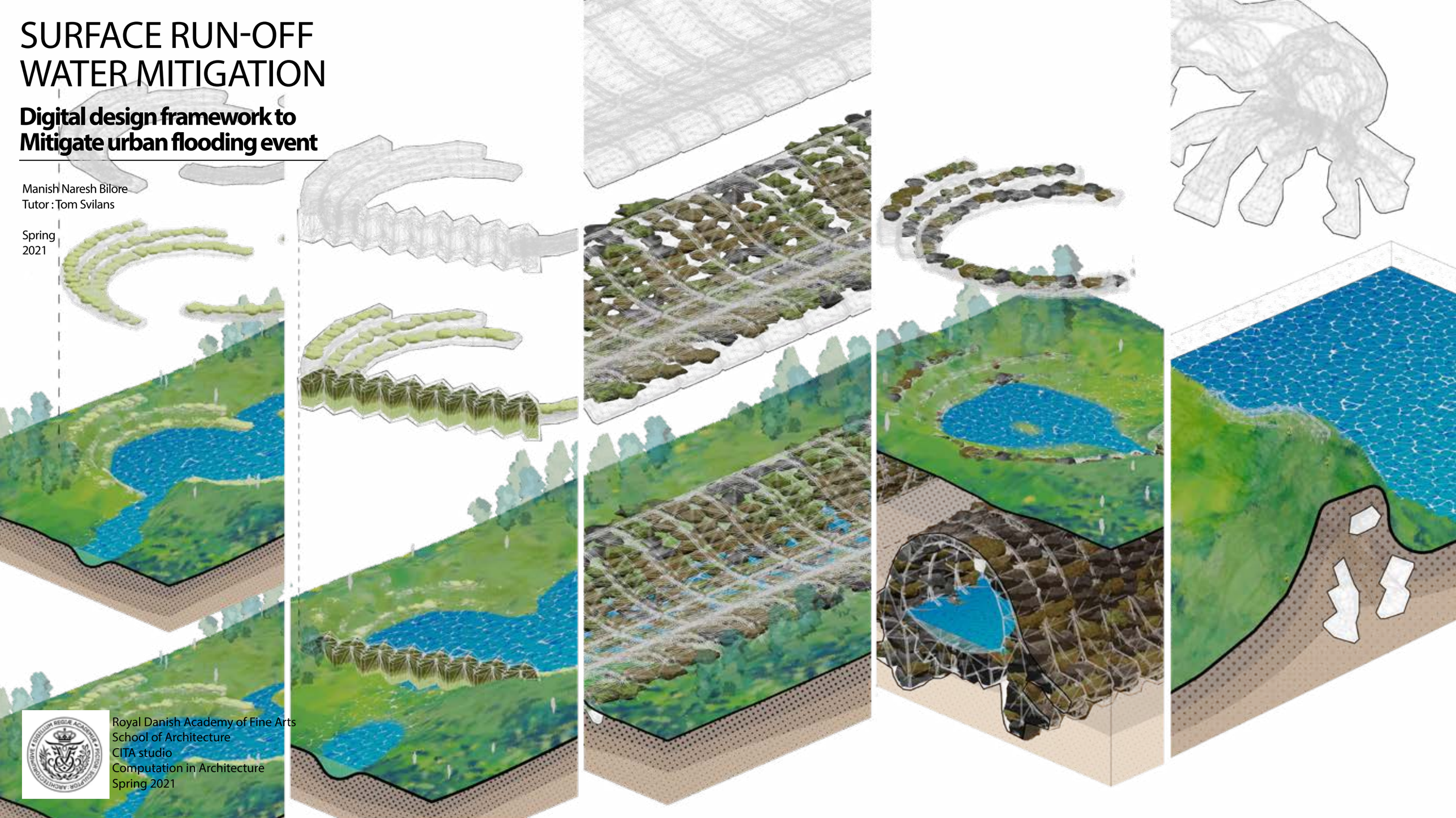
SURFACE RUN-OFF WATER MITIGATION

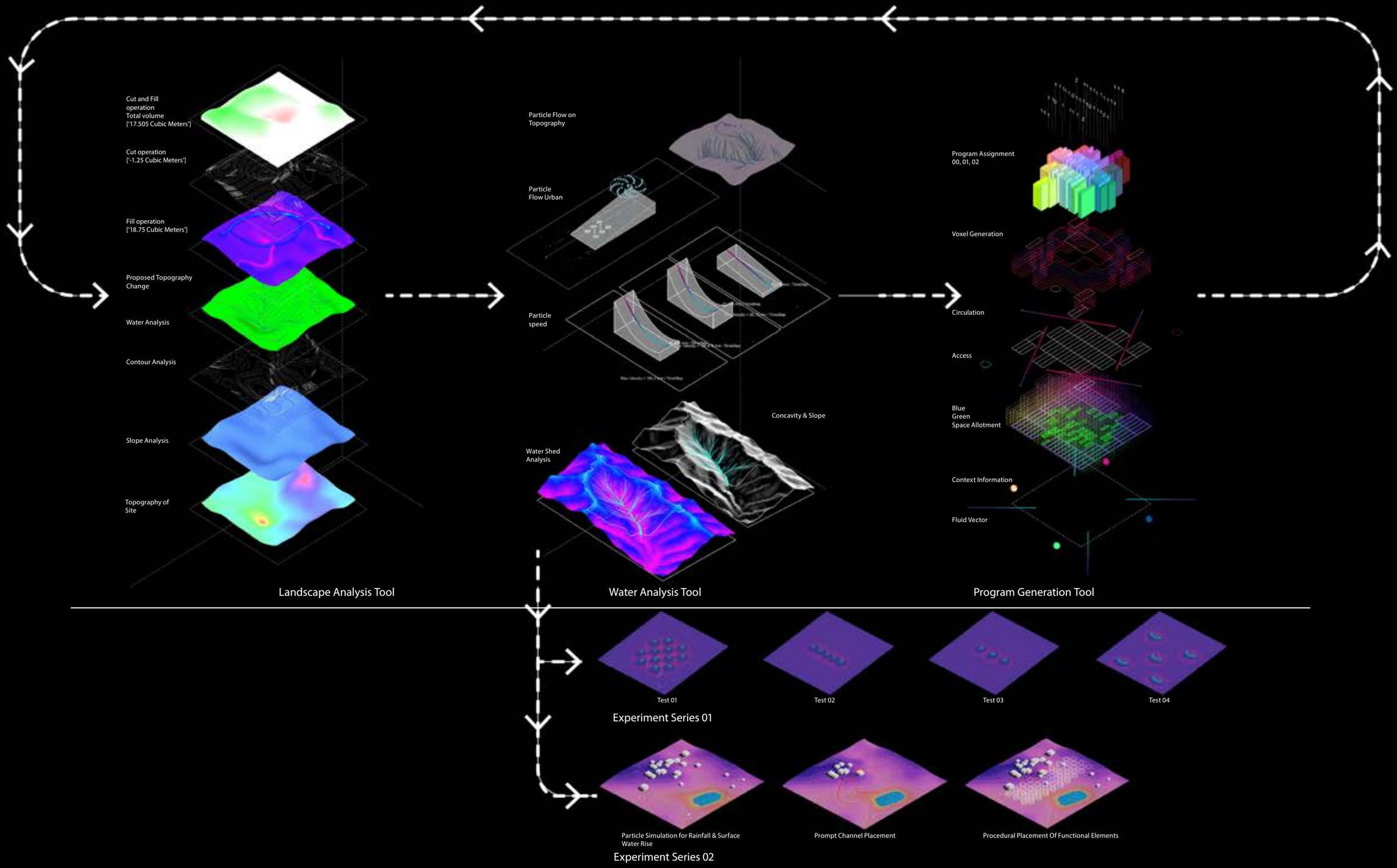
Digital design framework to Mitigate urban flooding event

Manish Naresh Bilore
Tutor : Tom Svilans

Spring
2021



Royal Danish Academy of Fine Arts
School of Architecture
CITA studio
Computation in Architecture
Spring 2021


Cut and Fill operation Total volume ['17.505 Cubic Meters']
Cut operation ['-1.25 Cubic Meters']
Fill operation ['18.75 Cubic Meters']
Proposed Topography Change
Water Analysis
Contour Analysis
Slope Analysis
Topography of Site
Landscape Analysis Tool
Particle Flow on Topography
Particle Flow Urban
Particle speed
Concavity & Slope
Water Shed Analysis
Water Analysis Tool
Program Assignment 00, 01, 02
Voxel Generation
Circulation
Access
Blue Green Space Allotment
Context Information
Fluid Vector
Program Generation Tool
Test 01
Test 02
Test 03
Test 04
Experiment Series 01
Particle Simulation for Rainfall & Surface Water Rise
Prompt Channel Placement
Procedural Placement Of Functional Elements
Experiment Series 02

