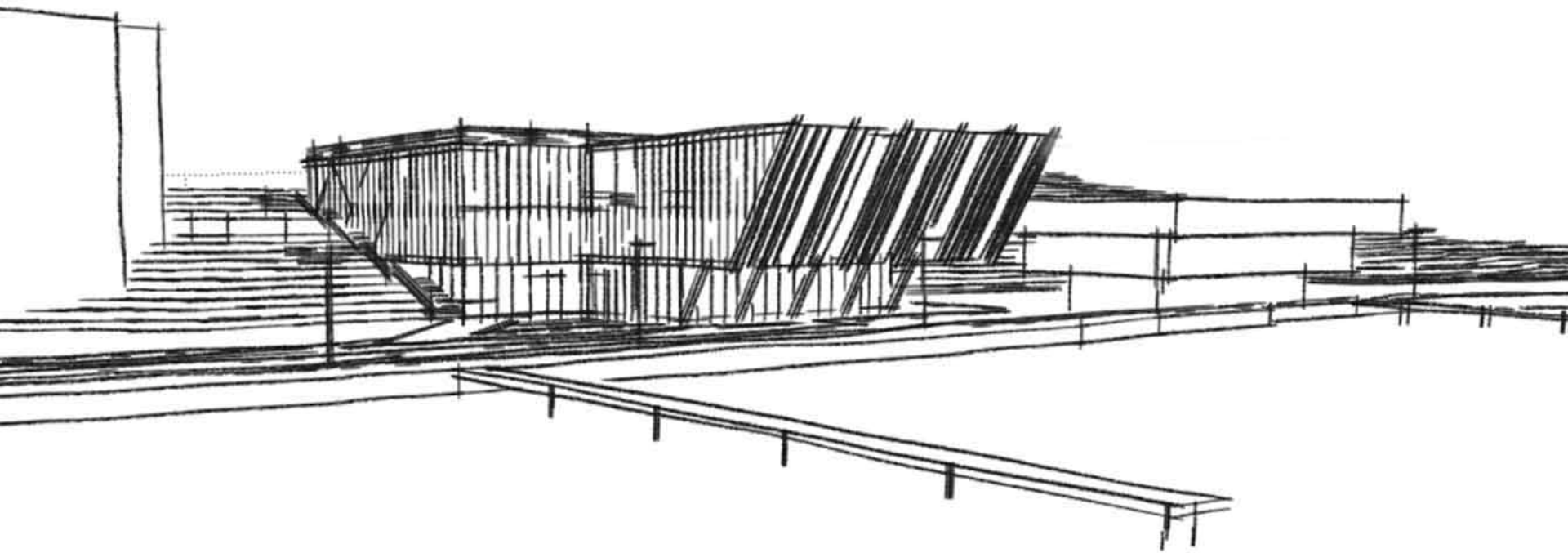


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School of Engineering: University of Wisconsin at Madison



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The Structural Engineers  
Markus Reuter: Bauhaus  
Anirudh Rao: Stanford University  
Robert Bingel: Bauhaus



The Construction Managers  
Michael Spittler: UW-Madison  
Hoss Nasser: Stanford University



The Owners  
Holger Keitel  
Josh Odelson



The Architect  
Maria Julia Escalona:  
University of Puerto Rico

Director:  
Renate Fruchter





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# Madison, Wisconsin

- Capital of US state: Wisconsin
- Called the City of Four Lakes
- Home to the University of Wisconsin, one of the largest public university in US
- Citizens aware of quality of life
- Low unemployment rate

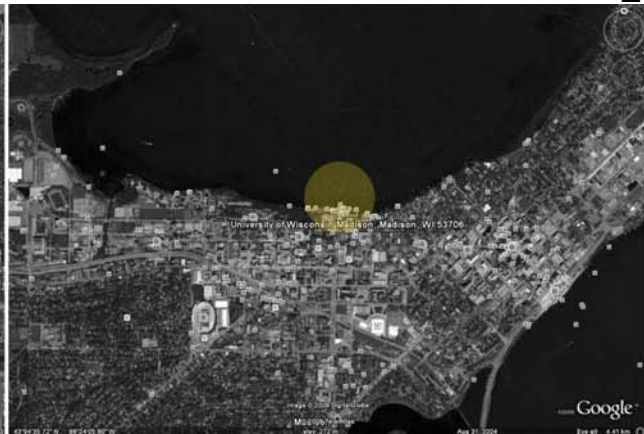
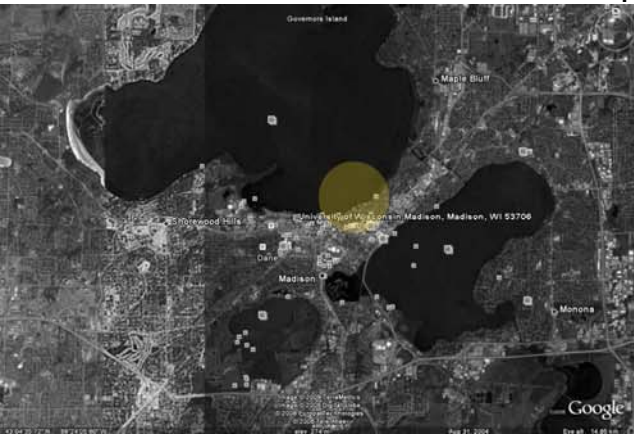


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1

2

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## Lake Mendota

- northernmost and largest of the four lake near in Madison
- Buildings face the Lake area
- University borders the Lake
- Shore of Lake is lined with expensive homes and condos
- Banks of Lake contain government protected natural areas and parks
- Winter: iceboating, ice-skating, ice hockey
- Summer: windsurfing, kayaking, canoeing, fishing





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# Site Location and Description

- Borders south coast of Lake Mendota
- Two climates: extreme winter/summers
- Benefits from outdoor activities
- Adjacent to Lakeshore Natural Preserve and Muir Woods
- Surrounded by campus buildings: Helen C. White and Limnology Laboratory
- Important topography on south and west
- Impressive view at the lake and activities



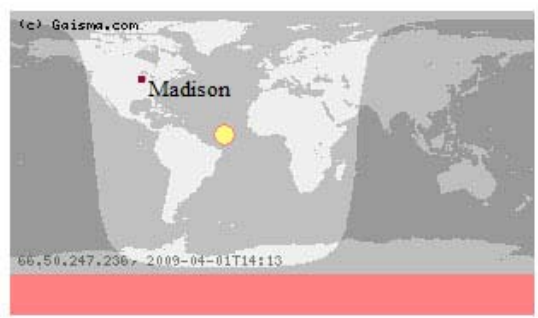


# Climate

- Temperate climate or humid continental
- Variable weather patterns
- Large seasonal temperature variance
- Winter: below 0 F
- Summers: between 80-90 F
- High levels of humidity
- Large amounts of snow fall

## Madison, Wisconsin, United States - Basic information

**Latitude:** +43.07306 (43°04'23.016"N)  
**Longitude:** -89.40111 (89°24'03.996"W)  
**Time zone:** UTC-6 hours  
**Local time:** 09:16:40  
**Country:** [Wisconsin](#), [United States](#)  
**Continent:** [Americas](#)  
**Sub-region:** [Northern America](#)  
**Distance:** ~3500 km (from your IP)  
**Altitude:** ~260 m  
[Change preferences.](#)



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Monthly average and record temperatures and precipitation												
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
<b>Record high °F (°C)</b>	56 (13.3)	64 (17.7)	82 (27.7)	94 (34.4)	93 (33.8)	101 (38.3)	104 (40)	102 (38.8)	99 (37.2)	90 (32.2)	76 (24.4)	64 (17.7)
<b>Average high °F (°C)</b>	25.2 (-3.7)	30.8 (-0.6)	42.8 (6)	56.6 (13.6)	69.4 (20.7)	78.3 (25.7)	82.1 (27.8)	79.4 (26.3)	71.4 (21.8)	59.6 (15.3)	43.3 (6.3)	30.2 (-1)
<b>Average low °F (°C)</b>	9.3 (-12.6)	14.3 (-9.8)	24.6 (-4.1)	35.2 (1.7)	46 (7.7)	55.7 (13.2)	61 (16.1)	58.7 (14.8)	49.9 (9.9)	38.9 (3.8)	27.7 (-2.4)	15.8 (-9)
<b>Record low °F (°C)</b>	-37 (-38.3)	-29 (-33.8)	-29 (-33.8)	0 (-17.7)	19 (-7.2)	31 (-0.5)	36 (2.2)	35 (1.6)	25 (-3.8)	13 (-10.5)	-11 (-23.8)	-25 (-31.6)
<b>Precipitation in (mm)</b>	1.25 (31.75)	1.28 (32.5)	2.28 (57.9)	3.35 (85.1)	3.25 (82.5)	4.05 (102.9)	3.93 (99.8)	4.33 (110)	3.08 (78.2)	2.18 (55.4)	2.31 (58.7)	1.66 (42.2)
<b>Snowfall in (cm)</b>	10.9 (27.7)	7.9 (20.1)	8.1 (20.6)	2.5 (6.4)	0.1 (0.3)	T	T	T	T	0.3 (0.8)	3.6 (9.1)	10.6 (26.9)

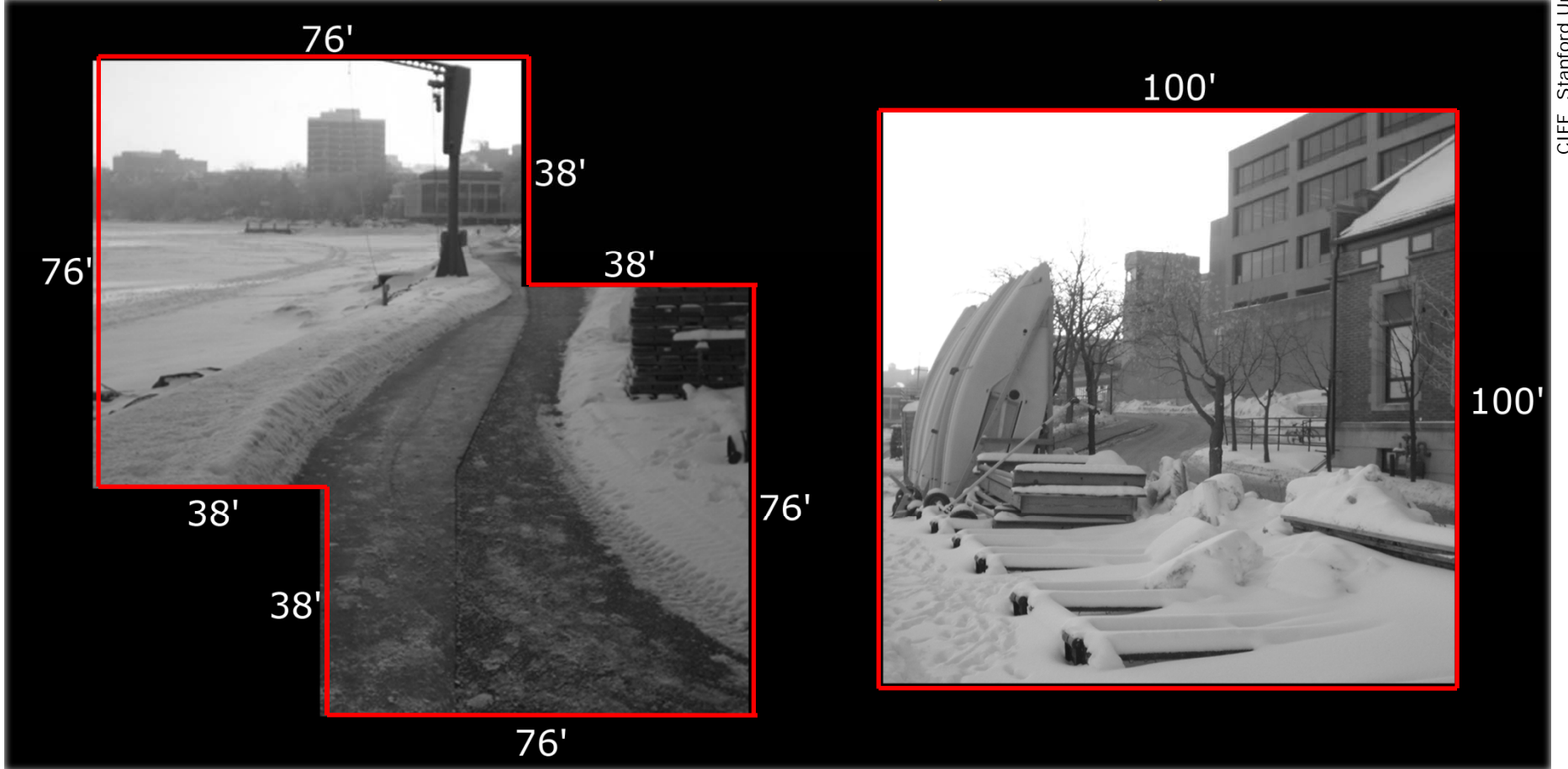
Source: Weather By Day<sup>[7]</sup>



# Two Floor Plans:

## Double Diamond

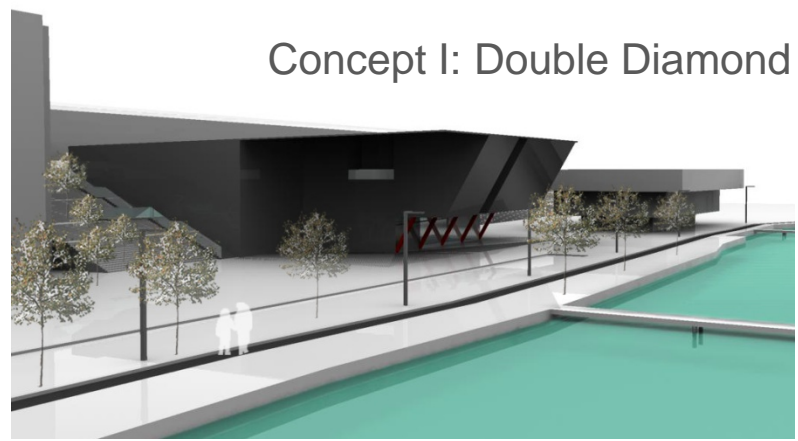
## Square



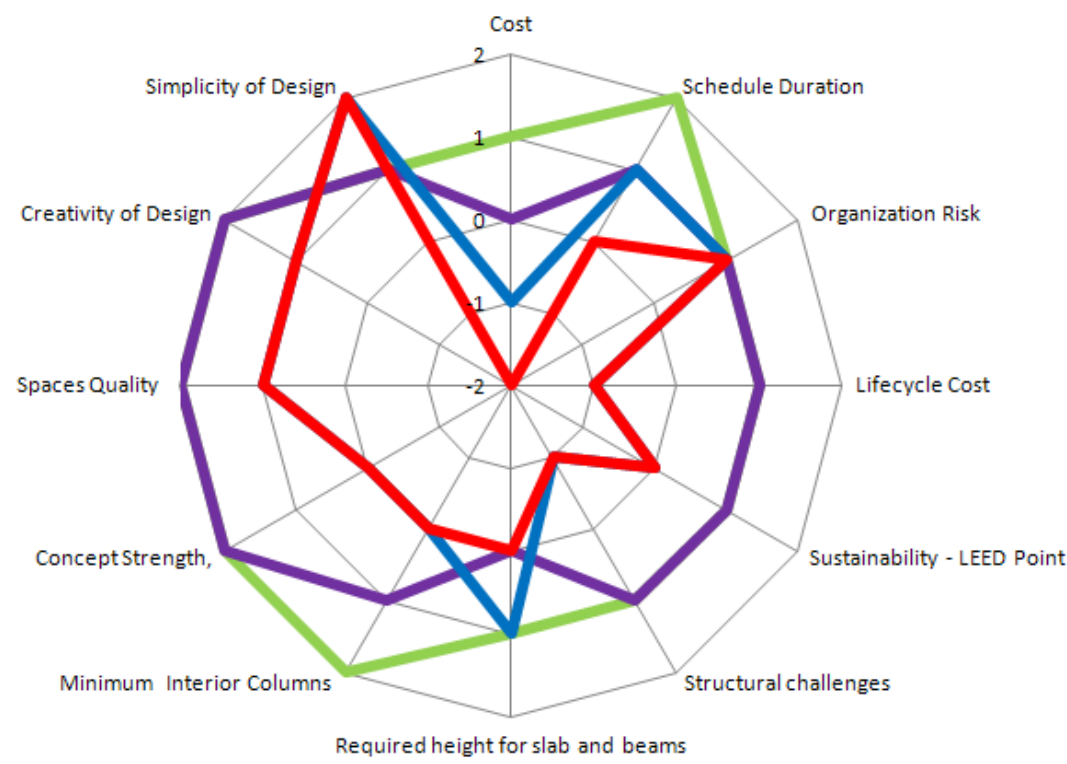
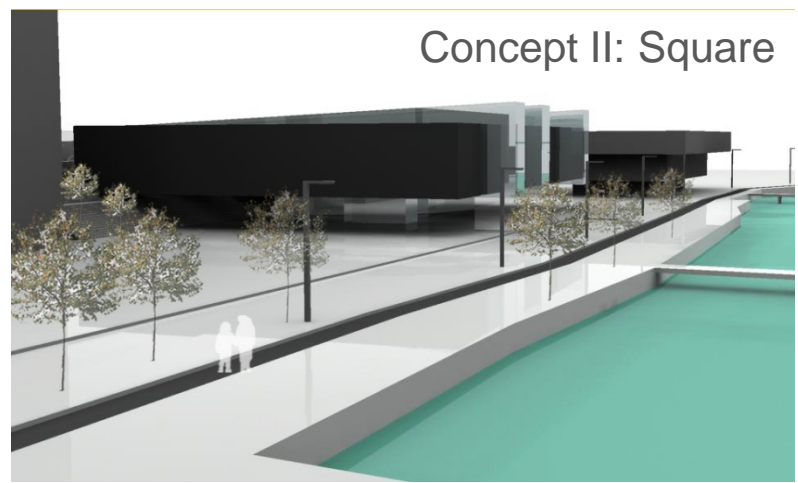


# Winter Quarter Decision Matrix

### Concept I: Double Diamond



### Concept II: Square





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## Site Photos



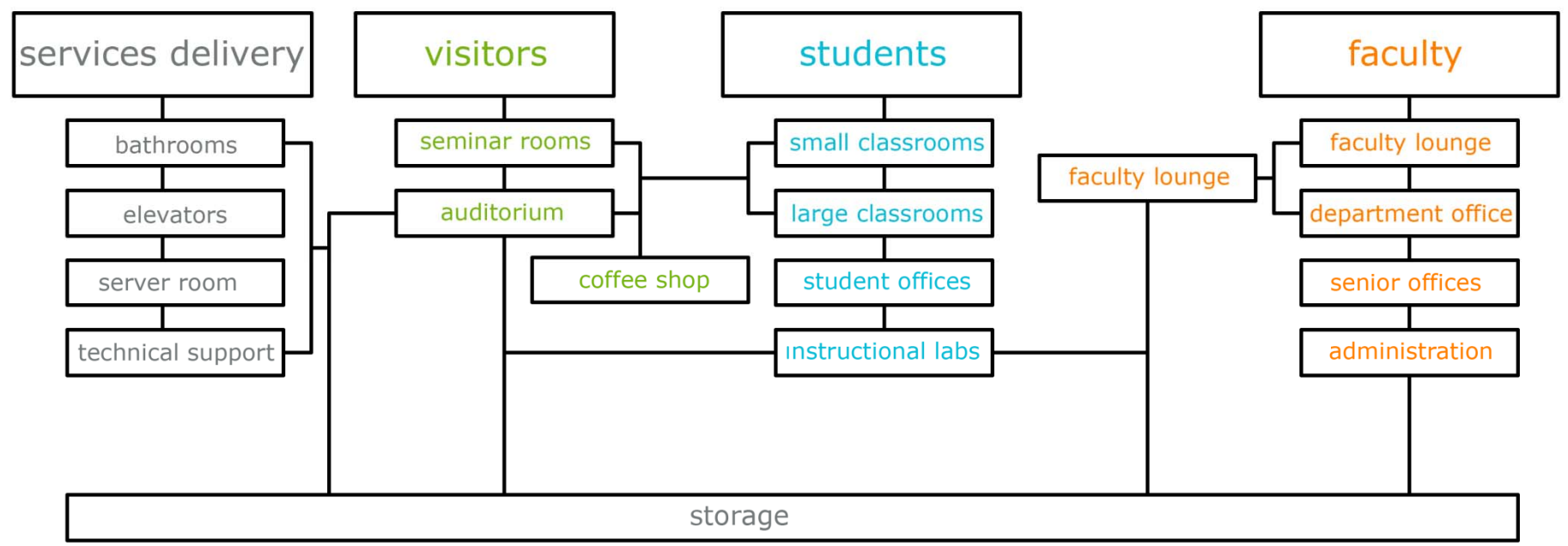


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# Program Relationship Diagram



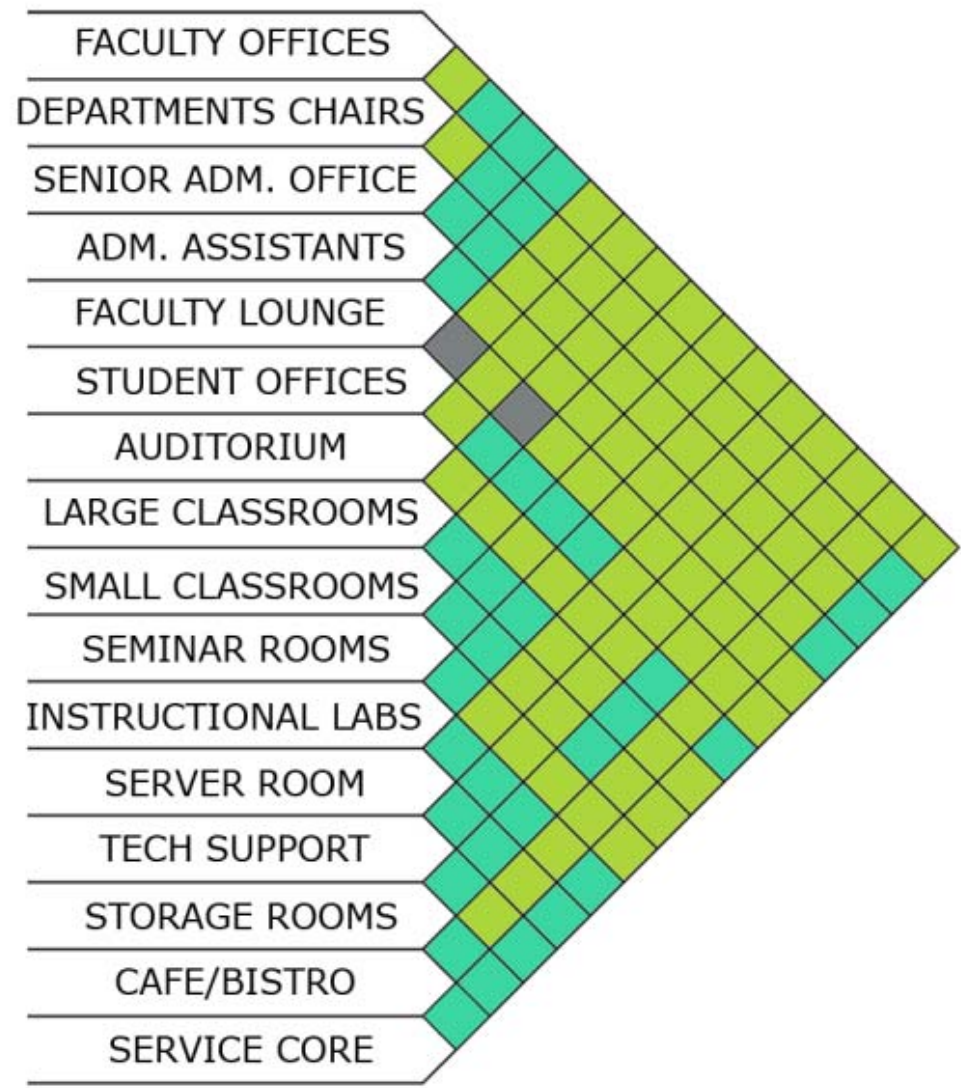


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# Program Relationship Diagram





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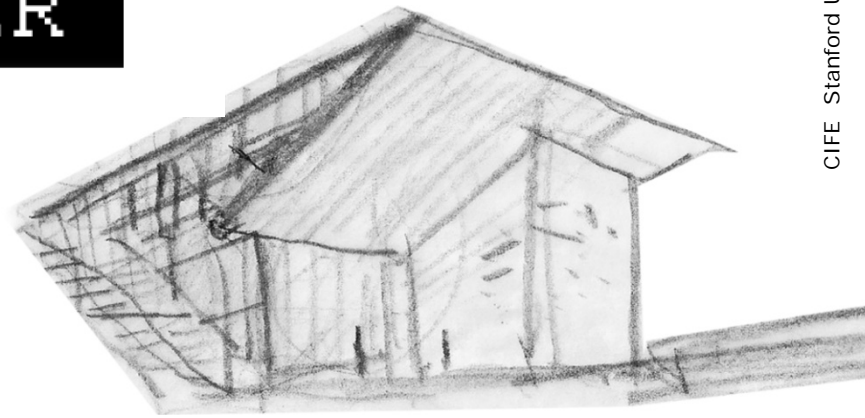
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# Concept Development

LAND <-----> WATER

➤ Building directly responds to:

- 1. Site
- 2. Landscape
- 3. Climate
- 4. Social environment



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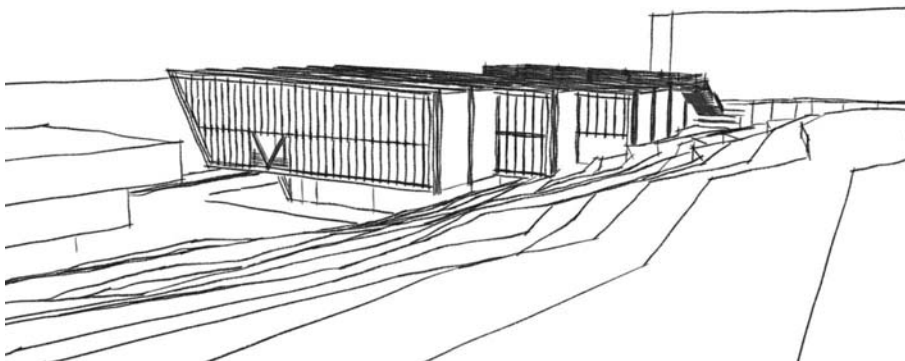
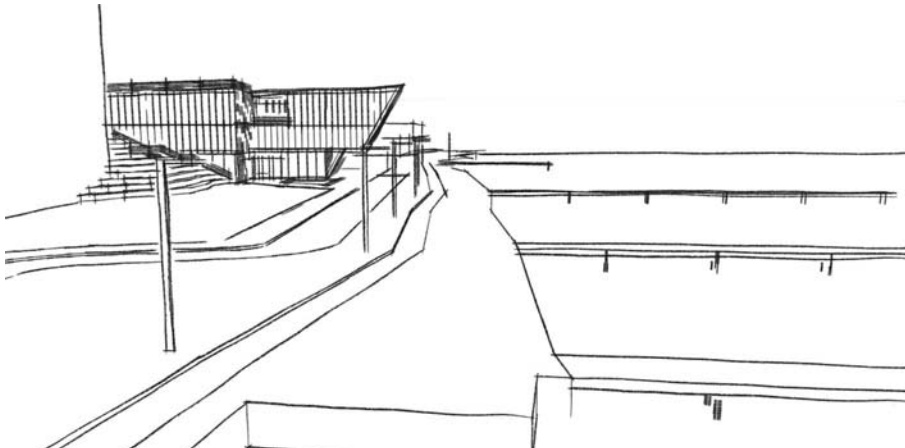
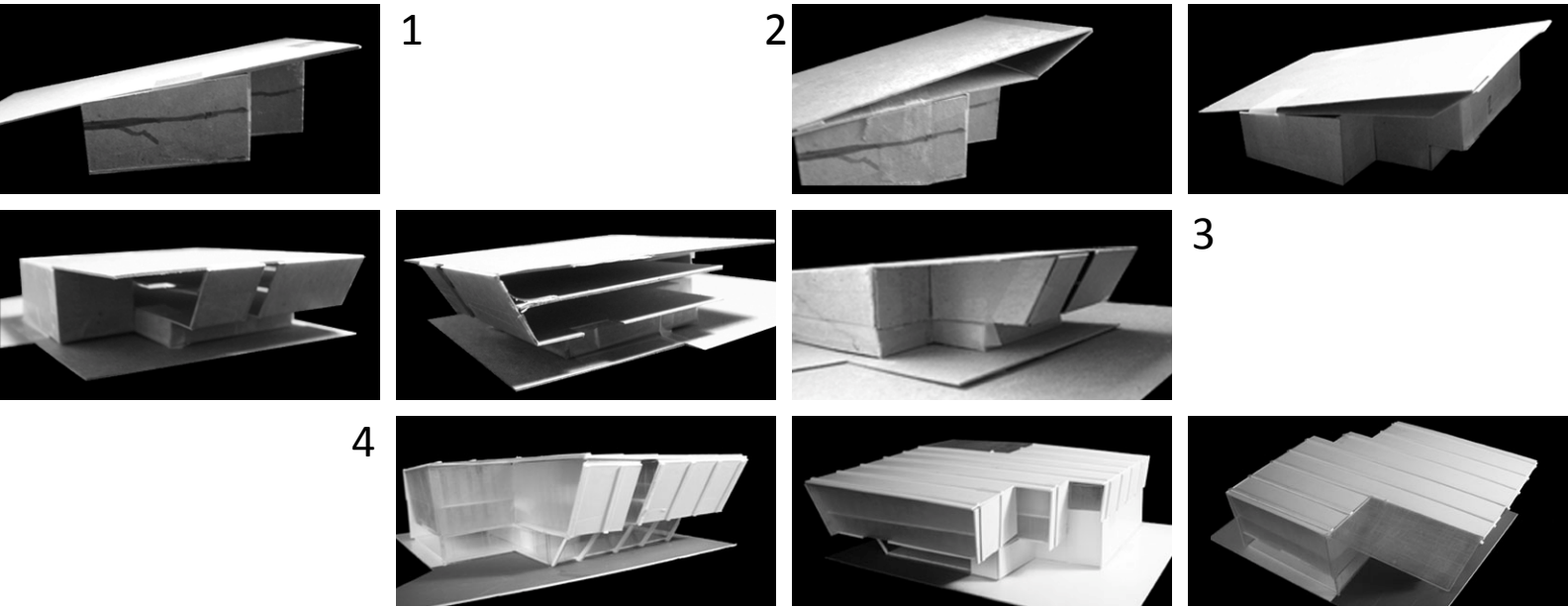
➤ Integration and Transition

➤ Importance to public spaces



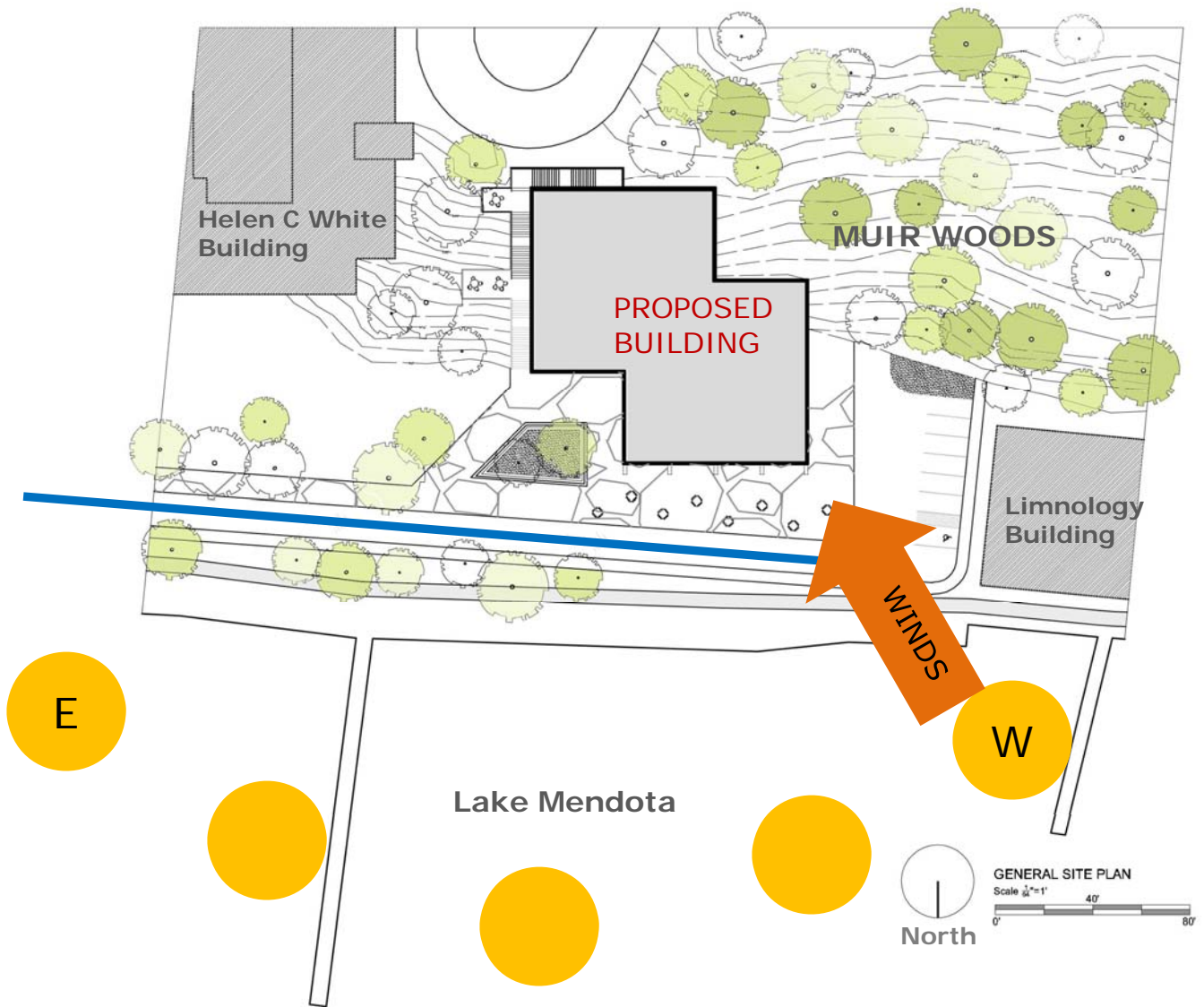


# Design Process: Study Models





# Site Analysis/Site Plan





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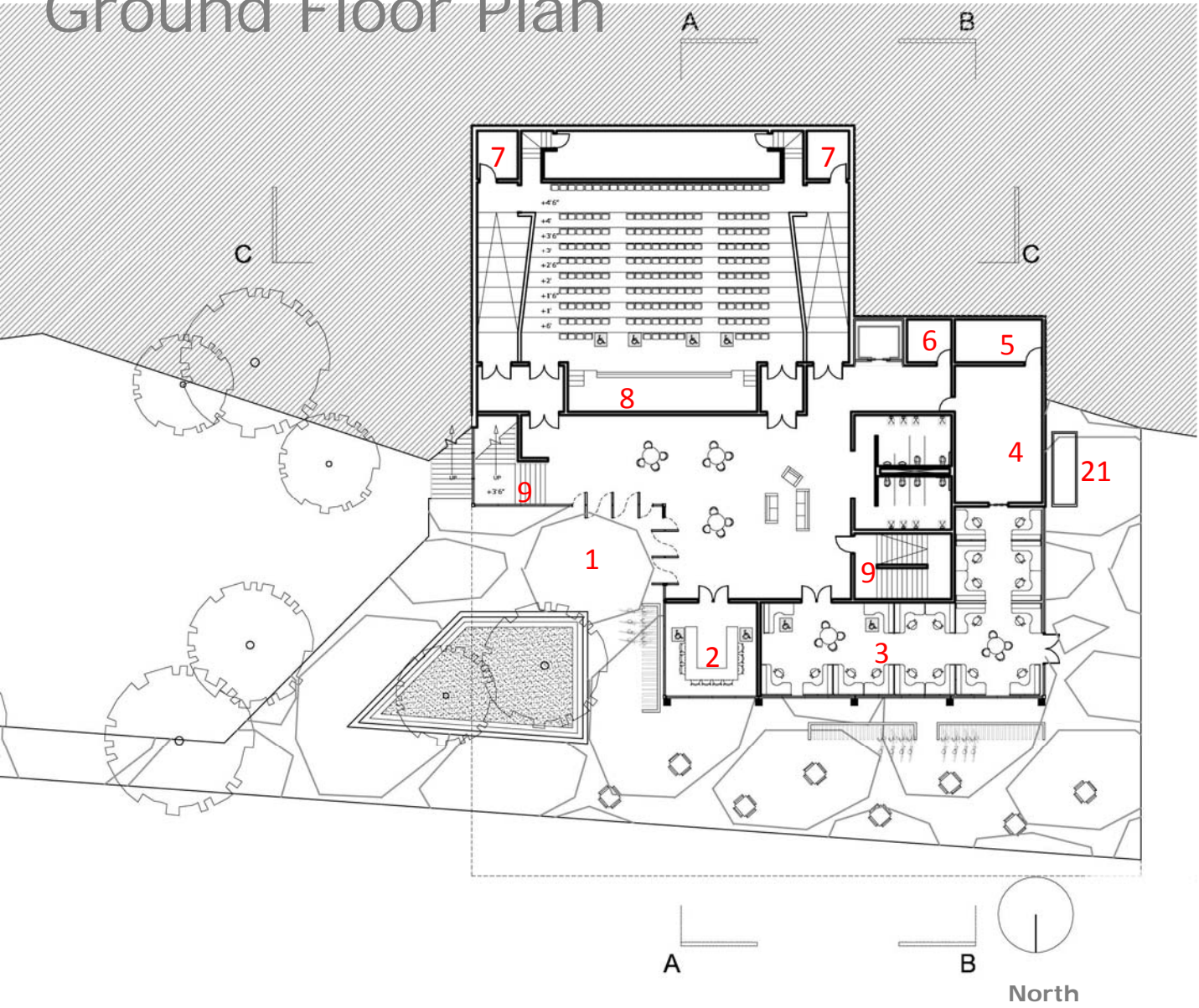
# Program Distribution

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	Ground Floor	First Floor	Second Floor	REQUIRED	Total
<b>Circulation and Public Areas</b>	2230 sq ft2	3,000 sq ft2	4686 sq ft2	% of total	10,000 sq ft2
<b>Coffee Shop</b>	-----	370 sq ft2	-----		370 sq ft2
<b>Mechanical rooms</b>	850 sq ft2	325 sq ft2	325 sq ft2	-----	1,500 sq ft2
<b>Student Offices</b>	1,378 ft 2	-----	-----	1,200 sq ft2	1,378 sq ft2
<b>Seminar Rooms</b>	336 sq ft2	500 sq ft2	360 sq ft2	800 sq ft2	1,200 sq ft2
<b>Service Cores</b>	700 sq ft2	700 sq ft2	700 sq ft2		2,100 sq ft2
<b>Auditorium</b>	3,250 sq ft2	-----	-----	3,000 sq ft2	3,000sq ft2
<b>Storage</b>	760 sq ft2	100 sq ft2	290 sq ft2	1,000 sq ft2	1,150 sq ft2
<b>Air Space Double Height (auditorium)</b>	-----	1,710 sq ft2	-----		1,710 sq ft2
<b>Small Classrooms</b>	-----	1,200 +1,035 sq ft2	-----	2,000 sq ft2	2,235 sq ft2
<b>Large Classrooms</b>	-----	-----	1,270 sq ft2	1,600 sq ft2	1,270 sq ft2
<b>Instructional Labs</b>	-----	1,920 sq ft2	-----	2,000 sq ft2	1,920 sq ft2
<b>Administration</b>	-----	-----	1,360 sq ft2	900 sq ft2	1,360 sq ft2
<b>Server Room + Tech Support</b>	-----	360 sq ft	310 sq ft2	800 sq ft2	670 sq ft2
<b>Faculty Lounge</b>	-----	-----	660 sq t2	1,000 sq ft2	660 sq ft2
<b>Faculty Offices</b>	-----	-----	3,390 sq ft2	3,600 sq ft2	3,390 sq ft2
<b>Exterior Staircase</b>	200 sq ft2	650 sq ft2	450 sq ft2		1,300 sq ft2
<b>Elevator</b>	8'2" x 6'8" sq ft2	8'2" x 6'8"	8'2" x 6'8"	min. ADA 5'8" X 4'3"	150 sq ft2
<b>TOTAL:</b>					34,860 sq ft2



