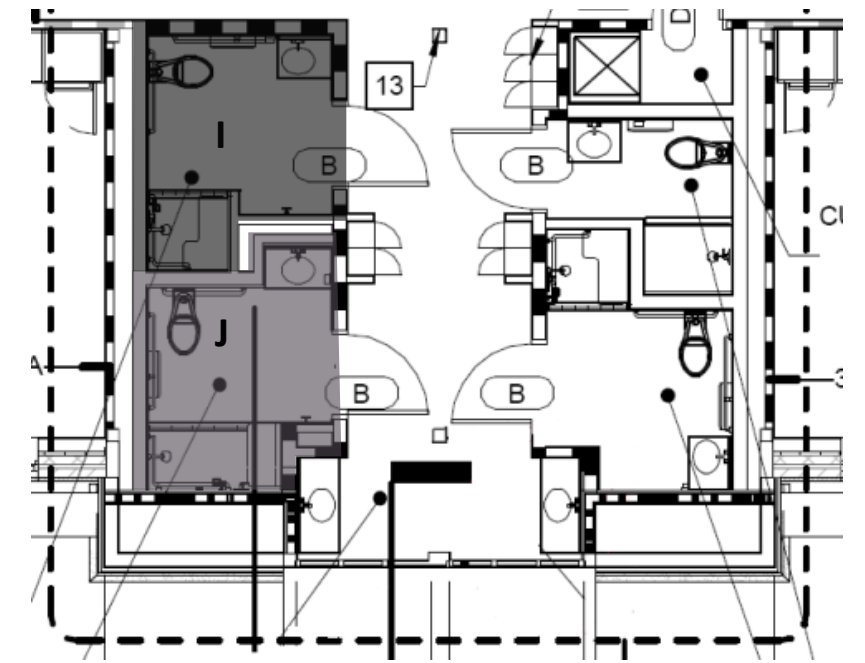
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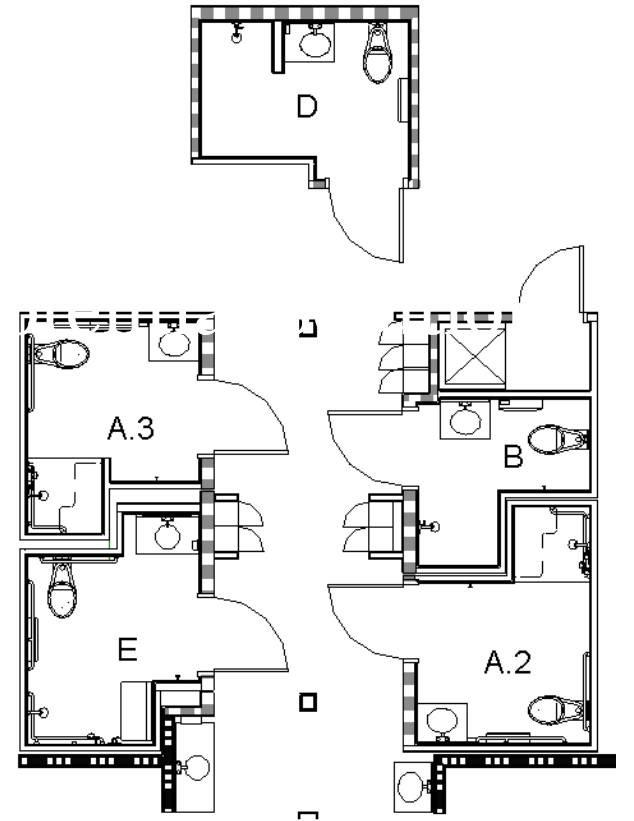
Design Evaluation - Arch. Breadth

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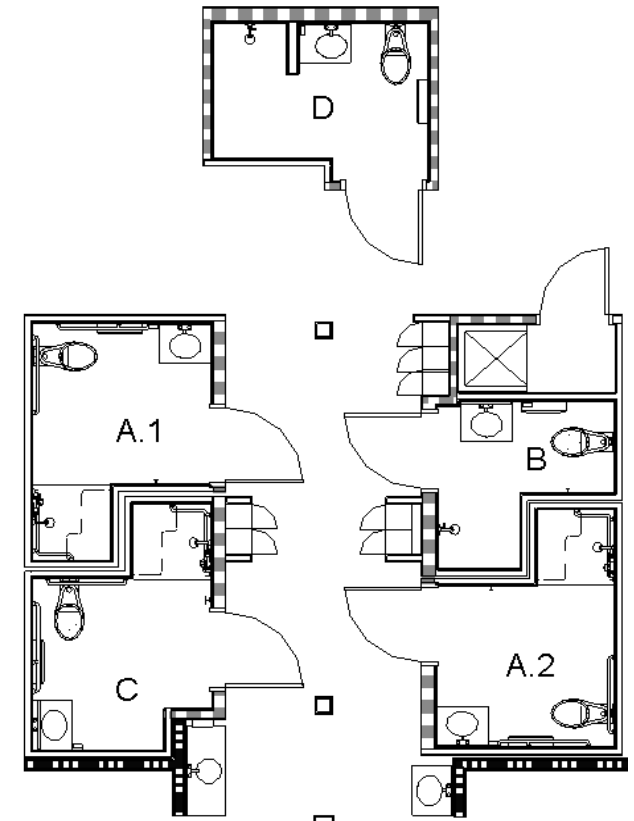
Proposed New Bathroom Layout



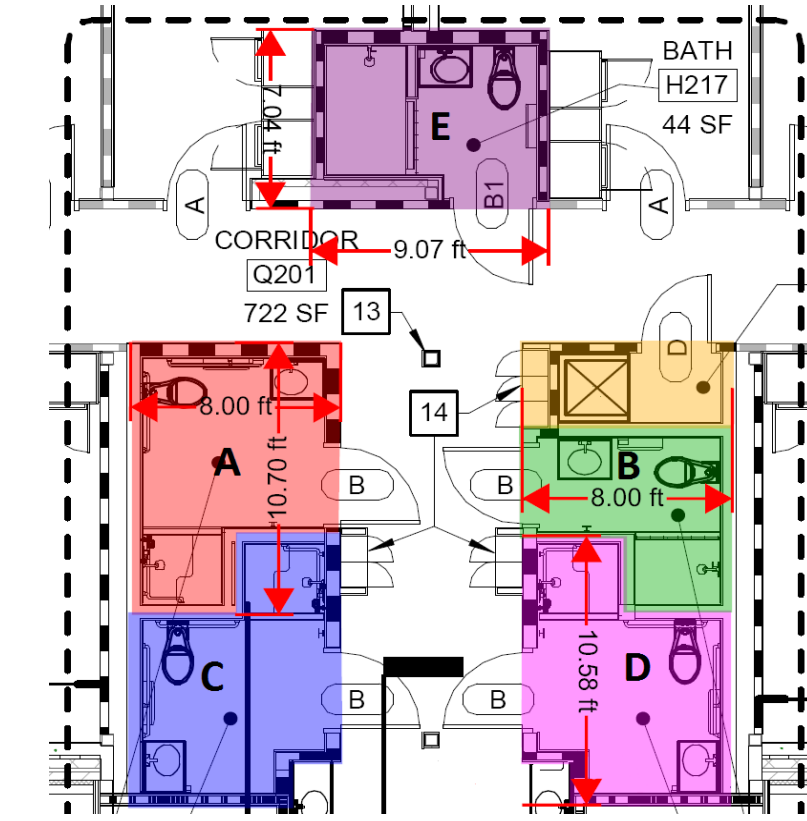
Original Roll-In Shower Layout



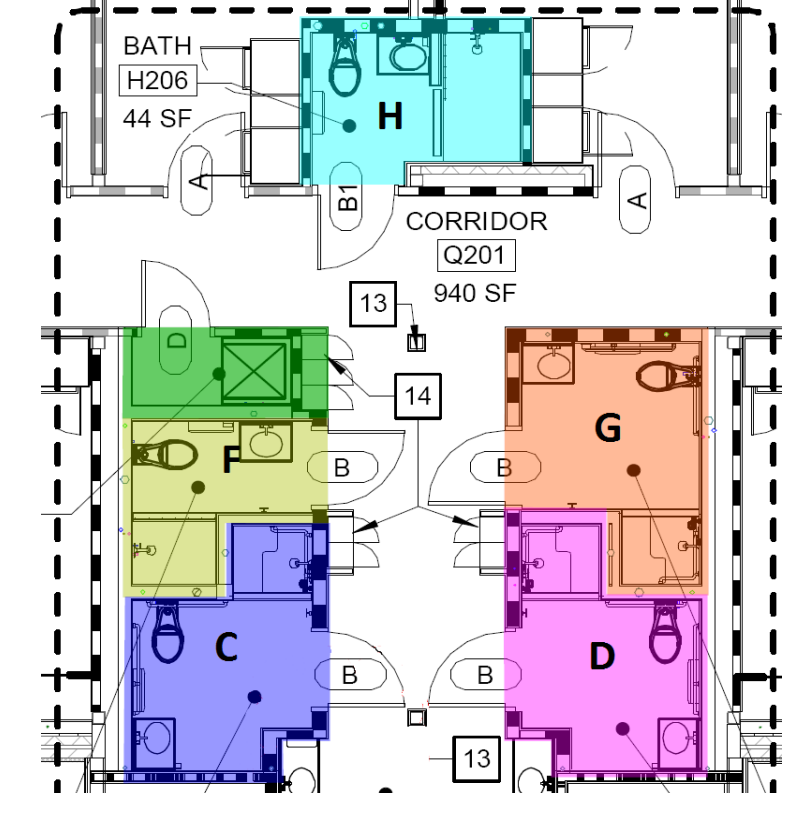
Proposed Roll-In Shower Layout



Proposed Typical Layout



Original Ewing Layout



Original Cross Layout

Project Overview

Analysis 1: Modular Bathrooms

Background Information

Planning & Procurement

Design Evaluation – Arch. Breadth

Results

Analysis 2: SIPS

Background Information

Approach

Results

Analysis 4: Phase Resequencing

Background Information

Process

Results

Final Recommendation

Acknowledgements

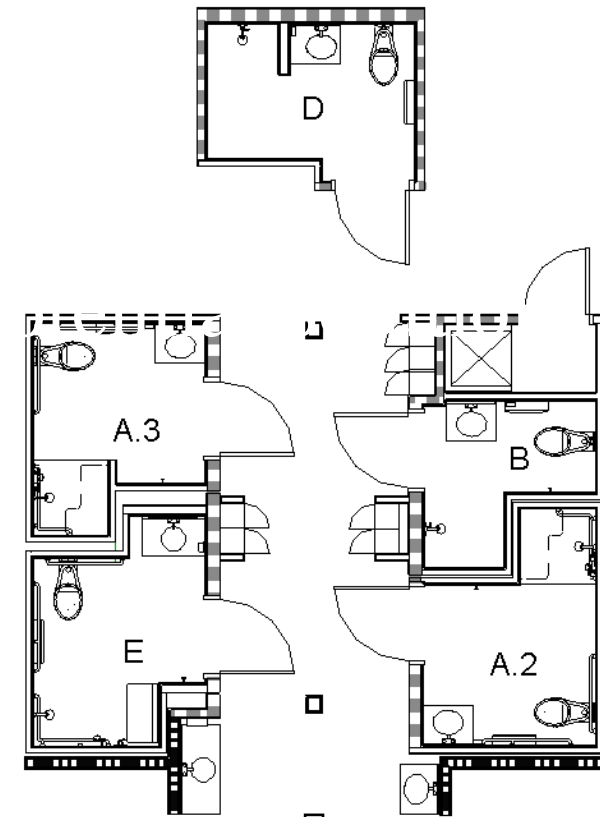
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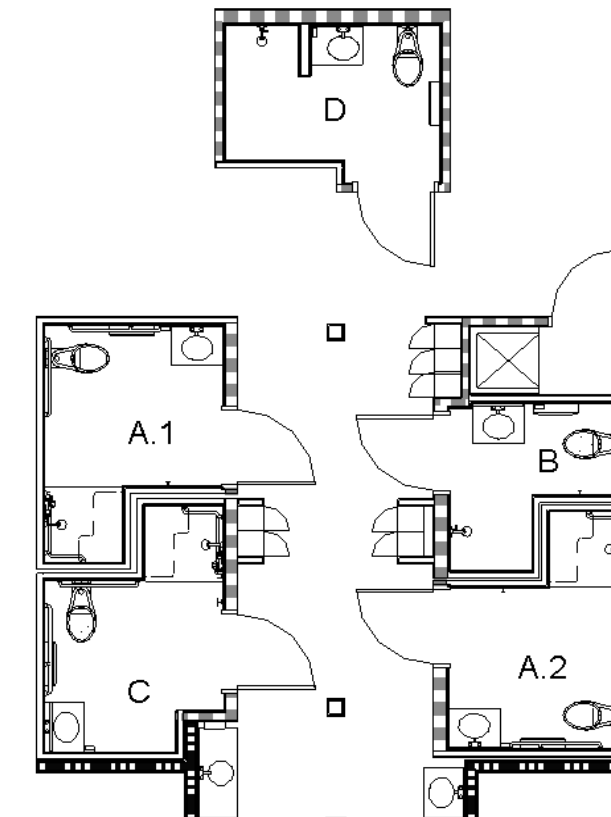
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Proposed New Bathroom Layout

Bathroom Module Designs		
Module	Qty/Bldg	Qty/Project
A.1/A.2	15	60
A.3	1	4
B	8	32
C	7	28
D	8	32
E	1	4
Total	40	160

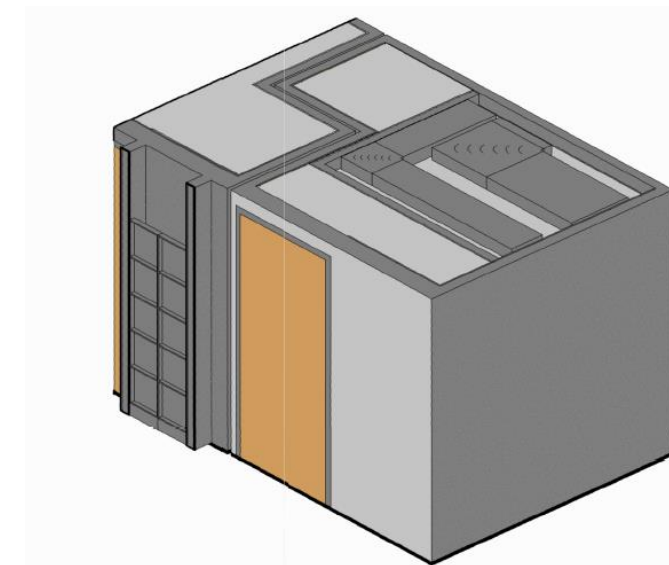
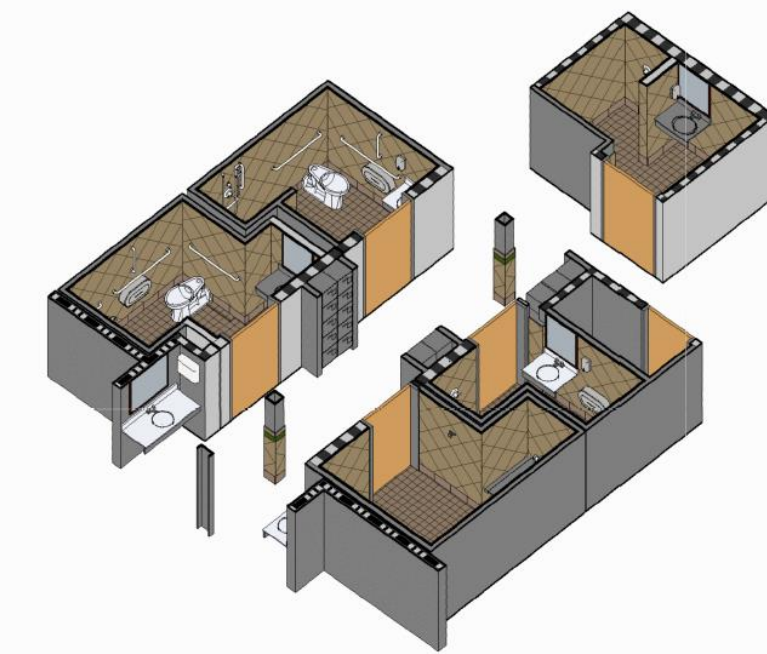


Proposed Roll-In Shower Layout



Proposed Typical Layout

- Reduced number of layouts from 10 down to 6
 - Increase benefits of modularization by optimizing layout



Results

Analysis 1: Modular Bathrooms

Project Overview

Analysis 1: Modular Bathrooms

- Background Information
- Planning & Procurement
- Design Evaluation – Arch. Breadth

Results

Analysis 2: SIPS

- Background Information
- Approach
- Results

Analysis 4: Phase Resequencing

- Background Information
- Process
- Results

Final Recommendation

Acknowledgements

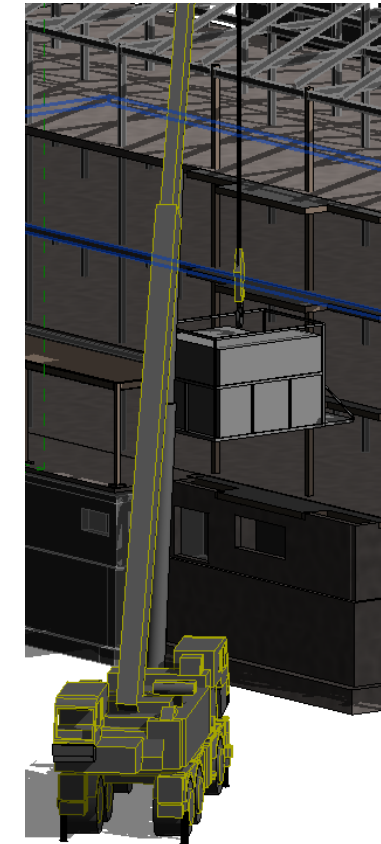
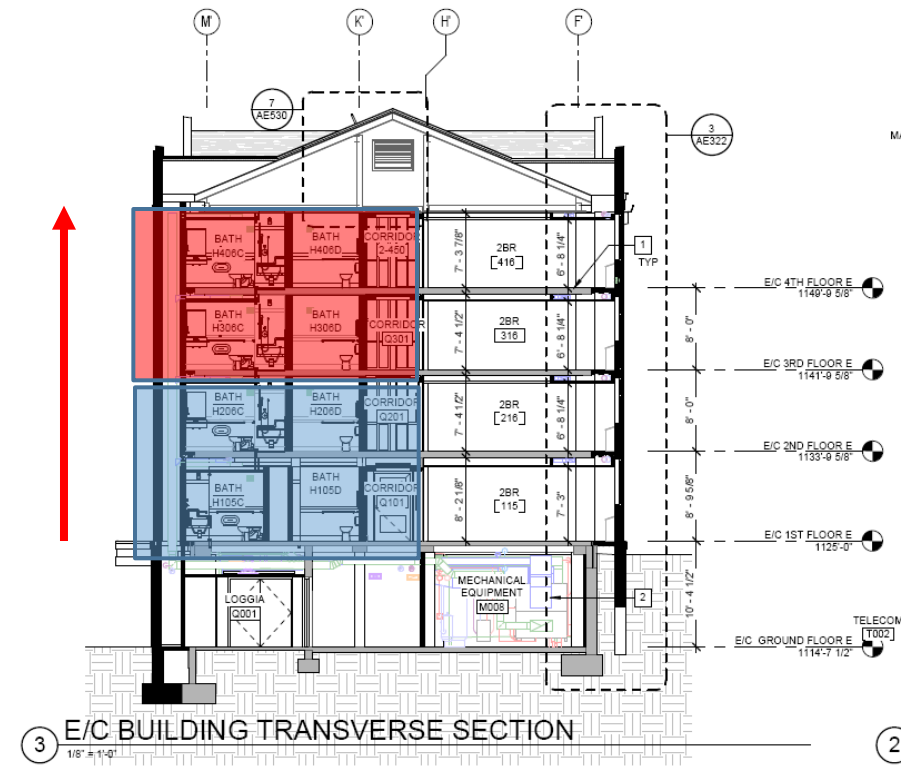
Hoisting and Sequencing

