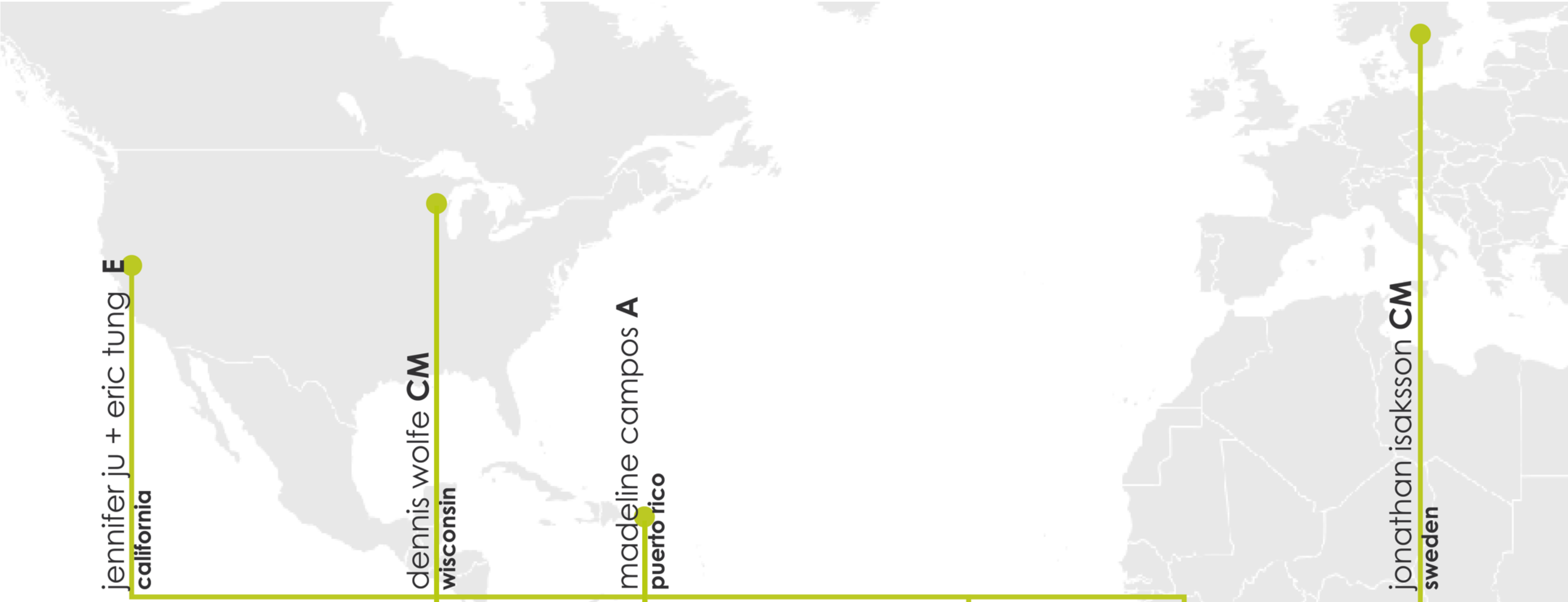
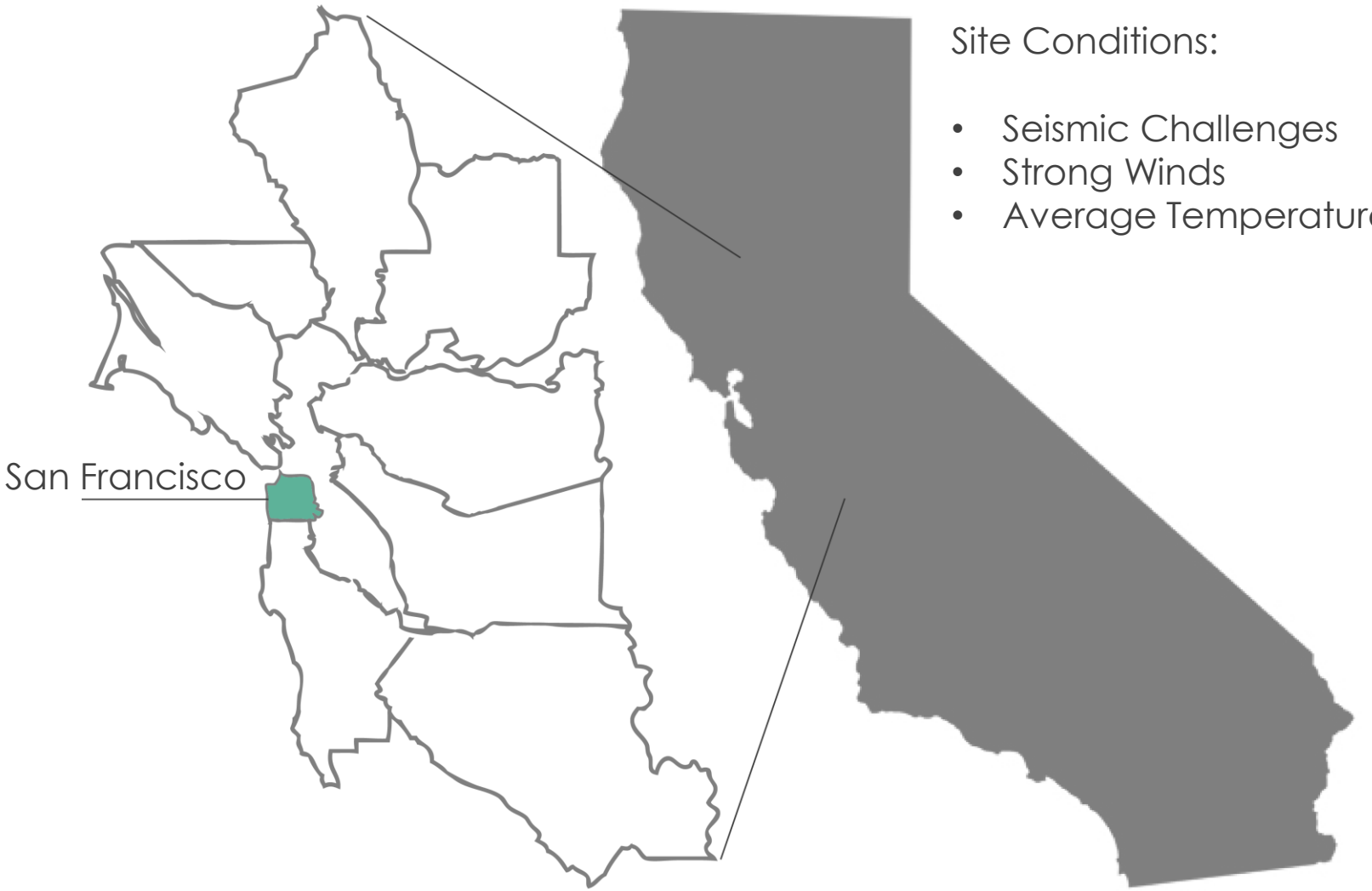


Pacific Team **2012**

A Site Analysis

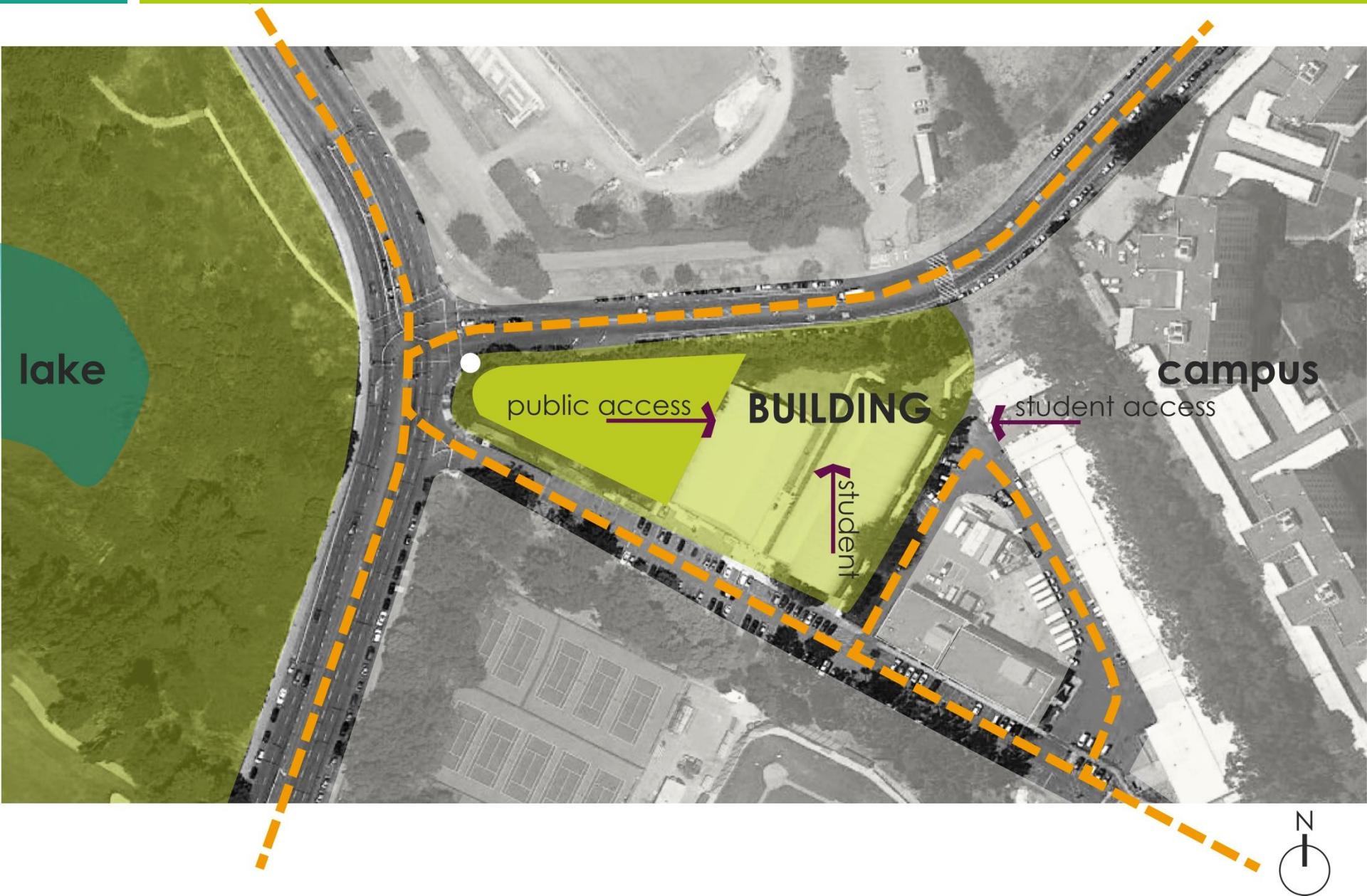


Site Conditions:

- Seismic Challenges
- Strong Winds
- Average Temperature 69’

N

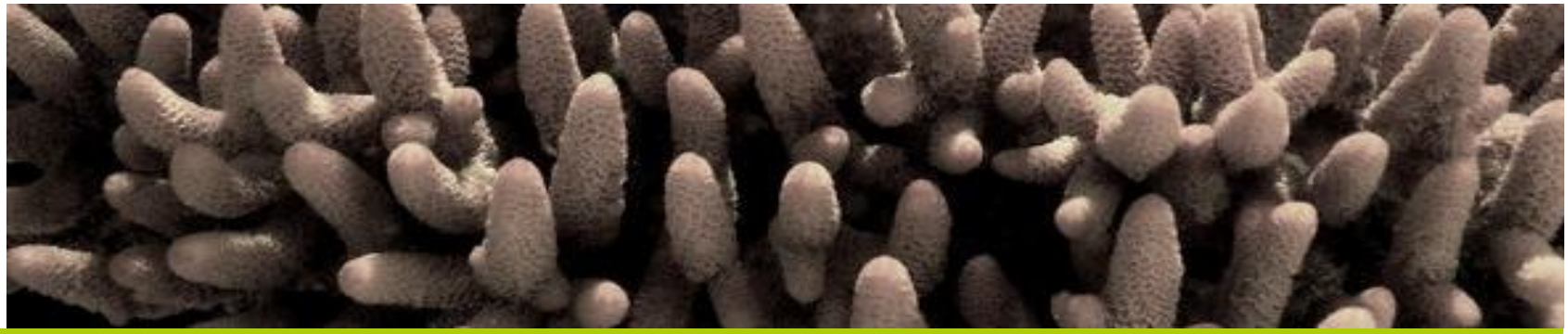
A Site Analysis



A

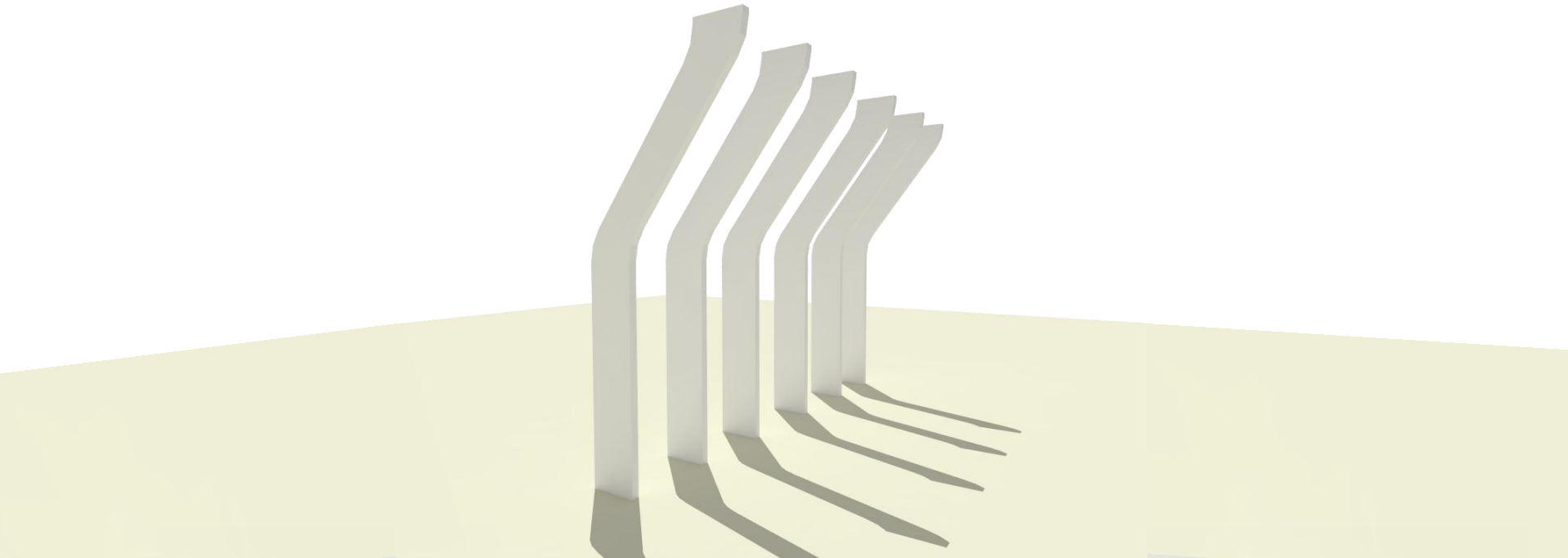
Engineering School of San Francisco Requirements

- 2015 Innovative Design
- Gold LEED Certification
- Introduce Cloud Computing
  [eliminates server rooms]
- Target Value Design:
  Biomimicry, Sustainability, Efficiency and Life Cycle Cost

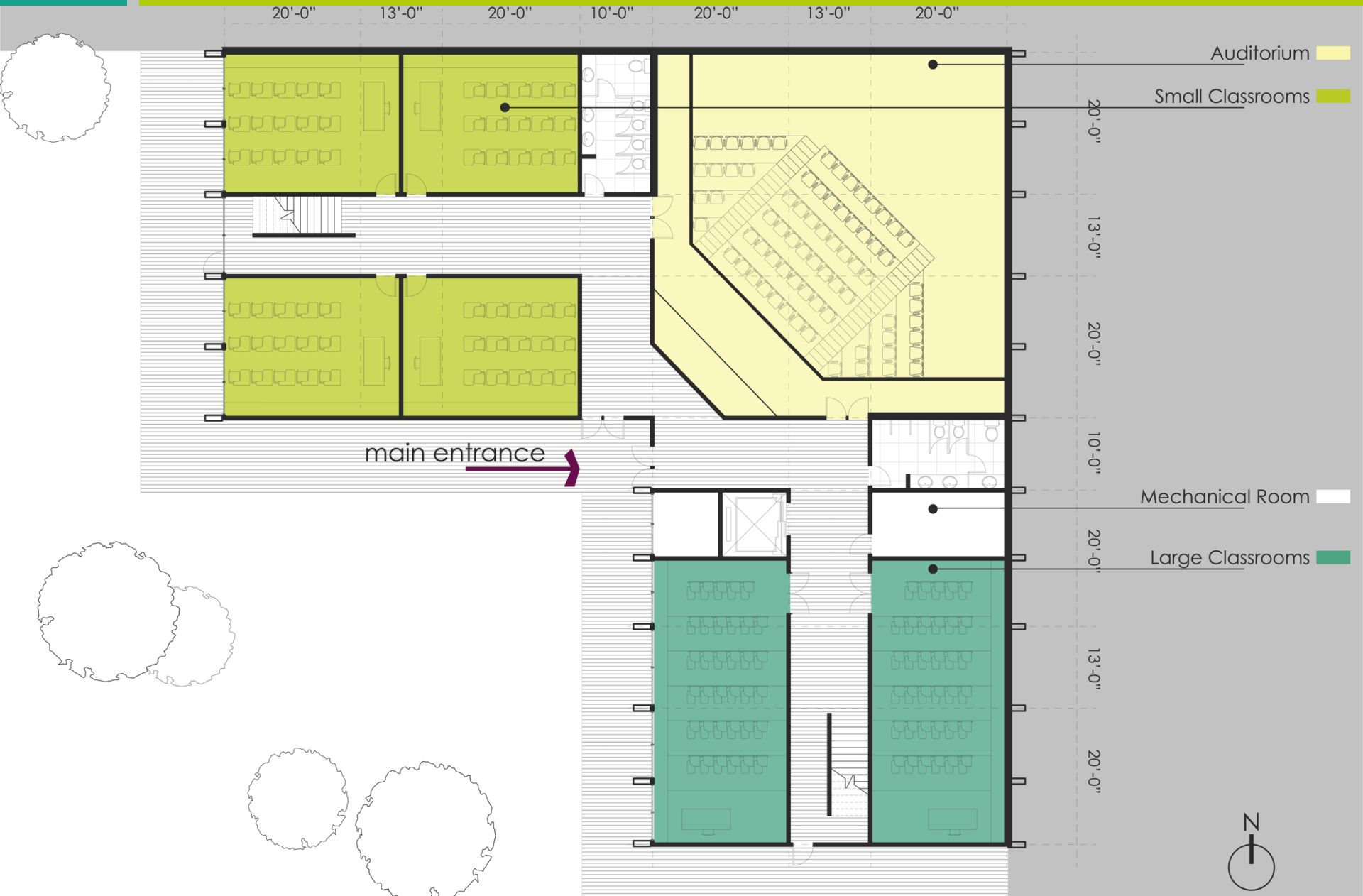


Concept 1: Exoskeleton

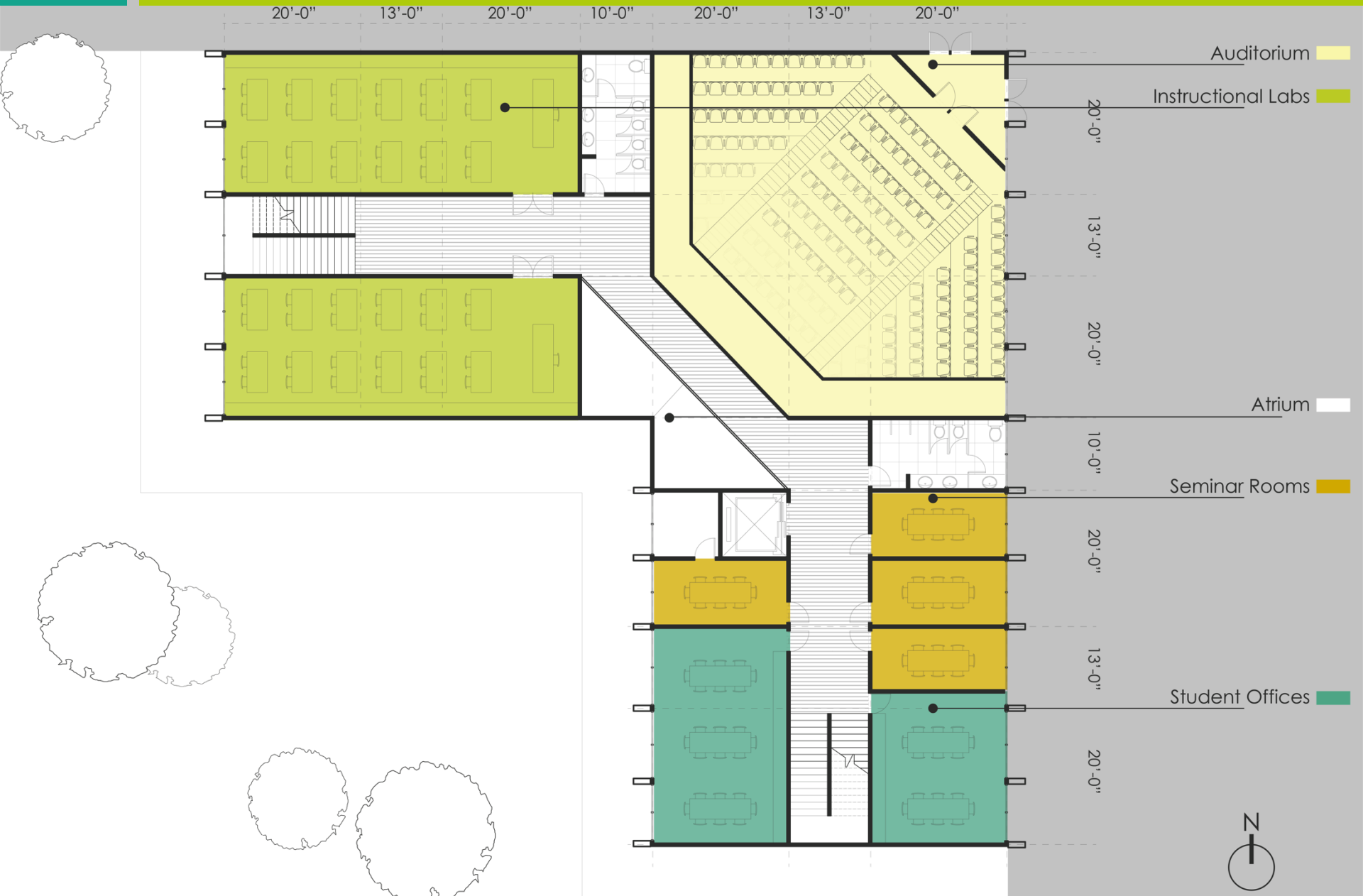
- Coral reefs have an exterior structure or **exoskeleton** with an interior core



