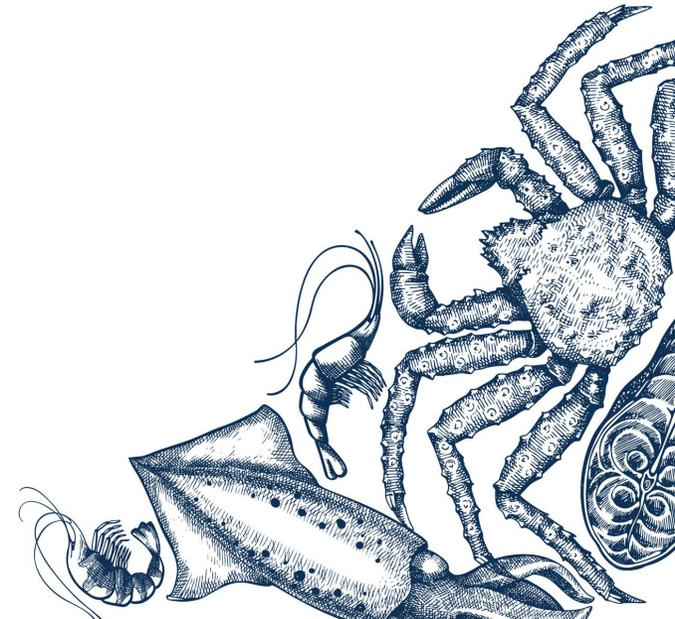
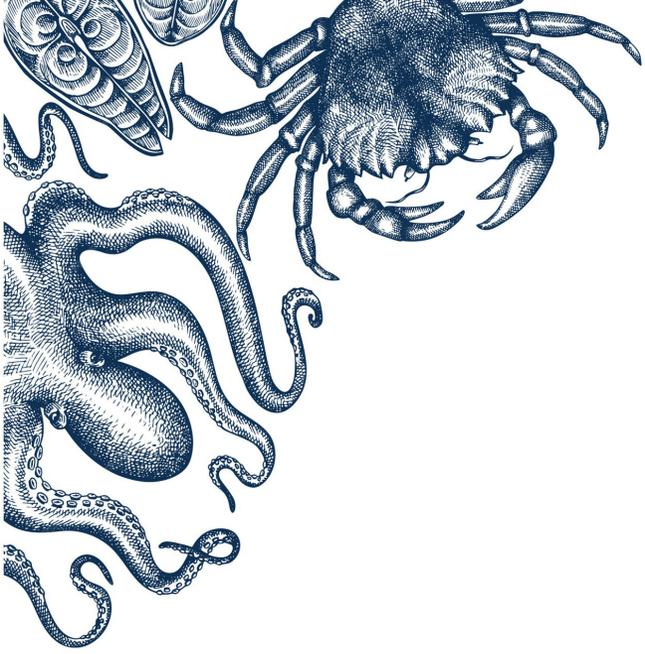


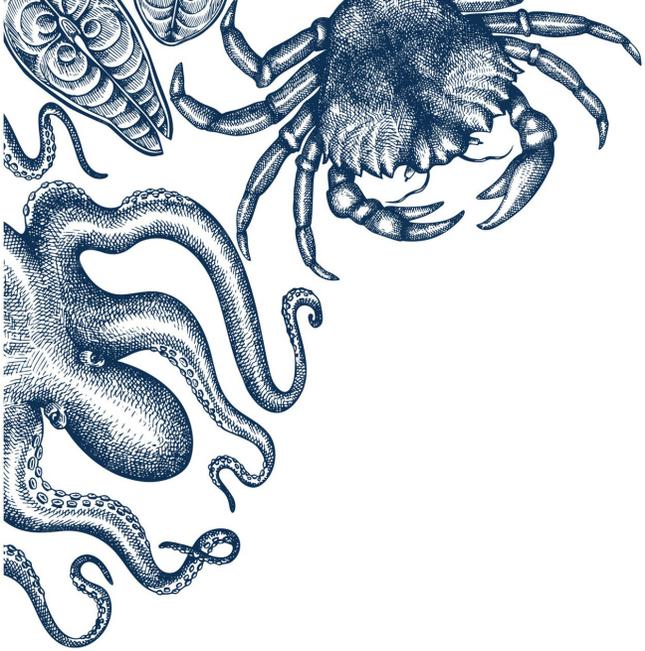


# SUBMERGED



# SUB MERGED

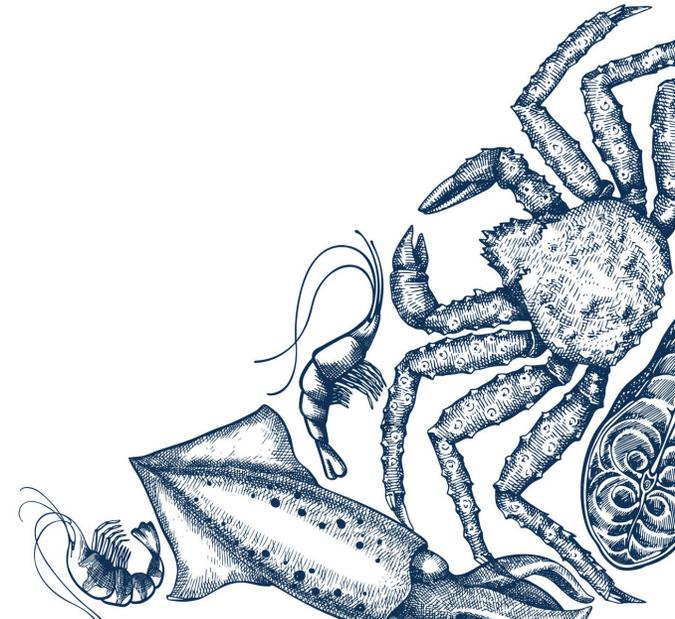




# SUB MERGED

## STARTERS

Studio assignment  
Research question



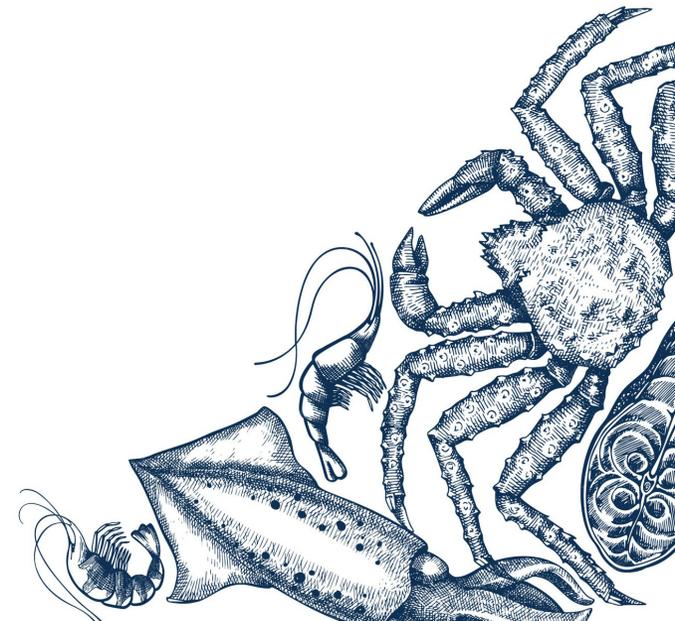
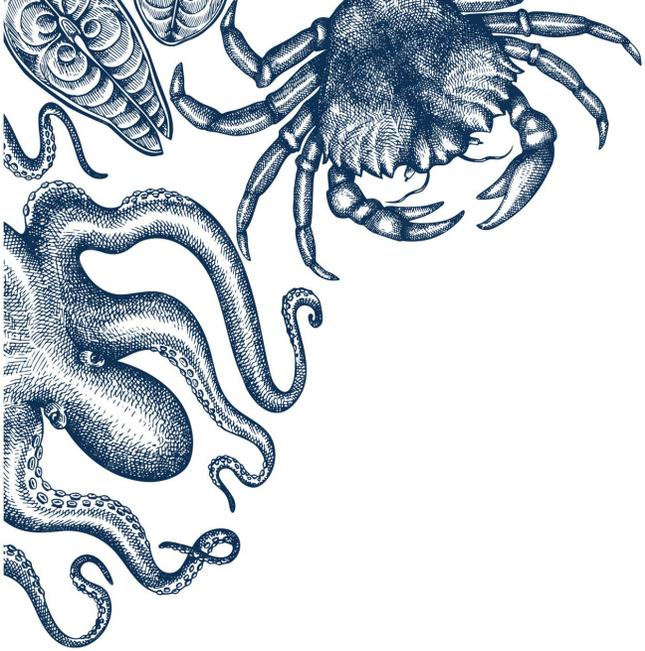
# SUB MERGED

## STARTERS

Studio assignment  
Research question

## MAIN COURSE

Energy  
Rising sea level  
Location



# SUB MERGED

## STARTERS

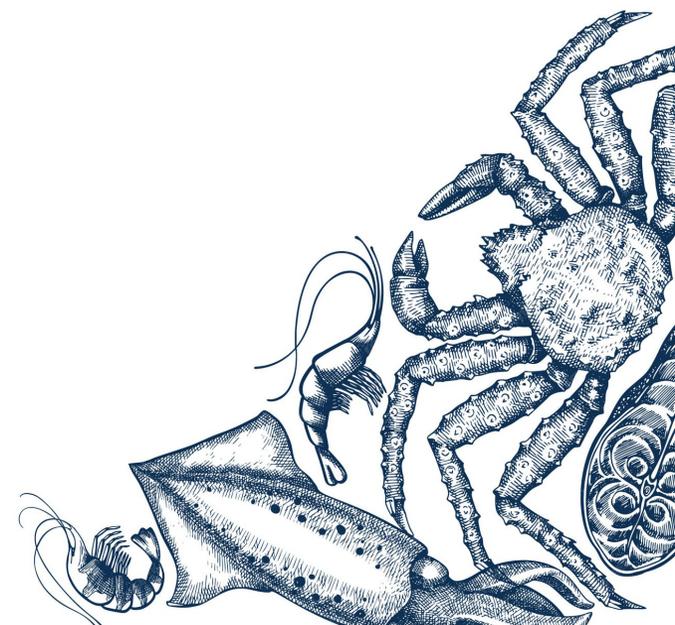
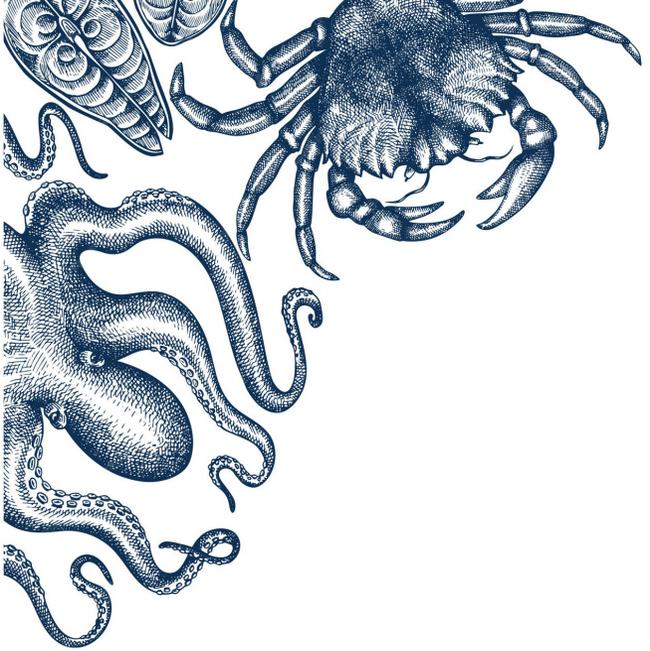
Studio assignment  
Research question

## MAIN COURSE

Energy  
Rising sea level  
Location

## SEASONAL SPECIALS

Design principles  
Form



# SUB MERGED

## STARTERS

Studio assignment  
Research question

## MAIN COURSE

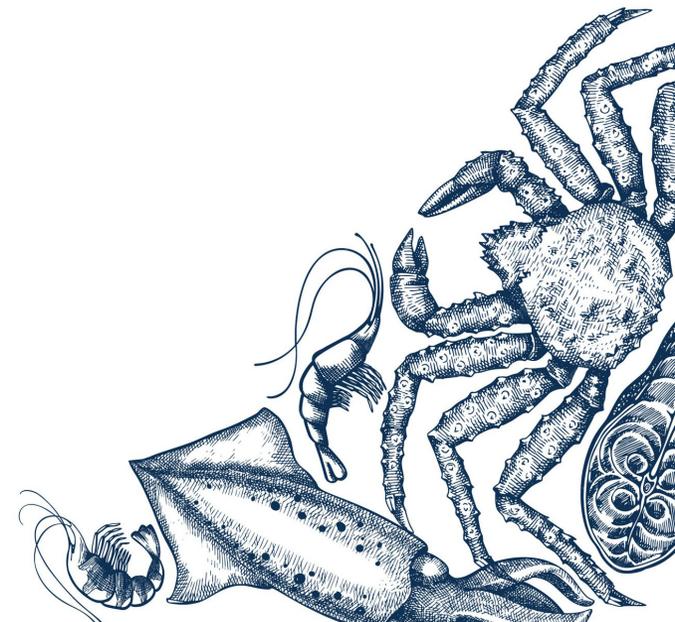
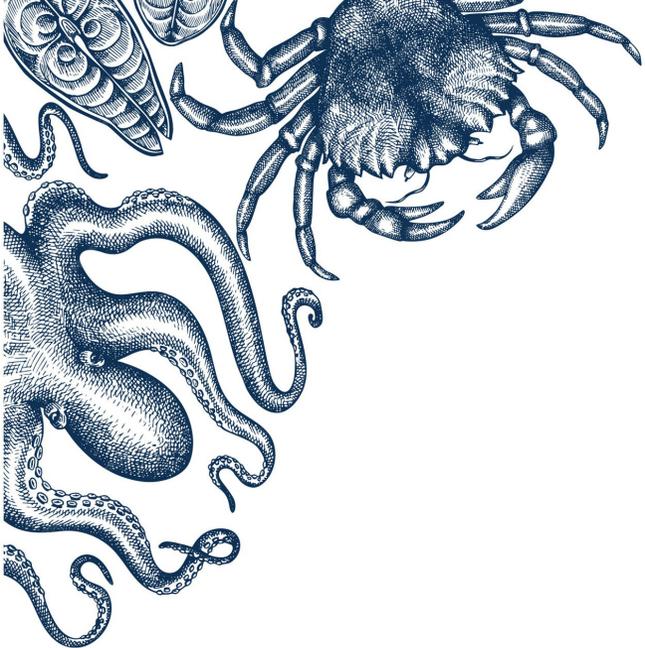
Energy  
Rising sea level  
Location

## SEASONAL SPECIALS

Design principles  
Form

## SIDE DISHES

Design  
Construction  
Climate



# SUB MERGED

## STARTERS

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## SEASONAL SPECIALS

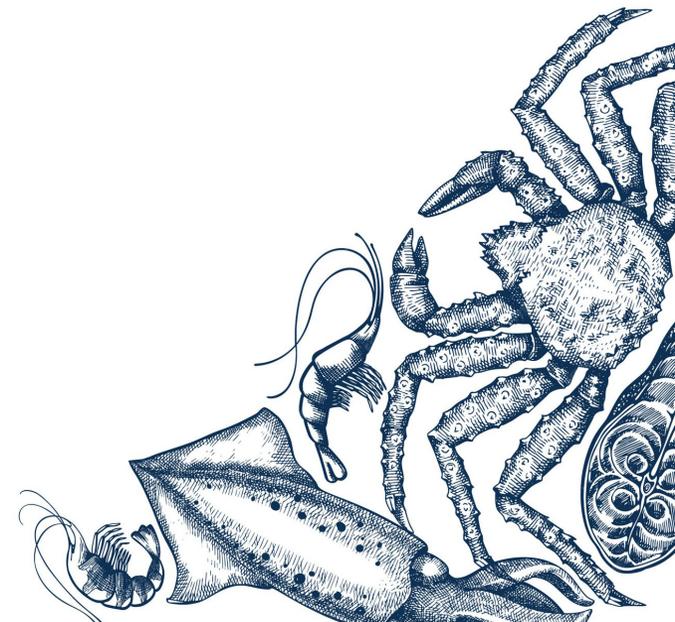
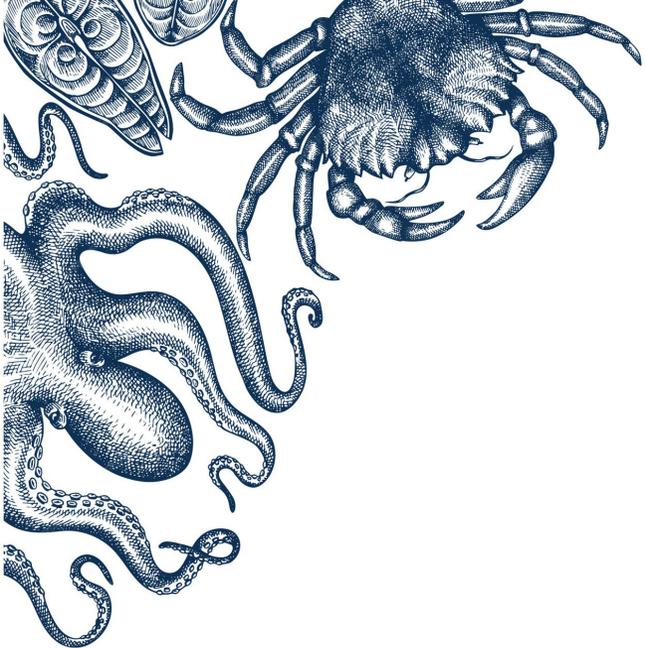
Design principles  
Form

## SIDE DISHES

Design  
Construction  
Climate

## DESSERTS

Conclusions







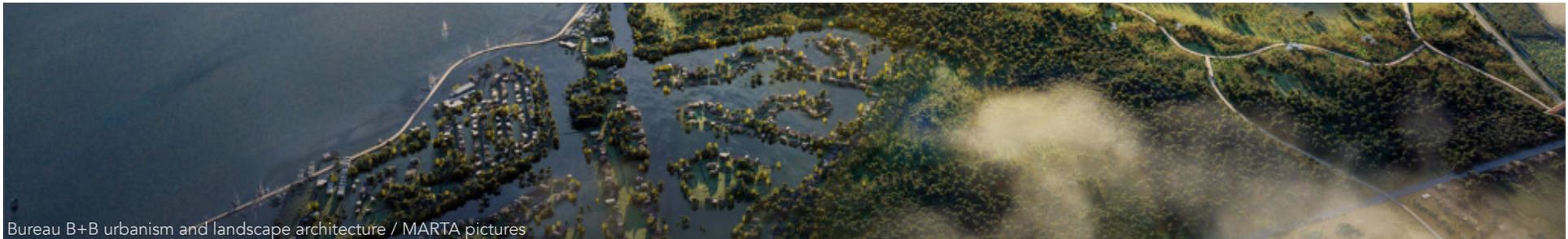
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FORM STUDIES

# TECHNOLOGIES & AESTHETICS



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**LOCATION**

**SEA LEVEL RISE**

**THEMES**



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**LOCATION**

**SEA LEVEL RISE**

**THEMES**

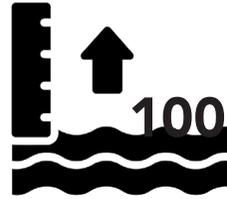


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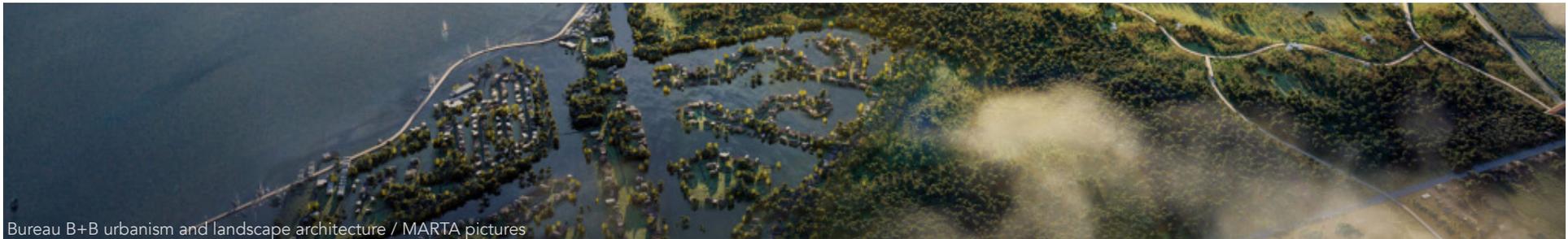


LOCATION



SEA LEVEL RISE

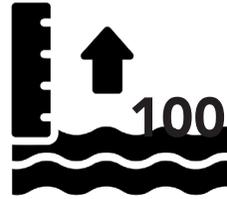
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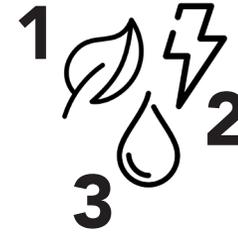
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## RESEARCH QUESTION



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RESEARCH QUESTION

*“How can a renewable energy technology serve as the main principle for both the design and function of a building in Groningen?”*



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1



# THEMATIC RESEARCH

2



3

1



ENERGY

RESEARCH

2



3

1  
SOLAR

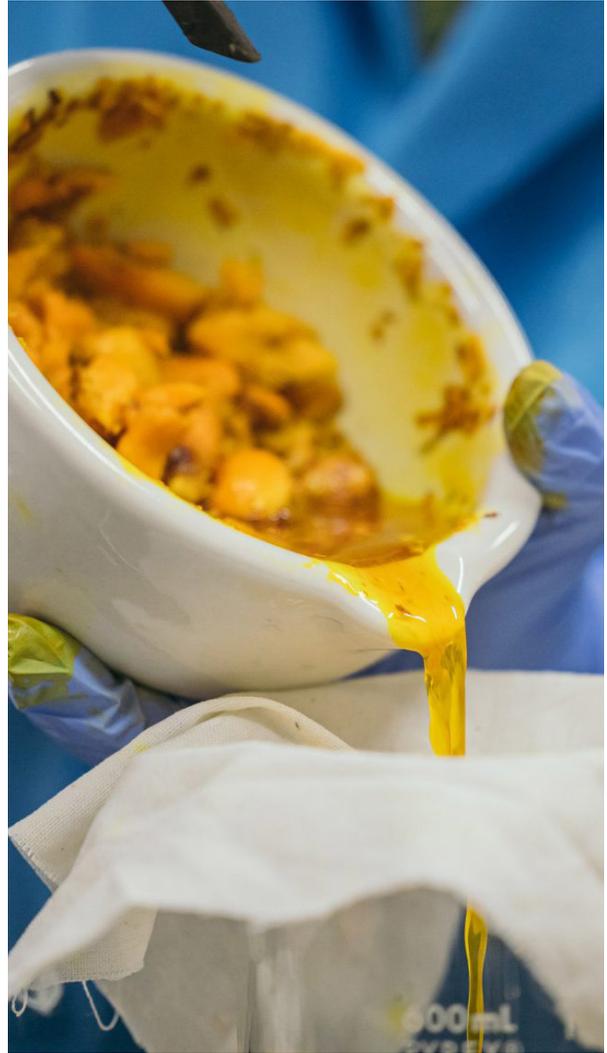
ENERGY

RESEARCH

2

3





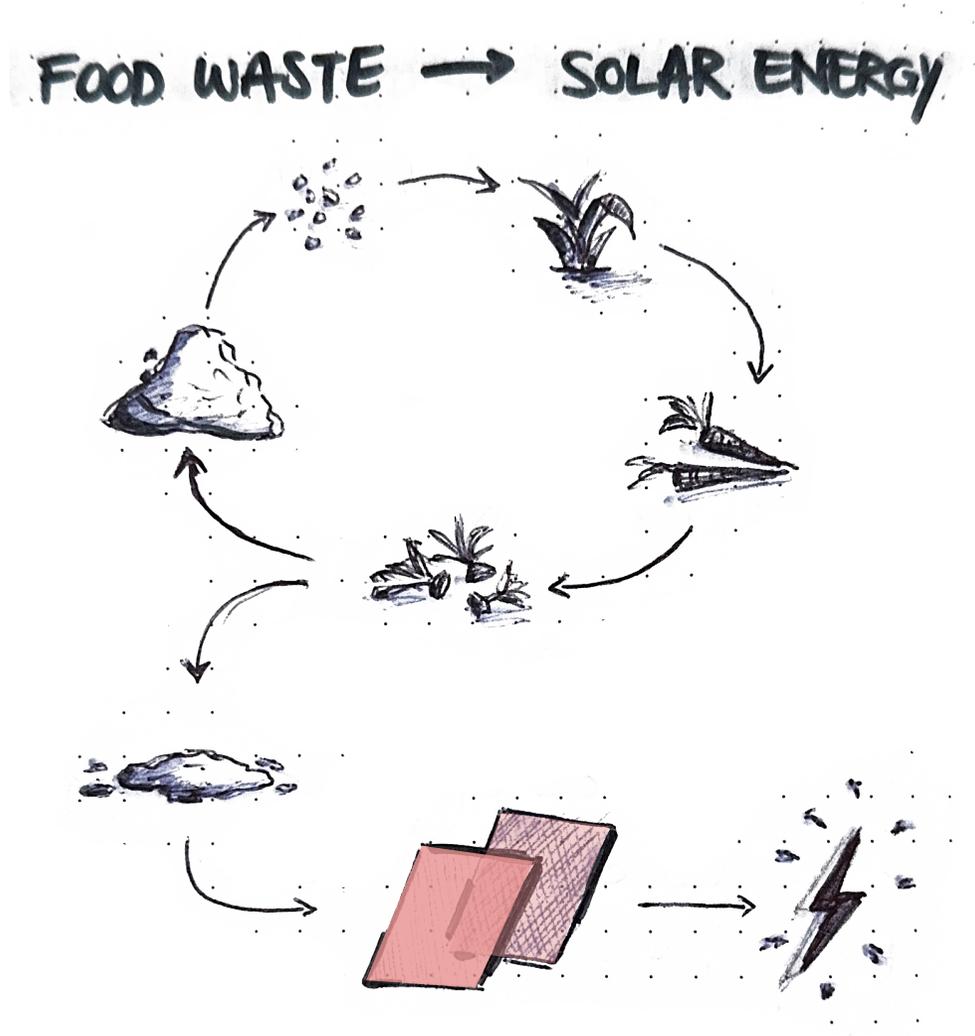
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# Aurora Renewable Energy and UV Sequestration

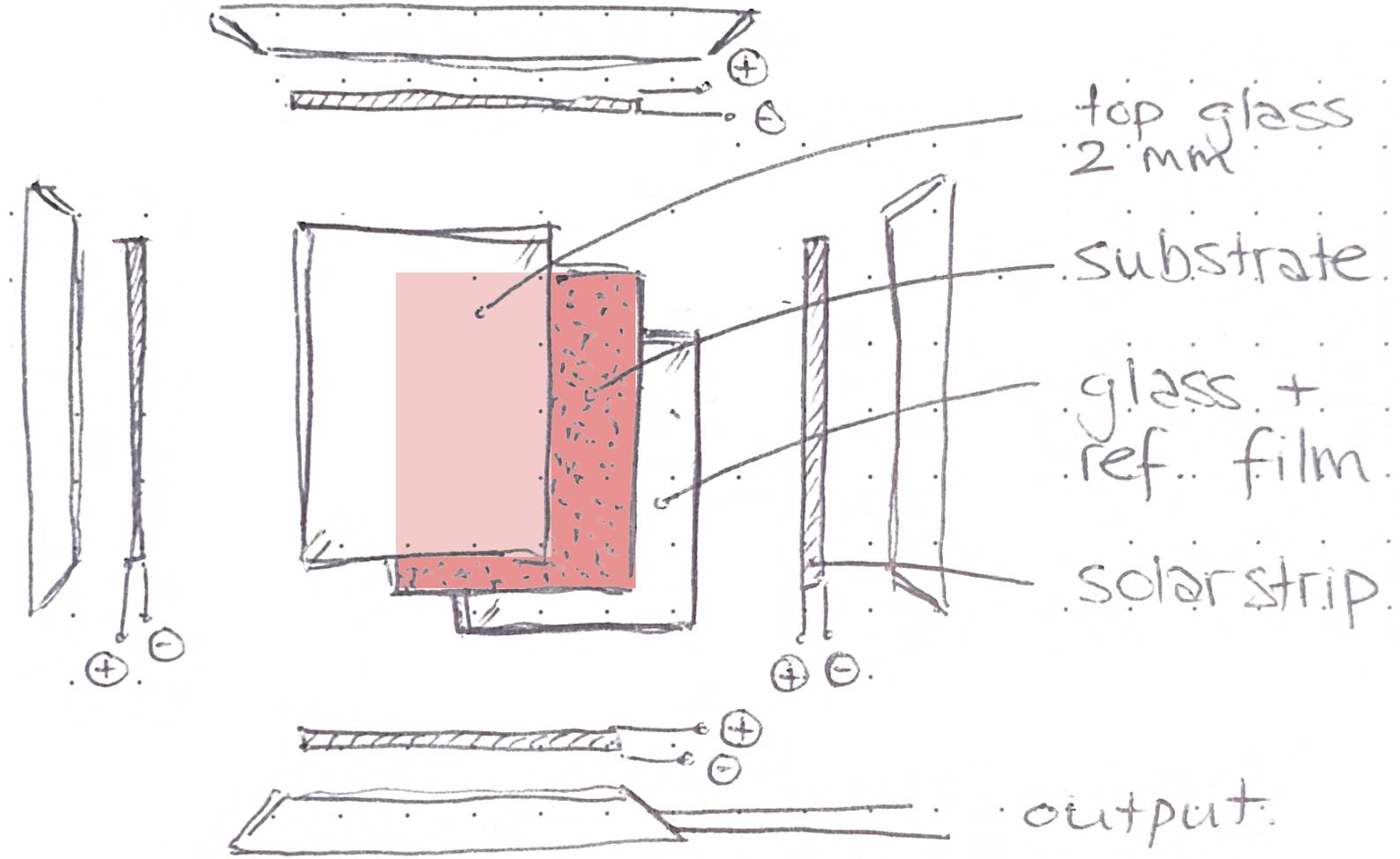


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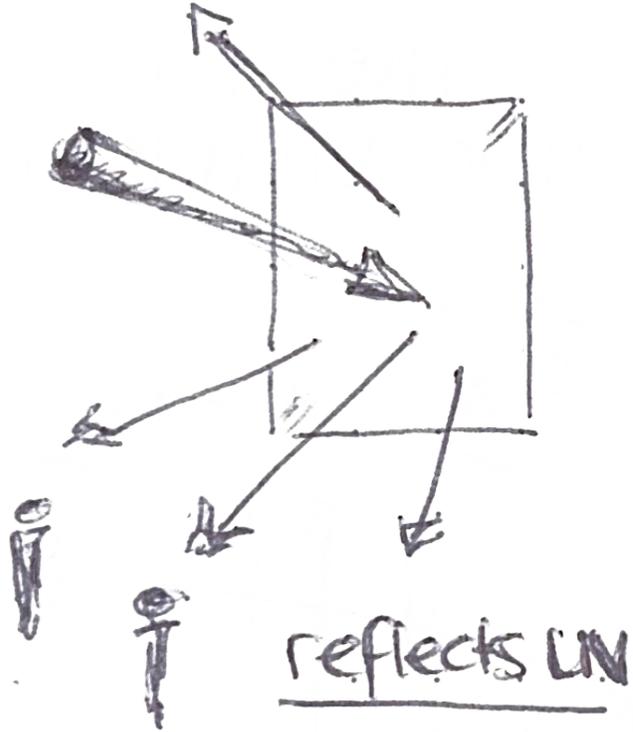
(Image by author)

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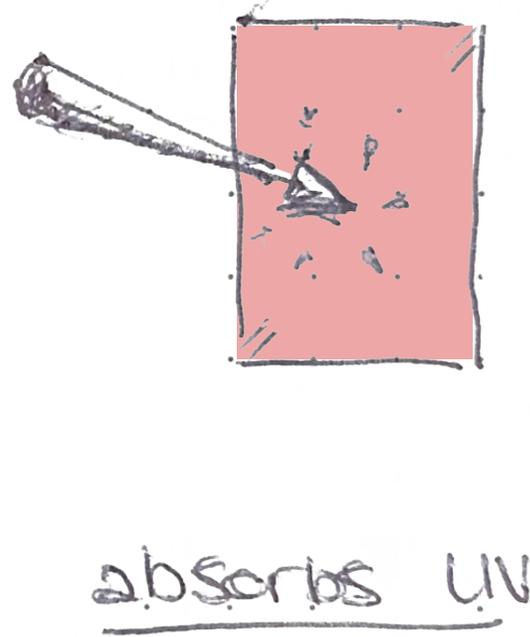


(Image by author, based on (AUREUS Aurora Renewable Energy UV Sequestration | James Dyson Award, n.d.))

normal window



AUREUS



(Image by author, based on (AUREUS Aurora Renewable Energy UV Sequestration | James Dyson Award, n.d.))

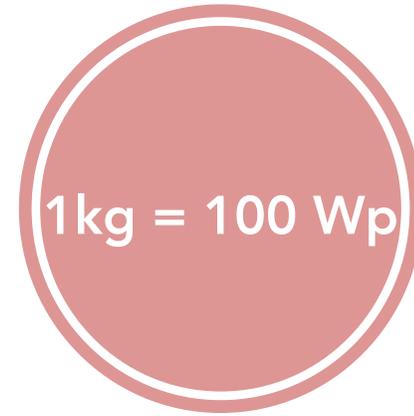
# REGULAR PV PANEL

# AUREUS

# REGULAR PV PANEL



# AUREUS



# REGULAR PV PANEL

250-400 W<sub>p</sub>

15-22%

# AUREUS

1kg = 100 W<sub>p</sub>

50%

# REGULAR PV PANEL

# AUREUS

250-400 Wp

1kg = 100 Wp

~ 60%

15-22%

50%



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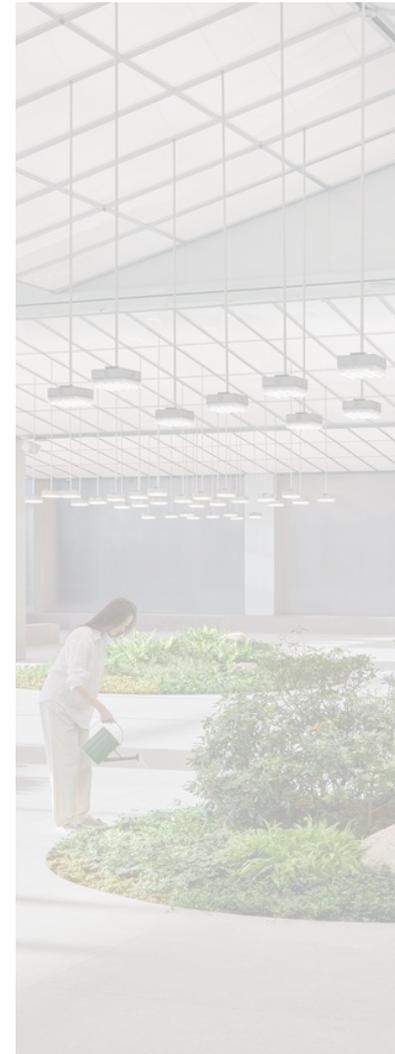
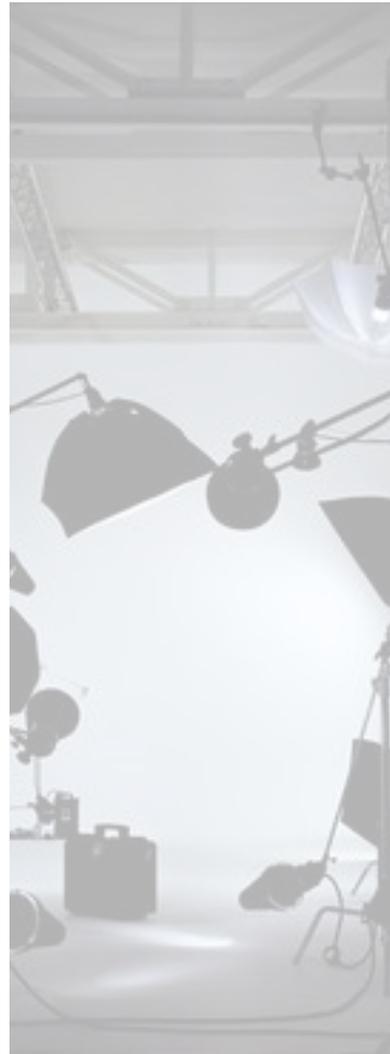
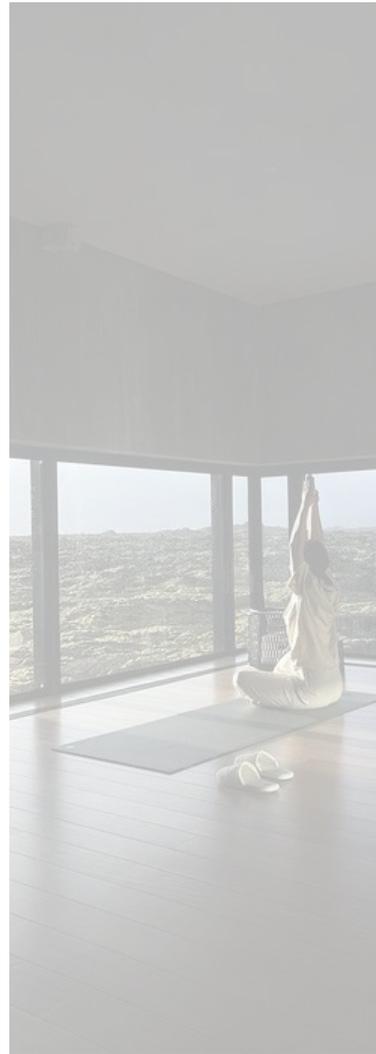
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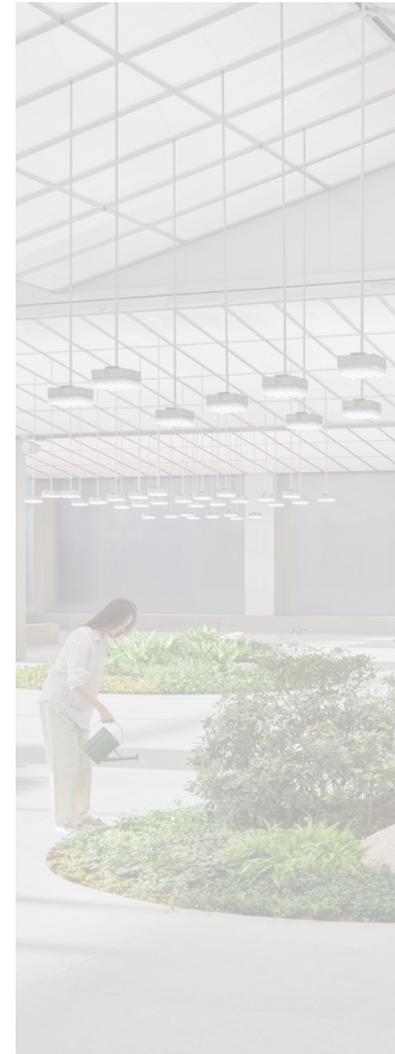
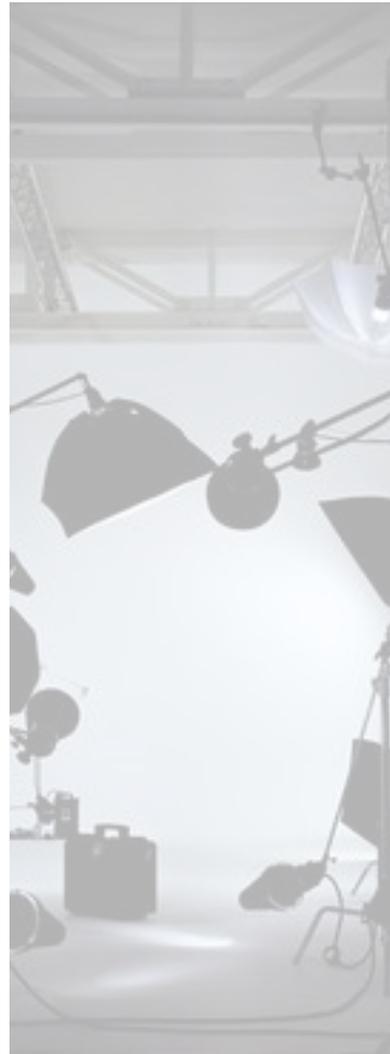
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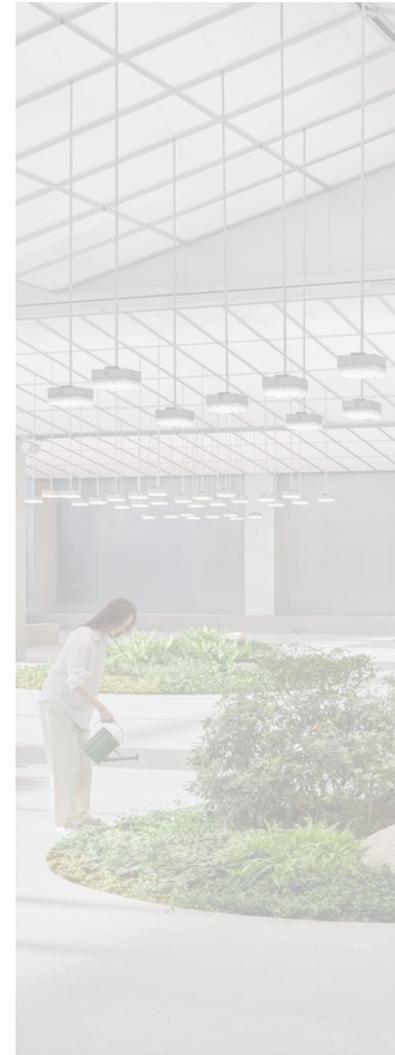
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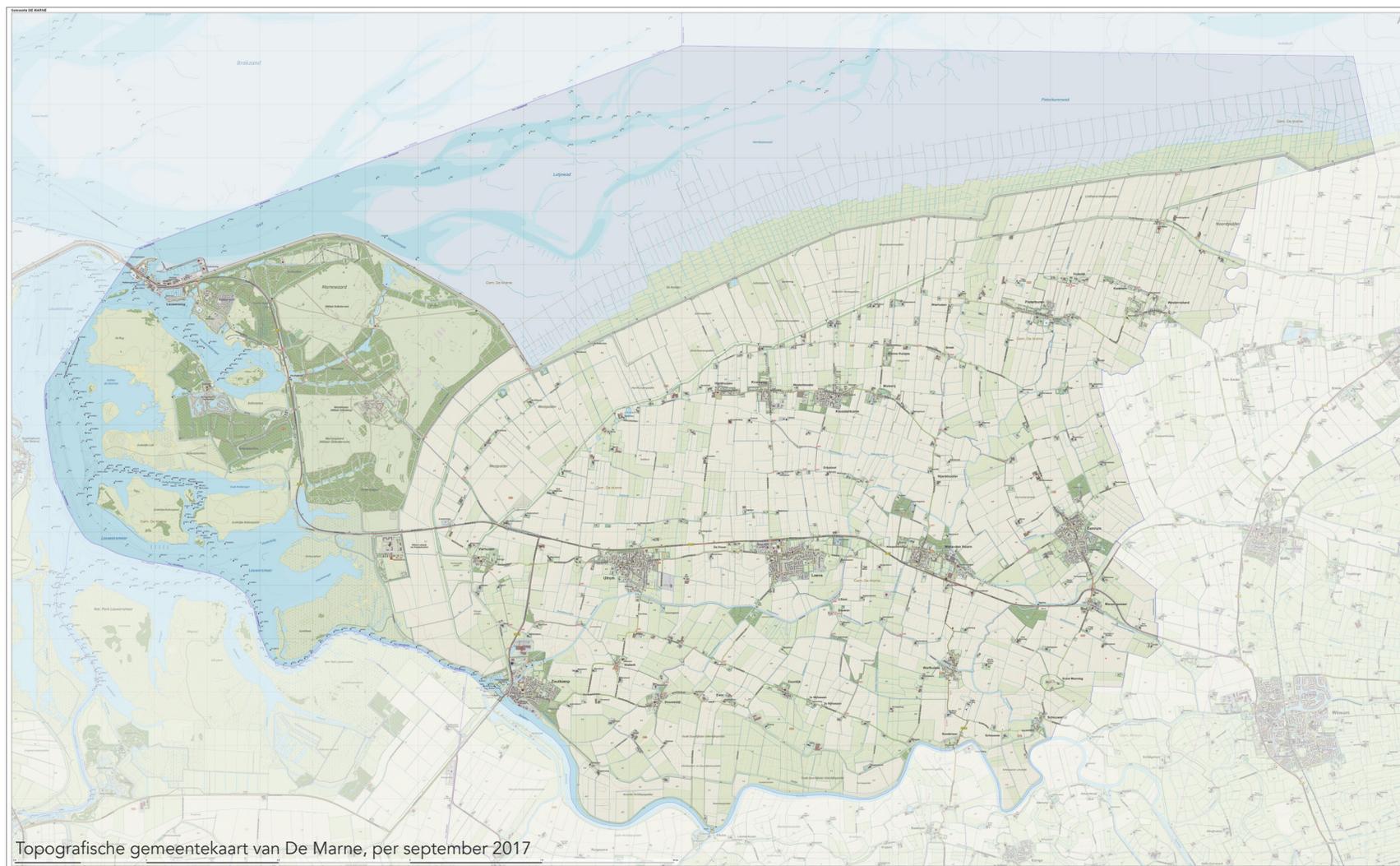
**LOCATION**



