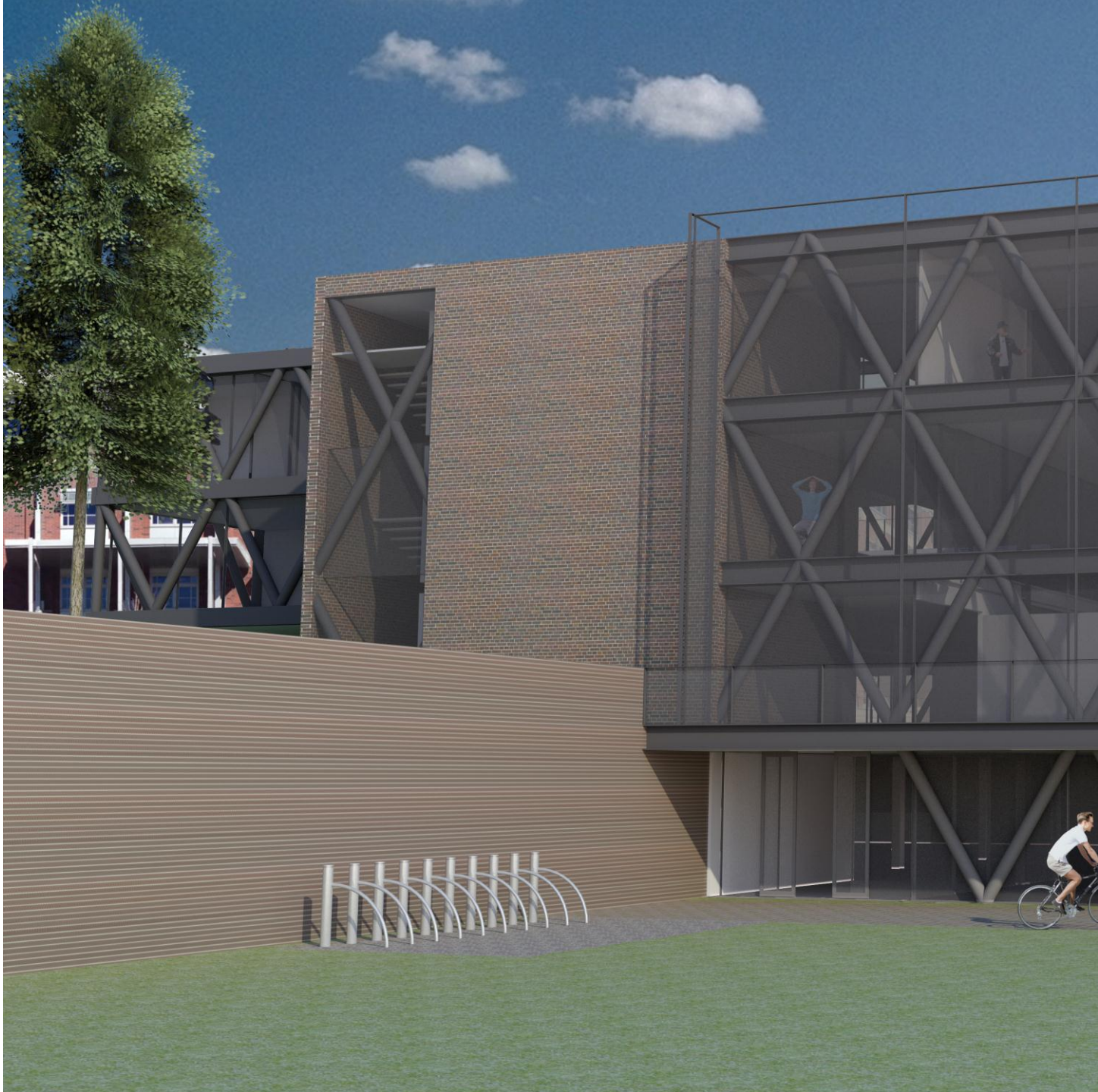
We are the Ridge team, which from now on, stands for awesome.

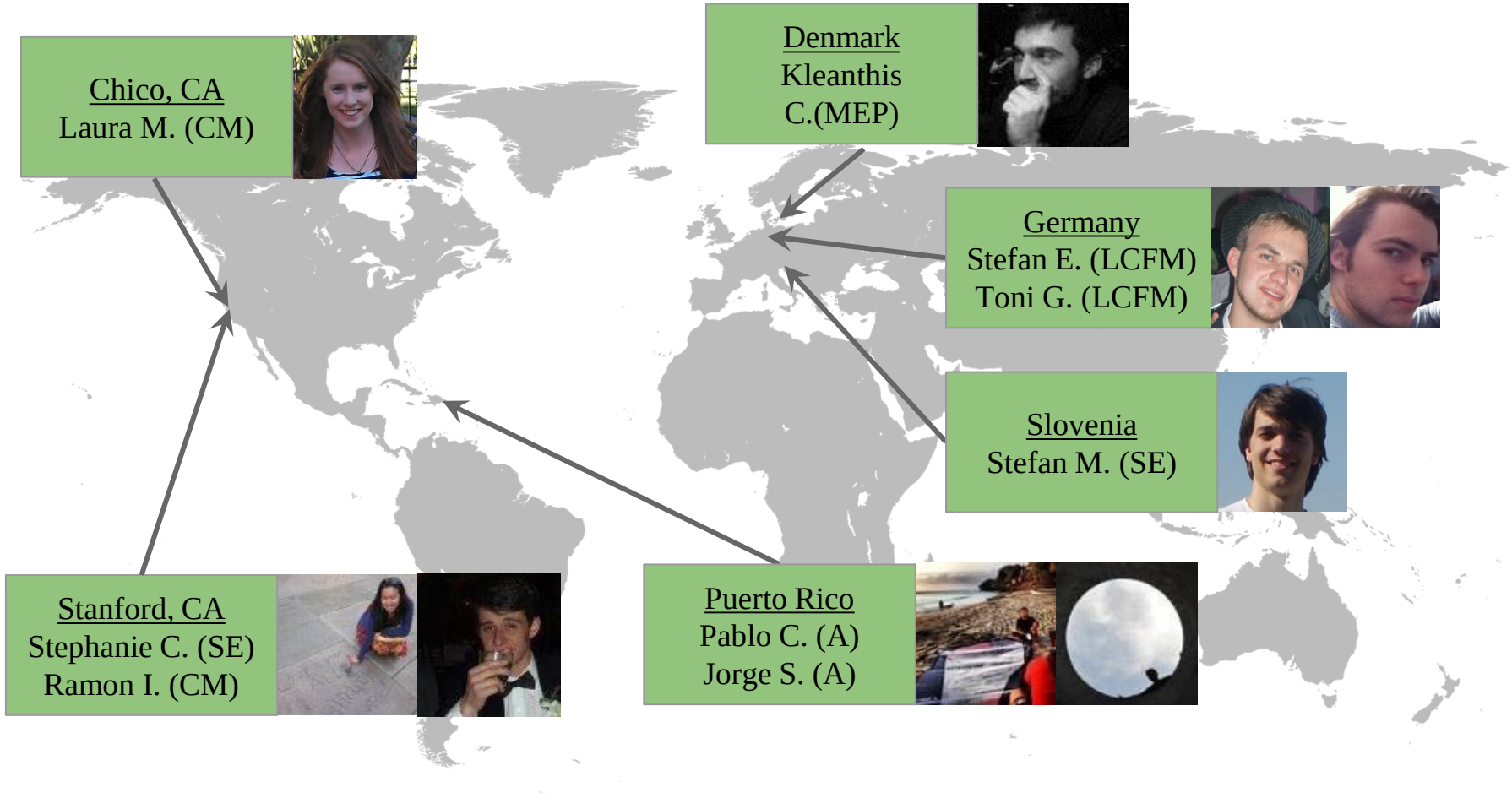
Spring Presentation
May 10th, 2013

A	SE	CM	MEP	LCFM



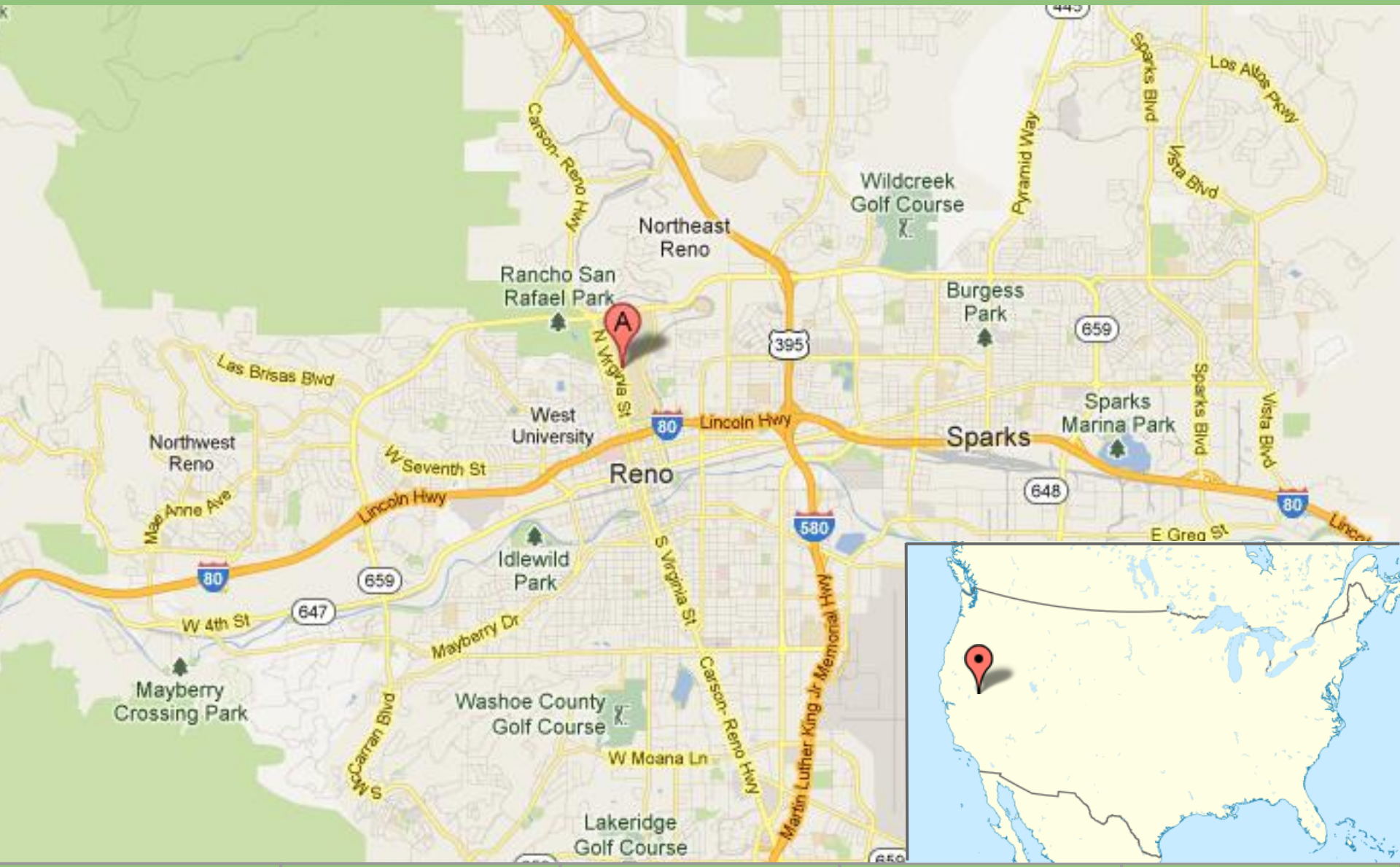
Ridge Team 2013

Owners: Sinan M. (SLO), Anirudh R. (CA), & Maria S. (MN)

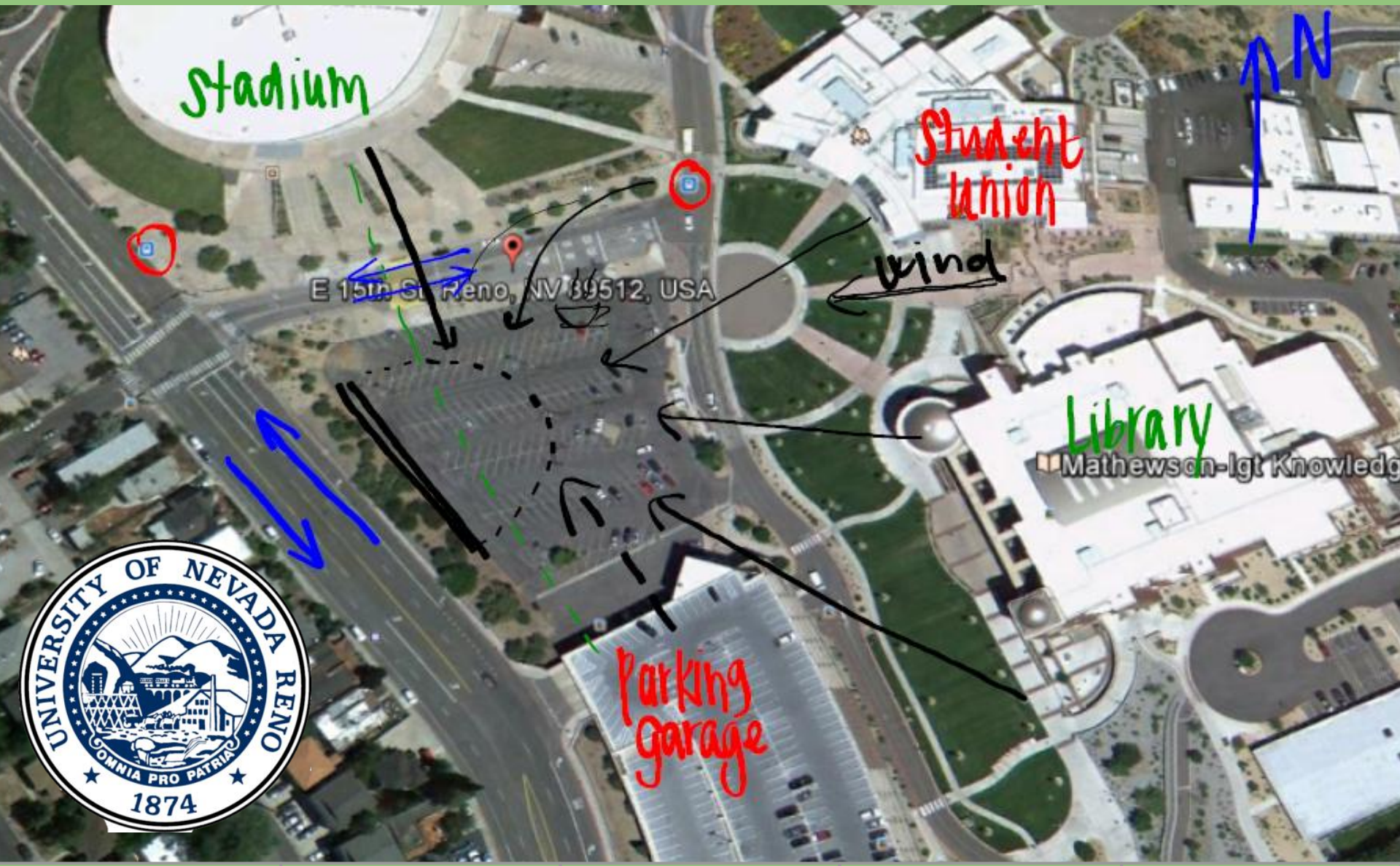


A	SE	CM	MEP	LCFM

Location: Reno, Nevada



Location: UN Reno

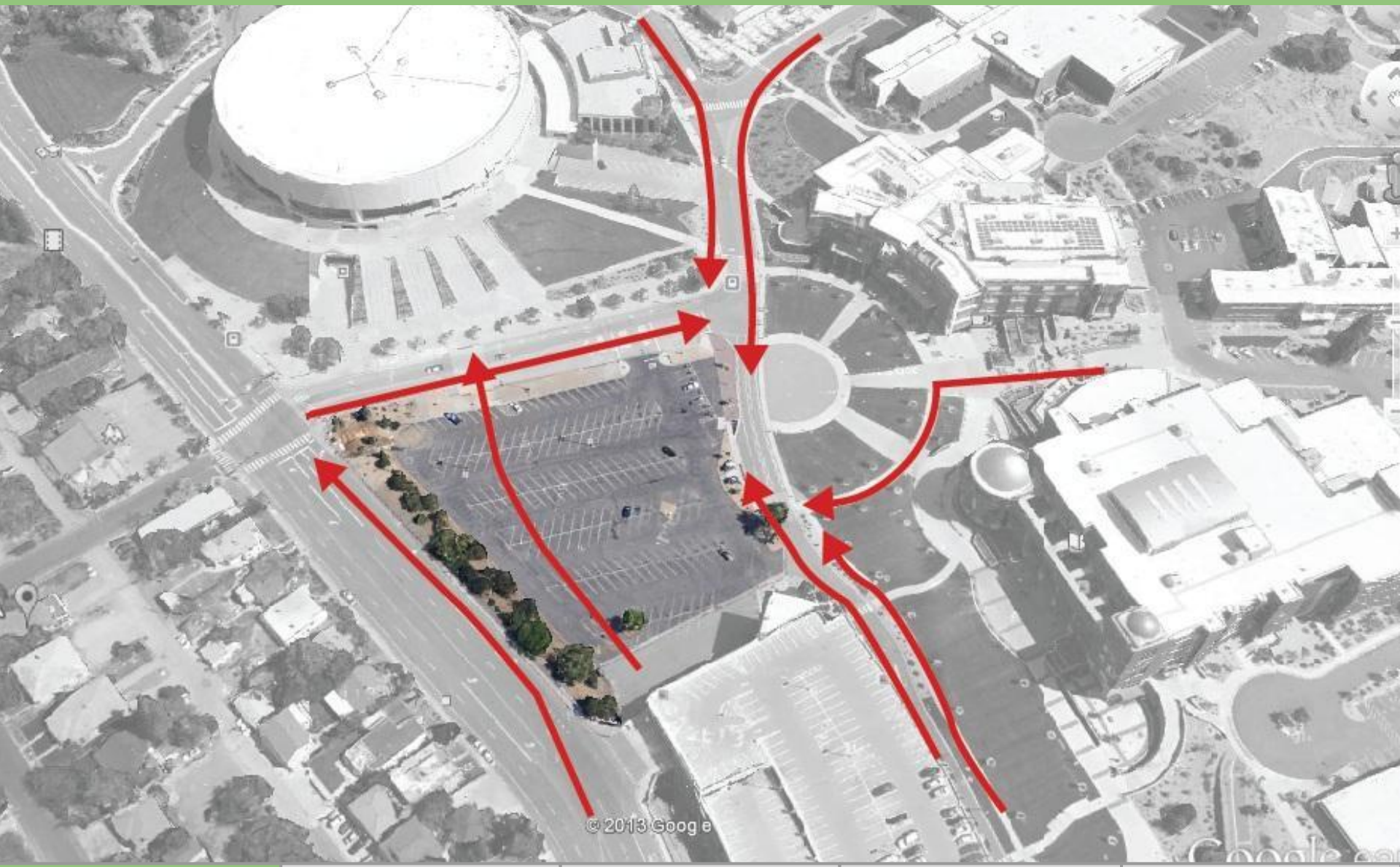


A	SE	CM	MEP	LCFM


STOP

Site Context

Site Context

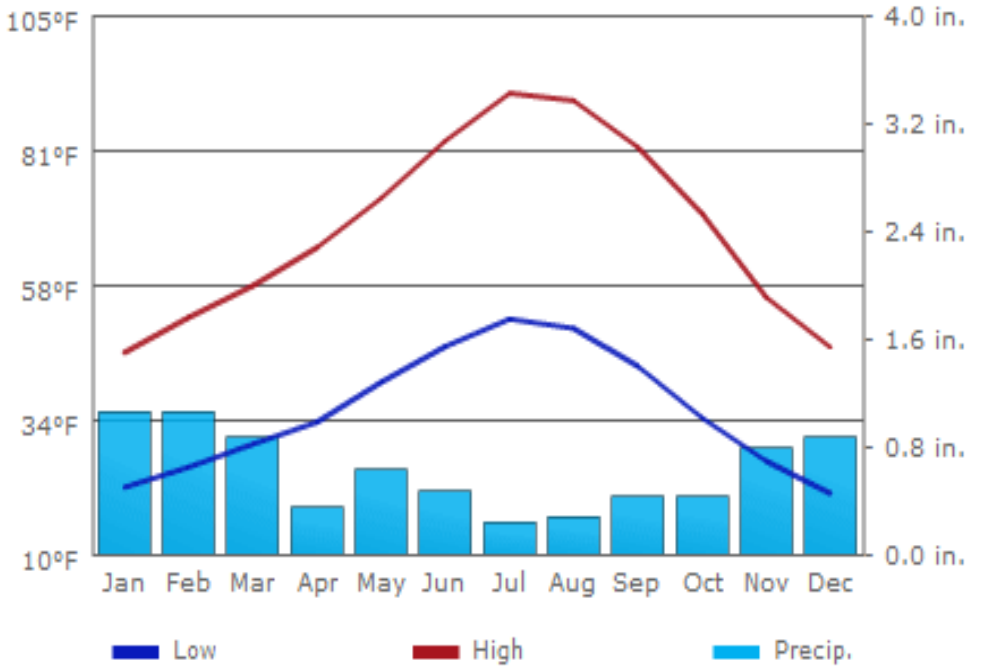


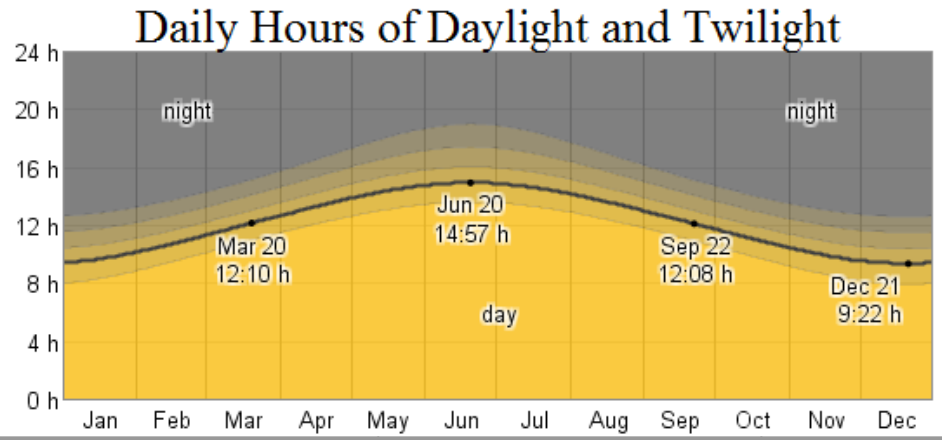
Site Challenges

Min. temperature 23.3 ^{0}F

Max. temperature 92.2 ^{0}F

Avg. precipitation 7.3 in/yr

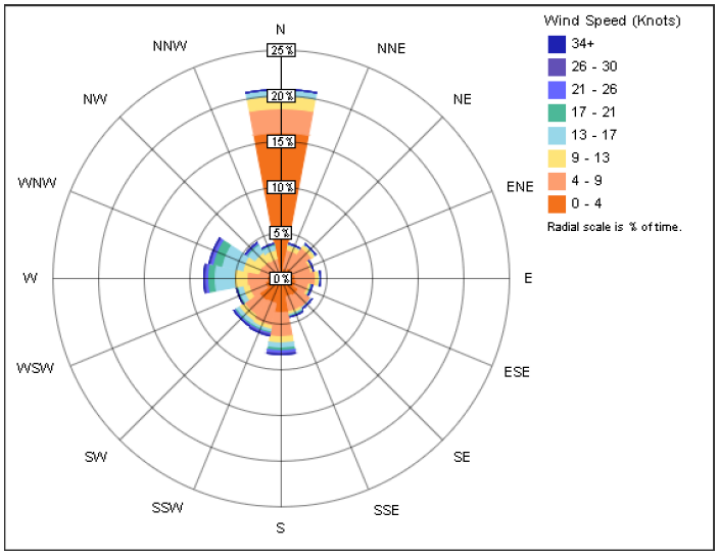




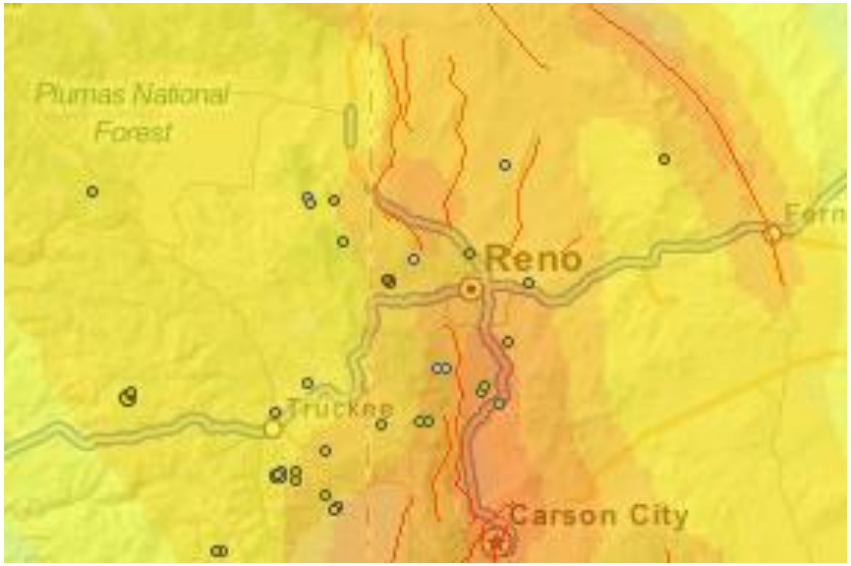
Mean sunshine 3650 hr/yr

Site Challenges

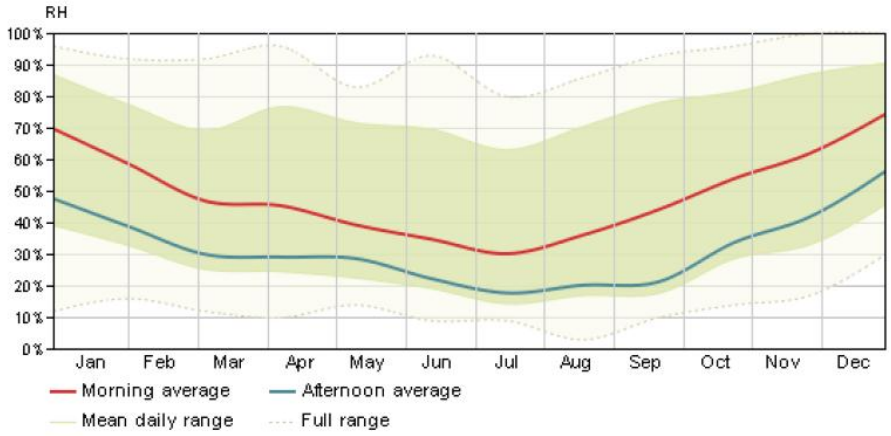
Average wind speed 5.7 knots



Seismically active zone



Average humidity 55 %

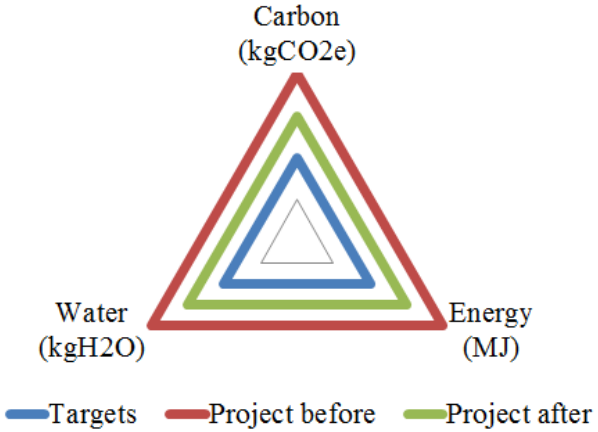


Design Challenges

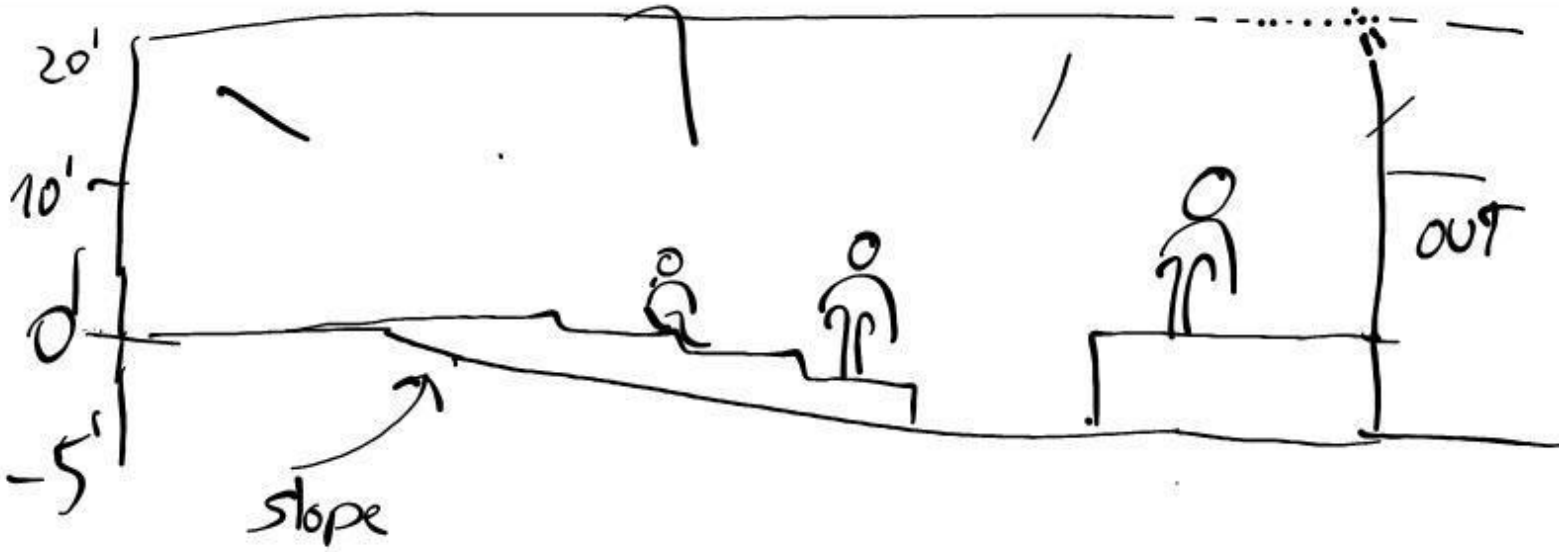
Swinerton:
Leapfrog
Challenge

DPR:
Whole Life
Cycle Challenge

STV:
Sustainable
Target Value



Big Idea



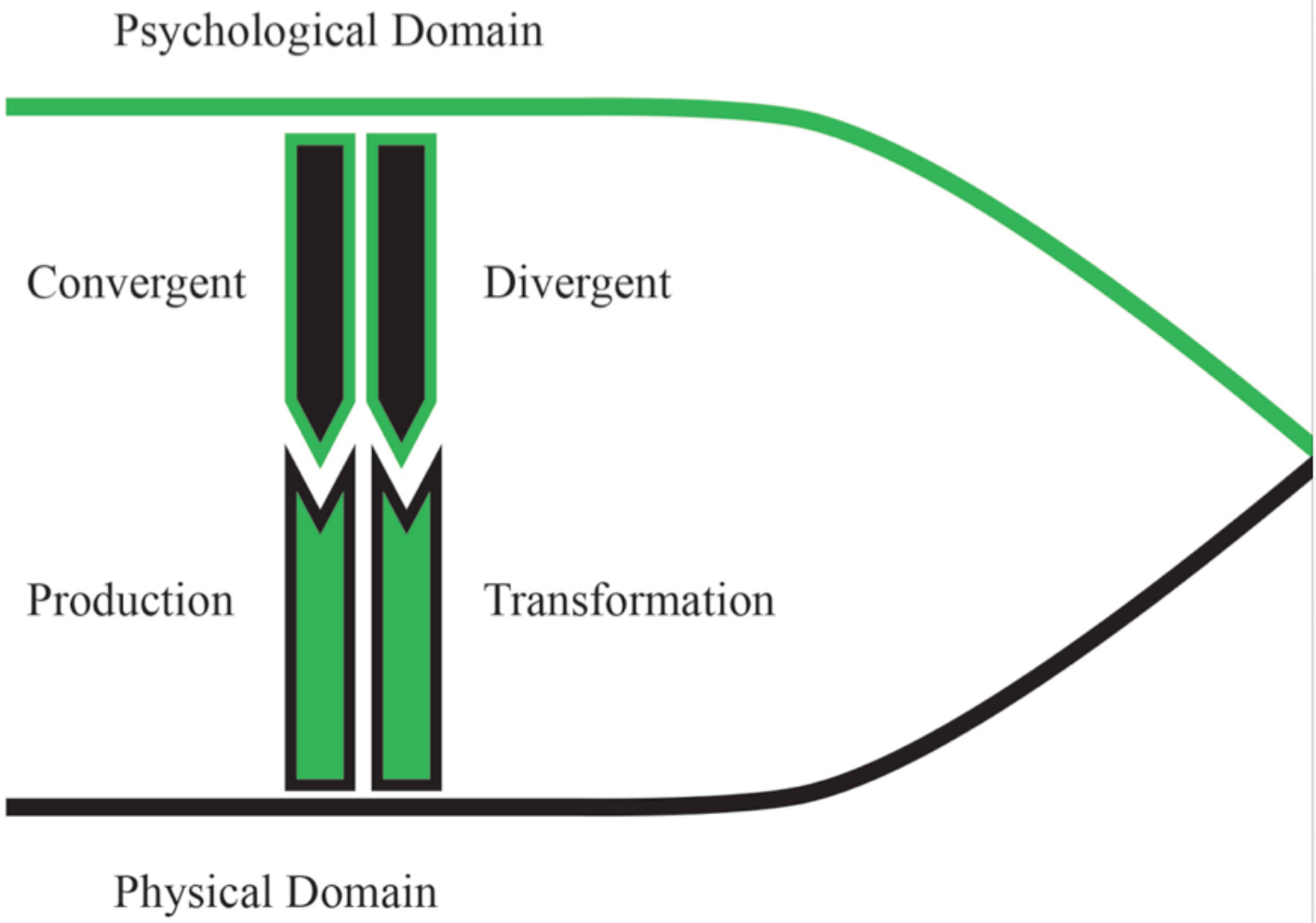
↳ smart building (security, SHM, etc.)

↳ collaborate N the building

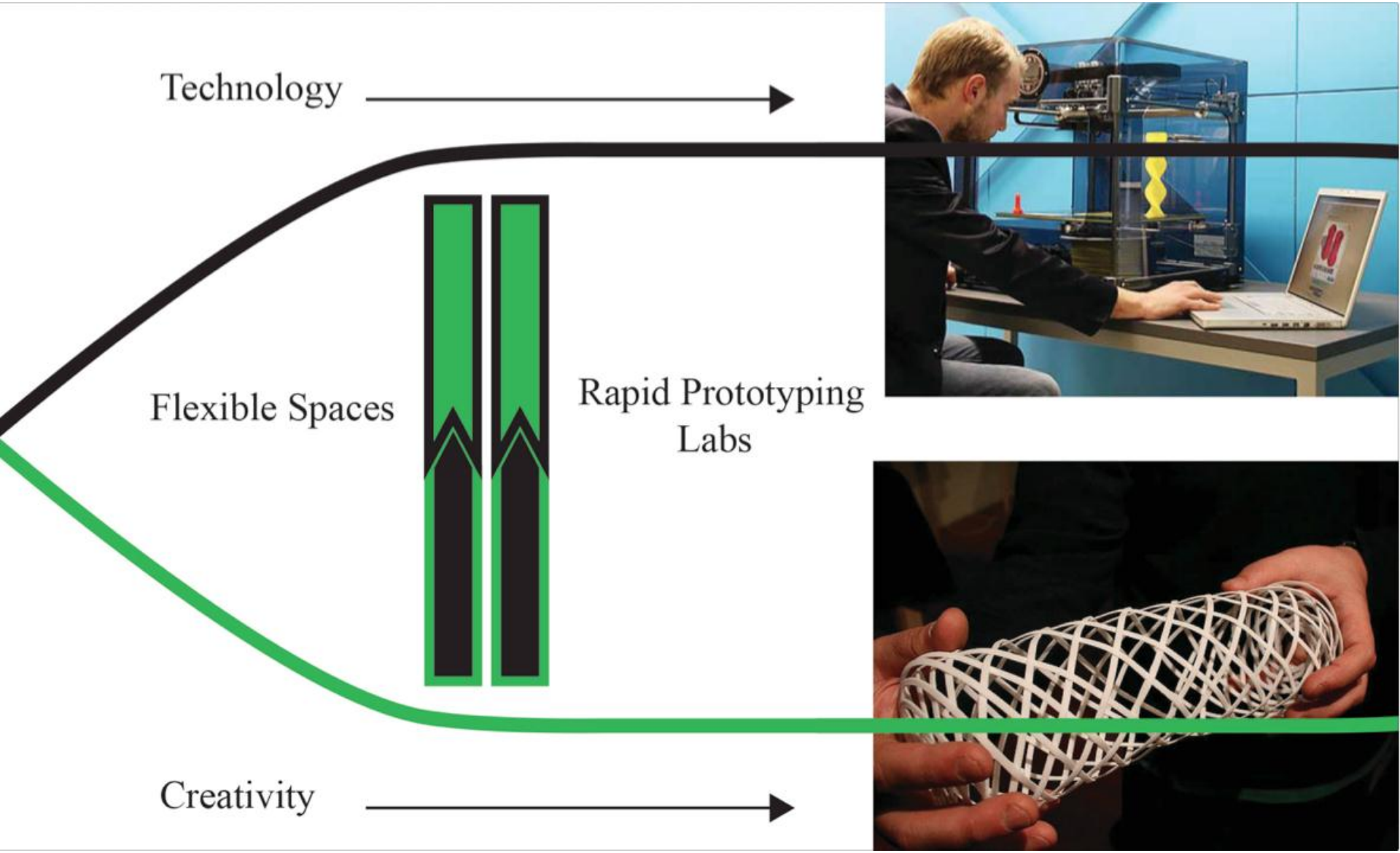
Energy/Environment ideas/goals?

