MIDTOWN

Right in the **MID**st of a climate resilient and vibrant Hous**TOWN**

COURSE
AR0086/93 | Infrastructure & Environmental Design

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ABSTRACT

MIDTOWN: RIGHT IN THE MIDST OF A CLIMATE RESILIENT AND A VIBRANT HOUSTOWN

KEYWORDS
Flood risk
Houston
Texas
Hurricane Harvey
Pluvial flooding
Flood resilience
Climate resilience
Urban beach
Bayou

Houston, TX is known for being flood prone. Recent disasters such as Hurricane Harvey (2017) severly damaged this city. Houston's flooding problem is caused by urban sprawl, the flatness of the city and the lack of policy. The urban sprawl increases the amount of concrete and limits the city's natural drainage, the flatness of the city means the water has nowhere to go, and the lack of policy causes a lack of stricter building regulations and zoning laws in regards to allowing developers to pave over crucial acres of land that could otherwise absorb rainwater.

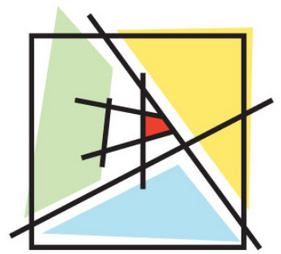
Recently the green light is given for the reroute project of the I–45 highway. The part of the I–45 between the districts of Midtown and Downtown will disappear. A new plan for this inbetween area is needed. In this report we will use an integrated approach to work from the biggest scale level of down towards the smallest scale level, combining the disciplines of urbanism, water mangement and infrastructure for the Midtown neighborhood of Houston.

The research question for this project is: "How can we make Midtown a flood and climate resilient, vibrant part of Houston?" Which will lead to our wider I–45 area vision.

We suggest to replace the I–45 with a lower level beach. The beach will function as a recreational public space and as a detention area for water in case of heavy rainfall. Around the beach there are mid rise buildings, and the beach will be connected to ditches that will be placed all over Midtown. Different measures of the 3 disciplines will be applied on 4 scales through passports containing guidelines based on the American grid system to realize a flood and climate resilient, vibrant Midtown. These sets of passports have great potential because they are also applicable in other neighborhood with the American grid system.

CONTENT

TOWARDS A FLOOD RESILIENT, CLIMATE RESILIENT, AND VIBRANT MIDTOWN



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INTRODUCTION

HOUSTON
MIDTOWN
HURRICANE HARVEY
SCOPING WORKSHOP

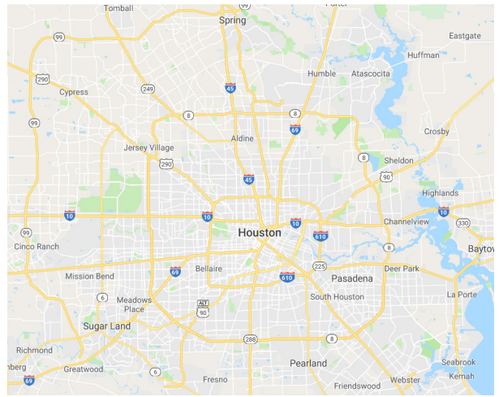

Fig.1.1 | Map of the USA highlighting Greater Houston (Sheridan, 2007). Fig.1.2 | Houston map (Google, n.d). Fig.1.3 | Houston panorama (Ligutti, 2014).

INTRODUCTION

HOUSTON | TEXAS | USA

In May 2019 we were the fortunate group to travel to Houston, Texas for our interdisciplinary design project. We attended lectures at Rice University, did a walking tour through Houston (very European) and presented our newly formed vision for the future of Houston. It is safe to say that we all experienced quite some culture shock when arriving in America.

We soon discovered that Houstonians completely depend to their cars, that there is asphalt and concrete everywhere, and that urban sprawl without any zoning laws can be quite a problem. Adding to this is the mindset of people. From our experience locals we discovered that they they are extremely kind to each other and to us, but not to the planet. Houston is the 4th largest city in the US with 2.3 million inhabitants (World Population Review, 2019). And their lifestyle choices are affecting the flood risk of the region.

How can future life in Houston be improved? How can we start shifting towards more sustainable behaviors? How can we prevent the devastating effects of disasters like Hurricane Harvey? How can we deal with water in a concrete, car depended city? In this report we will navigate a way towards a flood resilient and climate resilient future for Houston.

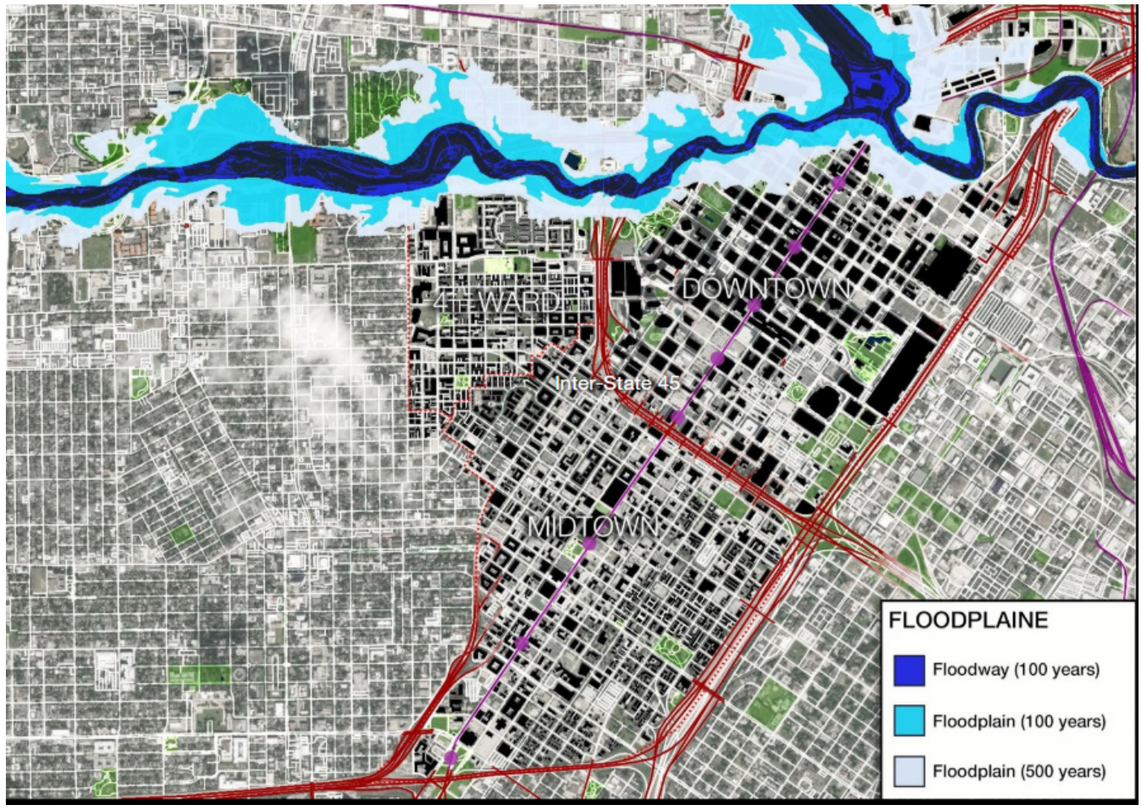

Fig. 1.4 | The three disctricts in relation to the floodplaine (Höller, 2019).

INTRODUCTION
MIDTOWN | HOUSTON

The starting point for our project is the partial removal of the I–45 of Houston's first ring. Three districts bordering this highway are Midtown, Downtown and the 4th Ward. Each project group chose to investigate one of these three neighbourhoods and for us it was Midtown. Each neighborhood has a distinct character and are quite different from each other. In terms of urban typology Midtown is a mixed–use neighborhood, Downtown is a business district, and the 4th Ward is a residential neighborhood.

When driving around Midtown, it sometimes feels as if a giant Monopoly board was dropped on the floor and someone hastily placed the hotels and houses together on random properties. This is all because of there is no zoning law in Houston (Ramirez, 2018) which causes urban sprawl. For comparison: you could fit Chicago, Washington D.C., Boston and Manhattan easily in Houston (Rentcafé, 2016).

We talked to locals in the streets and asked them what they think is the biggest issue in their neighborhood. Every person answered social security. And they did not mention flooding. When asked what he would like instead of the I–45 highway, one local answered "I'd like more parking space."

Our fieldtrip opened our eyes to the situation in Houston, and specifically Midtown. While we walked around idea's for improvement were discussed and the first steps towards our vision for Midtown's future were made.

Fig. 1.5 | Birdview Midtown (TFCL, n.d.)

Fig. 1.6 | Chenevert St (Google, n.d.)

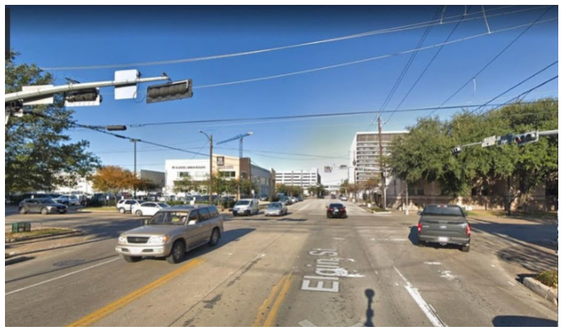

Fig. 1.7 | Elgin St (Google, n.d.)

Fig. 1.8 | Next to I–69 highway (Google, n.d.)

Fig. 1.9 | Gray St (Google, n.d.)

Flg.1.10 | The urban landscape of Houston makes flooding worse (Carson, n.d.).

INTRODUCTION
HURRICANE HARVEY

Hurricane Harvey was a Category 4 storm that hit Texas on August 25, 2017 and caused $125 billion in damage (National Hurricane Center, 2018). Around 13 million people were affected by the storm, and at least 88 people died. The flooding forced 39,000 people to abandon their homes (Amadeo, 2019). Hurricane Harvey damaged 204,000 homes, 75% were outside of the 100-year flood plain (Dempsey et al., 2018). Between 25 and 30 August 2017, hurricane Harvey dropped more than 1,300 mm of rain over and around Houston, leading to unprecedented flooding in large areas of the city (Smith et al., 2018). Houston has had the largest urban growth and the fifth-largest population growth in the US over the period 2001–2011 (Bounoua et al., 2018). The increase in asphalt and concrete has led to an increasing runoff ratio (the ratio between runoff and precipitation) across many watersheds in the area, pointing to reduced infiltration and larger runoff for a given rainfall value (Berke et al., 2018).

The increase in population and urbanization, combined with the flat clay terrain that characterizes this area, represents a very problematic mix from a flood perspective, despite the flood mitigation measures that have been put in place (Smith et al., 2018). Houston's urban landscape contributed directly to the torrential rainfall and deadly flooding during Hurricane Harvey and Houston's risk for extreme flooding during the hurricane was 21 times greater due to urbanization (Anderson Davy & Kelly, 2018).

Fig. 1.11 | Flooded neighborhood in Houston, TX (Fox News, 2017).

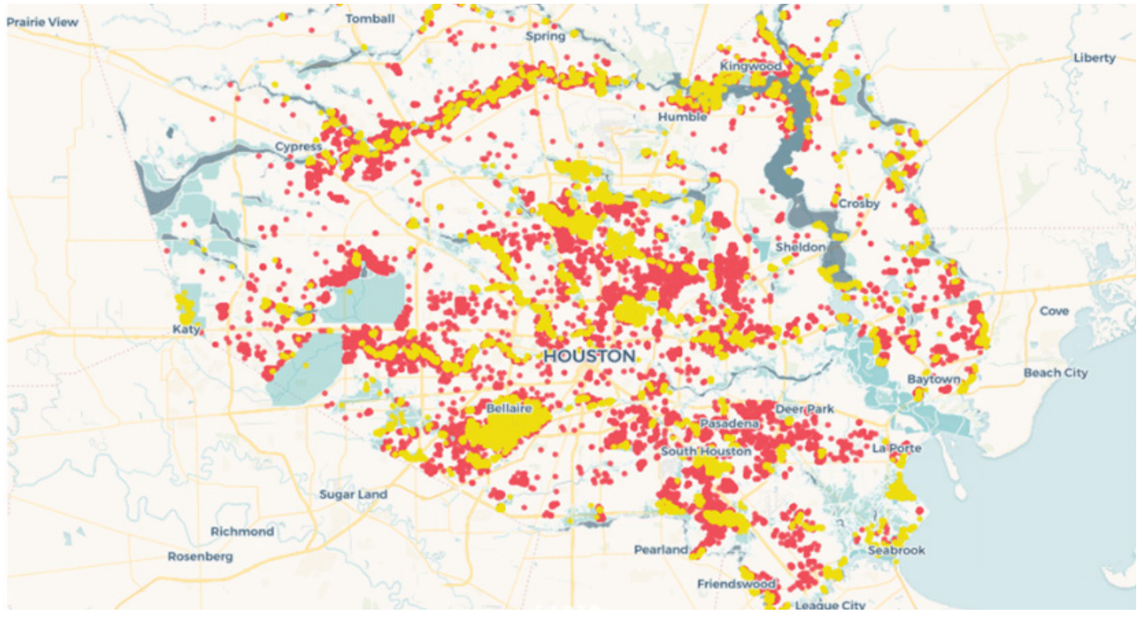

Fig. 1.12 | Flooded structures inside 100–year flood plane (yellow) and outside 100–year flood plane (red), (Harris County Flood Control District, 2018).

	URBANISM	TRAFFIC	WATER	CULTURE
Concept				
Fourth ward	Freedom town	Do minimal	Small steps Regulations for plots	Creating awareness / community driven Enforcing: regulations
Downtown	Manhattan concept	Optimising / enable active modes & PT	Small steps	
Midtown	Moderate densification / mixed use	Transit station		
I-45 corridor	Gradient densification	Connector for active modes & PT	Emergency retention	Facilitating: cycling corridor
Buffalo bayou	Living in park / Le Corbusier	Allen parkway as boulevard	Room for the river	Facilitating: cycling corridor

Fig. 1.13 | The main concepts of the different disciplines with the three project areas.

INTRODUCTION
SCOPING | HOUSTON WORKSHOP

During the workshop at Rice University we worked on the scoping of the three neighborhoods (Midtown, Downtown & the 4th Ward) in combination with the different disciplines of culture, traffic, water and urbanism. We started the charette scoping process by first making a scope for each individual subject. During this disciplinary scope we asked ourselves the questions:
– What do we know?
– What questions do we have?
– What examples do we have?
– What concepts can we define, as with its own strategy and set of measures?

The last scoping phase was when we lined our concepts out on PPP (people, planet, profit) and defined our project scope. Next to that, we also came together with our project groups for our first vision

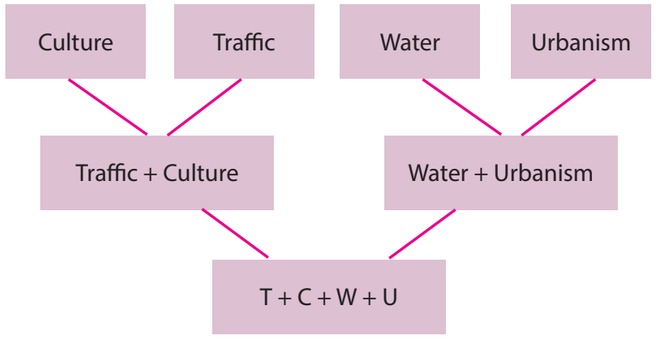

Fig. 1.14 | Scoping structure

discussion. For us this meant setting ambitions and goals as a group, with a motto for Midtown, but no measures yet.
– For the larger scale of the area: what do you think this replacement of the highway
can improve challenges of the are on the larger scale?
– For the district in relation to the highway area: how can the new dynamic on the
highway positively affect the district?

We continued then with combining culture + traffic scopes, and water + urbanism scopes. After several discussions one final scoping was made, which contained all elements (see Fig. 1.13 and 1.14). This led to the realization of 3 main concepts for each of the disciplines for the neighborhoods of Midtown, Downtown and the Fourth Ward.

CULTURE SCOPING

Three main concepts:

1. PROFIT DRIVEN
–Individualistic
–Focused on money
–Materialistic
–People want their own property with a lawn. This is enabled with infrastructure
–Not aware of /unwilling/scared for changes
–High carbon footprint
–No measures; no or minimal changes
–Very friendly people, but not for the planet

2. PROSPERITY DRIVEN = incentives & awareness to culture change
–Creating more awareness
–Facilitating changes in a positive way and in small steps
–Not only thinking about yourself, more about the bigger picture
–Start looking at alternatives and purpose
–Not only about money anymore
less car-dependent > facilitate active modes of transport

3. PURPOSE DRIVEN = enforce culture change
–Why are we doing it in this specific way?
–Sustainable development
–Thinking about the future = bigger picture
–Money is not the main factor anymore
–Low carbon footprint
–Done with the help of regulations

TRAFFIC SCOPING

WHAT DO WE KNOW?
Houston is a car centered society and a fast growing urban conglomeration. This resulted in a massive urban sprawl with a transport system that relies heavily on car use. The highway system is center orientated with multiple surrounding ring roads. Currently the construction of a 5th ring road has started. The current state of the infrastructure (road surface, signage and traffic coordination) is very poor with regards to Dutch standards. For example traffic lights are only on a timed cycle. Currently public transportation is scarce, however lately efforts have been made to implement a public transport system, this system is composed of a system of bus lines and three tramlines. There are plans for an additional two tramlines.

WHAT QUESTIONS DO WE HAVE?

Question 1: Would the grid structure remain?
– Downtown
– Midtown
– And further
Answer 1: While it could improve traffic flow, removing connection from the grid structure for Houstonians is like taking guns away from Texans. For example the removal of ten parking spaces to make way for a bike lane resulted in multiple lawsuit against the city of Houston. Getting Houstonians to drive even a half of a mile more is unlikely. Thus reducing the connections, even if it is just on the main road is difficult.

Question 2: Why is it needed to redirect traffic from the I–45?
Answer 2: The I–45 was officially built to relieve traffic from the I–69. However it also justified the partial demolishment of the Fourth Ward, a predominant black neighborhood. Currently the main traffic flow on the I–45 is through traffic. It is therefore possible to redirect traffic to the I–69 without much added travel time. Removal of the I–45 will release Downtown from the barrier that is the

I–45 and will open up a lot of new development areas.

Question 3: How does it affect accessibility of Downtown and Midtown?
Answer 3: Currently the highway is mostly through traffic. Furthermore no on ramp are being removed. Thus the accessibility will remain roughly the same. Also current simulations have shown little to no increase in the amount of traffic within Midtown.

Question 4: Is it feasible to implement smart traffic lights to improve traffic flows?
Answer 4: Yes, it would be feasible, but it still depends on the involved cost.

POLICY PACKAGE:
Do minimal; In this baseline proposal the I–45 will be torn down and through traffic will be redirected to the enhanced I–10 & I–69 corridor. No additional regulations will be implemented though. The mass transit line will be expanded by building of a new line in the form of a light rail vehicle system. These measures will provide a solid basis for the area to prosper. Additional property development will rely on private incentives. They will be very interested with the considering the raised quality of the area however.

OPTIMIZING THE CURRENT SYSTEM:
There is much to gain in Houston in addition to the baseline proposal. Current traffic lights have fixed timings. However, this system can be fine tuned. An intelligent traffic management system will be installed in the entire city to increase flow and thus facilitate future traffic levels. The traffic lights will predict traffic better with the help of ground loop detectors and other optical / electrical detectors. Big data will be used to analyse flow patterns and provide detailed traffic predictions on which the traffic management system can anticipate on. Accelerated expansion and build of new LRV mass transit lines with multiple convenient and centrally located park and ride facilities that will ease car traffic demand to Downtown.

