Gouverneur Healthcare Services Facility

New York, New York , 10002

Alex Despotovich | Construction Management

Faculty Advisor: Dr. John I. Messner

April 10, 2012

PROJECT BACKGROUND

PRESENTATION OUTLINE

- **PROJECT BACKGROUND**
- THE USE OF BUILDING INFORMATION MODELING
- SCHEDULE RE-SEQUENCING AND TENANT OCCUPANCY
- MATERIAL STAGING AND SYSTEM PREFABRICATION
- SUSTAINABLE GREEN ROOF GARDEN
- RECOMMENDATIONS AND CONCLUSIONS
- ACKNOWLEDGEMENTS

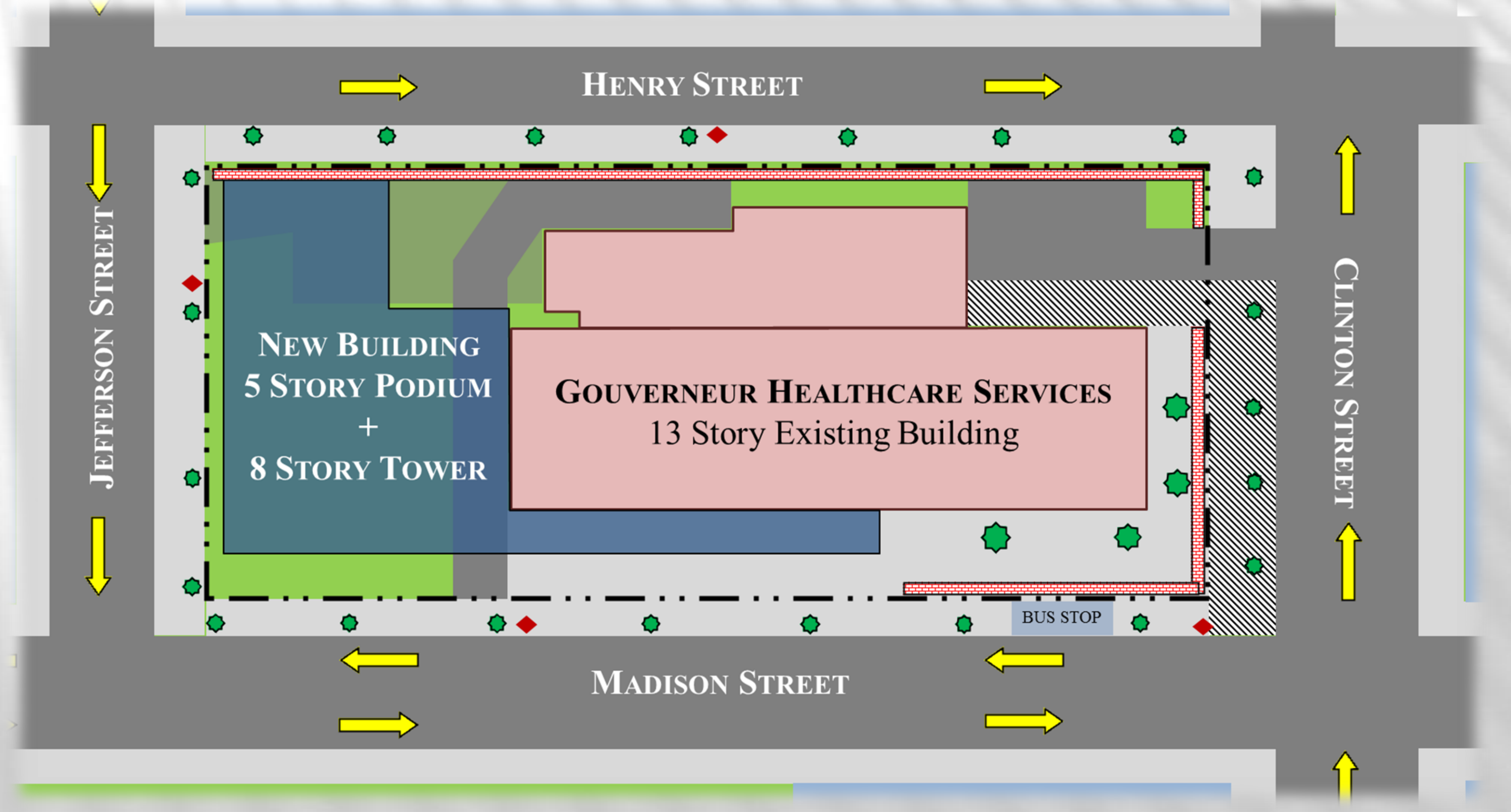
- **GOUVERNEUR HEALTHCARE SERVICES FACILITY**
  - New York, New York, 10002
- New York City Health and Hospitals Corporation, HHC
- Design-Bid-Build with CM Agency
  - Dormitory Authority of the State of New York, DASNY
  - Hunter Roberts Construction Group
- Total Project Cost: $207,000,000
- Project Construction Start Date: January 2009
- Final Project Completion Date: December 2013

Project Background

Presentation Outline

- Project Background
- The Use of Building Information modeling
- Schedule Re-Sequencing and Tenant Occupancy
- Material Staging and System Prefabrication
- Sustainable Green Roof Garden
- Recommendations and Conclusions
- Acknowledgements

- **Gouverneur Healthcare Services Facility**
  - New York, New York, 10002
- Scope of Work
  - Interior Demolition and Renovation of Existing Building
  - Modernization of Existing Mechanical Infrastructure
  - New 109,000 Square Foot Addition
- Construction Challenges
  - Existing Facility Active During Construction
  - Schedule Phasing of Floor Turnovers
  - Site Logistics of New York City
  - Asbestos Removal throughout Existing Facility



The Use of Building Information Modeling
Technical Analysis Background

Presentation Outline

- Project Background
- **The Use of Building Information modeling**
  - **Technical Analysis Background**
  - The Application of 3D Modeling
  - The Application of VELA Systems
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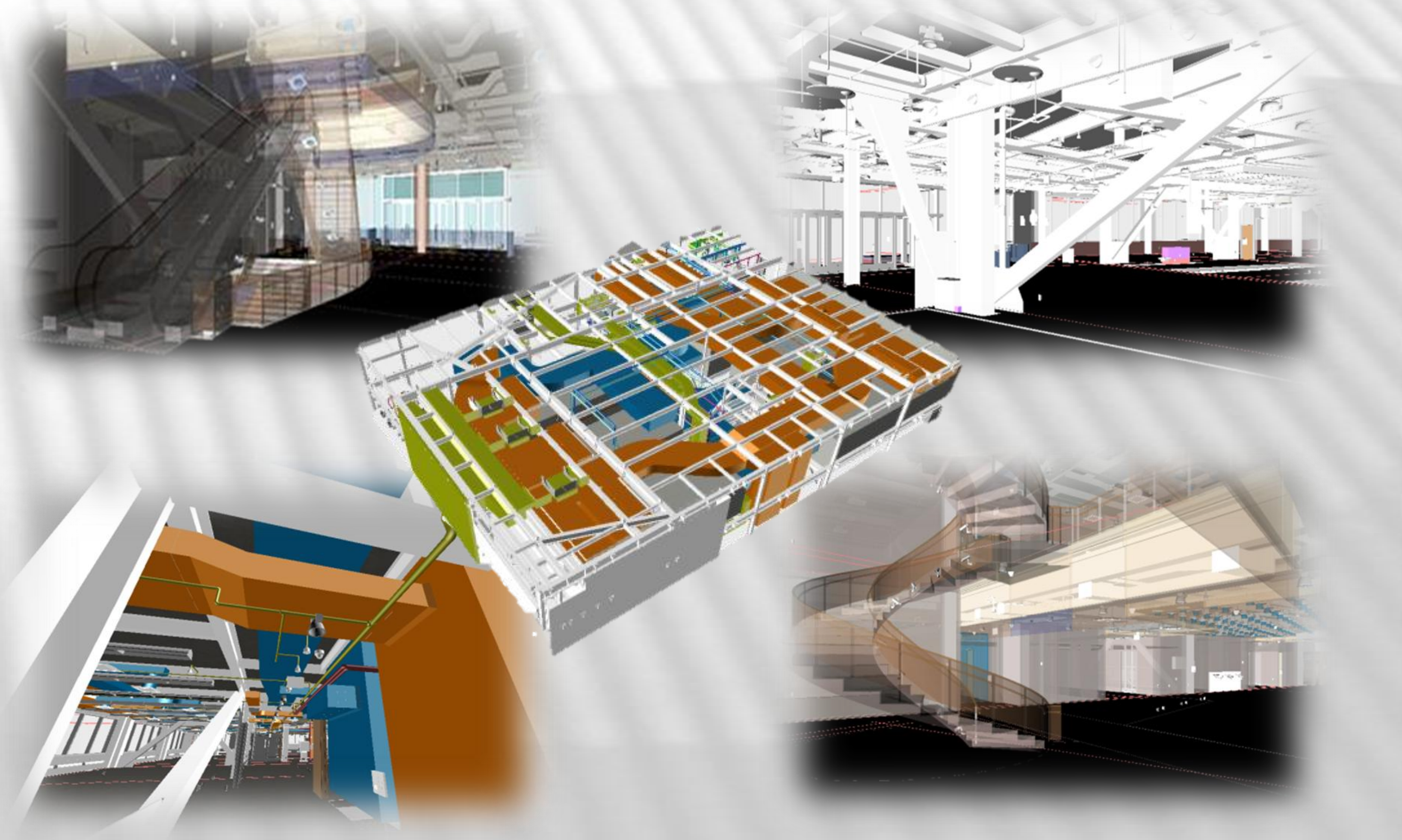
Technical Analysis Background

- Building Information Modeling methods not applied for design and construction
- Complex MEP systems to support buildings function designed and coordinated in 2-dimensions
- Large facility causes the current punchlist process to be tedious and time consuming

Technical Analysis Research Goals

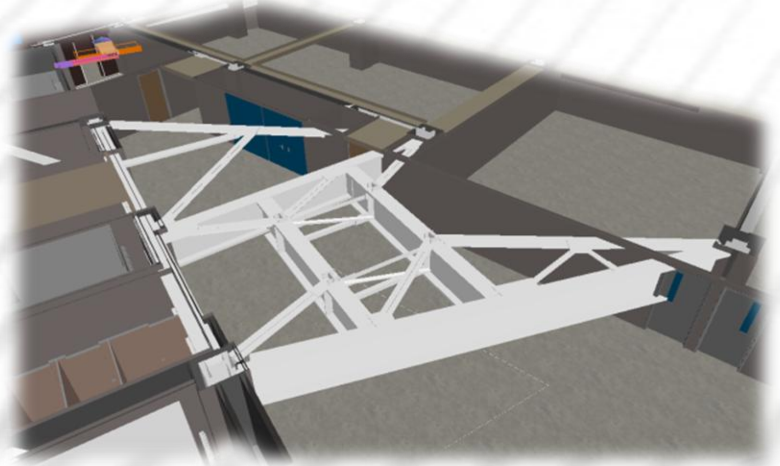
- Identify feasibility of implementing 3D model for coordination of design and construction for the new and existing building
- Identify more efficient method for the punch list process



