

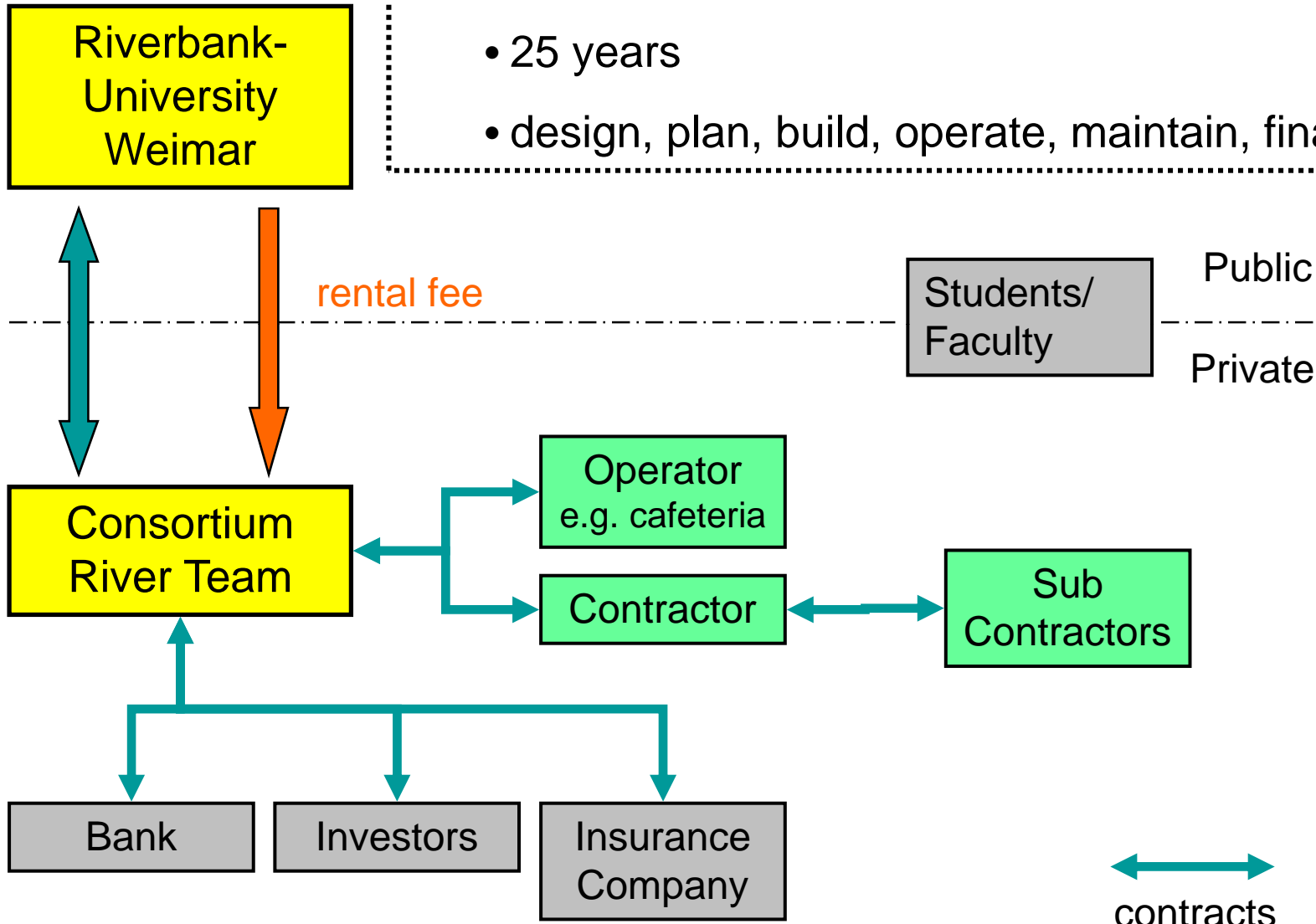
River Team 2009

The Engineering School of
Riverbank University

A:	JOSEFINE KÖPPEN	– Bauhaus-Universität Weimar
E:	XIAOYU LIU	– Stanford, CA
	JEFF BRUNTON	– Wisconsin Madison
	YURIY MIKHALEVSKIY	– Stanford, CA
C:	JIANG BIAN	– Stanford, CA
	MATT WATLEY	– Chico State, CA
LCFM:	NADIN DITTMANN	– Bauhaus-Universität Weimar

PPP-Project

- Project: April 2015 – March 2016
- PPP – Contract:
 - 25 years
 - design, plan, build, operate, maintain, finance



A
E
C
F

Site – Weimar, Germany

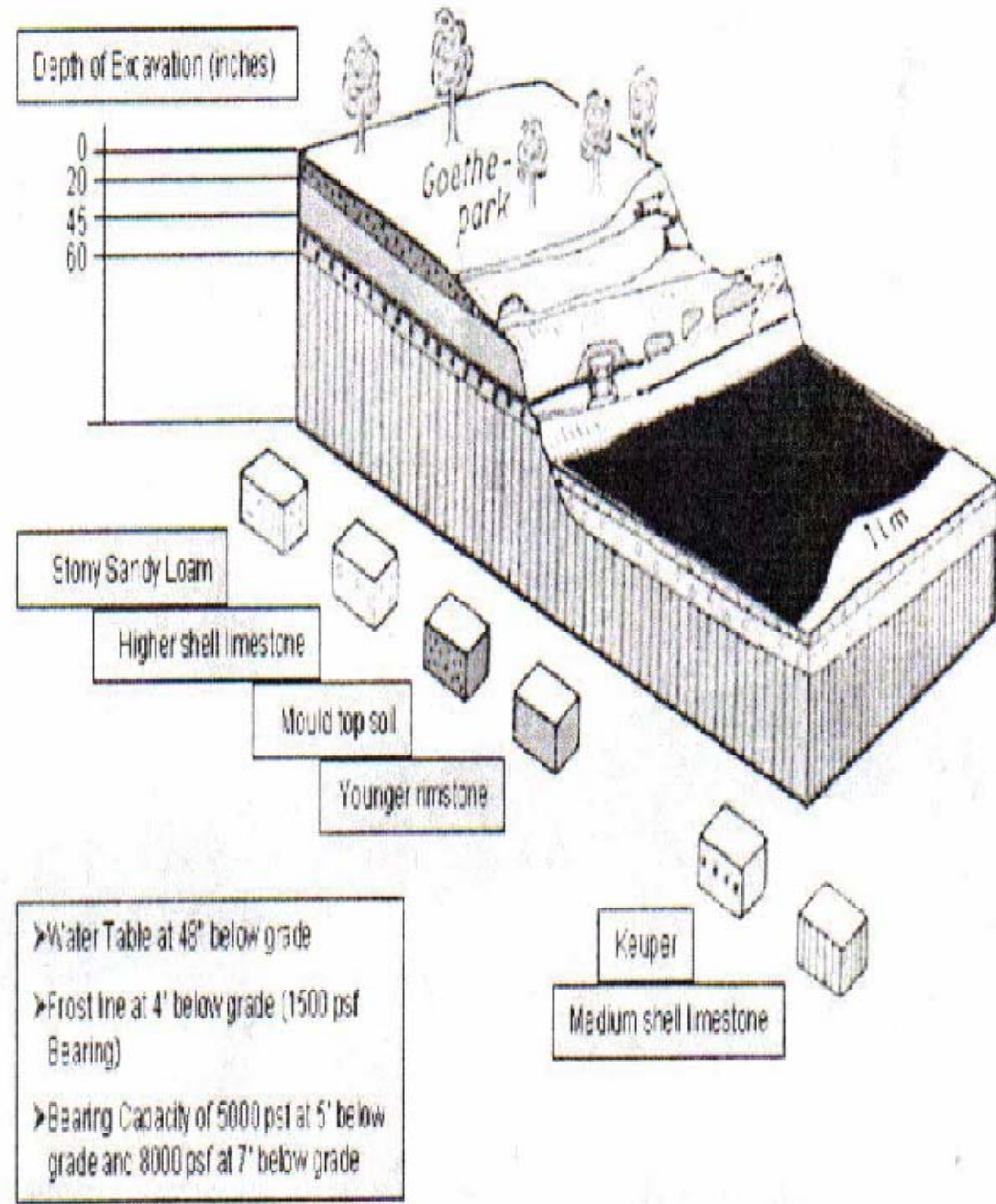


A
E
C
F

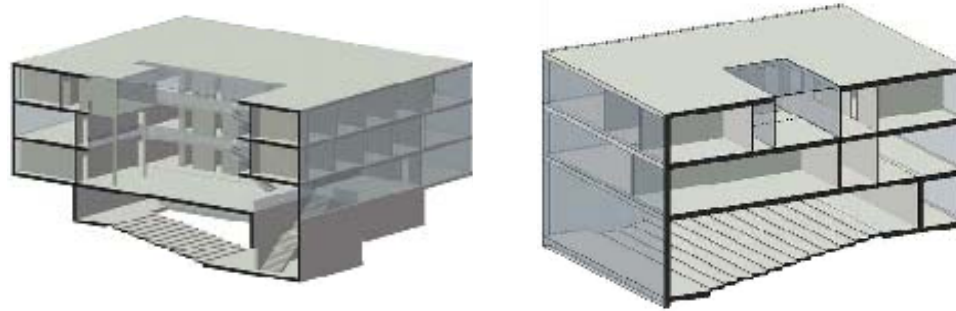
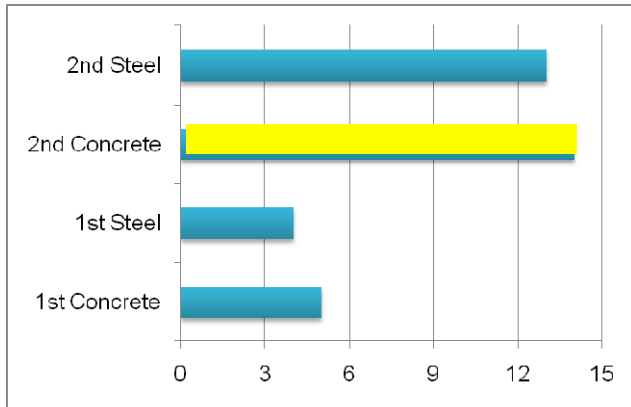
River 2009

Soil Conditions

- High Water Table
- High Frost Line
- Old Plants Adjacent
- 385kPa Bearing Capacity



WQ - DESIGN OPTIONS

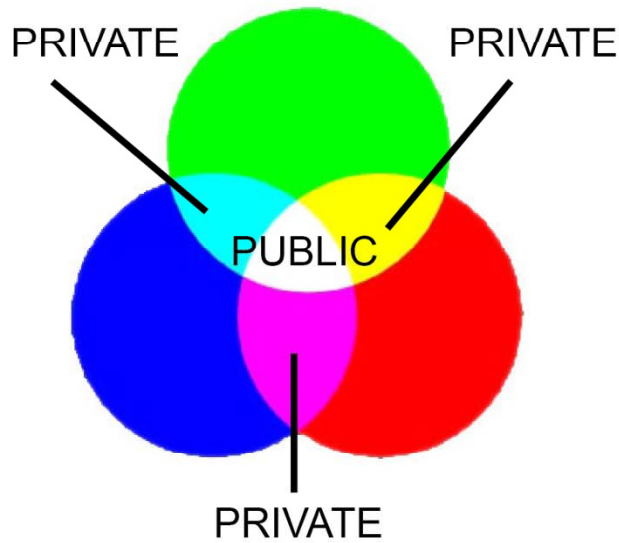


Criteria	1st Concrete	1st Steel	2nd Concrete	2nd Steel
Strength of Concept	1	1	3	2
Owner's Preferences	-2	-2	2	2
Constructability	2	1	2	1
Functionality	-1	-1	2	2
No waste of Materials	1	2	1	2
Sustainability	1	2	2	3
Least Cost	0	3	-3	1
Short Schedule	0	1	2	3
Local Building Method	3	-3	3	-3
Total	5	4	14	13

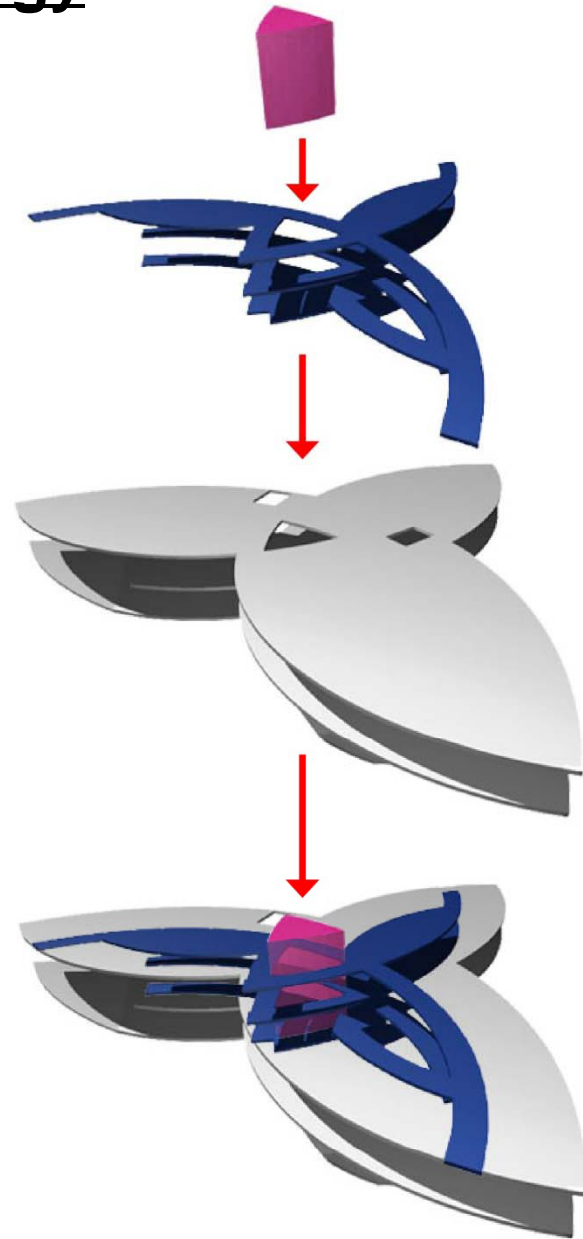
A
E
C
F

**Based on Mentor
Feedback the
DESIGN WAS
CHANGED**

Vision



Strategy



A

E

C

F

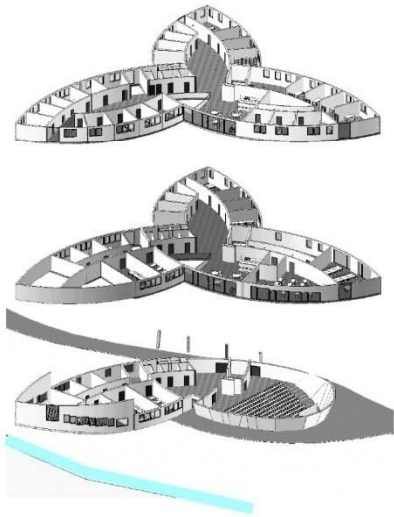
Site Plan



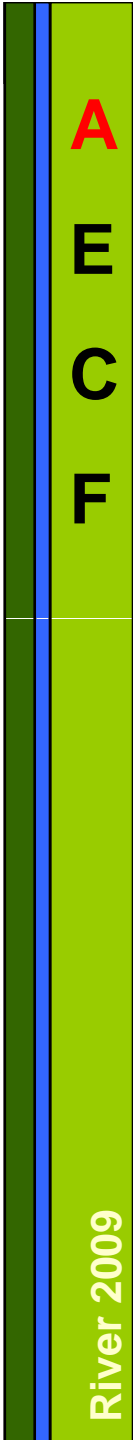
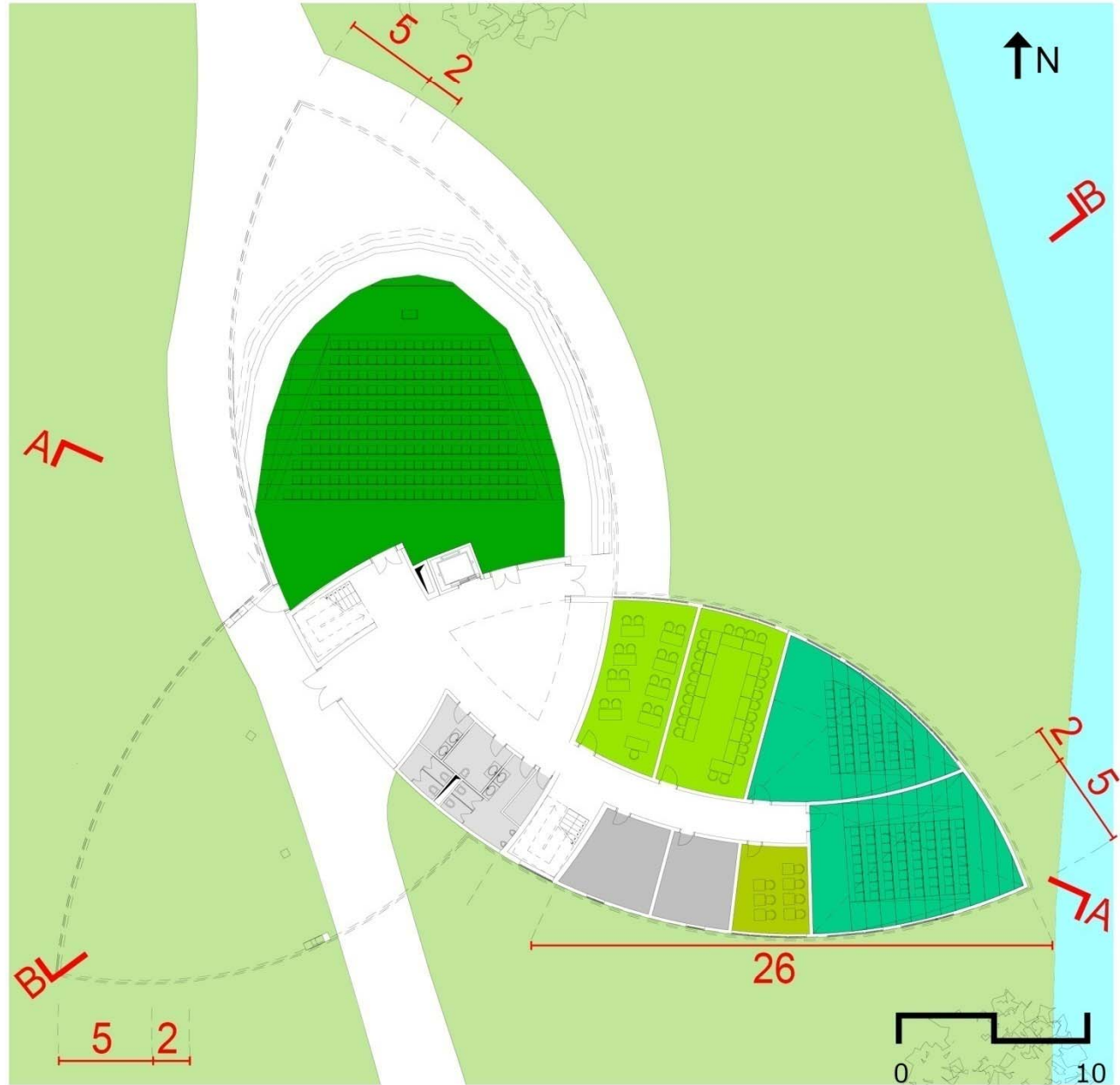
A
E
C
F

