2019

The Pursuit of the Future: an Investigation into a Sustainable Office Tower

Clayton R. Daher

The Pursuit of the Future

an investigation into a sustainable office tower

Contents

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An investigation into a sustainable office tower
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Introduction

The Project Statement |

The City of New York has long been known to be one of the most influential cities in the world for corporations. It is a hotbed for talent and innovation alike. It is a city that never sleeps and often times forces employees, whom are just trying to make a name for themselves, to work 60+ hours a week in cramped conditions.

In surveying the city, it is prevalent that there is a lack of sustainable office buildings which in return has adverse effects on the employees' health and productivity. Corporations are continuously transform their practices and missions to be in line with the twenty-first century consumer. They are forced to house their businesses in buildings that do not reflect what they are preaching and are causing more harm than good on our environment.

This project will work to investigate the Midtown East Business District Rezoning and look to employ the ideas it produces to one of the fourteen available sites within the district. The project will involve completely dismantling and demolishing an existing twenty-two story building and replacing it with a new efficient and sustainable tower for the twenty first century. It is provocative project; a project meant to inspire and generate conversation about building tectonics and create controversy.

Figure 1

The Problem Statement |

The pursuit of the future as architects we are given the civic responsibility to help change the way we live our lives and to ultimately lessen our impact on our precious earth. We are also presented with the opportunity to intervene in the business of real estate and improve the buildings that we produce. Although our first mindset is not to tear down buildings that seem perfectly okay, we have to understand the business behind it, the upcycling of materials and the greater impact our buildings can have as statement pieces and aspirational goals for architects, developers and skyline dwellers.

With the Midtown East Business District rezoning officially in place, we have the opportunity to partner with developers, the city and potential tenants and change the way buildings are built.

With numerous corporations including many Fortune 500 companies located within Midtown East, we also have the ability to transform their philosophy and the way they do business.

This project will address the social change in the way buildings are built and the materials that are used. It is meant to provoke criticism and engage fruitful conversations about how buildings are built, the future of taxes and how we fund radical towers.

The Issue |

It has been proven that the building's structure is the largest contributor of carbon emissions. Typical systems are concrete, steel and light wood framing. Concrete is the second most consumed substance on earth after water. The majority of structures built in the western hemisphere are built using concrete. Cement is one of the main components in concrete and alone, amounts for over five percent of global emissions annually.

As the global population continues to rise and more and more people are flocking to city centers, many more buildings will have to be built to house them and provide spaces for their employment as well. Tall buildings are vital for any urban environment as they are the best use for limited space and promote urban density.

They also reduce carbon dioxide emissions associated with cars as they promote walkability and use of mass transit. They also have the ability to be more energy efficient as they share common roofs, walls and other mechanical systems that single-family dwelling each need.

We need to change the way we think about buildings and have a greater acceptance that what we are doing now is not working. We have a building solution that has been common for well over a hundred years that could be transformed and drastically improve our impacts on our environment. We need to have all involved on the projects be more open and accepting of alternative building solutions

Structural engineers use concrete and steel primarily in high rise construction because the International Building Code and local city building codes require structures to be built out of noncombustible materials. Also, steel and concrete have a higher material strength than wood and masonry. There are two ways a structural engineer can reduce the carbon impact in a building. They can try to design a building that minimizes structural material and they can also design a building that uses less carbon intensive materials.

Context

Context | Maps

The United States of America | The Tri-States | New York City to the Region | The Boroughs of New York City | The Borough of Manhattan | Midtown East

Figures 2A-F

Context | Map of Manhattan

Context | Map of Midtown

Figure 3a-b

Context | The History of New York

New York City is one of the most diverse, religiously varied, commercially driven and congested cities in the world. It is comprised of five boroughs; Manhattan, Brooklyn, Queens, The Bronx and Staten Island. Each borough is unique in its own way and is also broken down into a series of smaller neighborhoods that have been built to showcase the ethnic culture and industry in their neighborhood. With a diverse population and varying workforce, each neighborhood is unique.

With origins dating back to 1524, the city has a very colorful history with influences dating back to the Dutch and British rule. The New York City that we relate to today is direct reflection to the 1811 Commissioner's Plan which redeveloped the city streets into a formal grid, which is often referred to as "The Greatest Grid".

The city has and will continue to evolve as more people move into the city and the greater Tri-State area and more corporations grow their operations here. Developable land is scarce and the only way to make room for the growth is upsizing the existing real estate.

Context | The Population of New York City

New York City is a melting pot of residents, comprising of over 8.5 million residents across the five boroughs and holding the rank of being the second largest city in all of North America. The city has long been known as a gateway for immigrants, welcoming over 12 million immigrants through the famous Ellis Island. Additionally, with many corporations, talent agencies and other companies headquartered in New York City, many Americans have relocated from their home states to move to the city to try to "make" their career and aspirational goals.

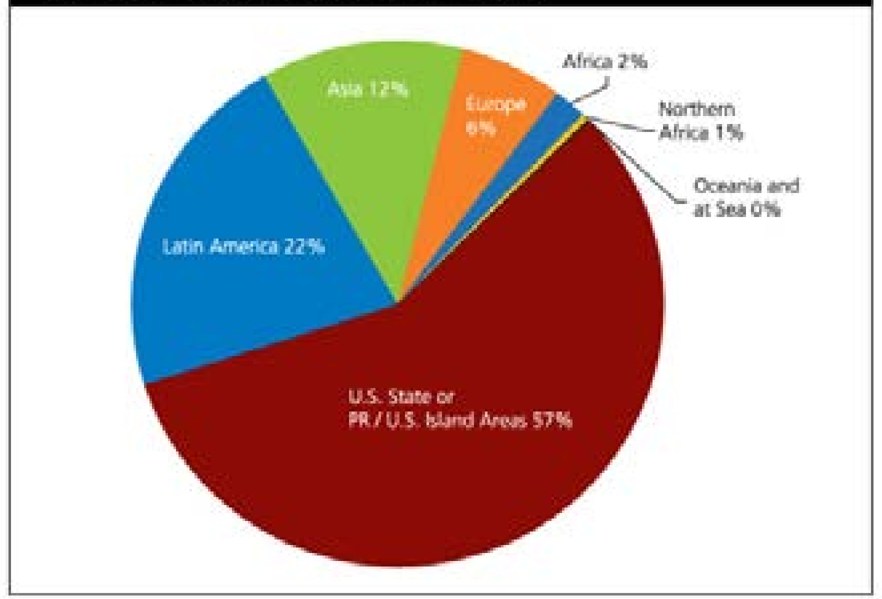


Figure I. NYC Workers by Place of Birth as a % of Total Civilian Employed Population in 2013

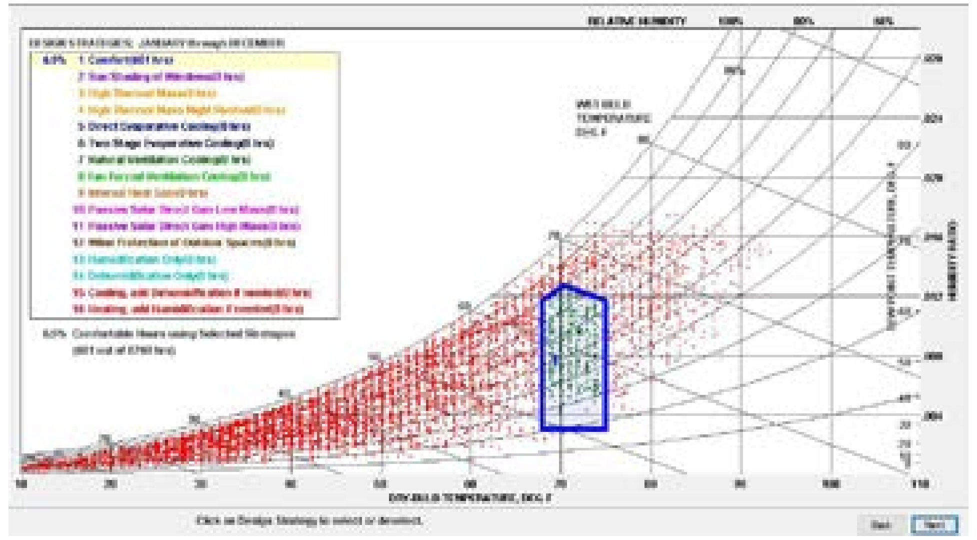
Source: U.S. Census Bureau, American Community Survey

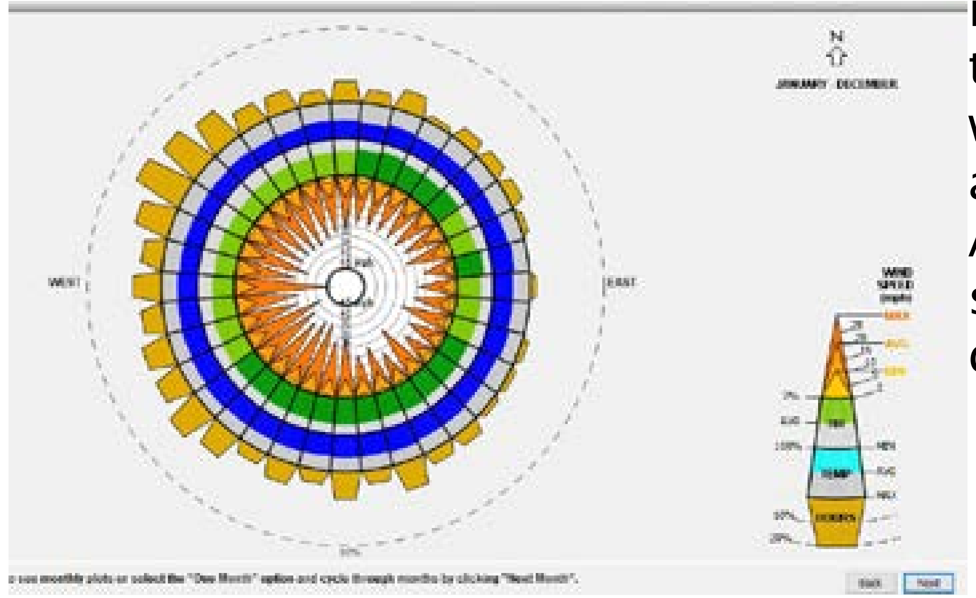
Figure 4

Context | Climate

Due to the vast compilation of high rise towers and dense urban fabric, New York City suffers from the heat island effect, which raises the temperature by 5 to seven degrees daily. Unlike the rest of the state, the climate is characterized as a humid subtropical climate.

The average temperature of the city is 55 degrees Fahrenheit, with the average low of 48 degrees Fahrenheit and a high of 62.3 degrees Fahrenheit. On average, the city receives about 46.25 inches of precipitation annually. The city also receives about 2667 hours of sunlight.





Context | Wind Analysis

The prevailing wind is generally from the west in New York State. A southwest component becomes evident in winds during the warmer months while a northwest component is characteristic of the colder half of the year. Occasionally, well-developed storm systems moving across the continent or along the Atlantic coast are accompanied by very strong winds, which cause considerable damage over wide areas.

Figure 5a-b

Rezoning | Midtown East

Rezoning | Midtown East Situation

The Midtown East Office District is one of the largest business centers in the city and is a premier business address. The area is comprised between of East 39th Street to the south, East 57th Street to the North. It extends from 5th Avenue to the west and 2nd Avenue to the East. It is comprised primarily of 70 million square feet of office space and employs over 200,000 workers.

At the center of the district, is the historic Grand Central Terminal which is one of the city's biggest and busiest transit and civic hubs. There is access to the 4, 5, 6, 7 and S subway lines, 11 bus lines and the Manhattan hub for the Metro-North Railroad. In combination, over 750,000 people travel through Midtown East and there are 33 miles of rail track below grade.

While Midtown East has performed strongly as an office district, there are still numerous long-term challenges that it faces which threatens its health. 300 of the 400 commercial office buildings in the district were constructed before the last district zoning took place in 1961. This constitutes to the average age of the buildings to be 71 years old. This means tenants do not have access to large floor plates or other amenities they desire when shelling out millions of dollars yearly in rent.

Numerous commercial buildings including the Library Hotel, the Marriott Courtyard and the condominiums at 5 East 44th Street, are being transformed into residential buildings and hotels which is hurting the stock of office space. There are also major commercial developments taking shape at Hudson Yards and the World Trade Center that are competing with Midtown East landlords with brand new buildings.

Figure 6

Rezoning | Goals and Ambitions

The purpose of the Midtown East rezoning is to protect and strengthen East Midtown as one of the most premier business districts and key job center for New York City and the region. It also works to produce up to 15 new, sustainable office towers buildings throughout the district, not all together, but spread throughout. It will also help to liven the old office stock and also compete with other mega developments happening elsewhere in the city. It also helps to renovate our transit system and enhance our green spaces as well as protecting and preserving our historic properties within the district.

Incentivizing the development of modern, sustainable, Class-A office space; Reducing challenges for the redevelopment of outdated, overbuilt buildings; Helping to preserve landmarked buildings and maintain the area's iconic built environment; Upgrading the area's transit network and pedestrian realm, befitting its status as a world-class business address; and enhancing key characteristics, such as access to light and air, active retail corridors, and the iconic street wall character in the area surrounding Grand Central Terminal.

Courtesy of the New York City Planning Department

Rezoning | Public Access

Mandatory Public Space | Sites of 30,000 square feet or more must provide an indoor or outdoor public space. Sites of 45,000 square feet or more must provide an outdoor public space except when precluded from doing so by district plan rules, such as street wall requirements. Ten percent of site must be dedicated to public space, or a minimum 10,000 square feet in the case of sites of 65,000 square feet or more.

Rezoning | Transportation Upgrades

The MTA/NYC Transit, and the City's Department of Transportation have been working with DCP, the East Midtown Steering Committee and local stakeholders to develop a menu of potential above- and below grade improvements. These improvements will comprise a Concept Plan that will be controlled, prioritized, and funded by a nine-member governing group through the Public Realm Improvement Fund as development occurs. The governing group would reserve the right to modify the Concept Plan, adding and removing projects based on criteria in the zoning text.

Grand Central -NYC GO

Rezoning | Transfer of Air Rights

Originally, landmarked buildings could only transfer their unused air rights to their neighboring sites or catty cornering sites but now with the new zoning in place, landmarked buildings can transfer their rights to any qualifying site within the district. Although, a minimum contribution to the District Improvement Fund would be required to ensure the new zoning improves the district's infrastructure. The City of New York also quantifies the going rate for the purchase of the air rights to ensure the sellers are getting a good price for their transfer. The profit of the air rights will also allow the landmarked buildings to do necessary improvements to their buildings as well as ensure they stay apart of the community forever.

Figures 8a-c

Rezoning | Improvements at 340 Madison

340 Madison Avenue is located on Madison Avenue between East 44th and East 45th Streets. It is a part of a larger zoning lot that includes lots 8, 62, 63 and 65. The zoning lot is split into C5-2.5 and C5-3 zoning districts and is within the Other Transit Improvement Zone Subarea. Currently the FAR are between 12 and 15, averaging 13.56. The site can gain between 2.3 and 4.6 FAR for transit improvements and 4.84 to 7.14 FAR for landmark transfer. 340 Madison currently contains 558,735 square feet of floor area, including air rights from the Grand Central Terminal. The lot contains an additional 687,487 zfa. If demolished, 340 Madison could achieve 1,255,072 square feet with an FAR of 26.

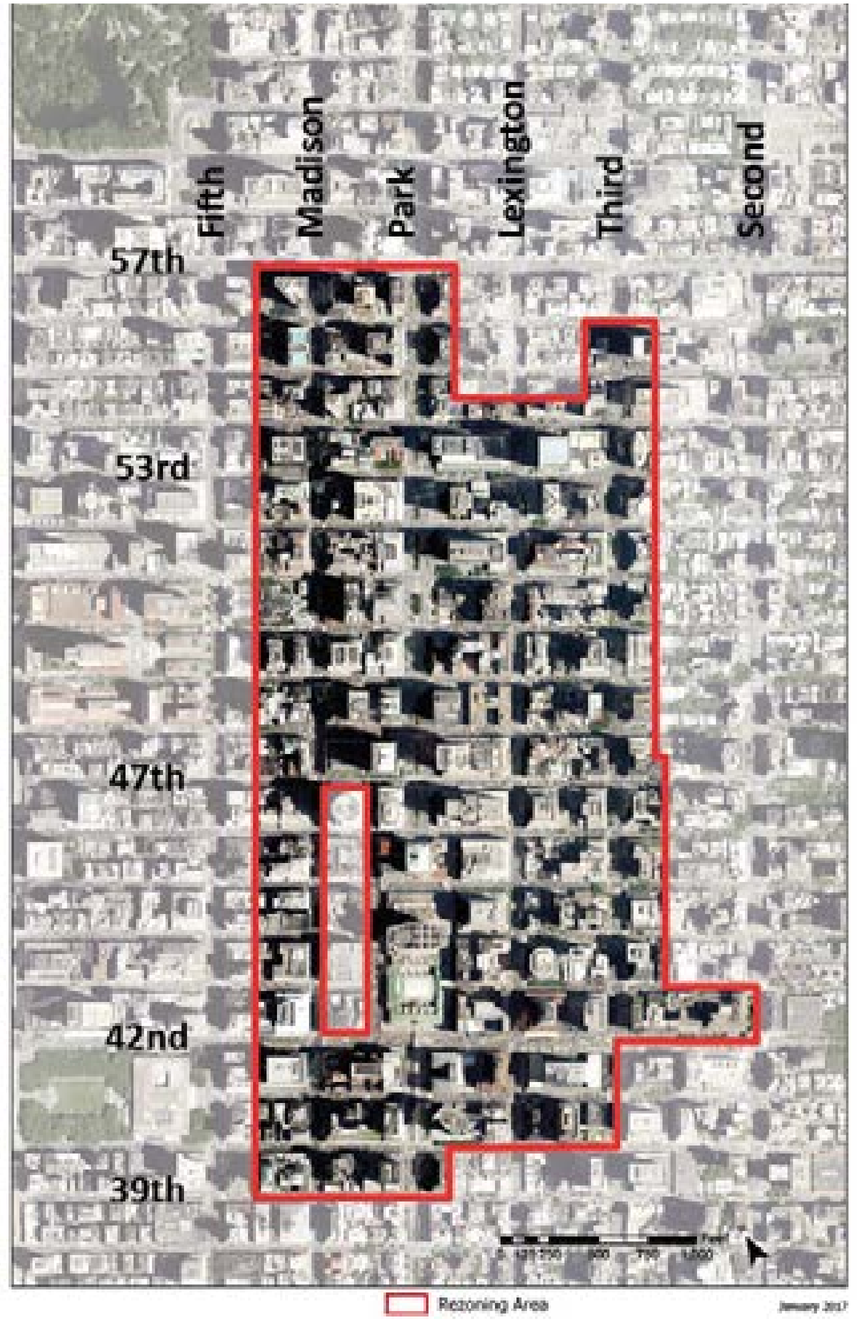
Zoning District:	C5-3/OT	C5-2.5/OT
Lot Area:	25,105	23,167
Total Lot Area:	48,272	
Existing Floor Area:	687,487	
Existing FAR:	14.24	