The Use of Building Information Modeling
The Application of 3D Modeling

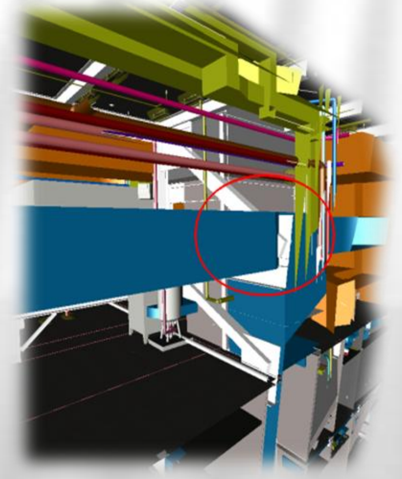
Presentation Outline

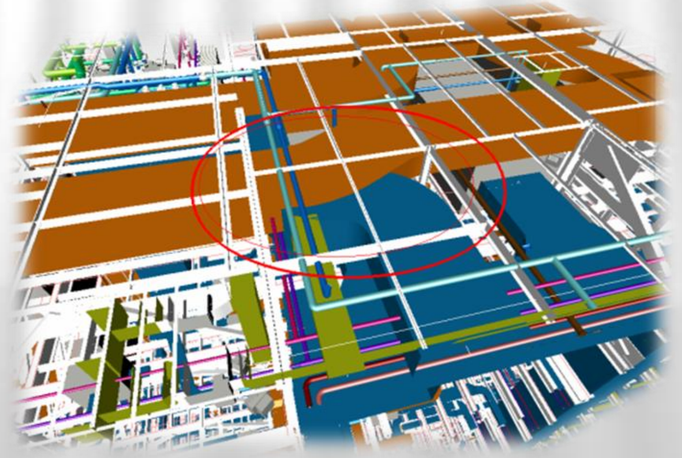
Tower Crane Planning



Fiterman Hall Case Study

- 400,000 ft^2, 14-story educational facility in New York, New York
- Hunter Roberts Construction Group initiated utilization of 3D model for design and construction coordination
    - 75 to 100 clashes per floor
    - Reduce changes orders and increase communication
- Most Beneficial:
    - Tower Crane Planning
    - Mechanical Penthouse Coordination





Gouverneur Healthcare Services Application of 3D Model

- Utilized 3D and 4D model for sequencing of major equipment of the existing 14th floor mechanical equipment room
- New Building Construction
    - Feasible to utilize 3D model for design and construction coordination
    - Reduce clashes between systems in the field – change order reduction
    - Primary Concern – Modeling new to existing building
- Existing Building Construction
    - Not feasible to utilize 3D model due to schedule phasing
    - Inaccuracy of as-builts unreliable for 3D model
    - Laser scanning cause delays in phased schedule

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The Use of Building Information Modeling

The Application of VELA Systems

Gouverneur Healthcare Services Facility

New York, New York, 10002

Presentation Outline

- Project Background
- **The Use of Building Information modeling**
    - Technical Analysis Background
    - The Application of 3D Modeling
    - **The Application of VELA Systems**
- Schedule Re-Sequencing and Tenant Occupancy
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Hudson Greene Case Study

- Two 50-story residential towers, 1.5 million ft^2
- Utilized VELA Systems software to increase efficiency of punchlist process
    - VELA-equipped tablets for field personnel
- Project Benefits
    - Increased Efficiency
    - Document Management
    - Increased Communication
- Future Recommendations
    - Use of iPad for Tablets
    - Training within company

Project Cost and Schedule Impact

Item	Cost
Project Setup on VELA Systems' Servers	$5000 – One Time Cost
VELA Training Session – 1 Day	$3000 – One Time Cost
License Cost per User – 8 Total Users	$200 per Month per User - $1600 per month
Field Tablets – 4 Total Tablets	$3000 per Tablet - $12,000 Total

12 apartment units per floor per Building

- 134 man hours for traditional process and 33 for VELA punchlist process

Total Man Hour Savings: **10,100 hrs.**

THE USE OF BUILDING INFORMATION MODELING
THE APPLICATION OF VELA SYSTEMS

PRESENTATION OUTLINE

- PROJECT BACKGROUND
- **THE USE OF BUILDING INFORMATION MODELING**
  - TECHNICAL ANALYSIS BACKGROUND
  - THE APPLICATION OF 3D MODELING
  - **THE APPLICATION OF VELA SYSTEMS**
- SCHEDULE RE-SEQUENCING AND TENANT OCCUPANCY
- MATERIAL STAGING AND SYSTEM PREFABRICATION
- SUSTAINABLE GREEN ROOF GARDEN
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GOUVERNEUR HEALTHCARE SERVICES APPLICATION OF VELA FOR PUNCHLIST

- Utilized VELA Systems software to increase efficiency of punchlist process
  - VELA-equipped tablets for field personnel
- Lessons Learned from Hudson Greene
  - Use iPad for Tablets to reduce costs
  - Train personnel within company to reduce costs

PROJECT COSTS IMPACT

Item	Cost
Project Setup on VELA Systems' Servers	$5000 – One Time Cost
VELA Training Session – 1 Day	$0
License Cost per User – 4 Total Users	$200 per Month per User - $800 per month
Field Tablets – 2 Total Tablets	$700 per Tablet - $1,400 Total

PROJECT SCHEDULE IMPACTS

FLOORS SIX THROUGH 11 - 40 RESIDENTIAL SPACES

- 160 man hours for traditional process and 36 for VELA punchlist process

FLOORS TWO THROUGH FIVE – 60 EXAM AND CONSULT SPACES

- 203 man hours for traditional process and 42 for VELA punchlist process

TOTAL MAN HOUR SAVINGS: **2000 hrs.**
TOTAL COST: **$25,000**

SCHEDULE RE-SEQUENCING AND TENANT OCCUPANCY

TECHNICAL ANALYSIS BACKGROUND

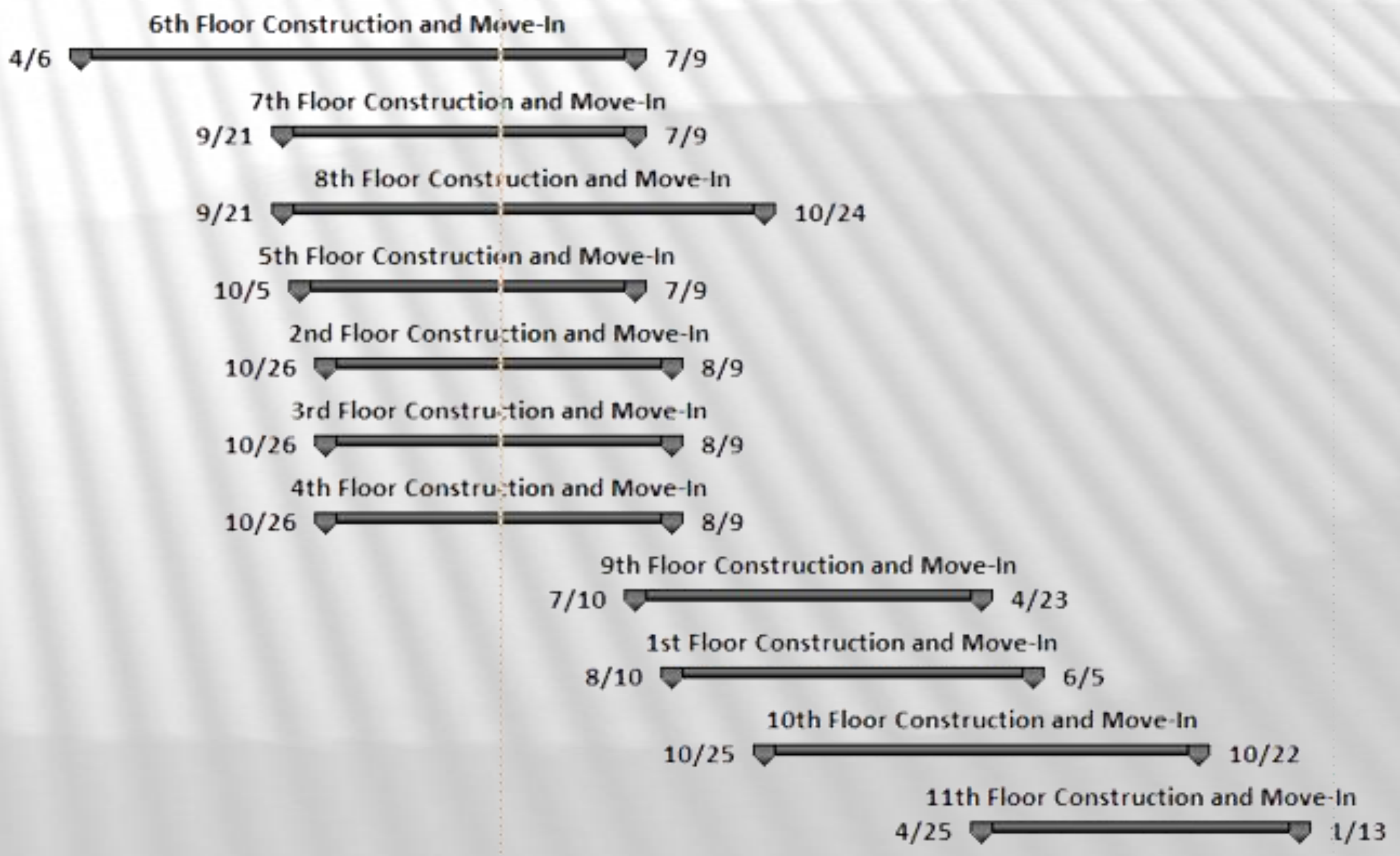
PRESENTATION OUTLINE

TECHNICAL ANALYSIS BACKGROUND

- Owner turns over floors to construction for demolition and renovation in scattered order
- Residential floors six through eleven contain identical floor layouts and share phasing relationship
- Phasing relationship is affected by the duration in which owner can move occupants from existing to newly renovated spaces

TECHNICAL ANALYSIS RESEARCH GOALS

- Perform schedule re-sequencing to create a direct relationship between residential floors
- Identify more efficient method to managing the occupancyy move-in process for newly constructed and renovated floors



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Schedule Re-Sequencing and Tenant Occupancy

Re-Sequencing the Project Schedule

Gouverneur Healthcare Services Facility

New York, New York, 10002

Presentation Outline

- Project Background
- The Use of Building Information modeling
- **Schedule Re-Sequencing and Tenant Occupancy**
  - Technical Analysis Background
  - **Re-Sequencing the Project Schedule**
    - Construction Impact
  - Owner Concerns
  - Facility Management Tools
    - FM:Interact Move Management
    - Cost and Schedule Impact
- Material Staging and System Prefabrication
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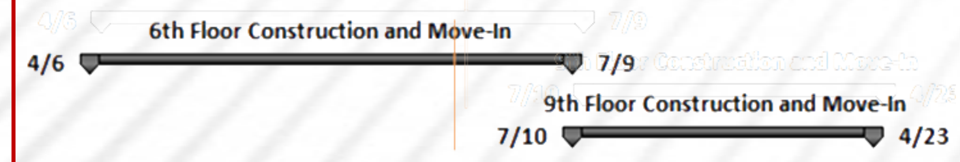
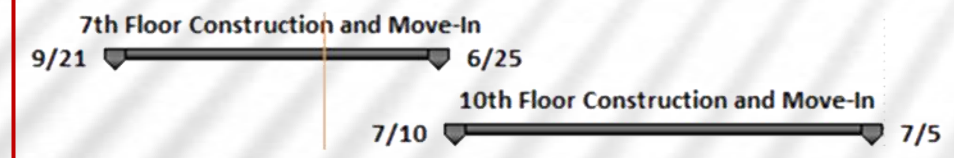
Create Relationship Between