HOUSTON SATELLITE CITY:
Houston will be transformed into a polycentric urban city. Multiple districts have areas with a higher concentration of commercial areas. These will be developed into worthy alternatives to the current CBD or sprawled out locations. These polycentric centres will be linked with a lot of public transit lines, with both LRV and metro rapid transit lines. This will lead to a modal shift to the CBD and less travel need to the centralised core overall. This will ease congestion.

CULTURE + TRAFFIC SCOPING
Concepts:
1. Profit driven and a lot of cars
2. Awareness for energy consumption
3. Public transport and active modes. Mixed land use > polycentric

WATER SCOPING
Problems from a water perspective:
–The drainage of rain in the city is insufficient for extreme weather events
–The urban planning around the flood plains

Feasible concept:
1. A small step for men but a giant step for mankind
–Creating greenspaces
–R/Detention areas (Willow waterhole)
–Water tanks for the roofs
–More ditches
–Bigger sewers and better maintenance (regularly removing trash from your neighbourhood storm sewers)
–Awareness about the problem (flooding, climate change, math)

In between concept:

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2. Forcing a difference
–Remove some impermeable infrastructure and replace with green space (assumption of reusing concrete)
–Stricter rules for urban planning on city scale (rules on green area, location of buildings at flood plains, buffer around the bayou)
–Room for the river program (ruimte voor de rivier)

Non feasible concept:
3. Surrender
–Telling people what to do
–Remove the city
–Move the people of Houston to a more suitable place in the USA

URBANISM SCOPING
Concept 2: Le Corbusier
– The concept of The Radiant City (Ville Radieuse).

The Radiant City is an unrealized urban masterplan by Le Corbusier from1924. It's designed to contain effective means of transportation, as well as an abundance of green space and sunlight. The city would not only provide residents with a better lifestyle, but would also contribute to create a better society.

Though radical and strict with order, symmetry and standardization, Le Corbusier's proposed principles had an extensive influence on modern urban planning and led to the development of new high-density housing typologies.

La Ville Radieuse promised future of sunshine, fresh air and greenery for city-dwellers. We think this concept, when adapted to the American context, fits best with the characteristics of the Midtown neighborhood.

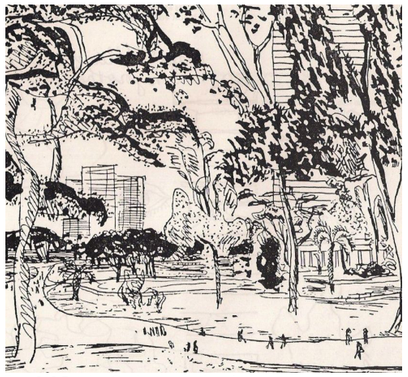
Fig. 1.15 | Le Corbusier's sketch illustrating the concept of the radiant city ("Ville Radieuse").

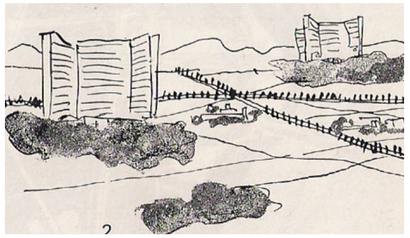
Fig. 1.16 | Le Corbusier's sketch illustrating the concept of the radiant city ("Ville Radieuse").

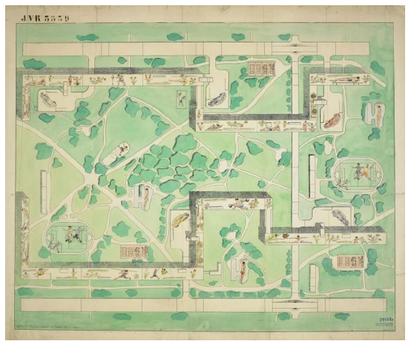
Fig. 1.17 | Topview of La Ville Radieuse by Le Corbusier


Fig. 1.18 | Scale model of Le Corbusier's Ville Radieuse concept, made by Philippe Bernon

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Concept 1: Frank Lloyd Wright
– The concept of Broadacre City

Structures in a Broadacre city ought to be organic and in harmony with humanity and the environment. There were farm units, factory units, roadside markets, leisure areas, schools and living spaces. Each living unit was given an acre to decorate.

The design was motor vehicle friendly, reflecting Wright's love for cars and the living units were called minimum houses. The design concept focused on the social right of every citizen, especially the family unit, to their place on land and air, where they were free to socialize. We think this concept fits best with the characteristics of the Fourth Ward neighborhood.

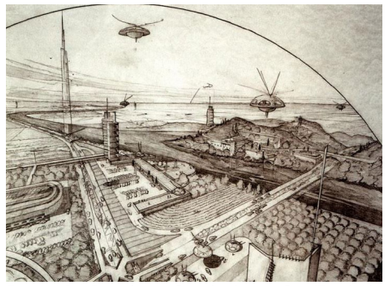
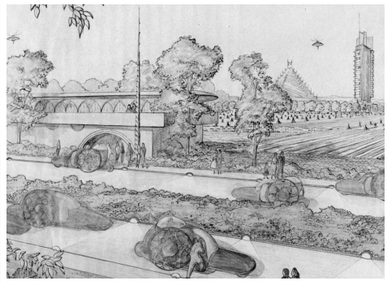



Fig. 1.19 | Broadacre City, the Living City (Frank Lloyd Wright, 1958).

Fig. 1.20 | Broadacre City of Frank Lloyd Wright (MoMA et al., n.d.)

Concept 3: Hong Kong
– A very densified city with new connectivity

Hong Kong is an extremely dense city. It appears to be a dense maze of skyscrapers. An interesting project realized in Hong Kong is The Central Elevated Walkay. It's a system with mid-levels escalator and walkway system and is the longest outdoor covered escalator system in the world.

The system covers over 800m in distance and traverses an elevation of over 135m from bottom to top. It opened in 1993 to provide an improved link between the Central and Mid-Levels districts on Hong Kong Island. We think this concept could fit best with the current characteristics of the Downtown neighborhood.

Fig. 1.21 | Central Elevated Walkway, Hong Kong (Asiatravelroutes, n.d.).

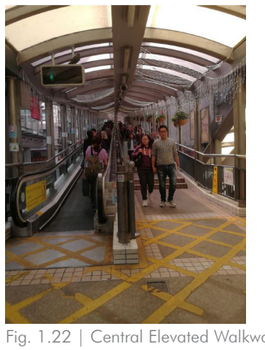


Fig. 1.22 | Central Elevated Walkway, Hong Kong, with escalators and stairs (Asiatravelroutes, n.d.).

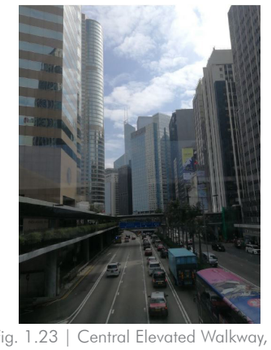
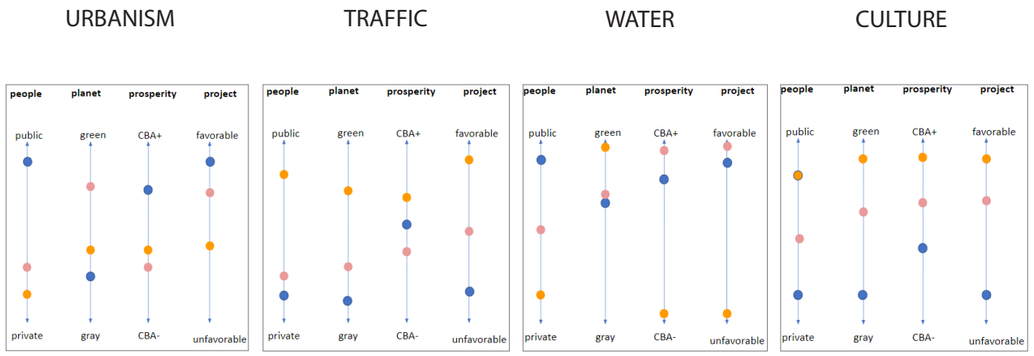


Fig. 1.23 | Central Elevated Walkway, Hong Kong, as seen from outside (Asiatravelroutes, n.d.).



Concept 1:	Frank Lloyd Wright	Do minimal	Small step for men...	Profit driven
Concept 2:	Le Corbusier	Optimising current system	Forcing a difference	Prosperity driven
Concept 3:	Hong Kong	Houston satellite city	Surrender	Purpose driven

Fig. 1.24 | Results of final scoping

URBANISM + WATER SCOPING

After discussing the Urbanism concepts with the Water concepts, we decided that the Urbanism concept 1 *'Frank Lloyd Wright'* fits best with Water concept 1 *'A small step for men but a giant step for mankind'* because both designs are based on scale of people rather than public scale. Water concept 2 *'Forcing a difference'* is also an option to combine this with as long as the local communities agrees upon bigger steps.

Urbanism concept 2 '*Le combusier*' creates a park with bigger and loose building typologies with mixed use. This creates enough room for big watermanagement purposes, therefore fits best with Water concept 2 *'Forcing a difference'. The 'small step…'* options can always be implemented next to this.

Urbanism concept 3 *The 'Manhattan/Shanghai'* idea is that the main buildings in the business area are all connected by a pedestrian road on a different level than the vehicles and fits best with Water concepts 2 and 1, and during extreme circumstances also Water concept 3 *'Surrender.*

CONCLUSION

In the final stage of the workshop we combined all the different scopes together. Conclusions were drawn for we want to achieve in for the future of each of the three neighborhoods

MIDTOWN:
Providing a solid basis for the area to prosper in a sustainable manner. Society will benefit from better transportation links, while profiting from a better walkable and recreational neighborhood. Enhanced climate resilience provides a safeguard for the future.

DOWNTOWN:
Creating a diverse and multilayered space with an extensive public transportation network and space to walk in a green area. Floodplains are respected and sustainability is achieved by densification and less car usage.

FOURTH WARD:
From controlling variables to complex systems with a shift from segregating boundaries towards gradient transitions to create synergies between neighbouring areas.

2 APPROACH

PROBLEM STATEMENT
RESEARCH QUESTION
METHOD

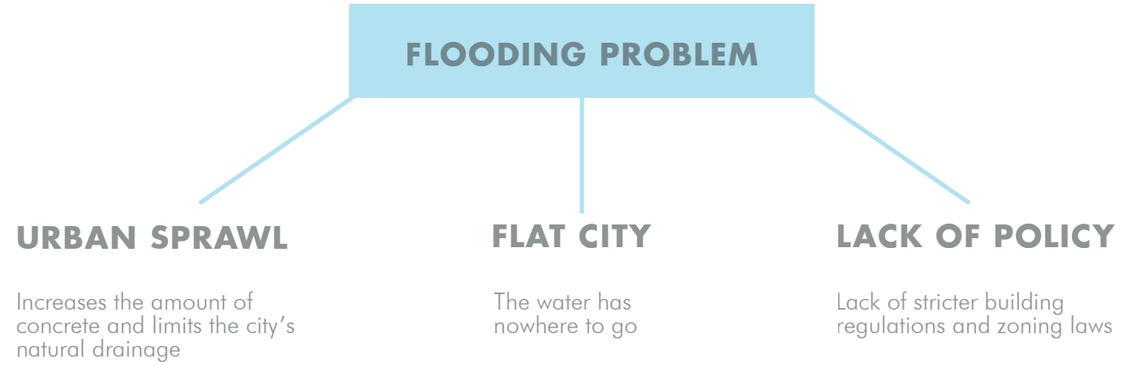


Fig. 2.1 | What are the main causes of Houston's flooding problem?

PROBLEM STATEMENT

HOUSTON, WE HAVE A PROBLEM...

A CITY DESIGNED TO FLOOD?
Not many cities are able to survive over 1 meter of rainfall unharmed. But Houston seems especially prone to floods; why is that?

Houston's characteristic urban sprawl causes low density development over a large area. There is a lot of concrete, less green space and this limits the city's natural drainage capacity (Resnick, 2017). In addition to this Houstonians are depended on their cars, which means more parking lots and thus more concrete and asphalt surfaces.

The flatness of the city makes drainage hard, because the water has nowhere to go (Resnick, 2017). And then there is the lack of policy. Local officials have largely snubbed stricter building regulations, allowing developers to pave over crucial acres of prairie land that once absorbed huge amounts of rainwater (Resnick, 2017).

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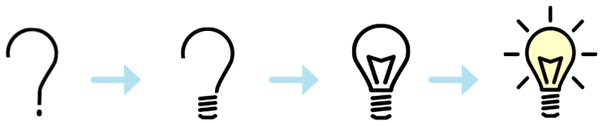
In addition to these problems, Midtown has its own site specific problems. There is a heavy presence of traffic and negative side effects this causes, such as (noise) pollution and traffic hazard. Then there is social insecurity experienced by the locals. Furthermore, certain parts of Midtown are very low rise and sometimes just empty, looking shabby and are definitely not inviting to passers–by. The neigborhood lacks public green space and recreational areas, having only one park for a 3000 km^2 neighborhood.



"HOW CAN MIDTOWN BE TRANSFORMED INTO A FLOOD AND CLIMATE RESILIENT, VIBRANT PART OF HOUSTON?"

Fig. 2.2 | Research question

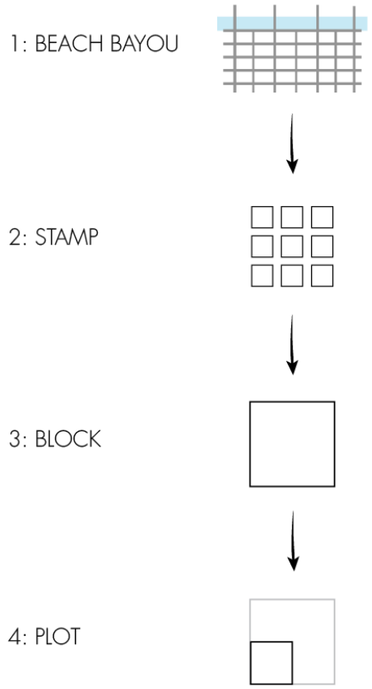


Fig. 2.3 | The four scales

RESEARCH QUESTION

FROM PROBLEM TO QUESTION

Based on the domain scoping and the problem statement on the previous page and our experiences during the Midtown site visit, the next research question was constructed:

"How can we make Midtown a flood and climate resilient, vibrant part of Houston?"

Which will lead to our wider I–45 area vision. During the proces we continuously worked with the three disciplines of urbanism, water and infrastructure to create a flood resilient design for Midtown.

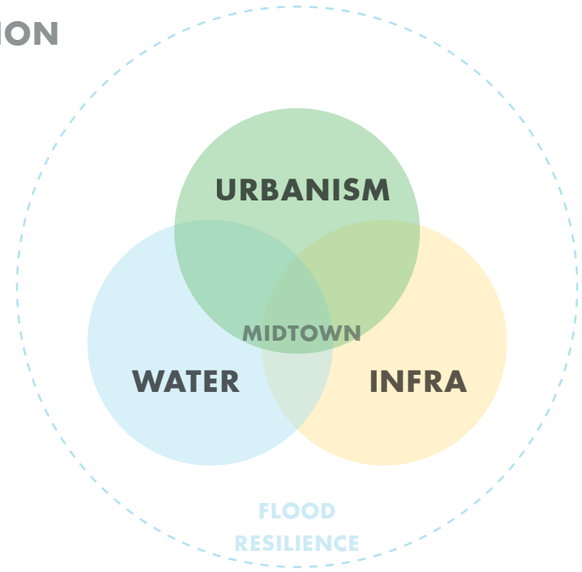


Fig. 2.4 | Methodology

	URBANISM	WATER	INFRASTRUCTURE
SCALE 1	**STRUCTURE**		
	Infrastructure	Room for the river	I–45 reroute
SCALE 2	**STAMP**		
	Stamp passport	Main ditches	Public transport Reversible lanes
SCALE 3	**BLOCK**		
	Block passport	Green ditches	Active modes of transportation
SCALE 4	**PLOT**		
	Plot passport	Water tanks	Ground floor parking

Fig. 2.5 | The four different scales combined with the disciplines urbanism, water management and infrastructure

METHOD

INTERDISCIPLINARY APPROACH

We use this integrated approach to work from the biggest scale level of down towards the smallest scale level of individual plots.

We will start with the bigget scale of the main structure of the area we are working with, then move down towards stamp scale (which includes 9 blocks of the original grid), towards block scale (which is only 1 block of the original grid), towards plot scale (which is each indiviually owned piece of property on each block).

Meanwhile we continue to include elements of each of the three disciplines of urbanism, water and infrastructure into our design. Conclusions will be made based on the three disciplines that are assembled per layer. A more in depth explanation of the structure will be given in Chapter 4 on page 29.

Connected to these levels are the passports for each one that contains guidelines which each entity must include. These passports allow for spatial variablity within these rules and act as a guideline for the development of the urban fabric.

3

CONTEXT ANALYSIS

FUNCTION
URBAN TYPOLOGY
RICE UNIVERSITY LECTURES
FLOOD MANAGEMENT
HARVEY DISASTER
HARVEY AFTERMATH
BARRIER
ACCESIBILITY
I-45 REROUTE
NEGATIVE EXTERNALITIES
OPPORTUNITIES

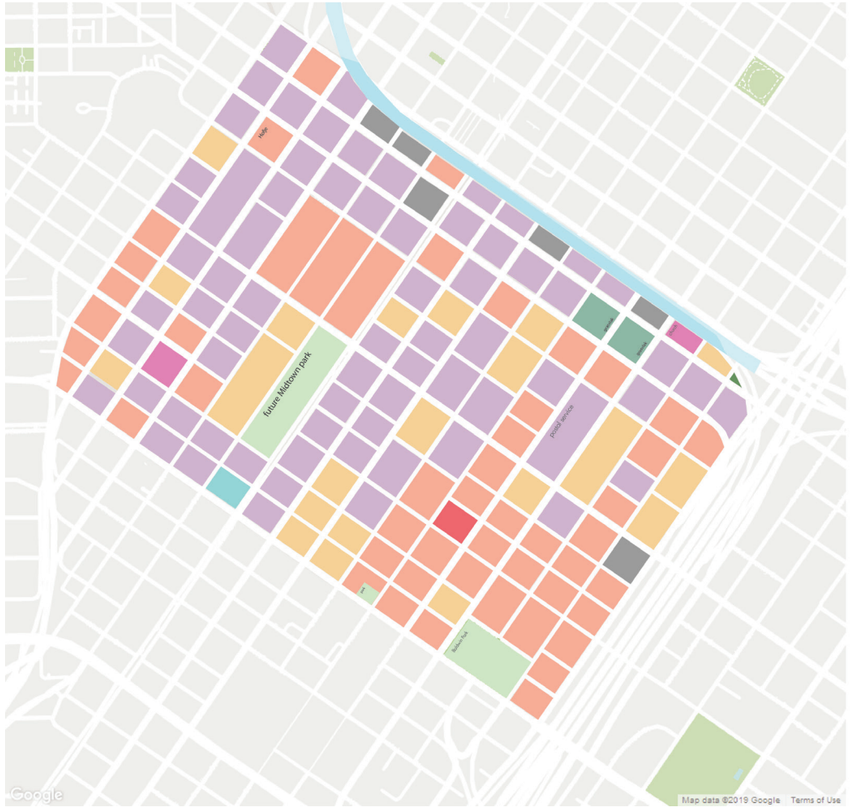


Fig 3.1 | Function map Midtown.