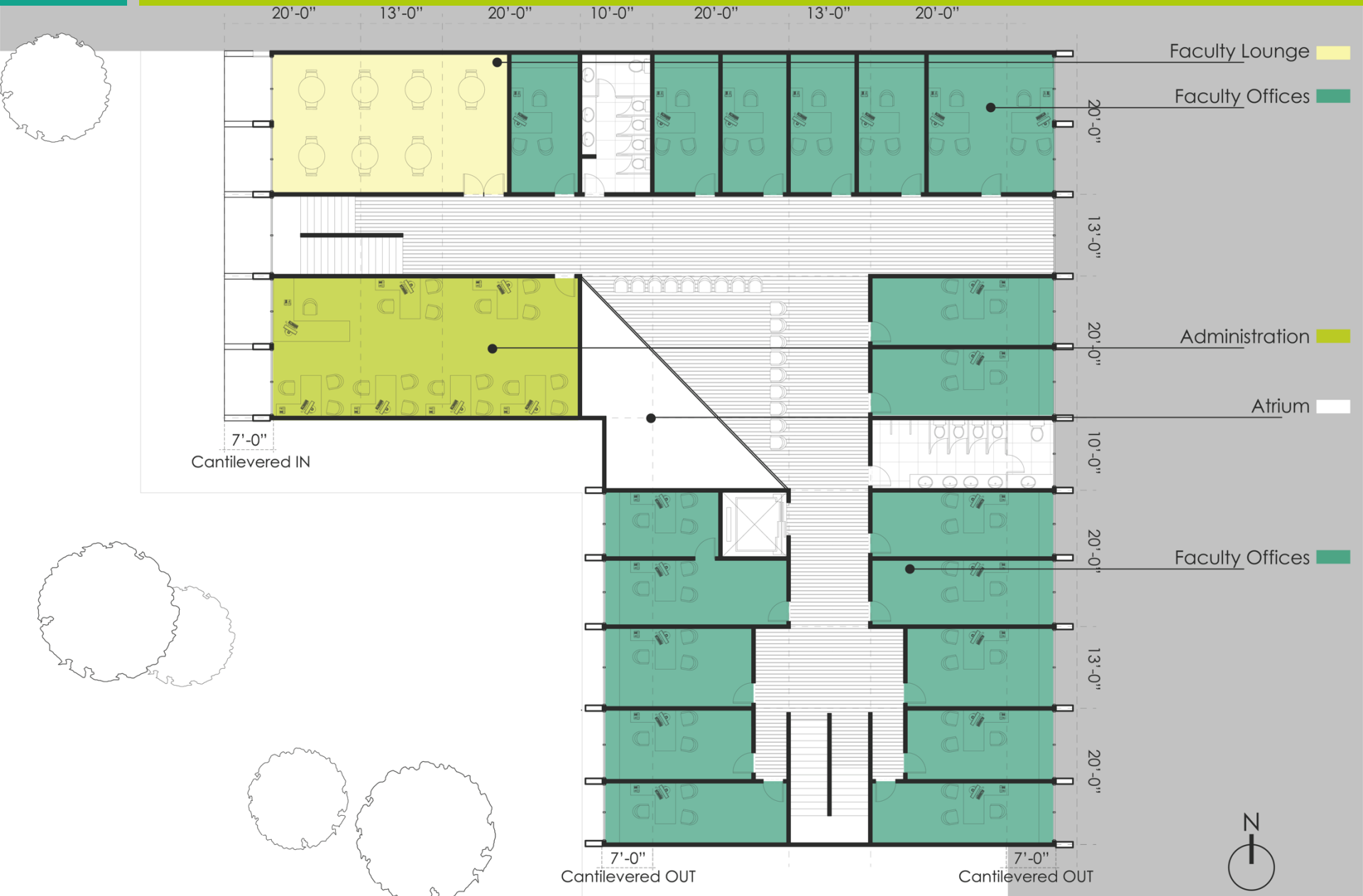
A First Floor Plan



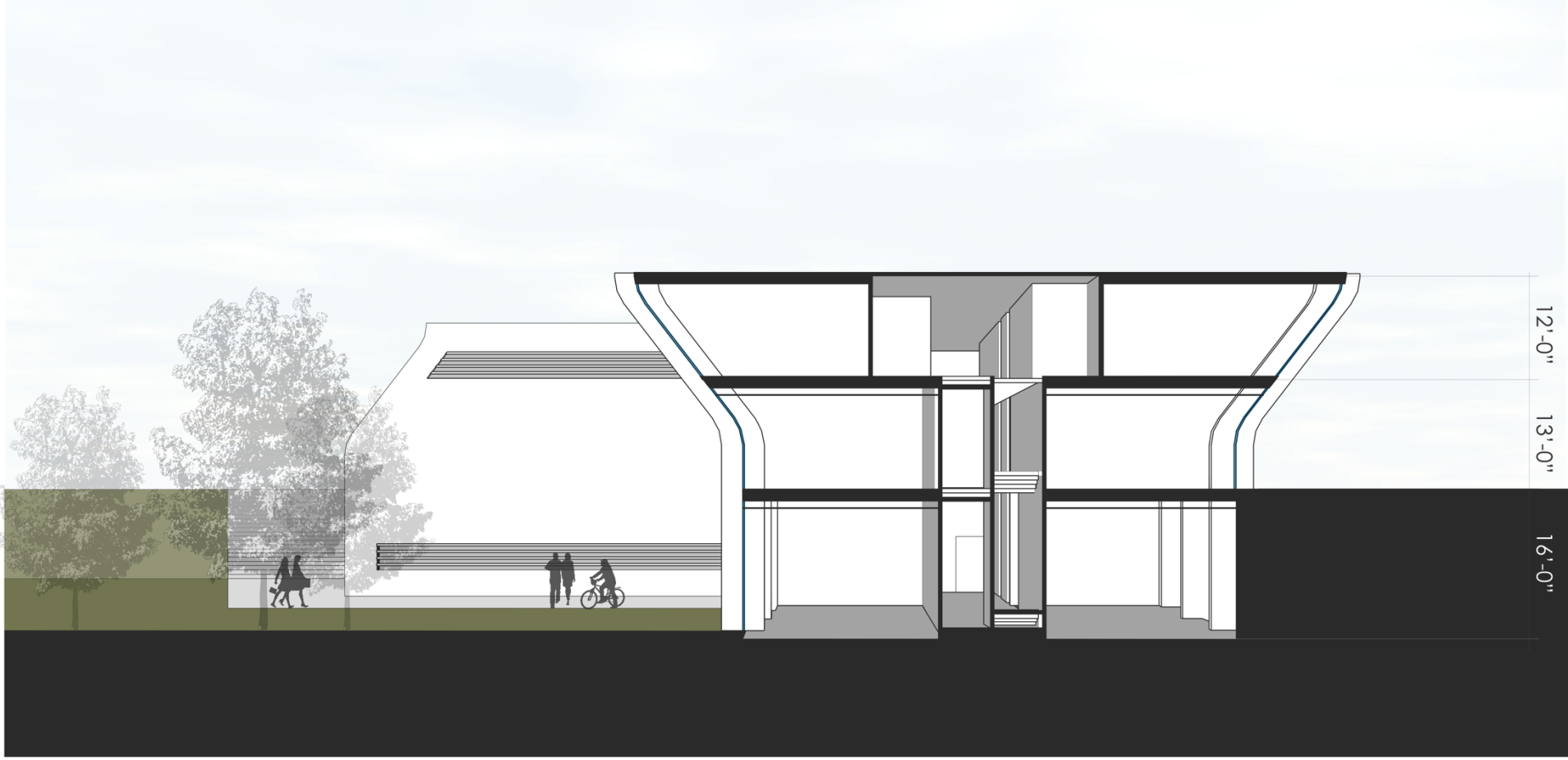
A Second Floor Plan



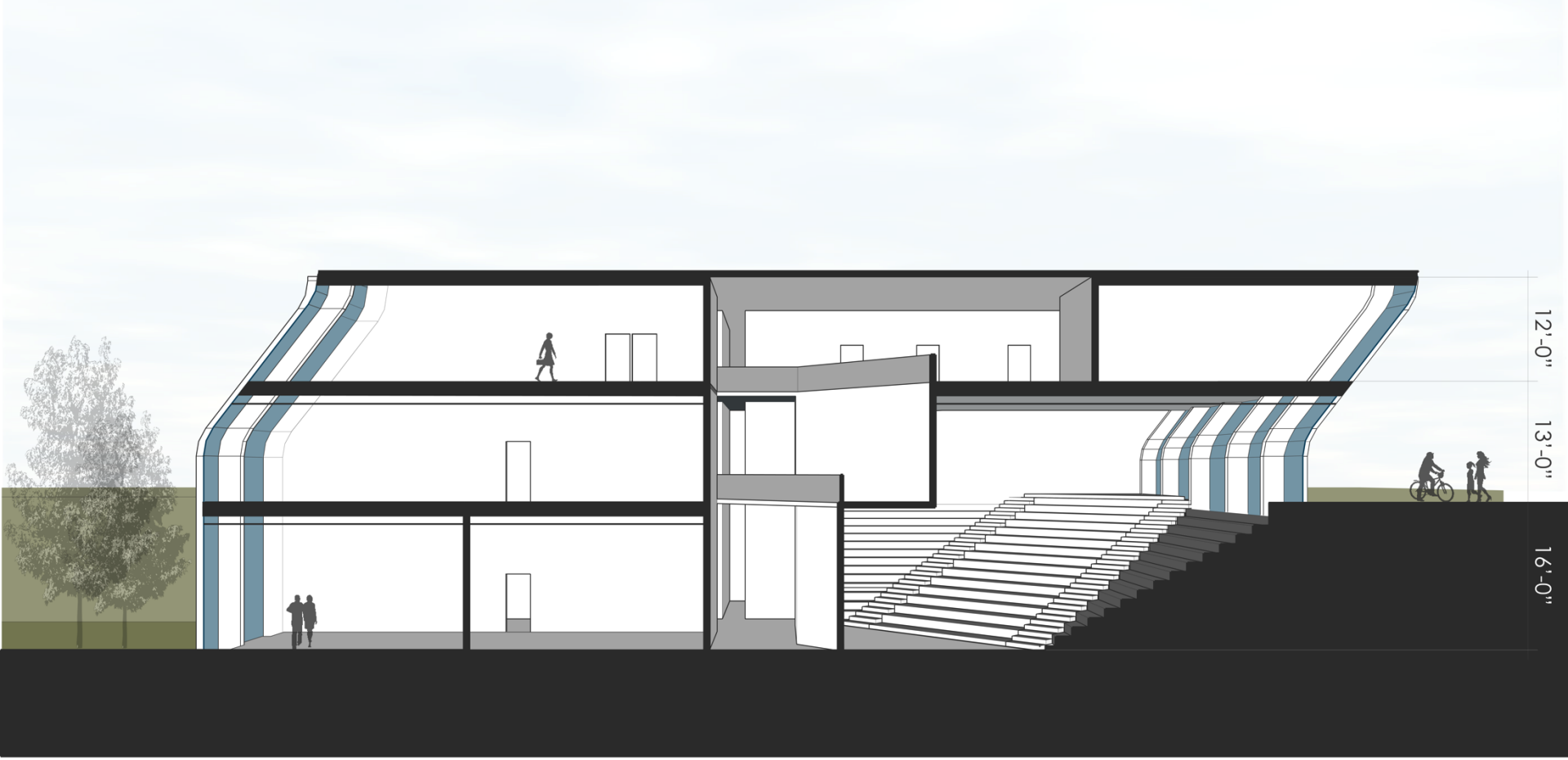
A Third Floor Plan



A East-West Section



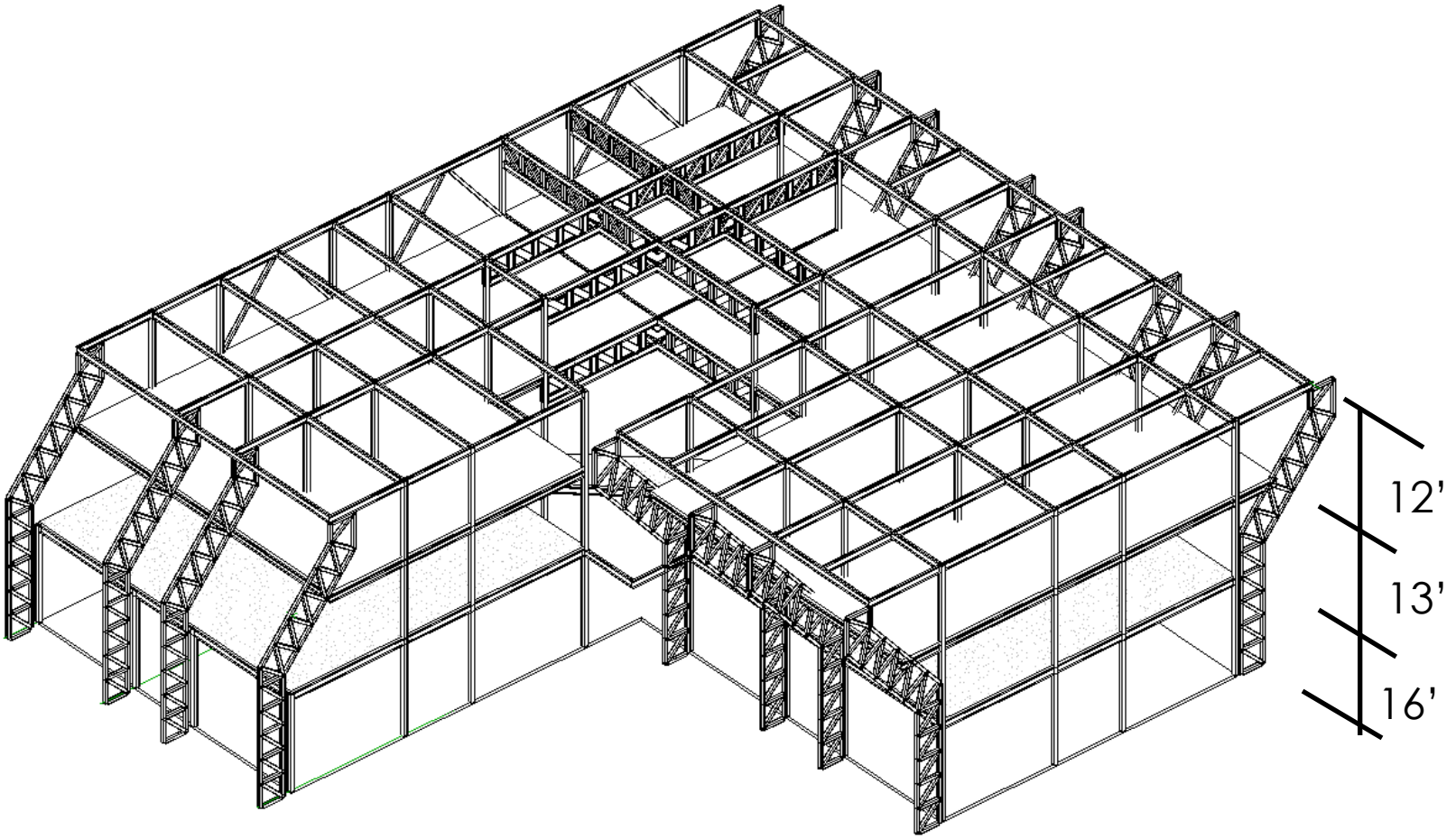
A Auditorium + Main Entrance Section



A Main Entrance [Public Connection]

E

Concept 1



E Design Loads & Soil Profile

- GRAVITY LOADS

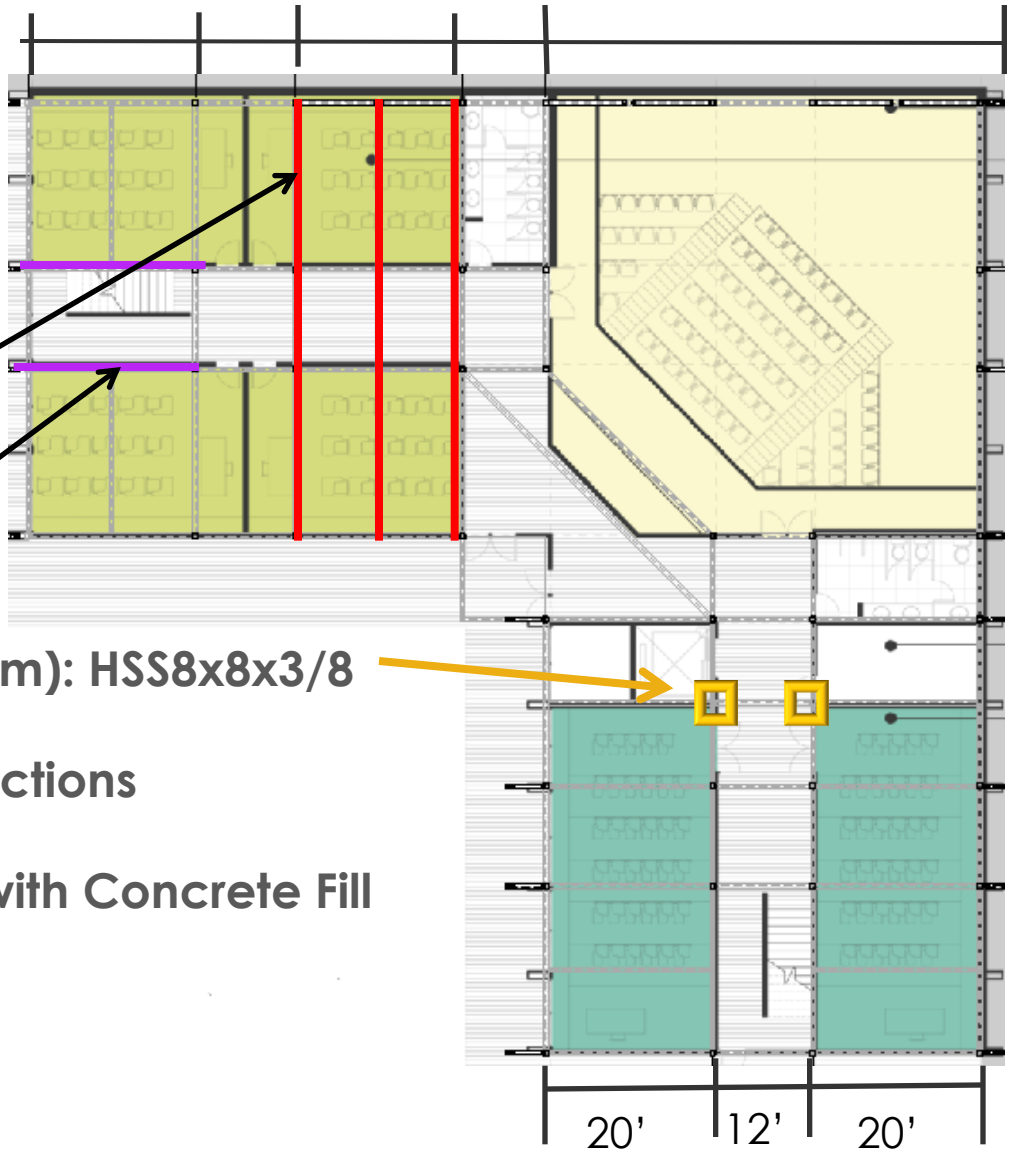
Floor	Dead Loads	Live Loads
First	75 psf	80 psf
Second	75 psf	80 psf
Third	67 psf	100 psf

- Soil Conditions
  - 3500psf bearing capacity
    Water table 14ft below grade
- SEISMIC LOADS (governs over wind loads)
  - Base Shear = 500 kips
  - Site Class D

E

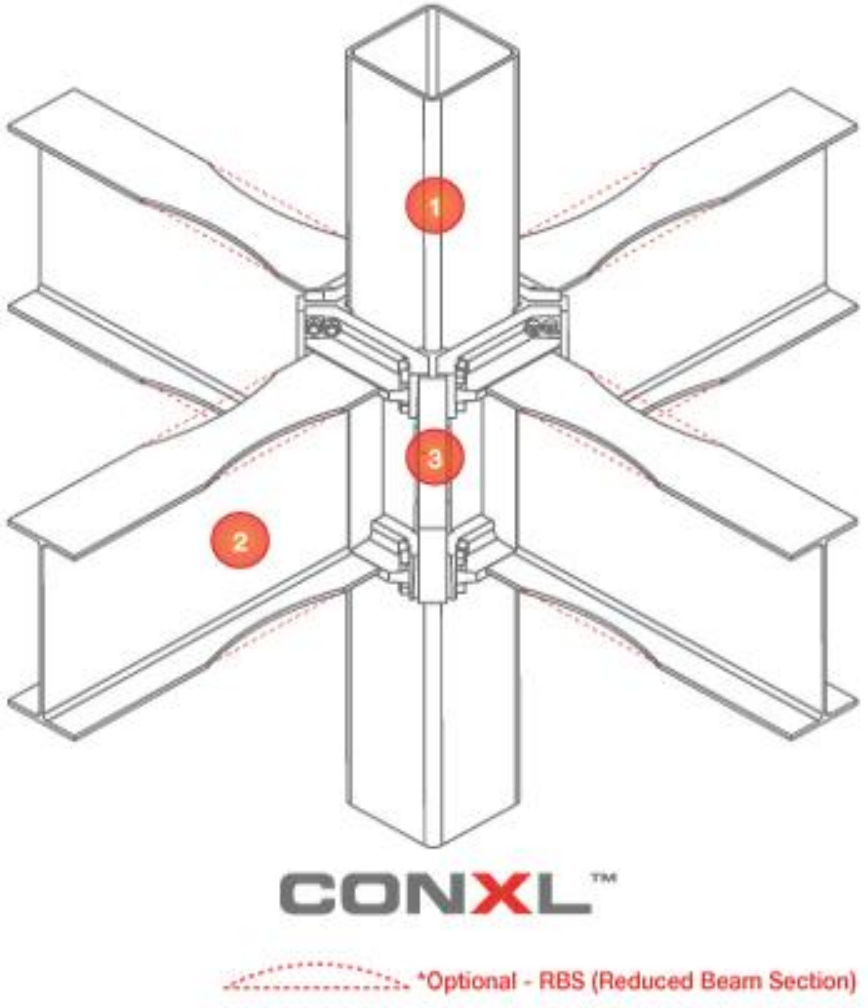
Steel Solution – Typical Member Sizes – First Floor Plan

- Typical Beam: W12x16
- Typical Girder: W16x26
- Gravity Columns (not touching Lateral system): HSS8x8x3/8
- ConXtech Moment Connections
- 3” composite Steel Deck with Concrete Fill



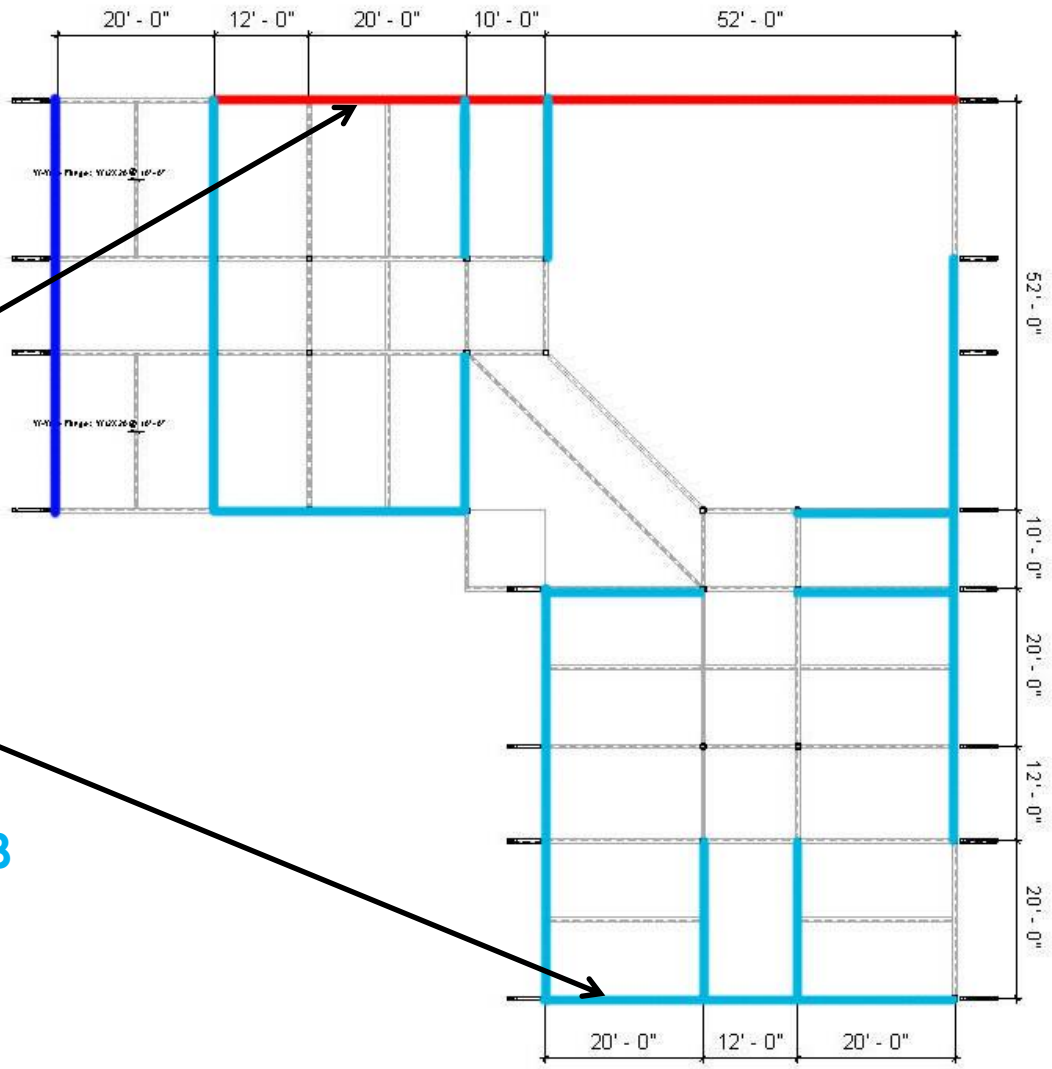
E

ConX System

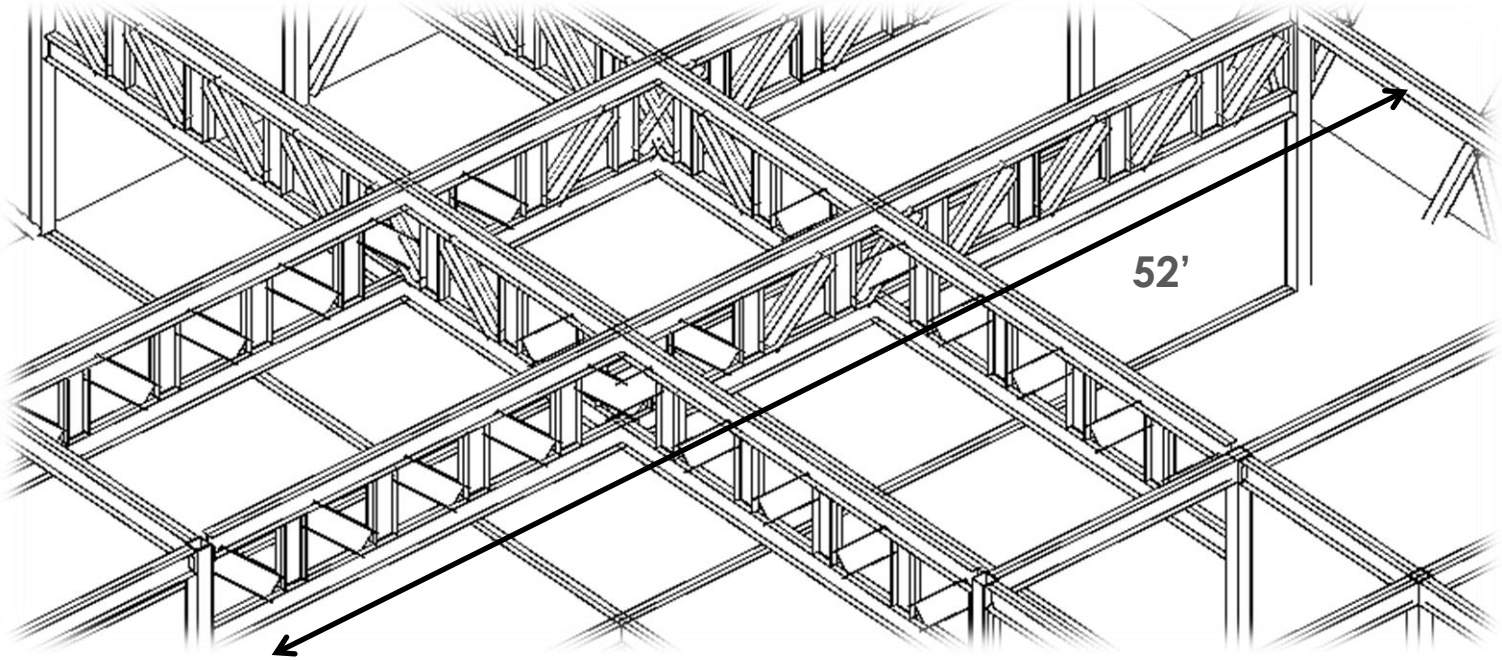


E Steel Solution – Lateral System sizes – First Floor Plan

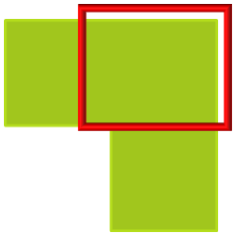
- Lateral System
- Red: BRBF
  - Maximum 3 in^2 braces
  - Columns: HSS8x8x1/2
  - Max beam: W18x65
- Teal: SMF
  - Max Beam: W30x116
  - Columns: HSS16x16x5/8 (with concrete fill)



E Auditorium



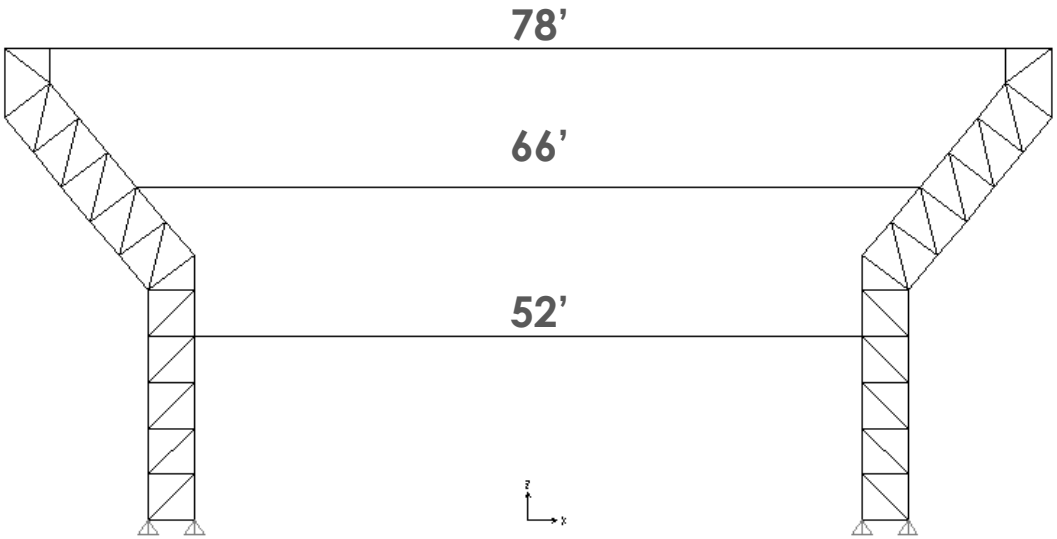
- Simple W-sections not cost efficient (52’ span)
- Truss built from HSS6x6x1/2 sections
- Pin Connected to prevent moment in column
- Allows for MEP space in trusses