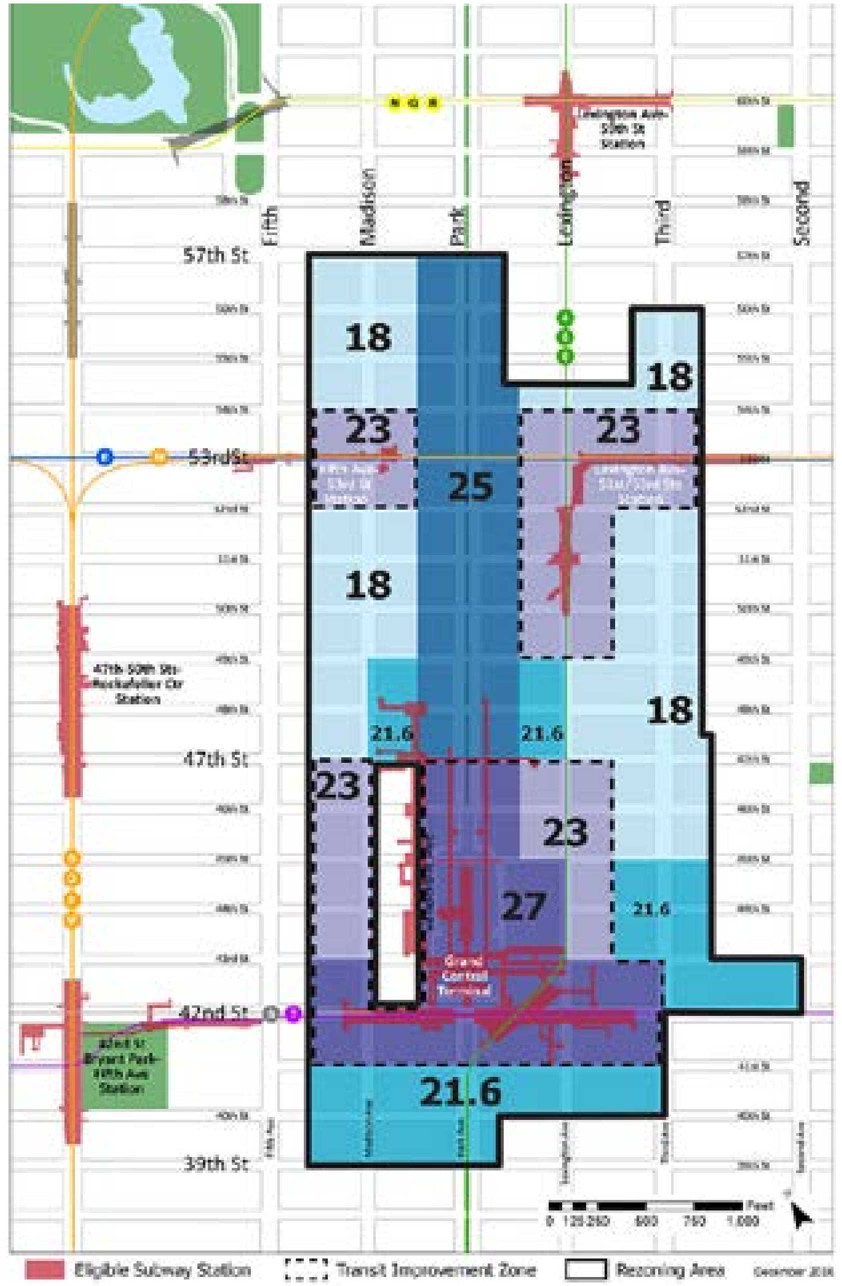
Potential improvements to maximize FAR

Transit Improvement: 2.3-4.6 FAR
Landmarks Transfer: 5.70 FAR
Combination: 9.44 FAR

With Special Permit: 26.00
Needed: Transit Improvement or Concourse

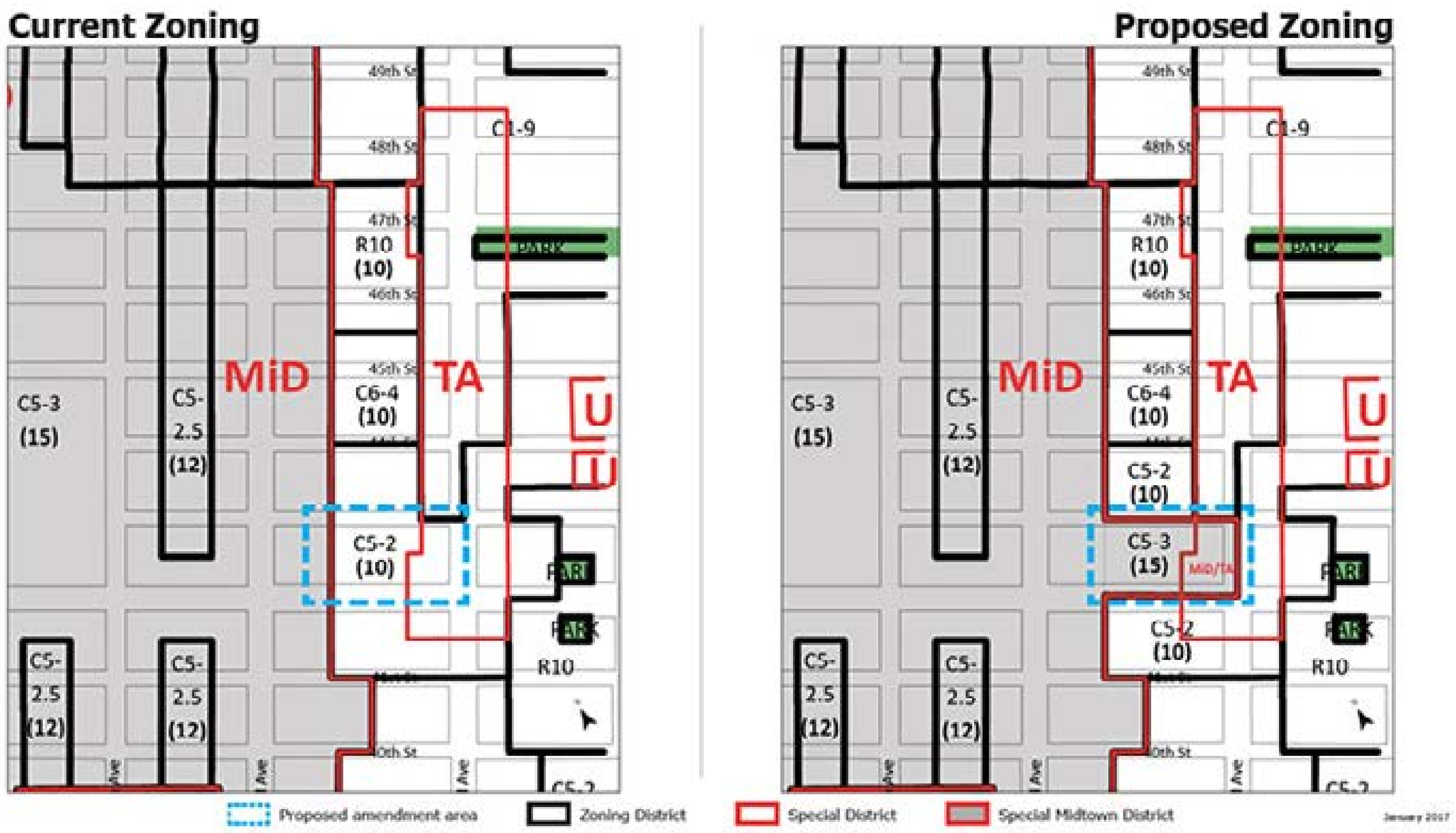
Rezoning | Maps





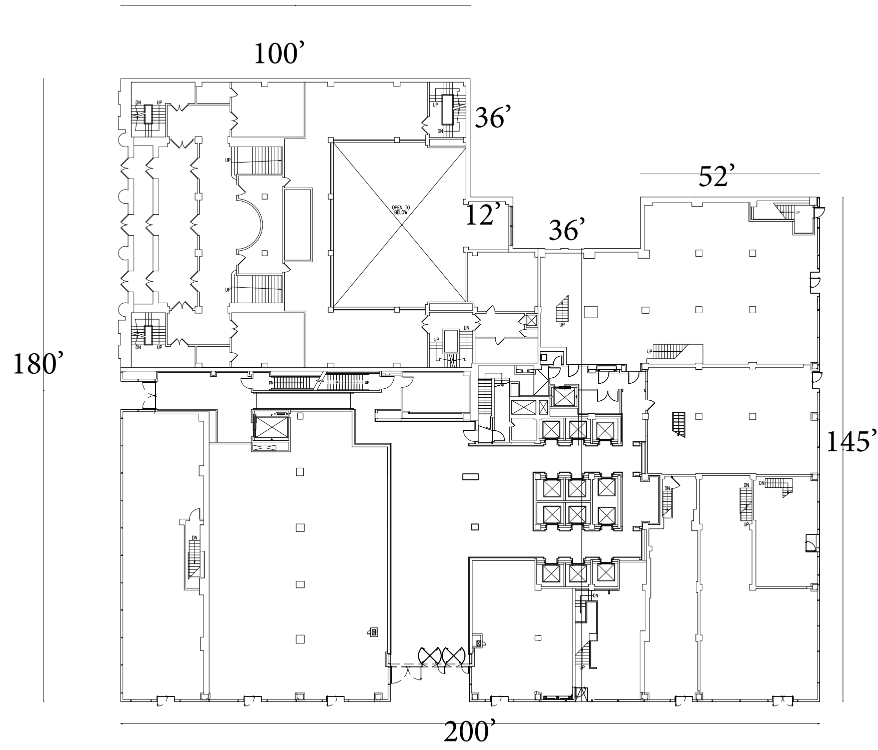
Figures 9a-c

Rezoning | Maps



Rezoning | Sky Exposure Plane:

To ensure that the city's inhabitants have ample access to ample daylight, the city enforces a Sky Exposure Plane that works to enforce that buildings are set back from the street level at a certain angle to ensure that the sky can still be seen from the sidewalks. The setback range is dependent on the location of the building's site, the width of street and the depth of the site. The city mandates that all buildings follow this ordinance even if adding onto a grandfathered structure.



Figures 10, 11

Site Analysis

Site Analysis | Site Evolution

340 Madison has a storied history. The site began as several small brownstone structures that were built around the 1860's. In the late 1800's Mary Baker Eddy's Christian Science Church constructed a church on 43rd Street and a Reading Room on 44th Street. In 1926 a real estate developer purchased the majority of the block, except for two holdout buildings and created a large commercial, concrete and stone building. At this time, he also purchased the air rights to the Christian Science Church with and built on top of the Church and the Reading Room.

First pitched in 2001 but later completed in 2008, Harry Macklowe evicted over 150 different businesses, mostly doctors' offices and other small clinics from the building and set off to completely revamp the building. He infilled the space from the two holdouts and removed the stone façade and replaced it with a sleek glass façade.

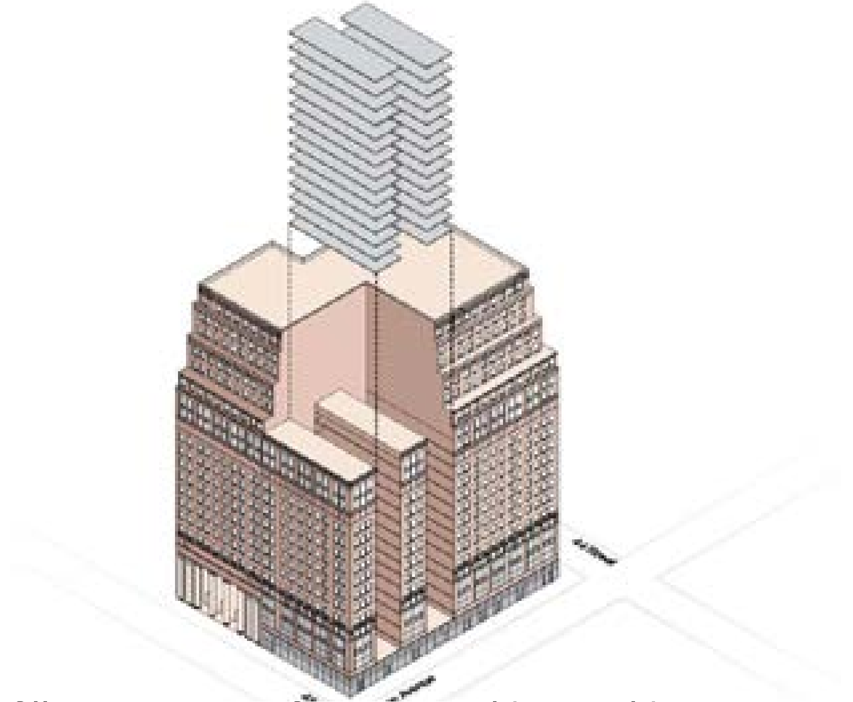
Circa 1900

Circa 1928

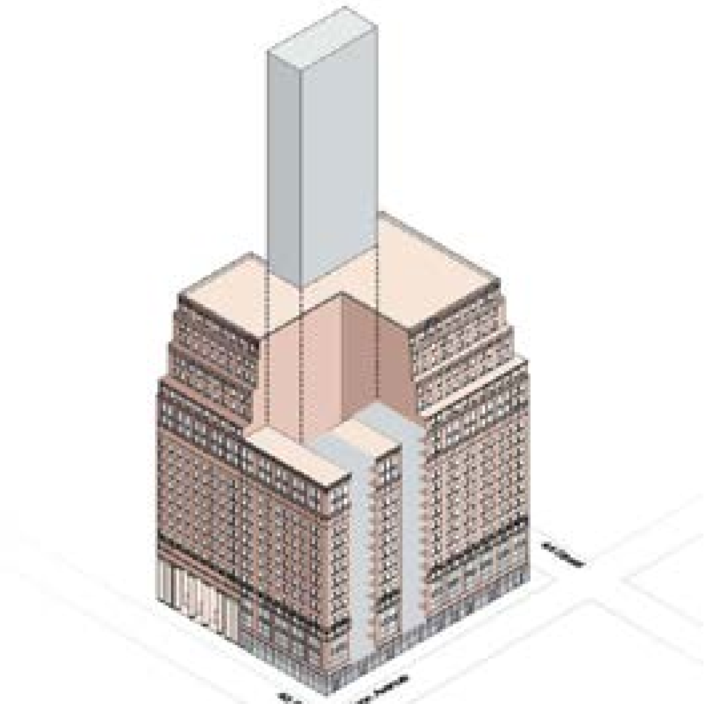
Circa 1928 - Note the Infill Sites

Figures 12a-c

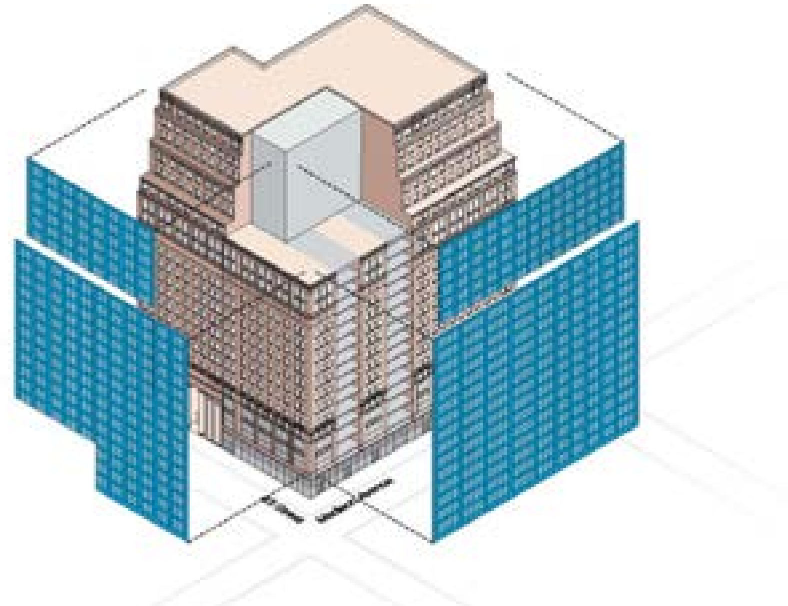
Site Analysis | Visual Evolution – 2008 Renovation

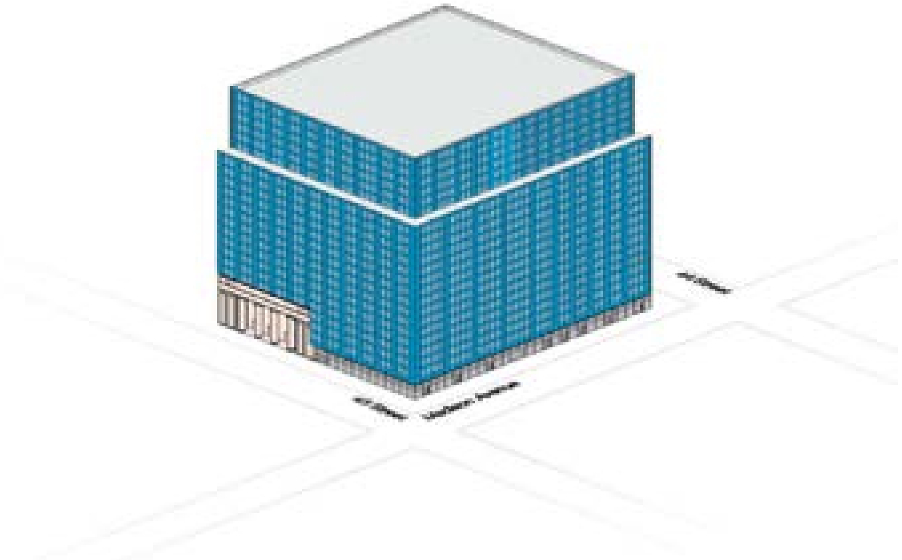


Infill Space Missing from Two Holdout Buildings



New Core for the Newly Combined Building

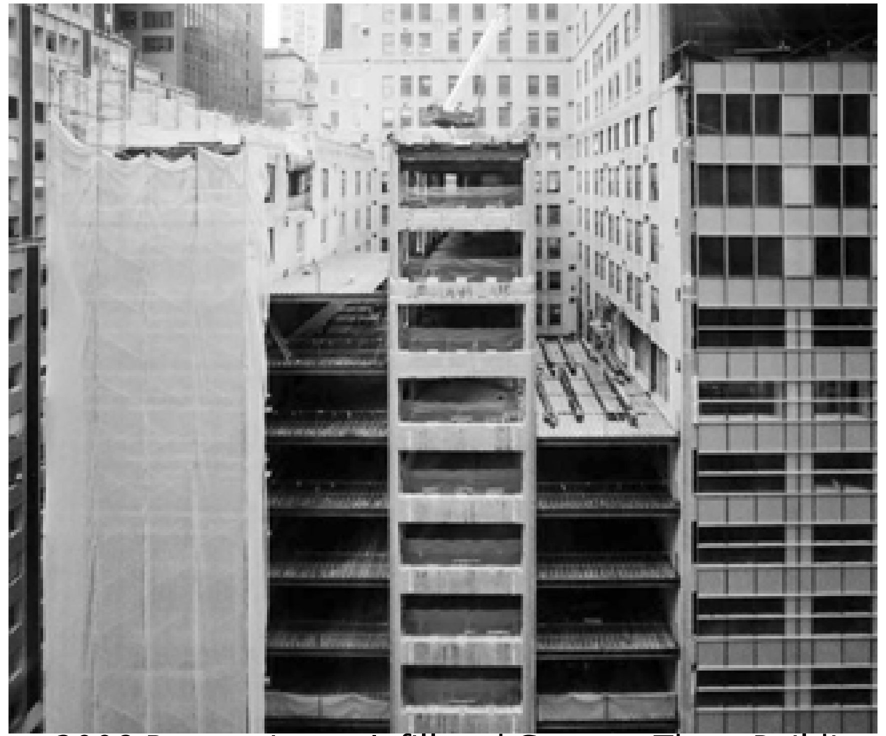




Removing Circa 1928 Facades and Replacing with Glass. Reducing Building Setbacks.

