

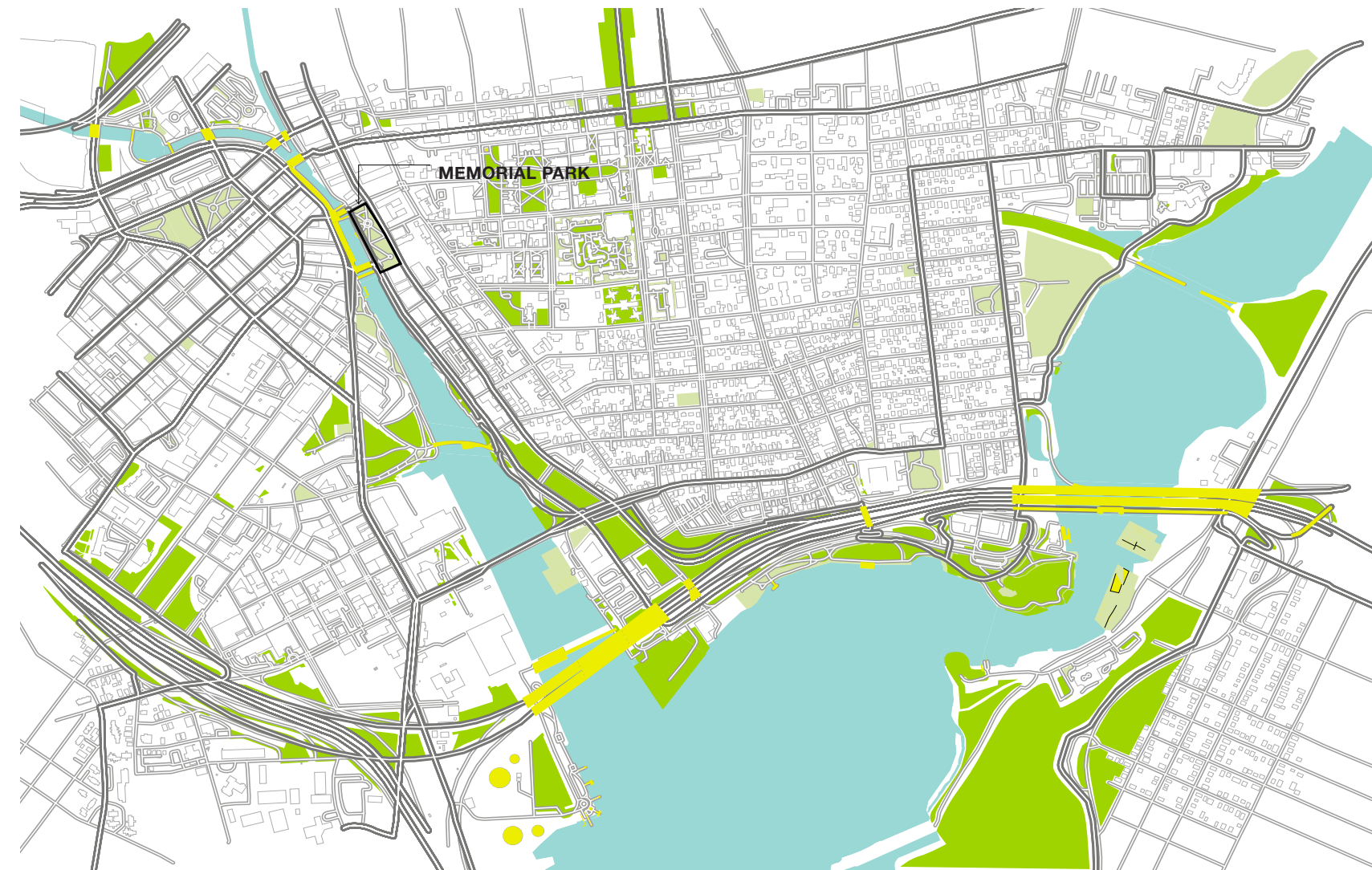
SITE ANALYSIS

Site Description

Providence is the capital and most populous city of the state of Rhode Island and is one of the oldest cities in the United States. It was founded in 1636 by Roger Williams, a Reformed Baptist theologian and religious exile from the Massachusetts Bay Colony. He named the area in honor of “God’s merciful Providence” which he believed was responsible for revealing such a haven for him and his followers. Providence has a humid continental climate. The city is situated at the mouth of the Providence River at the head of Narragansett Bay.¹

Downtown Providence has numerous 19th-century mercantile buildings in the Federal and Victorian architectural styles, as well as several post-modern and modernist buildings located throughout the area. In particular, a fairly clear spatial separation appears between the areas of pre-1980s development and post-1980s development. West Exchange Street and Exchange Terrace serve as rough boundaries between the two.

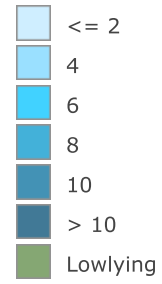
¹ “Providence - Google Arts & Culture.” Google. Google. Accessed May 19, 2020. <https://artsandculture.google.com/entity/providence/m0c1d0?hl=en>.



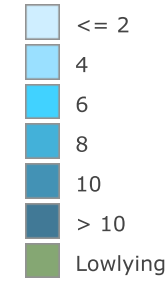
SITE MAP

The site is Memorial Park, Providence, RI. This sculpture-filled park pays homage to people who gave their lives during wars and conflicts around the world. This park is located in downtown Providence, closed to RISD, Brown, and also near to the business buildings. People always come to talk, smoke, eat lunch along the river. There are many activities happening on the park during the year. Some of them are mainly held for the waterfire, the most attractive activity in Providence.

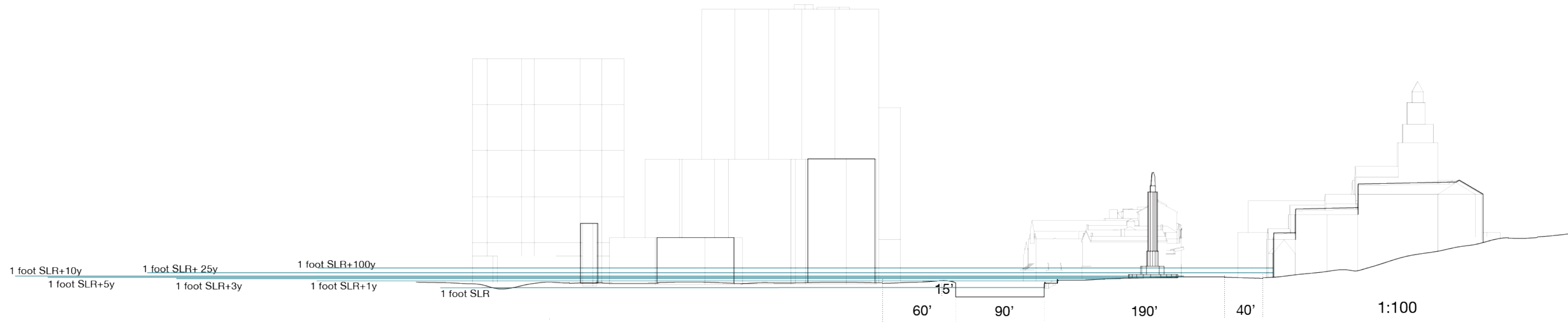
**10 Year Coastal Storm
With 1 foot Sea Level
Rise (feet above grade)**



**25 Year Coastal Storm
with 1 foot Sea Level
Rise (feet above grade)**

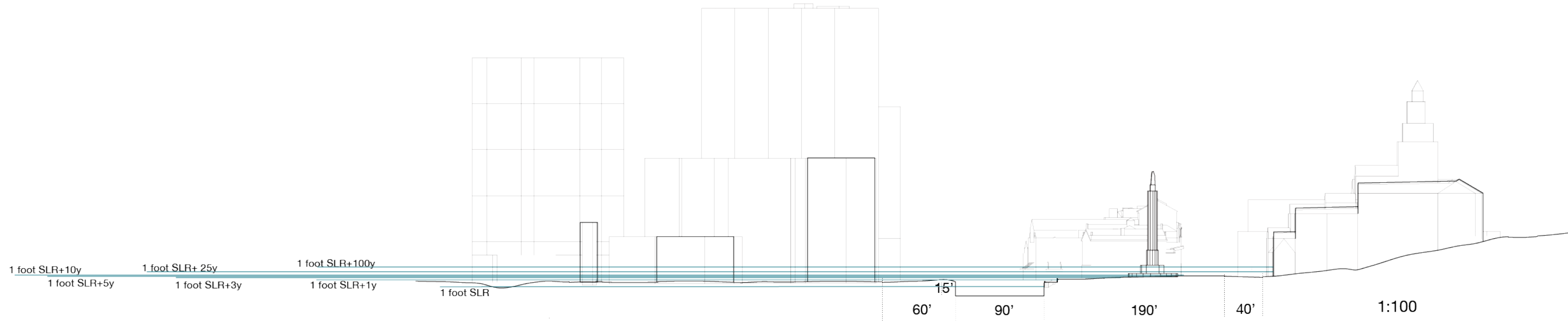


There are the flooding map I got in Advanced STORMTOOLS, which provides a series of maps that illustrate what coastal flooding could look like in the future under different storm scenarios. There are many similar research finished before, which provided great supports to my research.
 Source: "Advanced STORMTOOLS Gallery." arcgis.com. Accessed May 24, 2020. <https://www.arcgis.com/home/webmap/viewer.html?webmap=16686101a1e047b5a418da32929d999f>.