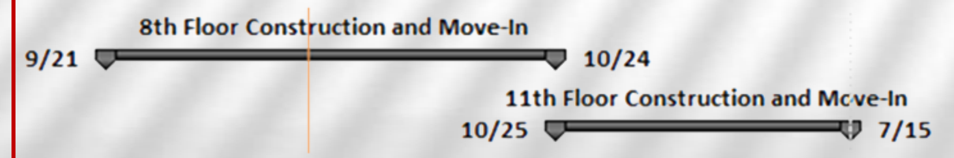
- Floors Six and Nine



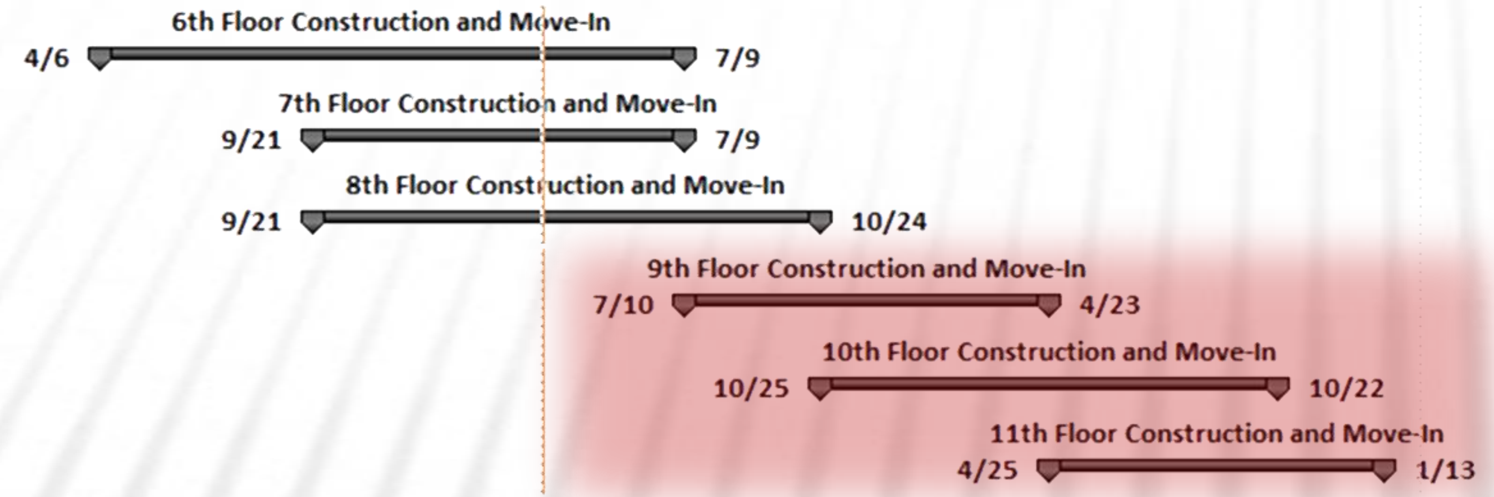
- Floors Seven and Ten



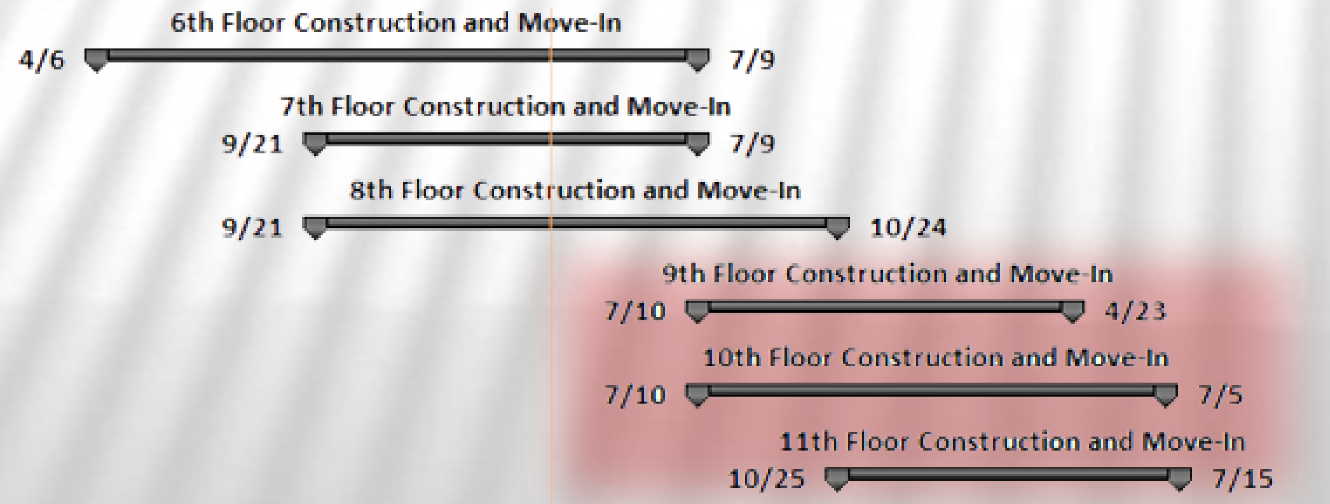
- Floors Eight and Eleven



Original Phasing Relationship



Re-Sequenced Phasing Relationship



Original versus Re-Sequenced Schedule Reduction

Task Name	Original Schedule		Re-Sequenced Schedule		Duration
	Start	Finish	Start	Finish	Saved
10th Floor Construction and Move-In	10/25/2012	10/22/2013	7/10/2012	7/5/2013	**107**
11th Floor Construction and Move-In	4/25/2013	1/13/2014	10/25/2012	7/15/2013	**182**
Project Substantial Completion	12/30/2013	12/30/2013	7/15/2013	7/15/2013	**168**

Schedule Re-Sequencing General Conditions Cost Savings

Task Name	Duration Saved	General Conditions per Day	Total Cost Savings
Project Substantial Completion	168	$ 10,013	$ 1,682,184
Total			**$ 1,682,184**

Duration Savings: **168 Days**

Cost Savings: **$1,682,184**

Schedule Re-Sequencing and Tenant Occupancy

Re-Sequencing the Project Schedule

Presentation Outline

- Project Background
- The Use of Building Information modeling
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  - **Re-Sequencing the Project Schedule**
    - **Construction Impact**
  - Owner Concerns
  - Facility Management Tools
    - FM:Interact Move Management
    - Cost and Schedule Impact
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Legend

Occupied Floors

Under Construction

Creates Efficient Flow of Construction

Phase I

Phase II

Phase III

Phase IV

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Schedule Re-Sequencing and Tenant Occupancy
Owner Concerns

Presentation Outline

New York City HHC Facility Map

Facility Business Plan

- How much revenue will be lost as a result of re-sequencing?
- Long-term residential care spaces = $255.27 per day per occupant
- Average of 50% occupancy for 40 patients per residential floor

Potential Patient Revenue Loss

Task Name	Duration Saved	Patient Revenue	Patients per Floor	Total Revenue
10th Floor Construction and Move-In	107	$ 255.27	20	$ 546,278
11th Floor Construction and Move-In	182	$ 255.27	20	$ 929,1823
Total Revenue				**$ 1,475,461**

Potential Revenue Versus General Condition Cost Savings

Item	Cost
General Conditions of Construction Manager	$ 1,682,184
10^{th} and 11^{th} Floor Revenue Loss	$ (1,475,461)
Total Cost Savings	**$ 206,723**

Total Cost Savings: $206,723

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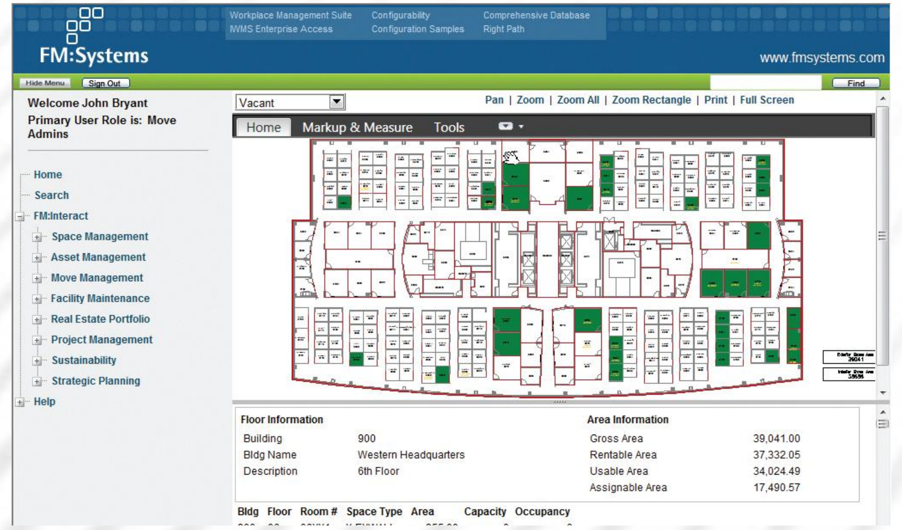
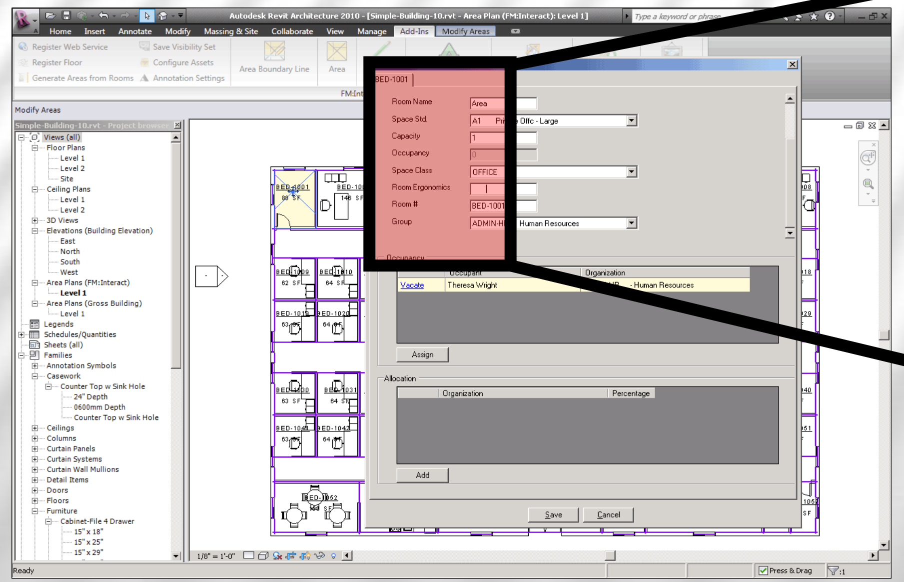
Schedule Re-Sequencing and Tenant Occupancy

Facility Management Tools

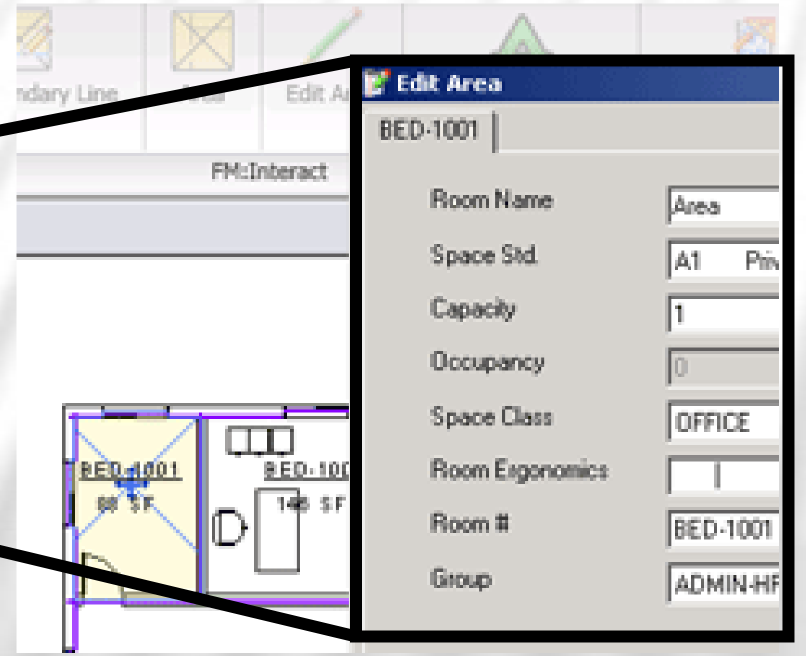
Presentation Outline





FM:Systems Interact Move management Software

- Manage building occupancy moves
- Cut down time and costs related to occupancy moves
  - "Twice the people in the half the time" – FM:Systems