Big Idea

Industrial Evolution



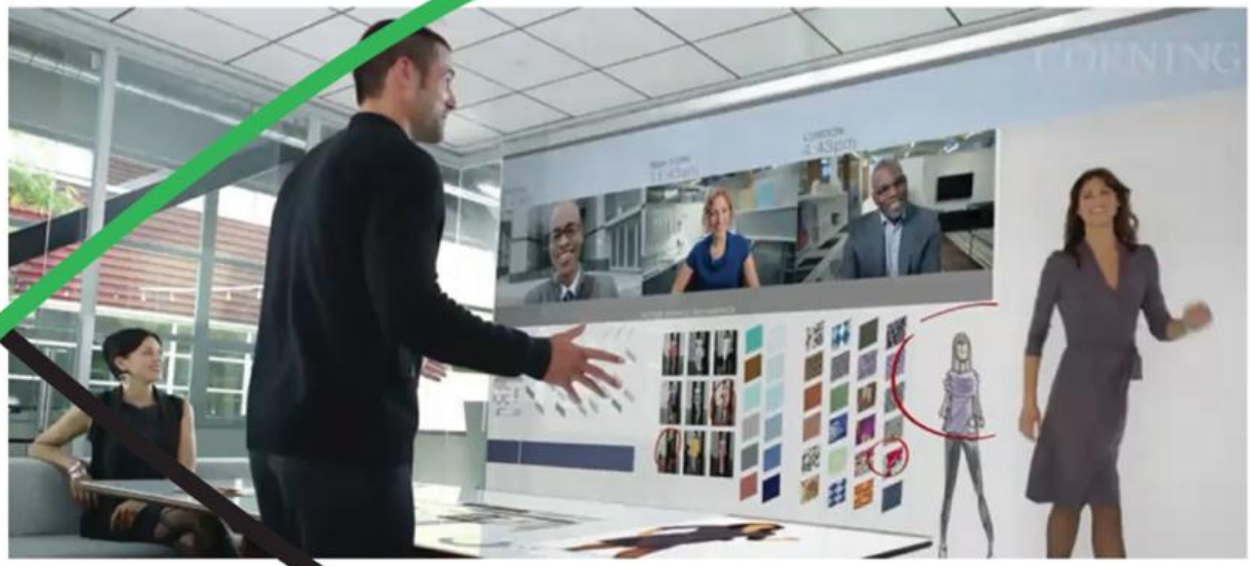
Big Idea


Technology
Flexible Spaces
Rapid Prototyping Labs
Creativity

Big Idea

Students

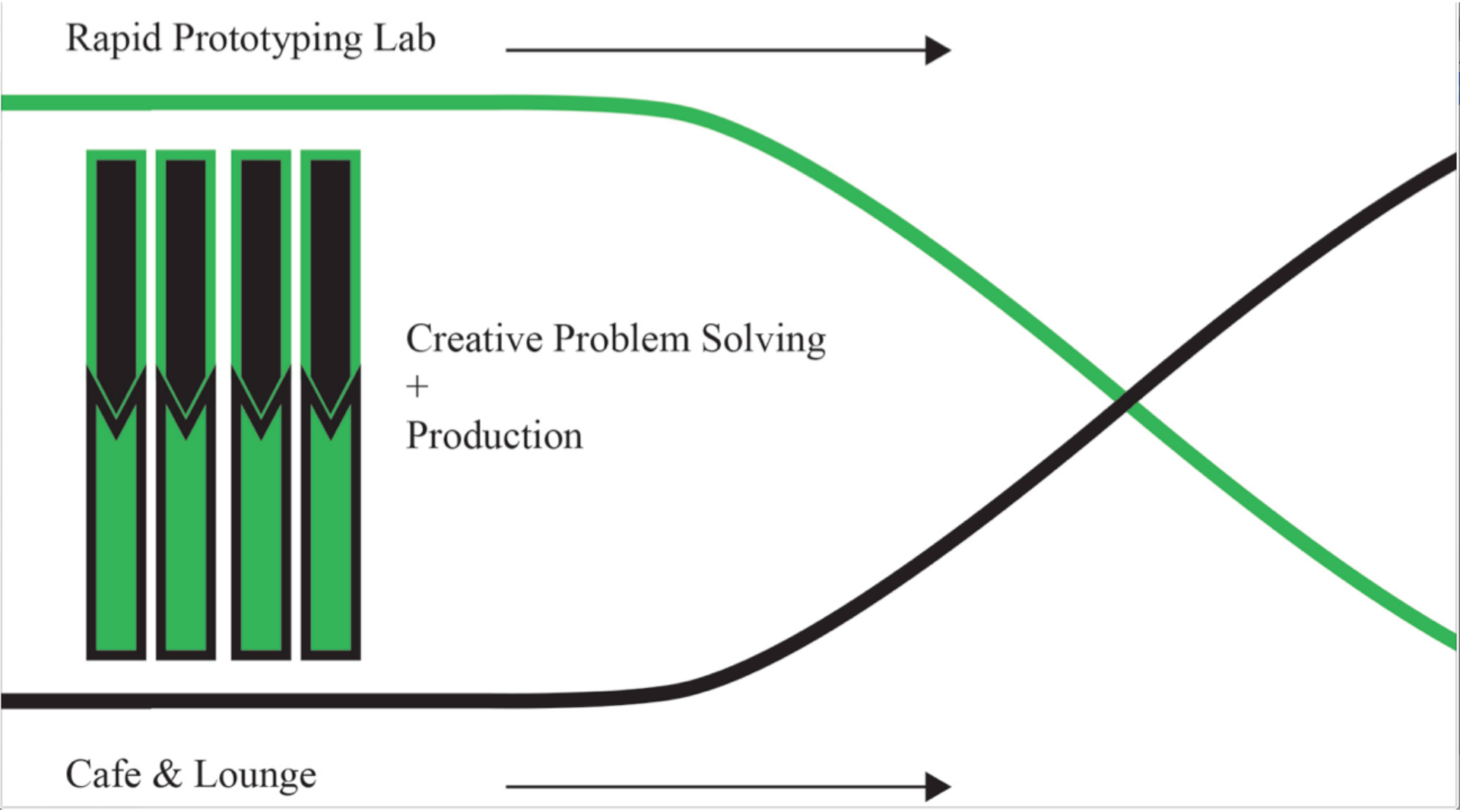
Collaboration Platform



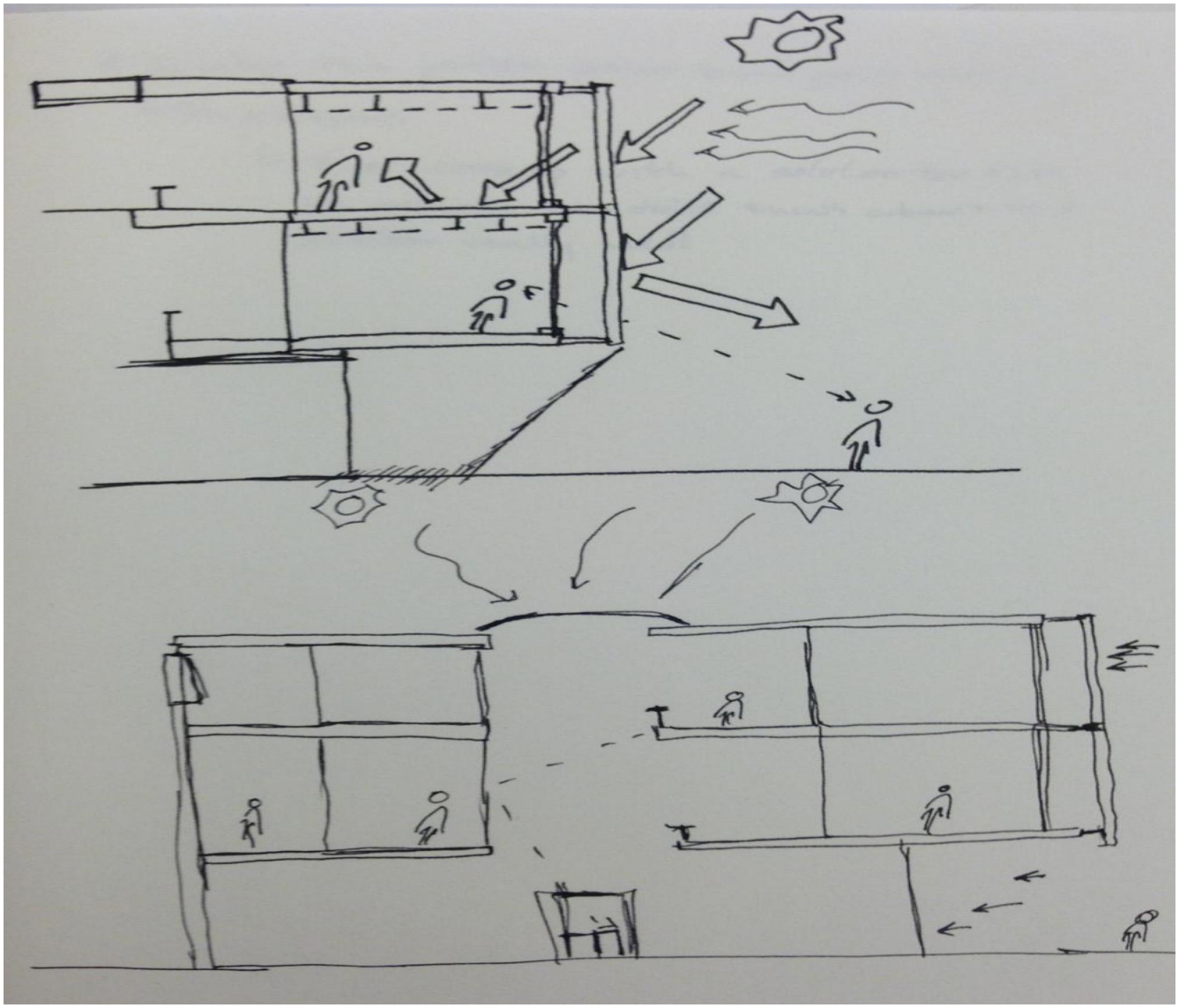
Profesors

A	SE	CM	MEP	LCFM

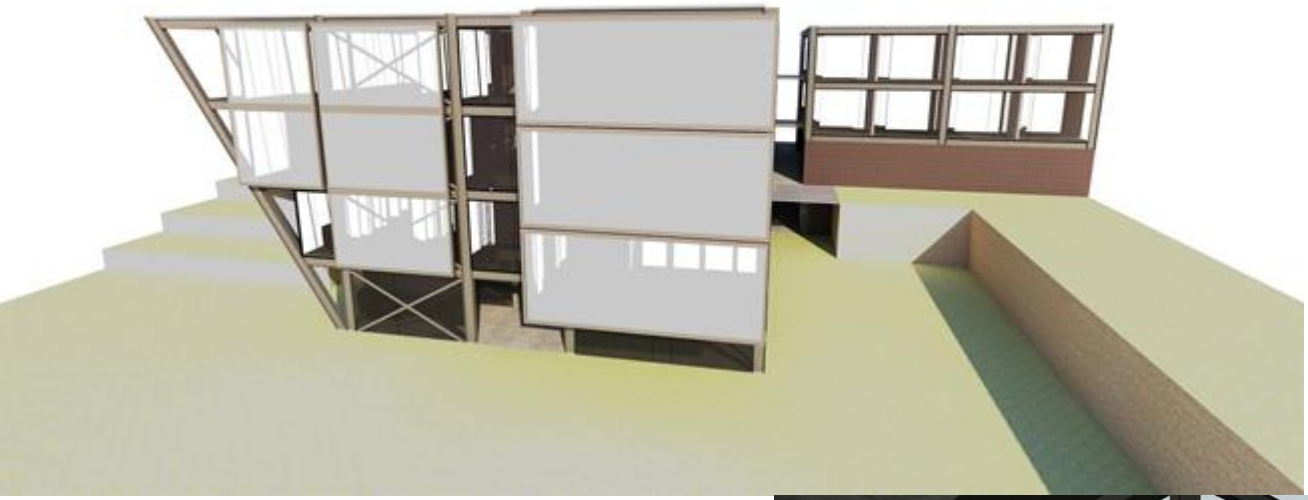
Big Idea


Rapid Prototyping Lab
Creative Problem Solving
+
Production
Cafe & Lounge

Big Idea

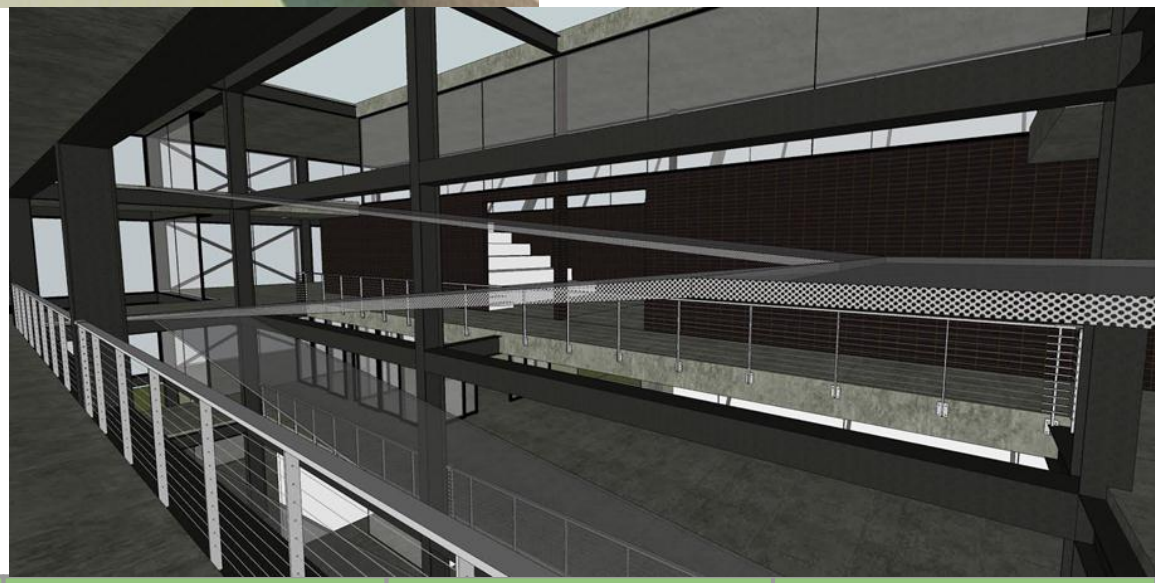


L Concept

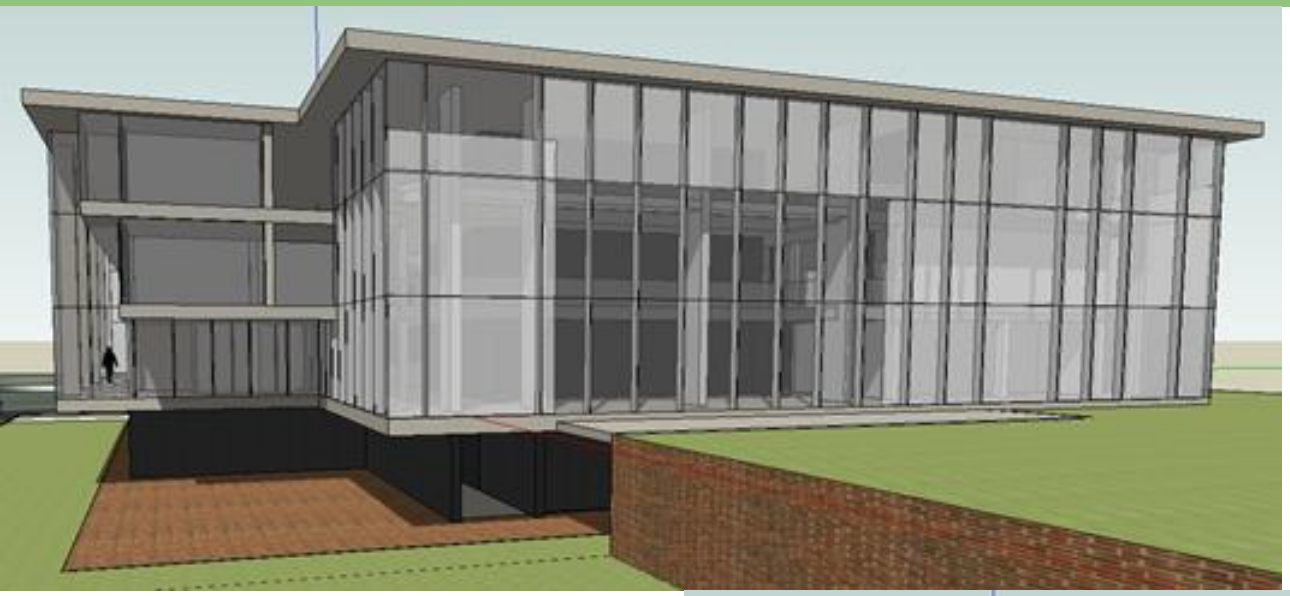


Transparent Engineering Building (TEB)

in steel & concrete



DD Concept



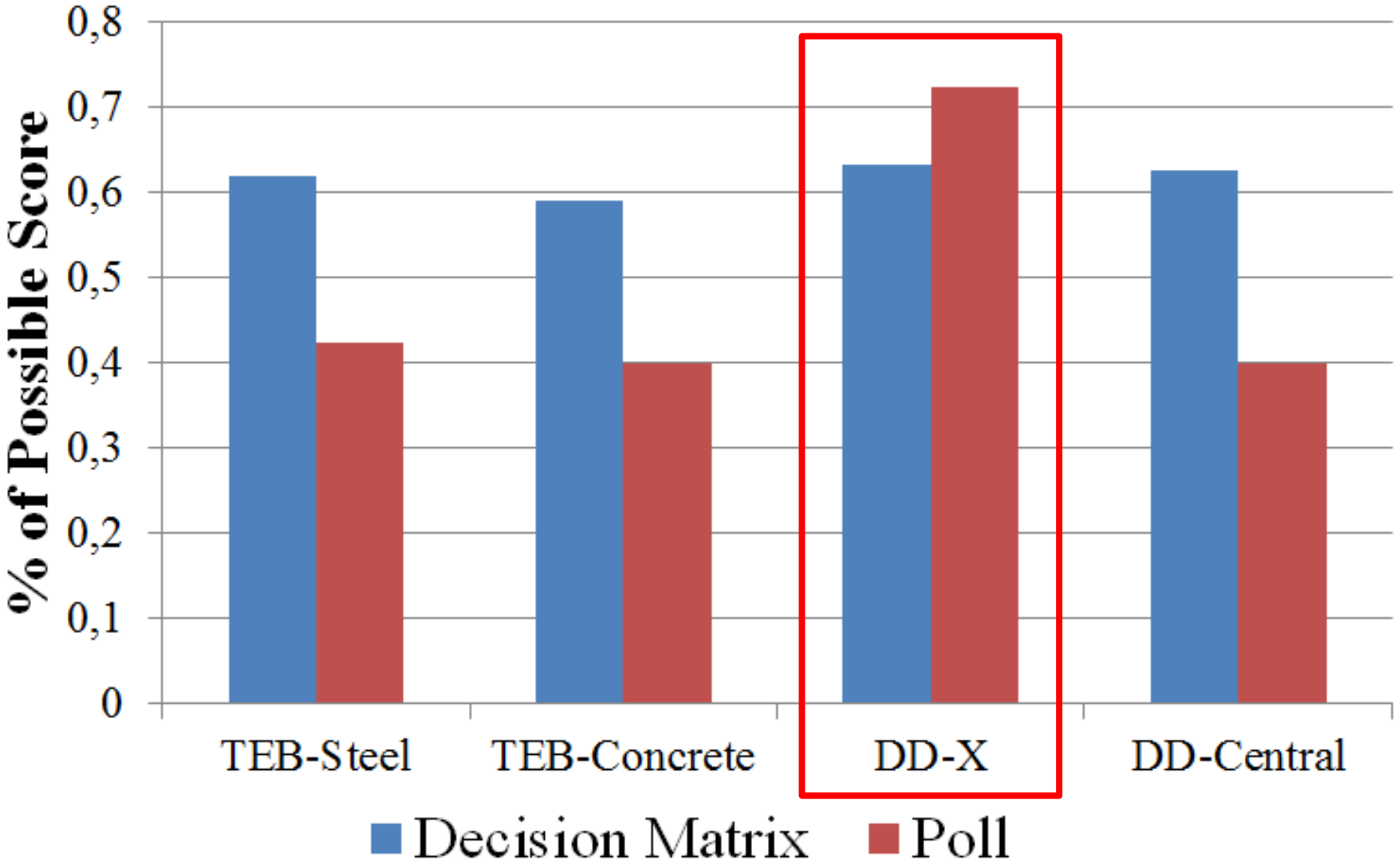
Central

X-Lattice

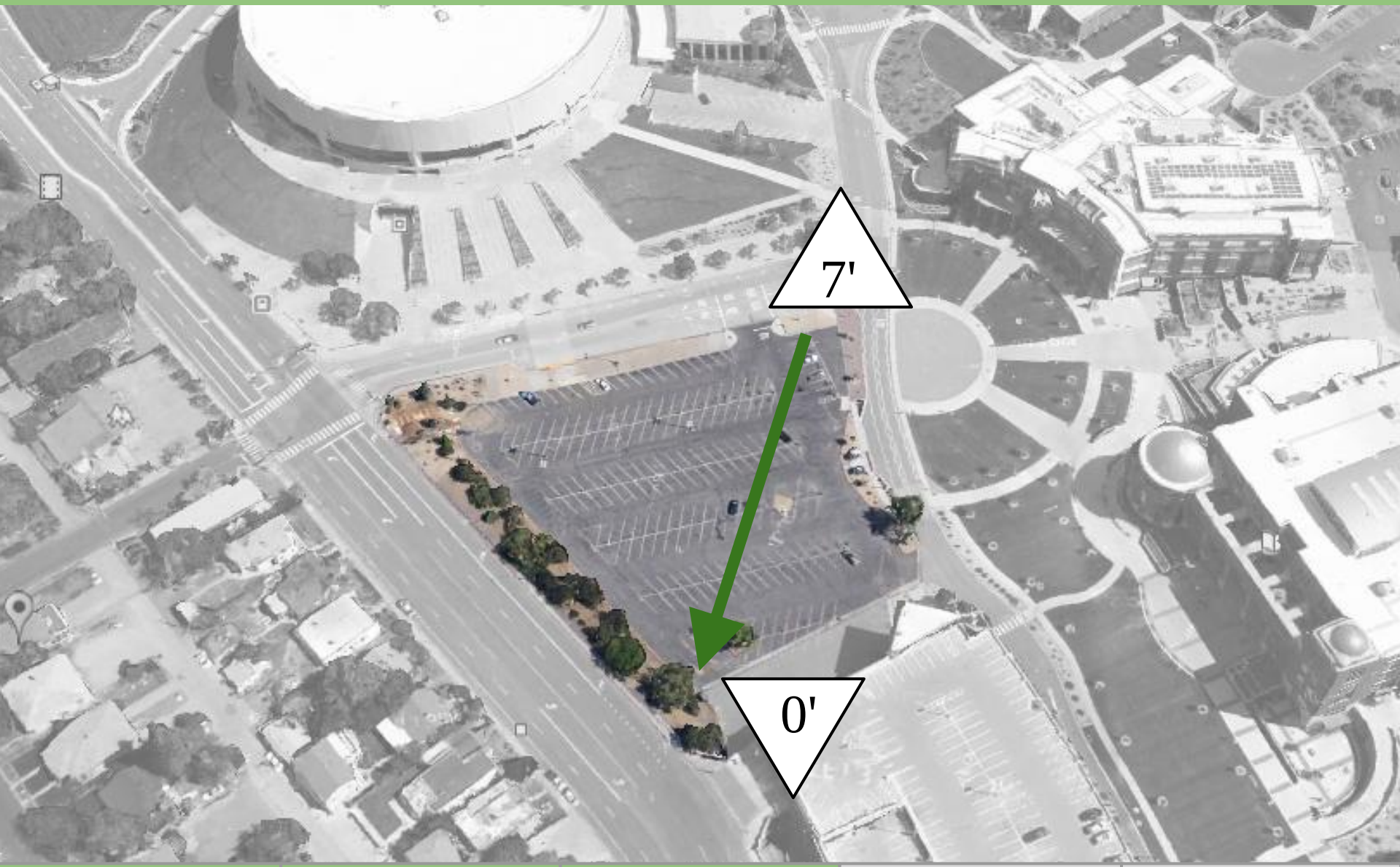
Decision Matrix

Criteria	Subcriteria	Description	Weighting [100 points]	DD-Cylinder	DD-X	L-Shape-Steel	L-Shape-Concrete
		Points available	1,33	[Scale from 1 to 5]			
Economical			**31,7**	**115,0**	**102,7**	**109,3**	**90,0**
	Construction Costs	Calculation of the construction costs by RSMeans.	7,7	4,0	4,0	3,0	3,0
	Operation & Maintenance Costs	Includes expenses for cleaning, energy and administration as w	7,3	3,0	3,0	4,0	4,0
	NEA/GEA	The ratio of net external area to gross external area to determine	4,3	3,0	3,0	3,0	3,0
	Construction Time	Required construction time according to the work schedules of	7,0	4,0	3,0	4,0	2,0
	Constructability	How the building will be built and what techniques will be used	5,3	4,0	3,0	3,0	2,0
Environmental (STV)			**21,3**	**58,7**	**58,7**	**64,3**	**69,7**
	CO2-Emission	CO2-Emission in tons per year.	5,3	2,0	2,0	3,0	4,0
	Renewable Energy	Usage of renewable energy (e.g. PV, wind turbine, earth heat).	6,3	3,0	3,0	3,0	3,0
	Life Cycle of Material	Life span of used materials.	5,0	3,0	3,0	4,0	4,0
	Recycled Material	Usage of recycled materials.	4,7	3,0	3,0	2,0	2,0
Social			**31,7**	**97,7**	**107,7**	**101,3**	**101,3**
	Comfort	Comfort of the users and employees (mostly depending on the	7,7	4,0	4,0	3,0	3,0
	Flexibility	Flexibility describes how spaces can be customized to different	5,3	3,0	3,0	3,0	3,0
	Student/Faculty Collaboration	Interaction and collaboration between students and faculty mer	6,3	3,0	3,0	4,0	4,0
	Design/Iconicity	Attractiveness and iconicity of the design/building.	5,0	2,0	4,0	3,0	3,0
	Innovation	In which extend innovations are included in the construction pr	7,3	3,0	3,0	3,0	3,0
Discipline specials			**14,0**	**42,0**	**48,7**	**35,3**	**35,3**
	Architectual/structual unity	Clarity of the structural and architectual concepts throughout t	6,7	3,0	4,0	2,0	2,0
	Context connection	How the design of the building connects with surroundings an	7,3	3,0	3,0	3,0	3,0
Total Score				**313,3**	**317,7**	**310,3**	**296,3**

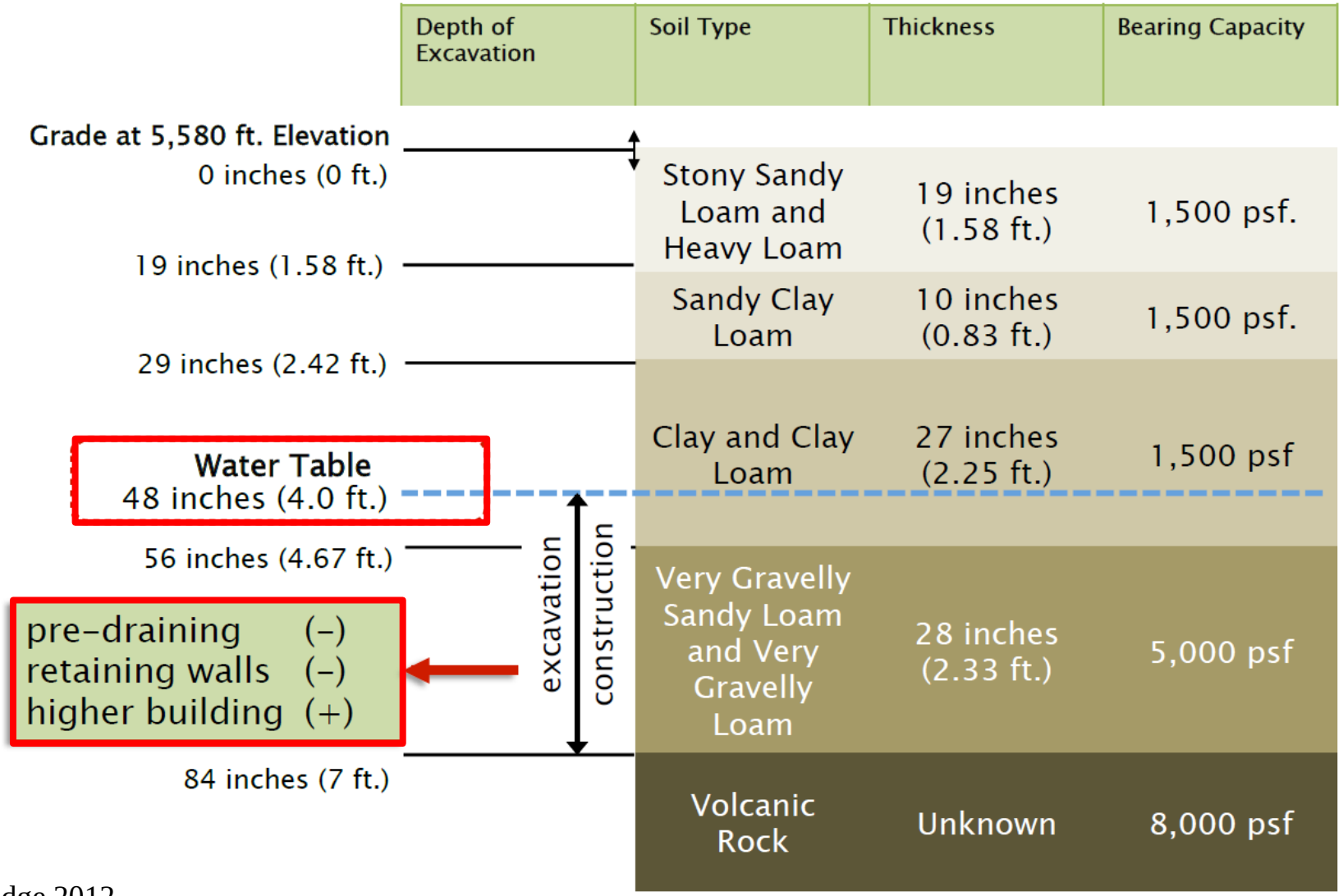
Chosen Concept



Site Topography

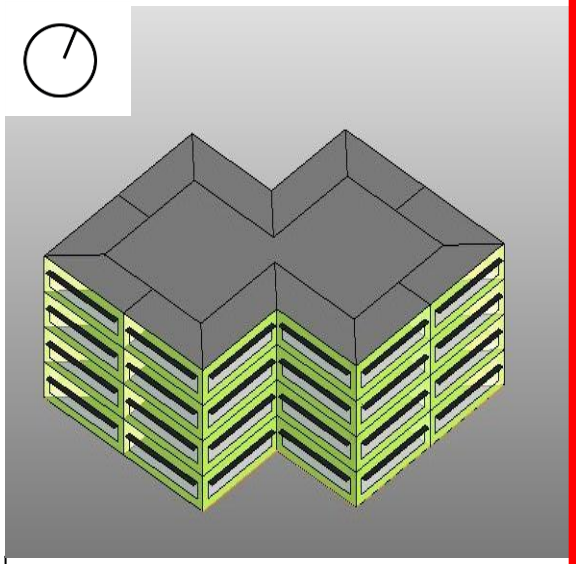


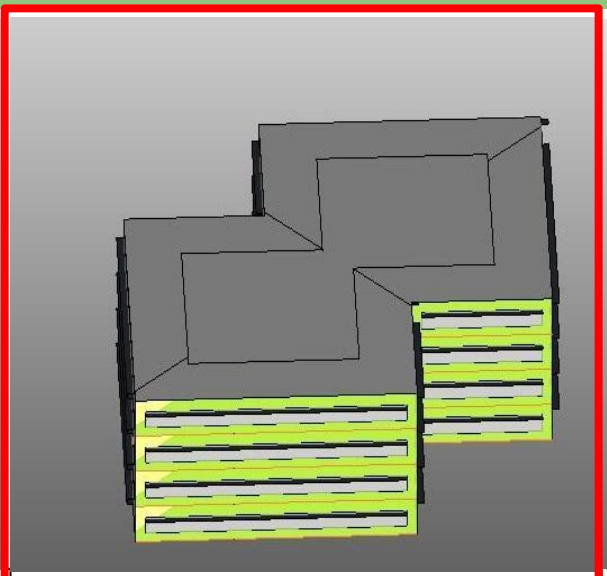
Soil Properties

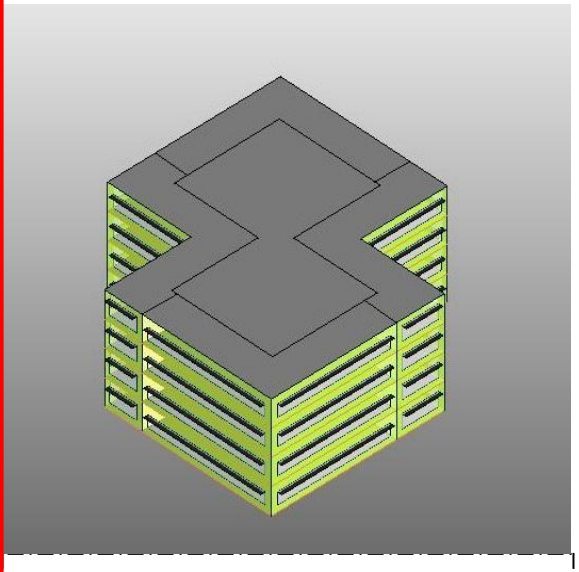


Source: Ridge 2012

Orientation

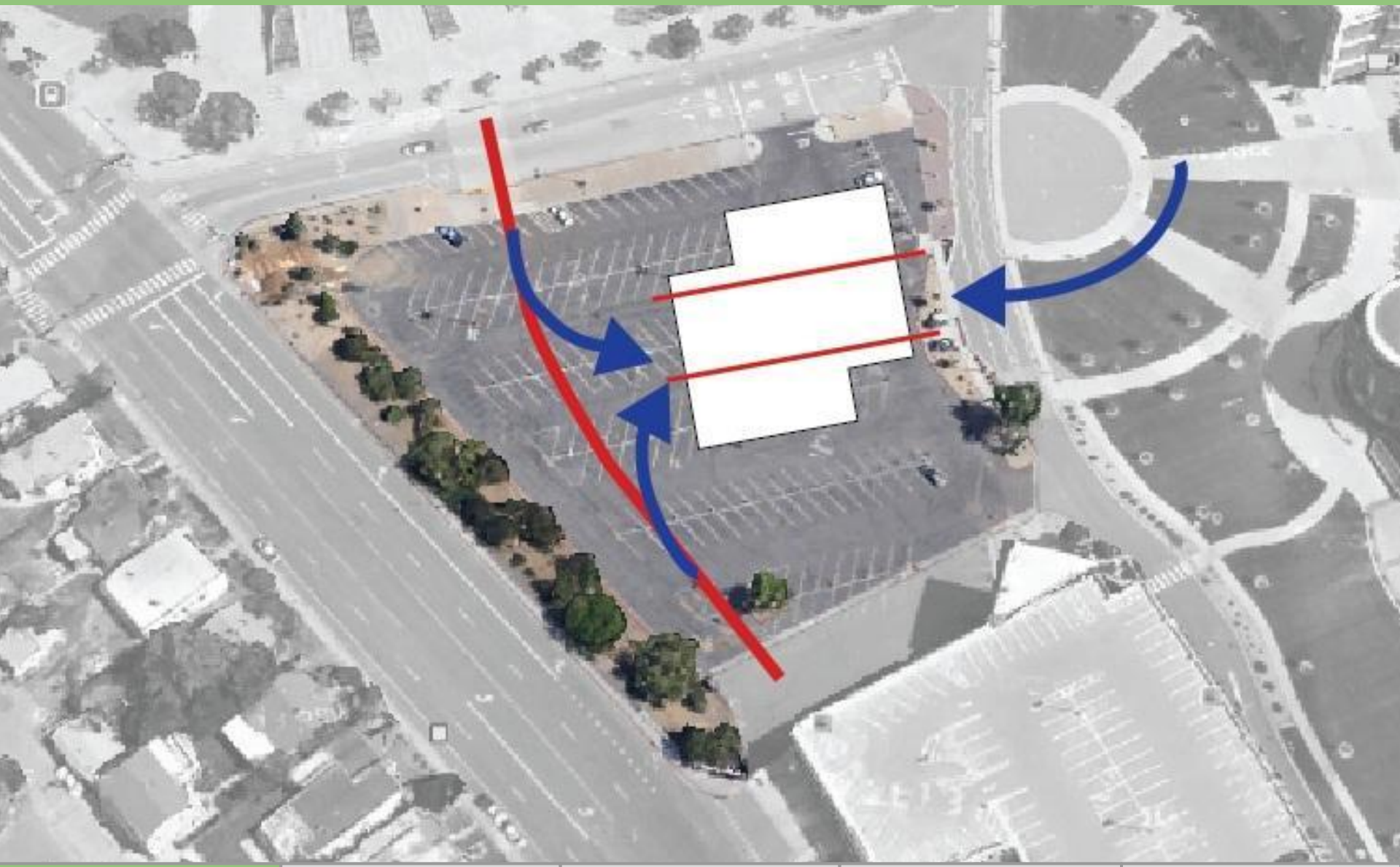




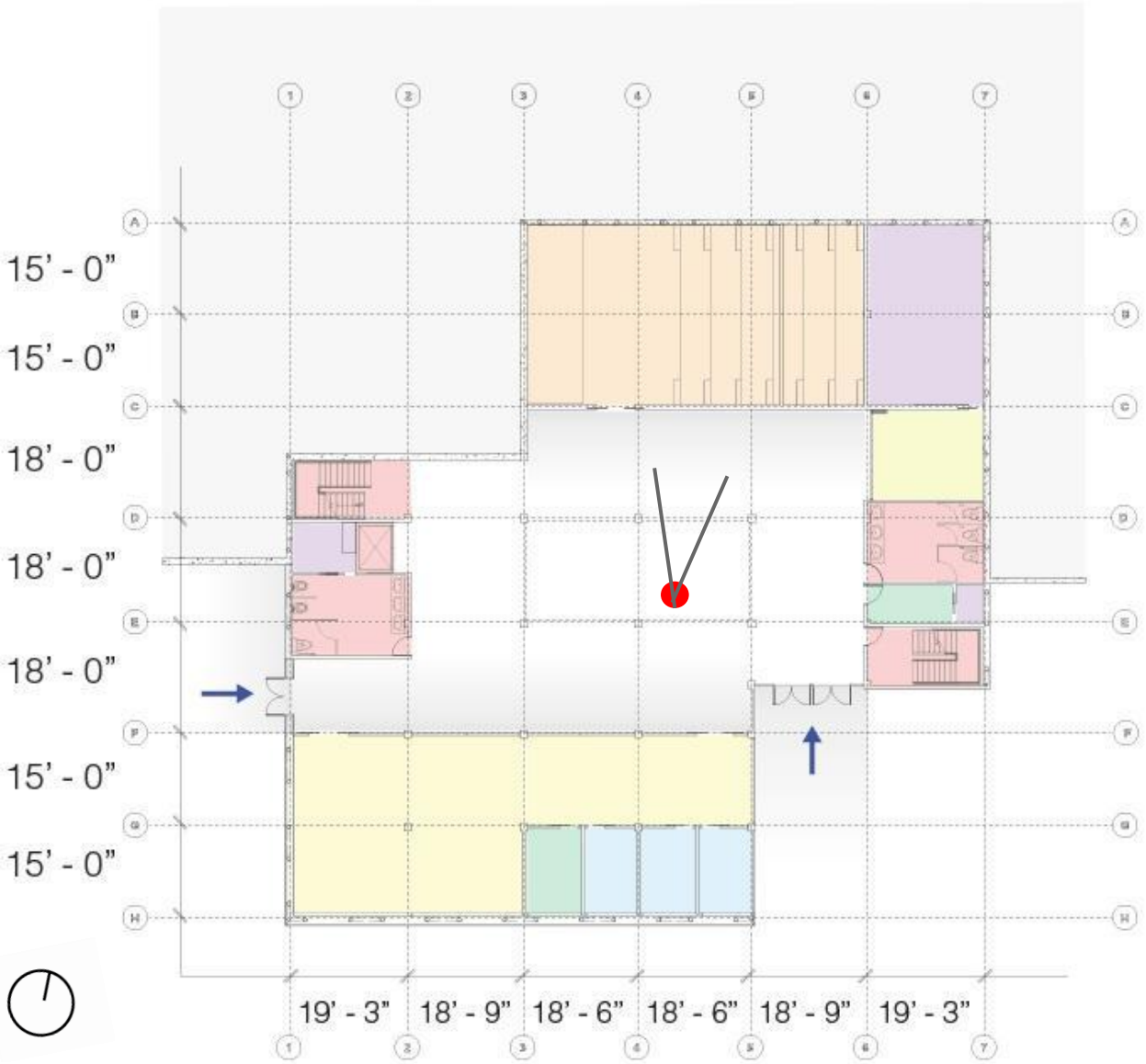


	Total EUI (kBtu/sf/yr)	
70	68	71
	Life Cycle Energy Cost ($)	
630,000	615,000	650,000
	Net CO_2 (tn/year)	
155	145	165

Building Placement

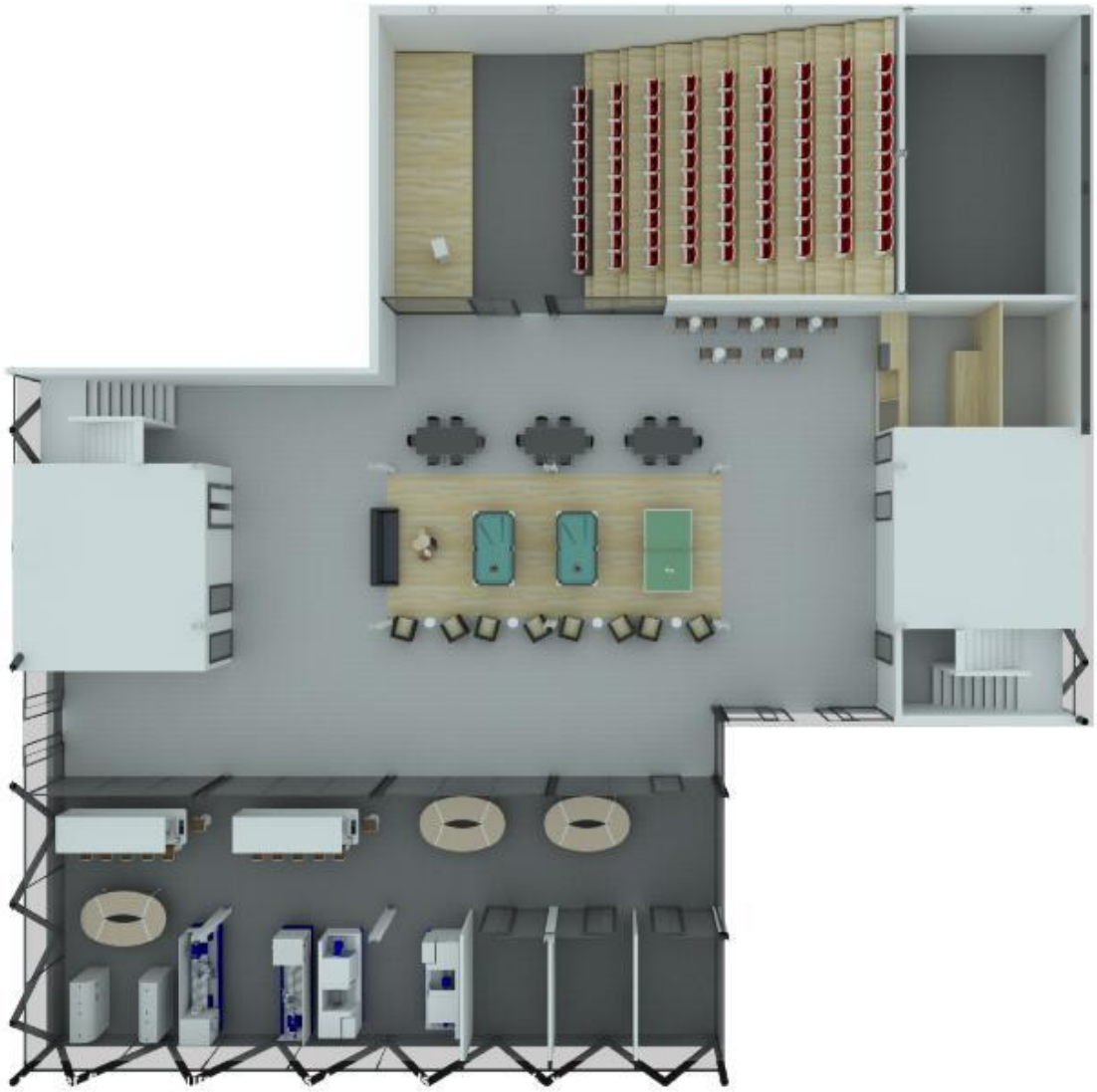


Basement Level - Floor Plan



- Core
- Rapid Prototyping Lab
- Auditorium
- Faculty Offices
- Mechanical Room & Shaft
- Storage

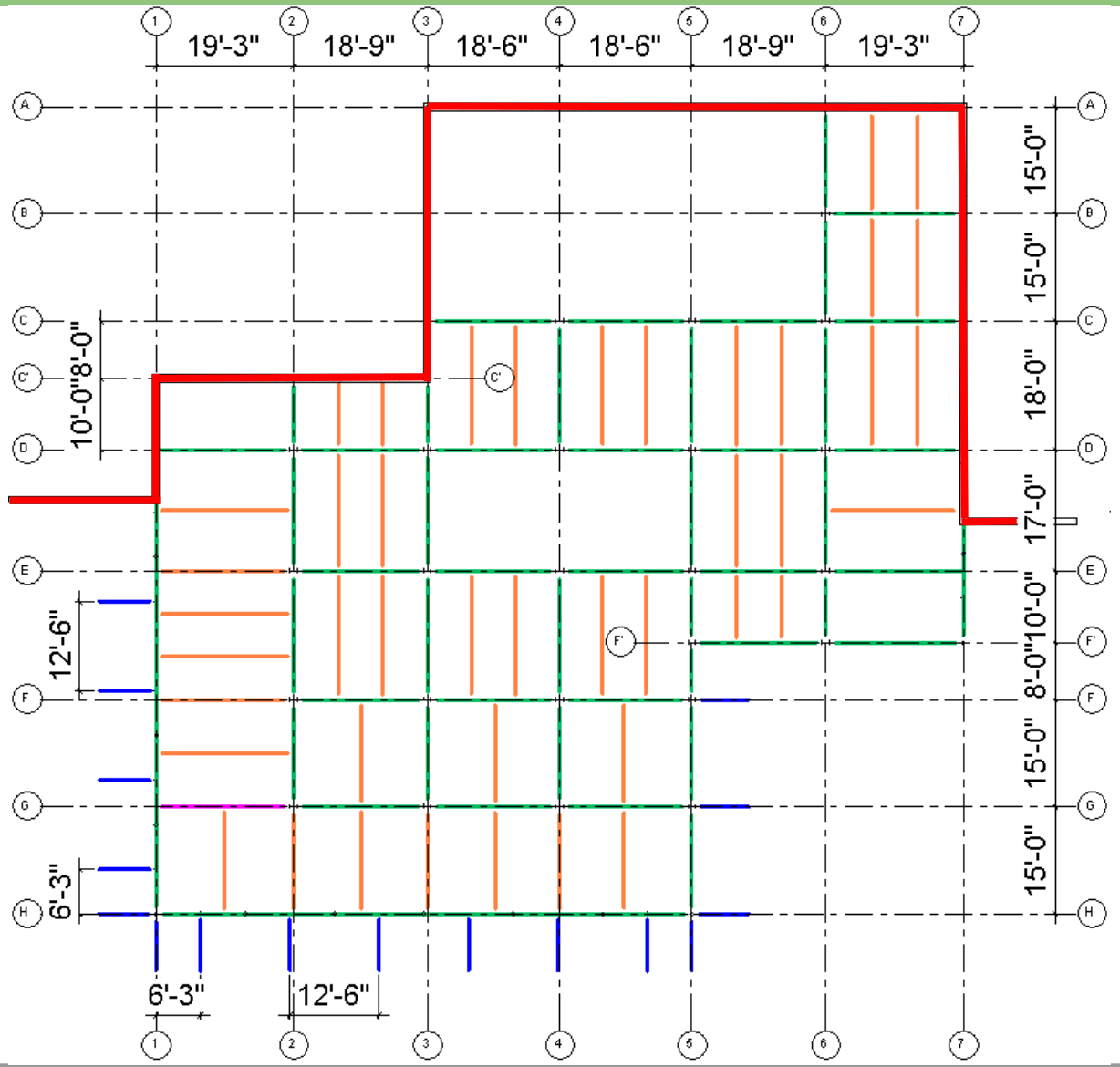
Basement Level - Furnished



Basement Level

Basement Level

Basement Level - Structure

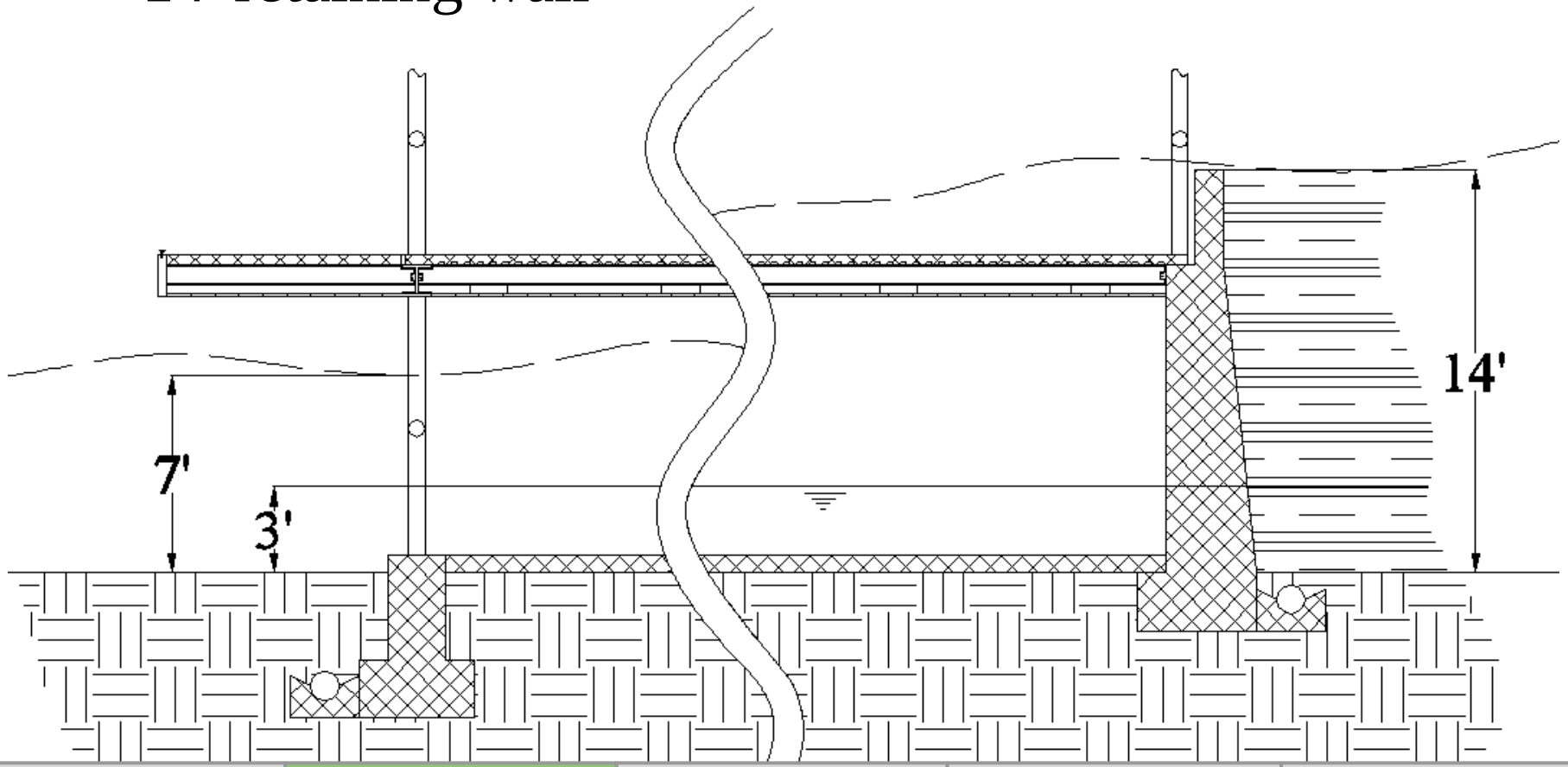


Legend:

- W8x24
- W8x40
- W12x30
- W12x50
- retaining wall

Foundations and Retaining Wall

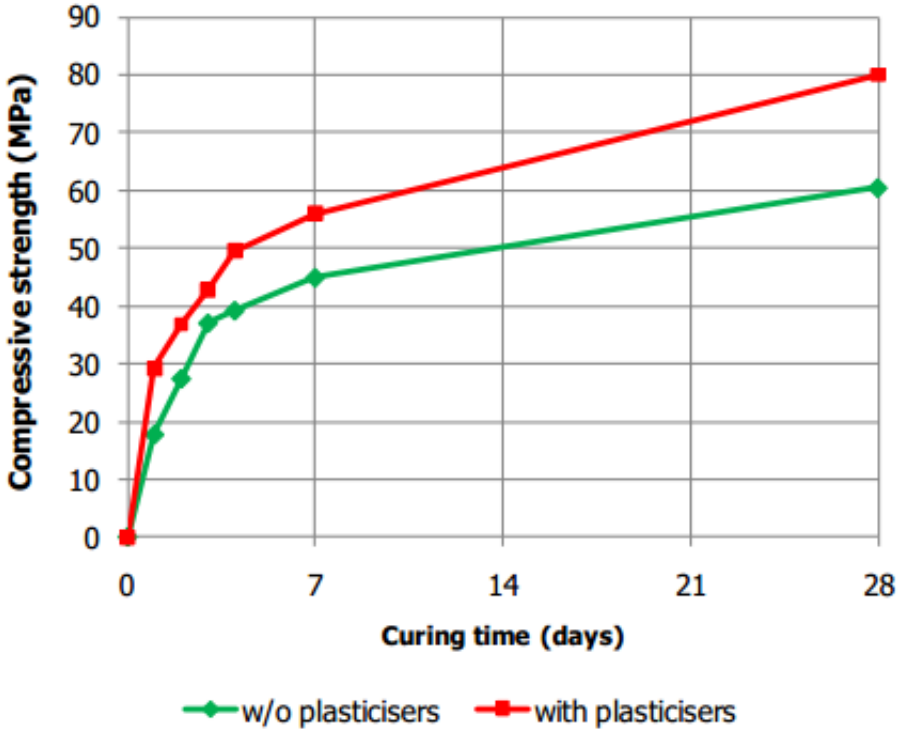
- pad footings
- foundation slab
- 14' retaining wall

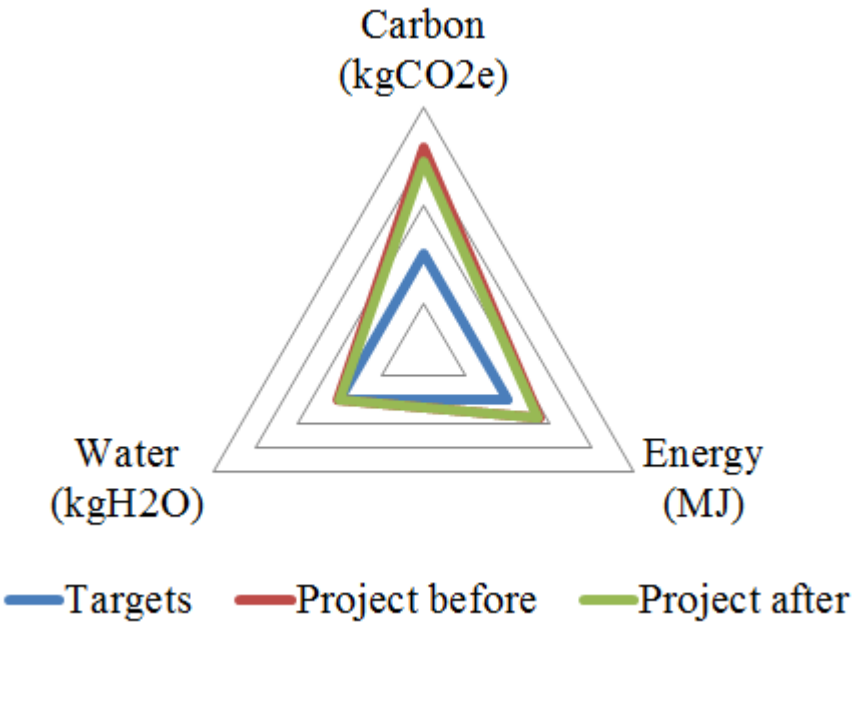


Concrete

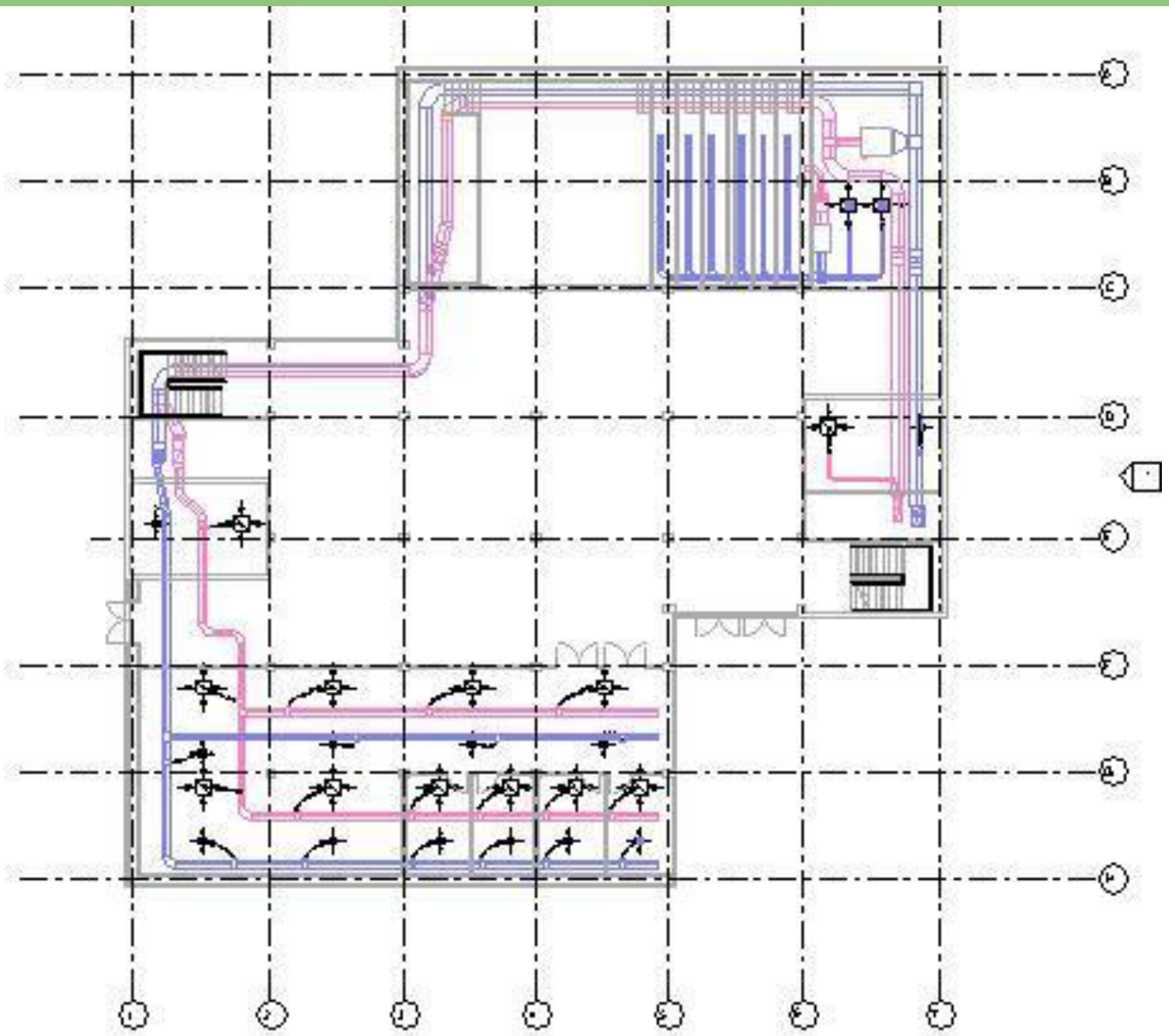
Novacem
Carbon negative cement

- Production of 1 tonne of cement absorbs up to 100 kg more CO_2 than it emits
- Strength and cost parity with traditional concrete





Basement Level - Duct Network

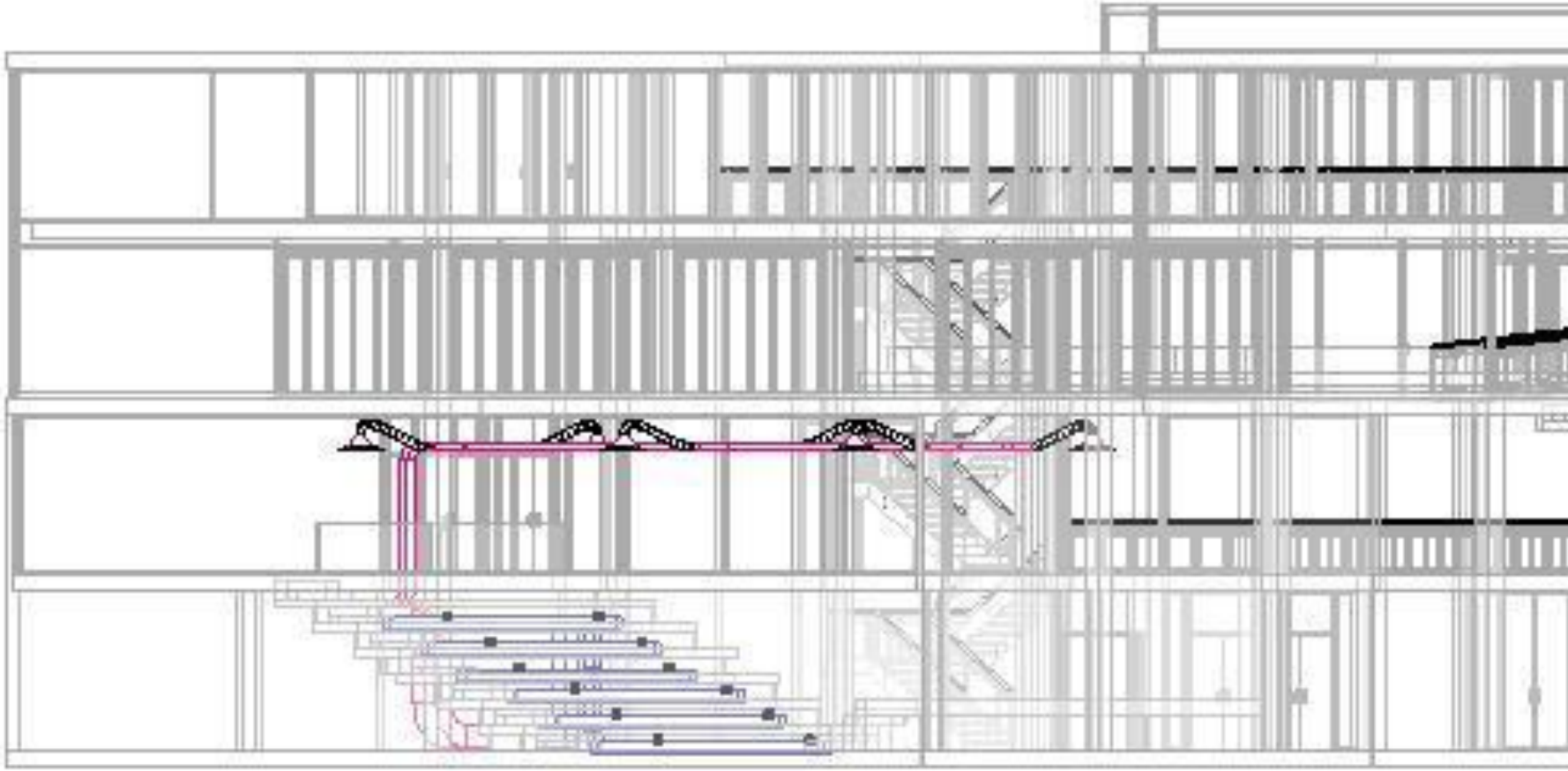


Overhead
System VAV

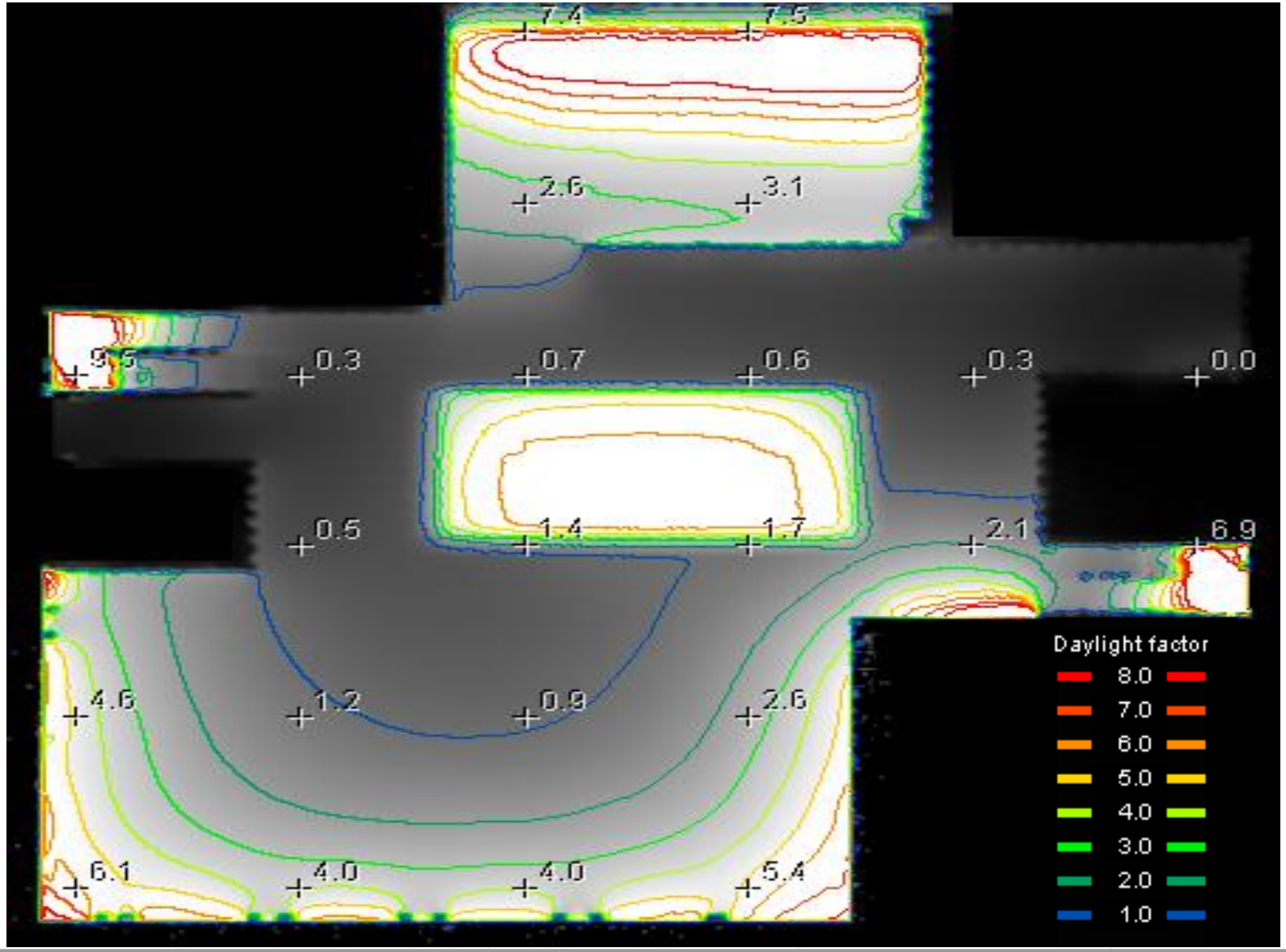
Supply

Return

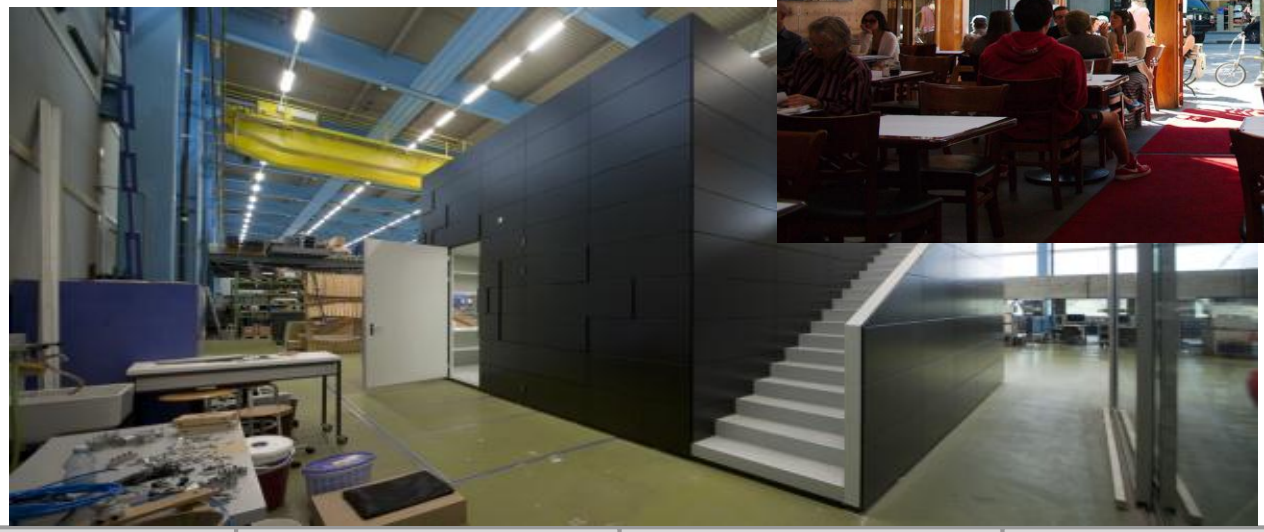
Auditorium 3D



Basement Level - Daylight

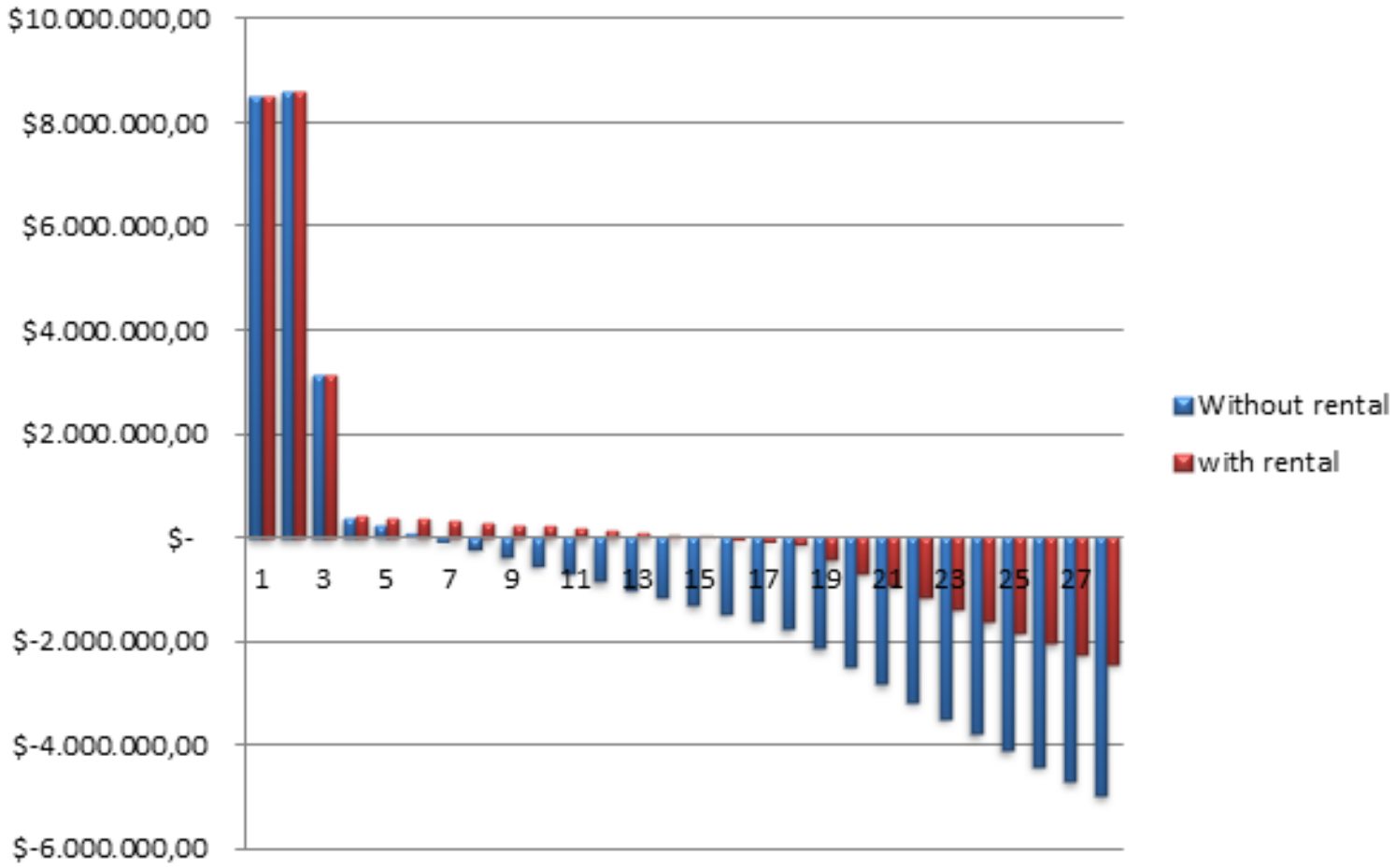


Additional Income

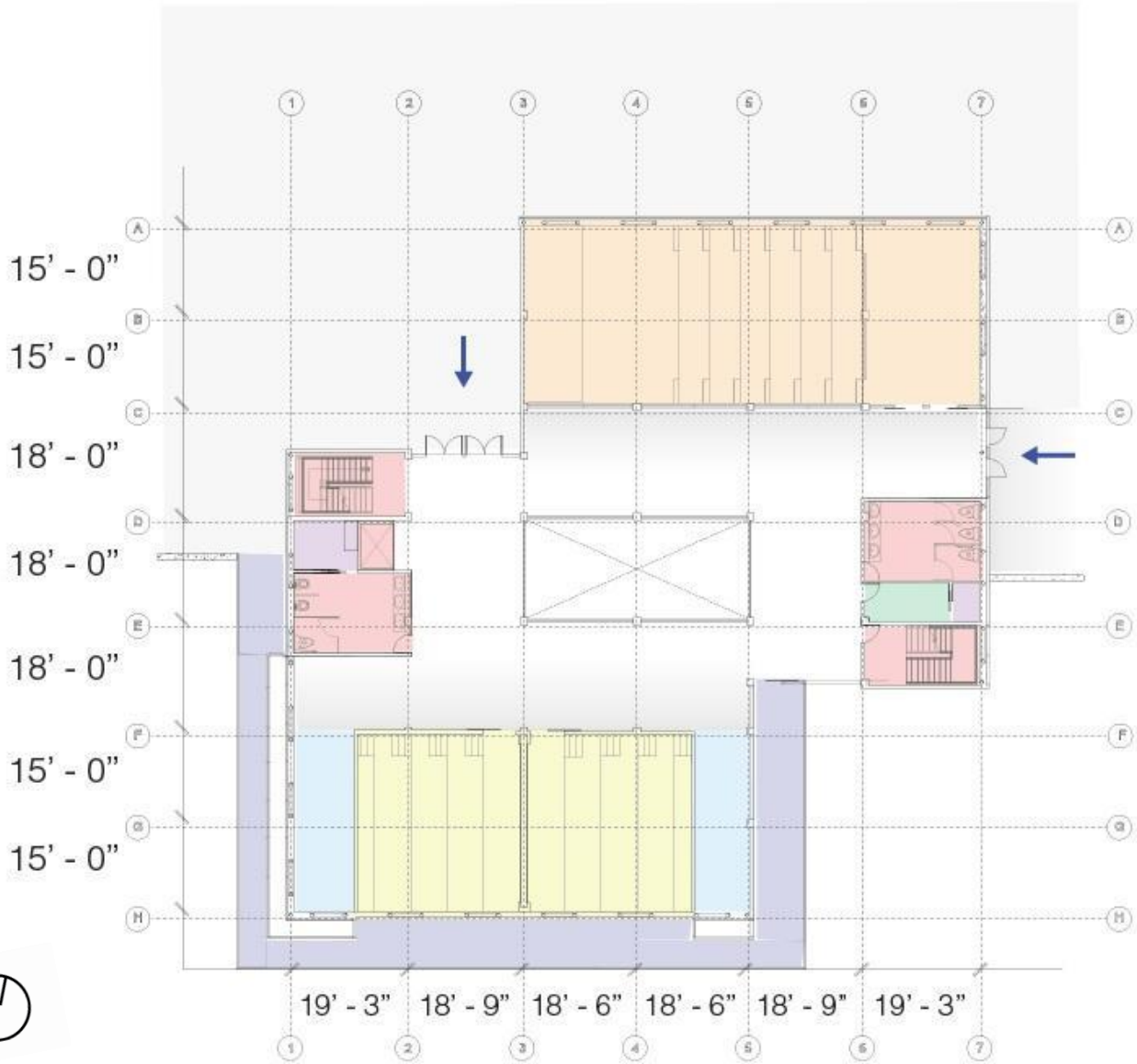


Additional Income

NPV: $9 820 000 with rental / $11 700 000 without rental

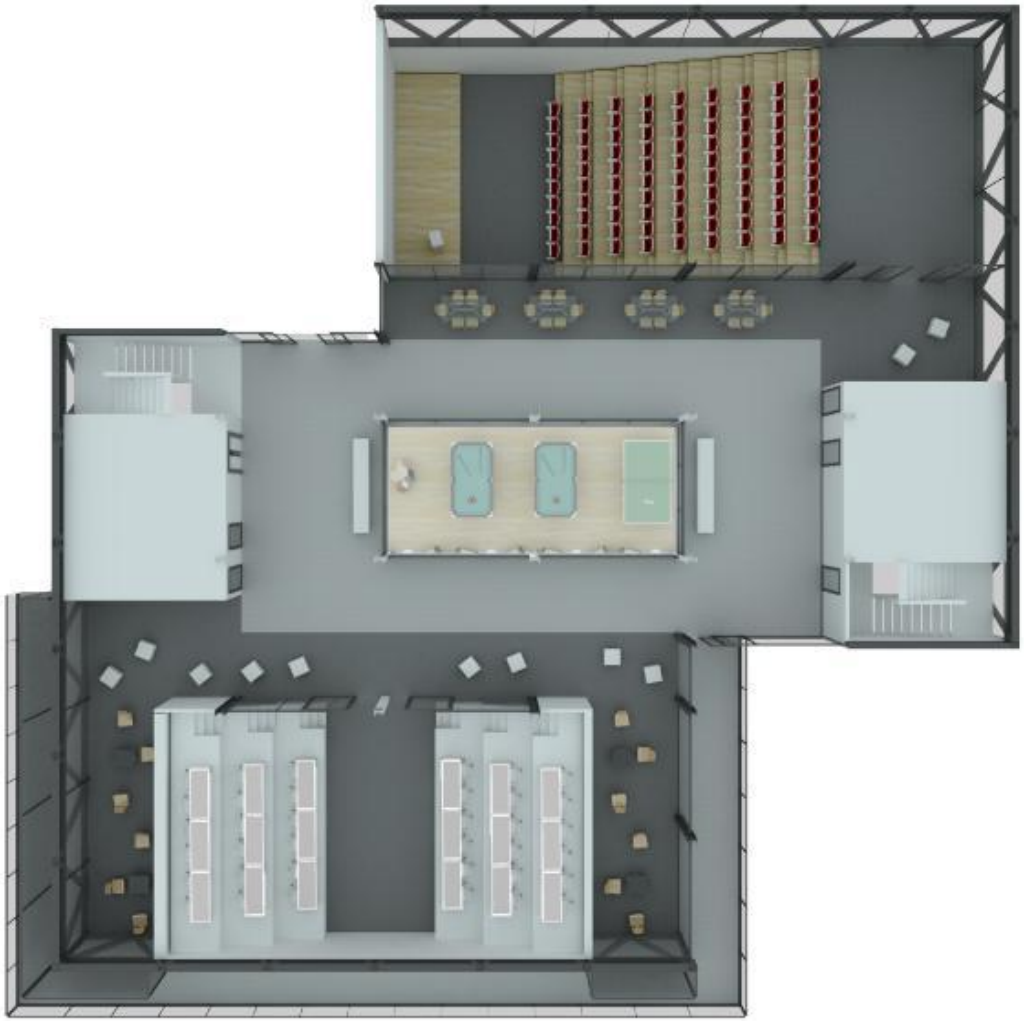


First Level - Floor Plan

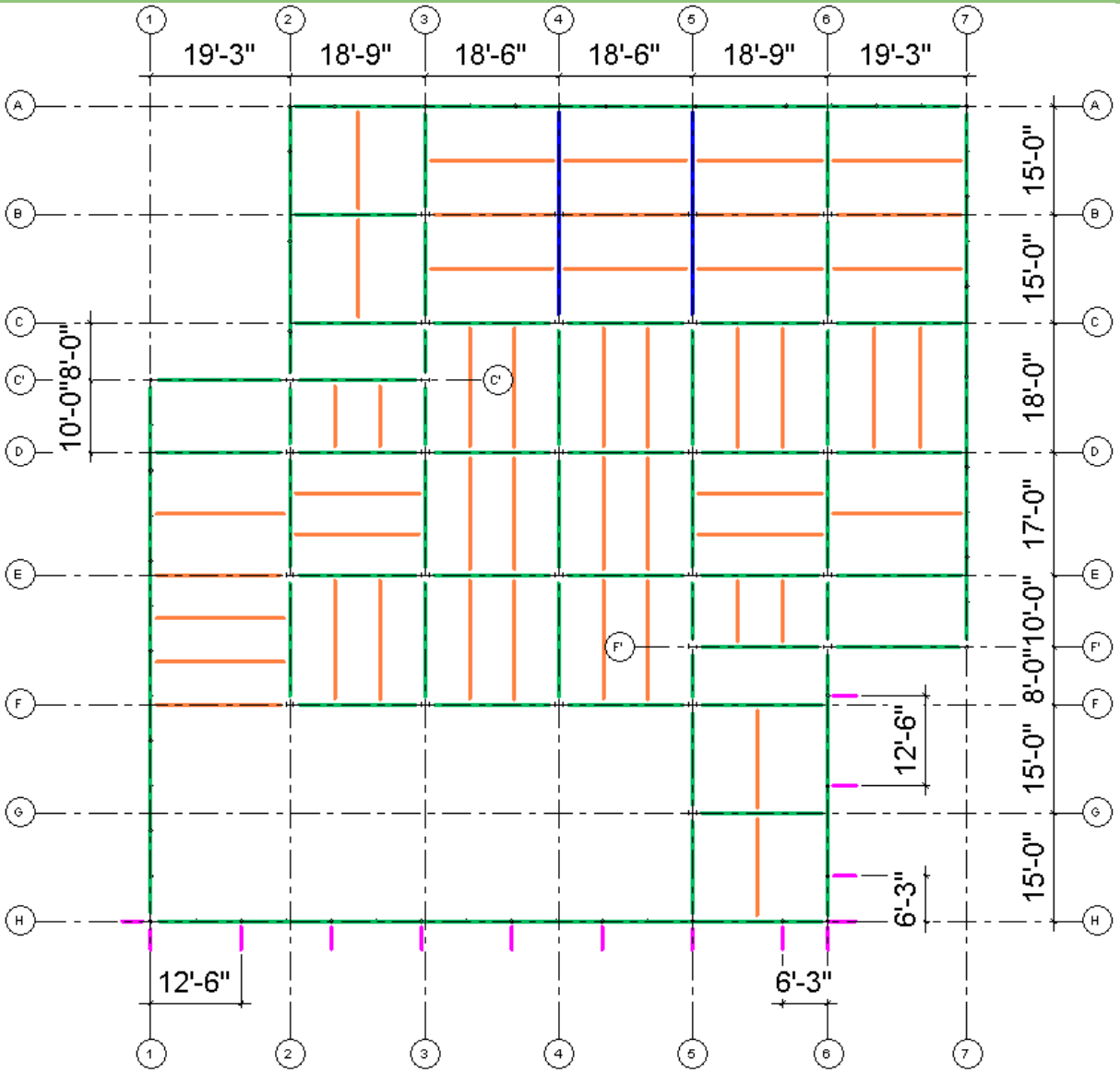


- Core
- Big Classrooms
- Auditorium
- Seminar Rooms
- Mechanical Shafts
- Storage
- Balcony

First Level - Furnished



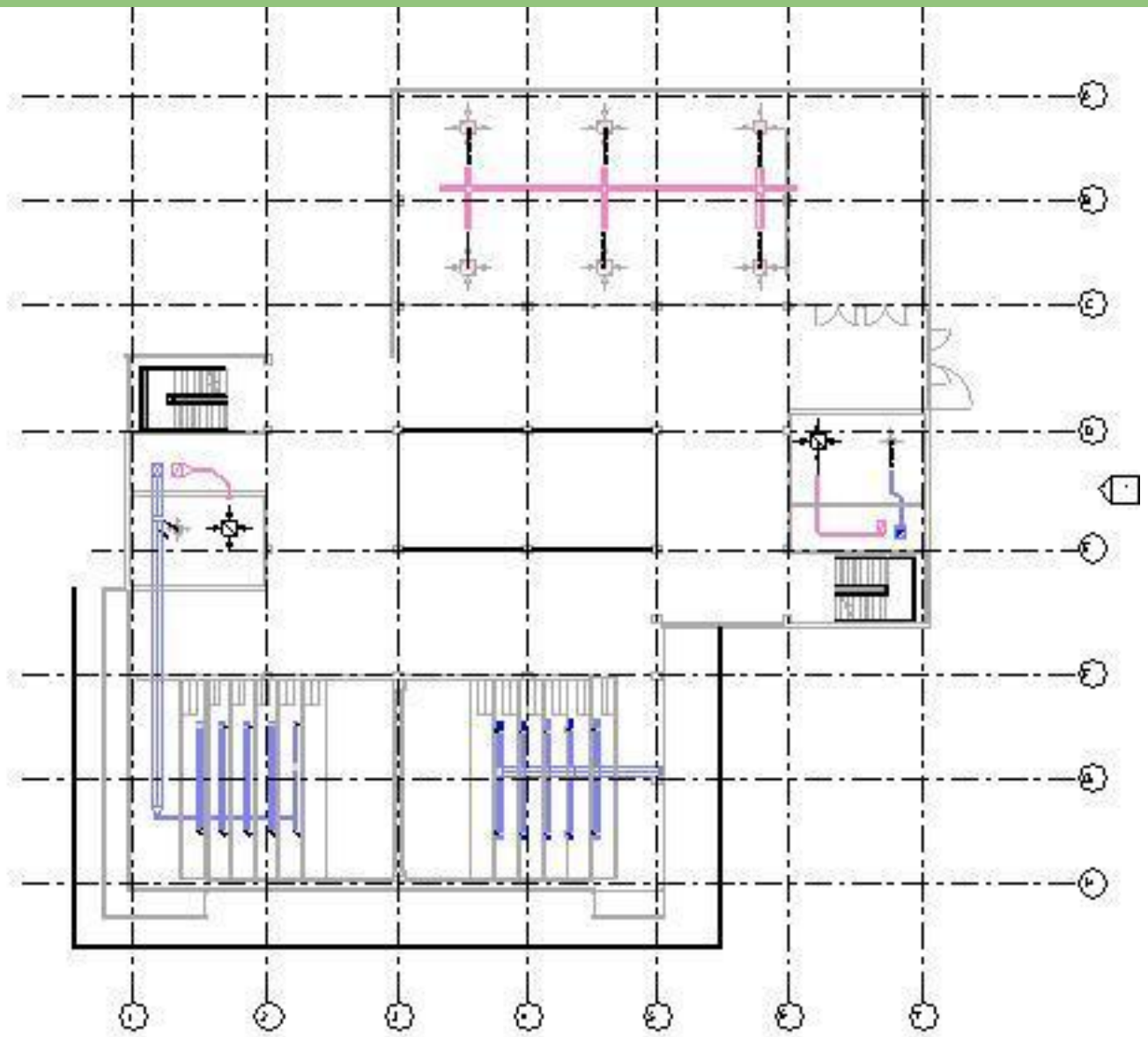
First Level - Structure



Legend:

- W8x18
- W8x24
- W12x50
- W27x129

First Level - Duct Network



Sensors

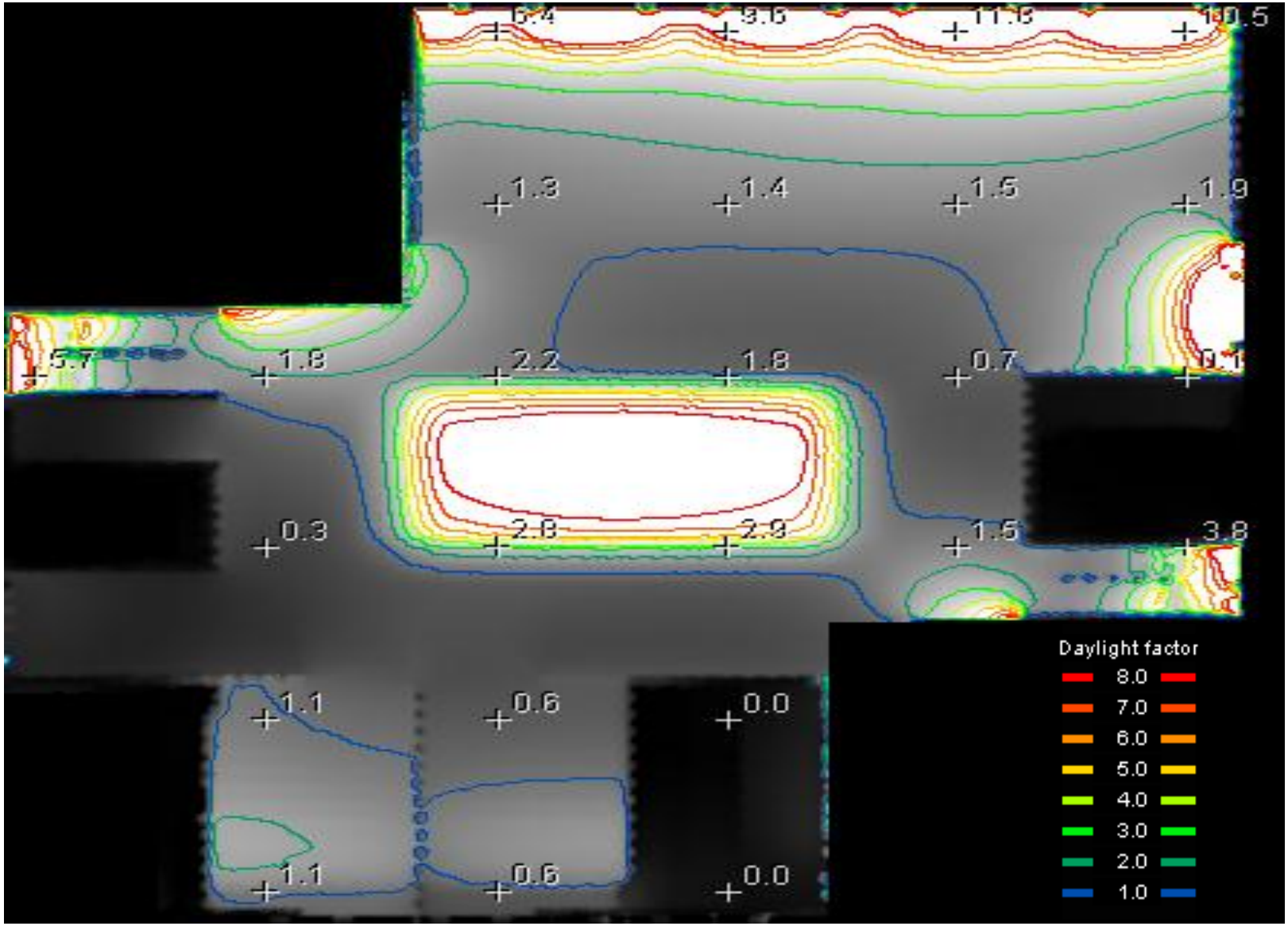
- CO_2
- Temperature

Supply

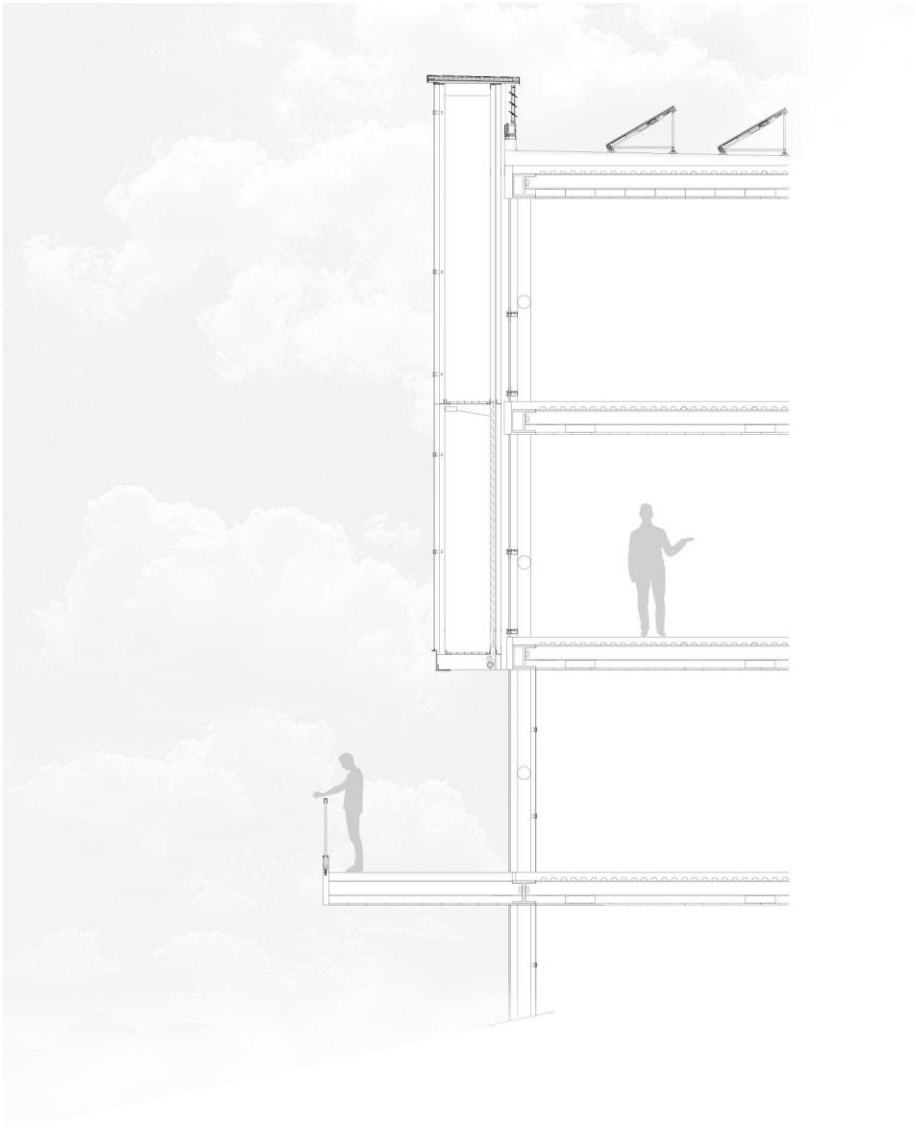
Return

Big Classrooms 3D

First Level - Daylight

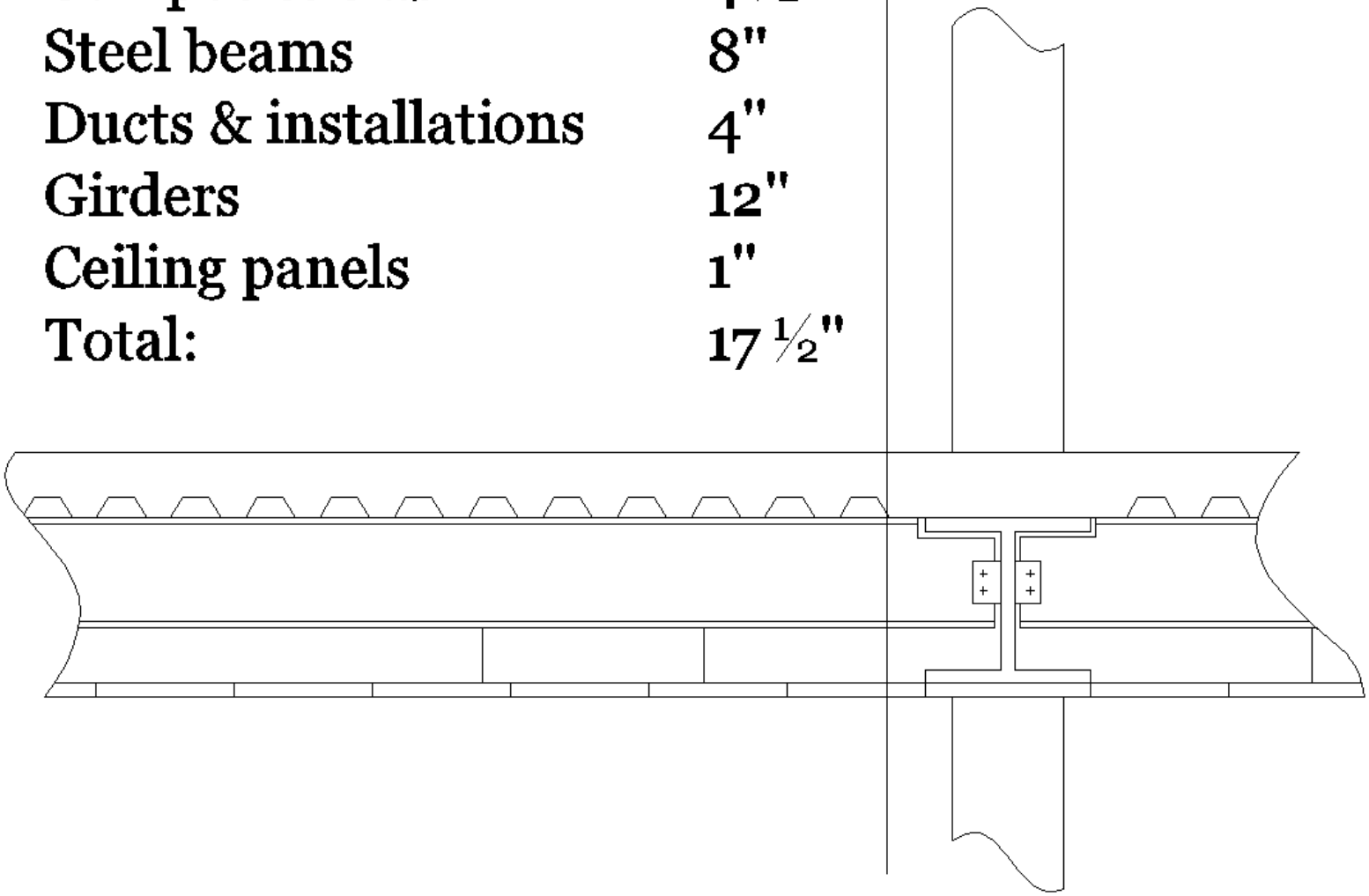


Floor Sandwich

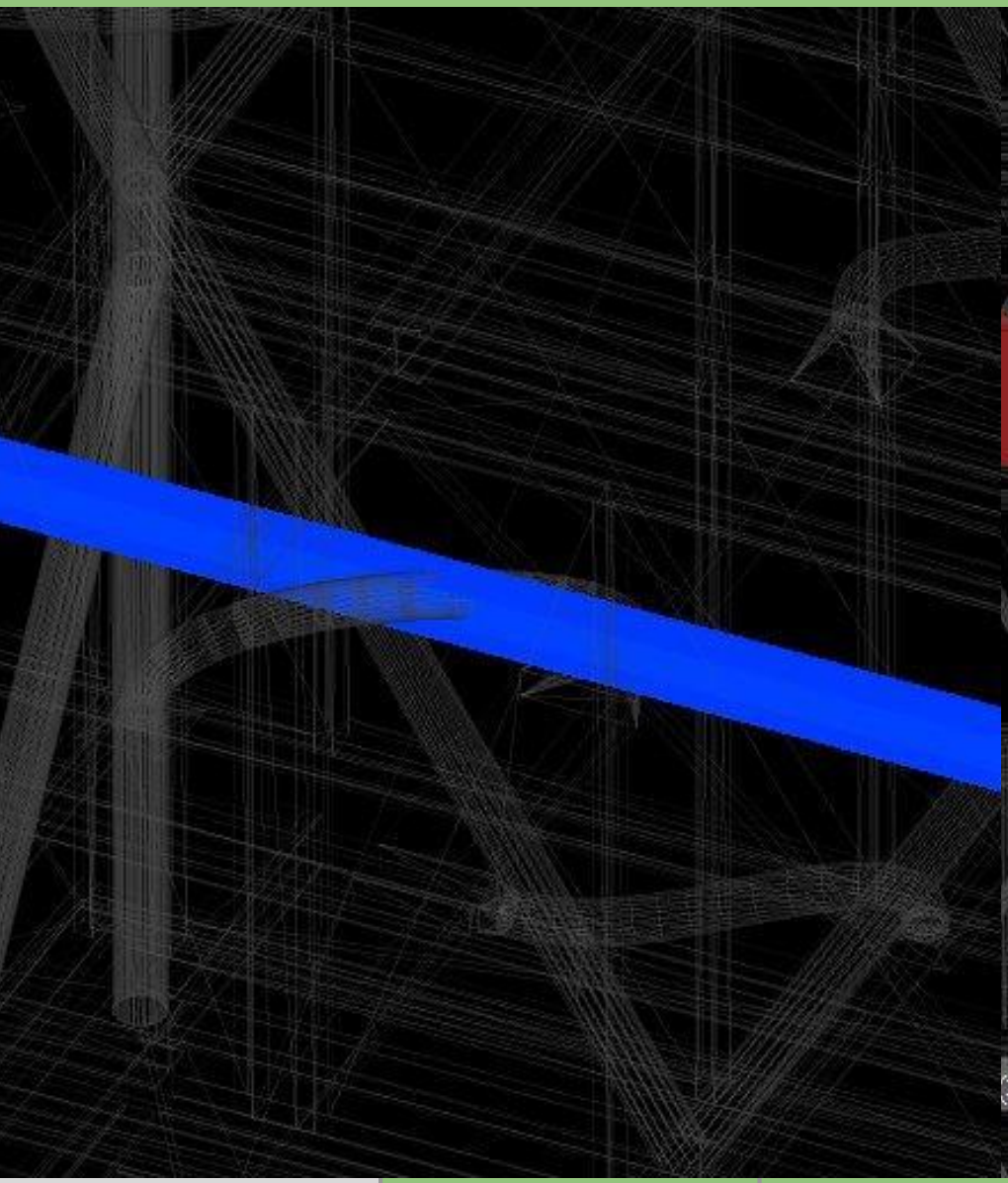


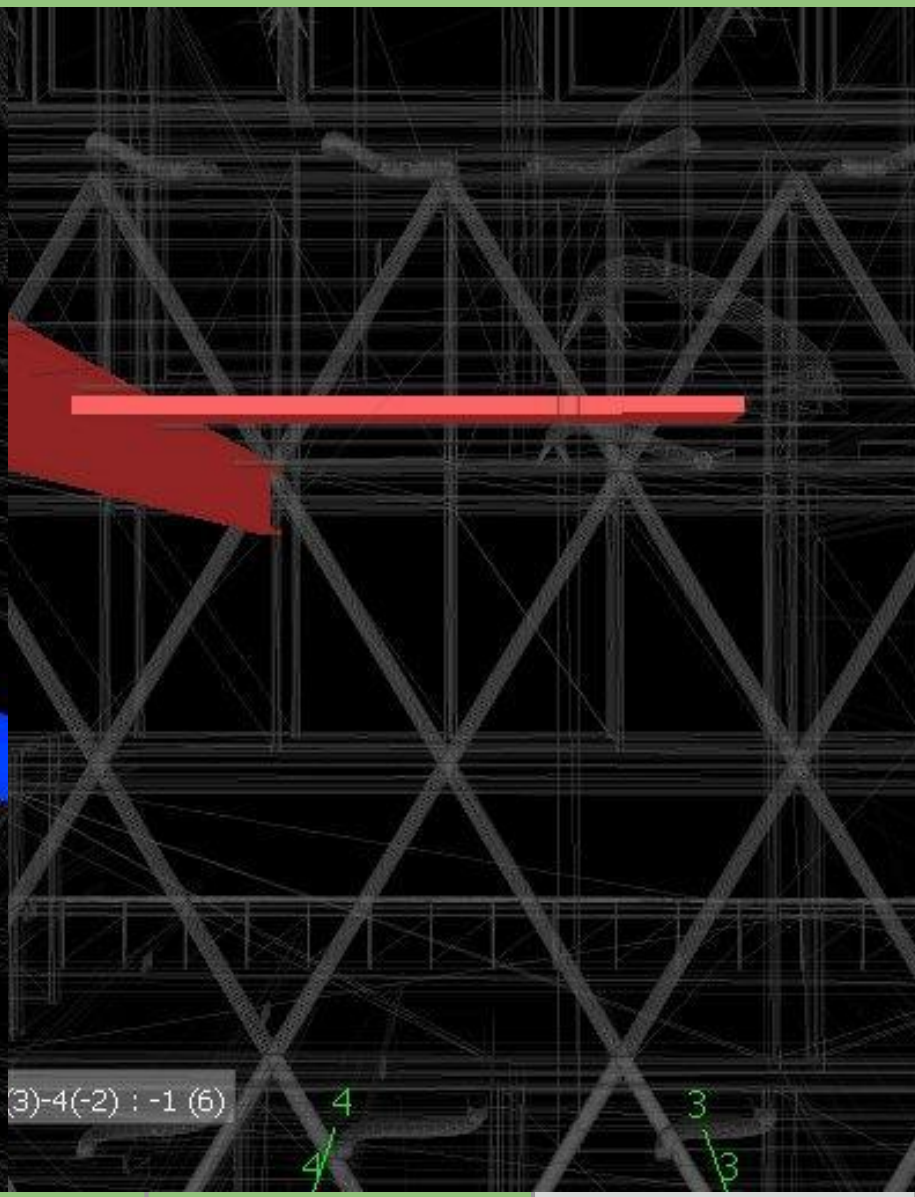
Floor Sandwich

Composite slab	4 ½"
Steel beams	8"
Ducts & installations	4"
Girders	12"
Ceiling panels	1"
Total:	17 ½"

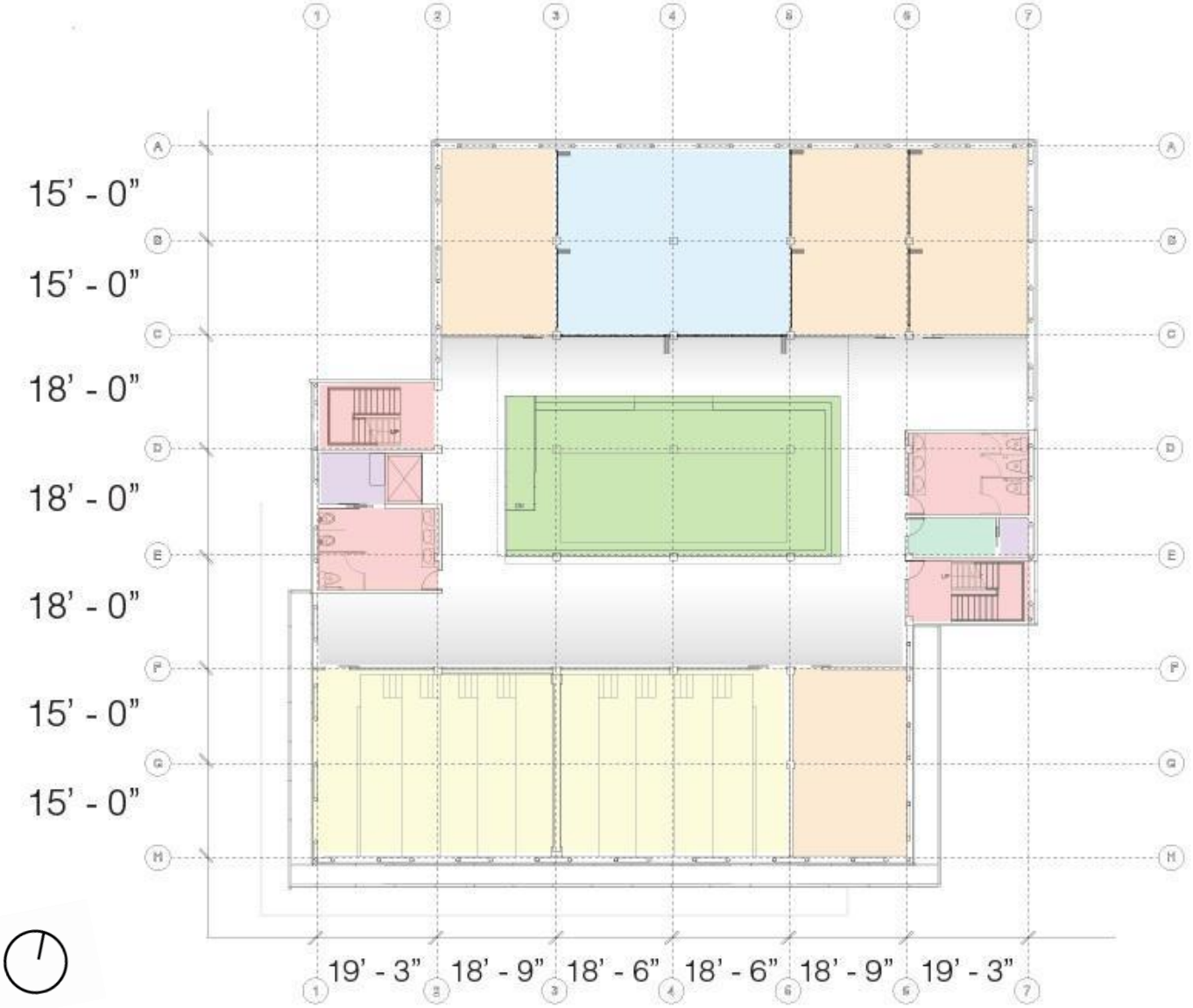


Clash Detection



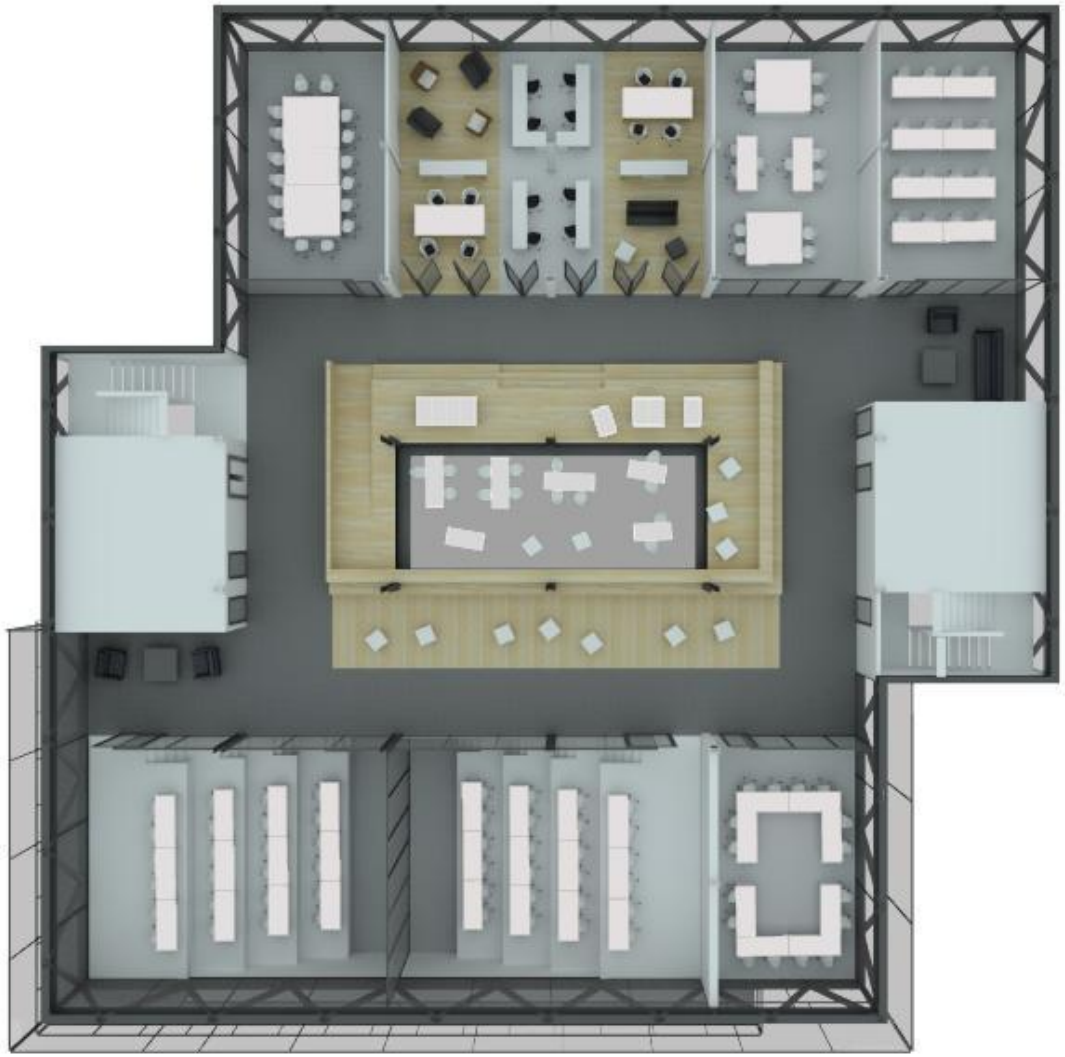


Second Level - Floor Plan



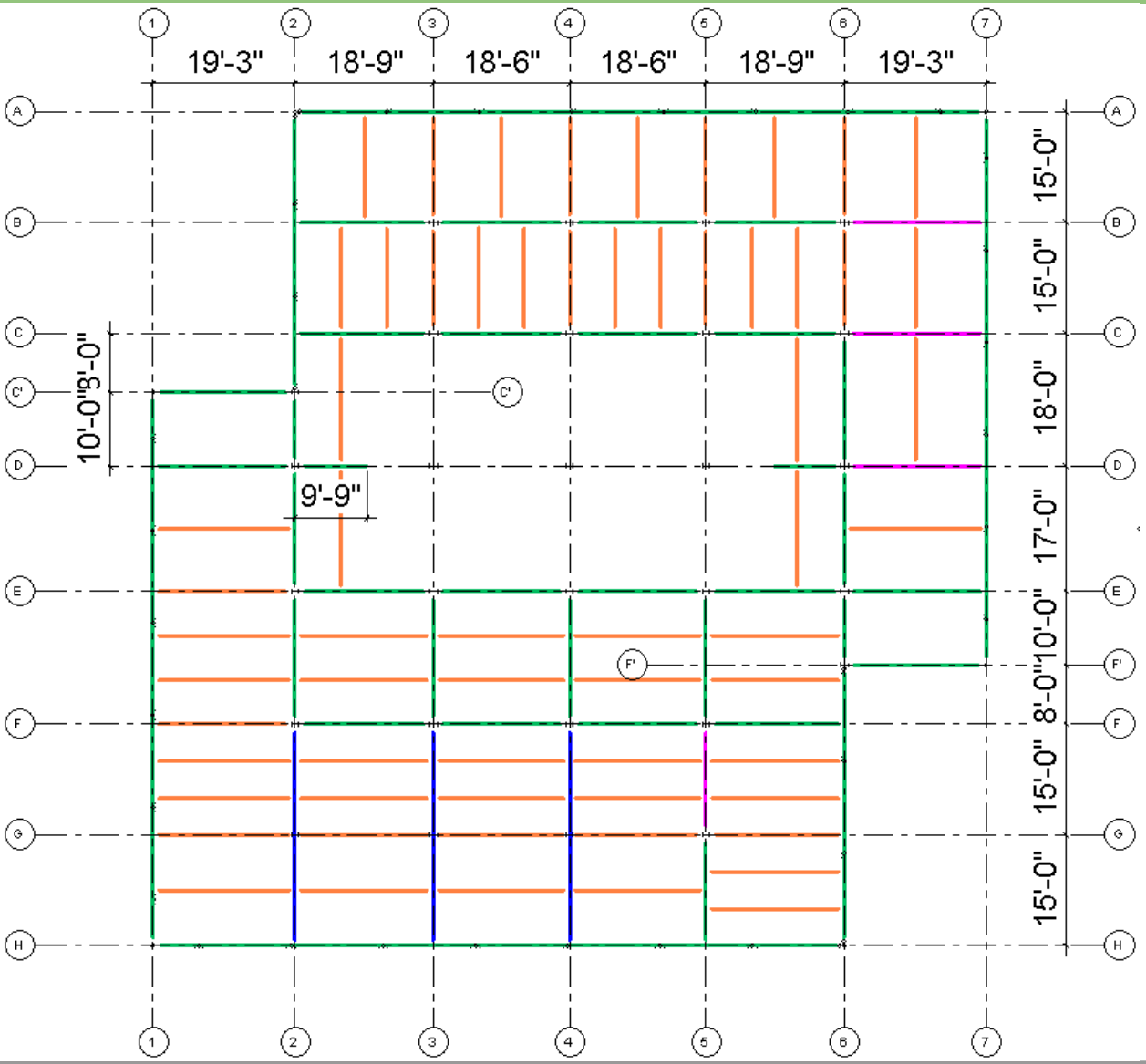
- Core
- Big Classrooms
- Small Classrooms
- Student Offices
- Mechanical Shafts
- Storage
- Collaboration Area

Second Level - Furnished



Second Level

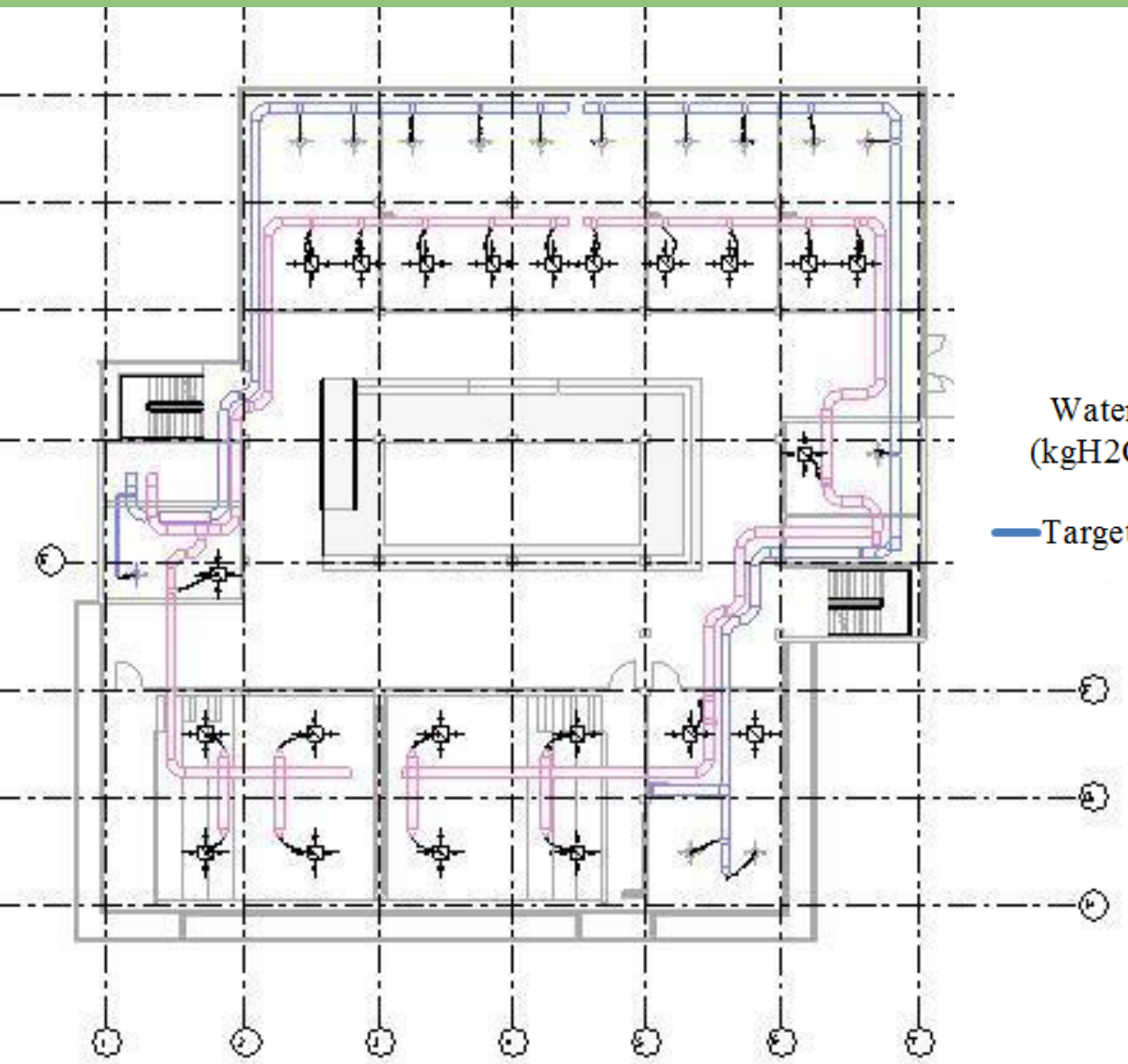
Second Level - Structure

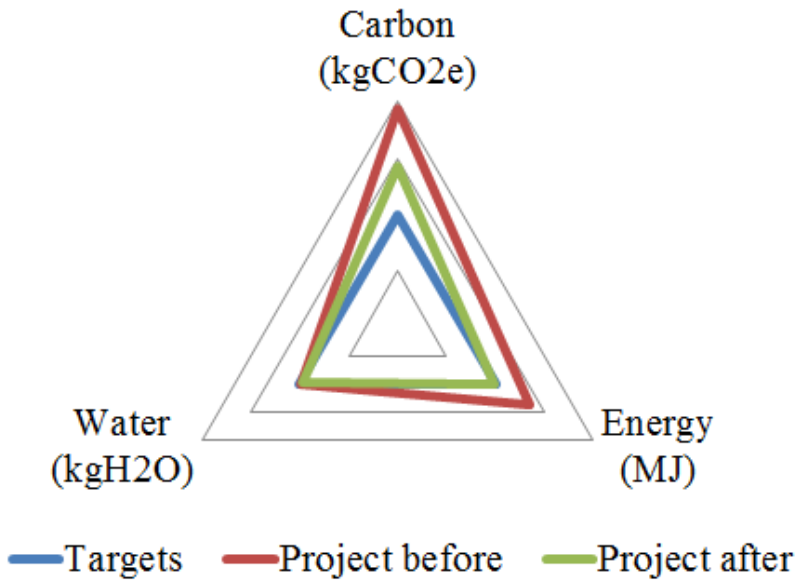


Legend:

- W8x24
- W8x40
- W12x50
- W27x129

Second Level - Duct Network

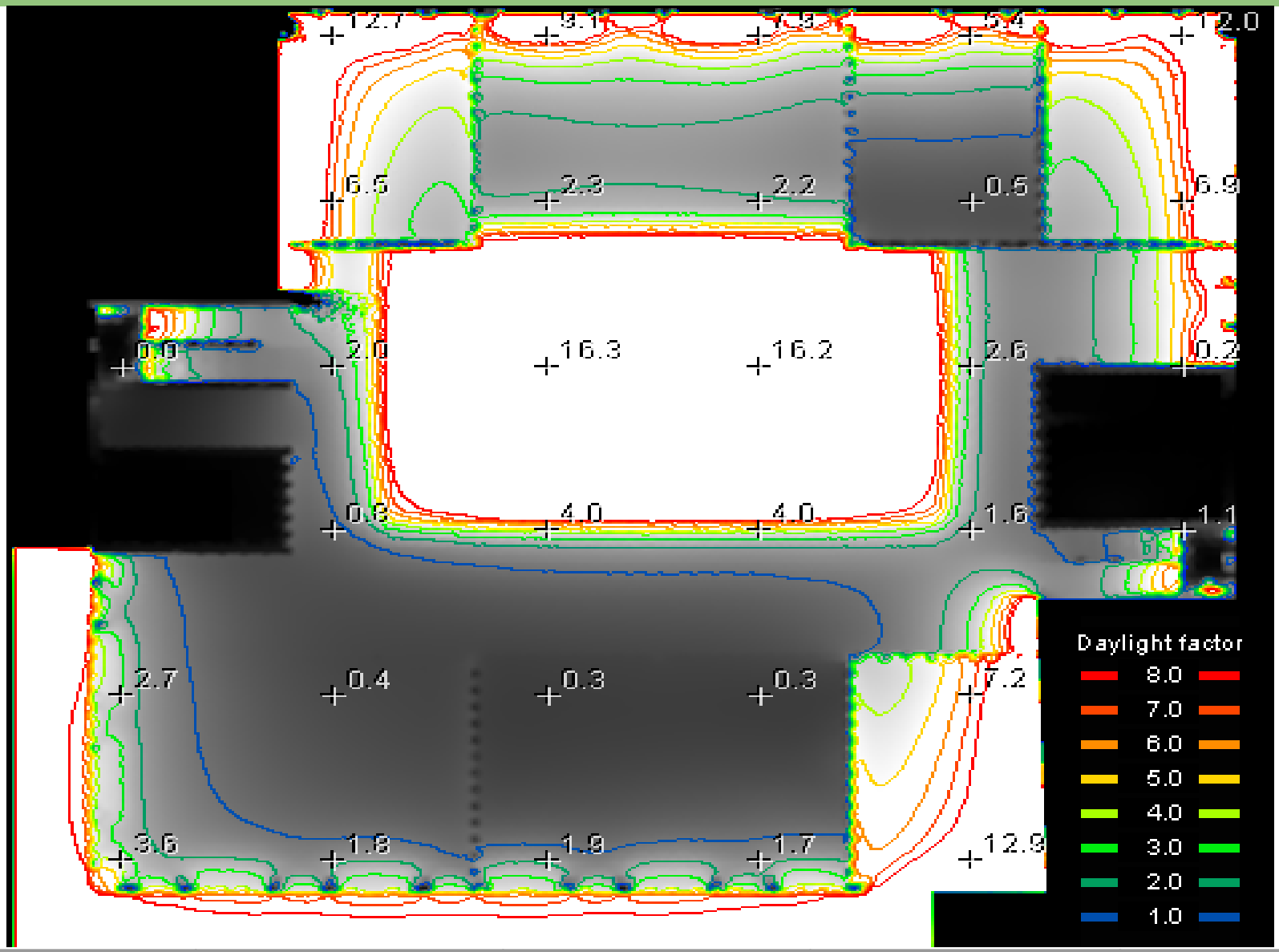




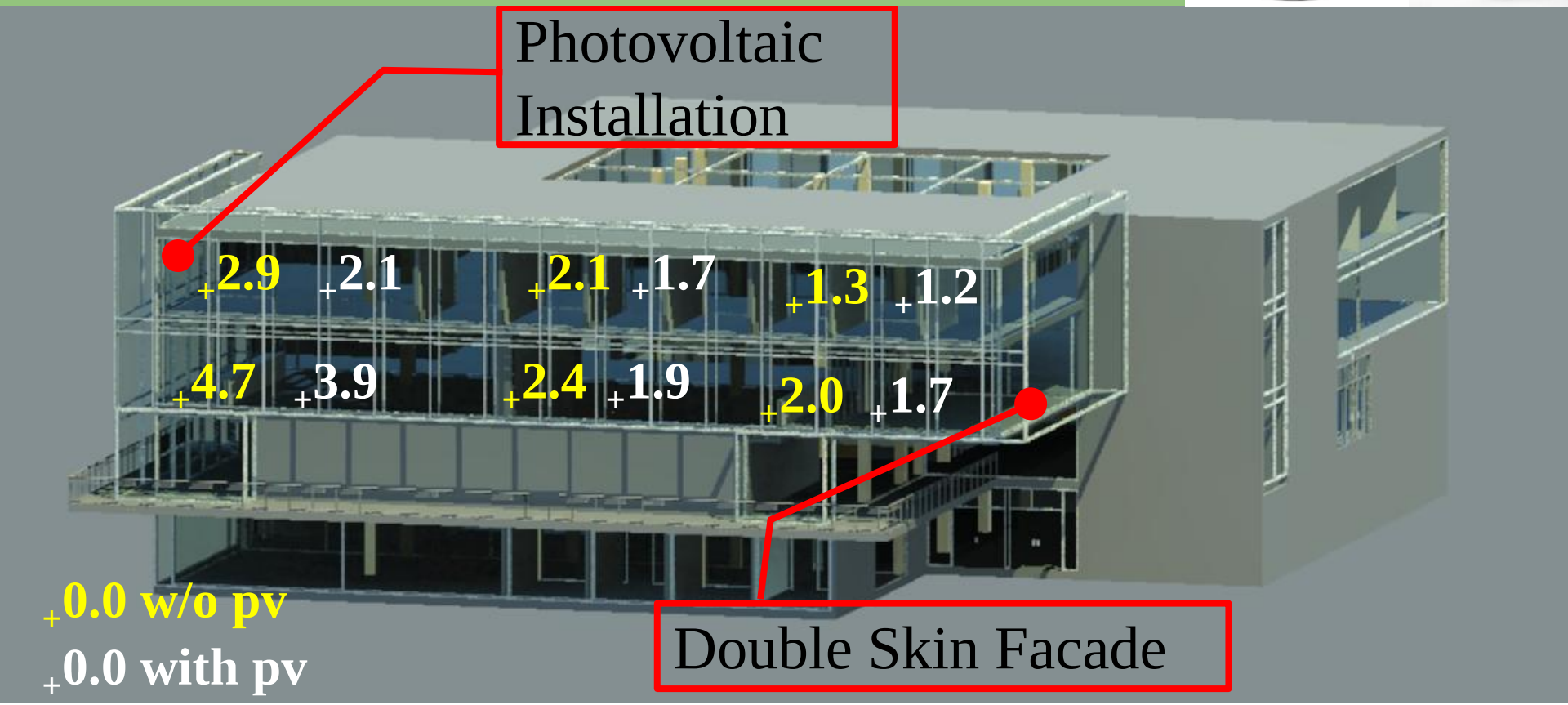
Supply

Return

Second Level - Daylight



Sustainability



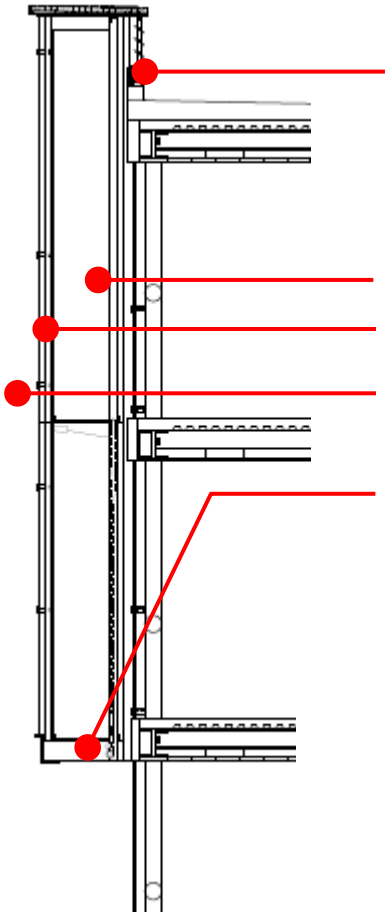
Double Skin Facade (DSF)

- improved IAQ
- reduced energy consumption

Photovoltaics

- energy production
- reduced CO_2

DSF Details



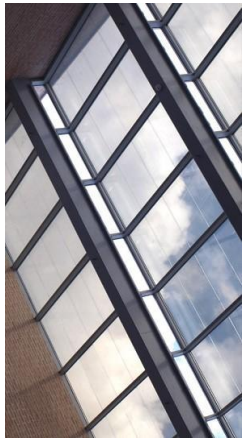
Exhaust vent with operable glass louvers

Inner skin with 2-pane glass

Outer skin - Fritting shading

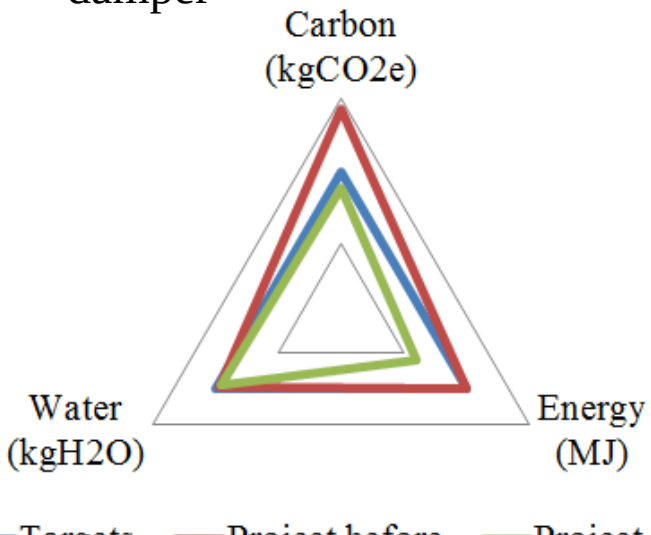
Outer skin - Transparent PV

Intake trench with operable damper



Transparent PV

- 50.1 MWh
- 20.1 %



*Cambridge Public Library, Cambridge MA

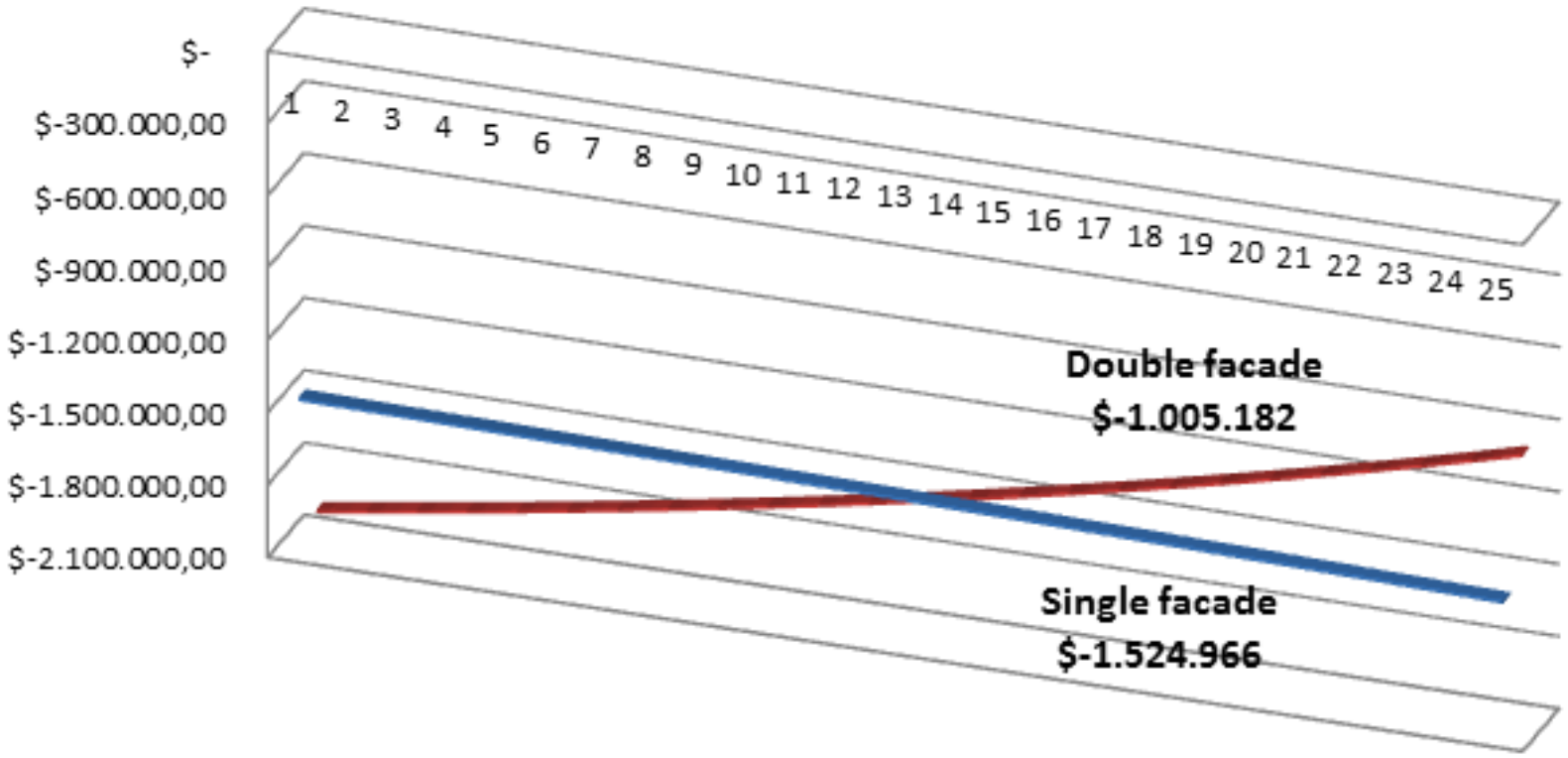
Double Skin Facade

- decision between single facade and double skin facade
- additional costs through DSF
- added annual savings & increased energy efficiency