# Ground Floor Plan



## Program Key Map

- 1. Main Entrance
- 2. Seminar Room
- 3. Student Offices
- 4. Mechanical Room
- 5. Shaft
- 6. Electrical Room
- 7. Storage
- 8. Auditorium
- 9. Vertical circulation
- 10. Study Hall
- 11. Coffee Shop
- 12. Small Classroom
- 13. Instructional Lab
- 14. Lockers
- 15. Balcony
- 16. Large Classrooms
- 17. Faculty Office
- 18. Server Room + Tech Sup
- 19. Administration
- 20. Faculty Lounge
- 21. Recycling Trashcans





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# Ground Floor Program

auditorium

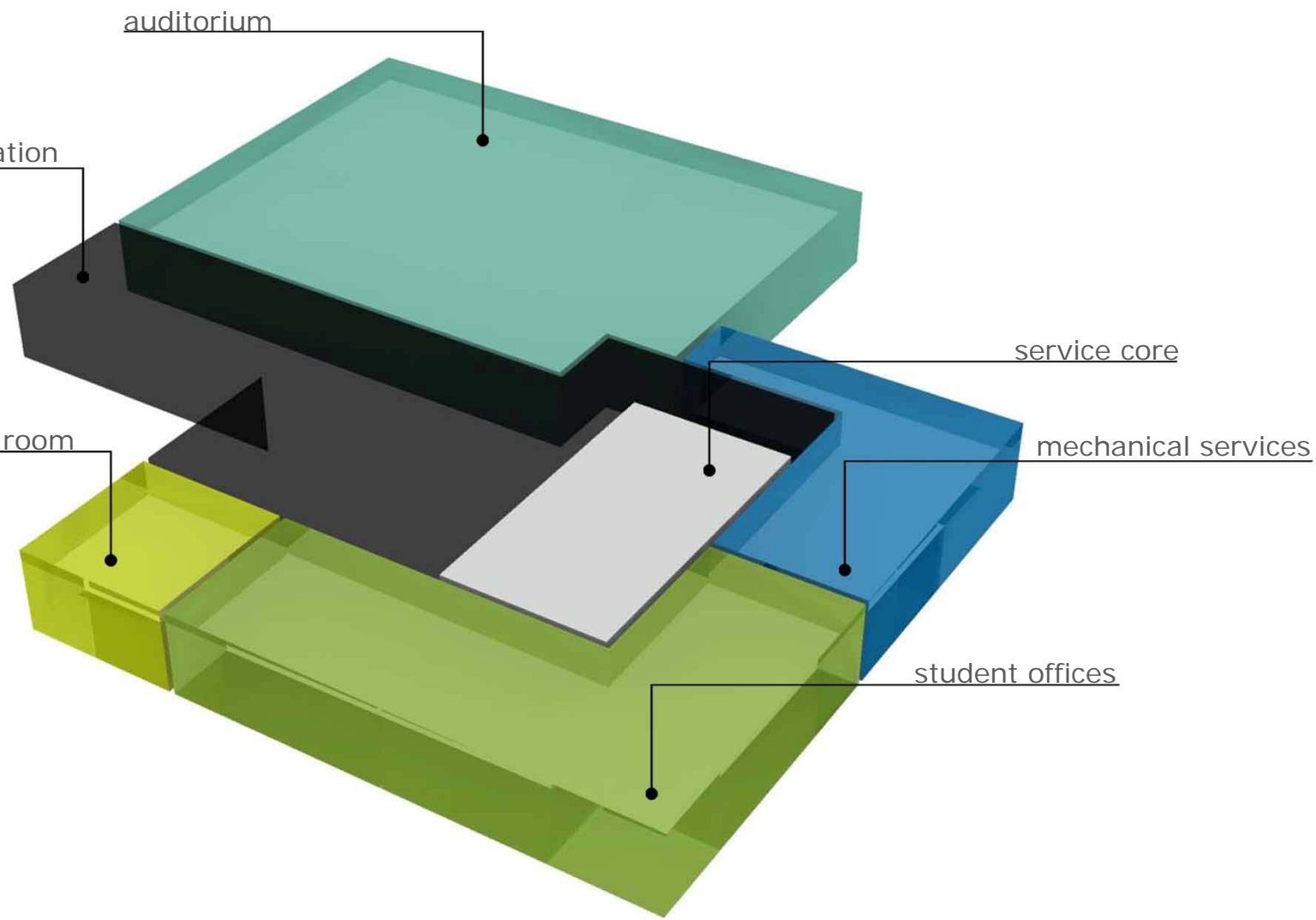
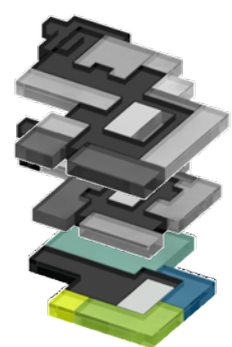
public + circulation

seminar room

service core

mechanical services

student offices





# First Floor Plan



### Program Key Map

- 1. Main Entrance
- 2. Seminar Room
- 3. Student Offices
- 4. Mechanical Room
- 5. Shaft
- 6. Electrical Room
- 7. Storage
- 8. Auditorium
- 9. Vertical circulation
- 10. Study Hall
- 11. Coffee Shop
- 12. Small Classroom
- 13. Instructional Lab
- 14. Lockers
- 15. Balcony
- 16. Large Classrooms
- 17. Faculty Office
- 18. Server Room + Tech Support
- 19. Administration
- 20. Faculty Lounge

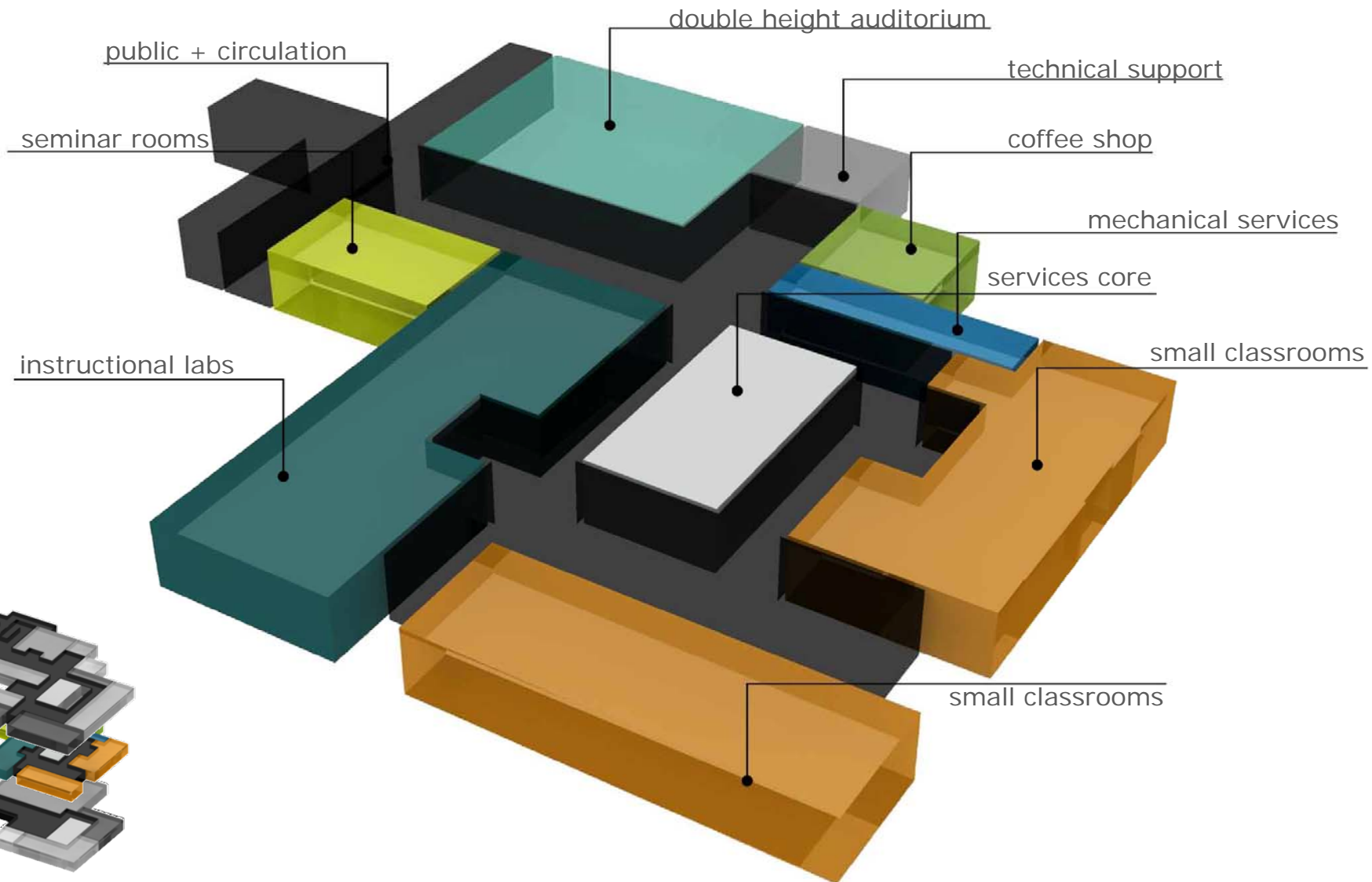


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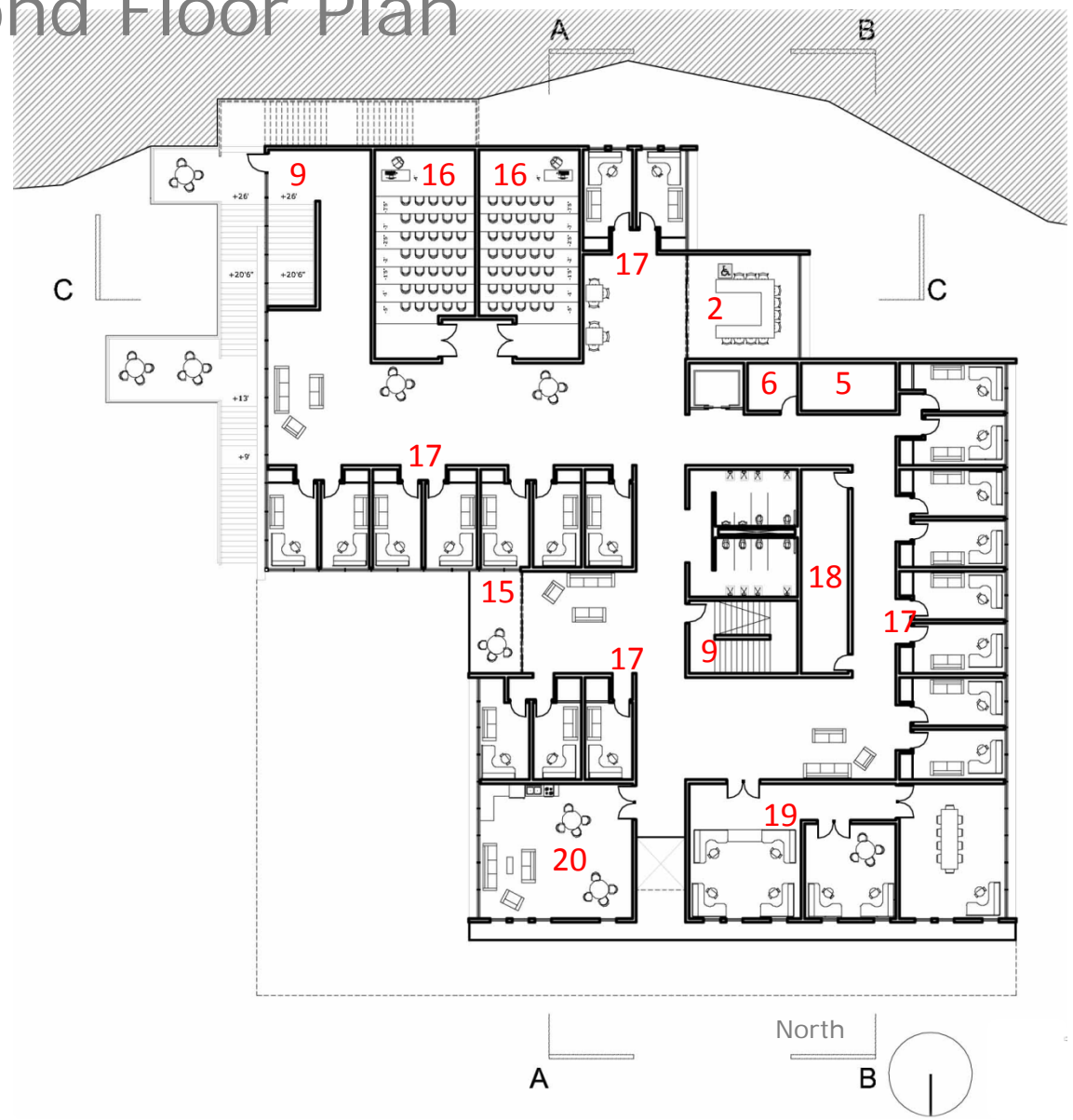
# First Floor Program



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# Second Floor Plan



## Program Key Map

- 1. Main Entrance
- 2. Seminar Room
- 3. Student Offices
- 4. Mechanical Room
- 5. Shaft
- 6. Electrical Room
- 7. Storage
- 8. Auditorium
- 9. Vertical circulation
- 10. Study Hall
- 11. Coffee Shop
- 12. Small Classroom
- 13. Instructional Lab
- 14. Lockers
- 15. Balcony
- 16. Large Classrooms
- 17. Faculty Office
- 18. Server Room + Tech Support
- 19. Administration
- 20. Faculty Lounge

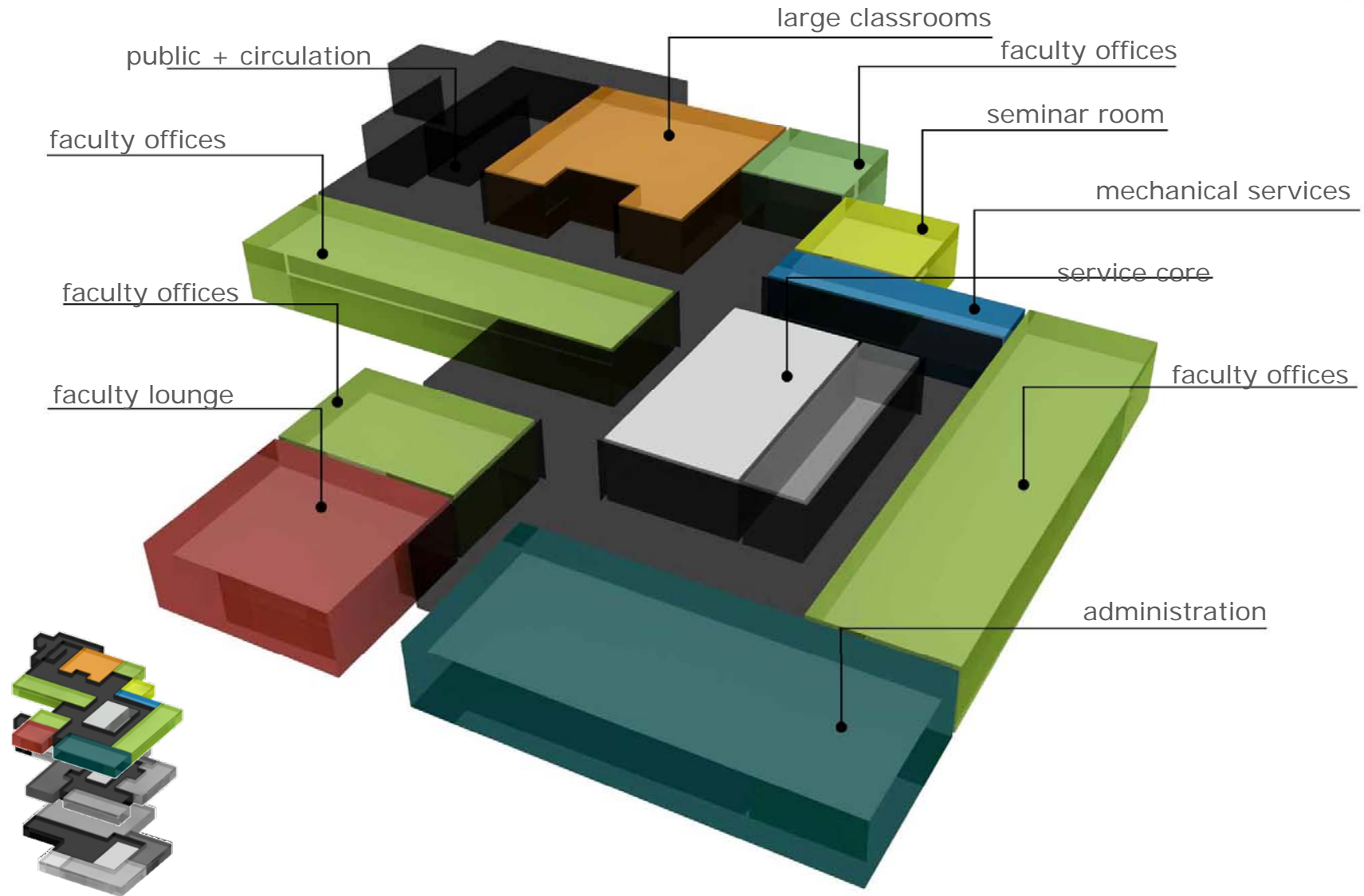


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# Second Floor Program



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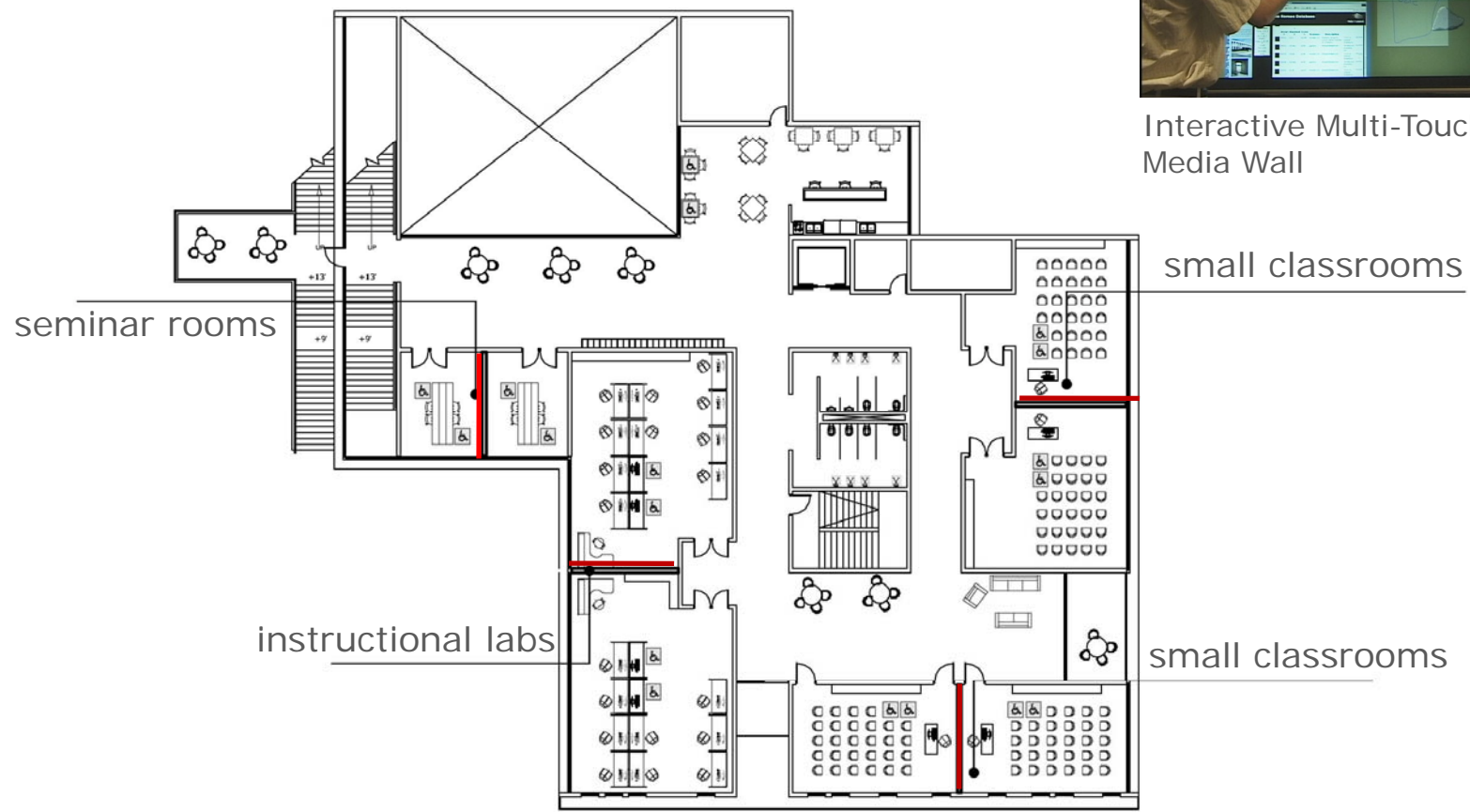
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# Technology Thinking 2015: Sharing Walls with technological capacity



Interactive Multi-Touch Media Wall



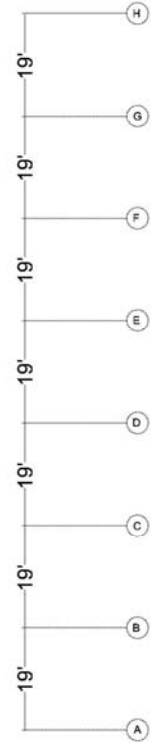
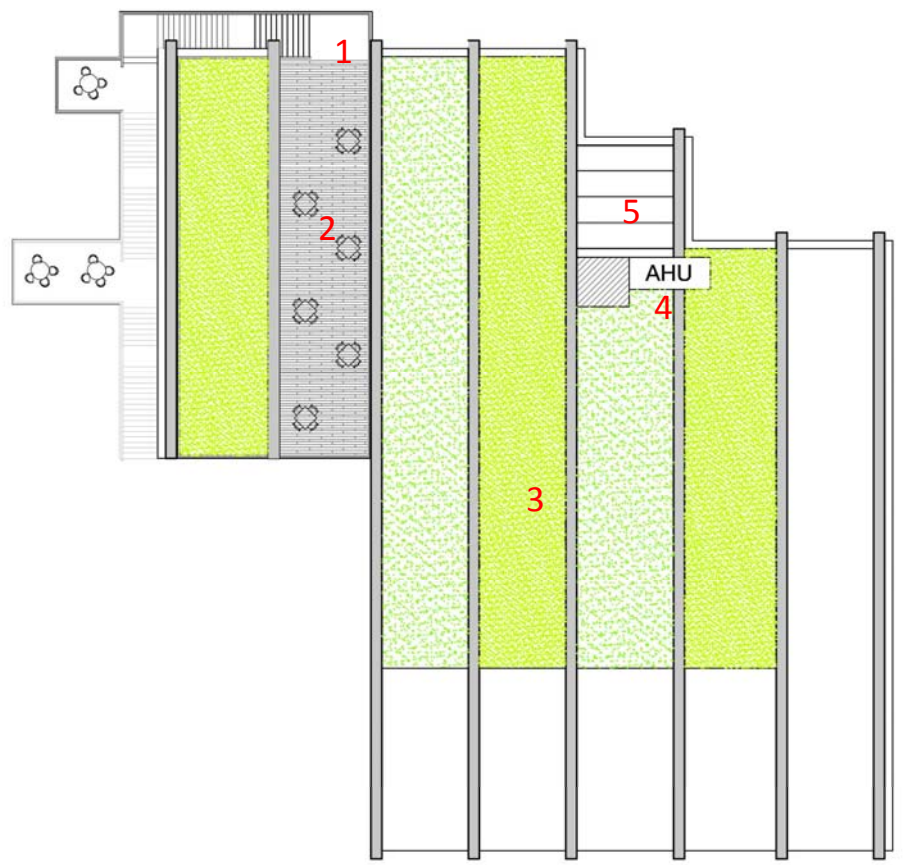
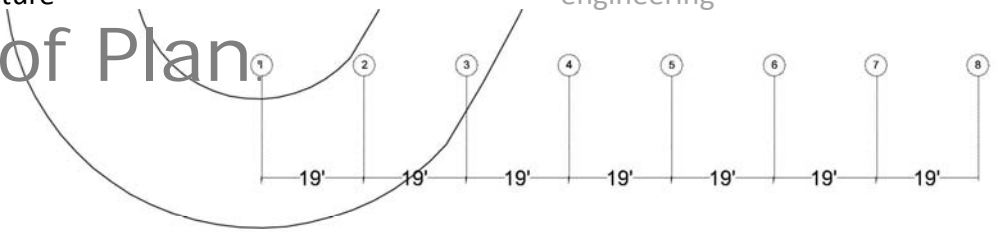


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# Roof Plan



## Program Key Map

- 1. Main Entrance
- 2. Public Area/Hangout
- 3. Green Roof
- 4. AHU
- 5. Skylight

Roof Plan

Scale 1/16"=1'





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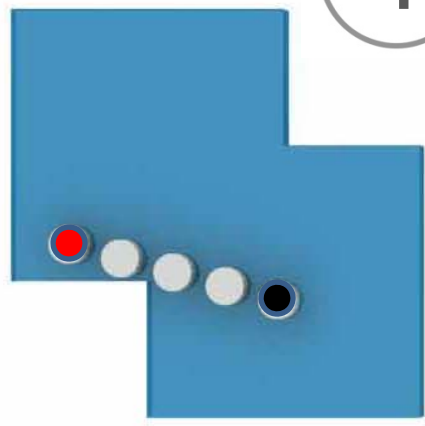
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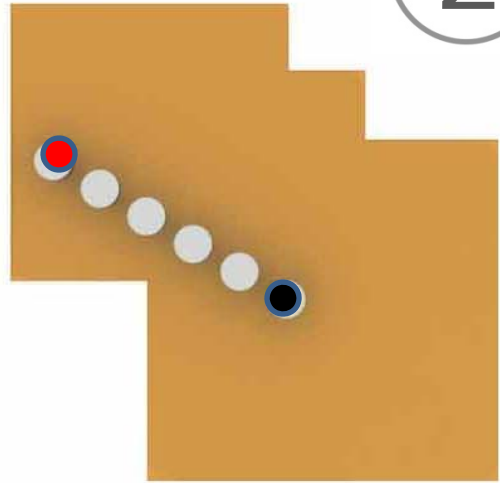
# Means of Egress Diagram

## UBC-1997

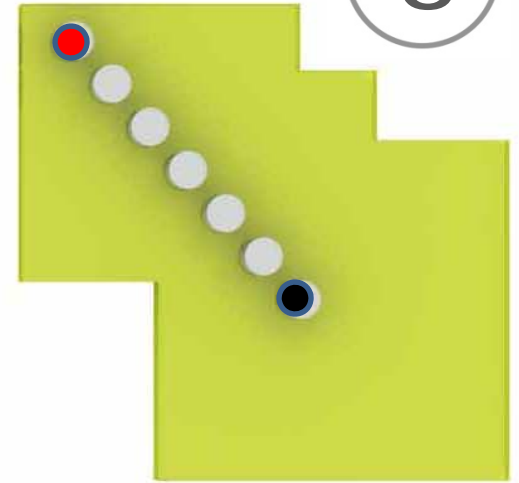
1





2



3

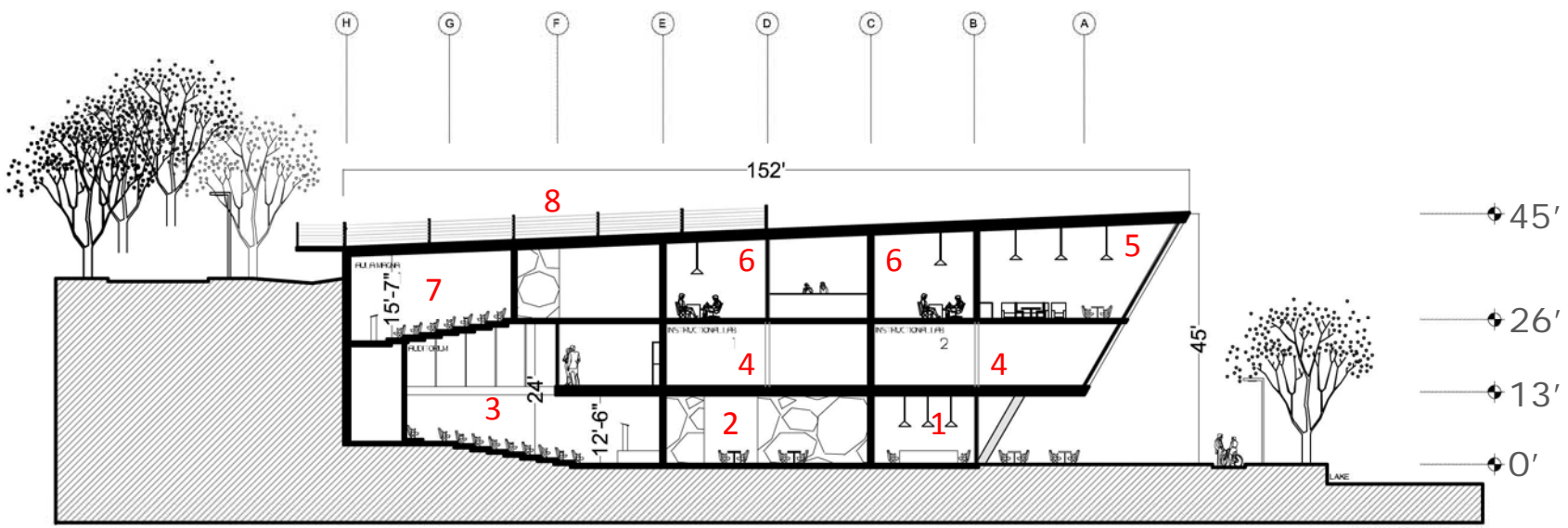


-  exterior exit
-  emergency exit



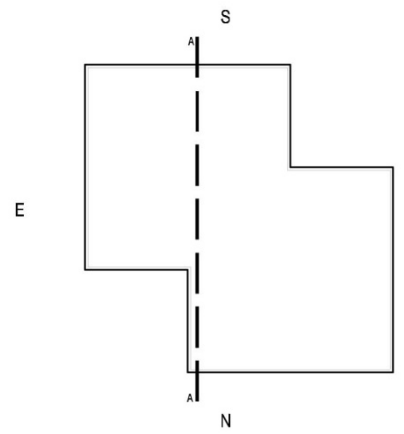
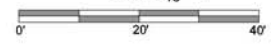


# Section AA



SECTION AA

Scale 1/16"=1'

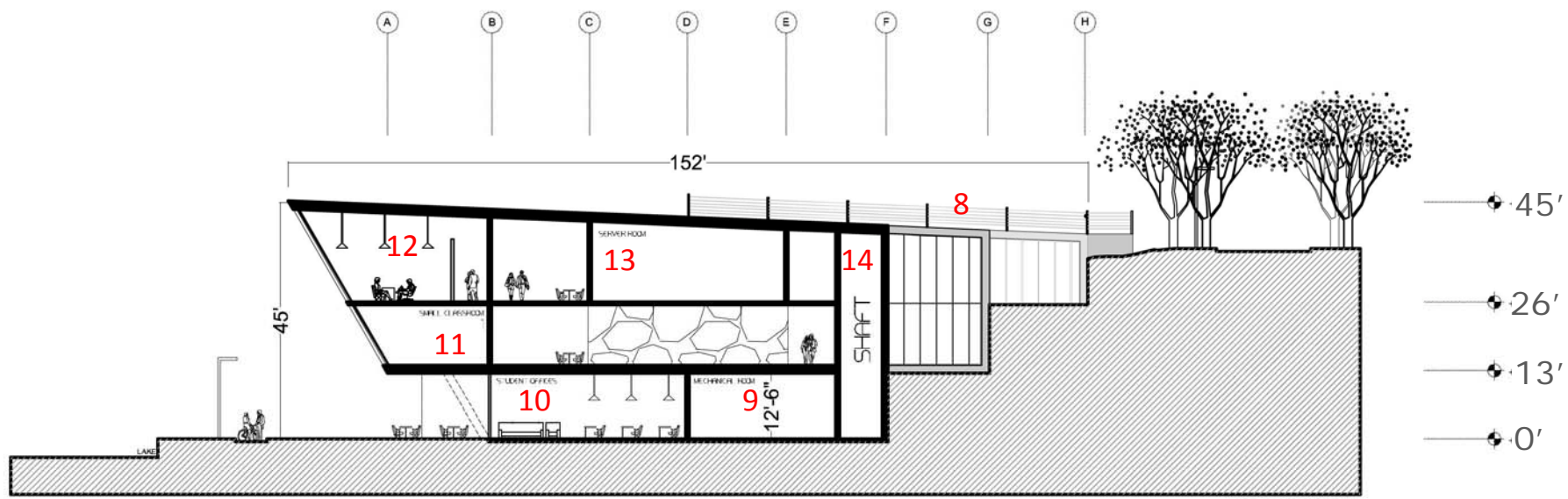


## Section Key Map

- 1. Seminar Room
- 2. Main Lobby
- 3. Auditorium
- 4. Instructional Lab
- 5. Faculty Lounge
- 6. Faculty Office
- 7. Large Classroom
- 8. Public Roof Access

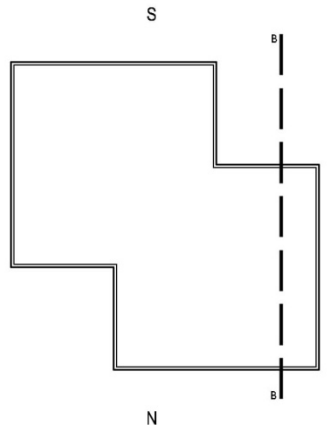
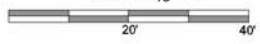


# Section BB



SECTION BB

Scale 1/16"=1'



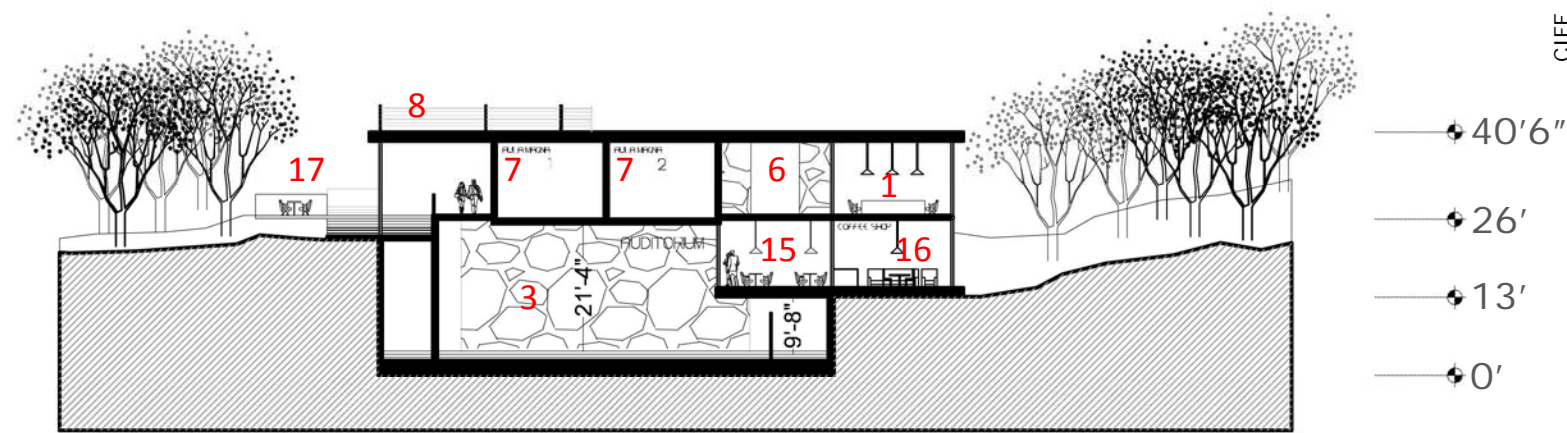
## Section Key Map

- 8. Public Roof Access
- 9. Mechanical Room
- 10. Student Offices
- 11. Small Classroom
- 12. Administration
- 13. Server Room
- 14. Shaft

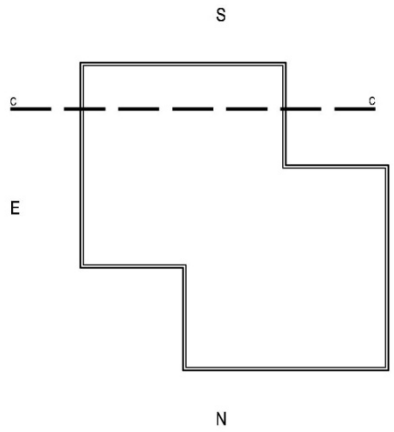
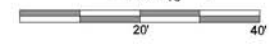


# Section CC

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SECTION CC  
Scale  $\frac{1}{16}''=1'$



## Section Key Map

- 1. Seminar Room
- 3. Auditorium
- 6. Faculty Offices
- 7. Large Classroom
- 8. Roof Public Access
- 15. Study Hall
- 16. Coffee Shop
- 17. Exterior Staircase



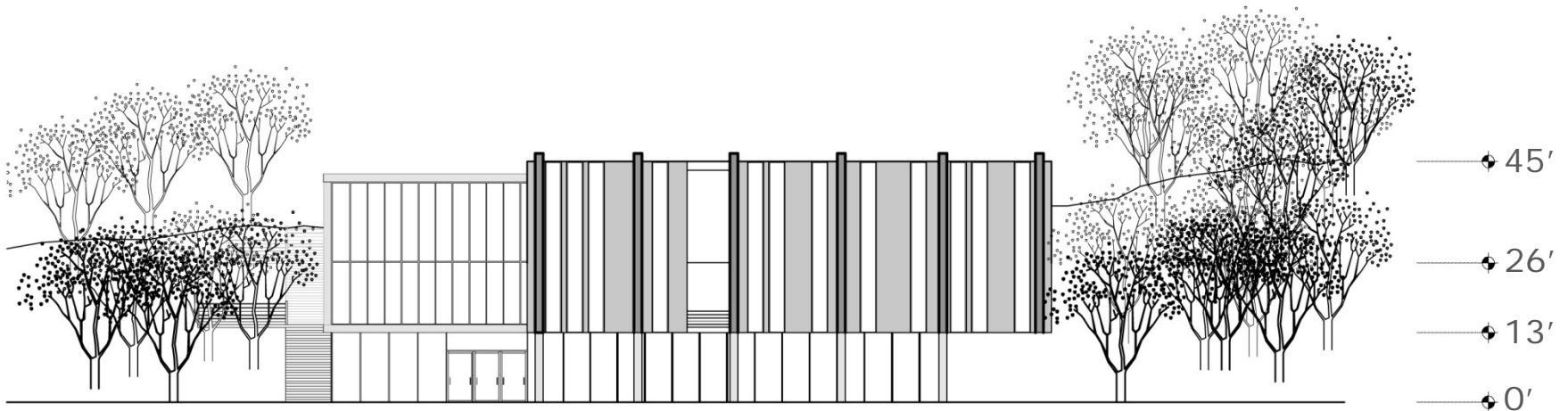
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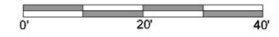
# North Elevation