- Color code departments and rooms to manage individuals locations before and after moving
- Manage individual assets during moves

Cost and Schedule Analysis

- Overall System Cost based on 2-year period of use: **$129,548**
- New Building Move-In Reduction: **14 days**
- Existing Building Move-In Reduction: **7 days/floor**
- Overall Schedule Reduction: **14 days**
- General Conditions Cost Savings: **$140,182**
- Revenue Generated through Reduction: **$428,854**

Overall Duration Savings: **14 Days**
Total Cost Savings: **$439,488**

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Material Staging and System Prefabrication

Technical Analysis Background

Gouverneur Healthcare Services Facility

New York, New York, 10002

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- Project Background
- The Use of Building Information modeling
- Schedule Re-Sequencing and Tenant Occupancy
- **Material Staging and System Prefabrication**
  - **Technical Analysis Background**
  - Miami Valley Hospital Case Study
  - Area of Implementation
  - Project Specific Modules
  - Material Staging Plan
  - Union Analysis
  - Cost and Schedule Analysis
- Sustainable Green Roof Garden
- Recommendations and Conclusions
- Acknowledgements

Technical Analysis Background

- Site access for material is a daily challenge for project team
- High volume of complex MEP equipment to support new buildings function

Technical Analysis Research Goals

- Utilize integrated, prefabricated MEP racks to reduce construction cost and schedule
- Identify more efficient approach to material delivery and site utilization
- Identify any issues that may arise with prefabrication and New York City construction unions

MATERIAL STAGING AND SYSTEM PREFABRICATION
MIAMI VALLEY HOSPITAL CASE STUDY

PRESENTATION OUTLINE

MIAMI VALLEY HOSPITAL CASE STUDY

- $137 million, 12-story, 484,000 SF diagnostic and treatment facility
- Major Prefabricated Components
  - Patient Rooms
  - Integrated MEP Racks
  - Temporary Pedestrian Footbridge
- Integrated MEP Racks
  - 16 foot corridors – Two 8x22 foot modules
  - Just-In-Time delivery method
  - 300% increase in labor productivity

3D Coordination Model

Working at Bench Height

Racks Complete for Delivery

Racks Delivered to Site

Crane Lifts Racks to Floor

Racks Installed in Corridor

http://www.cif.org/noms/2011/04_-_Multi-Trade_Offsite_Prefab.pdf

MATERIAL STAGING AND SYSTEM PREFABRICATION

AREA OF IMPLEMENTATION

PRESENTATION OUTLINE

- PROJECT BACKGROUND
- THE USE OF BUILDING INFORMATION MODELING
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- **MATERIAL STAGING AND SYSTEM PREFABRICATION**
  - TECHNICAL ANALYSIS BACKGROUND
  - MIAMI VALLEY HOSPITAL CASE STUDY
  - **AREA OF IMPLEMENTATION**
  - PROJECT SPECIFIC MODULES
  - MATERIAL STAGING PLAN
  - UNION ANALYSIS
  - COST AND SCHEDULE ANALYSIS
- SUSTAINABLE GREEN ROOF GARDEN
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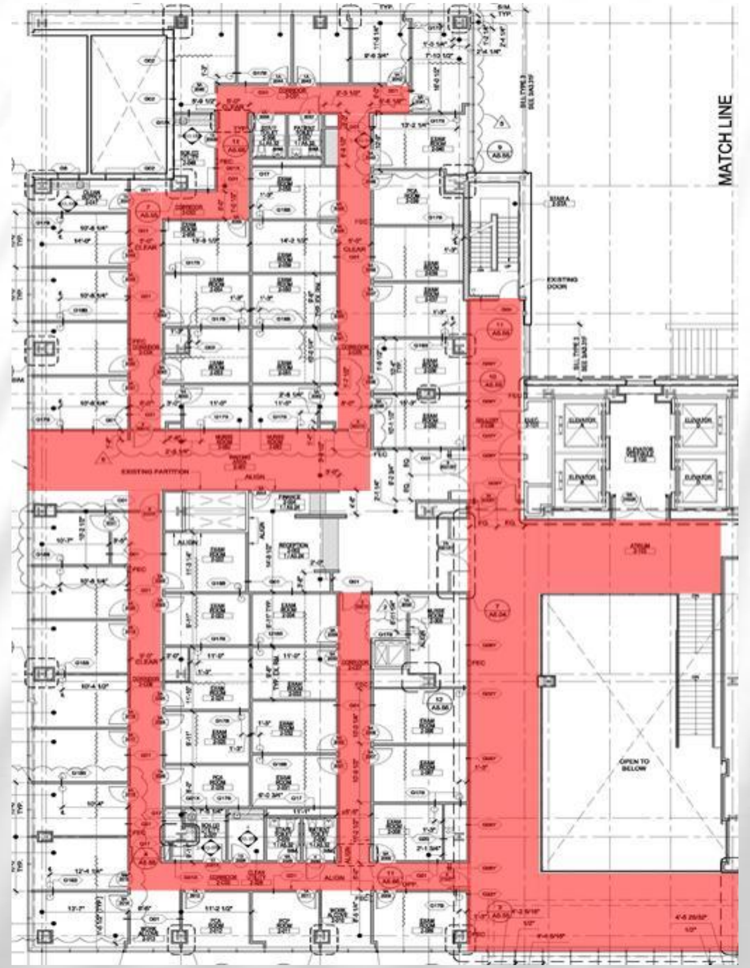
CORRIDOR LOCATION OF RACKS

- 2nd Floor Exam Room and Atrium
- 3rd Floor Exam Room and Atrium
- 4th Floor Mixed-Use and Atrium
- 5thFloor Consult and Group Room

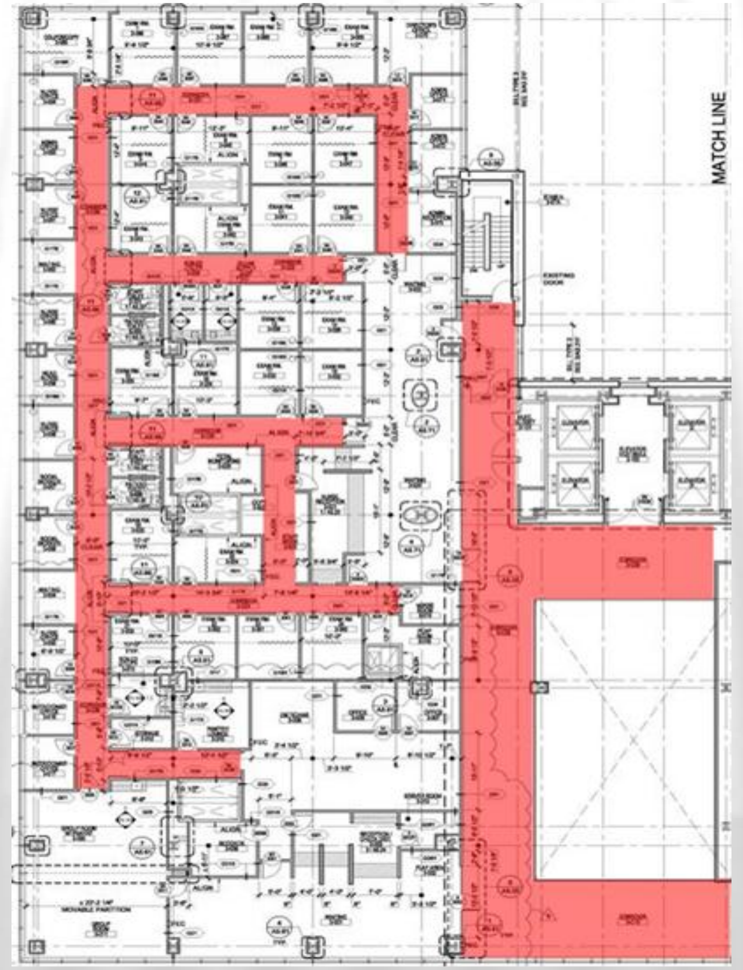
2ND FLOOR

4557 FT^2 OR 28% CEILING USAGE



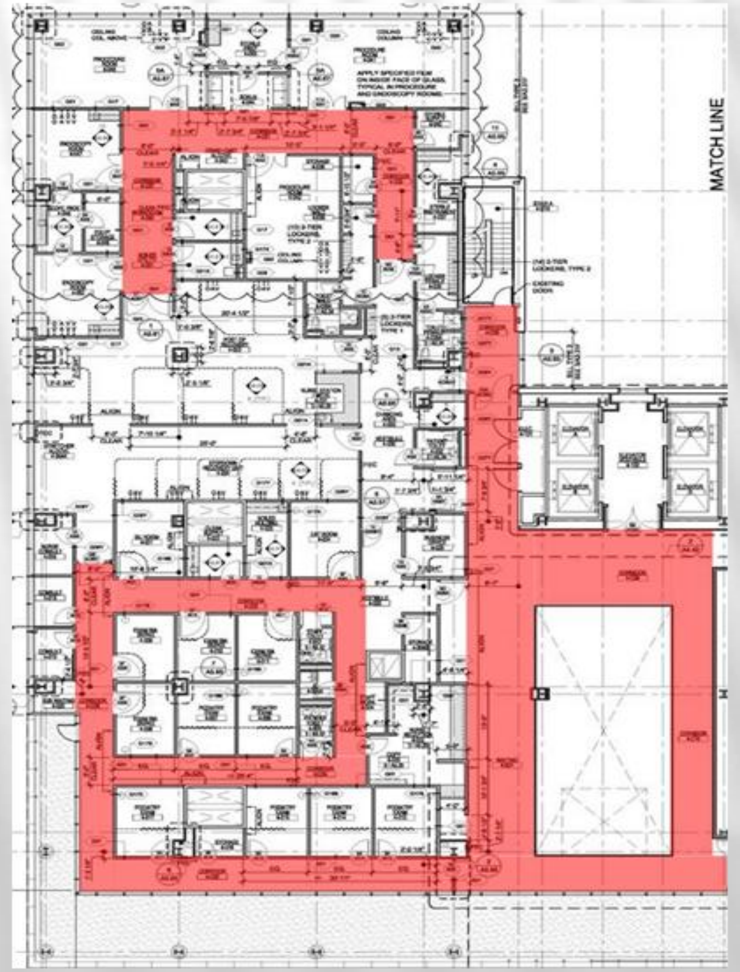
3RD FLOOR

4011 FT^2 OR 24% CEILING USAGE



4TH FLOOR

3946 FT^2 OR 26% CEILING USAGE



5TH FLOOR

1990 FT^2 OR 13% CEILING USAGE

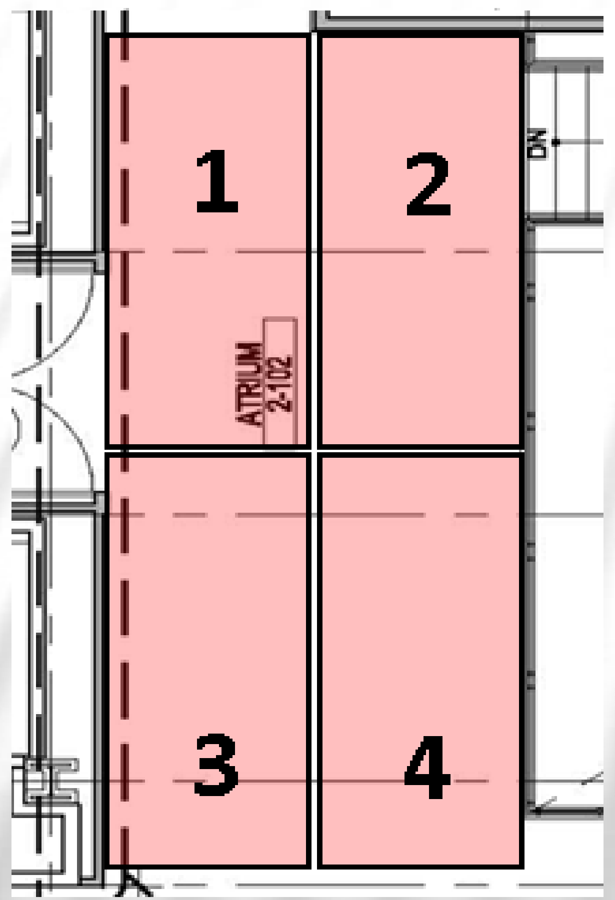
MATERIAL STAGING AND SYSTEM PREFABRICATION