FUNCTION
MIXED-USE

Midtown is known for its mixed–use typology. There are many small scale companies present, especially in the North–Western part, with housing clusteres on the South–Eastern part. In between there are many mixed–use blocks present.

Characteristic for the company blocks is that the whole block is occupied with only one medium sized buildings, that is completly surrounded by concrete parking lots. Close to these companies there are also some blocks that are completely used for parking alone. Then there is the housing, scathered all over Midtown. Midtown is not an extremely rich neighborhood, but there are quite some differences between certain parts of Midtown. About one fifth of the Midtown residents live below the Poverty Level (American Community Survey, 2017). Many residential buildings are also built alongside the I–69 highway.

Very little green space like parks is present, only two for the whole of Midtown. For the majority of Midtown this means a 15–25 min walk to reach the park, which discourage the use of them.

Fig. 3.2 | Louisiana St: Small businesses, with attached parking lots

Fig. 3.3 | Drew St: One of many parking lots

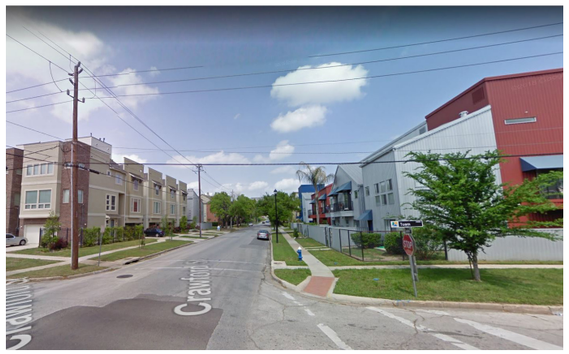


Fig. 3.4 | Crawford St: family homes, both attached and unattached.

Fig. 3.5 | Gray St: Cafes under 4 story apartments buildings

All images by (Google, 2019)

Fig. 3.6 | San Jacinto St: Low rise buildings

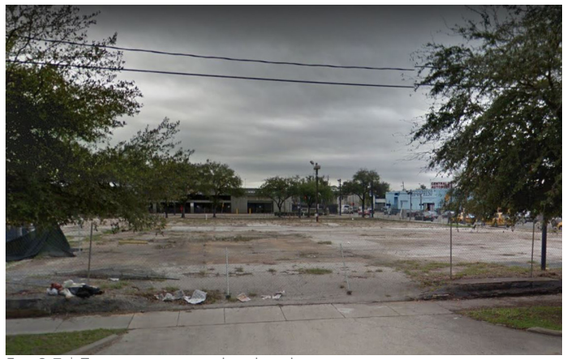


Fig. 3.7 | Travis street: unused parking lot

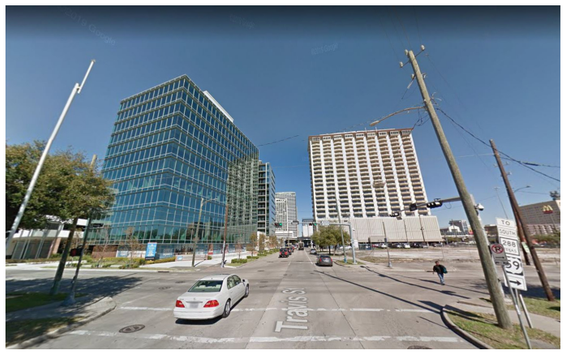


Fig. 3.8 | Travis St: High rise buildings near Downtown

Fig. 3.9 | Lousiana St: New building typology introduced in Midtown

URBAN TYPOLOGY

MIXED-USE

Midtown is quite a mixture of building typologies. It's possible to take one turn to the left and you will find yourself in a completely different environment. During our site visit we took note of the most occuring and prominent building typologies. These are eight of those building typologies we came across with in Midtown:

1. Small businesses with large parking lots. Half of the time they were unmaintained buildings, not very inviting.

2. Only parking. Especially in the northern part of Midtown there were complete blocks in the grid (100x100m) that were only for parking.

3. Family homes make up a large part of the residential housing (the other part are apartments). They are both attached and unattached houses, mostly 2–3 stories high.

4. Apartments mixed with cafes/ restaurants on the ground floor. This causes a more vibrant and inviting atmosphere on the streets.

5. Low rise buildings mostly 1–2 stories high and a mixe–use of small businesses (like sport club for example) and apartments. Most 1 story buildings are very shabby, and sometimes vacated.

6. Unused/underused parking lots. For some reason we saw them on several spots in Midtown.

7. There are several high rise buildings, both for residential and business functions. The majority of these are located close to Downtown, near the I–45 highway.

8. New building typology of five story high buildings, with parking on the ground floor, and often with a courtyard in the middle. These buildings are recently build and have a lot of potential for the Midtown neighborhood.

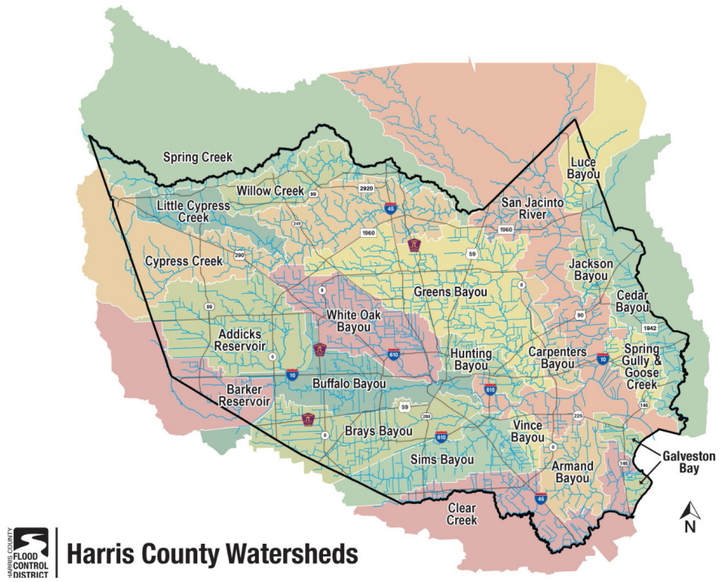


Fig. 3.10 | Harris county watersheds (Harris County Flood Control District, 2018).

RICE UNIVERSITY LECTURES

SAMUEL BRODY, PHILIP BEDIENT, ALBERT POPE, KYLE SHELTON

"IT TAKES 6 INCHES OF RAIN TO KILL SOMEONE IN HOUSTON"
During our visit to Rice University, we attended a lecture about Houston's vulnerability to floods and extreme weather by Samuel Brody, professor at the departments of marine sciences and landscape architecture and urban planning at Texas A&M University.

During his presentation he explained to us why Houston is the city with most flooding in the U.S. The main reasons were tropical storm, hurricanes, poorly drained soils, flat topography, and floodplains. Another problem is that the draining maintenance is not working, which causes clogged drains. And only it takes only 6 inches (0.15m) of rain to kill someone in Houston.

Brays Bayou is an area bordering on Buffalo bayou, where the flood problems are worse. Floodplains also expand.

Insurance against flooding is possible, but insurance is accepted failure. In the state of Texas (and also Florida) there is no state income tax. This causes the Texas property tax to be one of the highest property taxes in the U.S.

There is also a switch in what Houstonians want in a home. In the 1980s it was common to have big yards with smaller houses. Nowadays this is quite the opposite, with houses that take up as much of the property ground as possible.

"AMERICANS ARE NOT USED TO PUMPING WATER"
Another lecture was given about the Post Harvey Area: Lessons from Hurricane Harvey by Philip Bedient, Professor of Engineering in Civil and Environmental Engineering at Rice University.

Another aspect that causes the flooding in Houston is the impermeable clay layer that is the ground. This clay is 100 feet think (about 30m). In fact most ground in Texas is clay soils, except in the far North-West. Moving soil and replacing is too much money.

One problem area in terms of flooding during Hurricane Harvey is where the White Oaks Bayou meets the Buffalo Bayou. There is a plan for a part of the White Oak Bayou that right now has a sharp twist, will be cut off and redirected (see drawing).

Meyerland is a neighborhood in Houston. They started to elevate houses 6-8 feet (1.8-2.4m). Those lifted houses are still there after Hurricane Harvey. It's either lifted houses, or abandoned houses. Most buildings that are built here are made of wood.

One important thing to know about Americans, is that they are not used to pumping water.

But there are small improvements beginning in Houston. For example Bagby street in Midtown. The city has realized a rain garden infrastructure and small detention areas (the ditches). Houston is willing to do anything these days (against flooding).

"WATER'S GONNA BE WATER"
Albert Pope, professor of Architecture at Rice University, welcomed us with a lecture on the urban implications of climate change and new models of density.

How to address problem of climate change? Right now the density impact per capita consumption of energy and carbon emission is a huge problem. And Houston doesn't deal with it because they don't see a solution for the problem. So you don't embrace the problem.

Houston has a plan grid, characteristic to most American cities. There have been engineering attempts to control the floods, yet not effective enough during Hurricane Harvey.

Another issue is economic inequality. The lower areas in Houston, which are more prone to flooding, are also the places where the cheaper housing is located. Recognizing value causes gentrification. It starts moving housing out and building new, expensive housing. After Hurricane Harvey also richer households were affected by the flooding, which caused dialogue about flooding to become more serious. Around 2020 there is a chance that the flood is going to reach a trump estate. Probably then real action is going to be taken.

So there are different issues that need to change to prevent flooding. A culture change is need. Is it possible? Yes, historically it happened before

Part of the strategies and tactics includes that fact that in Houston the urban cycle for general buildings is 25 years, for houses it is 70 years. This gives us the opportunity to rebuild better housing, causing the city to evolve in a way that makes sense in the future. Policies won't work here.

There is friction between the car scale vs human scale. Car value is a problem everywhere in the U.S. Houston needs to be more humanized. "Oh, you're so European" was professor Pope's reaction when we told him that we walked through Houston for an entire afternoon the day before.

"NO REGULATIONS, ONLY FREEDOM"
Kyle Shelton, director of strategic partnerships at Rice University's Kinder Institute for Urban Research, talked to us about urban development, transportation and placemaking, as well as urban and metropolitan governance.

Developers want to make money, people want cheap houses. Developers think in value, profit, and prosperity. This causes unsustainable development of cities.

The I–45 highway doesn't stop in Downtown, there is no exit so it's meant to drive through it. The highway was originally built in its current location to segregate the historically more prosperous Downtown from the poorer neighborhoods of Midtown and the Fourth Ward. Houstonians also drive to parking spot and take a bus to Downtown from there.

There's no planning authority. There are no rules, only sueing. There is no policy and regulation, only freedom. Houstonians want to see a pilot project in Houston first. Otherwise they don't tend to accept it. This causes a vicious circle, worsening the situation.

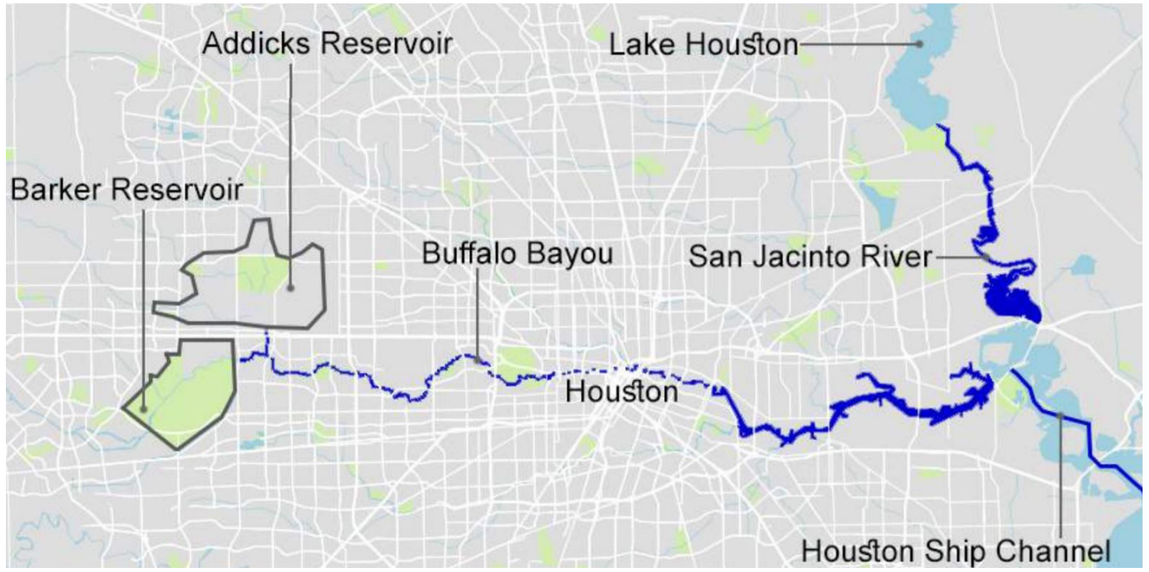


Fig. 3.11 | Diagram depicting Addicks and Barker reservoirs and their location relative to Houston (Brand et al., 2017).

FLOOD MANAGEMENT

In Houston, flooding is never a matter of 'if', but only 'when'. Intense rainfalls, characteristic of the Gulf of Mexico and brought about by tropical cyclones or strong convective systems, have the potential to drop extreme rainfall over the region (Brand et al., 2017).

With more than 1,500 bayous and creeks within the county totaling approx. 4023 km in length, the Harris County Flood Control District (HCFCD) is responsible for devising flood risk reduction plans, implementing them, and monitoring and maintaining infrastructure (Brand et al., 2017).

To alleviate flooding in downtown Houston the HCFCD designed and built two flood control reservoirs in the upstream portion of the Buffalo Bayou watershed, west of downtown Houston. The two reservoirs, Addicks and Barker, were completed in the 1940s. Several small creeks feed the reservoirs during normal events and Addicks also holds overflows from Cypress Creek during extreme events. The dams consist of earthen levees with a total height of 37m (Addicks) and 34m (Barker) and are equipped with flow gates to release water into Buffalo Bayou (Brand et al., 2017). In recent years, both Addicks and Barker have discovered to be at etremely high risk. Inspections revealed cracks and voids in and under the dams Repair and reinforcement renovations started in 2012 and are still on-going.

To manage overland flooding in urban areas there are storm water systems. Most of them consist of concrete pipes and in some older neighborhoods they are roadside ditches and are used to route water into the creeks and bayous. These systems are designed to handle the 5–10 year 24 hour rainfall totals at minimum. For larger storm events, the street network acts as a secondary drainage system (Brand et al., 2017).

In addition, there are several large on-going structural projects in Harris County, aimed at reducing the impacts of flooding in the watersheds. There are also several examples of successful buyout programs in which flood prone neighborhoods have been converted into detention areas, like the Bretshire. (Brand et al., 2017).

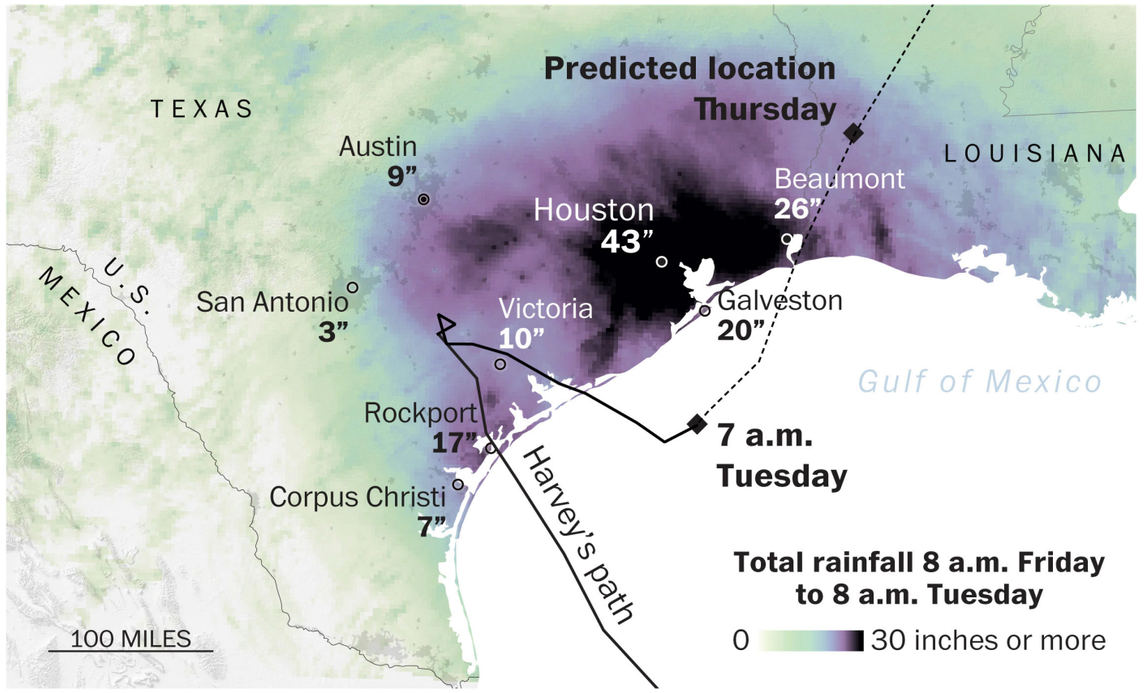


Fig. 3.12 | Total rainfall in Houston during Hurrican Harvey, (Washington Post, 2017).

DISASTERS

HURRICANE HARVEY

Hurricanes bring damaging winds and rainfall. The biggest danger to Houston with Hurricane Harvey was the overwhelming rainfall. The rain quickly filled up reservoirs and waterways. The totals were record–breaking in some areas (Houston Community Data Connections, n.d.)

Like the western plains of Texas, Houston never really has been controlled. For so many years, development patterns in Houston have approached nature as an adversary, laying ever more concrete and exploiting its flat surface, ever chasing the bottom line. American experts, journalists, and politicians are keen to deny a causal relationship between Houston's lack of zoning and Harvey's destruction (Vest, 2017).

But perhaps Harvey has exacted extreme enough damage take what has worked in a few parks and neighborhoods here and there, and scale up working with nature.

Midtown was also partially flooded by the extreme rainfall, especially northern and eastern parts near the highways had to deal with flooding, as can be seen on the pictures on the next page.

It's never too late to address the flooding issue. Due to climate change more extreme downpoors might occur in the future. If nothing is to be done, it's only going to become worse over time. Hurricane Harvey woke people up. Now it's time for things to change. We can always do more. In this report we propose our solution to the situation, with a focus on Midtown neighborhood of Houston.

HURRICANE HARVEY
AFTERMATH

Three and a half months after the Hurricane Harvey two large meetings were held. One pres conference, the other a forum on repsonses to the storm. They represent the two poles of power that will both help to determine Houston's future.

The press conference was organized during the annual meeting of the American Geophysical Union (AGU) in New Orleans. Dozens of science journalists, researchers, and university PR officials attended the meeting.

The Houston Chronicle organised a forum on responses to the storm, laden with emotional tales of storm damage. Hundreds of citizens packed into a hall at the paper; seven local policymakers and professors tossed out ideas for securing Houston's future. It was a deadly and expensive brush with nature—and an intensity that could become the new normal.

Harvey, the worst storm to ever strike the area, demonstrated once again that Houston's citizens are at mortal risk when the city floods.

Scientists say that the risk is rising and the city's leaders and citizens struggle to face and fund an inevitably costly plan to keep Houston safe. And Houston is not alone: climate change affects the occurrence of extreme weather all around the world. Recently devastating floods took place elsewhere, like in India, Bangladesh, and Nepal (Grossman, 2018).

All these events pose challenges for recovery and hold lessons for other cities around the world.