River 2009

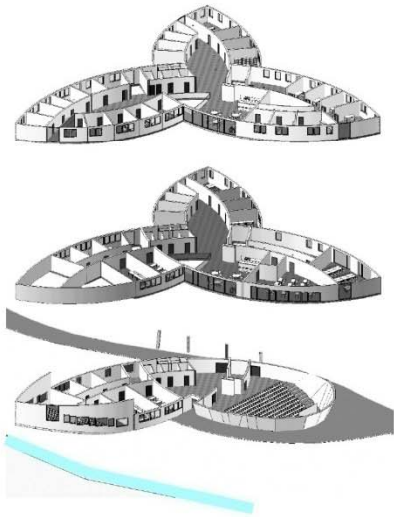
1st Floor



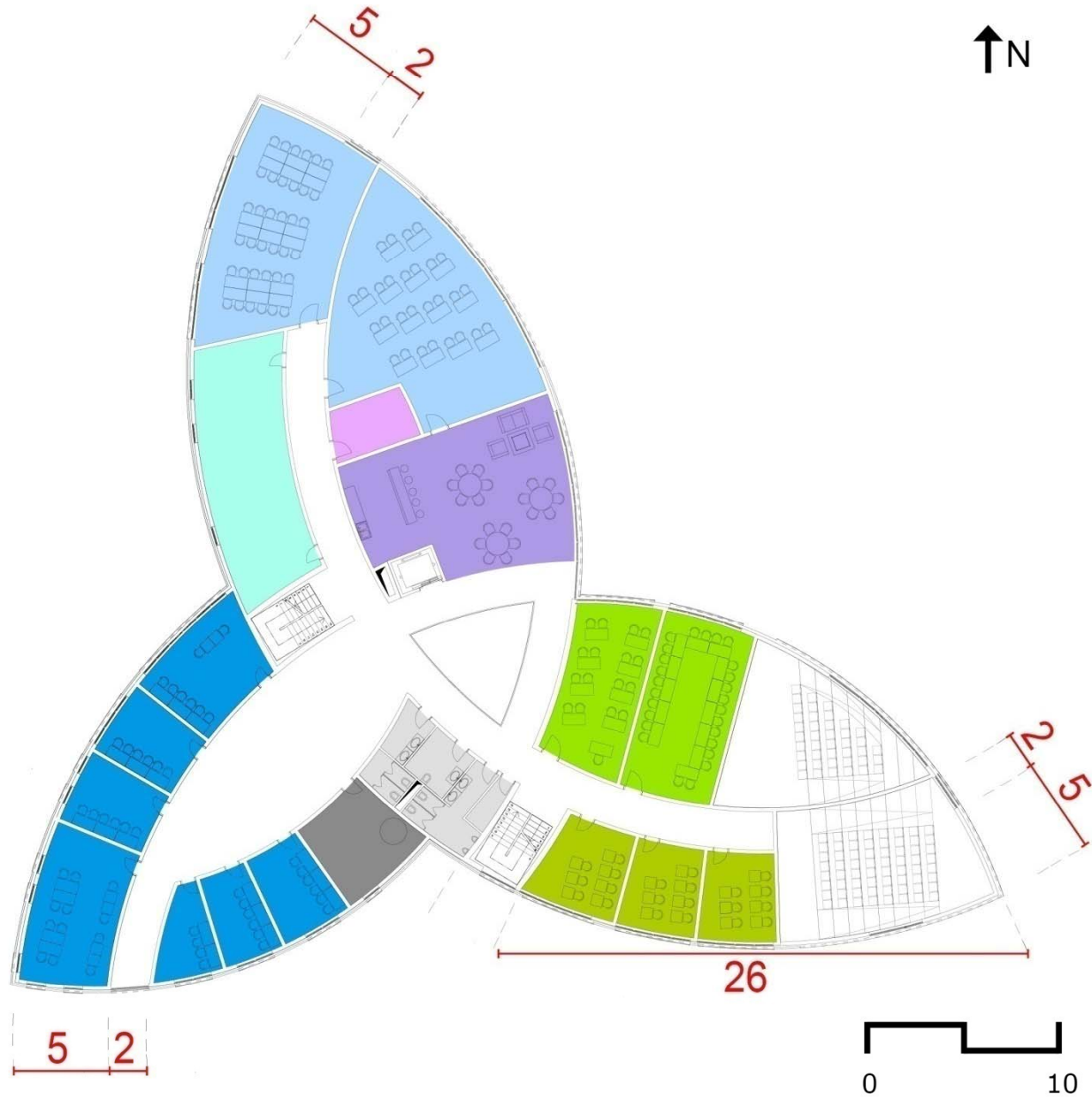
- Large Classroom
- Auditorium
- Small Classroom
- Seminar Room
- Mechanical Room
- Restrooms
- Storage



2nd Floor



- Server
- Instructional Lab
- Student Office
- Technical Support
- Small Classroom
- Seminar Room
- Lounge
- Mechanical Room
- Restrooms
- Storage



A

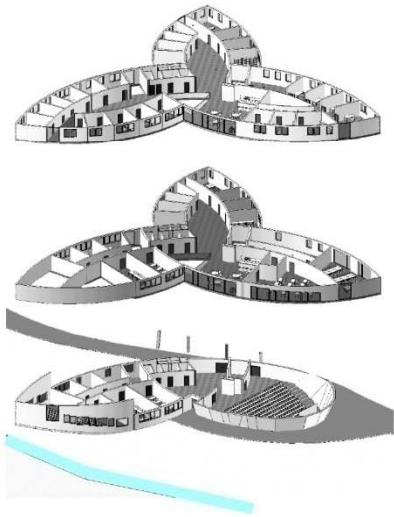
E

C

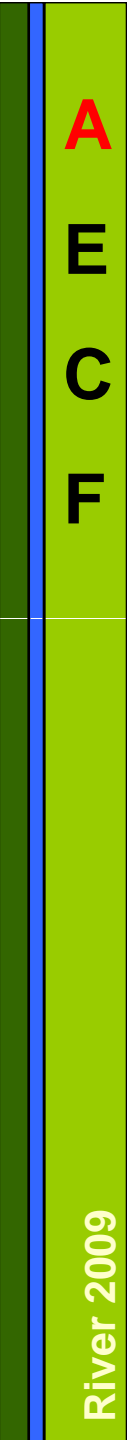
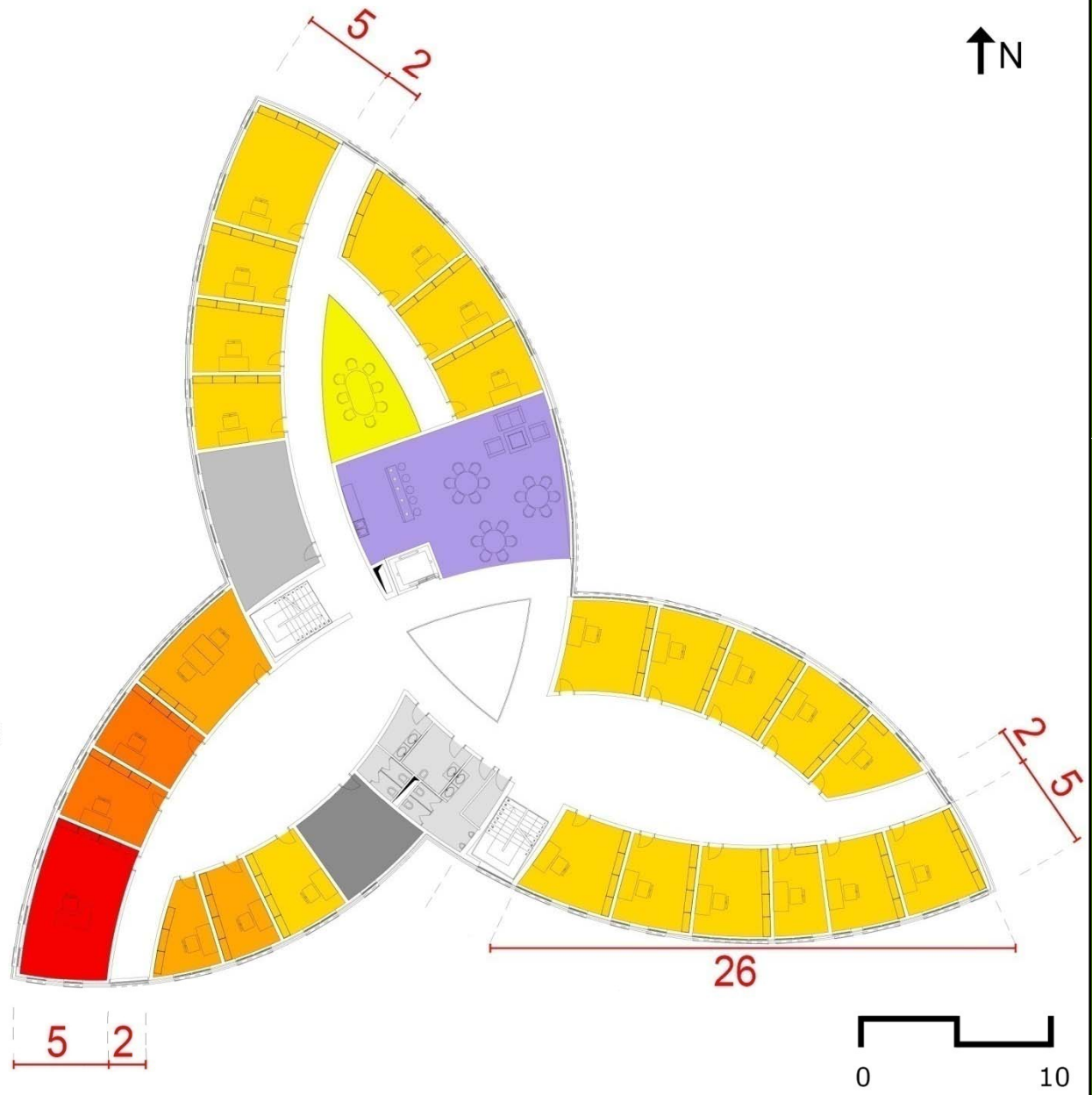
F

River 2009

3rd Floor



- Department Chair's Office
- Senior Admin. Assistance
- Administrative Assistance
- Faculty Office
- Meeting Room
- Lounge
- Mechanical Room
- Restrooms
- Storage

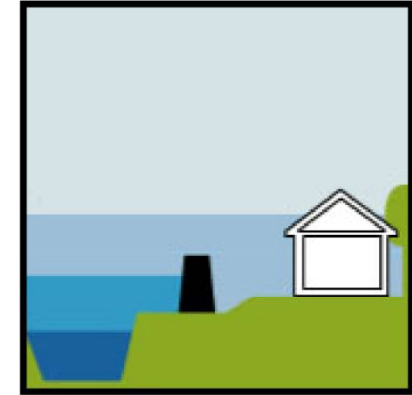






Evacuation Plan

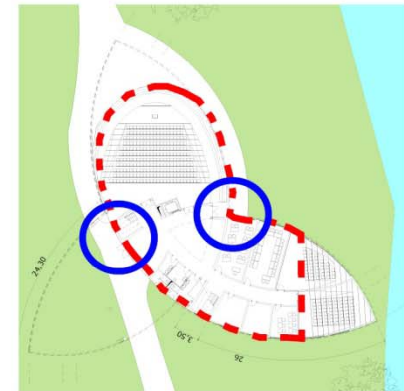
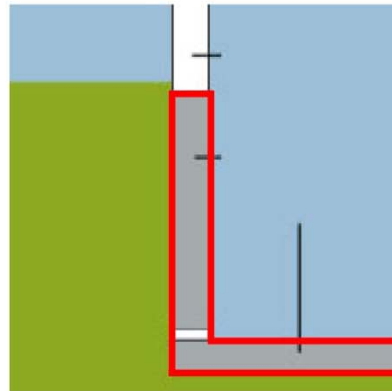
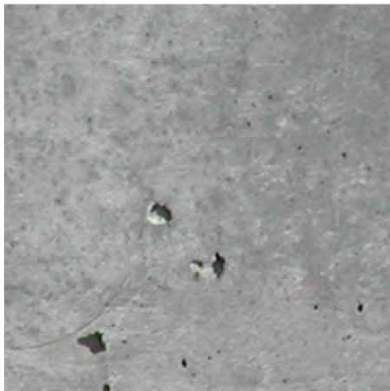
— Mobile Dykes



Evacuation Plan



-  Pile Foundation
-  Small Footprint with elevated electrical sys. / equip.
-  Entrance barrier; water protection system
-  White tank

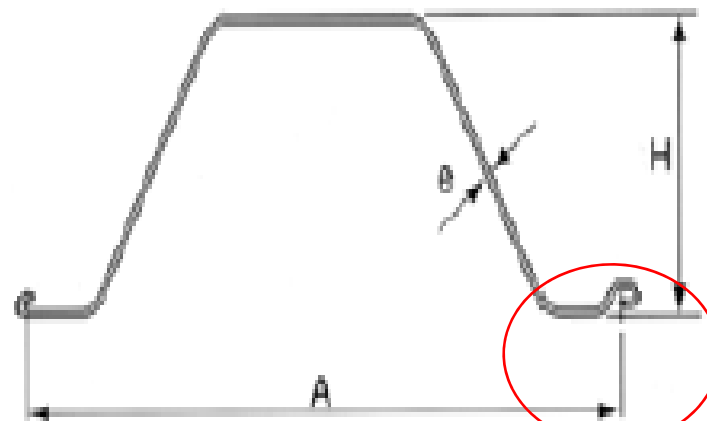


A
E
C
F

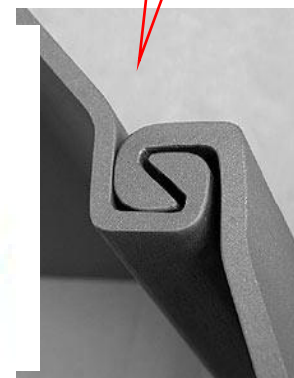
Site Protection - Sheet Piles

PAL 3030- Cold formed

Dimensions		
width	660	mm
height	89	mm
diameter e	3	mm
Sectional area		
single pile	37.5	cm ² /m
wall	29.4	kg/m ²
Moment of Inertia		
single pile	19.4	kg/m
wall	29.4	kg/m ²
Surface of resistance		
single pile	500	cm ⁴ /m
wall	112	cm ³ /m
Paint surface		
double-sided	0.8	m ² /m ²
Producer		
Supplier		



Connection

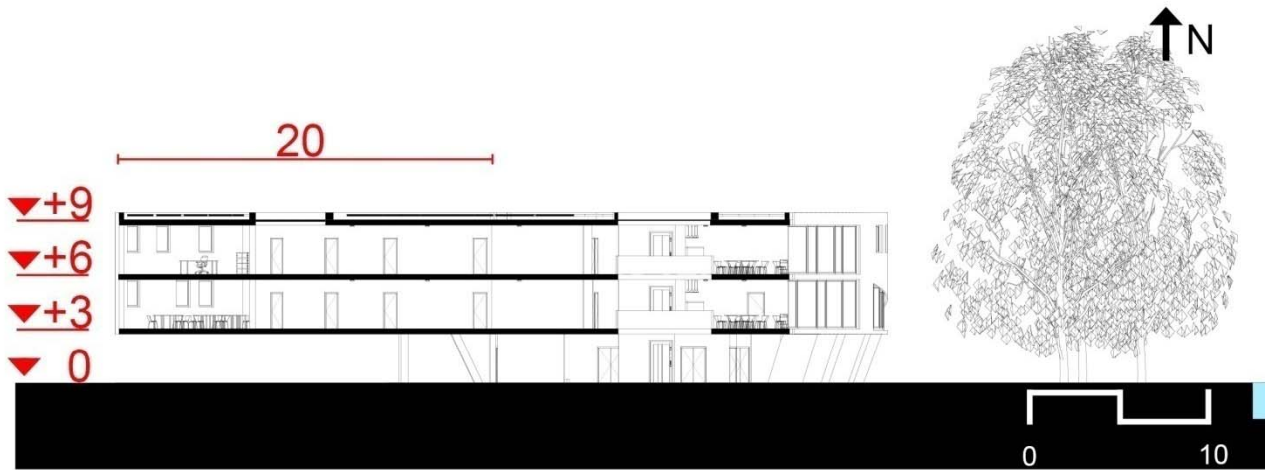


A
E
C
F

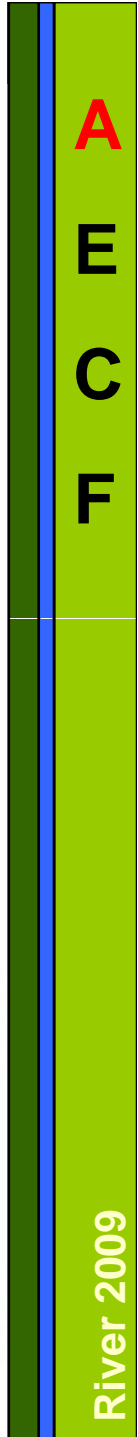
Sections



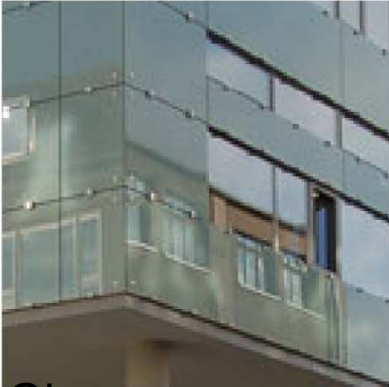
Section A



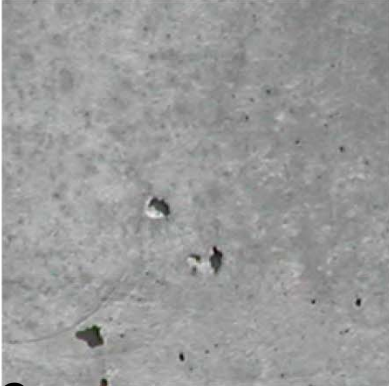
Section B



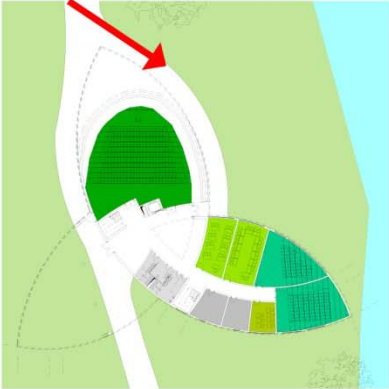
Materials - Exterior



Glass



Concrete



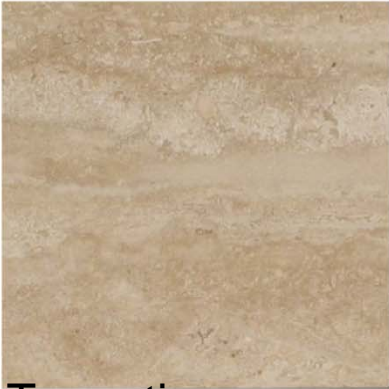
A

E

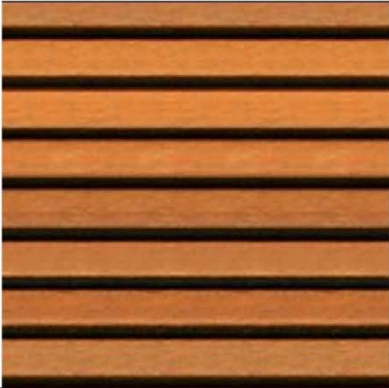
C

F

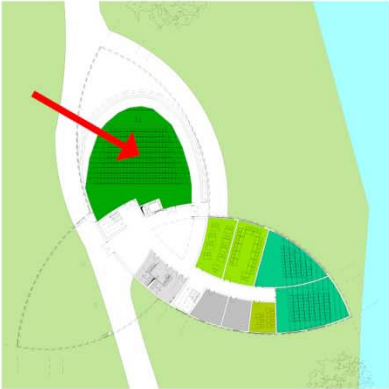
Materials - Interior



Travertine

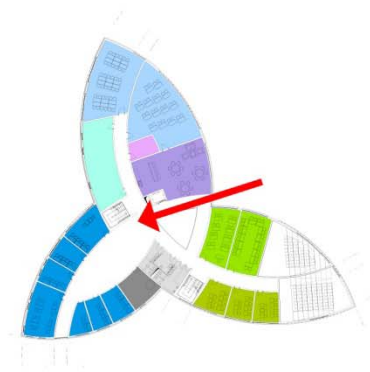


Wood

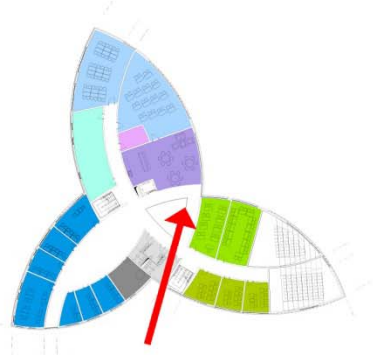


A
E
C
F

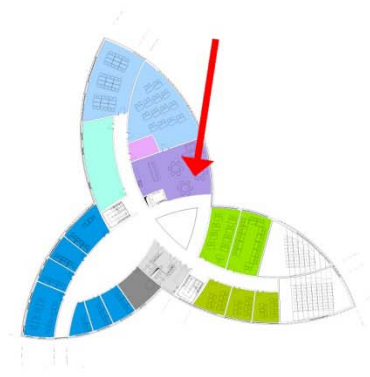
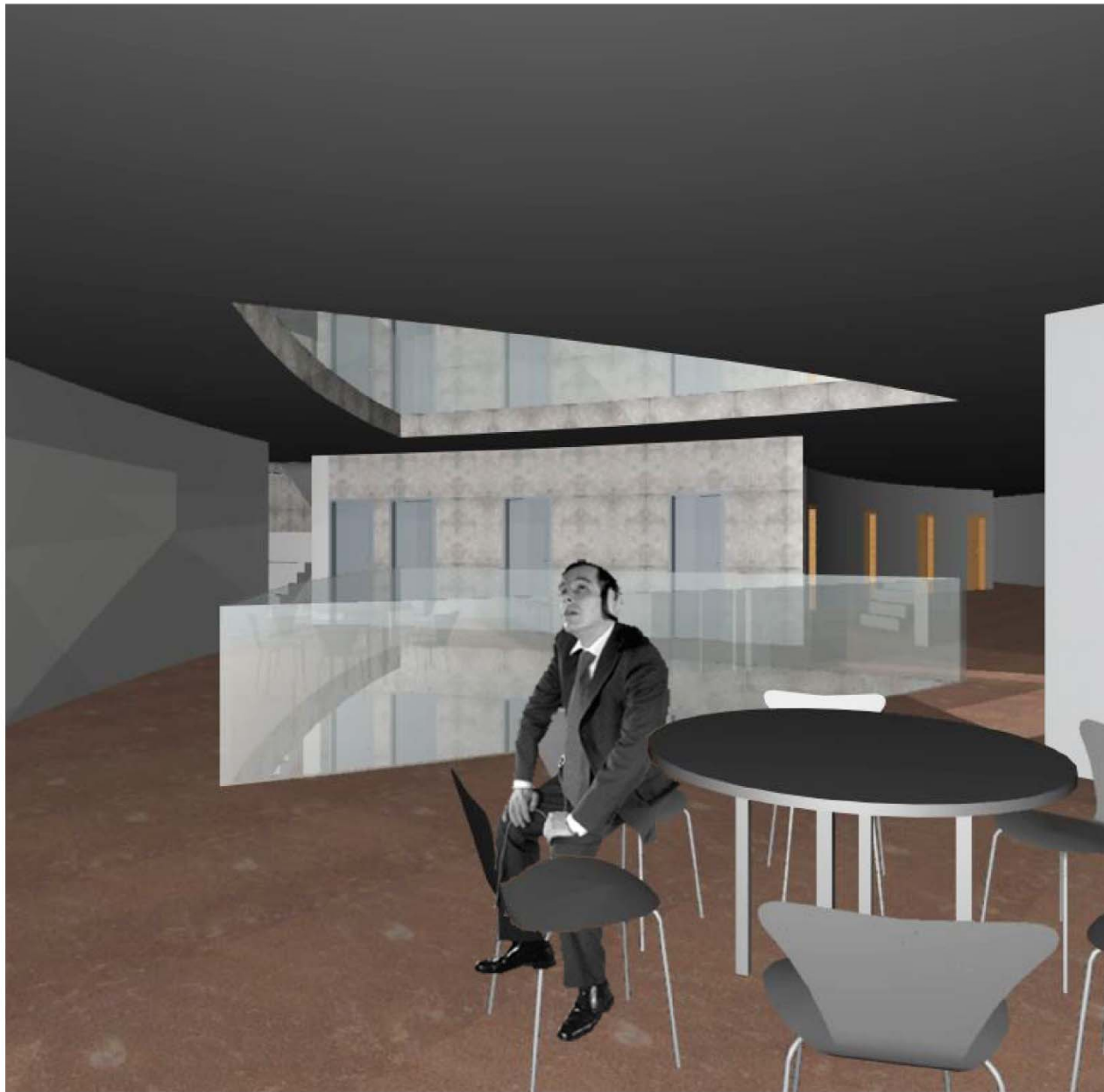
Atrium