PARTICLE SIMULATION

Meso Scale Tool for Water Behaviour Study

Analysing the Topography against Surface Water Rise and Extreme Rainfall Event

Combined Tool for Rainfall and
Surface water rise

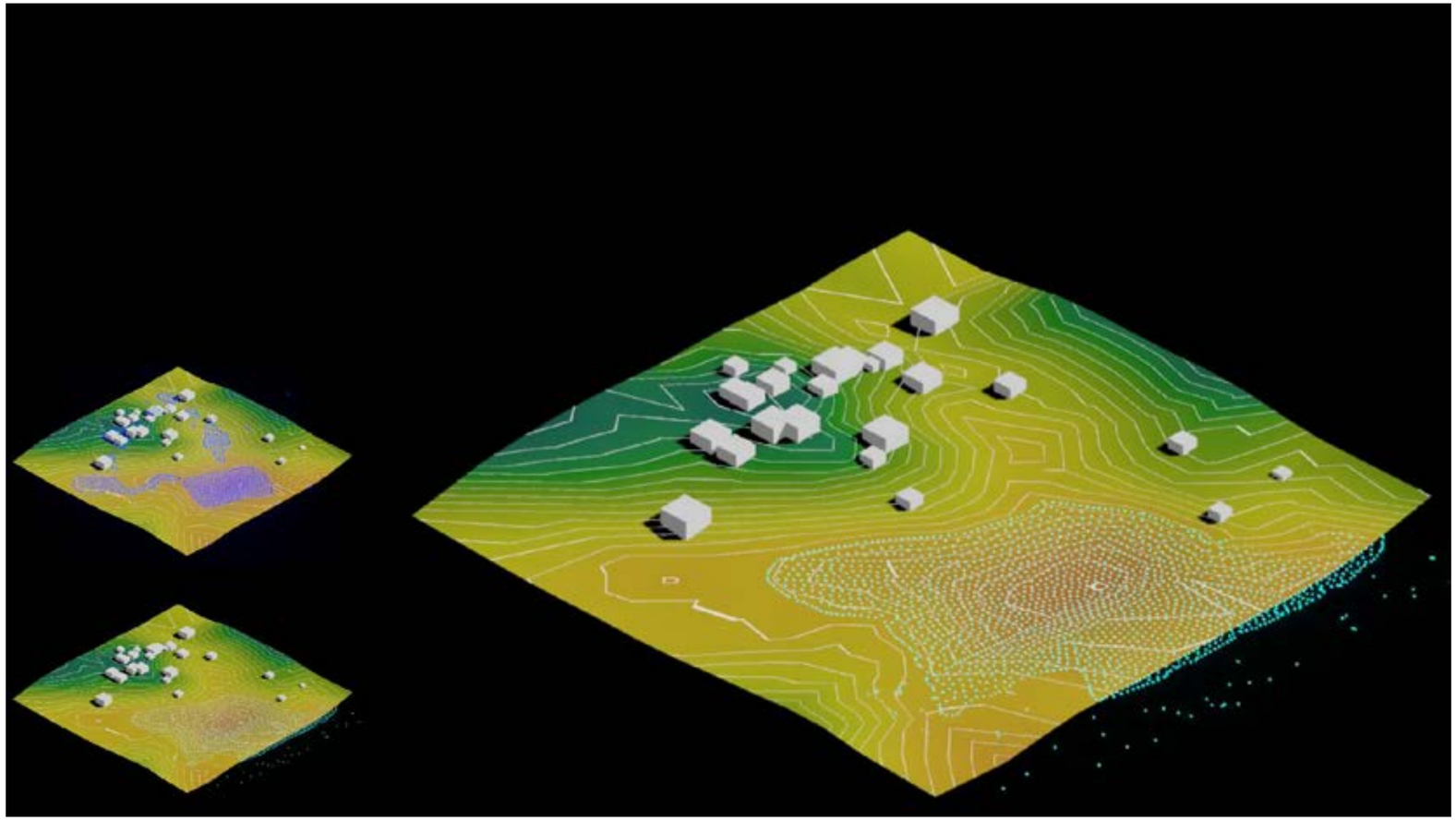
Number of particles_20,000
Brownian Force_____0.5
Drag_____0.1

Rainfall Interaction

Number of particles_10,000
Brownian Force_____0.5
Drag_____0.1

Surface Level Water
Rise Interaction

Number of particles_10,000
Brownian Force_____0.5
Drag_____0.1



Number of Time Frame Of Simulations: 15000

TOPOGRAPHY CHANGE

Experimental setup to determine patterns of landscape change

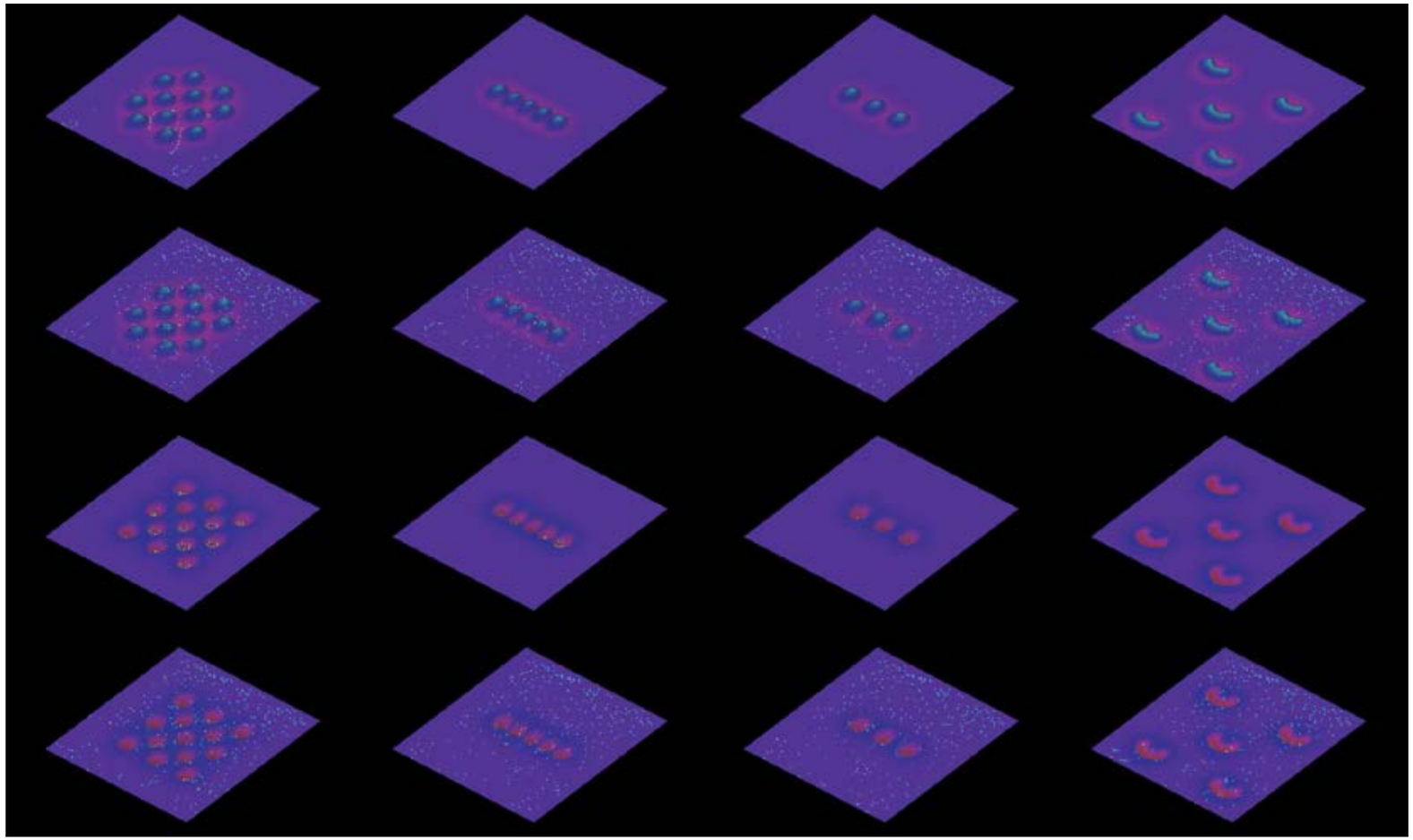
Series of hydrodynamic simulations to study the implications of water flow across parametric models to visualize different runoff and collection patterns by adjusting -

- Slope-to-depth ratios
- Placement of modification pattern

to guide and collect water across 500 time frames

Fluid Type 01 --- 250 particles
To represent flash flood

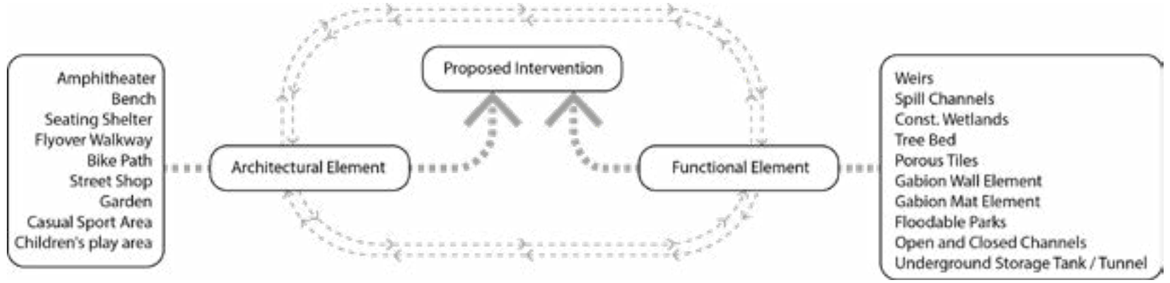
Fluid Type 02 --- 1000 particles
To represent continuous rainfall