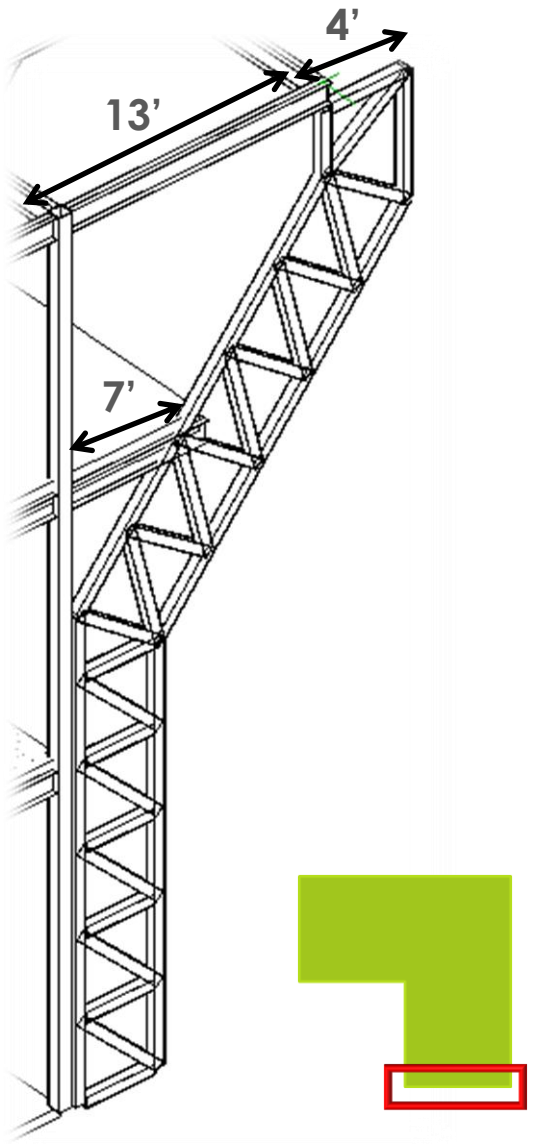


E

Curved Column Cantilevers

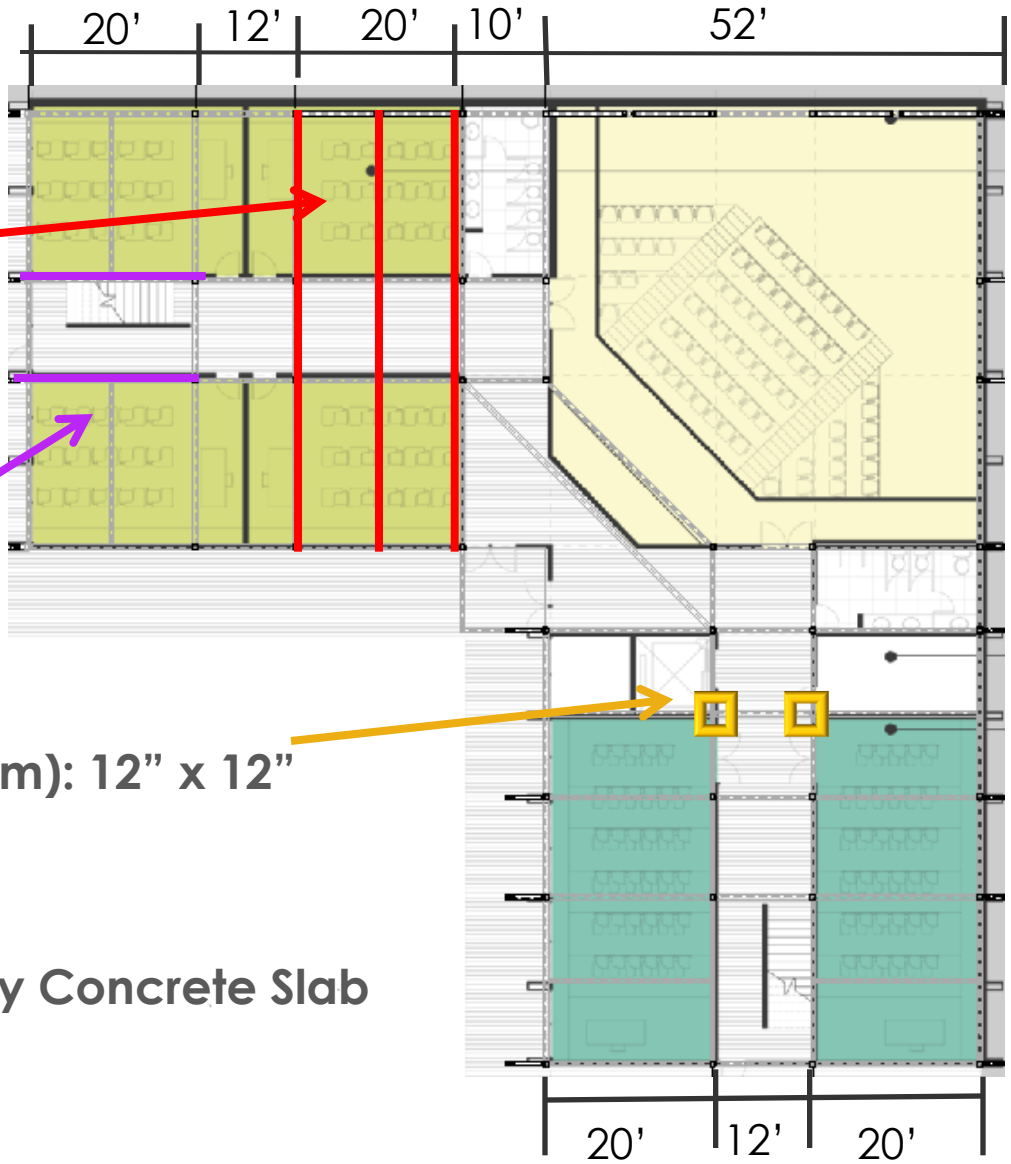
- Architectural feature
- Truss built from HSS6x6x1/2 sections
- Placed on opposite sides – self-supported





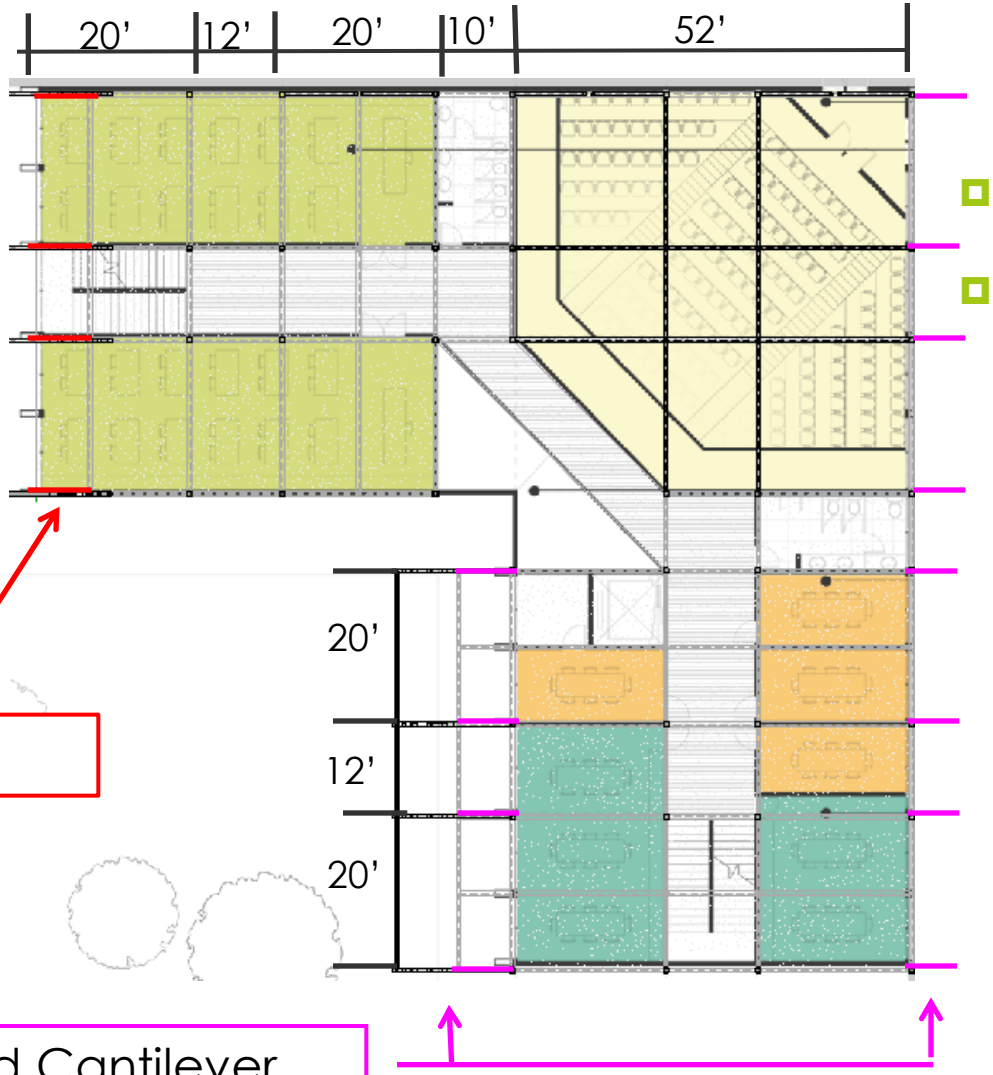
E Concrete Solution– Typical Member Sizes – First Floor Plan

- Typical Beam: 18” x 12”
  - 4 # 8 Rebar
- Typical Girder: 18” x 12”
  - 4 #8 Rebar
- Gravity Columns (not touching Lateral system): 12” x 12”
  - 6 #8 Rebar
- 8” Post-Tensioned Two-Way Concrete Slab



E Concrete Solution– Typical Member Sizes – Second Floor Plan

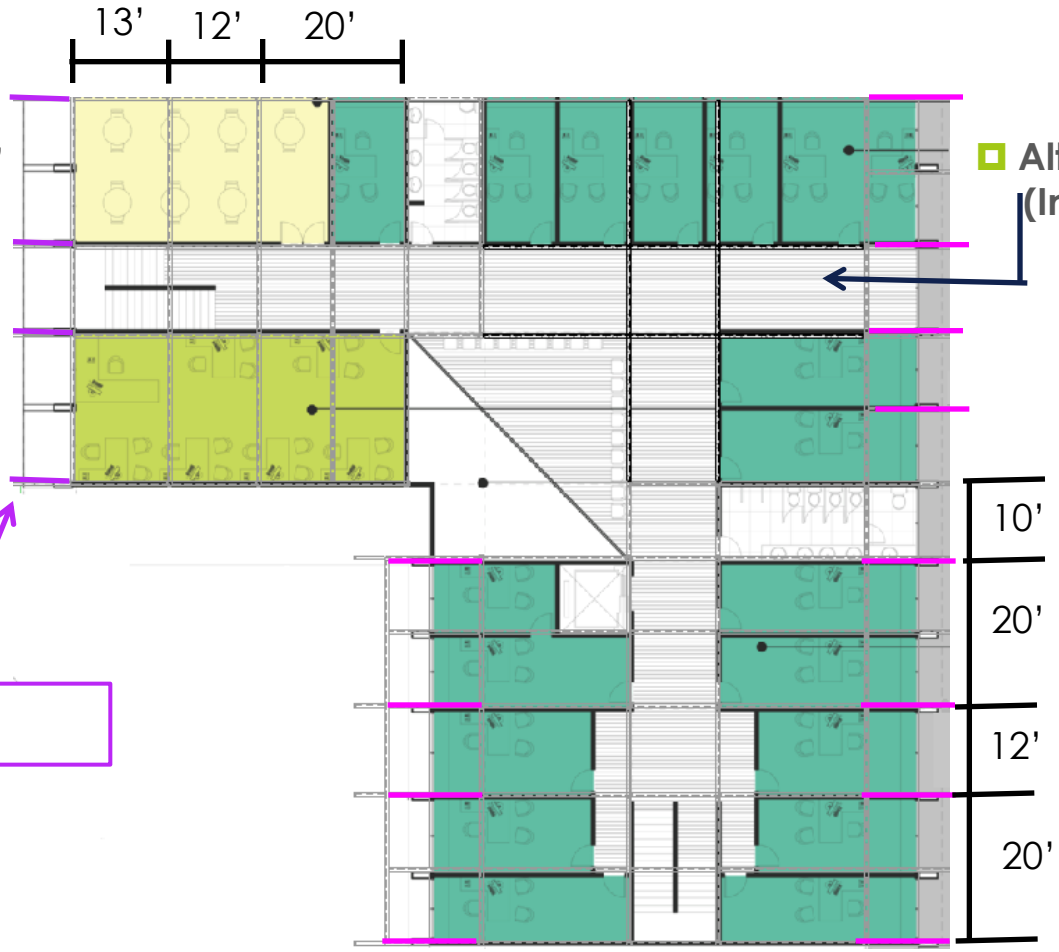
- Typ. Beam: 16” x 12”
  - 4 # 7 Rebar
- Typ.Girder: 16” x 12”
  - 4 #8 Rebar



- Auditorium (52’)
- Pre-Stressed Girder
  - 40” x 16”
  - Harped Tendon
  - 12” Eccentricity
  - 18 -1/2” Tendons

E Concrete Solution– Typical Member Sizes – Third Floor Plan

- Typ. Beam: 18” x 12”
  - 4 # 8 Rebar
- Typ. Girder: 18” x 12”
  - 4 #8 Rebar



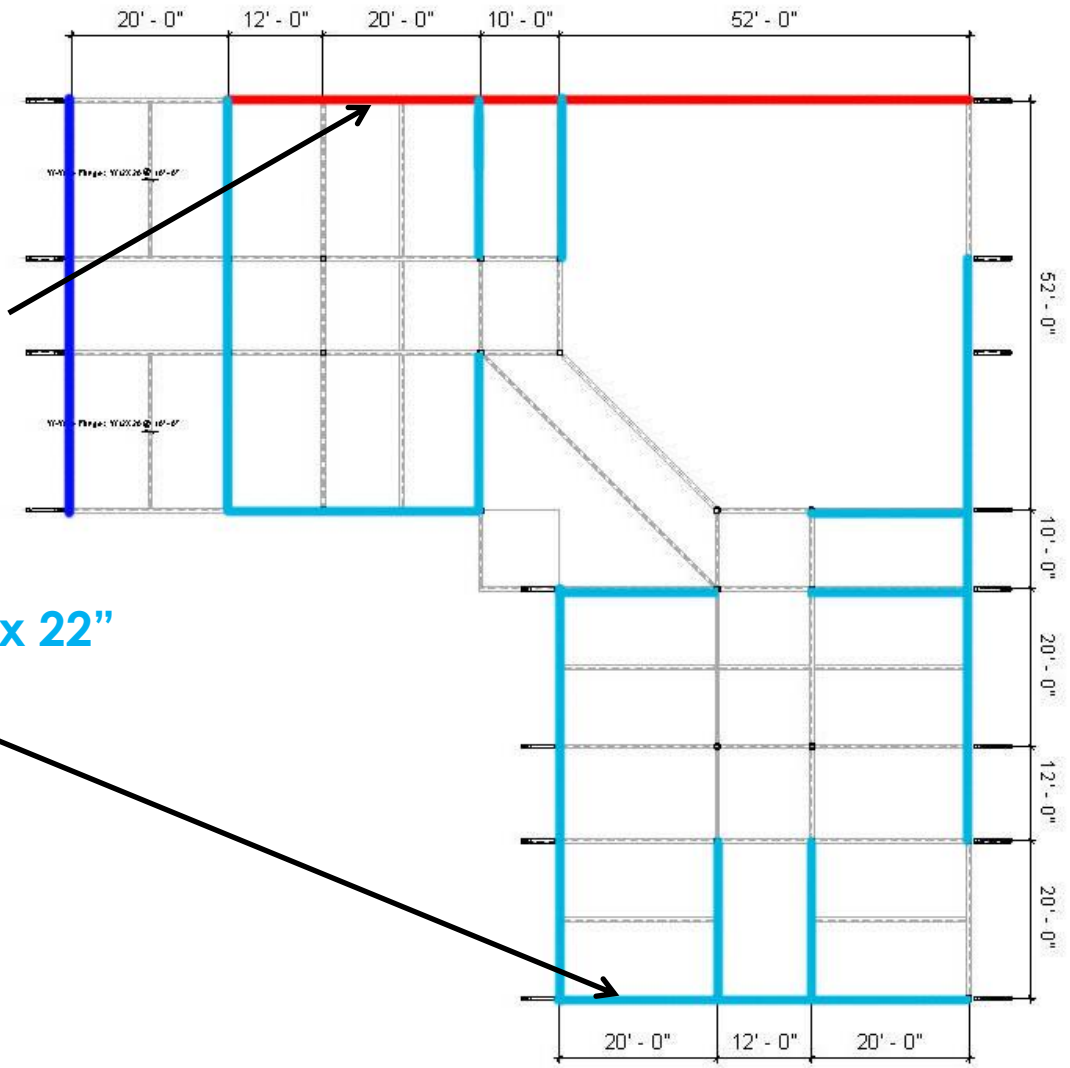
- Alternative Option: (Integration)
  - Steel HSS Trusses

7’ Inward offset

13’ Outward Cantilever

E Concrete Solution – Lateral System

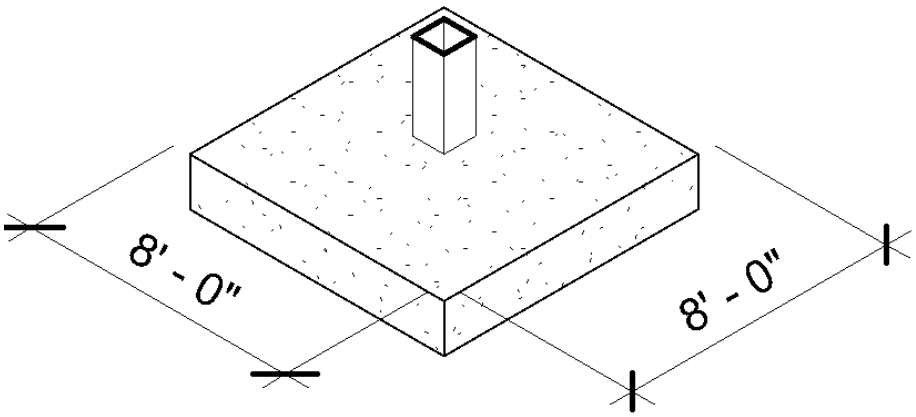
- Lateral System
- Red: Shear Walls
  - Minimum Thickness:
    - 8”
- Teal: SMF
  - Preliminary Beam: 18” x 22”
  - Columns: 22” x 22”
- Blue: 1st Floor Floor SMF
  - Height = 16’



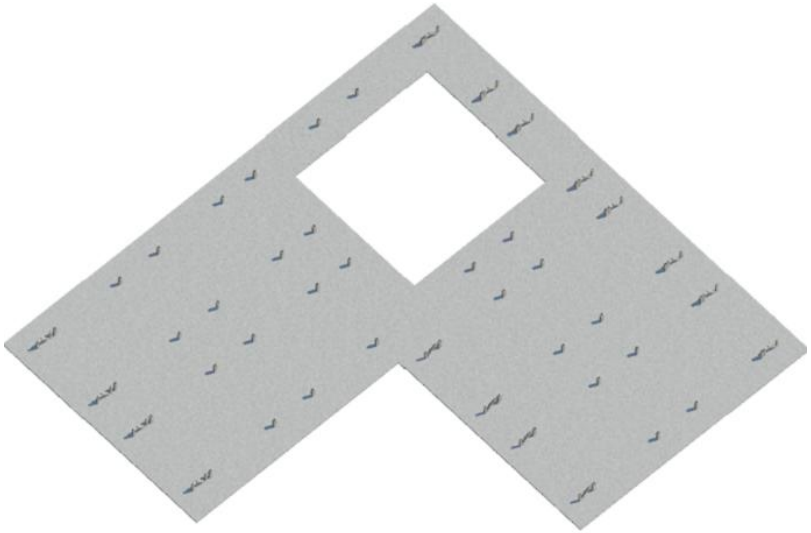
E

Foundations

Alternatives



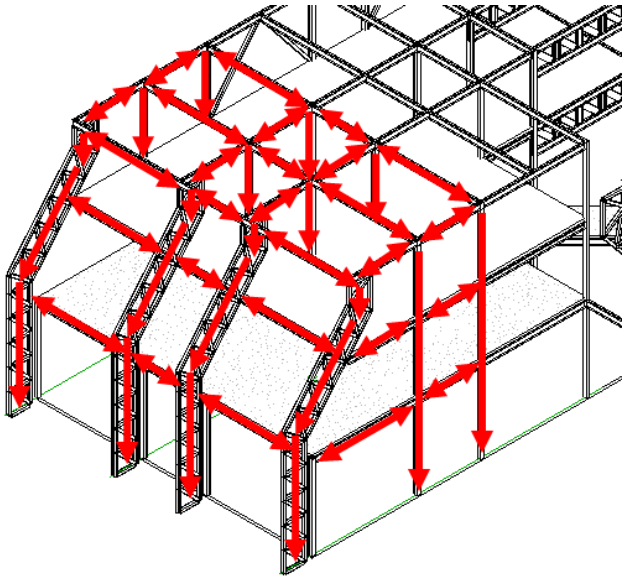
- Isolated Footing
  - 18" Thickness
  - #8 Rebar at 4.5" center-to-center

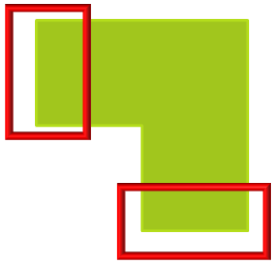


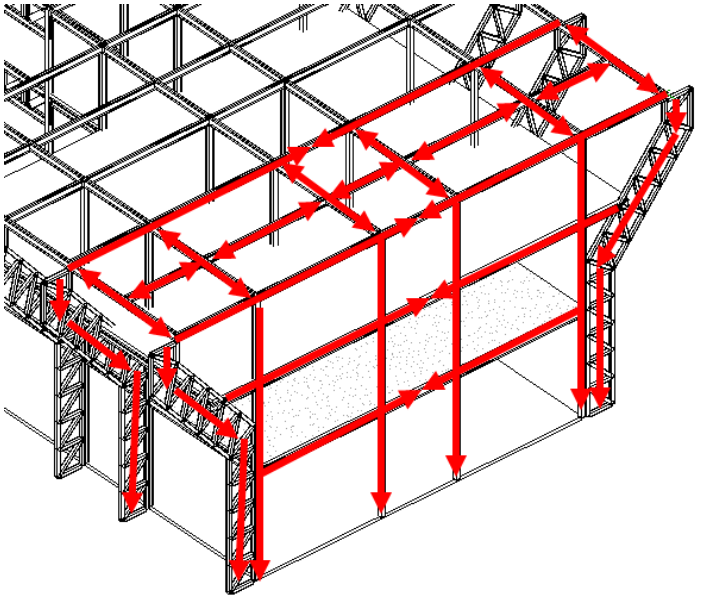
- Mat Foundation
  - Ease of Construction
  - Reduce Formwork

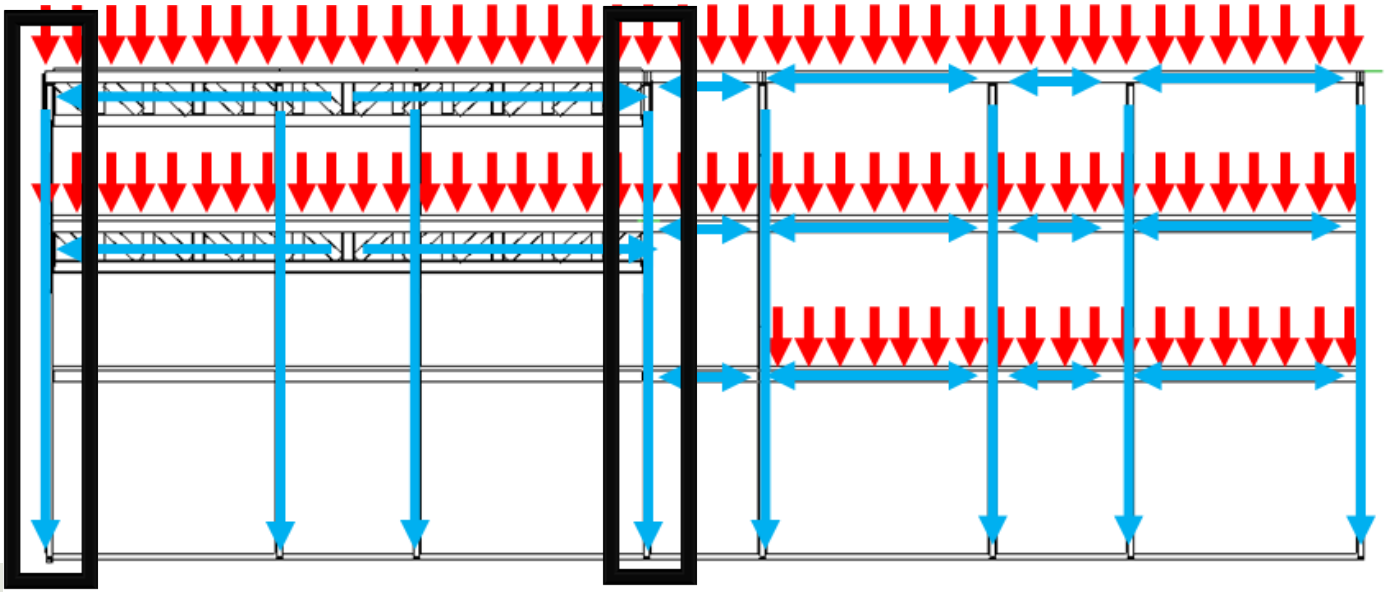
E

Gravity Load Path



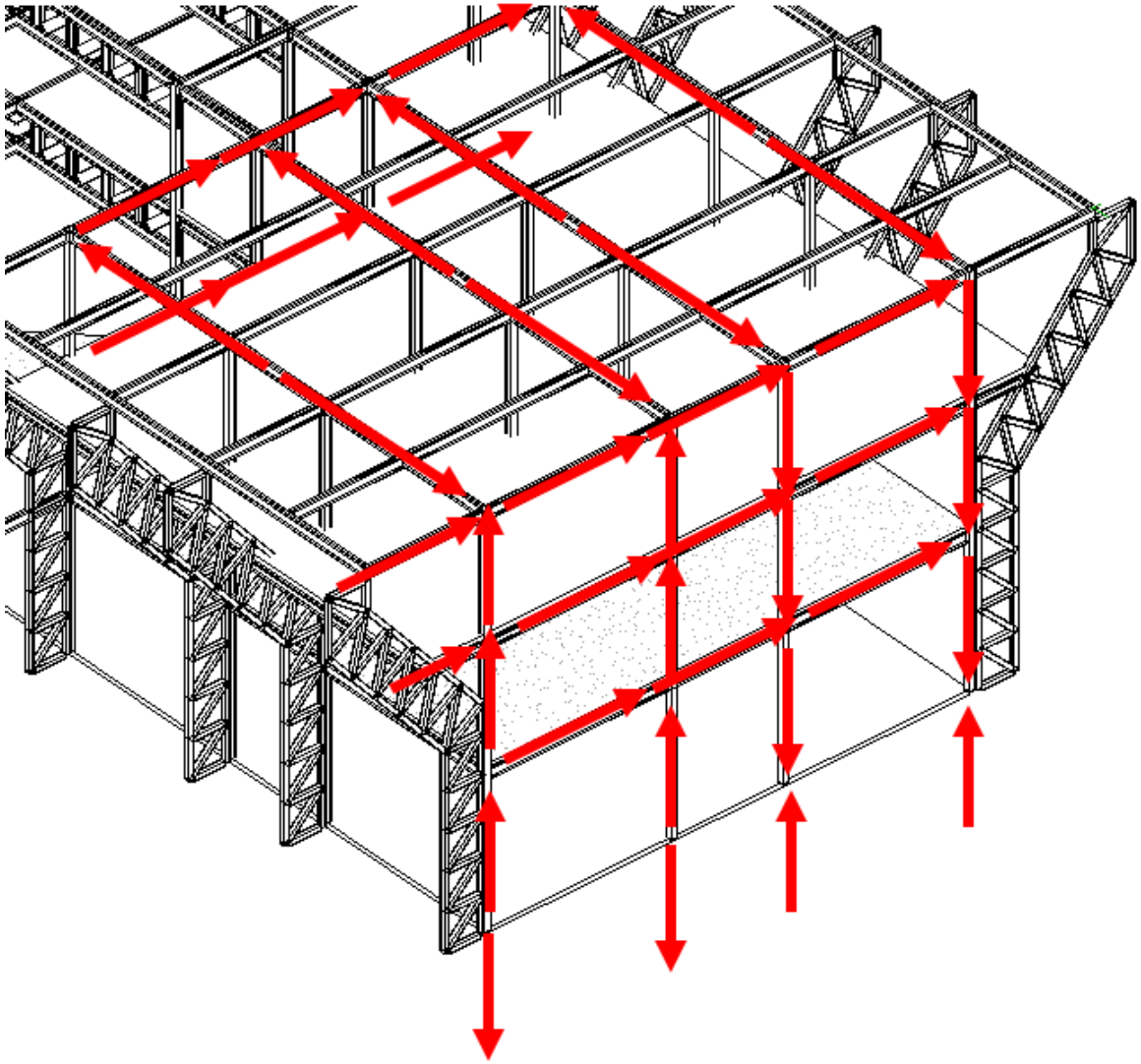






E

Lateral Load Path



Concept 2: Gateway

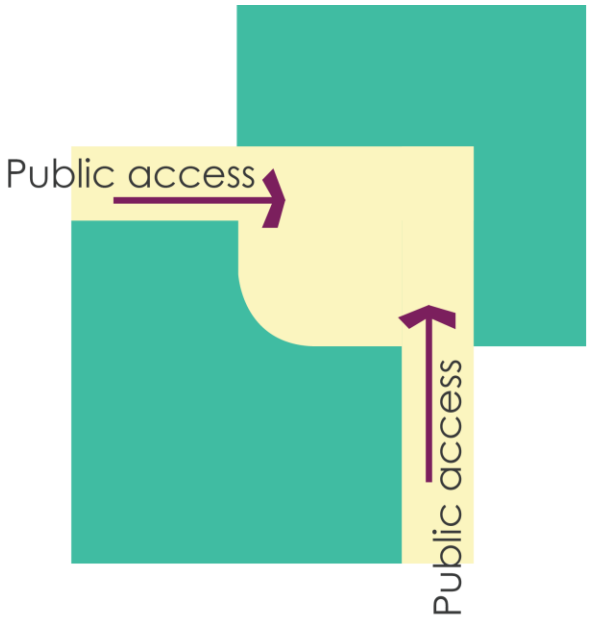
Golden Gate Bridge
connection between 2 points