PROJECT SPECIFIC MODULES

MODULES BY CORRIDOR TYPE

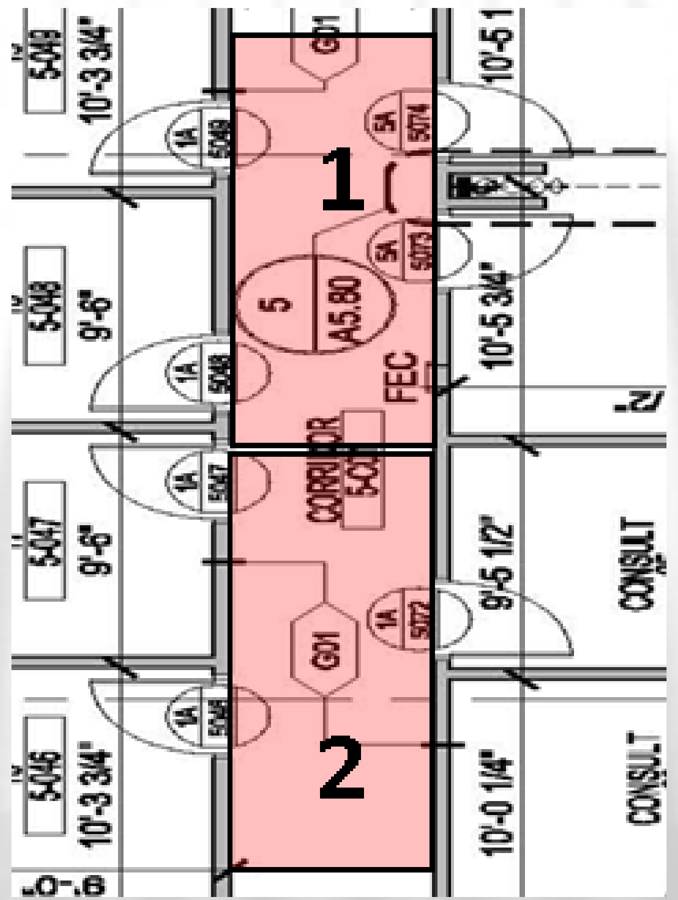
- 5 ft. Corridor: 1 – 5 ft. Module
- 8 ft. Corridor: 1 – 8 ft. Module
- 12 ft. Corridor: 2 – 6 ft. Modules
- 16 ft. Corridor: 2 – 8 ft. Modules

2 Modules – 12' to 16' Corridors



20 ft. Modules

1 Modules – 5' to 8' Corridors



QUANTITY OF MEP RACK TAKE-OFF

Space Designation		Length of Rack	Area of Prefabrication
Second Floor	5 ft Corridor	325	1625
	8 ft Corridor	37	296
	12 ft Corridor	137	1644
	16 ft Corridor	62	992
	Total	561	**4495**
Third Floor	5 ft Corridor	355	1775
	8 ft Corridor	37	296
	12 ft Corridor	79	948
	16 ft Corridor	62	992
	Total	533	**4011**
Fourth Floor	5 ft Corridor	290	1450
	8 ft Corridor	150	1200
	12 ft Corridor	64	768
	16 ft Corridor	33	528
	Total	537	**3946**
Fifth Floor	5 ft Corridor	398	1990
	Total	398	**1990**

Material Staging and System Prefabrication

Material Staging Plan

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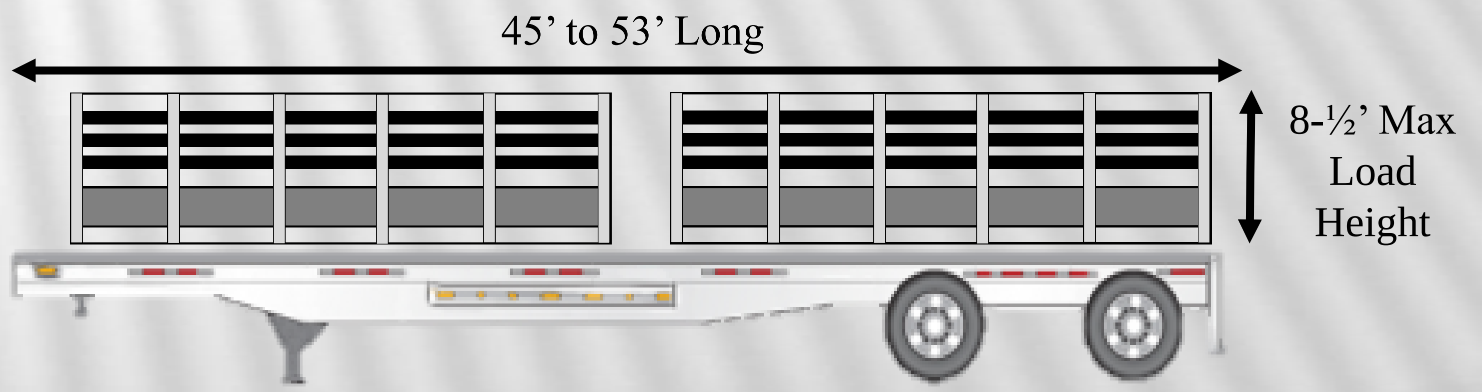
Just-In-Time Construction Approach

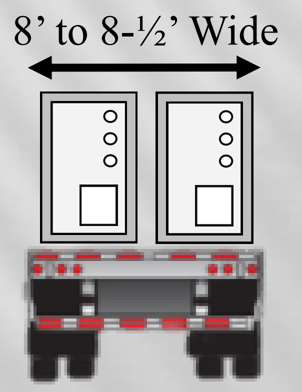
- Maximum efficiency for production and delivery of racks
- Understand manufacturing versus delivery versus installation rates

Quantity of 20 ft. MEP Modules

Corridor Width	Module Specifications			Total Quantity of 20 ft. Modules
	Quantity	Width	Total Length	
5 ft.	1	5 ft	1368	68
8 ft.	1	8 ft	224	11
12 ft.	2	6 ft	280	28
16 ft.	2	8 ft	157	16
Total				**123**

- 4 racks per truck = **32 Deliveries**
- Multiple warehouses with 10 to 15 miles of site
- Short Haul Flatbed Truck = $2.66 per mile[21]
- Estimated Delivery Cost: between **$2265 and $3400**





MATERIAL STAGING AND SYSTEM PREFABRICATION

UNION ANALYSIS

- **ATLANTIC YARDS PROJECT**
  - $4.9 billion basketball arena and 16 high-rise buildings in Brooklyn, New York
  - Seeking prefabrication of 350-unit apartment complex
  - Reduction of pay from on-site to warehouse about 60%

- **INDUSTRY PROFESSIONALS**
  - Purchased and assembled outside of New York City by non-union workers
  - Must be installed on-site by union laborers

http://topics.nytimes.com/top/reference/timestopics/subjects/a/atlantic_yards_brooklyn/index.html.

ALEX DESPOTOVICH | CONSTRUCTION MANAGEMENT
FACULTY ADVISOR: DR. JOHN I. MESSNER

MATERIAL STAGING AND SYSTEM PREFABRICATION

COST AND SCHEDULE ANALYSIS

GOUVERNEUR HEALTHCARE SERVICES FACILITY
NEW YORK, NEW YORK, 10002

PRESENTATION OUTLINE

COST AND SCHEDULE ASSUMPTIONS

- 150% Productivity Increase
- 40% Compensation Reduction
- 8-hour work days

SCHEDULE REDUCTION FROM MEP MODULES

Installation Activity	Original Installation Duration	Prefabrication Installation Duration	Duration Reduction
Mechanical Installation	195	128	66
Electrical Installation	118	78	40
Plumbing Installation	217	143	74
Fire Protection Installation	59	39	20
Total			**200**

WAGE REDUCTION FROM ON-SITE TO WAREHOUSE CONDITIONS

Contractor	Hourly Wages		Quantity of	Daily Costs per Contractor	
	Union On-Site	Union Off-Site	Laborers	Union On-Site	Union Off-Site
Mechanical	$ 109.57	$ 65.74	6	$ 5,259.36	$ 3,155.62
Electrical	$ 101.67	$ 61.00	5	$ 4,066.80	$ 2,440.08
Plumbing	$ 103.31	$ 61.99	6	$ 4,958.88	$ 2,975.33
Fire Protection	$ 134.80	$ 80.88	3	$ 3,235.20	$ 1,941.12

TOTAL LABOR COST SAVINGS

Contractor	Original Labor Costs	Prefabrication Labor Costs	Total Cost Savings
Mechanical	$ 1,023,734	$ 405,399	$ 618,336
Electrical	$ 478,662	$ 189,550	$ 289,112
Plumbing	$ 1,077,565	$ 426,716	$ 650,849
Fire Protection	$ 190,392	$ 75,395	$ 114,996
Total	$ 2,770,353	$ 1,097,060	**$ 1,673,293**

OVERALL DURATION SAVINGS: **200 Days**
TOTAL COST SAVINGS: **$1,673,293**

Sustainable Green Roof Garden
Technical Analysis Background

Technical Analysis Background

- Alternate roof design included sustainable roof garden on the 6th floor roof of the new building
- Financial restrictions prevented the owner from moving forward with implementing the green roof design

Technical Analysis Research Goals

- Provide an area for use of occupants, increase energy efficiency, and potentially save the owner long term money
- Determine impact of green roof to building mechanical and structural systems

http://www.greenroofs.com/projects/pview.php?id=67

Sustainable Green Roof Garden

Original vs. Proposed Green Roof Design

Presentation Outline

- Project Background
- The Use of Building Information modeling
- Schedule Re-Sequencing and Tenant Occupancy
- Material Staging and System Prefabrication
- **Sustainable Green Roof Garden**
    - Technical Analysis Background
    - **Original vs. Proposed Green Roof Design**
    - Proposed Green Roof Design
    - Constructability Review
    - Structural Breadth Analysis
    - Mechanical Breadth Analysis
    - Cost and Schedule Analysis
- Recommendations and Conclusions
- Acknowledgements