Stick Built

- All floors working simultaneous

Modular

- Construction sequenced 1st to 4th
- 4 deliveries per stack
 - Just in time deliveries



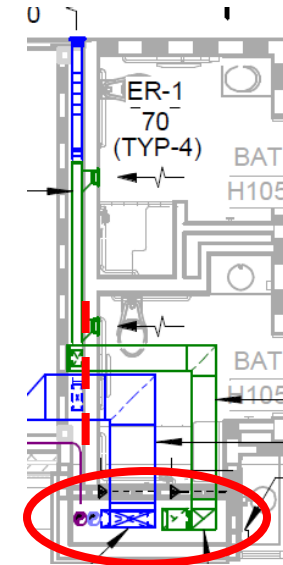
Truck	# PODS	Hoisting Sequencing																
		Day 1								Day 2								
		8AM	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	8AM	9AM	10AM	11AM	12PM	1PM	2PM	3PM
A	5	█	█	█	█													
B	5						█	█	█	█								
C	5										█	█	█	█				
D	5															█	█	█

Results

Analysis 1: Modular Bathrooms

Constructability

- Intense Coordination
- Duct Risers
- **Sequencing**
- Complete Punchlist Sooner
- Increased Quality
- Safer Work Environment



Project Overview

Analysis 1: Modular Bathrooms

- Background Information
- Planning & Procurement
- Design Evaluation – Arch. Breadth

Results

Analysis 2: SIPS

- Background Information
- Approach
- Results

Analysis 4: Phase Resequencing

- Background Information
- Process
- Results

Final Recommendation

Acknowledgements

Results

Analysis 1: Modular Bathrooms

Project Overview

Analysis 1: Modular Bathrooms

- Background Information
- Planning & Procurement
- Design Evaluation – Arch. Breadth

Results

Analysis 2: SIPS

- Background Information
- Approach
- Results

Analysis 4: Phase Resequencing

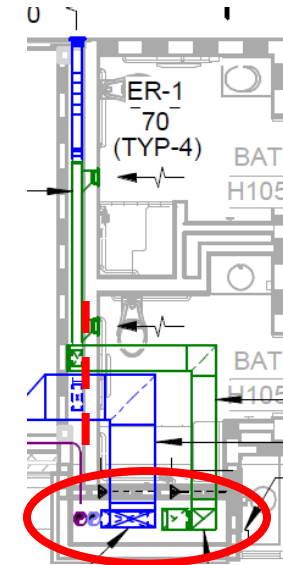
- Background Information
- Process
- Results

Final Recommendation

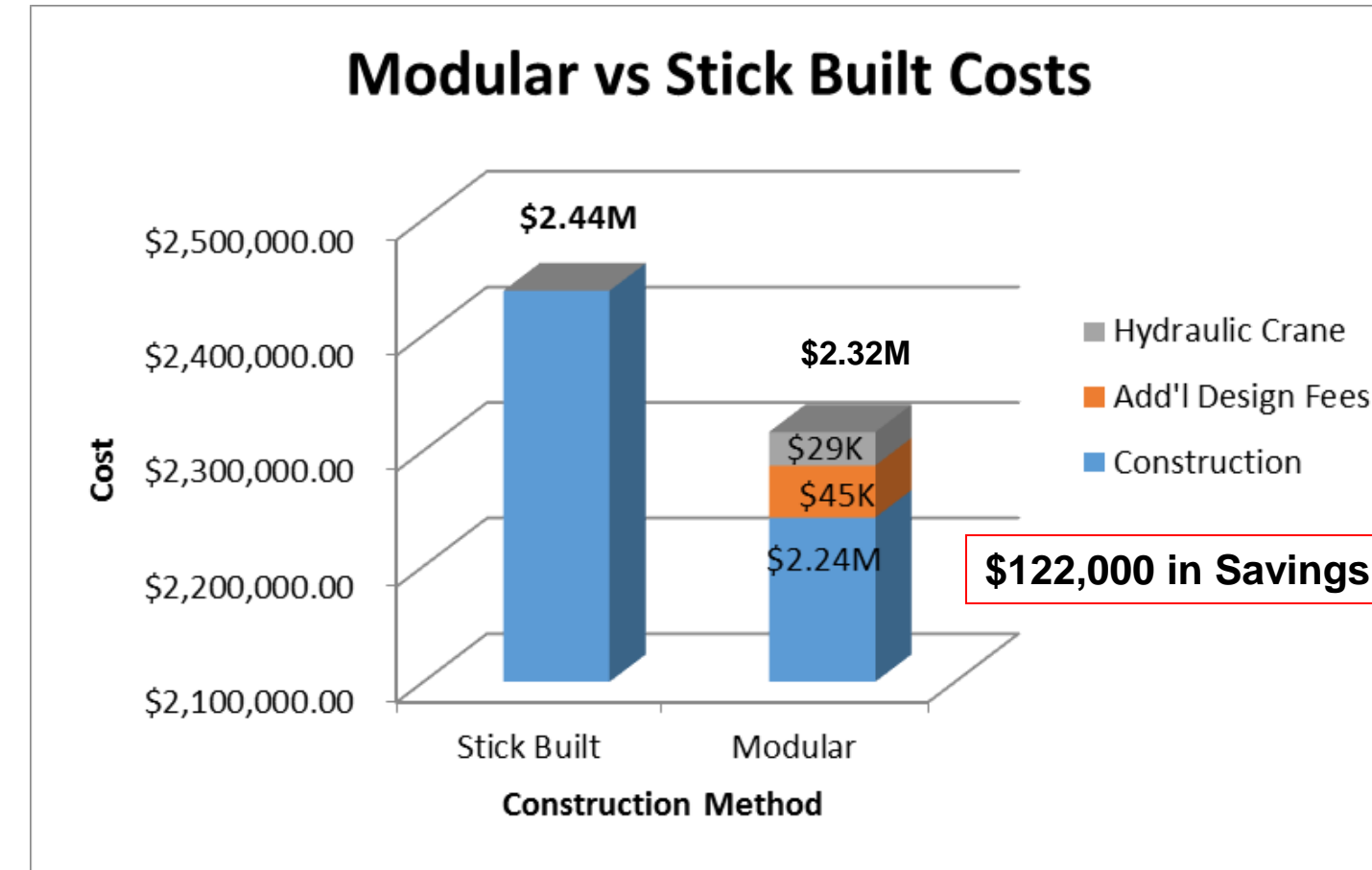
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Constructability

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- Duct Risers
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Cost Analysis



Project Overview

Analysis 1: Modular Bathrooms

Background Information
Planning & Procurement
Design Evaluation – Arch. Breadth

Results

Analysis 2: SIPS

Background Information
Approach
Results

Analysis 4: Phase Resequencing

Background Information
Process
Results

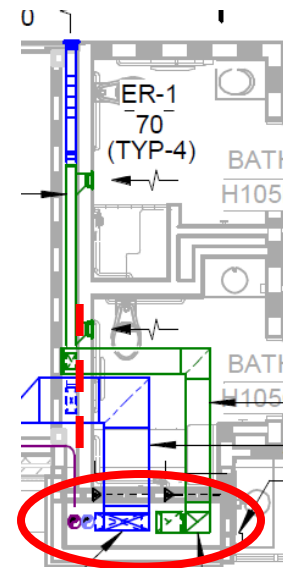
Final Recommendation

Acknowledgements

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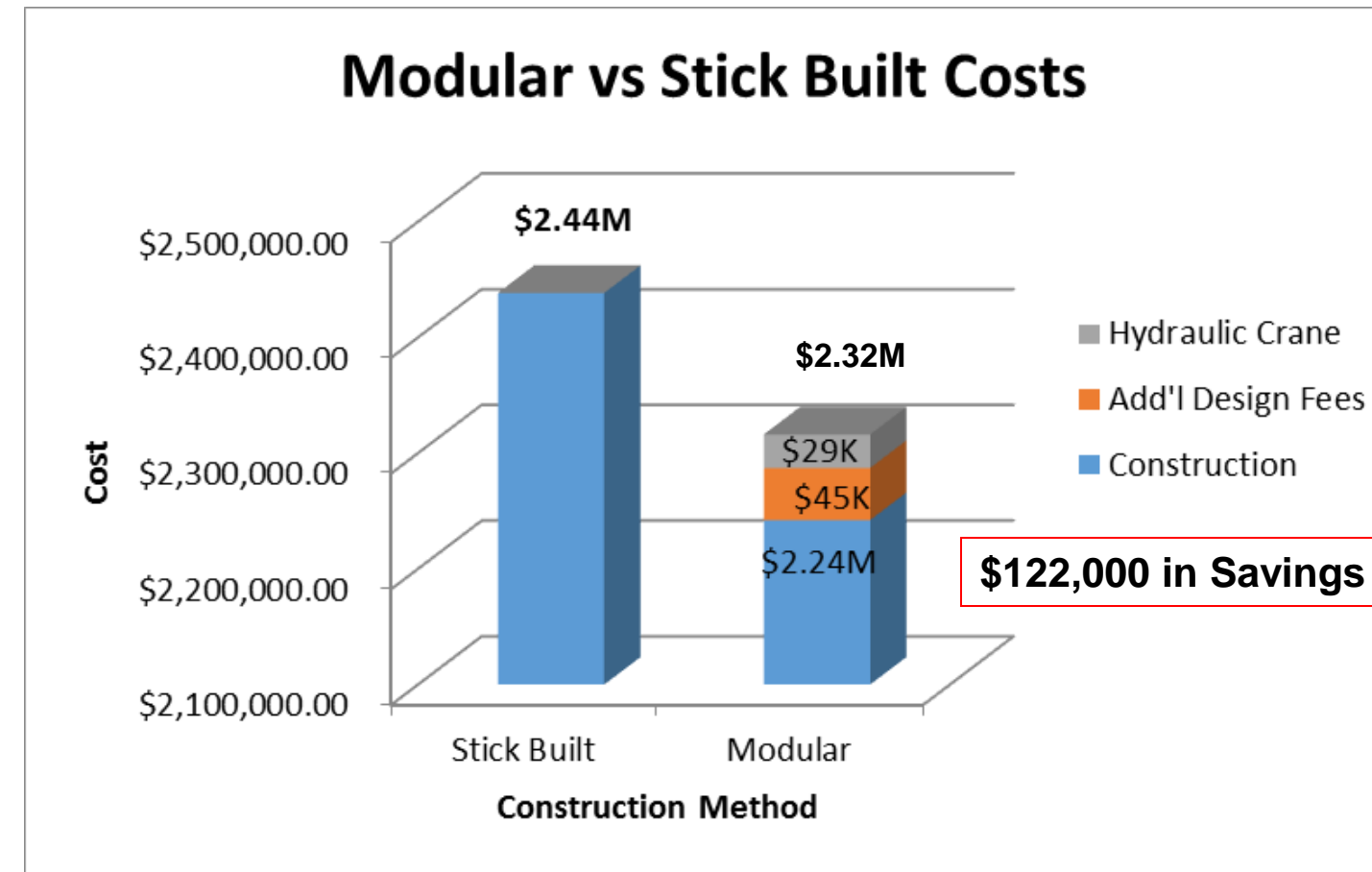
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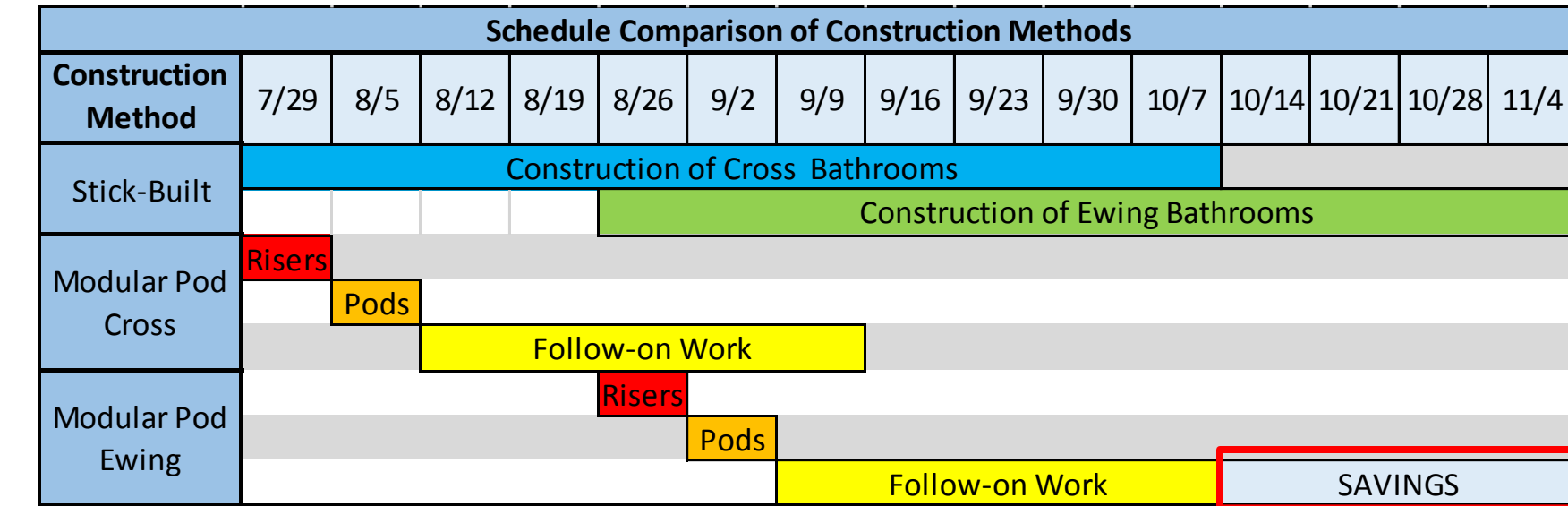
Results

Cost Analysis



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Schedule Analysis



- Schedule Savings = 21 working days
- Overall schedule cannot be reduced; bathrooms are on separate critical path

Implement Modular Bathrooms ✓

Project Overview

Analysis 1: Modular Bathrooms

- Background Information
- Planning & Procurement
- Design Evaluation – Arch. Breadth
- Results

Analysis 2: SIPS

- Background Information
- Approach
- Results

Analysis 4: Phase Resequencing

- Background Information
- Process
- Results

Final Recommendation

Acknowledgements

Analysis 2

SIPS for Student Rooms

Project Overview

Analysis 1: Modular Bathrooms

Background Information
Planning & Procurement
Design Evaluation – Arch. Breadth
Results

Analysis 2: SIPS

Background Information

Approach
Results

Analysis 4: Phase Resequencing

Background Information
Process
Results

Final Recommendation

Acknowledgements

Analysis 2: SIPS

Background Information

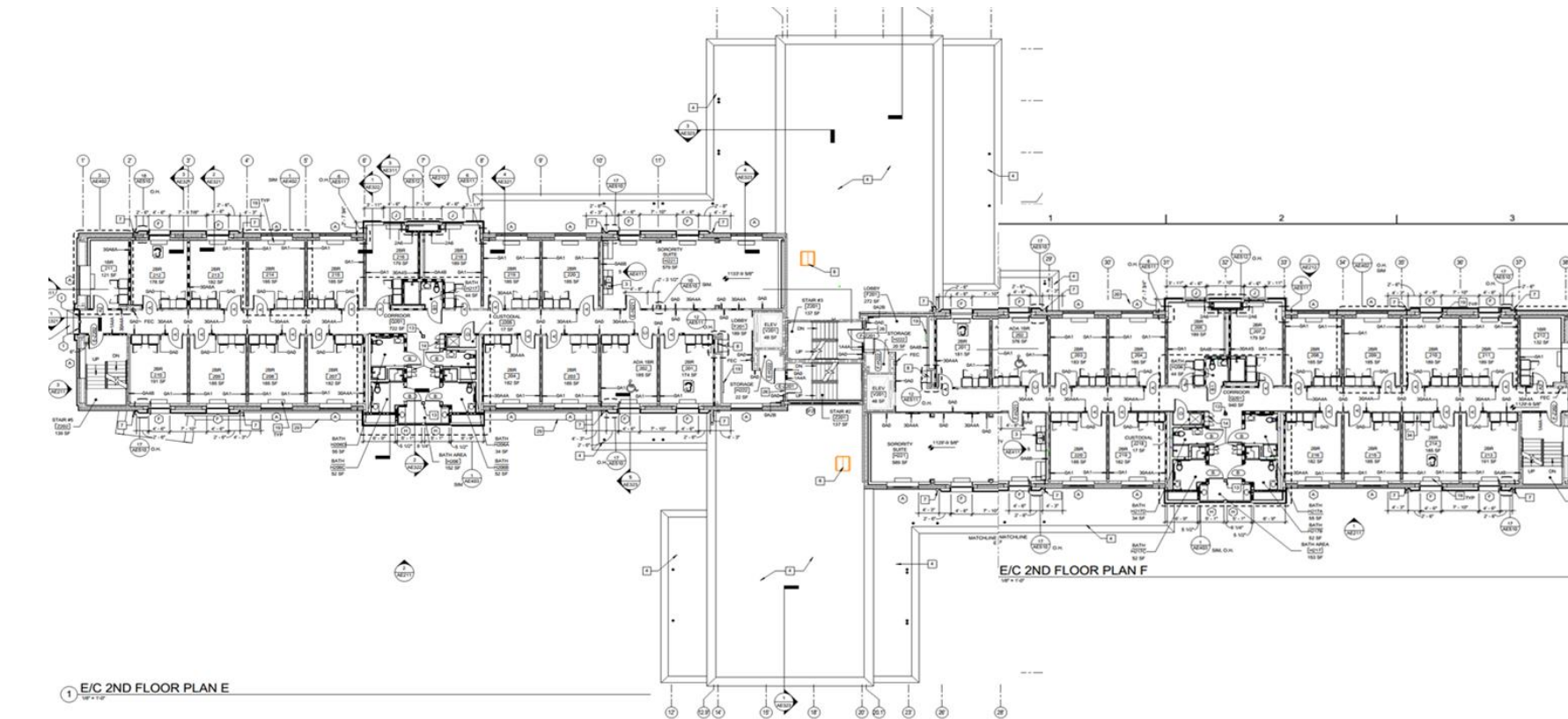
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Problem

- Punchlist and turnover to owner were critical for student rooms, with no room for error
 - Several activities took longer than scheduled duration

Goal

- Implement SIPS for the student rooms in an effort to promote earlier turnover to owner; allow FF&E to begin sooner



Project Overview

Analysis 1: Modular Bathrooms

- Background Information
- Planning & Procurement
- Design Evaluation – Arch. Breadth
- Results