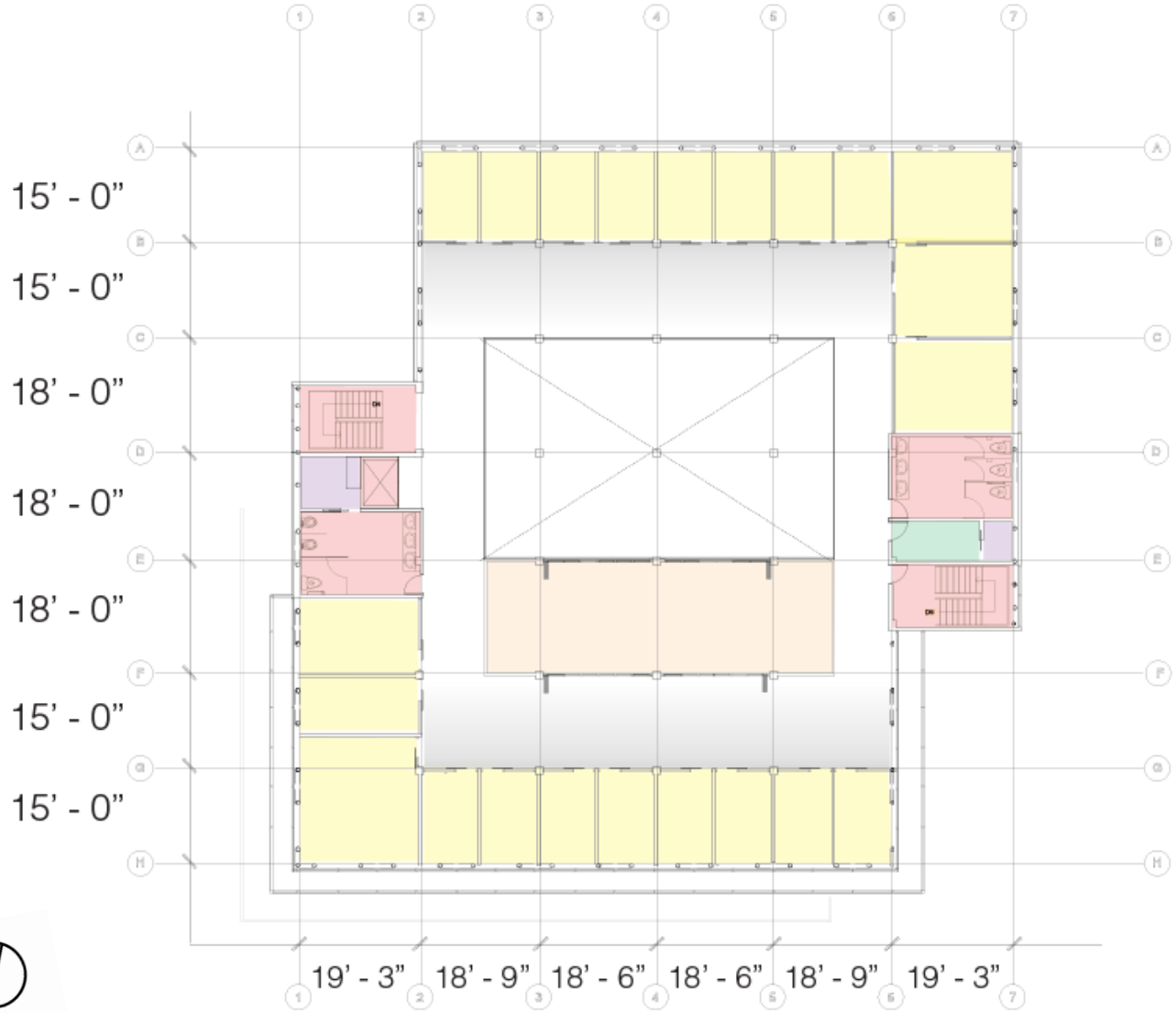
Double Skin Facade

Alternative life cycle

Savings $1 150 000

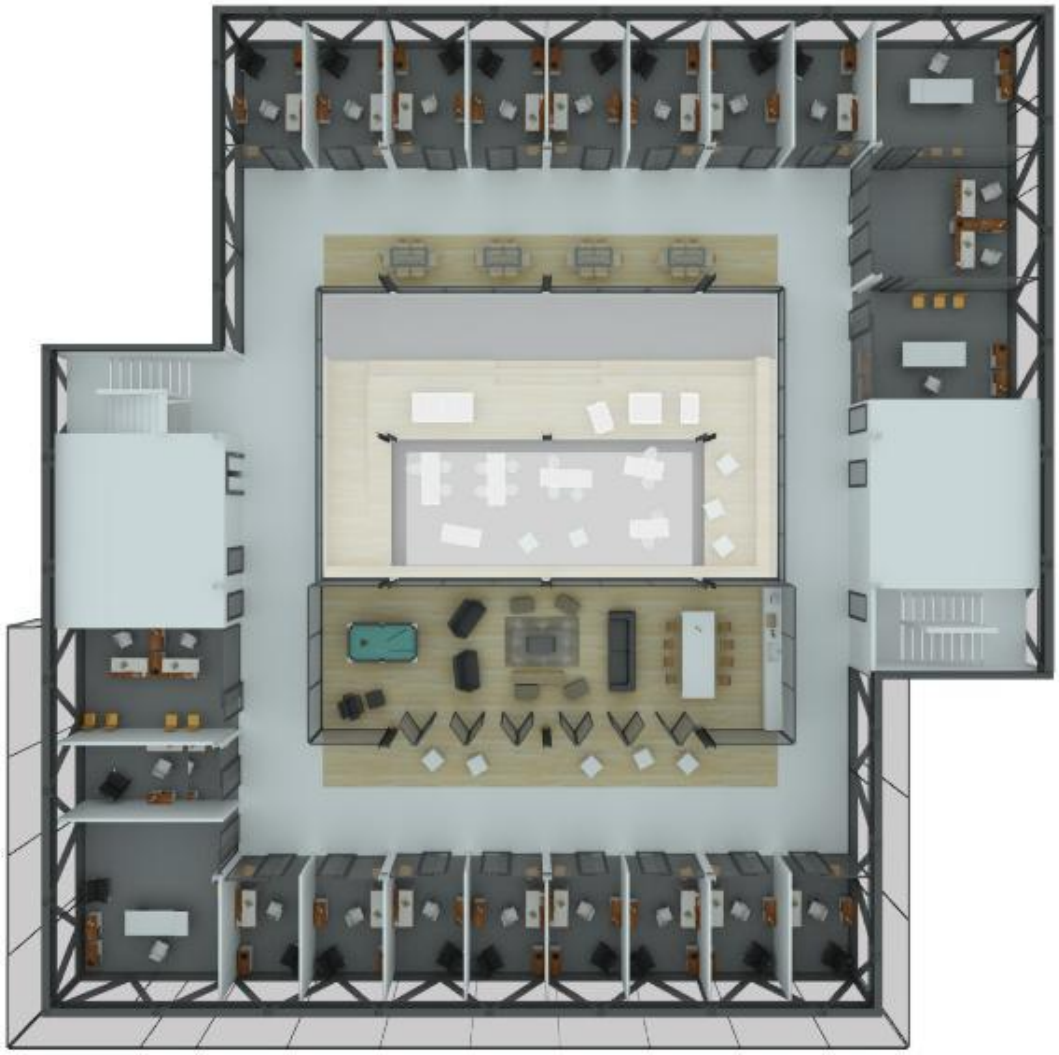


Third Level - Floor Plan



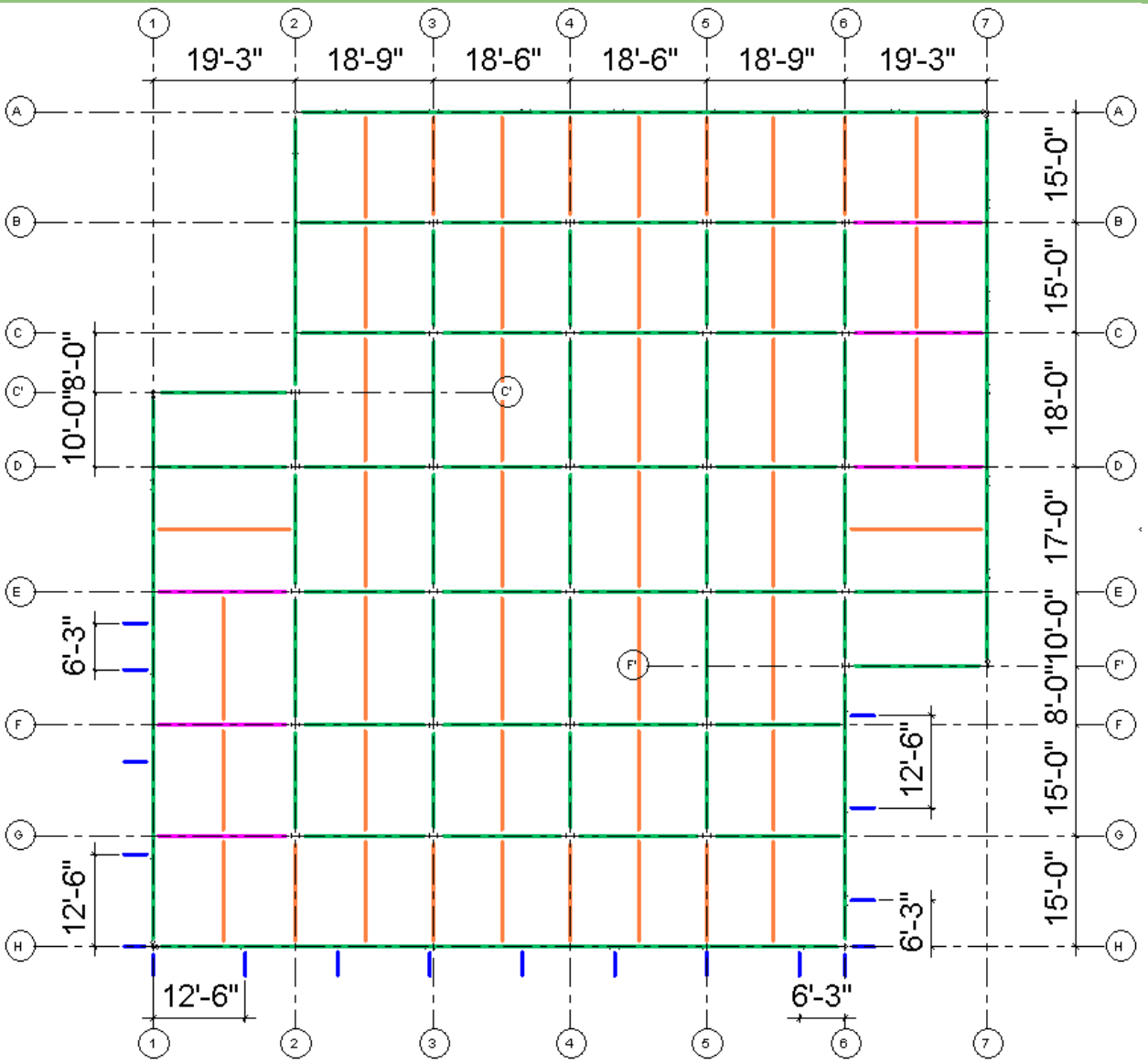
Core
Faculty Offices
Lounge
Mechanical Shafts
Storage

Third Level - Furnished



Third Level

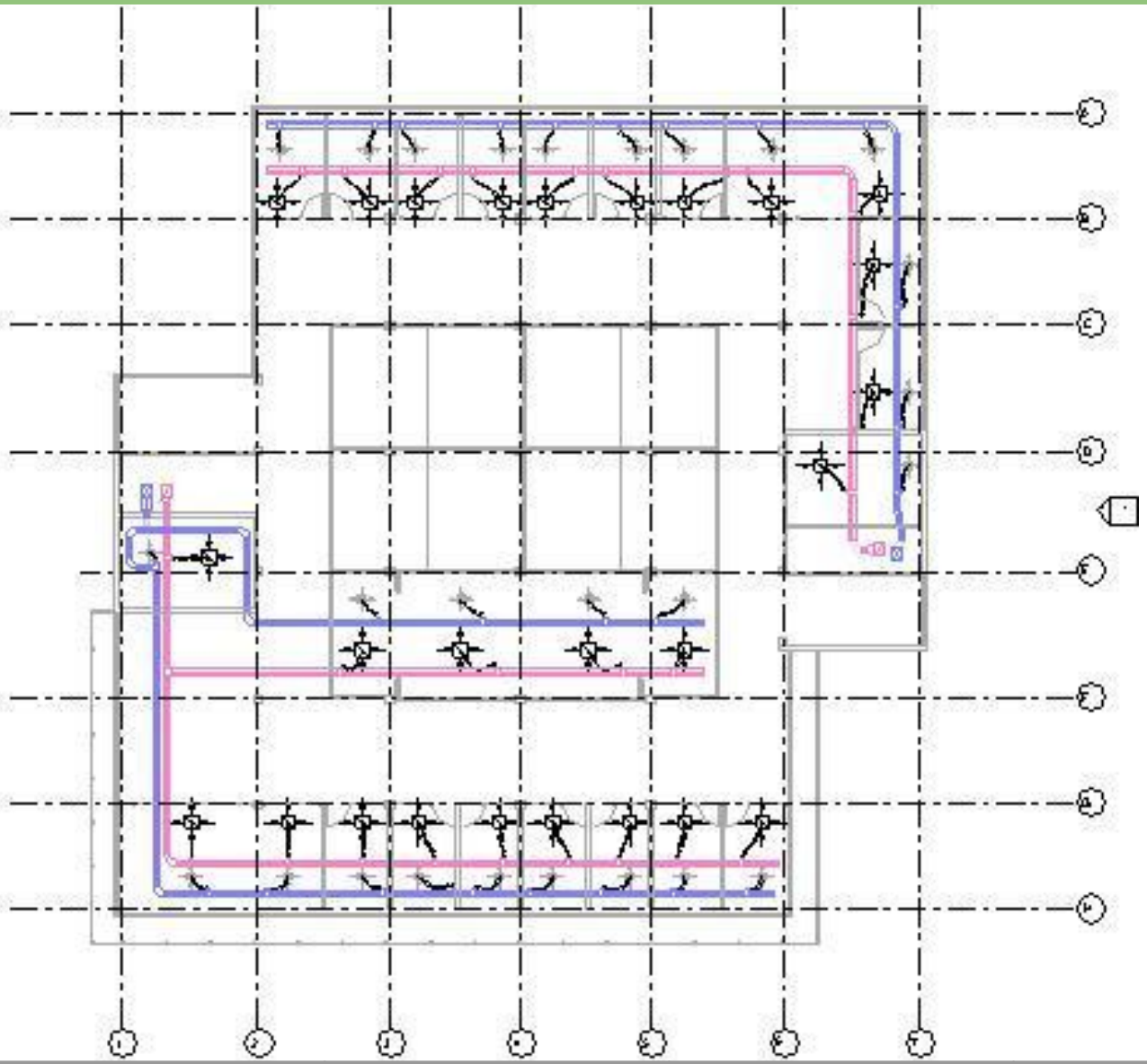
Third Level - Structure



Legend:

- W8x18
- W8x24
- W8x40
- W12x50

Third Level - Duct Network



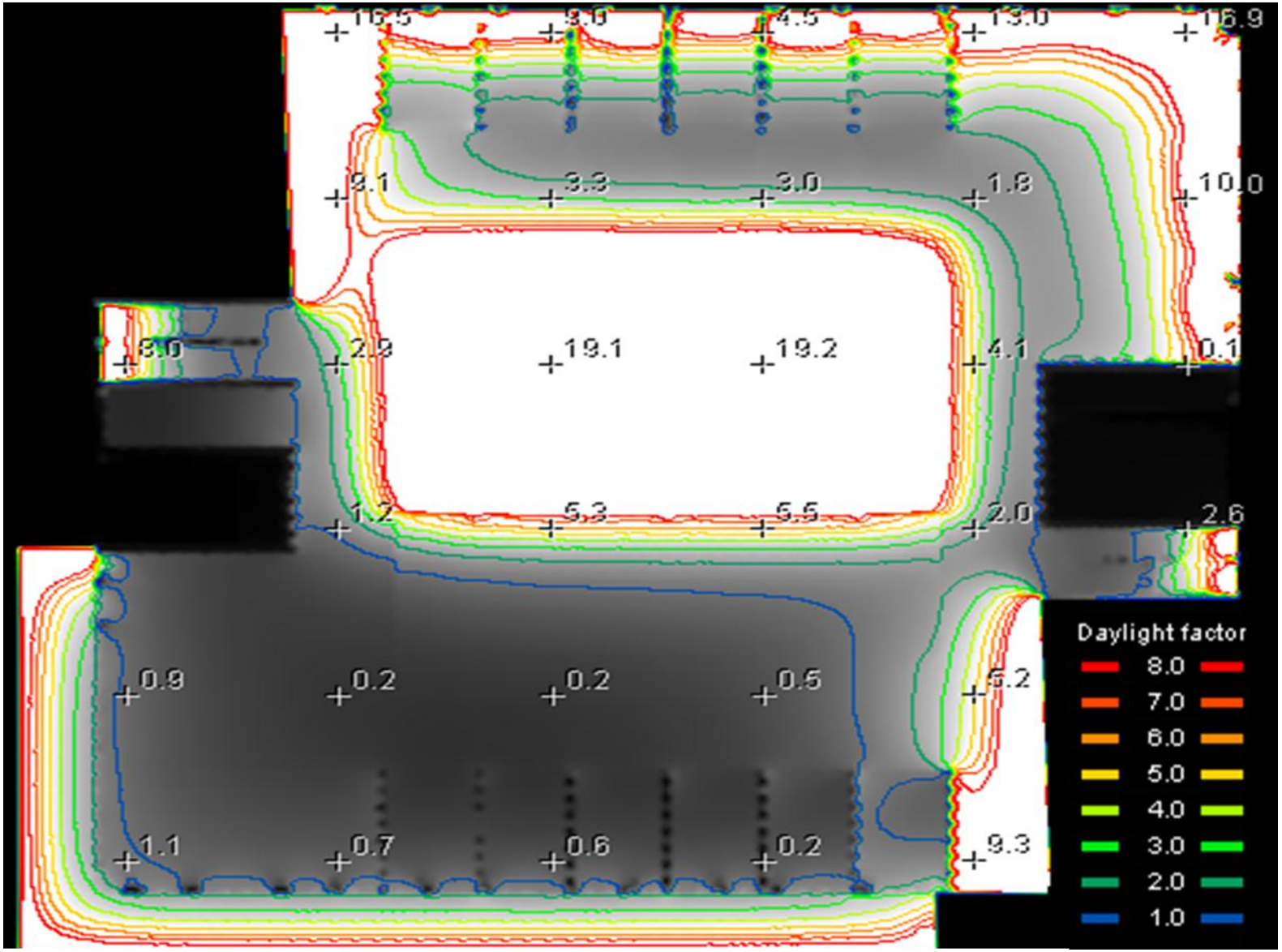
Velocity

- Main Ducts
  - 21.3 fps
- Branch Ducts
  - 11.5 fps

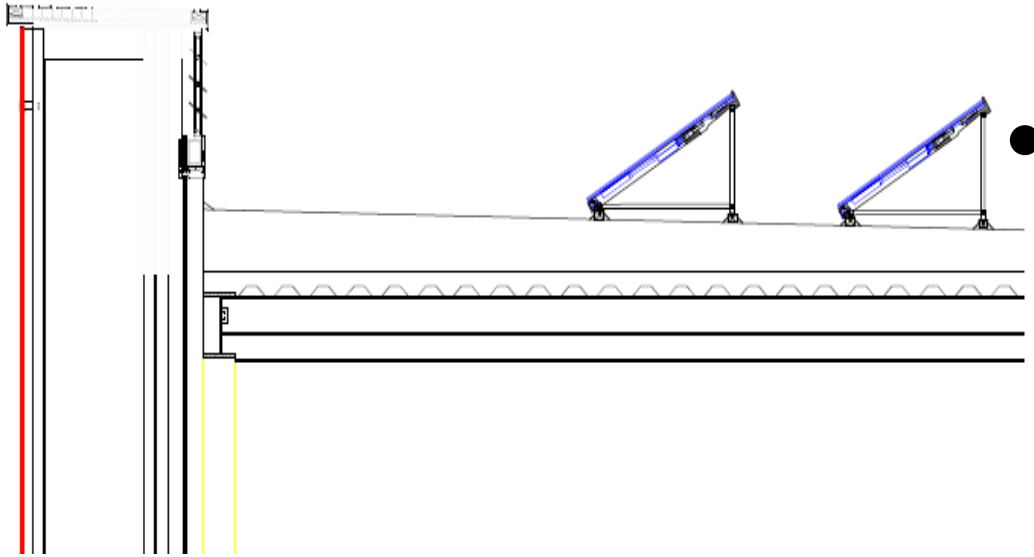
Supply

Return

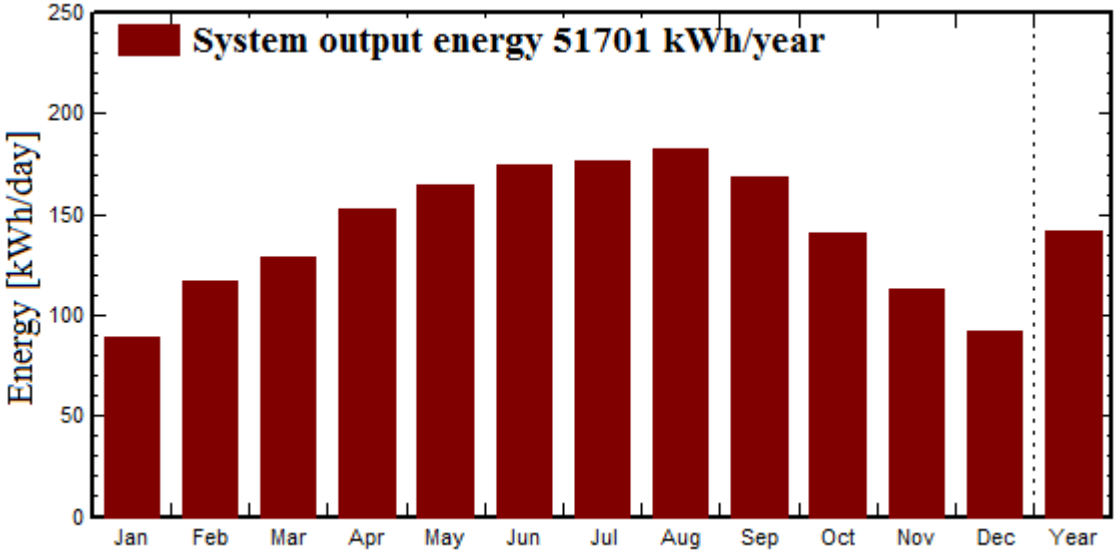
Third Level - Daylight

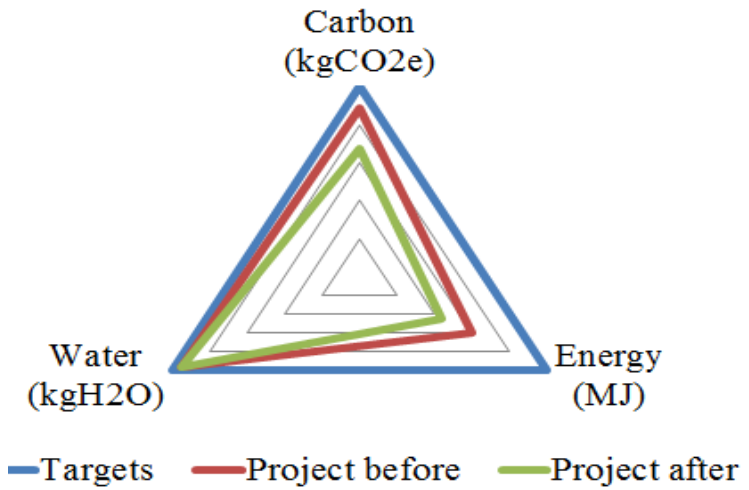


Photovoltaics



- Tilt 30^0
- Nominal Power 30 kW
- Area 250 m^2
- System Output 141.6 kWh/day

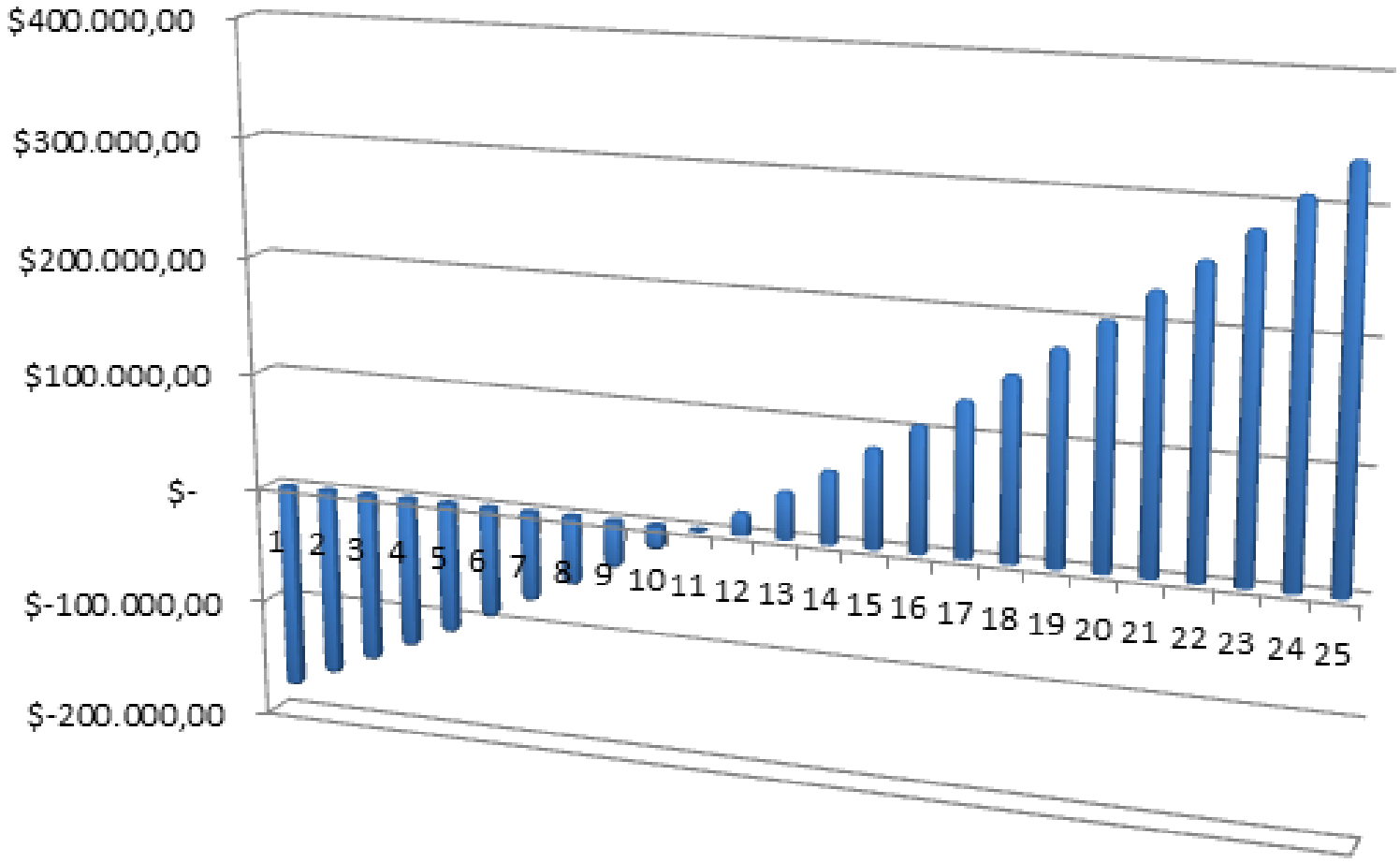




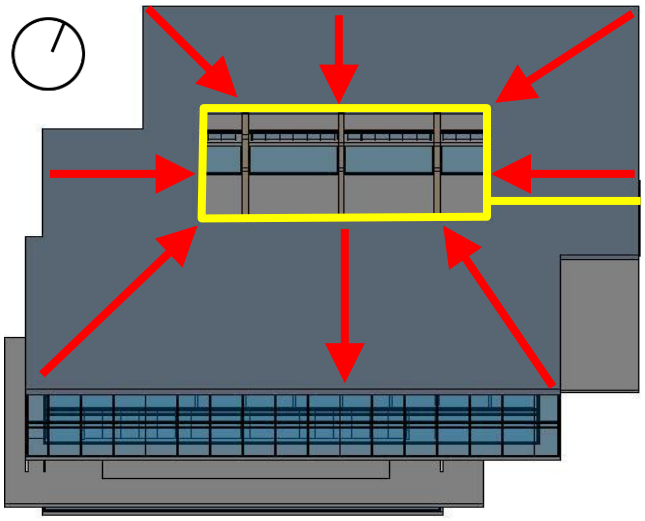
Photovoltaics

Life cycle PV roof

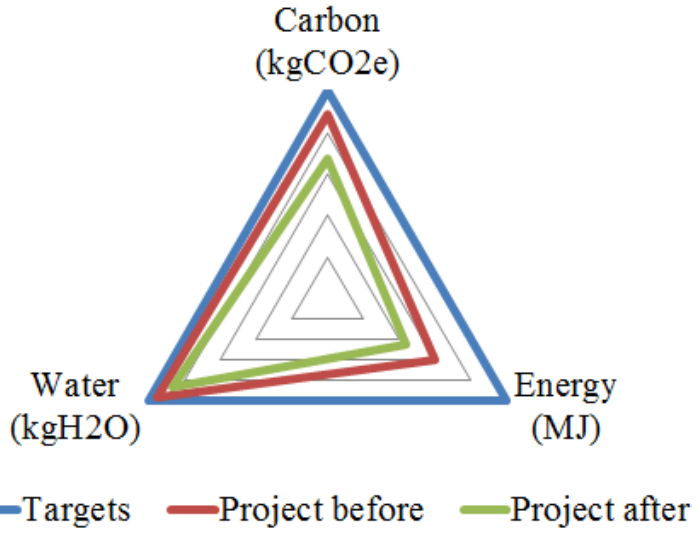
Savings $1 350 000

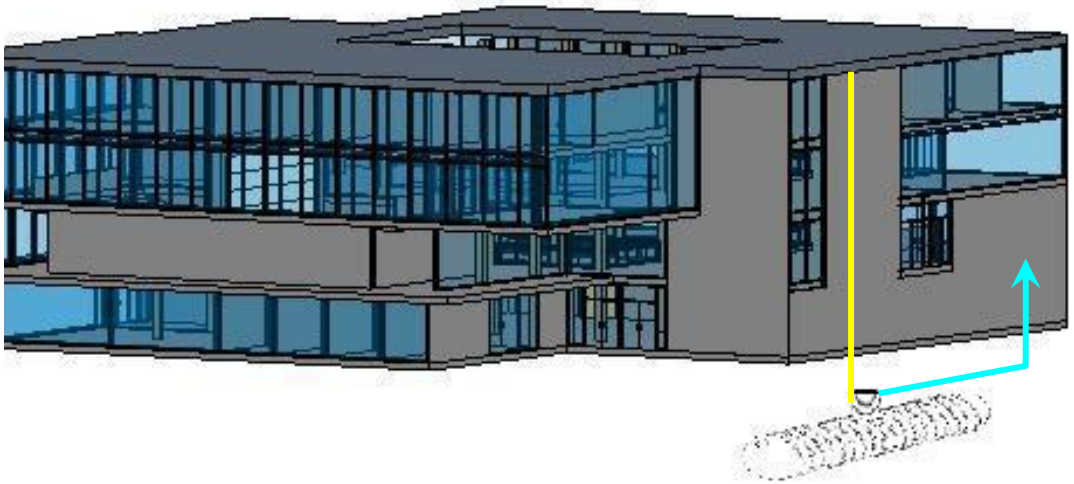


Rainwater Harvesting

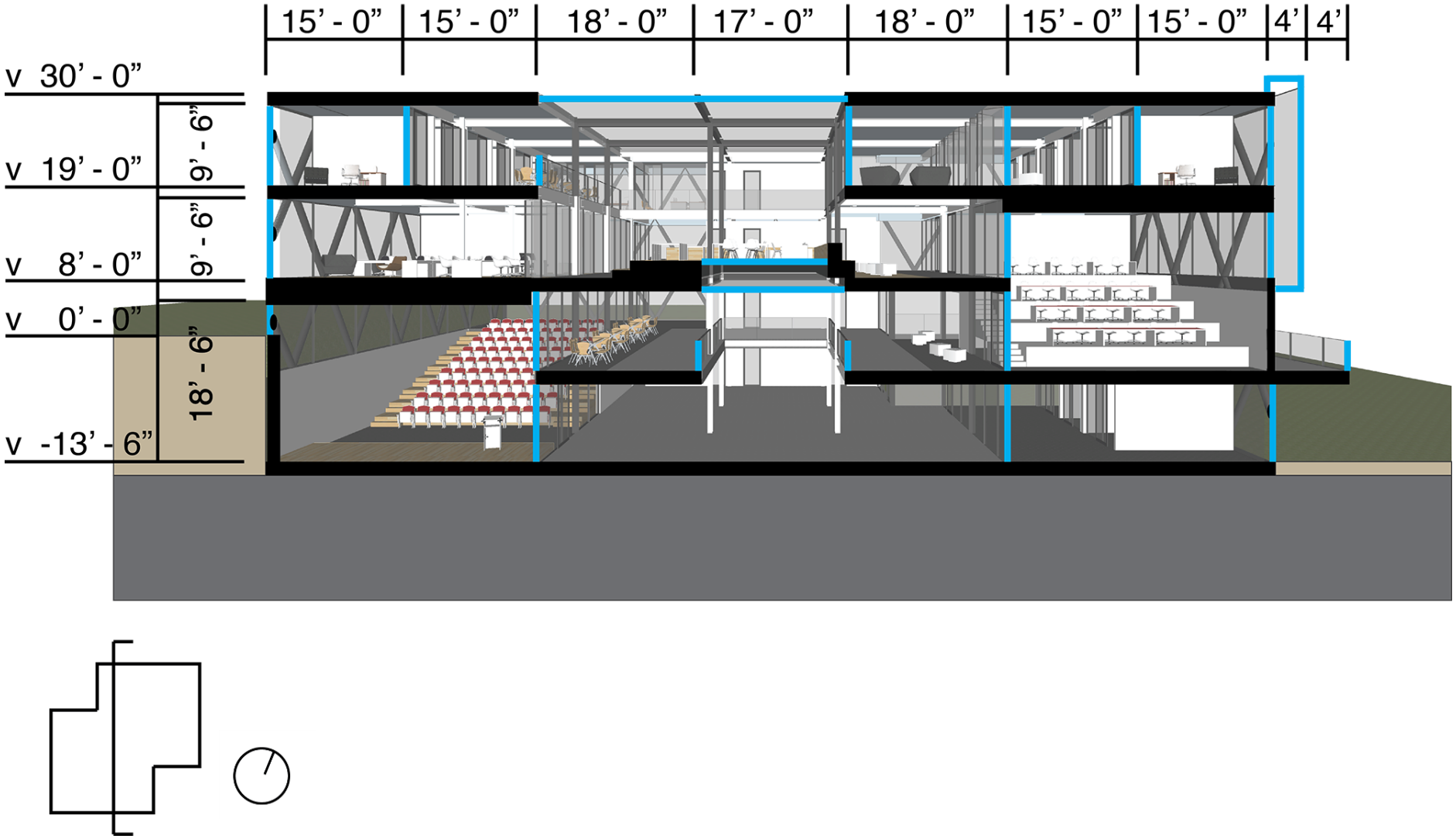


- Collectable rainwater/snow
  - 72200 gal/year
- Underground tank
  - 8000 gal (7' d x 30' l)
  - first-flush diverter