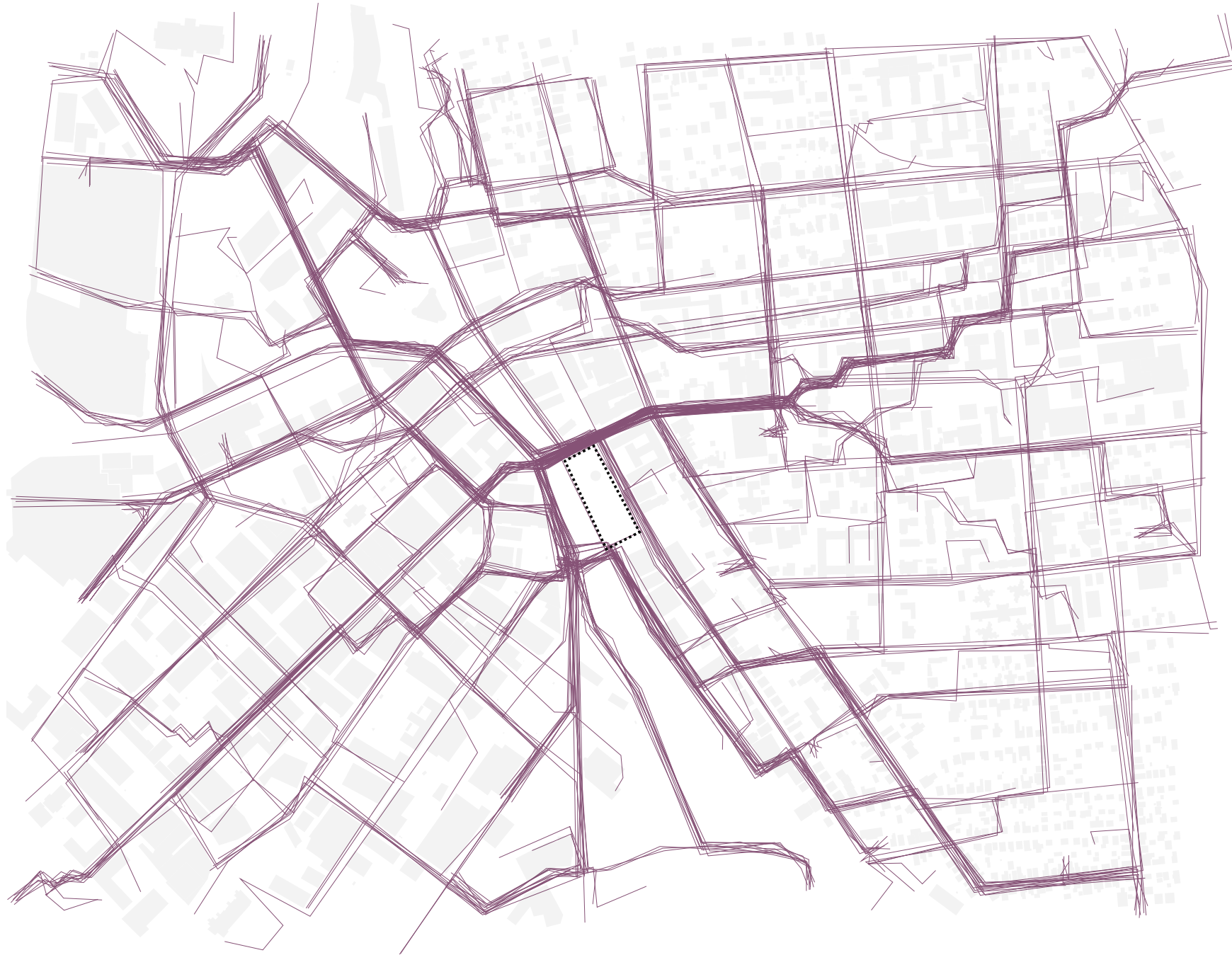


Section

According to the flooding data in Advanced STORMTOOLS, which provides a series of maps that illustrate what coastal flooding could look like in the future under different storm scenarios. It enables Rhode Island's municipal officials and decision makers to better understand their risk from coastal inundation. I draw these sections to show the destinations of each flooding in Providence.

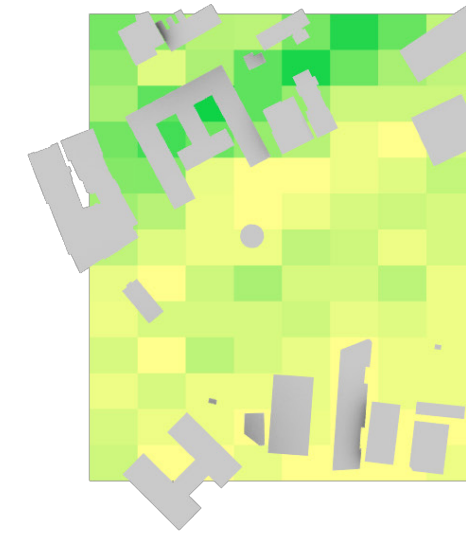


These lines represent the containers of flooding in different levels. Instead of static diagrams, how to visualize the process of water filling into the “containers”, and how to make the audiences tell structures are covered by water with the movement of flooding, and how flooding influence people’s life with the increasing height of water is the keypoint in my research.

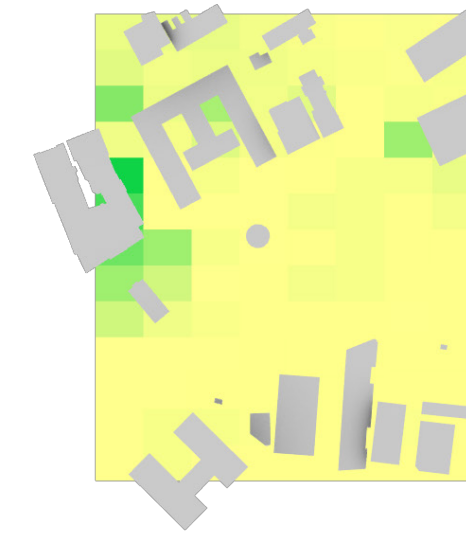


Flow of People

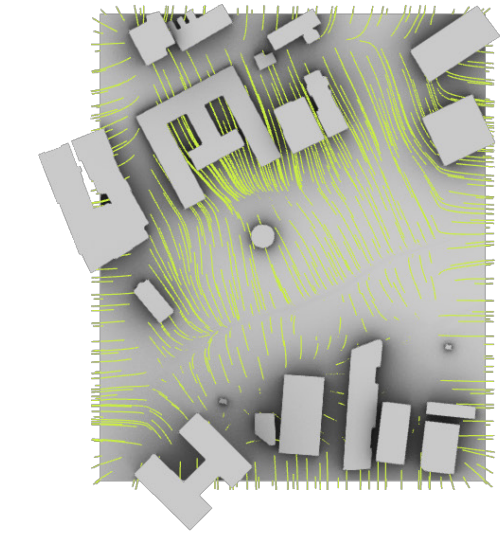
This is an analysis of the flow of people in downtown Providence. The black box in the middle is my research site, Memorial park. It's clearly seen that the streets around the site are very densely populated, so once the site is eroded by the flood, there will be a series of large influences on people's life. Therefore, we must use various data visualization methods to attract people's attention to the protection of this site.



Height Analysis



Slope Analysis



Waterflow Analysis

Height, Slope, and Water flow

These figures analyze the height, slope, and water flow of the surroundings to obtain basic information around the site. The level changes from yellow to green and becomes heavier and heavier. From this gradient maps, we can see that there are obvious changes in height around the site, and slope changes are also very obvious in some places. Rainwater mainly flows through the site and then eventually flows to the river, so it is necessary to protect the site.