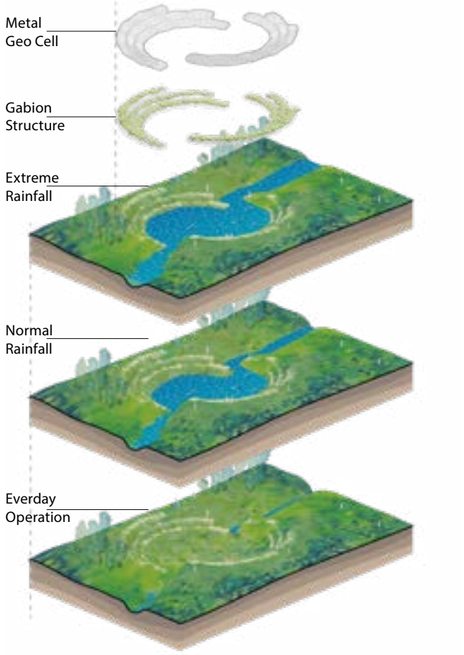


MEREOLOGICAL APPROACH TO LANDSCAPE DESIGN

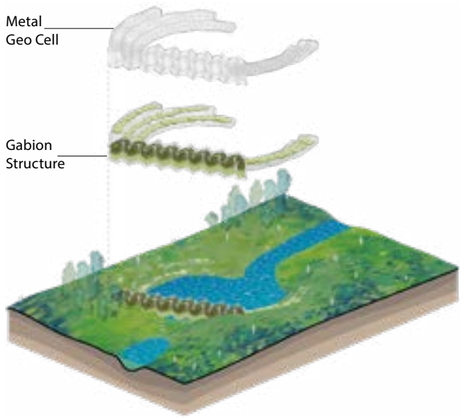
Method to mitigating flood water on Urban Scale

Intervention

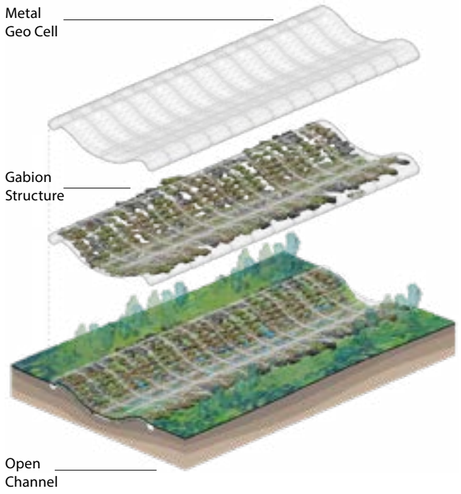




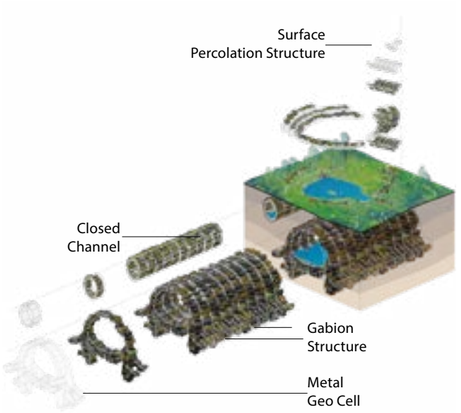
01 Amphitheatre



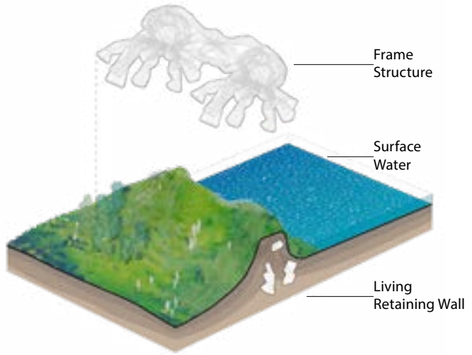
02 Weir



03 Drain Channel



04 Underground Tank and Channels

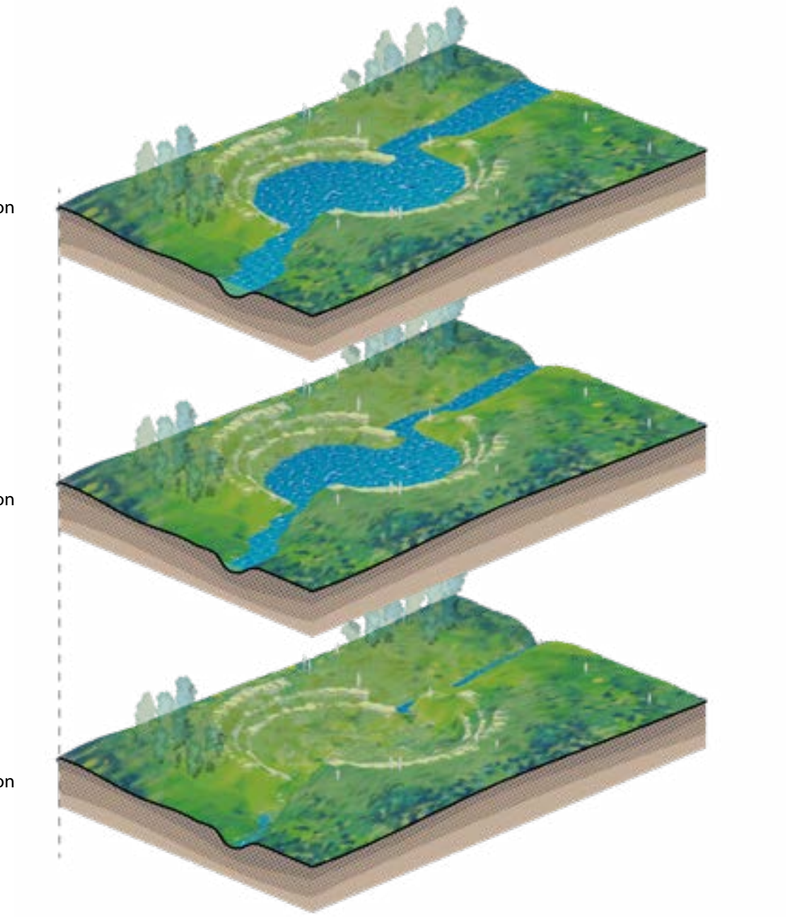


05 Retaining Wall

FLOOD-ABLE PARK - AMPHITHEATRE

Marking performance of functional elements

Determine the water flow mitigation grade for each element that enables the placement of the element in the procedural script automatically



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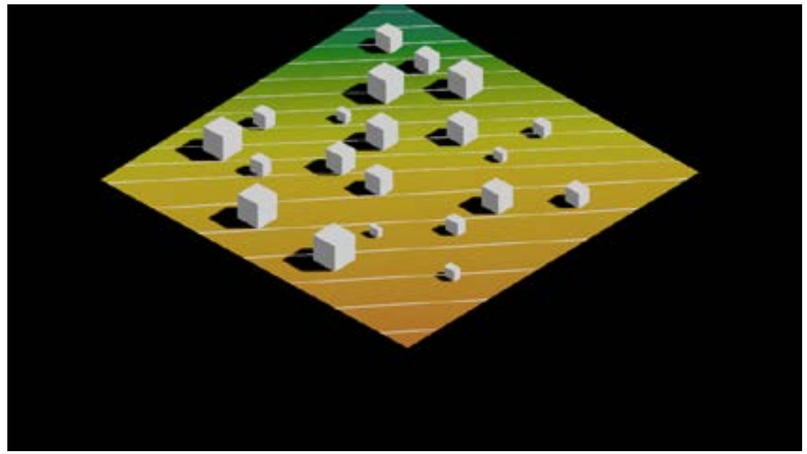
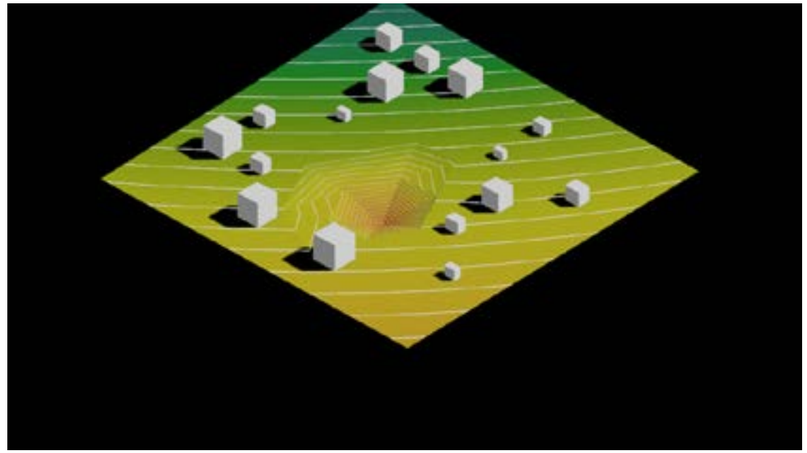