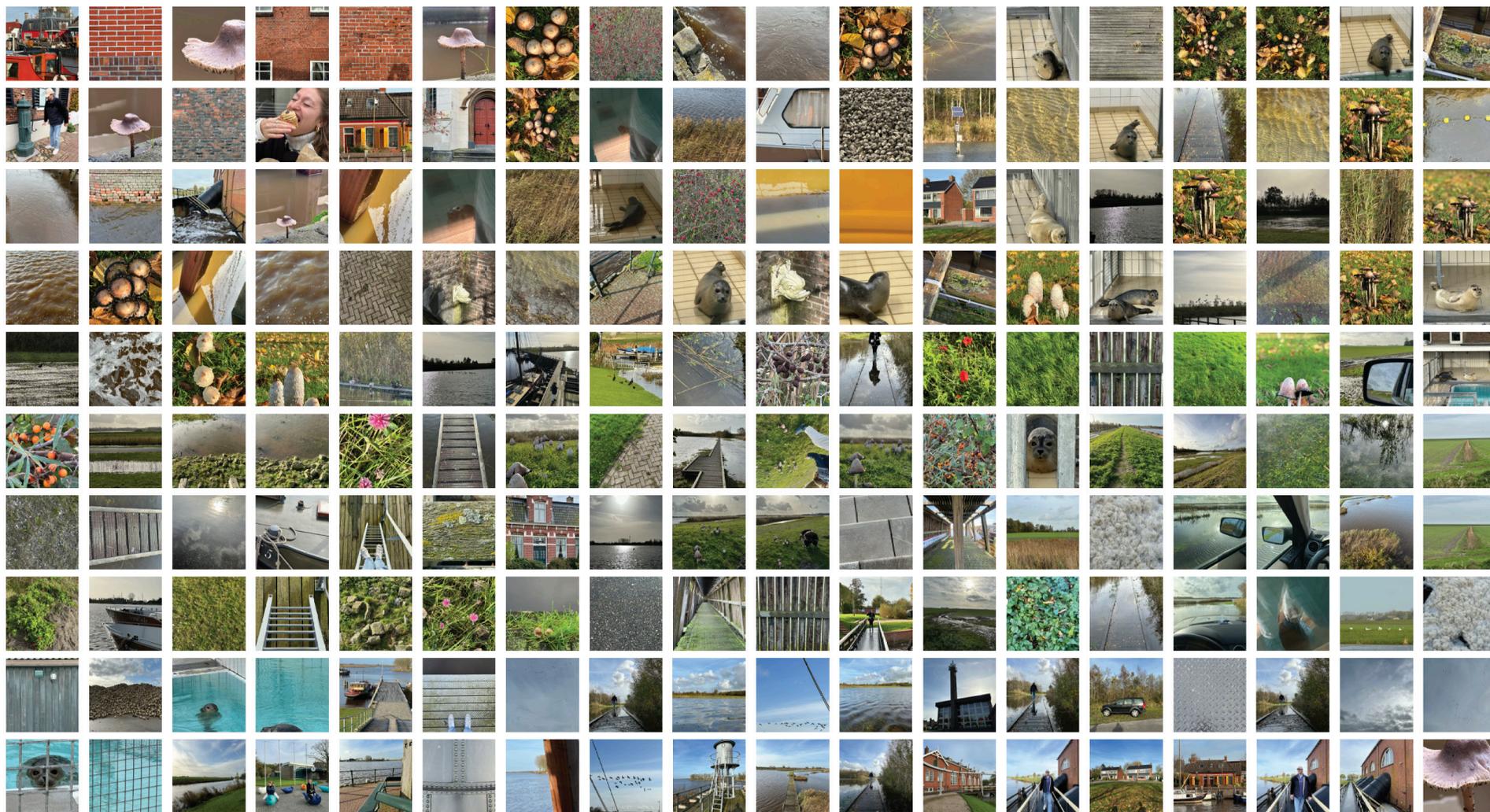
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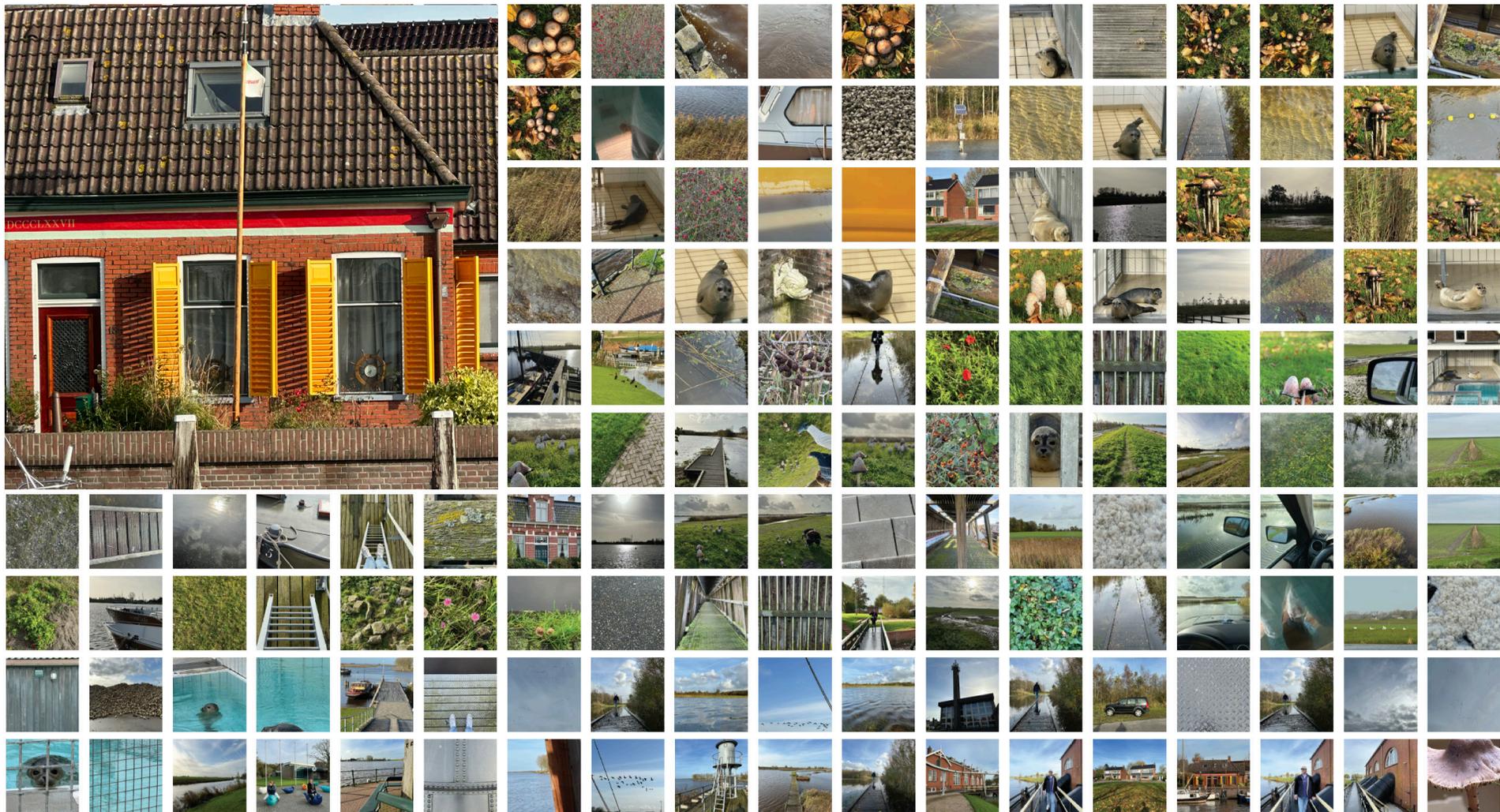
location

sea level rise

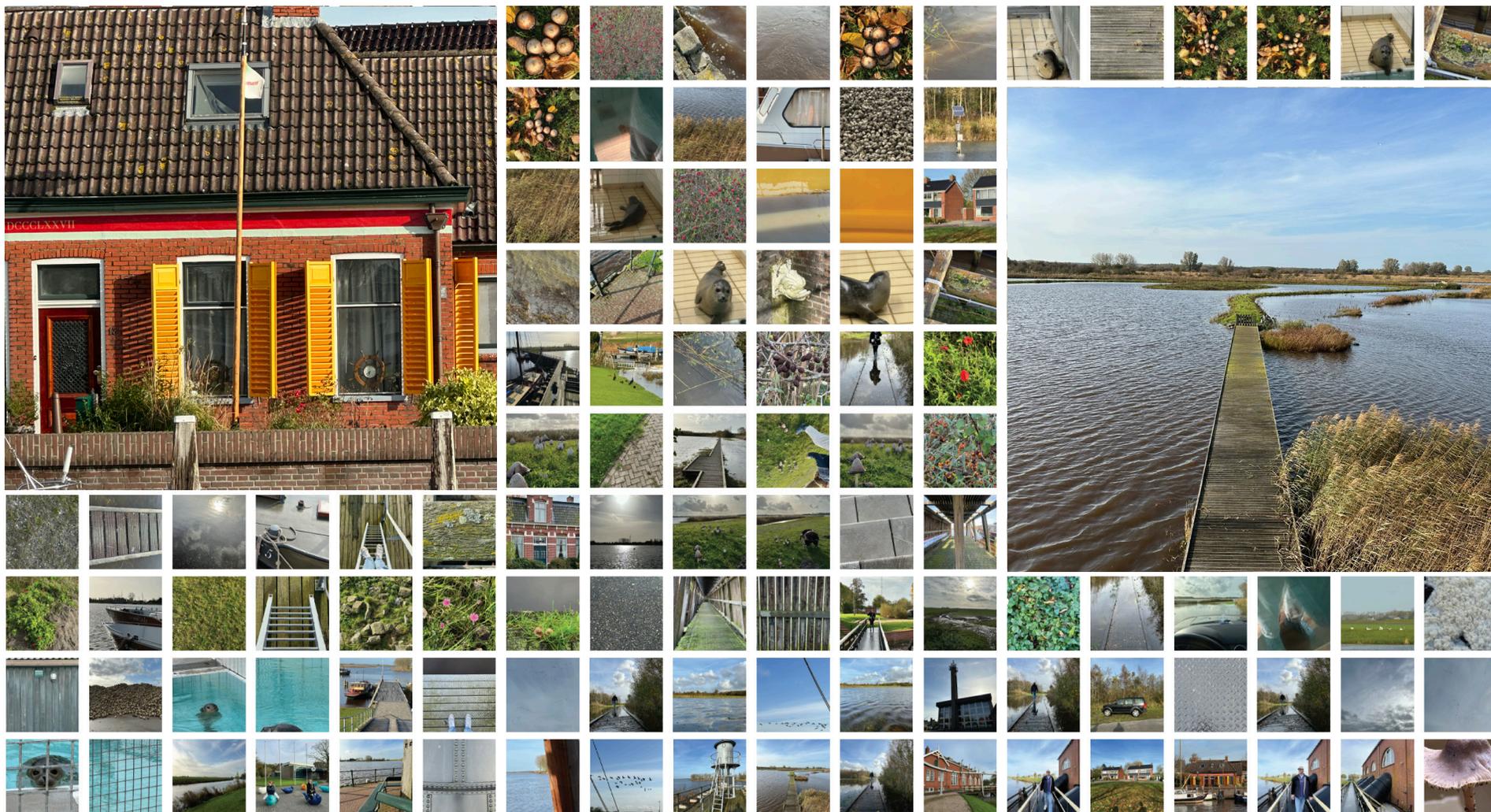
design principles

final design

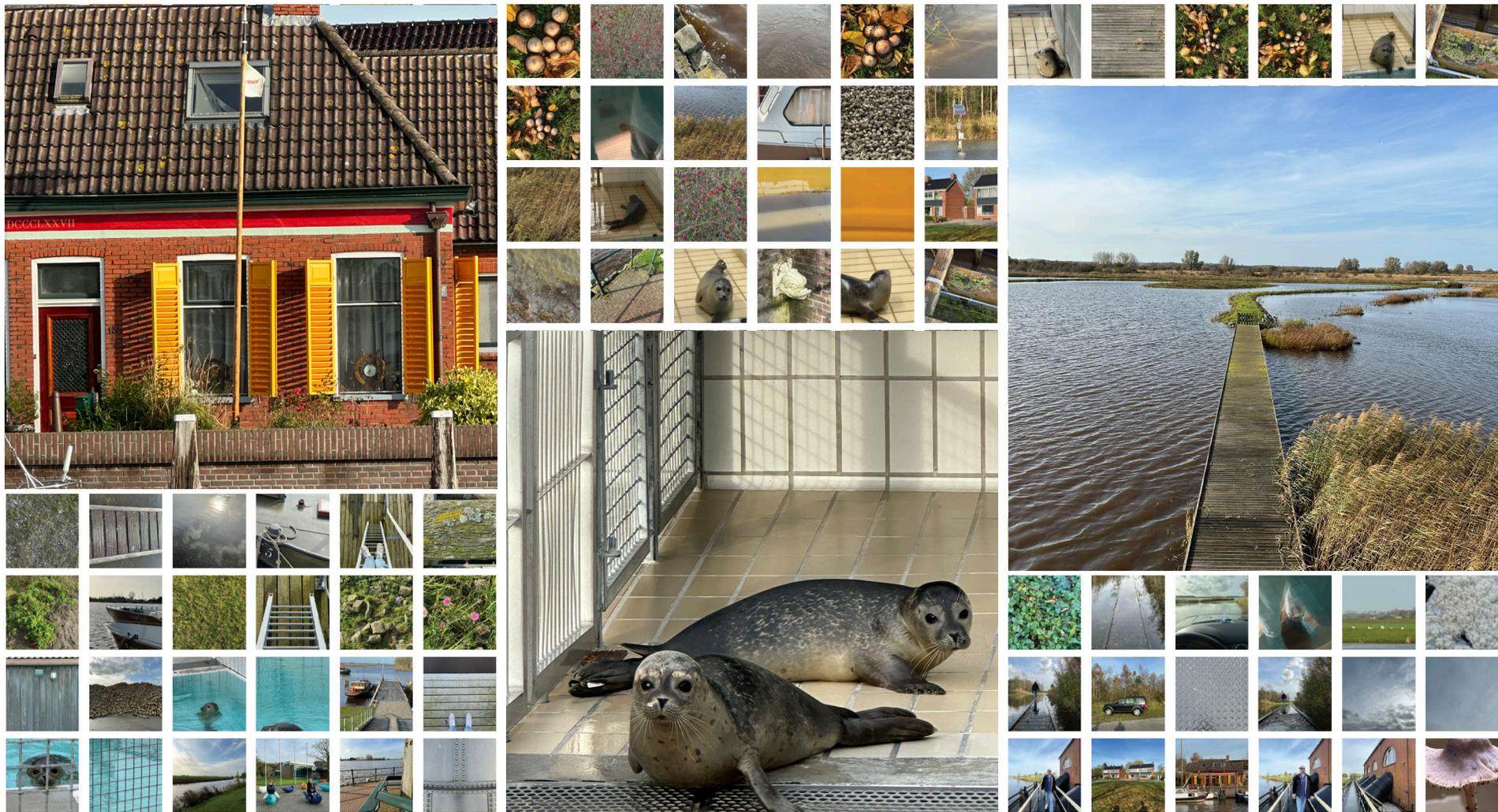
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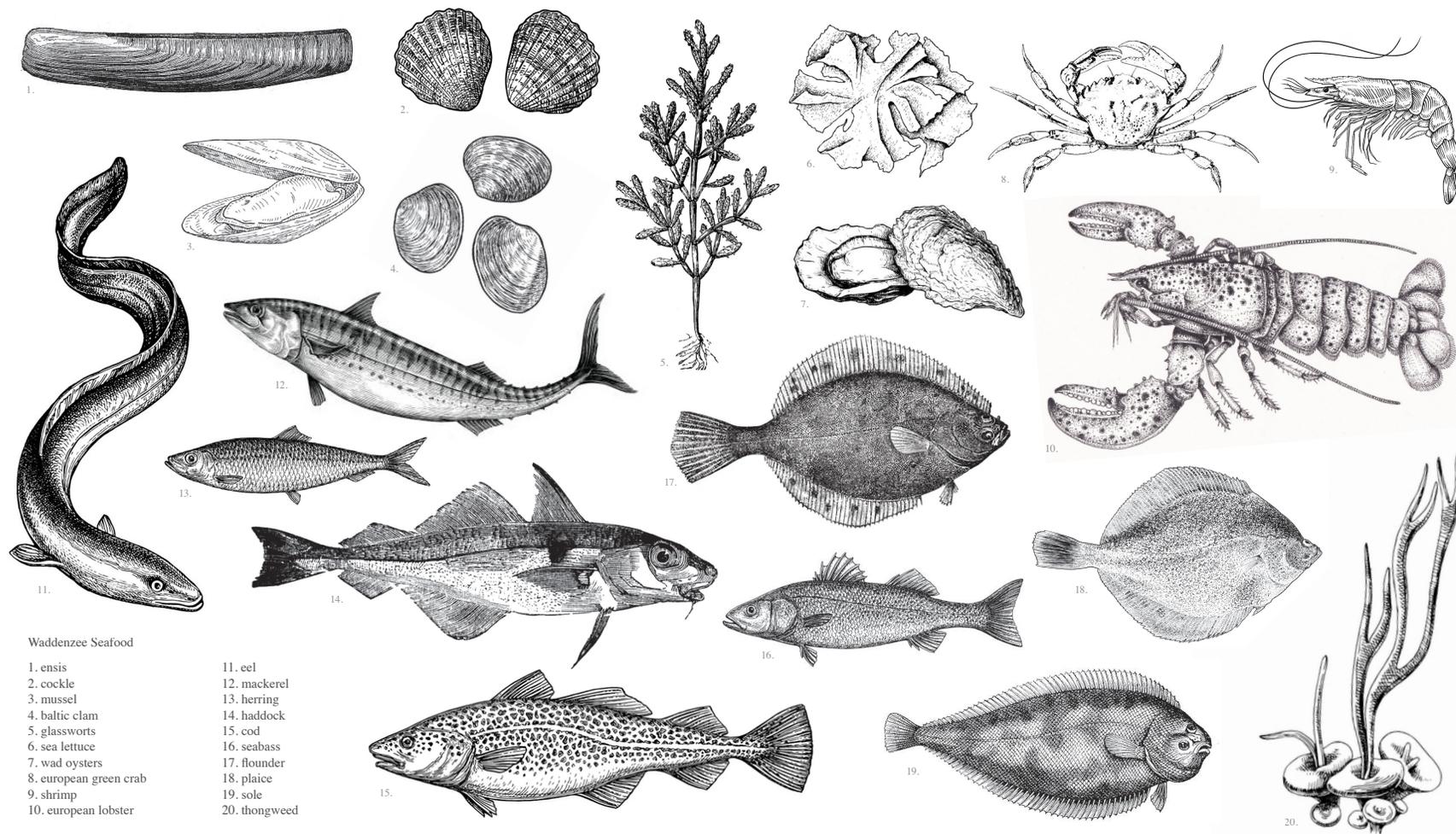
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Waddenzee Seafood

- 1. ensis
- 2. cockle
- 3. mussel
- 4. baltic clam
- 5. glassworts
- 6. sea lettuce
- 7. wad oysters
- 8. european green crab
- 9. shrimp
- 10. european lobster
- 11. eel
- 12. mackerel
- 13. herring
- 14. haddock
- 15. cod
- 16. seabass
- 17. flounder
- 18. plaice
- 19. sole
- 20. thongweed





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(Waddenvereniging, 2023)

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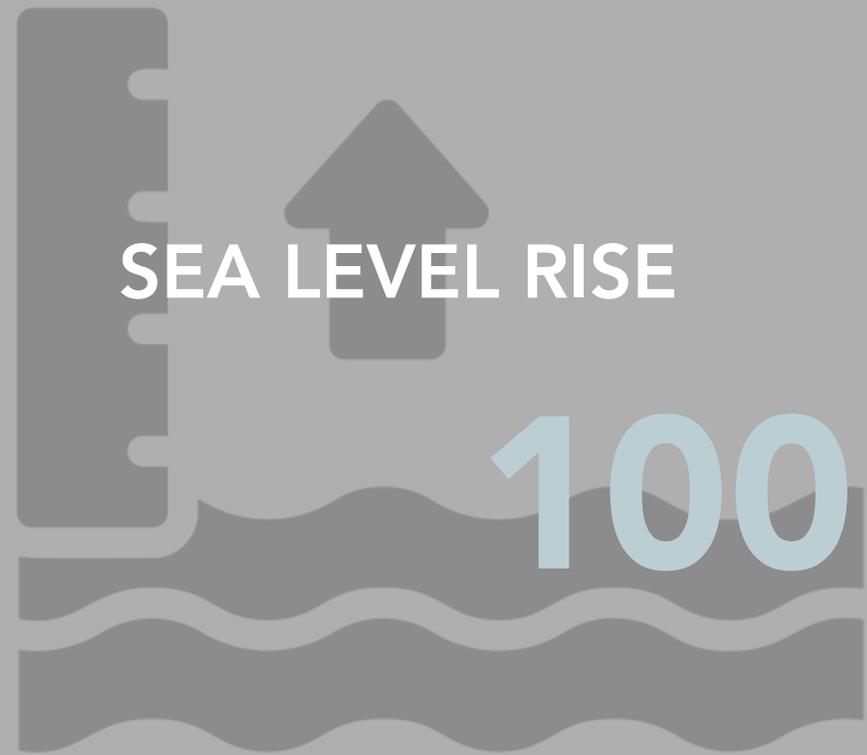
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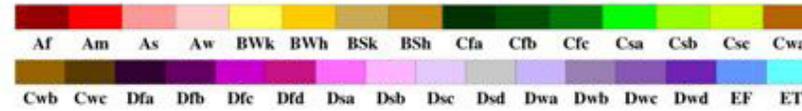


SEA LEVEL RISE

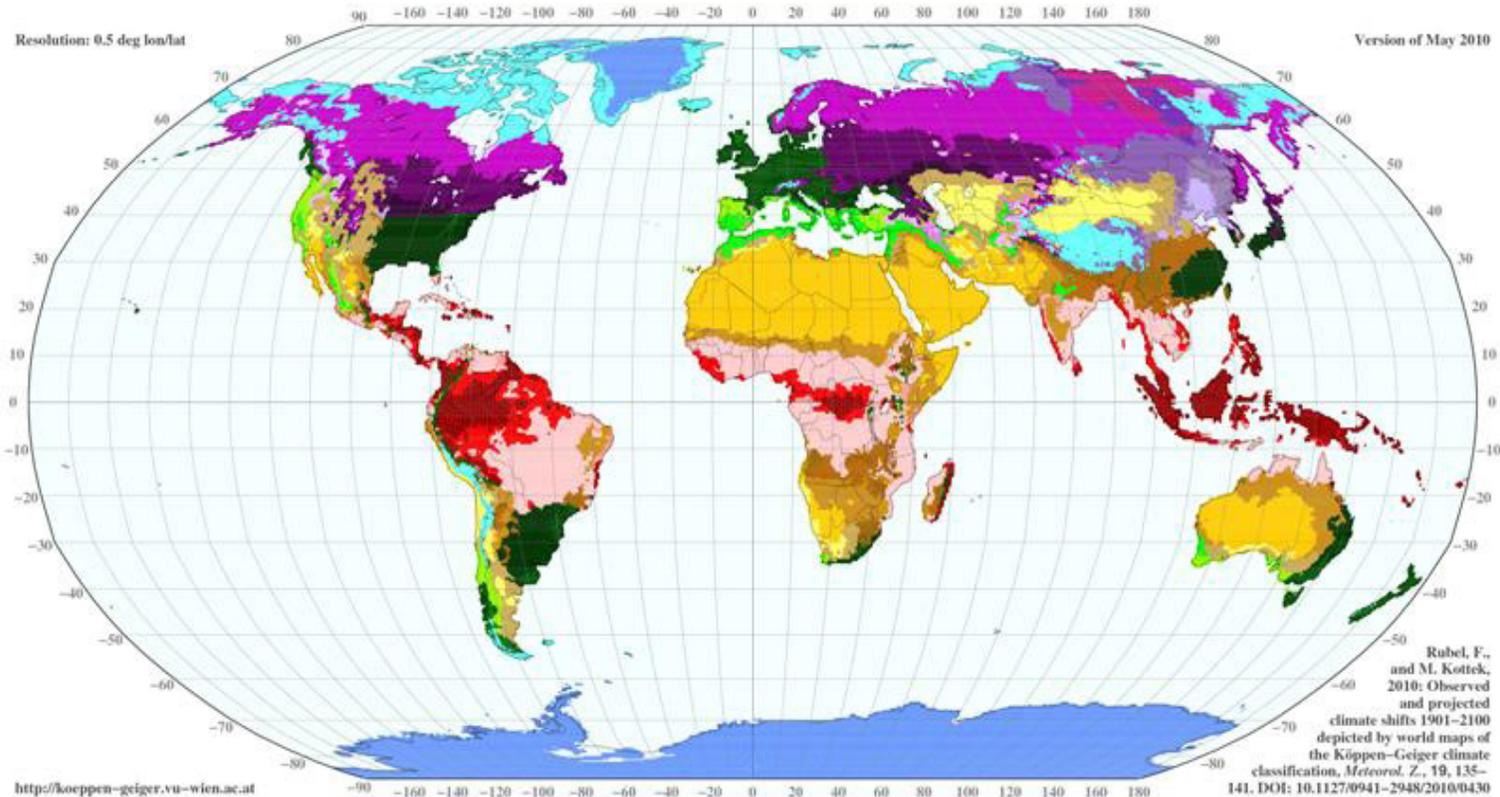
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# World Map of Köppen–Geiger Climate Classification

observed using CRU TS 2.1 temperature and GPCP Full v4 precipitation data, period 1901 to 1925



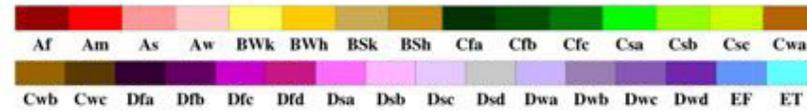
Main climates	Precipitation	Temperature
A: equatorial	W: desert	h: hot arid
B: arid	S: steppe	k: cold arid
C: warm temperate	f: fully humid	a: hot summer
D: snow	s: summer dry	b: warm summer
E: polar	w: winter dry	c: cool summer
	m: monsoonal	d: extremely continental
		F: polar frost
		T: polar tundra



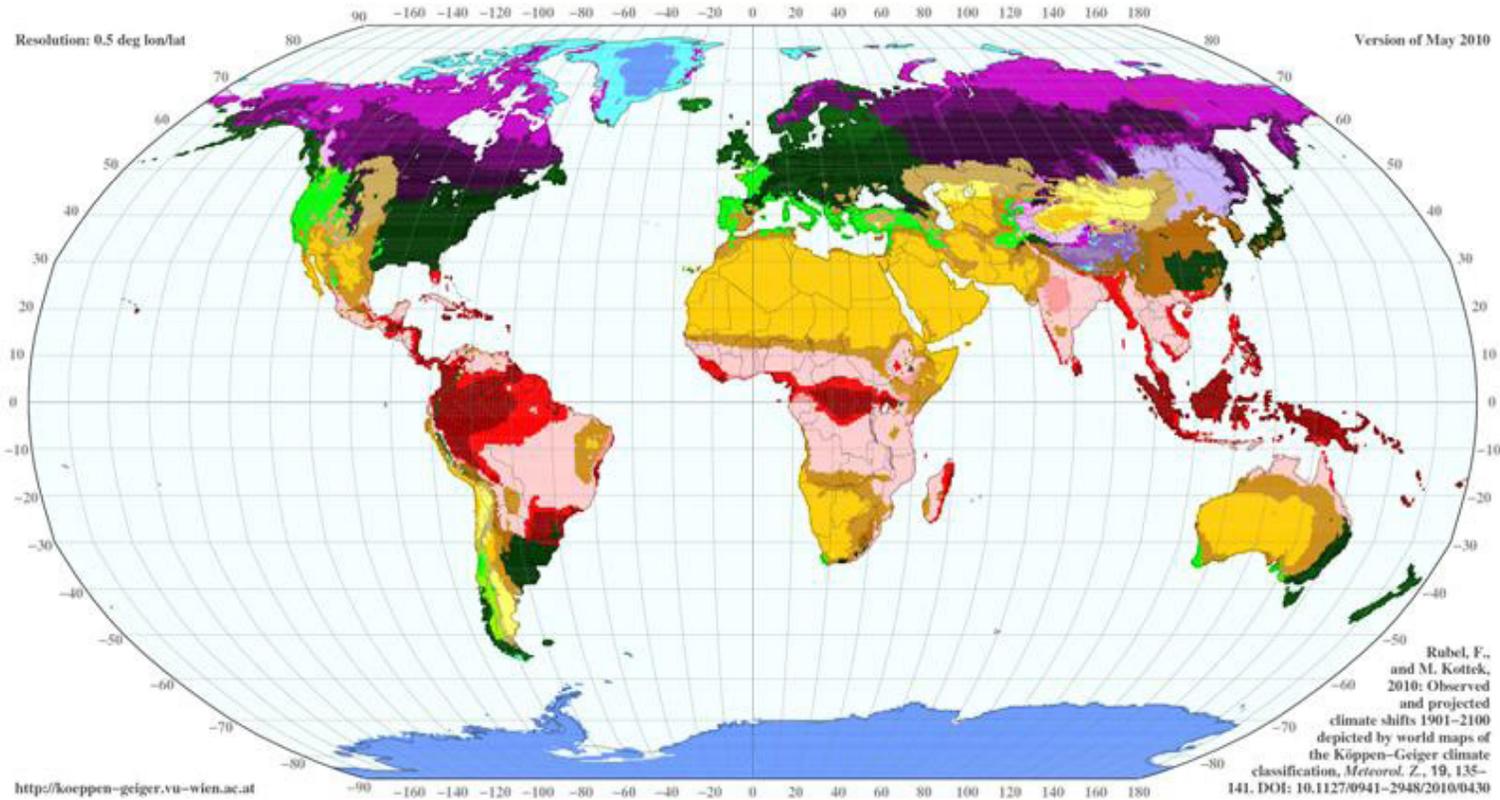
(World Maps of Köppen–Geiger Climate Classification, n.d.)

# World Map of Köppen–Geiger Climate Classification

projected using IPCC A1FI Tyndall SC 2.03 temperature and precipitation scenarios, period 2076 to 2100



- |                      |                      |                          |                 |
|----------------------|----------------------|--------------------------|-----------------|
| <b>Main climates</b> | <b>Precipitation</b> | <b>Temperature</b>       |                 |
| A: equatorial        | W: desert            | h: hot arid              | F: polar frost  |
| B: arid              | S: steppe            | k: cold arid             | T: polar tundra |
| C: warm temperate    | f: fully humid       | a: hot summer            |                 |
| D: snow              | s: summer dry        | b: warm summer           |                 |
| E: polar             | w: winter dry        | c: cool summer           |                 |
|                      | m: monsoonal         | d: extremely continental |                 |



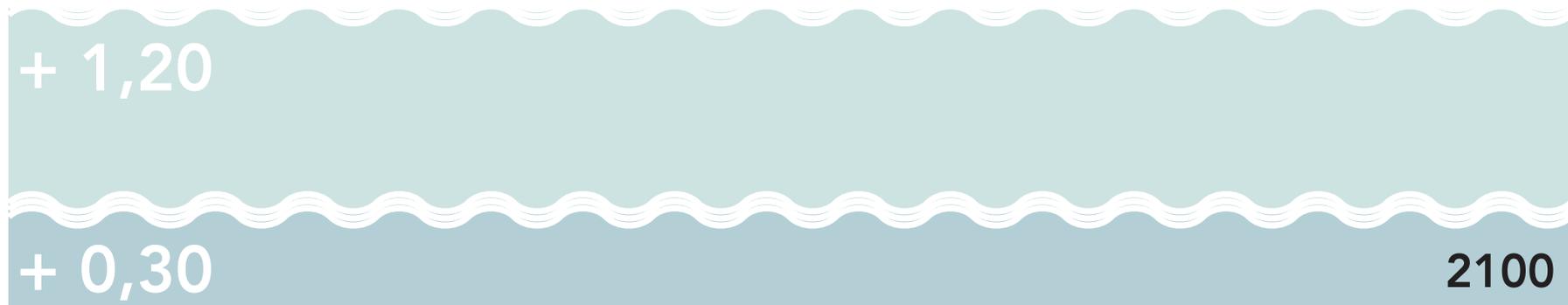
(World Maps of Köppen–Geiger Climate Classification, n.d.)



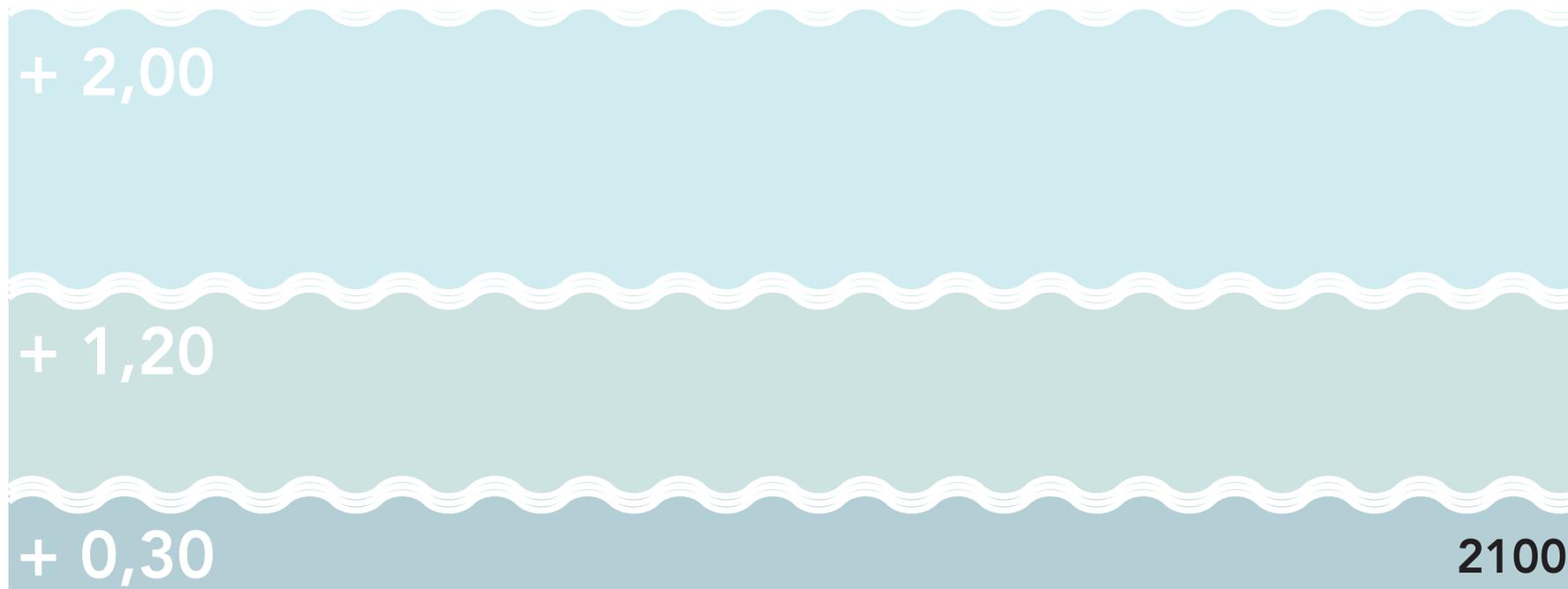
+ 0,30

2100

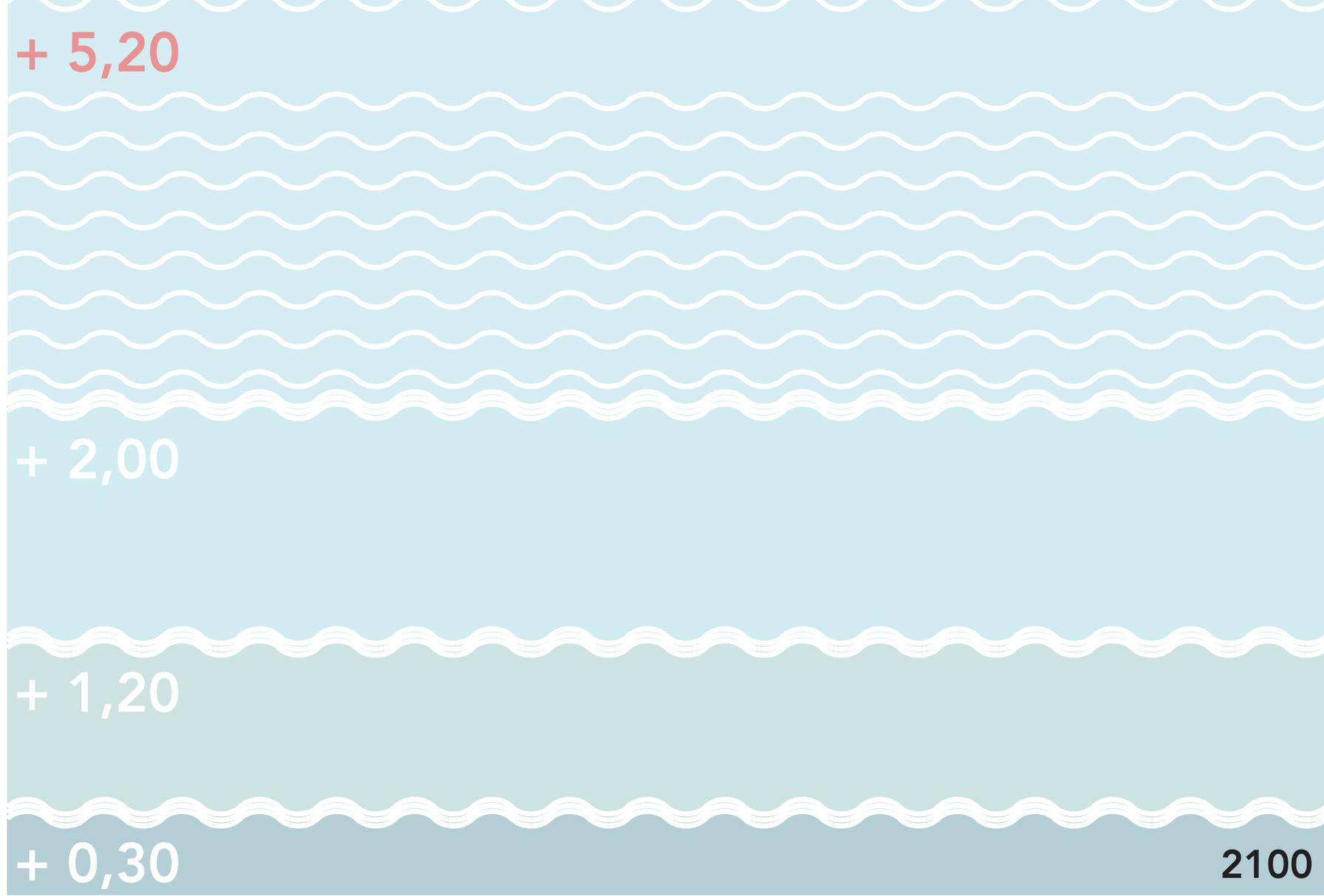
*(Ministerie van Algemene Zaken, 2022)*



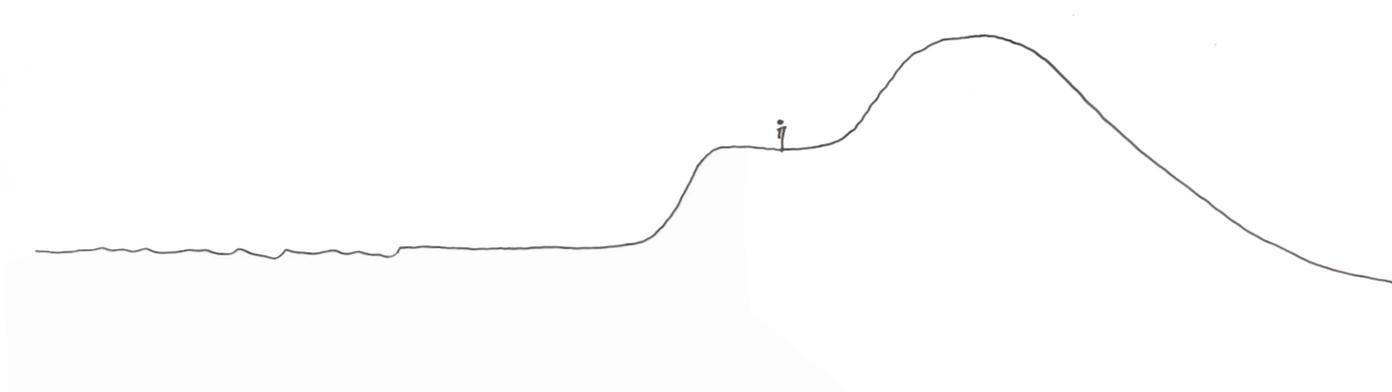
*(Ministerie van Algemene Zaken, 2022)*



(Ministerie van Algemene Zaken, 2022)



(Ministerie van Algemene Zaken, 2022)