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North Elevation

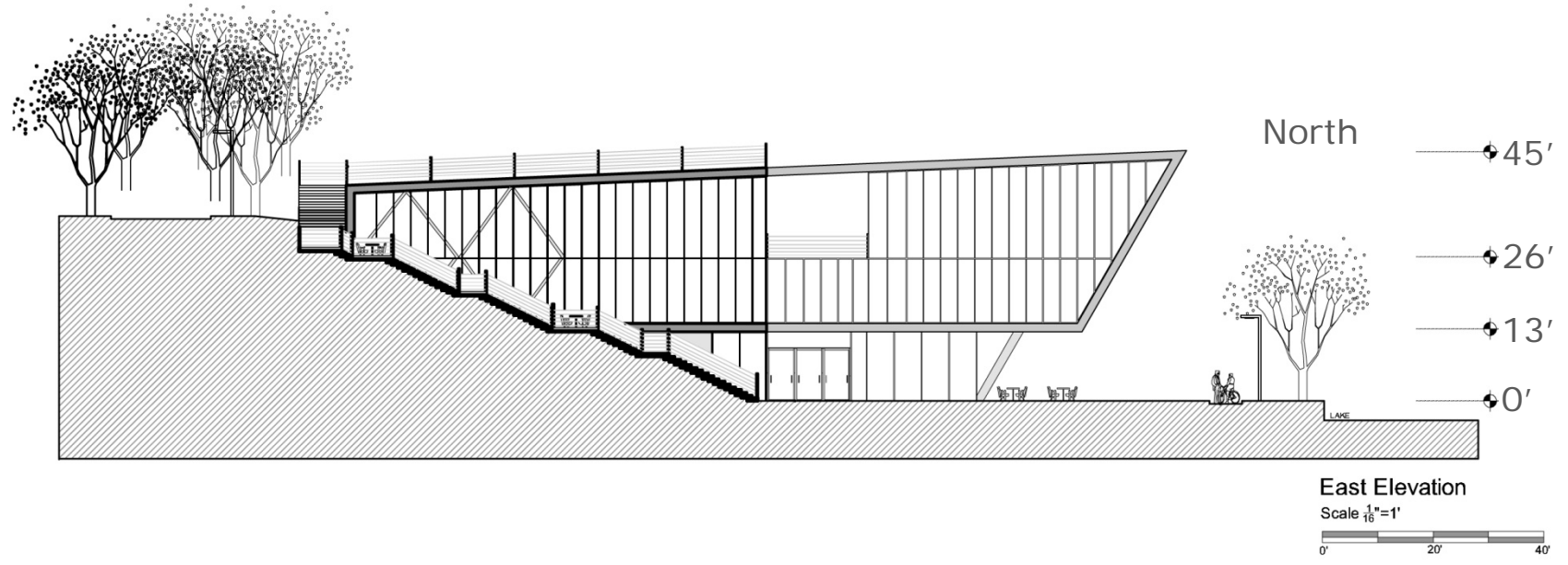
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# East Elevation

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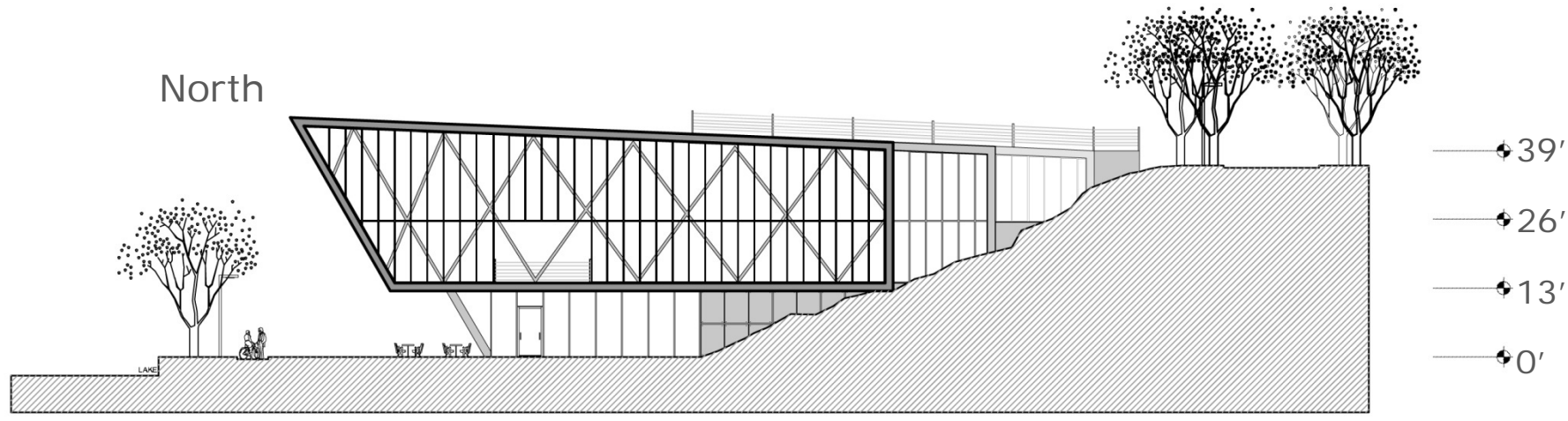




# West Elevation

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North



West Elevation

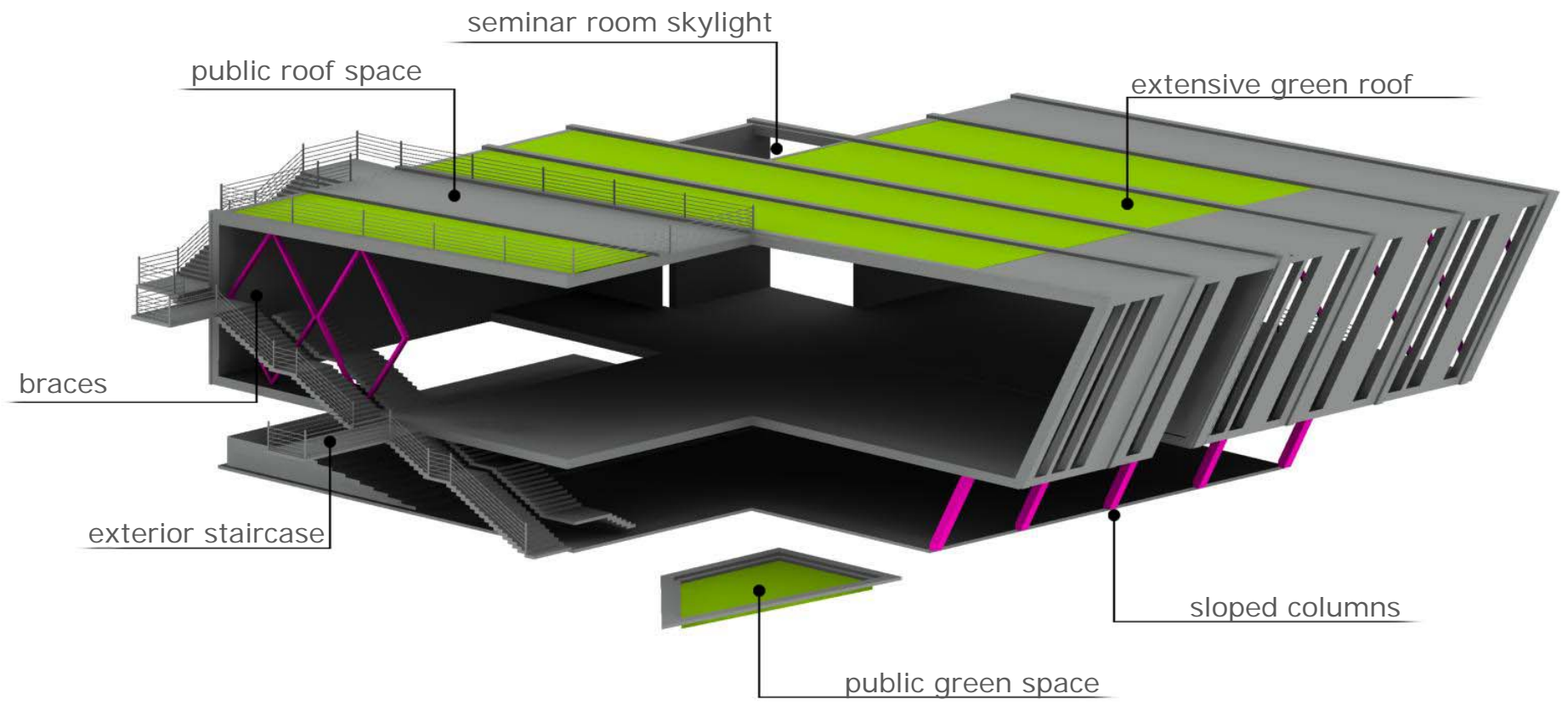
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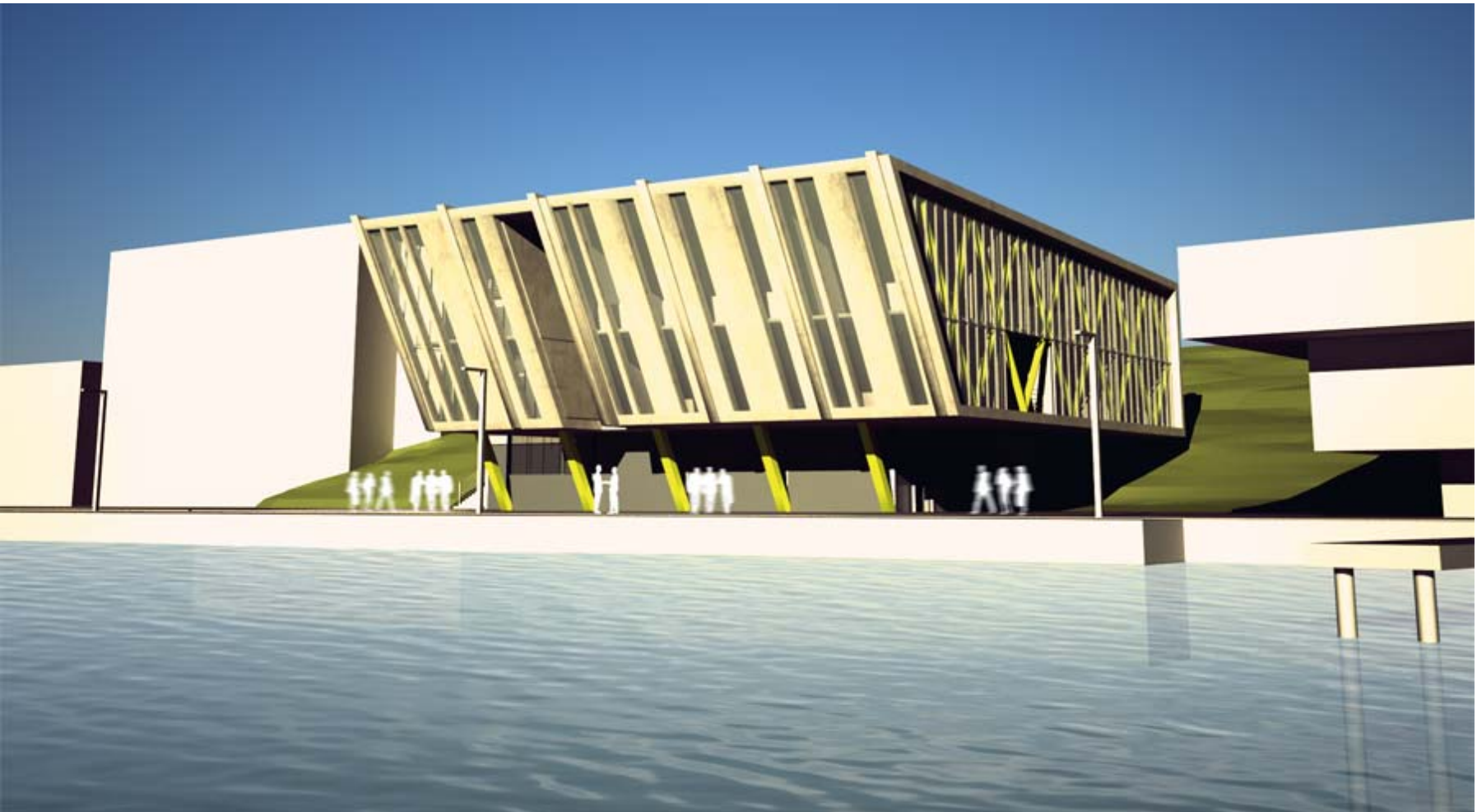
# Building Components

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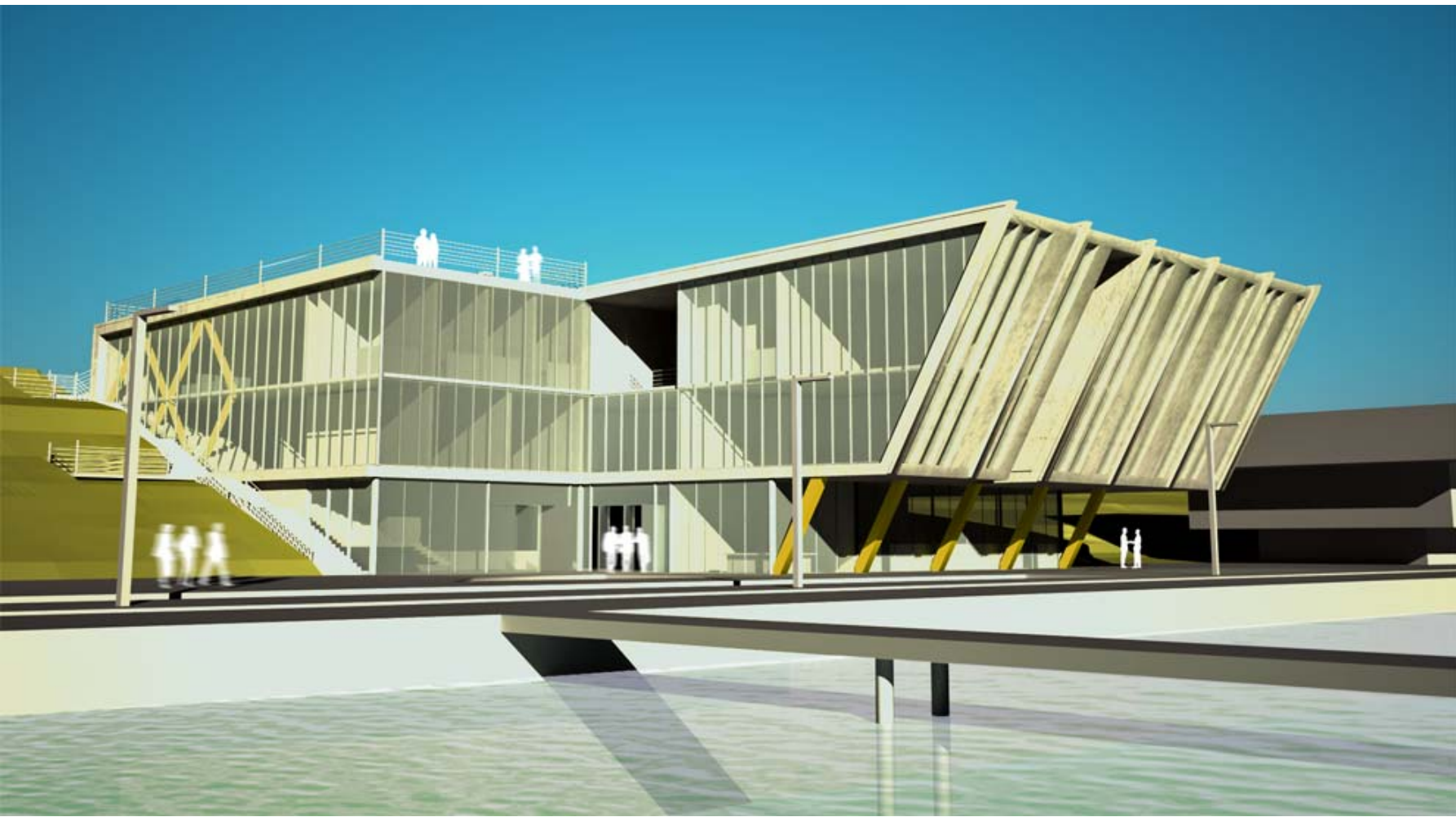
# Exterior Renders: View from Lake Mendota - NW





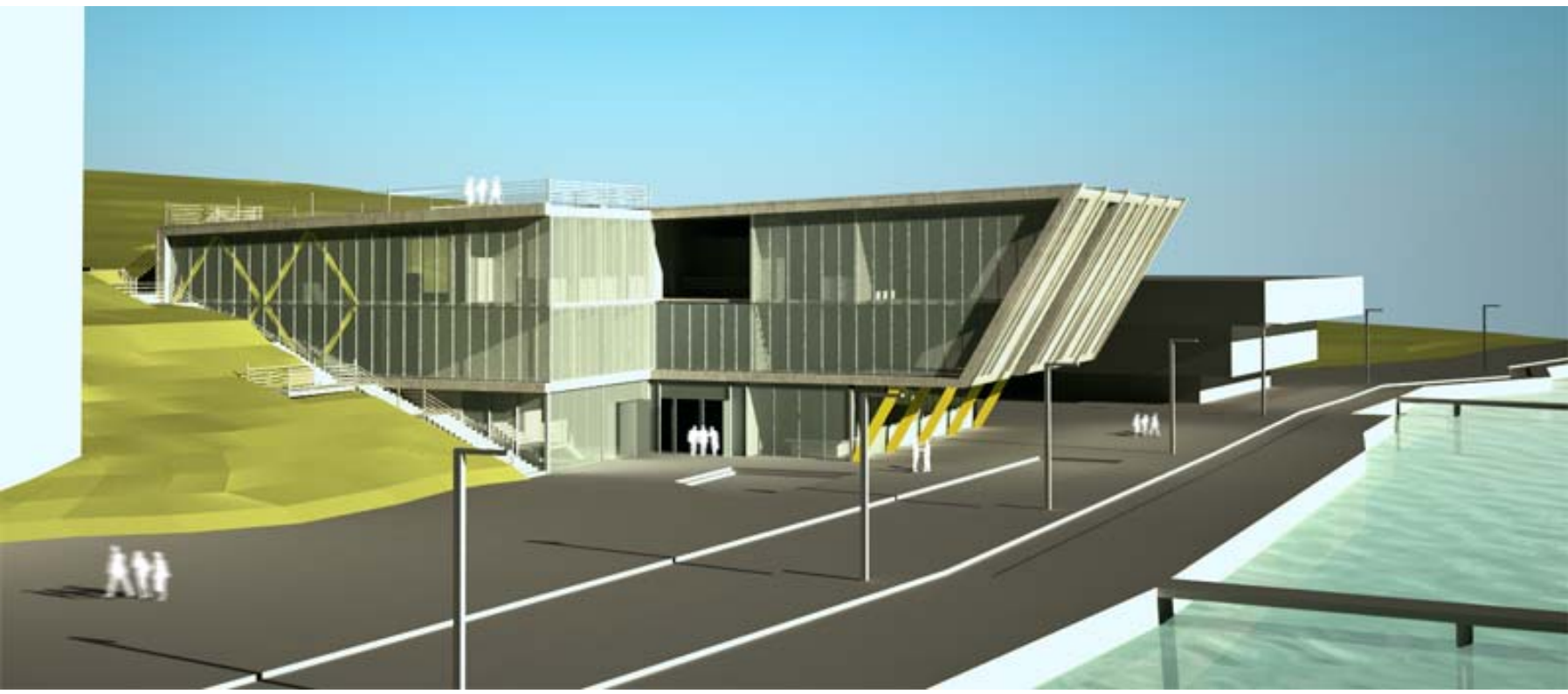


# Exterior Renders: View from Lake Mendota - NE



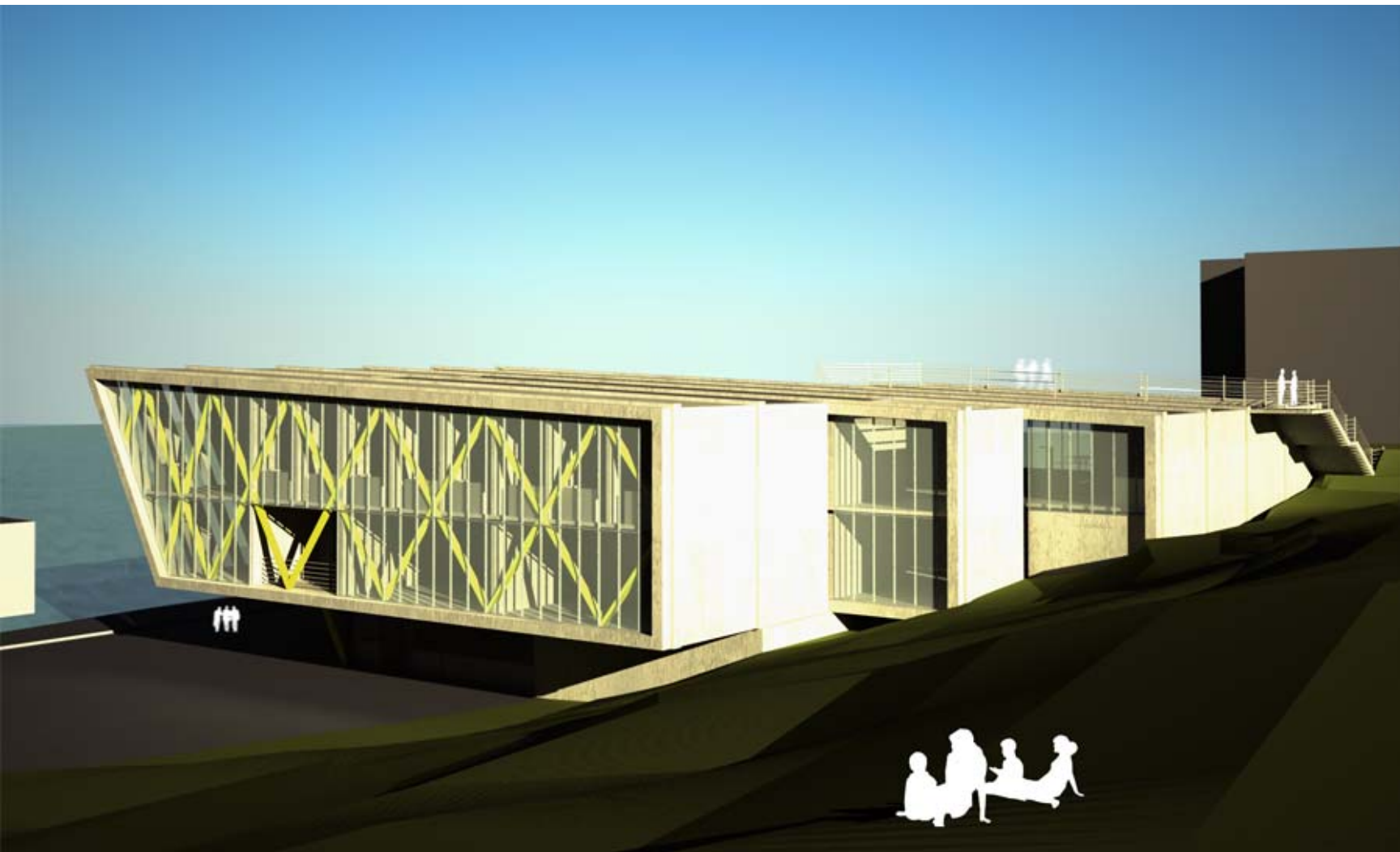


# Exterior Renders: View from Lake Mendota - NE



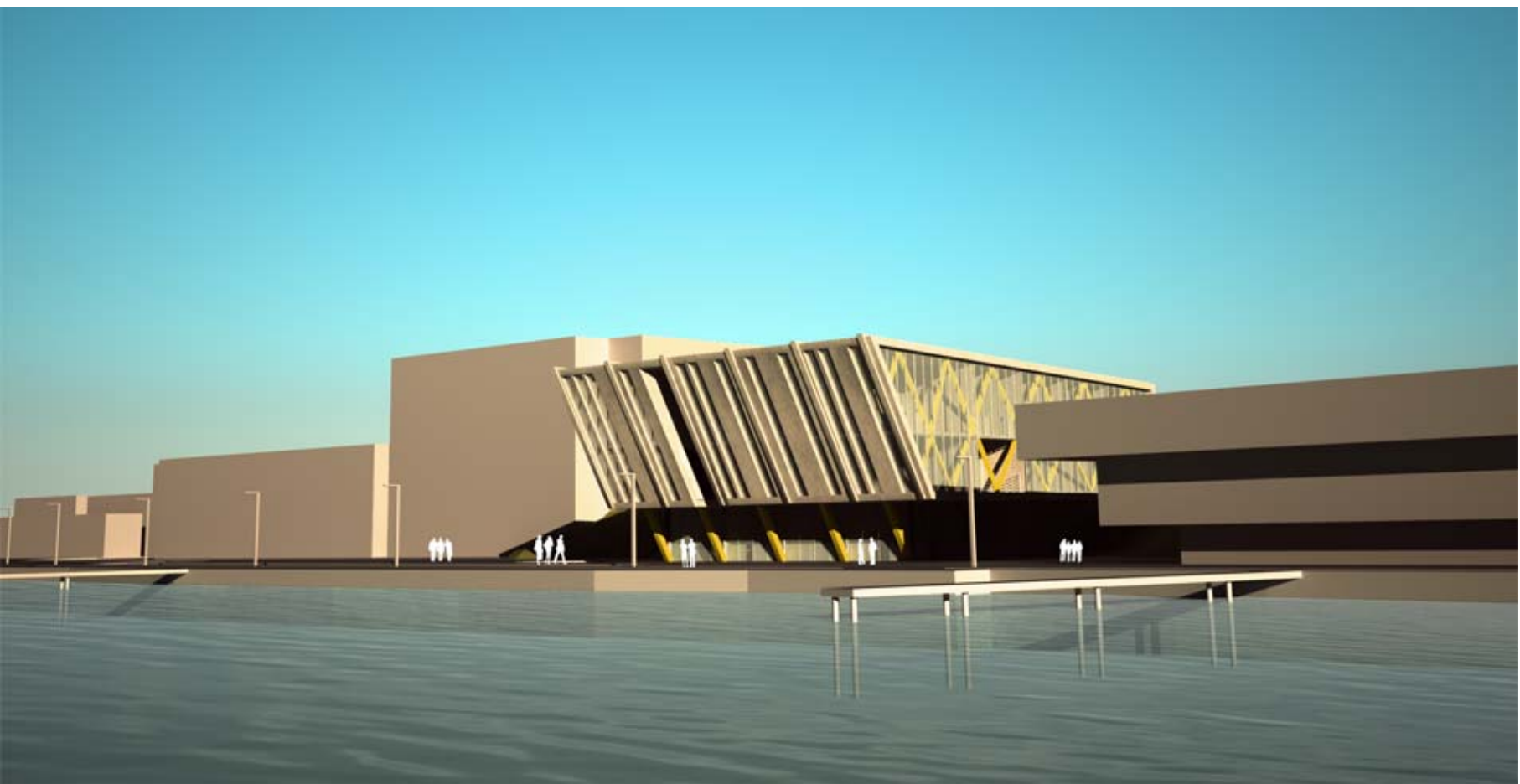


# Exterior Renders: View from Muir Woods



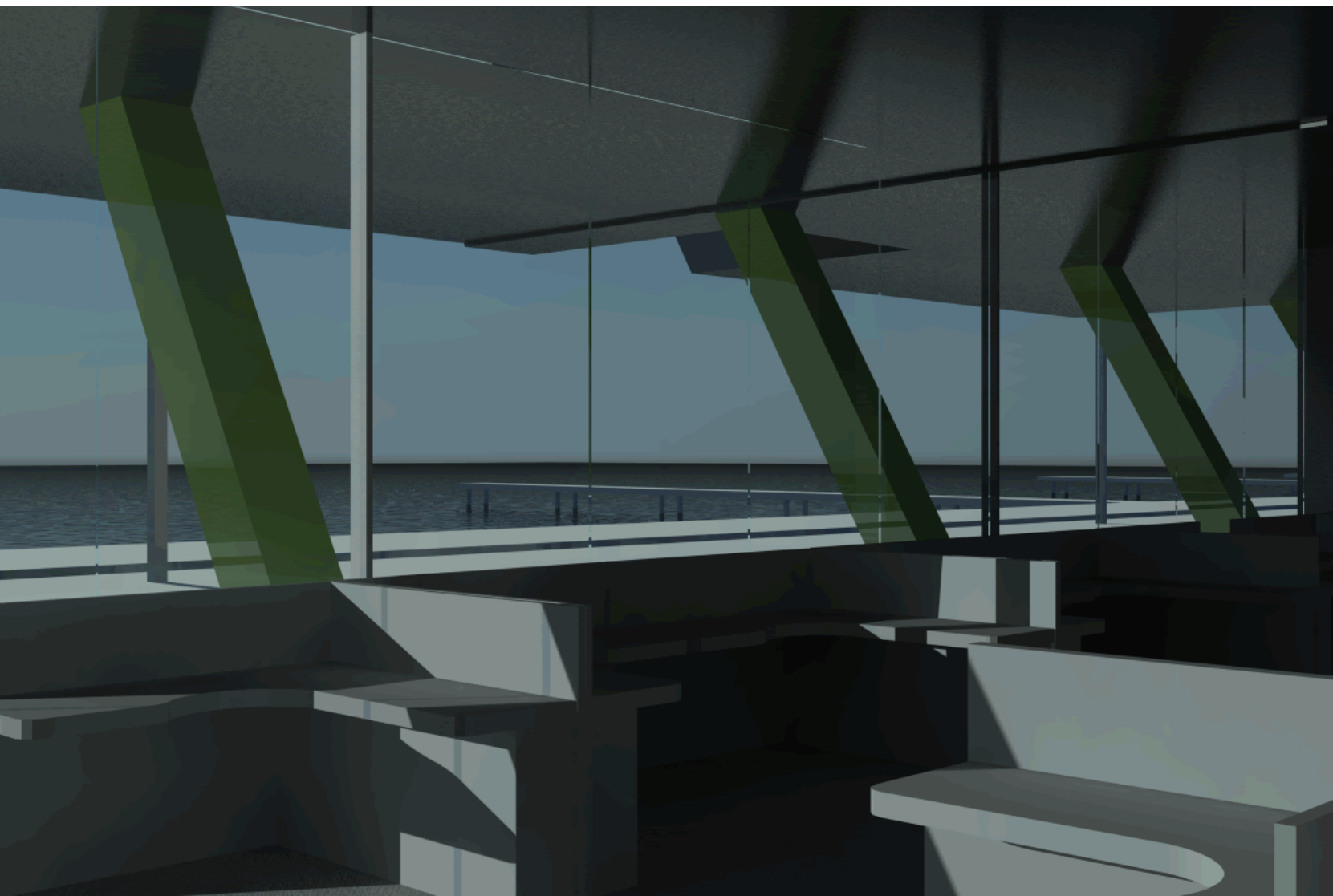


# Exterior Renders: View from Lake Mendota - NW



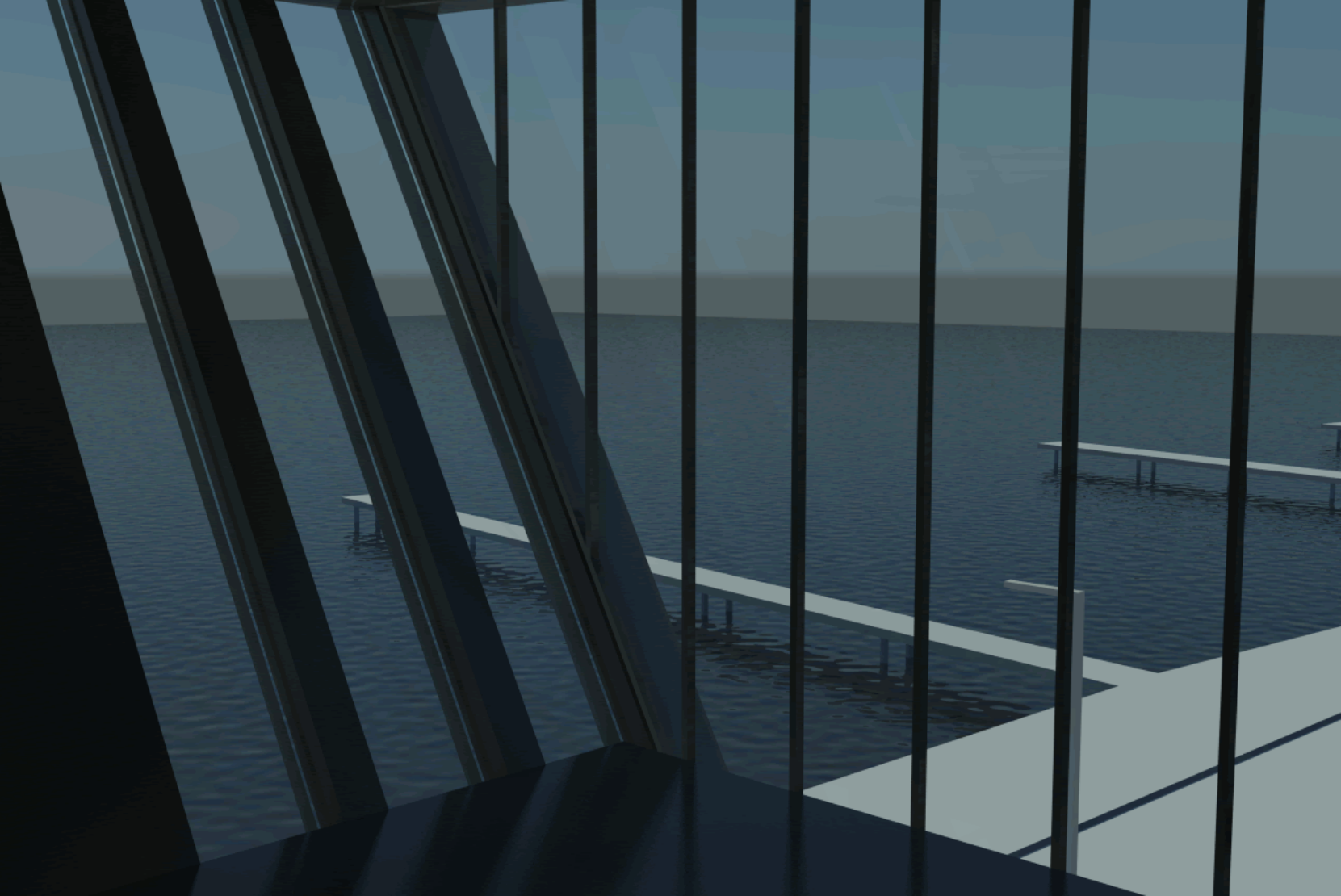


# Interior Renders: View from Student Offices





# Interior Renders: View from the Faculty Lounge



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School of Engineering: University of Wisconsin at Madison



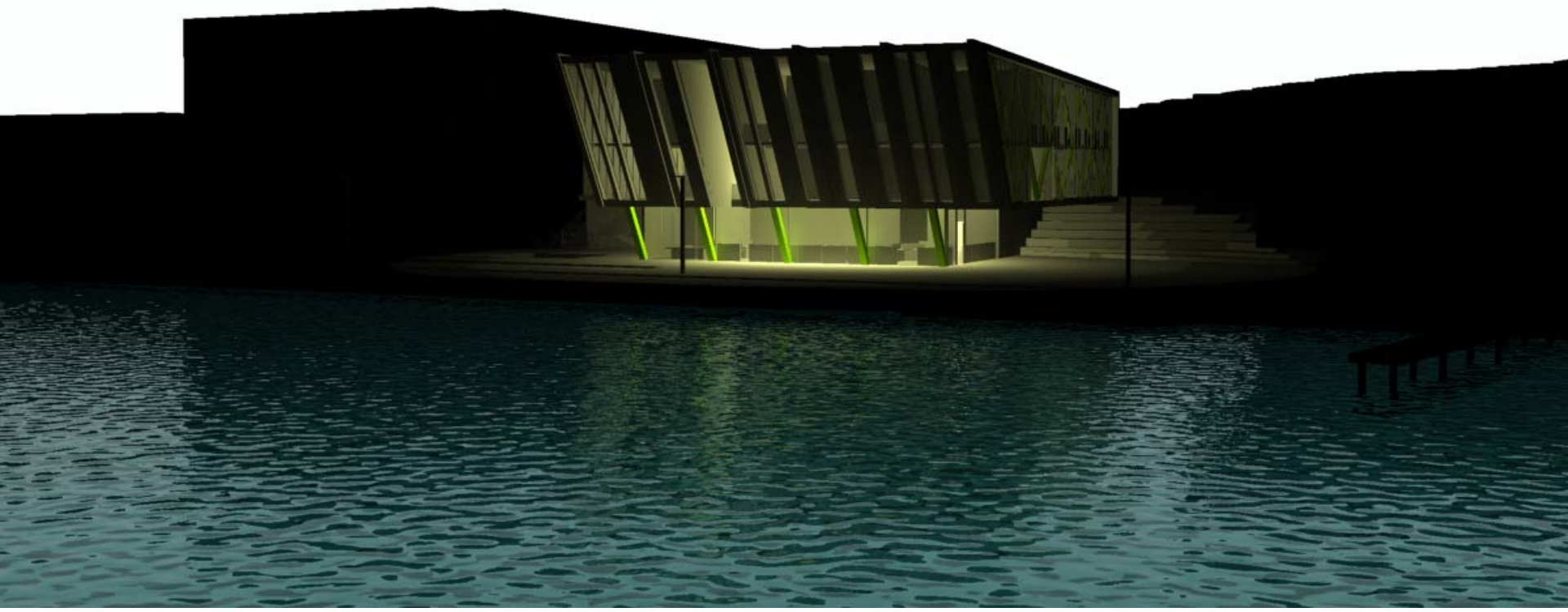
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# Night Renders: View from Lake Mendota - N

rd University



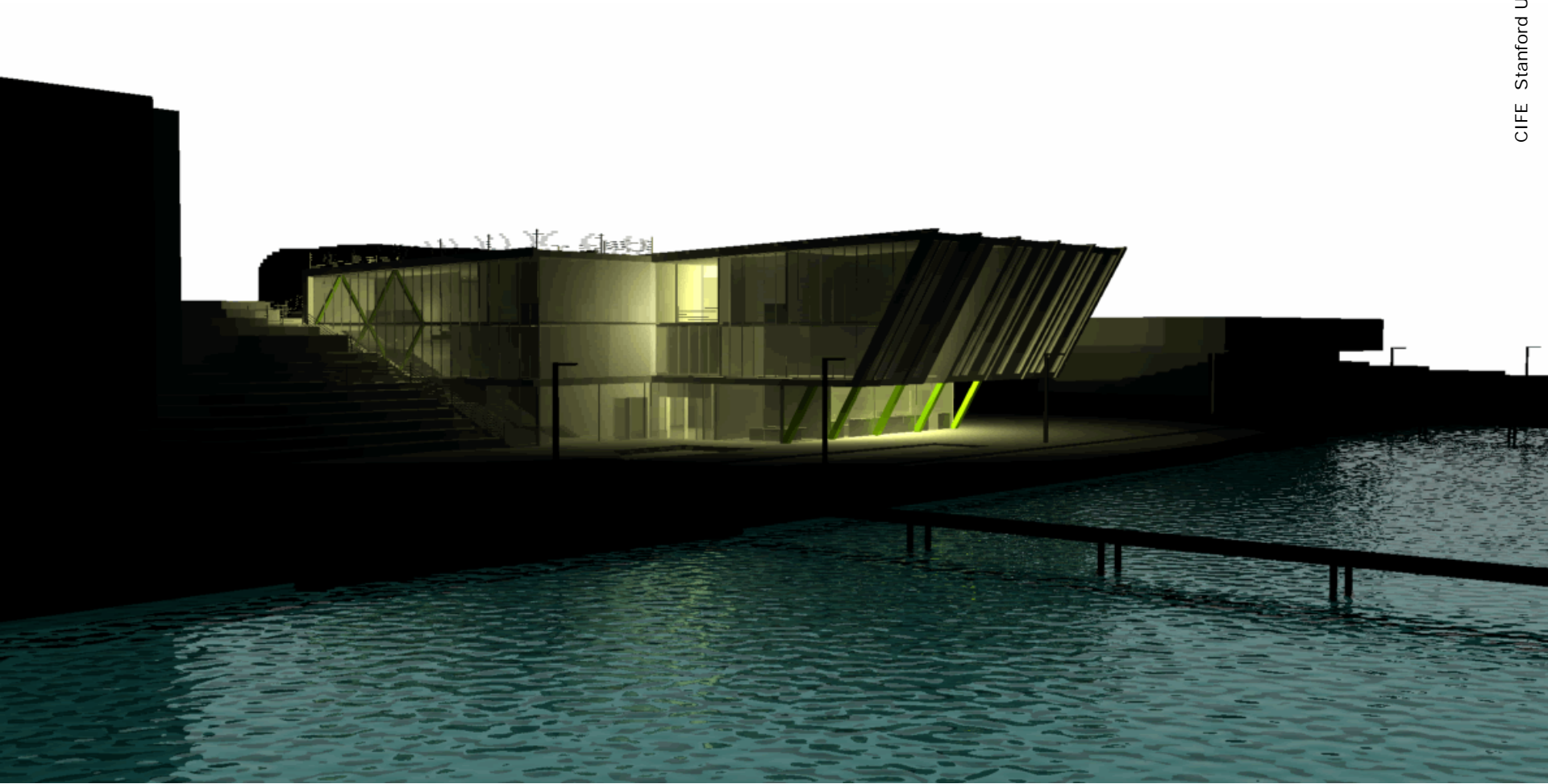


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# Night Renders: View from Lake Mendota - NE