SIMULATING FLOODING

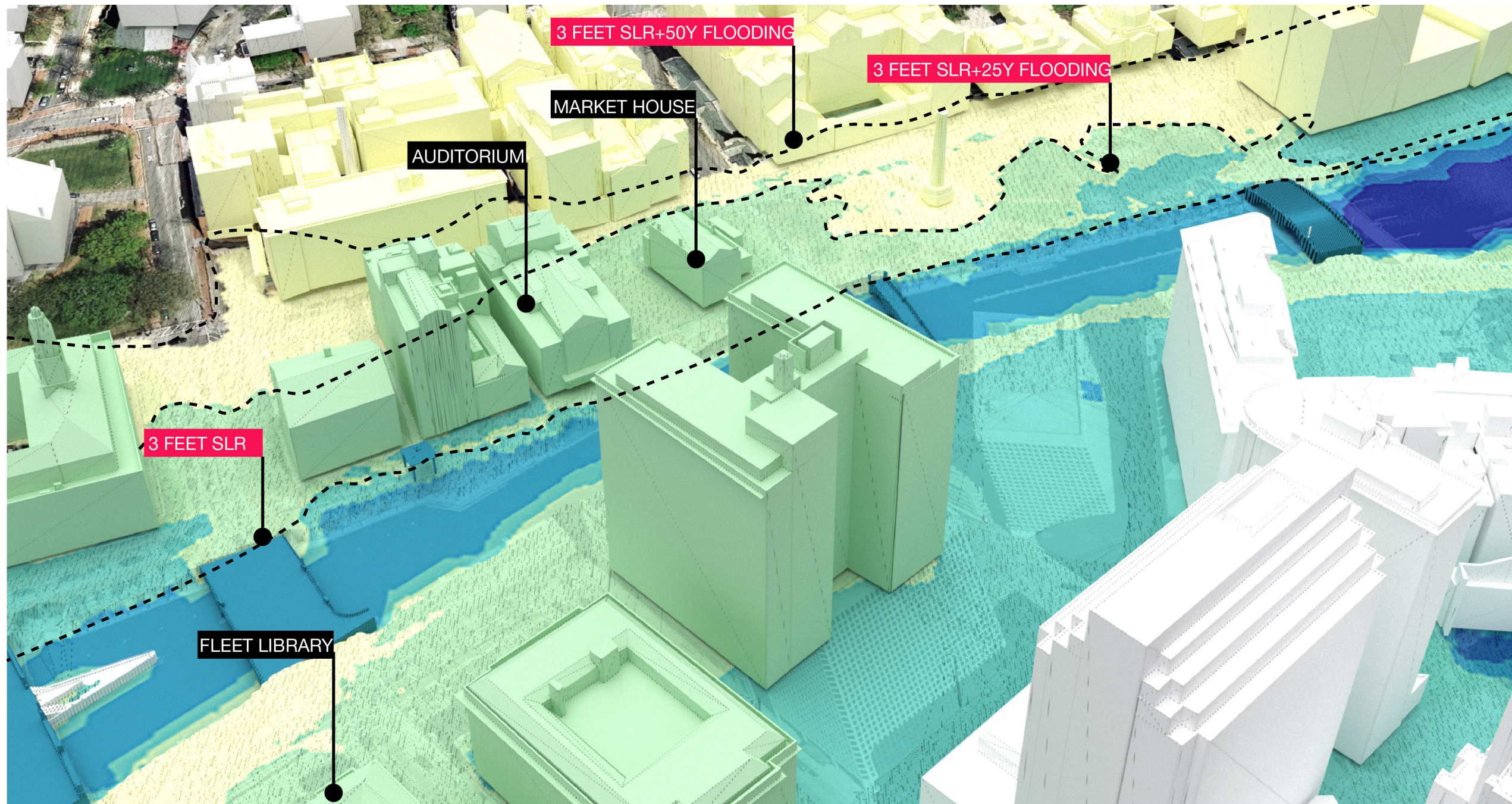
3D Modeling

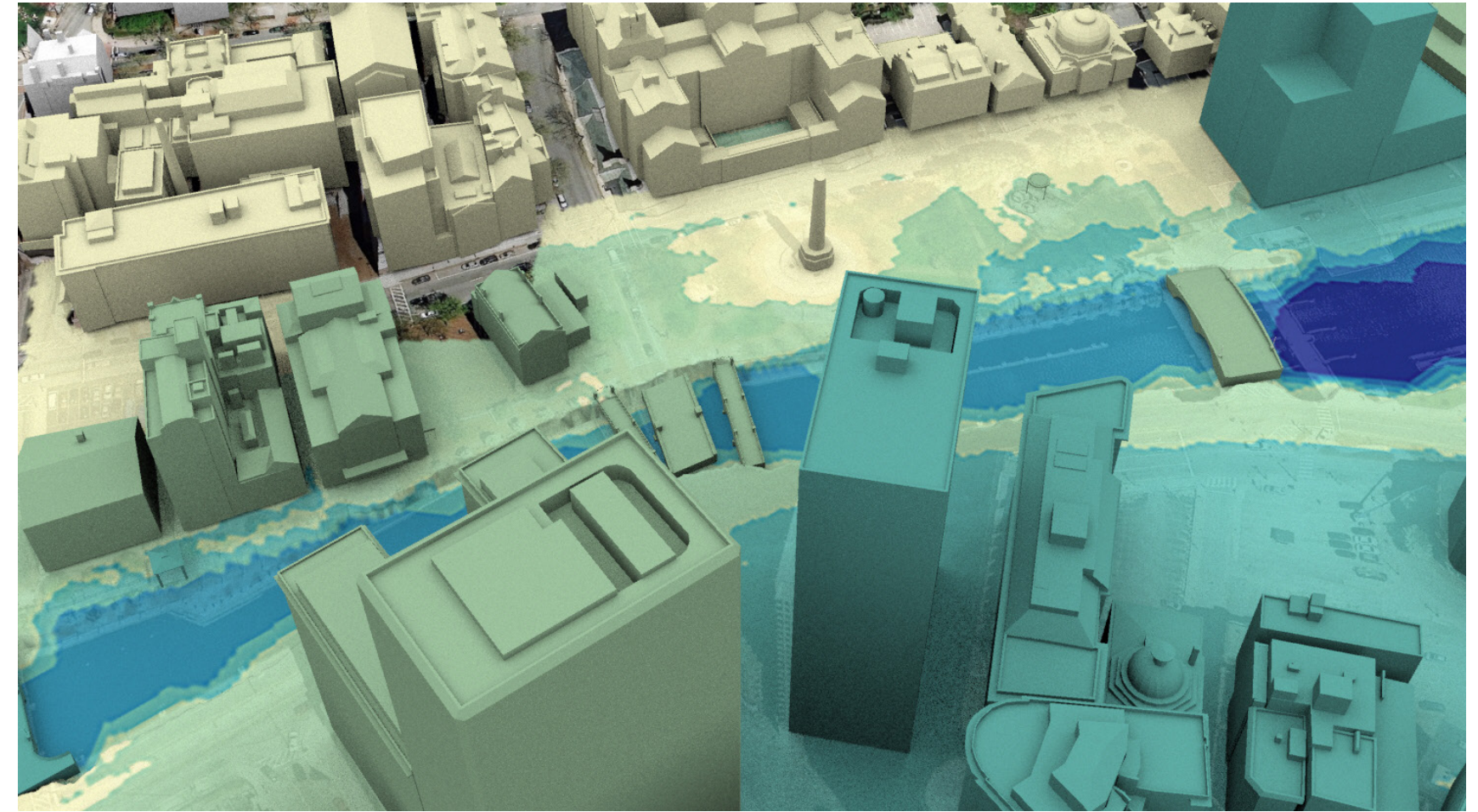
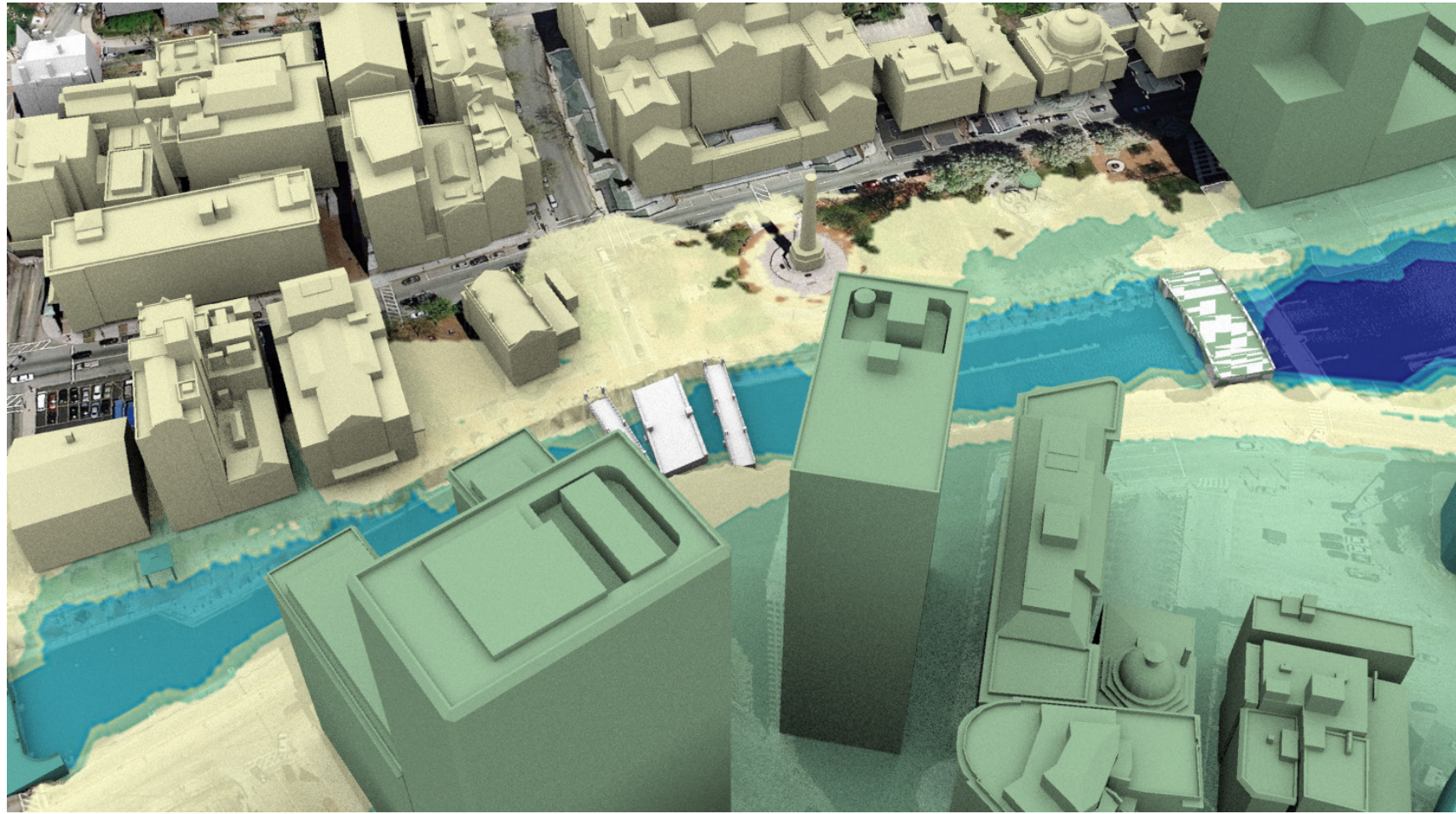
Compared with static diagrams and two-dimensional maps, the 3D models provide multiple perspectives to observe the site, with more levels of contents.

