[Arav Kumar | 4738268] Msc4:Robotic Building| Henriette Bier | Ferry Adema | Arwin Hidding

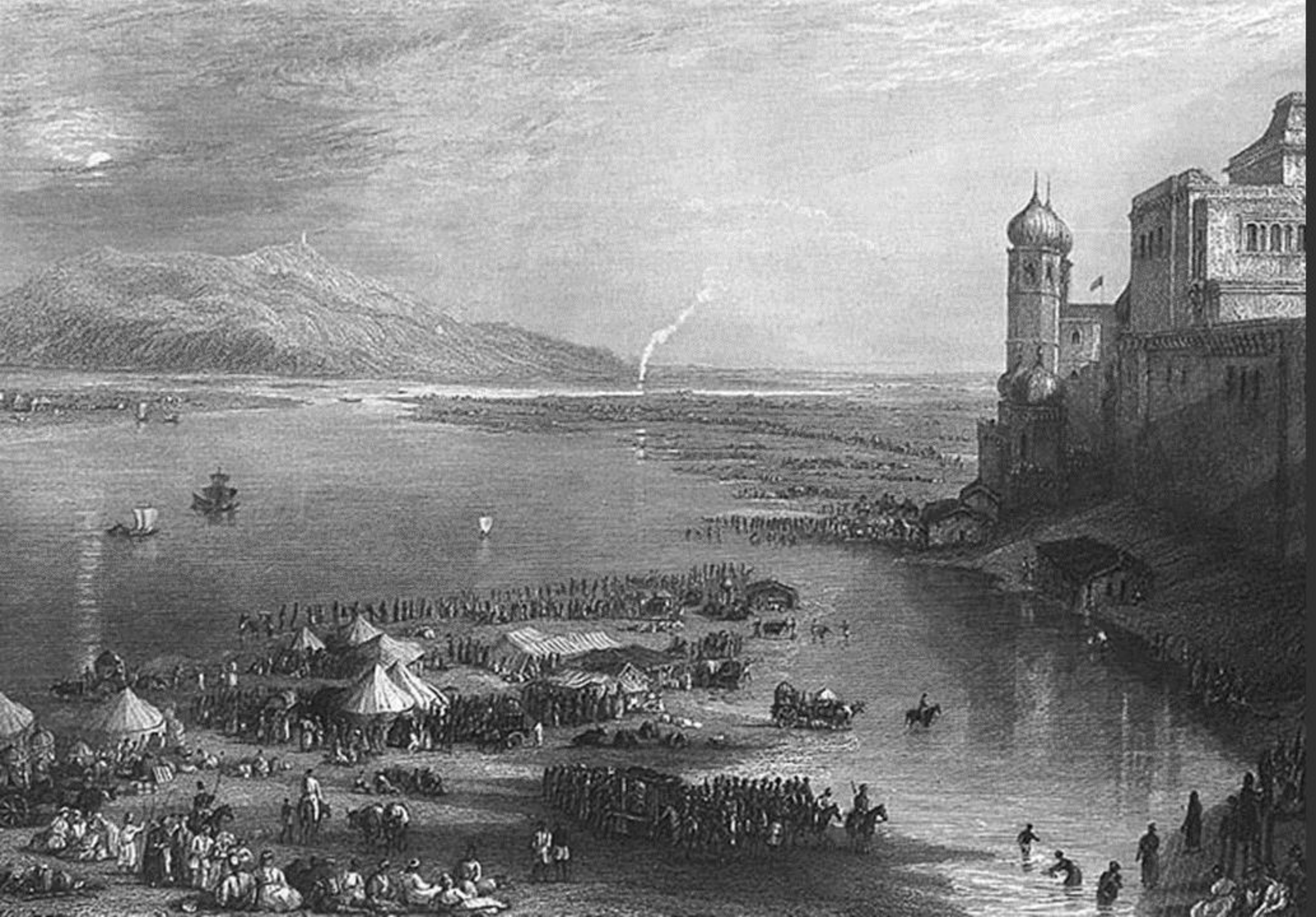
RB robotic building

[ROBOTIC BUILDING INTRODUCTION VIDEO- SEE VIDEOS FOR DETAIL]

MAHAKUMBH

MAHAKUMBH?

Hindu
Festival



7 AD

2

Rivers

32

Sqkm

60

Days

PERMANENT SETTLERS
PILGRIMS - BUSY DAYS
PILGRIMS-ENTIRE FESIVAL

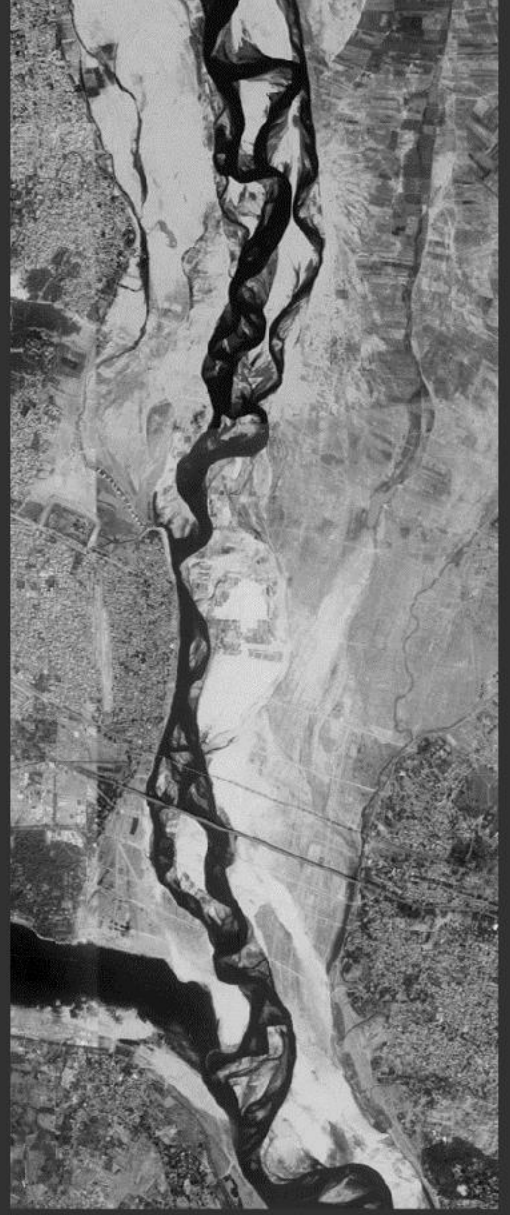
1M

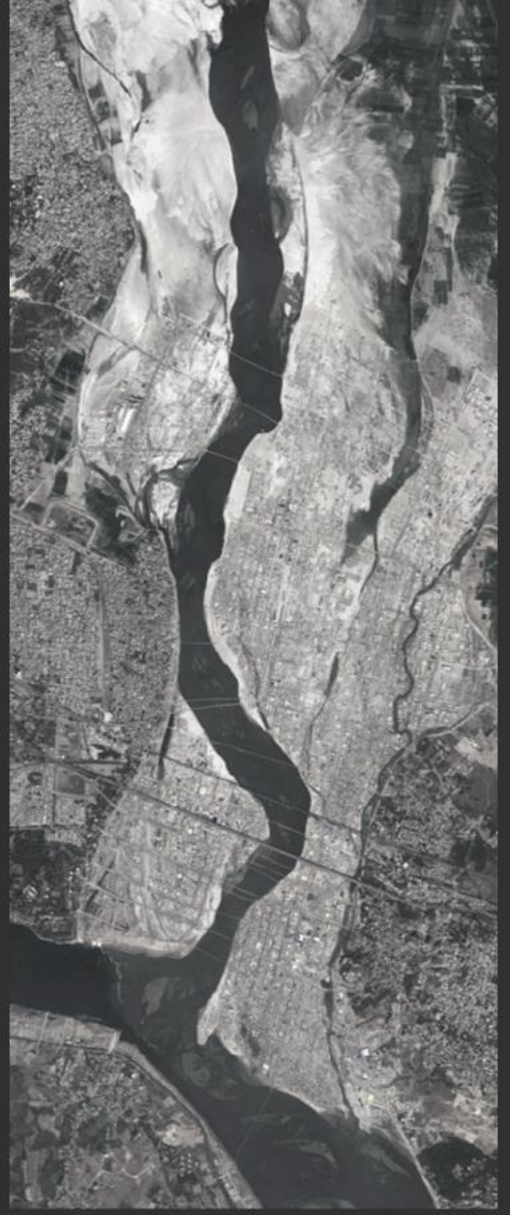
30M

100M

Temporary Urbanism

[SITE INTRODUCTION VIDEO- SEE VIDEOS FOR DETAIL]





[JULY] → [OCTOBER] → [JANUARY] → [APRIL]

[River] [Planning] [Metropolis] [Agropolis]

RESEARCH QUESTION?

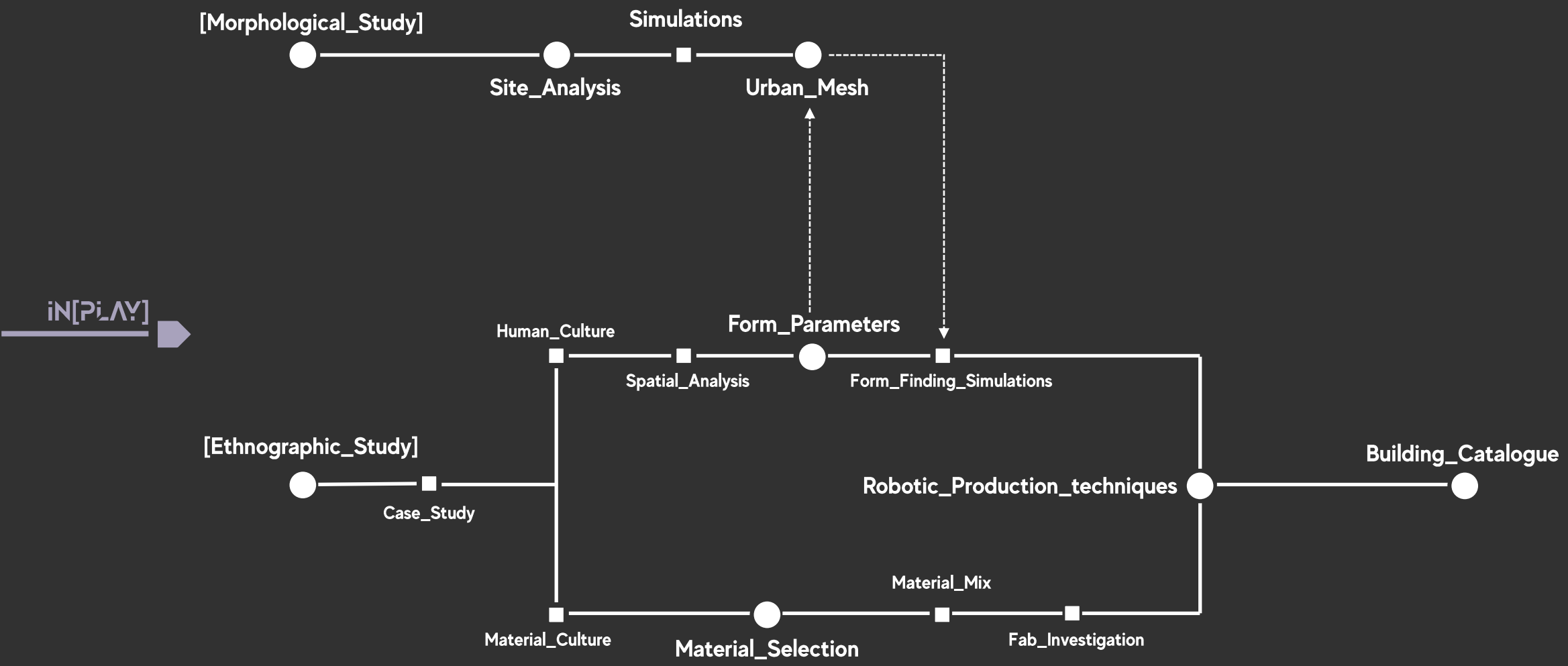
CAN THE EPHEMERAL NATURE OF KUMBH MELA SERVE AS A RICH CASE STUDY OF SPATIAL, SOCIAL, AND LOGISTICAL ELEMENTS THAT CAN LEAD TO UNDERSTANDING AND DEPLOYMENT OF THESE SYSTEMS IN A VARIETY OF PLACES AND SITUATIONS, IN PARTICULAR CAMPS FOR REFUGEES OF WAR AND NATURAL DISASTERS?

[BURNING MAN]

[PORT-AU-PRINCE, HAITI]

[AL ZAATARI,SYRIA]

[KUMBH MELA]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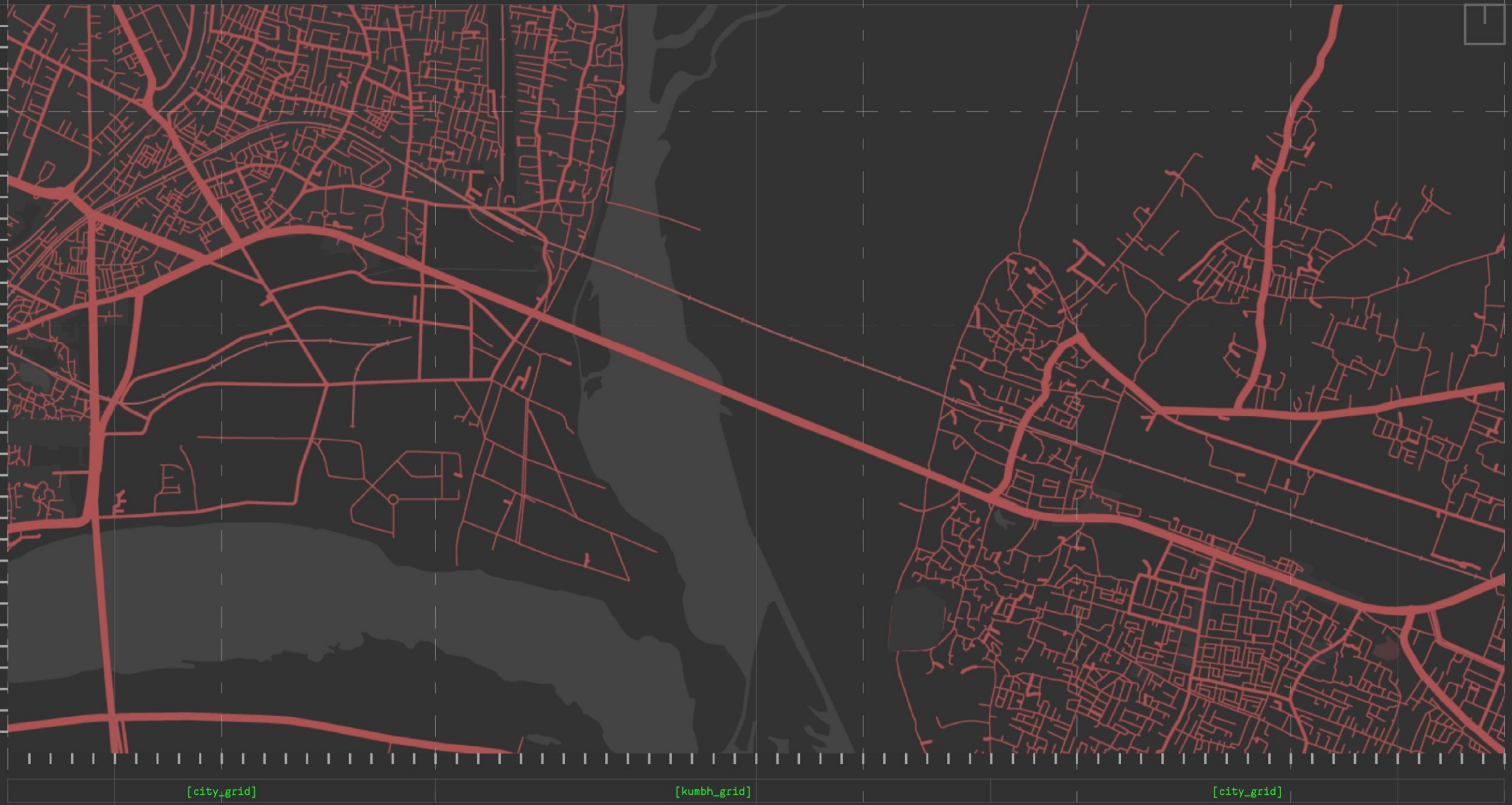
Site_Analysis
Urban_Mesh
iN[PLAY]
Human_Culture
Form_Parameters
Spatial_Analysis
Form_Finding_Simulations
[Ethnographic_Study]
Case_Study
Robotic_Production_techniques
Building_Catalogue
Material_Mix
Material_Culture
Material_Selection
Fab_Investigation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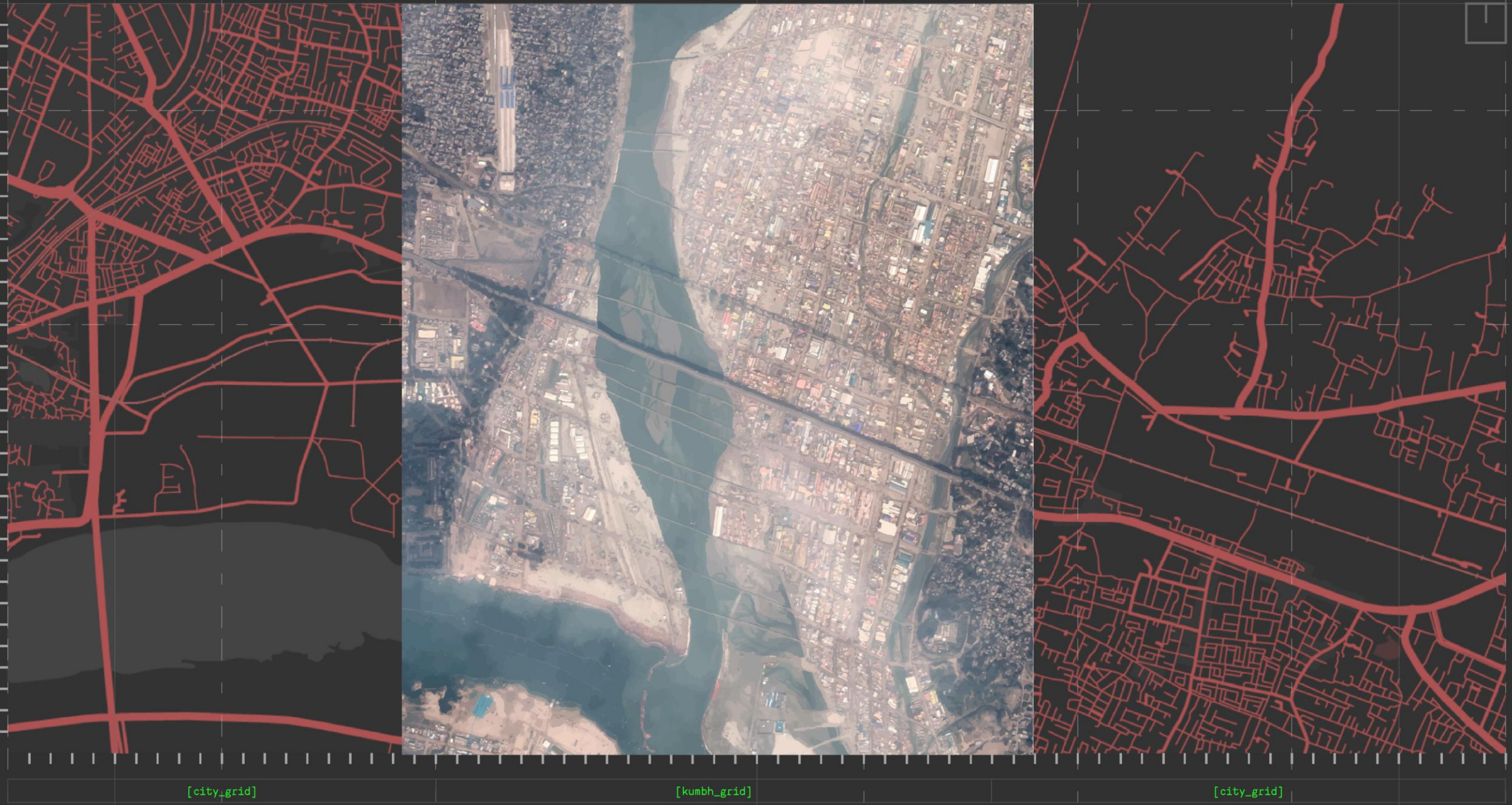
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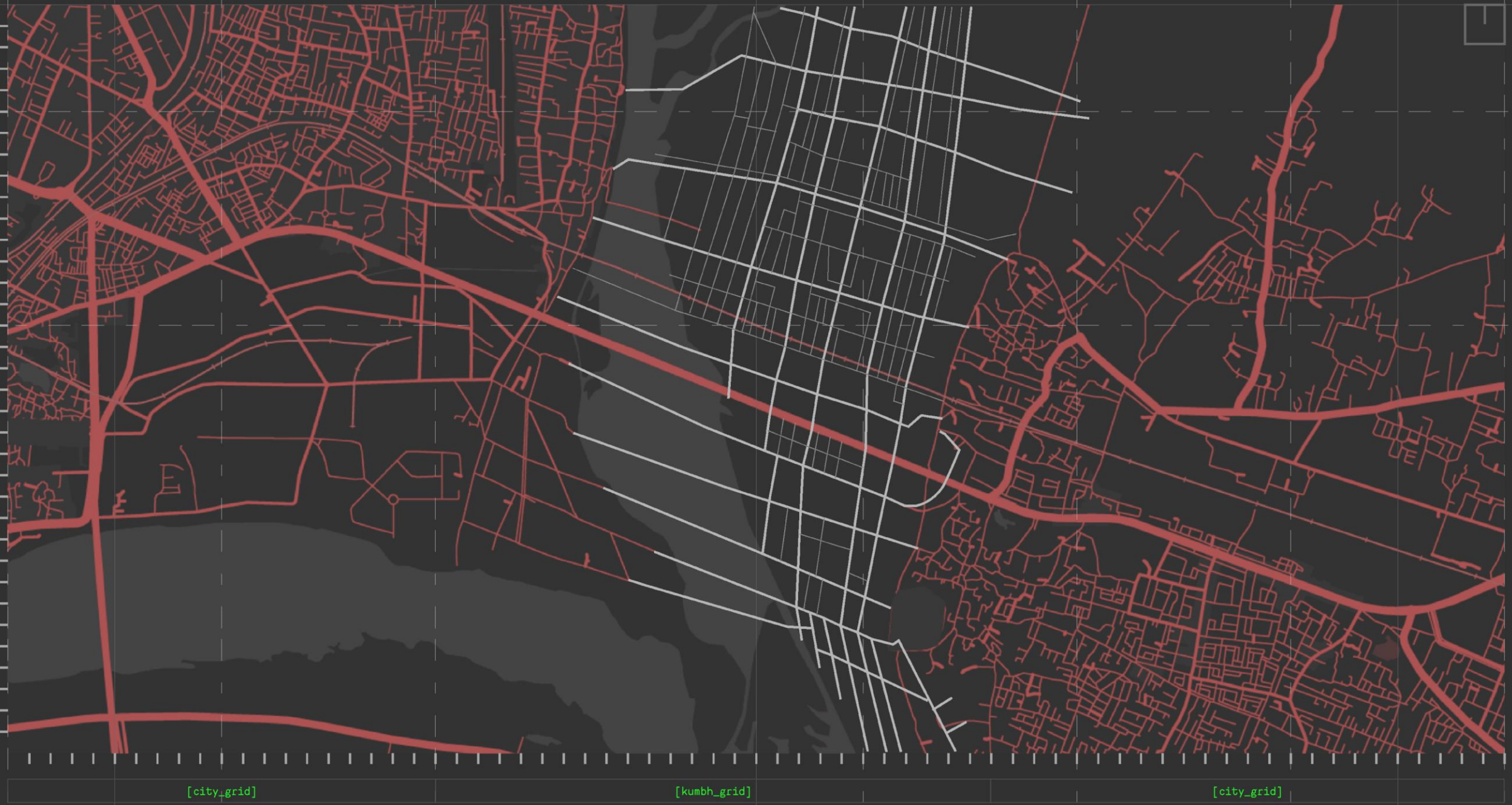
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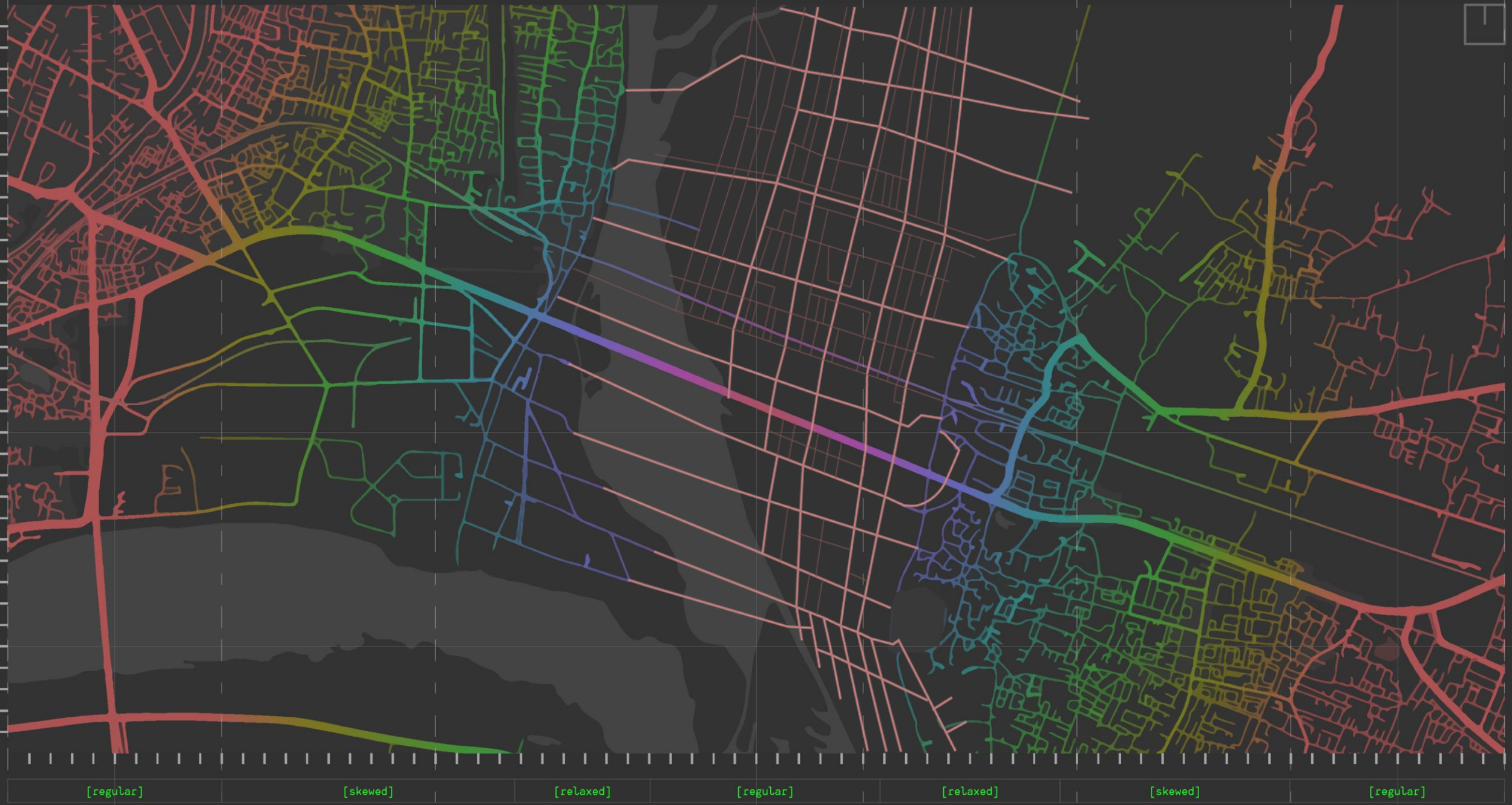

[regular]
[skewed]
[relaxed]
[regular]
[relaxed]
[skewed]
[regular]

[H]
[H]

[grid layout]

[90% of users are sadhus & villagers]

[90% of users are sadhus & villagers]

[compact layout-no buffer]

[inadequate space-function spill over]

[lack of designed public spaces]

[lack of designed public spaces - kitchen]

[lack of designed public spaces - kitchen]

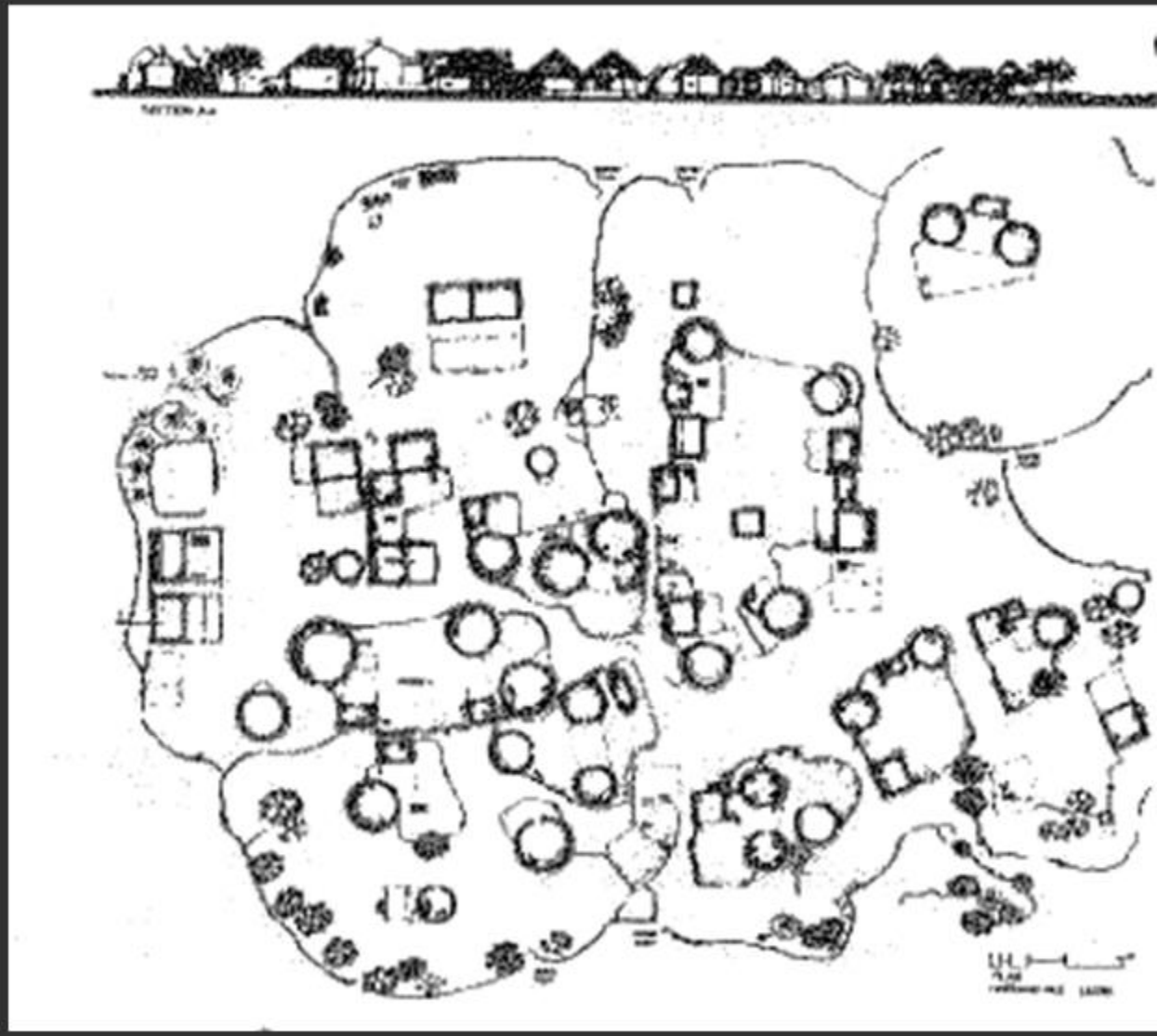
[thin tents inadequate for thermal comfort]

[prone to fire]

[lack of designed public spaces - toilets]

[lack of designed public spaces - toilets]

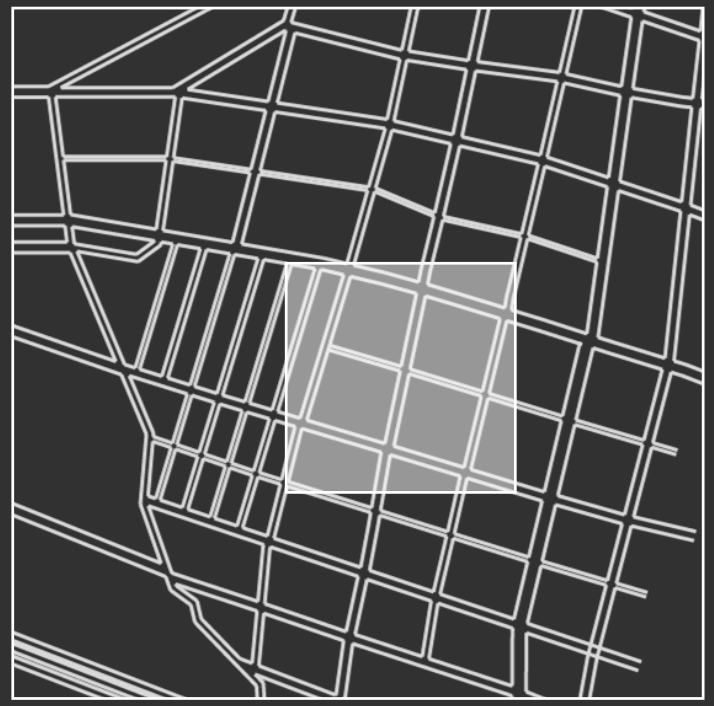
[cluster layout]



[cluster aggregation]

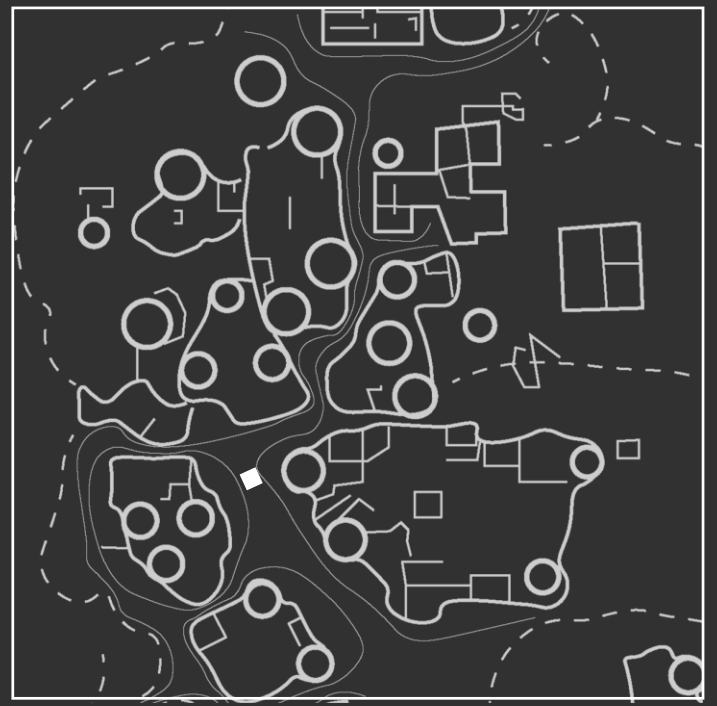
[mud houses- clay/sand/silt/thatch]

[MACRO SCALE-URBAN_STRUCTURE]



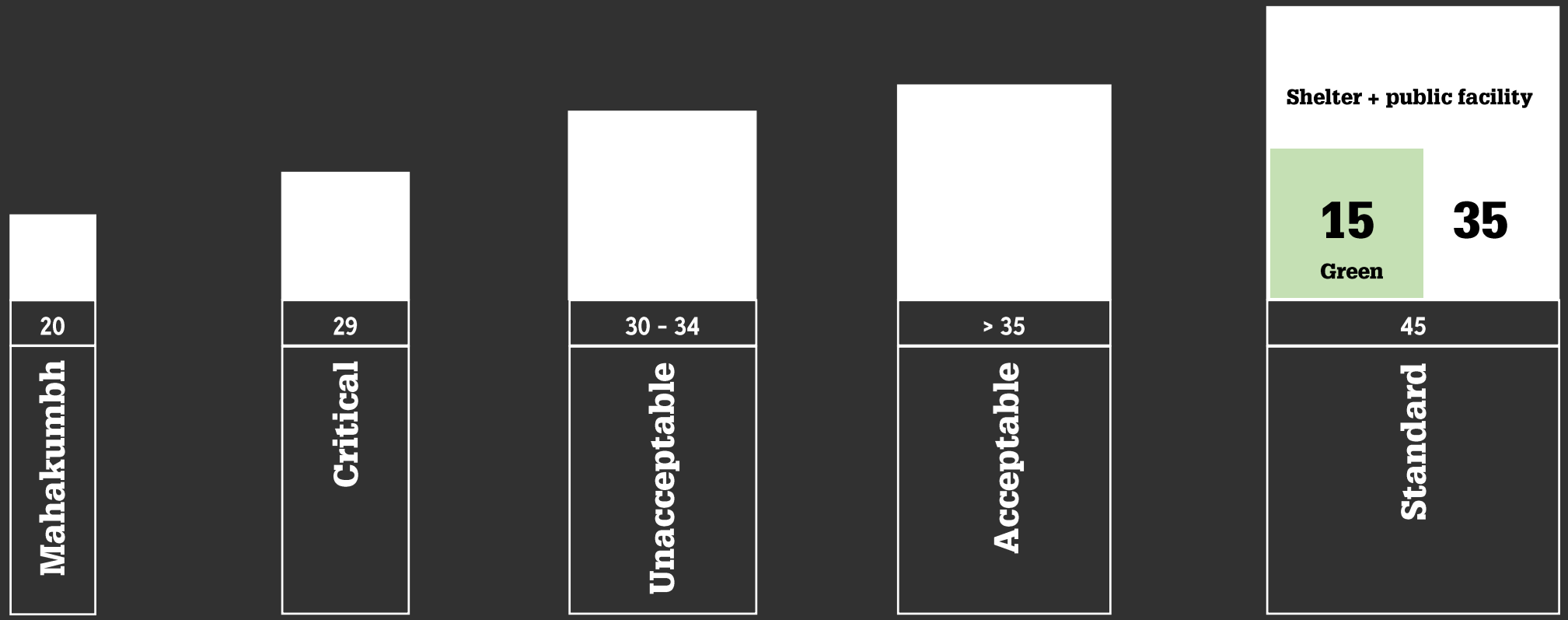
[Regular Grid]

[Dense figure ground]



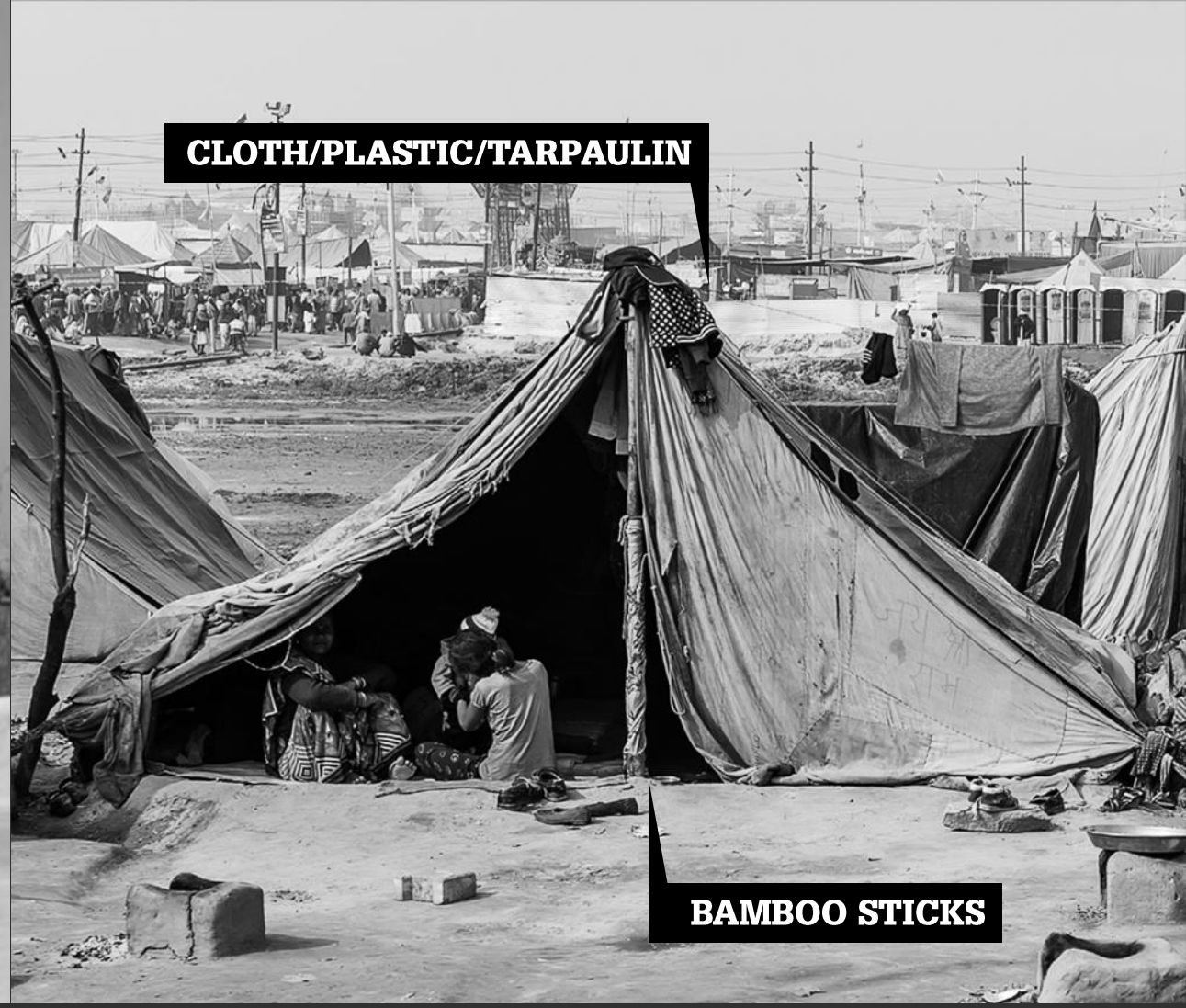
[Traditional Relaxed Structure]

[AVERAGE CAMP AREA PER PERSON]



Average camp area	45 sqm/person
Minimum covered area	4.5 sqm
Minimum ceiling height	2m

* Figures in accordance to UN Refugee agency emergency standards

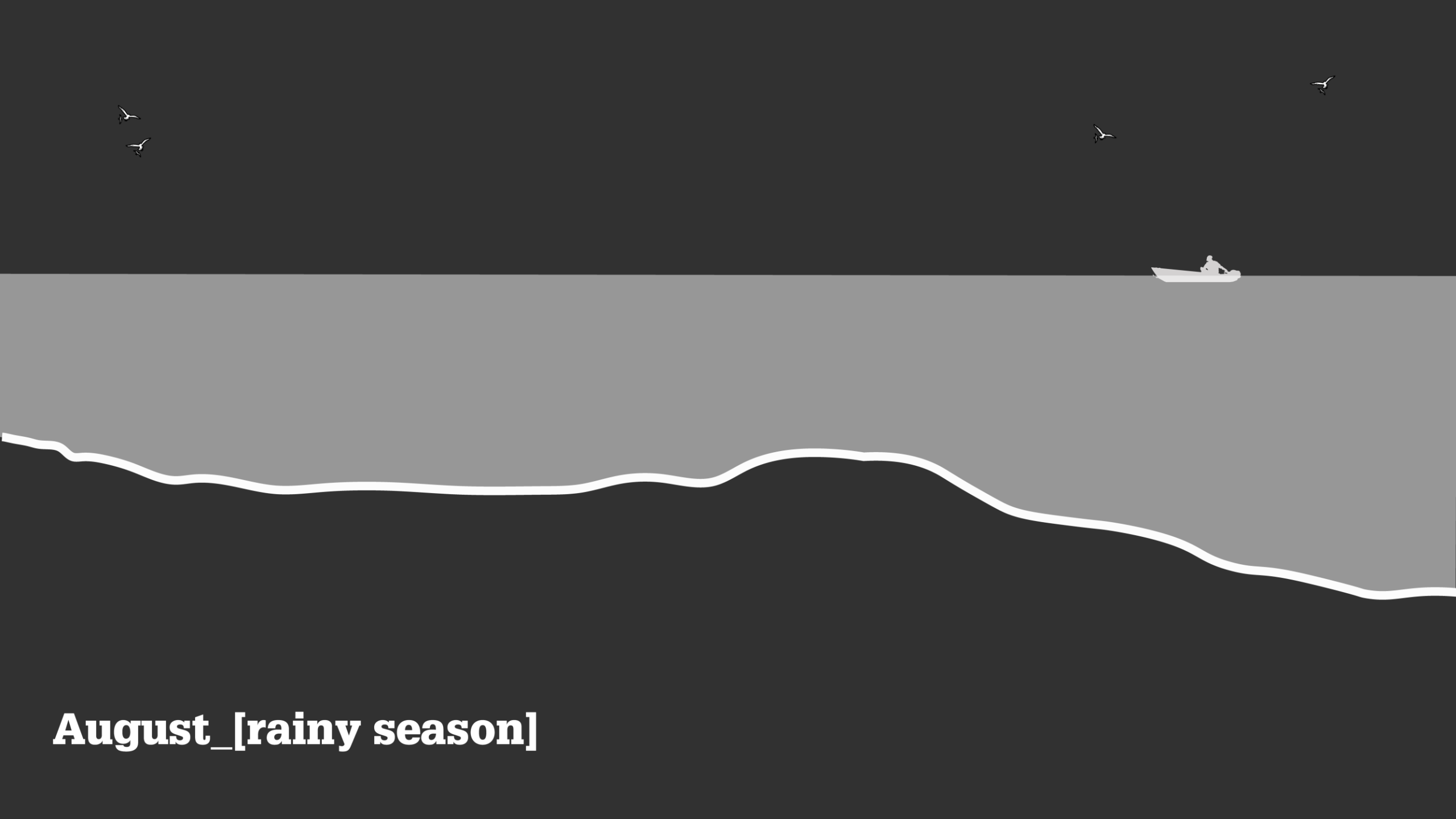


[BUILDING/FUNCTIONAL LIFESPAN = MATERIAL LIFESPAN]

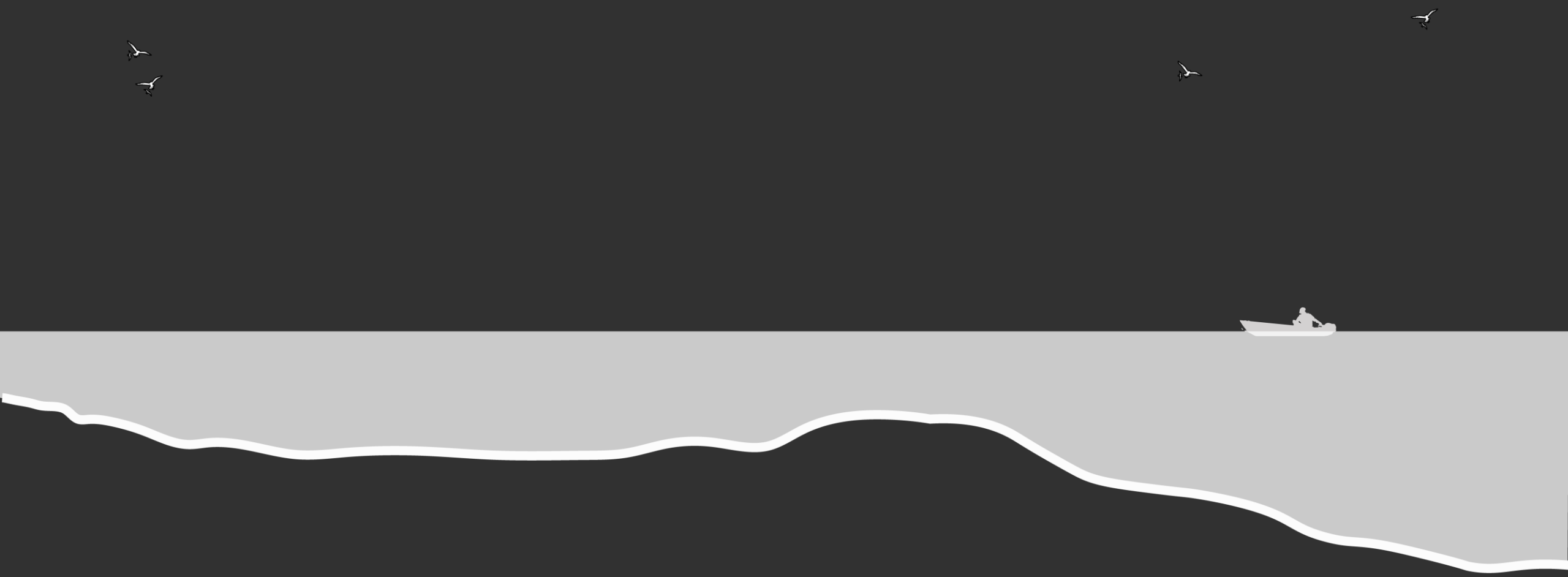
[BUILDING/FUNCTIONAL LIFESPAN < MATERIAL LIFESPAN]

SUB QUESTION

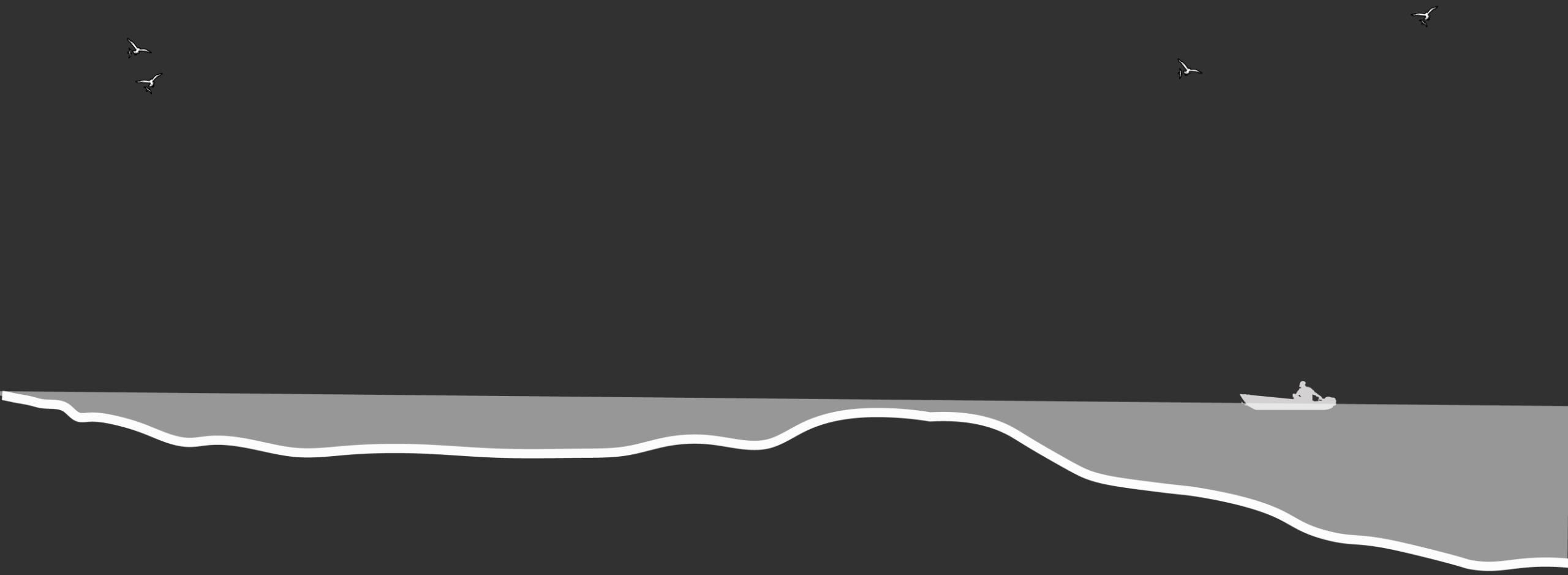
CAN WE CREATE A SYSTEM WHERE THE MATERIAL LIFESPAN IS EQUAL TO THE SITE FUNCTIONAL LIFESPAN?



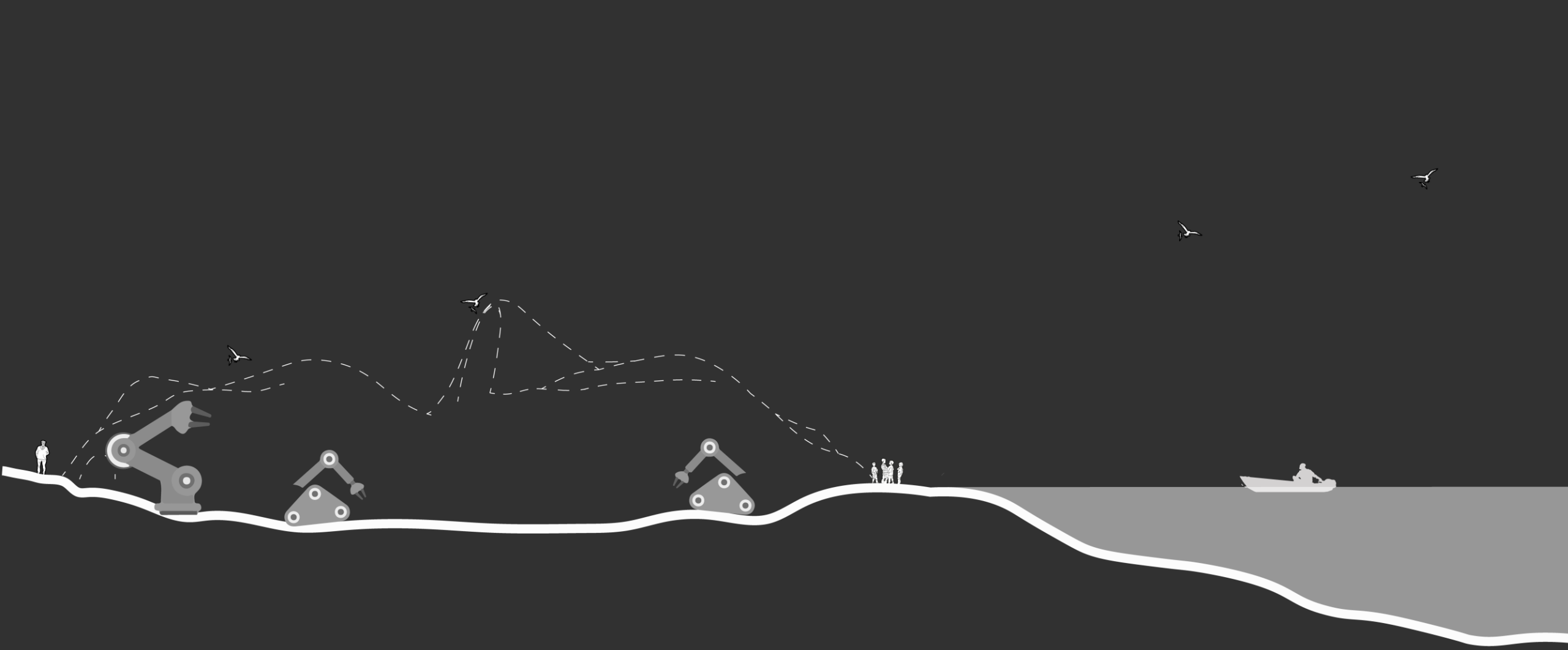
August_[rainy season]



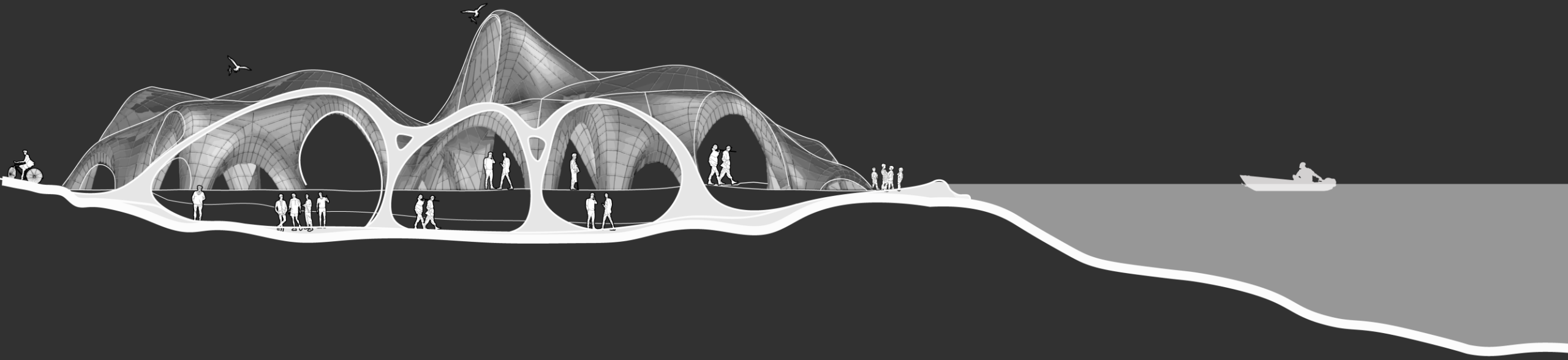
september_[rainy season]



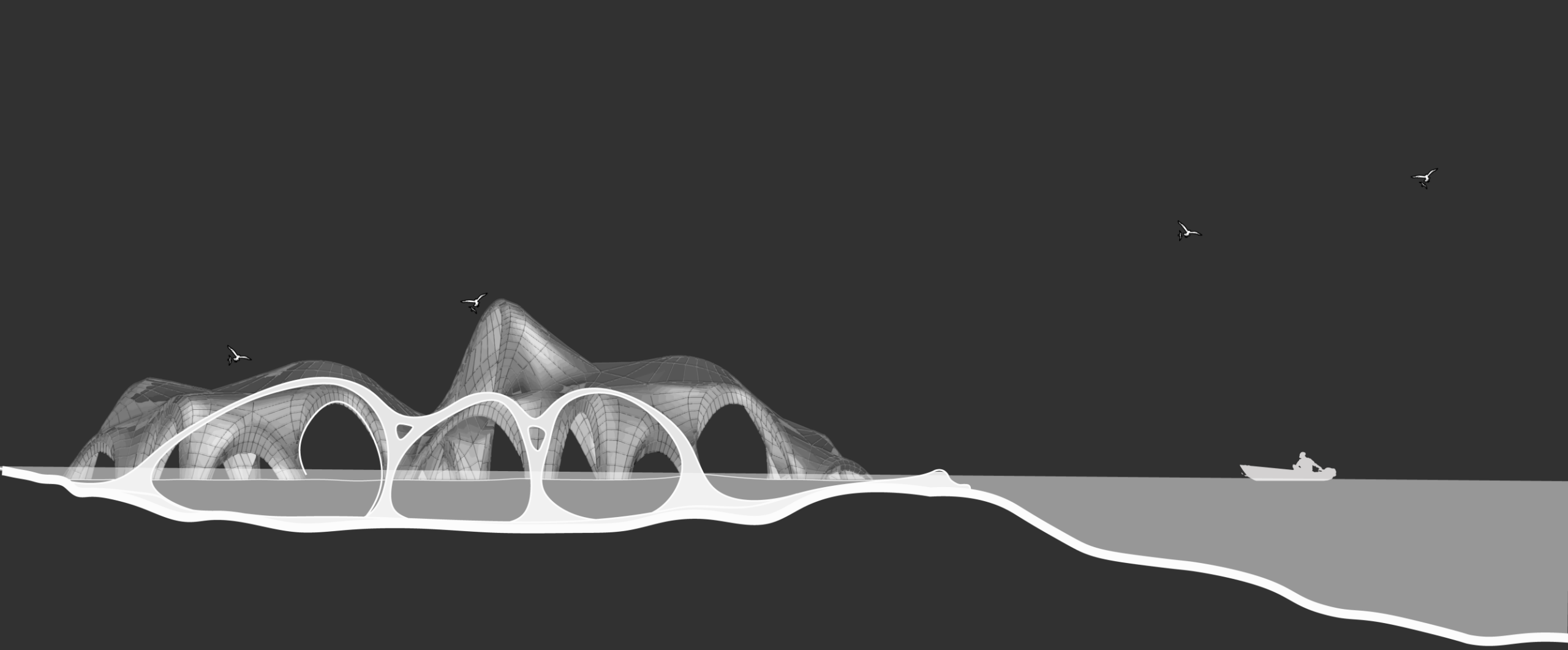
october_[rainy season]



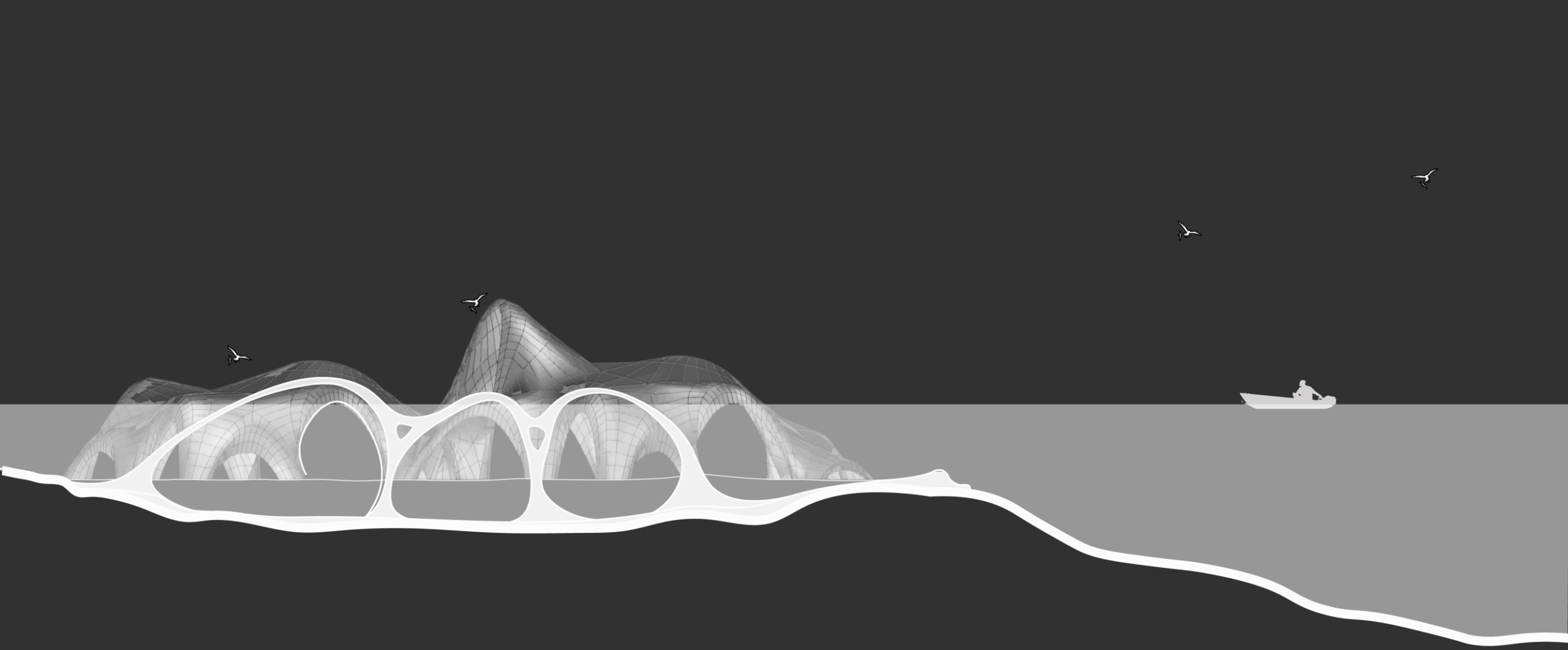
november-january_[construction]



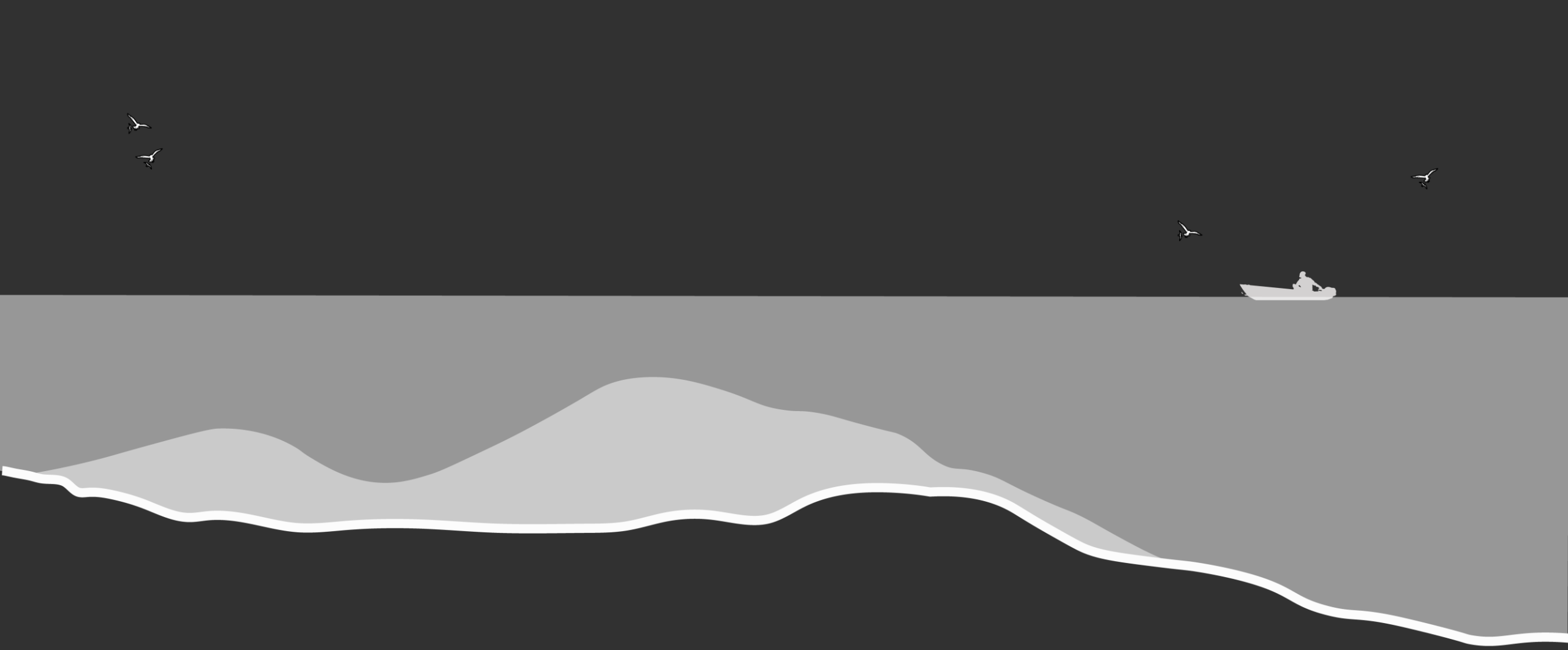
january-march_[mahakumbh]



june-october_[rainy season]



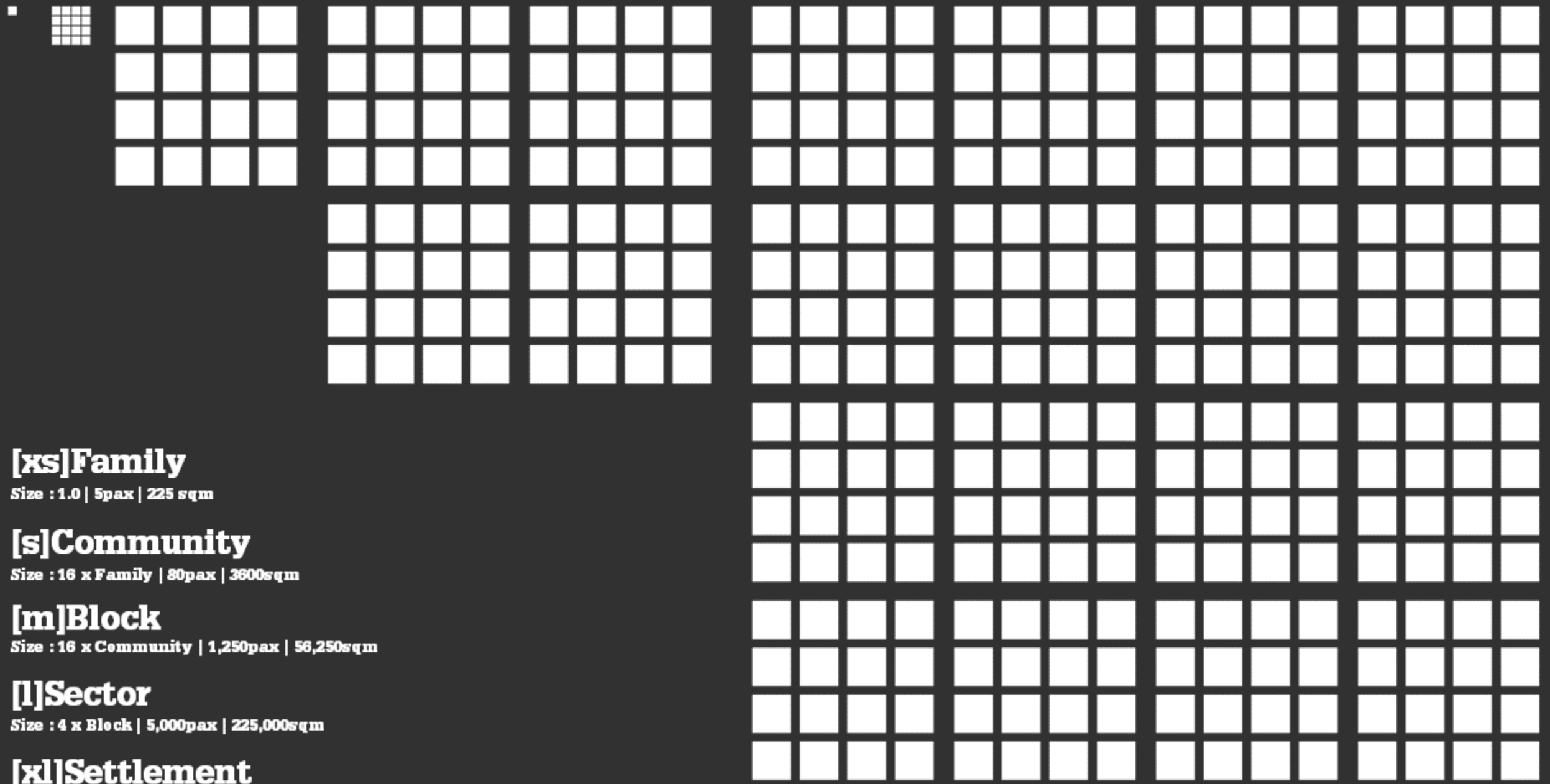
june-october_[rainy season]



june-october_[rainy season]