Test to measure water flow character after the intervention

Control Setup

Particle Velocity ■■■■■■■■■□□□□□□□□□□□
Innundation ■■■■■■■■■□□□□□□□□□□□

Number Of Houses Affected : 12/21

Slope To Depth Ratio : 15 degrees

Intervention Setup

Particle Velocity ■■■■■■■■■■■□□□□□□□□
Innundation ■■■■■■■■■□□□□□□□□□□□

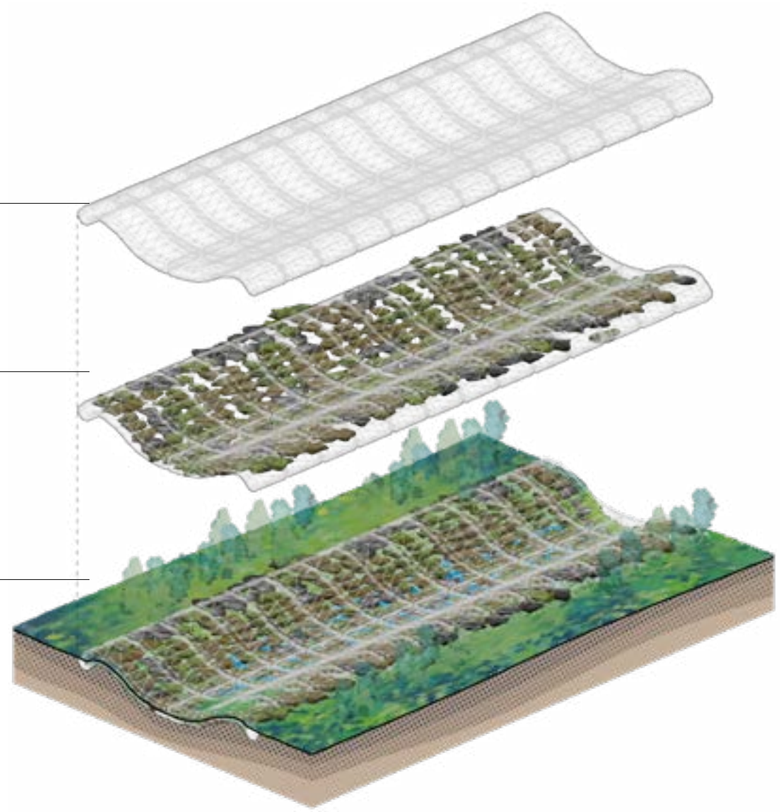
Number Of Houses Affected : 8/16

Slope To Depth Ratio : 15 degrees

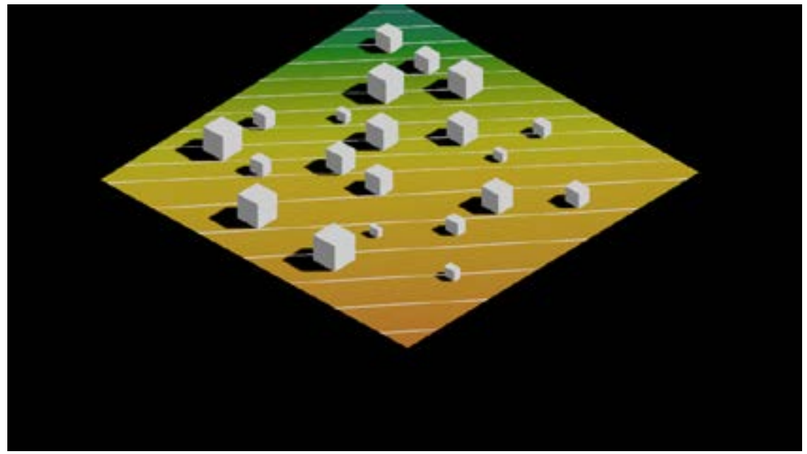
POROUS WATER CHANNEL - GEOCELL / GABION

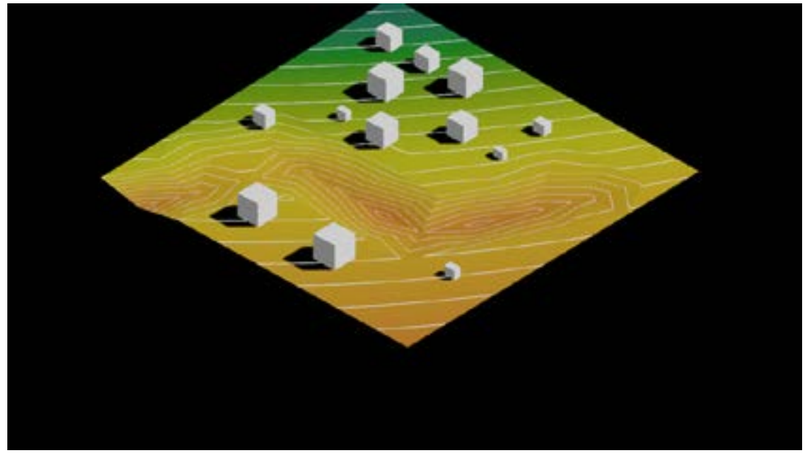
Marking performance of functional elements

Determine the water flow mitigation grade for each element that enables the placement of the element in the procedural script automatically



03 Drain Channel





Test to measure water flow character after the intervention

Control Setup

Particle Velocity ■■■■■■■■■■■■■■□□□□□□
Innundation ■■■■■■■■■■■■■■□□□□□□□□

Number Of Houses Affected : 12/21

Slope To Depth Ratio : 15 degrees

Intervention Setup

Particle Velocity ■■■■■■■■■■■■□□□□□□□□
Innundation ■■■■■■■■■■□□□□□□□□□□

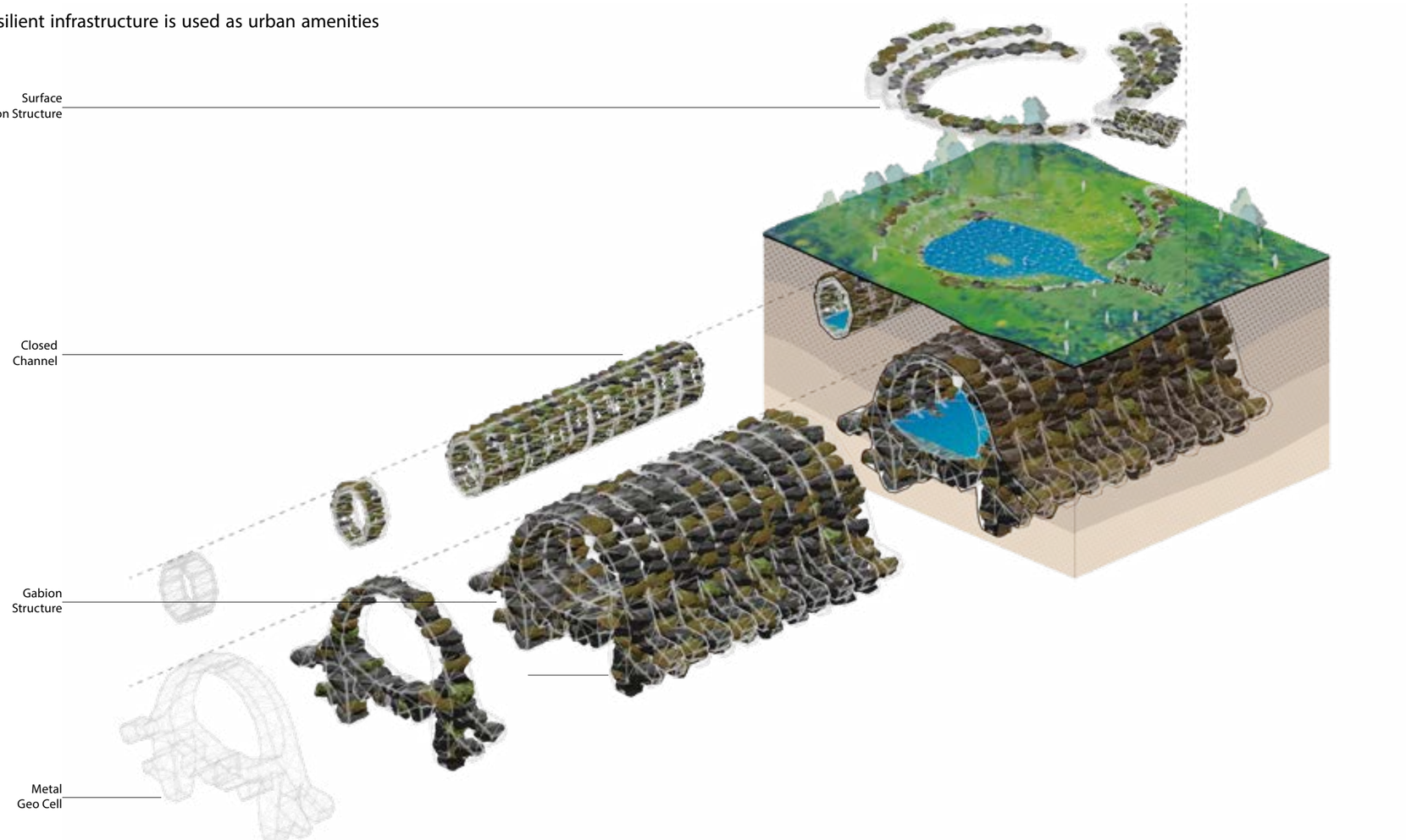
Number Of Houses Affected : 10/13

Slope To Depth Ratio : 15 degrees

ARCHITECTURAL SKIN

Blending the Functional Elements into the Urban Fabric

During normal days the resilient infrastructure is used as urban amenities like public parks and play areas