Figures 13a-d

Site Analysis | Visual Site Evolution



Circa 2008 Renovation to Infill and Connect Three Buildings

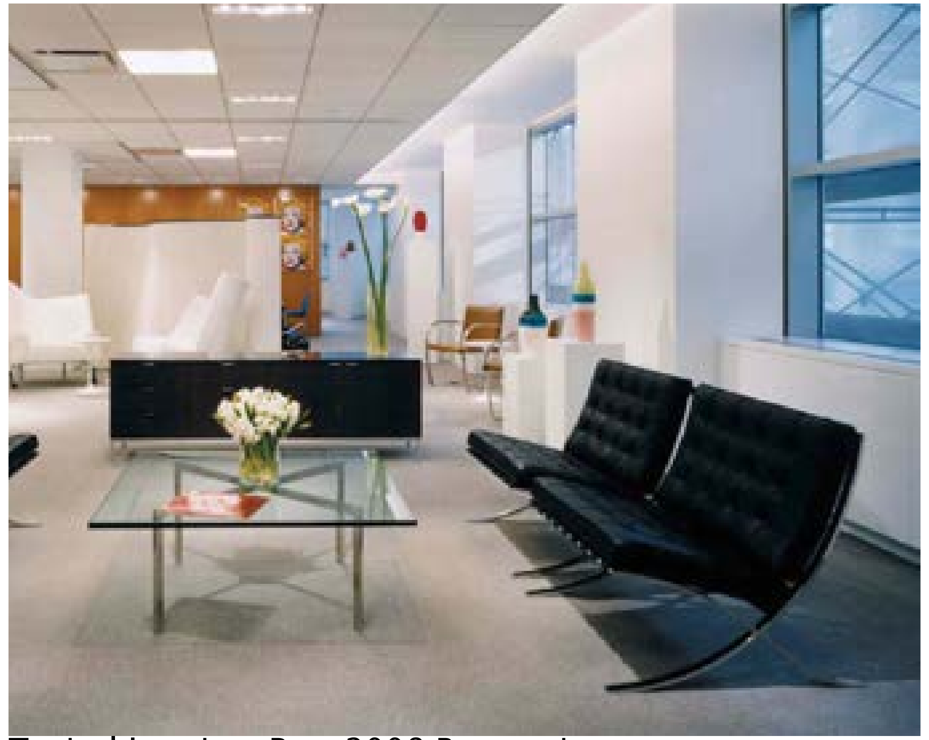
Buildings Circa1928

Combination of Three Buildings Circa 2008

Figures 14a-d

Site Analysis | Current Conditions

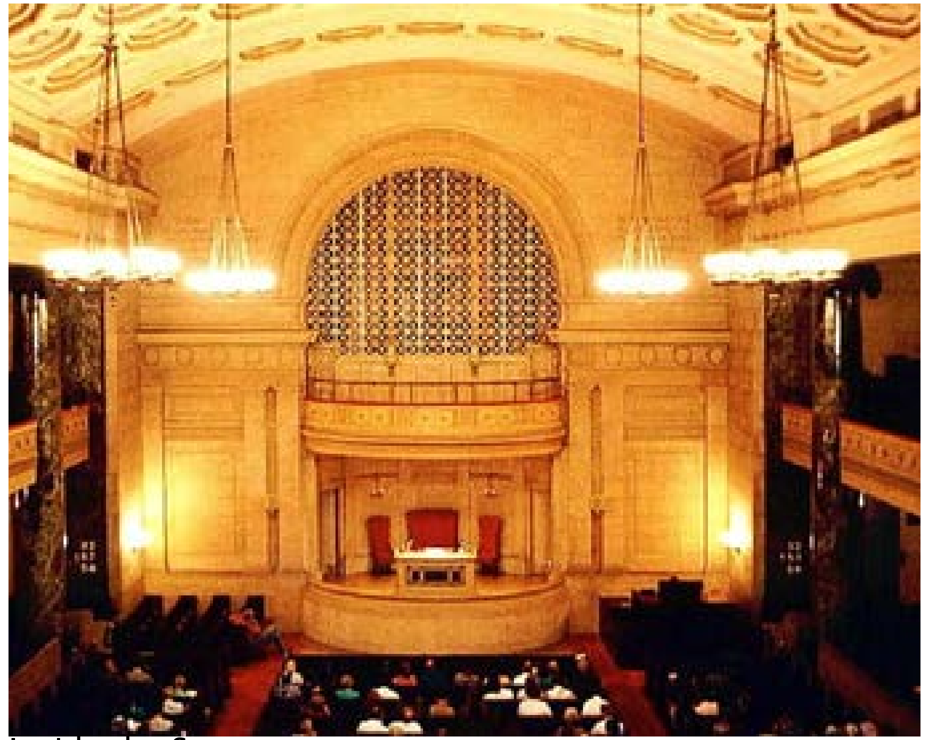
Transformation of a Typical Floorplate Circa 2008 Renovation



Typical Interiors Post 2008 Renovation

Site Analysis | The Fifth Church of Christ, Scientist

The Church has been a part of the agglomeration that makes up 340 Madison since the building's inception in 1921. The church was built within the Canadian Pacific Building and still continues to share use of the building's egress and structural system. Although its original façade is still visible from the street, the structure is not protected by the New York City's Landmark Commission due to the overall alterations to the rest of the building. The Church and its Reading Room Library continue to remain long term tenants of the building and do not actually own the rights to future use of the site. The building does have its own electrical and mechanical systems that were not altered in the 2008 renovation. The Church is closed except for Wednesday's prayer group and Sunday service. The reading room also has restricted access.

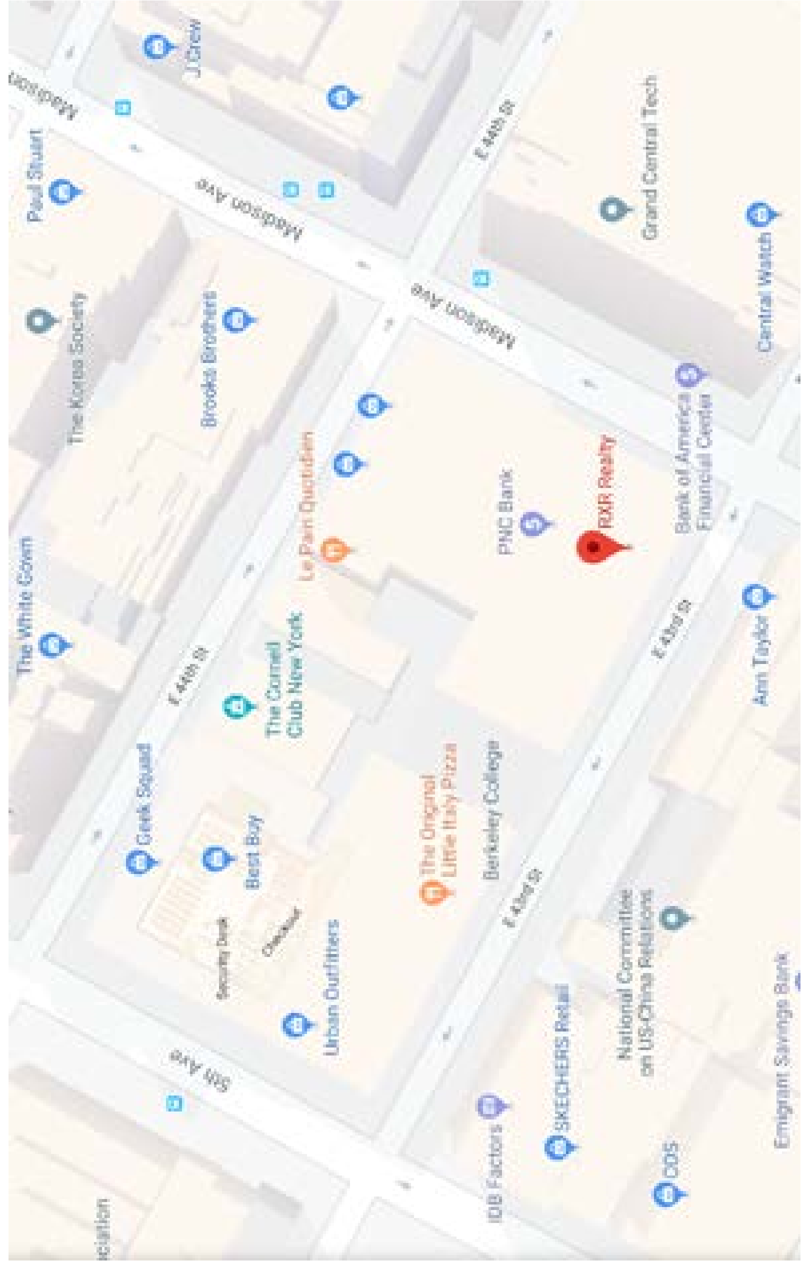

Inside the Sanctuary


The Church - 9 East 43rd Entrance

The Reading Room - 22 East 44th Street

Figures 17a-c

Site Analysis | Neighboring Buildings on the Block



Eleven Story Building - Home to Berkeley College

Twelve Story Office Building with a Two Story Retail at Base

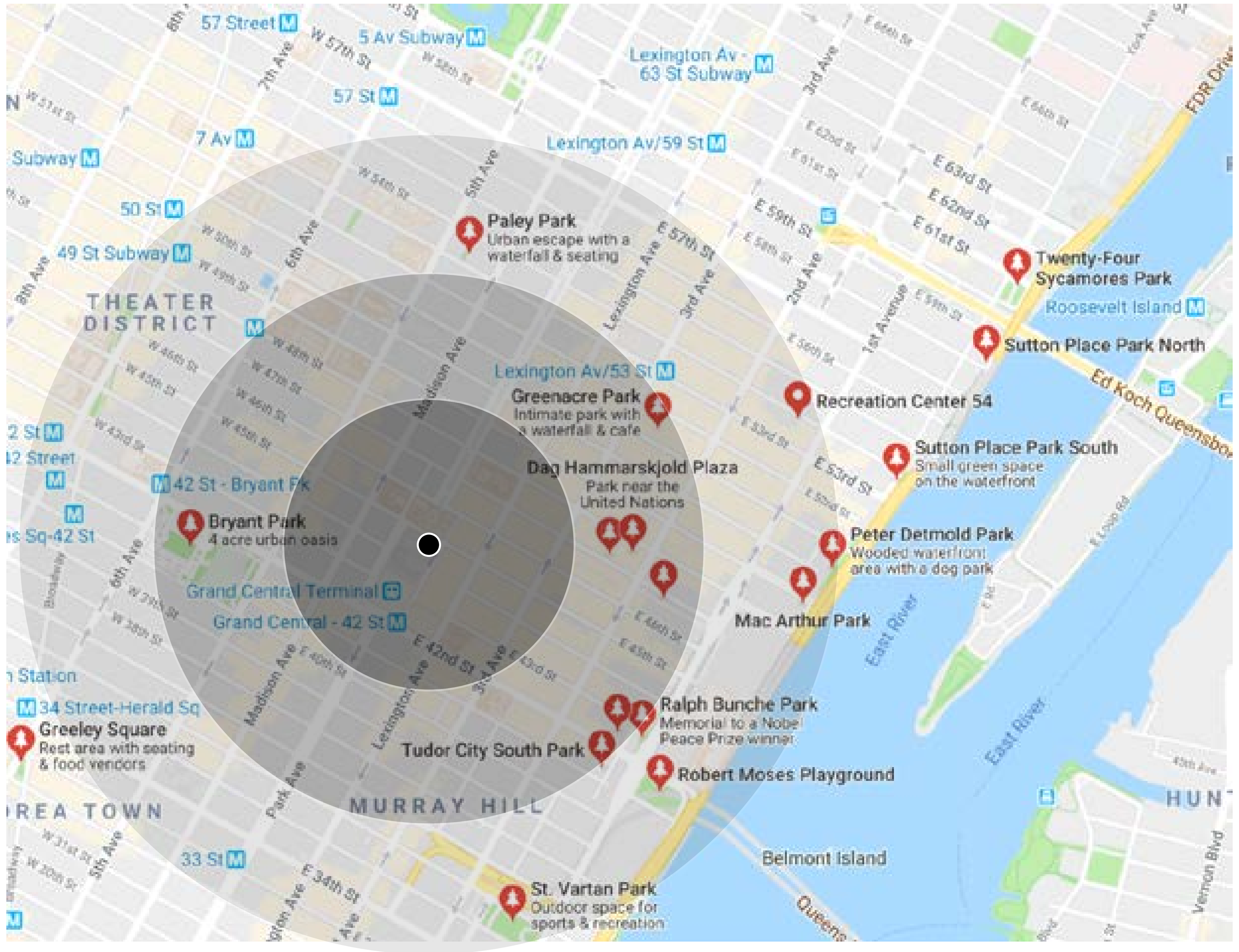
Three Small, Muli-Use Structures with Retail at Base.
One is Seven Stories and the Other Two are Nine Stories

Forty Story Office Tower with Two Levels of Retail at Base

The Cornell Club - Eleven Story Private Club

Figures 18, 19a-e

Site Analysis | Open Greenspaces in the Vicinity




Bryant Park


Dag Hammarskjold Plaza


Greenacre Park


Ralph Bunche Park


Paley Park


Robert Moses Park

Figures 20, 21a-f

Site Analysis | Notable Buildings in Midtown East

The Helmsley Building - 230 Park Avenue

A 35 Story Building built in 1929 as the New York Central Building designed by Warren Wetmore Architects, the same architects as the Grand Central Terminal. Before the completion of MetLife, the Helmsley served as a beacon for Midtown East with its prominent location in the center of Park Avenue. Currently it is occupied by first floor retail and 34 floors of LEED Gold multi-tenant commercial office

The Chrysler Building - 405 Lexington Avenue

A 77 story Art Deco style building designed by Architect William Van Alen. It reaches 925 feet tall of accusable space and its antenna reaches 1046 feet. It is most well-known for its bold metal panels and shiny crown. It is currently a LEED Silver commercial office building with ground floor retail.

The Seagram Building - 375 Park Avenue

A 38 story tower designed by Ludwig Mies van der Rohe in the International Style. Prominently located on Park Avenue, the tower takes full advantage of the sky plane exposure plane by incorporating a large, public open space at entrance of the soaring 516 foot tower. It paying homage to its original use, the headquarters for the Seagram's building is clad the building in amber glass to match the company's iconic ginger ale.

The Metlife Tower - Formerly PanAM - 200 Park Avenue

A 59 story building located on 45th and Park Avenue. It was designed by Emery Roth and Sons, Pietro Belluschi and Walter Gropius. The building stands at 808 feet tall and is often criticized for its harsh concrete façade and blocking Park Avenue views. It was built using Grand Central Terminal air rights as a way to fund its refurbishment and upkeep.

Figures 22a-d

Site Analysis | New Construction in Midtown East

One Vanderbilt - Expected 2020

One Vanderbilt was designed by KPF architects and will be completed in 2020. It is located prominently on Madison Avenue beside Grand Central Terminal and diagonally from the 340 Madison project site. Once complete, it will contain ground level retail space, an underground transit connection hub, 55 floors of commercial office space and a roof top observatory. Designed before Midtown East Rezoning took effect, the developers used many existing subsidies to such a height and also served as guidance for the new zoning.

390 Madison Avenue - Expected 2018

390 Madison Avenue is an extension renovation designed by KPF Architects and is expected to open in 2018. The project involved a full gut renovation where the lower floors were removed to create vaulted lower floors and new floors garnering higher rents were built above the existing structure. The building has several communal and private tenant only balconies throughout. 390 Madison was designed to serve the needs of a twenty first century creative tenant. Although it was designed before the Midtown East Rezoning took effect, the ingenious replacement of existing FAR at the top of the building helped to secure the needed rents to fund the project.

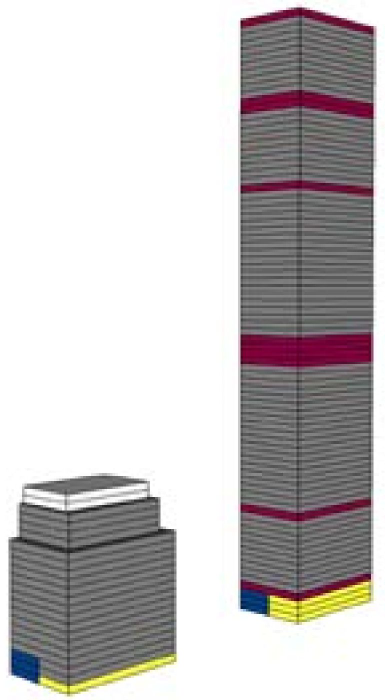
Figures 23a,b 24 a,b

Program Development

Program Development | Existing Use:

The building is currently 22 stories and is anchored by a retail base. Some of the retailers have built out mezzanines to increase their FAR while others have not. The building is currently 98% occupied and there are only two vacancies on floor three. Those are recently renovated partial floor units with kitchens and other modern amenities. They have been actively marketed and should have new tenants momentarily as they are pre-built units.

The only amenity offered to tenants is the basement level bike room which is required by code in New York City.



Program Development | Existing Occupants:

Basement Level: Mechanical Rooms, Building Maintenance, Security and Bike Storage
Ground Level: Main Building Lobby, 9 Retail Tenants (multi-use), Church
Mezzinane: Retail use
Floor Two: Fully Leased office
Floor Three: Four Pre-Built Offices (2 Vacant)
Floors Four - Twenty One: Fully Leased - varying occupants, uses and leases
Floor Twenty-Two: Mechanical Space and Property Management
Head Houses: Elevator and Mechanical

Church:
Occupies Floors Basement-Four
Has it's own mechanical and electrical equipment, that has never been updated.

Packaged HVAC for the entire building with supplemental per unit's conference and IT.
Electrical: Two Bus Ducts, one for high rise and one for lowrise

Elevators:
12 for office occupants, 6 for lowrise and 6 for highrise
1 for Service Entrance
1 for Church

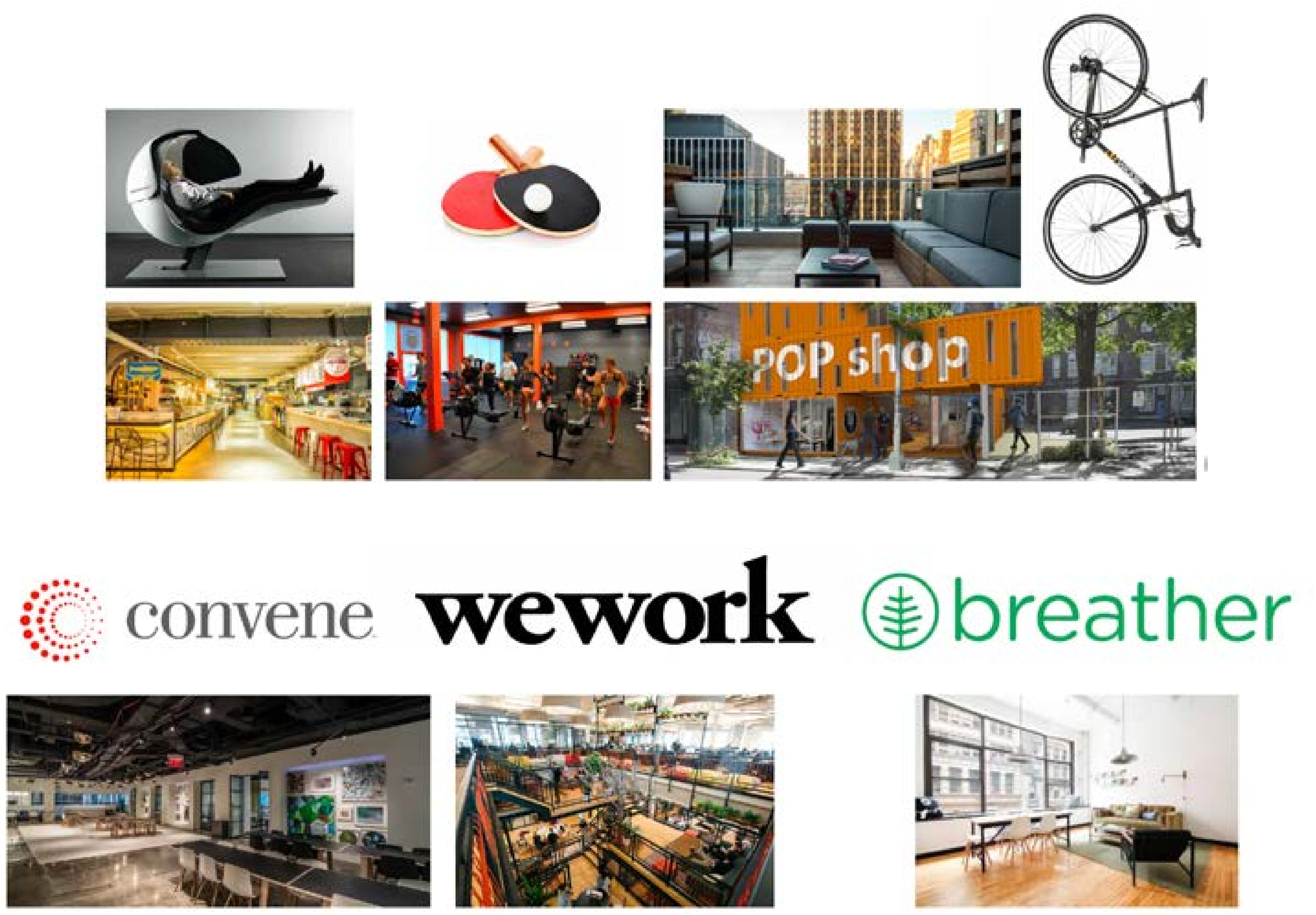
Program Development | Proposed Program

Commercial/Public Portion:
- Public/Commercial Lobby Space
- Commercial Retail Space
- Sudivideable Commerical Office Space
  - Single Floor Tenant
  - Creative WeWork Type Space
  - Multi-Tenant Floors
- Public Community Space - 10,000 sqft

Residential Units:
- Private Lobby with Concierge and Elevators
- Residential Units of Varying Sizes

Utilities:
- Basement Level utility floor
- Three Upper Floors at Varying Levels - dependent on where elevators cease
- Multiple shafts running from base of building to roof.