August_[rainy season]

[DESIGN STRATEGY MACRO]



[xs]Family

Size : 1.0 | 5pax | 225 sqm

[s]Community

Size : 16 x Family | 80pax | 3600sqm

[m]Block

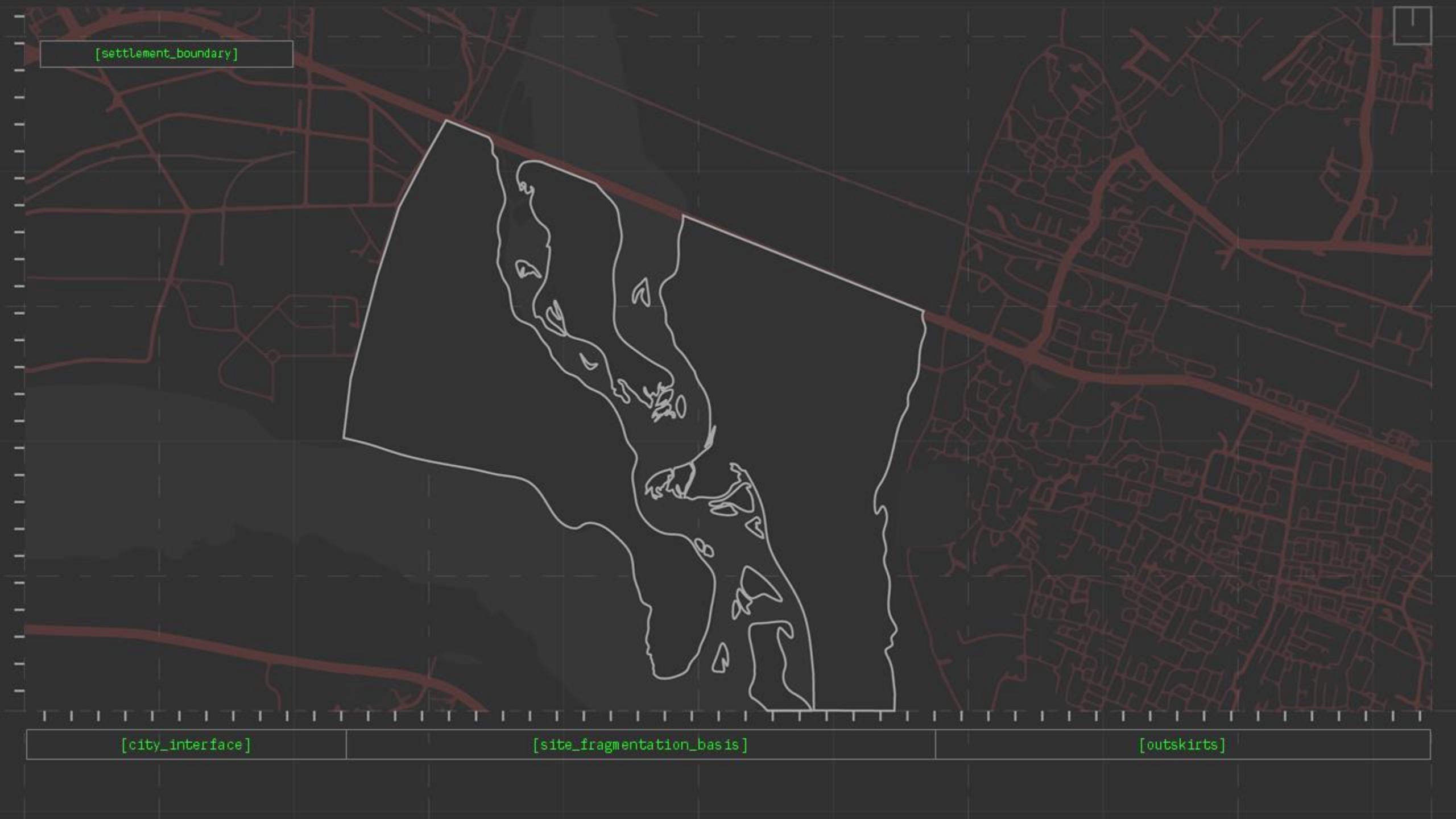
Size : 16 x Community | 1,250pax | 56,250sqm

[l]Sector

Size : 4 x Block | 5,000pax | 225,000sqm

[xl]Settlement

Size : 4 x Sector | 20,000pax | 900,000sqm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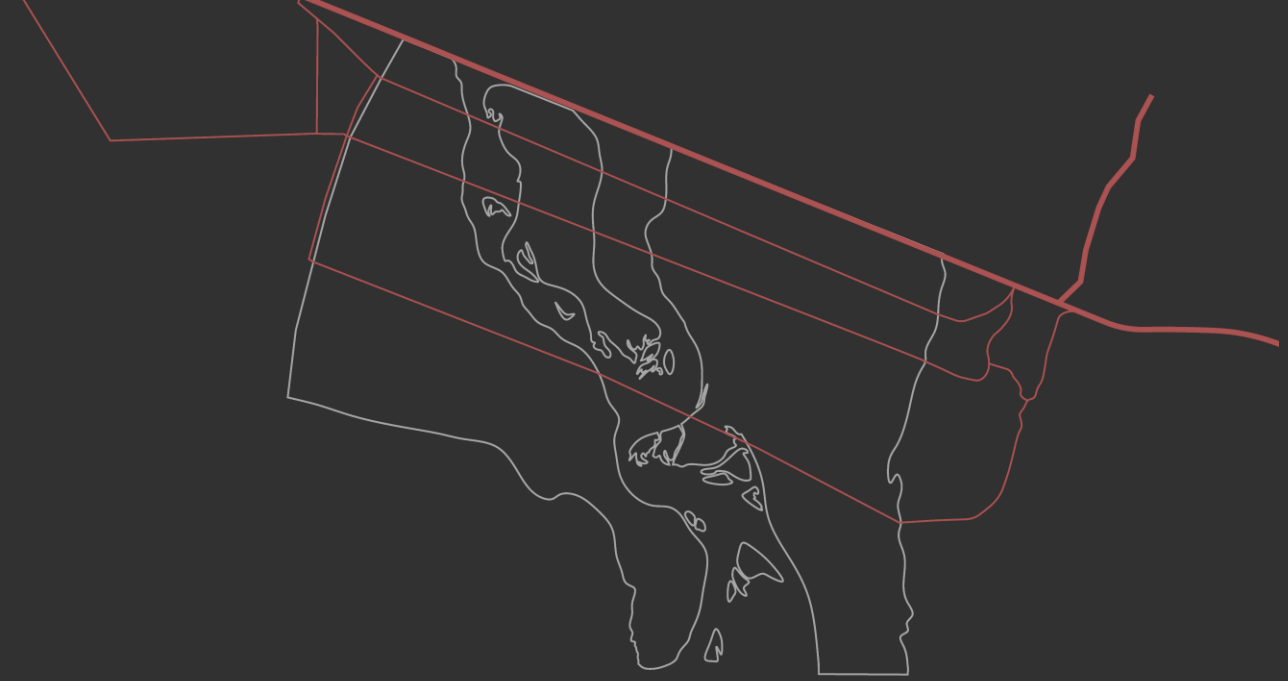

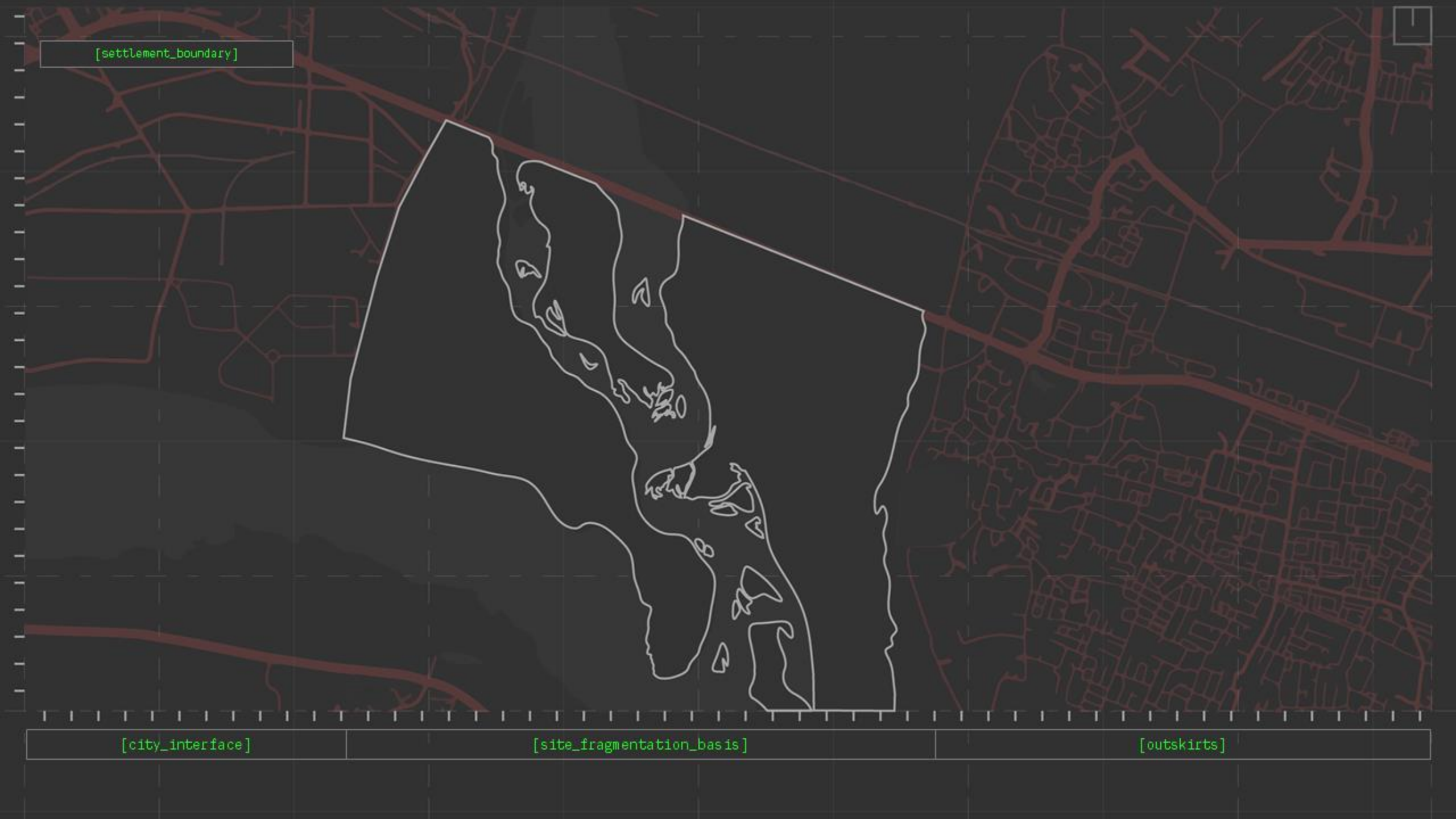
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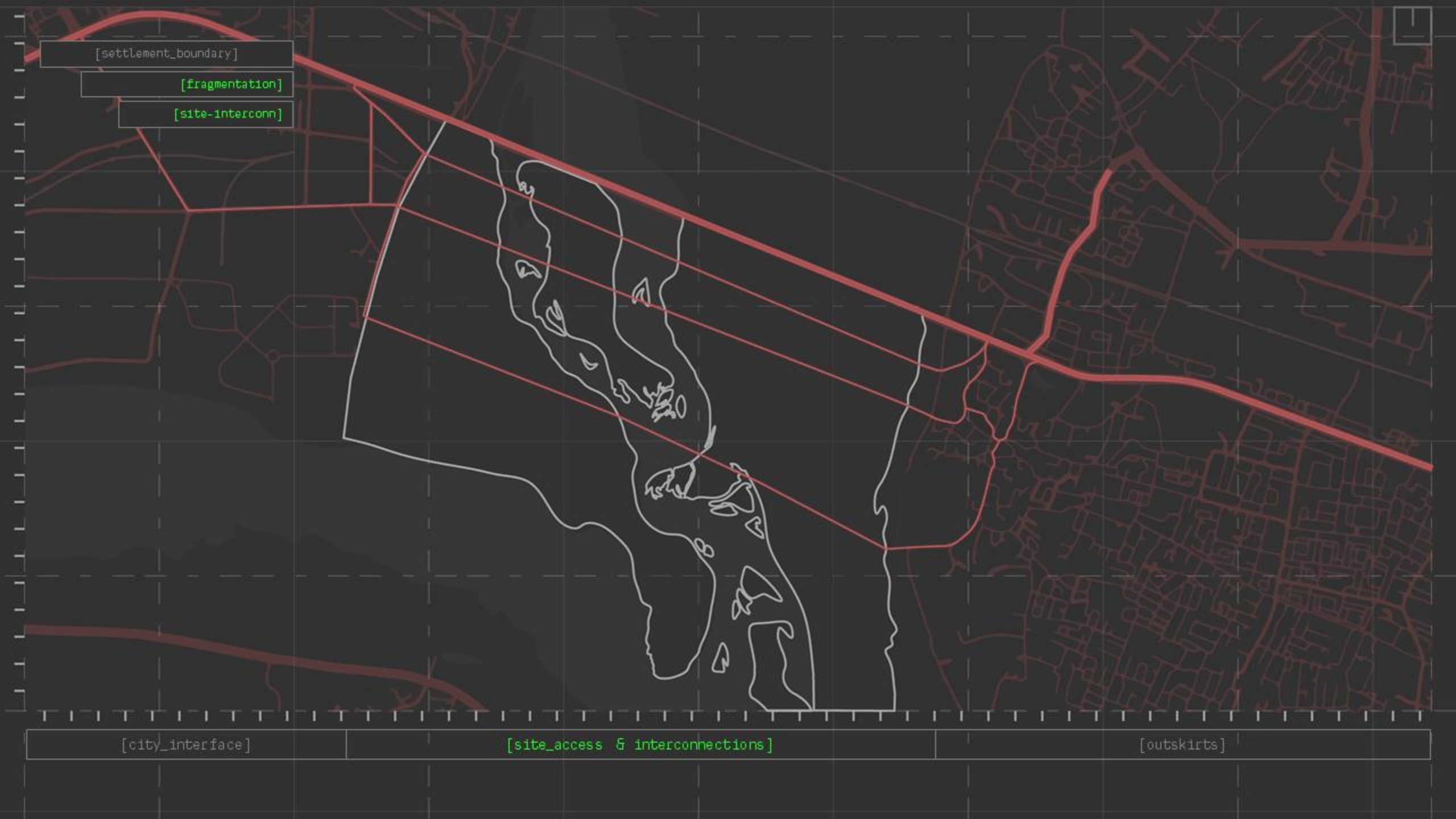
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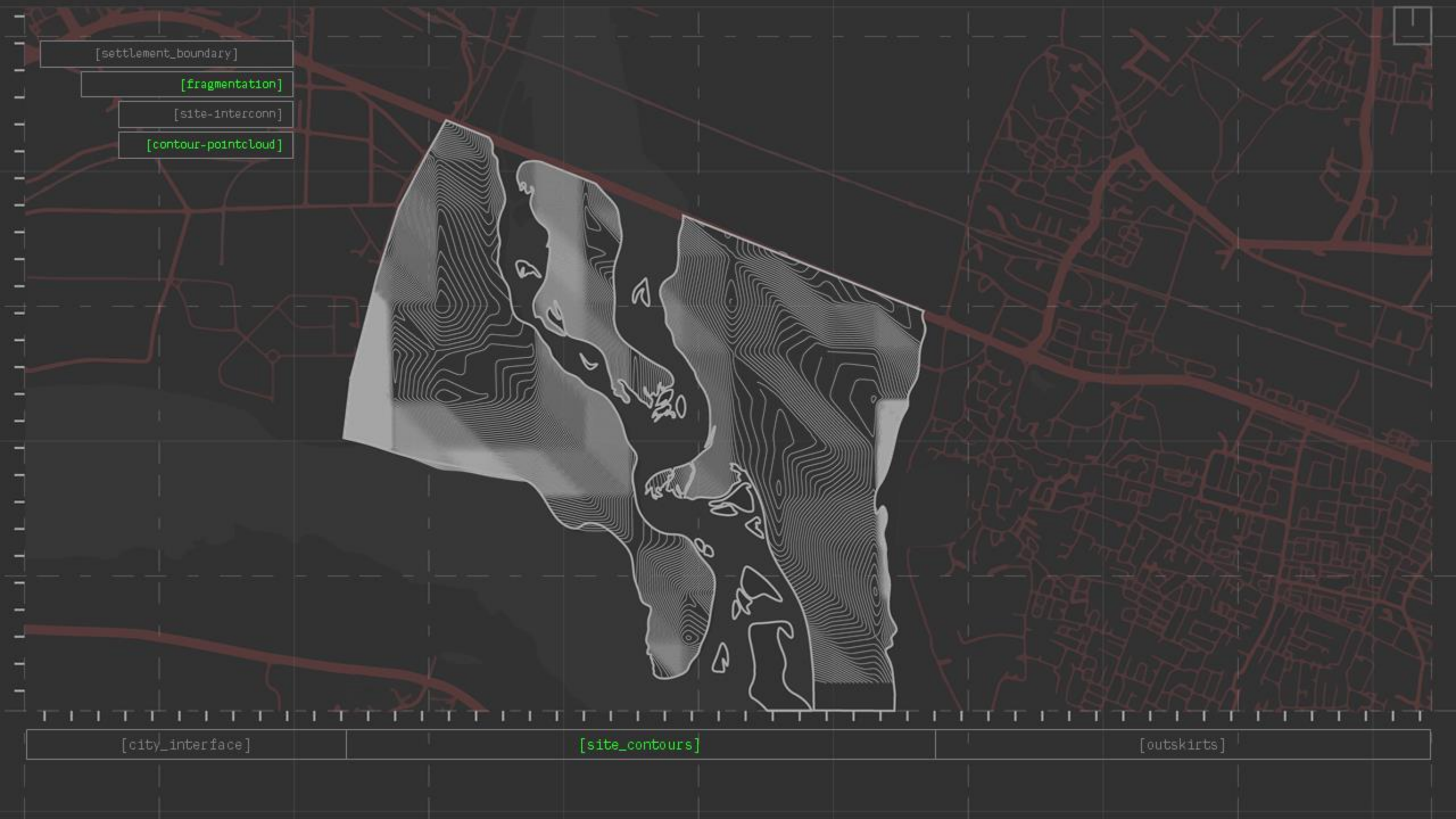
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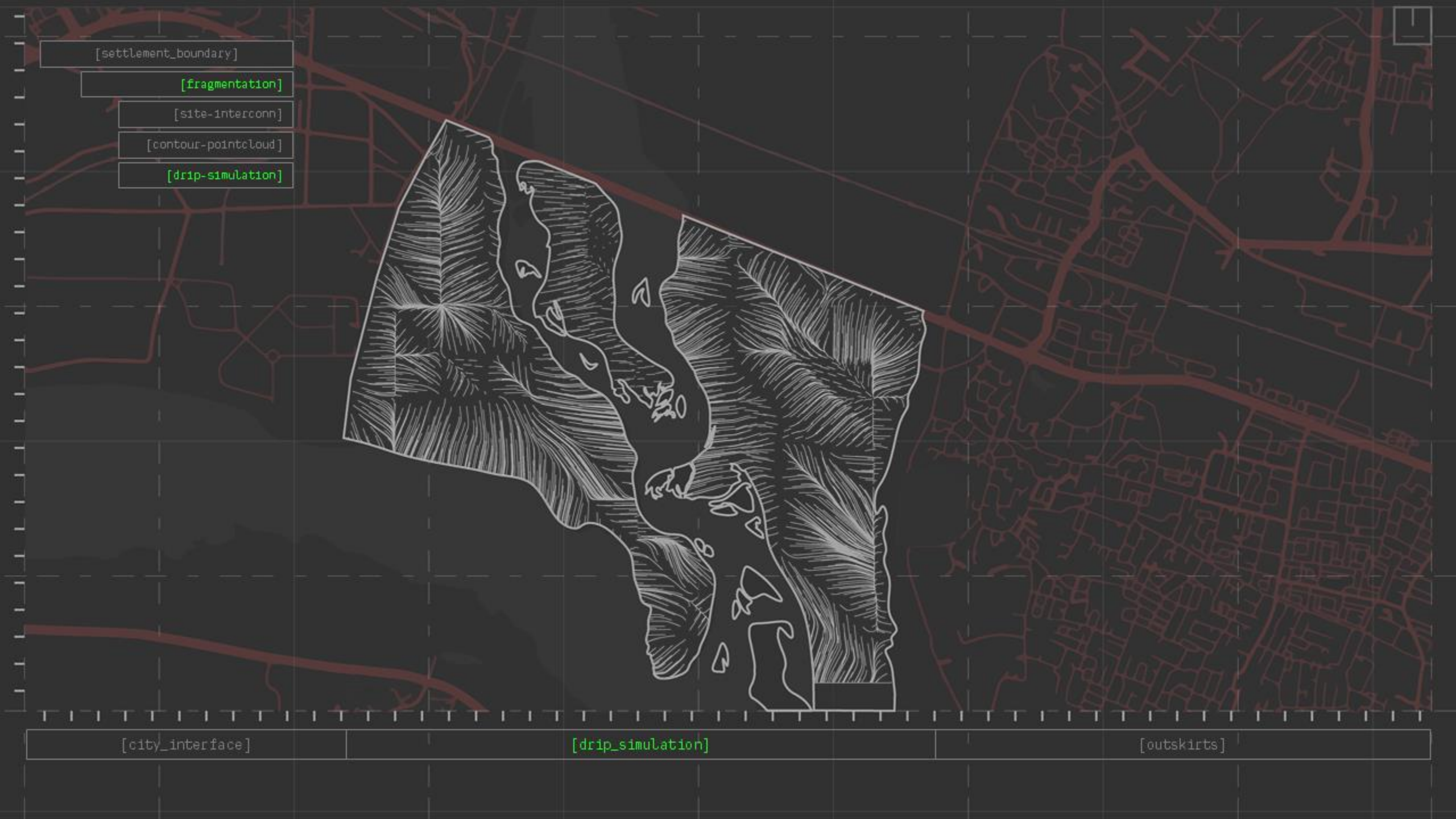
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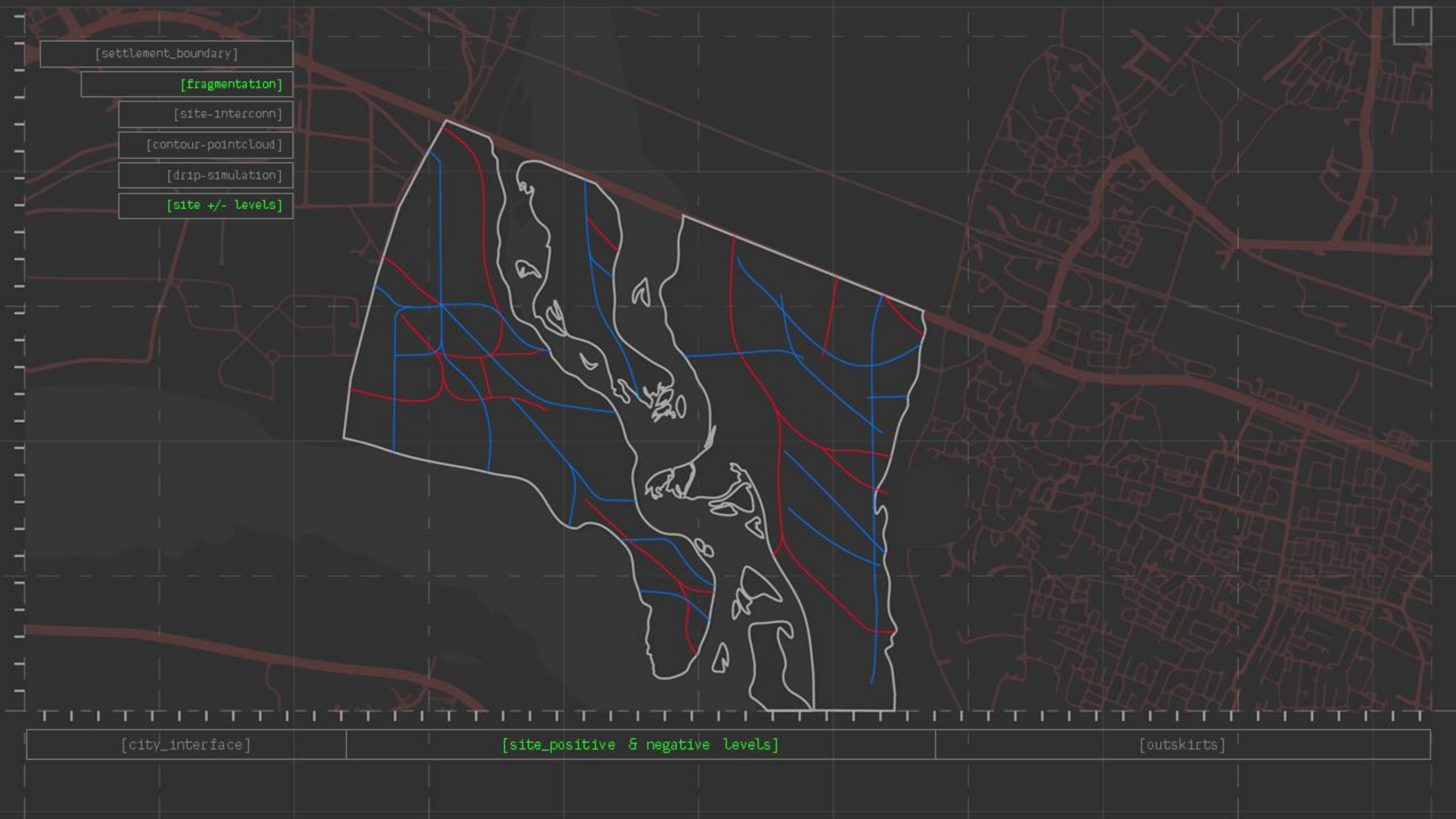
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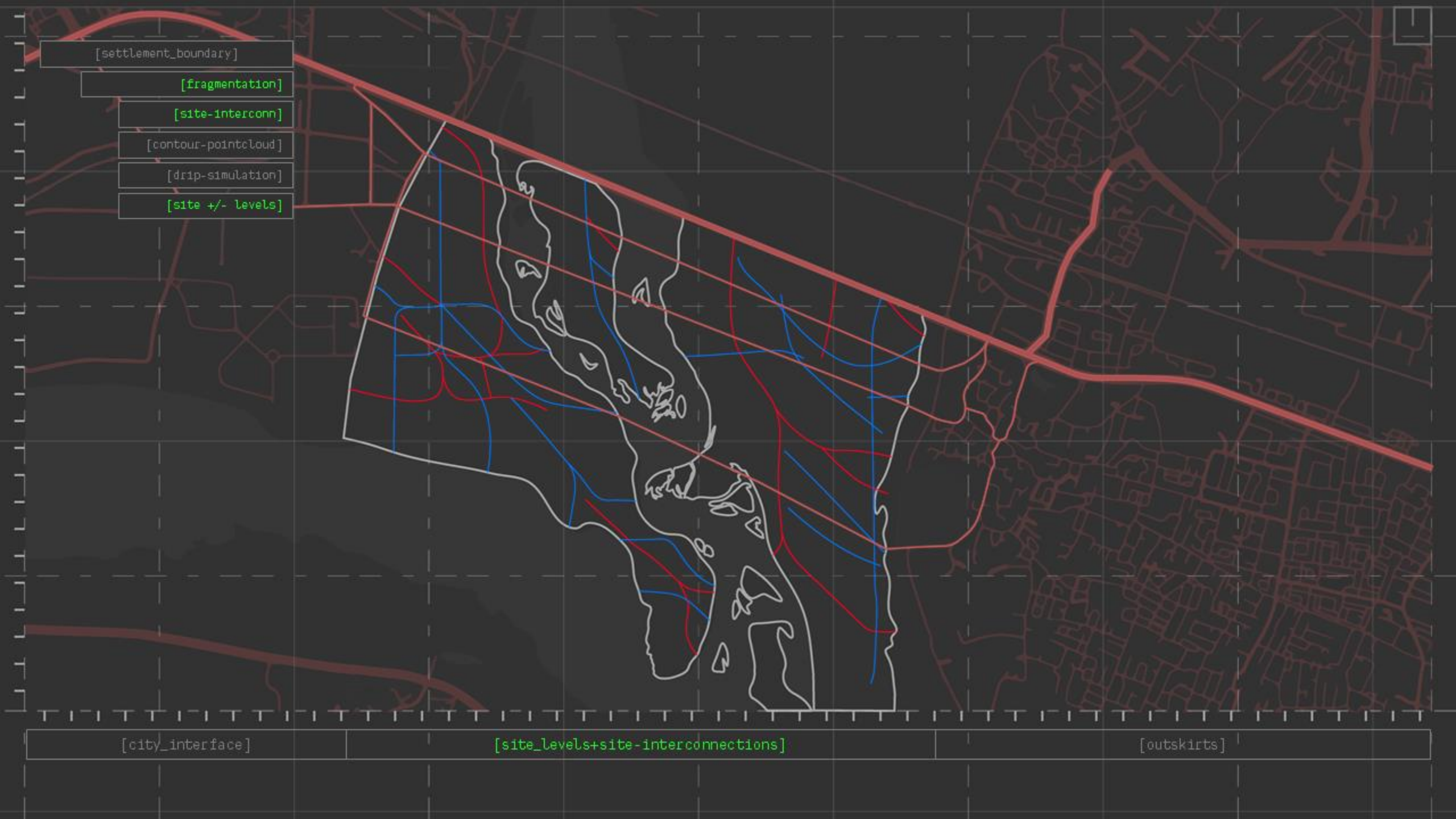
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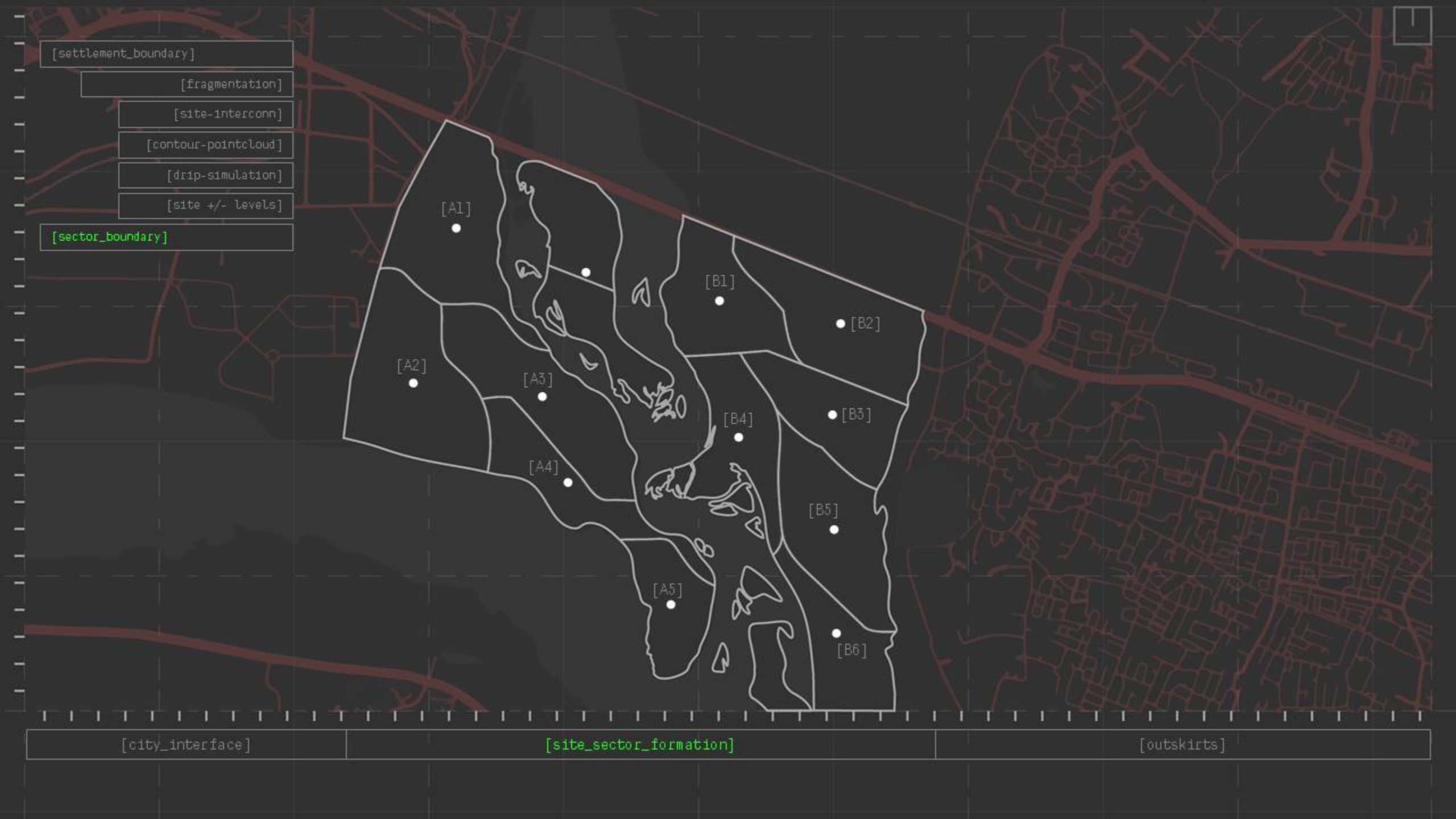
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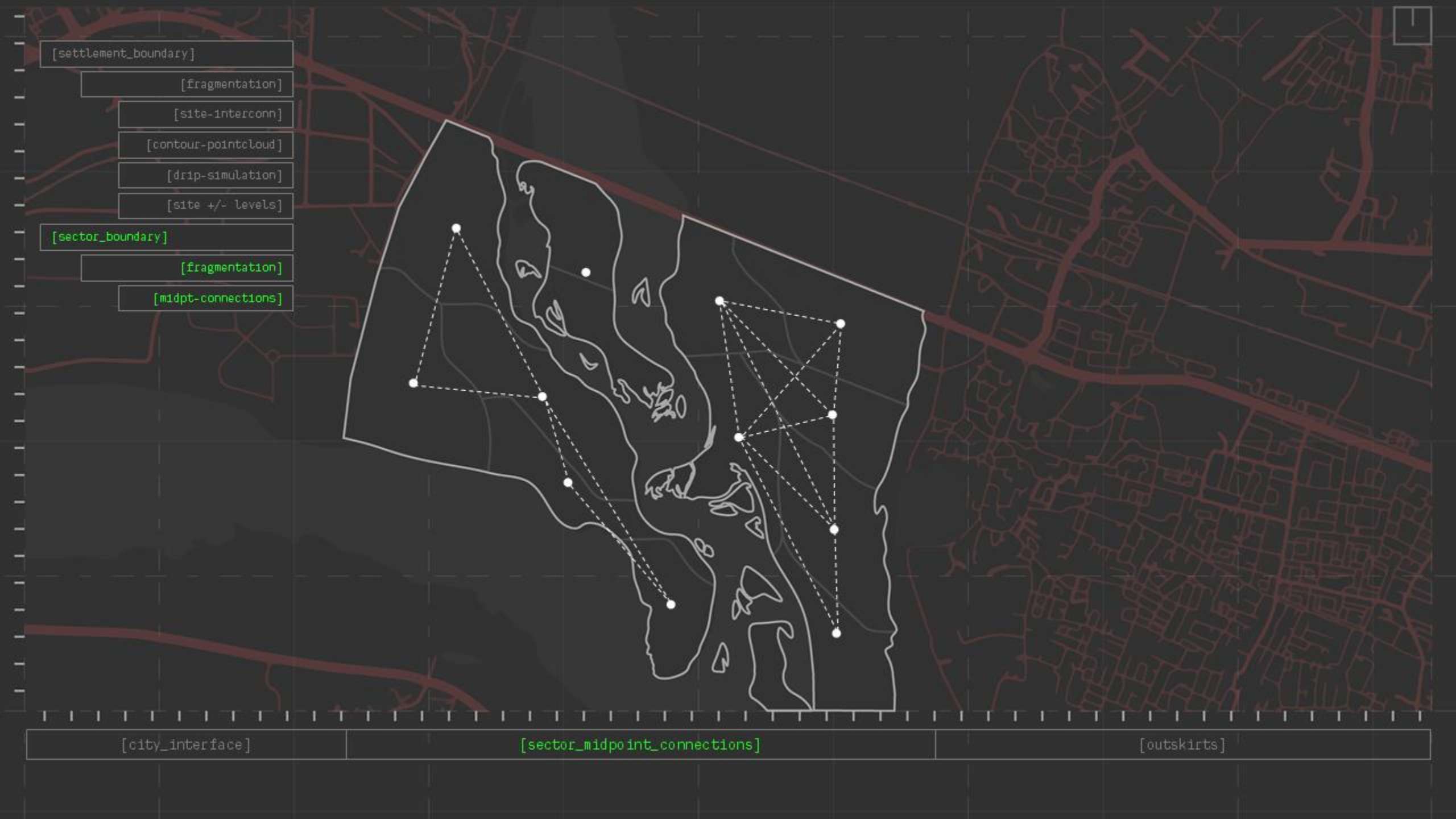
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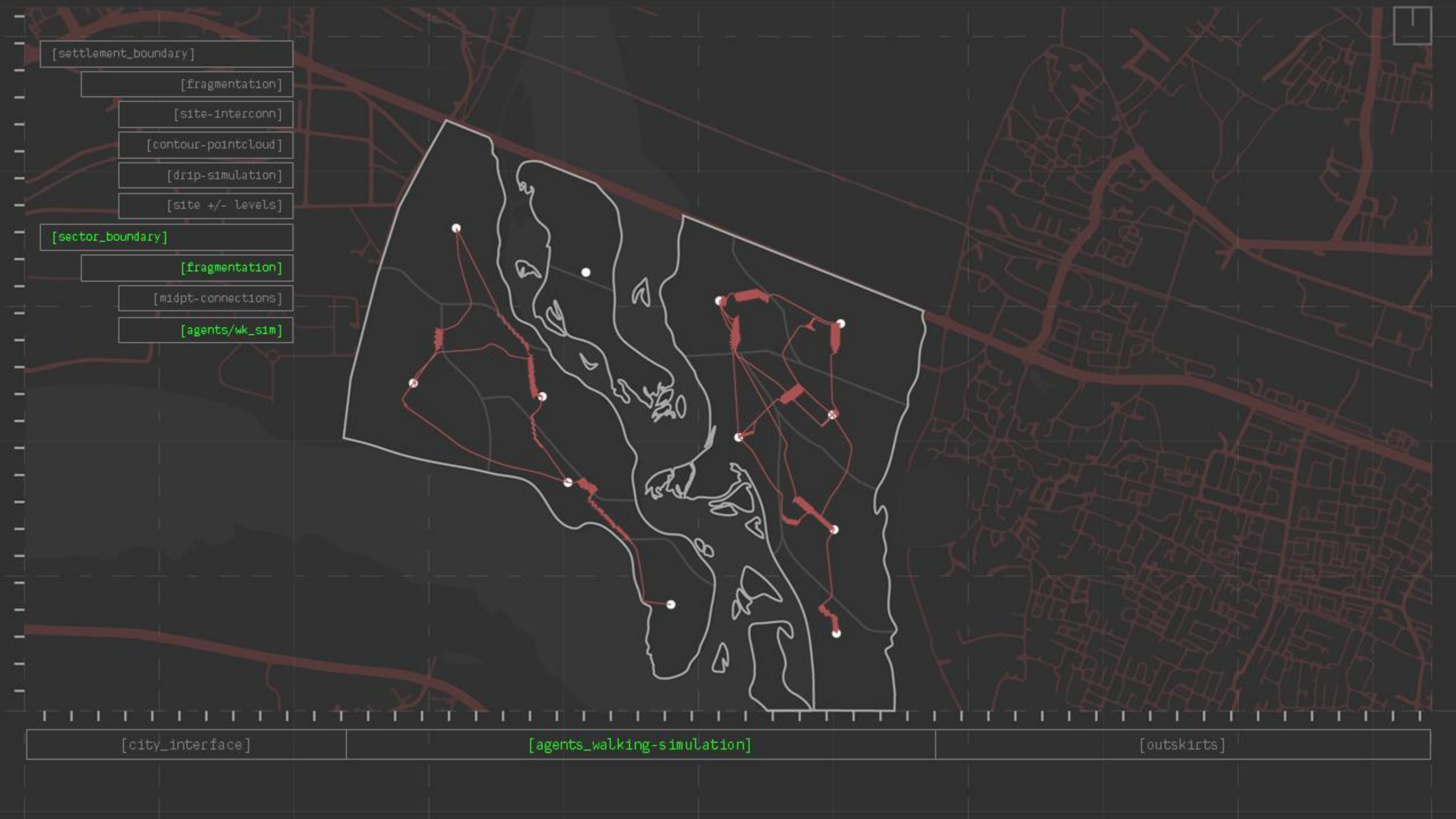
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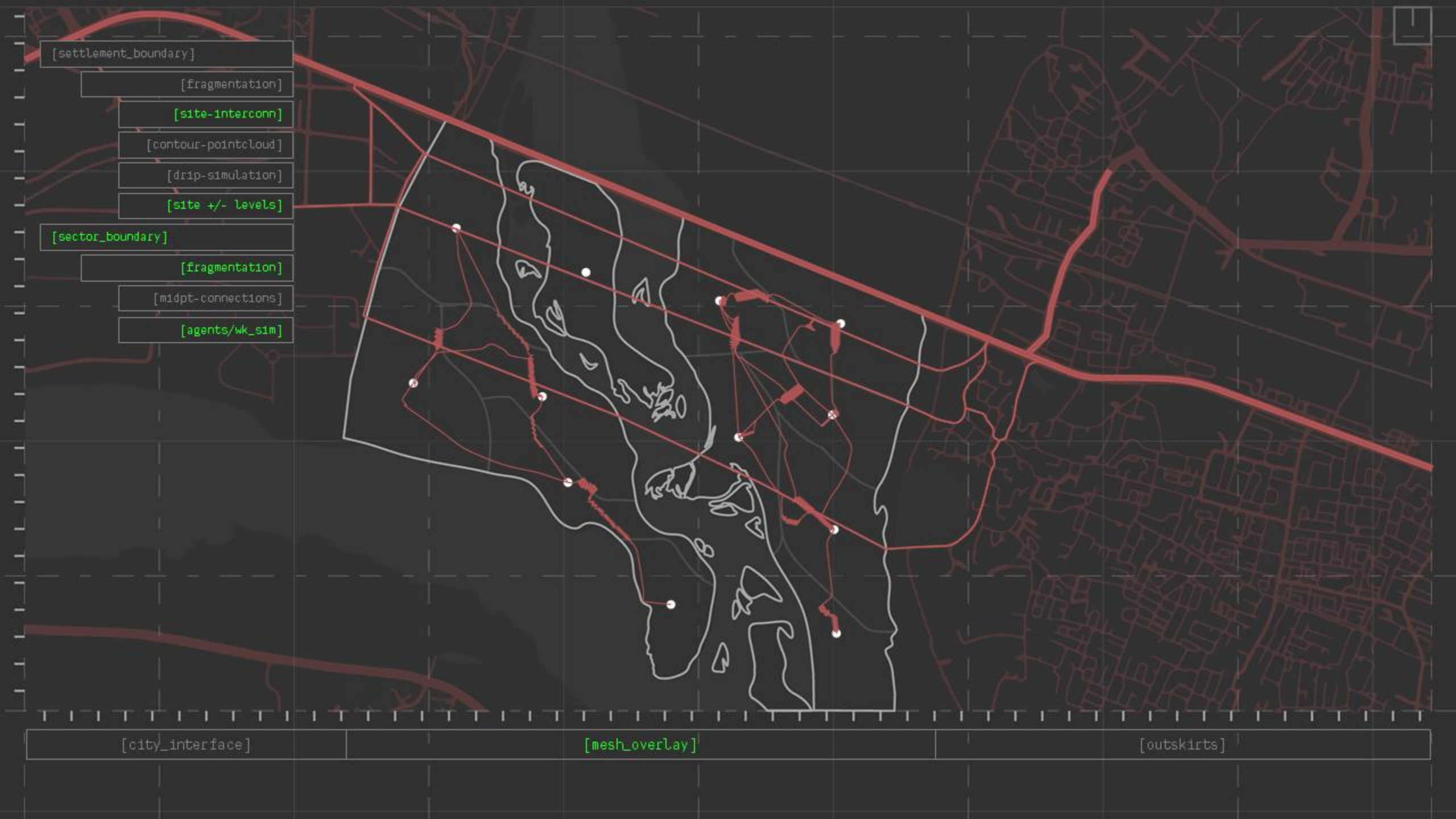
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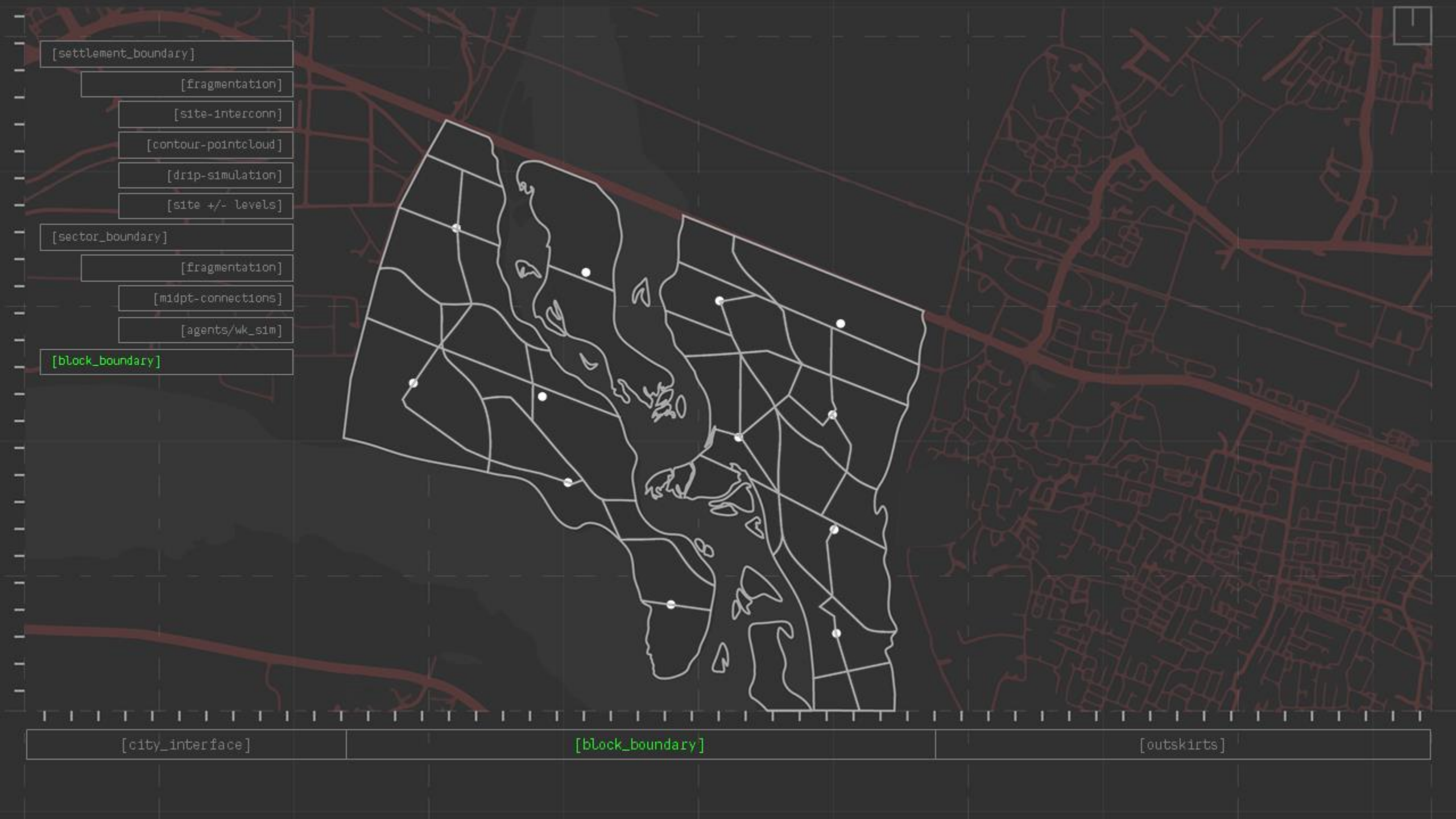
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[URBAN CATALOGUE]

[FUNCTION SCHEME]

[PUBLIC]

Food Court	Area – 400 sqm
Market Place	Area – 350 sqm
Pavilion	Area – 1500 sqm
Office	Area – 120 sqm
Hospital	Area – 300 sqm
Police Station	Area – 300 sqm

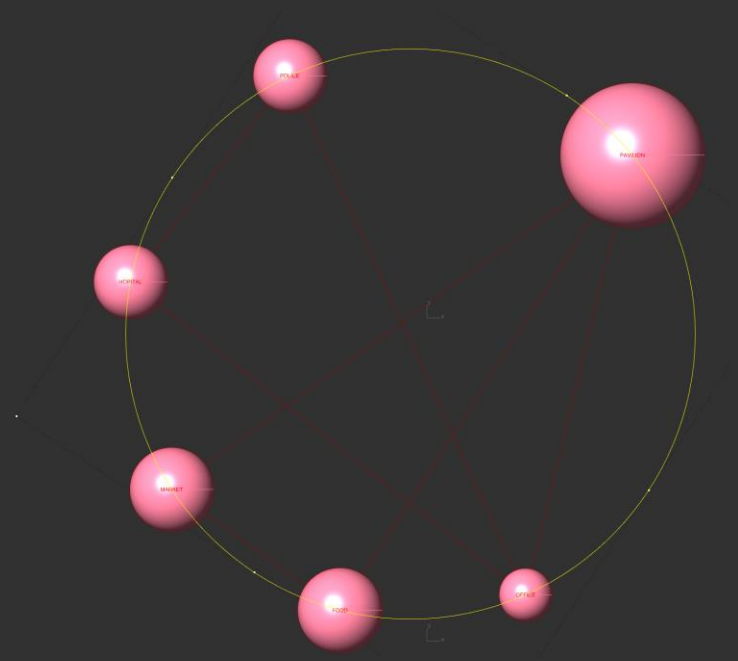
[COMMUNITY]

WATER TAP	Area – 15 sqm
LATRINES	Area – 30 sqm
SHOWER	Area – 30 sqm
SACRED SPACE	Area – 120 sqm
Dwelling Cluster	Area – 100 sqm

mad

[PROGRAM_CATALOGUE]

[Public Functions]



Food Court
Area – 400 sqm

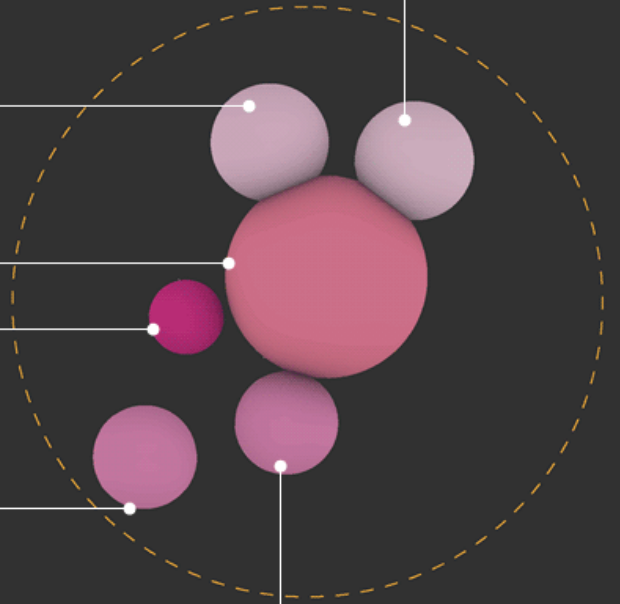
Market Place
Area – 350 sqm

Pavilion
Area – 1500 sqm

Office
Area – 120 sqm

Hospital
Area – 300 sqm

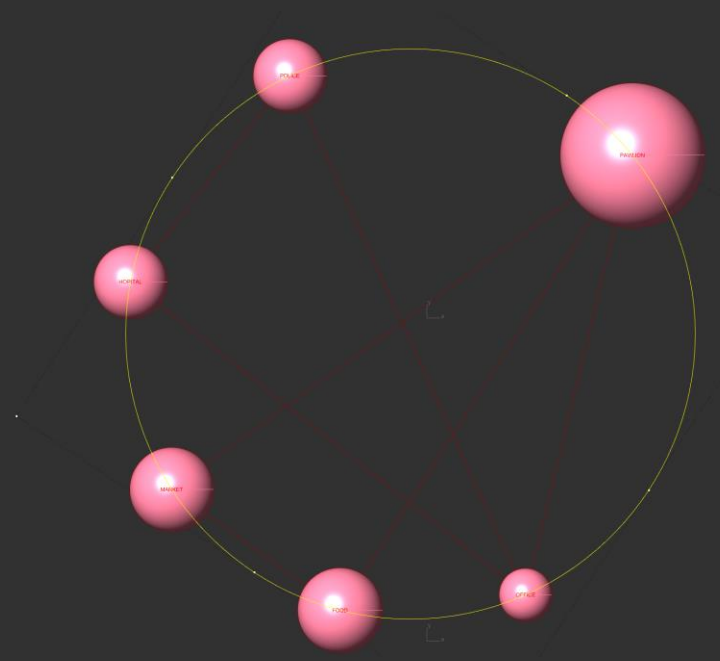
Police Station
Area – 300 sqm



Average Cluster Area – 3500 sqm

[PROGRAM_CATALOGUE]

[Public Functions]

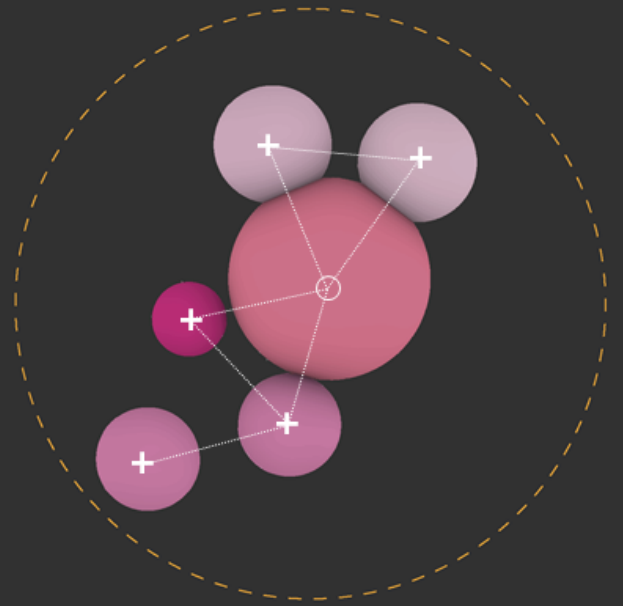


Urban Rules

- Pavilion >>> Food Court
- Pavilion >>> Market Place
- Food Court >>> Market Place

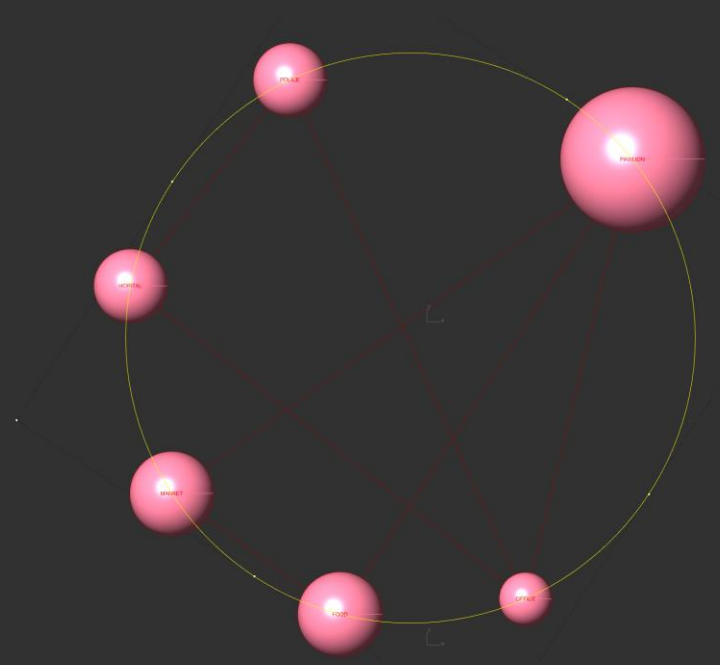
- Pavilion> Police Station
- Pavilion> Office

- Police Station >>> Office
- Police Station >>> Hospital



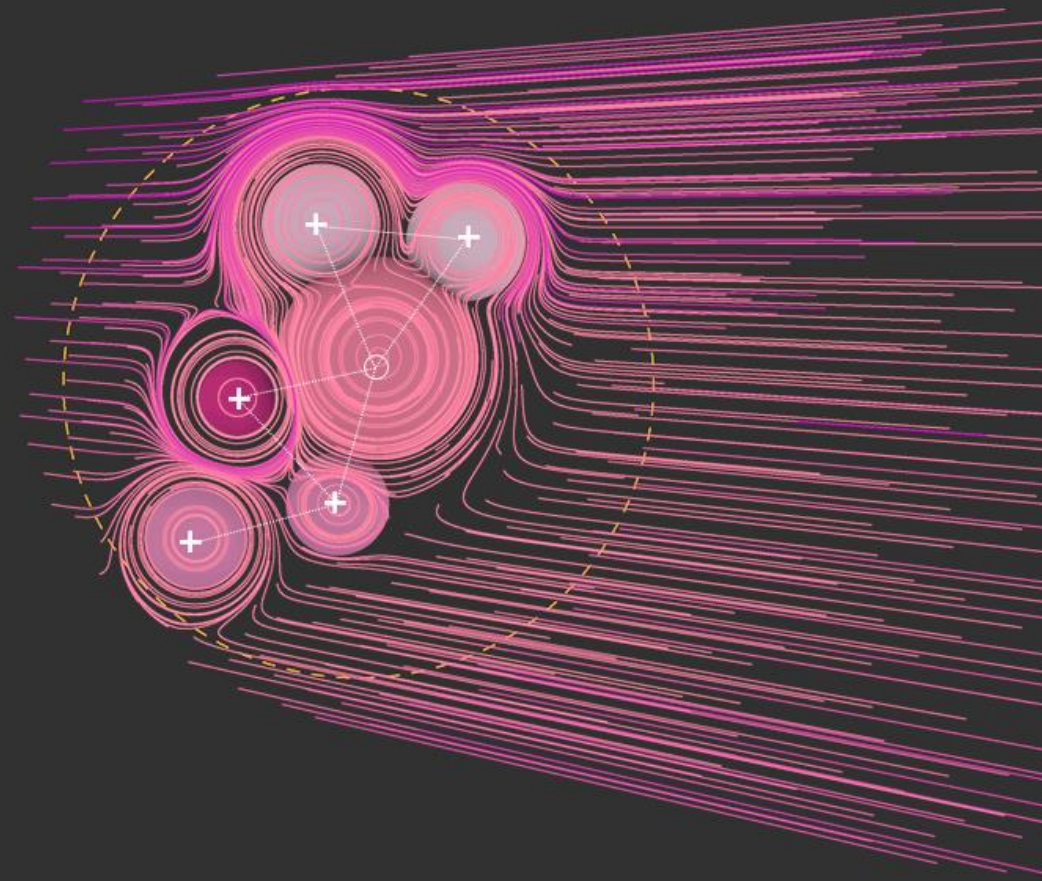
[PROGRAM_CATALOGUE]

[Public Functions]



Urban Rules

- Pavilion >>> Food Court
- Pavilion >>> Market Place
- Food Court >>> Market Place
- Pavilion> Police Station
- Pavilion> Office
- Police Station >>> Office
- Police Station >>> Hospital



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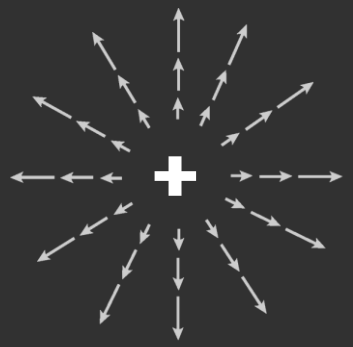

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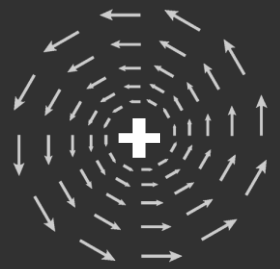
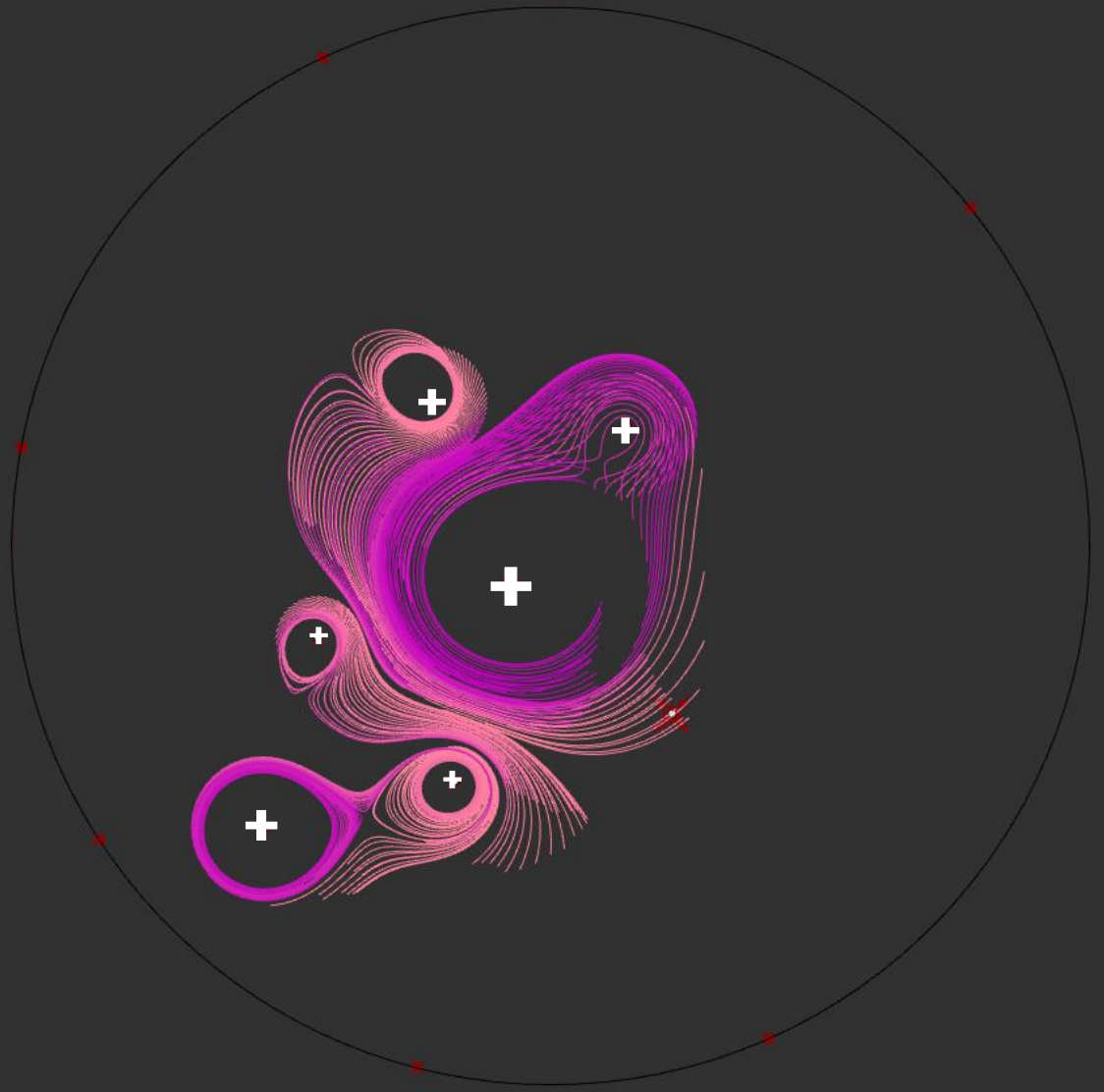


[Circulation & slope extent]



[VECTOR FIELD]

[PROGRAM_CATALOGUE]

[Community Cluster]

WATER TAP

Area – 15 sqm

LATRINES

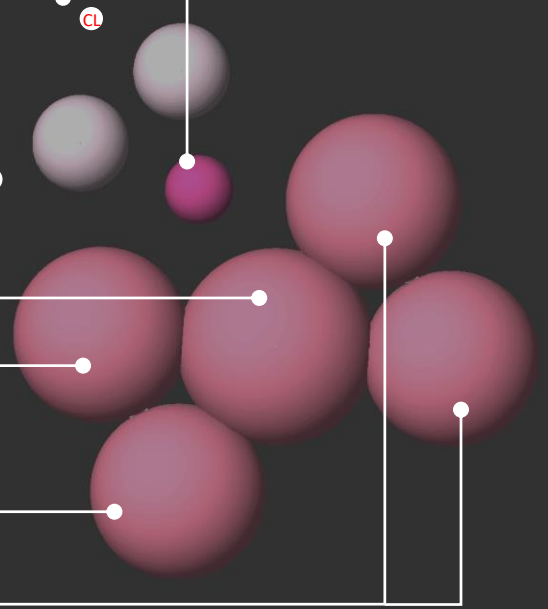
Area – 30 sqm

SHOWER

Area – 30 sqm

SACRED SPACE

Area – 120 sqm



Dwelling Cluster

Area – 100 sqm

Average Cluster Area – 750 sqm

[PROGRAM_CATALOGUE]

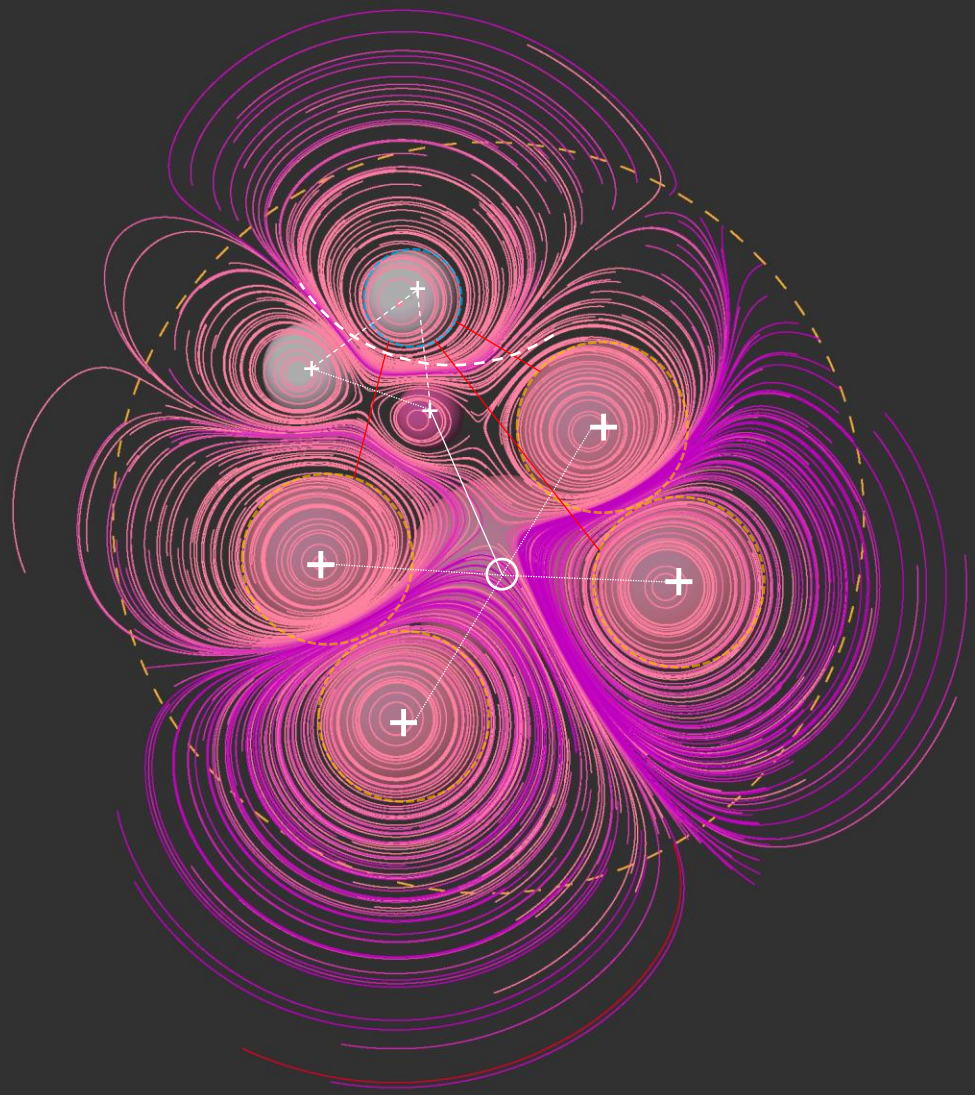
[Community Cluster]