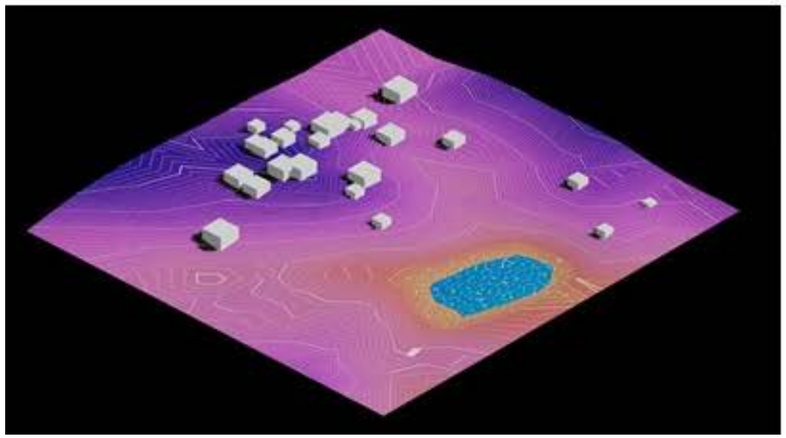


04 Underground Tank and Channels

LANDSCAPE TRANSFORMATION PROMPT

Procedural model to prompt design intervention based on the fluid

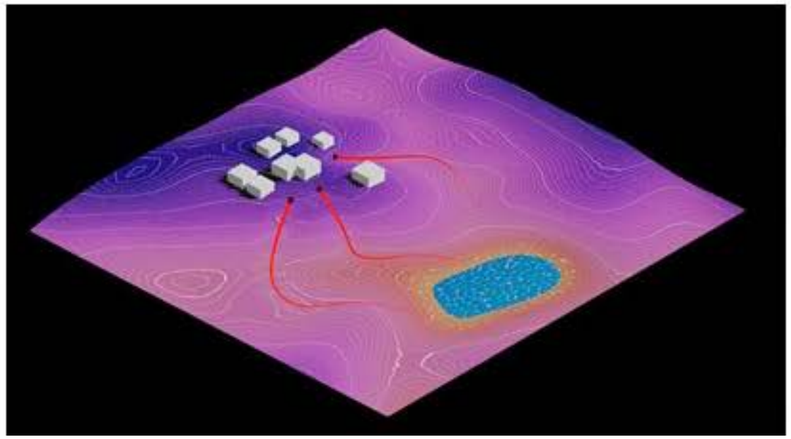
Experiment to determine the landscape layout for the most conducive water mitigation



Particle Simulation For Rainfall & Surface Water Rise

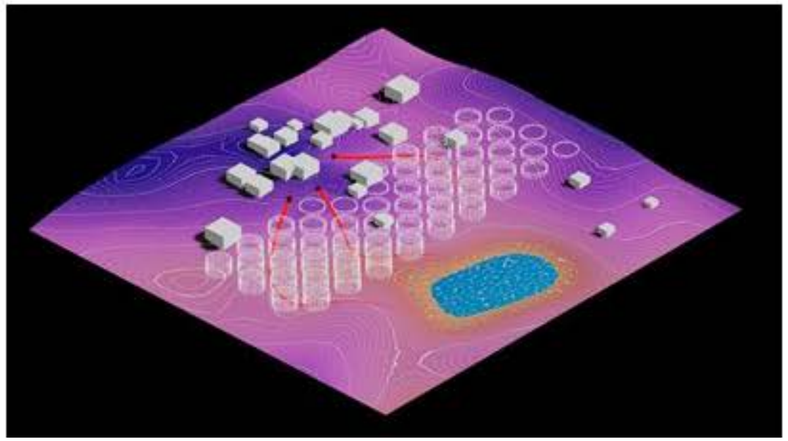
Identify innundation areas

Identify zones of accelerated water flow



Prompt Channel Placement

Identify quick trench placement to ameliorate innundation



Procedural Placement Of Functional Elements

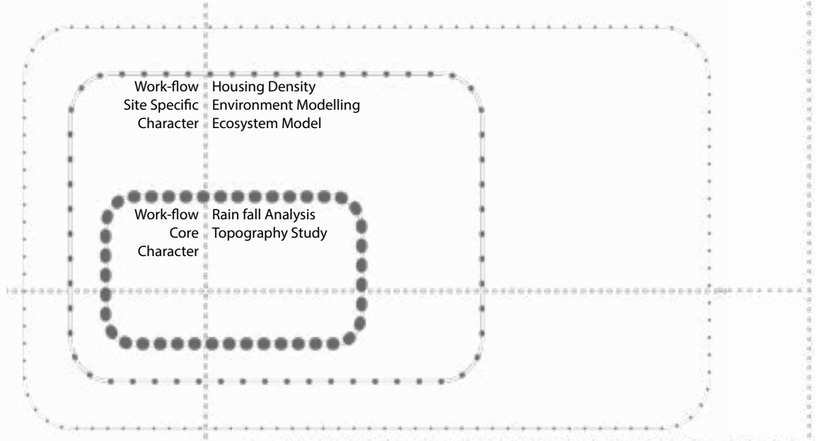
Based on empiral data & particle simulation, suggest optimum placement of mitigating elements

MAPPING THE WORK FLOW

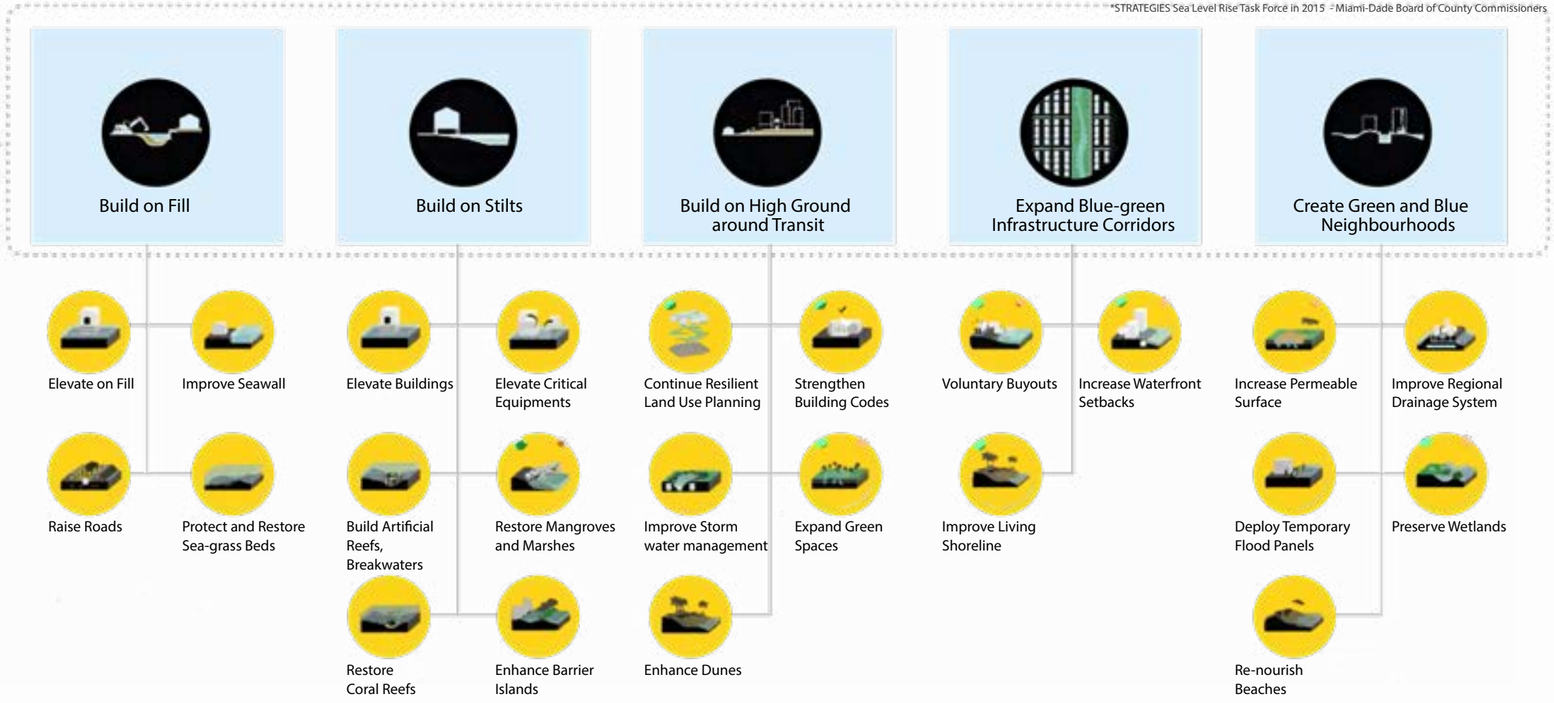
Comparative study of flooding and landscape response

With the aim of developing global strategies – applicable to other cities, – and identifying specific strategies that are applicable to particular cities.