**Atlantic Team 2009**

P5bILAB - Stanford University

School of Engineering: University of Wisconsin at Madison

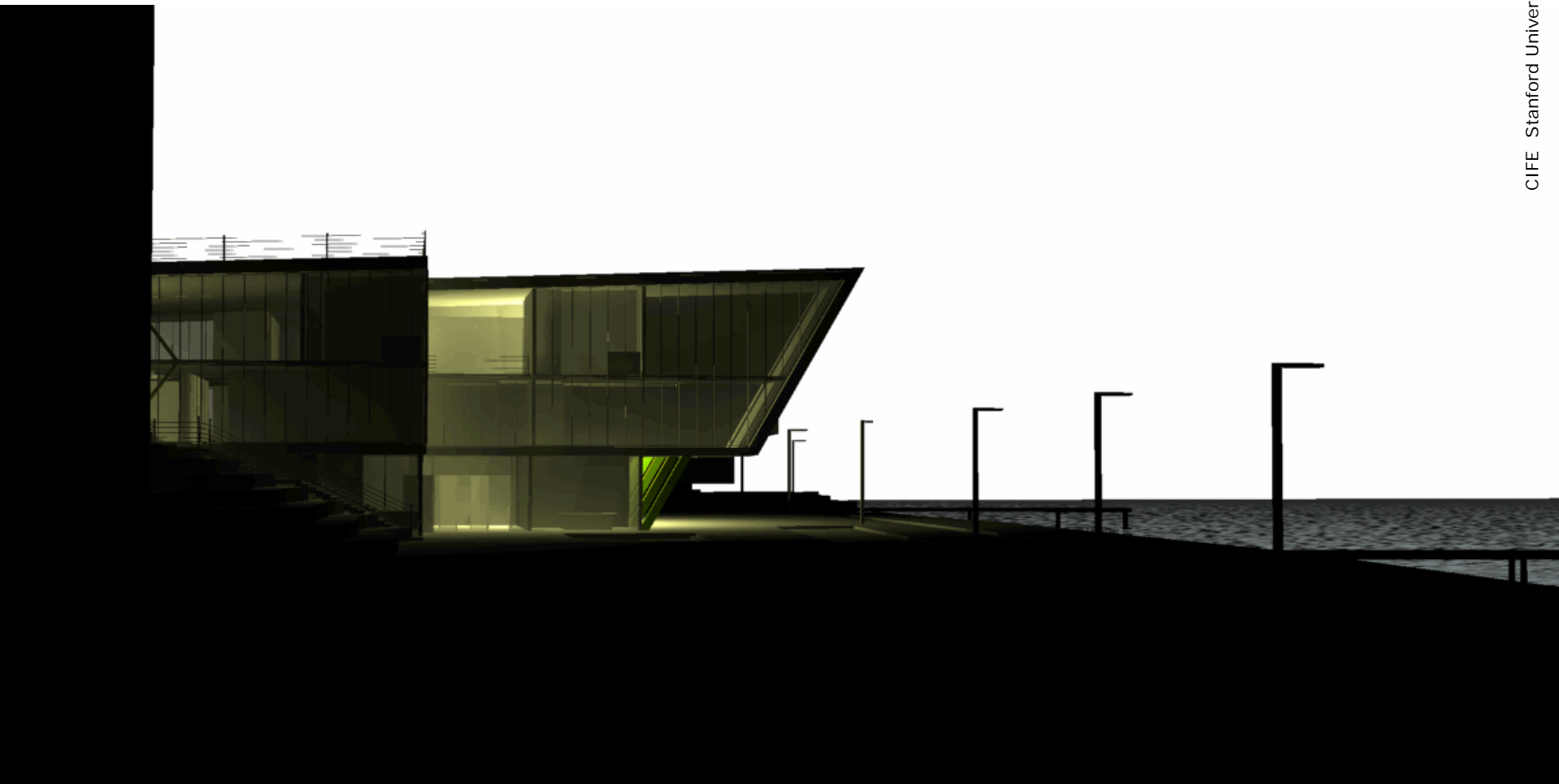


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# Night Renders: View from the Bike Path



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architecture

engineering

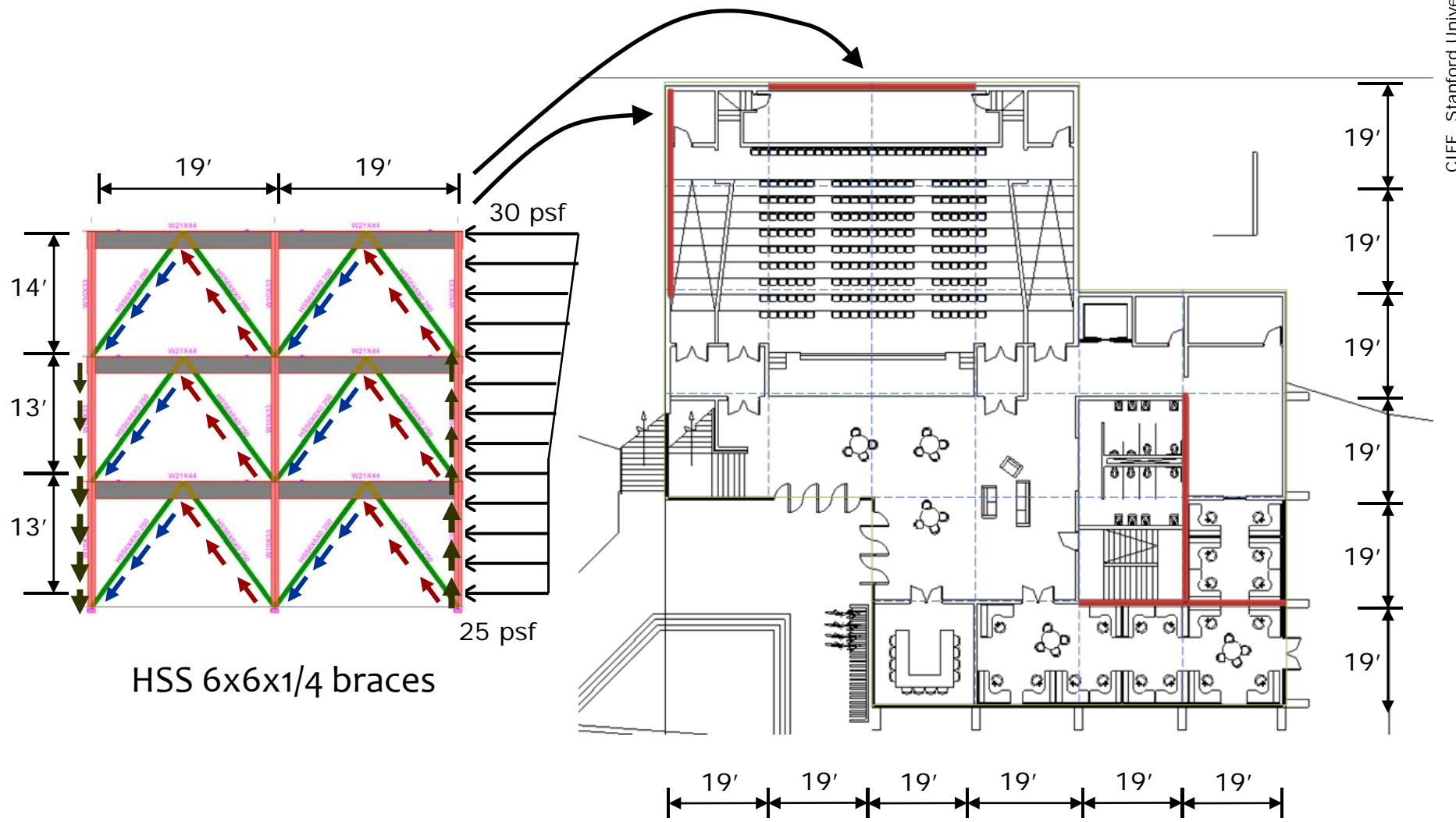
construction management

# Loads Considered

- Dead Loads
- Live Loads
  - 50 psf on cantilevered portions
  - 100 psf elsewhere
- Wind Load: 30 psf
- Snow Load: 18.5 psf
- Lightweight Green Roof: 17 psf

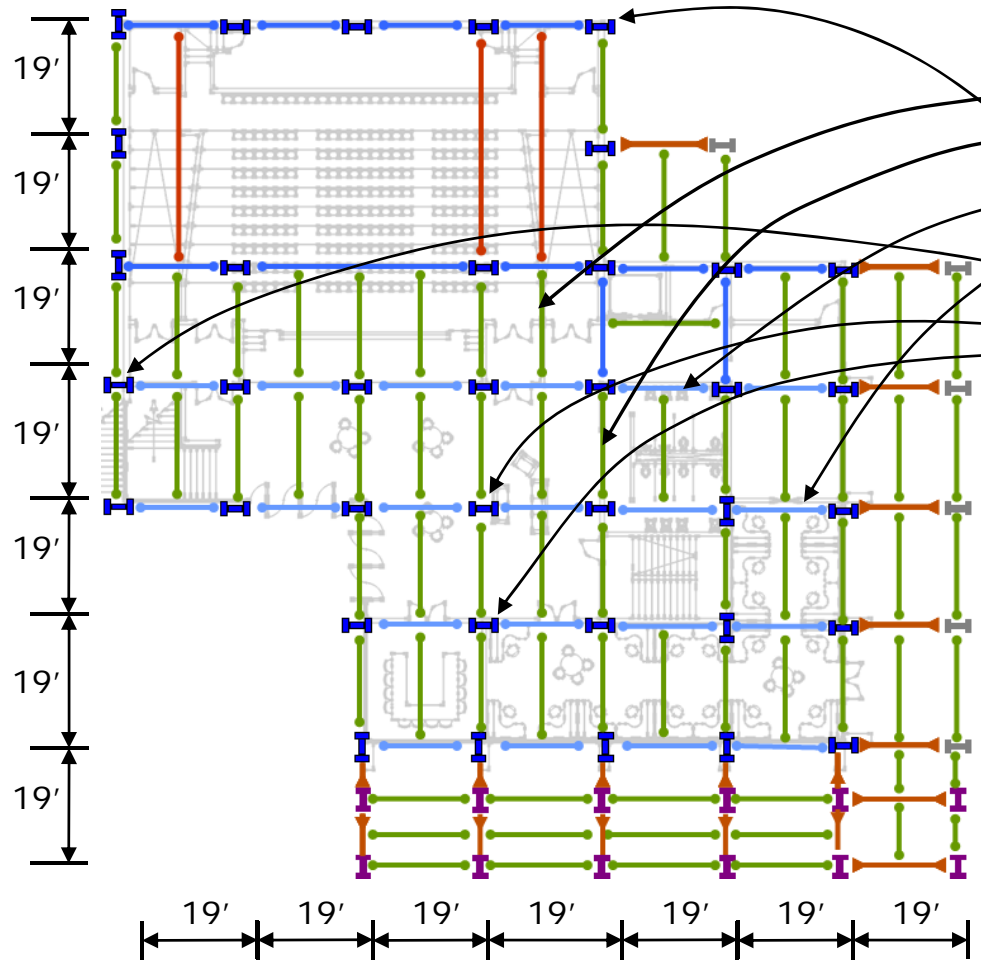


# Lateral System





# Gravity System

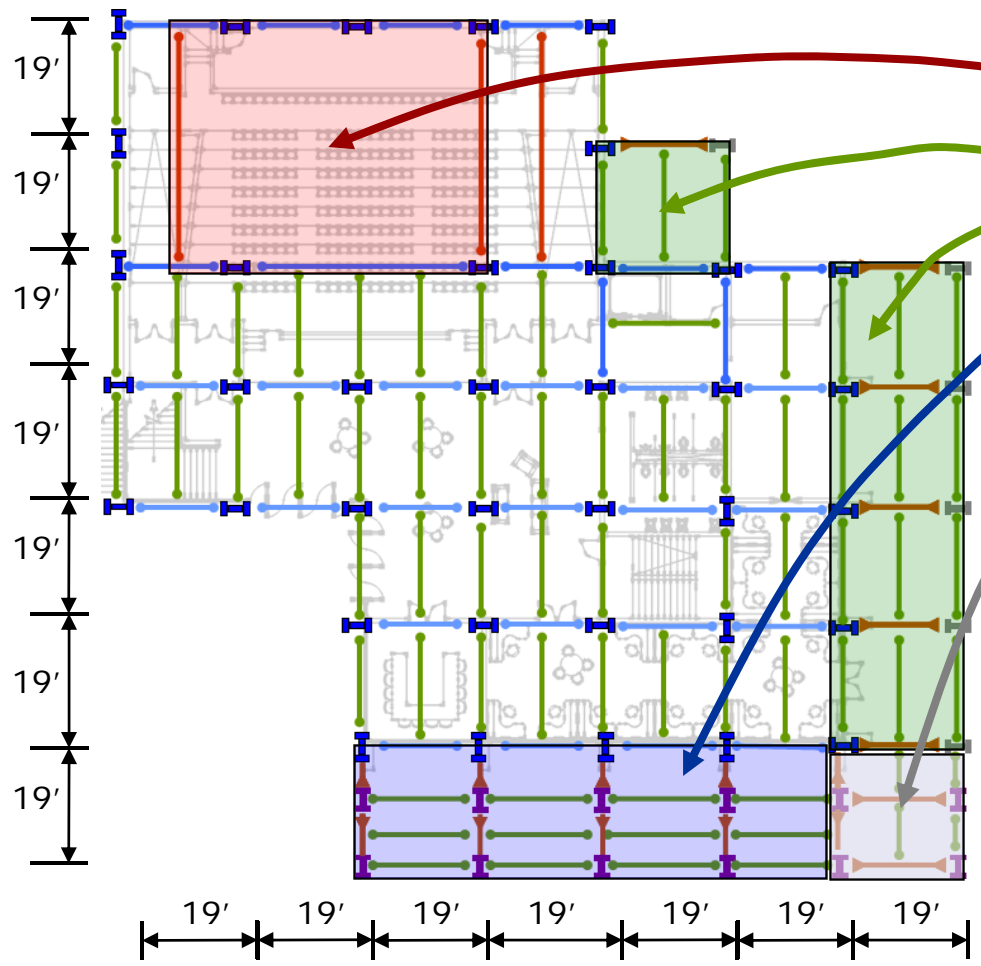


Regular 19'x19' grid

- W10x22 beams
- W12x30 girders
- W10x33 ext. columns
- W12x40 int. columns



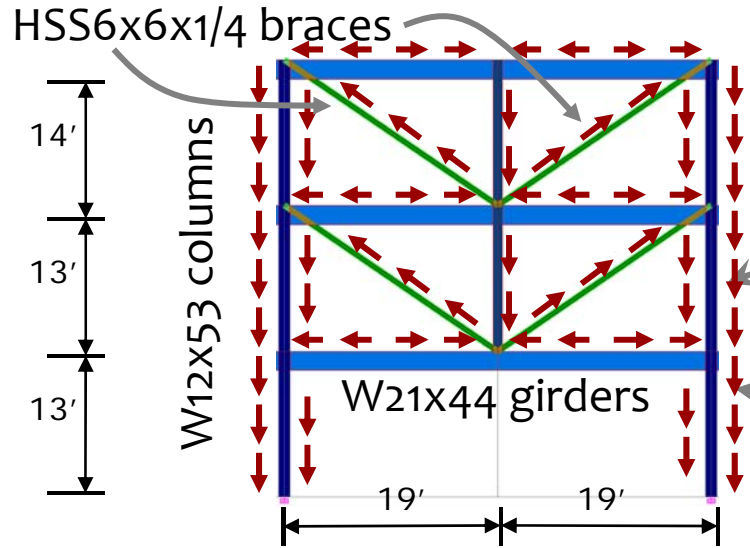
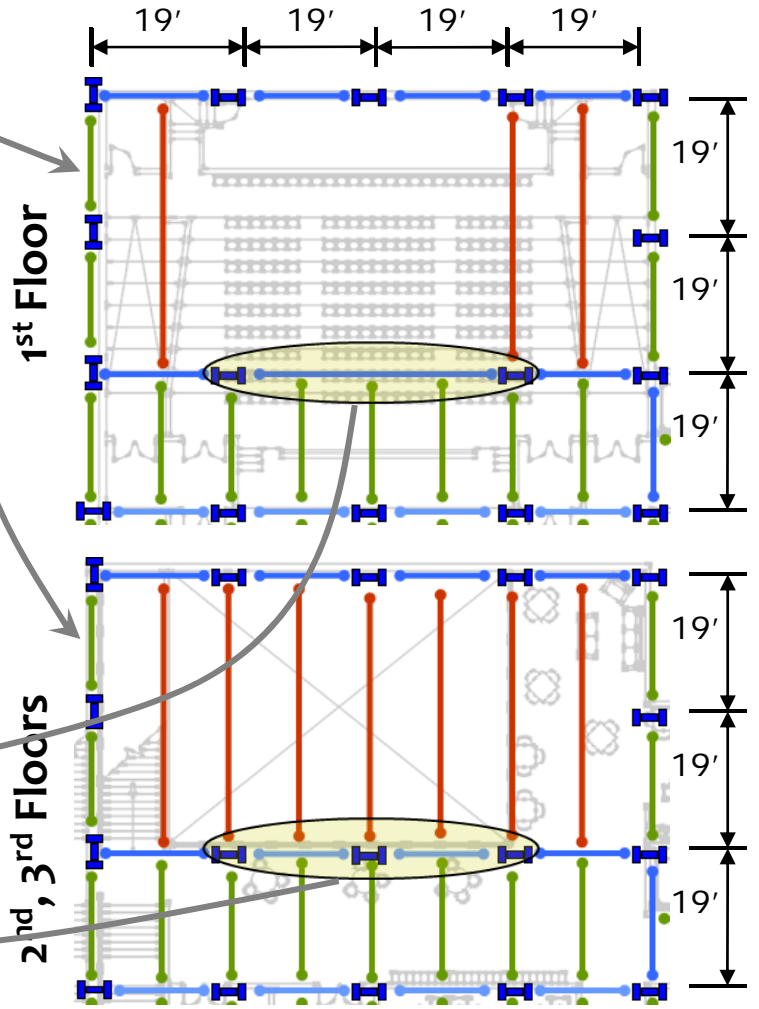
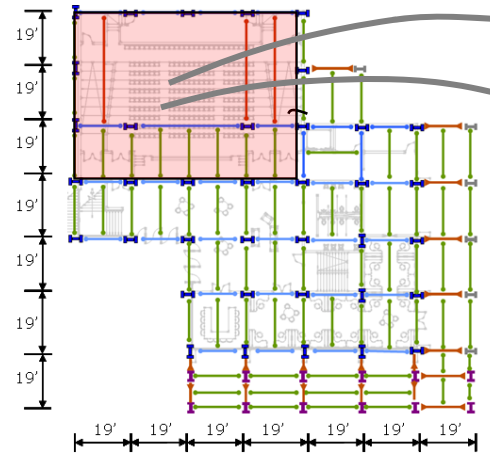
# Gravity System



- ### Challenges
- 38'x47.5' auditorium
  - 19' cantilevers on W
  - 37' cantilever on N
  - 19'x37' portion on NW

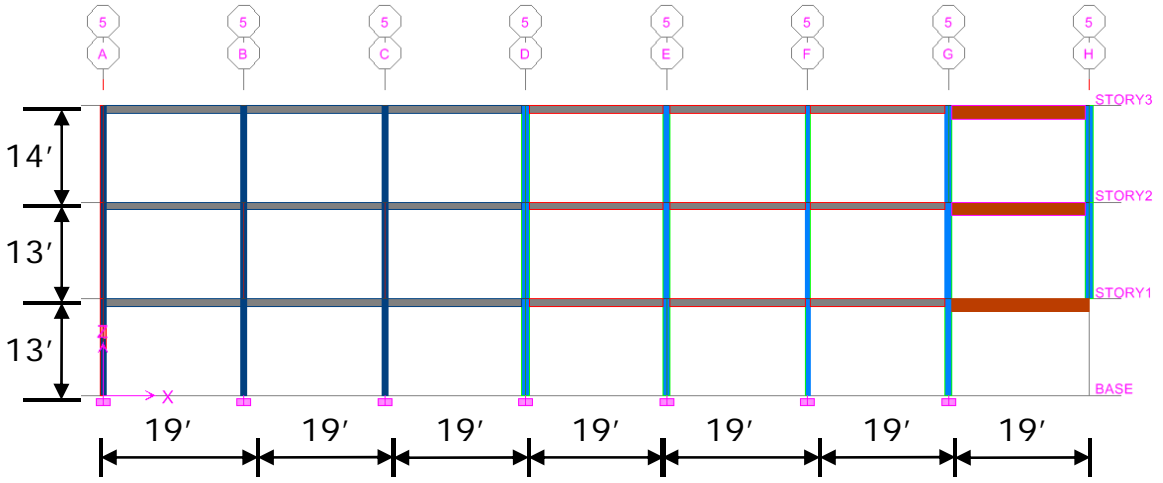
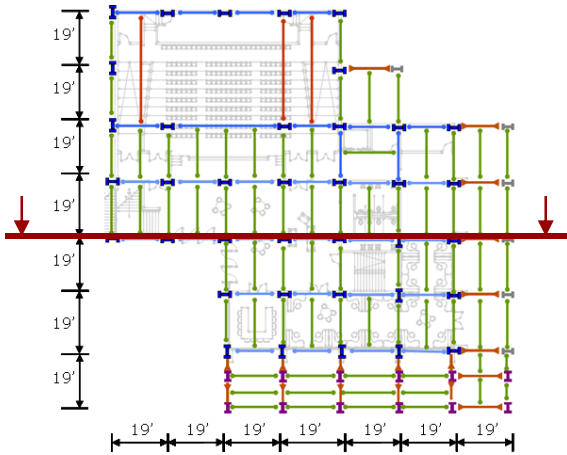


# Auditorium





# Overhang on West (19')

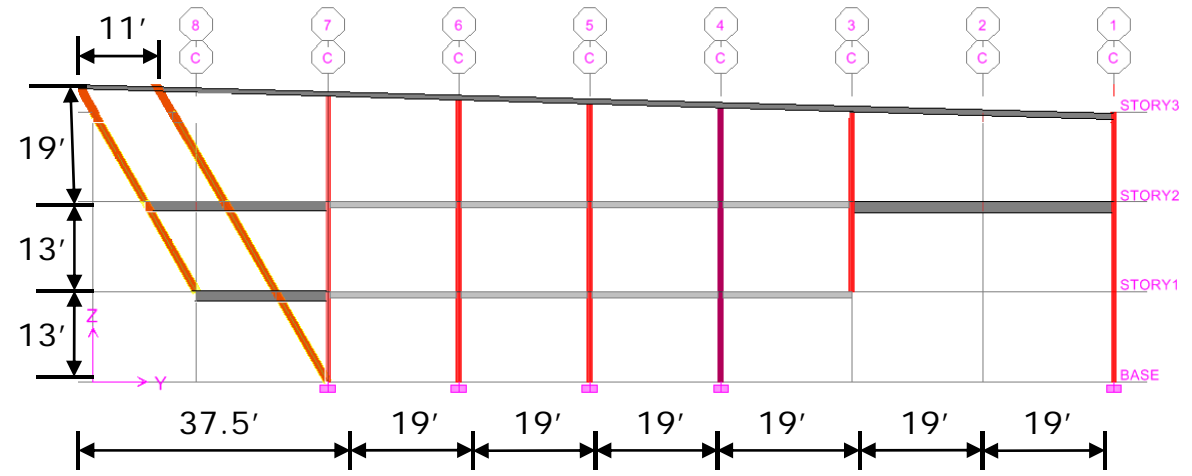
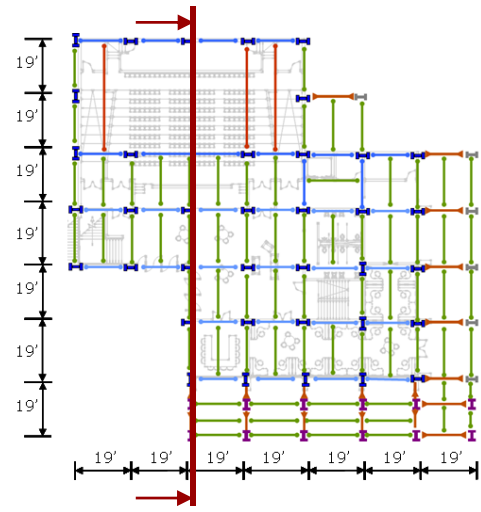


- Reduce live loads from 100 psf to 50 psf
- No green roof
- W21x73 cantilevered girders limit  $\Delta_{DL} + \Delta_{LL}$  to  $L/240$
- Girder axial forces transferred to lateral system



# Overhang on North (37.5')

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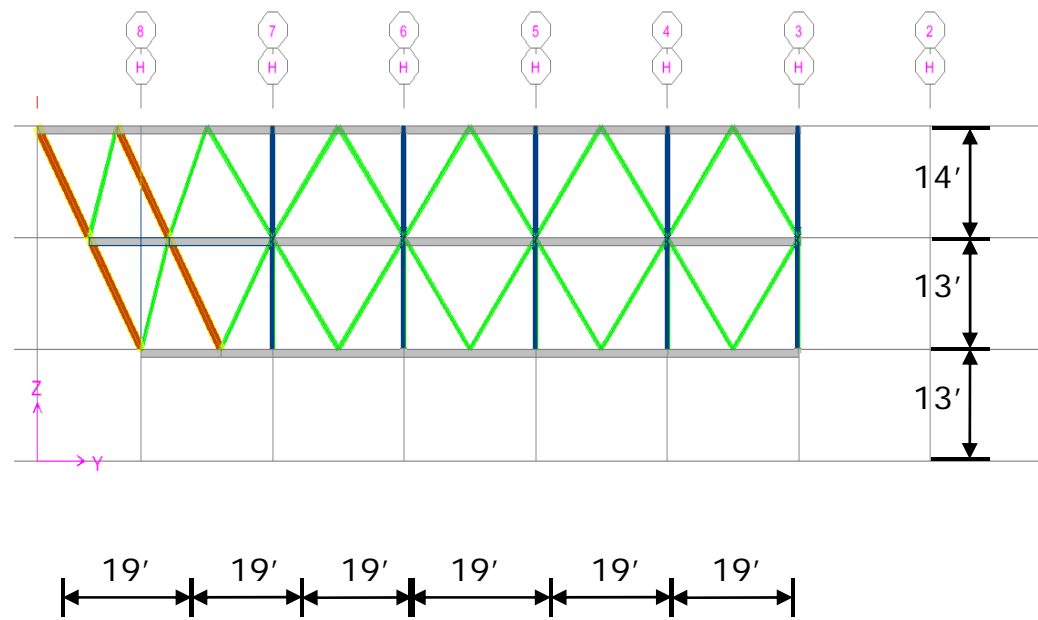
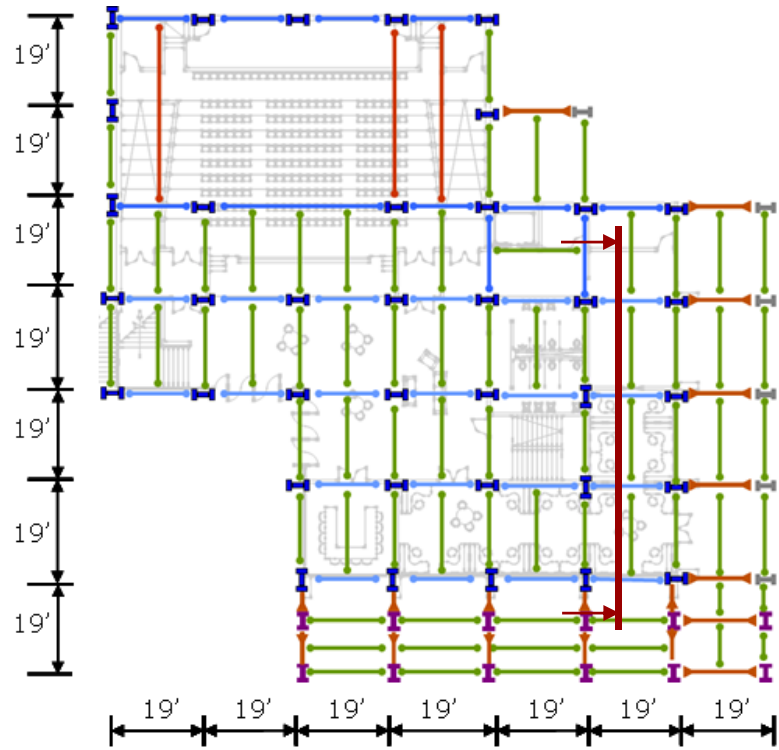


➤ Sloped columns reduce actual cantilevered length to 11'





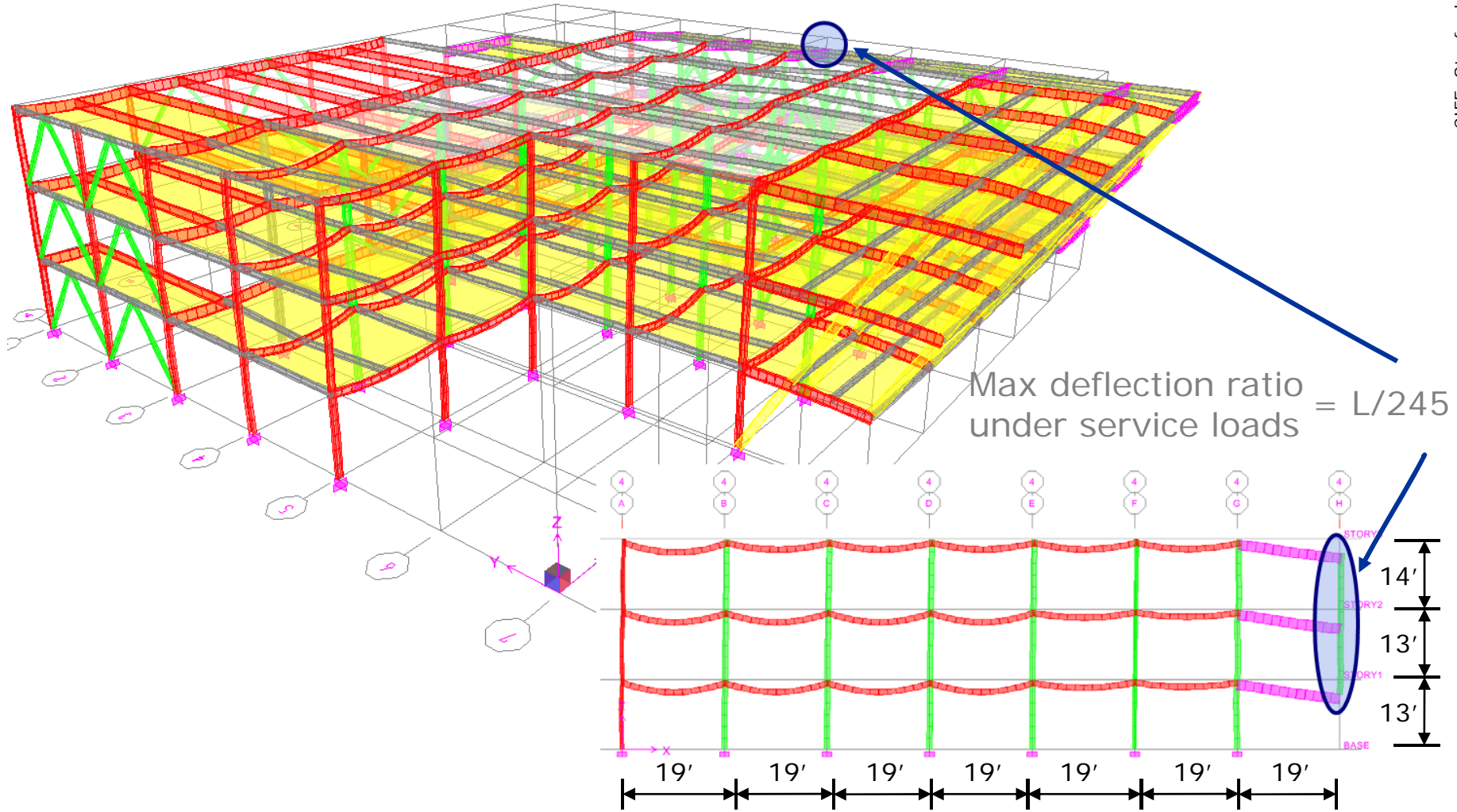
# 19' x 26' double overhang





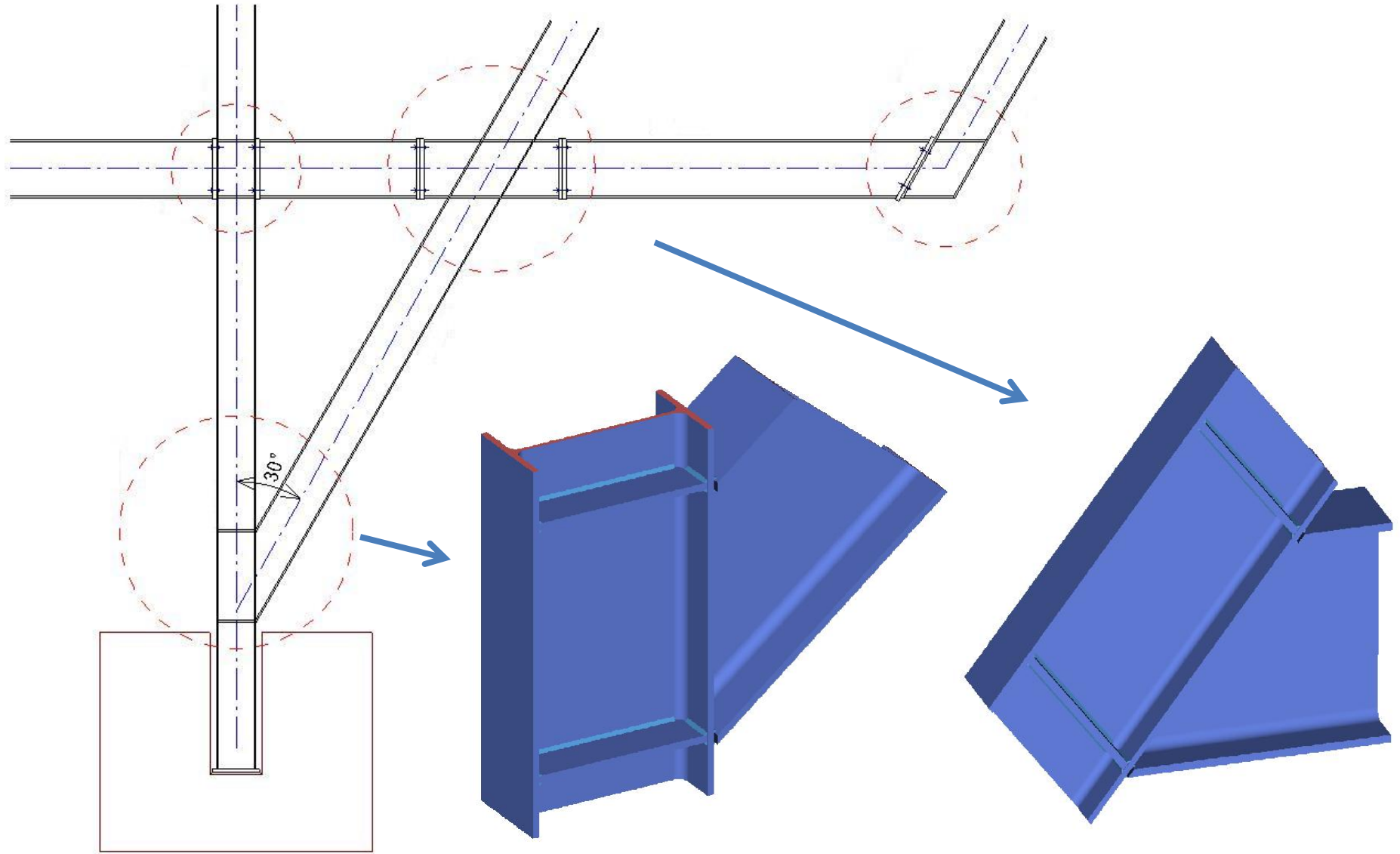
# Check for deflections

CIFE Stanford University



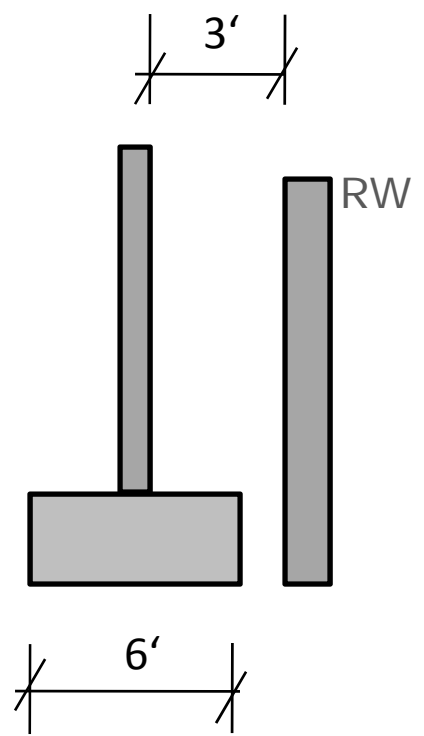
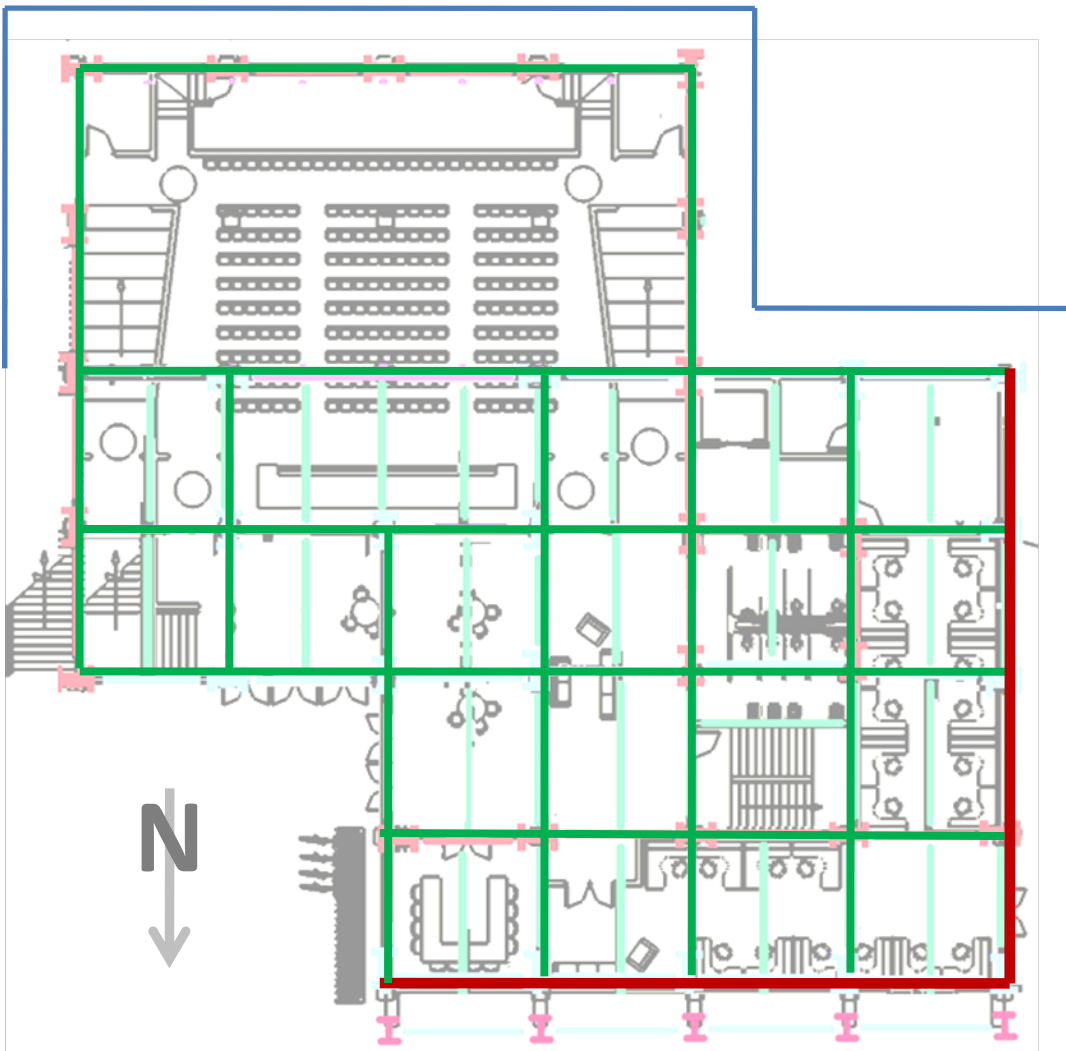


# Construction Details





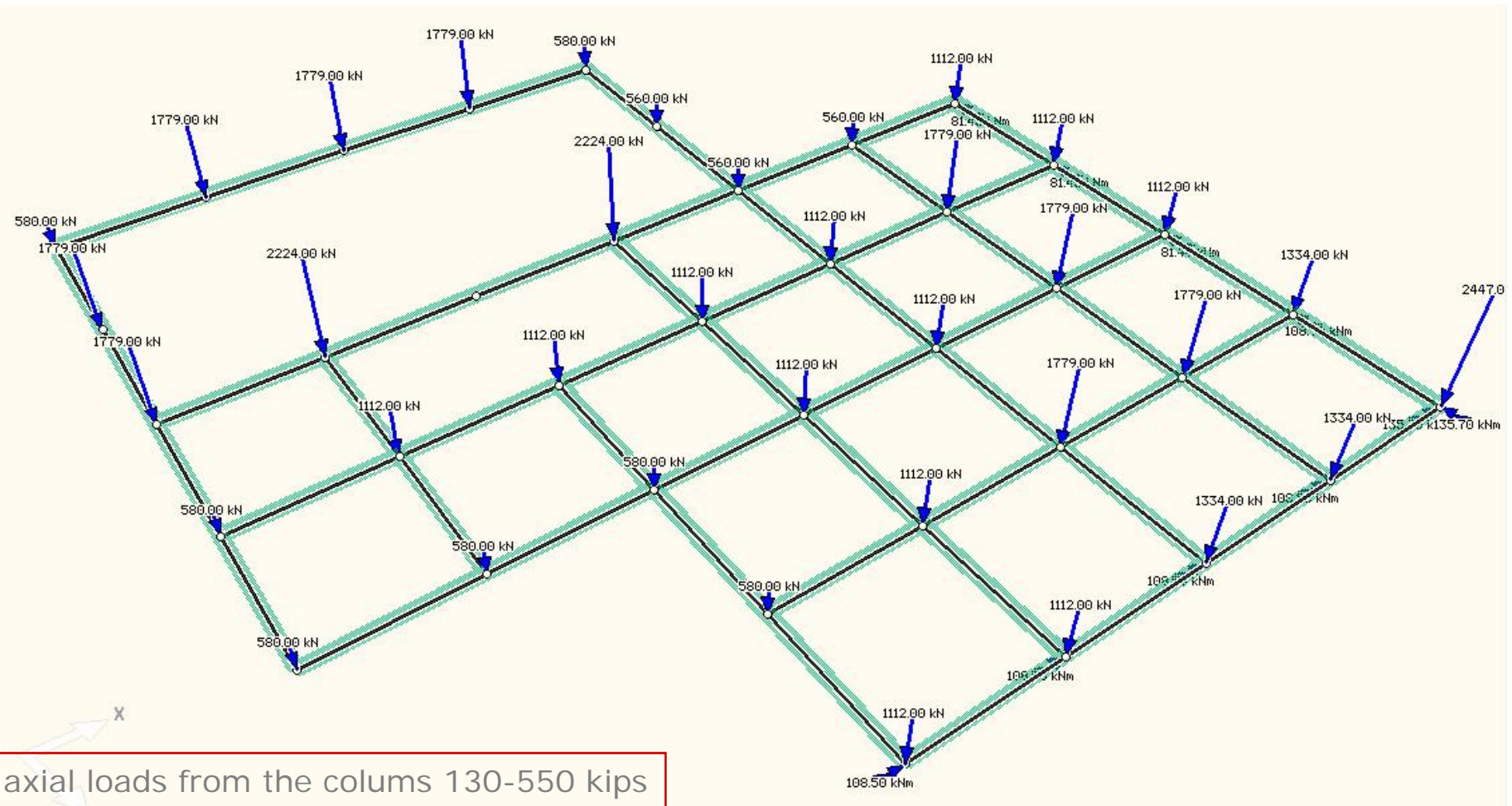
# Foundation: Grid System



- retaining Wall
- strip footing – 6x3ft.
- strip footing – 7x3ft.