Legend

- Utilized Green Roof Space
- Potential Green Roof Space
- Mechanical Space

Original Green Roof Design

2250 FT^2 of Roof Utilized

Proposed Green Roof Design

7050 FT^2 of Roof Utilized

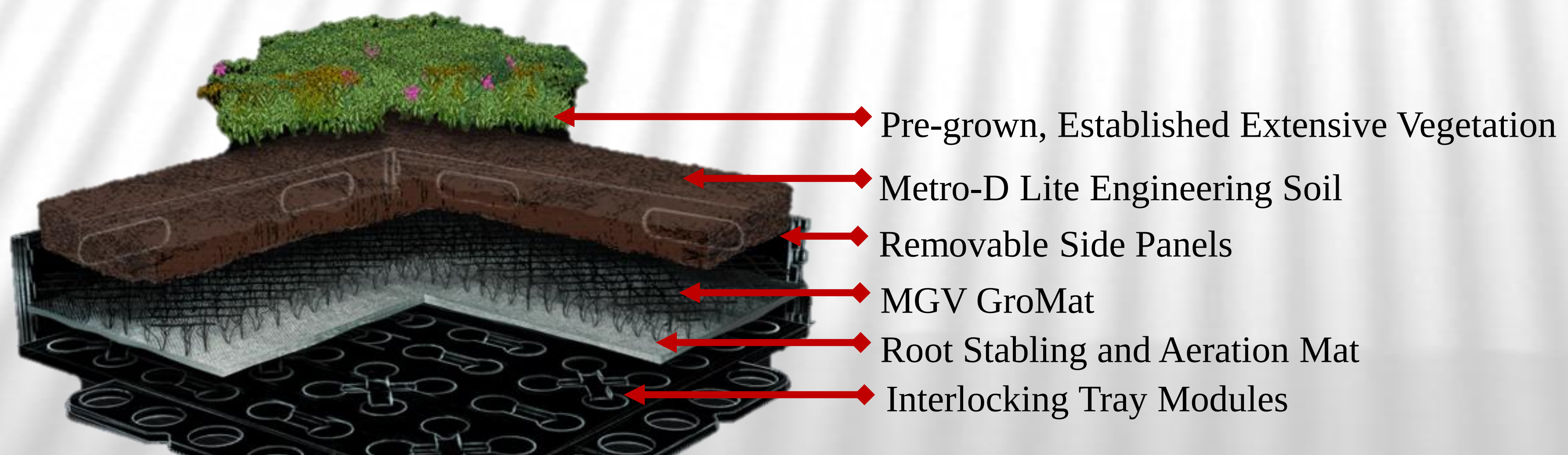
Sustainable Green Roof Garden

Proposed Green Roof Design

Presentation Outline

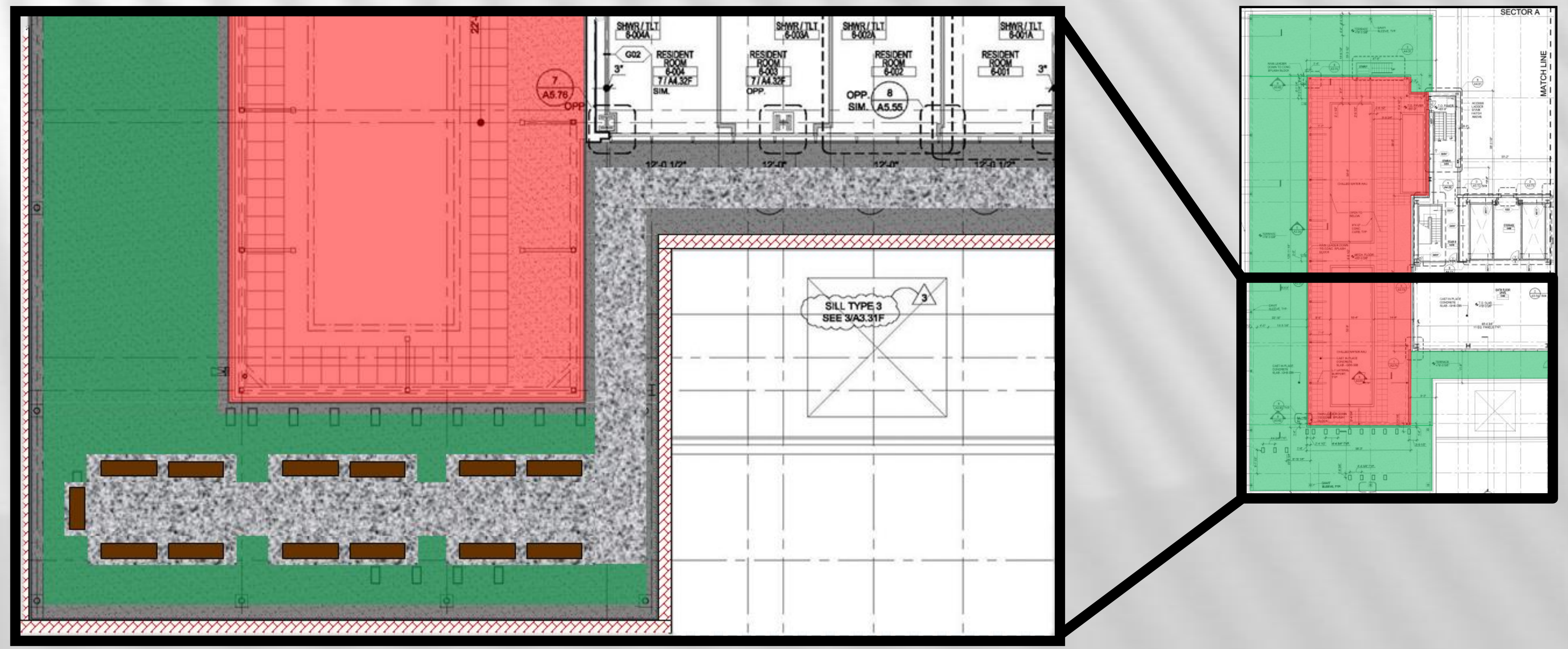
GroRoof Green Roof System

- 18”x18”x4.5” Extensive I Hybrid Modular Green Roof system
- Interlocking trays with 100% removable side panels
  - Allows for full soil integration with adjacent modules maximizing the thermal value of the system
- GroRoof Paver Modules with 2” Lightweight Concrete Pavers



Proposed Green Roof Material Breakdown

Material	Total Square Footage
18”x18”x4.5” GroRoof Extensive I modules	4075 SF
GroRoof Paver Platforms and 2” Lightweight Concrete Pavers	1030 SF
Roofing Ballast	1945 SF
Total	**7050 SF**



SUSTAINABLE GREEN ROOF GARDEN

STRUCTURAL BREADTH ANALYSIS

PRESENTATION OUTLINE

- PROJECT BACKGROUND
- THE USE OF BUILDING INFORMATION MODELING
- SCHEDULE RE-SEQUENCING AND TENANT OCCUPANCY
- MATERIAL STAGING AND SYSTEM PREFABRICATION
- **SUSTAINABLE GREEN ROOF GARDEN**
  - TECHNICAL ANALYSIS BACKGROUND
  - ORIGINAL VS. PROPOSED GREEN ROOF DESIGN
  - PROPOSED GREEN ROOF DESIGN
  - CONSTRUCTABILITY REVIEW
  - **STRUCTURAL BREADTH ANALYSIS**
  - MECHANICAL BREADTH ANALYSIS
  - COST AND SCHEDULE ANALYSIS
- RECOMMENDATIONS AND CONCLUSIONS
- ACKNOWLEDGEMENTS

EQUATIONS

LIVE LOAD REDUCTION:

$$L_r = L_o\left[.25 + \frac{15}{\sqrt{K_{LL}A_t}}\right]$$

FACTORED DISTRIBUTED LOAD:

$$W = (1.2)(D_L) + (1.6)(L_R)$$

$$w_u = (W)(Tributary\ Area)$$

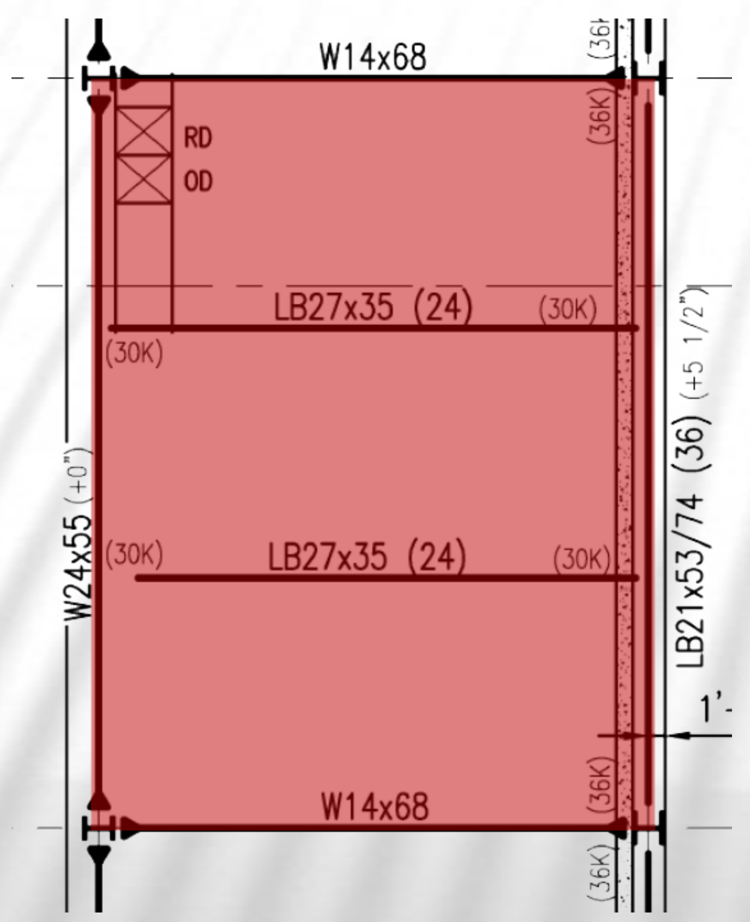
FACTORED BENDING MOMENT:

$$M_u = \frac{(w_u)(l^2)}{8}$$

FACTORED SHEAR:

$$V_u = \frac{w_u\ x\ Length}{2}$$

TYPICAL SIXTH FLOOR ROOF BAY



STRUCTURAL MEMBERS

GIRDERS:

- (1) – 30 ft. W24x55
- (1) – 30 ft. LB21x53/74 (36)

BEAMS:

- (2) – 22 ft. LB27x35 (24)
- (2) – 22 ft. W14x68

ALL MEMBERS - ACCEPTABLE DESIGN

LIVE AND DEAD LOADS ON SIXTH FLOOR ROOF

Item	Load
4 - ¼ " Lightweight Concrete on 2" LOK-Floor	55 lb/ft^2
Ceiling	2 lb/ft^2
Mechanical and Electrical	10 lb/ft^2
Fire Protection and Miscellaneous	5 lb/ft^2
Insulation	1 lb/ft^2
GroRoof Extensive Hybrid Modules	26 lb/ft^2
Beam/Girder Self-Weight (Assumption)	5 lb/ft^2
Total Dead Load	104 lb/ft^2
ASCE Roof Garden Live Garden (Table 4-1)	100 lbs/ft^2
Total Live Load	100 lbs/ft^2

Sustainable Green Roof Garden
Mechanical Breadth Analysis

Presentation Outline

Assumptions

- New York City Central Park, NY, USA (73.97W, 40.78N)
- Base Temperature = 65°F
- Roof Area = 7050 ft^2
- COP = 3.5 and η = 71.33%

Equations

Monthly Heating or Cooling Load:

$$Q_{monthly} = (UA)_h \; x \; DD \text{ x 24 hrs/day}$$

Total Heading or Cooling energy:

$$E_T = \frac{L_{monthly}}{\eta \; or \; COP}$$

Heating and Cooling Load Calculations

- Original Roof Material: R-Value = 6.63 and U-Value = 0.15
- Proposed Green Roof Material: R-Value = 12.43 and U-Value = 0.08

Month	Degree Days	$Q_{monthly}$ (BTU)		Q_{yearly} (BTU)	
		Original Roof	Green Roof	Original Roof	Green Roof
Heating Load				**145,236,380**	**77,467,192**
March	722	18,425,701	9,828,029		
April	369	9,417,014	5,022,912		
May	139	3,547,330	1,892,100		
October	272	6,941,538	3,702,526		
November	661	16,868,959	8,997,683		
December	840	21,437,104	11,434,272		
January	840	21,437,104	11,434,272		
February	710	18,119,457	9,664,682		
Cooling Load					
June	226	5,767,602	3,076,364		
July	453	11,560,724	6,166,340		
August	295	7,528,507	4,015,607		
September	164	4,185,339	2,232,405		