For the first simulation method, I used 3D modeling¹, which is also the most commonly method used in architecture. I build a model of the site, and reflected the results I got from maps into the structures of the models. Different materials and colors are used to show the difference in the level of impact of flooding, so that people can clearly determine whether a building or an area is affected by flooding, and how much it is affected.²

¹ "Assessing the Multiple Impacts of Extreme Hurricanes in Southern New England, USA", by David S. Ullman, Isaac Ginis, Wenrui Huang, Catherine Nowakowski, Xuanyu Chen, and Peter Stempel. 2019. URL: <https://www.mdpi.com/2076-3263/9/6/265>
Models from Peter Stempel (<https://peterstempel.com/>)

² Data source: "Real-Time Chronological Hazard Impact Modeling", by Peter Stempel, Isaac Ginis, David Ullman, Austin Becker, and Robert Witkop. 2018. URL: <https://www.mdpi.com/2077-1312/6/4/134>



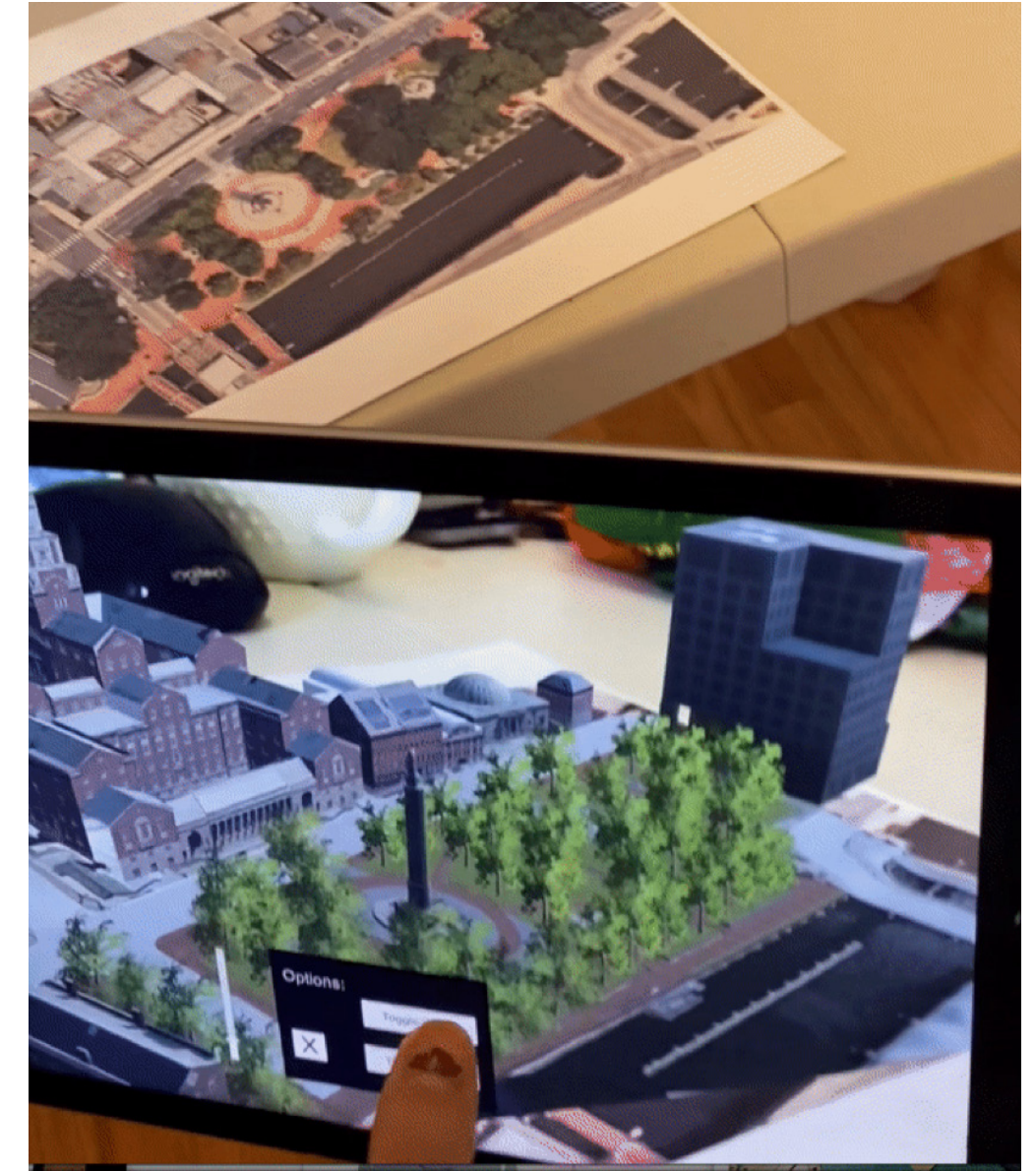
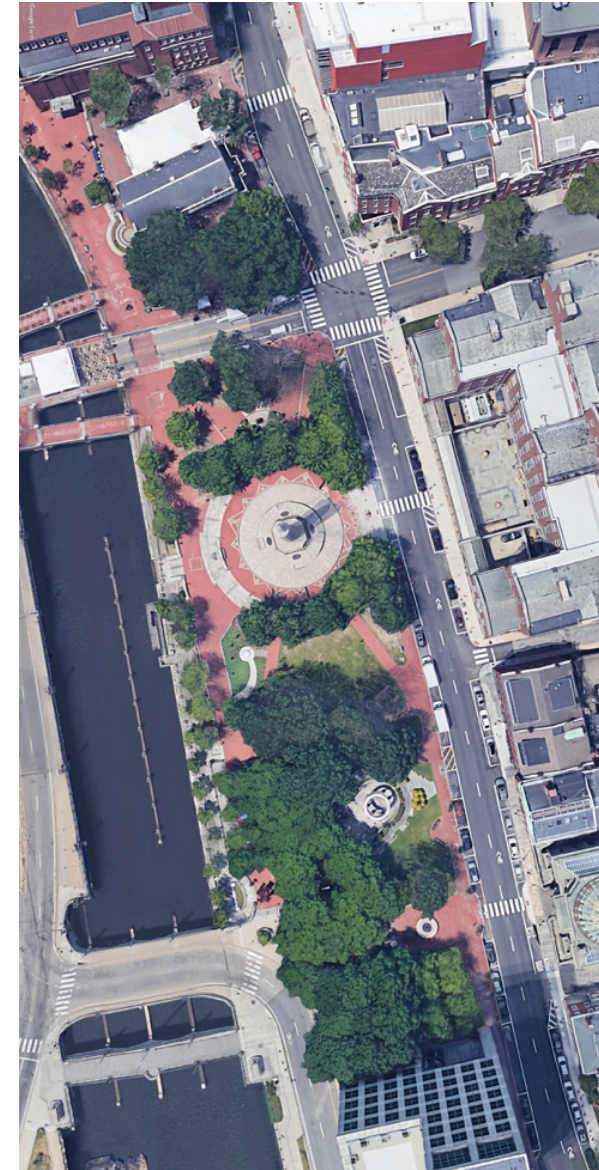


There are two floodings in the same site. As you can see, the darker color means the greater impact. 3D modeling can give people a clear idea about which areas are influences, and which areas are not. I also use this method into other research to figure out if there are some problems needed to be considered.