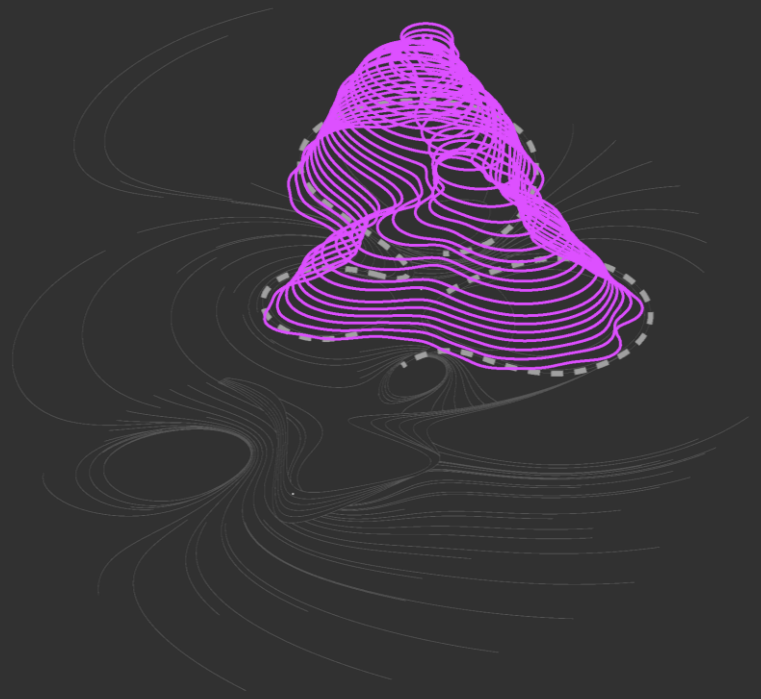
Urban Rules

- Sacred Space - Mid Point
- Dwelling >>> Sacred Space

- Water Tap >>> Sacred Space
- Water Tap >>> Shower

- Latrines > Shower
- Latrines > Water Tap
- Latrines () Dwellings | 6m>X>50m



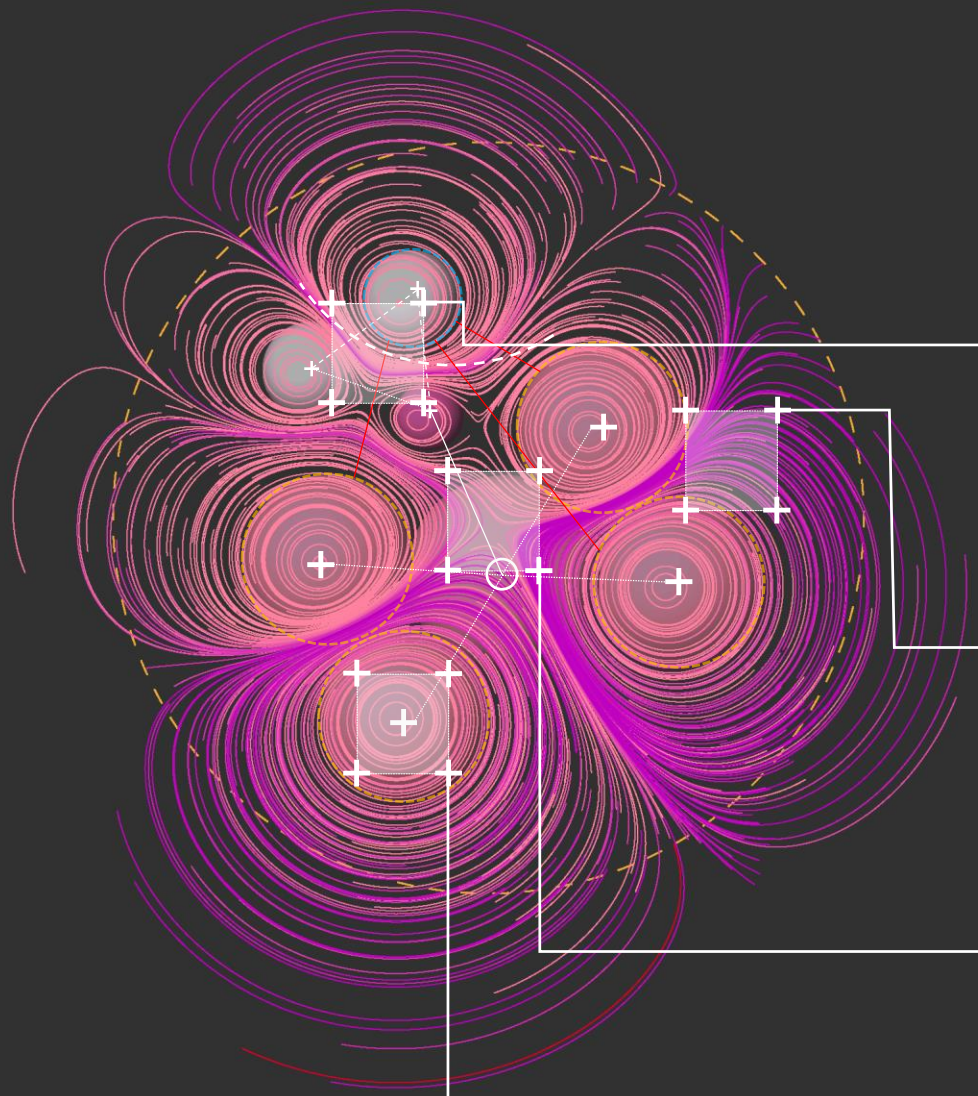


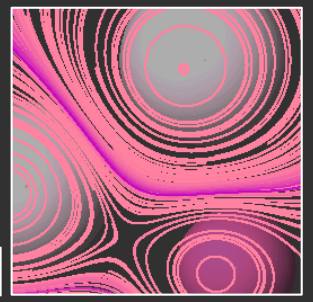
[PROGRAM_CATALOGUE]

[Community Cluster]

Urban Rules

- Sacred Space - Mid Point
- Dwelling >>> Sacred Space
- Water Tap >>> Sacred Space
- Water Tap >>> Shower
- Latrines > Shower
- Latrines > Water Tap
- Latrines () Dwellings | 6m>X>50m





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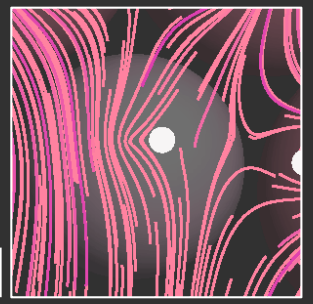

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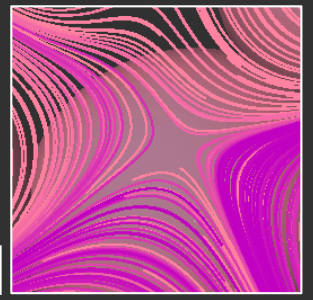

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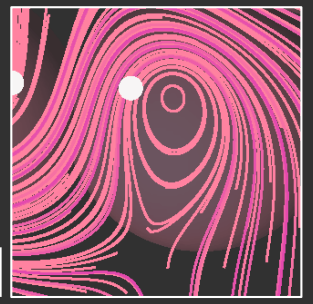

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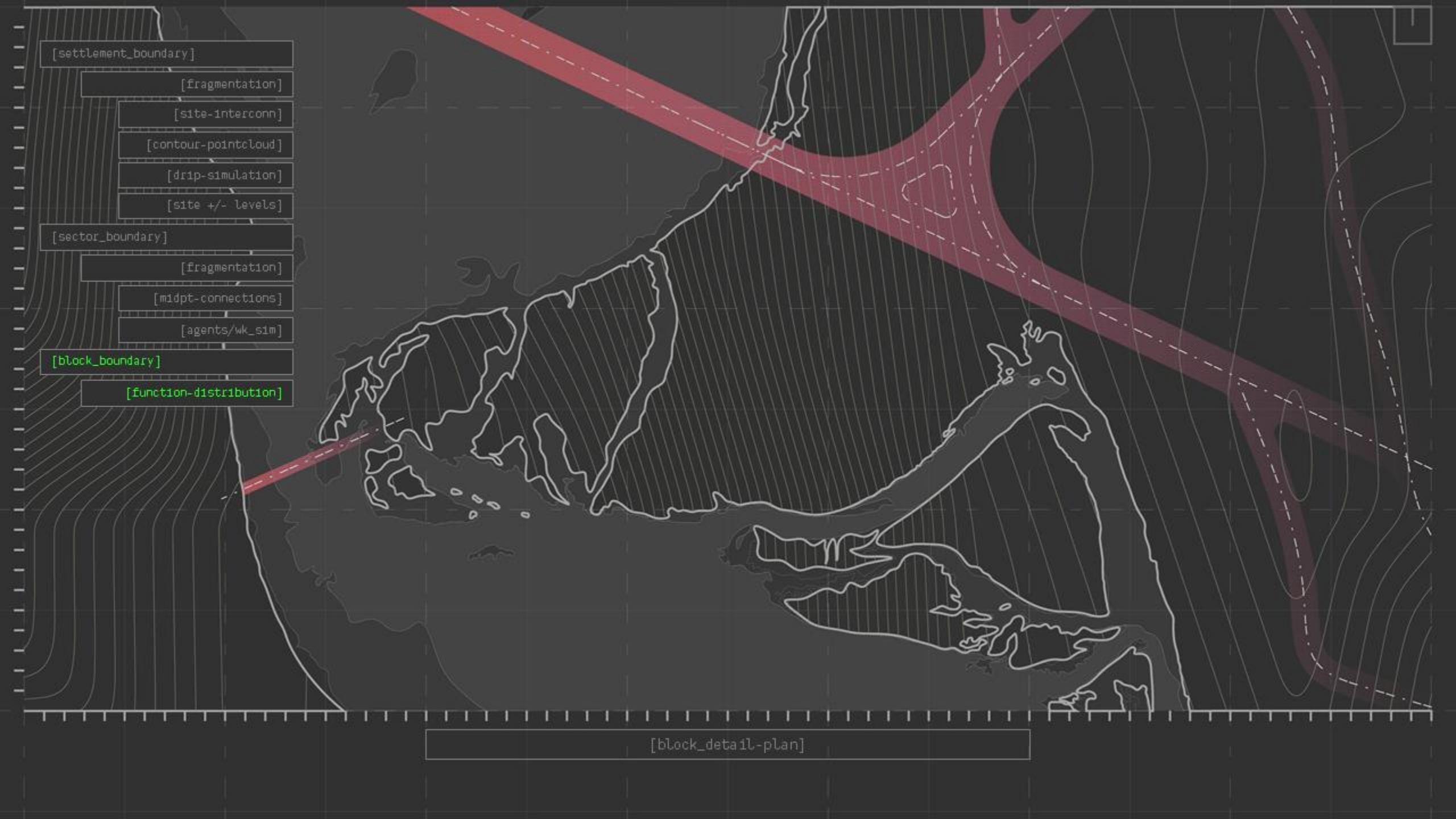
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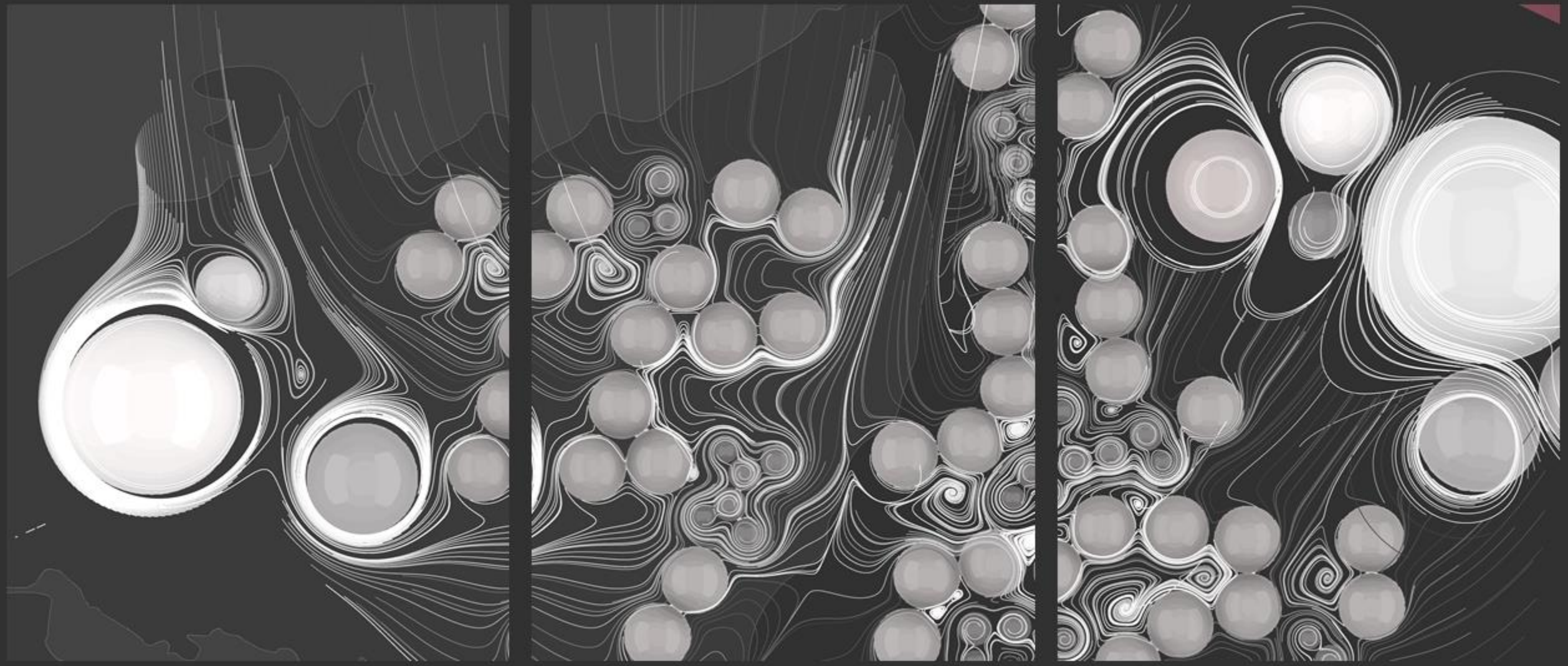
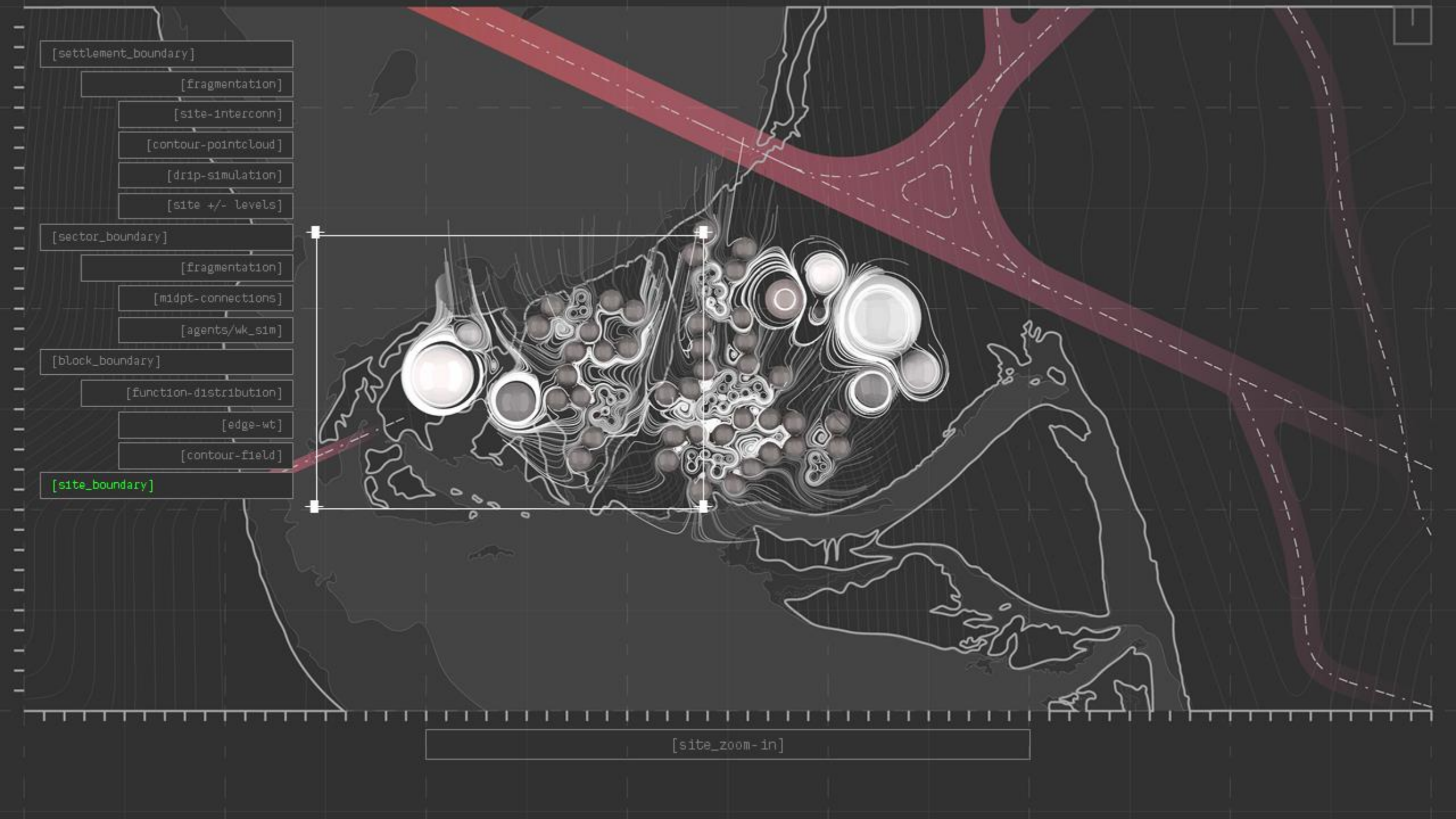


[Meso-Detailing]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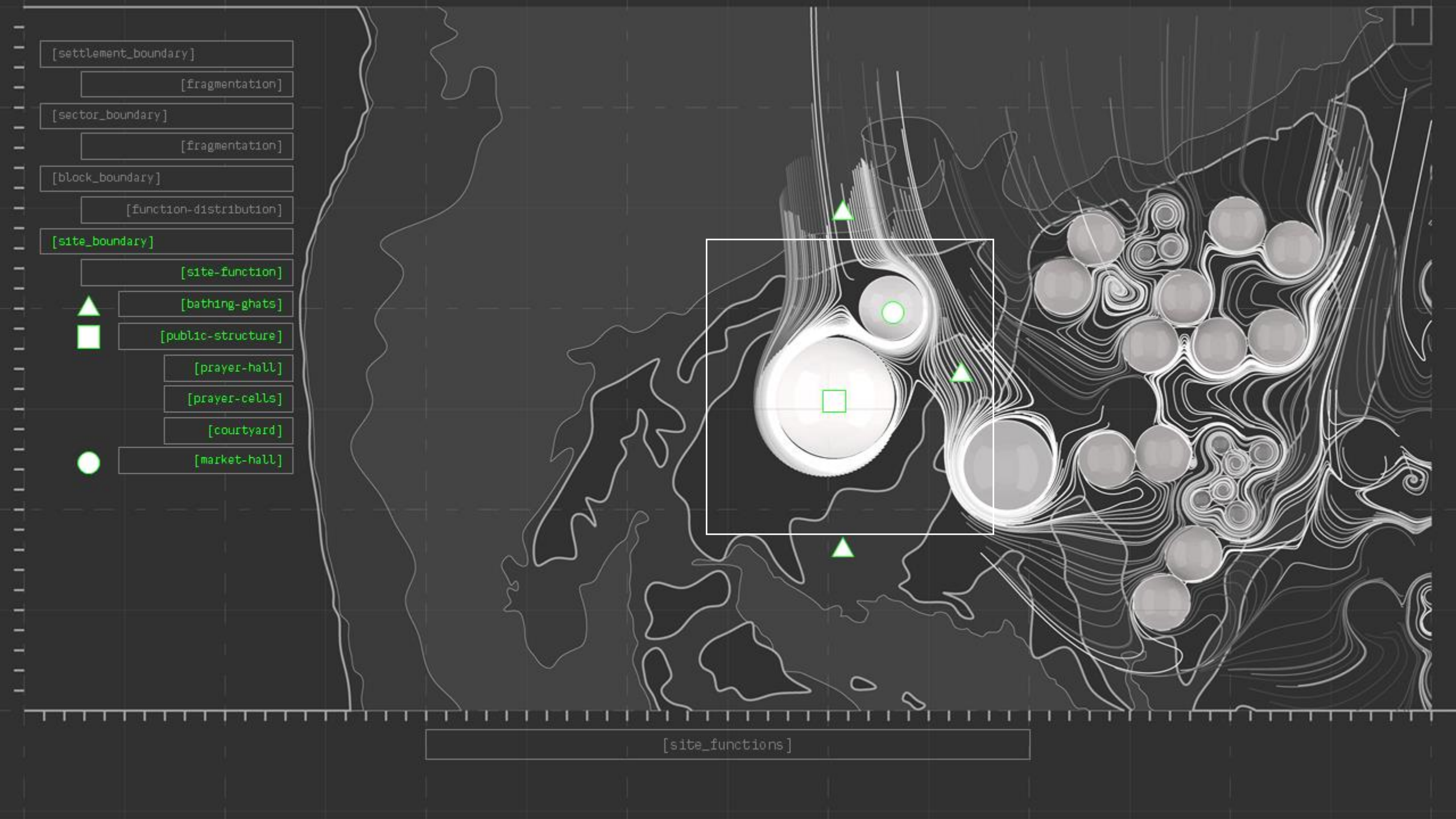
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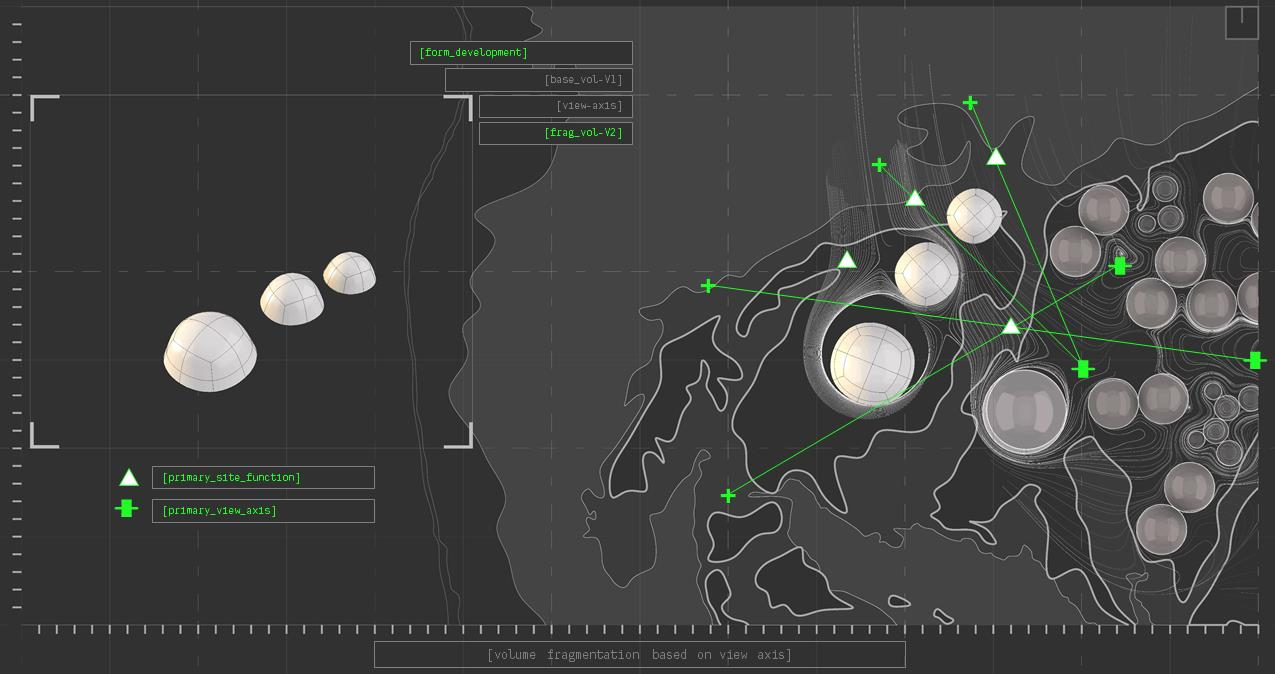
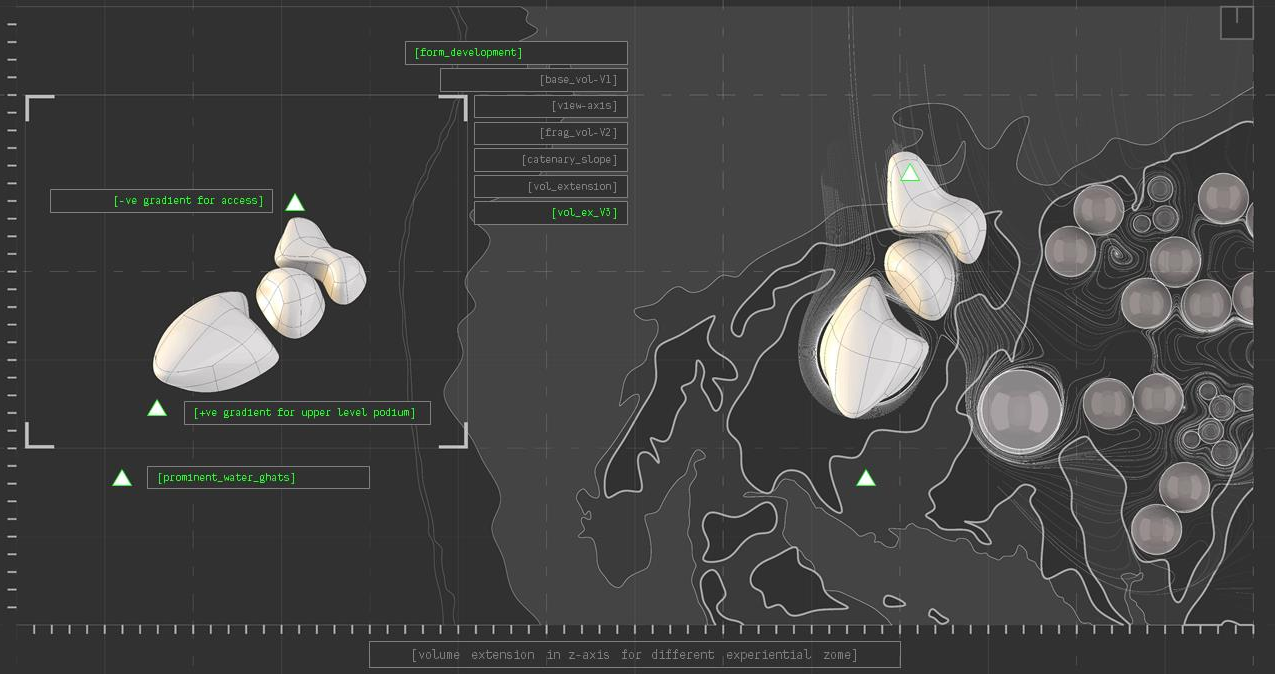
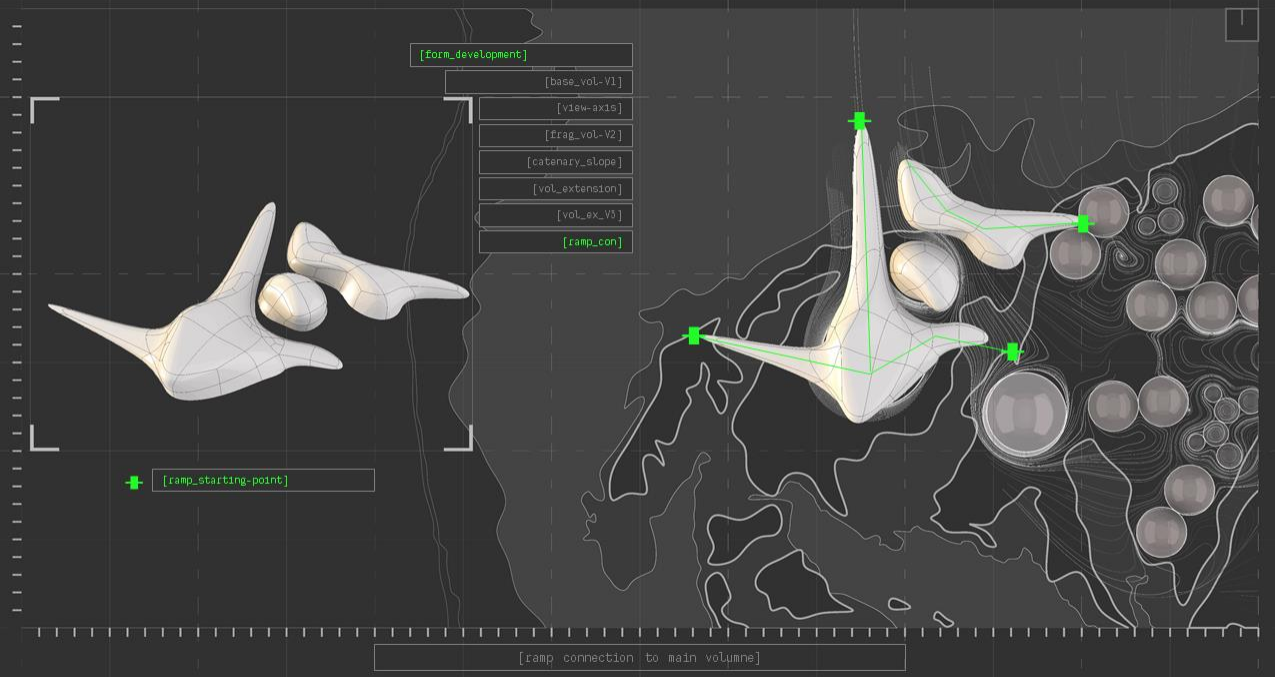


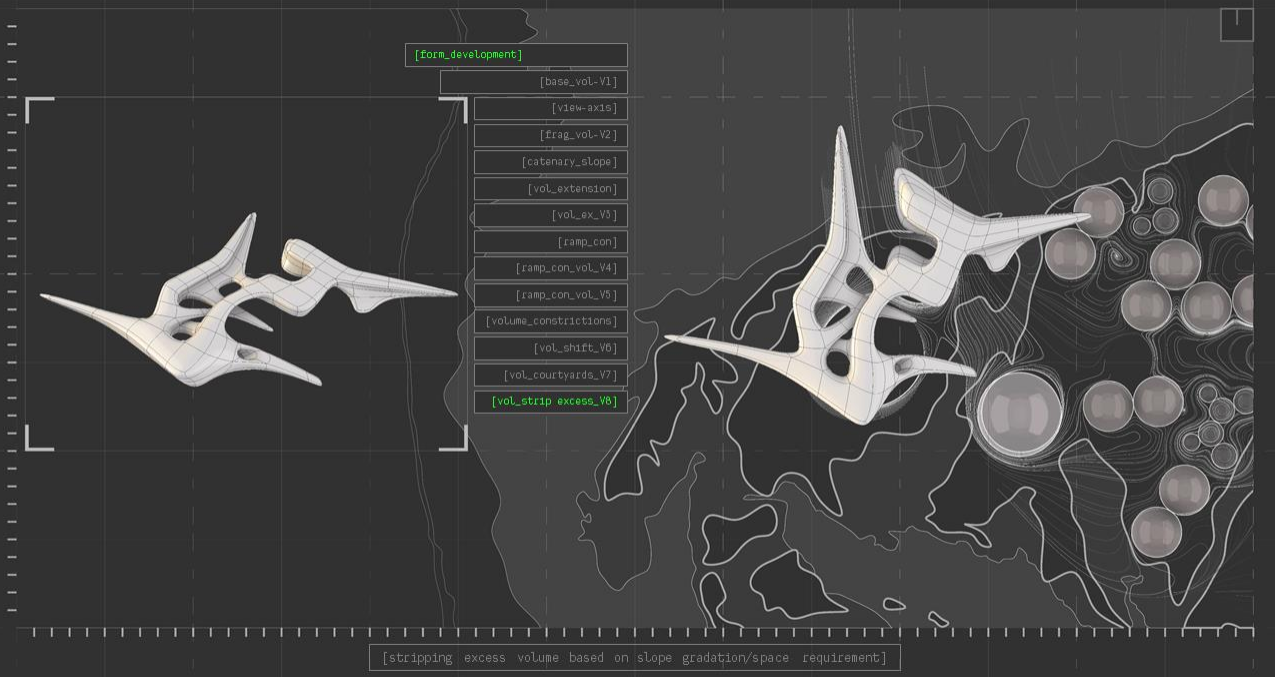
[volume fragmentation based on view axis]



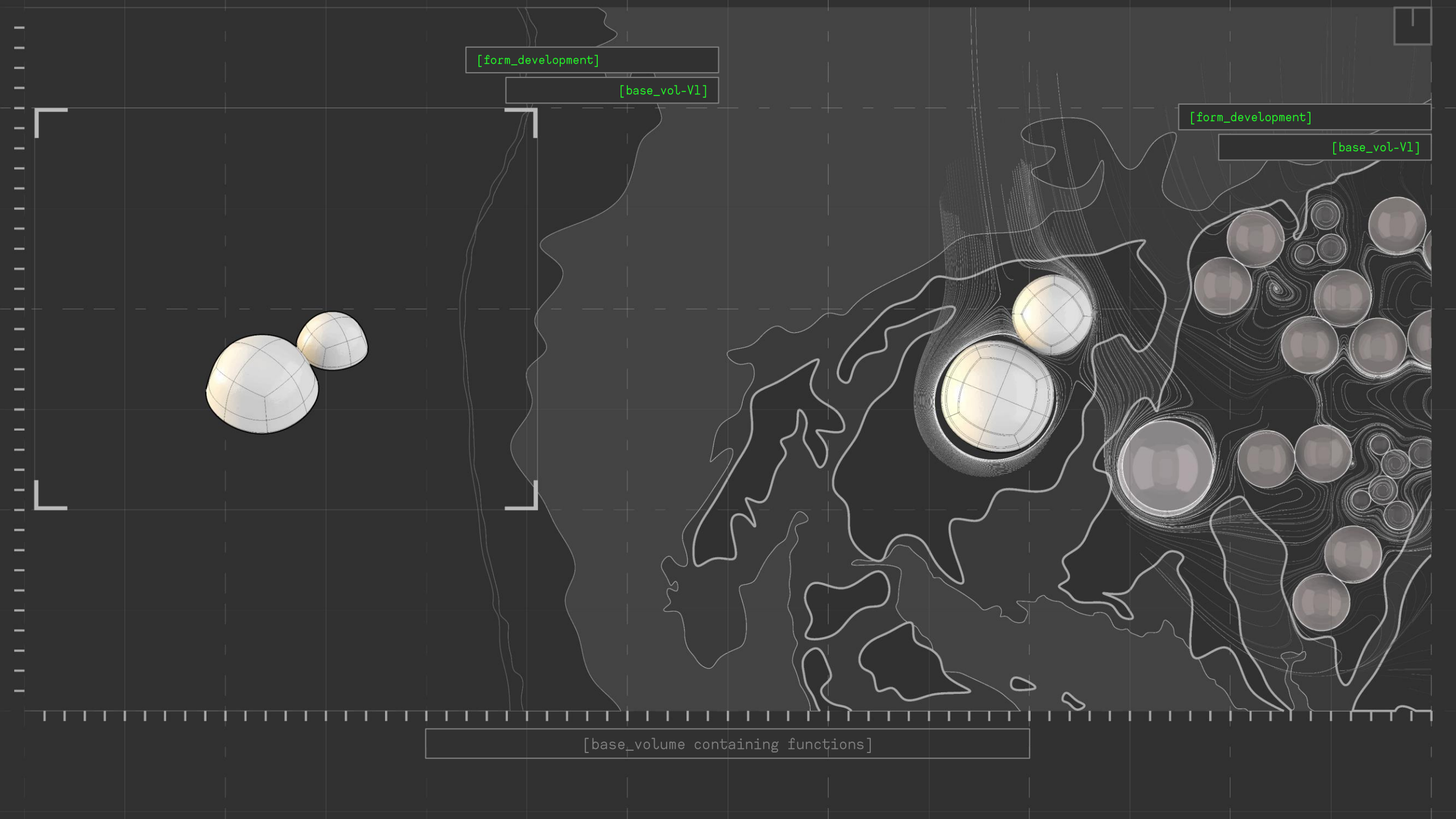
[volume extension in z-axis for different experiential zone]



[ramp connection to main volumne]



[stripping excess volume based on slope gradation/space requirement]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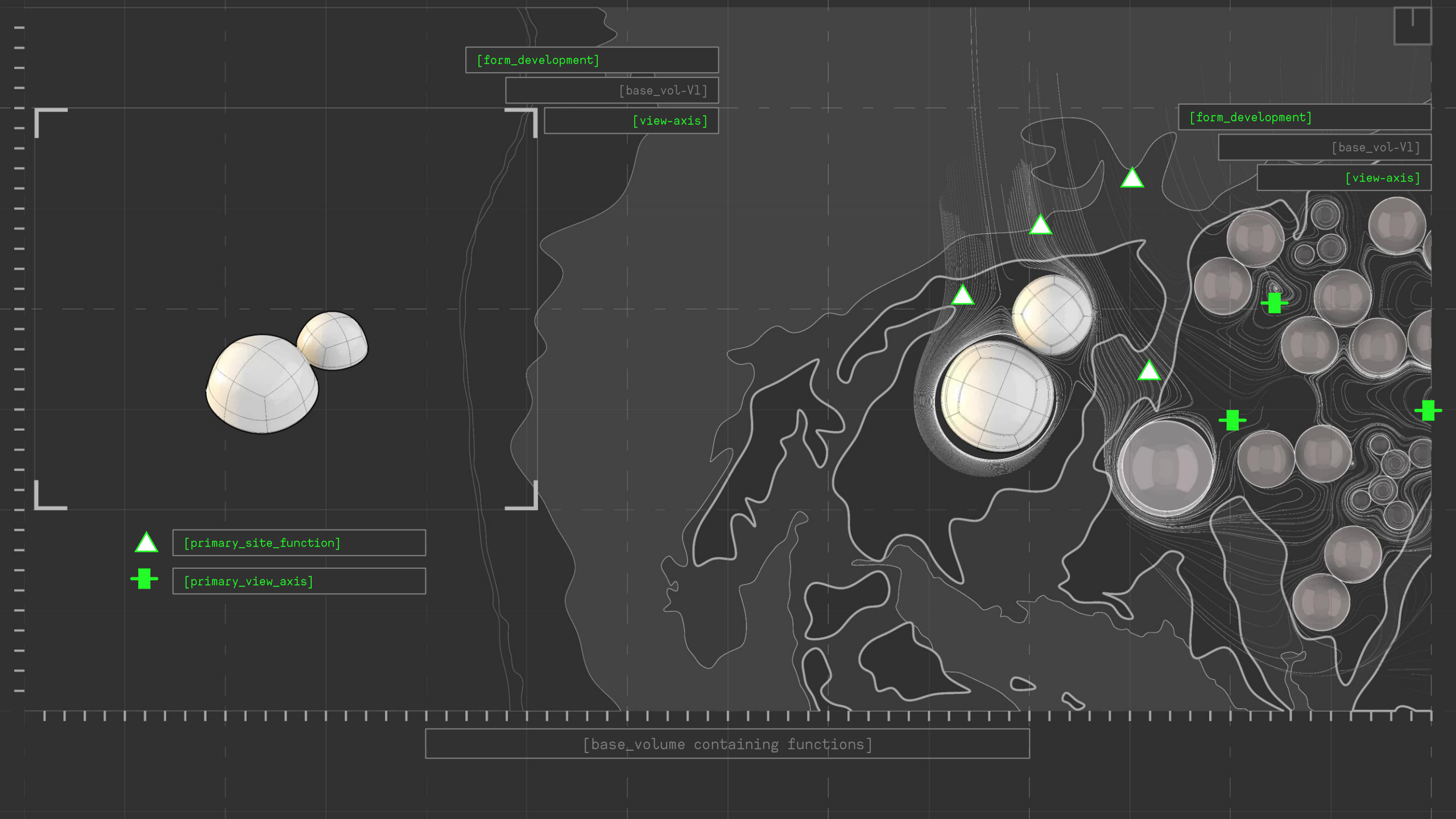
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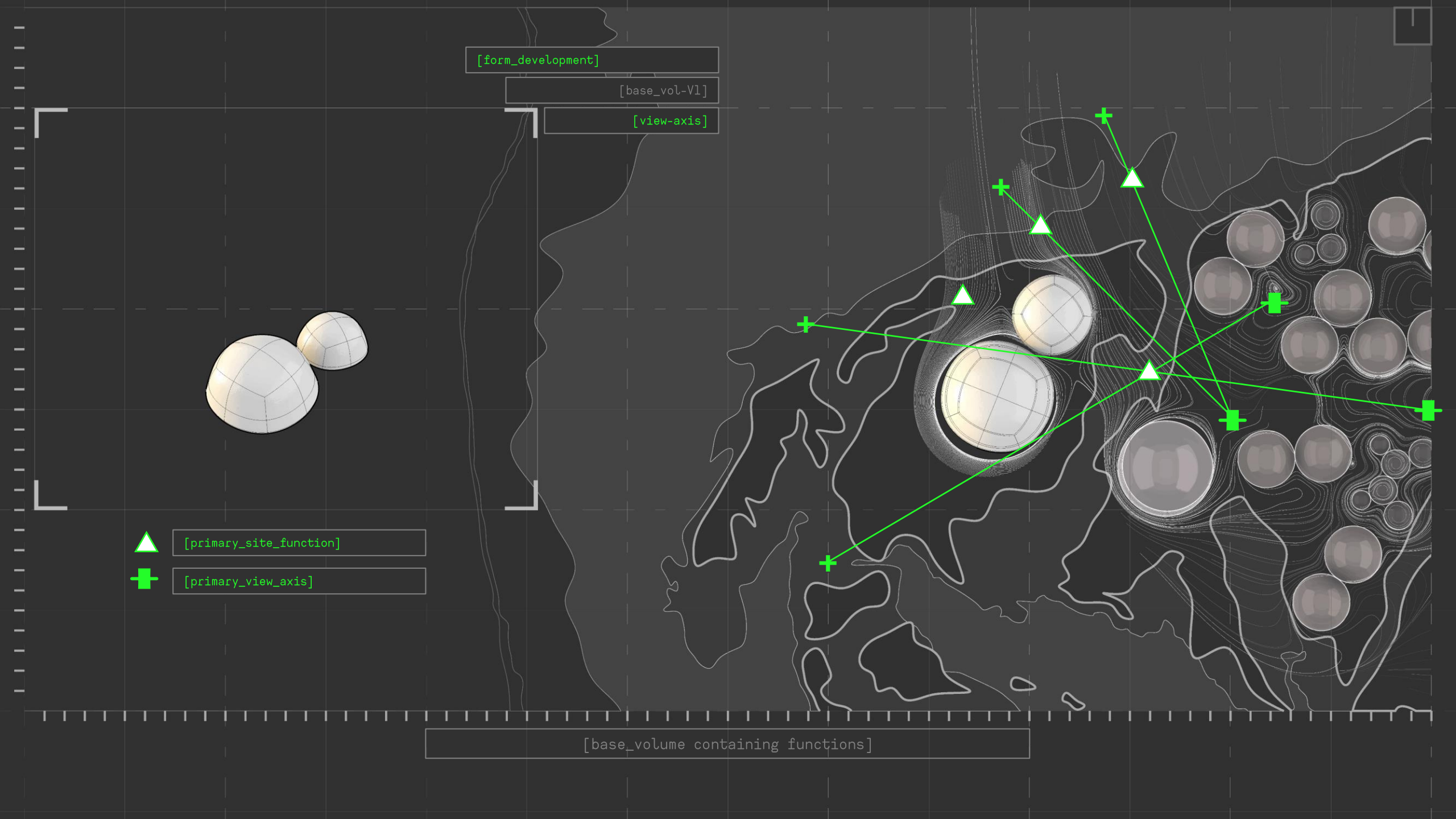
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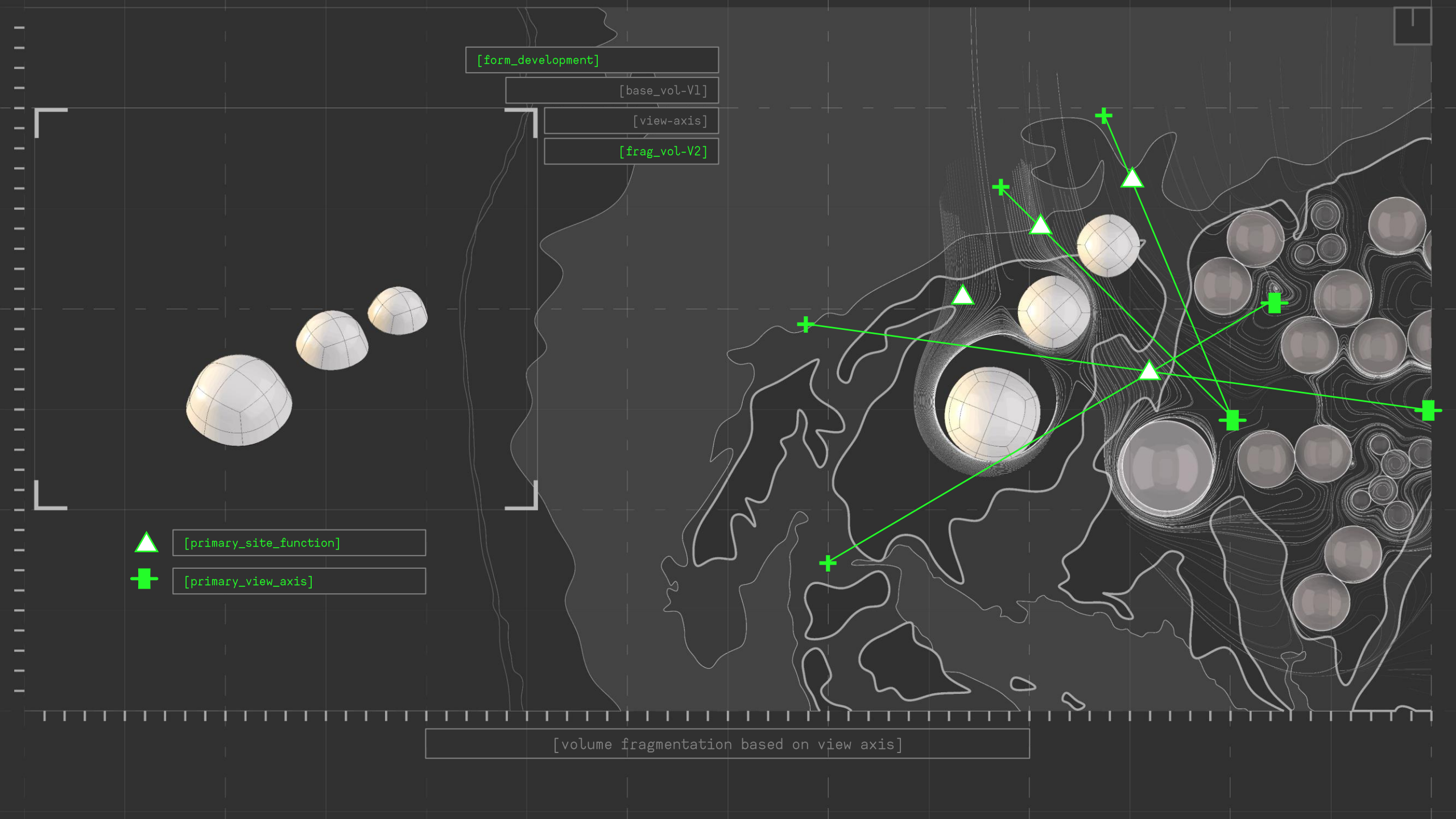
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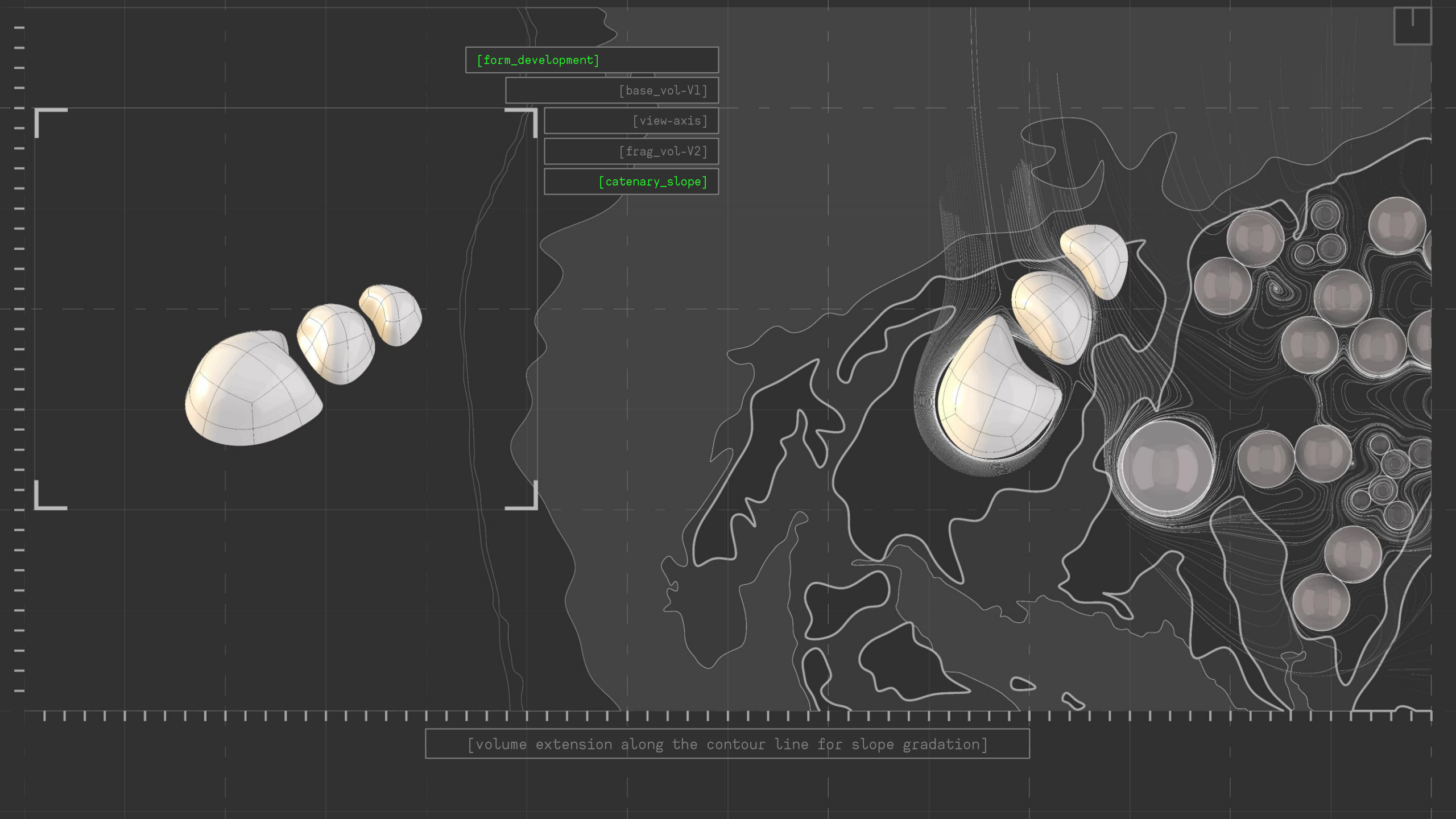
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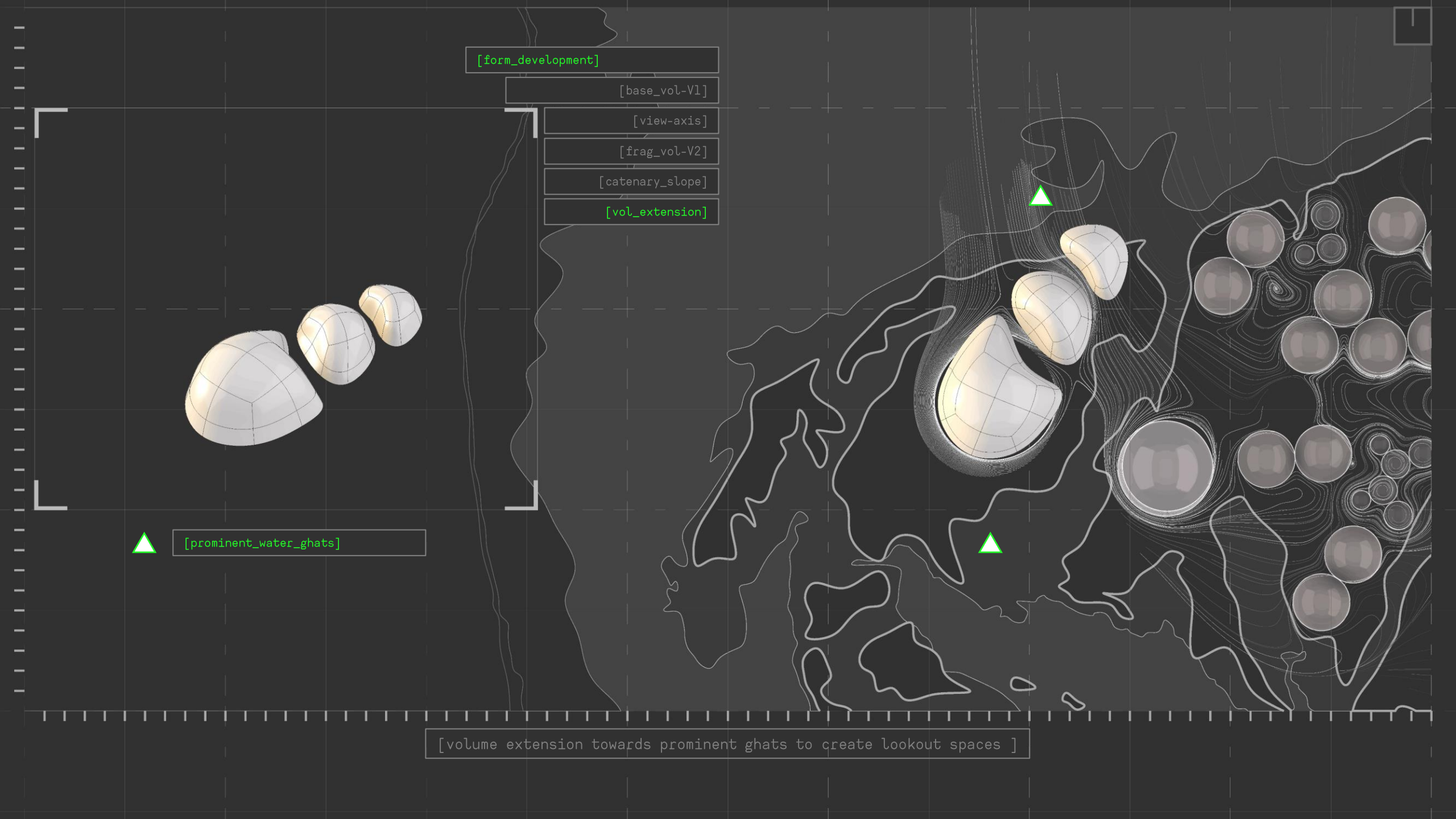
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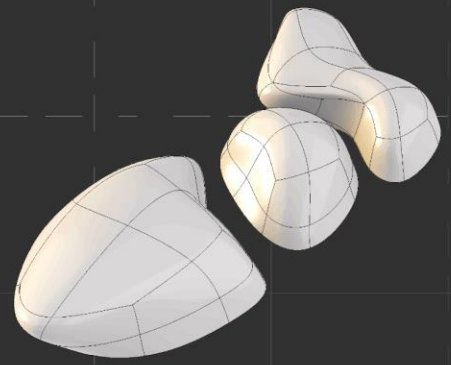

[+ve gradient for upper level podium]

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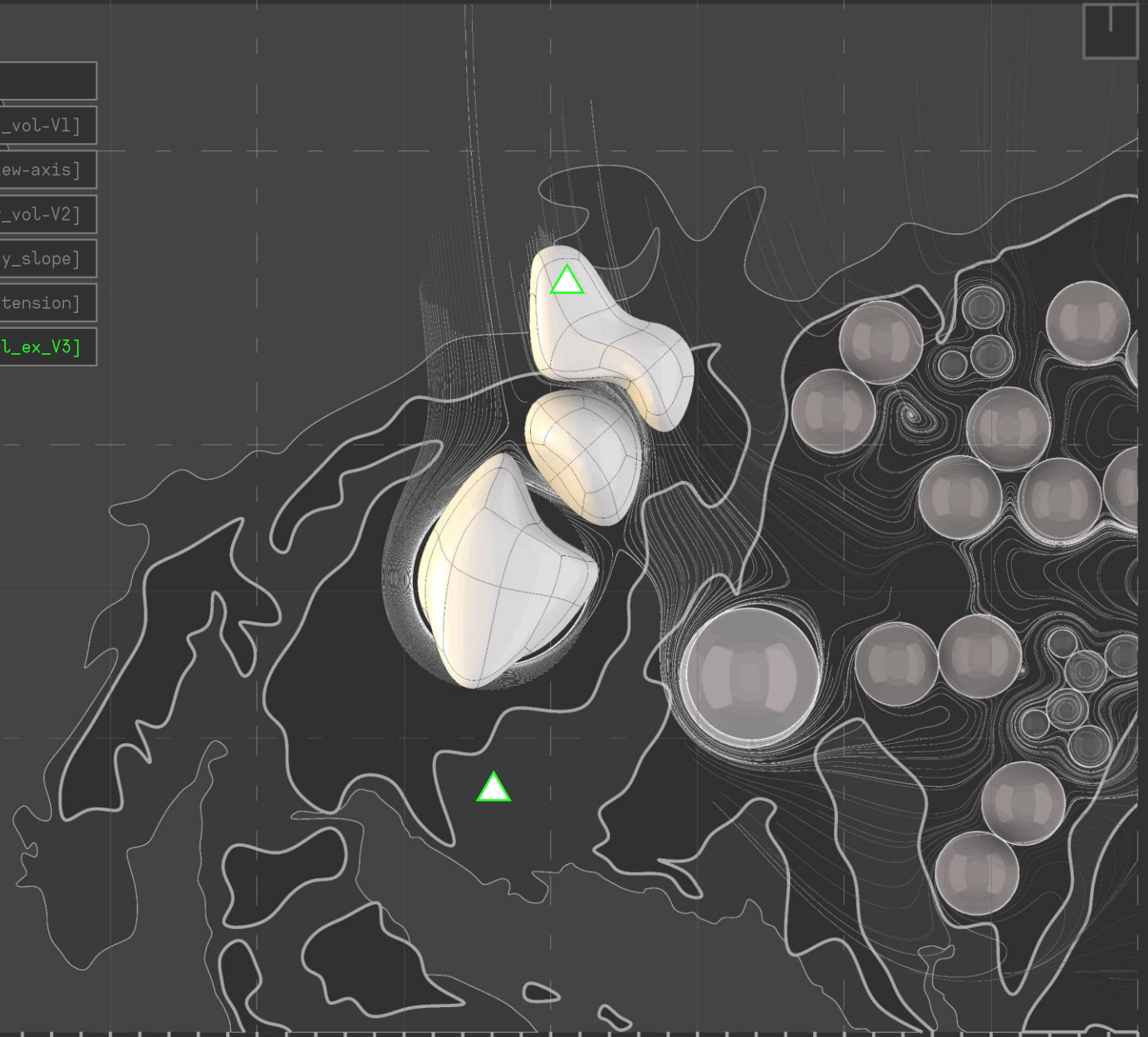
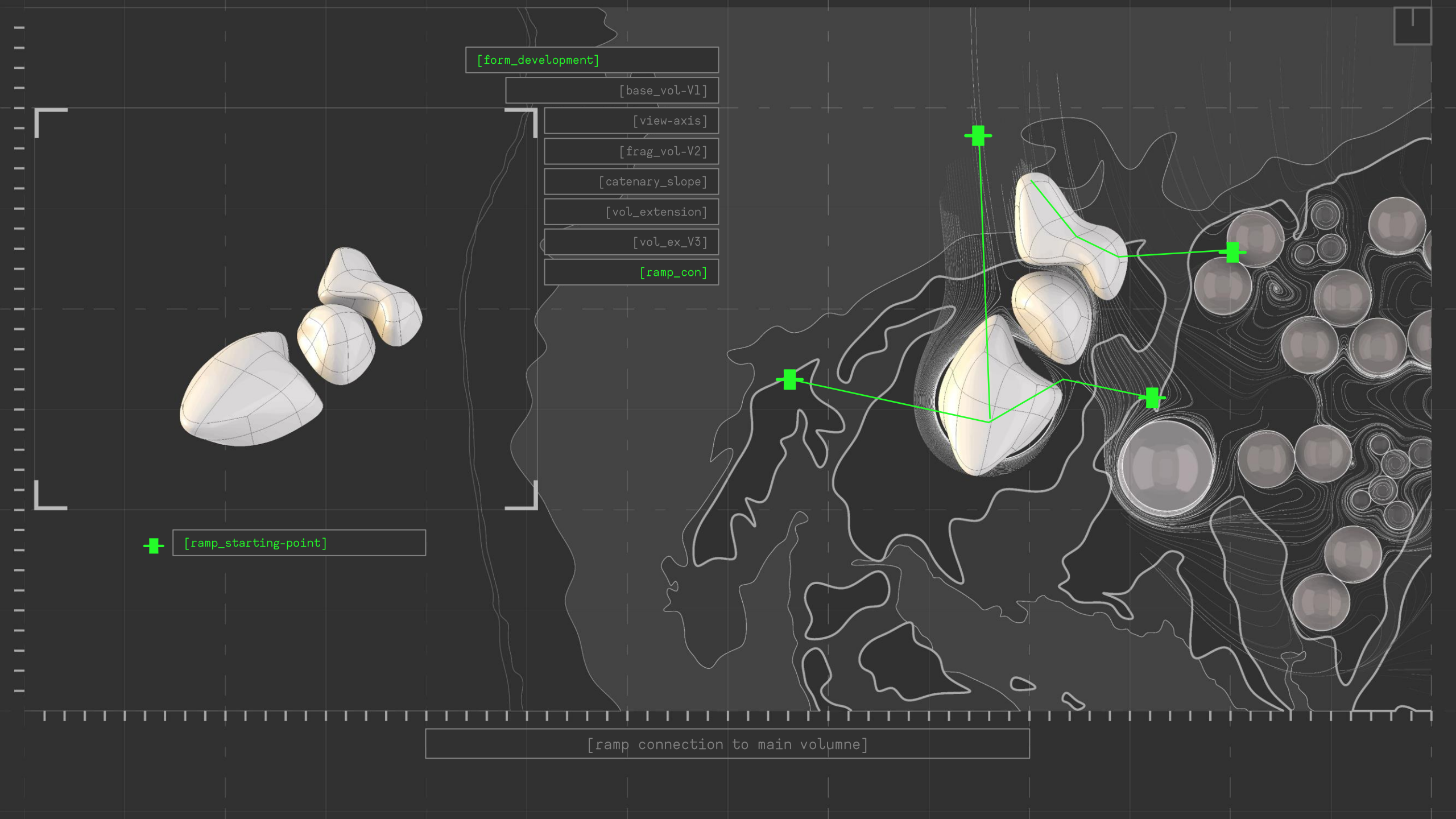