Other Needs:
- Bike Storage for Building
- Service Entrance with Access for both Residential and Commercial Entrances



Figures 25a-m

Precedent Projects

Precedent Projects | Hudson Yards

The Shed at Hudson Yards

Although not a commercial office or residential building, the Shed at Hudson Yards was designed. By Diller Scofidio and Renfro. It is a column free, cultural and event space that will open in 2019. It is was chosen as a precedent for its out of the box building tectonics and its ability to move and transform itself for its different intended uses.

Hudson Yards Under Construction

Located on the west side of the island of Manhattan, above an active MTA train yard, some 25 million plus square feet of mixed use buildings are under construction and or in planning. Though not a singular tower was chosen, the overall complexity and engineering feat to build an entire neighborhood over an active trail yard and in the midst of the hustle and bustle of the city is remarkable and admirable.

Precedent Projects | The World Trade Center

Two World Trade Center - Bjarke Ingels

Following the September 11th, 2001 tragedies, much of what was known as the World Trade Center, a commercial office hub built by the Port Authority of New York and New Jersey had to be replaced. One of the many tower proposals, Two World Trade Center by Bjarke Ingels consists of a series of stacked, cantilevering boxes. As there is a demand for modern, twenty-first century office space in Manhattan, this surely will be a top contender for people abandoning Midtown East's old commercial portfolio for other centrally located transit hubs in the city.

Figures 26a,b 27a,b

Precedent Projects | One Willoughby

Designed by FX Collaborative in partnership with JEMB Realty.

That's not the only thing that's changed: The building was initially planned as a 65-story, nearly 700-foot-tall tower, but was eventually trimmed down to a modest 495 feet. KPF had initially signed on to design, but dropped out at some point. Although not located on the island of Manhattan, this project meets the needs of commercial office tenants that desire, new, contemporary office space that drives creativity and community.

Figures 28a-c

Precedent Projects | 320 and 360 Wythe Avenue, Brooklyn


Exterior Render


Interior Render

The buildings will be located at 320 and 360 Wythe Avenues, and will rise three and five stories, respectively. While they'll largely be made up of office and retail space, there will be two floors of apartments on 360 Wythe, the taller of the two buildings.
As far as materials go, the buildings will be constructed from raw Canadian wood, which will be engineered into nail-laminated timber panels. The timber structure will rise above a concrete foundation, and the facades will be constructed from brick. According to the firm, they're the first two brick-and-beam buildings—brick front over a wooden structure—to rise in the city in at least 100 years.

Precedent Projects | Newark, NJ

Exterior Render
Source: Michael Green Architects

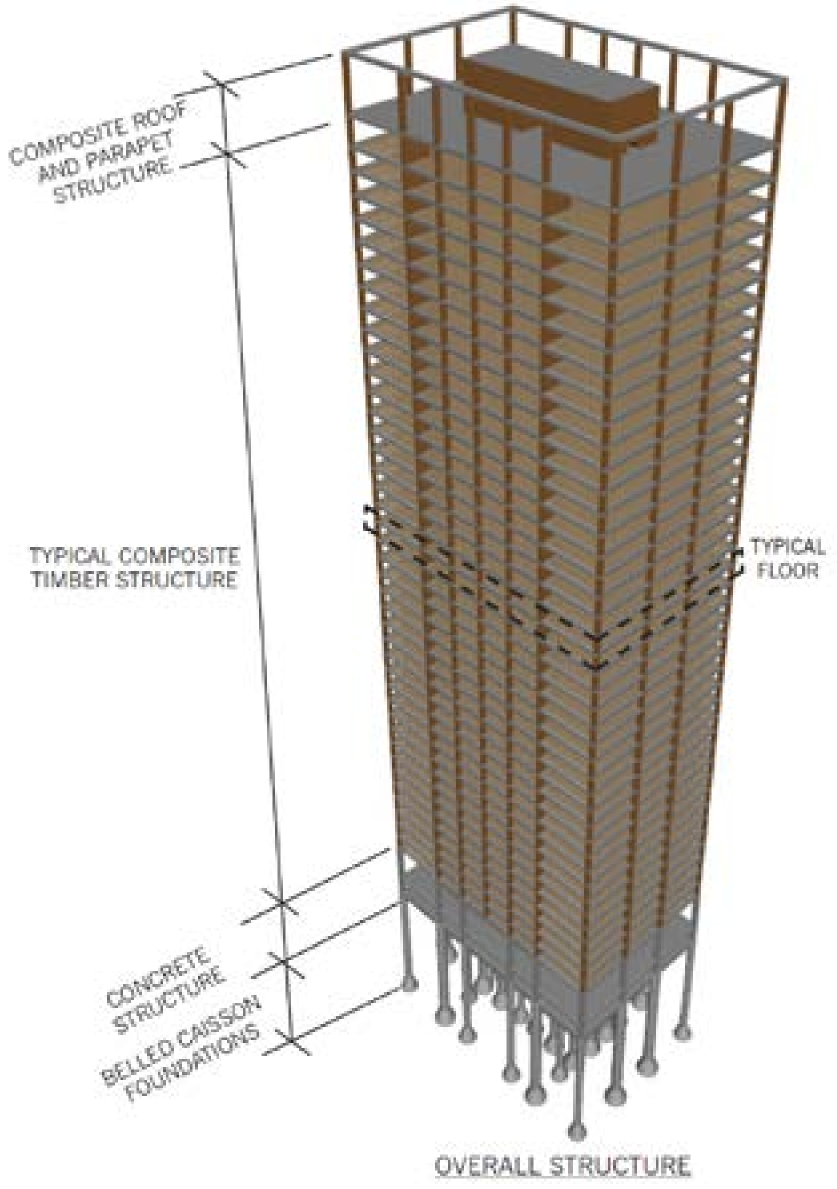
Although not located in New York City, this proposal for three Cross Laminated Timber commercial office buildings across the Hudson River in Newark, New Jersey proves the point that developers are eager to try new innovative techniques and that timber could also be seen as a viable option on the island of Manhattan in the near future.

Figures 29a,b 30 a,b

Case Study Precedents

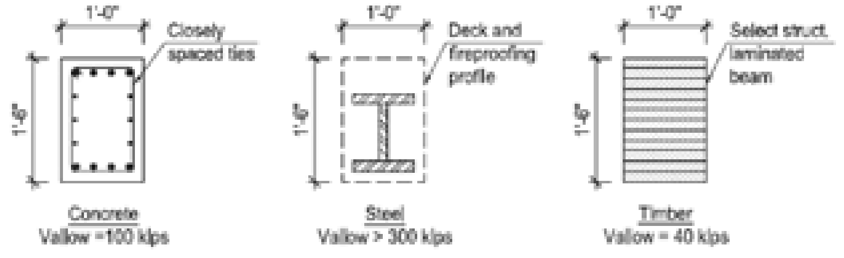
Case Study One | Introduction
Skidmore, Owings and Merrill

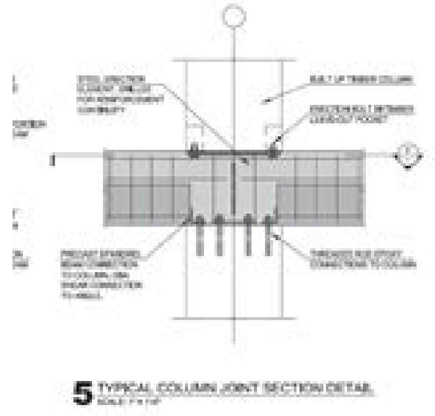
Skidmore Owings and Merrill set out in 2013 to find a way in which they could design a structural system for tall buildings that is sustainable. A system that is flexible to fit many different layouts, geometries and configurations. They decided to use mass timber due to its plethora of materials and ability to manipulate it into nearly any size.



Case Study One | Structural Overview
Skidmore, Owings and Merrill

SOM designed the structure out of a Concrete Jointed Timber Frame that consists of solid mass timber products that are connected with steel rebar reinforcement through a series of concrete joints. Mass timber products are used for the primary structural elements including the floors, columns and shearwalls. Steel rebar reinforcement is connected to the primary structural elements by drilling holes in the timber and epoxy bonding reinforcement through the concrete joints. This creates a band of concrete at the perimeter of the building and bands of concrete at all wall/floor intersections. Supplementary reinforcement is provided in the concrete perimeter beams to achieve long spans as well as the concrete link beams which couple the behavior of individual wall panels. concrete by volume for a typical floor.





Figures 30a-c

Case Study One | Gravity Load Resisting:

Skidmore, Owings and Merrill

The floor system consists of solid mass timber CLT that spans between timber shear walls at the center of the building and the reinforced concrete spandrel beams and timber columns at the perimeter. there are also rebar at the connection points to help stiffen the structure and enhance the deflection This scheme stiffens the floor. The spandrel beams were designed to resist torsion to deliver the floor panel end moments to the columns. The columns and walls deliver the gravity loads to the stories below and ultimately the foundations.

Structural System Diagram

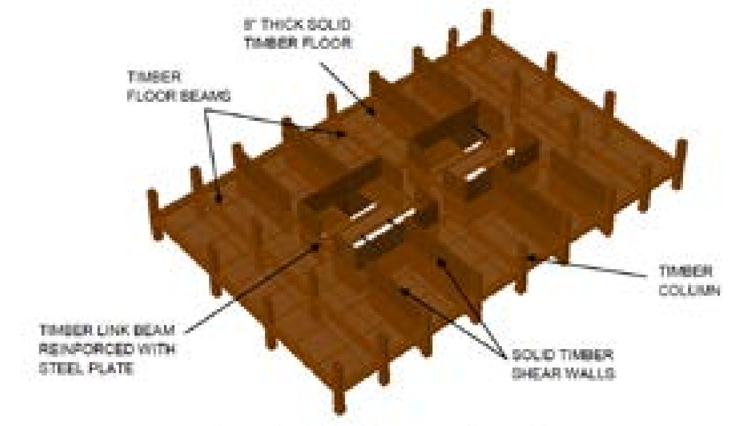


Figure C.1: 'All-Timber' Structural System Diagram

Case Study One | Lateral Load Resisting:

Skidmore, Owings and Merrill

The lateral load resisting system consists of solid mass timber CLT. The shear walls are primarily located around the vertical transportation and service core at the center of the building forming a large tube which resists wind in both directions as well as overall building torsion. Supplementary shear walls extend from the central core to the perimeter of the building at the east and west ends of the core. These walls are critical to resist net building uplift due to wind forces on the broad face of the building.

Figures 30d

Case Study One | The Building's Base

Skidmore, Owings and Merrill

The entire base of the building is made of concrete (the basement level and ground floor). The increased strength of the concrete shear walls and columns through the lobby allows a reduced shear wall system through this zone. This allows for increased flexibility in the floor plate and allows for an large open expanses. The ground floor is to be framed with reinforced concrete beams and slabs. Concrete framing was chosen for these levels to resist high construction loads as well as enhance the durability of the building that will be in contact with outside weather.

Case Study One | Timber Fire Safety Principals

Skidmore, Owings and Merrill

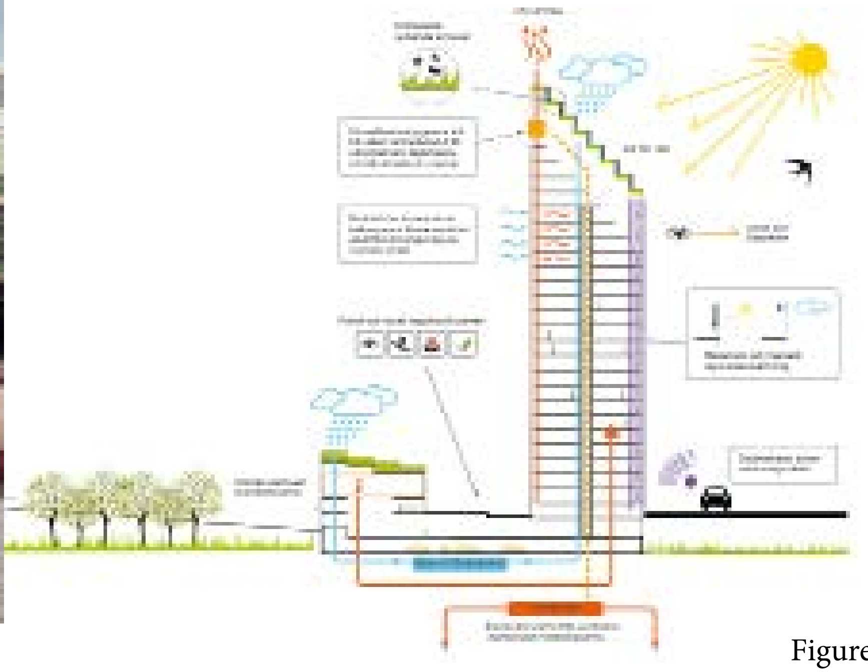
1. The structure should have some level of passive resistance where practical.
2. Consideration should be given to the condition of the structure after a fire.
3. Timber elements should be simple shapes with high volume to surface ratios to limit charring surfaces and heat feedback potential. Square columns are preferred to rectangular columns.
4. A solid floor system is preferable to one with ribs.
5. Fewer vertical structural elements lead to larger elements which are more efficient at resisting fire.
6. Penetrations through timber walls should be avoided.
7. Standard charring rates such as an average rate of 1.5"/hour should not be used for final design. Rather, an analysis of the building under potential fire scenarios should be considered in sizing of the members.
8. Fire 'burn out' time should be considered in developing fire assemblies.
9. Fire progression: To meet the intent of the code, fire cannot be allowed to jump between floors up the height of the building.
10. Protecting the bottom surface of the CLT may not be required assuming it self-extinguishes.
11. Treatments required for acoustic separation may also provide fire separation.

Case Study Two | Overview

C.F. Moller

HSB Stockholm is the oldest building society in Sweden and to commemorate its 100 year anniversary in 2023, they led a competition for innovative proposals for residences of the future. One of the teams, C.F. Moeller Architects, are working with the architects Dinell Johansson and consultants Tyrens for an timber entry. They have proposed a 34 story tower that will be seen for miles. The envision that the building will give the people of Stockholm a new characteristic beacon and a meeting place in their city.

The building will be 11.450 square meters. The buildings core will be constructed out of concrete. The pillars and beams will be constructed out of solid wood. The walls, ceilings and window frames will also be fabricated out of wood.



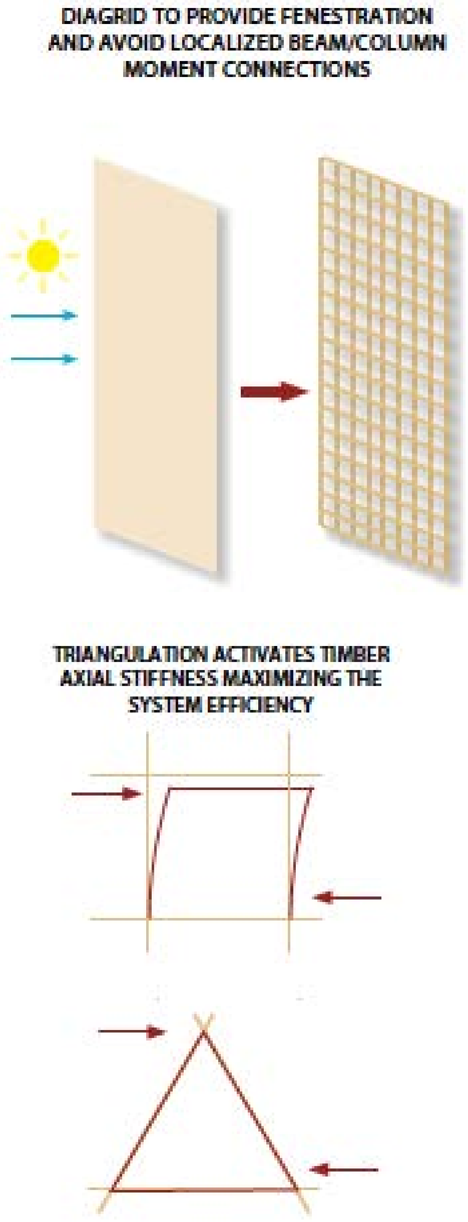
Figures 30c-d

Case Study Three | Introduction
Perkins + Will, Thornton Thomasetti

The River Beech Tower: A Tall Timber Experiment was a the resultant of a partnership between Perkins and Will, Thornton Tomasetti and the University of Cambridge's Centre for Natural Materials Innovation. The proposal is for an 80-story tower constructed out of timber, using minimal steel and concrete. The research done was to take a greater look at wood and how it behaves as a material. Its properties were compared to steel and concrete in terms of structural behavior, fire resistance, construction methods, environmental impact and architectural expression.

The proposed tower is 80 stories and more 244 meters or 800 feet tall. The building would also be composed of 300 residential units. They wanted to leave the material as exposed as possible to allow for a unique experience by connecting the residents with natural materials. To best gauge the project, they used a typical residential floor plate to layout the building.

Case Study Three | Materials and Design
Perkins + Will, Thornton Thomasetti



Materiality:

The material values of timber drive the design in many ways. Natural and reinforced timber have a lower strength, stiffness and density as that of concrete and steel. New hybrid wood variations are becoming increasingly stronger though. The team looked directly to the softer elastic stiffness of the timber to influence their design of the building.

Tower design:

The building is created by interconnecting two separate thin towers multi-story atrium spaces. The slim profile of the towers is also the ideal solution for laying out housing. The two towers are also connected across the atrium space by using Glue Laminated Timber cross bracing. The atrium spaces helps to increase the footprint of the overall structure and connect the two towers into one superstructure as well as minimizing individual member stresses and maximizing the structure's performance.

Figures 32

Case Study Three | A Tall Timber Experiment
Perkins+Will, Thornton Thomasetti

The lateral system in the building connects all of the vertical members together using Cross Laminated Timber shear walls, Glue Laminated Timber bracing and Laminated Veneer Lumber diagrids that engages all of the vertical members and using gravity-carrying members.

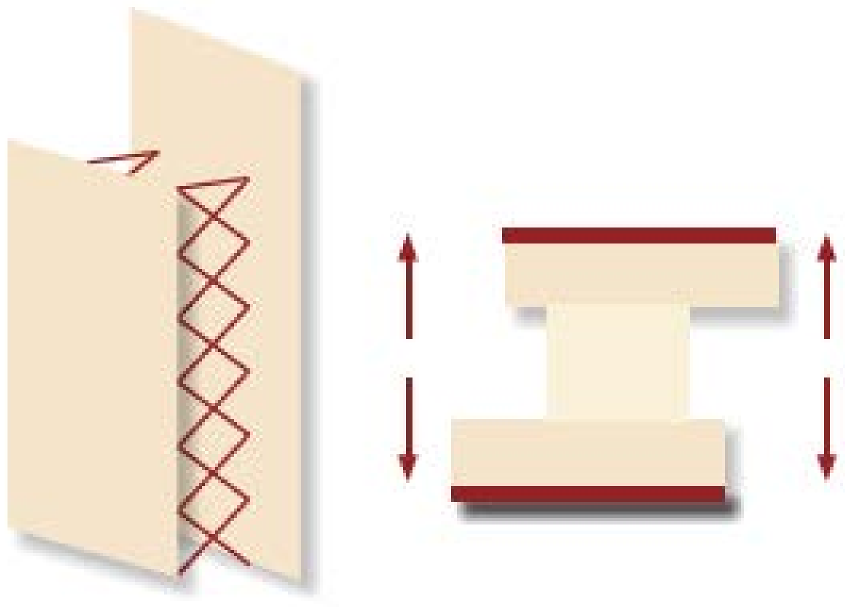
The most effective way to use a material is in its natural way. The tower uses a series of different timber materials including Glue Laminated Timber, Laminated Veneer Lumber and Cross Laminated Timber.