Augmented Reality (AR)

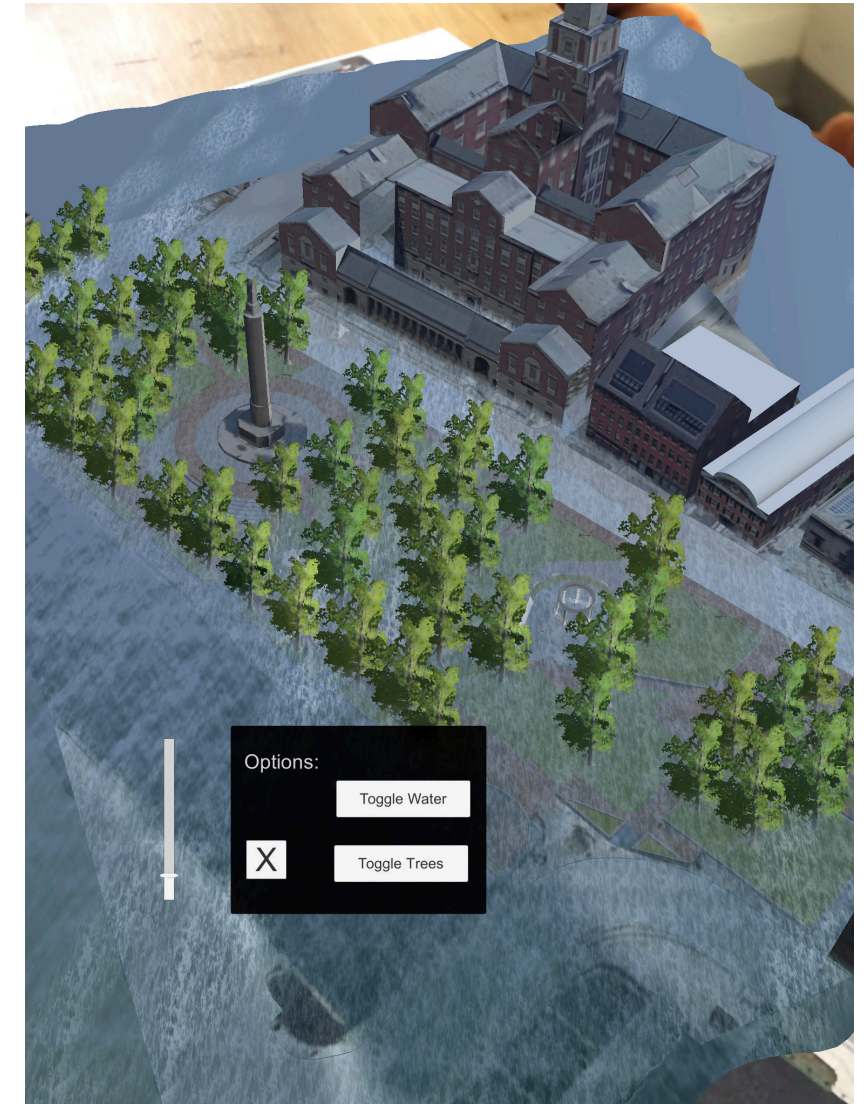
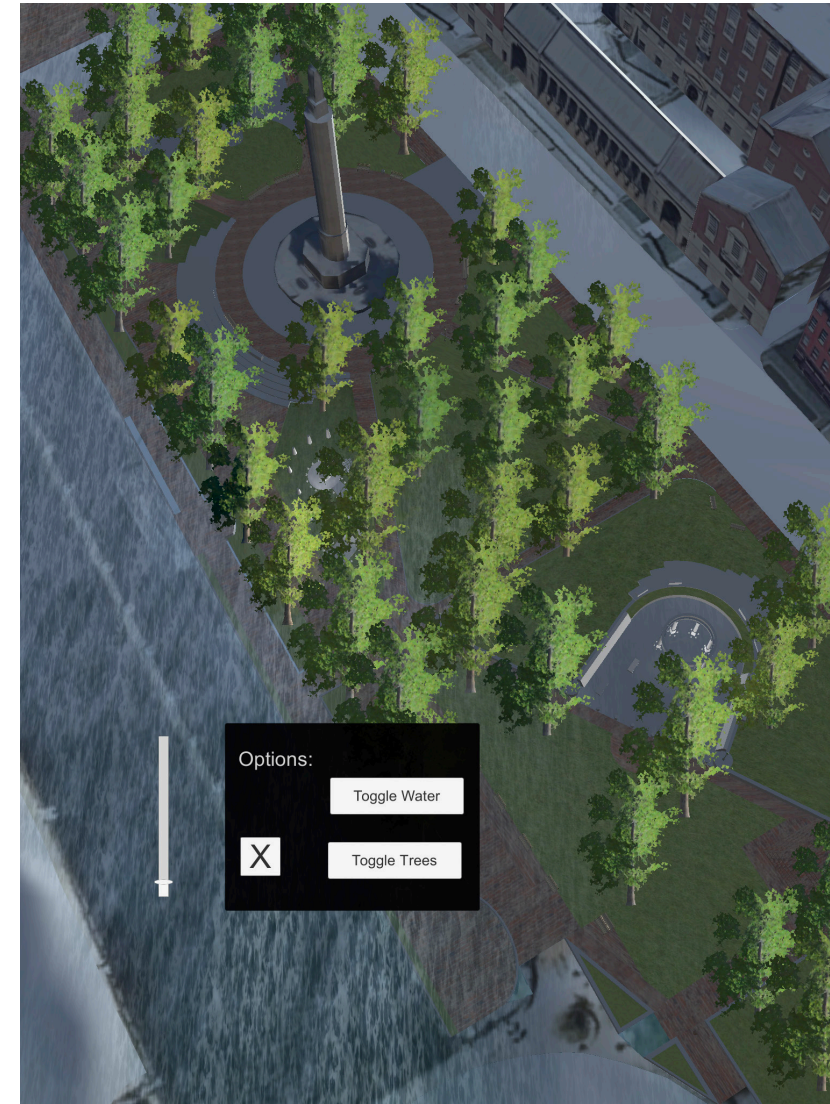
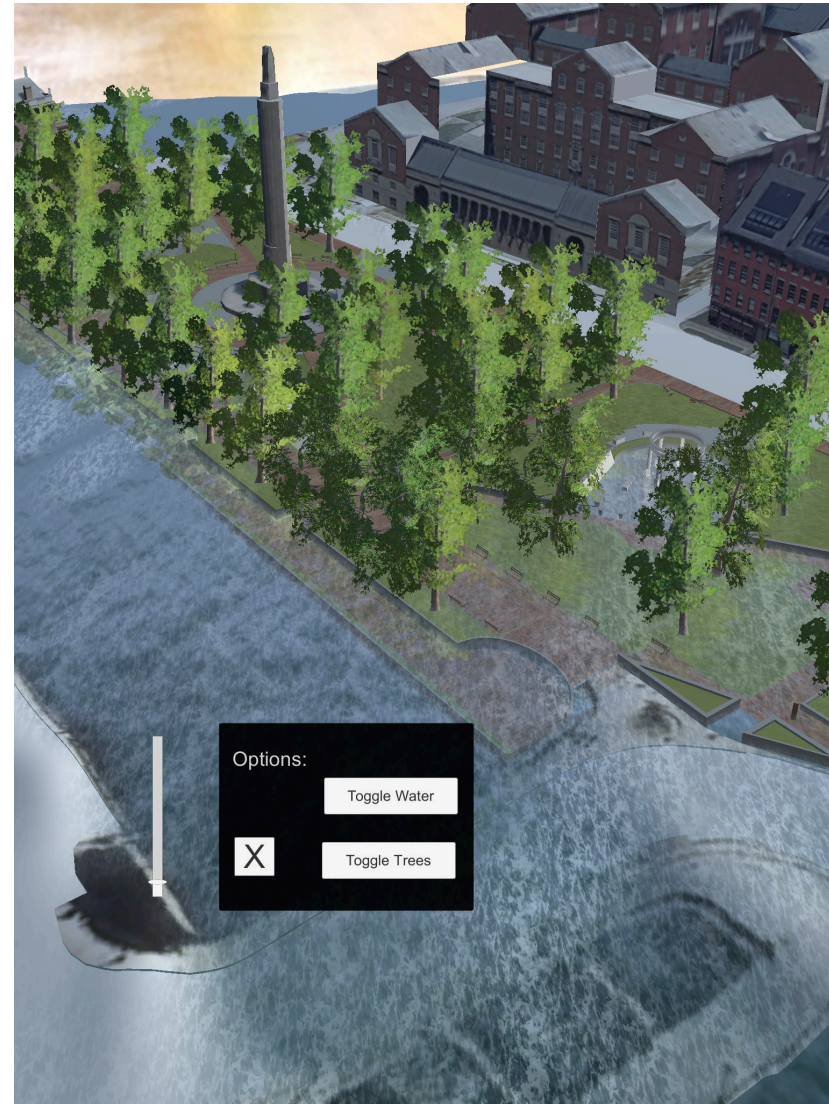
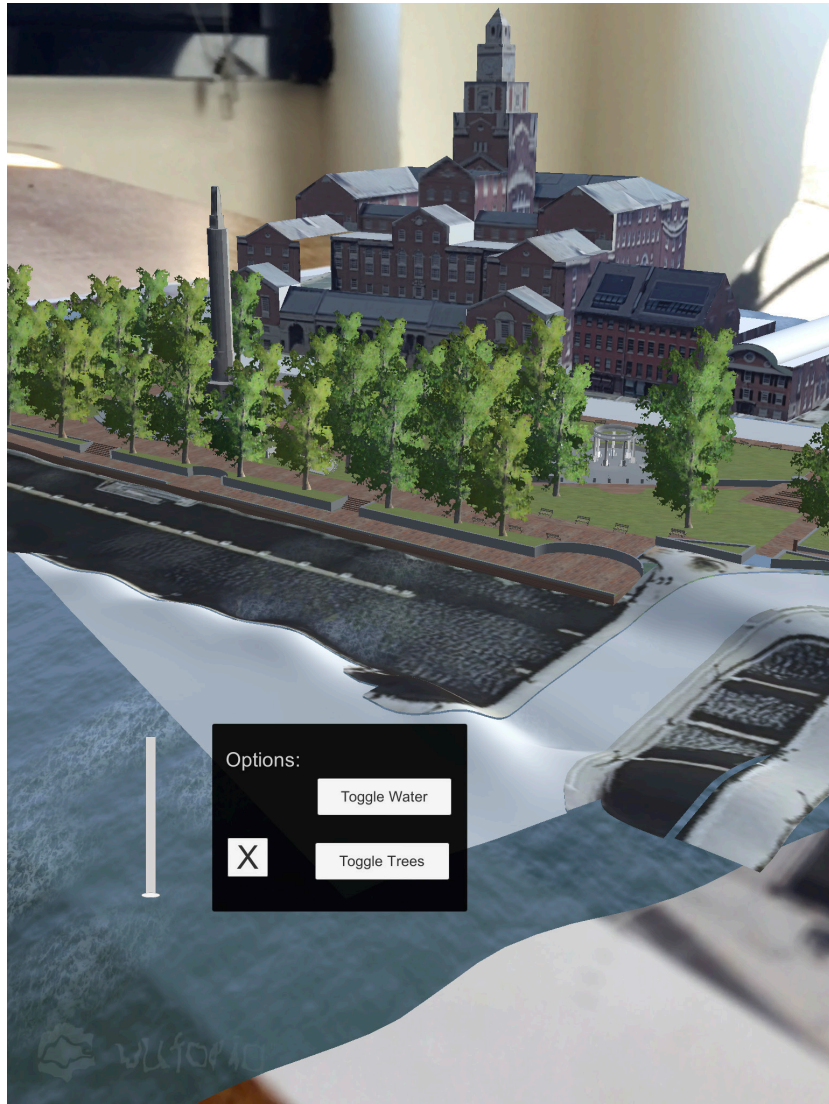
Augmented reality (AR) is an interactive experience of a real-world environment where the objects that reside in the real world are enhanced by computer-generated perceptual information, sometimes across multiple sensory modalities, including visual, auditory, haptic, somatosensory and olfactory.¹

