DESIGN IN CONTEXT

Selected Academic Works from Columbia GSAPP Between 2020-24

Wei Xiao, M.Arch+M.S.UP 24'

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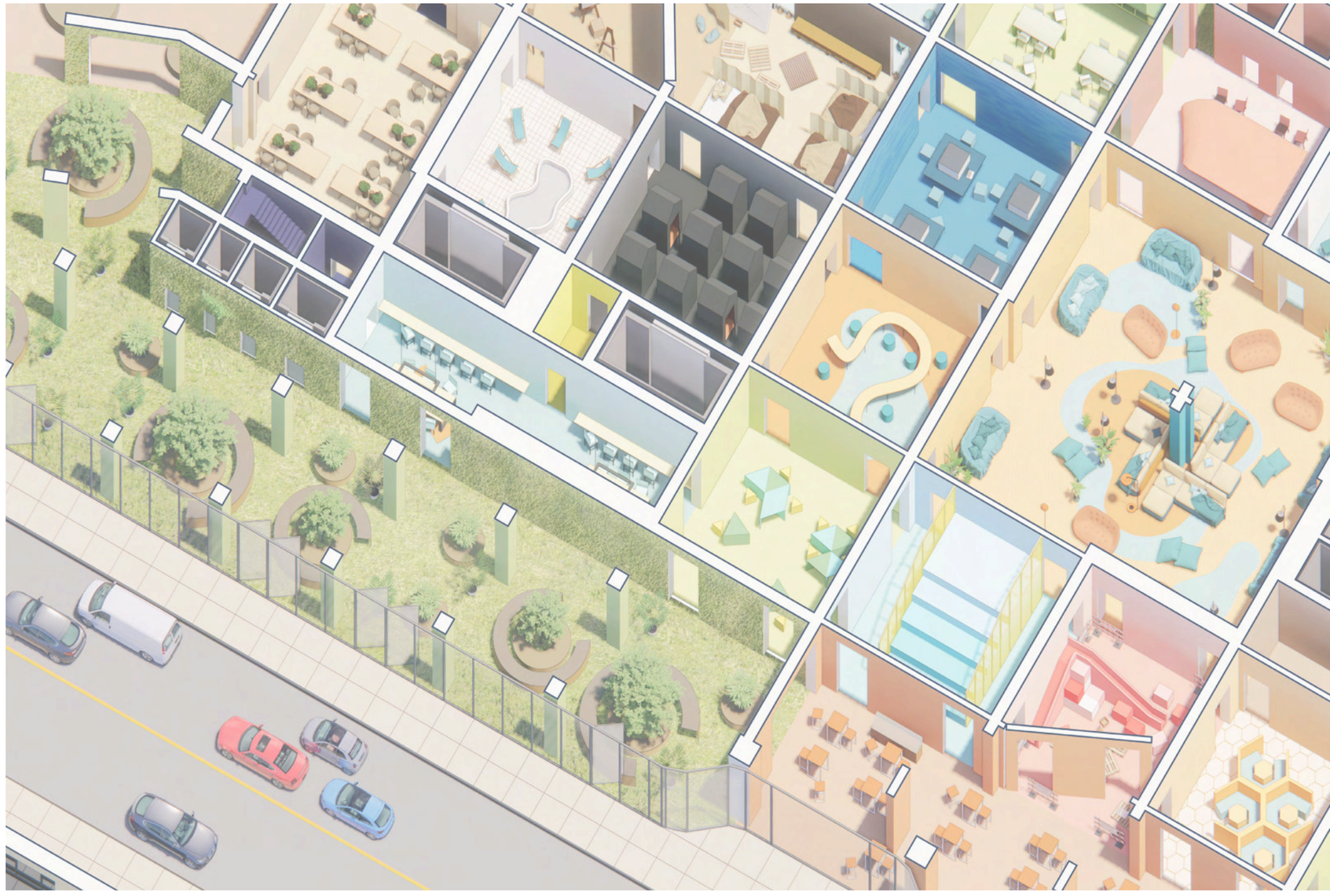
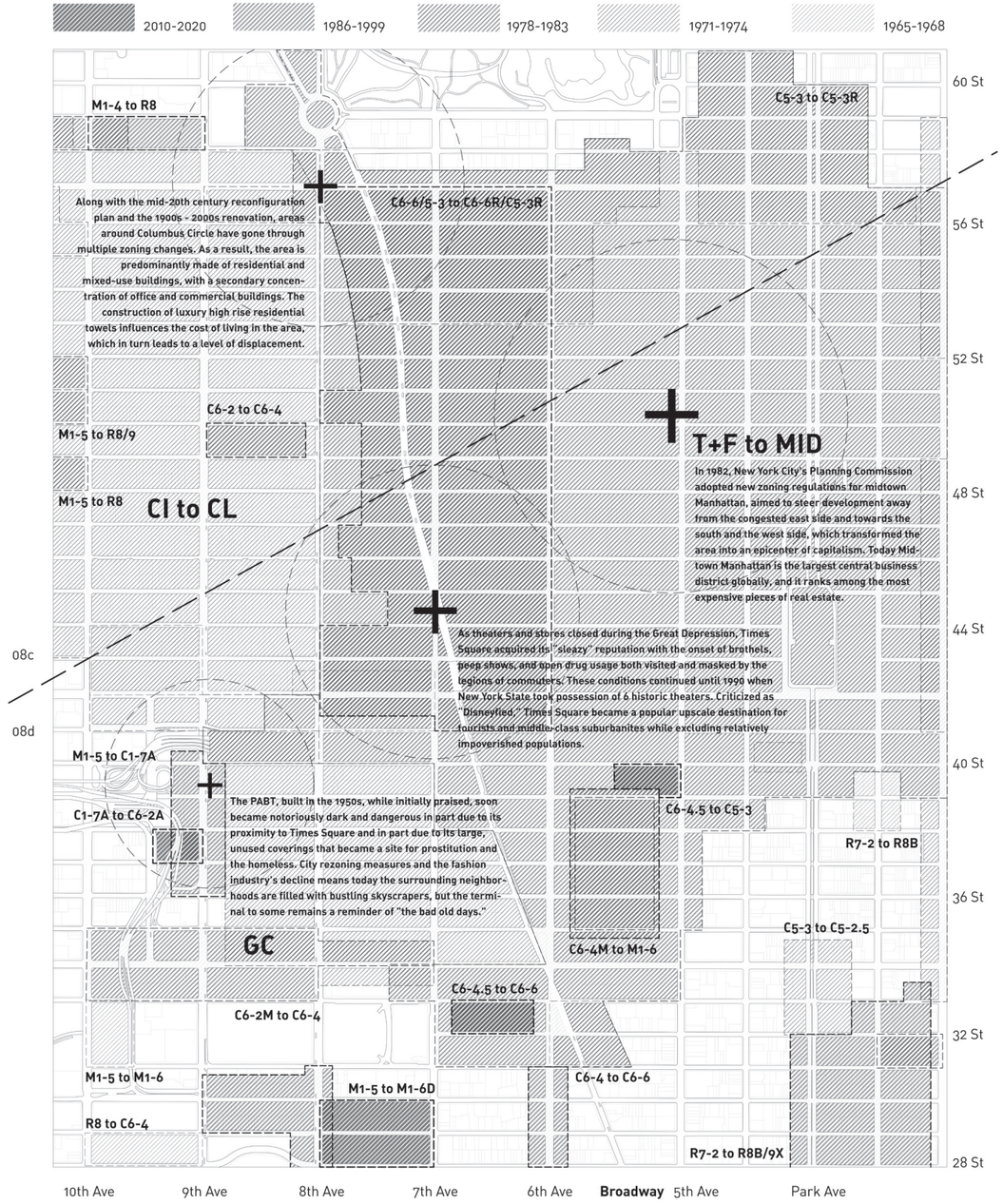
Non-stop Manhattan: Design for Adaptive Reuse in the Ever-evolving New York City

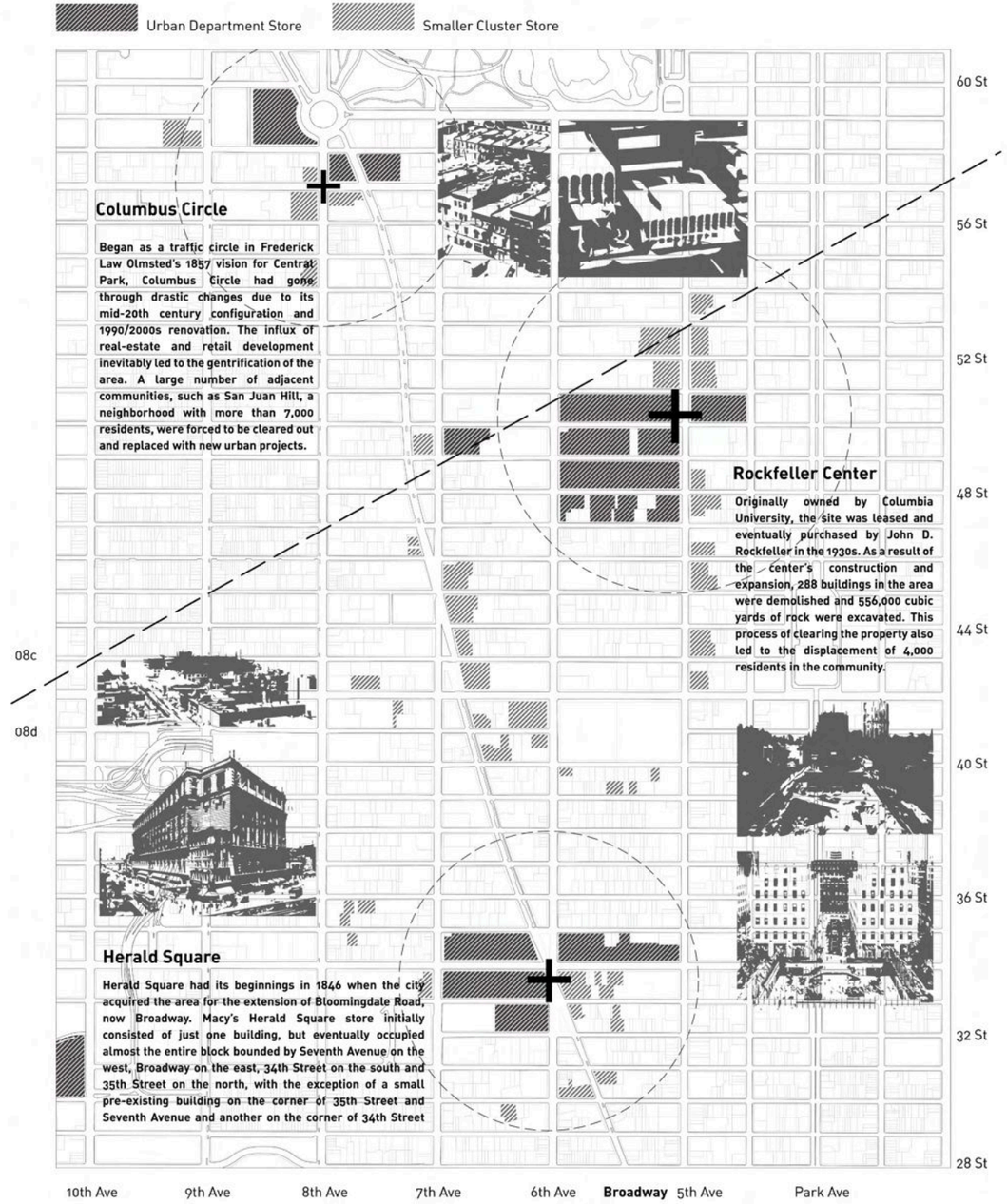


In response to the nature of the ever-evolving urban realm in Manhattan, the project aims to provide a flexible framework to set up stages to reflect and critique those transformations. The immediate proposal resides under the context of pandemic, exploring the increasing blur between the domestic and labor realm, which has fostered workspace towards a less defined framework. The immediate proposal resides under the context of pandemic and how it changes the ways in which people work and live, aming to offer moments of reflection and criticism of the ambiguity and unpredictability of future working spaces.

Fall 2020, Core I Studio
Studio critic: Emmett Zeifman



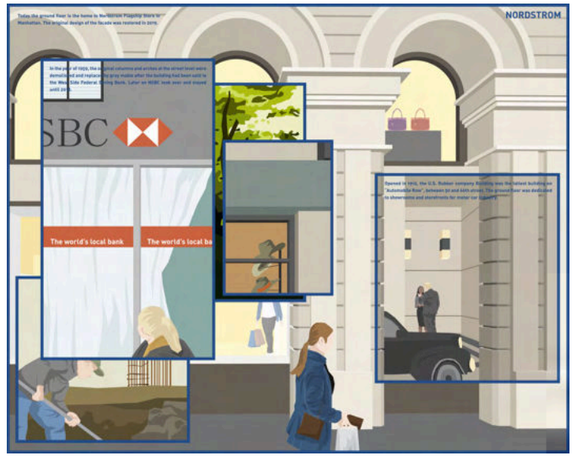
Context Zoning Analysis



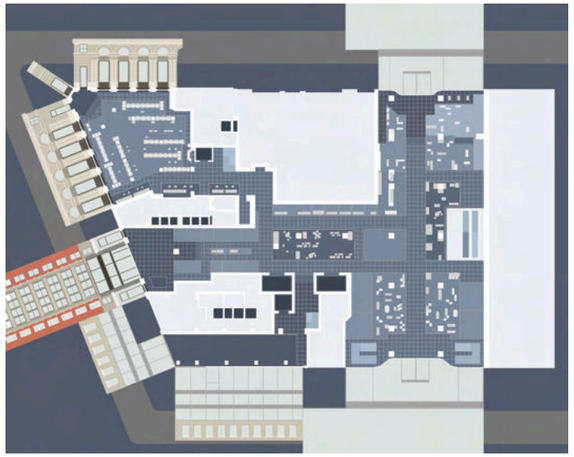
Context Development Analysis

DESIGN APPROACH

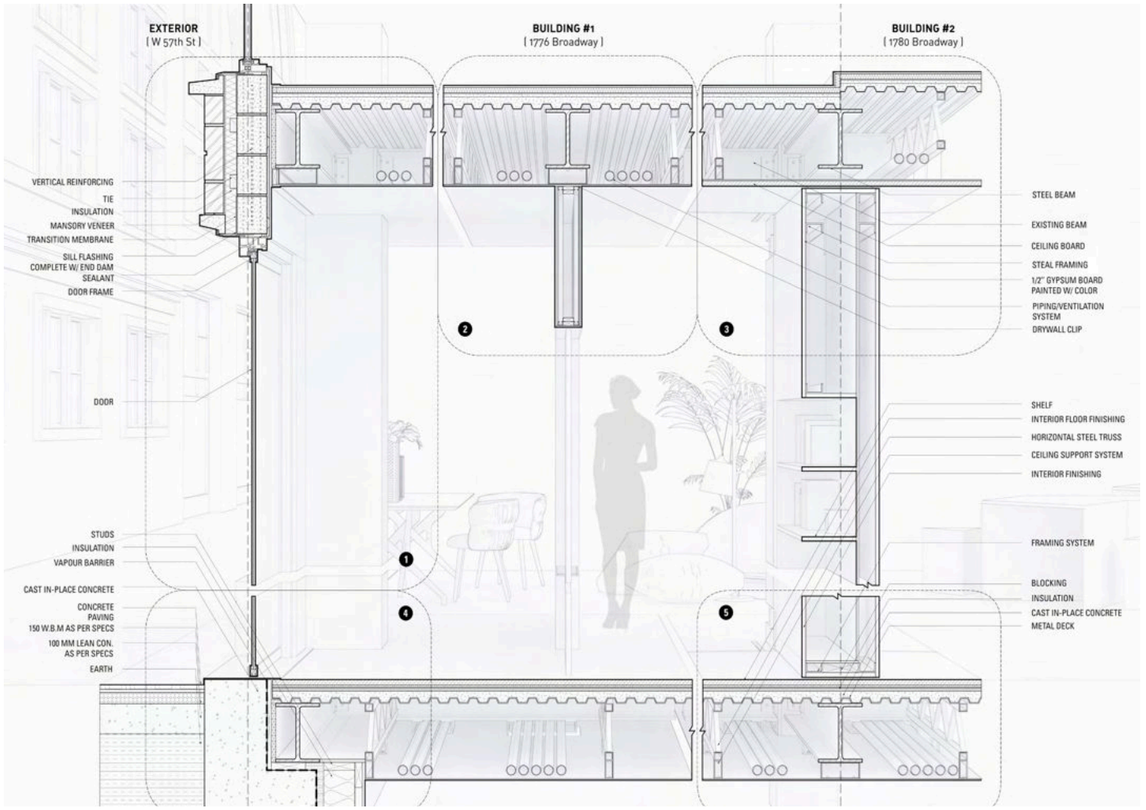
The project takes Nordstrom Flagship Store near Columbus Circle as the investigation site. The interior construction maximize the function of the original building structure and design the operable components according to the dimension of the existing frame. Through a continuous ceiling proposal, the original isolation between each buildings can be eliminated, which allows for a continuous spatial experience throughout.



Site Diagram



Existing Floor Plan

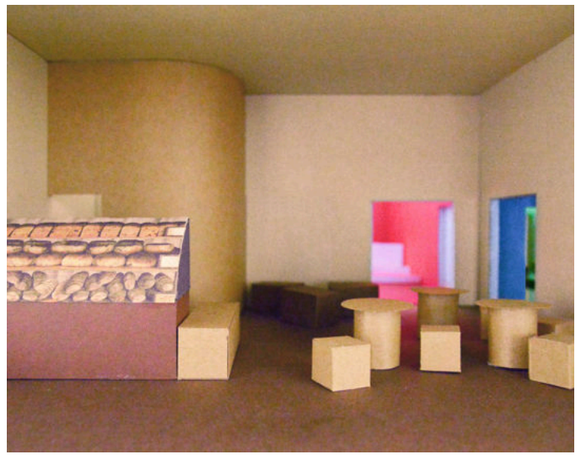


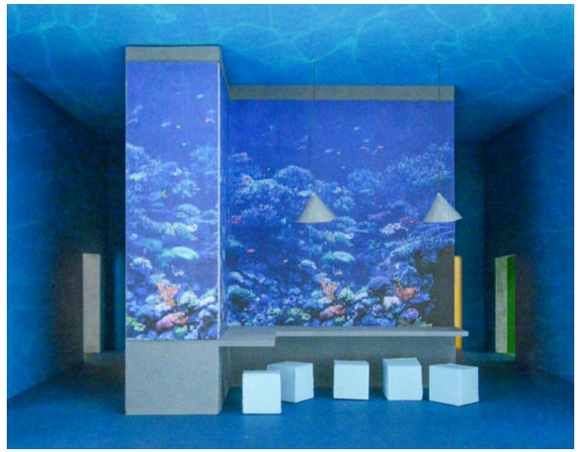
Construction Details

Plan Drawing

Section Drawing

The immediate proposal resides under the context of pandemic and how it changes the ways in which people work and live. The pandemic has fostered the definition of workspace towards a less defined framework – the current forms of labor breaks the physical boundary of the office space, instead, dedicated by the potential of the multiple environments that can be found and utilized.





(Above) Interior Physical Model

(Left): 1:1 Coonstruction Model

As a response, the design proposal consists of a field of distinctive rooms with collections of daily working and living environments. By creating this continuous but various range of conditions with their limitations, the collection together aims to offer moments of reflection and criticism of the ambiguity and unpredictability of future working spaces.