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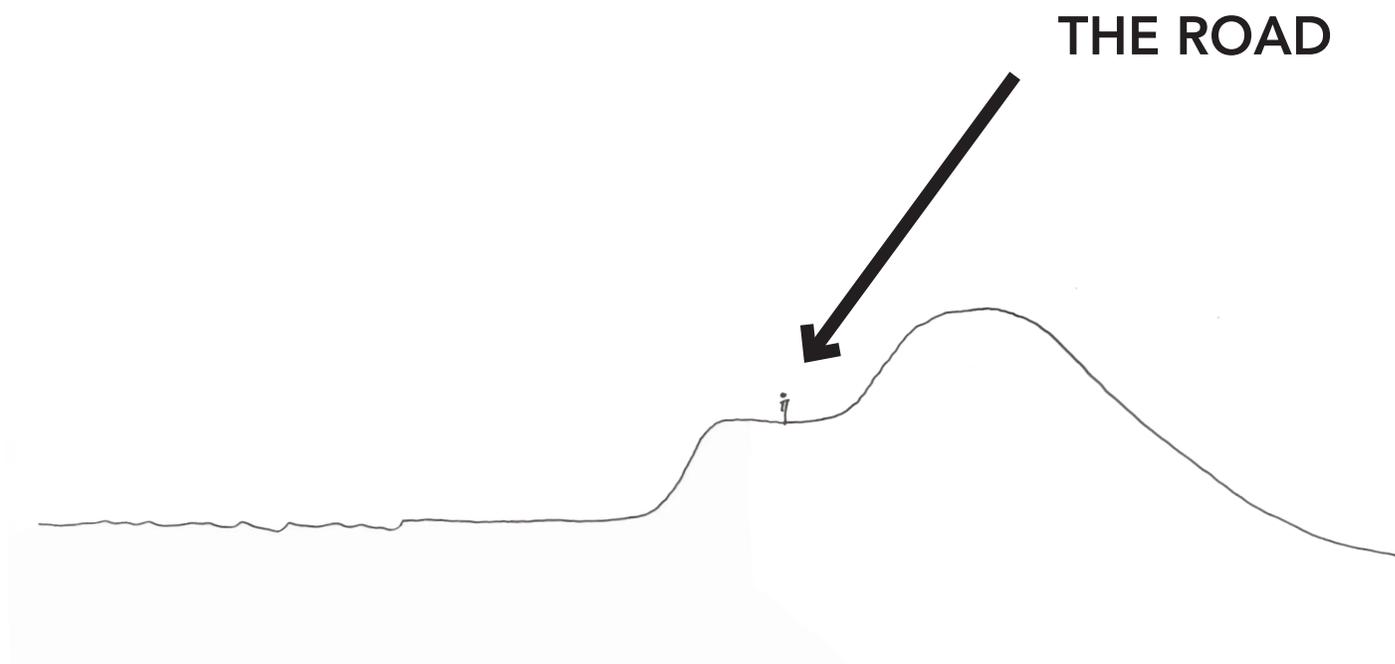
location

sea level rise

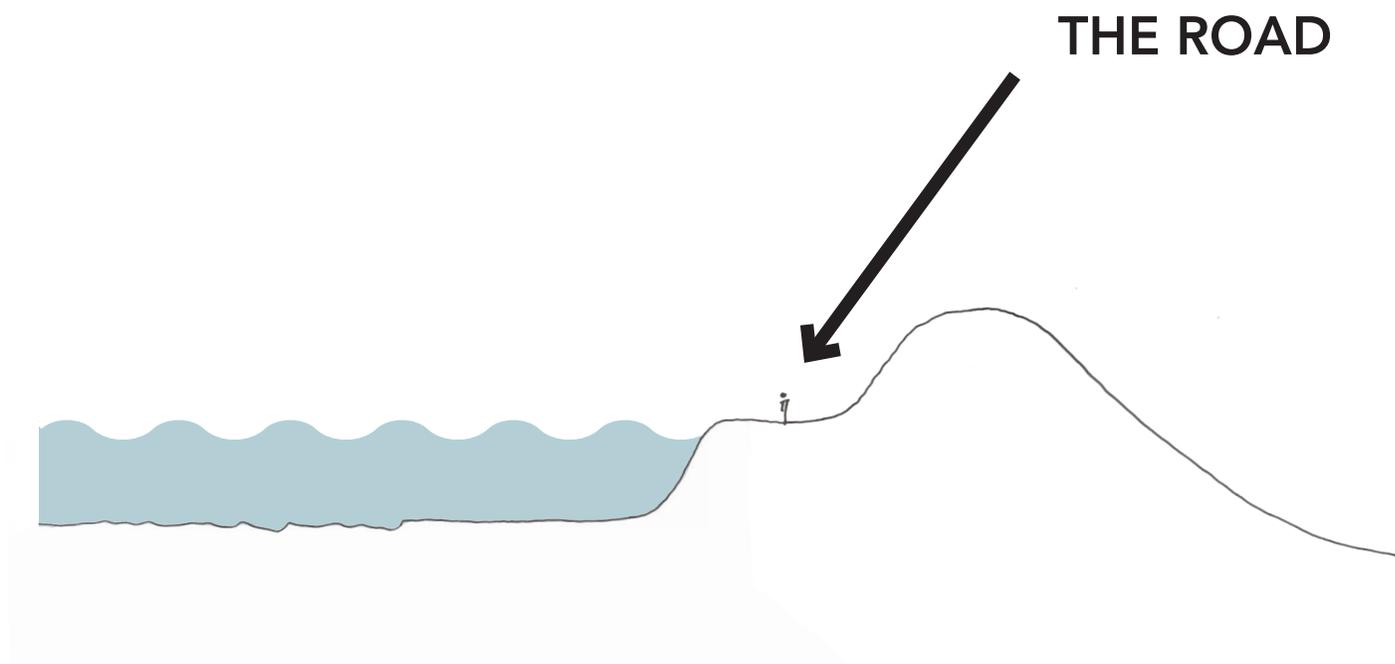
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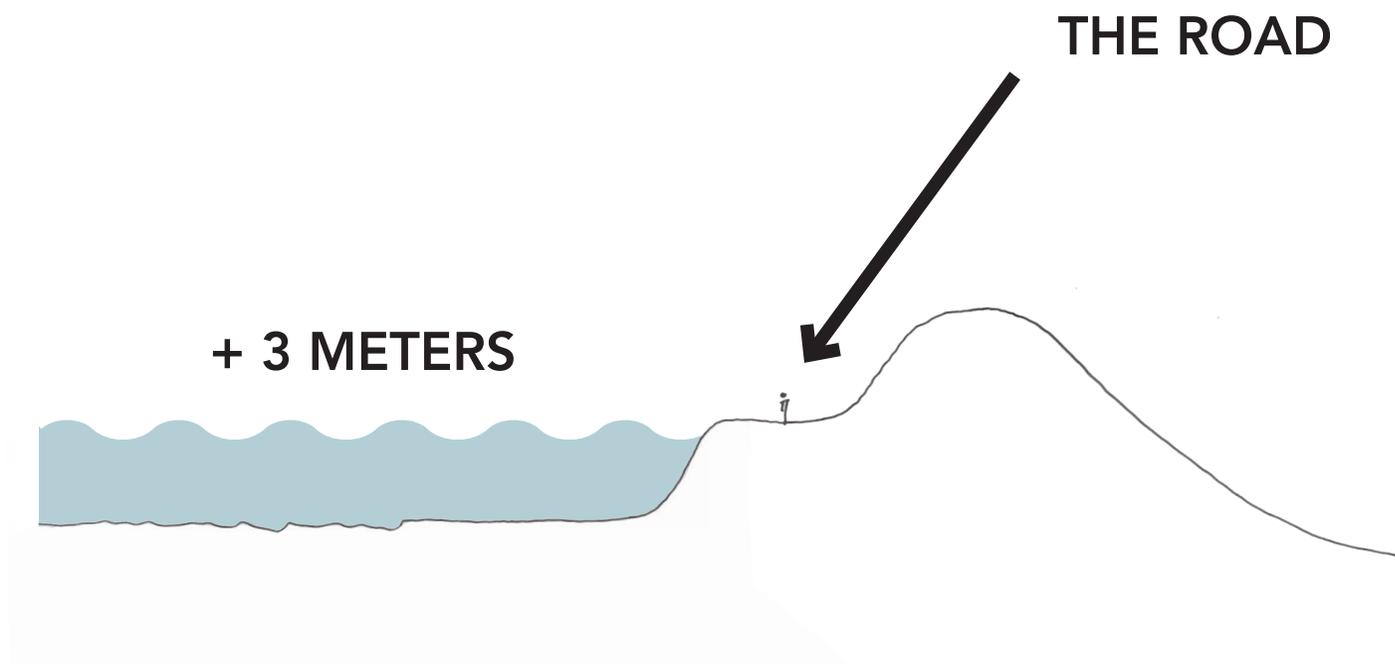
final design

conclusions



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# ELEVATED



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ELEVATED



FLOATABLE



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# DESIGN PRINCIPLES

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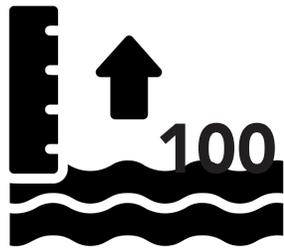
location

sea level rise

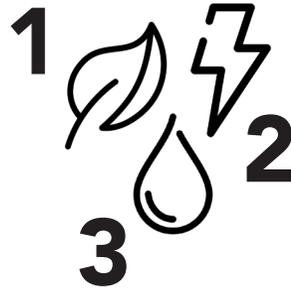
design principles

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SEA LEVEL RISE



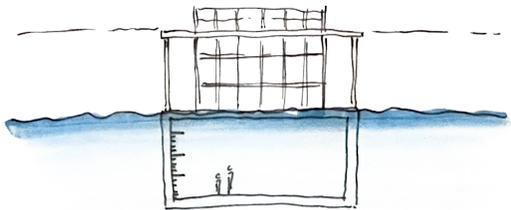
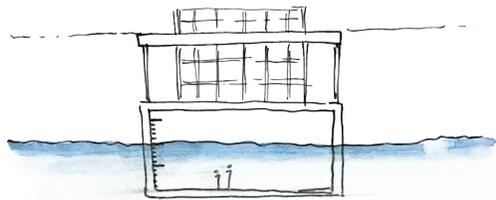
THEMES



LOCATION

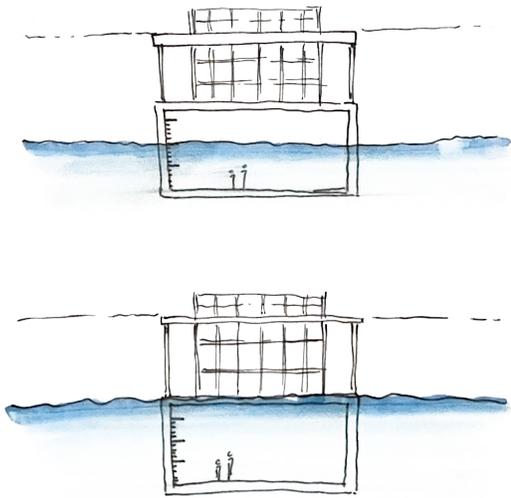
# USER EXPERIENCE

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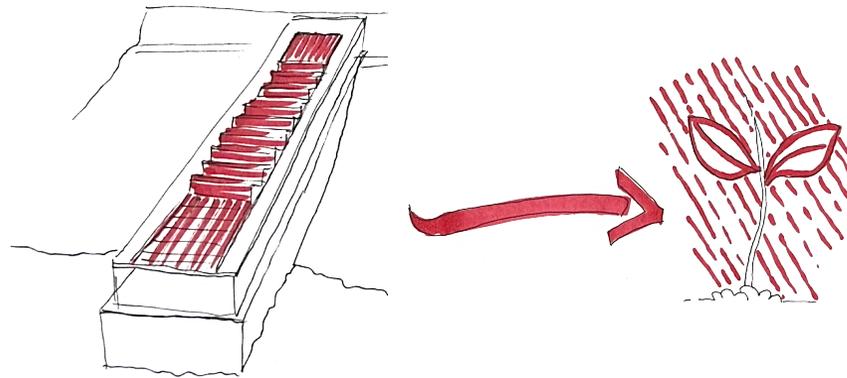


## RISING WATER LEVEL

# USER EXPERIENCE



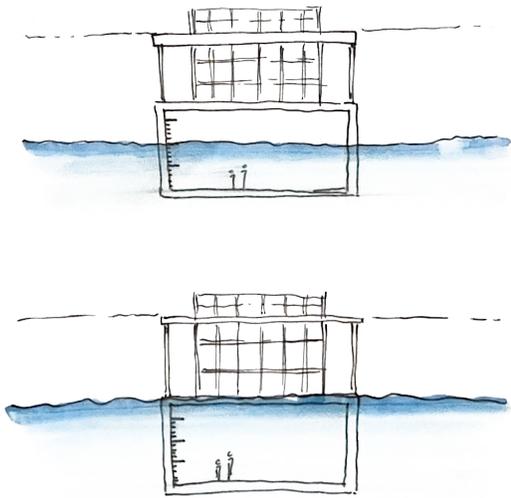
**RISING WATER LEVEL**



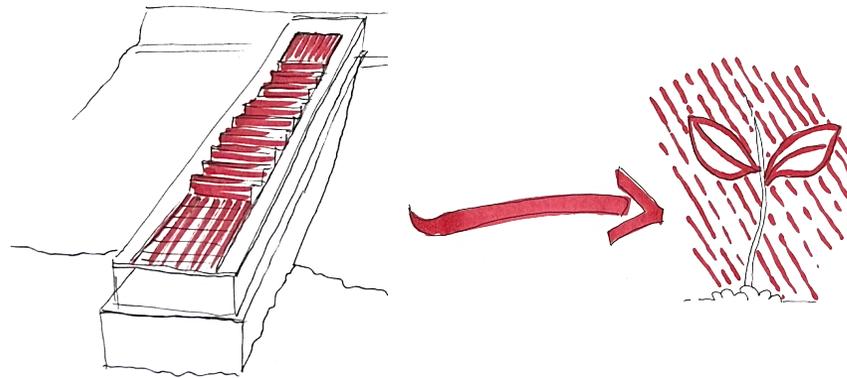
**SOLAR ENERGY**

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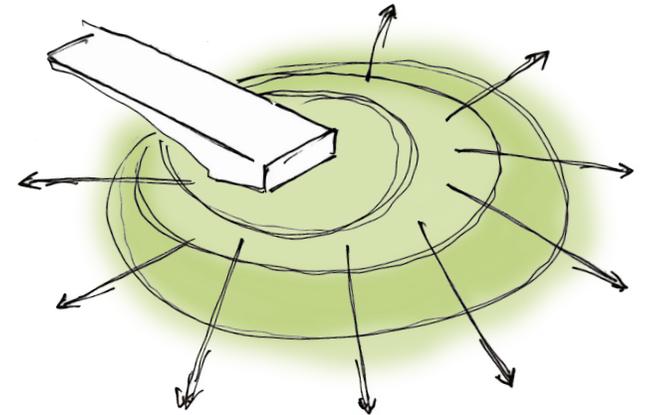
# USER EXPERIENCE



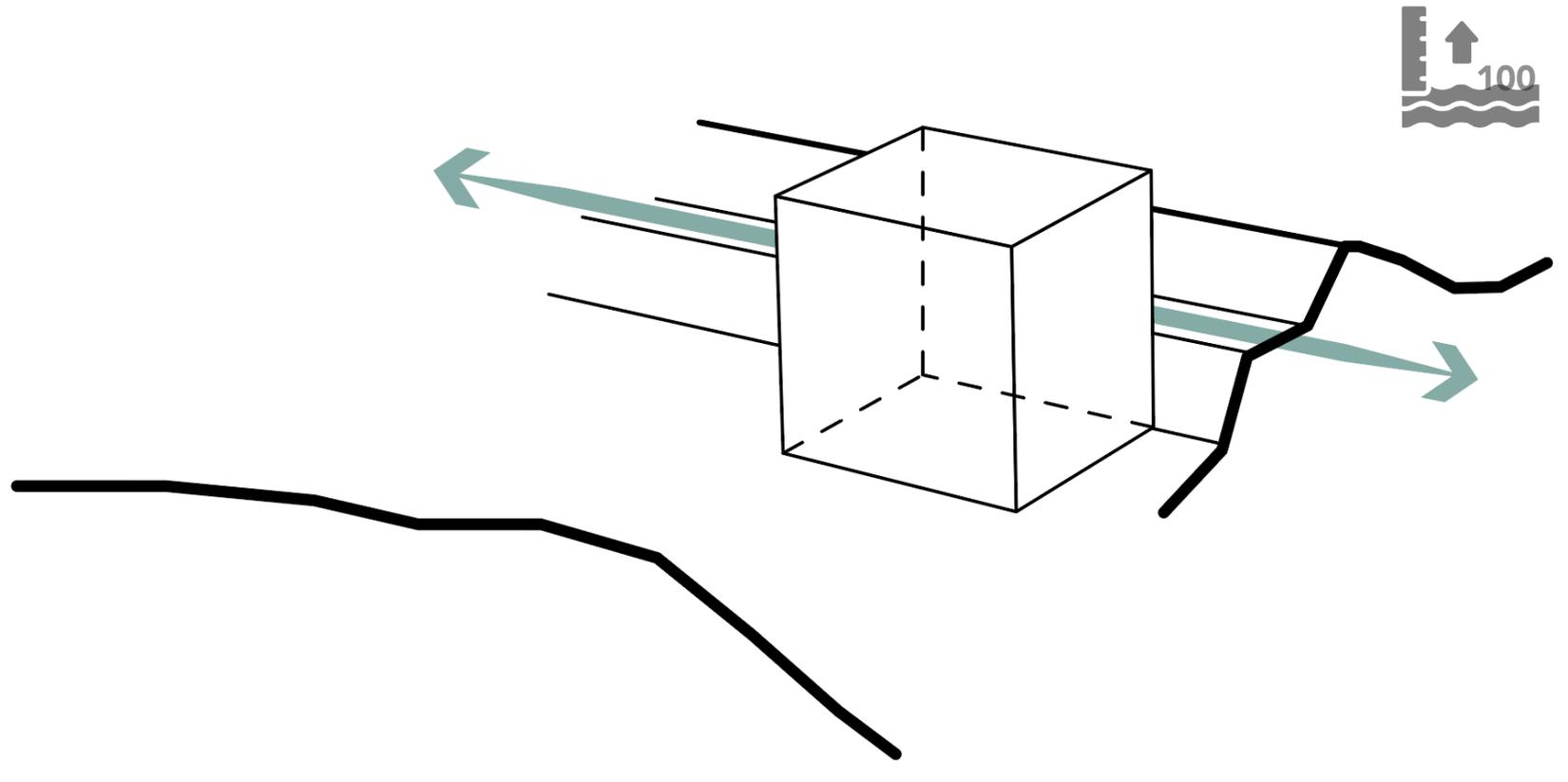
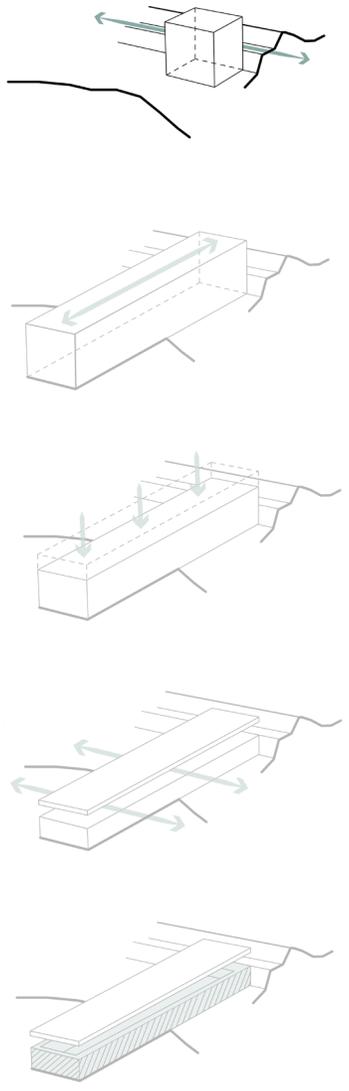
**RISING WATER LEVEL**



**SOLAR ENERGY**

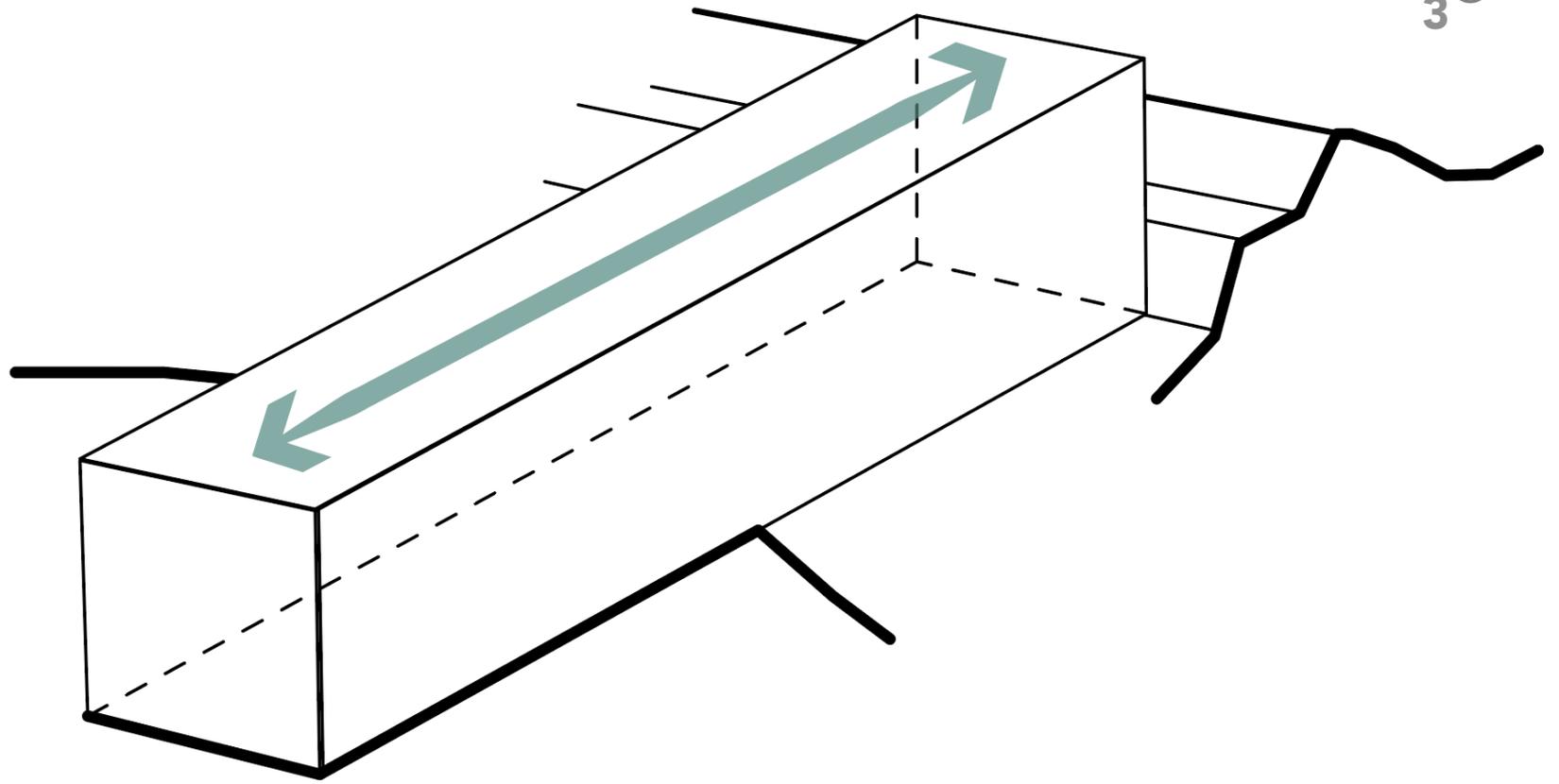
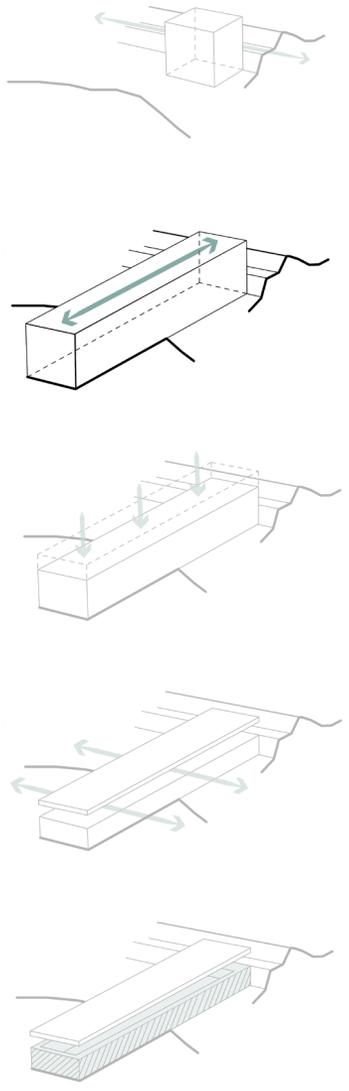


**ENVIRONMENT**



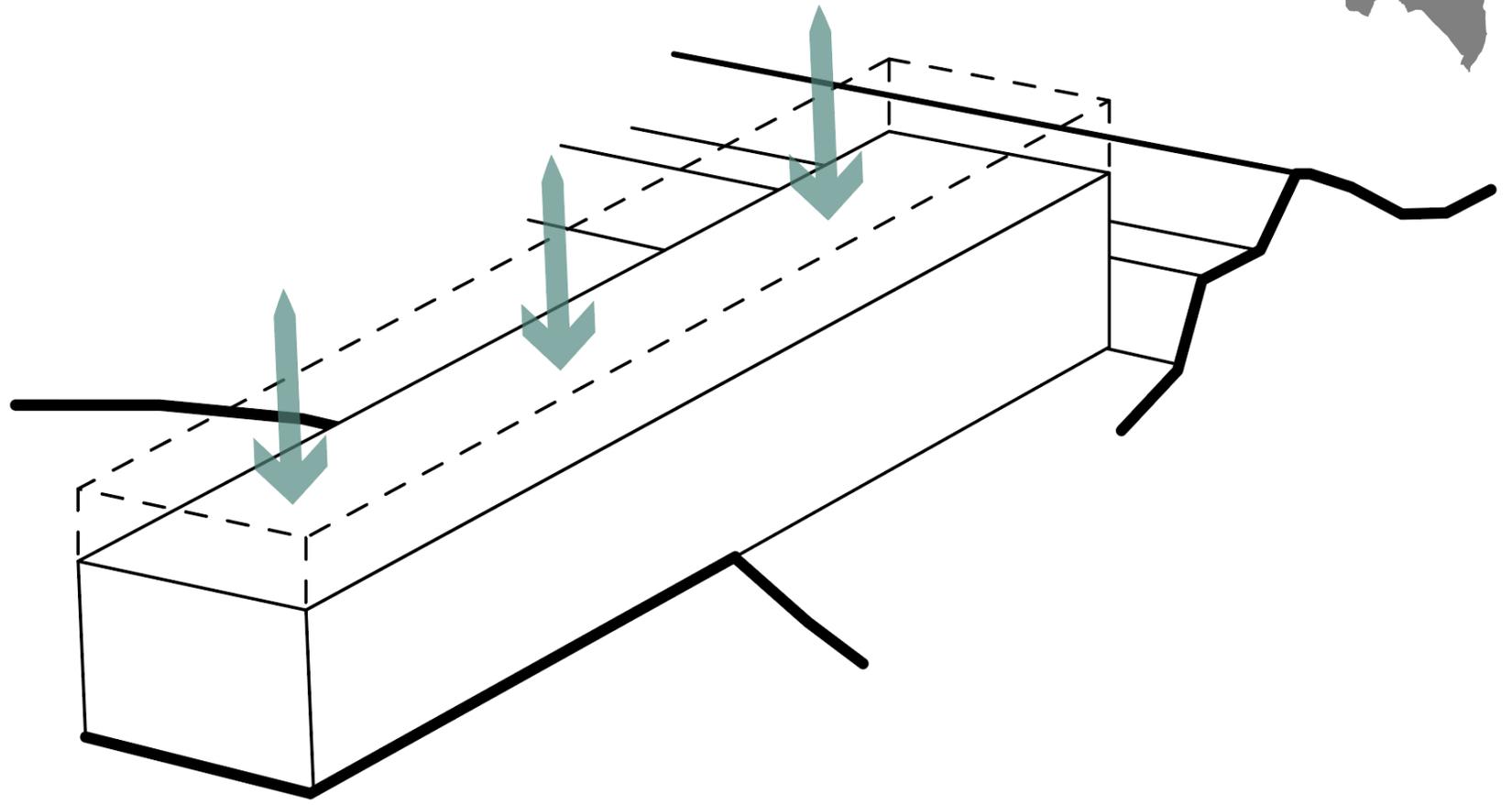
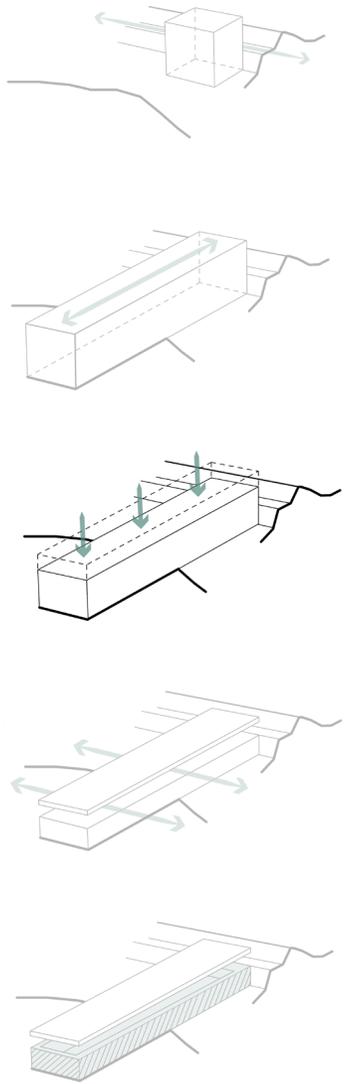
# ACCESSIBILITY

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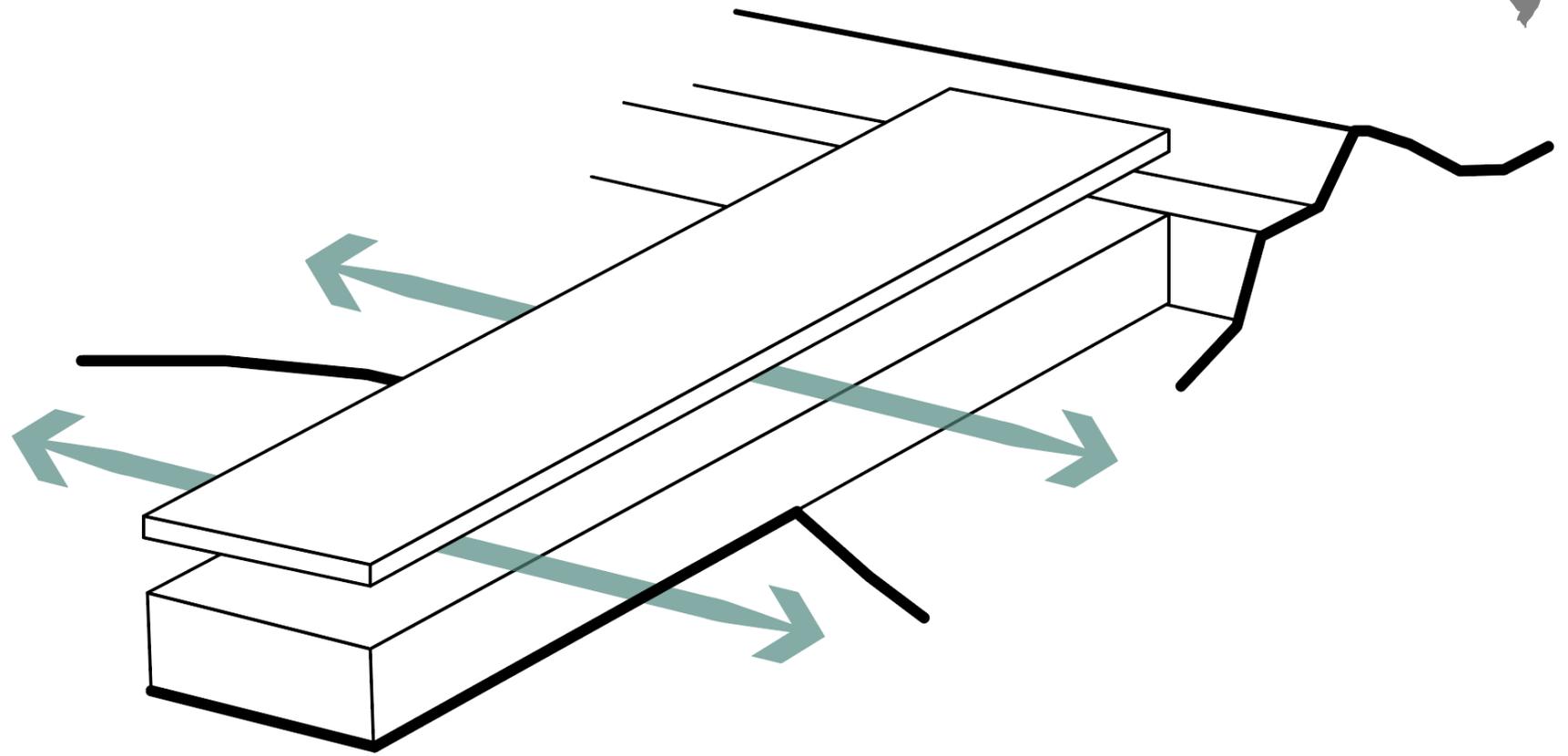
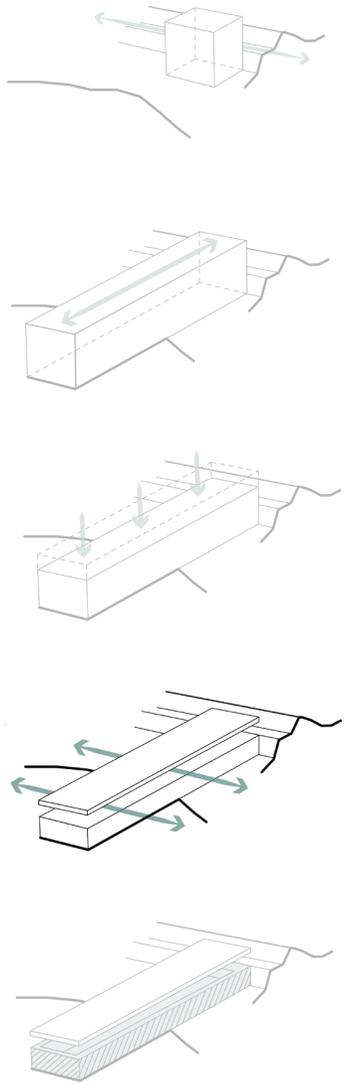
# GENERATING ENERGY

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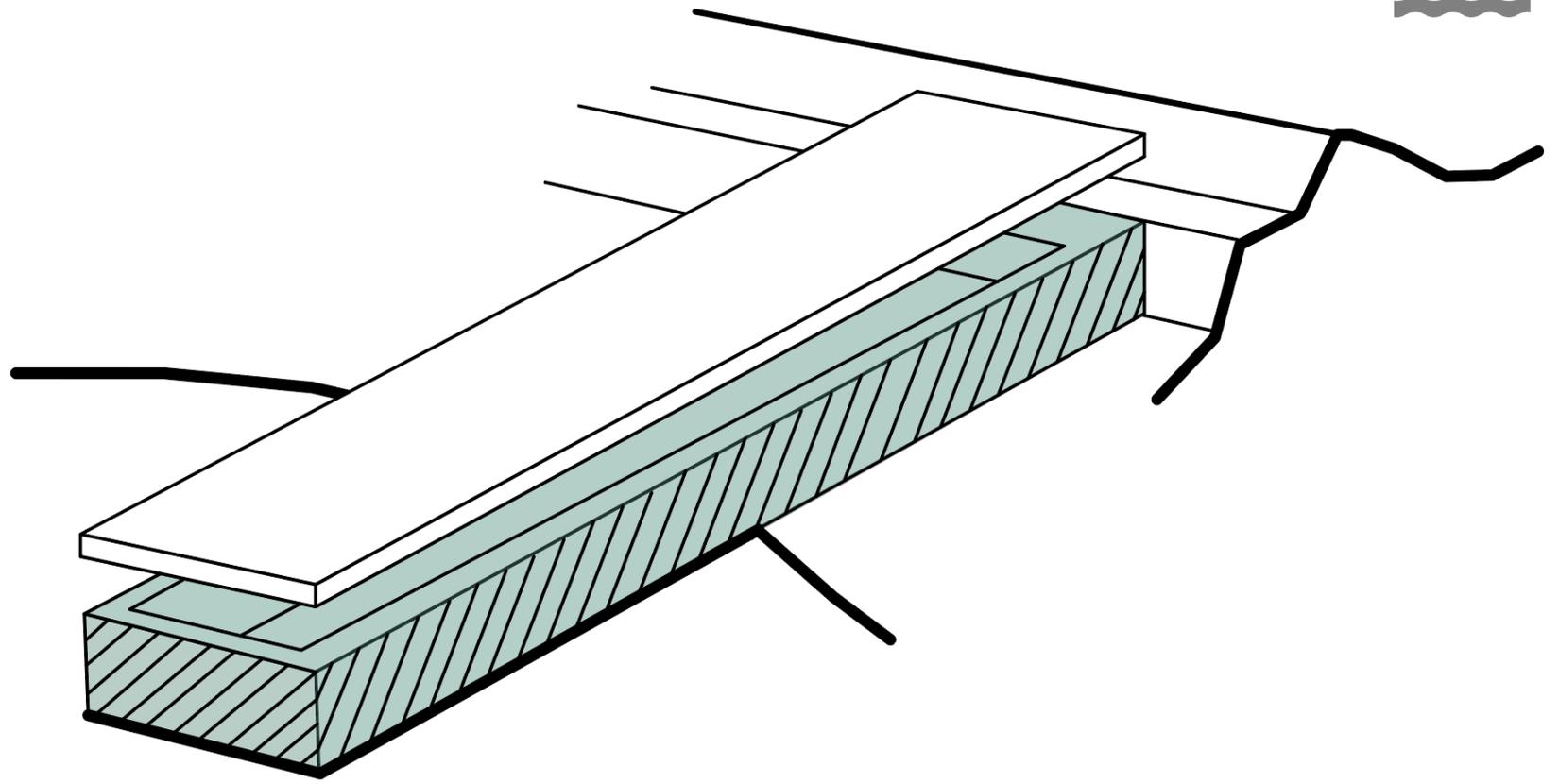
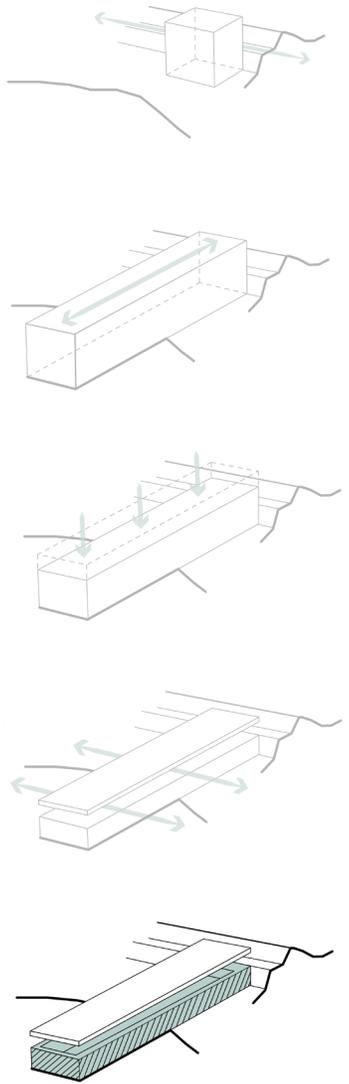
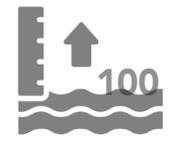
# ADAPT TO SURROUNDINGS

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# OPEN STRUCTURE

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# WATERPROOF

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# FINAL DESIGN

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studio assignment

energy research

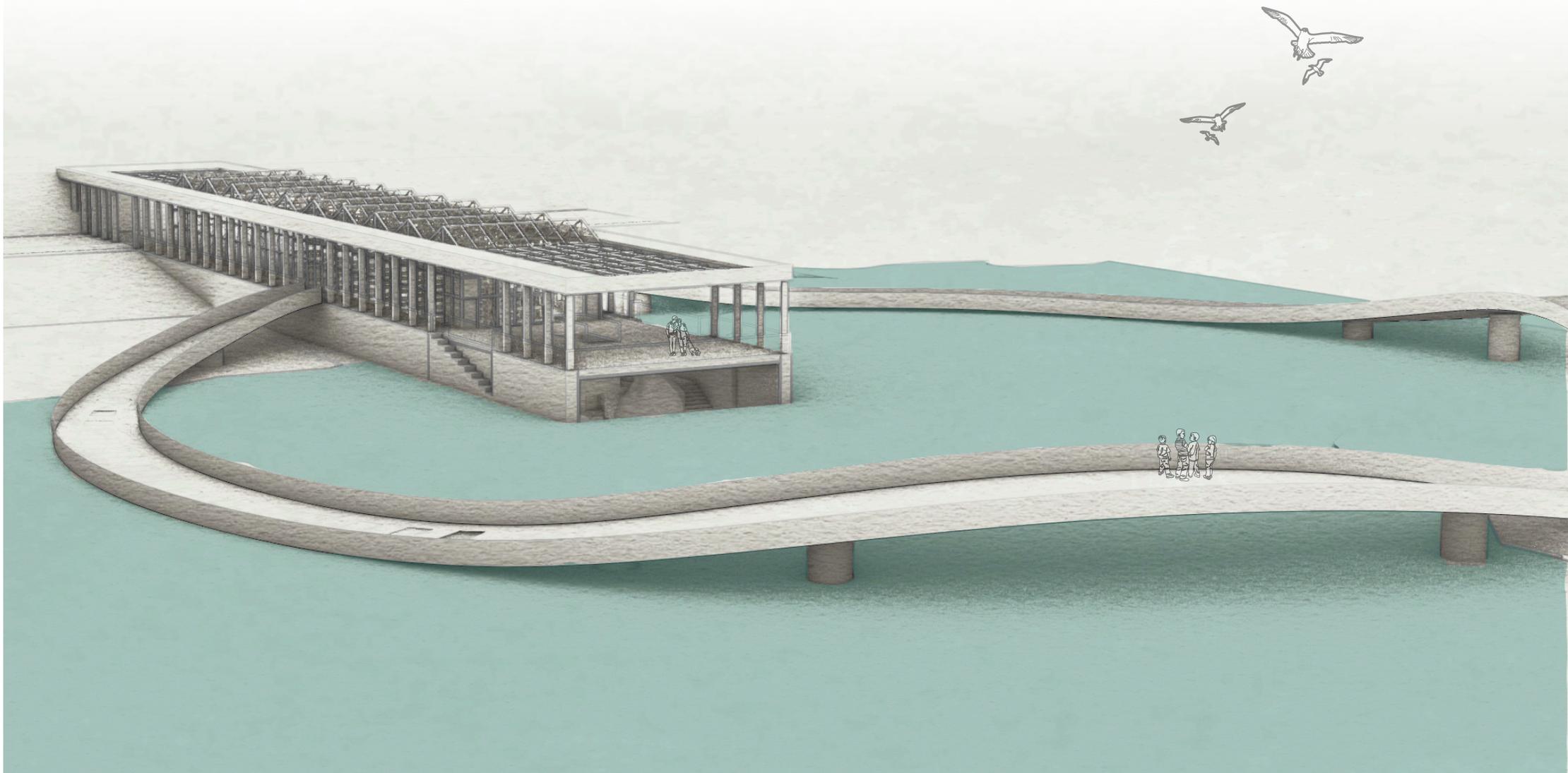
location

sea level rise

design principles

final design

conclusions

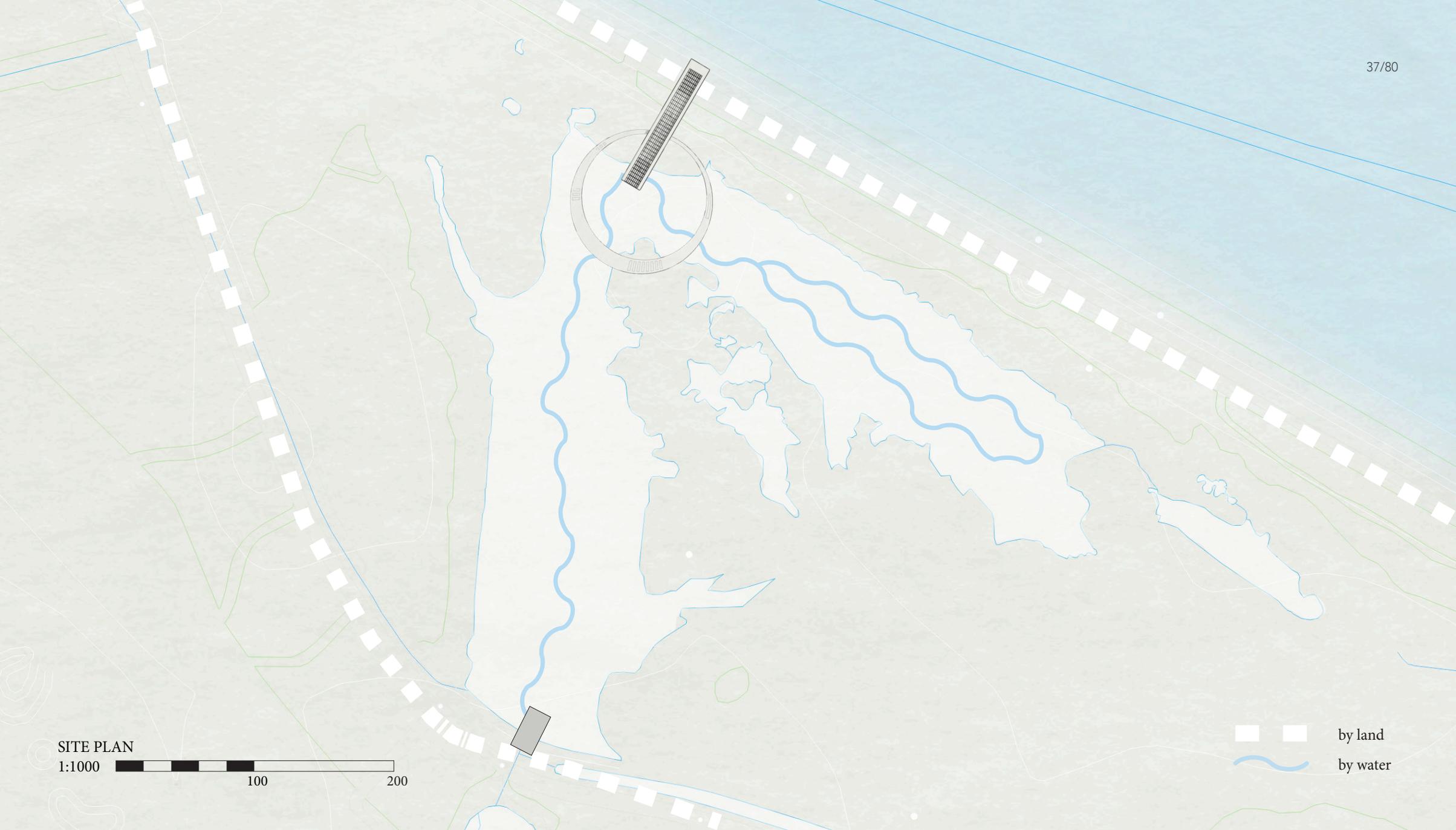


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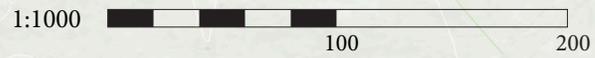
**FOOTPRINT** 1544 M<sup>2</sup>  
**GROSS INTERNAL AREA** 1152 M<sup>2</sup>  
**TOTAL FLOOR AREA** 2155 M<sup>2</sup>