+

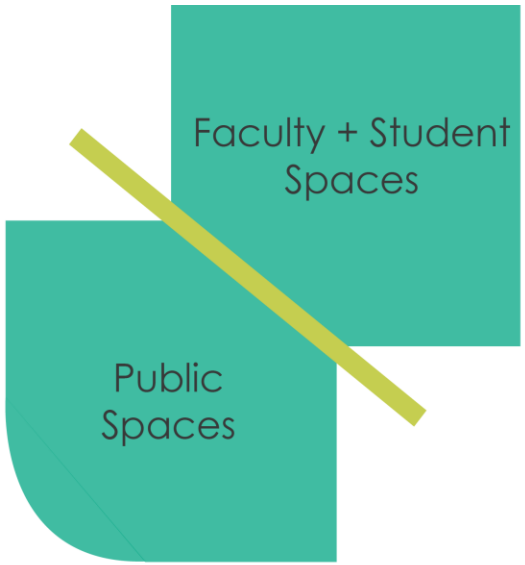
=

building circulation
access between lake+campus

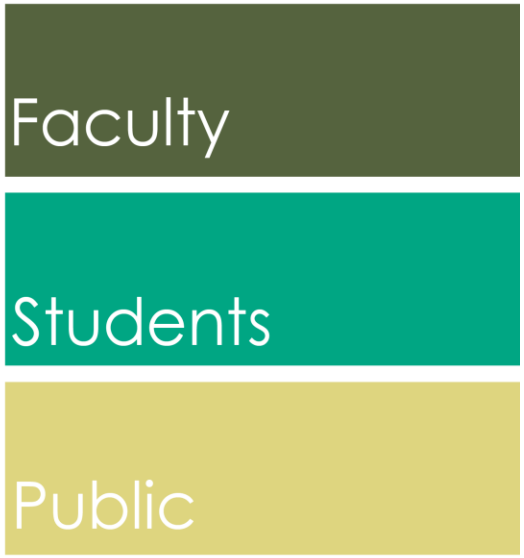
A Social Connection



First Floor Diagram

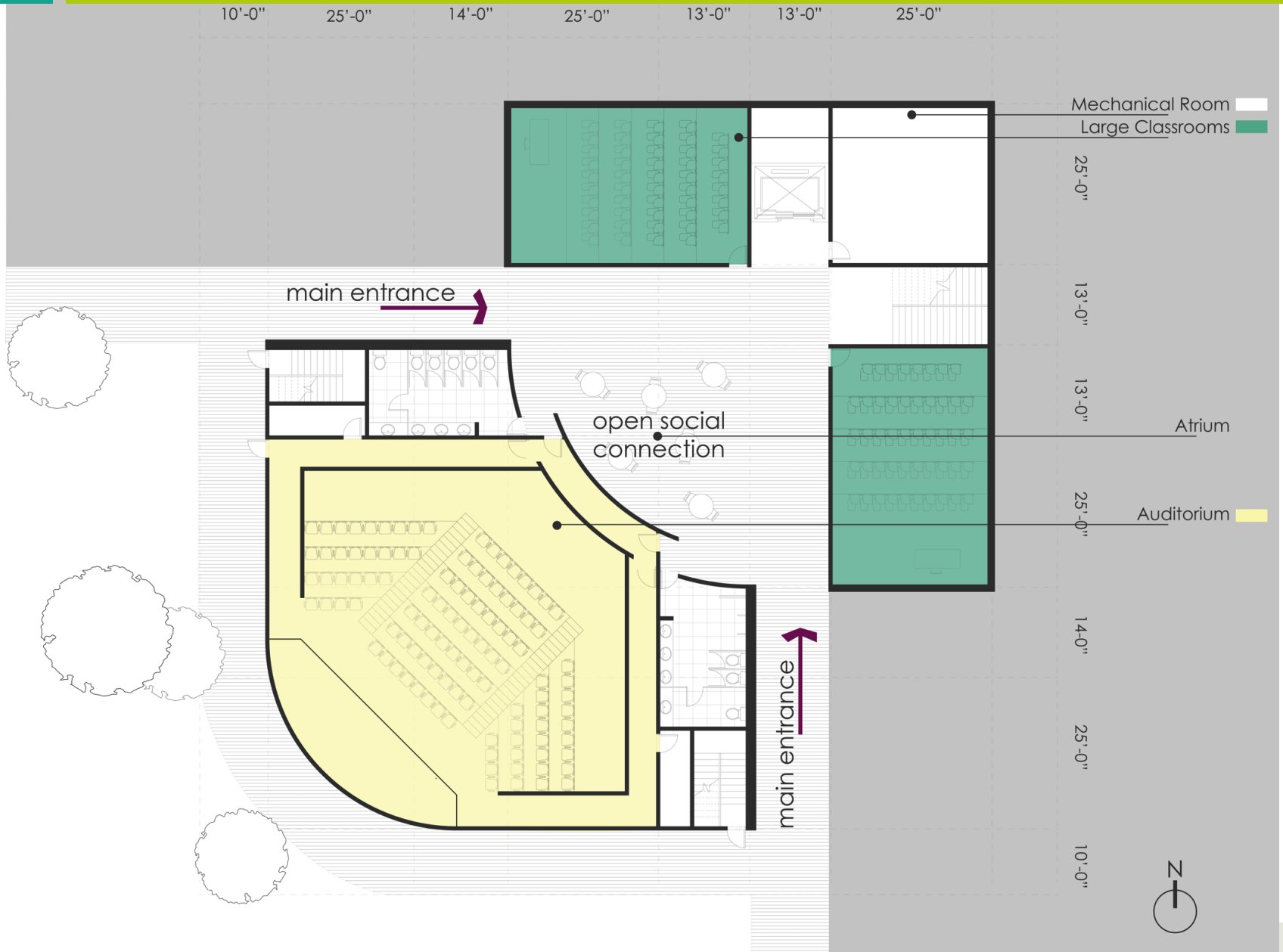


Building Form Diagram

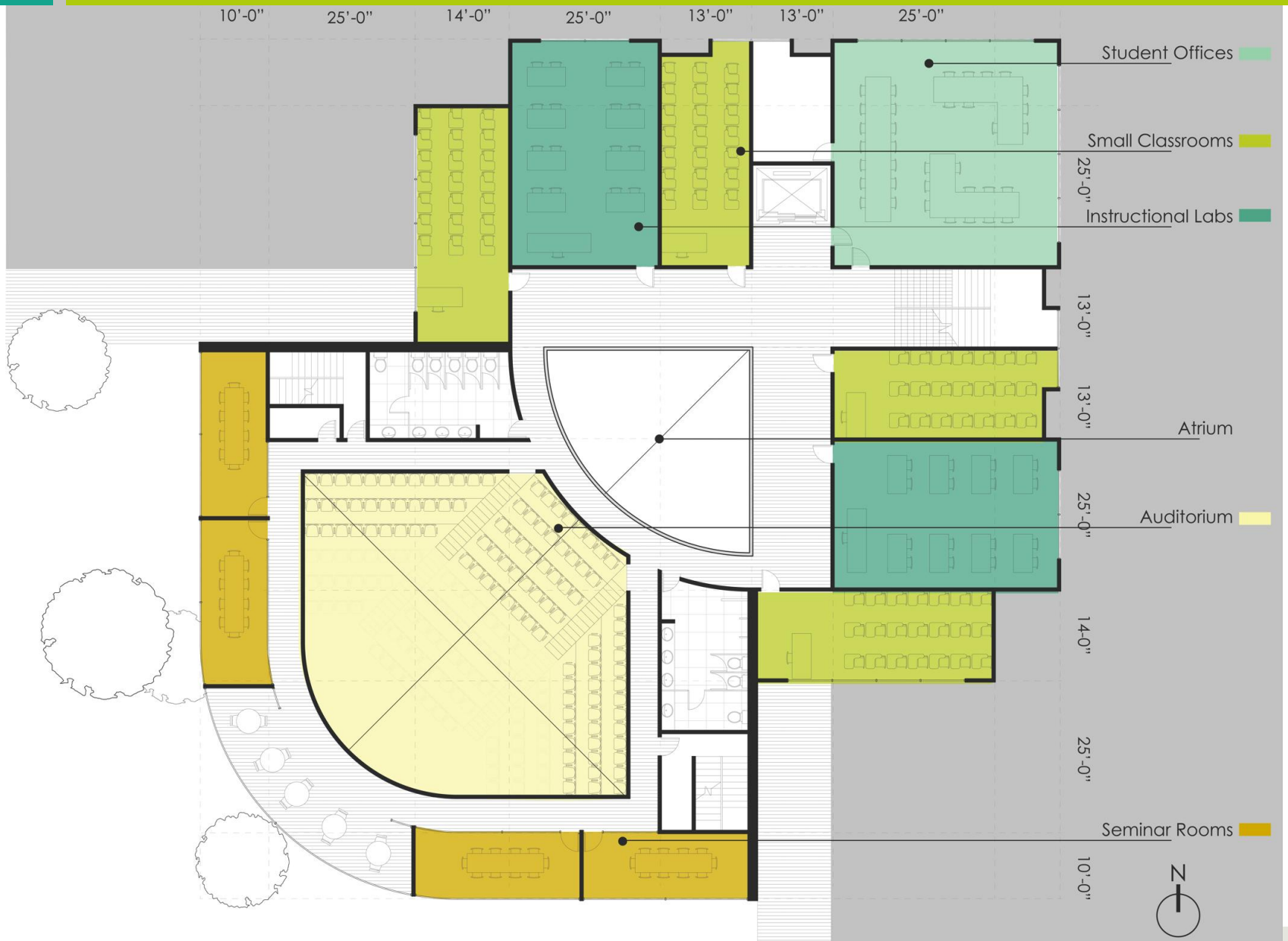


Section Diagram

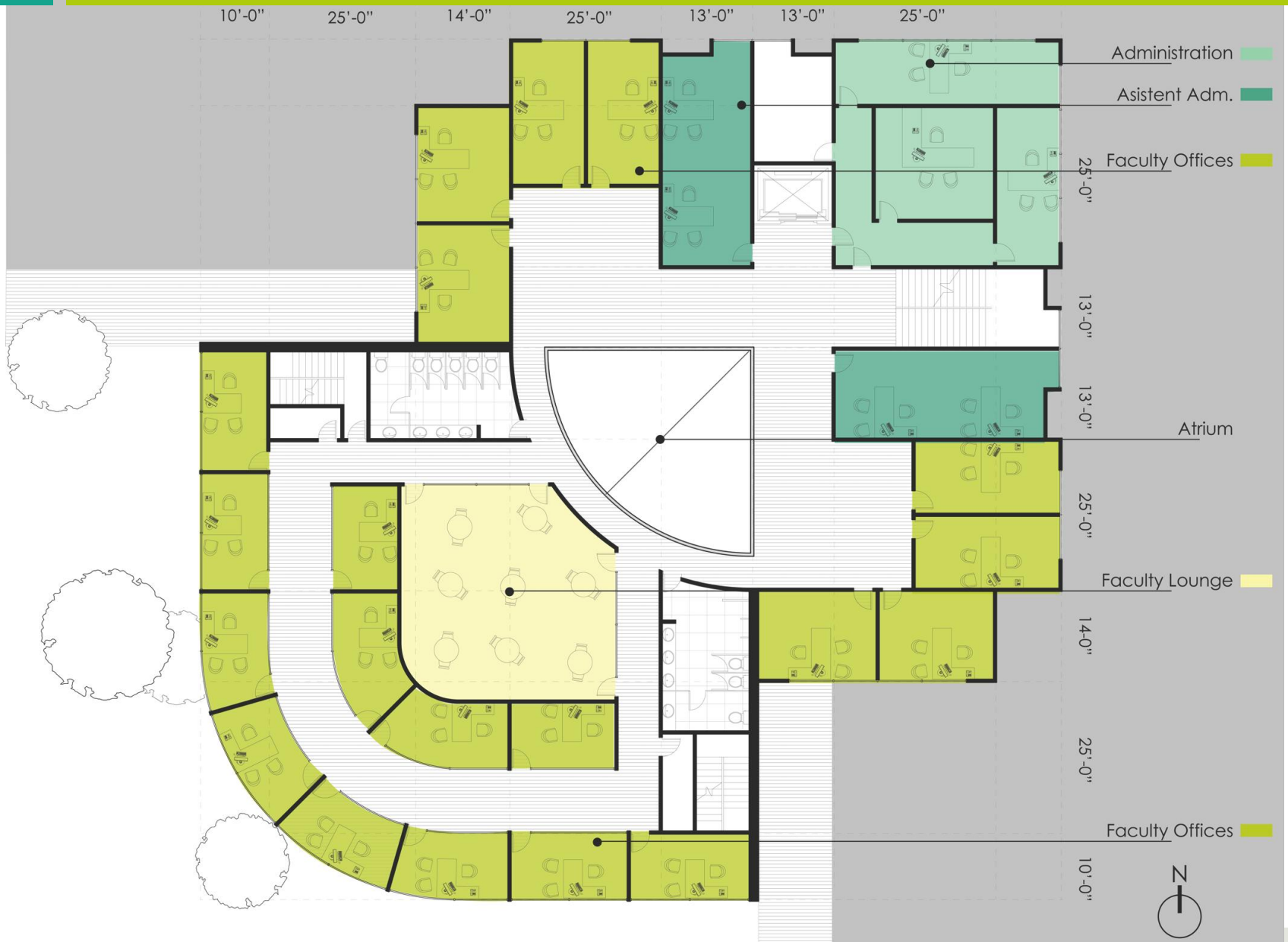
A First Floor Plan



A Second Floor Plan

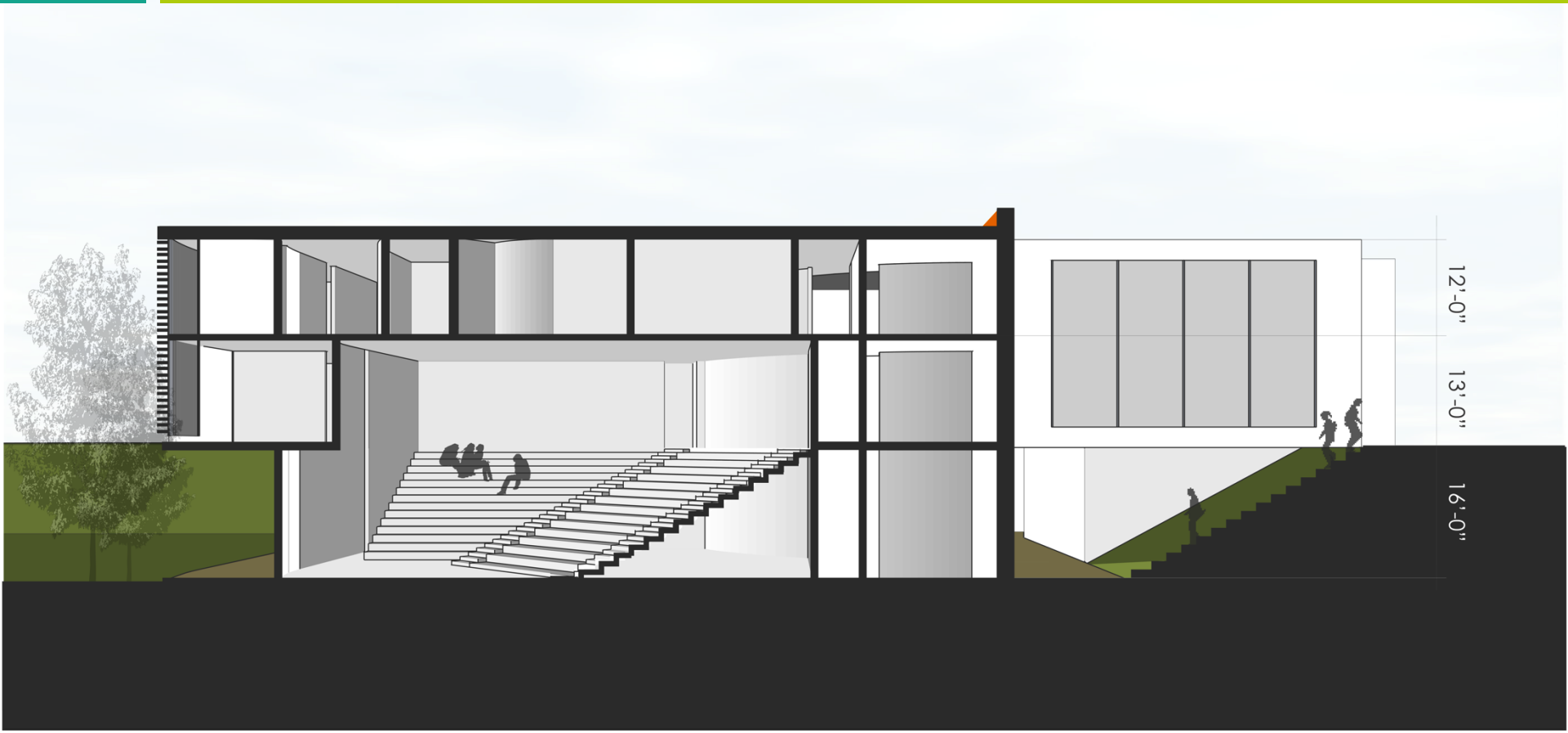


A Third Floor Plan



A Atrium + Entrance Section

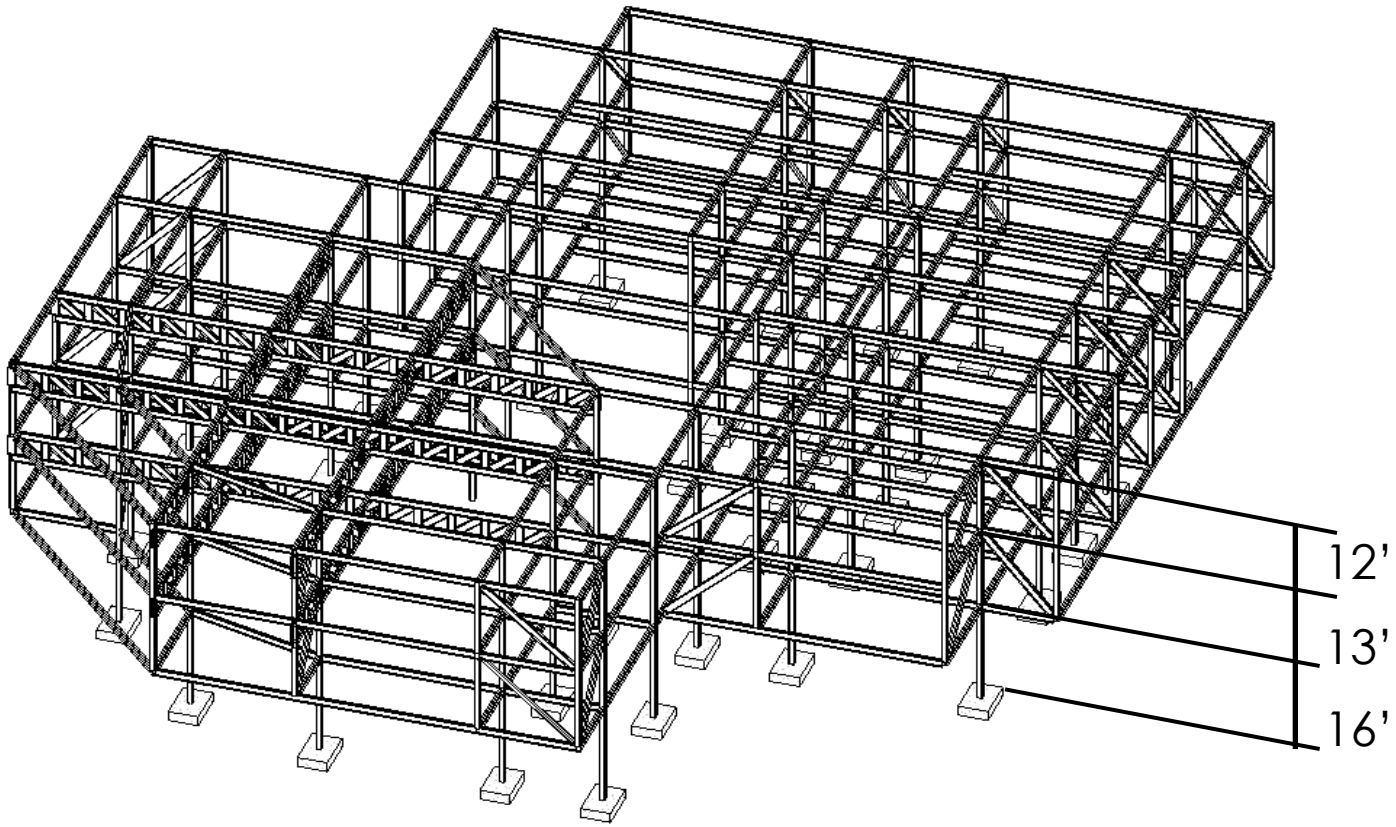
A Auditorium + Entrance Section



A Main Entrance [Public Connection]

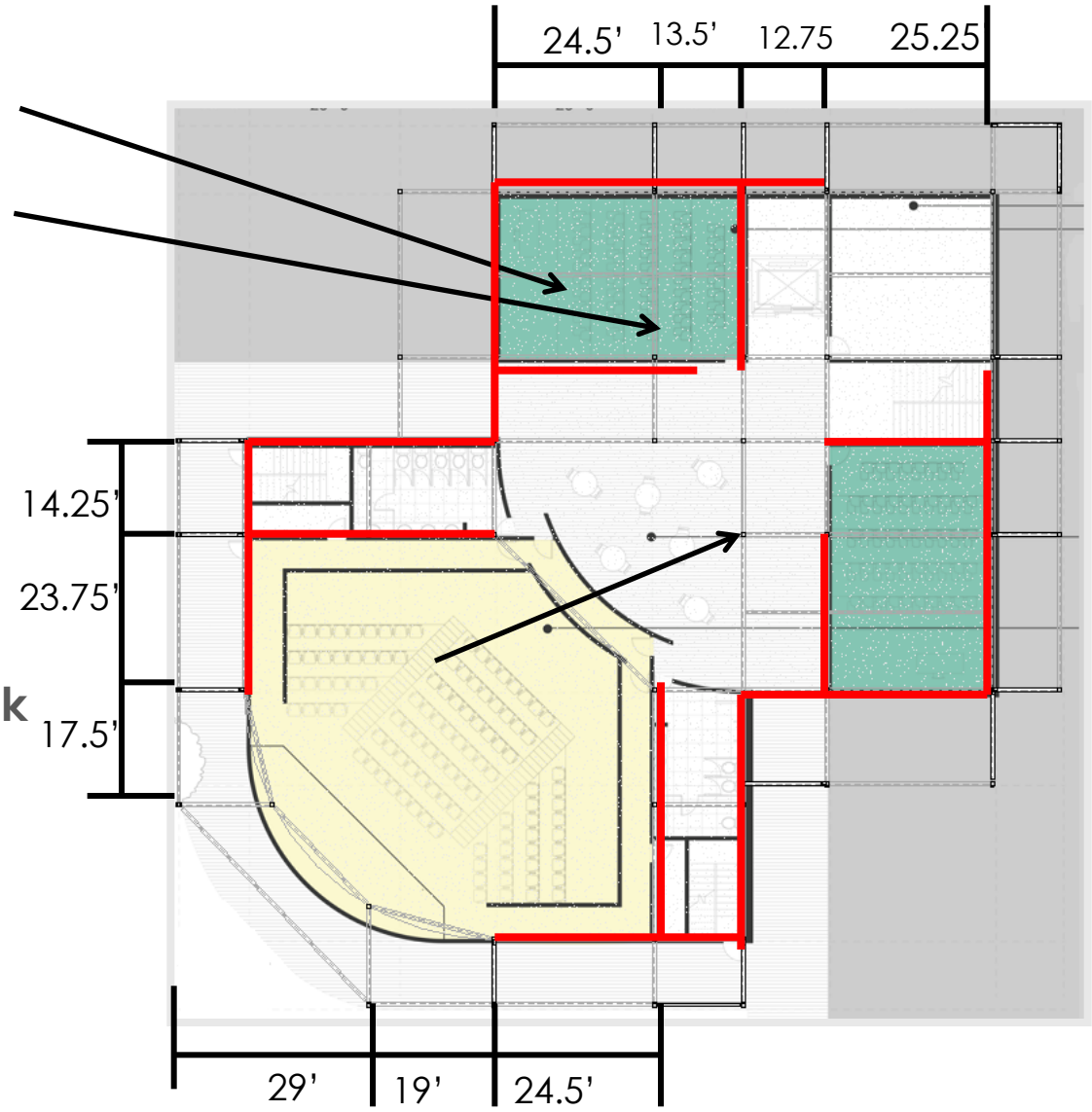
E

Concept 2



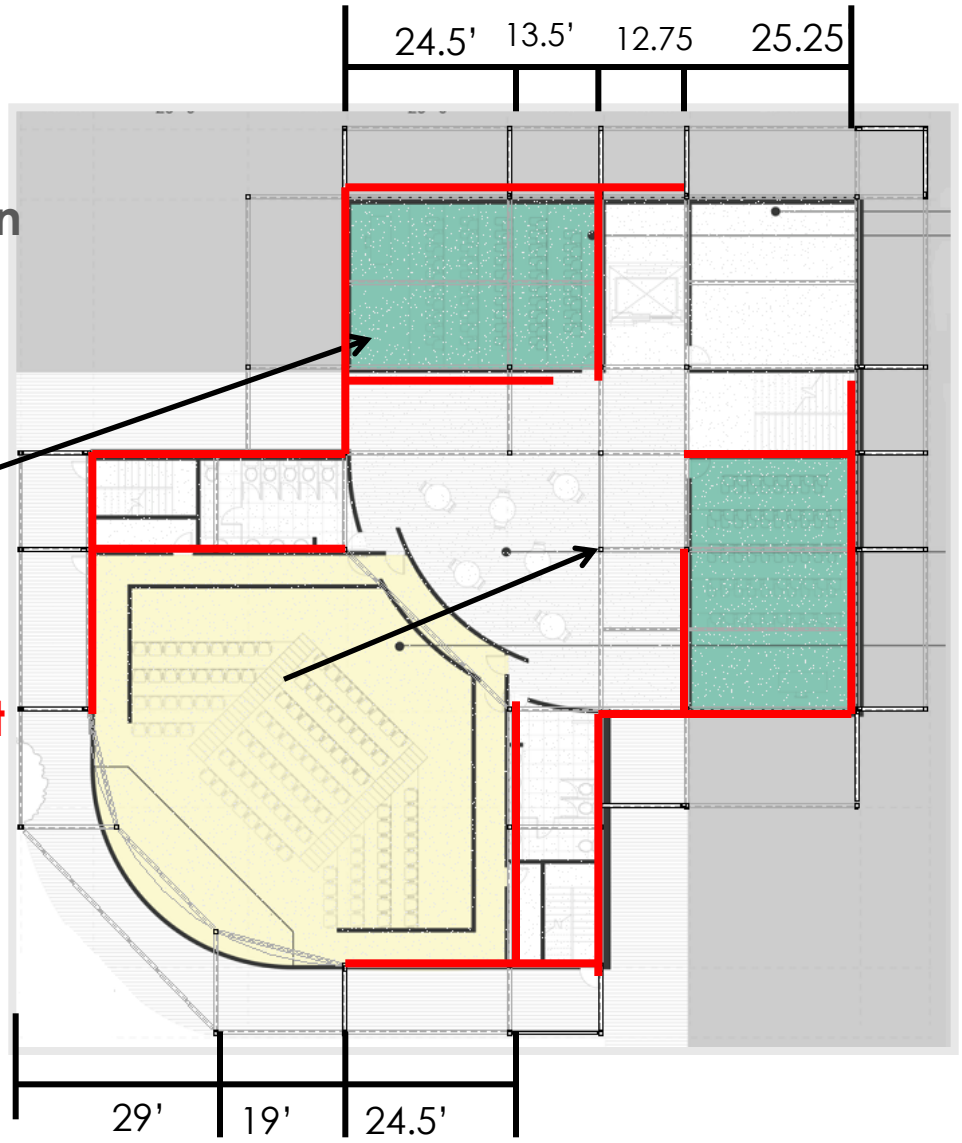
E Steel Solution – Typical Member Sizes – First Floor Plan

- Typical Beam: W14x22
- Typical Girder: W18x35
- Gravity Columns (not touching Lateral system): HSS8x8x1/2
- ConXtech Moment Connections
- 3” composite Steel Deck with Concrete Fill