Analysis 2: SIPS

- Background Information

Approach

- Results

Analysis 4: Phase Resequencing

- Background Information
- Process
- Results

Final Recommendation

Acknowledgements

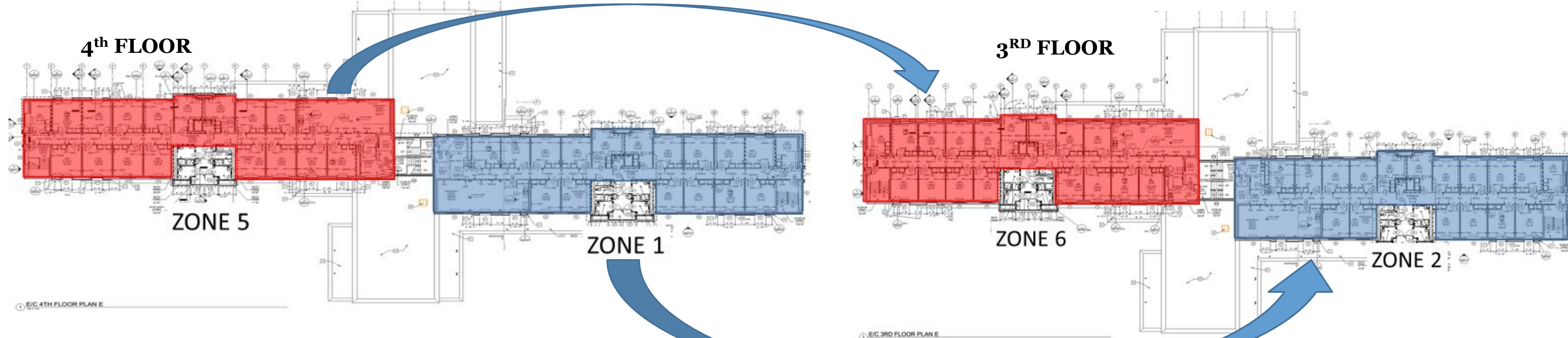
Analysis 2: SIPS

Approach

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Area Per Zone		
Zone	Floor	Square Footage
1	4th	5600
2	3rd	5600
3	2nd	5600
4	1st	5600
5	4th	5600
6	3rd	5600
7	2nd	4650
8	1st	4260
9	1st	5650

Building Zones



Project Overview

Analysis 1: Modular Bathrooms

- Background Information
- Planning & Procurement
- Design Evaluation – Arch. Breadth
- Results

Analysis 2: SIPS

- Background Information

Approach

- Results

Analysis 4: Phase Resequencing

- Background Information
- Process
- Results

Final Recommendation

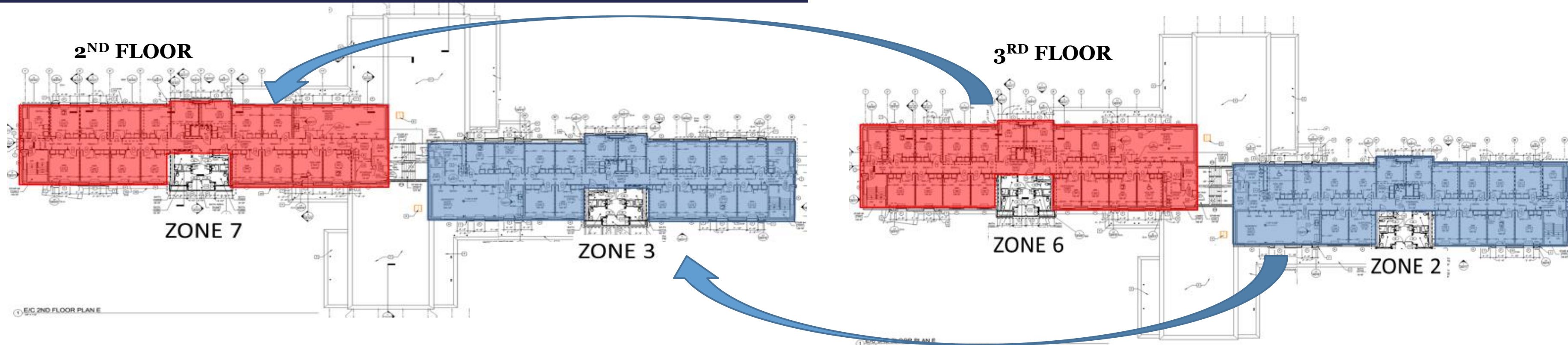
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Analysis 2: SIPS

Approach

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Project Overview

Analysis 1: Modular Bathrooms

- Background Information
- Planning & Procurement
- Design Evaluation – Arch. Breadth
- Results

Analysis 2: SIPS

- Background Information
- Approach**
- Results

Analysis 4: Phase Resequencing

- Background Information
- Process
- Results

Final Recommendation

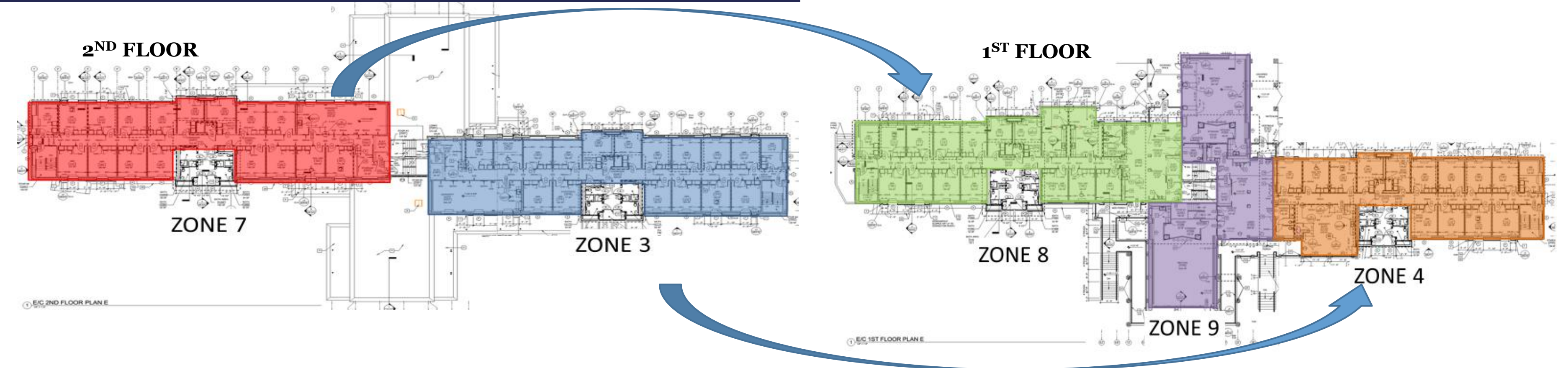
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Approach

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Project Overview

Analysis 1: Modular Bathrooms

- Background Information
- Planning & Procurement
- Design Evaluation – Arch. Breadth
- Results

Analysis 2: SIPS

- Background Information
- Approach**
- Results

Analysis 4: Phase Resequencing

- Background Information
- Process
- Results

Final Recommendation

Acknowledgements

SIPS Methodology

- Adjust crew sizes to achieve 5 day durations
- Parallel production of dorm wings
- 5 Day work weeks; Saturday serves as catchup day

Student Room SIPS

Area	2013																																
	June				July				August				September				October				November				December								
	6/3	6/10	6/17	6/24	7/1	7/8	7/15	7/22	7/29	8/5	8/12	8/19	8/26	9/2	9/9	9/16	9/23	9/30	10/7	10/14	10/21	10/28	11/4	11/11	11/18	11/25	12/2	12/9	12/16	12/23	12/30		
Zone 1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24									
Zone 2		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24								
Zone 3			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24							
Zone 4				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24						
Zone 5	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24									
Zone 6		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24								
Zone 7			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24							
Zone 8				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24						
Zone 9					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24					

1 Layout and Top Track	6 Perim. Bedroom Piping	11 Finish GWB	16 FCU & Mech Trim Out	21 Final Paint
2 Perim. Bedroom Framing/Insulation	7 Door Frames & Clg/Bulkhead Framing	12 Windows	17 Doors & Hardware	22 Carpet
3 Ductwork	8 Sprinkler Rough In	13 Prime & Paint	18 Adjust Sprinkler Heads	23 Final Clean & Punchlist
4 MEP Coring	9 Plumbing Rough In	14 Lights & Final Tele-Data	19 Elec/Tele/Fire Alarm Trim Out	24 Owner FF&E
5 Elec. Rough In & Tele-Data	10 Hang GWB	15 Install Flooring	20 Suite/Lobby Case & Window Treat	

Cost Analysis

- No additional costs incurred
- Manhours remained the same
- No perceivable cost savings due to schedule reduction

Project Overview

Analysis 1: Modular Bathrooms

- Background Information
- Planning & Procurement
- Design Evaluation – Arch. Breadth
- Results

Analysis 2: SIPS

- Background Information
- Approach

Results

Analysis 4: Phase Resequencing

- Background Information
- Process
- Results

Final Recommendation

Acknowledgements

Project Overview

Analysis 1: Modular Bathrooms

- Background Information
- Planning & Procurement
- Design Evaluation – Arch. Breadth
- Results

Analysis 2: SIPS

- Background Information
- Approach
- Results**

Analysis 4: Phase Resequencing

- Background Information
- Process
- Results

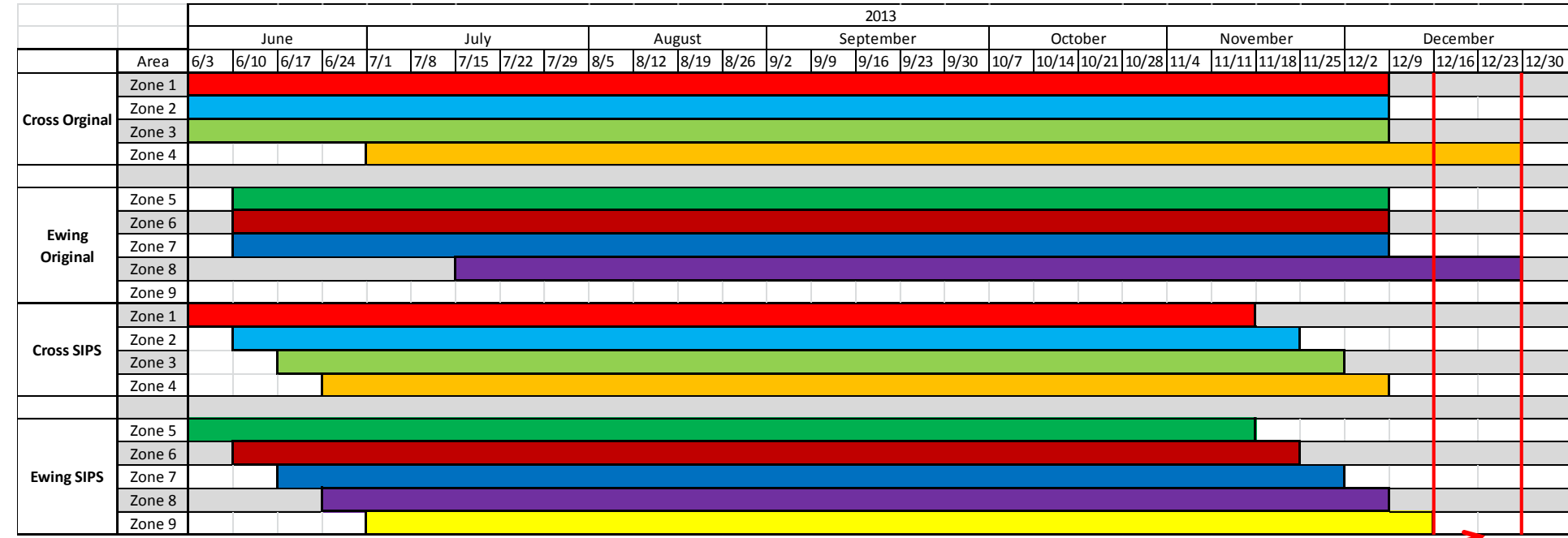
Final Recommendation

Acknowledgements

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Schedule Analysis



- 10 day schedule acceleration

Project Overview

Analysis 1: Modular Bathrooms

- Background Information
- Planning & Procurement
- Design Evaluation – Arch. Breadth
- Results

Analysis 2: SIPS

- Background Information
- Approach
- Results**

Analysis 4: Phase Resequencing

- Background Information
- Process
- Results

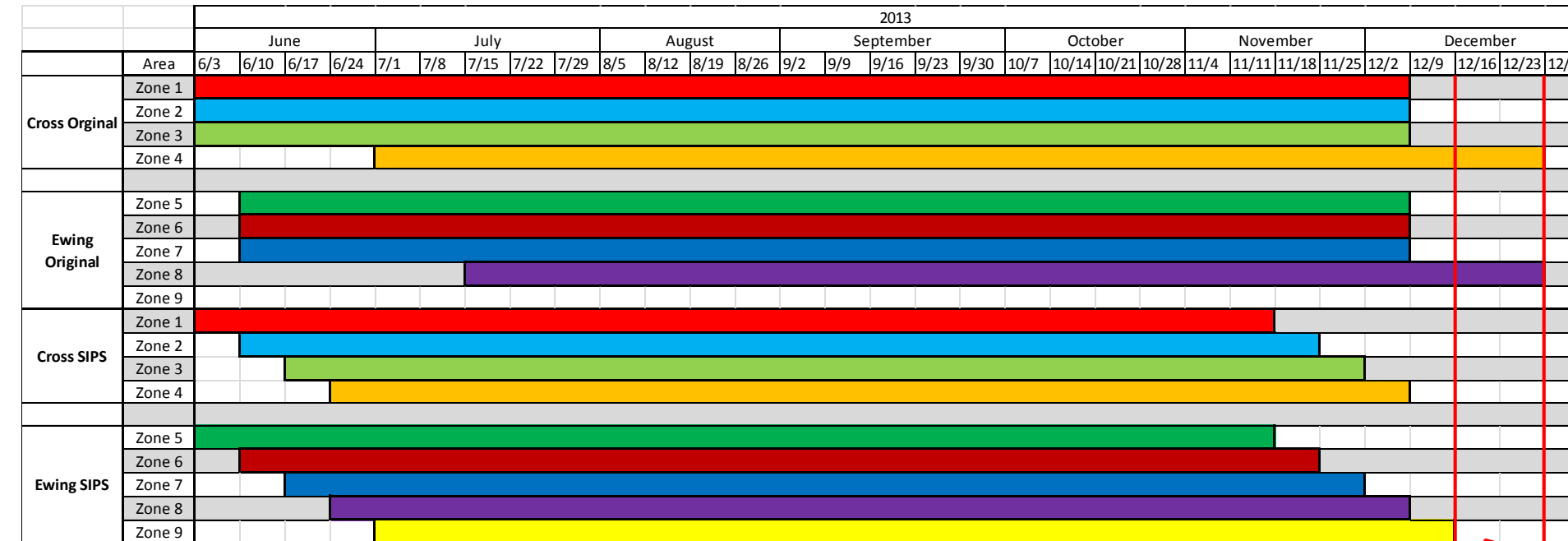
Final Recommendation

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Cost Analysis

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- No perceivable cost savings due to schedule reduction

Schedule Analysis



- 10 day schedule acceleration

Constructability

- Increased Collaboration
- Timely Deliveries
- Subcontractor Buy-in
- More predictable durations
- Other Construction Activities
 - Enclosure
 - Bathrooms

Implement SIPS ✓

- Project Overview**
- Analysis 1: Modular Bathrooms**
 - Background Information
 - Planning & Procurement
 - Design Evaluation – Arch. Breadth
 - Results
- Analysis 2: SIPS**
 - Background Information
 - Approach
 - Results
- Analysis 4: Phase Resequencing**
 - Background Information
 - Process
 - Results
- Final Recommendation**
- Acknowledgements**

Analysis 4

Master Phase Resequencing

Project Overview

Analysis 1: Modular Bathrooms

- Background Information
- Planning & Procurement
- Design Evaluation – Arch. Breadth
- Results

Analysis 2: SIPS

- Background Information
- Approach
- Results

Analysis 4: Phase Resequencing

Background Information

- Process
- Results

Final Recommendation

Acknowledgements

Problem

- Current Project Schedule = 33 months
- Difficult to shuffle students between dormitories

Potential Solution

- Renovate two buildings at once
 - Reduce overall schedule
 - Quicker turnover = Revenue generated sooner

Project Overview

Analysis 1: Modular Bathrooms

- Background Information
- Planning & Procurement
- Design Evaluation – Arch. Breadth
- Results

Analysis 2: SIPS

- Background Information
- Approach
- Results

Analysis 4: Phase Resequencing

- Background Information

Process

- Results

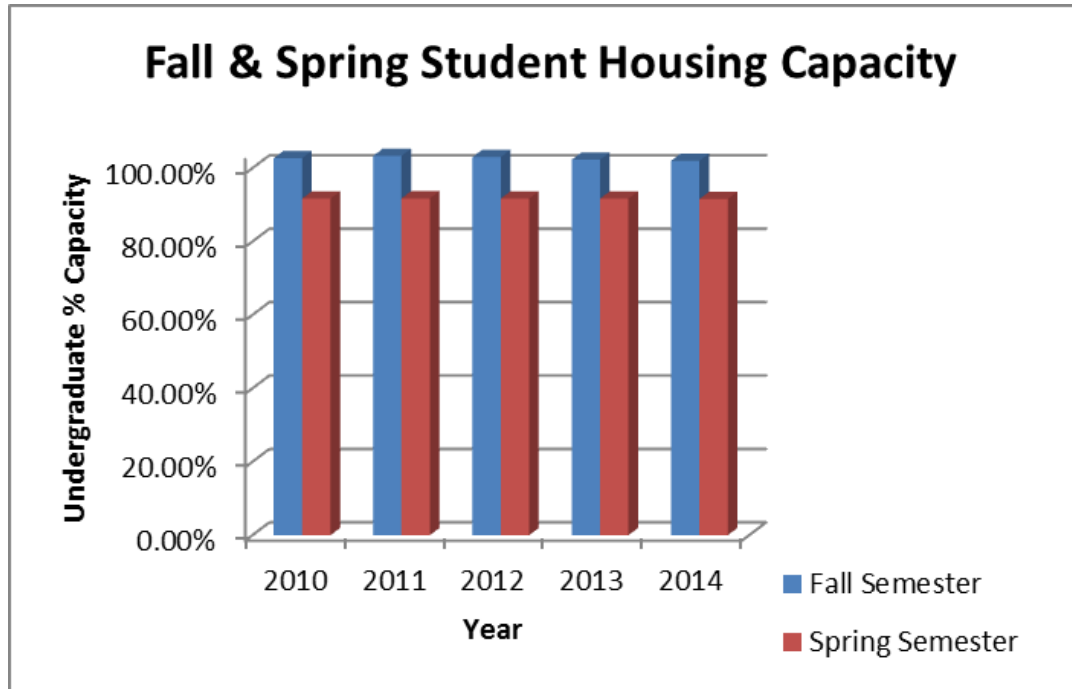
Final Recommendation

Acknowledgements

Analysis 4: Phase Resequencing

Process

PSU Capacity



- Typ. 1000 – 1200 fewer students
 - PSU would have capacity for multiple renovations