# Foundation: Loads

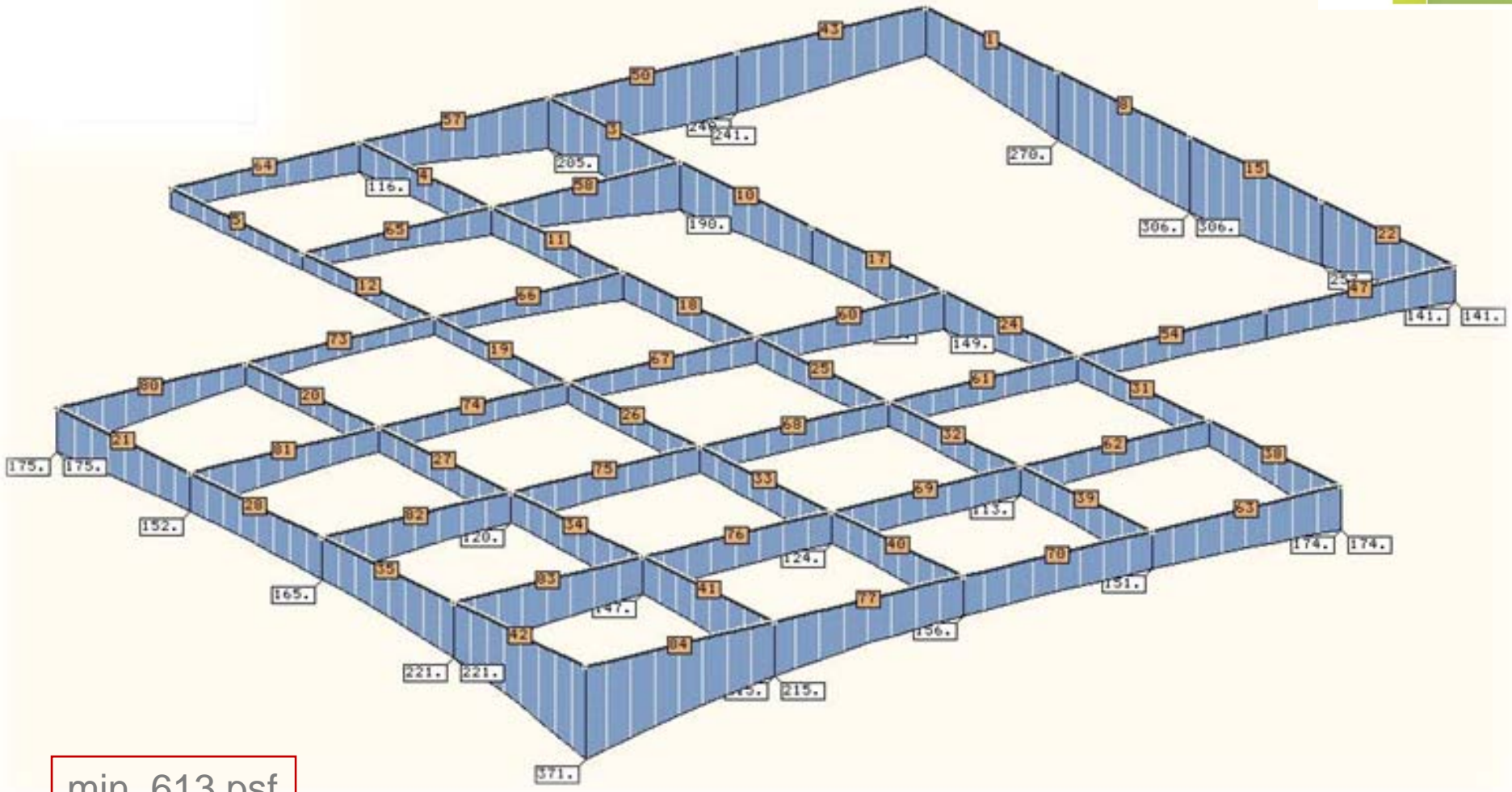


axial loads from the columns 130-550 kips

moments from sloped columns: 60-100 kip-ft



# Foundation: Soil Pressure

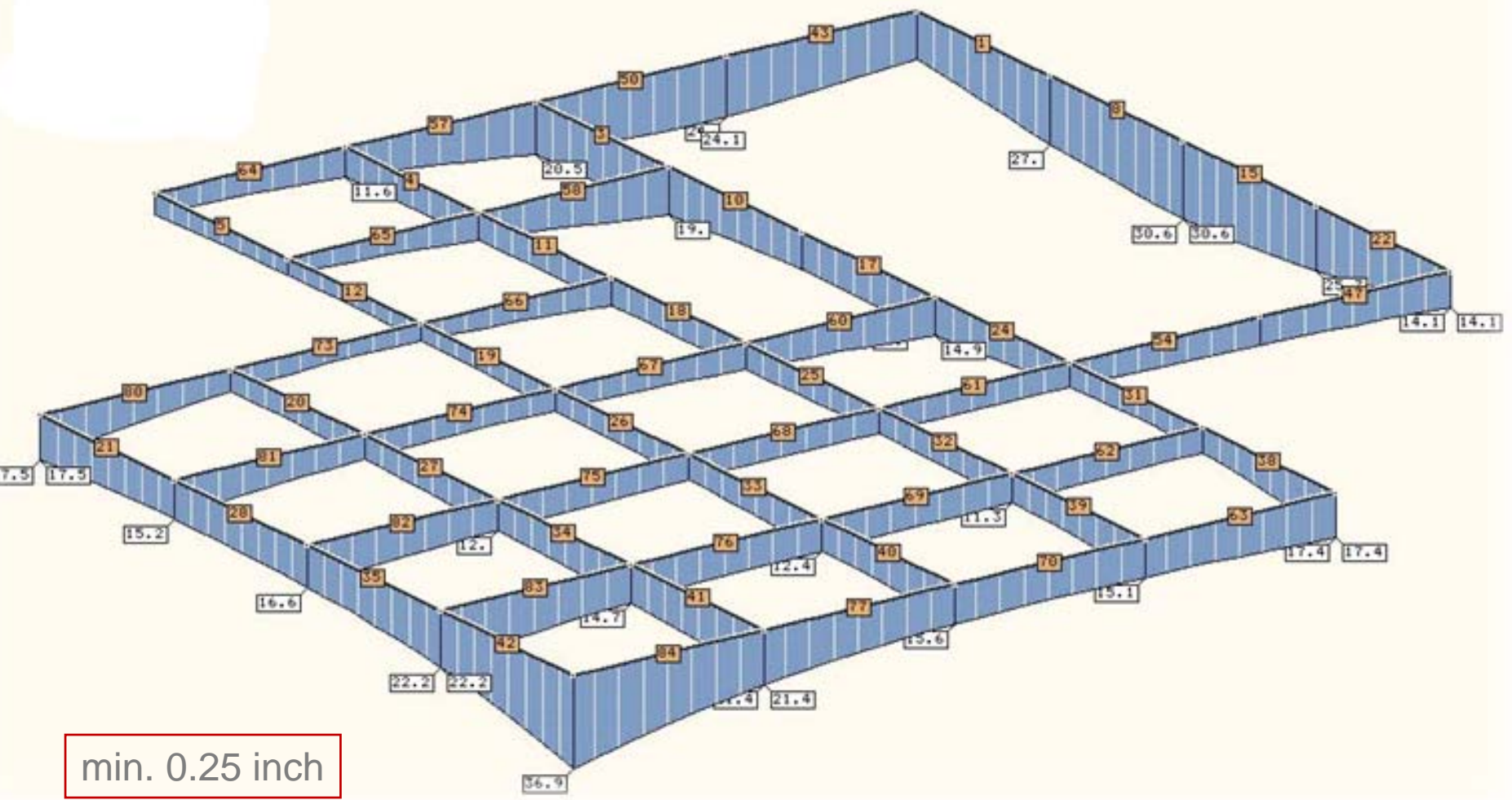


min. 613 psf

max. 3640 psf



# Foundation: Displacement

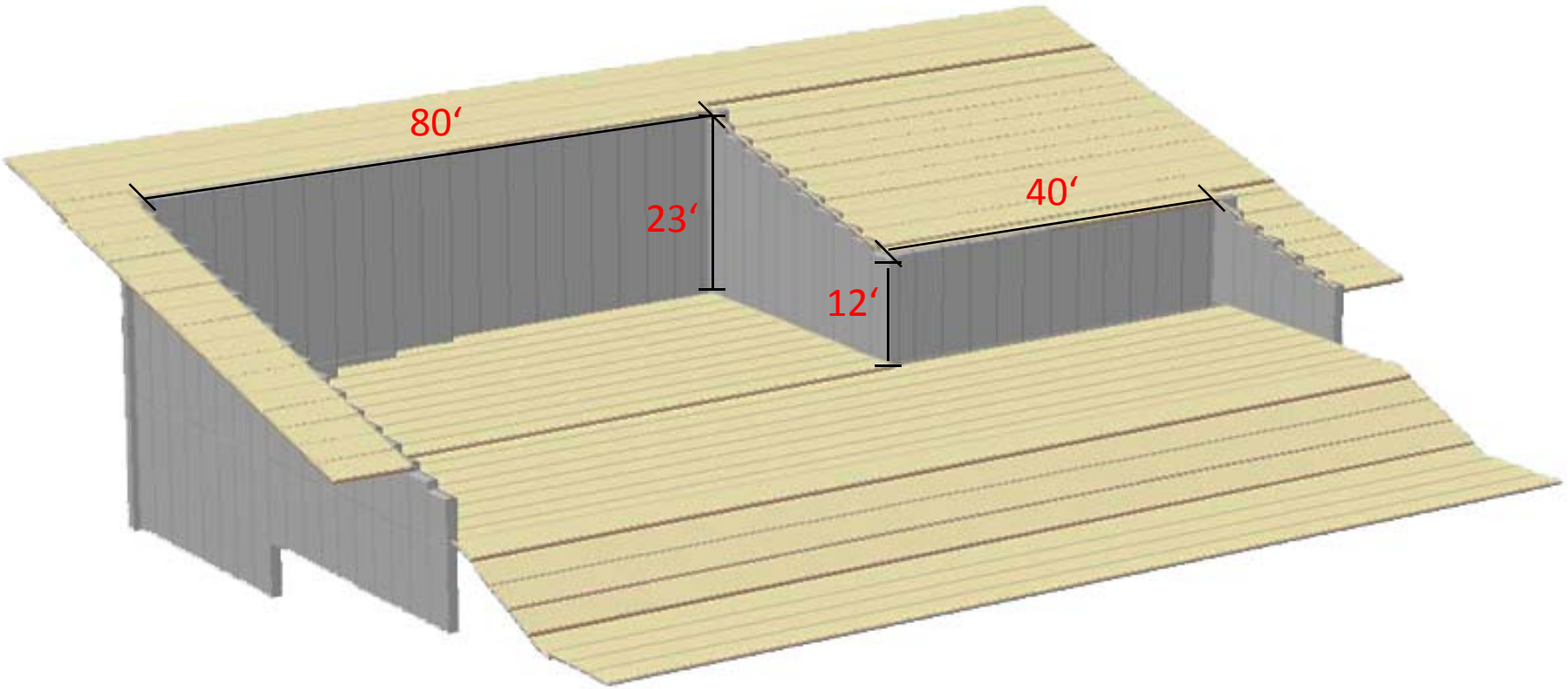


min. 0.25 inch

max. 1.45 inch



# Retaining Wall: Diaphragm Wall System





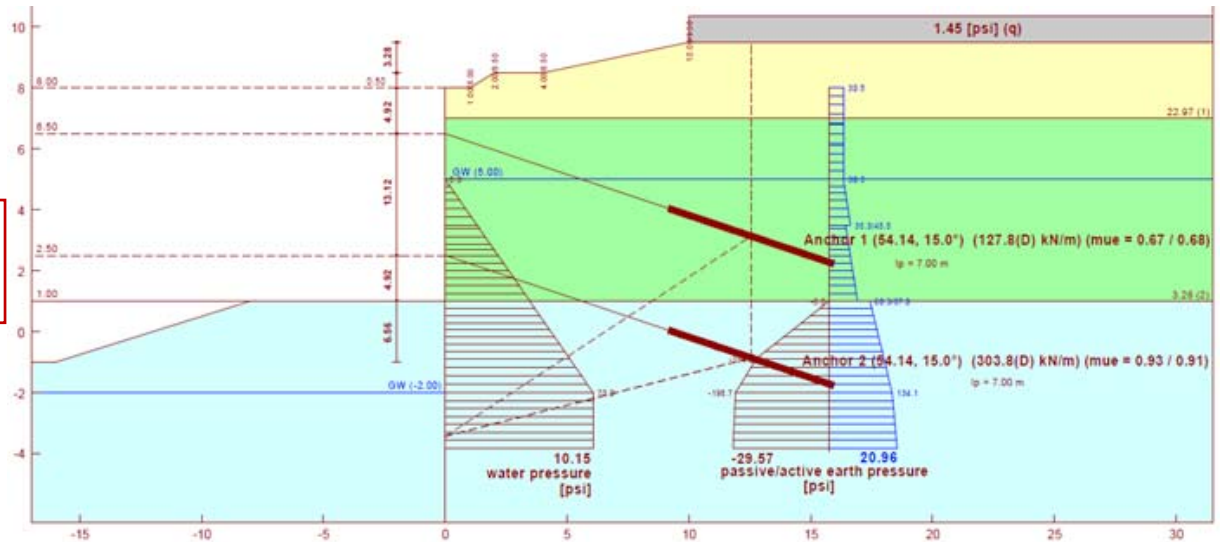


# Retaining Wall: Pressure

Water pressure:  
1462 psf

Passive earth pressure:  
4258 psf

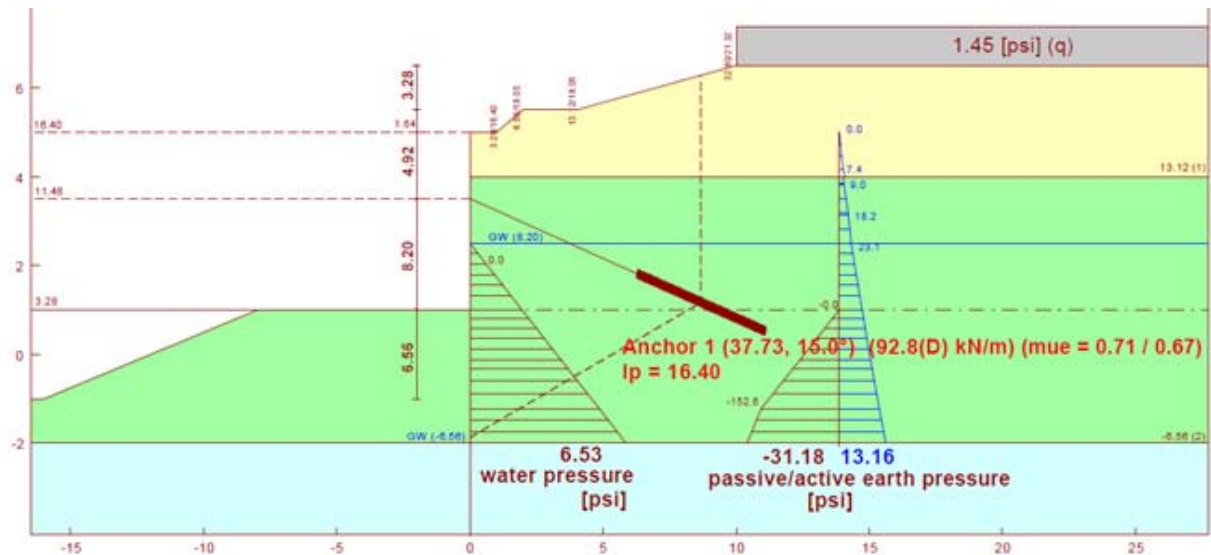
Active earth pressure:  
3018 psf



Water pressure:  
940 psf

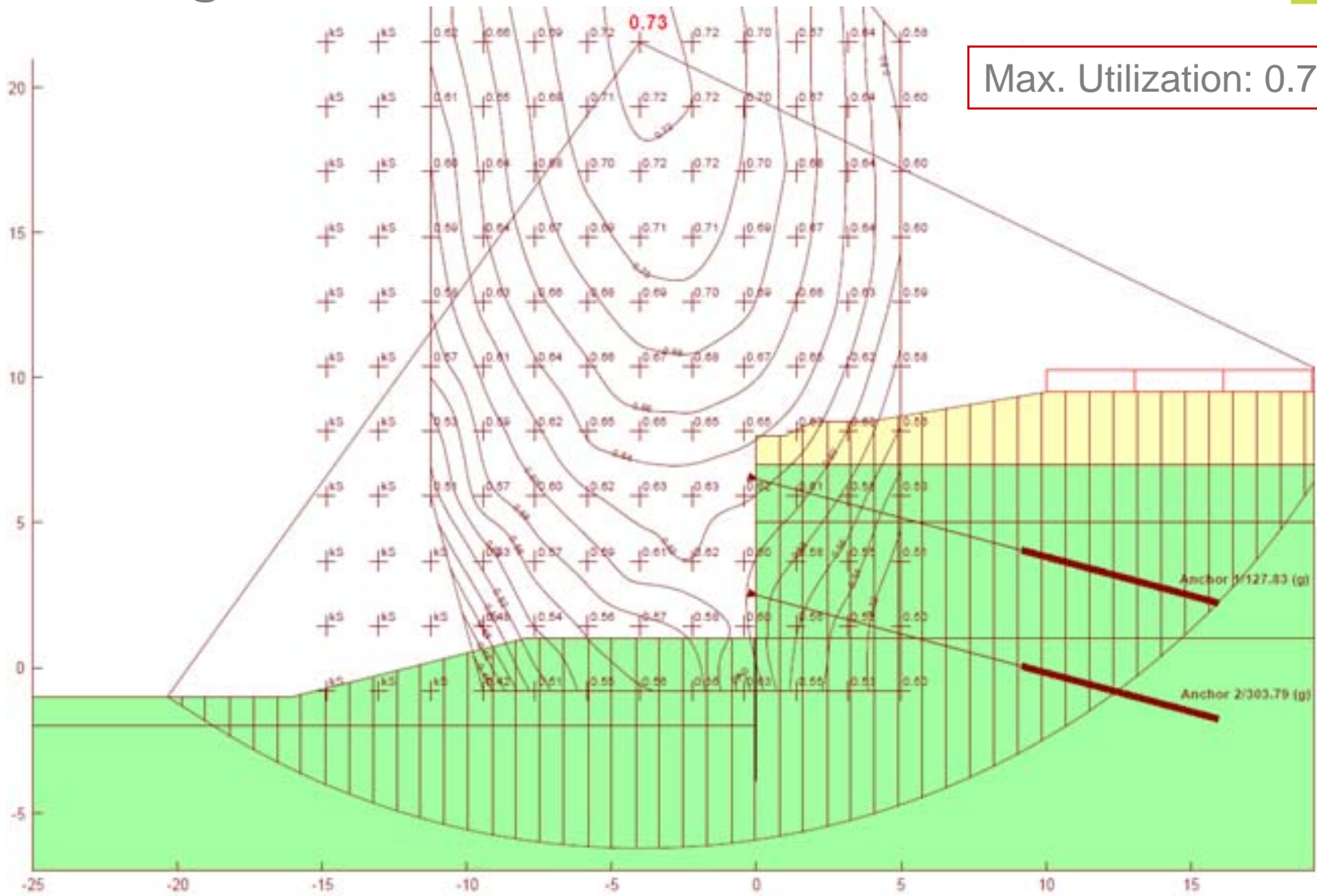
Passive earth pressure:  
4490 psf

Active earth pressure:  
1895 psf





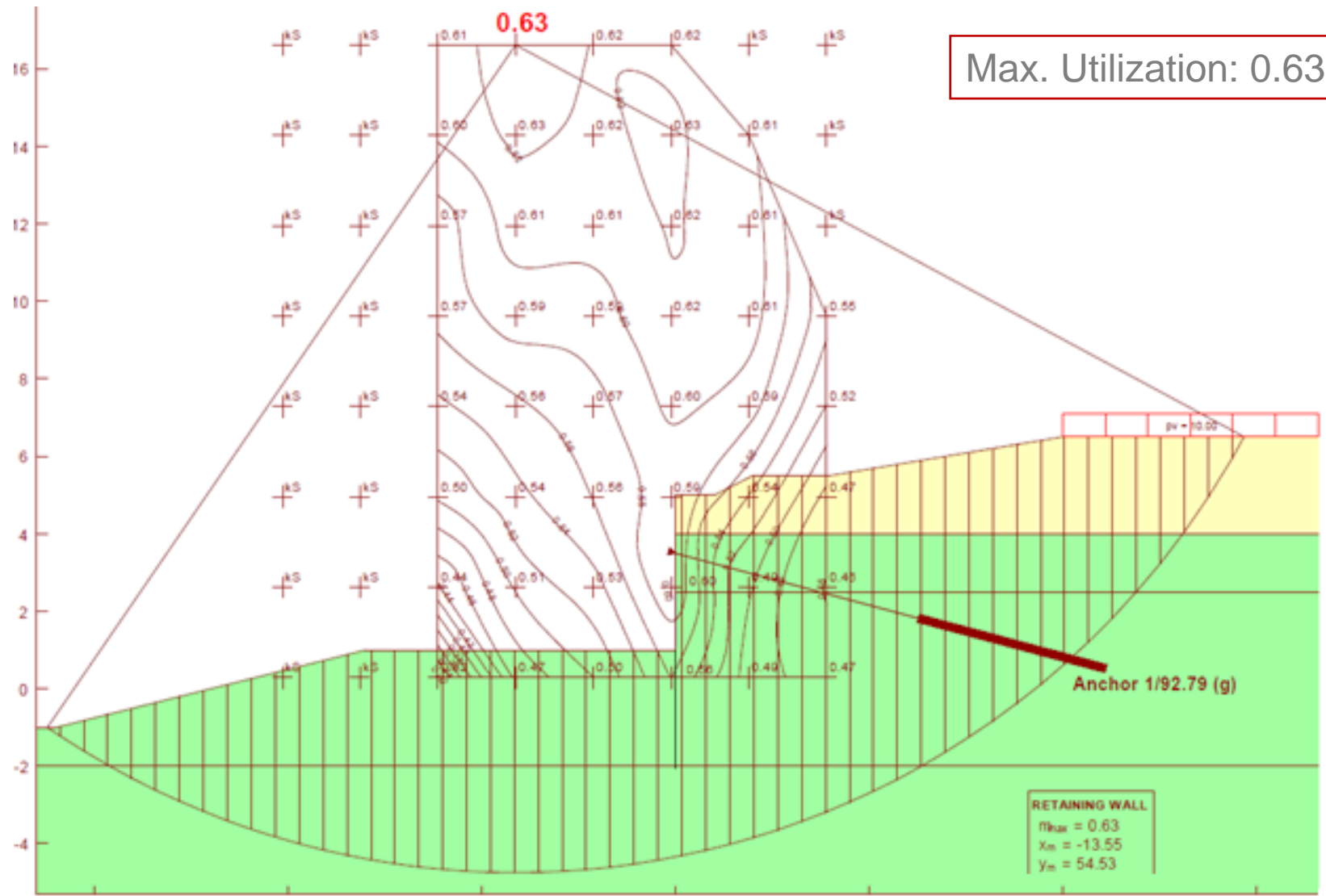
# Retaining Wall: Method Of Slices



Max. Utilization: 0.73

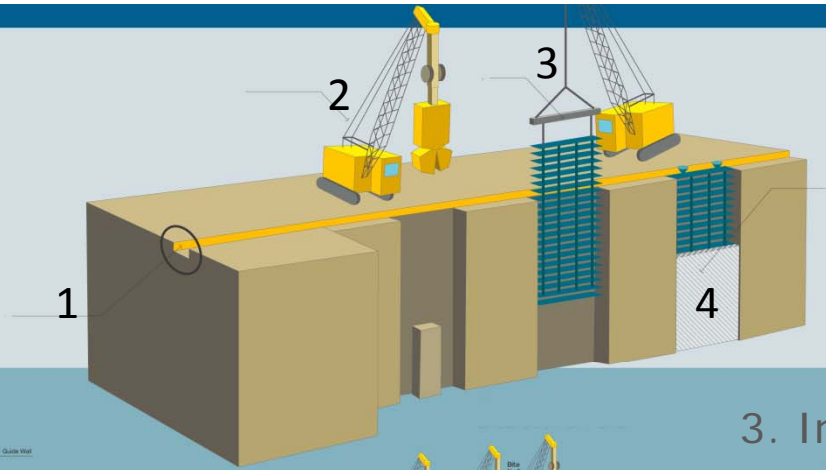


# Retaining Wall: Method Of Slices

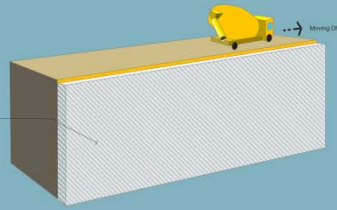
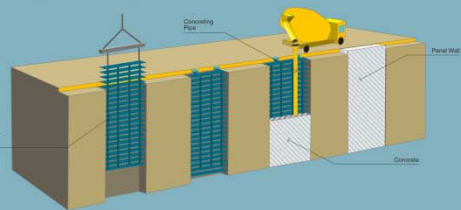
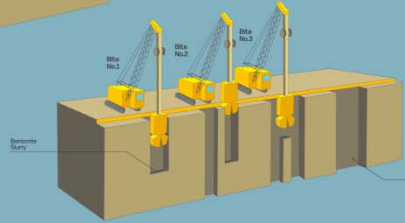
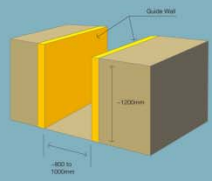




# Retaining Wall: Construction



## 3. Installation of Rebar Cage



1. Construction of Guide Wall

2. Excavation of Panel

4. Concreting of Panel

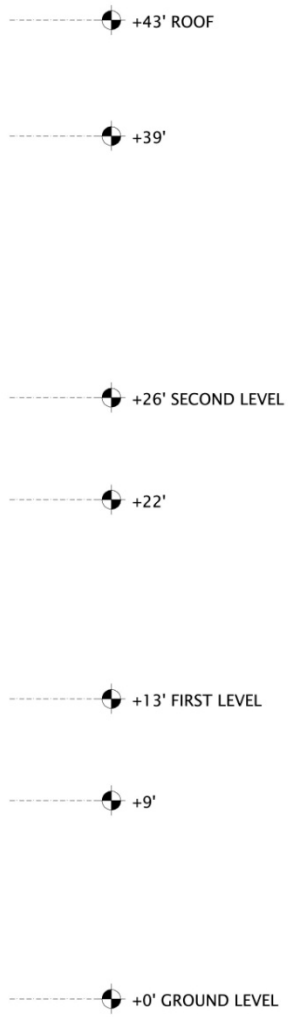
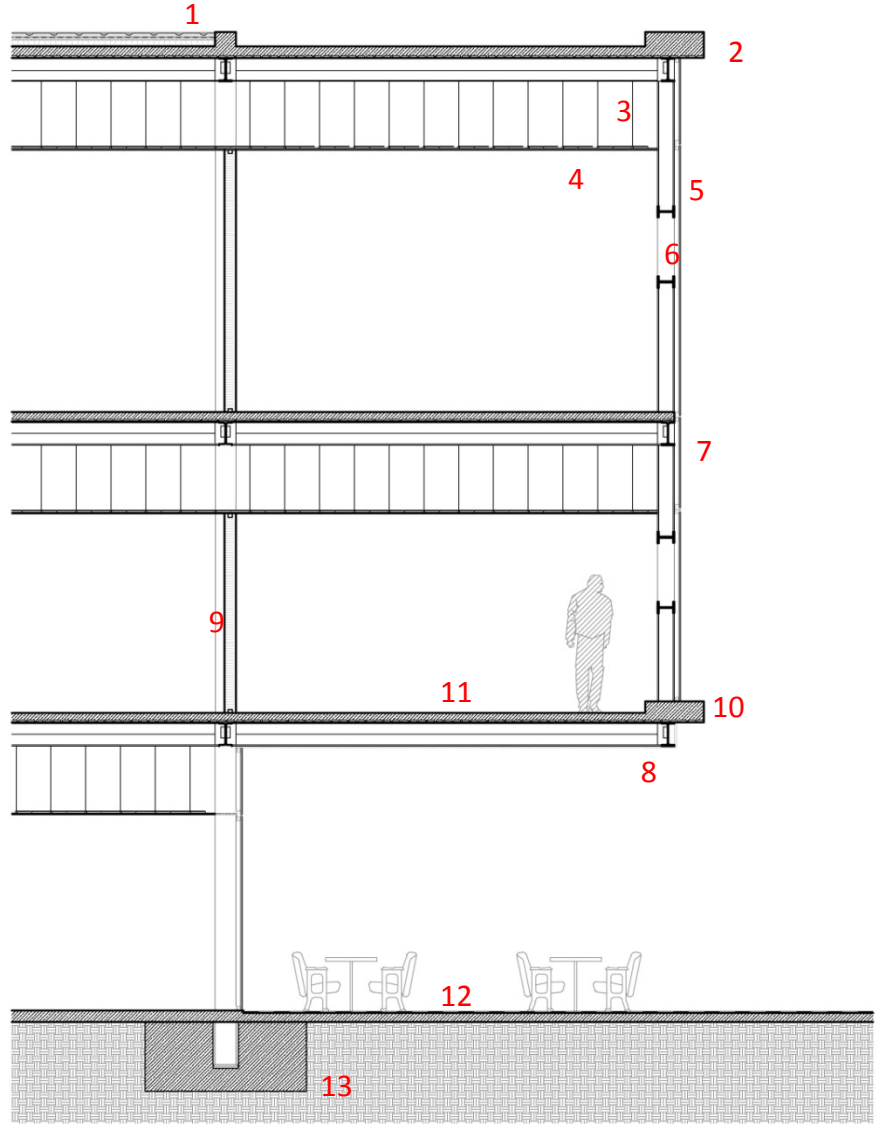
5. Repetition of Process



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WALL SECTION WEST  
Scale 1/8"=1'  
0' 6' 12'

# West Wall Section

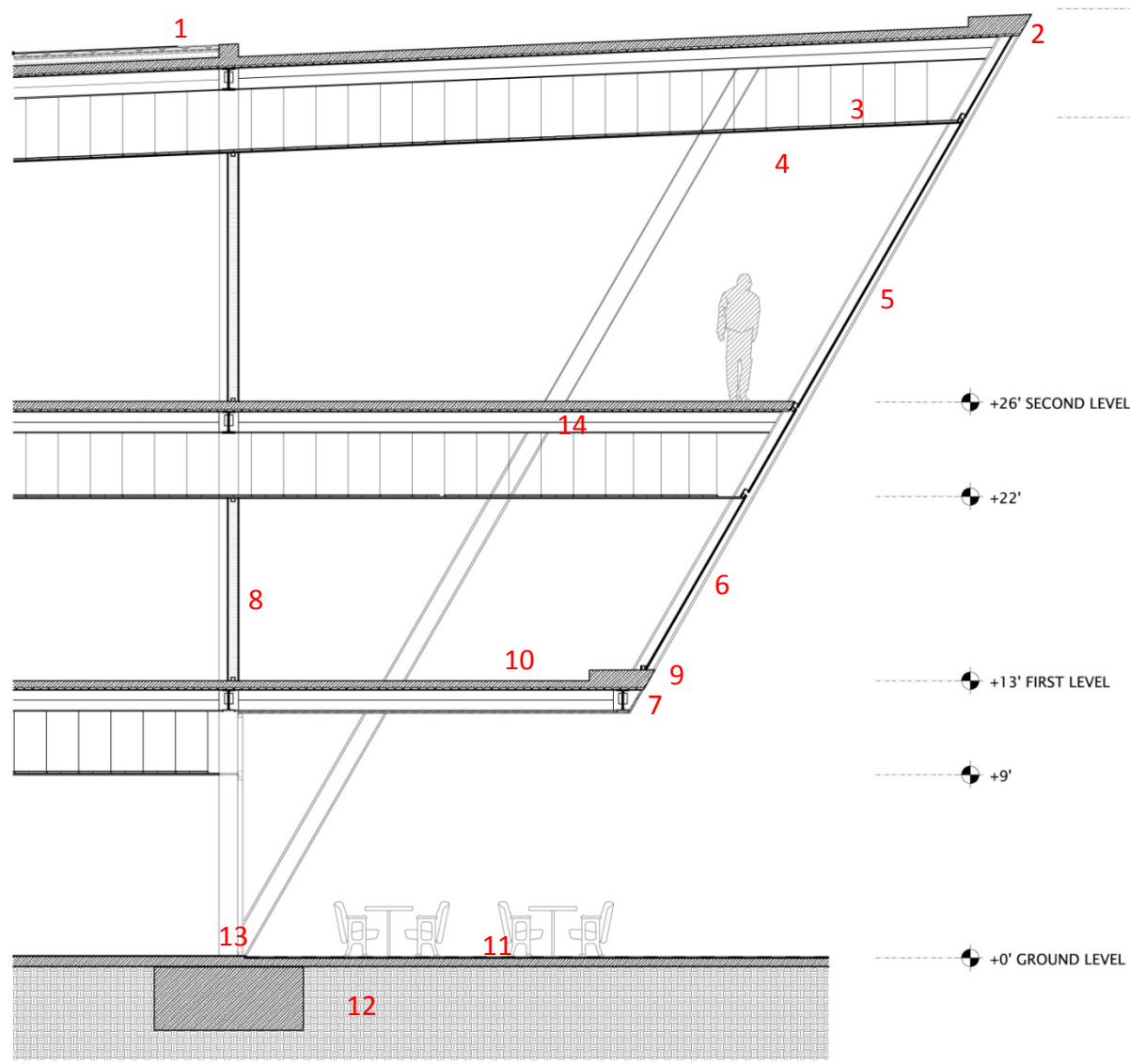
- I. ROOF:**
  - 1. Live Roof (R) Lite Green Roof System
  - 2. 1 1/2" cellular steel deck + 4 1/2" concrete slab
  - 3. 4' space for mechanical systems
  - 4. 3/4" thick gypsum ceiling
- II CURTAIN WALL SYSTEM**
  - 5. double glazed insulated wall
  - 6. structural braces
  - 7. glazed vision panel sealed unit
  - 8. galvanized steel covering
- III. STANDARD WALL SYSTEMS**
  - 9. 5" gypsum wall
- IV. FLOOR SYSTEM**
  - 10. 1 1/2" cellular steel deck + 3 1/4" thick concrete slab
  - 11. polished concrete floor
  - 12. insulating and draining paver of porous concrete with waterproof membrane
- V. FOUNDATION**
  - 13. Strip Foundation



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# North Wall Section

## I. ROOF:

- 1. Live Roof (R) Lite Green Roof System
- 2. 1 1/2" cellular steel deck + 4 1/2" concrete slab
- 3. 4' space for mechanical systems
- 4. 3/4" thick gypsum ceiling

## II CURTAIN WALL SYSTEM

- 5. double glazed insulated wall
- 6. glazed vision panel sealed unit
- 7. galvanized steel covering