Set of tactics deployed at the regional and urban scale in Coastal cities to provide a layer of resilience to the urban fabric



*STRATEGIES Sea Level Rise Task Force in 2015 - Miami-Dade Board of County Commissioners




Copenhagen


Mumbai


Hong Kong

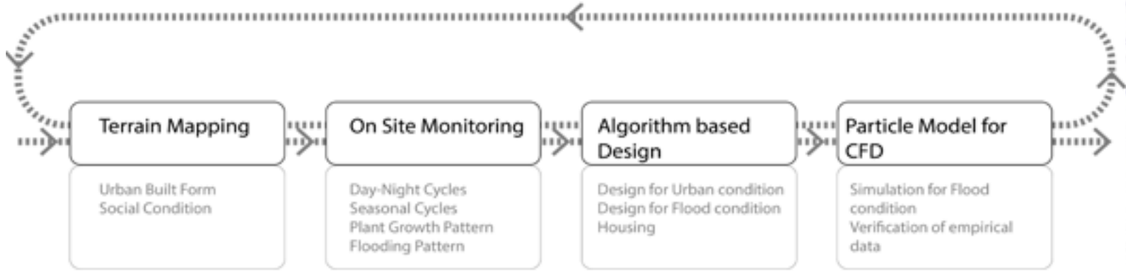

Miami


New York


Oslo

MACRO SCALE

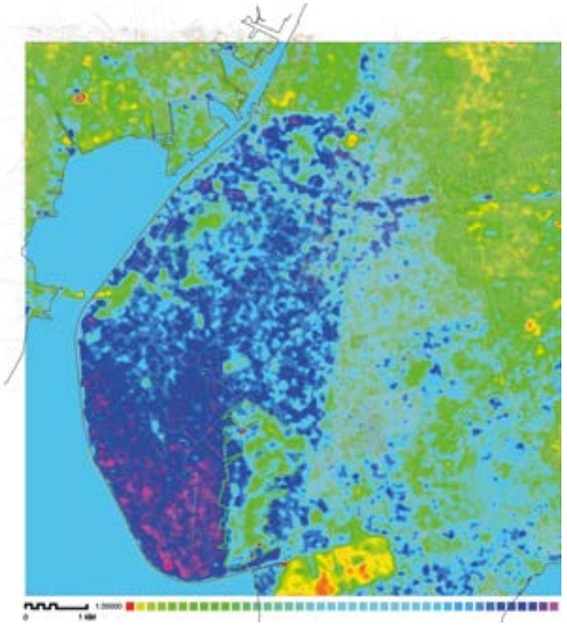
Responsive Landscape, Water Mitigation,



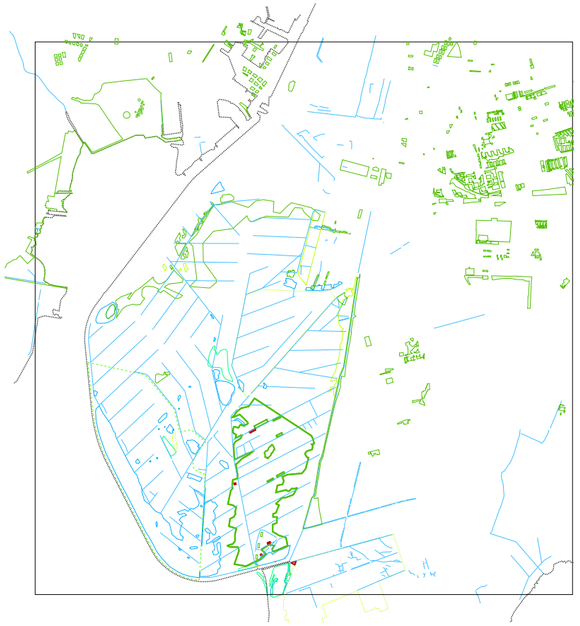
Project Iteration Loop

Copenhagen Water scape

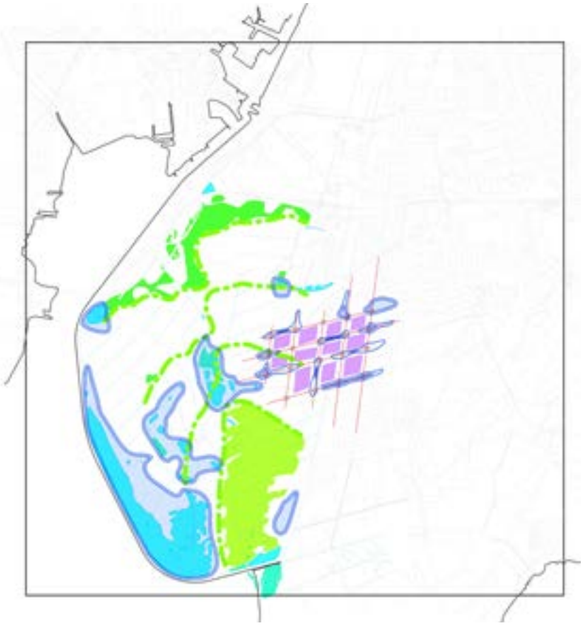
City Model to propose and test design interventions



Terrain Model to test Environmental actions - UHI and Flooding



Model of the Existing Blue Green Infrastructure



Testing the proposed idea

RAINFALL SIMULATION

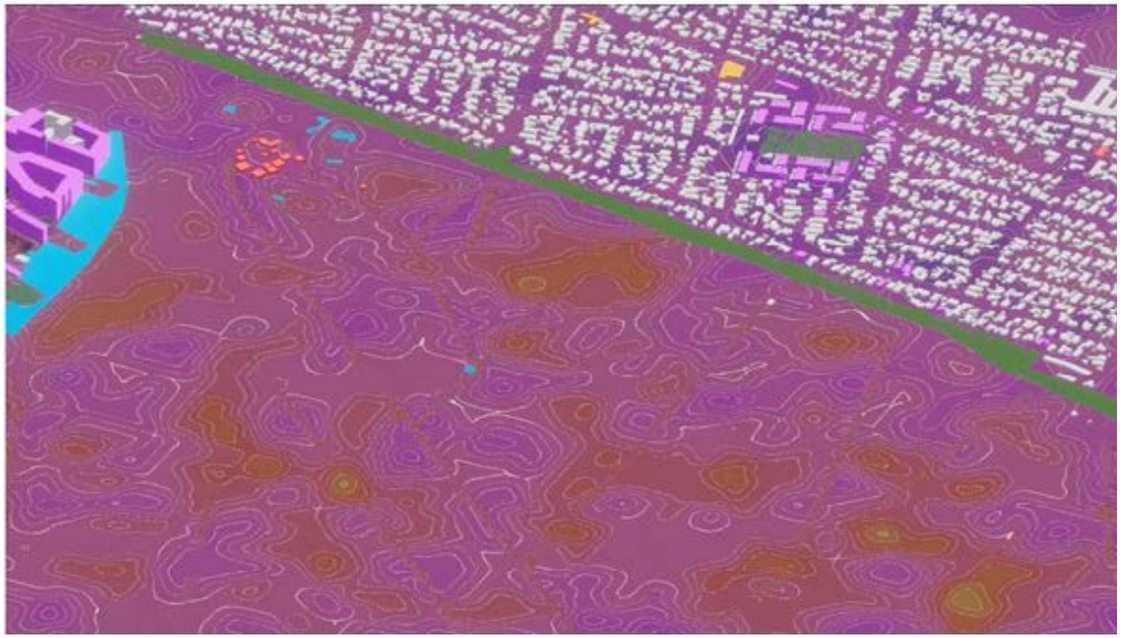
Iteration In Amager To Test The Proposed Work-flow