Process

Analysis 4: Phase Resequencing

Project Overview

Analysis 1: Modular Bathrooms

- Background Information
- Planning & Procurement
- Design Evaluation – Arch. Breadth
- Results

Analysis 2: SIPS

- Background Information
- Approach
- Results

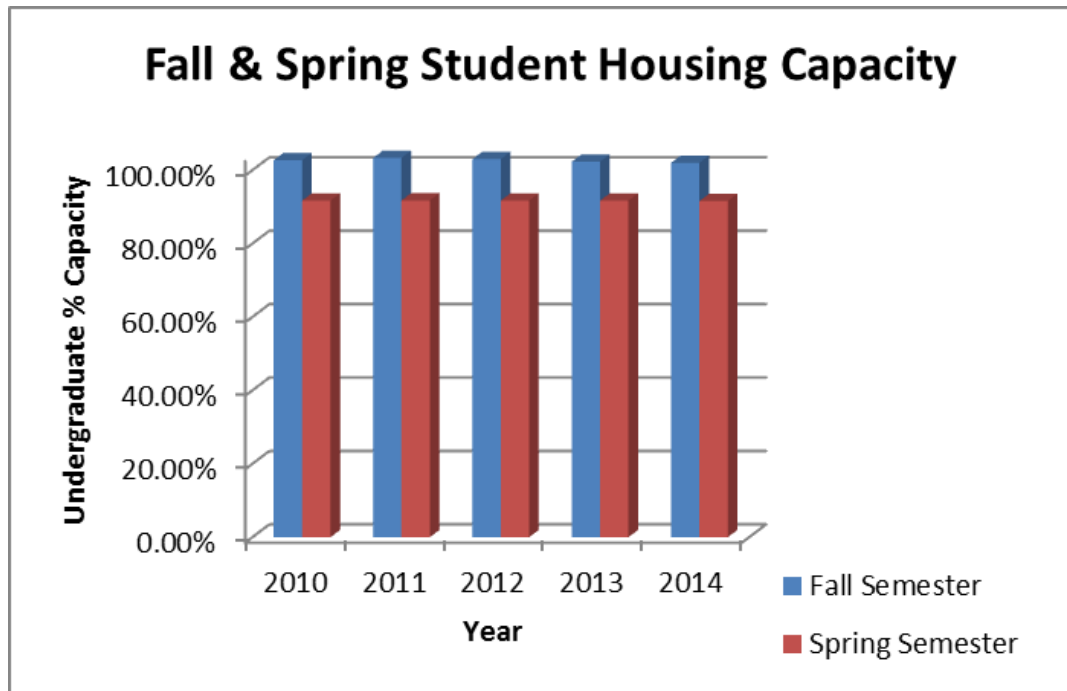
Analysis 4: Phase Resequencing

- Background Information
- Process**
- Results

Final Recommendation

Acknowledgements

PSU Capacity



- Typ. 1000 – 1200 fewer students
 - PSU would have capacity for multiple renovations

Project Management Staff

- Phase 1 saw Chace and Haller – Lyons built together
 - Logical to maintain this level of staffing for P2

Current Phase 2 Staffing	Proposed Phase 2 Staffing
Project Director	Project Director
Project Manager	Project Manager
Project Engineer	Senior Project Engineer
Senior Superintendent	Project Engineer
Project Technician	Senior Superintendent
Intern	Field Superintendent
-	Field Superintendent
-	Project Technician
-	Intern
-	Intern

Project Overview

Analysis 1: Modular Bathrooms

- Background Information
- Planning & Procurement
- Design Evaluation – Arch. Breadth
- Results

Analysis 2: SIPS

- Background Information
- Approach
- Results

Analysis 4: Phase Resequencing

- Background Information

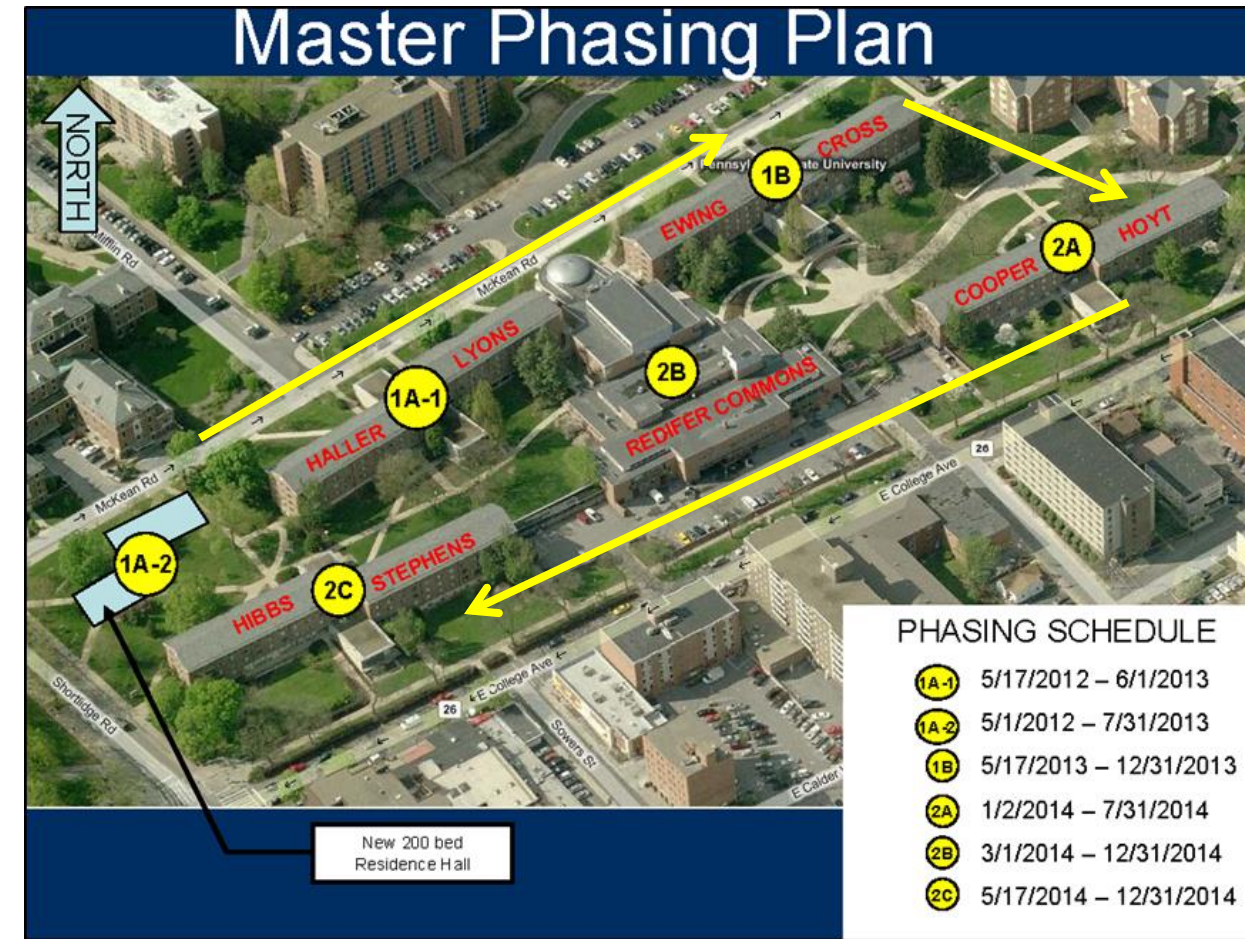
Process

- Results

Final Recommendation

Acknowledgements

New Master Phasing



Project Overview

Analysis 1: Modular Bathrooms

Background Information
Planning & Procurement
Design Evaluation – Arch. Breadth
Results

Analysis 2: SIPS

Background Information
Approach
Results

Analysis 4: Phase Resequencing

Background Information
Process
Results

Final Recommendation

Acknowledgements

Analysis 4: Phase Resequencing

- New Phasing = left to right flow
 - Eliminate temp landscaping between H-L and H-S
- Redifer = buffer for P2 construction
- Renovate E-C and C-H together

Process

New Master Phasing



Quaid Spearing | Construction Option South Halls Renovation | Penn State University



Results

Analysis 4: Phase Resequencing

Constructability

- Site Logistics
 - [Offsite Fabrication](#)
- Manpower



Project Overview

Analysis 1: Modular Bathrooms

Background Information
Planning & Procurement
Design Evaluation – Arch. Breadth
Results

Analysis 2: SIPS

Background Information
Approach
Results

Analysis 4: Phase Resequencing

Background Information
Process

Results

Final Recommendation

Acknowledgements

Results

Analysis 4: Phase Resequencing

Project Overview

Analysis 1: Modular Bathrooms

- Background Information
- Planning & Procurement
- Design Evaluation – Arch. Breadth
- Results

Analysis 2: SIPS

- Background Information
- Approach
- Results

Analysis 4: Phase Resequencing

- Background Information
- Process
- Results

Final Recommendation

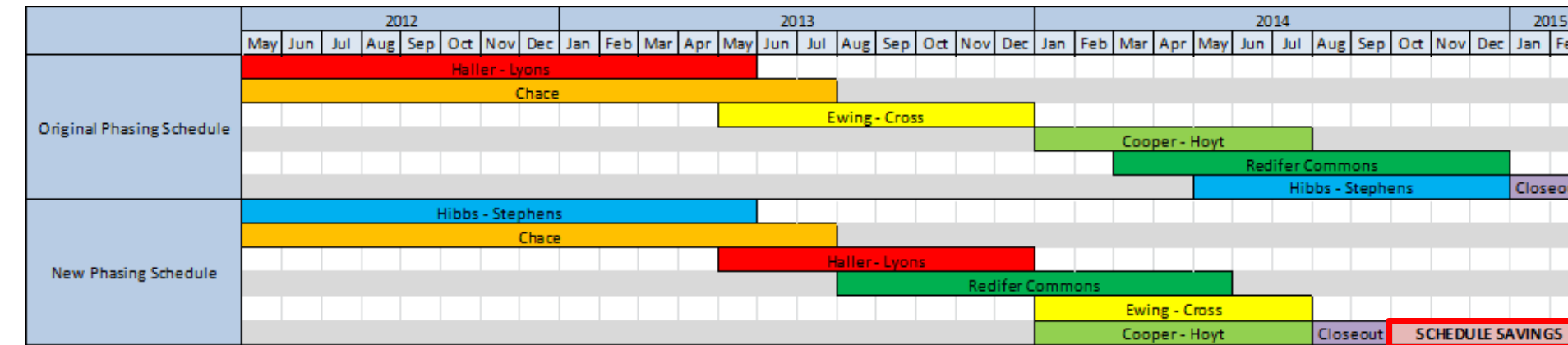
Acknowledgements

Constructability

- Site Logistics
 - Offsite Fabrication
- Manpower



Schedule Analysis



- 5 month schedule reduction
- South Halls fully opened for fall 2014

Results

Analysis 4: Phase Resequencing

Project Overview

Analysis 1: Modular Bathrooms

- Background Information
- Planning & Procurement
- Design Evaluation – Arch. Breadth
- Results

Analysis 2: SIPS

- Background Information
- Approach
- Results

Analysis 4: Phase Resequencing

- Background Information
- Process
- Results

Final Recommendation

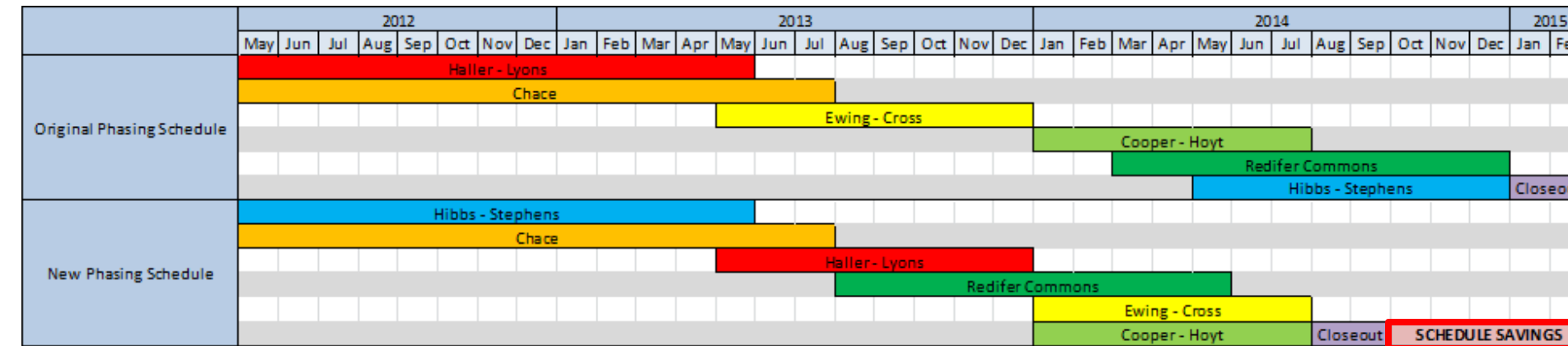
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Constructability

- Site Logistics
 - Offsite Fabrication
- Manpower



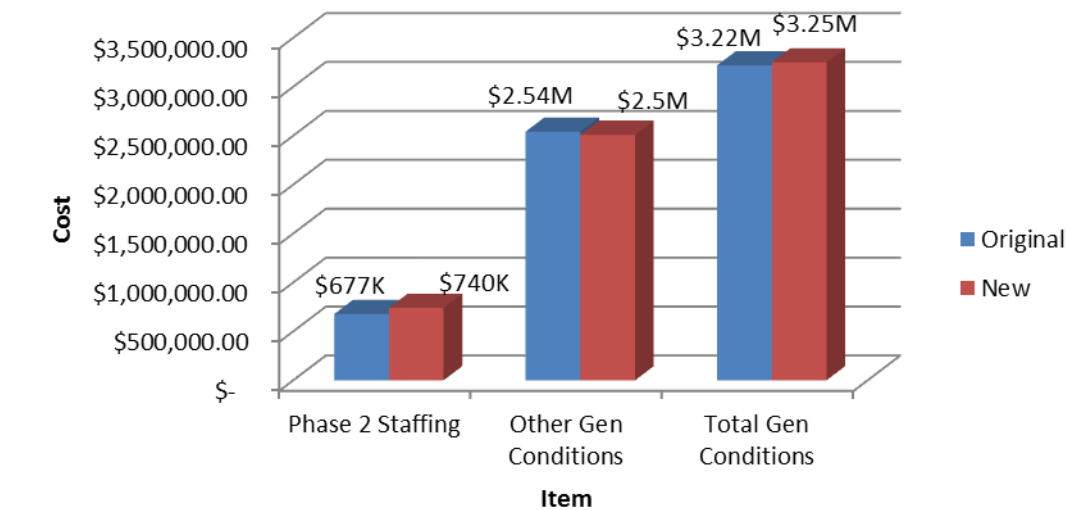
Schedule Analysis



- 5 month schedule reduction
- South Halls fully opened for fall 2014

Cost Analysis

General Conditions Summary



- Would add \$31K to project cost

Results

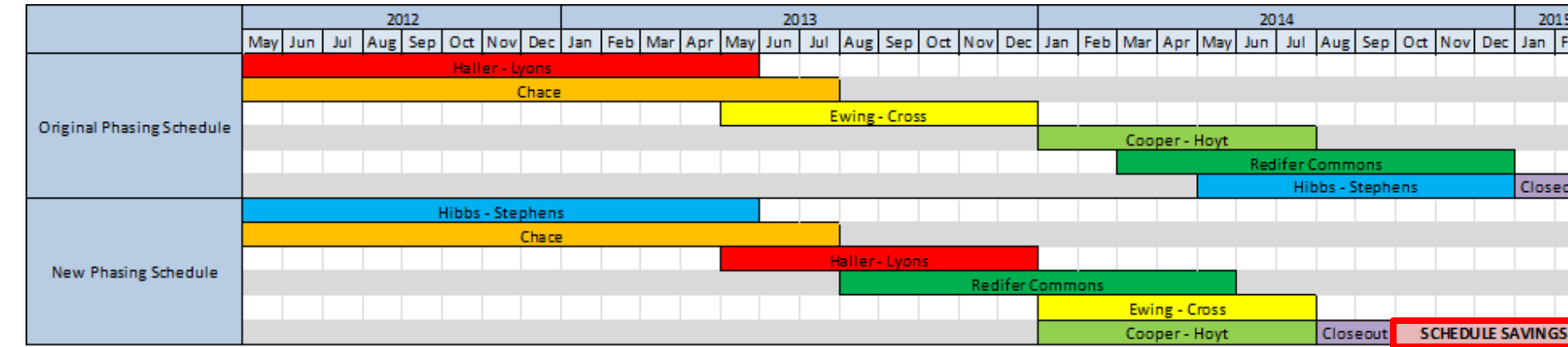
Analysis 4: Phase Resequencing

Constructability

- Site Logistics
 - Offsite Fabrication
- Manpower



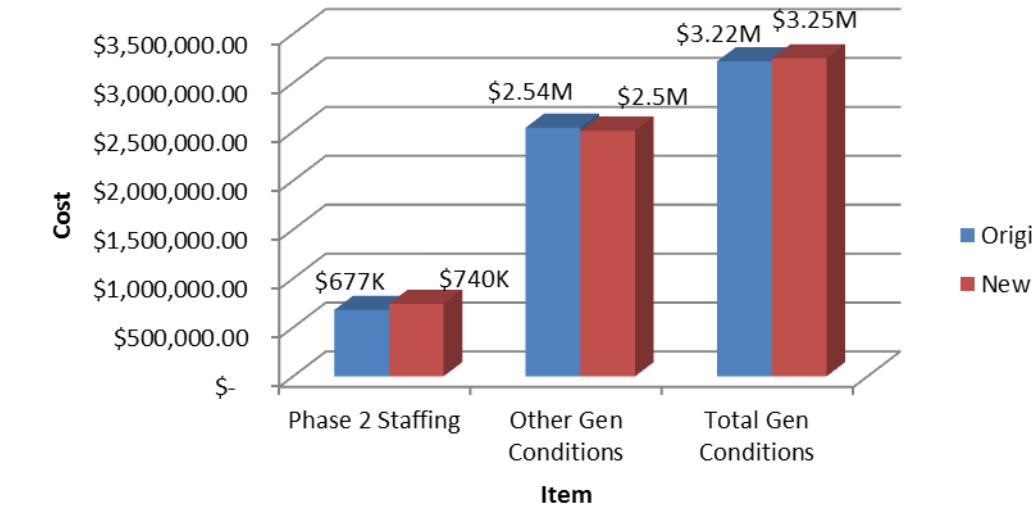
Schedule Analysis



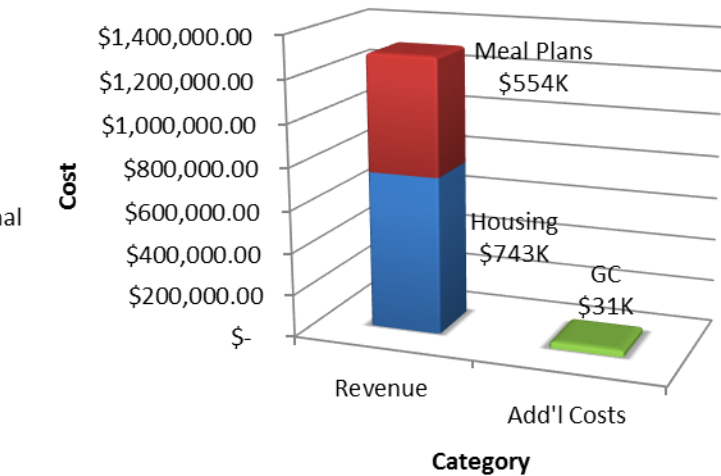
- 5 month schedule reduction
- South Halls fully opened for fall 2014

Cost Analysis

General Conditions Summary



Revenue to Increased GC Costs



- Would add \$31K to project cost
- However, PSU could generate **\$1.3M** in revenue

Implement Phase Resequencing ✓

Project Overview

Analysis 1: Modular Bathrooms

- Background Information
- Planning & Procurement
- Design Evaluation – Arch. Breadth
- Results

Analysis 2: SIPS

- Background Information
- Approach
- Results

Analysis 4: Phase Resequencing

- Background Information
- Process
- Results

Final Recommendation

Acknowledgements

Conclusion

Project Overview

Analysis 1: Modular Bathrooms

Background Information
Planning & Procurement
Design Evaluation – Arch. Breadth
Results

Analysis 2: SIPS

Background Information
Approach
Results

Analysis 4: Phase Resequencing

Background Information
Process
Results

Final Recommendation

Acknowledgements



Analysis 1: Modular Bathrooms

- Decrease bathroom schedule by 4 weeks
 - \$122,000 cost savings
 - Improved finished quality

Analysis 2: SIPS

- Accelerates student room schedule by 10 days
 - Allow owner FF&E to begin sooner

Analysis 4: Phase Resequencing

- Accelerates Schedule by 5 months
 - \$1.3M in potential revenue

Recommendations

- Implement modular bathrooms
- Implement SIPS
- Implement Phase Resequencing

Total Savings Through all 4 Analyses

- \$264,000 saved in project costs
- \$1.3M in potential revenue for owner
- 5 month schedule acceleration

Acknowledgements

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South Halls Renovation | Penn State University

Project Overview

Analysis 1: Modular Bathrooms

Background Information
Planning & Procurement
Design Evaluation – Arch. Breadth
Results

Analysis 2: SIPS

Background Information
Approach
Results

Analysis 4: Phase Resequencing

Background Information
Process
Results

Final Recommendation

Acknowledgements



Thank You!