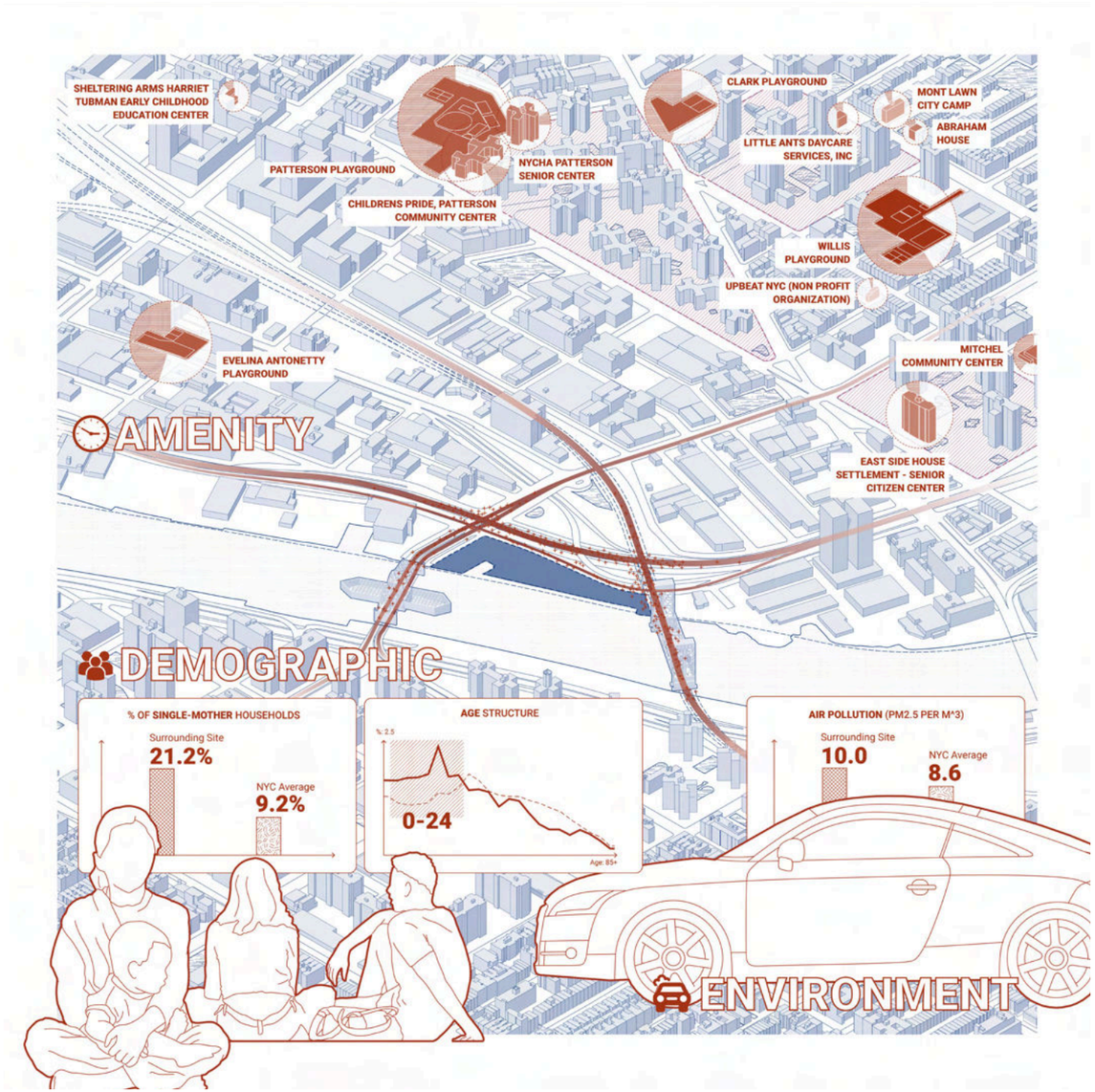
The Collective: Housing Complex in Mott Haven, New York

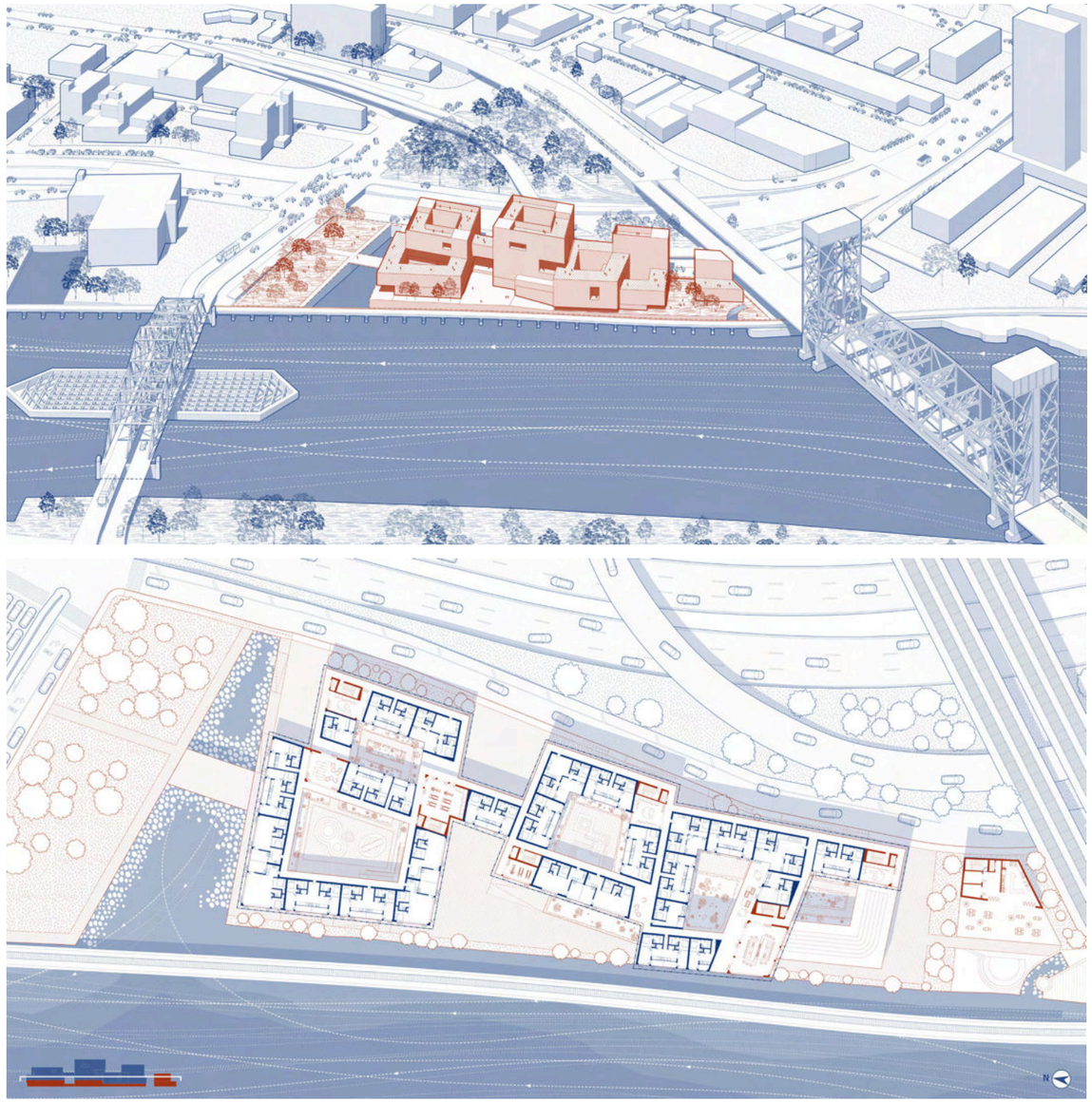
In response to the environmental and social challenges resulting from the close adjacency to transportation infrastructure, the high concentration of single-family households and the younger generation, as well as the lack of shared neighborhood amenities surrounding the site, the project proposes collective housing as a solution to enhance community connection and maximizing housing affordability under a protected urban environment. Through an interconnected courtyard system that embraces multiple scales of shared programs, the housing complex provides a layering of controlled collectiveness for residents. On and towards your way home, "housing" is constructed from both the social interactions that can happen among residents themselves and the autonomy to stay in privacy if preferred.

Fall 2022, Core 3 Studio
Studio critic: Mimi Hoang
In collaboration with: Yingxi Dong (M.Arch 24')

DESIGN APPROACH

The idea of protection and degrees of controlled collectiveness drives how the buildings respond to the site and the adjacent urban context, the design of the unit, and how they are arranged across floors and buildings. From the unit scale, there are three types of units designed, including single studio, one-bedroom, and two-bedroom units. They are arranged around the courtyards through an interconnected corridor system.

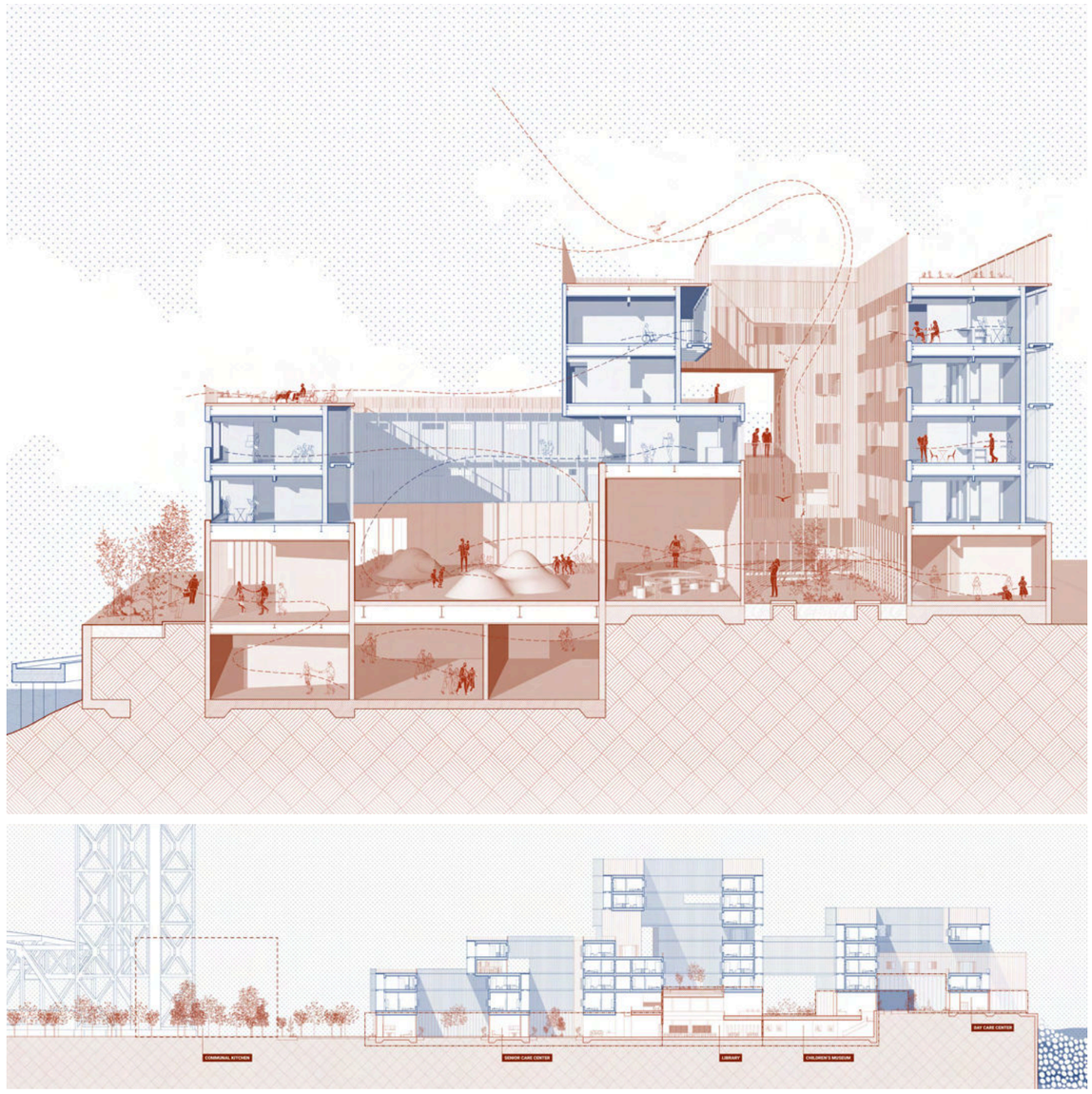




(Left) Site Analysis

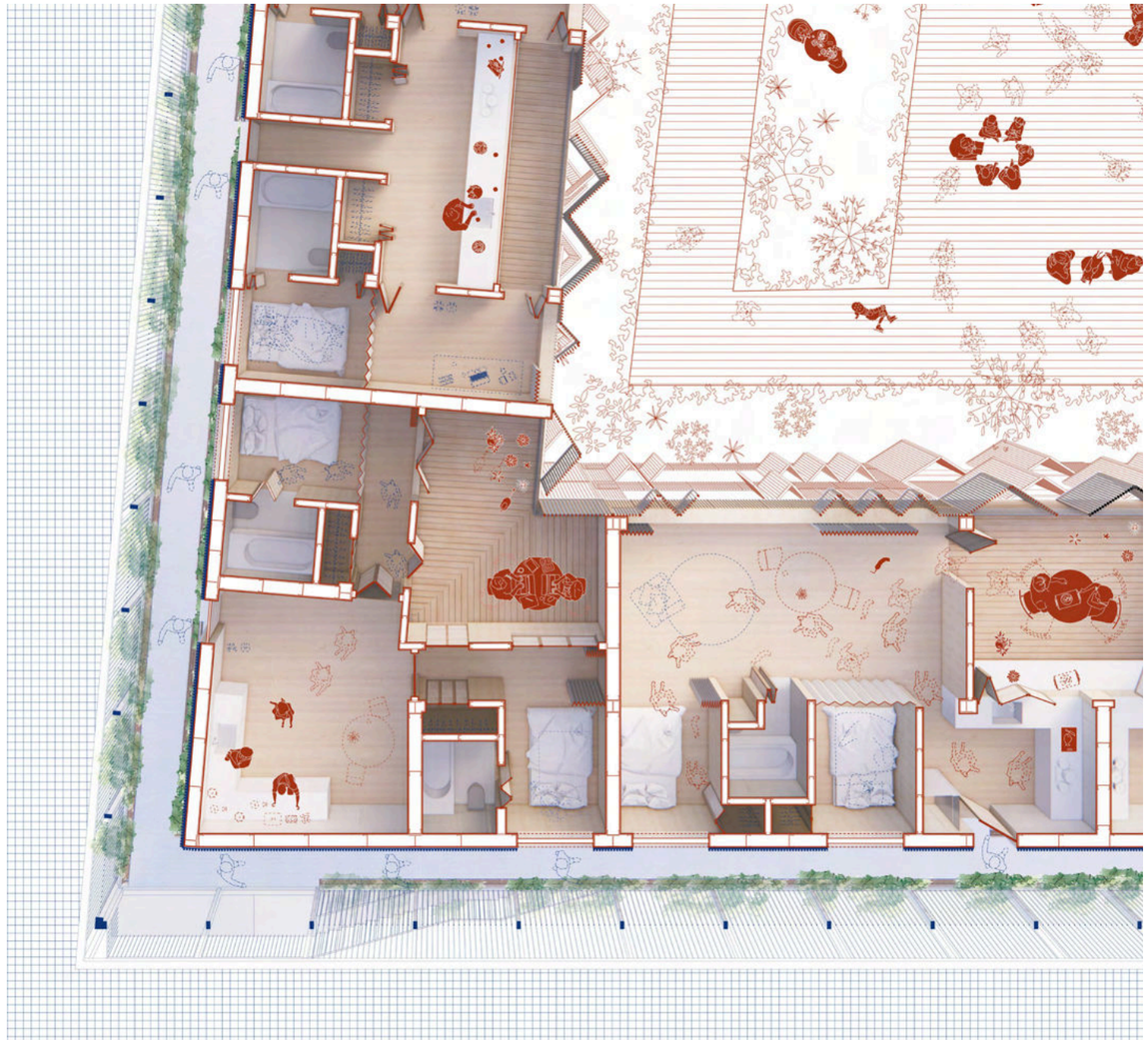
(Above) Site Bird's-eye View

(Below) Typical Floor Plan



(Above) Perspective Section

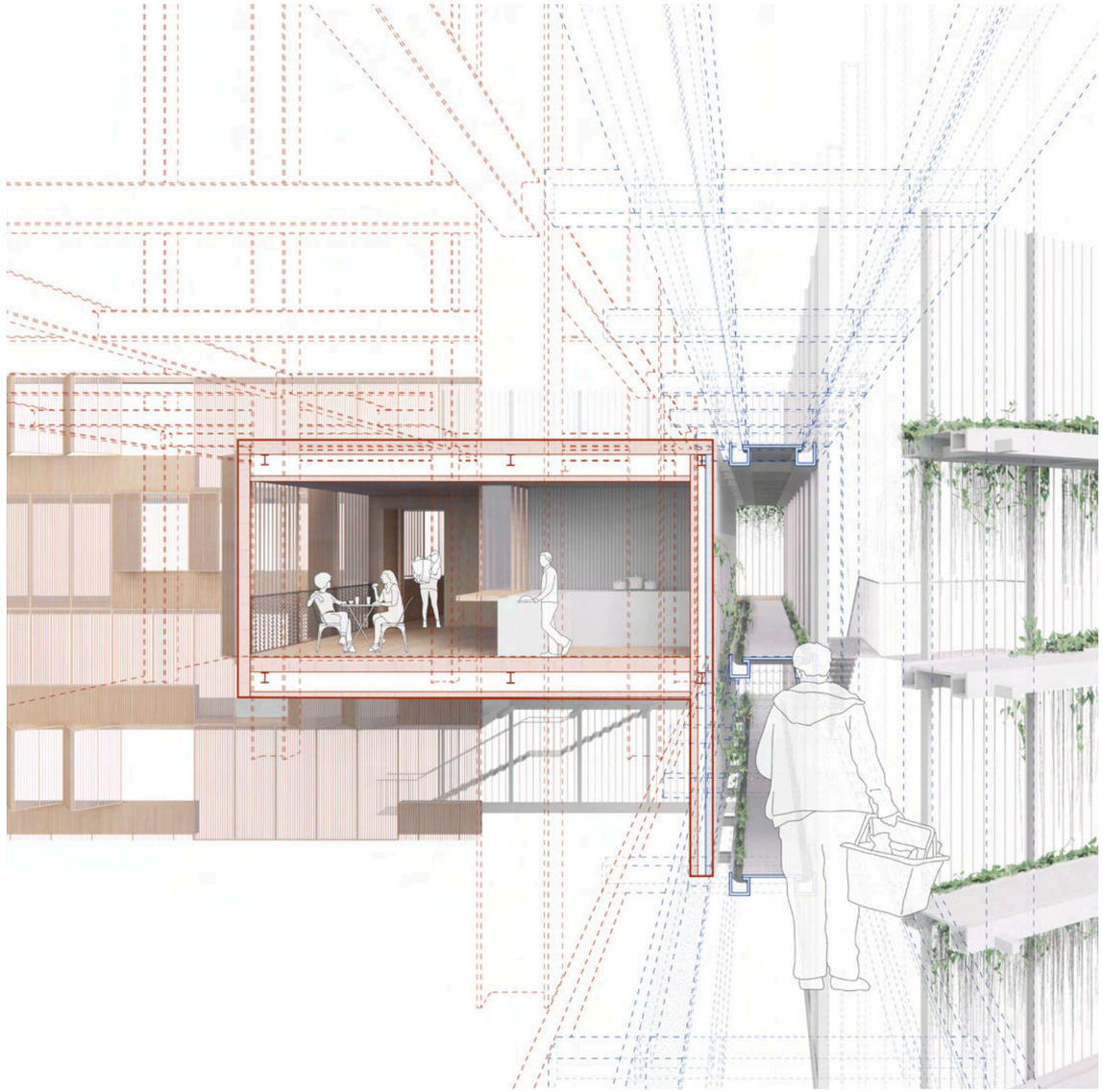
(Below) Long Cross Section



Plan Perespective

DESIGN FOR THE COLLECTIVE

Each unit type has a shared component with its neighbor, ranging from a shared balcony, a shared kitchen, and a shared living room. Units with a more compact private space would have a larger shared program. With operable elements such as windows and doors, the residents can control the degrees of sharing they prefer, whether packed the units more for individual dwelling experiences or open up for more collective activities at larger scales.



(Above) Material Collage

(Left) Exterior Perspective

(Above) Model Collection

(Right) Section Model

Sitting on top of the concrete foundation, buildings are constructed in steel and CLT structure with extended green corridors attached, working as a green living zone that filters air and provides degrees of shading for the residents. The various degrees of material porosity and massing opening shape the interwoven collective housing experiences for the residents. From exterior to interior, it transits from a more industrial-felt exterior corridor to a more welcomed, warm-tone living sense.