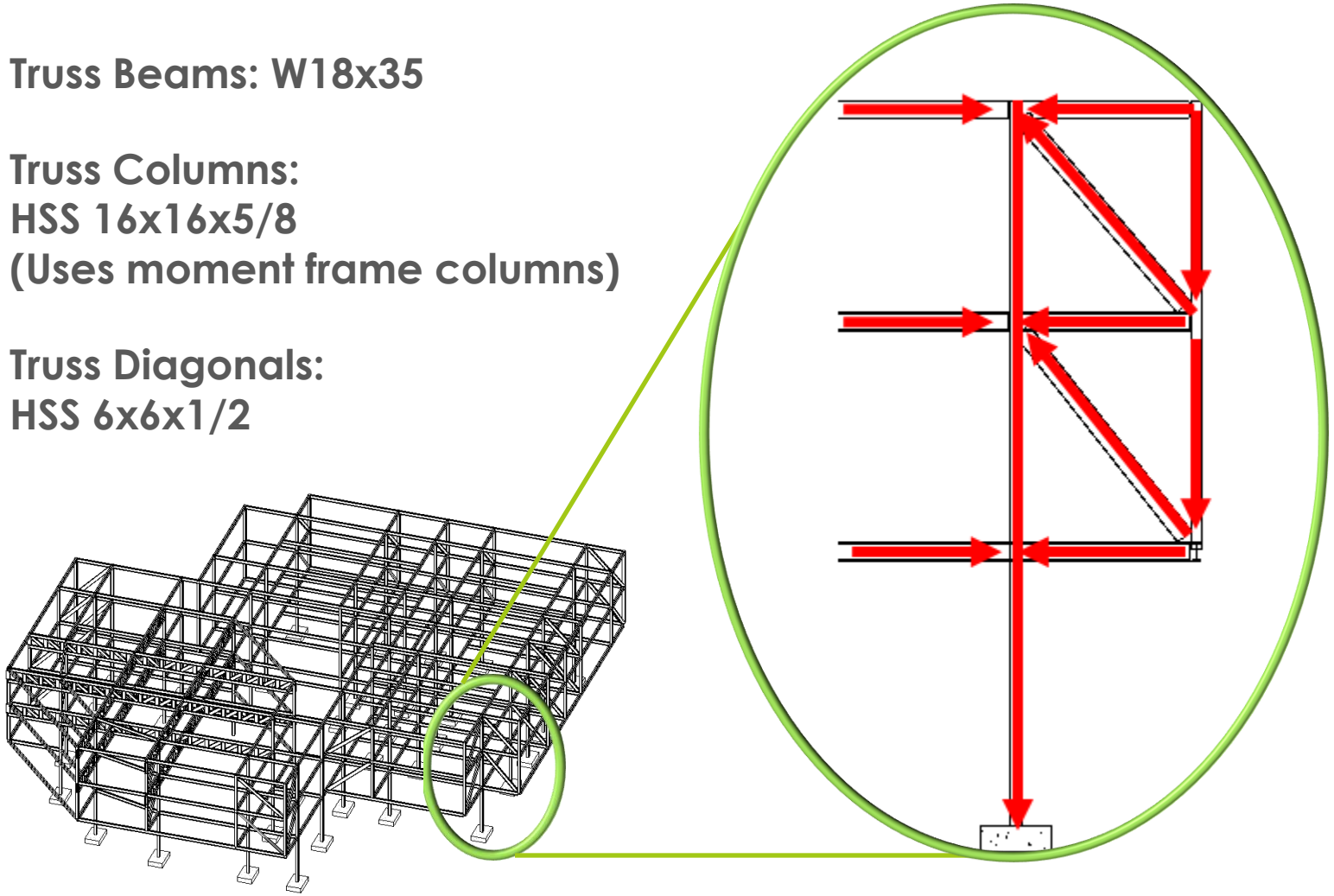
E Steel Solution – Lateral System sizes – First Floor Plan

- Lateral System
  - Symmetry to minimize torsion
- SMF
  - Max Beam: W30x116
  - Columns: HSS16x16x5/8 (with concrete fill)
  - All connections are moment connections



E Cantilever Solution - Steel

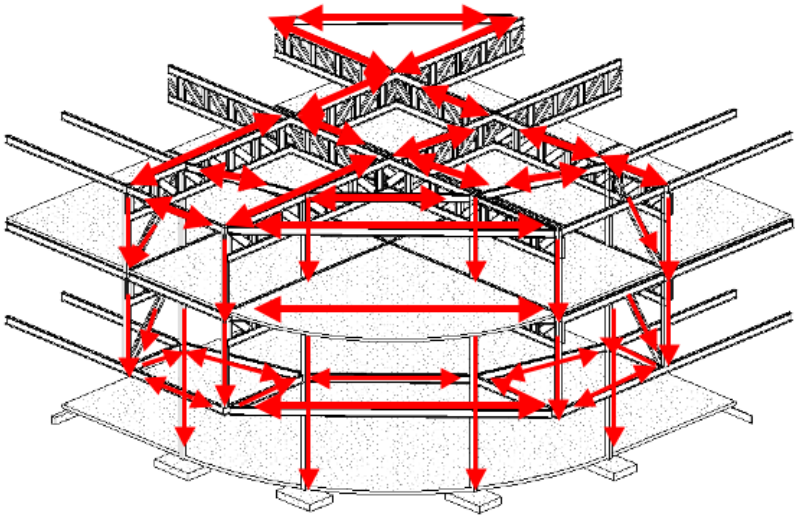
- **Truss Beams: W18x35**
- **Truss Columns:**
  HSS 16x16x5/8
  (Uses moment frame columns)
- **Truss Diagonals:**
  HSS 6x6x1/2

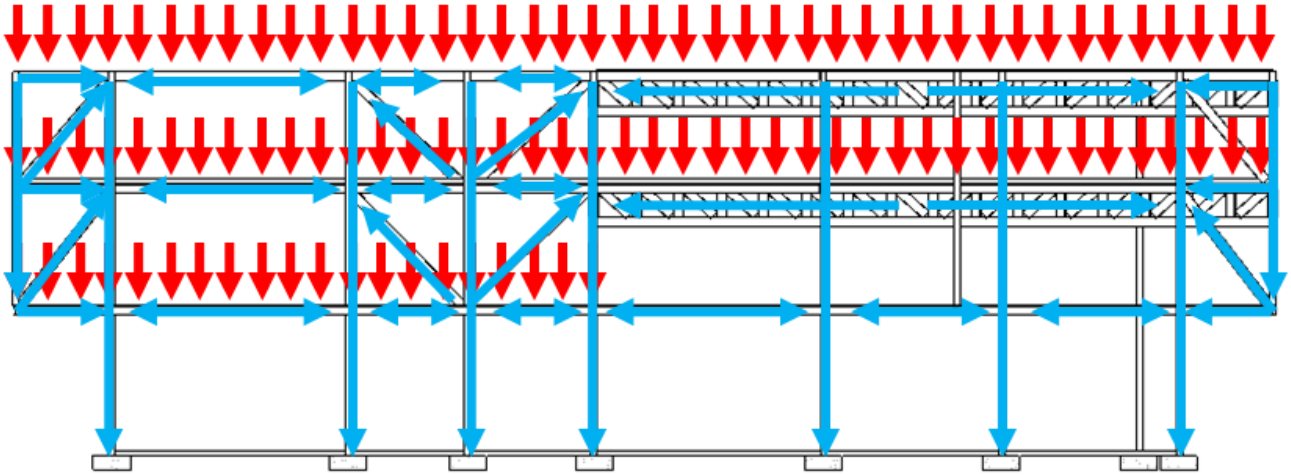


- **Takes advantage of large columns to transfer load to it**

E

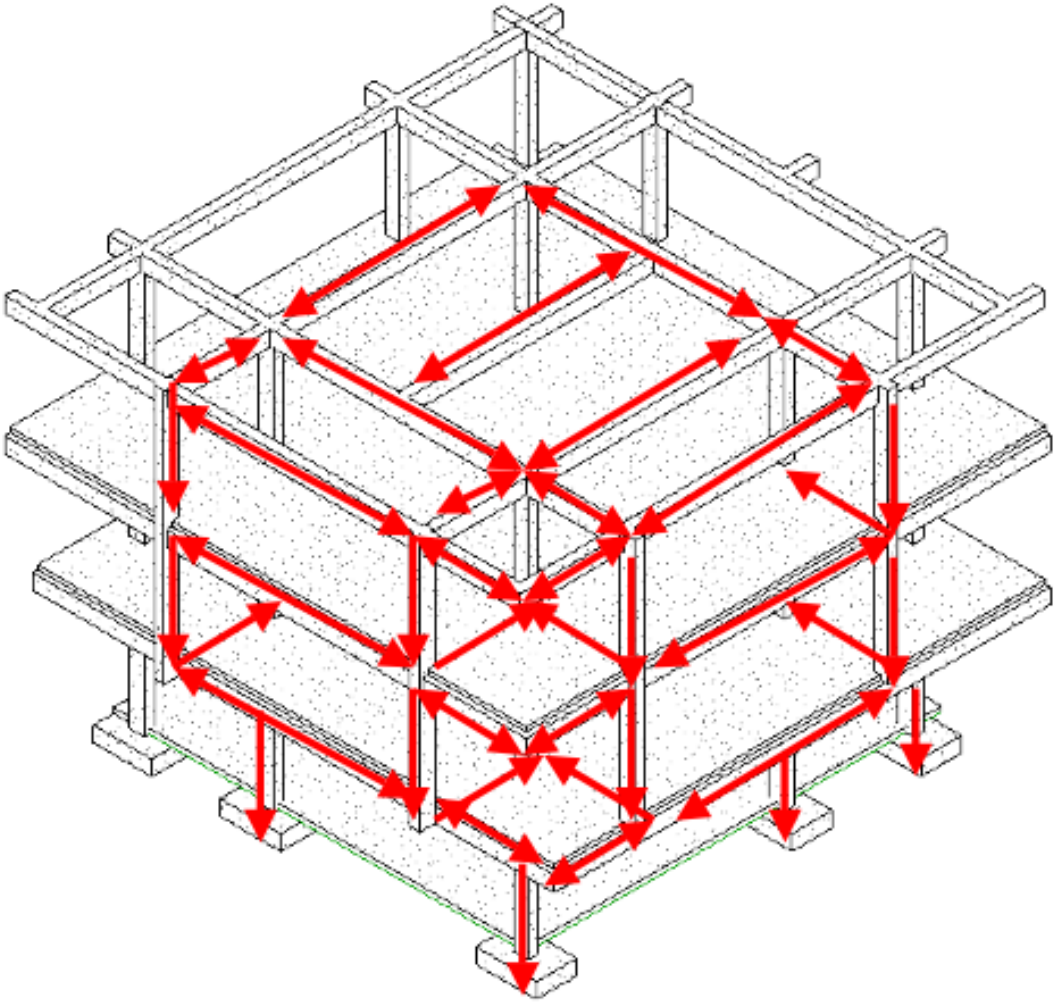
Gravity Load Path





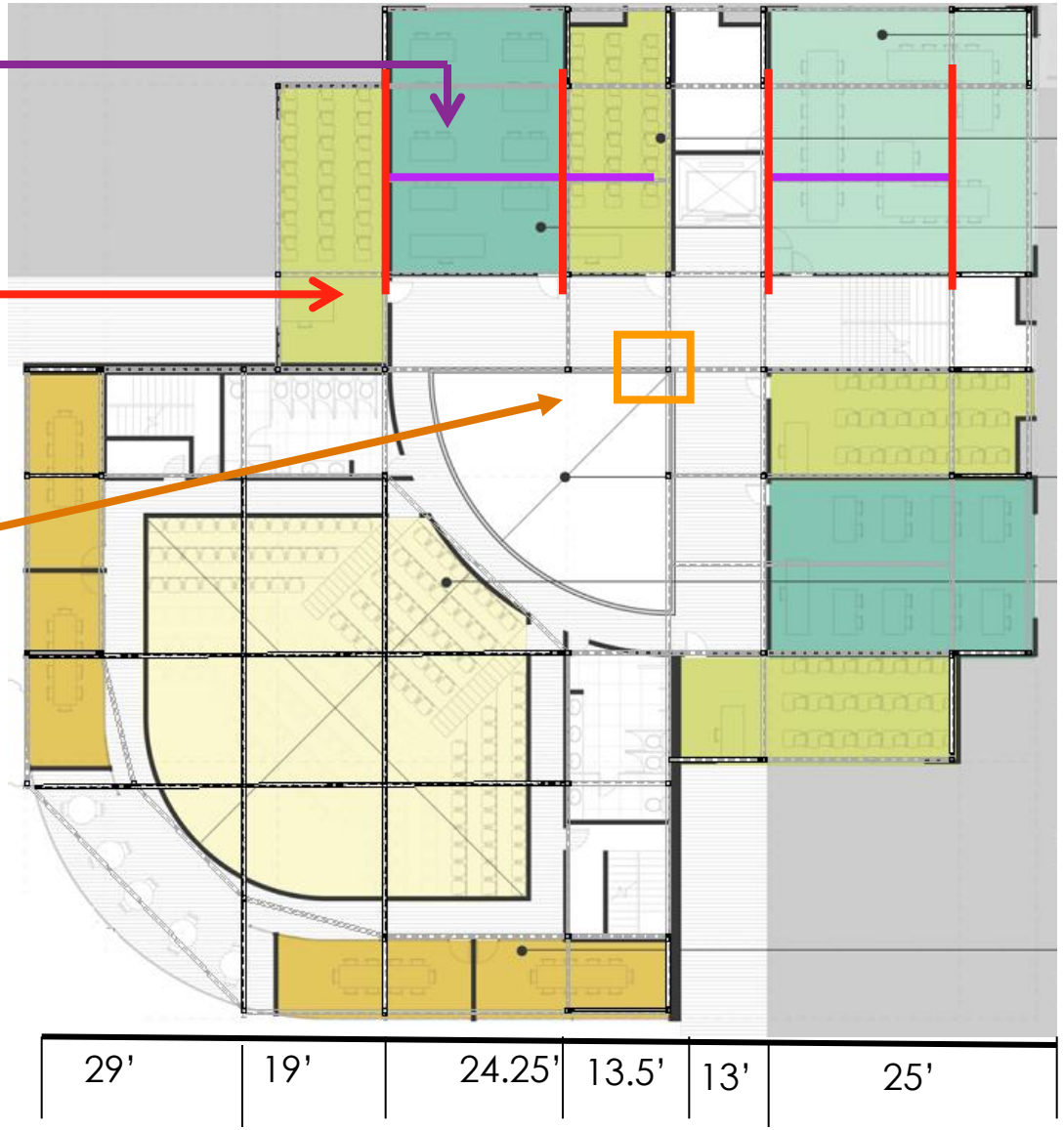
E

Gravity Load Path



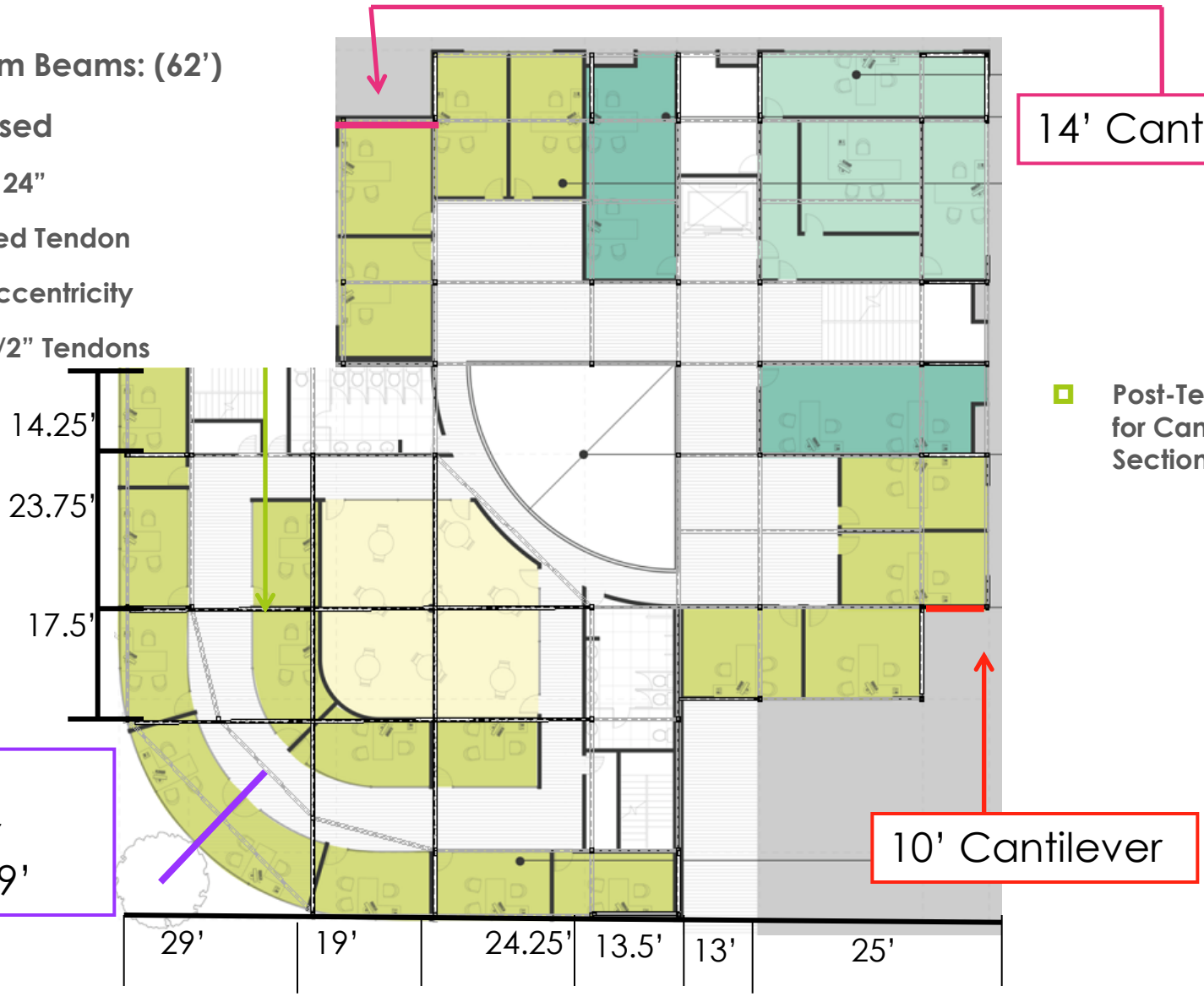
E Concrete Solution– Typical Member Sizes

- Typical Beam: 20” x 12”
  - 6 # 8 Rebar
- Typical Girder: 22” x 16”
  - 6 #8 Rebar
- Gravity Columns: 14” x 14”
  - 6 #8 Rebar
- 8” Post-Tensioned Two-Way Concrete Slab



E Concrete Solution – Auditorium and Cantilevers

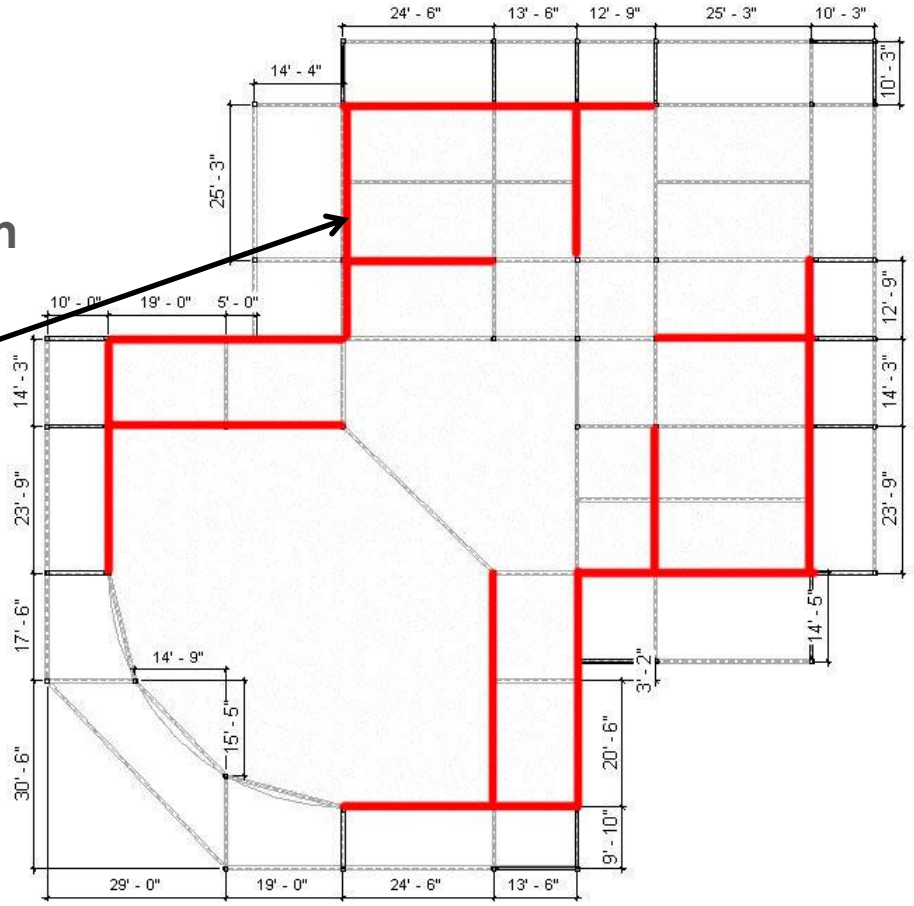
- Auditorium Beams: (62')
- Pre-Stressed
  - 48" x 24"
  - Harped Tendon
  - 15" Eccentricity
  - 30 -1/2" Tendons



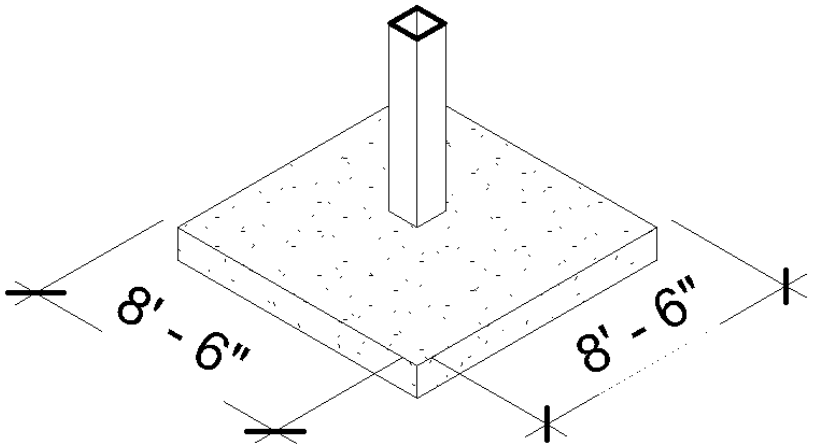
- Post-Tensioning for Cantilevered Sections

E Concrete Solution – Lateral System sizes – First Floor Plan

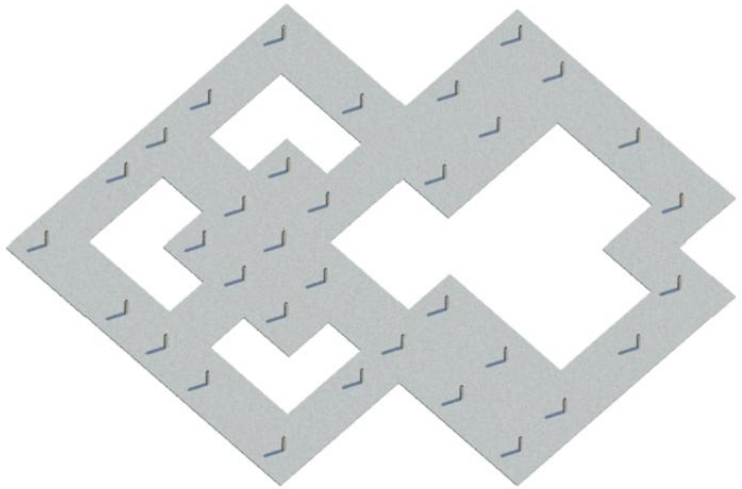
- Lateral System
  - Symmetry to minimize torsion
- SMF
  - Preliminary Beam: 20” x 24”
  - Columns: 24” x 24”



E Foundations



Alternatives

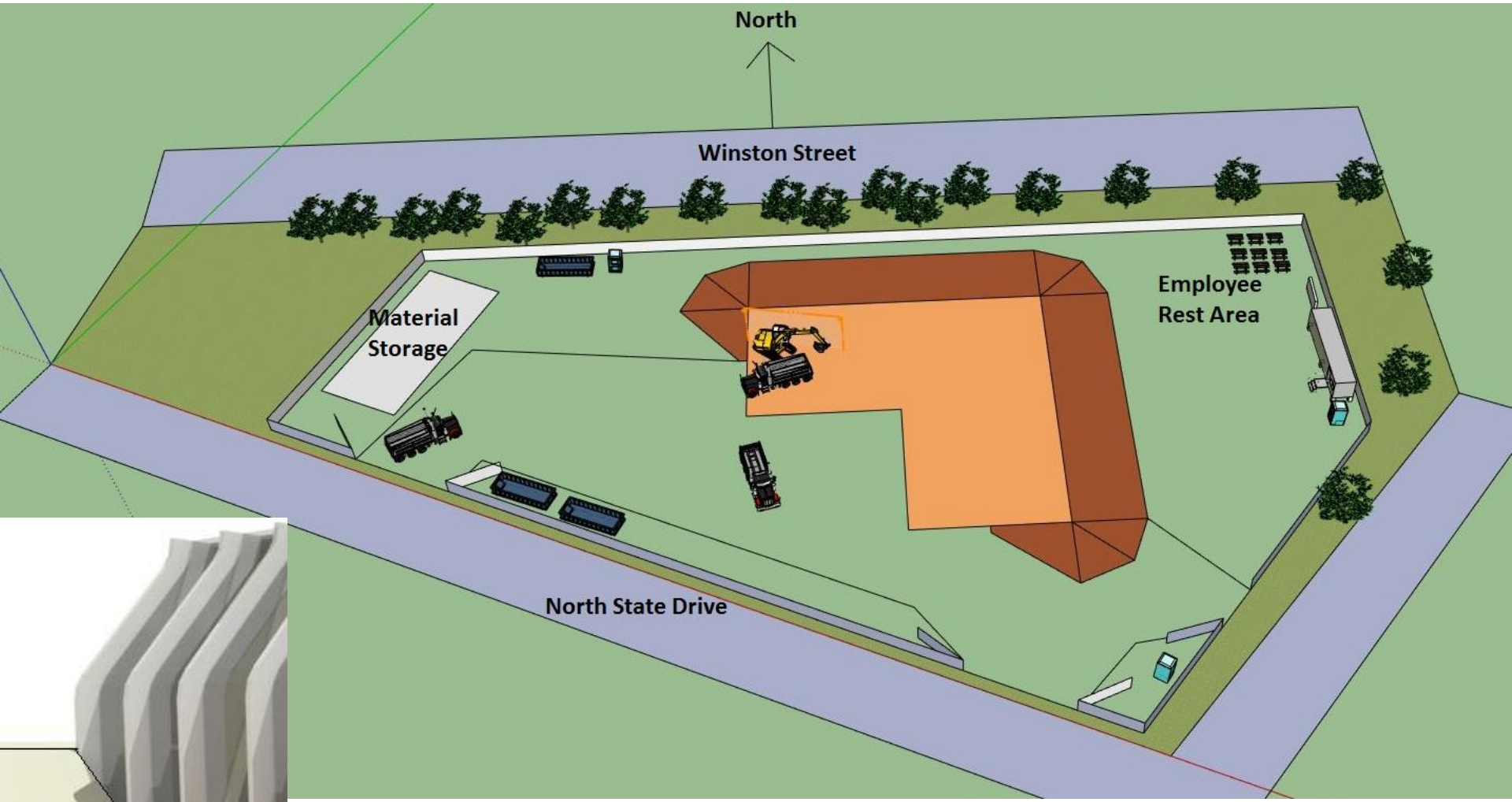


- Isolated Footing
  - 18" Thickness
  - #8 Rebar at 4.5" center-to-center
- Strip Footing
  - Along Exterior
- Spread Footing
  - For Interior

E Advantages and Disadvantages

Steel Advantages	Concrete Advantages
▫ Simplified Moment Connections (ConXtech) ▫ Allows for open floor plans ▫ Faster erection time ▫ Simple transition/connection into truss members ▫ Allows for trusses to be erected for cantilevered areas	▫ Slightly cheaper Material ▫ Ease of connecting angular members