[volume extension in z-axis for different experiential zome]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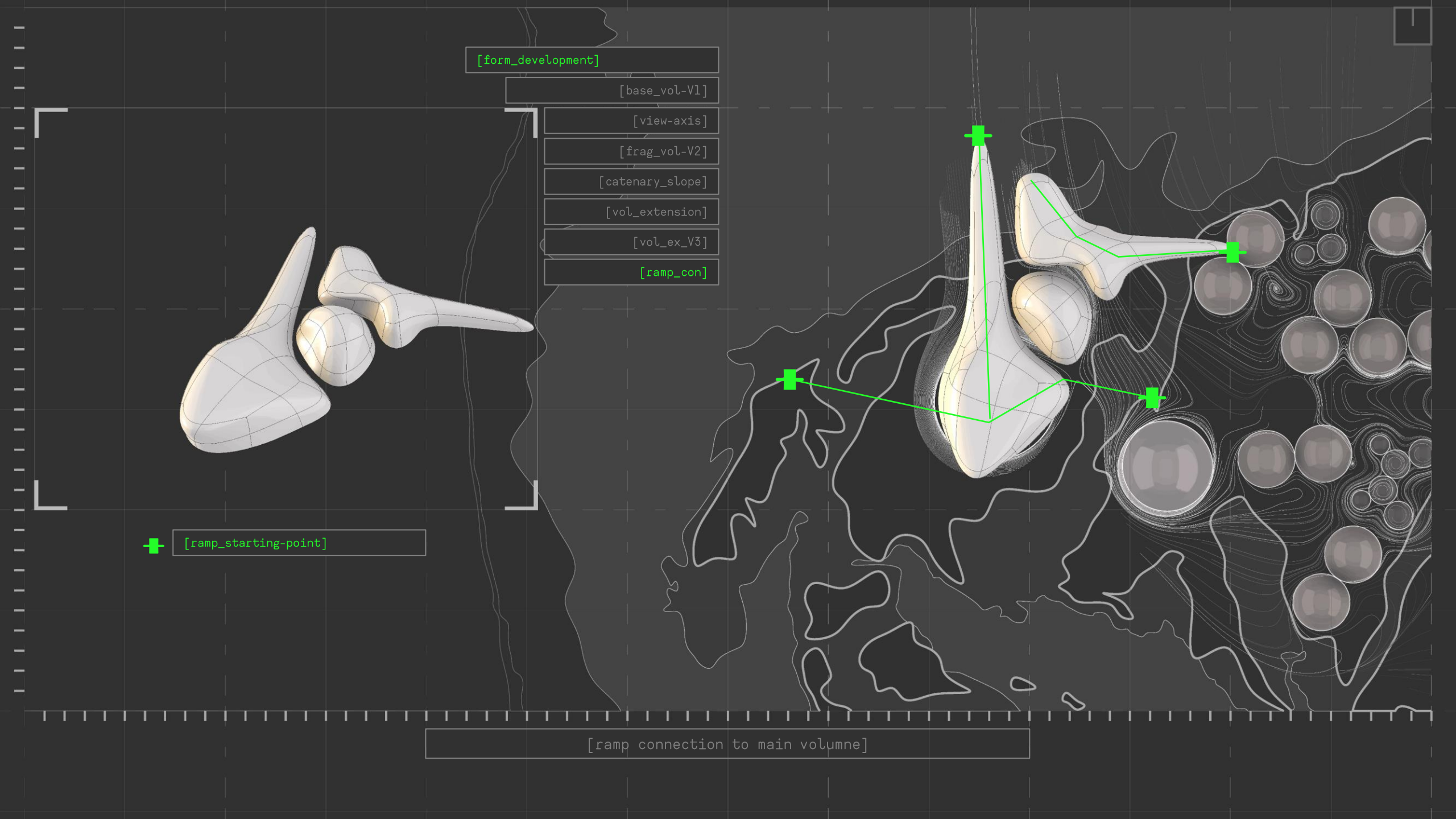
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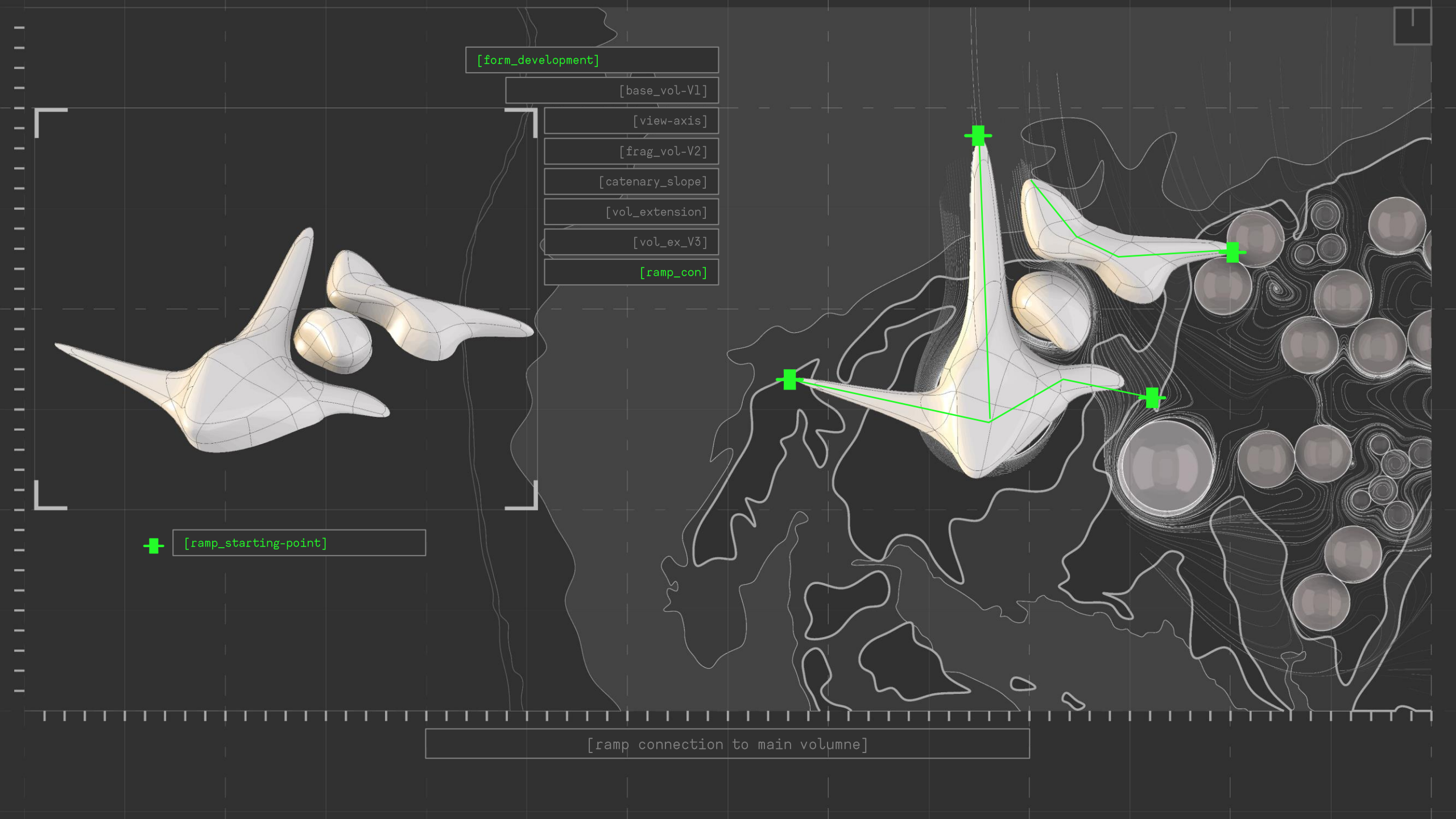
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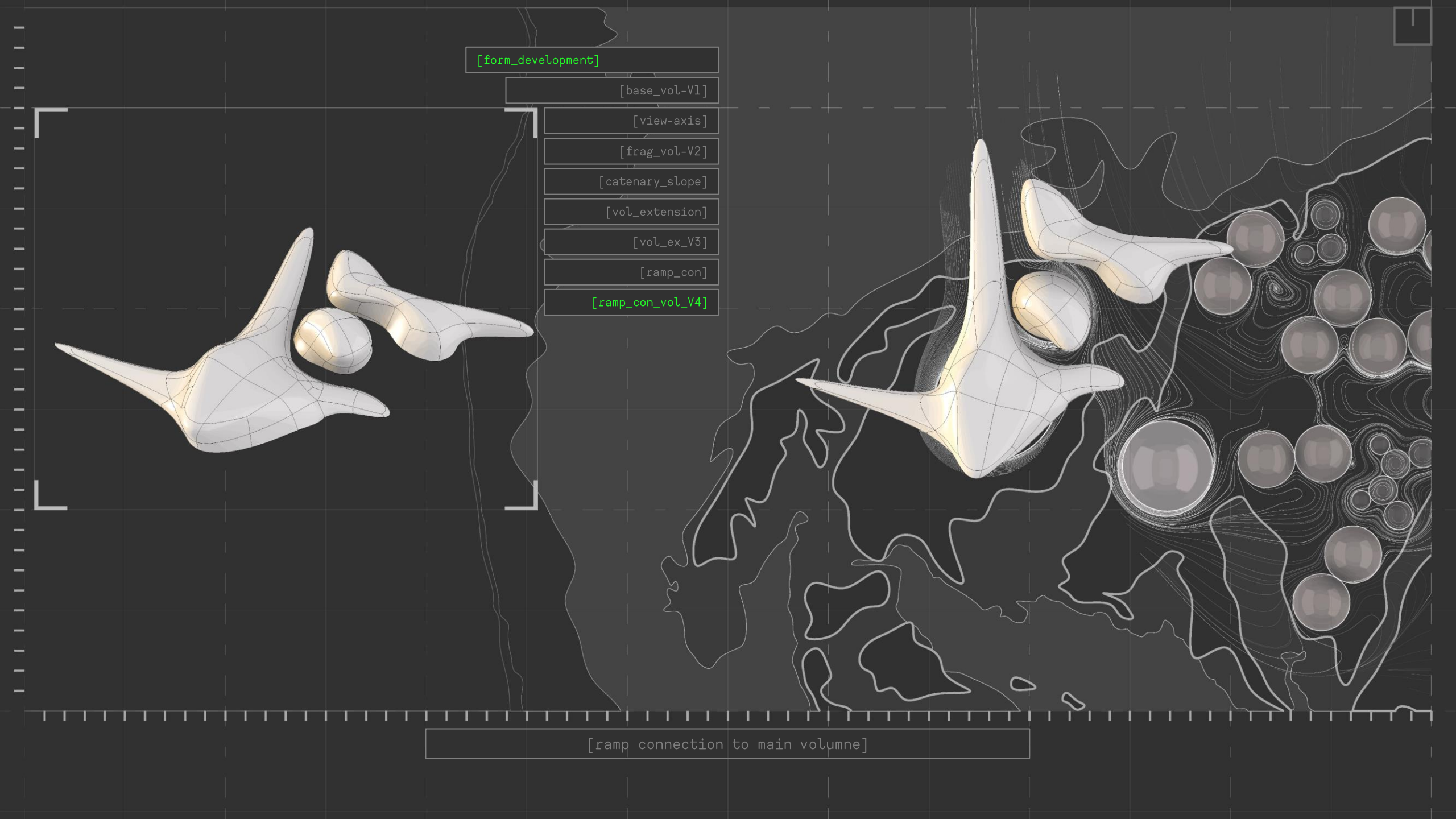
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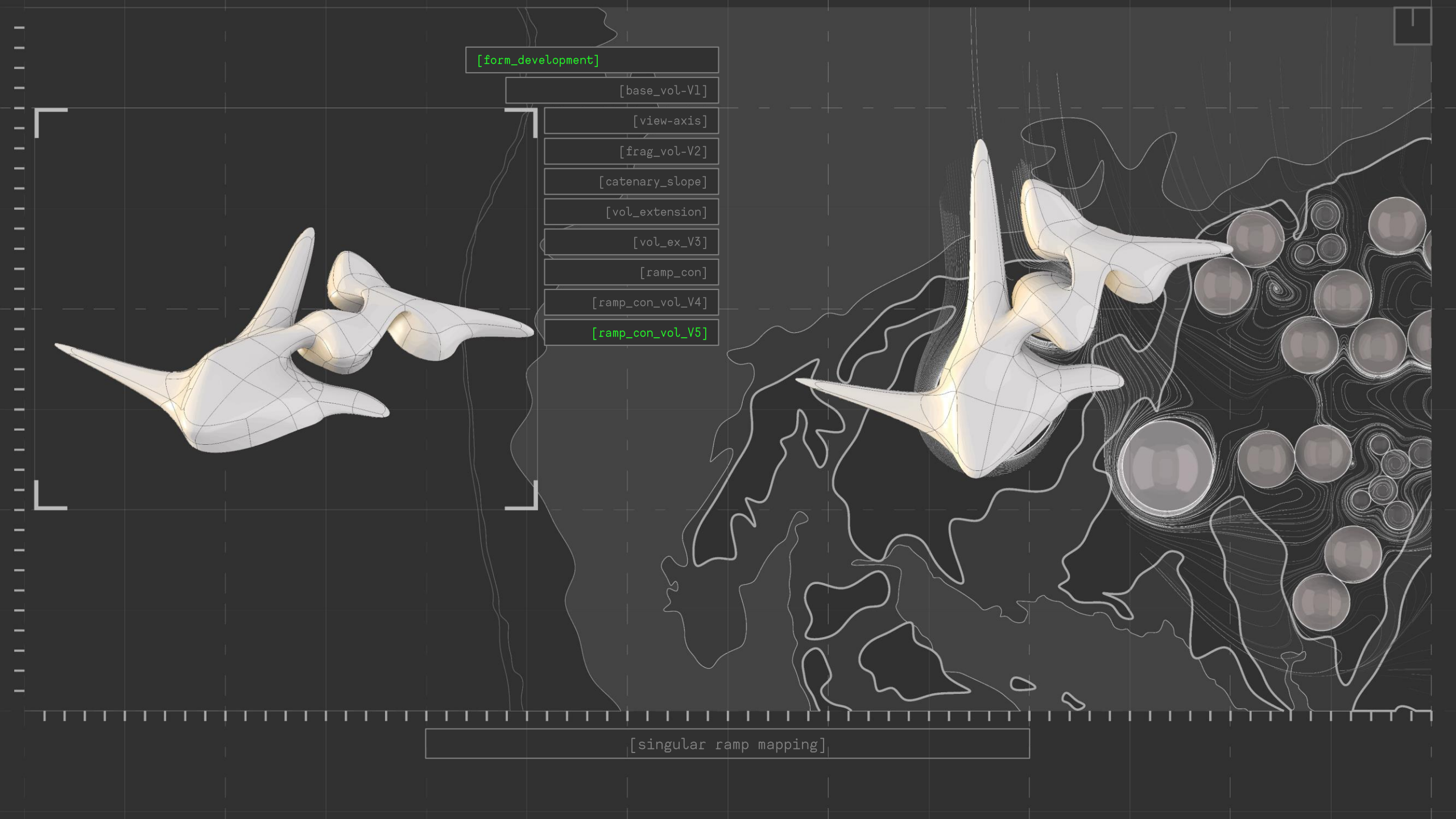
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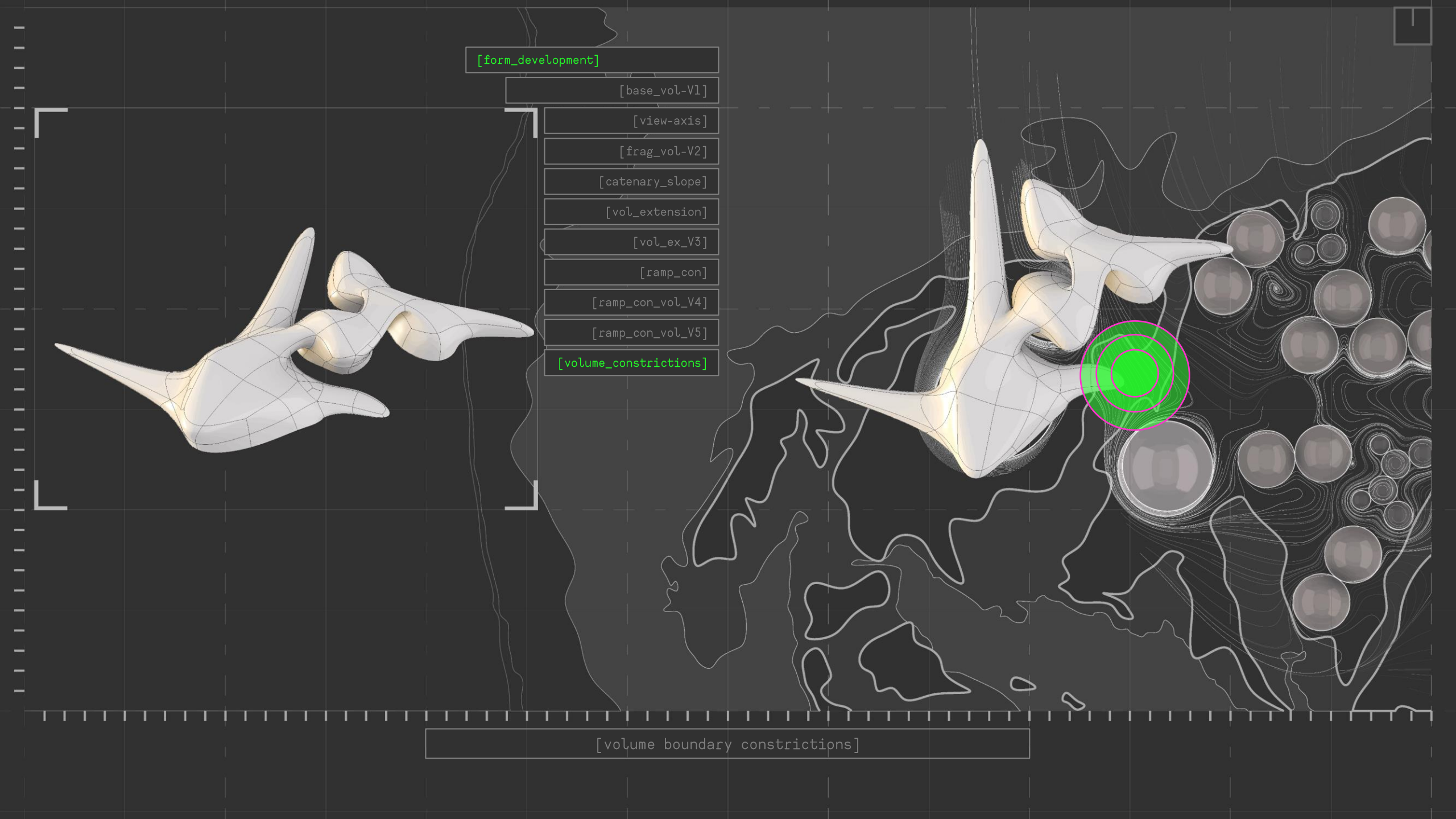
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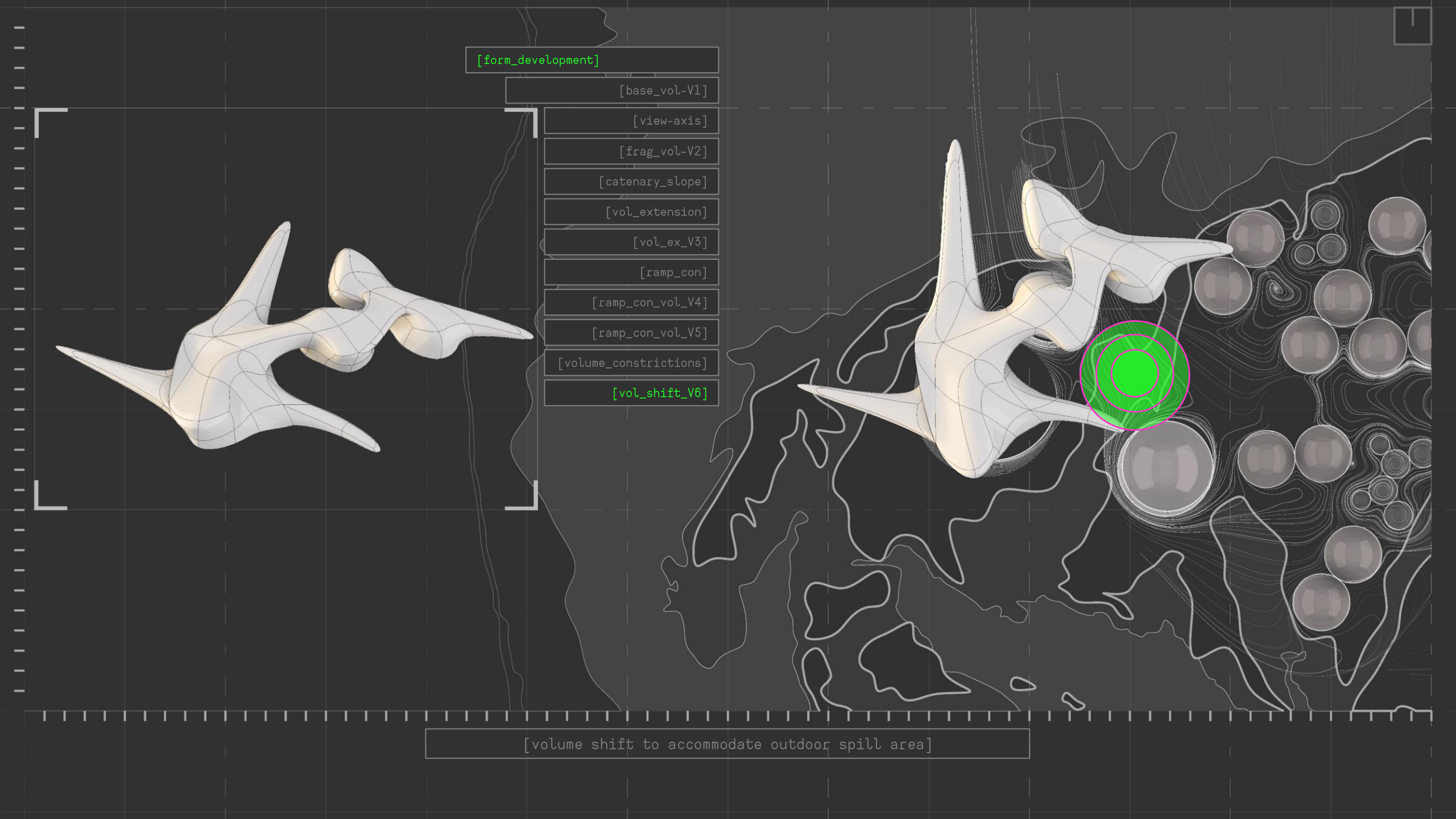
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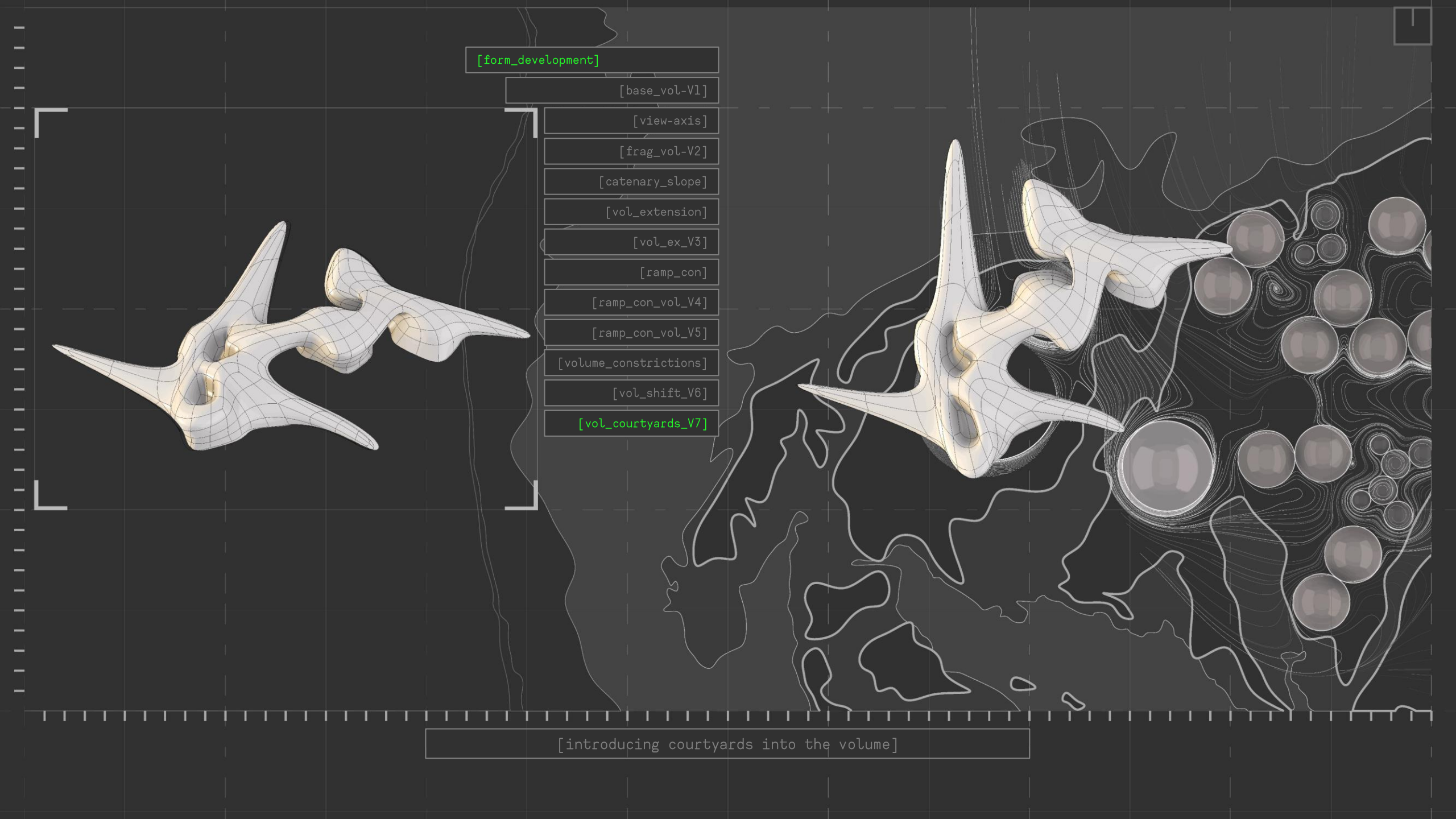
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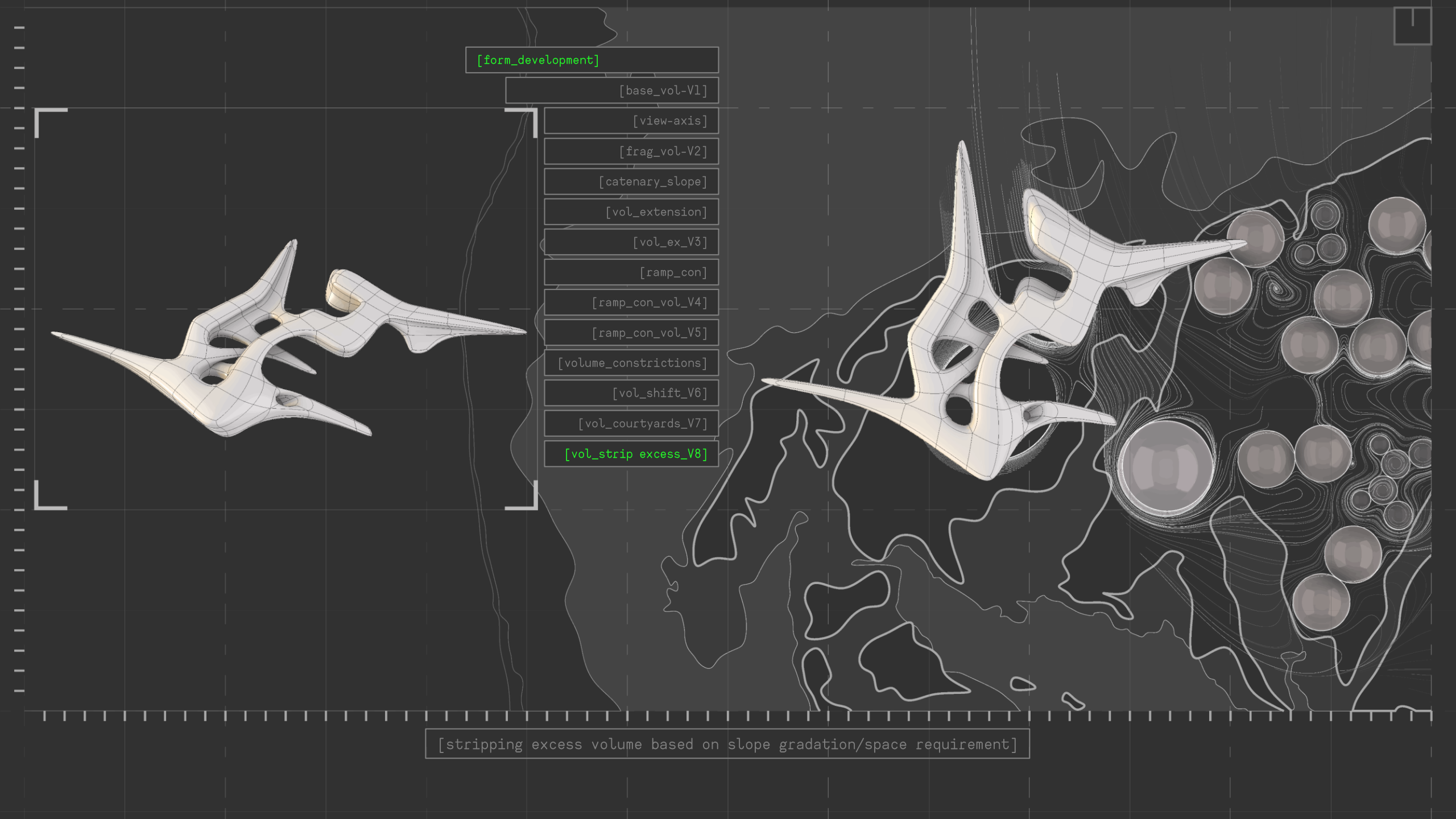
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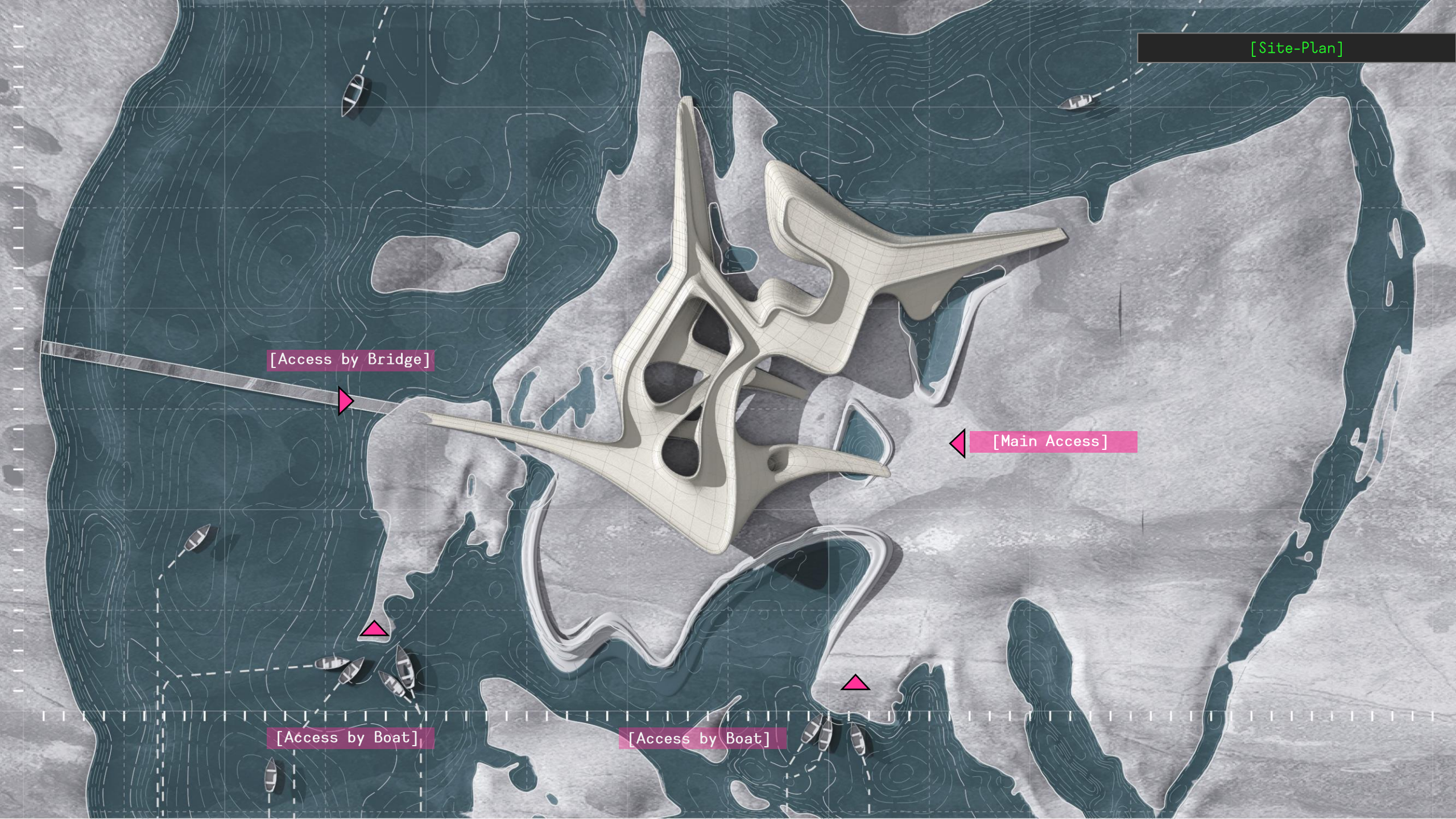
[stripping excess volume based on slope gradation/space requirement]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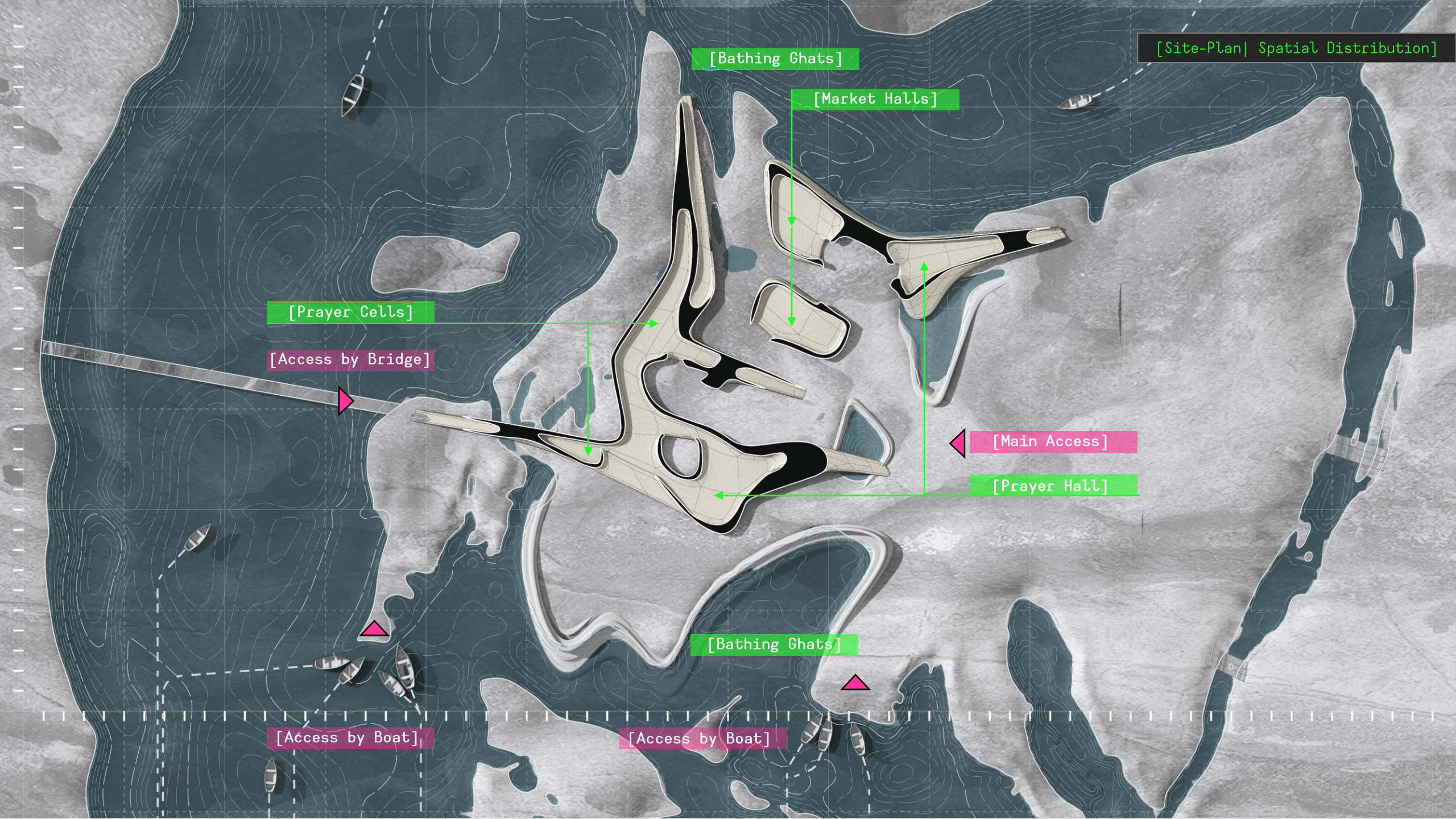
[Access by Bridge]
[Main Access]
[Access by Boat]
[Access by Boat]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[Market Halls]
[Prayer Cells]
[Access by Bridge]
[Main Access]
[Prayer Hall]
[Bathing Ghats]
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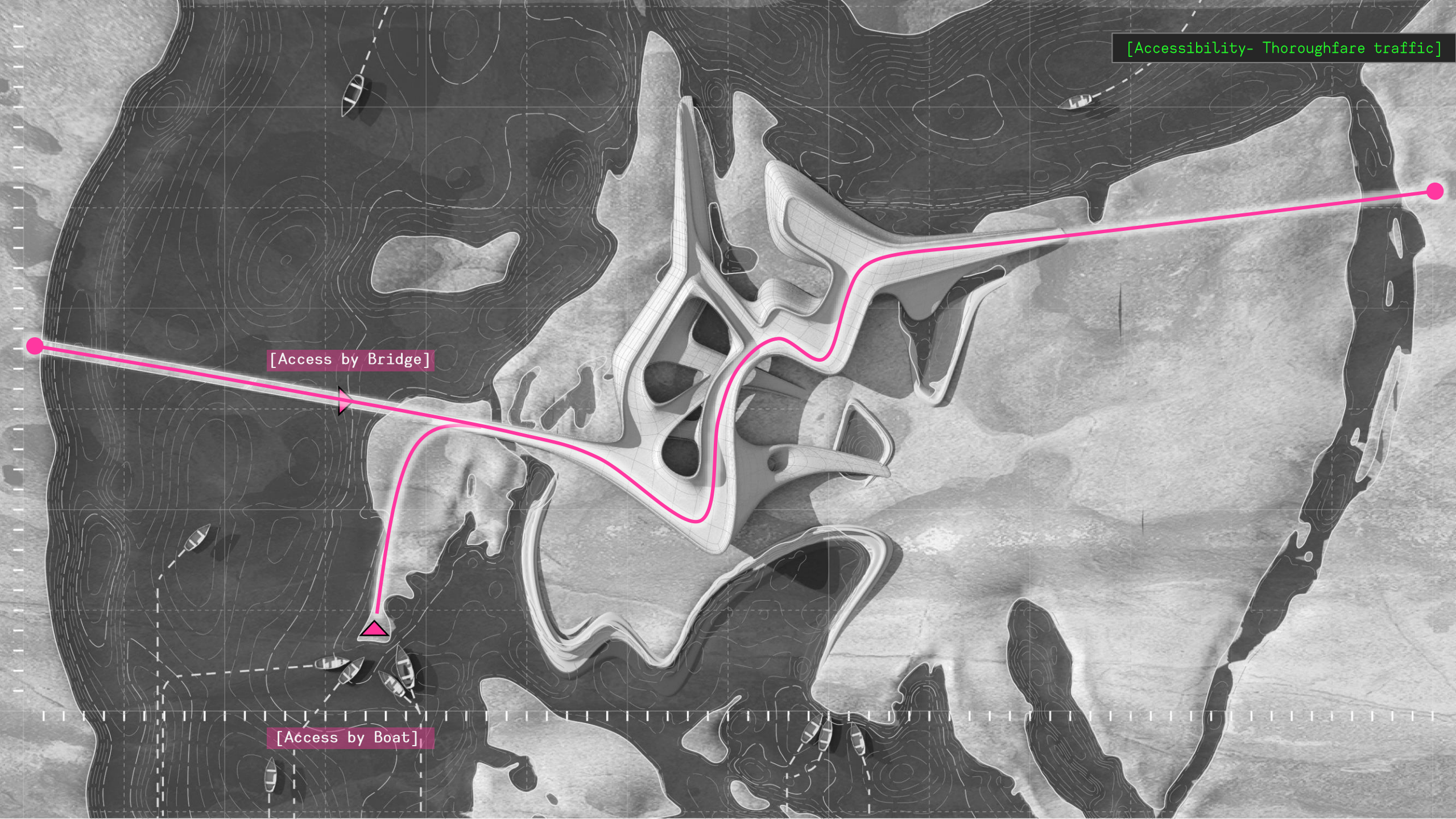
[Access by Boat]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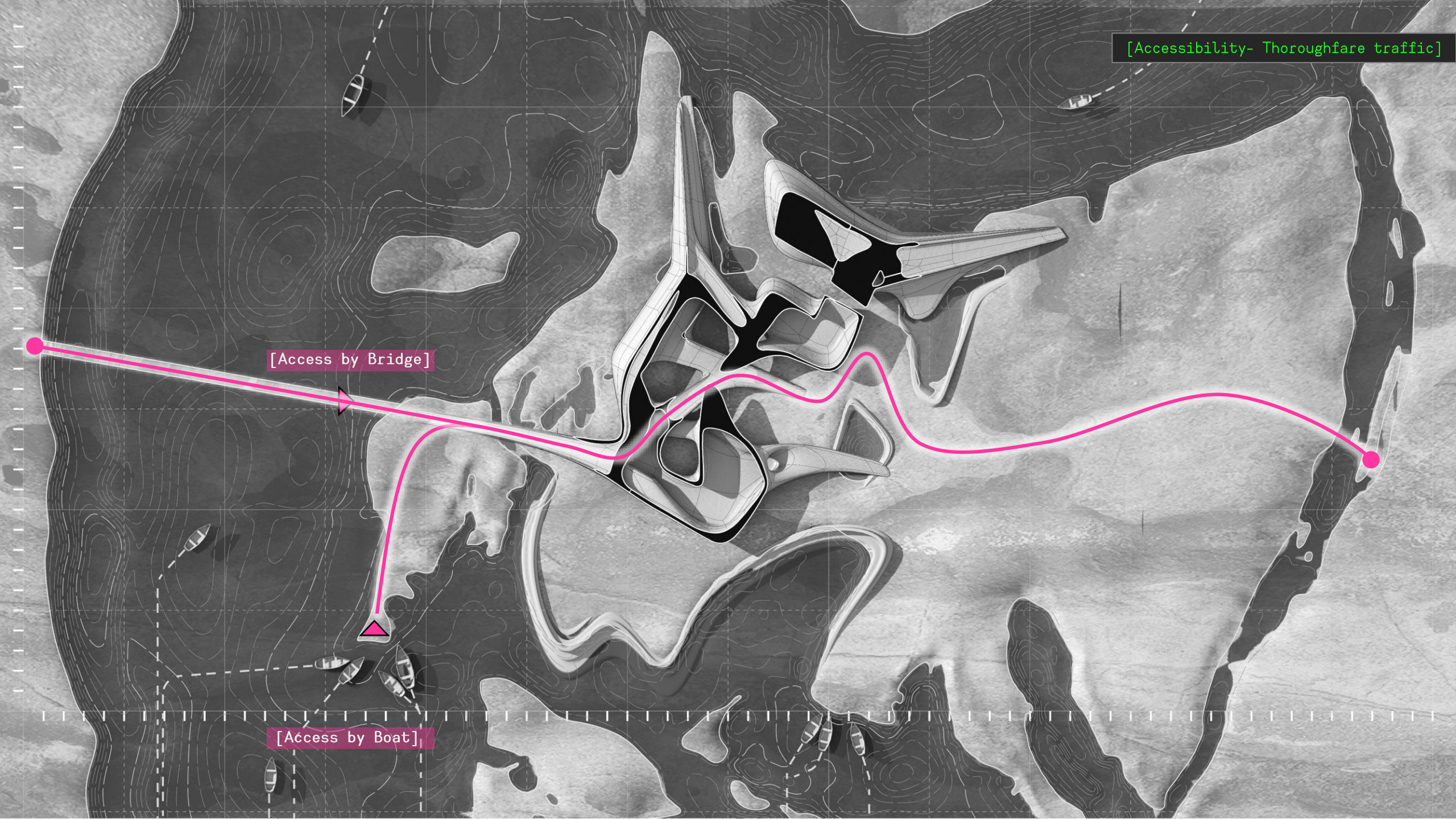
[Access by Bridge]
[Access by Boat]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[Access by Bridge]
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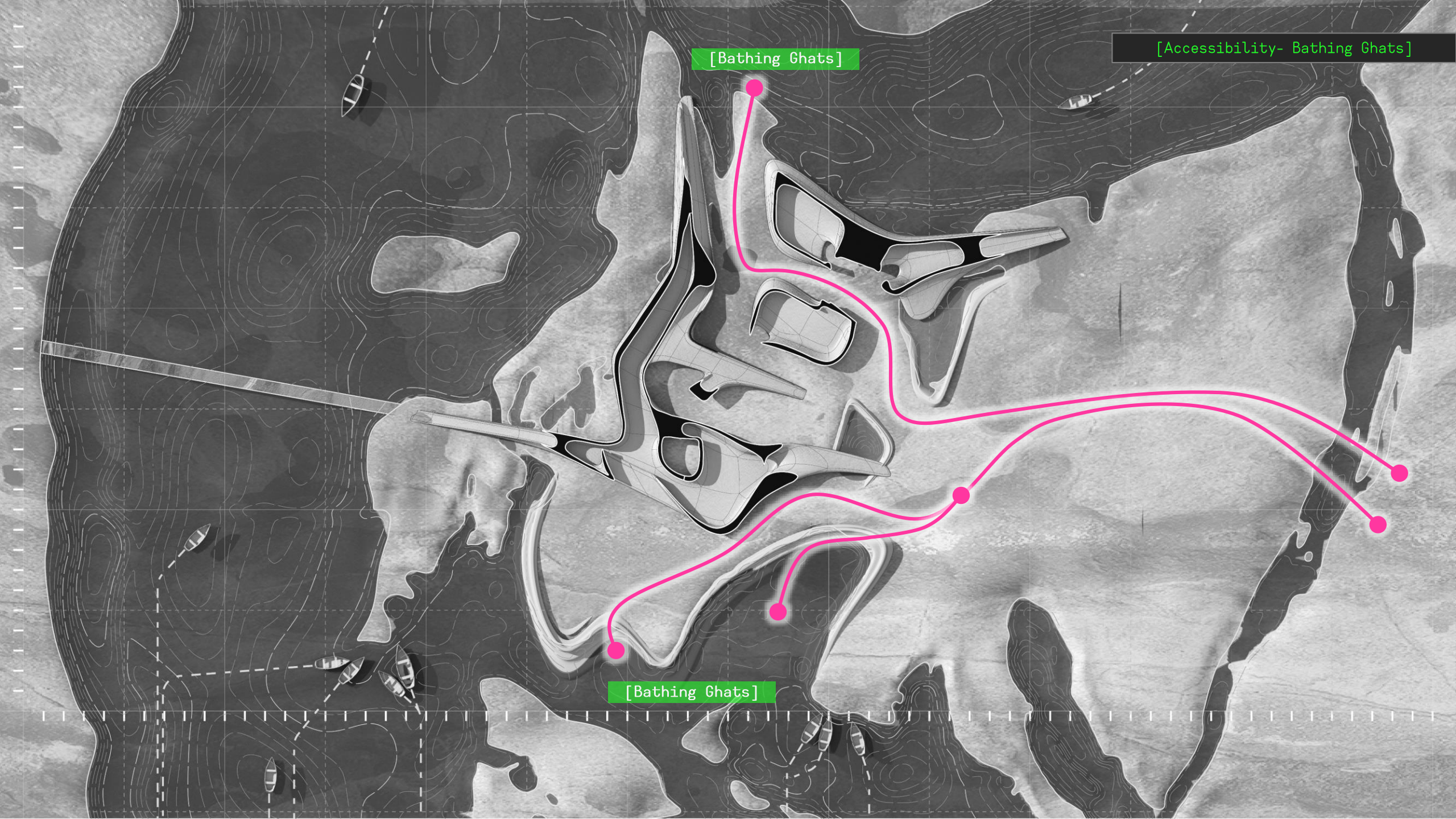
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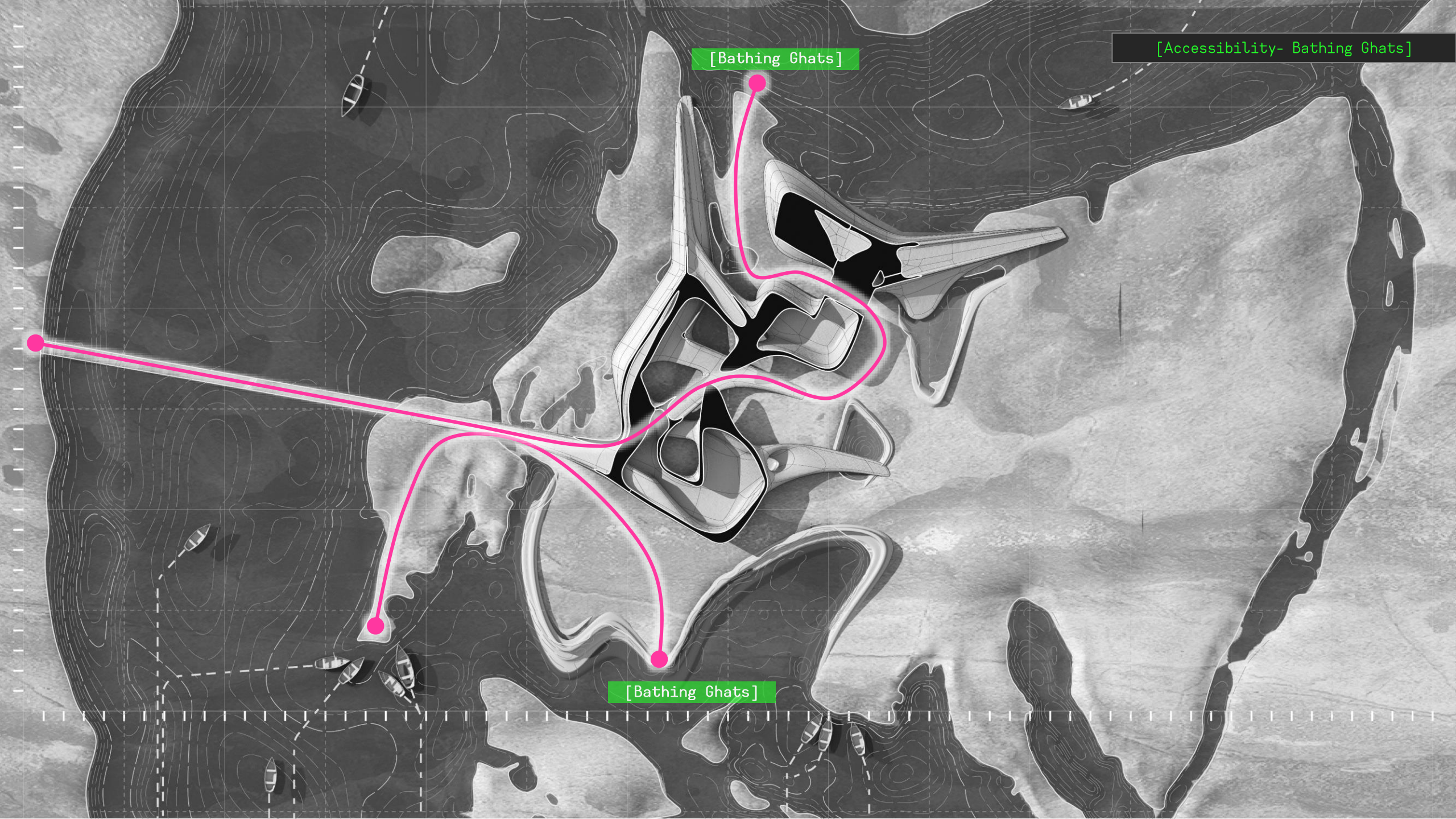
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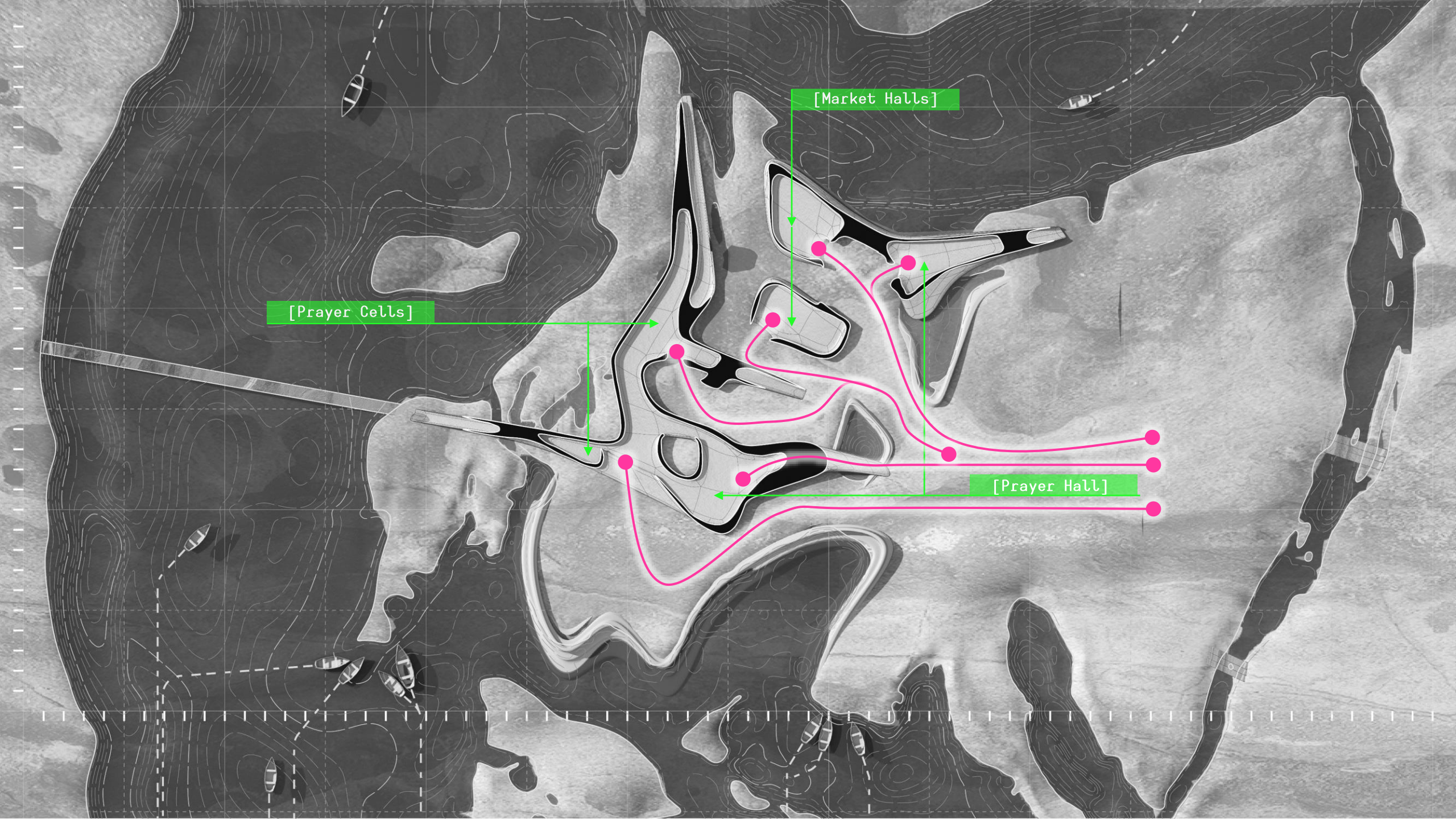
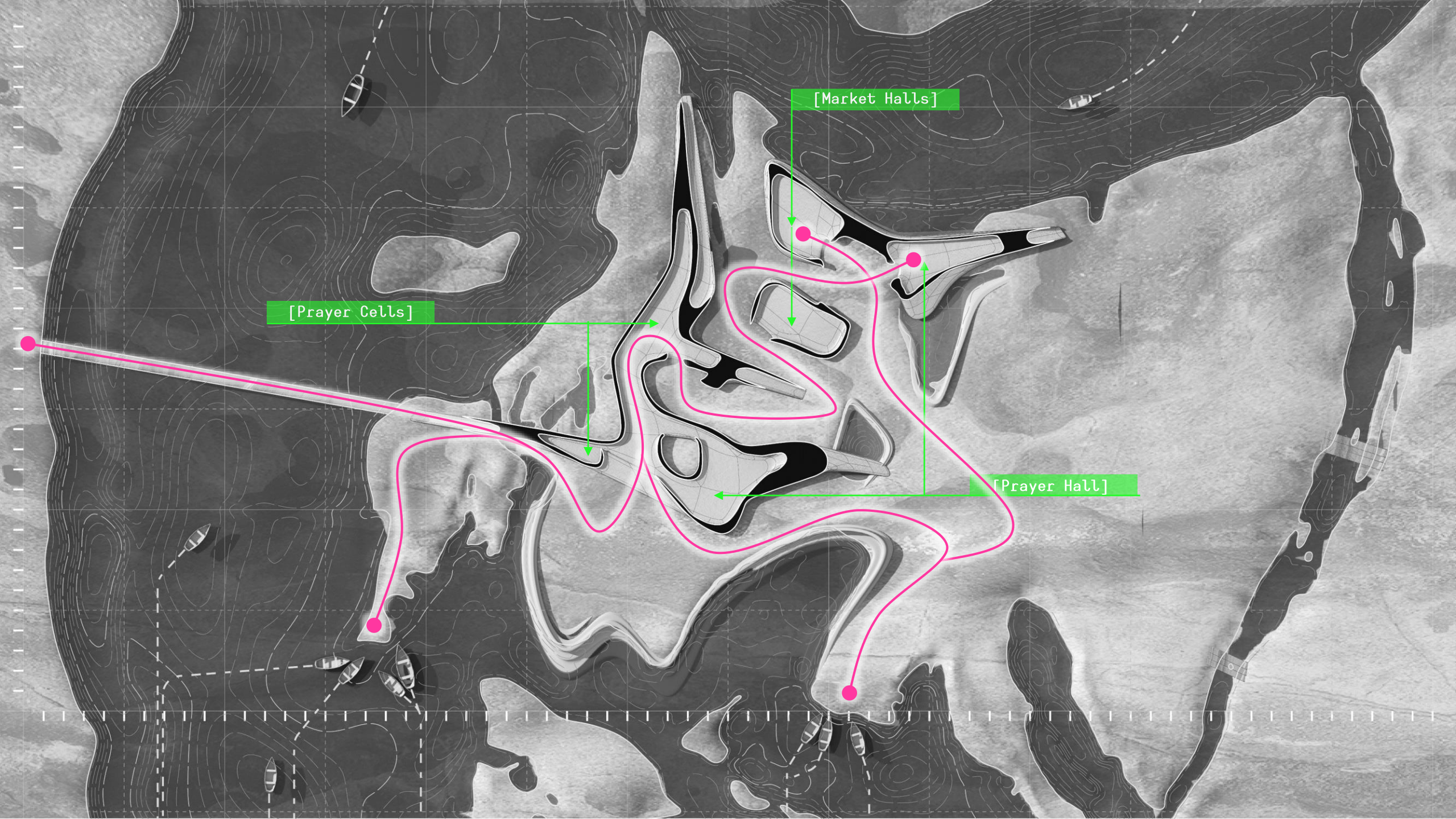
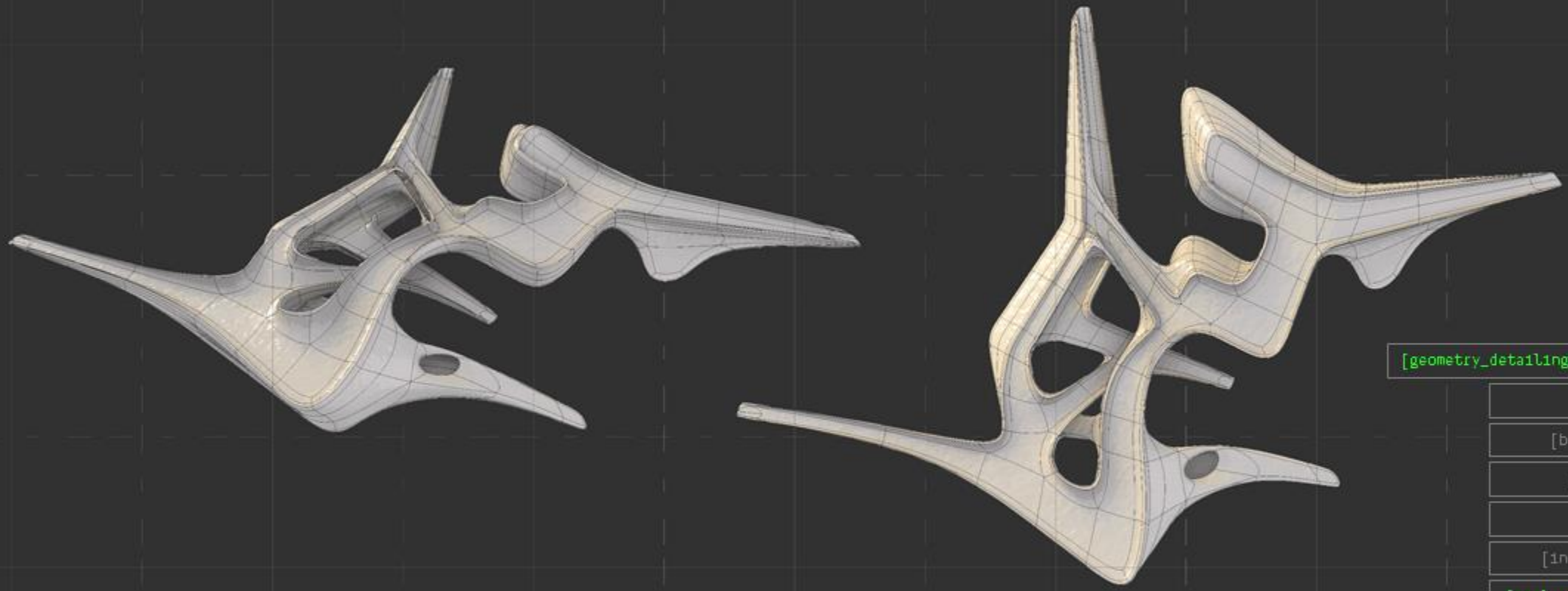
[Bathing Ghats]


[Market Halls]
[Prayer Cells]
[Prayer Hall]


[Market Halls]
[Prayer Cells]
[Prayer Hall]

pavilion
y
x



[geometry_detailing]

[base_mesh_V1]

[bridge_addition]

[outer_profile]

[mesh_V2]

[inner_profile_v3]

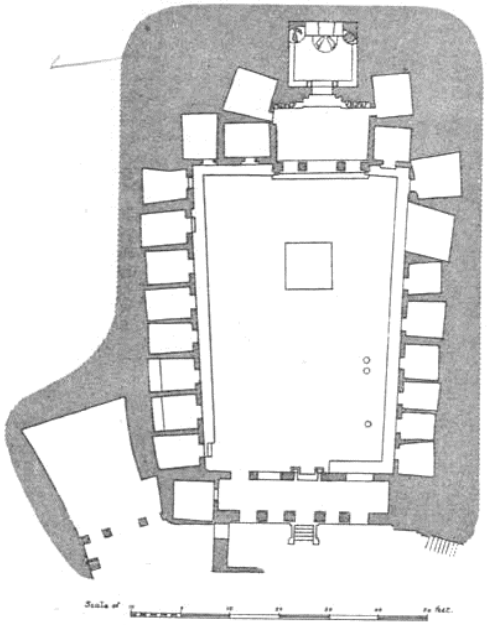
[railing_variation_v4]

[final geometry]

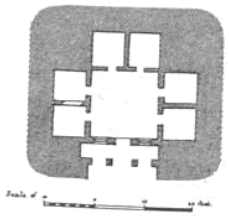
Plate XXVI.

NASIK.

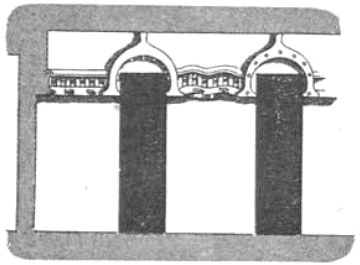
1. PLAN OF CAVE XV.



2. PLAN OF CAVE XIV.



3. WALL ELEVATION IN CAVE XIV.



J. Burgess.

W. GRIGGS, PHOTO LITH. LONDON, S. E.

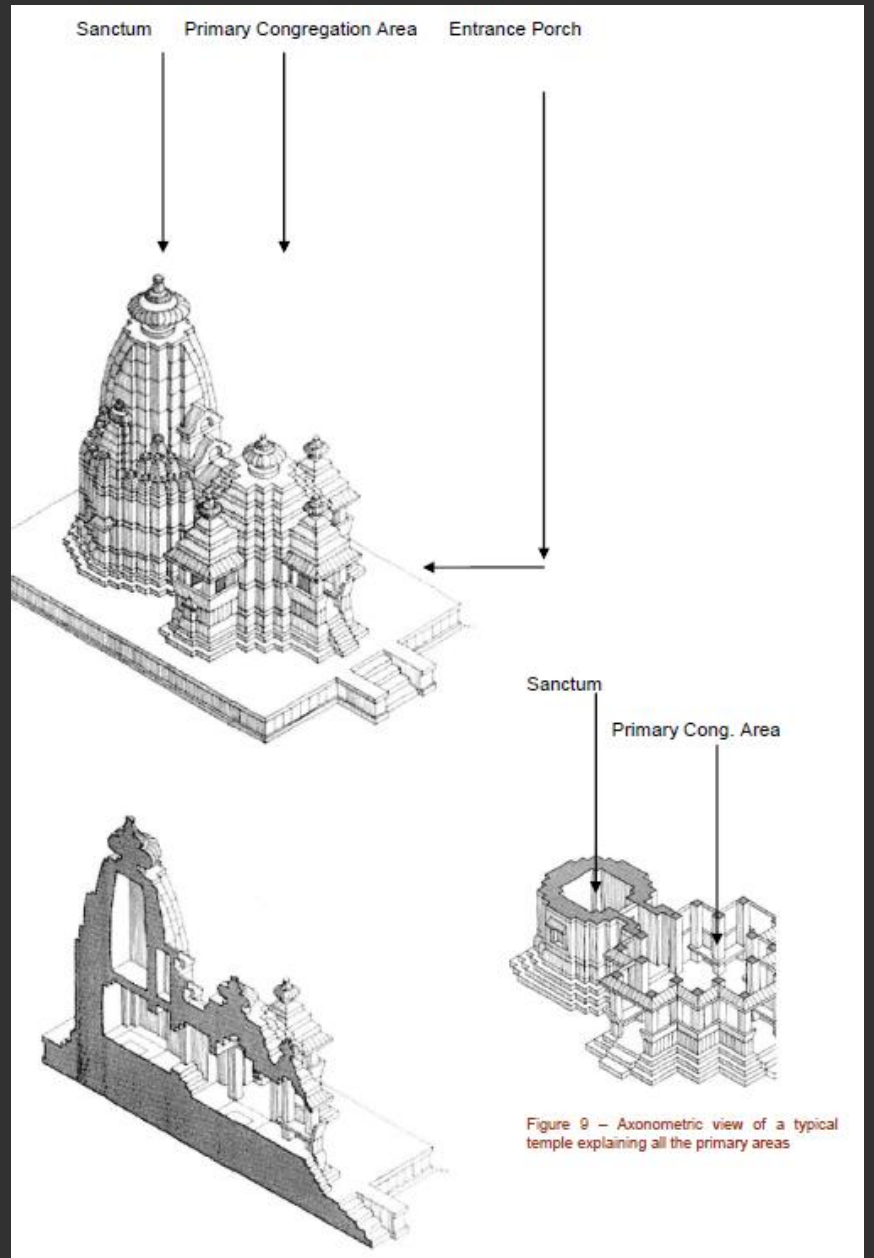
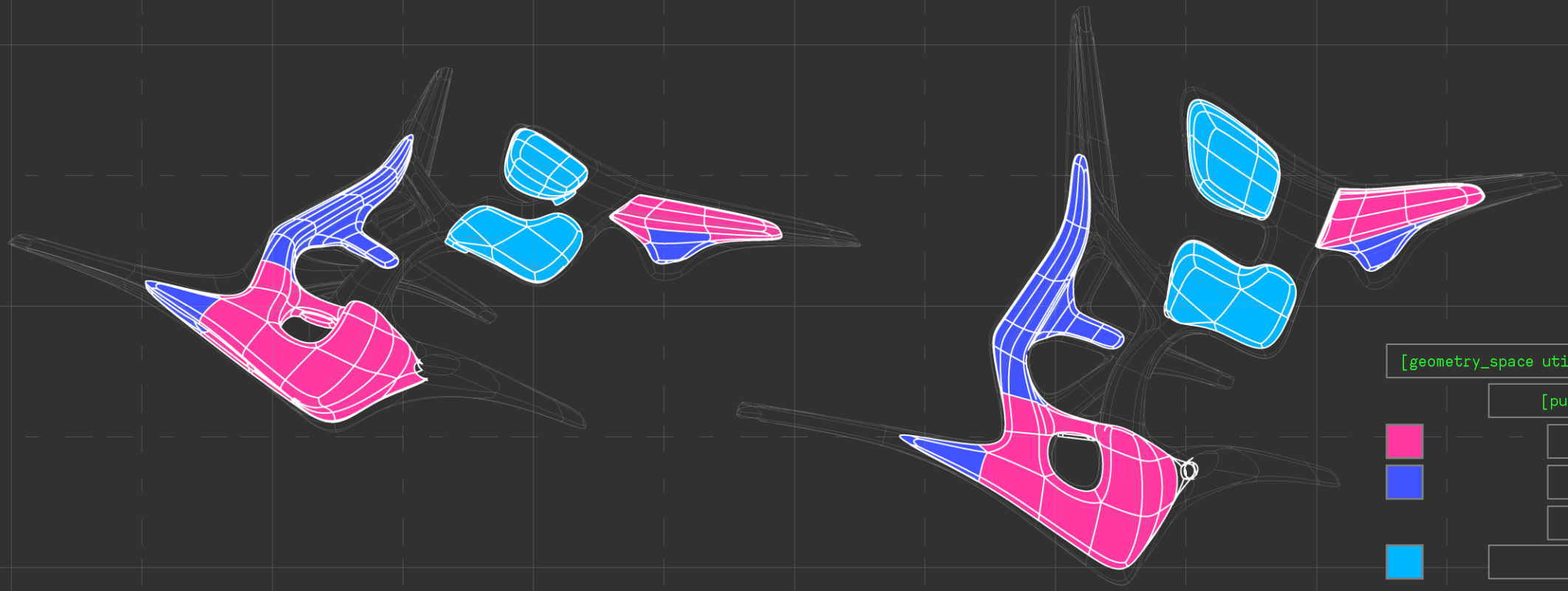
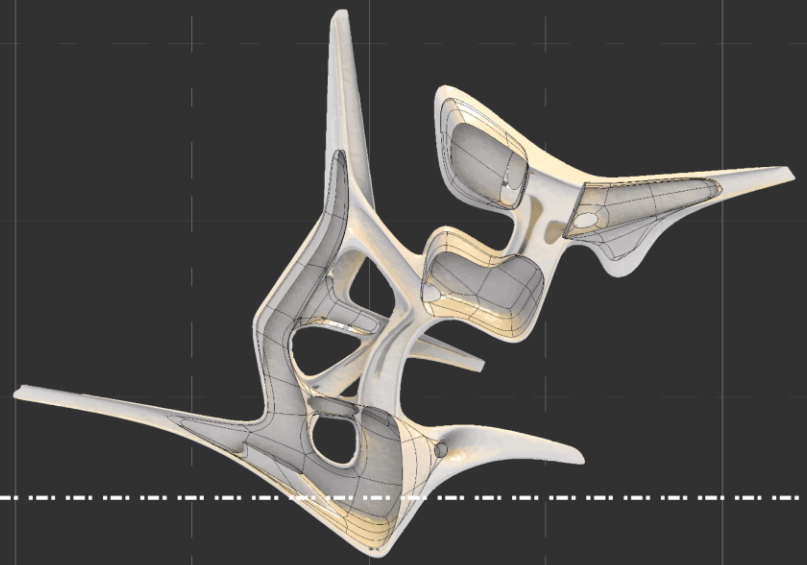


Figure 9 – Axonometric view of a typical temple explaining all the primary areas



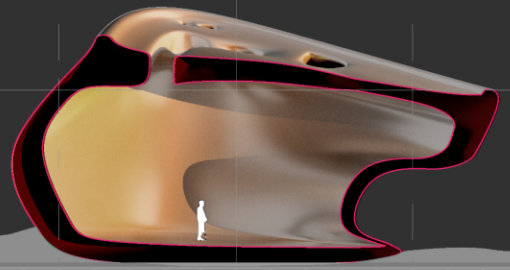
[geometry-space distribution]



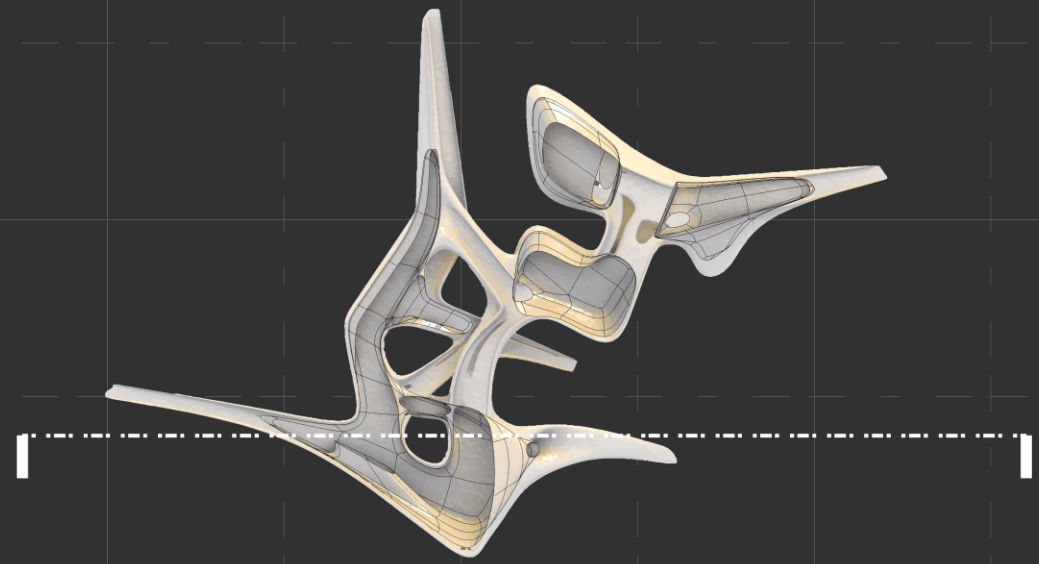
16m

8m

0m



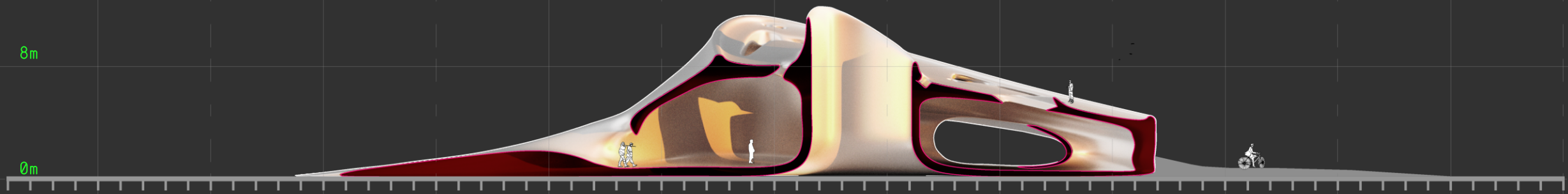
[section-AA’ through prayer hall]