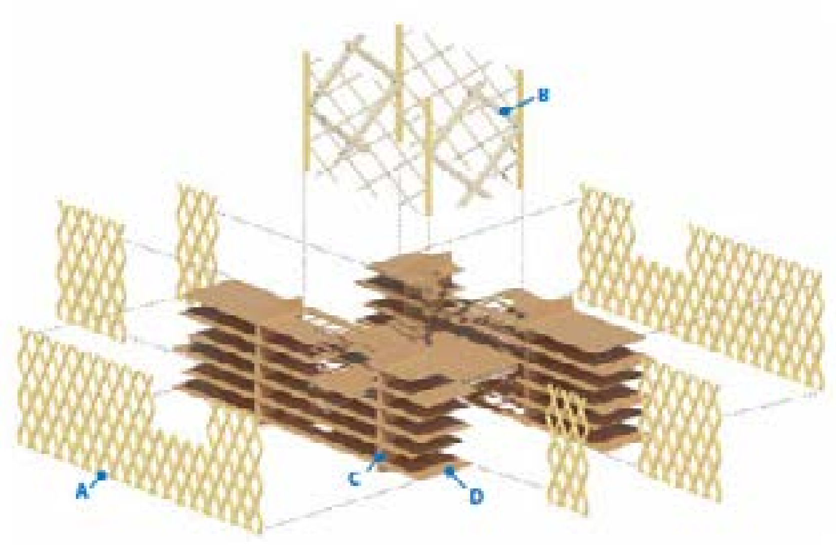
Wider Tower Faces: Laminated Veneer Lumber Diagrid
Several members emulate the performance of a large perforated solid wall.
LVL is axially strong and increases thickness as the building reaches the lower floors.

Atrium Brace Beams: Glue Laminated Timber
Span 18.3 Meters so the GLT minimizes the depth of the beams required.

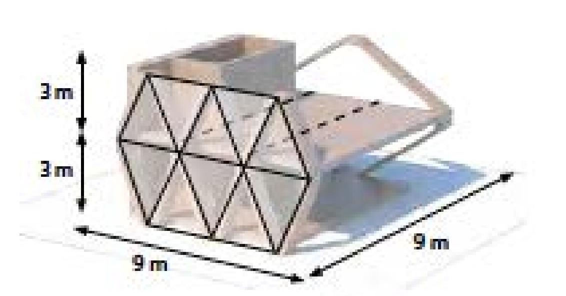
Walls: Cross Laminated Timber
Taking advantage of the two-way behavior of CLT.

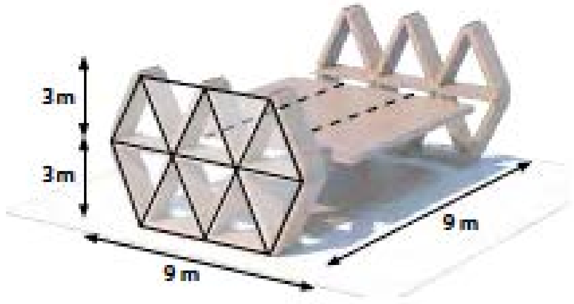
Floor Slabs: Nail Laminated Timber
Stronger in one-way behavior, ultimately reducing the number of columns needed.





Case Study Three | A Tall Timber Experiment
Perkins+Will, Thornton Thomasetti





Project Analysis:
Timber superstructure responds similarly to that of buildings of like-kind built out of cement and steel

The interconnection of the structure using cross-bracing shear walls and diagrids successfully activates the vertical members to resist lateral loads.

Under gravity load, there is a good balance across the diagrid.

The towers joined together by cross bracing show good lateral load distribution across the system.

The diagrid is highly engaged for load resistance.

The research makes considerable headway on constructing a tower at this height. The team looks to further their research in the following ways:

Wind engineering to assess the unique response of a tower with low-mass density and low-dynamic periods.

Further develop the connection details.

Conduct testing with seismic loading

Coordinate fire engineering
Research material modifications that could increase the strength and stiffness of members

Figures 32

Case Study Three | A Tall Timber Experiment
Perkins+Will, Thornton Thomasetti

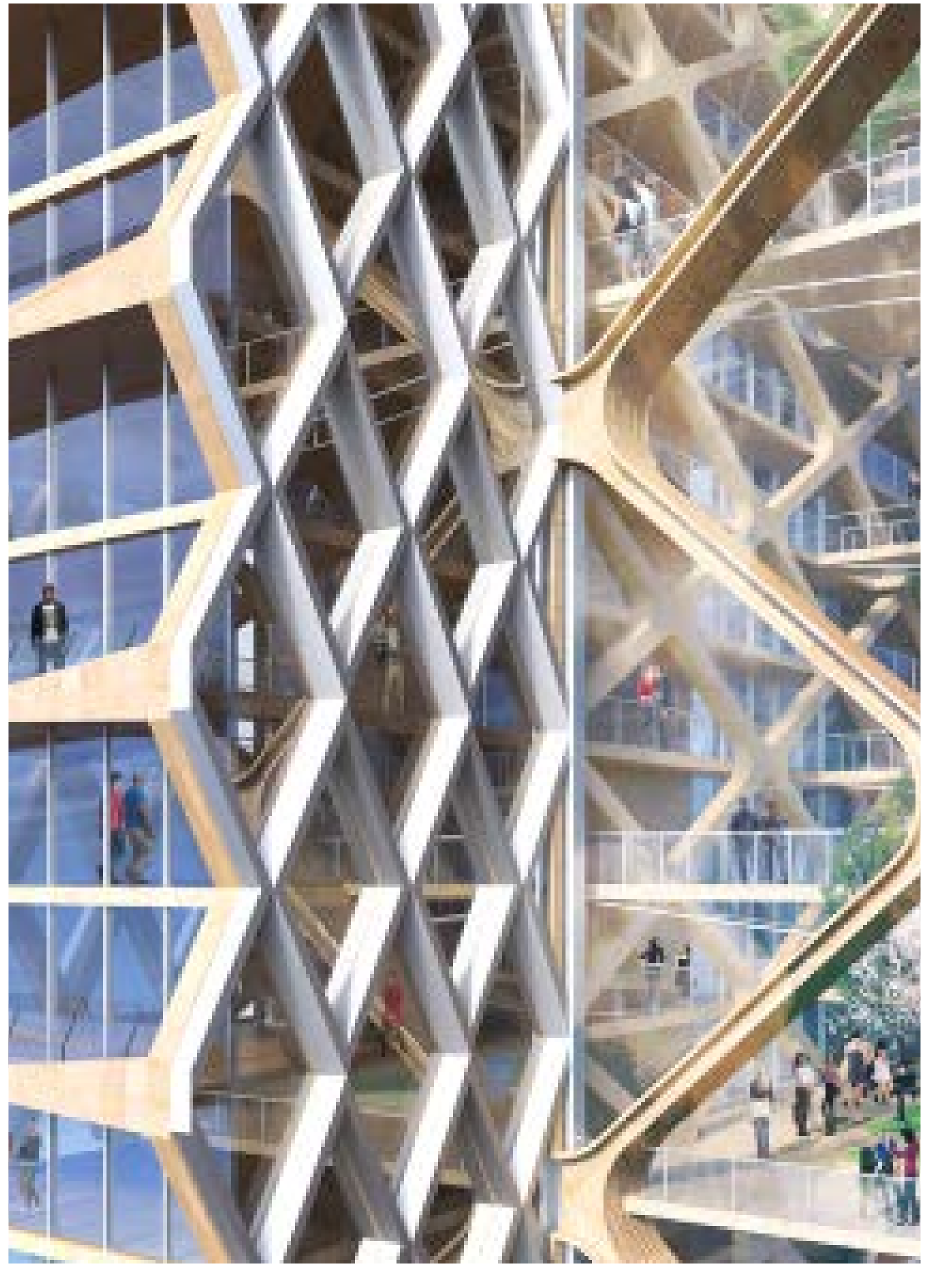
Ultimately this building is not able to be permitted for construction within Chicago or ultimately anywhere in the world. For one, the Chicago Building Code prohibits wood construction within the city's downtown area. The 2012 International Building Code also limits wood construction, Type IV, to five stories. The Team outlined three possible scenarios to allow for the building to be built.

Scenario One: According to the IBC, Type 1A, the structure must be protected and non-combustible.

Timber meets this criteria by virtue of charring and is recognized as so by the IBC. The wood would either have to be genetically modified, treated or engineered as a composite material to pass the ASTM E136 test for combustibility.

Courtesy of Forest Products Laboratory

Case Study Three | A Tall Timber Experiment
Perkins+Will, Thornton Thomasetti



Scenario Two: Encapsulate the entire structure in a fire-resistant material to achieve the fire rating.

A similar structure in British Columbia did this, by covering the entire structure in 1 inch of concrete. This will ultimately add extra weight to the structure meaning all of the members will need to be upsized. The material also risks the ability to be reused after the lifespan of the building. Additionally, the concrete will go against the ideology of creating a sustainable tower and still require a large amount of the material.

Figures 32, 33, 34

Case Study | Why Timber

Ultimately the construction process can be expedited as pieces can be manufactured off site and lifted into place by crane. The building modules were designed to be light enough for a crane to pick them up. Additionally the pieces were made small enough for transit on the Chicago River and ultimately reducing the road hazards.

The industry needs to understand the life process of a material from its farming, manufacturing, fabrication, construction and reuse. As buildings are often demolished before the end of their lifespan, the reuse of timber could create a solid reason to choose the material.

The increased value of timber is going to confer the increased value on well-managed forestry. North America and Europe already have strong forestry management but the growth in the industry could lead to long term improvements in forestry globally. Additionally, with technology increasingly reducing the need for paper pulp, this new industry could help to alleviate the job loss as well as the use of the materials from
well-maintained forests.

Courtesy of the Artists Information Group

Timber has been used in building structures for hundreds of years. From the Primitive Hut to cabins and teepees and more. The material used has morphed over the years and quality of the material has dwindled down due to demand and cost restraints. In the sixty years we have seen the products radically transform as the industry is becoming more involved with the environment and the impacts buildings have on the global scale of climate change. As technologies and sciences have advanced we have seen timber evolve into prominence in twenty first centuries. According to research out of the International Building Code, their committee on manufactured Timber could ready to adopt these new innovative building techniques by 2020.

The next few pages will provide a glossary for manufactured timber products available on the market today and others that are still in being tested.

Figures 35, 36

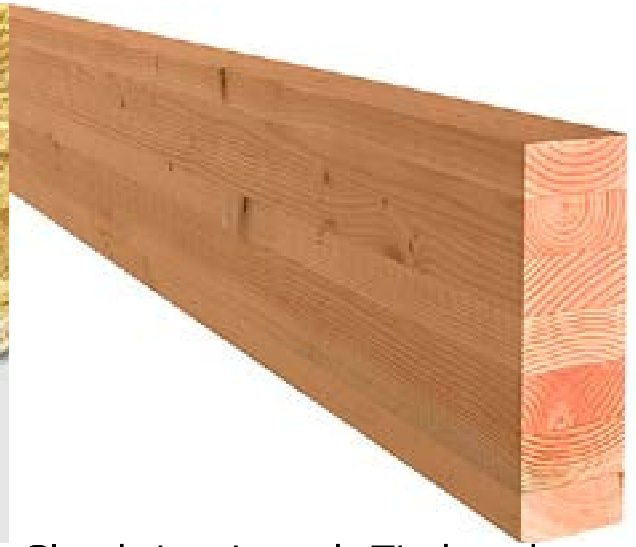
Ply-Wood

Plywood is a structural panel of wood and is often referred to as the original engineered wood. It is manufactured from sheets of cross laminated veneer wood and bonded under heat and pressure. By alternating the direction of the veneer on each level, the panel is able to gain strength and stiffness in both directions.

Orientated Strand Board (OSB)

Oriented strand board is manufactured from rectangular strands of wood that are orientated lengthwise and then arranged in layers, laid in mats and bonded together. Often times the layers are cross oriented to increase the strength in both directions.

Glued Laminated Timber



Glued Laminated Timber better known as Glulam is a type of structural engineered wood product comprised of a number of layers of dimensioned lumber bonded together. Glulam is durable and moisture resistant. It can be manufactured to nearly any size and works in both interior and exterior applications.

Cross Laminated Timber

Cross laminated timber is a versatile material that is comprised of several long strands of veneer stacked perpendicularly. It is then bonded together with an adhesive and pressed together. CLT is commonly used in long spans and floor, wall and roof assemblies. It can also be used for columns and beams and can be flat packed and shipped anywhere. It also has a good fire rating.

Nail Laminated Timber

Nail Laminated Timber is a centuries old technology that is being transformed into a twenty-first century building product. It gets its strength and durability from the nails that fasten individual dimensional lumber together. The wood is stacked in alternated grains so that the lumber is stronger in both directions. The panels can support and range of structural and design needs including curves and cantilevers.

Finger Joint

Finger joint is made up of short pieces of pieces of wood that are connected to make longer pieces of wood. It is commonly used for studs, doorjambs and moldings. It can also be used as flooring.

Figures 37a-f

Laminated Veneer Lumber (LVL)

Laminated veneer lumber is produced by bonding thin wood veneers together in a large billet. The grains in the veneer are parallel the long direction. This provides a broader length than conventional structural wood.

Fiber Board

Fiberboard is produced by breaking down hardwood and softwood into fibers and combining them with wax and resin. After applying heat and pressure, the mixture forms panels.

Particle Board

Particle Board is manufactured using woodchips, sawmill shavings and saw dust. A binder is then applied and then the fibers are then heated and pressed together at a high force. Particle board is often cheaper and denser than most other materials. It absorbs moisture and often gets disintegrates.

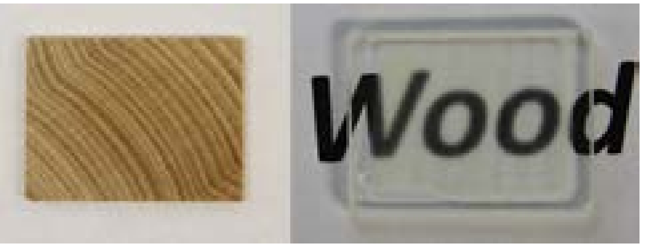
Parallel Strand Lumber

Parallel strand lumber is made from parallel wood strands bonded together with adhesive. It can be used for beams, headers, columns and posts. Each layer of wood is less than .25 inches. The lumber is a lot denser and stronger than traditional timber.

Laminated Strand Lumber

Laminated Strand Lumber is fairly new to the market. Unlike other manufactured woods, the strands are arranged parallel to the longitudinal axis of the member. Like its counterparts, it offers a predictable strength, weather ability and ability to use it for most uses.

Transparent Wood Composites



Transparent wood composites are being made tested in laboratories. They are working to combine transparency and stiffness together in an interesting new product. They are not available to purchase yet.

Figures 38a-f

Project Development

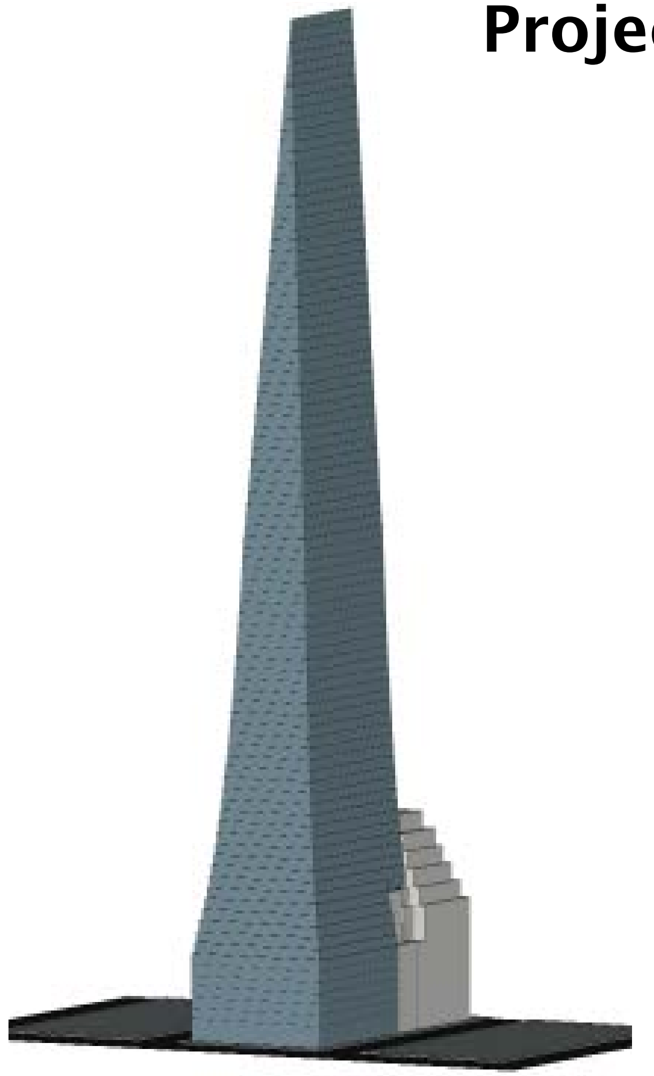
Project Development | Massing

It is important that we understand what others are contributing to in our built environment and how their research can also be of benefit for us designers and dreamers. It is also important to understand the existing city building code and the IBC and how they also play a part in designing the new 340 Madison.

Timber architecture will forever be a contentious subject amongst critics forever - until it finally becomes the norm and accepted by municipalities and designers alike. It will also take a lot convincing to get developers behind this type of construction and expos-ing them to benefits and that the 20% plus surplus cost in construction fees is justifiable.

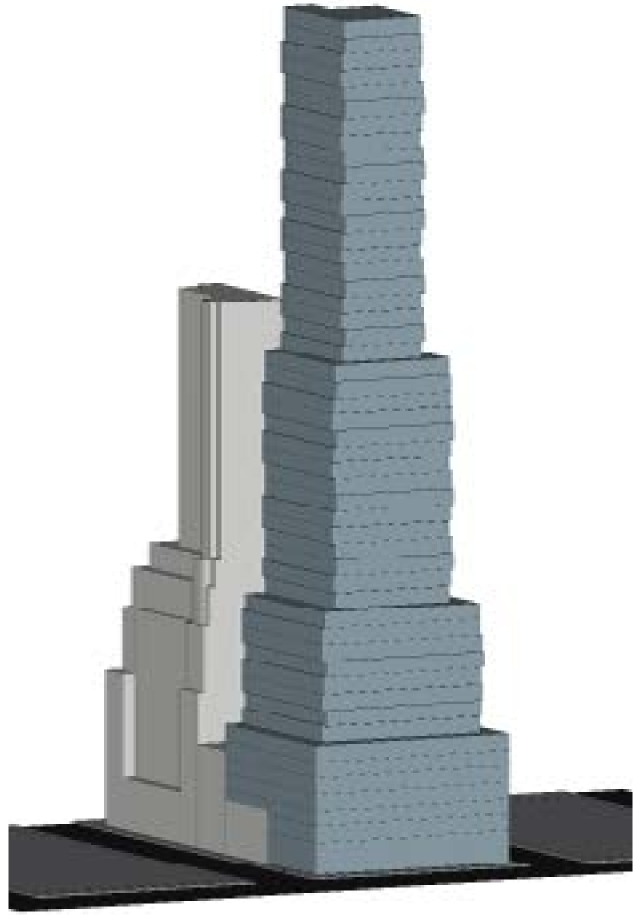
It is also not an everyday occurrence where zoning dictates that buildings have to be 100% demolished before construction of new upsized buildings can take place. As movers and shakers we have to leverage the overall cost and impact the demolition causes and truly find sustainable approaches to building towers that no longer will live on 100 plus years as earlier planned.