Acknowledgements

Barton Malow Company

Clark Nexsen

Penn State University

Dr. Anumba: CM Advisor

Penn State AE Faculty

My Family & Friends

Project Overview

Analysis 1: Modular Bathrooms

- Background Information
- Planning & Procurement
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Analysis 2: SIPS

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- Approach
- Results

Analysis 4: Phase Resequencing

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- Process
- Results

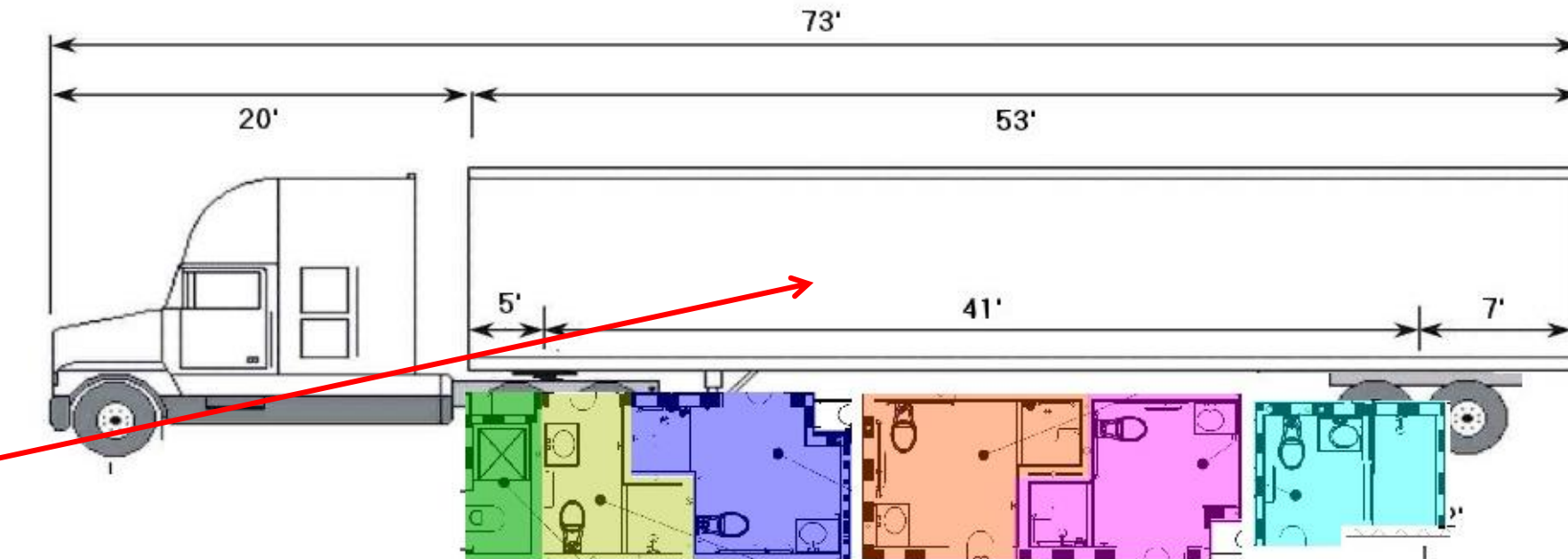
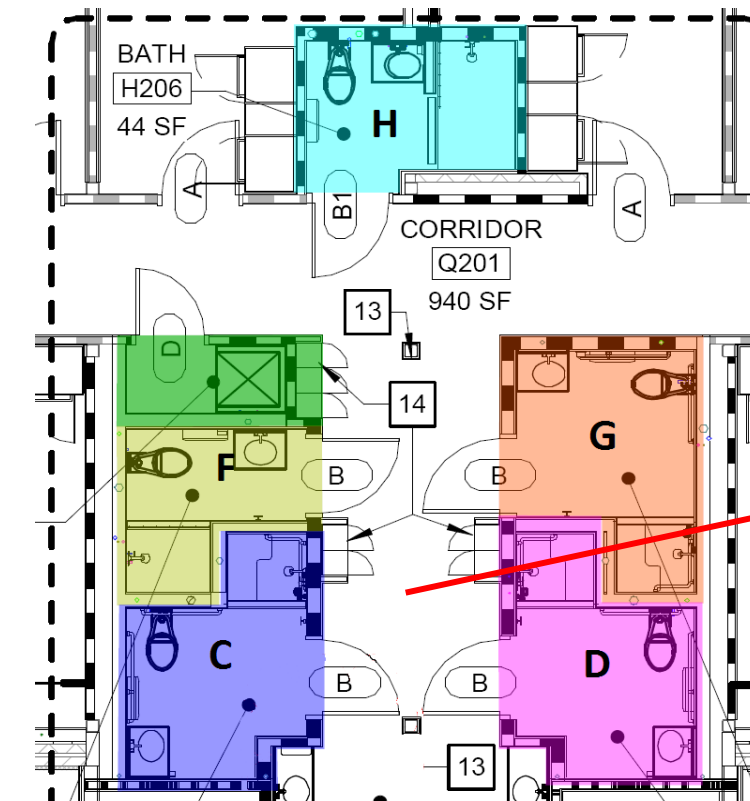
Final Recommendation

Acknowledgements

Pennsylvania Truck Information	
Size Limitations	
Width	8 feet
Height	13 feet 6 inches
Length	53 feet trailer
Maximum Gross Weight	
Two-Axle Motor Vehicle	38,000 lbs

Transportation

- Typical delivery could hold 5 pods



Project Overview

Analysis 1: Modular Bathrooms

- Background Information
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- Results

Analysis 2: SIPS

- Background Information
- Approach
- Results

Analysis 4: Phase Resequencing

- Background Information
- Process
- Results

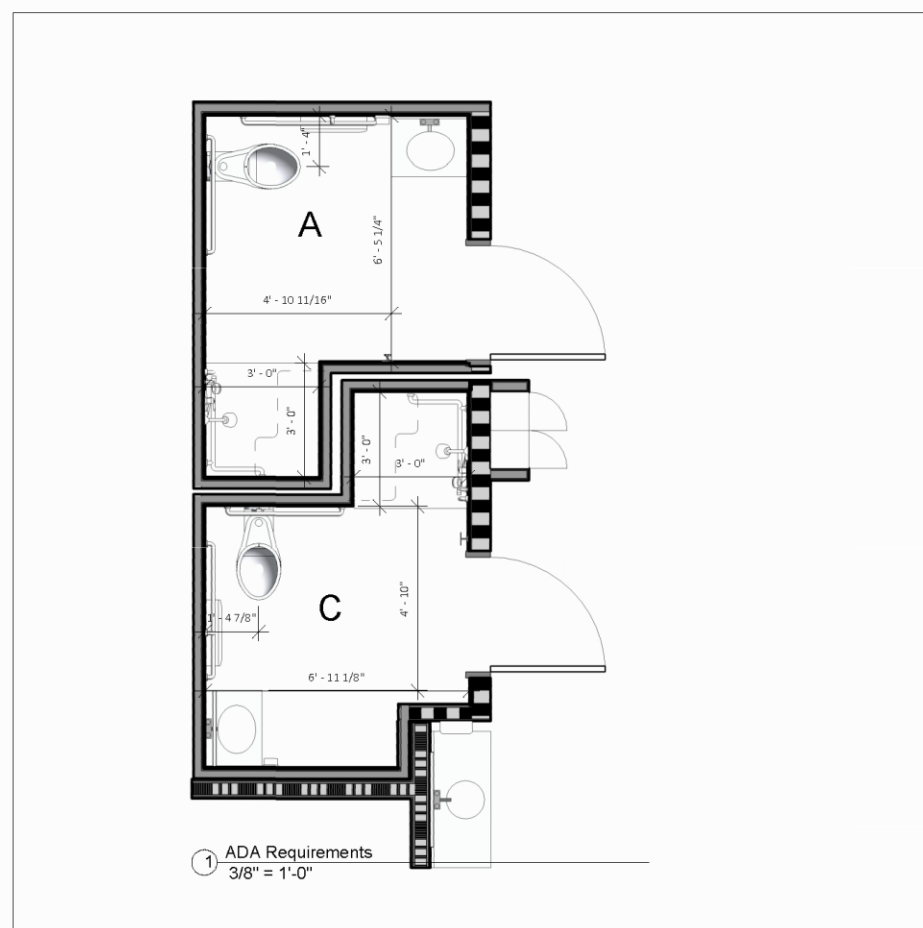
Final Recommendation

Acknowledgements

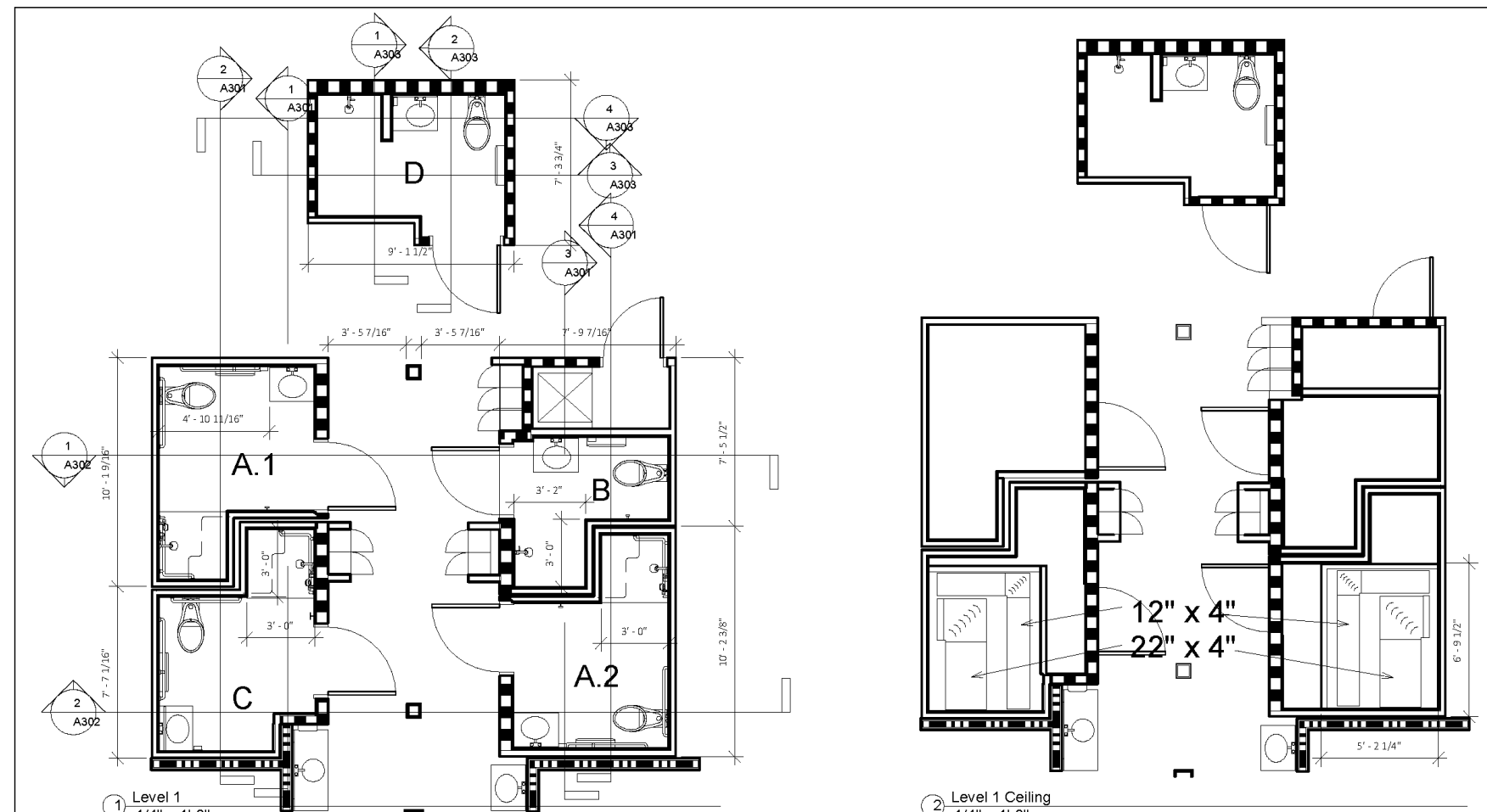
Appendix A - Analysis 1

Bathroom Pod Design

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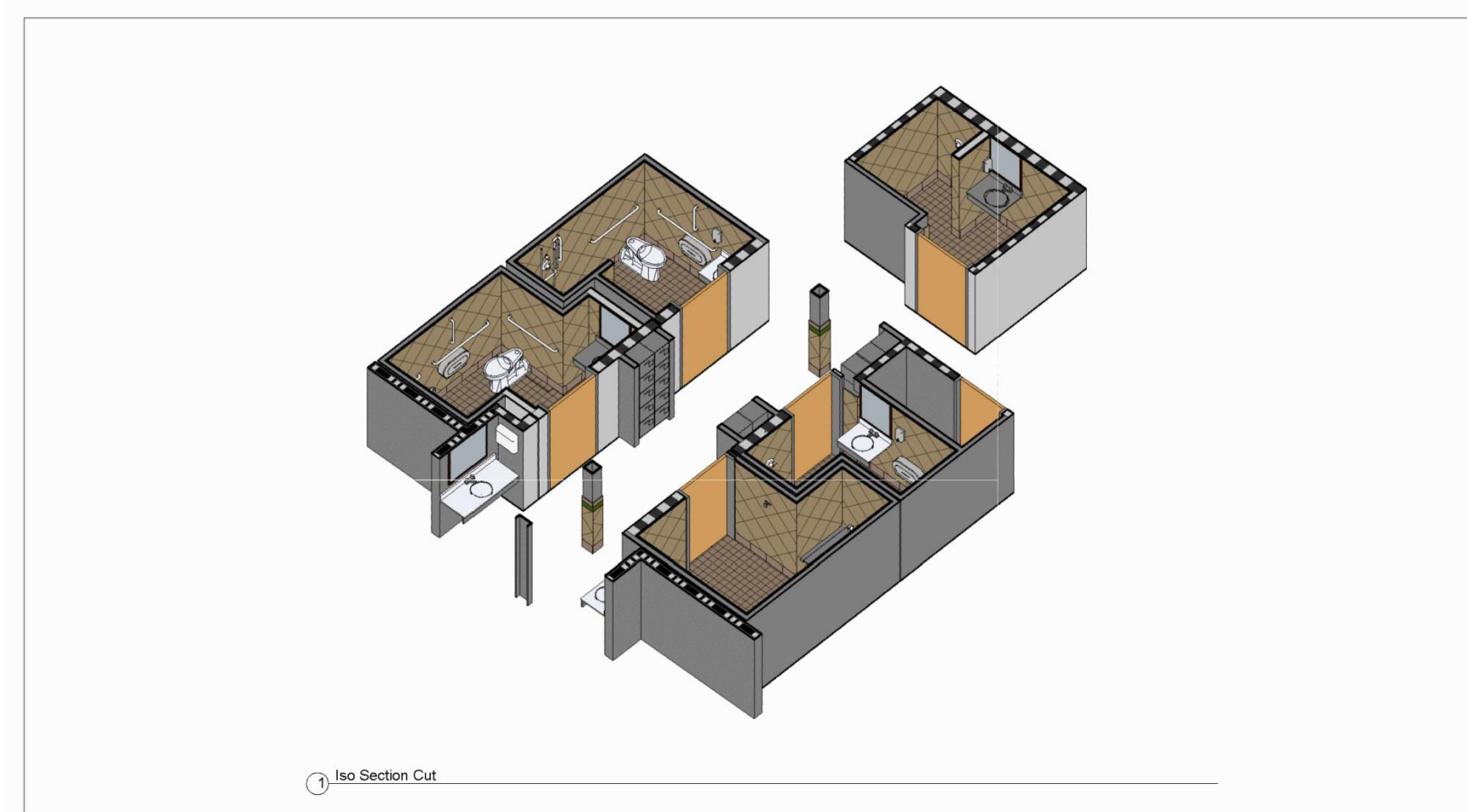
Autodesk Revit Penn State South Halls Renovation
 www.autodesk.com/revit



Autodesk Revit Penn State South Halls Renovation

No.	Description	Date

Bathroom Pod Typical Layout
 Project number: Project Number
 Date: 01/26/2014
 Drawn by: QWS
 Checked by: Checker
 Scale: 1/4" = 1'-0"



Autodesk Revit Penn State South Halls Renovation

No.	Description	Date

Iso Section Cut Roll-In Shower
 Project number: Project Number
 Date: 01/28/2014
 Drawn by: Author
 Checked by: Checker
 Scale: A901

Project Overview

Analysis 1: Modular Bathrooms

- Background Information
- Planning & Procurement
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- Results