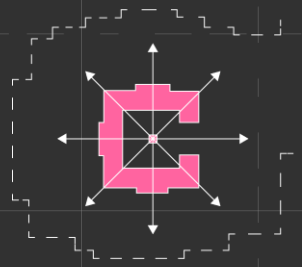
16m

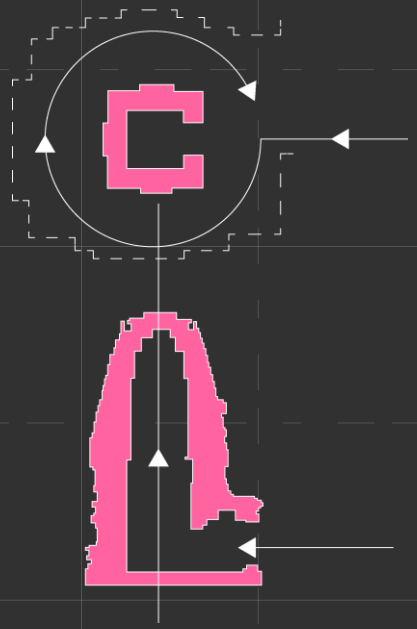
8m

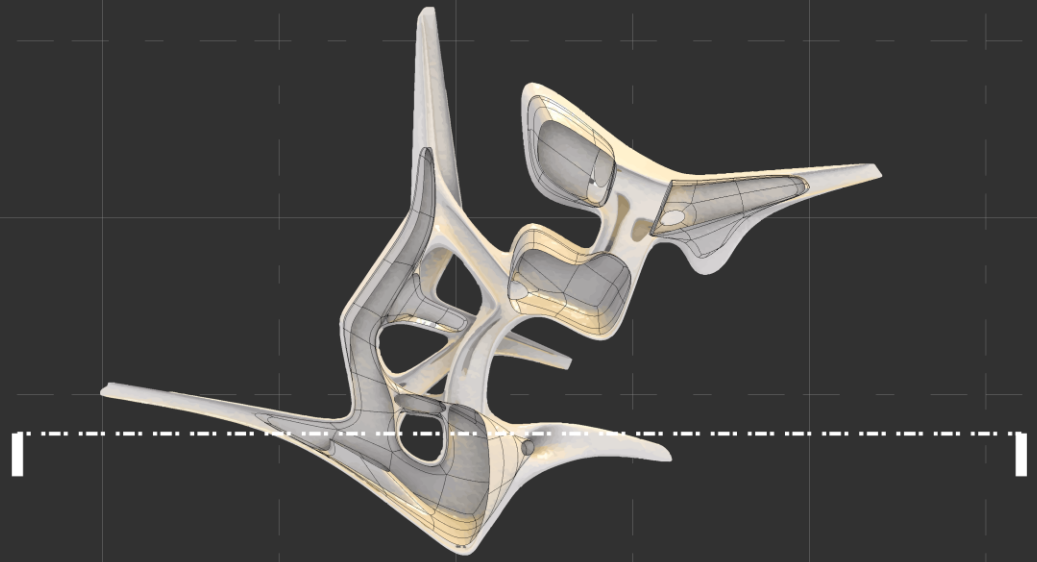
0m

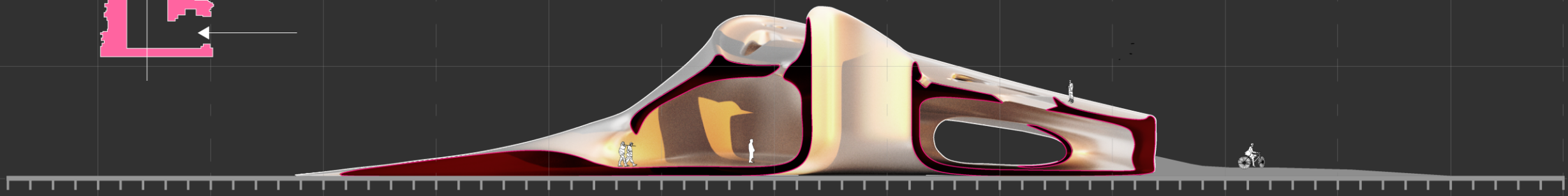


[section-BB’ through sanctum]

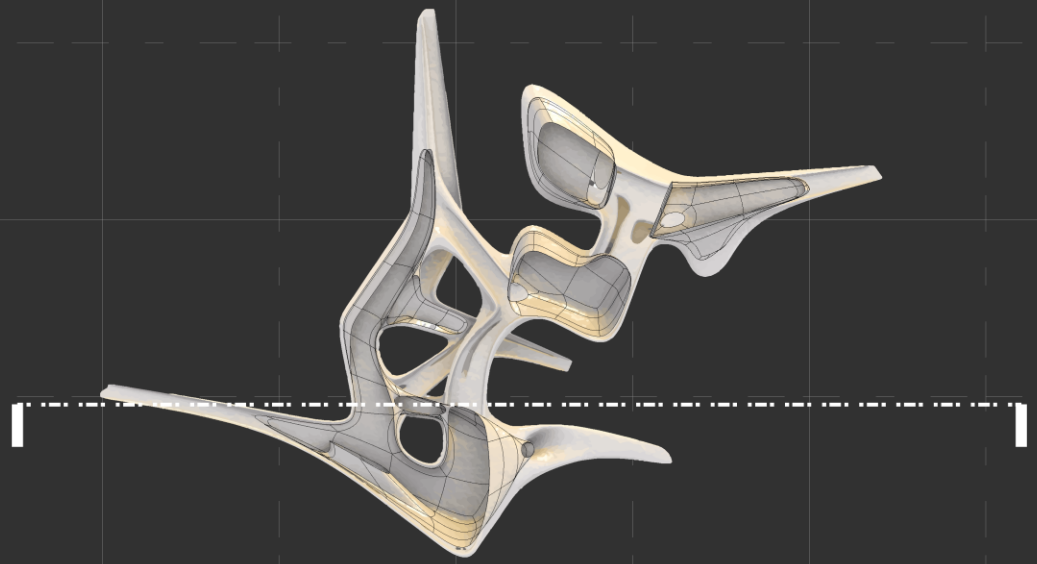


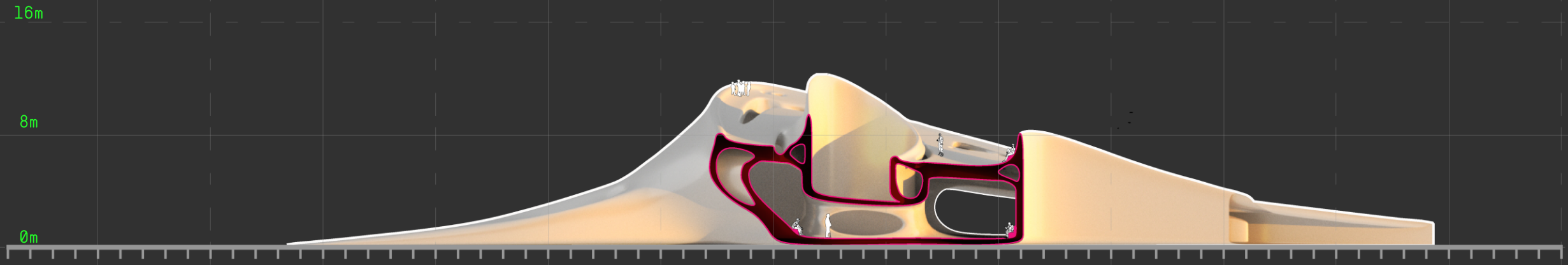




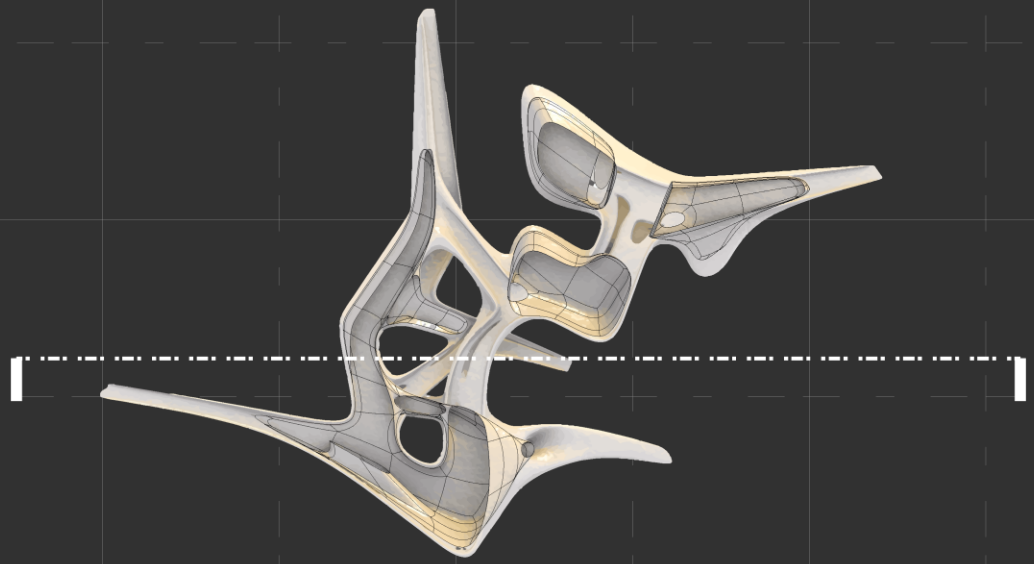


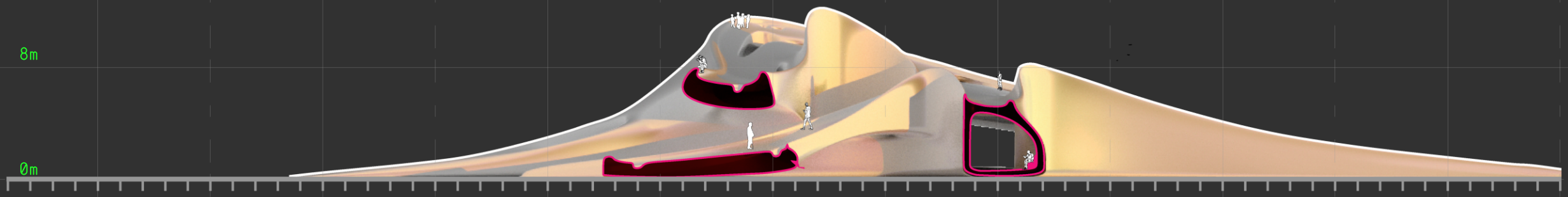
[section-BB’ through sanctum]



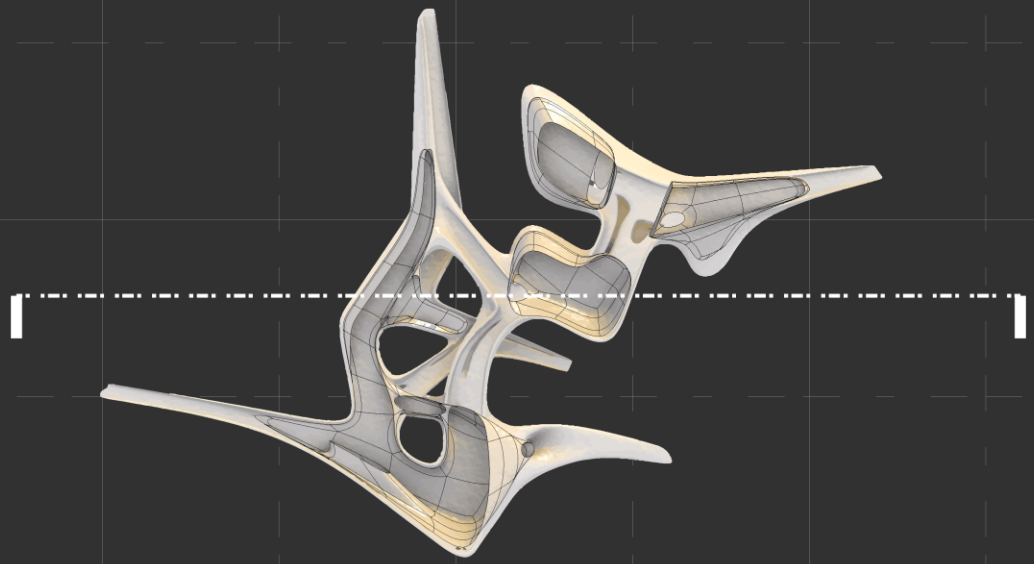


[section-CC’ through connecting cave between sanctum & hall]





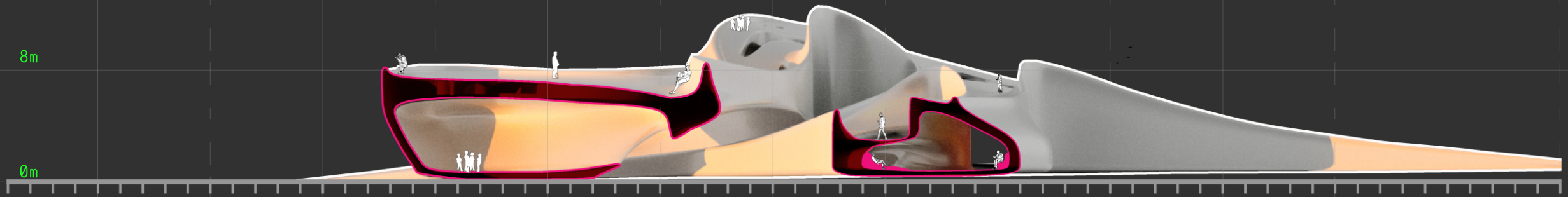
[section-DD’ through cells & bridges]



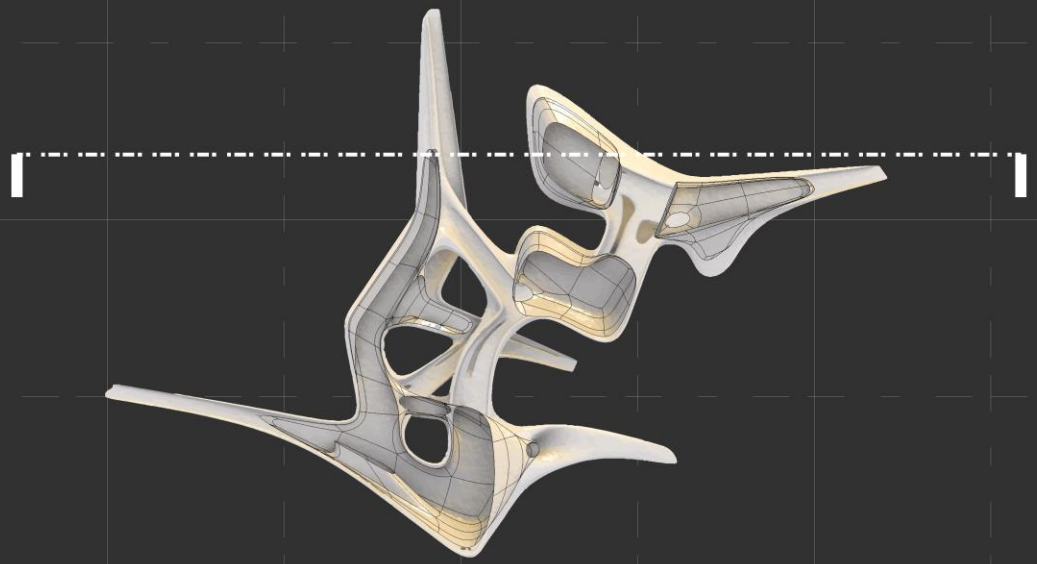
16m

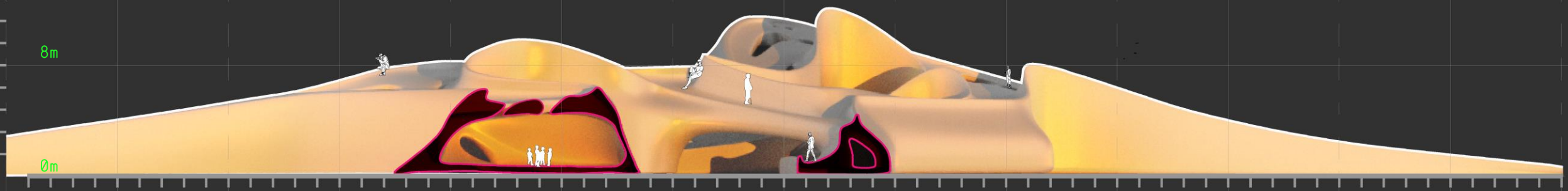
8m

0m

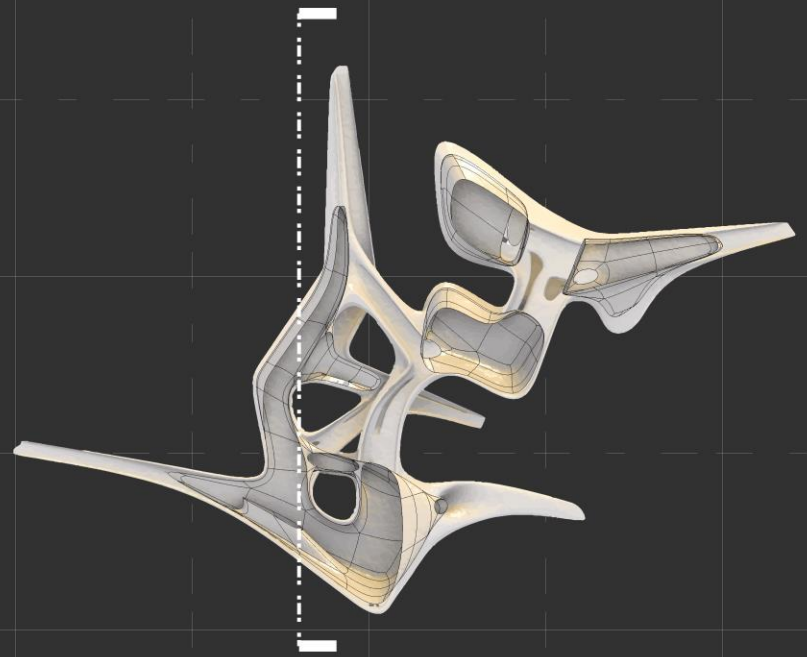


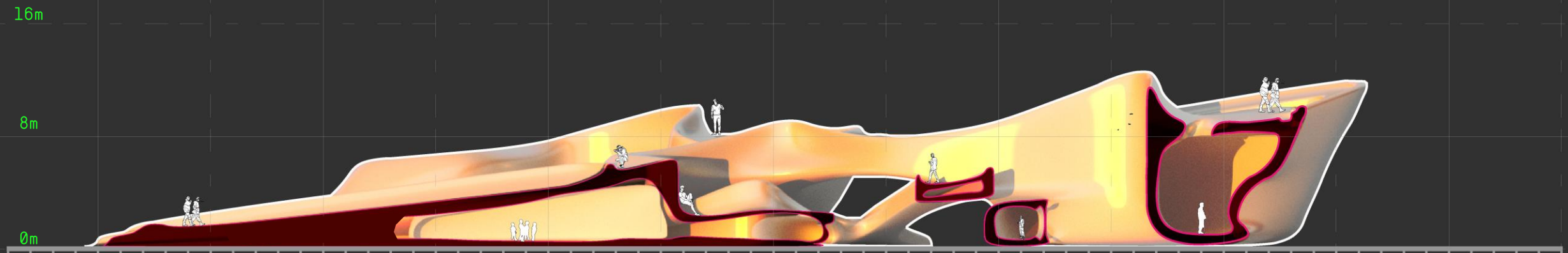
[section-EE' through market hall & cells]



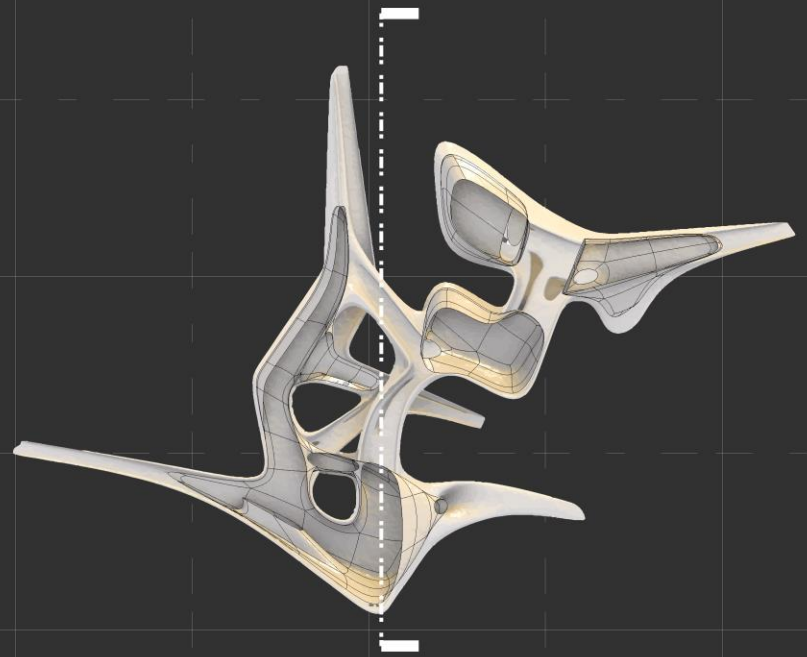


[section-GG' through meeting hall & cells]





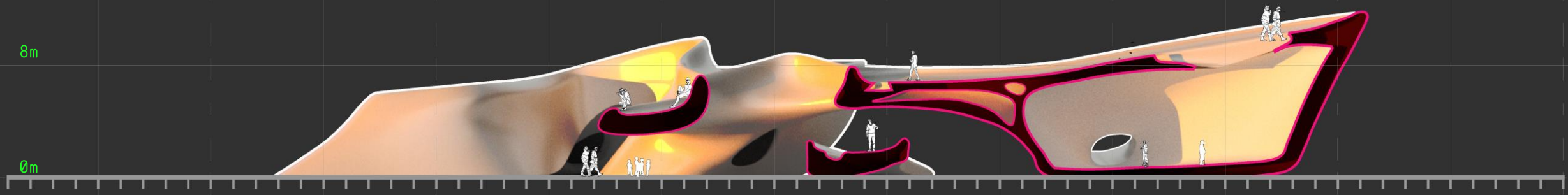
[section-HH’ through cells, sanctum & halls]



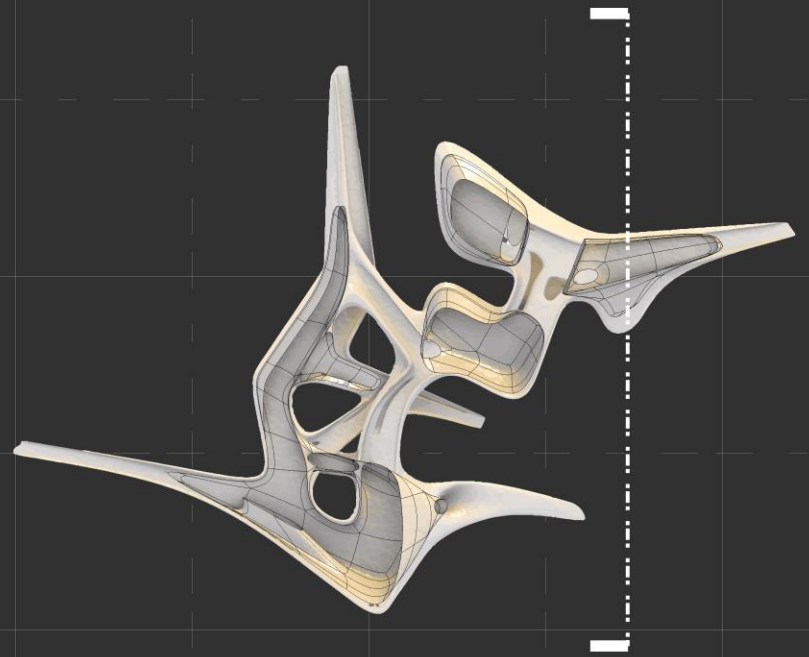
16m

8m

0m



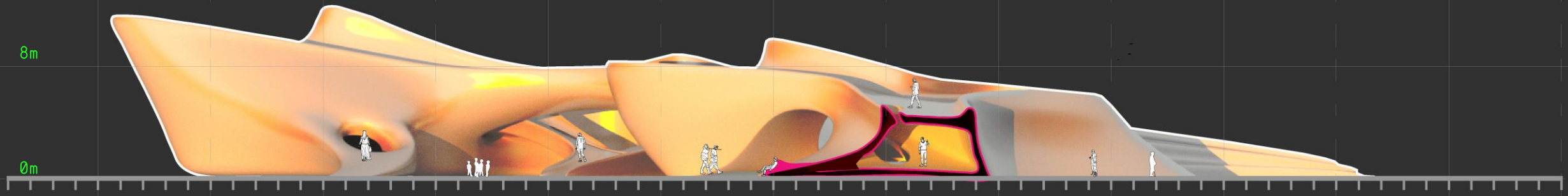
[section-II' through bridges & prayer hall]



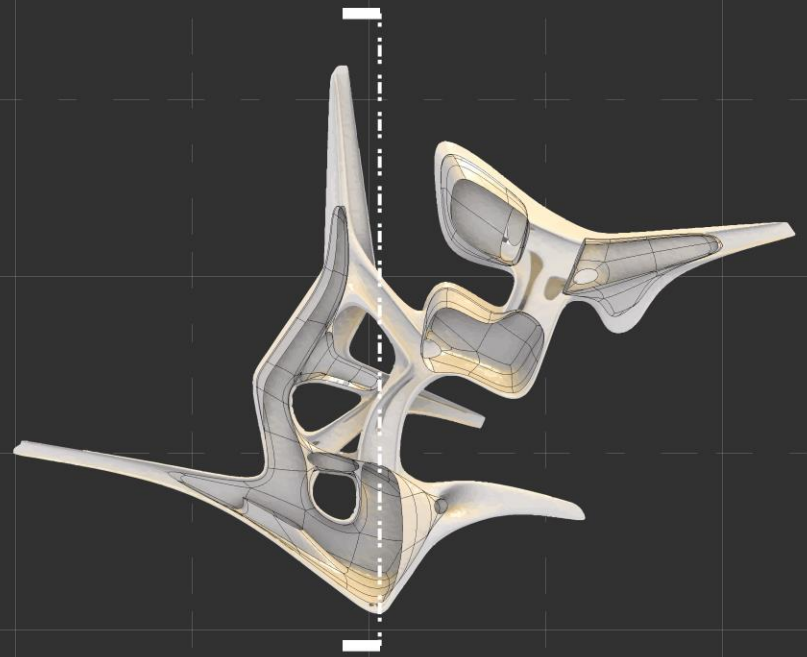
16m

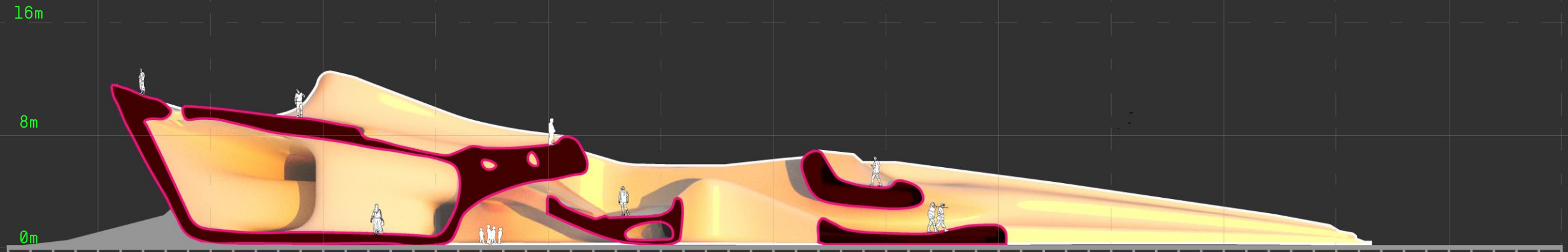
8m

0m

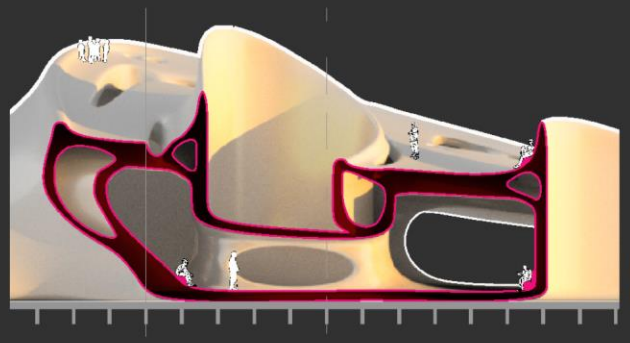


[section-JJ’ through meeting hall]

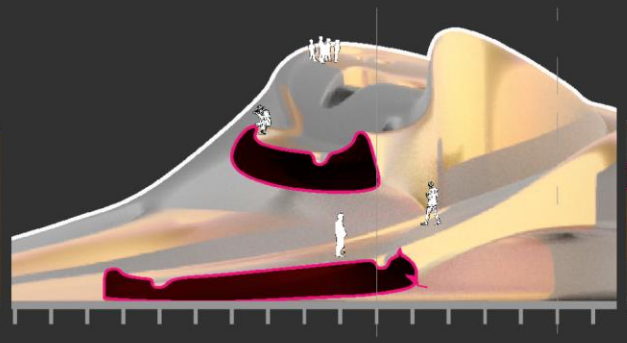




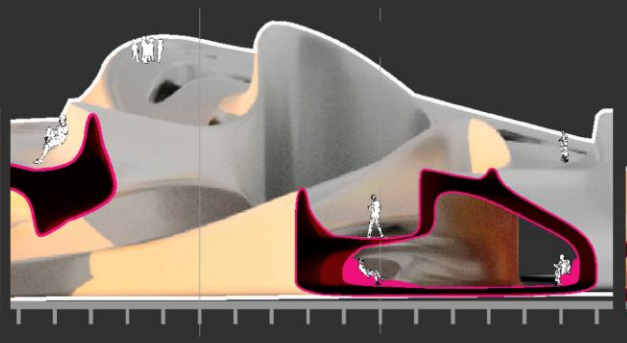
[section-LL' through prayer hall & bridges]



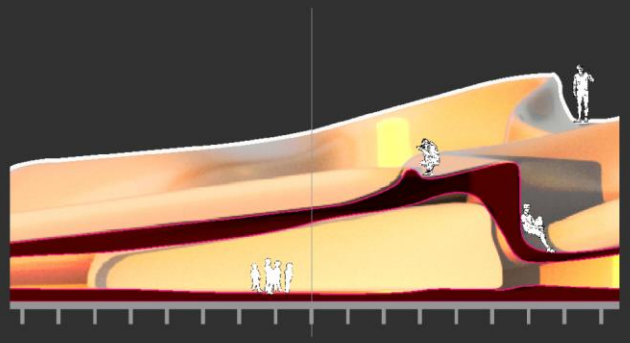
[Embeded Furniture in form]



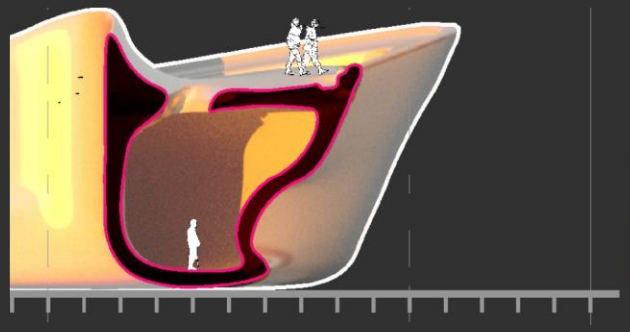
[Clear space between bridges]



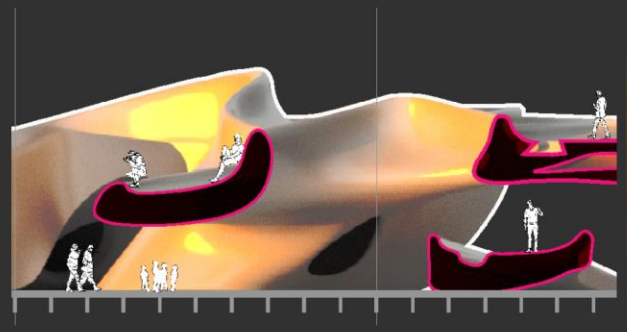
[Furniture along Anthro Curves]



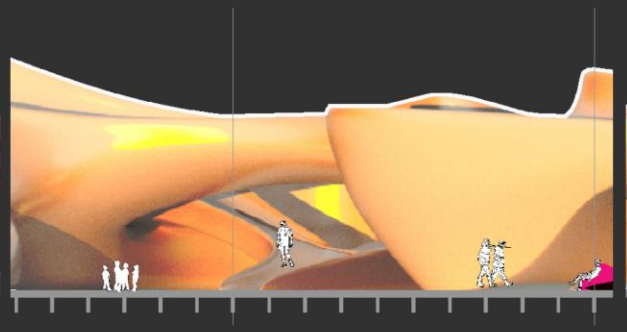
[Furniture along Anthro Curves]



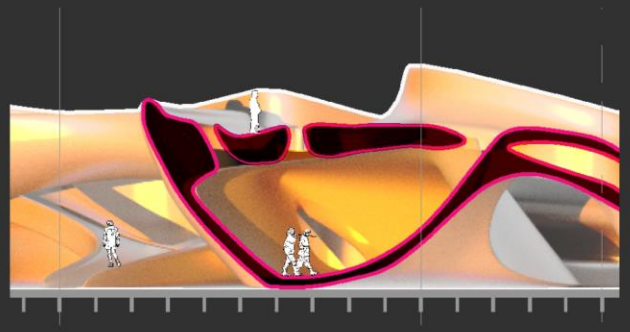
[integrated perforations]



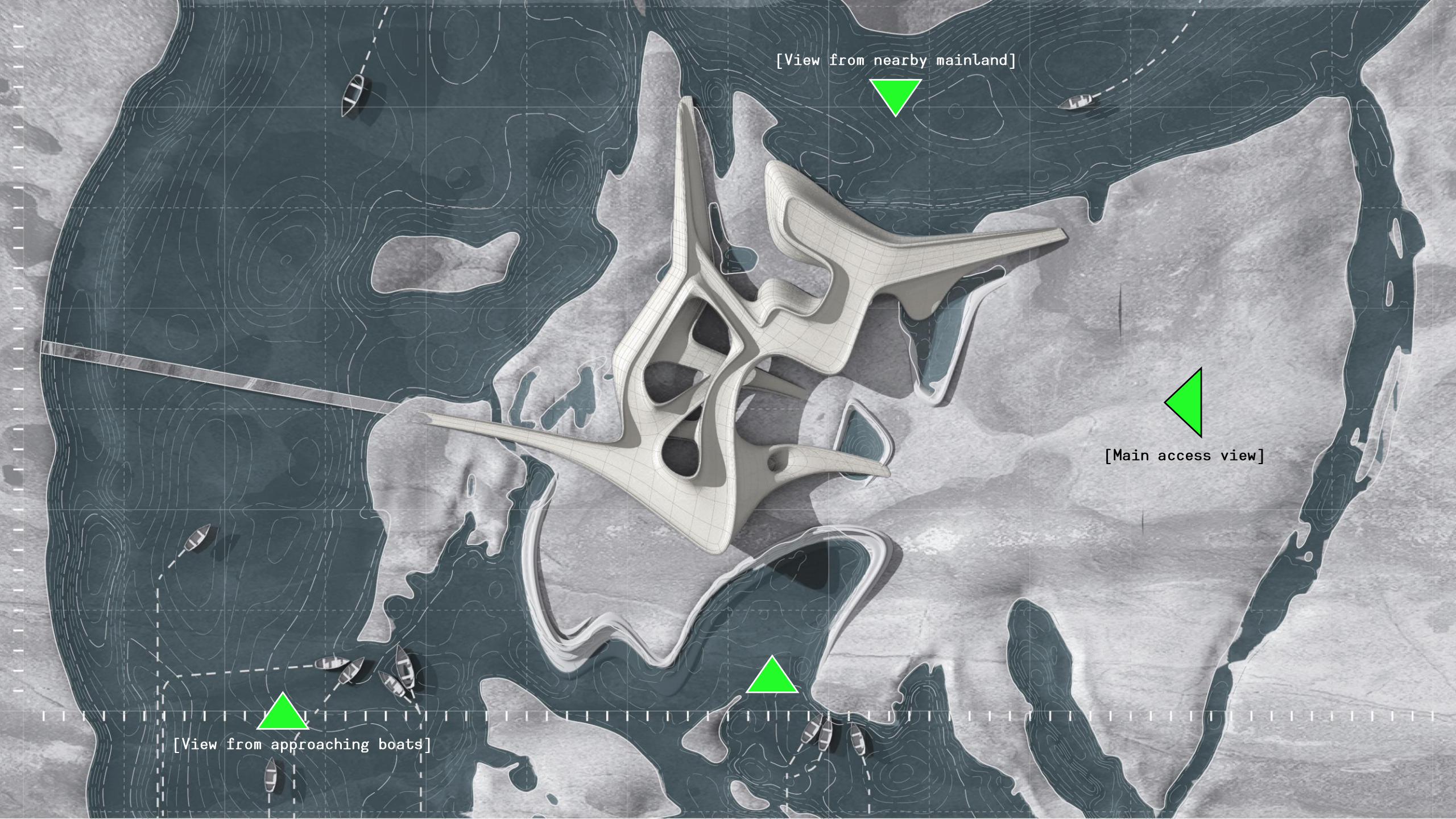
[Bridges used as view spots]



[Ramps & Bridges]



[Integrated Perforations]


[View from nearby mainland]
[Main access view]
[View from approaching boats]

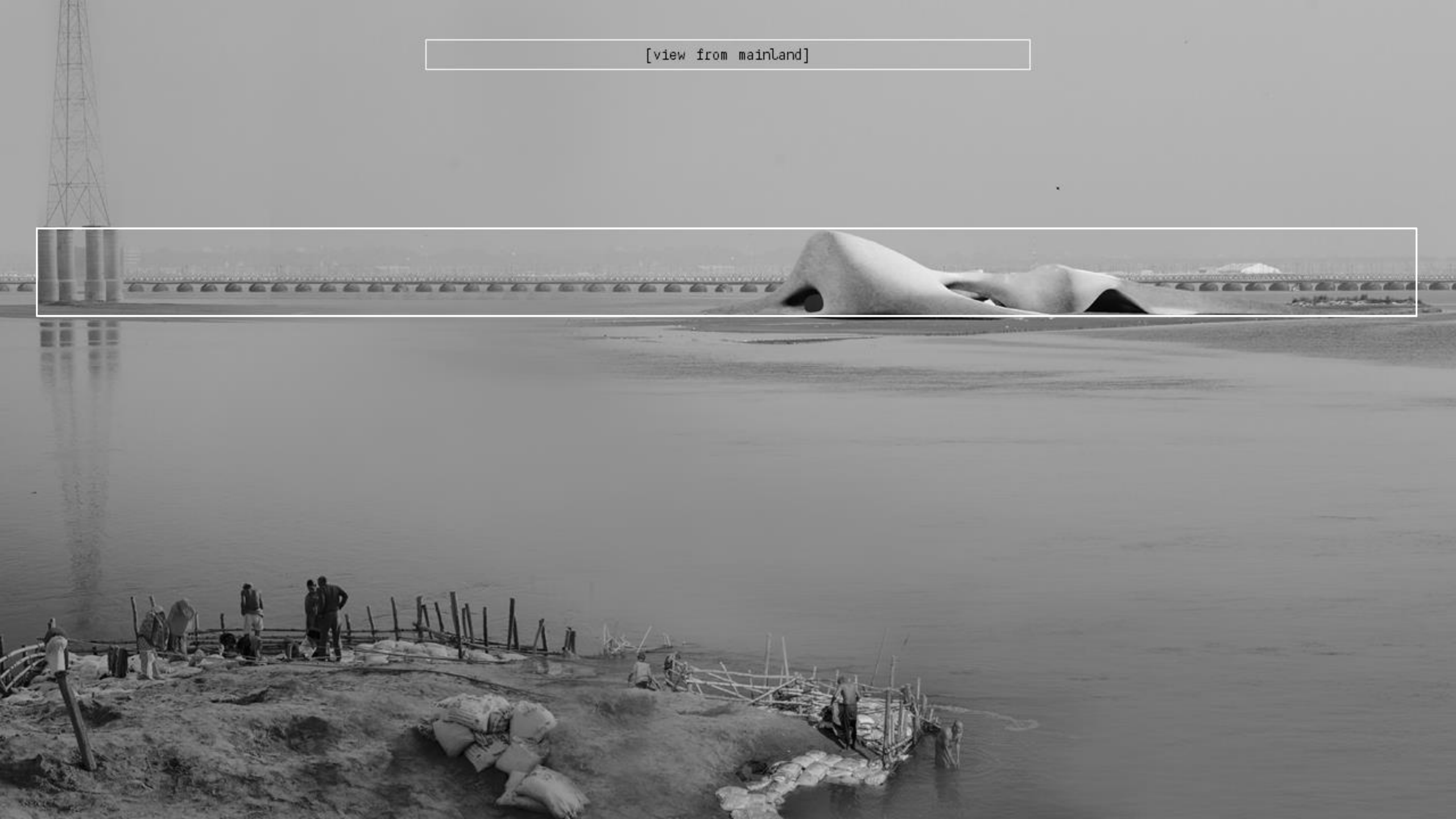
[view from approaching boats]

[view from approaching boats]

[view from approaching boats]

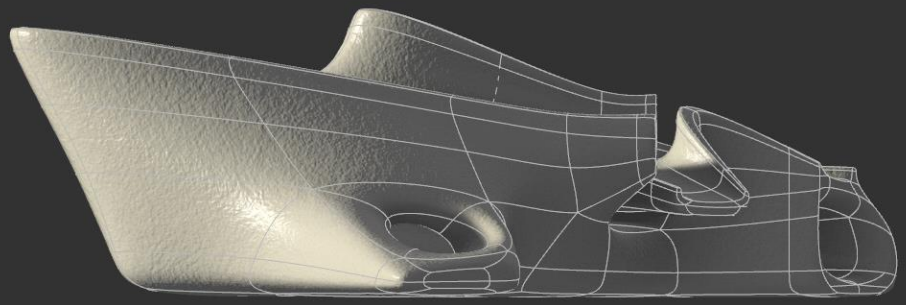
[view from nearby mainland]

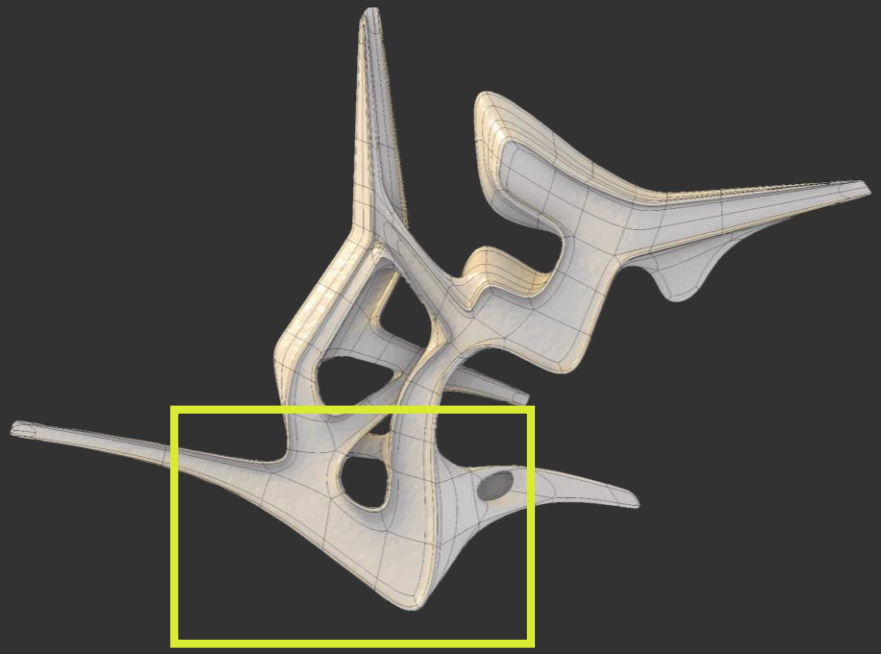
[view from main access path]


[view from mainland]

[view from mainland]

[Fragment-Detailing]



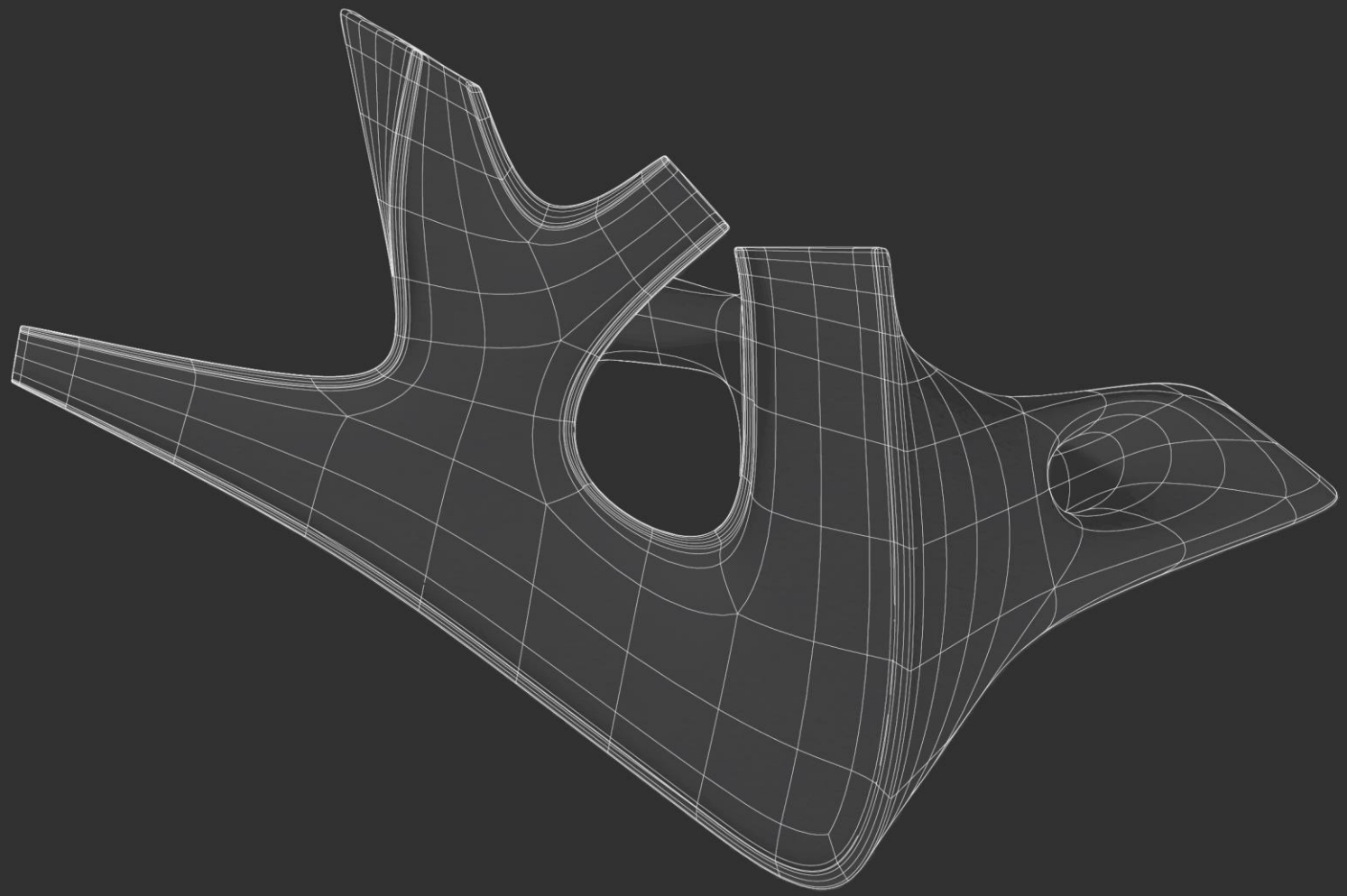


【MESO FRAGMENT】

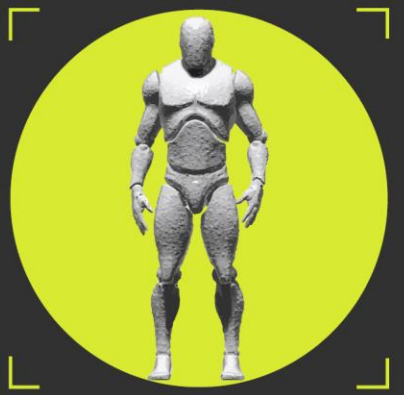
【INTEGRATED FURNITURE CONCEPT】

【PERFORATION CONCEPT】

【DETAIL PATTERN CONCEPT】



[Meso_Fragment]

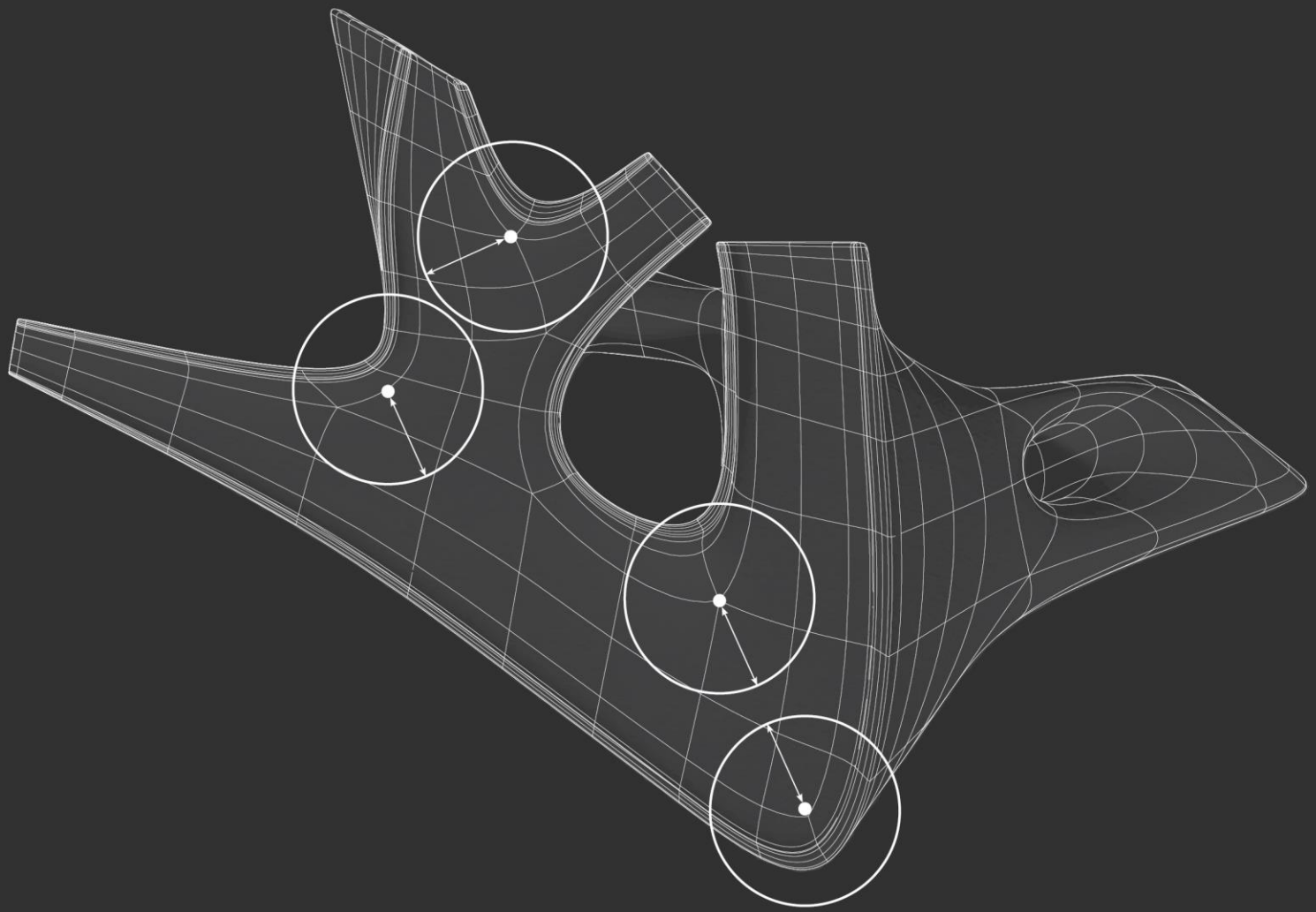


[Anthro_min-areas]

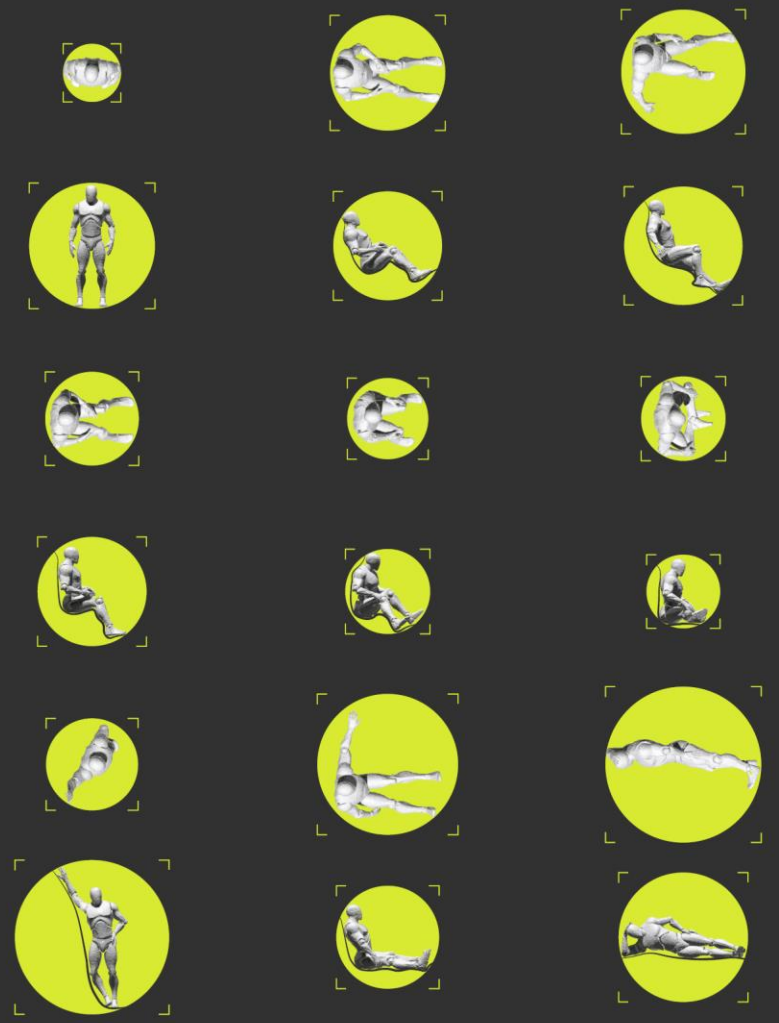
[Seating-Configuration]

[Seating-Configuration]

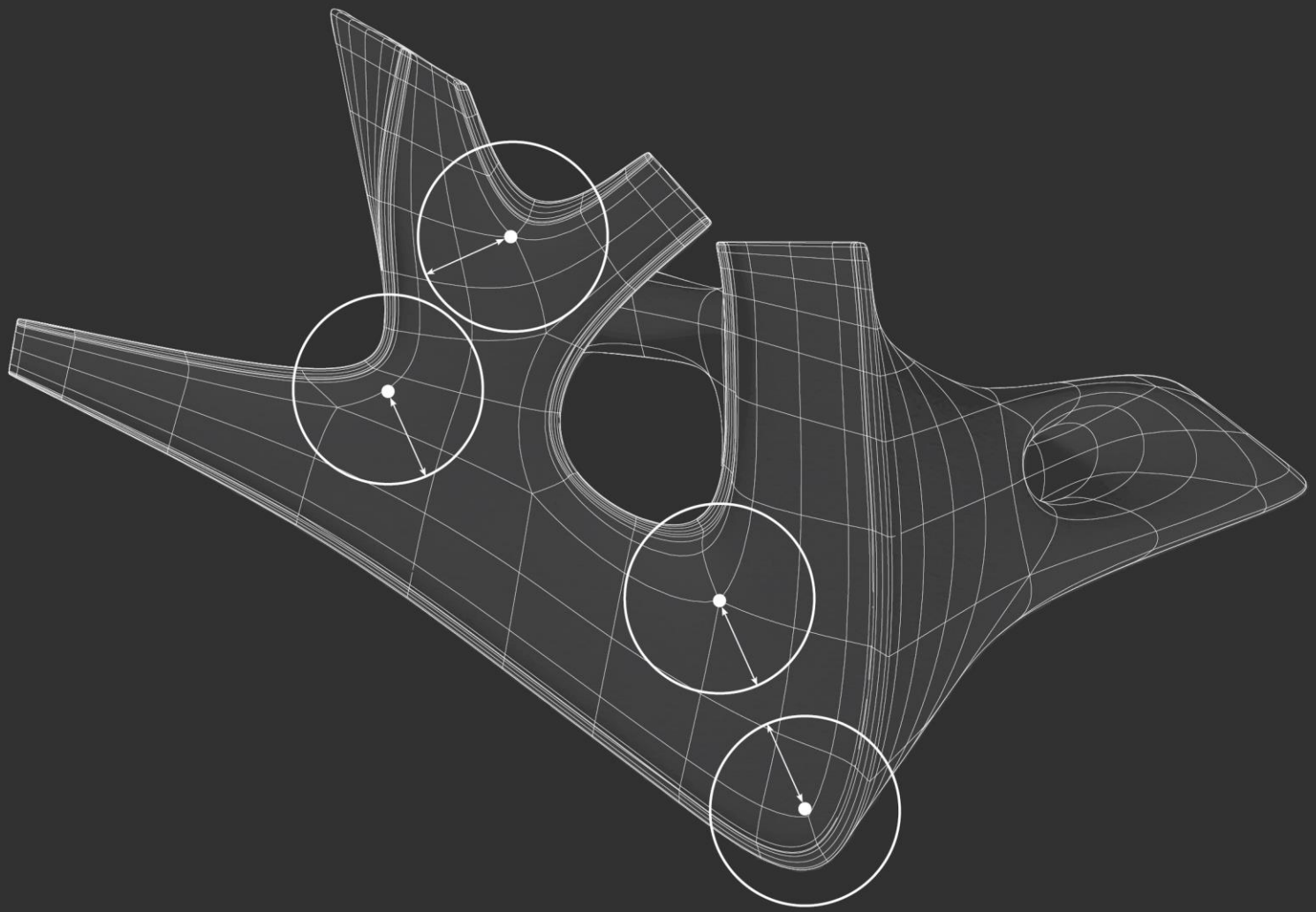
[Seating-Configuration]



[Meso_Fragment]

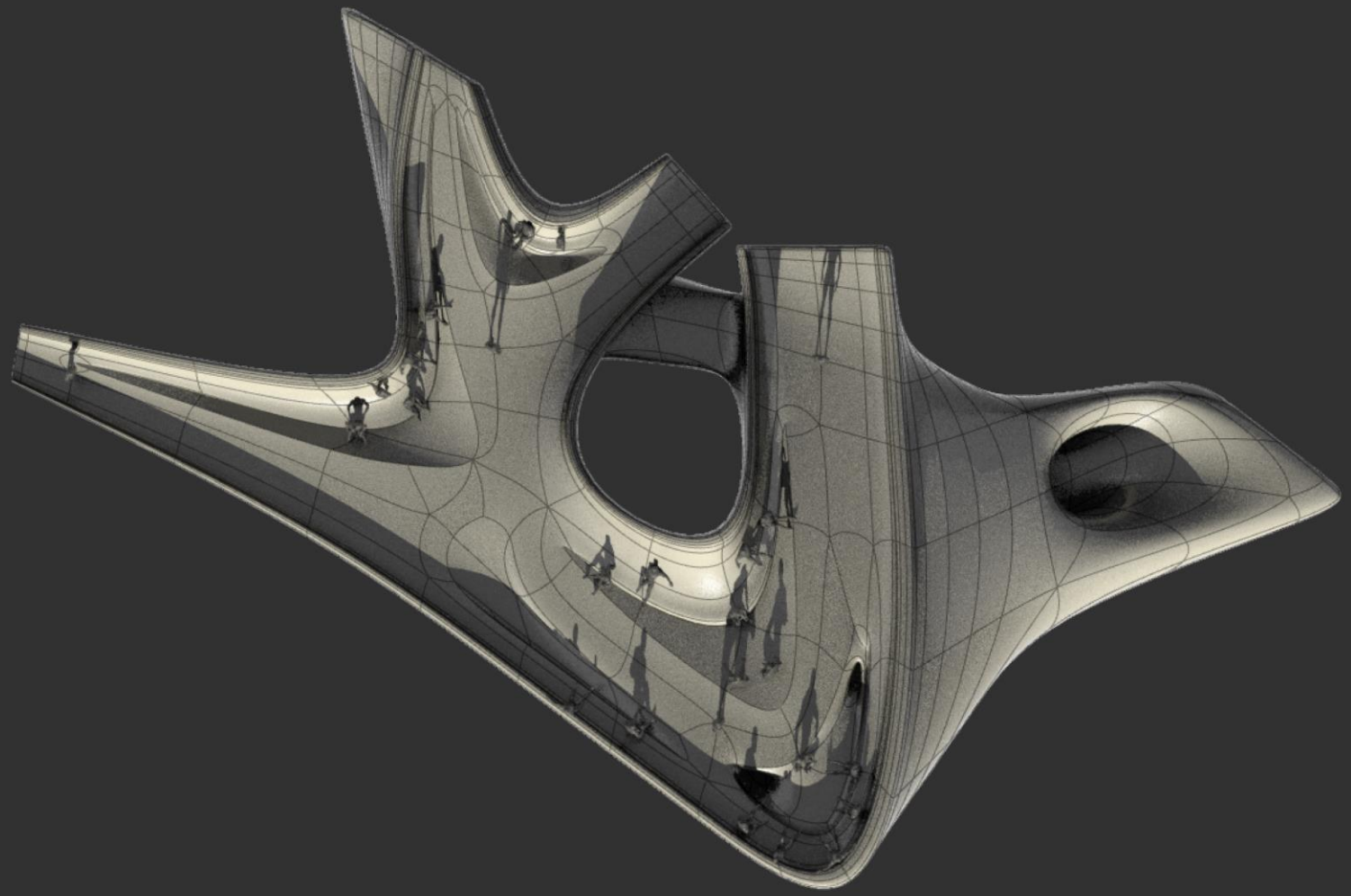


[Anthro_min-areas]



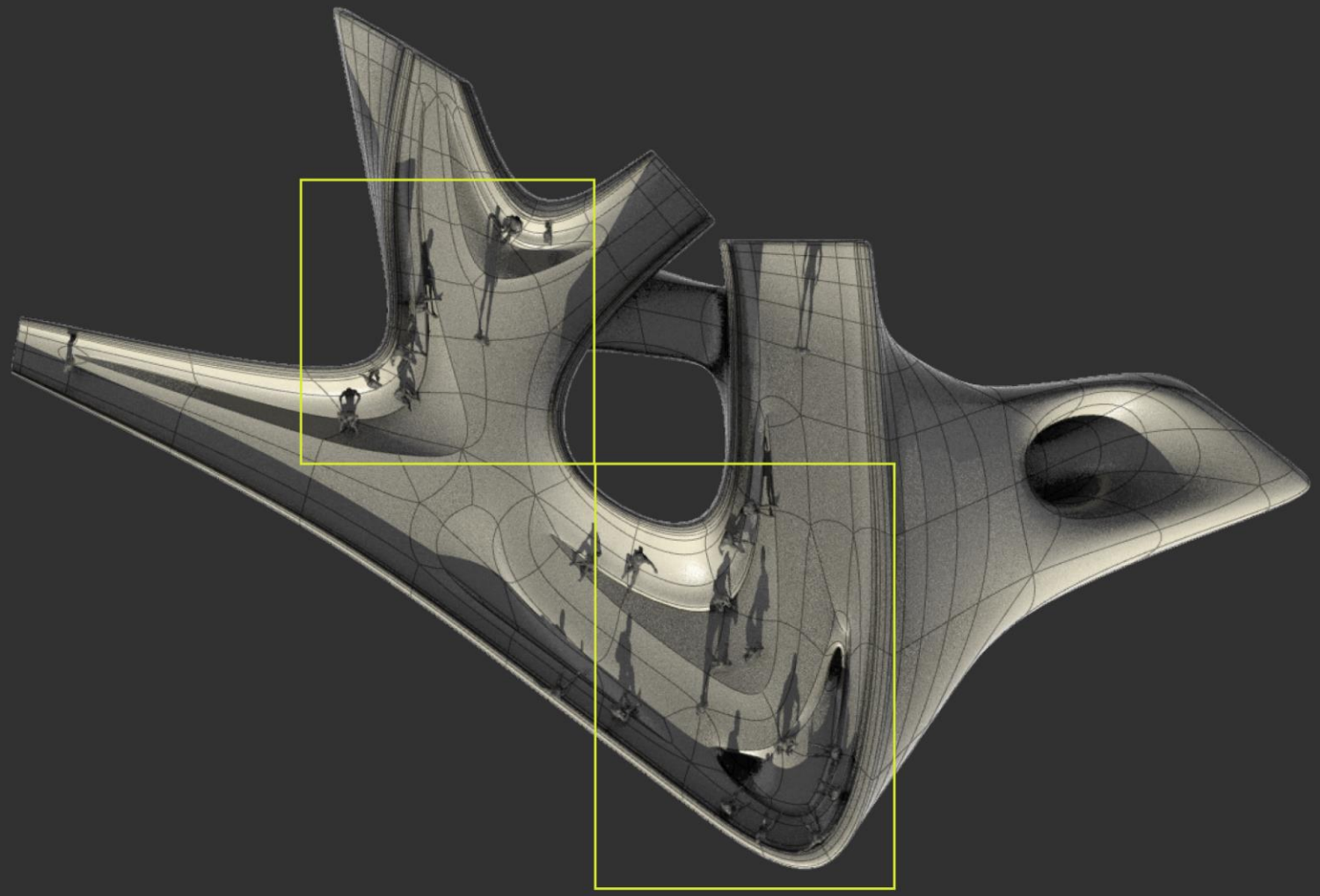
[Meso_Fragment]

[Anthro_min-areas]



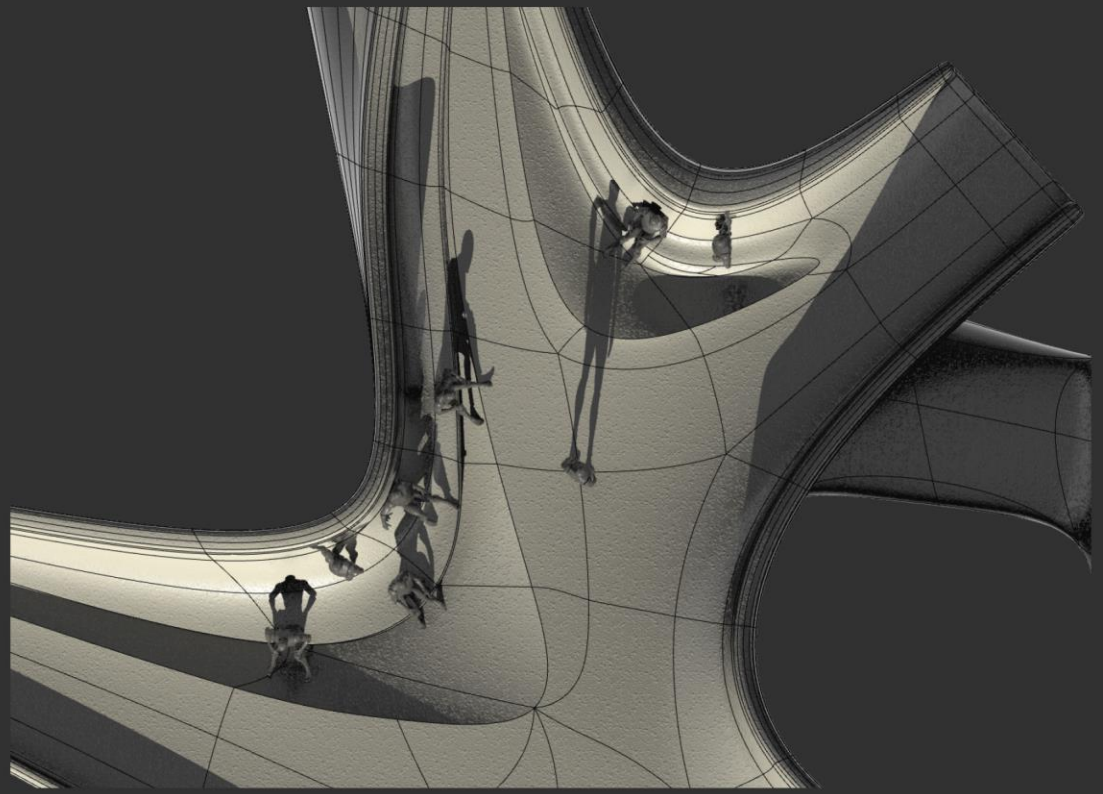
[Meso_Fragment]

[Anthro_min-areas]

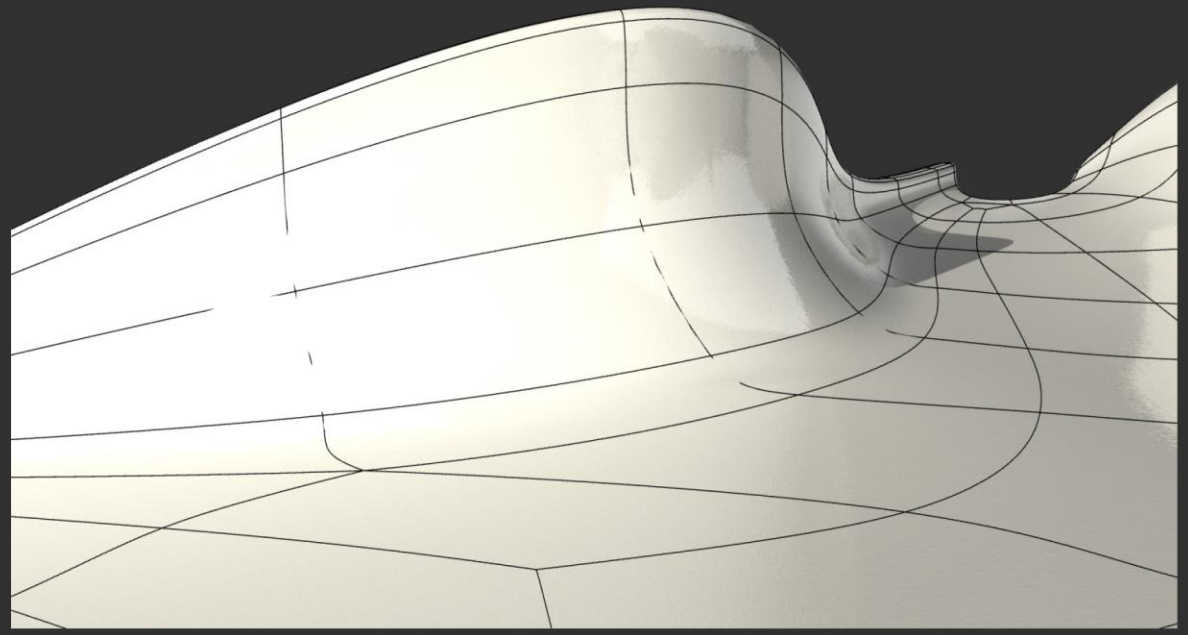


[Seating_Plan]