Project Development | Aspirational Massing



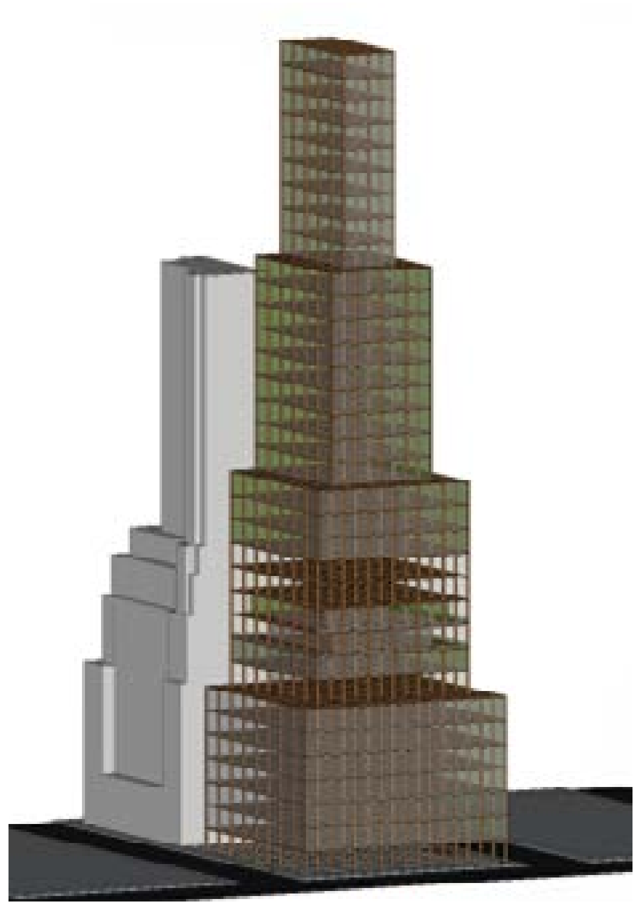
Reaching for the Stars

aspirational tower that reaches its max-imum height within the New York City building code



Rhythmic Waves

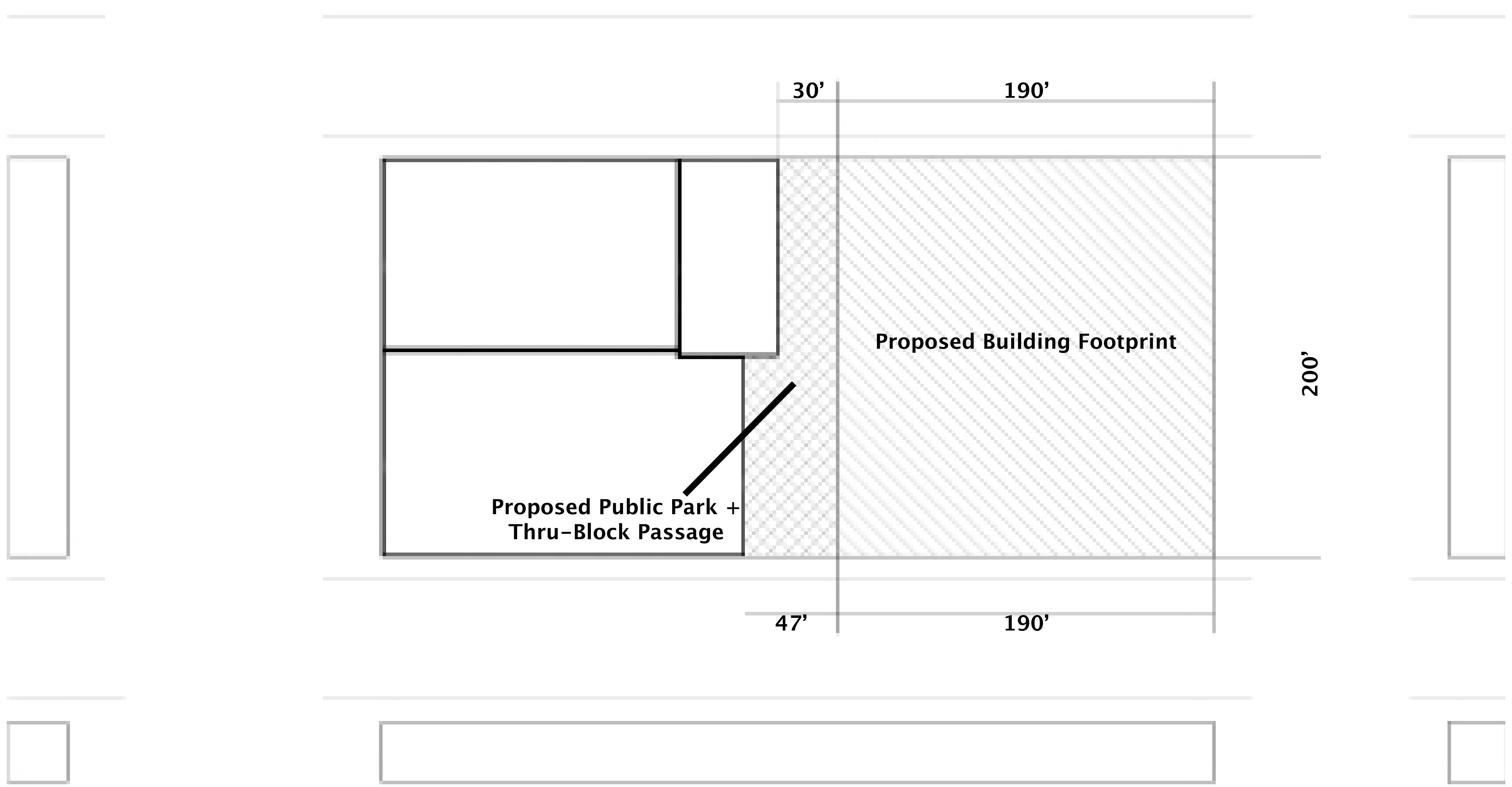
working to create an gracious and artful tower to rival the Jenga Tower, 111 West 57th and other recent additions

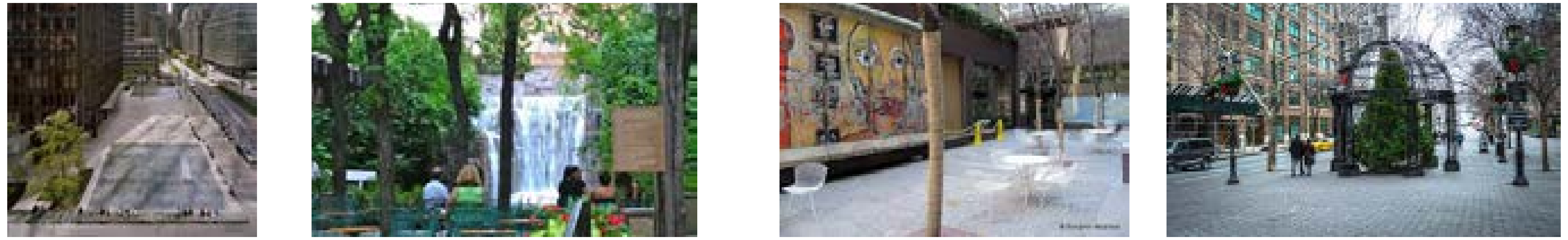


Adaptable Kit of Parts

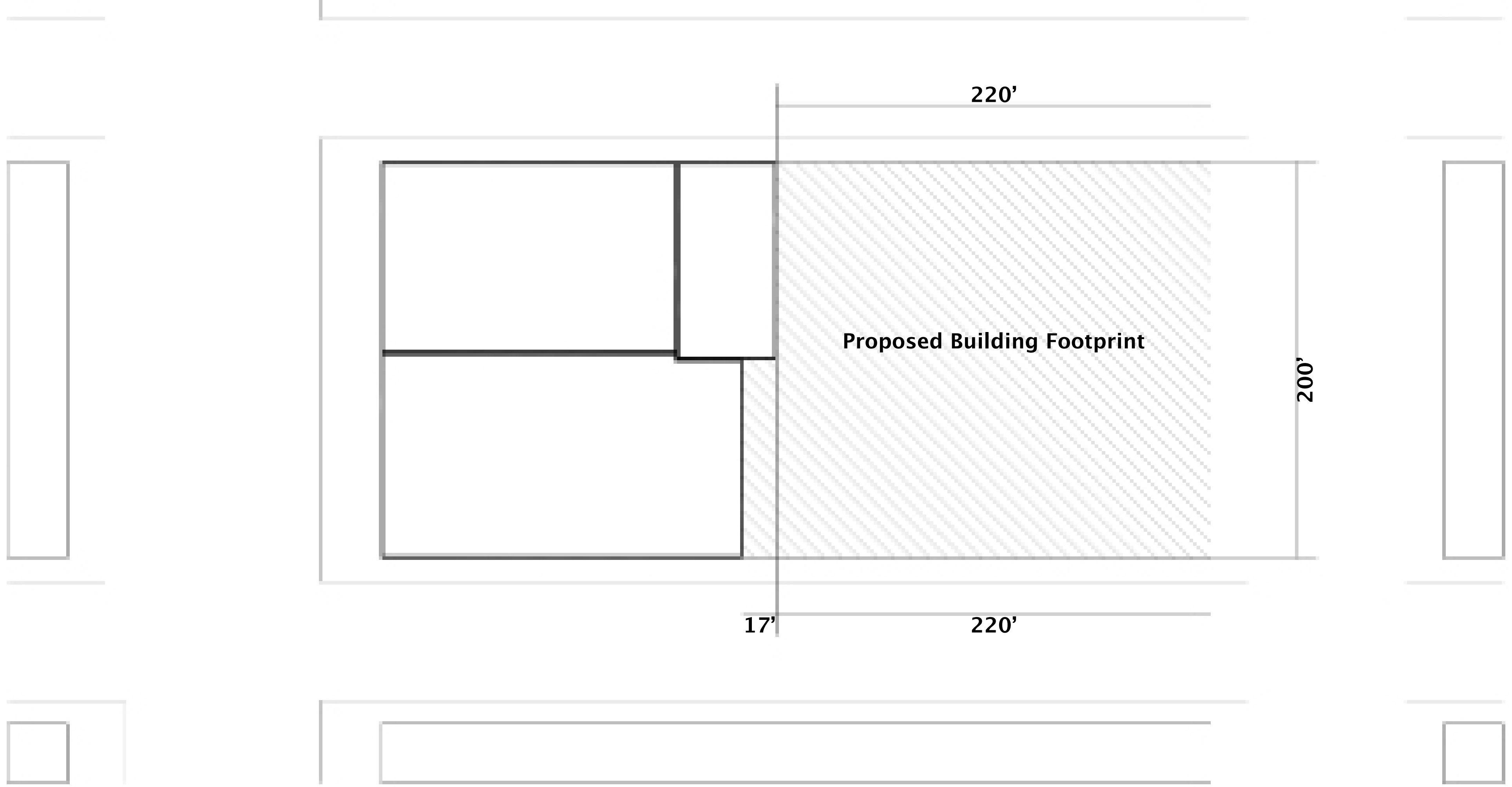
where there is a strong overarching structure that each tenant dictates the amount of outdoor space and can easily be changed per new tenant.

Project Development | Site Plan A



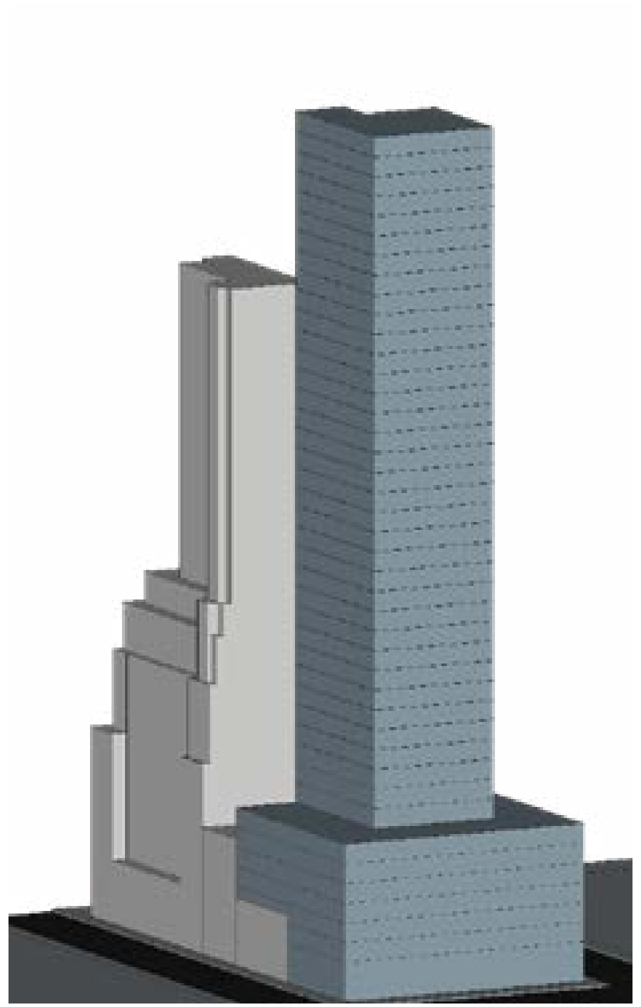


Project Development | Site Plan B



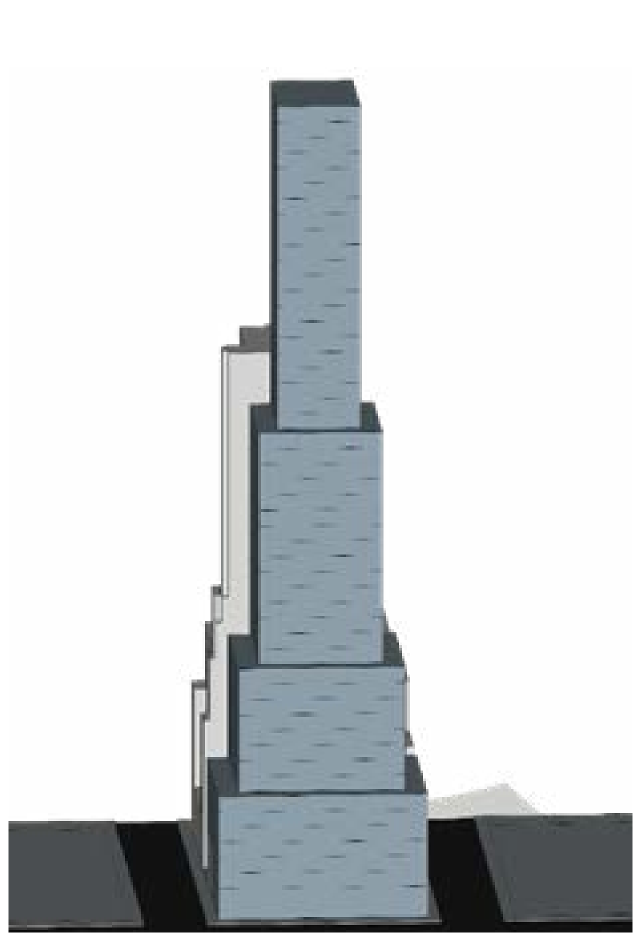
Figures 39a-d, 40a-f

Project Development | Massing Studies



Site A with Single Tower
42 Floors
Total Square Feet: 620,165

Upper Floors:
appx. 11,000 sqft floorplates

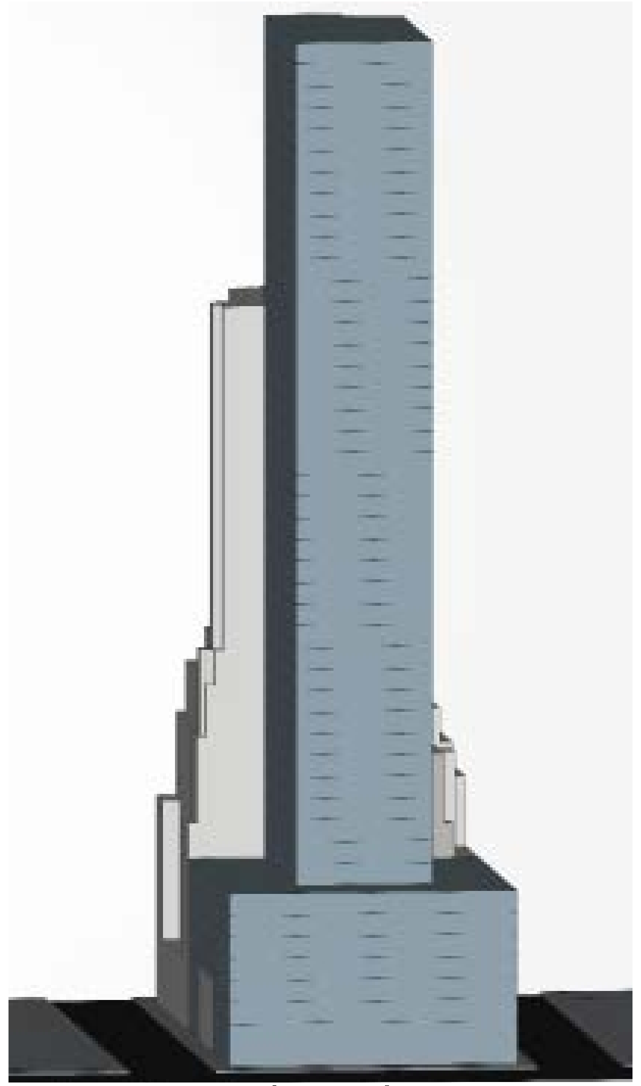


Site A with 20' Setbacks
51 Floors
Total Square Feet: 800,629

Upper Floors:
appx. 22,000-8,000 sqft floorplates

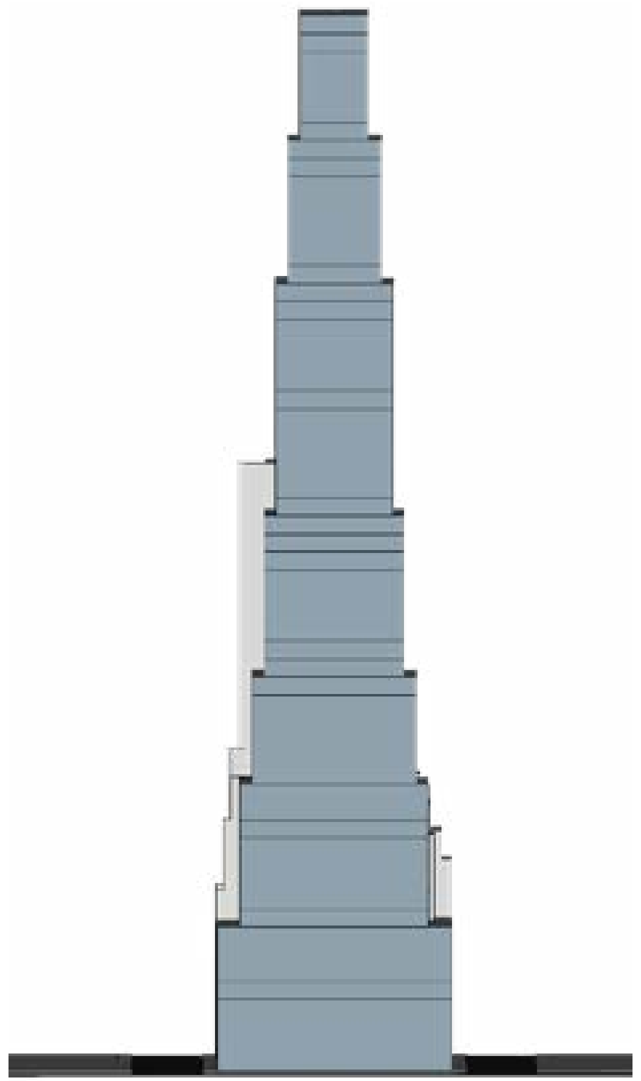
Site A with 10' Setbacks
58 Floors
Total Square Feet: 898,987

Upper Floors:
appx. 22,000-5,000 sqft floorplates



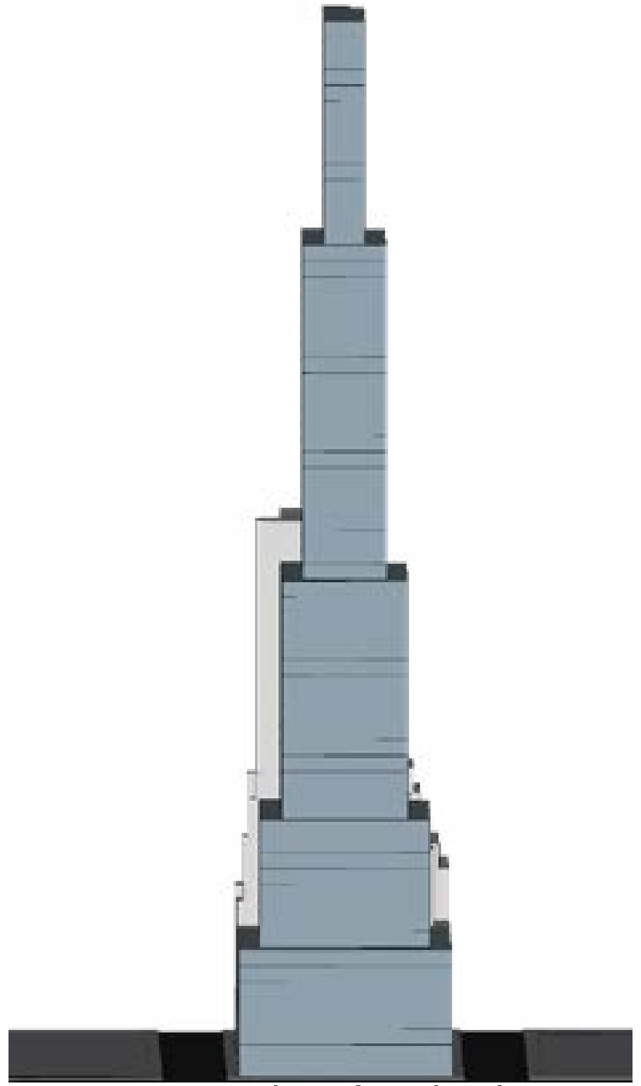
Site B with Single Tower
46 Floors
Total Square Feet: 974,636