Fig. 3.13 | Flooding in Midtown
1. People stranded on I–45 ramp in Midtown.
2. Submerged I–69 and Downtown skyline in background, seen from Midtown.
3. I–69/I–49 interchange submerged under severe flooding in Midtown. (Brewer & Drake, 2017).
4–6: Flooding in residential area in Midtown on Drew St and Chenevert St intersection (Chen, 2017).

Fig. 3.14 | Highway barrier between Midtown and Downtown (Google, n.d.)

Fig. 3.15 | Parking lots under the highway (Google, n.d.)

Fig. 3.16 | Midtown on the left, Downtown on the right (Google, n.d.)

Fig. 3.17 | Contrast between Downtown (left) en Midtown (right), with the I–45 highway in the middle, seperating the two districts (Google, n.d.)

BARRIER
BETWEEN MIDTOWN AND DOWNTOWN

Currently the barrier between Midtown and Downtown is an 'Inbetween space'. Most of the space near and underneath the I–45 highway is now used for parking lots, or is just empty. There is no available green space, no open water anywhere, and most notably, no people walking on the streets.

The noise and air is quite bad, yet there are apartment building situated right next to the highway. We have seen several camp sites of homeless people, which was quite a shock.

There is a lot of traffic going on between Midtown and Downtown. Downtown is an important connection to Midtown. After all, it is the business district with a lot of jobs and facilities. All in all, the I–45 highway is quite an effective barrier between Midtown and Downtown right now.

The question is, when the I–45 between Midtown and Downtown is removed, do we want to keep some kind of barrier seperating the two districts, or do we want Downtown to flow over into Midtown?

We think it is important to highlight the characteristics of Midtown itself, and show that it has more potential than just being near Downtown. This reasoning leads to our vision proposal, which will continue to include a barrier between the two districts, but with a much more positive impact for the residents and environment, including water management. A further in depth explanation for this is given starting from page 36.

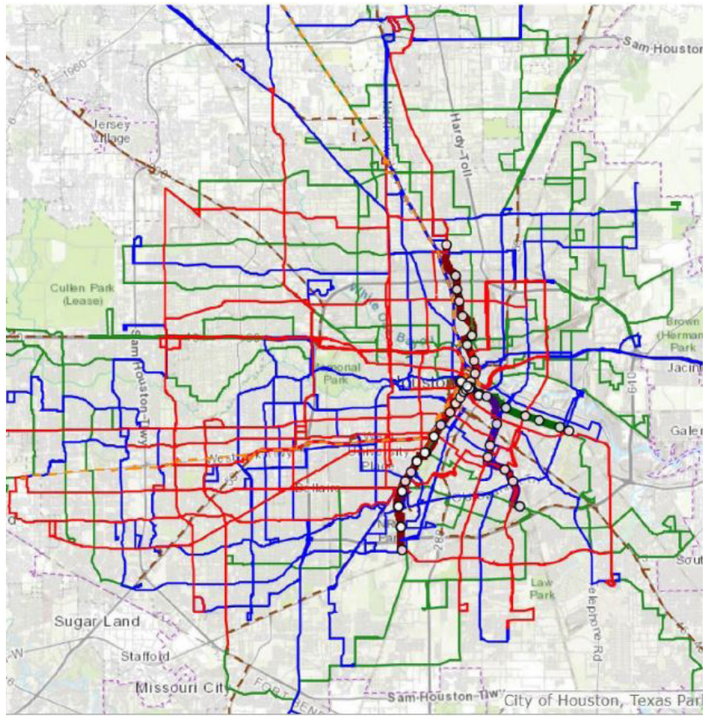


Fig. 3.18 | Accesibility by public transport modes. Bus lines are in red (every 15min or less), blue (every 20-30 min), and green (every 60 min). The METRO-rail lines are the the thicker lines in the middle (there are 3 METROrail lines) with the white dots for rail stations (ArcGis, 2019).

ACCESIBILITY
PUBLIC TRANSPORT MODES

It's no surprise that most of Houstonians depend on their car. Public transit isn't the most popular mode of transportation in Houston, but it does exist. Nearly five million people take the city's local METRO buses every month, with another two million using the METRORail train and commuter network's park & rides (Correll, 2019). It might take quite some more time than driving, but the public transport network is still being improved.

Rides on local buses are $1.25. Local bus routes run every day of the week, but how often and how long can vary. Higher traffic buses run every 15 minutes (or less), while lighter routes might only be scheduled every hour. METRO buses, platforms and trains are accessible to people with disabilities, including having ramps, designated seating (Correll, 2019).
Houston's light rail isn't long: 35km of track. The METRORail has three lines, but the longest and most utilized is the Red Line. This track connects some of Houston's busiest neighborhoods, including Downtown, Midtown, the Museum District and the Texas Medical Center. Fares are $1.25/ride (Correll, 2019).

Houston is massive and local bus and train routes can only go to so many places. In those cases, direct commuter buses, bike– and ride–shares and rental cars might be a better bet.

The map above shows the proximity range of the public transport modes of Houston. Accesibility based on the different types of public transport and their area of influence still doesn't compare to the wide range accesibility by car.

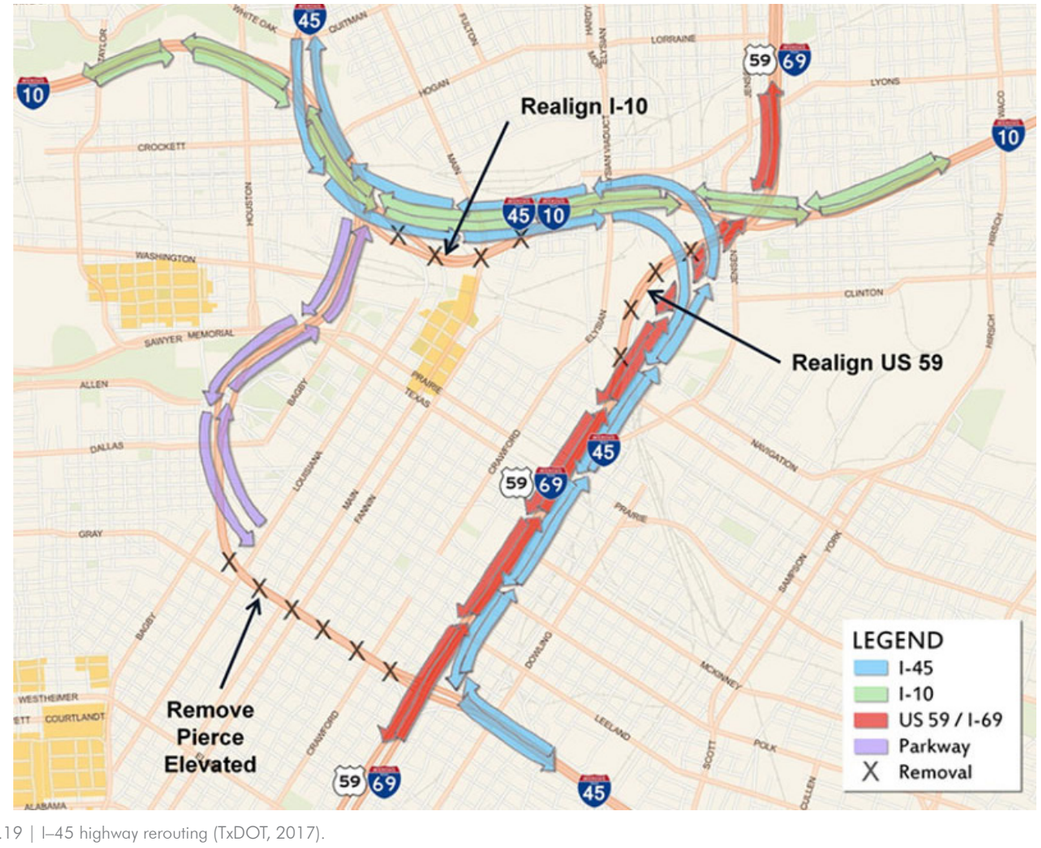


Fig. 3.19 | I–45 highway rerouting (TxDOT, 2017).

REROUTE
I-45

The relocation of the highway is the driver of our project.

The Houston metropolitan region is home to more than six million people and an economic hub for many different industries and has - next to large exposure to hurricanes – to deal with fluvial and pluvial flooding. Big flooding in 2017 disrupted large parts of the city and accommodation water since then has to be incorporated in the cities' economy, population and built environment that are still growing rapidly.

Houston itself is famous for its urban sprawl, car-dependency and lack of zoning laws, issues that need to be adapting to the effects of climate change. Our project will deal with pluvial flooding and changing infrastructure.

The case is the reroute of the I-45 around the metropoles core, giving room for urban development, nature and water. The potential of the reroute on the larger scale of ecological and hydrological improvement of the city are explored, and how this affects the development options of Midtown on a smaller scale.

The I–45 reroute project will start in late 2020.

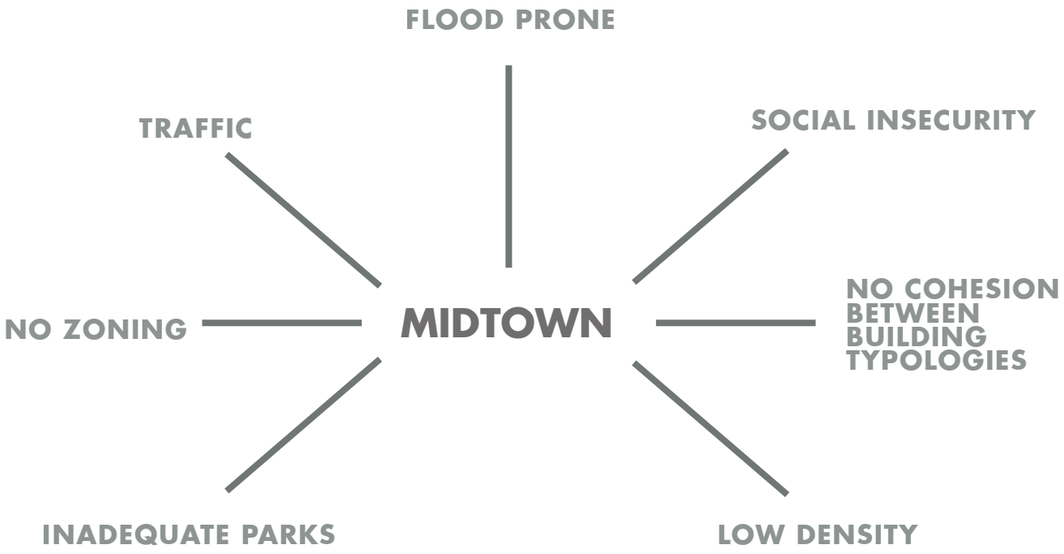


Fig. 3.20 | What negative externalities is Midtown dealing with?

NEGATIVE EXTERNALITIES
WHAT TO DEAL WITH?

CURRENT ISSUES OF MIDTOWN

There is a lot of presence of traffic. The traffic inside Midtown is heavy on the road going to and from Downtown. Additionally, there is the I–45 highway in the north and I–69 highway on the east that also cause negative side effects as such as (noise) pollution.

From our talks to local people in Midtown, we discovered that they believe the most pressing issue of Midtown is social insecurity, mostly due to homeless people (in their words).

Next to that the area is prone to flooding during heavy rainfall. Much of the existing buildings are low rise, not inviting to passers–by and very low dense.

From our function analysis it can be concluded that the majority of Midtown is built up, either with buildings or concrete, without much green parks or recreational areas.

The absence of zoning makes it harder to control the implementation of environmental friendly measures, such as permeable surfaces. The building typologies are also very varied, with no clear cohesion among each other.

Our redevelopment of the Midtown area will aid these current issues.

- ✓ Space for new development
- ✓ Location near downtown
- ✓ Already a good start for further development of a characteristic new buidling typology for Midtown
- ✓ Good connectivity
- ✓ Cosy bars, nice shopping boutiques and night clubs
- ✓ Midtown's location is outside the Buffalo Bayou 100 & 500 year floodplaine

Fig. 3.21 | Midtown's strengths

OPPORTUNITIES
FOR THE FUTURE

Despite these negative externalities, we see potential for a flood resilient, climate resilient and vibrant Midtown in the future. The current low density urban fabric of Midtown also means that there is a lot available space for new development.

Another important advantage is Midtown's location near Downtown. We are aware of the fact that Midtown has more strengths than just being close to Downtown, yet it is undeniably an important factor for why people might want to settle here.

There are architectural qualities scattered around several places in Midtown. Like the buidling typology of 5 story housing with ground level parking. This is a good start for further development of a characteristic new buidling typology for Midtown.

Then there is the good connectivity with the freeways I–45 en I–69 closeby, and the presence of the red line of the METROrail system. And of course several busses make their routes through Midtown.

Cosy bars, nice shopping boutiques and many night clubs have potential to make Midtown a dynamic neighborhood. Most of these are located on the west side of Midtown. Another important aspect is the fact that Midtown's location is outside the Buffalo Bayou 100 & 500 year floodplain, see fig.1.4.

And the potential of the I–45 reroute on the larger scale of ecological and hydrological improvement of the city. This, and how this will affect the development options of Midtown on a smaller scale will be further explored.

4

VISION

PROPOSAL
POLICIES
STRUCTURE
SCALE 1: STRUCTURE
SCALE 2: STAMPS
SCALE 3: BLOCKS
SCALE 4: PLOTS

Fig. 4.1 | Outdoor gym (Steele, 2015).

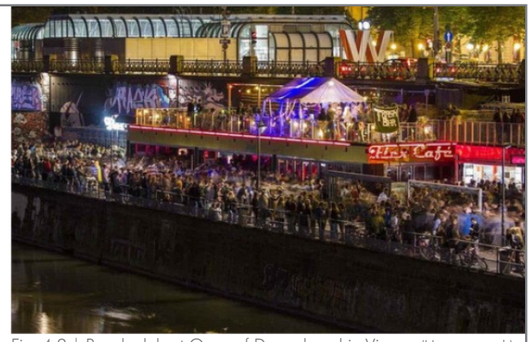


Fig. 4.2 | Beach club at Quay of Donaukanal in Vienna (Hennesy, n.d.).

Fig. 4.3 | Water education park at Maeslantkering in Hook of Holland, the Netherlands (Het Keringhuis, n.d.).

Fig. 4.4 | Voie Georges Pompidou in Paris (Cuor Business, 2013).

VISION
PROPOSAL

The combination of our research question, the scoping workshop and our experiences in Houston led to the following vision for Midtown:

WIDER I-45 AREA VISION
A mixed green blue recreational oasis within the city with the option to store ample surplus water during heavy rainfall will be created.

PROPOSAL
The area where currently the I–45 is located will become a detention area for surplus water. This basin will get a recreational area in the form of an urban beach on the side of Midtown, inspired by city beaches such as those in Vienna and Paris .In addition to this, the Midtown area will be densified and a new building typology of five story high buildings will be introduced. Together this will create a new spatial character for Midtown in a water resilient way.

RECREATIONAL DEVELOPMENT
– Outdoor gym: As elsewhere in Houston: Buffalo Bayou, Benwood Park. It will nudge healthy behaviour and social security will benefit from run-up.
– Cafes + bars: Opening of cafes and bars on the urban beach. Attractive and vibrant atmosphere. Provides amenities
– Patios with parasols: Provides a pleasant habitat with shade. Aides stay in soaring temperatures.
– Playground for children: with educational water management element.

Fig. 4.5 | People enjoying the sand at Paris urban beach (Rosa, n.d.)

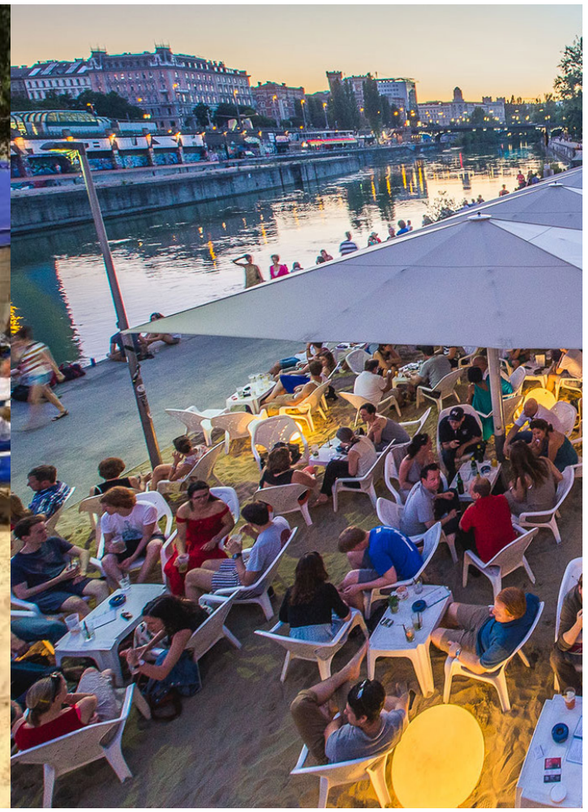
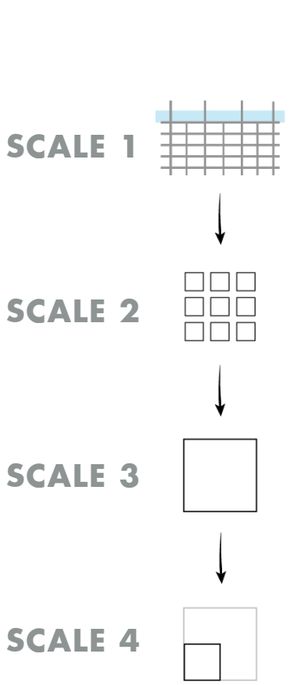


Fig. 4.6 | Urban beach cafe in the evening, Vienna (Hostel Wien, 2015).



	URBANISM	WATER	INFRASTRUCTURE
SCALE 1	**STRUCTURE**		
	Beach bayou	Room for the river	I–45 reroute
SCALE 2	**STAMP**		
	Stamp passport	Main ditches	Public transport Reversible lanes
SCALE 3	**BLOCK**		
	Block passport	Green ditches	Active modes of transportation
SCALE 4	**PLOT**		
	Plot passport	Water tanks	Ground floor parking

Fig. 4.7 | The four different scales combined with the disciplines urbanism, water management and infrastructure

VISION
POLICIES

SECURITY POLICY
Social security will be safeguarded with restricted access control.The urban beach will be closed off during after hours, to prevent undesired flocking of homeless people. Social security will also be incorporated in the design of the open areas.

ENVIRONMENTAL AWARENESS
The embankment walls near the water will have no advertisements. Instead, socially desired ads are going to be put up to promote environmentally friendly behaviors. This includes practical information about the urban beach, information about the combined watershed and recreational function, and promotion of the public transit system.

STEPPING STONE
The redevelopment of the I–45 corridor will provide a stepping stone to boost the quality of life in the Midtown district and beyond.
Midtown will flourish if:

– Vehicle emissions are reduced
– Provision of a modal shift change to facilitate better walkability and more public transport options.
– Social security is increased
– Resilience against high water levels is raised
– Expanded recreation possibilities
– Area development is improved via passport guidelines.

VISION
STRUCTURE

We use this integrated approach to work from the biggest scale level, down towards the smallest scale level of individual plots. Conclusions will be made based on the three disciplines that are assembled per layer. Connected to these levels are the passports that contain rules which each entity must include. These passports allow for spatial variablity within these rules and act as a guideline for the urban fabric.

The passports relate to the spatial interventions for urbanism, water management and infrastructure. In fig.4.7 the main design interventions are shown per each scale and discipline. In the next pages all scale interventions will be explained in depth.

