

UCLA Engineering School

TEAM CENTRAL 2009

Eric Kneer
(Owner)

Anja Jutraz
(Architect, Slovenia)

Ena Tobin
(MEP, Ireland)

Tobias Wolff
(LFCM, Germany)

Pinar Okumus
(Structural, USA - Madison)

Andres Beijer Lundberg
(CM, Sweden)

Jonathan Glassman
(Structural, USA - Stanford)

Prashant Sharma
(CM, USA, Stanford)

The TEAM

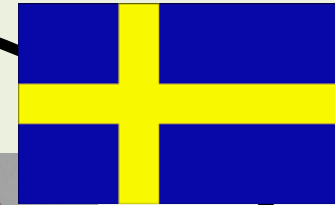
Jonathan
E
Stanford
University



Pinar
CM
UW Madison



Anders
CM
KTH



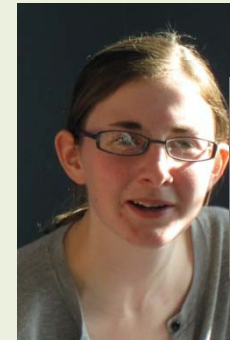
Anja
A
University of Ljubljana



Tobi
LCFM
Bauhaus University



Prashant
CM
Stanford University



Ena
MEP
University College
Cork

U
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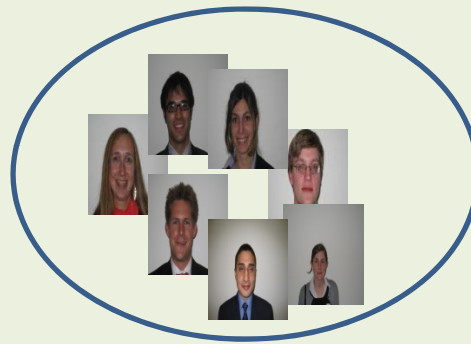
M

L

TEAM CENTRAL: PROJECT STRUCTURE



Contractors



Project Team



User / students



Bank



University



Private



Owner/
Investors

PARTNERSHIP

LOCATION



UCLA

LA
DOWNTOWN

A
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LOCAL WEATHER



Summer Temperature

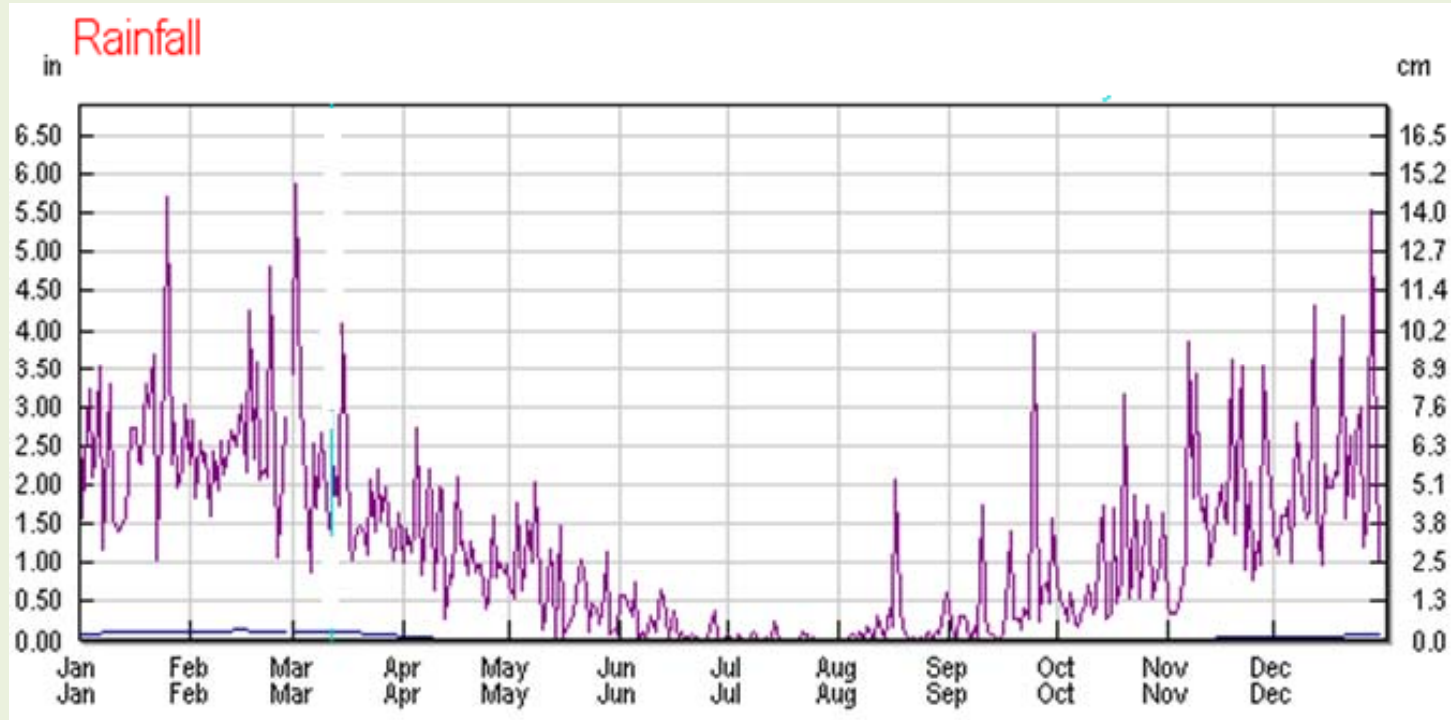
- Avg. Max : 85 F
- Avg. Min : 61 F

Winter Temperature

- Avg. Max: 68 F
- Avg. Min : 48 F



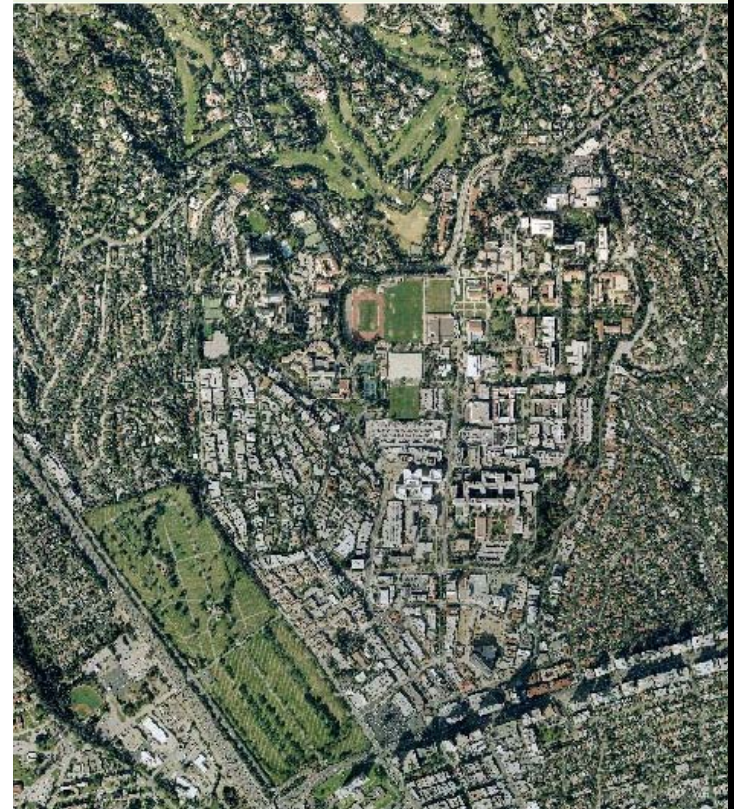
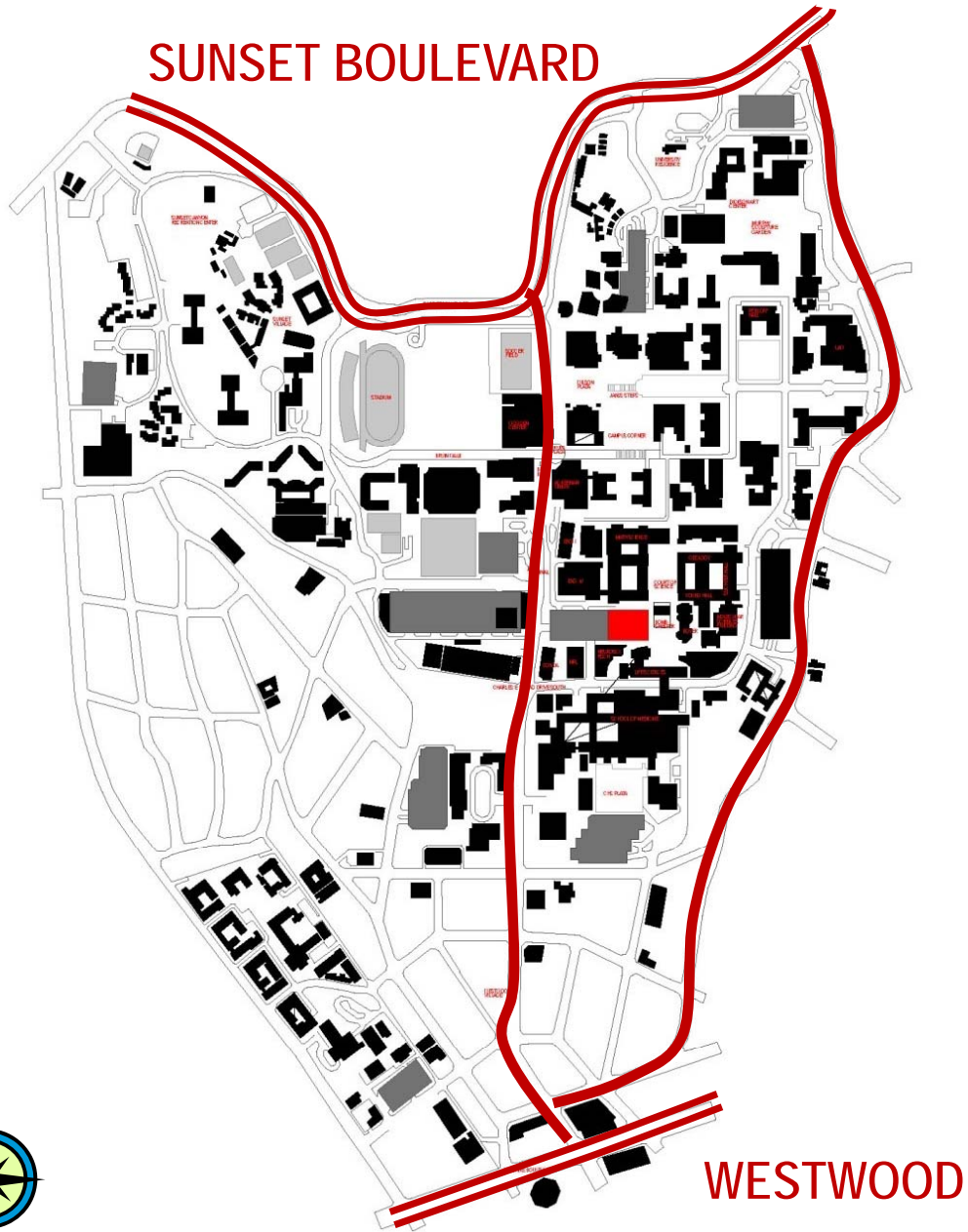
LOCAL - WEATHER



- Rainfall
Summer: 1.75 inch,
Winter: 13.04 inch
- Wind Speed
Avg. Max. : 8.5 MpH
Avg. Min. : 6.2 MpH
- Max Humidity
Summer: 86% (morning)
Winter: 68% (morning)
- Avg. morning humidity: 79%
- Avg. afternoon humidity: 65%



UCLA CAMPUS



U
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A



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SURROUNDING

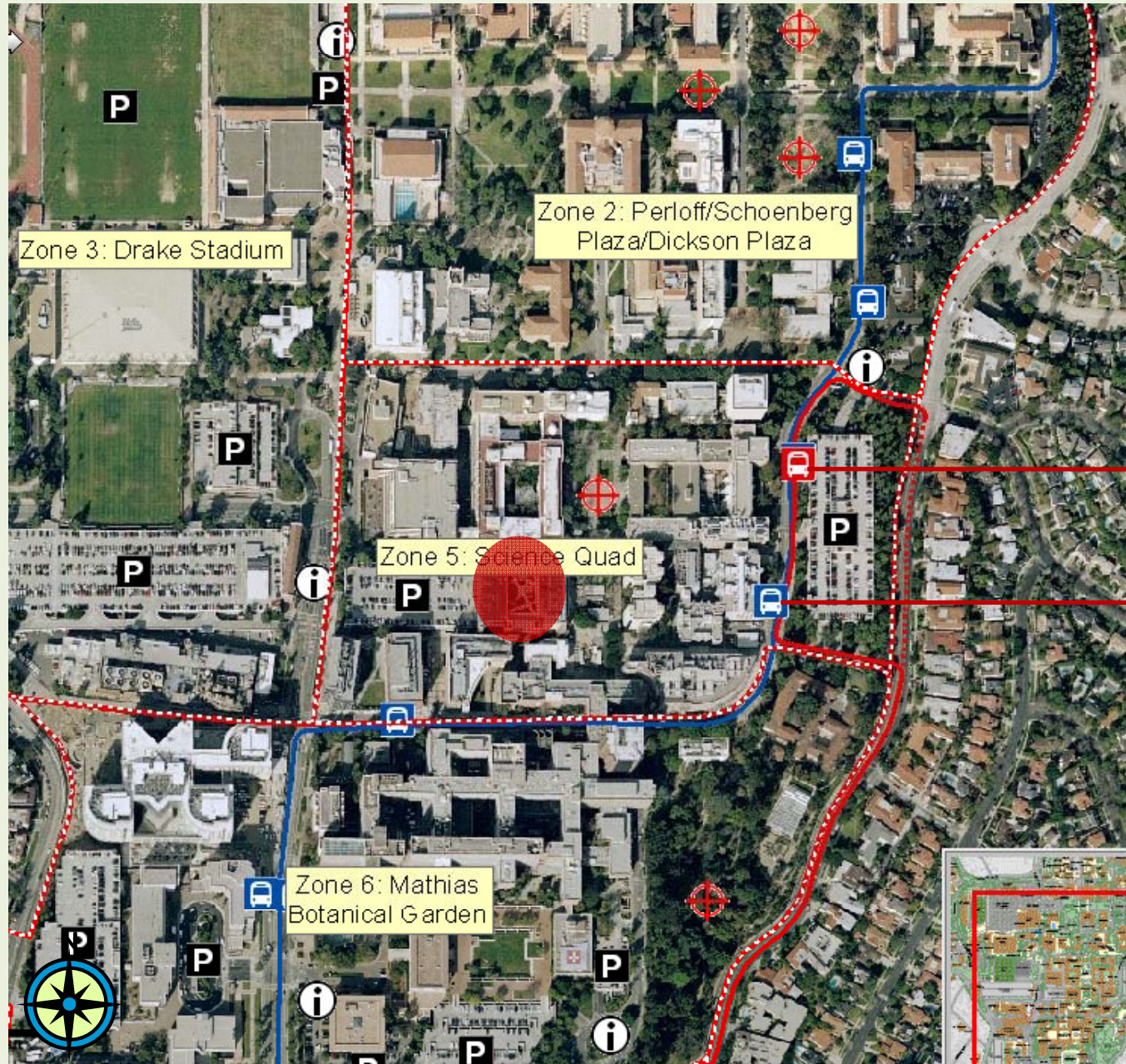


OUR SITE



**A
E
C
M
L**

SCIENCE QUAD

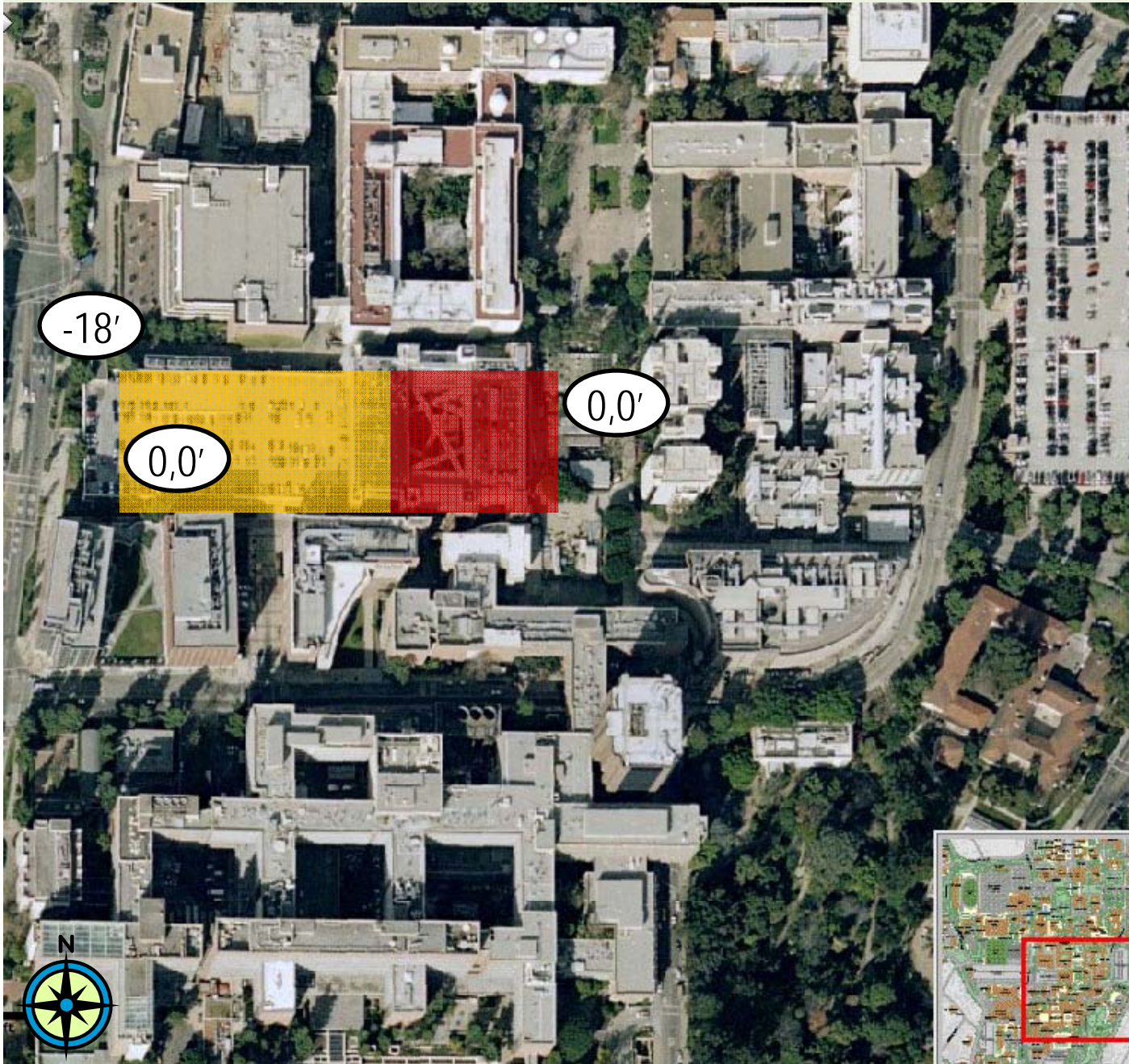




BUS STOP

BUS STOP



PARKING GARAGE



-  OUR SITE
-  PARKING GARAGE



PHOTOS - courtyard



U
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A

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PHOTOS



U
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A

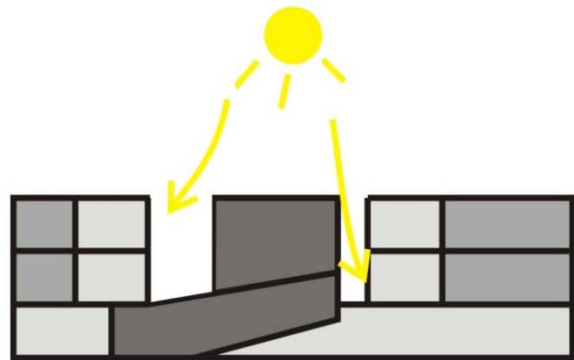
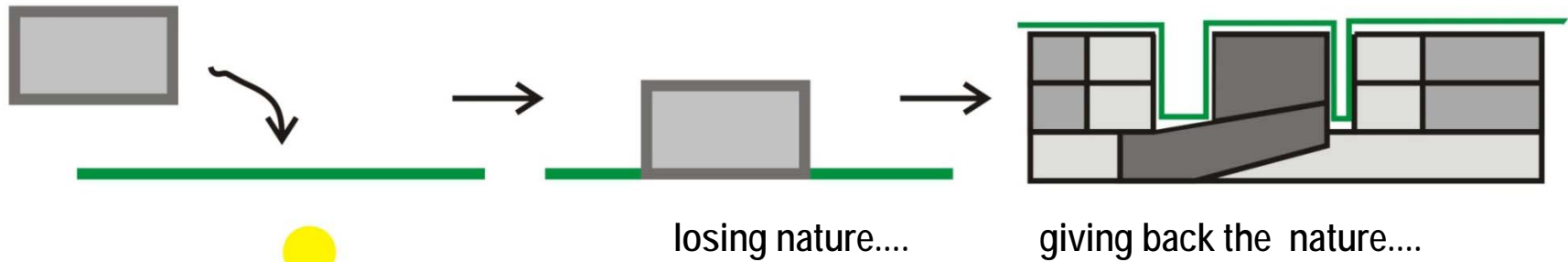
E

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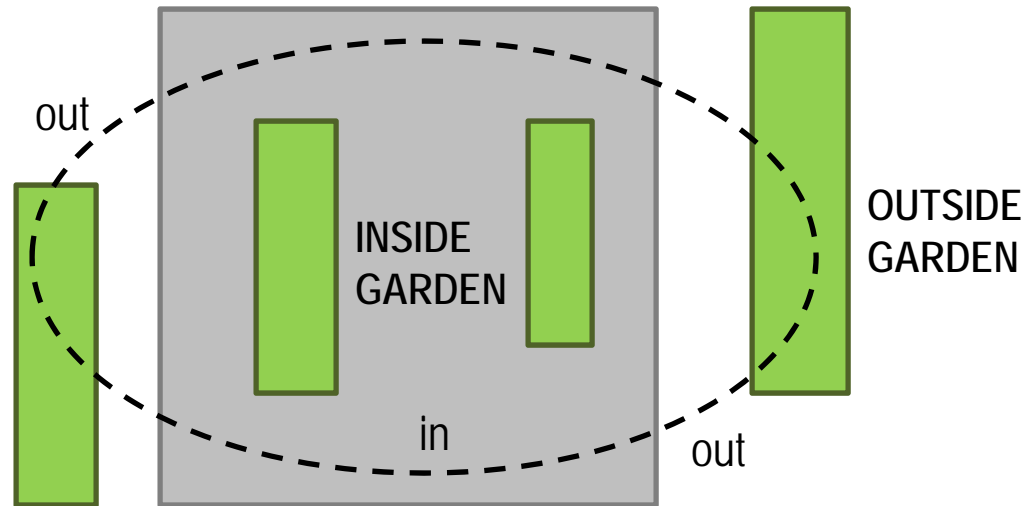
M

L

BIG IDEA 1 - NATURE

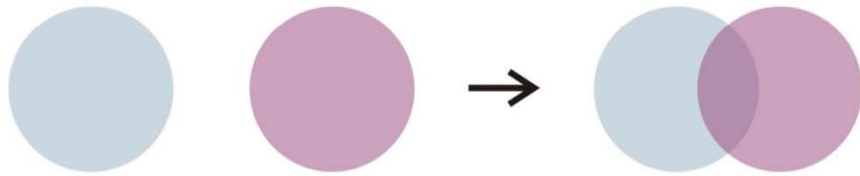


...bringing daylight in the building - PATIOS

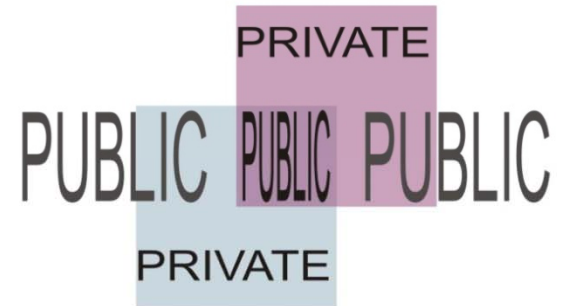
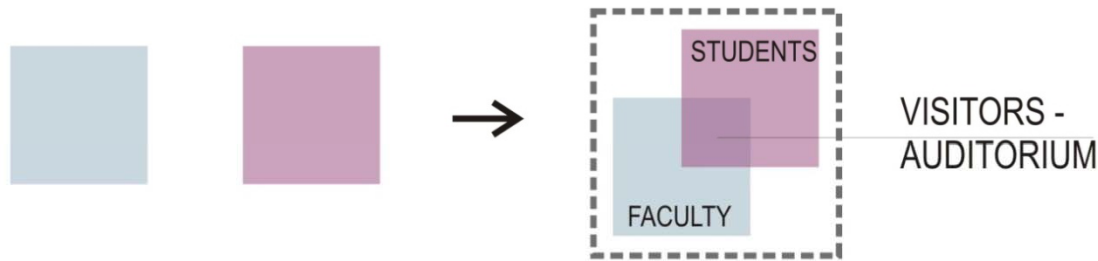


...connecting outside and inside greener space

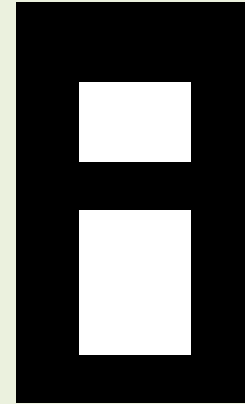
BIG IDEA 2 – TWO HANDS



2 GROUPS OF PEOPLE
2 PROGRAMS
need/wish to be alone & together



T TYPOLOGY OF OTHER BUILDINGS



CONCEPT OF
ATRIUMS

U
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A



A

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PARKS IN UCLA



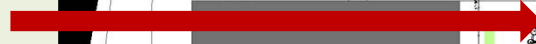
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A
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ACCESS

Service access -
through the
parking garage



bus stop



people



U
C
L
A



A

E

C

M

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LANDSCAPING AND SURROUNDING

U
C
L
A



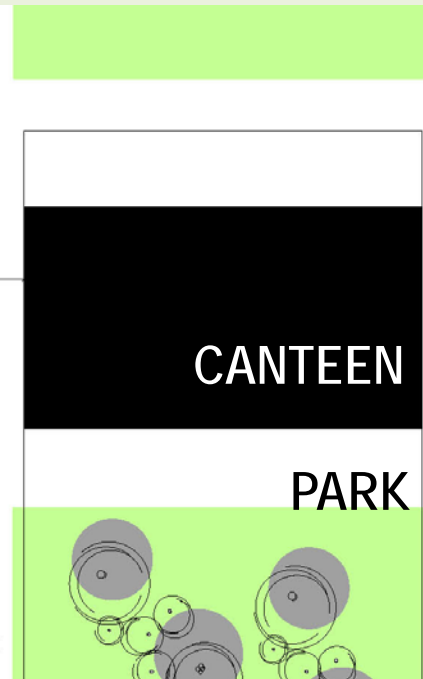
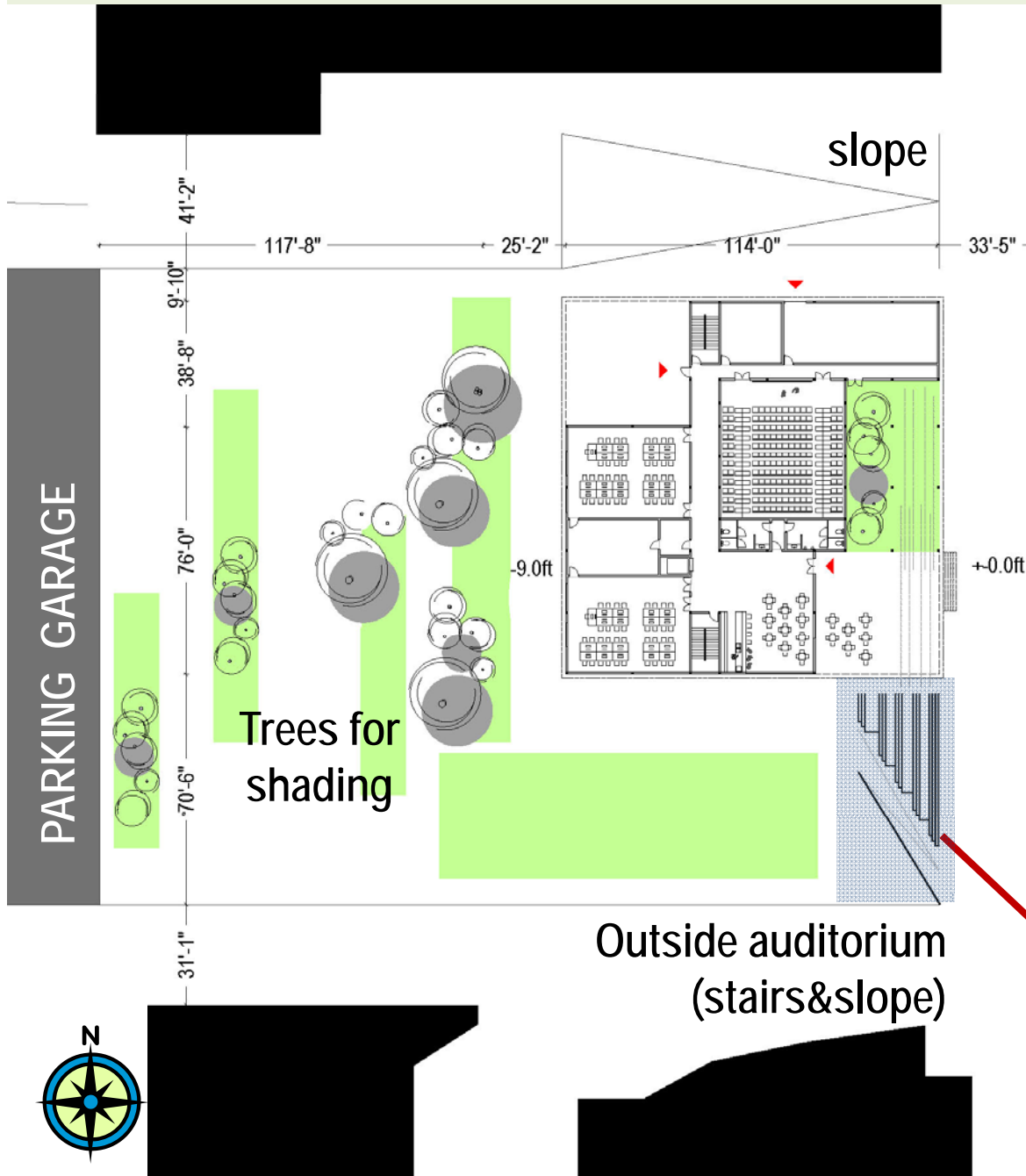
A