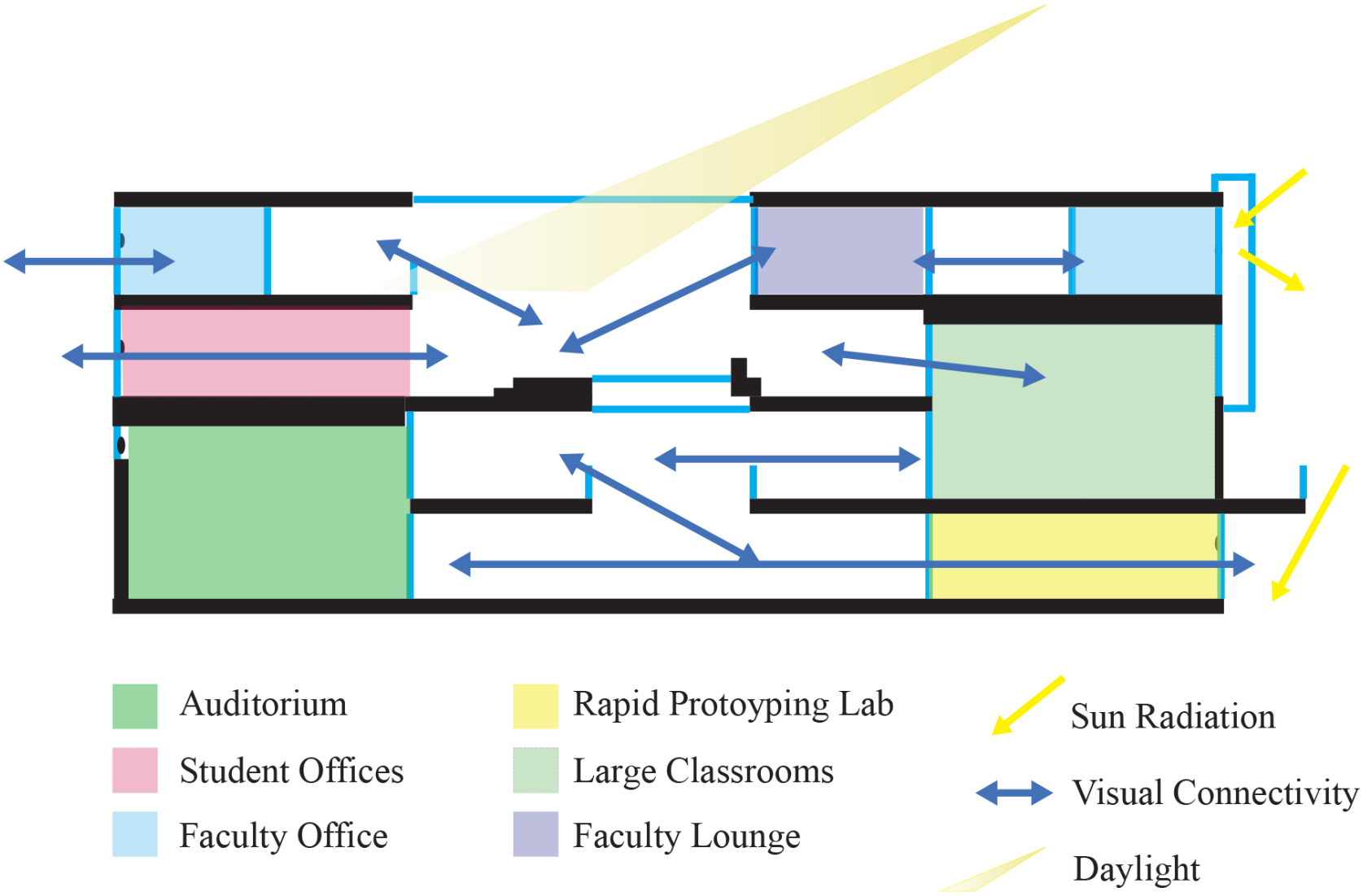




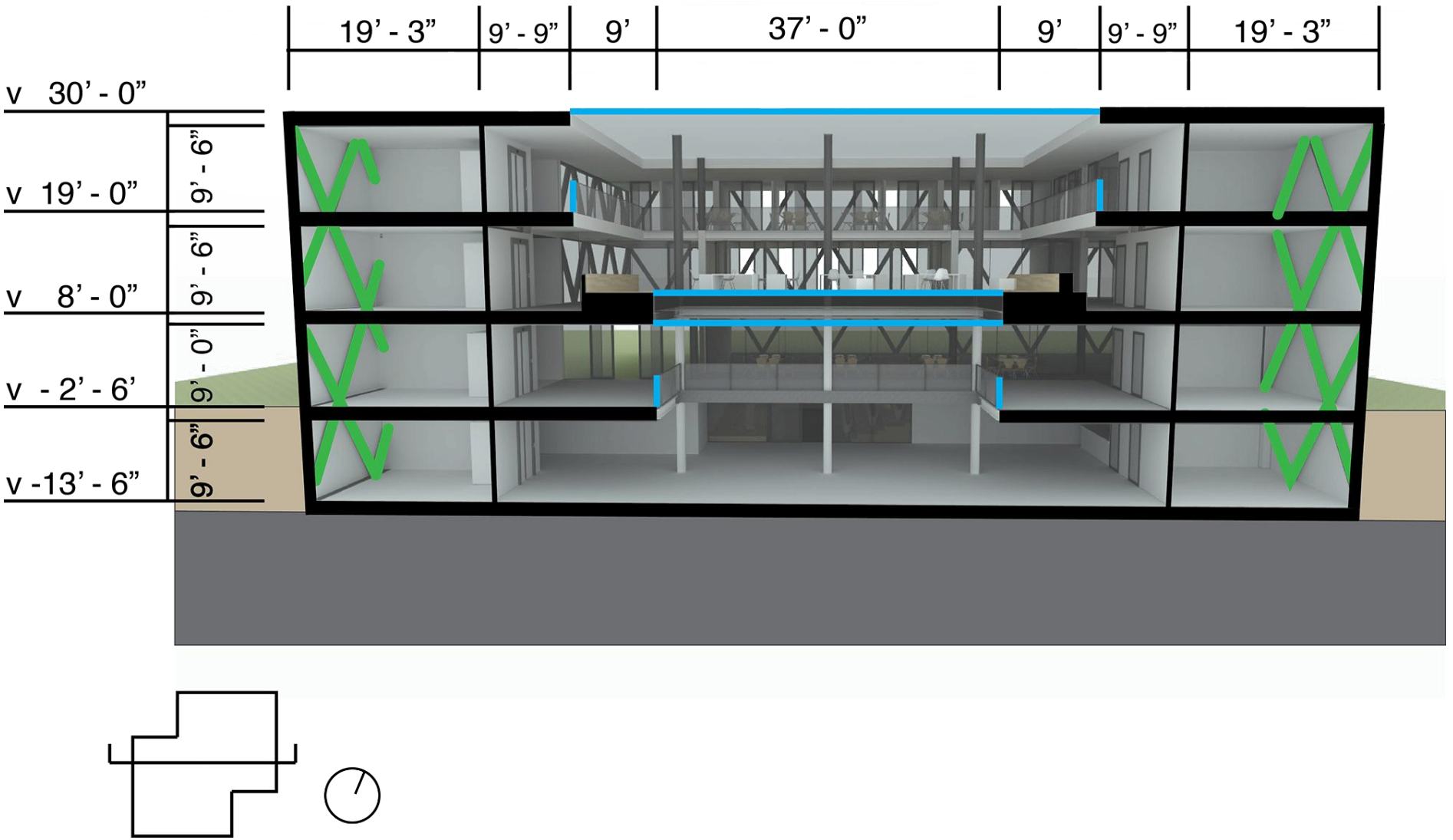
Section AA



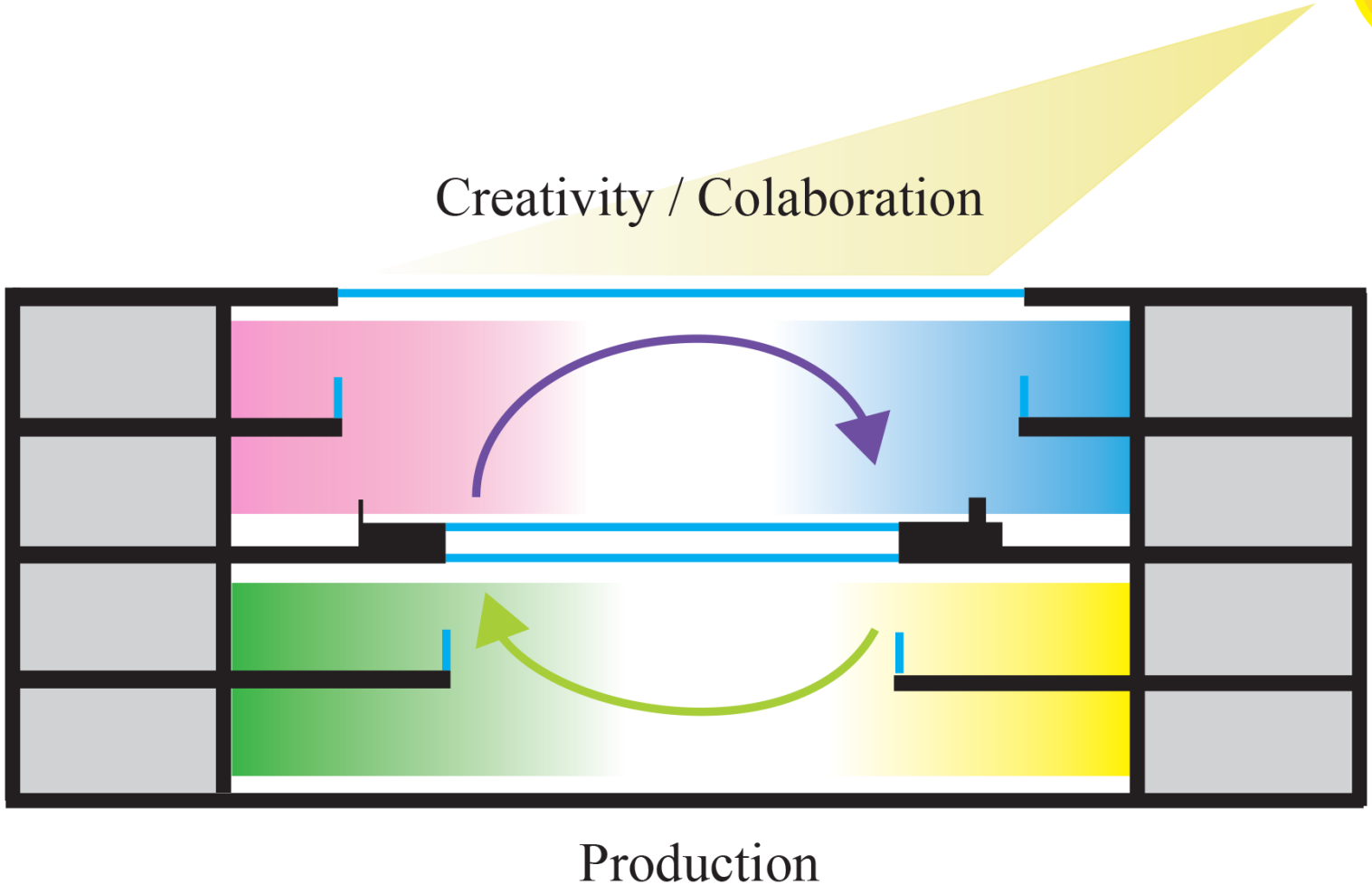
Section AA Diagram



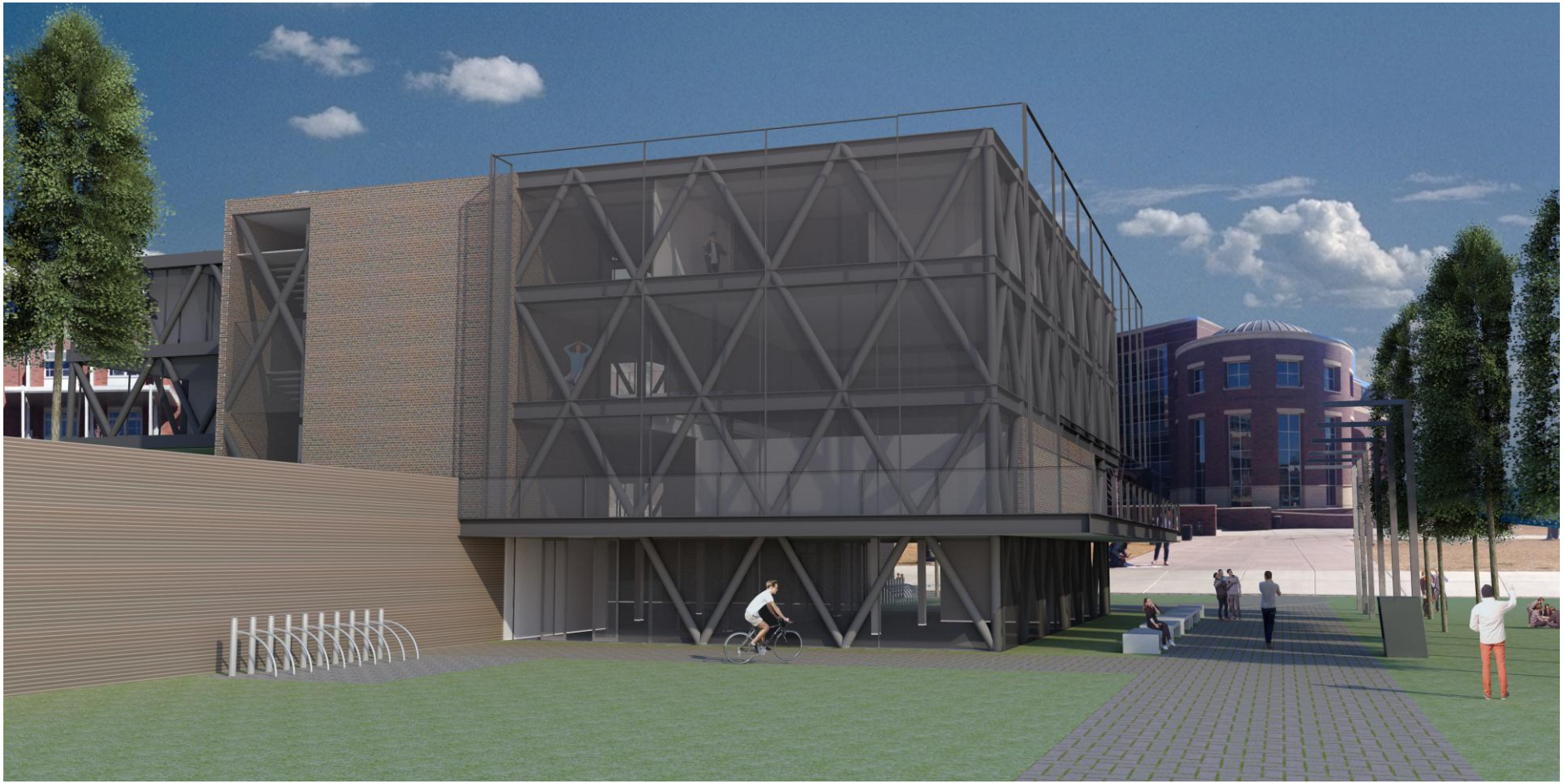
Section BB



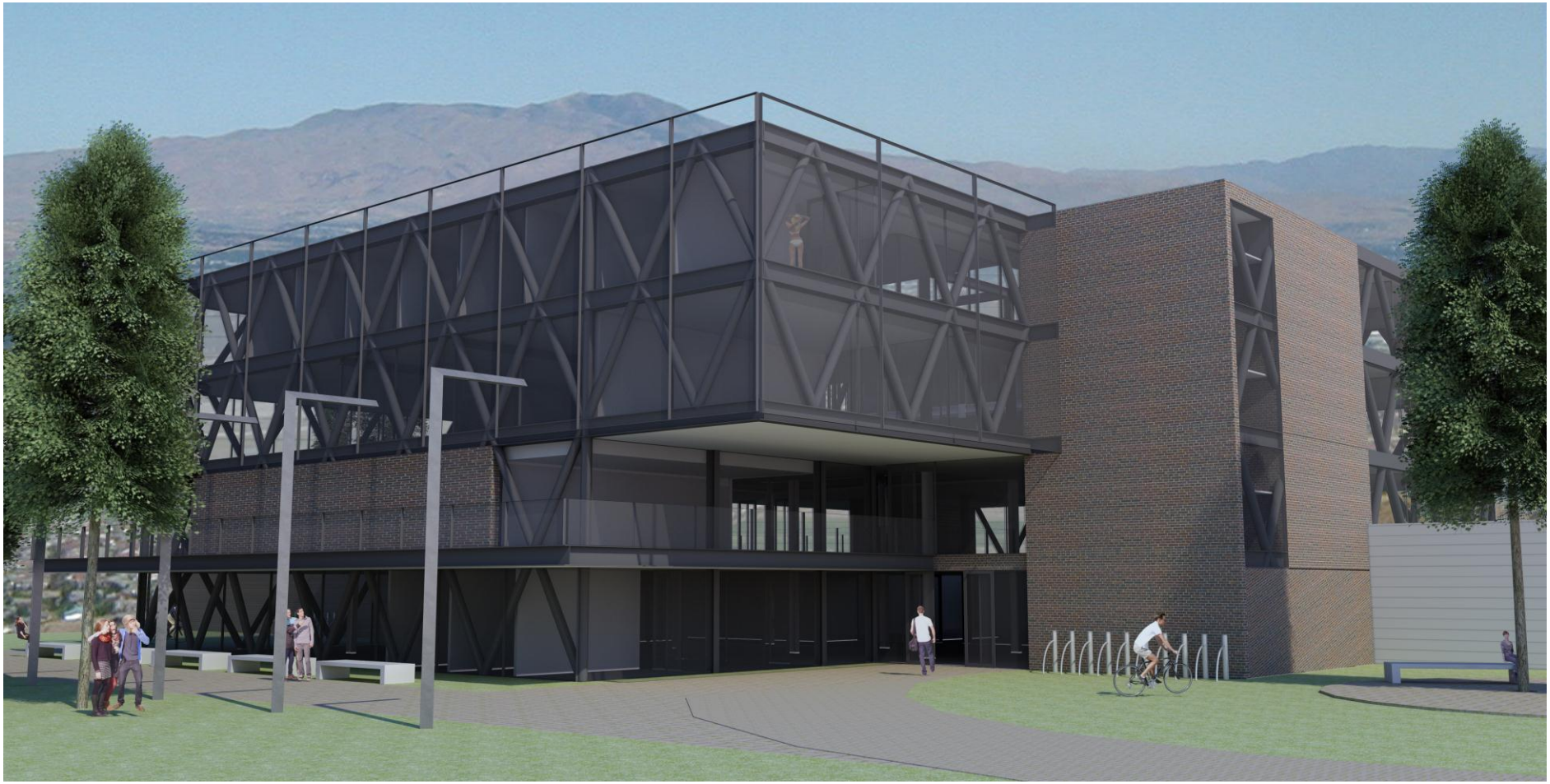
Section BB Diagram



Southwest Elevation

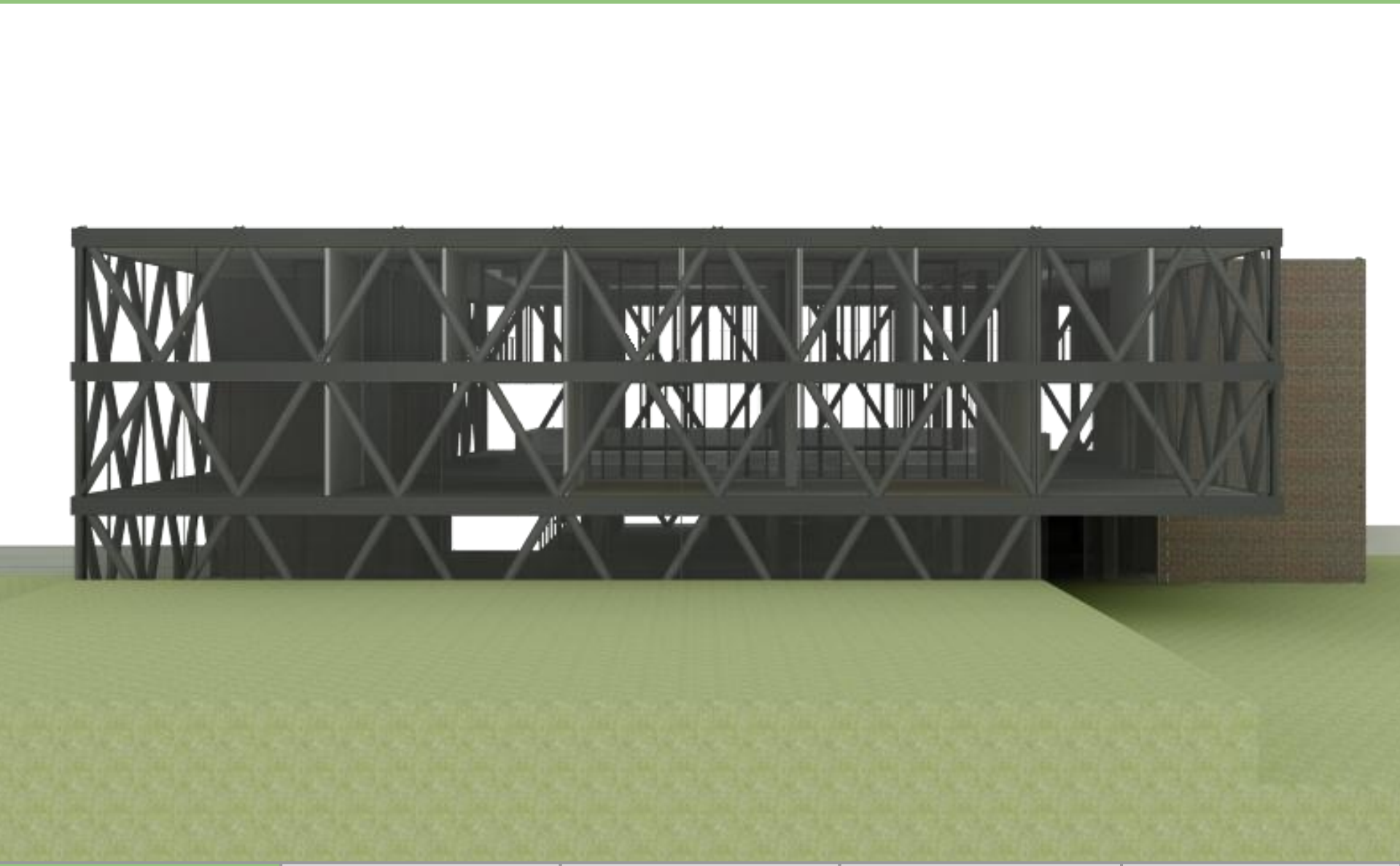


Southeast Elevation



A	SE	CM	MEP	LCFM

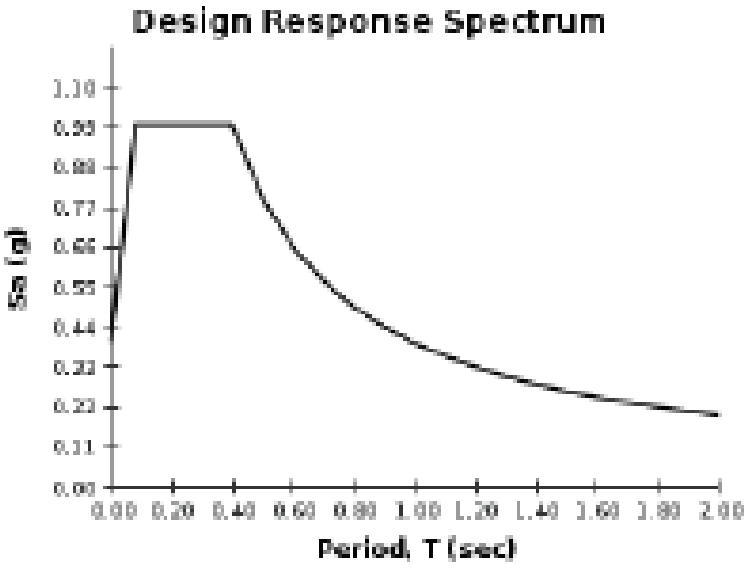
North Elevation

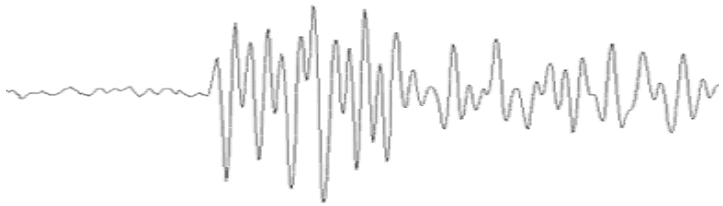


SE Load Conditions

	IBC 2006
Roof Dead Load	90 psf
Roof Live Load	20 psf
Roof Snow Load	40 psf
Other Floor Dead Loads	75 psf
Other Floor Live Loads	60-100 psf
Wind Shear	100 mph => 1.5 kips / foot
Earthquake Shear	R=3.25 => 1900 kips
Retaining-soil Shear	4.7 kips / foot

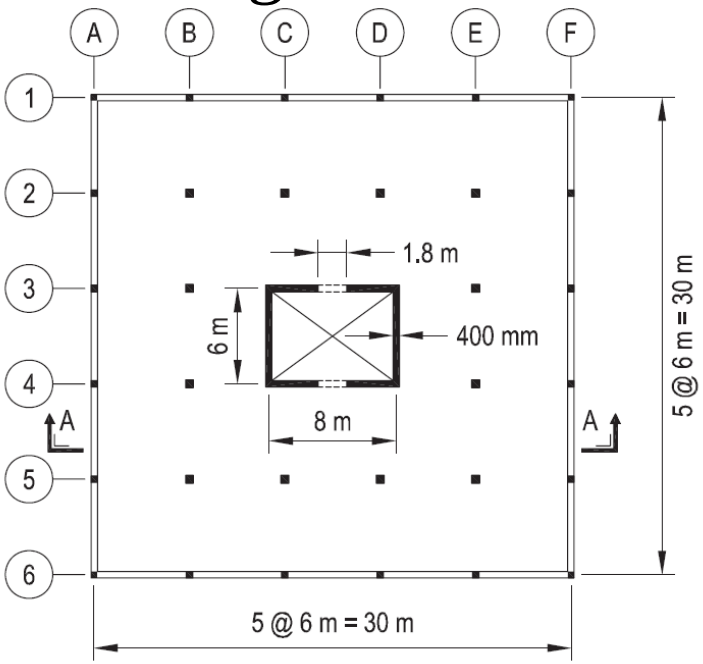
Site Class	B - Rock
Occupancy	I

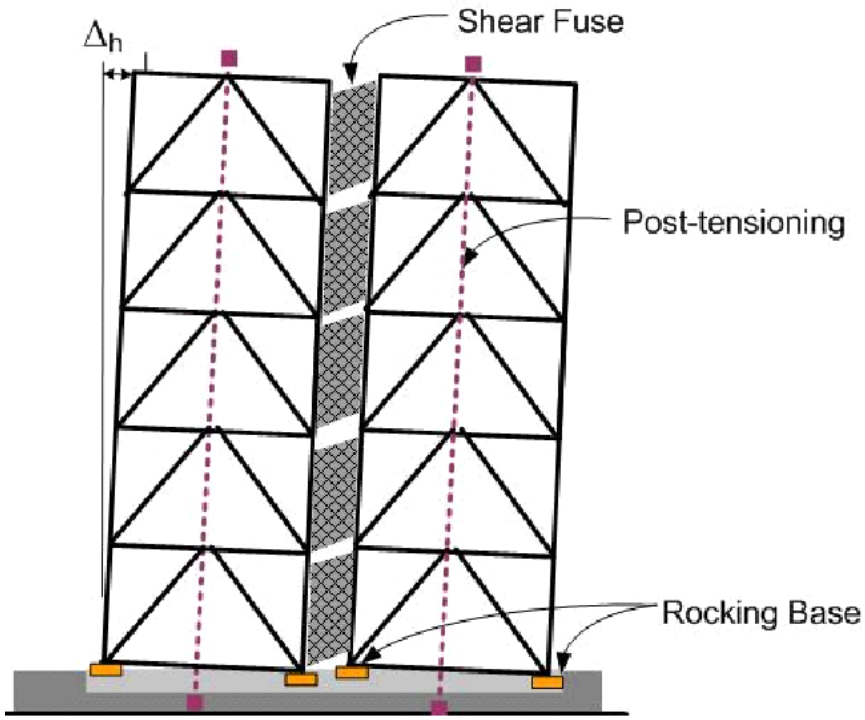




Lateral Support

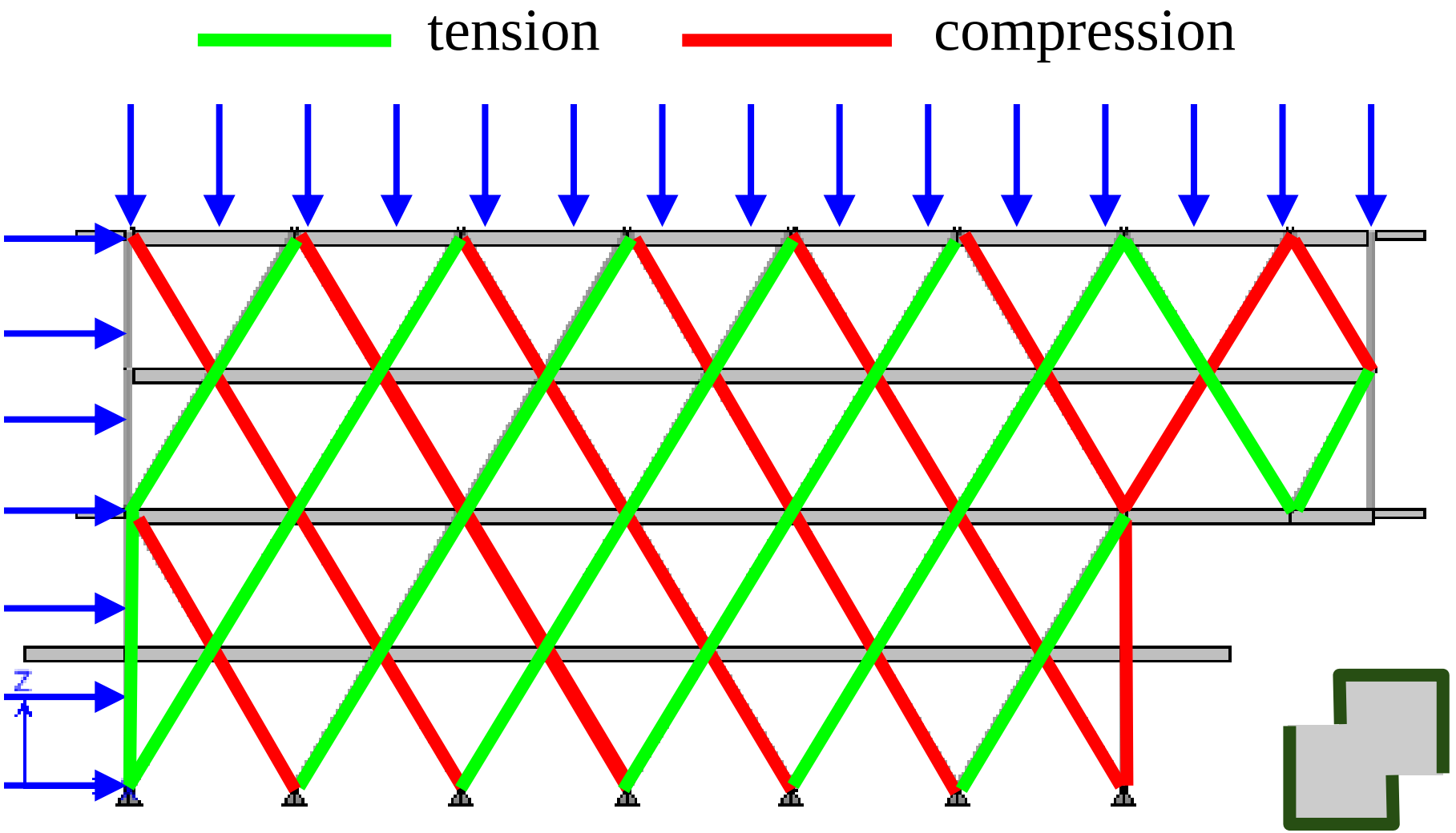
- Earthquake shear: prevailing load
- Options considered
  - Shear walls
  - Rocking frames
  - Diagrid



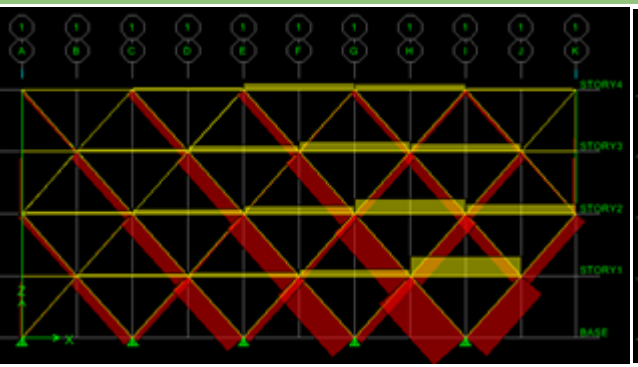


dual frames

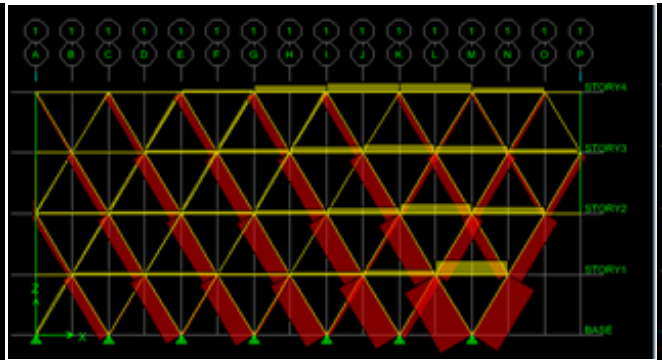
Shape & Load Paths



Diagrid Shape



1



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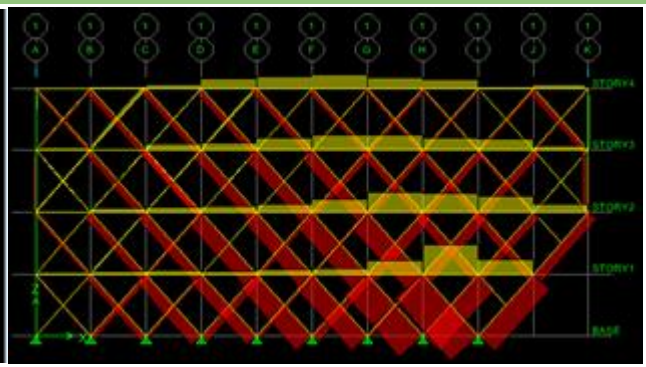
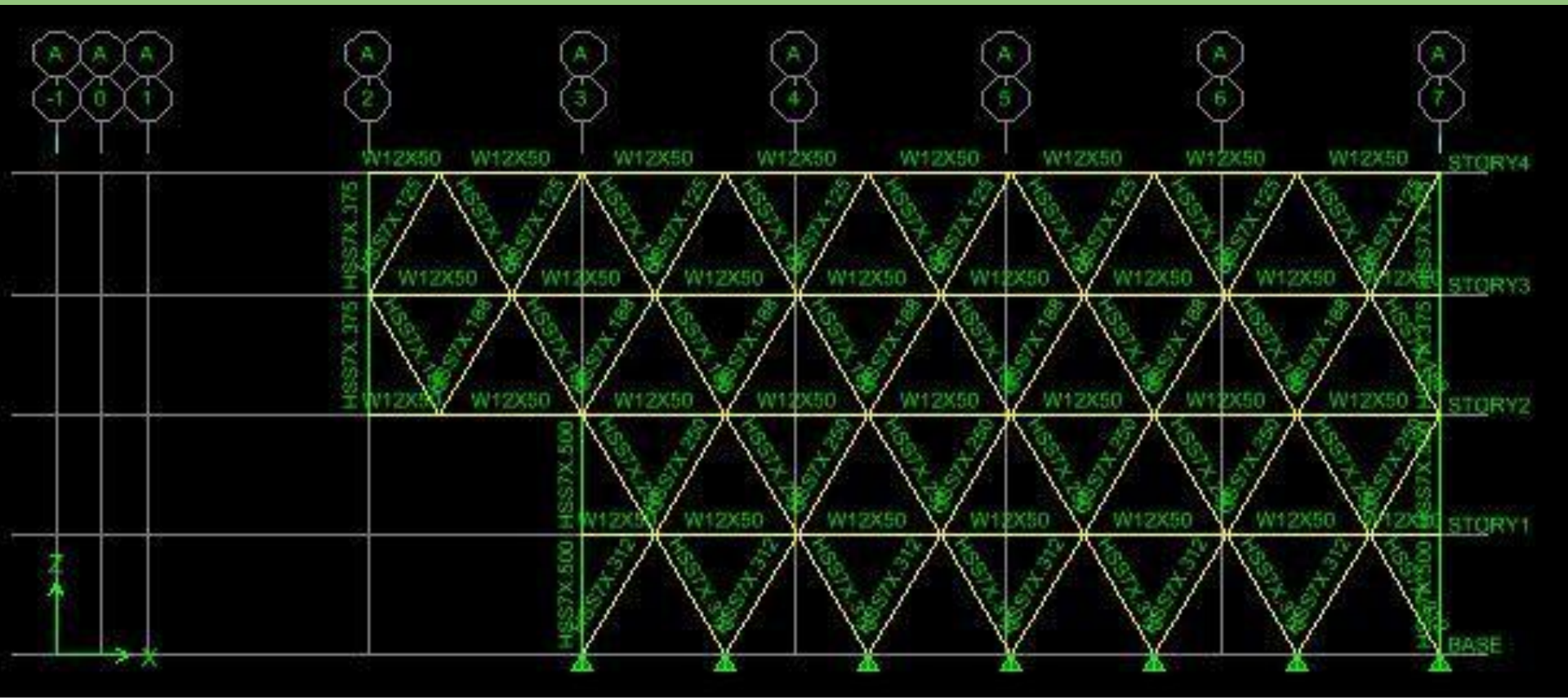


3

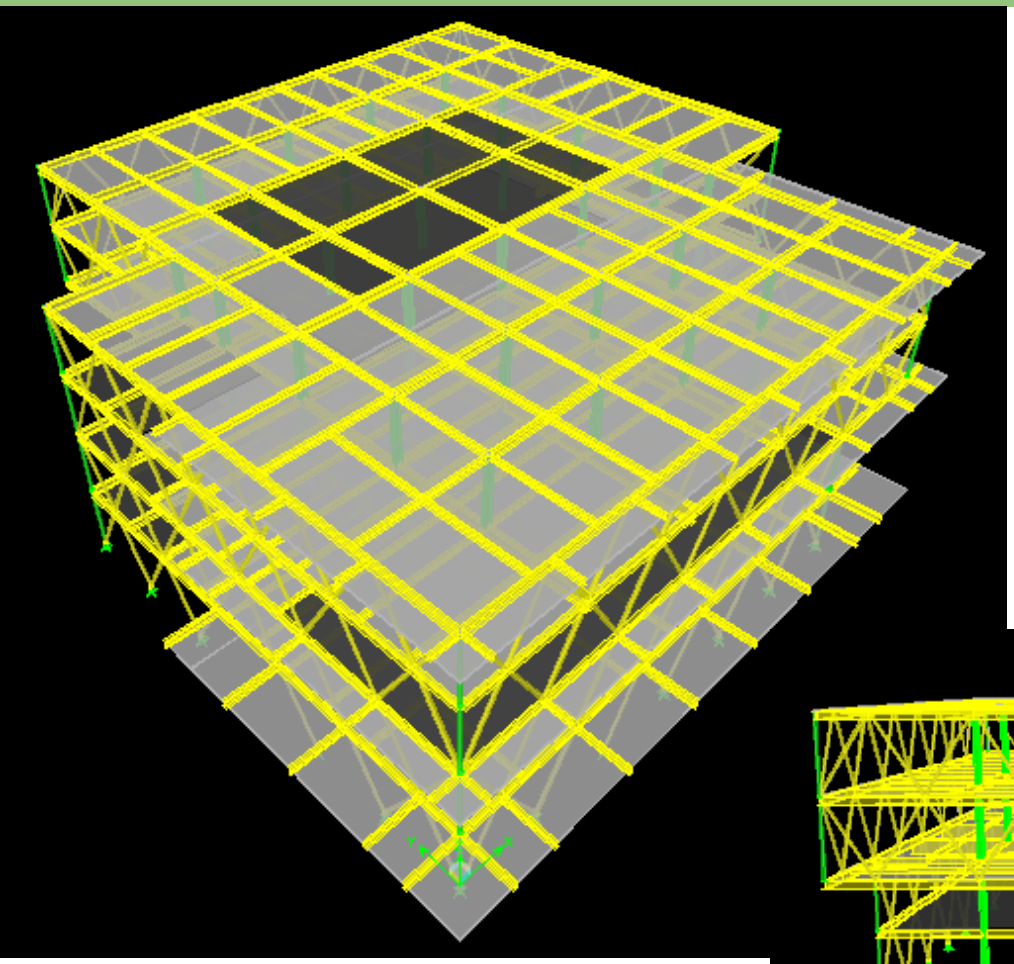
	No. Diag	Length (ft.)	No. Joints	Max Comp. (k)	Max Tens. (k)	Avg. Force (k)	Avg. Area (sq. in.)	Est. Weight (lb)
1	39	14.1	27	-285.9	127.6	69.3	1.39	2592
2	57	12.2	38	-185.5	70.2	46.3	0.93	2198
3	77	14.1	91	-189.9	146.5	36.4	0.73	2691

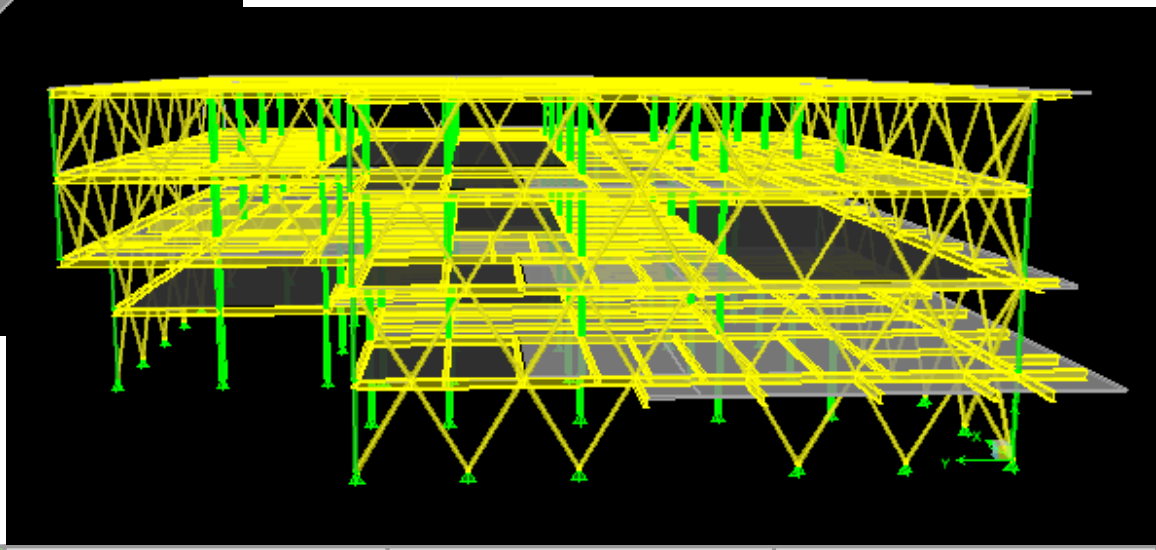
Diagrid Optimization



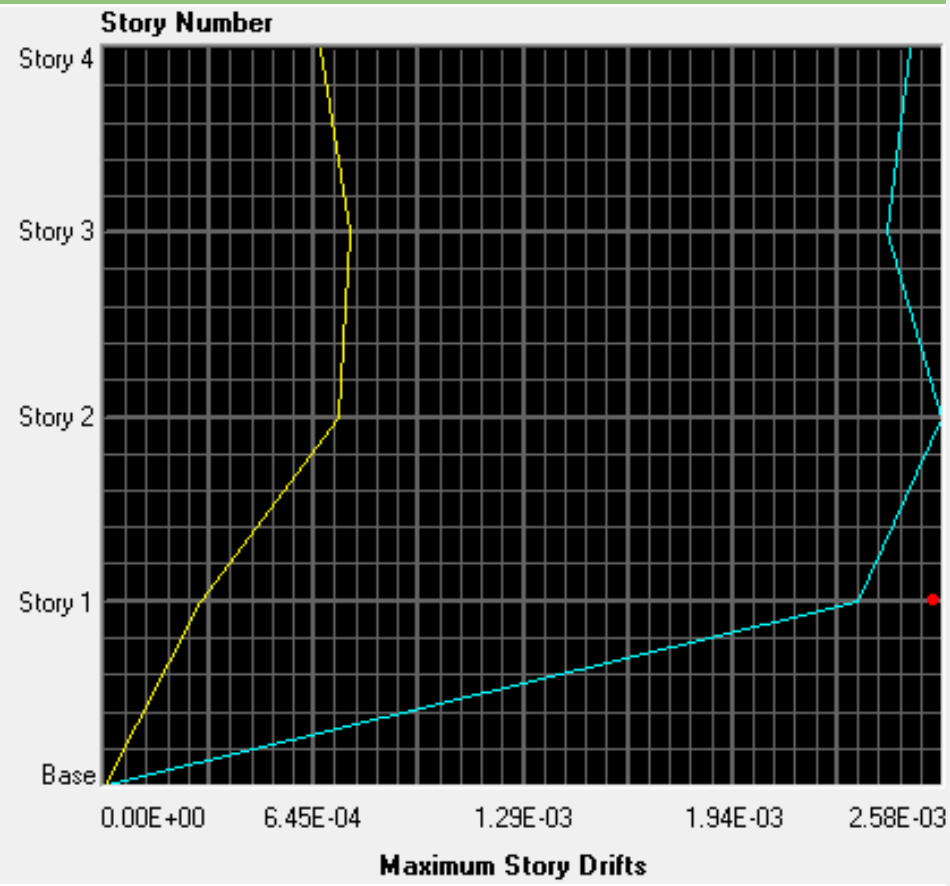
Maintain constant diameter to keep constant appearance among floors, but vary HSS thickness to optimize for weight

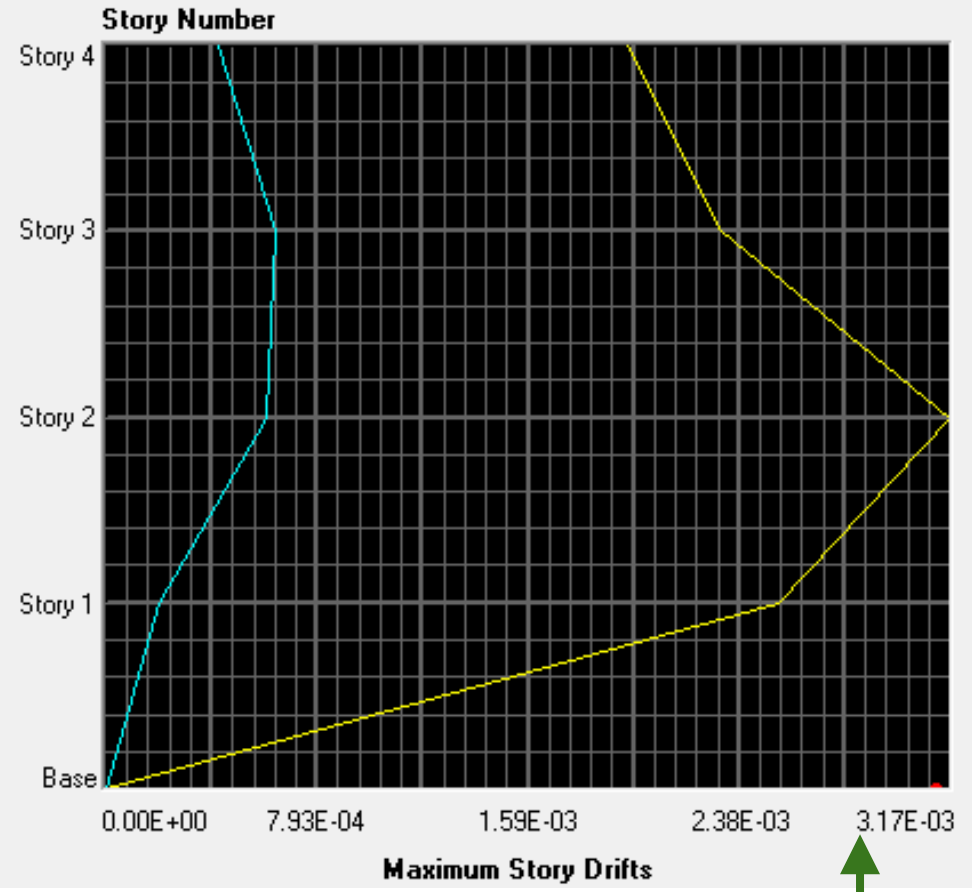
ETABS Analysis

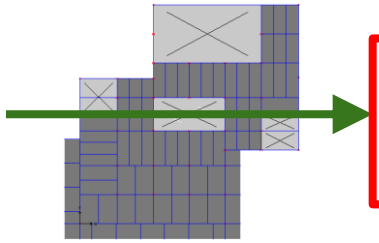




Seismic - Story Drifts





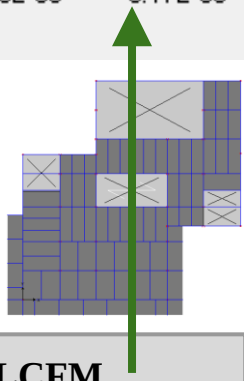


Max = 0.26%

Global X-Direction Color

Global Y-Direction Color

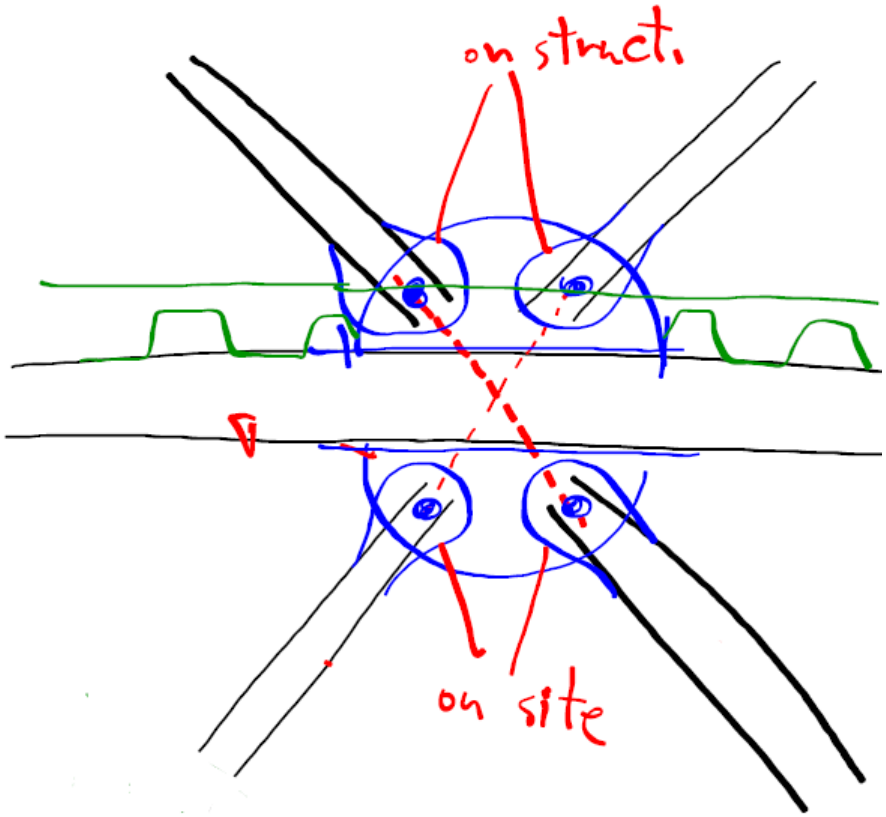
Max = 0.32%

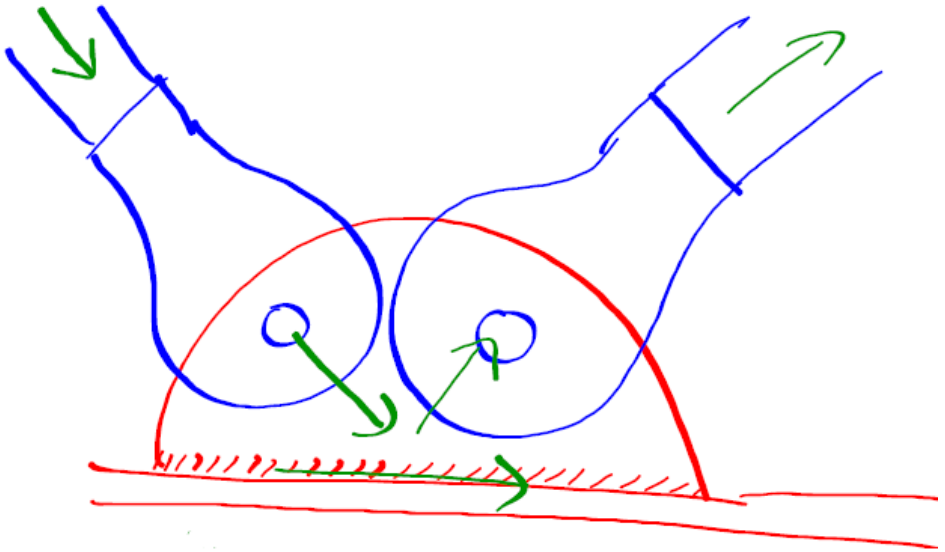


A	SE	CM	MEP	LCFM

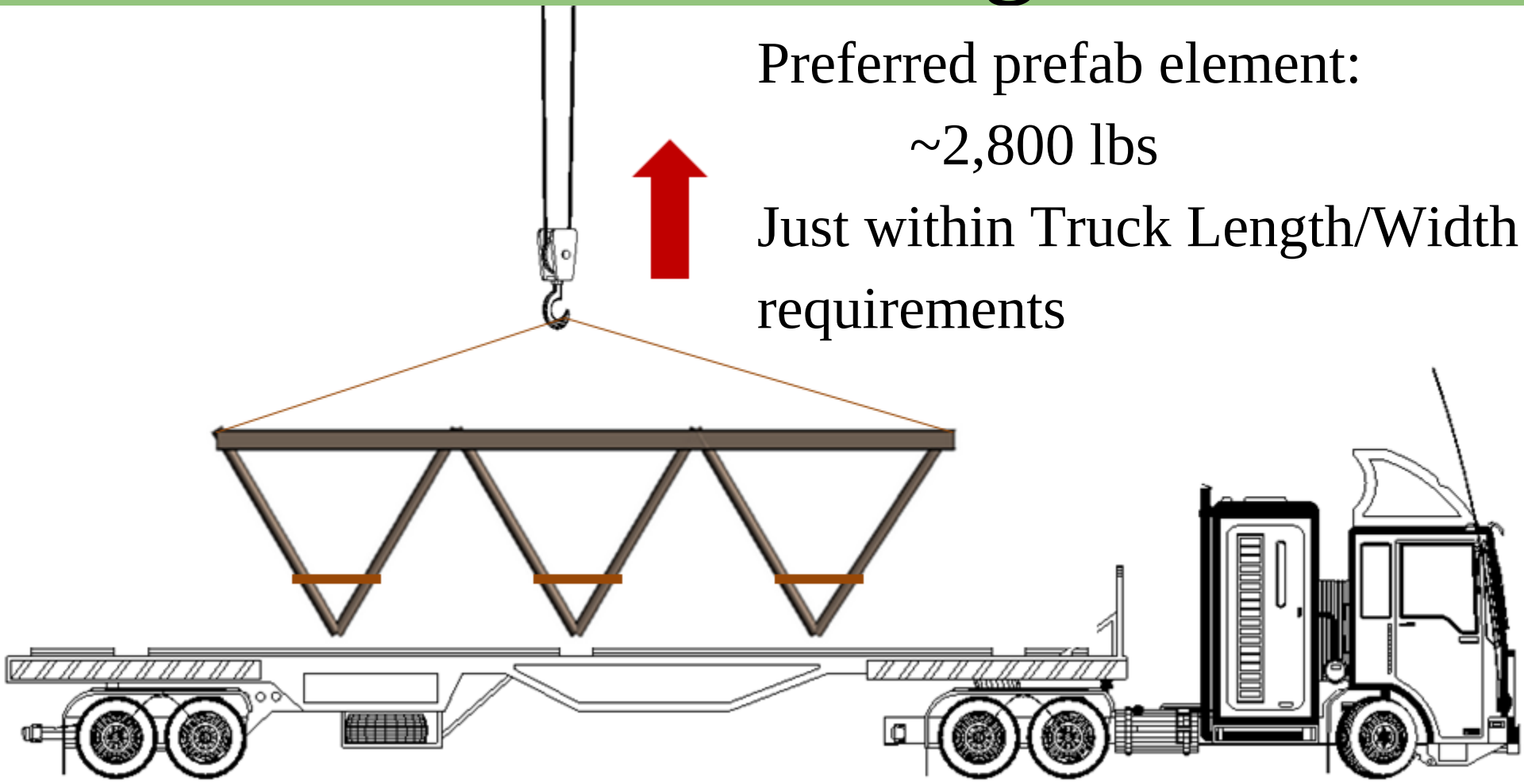
Connection Detail

- Bolt the diagonals to gusset plate
- Weld the gusset plate to the flange of the girder





The Rise of the Diagrid

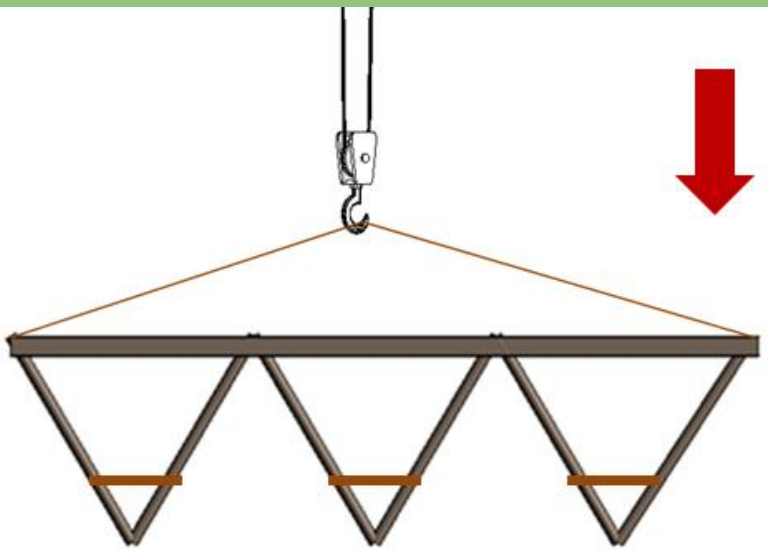


Preferred prefab element:

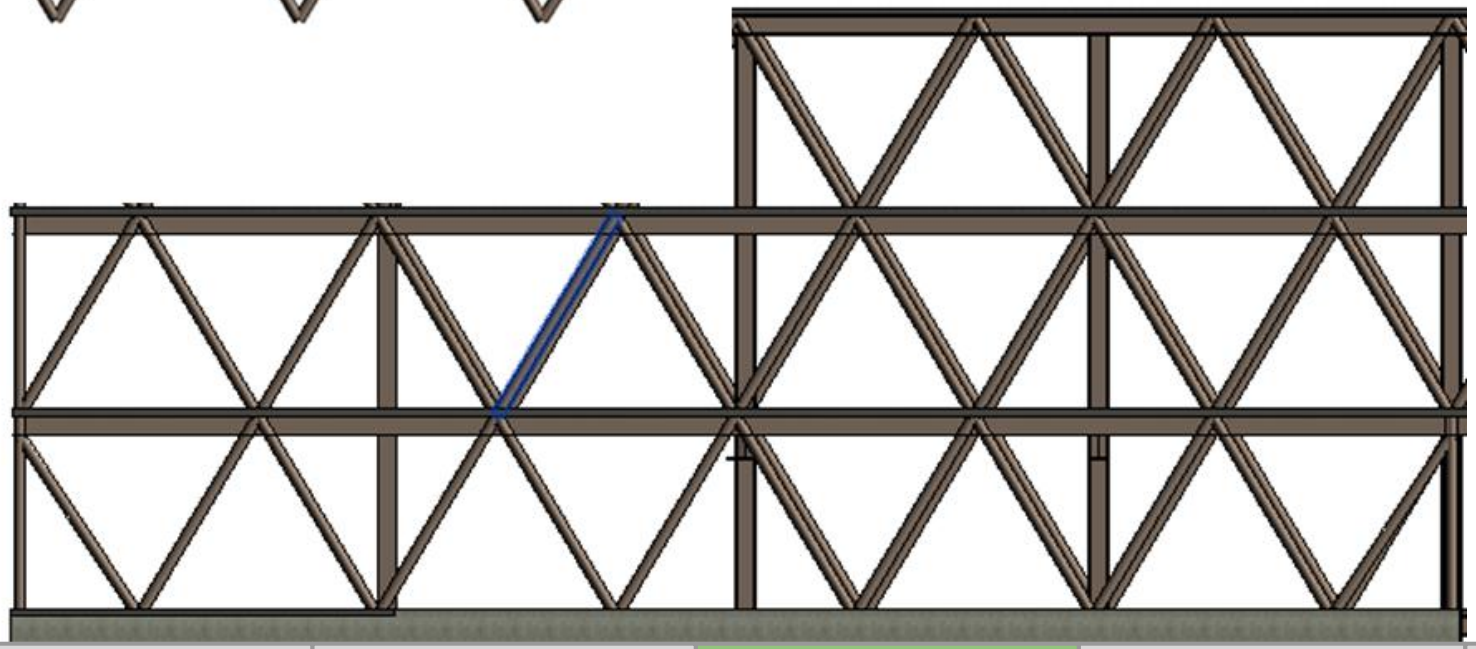
~2,800 lbs

Just within Truck Length/Width requirements

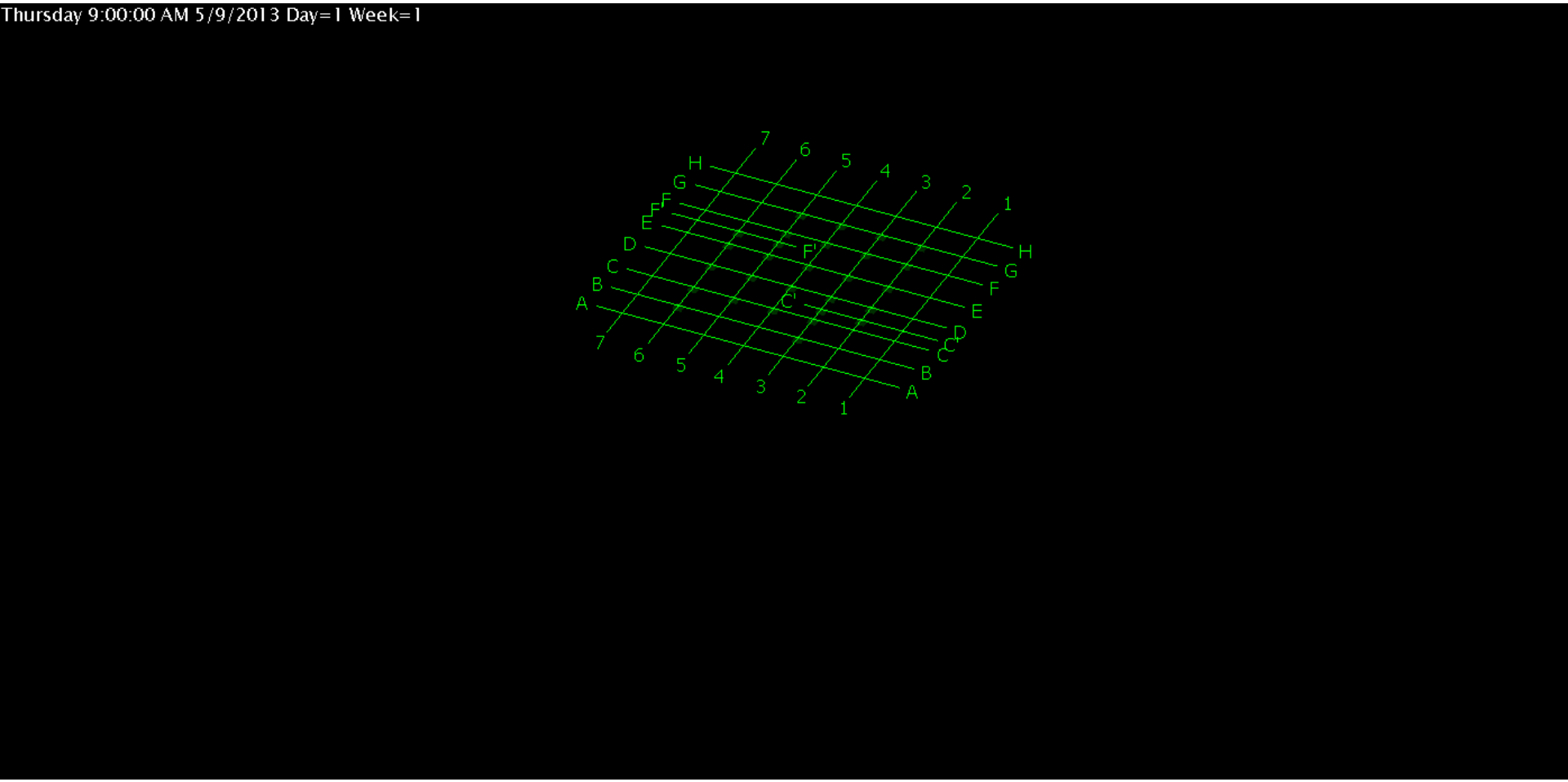
The Rise of the Diagrid



1. Bolt HSS to Girder
2. Bolt Girder to Girder
3. Remove Temporary Structure



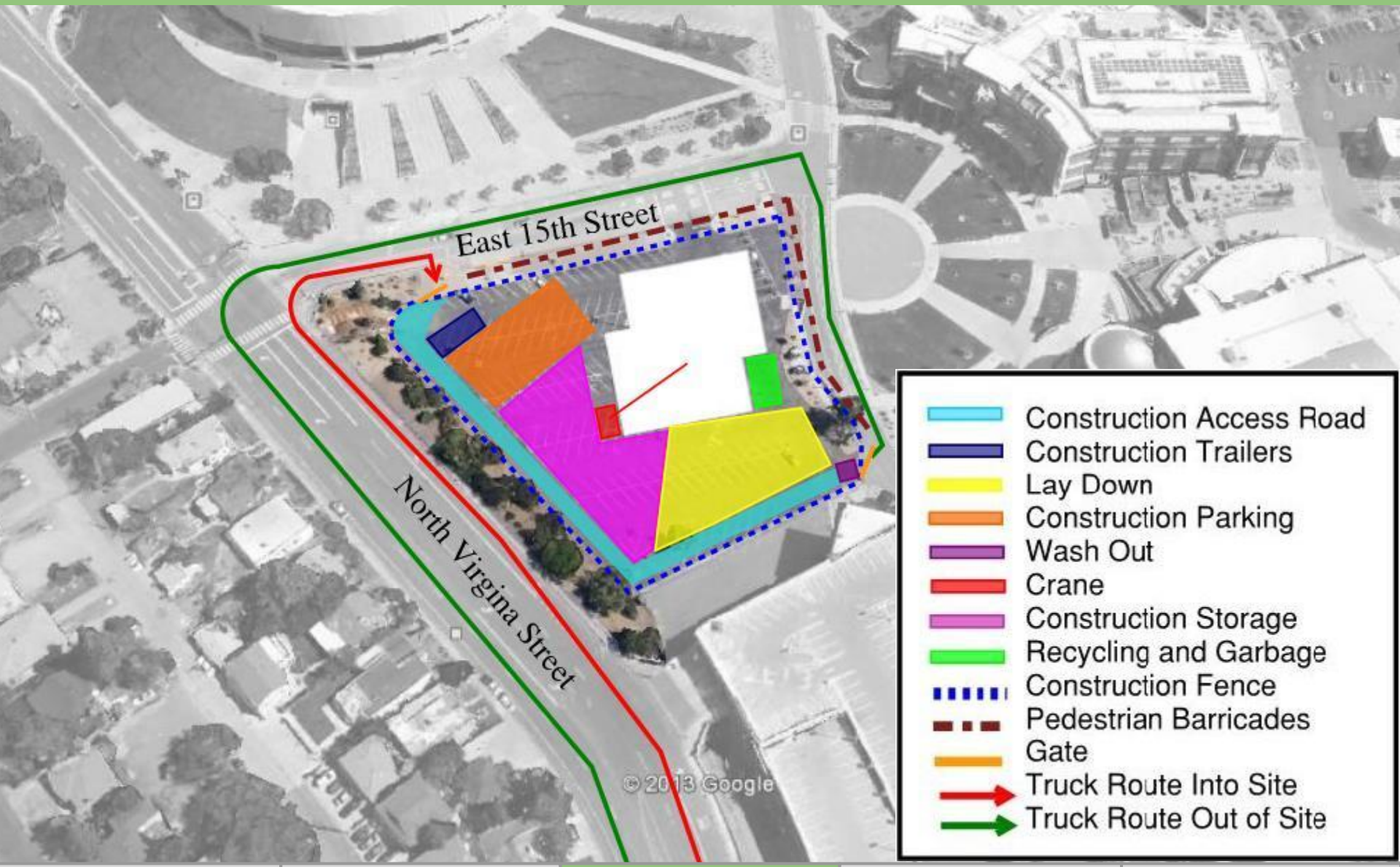
4D Sequence



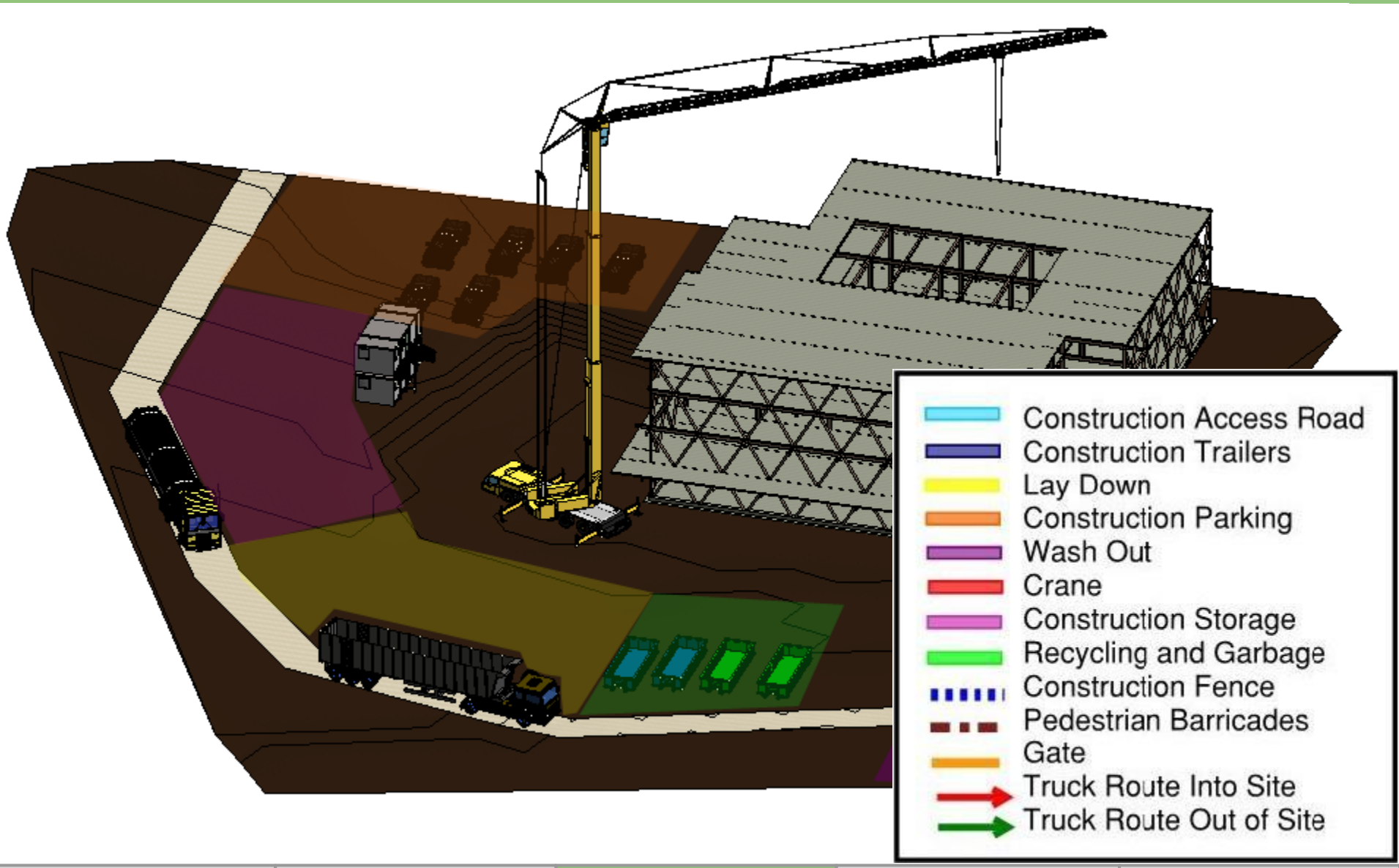
A	SE	CM	MEP	LCFM

Construction Site Access

Construction Site Logistics

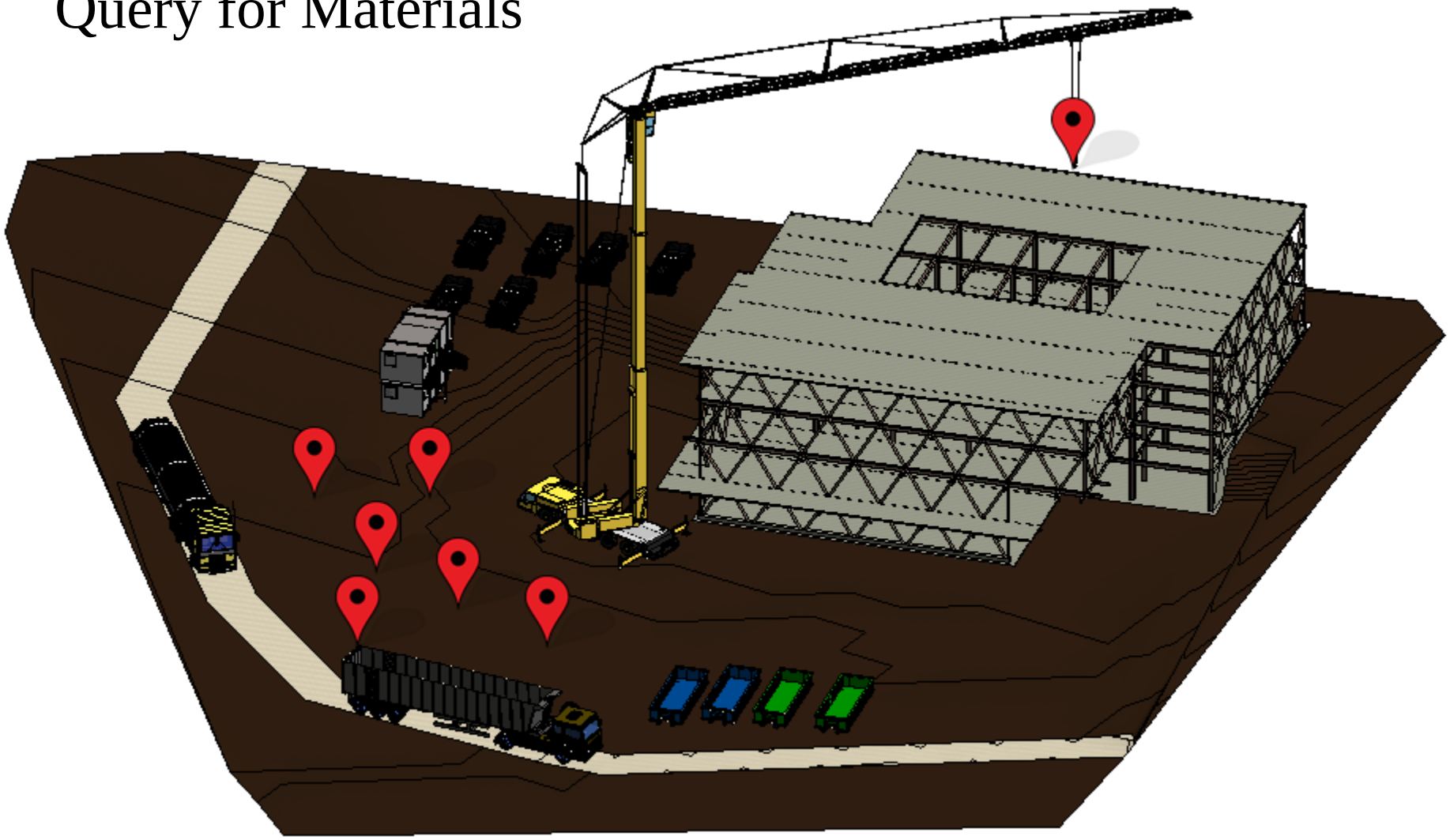


Construction Site Logistics

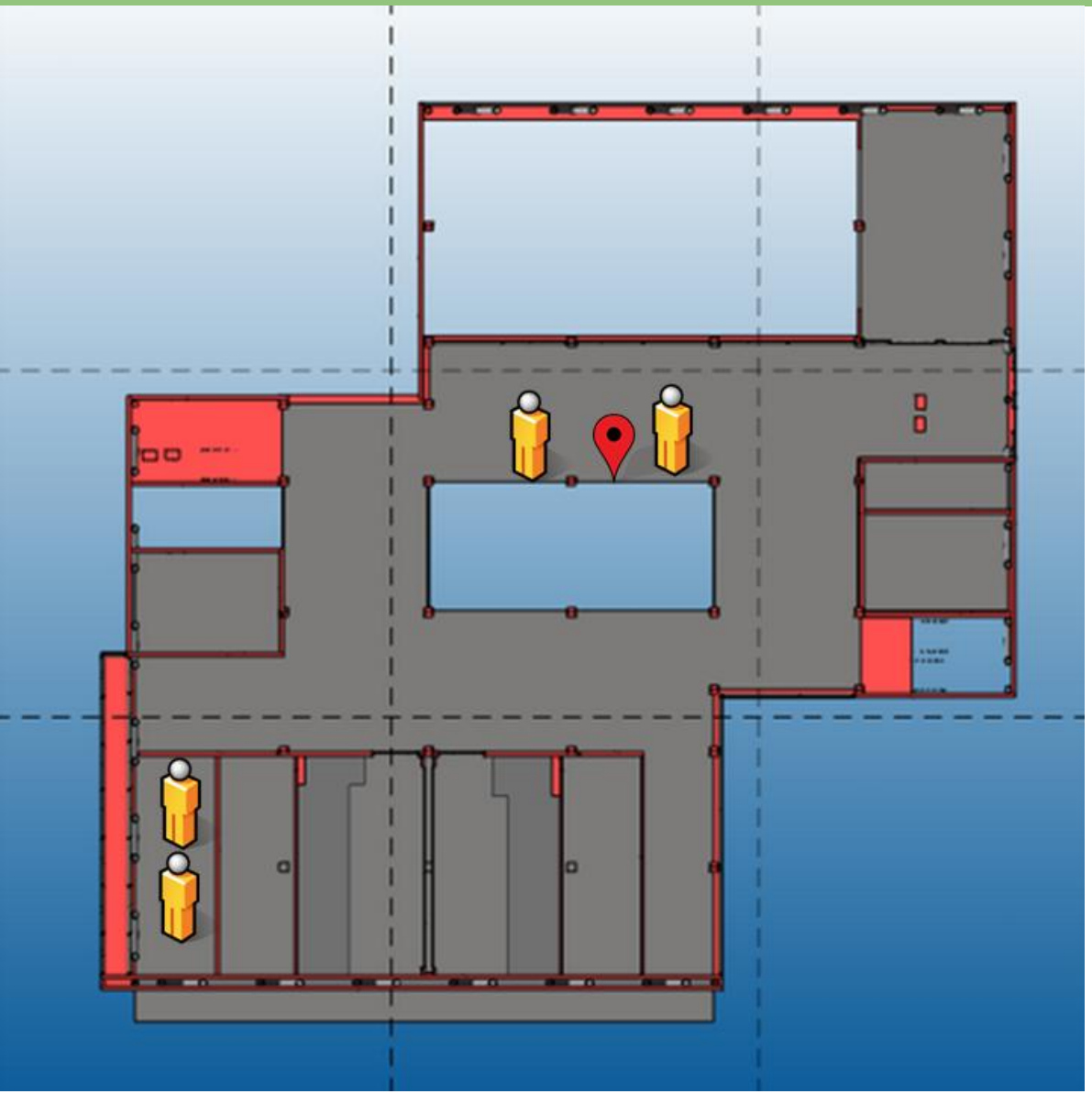


Construction Tracking

Query for Materials



Construction Tracking



Monitor activities and resources in real time

A	SE	CM	MEP	LCEM

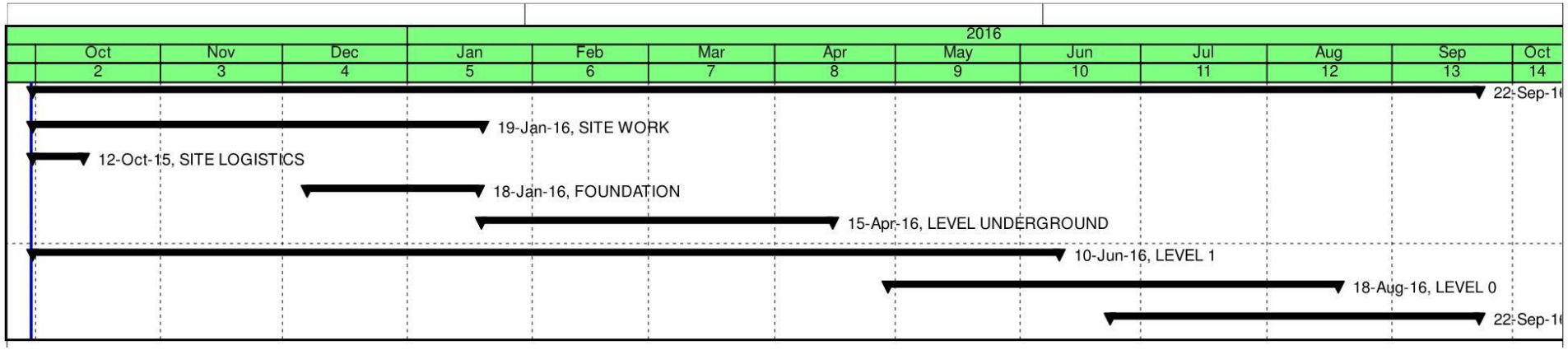
Construction Tracking

People: Helmet worn unit with GPS, WiFi and IMU

Material: Slim chip uses WiFi and GPS, integration with MEP and Structural sensors

Equipment (crane): Integration of built-in software with GPS

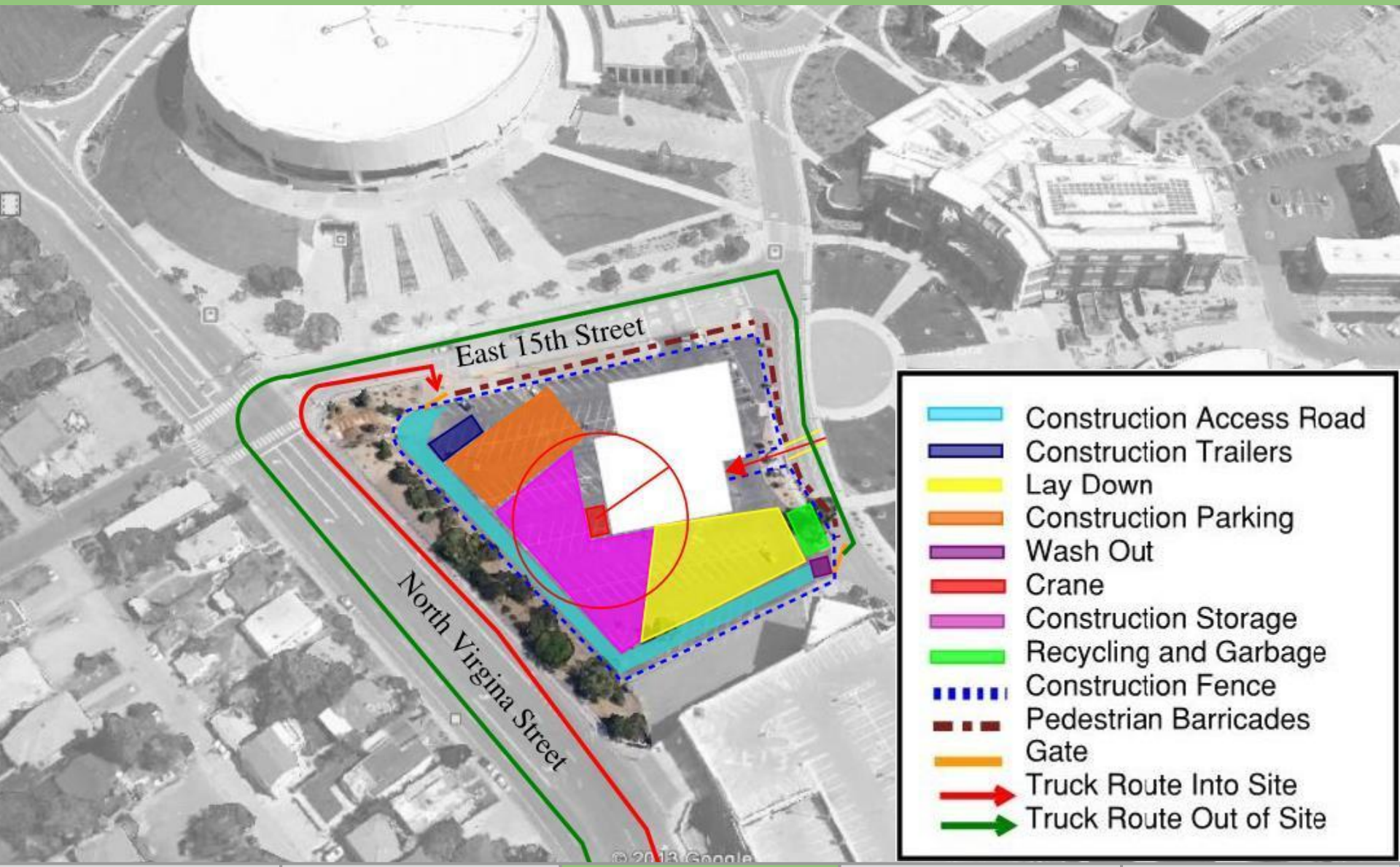
Construction Schedule



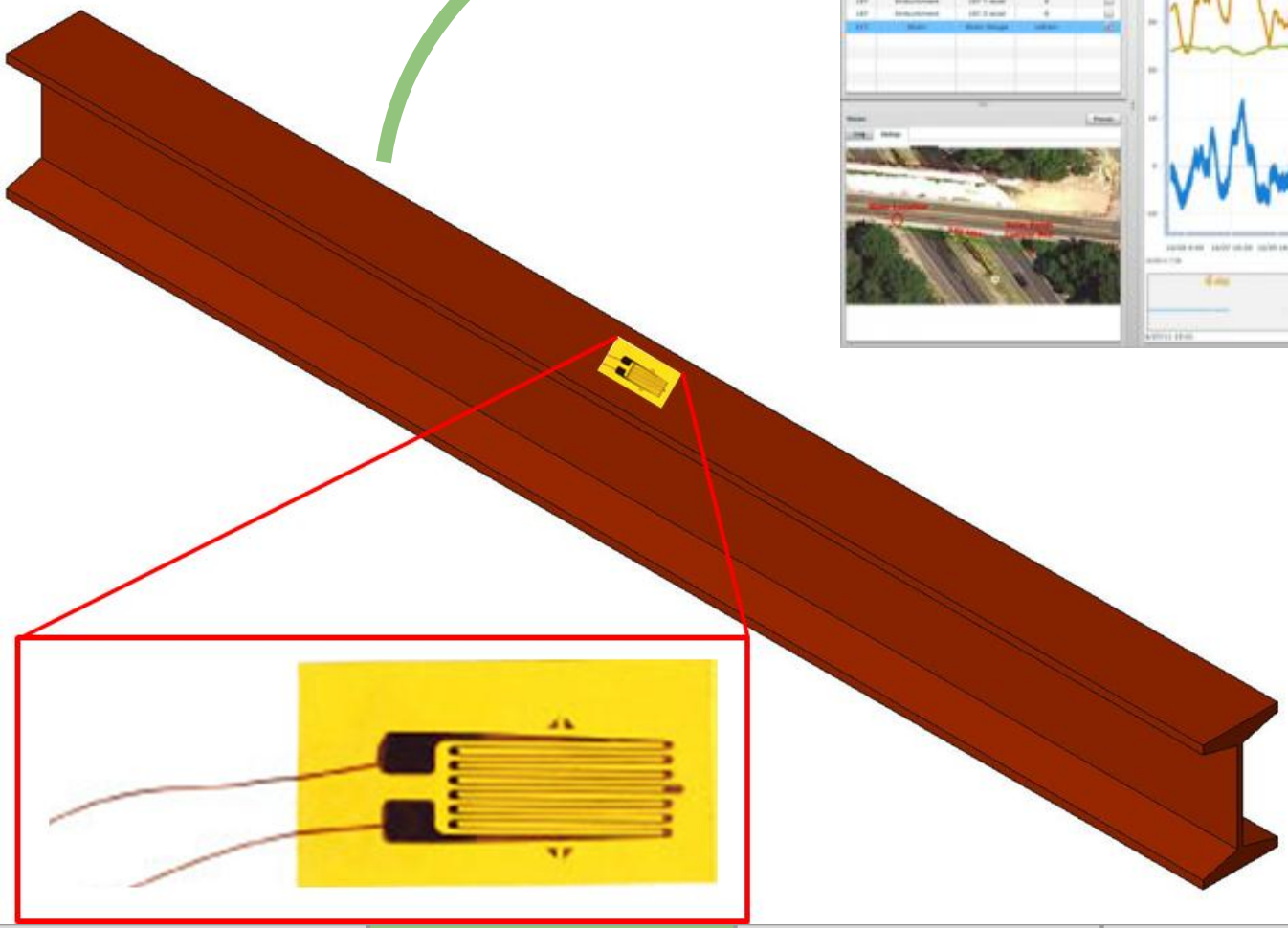
Milestones:

- Retaining wall
- Finishing the computer labs (April 15th 2016)
- Installation of the diagrid

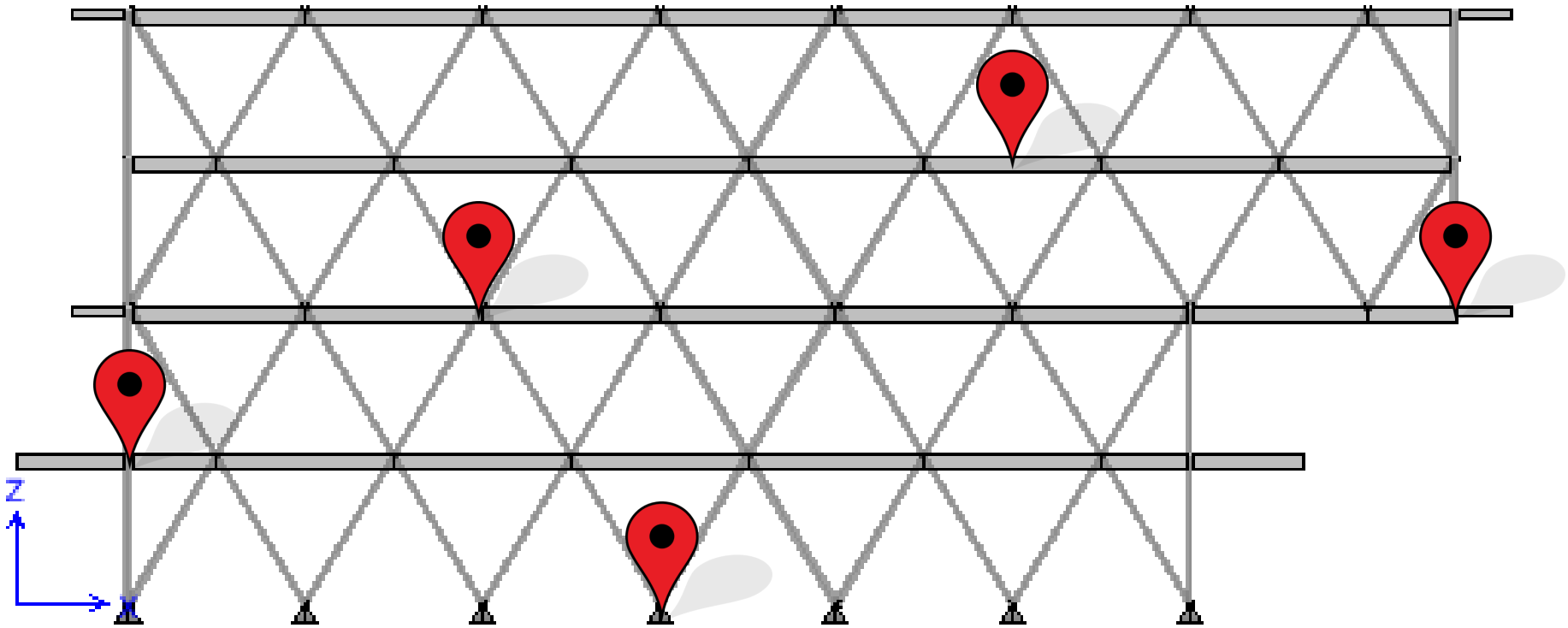
Access to Computer Labs



Structural Health



Structural Health



Approx. 500 strain gauges at critical locations on steel framing (i.e. diagrid connections, center of girders)

At $ 50/sensor, total cost = $ 25 000

Occupancy Sensors

Low | Medium | High

Low Level - Motion detectors used to control lighting

Medium Level - Count the number of occupants in a zone to refine estimates for HVAC and lighting needs. Potential to identify presence in case of emergency

High Level - Activity monitoring or ability to identify specific persons for best estimate of HVAC needs and security

Owners request sensors capable of a rough estimate of the number of people in a room (+/- 5)

HVAC & Light Sensors

Room controllers with batteryless sensors

Energy harvesting from surroundings

HVAC & Light Sensors

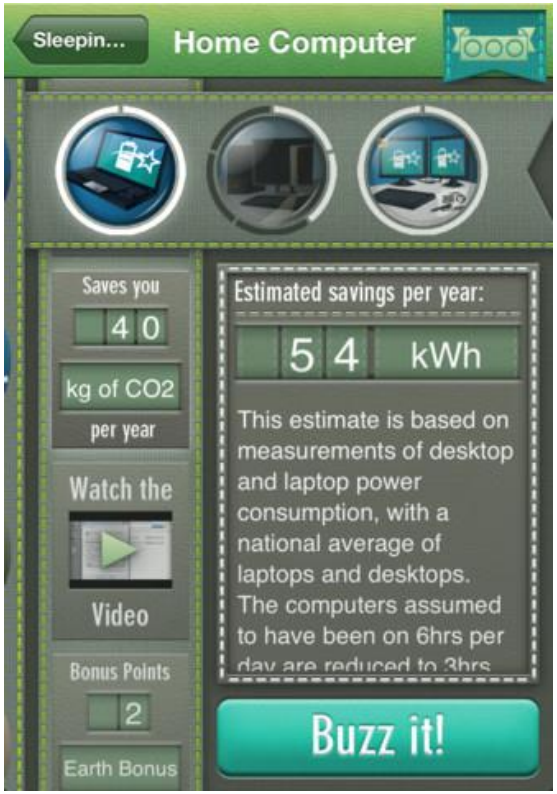
investment costs ~ $ 34 000

annual savings $ 16 000

overall productivity increase up to ~ 30 %

Sustainability App

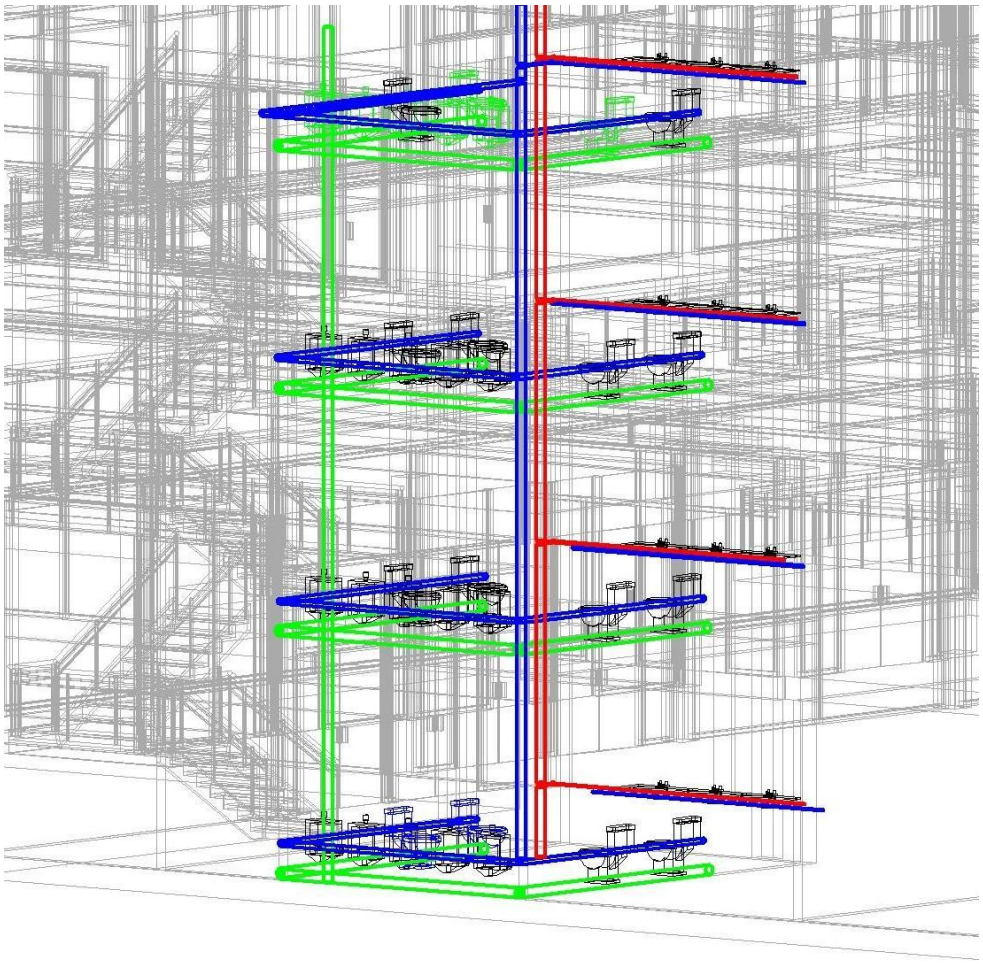
- Encourage occupants to act more sustainably
- Provide sensor data in an easy-to-understand format



Water Management

Water savings

- Dual mode toilets
  - 72 % in partial mode
  - 59 % in full mode
- Waterless urinals
  - 375 gal./per day
- Sensor bathroom faucets
  - 60 % to conventional



Plug Load & Solar Pads

7020 kWh/year through mobile devices & laptops lead to about $ 3750 a year for electricity

80 solar pads with the total cost of $ 9920 preserve those expenses

Delivered Energy Overview

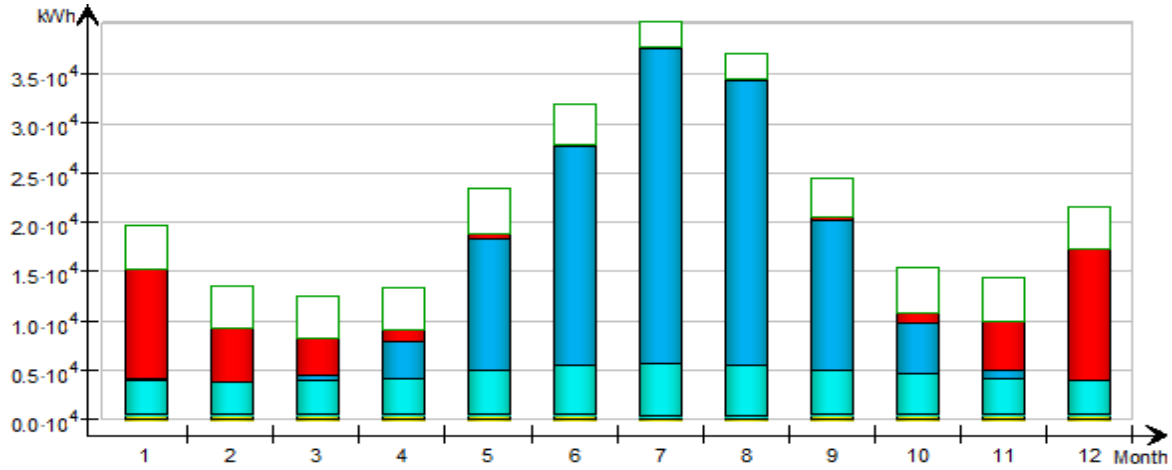
	Delivered energy	
	kWh	kWh/m²
Lighting, facility	5749	1.7
HVAC aux	50576	15.1
Total, Facility electric	56325	16.8
District cooling	121537	36.3
District heating	41679	12.4
Total, Facility district	163216	48.7
Total	219541	65.5
Equipment, tenant	48366	14.4
Total, Tenant electric	48366	14.4
Grand total	267907	80.0

Natural Gas 163216 kWh

Electricity 104691 kWh

PV production 101801 kWh

49.6 kWh/m²



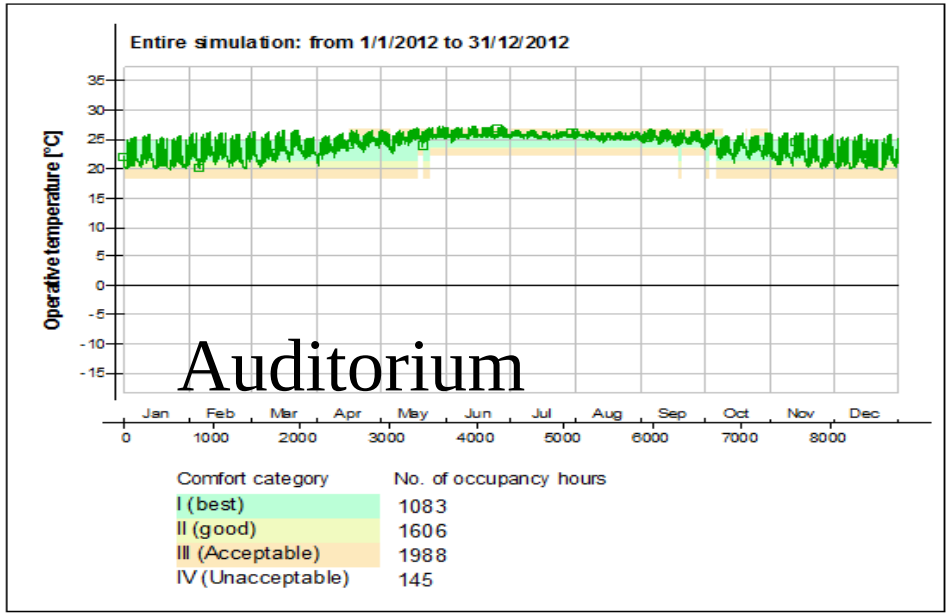
Building Indoor Comfort

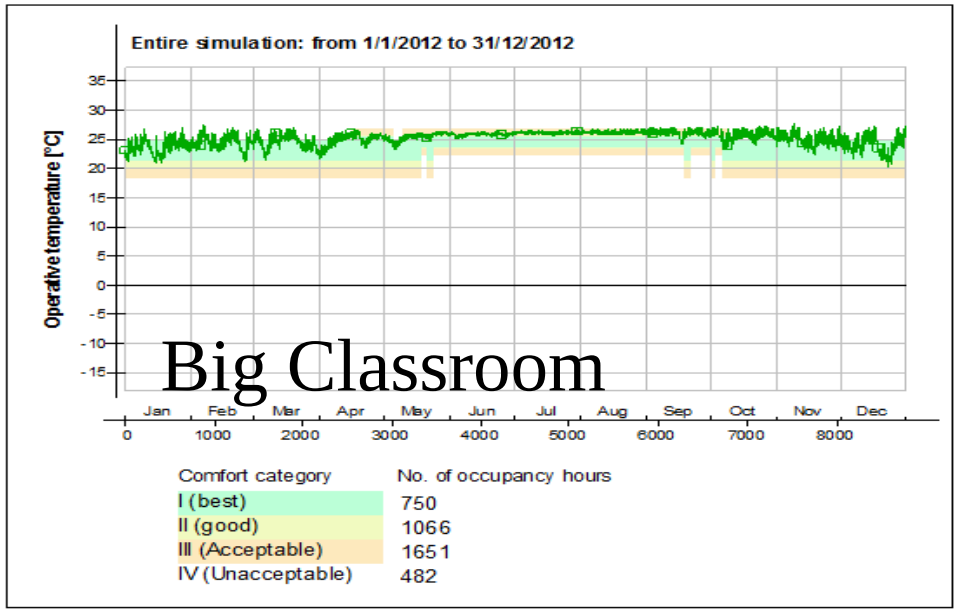
% of hours when operative temperature is above 27 ^{0}C