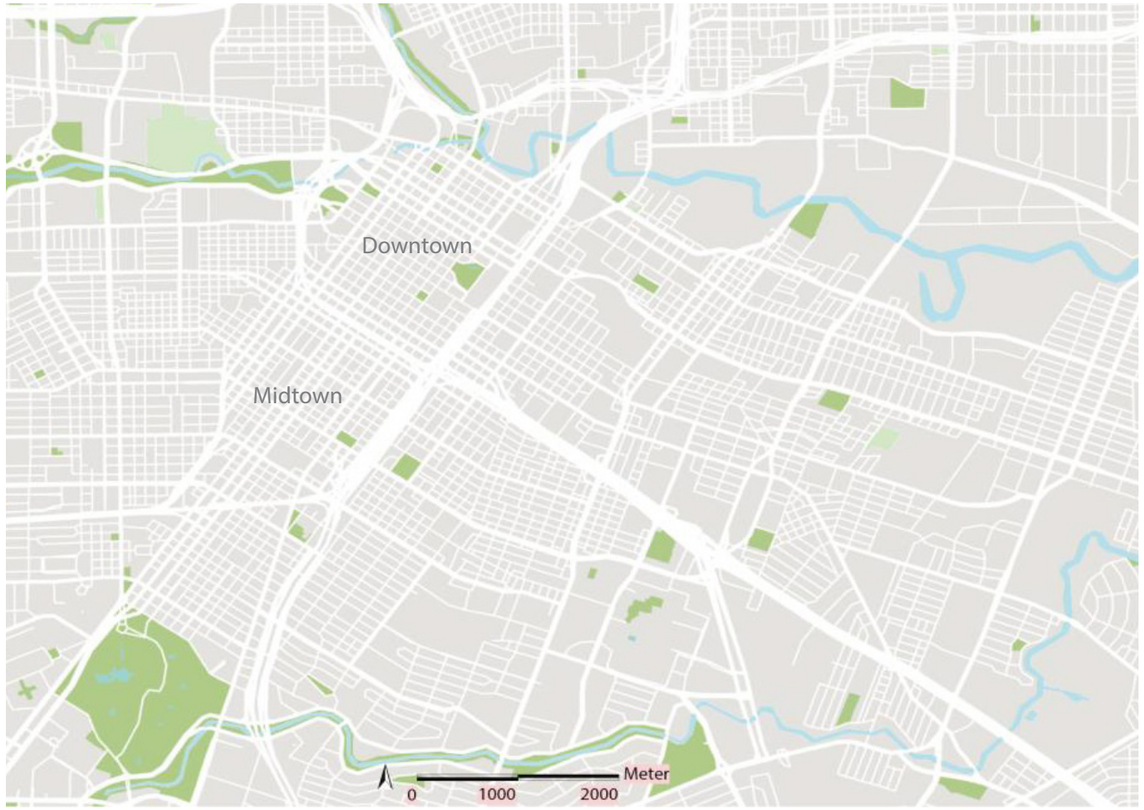


Fig. 4.8 | W1: Current Buffalo Bayou

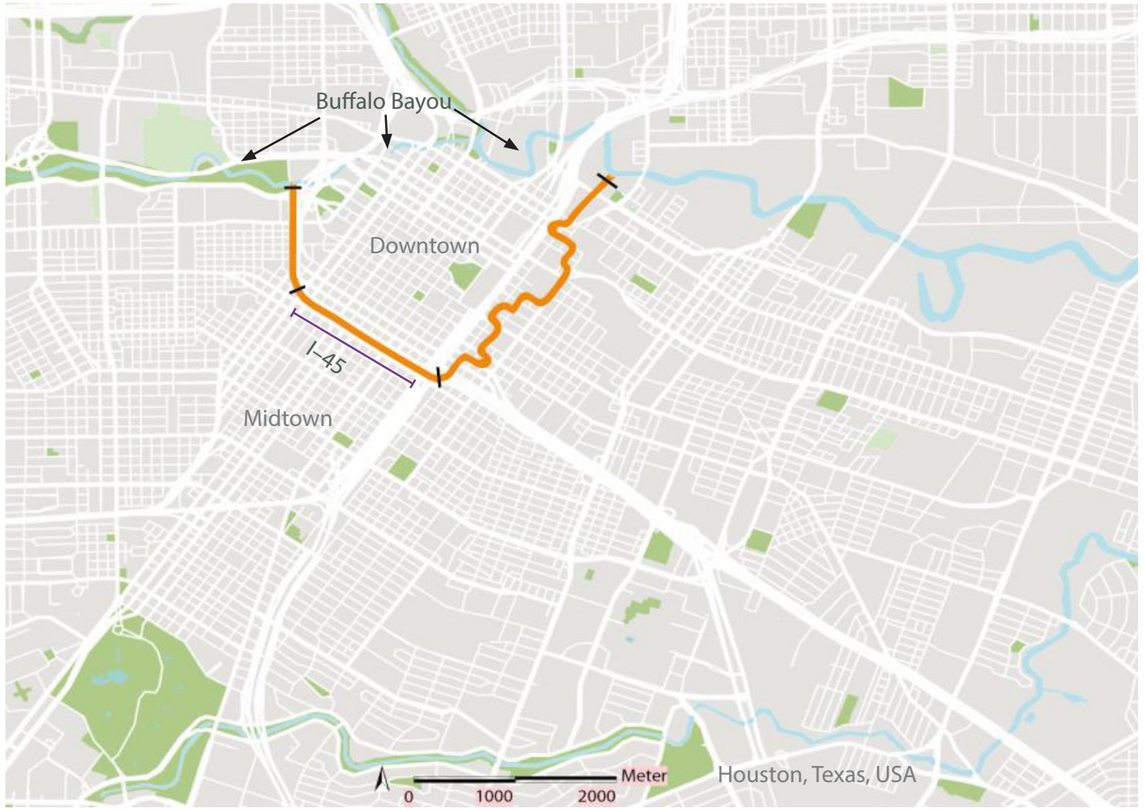


Fig. 4.9 | W2: Bypass + locks

SCALE 1: STRUCTURE

WATER

Houston's current water drainage system consists of one main river: the Buffalo Bayou. Since there has been a lot of flooding in Houston "the Nation's flood capital", the idea in this project is to enhance the Buffalo Bayou.

Based on the Dutch Room for the River concept, a bypass and 4 locks are designed. This is a big scale design, creating a water way around downtown and using the new parts of this ring to develop the areas around downtown. This does not only create room for the river, it also creates room for biodiversity, aquatic ecology and development within the center of Houston.

The bypass contains 4 locks to manage the water flows within the bypass. The inclination of the bypass equals the difference in ground level between the entrance and exit point of the bypass with the Buffalo Bayou. This way the intersections of the Bayous are at the same level. The locks may be closed when the Buffalo Bayou is oversaturated, this way water can be detained within the bypass.

When opened, the bypass is used as a drainage system for Midtown and the southern part of Downtown. As shown in figure W3, the ground level of the Buffalo Bayou is about 5.5 m lower than that of the area in Midtown.

This creates a lower level river and beach, which can be used as water detention area during heavy rainfall. When used for water detention, the beach on its own can hold 5.5 m x 1,000 m x 50 m = 275,000 m^3 in this area. Using an average width of 20 m for the Beach Bayou bypass, a length of 6,200 m and a depth of 3 m, the bypass itself can detain up to 3 m x 6,200 m x 20 m = 372,000 m^3 of water. This gives a total extra potential water detention of 275,000 m^3 + 372,000 m^3 = 647,000 m^3 in the new Beach Bayou area.

The discharge of the bypass can be calculated as Q = v*A. The profile area of the Beach Bayou is its width multiplied by the height of the water level, which gives 20 m x 3 m = 60m^2. The speed of the flow is highly dependent on the amount of water in the system, the inclination and the balance with the Buffalo Bayou. This calculation will not be done in this paper due to lack of expertise.
The parts of the Beach Bayou touching the Fourth Ward and Midtown are straight.

The bypass is implemented this way because the historic value of the Fourth Ward and the stories it tells (Pando, 2011). For Midtown, the removal of the I–45 highway creates the desired space for the beach and the bypass. The eastern part of the bypass, between Downtown and East-Downtown, is created along the streets in the area. Some parts of this area are still under developed, for example due to uncultivated plots and industrial buildings. To upgrade this part of Houston, the bypass will create a more attractive environment. The bypass is for this reason not a straight line, but more like a natural river along the current roads, with a green stroke added next to it.

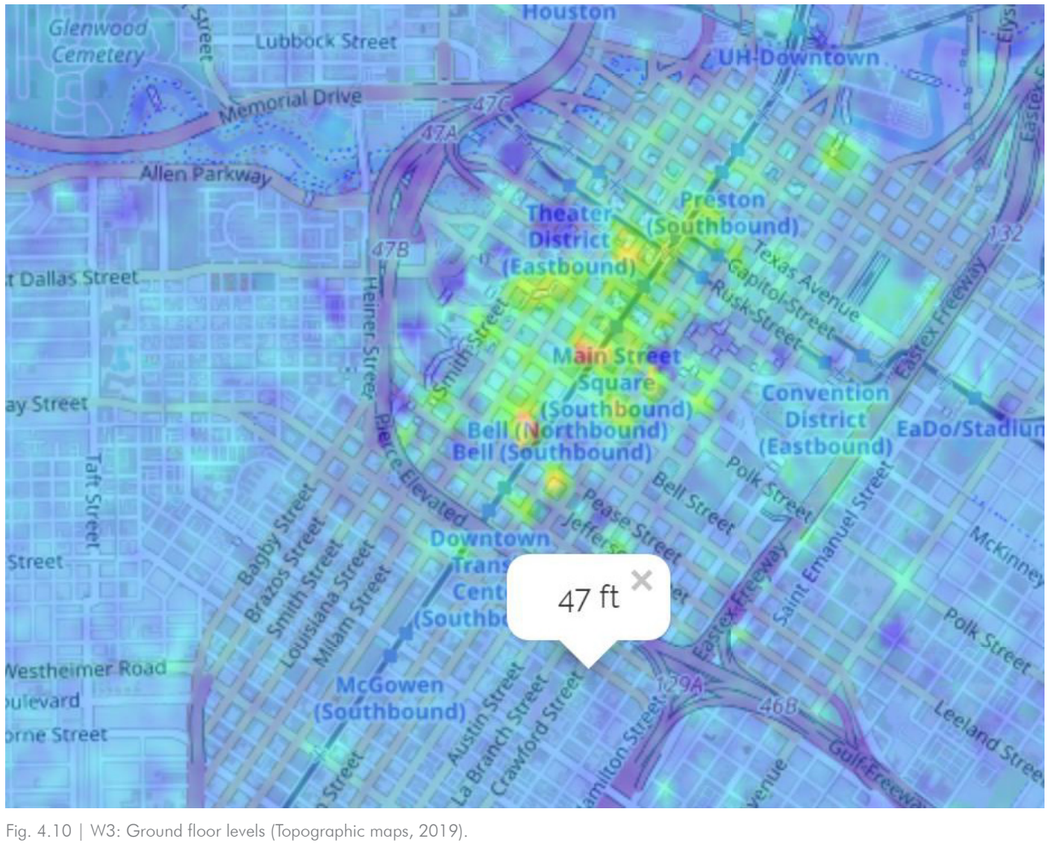


Fig. 4.10 | W3: Ground floor levels (Topographic maps, 2019).

SCALE 1: STRUCTURE

WATER

The advantages of a river-like structure are that more area is covered and it is more useful for leisure since the speed of the water will be dropped, and it is more interesting to for instance go kayaking.

On one side the area will be developed with a green river-like bypass, and on the other side the opportunities for businesses will develop the area economically.

There are also challenges of using a more river-like structure for the bypass, because rivers will meander, so there must be reinforcements in the corners, or room for the bypass the meander.

Also the traffic will need a sufficient amount of bridges to connect both sides of the bypass with each other. Bridges would be necessary to deal with this problem. Tunnels are very sensitive to flooding so in order to keep the infrastructure functional during rainfall, tunnels are not implemented.

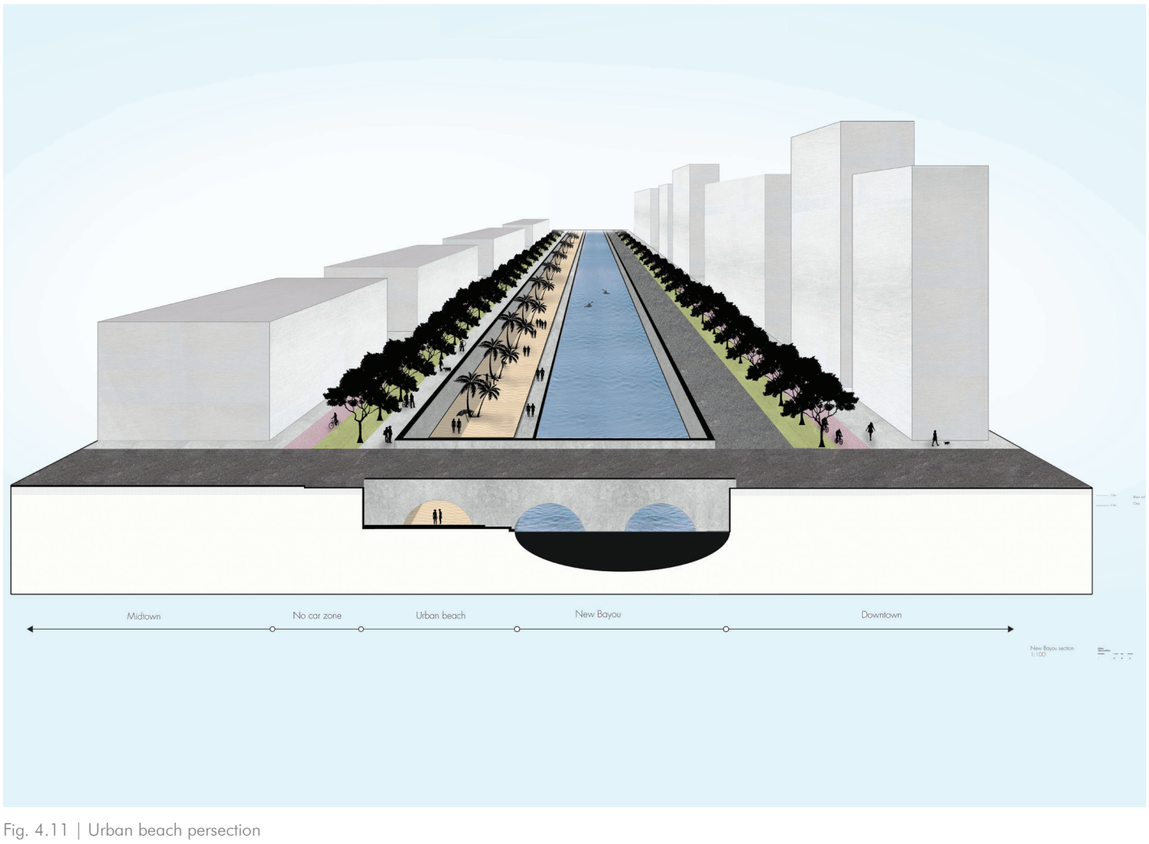


Fig. 4.11 | Urban beach persection

SCALE 1: STRUCTURE

URBANISM

The form of this new bayou will be that of an urban beach. The urban beach will provide an invititing, recreational oasis in the middle of a busy, concrete city. This will be the new highlight of Midtown, attracting people from its own neighborhood, as well as from Downtown and beyond. With the removal of the I–45 highway there were two possibilities how the newly available space could be treated. It could become an extention of Downtown, and by addition Midtown would become that too. Or it would remain a barrier between Midtown and Downtown.

We see more potential in Midtown than just being close to Downtown; with the right interventions and design choices, Midtown can strengthen their image, and increase the characteristics that are a strength for Midtown right now.

Therefore our decision to let the axis of the I–45 remain in its place, only now in the form of an urban beach.

What will change of course is what kind of new space there will be between these two neighborhoods. With an urban beach in the heart of Houston a new unique characteristic will be given to not only Midtown, but the city of Houston as well.

Apart from these added qualities, the urban beach will also add more safety to the city. It also functions as a basin where surplus rain water during heavy storms can be collected. This includes water from the whole Midtown neighborhood that will be moved to this new bayou through ditches.

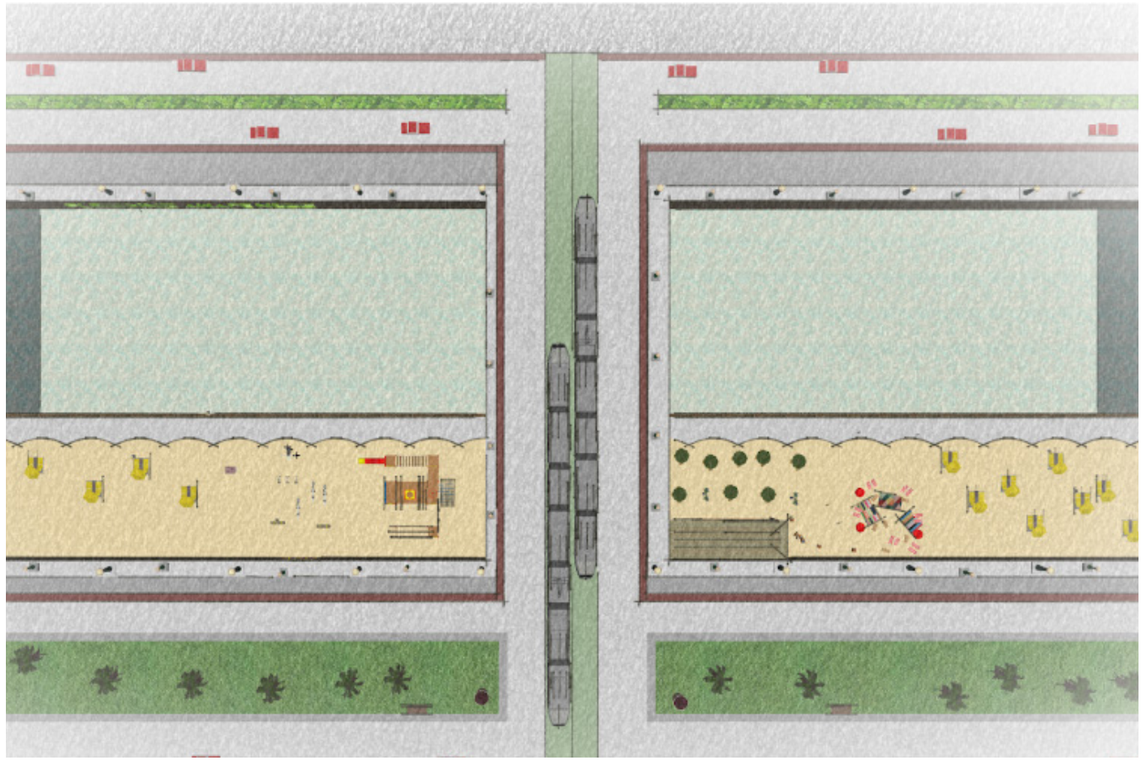


Fig. 4.12 | Urban beach top view

SCALE 1: STRUCTURE

URBANISM

In the plan of the urban beach (fig. 4.12) the urban design for it is shown. A 20m wide beach + boulevard lies next to a 30m wide bayou. The bridges over this new bayou are chosen based on important roads, such as roads with an existing tramline, roads near hospitals.

Midtown's boulevards are on two levels: one on the beach next to the water, and a second one on top of the embankment overlooking the new bayou. The boulevard parallel to the new bayou on Midtown's side will be car free and no parking lots will be created next to the beach. This way an enjoyable urban environment will be created, with more open green space. On top of that it encourages Houstonians to walk, to use their bike, or to use the public transportantiontransportation system (that we will also improve).