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ACCESS

MAIN ENTRANCE

2nd storey

U
C
L
A



A

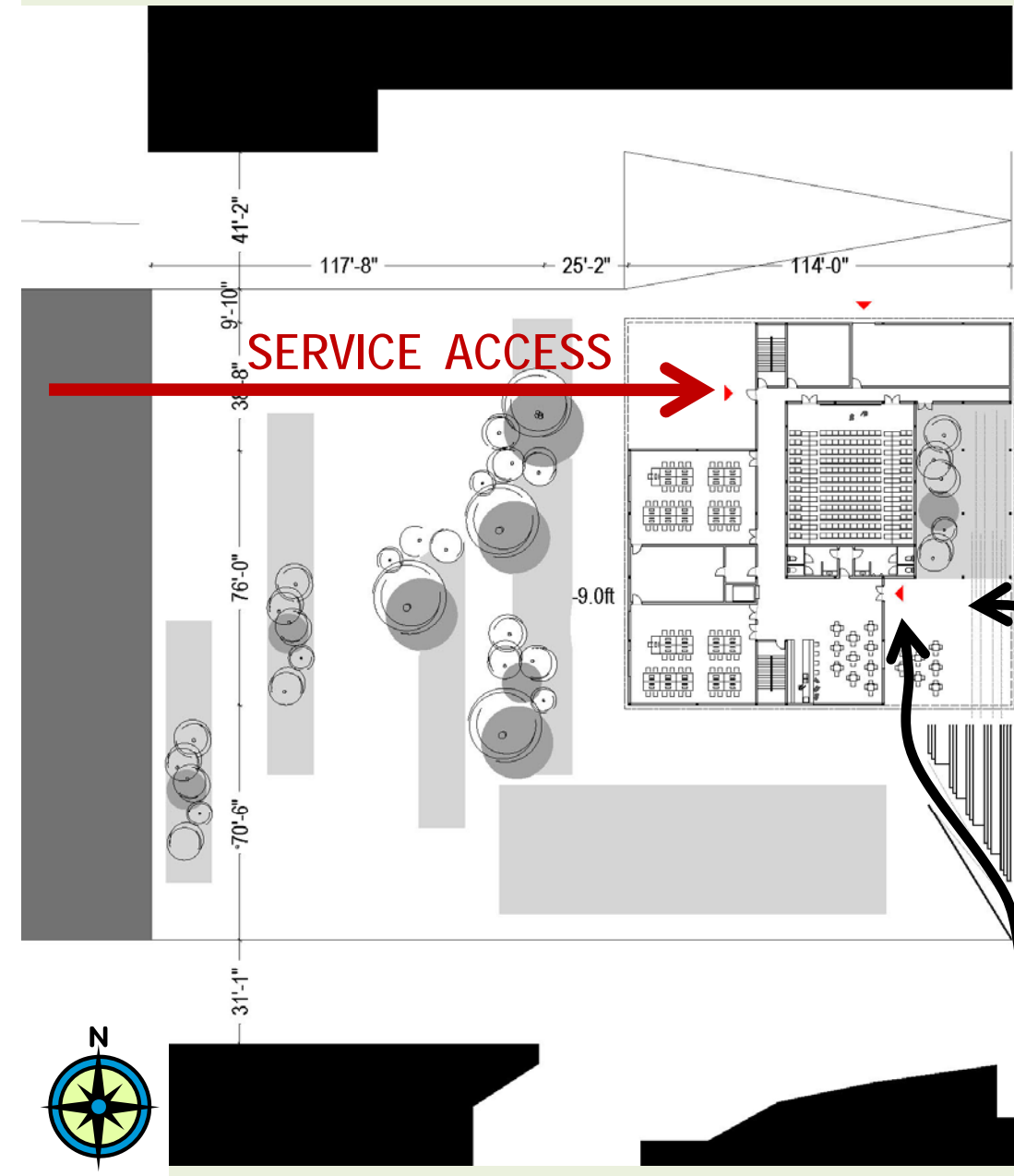
E

C

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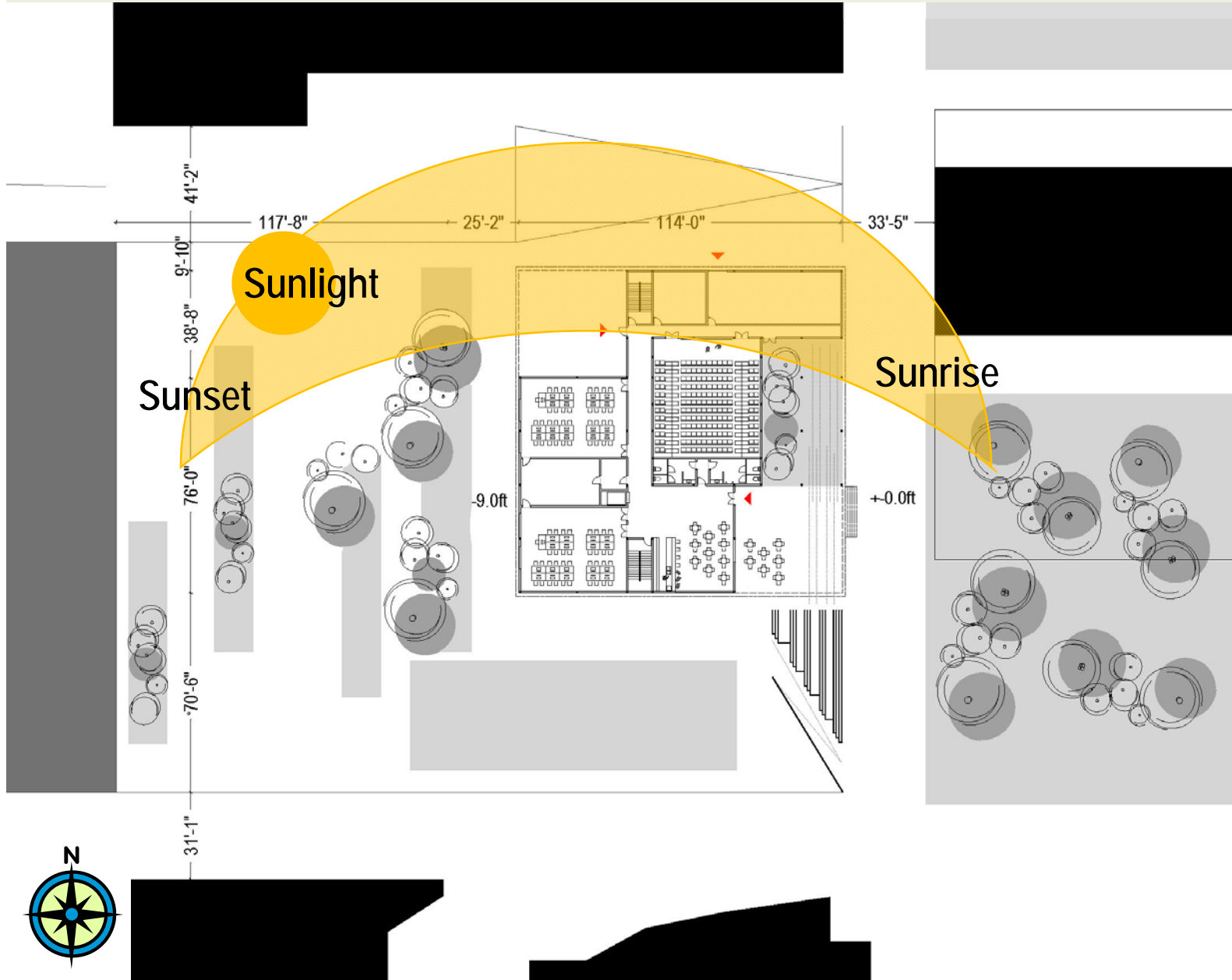
SERVICE ACCESS



ADA ACCESS

1st storey

ORIENTATION - SUN



U
C
L
A



A

E

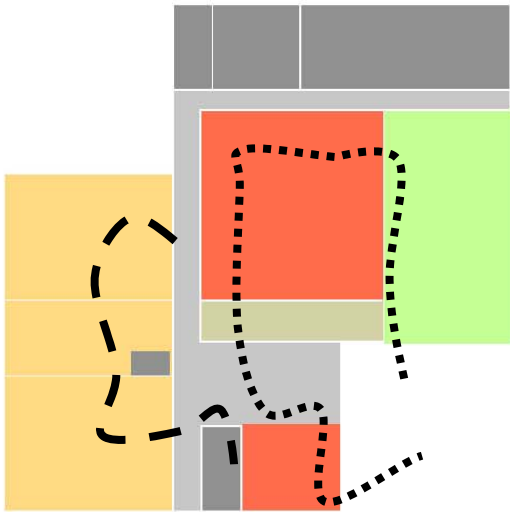
C

M

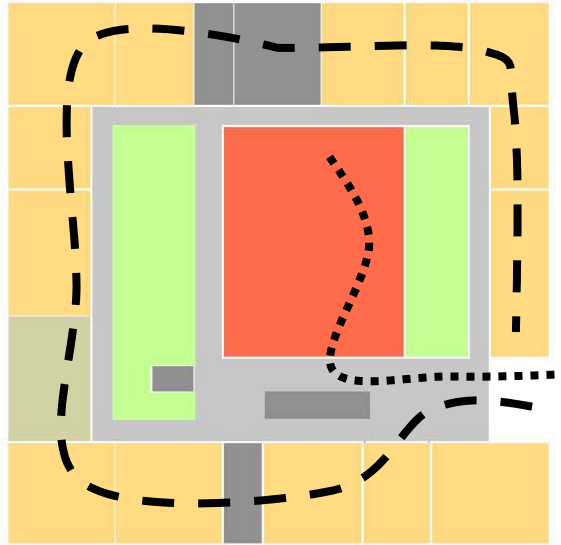
L

ACTIVITY MODEL

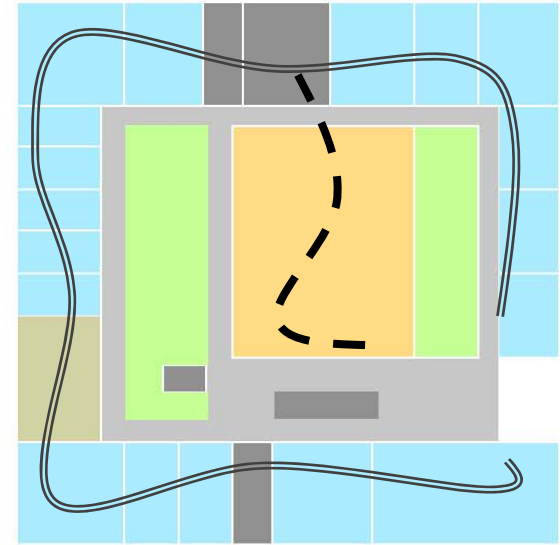
1 STOREY



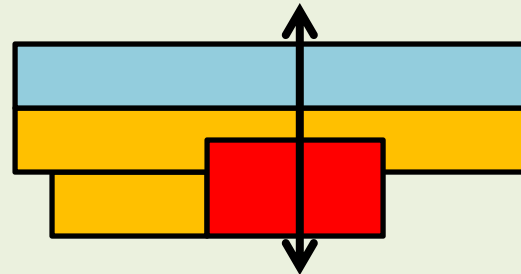
2 STOREY



3 STOREY



PRIVATE



SEMI-PRIVATE

PUBLIC



STUDENTS



VISITORS



FACULTY



U
C
L
A



A

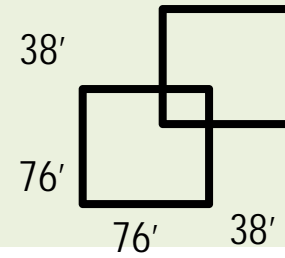
E

C

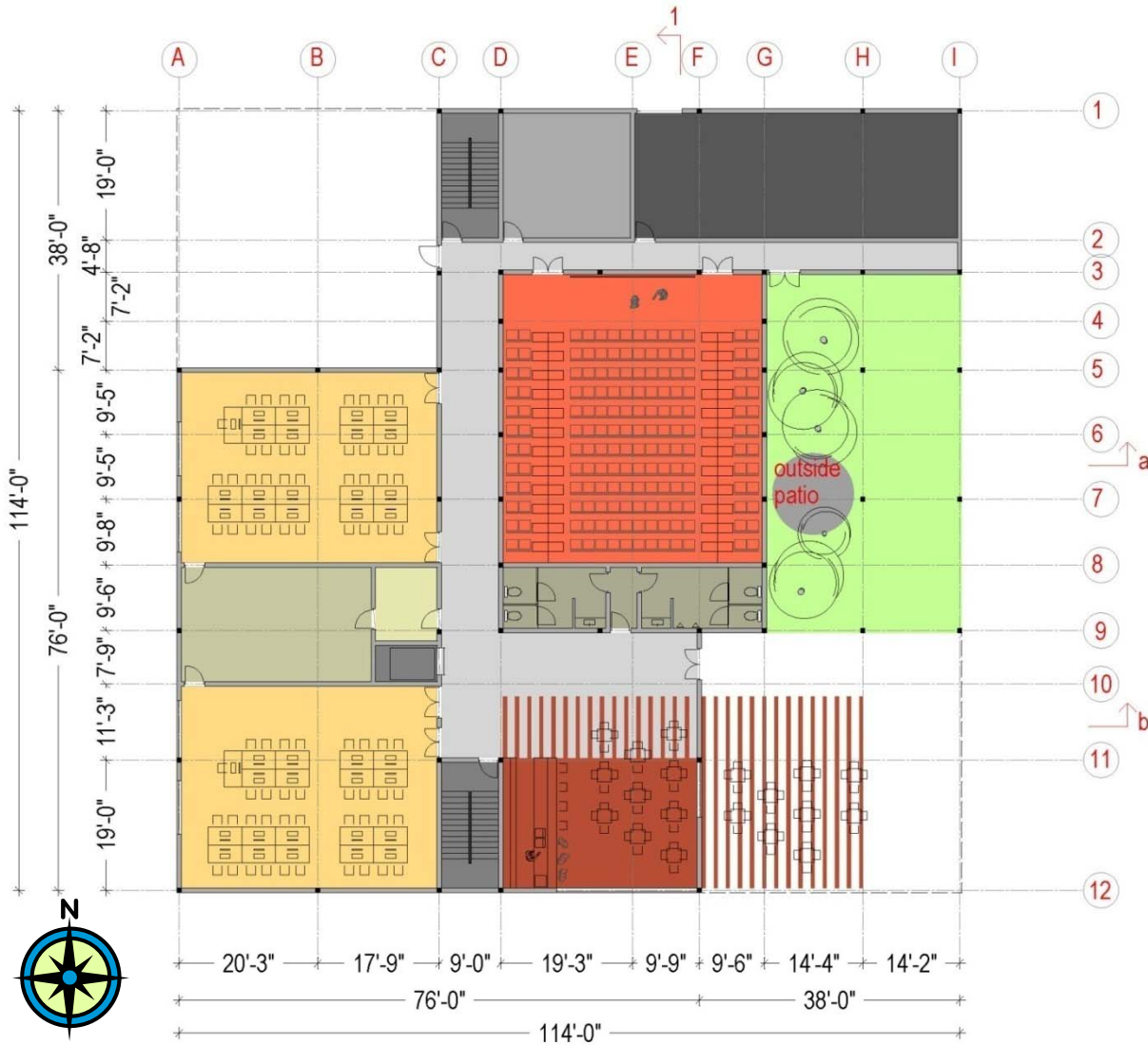
M

L

1st STORY



U
C
L
A



SERVICES

- CORRIDORS
- MECHANICAL SCHAFT
- STAIRS
- MECHANICAL ROOM
- RESTROOMS
- SERVER ROOM
- TECHNICAL SUPPORT

VISITORS

- AUDITORIUM
- CAFE (with exhibiton space)

STUDENTS

- INSTRUCTIONAL LABS

A

E

C

M

L

MAIN ENTRANCE – 2nd storey



2nd STORY

U
C
L
A



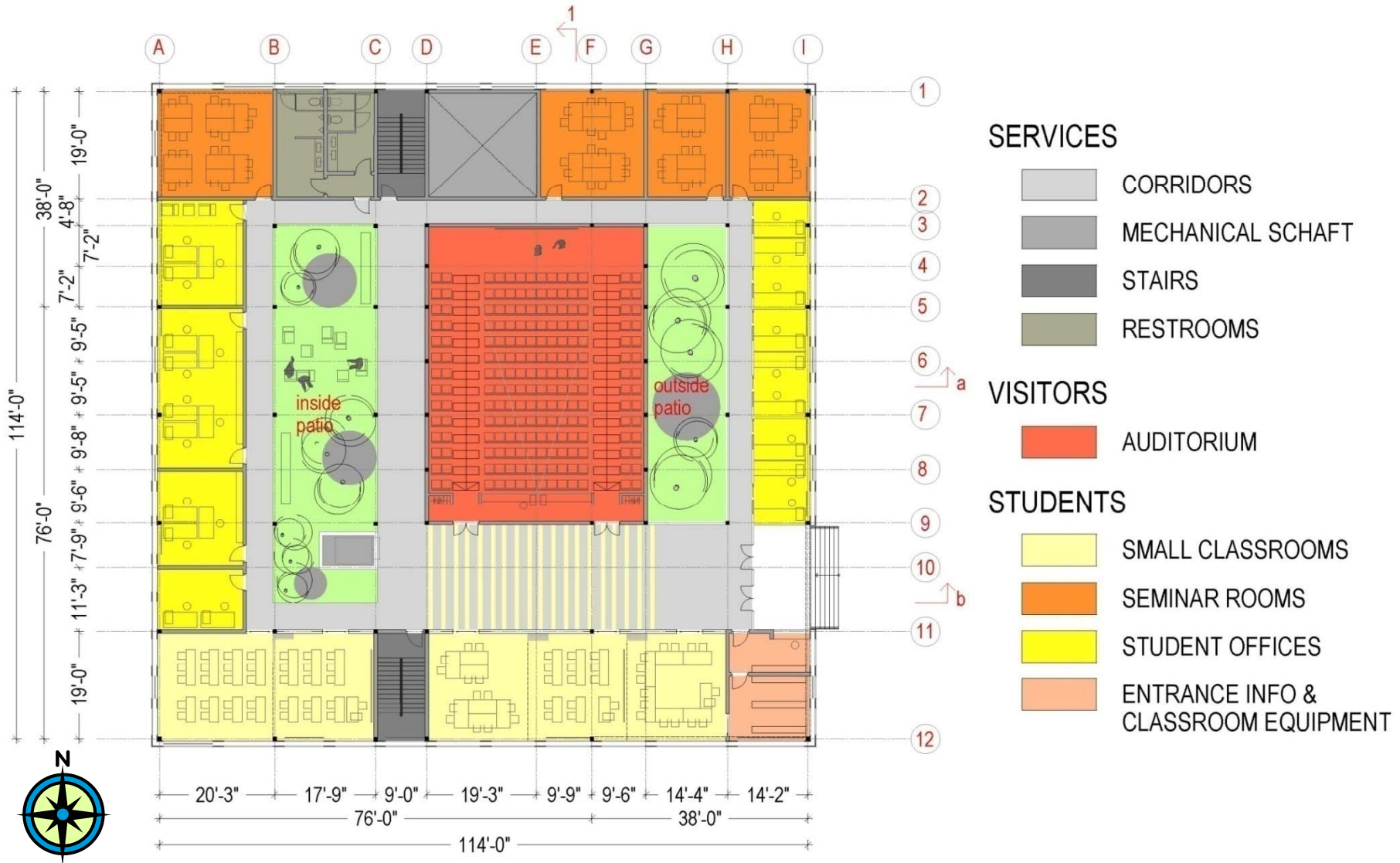
A

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ENTRANCE HALL



3rd STORY

U
C
L
A



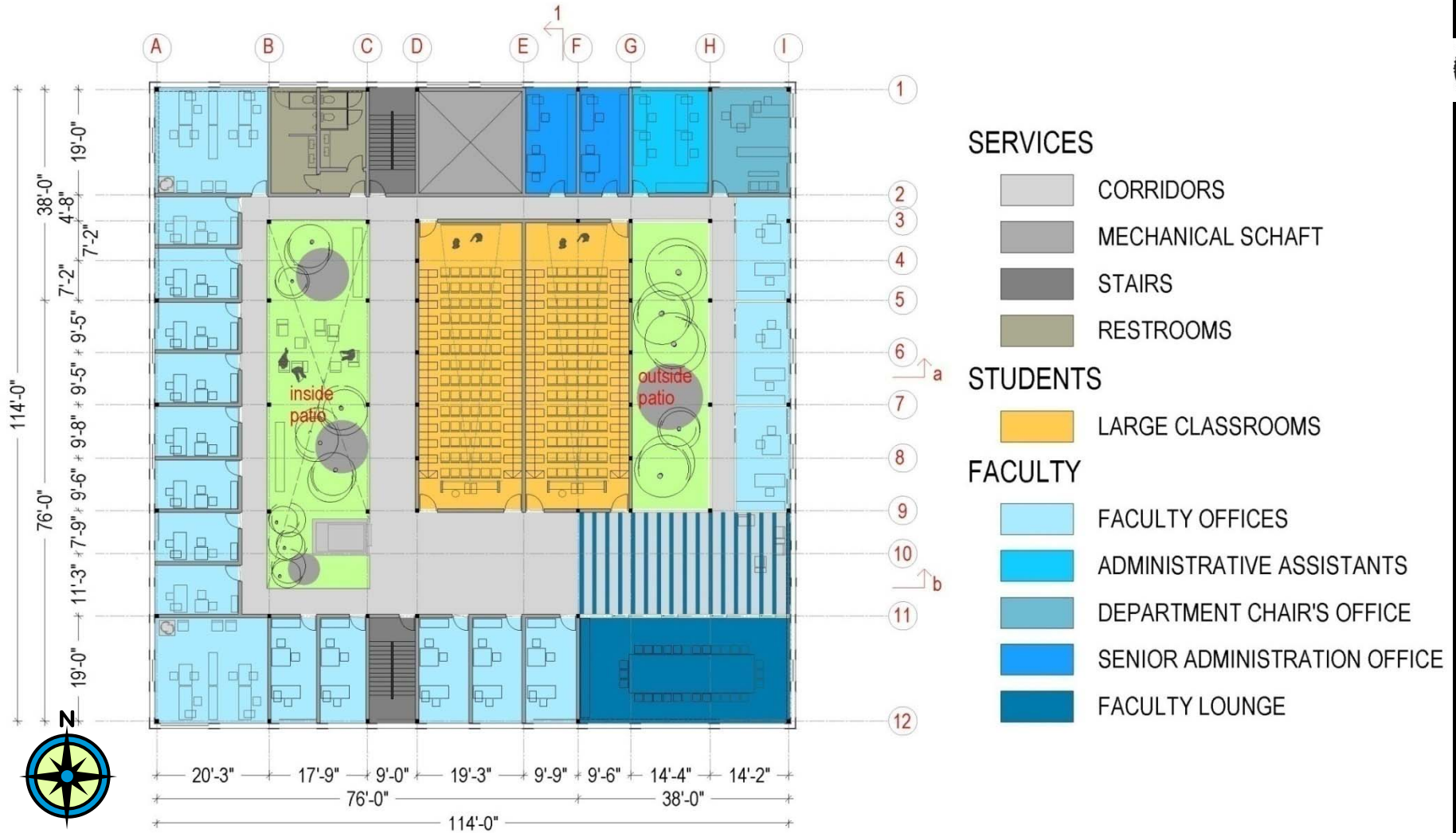
A

E

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INSIDE PATIO



U
C
L
A



A

E

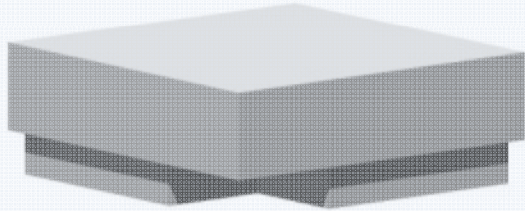
C

M

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FLOOR AREAS



Gross floor area

36,100

Net usable area

25,270

Net assignable area

17,942

Non assignable area

7,328

Structural area

10,830

Audi-
torium

2,498

Labs

2,355

Class-
rooms

6,001

Lounge

1,148

Offices

5,940

ROOF

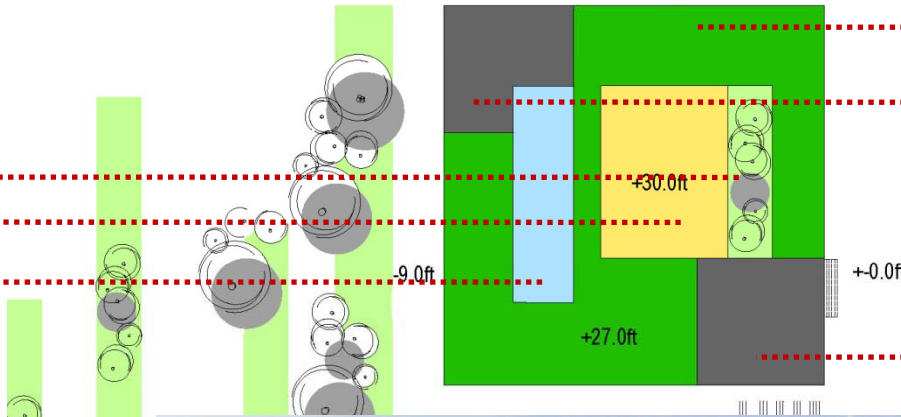
U
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A



Open space

Wood

Glass



Green roof

Solar cells

Solar cells

A

E

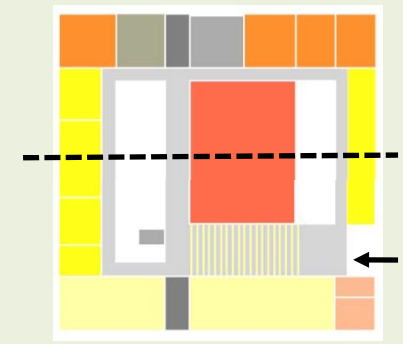
C

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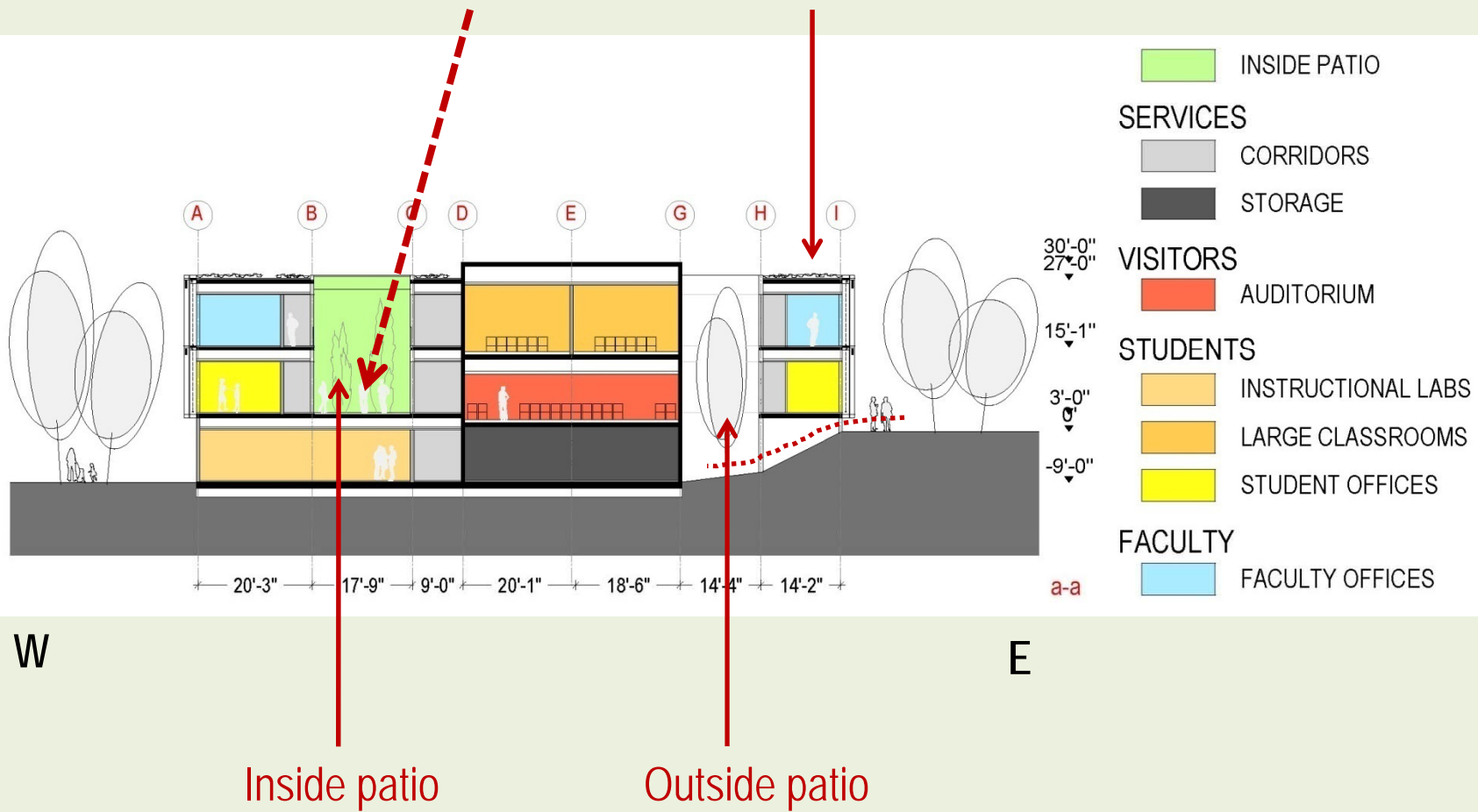