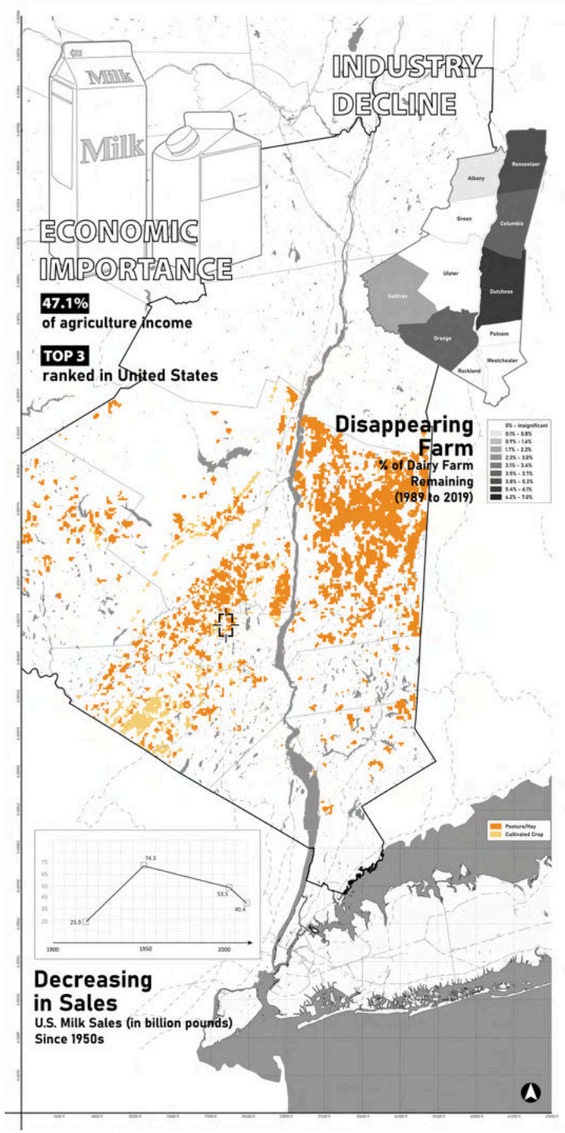
Milk Hub 2.0: Fostering Sustainable Industry Transaction and Community Development

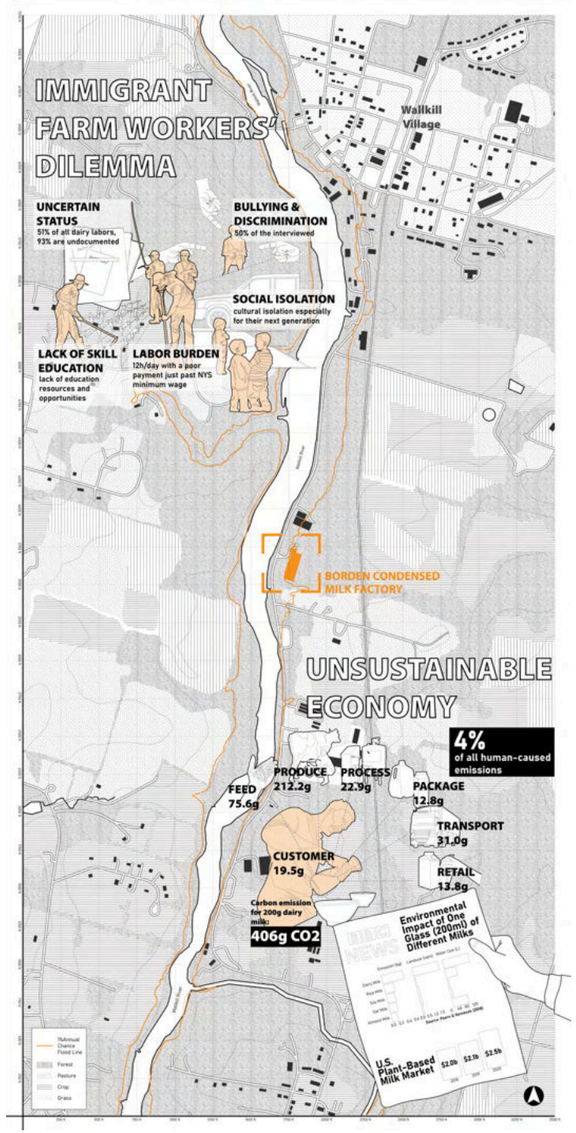
As the dairy industry in the Hudson Valley region is declining, we are now confronted with an economic crisis, labor unemployment and related social issues, as well as abandoned buildings and infrastructures. As a response, our proposal takes the abandoned Borden Dairy factory as the stranded asset, aiming to provide an alternative prototype to the current dairy milk industry, fostering the production transaction for a sustainable economy and an inclusive community.

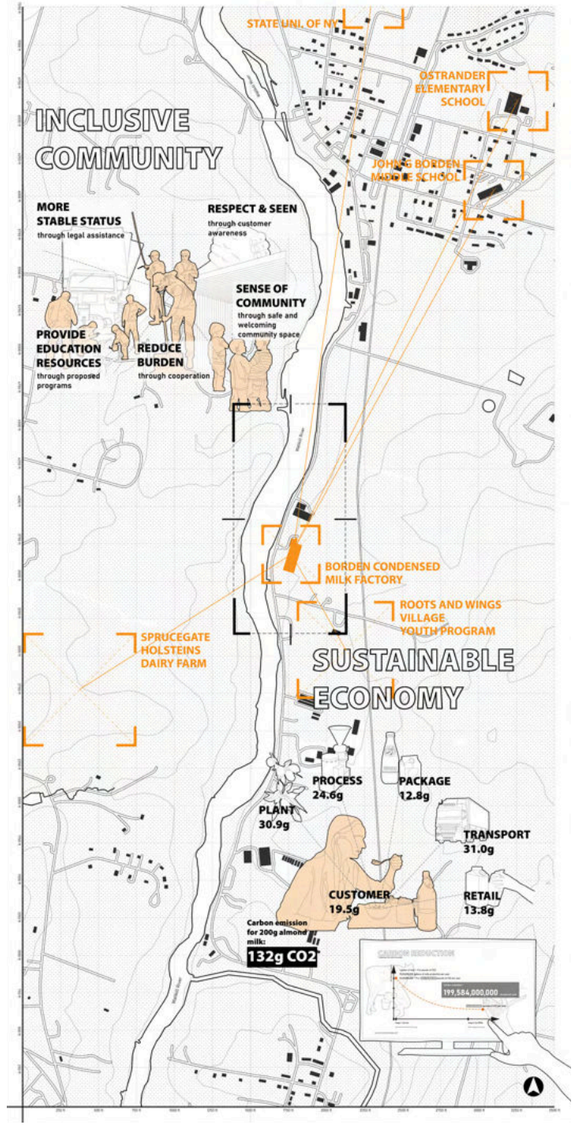
Spring 2022, ADV IV Studio
Studio critic: Pedro Rivera Monteiro, Ubaldo Escalante
In collaboration with: Ruonan Du (M.Arch 23')

DESIGN FOR INDUSTRY

Dairy farming holds great economic importance to the Upstate New York region. However, there has been a steady decline in the dairy industry since the 1950s, featured by the drop in milk sales and the number of farms remaining. This project envisions an industry transformation from conventional dairy to plant-based farming. This transition not only helps elevate the competitiveness of milk farming in Hudson Valley but also reduces a significant amount of carbon emissions.





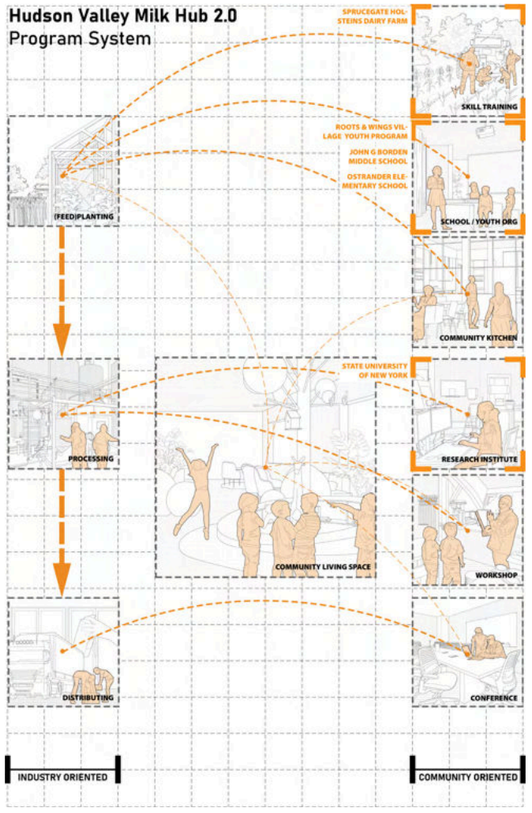


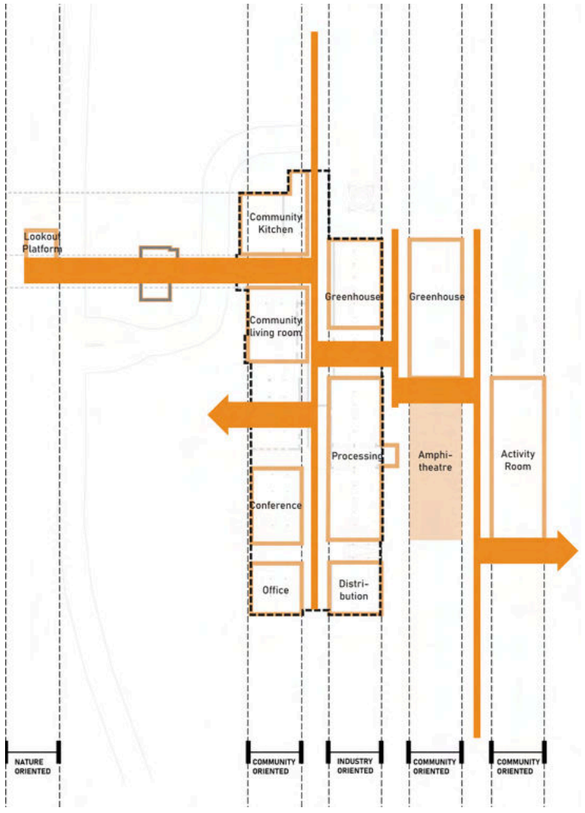
Site/Context Analysis

In addition, as an essential group within the broadly defined socially disadvantaged workers in the agriculture industry, immigrant farmworkers face various challenges to improve or even maintain their quality of life. We have identified five main issues throughout our research and proposed corresponding strategies.

DESIGN FOR NETWORK

The existing resources around the site provide opportunities to form a regional network of programs that can support the industry transition and serve the immigrant farm worker population/communities. The program consists of two intertwined threads for both the industry and the community.

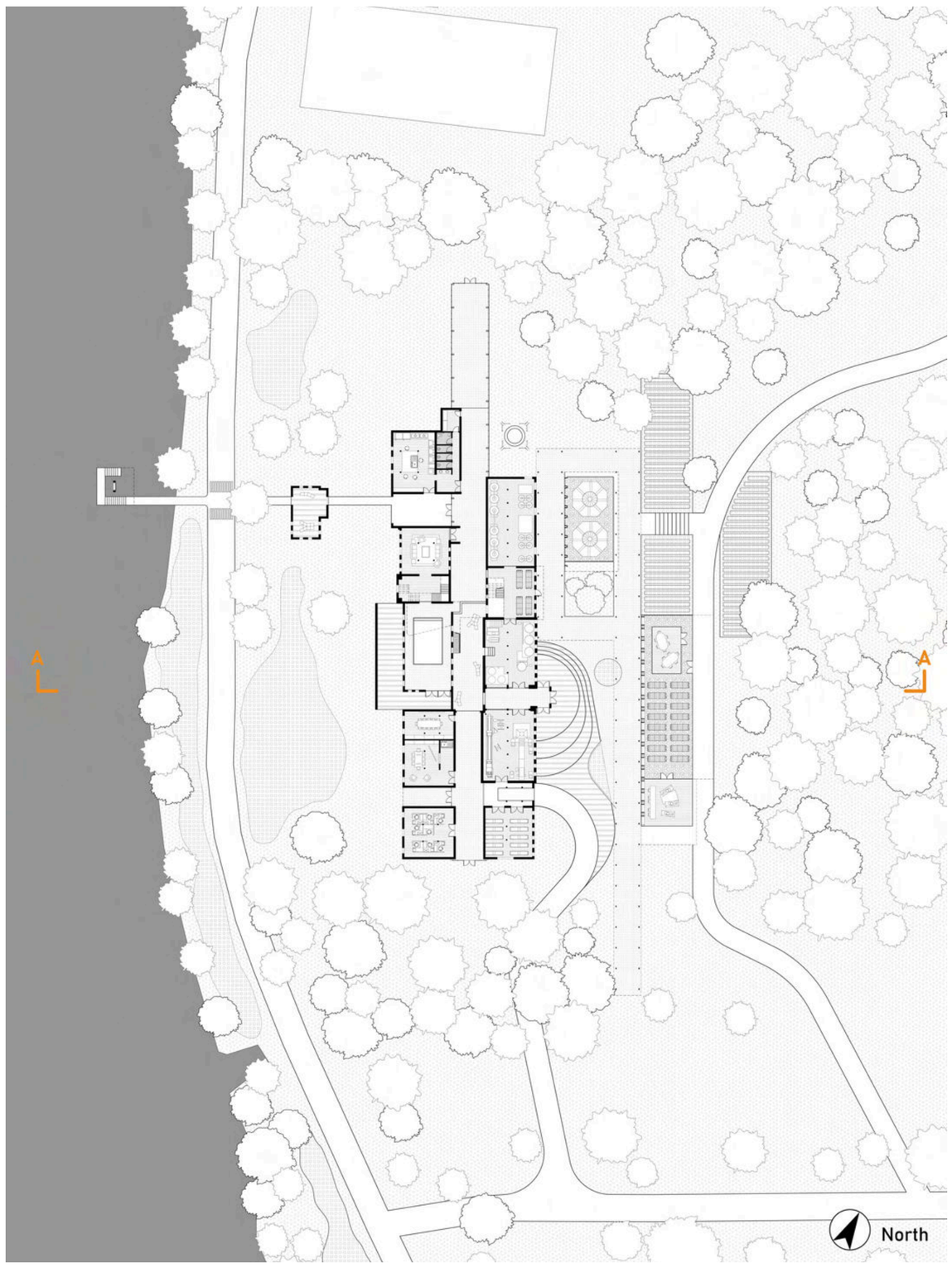


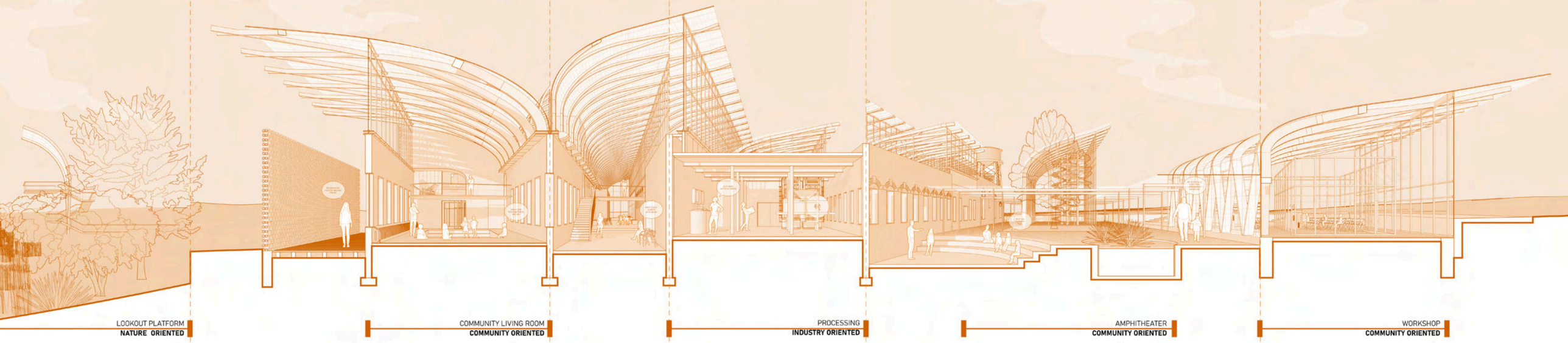


Program Diagram

(Above) Layout Diagram

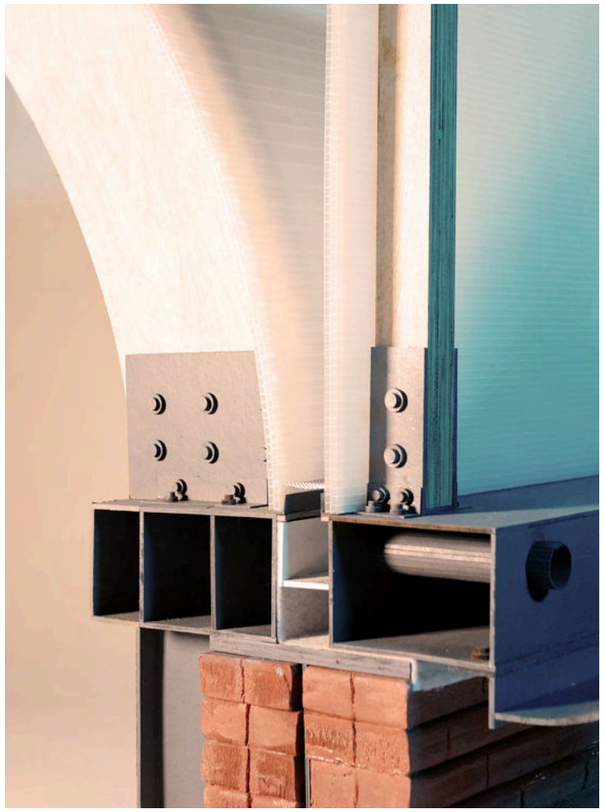
(Right) Project Plan





Perspective Section A-A

Alleway Rendering



Detail Model

Physical Model

DESIGN TO ADAPT

As a result, the newly proposed renovation utilizes the existing structure, including its parallel allies, to weave the community and industry into an inseparable system. The building, once witnessed the flourishing and declining of dairy farming across the region, will step up again to promote a more cohesive community network and sustainable milking practices.

Eco-Winery +: Repositioning Industry to Biodiversity and Beyond

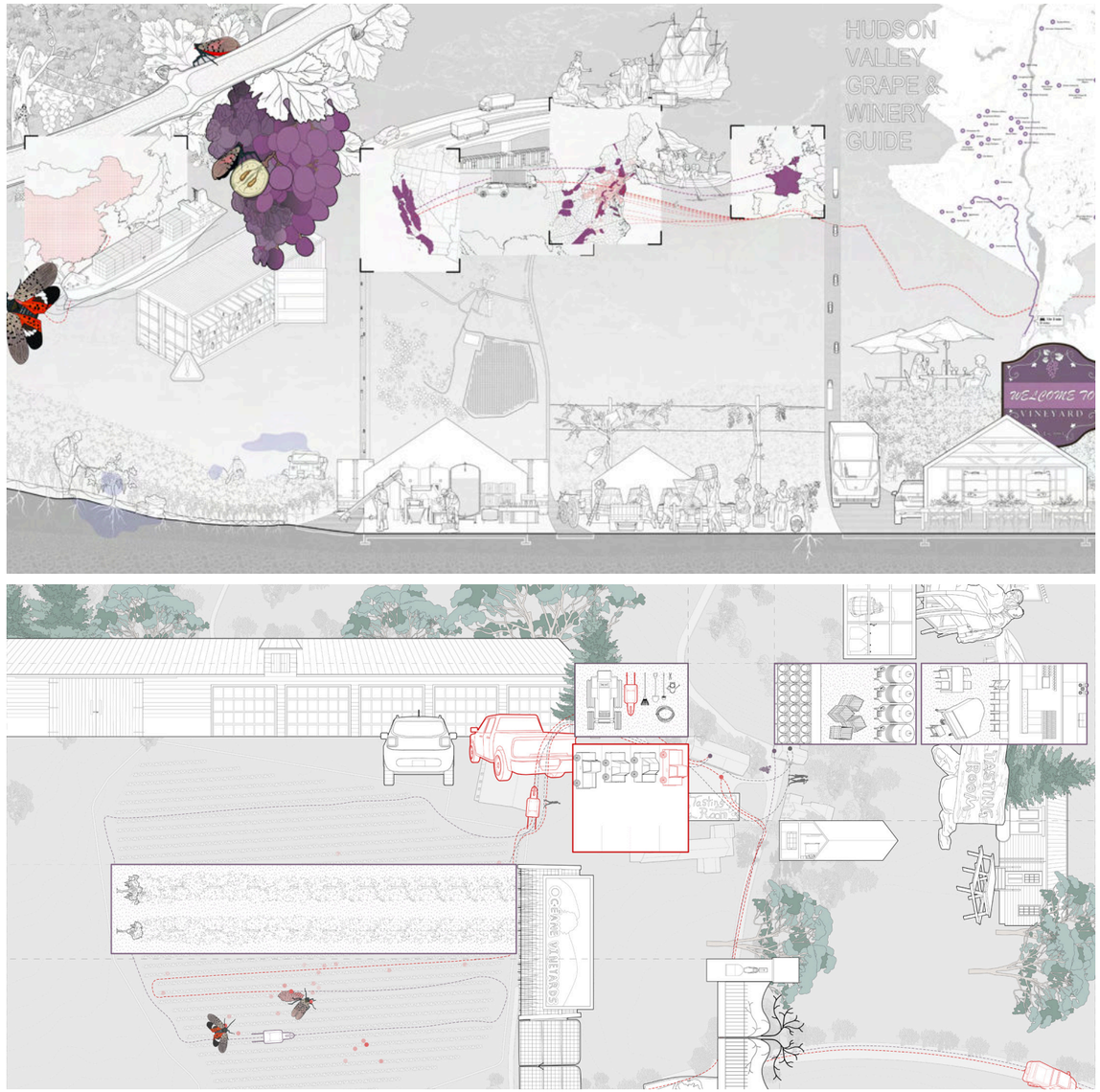
The global industrialization of trade has facilitated the movement of goods and people across the world at an unprecedented scale, leading to the inadvertent spread of invasive species to new habitats. Unfortunately, this has also become a growing concern for wineries, as their monoculture practices make them highly vulnerable to the adverse effects of invasive species. Our project aims to mitigate this risk by using biodiversity as a design tool to promote natural balance between different species. By implementing inter-cropping techniques, the design aims to diversify production patterns and achieve consistent economic outcomes throughout the year while also aligning with the farm-to-table movement by promoting sustainable agricultural practices that prioritize the health of the environment and consumers.