Both young and old target groups are taken into account with the added activities surrounding the urban beach. Both groups can of course make use of the beach for their leasure, and swim in the water to cool down from the hot weather. In addition to this, childeren will find plenty of playgrounds that they can use. Adults on the other hand will have more use for fitness devices that are available for them. It will provide an opportunity for a more healthy lifestyle.

A beach wouldn't be complete without some beach club, which will provide food and drinks during the day, and music and dance during the evening.

Fig. 4.13 | Urban beach with activiities for childeren, lika playground and climbing wall, and outdoor fitness for adults.

Fig. 4.14 | Urban beach bridge where the existing tramline will continue.

Fig. 4.13 | Urban beach with a beach club and terrace to enjoy the surroundings.

SCALE 1: STRUCTURE

URBANISM

People will be encouraged to visit the urban beach for the new architecutral and environmental qualities the place offers.

In fig.4.14 on the right the new bayou is shown in the situation after an extreme storm. It is able to fill itself with rainwater that falls directly from the sky, the accumulated rainwater from Midtown that will be supplied towards the new bayou by ditches, and this principle of ditches will also be possible to implement to the Downtown side of the bayou. The capacity of the new bayou is large enough to also accomodate Downtown's surplus rainwater during extreme events such as a hurricane or a tropical storm.

Fig.4.14 | Situation with the new bayou filled with water after heavy rainfall

Fig. 4.15 | I–45 reroute (TxDOT, 2017).

SCALE 1: STRUCTURE

INFRASTRUCTURE

Our redevelopment plan for Midtown is influenced by the larger scale project to reroute the I-45 along the North-Eastern ringway and teardown of Pierce elevated highway. On the large scale, there is only one on / off ramp at the edge of midtown and most works of this major rerouting will happen outside of our focus area. The effects of the rerouting will be addressed when they influence the mid- and small scale of our project.

Our interventions to the the spatial structure of Midtown influences transportation mainly on the mid and small scale. On the mid scale local traffic will be rerouted and the small scale will tailor to active modes of transportation; cycling and walking.

We propose to facilitate a modal shift change from car to public transit and active modes of transportation. This consequently changes the infrastructure to better suit these modes. Since the change of modal shift will happen over time, the current transit needs of the area need to be taken into consideration.

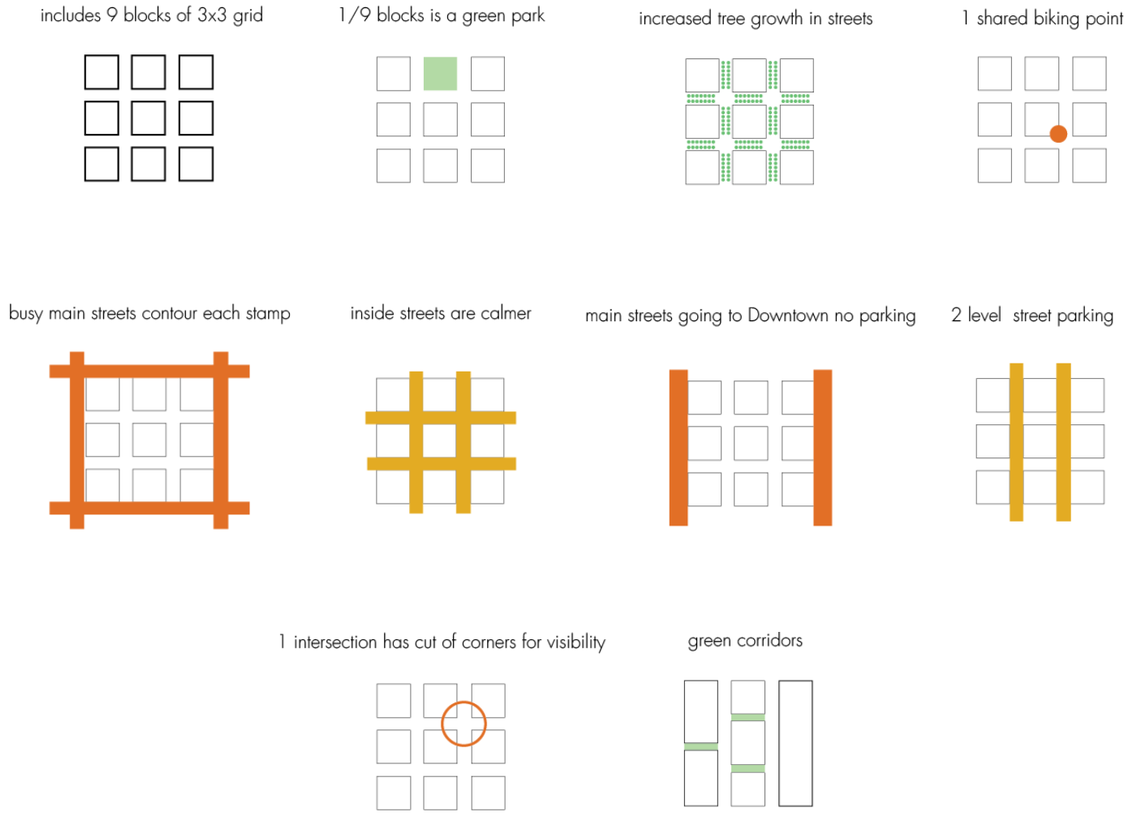


Fig. 4.16 | The stamp passport

SCALE 2: STAMPS
URBANISM

To improve the current urban situation in Midtown in terms of spatial quality and flood risk, we have a passport for each different level to guide the urban development. As mentioned before, Houston does not have any zoning laws. Therefore sustainable urban development needs to be guided. No strict rules on *how* the area should be planned, but guidelines stating *what* should be included in each stamp (or block or plot). It allows freedom to be interpreted in different ways, as long as the main objective is reached.

On stamp level we deal with stamps of 3 x 3 blocks. Each block is about 100 x 100 m. This stamp is repeated on the existing grid structure of Midtown. An important effect of using this stamps is the densification on a now very low dense area. This densification process will focus on 5 – 6 story dwelling typologies. These type of buildings have been chosen because they will give an urban atmosphere, yet on a human scale (in contrast to Downtown).

One of the important guidelines in this passport is that 1 out of 9 blocks from the stamp is an open green space. This will lead to less concrete surface, and rain water will be able to infiltrate the ground. Another plus is a decrease in the urban heat island effect. It is also good to look at the road structure that follows this type of stamp. Using a stamps on a grid system means that there outer and inner roads will be created. In our new urban plan the outer roads (see the red lines in fig. 4.17 will be busier and contain more lanes than the inner roads. The outer roads leading to Downtown will also

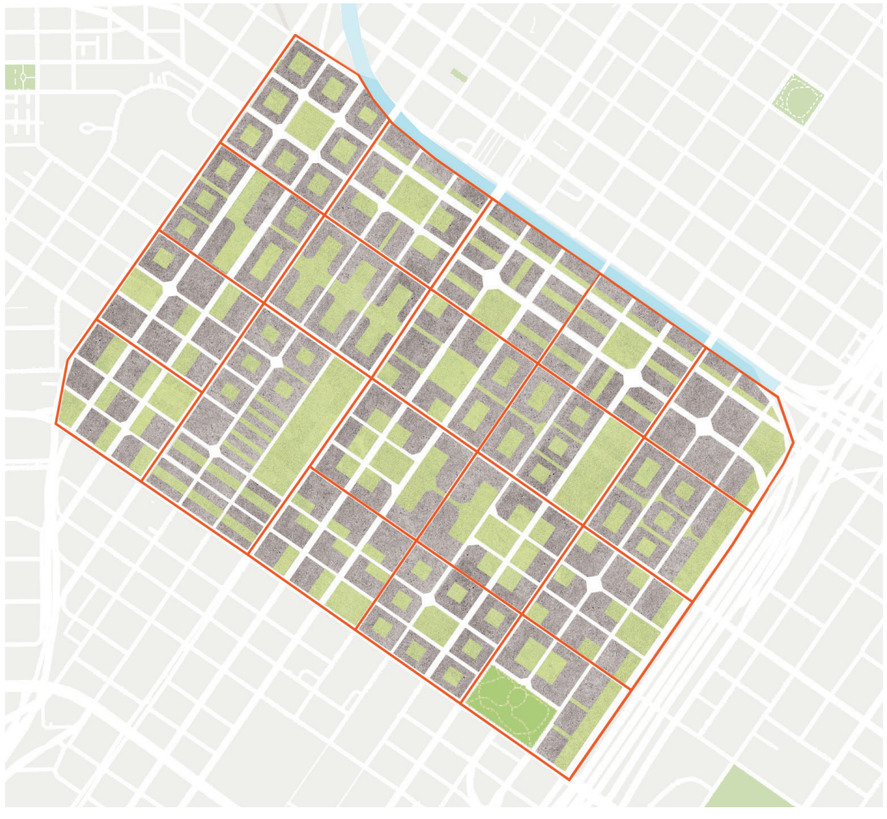


Fig. 4.17 | Proposed urban plan based on the several passports

SCALE 2: STAMPS
URBANISM

cross over the new bayou as a bridge. There will be less space for parking here, making full use of the width to accomodate the increased traffic (because not all existing roads will turn into bridges).

Instead, parking will be provided in the calmer inner streets of each stamp. There will be space for double parking in the streets (see the Infrastructure chapter). In addition to this, the new building typology will provide parking spaces on the ground floors of buildings. And to encourage bike use, there will be one shared biking point in each stamp. This way not everyone has to buy a bike in order use it, and the bike can be dropped of at different points, not only the starting point.

To accomodate biking even more, existing, discontinuous roads (meaning they don't follow the grid) will be turned into green corridors. These roads do not accommodate much traffic at the moment, so they will be usefull addition to the biking network. Of course additional trees will be added for a comfortable trip.

Furthermore, the building corners of at least 1 intersection will be 'cut off' to increase visibility, creating longer sight lines.

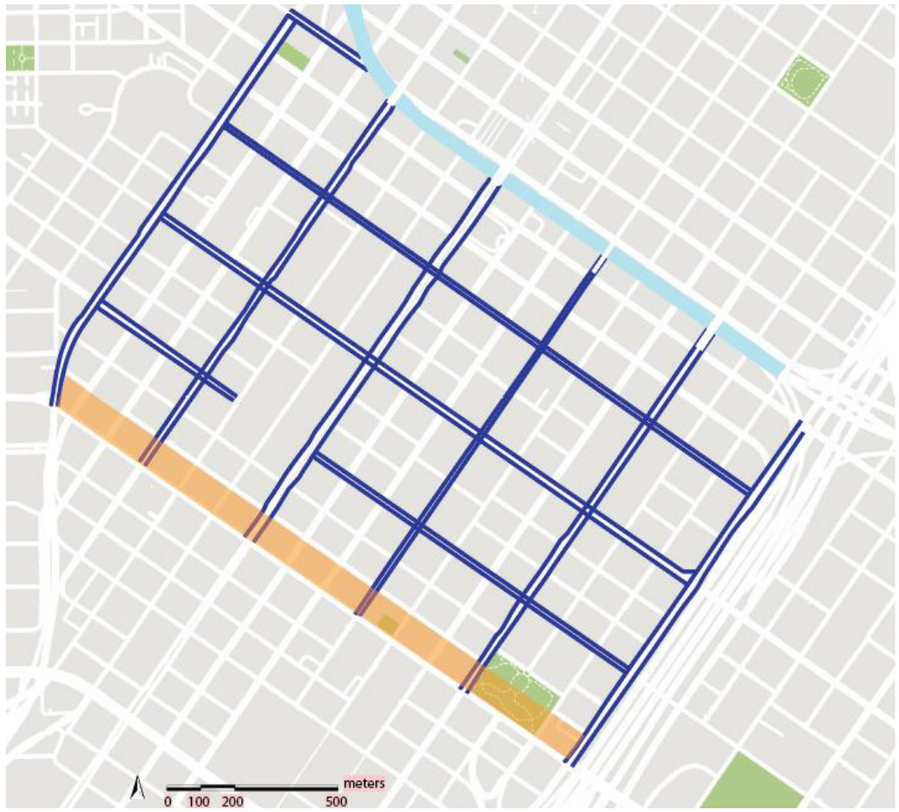
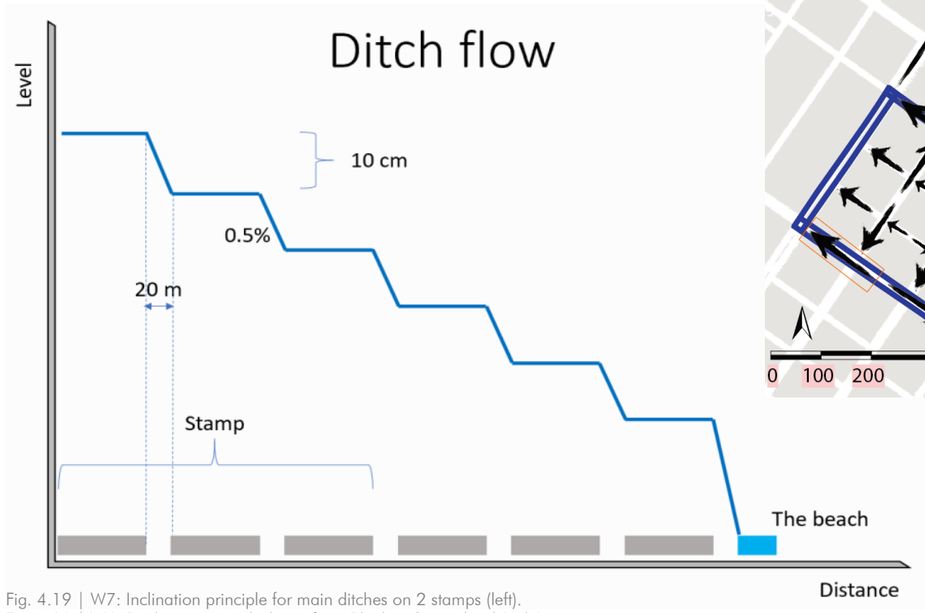


Fig. 4.18 | W5: Main ditch network (in blue).



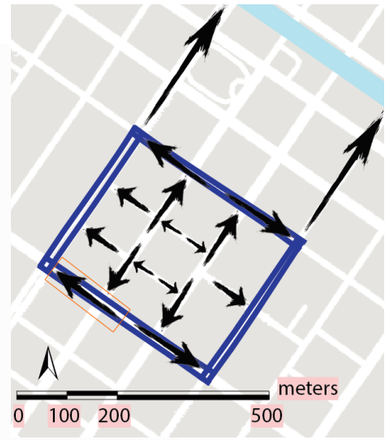


Fig. 4.19 | W7: Inclination principle for main ditches on 2 stamps (left).
Fig. 4.20 | W6: Ditches to main ditches – from Block to Stamp level (right).

SCALE 2: STAMPS

WATER

The main ditches are created in lateral and longitudinal direction along the main roads on stamp level. The main ditch network is shown in figure W5. The longitudinal main ditches pour out on the Beach Bayou, and the lateral ditches transport the water towards the longitudinal ditches. Due to the lower ground floor level of the Bayou's (figure W3), the beach can be used as a sinkhole. The green ditches on block level will pour out on the nearest main ditches, as shown in figure W6.

To steer the water flow directions naturally, the ditches need an inclination to use gravity as the systems propulsion. To create this inclination, the main ditches start with a depth of 1 m on the part furthest away from the Beach Bayou, adding 10 cm of depth for every block in the longitudinal direction. The actual ditches are straight, and the inclination to create the water flow is implemented within the pipelines underneath the intersections. With a spacing of 20 m per intersection, a 10 cm height difference gives a 0.5% slope. This principle is shown in figure W7. The water flows from the ditches to the main ditches are also created via this inclination principle in both longitudinal and lfateral directions.

The pipes between the ditches are designed with a diameter D = 691 mm. Based on a Belgian designing guideline for domestic water drainage (Vlaamse Milieumaatschappij, 2019), a water flow design speed of 2 m/s in the pipes is selected. Note that ditch invert protection has to be implemented according the stormwater design requirements document for speeds exceeding 0.91 m/s (City of Houston, 2010). Since the drainage system is dealing with precipitation, the whole surface of the pipe can be used. This results into a possible discharge of Q = v*A = 0.75 m3/s = 750 L/s per pipe. The ditches have to be designed for 18 cm of rainfall in an hour = 1800 m3 per block. Since the ditches can handle an initial storage of at least 900 m3 per block of 100x100 m2, this covers half

SCALE 2: STAMPS

WATER

of that rainfall. The other half can be discharged to the Beach Bayou using the pipes, since 0.75 m3/s = 2700 m3/h, and 3 blocks are covered by one longitudinal main ditch in the lateral direction: 1.5 block on each side, as shown in one side in figure W6. Three blocks multiplied with the remaining 900 m3/h of rainfall equals exactly the discharge of the pipe of 2700 m3/h.

The system is made resilient by adding extra depth in the ditches towards the Beach Bayou, and by having multiple routes for the water to flow naturally into the least resistant ditches. Note that the ditches are not first filled and then discharge to the Beach Bayou, because then the downstream ditches will flood because the inflow will be double the outflow, from both the rain and the upstream ditches. At the start of the rainfall the ditches will immediately start discharging instead, with the initial storage capability in the ditches as a fallback for heavy rainfall. The total amount of water that can be stored in the ditches in Midtown (detention, no discharge) is approximated by using the 1 m deep ditches upstream as a start, and assuming 3x3 blocks per stamp, with 9% ditch coverage of the area. The first row of blocks is highlighted in orange in figure W5, these ditches can contain 900 m3 per block, so that is 3 x 5 x 900 m3 = 13,500 m3 water detention in the most upstream row.

The second row can detain 10% more compared to this row, because the ditches in this row are 10 cm deeper. The third row 20% and so on. The total amount of water that can be detained in these 12 rows of ditches is then 251,100 m3. This is an estimation based on the longitudinal inclination, due to the lateral inclinations that have to be made, a 10% deduction is made to estimate a more realistic amount of detention capability in the ditches. This gives a final number of 225,990 m3 of water detention in the ditches.