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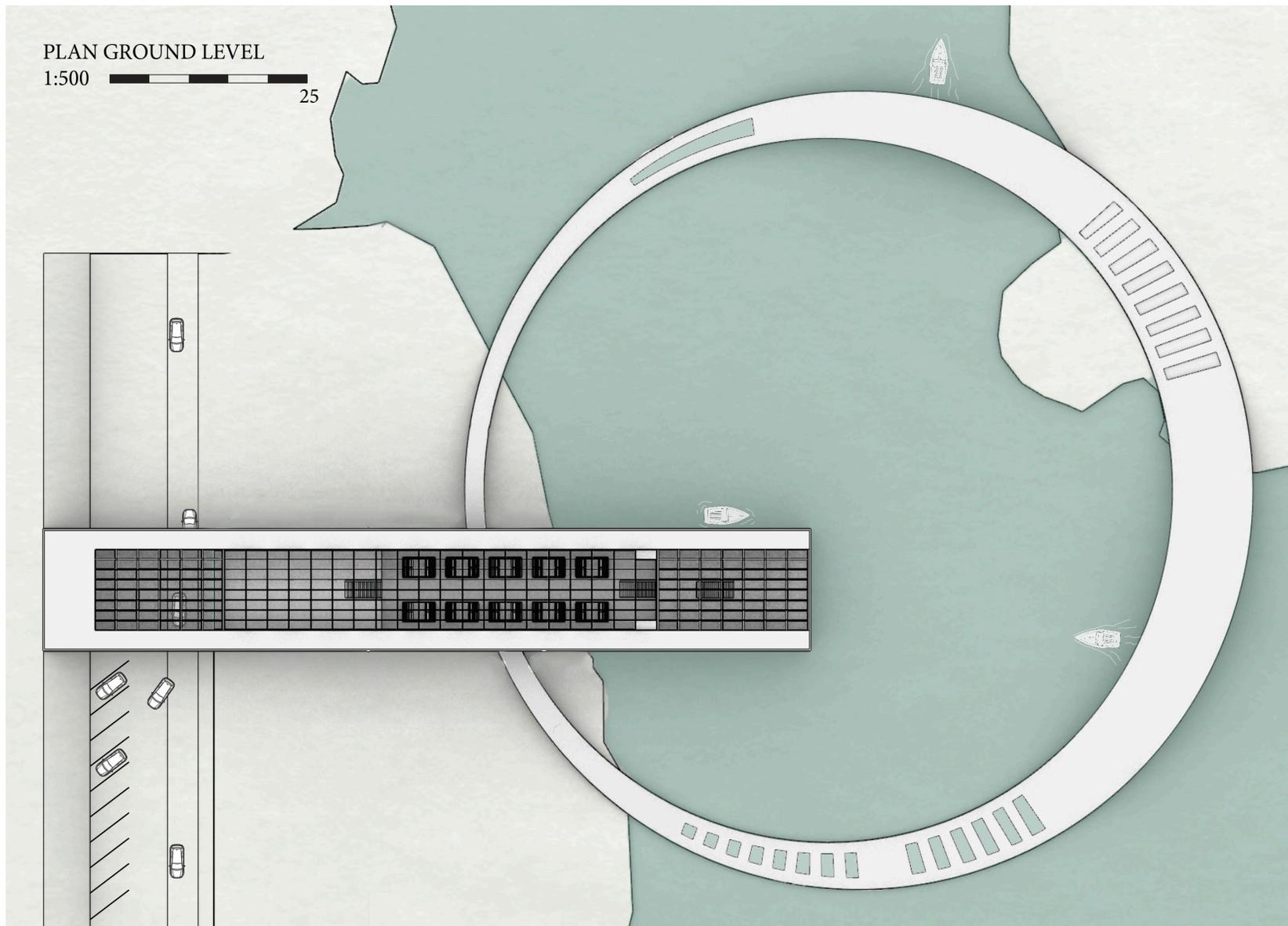


SITE PLAN

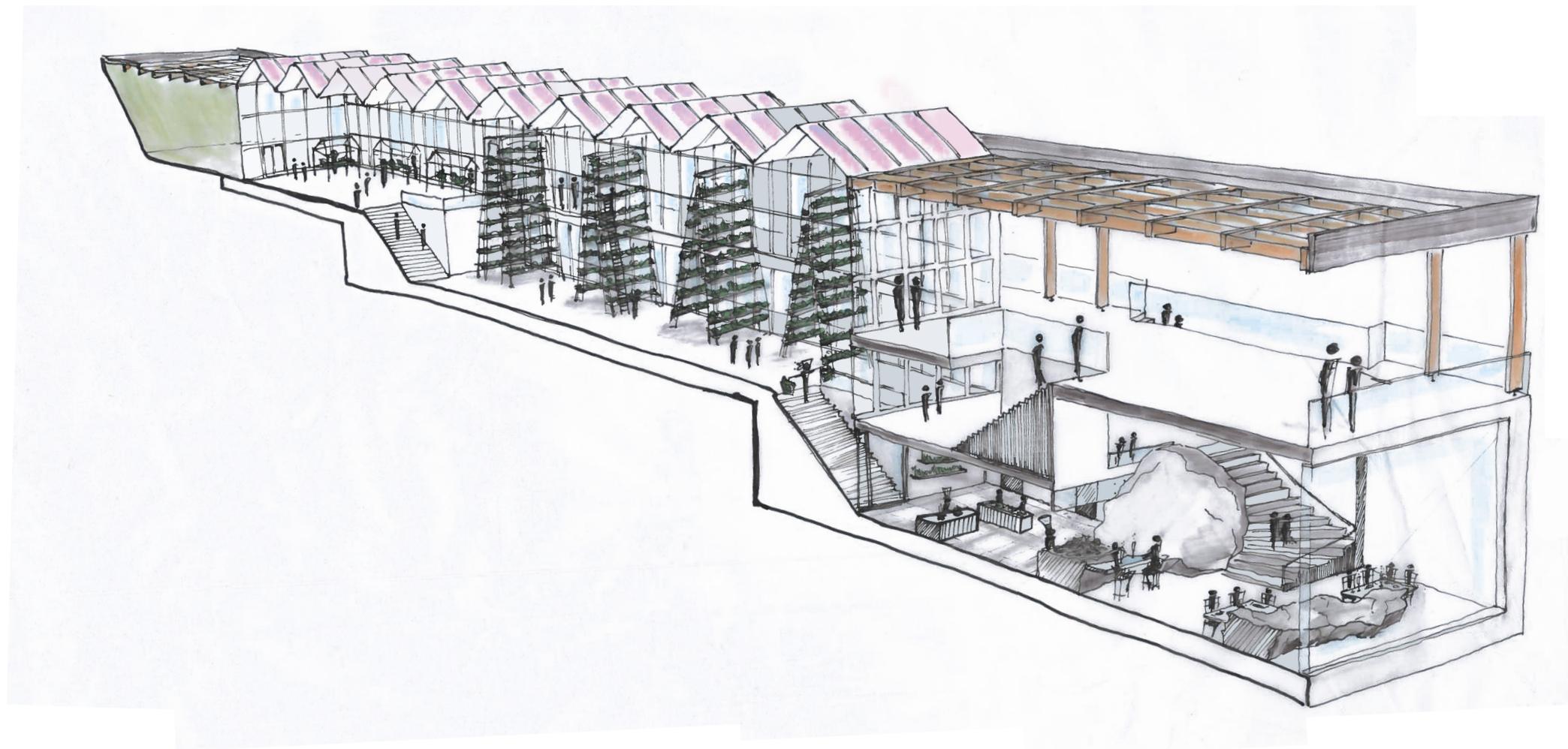


by land

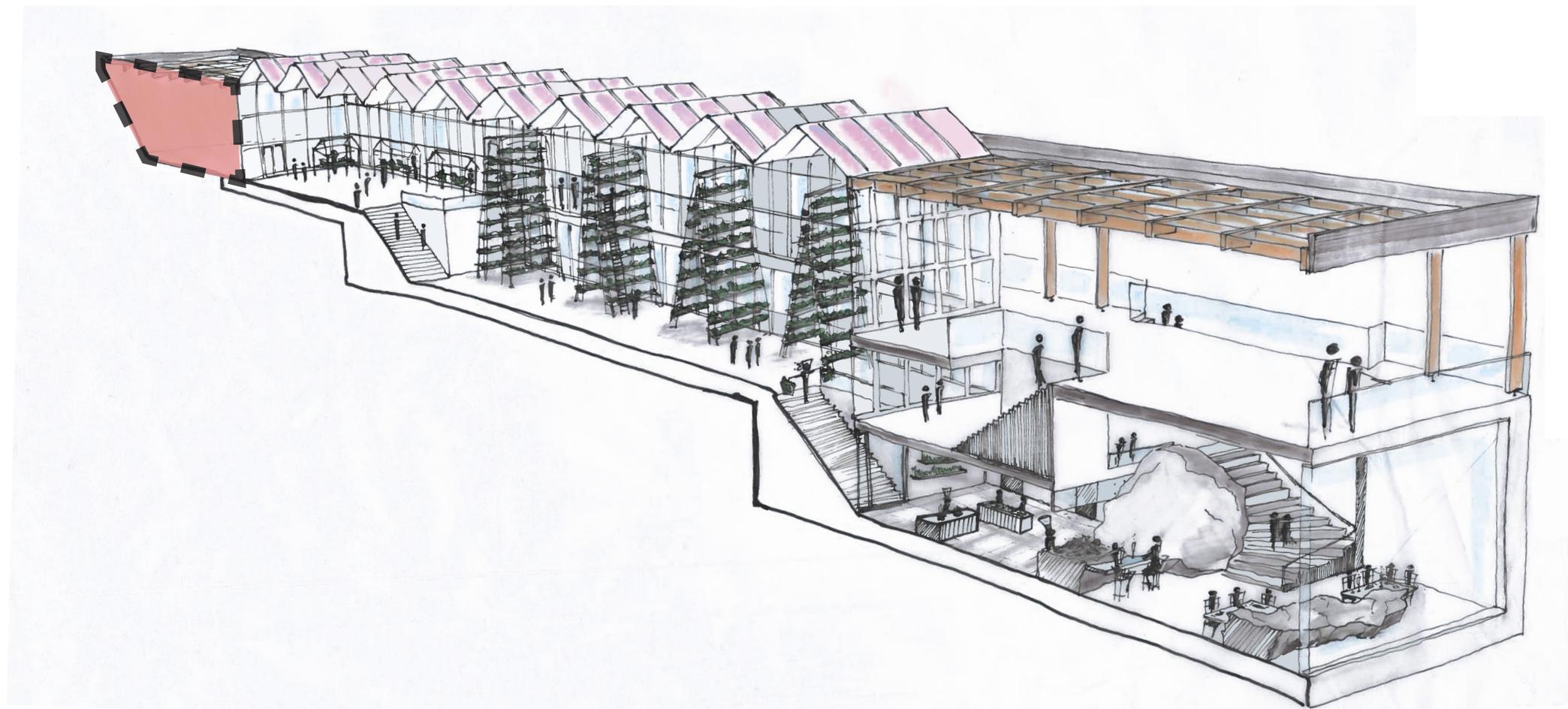
by water



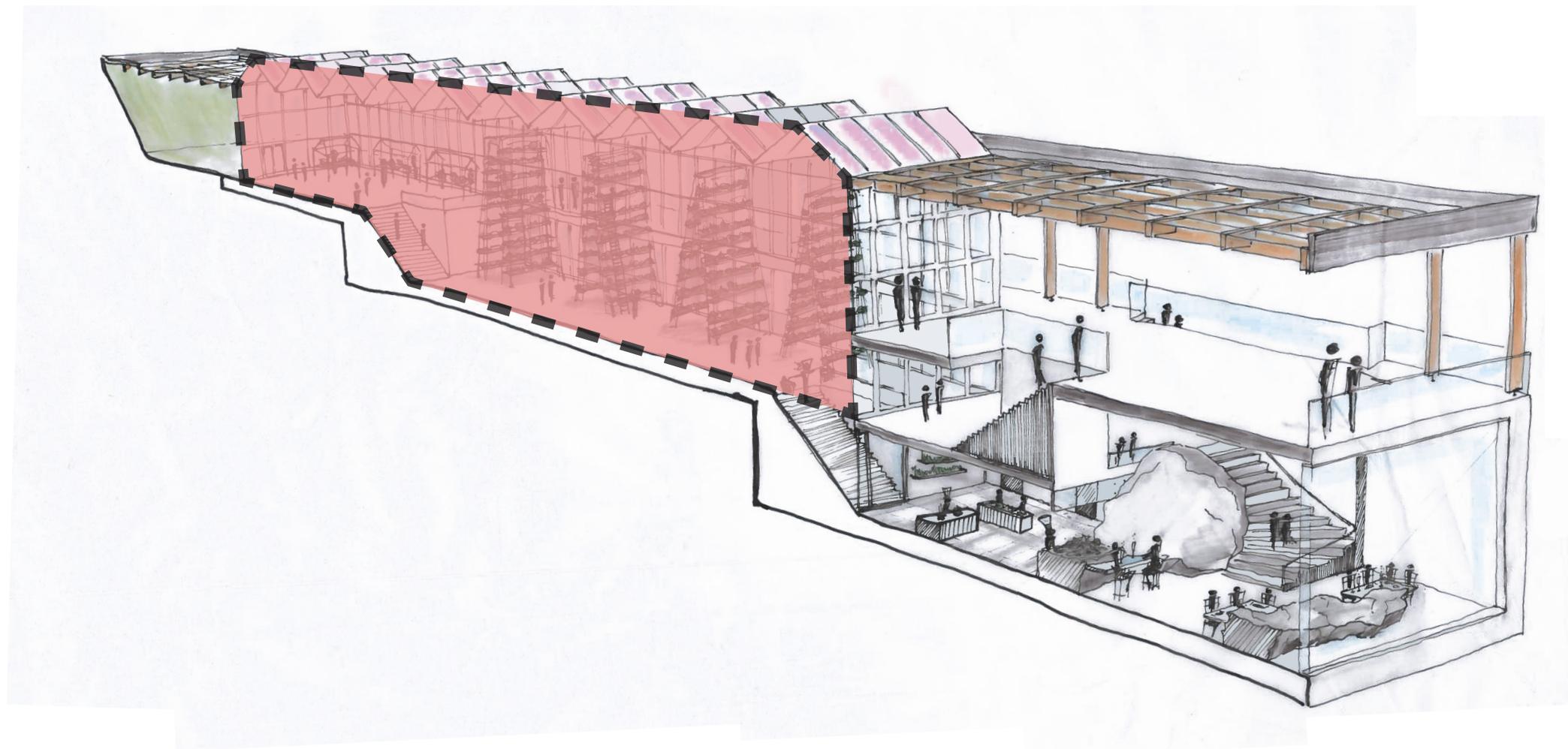
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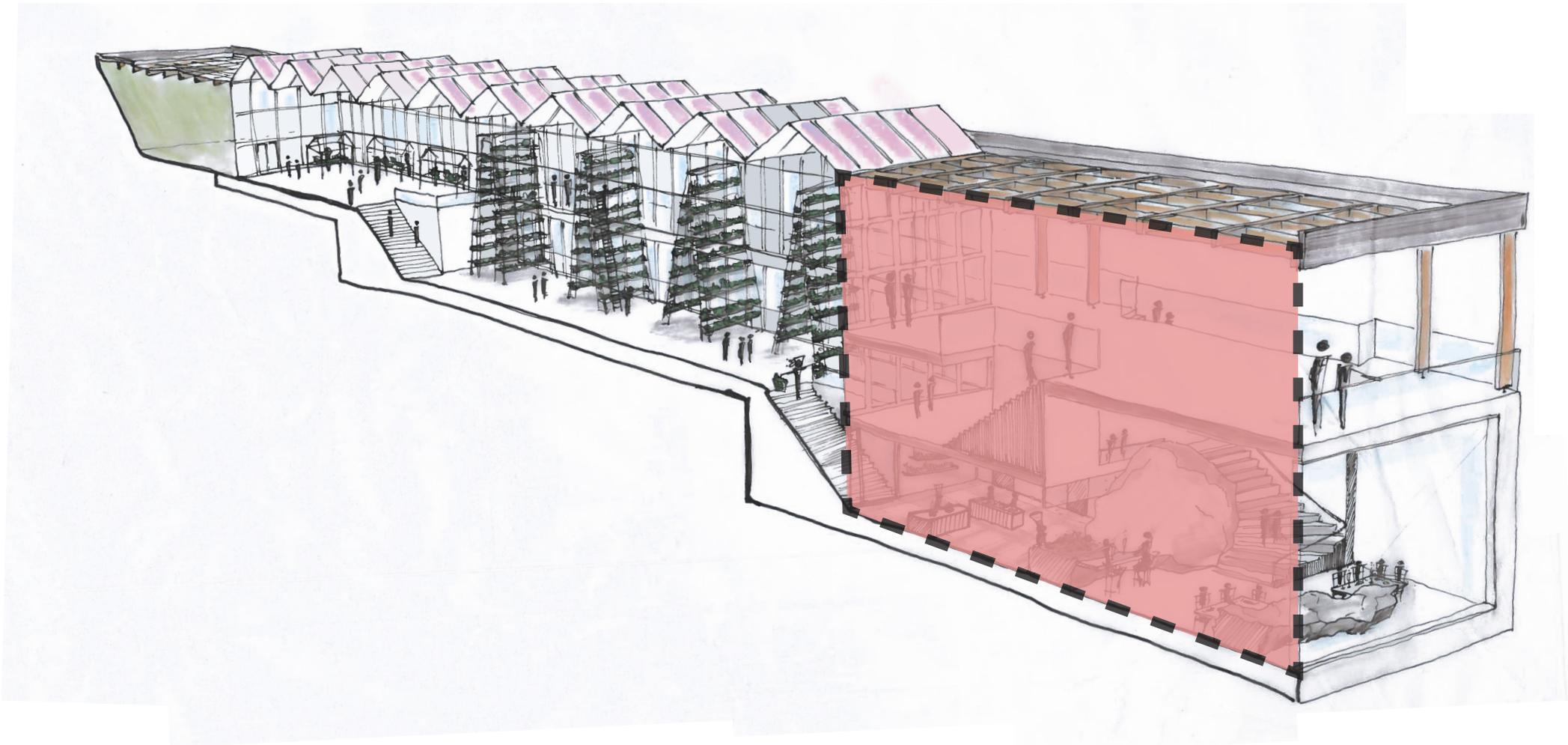
MARC KELLERMAN | T&amp;A SUBMERGED



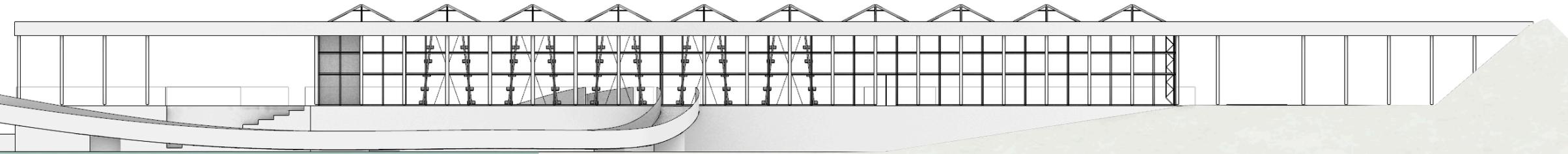
MARC KELLERMAN | T&amp;A SUBMERGED



MARC KELLERMAN | T&amp;A SUBMERGED



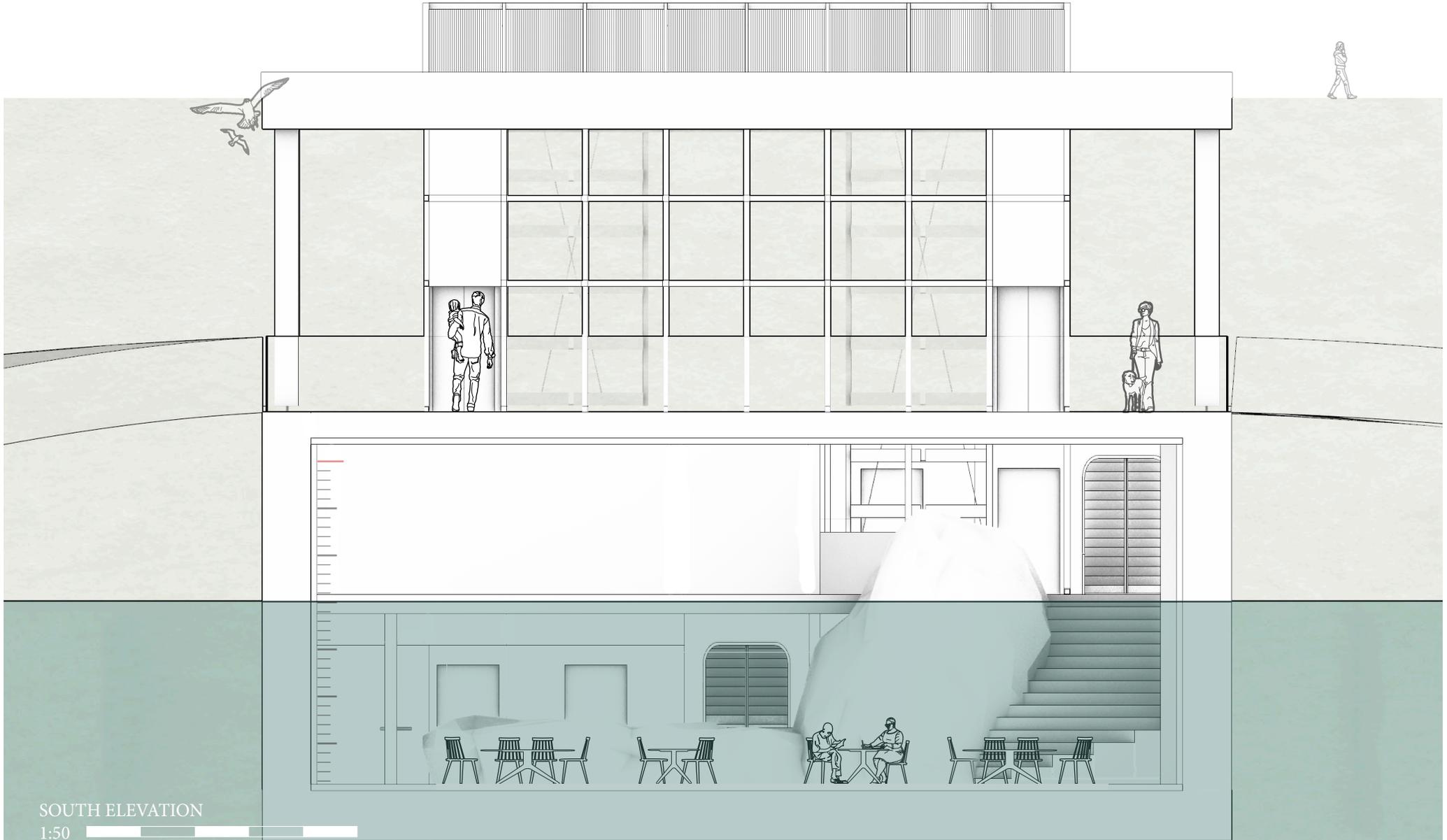
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EAST ELEVATION

1:100



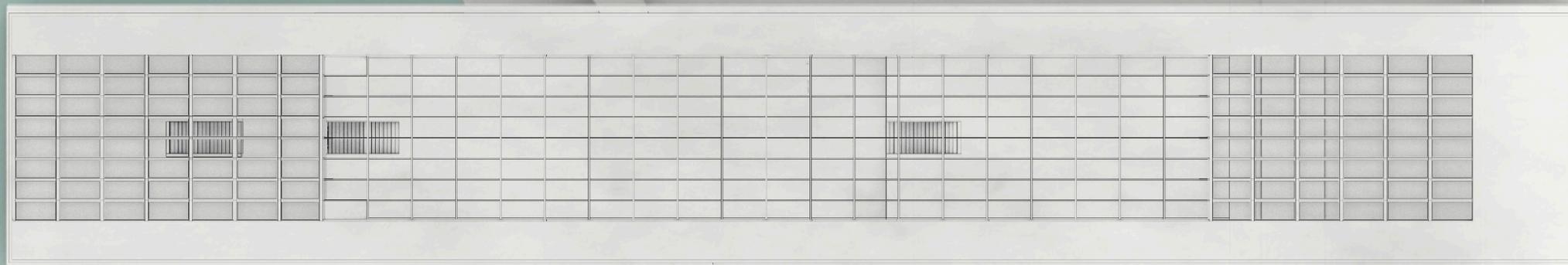


SOUTH ELEVATION

1:50

5

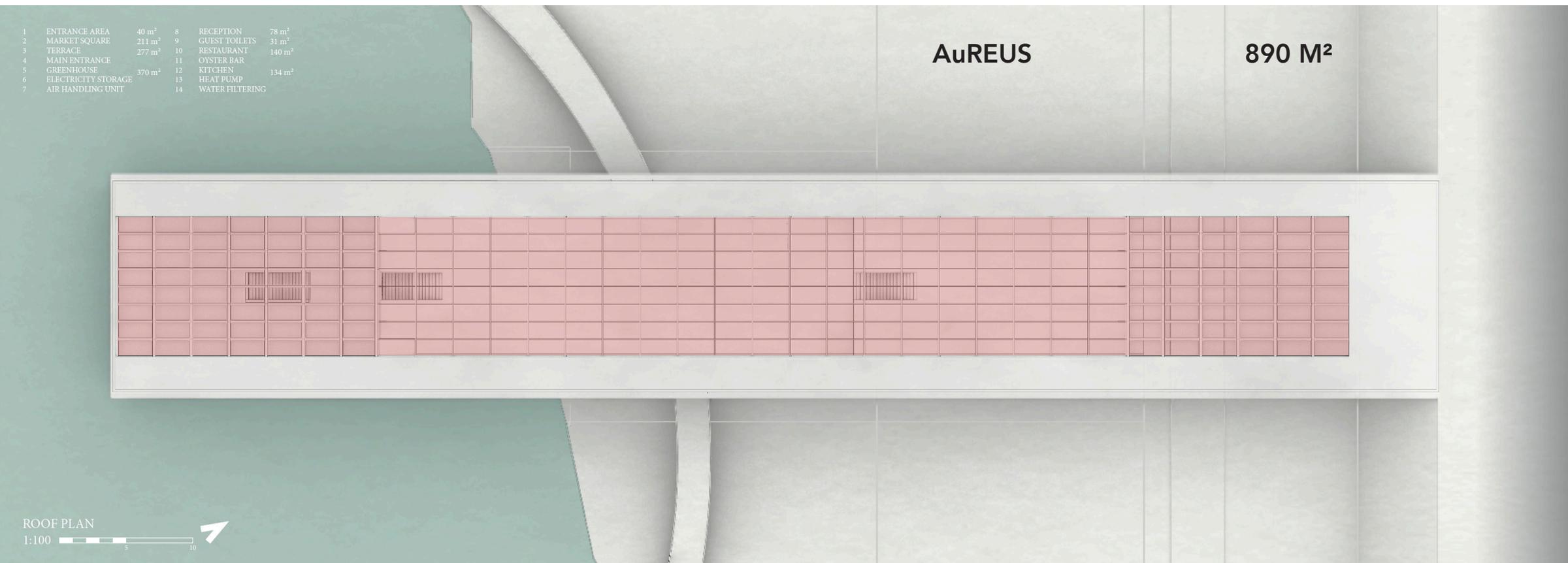
1	ENTRANCE AREA	40 m <sup>2</sup>	8	RECEPTION	78 m <sup>2</sup>
2	MARKET SQUARE	211 m <sup>2</sup>	9	GUEST TOILETS	31 m <sup>2</sup>
3	TERRACE	277 m <sup>2</sup>	10	RESTAURANT	140 m <sup>2</sup>
4	MAIN ENTRANCE		11	OYSTER BAR	
5	GREENHOUSE	370 m <sup>2</sup>	12	KITCHEN	134 m <sup>2</sup>
6	ELECTRICITY STORAGE		13	HEAT PUMP	
7	AIR HANDLING UNIT		14	WATER FILTERING	



ROOF PLAN

1:100

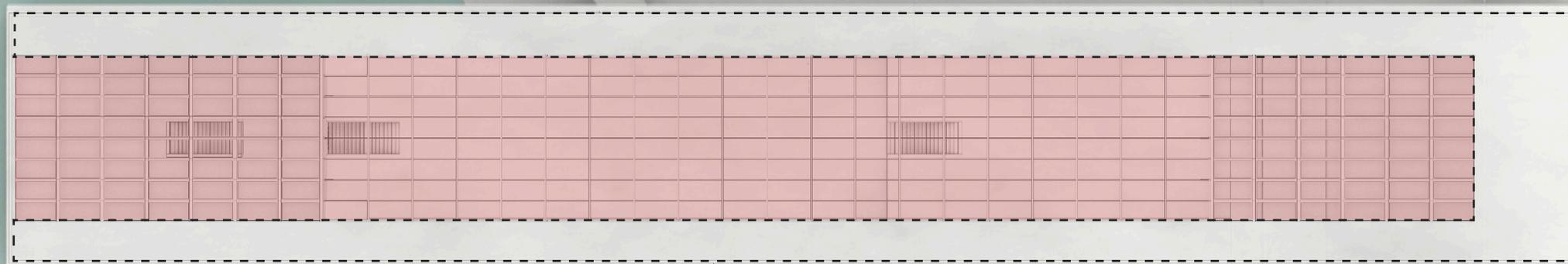




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7	AIR HANDLING UNIT		14	WATER FILTERING	

**AuREUS  
GREENROOF**

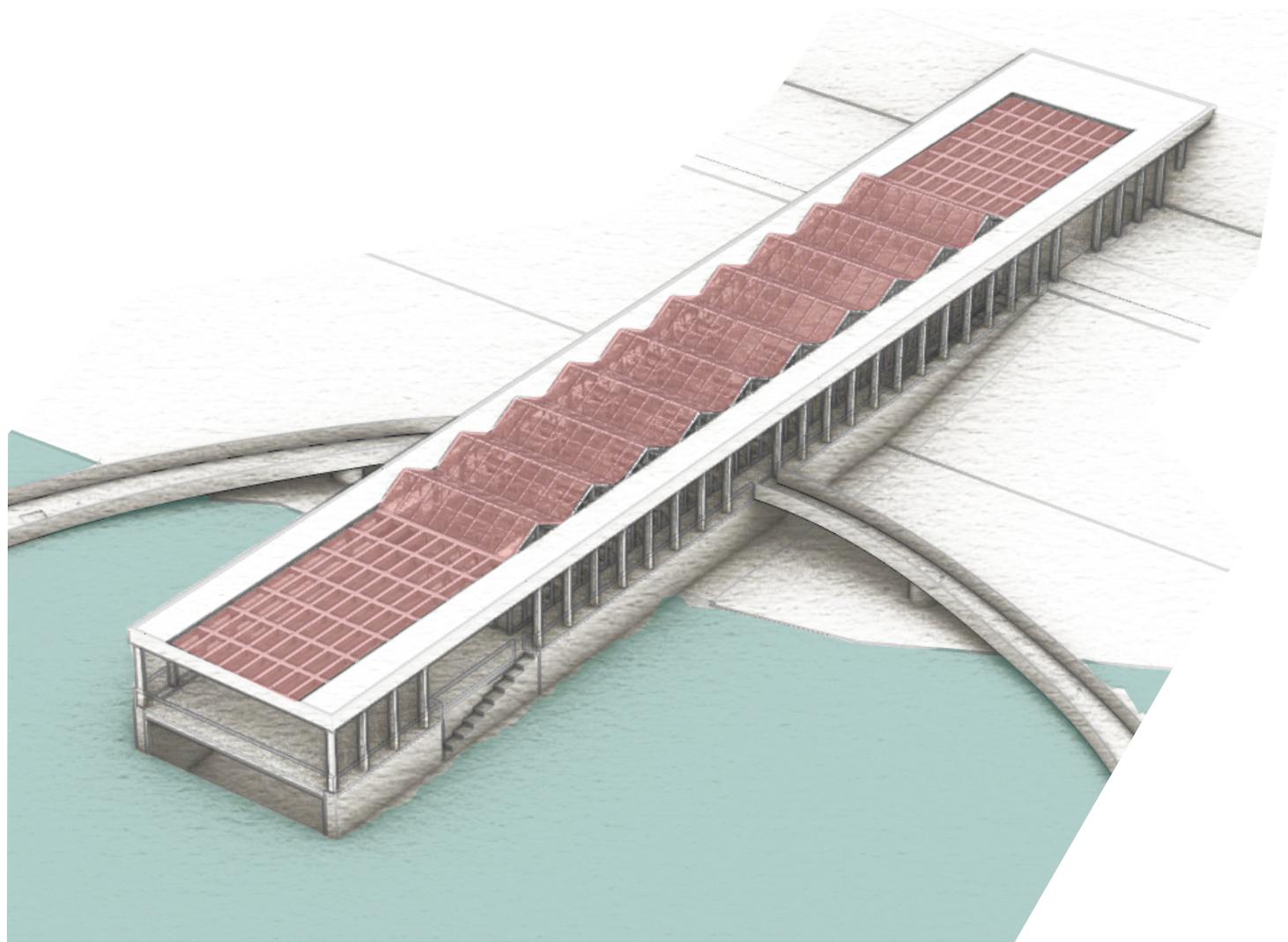
**890 M<sup>2</sup>  
654 M<sup>2</sup>**



ROOF PLAN

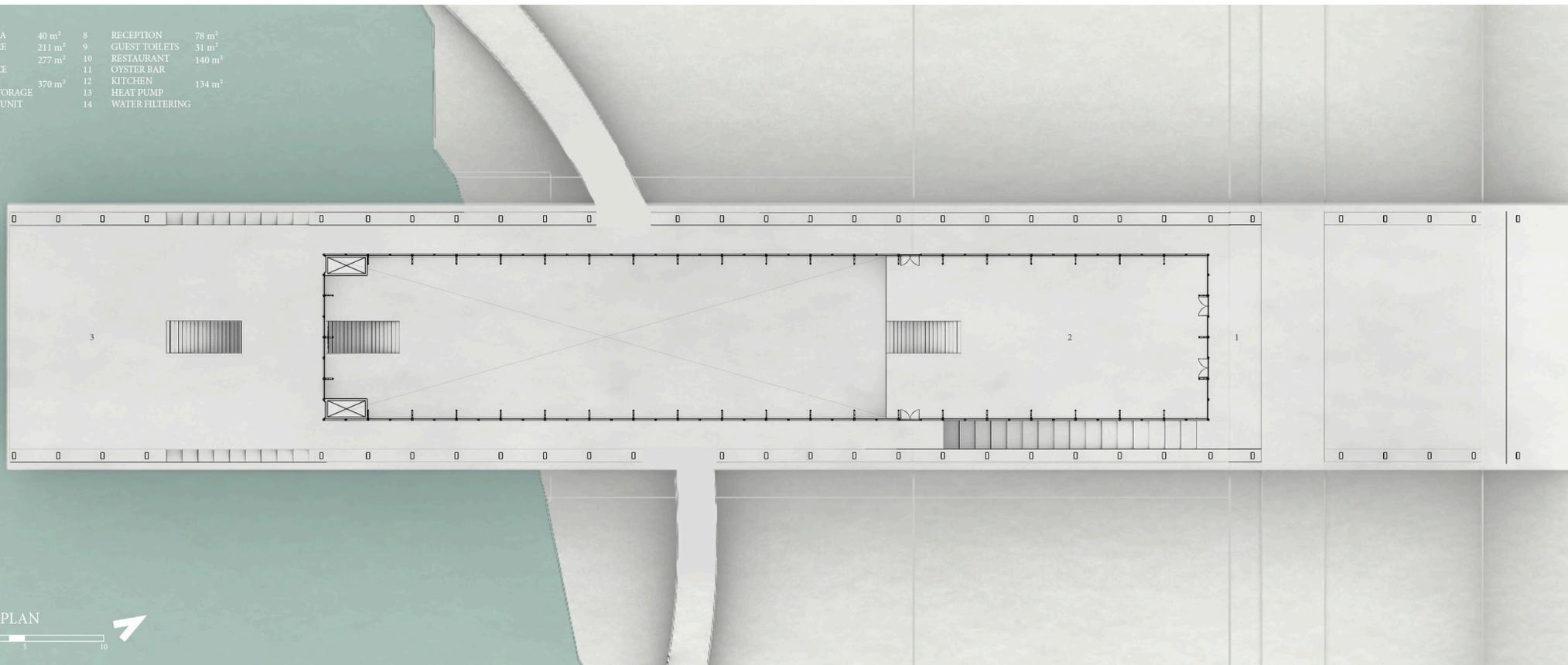
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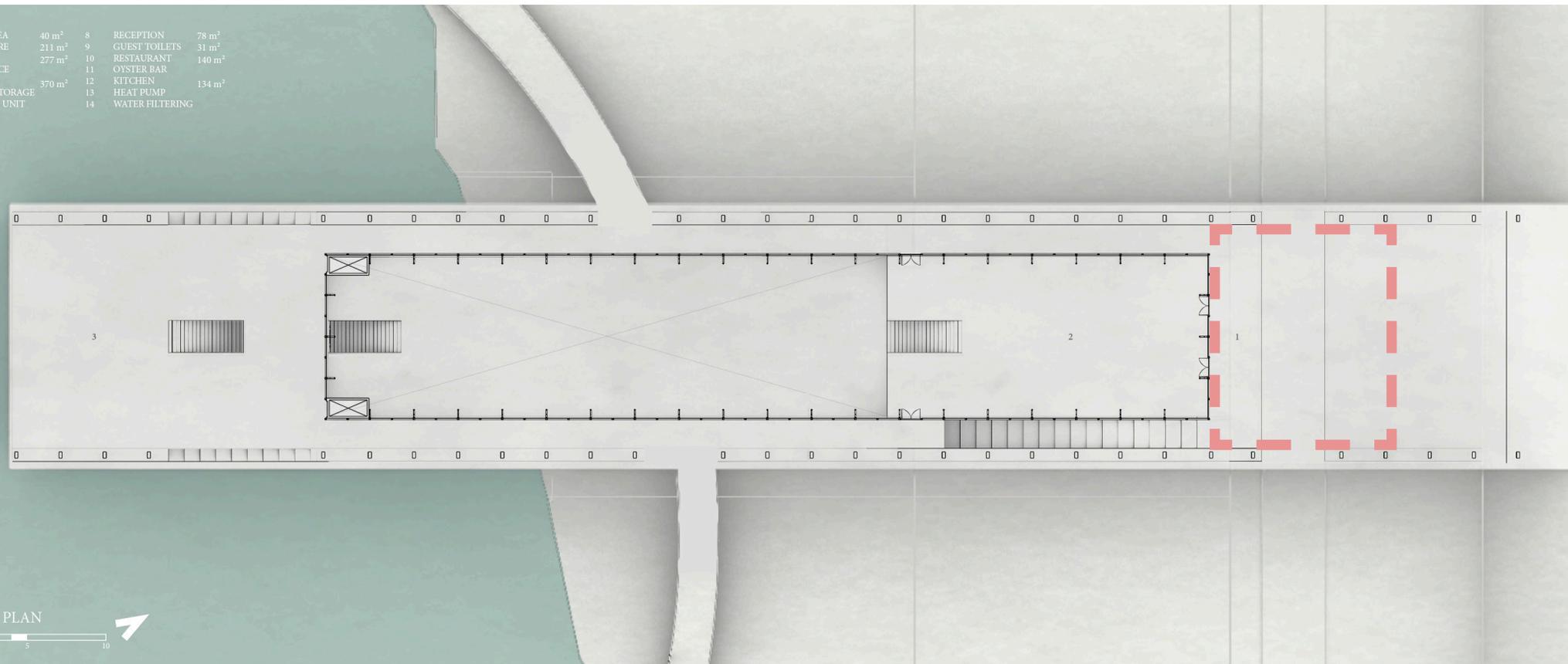