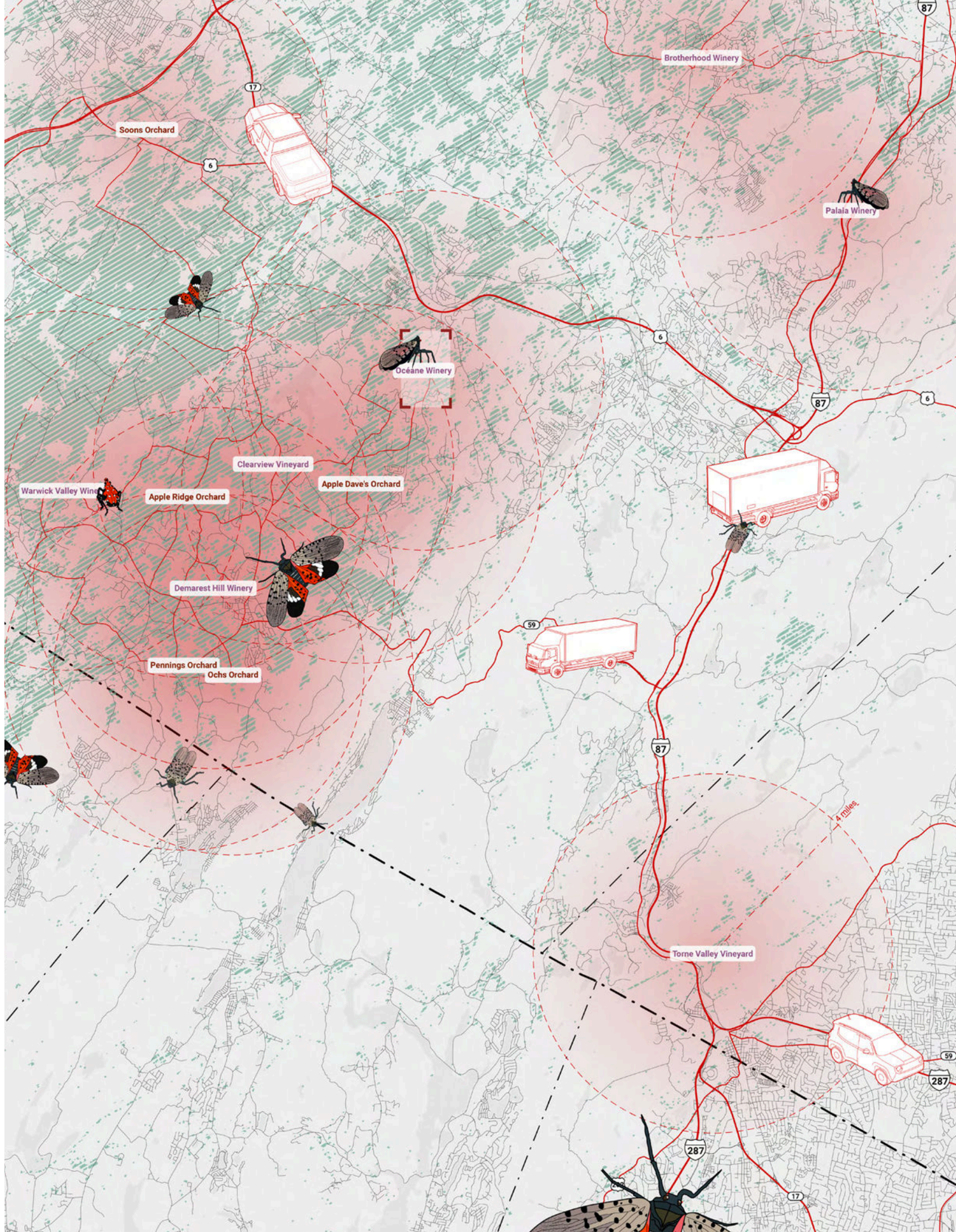
Spring 2023, ADV IV Studio
Studio critic: Feifei Zhou
In collaboration with: Yingxi Dong (M.Arch 24')

DESIGN FOR INDUSTRY

As with the many other typical vineyards that one can find around the globe, the existing winery model in Hudson Valley is not without problems. Along with the invasive spotted lanternfly, increasing human mobility further increases the vulnerability of those places with monoculture production patterns. Aside from the regional pressure, internal concerns also arose from the issue of seasonality and the related issue of product singularity.

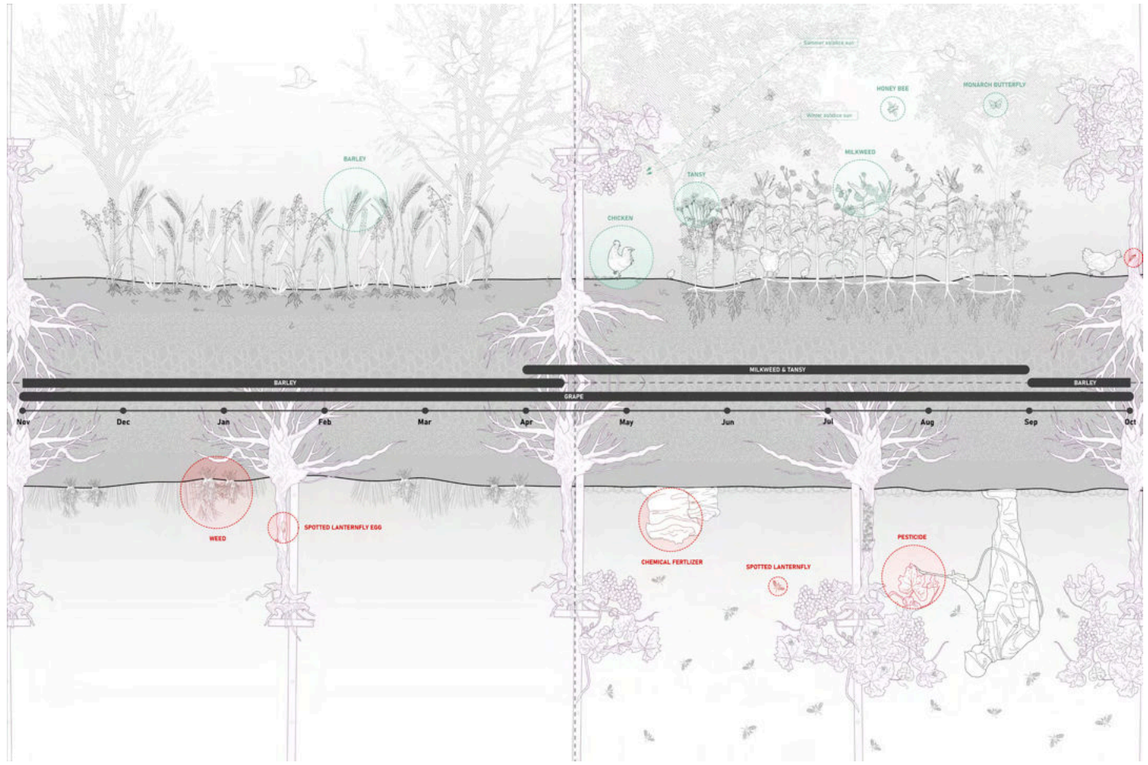
Context and Site Analysis



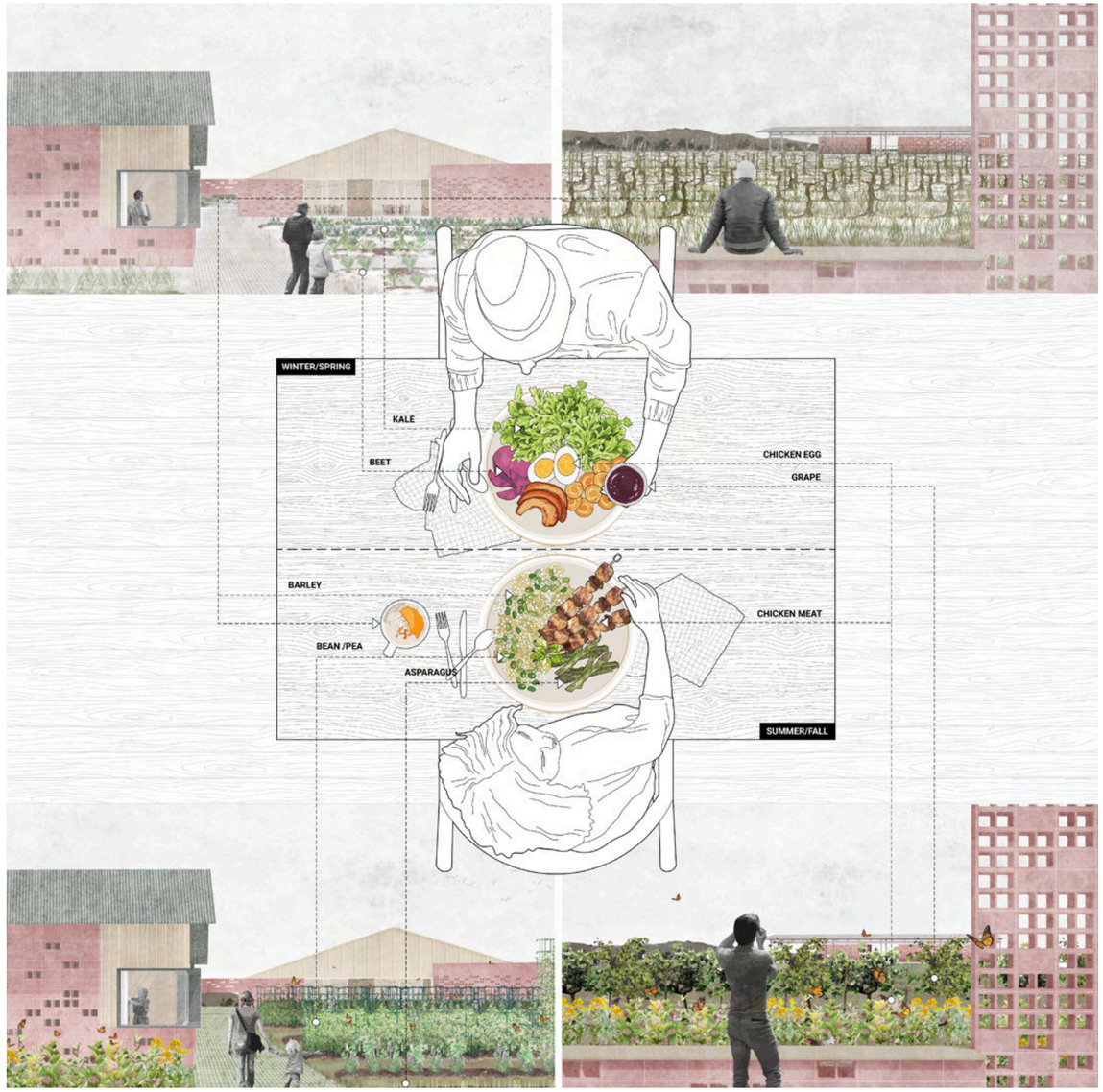


DESIGN FOR BIODIVERSITY

In the design intervention, by implementing inter-cropping techniques , biodiversity as a driven design tool allows us to re-evaluate the potential natural balances between various species while simultaneously diversifying the production patterns for greater and more consistent economic outcomes throughout all year-round seasons while aligns with the farm-to-table movement.



Field Analysis



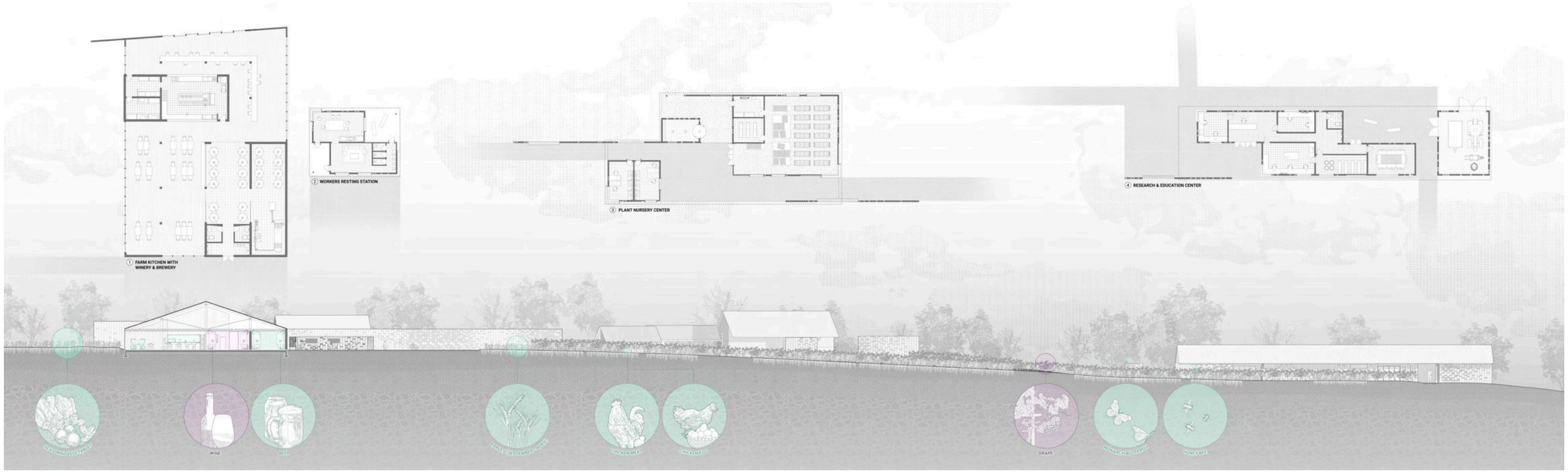
Seasonal Analysis

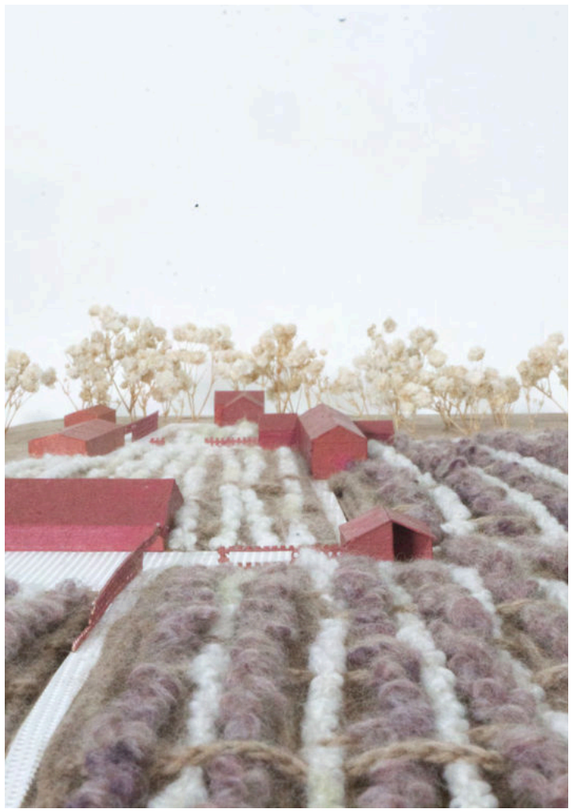
DESIGN FOR INTERGATION

At a building scale, besides maintaining the existing buildings on site to reorganize the farm programs, five more structures are introduced to the site with new programs. The buildings are integrated with previous circulation paths across the growing fields, generating a more intimate relationship between consumption and production, between users and the environment.

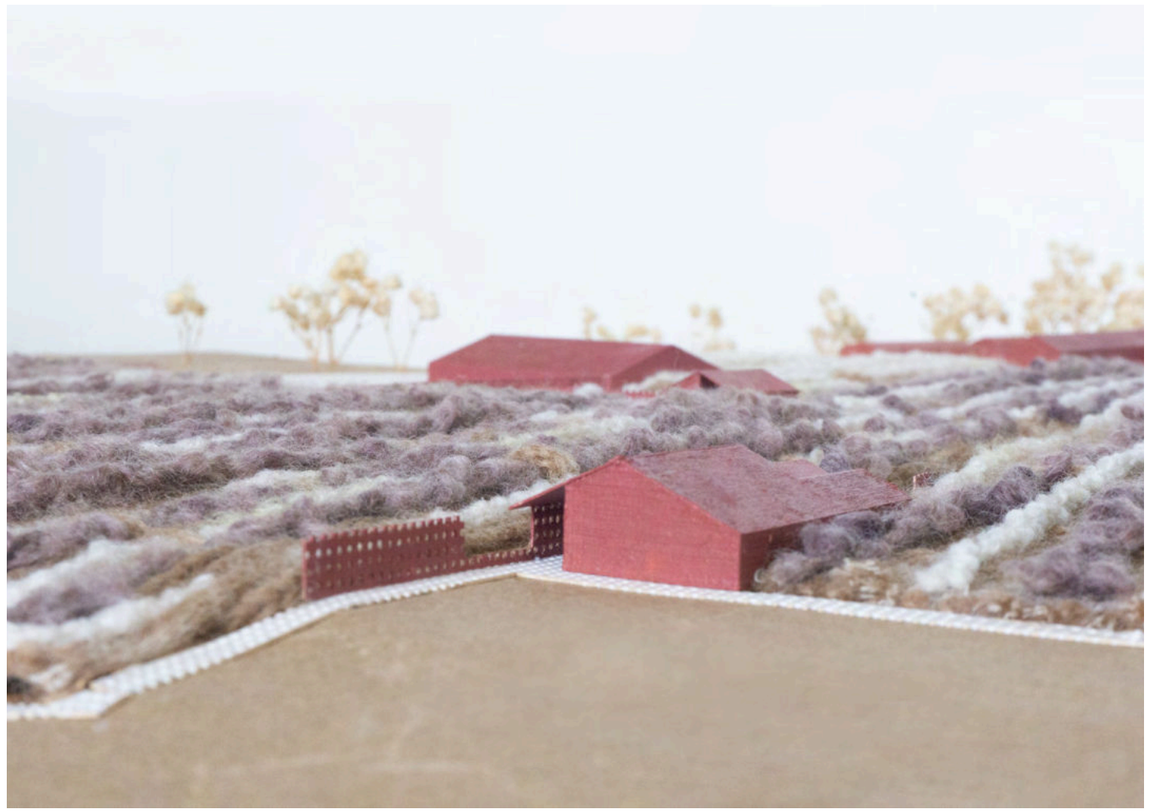
(Above) Seasonal Axonometric View

(Right) Site Section





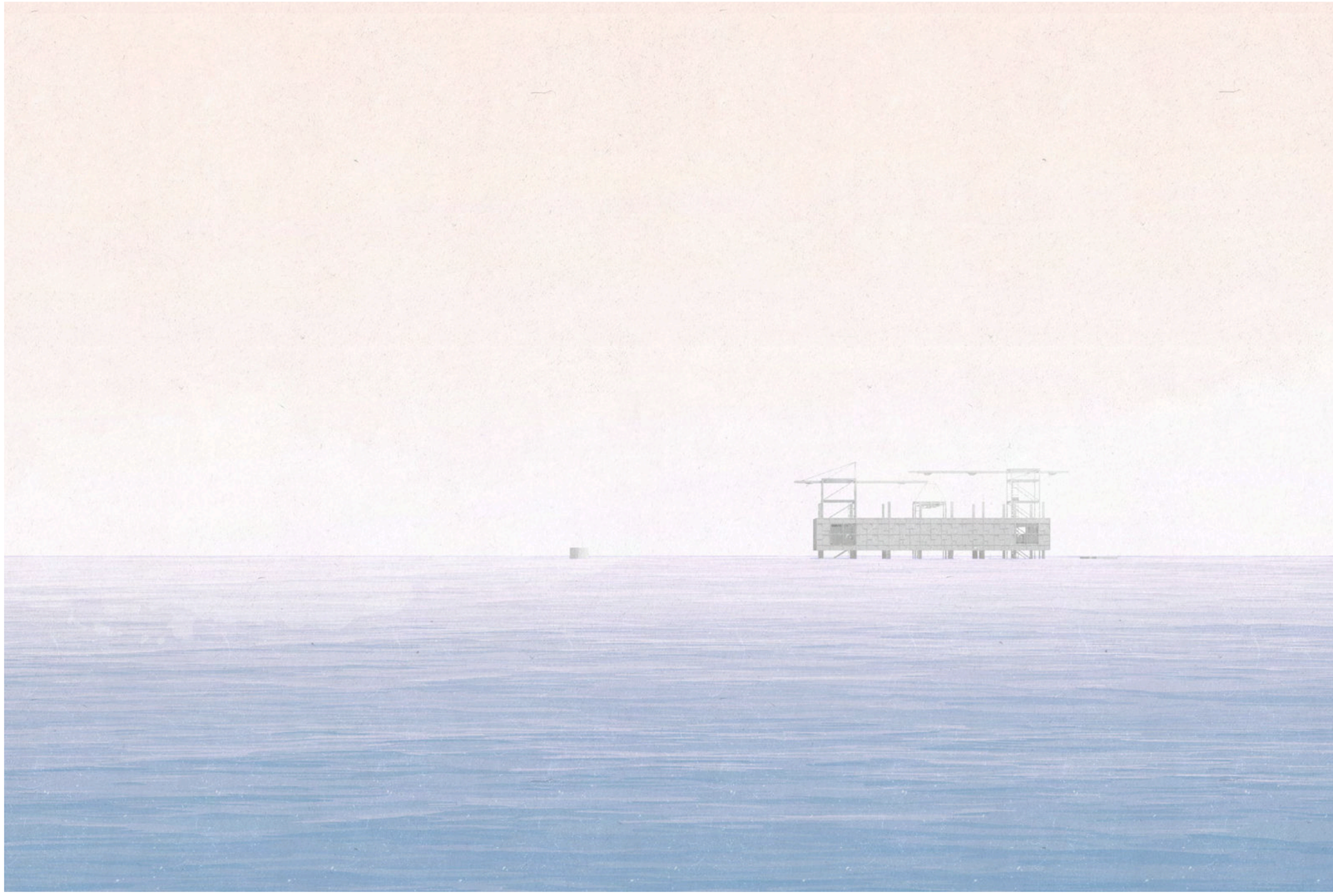
Physical Model



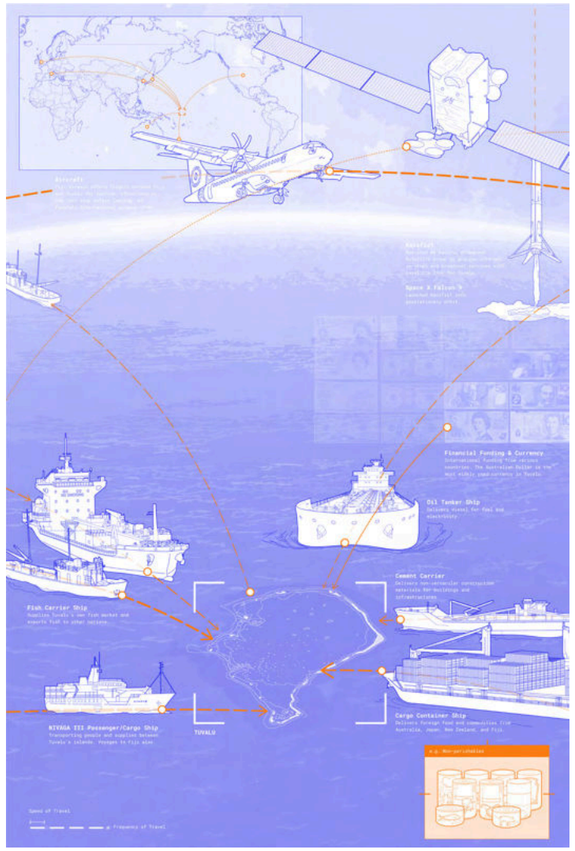
From a material perspective, rammed earth masonry blocks are introduced along with the existing wood and metal panel construction technique. The porosity of such material creates both visual/light connections across the landscape and rooms for species like insects to inhabit.