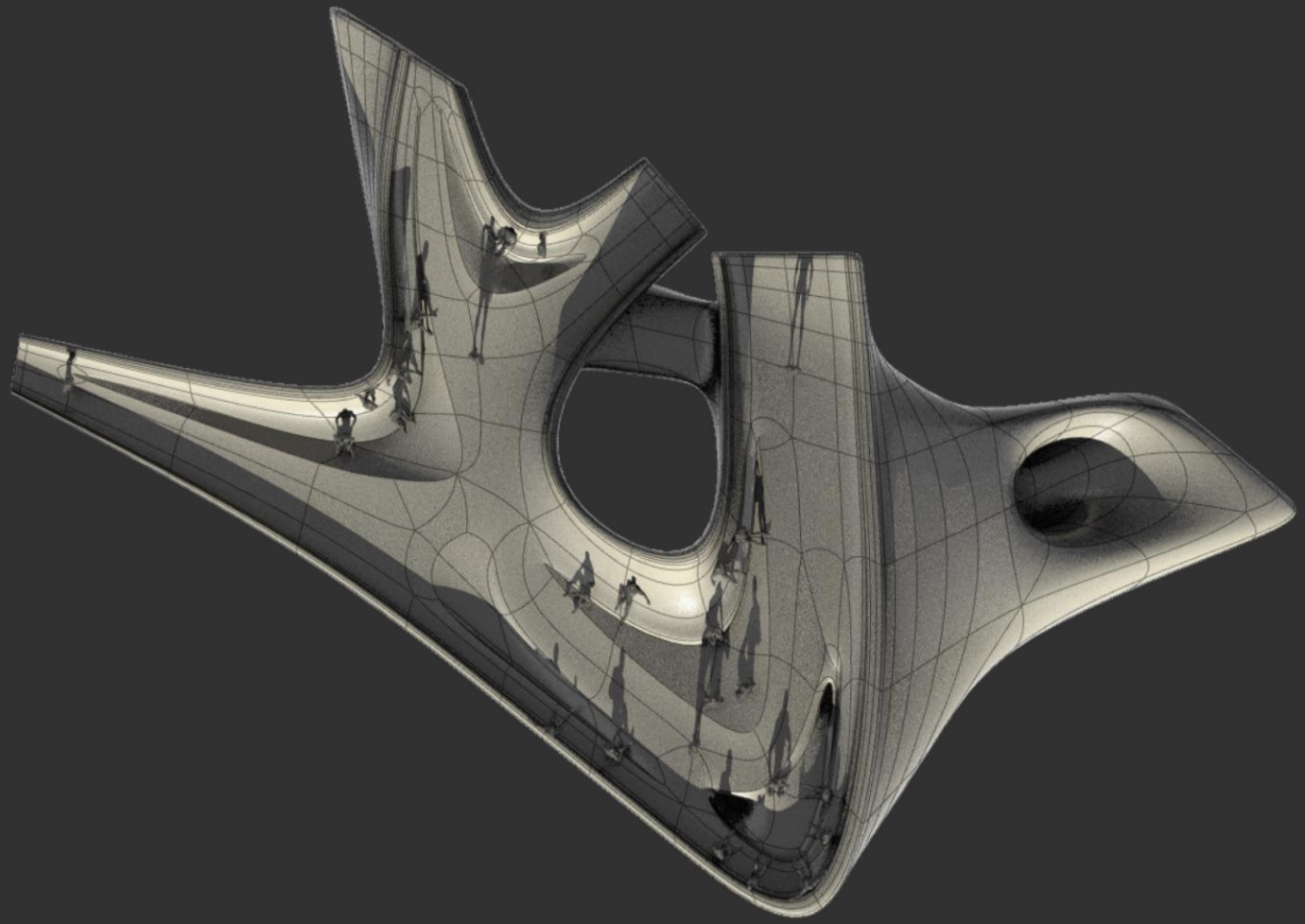
[Anthro_min-areas]

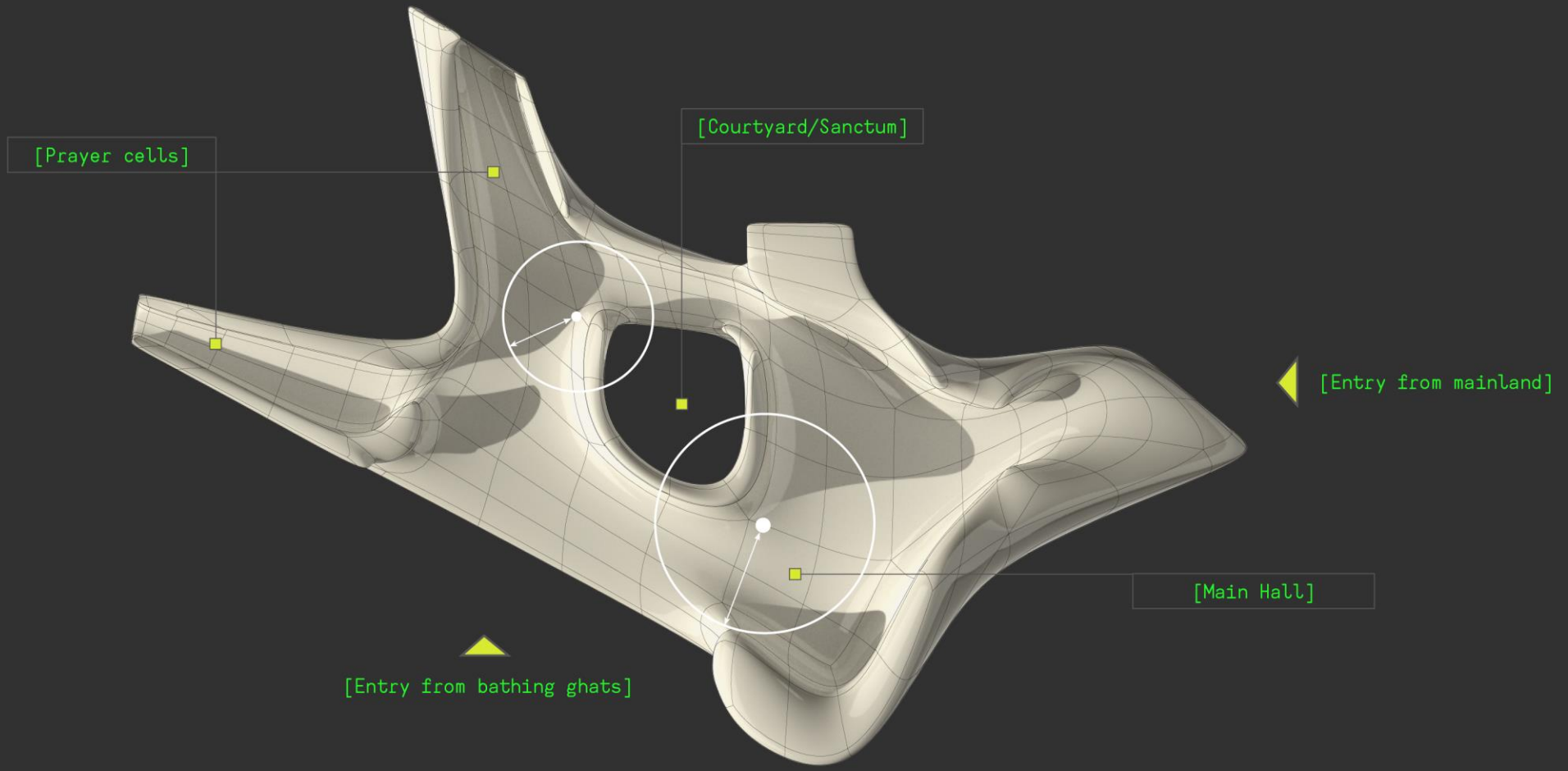


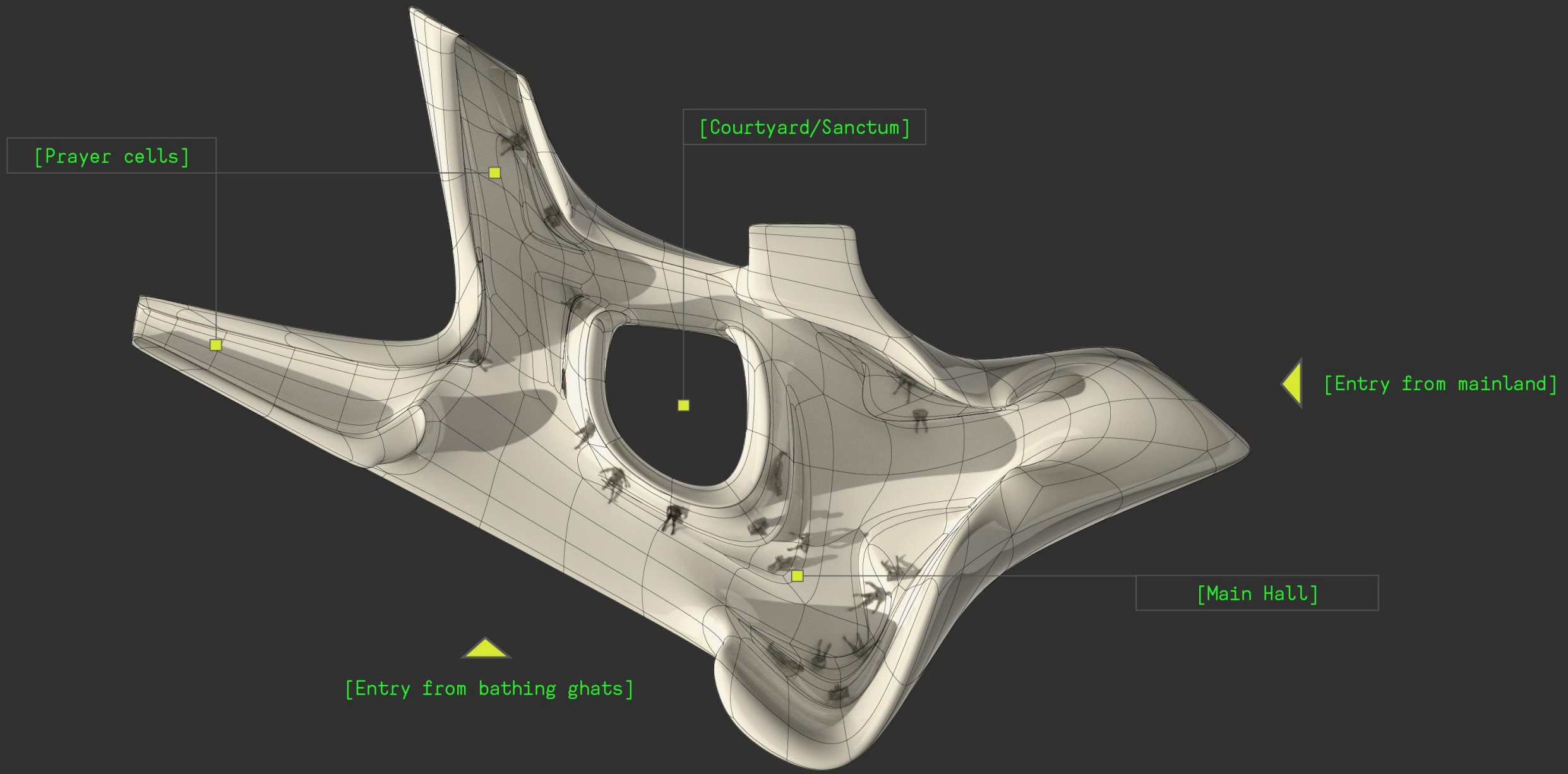
[Seating_Plan-A]

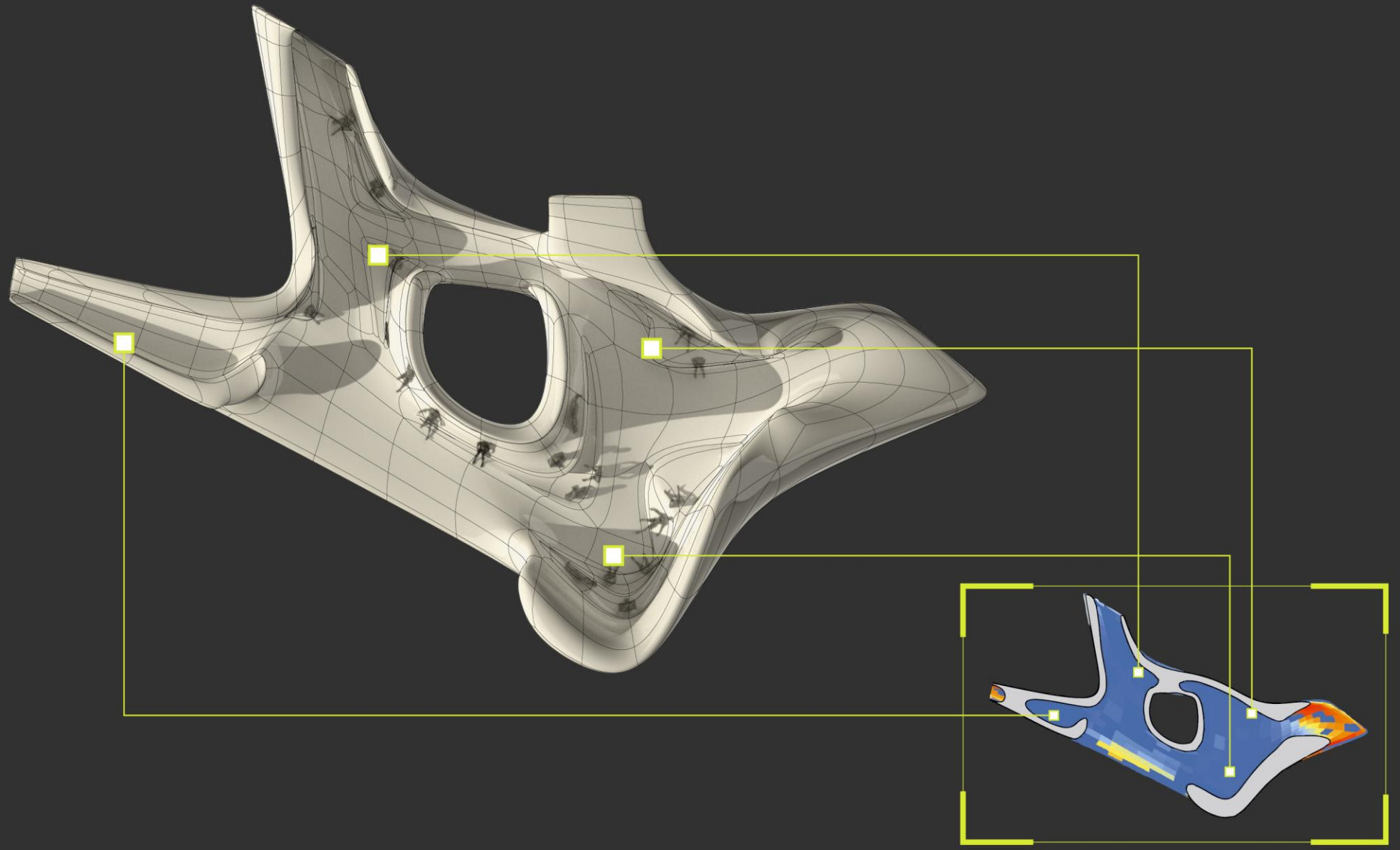


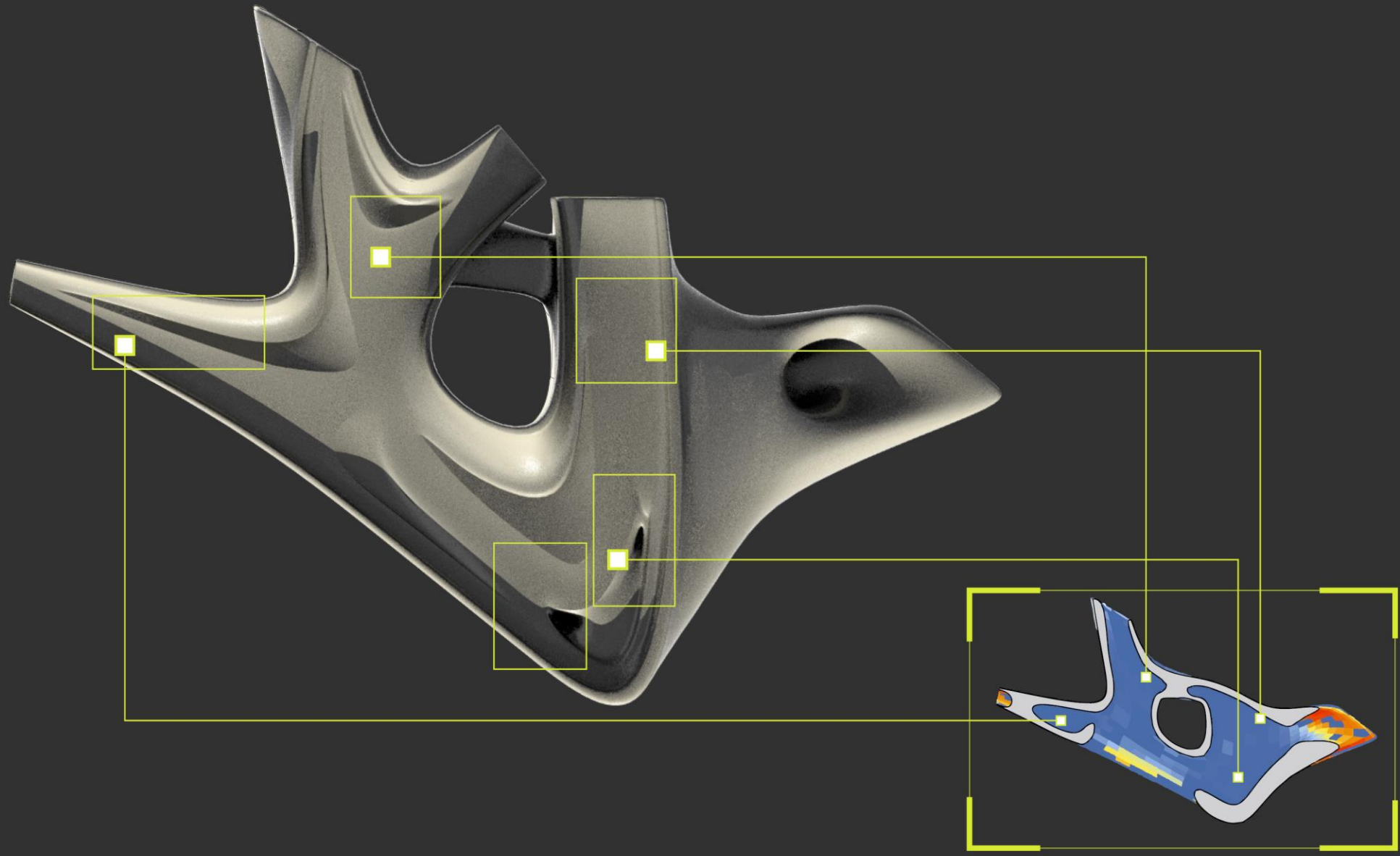
[Sectional_Deformations]

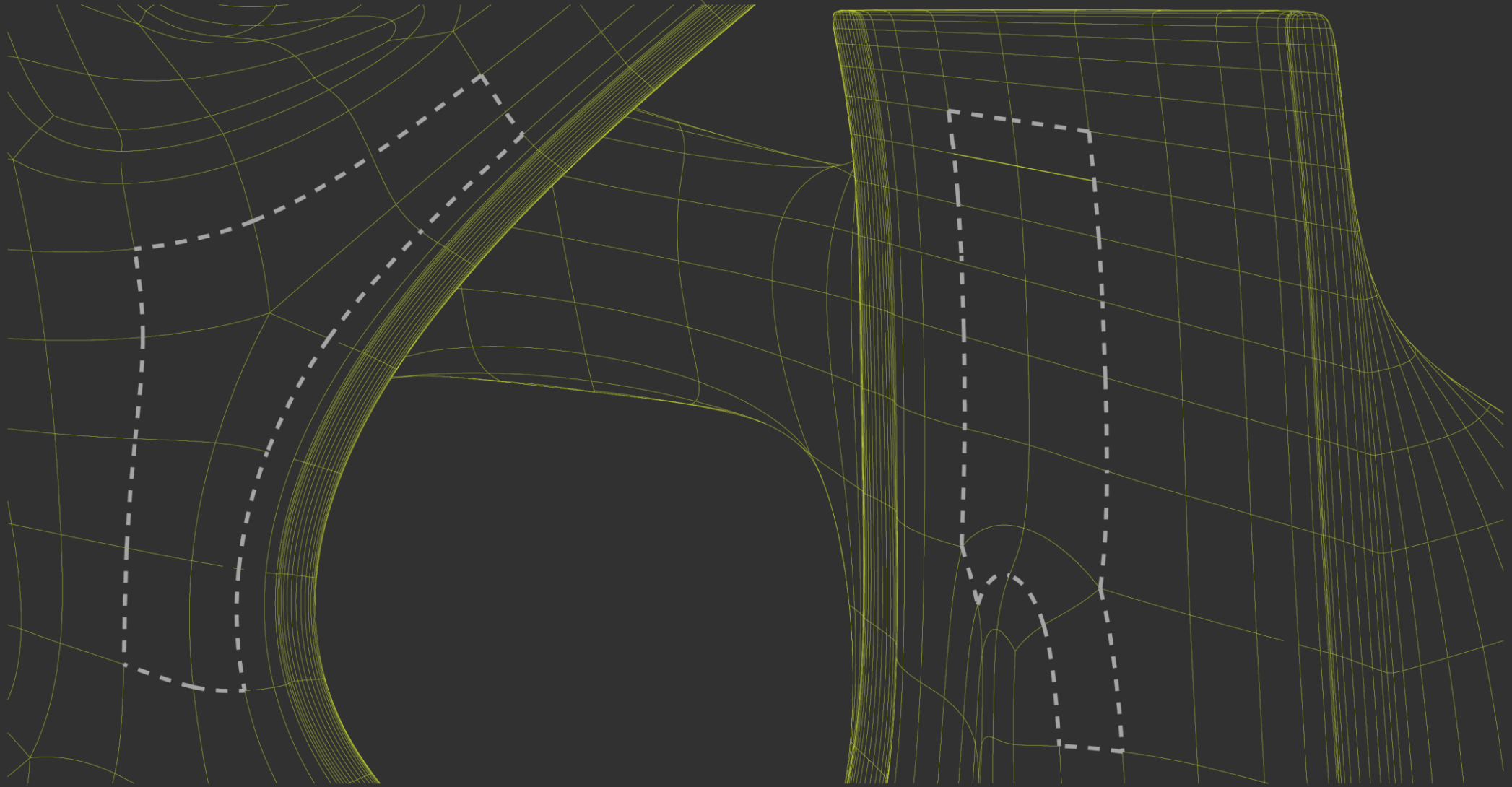



[Prayer cells]
[Courtyard/Sanctum]
[Entry from mainland]
[Main Hall]
[Entry from bathing ghats]

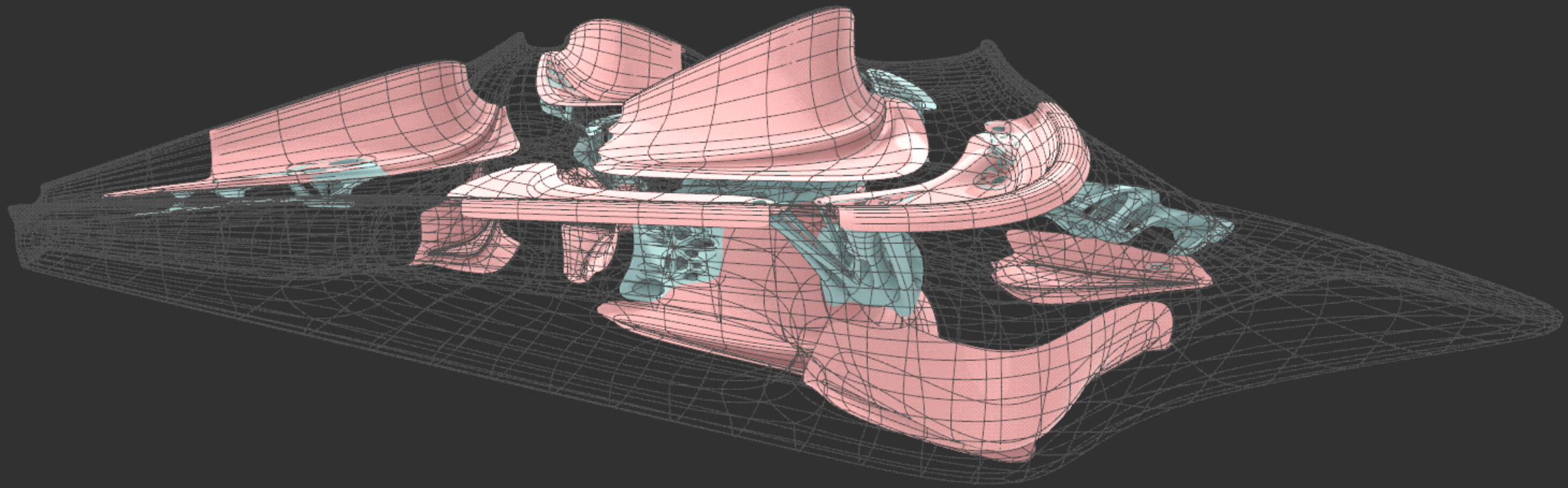

[Prayer cells]
[Courtyard/Sanctum]
[Entry from mainland]
[Main Hall]
[Entry from bathing ghats]

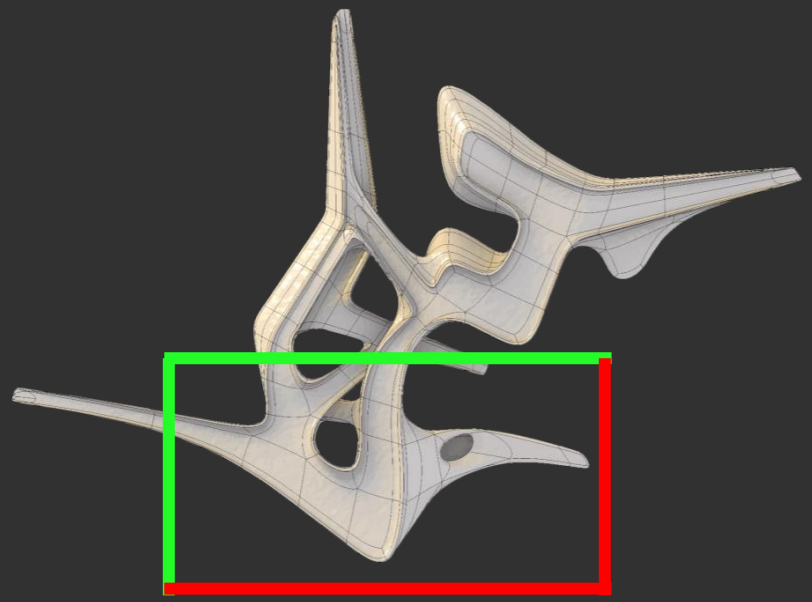






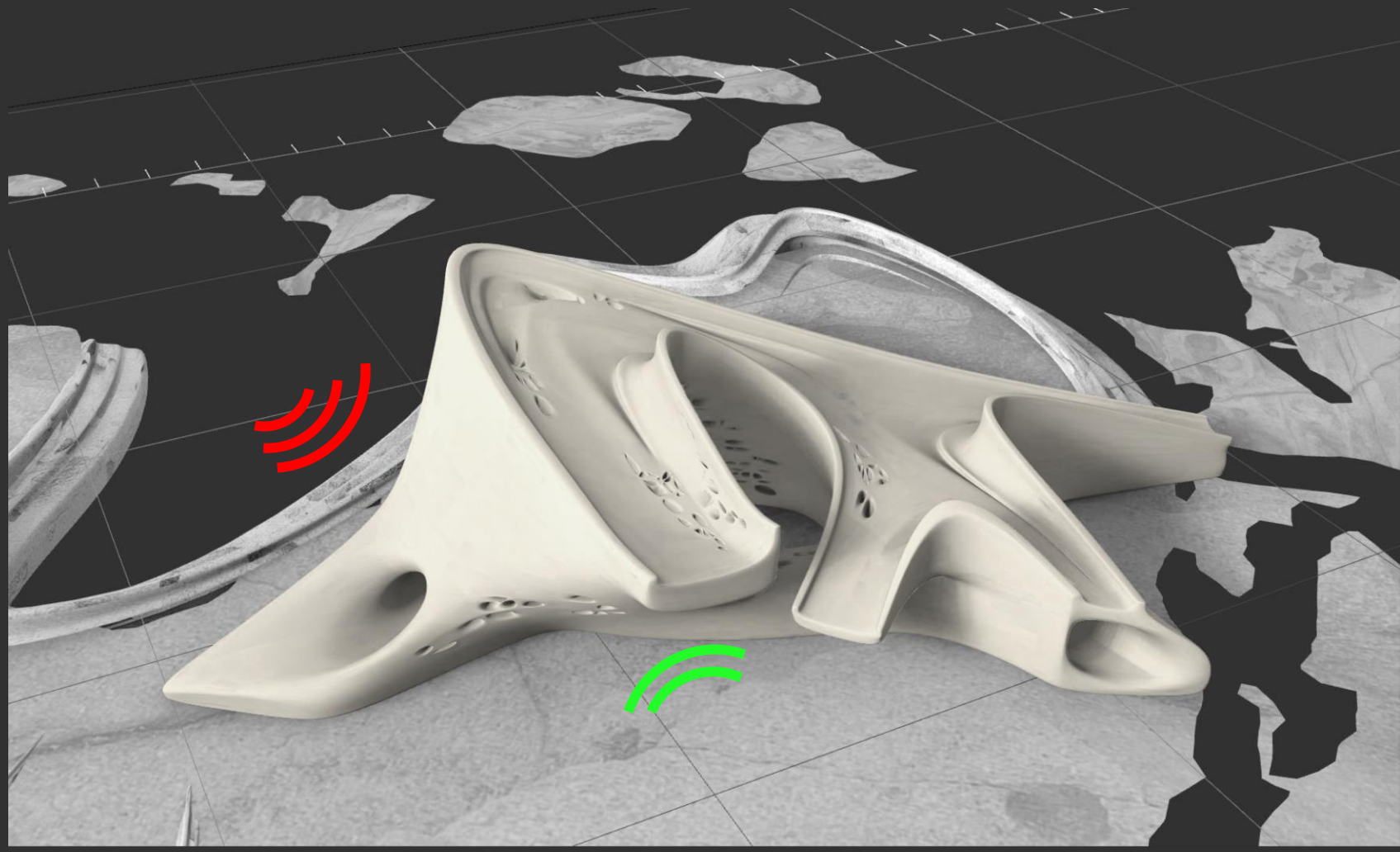
[Polygon face selecton for perforation]

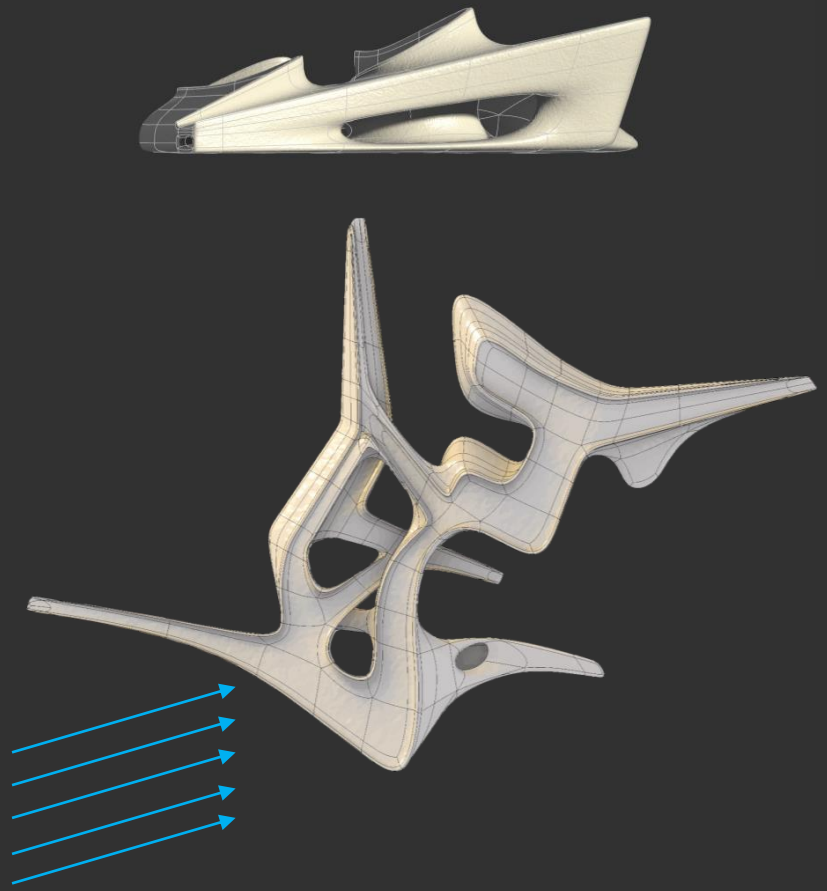




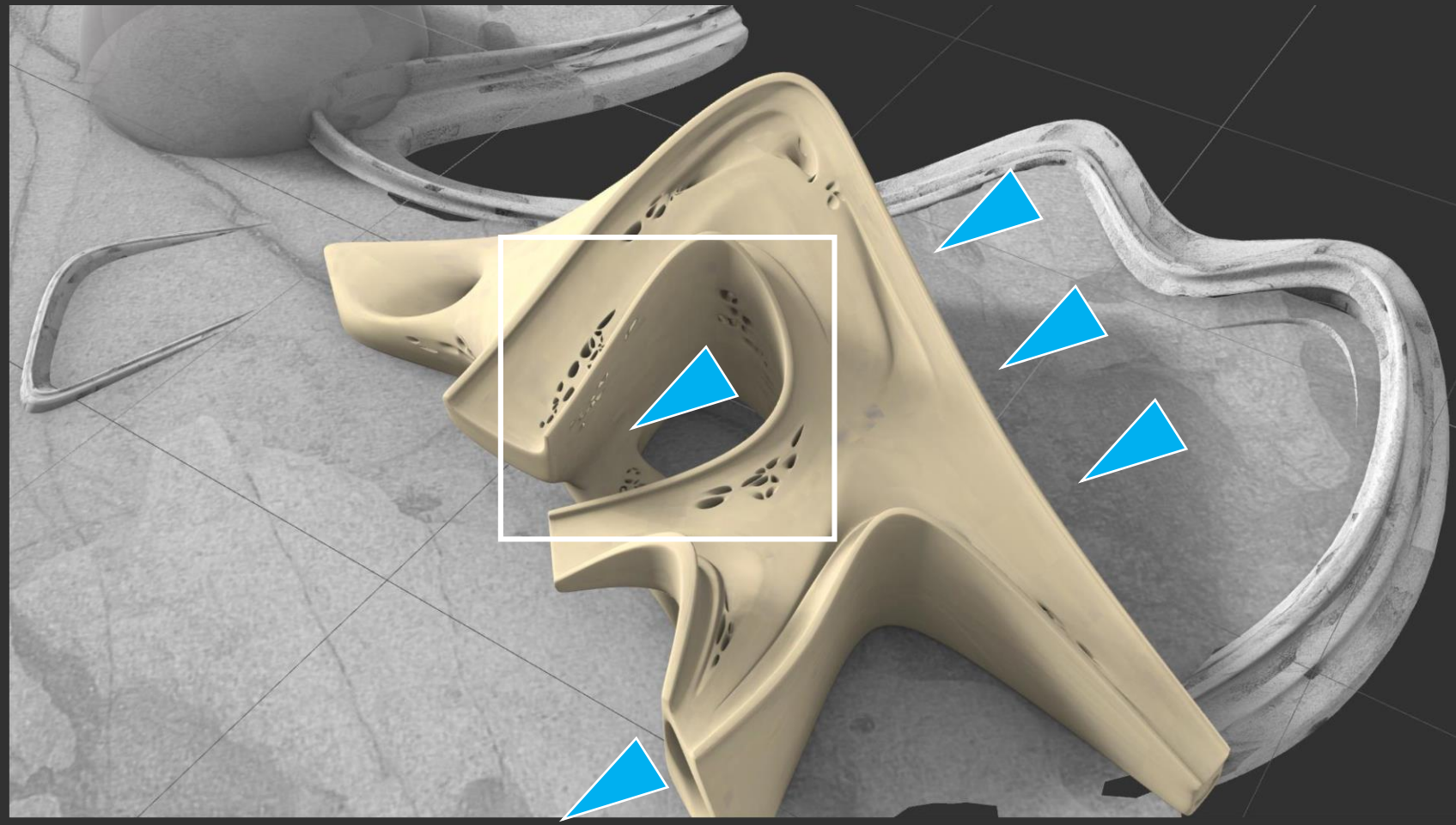
[Noise Location]

[Quiet Location]

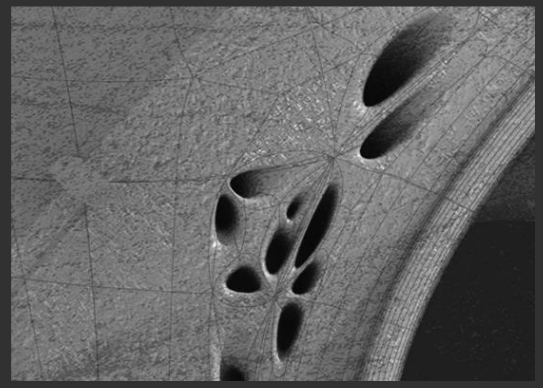


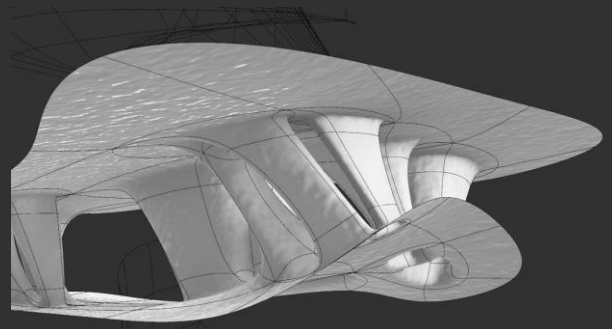


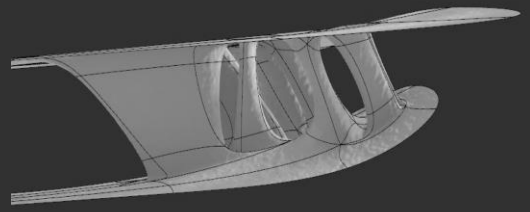
[Wind_Direction-Jan to Mar (43%)]

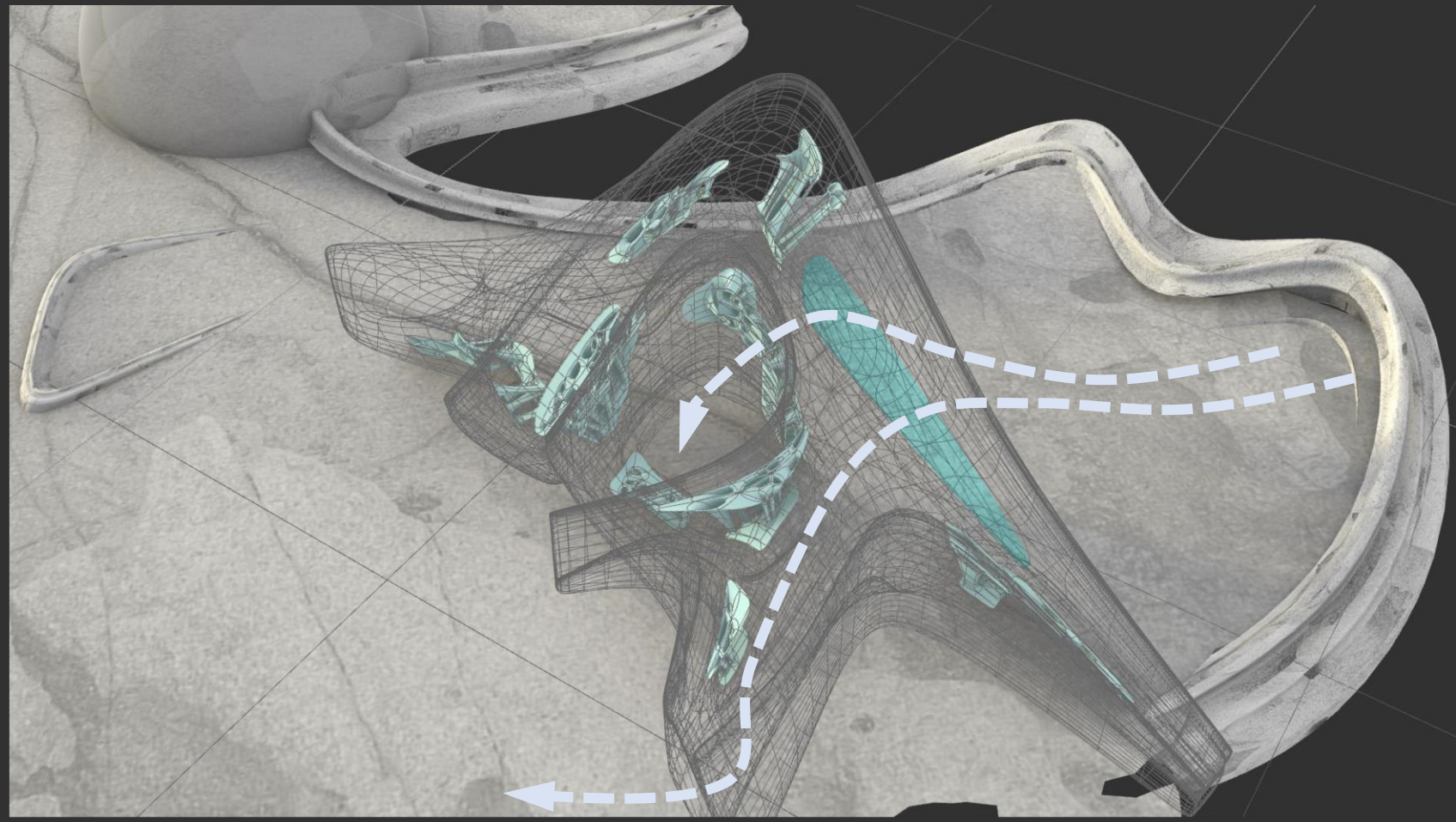


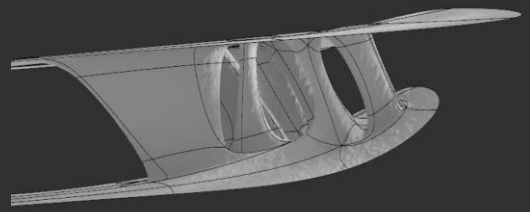
Ventillation & light for inner parts

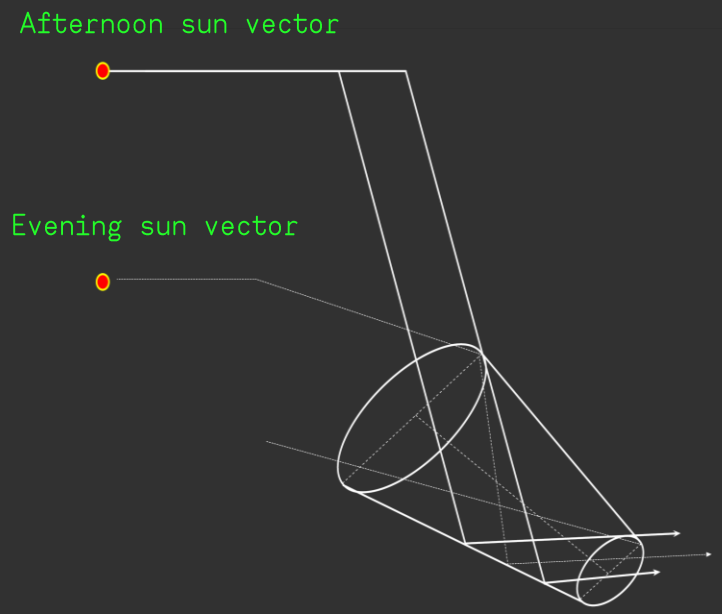


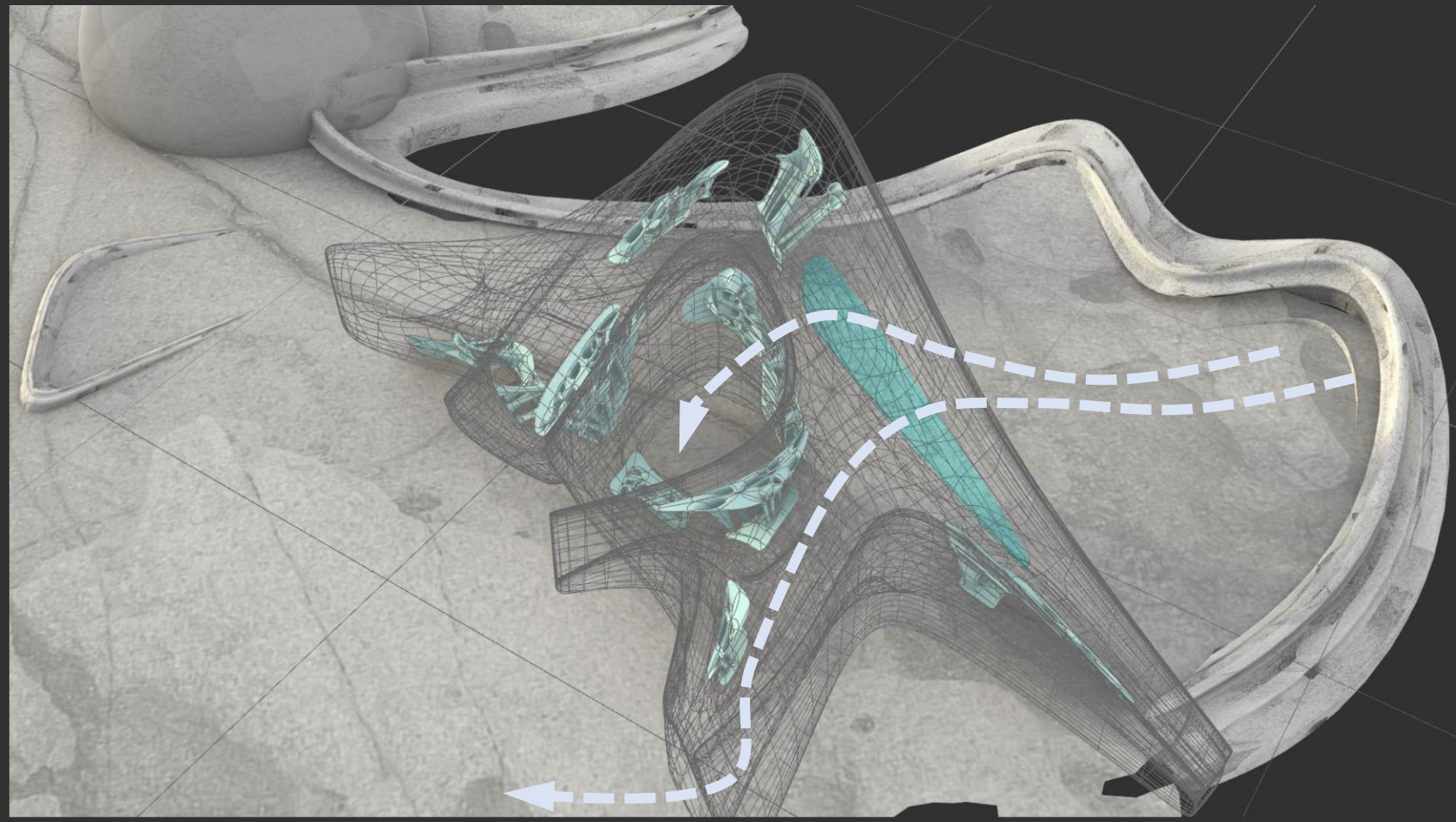




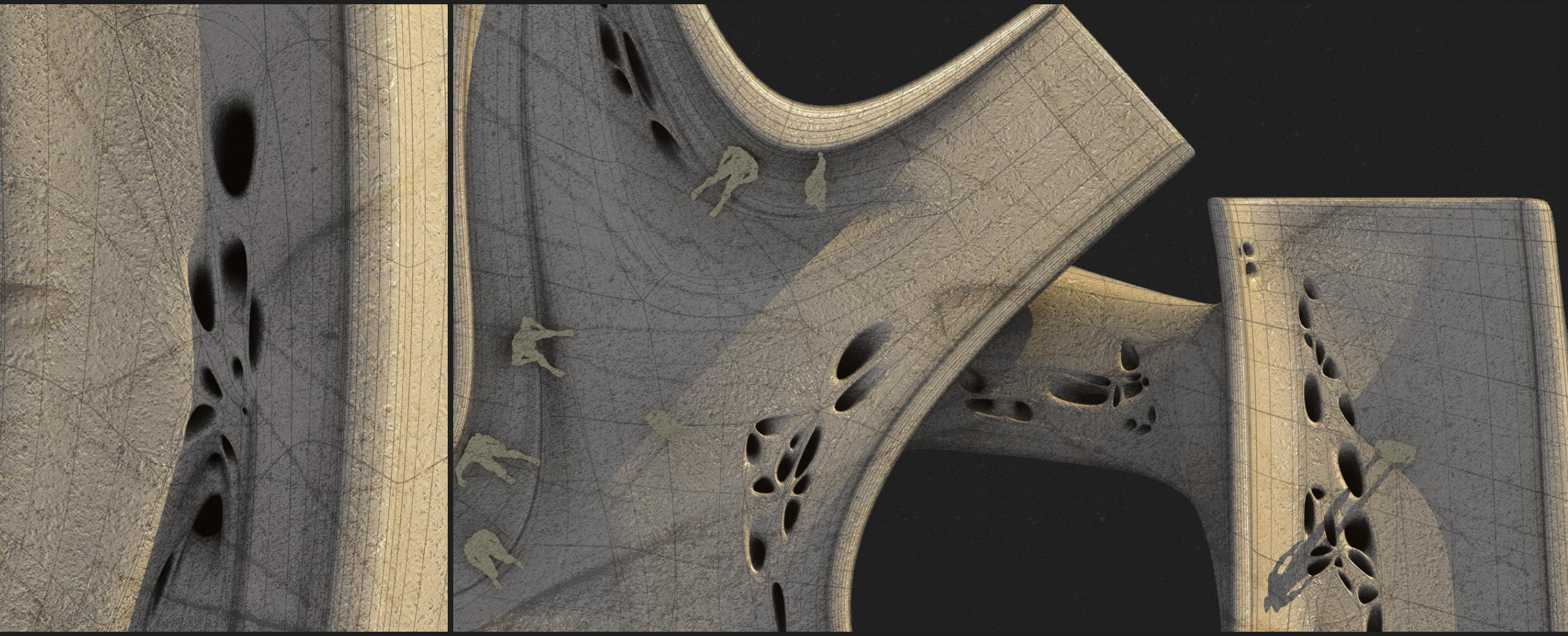




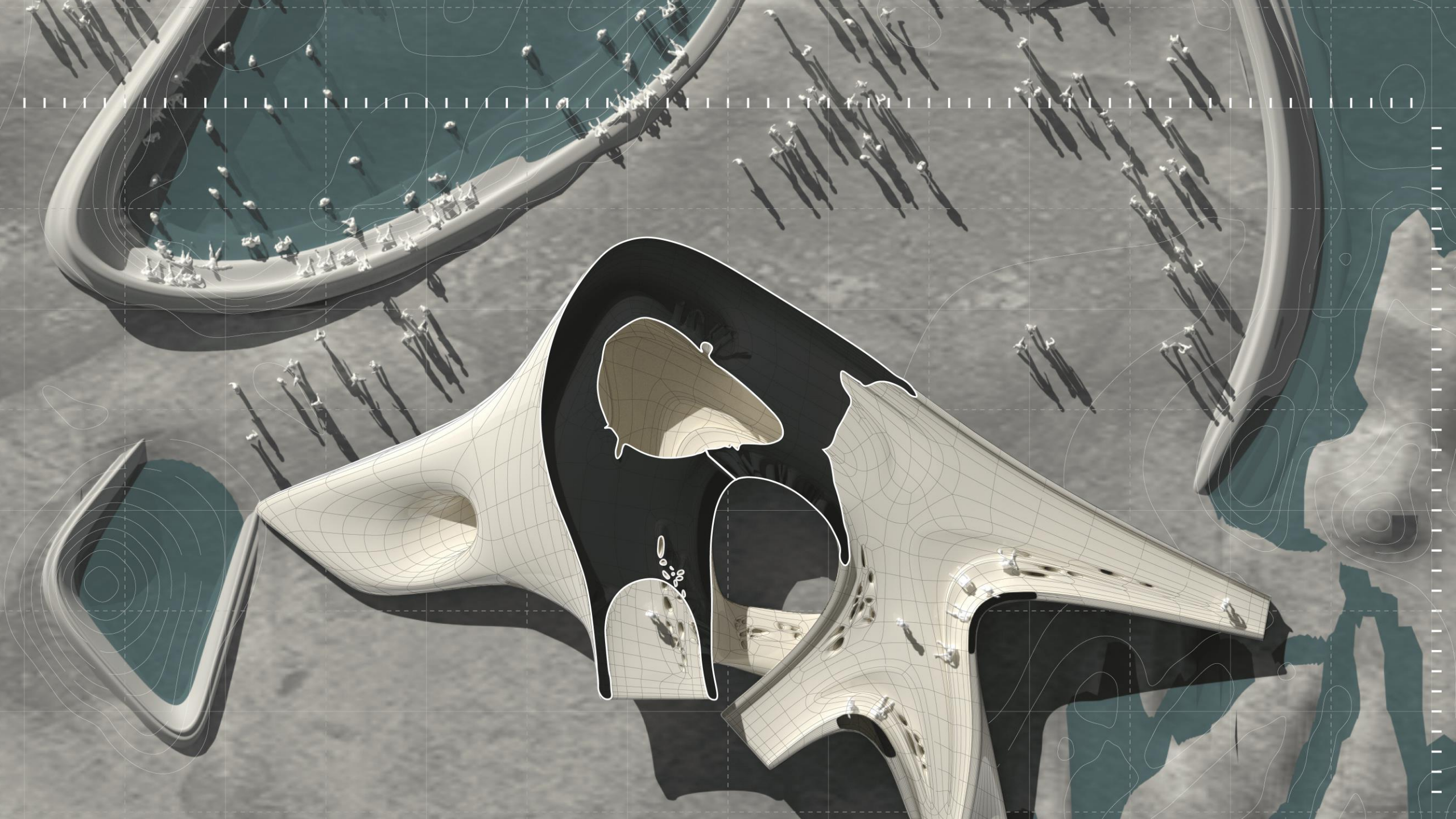


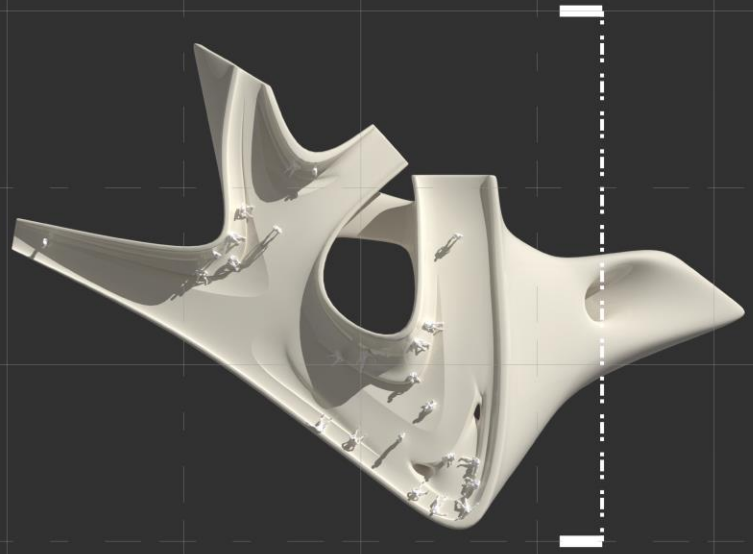


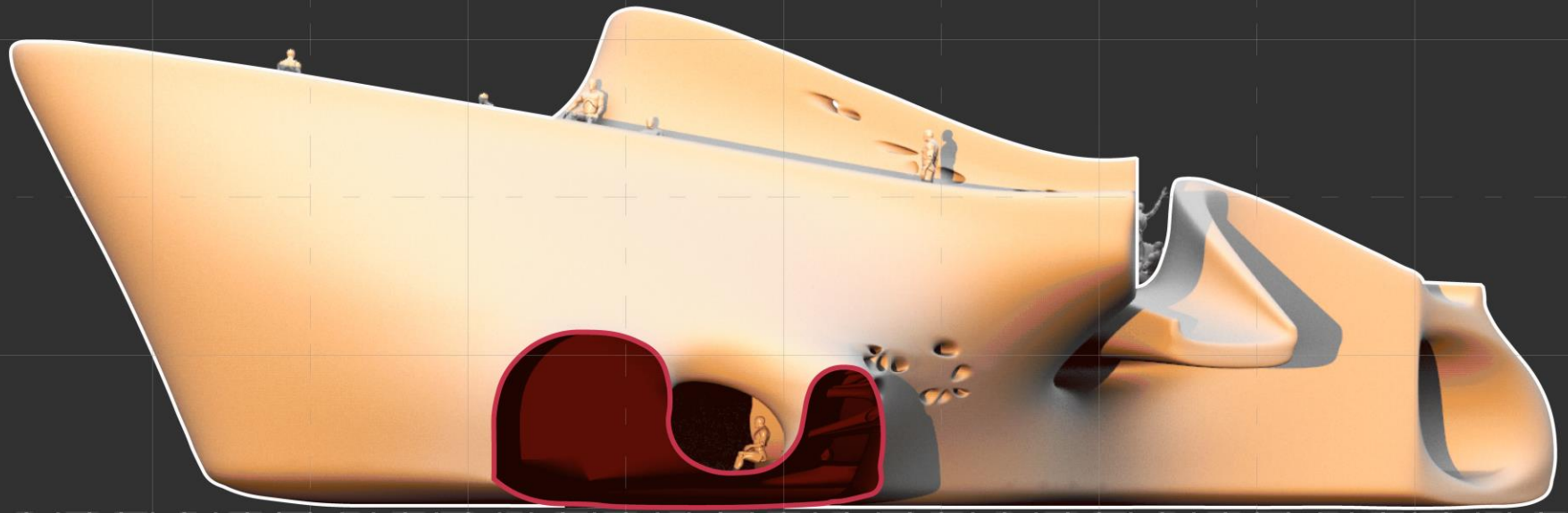
[Perforations at different angles to
Accommodate diffused lighting]



[Perforation Pattern]





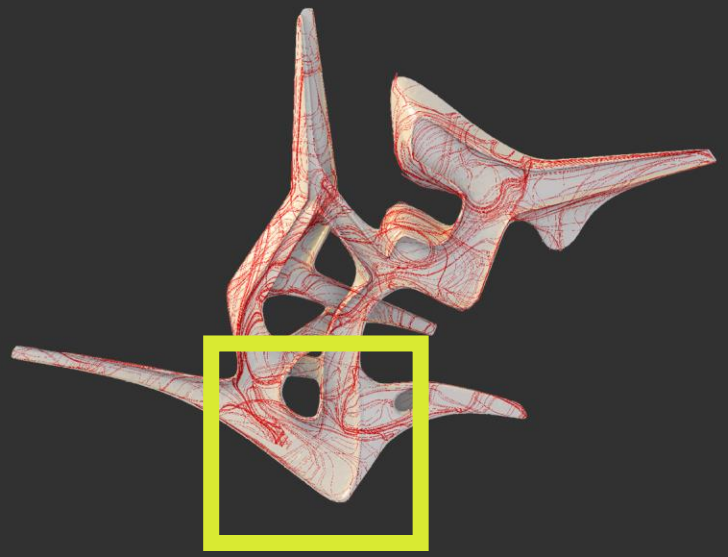


[Micro-Detailing]

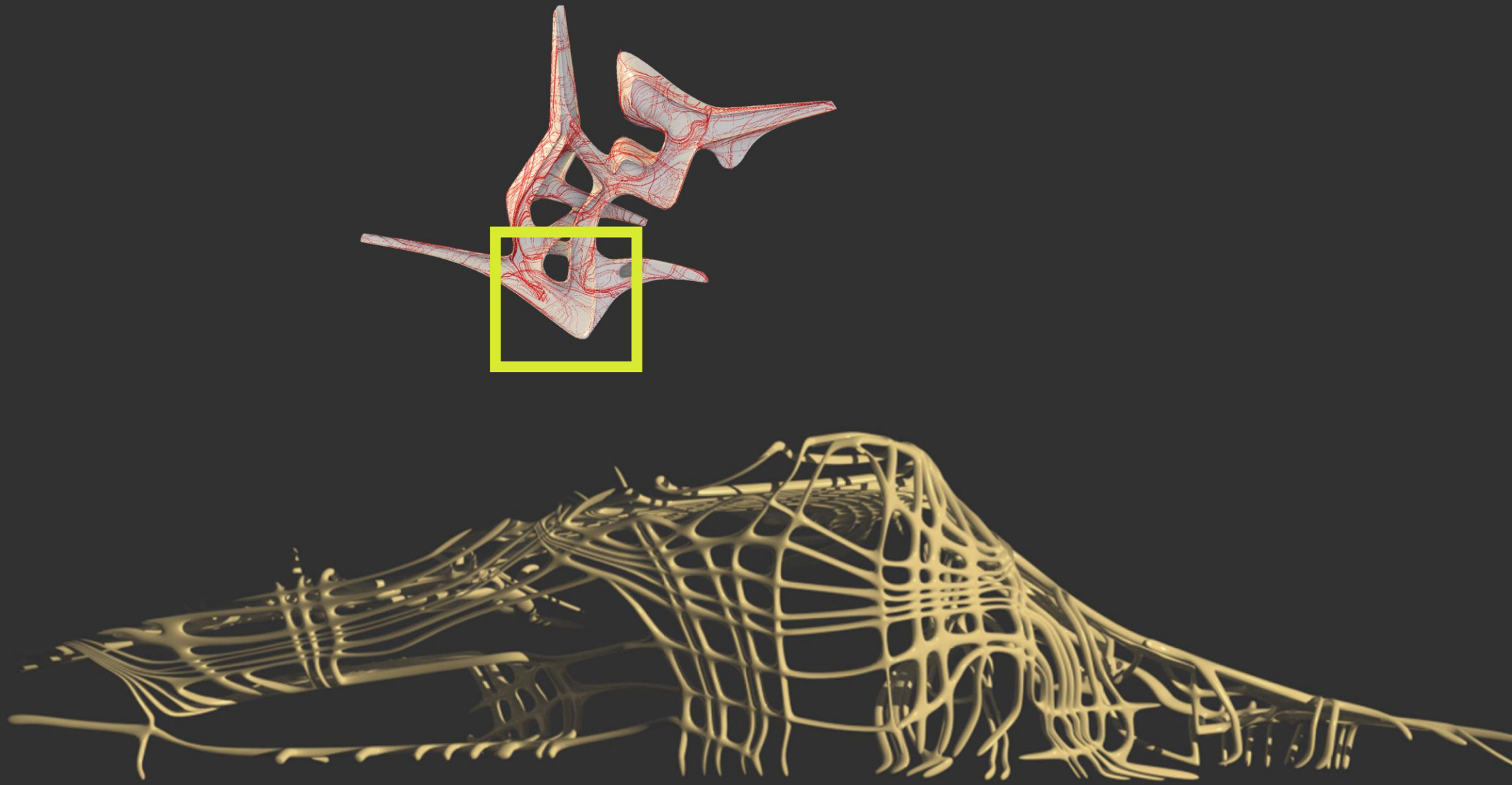
[Temple architecture_Stone-Detailing/Engraving]

[Banyan tree roots induced pattern]

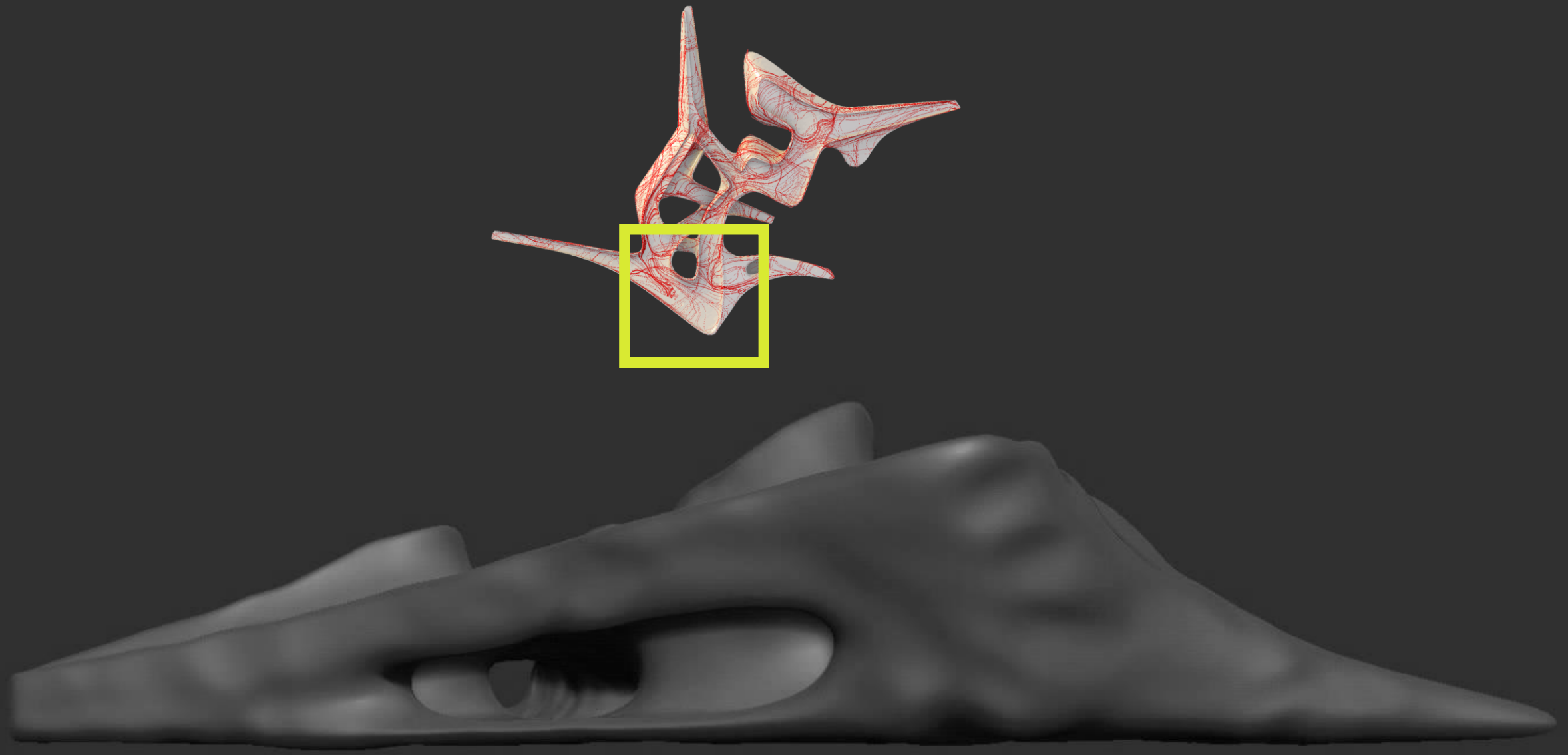
[Banyan tree roots induced pattern]



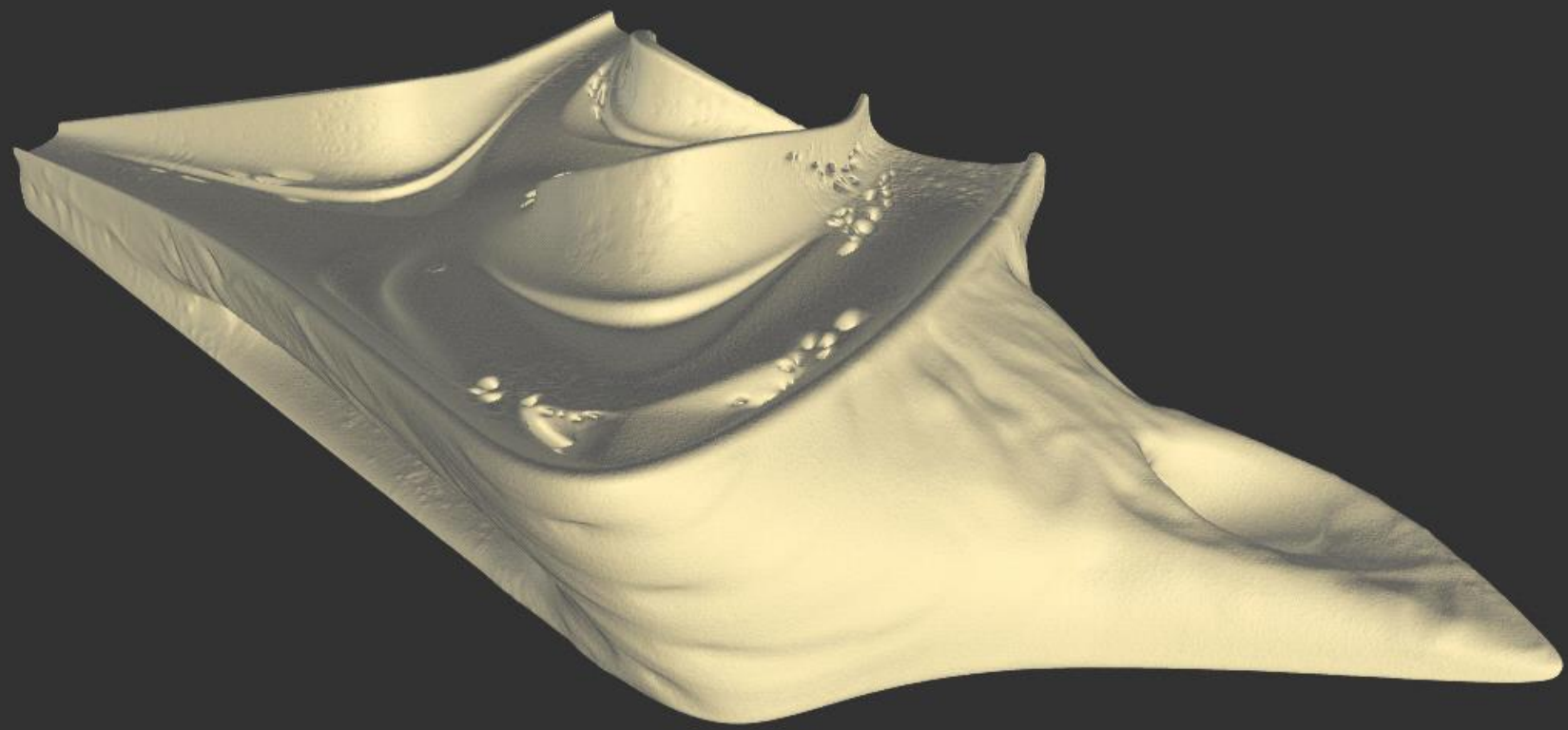
[Primary Stress lines]



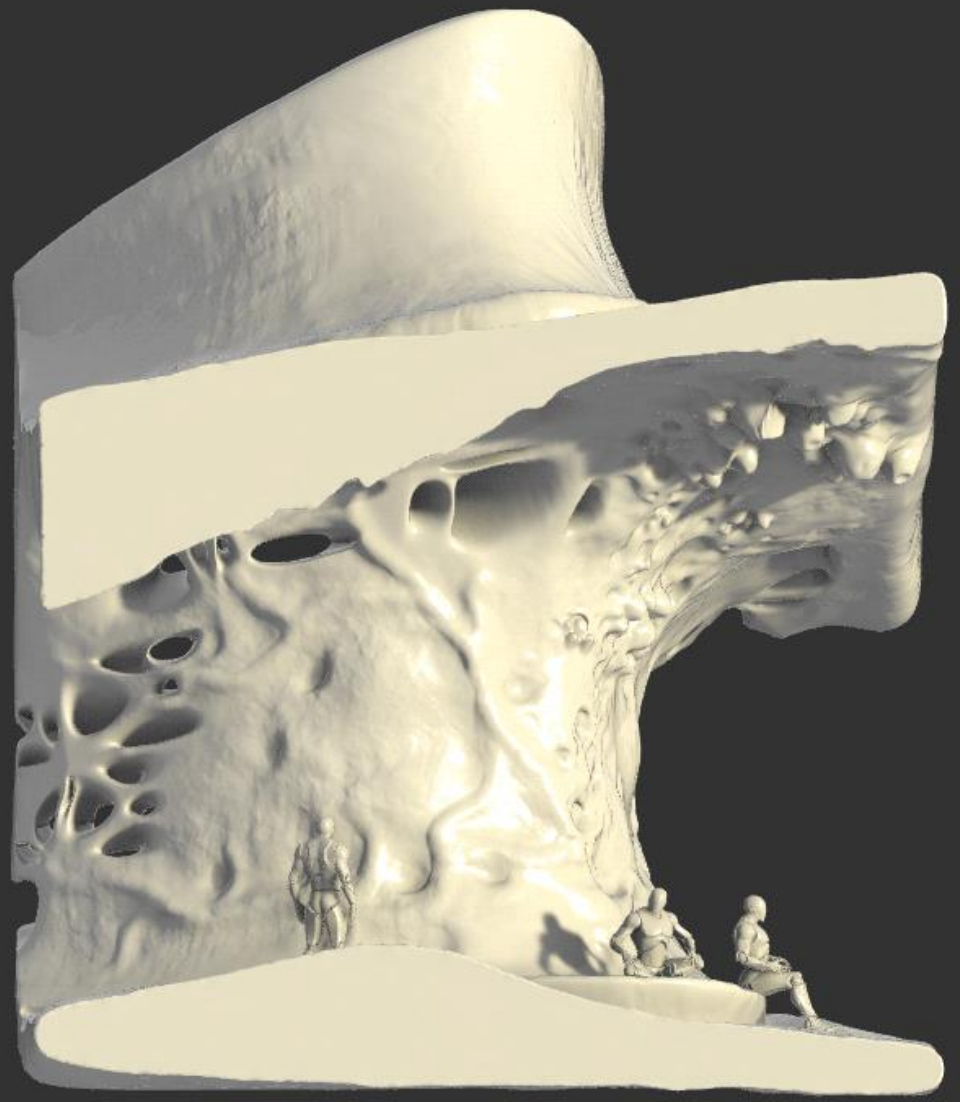
[Primary Stress lines]



[Material Extraction - Primary Stress lines]



[Material Extraction - Primary Stress lines]



[Fraction]

[Temple architecture_Stone-Detailing/Engraving]

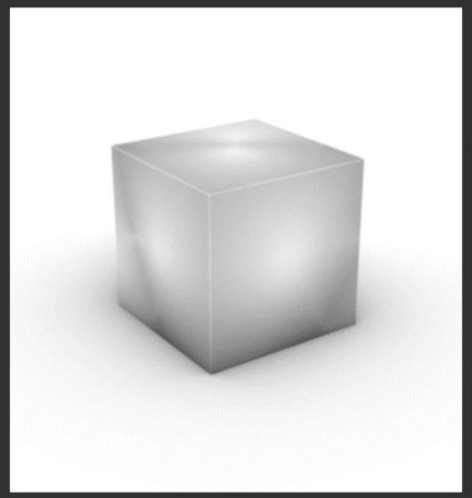
[Micahel Hansmeyer-Digital Grotesque/Engraving]

TEMPLE FORM GENERATION

All these progression and iteration have some specific behavioural attributes of action.