Lounge



Atrium



A

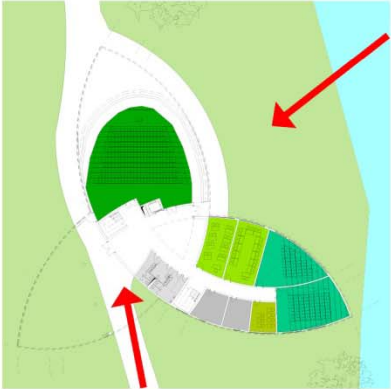
E

C

F

River 2009

Evacuation Plan



Engineering - Loads (ASCE 7)

Live Load

- Storage – 125 psf / 6 kN/m²
- Corridors, server, lobbies – 100 psf / 4.79 kN/m²
- Assembly, stairs – 100 psf / 4.79 kN/m²
- Classrooms – 40 psf / 1.92 kN/m²
- Office – 50 psf / 2.4 kN/m²

Dead Load

- Collateral – 25 psf / 1.2 kN/m²

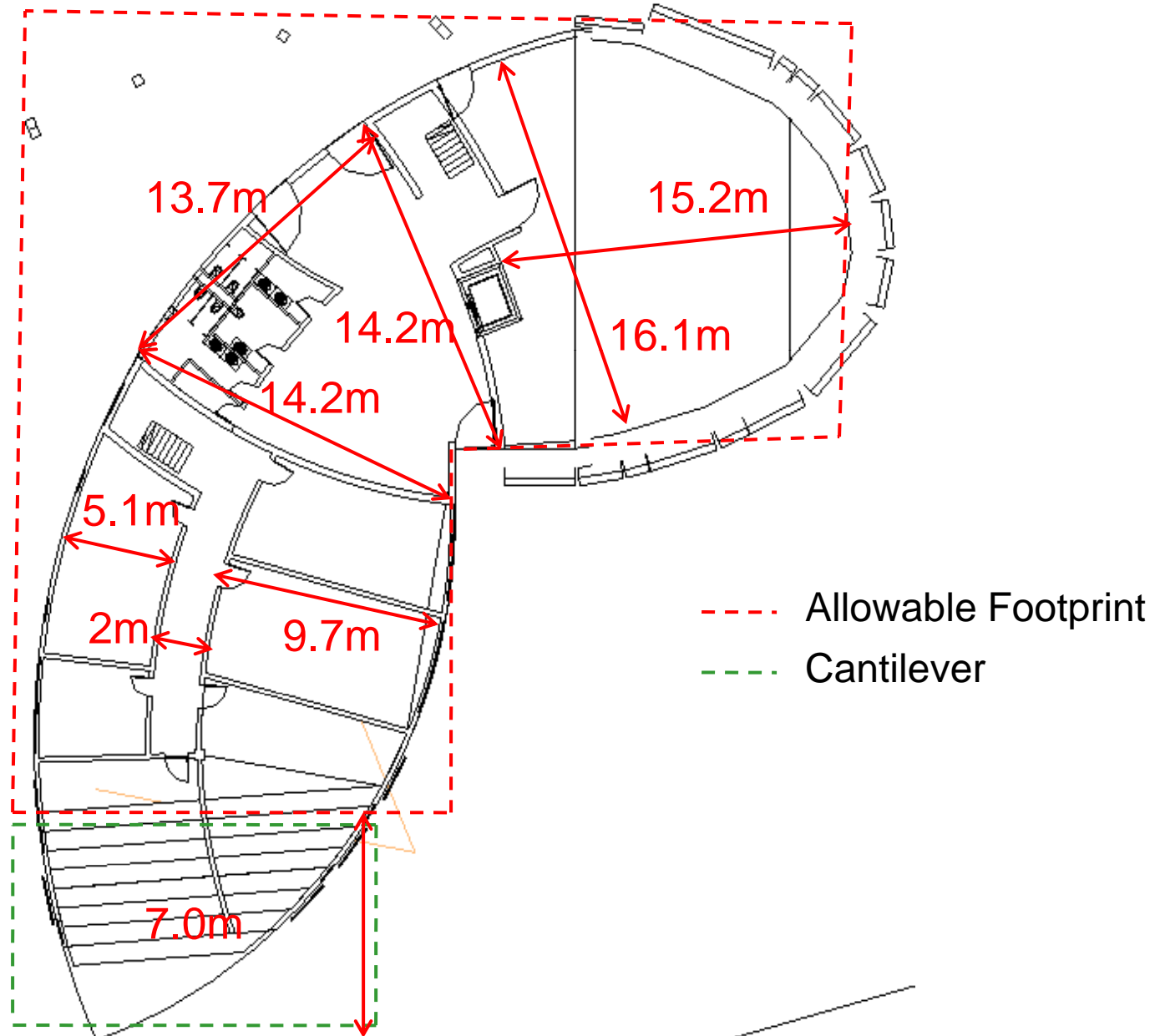
A

E

C

F

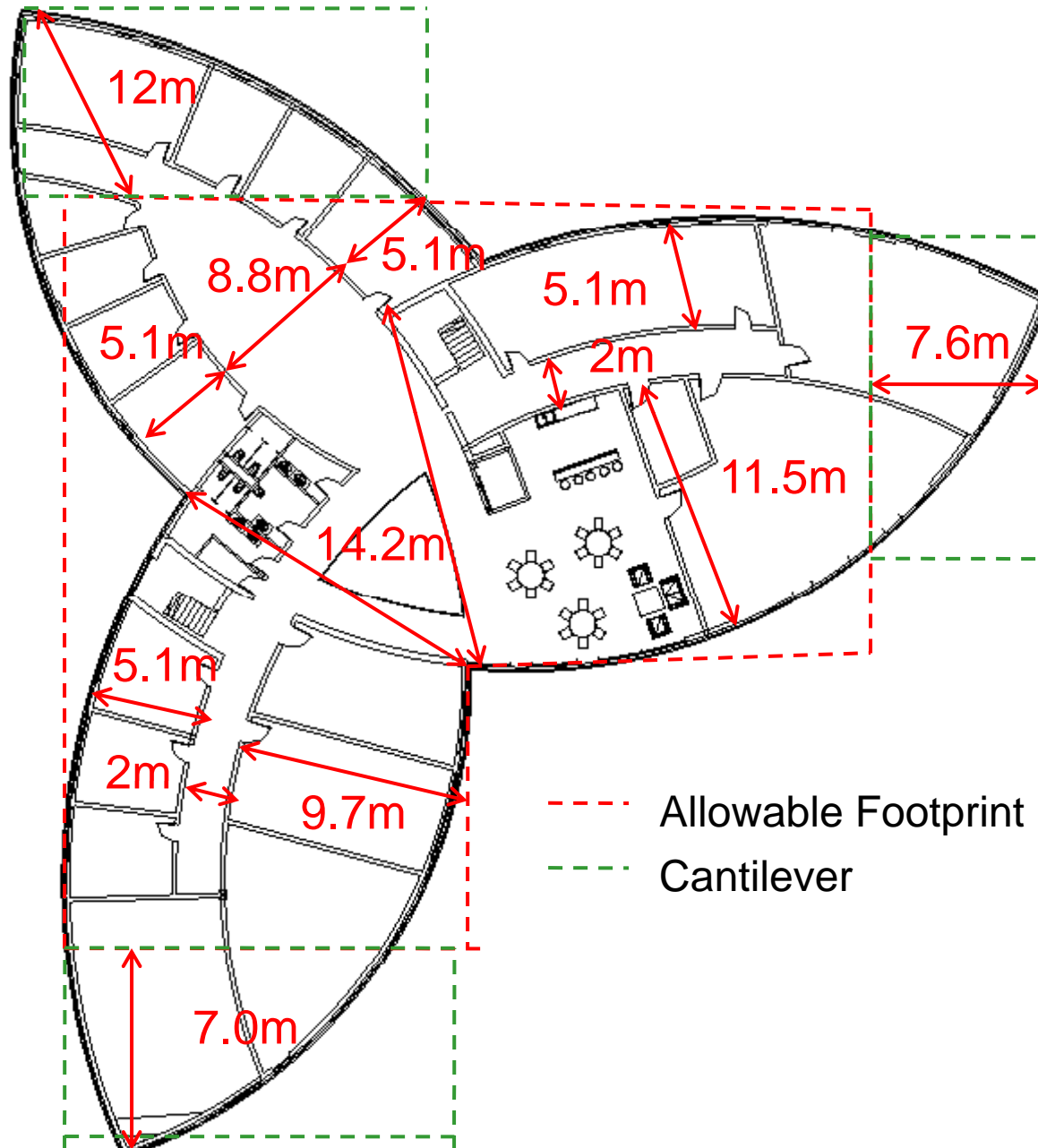
Dimensions – First Floor



A
E
C
F

Dimensions – Second Floor

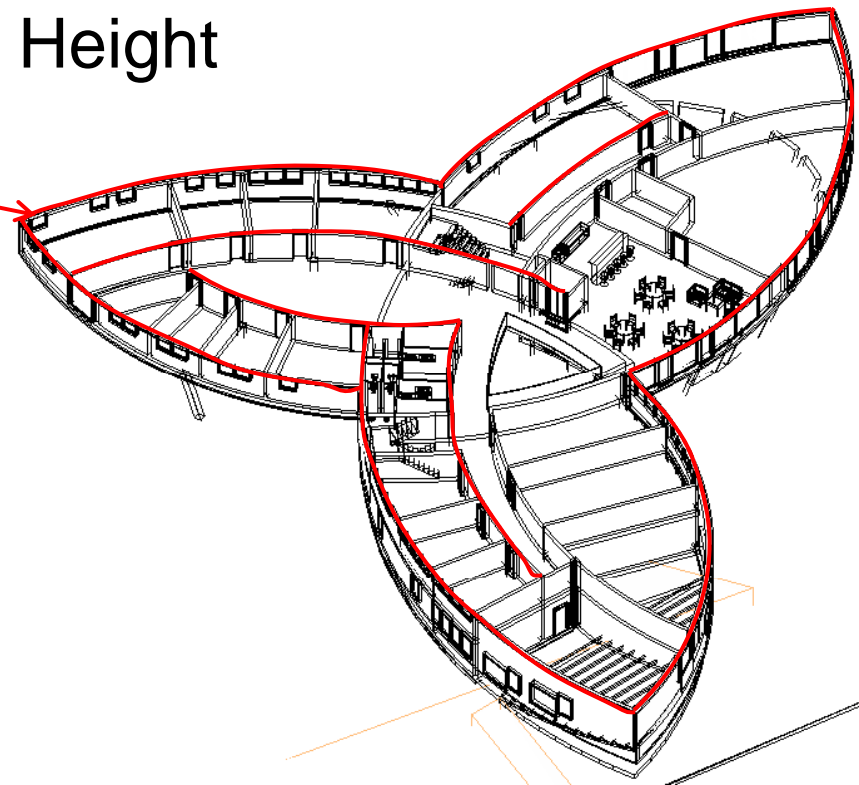
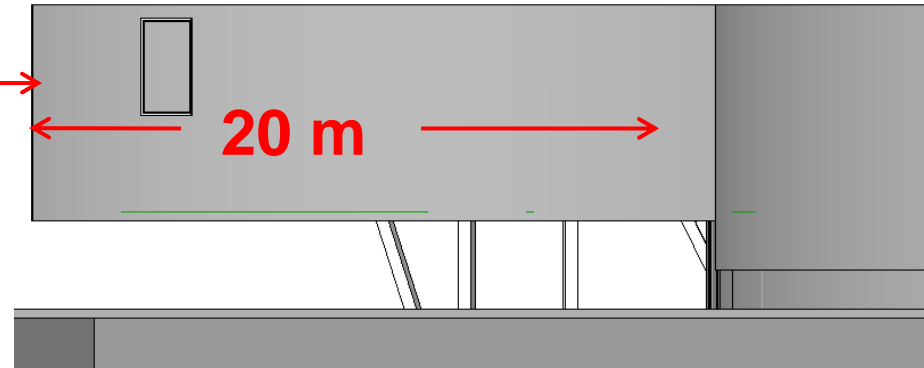
**Similar to
3rd floor**



A
E
C
F

Major Design Topics for Engineers

- Large Cantilevers
- Poor soils
- Flooding
- Limited Floor to Ceiling Height
- Irregular Geometry

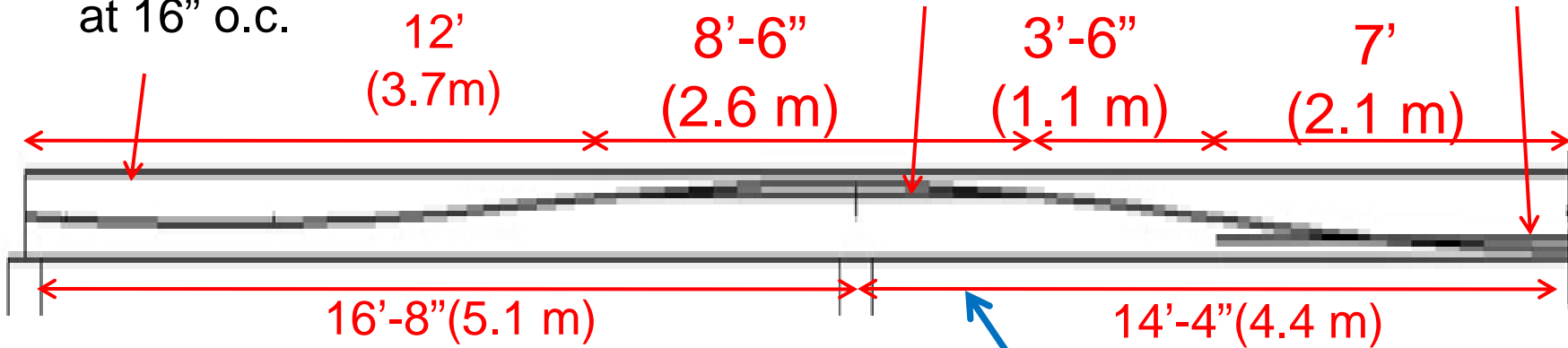


Ceiling Height and Irregular Geometry Solution

1/2" diameter
270 ksi
7 wire strands
at 16" o.c.

1/2" diameter
60 ksi
rebar at 5" o.c.

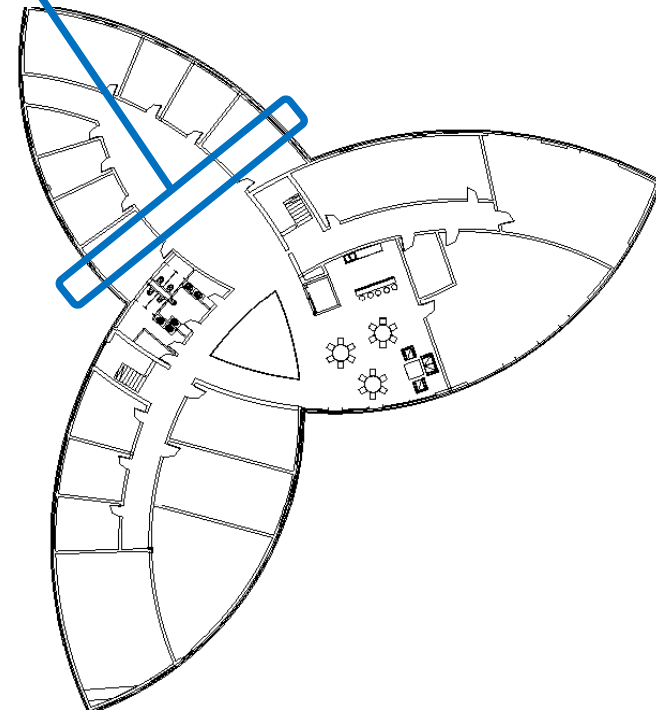
1/2" diameter
60 ksi
rebar at 12" o.c.



Post tensioned floor slabs

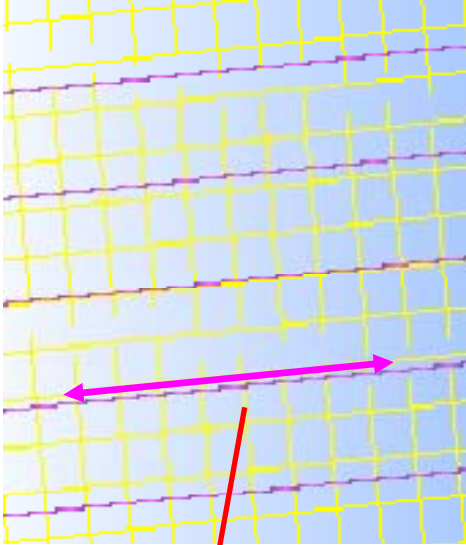
- No geometric constraints
- similar to precast (span to depth ratio)

Idea from Greg!