Land in Cans: Pacific Flavors of Adaptation and Resilience

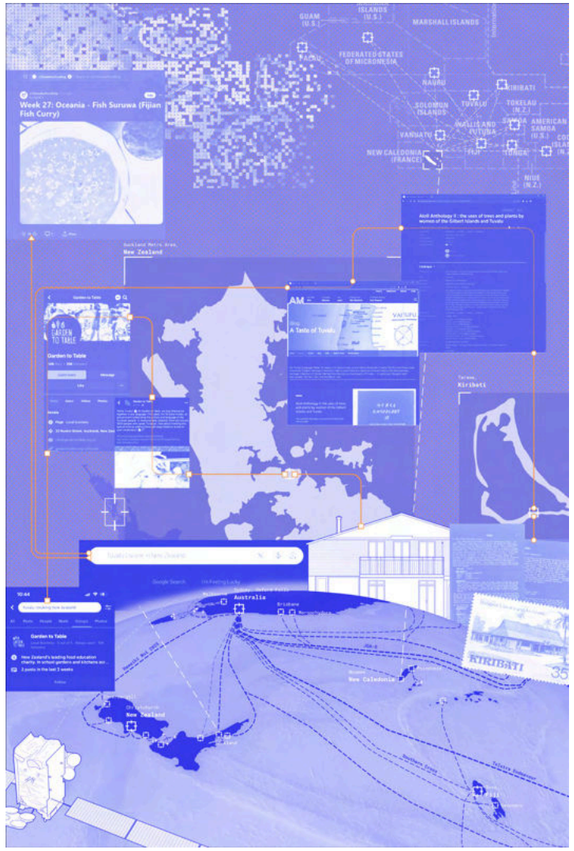
The global temperature continues to increase and cause further sea level rise in the years to come. By 2050, all territories of Tuvalu will be submerged. With the urgent need to maintain national identity and statehood, the government of Tuvalu has collaborated with the Land in Cans Co-Op to establish a pilgrimage to the homeland as well as the production and worldwide distribution of Instant Tuvuluan cuisine by reappropriating existing infrastructures and global networks, particularly those facilitating the movement of people and goods. This industry introduces an operation that fosters a novel form of assembly and reunion: an annual pilgrimage and week-long celebration at the site of Tuvalu's Funafuti Port, a joyful diasporic homecoming that involves collective cooking, meal sharing, and cultural production.



Fall 2023, ADV V Studio
Studio critic: Marina Otero, Farah Alkhoury
In collaboration with: Carmen Chan (M.Arch 24')



Instrument of Care Diagram



Digital Diaspora Diagram

DESIGN WITH INFRASTRUCTURE

Tuvalu, a critical node in the Southern Pacific trade network, relies on multiple interdependent flows of physical and digital infrastructures. Whereas Tuvaluan culture is intrinsically connected to the ecosystem they inhabit, the lack of sufficient land for agricultural and industrial production has further caused Tuvalu to rely heavily on foreign resources to supplement its development.

These imported materials coexist with and transform the islands' traditional fluid vernacular and, in turn, shape the physical territory of Tuvalu, but also the immaterial cultural heritage of Tuvaluans, such as the project's point of focus: Cuisine. The imported non-perishable food and cans have gradually become crucial components in the food culture of Tuvalu today.

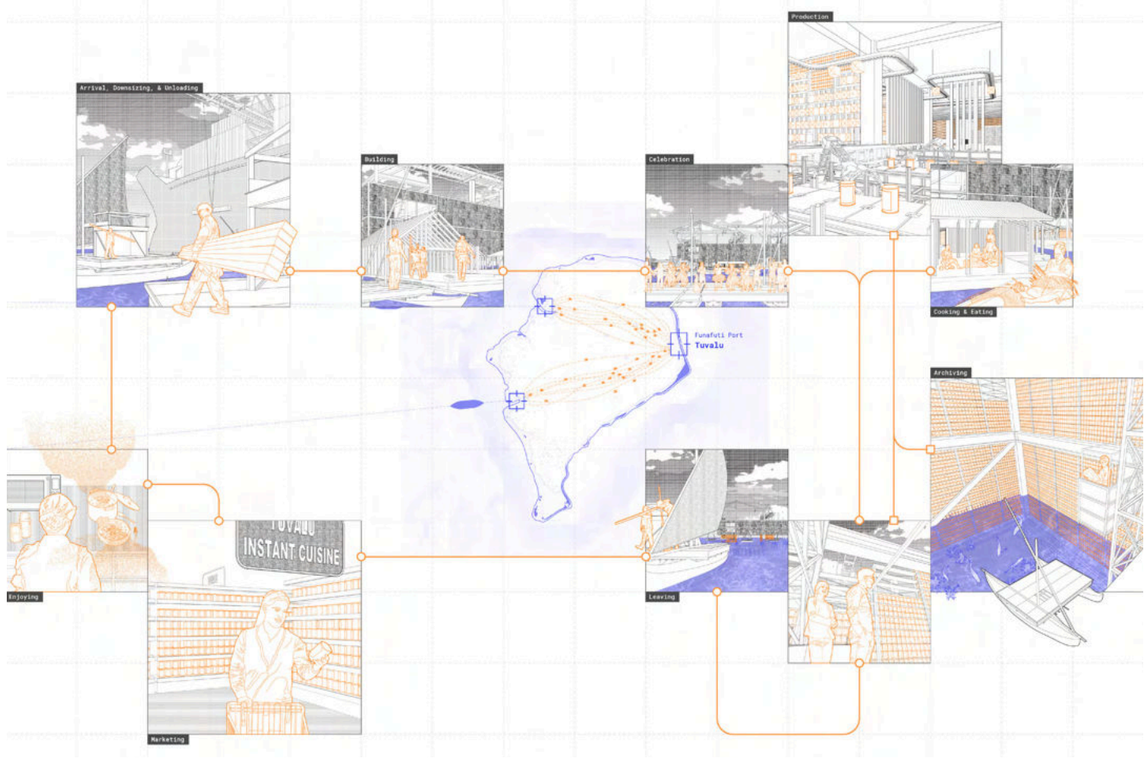
Food practices contribute to the lived experience of the diasporic communities, creating experiences of belonging. As a low-barrier practice, the diaspora communities consciously preserve recipes by posting and sharing them to the digital cultural archive, enriching the formalized archives of various state institutions. This act of sharing and posting recipes serves as an essential informal avenue for collectively preserving the territory and culinary heritage of Tuvalu and allows the nation to continuously self-reproduce in other spheres and demographics.

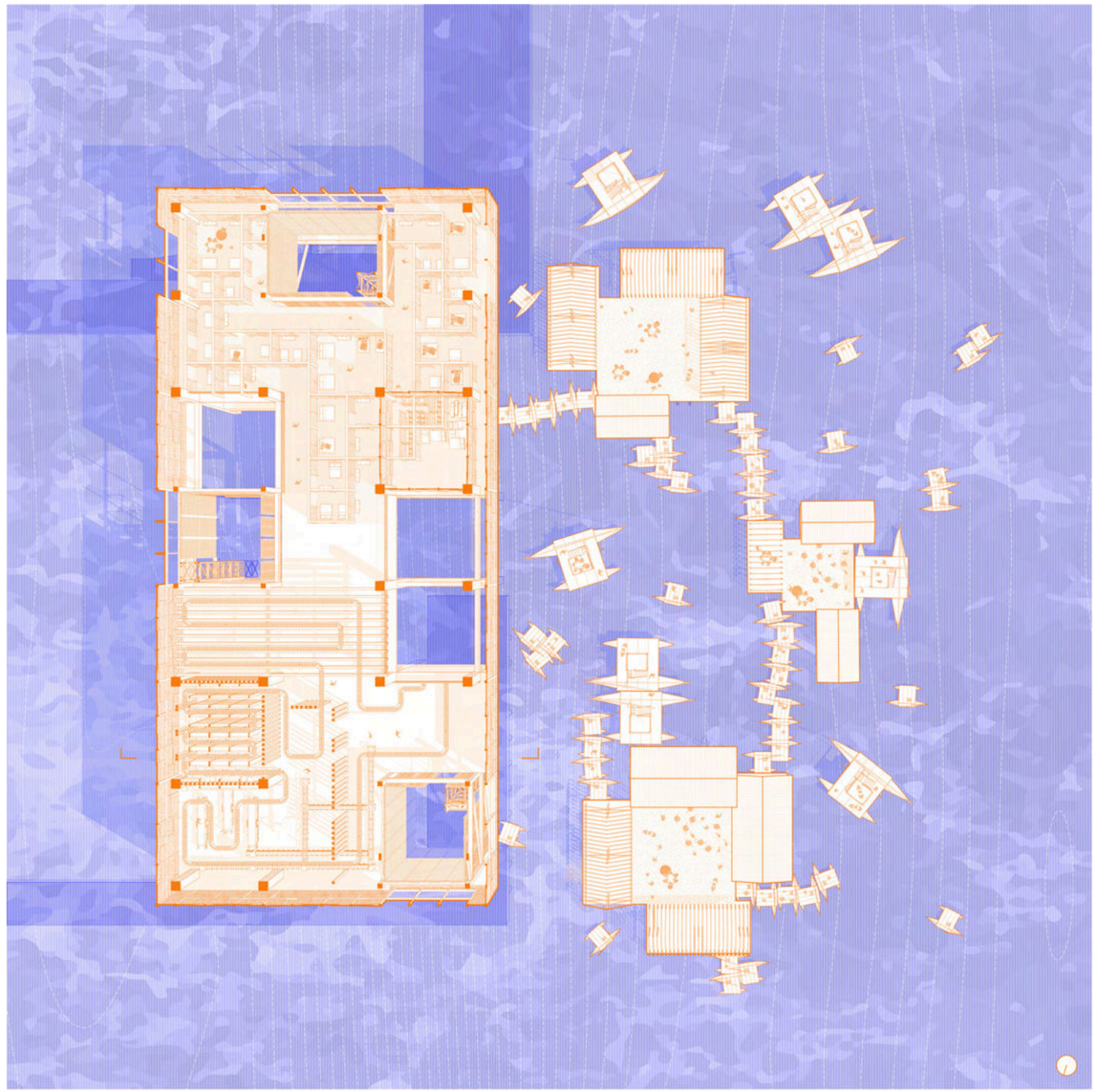
Tuvalu Cuisine Diagram

DESIGN FOR GATHERING AND REMEMBRANCE

In the development of this festival, this project intricately maps, gathers, analyzes, and understands the aforementioned framework of commercialization and capital that has shaped Tuvalu's (im)material culture. These digital and physical flows of infrastructure serve as a medium to further integrate new means of gathering and archiving in order to connect with the Tuvaluan homeland and identity when the land itself ceases to exist.

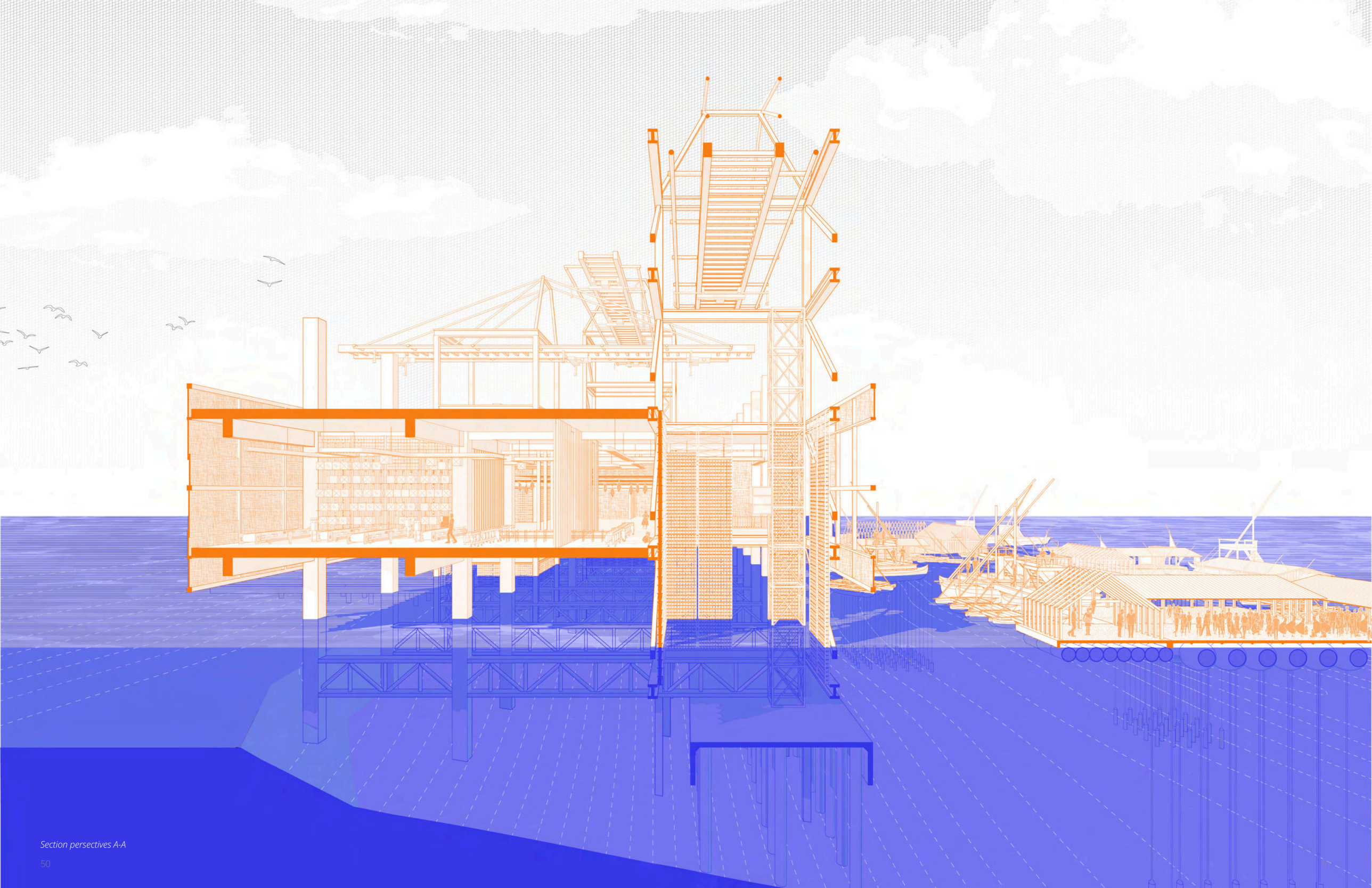
(Below) Journey and System Diagram
(Left) Bird's-eye View Rendering





(Above) Plan Perspective

(Left) Exterior Rendering



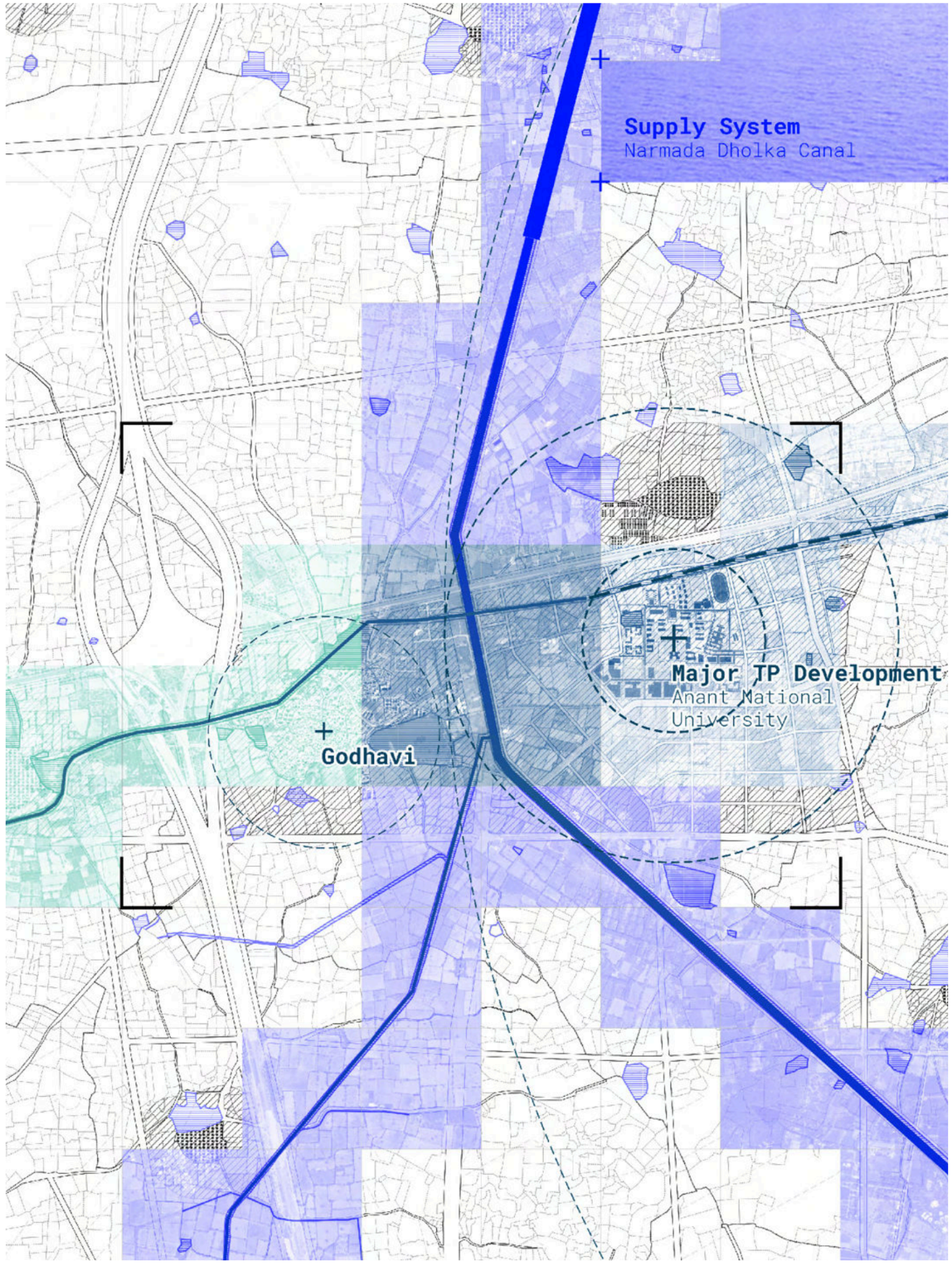
Section persectives A-A

The Woven Water Corridors: Responsive Urban Landscape

By creating a series of horizontal water corridors connecting the village of Godhavi and the new institutional campus, this project aims to break the superimposing pattern of mega-scale developments, including the regional Gota-Godhavi canal and the new TP scheme, and its relation to the natural boundary and growth of the Village.

The water corridors will offer both channels integrating local scale water sources and pedestrian-oriented paths to foster a new dynamic between infrastructure and people's engagement with water and land. Meanwhile, along the corridors, the design considers the various interfaces that bring different environmental and ecological conditions to our attention. Through an investigation of these conditions and thereby proposing corresponding toolkits of local/small-scale water infrastructures, this project offers a flexible yet impactful approach that can be adopted within the broader framework of the regional watershed.