Upper Floors:
appx. 16,000 sqft floorplates



Site B with 10' Setbacks
42 floors
Total Square Feet: 1,172,988

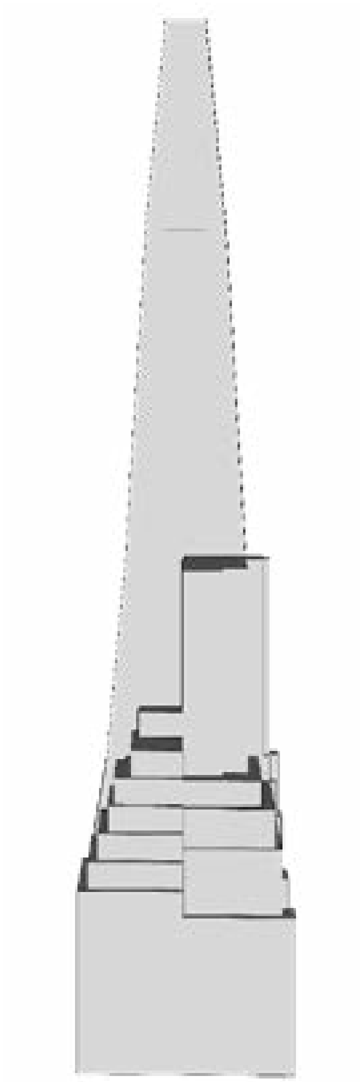
Upper Floors:
appx. 33,000-17,000 sqft floorplates



Site B with 20' Setbacks
65 Floors
Total Square Feet: 1,291,752

Upper Floors:
appx. 33,000-5,000 sqft floorplates

Project Development | Chosen Massing



Site B with Single Tower
66 Floors
Total square feet: 1,505,908

Upper Floors:
44,000-6,000 sqft floorplates

Building Break Down:

15': Floor to Floor Height

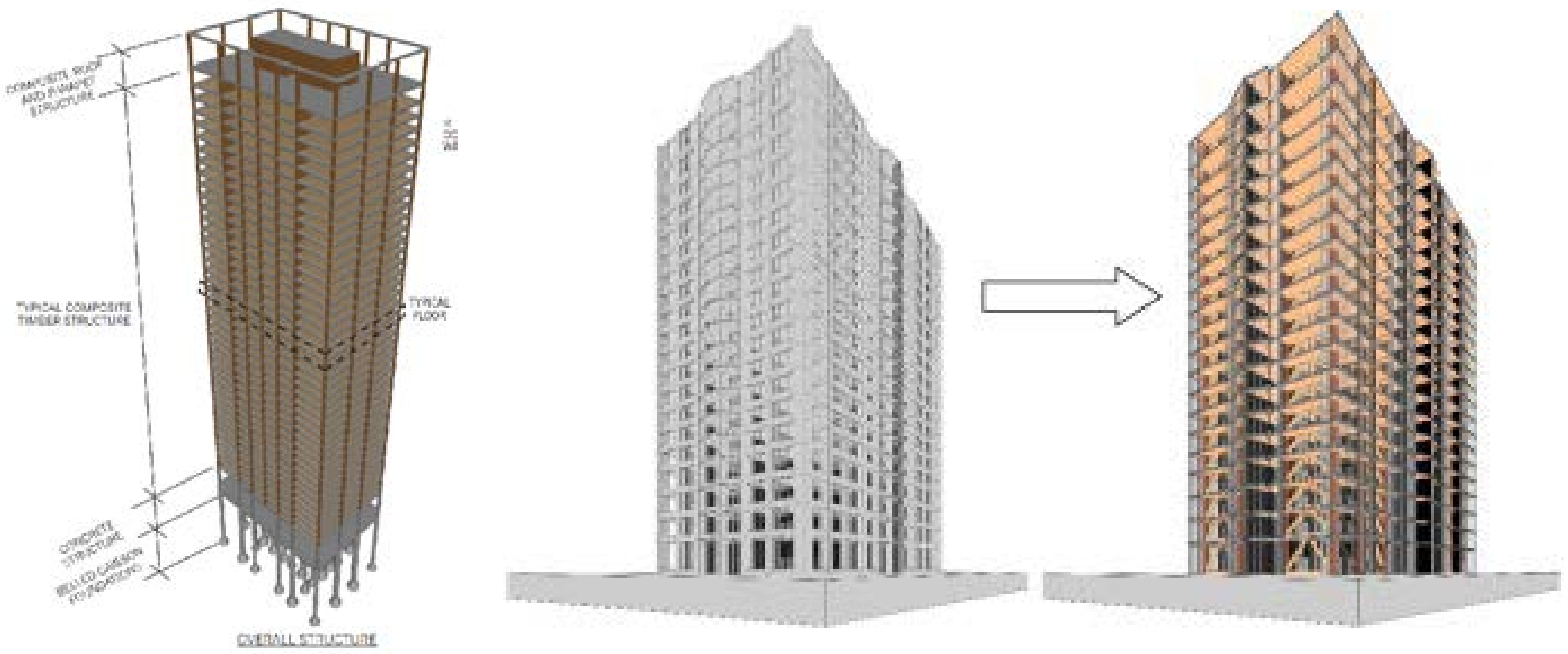
Floors 1-8: appx. 44,000 sqft - No Setback up to 120'
Floors 9-16: appx. 37,118 sqft - 2.5' Setback
Floors 17-30: appx. 26,295 sqft - 1.3' Setback
Floors 32-51: appx. 16,866 sqft - .9' setback
Floors 52-66: appx. 9,057 sqft - 1.4' setback

Total: 1,505,908 sqft
301,181 sqft or 20% Max Portion Resi.

Residential:296,179 sqft - Floors 41-66
Commericial-Retail: 64,000 sqft - Floors 1-2
Commercial-Office: 1,121,729 sqft - Floors 3-40
Community Space: 10,000 sqft+ per use

Project Development | Precedent Analysis

Skidmore, Owings and Merrill



In diving deeper into the research The realization of a full timber tower is unrealistic. After much research into the Perkins + WIll case study it was realized that a hybrid mix would be needed to achieve the desired height.

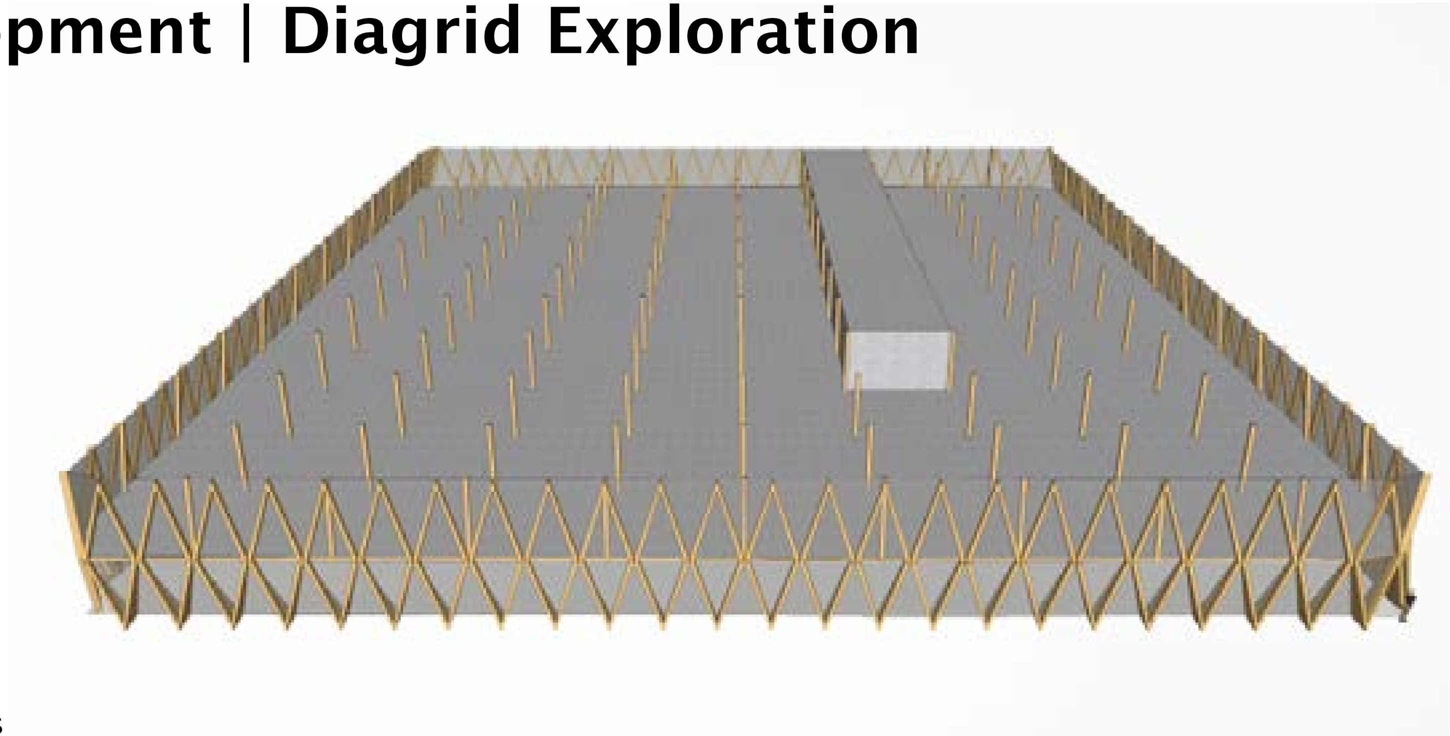
Figures 41a,b

Project Development | Diagrid Exploration

The diagrid is one the most compelling pieces of the entire project. It not only helps with lateral wind loads and the overall structure of the building but it is also the outer most skin of the building. It is a bold move and much time and thought were put in to establish the most harmonious way to implement this element. As a driving factor for the project, the alignment of this feature and the need for a uniformly shaped building actually helped to dictate the use of the larger site and forgoing the cross block park.

With the building's being 200' x 220' each structural grid is aligned on the 20' mark. The Diagrid and curtain wall system are divided equally into 5' sections and in doing so, the columns align on the exterior of the building along the vertical mullions to allow for greater openings and to assure there are no barricades across the window planes.

After much development - straight edges, not cutting in like the Hearst Tower



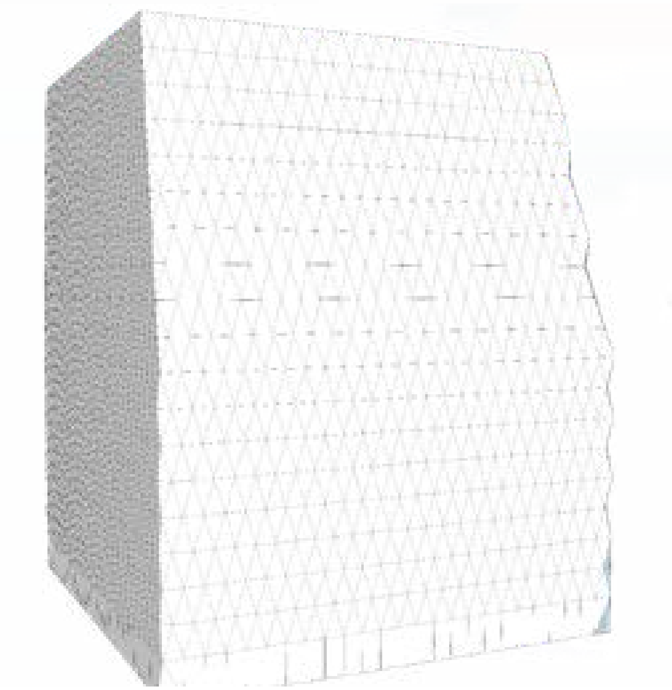
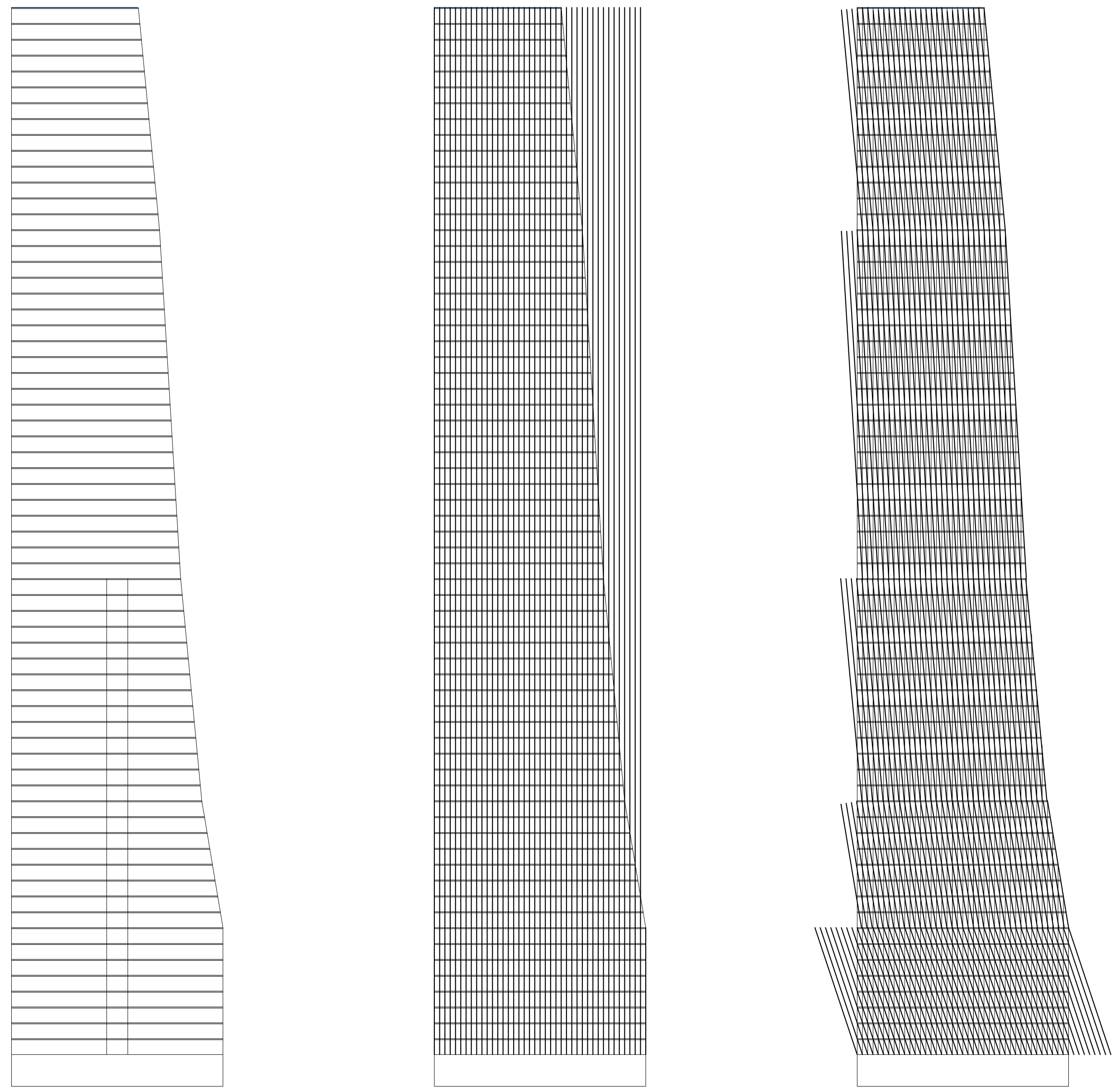


Image Above: (from the development phase of the project) Helps to articulate the importance of the uniformity of the Diagrid to the rest of the structure and how unaligned columns can become an eyesore on the exterior of the building.

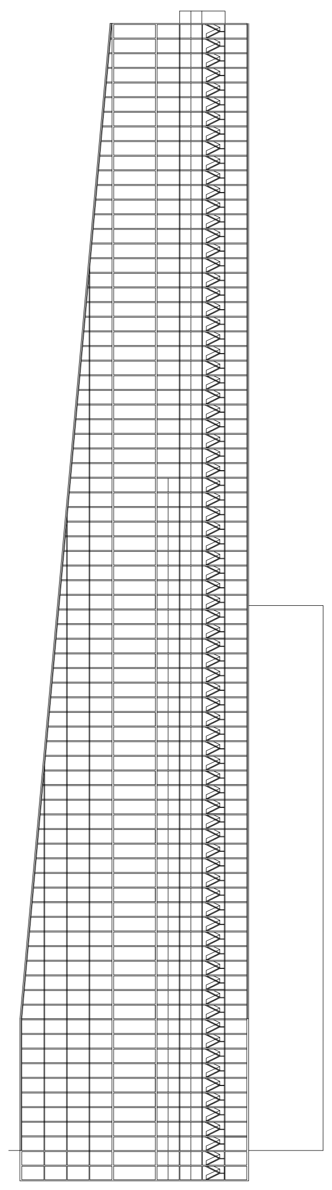
Image at Left: A development phase diagram working to detail the Diagrid and how artful the edges could be.