SECTION a-a

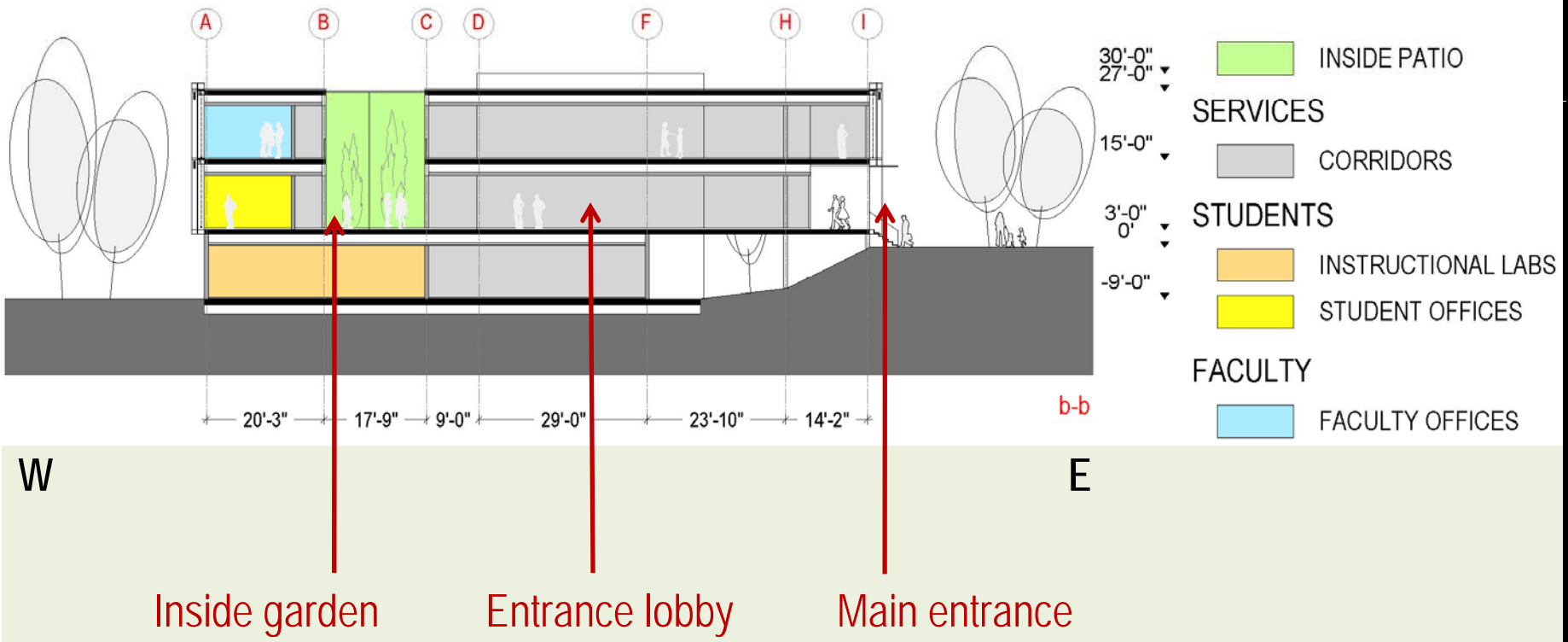
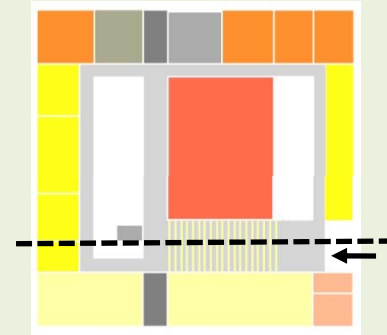


DAYLIGHT

Green roof

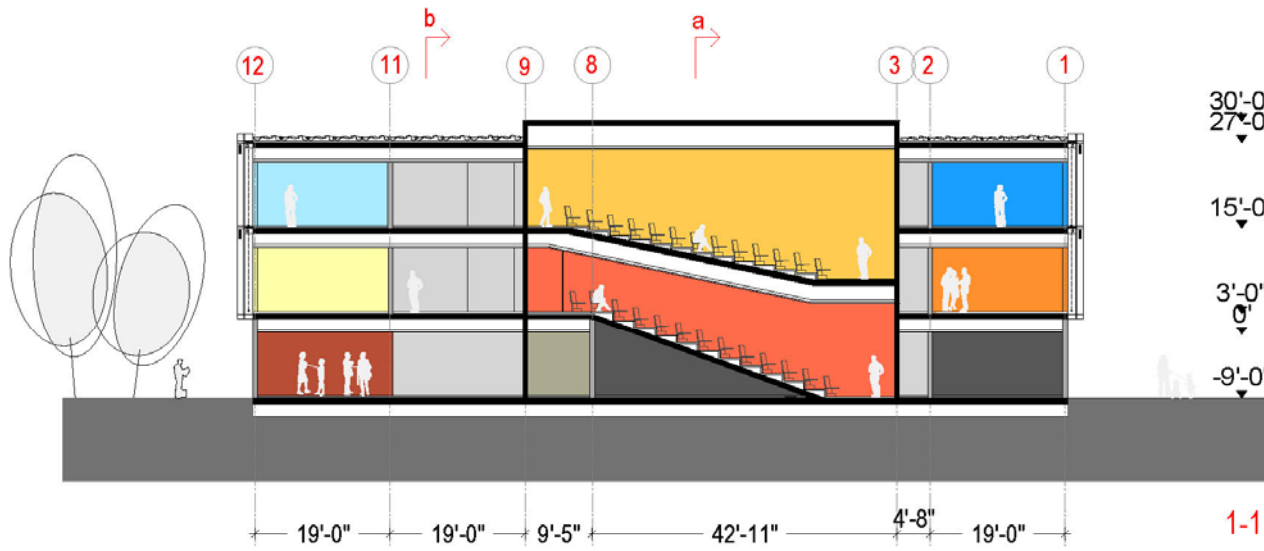
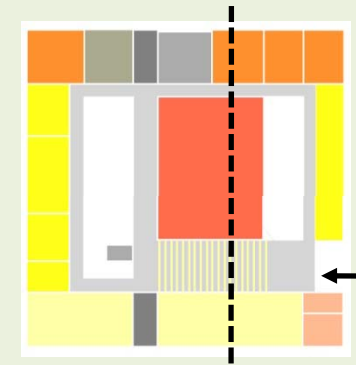


SECTION b-b



A
E
C
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SECTION 1-1



SERVICES

- CORRIDORS
- MECHANICAL ROOM
- STORAGE
- RESTROOMS

VISITORS

- AUDITORIUM
- CAFE

STUDENTS

- SMALL CLASSROOMS
- LARGE CLASSROOMS
- SEMINAR ROOMS

FACULTY

- FACULTY OFFICES
- SENIOR ADMINISTRATION OFFICE

W

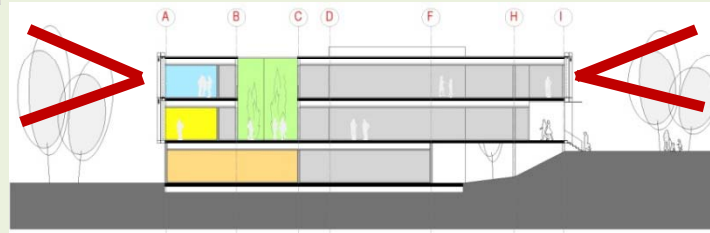
E

A
E
C
M
L

ORIENTATION AND SHADING

- MAINTAIN THE VIEWS

U
C
L
A



W

E

A

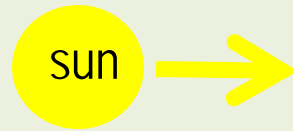
E

C

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L

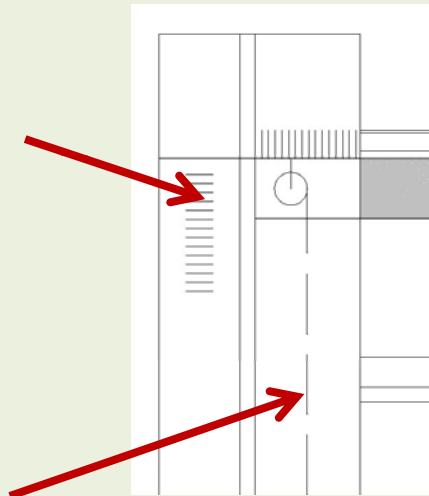
ORIENTATION AND SHADING



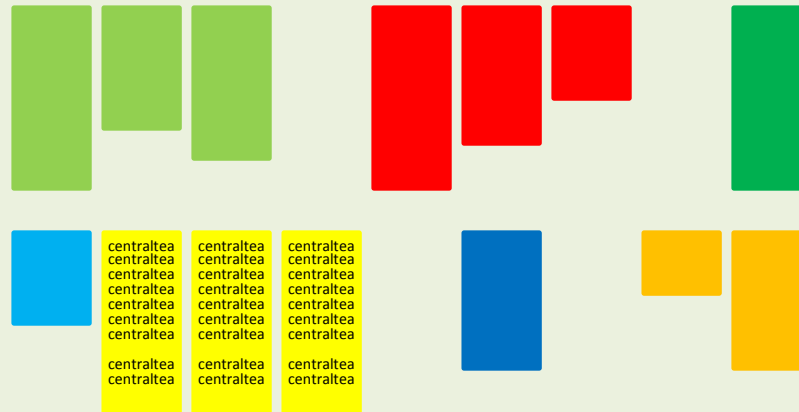
- TREES



- OUTSIDE METAL SHADING ELEMENTS



- INSIDE TEXTILE SHADING ELEMENTS



Different programs → different colours

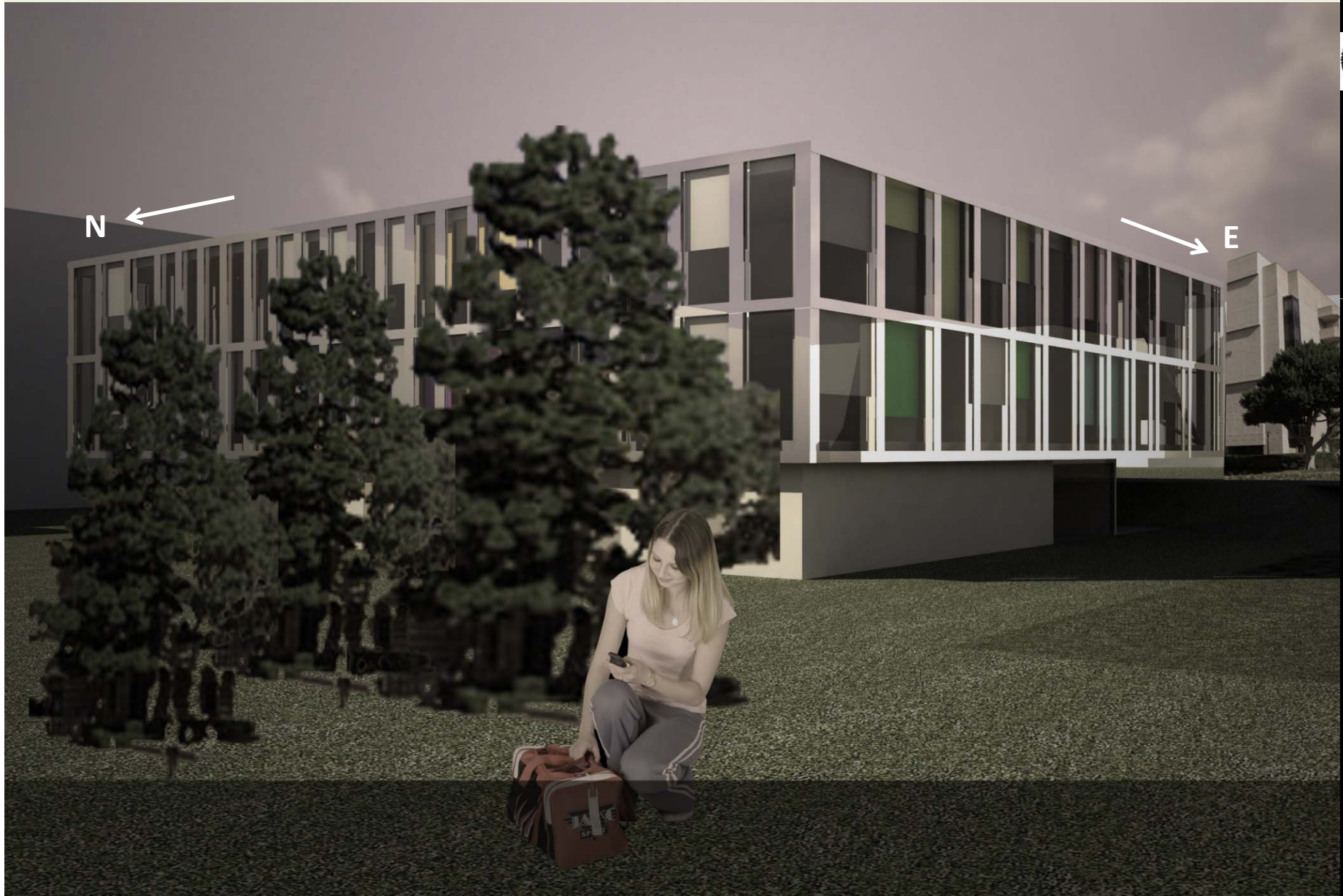
For different projections on the textile



FACADE

1_ CONCRETE

2 & 3_ GLASS / INOX (to reflect the surrounding)



FACADE

FLOOR-TO-CEILING GLAZING → EXTEND YOUR ROOM, YOUR VIEW

Lacaton&Vassal: "...floor-to-ceiling glazing, which grants the inhabitants of the apartment for the first time the advantages of the high rise, namely living spaces flooded with daylight and featuring panorama vistas on the surrounding landscape."



EXPERIENCE IN THE BUILDING

Inside patio



Studying, relaxing



Orestad – Denmark - Gimnasium

INSIDE PATIO – studying, relaxing



A
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M
L

COURTYARD ON EAST



U
C
L
A



A

E

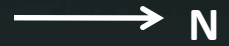
C

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NIGHT VIEW

U
C
L
A



CENTRAL SCHOOL OF ENGINEERING

A

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C

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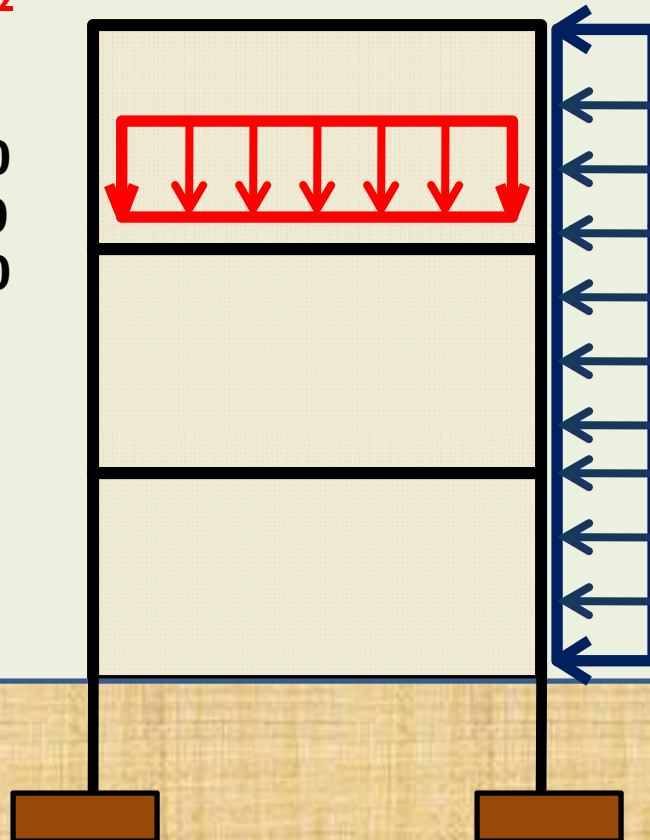
L



LOADS

Live Loads: (psf)

Classrooms:	40
Offices:	50
Corridors:	100
Auditorium:	100
Roof (green):	100



Earthquake:

Design Category:	D
Occupancy Category:	III
Importance Factor:	1.25
S_{DS}:	1.225
S_{D1}:	0.626

Wind:

Wind Speed:	<85mph
Building Class:	III
Exposure	B

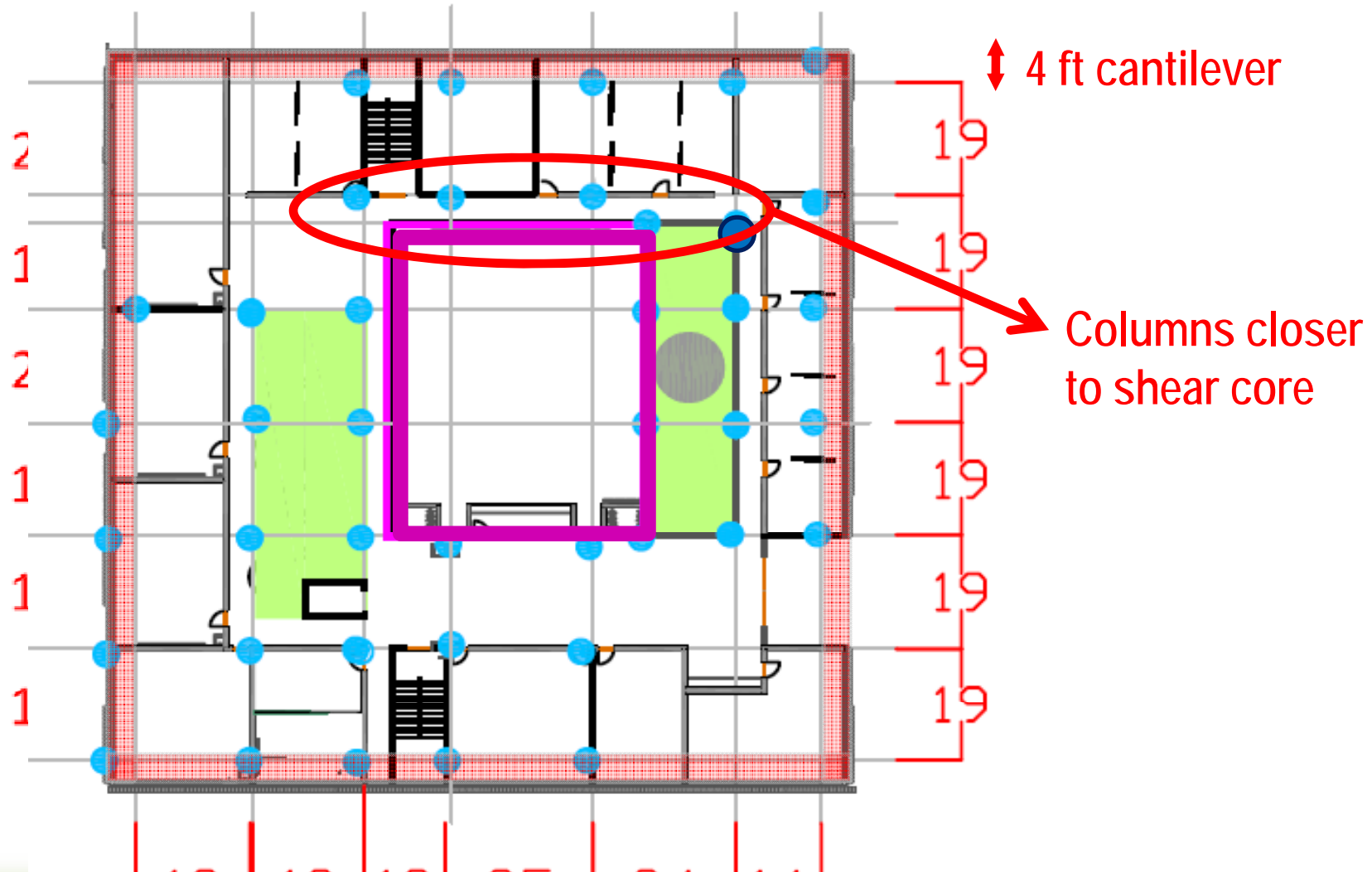
Soil:

Type:	Sandy soil
Bearing pressure:	5000 psf
Water depth:	15 ft
Liquefaction:	No



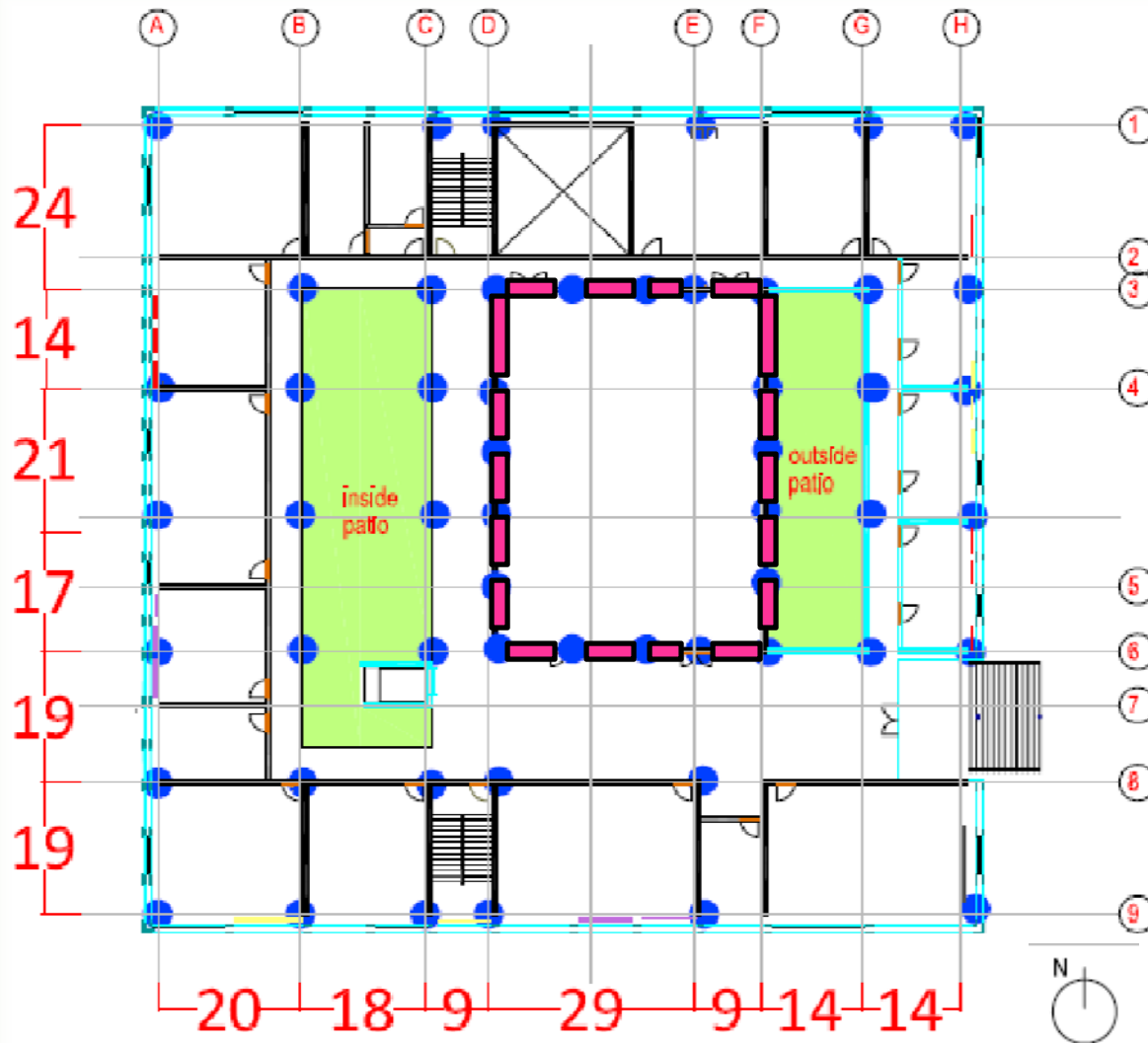
COLUMN LAYOUT

First Floor:



COLUMN LAYOUT

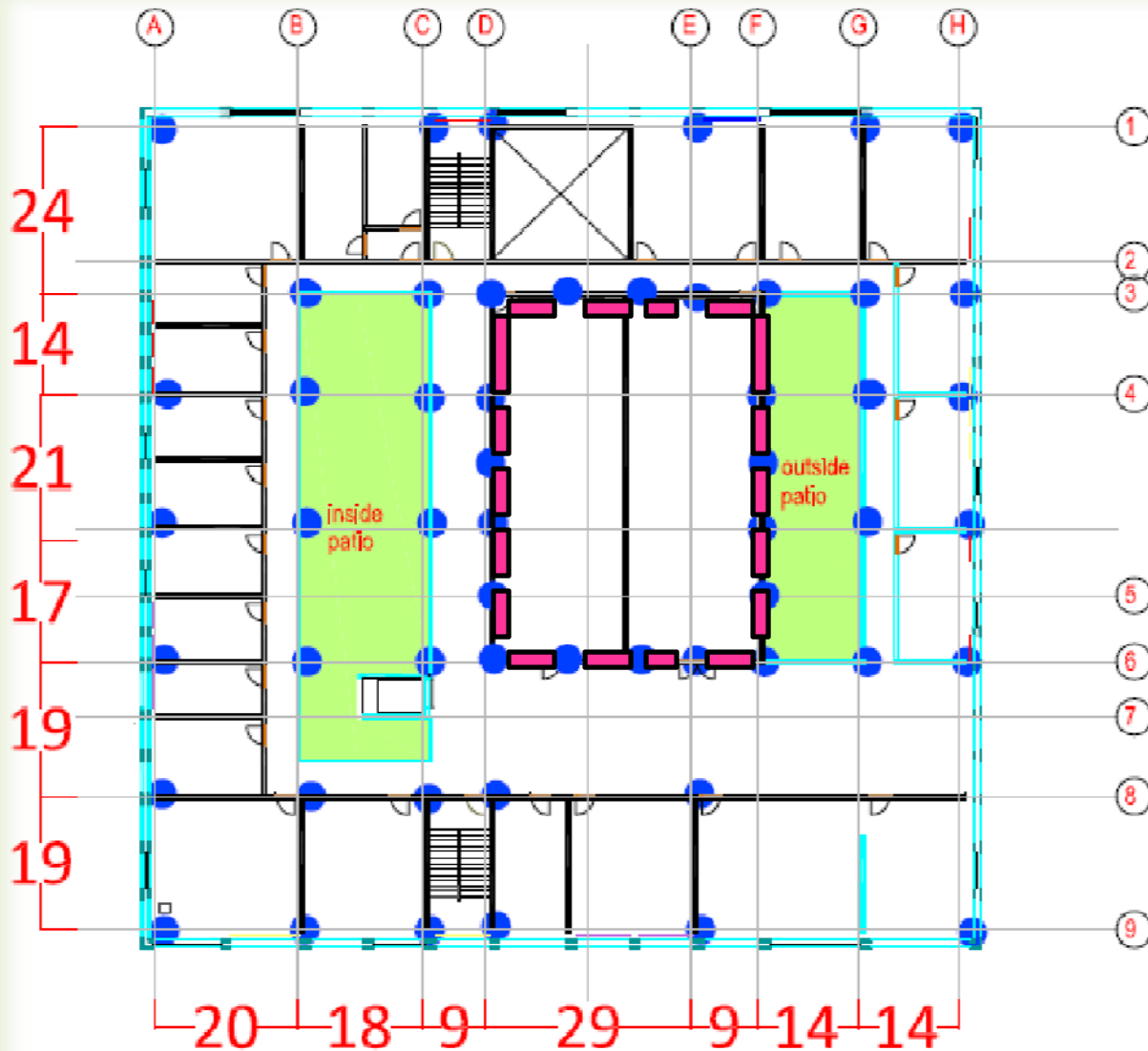
Second Floor:



- Columns
- Rotating Shear Walls

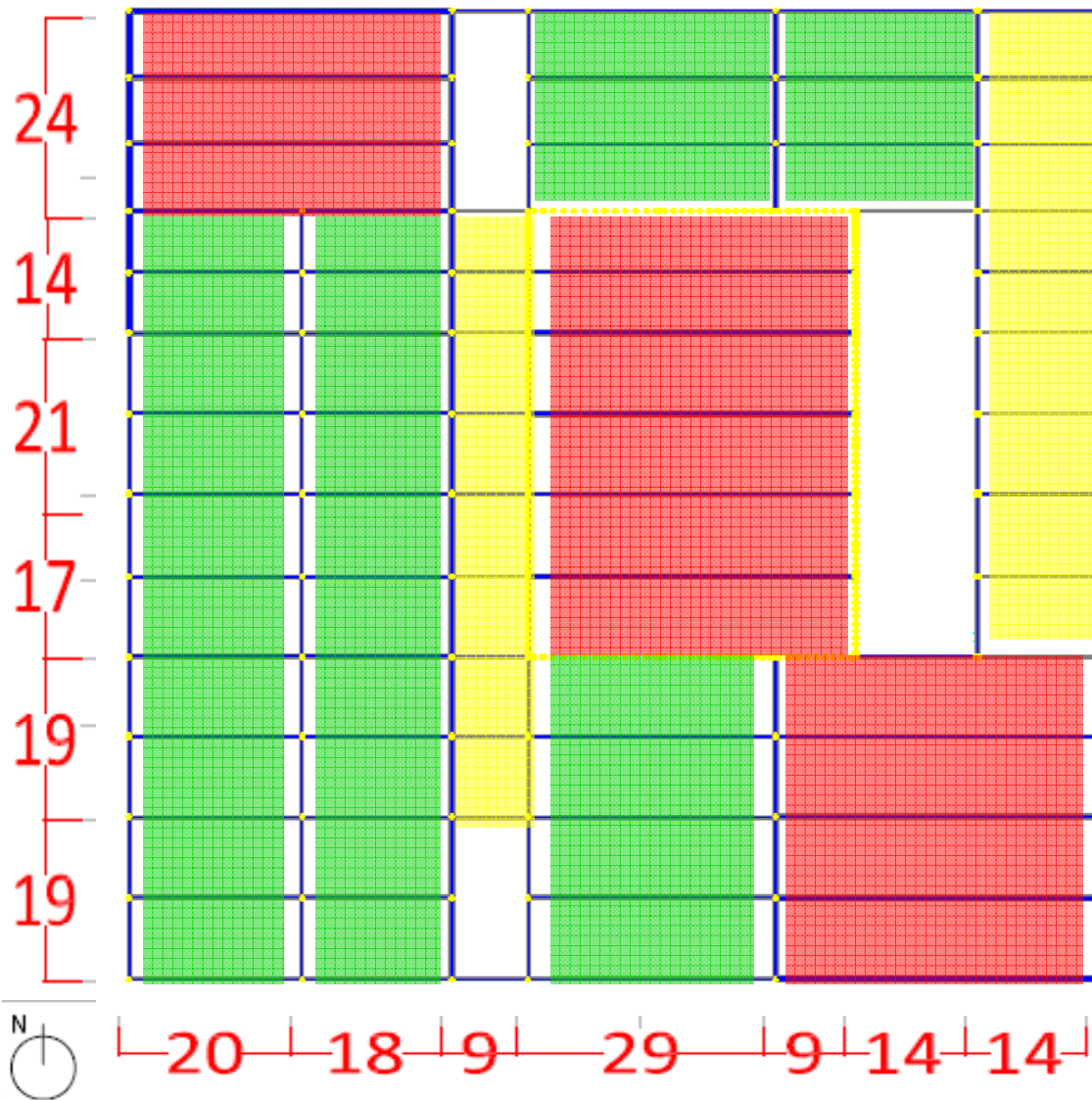
COLUMN LAYOUT

Third Floor:


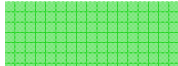
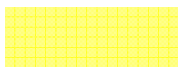


- Columns
- Rotating Shear Walls

TYPICAL MEMBERS - BEAMS

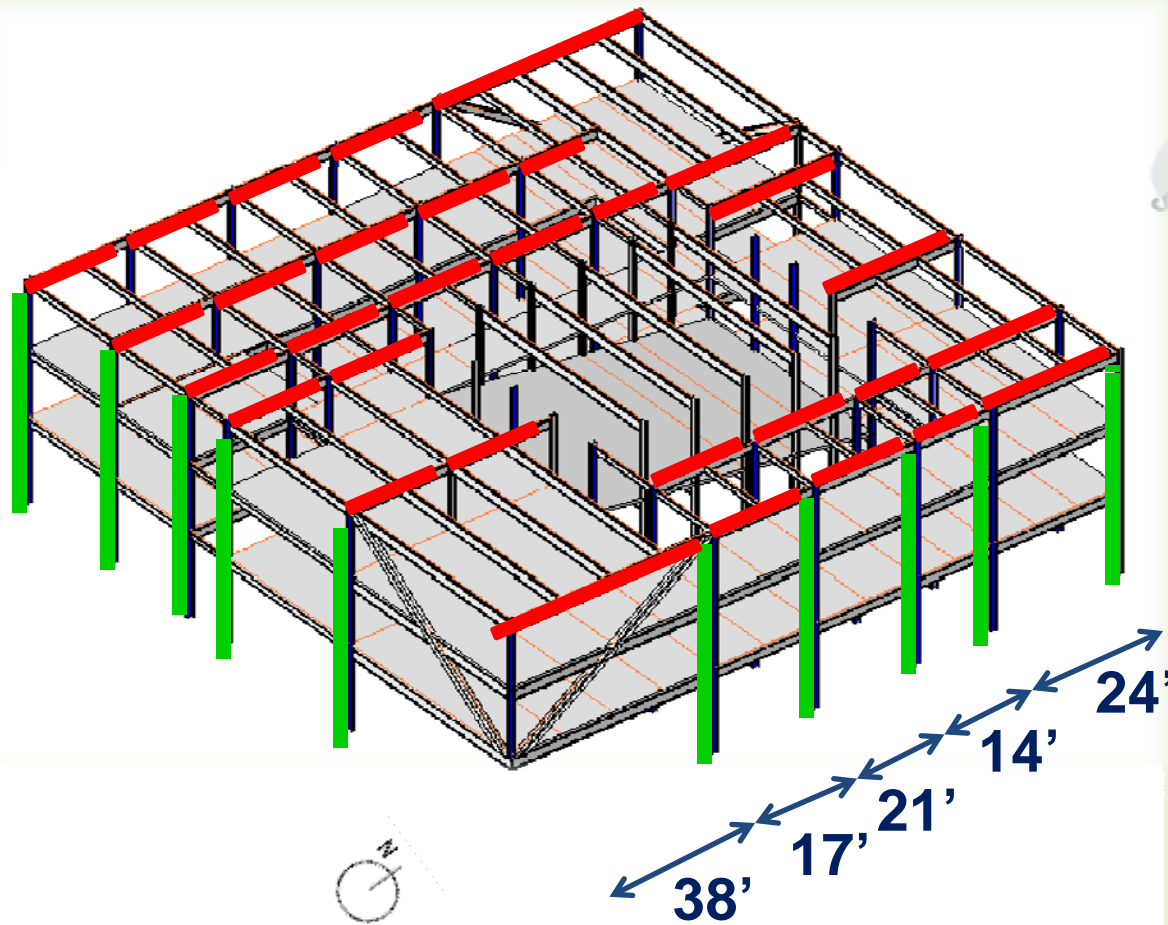


Composite deck:

-  **W 21 x 50**
-  **W 14 x 26**
-  **W 10 x 19**



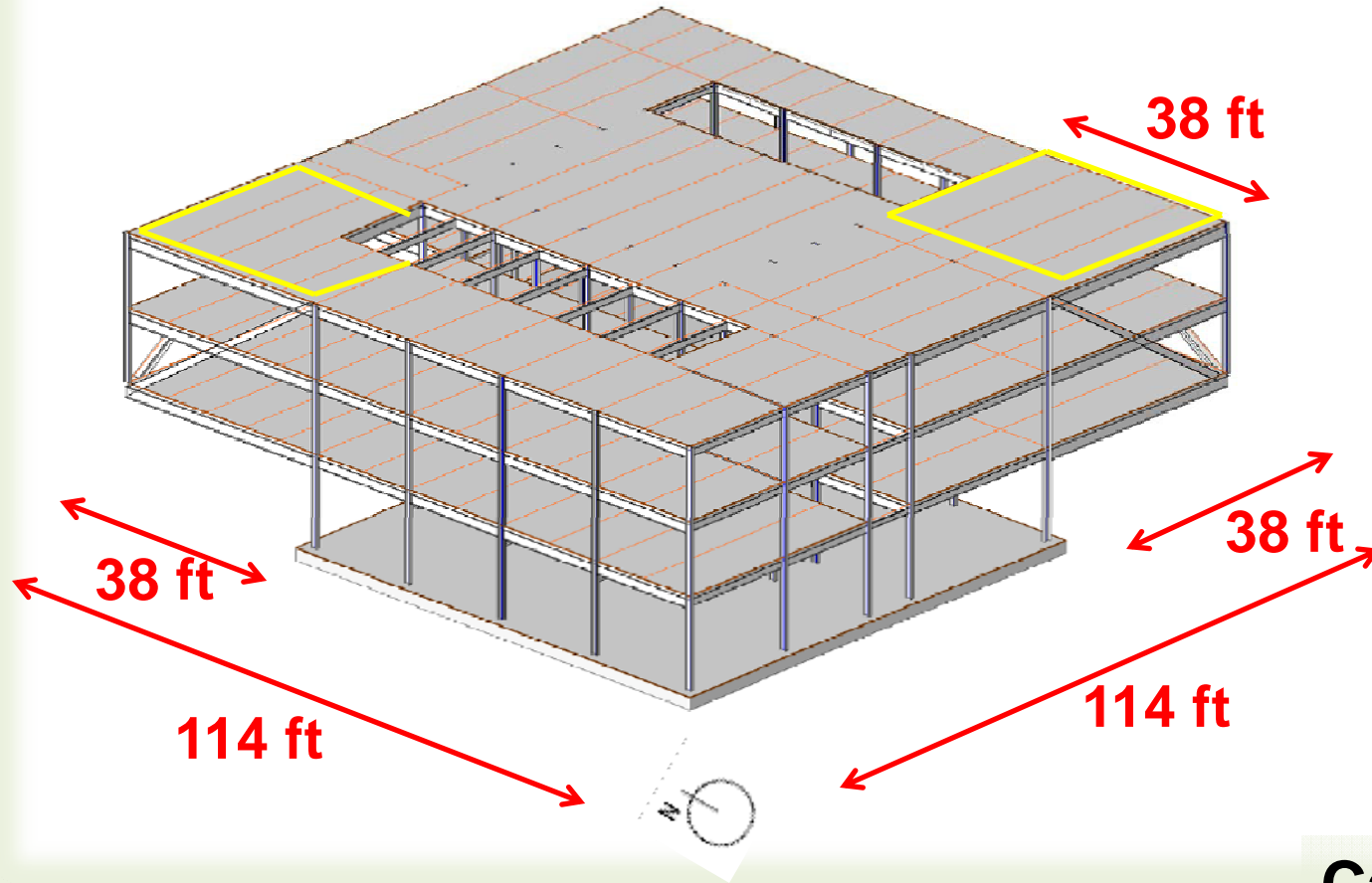
TYPICAL MEMBERS – GIRDERS & COLUMNS



Girders: W 18 x 46

Columns: W 14 x 43

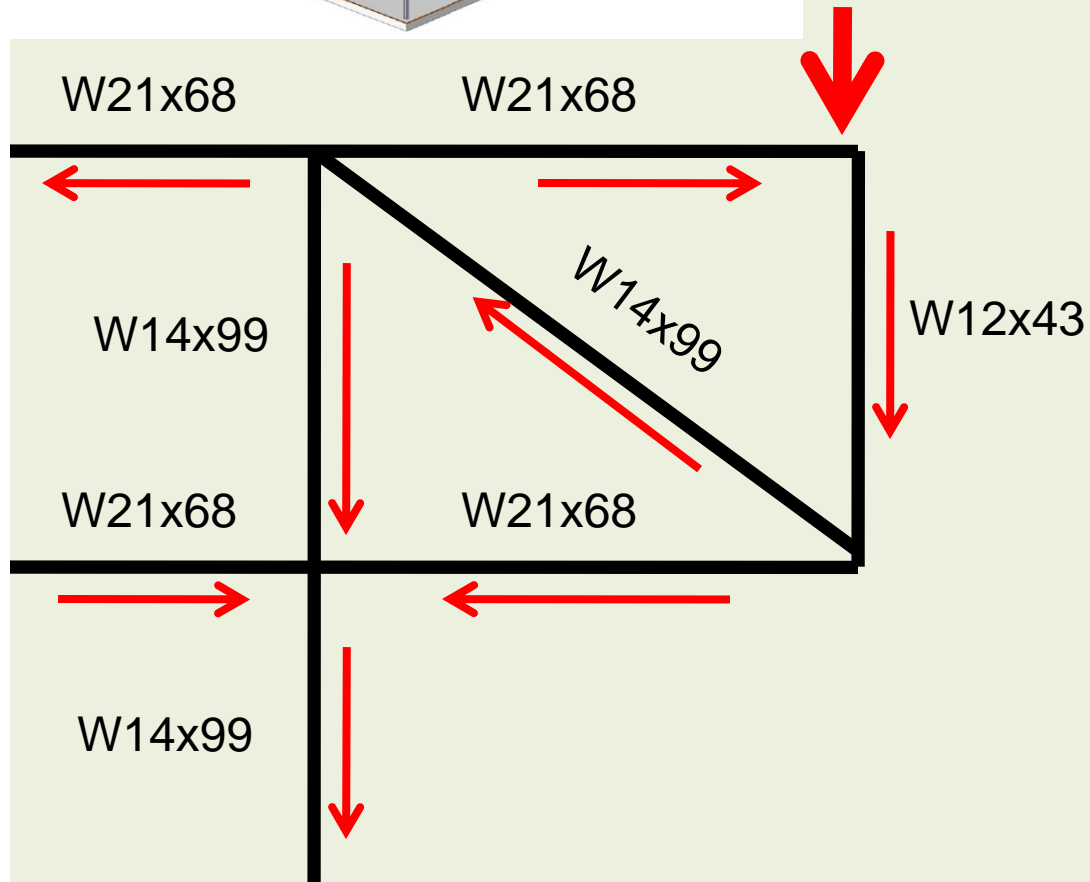
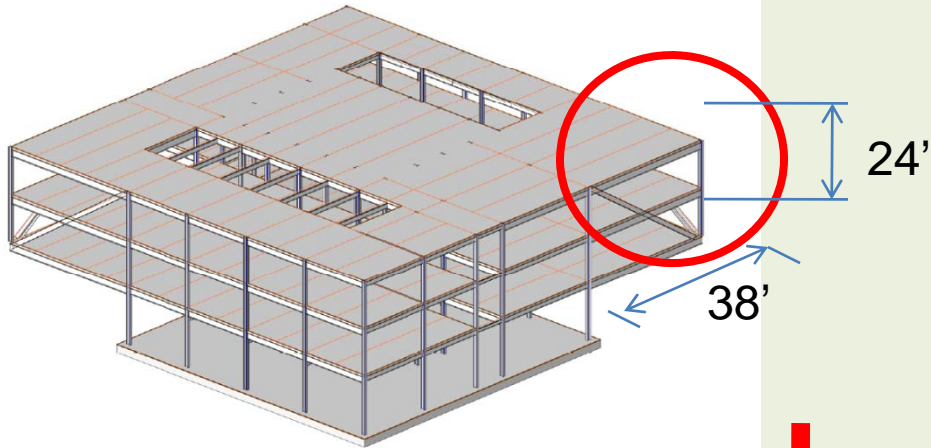
CANTILEVERS



- Cantilevers:**
- **Balanced**
 - **Symmetrical**



Cantilever Design



DL Weight of One Cantilever
507 kips

From SAP Analysis:

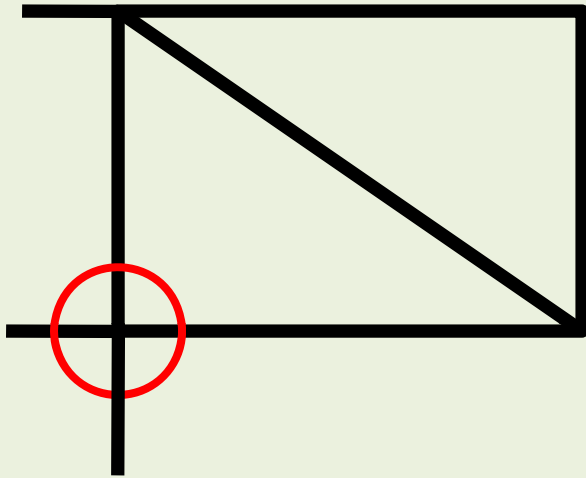
Max. Axial Force = 313 kips

Max. Shear Force = 60 kips

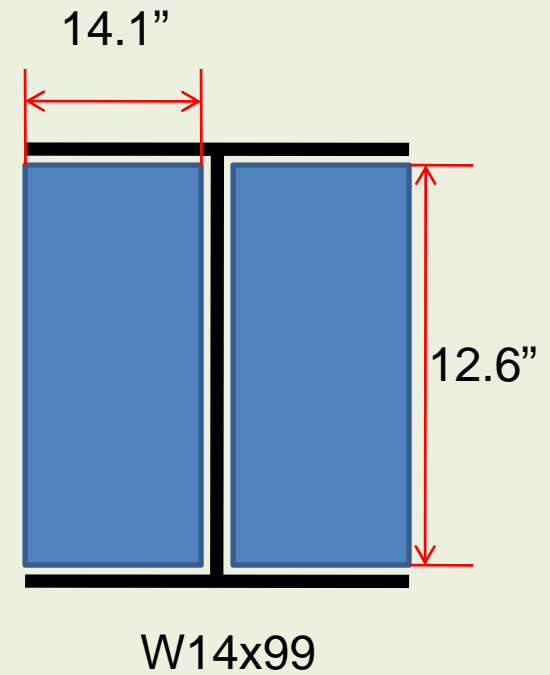
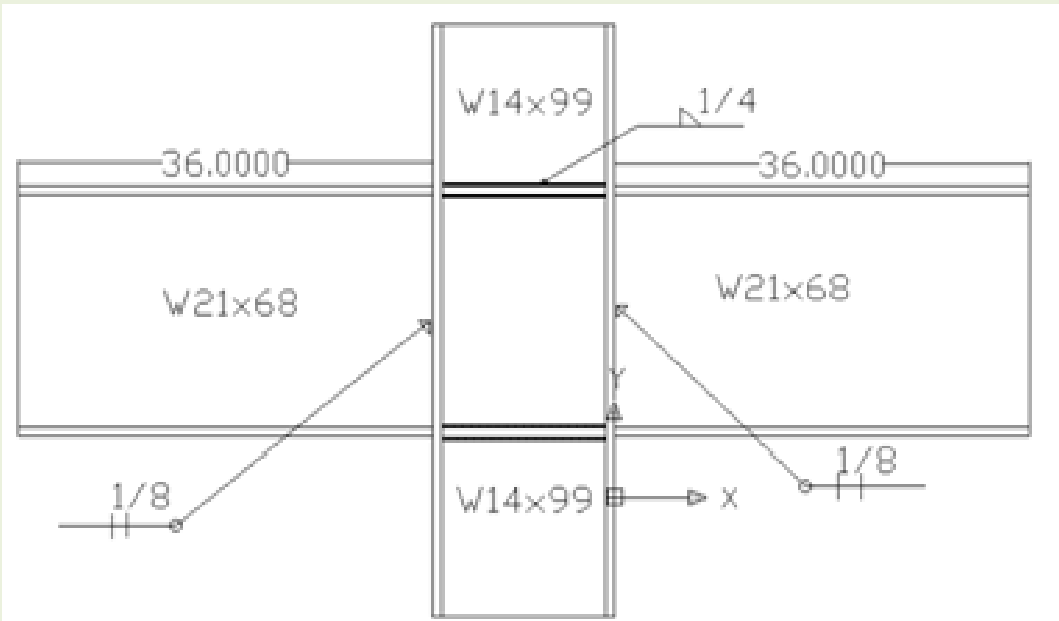
Max. Moment = 756 kip-ft



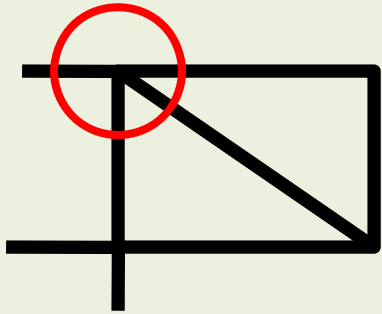
Cantilever Connection



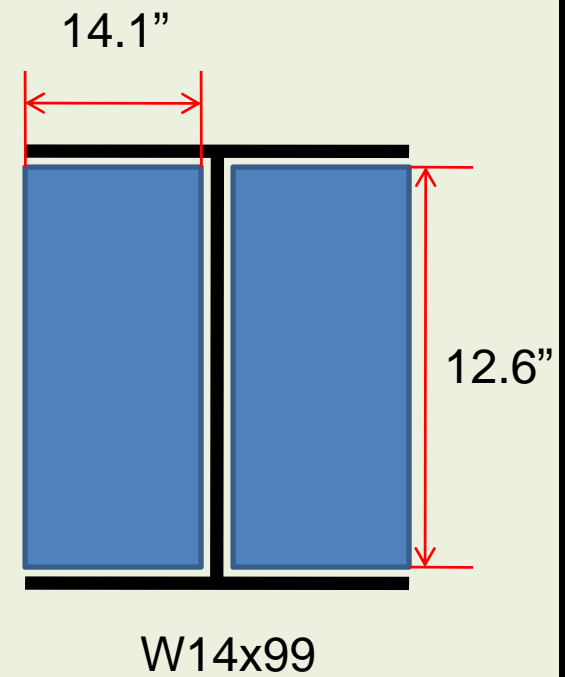
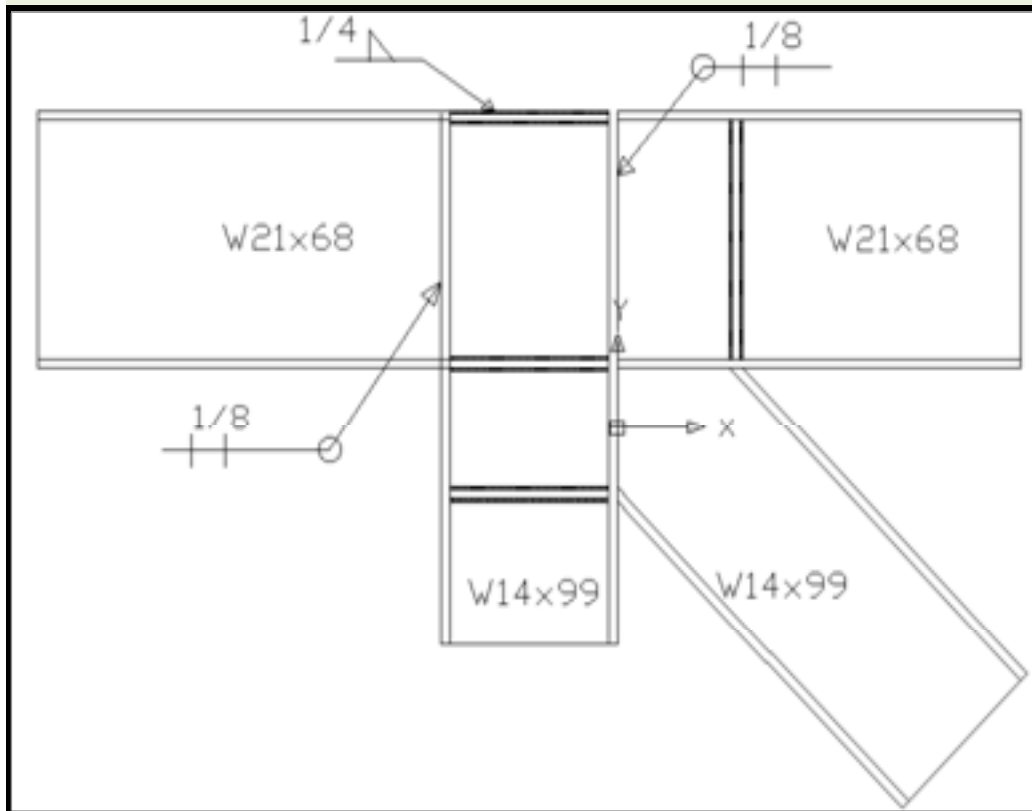
PL 14.1 x 12.6 x 3/4



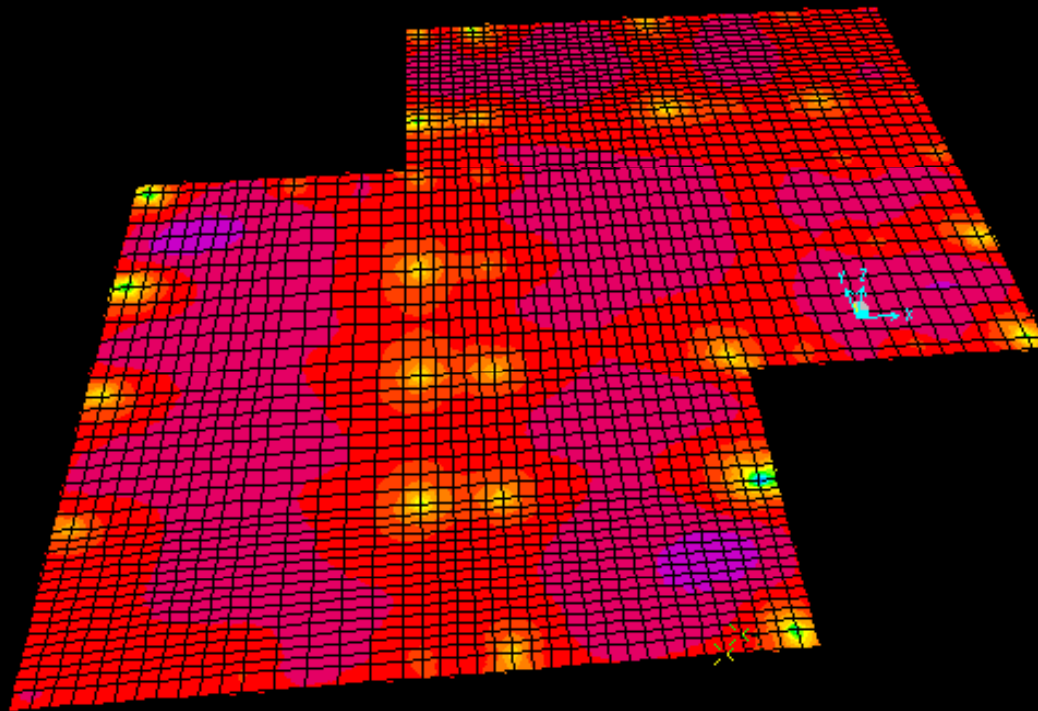
Cantilever Connection



PL 14.1 x 12.6 x 3/4



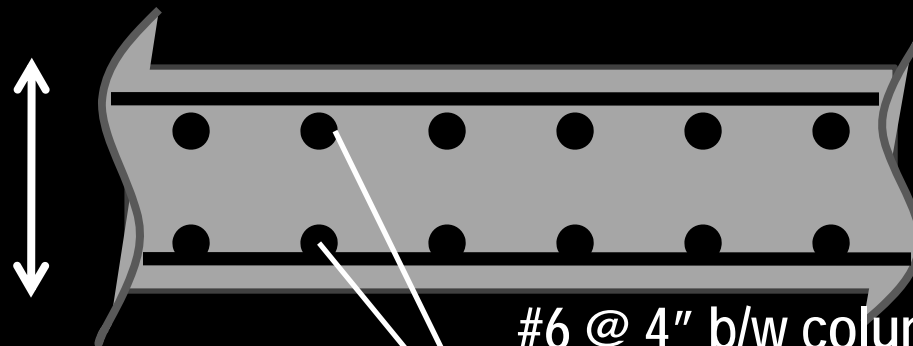
FOUNDATION – MAT FOUNDATION



Bearing Capacity: 5 ksf
Sandy Soil
No Liquefaction

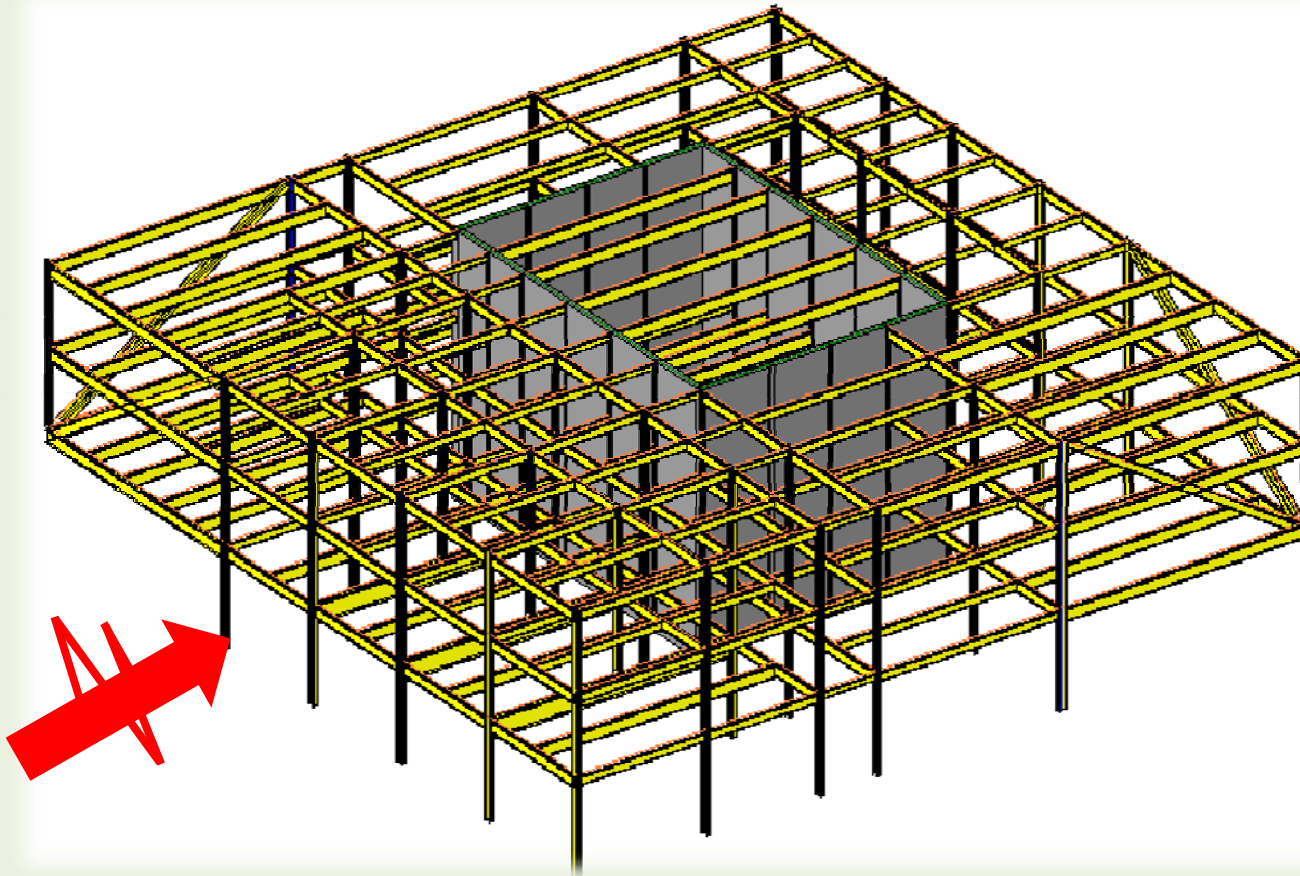
$k_s = 300 \text{ k/ft}^3$
Less than $\frac{1}{2}$ " max settlement