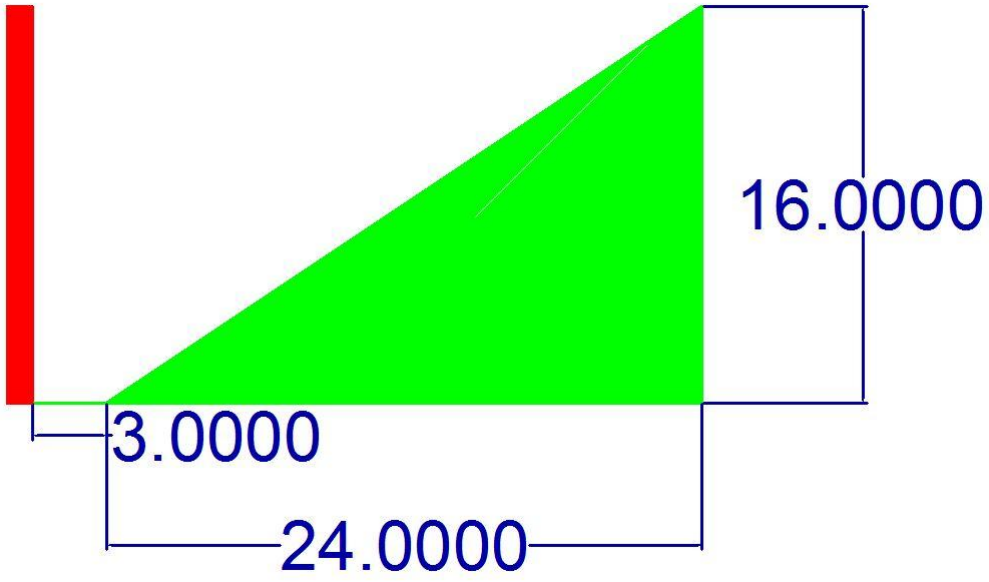
C Site Plan - Excavation



C

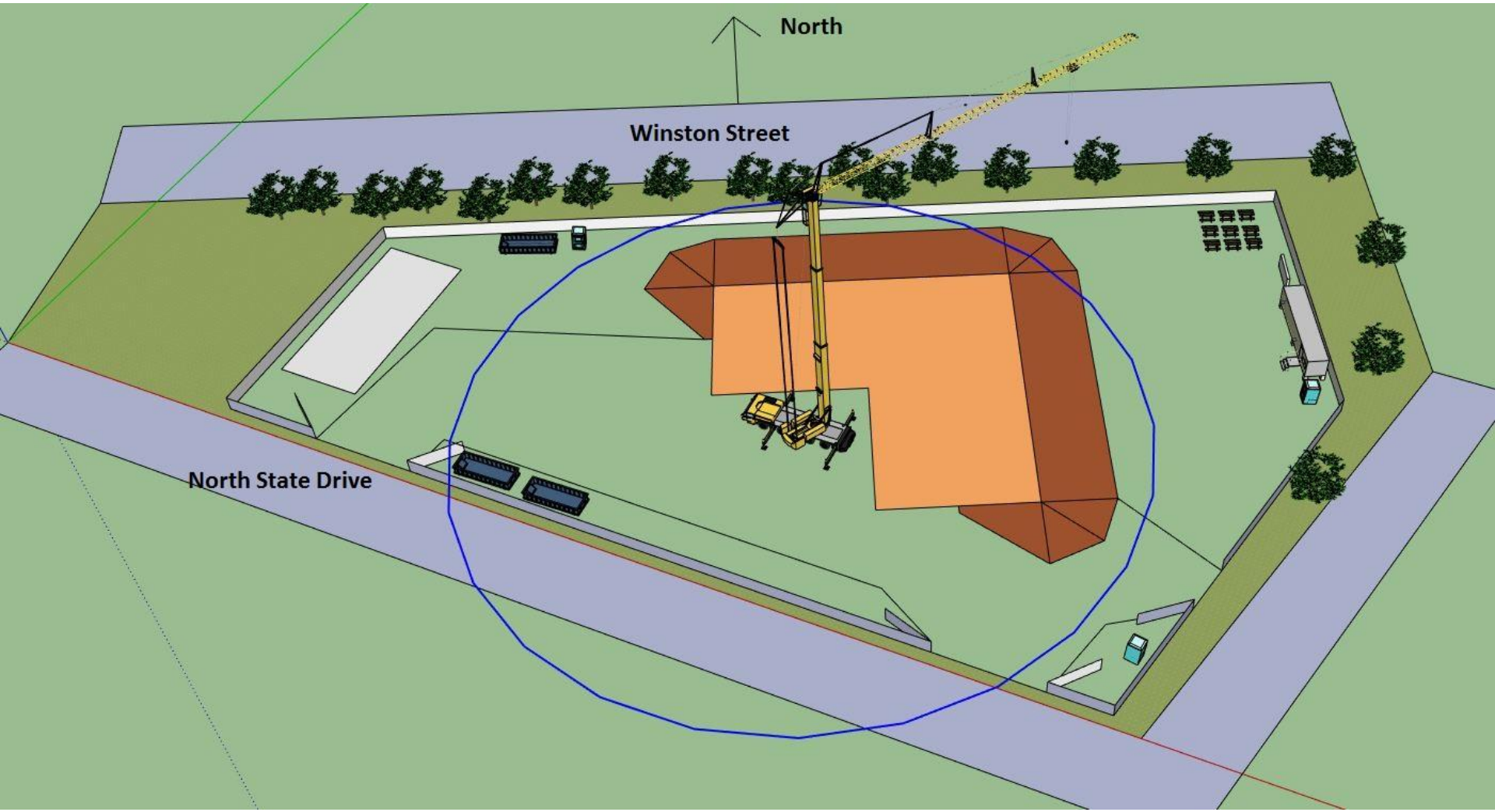
Site Conditions

Soil Conditions
Well sorted fine to medium sand
Bearing Capacity: 3500psf
Not in Liquefaction Zone
Water Table: 14ft below grade



Site Section View

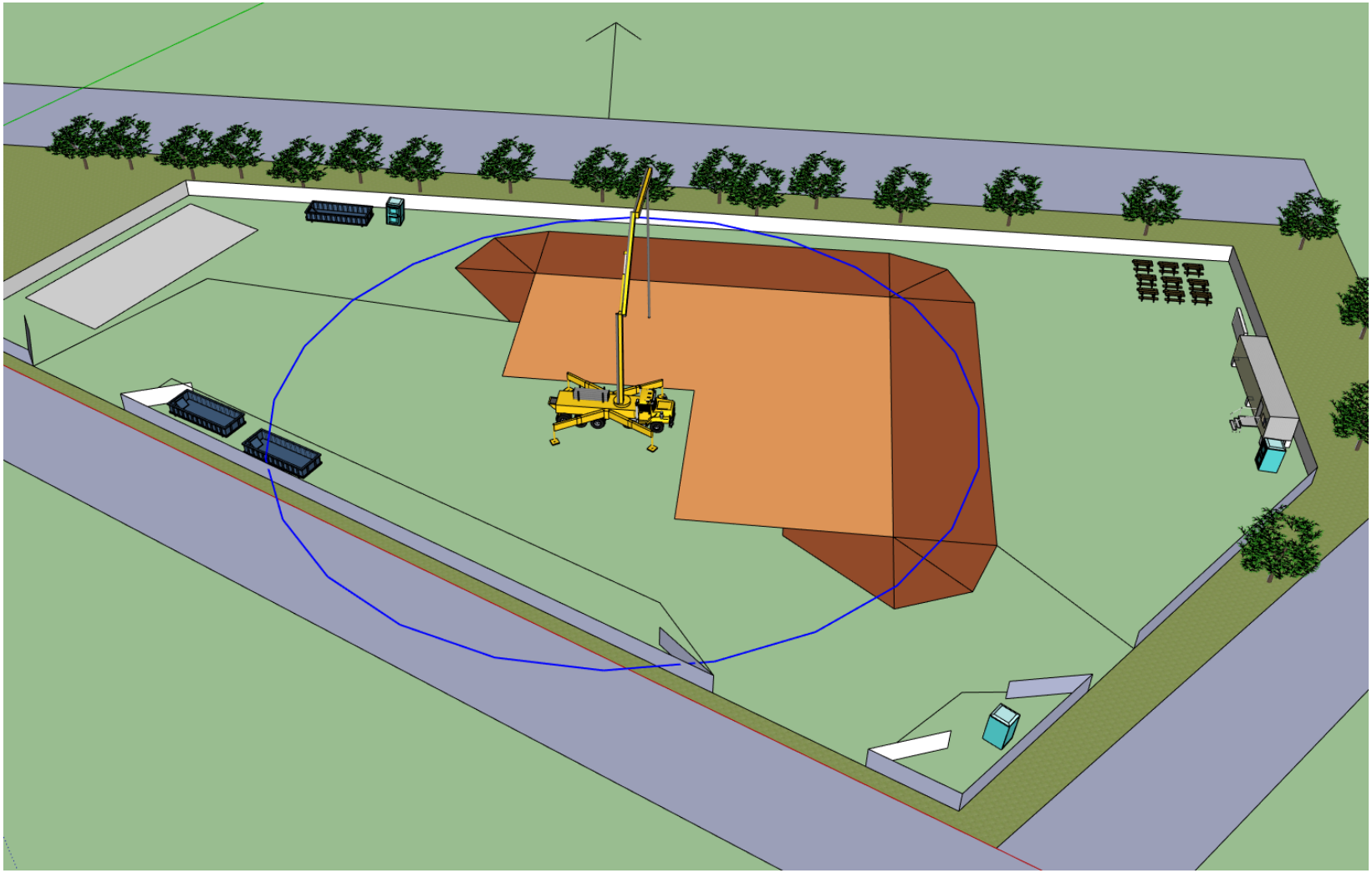
C Site Plan – Crane Placement



Crane has required swing of 125’

C

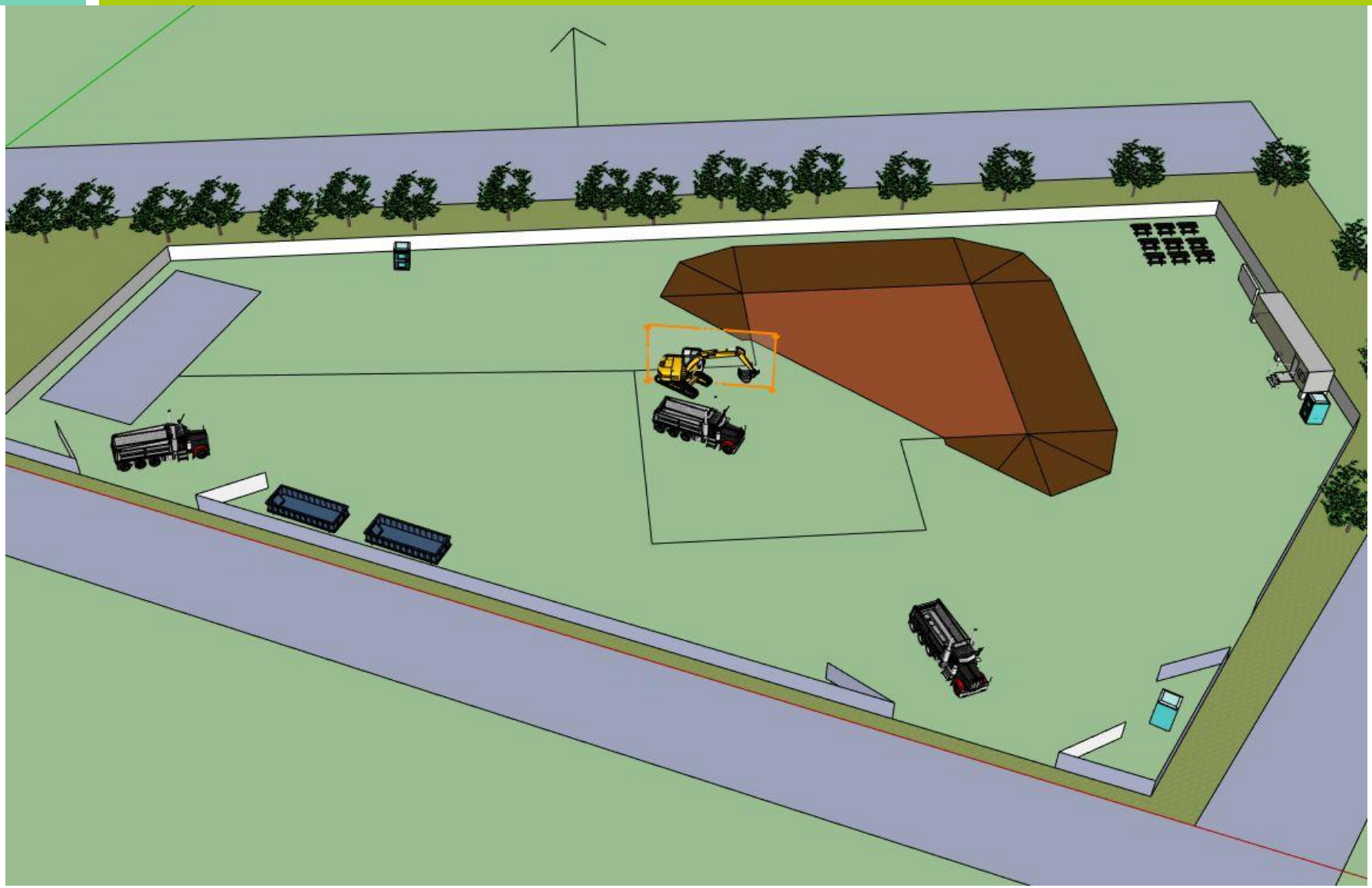
Site Plan – Concrete Pump Truck Placement



Pump Truck swing 100’

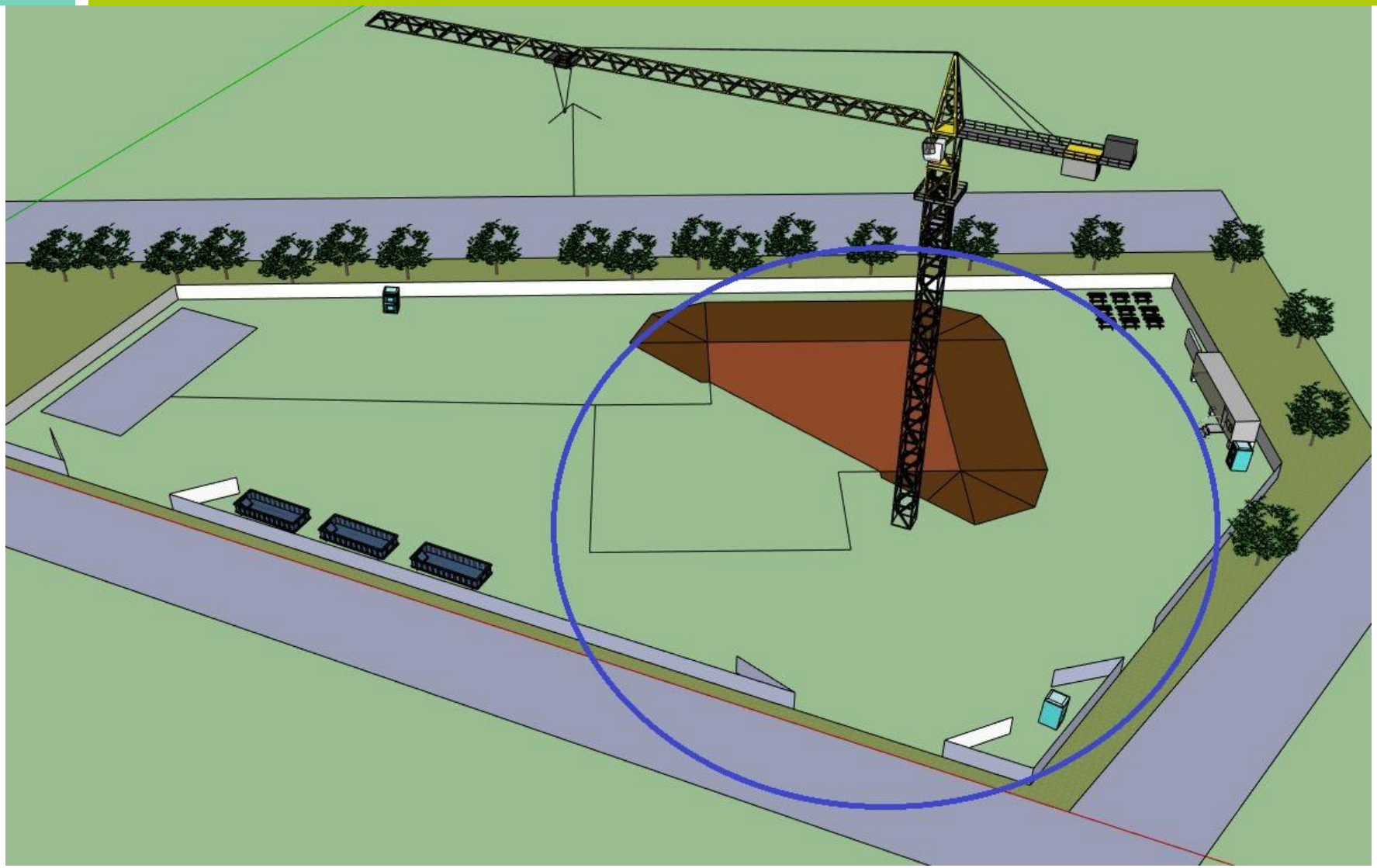
C

Site Plan – Excavation



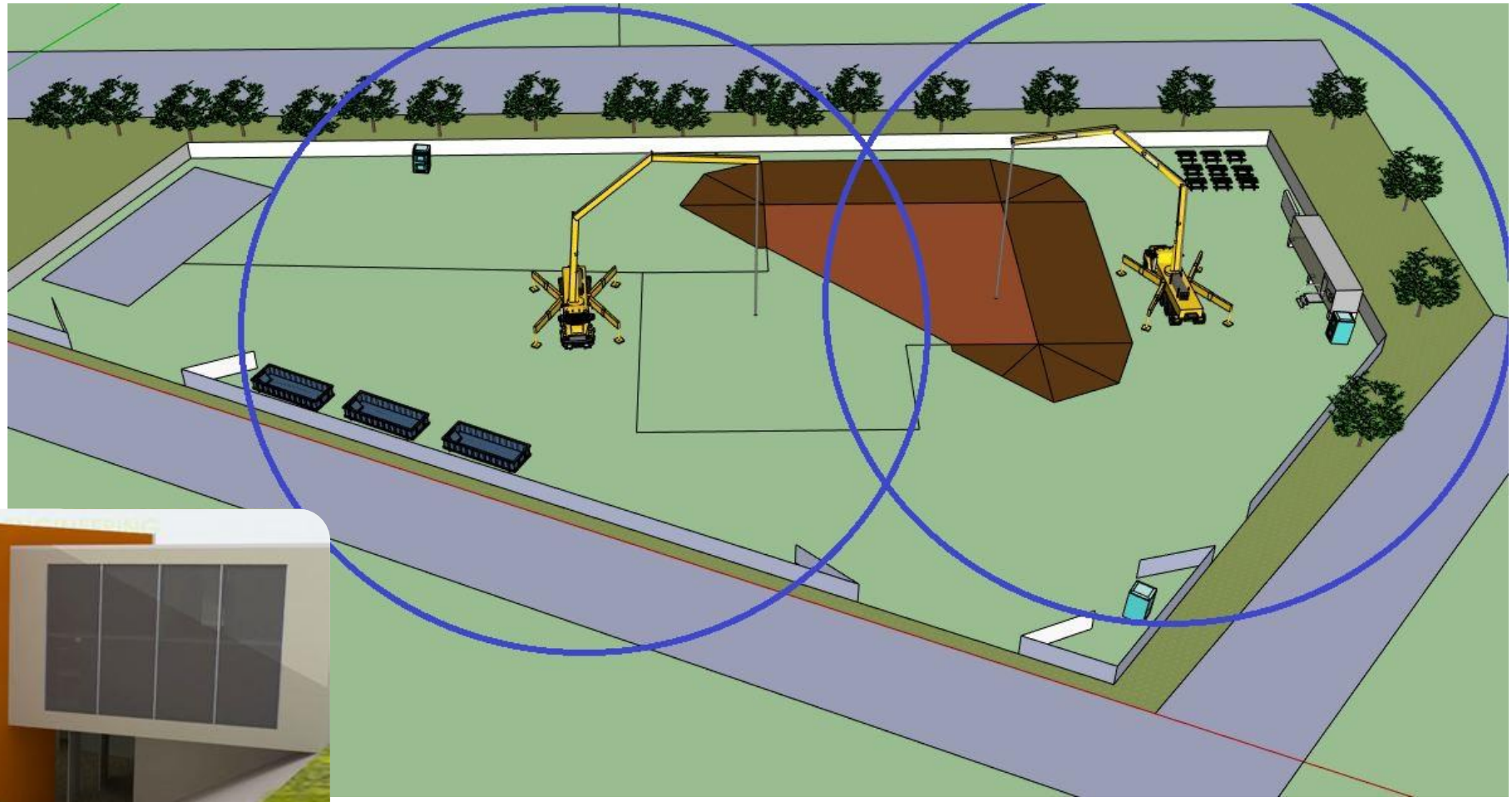
C

Site Plan – Crane



Crane has required swing of 125’

C Site Plan – Concrete Pump Truck



Pump Truck swing 100’

C Equipment

Tower Crane or Mobile crane

- Max. peak load 3 sh.tn
- Radius 90-125 foot

- Max. peak load 3,1 sh.tn
- Radius 0-210 foot

Excavators

- Weight 33 sh.tn
- Bucket 2,2 yd³

Dumper

- Capacity 26 sh.tn
- Bucket 16,9 yd³

Wheel loaders

- Weight 12 sh.tn
- Bucket 3,3 yd³

C

Site Access

Traffic

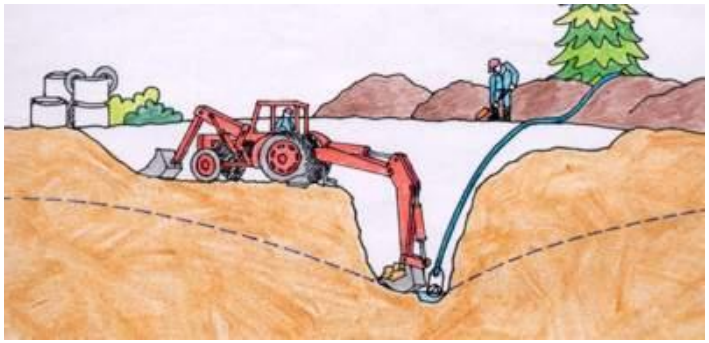
Pedestrian

Critical spots

C

Risks

- Construction
  - Keep time for superstructure
  - Safety on site
  - Ground water level
  - Utilities (location and depth)

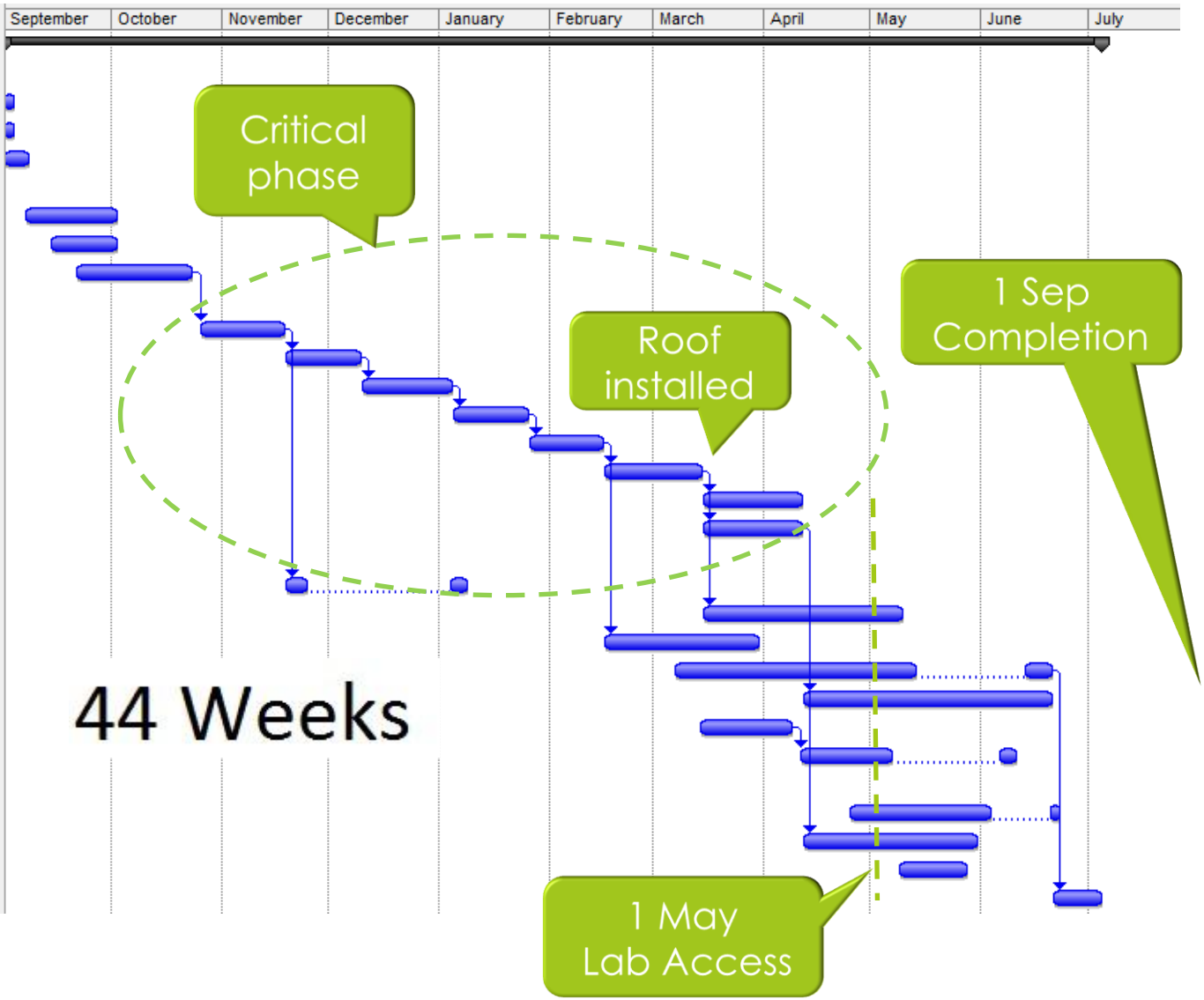


811

Know what's **below.**
Call before you dig.