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studio assignment

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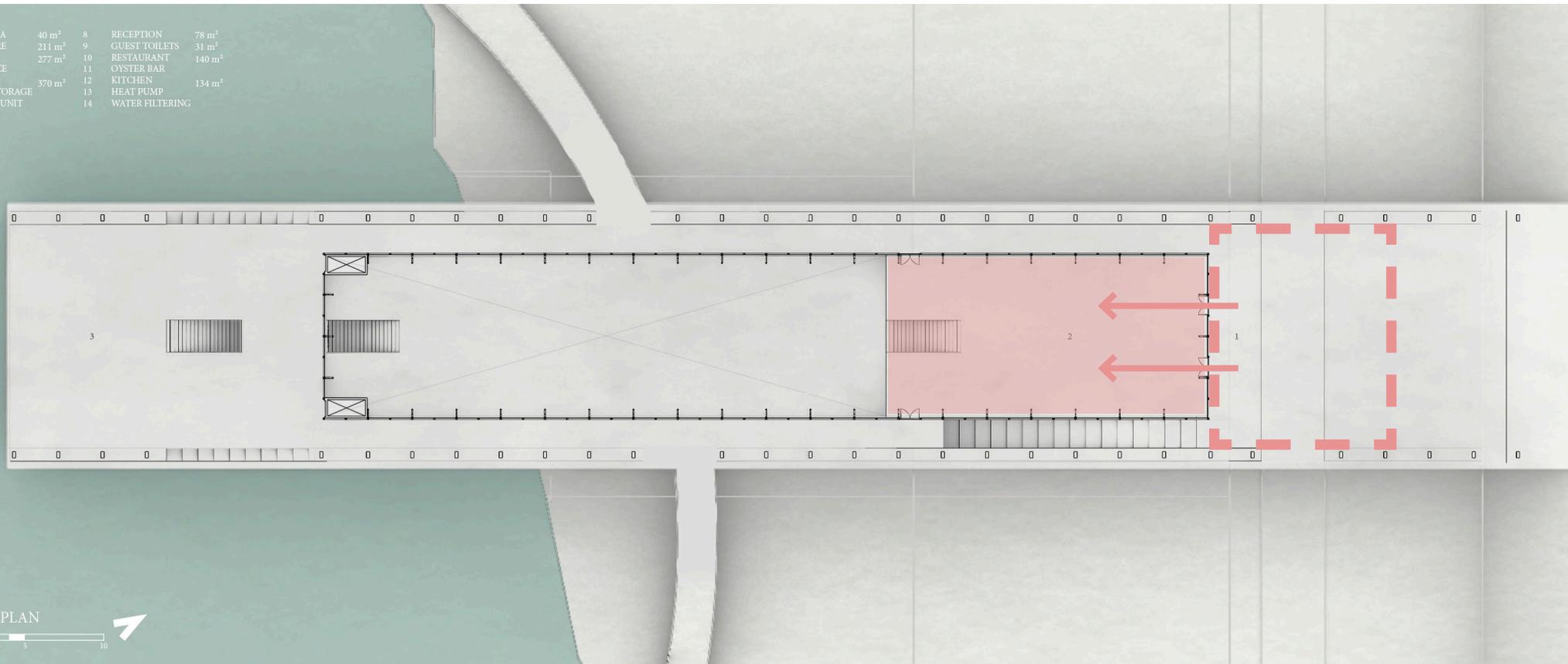
sea level rise

design principles

final design

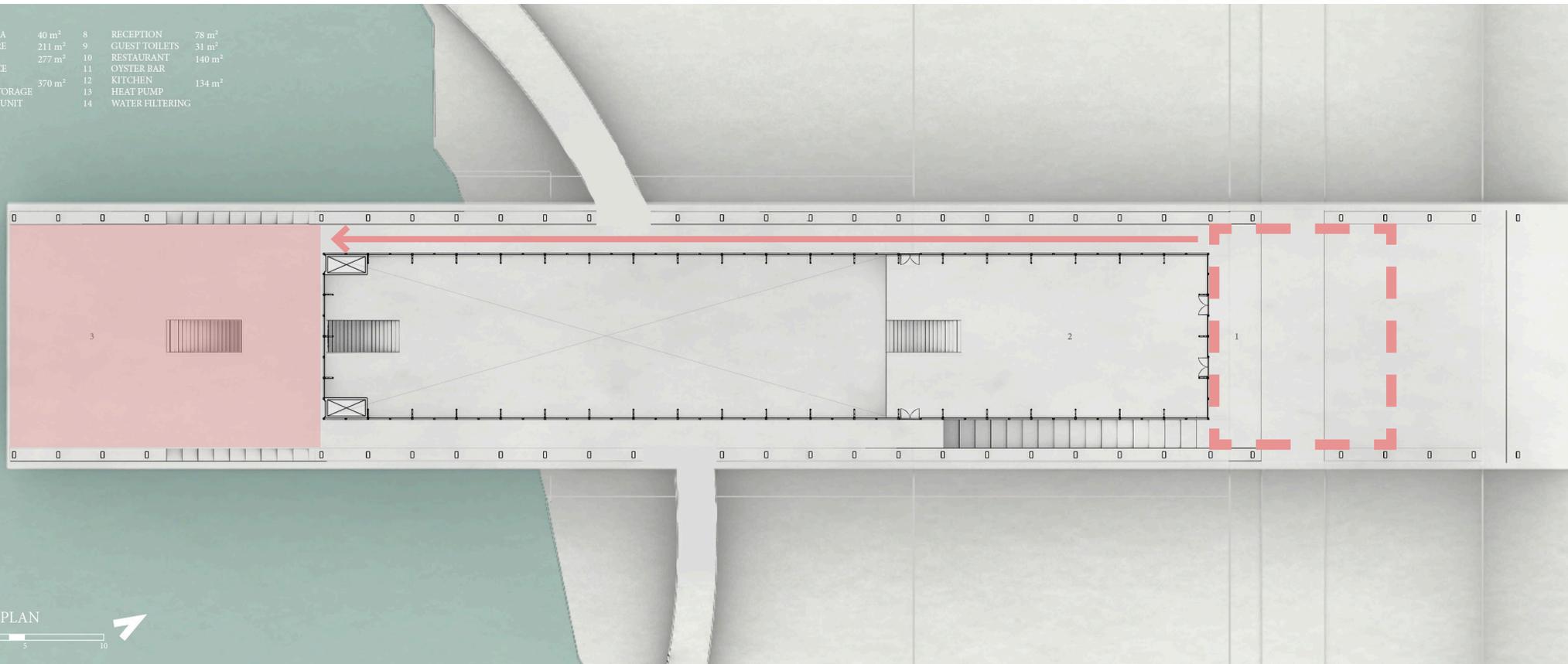
conclusions

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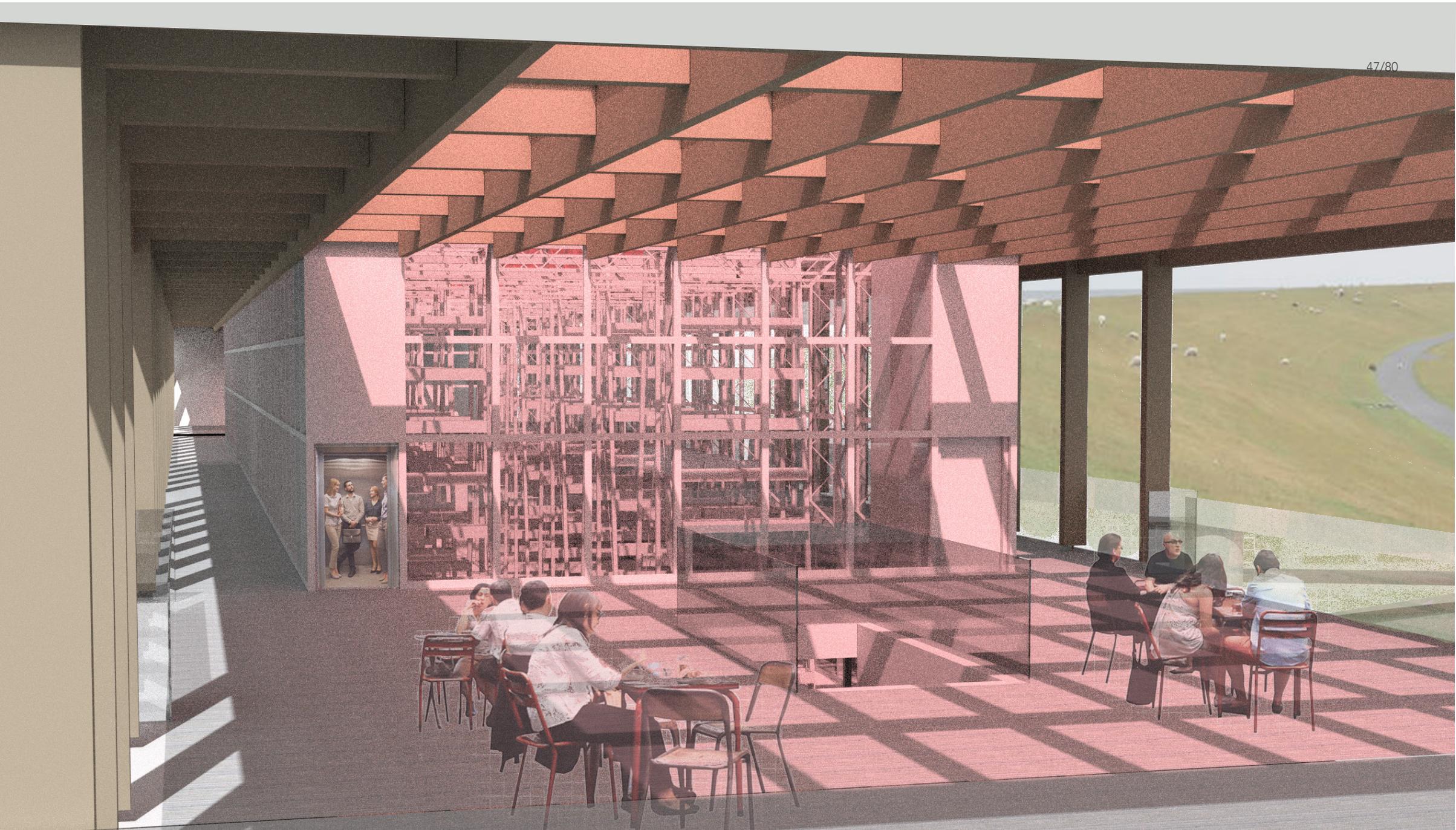
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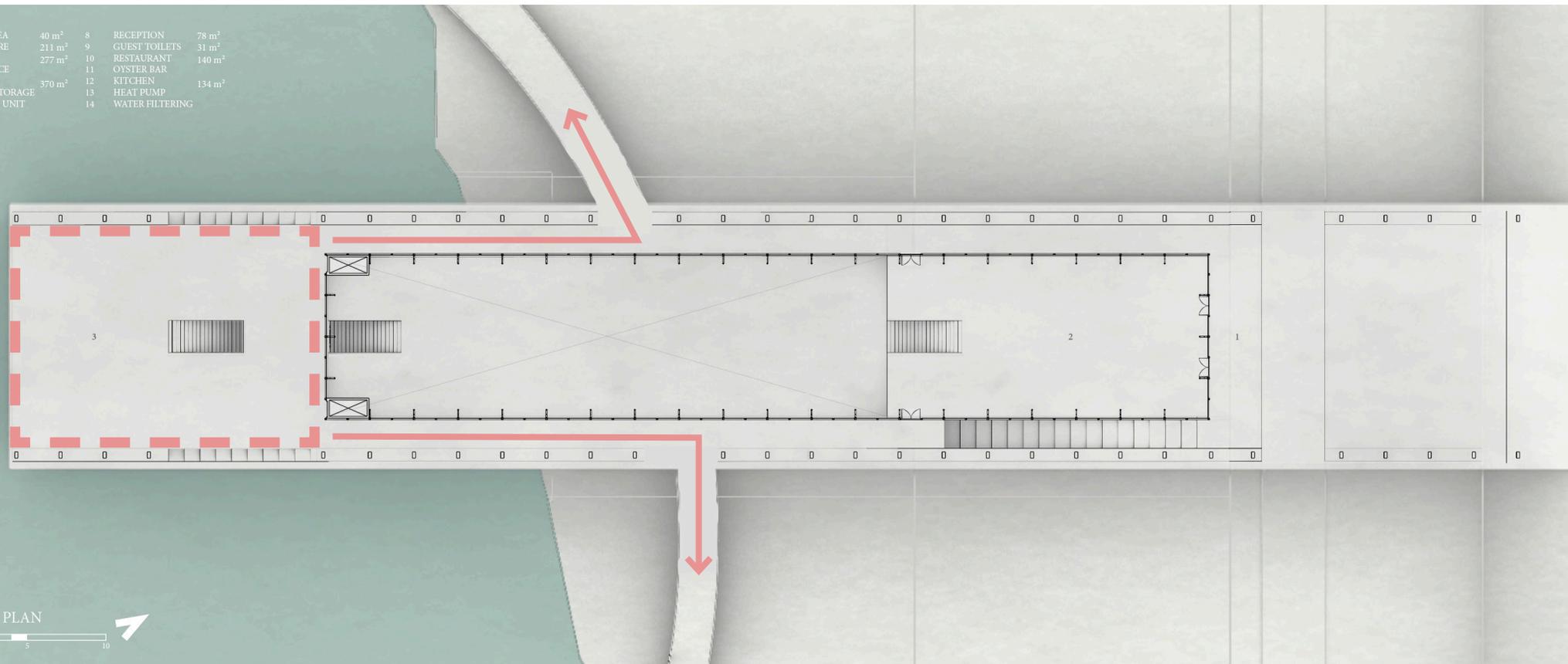
FIRST FLOOR PLAN

1:100





1	ENTRANCE AREA	40 m <sup>2</sup>	8	RECEPTION	78 m <sup>2</sup>
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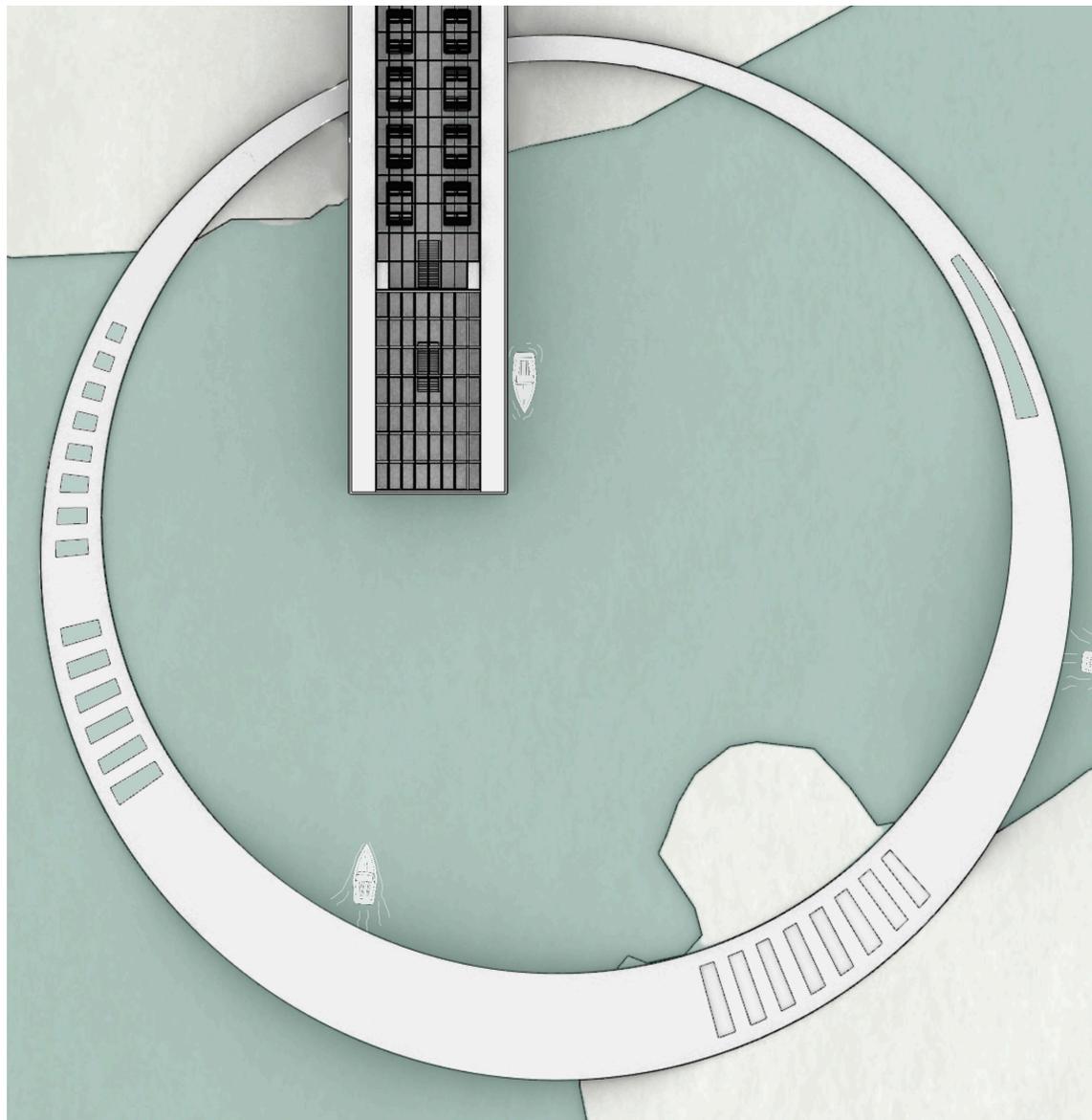
location

sea level rise

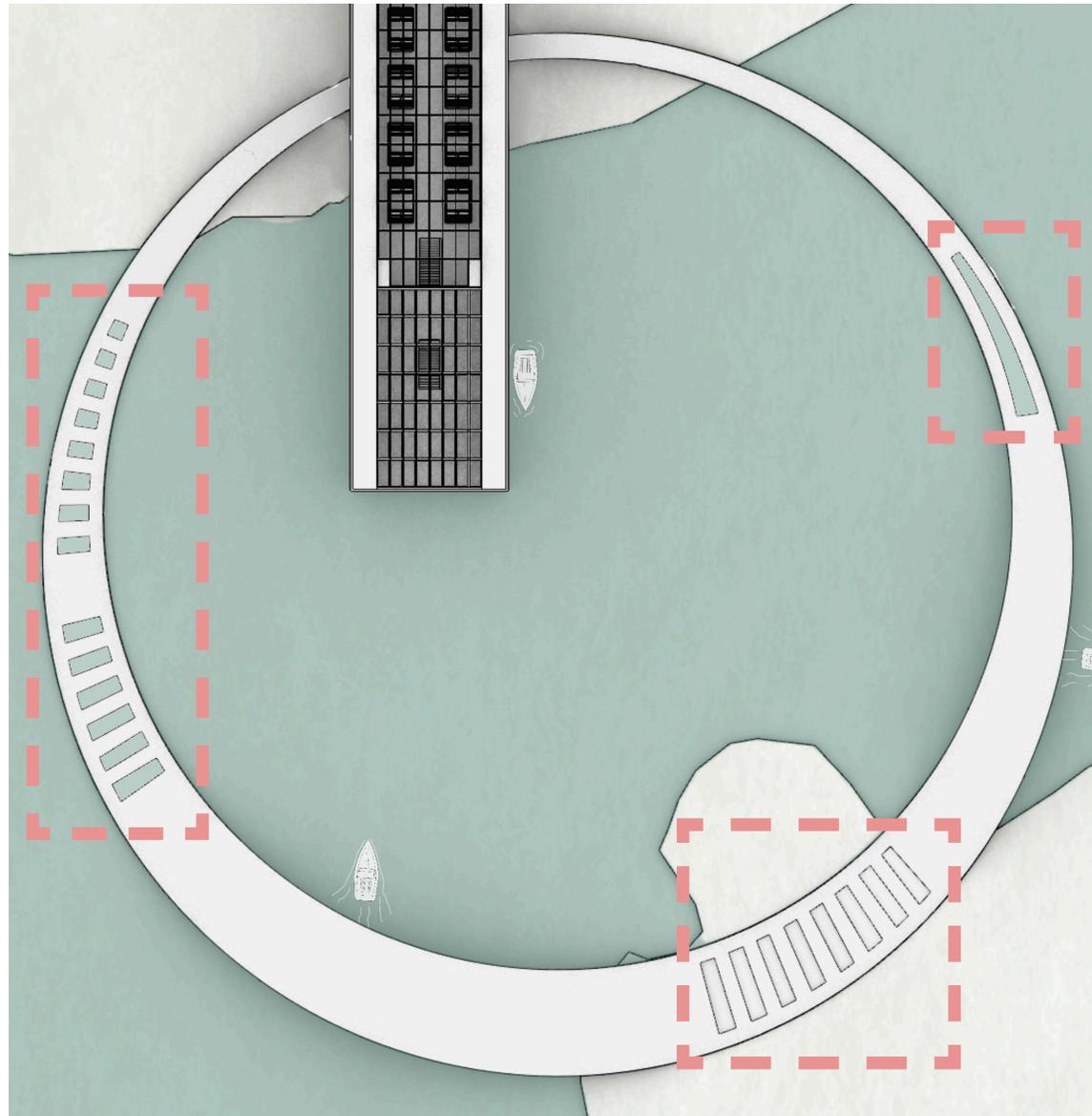
design principles

final design

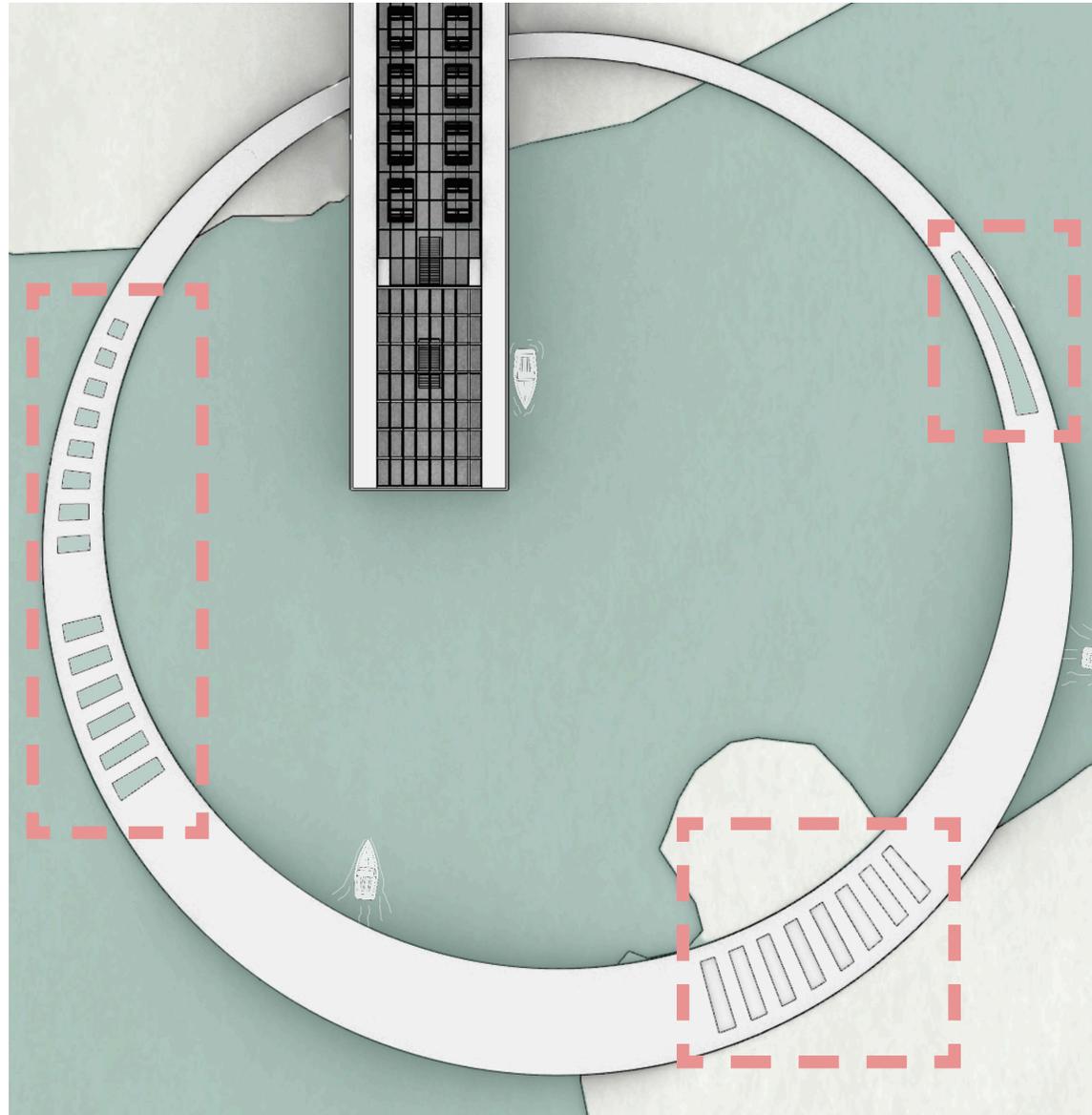
conclusions



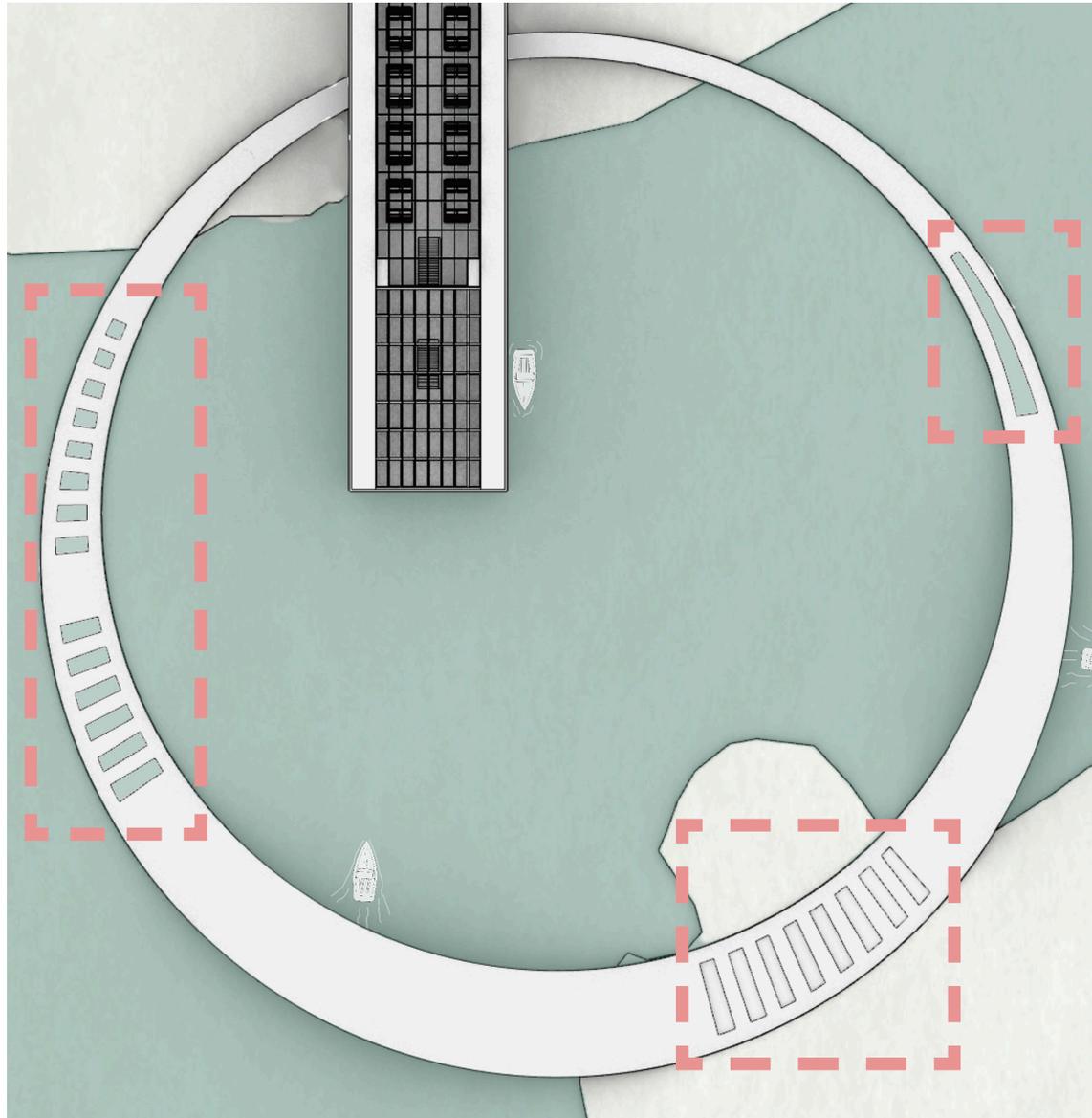
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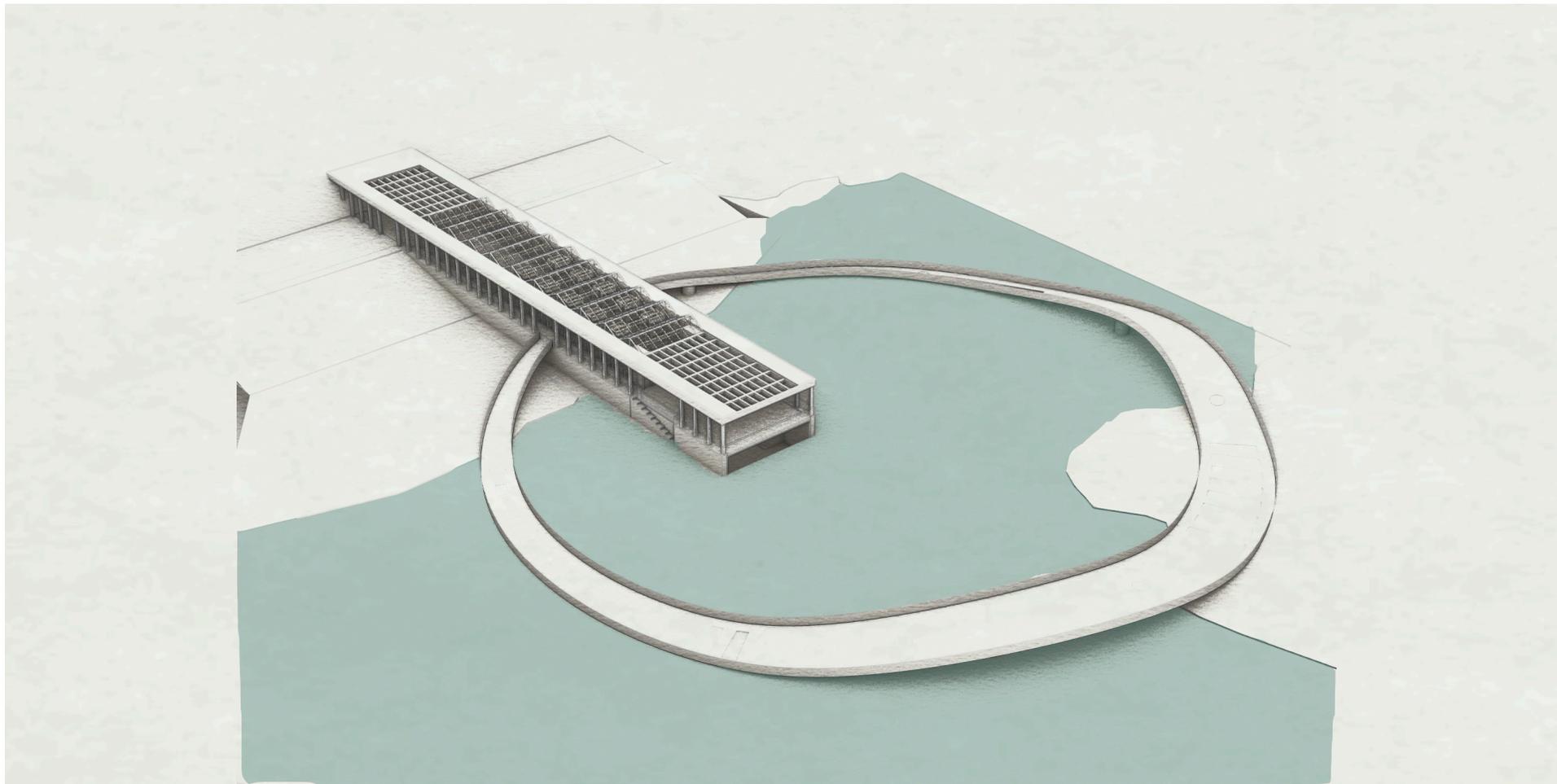
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studio assignment

energy research

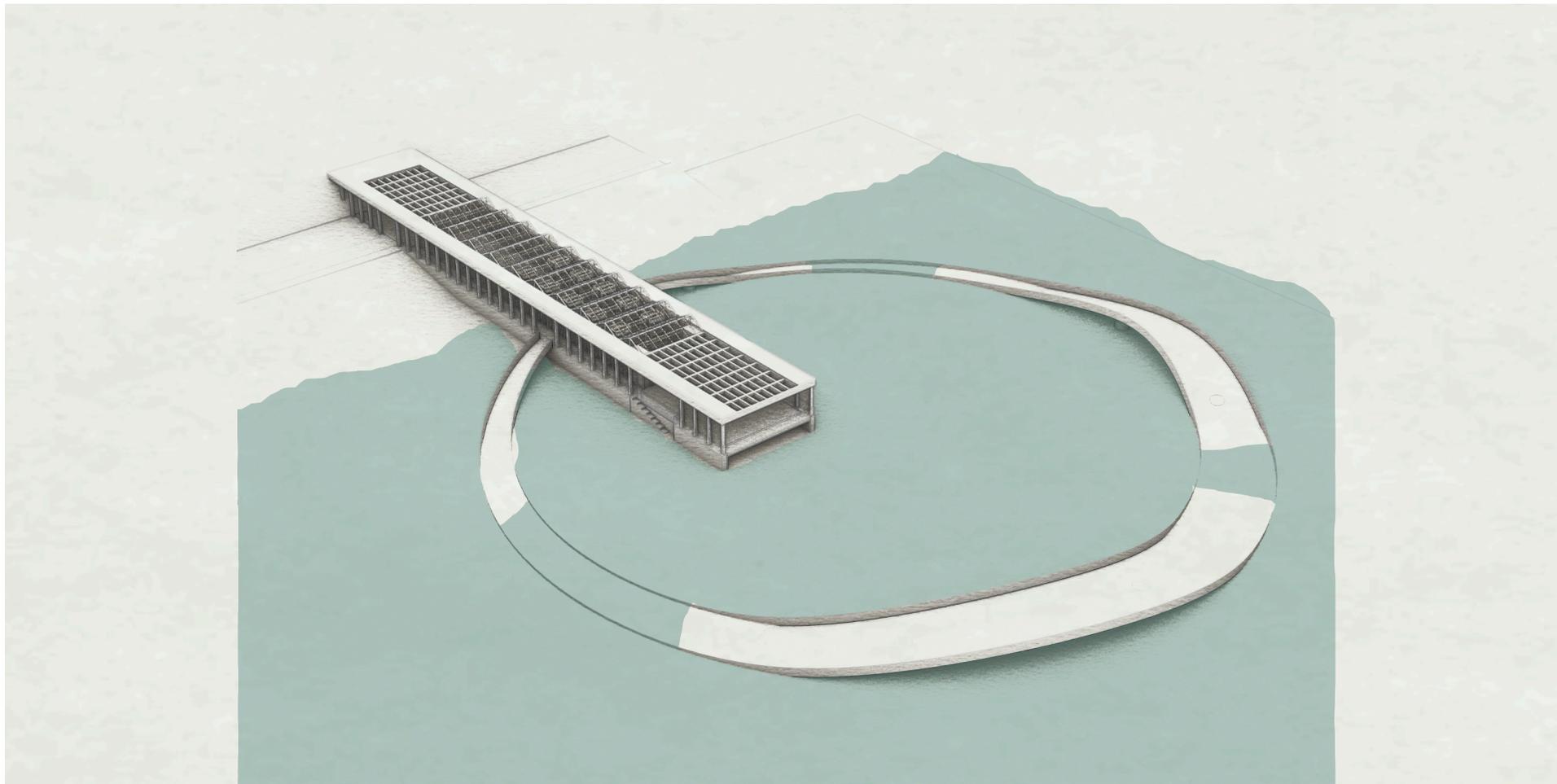
location

sea level rise

design principles

final design

conclusions



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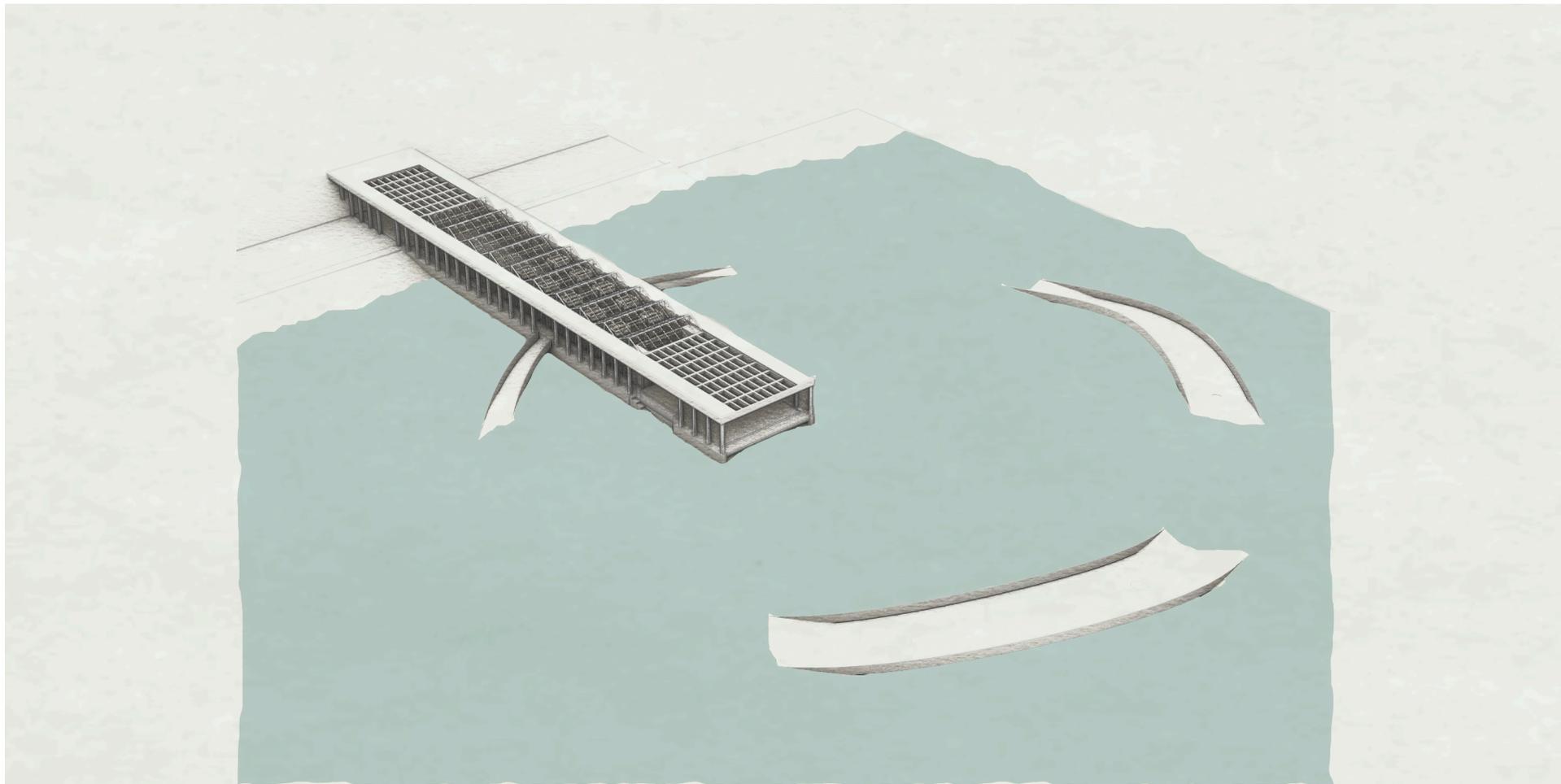
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sea level rise

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conclusions



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energy research

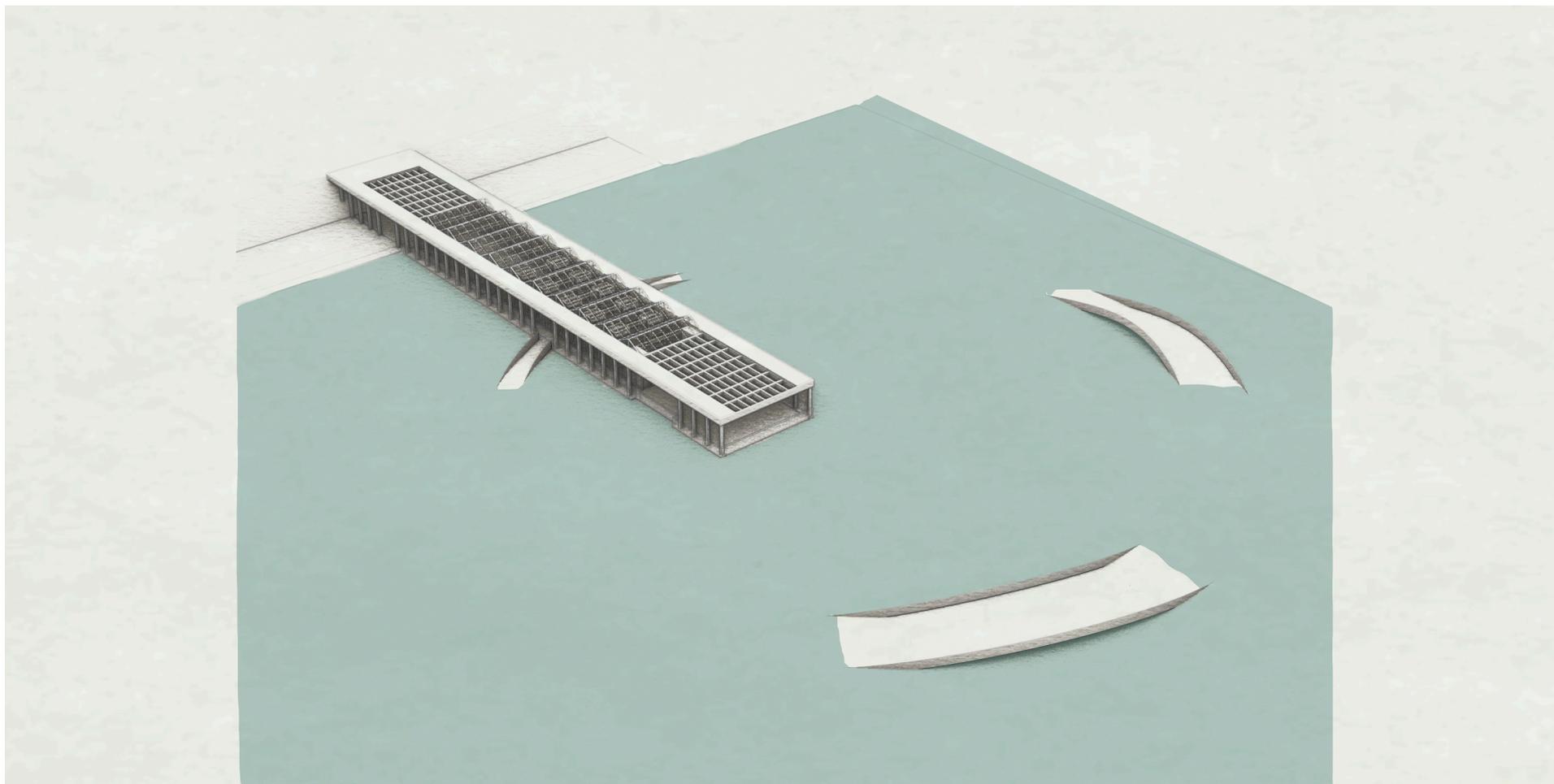
location

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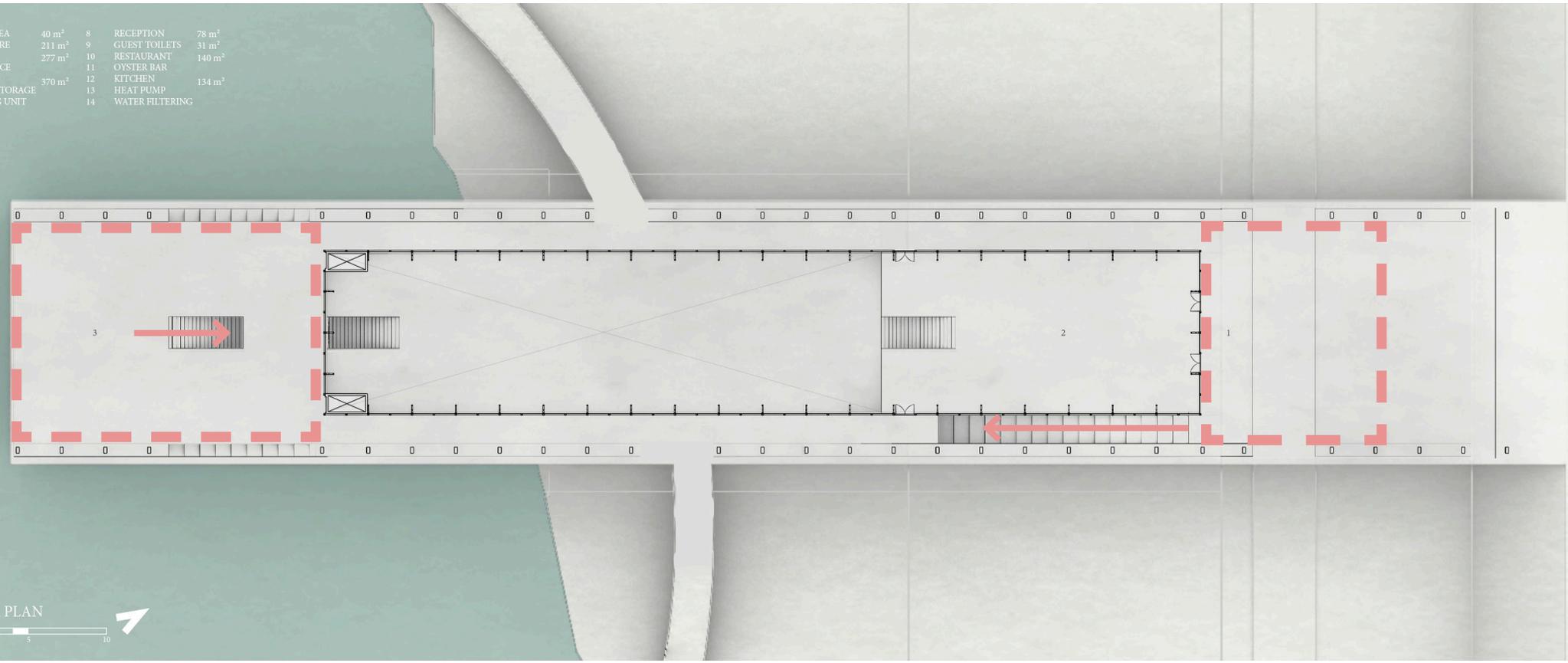
sea level rise

design principles

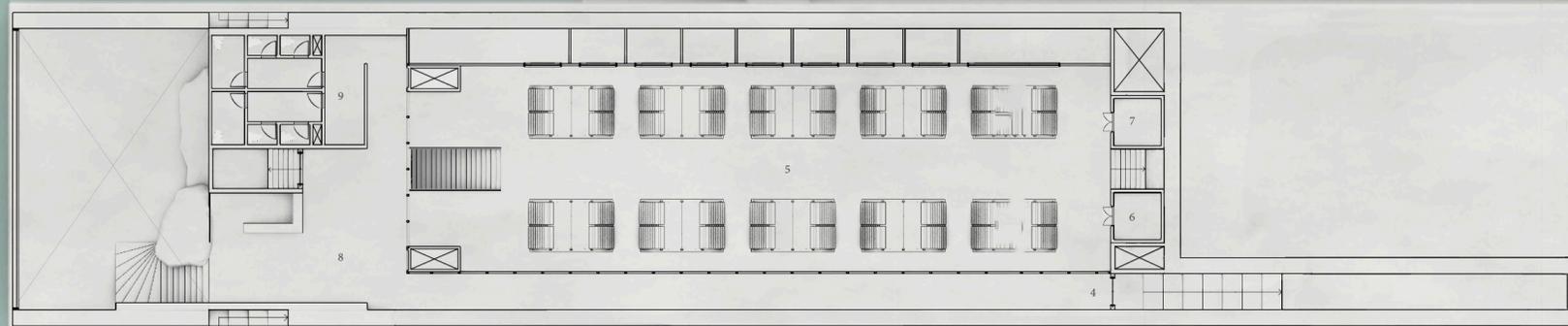
final design

conclusions

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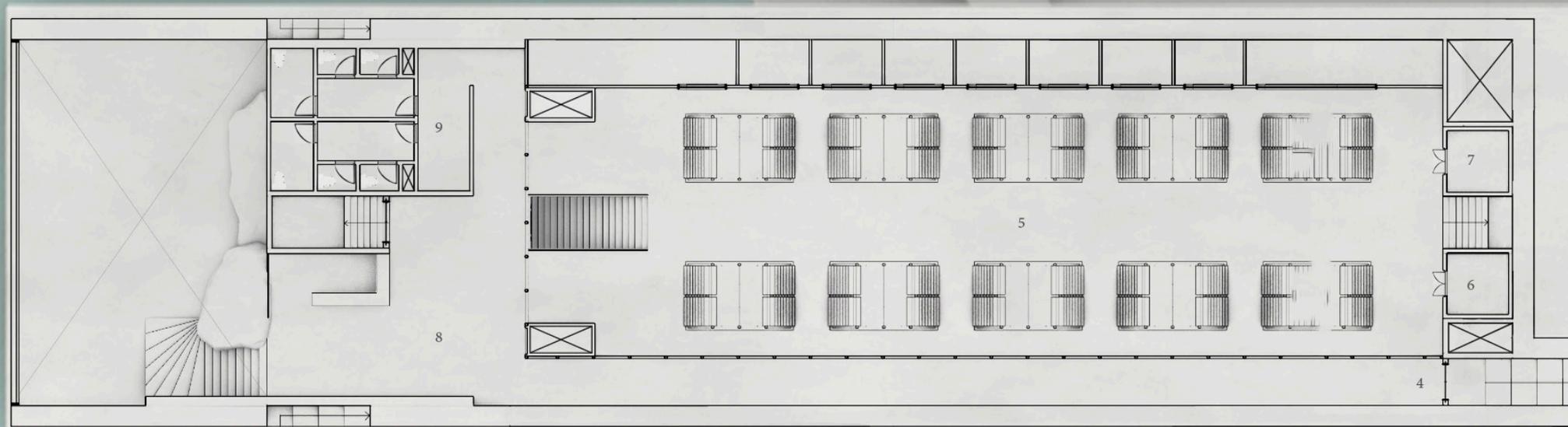