## III. STANDARD WALL SYSTEMS

- 8. 5" gypsum wall

## IV. FLOOR SYSTEM

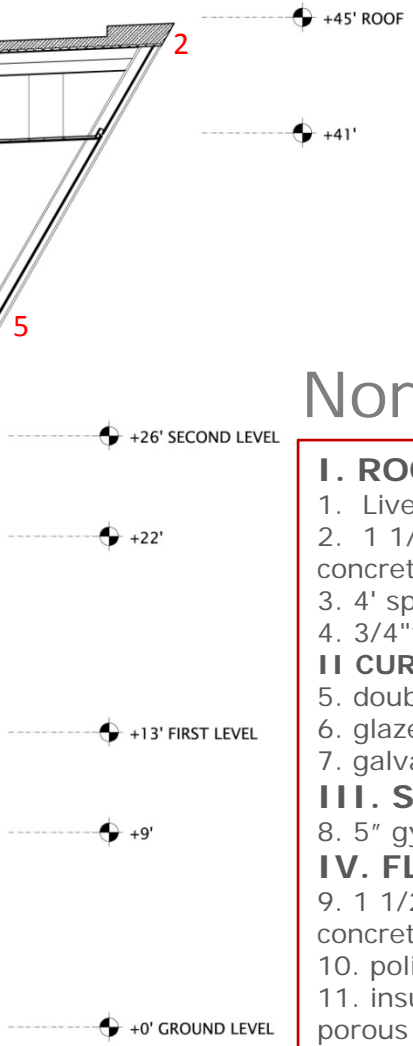
- 9. 1 1/2" cellular steel deck + 3 1/4" thick concrete slab
- 10. polished concrete floor
- 11. insulating and draining paver of porous concrete with waterproof membrane

## V. FOUNDATION

- 12. Strip Foundation

## VI. STRUCTURE

- 13. Welded Moment Connection
- 13. Frame Shear Connection



WALL SECTION NORTH  
Scale 1/4"=1'  
0' 6' 12'



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# Energy, Heating and Cooling

➤ UW-Madison Central Heating and Cooling System

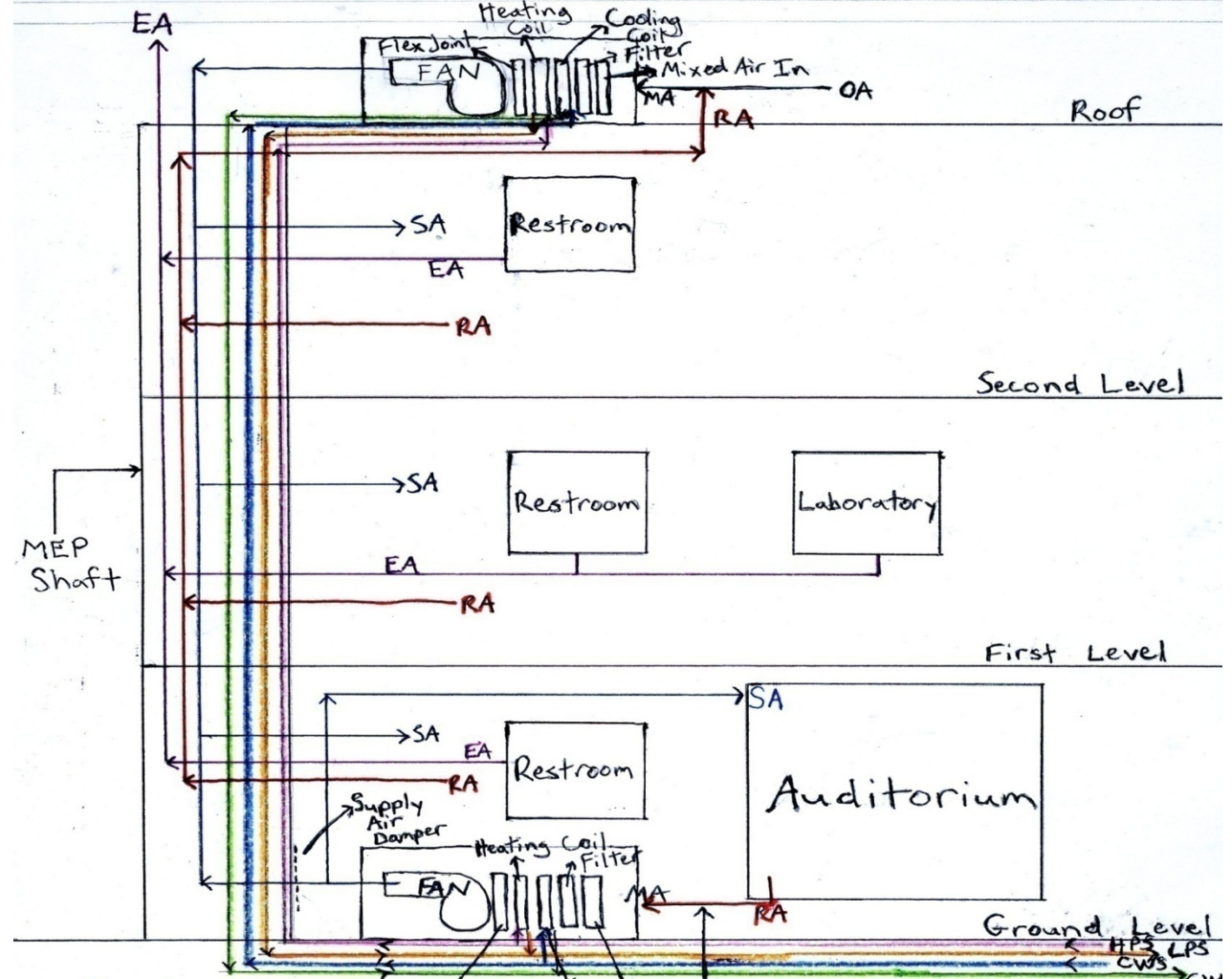
➤ Charter Street Heating Plant

➤ West Campus Cogeneration Facility





# MEP SCHEMATIC DIAGRAM







- Supply Air
- Return Air
- Exhaust Air
- High Pressure Steam
- Low Pressure Steam
- Cold Water Supply
- Cold Water Return

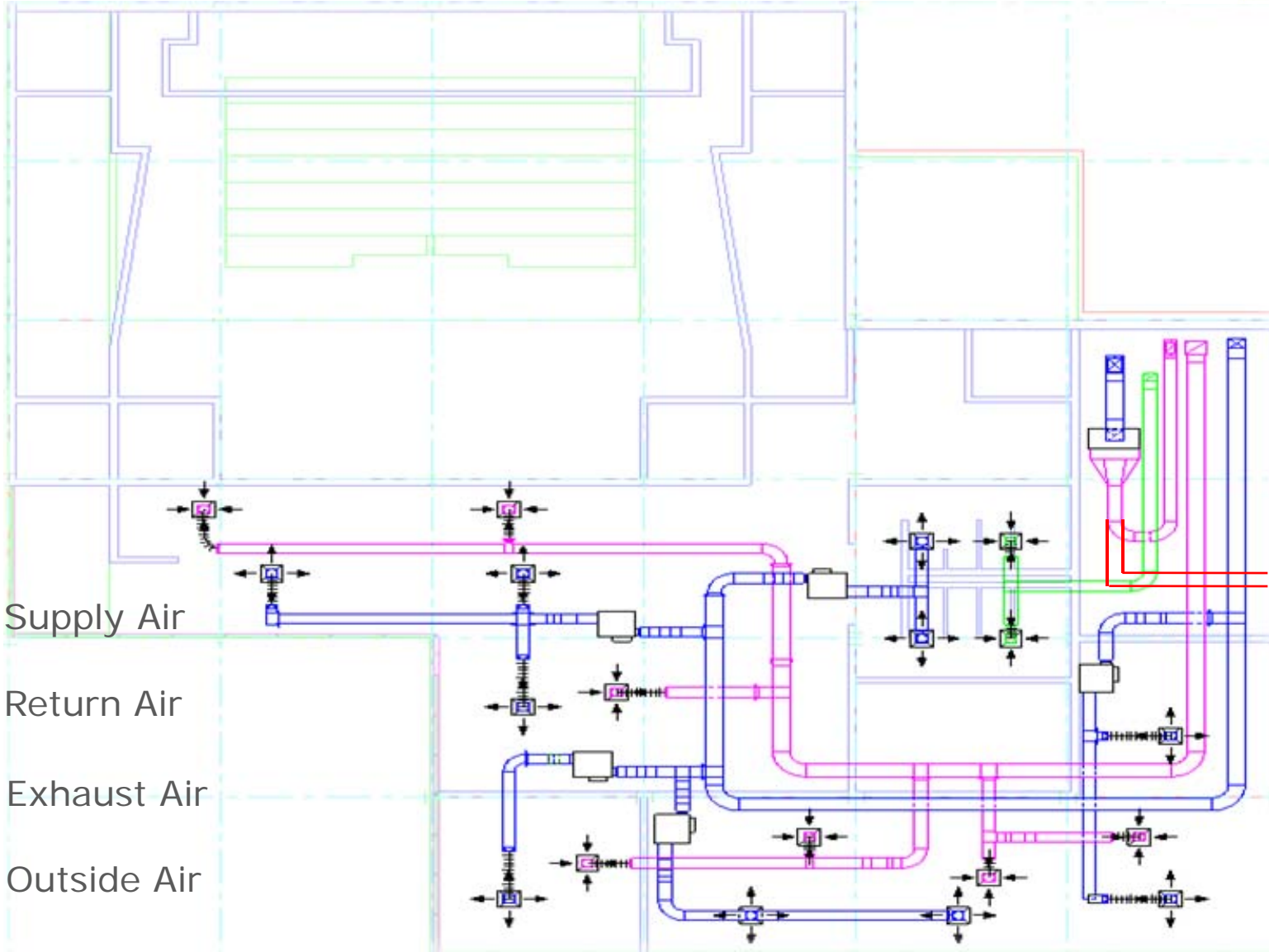




# Ground Floor

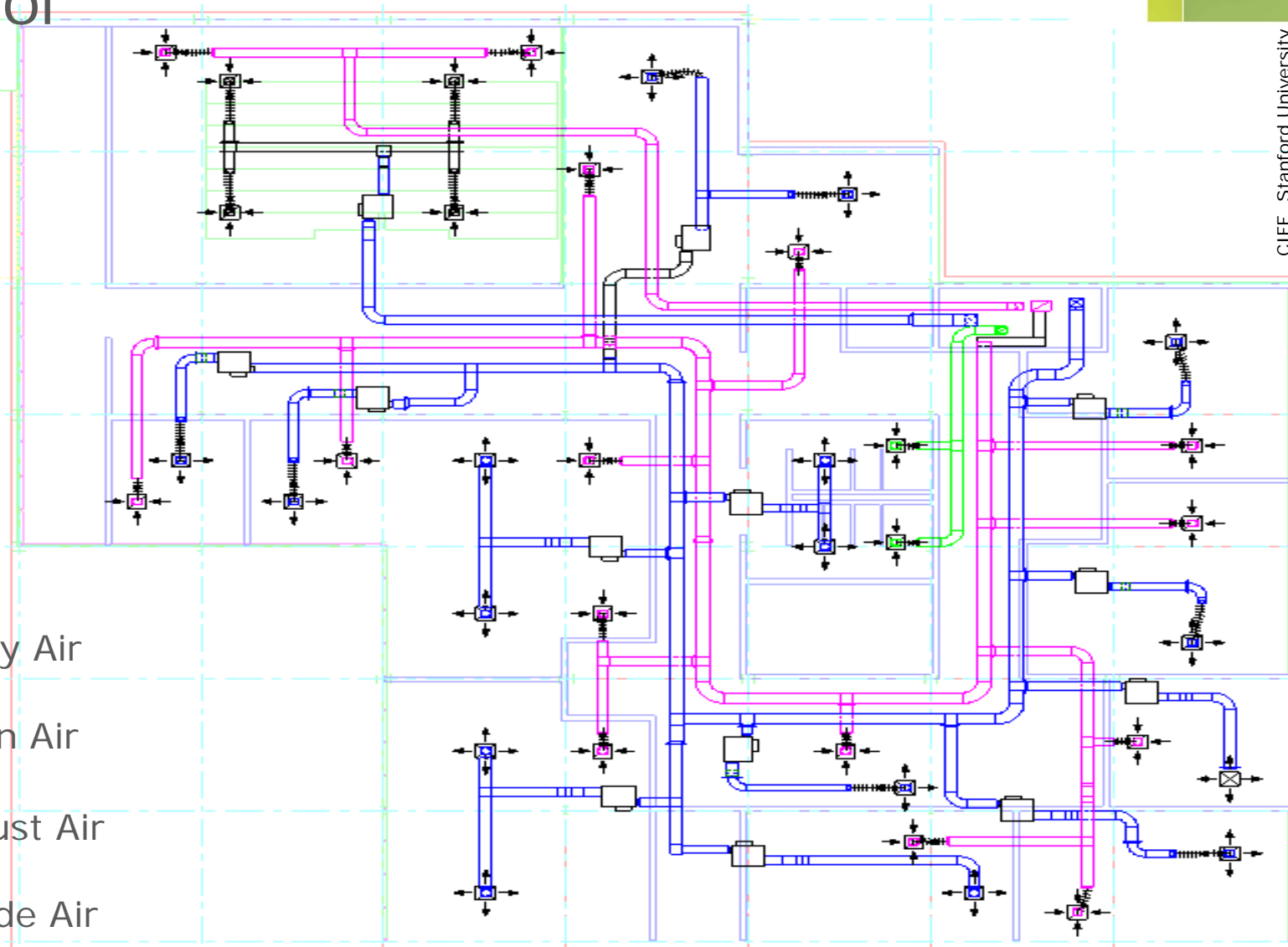
Key:

-  Supply Air
-  Return Air
-  Exhaust Air
-  Outside Air









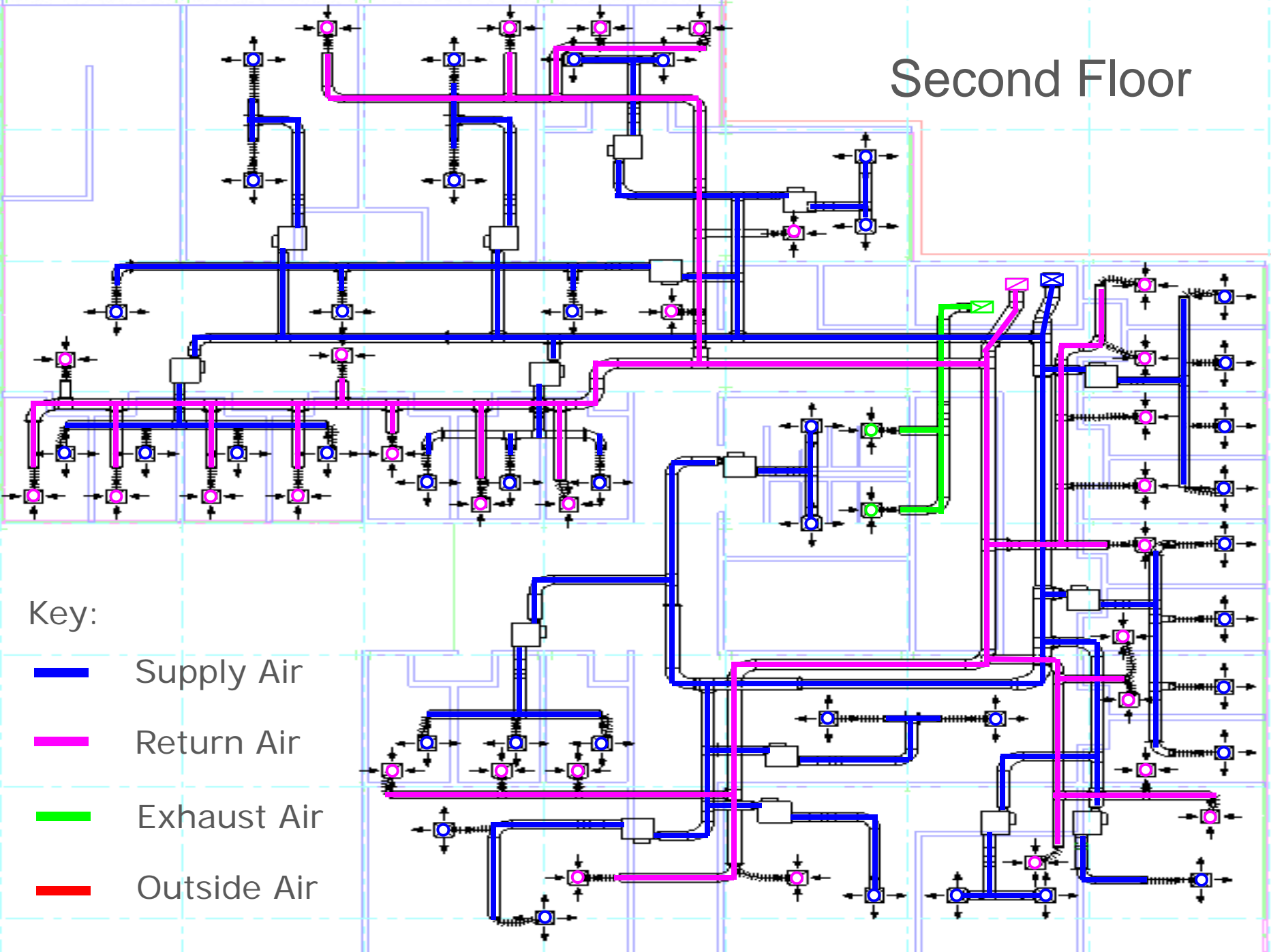
# First Floor



## Key:

-  Supply Air
-  Return Air
-  Exhaust Air
-  Outside Air

# Second Floor

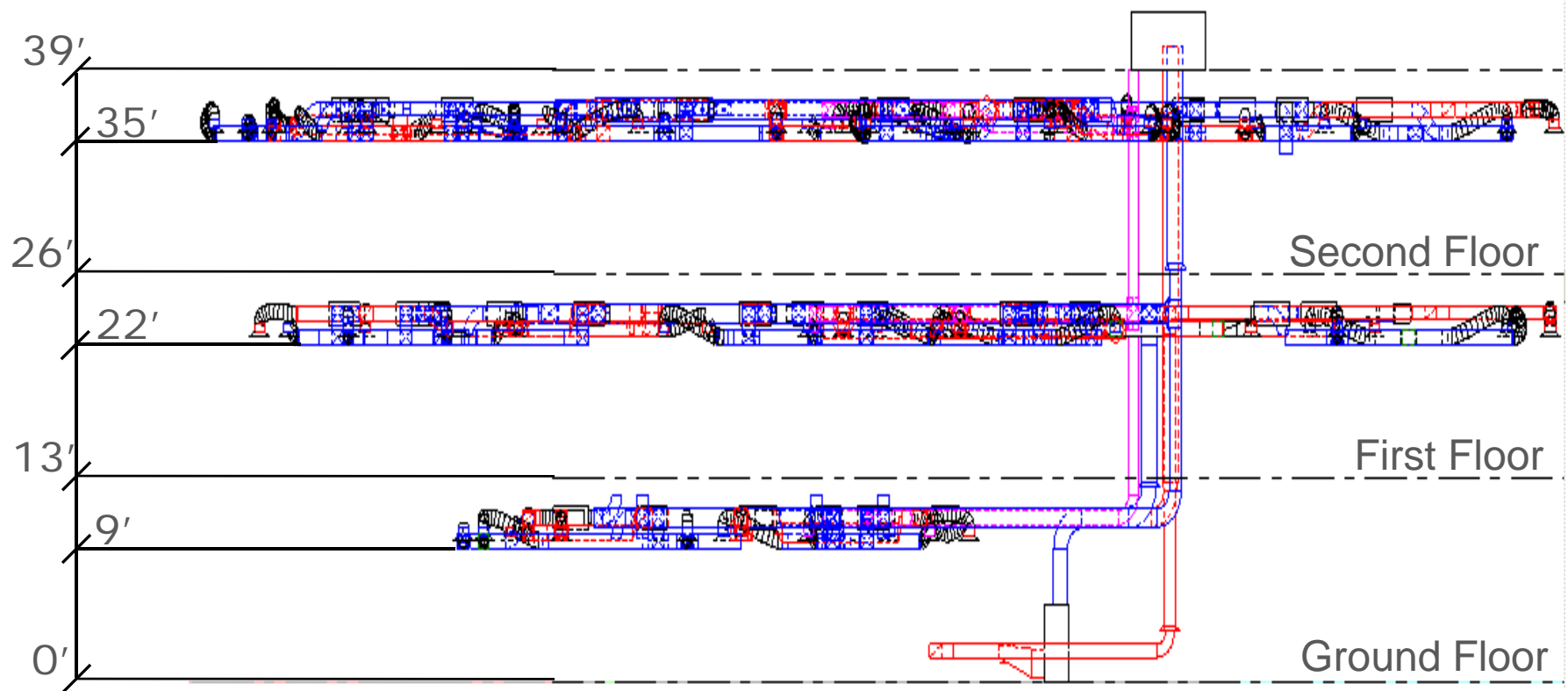


Key:

- █ Supply Air
- █ Return Air
- █ Exhaust Air
- █ Outside Air

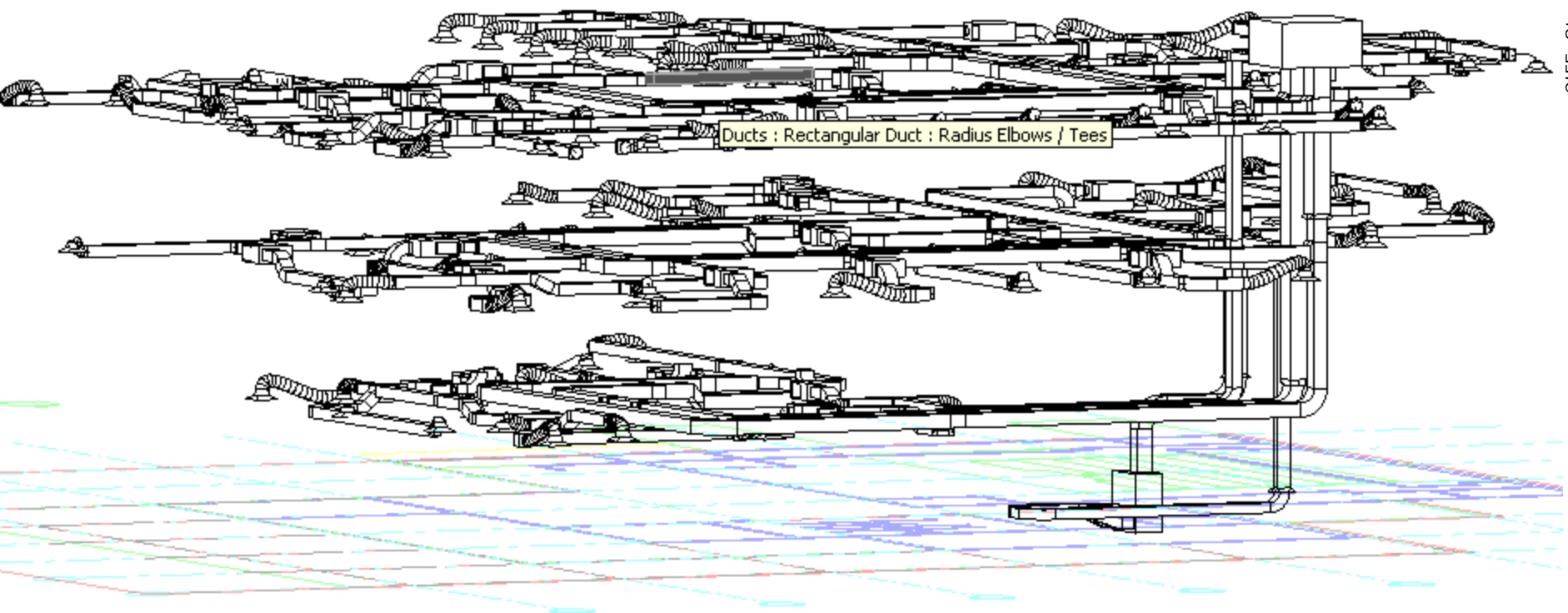


# MEP Vertical Distribution



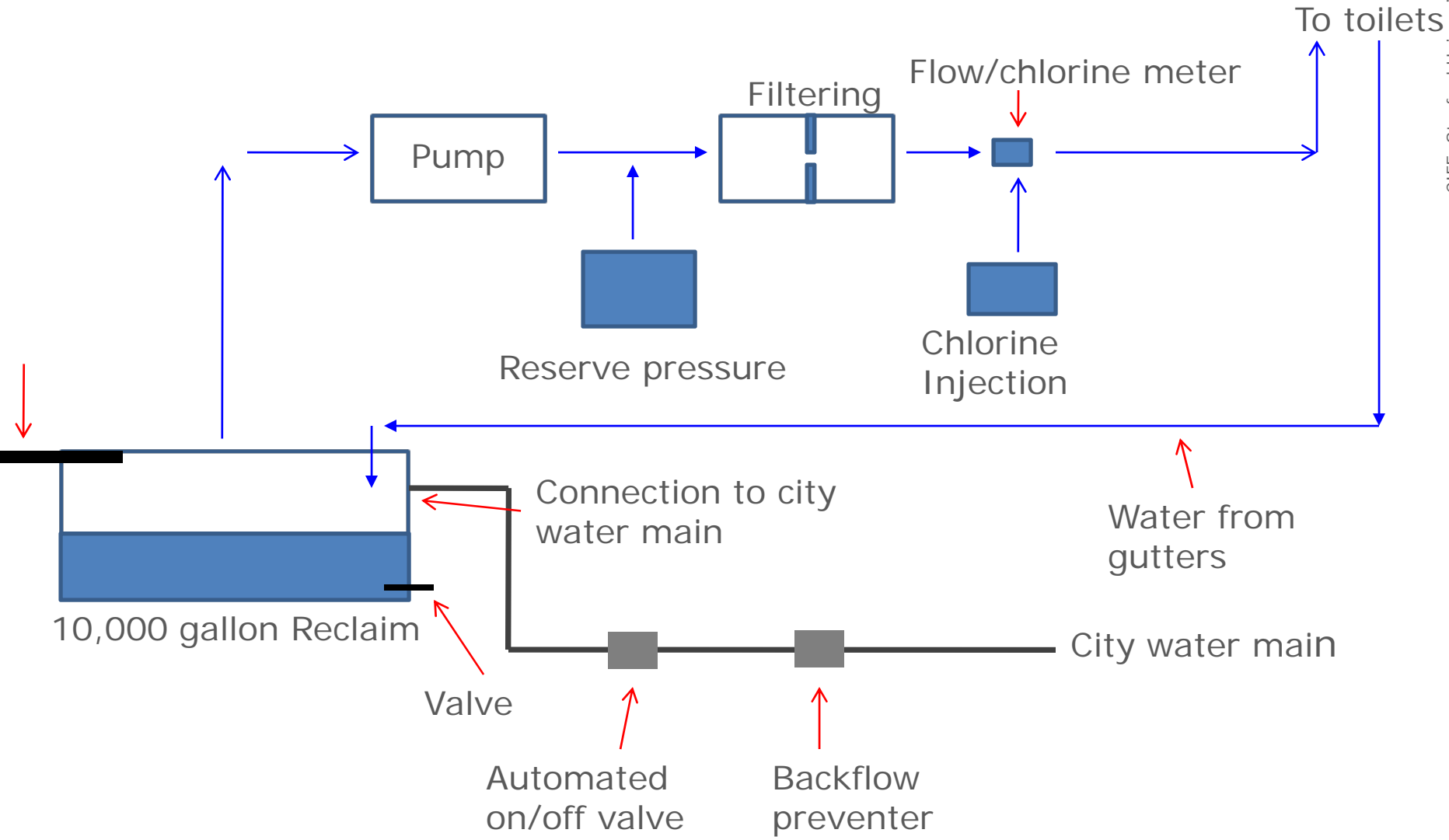


# MEP Building System





# Storm Water Reclaim System





**Project Site**



**Ready Mix Concrete**



**Tentative Storage Area**



1 mile  
2000 ft  
500 m

**Steel Fabrication**





Demolished Building

Trucks enter and leave site

Project Site

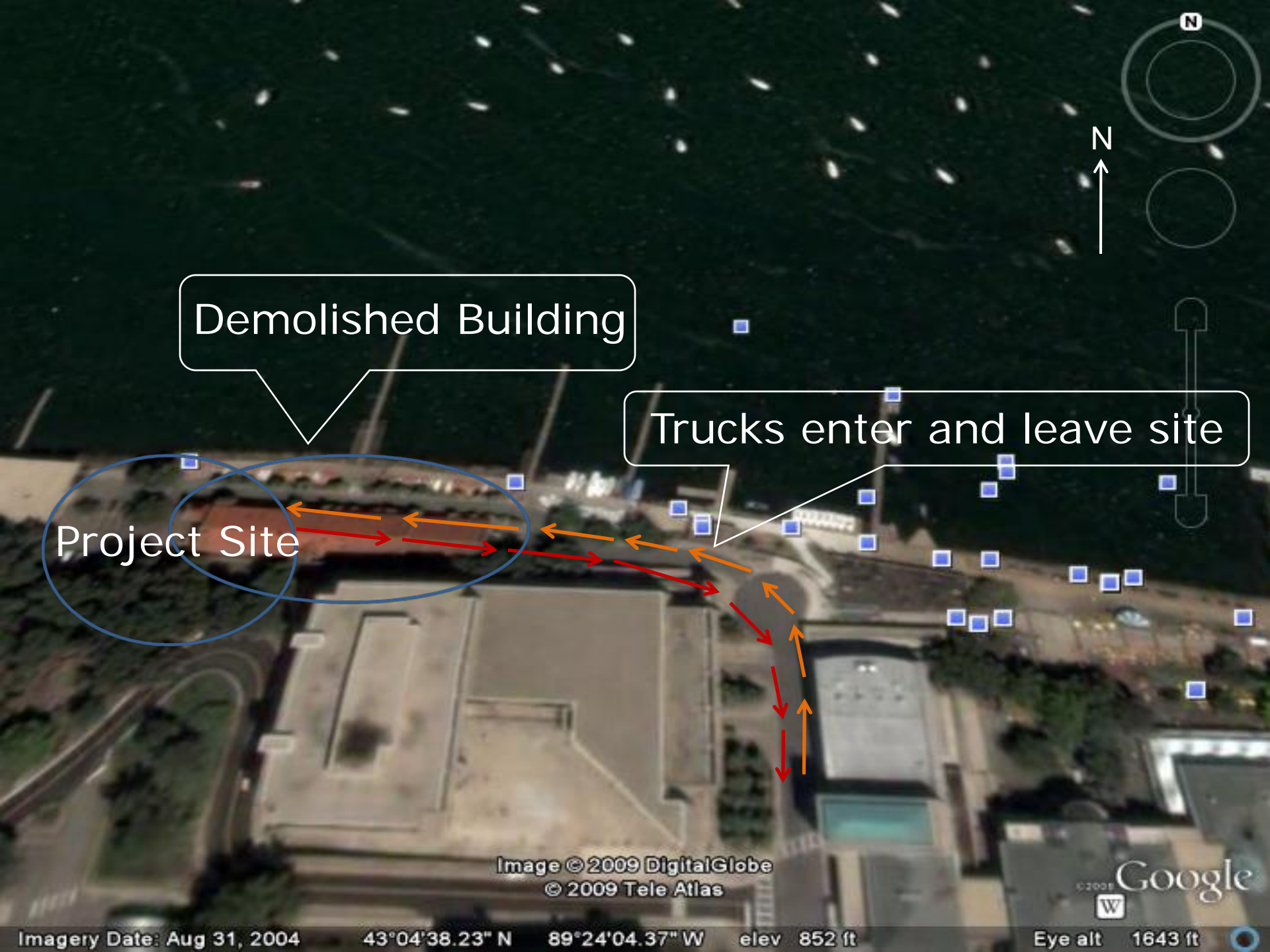


Image © 2009 DigitalGlobe  
© 2009 Tele Atlas

© 2008 Google  
W

Imagery Date: Aug 31, 2004

43°04'38.23" N

89°24'04.37" W

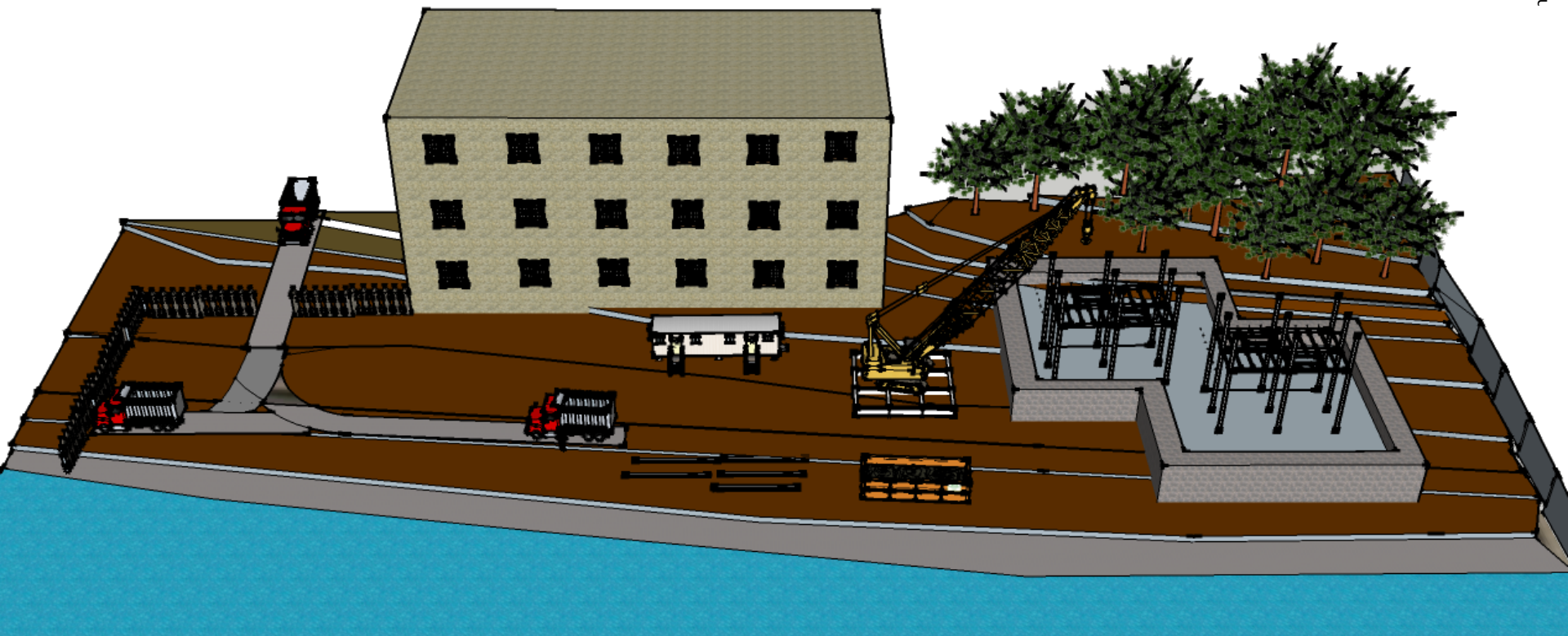
elev 852 ft

Eye alt 1643 ft





# Construction Site Plan





# Just In Time Delivery

- A,E,C,MEP have weekly coordination meetings

**Consistent Descriptions with Verb, Noun, and Physical Location Abbreviation**

**Monitor Total Float watching Near-critical and Critical Activities**

**Comparison to previous schedules for Activity Finish Date Variances**

**Monitor Critical Path Activities**

Activity Description	Orig Dur	Start	Early Finish	Total Float	Schedule Cost
Backfill, Grade Truck Dump Walls WP3	8	24MAR05	01APR05	2d	2d
Terminate Feeder 1307A EP1	3	01APR05	05APR05	0	-3d
Install TX-305A EP1	4	05APR05	08APR05	0	-3d
Remove Amine Booster P568 WP2	2	11APR05	12APR05	0	-3d

**Consistent Coding and Organization for Multiple Views of the Schedule**

**Organizing by Responsibility**

**Organizing by Area**

**Organizing by Subcontractor or Discipline**

**Organizing by CSI Codes or Schedule of Values**

**Capturing and Organizing by Impacts/Delays**

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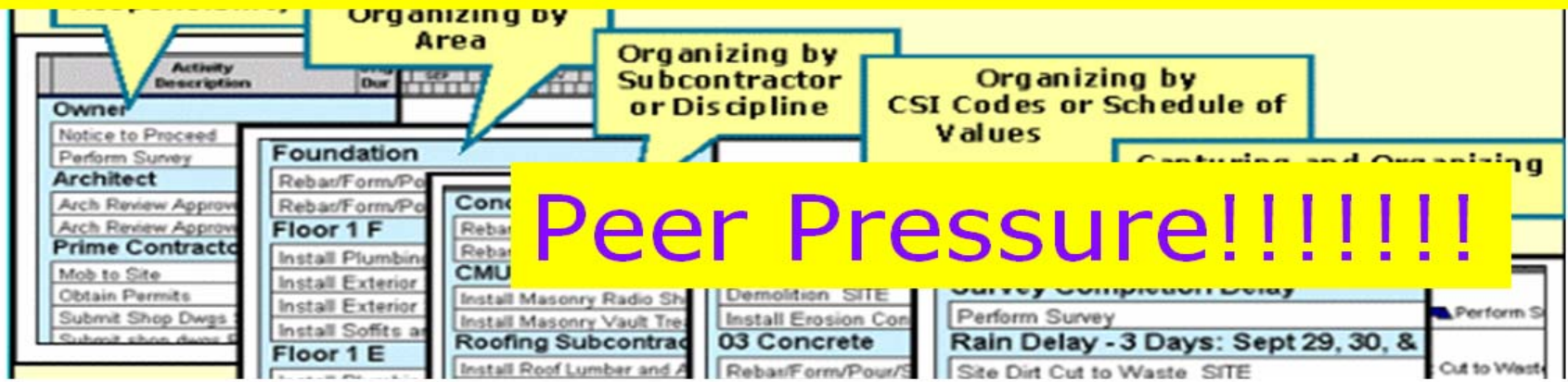
# Just In Time Delivery