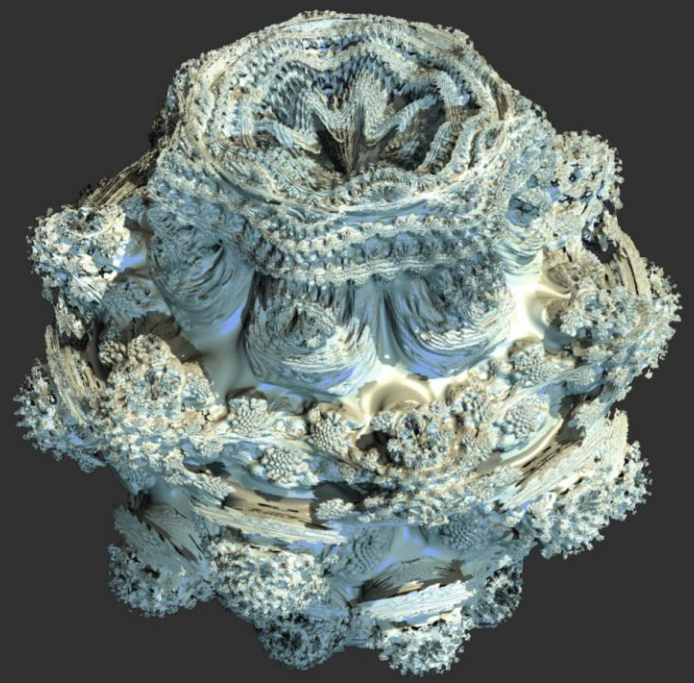
[Projection,Staggering,Splitting,
Progressive Multiplication & Expanding Repitition]

[Michael Hansmeyer- Subdivision Alorithm]



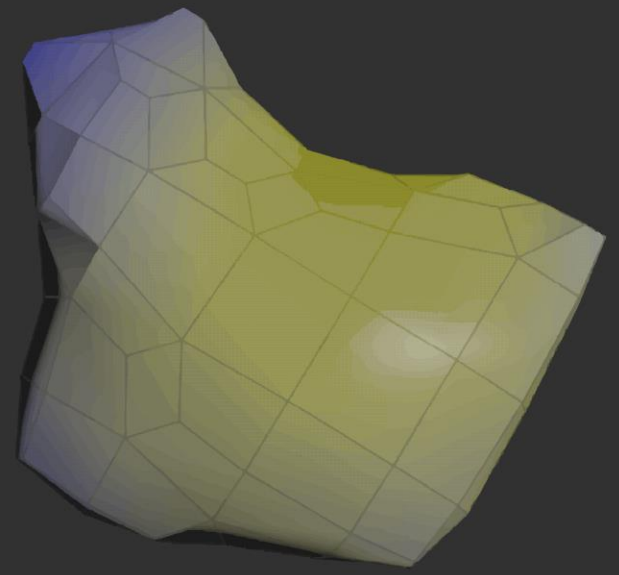
SUBSIVISION ALGORITHMS

The algorithm divides a square area into four small areas, which are divided again until the corners for the naked eye to be recognized as a concave or convex shape, whereas, in fact, be quite small polygons.



MANDELBULB FORMULA

The Mandelbulb is a three-dimensional fractal, constructed by Daniel White and Paul Nylander using spherical coordinates in 2009



Formula1 • Fo.2 • Fo.3 • Fo.4 • Fo.5 • Fo.6
3D 3D 3Da 4D 4Da Ads Ads Ads dIFS dIFS dIFS
_RotatedFolding i hidden JIT
Fold rotation X 0
Fold rotation Y -10.875
Fold rotation Z 0
Fold of x 1.4

Alternate Interpolate DEcombinate Reset
Formula1 • Fo.2 • Fo.3 • Fo.4 • Fo.5 • Fo.6
3D 3D 3Da 4D 4Da Ads Ads Ads dIFS dIFS dIFS
_Rotate i hidden JIT
Rotation1 X 11.625
Rotation1 Y 45.75
Rotation1 Z 0

Alternate Interpolate DEcombinate Reset
Formula1 • Fo.2 • Fo.3 • Fo.4 • Fo.5 • Fo.6
3D 3D 3Da 4D 4Da Ads Ads Ads dIFS dIFS dIFS
_Scaling i hidden JIT
Scale 1.2

being repeated at differ-

Alternate Interpolate DEcombinate Reset
Formula1 • Fo.2 • Fo.3 • Fo.4 • Fo.5 • Fo.6
3D 3D 3Da 4D 4Da Ads Ads Ads dIFS dIFS dIFS
_addC i hidden JIT
Cx multiplier 1
Cy multiplier 1
Cz multiplier 1

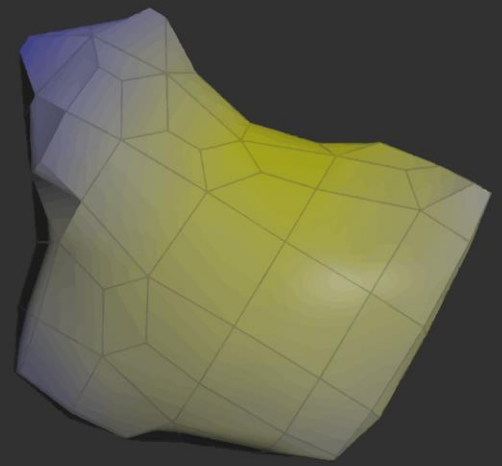
Alternate Interpolate DEcombinate Reset
Formula1 • Fo.2 • Fo.3 • Fo.4 • Fo.5 • Fo.6
3D 3D 3Da 4D 4Da Ads Ads Ads dIFS dIFS dIFS
_RotatedAbs i hidden JIT
Fold rotation X 0
Fold rotation Y 0
Fold rotation Z 0
AddX 0
SubX 0

[iteration] [10]

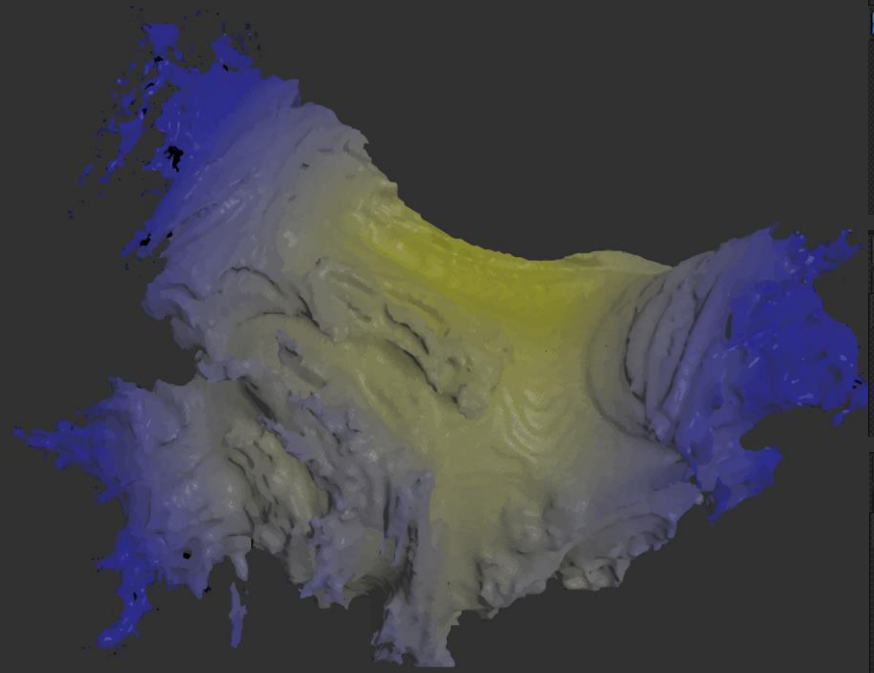
[n] [2.4]

[resolution] [1]

[formula] [x]



[BASE_GEOMETRY]



[DETAIL_GEOMETRY]

Formula1 • Fo.2 • Fo.3 • Fo.4 • Fo.5 • Fo.6

3D 3D 3Da 4D 4Da Ads Ads Ads dIFS dIFS dIFS

_RotatedFolding i hidden JIT

Fold rotation X 0

Fold rotation Y -10.875

Fold rotation Z 0

Fold of x 1.4

Alternate Interpolate DEcombinate Reset

Formula1 • Fo.2 • Fo.3 • Fo.4 • Fo.5 • Fo.6

3D 3D 3Da 4D 4Da Ads Ads Ads dIFS dIFS dIFS

_Rotate i hidden JIT

Rotation1 X 11.625

Rotation1 Y 45.75

Rotation1 Z 0

Alternate Interpolate DEcombinate Reset

Formula1 • Fo.2 • Fo.3 • Fo.4 • Fo.5 • Fo.6

3D 3D 3Da 4D 4Da Ads Ads Ads dIFS dIFS dIFS

_Scaling i hidden JIT

Scale 1.2

being repeated at differ-

Alternate Interpolate DEcombinate Reset

Formula1 • Fo.2 • Fo.3 • Fo.4 • Fo.5 • Fo.6

3D 3D 3Da 4D 4Da Ads Ads Ads dIFS dIFS dIFS

_addC i hidden JIT

Cx multiplier 1

Cy multiplier 1

Cz multiplier 1

Alternate Interpolate DEcombinate Reset

Formula1 • Fo.2 • Fo.3 • Fo.4 • Fo.5 • Fo.6

3D 3D 3Da 4D 4Da Ads Ads Ads dIFS dIFS dIFS

_RotatedAbs i hidden JIT

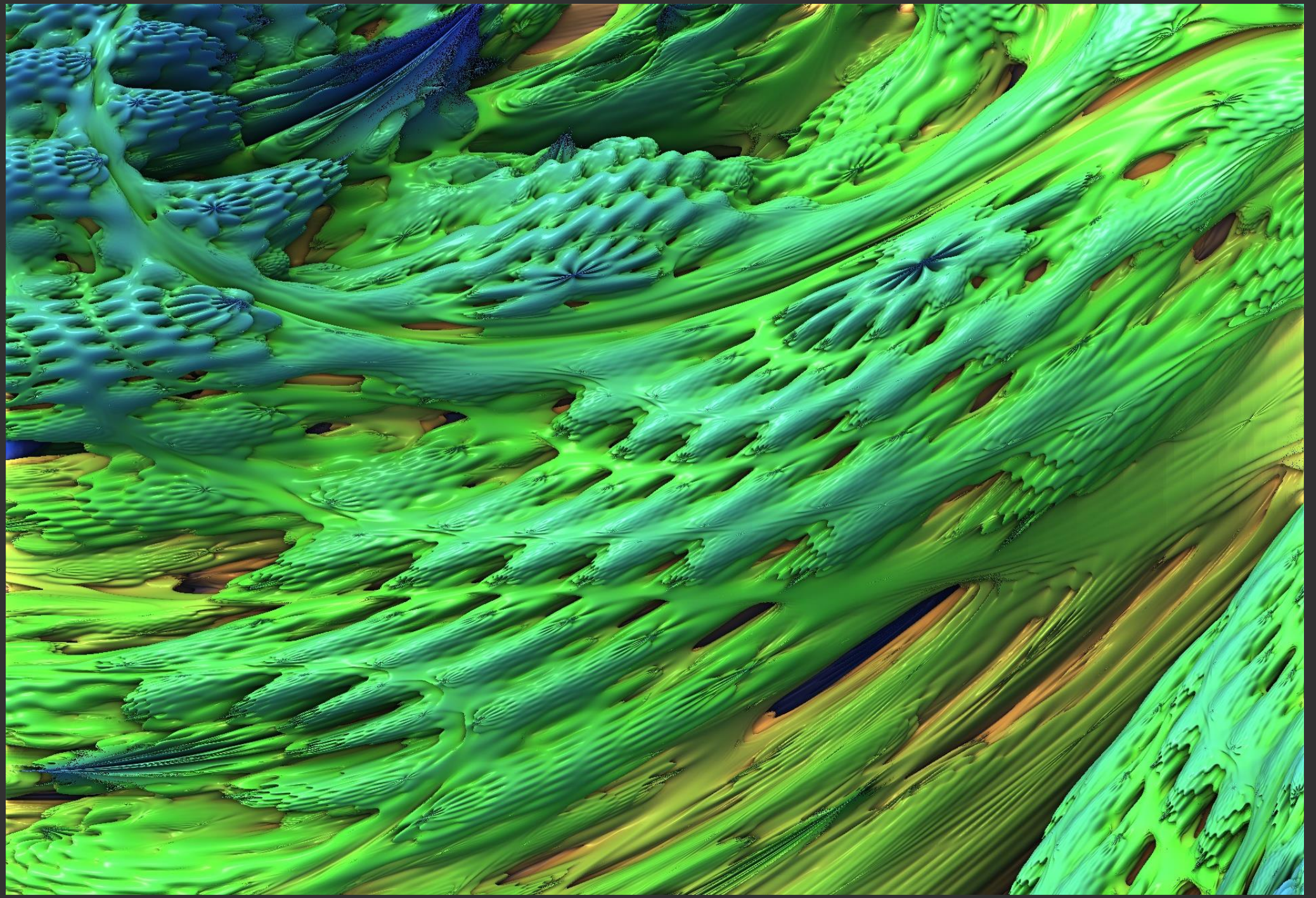
Fold rotation X 0

Fold rotation Y 0

Fold rotation Z 0

AddX 0

SubX 0



Formula1 • Fo.2 • Fo.3 • Fo.4 • Fo.5 • Fo.6

3D 3D 3Da 4D 4Da Ads Ads Ads dIFS dIFS dIFS

_RotatedFolding i hidden JIT

Fold rotation X	0
Fold rotation Y	-10.875
Fold rotation Z	0
Fold of x	1.4

Alternate Interpolate DEcombinate Reset

Formula1 • Fo.2 • Fo.3 • Fo.4 • Fo.5 • Fo.6

3D 3D 3Da 4D 4Da Ads Ads Ads dIFS dIFS dIFS

_Rotate i hidden JIT

Rotation1 X	11.625
Rotation1 Y	45.75
Rotation1 Z	0

Alternate Interpolate DEcombinate Reset

Formula1 • Fo.2 • Fo.3 • Fo.4 • Fo.5 • Fo.6

3D 3D 3Da 4D 4Da Ads Ads Ads dIFS dIFS dIFS

_Scaling i hidden JIT

Scale	1.2

Alternate Interpolate DEcombinate Reset

Formula1 • Fo.2 • Fo.3 • Fo.4 • Fo.5 • Fo.6

3D 3D 3Da 4D 4Da Ads Ads Ads dIFS dIFS dIFS

_addC i hidden JIT

Cx multiplier	1
Cy multiplier	1
Cz multiplier	1

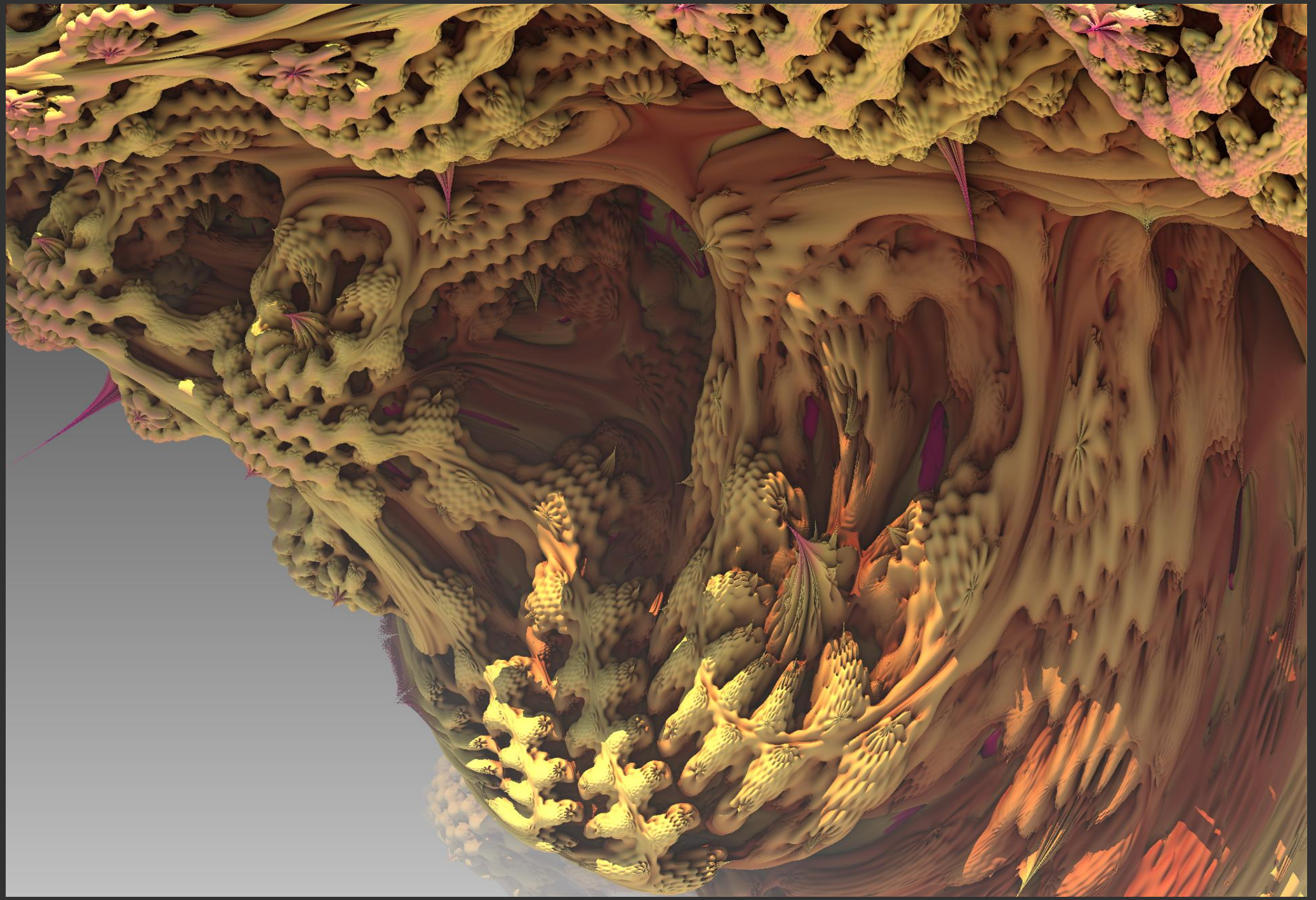
Alternate Interpolate DEcombinate Reset

Formula1 • Fo.2 • Fo.3 • Fo.4 • Fo.5 • Fo.6

3D 3D 3Da 4D 4Da Ads Ads Ads dIFS dIFS dIFS

_RotatedAbs i hidden JIT

Fold rotation X	0
Fold rotation Y	0
Fold rotation Z	0
AddX	0
SubX	0



Formula1 • Fo.2 • Fo.3 • Fo.4 • Fo.5 • Fo.6

3D 3D 3Da 4D 4Da Ads Ads Ads dIFS dIFS dIFS

_RotatedFolding i hidden JIT

Fold rotation X	0
Fold rotation Y	-10.875
Fold rotation Z	0
Fold of x	1.4

Alternate Interpolate DEcombinate Reset

Formula1 • Fo.2 • Fo.3 • Fo.4 • Fo.5 • Fo.6

3D 3D 3Da 4D 4Da Ads Ads Ads dIFS dIFS dIFS

_Rotate i hidden JIT

Rotation1 X	11.625
Rotation1 Y	45.75
Rotation1 Z	0

Alternate Interpolate DEcombinate Reset

Formula1 • Fo.2 • Fo.3 • Fo.4 • Fo.5 • Fo.6

3D 3D 3Da 4D 4Da Ads Ads Ads dIFS dIFS dIFS

_Scaling i hidden JIT

Scale	1.2

Alternate Interpolate DEcombinate Reset

Formula1 • Fo.2 • Fo.3 • Fo.4 • Fo.5 • Fo.6

3D 3D 3Da 4D 4Da Ads Ads Ads dIFS dIFS dIFS

_addC i hidden JIT

Cx multiplier	1
Cy multiplier	1
Cz multiplier	1

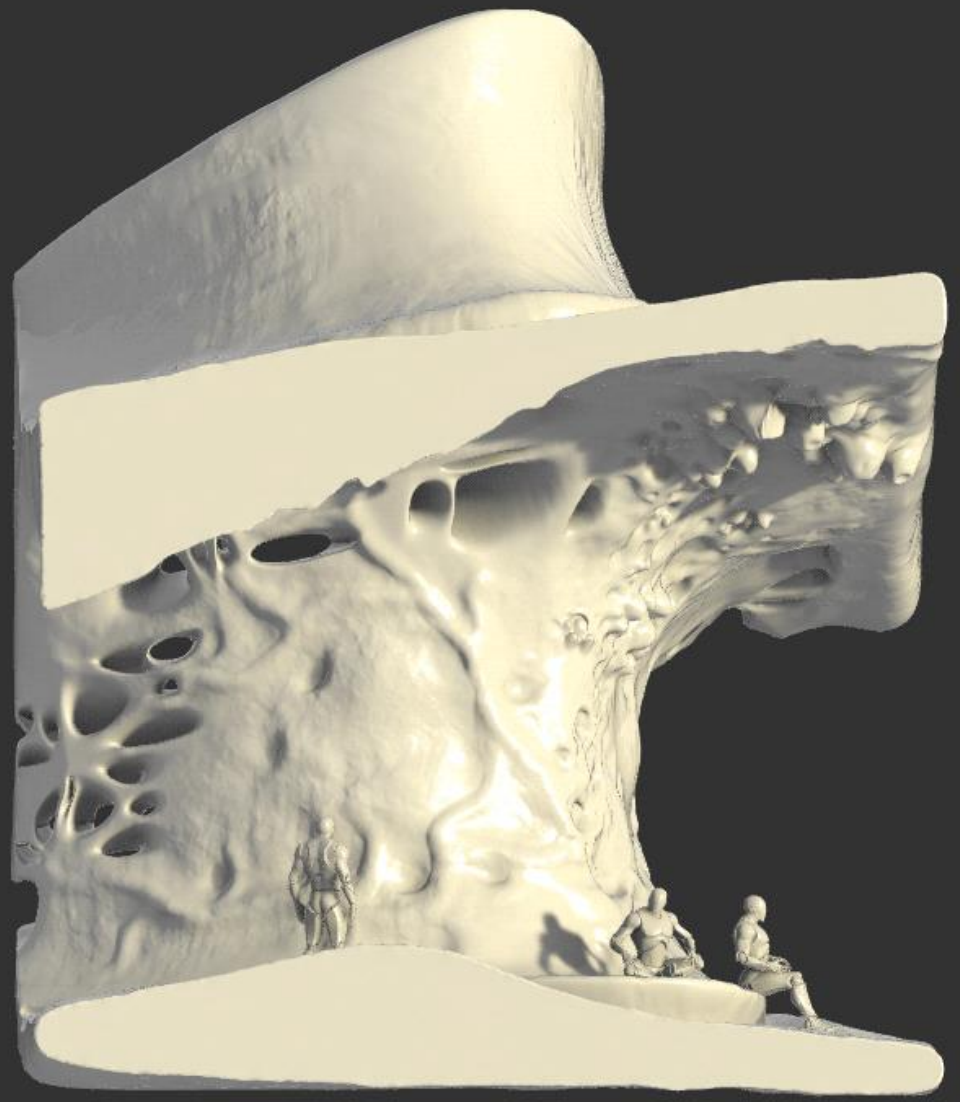
Alternate Interpolate DEcombinate Reset

Formula1 • Fo.2 • Fo.3 • Fo.4 • Fo.5 • Fo.6

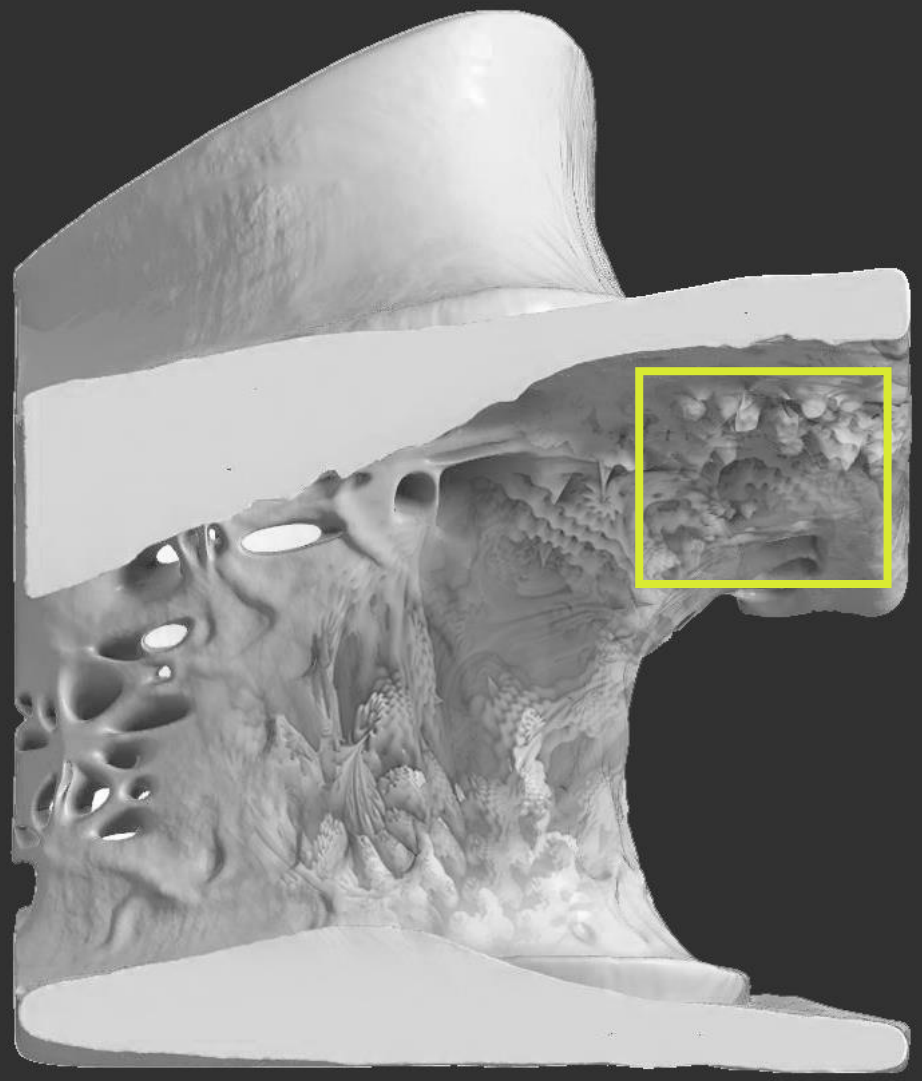
3D 3D 3Da 4D 4Da Ads Ads Ads dIFS dIFS dIFS

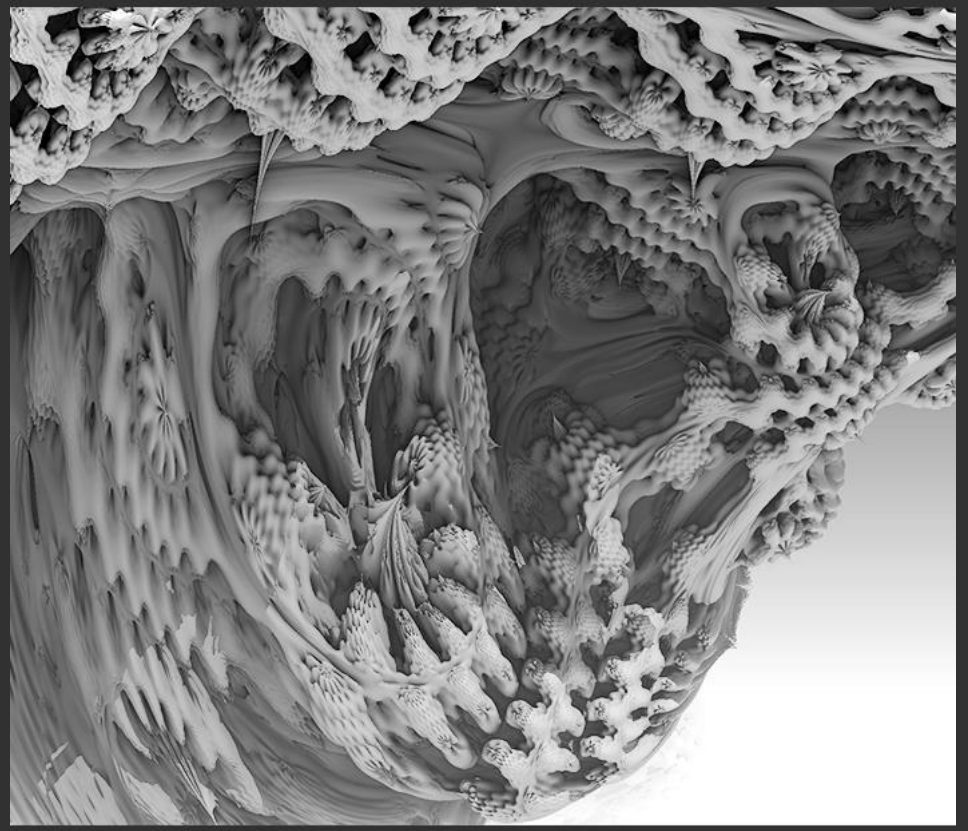
_RotatedAbs i hidden JIT

Fold rotation X	0
Fold rotation Y	0
Fold rotation Z	0
AddX	0
SubX	0



[Fraction]





Formula1 • Fo.2 • Fo.3 • Fo.4 • Fo.5 • Fo.6

3D 3D 3Da 4D 4Da Ads Ads Ads dIFS dIFS dIFS

_RotatedFolding i hidden JIT

Fold rotation X	0
Fold rotation Y	-10.875
Fold rotation Z	0
Fold of x	1.4

Alternate Interpolate DEcombinate Reset

Formula1 • Fo.2 • Fo.3 • Fo.4 • Fo.5 • Fo.6

3D 3D 3Da 4D 4Da Ads Ads Ads dIFS dIFS dIFS

_Rotate i hidden JIT

Rotation1 X	11.625
Rotation1 Y	45.75
Rotation1 Z	0

Alternate Interpolate DEcombinate Reset

Formula1 • Fo.2 • Fo.3 • Fo.4 • Fo.5 • Fo.6

3D 3D 3Da 4D 4Da Ads Ads Ads dIFS dIFS dIFS

_Scaling i hidden JIT

Scale	1.2

Alternate Interpolate DEcombinate Reset

Formula1 • Fo.2 • Fo.3 • Fo.4 • Fo.5 • Fo.6

3D 3D 3Da 4D 4Da Ads Ads Ads dIFS dIFS dIFS

_addC i hidden JIT

Cx multiplier	1
Cy multiplier	1
Cz multiplier	1

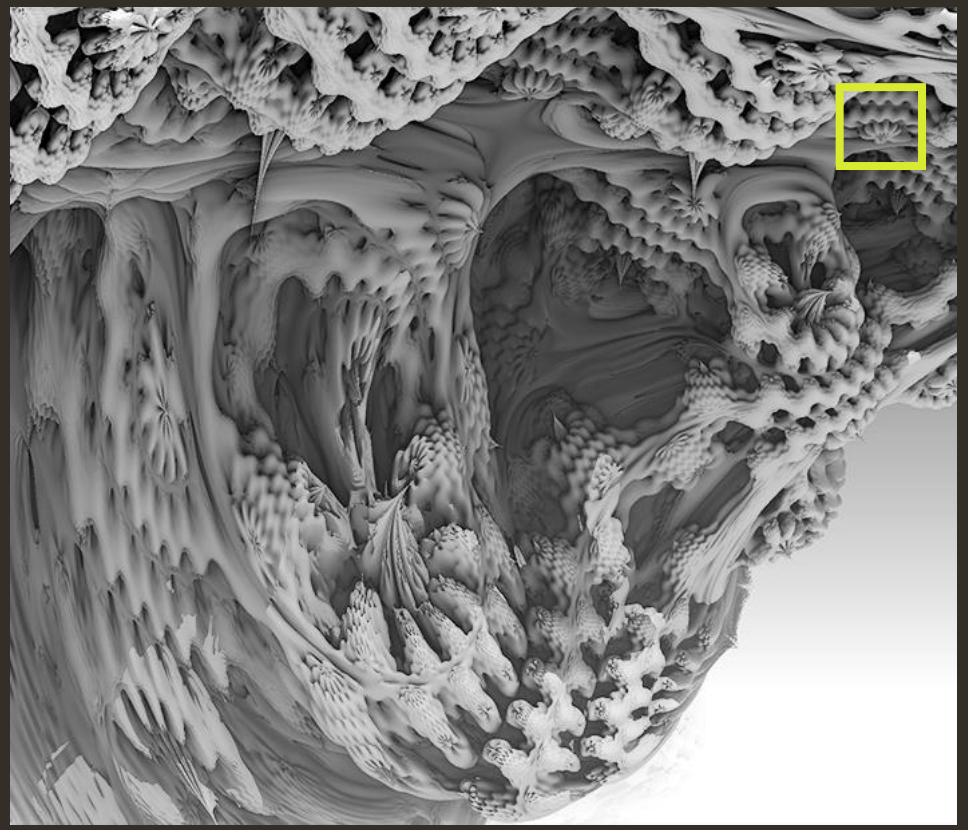
Alternate Interpolate DEcombinate Reset

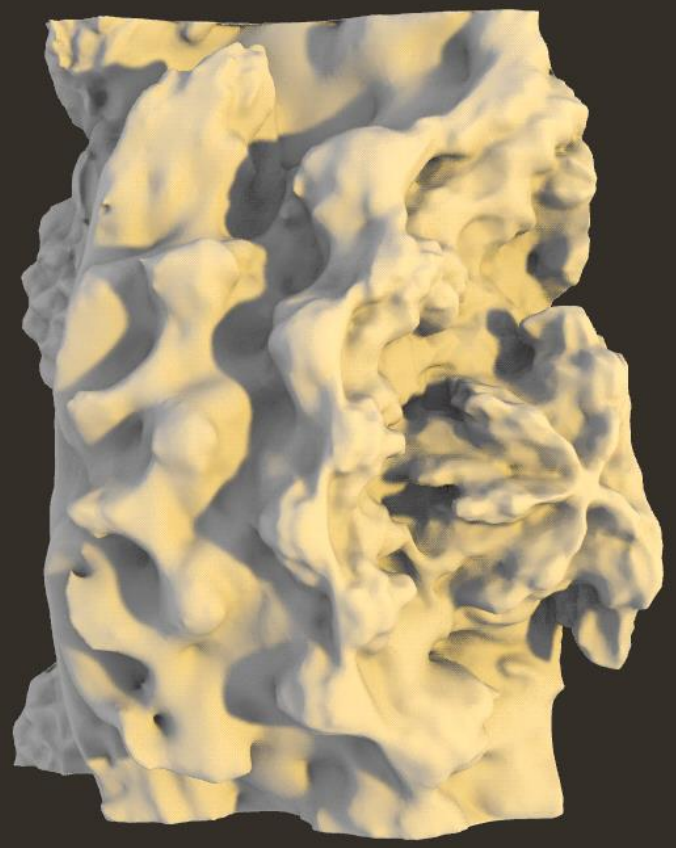
Formula1 • Fo.2 • Fo.3 • Fo.4 • Fo.5 • Fo.6

3D 3D 3Da 4D 4Da Ads Ads Ads dIFS dIFS dIFS

_RotatedAbs i hidden JIT

Fold rotation X	0
Fold rotation Y	0
Fold rotation Z	0
AddX	0
SubX	0





Formula1 • Fo.2 • Fo.3 • Fo.4 • Fo.5 • Fo.6

3D 3D 3Da 4D 4Da Ads Ads Ads dIFS dIFS dIFS

_RotatedFolding i hidden JIT

Fold rotation X	0
Fold rotation Y	-10.875
Fold rotation Z	0
Fold of x	1.4

Alternate Interpolate DEcombinate Reset

Formula1 • Fo.2 • Fo.3 • Fo.4 • Fo.5 • Fo.6

3D 3D 3Da 4D 4Da Ads Ads Ads dIFS dIFS dIFS

_Rotate i hidden JIT

Rotation1 X	11.625
Rotation1 Y	45.75
Rotation1 Z	0

Alternate Interpolate DEcombinate Reset

Formula1 • Fo.2 • Fo.3 • Fo.4 • Fo.5 • Fo.6

3D 3D 3Da 4D 4Da Ads Ads Ads dIFS dIFS dIFS

_Scaling i hidden JIT

Scale	1.2

Alternate Interpolate DEcombinate Reset

Formula1 • Fo.2 • Fo.3 • Fo.4 • Fo.5 • Fo.6

3D 3D 3Da 4D 4Da Ads Ads Ads dIFS dIFS dIFS

_addC i hidden JIT

Cx multiplier	1
Cy multiplier	1
Cz multiplier	1

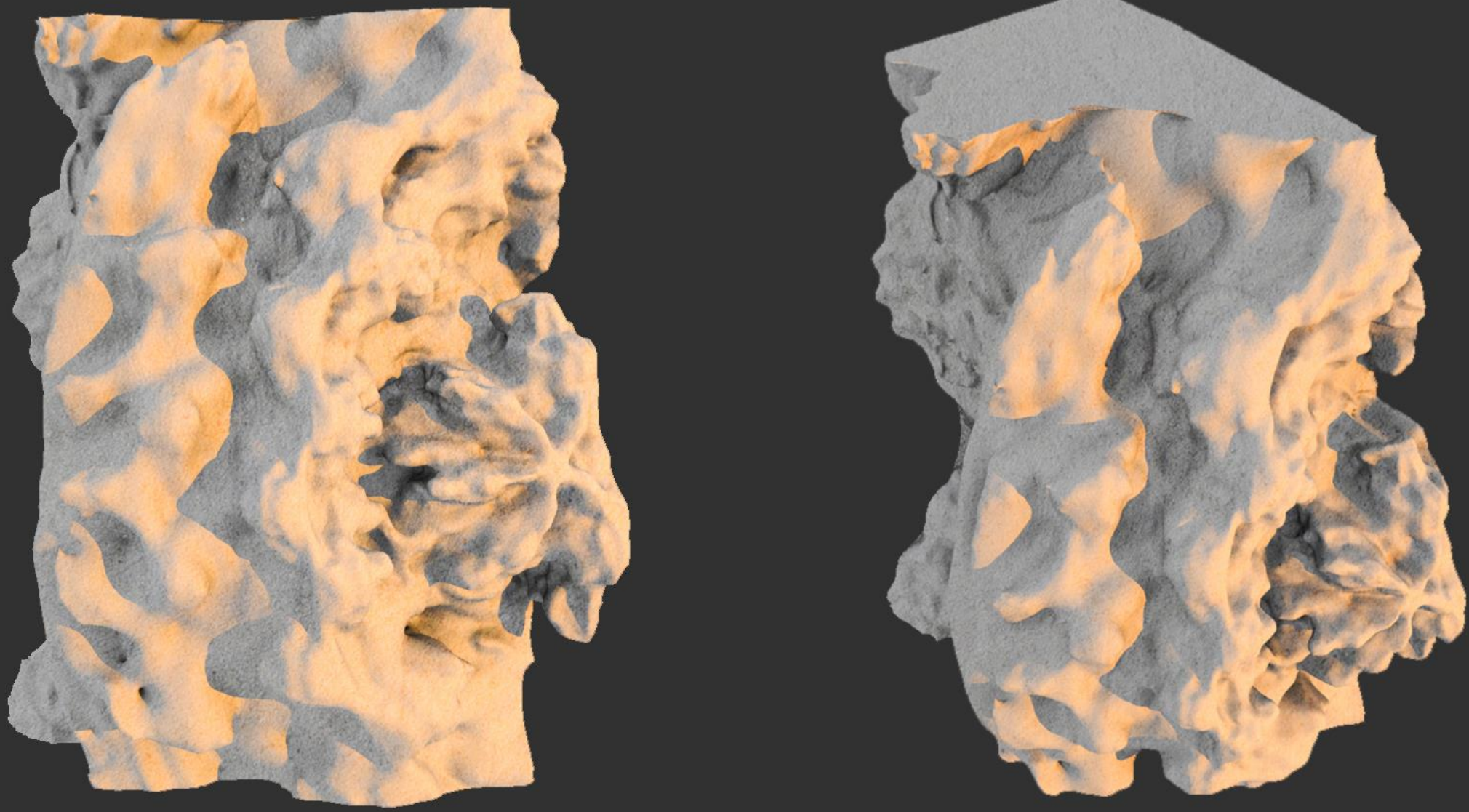
Alternate Interpolate DEcombinate Reset

Formula1 • Fo.2 • Fo.3 • Fo.4 • Fo.5 • Fo.6

3D 3D 3Da 4D 4Da Ads Ads Ads dIFS dIFS dIFS

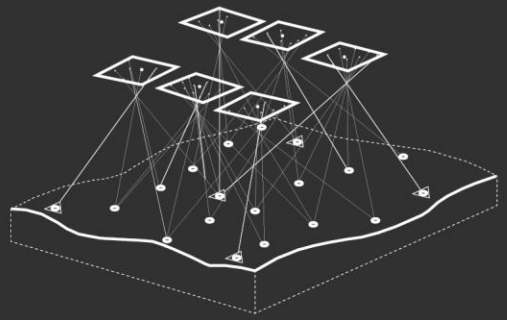
_RotatedAbs i hidden JIT

Fold rotation X	0
Fold rotation Y	0
Fold rotation Z	0
AddX	0
SubX	0

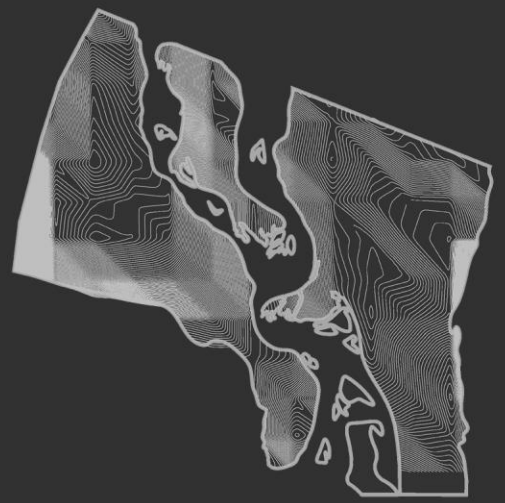


[Nano_Fragment]

[Building-Technology]

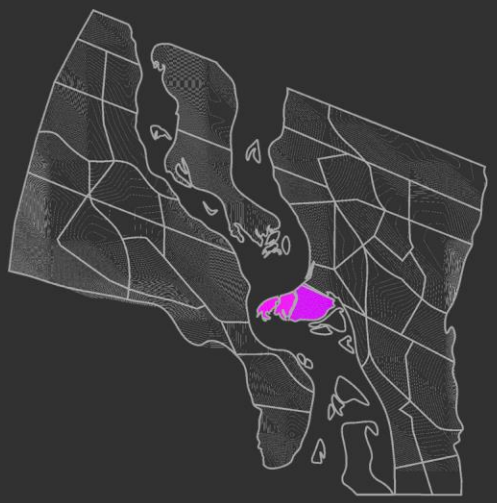


[Drone 3D aerial photogrammetry]

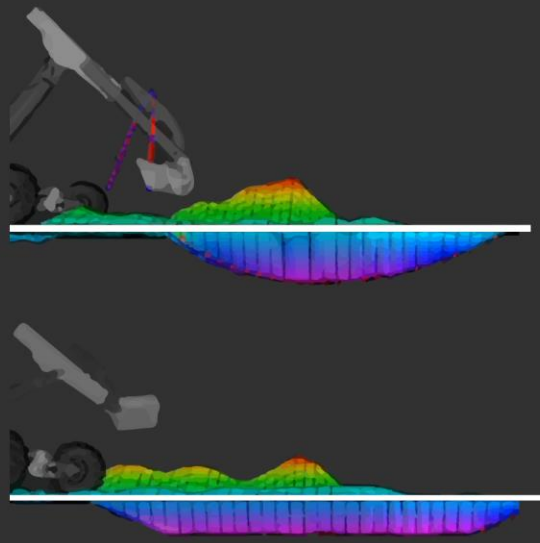


[Digital Terrain Model]

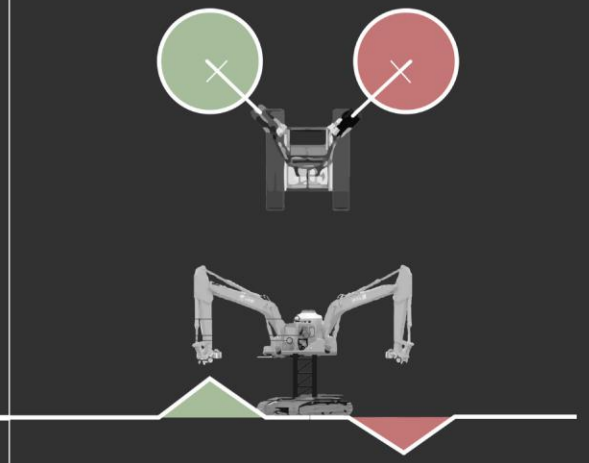
[Digital Terrain Model]



[Upload Design Mesh- Cloud Points]



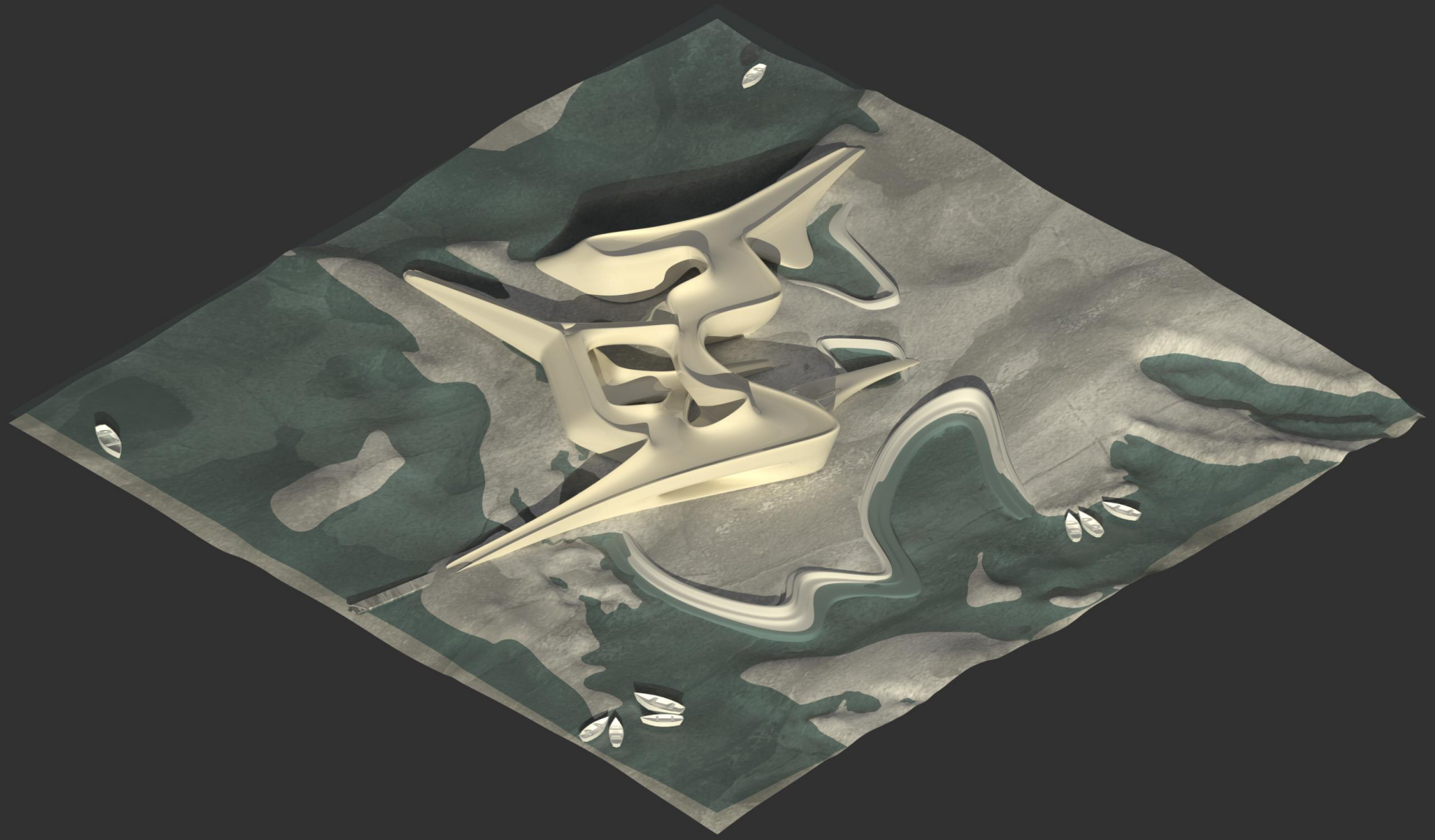
[Global & Local navigation]



[Autonomous Robot digging according to cloud points]

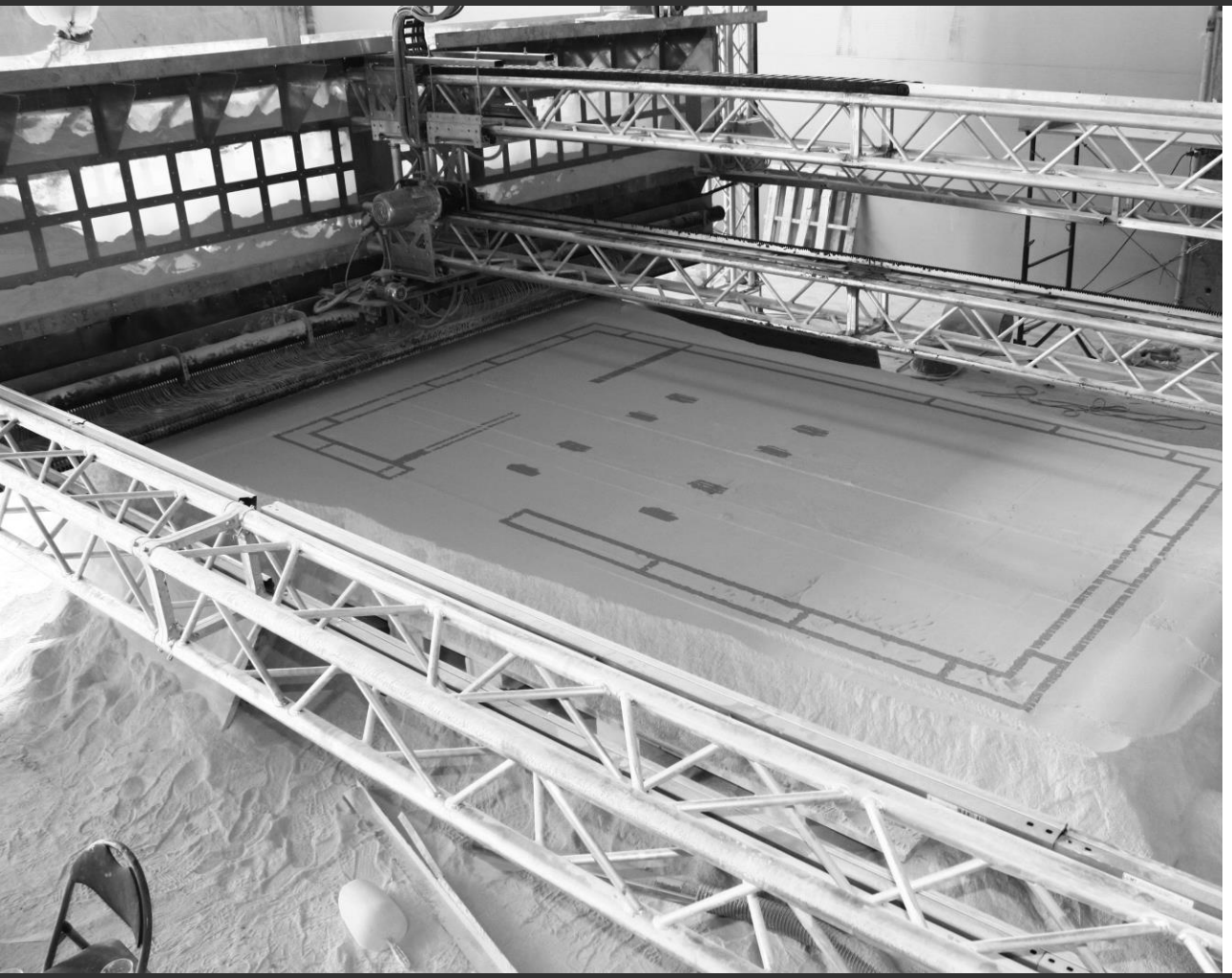
[Autonomous Robot adjusting generation sand]

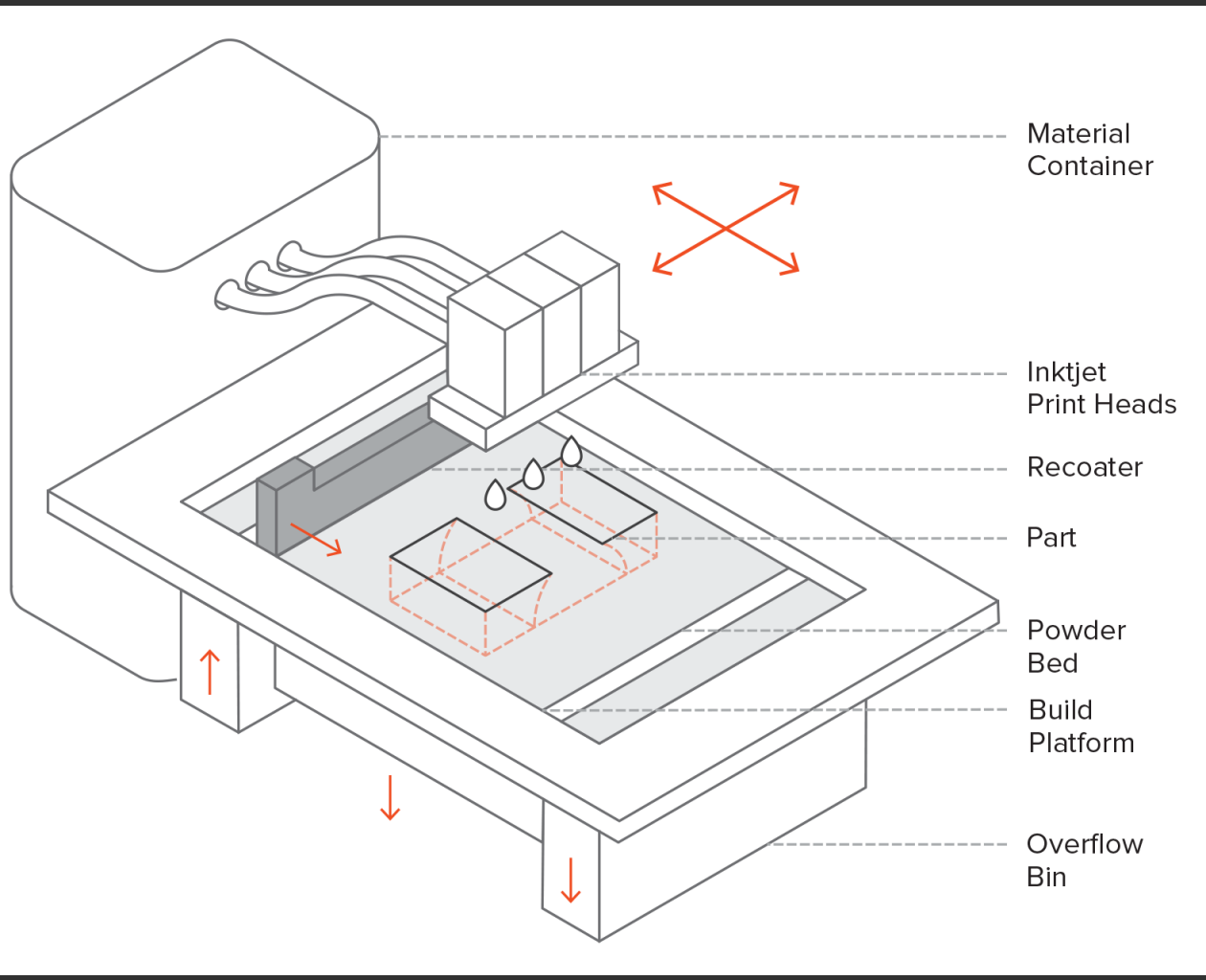
[HEAP-ETH Zurich, Prototype Autonomous Digger]



[Construction Strategy_Meso to Micro Scale]

[Particle Bed 3D-Printing]

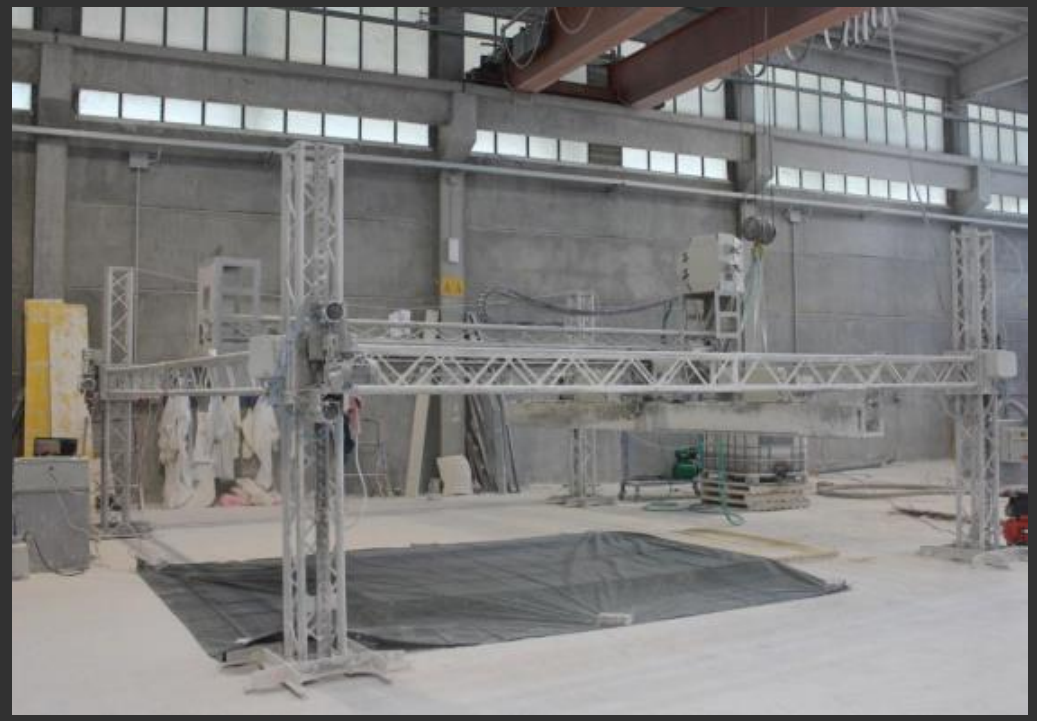




[Particle Bed 3d Printer]

[Particle Bed 3d Printer]

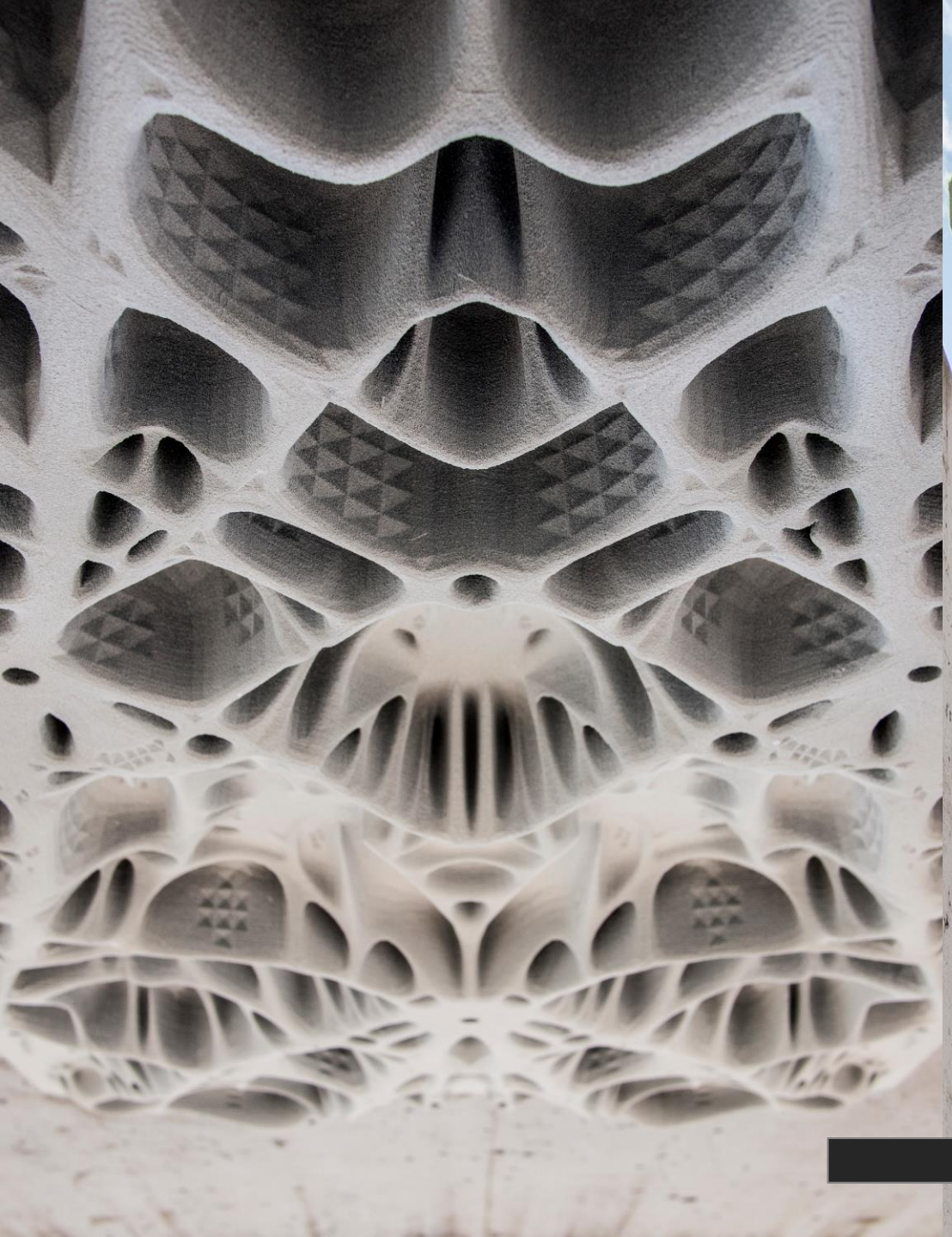
granular material in a range of diameter starting from 0,1 to 4 mm (and theoretically also up to 20 mm, if requested), and any liquid Binder having a viscosity between water and a cementitious slurry.