24 in

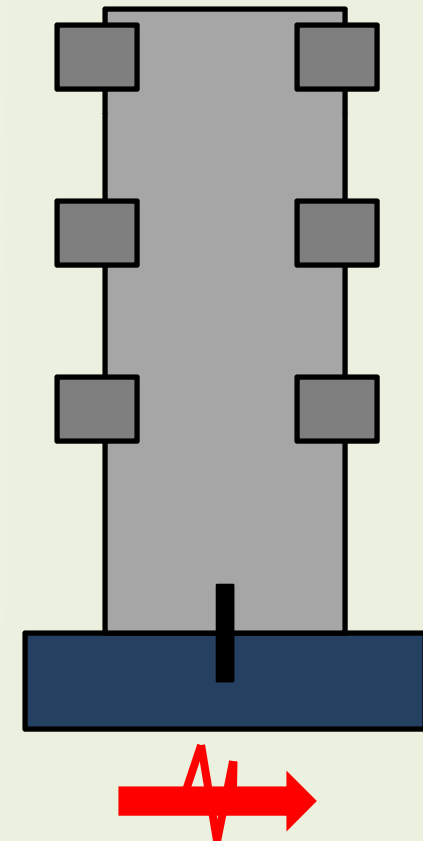


#6 @ 4" b/w columns
#6 @ 12" midspan

LATERAL LOAD RESISTING SYSTEM



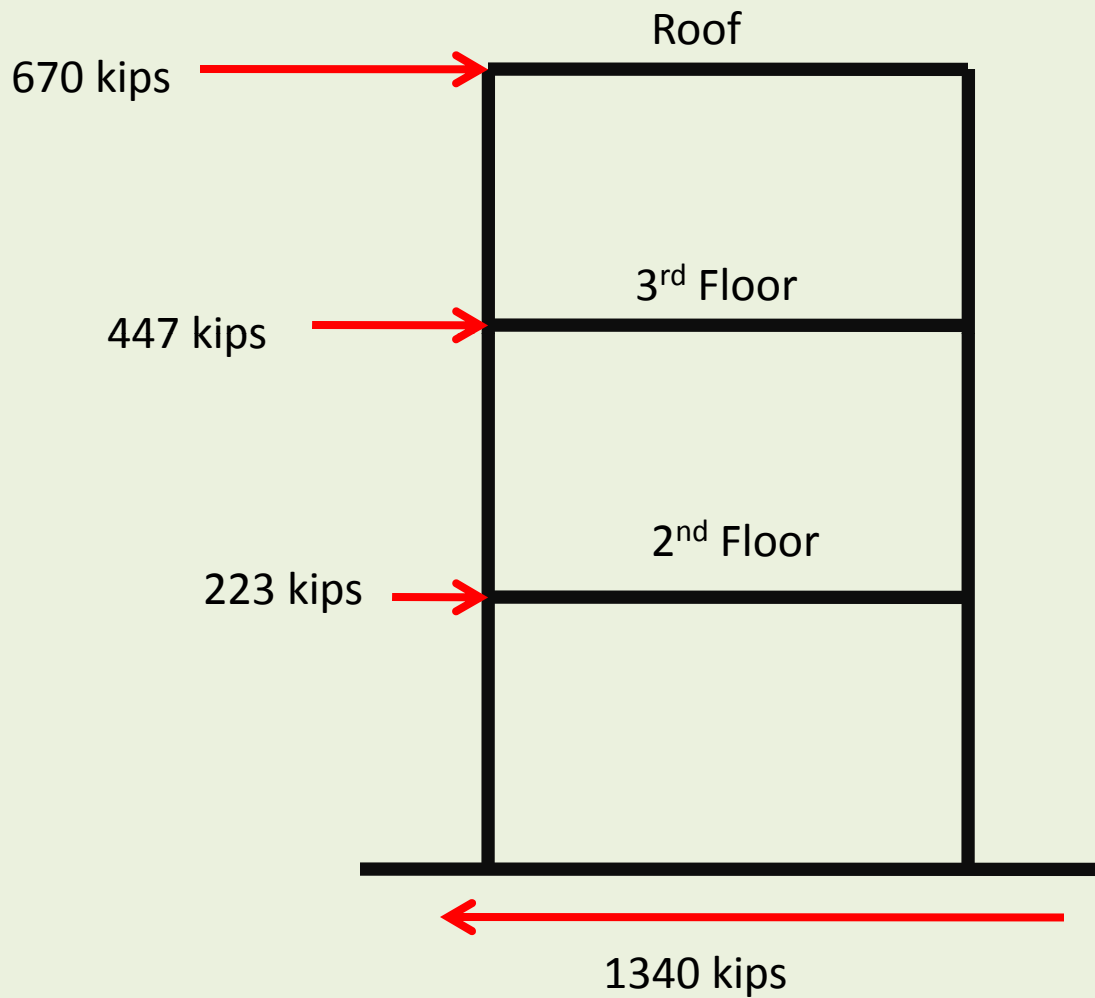
Rotating Walls around the auditorium



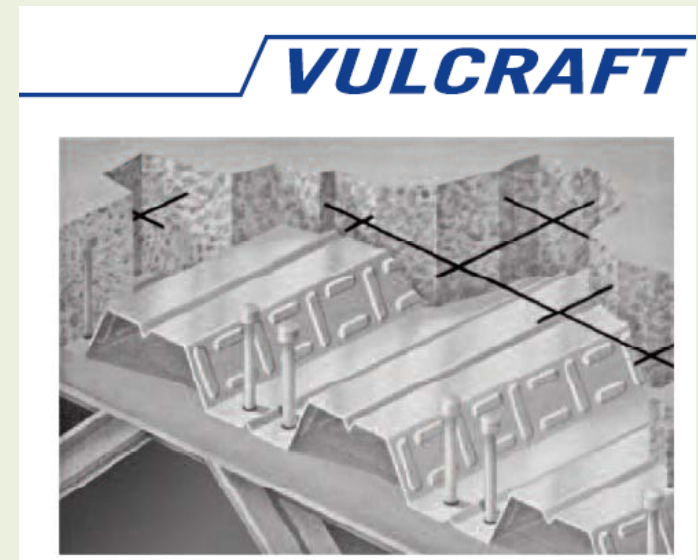
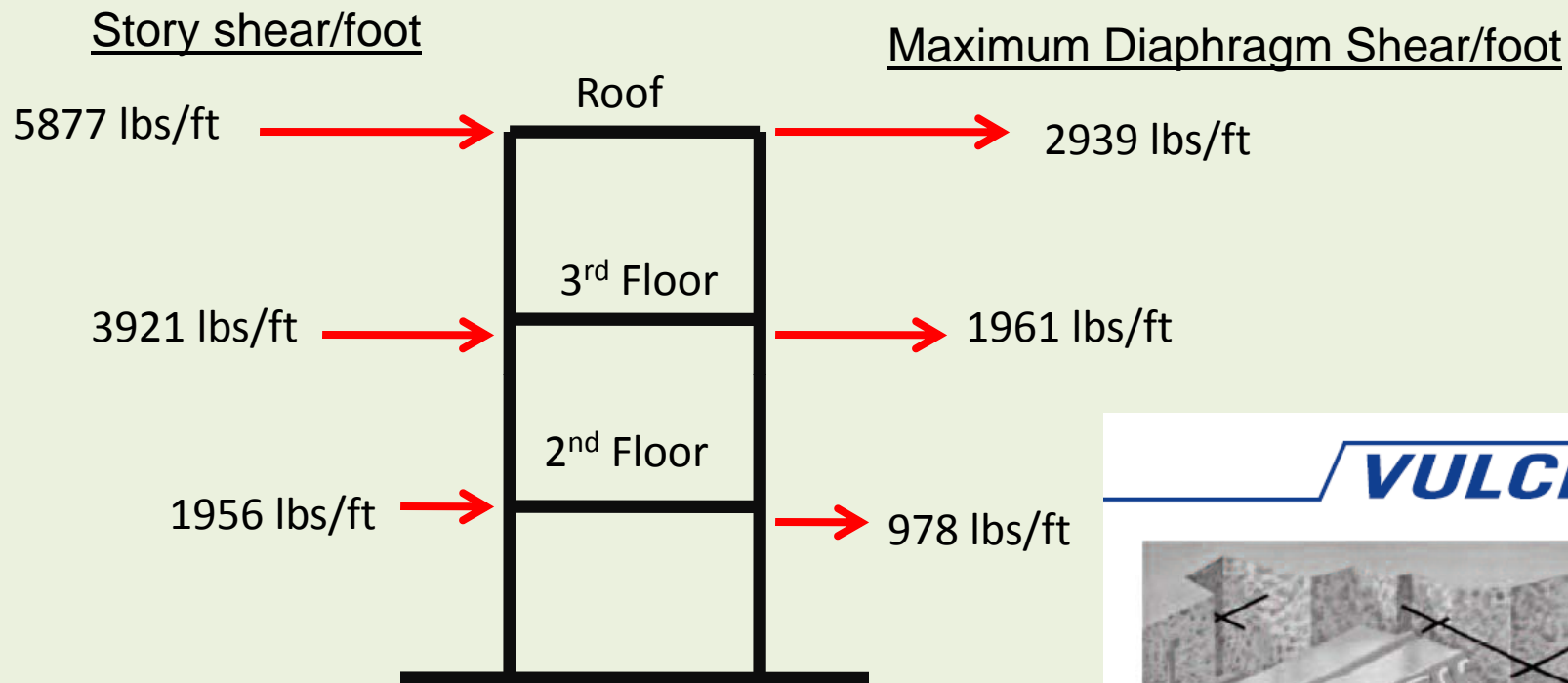
Acknowledgment: GPLA and STANFORD UNIVERSITY



Distribution of Story Shear Forces



Diaphragm Selection



Type 16 – 36/4 with:

→ 6' joist spacing

→ 5/8" puddle weld support fasteners

→ Welded sidelap fasteners: 10 for roof

2 for 2nd and 3rd floors

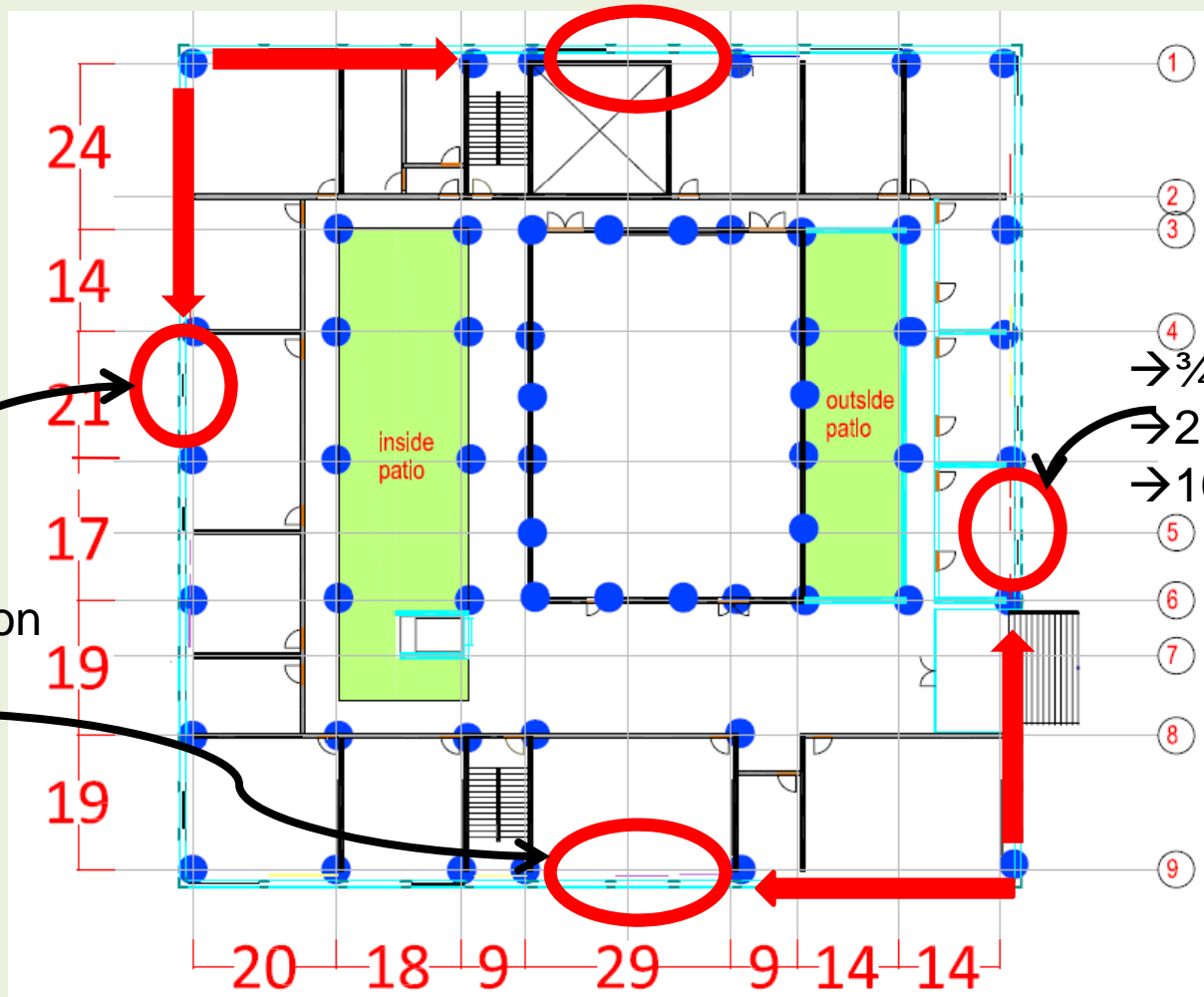
Cantilever Loads to Diaphragm



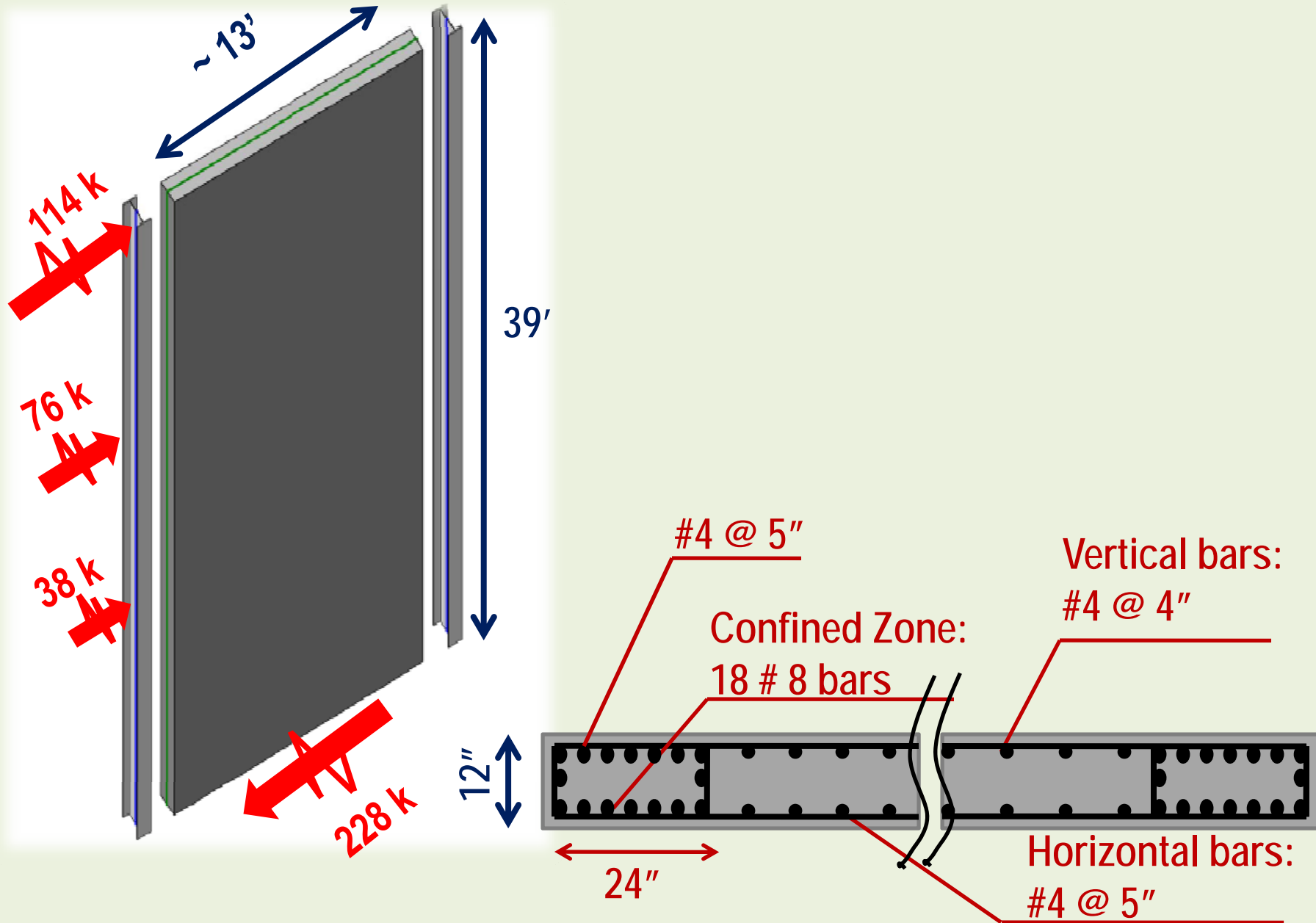
Axial Force:
313 kips

→ 3/4" x 2"
→ 2 studs/section
→ 12" o/c

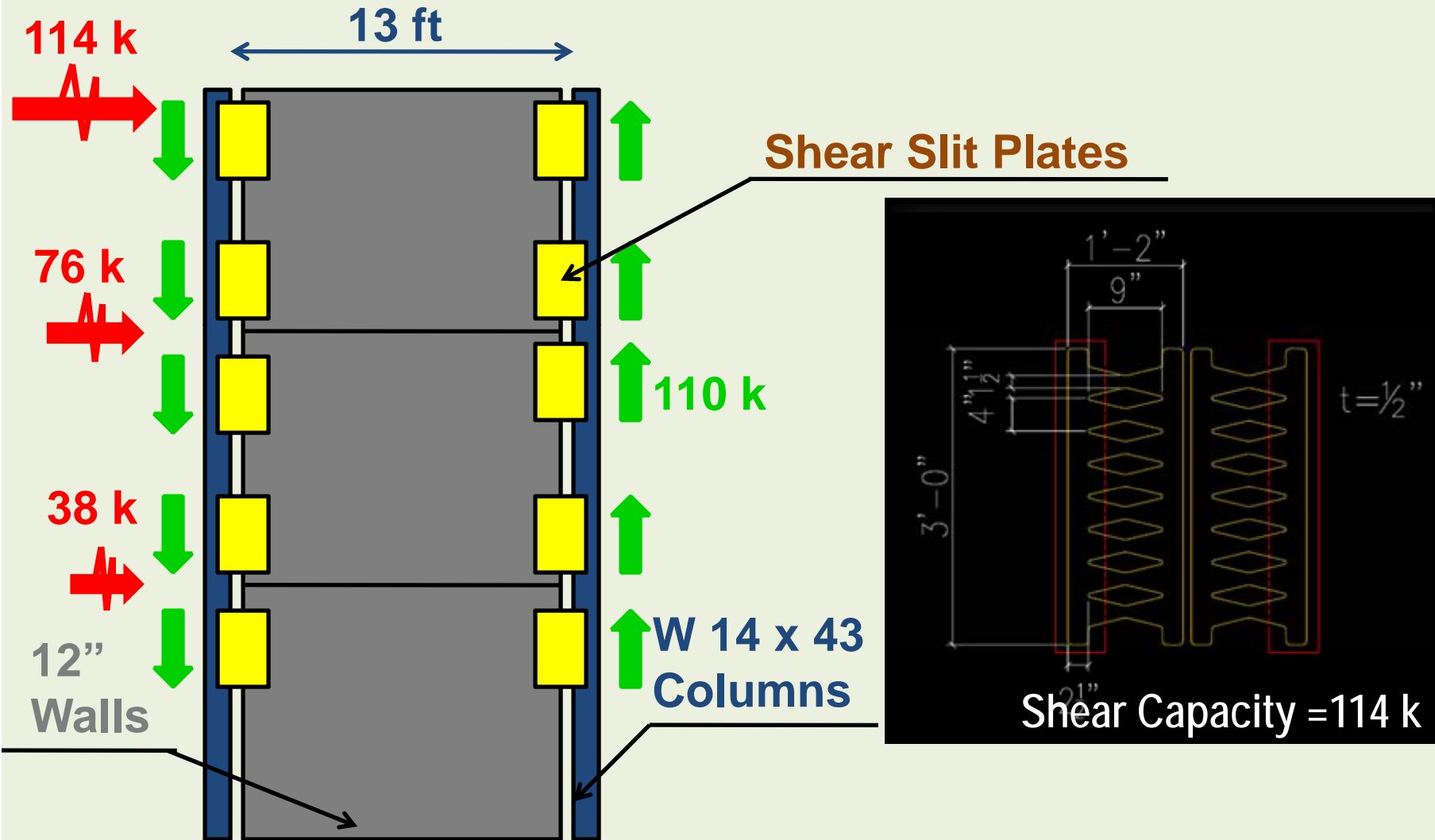
→ 3/4" x 2"
→ 2 studs/section
→ 10" o/c



SHEAR WALLS



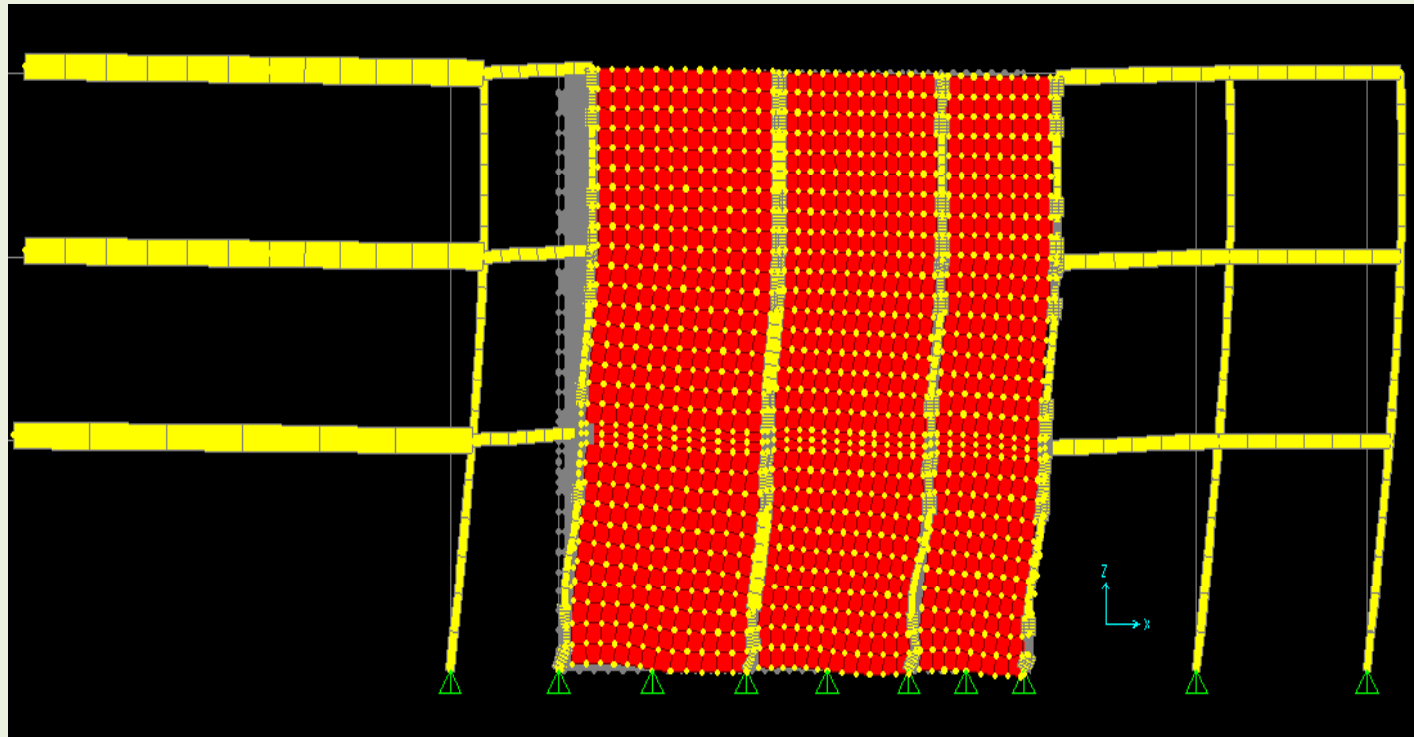
SHEAR WALL / COLUMN CONNECTION



Acknowledgment: GPLA and STANFORD UNIVERSITY



INTERSTORY DRIFT



$$\Delta = .05\%$$

$$\Delta = .07\%$$

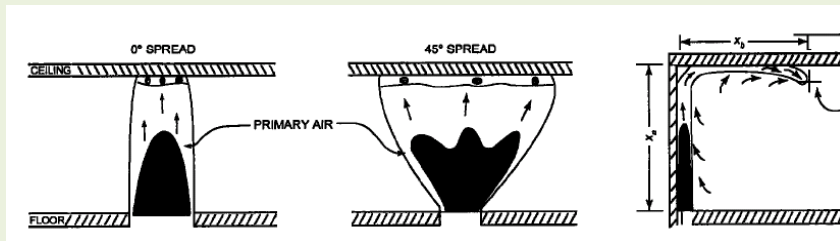
$$\Delta = .05\%$$

Acknowledgment: GPLA and STANFORD UNIVERSITY

WINTER SYSTEM REVISITED

Cooling System:
(44F/4C chilled water from CHP plant)
Dew point cooling humidity control

Heating System
CHP plant (43MW of heating)



Under Floor air diffusers
Concentrated along exterior of the room



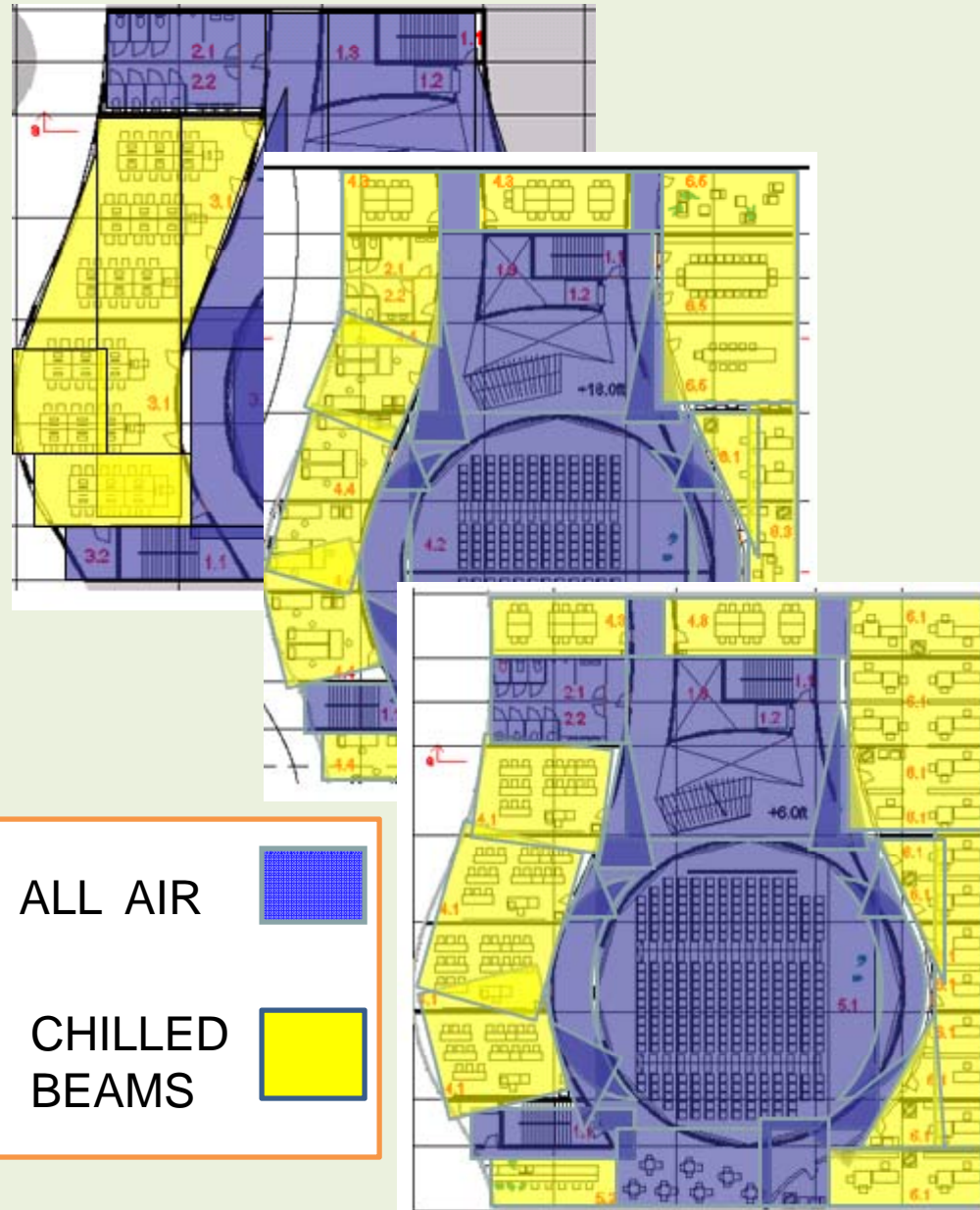
Chilled beams – passive
Of various lengths and widths
Of constant height = 147mm
Spanning parallel to beams



WINTER SYSTEM LAYOUT

SOLAR GAIN VALUES

	kW
North	10
South	29.8
East	52.05
West	49.8818



ENERGY SIMULATIONS

Solar Gain Values kW		
<i>Façade Blinds Fully Open</i>	<i>Façade Blinds Fully Closed</i>	<i>No Façade Double Glazed</i>
37.29	4.1898	82.8

Cooling Load - No Façade	
Zone 1	
Offices	811.9 kW
Zone 2	
Classrooms/Hallways	543.0 kW
TOTAL	1354.9 kW

Cooling Load - With Shades Fully Closed	
Zone 1	
Offices	567.3 kW
Zone 2	
Classrooms/Hallways	526.8 kW
TOTAL	1094.2 kW

Cooling Load - With Shades Fully Open	
Zone 1	
Offices	573.2 kW
Zone 2	
Classrooms/Hallways	531.6 kW
TOTAL	1104.8 kW

Ducts sizes up to 1.7m

ENERGY SIMULATION FOR CALCULATIONS



Cooling Load- With Blinds Fully Open		
Zone 1		
East Side of Building	170.7	<i>kW</i>
<i>(mainly offices)</i>		
Zone 2		
West Side of Building	240.1	<i>kW</i>
<i>(small classrooms, offices)</i>		
Zone 3		
Center/North/South	722.8	<i>kW</i>
<i>(auditorium/Corridors/Common space)</i>		

Total Cooling Load: 1133.6 kW

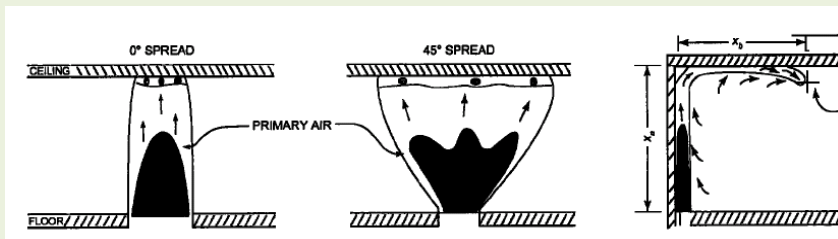
FINAL SYSTEM CONFIGURATION



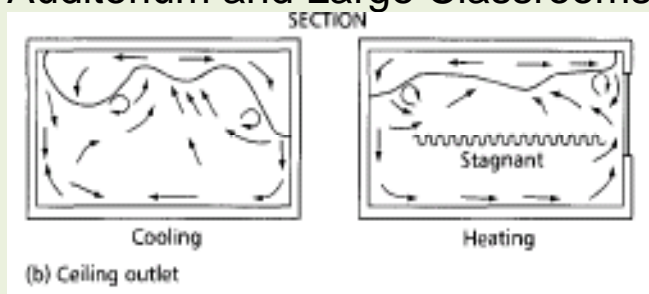
Cooling System:
(44F/4C chilled water from CHP plant)
Dew point cooling humidity control

Heating System
CHP plant (43MW of heating)

Method of Delivery



- Under Floor Air diffusion for the Auditorium and Large Classrooms.