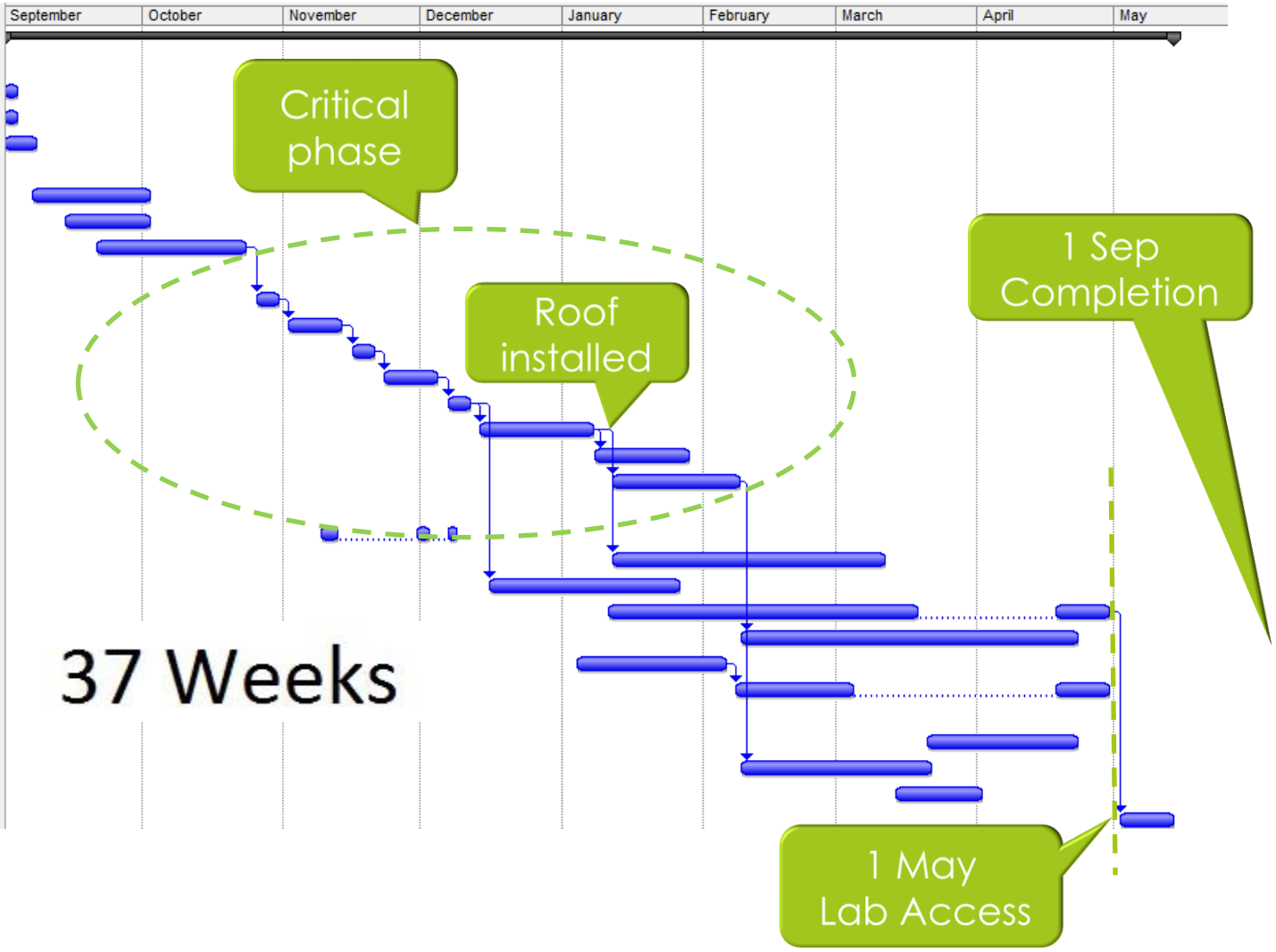
C Schedule Skeleton in Concrete

Task Name	Duration
Project duration	**220 days?**
Establishment	**5 days**
Site survey	3 days
Instal erosion control	3 days
Mobilize Excavation Crew	5 days
Sub Structure	**35 days**
Excavate/Foundation	20 days
Electrical/Plumbing rough in	15 days
Basement construction	25 days
Superstructure and Shell	**121 days**
Set Colums/Beams B	18 days
Decking/Electrical/Plumbing L1	15 days
Set Colums/Beams L1	18 days
Decking/Electrical/Plumbing L2	15 days
Set Colums/Beams L2	15 days
Set roof L2	20 days
Set fascade B, L1 and L2	20 days
Set windows B, L1 and L2	20 days
Interior/Installation	**153 days**
Stairs	9 days
Ventilation B, L1 and L2	40 days
Plumbing	32 days
Electrical B, L1 and L2	56 days
Indoor walls B, L1 and L2	50 days
Elevators	20 days
Fire protection / larm	25 days
Finalizing	**60 days?**
Painting etc	33 days
Excavation/ restore outside	35 days
Equipment	15 days?
Final Inspection	10 days



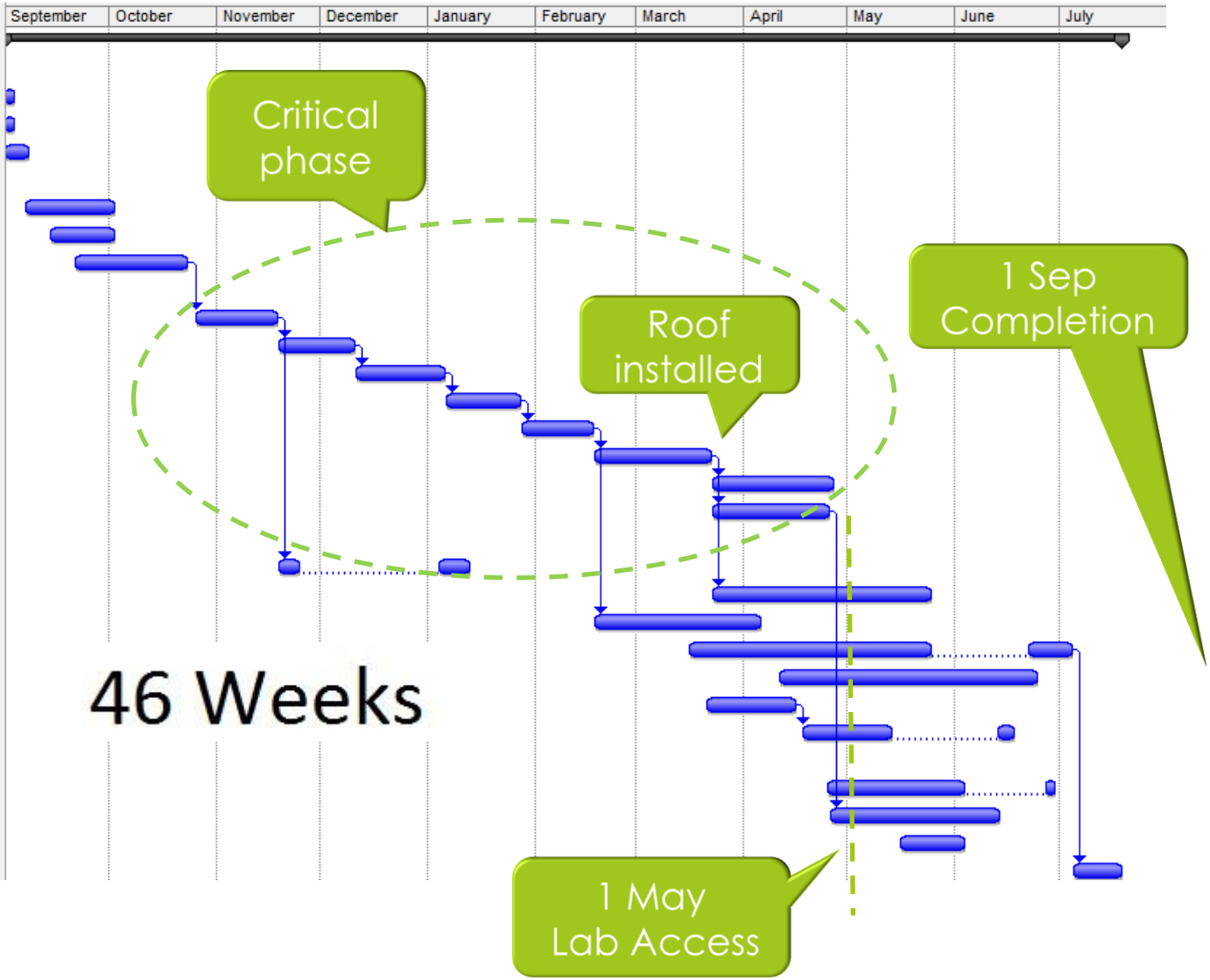
C Schedule Skeleton in Steel

Task Name	Duration
Project duration	**184 days?**
Establishment	**5 days**
Site survey	3 days
Instal erosion control	3 days
Mobilize Excavation Crew	5 days
Sub Structure	**35 days**
Excavate/Foundation	20 days
Electrical/Plumbing rough in	15 days
Basement construction	25 days
Superstructure and Shell	**76 days**
Set Colums/Beams B	5 days
Decking/Electrical/Plumbing L1	10 days
Set Colums/Beams L1	5 days
Decking/Electrical/Plumbing L2	10 days
Set Colums/Beams L2	5 days
Set roof L2	19 days
Set fascade B, L1 and L2	15 days
Set windows B, L1 and L2	20 days
Interior/Installation	**125 days**
Stairs	9 days
Ventilation B, L1 and L2	44 days
Plumbing	30 days
Electrical B, L1 and L2	60 days
Indoor walls B, L1 and L2	54 days
Elevators	25 days
Fire protection / larm	30 days
Finalizing	**69 days?**
Painting etc	25 days?
Excavation/ restore outside	30 days
Equipment	15 days?
Final Inspection	10 days



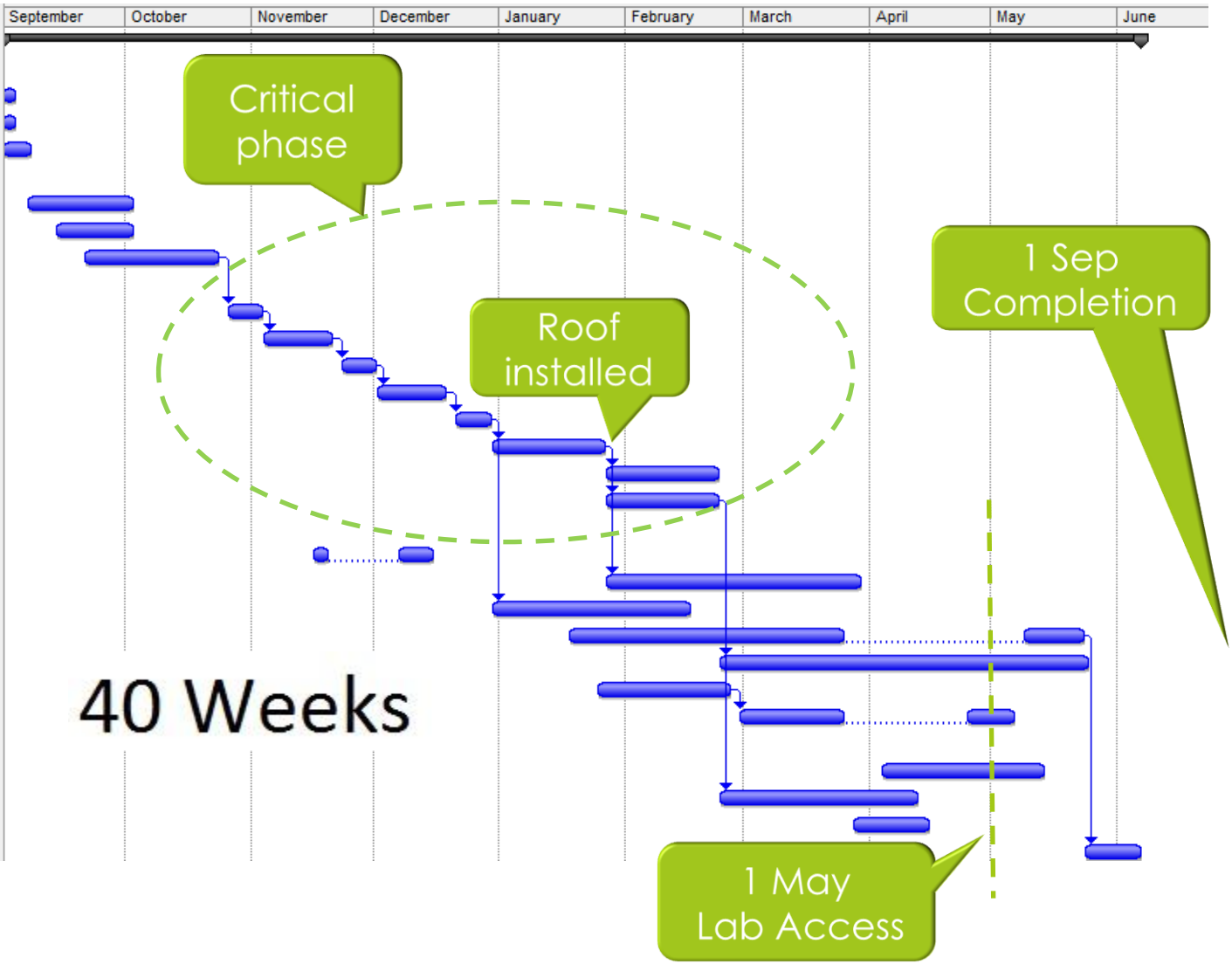
C Schedule Gateway in Concrete

Task Name	Duration
Project duration	**230 days?**
Establishment	**5 days**
Site survey	3 days
Instal erosion control	3 days
Mobilize Excavation Crew	5 days
Sub Structure	**35 days**
Excavate/Foundation	20 days
Electrical/Plumbing rough in	15 days
Basement construction	25 days
Superstructure and Shell	**132 days**
Set Colums/Beams B	18 days
Decking/Electrical/Plumbing L1	16 days
Set Colums/Beams L1	18 days
Decking/Electrical/Plumbing L2	16 days
Set Colums/Beams L2	15 days
Set roof L2	24 days
Set fascade B, L1 and L2	25 days
Set windows B, L1 and L2	24 days
Interior/Installation	**163 days**
Stairs	11 days
Ventilation B, L1 and L2	45 days
Plumbing	34 days
Electrical B, L1 and L2	59 days
Indoor walls B, L1 and L2	55 days
Elevators	20 days
Fire protection / larm	25 days
Finalizing	**61 days?**
Painting etc	33 days
Excavation/ restore outside	35 days
Equipment	15 days?
Final Inspection	10 days



C Schedule Gateway in Steel

Task Name	Duration
Project duration	**200 days?**
Establishment	**5 days**
Site survey	3 days
Instal erosion control	3 days
Mobilize Excavation Crew	5 days
Sub Structure	**35 days**
Excavate/Foundation	20 days
Electrical/Plumbing rough in	15 days
Basement construction	25 days
Superstructure and Shell	**87 days**
Set Colums/Beams B	7 days
Decking/Electrical/Plumbing L1	13 days
Set Colums/Beams L1	7 days
Decking/Electrical/Plumbing L2	13 days
Set Colums/Beams L2	7 days
Set roof L2	20 days
Set fascade B, L1 and L2	20 days
Set windows B, L1 and L2	20 days
Interior/Installation	**137 days**
Stairs	11 days
Ventilation B, L1 and L2	45 days
Plumbing	35 days
Electrical B, L1 and L2	61 days
Indoor walls B, L1 and L2	65 days
Elevators	25 days
Fire protection / larm	30 days
Finalizing	**74 days?**
Painting etc	30 days
Excavation/ restore outside	35 days
Equipment	15 days?
Final Inspection	10 days



C Estimation

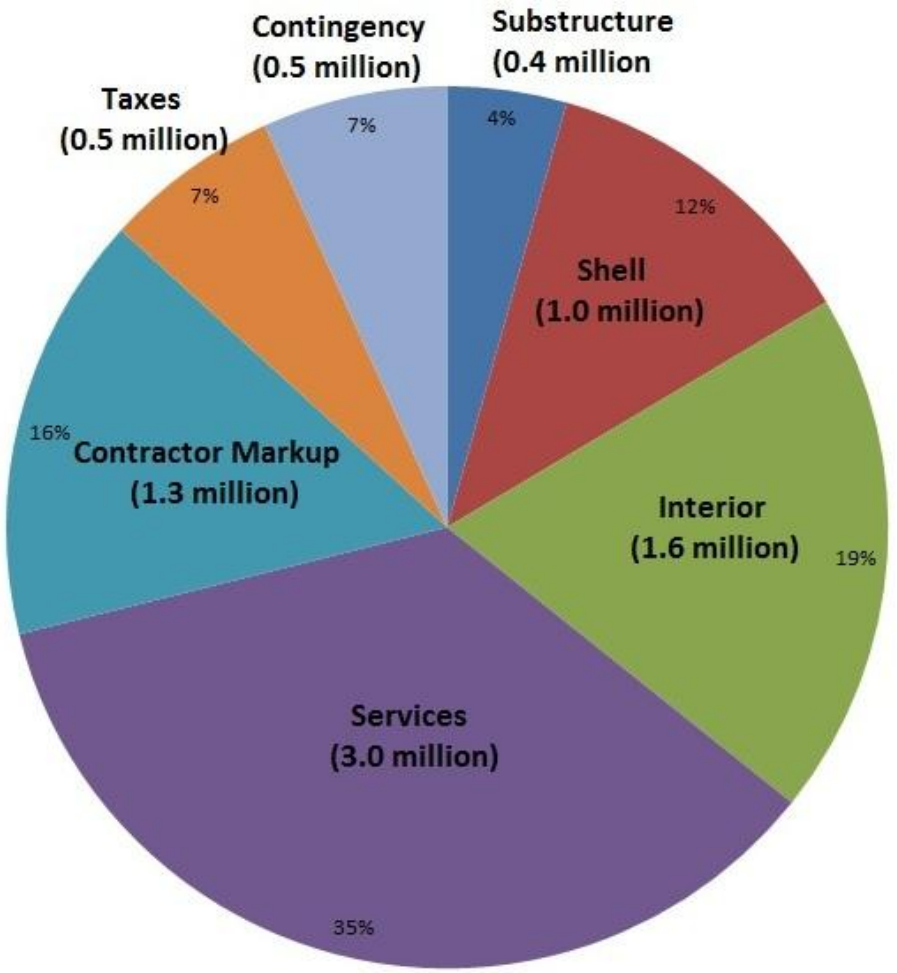
Substructure:
- Foundation
- Slab on Grade
- Basement Excavation
- Basement Walls

Shell:
- Floor Construction
- Roof Construction
- Exterior Walls
- Exterior Windows
- Exterior Doors
- Roof Coverings

Interiors:
- Partitions
- Interior Doors
- Stairs
- Wall Finishes
- Ceiling Finishes
- Floor Finishes

Services:
- Elevator
- Plumbing
- Electrical
- HVAC
- Fire Protection

Target Value

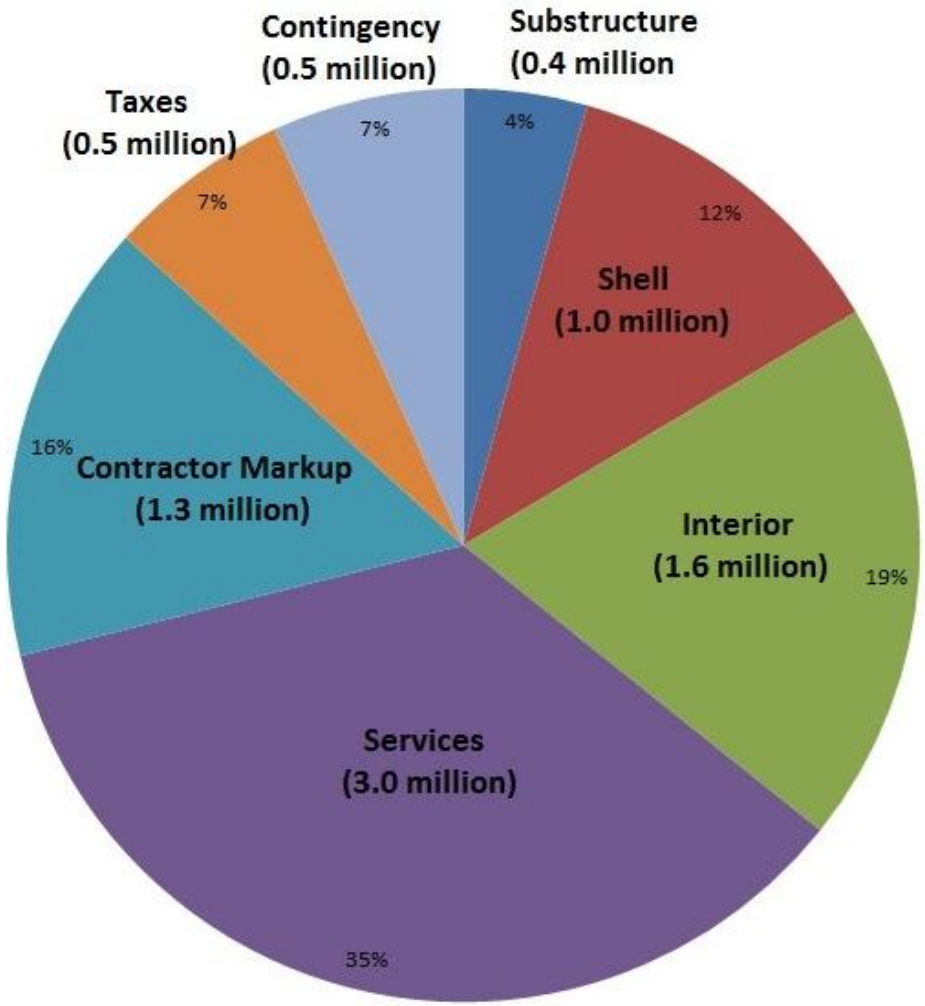


$8,500,000 with contingency

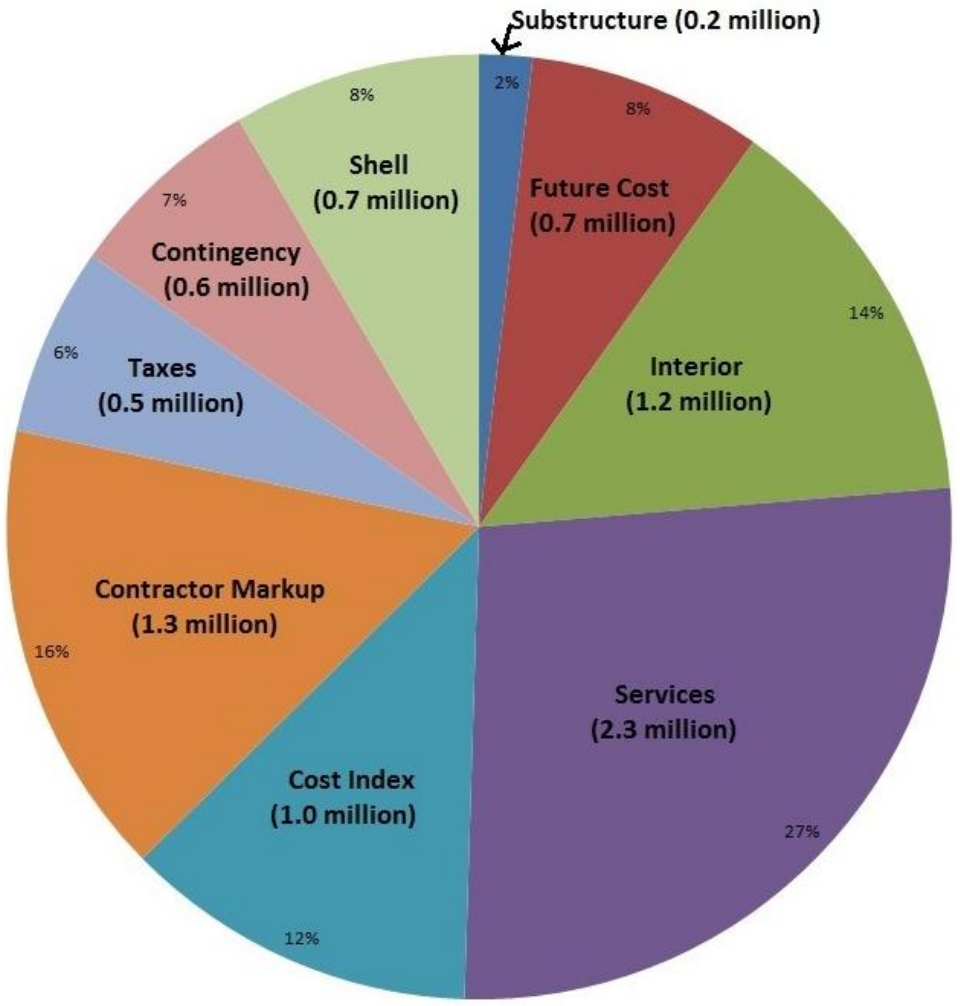
C

Estimation – Target Value

CI, FC Included



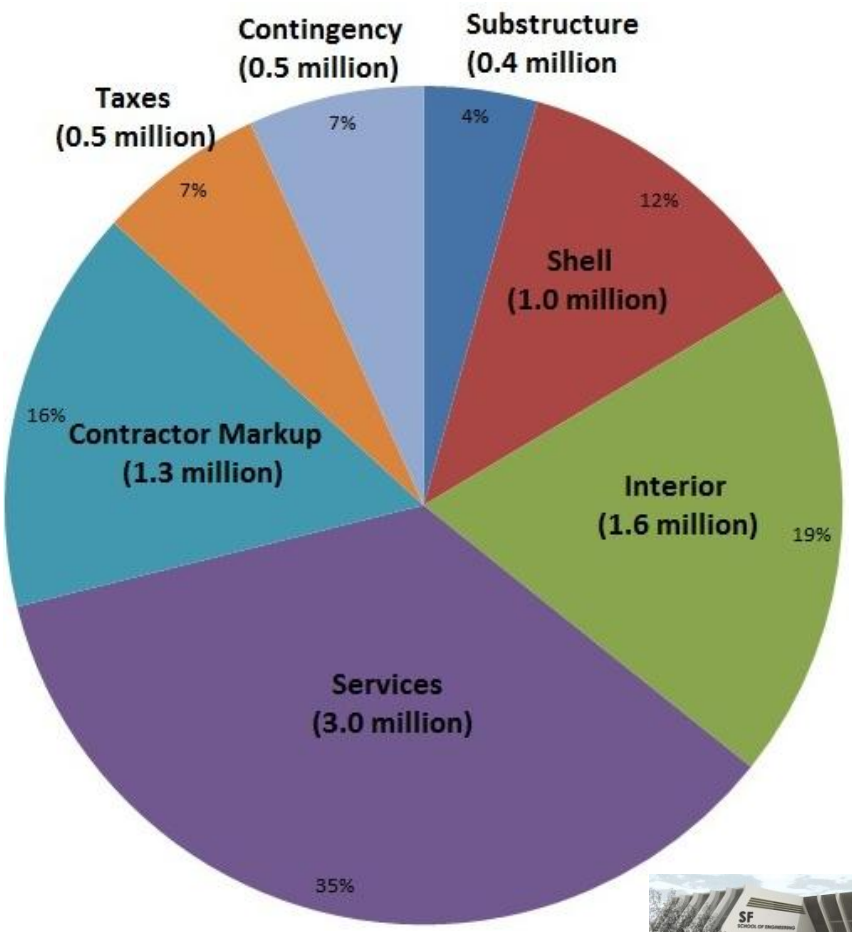
CI, FC Separate

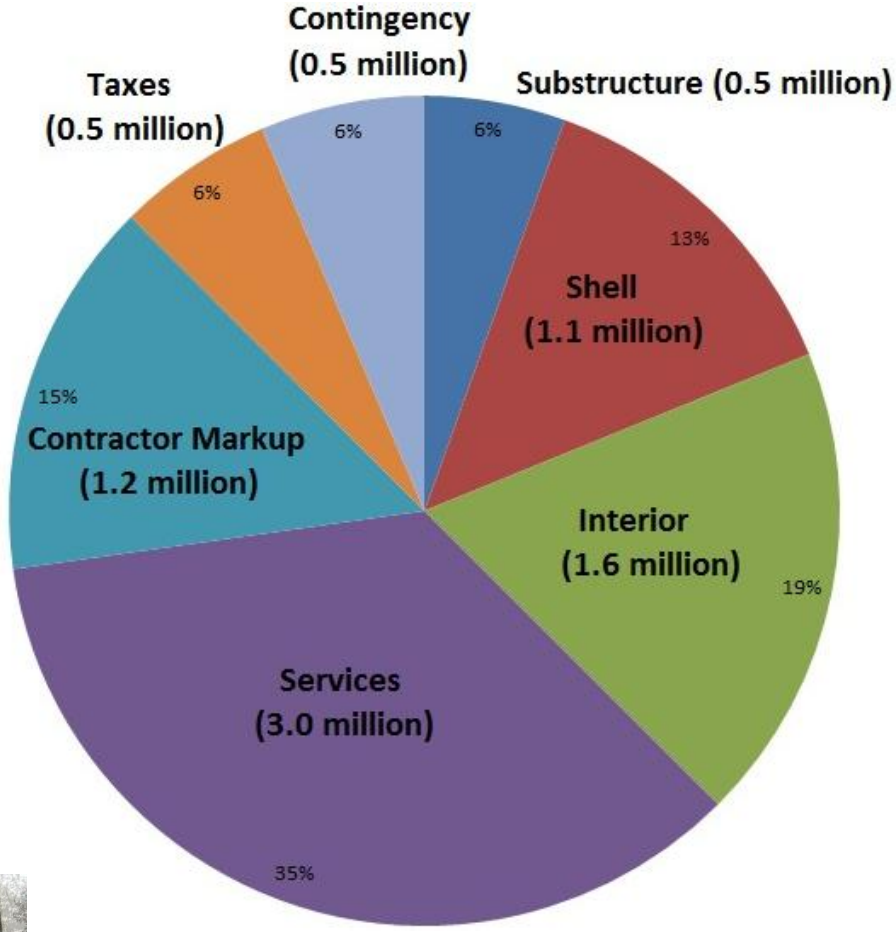


$8,500,000 (with contingency)