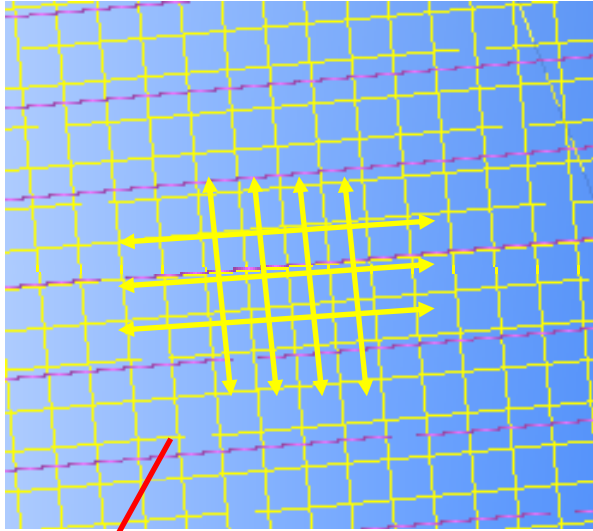


A
E
C
F

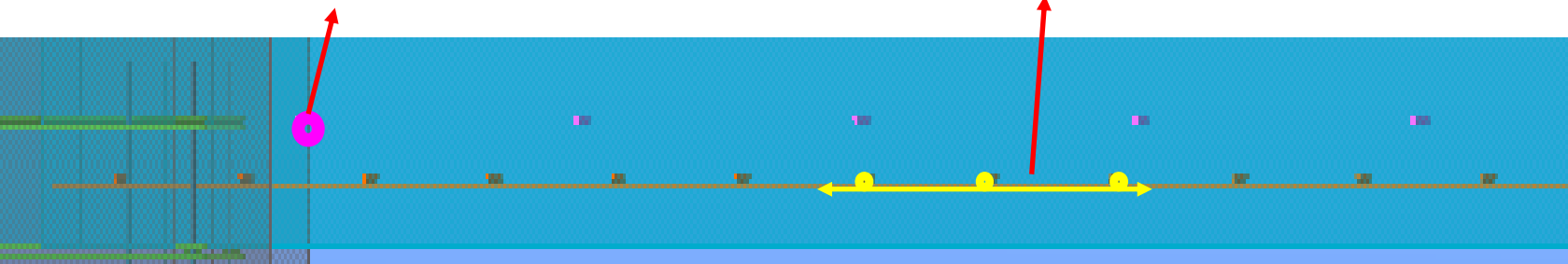
Typical Slab Detailing



Strands 1/2" diameter
16" c/c



1/2" diameter
Typically 12" c/c



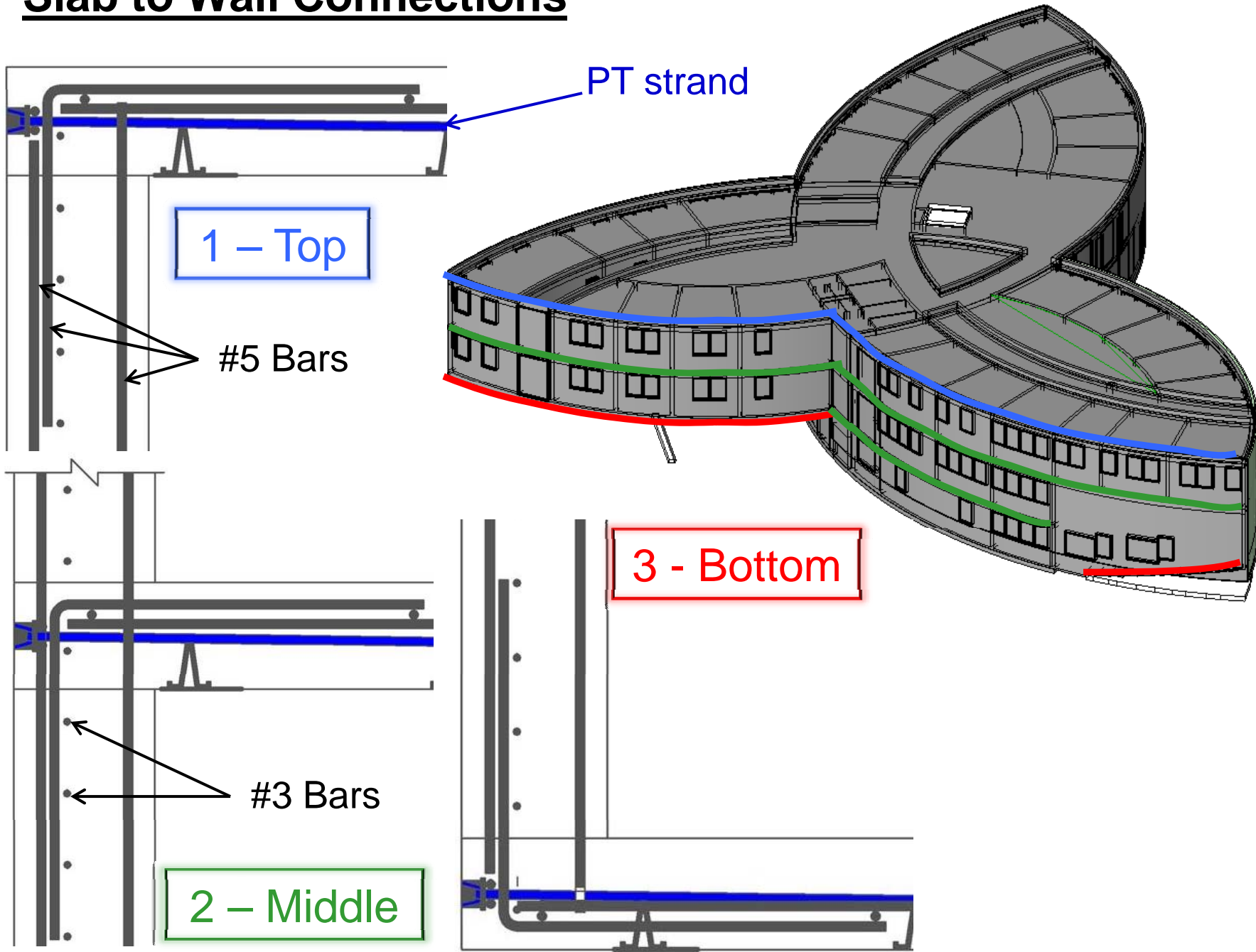
A

E

C

F

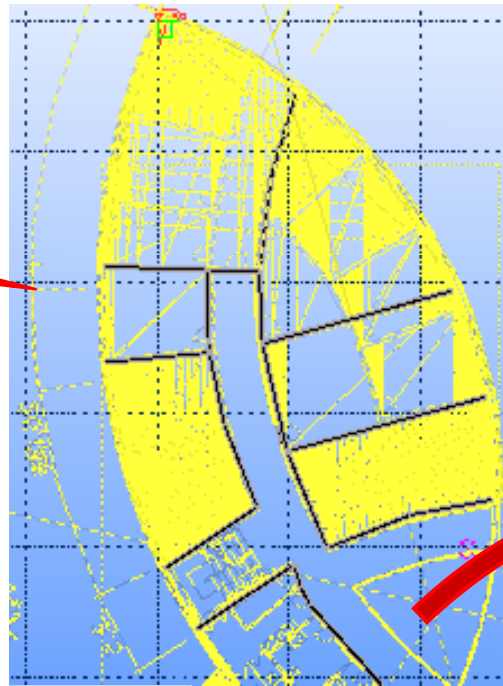
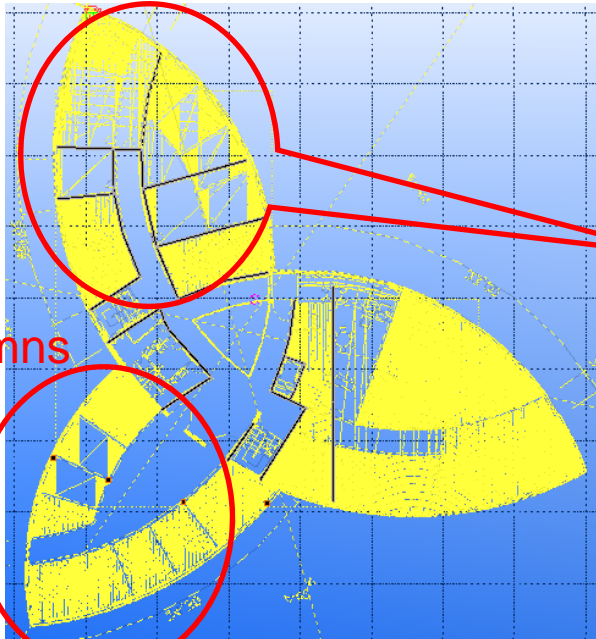
Slab to Wall Connections



Vertical System

Walls

Columns

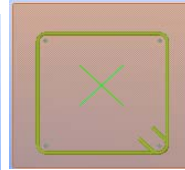
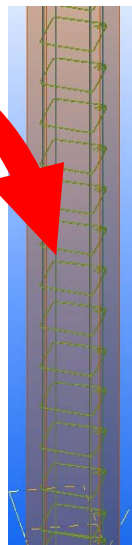
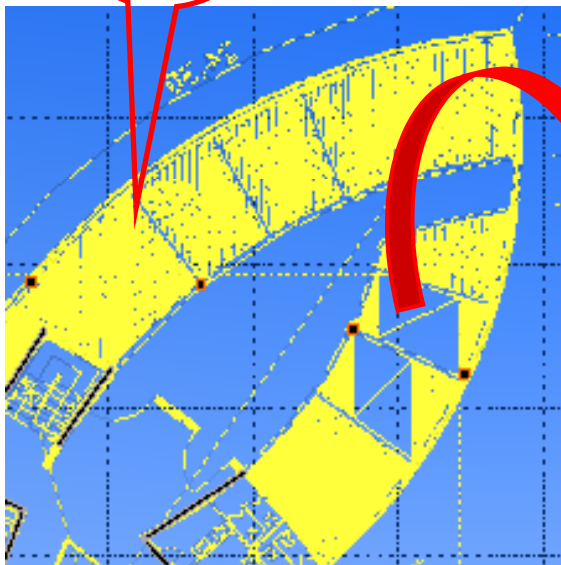


Reinforcement:

#5 80mm c/c

Transverse Rebar:

#3 100mm c/c



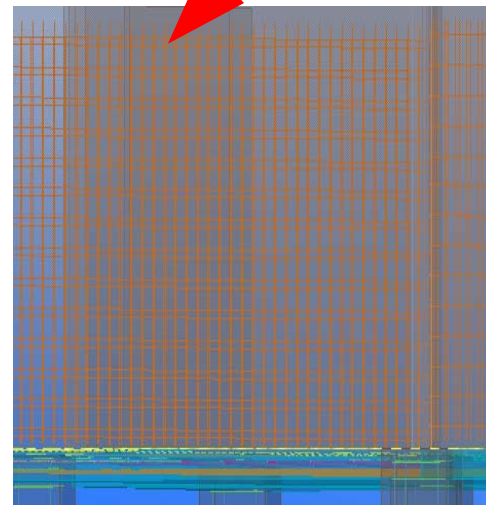
200mm

Reinforcement:

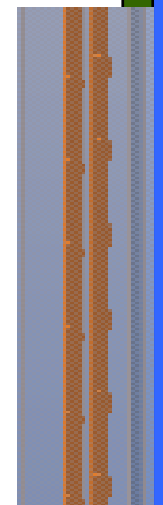
#5 bars X4

Tie:

#3 200 c/c



200mm



A

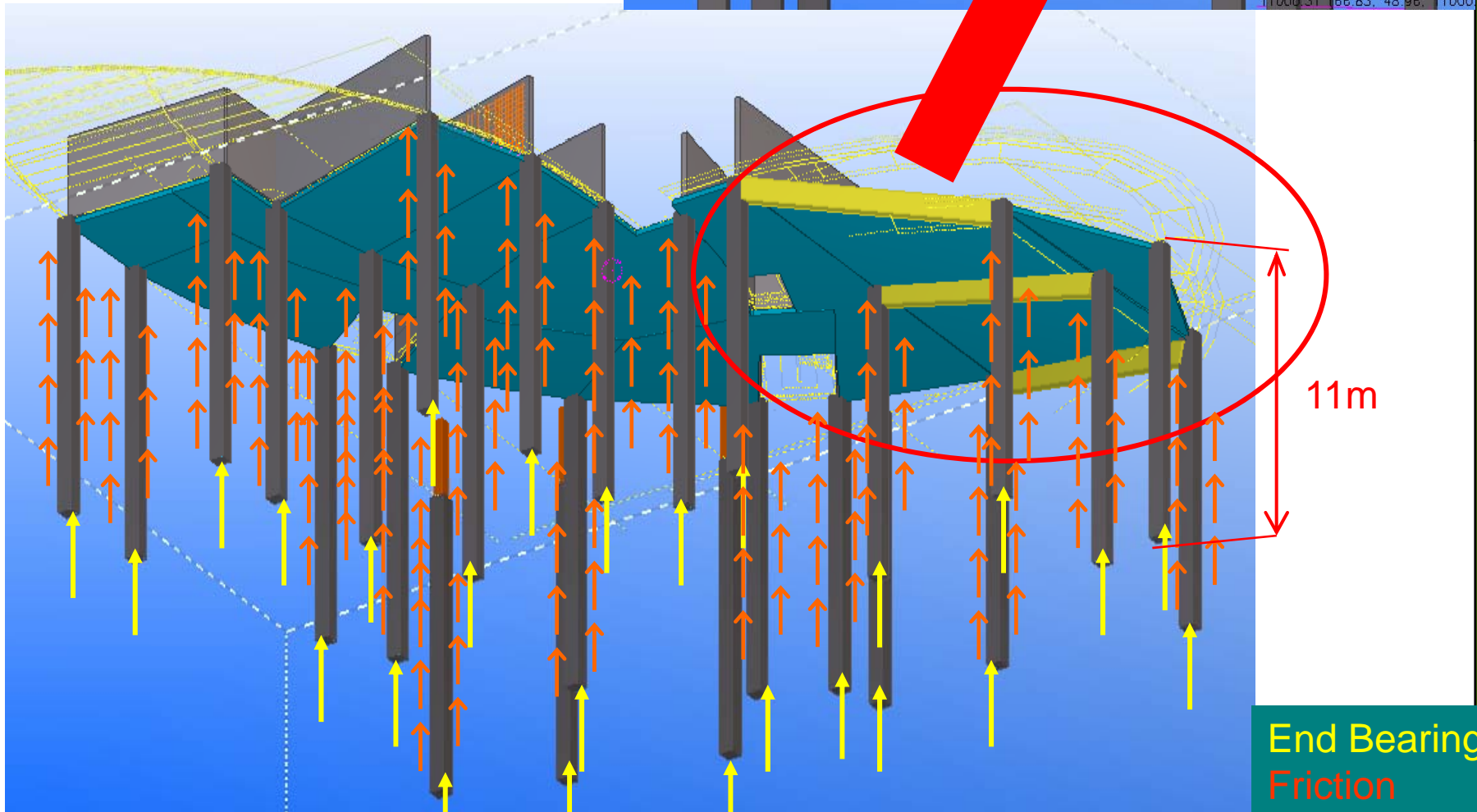
E

C

F

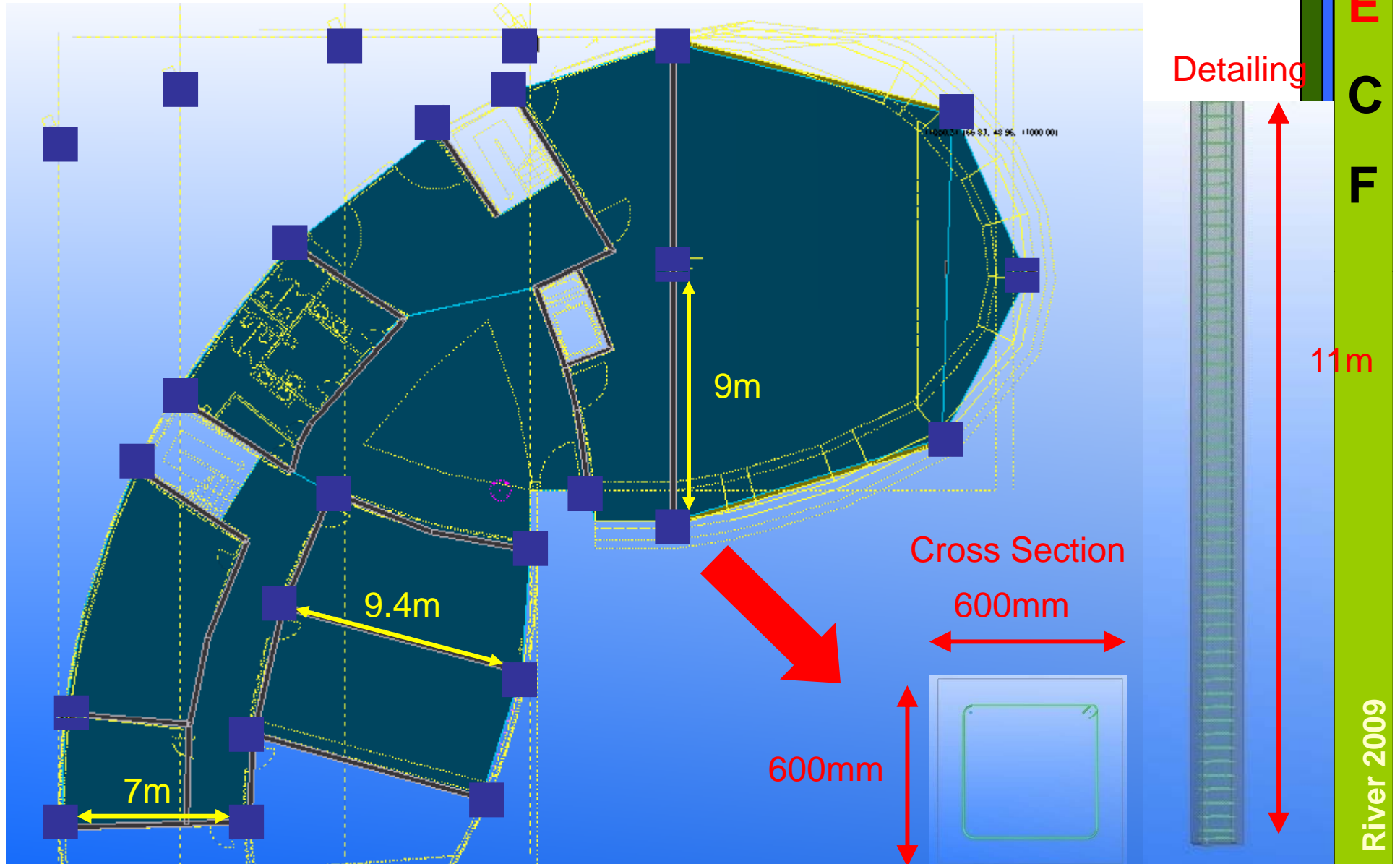
River 2009

Pile Foundation

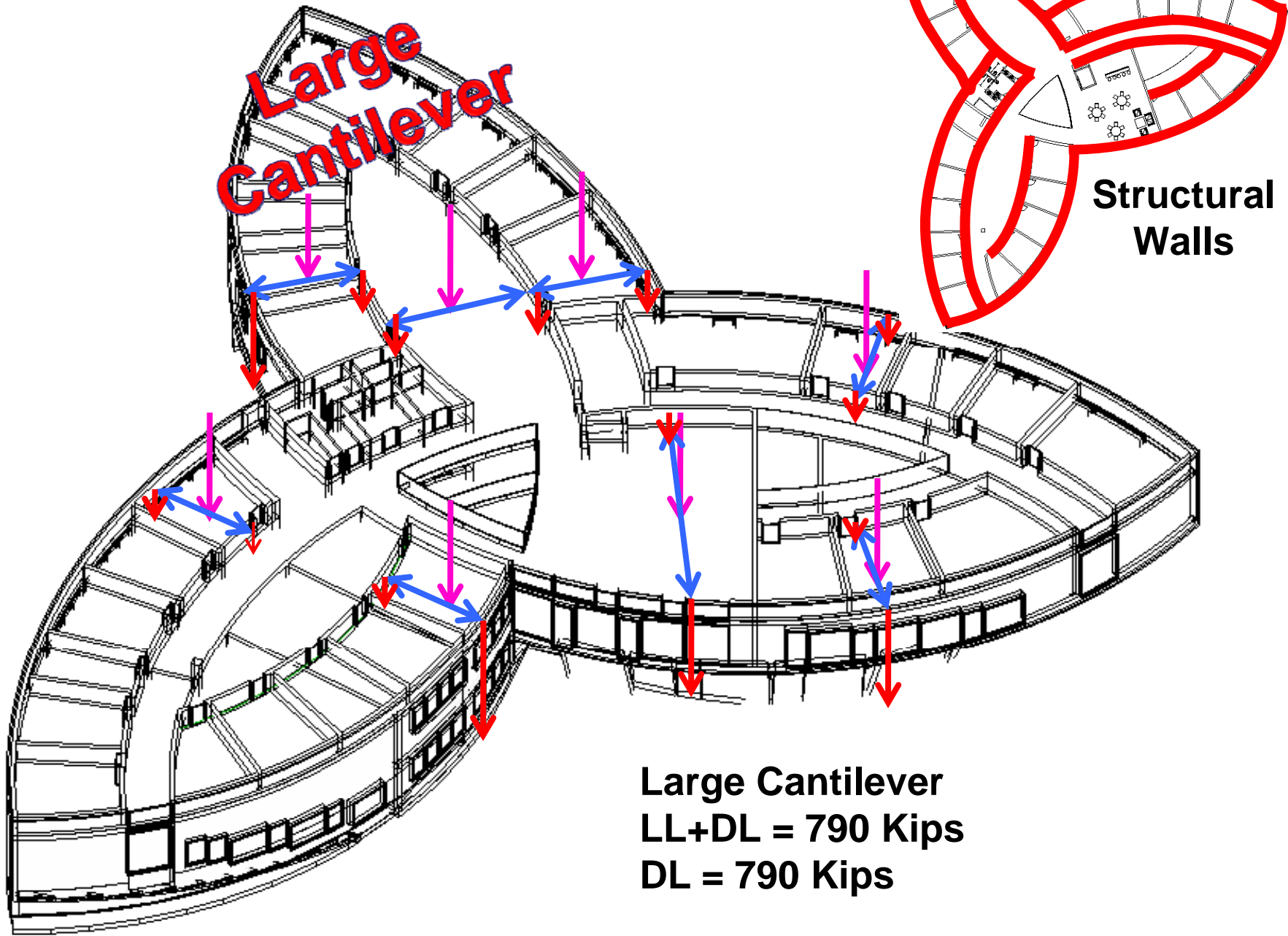


A
E
C
F

Foundation – Plan & Details



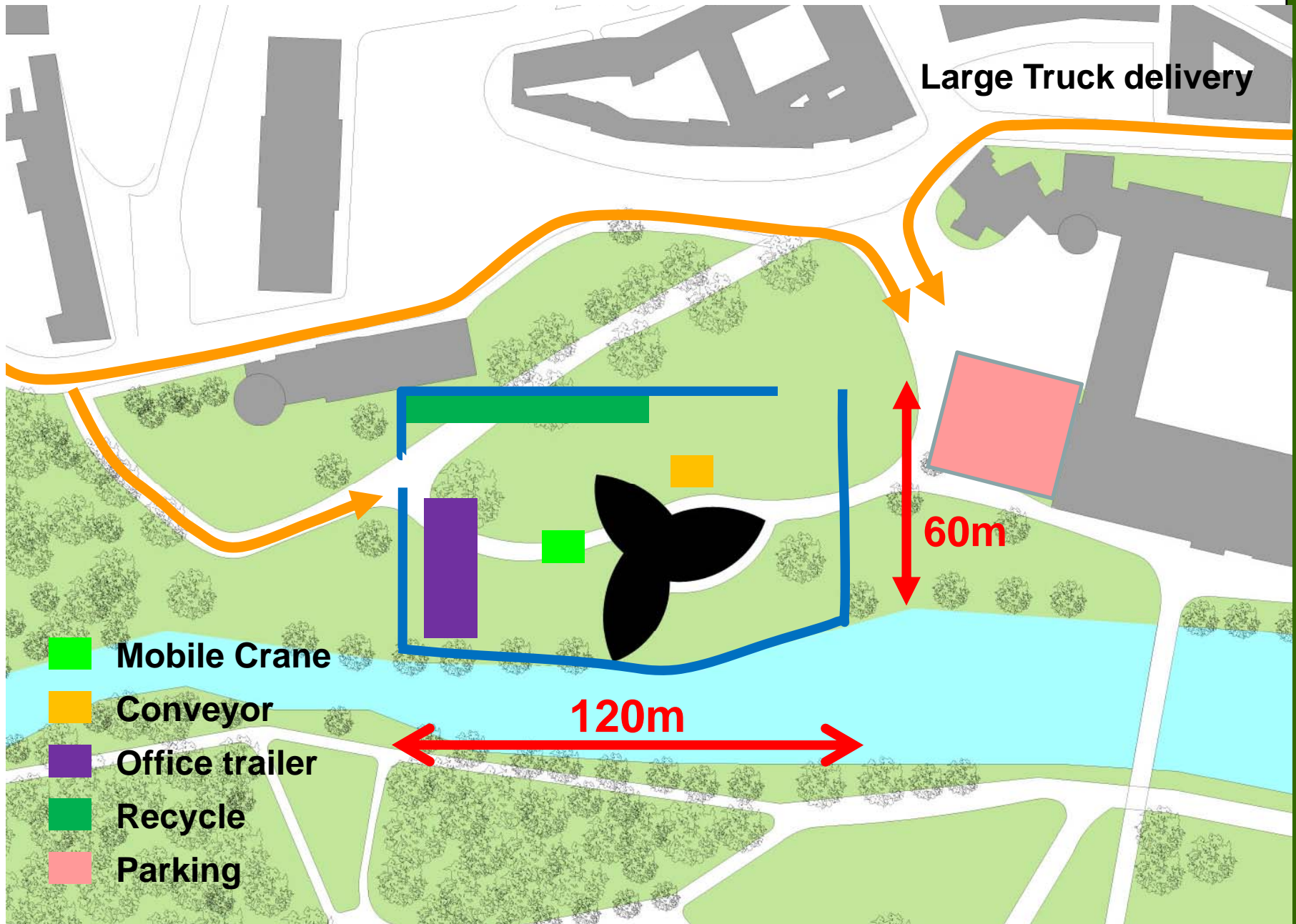
Load Path



Large Cantilever
LL+DL = 790 Kips
DL = 790 Kips

A
E
C
F

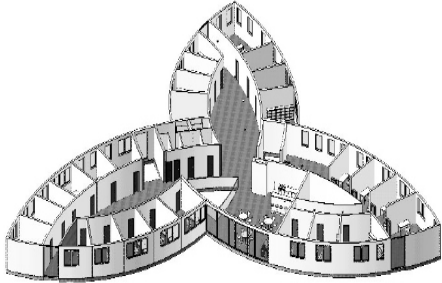
Site Plan



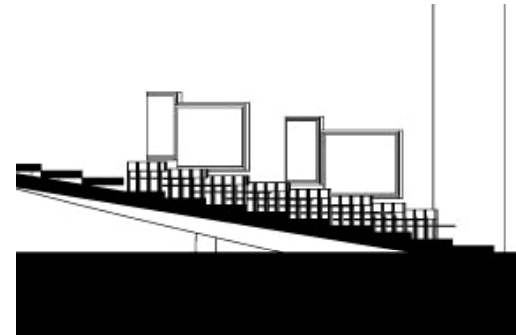
A
E
C
F

River 2009

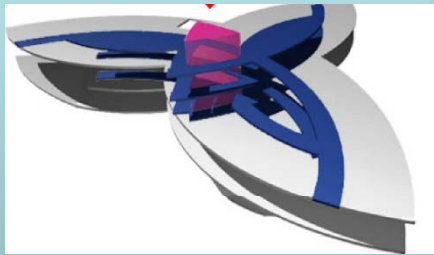
Construction Challenges



Zero waste



Irregular geometry



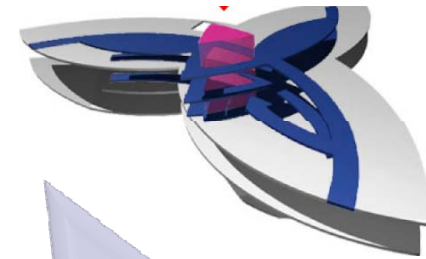
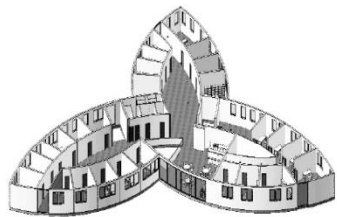
15 deg slope

Curved walls

Flooding

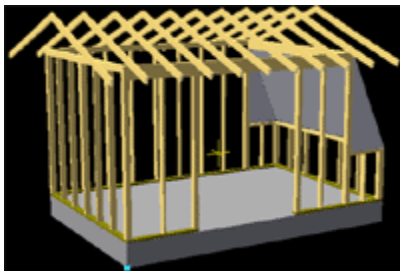
A
E
C
F

Construction Solutions



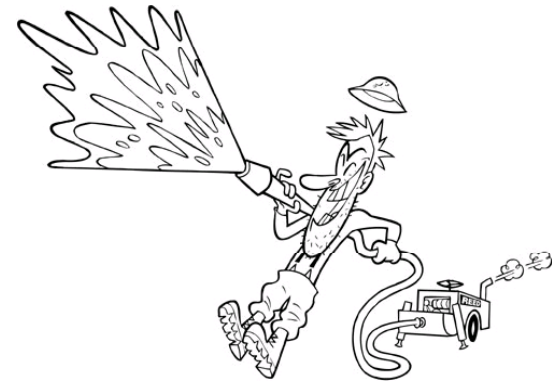
Laser positioning

BuildE~~x~~act



Customized forms

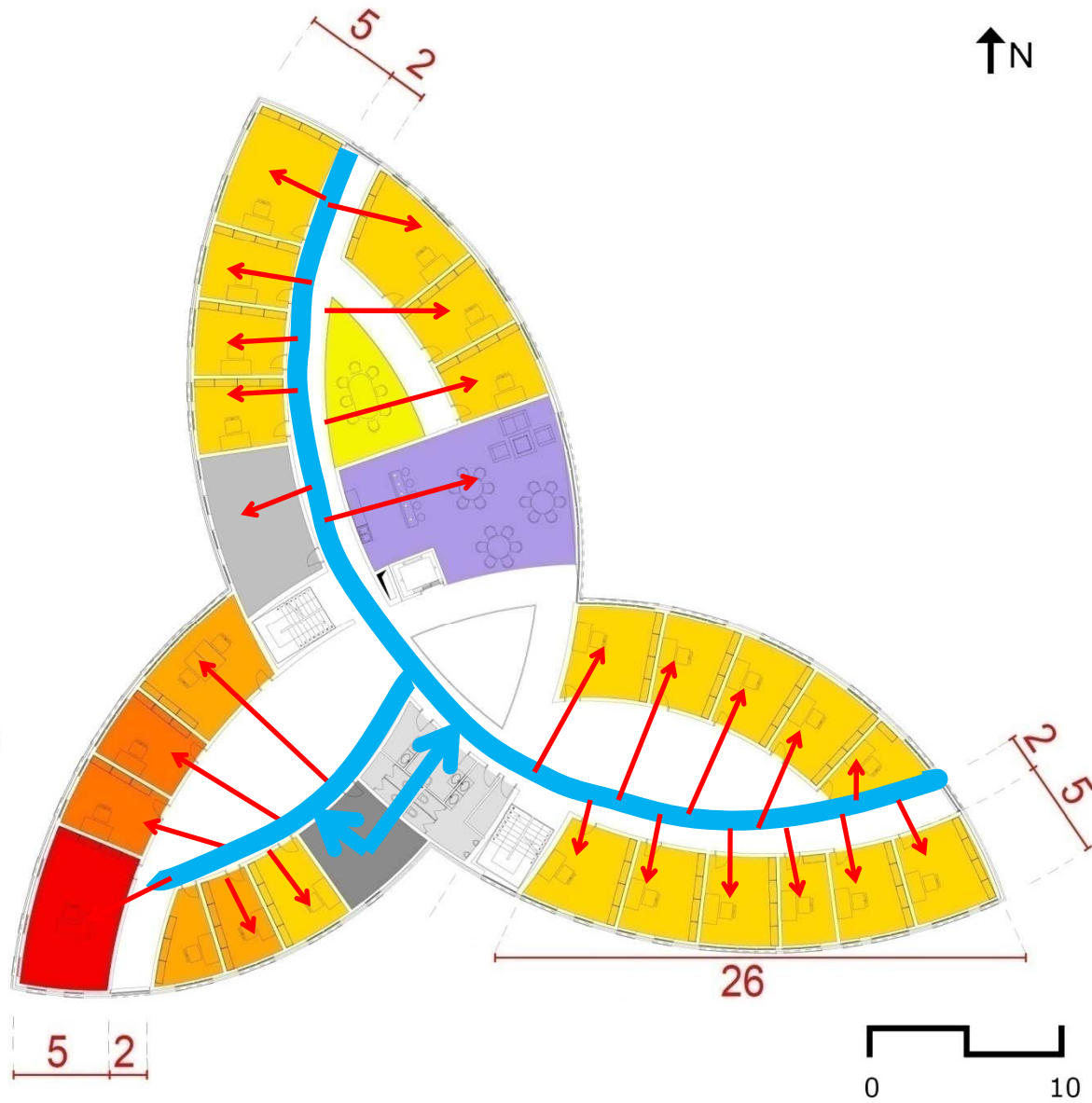
Shotcrete



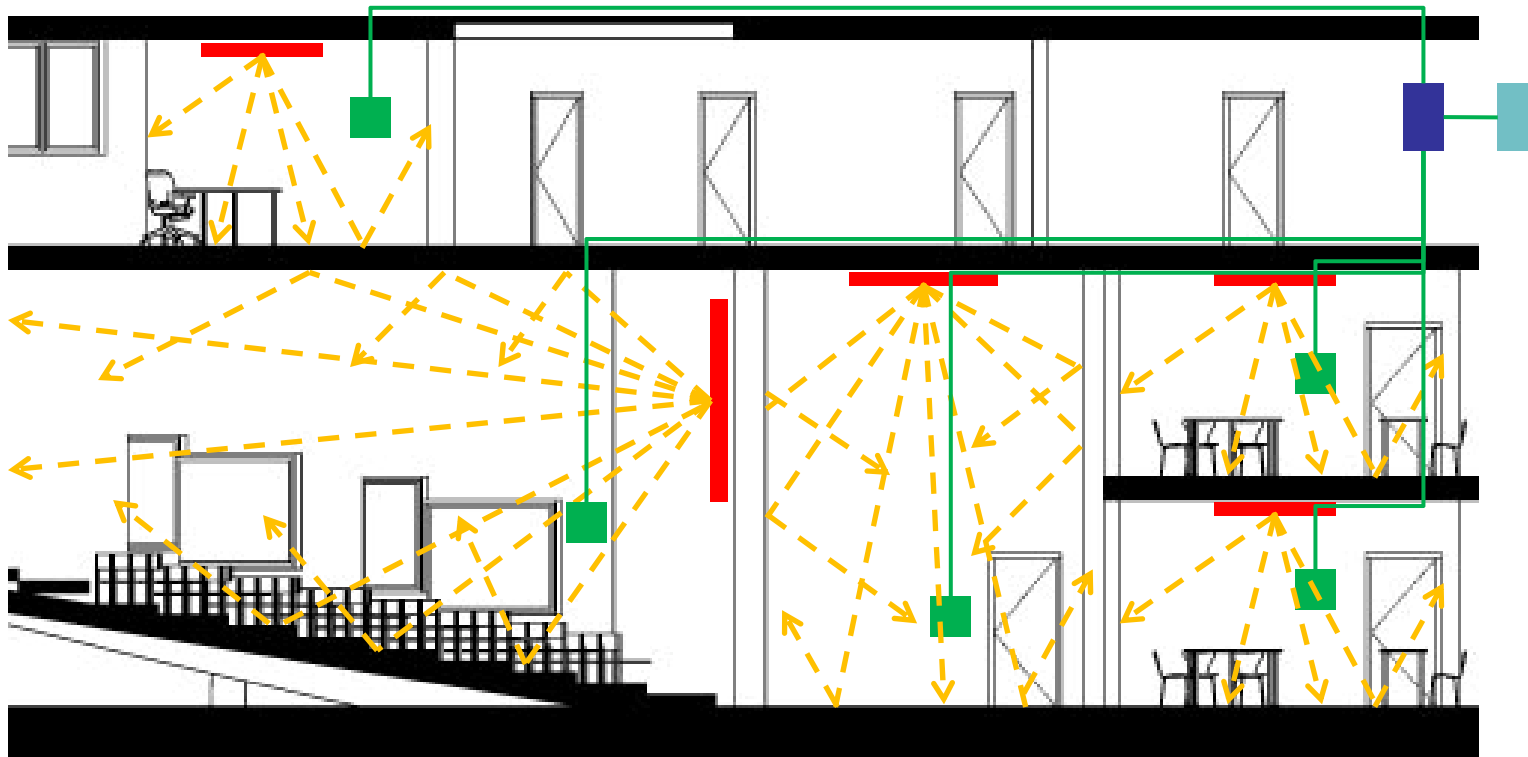
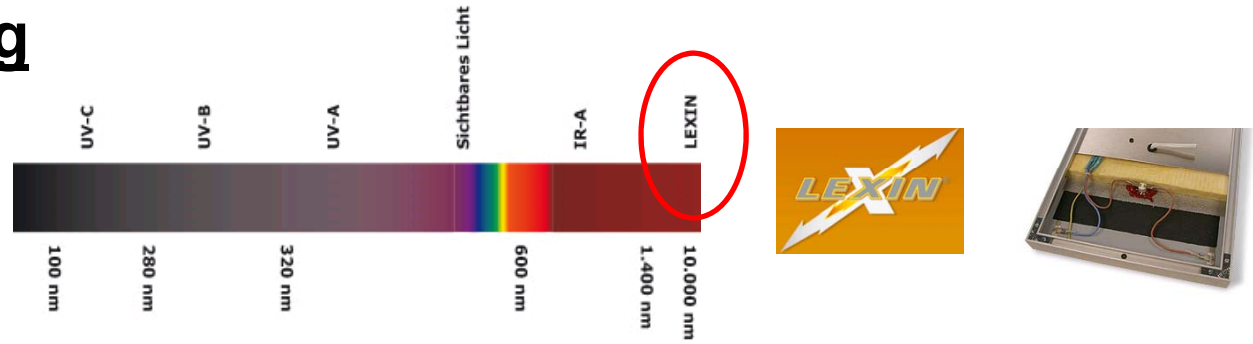
A
E
C
F

MEP Distribution

- Department Chair's Office
- Senior Admin. Assistance
- Administrative Assistance
- Faculty Office
- Meeting Room
- Lounge
- Mechanical Room
- Restrooms
- Storage



Infrared Heating



- Ceiling/Wall mounted panels
- Thermostat
- Controller
- Power-entry panel

Cost Estimate

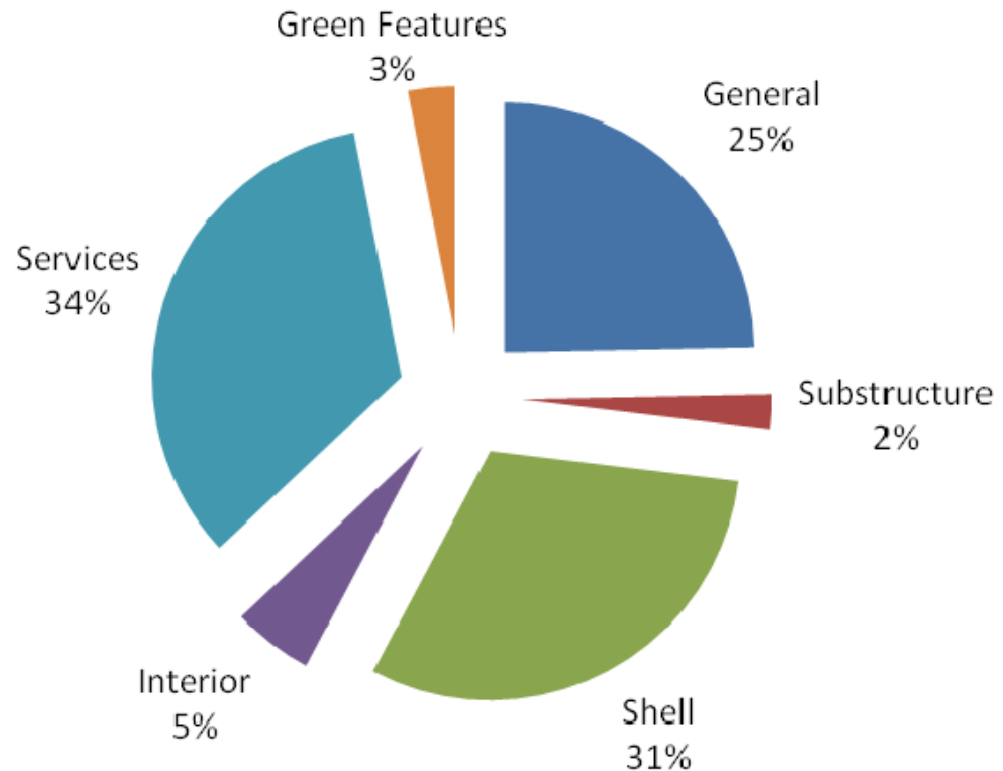
Code	Specification	Quantity	Unit	USD/Unit	USD
	Project	1.00	sf	\$7,833,802.04	\$7,833,802.04
Z2010 Z2010.5000	Project / Fees and Contingency	1.00	pcs	\$1,933,131.40	\$1,933,131.40
Z3010 5340354	Project / Green Features	1.00	pcs	\$238,906.76	\$238,906.76
	Roof	10,698.90	sf	\$33.06	\$353,729.37
B1030 B1030.1300	Roof / Roof	10,556.90	sf	\$30.40	\$320,967.00
B2010 B2010.01_1	Roof / Lateral Walls	1,342.72	sf	\$24.40	\$32,762.37
	Third Floor	11,967.20	sf	\$139.54	\$1,669,917.55
	Second Floor	11,967.20	sf	\$141.05	\$1,687,936.53
	First Floor	13,201.80	sf	\$134.47	\$1,775,304.20
A1030 A1030.01_1	First Floor / Slab on Grade	4,676.64	sf	\$12.00	\$56,119.68
A1030 A1030.01_2	First Floor / Slab on Grade	296.37	sf	\$25.13	\$7,446.20
B1010 B1010.2110	First Floor / Column	4.00	pcs	\$150.00	\$600.00
B1020 B1020.13_1	First Floor / Stadium Slab	2,413.74	sf	\$23.70	\$57,205.64
B2010 B2010.01_1	First Floor / Lateral Walls	5,189.76	sf	\$24.40	\$126,630.14
B2020 B2020.0505	First Floor / Exterior Glass Cover	13,201.80	sf	\$47.50	\$627,085.50
C1020 C1020.0100	First Floor / Intr HM Door	35.00	pcs	\$1,390.00	\$48,650.00
C2010 C2010.0100	First Floor / Stairs	1.00	pcs	\$8,725.00	\$8,725.00
C3020 C3020.0200	First Floor / Floor Finish	238.49	sf	\$144.67	\$34,503.08
C3030 C3030.1100	First Floor / Ceiling Finish	4,600.41	sf	\$4.95	\$22,772.03
D1010 D1010.0300	First Floor / Hydraulic Freight Elevator	1.00	pcs	\$114,800.00	\$114,800.00
D2010 D2010.9001	First Floor / Electrical	8,564.44	sf	\$28.33	\$242,630.59
D2010 D2010.9002	First Floor / Fire Protection	8,564.44	sf	\$5.49	\$47,018.78
D2010 D2010.9003	First Floor / Plumbing	8,564.44	sf	\$17.00	\$145,595.48
D2010 D2010.9004	First Floor / HVAC	8,564.44	sf	\$27.50	\$235,522.10
	Subgrade	2,434.14	sf	\$71.84	\$174,876.22
A1010 A1010.0100	Subgrade / Piles	25.00	pcs	\$2,530.00	\$63,250.00
A1030 A1030.0100	Subgrade / Slab on Grade	2,434.14	sf	\$25.13	\$61,157.77
A2020 A2020.0100	Subgrade / Basemnt Foundtn Wall	174.72	ft	\$288.85	\$50,468.45
	In total				\$7,833,802.04

Cost Estimate

General	\$1,933,131
Substructure	\$174,876
Shell	\$2,417,796
Interior	\$410,350
Services	\$2,658,742
Green Features	<u>\$238,907</u>

5,890,000 EUR

	\$7,833,802
Total Budget 2009	\$7,800,000
Future Cost 2015	\$9,300,000



A
E
C
F

Cost Estimate

Project

- Project
- Roof
- Third Floor
- Second Floor
 - B SHELL
 - C INTERIORS
 - D SERVICES
- Legacy
- First Floor
 - A SUBSTRUCTURE
 - B SHELL
 - C INTERIORS
 - D SERVICES
- Subgrade

Recipe

Code	Name	5/4/2...	Older	Diff...	?
B1020.1300	Raise Slab	\$250,115.58			
B2010.01_1	Lateral Walls	\$282,430.00			
B2020.0504	Mid Rise CrtnWl G1Ctg	\$52,245.25			
C1020.0100	Intr HM Door	\$29,190.00			
C2010.0100	Stairs	\$8,725.00			
C3020.0200	Floor Finish	\$77,496.00			
D2010.9002	Fire Protection	\$65,623.07			
D2010.9004	HVAC	\$328,724.00			
D2010.9003	Plumbing	\$203,209.50			
D2010.9001	Electrical	\$339,030.78			