- A,E,C,MEP have weekly coordination meetings

Last planner system



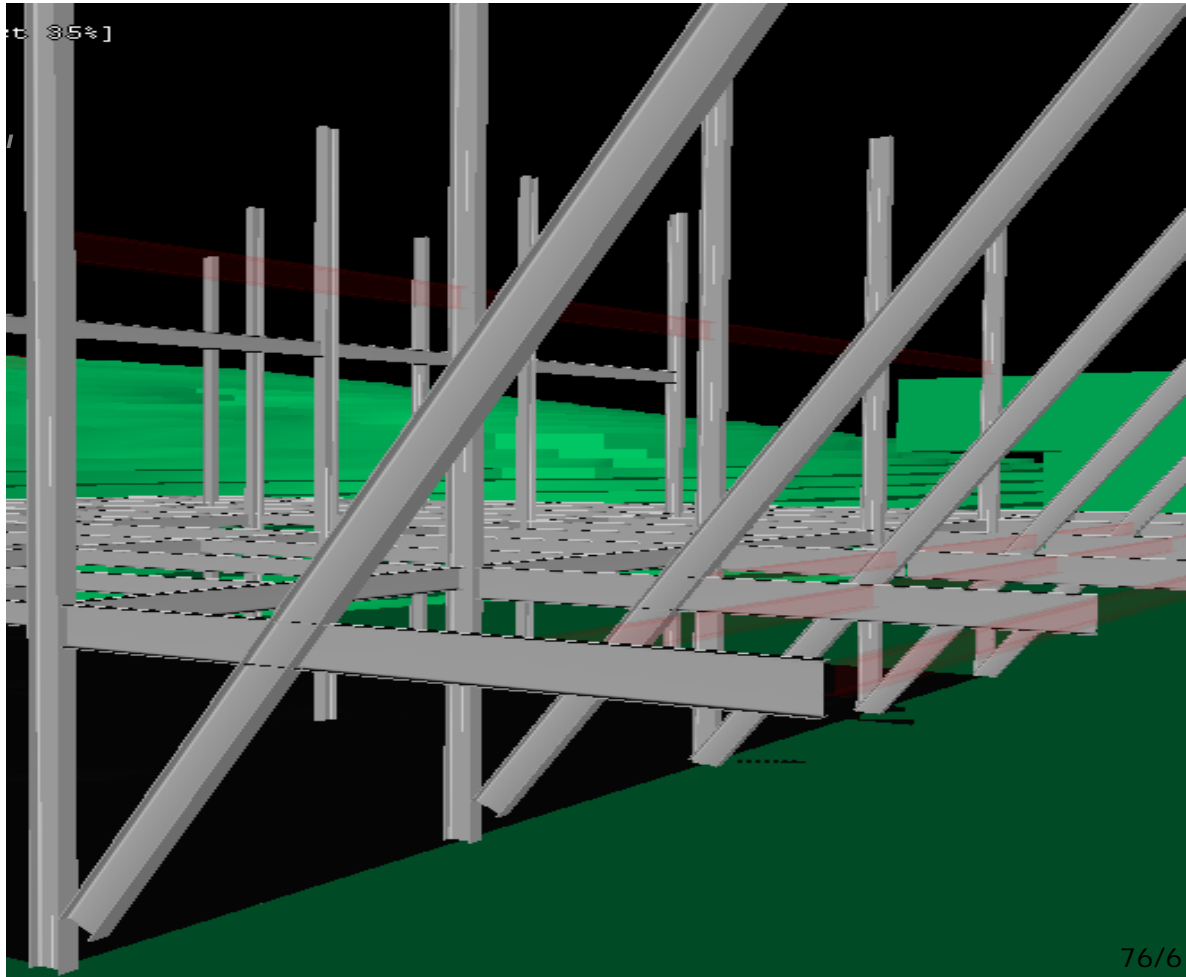
Six and Three weeks look ahead

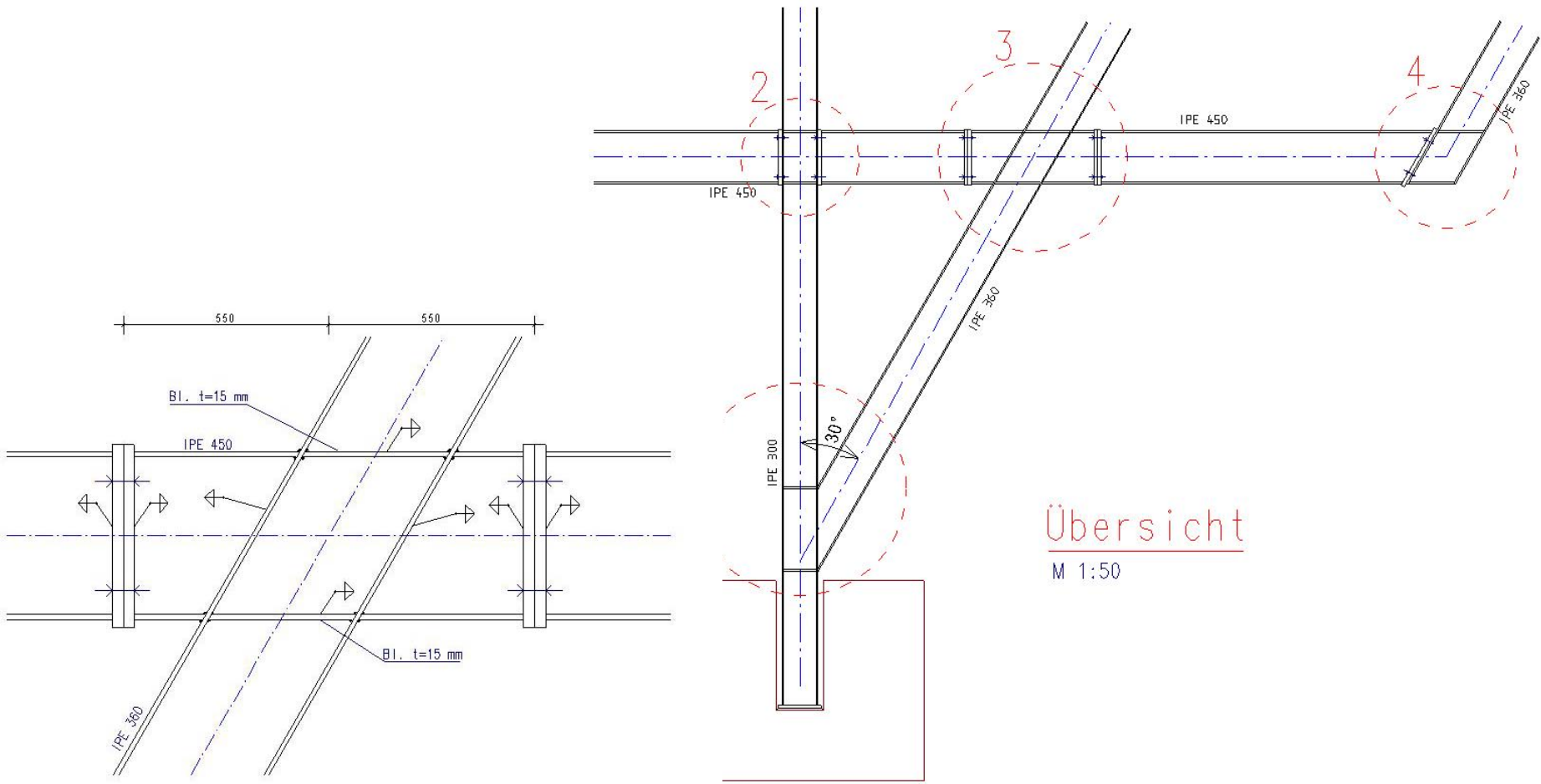




# Engineers – CM Collaboration

- Pre welded connections to reduce on site labor
- Maximize use of bolted connections, minimize welding

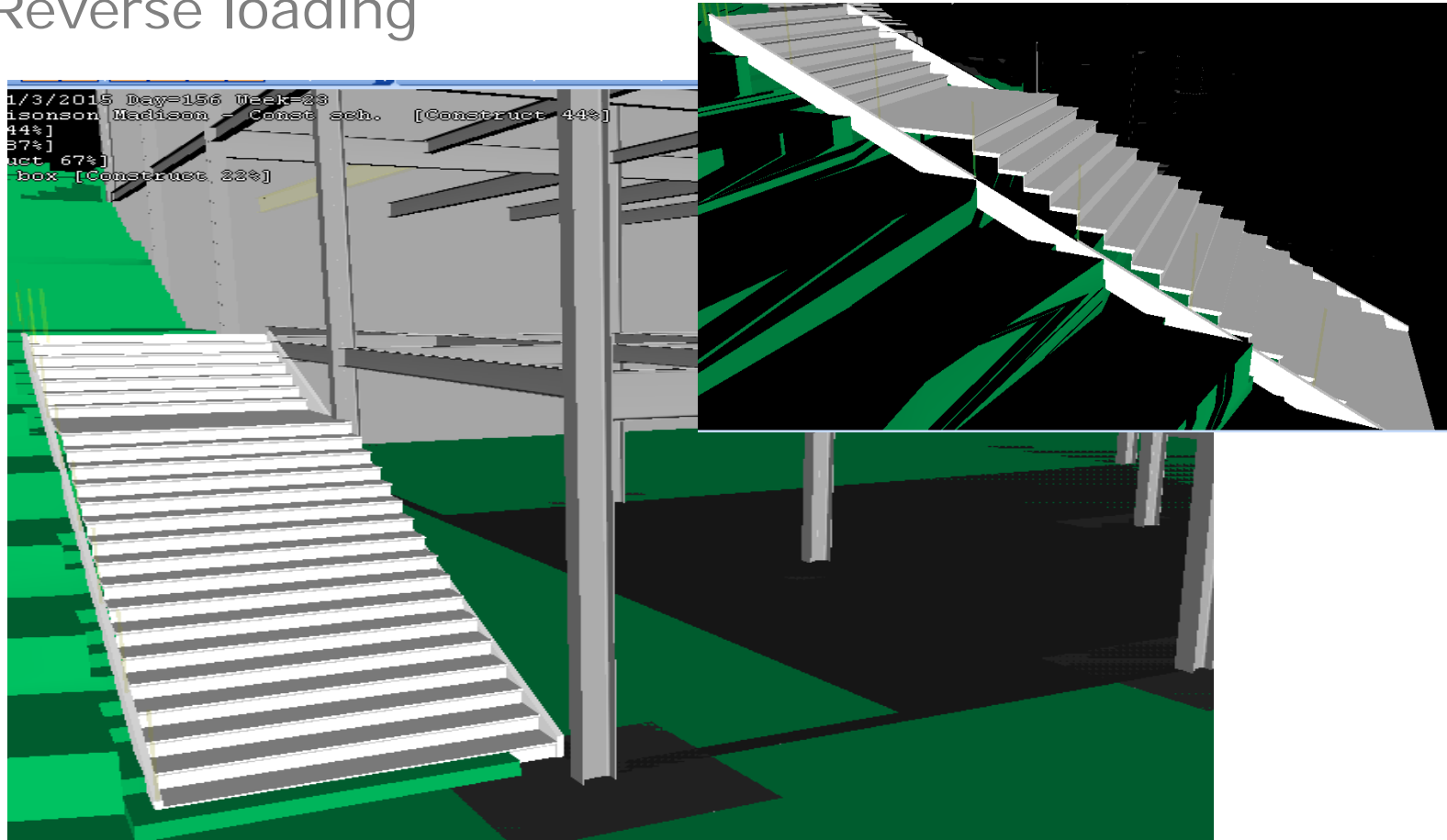






# A/E/C Collaboration

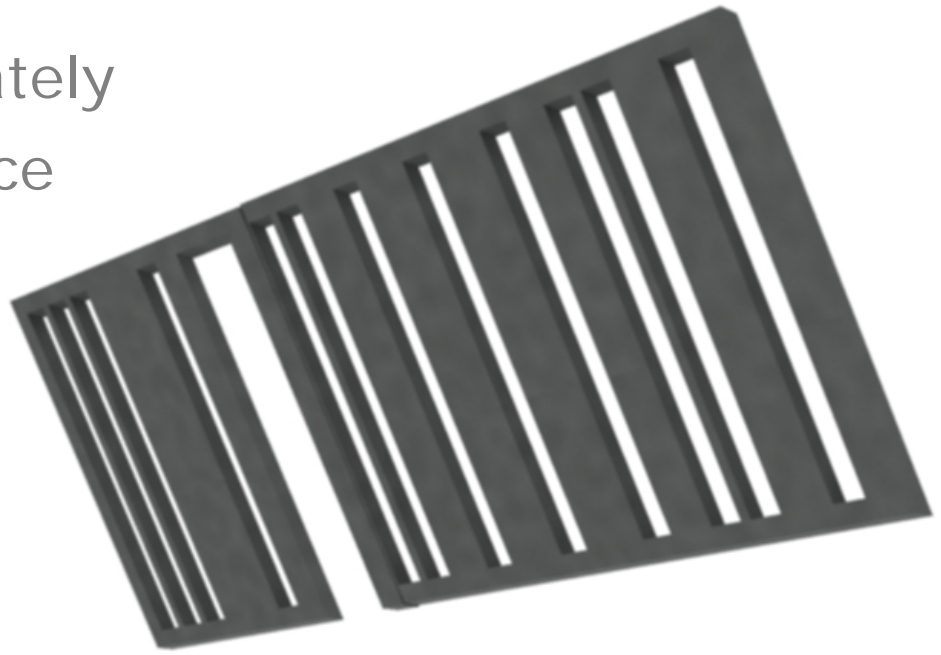
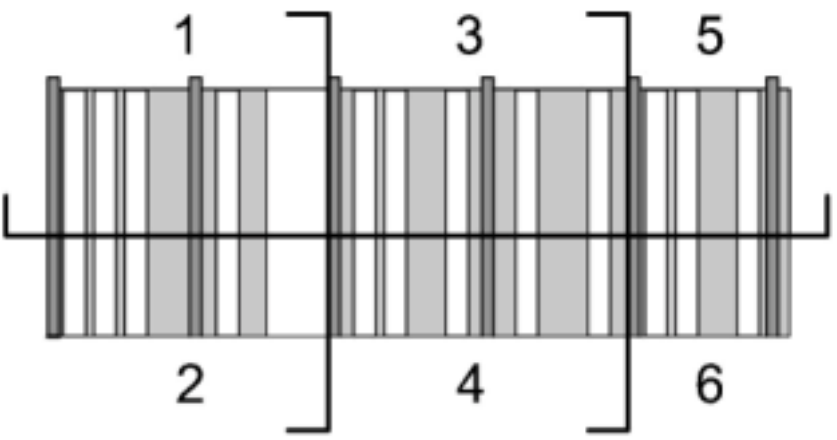
- Large pre-fabricated pieces
- Reverse loading





# A/E/C Collaboration

- Detailed design of north façade
- Hangers to set the pre fabricated sections
- Total Station to accurately set the sections in place



# Atlantic Team 2009

P5bILAB - Stanford University  
School of Engineering: University of Wisconsin at Madison

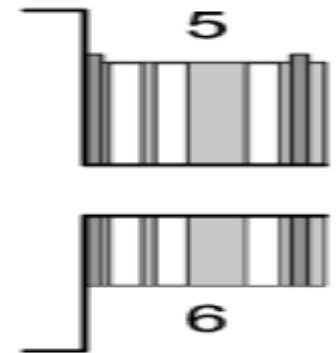
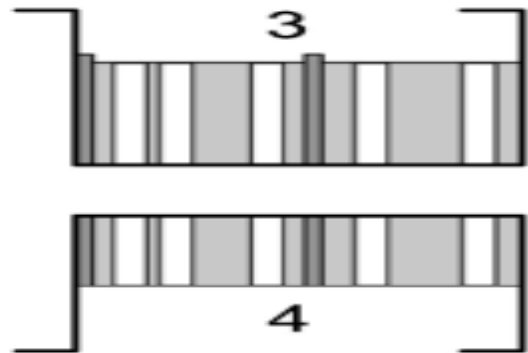
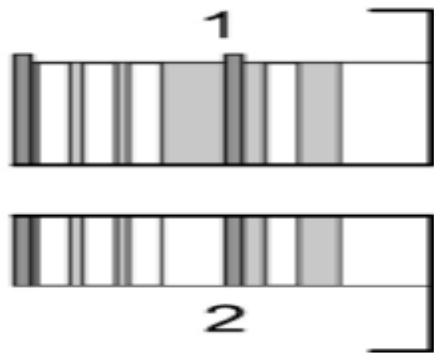
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# Atlantic Team 2009

P5bILAB - Stanford University

School of Engineering: University of Wisconsin at Madison

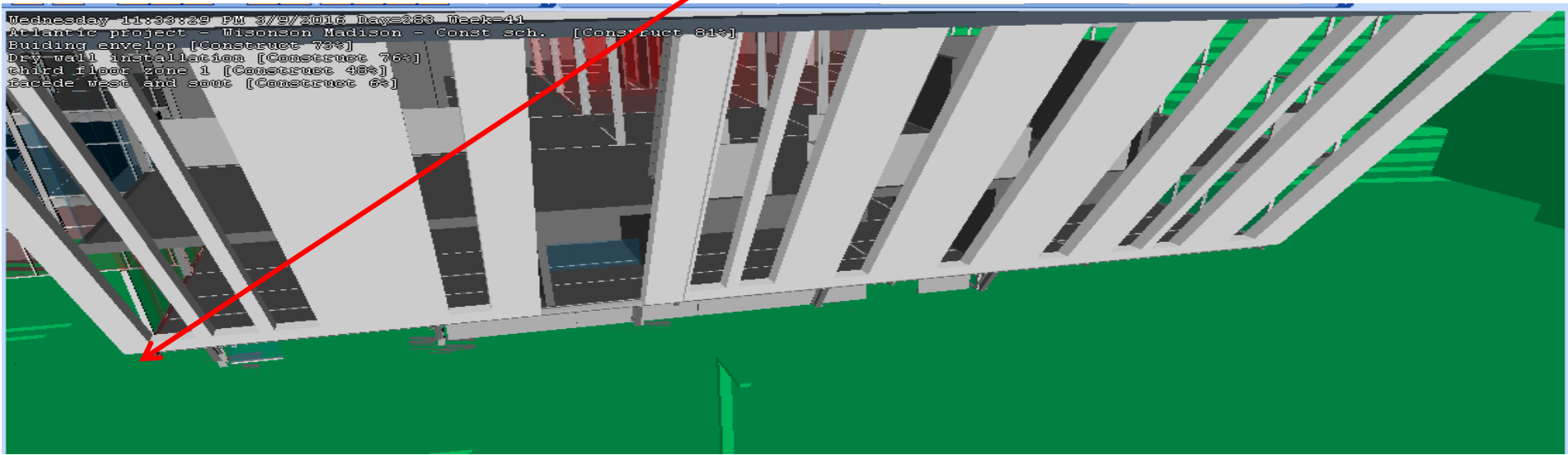
architecture

engineering

construction management



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# Life Cycle Cost Analysis



Organization: University of Wisconsin-Madison  
 Owner: Holgar  
 Project: Atlantic Project  
 GSF: 34,680 GSF  
 Interest rate: 3.00%  
 Design Life: 100

Quantity Unit Unit Cost Total Cost Years Est. Year Occuring Total Present Value (for project life)

**Initial Expenses**

Item	Quantity	Unit	Unit Cost	Total Cost	Years	Est. Year Occuring	Total Present Value (for project life)
<b>Initial Investment Costs</b>							
Construction Management	0	LPSM	\$ -	\$ -	100	Prior to Occupancy	\$ -
Land Acquisition	0	LPSM	\$ -	\$ -	100	Prior to Occupancy	\$ -
Site Investigation	0	LPSM	\$ -	\$ -	100	Prior to Occupancy	\$ -
Design Services	0	LPSM	\$ -	\$ -	100	Prior to Occupancy	\$ -
Construction	1	LPSM	\$ -	\$ 7,500,000.00	100	Prior to Occupancy	\$ 7,500,000.00
Equipment	0	LPSM	\$ -	\$ -	100	Prior to Occupancy	\$ -
Technology	0	LPSM	\$ -	\$ -	100	Prior to Occupancy	\$ -
Overhead Admin	1	LPSM	\$ 100,000.00	\$ 100,000.00	100	Prior to Occupancy	\$ 100,000.00
Art	0	LPSM	\$ -	\$ -	100	Prior to Occupancy	\$ -
Contingency	1	LPSM	\$ -	\$ -	100	Prior to Occupancy	\$ -
<b>Total Initial Investments</b>				<b>\$ 7,600,000.00</b>			<b>\$ 7,600,000.00</b>

**Future Expenses** estimated total per square foot for UW-Madison Campus = \$5.5/sf

cleaning UW-Madison buildings are based on an APPA standard of 3 1/2 Lowest in Big Ten and not up to par with the kind of maintenance they would like

Item	Quantity	Unit	Unit Cost	Total Cost	Years	Est. Year Occuring	Total Present Value (for project life)	Notes
<b>Operation Costs (annual)</b>								
Heating Fuel	1,360,000	CF	\$ 0.01	\$ 17,666.40	100	Every	\$ 558,238.90	Approx. given 40 times SF for natural gas, \$12.99/1000 of
Electricity	34,000	SF	\$ 1.13	\$ 38,420.00	100	Every	\$ 1,214,029.94	Value from MG&E website
Water and Sewer	34,000	SF	\$ 0.20	\$ 6,800.00	100	Every	\$ 214,872.56	Approx
Garbage Disposal	34,000	SF	\$ 0.30	\$ 10,200.00	100	Every	\$ 322,308.83	Approx
Custodial	34,000	SF	\$ 1.95	\$ 66,300.00	100	Every	\$ 2,095,007.42	Value from Madison physical plant
Grounds	34,000	SF	\$ 1.16	\$ 39,440.00	100	Every	\$ 1,246,260.83	Value from Madison physical plant
Other	34,000	SF	\$ 0.70	\$ 23,800.00	100	Every	\$ 752,063.95	
<b>Total</b>			<b>\$ 5.50</b> approx				<b>\$ 6,402,772.43</b>	
Lease	34,000	LPSM	\$ -	\$ -	100	Every	\$ 537,752.00	10% of operation cost. provided by the state
Insurance	34,000	LPSM	\$ -	\$ -	100	Every	\$ 1,344,380.00	25% of operation cost. provided by the state
<b>Total Operations</b>							<b>\$ 8,284,904.43</b>	

**Maintenance & Repair Costs (est. annual)**

Item	Quantity	Unit	Unit Cost	Total Cost	Years	Est. Year Occuring	Total Present Value (for project life)	Notes
Site Improvements	1	LPSM	\$ 2,000.00	\$ 2,000.00	100	Every	\$ 63,197.81	
Site Utilities	1	LPSM	\$ 4,000.00	\$ 4,000.00	100	Every	\$ 126,395.62	
Foundation/Substructure	34,000	GSF	\$ 0.50	\$ 17,000.00	100	Every	\$ 537,181.39	From corrosion due to water
Superstructure	34,000	GSF	\$ -	\$ -	100	Every	\$ -	None
Exterior Wall Systems	20,000	SF	\$ 0.70	\$ 14,000.00	100	Every	\$ 442,384.67	
Exterior Windows	10,000	SF	\$ 0.80	\$ 8,000.00	100	Every	\$ 252,791.24	
Exterior Doors	6	EA	\$ 100.00	\$ 600.00	100	Every	\$ 18,959.34	
Roof Systems (Green roof maintenance)	10,000	SF	\$ 0.50	\$ 5,000.00	100	Every	\$ 157,994.53	Green Roof Maintenance
Interior Partitions (movable)	34,000	SF	\$ 0.20	\$ 6,800.00	100	Every	\$ 214,872.56	
Interior Doors	50	EA	\$ 50.00	\$ 2,500.00	100	Every	\$ 78,997.26	
Interior Floor Finishes	34,000	SF	\$ 0.20	\$ 6,800.00	100	Every	\$ 214,872.56	
Interior Wall Finishes	34,000	SF	\$ 0.44	\$ 14,960.00	100	Every	\$ 472,719.82	
Interior Ceiling Finishes	34,000	SF	\$ 0.20	\$ 6,800.00	100	Every	\$ 214,872.56	
Interior Specialty Finishes	34,000	SF	\$ 0.10	\$ 3,400.00	100	Every	\$ 107,436.28	
Conveying Systems	1	LPSM	\$ 4,150.00	\$ 4,150.00	100	Every	\$ 131,135.46	3000 lb conveying system
Plumbing Piping (sewage)	1,000	LF	\$ 2.00	\$ 2,000.00	100	Every	\$ 63,197.81	
Plumbing Fixtures	50	EA	\$ 40.00	\$ 2,000.00	100	Every	\$ 63,197.81	
Fire protection Systems	1	LPSM	\$ 300.00	\$ 300.00	100	Every	\$ 9,479.67	
HVAC Distribution	30,000	GSF	\$ 0.047	\$ 1,410.00	100	Every	\$ 44,554.46	
HVAC Demo	EA	\$ -	\$ -	\$ -	100	Every	\$ -	
Boiler	2	LPSM	\$ 320.00	\$ 322.00	100	Every	\$ 10,174.85	
Ductwork	10,000	LF	\$ 1.00	\$ 10,000.00	100	Every	\$ 315,989.05	
HVAC Controls	10	EA	\$ 35.00	\$ 350.00	100	Every	\$ 11,059.62	
Electrical Service/Generation	1	LPSM	\$ -	\$ -	100	Every	\$ -	
Electrical Distribution	34,000	SF	\$ 0.40	\$ 13,600.00	100	Every	\$ 429,745.11	
Electrical Lighting	34,000	SF	\$ 0.15	\$ 5,100.00	100	Every	\$ 161,154.42	
Special Electrical Systems	GSF	\$ -	\$ -	\$ -	100	Every	\$ -	
Equipment & Furnishings	50	LPSM	\$ 50.00	\$ 2,500.00	100	Every	\$ 78,997.26	
Other	34,000	LPSM	\$ 10,000.00	\$ 10,000.00	100	Every	\$ 315,989.05	
<b>Total Maintenance &amp; Repair</b>							<b>\$ 4,537,350.02</b>	

**Replacement Cost (scheduled)**

Item	Quantity	Unit	Unit Cost	Total Cost	Years	Est. Year Occuring	Total Present Value (for project life)	Notes
Site Improvements	1	LPSM	\$ 40,000.00	\$ 40,000.00	100	25 years	\$ 32,586.31	
Site Utilities	1	LPSM	\$ 20,000.00	\$ 20,000.00	100	25 years	\$ 16,293.16	
Foundation/Substructure	GSF	\$ -	\$ -	\$ -	100	Every	\$ -	None
Superstructure	GSF	\$ -	\$ -	\$ -	100	Every	\$ -	None
Exterior Wall Systems	SF	\$ -	\$ -	\$ -	100	Every	\$ -	Just Repair Costs
Exterior Windows	EA	\$ -	\$ -	\$ -	100	Every	\$ -	Just Repair Costs
Exterior Doors	6	EA	\$ 1,000.00	\$ 6,000.00	100	Every	\$ 2,841.40	P given F
Roof Systems	3	LPSM	\$ 50,000.00	\$ 150,000.00	100	Every	\$ 32,582.38	Non Green Roof Section
Interior Partitions	1	LPSM	\$ 150,000.00	\$ 150,000.00	100	20 years	\$ 168,591.42	Rearrange
Interior Doors	50	EA	\$ 200.00	\$ 10,000.00	100	40 years	\$ 4,005.34	replace all doors twice
Interior Floor Finishes	30,000	SF	\$ 4.50	\$ 135,000.00	100	15 years	\$ 225,030.61	Tile Flooring
Interior Wall Finishes	34,000	SF	\$ 3.30	\$ 112,200.00	100	15 years	\$ 187,025.44	
Interior Ceiling Finishes	34,000	SF	\$ 3.50	\$ 119,000.00	100	15 years	\$ 198,360.32	
Interior Specialty Finishes	10,000	SF	\$ 20.00	\$ 200,000.00	100	20 years	\$ 263,657.47	
Carpeting	1,000	Sq. Yard	\$ 30.00	\$ 30,000.00	100	10 years	\$ 81,130.67	
Conveying Systems	1	LPSM	\$ 85,000.00	\$ 85,000.00	100	50 years	\$ 19,389.10	Replacement elevator 50 yrs in future
Plumbing Piping	1,000	LF	\$ 5.00	\$ 5,000.00	100	25 years	\$ 4,073.29	Allowance
Plumbing Fixtures	36	EA	\$ 200.00	\$ 7,200.00	100	25 years	\$ 5,865.54	
Fire protection Systems	1	LPSM	\$ 10,000.00	\$ 10,000.00	100	25 years	\$ 8,146.58	
HVAC Equipment	EA	\$ -	\$ -	\$ -	100	30 years	\$ -	Replaced every 30 yrs
VAV Boxes	30	EA	\$ 5,000.00	\$ 150,000.00	100	30 years	\$ 97,747.15	
Air Handling Units	2	EA	\$ 50,000.00	\$ 100,000.00	100	30 years	\$ 65,164.76	
Diffusers	60	EA	\$ 150.00	\$ 9,000.00	100	30 years	\$ 5,864.83	
Ductwork	34,000	SF	\$ 0.10	\$ 3,400.00	100	30 years	\$ 107,436.28	
HVAC Controls	EA	\$ -	\$ -	\$ -	100	30 years	\$ -	
Electrical Service/Generation	1	LPSM	\$ 370,000.00	\$ 370,000.00	100	30 years	\$ 241,109.63	Total Electrical Replacement every 30 yrs, 34000 sf building
Electrical Distribution	GSF	\$ -	\$ -	\$ -	100	30 years	\$ -	included in electrical cost
Electrical Lighting	GSF	\$ -	\$ -	\$ -	100	30 years	\$ -	included in electrical cost
Special Electrical Systems	GSF	\$ -	\$ -	\$ -	100	30 years	\$ -	included in electrical cost
Equipment & Furnishings	LPSM	\$ -	\$ -	\$ -	100	30 years	\$ -	included in electrical cost
Other	\$ -	\$ -	\$ -	\$ -	100	Every	\$ -	
Contingency	1	LPSM	\$ -	\$ 200,000.00	100	Every	\$ 200,000.00	
<b>Total Replacement</b>							<b>\$ 1,966,901.67</b>	
<b>Residual Value (est.)</b>								
Site Improvements	LPSM	\$ -	\$ -	\$ -	100	Every	\$ 0	
Site Utilities	LPSM	\$ -	\$ -	\$ -	100	Every	\$ 0	
Foundation/Substructure	GSF	\$ -	\$ -	\$ -	100	Every	\$ 0	
Superstructure	GSF	\$ -	\$ -	\$ -	100	Every	\$ 0	
Exterior Wall Systems	SF	\$ -	\$ -	\$ -	100	Every	\$ 0	
Exterior Windows	SF	\$ -	\$ -	\$ -	100	Every	\$ 0	
Exterior Doors	EA	\$ -	\$ -	\$ -	100	Every	\$ 0	
Roof Systems	SF	\$ -	\$ -	\$ -	100	Every	\$ 0	
Interior Partitions	SF	\$ -	\$ -	\$ -	100	Every	\$ 0	
Interior Doors	EA	\$ -	\$ -	\$ -	100	Every	\$ 0	
Interior Floor Finishes	SF	\$ -	\$ -	\$ -	100	Every	\$ 0	
Interior Wall Finishes	SF	\$ -	\$ -	\$ -	100	Every	\$ 0	
Interior Ceiling Finishes	SF	\$ -	\$ -	\$ -	100	Every	\$ 0	
Interior Specialty Finishes	SF	\$ -	\$ -	\$ -	100	Every	\$ 0	
Conveying Systems	LPSM	\$ -	\$ -	\$ -	100	Every	\$ 0	
Plumbing Piping	LF	\$ -	\$ -	\$ -	100	Every	\$ 0	
Plumbing Fixtures	EA	\$ -	\$ -	\$ -	100	Every	\$ 0	
Fire protection Systems	GSF	\$ -	\$ -	\$ -	100	Every	\$ 0	
HVAC Distribution	GSF	\$ -	\$ -	\$ -	100	Every	\$ 0	
HVAC Equipment	EA	\$ -	\$ -	\$ -	100	Every	\$ 0	
HVAC Controls	EA	\$ -	\$ -	\$ -	100	Every	\$ 0	
Electrical Service/Generation	LPSM	\$ -	\$ -	\$ -	100	Every	\$ 0	
Electrical Distribution	GSF	\$ -	\$ -	\$ -	100	Every	\$ 0	
Electrical Lighting	GSF	\$ -	\$ -	\$ -	100	Every	\$ 0	
Special Electrical Systems	GSF	\$ -	\$ -	\$ -	100	Every	\$ 0	
Equipment & Furnishings	LPSM	\$ -	\$ -	\$ -	100	Every	\$ 0	
Other	\$ -	\$ -	\$ -	\$ -	100	Every	\$ 0	
<b>Total Residual Value</b>			<b>2% OF TOTAL LIFE CYCLE COST</b>				<b>\$ 438,827.46</b>	Assume 2% of Total Life Cycle Cost

**Total Life Cycle Cost**

\$ 21,941,372.99 Including initial cost

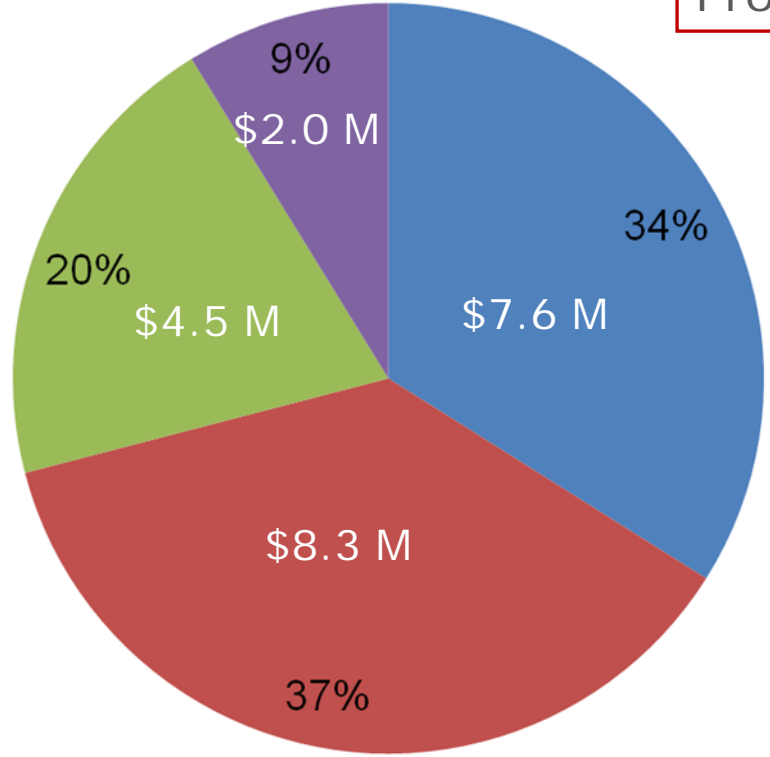
**Estimated Annual Cost**

\$ 468,027.48 Not including initial cost



# Life Cycle Cost Summary

Projected LCC time frame: 100 years



- Initial Investment Costs
  - Operations Costs
  - Maintenance and Repair Costs
  - Replacement Costs
- \*Residual Value = \$445,000

**Total Life Cycle Cost = \$21,900,000**

**Estimated Annual Cost = \$468,000**



# Sustainability: LEED Certification



## LEED Points

### LEED Categories

Sustainable Sites



8 pts

Water Efficiency



3 pts

Energy and Atmosphere



10 pts

Materials and Resources



10 pts

Indoor Environmental Quality



12 pts

Innovation and Design Process



3 pts

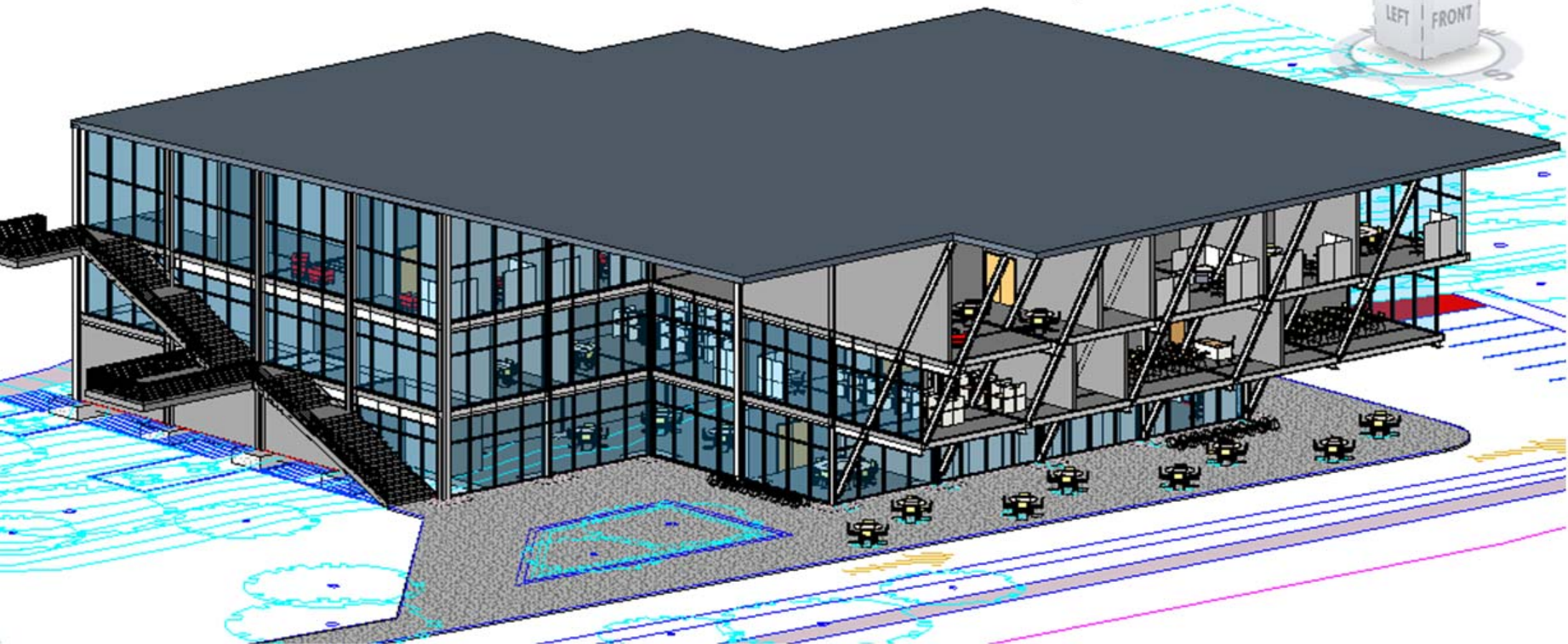
**LEED Gold Certification**



**44 pts**



# A/E/C Collaboration + Owner Input

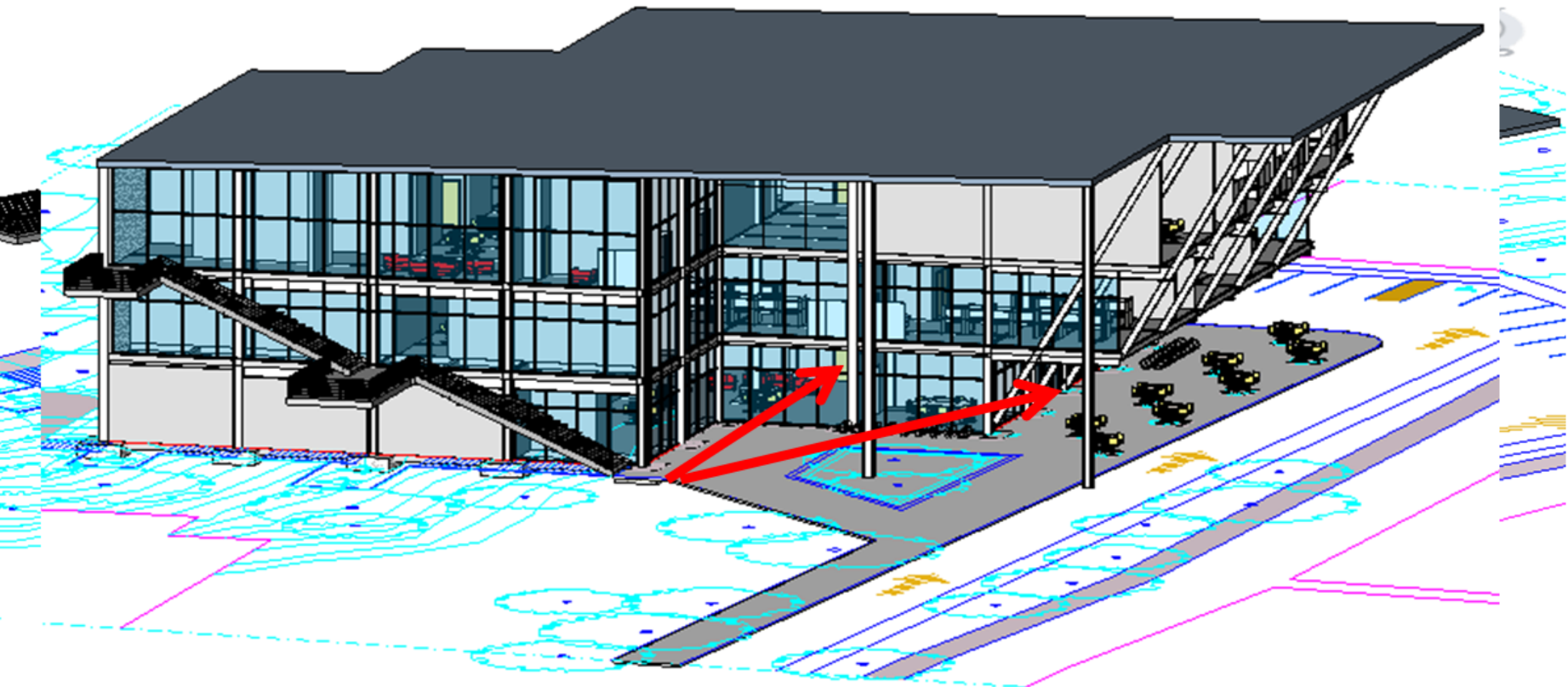


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- Collaborative decision making and continuous zero waste intentions led to excluding the roof overhang



# A/E/C Collaboration + Owner Input



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- Collaborative decision making and continuous zero waste intentions led to excluding the roof overhang



# A/E/C Collaboration + Owner Input



- Collaborative decision making and continuous zero waste intentions led to excluding the roof overhang



# A/E/C Collaboration + Owner Input



- Collaborative decision making and continuous zero waste intentions led to excluding the roof overhang