Spring 2024, ADV VI Studio
Studio critic: Sandro Marpillero, Sonal Beri



DESIGN WITH WATER AND BEYOND

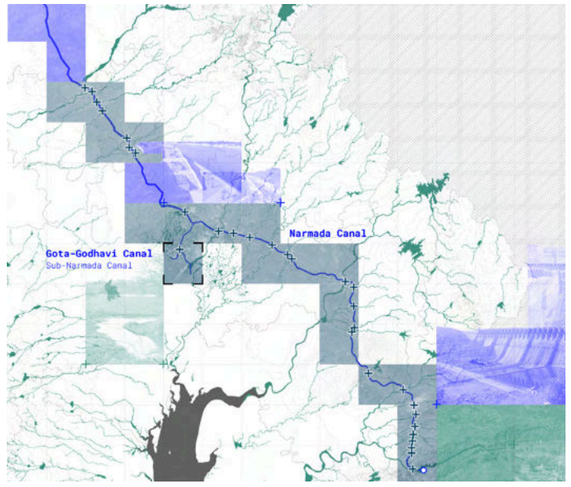
Central to the watershed in Gujarat is the Narmada River - it is a crucial source of the 331-mile Narmada Canal and its sub-branches, which together bring water to supply human settlements, agricultural fields and faciliate significant development projects. Along its route, the Narmada Canal and its sub-branches intersect with many rivers and water bodies, creating complex junctures between constructed and natural water systems. One such point is near Godhavi village.

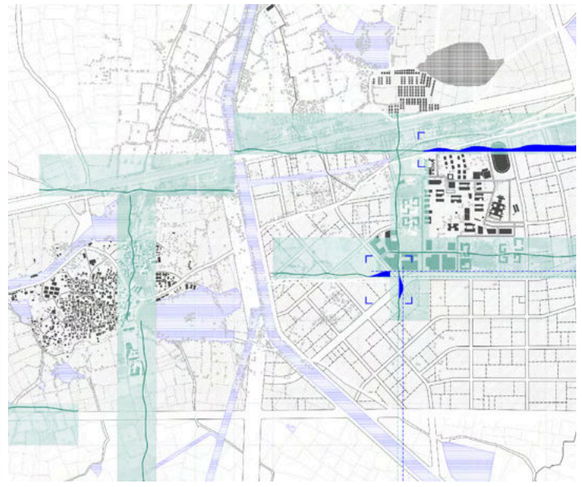
Besides involving the convergence of the local drainage system and the supply system, the situation at Godhavi is further complicated by AUDA's new town planning initiative as it encounter the rural landscape of Godhavi. This juxtaposition creates a greater tension between the superimposing pattern of systematic mega-scale development and the natural boundary, environment, and growth of Godhavi village.

(Left) Regional Diagram

(Right Above) State Watershed & Local topography Diagram

(Right Below) Existing Water Engagement models





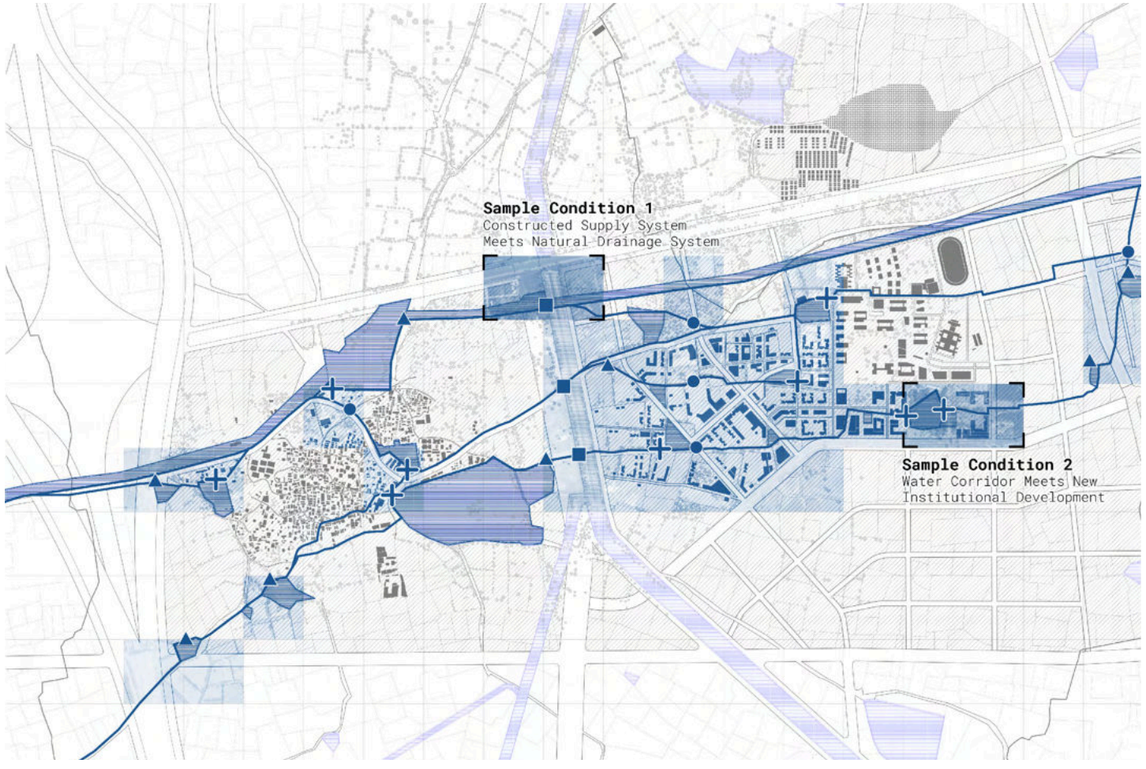
DESIGN TO RESPOND

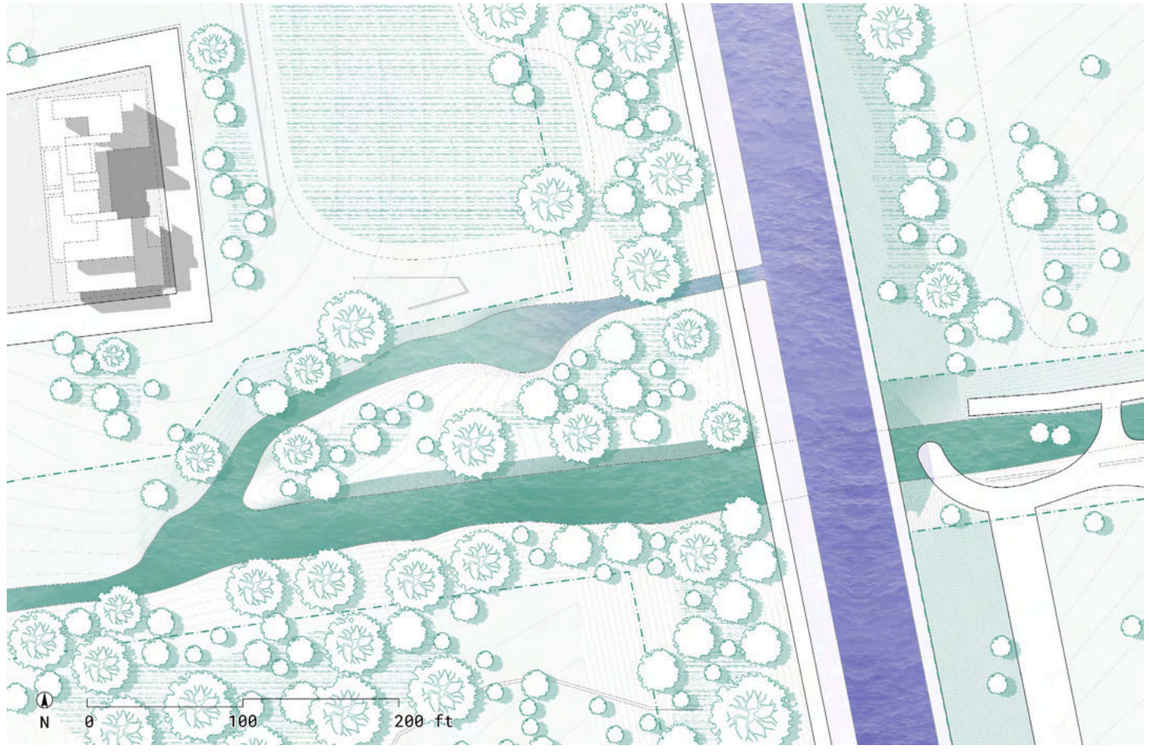
This project aims to critique, investigate, and break the super-imposing pattern of systematic mega-scale developments and its relation to the natural boundary, growth, and the associated water environment of Godhavi Village.

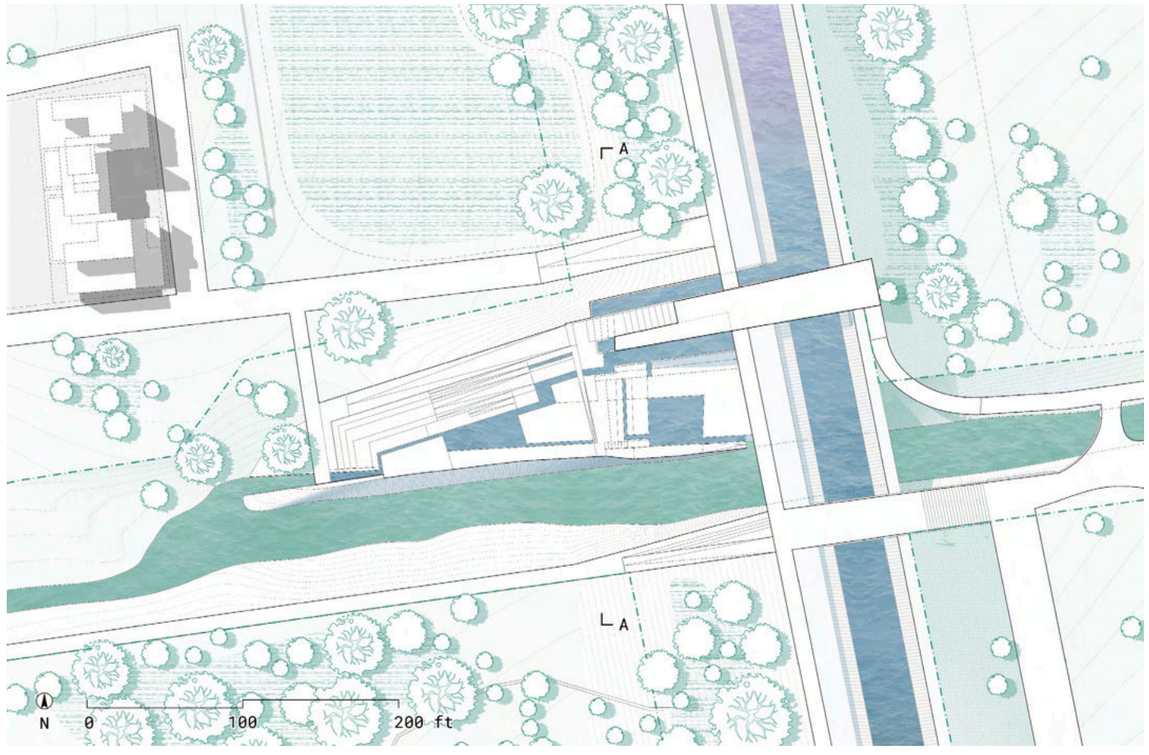
As a response, this project proposes reorienting development to align with the natural fields and introducing a series of horizontal water corridors connecting Godhavi Village to the new institutional developments. Meanwhile, along the corridors, the design identifies and considers the various types of interfaces. With interventions, those interfaces serve as critical nodes along the water corridors that invite both the local villagers and new residents of the TP development to engage with the watershed and the associated infrastructure without barriers.

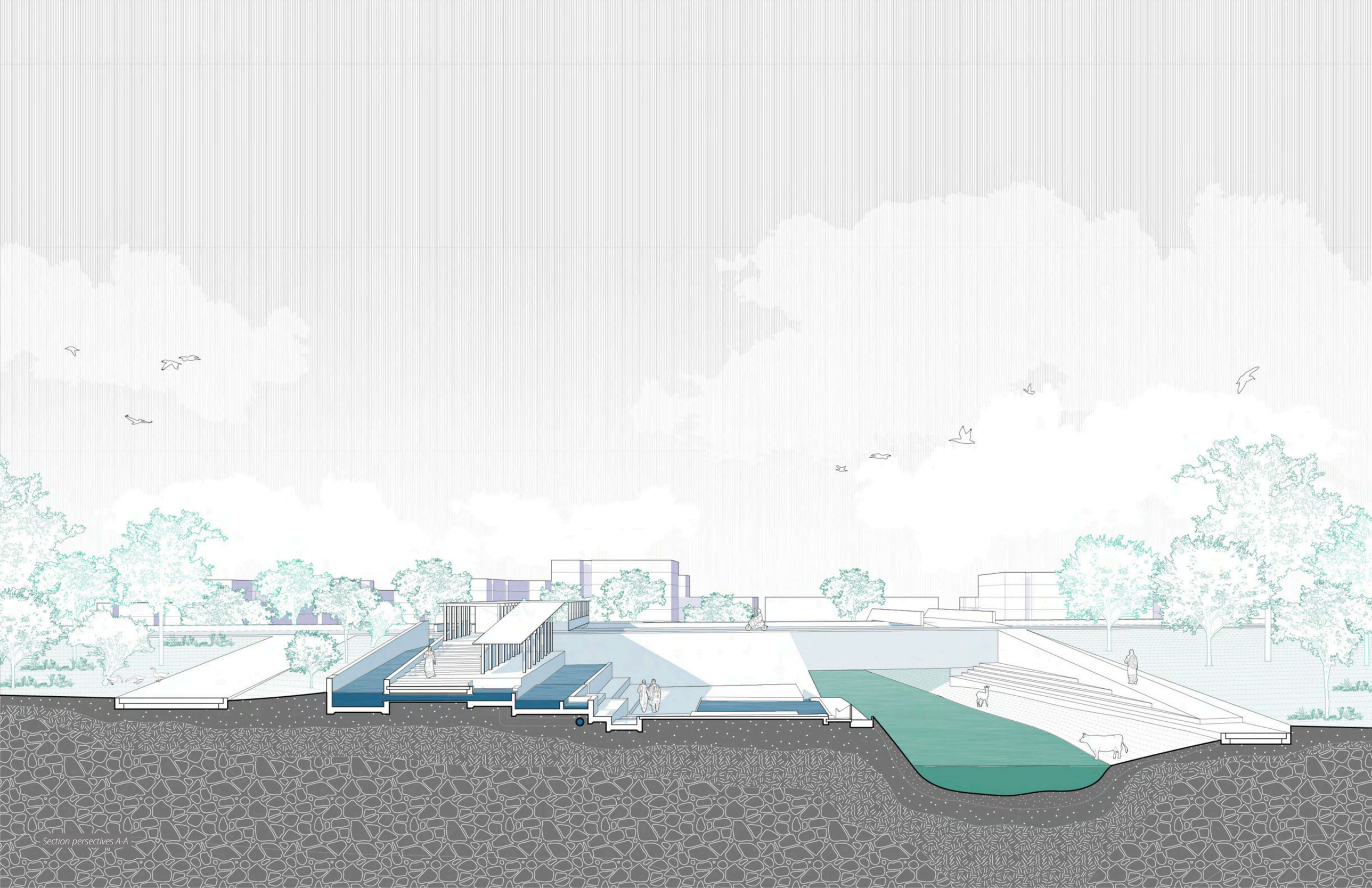
As a semester-long project, two conditions were selected to further explore with design interventions. The idea is that they can help establish a methodology or toolkit that can be adopted or replicated in other similar situations within the broader framework of the regional watershed.

(Left) Water Corridor Proposal
(Right Above) Sample Condition 1, Before
(Right Below) Sample Condition 2, After

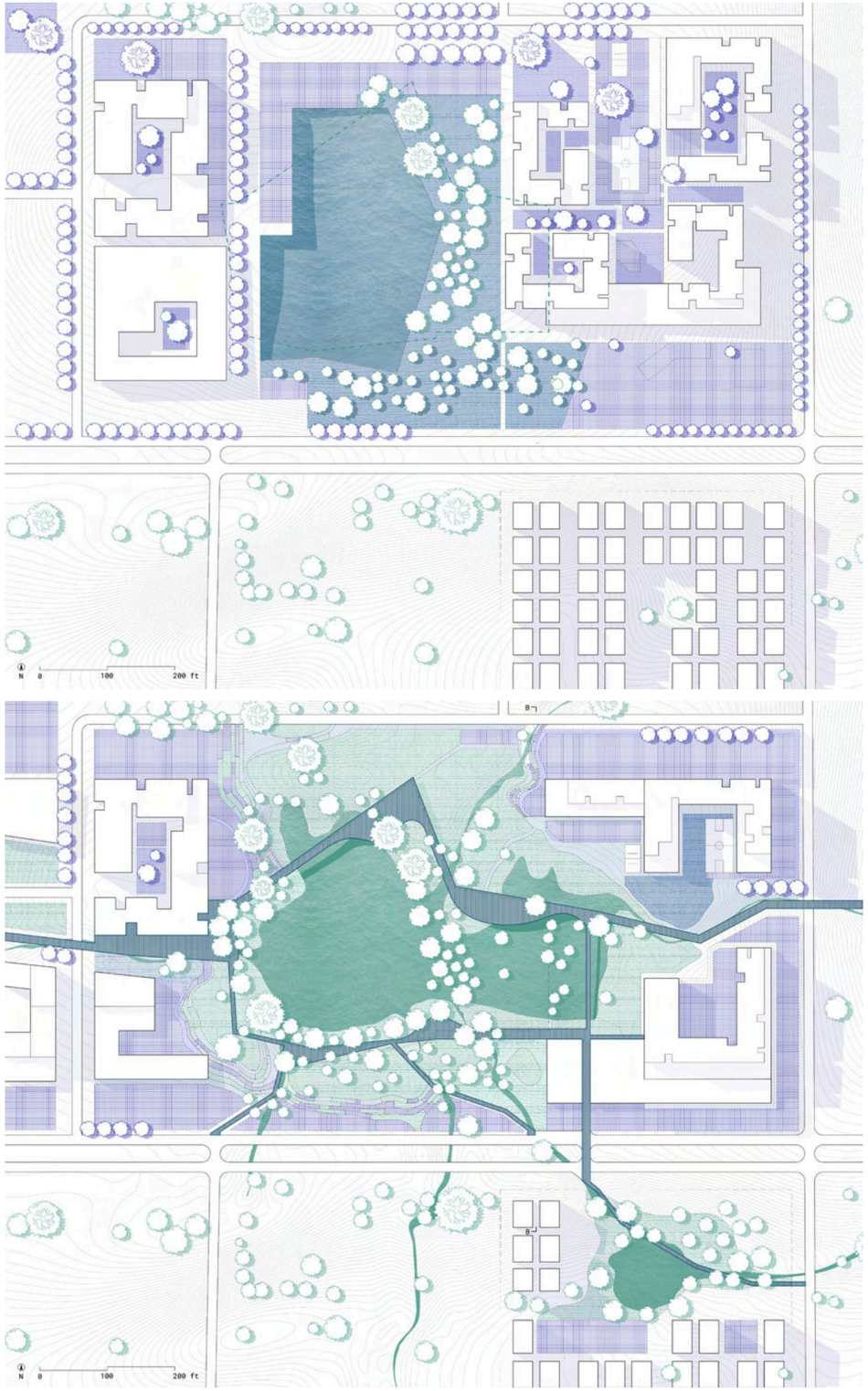








Section persectives A-A



(Left Above) Sample Condition 2, Before

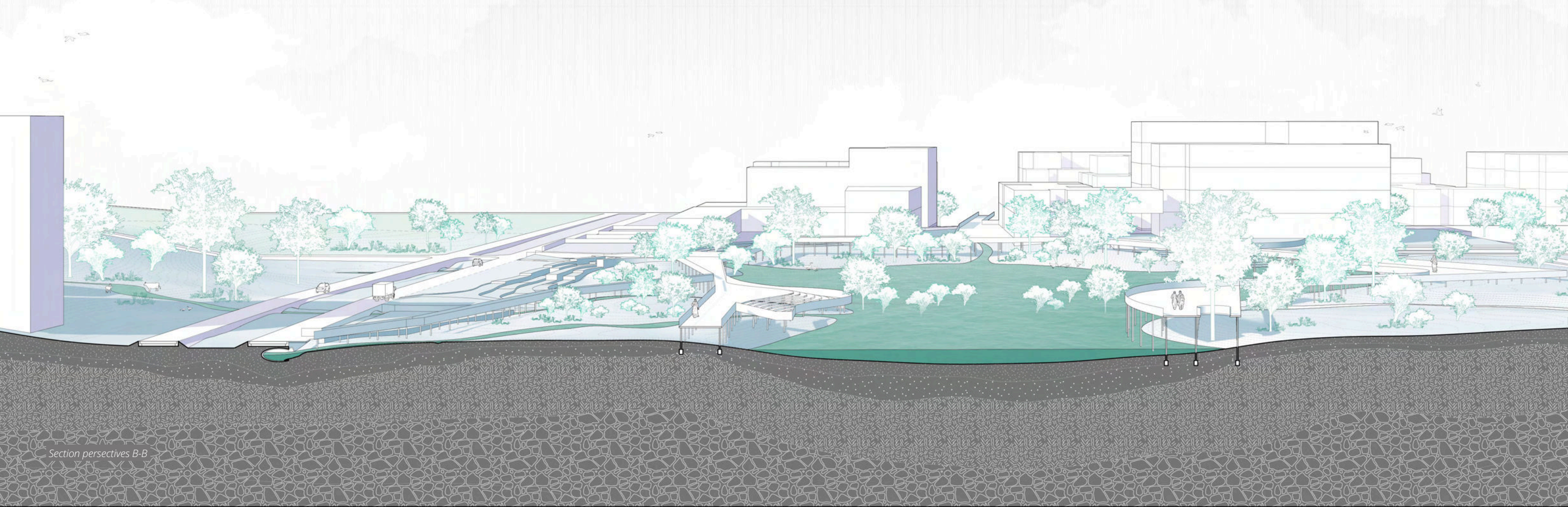
(Left Below) Sample Condition 2, After

(Right) Sample Condition 2, Exterior Rendering

DESIGN TO RESPOND

Sample Condition 1: The intersection where the supply canal connects and goes above the natural drainage system, controling by a small water gate inaccessible to general public. As a response, the design expands the existing control point to a field condition. Taking inspiration from the traditional Indian step wells, the design reshapes the parcel with modified contours following the natural topography and redirects the water flow as it passes through the land with moments of direct public engagements.