Analysis 2: SIPS

- Background Information
- Approach
- Results

Analysis 4: Phase Resequencing

- Background Information
- Process
- Results

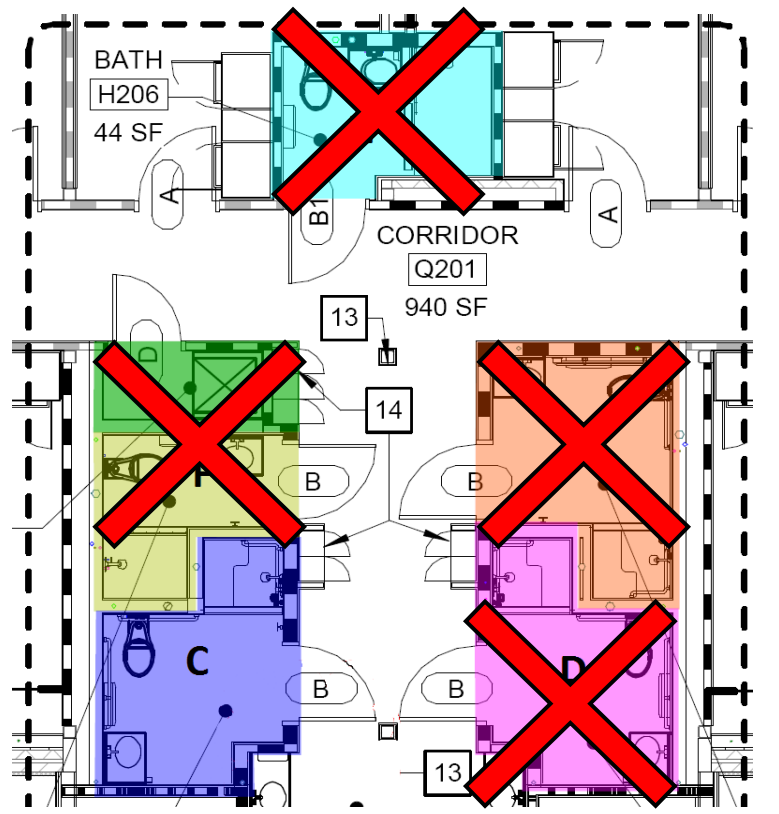
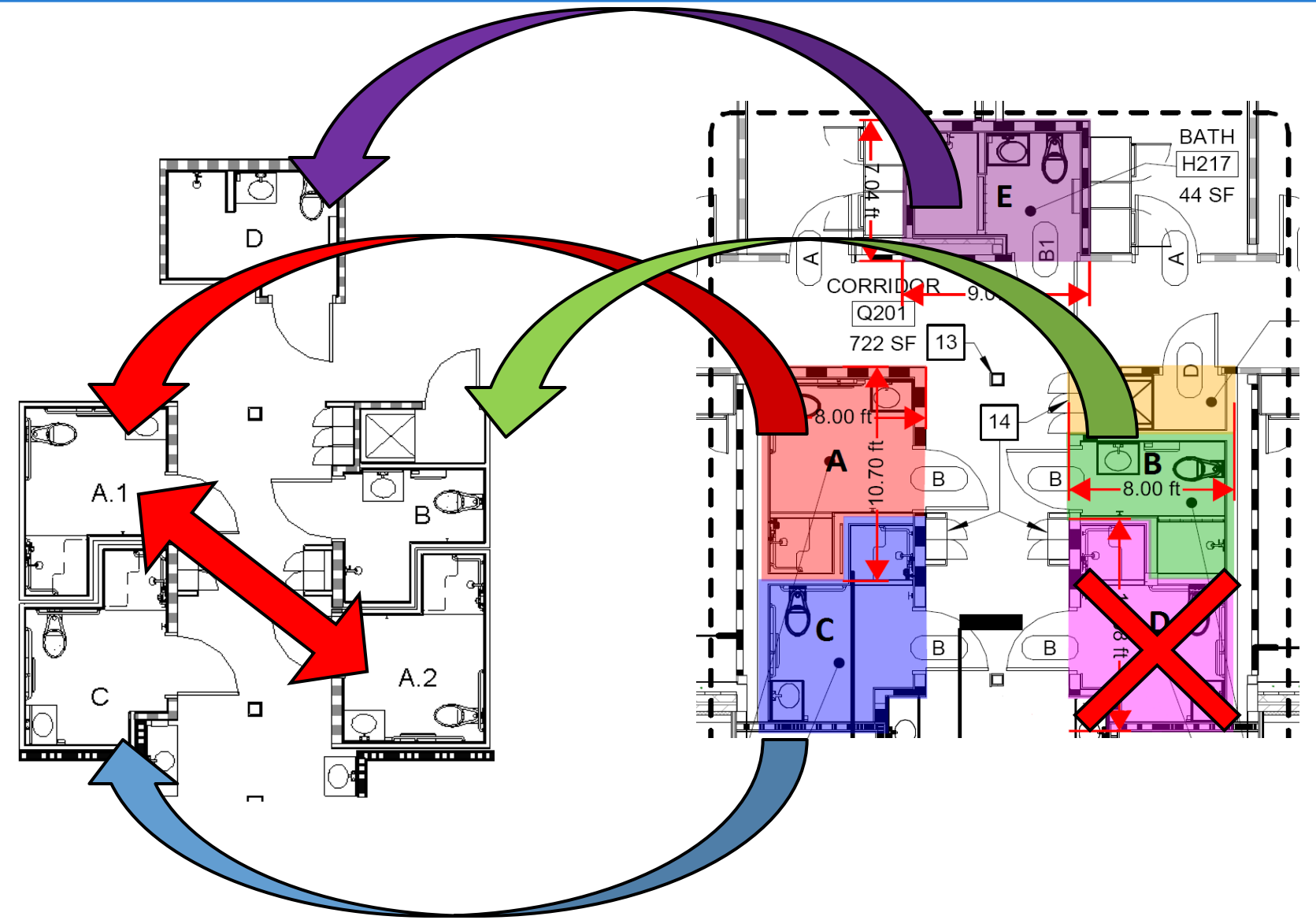
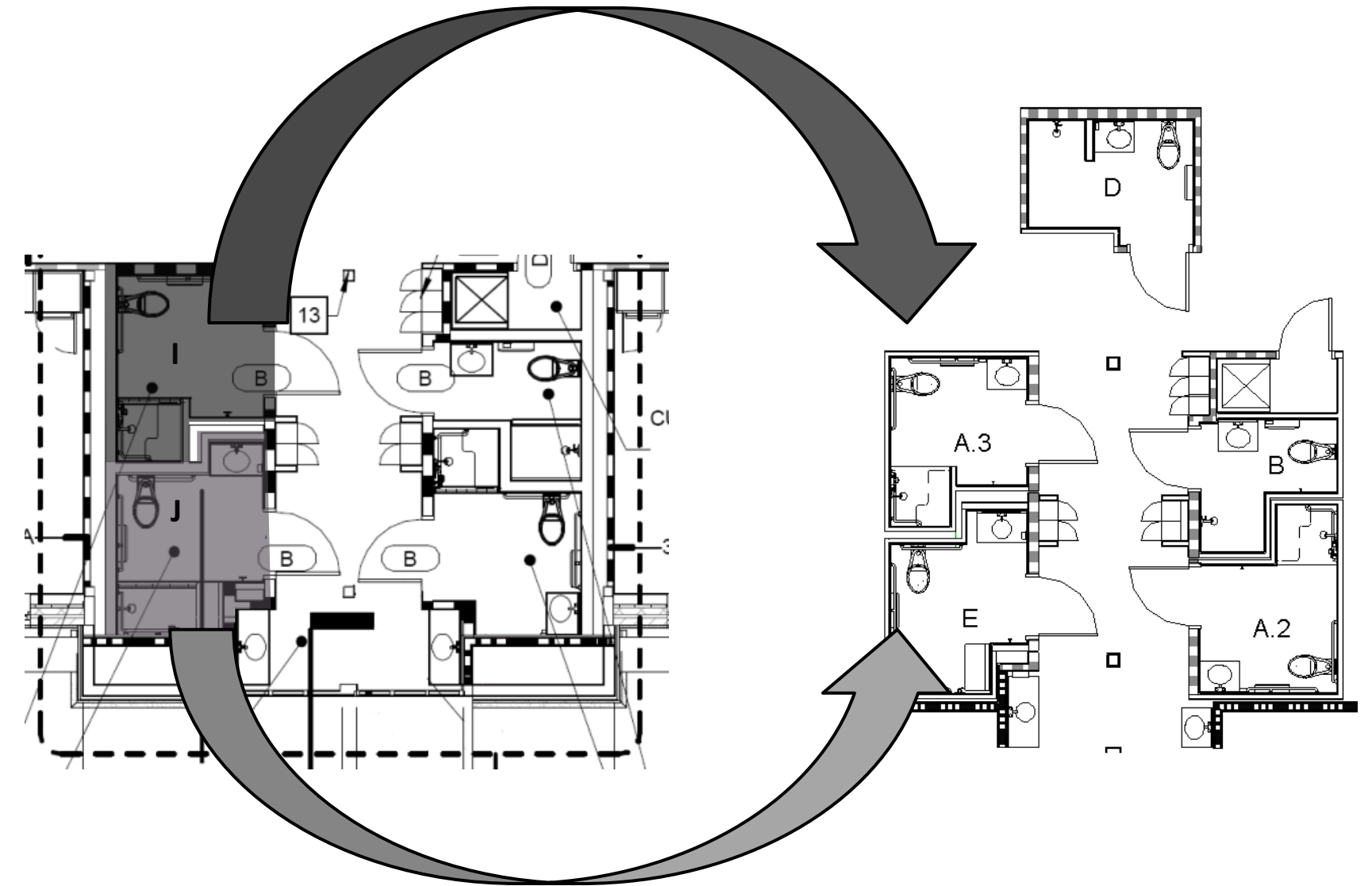
Final Recommendation

Acknowledgements

Appendix A - Analysis 1

Bathroom Pod Design

Quaid Spearing | Construction Option
South Halls Renovation | Penn State University



Project Overview

Analysis 1: Modular Bathrooms

- Background Information
- Planning & Procurement
- Design Evaluation – Arch. Breadth
- Results

Analysis 2: SIPS

- Background Information
- Approach
- Results

Analysis 4: Phase Resequencing

- Background Information
- Process
- Results

Final Recommendation

Acknowledgements

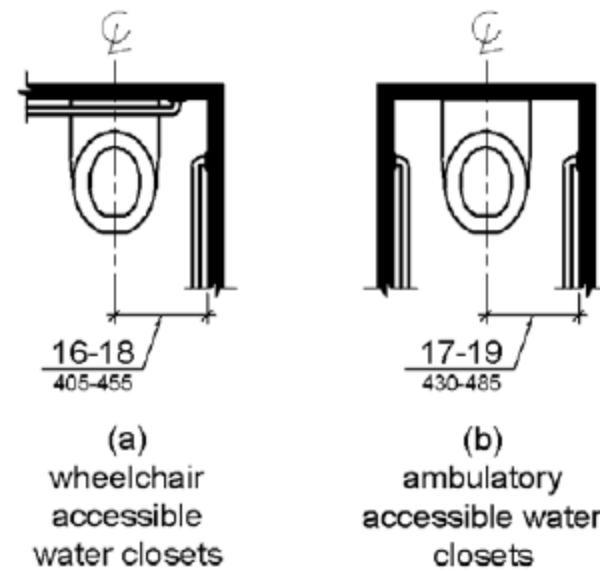
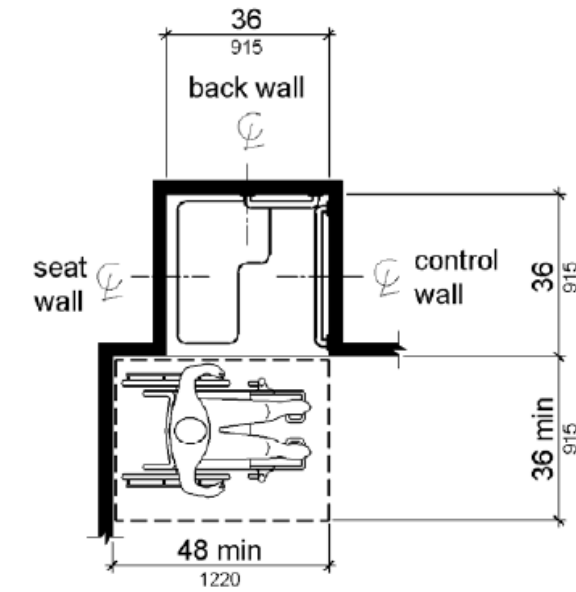
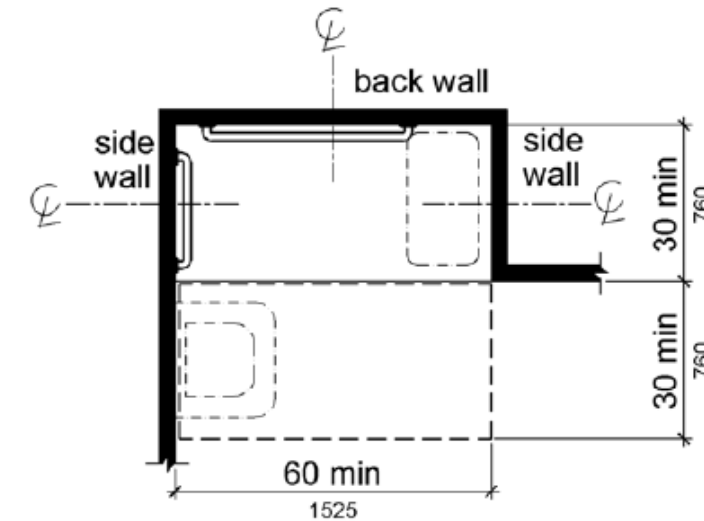


Figure 604.2
Water Closet Location



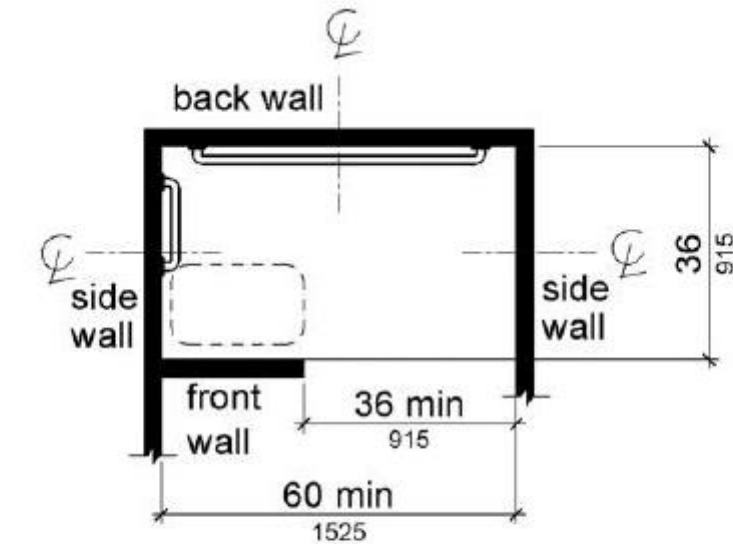
Note: inside finished dimensions measured at the center points of opposing sides

Figure 608.2.1
Transfer Type Shower Compartment Size and Clearance



Note: inside finished dimensions measured at the center points of opposing sides

Figure 608.2.2
Standard Roll-In Type Shower Compartment Size and Clearance



Note: inside finished dimensions measured at the center points of opposing sides

Figure 608.2.3
Alternate Roll-In Type Shower Compartment Size and Clearance

Appendix A - Analysis 1

Stick-built Bathroom Costs

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Project Overview

Analysis 1: Modular Bathrooms

Background Information

Planning & Procurement

Design Evaluation – Arch. Breadth

Results

Analysis 2: SIPS

Background Information

Approach

Results

Analysis 4: Phase Resequencing

Background Information

Process

Results

Final Recommendation

Acknowledgements

Typical Bathroom Takeoff										
RS Means Code	Description	Quantity	Unit	Daily Output	Labor Hours	Mat. \$/Unit	Mat. Total	Labor \$/Unit	Labor Total	Grand Total
	Flooring									
093013103310	PRCG	57	SF	190	0.08	\$ 5.49	\$ 311.28	\$ 2.50	\$ 141.75	\$ 453.03
093413100030		74	SF	250	0.06	\$ 2.06	\$ 151.41	\$ 1.90	\$ 139.65	\$ 291.06
	Ceiling									
092910303250		57	SF	765	0.02	\$ 0.47	\$ 26.65	\$ 0.79	\$ 44.79	\$ 71.44
	Wall Assemblies									
054113304200	30A6S	15	LF	73	0.22	\$ 10.49	\$ 161.80	\$ 11.96	\$ 184.48	\$ 346.28
072116200020		123	SF	1350	0.01	\$ 0.27	\$ 33.32	\$ 0.25	\$ 30.85	\$ 64.17
092813100200		123	SF	350	0.05	\$ 0.89	\$ 109.82	\$ 1.72	\$ 212.24	\$ 322.06
054113304200	0A6S	7	LF	73	0.22	\$ 10.49	\$ 75.45	\$ 11.96	\$ 86.02	\$ 161.47
072116200160		58	SF	1350	0.01	\$ 0.44	\$ 25.32	\$ 0.25	\$ 14.39	\$ 39.70
092813100200		58	SF	350	0.05	\$ 0.89	\$ 51.21	\$ 1.72	\$ 98.97	\$ 150.18
054113304140	0A4B	3	LF	76	0.21	\$ 7.86	\$ 23.58	\$ 11.48	\$ 34.44	\$ 58.02
092813100200		24	SF	350	0.05	\$ 0.89	\$ 21.36	\$ 1.72	\$ 41.28	\$ 62.64
054113304200	0A6B	7	LF	73	0.22	\$ 10.49	\$ 73.43	\$ 11.96	\$ 83.72	\$ 157.15
092813100200		56	SF	350	0.05	\$ 0.89	\$ 49.84	\$ 1.72	\$ 96.32	\$ 146.16
	Wall Tile									
093013105820	PRC1	235	SF	80	0.2	\$ 4.02	\$ 945.50	\$ 5.94	\$ 1,397.09	\$ 2,342.59
093013100050	PRC4	34	LF	82	0.2	\$ 5.45	\$ 183.12	\$ 5.80	\$ 194.88	\$ 378.00
093023100450	GT2	11	SF	73	0.22	\$ 25.38	\$ 281.41	\$ 6.51	\$ 72.18	\$ 353.60
093013102700	PRCS	34	LF	84	0.19	\$ 3.94	\$ 132.38	\$ 5.64	\$ 189.50	\$ 321.89
	Electrical									
260923100150		1	EA	24	0.333	\$ 58.57	\$ 58.57	\$ 19.78	\$ 19.78	\$ 78.35
265113502310	A1	1	EA	8	1	\$ 200.00	\$ 200.00	\$ 59.44	\$ 59.44	\$ 259.44
265113501100	C1	1	EA	7	1.14	\$ 150.00	\$ 150.00	\$ 67.77	\$ 67.77	\$ 217.77
266113300150		4	EA	28	0.29	\$ 8.26	\$ 33.04	\$ 16.94	\$ 67.76	\$ 100.80
260505101720		2	EA	80	0.1	\$ -	\$ -	\$ 5.94	\$ 11.88	\$ 11.88
260590104320		1	EA	10.67	0.75	\$ 53.12	\$ 53.12	\$ 44.44	\$ 44.44	\$ 97.56
	Plumbing - Waste									
221113741140		8	LF	50	0.32	\$ 27.49	\$ 219.92	\$ 13.76	\$ 110.08	\$ 330.00
221113762470		1	EA	13.9	1.15	\$ 40.76	\$ 40.76	\$ 49.33	\$ 49.33	\$ 90.09
221113741110		4	LF	34	0.23	\$ 10.43	\$ 41.72	\$ 11.23	\$ 44.92	\$ 86.64
221113762160		1	EA	18.2	0.44	\$ 6.92	\$ 6.92	\$ 21.14	\$ 21.14	\$ 28.06
221316606733		1	EA	18	0.44	\$ 11.33	\$ 11.33	\$ 21.14	\$ 21.14	\$ 32.47
221113741150		12	LF	46	0.35	\$ 38.87	\$ 466.44	\$ 14.92	\$ 179.04	\$ 645.48
221113762480		2	EA	11	1.46	\$ 46.93	\$ 93.86	\$ 62.59	\$ 125.18	\$ 219.04
221113762190		1	EA	16.5	0.97	\$ 33.65	\$ 33.65	\$ 41.45	\$ 41.45	\$ 75.10
221113765287		1	EA	12.2	1.31	\$ 36.50	\$ 36.50	\$ 56.37	\$ 56.37	\$ 92.87
221113741120		12	LF	55	0.29	\$ 13.51	\$ 162.12	\$ 12.48	\$ 149.76	\$ 311.88