- All other spaces have Ceiling diffusers

Zones

Zone 1:

East

Zone 2:

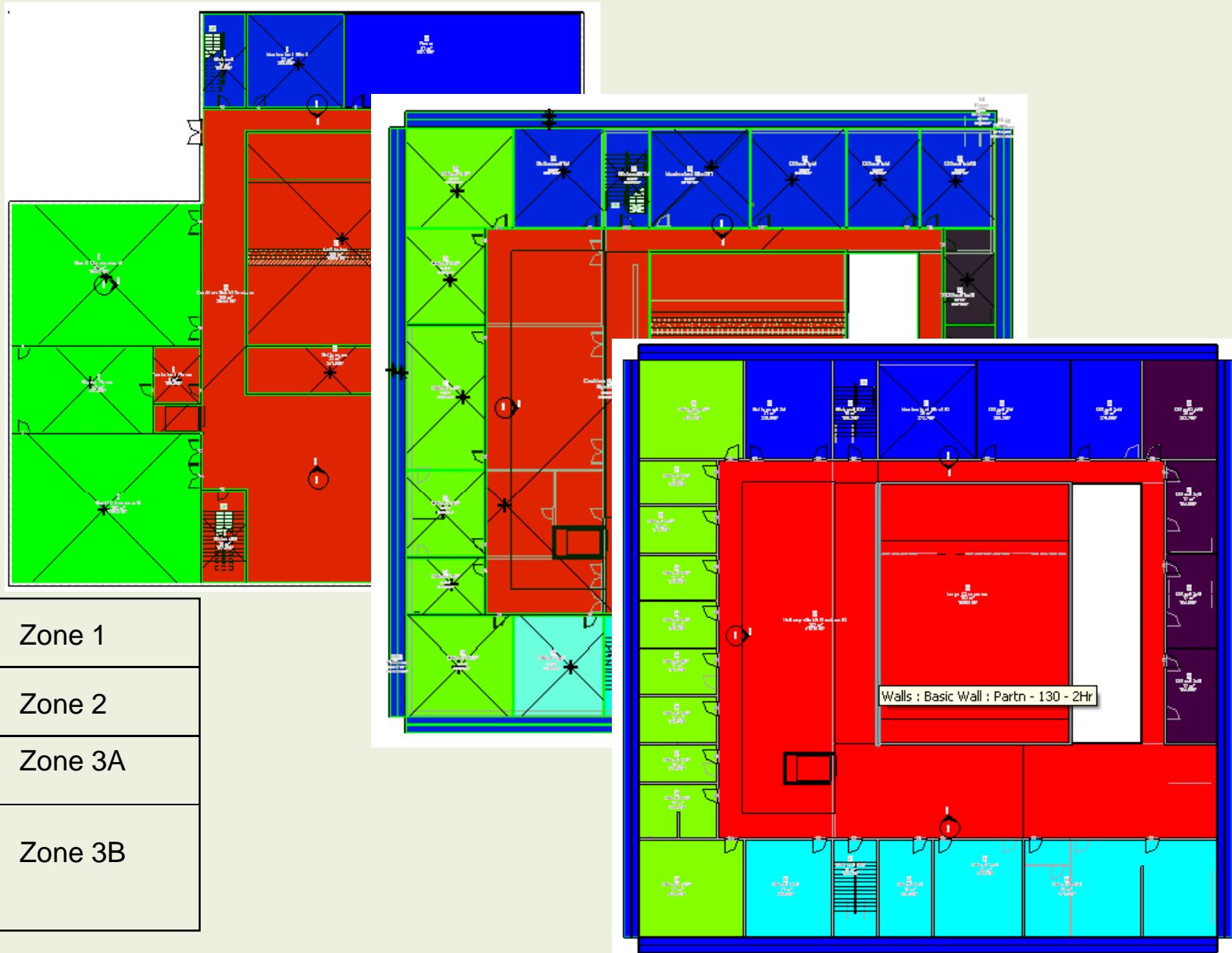
West


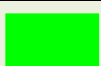


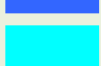
Zone 3:

Zone 3A – Center

Zone 3B – North and South

ZONE LAYOUT DIAGRAM



	Zone 1
	Zone 2
	Zone 3A
	Zone 3B
	Zone 3C

PLANT ROOM DETAILS

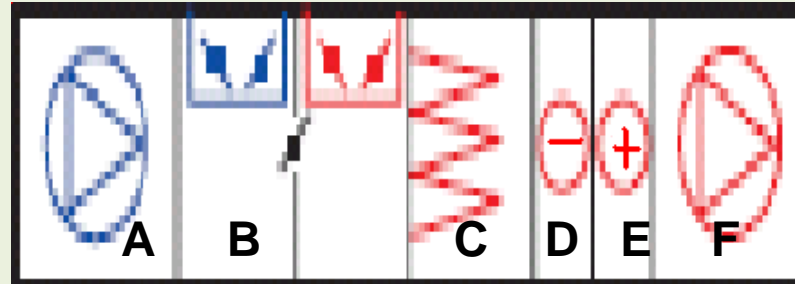
3 AHU Units:

Zone 1:		East
<i>AHU Dimensions</i>		
Width	1120	mm
Height	1120	mm
Length	4030	mm
Weight	570	kg

Zone 2:		West
<i>AHU Dimensions</i>		
Width	1420	mm
Height	1420	mm
Length	4330	mm
Weight	780	kg

Zone 3:		Center/North/South
<i>AHU Dimensions</i>		
Width	2170	mm
Height	2540	mm
Length	5530	mm
Weight	1650	kg

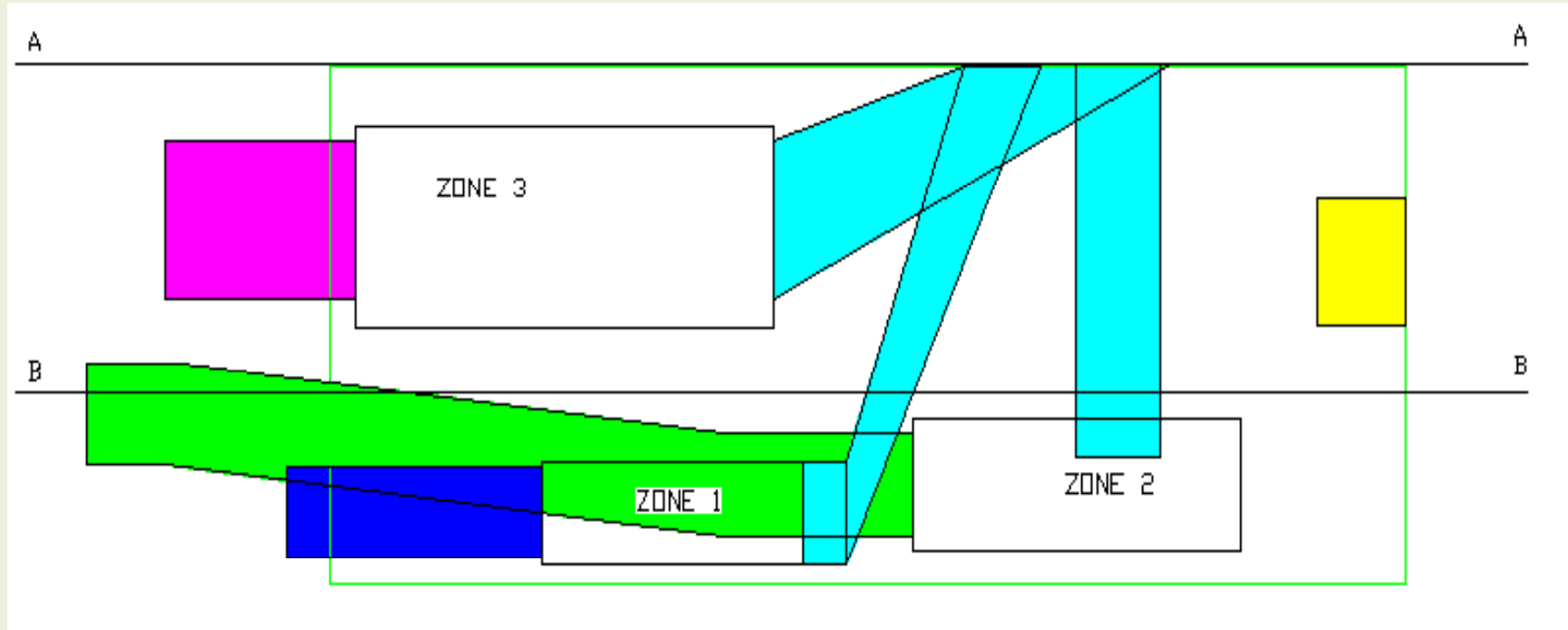
AHU Components








- A** Fan (Return Air)
- B** Mixing Box
- C** Filter
- D** Cooling Coil
- E** Reheating Coil
- F** Fan (Supply Air)



PLANT ROOM LAYOUT DIAGRAM



-  Supply Duct – Zone 3
-  Electrical Controls
-  Supply Duct – Zone 1
-  Fresh Air Ducts
-  Supply Duct – Zone 2



DUCT SIZING DETAILS – All Square Ducts



Plant Room Ducts			
Velocity	10		m/s
	Air Supply		Size
	l/s	ft	mm
Zone1	7111.7	3.28	1000
Zone2	9304.9	3.61	1100
Zone3	23621.2	5.58	1700

Maximum Duct Size in Plant Room

Supply Ducts			
Velocity	6		m/s
	Air Supply		Size
	l/s	ft	mm
Zone1			
Floor 00	-	-	-
Floor 01	4481	3.28	1000
Floor 02	2630	2.46	750
Zone2			
Floor 00	2140	2.30	700
Floor 01	5010	3.28	1000
Floor 02	2150	2.30	700
Zone 3A			
Floor 00	7140	3.94	1200
Floor 01	2110	2.30	700
Floor 02	4770	3.28	1000
Zone 3B			
Floor 00	950	0.49	150
Floor 01	6060	3.61	1100
Floor 02	2600	2.62	800

Maximum Duct Size in Mech. Shaft

A
E
C
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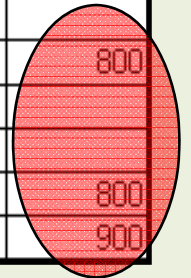
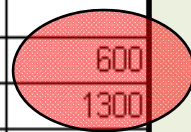
DUCT SIZING DETAILS

Smaller Beams
in Corridor
allow for larger
duct sizes

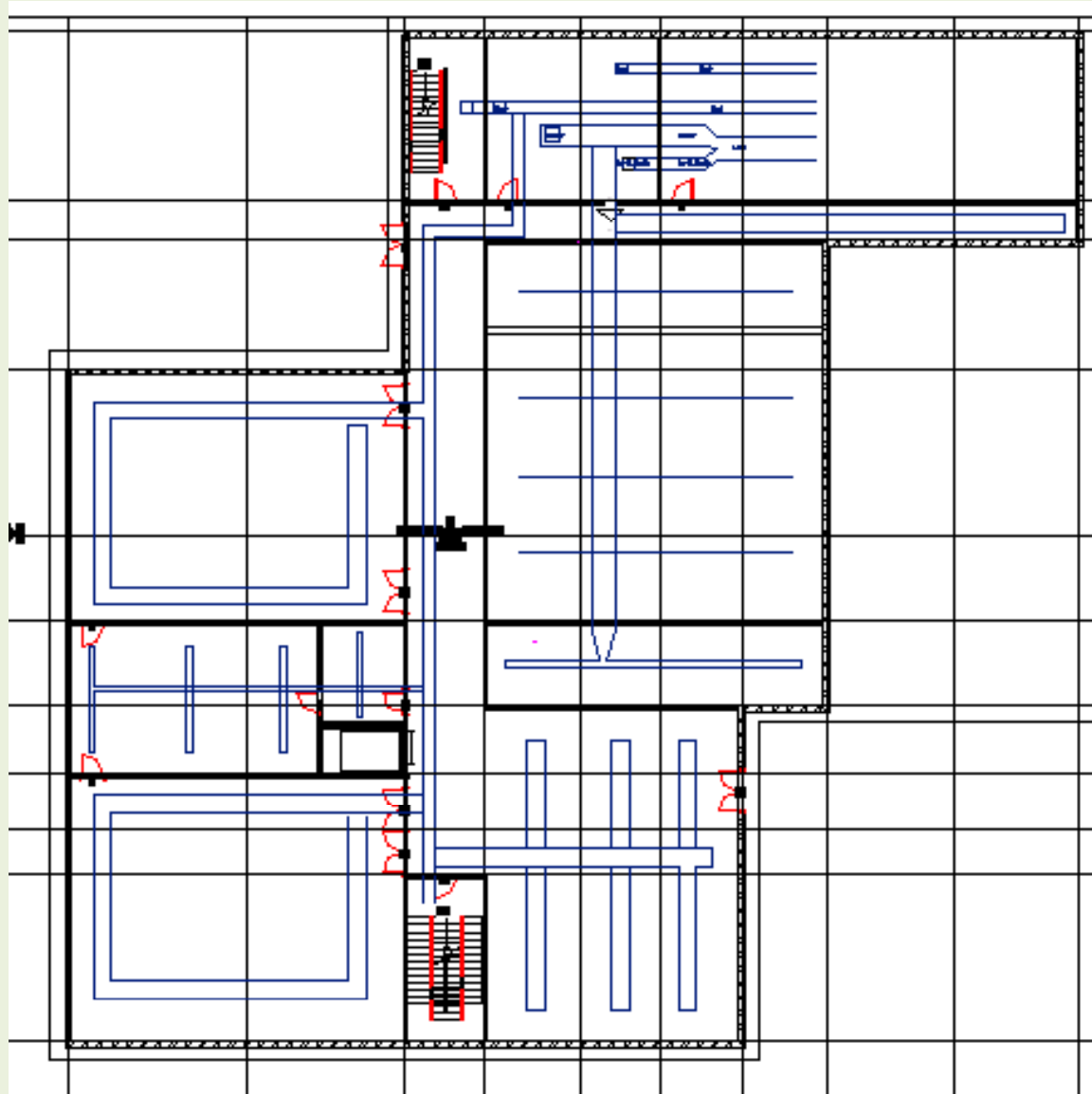
Supply Ducts - Zone 1			
Velocity	4		m/s
	Air Supply		Size
	l/s	ft	mm
Floor 01			
Se	1907	2.62	800
E	510	1.31	400
E	551	1.39	425
E	528	1.39	425
NE	985	1.80	550
Floor 02			
SE	1427	2.13	650
E	275	0.98	300
E	275	0.98	300
E	275	0.98	300
NE	380	1.15	350

Supply Ducts - Zone 2			
Velocity	4		m/s
	Air Supply		Size
	l/s	ft	mm
Floor 00			
Small CR N	1018	1.97	600
Tech Room	88.4		
Small CR S	1037		
Floor 01			
bW	530		
cW	900		
dW	519		
eW	336		
SW	1434		
aNW	1291		
Floor 02			
aNW	567		
bW	127		
cW	129		
dW	127		
eW	130		
fW	130		
gW	130	0.66	200
hW	111.3	0.66	200
iW	144	0.82	250
jSW	556	1.48	450

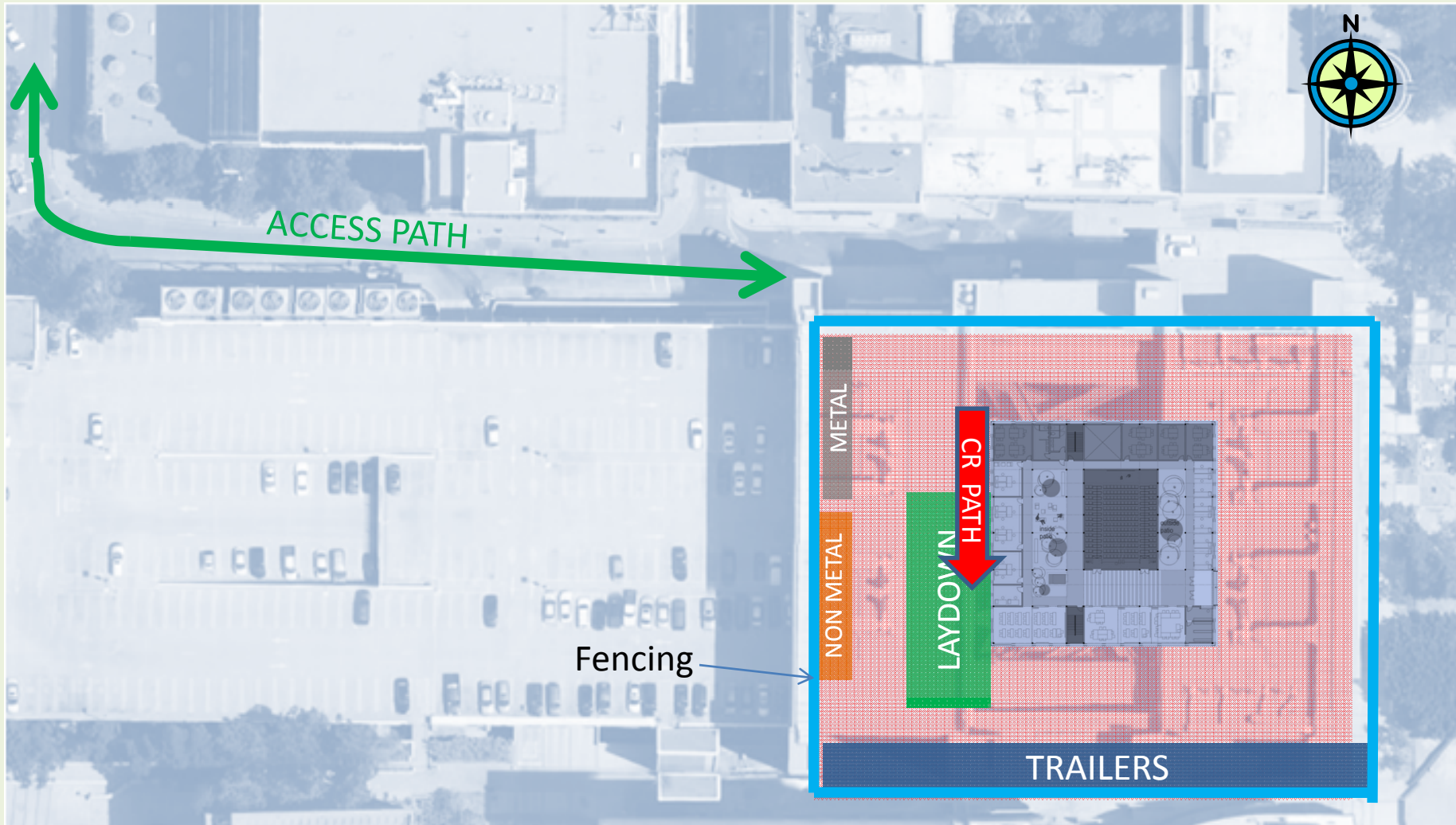
Supply Ducts - Zone 3A			
Velocity	4		m/s
	Air Supply		Size
	l/s	ft	mm
Floor 00			
Corridors	1145	1.97	600
Auditorium	5435	4.27	1300
Bathroom	124	0.82	250
Server Room	434	1.31	400
Floor 01			
Corridors	2113	2.62	800
Floor 02			
Corridors	2021	2.62	800
Large Classrooms	2745	2.95	900



DUCT LAYOUT DIAGRAM



SITE LAYOUT



CRANE DURING DIFFERENT PHASES



Wheel mounted Hydraulic
Grove RT535E

pipings)



CRANE REACH

U
C
L
A



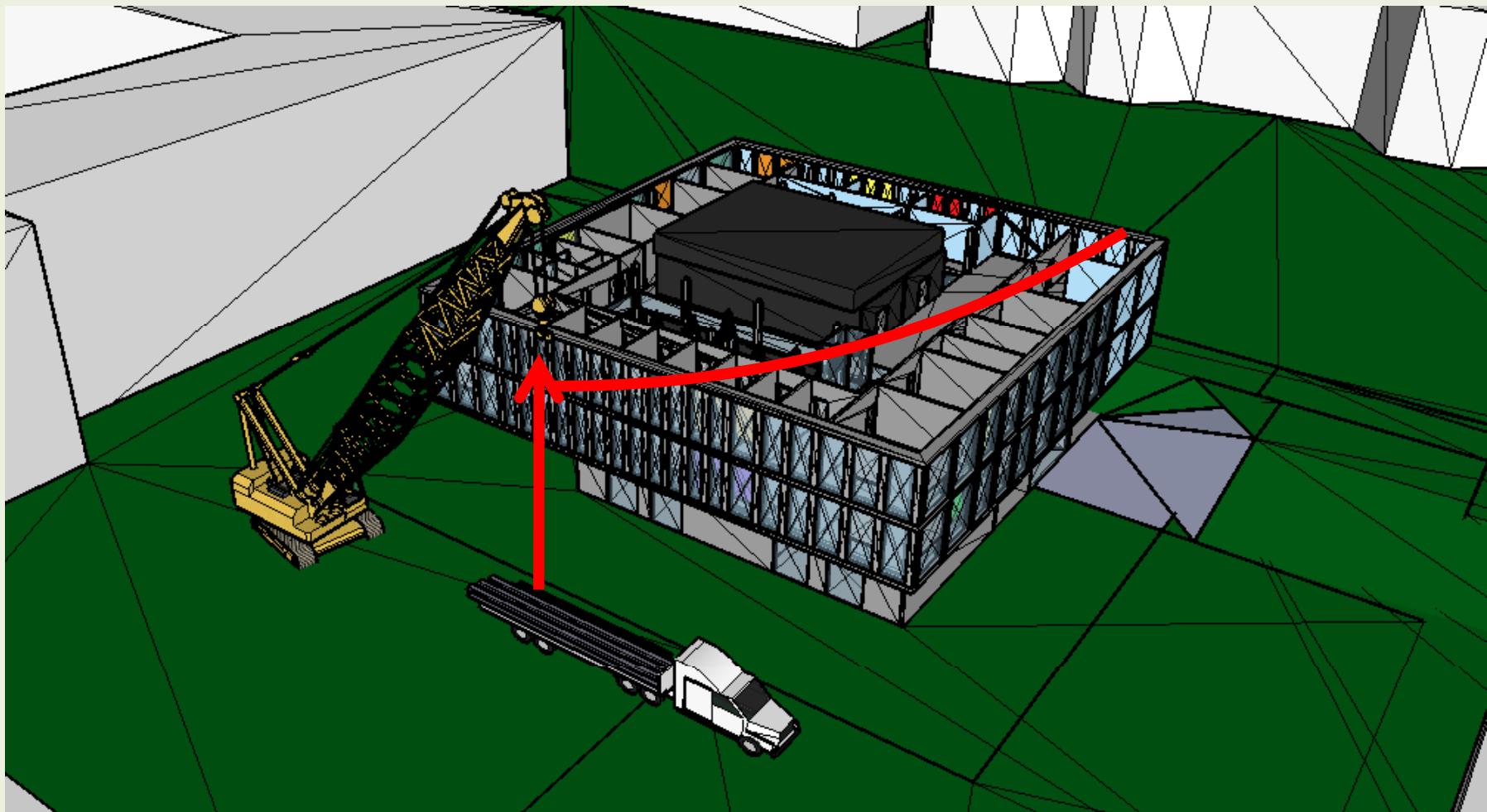
A

E

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M

L



STANDARD vs PREFABRICATION

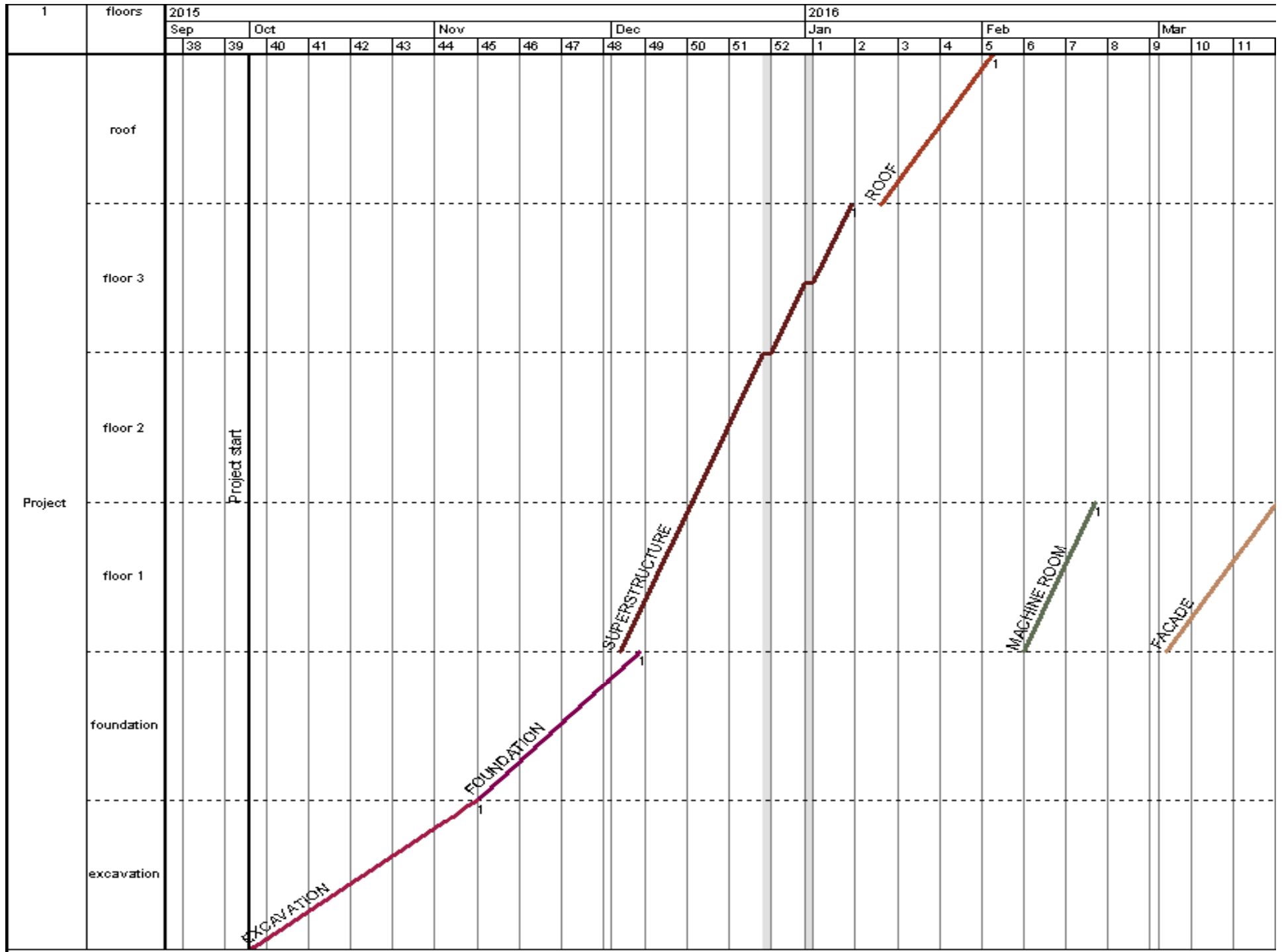
Standard

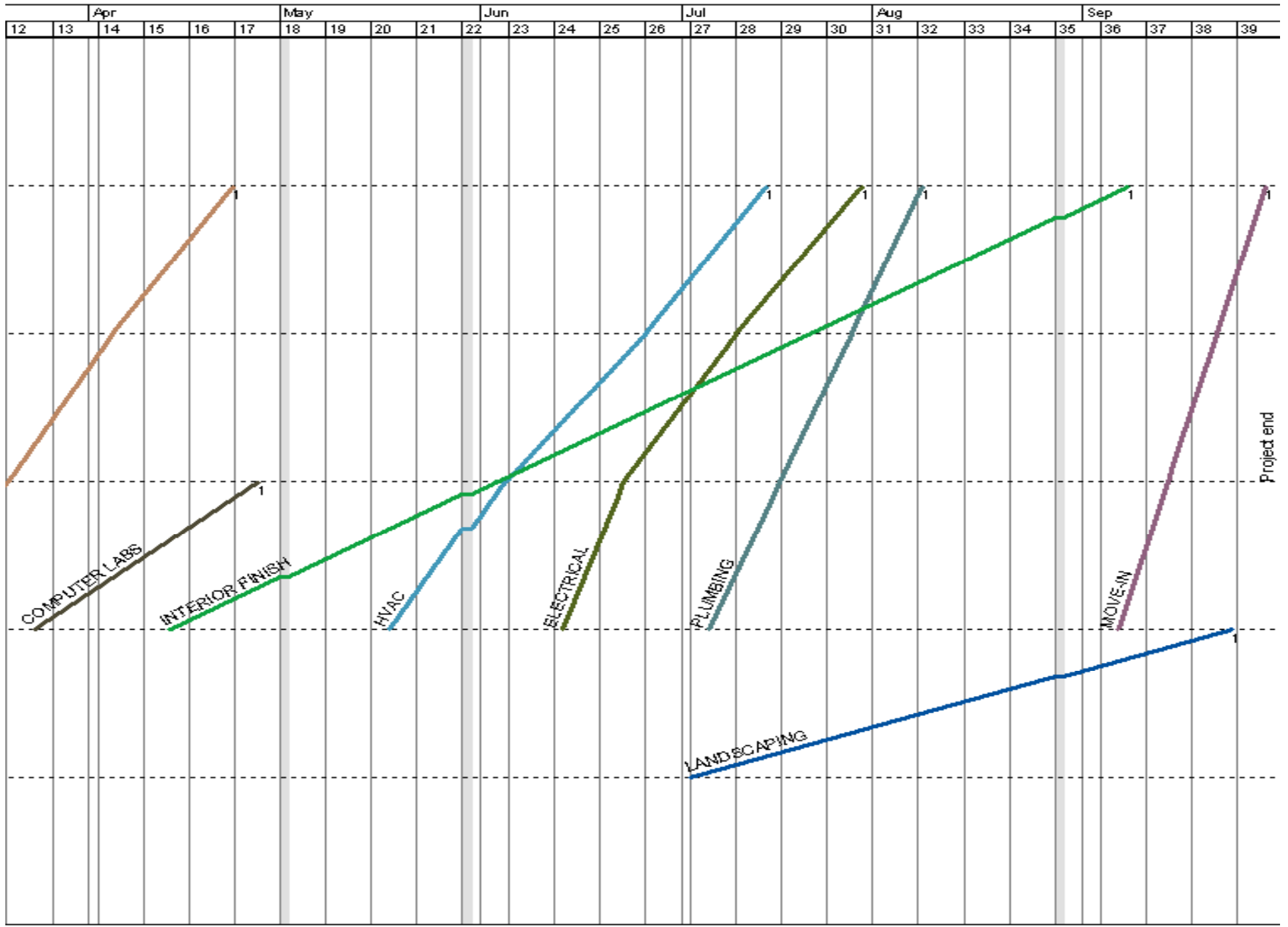
- Design
- Construction
- Subcontractors
- Small project
- Normal difficulties
- Cantilever problem
- Future changes