7 %

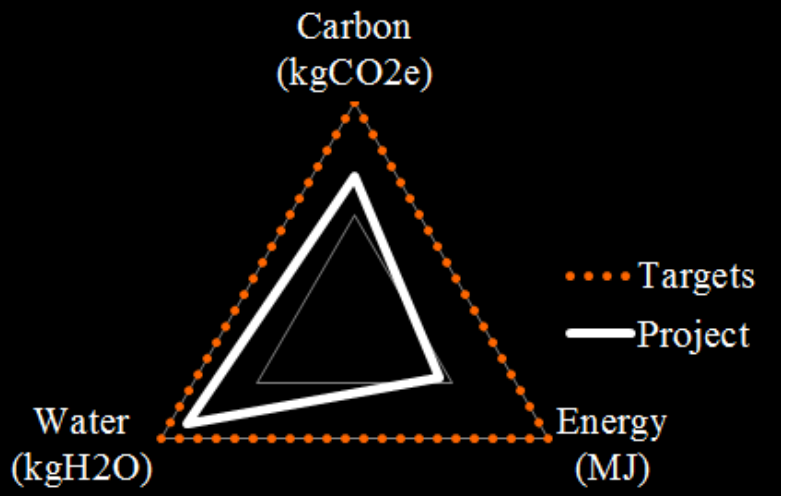
% of total occupants hours with thermal dissatisfaction

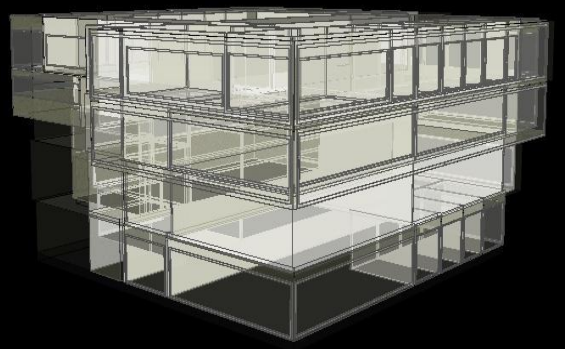
10 %

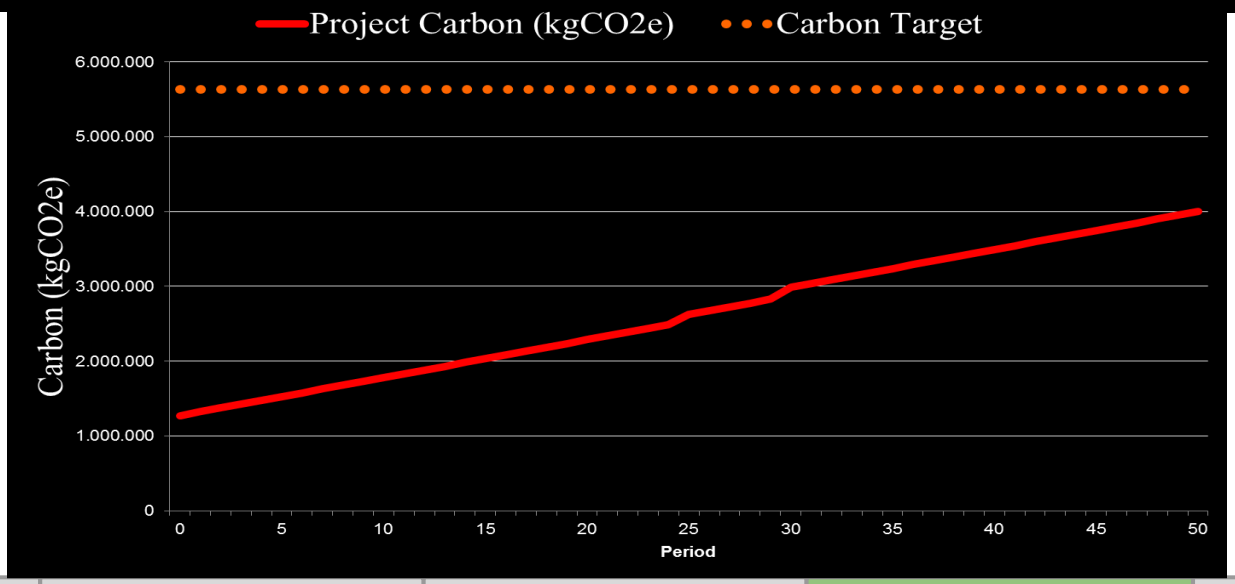




Sustainable Target Value







LEED Scorecard

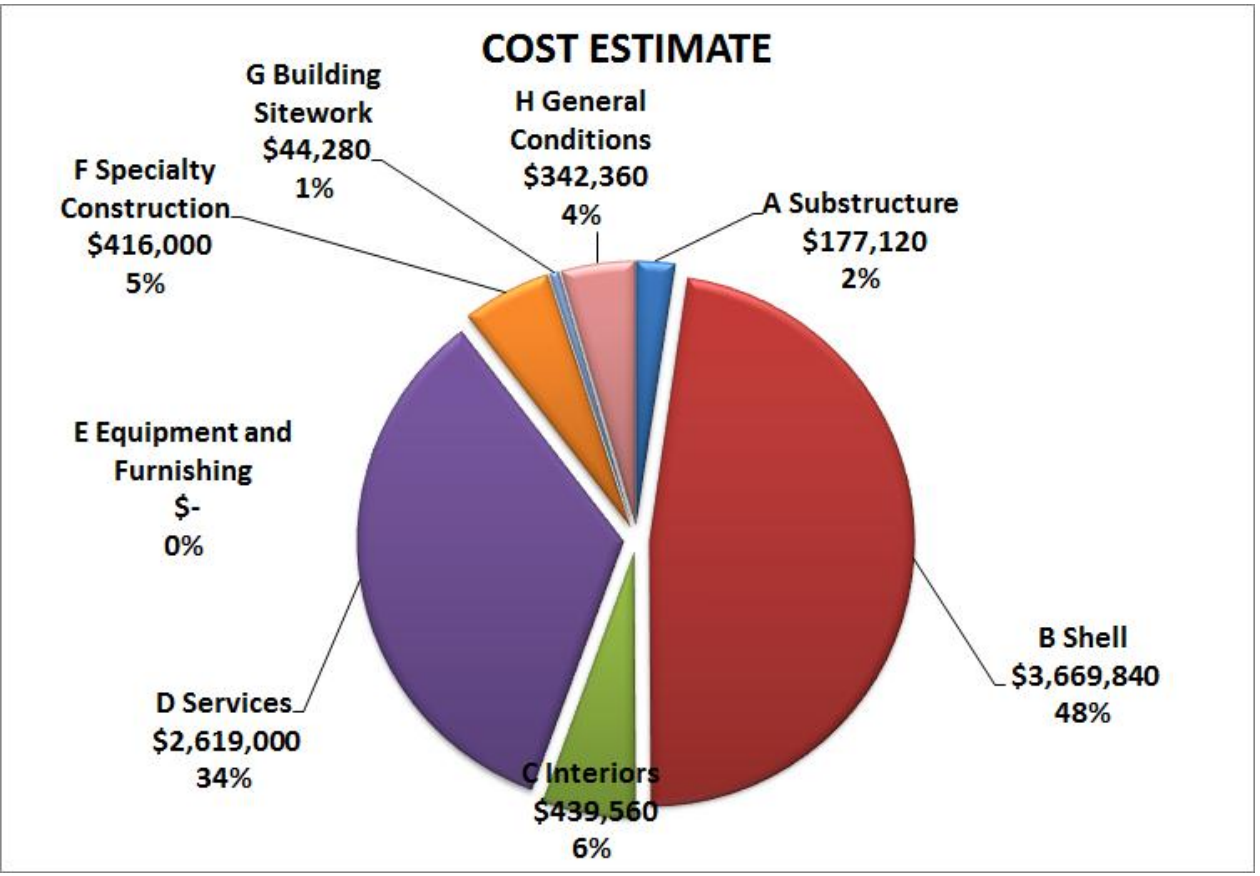
- LEED for New Construction
- LEED Gold

Sustainable Sites	17 to 21
Water Efficiency	10
Energy & Atmosphere	27
Materials & Resources	5
Indoor Environmental Quality	13 to 15
Total	72 to 78

Construction Cost Estimate

Final Cost: $8,391,000

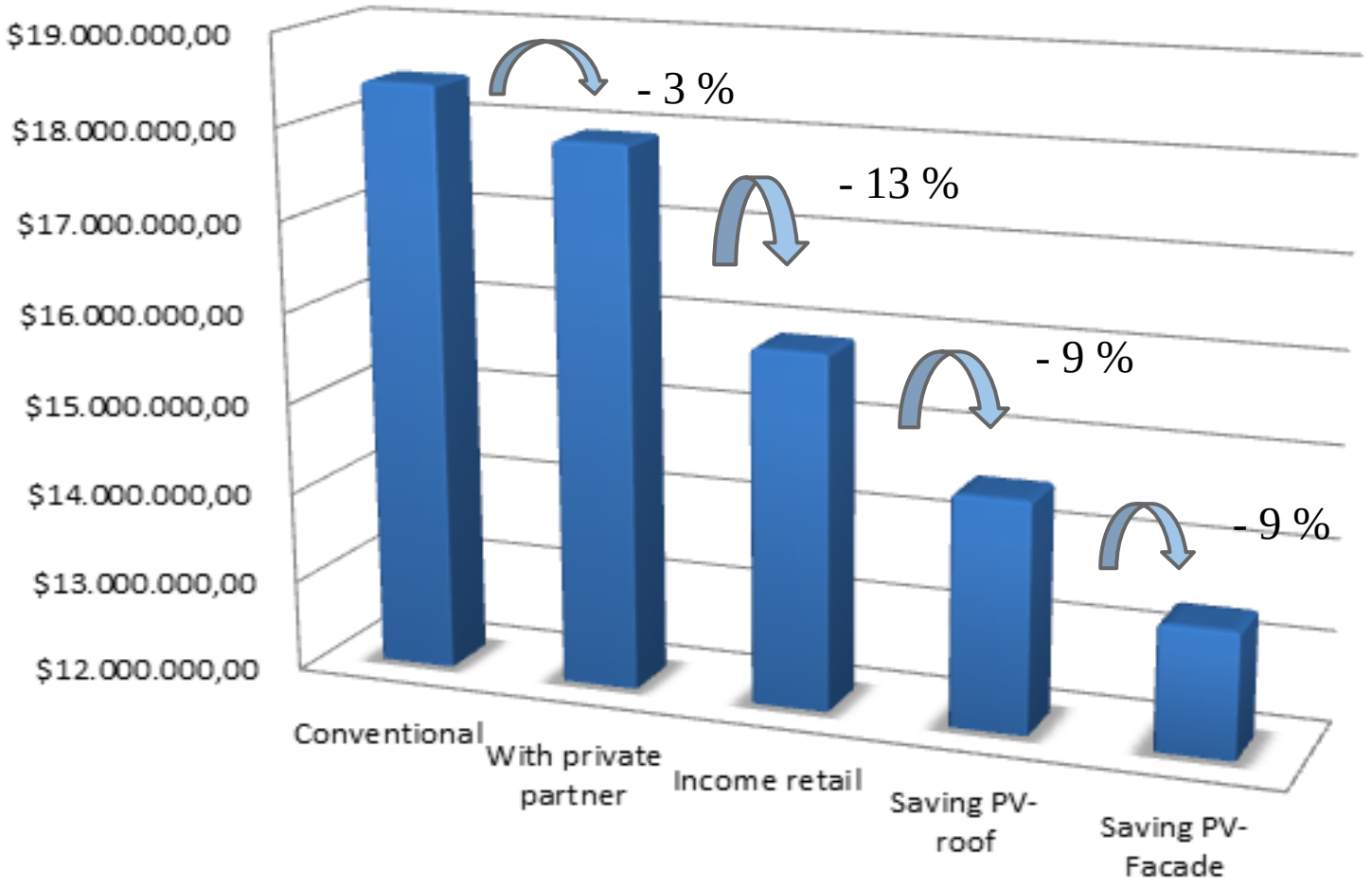
Target Budget: $8,382,000



Glazing is ~24% of total cost!

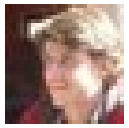
Life Cycle Process Savings

Summed up for whole life cycle savings of 34 %



Team Process & Interactions

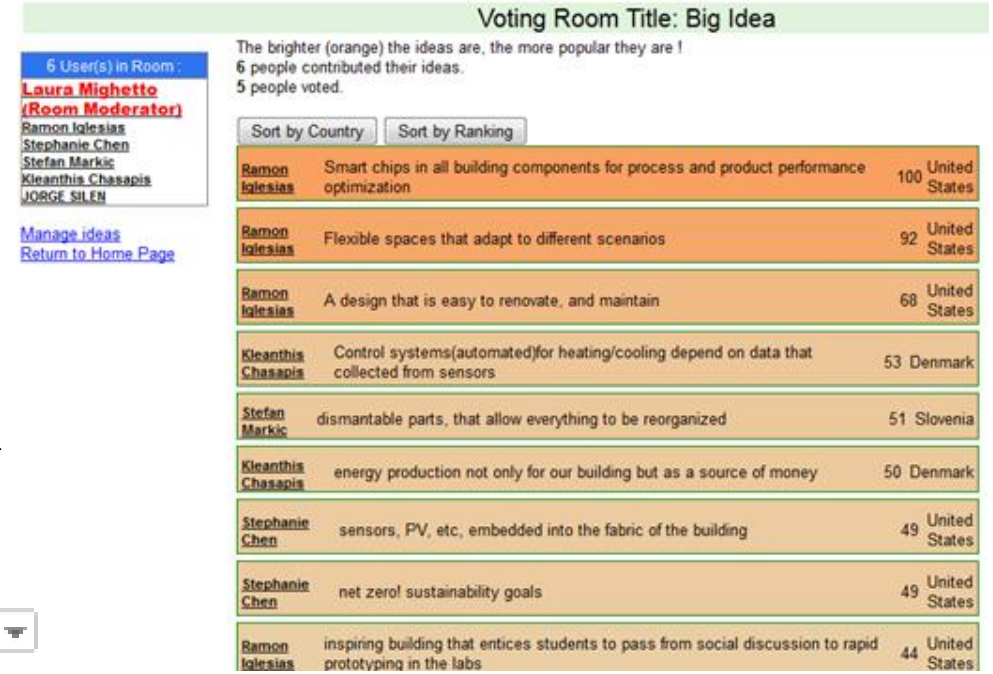
- emails not needed
  - except for with owners/mentors
- team & subgroup meetings
- discussion and links
- file sharing
- modeling and analysis
- graphic communication



Ramon Iglesias

to Stephanie, Stefan, Laura

Damn, an email!



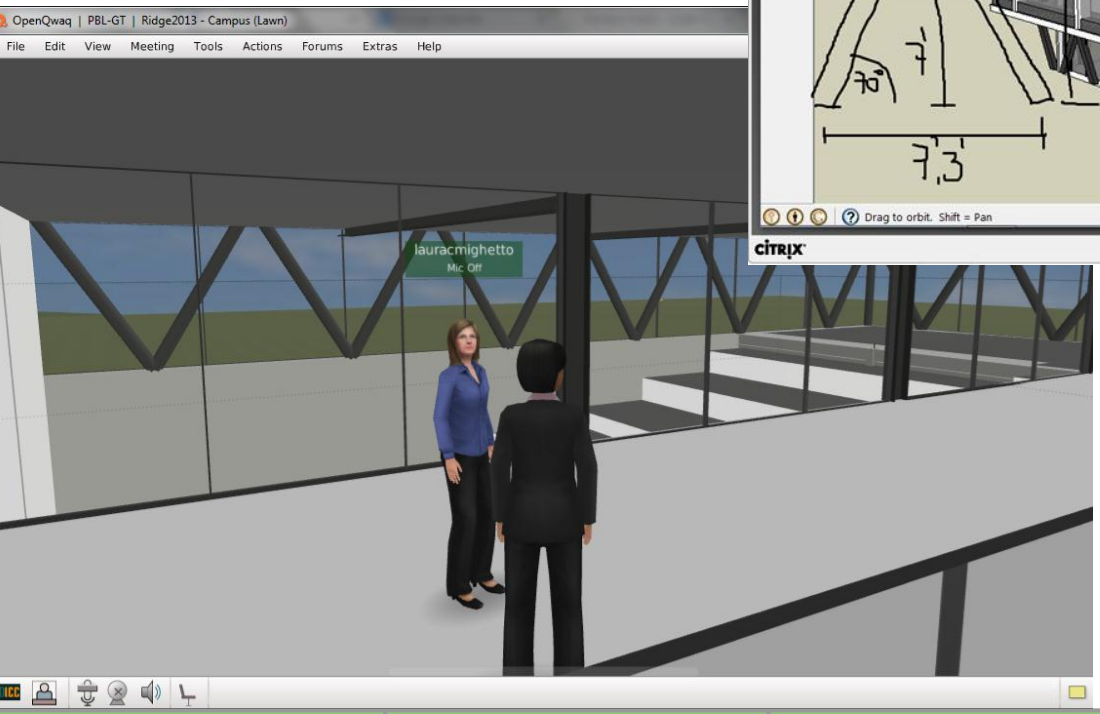
Modes of Communication

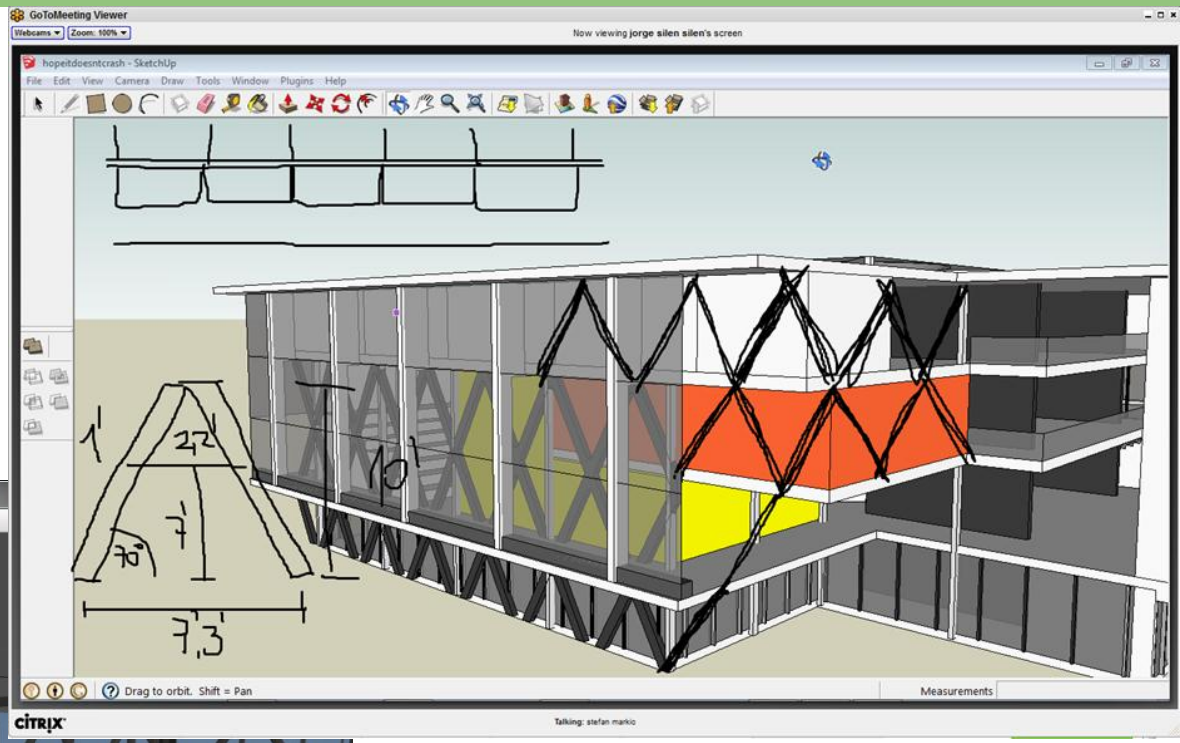
	Primary	Secondary
Text, images, videos, links to other websites, etc.	facebook	Gmail by Google
Instant messaging	facebook	talk skype
Voice	GoToMeeting	skype 3DICC IMMERSIVE COLLABORATION CONSULTING
File Sharing	Google Drive	Dropbox box

Team & Subgroup Meetings

3D I.C.C.
IMMERSIVE COLLABORATION CONSULTING

for walkthroughs





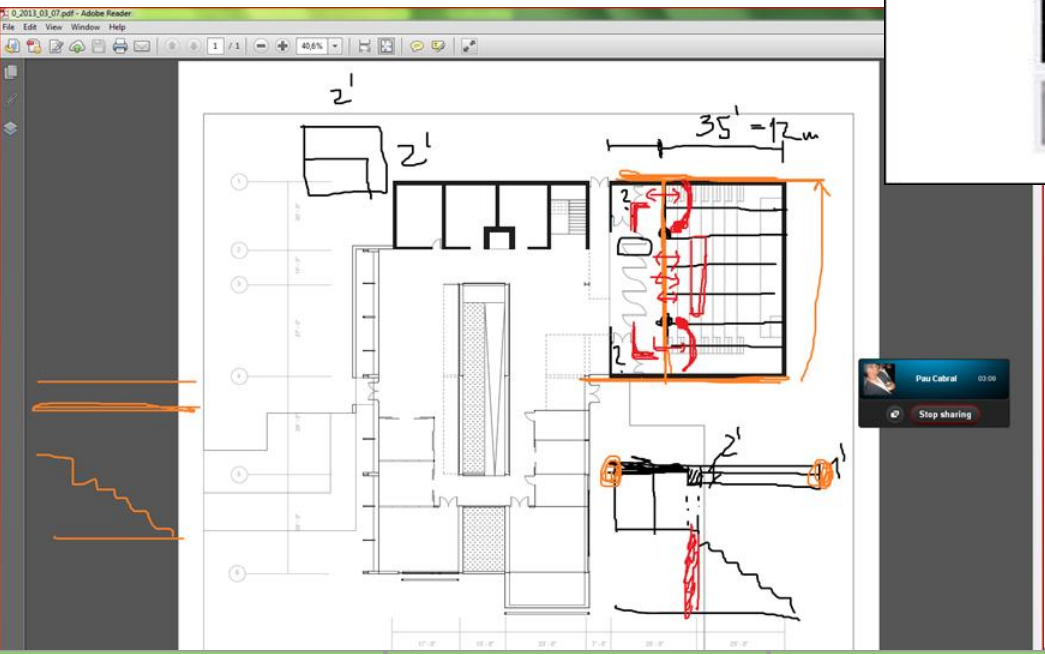
Screen sharing & sketching in

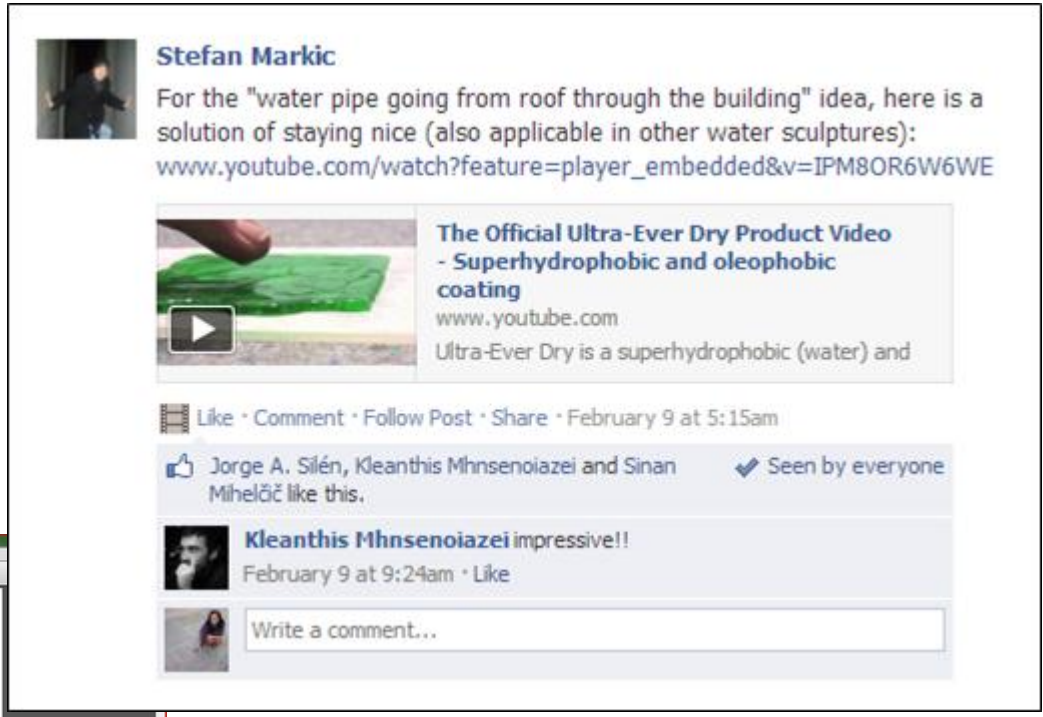
GoToMeeting by CITRIX

A	SE	CM	MEP	LCFM

Discussion and Links

for 2 person meetings



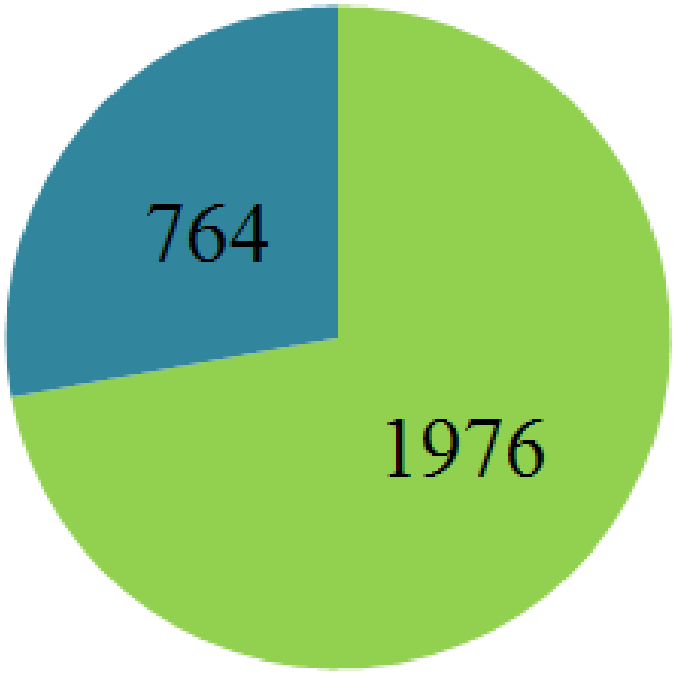


Idea sharing and discussions in

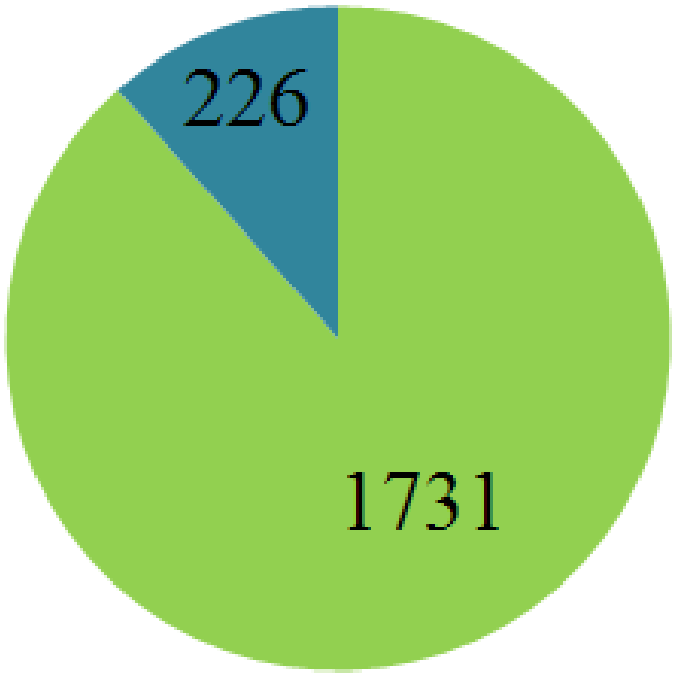
facebook

File Sharing

Usage in Megabytes



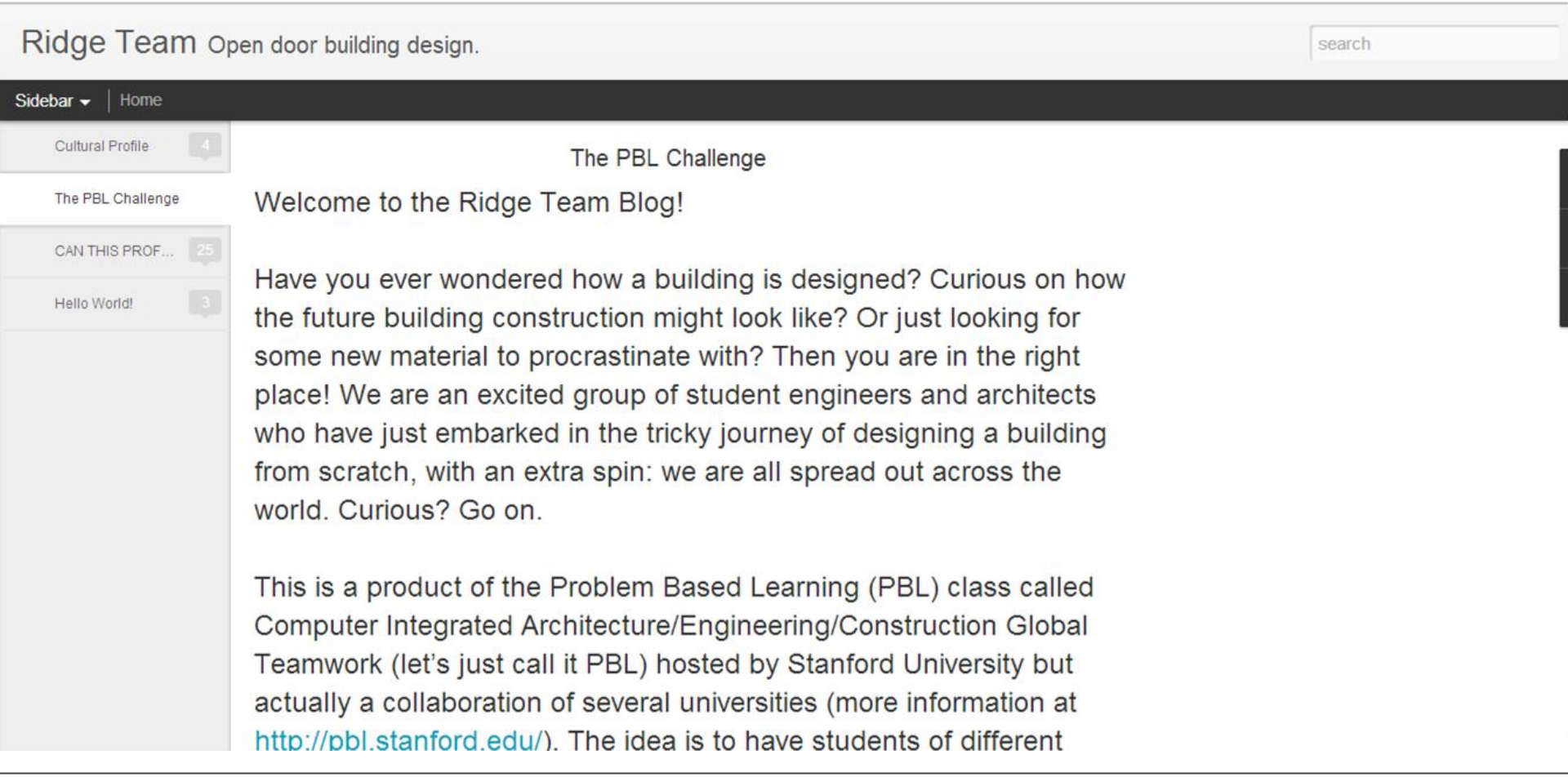
Usage by Number of Files



Google Drive

Dropbox

Discussion Forum/Feedback



www.ridgeteam.com

A	SE	CM	MEP	LCFM

Modeling and Analysis

Architecture

SketchUp

Structure

bluebeam

VICO SOFTWARE
Integrating Construction

PVSYST

EQUA. IDA ICE

Daylight Visualizer | VELUX

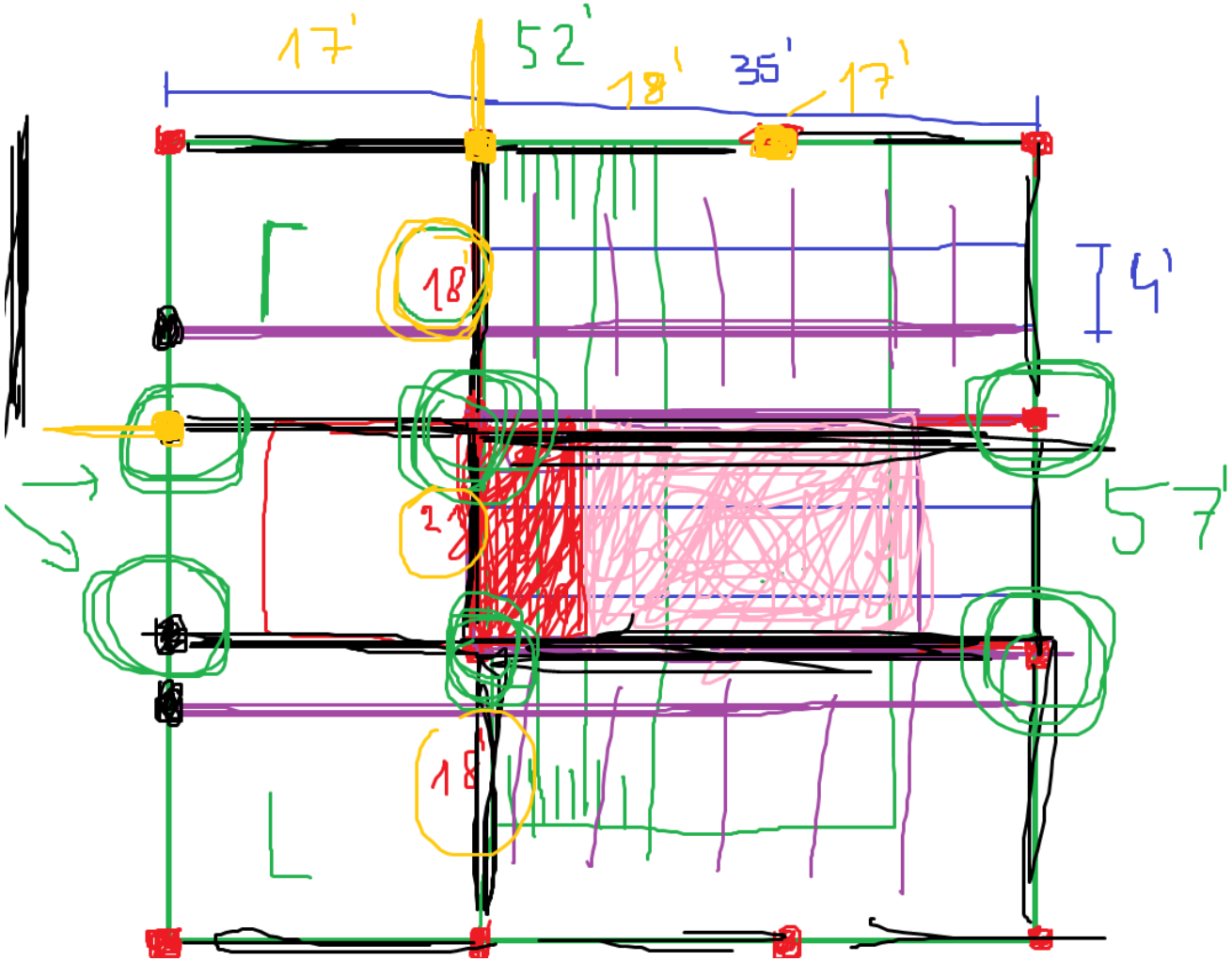
Construction

MEP

A	SE	CM	MEP	LCFM

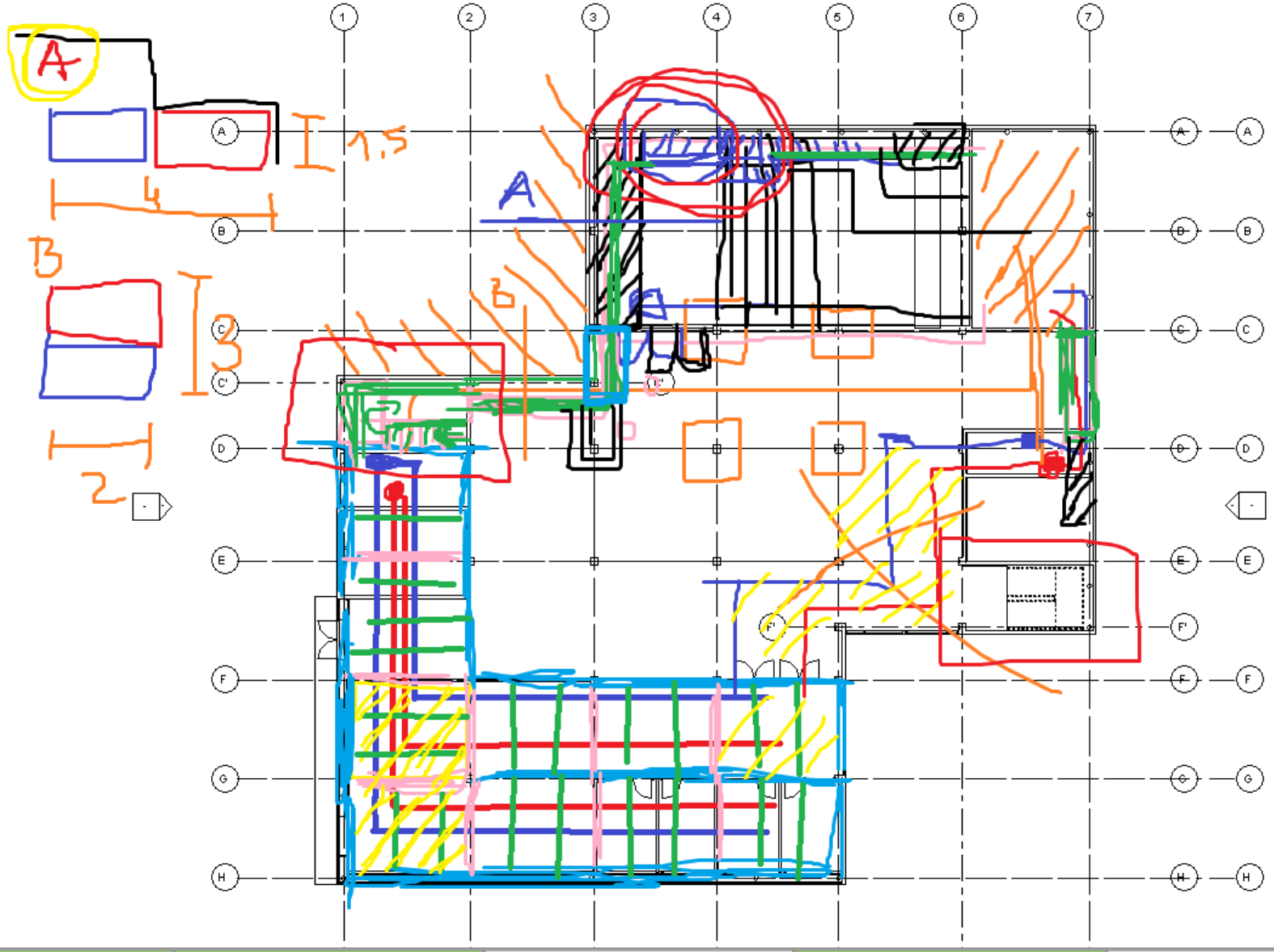
Graphic Communication

MS Paint

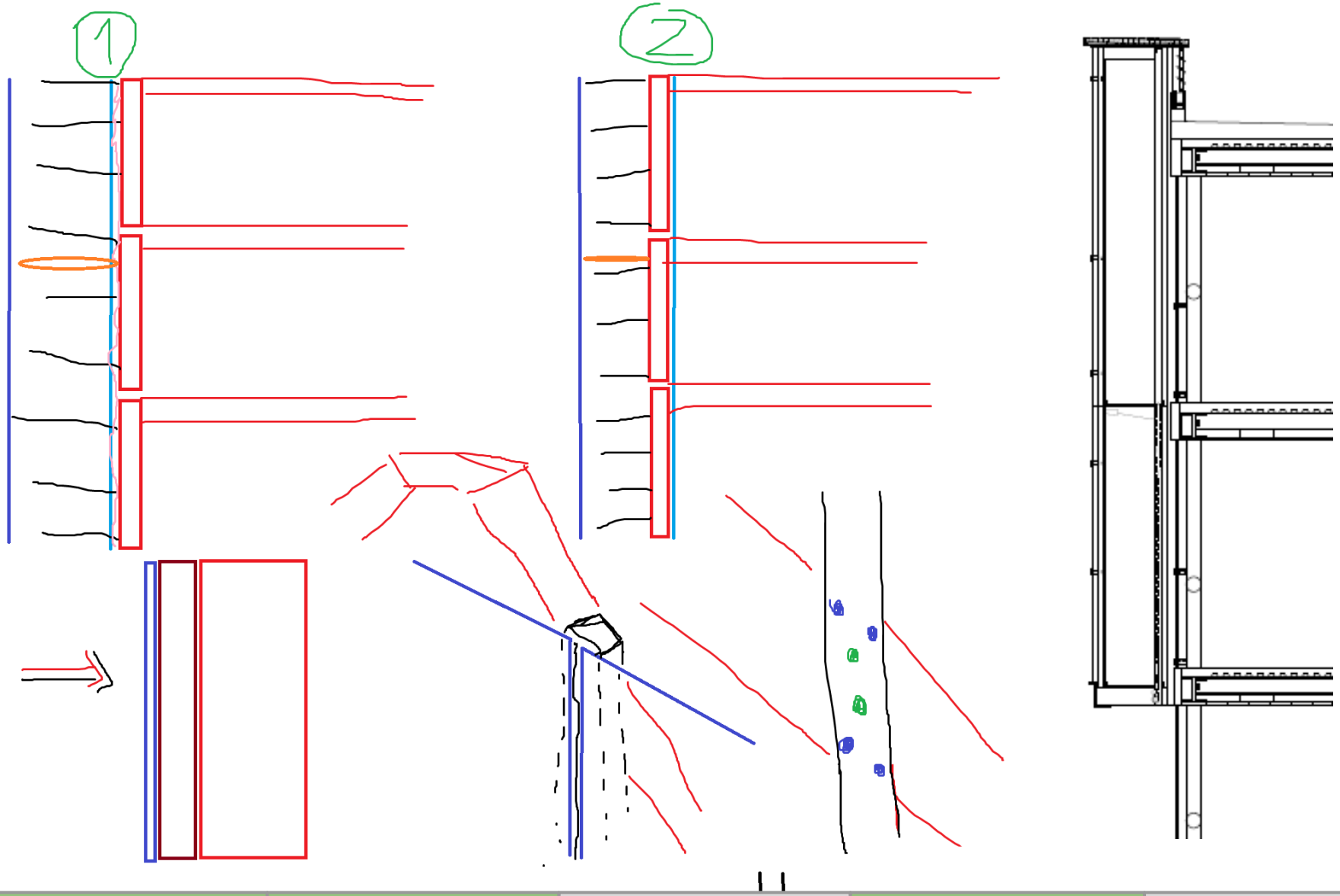


A	SE	CM	MEP	LCFM

Duct Network - Basement



Double Skin Facade



Lessons Learned

Laura M: Flexibility is key.

Stephanie C: Sometimes it is better NOT to be colocated (... that way one infection can't decimate an entire team).

Kleanthis C: When nine individualists set a common goal, that is the key for a successful team.

Lessons Learned

Stefan M: Time zones are logical. But imperial ...

Ramon I: In low context, high latency communication, clarity and specificity are essential.

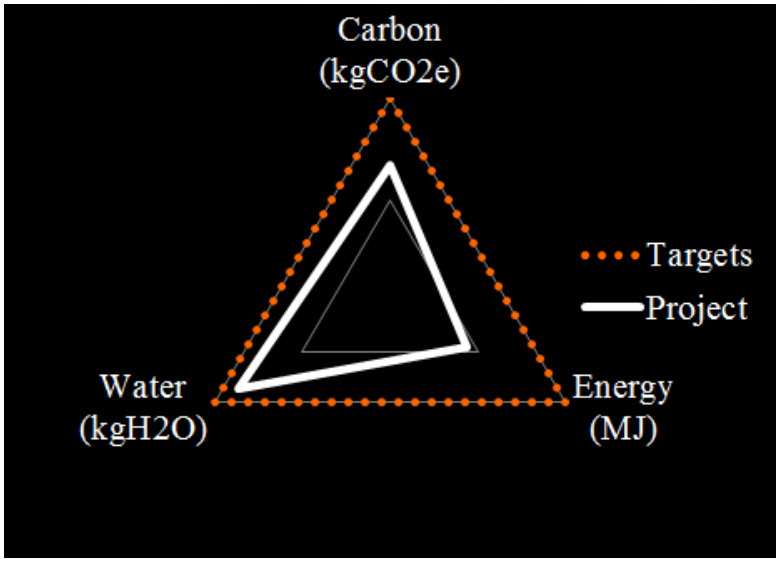
Pablo C: Love your engineer as much as you love yourself.

Jorge A: See things from a new perspective.

Summary

- innovative technology
- user friendly facility
- "smart" building

- LEED Gold
- constructed on schedule
- final cost = $8 391 000



Thanks!

Special thanks to Renate, Maria, Sinan, Anirudh and the mentors we've worked with:

Humberto Cavallin, Greg Luth, Justin Bocian, Prof. Jon Wren, Prof. Eduardo Miranda, Prof. Hamid Aghajan and AIR Lab, John Nelson, Sarah Russell-Smith, Luis Rivera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