221113762170		2" 90 Elbow	1	EA	33.1	0.48	\$ 8.39	\$ 8.39	\$ 20.73	\$ 20.73	\$ 29.12
221113762460		2" T	1	EA	20	0.8	\$ 29.86	\$ 29.86	\$ 34.40	\$ 34.40	\$ 64.26
221113741140	Shower	3" Waste Line	8	LF	50	0.32	\$ 27.49	\$ 219.92	\$ 13.76	\$ 110.08	\$ 330.00
221113764942		3" to 1-1/2" Wye	1	EA	10.6	1.51	\$ 62.57	\$ 62.57	\$ 64.66	\$ 64.66	\$ 127.23
221113741110		1-1/2" Waste Line	4	LF	34	0.23	\$ 10.43	\$ 41.72	\$ 11.23	\$ 44.92	\$ 86.64
221113762160		1-1/2" 90 Elbow	1	EA	18.2	0.44	\$ 6.92	\$ 6.92	\$ 21.14	\$ 21.14	\$ 28.06
221316606733		1-1/2" P-Trap	1	EA	18	0.44	\$ 11.33	\$ 11.33	\$ 21.14	\$ 21.14	\$ 32.47
	Plumbing - Water										
221113231140		1/2" Copper Line	49	LF	78	0.1	\$ 4.24	\$ 209.24	\$ 4.89	\$ 241.32	\$ 450.57
221113231180		3/4" Copper Line	8	LF	74	0.11	\$ 7.39	\$ 62.08	\$ 5.14	\$ 43.18	\$ 105.25
221113231200		1" Copper Line	8	LF	66	0.12	\$ 10.05	\$ 84.42	\$ 5.80	\$ 48.72	\$ 133.14
221113231260		2" Copper Line	8	LF	40	0.2	\$ 25.12	\$ 211.01	\$ 9.53	\$ 80.05	\$ 291.06
221113250100		1/2" Copper Elbow	4	EA	20	0.4	\$ 2.92	\$ 11.68	\$ 19.07	\$ 76.28	\$ 87.96
221113250480		1/2" T Copper	4	EA	13	0.61	\$ 4.98	\$ 19.92	\$ 29.43	\$ 117.72	\$ 137.64
221113250510		1" T Copper	1	EA	10	0.8	\$ 37.45	\$ 37.45	\$ 38.13	\$ 38.13	\$ 75.58
221113250130		1" Copper Elbow	1	EA	16	0.5	\$ 16.12	\$ 16.12	\$ 24.04	\$ 24.04	\$ 40.16
220719101016		1/2" Fiberglass	74	LF	230	0.07	\$ 1.57	\$ 116.42	\$ 2.71	\$ 200.95	\$ 317.36
220719101026		1" Fiberglass	8	LF	205	0.08	\$ 1.81	\$ 15.20	\$ 3.04	\$ 25.54	\$ 40.74
	FF&E										
123661170015	7	Vanity Countertop	1	EA	12	0.67	\$ 186.00	\$ 186.00	\$ 28.00	\$ 28.00	\$ 214.00
102813133200	TA6	42" H Mirror	1	EA	10	0.8	\$ 139.00	\$ 139.00	\$ 33.51	\$ 33.51	\$ 172.51
102813131105	TA1	42" SS Grab Bar	1	EA	20	0.4	\$ 46.00	\$ 46.00	\$ 16.85	\$ 16.85	\$ 62.85
102813130800	TA19	18" Vertical SS Grab Bar	1	EA	24	0.33	\$ 29.00	\$ 29.00	\$ 14.05	\$ 14.05	\$ 43.05
102813131300	TA2	36" SS Grab Bar	1	EA	20	0.4	\$ 33.50	\$ 33.50	\$ 16.85	\$ 16.85	\$ 50.35
102813131120	TA17	18" x 30" L-Shape SS Grab Bar	1	EA	20	0.4	\$ 85.50	\$ 85.50	\$ 16.85	\$ 16.85	\$ 102.35
102813130350	TA12	36" Heavy Duty Shower Rod	1	EA	13	0.61	\$ 32.50	\$ 32.50	\$ 25.70	\$ 25.70	\$ 58.20
102813134300	TA21	Robe Hook	2	EA	36	0.22	\$ 18.10	\$ 36.20	\$ 9.36	\$ 18.72	\$ 54.92
224116106000	P-3	15" x 12" ADA Lavatory	1	EA	7	2.29	\$ 218.99	\$ 218.99	\$ 97.82	\$ 97.82	\$ 316.81
224113401110	P-1B	ADA WC 16-1/2" Hgt	1	EA	5.3	3.02	\$ 283.45	\$ 283.45	\$ 129.32	\$ 129.32	\$ 412.77
224123405200	P-6	Shower; Head/Handset; Single Lever	1	EA	3.6	2.22	\$ 241.74	\$ 241.74	\$ 106.11	\$ 106.11	\$ 347.85
081416090210	2	3' x 6'-8" x 1-3/4" Wood	1	EA	16	1	\$ 97.01	\$ 97.01	\$ 45.59	\$ 45.59	\$ 142.60
081213130025		HM Door Frame	1	EA	16	1	\$ 129.05	\$ 129.05	\$ 45.59	\$ 45.59	\$ 174.64
233713301000	12	6" X 4" Mech Grille EA	1	EA	26	0.31	\$ 18.68	\$ 18.68	\$ 13.16	\$ 13.16	\$ 31.84
083113101350		42" x 36" Access Panel	1	EA	7.5	1.07	\$ 440.55	\$ 440.55	\$ 48.56	\$ 48.56	\$ 489.11
Subtotal								\$ 7,446.26		\$ 6,001.70	\$ 13,447.96
Tax								\$ 446.78		\$ 360.10	\$ 806.88
Overhead and Profit								\$ 744.63		\$ 600.17	\$ 1,344.80
Grand Total								\$ 8,637.66		\$ 6,961.98	\$ 15,599.64

Appendix A - Analysis 1

Bathroom Pod Costs

Quaid Spearing | Construction Option South Halls Renovation | Penn State University

Project Overview

Analysis 1: Modular Bathrooms

- Background Information
- Planning & Procurement
- Design Evaluation – Arch. Breadth Results

Analysis 2: SIPS

- Background Information
- Approach Results

Analysis 4: Phase Resequencing

- Background Information
- Process Results

Final Recommendation

Acknowledgements

Cost Analysis of Modular Bathrooms

Item	Cost/POD	Quantity /Building	Total Cost/Bldg	Quantity (Total Project)	Total Cost/Project
Stick Built Bathroom	\$ 15,240.00	40	\$ 609,600.00	160	\$ 2,438,400.00
Modular Bathroom					
Layout A.1/A.2	\$ 14,222.00	15	\$ 213,330.00	60	\$ 853,320.00
Layout A.3	\$ 14,222.00	1	\$ 14,222.00	4	\$ 56,888.00
Layout B	\$ 14,801.00	8	\$ 118,408.00	32	\$ 473,632.00
Layout C	\$ 14,801.00	7	\$ 103,607.00	28	\$ 414,428.00
Layout D	\$ 12,134.00	8	\$ 97,072.00	32	\$ 388,288.00
Layout E	\$ 13,907.00	1	\$ 13,907.00	4	\$ 55,628.00
Design Fees for Pods	\$ 7,500.00	6	\$ 45,000.00	6	\$ 45,000.00
25-Ton Hydraulic Crane, Truck Mounted	\$ 1,807.00	4	\$ 7,228.00	16	\$ 28,912.00
Total Costs/Savings			\$ (3,174.00)		\$ 122,304.00

Quotation



Client Information	Proposal Information
Name: _____	Quotation No: XXXX
Address: _____	Author: Tom Caldwell
Phone: _____ Fax: _____	Date: 2/4/2014

Item	Description	QTY	Unit Price	Total
1	Penn State South Halls Renovation - Modular Bathroom Type A Layout	64	\$12,134	\$776,576
2	Penn State South Halls Renovation - Modular Bathroom Type B Layout (w/ Rough-In For Bath Area Sink)	32	\$14,801	\$473,632
3	Penn State South Halls Renovation - Modular Bathroom Type C Layout (w/ Rough-In For Bath Area Sink)	28	\$14,801	\$414,428
4	Penn State South Halls Renovation - Modular Bathroom Type D Layout	32	\$14,422	\$461,504
5	Penn State South Halls Renovation - Modular Bathroom Type E Layout (w/ Accessible Roll-In Tiled Shower)	4	\$13,907	\$55,628

***POD Fabrication, Delivery, Staging, & Installation Subtotal: \$2,181,768**

6	POD Transportation - 53' Enclosed Trailer Deliveries From South Plainfield, NJ to State College, PA	34	-	Included In POD Unit Prices
7	**PSU South Halls Renovation Bathroom POD Staging & Installation	160	-	Included In POD Unit Prices

8	Penn State South Halls Modular Bathroom Prototype (Dedicated Throw Away Unit, Delivered To Penn State For Project Team Review)	15	\$22,822	\$32,822
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Tax: Excluded

Penn State South Halls Renovation POD Scope of Work Grand Total: \$2,204,590

Notes:
 *All POD types identified above were developed from the Penn State South Halls Phase 1 architectural drawing AE014 without deviation to interior layouts. An 7'-0" bathroom interior ceiling height was assumed for all units to allow installation into the current designed building structure. Further review of MEP & building structure is required to assure POD installation is accessible based on current slab-to-slab height. Bathroom POD walls do not carry a fire rating due to modular construction technique, bathroom modules to be installed against field built rated partitions. Modules include all framing, fixtures, finishes, door, hardware, & accessories as detailed in the accompanying POD specifications. Specifications developed from architectural layout of units and AmeriPOD's previous dormitory experience. Full height tile finish provided for all wall applications, possible project savings can be achieved through less tiled surfaces in unnecessary areas. Any deviations or desired changes to the specifications can be made in future proposals.

****Bathroom POD Staging and Installation Includes:** Off-loading modules from coordinated delivery vehicles and staging them into the building. PODs will be staged near their final location to await future installation. AmeriPOD will provide installation team with taglines for coordination of incoming delivery vehicles. AmeriPOD currently anticipates coordinating use of site crane with GC for hoisting PODs up and into the building. AmeriPOD will provide all loading platforms and spreader bars for lifting PODs into the building. Adjustable casters and extended pallet jacks will also be provided for moving PODs around the building floor into final location. GC is to provide an open, level floor surface for movement of the POD into coordinated installation locations. Once necessary framing and MEP connections are prepared and building is weather-tight, installation team will return to complete POD setting. Any leveling, if necessary will be performed by AmeriPOD installation team. Once slab is ready, PODs will be lowered off of the adjustable casters and mechanically fastened to the floor. MEP tie-ins to be performed by others.

Appendix A - Analysis 1

Bathroom Pod Schedule

Quaid Spearing | Construction Option
South Halls Renovation | Penn State University

Project Overview

Analysis 1: Modular Bathrooms

Background Information
Planning & Procurement
Design Evaluation – Arch. Breadth
Results

Analysis 2: SIPS

Background Information
Approach
Results

Analysis 4: Phase Resequencing

Background Information
Process
Results

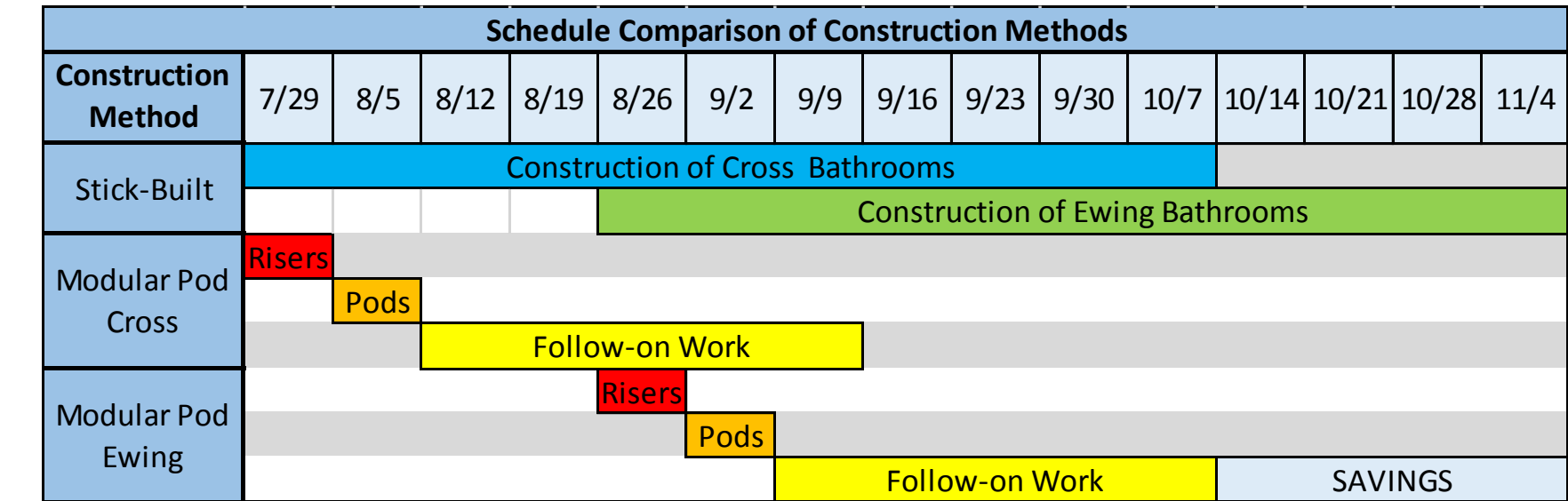
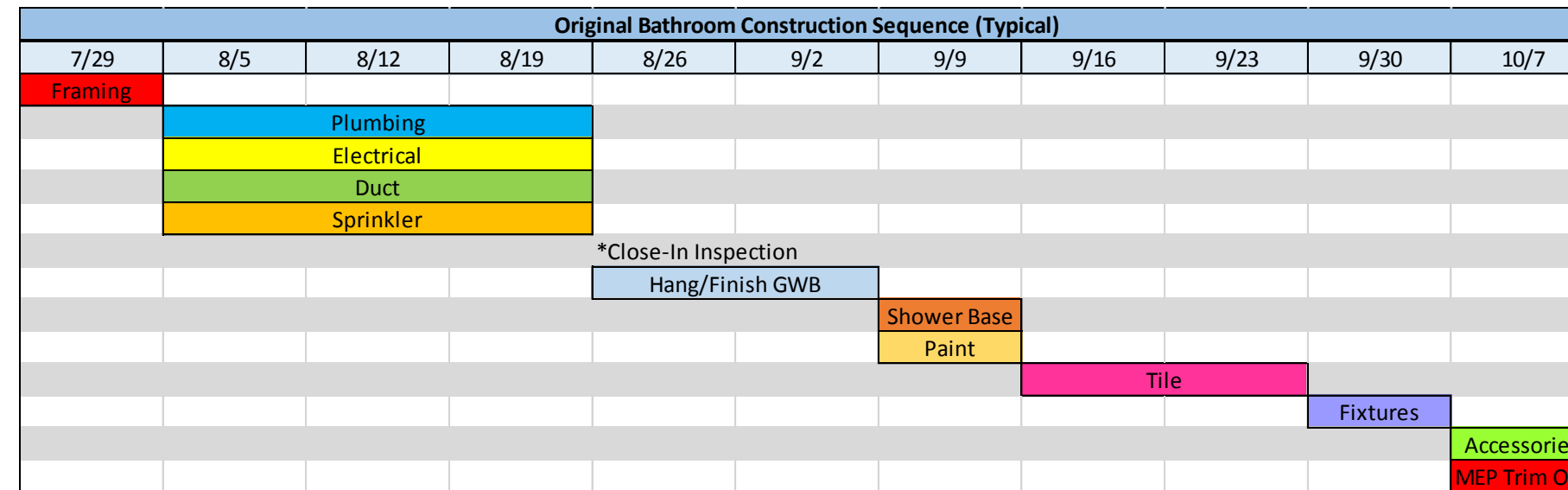
Final Recommendation

Acknowledgements

Anticipated Schedule Reduction for a Typical Floor

Activity	Original Duration	New Duration	Total Days Saved/Added
Framing	5	0	5
Plumbing Rough-In	15	0	15
Electrical Rough-In	15	0	15
Duct Rough-In	15	3	12
Sprinkler Rough-In	15	0	15
Close-In Inspection	1	0	0
Hang & Finish Drywall	8	4	4
Install Shower Bases	3	0	3
Prime & Coat First Paint	2	2	0
Install Ceramic Tile	12	2	10
Plumbing Fixtures	2	1	1
Accessories	3	1	2
Mech/Elec Trim Out	3	2	1
Place Bathroom Pods	0	1	1
Final MEP Connection	0	3	3
Total	54	19	35

Schedule Analysis



- Schedule Savings = 21 working days
 - Overall schedule cannot be reduced; bathrooms are on separate critical path

Project Overview

Analysis 1: Modular Bathrooms

Background Information
Planning & Procurement
Design Evaluation – Arch. Breadth
Results

Analysis 2: SIPS

Background Information
Approach
Results

Analysis 4: Phase Resequencing

Background Information
Process
Results

Final Recommendation

Acknowledgements

Appendix B - Analysis 2

Crew Size Calculations

Quaid Spearing | Construction Option South Halls Renovation | Penn State University

Sample Calculation: Hang GWB

- $5600\text{SF} / 6 \text{ Workers} = 933 \text{ SF/Worker}$
- $(933 \text{ SF/Worker}) / 8 \text{ days} = \mathbf{117 \text{ SF/Day}}$
- $5600 \text{ SF} = (117 \text{ SF/Day})(5 \text{ Days})(X \text{ Wrkrs})$
 - $X = 10 \text{ Man Crew}$

Crew Size Adjustments

- Adjust crew sizes to achieve 5 day durations
- Combined several activities performed by same subcontractor(s)
 - **Schedule Adjusted to 23 activities | 1 week/activity**