Annual Cost Savings

- Average Cost of Electricity in New York City = $0.16/kWh

Heating Energy			Cooling Energy		
Q_{Total} (kWh)	η	E_{Total} (kW)	Q_{Total} (kWh)	COP	E_{Total} (kW)
Original Roofing System					
34052	0.7133	47738	8511	3.5	2432
Green Roofing System					
18163	0.7133	25463	4540	3.5	1297
Energy Difference		**22275**	Energy Difference		**1135**

Total Energy Reduction: **23,410 kW**
Annual Cost Savings: **$3,746/year**

Alex Despotovich | Construction Management

Faculty Advisor: Dr. John I. Messner

Sustainable Green Roof Garden

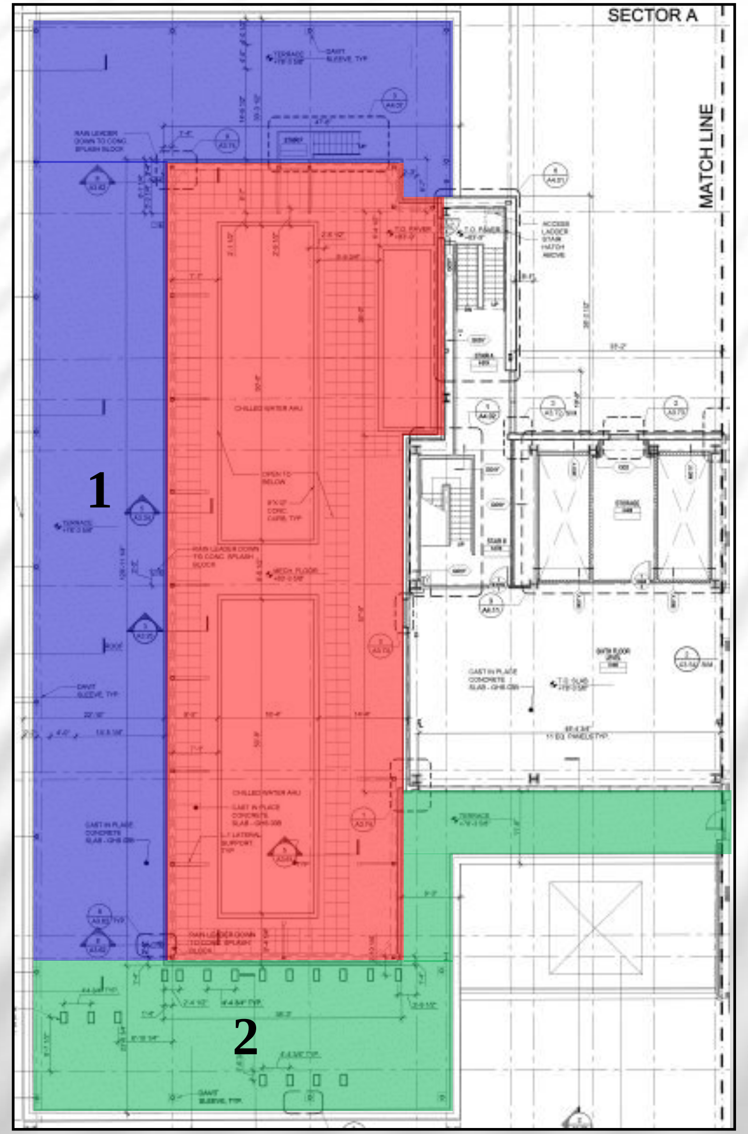
Cost and Schedule Analysis

Gouverneur Healthcare Services Facility

New York, New York, 10002

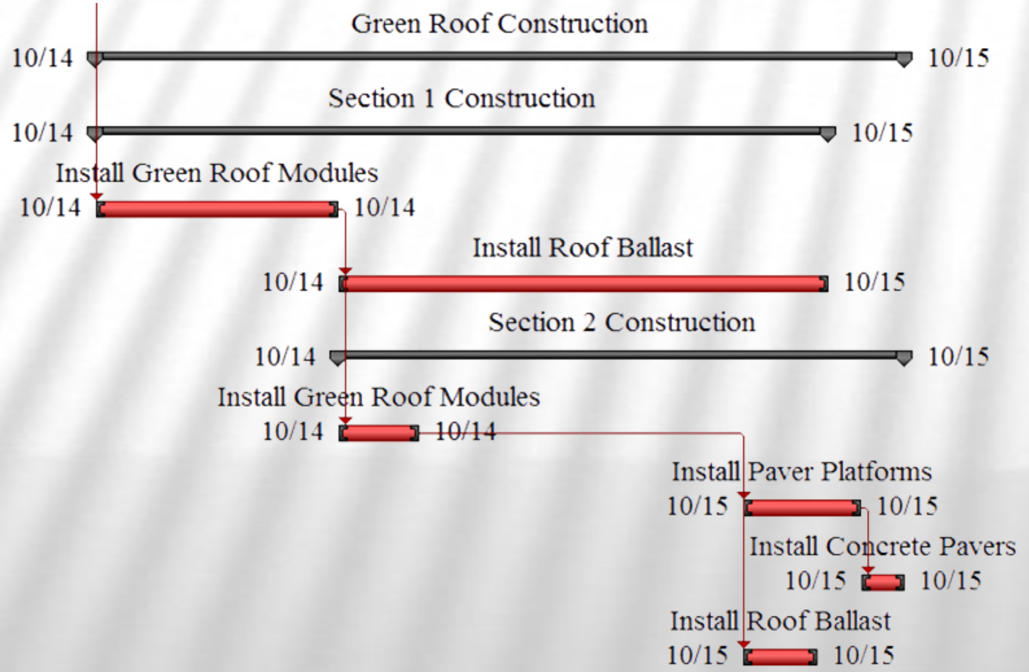
Presentation Outline

- Project Background
- The Use of Building Information modeling
- Schedule Re-Sequencing and Tenant Occupancy
- Material Staging and System Prefabrication
- **Sustainable Green Roof Garden**
    - Technical Analysis Background
    - Original vs. Proposed Green Roof Design
    - Proposed Green Roof Design
    - Constructability Review
    - Structural Breadth Analysis
    - Mechanical Breadth Analysis
    - **Cost and Schedule Analysis**
- Recommendations and Conclusions
- Acknowledgements



Schedule Assumptions

- Two sections for simultaneous installation of materials
- Material Durations:
    - Green Roof Modules, Concrete Pavers and Roof Ballast = 4000 ft^2/day
    - Concrete Pavers = 5000 ft^2/day



Total Duration – 1.5 Days

Green Roof System Cost

Material	Total SF	Total Cost per SF	Total System Cost
GroRoof 18"x18"x4.5" Extensive I Hybrid modules	4075 SF	$14.00	$ 57,050
GroRoof Paver Platforms	1030 SF	$9.50	$ 9,785
2" Concrete Pavers	1030 SF	$7.00	$ 7,210
Roof Ballast	1945 SF	$2.00	$ 3,890
Total			$ 77,935

Life-Cycle Cost Analysis

Payback Period – 21 Years

Cost Savings - $113,090

RECOMMENDATIONS AND CONCLUSIONS

PRESENTATION OUTLINE

- PROJECT BACKGROUND
- THE USE OF BUILDING INFORMATION MODELING
- SCHEDULE RE-SEQUENCING AND TENANT OCCUPANCY
- MATERIAL STAGING AND SYSTEM PREFABRICATION
- SUSTAINABLE GREEN ROOF GARDEN
- **RECOMMENDATIONS AND CONCLUSIONS**
- ACKNOWLEDGEMENTS

THE USE OF BUILDING INFORMATION MODELING

- Implement 3D Model for New Building Design and Construction
- Do Not Implement 3D Model for Existing Building Design and Construction
- Utilize VELA Systems for Punchlist
  - **2000 Man Hour** Savings

SCHEDULE RE-SEQUENCING AND TENANT OCCUPANCY

- Re-Sequence the Project Schedule for
  - Schedule Reduction of **168 days**
  - Cost Savings of **$206,723**
- Utilize FM:Interact Move Management for
  - Overall Schedule Reduction of **14 days**
  - Cost Savings of **$439,488**

MATERIAL STAGING AND SYSTEM PREFABRICATION

- Implement Integrated, Prefabricated MEP Racks for
  - Schedule Reduction of **200 Days**
  - Labor Cost Savings of **$1,673,293**

SUSTAINABLE GREEN ROOF GARDEN

- Implement Proposed Green Roof Garden for
  - Annual Cost Savings of **$3,746 per Year**
  - Payback Period of **21 Years**
  - Overall Cost Savings of **$113,090**

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VELA SYSTEMS

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Zach Miller, Director of Technical Sales at Metro Green Visions

My Family and Friends

TABLE 8: TRADITIONAL PUNCHLIST VERSUS VELA PUNCHLIST PROCEDURE [6]

Traditional Punchlist Procedure	Man Hours	VELA Punchlist Procedure	Man Hours
HRCG punchlist hand written during walkthrough	16	HRCG punchlist entered into Vela during walkthrough	**5**
HRCG punchlist entered into Excel and delivers copy to Owner	8	Punchlist uploaded to system via Sync and Owner instantly receives punchlist	**0**
Owner reviews hard copy and adds handwritten list to punchlist	48	Owner reviews and adds to punchlist via Vela	**16**
Owner enters hand written items into excel and emails them to HRCG	8	Owner uploads revised punchlist via Sync – HRCG instantly receives list	**0**
HRCG combines lists in excel, sorts by subcontractor and prints legible reports for Sub to complete	6	HRCG prints list by sub out of Vela and provides to Subcontractor	**1**
Subcontractor completes list	-	Subcontractor completes list	**-**
HRCG reviews list to see if complete and hand writes updates	16	HRCG reviews list to see if complete	**5**
HRCG updates Excel spreadsheet to reflect updates	8	HRCG updates Vela to reflect updates via Sync	**0**
Owner reviews updated Excel spreadsheet to confirm items as completed	16	Owner reviews Vela to confirm items updated are completed	**6**
List of completed items is updated in Excel and returned to HRCG	8	List of completed items is updated in Excel and returned to HRCG via Sync	**0**
Total Hours Prior to Vela	**134**	**Total Hours Using Vela**	**33**

APPENDICES: BIM

TABLE 10: TRADITIONAL PUNCHLIST VERSUS VELA PUNCHLIST PROCEDURE

Traditional Punchlist Procedure	Man Hours	VELA Punchlist Procedure	Man Hours
HRCG punchlist hand written during walkthrough	25	HRCG punchlist entered into Vela during walkthrough	8
HRCG punchlist entered into Excel and delivers copy to Owner	13	Punchlist uploaded to system via Sync and Owner instantly receives punchlist	0
Owner reviews hard copy and adds handwritten list to punchlist	48	Owner reviews and adds to punchlist via Vela	16
Owner enters hand written items into excel and emails them to HRCG	13	Owner uploads revised punchlist via Sync – HRCG instantly receives list	0
HRCG combines lists in excel, sorts by subcontractor and prints legible reports for Sub to complete	9	HRCG prints list by sub out of Vela and provides to Subcontractor	2
Subcontractor completes list	-	Subcontractor completes list	-
HRCG reviews list to see if complete and hand writes updates	16	HRCG reviews list to see if complete	5
HRCG updates Excel spreadsheet to reflect updates	13	HRCG updates Vela to reflect updates via Sync	0
Owner reviews updated Excel spreadsheet to confirm items as completed	16	Owner reviews Vela to confirm items updated are completed	6
List of completed items is updated in Excel and returned to HRCG	8	List of completed items is updated in Excel and returned to HRCG via Sync	0
Total Hours Prior to Vela	160	Total Hours Using Vela	36