Target Cost Monitor

Title	Target	5/4/2009	Older
Project Cost		\$6,829,162.82	
Cost of Selected		\$1,636,789.17	

May 2009

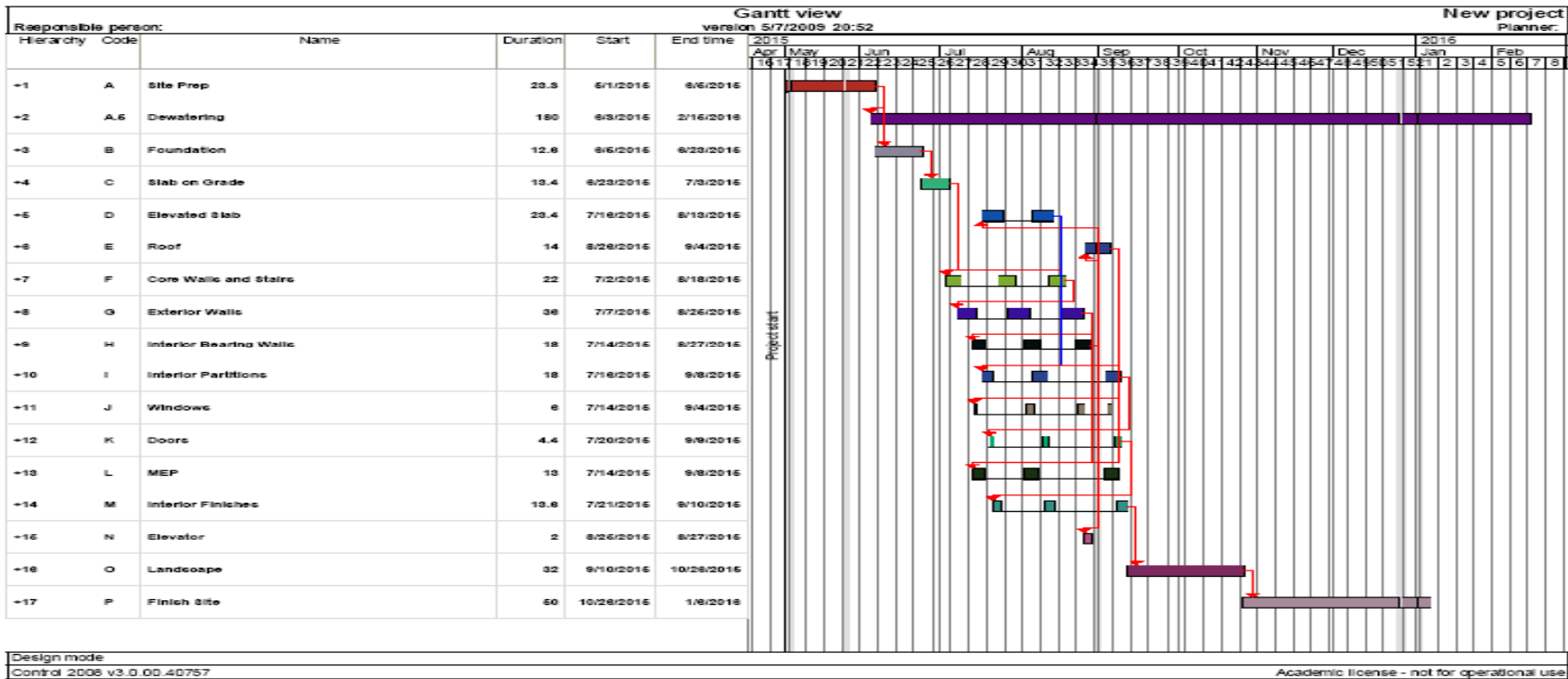
Monday 4 Tuesday 5 Wednesday 6 Thursday 7 Friday 8

A
E
C
F

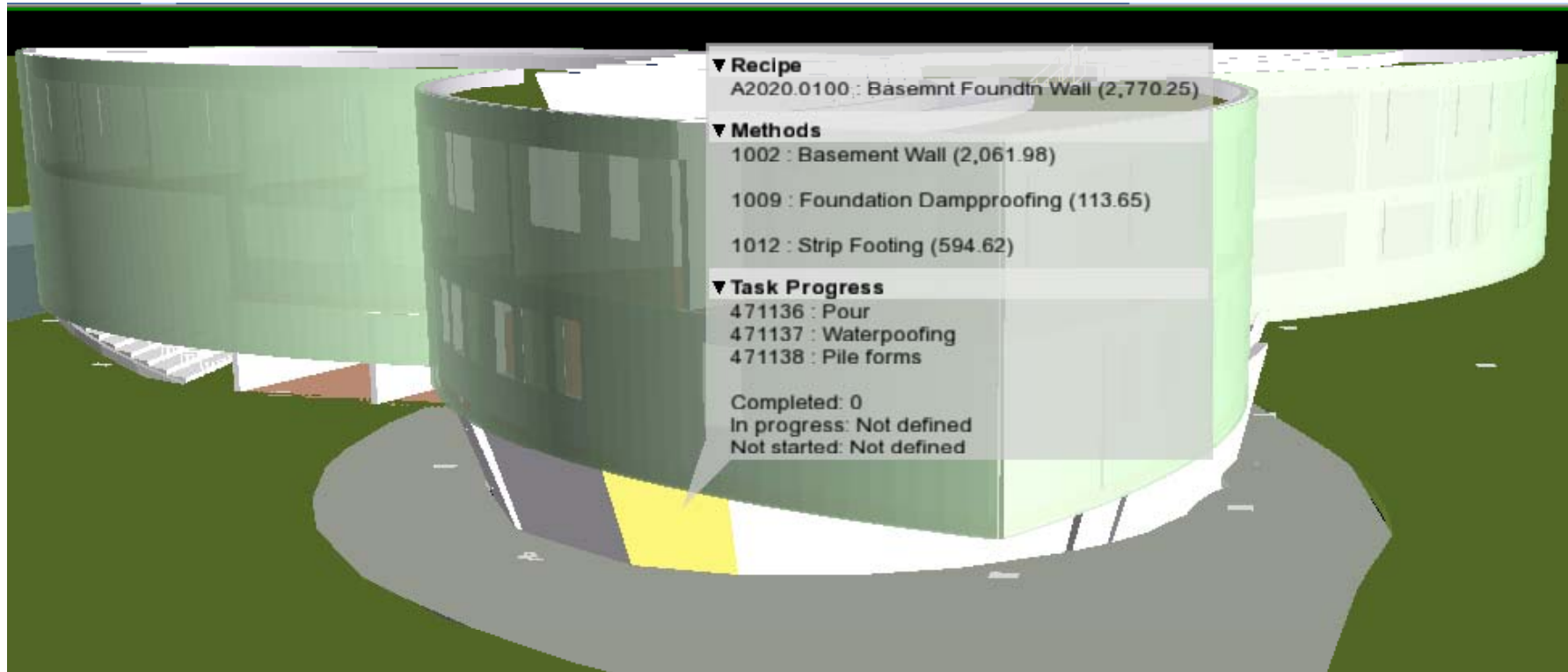
River 2009

Line of Balance

Start Date: 5/1/2015
 Finish Date: 1/31/2016
 *Dewatering: 3/31/2016



4D Model



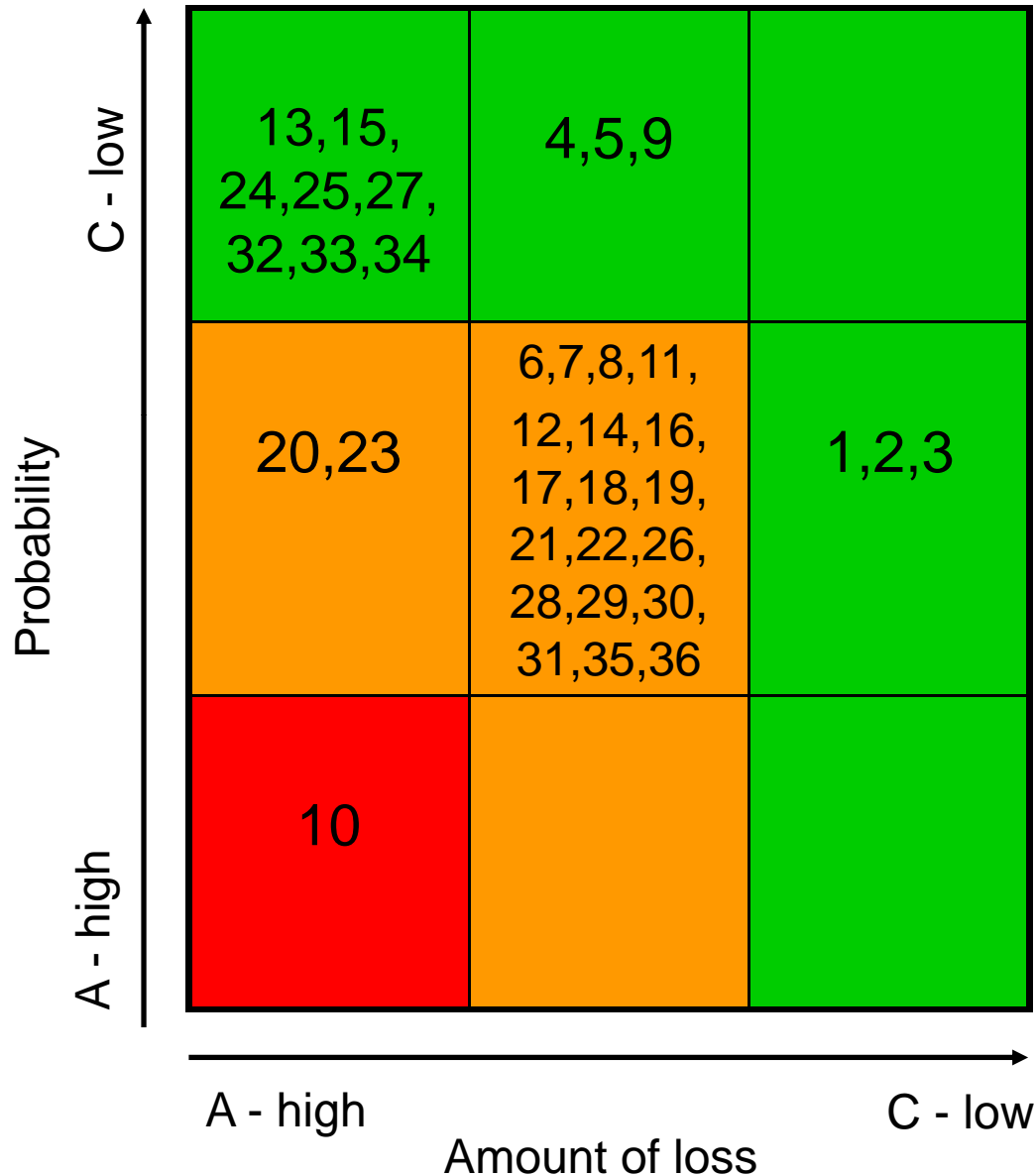
A

E

C

F

Risk Management – ABC-Analysis

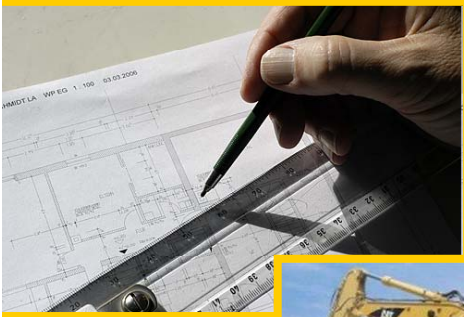


RISKS:

- Flood (10)
- Exceeding Schedule (14)
- Change in interest rate (8)
- Operation Costs (30)
- political risks (1-3)
- legal risks (4-5)
- contamination (15)

A
E
C
F

Financing



Planning/
Construction
5.890.00 €



Maintenance
46.900 €

Risks
642.600 €



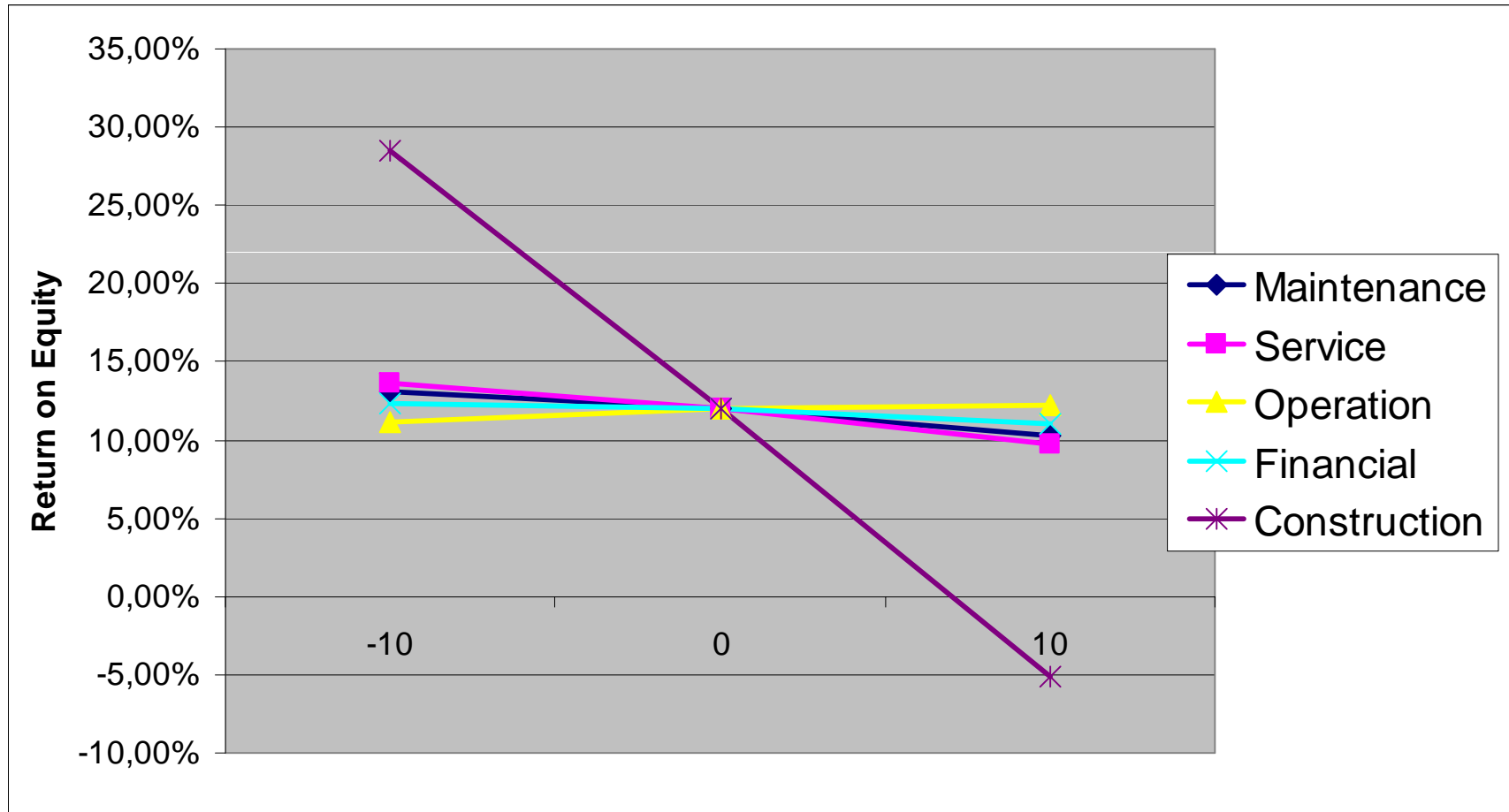
Service
46.900 €



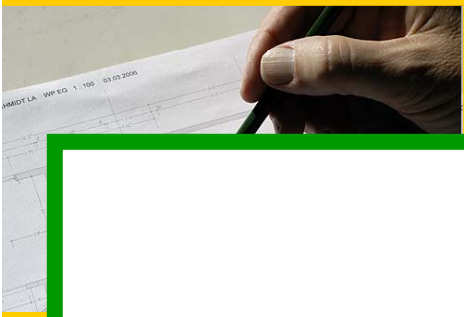
Operation
-12.200 €

A
E
C
F

Sensitivity Analysis



Financing



Planning/
Construction



Total Costs

5.890.000 €



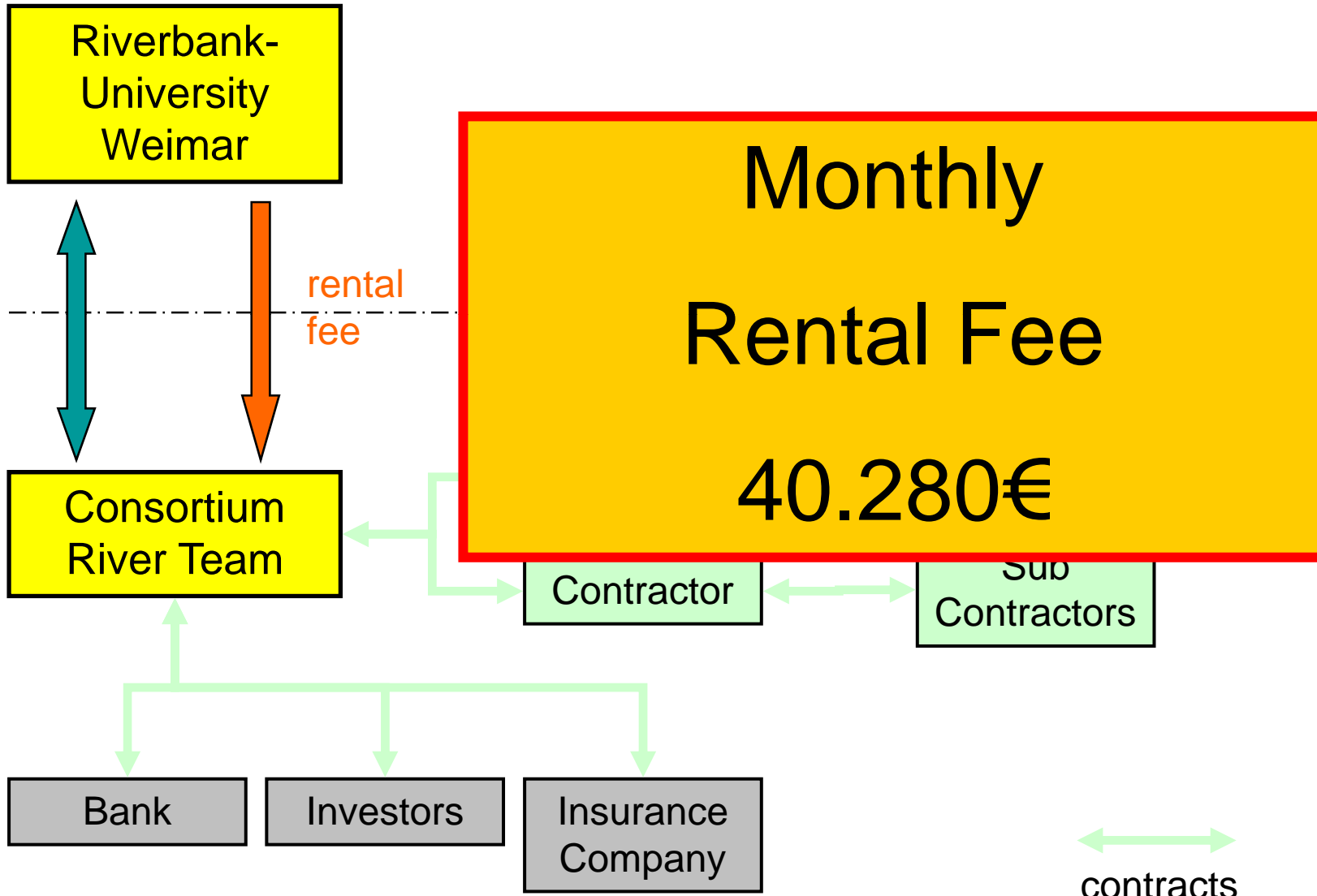
\$7,834,000

46.900 €

-12.200 €

A
E
C
F

PPP-Project



Sustainability - LEED



Sustainable Site

11/14



Water Efficiency

5/5



Energy / Atmosphere

11/17



Material Resources

7/13



Indoor Environmental Quality

13/15



LEED Innovation

3/5

required:



33-38
points



Project:

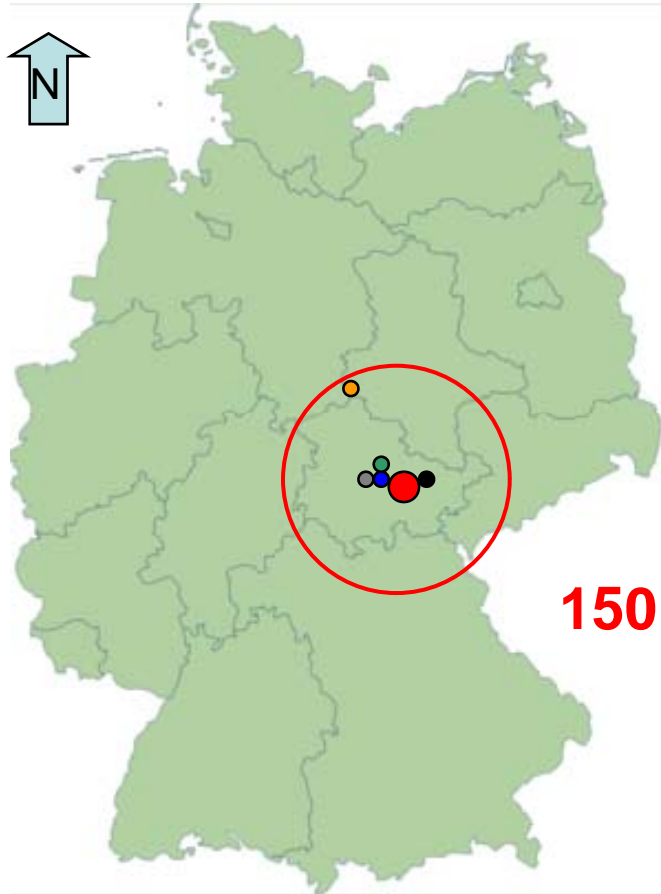


50 / 69
points

A
E
C
F

River 2009

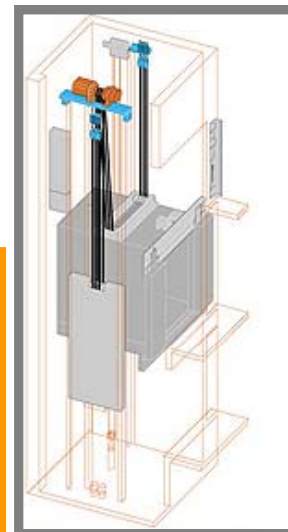
Sustainability



High Requirements:

- green company policy
- supply of using recycled material
- Local materials
- Local companies

150km/93 miles

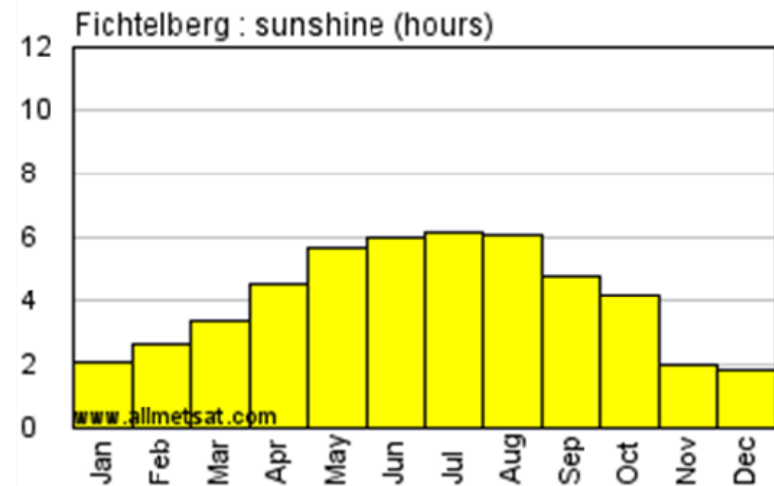
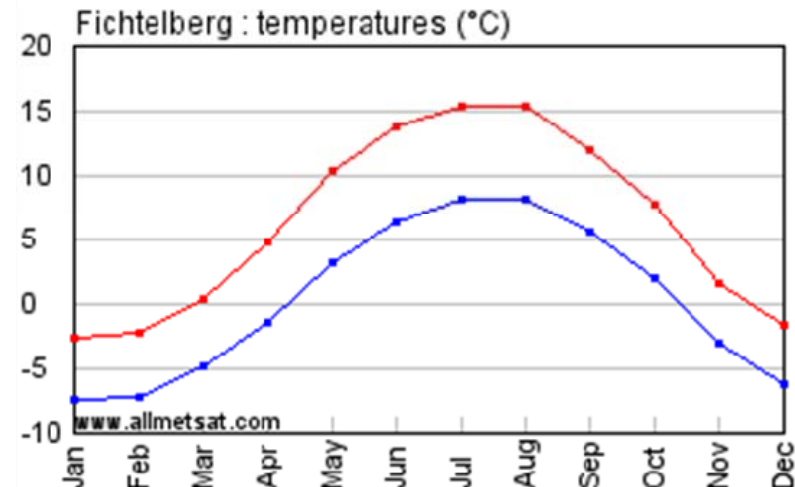
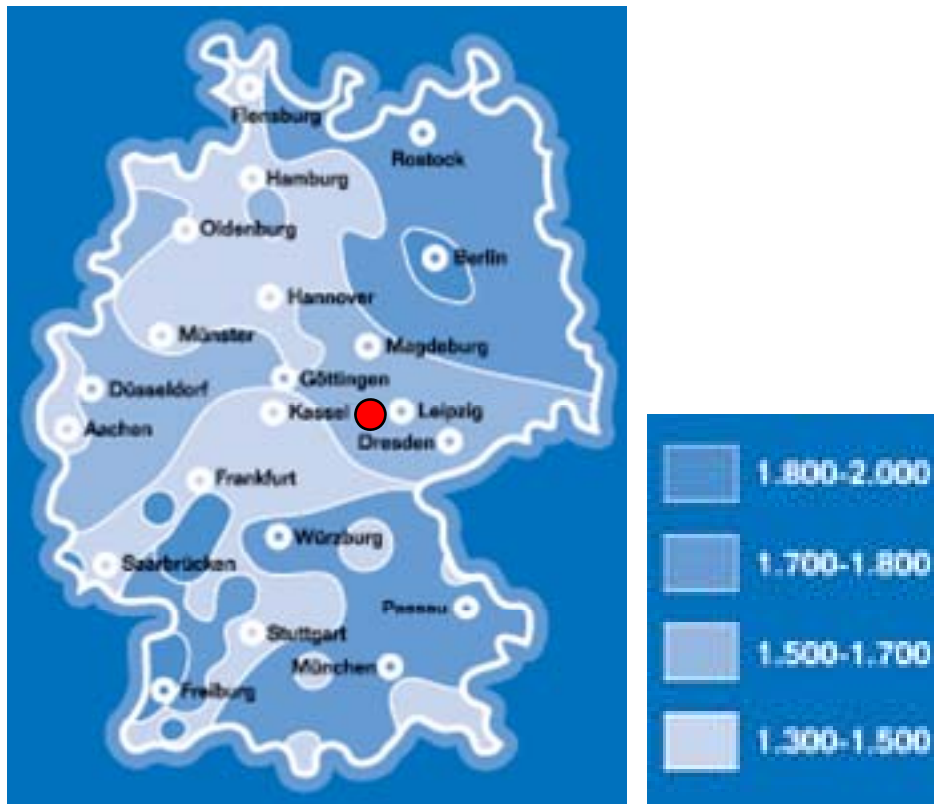


A
E
C
F

Sustainability

GERMANY – Worldwide Leader for Solar Energy
(Federal Association for Solar Energy, April 2009)

Renewable Energy Law

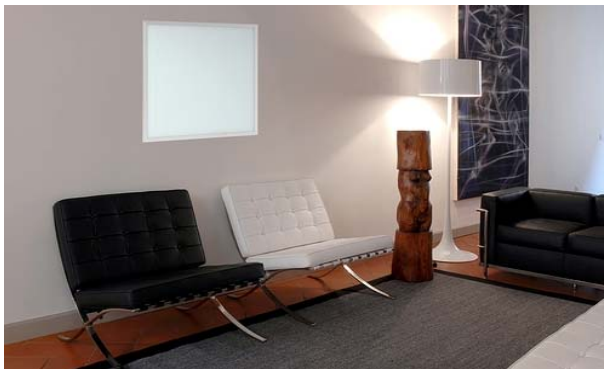


Sustainability – Trade-off-Analysis

Photovoltaics



800 m²/600 m²
 58.000 kWh
 5760 kWh
 683 g/kWh
 39.600 kg/year



Solar Panels



300 m²/240 m²

 79100 kWh
 232 g/kWh
 19.488 kg/year



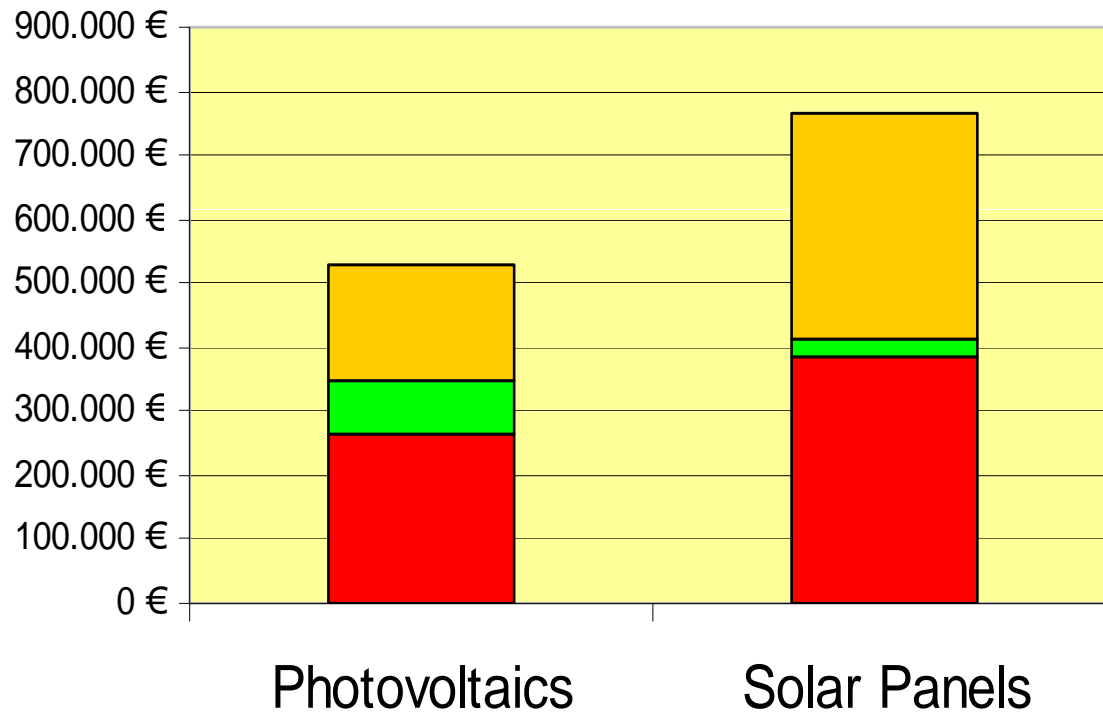
Area/Effective area
 Line entry
 Consumption
 CO₂ – Avoiding
 total

A
E
C
F

Sustainability – Trade-off-Analysis

Photovoltaics

Solar Panels



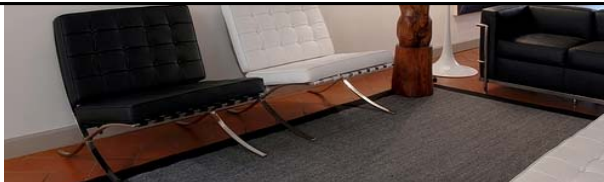
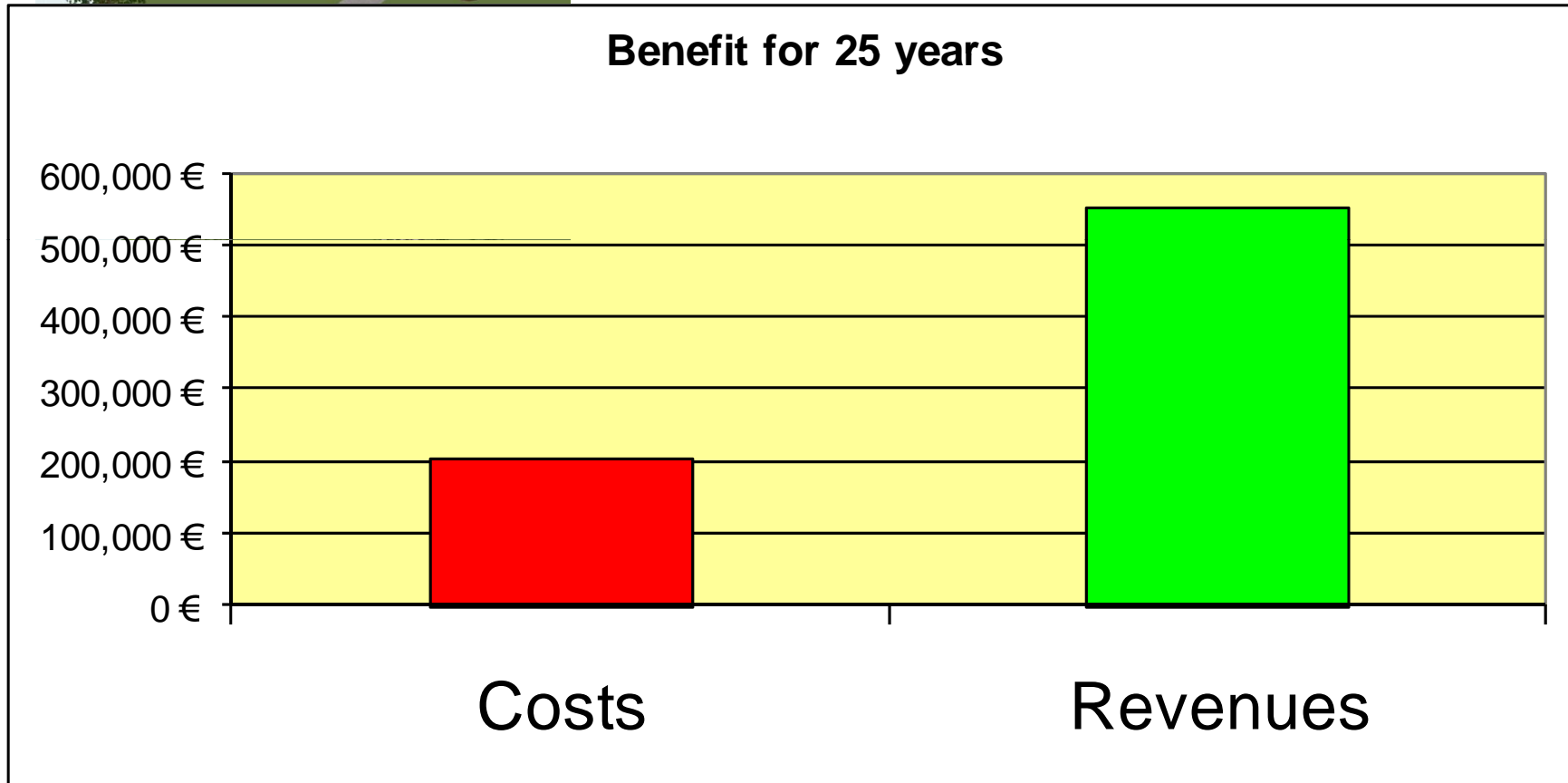
- Investment Costs without Subsidies
- Subsidies
- Investment Costs with Subsidies



A
E
C
F

Sustainability – Trade-off-Analysis

Photovoltaics

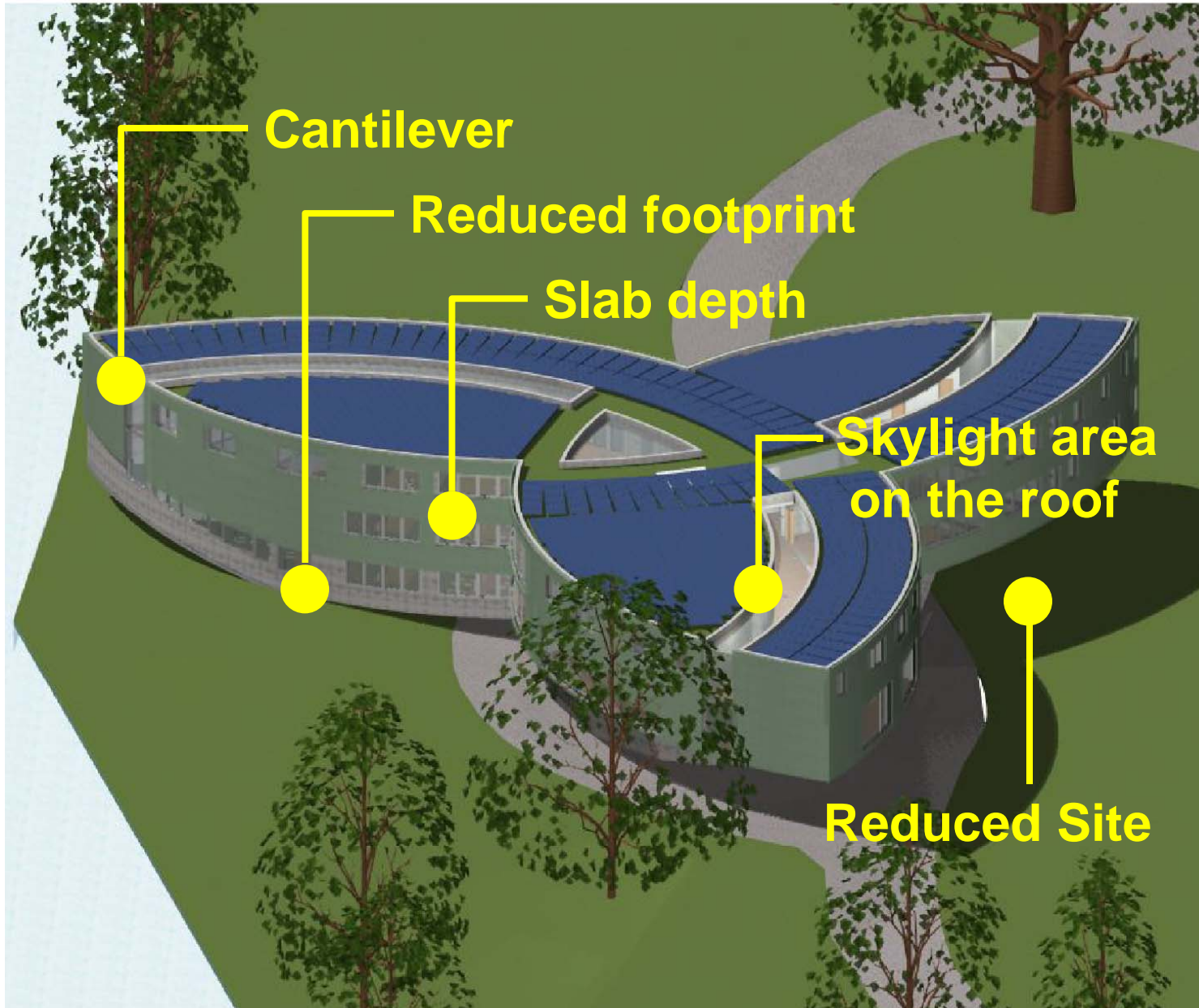


Zero Waste

A
E
C
F

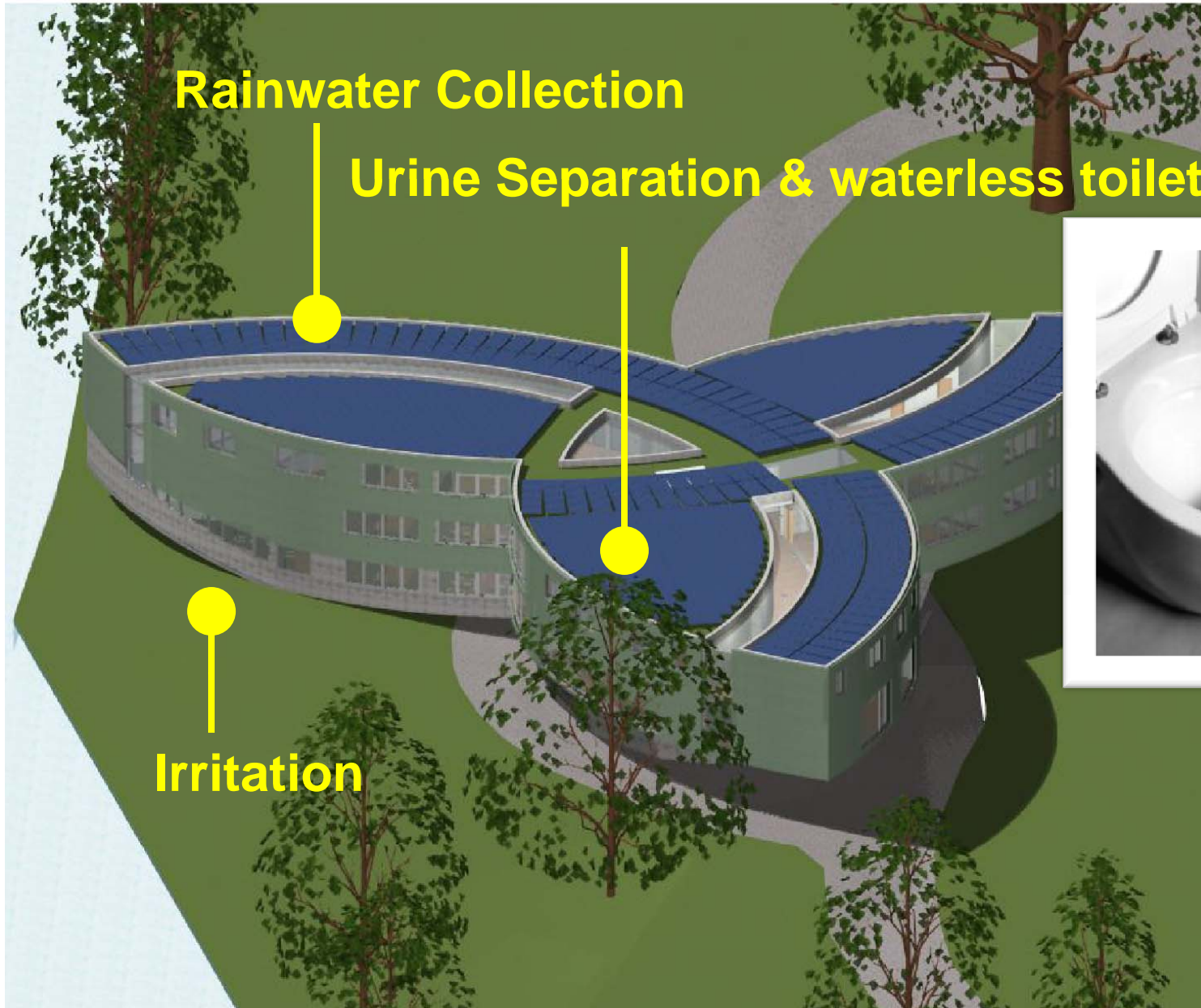
River 2009

Save Space & Materials...