Sample Condition 2: Where institutional developments reshape and ignore natural state of water and its relation to human from cultural and pragmatic perspectives. The proposal reconsiders the existing Talav and its associated ecology as the courtyard itself, reorienting the development to follow water. The water corridors will be elevated to reduce footprint while connecting to adjacent ground features through pedestrian-oriented paths and platforms, to allow water engagements under different circumstances.



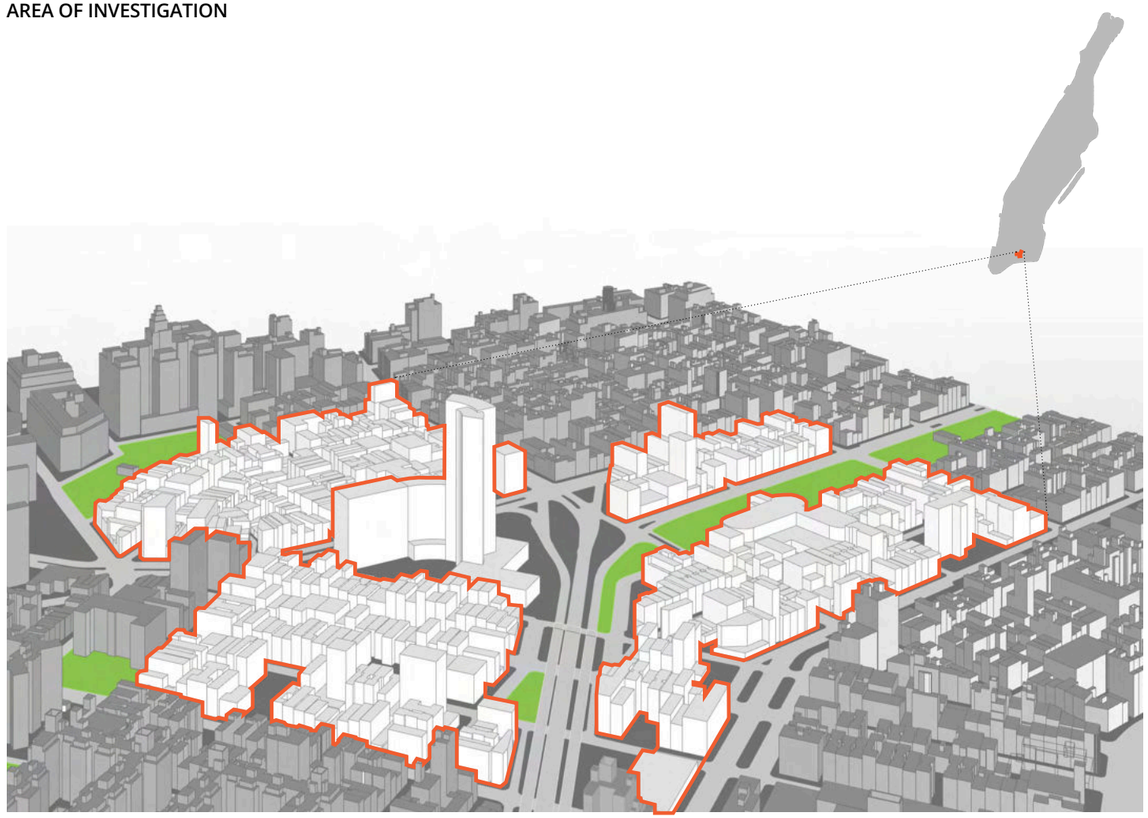
Section persectives B-B

Alternate Chinatown: A Parametric Design Approach to Reimagine the Potential of Chinatown's Urban Landscape

Ever since their establishment, Chinatown and the broader Lower East Side of Manhattan have always been a field of confliction centered around the issue of urban development and gentrification. Built upon both the historical and contemporary context of urban development, our project aims to reimagine alternate urban configurations of Chinatown with the assistance of parametric design tools such as grasshopper.

Fall 2023, X-Information Modeling
Course instructor: Snoweria Zhang
In collaboration with: Kelly He (M.Arch 24')

AREA OF INVESTIGATION



OBSERVATION

The abundance of tenement housing and the unequal distribution of light and view access for buildings in Chinatown core areas have highlighted the potential for rethinking the urban landscape while maintaining the unique street/cultural life of Chinatown.

QUESTION

With the considerations of streetscape design, amenity network design, and building typology design in compliance with zoning regulation, how can we reimagine future Chinatown's urban landscape?

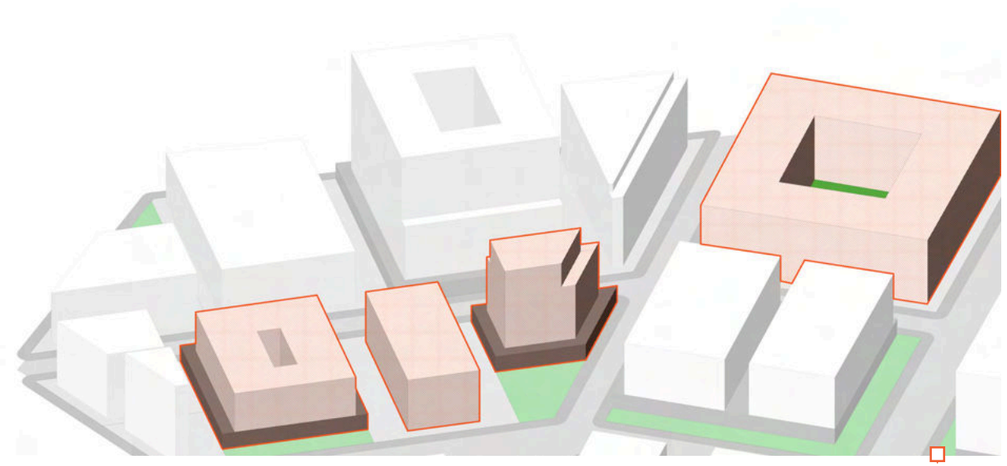
HYPOTHESIS

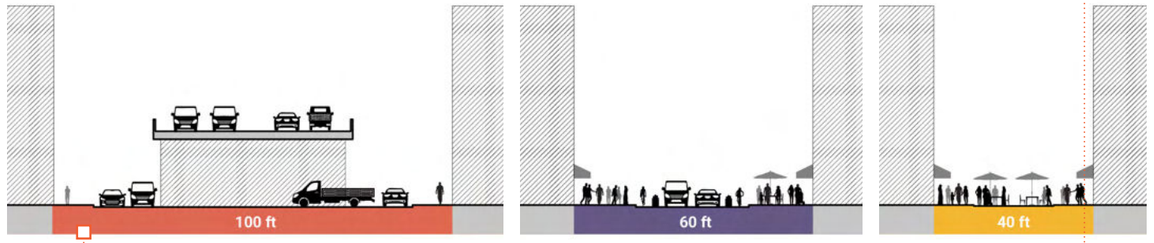
Through streetscape reconfiguration concerning street width/setback/amenity network, density variation concerning land use, and building typology variation,a more optimal Chinatown development can be achieved increasing both living qualities and street/cultural life for residents.

For the purpose of this study, zoning regulations for the area has been modified to: 1) Commercial (C6-1) with FAR: 1.0-6.0, upper residential portion allowed; 2) Residential (C7-2) with FAR: 0.87-3.44, recalculate OPS requirement at site level.

VARIABLES & ITERATIONS

7 key variables are established in the parametric design model, resulting in 80 design iterations. The project considered not only the street types and scapes but also the distribution of density, commercial use lots, building typologies, etc.

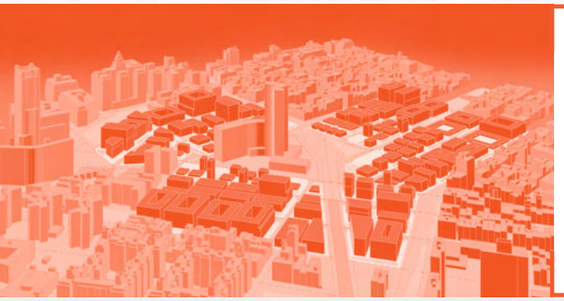




Inputs	# of options	Description of the options
*Street Type Option	3*	Primary, Secondary, Tertiary
Streetscape Configuration	4	4 options was generated with 3 street type options
Density Attraction	4	Towards center, Towards periphery, Linear, Dispersed
Percentage of parcels with commercial use	5	30%, 50%, 60%, 80%, 90% of parcel ground floor
*Building Typology	4	Regular residential, Residential courtyard, Podium type 1, Podium type 2
* FAR	x	0.87-3.44 residential, 1.0-6.0 commercial (mixed-use)
* Parcel Width	x	60 - 125 ft
Design Space Size	80	

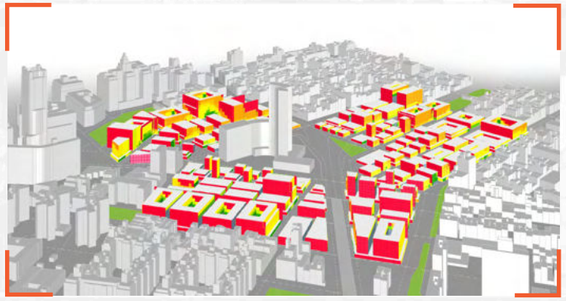
SELECTED ITERATION

Among the 80 options, iteration 33 is the cloestest to existing Chinatown streetscape with overall great performances and urban design in relation to neighborhood context.



Average daylight hours for open space **increases 0.1 hours**

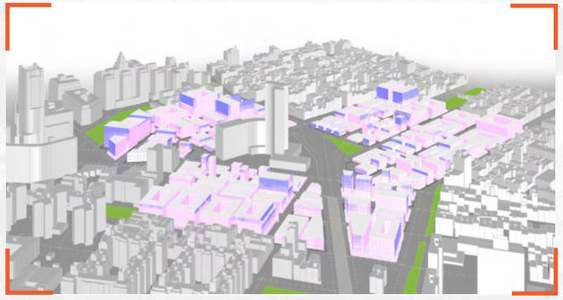
Average % of days with daylight for open space **increases 1%**



Average daylight hours for buildings **increases 50% by 2.9 hours**

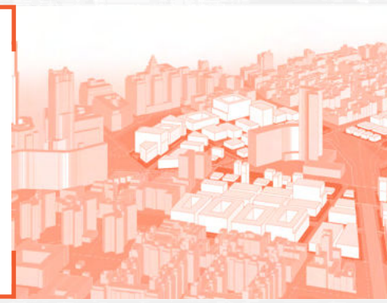
Average % of days with daylight for buildings **increases 20%**

% of open view above threshold **increases 22.7 %**



Average number of parks within 3 mins walking for commercial stores **increases 175% by 1.47**

% of commercial stores with 3 or more parks connection **increases 23.9%**



Can We Have More Green Roofs?
A GIS Analysis of Queens, NYC to Cope with Urban Heat Island Effect

HEAT ?

Metropolises like New York City have long been affected by the Heat Island phenonmenon. As indicated in the Land Surface Temperature Visualization with data measured from August 26th to September 1st, 2021, the urban surface temperatures vary widely, ranging from 15.4°C to 43.6°C, suggesting a significant pattern of urban heat island effect across the city. Among all five boroughs, Queens had experienced the most drastic pattern of urban heat island effect among all boroughs in the city with a LST ranging from 15.4°C to 41.3°C.

For dense cities like New York, the establishment of new green infrastructures can be prominently realized with green roofs. This research project suggests the addition of green roof to available & appropriate roof spaces in Queens owned by the city government.

Fall 2021, Geographic Information System (GIS)
Course instructors: Leah Meisterlin, Daniel Froehlich
In collaboration with: Fang Wan (M.S. AAD 22')

METHODOLOGY OVERVIEW

The employed methodology derives from logical thinking of how each layer of information should be appropriately aggregated to inform our decision-making. The scheme of our process begins from identifying heat island effect pattern across the City of New York, then investigating how it corresponds to the built environment and what the city has done to mediate its impact upon our living environment. The investigation further informs us what we can do more to alleviate its influence through green roof conversion for buildings that are government owned.

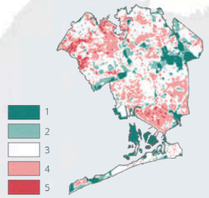
As a result, among all existing but not utilized government property roofs in Queens, NYC, three were selected for green roof sites to mediate the heat island effect across the borough. The final selection was made based on a weighted decision map that evaluates the site's four identified characteristics that contribute to the urban heat island generation, with a score ranging from 7-49. The higher the score is, the more suitable the site is for the green roof proposal.

(Below) Evaluation and MCDA criteria
(RIGHT) MCDA Results

3x +

Land Surface Temperature (Degree)

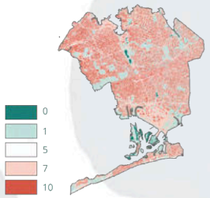
Full Temperature Range	Temperature Range	Reclassified Score
15.4- 43.6°C	15-28 °C	1
	28-30 °C	2
	30-32 °C	3
	32-34 °C	4
	34-44 °C	5



2x +

Categorized Land Cover Type (Per Type)

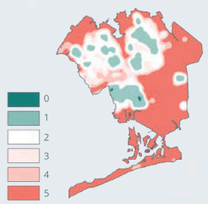
Classification	Land Cover Types	Reclassified Score
Water Body	Water	0
	Open Water	
	Pool	
Natural Landscape	Tree	1
	Bush	
	Grass	
Bareland	Bare Soil	5
	Gravel	
	Rock	
	Sand	
	Wood	
Impervious Surface	Asphalt	7
	Concrete	
	Metal	
	Brick Paver	
Building	Roof	10
	Solar Panel	
	Sythetic Turf	



2x +

Green Infrastructure Need (Kernenl Density)

Full Kernel Density Range	Kernel Density Range	Reclassified Score
0-1117.07	0-13	5
	13-39	4
	39-87	3
	87-196	2
	196-558	1
	558-1118	0



1x =

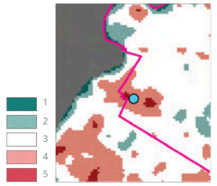
Level of Urbanization (Number of Floor per Lot)

Full Num. of Floor Range	Num. of Floor Range	Reclassified Score
0-104	0-1	0
	1-3	1
	3-5	2
	5-8	3
	8-11	4
	11-104	5

SELECTED BUILDING ROOF FOR CONVERSION

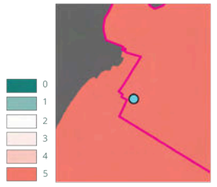
1 Long Island City High School in City Council District 22 ranks at the top with a score of 44. The school is located in an area with the highest temperature score and land cover score due to the high concentration of materials contributing to the urban heat island effect while significantly lacking green infrastructure. The green roof addition to a school will contribute to the educational purposes of this program.

Land Surface Temperature (Degree)

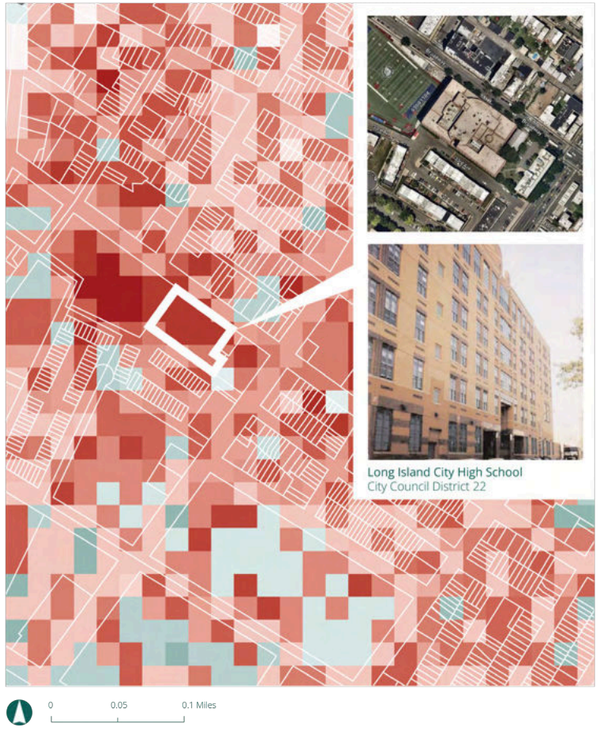


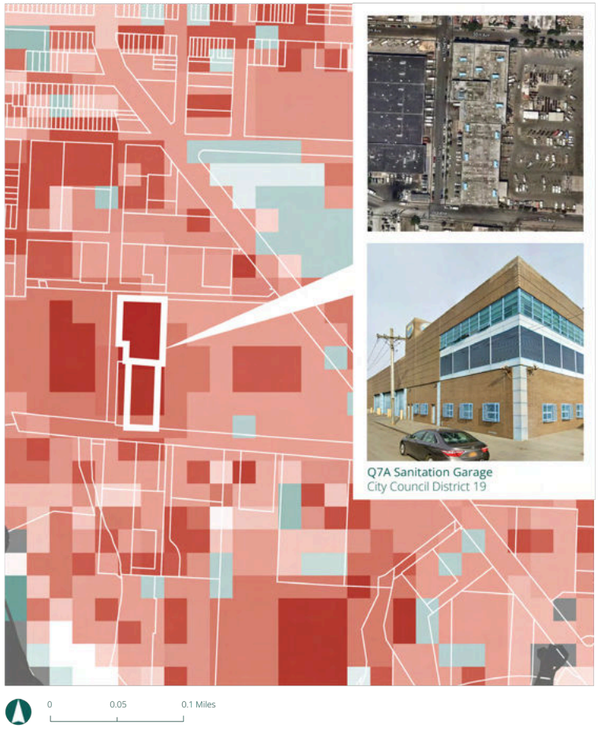
Categorized Land Cover Type (Per Type)

Green Infrastructure Need (Kernenl Density)

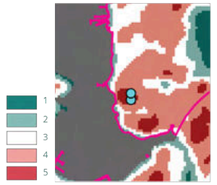


Level of Urbanization (Number of Floor per Lot)



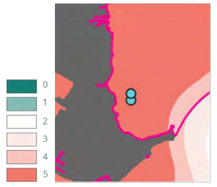


Land Surface Temperature (Degree)



Categorized Land Cover Type (Per Type)

Green Infrastructure Need (Kernenl Density)



Level of Urbanization (Number of Floor per Lot)

2 Q7A Sanitation Garage in City Council District 19 also ranks among the top choices with a score of 44.5. The garage is located in an area with the highest temperature score and land cover score similar to Long Island City High School. As a sanitation garage, the green roof addition will bring awareness of environmental concerns for the citizens.

Those Who Live and Travel in the Dark: Examing Infrastructure Exclusion in Africa through Informal Mobility Network

This project seeks to challenge the conventional use of night light imagery to estimate population density and economic activity by integrating other sources of datasets to provide a more comprehensive understanding of the lives and infrastructure behind nighttime activities. Specifically, the project aims to compare nighttime light satellite imagery with informal mobility network datasets, census grid counts, and building footprint datasets produced by governments and researchers worldwide.

By examining the relationship between the built environment, infrastructure, and human settlement at the scale of satellite imagery, the project aims to challenge existing assumptions about the geographies of belonging and infrastructure exclusion.

Spring 2023, Confict Urbanism

Course instructors: Laura Kurgan

In collaboration with: Candice Ji (M.S. UP 23'), Shining Hong (M.Arch 23'), Alan Ren (M.S.AUD 23')

AREAS OF FOCUS

This comparative analysis across different datasets will enable the project to identify global patterns and reveal untold stories of places where people live but lack adequate infrastructure at night. Specifically, this project zoomed in on five case study cities in Africa, examining the intersection of nighttime activity and the built environment to reveal new insights into the spatial and social dimensions of urban life in these contexts. The five African case study cities are Accra in Ghana, Addis Ababa in Ethiopia, Cairo in Egypt, Harare in Zimbabwe, and Nairobi in Kenya.