I added support for my urbansimulation game into augmented reality. If you scan a flat site plan, a 3D site model appears on it. It means that I have “2 realities” —the site plan which is informative and flat, and the 3D model which begins to bring in more information and possibly offers the chance to show perspective and emotion. Also, there are many buttons along the screen, which allows you to easily interact with the game and change aspects of the site model, like the water level and availability of trees. So designers don’t have to spend a long time to have dialogues with kinds of stakeholders.



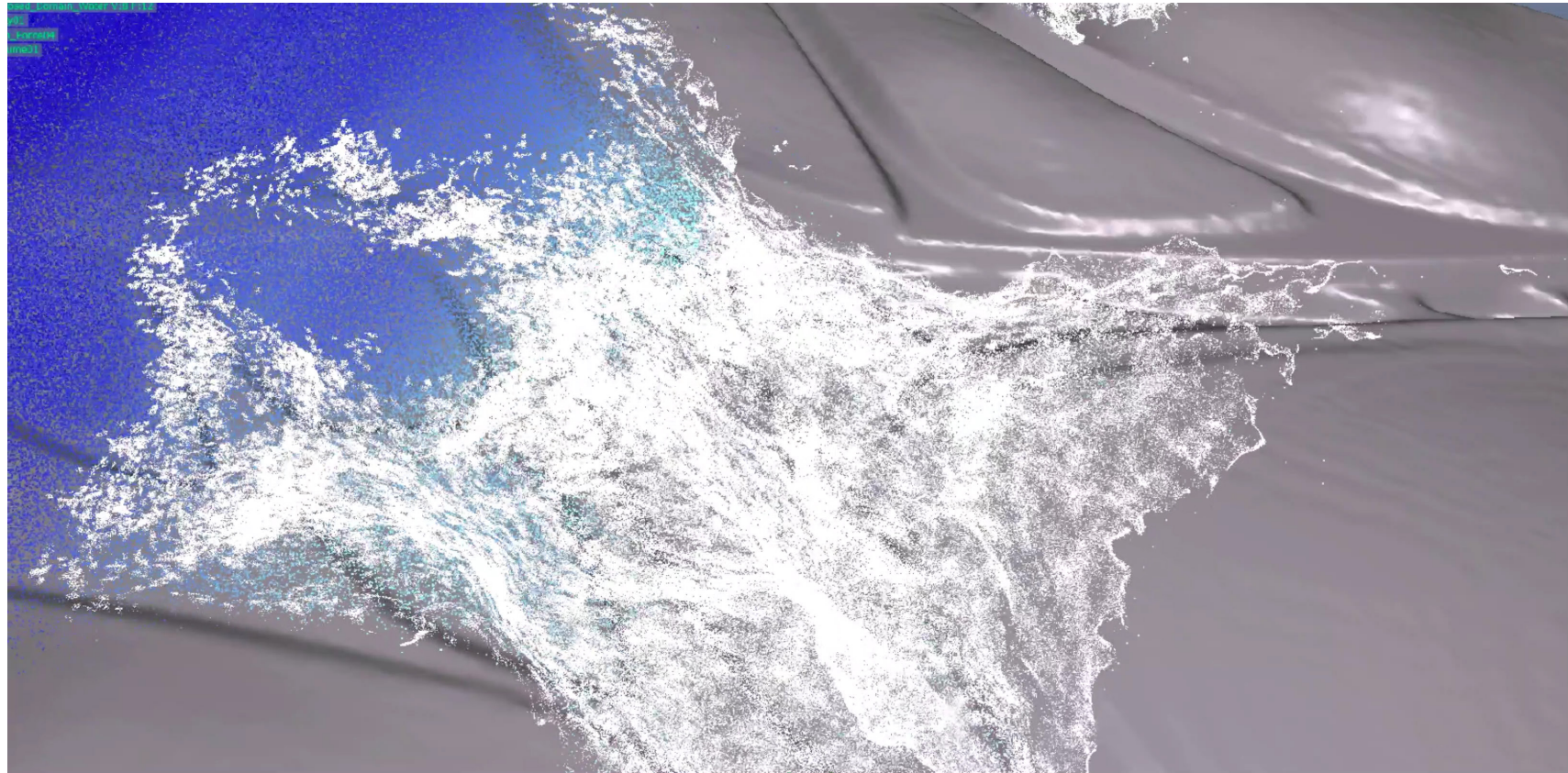
Scan the map on the left, a 3D model will appear in front of your eyes instantly. You can observe the 3D model in different perspectives, toggles it easily and change the height of water by using the buttons and side bar.

¹ “Augmented Reality.” Wikipedia. Wikimedia Foundation, May 18, 2020. https://en.wikipedia.org/wiki/Augmented_reality.



AR SCENARIOS

These are the scenarios made in AR system. You can change the height of water easily by using the side bar, and also you can tell which structures are covered by the water if you adjust the height. But the water here is static, we can't see the foams, or any collisions made by water with structures. So it's hard to engage the audiences into the flooding scenarios.