Prefabrication

- innovative
- Faster
- Efficient
- Less waste
- Adjusted conditions
- Earlier move-in
- Replaceability

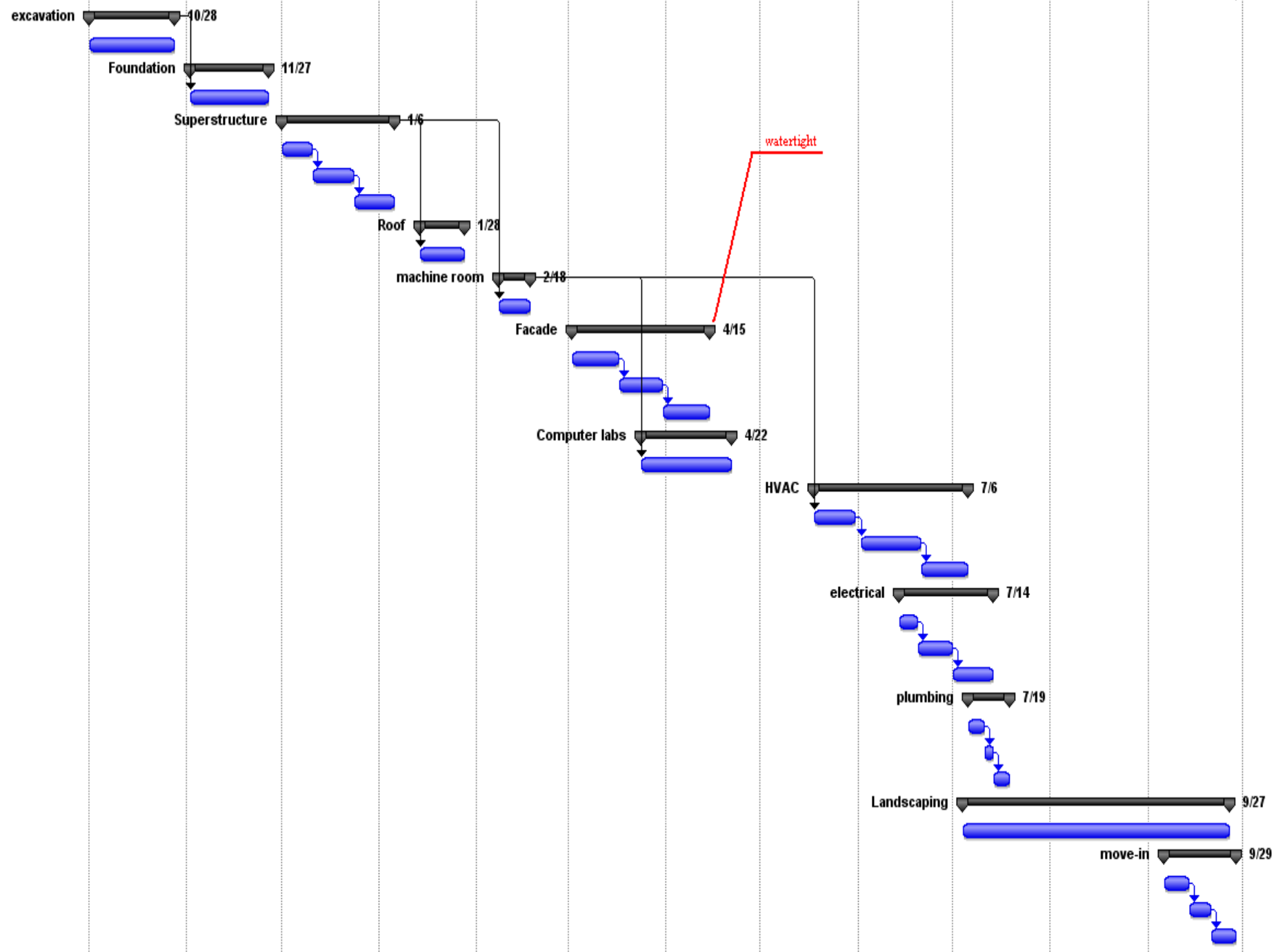






Schedule tasks

9/29



Critical construction zone 1: AUDITORIUM



U
C
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A

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C

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L

Critical construction zone 2: MECHANICAL ROOM

U
C
L
A



A

E

C

M

L



Critical construction zone 3: ROOF



LEED - Rating

37 / 69 credits

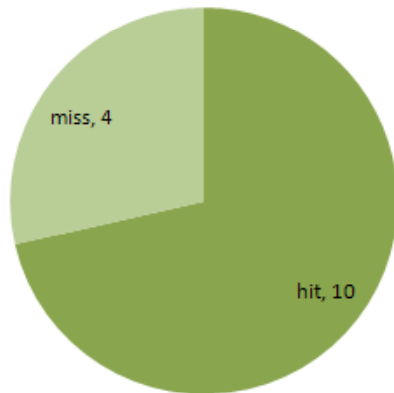
- Conservative estimate
- Later adjustments
- Owners needs
- Realistic estimates
- Need for greater detail



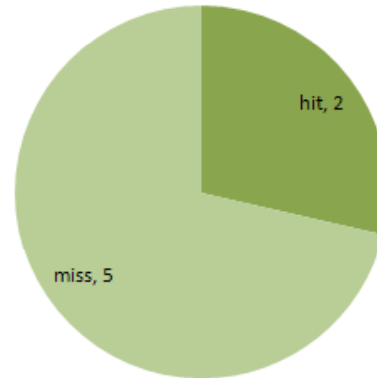
LEED - rating



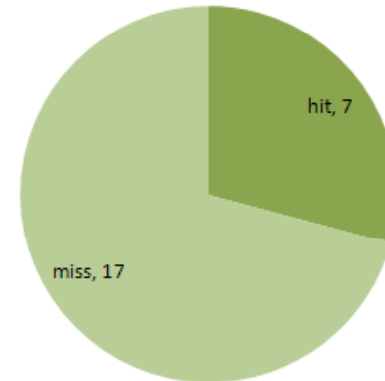
Sustainable sites



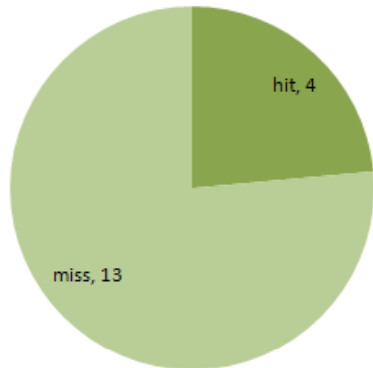
Water efficiency



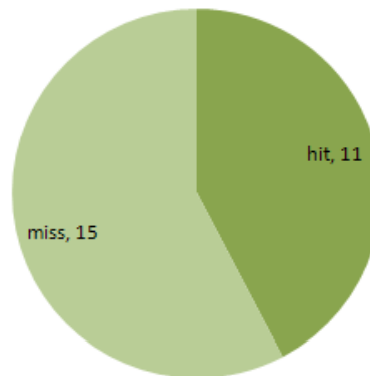
Energy & atmosphere



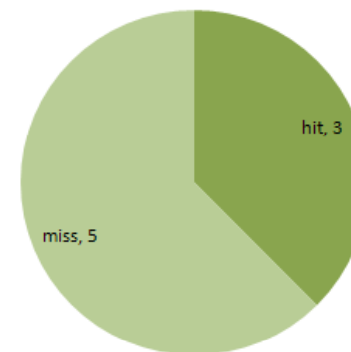
Materials & resources



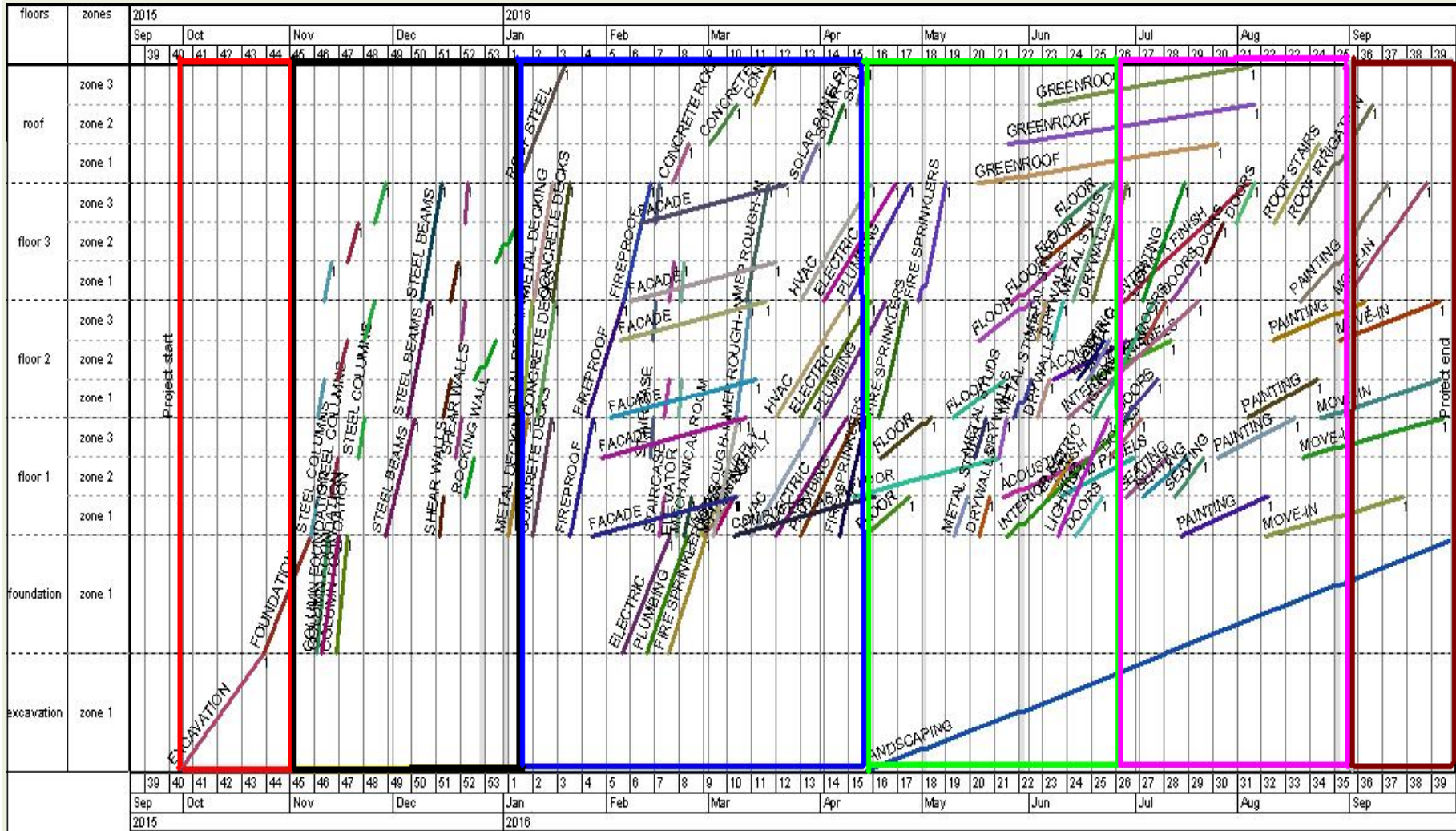
Indoor air quality



Innovation & design



RECYCLING PHASES



RECYCLING PHASES

- Excavation phase
- Structural phase
- Main construction phase
- Carpenting phase
- Finishing phase
- Move-in phase



RECYCLING ON-SITE

- Different zones - different phases
- Metal - recycling
- Non-metal - recycling
- Transports – depending on phase
- Choosing material deliverers
- Small-scale storage
- No unnecessary transports



COST ESTIMATE

- **UNIFORMAT**
 - Phase to detailed components

- **Masterformat**

- RS
- Sa

- **Mat**

- wh
- zer

Uniformat Level
A
A20
A2010a
A2010b
A2010c
A10
A1010
B
B10
B1010a
R1010a

The screenshot displays the Revit software interface. On the left is the 'Basics' ribbon with various tool icons. The central area shows a 3D perspective view of a building's structural frame, including columns and beams. On the right, a 'Schedule: Structural' window is open, showing a table of structural column data.

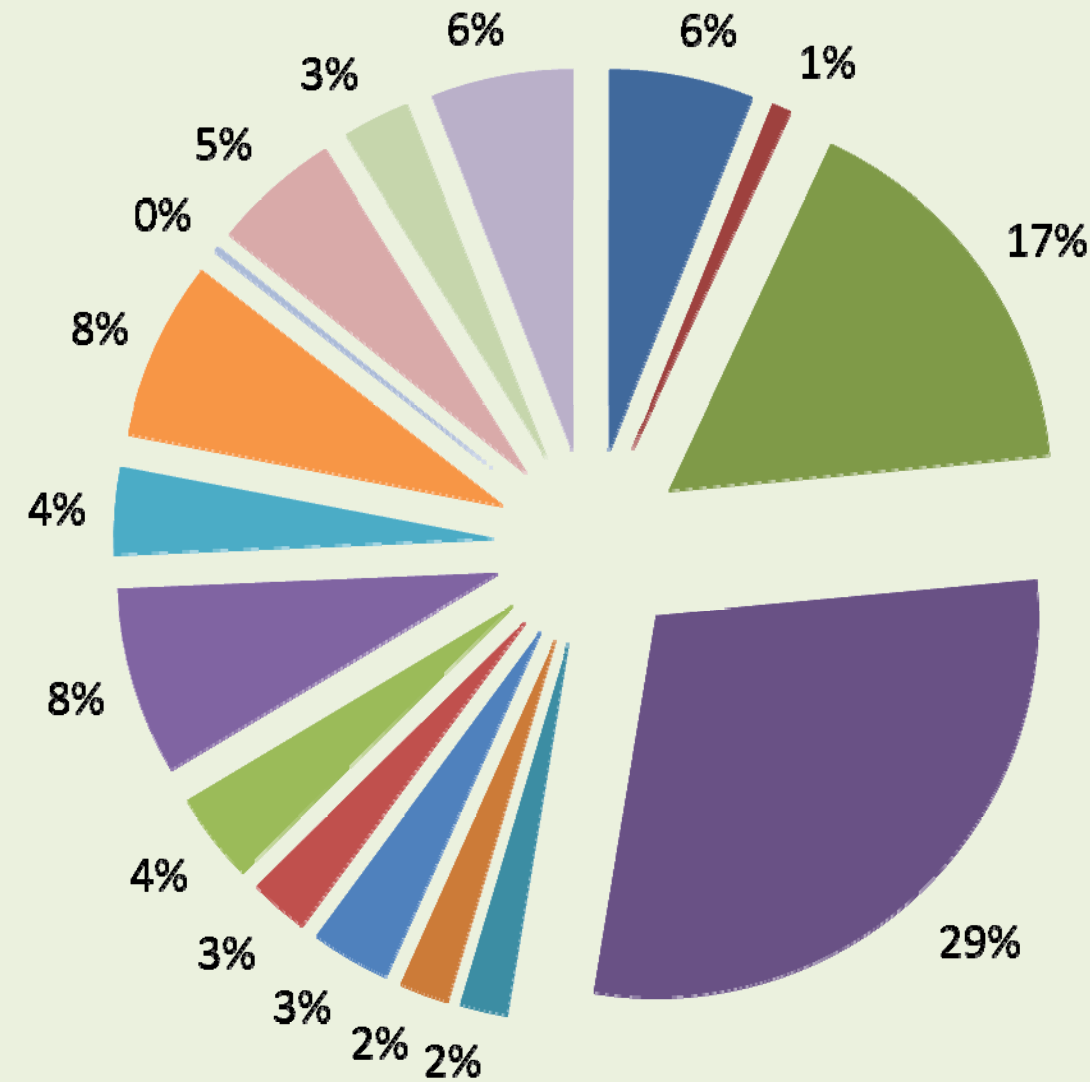
Structural Column Schedule 2			
Count	Type	Length	RS Unique Id
1	W12X40	24' - 0"	220611
1	W12X40	24' - 0"	220662
1	W12X40	24' - 0"	220780
1	W12X40	24' - 0"	221132
1	W12X40	24' - 0"	221174
24' - 0": 5			
1	W12X40	39' - 0"	216883
1	W12X40	39' - 0"	216906
1	W12X40	39' - 0"	217020
1	W12X40	39' - 0"	217063
1	W12X40	39' - 0"	217118
1	W12X40	39' - 0"	217291
1	W12X40	39' - 0"	217365
1	W12X40	39' - 0"	217459
1	W12X40	39' - 0"	217500
1	W12X40	39' - 0"	218003
1	W12X40	39' - 0"	218170
1	W12X40	39' - 0"	218209
1	W12X40	39' - 0"	218246
1	W12X40	39' - 0"	218361
1	W12X40	39' - 0"	218404
1	W12X40	39' - 0"	218494
1	W12X40	39' - 0"	218590
1	W12X40	39' - 0"	218658
1	W12X40	39' - 0"	218698
1	W12X40	39' - 0"	218772
1	W12X40	39' - 0"	218802
1	W12X40	39' - 0"	218836
1	W12X40	39' - 0"	218958
1	W12X40	39' - 0"	219018
1	W12X40	39' - 0"	219098

COST ESTIMATE SUMMARY

Cost Estimate Summary

Level 1	Level 2	Level 2 Cost	Percent	Level 1 Cost	Per cent
Substructure	EXCAVATION	326479	6.1	371283	7.0
	FOUNDATION	44804	0.8		
Shell	SUPERSTRUCTURE	881922	16.6	2431240	45.6
	EXTERIOR CLOSURE	1549318	29.1		
Interiors	INTERIOR CONSTRUCTION	107552	2.0	399164	7.5
	STAIRS	112042	2.1		
	INTERIOR FINISHES	179571	3.4		
Services (MEP)	CONVEYING SYSTEM	134565	2.5	1357264	25.5
	PLUMBING	201399	3.8		
	HVAC	423317	7.9		
	Fire Protection	196267	3.7		
	ELECTRICAL	401717	7.5		
Equipment & Furnishing	EQUIPMENT	12560	0.2	297560	5.6
	FURNISHING	285000	5.3		
Spl Const	SPECIAL CONSTRUCTION	152000	2.9	152000	2.9
Site Prep	SITWORK	320000	6.0	320000	6.0
	Sub Total	5328512			
	INDIRECT COST	1939578			
	Total Cost	7268090			

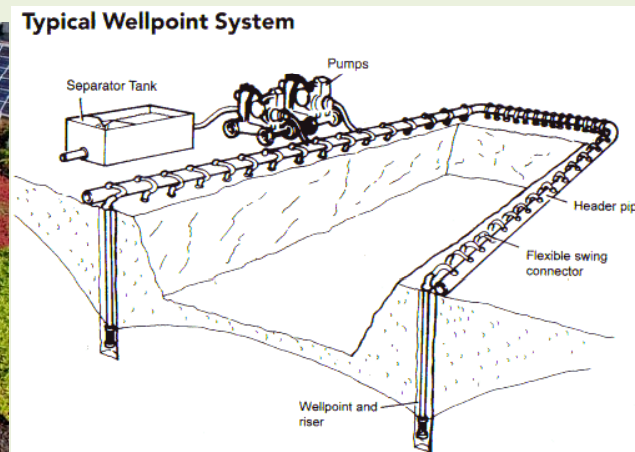
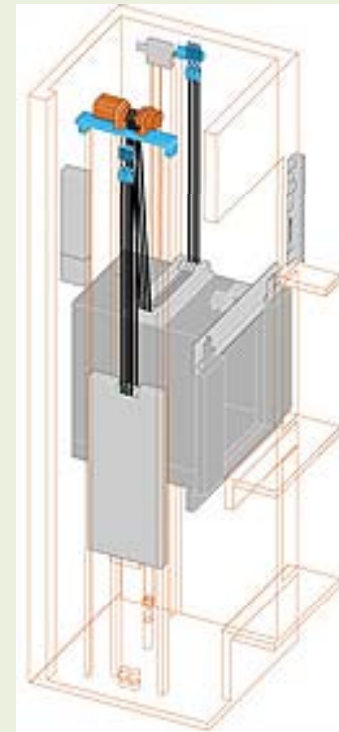
COST ESTIMATE BREAKDOWN



- EXCAVATION
- FOUNDATION
- SUPERSTRUCTURE
- EXTERIOR CLOSURE
- INTERIOR CONSTRUCTION
- STAIRS
- INTERIOR FINISHES
- CONVEYING SYSTEM
- PLUMBING
- HVAC
- Fire Protection
- ELECTRICAL
- EQUIPMENT
- FURNISHING
- SPECIAL CONSTRUCTION
- SITework

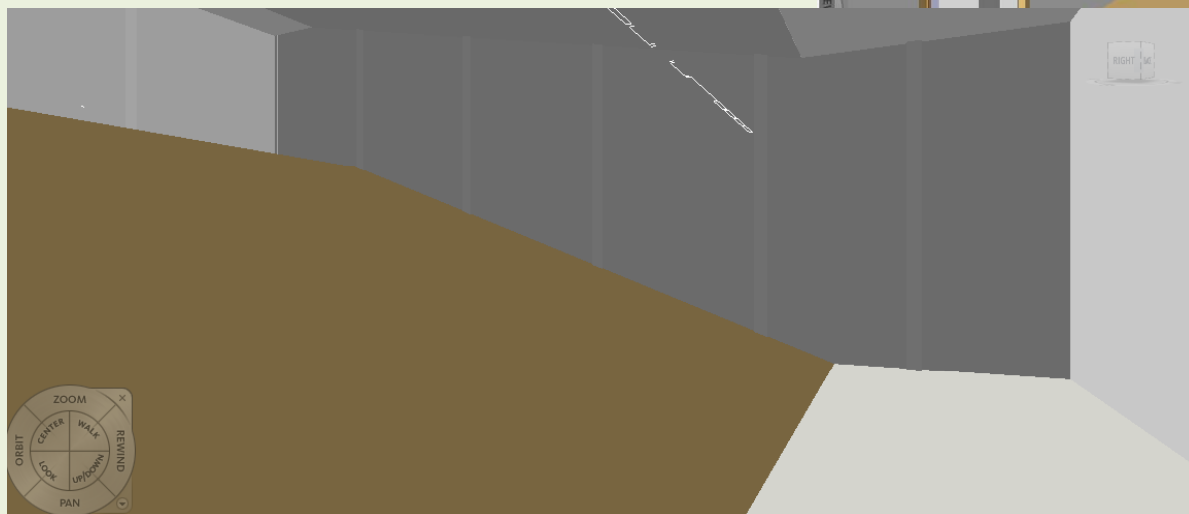
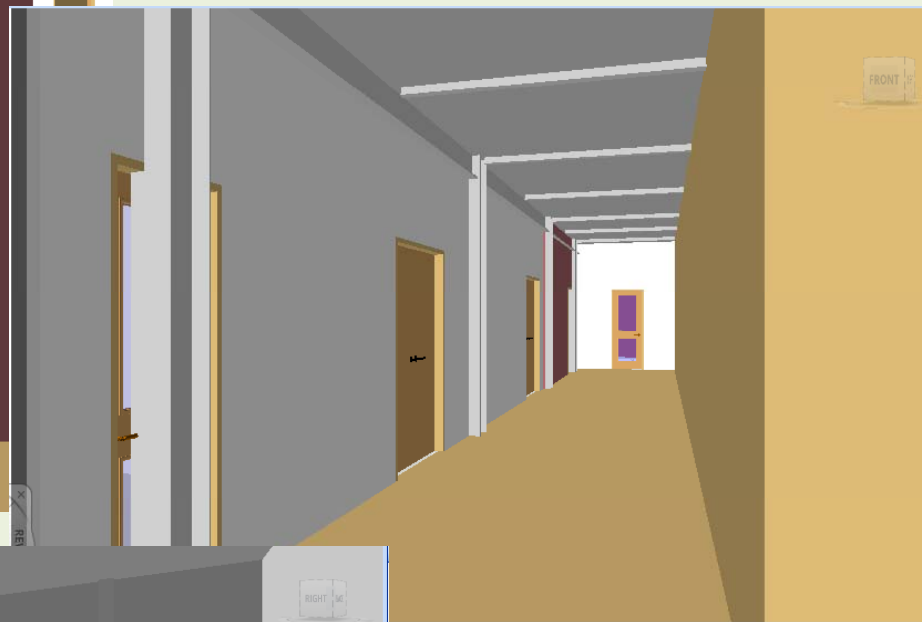
COST SPECIFIC DECISIONS

- **Elevators**
 - machine room less
- **Emergency dewatering**
 - Until foundation & walls are waterproofed
- **Glass Facade**
 - finally **single glazed**
- **Photos Voltaic**
 - 2800 sq Ft, 16.8 KW
- **Green roof**
 - \$ 20 /sf