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# Uniformat Cost Estimate

Number	Description	Quantity	Unit	Unit Price	Sub Total	Cost/56	Comments	Number
<b>A SUBSTRUCTURE</b>								
<b>A20 EXCAVATION</b>						\$425,300	\$425.30	
A2010	Excavation	7,000	sq	\$ 6.00	\$ 42,000	\$ 6.02	10 feet deep	
A2010	Hauling	7,000	sq	\$ 8.00	\$ 56,000	\$ 5.53	20 miles with 12 PCY	31 23 23.2 160
A2010	Pumping Water	2	no	\$ 3,000.00	\$ 6,000	\$ 8.52	5 pumps, \$500/wk, 2 weeks	31 41 16.1 430
<b>A30 FOUNDATION</b>						\$457,820	\$457.82	
A3010	Strip Footings	450	CY	\$ 385.00	\$ 173,250	\$ 3.55	DEPTH OF 2 FEET	05 30 53.4 485
A3030	1 Floor slab	10,495	sf	\$ 2.50	\$ 26,238	\$ 8.63		05 30 53.4 485
	Waterproofing Seal	10,495	sf	\$ 4.00	\$ 41,980	\$ 4.10		
<b>A20 RETAINING WALL</b>						\$120,350	\$120.35	
A2020	Diaphragm wall	3,700	sf	\$ 32.50	\$ 120,350	\$ 3.27		
<b>B SHELL</b>								
<b>B10 SUPERSTRUCTURE</b>						\$757,450	\$757.45	
B1010	Structural Steel	147	TON	\$ 5,230.00	\$ 768,810	\$ 5.24	Beams and columns	05 12 23.7 000
B1010	Metal Deck	26,050	SF	\$ 5.00	\$ 130,250	\$ 3.63	4.5" concrete metal deck	05 31 19.5 900
B1010	Metal Deck concrete	26,050	SF	\$ 3.00	\$ 78,150	\$ 2.10	4.5" concrete metal deck	05 30 53.4 900
B1010	Fireproofing	40,350	SF	\$ 2.00	\$ 80,700	\$ 2.10		07 01 16.1 070
B1020	Composite Deck Roofing Metal Deck	10,500	SF	\$ 8.00	\$ 84,000	\$ 2.15	4.5" concrete metal deck	05 31 19.5 350
	Composite Deck Roofing Decks above Cantilever	5,000	SF	\$ 2.00	\$ 10,000	\$ 8.27		
B1020	Composite Deck Roofing Metal Deck concrete	8,500	SF	\$ 3.00	\$ 25,500	\$ 8.63	2" normal weight concrete metal deck	05 30 53.4 900
<b>B20 EXTERIOR CLOSURE</b>						\$1,434,685	\$1,434.69	
B2010	Curtain Wall	11,500	SF	\$ 85.00	\$ 977,500	\$ 26.45	12 5/8 x 2 1/4, nonstructural	00 44 19.1 010
B2010	Personal concrete panels with exposed aggregate	7,000	SF	\$ 47.00	\$ 329,000	\$ 3.51	1 1/2 x 12 x 4, 3000 lb floor wall	05 45 19.5 010, 025
B2020	Exterior Windows with 000	800	SF	\$ 50.00	\$ 40,000	\$ 1.00	10' x 11' floor exterior 3 1/4 x 3 1/2 2 doors for main entrance & 1 for bank	00 41 19.1 020
B2030	Exterior Sluice door 2	OPH	\$ 5,000.00	\$ 5,000	\$ 8.37			
B2040	Waterproofing Seal & Coat	36,385	SF	\$ 1.00	\$ 36,385	\$ 1.00		
<b>C INTERIORS</b>								
<b>C10 INTERIOR CONSTRUCTION</b>						\$450,700	\$450.70	
C1010	Dry Wall with fire rating	45,000	SF	\$ 5.00	\$ 225,000	\$ 5.32		05 21 16.3 220
C1020	Inclusion Doors & Frames 1 50	PA	\$ 700.00	\$ 700.00	\$ 8.94		Clear Disk door /	00 14 16.0

<b>C20 STAIRS</b>						\$57,300	\$57.30	
C2010	General fill metal plate stair	2	EA	\$ 28,350.00	\$ 56,700	\$ 1.57	30" wide with 9 risers per flight,	05 51 19.5 020, 030
<b>C30 INTERIOR FINISHES</b>						\$211,163	\$211.16	
C3010	Wall Finishing Wallpaper	45,000	SF	\$ 2.00	\$ 90,000	\$ 2.37	granular surface	03 72 23.1 120
	Building Insulation	36,385	SF	\$ 0.50	\$ 18,193	\$ 8.58		
C3020	Roof Finishing	1	LS	\$ 5,000.00	\$ 5,000	\$ 8.14		
C3030	Floor Finish	36,385	SF	\$ 2.00	\$ 72,770	\$ 2.00	acrylic floor finish	03 65 19.1 000
C3030	Floor Finish Auditorium	4,500	SF	\$ 5.00	\$ 22,500	\$ 8.74	includes aluminum	03 54 16.1 000
<b>D SERVICES</b>								
<b>D10 CONVEYING SYSTEM</b>						\$224,600	\$224.60	
D1010	Elevators	2	EA	\$ 110,000.00	\$ 220,000	\$ 5.33	4000 lbs capacity freight elevators	14 21 19.1 040
<b>D20 PLEADING</b>						\$244,410	\$244.41	
D2020	Planking	36,385	SF	\$ 6.00	\$ 218,310	\$ 6.00		
D2030	Trailer and Bulk Hauler	3	EA	\$ 7,500.00	\$ 22,500	\$ 8.61		
<b>D30 HVAC</b>						\$1,103,550	\$1,103.55	
D3010	HVAC	36,385	SF	\$ 30.00	\$ 1,091,550	\$ 30.00	Heat pump system	
<b>D40 FIRE PROTECTION</b>						\$75,370	\$75.37	
D4010	Fire Protection	36,385	SF	\$ 2.00	\$ 72,770	\$ 2.00		
<b>D50 ELECTRICAL</b>						\$400,005	\$400.01	
D5010	Electrical	36,385	SF	\$ 10.00	\$ 363,850	\$ 10.00		
<b>E EQUIPMENT &amp; FURNISHING</b>								
<b>E10 EQUIPMENT</b>						\$23,850	\$23.85	
E1020	Classroom projectors	2	EA	\$ 3,500.00	\$ 7,000		roof mounted, with automatic sensor	11 52 16.1 130
E1020	Sound System	1	EA	\$ 4,850.00	\$ 4,850		for auditorium	11 52 16.1 370
<b>E20 FURNISHING</b>						\$200,000	\$200.00	
E2010	Fixed - Casework	28	OFF	\$ 7,000.00	\$ 196,000		number adjusted for size	
E2010	Fixed - Casework	12	Slab	\$ 2,000.00	\$ 24,000		number adjusted for size	
E2020	Mobile - Parallele (off)	28	OFF	\$ 2,000.00	\$ 56,000		number adjusted for size	
E2020	Mobile - Parallele (slab)	3	slab	\$ 10,000.00	\$ 30,000		number adjusted for size	
E2020	Mobile - Parallele (slab)	12	Slab	\$ 2,500.00	\$ 30,000		number adjusted for size	
E2020	Mobile - Parallele (Lan)	2	Lan	\$ 5,000.00	\$ 10,000		number adjusted for size	
<b>F SPECIAL CONSTRUCTION</b>								
<b>G SITE IMPROVEMENT</b>								
<b>G10 SITEWORK</b>						\$320,000	\$320.00	
G1010	Site Preparation	1	ALL	\$ 50,000.00	\$ 50,000	\$ 1.35		
G1010	Site Concrete	1	ALL	\$ 50,000.00	\$ 50,000	\$ 1.35		
G1010	Site Improvements, AC P.	1	ALL	\$ 60,000.00	\$ 60,000	\$ 1.62		
G1010	Landscaping & Irrigation	1	ALL	\$ 100,000.00	\$ 100,000	\$ 2.70		
G1010	Site Utilities	1	ALL	\$ 60,000.00	\$ 60,000	\$ 1.62		
<b>INDIRECT COST</b>						\$ 5,162,270	\$5,162.27	\$466.62
	Dead, Gen Lic & Bond Ris	6.33		\$ 385,882	\$385,882	\$ 8.25		
	OH & Profit	7X		\$ 450,330	\$450,330	\$41.55		
	Contingency	10X		\$ 16,588	\$16,588	\$1.55		
<b>TOTAL COST</b>						\$ 2,434,000	\$2,434.00	\$200.00

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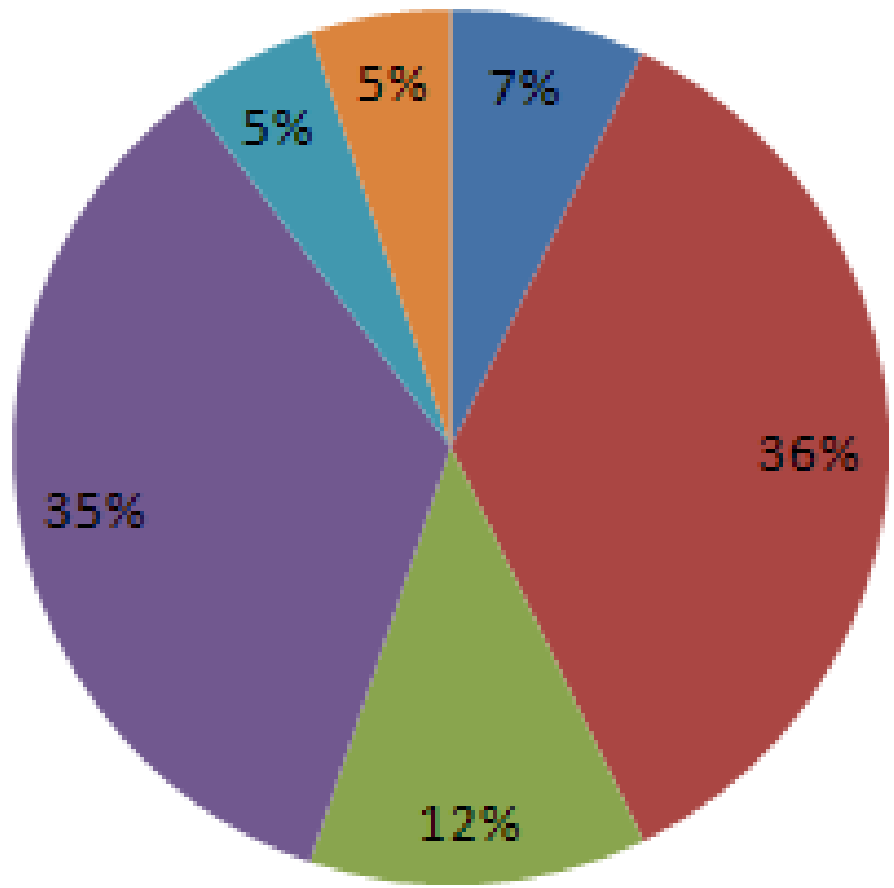
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## All of this for \$7.5M !!!

Level 1	Level 2	Level 2 Cost	Percent	Level 1 Cost	Per cent
Substructure	EXCAVATION	125000	2.0	443000	7%
Shell	SUPERSTRUCTURE	757500	12.3	2192200	36%
Interiors	INTERIOR CONSTRUCTION	499000	8.1	768100	12%
Services (MEP)	CONVEYING SYSTEM	221600	3.6	2130300	35%
Equipment & Furnishing	EQUIPMENT	23050	0.4	309000	5%
Site Prep	SITework	320000	5.2	320000	5%
<b>Sub Total</b>		<b>6162620</b>			
		<b>INDIRECT COST</b>		<b>1352300</b>	
<b>Total Cost</b>		<b>7515000</b>			



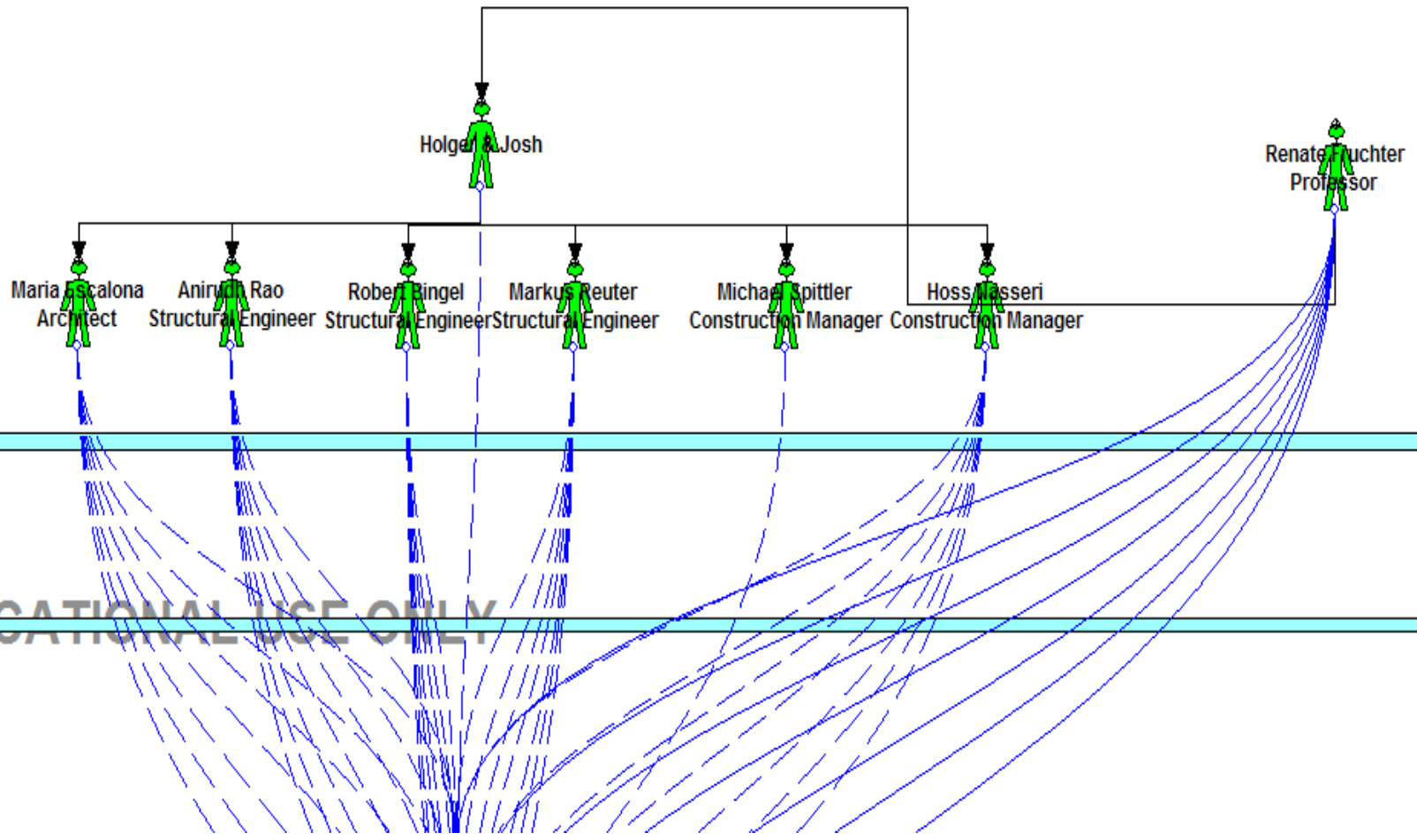
# Cost Summary



- Substructure
- Shell
- Interiors
- Services (MEP)
- Equipment & Furnishing
- Site Prep



# SimVision Setup



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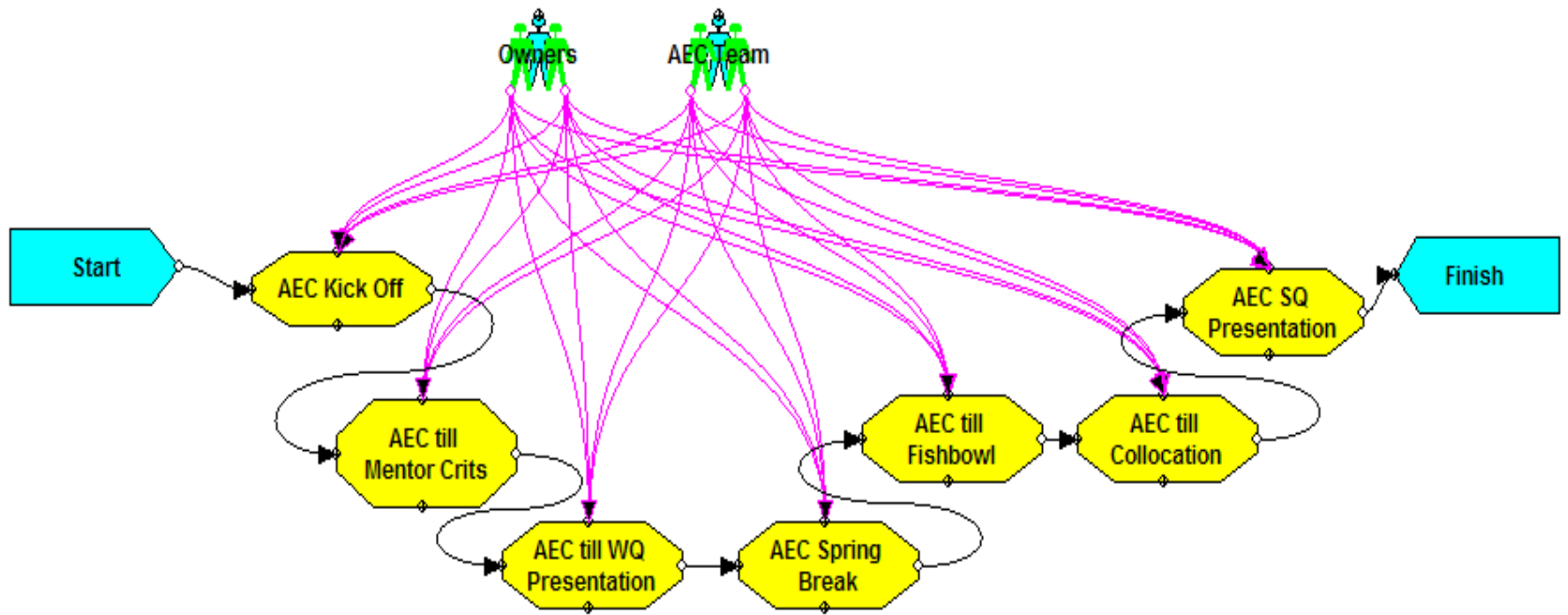
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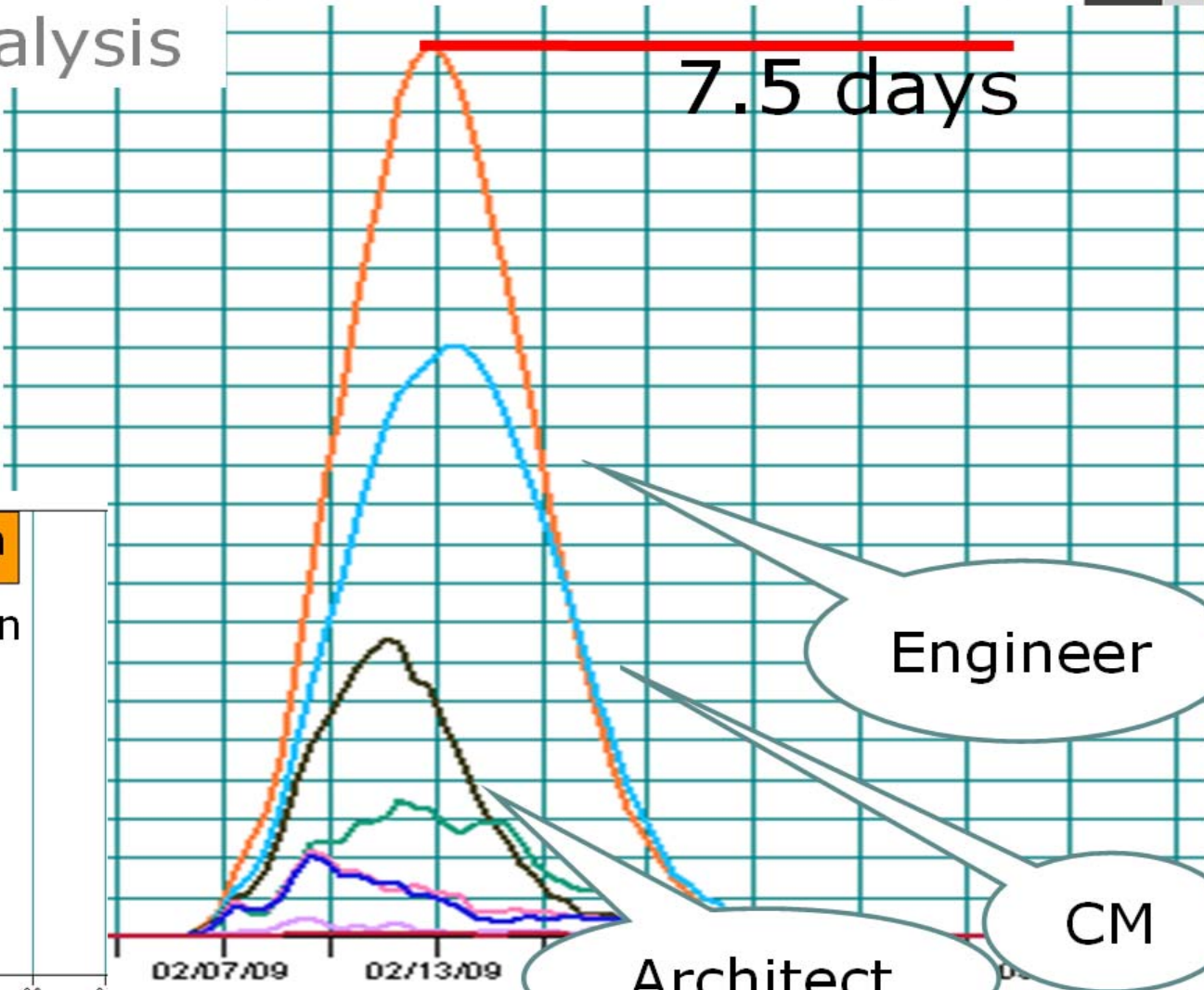


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## SimVision Analysis

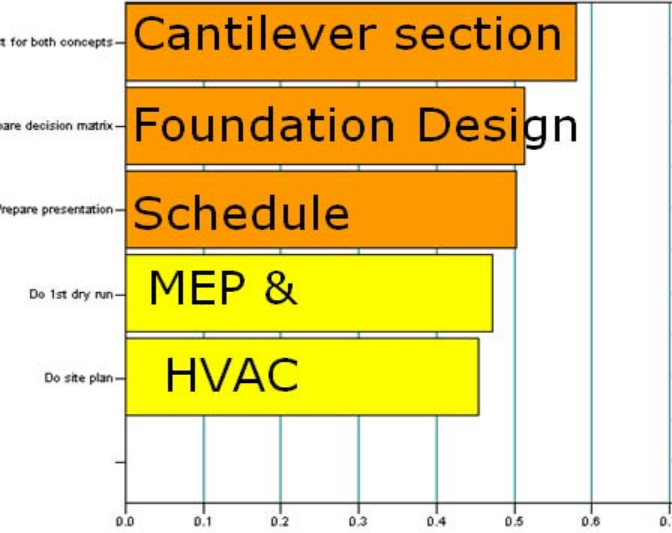


7.5 days

Engineer

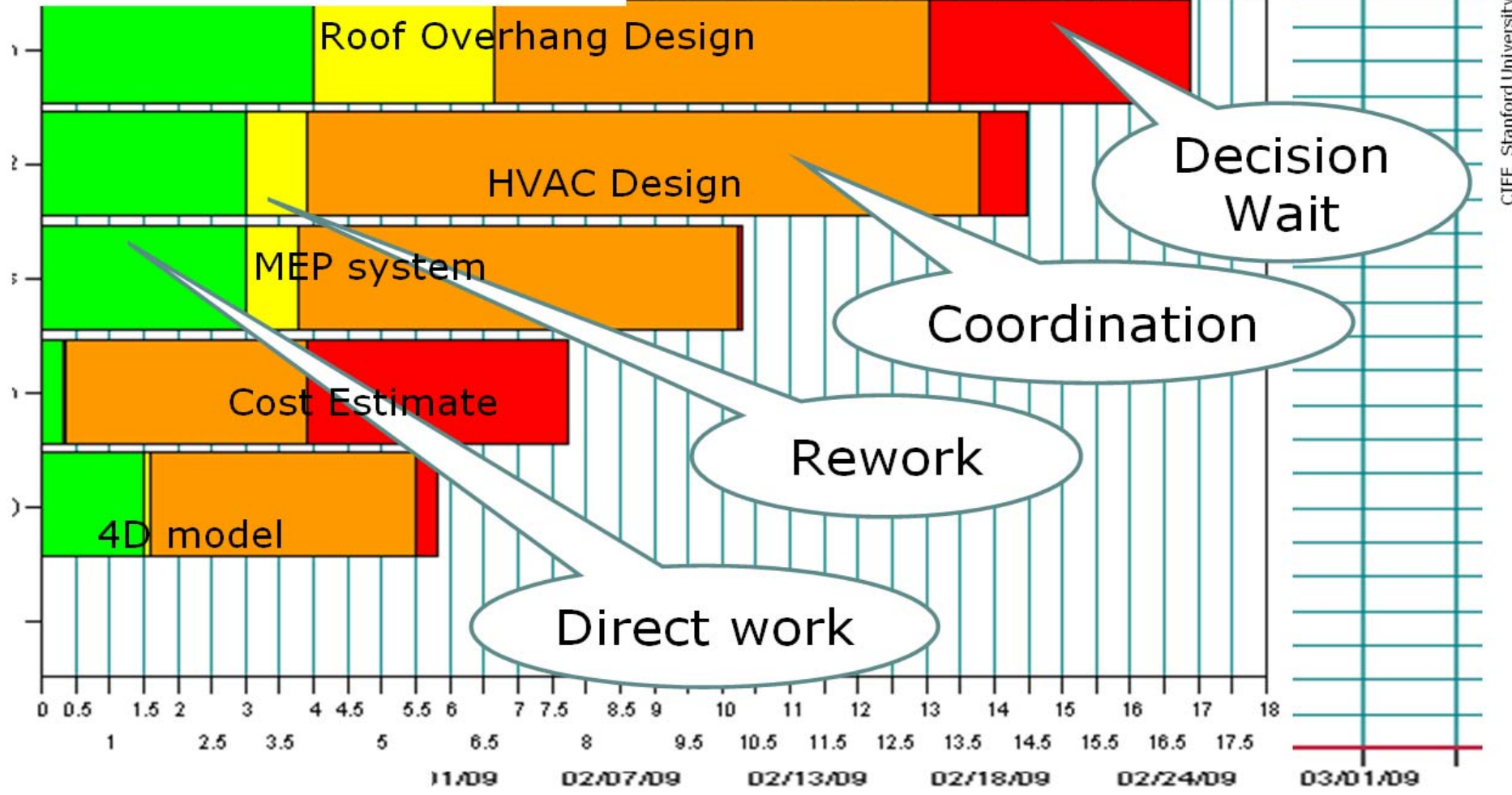
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# SimVision Analysis



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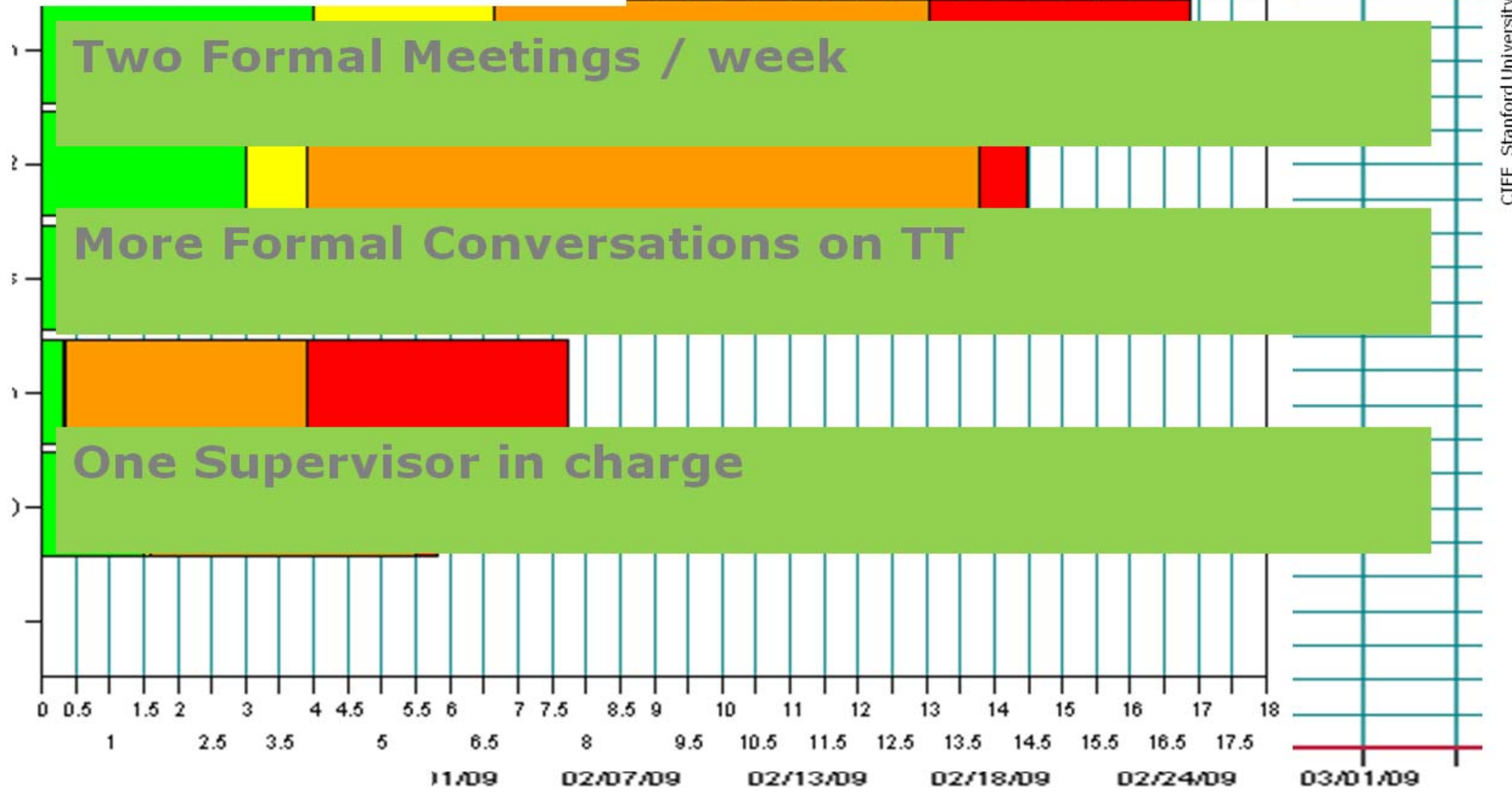
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## SimVision Analysis



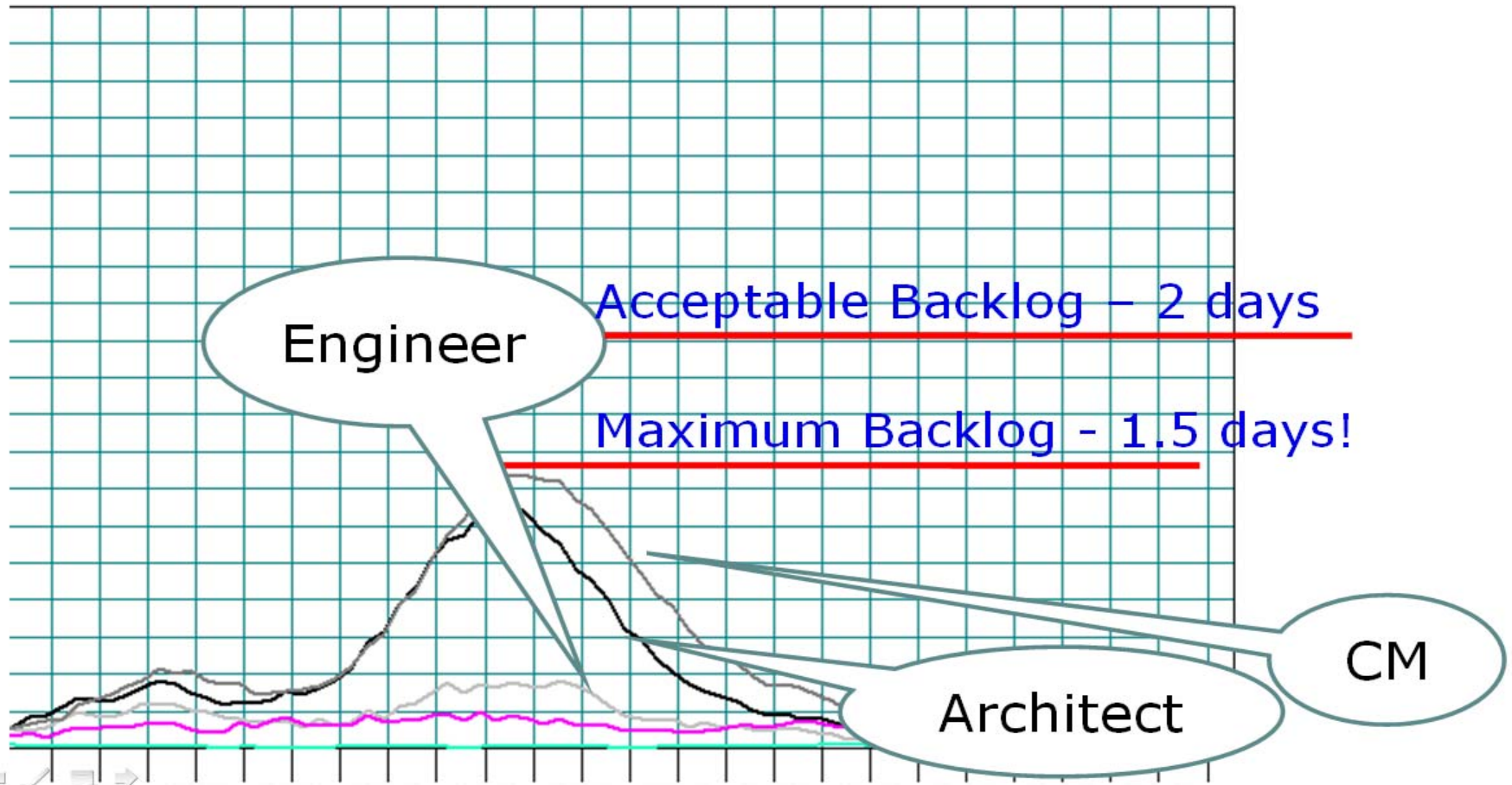
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# Result of our Interventions

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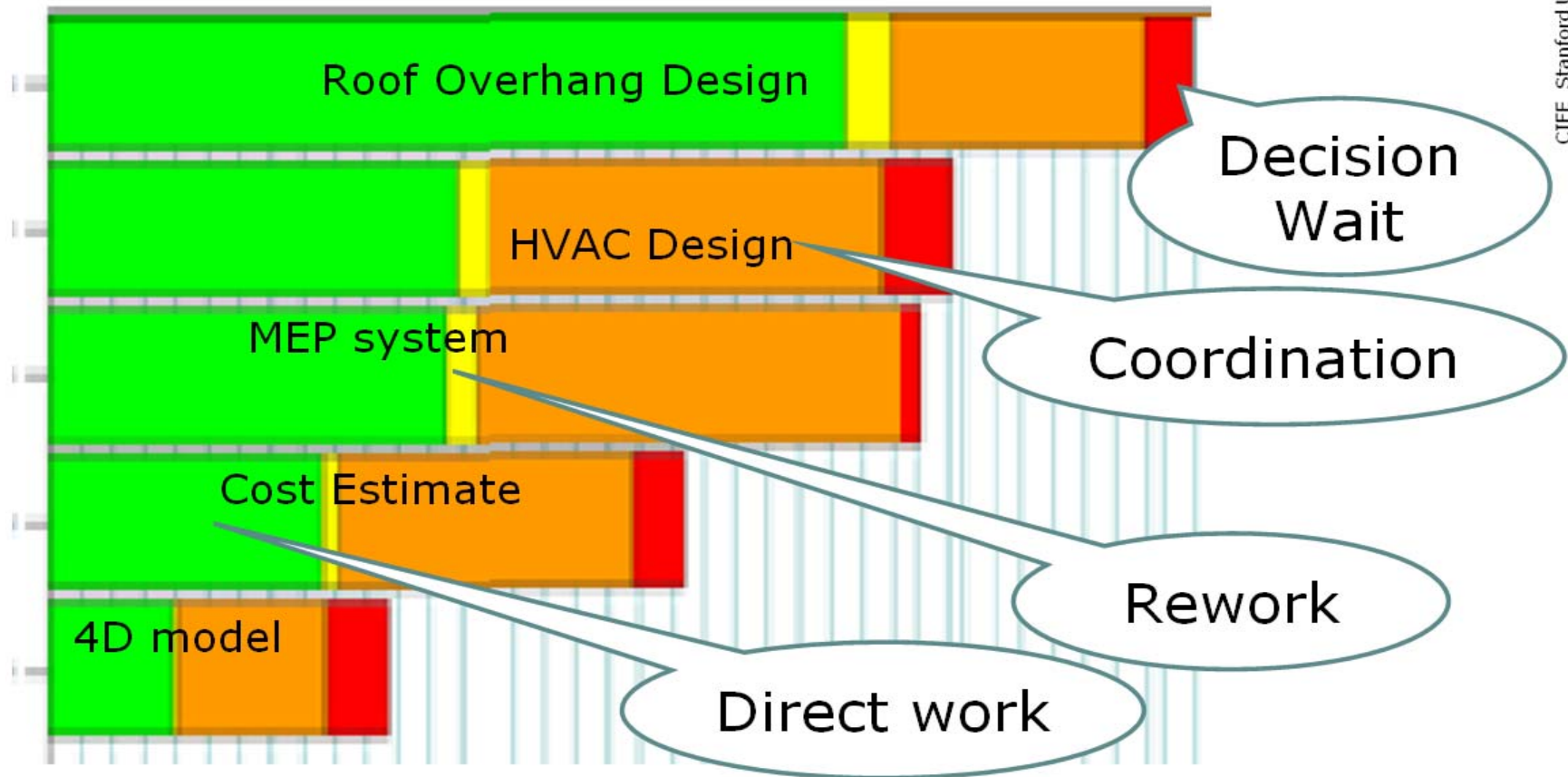
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# Result of our Interventions

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# Zero Waste Summary: **A**

- Minimize square footage
- Create efficient circulation areas
- Material selection
- Efficient slope of auditorium floor
- Elimination of roof overhang
- Maximizing use of daylight



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# Zero Waste Summary: **E**

- Optimal structural design
- Lightweight structure eliminates need for piles
- Replacing of MRFs by braced frames
- Use of sloped columns reduces member sizes



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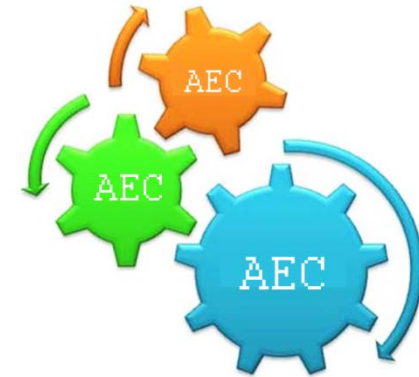
# Zero Waste Summary: **C**

- Last Planner System
- Just in Time Delivery
- Blue Jeans Insulation
- 2 Air Handling Units
- Glass and fly-ash in concrete aggregates
- Storm water reclaim system



# Lessons Learned

- Adapt to different time zones
- Effective information organization
- Learning to work with the different disciplines
- Presenting a lot of information in a short time frame effectively
- Just because you say you understand, does not mean you understand (Pacific 2006)
- Sometimes, all you have to do is ask 





# Special Thanks

Dr. Renate Fruchter

**Our Owners:** Josh Odelson and Holger Keitel

## **Architects:**

- Professor Humberto Cavallin
- David Bendet

## **Engineering**

- Professor Luis Daza Duarte
- Professor Helmut Krawinkler
- Nick Arenson
- Dr. Greg Luth

## **MEP**

- Professor John Nelson

## **Construction Managers**

- Dan Gonzales
- Igor Starkov
- Henry Tooryani