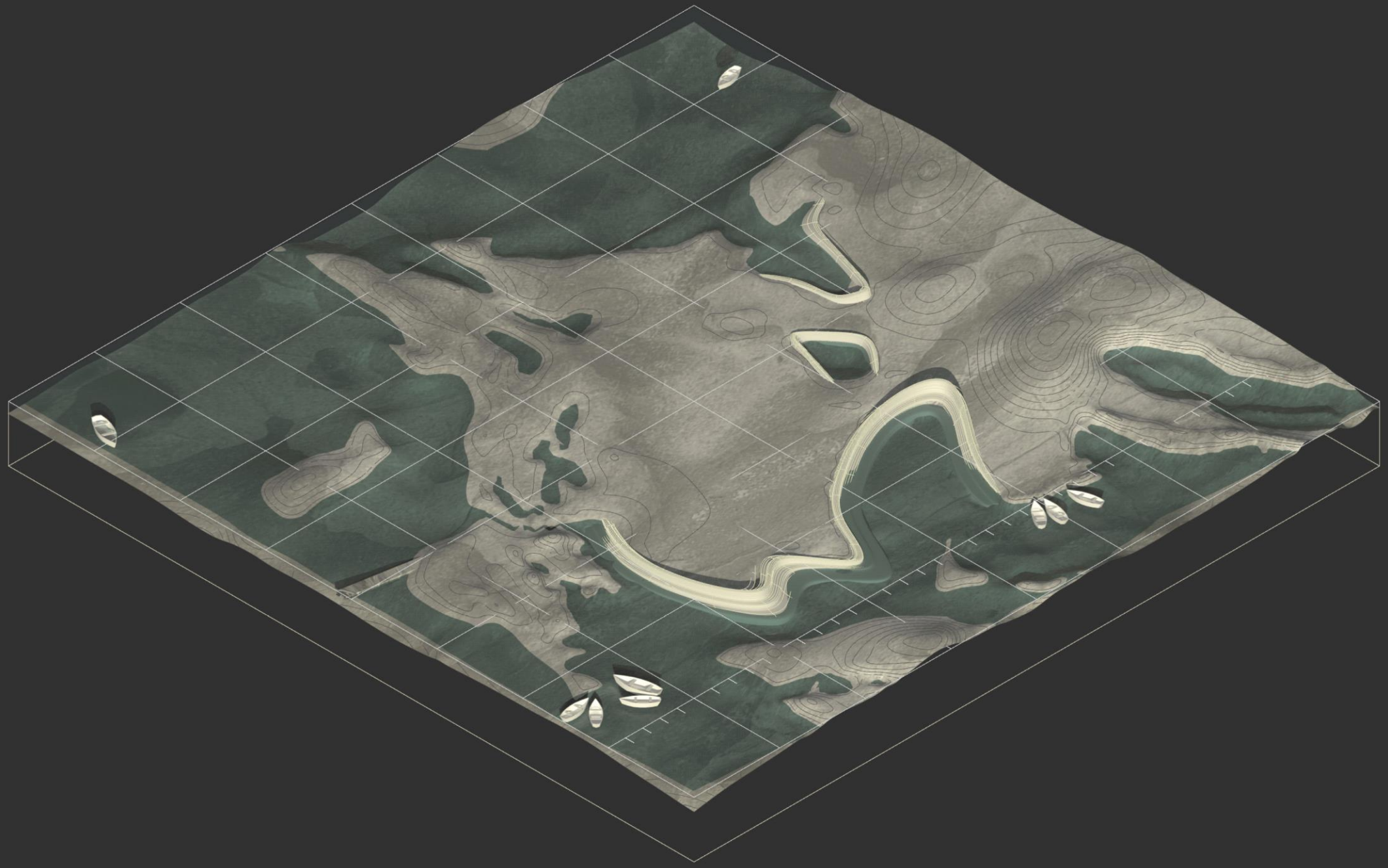
[D-SHAPE]

[MICHAEL HANSMEYER_DIGITAL GROTESQUE]

at a resolution of a tenth of a millimeter



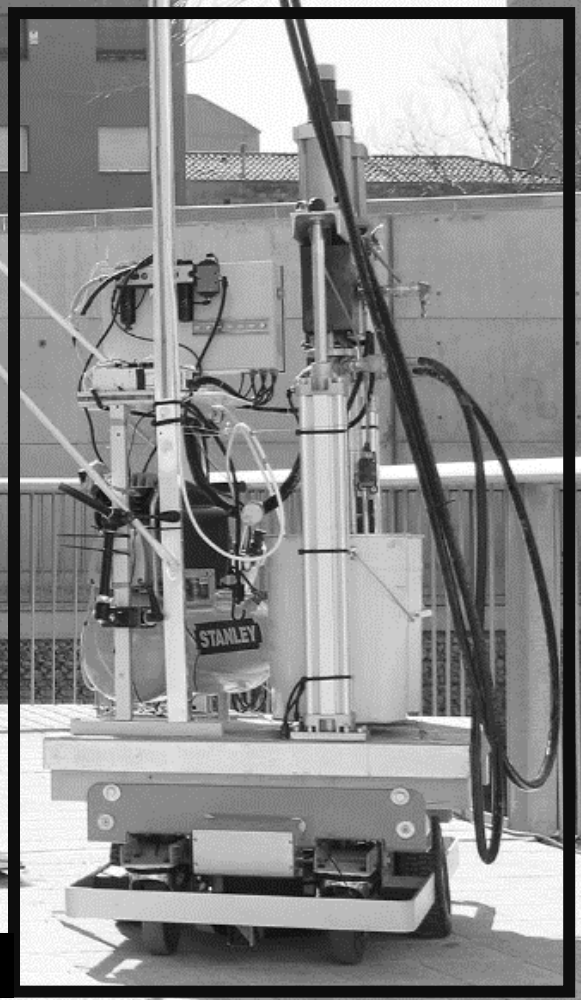
[SMART SLAB_ETH ZURICH]



[Robotic Swarm Printing]

[MINI-BUILDERS, IAAC]
STANLEY

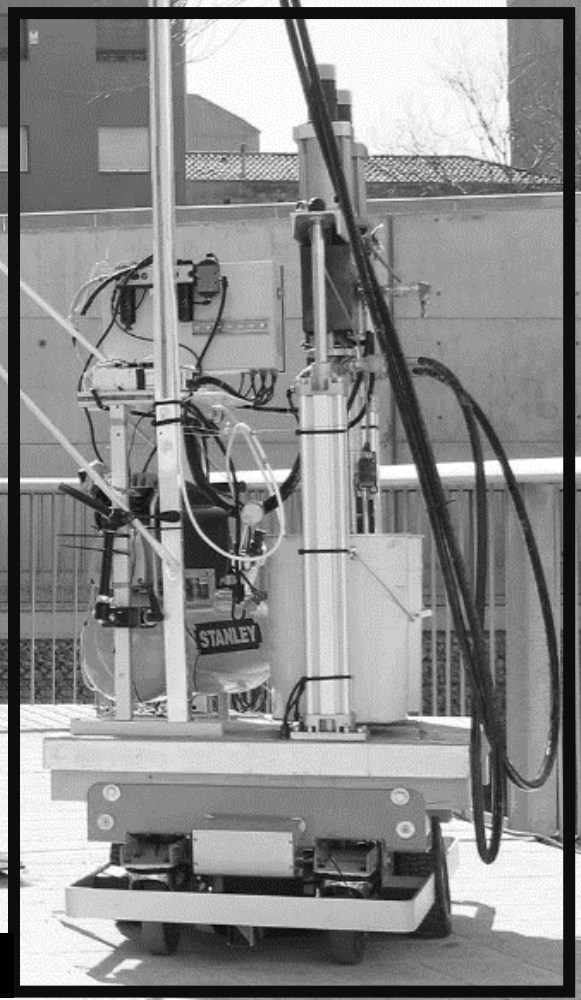
[MINI-BUILDERS, IAAC]



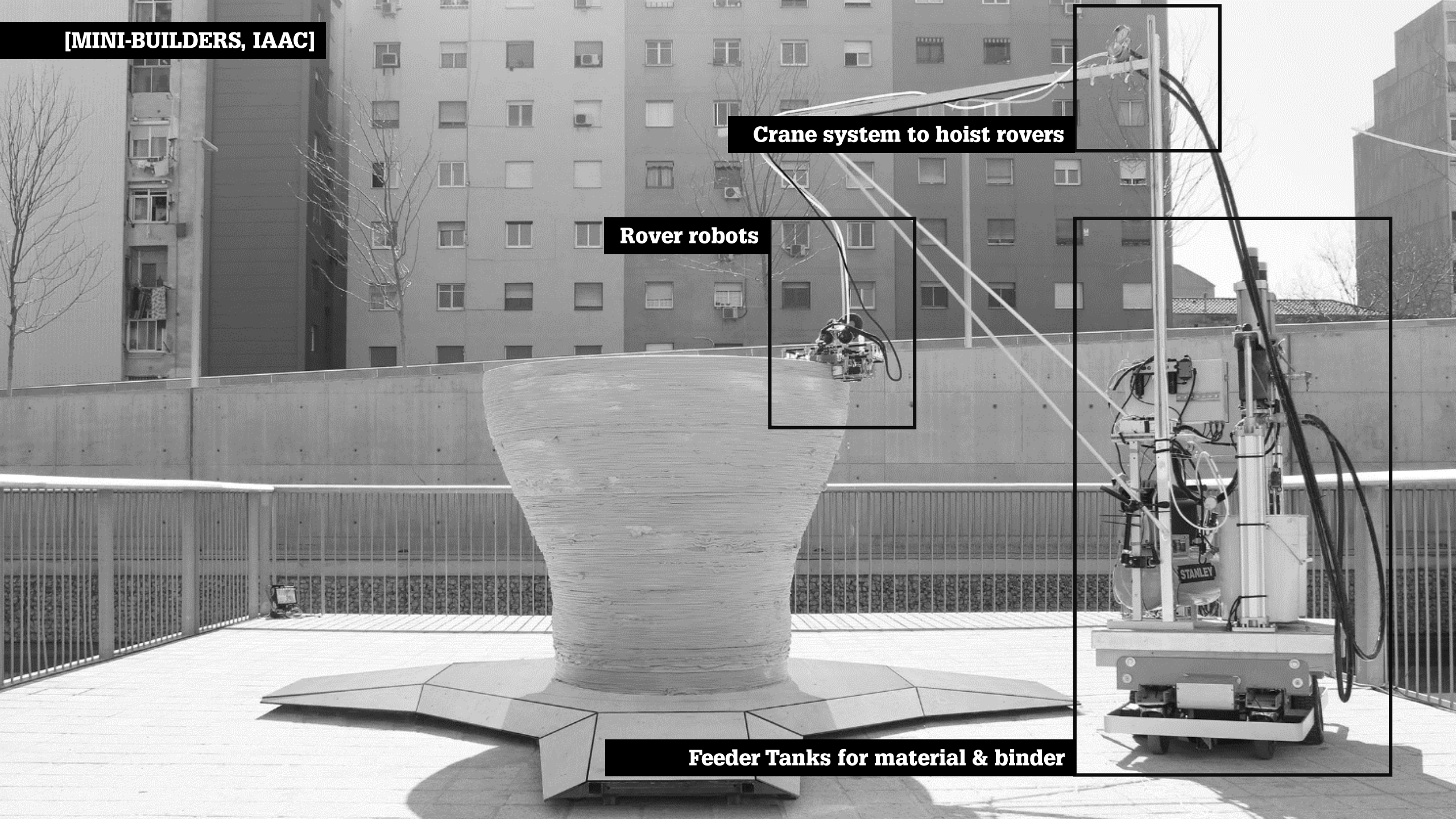
Feeder Tanks for material & binder

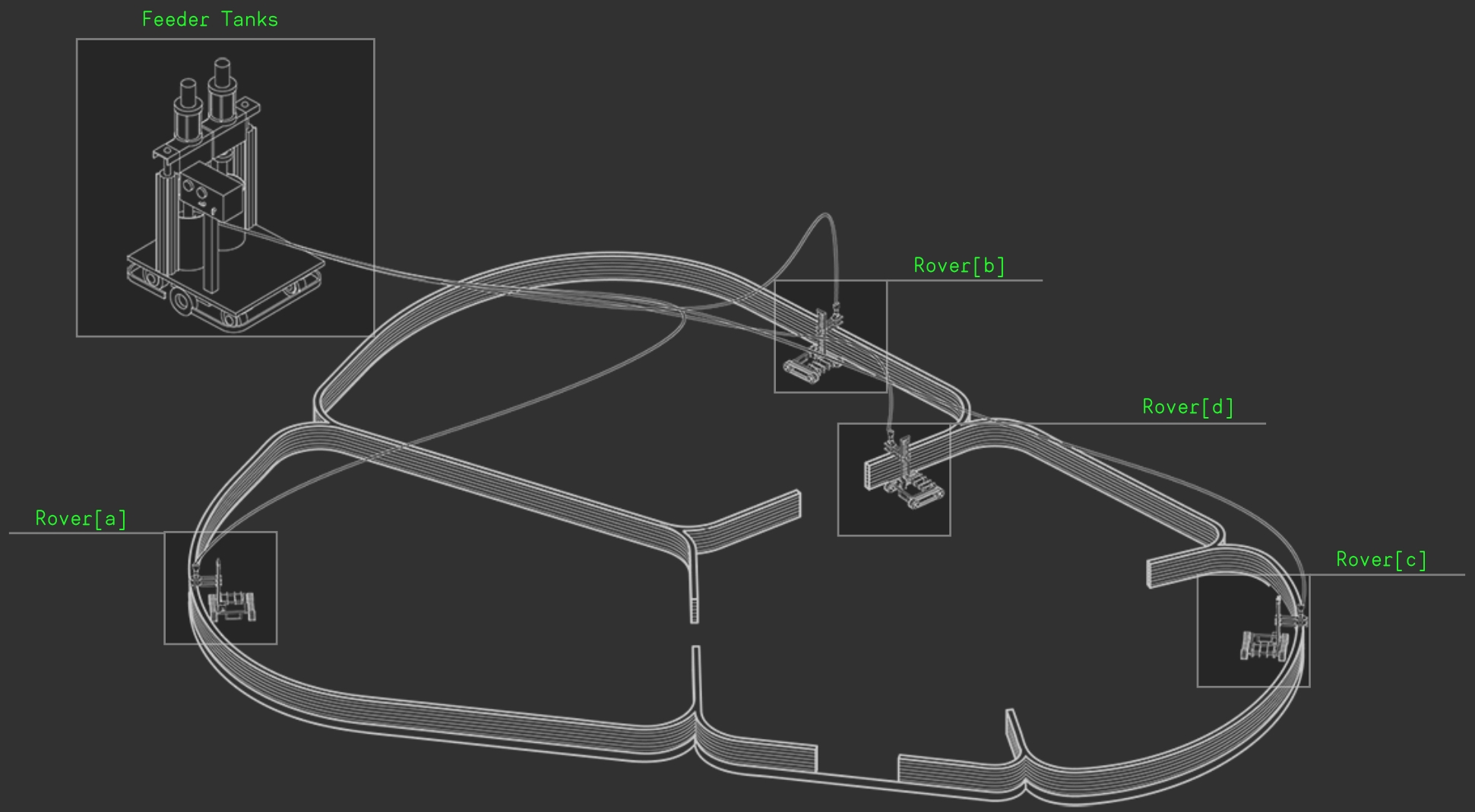
[MINI-BUILDERS, IAAC]

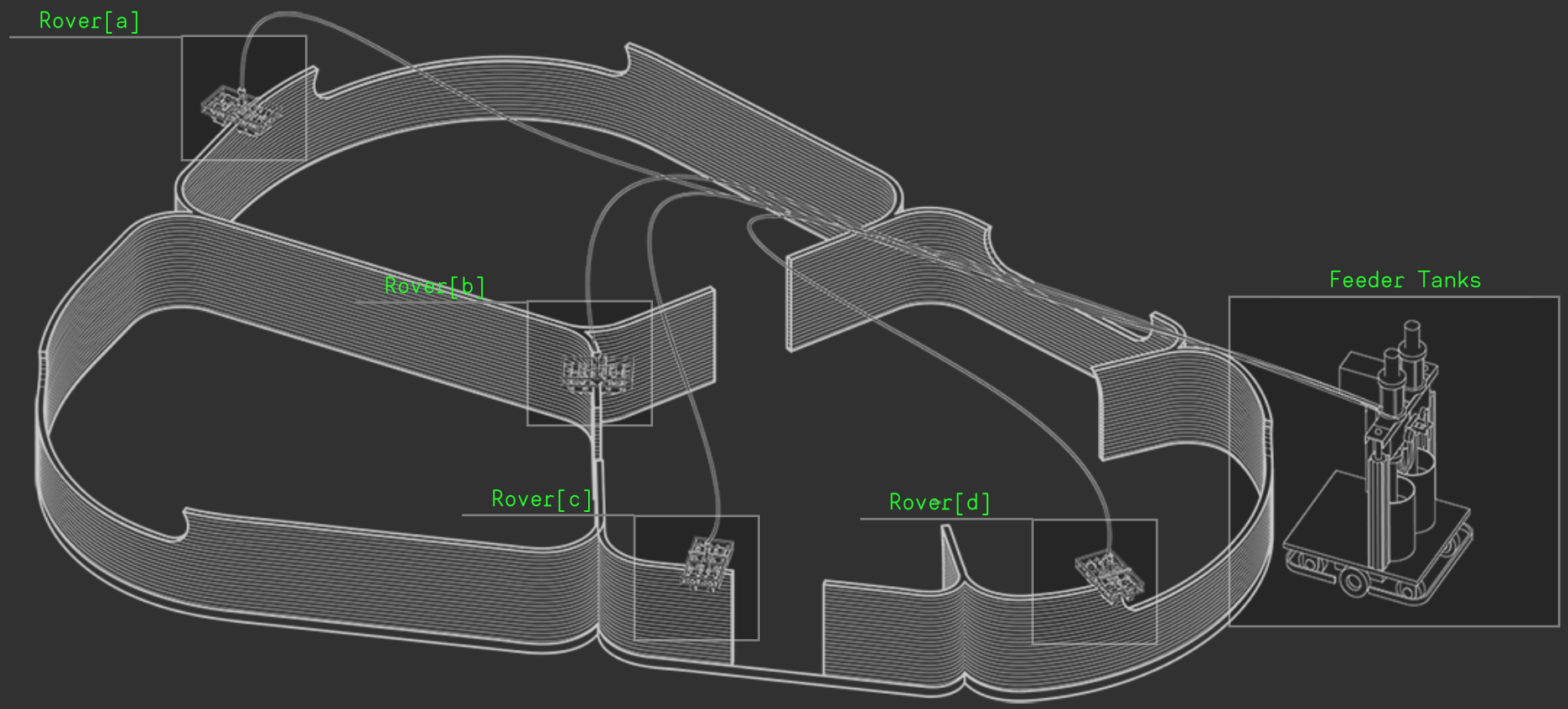
Crane system to hoist rovers

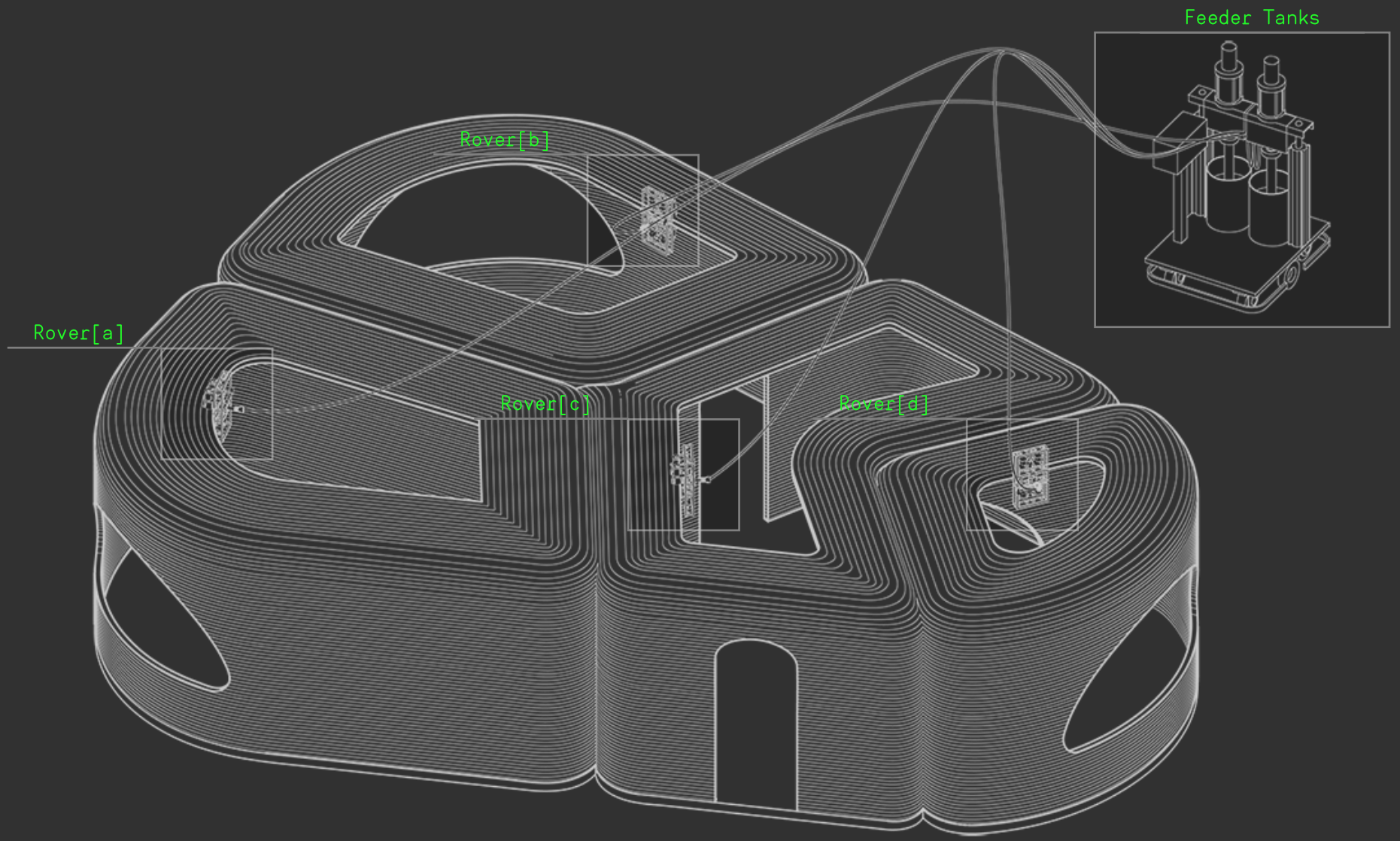


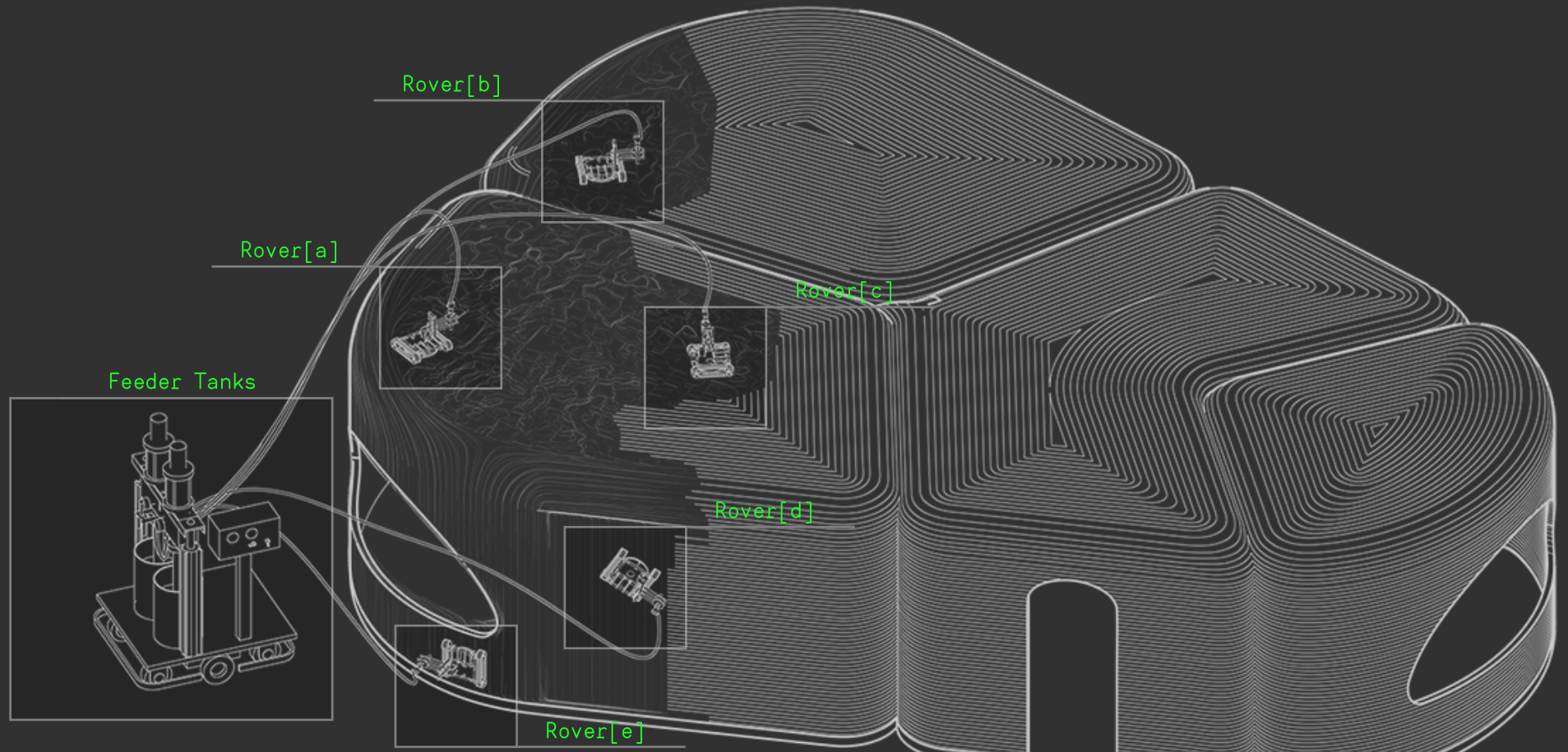
Feeder Tanks for material & binder

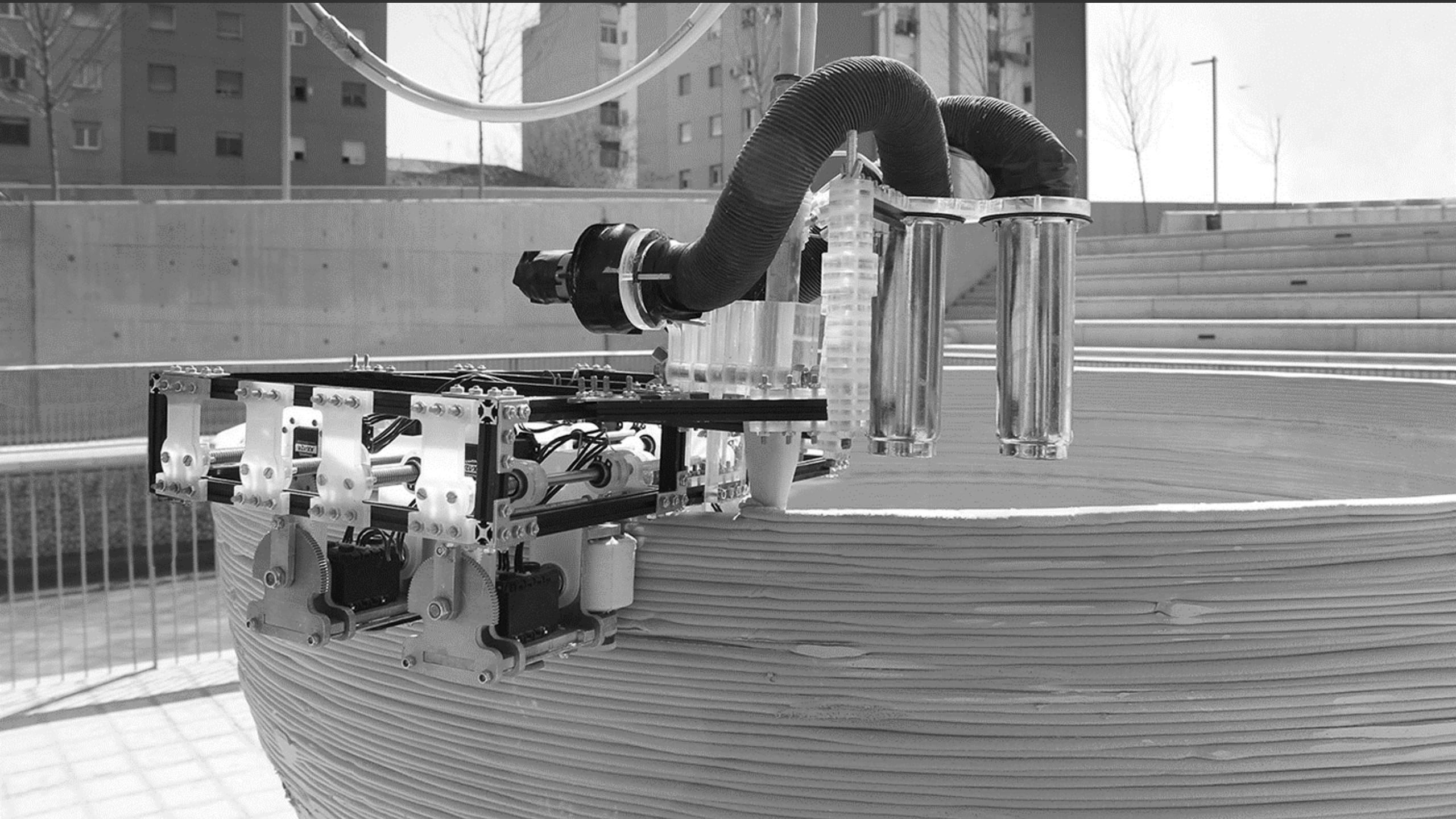

[MINI-BUILDERS, IAAC]
Crane system to hoist rovers
Rover robots
Feeder Tanks for material & binder
STANLEY

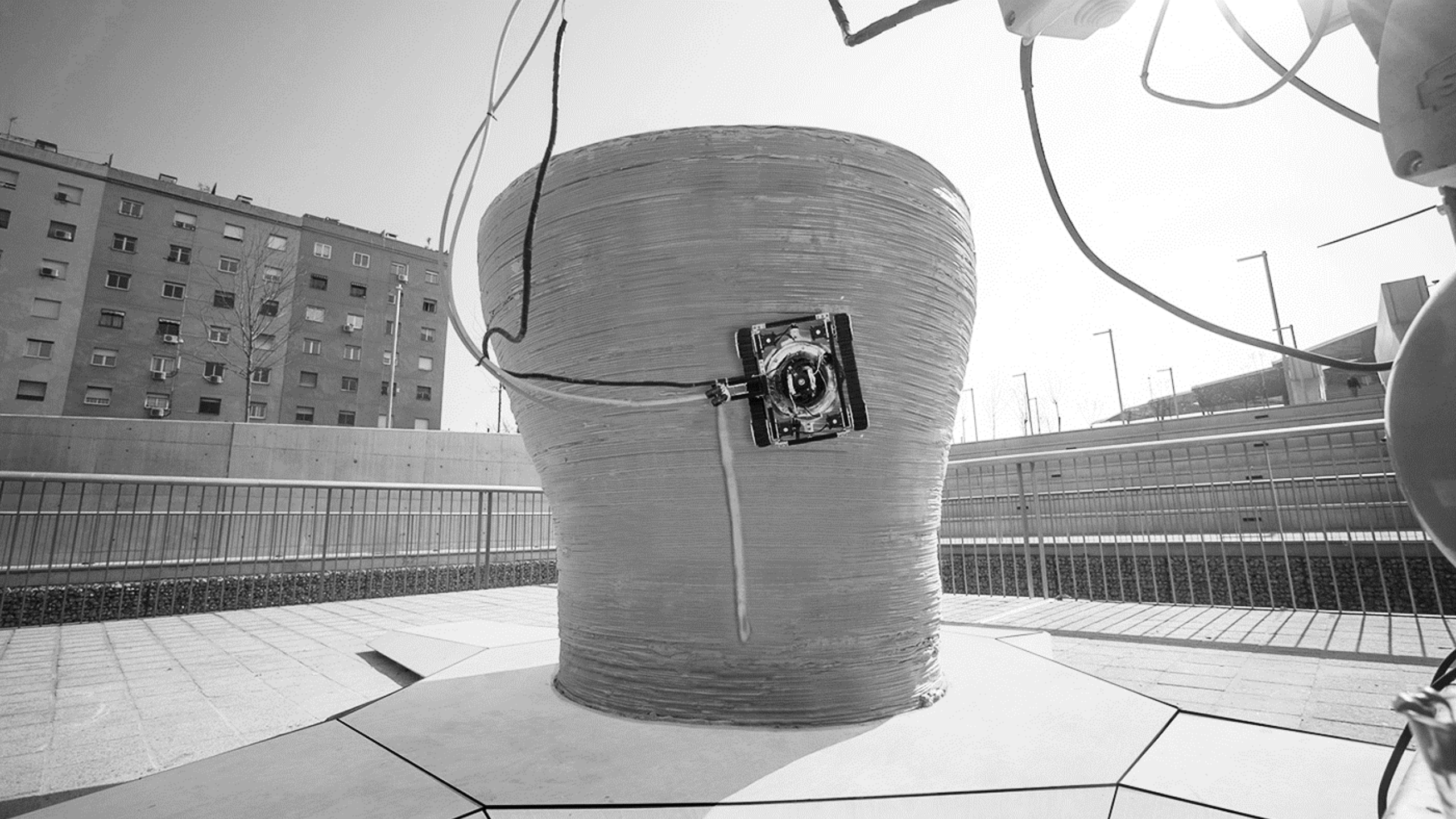

Feeder Tanks
Rover[b]
Rover[d]
Rover[a]
Rover[c]

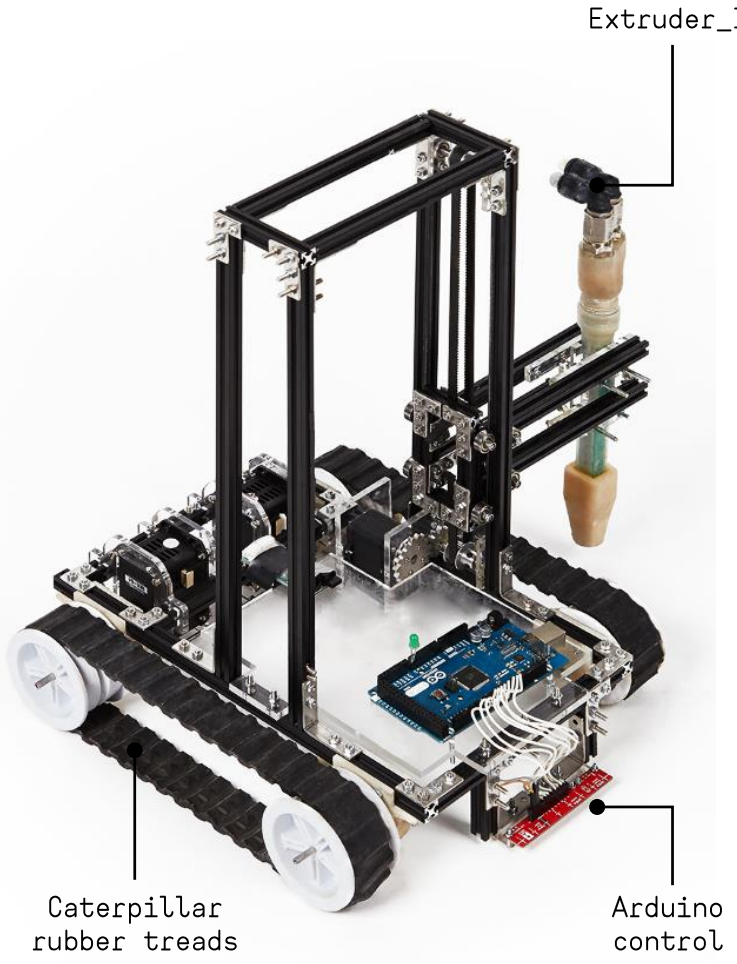

Rover[a]
Rover[b]
Rover[c]
Rover[d]
Feeder Tanks


Feeder Tanks
Rover[b]
Rover[a]
Rover[c]
Rover[d]

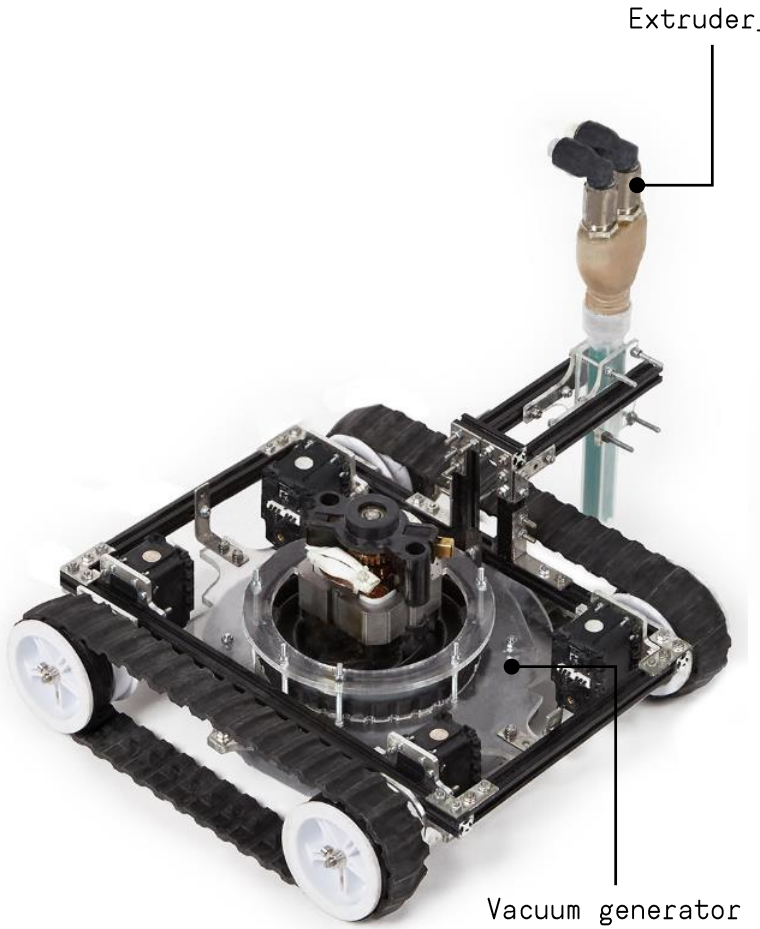

Rover[b]
Rover[a]
Rover[c]
Feeder Tanks
Rover[d]
Rover[e]



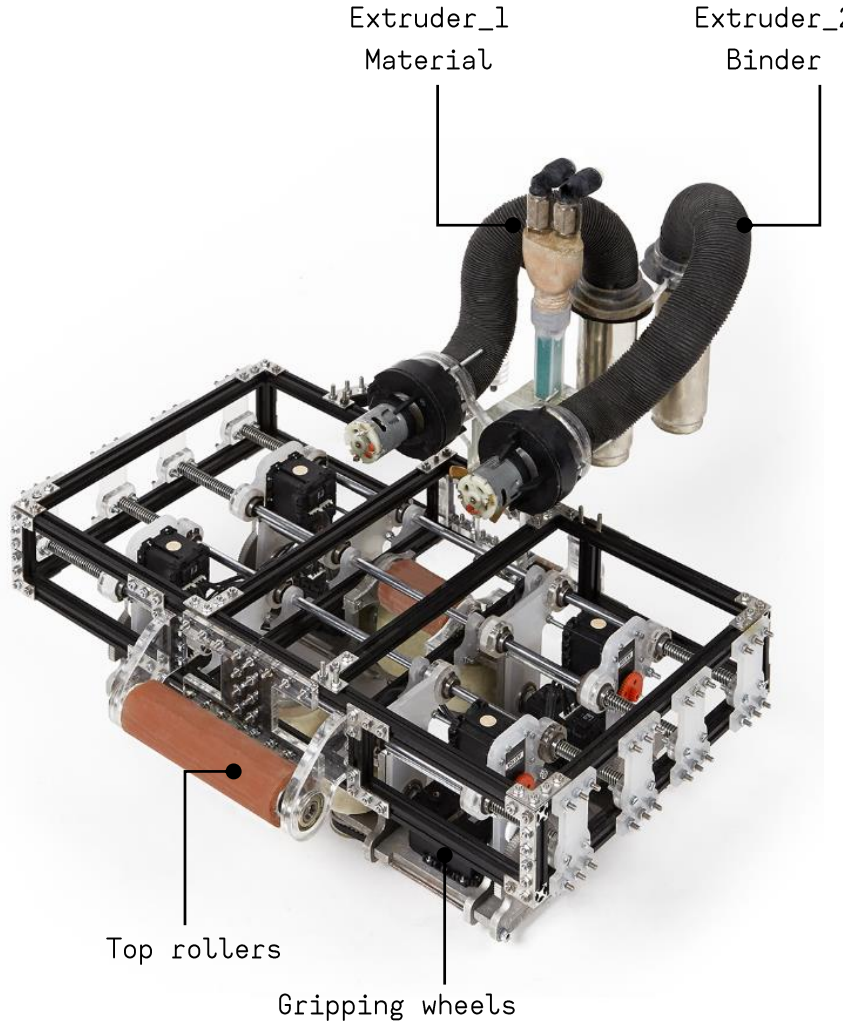




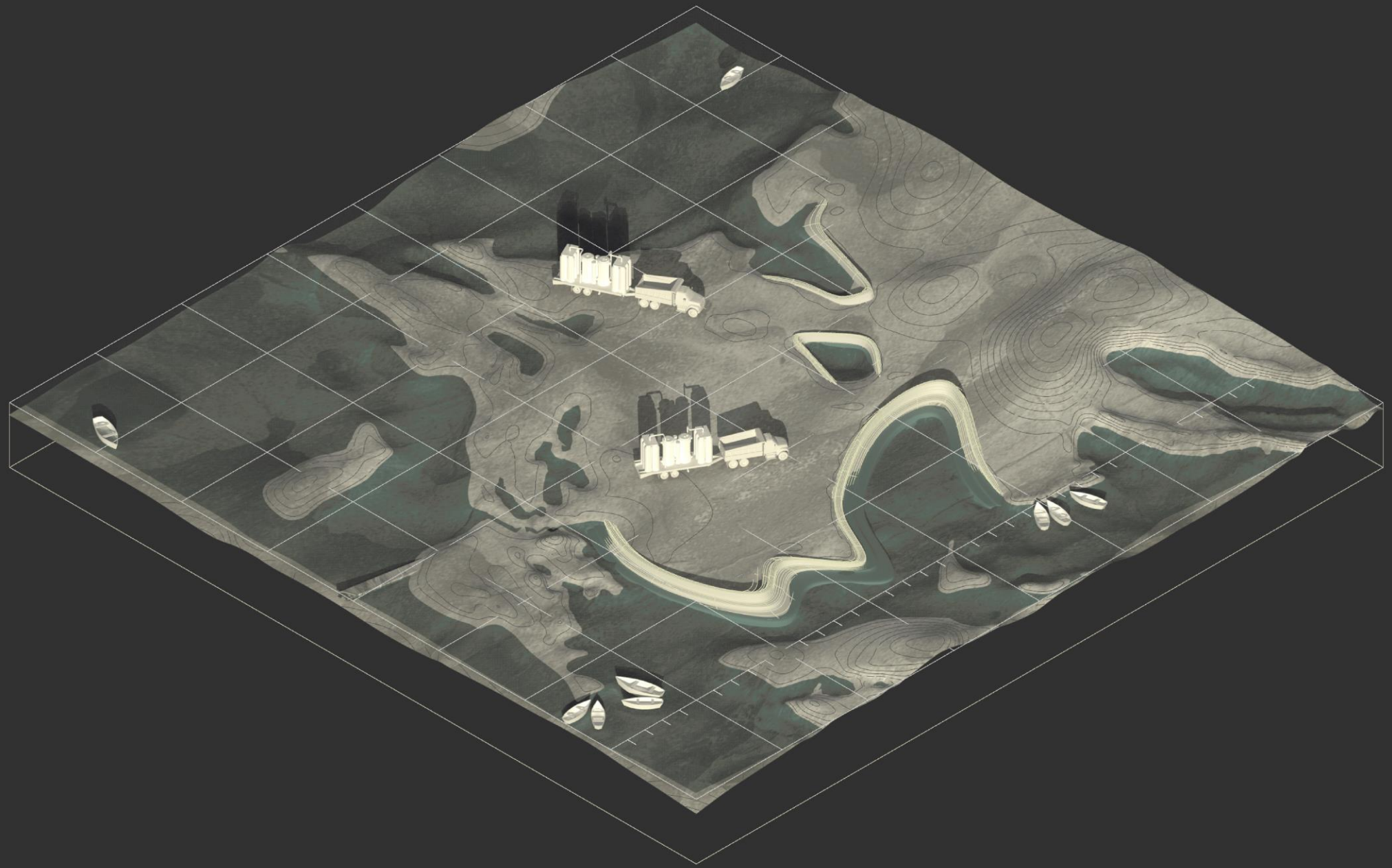
[Robot_A]

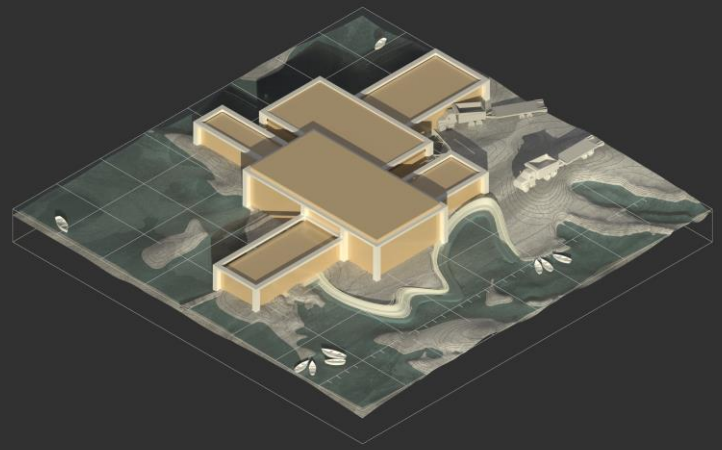


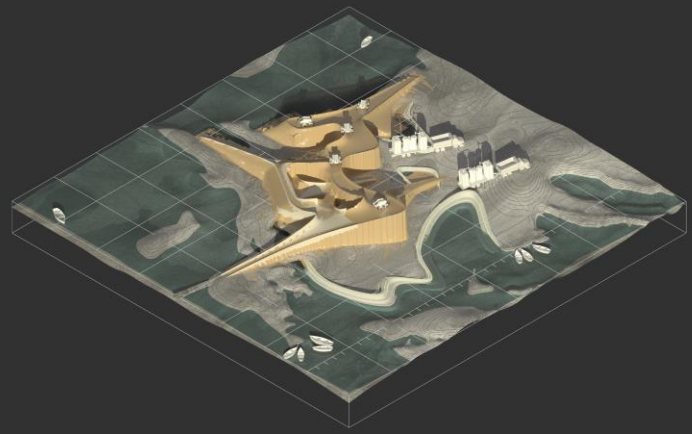
[Robot_B]

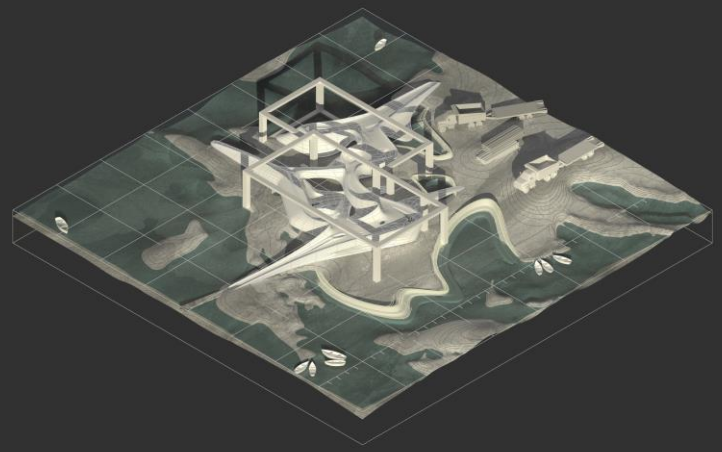


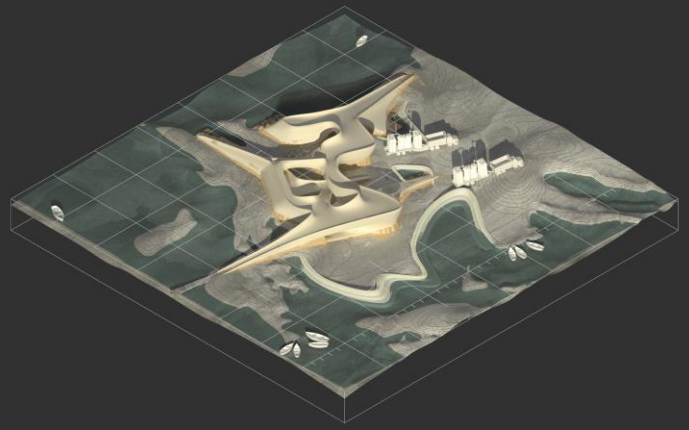
`[Robot_C]











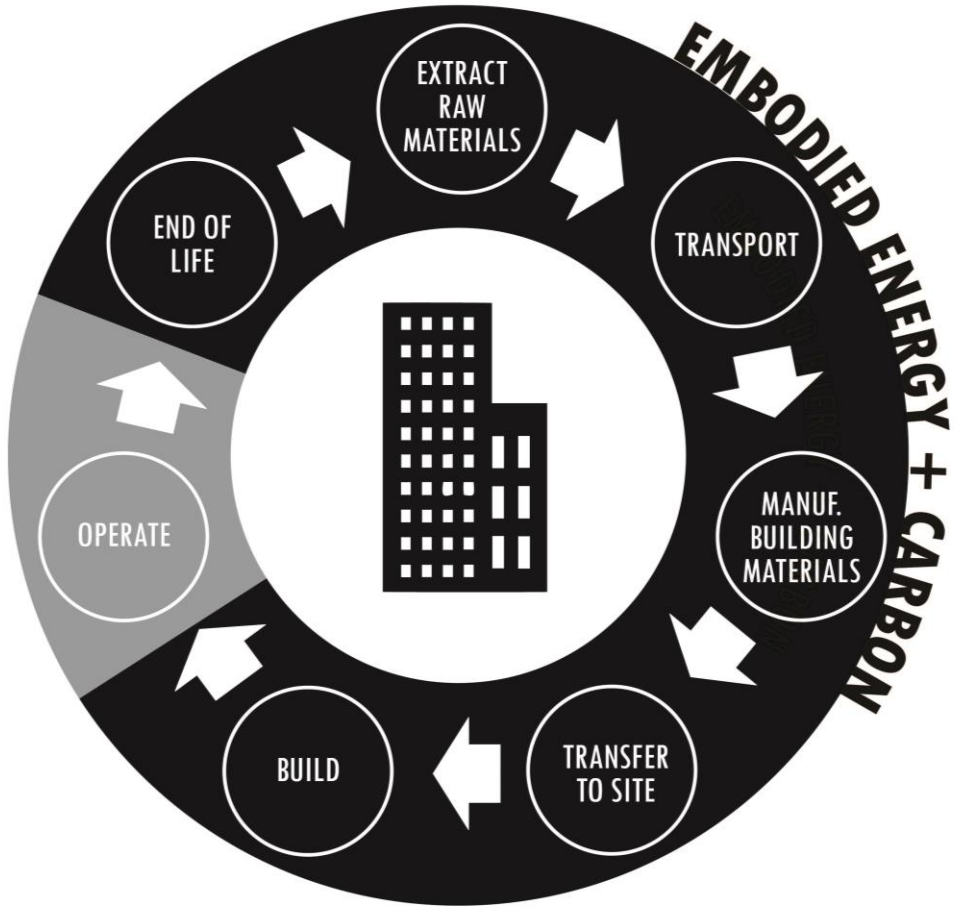
Total sand = printer bed volume including the design mesh	19000 cu.mts
Design mesh volume	3100 cu.mts
Print time @ 6 cu.mt/hr	3166 hrs/131 days

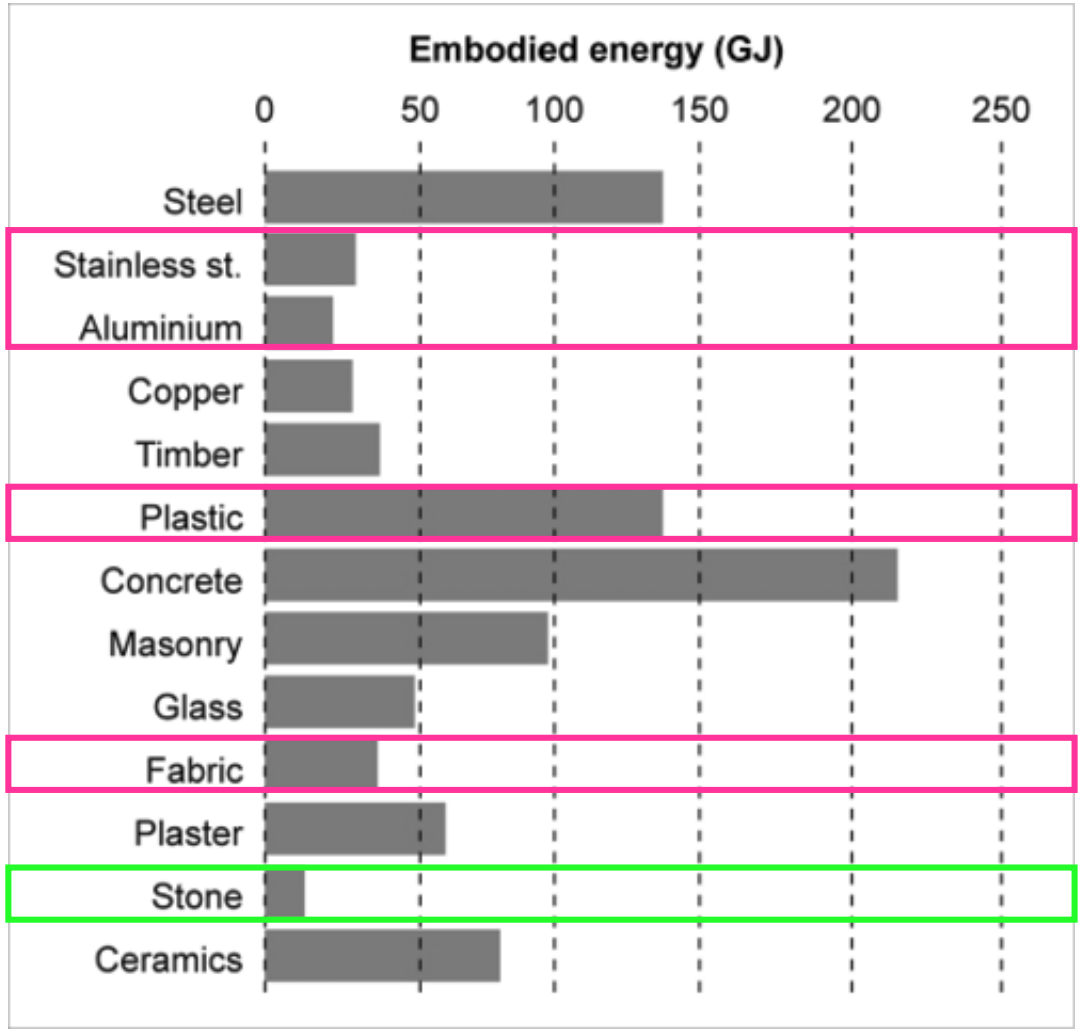
Total sand = support volume plus design mesh	7200 cu.mts
Design mesh volume	3100 cu.mts
Print time @ 6 cu.mt/hr	1200 hrs/50 days
Print time with 5 robots	10 days

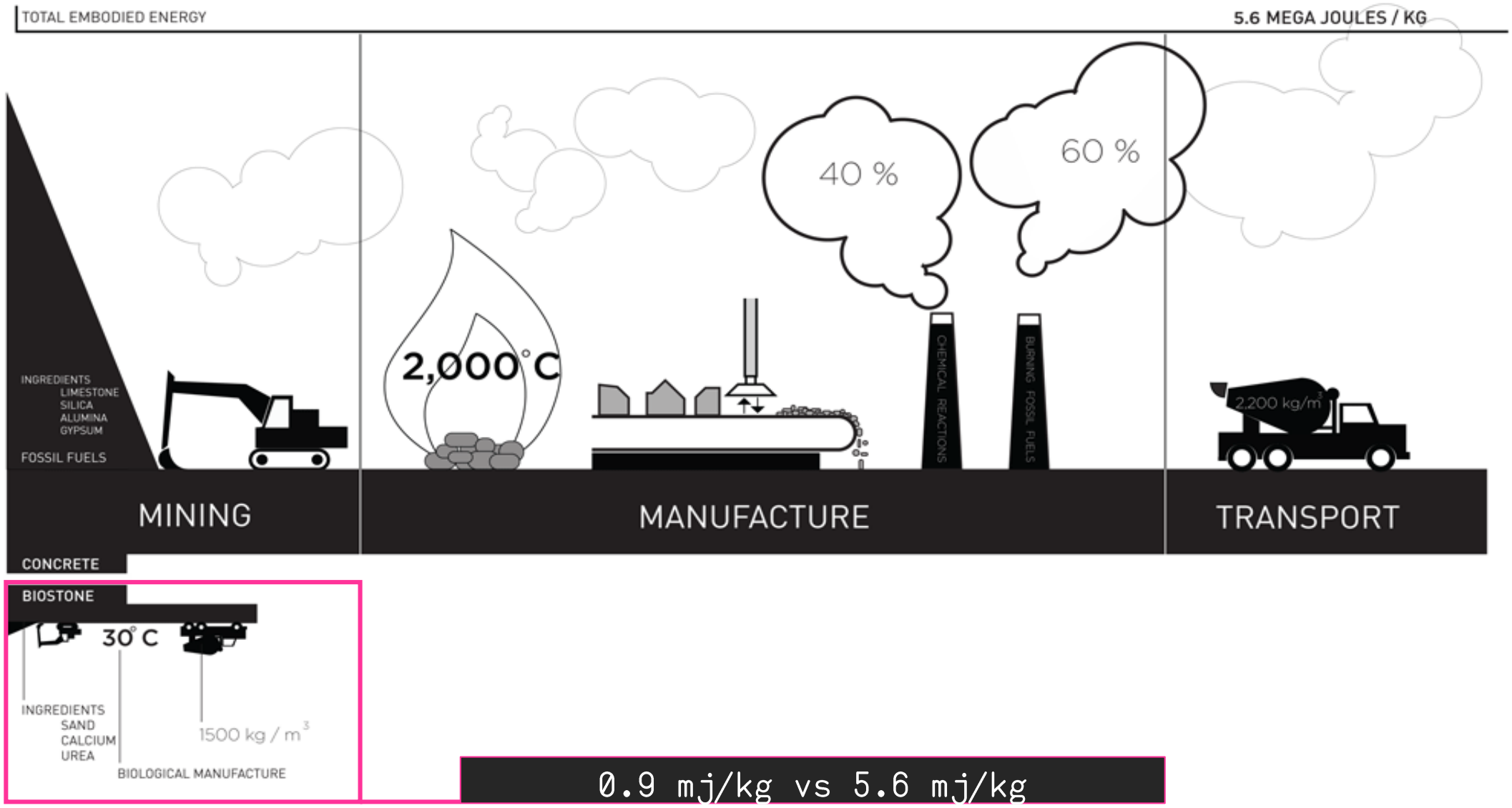
[Specifications & Requirements]

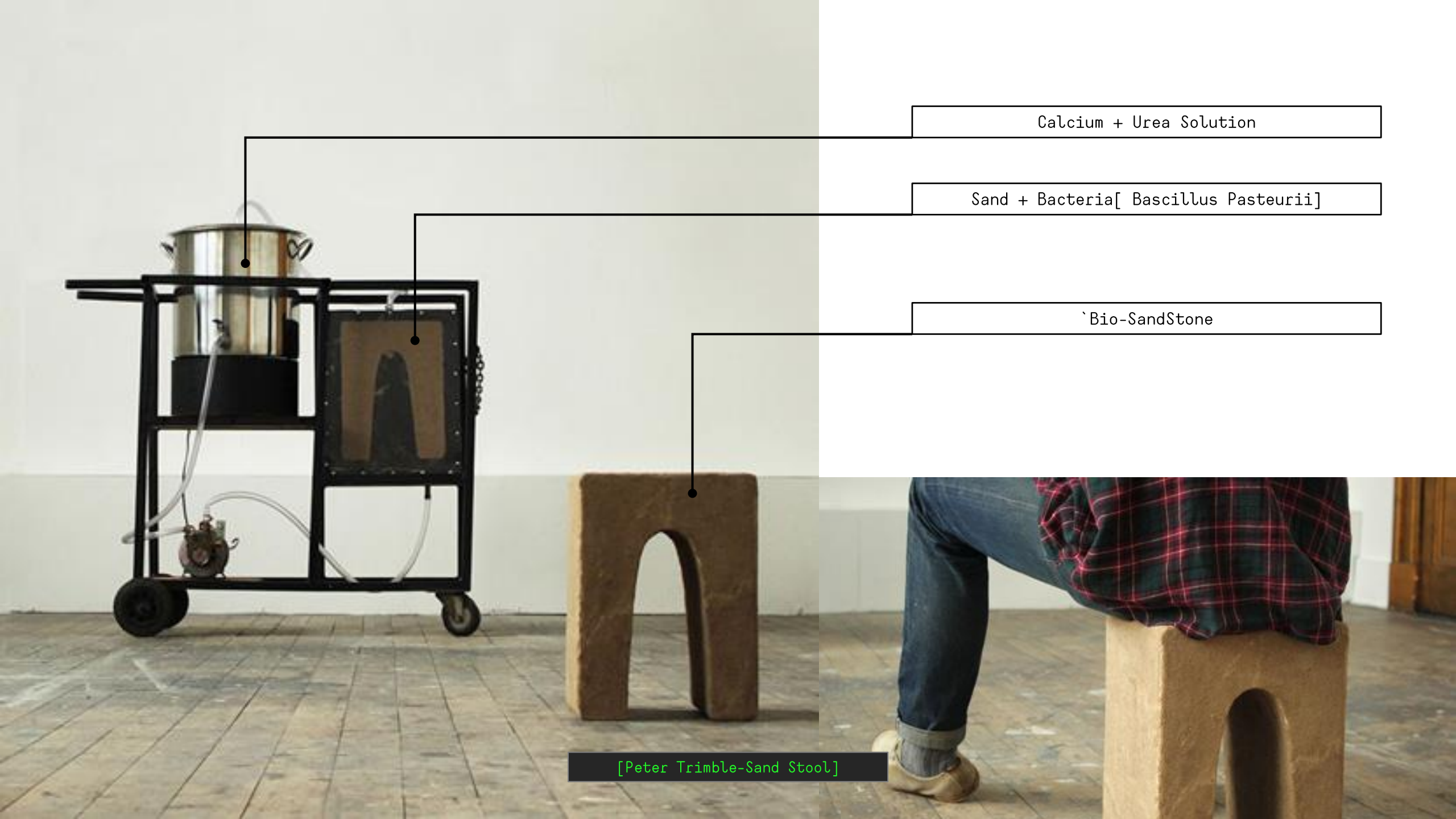
[Material]

LIFE CYCLE OF A BUILDING






TOTAL EMBODIED ENERGY
5.6 MEGA JOULES / KG
INGREDIENTS
LIMESTONE
SILICA
ALUMINA
GYPSUM
FOSSIL FUELS
2,000°C
40 %
60 %
CHEMICAL REACTIONS
BURNING FOSSIL FUELS
2,200 kg/m³
MINING
MANUFACTURE
TRANSPORT
CONCRETE
BIOSTONE
30° C
INGREDIENTS
SAND
CALCIUM
UREA
1500 kg / m³
BIOLOGICAL MANUFACTURE
0.9 mj/kg vs 5.6 mj/kg
TOTAL EMBODIED ENERGY 0.9 MEGA JOULES / KG


Calcium + Urea Solution
Sand + Bacteria[Bascillus Pasteurii]
`Bio-SandStone
[Peter Trimble-Sand Stool]

[Magnus Larsson - Soil interaction Laboratory,University of California]

[BINDER INGREDIENTS]

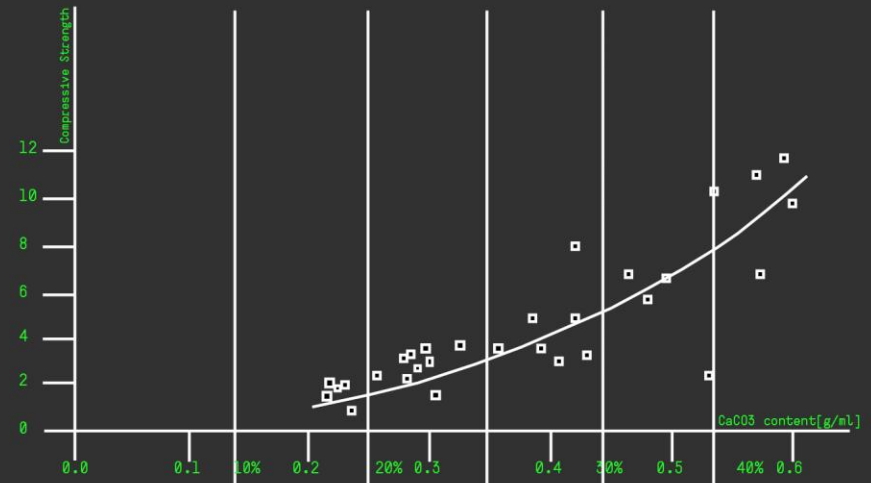
Bascillus Pasteurii

Sand

Clay

Urea solution

Calcium Chloride

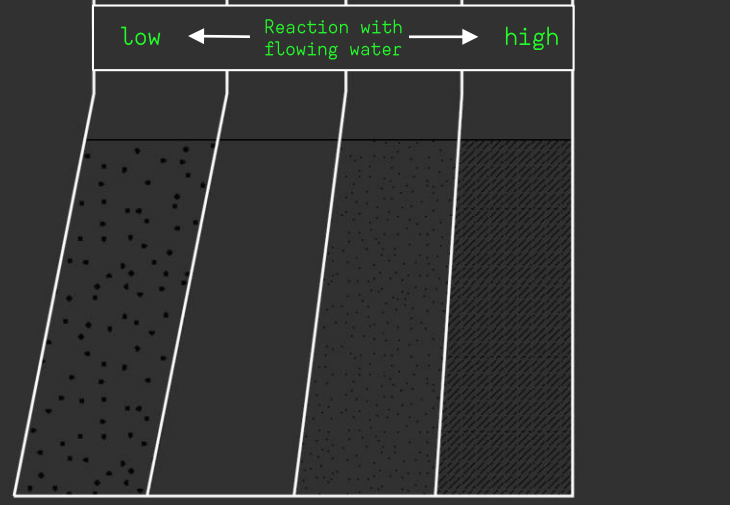


Bascillus Pasteurii & urea + Water = Ammonium + Carbonate

CO[NH2]2 + 2H2O = 2NH4 + CO3

Ammonium & Carbonate + Calcium Chloride = Calcium Carbonate Crystals[CACO3]

Calcium Carbonate Crystals[CACO3] Reacts with flowing water to disintegrate



[Binder]

3500 PSI

Concrete

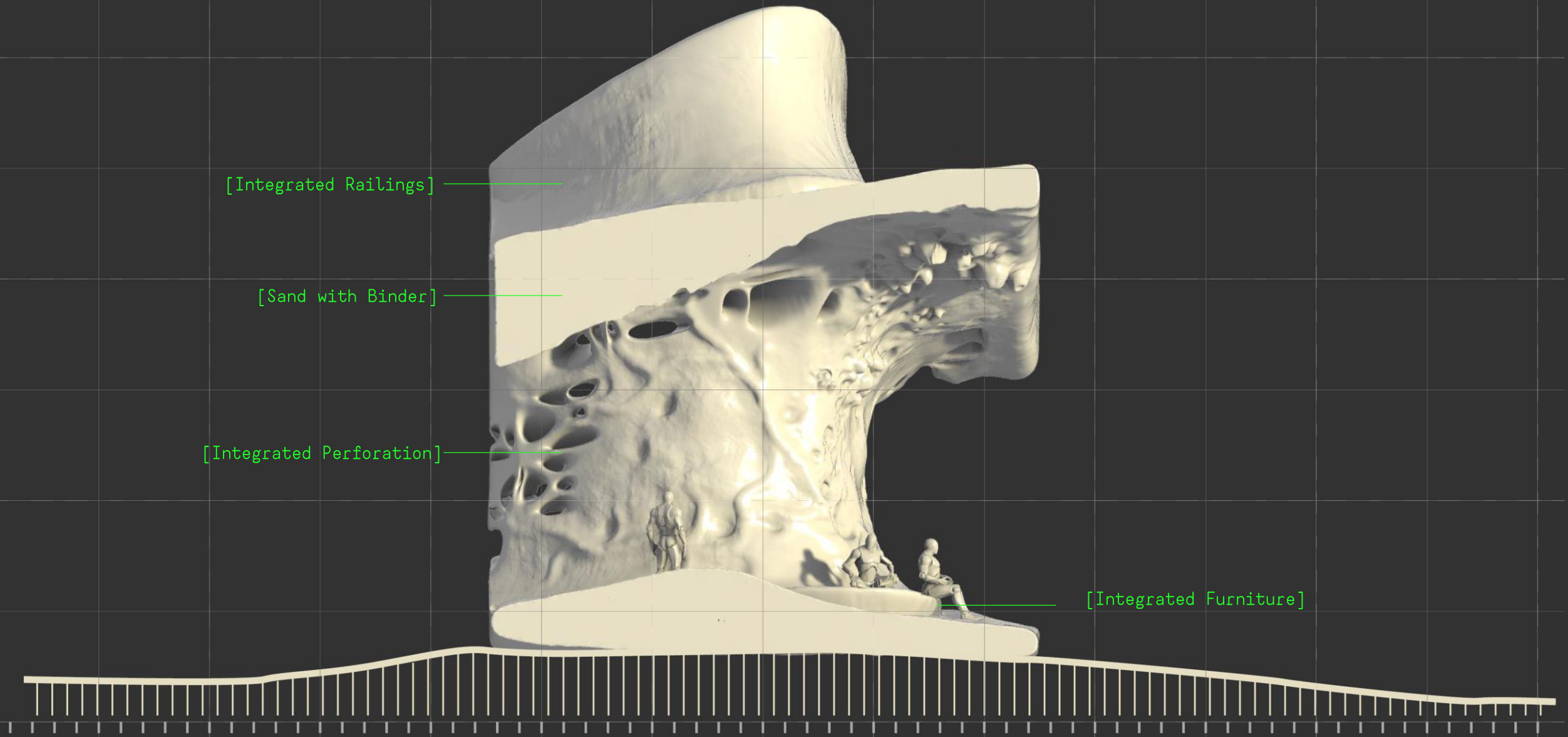
3000 PSI

Clay-Brick

2400 PSI

Bio-Stone

Compression Strength| psi[pounds per square inch]



[Fraction Detail]

[VR in construction]

IN-FLOW

Robotic Building| TU Delft
An inside look into Kumbh Mela's extreme form of temporary urbanism

Msc Cand: Arav Kumar
Tutors: Henriette Bier, Ferry Adema, Arwin Hidding
Date: January 2020

in[FLOW]

Architecture in Motion

[MAHAKUMBH | POP-UP CITY]