GROUND FLOOR PLAN

1:100



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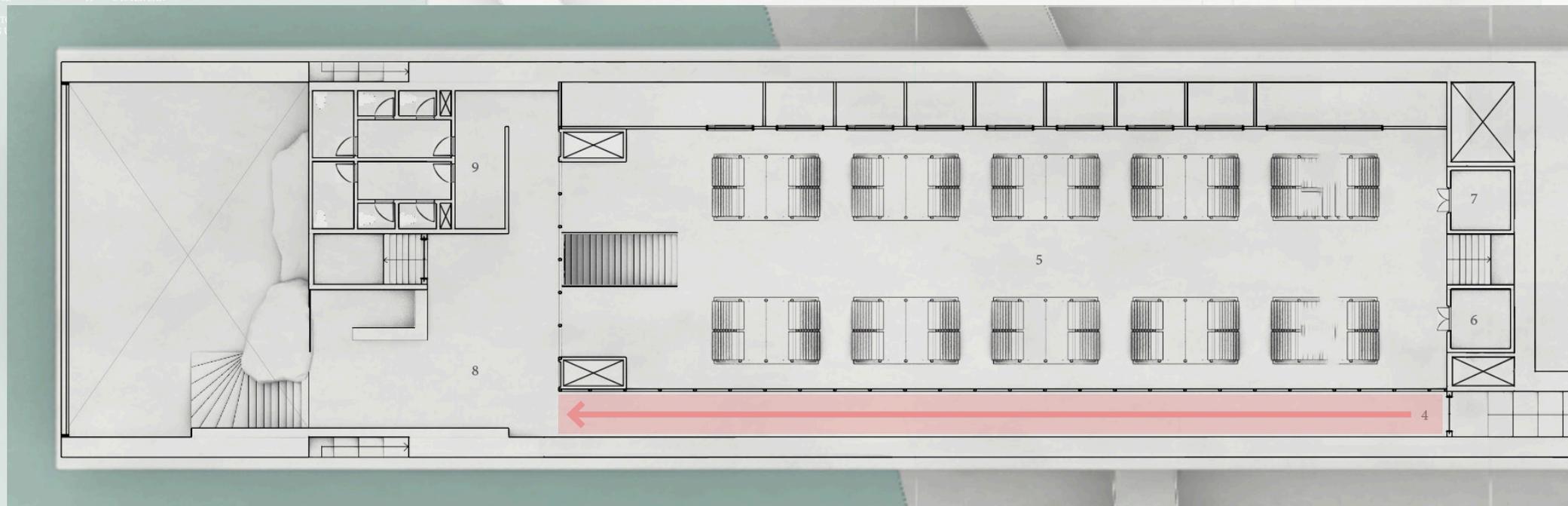


GROUND FLOOR PLAN

1:100

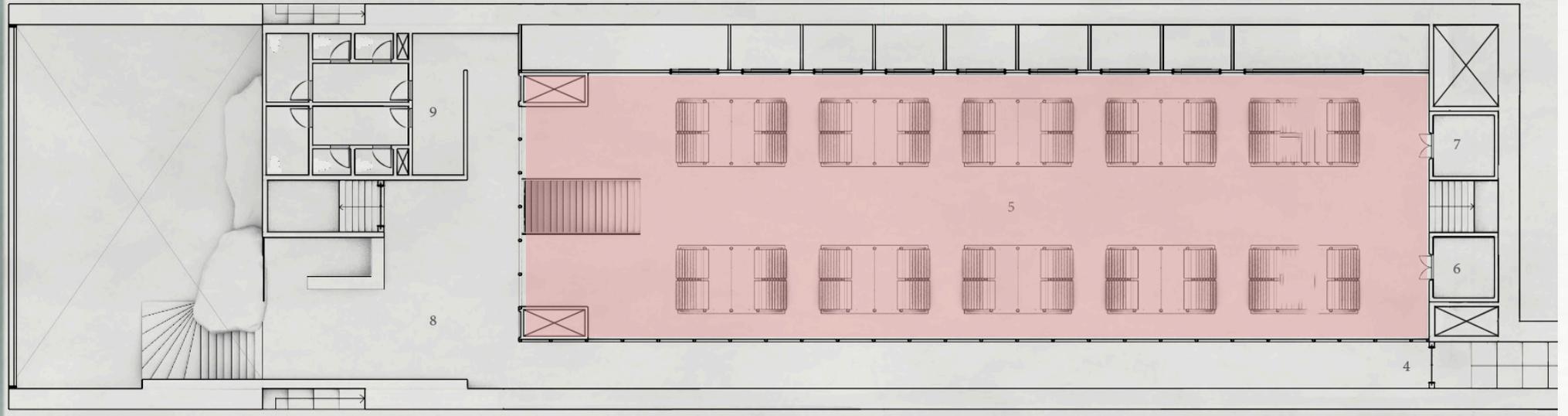


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GROUND FLOOR PLAN  
1:100  

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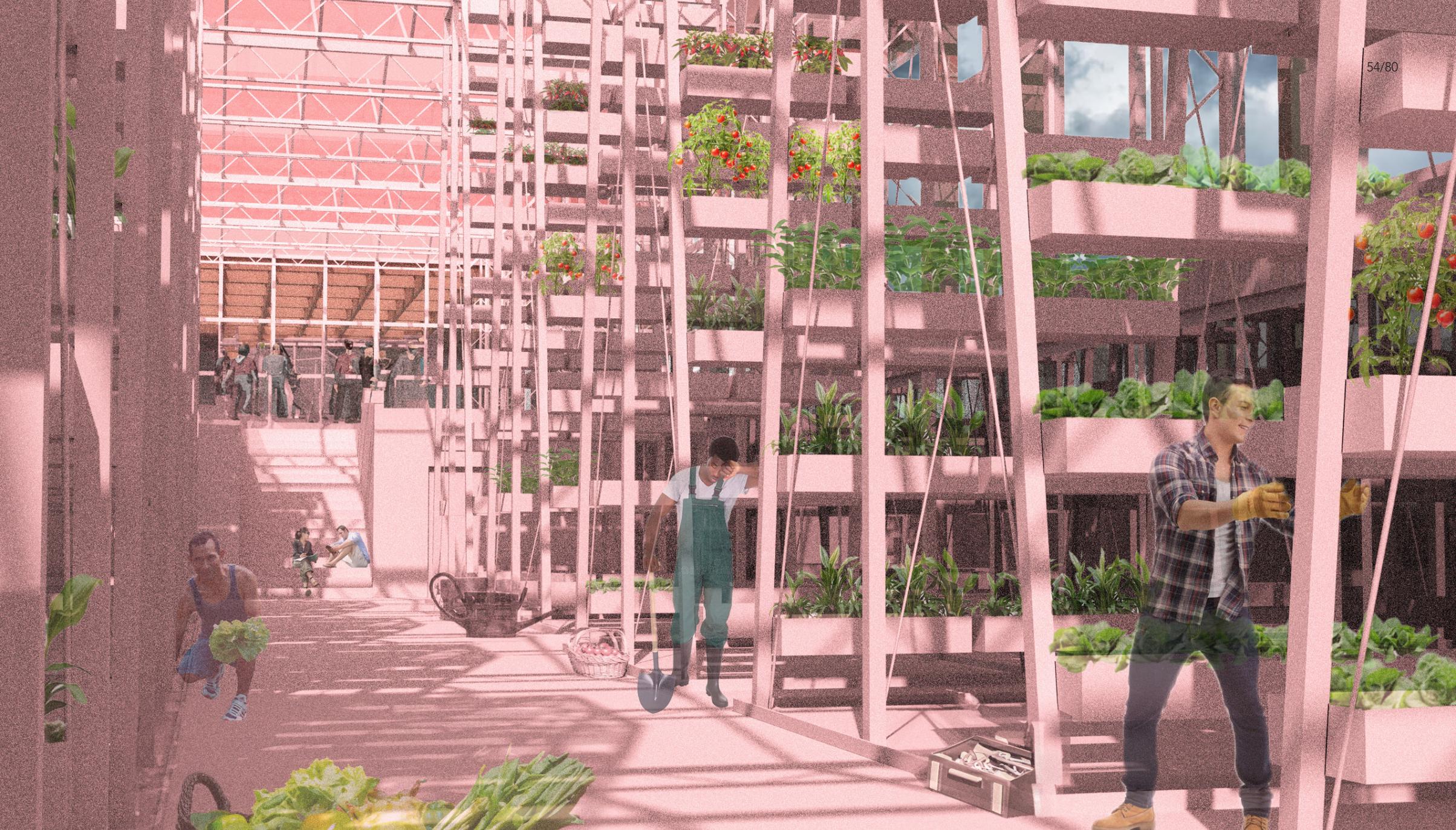
location

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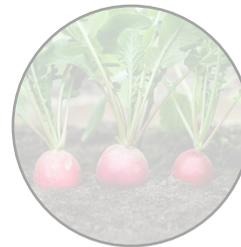
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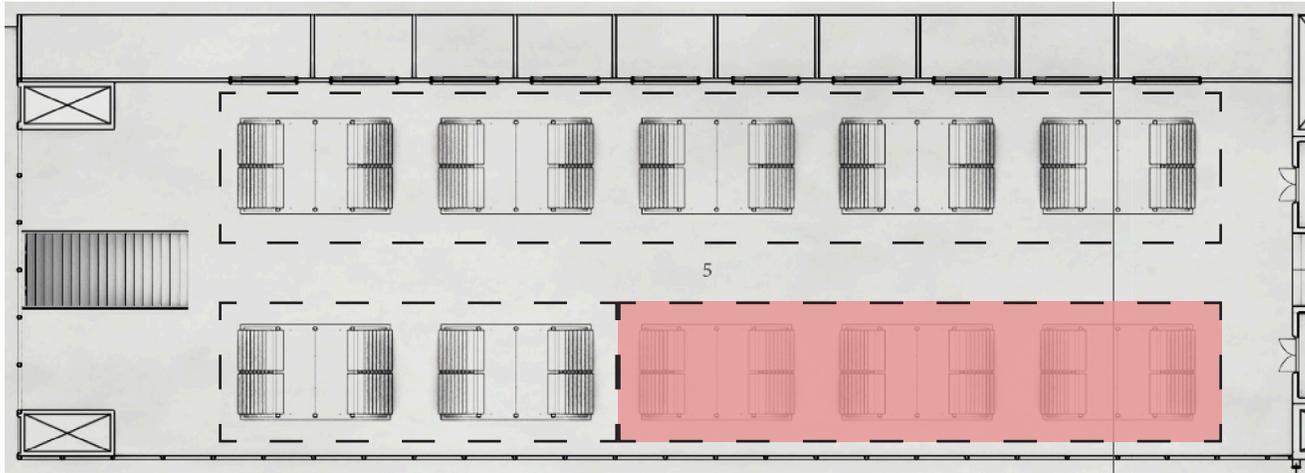
design principles

final design

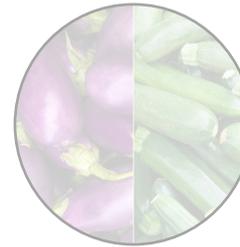
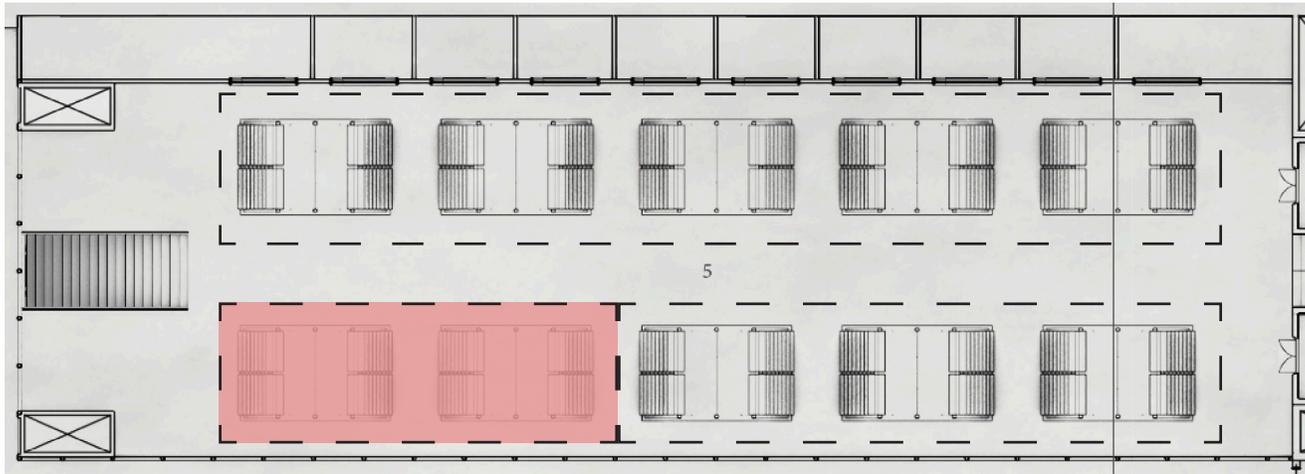
conclusions



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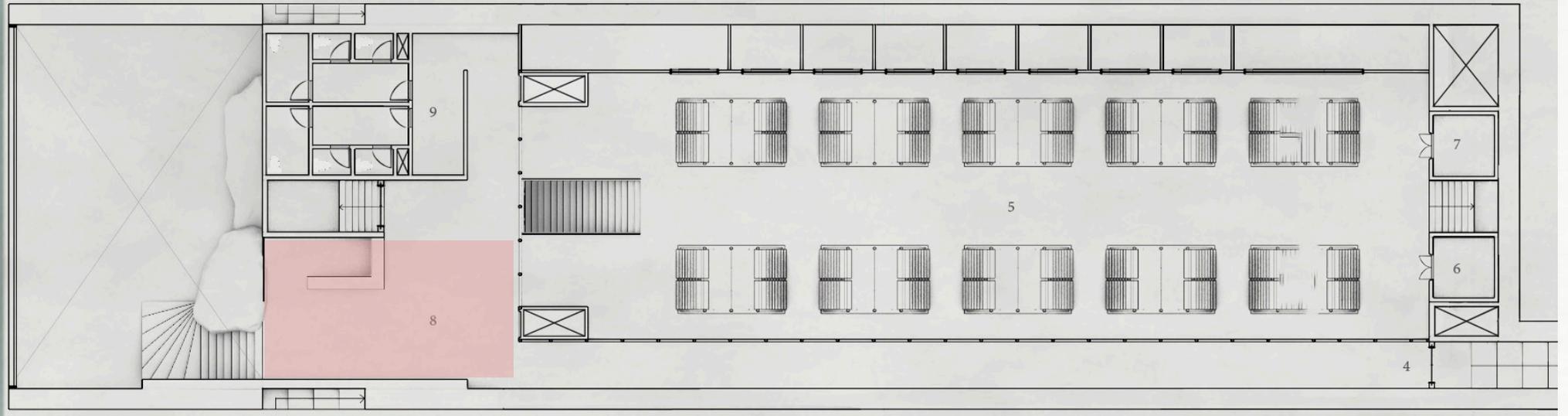


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GROUND FLOOR PLAN  
1:100

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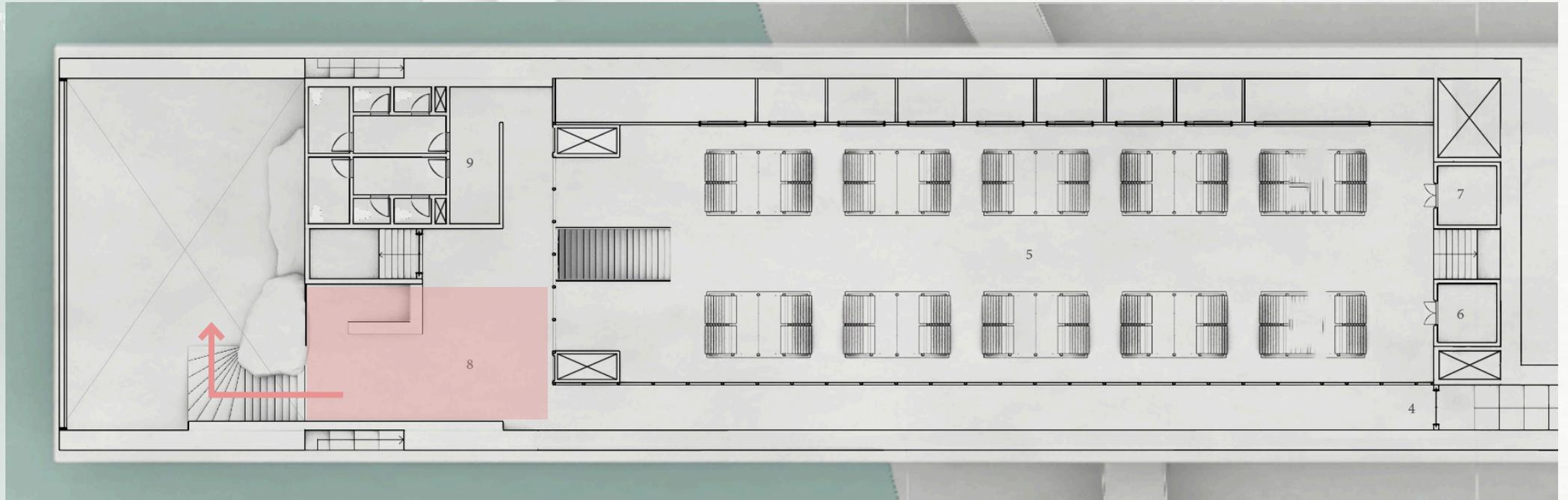
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6	ELECTRICITY STATION				
7	AIR HANDLING UNIT				



GROUND FLOOR PLAN  
1:100

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studio assignment

energy research

location

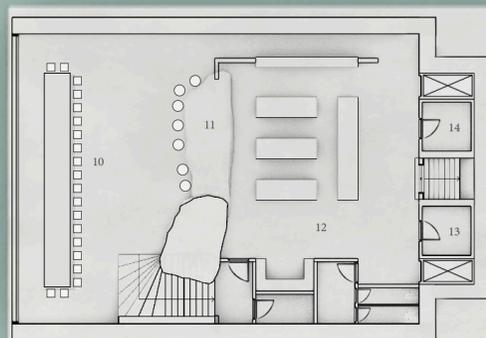
sea level rise

design principles

final design

conclusions

1	ENTRANCE AREA	40 m <sup>2</sup>	8	RECEPTION	78 m <sup>2</sup>
2	MARKET SQUARE	211 m <sup>2</sup>	9	GUEST TOILETS	31 m <sup>2</sup>
3	TERRACE	277 m <sup>2</sup>	10	RESTAURANT	140 m <sup>2</sup>
4	MAIN ENTRANCE		11	OYSTER BAR	
5	GREENHOUSE	370 m <sup>2</sup>	12	KITCHEN	134 m <sup>2</sup>
6	ELECTRICITY STORAGE		13	HEAT PUMP	
7	AIR HANDLING UNIT		14	WATER FILTERING	

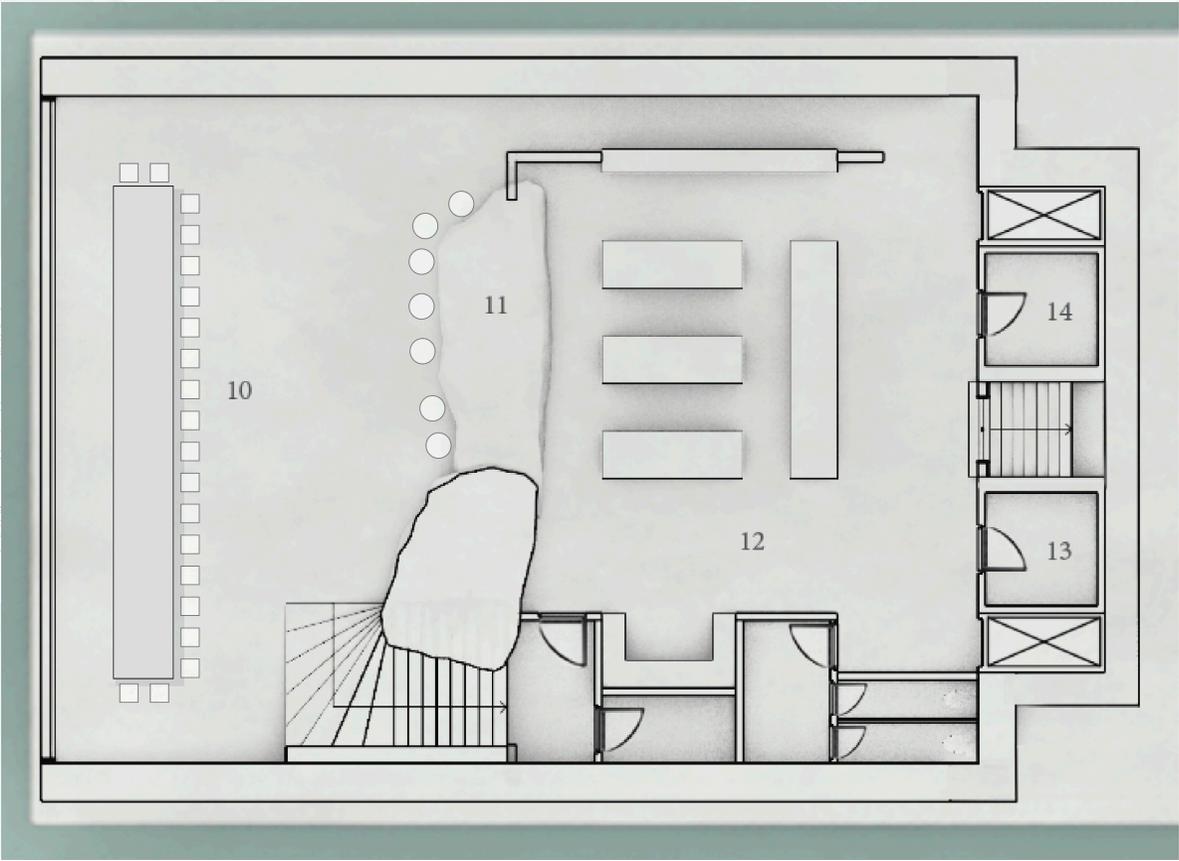
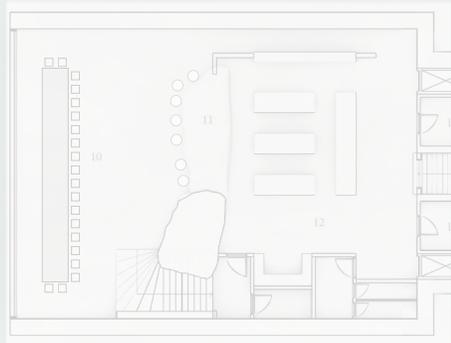


BASEMENT FLOOR PLAN

1:100



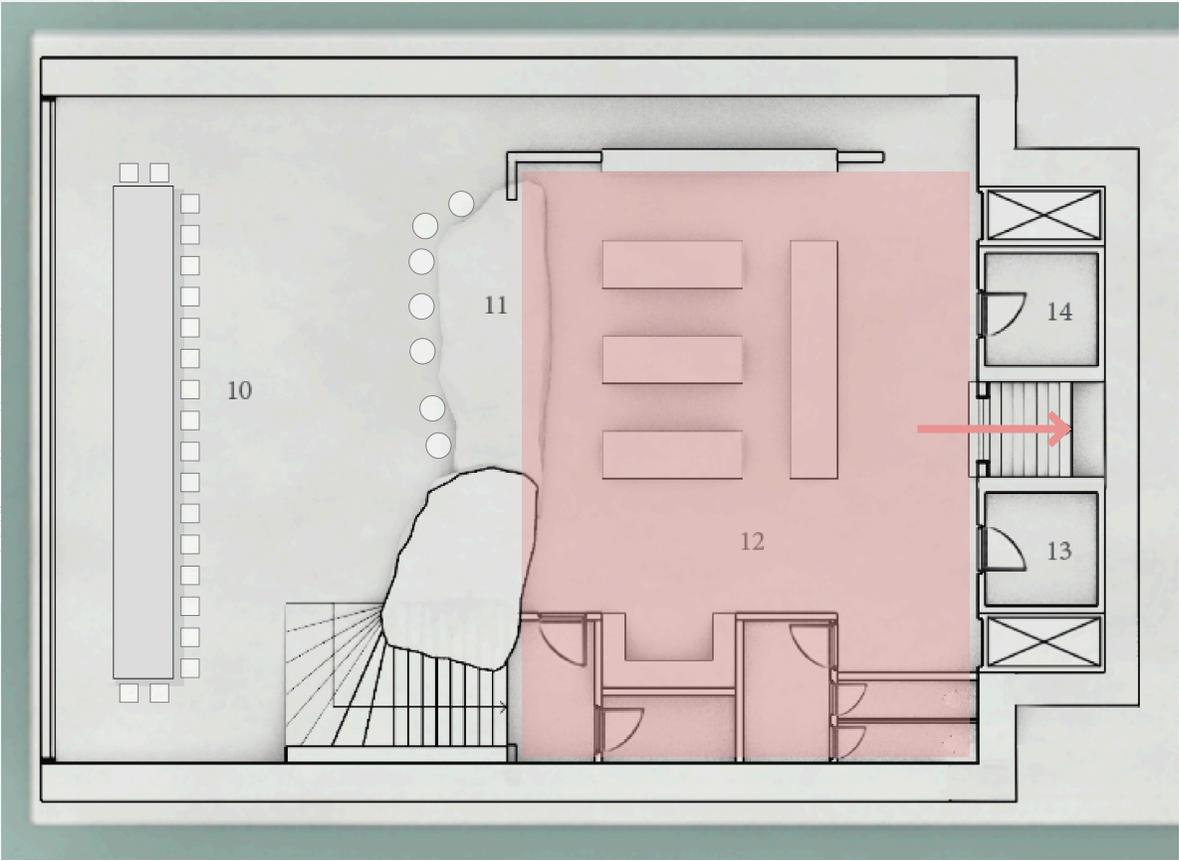
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- 2 MARKET SQUARE
- 3 TERRACE
- 4 MAIN ENTRANCE
- 5 GREENHOUSE
- 6 ELECTRICITY STORAGE
- 7 AIR HANDLING UNIT
- 8 RECEPTION
- 9 GUEST TOILETS
- 10 RESTAURANT
- 11 OYSTER BAR
- 12 KITCHEN
- 13 HEAT PUMP
- 14 WATER FILTERING



BASEMENT FLOOR PLAN  
1:100



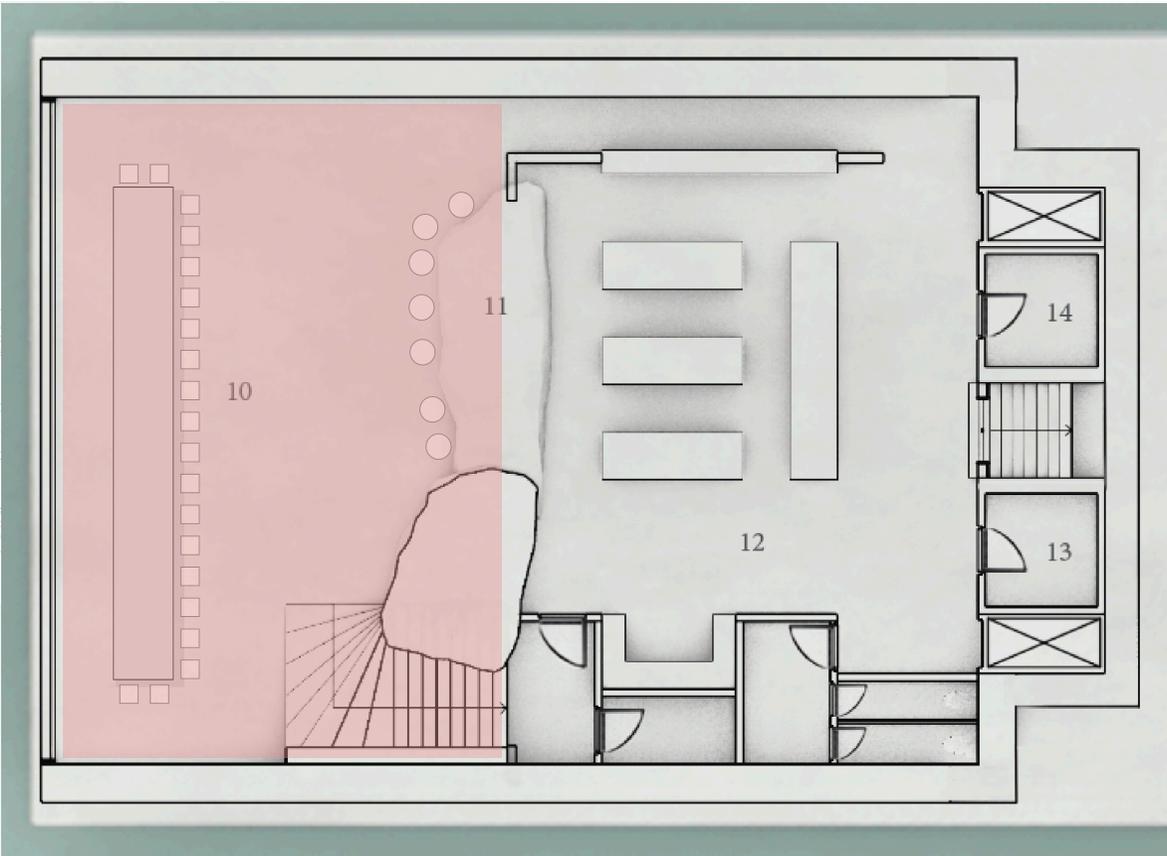
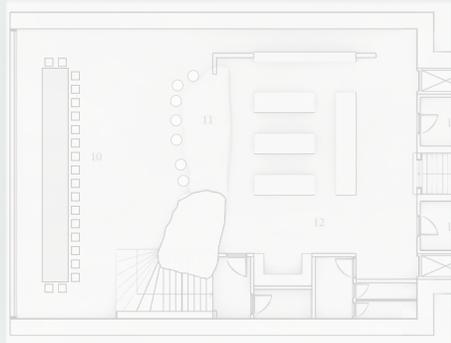
- 1 ENTRANCE AREA
- 2 MARKET SQUARE
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- 4 MAIN ENTRANCE
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- 10 RESTAURANT
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- 12 KITCHEN
- 13 HEAT PUMP
- 14 WATER FILTERING



BASEMENT FLOOR PLAN  
1:100

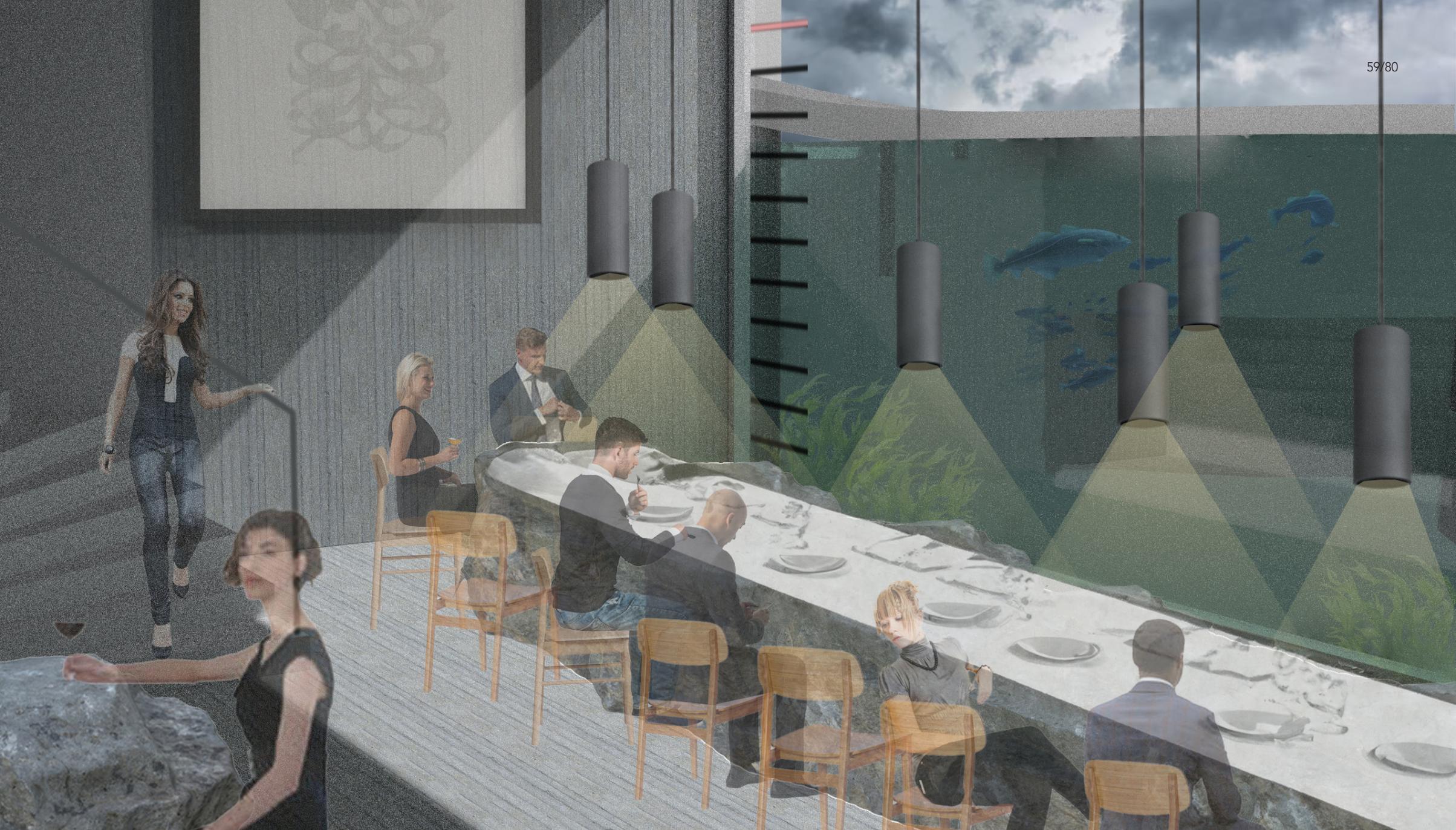


- |   |                     |    |                 |
|---|---------------------|----|-----------------|
| 1 | ENTRANCE AREA       | 8  | RECEPTION       |
| 2 | MARKET SQUARE       | 9  | GUEST TOILETS   |
| 3 | TERRACE             | 10 | RESTAURANT      |
| 4 | MAIN ENTRANCE       | 11 | OYSTER BAR      |
| 5 | GREENHOUSE          | 12 | KITCHEN         |
| 6 | ELECTRICITY STORAGE | 13 | HEAT PUMP       |
| 7 | AIR HANDLING UNIT   | 14 | WATER FILTERING |

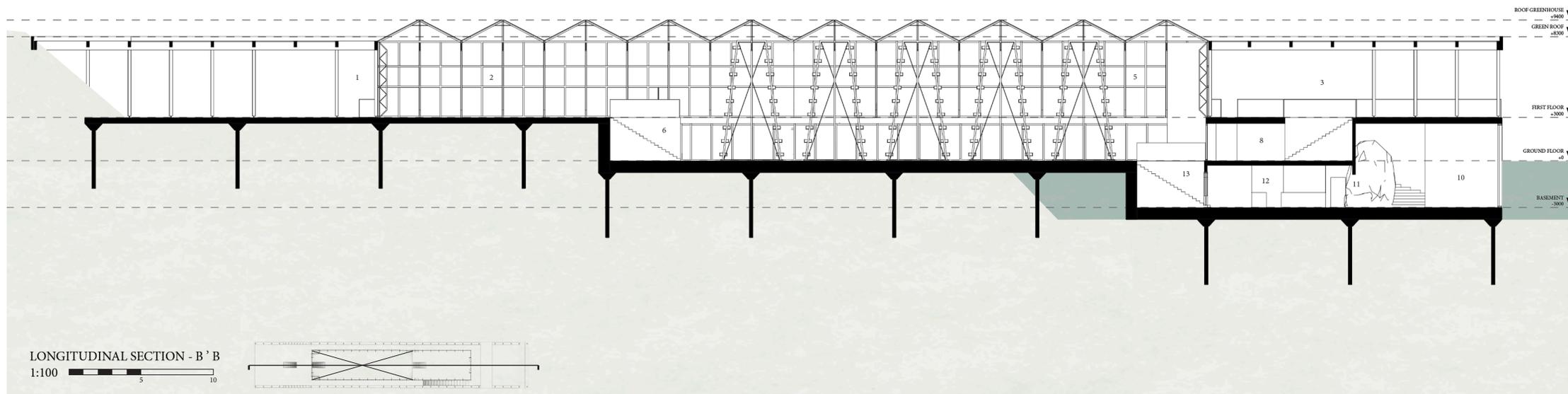


BASEMENT FLOOR PLAN  
1:100





- |   |                     |    |                 |
|---|---------------------|----|-----------------|
| 1 | ENTRANCE AREA       | 8  | RECEPTION       |
| 2 | MARKET SQUARE       | 9  | GUEST TOILETS   |
| 3 | TERRACE             | 10 | RESTAURANT      |
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energy research

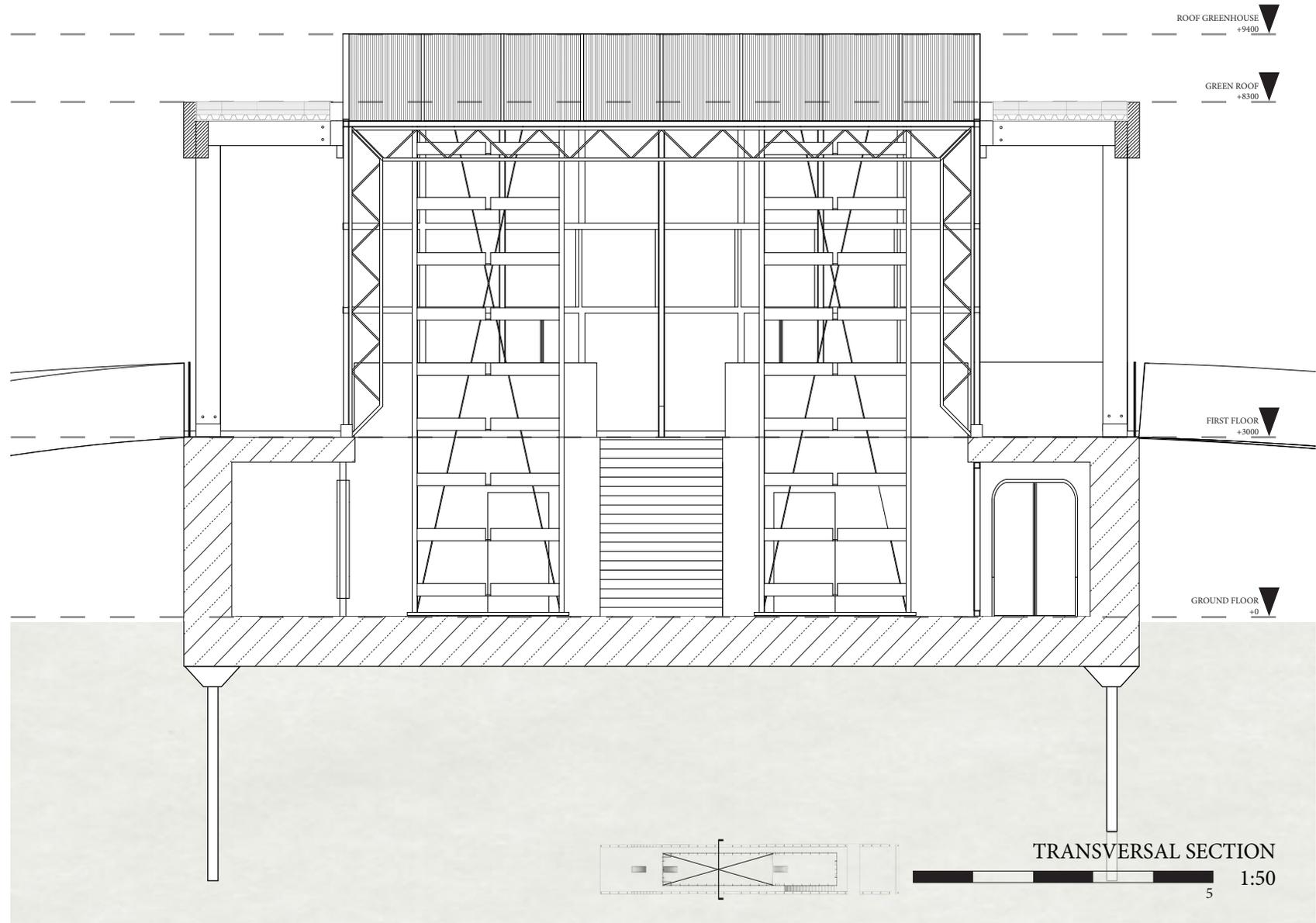
location

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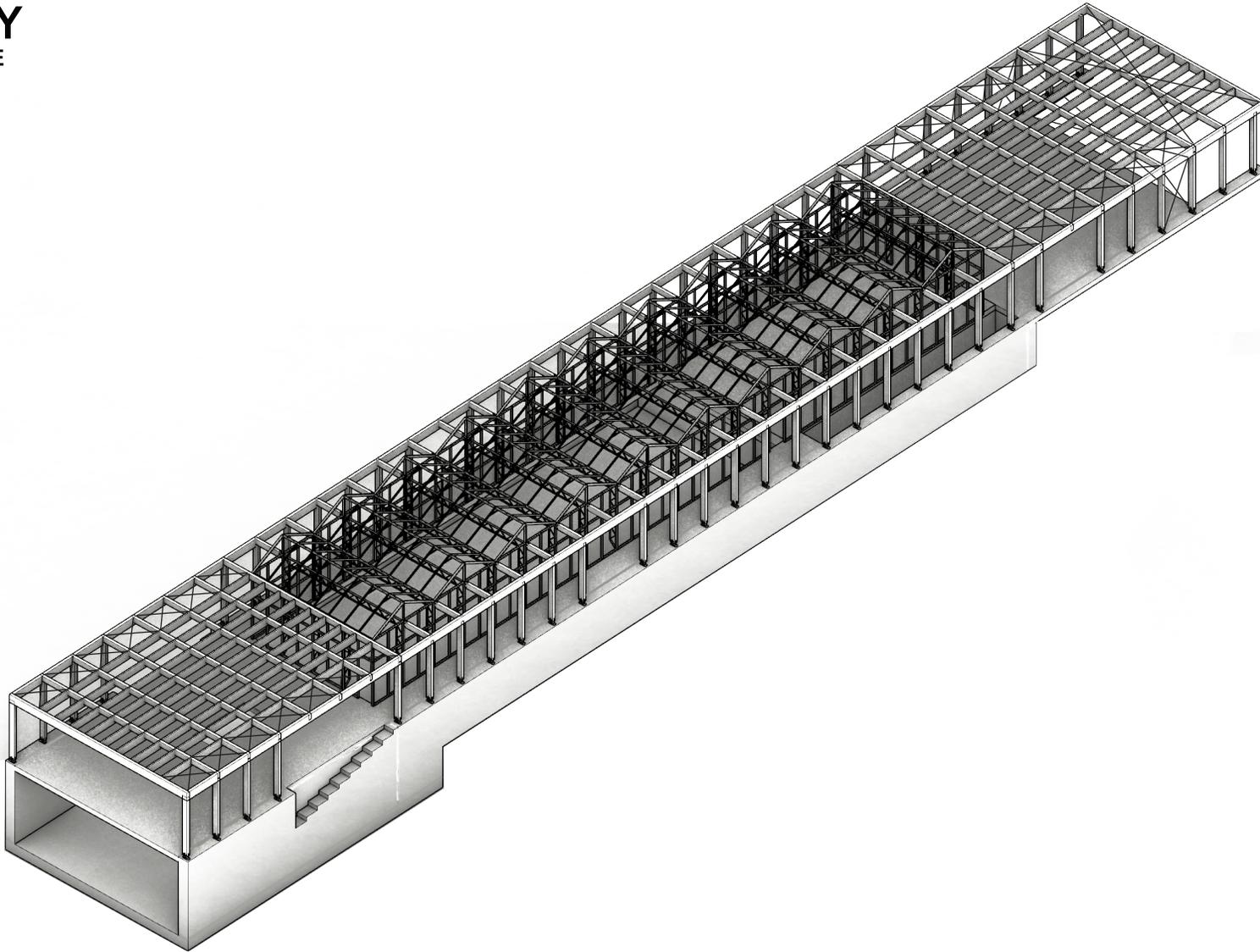
conclusions