New Duration and Production Rates					
No.	Activity	New Duration	Subcontractor	Crew Size	Production/Wrkr (SF/Day)
1	Layout & Top Track	5	Penn Install	5	224
2	Perimeter Bedroom Framing & Insulation	5	Penn Install	6	187
3	Ductwork	5	McClure	2	224
4	MEP Coring	5	McClure & FE	6	560
5	Electrical Rough In & Tele-Data	5	FE	8	140
6	Perimeter Bedroom Piping	5	McClure	5	224
7	Door Frames & Clg/Bulkhead Framing	5	Penn Install	11	160
8	Sprinkler Rough In	5	SAC	2	467
9	Plumbing Rough In	5	McClure	5	224
10	Hang GWB	5	Penn Install	10	117
11	Finish GWB	5	Penn Install	8	140
12	Windows	5	NBS	2	622
13	Prime & Paint	5	PAT	2	467
14	Install Lighting and Final Tele-Data Pull	5	FE	4	373
15	Install Flooring	5	NBS	4	280
16	Install FCU & Mech. Trim Out	5	McClure	3	560
17	Doors & Hardware	5	Hood Co	2	467
18	Adjust Sprinkler Heads	5	SAC	2	700
19	Elec/Tele/Fire Alarm Trim Out	3	FE	2	933
20	Suite/Lobby Casework & Window Treatment	5	Penn Install	5	280
21	Apply Final Paint	5	PAT	3	373
22	Floor Install/Carpet Base	2	NBS	2	933
23	Final Clean	2	BMC	5	560

Appendix B - Analysis 2

Student Room SIPS

Quaid Spearing | Construction Option
South Halls Renovation | Penn State University

Project Overview

Analysis 1: Modular Bathrooms

Background Information
Planning & Procurement
Design Evaluation – Arch. Breadth
Results

Analysis 2: SIPS

Background Information
Approach
Results

Analysis 4: Phase Resequencing

Background Information
Process
Results

Final Recommendation

Acknowledgements

		2013																														
		June				July				August				September				October				November				December						
Area		6/3	6/10	6/17	6/24	7/1	7/8	7/15	7/22	7/29	8/5	8/12	8/19	8/26	9/2	9/9	9/16	9/23	9/30	10/7	10/14	10/21	10/28	11/4	11/11	11/18	11/25	12/2	12/9	12/16	12/23	12/30
Zone 1		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24							
Zone 2		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24							
Zone 3		1		2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24						
Zone 4		1			2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24					
Zone 5		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24							
Zone 6		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24							
Zone 7		1		2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24						
Zone 8		1			2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24					
Zone 9		1				2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24				

1 Layout and Top Track	6 Perim. Bedroom Piping	11 Finish GWB	16 FCU & Mech Trim Out	21 Final Paint
2 Perim. Bedroom Framing/Insulation	7 Door Frames & Clg/Bulkhead Framing	12 Windows	17 Doors & Hardware	22 Carpet
3 Ductwork	8 Sprinkler Rough In	13 Prime & Paint	18 Adjust Sprinkler Heads	23 Final Clean & Punchlist
4 MEP Coring	9 Plumbing Rough In	14 Lights & Final Tele-Data	19 Elec/Tele/Fire Alarm Trim Out	24 Owner FF&E
5 Elec. Rough In & Tele-Data	10 Hang GWB	15 Install Flooring	20 Suite/Lobby Case & Window Treat	

Appendix C - Analysis 4

Phase Resequencing Schedule

Quaid Spearing | Construction Option
South Halls Renovation | Penn State University

Project Overview

Analysis 1: Modular Bathrooms

Background Information
Planning & Procurement
Design Evaluation – Arch. Breadth
Results

Analysis 2: SIPS

Background Information
Approach

Results

Analysis 4: Phase Resequencing

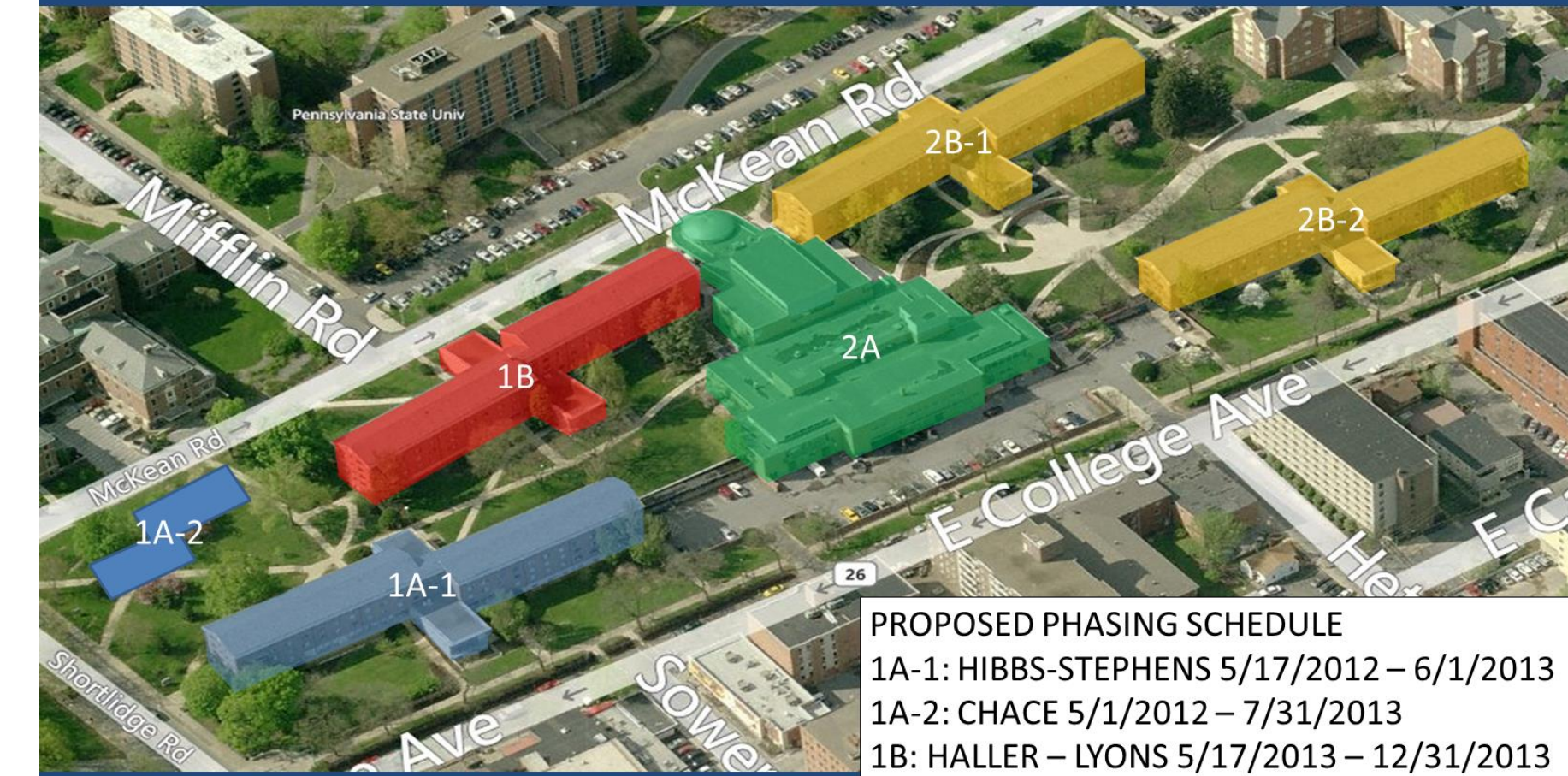
Background Information
Process
Results

Final Recommendation

Acknowledgements

		South Halls Renovation Schedule Comparisons																															
		2012							2013							2014							2015										
		May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Original Phasing Schedule	Haller - Lyons	[Red]							[Grey]							[Grey]							[Grey]										
	Chace	[Yellow]							[Grey]							[Grey]							[Grey]										
	Ewing - Cross	[Grey]							[Yellow]							[Grey]							[Grey]										
	Cooper - Hoyt	[Grey]							[Grey]							[Green]							[Grey]										
	Redifer Commons	[Grey]							[Grey]							[Green]							[Grey]										
New Phasing Schedule	Hibbs - Stephens	[Blue]							[Grey]							[Grey]							[Grey]										
	Chace	[Yellow]							[Grey]							[Grey]							[Grey]										
	Haller - Lyons	[Grey]							[Red]							[Grey]							[Grey]										
	Redifer Commons	[Grey]							[Green]							[Grey]							[Grey]										
	Cooper - Hoyt	[Grey]							[Grey]							[Green]							[Closeout]										
																							[Closeout]		[SCHEDULE SAVINGS]								

PROPOSED MASTER PHASING PLAN



PROPOSED PHASING SCHEDULE

1A-1:	HIBBS-STEPHENS	5/17/2012 – 6/1/2013
1A-2:	CHACE	5/1/2012 – 7/31/2013
1B:	HALLER – LYONS	5/17/2013 – 12/31/2013
2A:	REDIFER COMMONS	8/1/2013 – 5/31/2014
2B-1:	EWING – CROSS	1/2/2014 – 7/31/2014
2B-2:	COOPER – HOYT	1/2/2014 – 7/31/2014

Phase Resequence Gen Cond.

Project Overview

Analysis 1: Modular Bathrooms

- Background Information
- Planning & Procurement
- Design Evaluation – Arch. Breadth
- Results

Analysis 2: SIPS

- Background Information
- Approach
- Results

Analysis 4: Phase Resequencing

- Background Information
- Process
- Results

Final Recommendation

Acknowledgements

Phase 1 Original Staffing					
Cost Code	Description	Quantity	Unit	Labor/Unit	Labor Total
013113200220	Project Executive	17	Weeks	3825	\$ 66,555.00
013113200200	Project Director	44	Weeks	3350	\$ 145,725.00
013113200180	Project Manager	87	Weeks	2900	\$ 252,300.00
013113200120	Senior Project Engineer	87	Weeks	2050	\$ 178,350.00
013113200100	Project Engineer	87	Weeks	1575	\$ 137,025.00
013113200260	Senior Superintendent	87	Weeks	3100	\$ 269,700.00
013113200240	Field Superintendent	87	Weeks	2825	\$ 245,775.00
013113200240	Field Superintendent	87	Weeks	2825	\$ 245,775.00
013113200020	Project Technician	87	Weeks	570	\$ 49,590.00
013113200010	Intern	13	Weeks	1040	\$ 13,520.00
013113200010	Intern	13	Weeks	1040	\$ 13,520.00
					\$ 1,617,835.00

Phase 2 Original Staffing					
Cost Code	Description	Quantity	Unit	Labor/Unit	Labor Total
013113200220	Project Executive	12	Weeks	3825	\$ 45,900.00
013113200200	Project Director	30	Weeks	3350	\$ 100,500.00
013113200180	Project Manager	60	Weeks	2900	\$ 174,000.00
013113200100	Senior Project Engineer	60	Weeks	2050	\$ 123,000.00
013113200260	Senior Superintendent	60	Weeks	3100	\$ 186,000.00
013113200020	Project Technician	60	Weeks	570	\$ 34,200.00
013113200010	Intern	13	Weeks	1040	\$ 13,520.00
				Subtotal	\$ 677,120.00

Phase 2 New Staffing					
Cost Code	Description	Quantity	Unit	Labor/Unit	Labor Total
013113200220	Project Executive	8	Weeks	3825	\$ 29,835.00
013113200200	Project Director	20	Weeks	3350	\$ 65,325.00
013113200180	Project Manager	39	Weeks	2900	\$ 113,100.00
013113200120	Senior Project Engineer	39	Weeks	2050	\$ 79,950.00
013113200100	Project Engineer	39	Weeks	1575	\$ 61,425.00
013113200260	Senior Superintendent	39	Weeks	3100	\$ 120,900.00
013113200240	Field Superintendent	39	Weeks	2825	\$ 110,175.00
013113200240	Field Superintendent	39	Weeks	2825	\$ 110,175.00
013113200020	Project Technician	39	Weeks	570	\$ 22,230.00
013113200010	Intern	13	Weeks	1040	\$ 13,520.00
013113200010	Intern	13	Weeks	1040	\$ 13,520.00
				Subtotal	\$ 740,155.00

Appendix C - Analysis 4

Phase Resequence Gen Cond.

Quaid Spearing | Construction Option South Halls Renovation | Penn State University

Project Overview

Analysis 1: Modular Bathrooms

Background Information

Planning & Procurement

Design Evaluation – Arch. Breadth

Results

Analysis 2: SIPS

Background Information

Approach

Results

Analysis 4: Phase Resequencing

Background Information

Process

Results

Final Recommendation

Acknowledgements

Phase 1 General Conditions					
	Field Office				
015213400100	Equipment	20	Month	217.8	\$ 4,356.00
015213400120	Supplies	20	Month	100	\$ 2,000.00
015213400140	Telephone	20	Month	88.11	\$ 1,762.20
015213400160	Lights and HVAC	20	Month	165.33	\$ 3,306.60
01521340010	Computer Equipment/Software	1	LPSM	50000	\$ 50,000.00
01521340010	Furniture	1	LPSM	10000	\$ 10,000.00
01521340010	Postage/Packaging	20	Month	200	\$ 4,000.00
	Safety & Security				
Misc.	Subtotal Safety/Security	1	LPSM	10000	\$ 10,000.00
	Quality & Testing				
014523505570	Testing (1/month)	20	Each	301.32	\$ 6,026.40
	Temporary Utilities				
015113500140	Temporary Electrical Power	1	LPSM	3268	\$ 3,268.00
	Temporary Facilities				
015626500250	Site Fencing	2700	LF	7.43	\$ 20,061.00
015813500020	Signage	200	SF	37.13	\$ 7,426.00
015433406410	Temporary Toilets (4)	80	Month	227.88	\$ 18,230.40
	Small Tools				
015433400010	Small Tools/Equipment	1	LPSM	5000	\$ 5,000.00
	Cleaning and Waste Management				
024119190600	Dumpsters (2)	174	Weeks	505	\$ 87,870.00
017413200010	Final Cleaning	1420.04	MSF	90.46	\$ 128,456.82
					\$ 361,763.42

Phase 1 Chace General Conditions					
	Field Office				
015213400100	Equipment	15	Month	217.8	\$ 3,267.00
015213400120	Supplies	15	Month	100	\$ 1,500.00
015213400140	Telephone	15	Month	88.11	\$ 1,321.65
015213400160	Lights and HVAC	15	Month	165.33	\$ 2,479.95
01521340010	Computer Equipment/Software	1	LPSM	50000	\$ 50,000.00
01521340010	Furniture	1	LPSM	10000	\$ 10,000.00
01521340010	Postage/Packaging	15	Month	200	\$ 3,000.00
	Safety & Security				
Misc.	Subtotal Safety/Security	1	LPSM	10000	\$ 10,000.00
	Quality & Testing				
014523505570	Testing (1/month)	15	Each	301.32	\$ 4,519.80
	Temporary Utilities				
015113500140	Temporary Electrical Power	1	LPSM	3268	\$ 5,500.00
	Temporary Facilities				
015626500250	Site Fencing	3000	LF	7.43	\$ 22,290.00
015813500020	Signage	100	SF	37.13	\$ 3,713.00
015433406410	Temporary Toilets (4)	60	Month	227.88	\$ 13,672.80
	Small Tools				
015433400010	Small Tools/Equipment	1	LPSM	5000	\$ 5,000.00
	Cleaning and Waste Management				
024119190600	Dumpsters (2)	128	Weeks	505	\$ 64,640.00
017413200010	Final Cleaning	415.78	MSF	90.46	\$ 37,611.46
					\$ 238,515.66

Appendix C - Analysis 4

Phase Resequence Gen Cond.

Quaid Spearing | Construction Option
South Halls Renovation | Penn State University

Project Overview

Analysis 1: Modular Bathrooms

- Background Information
- Planning & Procurement
- Design Evaluation – Arch. Breadth
- Results

Analysis 2: SIPS

- Background Information
- Approach
- Results

Analysis 4: Phase Resequencing

- Background Information
- Process
- Results

Final Recommendation

Acknowledgements

Phase 2 Original General Conditions					
	Field Office				
015213400100	Equipment	14	Month	217.8	\$ 3,049.20
015213400120	Supplies	14	Month	100	\$ 1,400.00
015213400140	Telephone	14	Month	88.11	\$ 1,233.54
015213400160	Lights and HVAC	14	Month	165.33	\$ 2,314.62
01521340010	Computer Equipment/Software	1	LPSM	50000	\$ 50,000.00
01521340010	Furniture	1	LPSM	10000	\$ 10,000.00
01521340010	Postage/Packaging	14	Month	200	\$ 2,800.00
	Safety & Security				
Misc.	Subtotal Safety/Security	1	LPSM	10000	\$ 10,000.00
	Quality & Testing				
014523505570	Testing (1/month)	14	Each	301.32	\$ 4,218.48
	Temporary Utilities				
015113500140	Temporary Electrical Power	1	LPSM	3268	\$ 3,268.00
	Temporary Facilities				
015626500250	Site Fencing	2700	LF	7.43	\$ 20,061.00
015813500020	Signage	200	SF	37.13	\$ 7,426.00
015433406410	Temporary Toilets (4)	56	Month	227.88	\$ 12,761.28
	Small Tools				
015433400010	Small Tools/Equipment	1	LPSM	5000	\$ 5,000.00
	Cleaning and Waste Management				
024119190600	Dumpsters (2)	122	Weeks	505	\$ 61,610.00
017413200010	Final Cleaning	1420.04	MSF	90.46	\$ 128,456.82
					\$ 323,598.94

Phase 2 New General Conditions					
	Field Office				
015213400100	Equipment	9	Month	217.8	\$ 1,960.20
015213400120	Supplies	9	Month	100	\$ 900.00
015213400140	Telephone	9	Month	88.11	\$ 792.99
015213400160	Lights and HVAC	9	Month	165.33	\$ 1,487.97
01521340010	Computer Equipment/Software	1	LPSM	50000	\$ 50,000.00
01521340010	Furniture	1	LPSM	10000	\$ 10,000.00
01521340010	Postage/Packaging	9	Month	200	\$ 1,800.00
	Safety & Security				
Misc.	Subtotal Safety/Security	1	LPSM	10000	\$ 10,000.00
	Quality & Testing				
014523505570	Testing (1/month)	9	Each	301.32	\$ 2,711.88
	Temporary Utilities				
015113500140	Temporary Electrical Power	1	LPSM	3268	\$ 3,268.00
	Temporary Facilities				
015626500250	Site Fencing	2700	LF	7.43	\$ 20,061.00
015813500020	Signage	200	SF	37.13	\$ 7,426.00
015433406410	Temporary Toilets (4)	36	Month	227.88	\$ 8,203.68
	Small Tools				
015433400010	Small Tools/Equipment	1	LPSM	5000	\$ 5,000.00
	Cleaning and Waste Management				
024119190600	Dumpsters (2)	78	Weeks	505	\$ 39,390.00
017413200010	Final Cleaning	1420.04	MSF	90.46	\$ 128,456.82
					\$ 291,458.54

General Conditions Summary			
Description	Original \$	New \$	Cost Difference
Phase 1 Staffing	\$ 1,617,835.00	\$ 1,617,835.00	\$ -
Phase 2 Staffing	\$ 677,120.00	\$ 740,155.00	\$ 63,035.00
Phase 1 Gen Cond.	\$ 361,763.42	\$ 361,763.42	\$ -
Phase 1 Chace Gen Cond.	\$ 238,515.66	\$ 238,515.66	\$ -
Phase 2 Gen Cond.	\$ 323,598.94	\$ 291,458.54	\$ (32,140.40)
Total	\$ 3,218,833.02	\$ 3,249,727.62	\$ 30,894.60