Fig. 4.21| Current one way roads

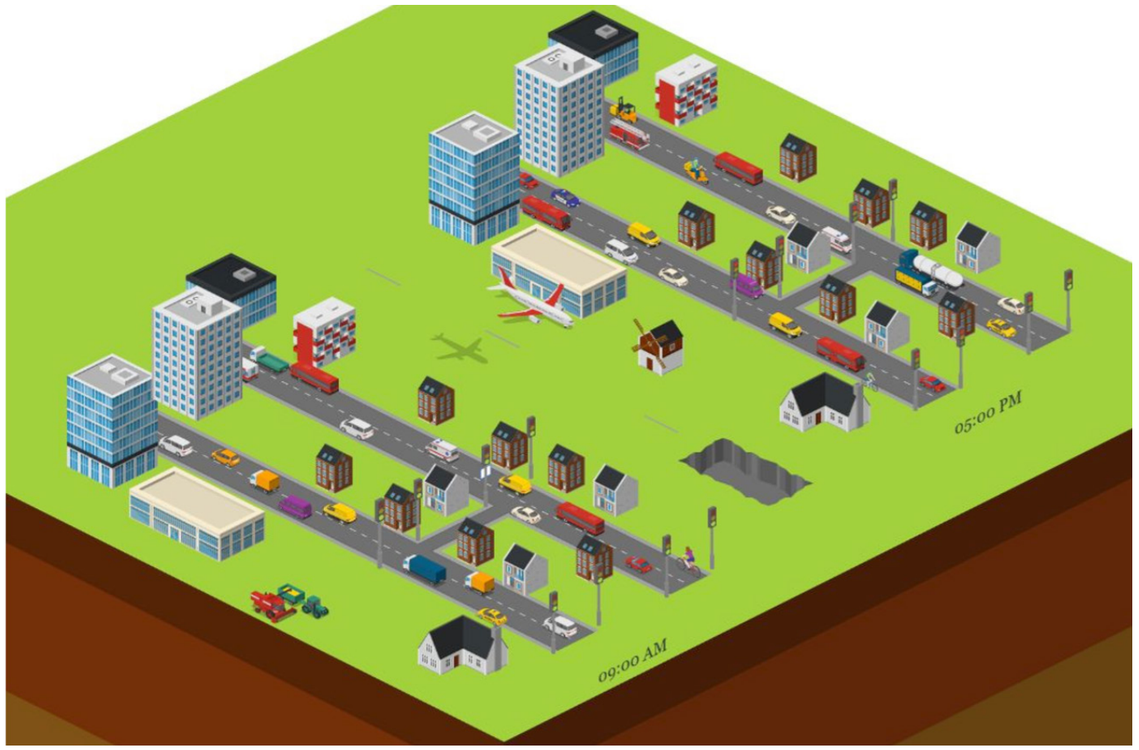


Fig. 4.22| Future reversible lane roads

CAR INFRASTRUCTURE

The population of the Houston region is growing and will remain to do so for the foreseeable future (Ortiz, 2018). These new inhabitants will most likely be car users. In the short term we do not expect that our investments in active modes of transportation will lead to a significant decrease in car use. This is underpinned by a study in the UK (Ogilvie et. al., 2017). So a reduction in car traffic cannot be expected for the short to mid term.

In order to keep redeveloped Midtown an attractive neighbourhood the motorised traffic needs should be included in our design. Midtown is currently subject to rush hour peaks in traffic. These peak flows are directional towards or originating from the neighbouring CBD.
The roads to and from the CBD are one way roads, with the exception of main street. This leads to a lot of vehicles on the roads in the direction of the traffic, whereas the utilisation of roads in the opposing direction is substantially less. This is schematically displayed in fig. 4.21

We propose to exploit the directionality of the CBD bound flows by rebuilding the trunk routes that cross the basin into reversible lane operations. In a reversible lane operation one, a couple or all lanes change direction according to the direction of the traffic peak flow, as shown in fig. 4.22. Reversible lanes can provide a significant capacity increase within the current embankment.

Reversible lanes currently exist on West Alabama Street in Houston. An

SCALE 2: STAMPS
INFRASTRUCTURE

important point is the transition area of the operation (Lambert, Wolshon 2007). The two trunk roads next to Main street will have a fully reversible, the remainder always keeps at least one contraflow lane. For a smooth transition these reversible lanes will continue well into adjacent neighbourhoods.

Currently Midtown has a total of 25 lanes in North and Southern direction. The five available through roads can provide this capacity since the existing road embankments fit five lanes. Figure 4 contains a map of the detailed design.

Fig. 4.23 | Mid-level plan of major car roads and transit lanes

Fig. 4.24 | Reversible lanes system in practice in Taylorsville, Utah (Griffin, n.d.)

REVERSIBLE LANES

The population of the Houston region is growing and will remain to do so for the foreseeable future (Ortiz, 2018). These new inhabitants will most likely be car users. In the short term we do not expect that our investments in active modes of transportation will lead to a significant decrease in car use. This is underpinned by a study in the UK (Ogilvie et al., 2017). So a reduction in car traffic cannot be expected for the short to mid term.

In order to keep redeveloped Midtown an attractive neighborhood current traffic should be included in our design. Midtown is currently subject to rush hour peaks in traffic. These peak flows are directional towards or originating from the neighboring CBD. We propose to exploit the directionality of these flows by rebuilding the trunk routes that cross the basin into reversible lane operations. In a reversible lane operation one, a couple or all lanes change direction according to the direction of the traffic peak flow. Reversible lanes can provide a significant capacity increase within the current embankment. Reversible lanes currently exist on West Alabama Street in Houston.

An important point is the transition area of the operation (Lambert, Wolshon 2007). The two trunk roads next to Main street will have a fully reversible, the remainder always keeps at least one contraflow lane. For a smooth transition these reversible lanes will continue well into adjacent neighborhoods. Currently Midtown has a total of 25 lanes in North and Southern direction.

The five available through roads can provide this capacity since the existing road embankments fit five lanes.

Additionally intelligent traffic lights will be installed allowing for smart adjustment of cycle times to reflect the actual demand (Austin, 2019). A secondary benefit of these intelligent lights is the ability to prioritise traffic, i.e. a green light corridor for a rushing ambulance.Main street will be kept in its current state, due to the presence of METRO mass transit red line. Public transit will be covered later.

A connector highway will feed into this mid-scale plan on Brazos street. This is comparable to the existing situation and we expect that traffic entering midtown will not grow. Possible undesirable through traffic seeking paths (i.e. rat running) can be discouraged by adjusting the timings of the intelligent traffic lights. By shortening the green signal aspects on the path with rat running traffic will build up leading to an adjustment of the route guidance algorithms of the vehicles away from Brazos street due to the longer journey times.

With these measures, the peak capacity can be maintained with less roads, freeing up space for the water basin and beach. The system can also facilitate future tests on lane reductions by simply closing a lane for an extended period. If the subtraction did not significantly worsen the traffic flow in peak periods a lane can then be rebuilt to green / pedestrian space permanently.

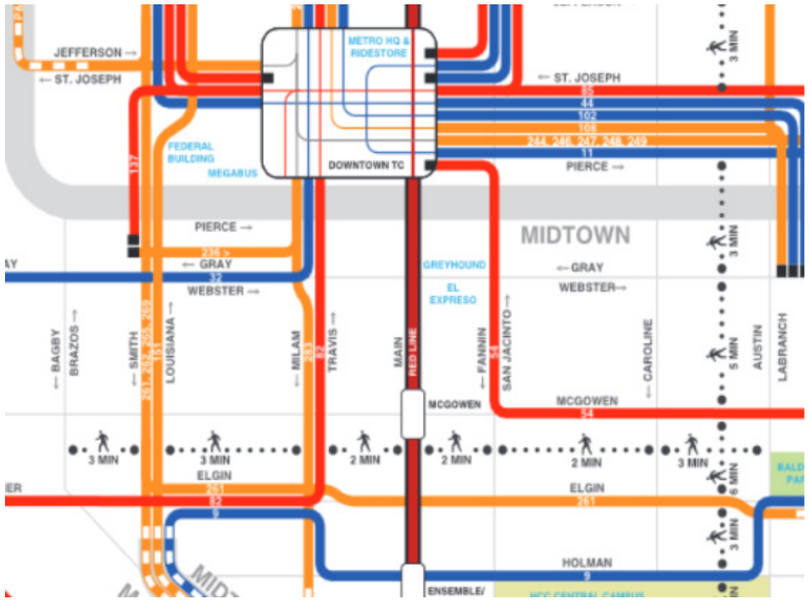


Fig. 4.25 | Public transit network (Metro, n.d.)

SCALE 2: STAMPS
INFRASTRUCTURE

PUBLIC TRANSIT
Public transit presently rides over a couple of streets in Midtown, as indicated in fig. 4.25. Most notably is the Metro mass transit red line, but a few bus routes go through Midtown as well.These bus lines will be incorporated into our new spatial structure. One of the main roads in the redeveloped grid is McGowen street.

This East-West road is going to be rebuilt as a boulevard with dedicated BRT lanes into the middle. Building a bus track in the middle of this 1,5 kilometre road will cost approximately 3 million euro (Goudappel Coffeng, 2019).

A dedicated bus track is preferred over on street running because of the higher quality of service, making public transit more attractive. In a later stage this corridor can be rebuilt into a tram track easily. This will benefit the discussed future university transit line.
Busses are rerouted to the downtown transit centre onto the reversible lanes or Main street tram track elsewhere. The exact location of these transit roads is indicated in fig. 4.23.

REVERSIBLE LANES
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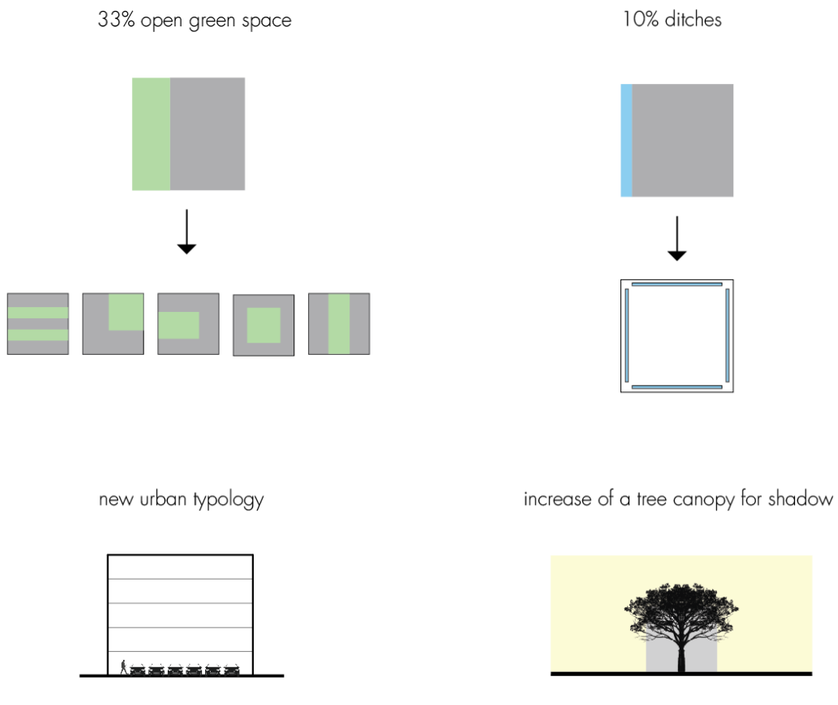


Fig. 4.26 | Block passport

SCALE 3: BLOCKS
URBANISM

Now we go another step lower: to the block scale. Implementation of passport guidelines on this level focuses on the use of build and unbuild space. It is important that 1/3 of each block in the existing grid is open green space. This will help increase the neighborhood living quality, as well as more water infiltration during rainfall. The way that the block is organized is up to the developer or the designer, see fig.4.26 for suggestions of the new urban fabric pattern of the blocks.

The blocks can be closed off, with a private/collective green courtyard in the center of the block, or the blocks can be organized in a more open manner, allowing people to walk through them, and thus creating shortcuts to arrive at a destination faster. The green corridors, as mentioned in the previous level, support this too.

And then there is the implementation of the ditches. Around the circumference of each block water ditches will be implemented to aid water drainage during (heavy) rainfall, as mentioned in the previous section about the main ditches. According to our calculations, these ditches should make up around 10% of each block to accomodate extreme rain fall events.

This is also the scale where the new urban typology is introduced; an example is showed in fig.4.27. In the section in fig.4.29 a conclusion of all the passports is shown. Here the new building typology can also be seen,

Fig. 4.27 | New urban typology

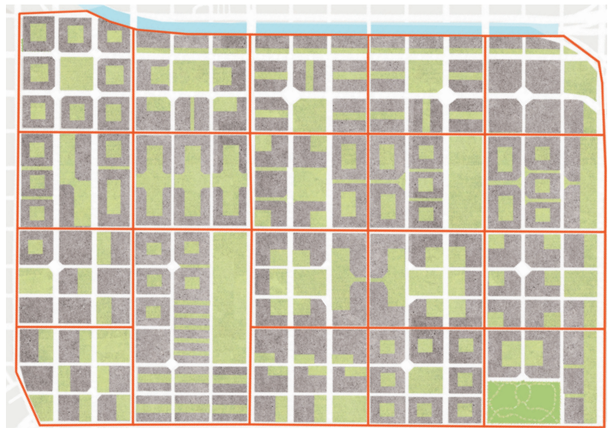


Fig. 4.28 | Suggestion of urban fabric pattern (now in relation to block passport)

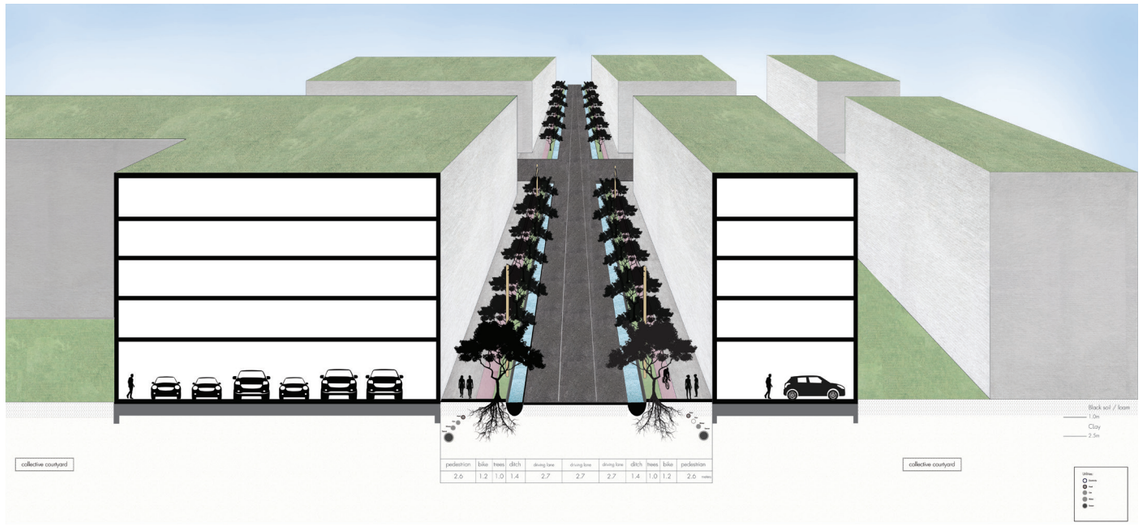


Fig. 4.29 | New street persection

with the parking on the ground floor and apartments above, including the green roofs. The increased trees in the street provide a lager tree canopy which causes a larger area of shade in the streets, making it more pleasant for residents to walk outside during the heat.

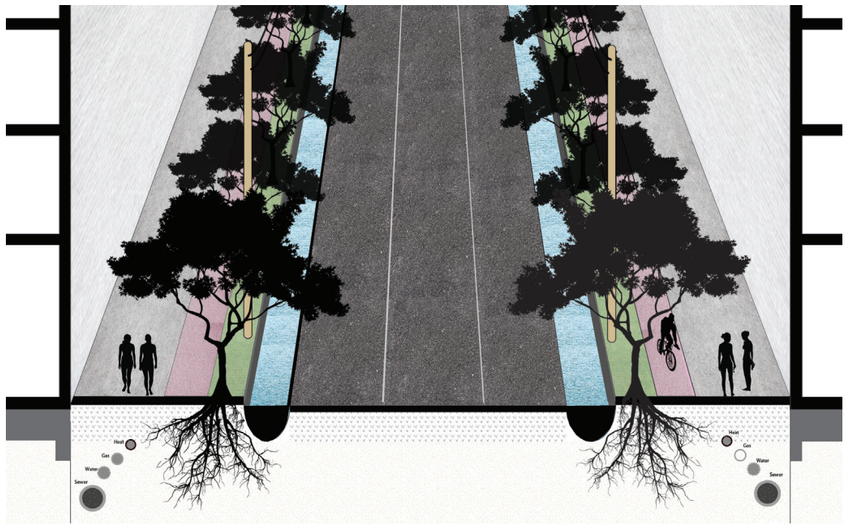
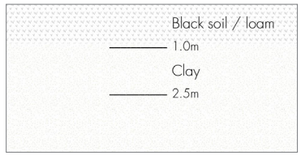
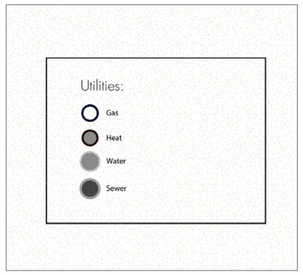


Fig. 4.30 | Details soil



Type of soil



Utilities underground

SCALE 3: BLOCKS

URBANISM

In the section above the situation underground is also explained. Houston has predominantly a clay soil layer, so we assumed Midtown has also this type of clay soil.

Due to insufficient accesible data, specific maps about underground pipes were not available to us. Instead, we based these technical details on assumption for where these pipes may lie in Midtown. The position of gas, heat, water, sewer pipes are underground, underneath the walkway.

For electricity, the situation in the US is different than in the Netherlands. In the Netherlands electricity lines with a voltage less than 150 kV (which are all the low to medium voltage cables) are also constructed underground.

In the US you usually see electricity masts above ground for their electricity supply. Wich makes them quite vulnerable for extreme weather.

Having your electricity cables above ground in a hurricane prone area means that the electricity supply will be regularly cut-off because of trees that fall over and ruin the electricity masts. A solution would be putting the electricity cables underground, like in the Netherlands. Several studies calculated the costs for this in the US, and the conclusion is that it's too expensive; consumers are not willing to pay more for it (Persson, 2017). Another problem is that not all soil in the US is not suitable for underground cables.

Fig. 4.31 | Figure W4: Green ditches along the road in Midtown, Houston.

Fig. 4.32 | Project with ditches in Amsterdam (Dienst Zuidas, 2019)

SCALE 3: BLOCKS

WATER

GREEN DITCHES

For every stamp that consists of 9 blocks, every block has ditches along the roads. The ditches are, unlike the traditional ditches we know in the Netherlands, dry in the initial state and covered with plants and trees. Along every road there will be ditches, and they will connect with each other with pipelines under the intersections. The storage capability of these green ditches differs from 900m^2 per block to 1890m^3 per block, due to different depths.

In fig.4.31 an example is shown of green ditches that are already implemented in Midtown. It is a good example for both the local residents and the developer to see with their own eyes how such a solution is realized in Midtown before we implement it on a bigger scale.

Another example of how the ditches could look liek is shown in fig. 4.32. There they use small 'bridges' for people to be able to cross the ditches, in contrast with the paved over ditches in Midtown. A lot of variablility is possible with the design of ditches, and when implemented in a large enough number (so more than 1 street, which is now the case in Midtown), their effect will be powerful.

Fig.4.33| Small scale plan near HCC

Fig.4.34| Small scale plan near bayou

Fig. 4.35 | Shared biking point at Rice University, Houston. (Rice University, n.d.)

SCALE 3: BLOCKS
INFRASTRUCTURE

ACTIVE MODES

The biggest chance and challenge lies in the smallest scale of our plan; accelerate active modes of transportation.
Currently there is not a lot of pedestrian nor cycling traffic in Midtown. Most trips are being done by car and special infrastructure is lacking for active modes of transportation. Segregated cycle tracks are lacking for example. There is substantial recreational cycling and walking along the Buffalo bayou however. Projects to change modal split out of the car have proved successful elsewhere in the US. With the right power of will it is possible to make a cycling boom a reality Midtown. This is a chance for Midtown, especially considering its location between CBD, the universities and gentrified areas nearby. These factors have been identified by Buehler et. al.(2011) as accelerators. With the right attention cycling can grow from a marginal mode to a major one, as happened in Portland for example. As a previously car dependent city Portland invested heavily in cycling. Now 18% of their residents considers cycling their primary or secondary mode of transport, which is a sixfold increase and now comparable to European standards (Buehler et. al., 2011). So investing in segregated cycle lanes, traffic calming, cycle to transit stations, providing cycle sharing schemes, parking spots and so on are paying off in the long run since cycling will catch on.