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# AXONOMETRY

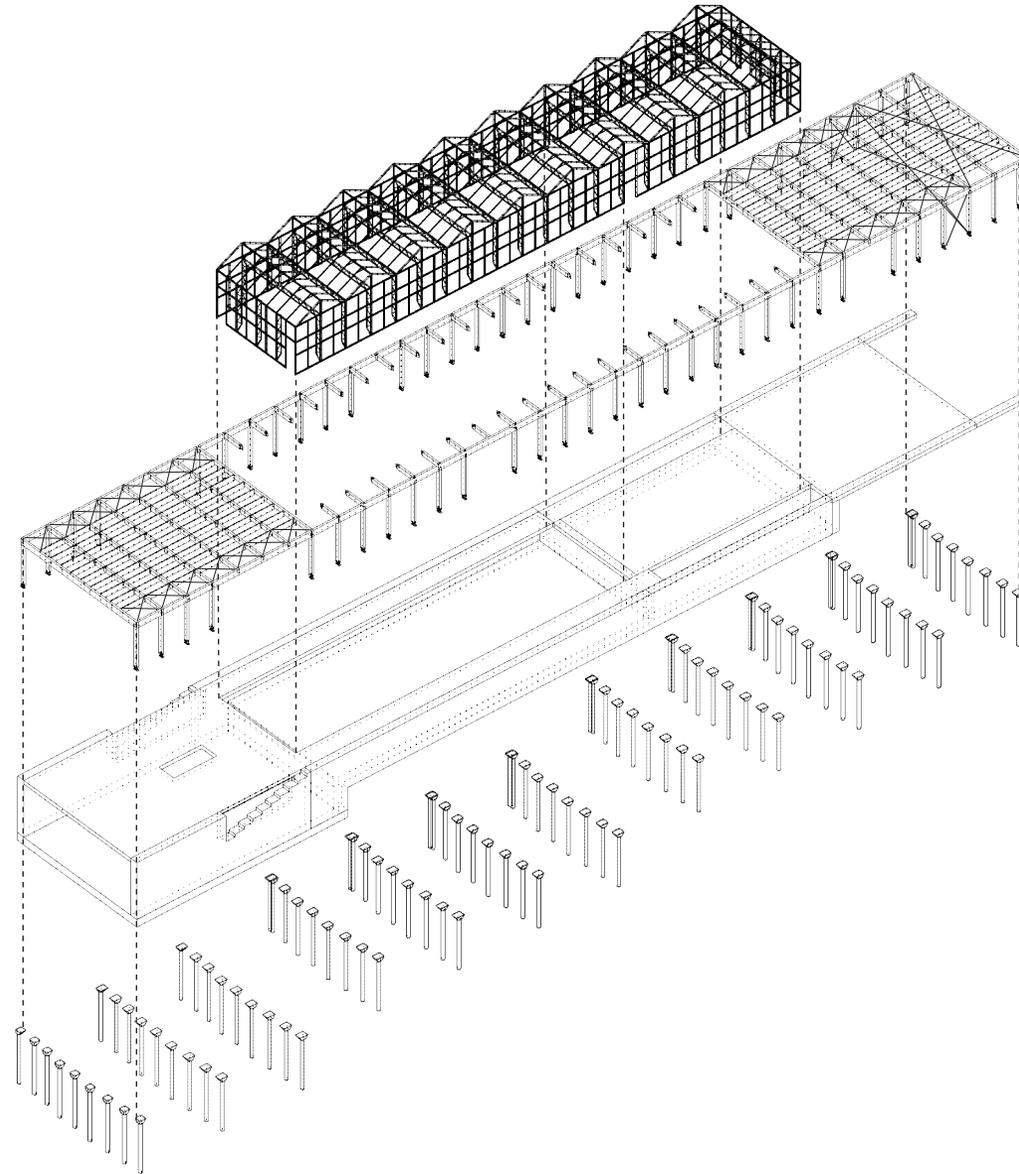
LOAD-BEARING STRUCTURE



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# AXONOMETRY

LOAD-BEARING STRUCTURE



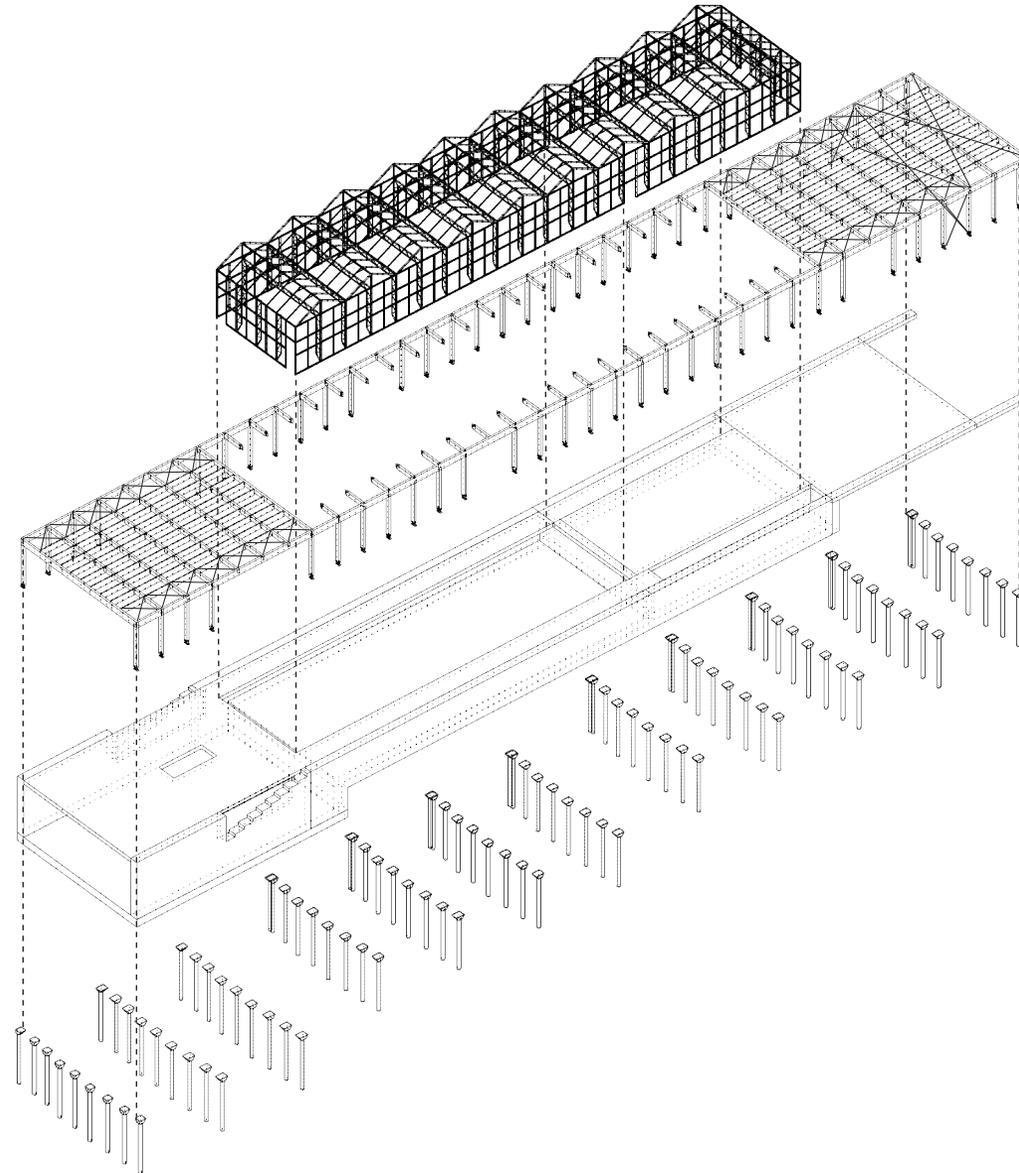
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# AXONOMETRY

## LOAD-BEARING STRUCTURE

### 1 CONCRETE BASE

1

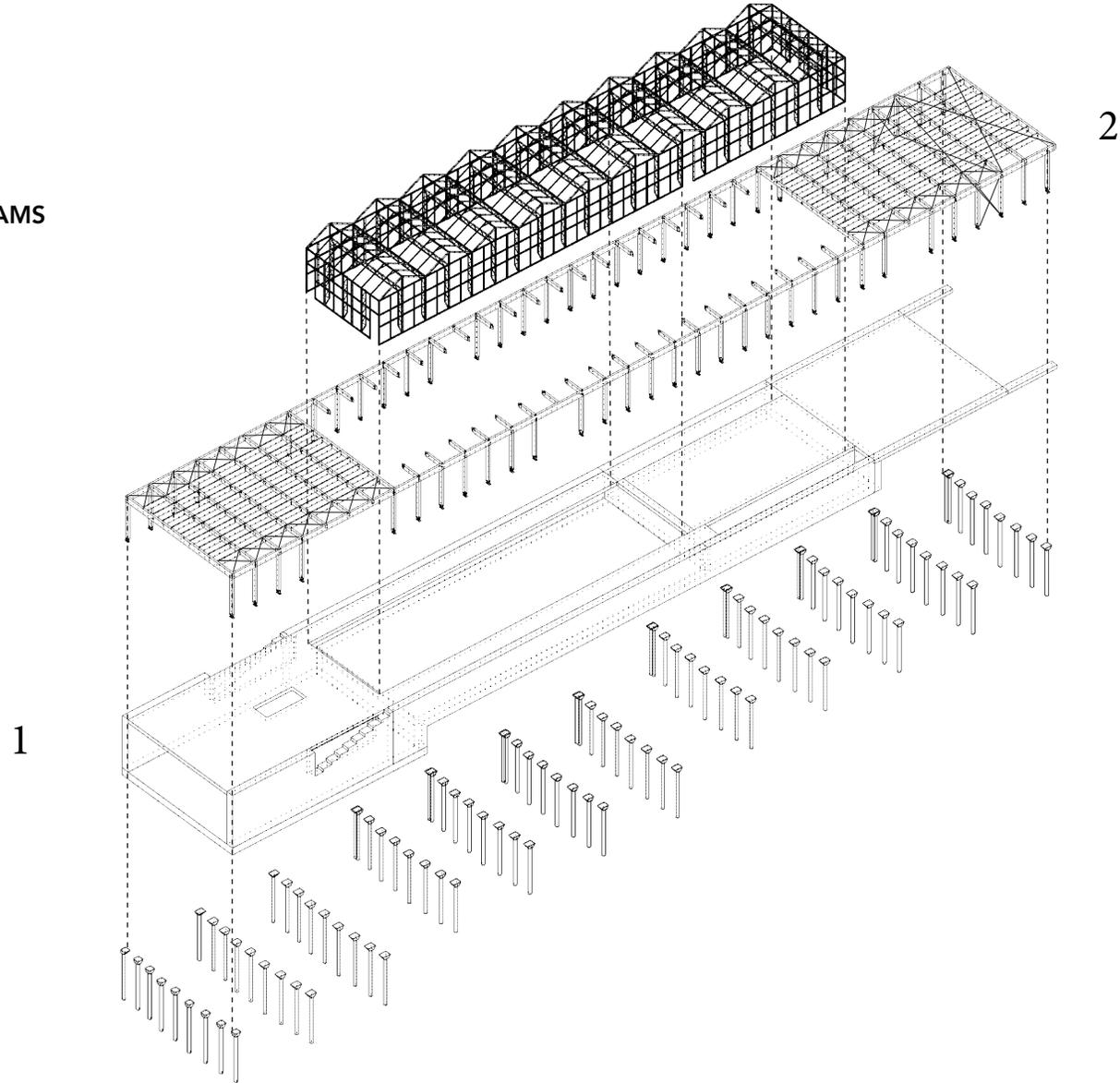


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# AXONOMETRY

LOAD-BEARING STRUCTURE

- 1 CONCRETE BASE
- 2 WOODEN COLUMNS AND BEAMS

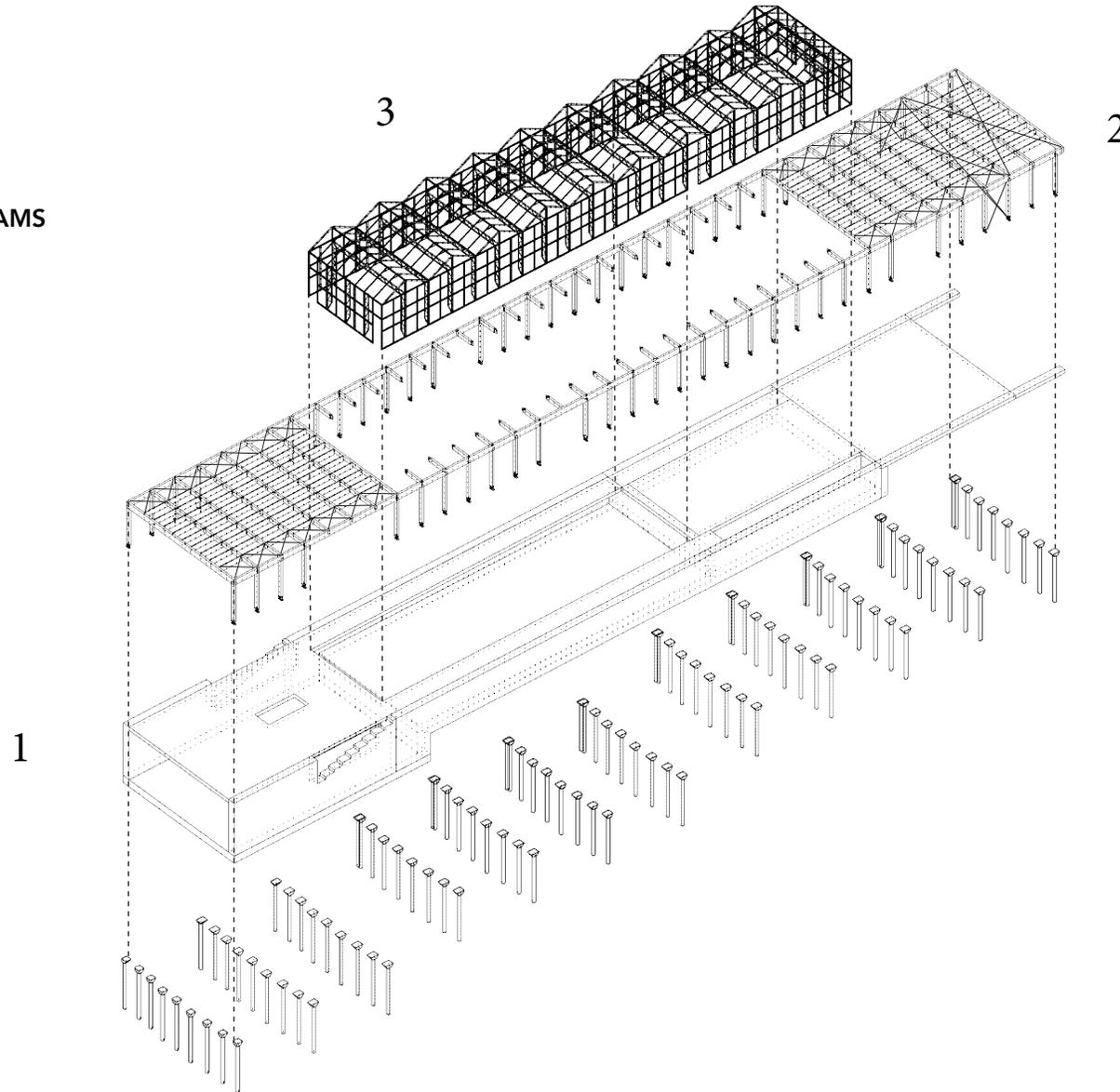


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# AXONOMETRY

LOAD-BEARING STRUCTURE

- 1 CONCRETE BASE
- 2 WOODEN COLUMNS AND BEAMS
- 3 STEEL FRAME GREENHOUSE

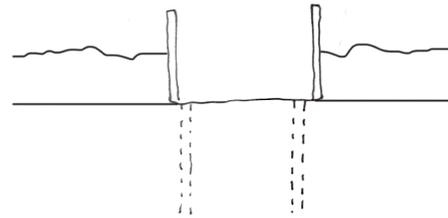


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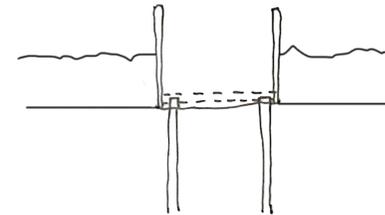
1. INSTALL SHEET PILE WALLS



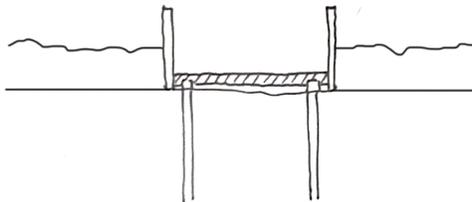
2. PLACE FOUNDATION PILES



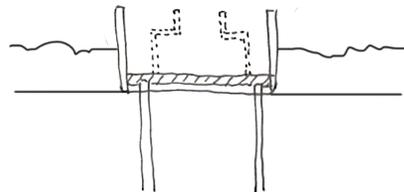
3. PLACE FORMWORK



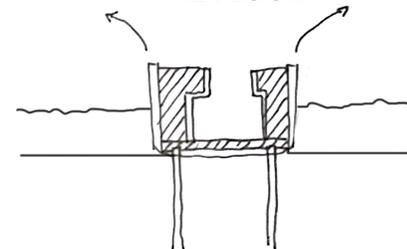
4. POUR CONCRETE BEAMS AND FLOOR



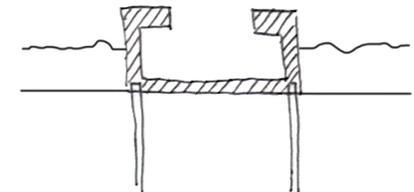
5. INSTALL FORMWORK FOR WALLS

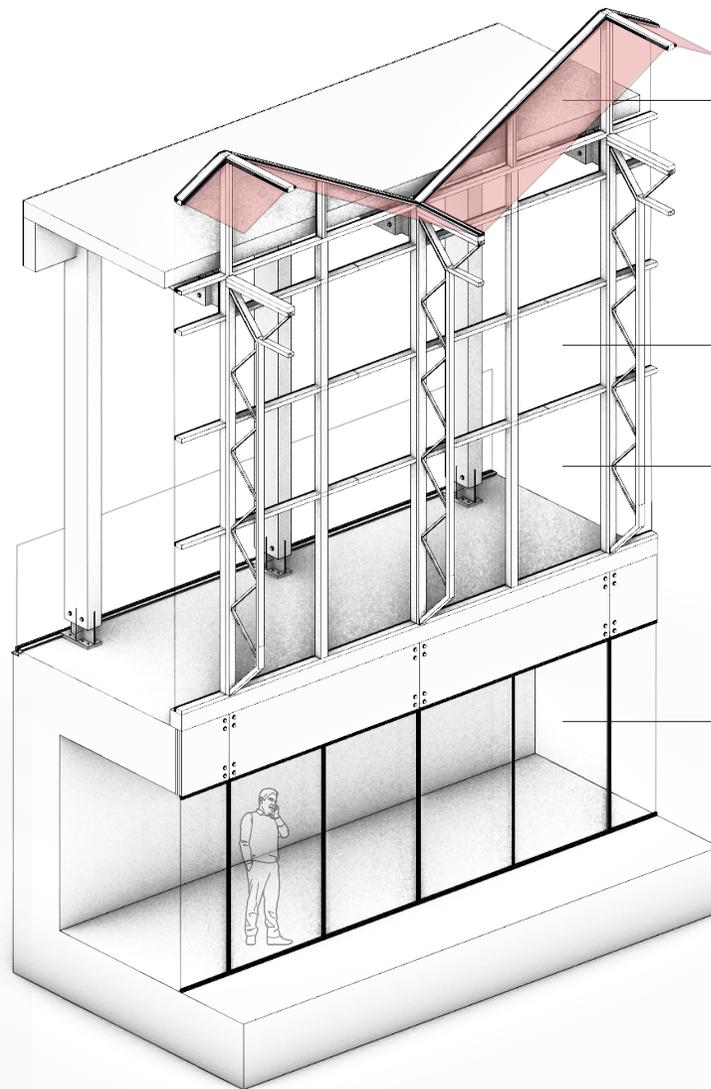
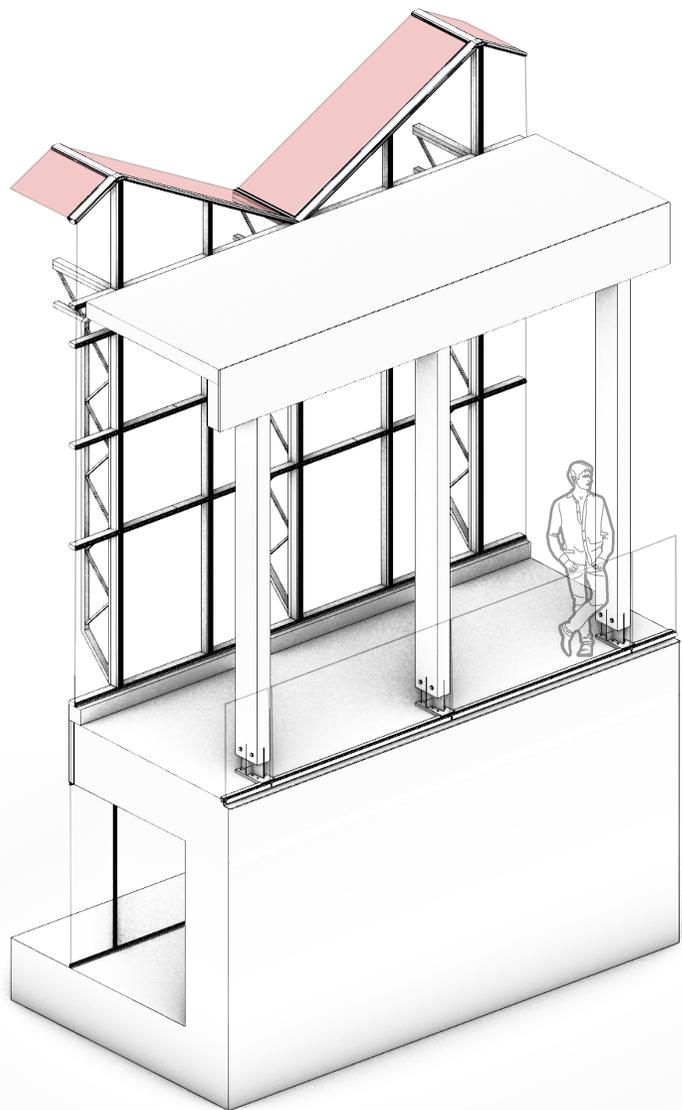


6. POUR CONCRETE ON STARTER BARS TO CONNECT WALLS TO THE FLOOR



7. REMOVE FORMWORK AND SHEET PILE WALLS





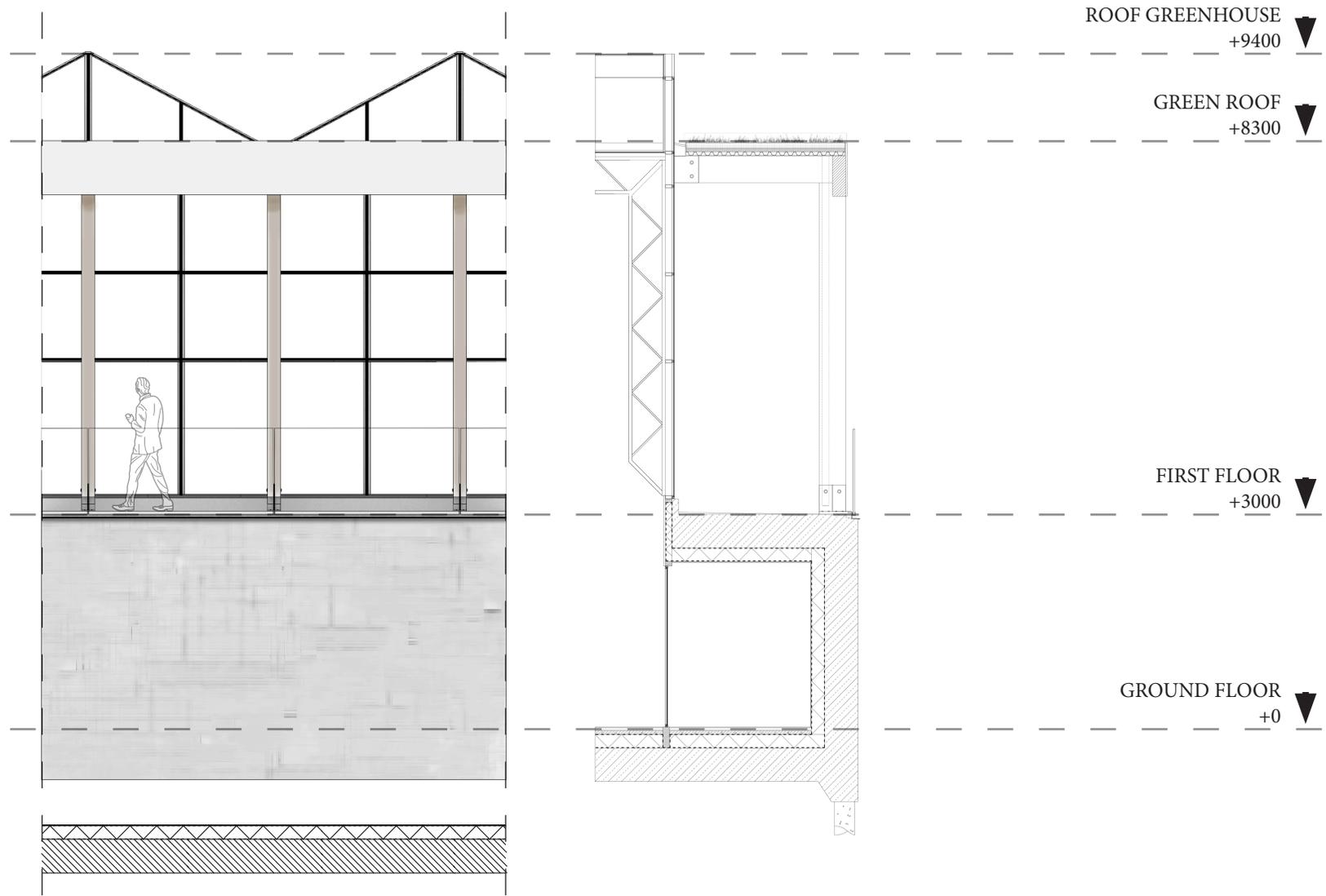
Red-tinted AuREUS solar windows

Diffused single glass with an anti-reflective (AR) coating

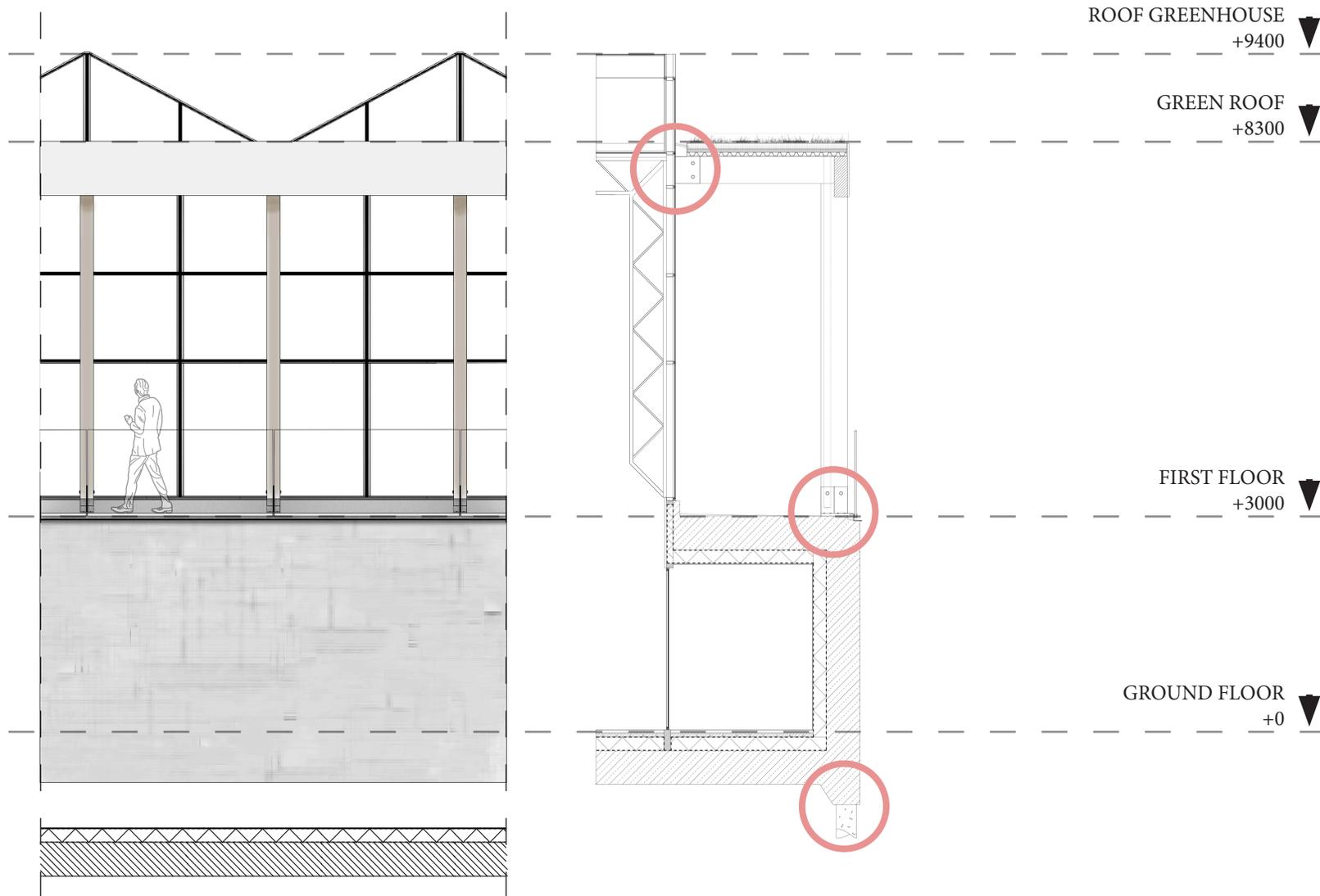
Single glass with an anti-reflective (AR) coating

Double glass

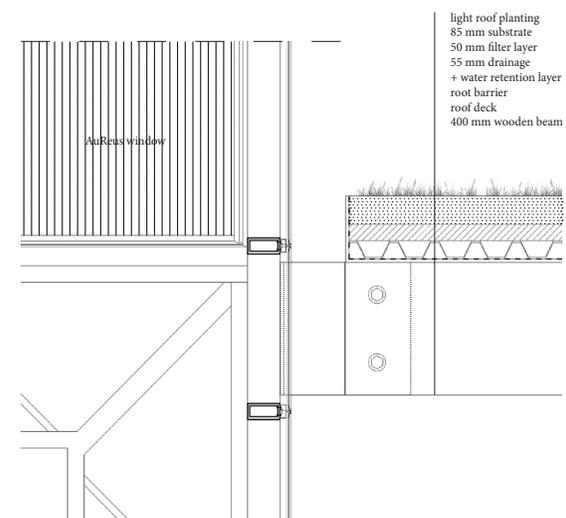
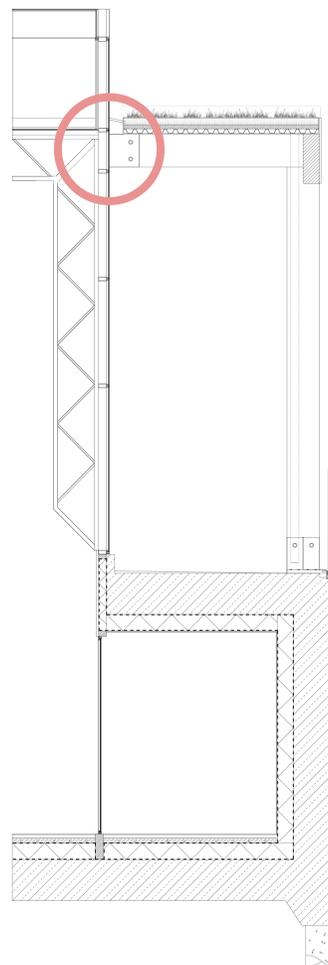
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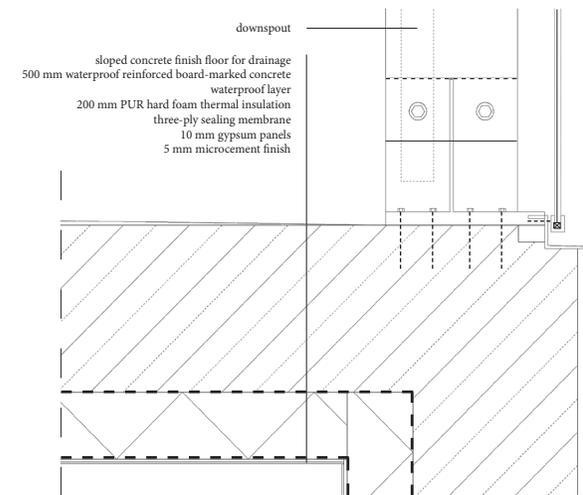
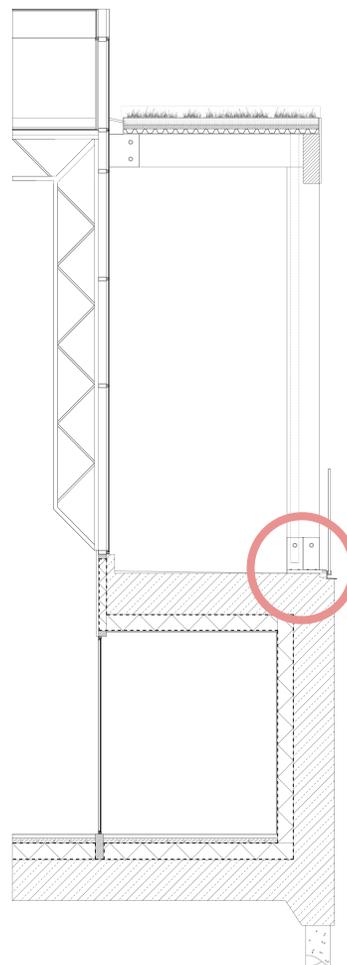
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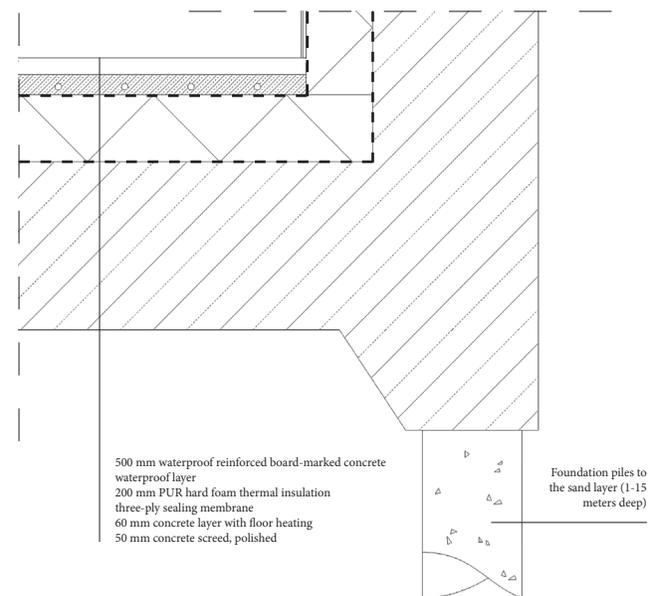
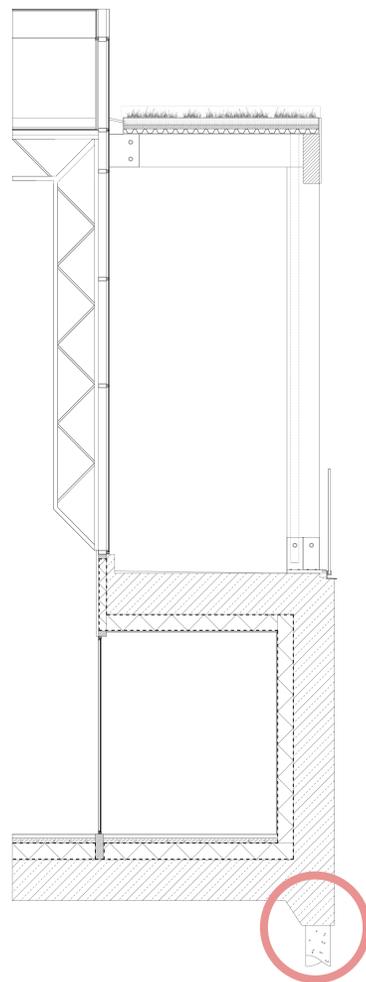
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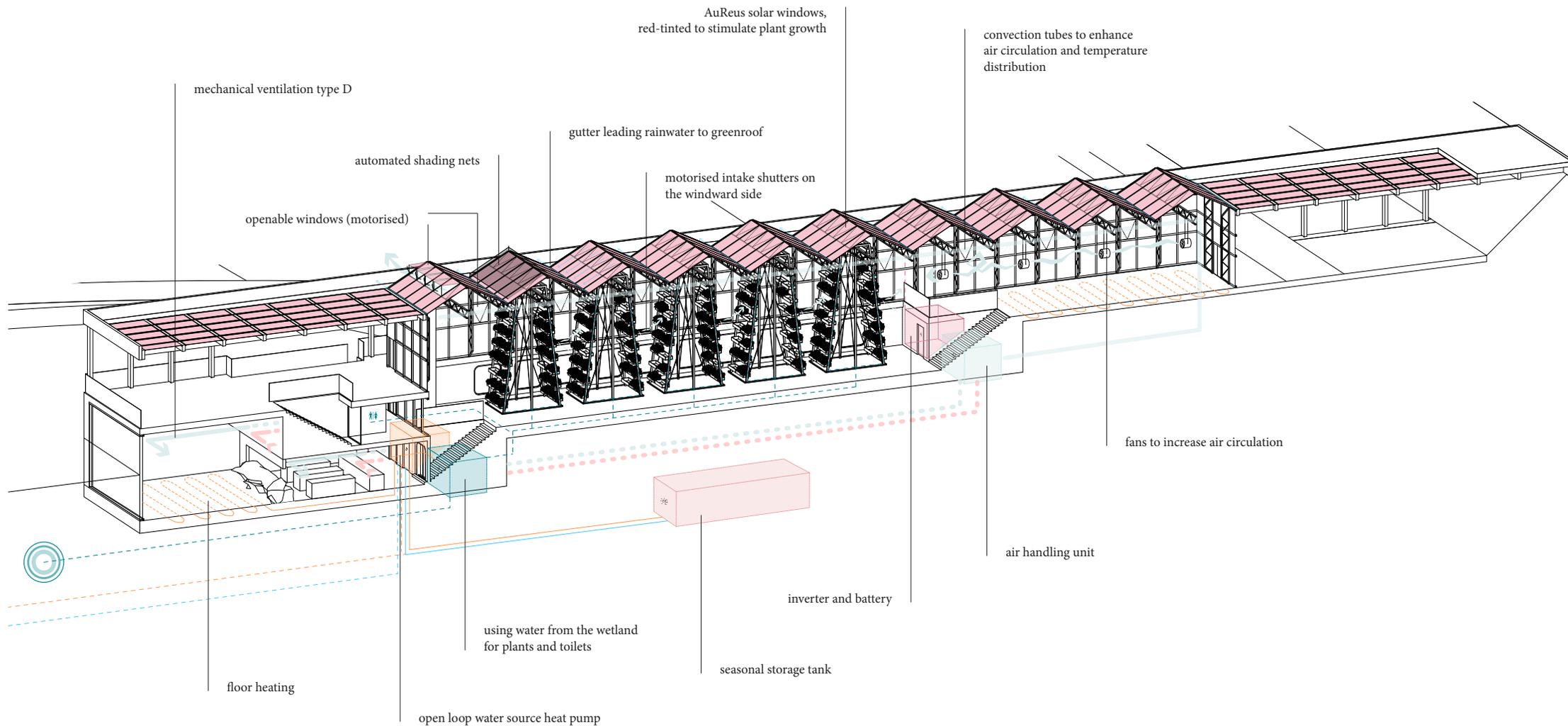
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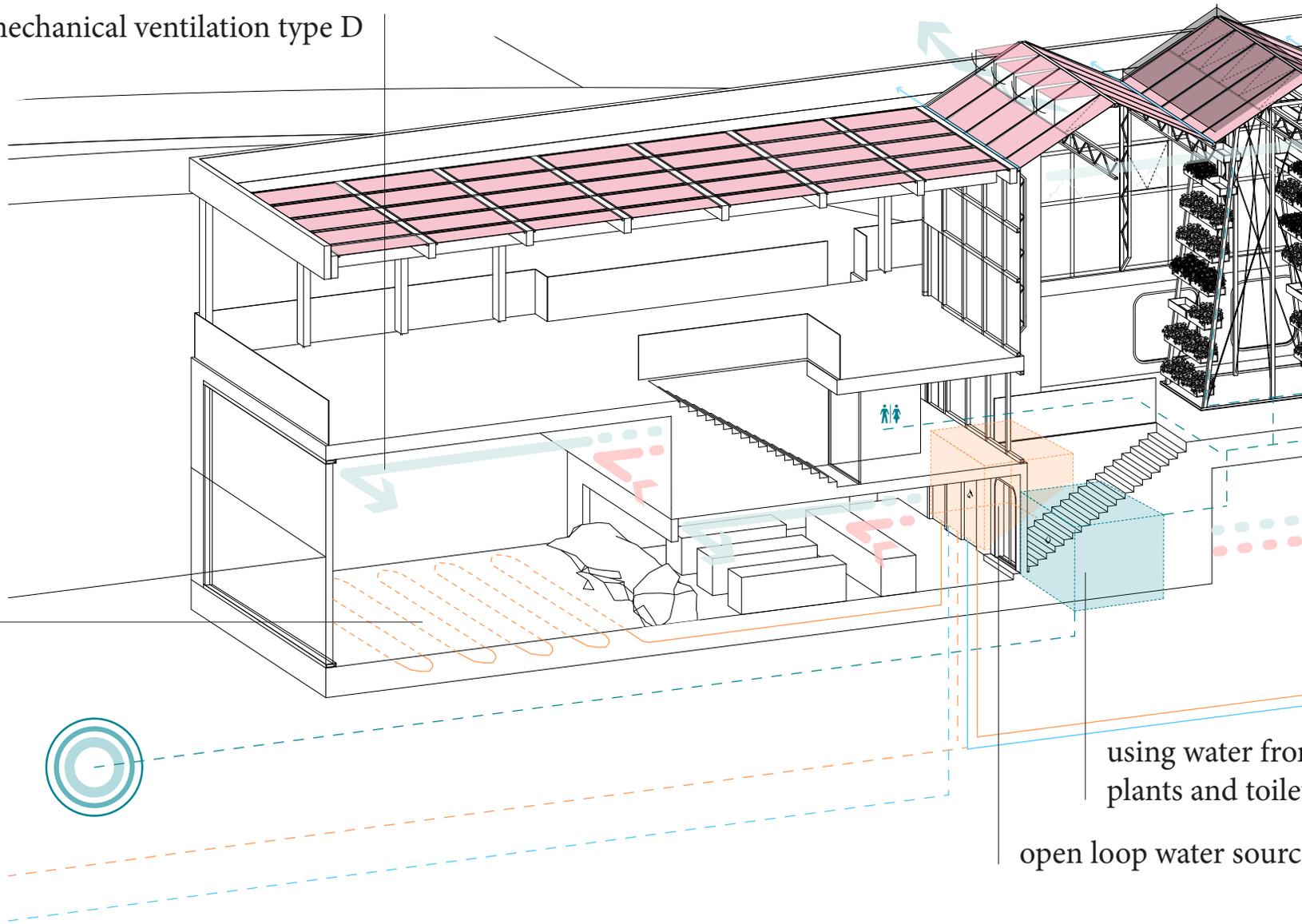
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mechanical ventilation type D