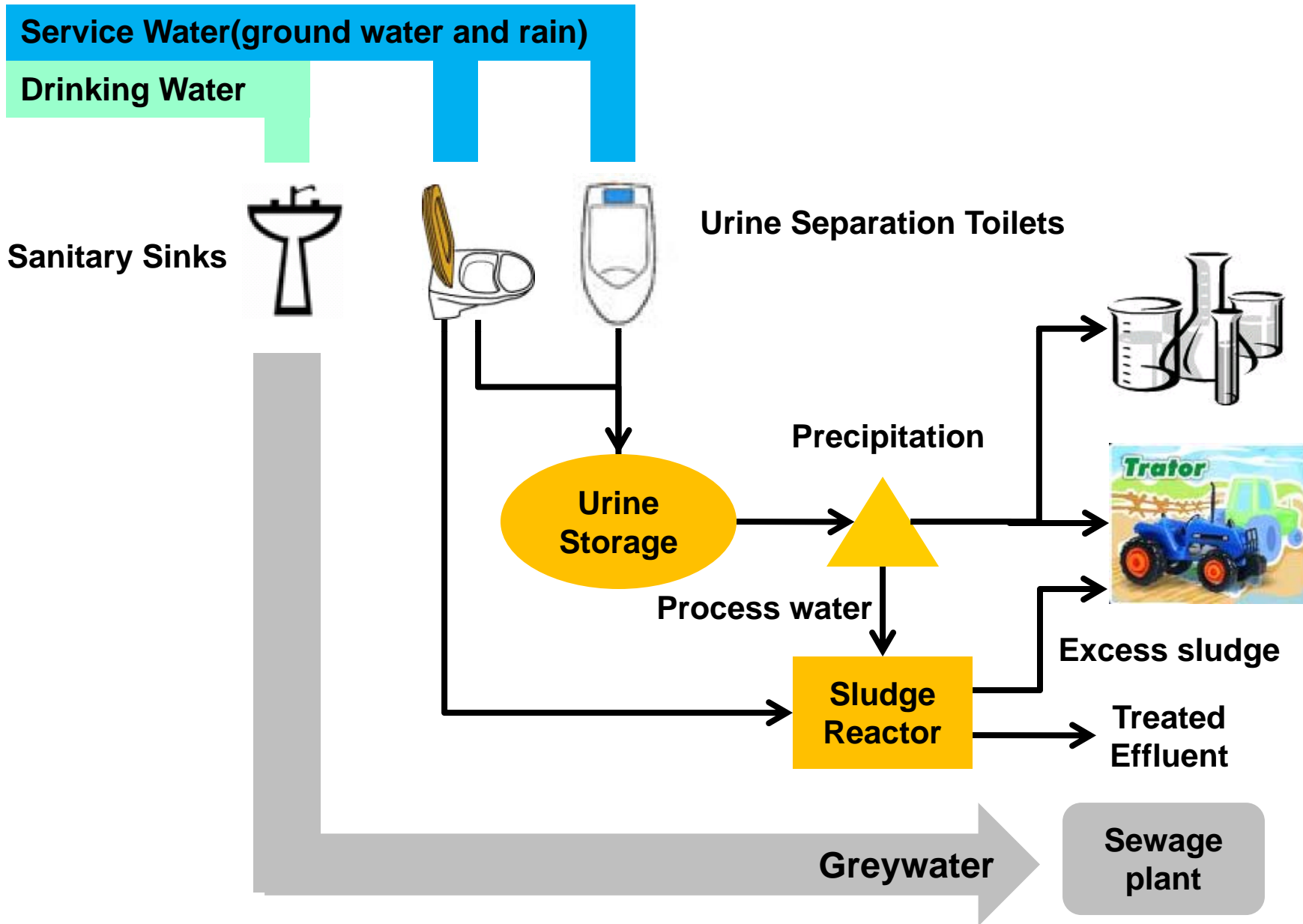


A
E
C
F

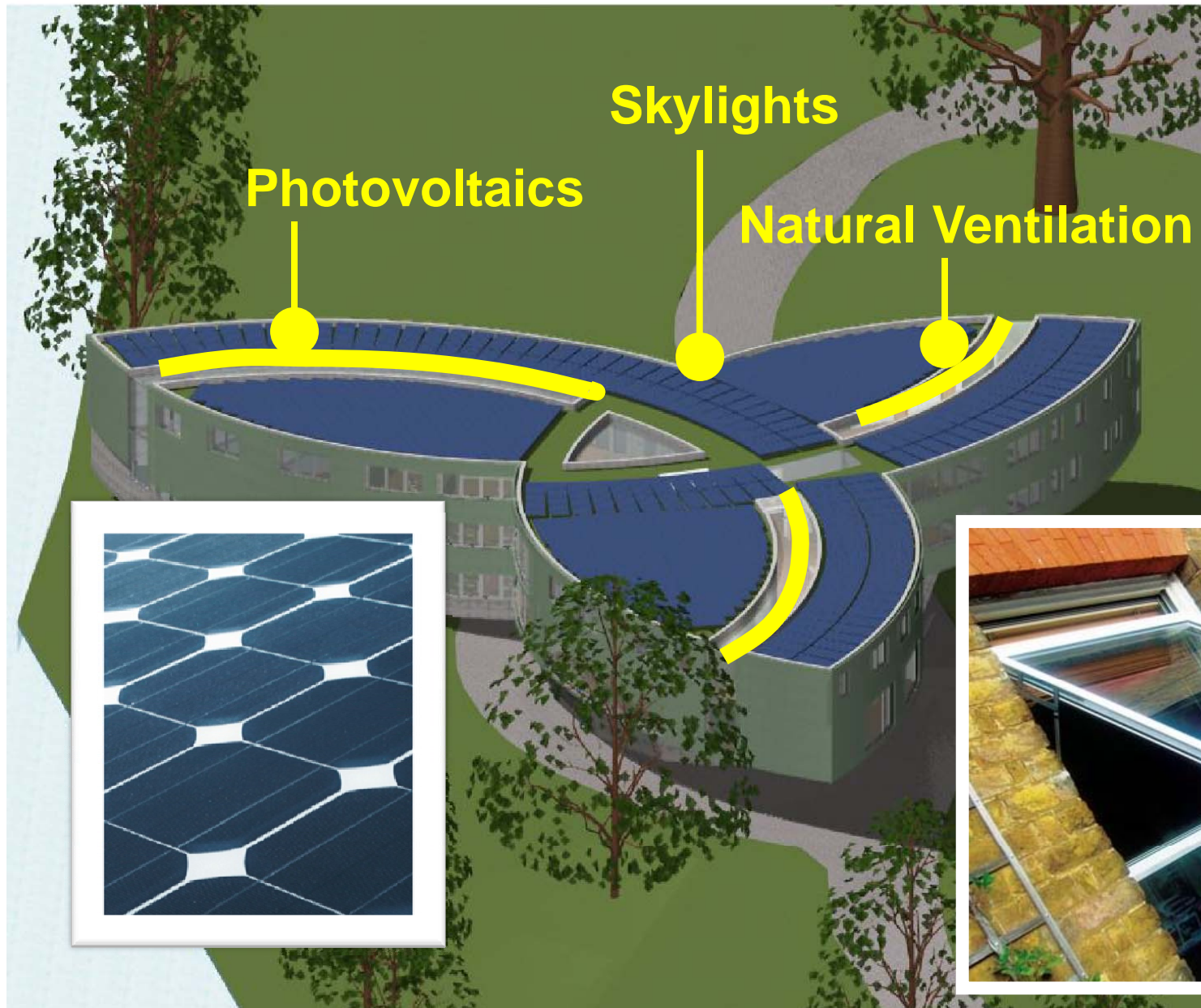
Save Water



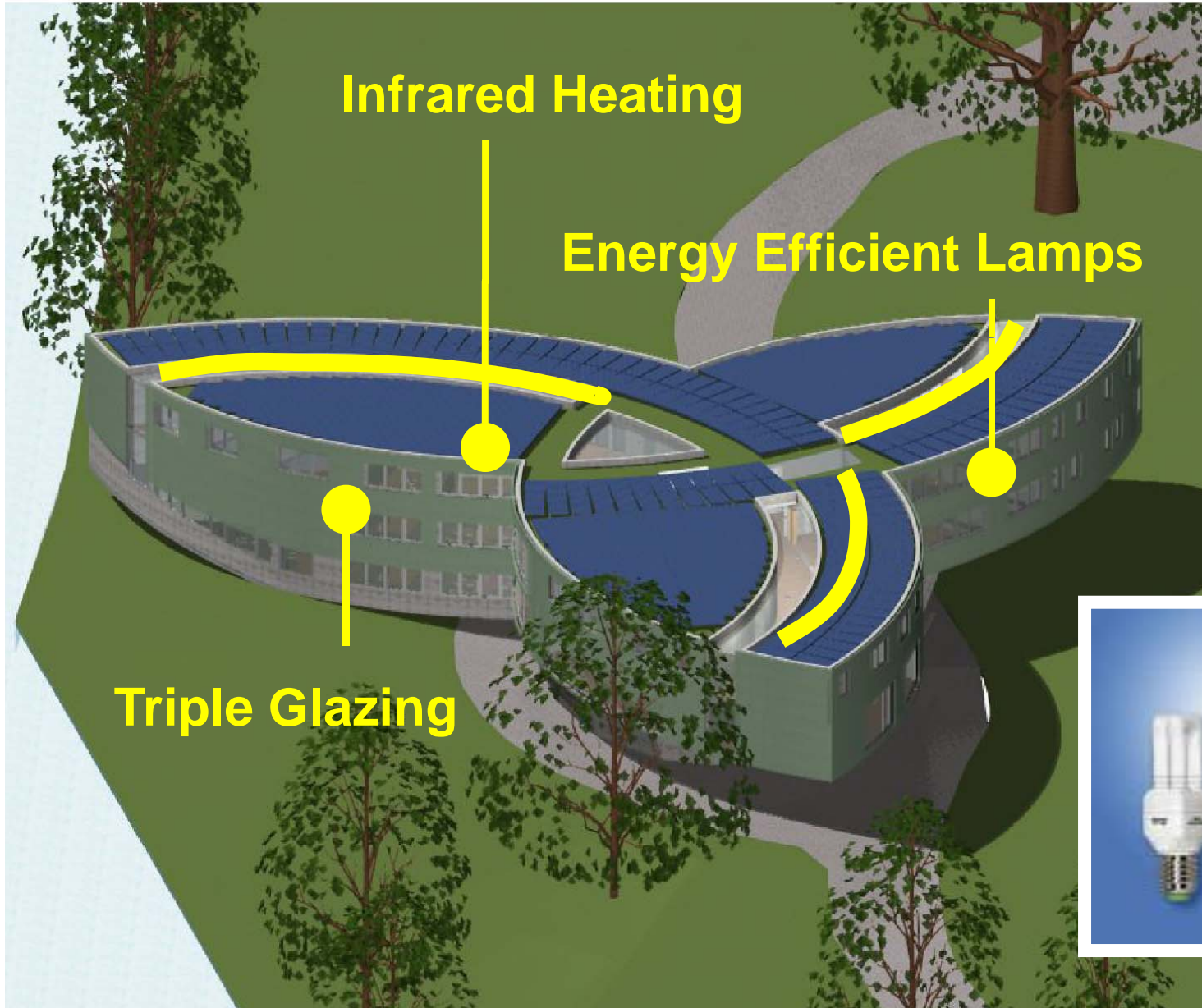
Urine and Brownwater Reuse System



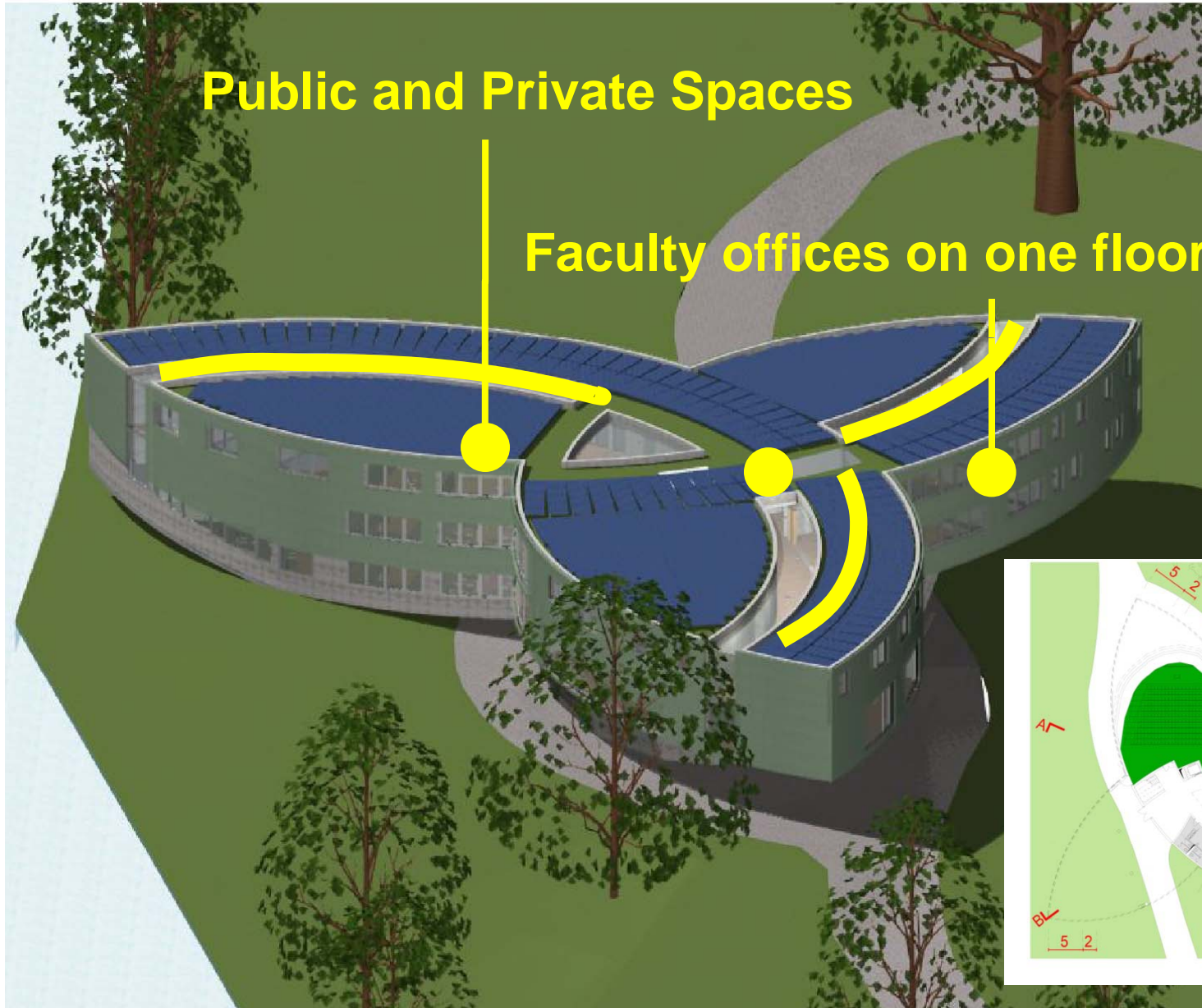
Increased Air Quality .../ Reduced CO₂ ...



Save Energy .../ Save Heat ...



Save Indoor Quality.../ Save Time.../Save Ways ...



A
E
C
F

Software

- Revit
- ArchiCad
- Tekla
- AutoCad
- Exel
- Google Docs
- Think Tank
- Oslo
- Brainstorm
- Gmail
- Skype

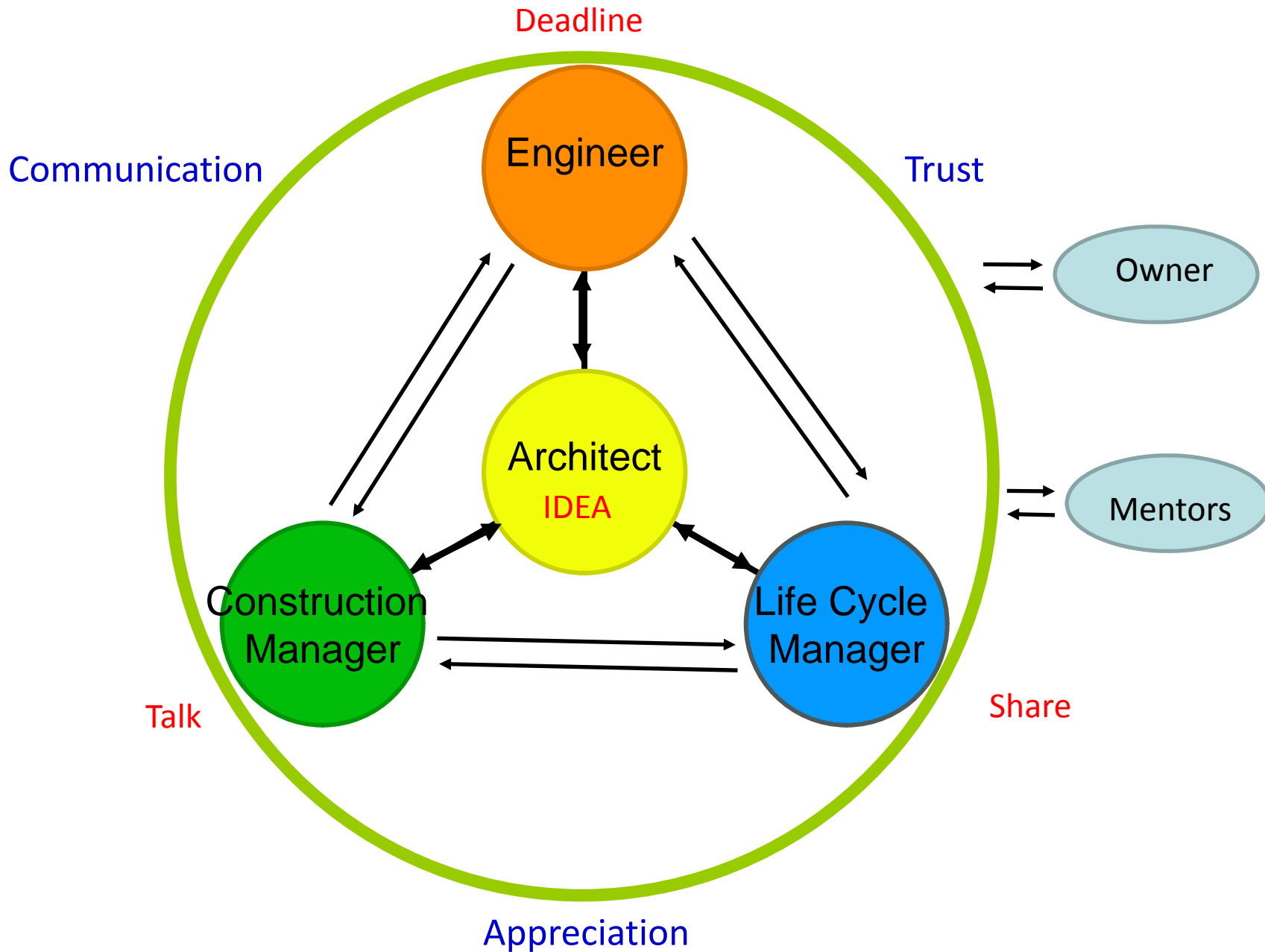


TEKLA

A
E
C
F

River 2009

Team Process



A
E
C
F

Learning



- Nadin: Not only interdisciplinary, but also inter-team collaboration.



- Jeff: Interoperability is essential in global team work.



- Jiang: Construction Manager needs to enter as early as possible.



- Brenda: Paraphrasing words does help to understand better.



- Josefine: Programs need to be interoperable



- Matt: The way to get all the work done is not to wait until the last minute

Ideas will not be realized without you!

We would like to thank:

! Renate Fruchter, Stanford University!

Our owner: David Borowicz, University of Wisconsin, Madison

Mentors:

A: Hans Verheij, Netherland

Jörg Braunes, Bauhaus University, Germany

Christian Tonn, Bauhaus University, Germany

E: Helmut Krawinkler, Stanford University

Ronnie Borja, Stanford University

Greg Luth, GPLA of California

Michael Oliva, University of Wisconsin, Madison

Larry Bank, University of Wisconsin, Madison

Nick Arenson,

C: Martin Fischer, Stanford University

Eduardo Miranda, Stanford University

Henry Tooriany, Microestimating Inc.

Adhamina Rodriguez, Swinerton Builders

John Nelson, UW Madison

LCFM: Andrea Frank-Jungbecker, Bauhaus University, Germany

Roberto Friedrich, Hochtief PPP Solutions

Axel Seifert

A

E

C

F

Q&A