TABLE 11: TRADITIONAL PUNCHLIST VERSUS VELA PUNCHLIST PROCEDURE

Traditional Punchlist Procedure	Man Hours	VELA Punchlist Procedure	Man Hours
HRCG punchlist hand written during walkthrough	40	HRCG punchlist entered into Vela during walkthrough	13
HRCG punchlist entered into Excel and delivers copy to Owner	20	Punchlist uploaded to system via Sync and Owner instantly receives punchlist	0
Owner reviews hard copy and adds handwritten list to punchlist	48	Owner reviews and adds to punchlist via Vela	16
Owner enters hand written items into excel and emails them to HRCG	20	Owner uploads revised punchlist via Sync – HRCG instantly receives list	0
HRCG combines lists in excel, sorts by subcontractor and prints legible reports for Sub to complete	15	HRCG prints list by sub out of Vela and provides to Subcontractor	3
Subcontractor completes list	-	Subcontractor completes list	-
HRCG reviews list to see if complete and hand writes updates	16	HRCG reviews list to see if complete	5
HRCG updates Excel spreadsheet to reflect updates	20	HRCG updates Vela to reflect updates via Sync	0
Owner reviews updated Excel spreadsheet to confirm items as completed	16	Owner reviews Vela to confirm items updated are completed	6
List of completed items is updated in Excel and returned to HRCG	8	List of completed items is updated in Excel and returned to HRCG via Sync	0
Total Hours Prior to Vela	203	Total Hours Using Vela	42

APPENDICES: RE-SEQUENCING

TABLE 17: ORIGINAL AND REDUCED TENANT PHASING SCHEDULE REDUCTION

Task Name	Original Schedule		Re-Sequenced Schedule		Duration
	Start	Finish	Start	Finish	Saved
New Building Occupancy Move-In	9/7/2011	10/4/2011	9/7/2011	9/20/2011	14
Podium -Floors 1-5 Occupancy Move-In	9/7/2011	10/4/2011	9/7/2011	9/20/2011	14
Existing Building Occupancy Move-In	8/23/2011	7/15/2013	8/23/2011	7/8/2013	7
13th Floor Occupancy Move-In	8/23/2011	9/5/2011	8/23/2011	8/29/2011	7
6th Floor Occupancy Move-In	6/26/2012	7/9/2012	6/26/2012	7/2/2012	7
7th Floor Occupancy Move-In	6/26/2012	7/9/2012	6/26/2012	7/2/2012	7
8th Floor Occupancy Move-In	10/11/2012	10/24/2012	10/11/2012	10/17/2012	7
5th Floor Occupancy Move-In	6/26/2012	7/9/2012	6/26/2012	7/2/2012	7
2nd Floor Occupancy Move-In	7/27/2012	8/9/2012	7/27/2012	8/2/2012	7
3rd Floor Occupancy Move-In	7/27/2012	8/9/2012	7/27/2012	8/2/2012	7
4th Floor Occupancy Move-In	7/27/2012	8/9/2012	7/27/2012	8/2/2012	7
9th Floor Occupancy Move-In	4/10/2013	4/23/2013	4/4/2013	4/9/2013	14
1st Floor Occupancy Move-In	5/23/2013	6/5/2013	5/23/2013	5/29/2013	7
10th Floor Occupancy Move-In	6/24/2013	7/5/2013	6/17/2013	6/21/2013	14
11th Floor Occupancy Move-In	7/2/2013	7/15/2013	5/28/2013	7/1/2013	14
Project Substantial Completion	7/15/2013	7/15/2013	7/1/2013	7/1/2013	14

TABLE 19: REDUCED TENANT PHASING SCHEDULE REVENUE COST SAVINGS

Task Name	Duration Saved	Patient Revenue per Day	Patients per Floor	Total Revenue
New Building Occupancy Move-In				
Floors 1-5 Occupancy Move-In	14	$ 255.27	20	$ 71,476
Existing Building Occupancy Move-In				
13th Floor Occupancy Move-In	7	$ 255.27	20	$ 35,738
6th Floor Occupancy Move-In	7	$ 255.27	20	$ 35,738
7th Floor Occupancy Move-In	7	$ 255.27	20	$ 35,738
8th Floor Occupancy Move-In	7	$ 255.27	20	$ 35,738
5th Floor Occupancy Move-In	7	$ -	-	$ -
2nd Floor Occupancy Move-In	7	$ -	-	$ -
3rd Floor Occupancy Move-In	7	$ -	-	$ -
4th Floor Occupancy Move-In	7	$ -	-	$ -
9th Floor Occupancy Move-In	14	$ 255.27	20	$ 71,476
1st Floor Occupancy Move-In	7	$ -	-	$ -
10th Floor Occupancy Move-In	14	$ 255.27	20	$ 71,476
11th Floor Occupancy Move-In	14	$ 255.27	20	$ 71,476
Total Cost Savings				$ 428,854

APPENDICES: PREFABRICATION

TABLE 39: PREFABRICATION SCHEDULE REDUCTION TAKE-OFFS

Location	Installation Activity	Original Installation Duration	Prefabrication Installation Duration	Duration Reduction
Second Floor	**Mechanical Installation**			
	Supply Air Ductwork AHU 6	11	7	4
	Return Air Ductwork AHU 6	11	7	4
	Supply Air Ductwork AHU 7	11	7	4
	Return Air Ductwork AHU 7	11	7	4
	Exam Room Ductwork Branches	6	4	2
	Mechanical System Piping	6	4	2
	Electrical Installation			
	Power Conduit and Wiring	11	7	4
	Lighting Conduit and Wiring	11	7	4
	Nurse Call Conduit and Wiring	5	3	2
	AHU Component Conduit and Wiring	5	3	2
	Plumbing Installation			
	Soil, Waste, and Sanitary Piping	34	22	12
	Domestic Hot and Cold Water Piping	23	15	8
	Fire Protection Installation			
	Sprinkler Piping	16	11	5
	Total			
	-	161	106	55
Third Floor	**Mechanical Installation**			
	Supply Air Ductwork AHU 6	11	7	4
	Return Air Ductwork AHU 6	11	7	4
	Supply Air Ductwork AHU 7	11	7	4
	Return Air Ductwork AHU 7	11	7	4
	Exam Room Ductwork Branches	6	4	2
	Mechanical System Piping	6	4	2
	Electrical Installation			
	Power Conduit and Wiring	11	7	4
	Lighting Conduit and Wiring	11	7	4
	Nurse Call Conduit and Wiring	5	3	2
	AHU Component Conduit and Wiring	5	3	2
	Plumbing Installation			
	Soil, Waste, and Sanitary Piping	34	22	12
	Domestic Hot and Cold Water Piping	23	15	8
	Fire Protection Installation			
	Sprinkler Piping	16	11	5
	Total			
	-	161	106	55
Fourth Floor	**Mechanical Installation**			
	Supply Air Ductwork AHU 6	10	7	4
	Return Air Ductwork AHU 6	10	7	4
	Supply Air Ductwork AHU 7	10	7	4
	Return Air Ductwork AHU 7	10	7	4
	Mixed-Use Ductwork Branches	5	3	2
	Mechanical System Piping	5	3	2
	Electrical Installation			
	Power Conduit and Wiring	18	12	6
	Lighting Conduit and Wiring	18	12	6
	Nurse Call Conduit and Wiring	8	5	3
	AHU Component Conduit and Wiring	8	5	3
	Plumbing Installation			
	Soil, Waste, and Sanitary Piping	39	26	13
	Domestic Hot and Cold Water Piping	39	26	13
	Medical Gas Piping	52	34	18
	Fire Protection Installation			
	Sprinkler Piping	26	17	9
	Total			
	-	261	172	89
Fifth Floor	**Mechanical Installation**			
	Supply Air Ductwork AHU 6	15	10	5
	Return Air Ductwork AHU 6	15	10	5
	Supply Air Ductwork AHU 7	15	10	5
	Return Air Ductwork AHU 7	15	10	5
	Consult Room Ductwork Branches	8	5	3
	Mechanical System Piping	8	5	3
	Electrical Installation			
	Power Conduit and Wiring	11	7	4
	Lighting Conduit and Wiring	11	7	4
	Nurse Call Conduit and Wiring	5	3	2
	AHU Component Conduit and Wiring	5	3	2
	Plumbing Installation			
	Soil, Waste, and Sanitary Piping	18	12	6
	Domestic Hot and Cold Water Piping	12	8	4
	Fire Protection Installation			
	Sprinkler Piping	15	10	5
	Total			
	-	153	101	52
Total		737	486	250

Table 40: Life-Cycle Cost Analysis

Year	Annual Cost Savings		Life-Cycle Cost	
1	$	3,745.58	$	(74,189.42)
2	$	3,745.58	$	(70,443.84)
3	$	3,745.58	$	(66,698.26)
4	$	3,745.58	$	(62,952.68)
5	$	3,745.58	$	(59,207.10)
6	$	3,745.58	$	(55,461.52)
7	$	3,745.58	$	(51,715.94)
8	$	3,745.58	$	(47,970.36)
9	$	3,745.58	$	(44,224.78)
10	$	3,745.58	$	(40,479.20)
11	$	3,745.58	$	(36,733.62)
12	$	3,745.58	$	(32,988.04)
13	$	3,745.58	$	(29,242.46)
14	$	3,745.58	$	(25,496.88)
15	$	3,745.58	$	(21,751.30)
16	$	3,745.58	$	(18,005.72)
17	$	3,745.58	$	(14,260.14)
18	$	3,745.58	$	(10,514.56)
19	$	3,745.58	$	(6,768.98)
20	$	3,745.58	$	(3,023.40)
21	$	3,745.58	$	722.18
22	$	3,745.58	$	4,467.76
22	$	3,745.58	$	8,213.34
23	$	3,745.58	$	11,958.92
24	$	3,745.58	$	15,704.50
25	$	3,745.58	$	19,450.08
26	$	3,745.58	$	23,195.66
27	$	3,745.58	$	26,941.24
28	$	3,745.58	$	30,686.82
29	$	3,745.58	$	34,432.40
30	$	3,745.58	$	38,177.98
31	$	3,745.58	$	41,923.56
32	$	3,745.58	$	45,669.14
33	$	3,745.58	$	49,414.72
34	$	3,745.58	$	53,160.30
35	$	3,745.58	$	56,905.88
36	$	3,745.58	$	60,651.46
37	$	3,745.58	$	64,397.04
38	$	3,745.58	$	68,142.62
39	$	3,745.58	$	71,888.20
40	$	3,745.58	$	75,633.78
41	$	3,745.58	$	79,379.36
42	$	3,745.58	$	83,124.94
43	$	3,745.58	$	86,870.52
44	$	3,745.58	$	90,616.10
45	$	3,745.58	$	94,361.68
46	$	3,745.58	$	98,107.26
47	$	3,745.58	$	101,852.84
48	$	3,745.58	$	105,598.42
49	$	3,745.58	$	109,344.00
50	$	3,745.58	$	113,089.58

Appendices: Green Roof

Table 32: Roof System R- Value and U-Value Calculation

Material	R-Value (ft^2-^{o}F-hr/BTU)		U-Value (BTU/ft^2-^{o}F-hr)	
	Original Roof	Green Roof	Original Roof	Green Roof
4-1/2" GroRoof System	-	6	-	0.17
Stone Roof Ballast	0.2	-	5.00	-
2" Thick Drainage Insulation Panels	5.88	5.88	0.17	0.17
Hot Fluid Applied, Rubberized Asphalt Waterproofing Membrane	0.15	0.15	6.67	6.67
4" Concrete Slab	0.4	0.4	2.50	2.50
Total	6.63	12.43	0.15	0.08