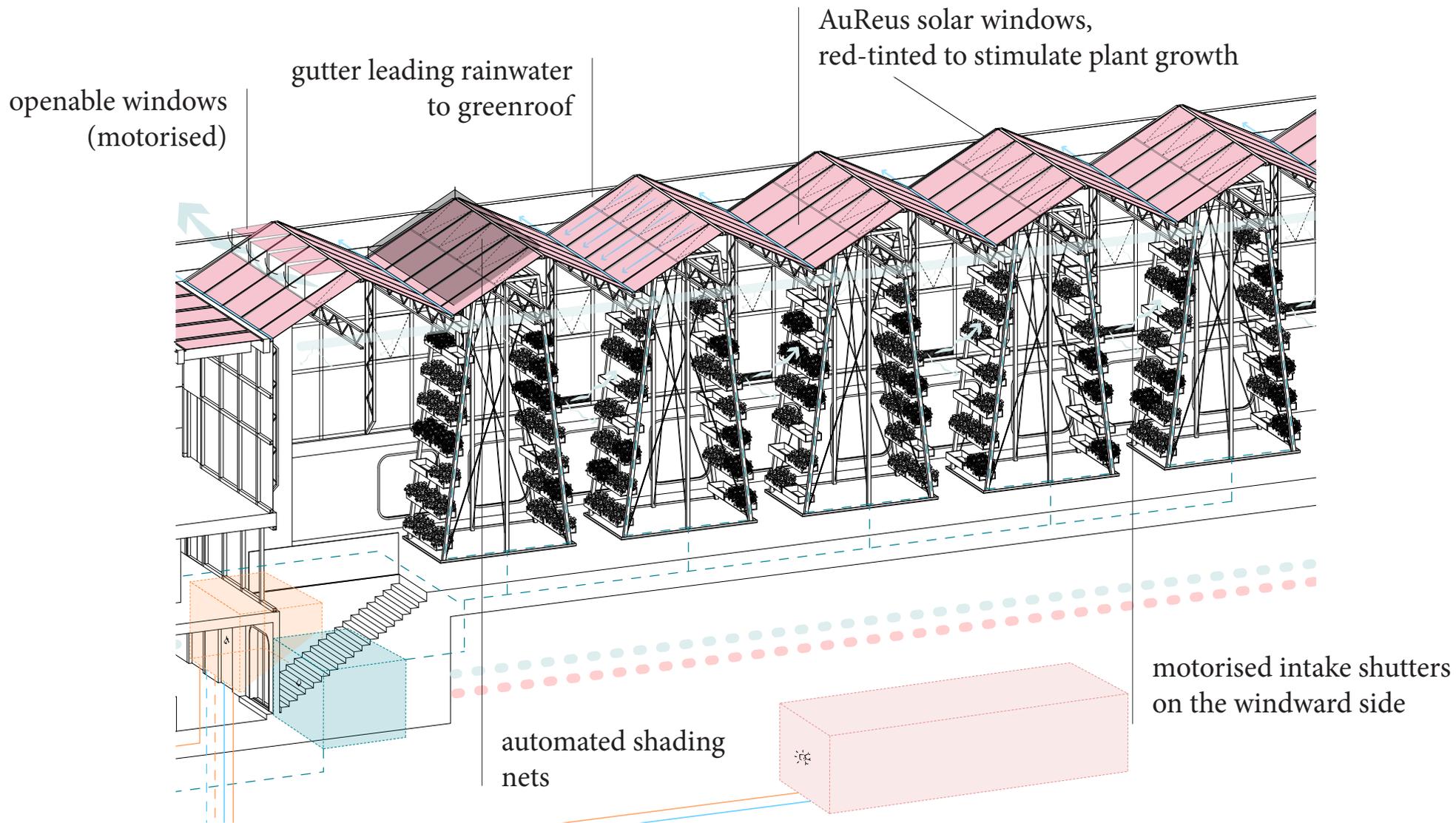
floor heating

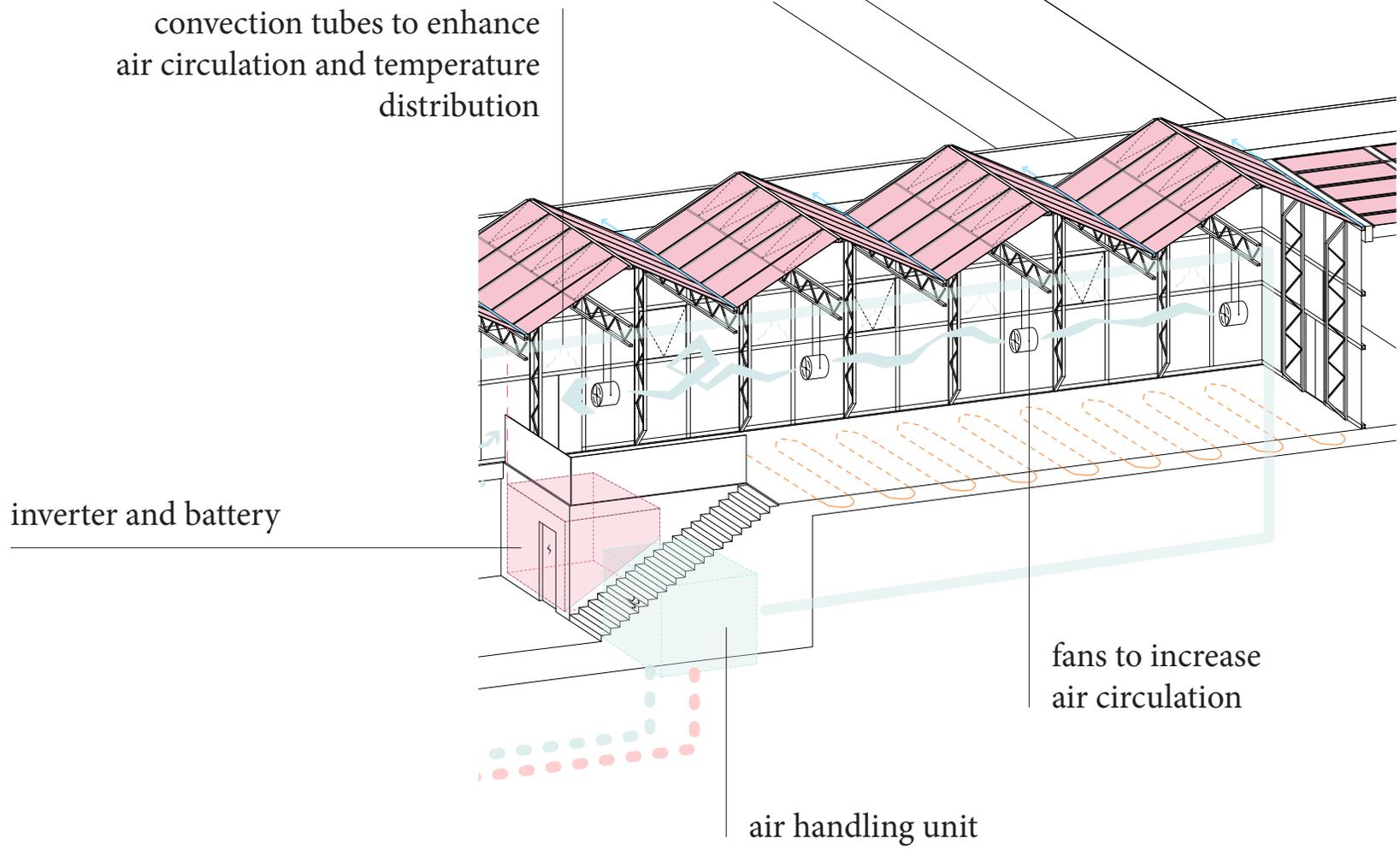


using water from the wetland for plants and toilets

open loop water source heat pump

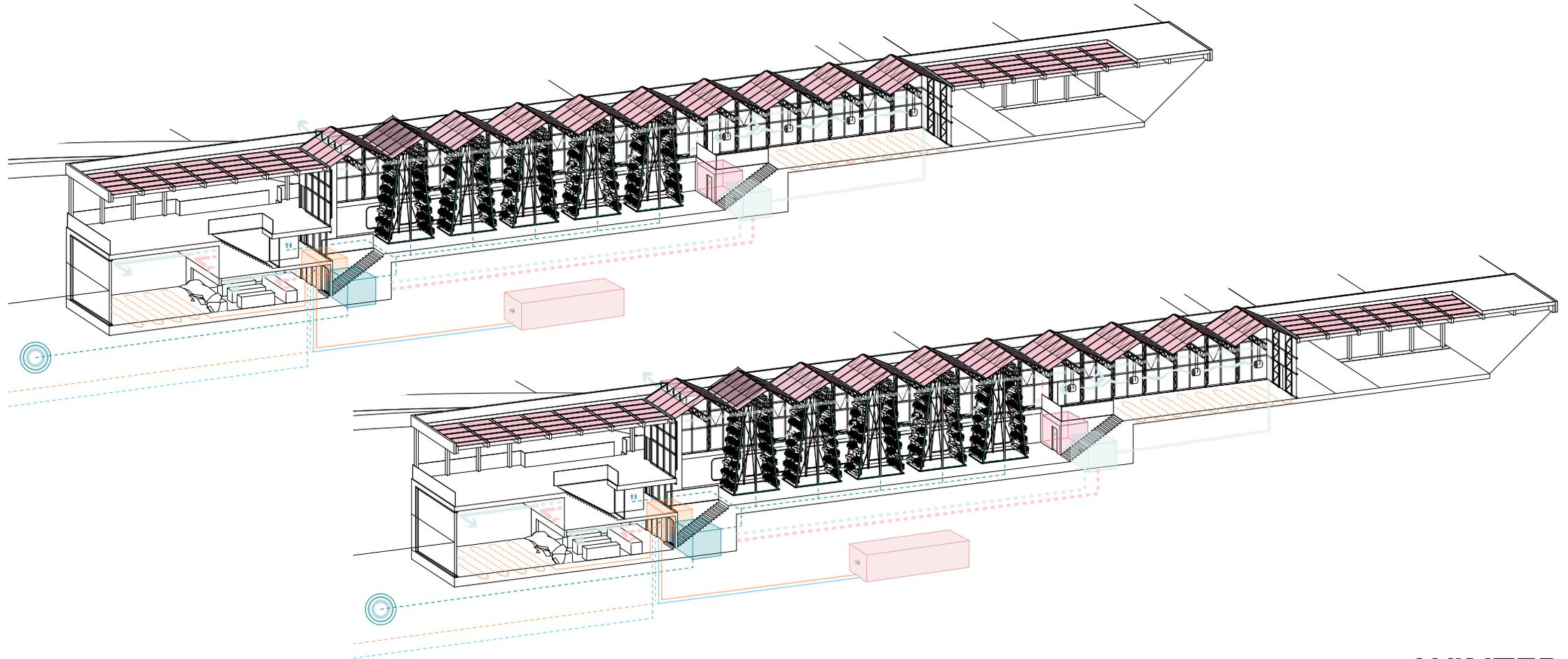
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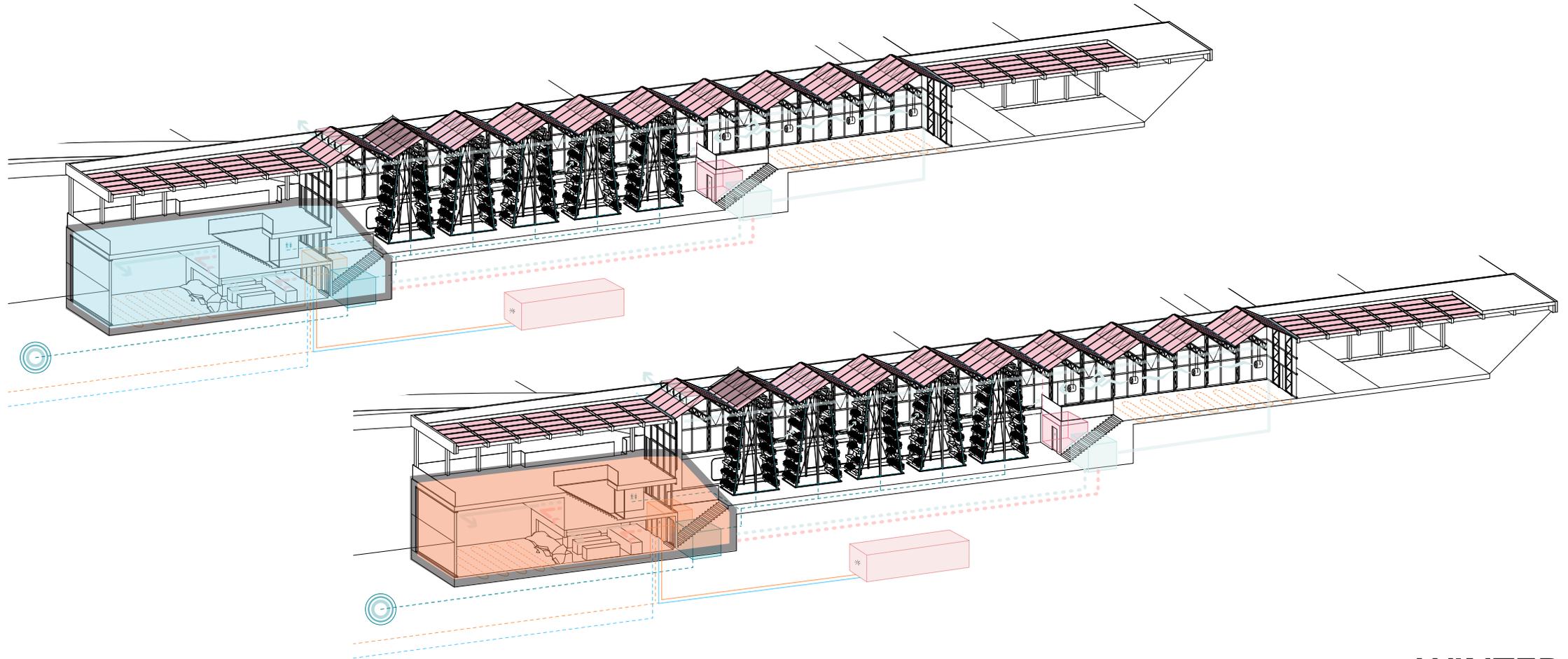
# SUMMER



# WINTER

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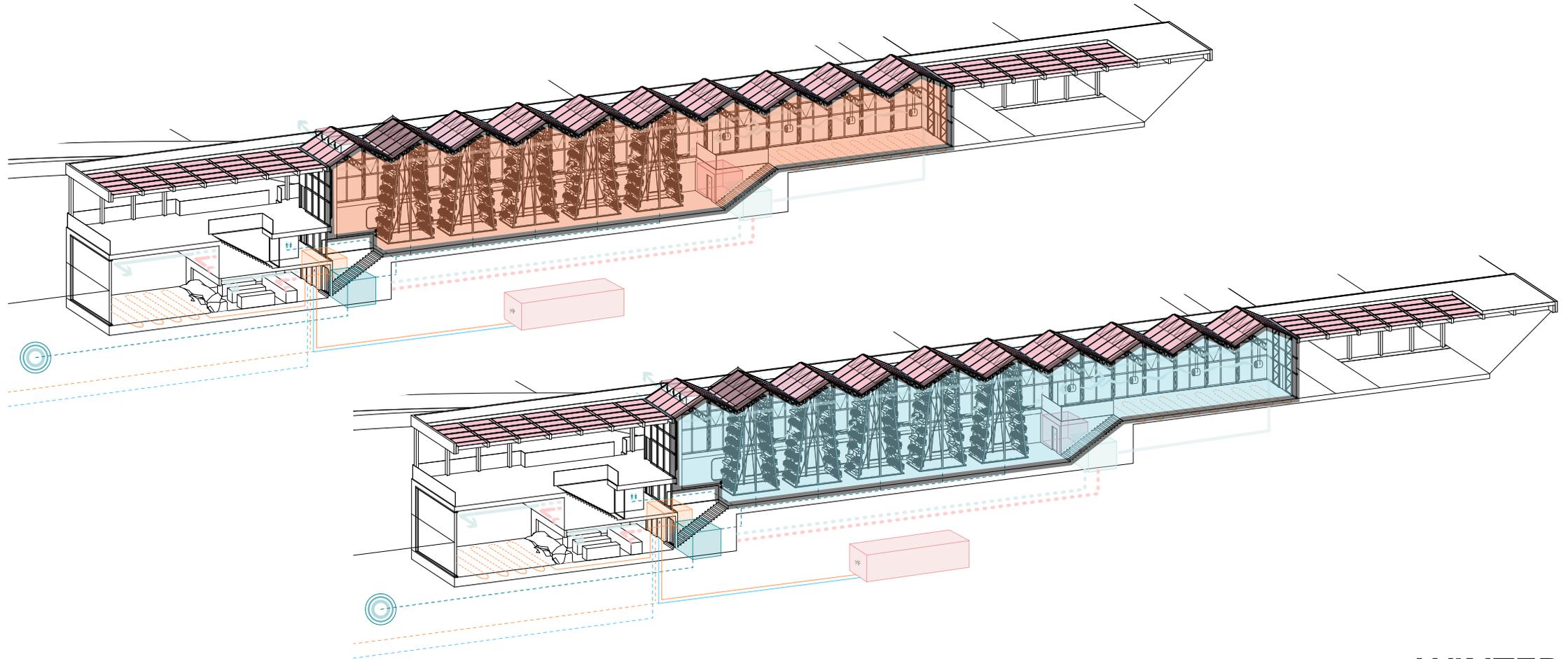
# SUMMER



# WINTER

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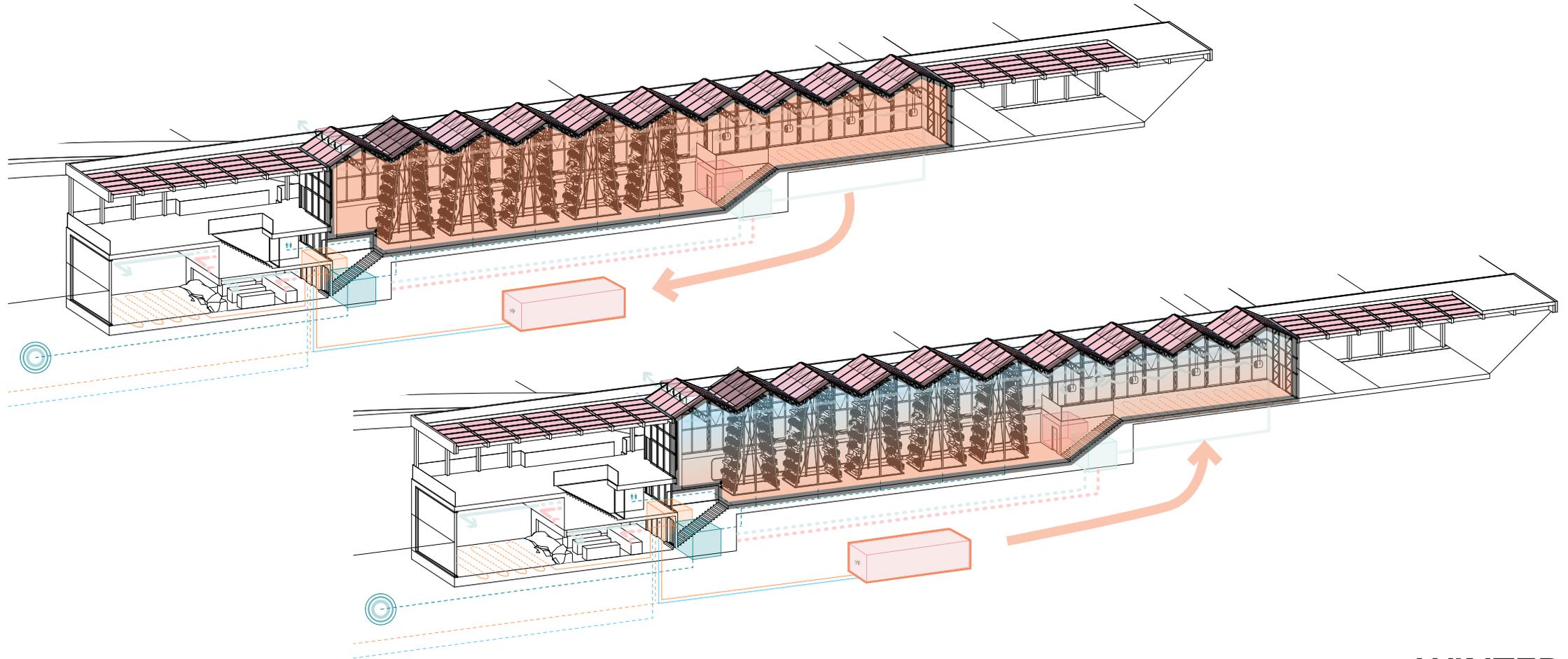
# SUMMER



# WINTER

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# SUMMER



# WINTER

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studio assignment

energy research

location

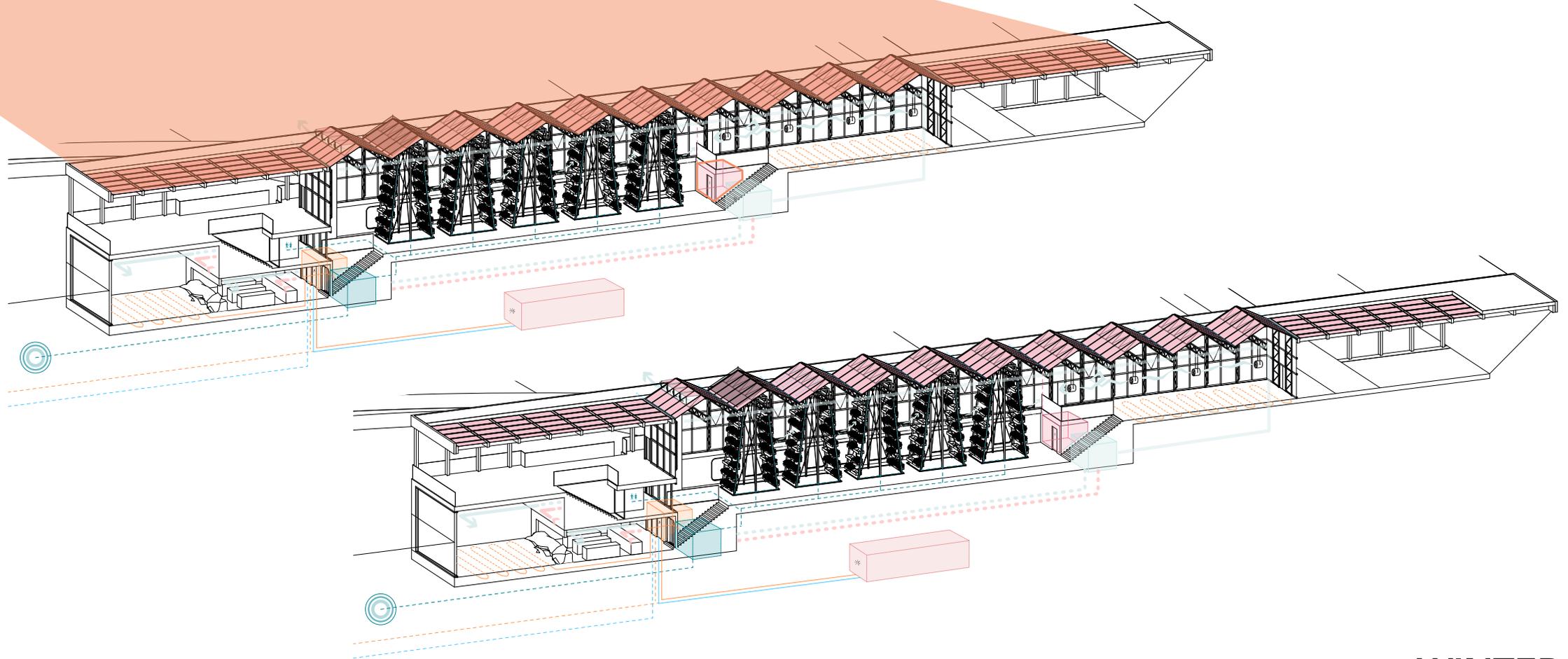
sea level rise

design principles

final design

conclusions

# SUMMER



# WINTER

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## ENERGY YIELD vs ENERGY CONSUMPTION

### YIELD

AuREUS            200 kWh per year/m<sup>2</sup> (60% of a regular solar panel)  
                         890 m<sup>2</sup> on the building  
Total                178.000 kWh per year

## ENERGY YIELD vs ENERGY CONSUMPTION

### YIELD

AuREUS	200 kWh per year/m <sup>2</sup> (60% of a regular solar panel)
	890 m <sup>2</sup> on the building
<b>Total</b>	<b>178.000 kWh per year</b>

### CONSUMPTION

Greenhouse	581 m <sup>2</sup>
Restaurant and kitchen	289 m <sup>2</sup>
Other	282 m <sup>2</sup>

## ENERGY YIELD vs ENERGY CONSUMPTION

### YIELD

AuREUS	200 kWh per year/m <sup>2</sup> (60% of a regular solar panel) 890 m <sup>2</sup> on the building
<b>Total</b>	<b>178.000 kWh per year</b>

### CONSUMPTION

Greenhouse	581 m <sup>2</sup>
Restaurant and kitchen	289 m <sup>2</sup>
Other	282 m <sup>2</sup>

### REFERENCE 1

Greenhouse	600 kWh per year/m <sup>2</sup>
Restaurant and kitchen	125 kWh per year/m <sup>2</sup>
Other	50 kWh per year/m <sup>2</sup>
<b>Total</b>	<b>398.225 kWh per jaar</b>

### REFERENCE 2

Greenhouse	200 kWh per year/m <sup>2</sup>
Restaurant and kitchen	100 kWh per year/m <sup>2</sup>
Other	50 kWh per year/m <sup>2</sup>
<b>Total</b>	<b>159.200 kWh per jaar</b>

## ENERGY YIELD vs ENERGY CONSUMPTION

### YIELD

AuREUS 200 kWh per year/m<sup>2</sup> (60% of a regular solar panel)  
890 m<sup>2</sup> on the building  
Total **178.000 kWh per year**

### CONSUMPTION

**300.000 kWh per year**

## ENERGY YIELD vs ENERGY CONSUMPTION

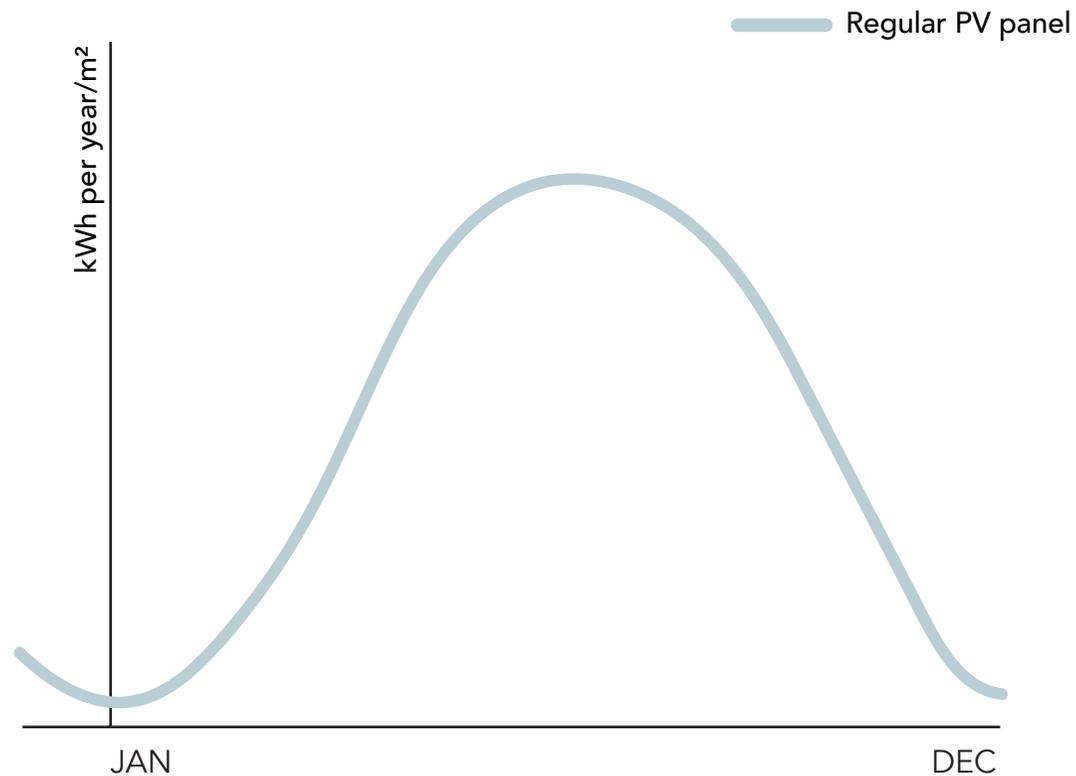
### YIELD

AuREUS 200 kWh per year/m<sup>2</sup> (60% of a regular solar panel)  
890 m<sup>2</sup> on the building

Total 178.000 kWh per year

### CONSUMPTION

300.000 kWh per year



## ENERGY YIELD vs ENERGY CONSUMPTION

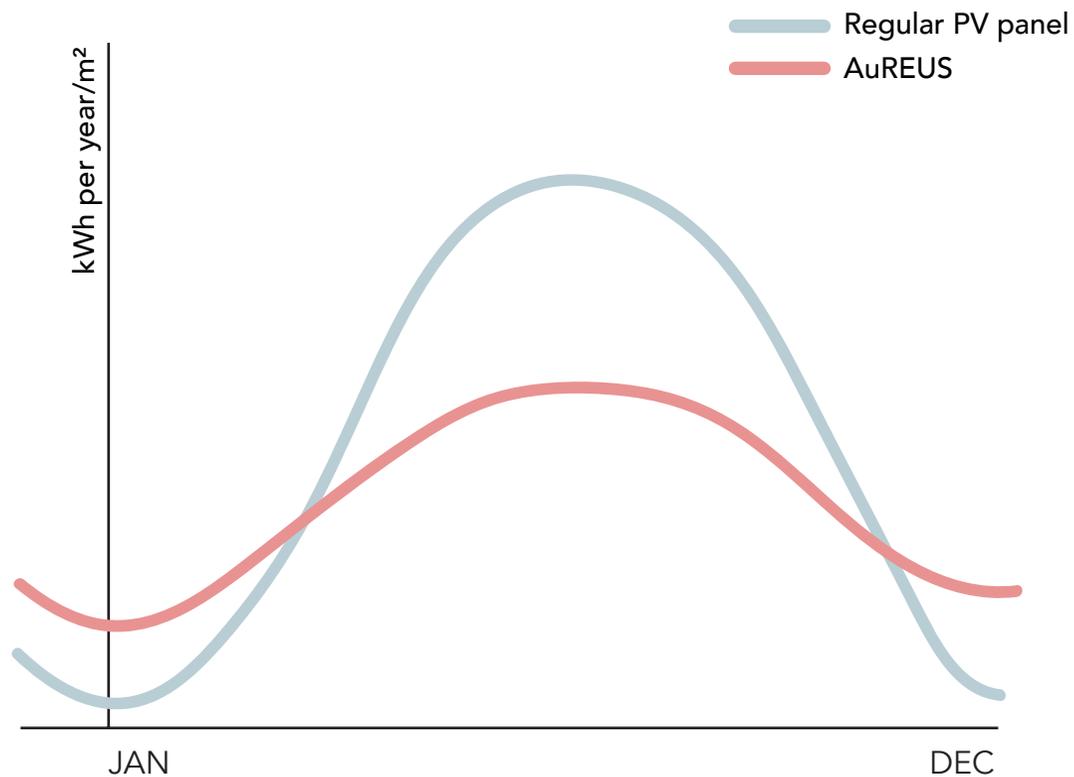
### YIELD

AuREUS 200 kWh per year/m<sup>2</sup> (60% of a regular solar panel)  
890 m<sup>2</sup> on the building

Total **178.000 kWh per year**

### CONSUMPTION

**300.000 kWh per year**



## ENERGY YIELD vs ENERGY CONSUMPTION

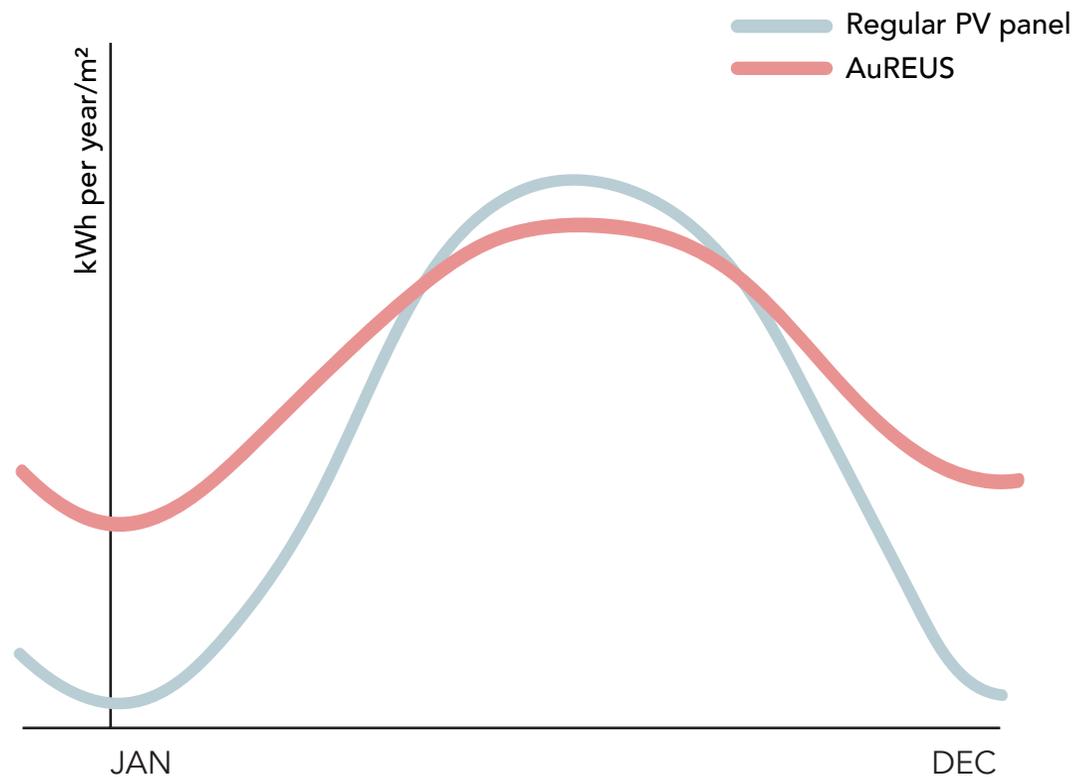
### YIELD

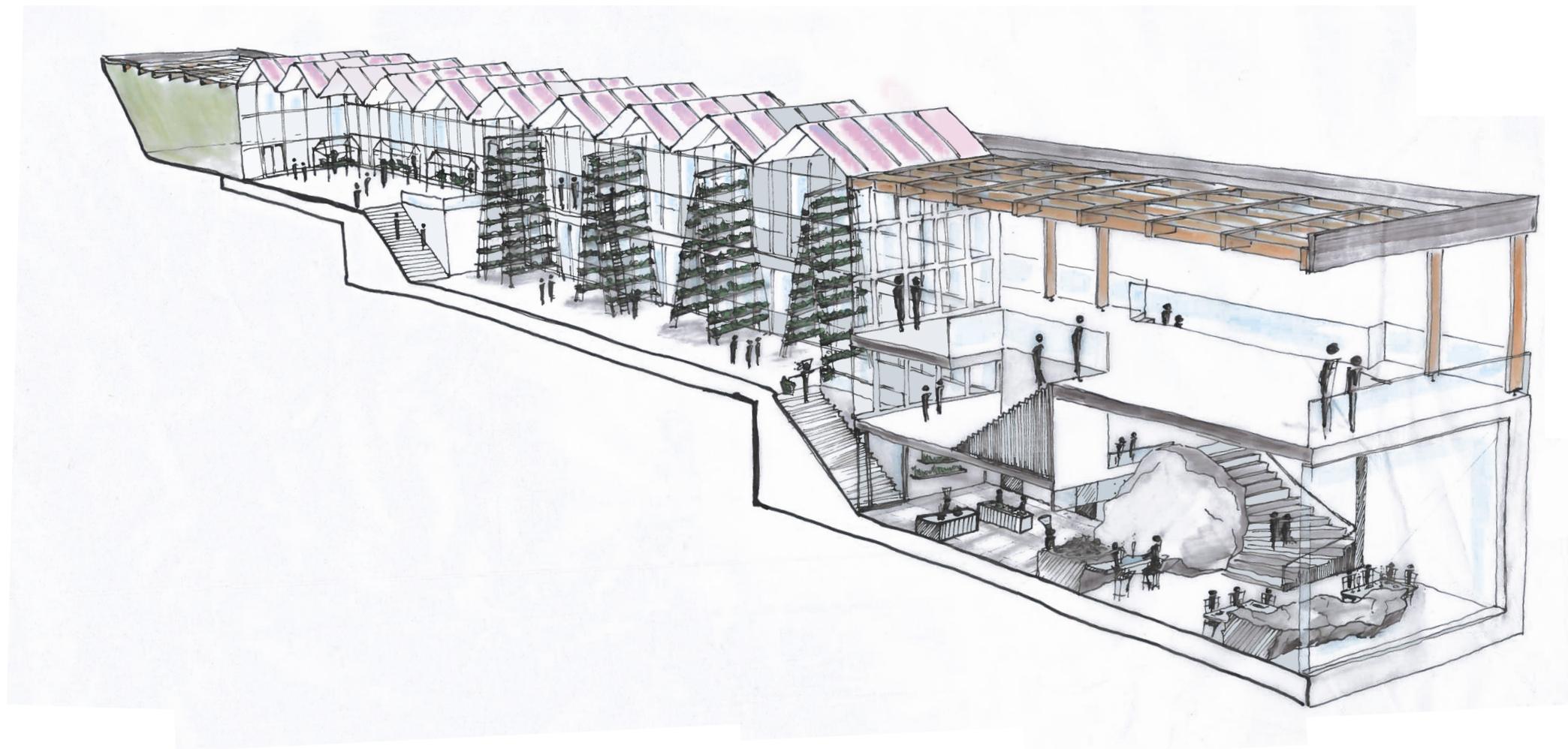
AuREUS 200 kWh per year/m<sup>2</sup> (60% of a regular solar panel)  
890 m<sup>2</sup> on the building

Total 178.000 kWh per year

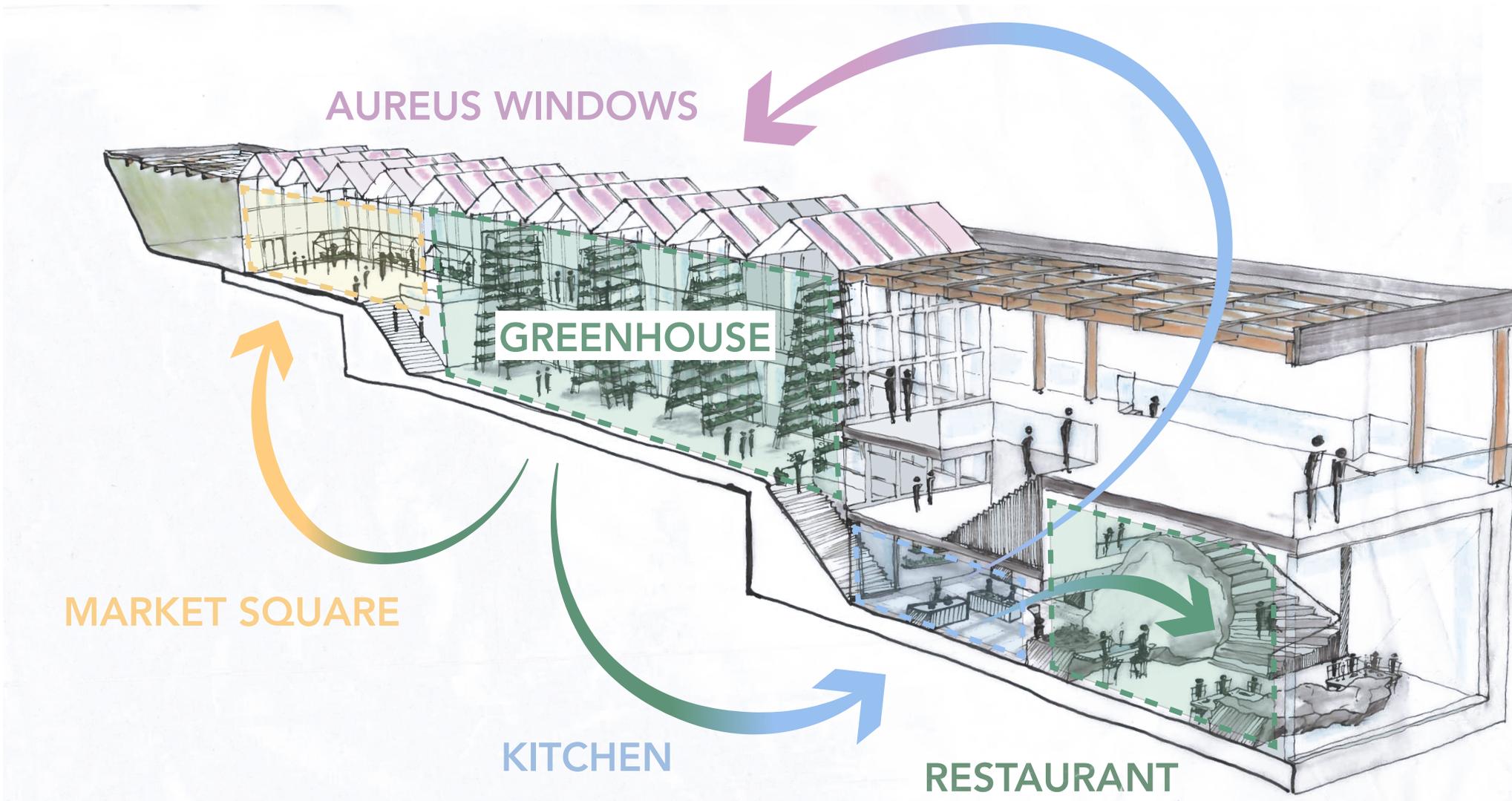
### CONSUMPTION

300.000 kWh per year





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# CONCLUSIONS



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## RESEARCH QUESTION

***“How can a renewable energy technology serve as the main principle for both the design and function of a building in Groningen?”***

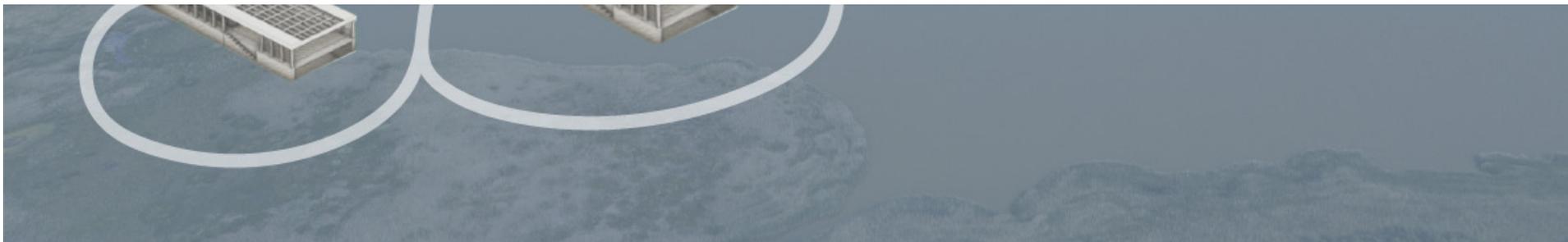


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RESEARCH QUESTION

# THE RIGHT CONDITIONS



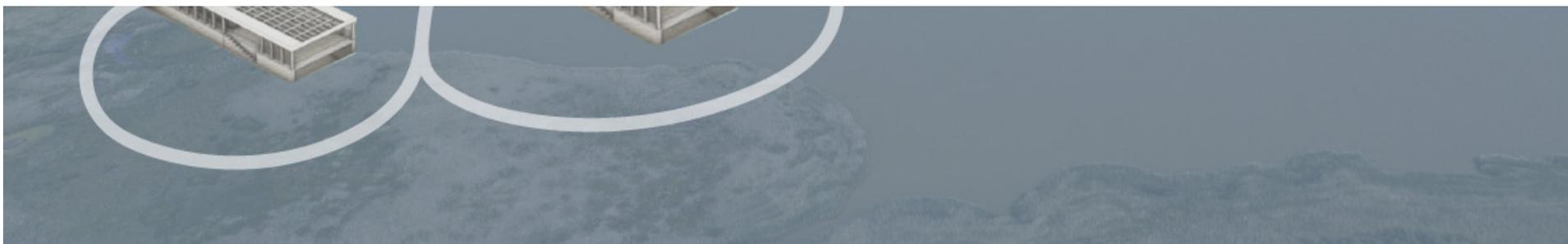
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RESEARCH QUESTION

**THE RIGHT CONDITIONS**

**CREATING A STORY**



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THANK YOU FOR LISTENING