4 D AND COORDINATION MEETING

U
C
L
A



A

E

C

M

L

Cash Flow Modelling



year	2016	2028	2040	2019
Construction				\$0
financial cost				
equity 10 %	1	13	25	
debt 90 %				
senior loan	\$76.079	\$87.402	\$96.081	10.606
debt				
interests				
monthly loans pay back				
yearly loan				
monthly re				
Life cycle				
Operation				
per month				
Service costs				
per month				
Maintenance costs				
per month				
revenues				
calculated rental fee per month				
risk charge				
profit charge				
real rental fee per year				
real rental fee per month				

real rental fee per month

A
E
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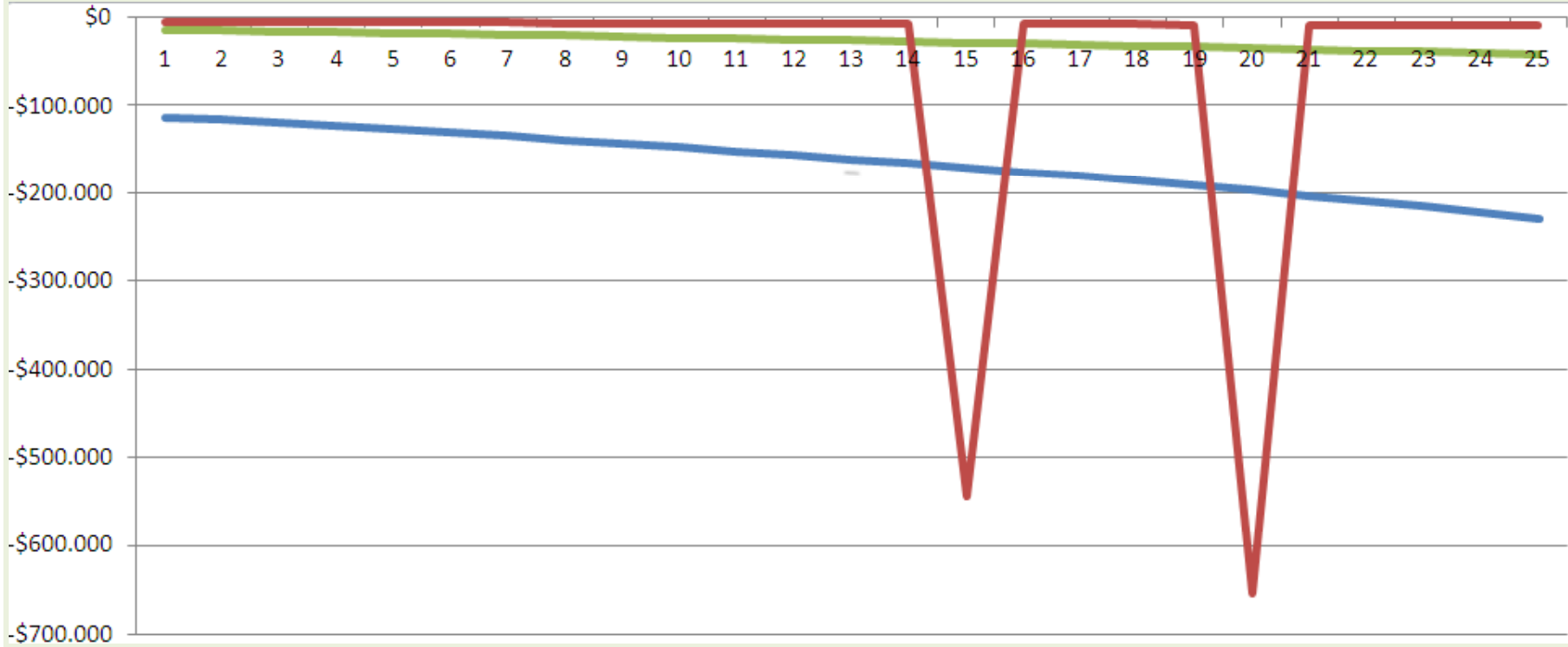
Main cost drivers

year	2015	2016	2017	2018	2019
	0	1	2	3	4
Construction costs	\$7.268.090	\$0	\$0	\$0	\$0
financial costs					
equity 10 %	\$726.809				
debt 90 %	-\$6.541.281				
senior loan	-\$7.129.996				
debt	-\$7.129.996	-\$6.914.367	-\$6.687.956	-\$6.450.224	-\$6.200.606
interests		-\$356.500	-\$345.718	-\$334.398	-\$322.511
monthly loans pay back		-\$47.677	-\$47.677	-\$47.677	-\$47.677
yearly loans pay back		-\$572.129	-\$572.129	-\$572.129	-\$572.129
monthly rental fee		\$64.232	\$64.759	\$65.301	\$65.858
Life cycle costs					
Operation costs		-\$14.833	-\$15.673	-\$16.534	-\$17.416
per month		-\$1.236	-\$1.306	-\$1.378	-\$1.451
Service costs		-\$113.302	-\$116.678	-\$120.155	-\$123.736
per month		-\$9.442	-\$9.723	-\$10.013	-\$10.311
Maintenance costs		-\$4.230	-\$4.357	-\$4.486	-\$4.620
per month		-\$5.877	-\$6.052	-\$6.233	-\$6.418
revenues					
calculated rental fee per month		\$64.232	\$64.759	\$65.301	\$65.858
risk charge		\$31.844	\$31.844	\$31.844	\$31.844
profit charge		\$110.312	\$113.600	\$116.985	\$120.471
real rental fee per year		\$912.946	\$922.551	\$932.439	\$942.617
real rental fee per month		\$76.079	\$76.879	\$77.703	\$78.551



A
E
C
M
L

Life Cycle Cost development



— Service — Operation — Maintenance

U
C
L
A



A

E

C

M

L

Detailed cost factors



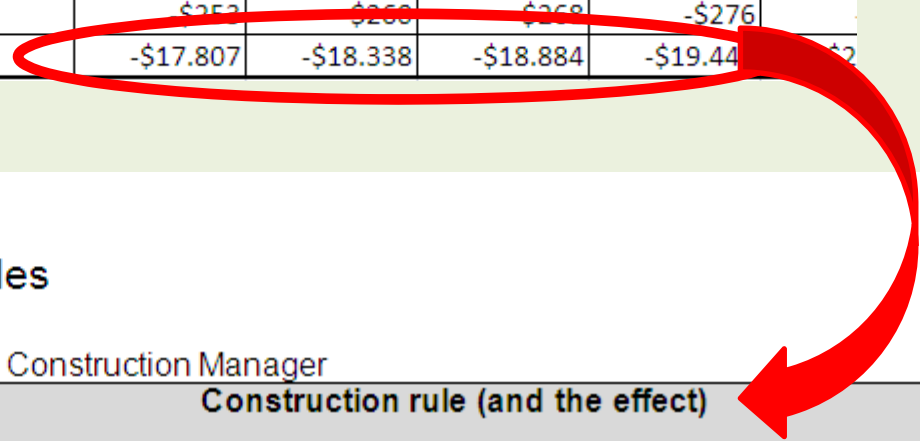
life cycle costs [service]							
current year	2015	2016	2017	2018	2019	2020	2021
year	0	1	2	3	4	5	6
cleaning costs							
windows/glass surfaces		-\$270	-\$278	-\$286	-\$295		
solar panels		\$252	\$260	\$268	\$276		
cleaning average		-\$17.807	-\$18.338	-\$18.884	-\$19.44		

Influences on LCC – Design and construction rules

Profession: A = Architect E = Engineer C = Construction Manager

Who?	Costs	What to reduce or improve?	Construction rule (and the effect)
A	Cleaning Costs	Cleaning frequent	Pollution lock and mudflap measure avoid dirt. A protected entrance situation, areas to collect the mud from outside will help.

A
E
C
M
L

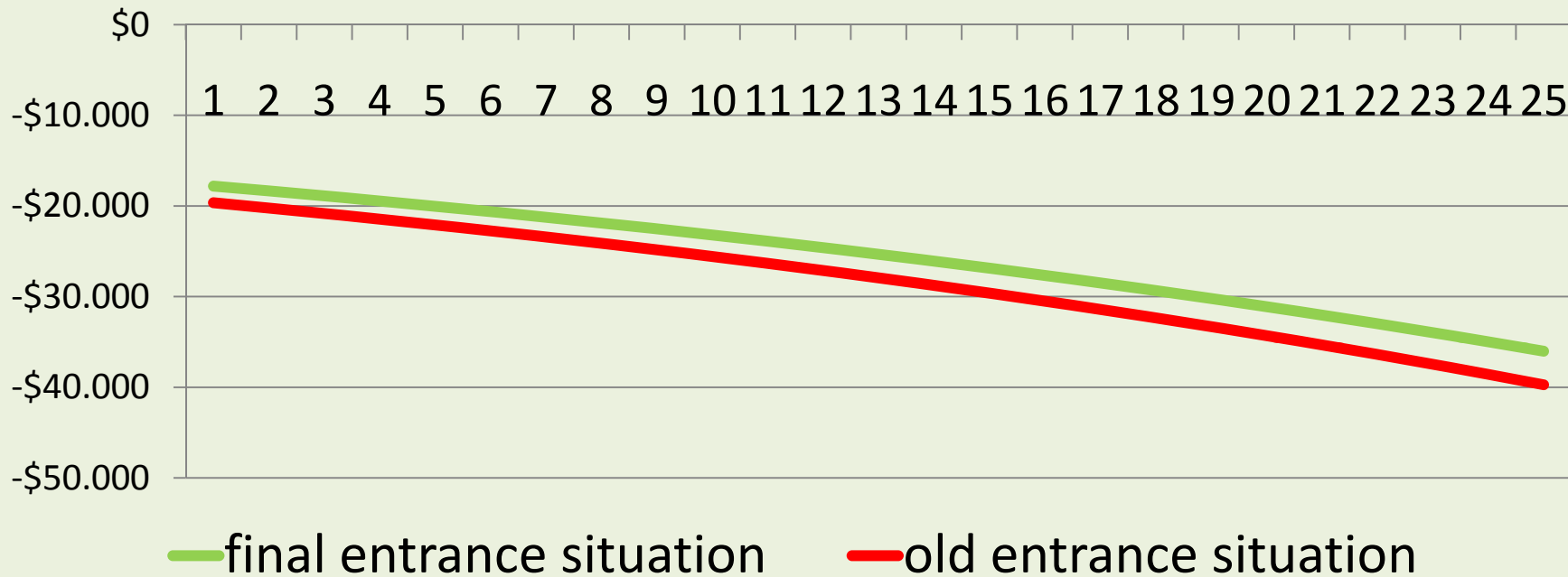


Implementation of construction rule



Monetary advantage of the protected entrance

on the example of cleaning costs over the life cycle



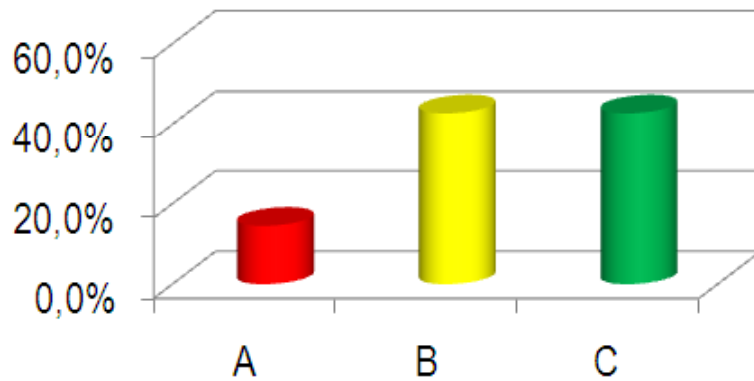
\$1,826 \$1,881 \$1,937 \$1,995 \$2,054 \$2,115 \$2,178 \$2,243 \$2,310 \$2,379 \$2,450 \$2,523 \$2,598 \$2,675 \$2,755 \$2,837 \$2,922 \$3,009 \$3,098 \$3,191 \$3,286 \$3,384 \$3,485 \$3,588

Total savings over the life cycle:
\$ 66,414

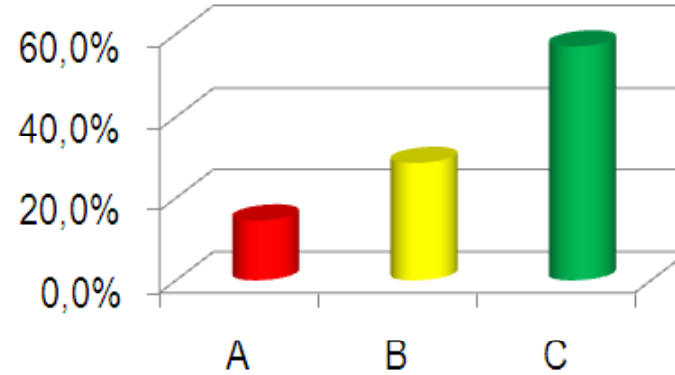


Risk allocation

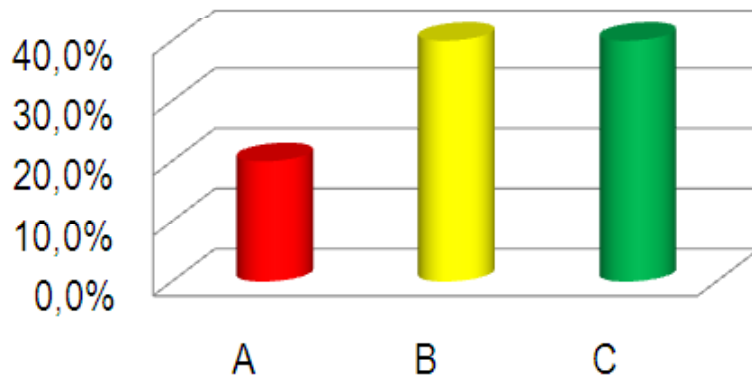
Service risk allocation



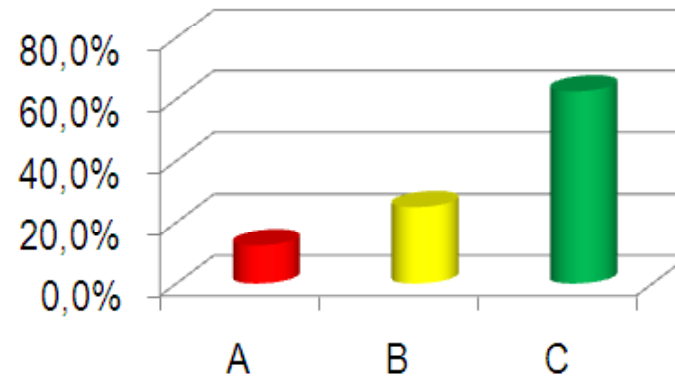
Operation risk allocation



Maintenance risk allocation



Construction risk allocation



Risk charge optimization

on the example of a structural decision



Rotating walls

Construction period	-\$181.006
Operation period	-\$412.367
Maintenance period	-\$53.302
Services	-\$149.429
total	-\$796.104

risk charge per year	risk charge per month
-\$31.844	-\$2.654

Shear walls

Construction period	-\$171.413
Operation period	-\$412.367
Maintenance period	-\$215.743
Services	-\$149.429
total	-\$948.952

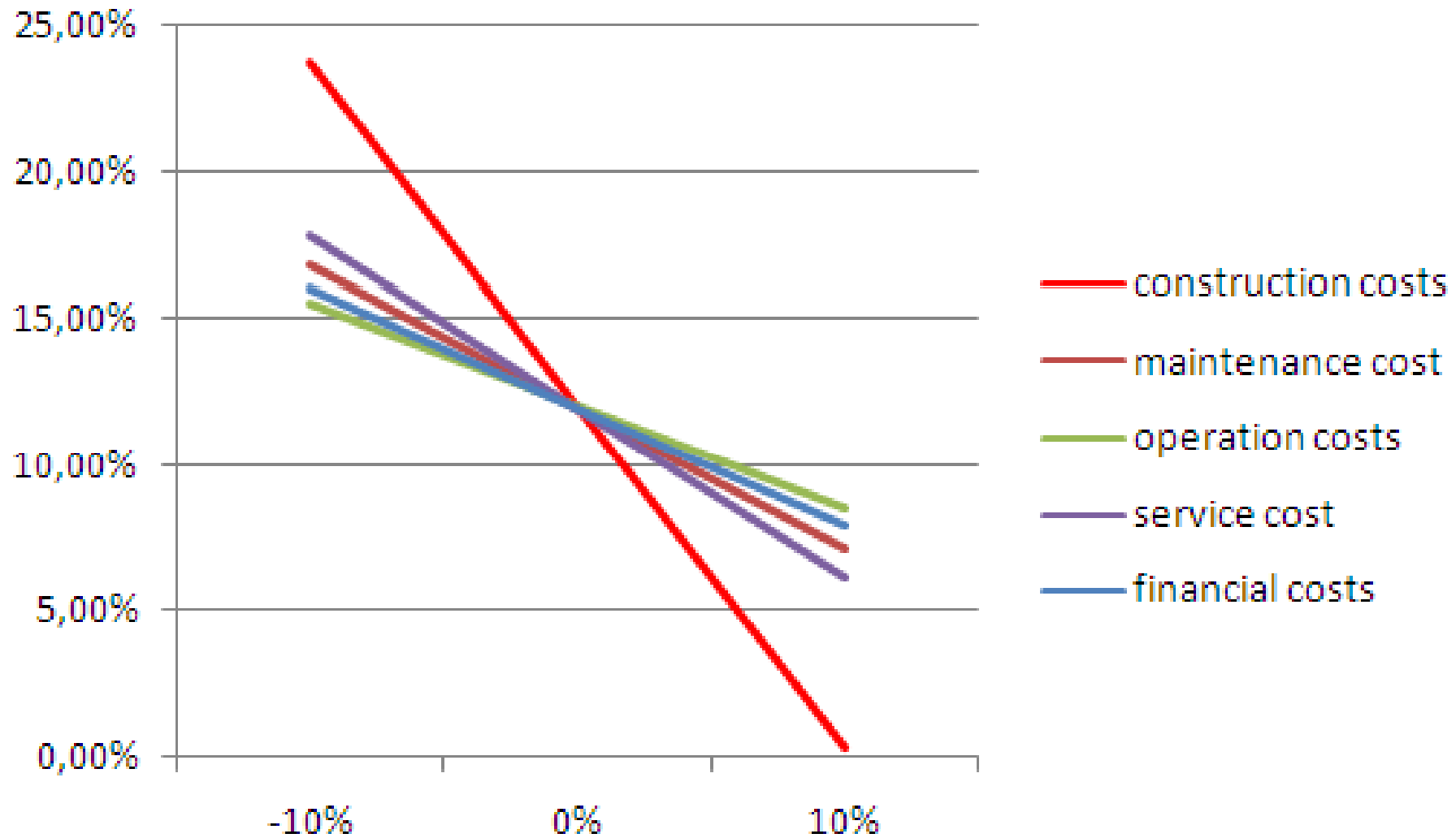
risk charge per year	risk charge per month
-\$37.958	-\$3.163

Yearly savings:
Life cycle savings:

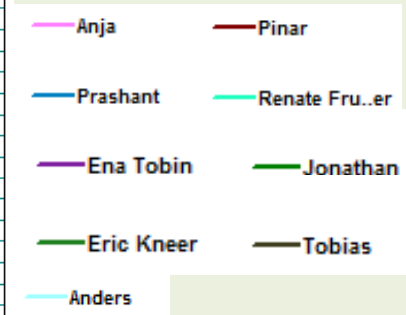
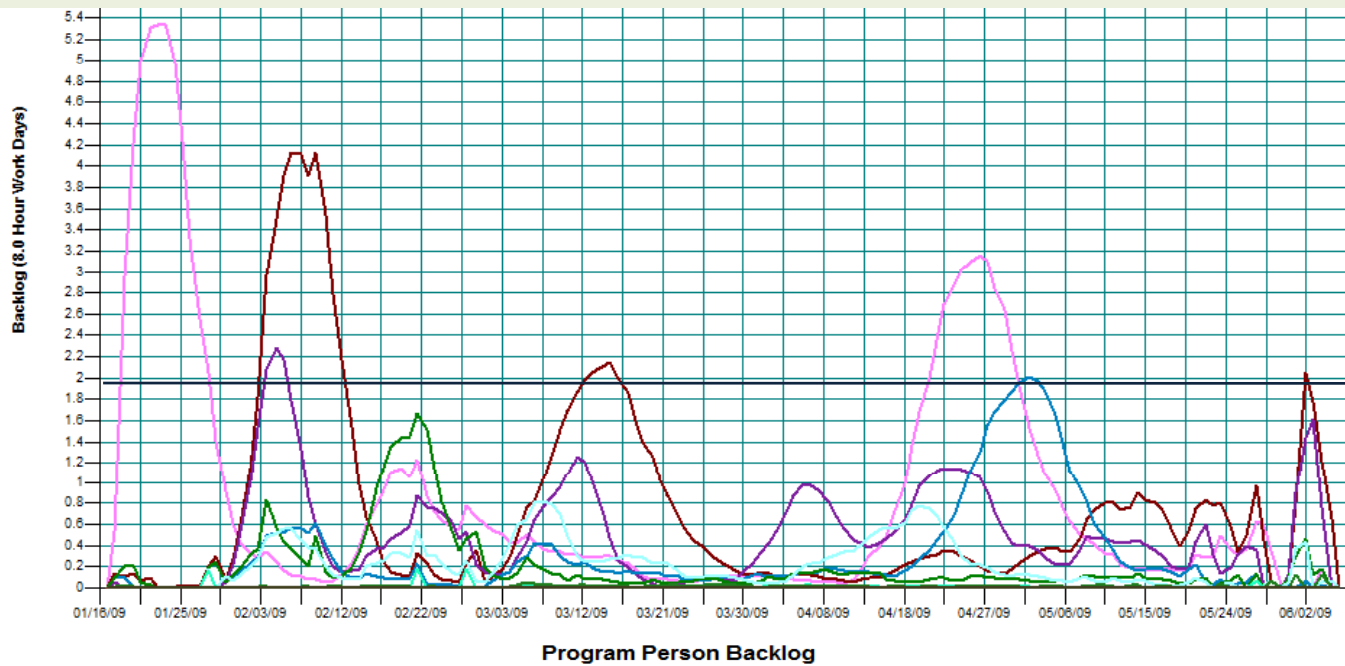
\$6,114
\$152,850

A
E
C
M
L

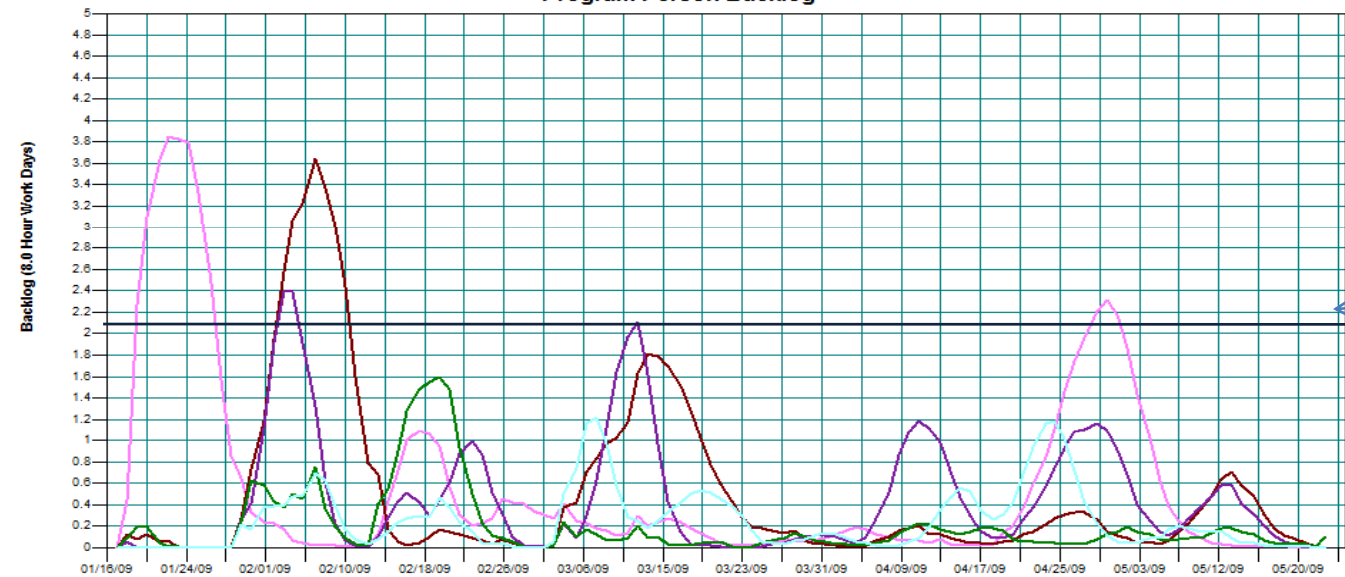
Sensitivity analysis



SIM VISION : PERSON BACKLOG



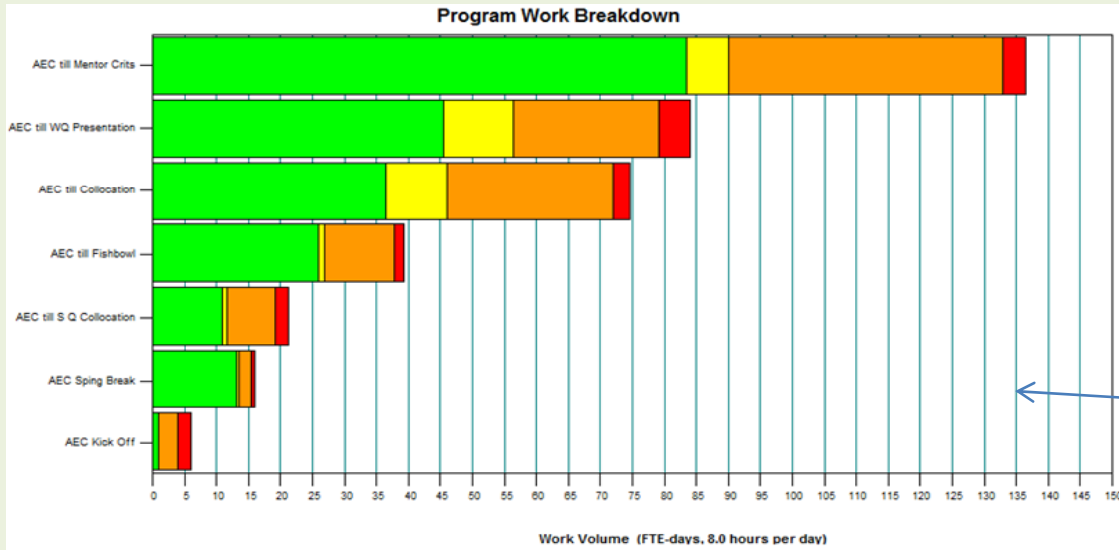
With out Intervention



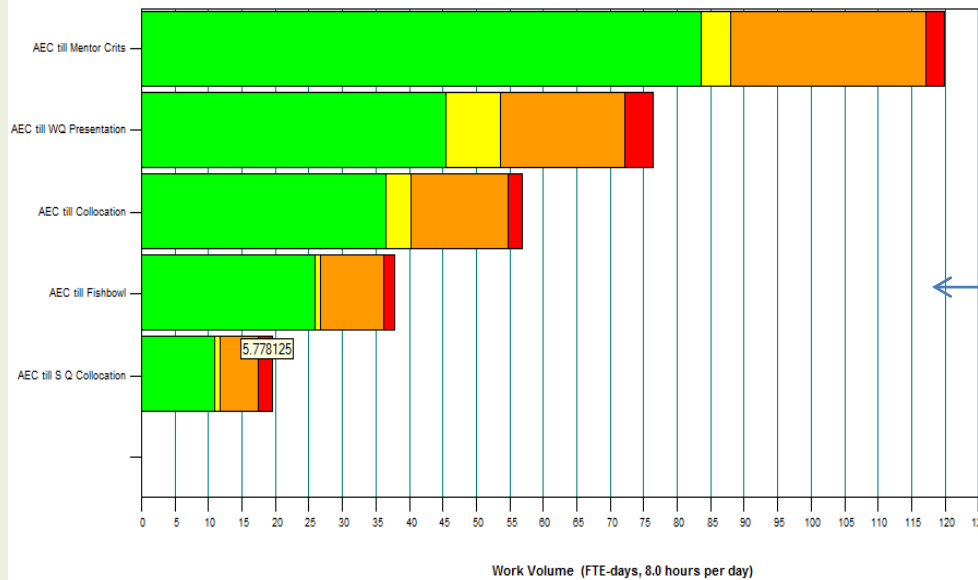
With Intervention

A
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SIM VISION : PROGRAM WORK BREAKDOWN



With out Intervention



With Intervention

TEAM PROCESS



Speeches

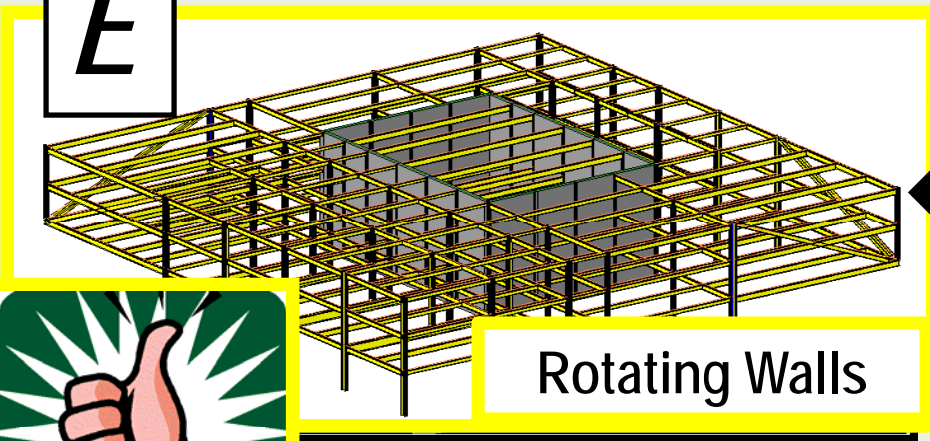


Discussions



TEAM PROCESS – Lateral Load Resisting System

E



L



*...nal Braces help the
...ever deflections*



...ement!

MEP



...s in aud.

A



...transparent facade

CM



...!

U
C
L
A



A

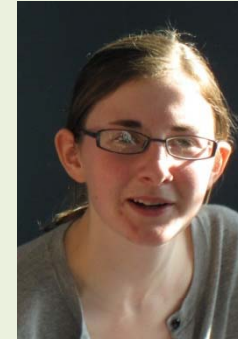
E

C

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LESSONS LEARNED



U
C
L
A



A

E

C

M

L

Thank You!

Renate Fruchter

Erik Kneer

Greg Luth

Helmut Krawinklar

Nick Anderson

Adhamina Rodriguez

Andrea Frank-Jungbecker

Daniel Kuron

Henry Tooriyani

Yash Ahuiva