Particle Simulation for Rainfall to determine areas inundated by rain

Copenhagen

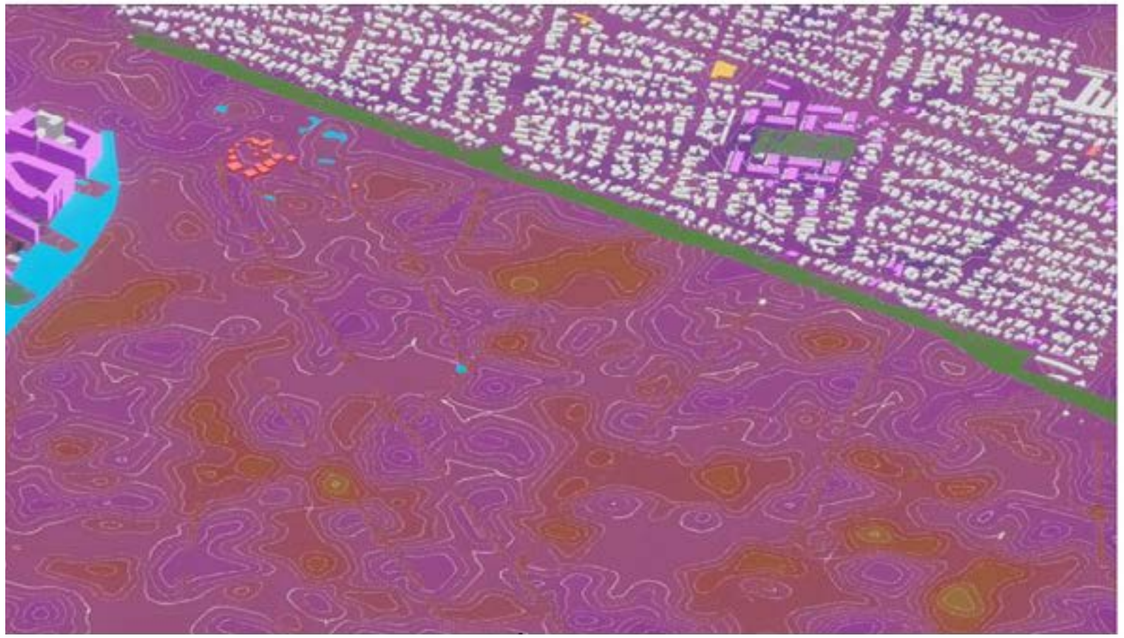
Amager

Tårnby



Simulation For Normal Rainfall

Observed parameters in particle simulation-
Speed
Accumulation
for 10,000 particles across 15,000 time steps



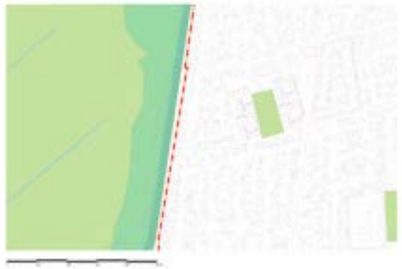
Simulation For Extreme Rainfall

Observed parameters in particle simulation-
Speed
Accumulation
for 100,000 particles across 15,000 time steps

MAKING A POROUS URBAN FABRIC

Identifying the intervention area of required blue green infrastructure

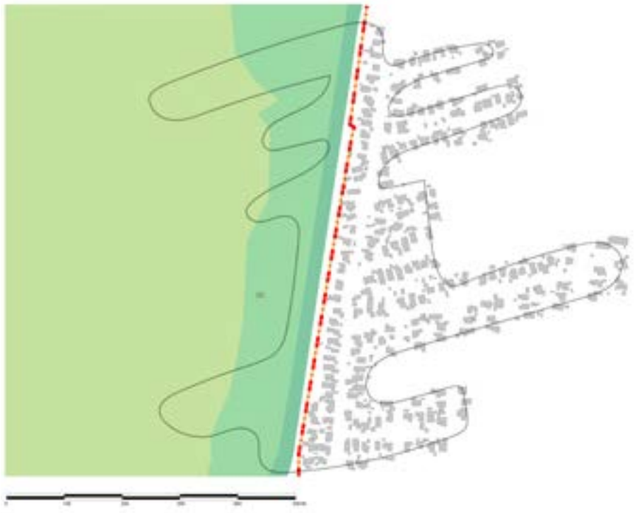
Observing the Fluid flow on a city block and proposing interventions and block redevelopment. Area marked for design intervention may be different to the areas affected by flood.



Tårnby

Identfying flood prone area and mitigation strategies

Area affected by innundation

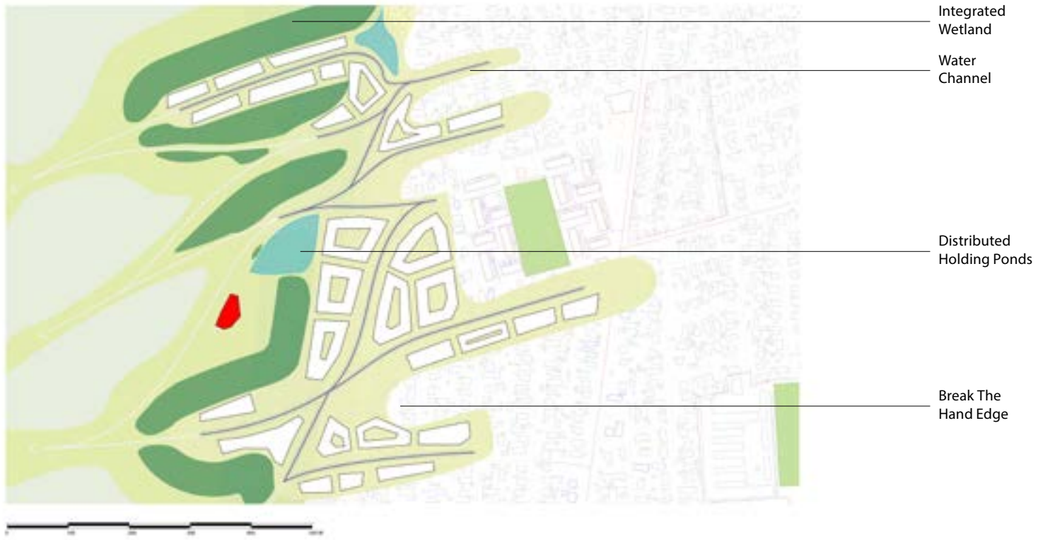


Area marked for re-development to mitigate flooding

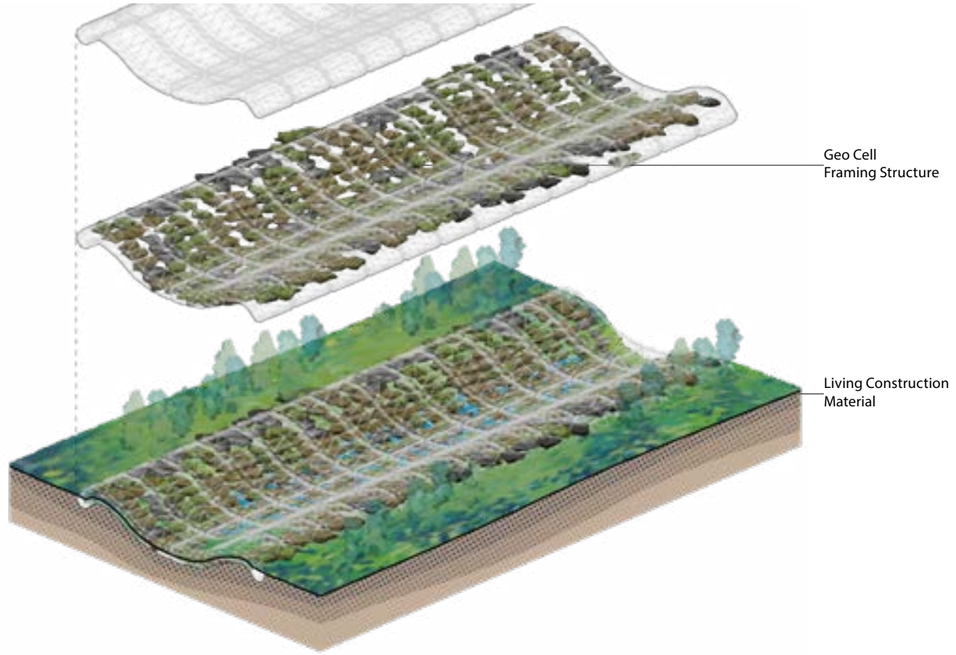
POROUS BUILT FORM

Strategies for the built form

A porous strategy for the built form where modules of tetrahedrons acting as massing volume for frame structure that aggregate together.
The aggregation of simple tetrahedron of load transferring rod results is a space