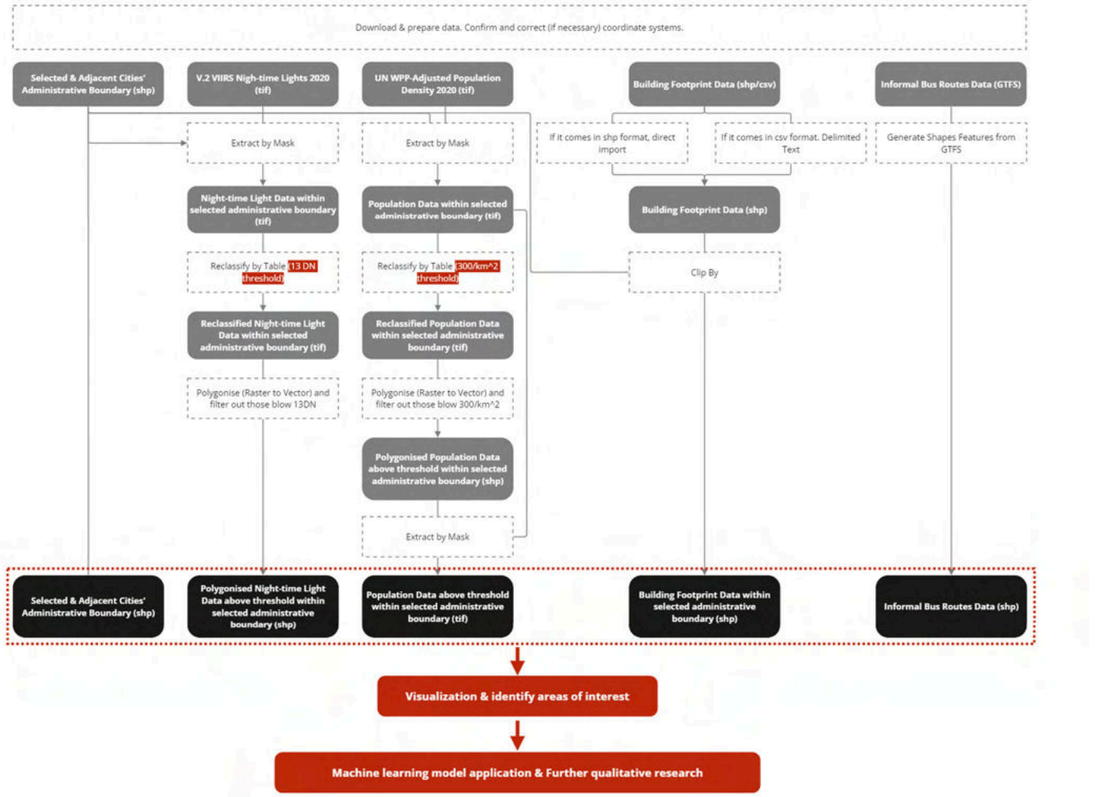
RESEARCH QUESTIONS

1. Are there areas where urban clusters exist, but lacking access to infrastructural light and not considered as urban zones? Which of these areas are serviced by informal buses?

2. What are the transportation options and conditions in these areas?

3. How does the built environment pattern in these areas compare to their respective city centers?

Map of Case Study Cities



Methodology Breakdown

The above diagram illustrates a detailed step-by-step methodology breakdown of the research project. Overall, the methodology of this project can be divided into four main steps.

Step 1: Raw Data Collection

In this step, five primary datasets are collected from each source's website. Besides nighttime and population data at the global scale, other datasets should be collected locally depending on each study city.

Step 2: Data Processing

This step requires raster (image) and vector manipulation with geoprocessing software, including QGIS and ArcGIS. The datasets that require raster processing are V.2 VIIRS Nighttime Lights and UN WPP-Adjusted Population Density.

Step 3: Data Visualization

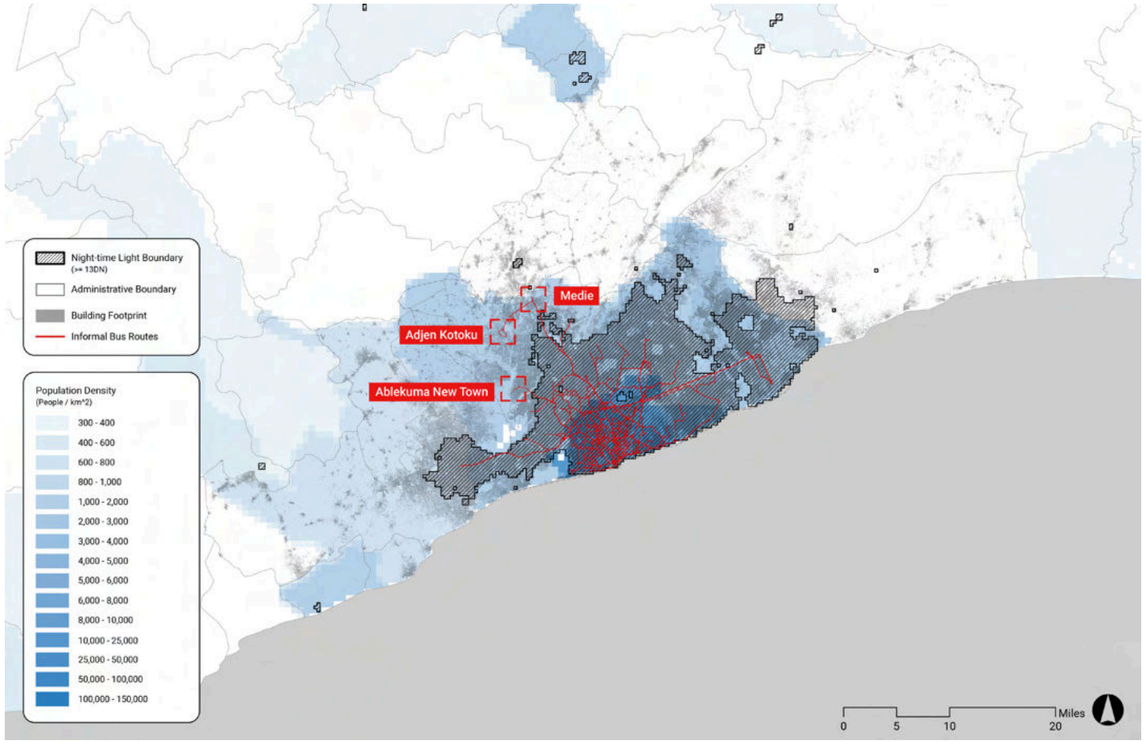
After processing, datasets are overlaid to identify areas of research interests based on the following criteria - places where urban clusters are presented but without nighttime light, while informal bus routes reach to the spots.

Step 4: Machine Learning

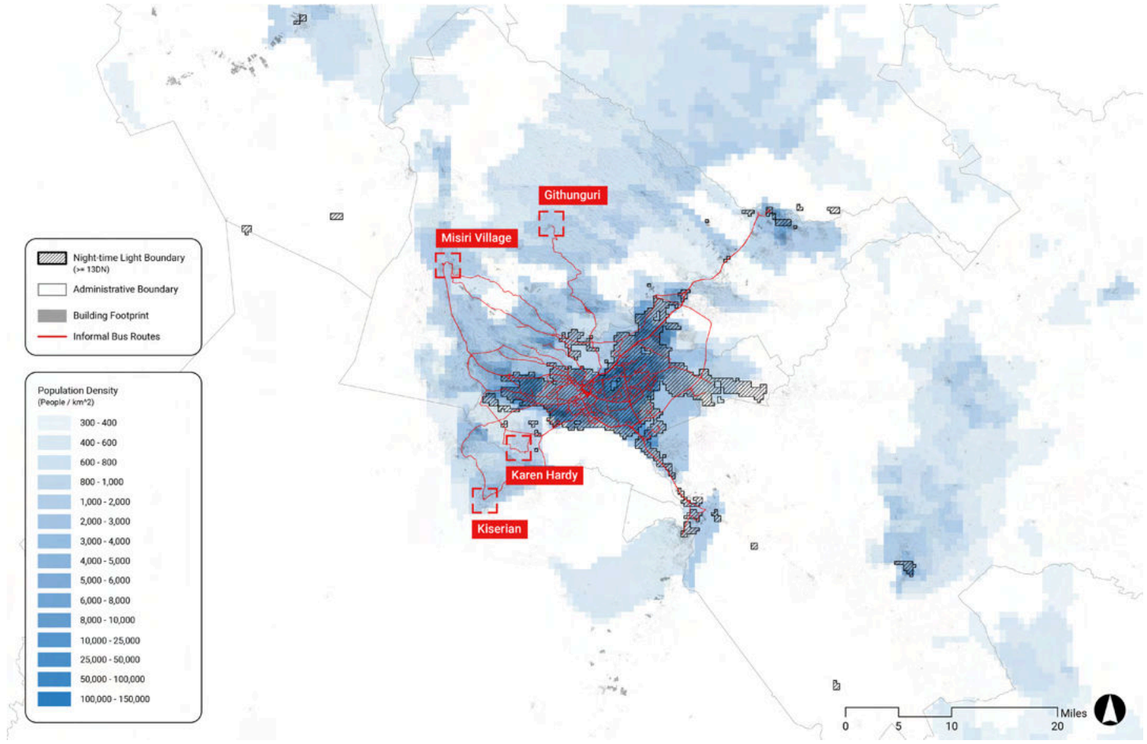
Further research is then done to explore the urban fabrics and materiality of the built environment. A machine learning classification model is employed in this step.

SELECTED CASE STUDY SITE RESULTS

In Accra, Ghana, informal bus routes are primarily distributed along the coastline, while three emerging new towns near the NASA nighttime light image boundary exhibit a relatively low building footprint density.



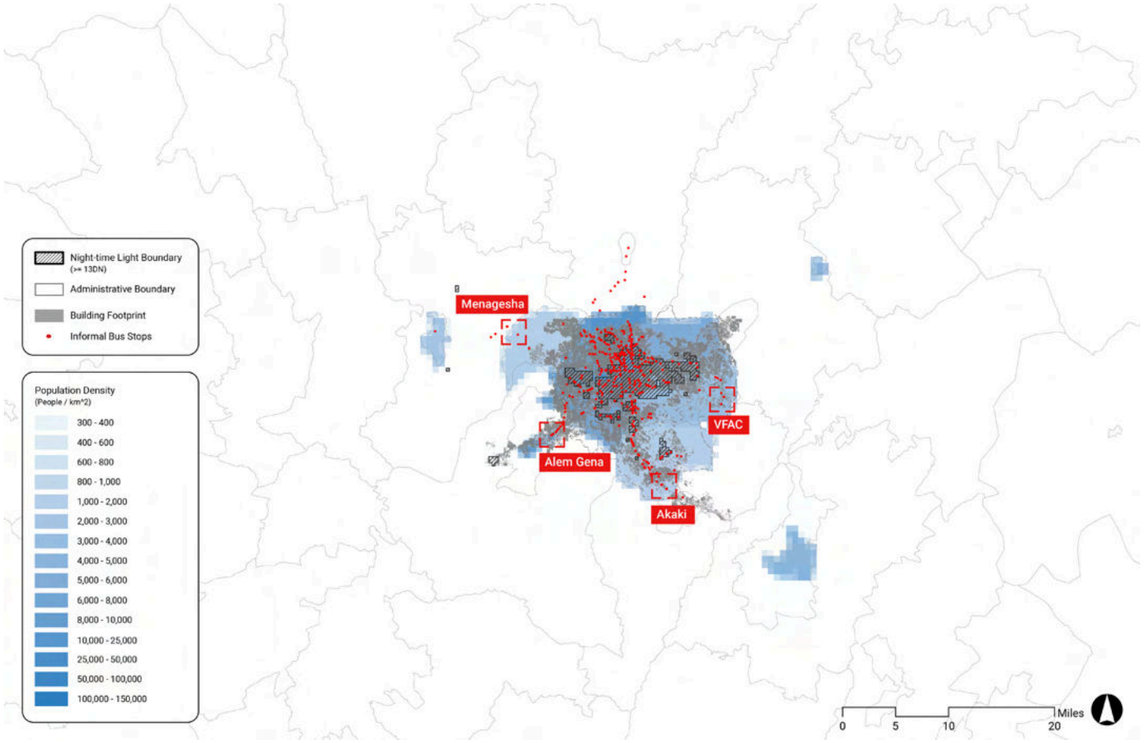
Map of Accra, Ghana



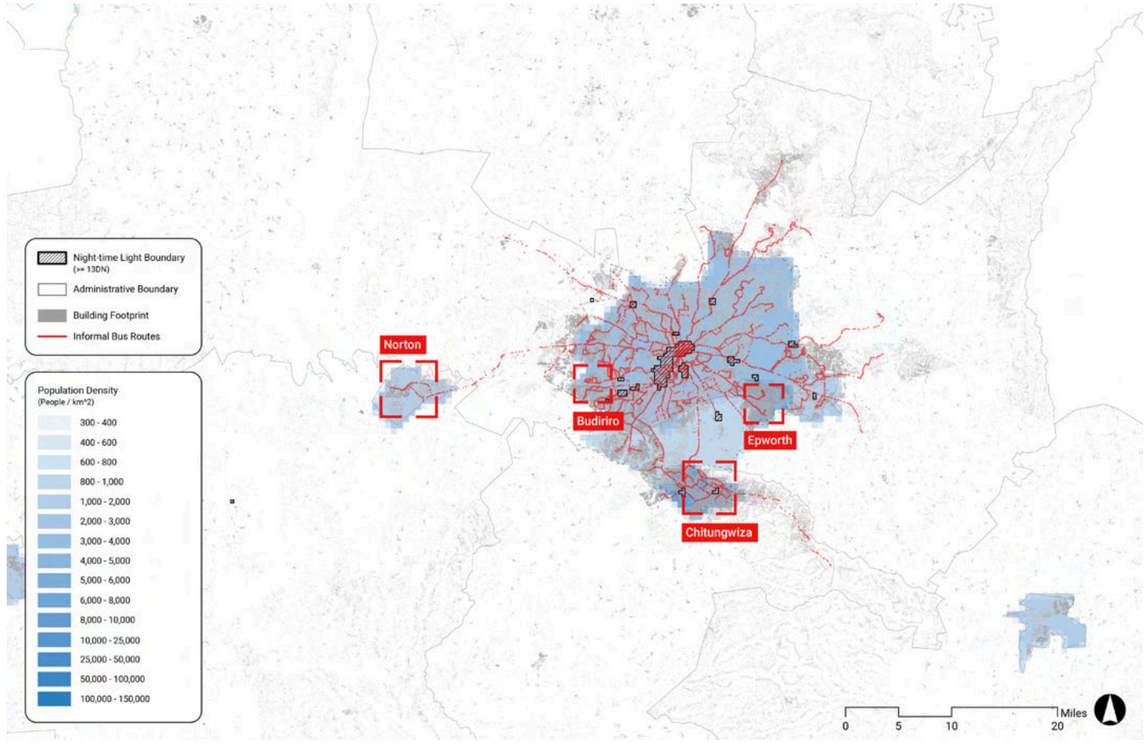
Map of Nairobi, Kenya

In Nairobi, Kenya, the urban cluster extent exceeds its planned administrative area, blurring the concept of downtown and suburbs when considering areas with a population density of 300 people per square kilometer. The NASA nighttime light image and urban extent almost coincide within the Nairobi administrative area. Although the informal bus system connects numerous surrounding villages and new towns, it does not overlap with the NASA nighttime light image boundary in the city's western part, suggesting an imbalanced development between Nairobi's eastern and western regions.

Informal bus stops in Addis Ababa, Ethiopia are primarily situated along the city's main roads, while two satellite towns lack such stops. Furthermore, the NASA nighttime light image boundary is significantly smaller than the regions with the lowest population density, indicating that numerous self-built houses may lack electricity at night.



Map of Addis Ababa, Ethiopia



Map of Harare, Zimbabwe

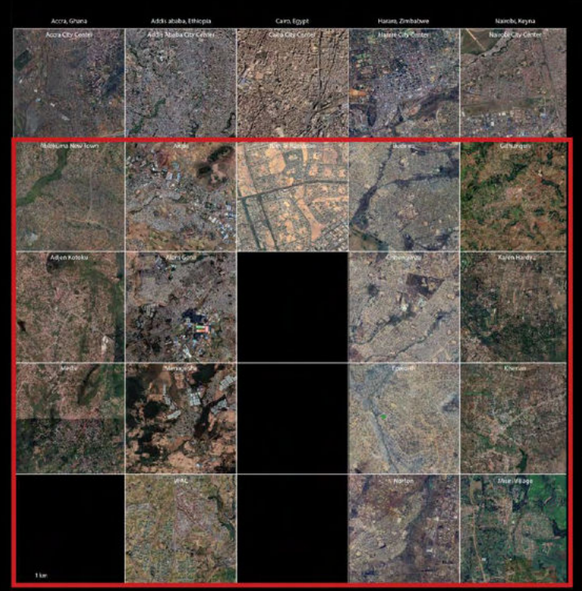
Harare, Zimbabwe's urban morphology resembles that of Addis Ababa, featuring a central radial pattern connecting surrounding satellite towns. However, the areas containing informal bus stops almost entirely overlap with regions exhibiting the lowest urban population density. Interestingly, the NASA nighttime light image in Harare is significantly smaller than the areas with the lowest population density boundary, excluding the city's most populated areas in the southern and eastern regions.

FINDINGS FROM DATA OVERLAY

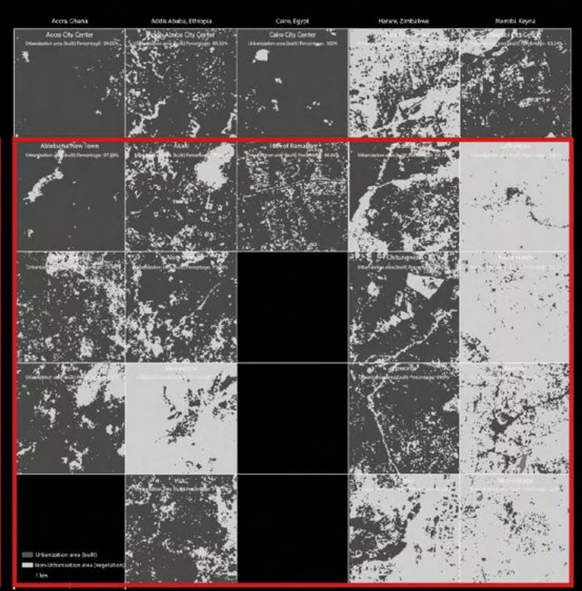
By analyzing the layers of datasets, a few key themes emerged highlighting the urban fabric patterns, the percentage of earth, the availability of transportation options, and the informal mobility conditions experienced by residents living in areas with low levels of night light. To further explore the urban fabrics and materiality of the built environment. A machine learning classification model is employed in this step, at the satellite scale in the unit of two kilometers by two kilometers square from the central coordinate of each city and selected towns. In addition, qualitative research is performed for ground transportation analysis.

MACHINE LEARNING 1: CITY FABRIC STUDY

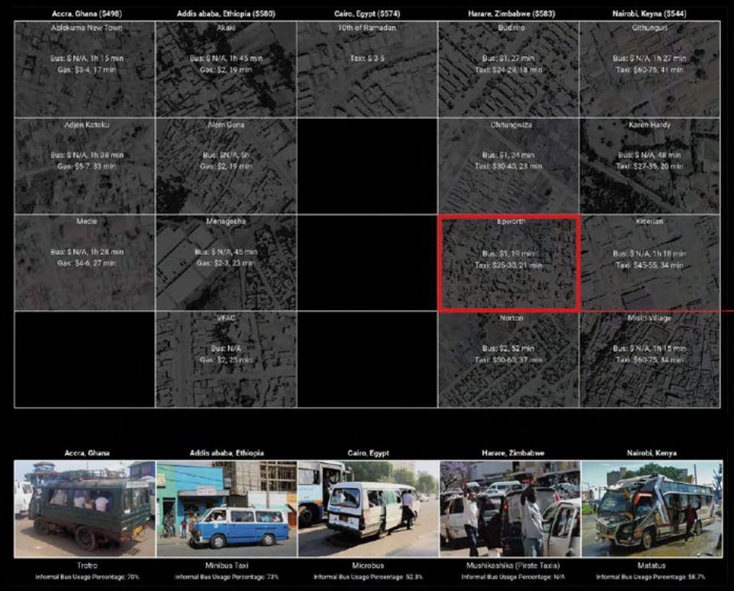
The model reclassified the urban patterns into built, vegetation, and water coverage using Landsat 8 images by breaking it down into individual bands and extracting pixels based on an existing training set, from which we can investigate the degree of urbanization from the categories identified. The findings reveal that towns located at the end of informal bus routes generally have lower levels of built features compared to their respective city centers. The results indicate a possible relationship between the absence of formal transportation infrastructure and the built environment and urban fabric in these regions.



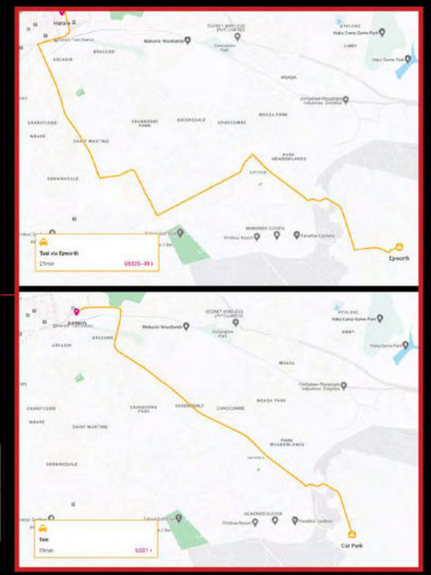
Satellite images of selected towns vs. corresponding city centers



Machine learning identifying urbanized vs. non-urbanized areas



Transportation options from neighboring towns to respective capital cities



Transportation comparison examples in Epworth

GROUND TRANSPORTATION ANALYSIS

Individuals residing in the selected sites located near the capital cities face significant challenges in accessing affordable and convenient means of transportation. Owning a personal vehicle is often financially unattainable, while the cost of hiring a taxi is exorbitant and may exceed a day's wage. Additionally, public buses are frequently time-consuming. Consequently, informal transportation modes often become the preferred choice for individuals needing to travel at night.

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