C

Estimation – Steel Frame





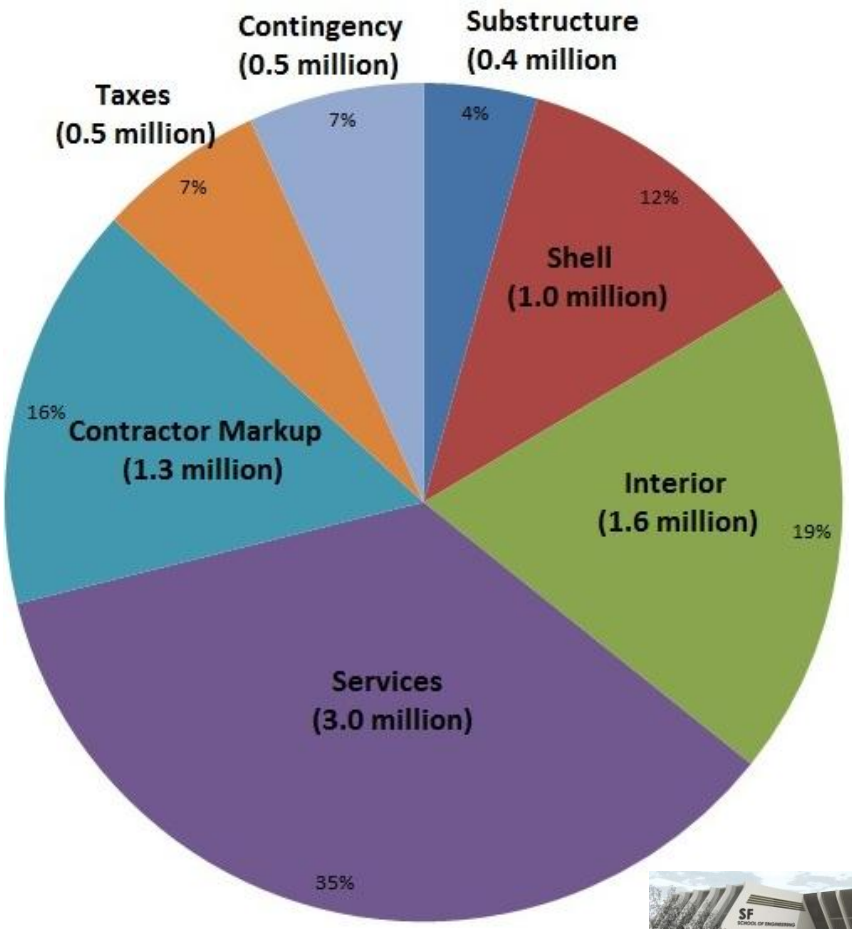
Target Value

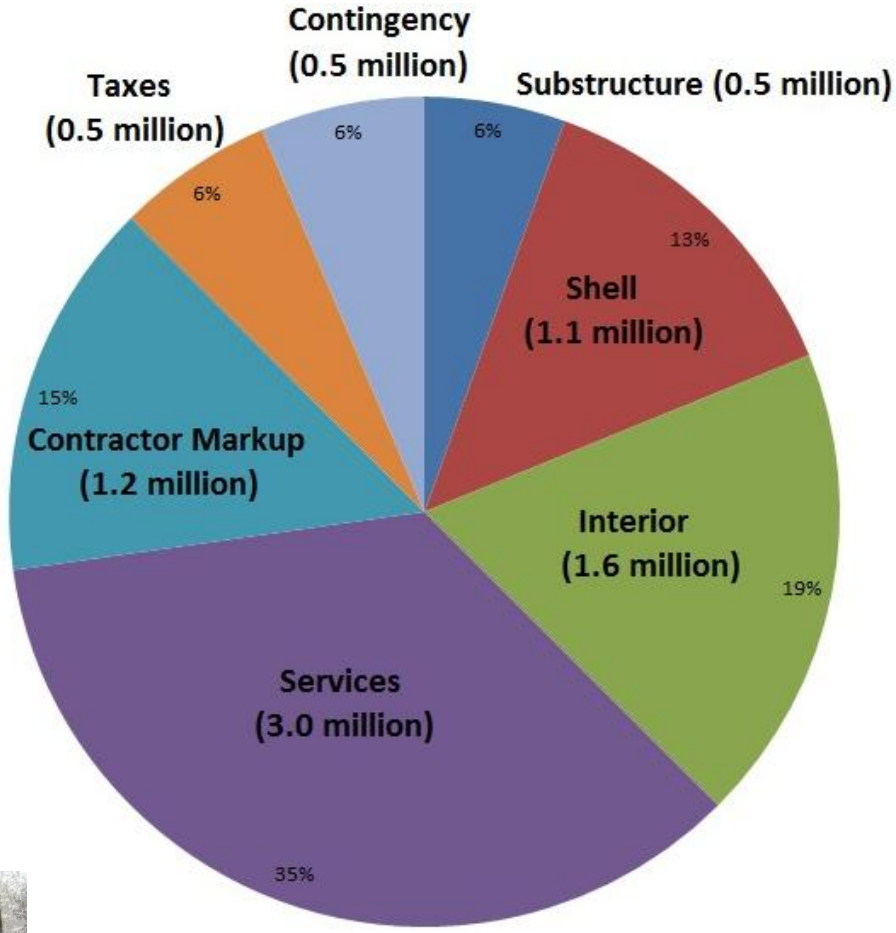
Skeleton: $8.42 million

Gateway: $8.41 million

C

Estimation – Cast-In Place





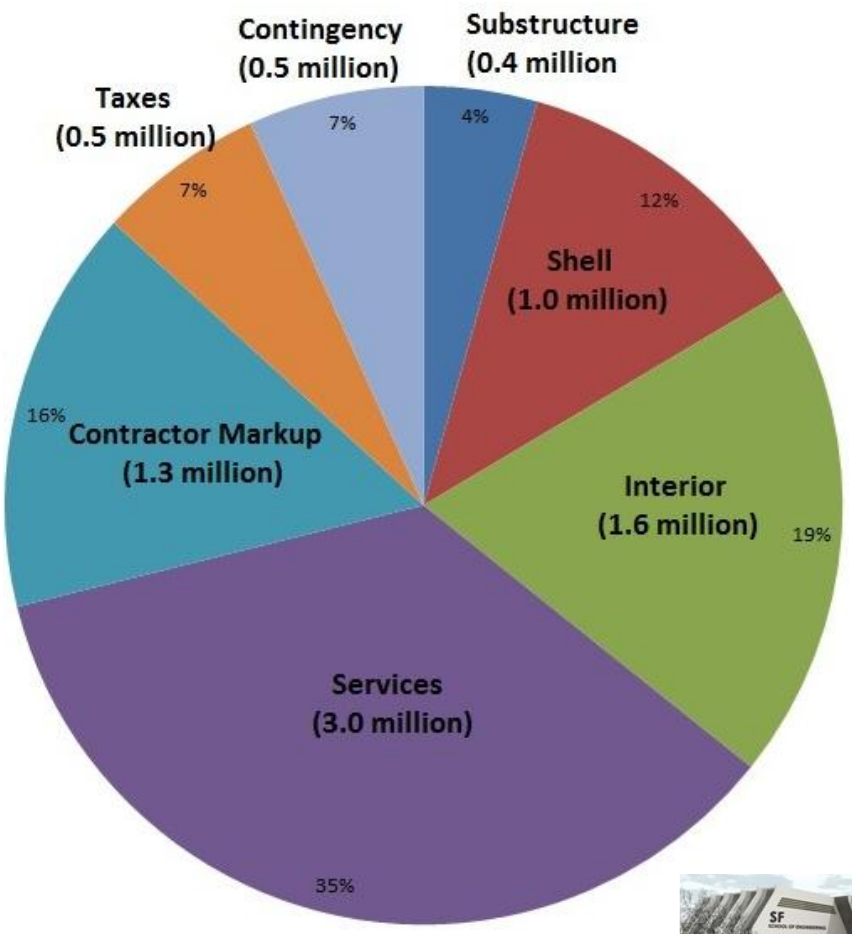
Target Value

Skeleton: $8.18 million

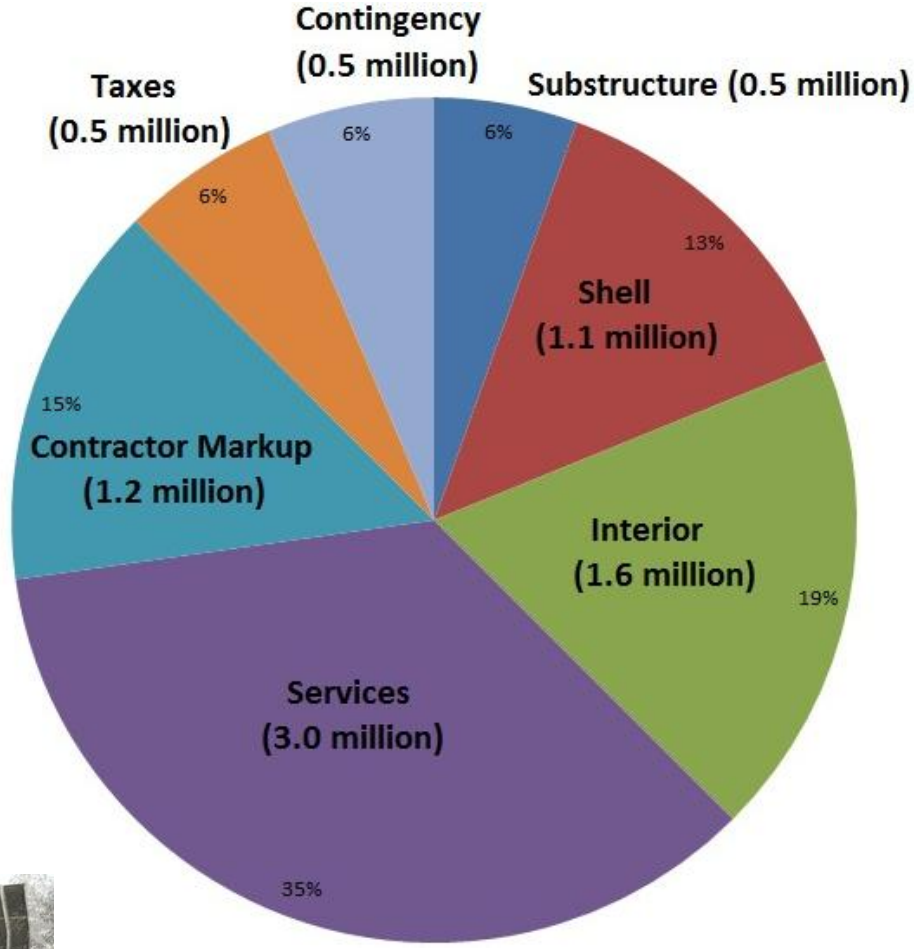
Gateway: $8.18 million

C

Estimation - Precast



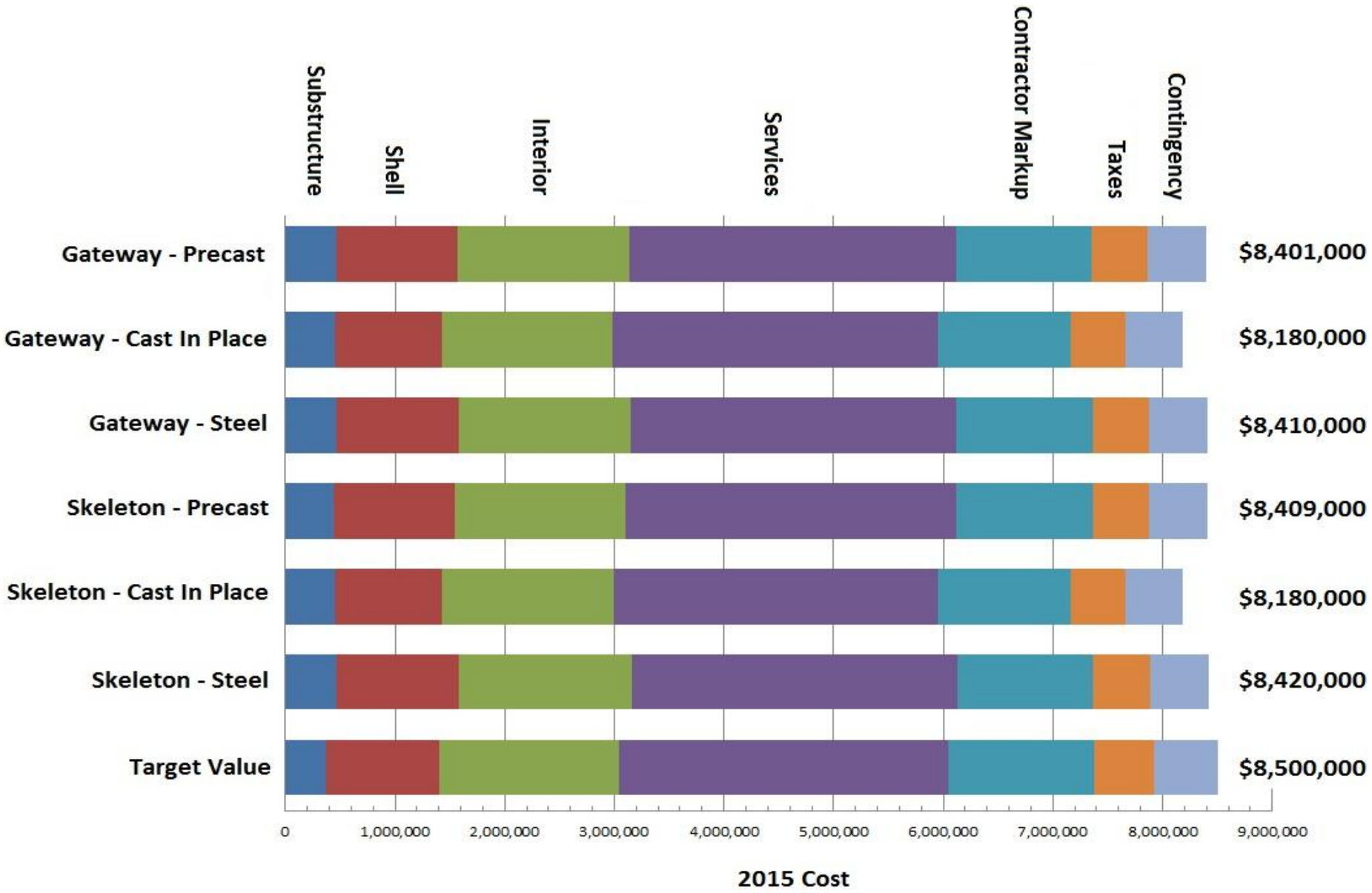
Target Value



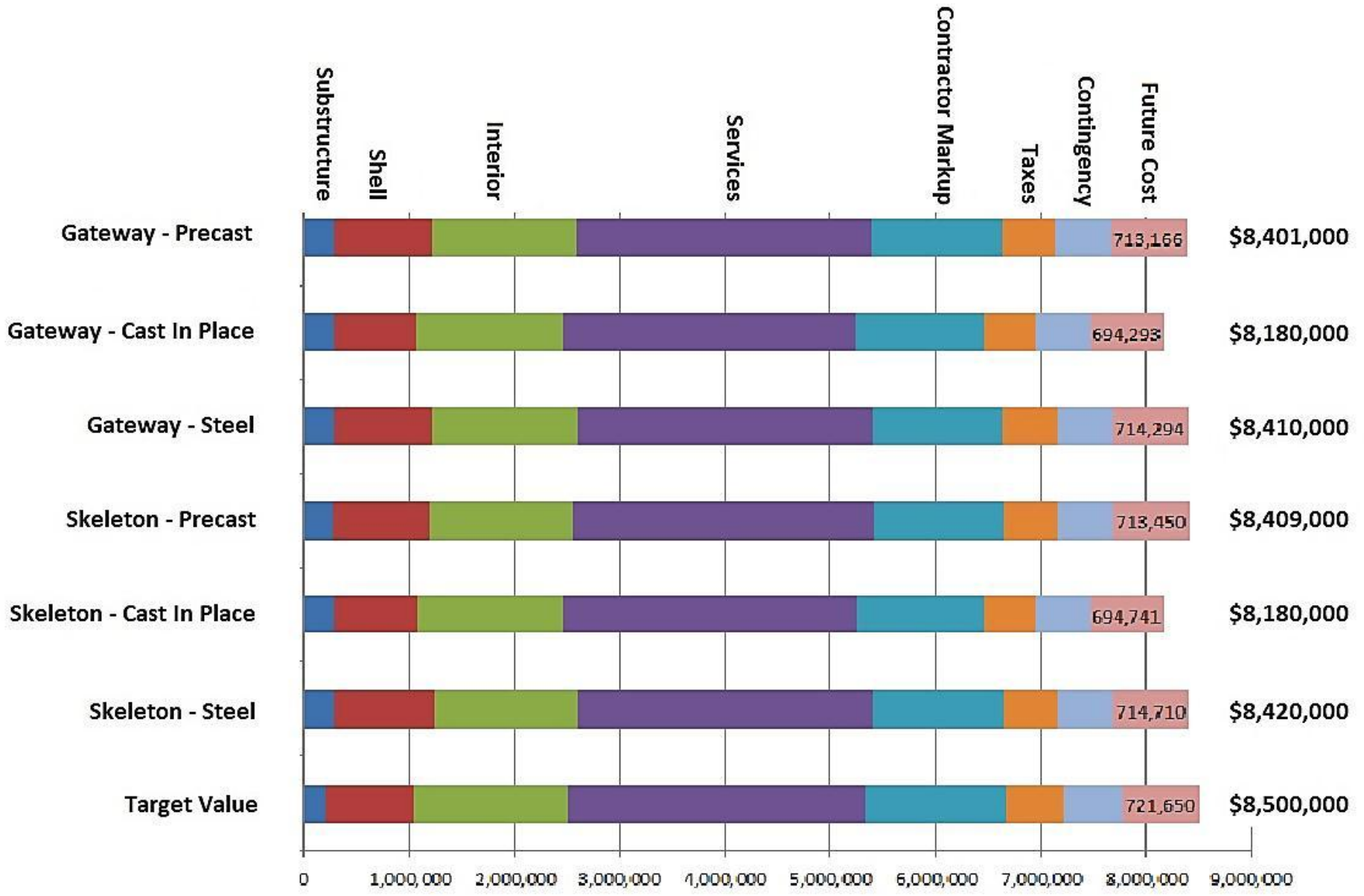
Skeleton: $8.41 million

Gateway: $8.40 million

C Cost Comparison



C Cost Comparison – Future Costs



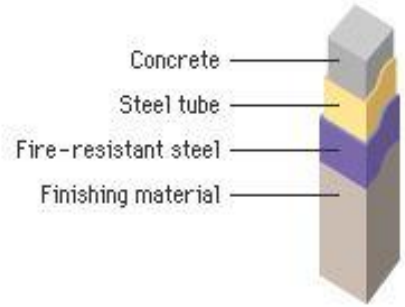
C Component Comparison – Structural Columns

Cast-In Place

M: 15.02
I: 61.20

Total: $76.22/lin. Ft.

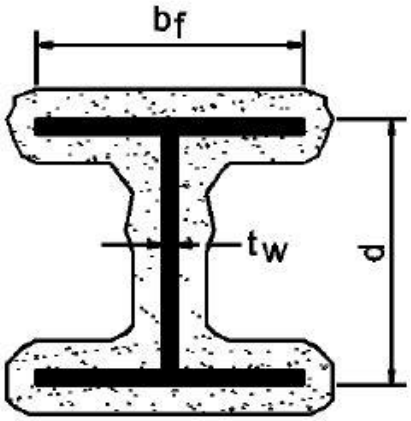
Concrete-filled Steel



M: 47.68
I: 8.36

Total: $56.04/lin. Ft.

Wide Flange



M: 63.93
I: 8.36

Total: $72.29/lin. Ft

Precast

M: 148.01
I: 11.54

Total: 159.55/lin. Ft.

C Component Comparison – Exterior Walls

Cast-In Place	Precast (8'x20')	Precast (8'x8')	Tilt-up	Stucco (Metal Studs)
M: 5.39 I: 17.64 T: 23.03/sf	M: 25.05 I: 4.75 T: 29.79/sf	M: 44.28 I: 4.57 T: 48.81/sf	M: 6.83 I: 7.56 T: 14.39/sf	M: 2.77 I: 10.72 T: 13.50/sf

Skeleton Savings

Tilt-Up Cost = $200,000

Stucco Cost = $188,000

Gateway Savings

Tilt-Up Cost = $197,000

Stucco Cost = $185,000

Savings= **$12,000**

C

Spring Quarter Considerations

CONXTECH
SPACE FRAME SYSTEMS

Benefits over Conventional Steel

- Significant time gain
- Less field labor/no welding
- Lower cost
- Safer work environment
- Better Seismic performance
- Faster inspection

Benefits over Concrete

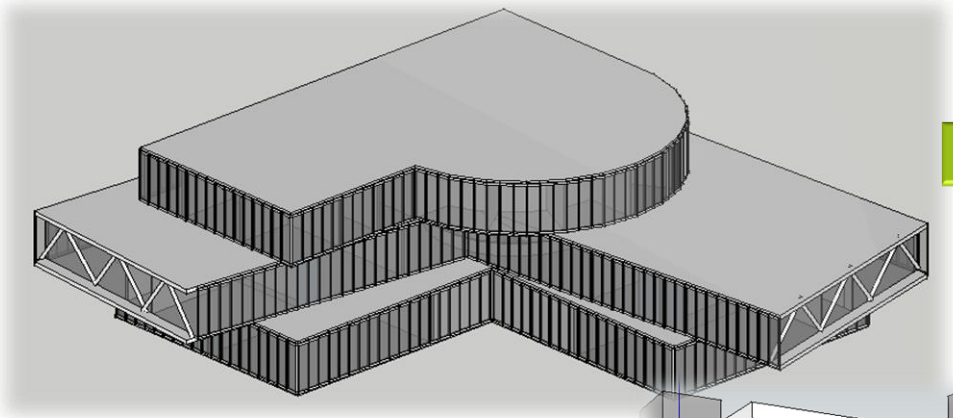
- Lower cost
- Faster construction
- Significantly lower CO_2
- Lighter

Team Process - Communication

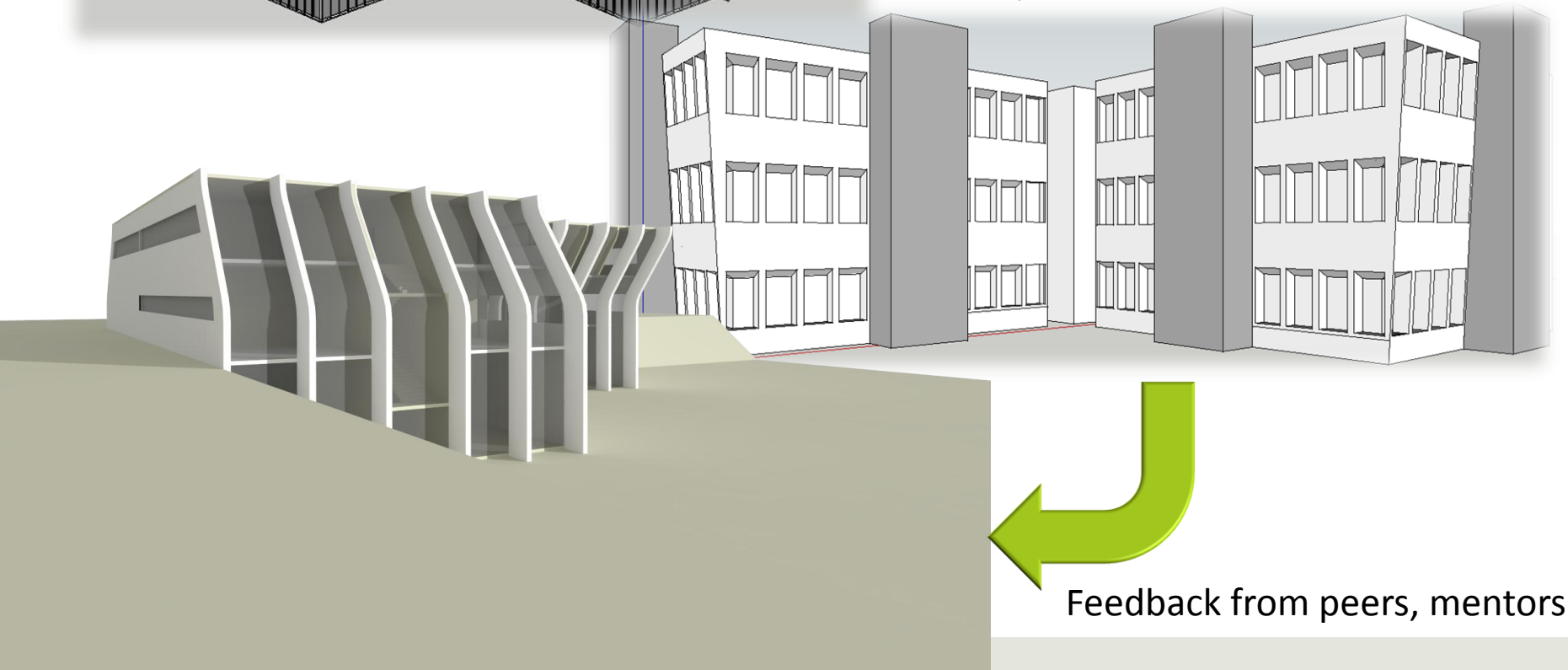
Team Process - Production

5TH MEETING [MONDAY FEBRUARY 20, 2012]							
Who Acts	**Task**	**Status**	**Due Date**	**For Whom**	**Time Allocated**	**Time Completed**	**Date of Completion**
A	Cross section Auditorium+Large Classrooms	Complete	Feb.20	ALL	2	2	Feb.20
A	1st Concept Facade in Sketchup	Complete	Feb.20	ALL	3	3	Feb.20
E	Initial Shallow Foundation Design	Complete	Feb.24	E			
E	Initial Retaining Wall Design	Complete	Feb.24	ALL	2+		Feb.24
E	Concrete Special Moment Frame	Complete	Feb.23	C			
E	Post-Tensioned Slab Design (Preliminary)	Complete	Feb.29	E	2	1	Feb.29
MEP	Vent. Table	In Progress	Feb.24	MEP	5	1	
MEP	MEP Size Estimate	In Progress	Feb.24	MEP	2		
MEP	Heating/Cooling Loads	In Progress	Feb.24	MEP	2		
C	Auditorium Design	Complete	Feb.24	ALL	4	4	
C	Cost and time estimation			ALL			
ALL	Critique your own school	Complete	Feb.20	ALL	1	1	

Team Process



Feedback from E, CM



Feedback from peers, mentors

Decision Matrix

- Innovative Design (WOW! Factor)
- Functionality/Efficiency
- Sustainability

Decision Matrix

TEAM		RANKING EACH CONCEPT (1-10)			
	IMPORTANCE	SKELETON		GATEWAY	
CRITERIA	FACTOR (1-10)	STEEL	CONCRETE	STEEL	CONCRETE
Design/Aesthetic	10	9	8	8	7
Strength of Concept/Biomimicry	6	8	8	6	6
Functionality/Space Efficiency	10	7	7	8	8
Constructability/Schedule	8	9	7	8	7
Cost	8	8	7	8	7
Sustainability [Materials]	8	8	6	8	6
RANKING (%)		68.00%	59.67%	64.67%	57.67%

OWNER: MICHAEL		RANKING EACH CONCEPT (1-10)			
	IMPORTANCE	SKELETON		GATEWAY	
CRITERIA	FACTOR (1-10)	STEEL	CONCRETE	STEEL	CONCRETE
Design/Aesthetic	10	10	7	8	6
Strength of Concept/Biomimicry	9	9	7	6	6
Functionality/Space Efficiency	7	8	8	8	8
Constructability/Schedule	8	10	6	7	6
Cost	7	10	9	10	9
Sustainability [Materials]	7	7	6	7	6
RANKING (%)		75.00%	60.00%	64.67%	57.33%

OWNER: MARIA		RANKING EACH CONCEPT (1-10)			
	IMPORTANCE	SKELETON		GATEWAY	
CRITERIA	FACTOR (1-10)	STEEL	CONCRETE	STEEL	CONCRETE
Design/Aesthetic					
Strength of Concept/Biomimicry					
Functionality/Space Efficiency					
Constructability/Schedule					
Cost					
Sustainability [Materials]					
RANKING (%)		0.00%	0.00%	0.00%	0.00%

Pacific Team 2012 Presents…

Pacific Team 2012

Special Thanks to:

- **MENTORS:**

  Greg Luth

  Tim Schrotenboer

  David Bendet

  John Nelson

- **OWNERS:**

  Michael Seaman

  Maria Selk

  Renate Fruchter