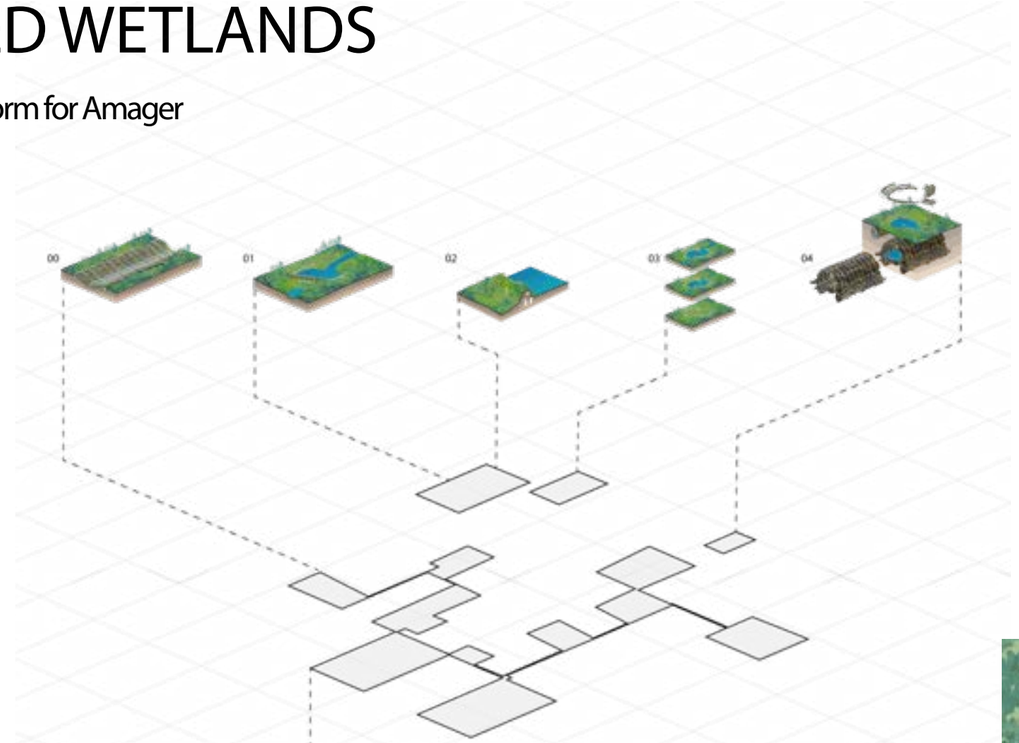
Urban Scale Strategy



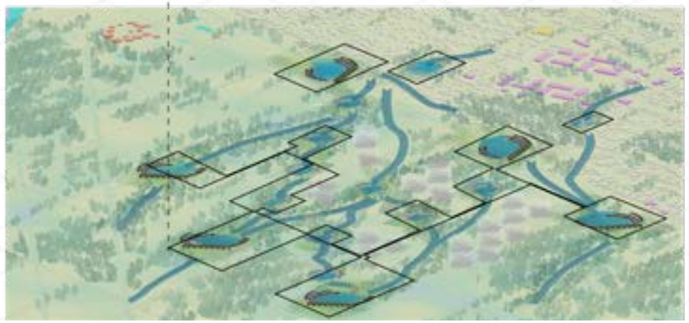
Architectural Scale Strategy

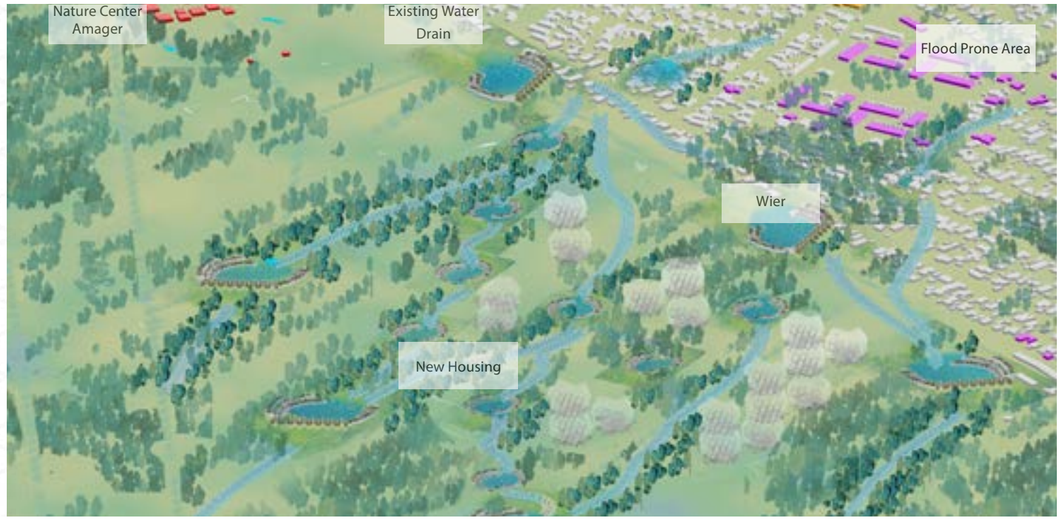
INTEGRATED WETLANDS

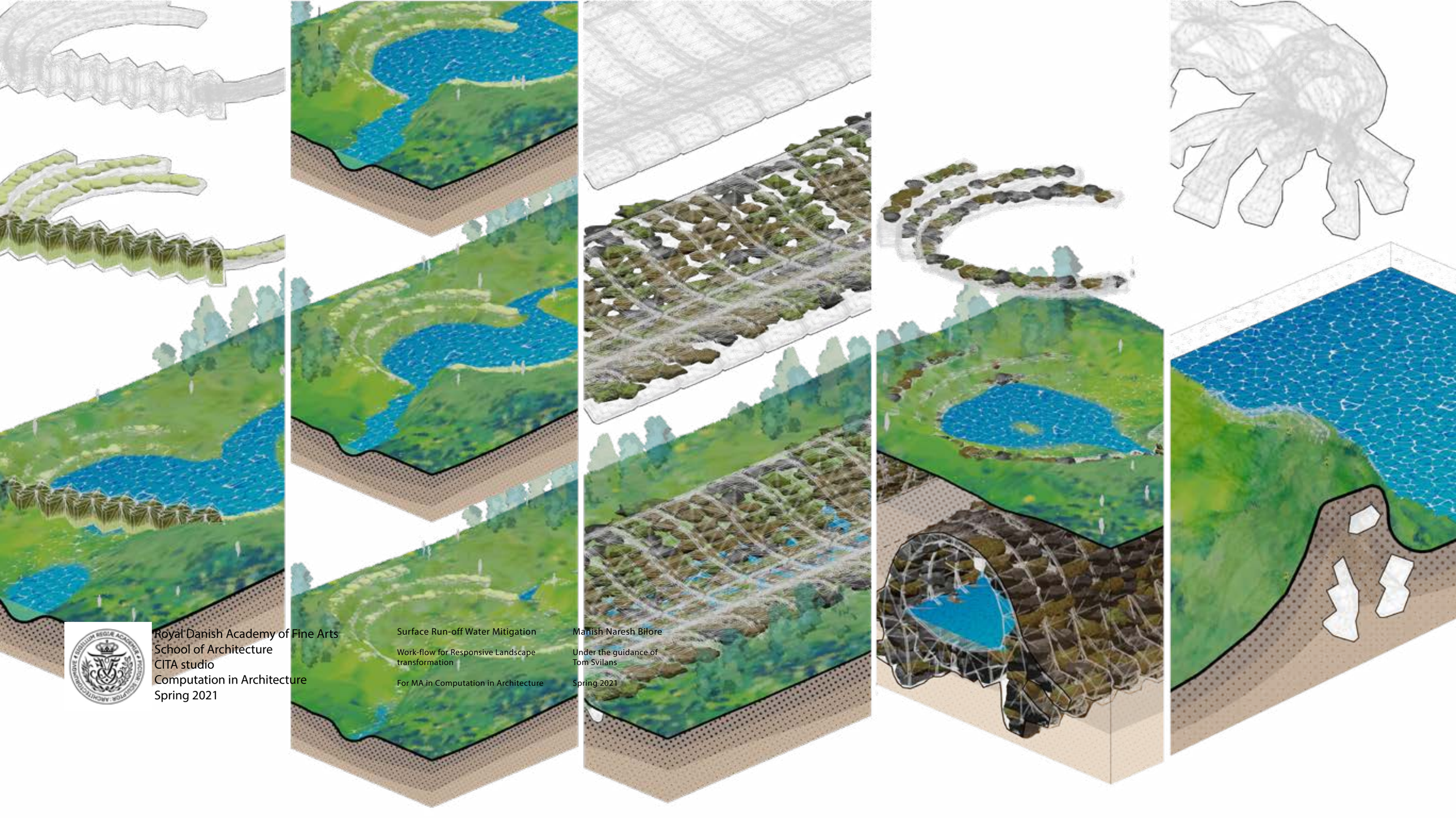
Plan of a Porous Urban Form for Amager



Key Plan Of Tårnby







Surface Run-off Water Mitigation

Work-flow for Responsive Landscape transformation

For MA in Computation in Architecture

Manish Naresh Bilore

Under the guidance of
Tom Svilans

Spring 2021

Royal Danish Academy of Fine Arts
School of Architecture
CITA studio
Computation in Architecture
Spring 2021