On the smallest scale of our plan we want to connect the cycling and walking facilities in our redeveloped basin / bayou to a wider network for active modes of transportation in Midtown. Special attention is also paid to education, since it is investigated that a significant number of bike crashes happens within half a mile radius of a school (Fulton, 2019). Houston Community College is located on the corner of Elgin and Main street. This is a higher education institute with a culturally diverse group of students, who are an interesting target group to make the change to walking and cycling first. The Beach Bayou and local school will be pivots in our cycling and walking plan, since these have highest potential of a swift change to active modes of transportation.

Travis street, directly west of Main street, will be rebuilt into a calm side street with a wide cycle path. Austin street, will get a similar arrangement. This is indicated in Fig.4.33. Segregated cycle paths will be built along all East-West trunk roads.

This will function as a through cycle network. The streets dead- ending on the bayou basin have increased space for cycling and walking, ending into a shared space arrangement on the urban beach as indicated in Fig.4.34. This will draw people towards this area. The Beach Bayou will have a lot of cycle and pedestrian friendly amenities, like benches or shared cycling parking stations of houston-bcycle. These are installed elsewhere as well, strengthening the area. At least one shared biking facility is needed in every plot to facilitate a modal shift.

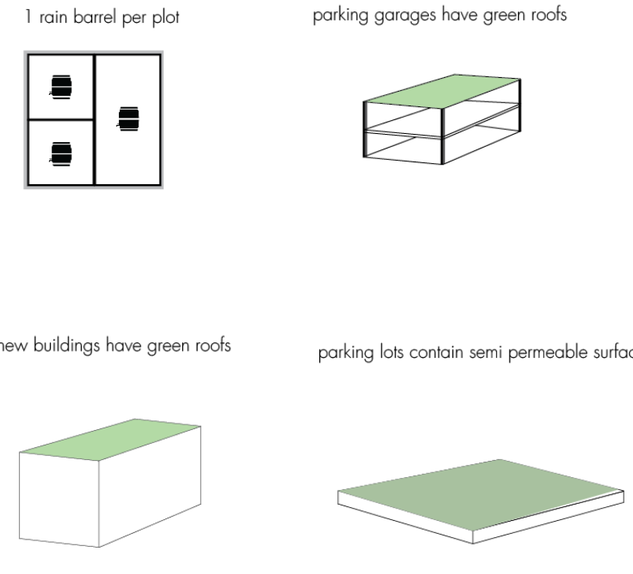


Fig. 4.36 | Plot passport

SCALE 4: PLOTS
URBANISM

The smallest scale we are working with its the plot scale. With a plot we mean every individually owned peace of property. So it could happen that an entire block is also one plot (which is often the case with restaurants etc.), but more often than not a block is devided in several plots.

For each of these plot owners there are a set of guidelines. Each plot should have at least one rain barrel (or water tank) to retain the rainwater that falls on the roof of the buidlings. More of this concept will be explained on page 66.

In addition to this, it is important that green roofs will be implemented, not only of residential buildings, but also on top of the parking garages.

Then there is the added measure of semi-permeable parking lots. Because Houston does love its cars it is inevitable that there will be parking lots scattered around the city.

To lessen the impact of the concrete and asphalt surfaces that come with parking lots, the solution of semi-permeable parking lots its suggested. It has benefits in terms of water drainage, and as visually pleasing element because it improves the appearance of the parking lot

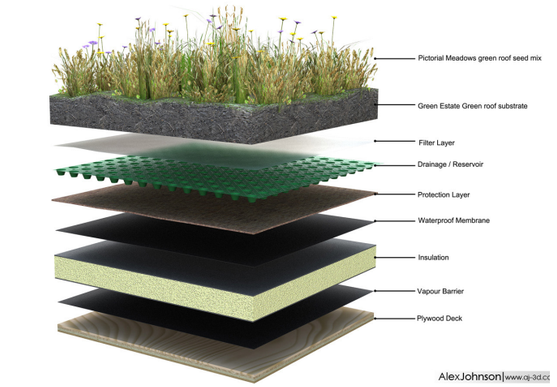


Fig. 4.37 | Example of a green roof detail DC Greenworks, 2014)

Fig. 4.38 | Green roof on top of a parking garage (Sempergreen, n.d.)

Fig. 4.39| Semi-permeable parking lots (Green solutions, 2017)

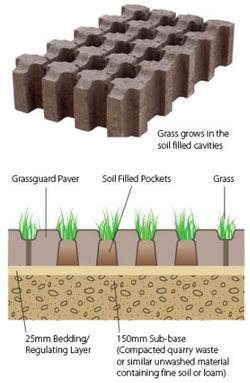


Fig. 4.40 | Example of semi-permeable paving detail (Grassguard, n.d.)

SCALE 4: PLOTS
URBANISM

The reason for the implementation of green roofs in Midtown is because they provide several important benifits regarding the environment. For instance, green roofs can improve stormwater management by reducing runoff and improving water quality, mitigate the urban heat island effect, increase longevity of roofing membranes, reduce noise and air pollution, increase urban biodiversity. Next to these benefits it also provides a more aesthetically pleasing and healthy environment to work and live, and improve return on investment compared to traditional roofs.

The semi-permeable parking lots are a method of paving vehicle and pedestrian pathways that allows for infiltration of fluids. It reduces the total impermeable cover. Such lots feature a porous design to reduce the runoff volume of storm-water.

Porous pavements can be used in areas with either low or high traffic. Less heat will be generated, which will also help reduce the urban heat island effect during warm periods. It provide effective storm-water management and re-absorption of water into the ground.

Fig. 4.41 | Water tank example (Gamma, n.d.)

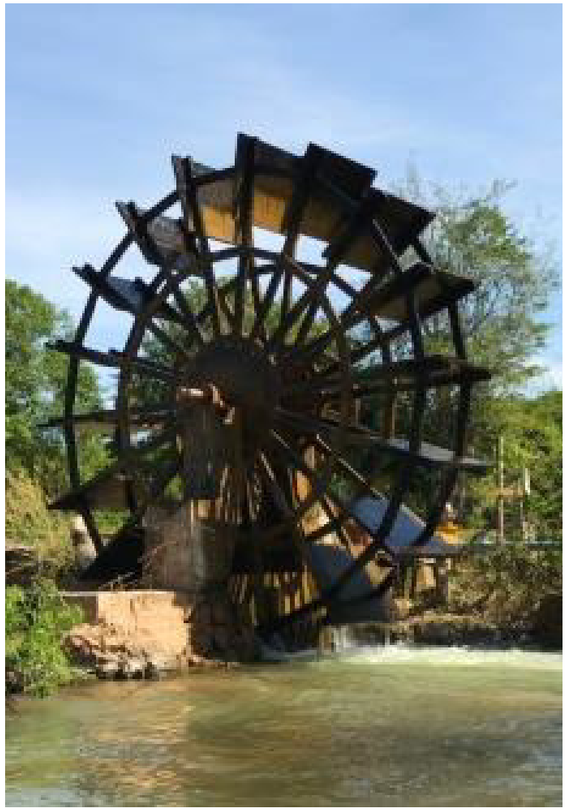


Fig. 4.42 | Water wheel example (Kosolapov, n.d.).

LEVEL 4: PLOTS

WATER

WATER TANKS

On plot level, awareness is more important than actual storage capabilities. To create awareness, every household in the area will be actively participating by having their own 250L water tank, or a communal water tank equal to 250L per household.

Being actively involved in fighting the flooding helps to create awareness and political support to invest into bigger projects. The inhabitants of Midtown will learn to live with the water rather than ignoring it.

At the 4 locks on the bypass, symbolic traditional waterwheels are added together with factsheets and information about flooding in Houston, the Beach Bayou room for the river program and the green ditches. The generated energy will be supplied to the grid, and monitored.

At the end of the year, a balance can be made to show if there was sufficient energy generated to counteract the energy usage of the locks. This will add to the sustainability awareness and mentality of the locals.

Currently there are 3,500 households in Midtown (Point2Homes, 2019), which would lead to a total storage capability of 875 m3 in the water tanks.

Overview water detention areas

Level	What	Detention (m^3)
1. Beach Bayou	Room for the river	*647,000*
2. Stamp	Main ditches	*225,990*
3. Block	Green ditches	
4. Plot	Water tanks	*875*
	Total	***873,865***

Fig. 4.43 | Overview of the water detention areas

LEVEL 4: PLOTS

WATER

Compared to the storm basins of Project Brays that have a water detention capacity of up to 13,250,000 m3, the water detention capabilities of this project are nihil. Although, the location of detaining the water is within the city, instead of for instance the Willow Waterhole which is about 15 km away from the city center of Houston.

This project is not only focused on detaining water, the main purpose is actually to drain the system before it floods, with the option to detain water when drainage is clogged.

Fig. 4.44 | Car parking lift in semi raised position showing upper and lower parking bay (Cardok, s.d.)

LEVEL 4: PLOTS
INFRASTRUCTURE

The redevelopment of Midtown will involve removing streets from the network. Cars parked on these streets need to be parked elsewhere. In order to prevent extra pressure on the remaining parking spots we decided to install car storage lifts on the main streets. With these lifts the parking space per spot is doubled; one recessed in the bunk and one on the street level. The lift raises if the lower access is needed. Initially we suggest to convert a part of the parking places along the main roads. Additional ones can be installed if insufficient. Automated car parking saves a lot of building space compared to conventional parking (Price-Robinson, 2018). We urge all new high-rise developments to build automated parking with ample capacity to benefit the wider area.
Self-driving vehicles will become a reality before 2030. It is expected by McKinsey (2019) that 50% of all miles travelled will be in a self-driving vehicle by 2040. What is not sure yet is the ownership of self driving vehicles. One direction is that these vehicles are privately owned and driving around downtown to avoid parking fees. The more likely direction is that the majority of these vehicles are owned by hire or lease companies and form a pool.

They transport people from point to point, picking up other passengers moments after they dropped people off. This is an ideal scenario for midtown since the need for parking will be reduced. Valuable land will become available for other uses. Street parking places can be repurposed as green spaces and additional apartments can be built in high rise buildings

PARKING CALCULATION

		meter per parkeerplaats	6,1						
blok 3x3				standaard		met lift met grenswegen		met lift zonder grenswegen	
	lengte bruikbaar	aantal kanten parkeren	aantal keer aanwezig	parkeermeters	parkeerplaatsen	parkeermeters	parkeerplaatsen	parkeermeters	parkeerplaatsen
Blokgrens	222	1	4	888	146		219	0	0
binnenweg	225	2	4	1800	295		443	2700	443
totaal					441		662		443
blokken in wijk	20								
parkeerplekken nu	8820								
parkeerplekken met lift	13240								
parkeerplekken zonder hoofdwegen met lift	8860								

Fig. 4.45 | Parking calculations

LEVEL 4: PLOTS
INFRASTRUCTURE

by converting car parking floors to apartments.

So the future regarding parking in midtown is twofold. Firstly the redevelopment and densification of the area will lead to an increased demand for parking. Later the demand will get substantially lower because of the use of self driving vehicles, public transit and active modes of transportation. Excessive investment in parking might prove to be a waste. The catch is that there needs to be sufficient parking capacity available initially, but not too much considering the promising developments in the future.
In the current situation our area has approximately 8820 on-street parking places. This has been derived from measurements of block and data of advised parking bay length(University of Houston, 2012). Should we refrain from parking on the arterial roads but install parking lifts on every other parking place along the remainder of roads we get 8860 parking places in our district. So installing these lifts are useful to keep parking capacity constant, with a smaller footprint. An example of a park lift is indicated in Fig.4.44.

We suggest to address property developments to build internal parking, should additional parking be needed for their project. Preferably internal automated parking garages, because of their space saving nature.

5 IN CONCLUSION

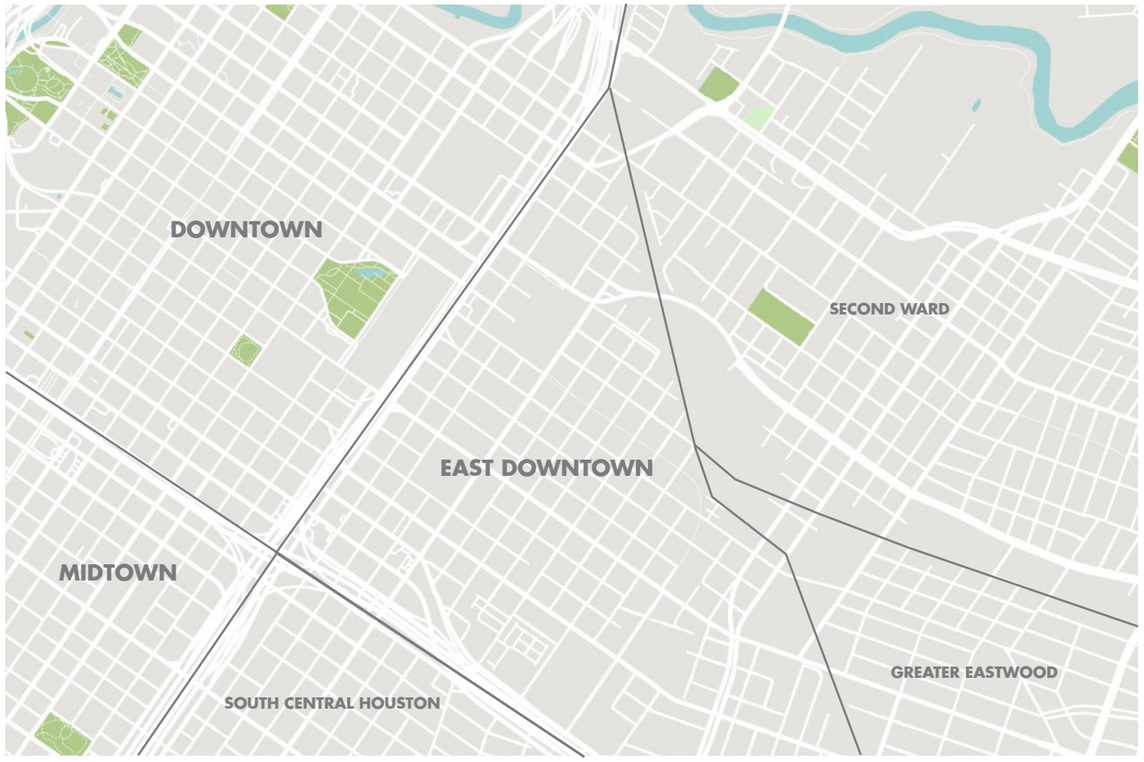


Fig. 5.1 | Map of East Downtown in relation to Midtown and Downtown (Snazzymaps, 2019).

CONCLUDING
MAIN PROPOSAL

MAIN PROPOSAL

With our Masterplan for Midtown we want to make the first steps towards humanizing Houston. We want to create more places where people can stay instead of only passing through to go somewhere else. To make Midtown into a real town within a city and increase the qualities of Midtown so people will be more attracted to live there. The combinations of the passports, grid, and urban beach have a great potential to realize this.

Furthermore, there is an urgency for a flood proof Houston as extreme weather and storms will probably be more frequent in the future. We should also focus on a cultural shift in the near future to make a flood proof Houston possible.

WHAT'S NEW

The concept of making more room for a river is not new. One of the most well known examples for this is the Dutch Room for the River project that finished in 2015. However, its spatial implications in the American context of Houston, with a different climate, policies, mindset and necessary water structures is a unique case.

Our project will be leading Houston to a continuation of a quite extensive way of dealing with water. The aim of the project is to show the potentials that Midtown has for the future, and use these potentials to increase its flood and climate resilience, not only on the scale of Midtown, but also on the scale of Houston.

Fig. 5.2 | The concept made for Midtown, can also be applied to the neighborhood of East Downtown.

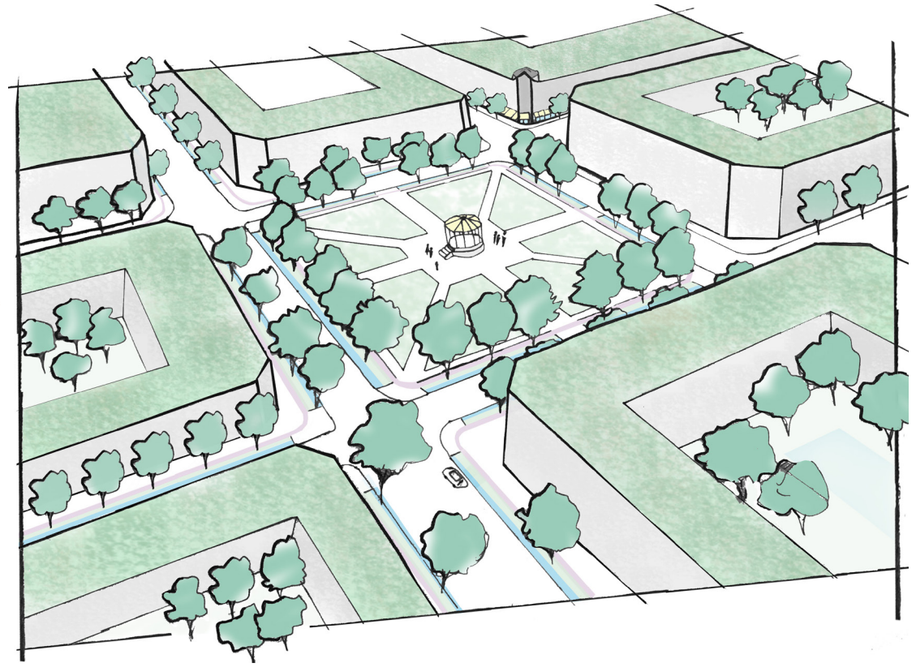


Fig. 5.3 | Impression of a neighborhood stamp, consisting of nine blocks.

CONCLUDING
SOCIETAL RELEVANCE

SOCIETAL RELEVANCE

With our Masterplan we aim to solve several of Midtown's problems. Yet our concept is not just limited to just Midtown. The concept we created of passports with guidelines that we designed for Midtown is applicable for other areas as well. To prove this we will show how our concept fits in an area in Houston that is quite similar to Midtown. This is the neighborhood of East Downtown (see fig.5.1 & 5.2).

East Downtown has the same position and relation towards Downtown as Midtown has: it also borders on Downtown, with a highway inbetween. Furthermore, it has a building typology similar to what can be found in Midtown right now, with a lot of mixed-use, but slighlty more industrial than Midtown.

Our concept also fits East Downtown, because of the passport guidelines that allign with the American grid system. With our project, East Downtown, (among other neighborhoods), can also be improved towards a flood reslient and vibrant neighborhood of Houston.

Fig. 5.2 illustrates how an examples of this might look like in both Midtown and East Downtown. Each stamp of nine blocks will look slightly different from each other, yet the main characteristics match. Together with the new bayou and urban beach, this will guide the way towards a thriving and safe Houston.

CONCLUDING
RECOMMENDATIONS

RECOMMENDATIONS FOR FURTHER RESEARCH

In this project the flood resilience of Houston has been analysed and this led to ways to improve the city on the disciplines of urban planning, water management and infrastrucutre.

A more in-depth study of the stakeholders related to the sectors that are of interest should be done to be able to estimate the timeline in which this project could be realized. The collabartive capacities of the key actors should be studied as well.

This will help develop progress that will provide the level of security on flooding in Midtown and Houston as there is in the Netherlands.

A big challange is how to trigger these changes. Not only in a technical or policy way, but in a cultural way as well. To improve Houston's ability to protect itself against flooding, a change in mindset is needed. This brings new challenges that accompany a cultural shift.

With our Masterplan the first step towards envisioning a new sustainable and flood–resilient future for Midtown and for Houston is being made.

APPENDIX

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TOWARDS A FLOOD RESILIENT, CLIMATE RESILIENT, AND VIBRANT

MIDTOWN