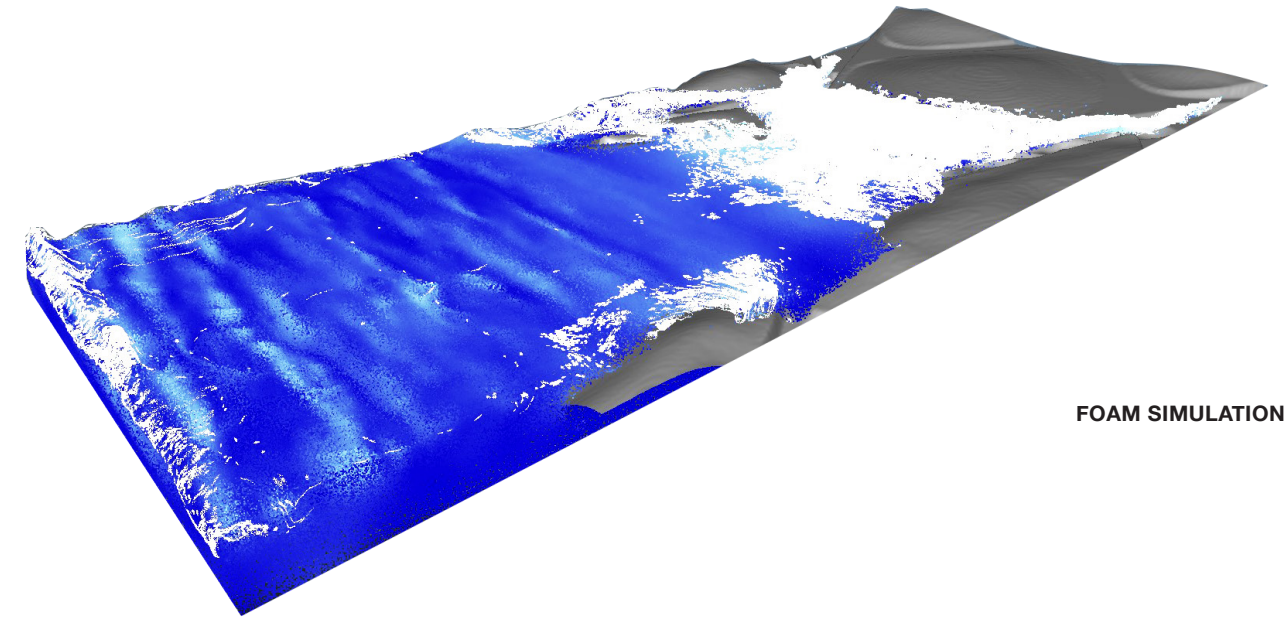


WATER MOVEMENT SIMULATION

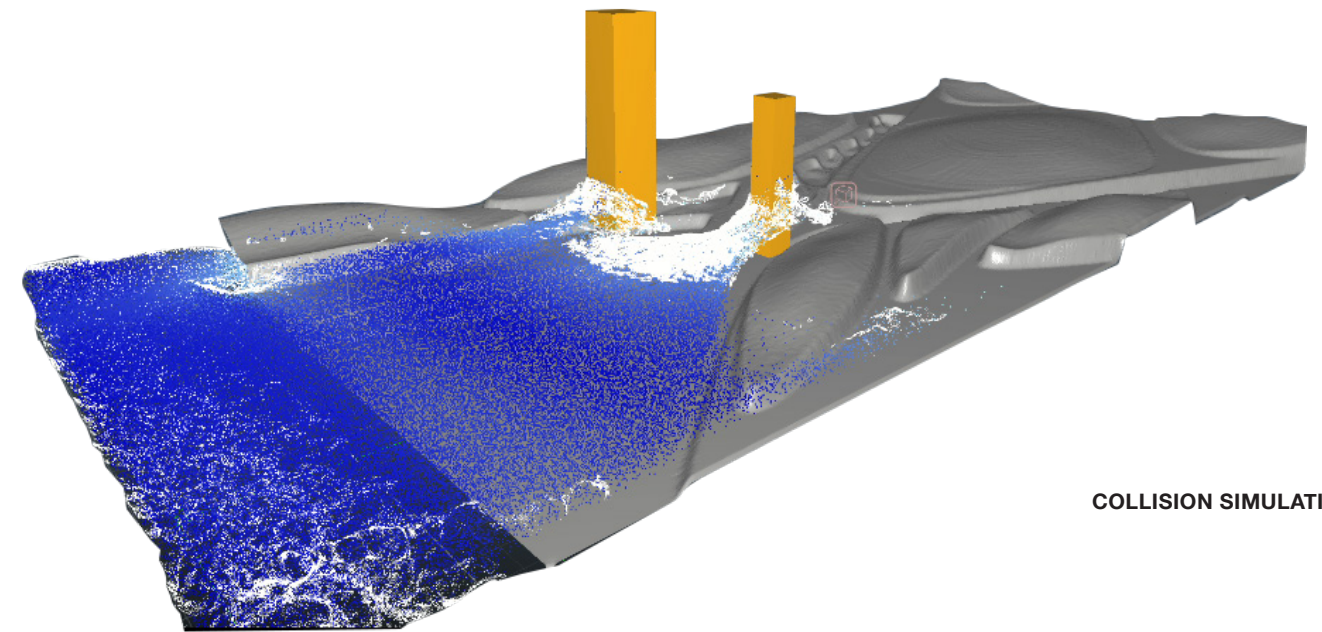
Flooding Animation

Animation is a method in which figures are manipulated to appear as moving images¹, which means we can use this media to show the dynamic movement of flooding to illustrate the nature and extent of flooding events.

¹ "Animation." Wikipedia. Wikimedia Foundation, May 17, 2020. <https://en.wikipedia.org/wiki/Animation>.



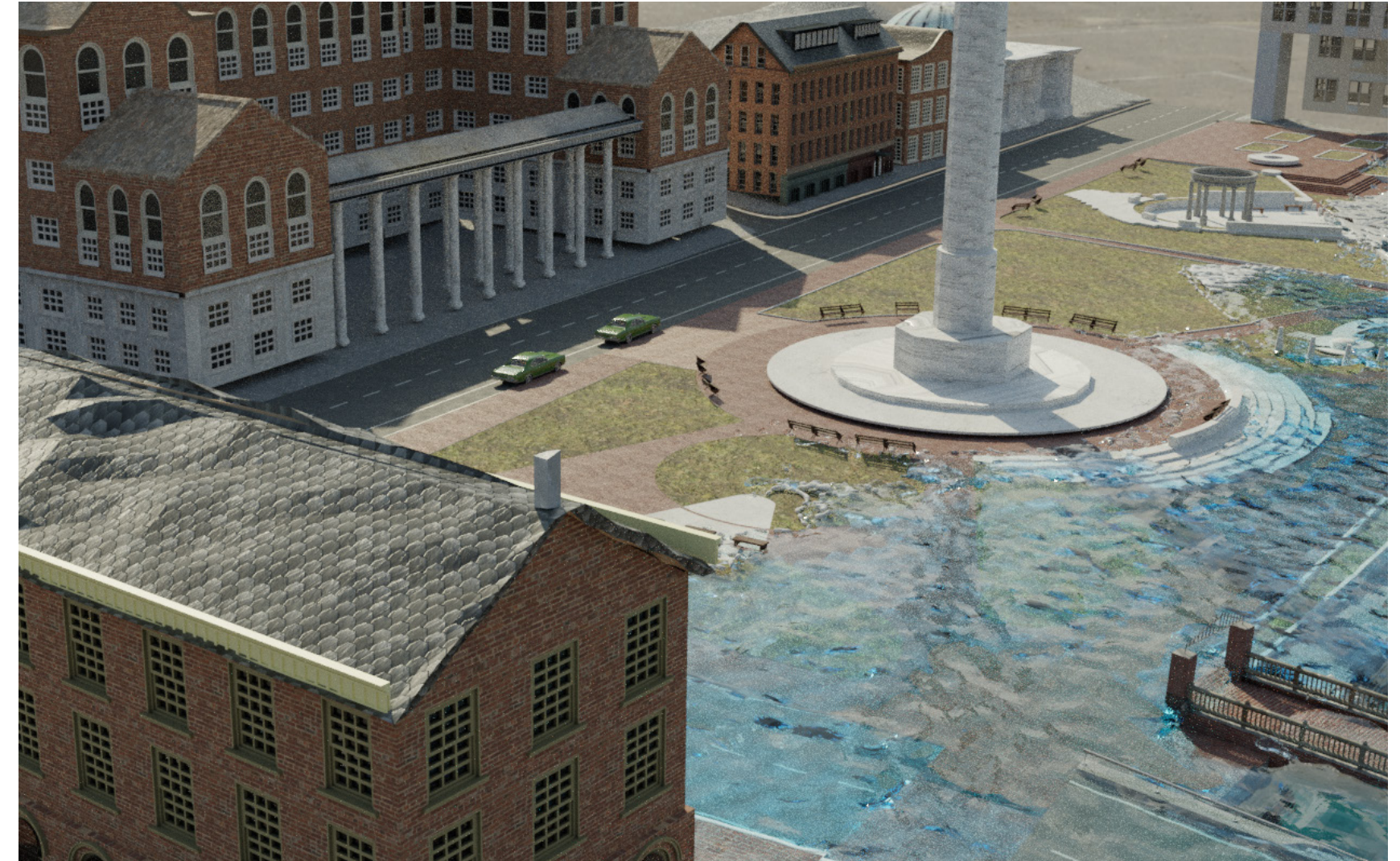
FOAM SIMULATION



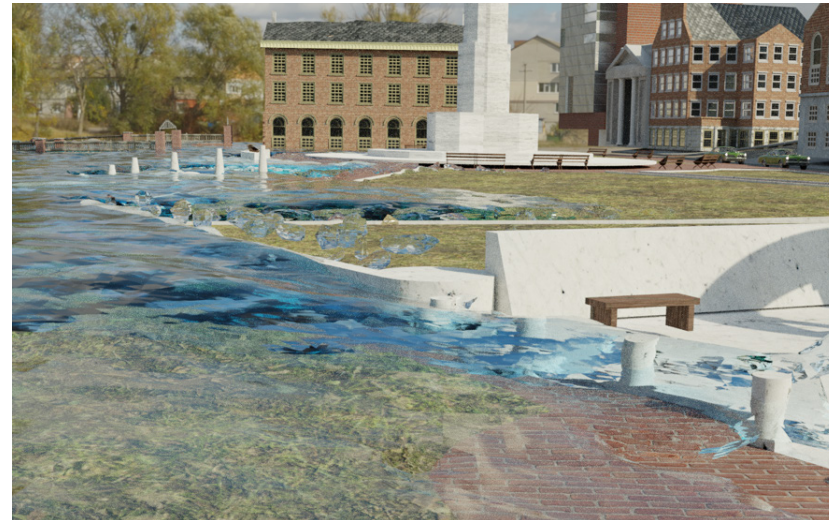
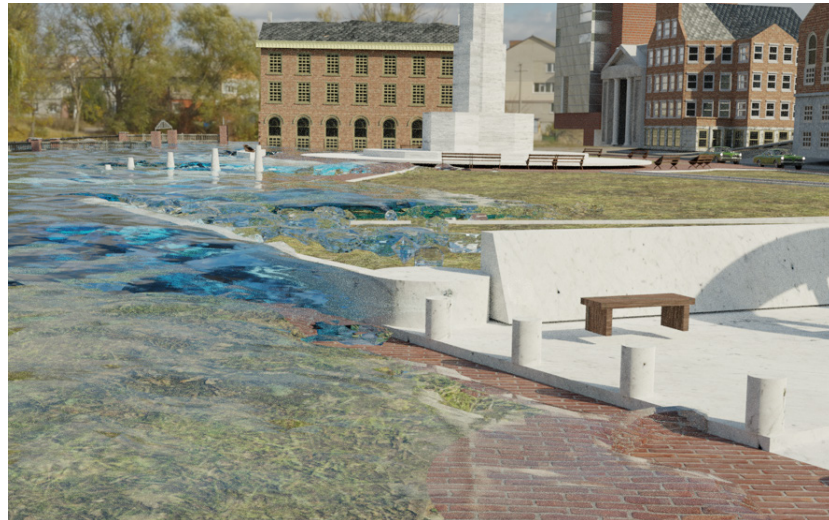
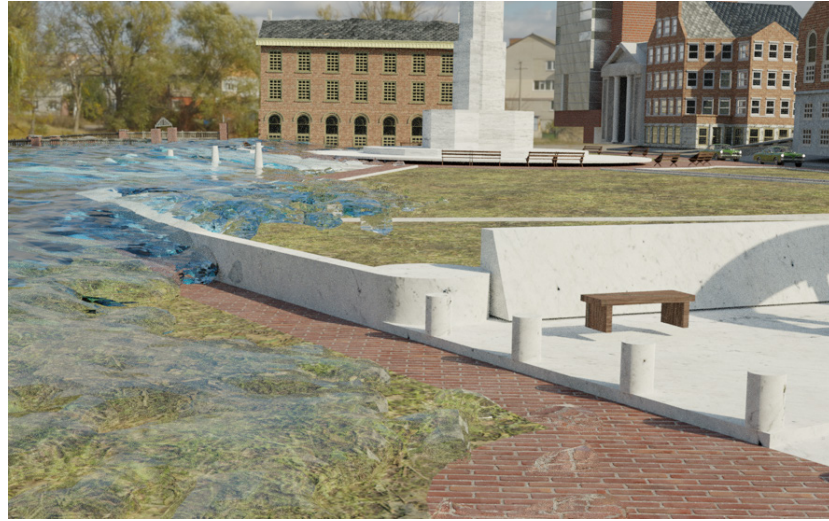
COLLISION SIMULATION



The first thing I did for flooding animation is to make a realistic model for this site, so people can easily tell the buildings they are very familiar with. Then they can more engaged into this simulation, and arise people's concerns as much as possible.



Then I added transparent materials into the water to make sure people can tell the structures under the water. Also, you can change the perspective you observe the site in the animation-making process, so you get several animations focusing on different areas.

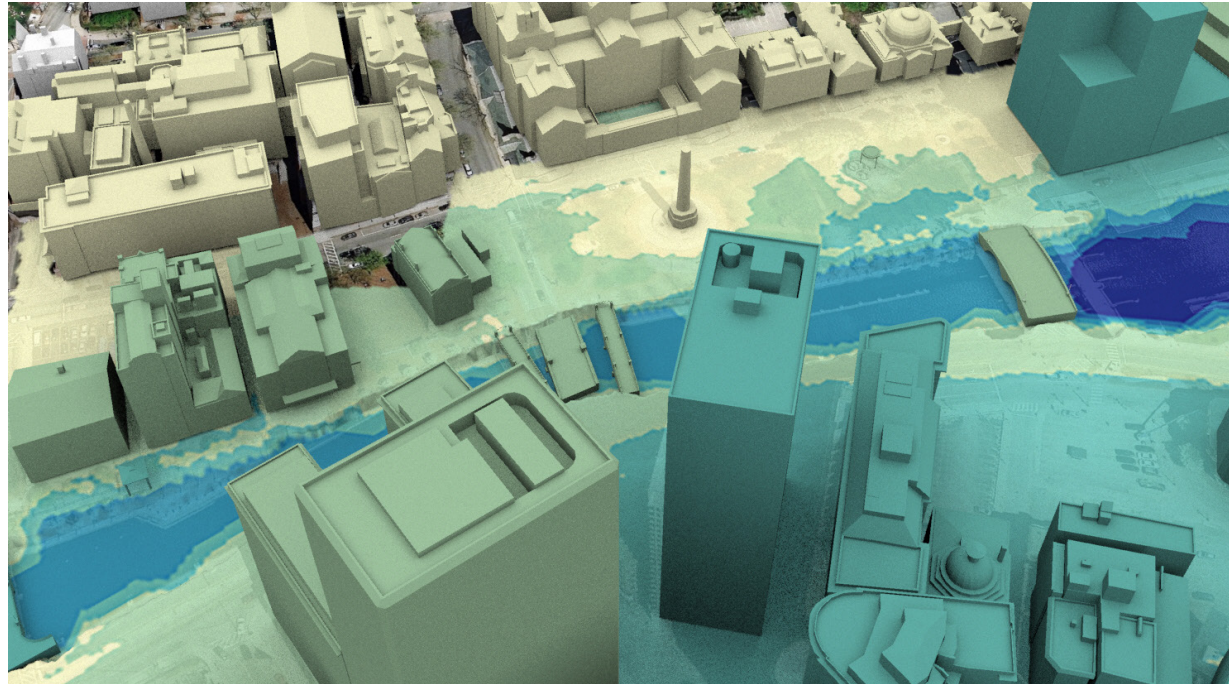


From these pictures, you can see the process of water entering the site. You can tell the different results based on whether there are any obstructions or not. These simulations allow the observer to directly see the damage caused by the flood to the site they are familiar with and how they will affect their life. This is the biggest difference from the other two methods.

It's also helpful for the designers, urban planners to test their strategies in the specific site. Just dragging the site model into the system, you can easily see how the water walk into the structures and if your strategies are strong enough to protect the site away from the water.



Once you understand the water movement in this site, you can even have specific markings on the physical buildings to tell the audiences how serious results the site will have based on the water movement simulation, and we can also put an QRcode around the mark and you can get the flooding animation by scanning the QRcode, so people can actually compare the reality and imagination directly.



Summary

These are the three stages of research, from static 3D models to dynamic AR systems, to animation simulations, which allow viewers to see more and more flooding processes and details. I eventually want a result of combining these three stages together into a complete flooding process. First of all, we want to make the 3D model more detailed, changing it from a general RHINO model to an animated model with many details, and then use this refined model to do flood simulation animation in order to simulate more processes, and then put this flood process and model into unity to make AR effect. Audiences are able to have more interactions with this process, so as to achieve our purpose of raising people's concern about climate change and taking action to protect the environment.