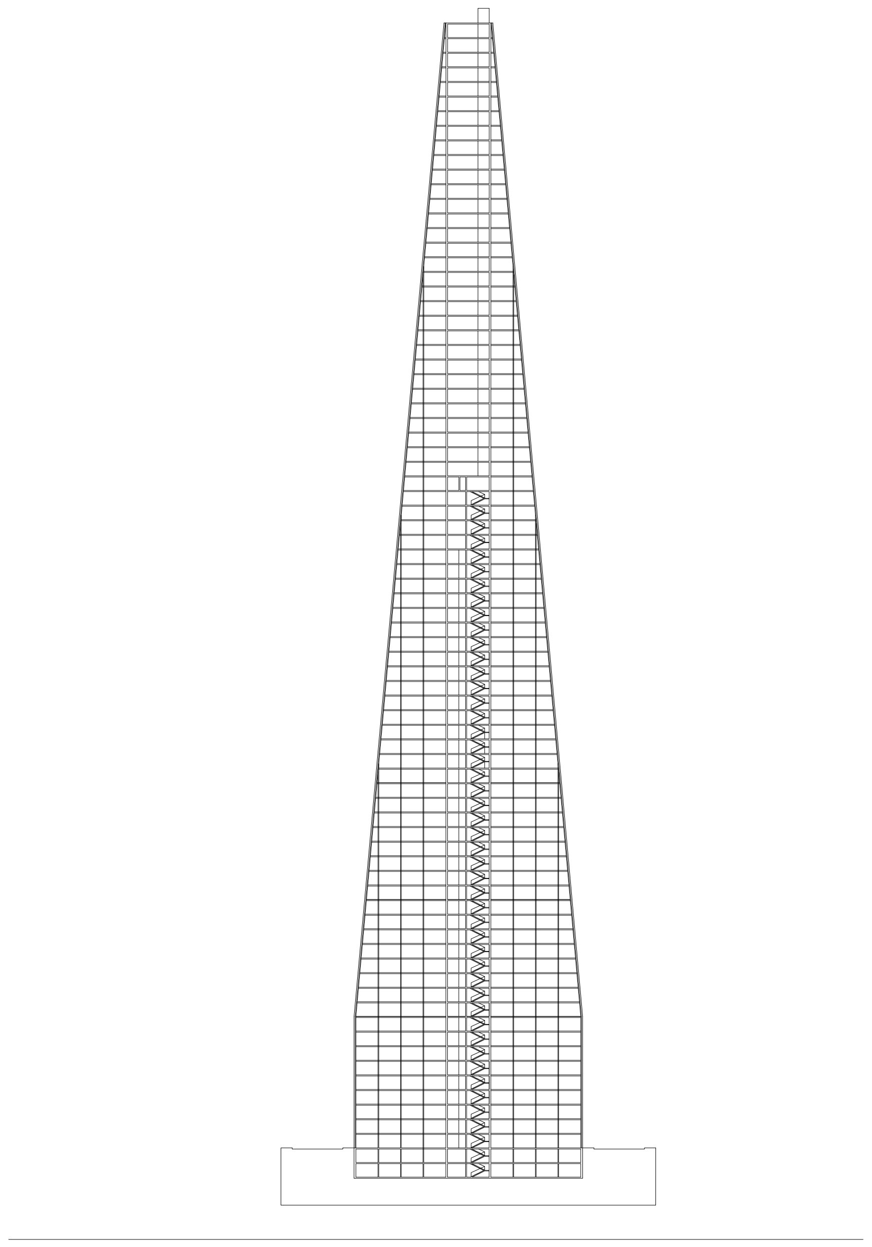
Diagrid - Grid Detail



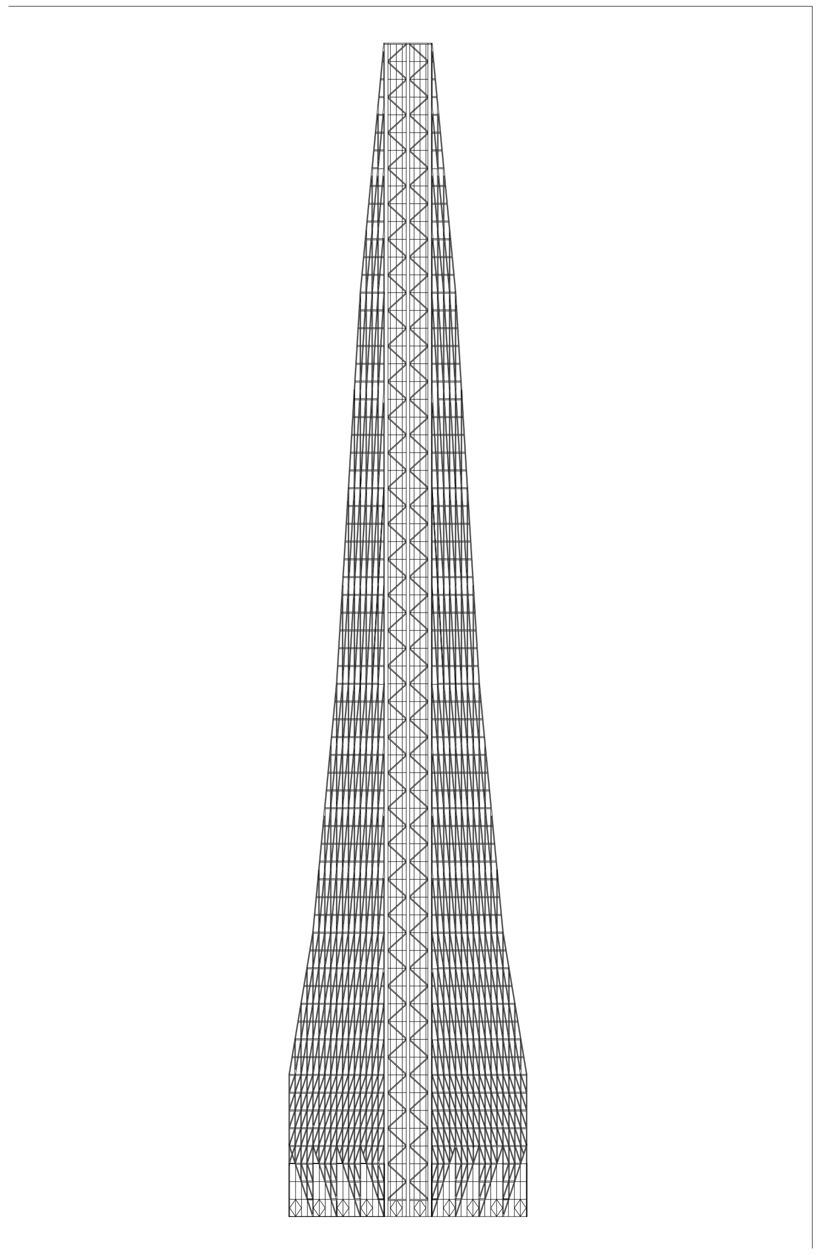
This Diagram Helps to draw attention to system implemented for the 5' grid that both the mullions and diagrid work on - which is between the 20' structural column grid.

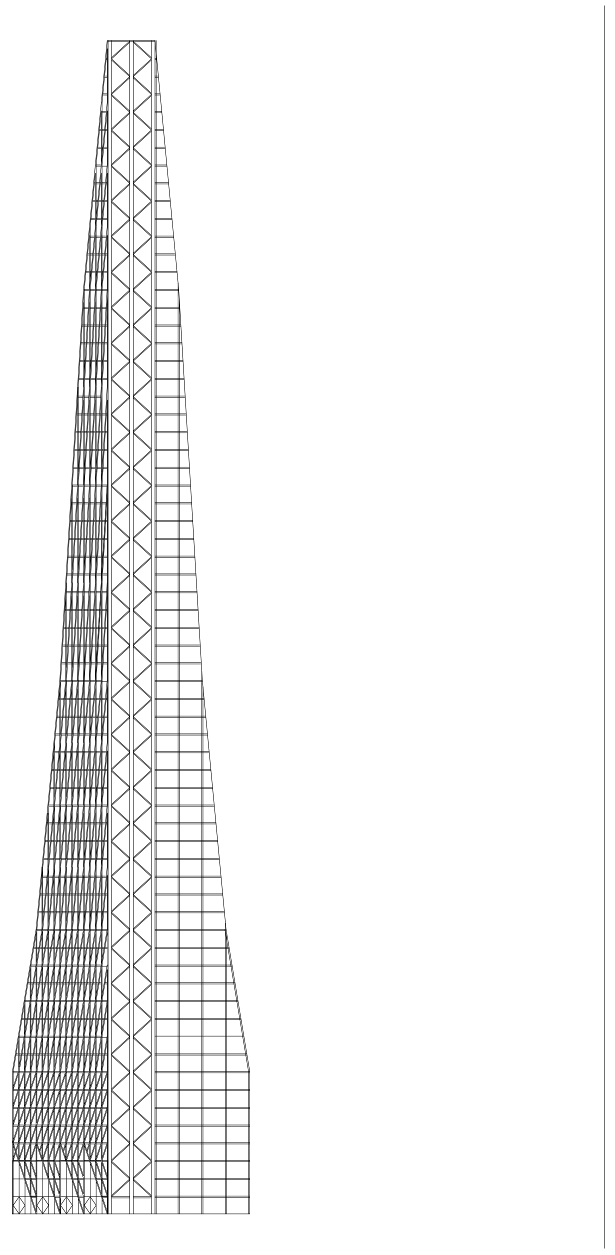
Project Development | Building Sections



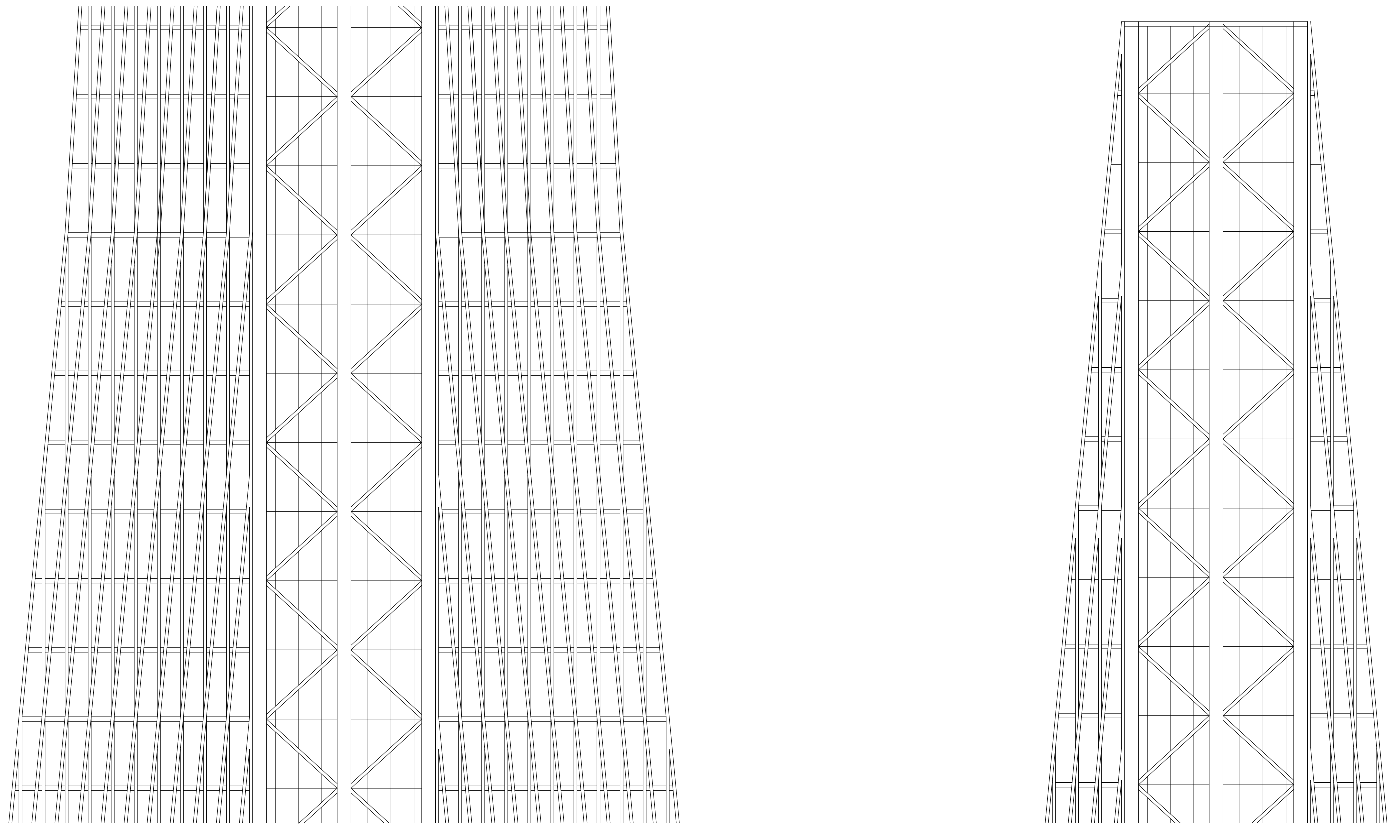


Project Development | Building Elevations

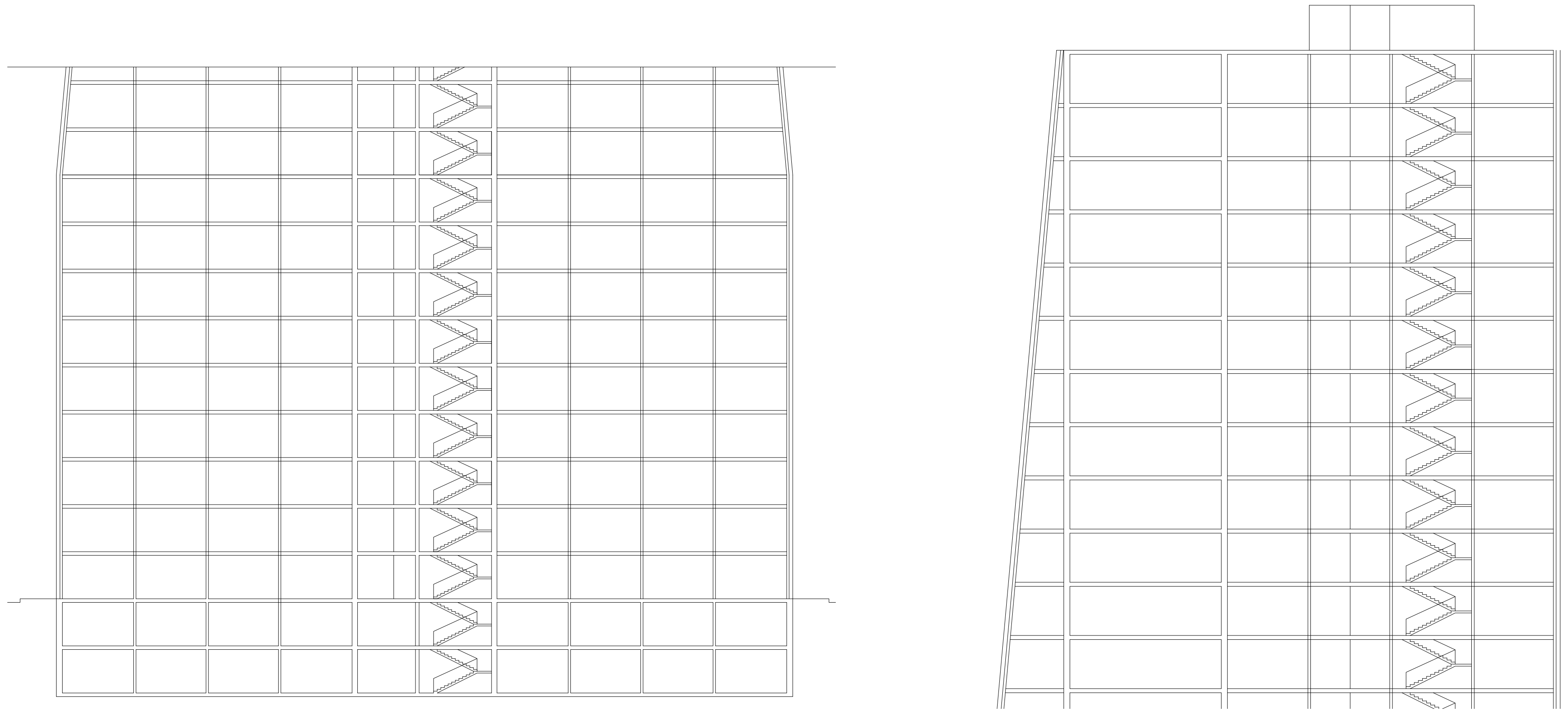




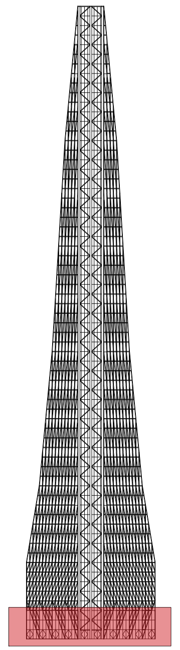
Project Development | Building Elevation Details

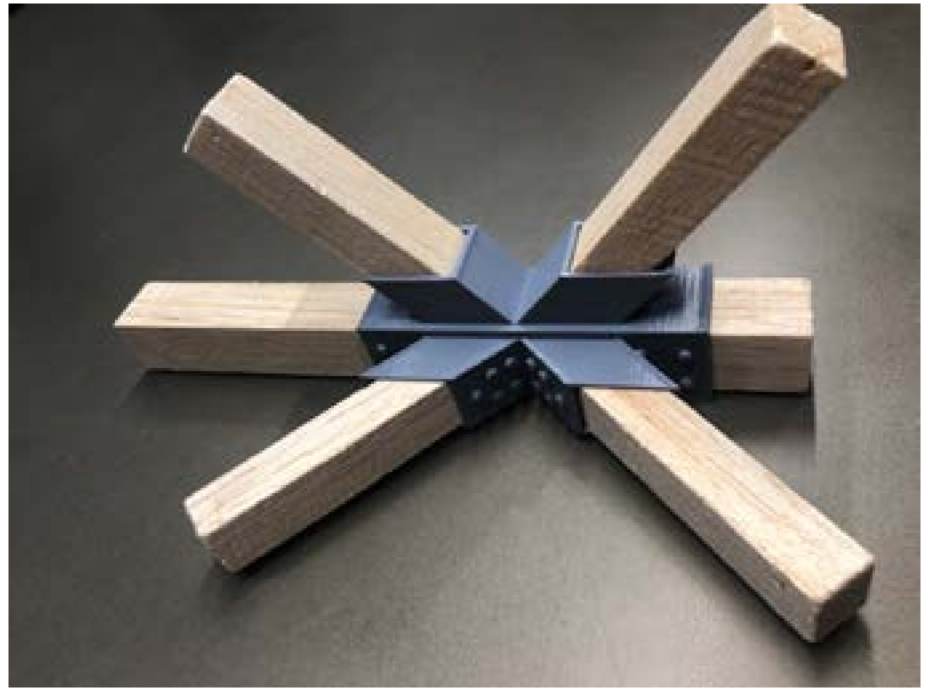


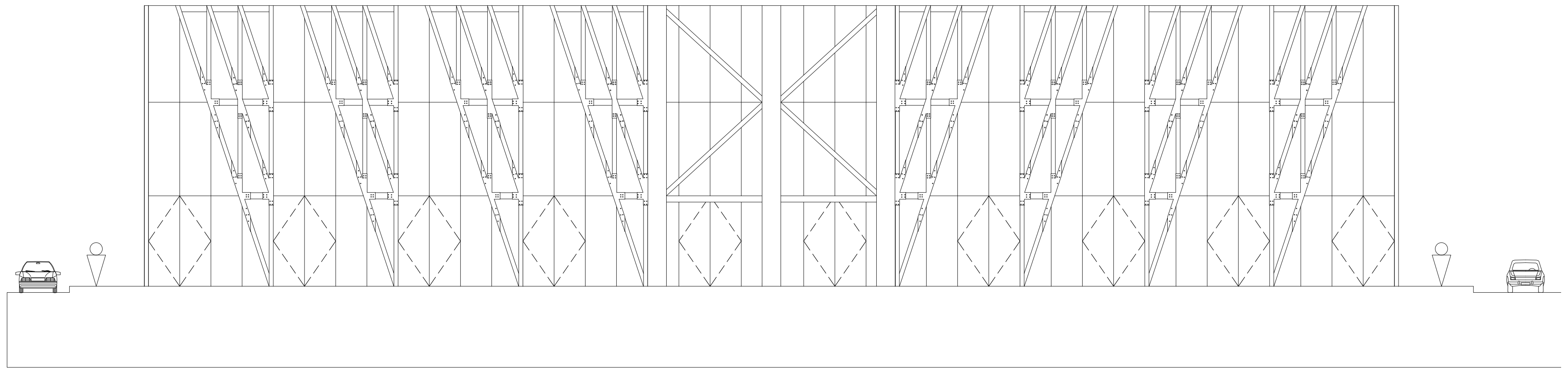
Project Development | Building Section Details

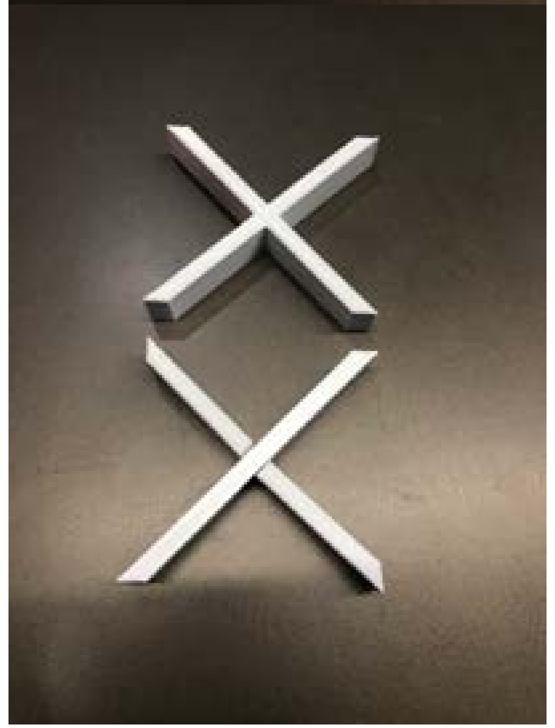


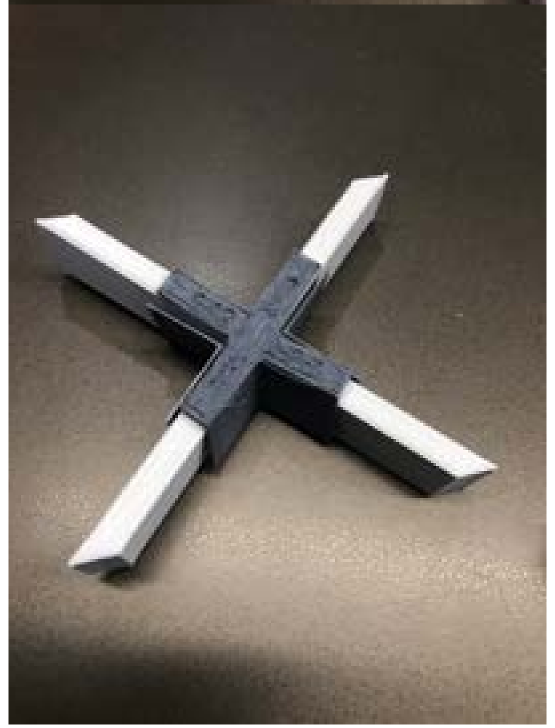
Project Development | Details





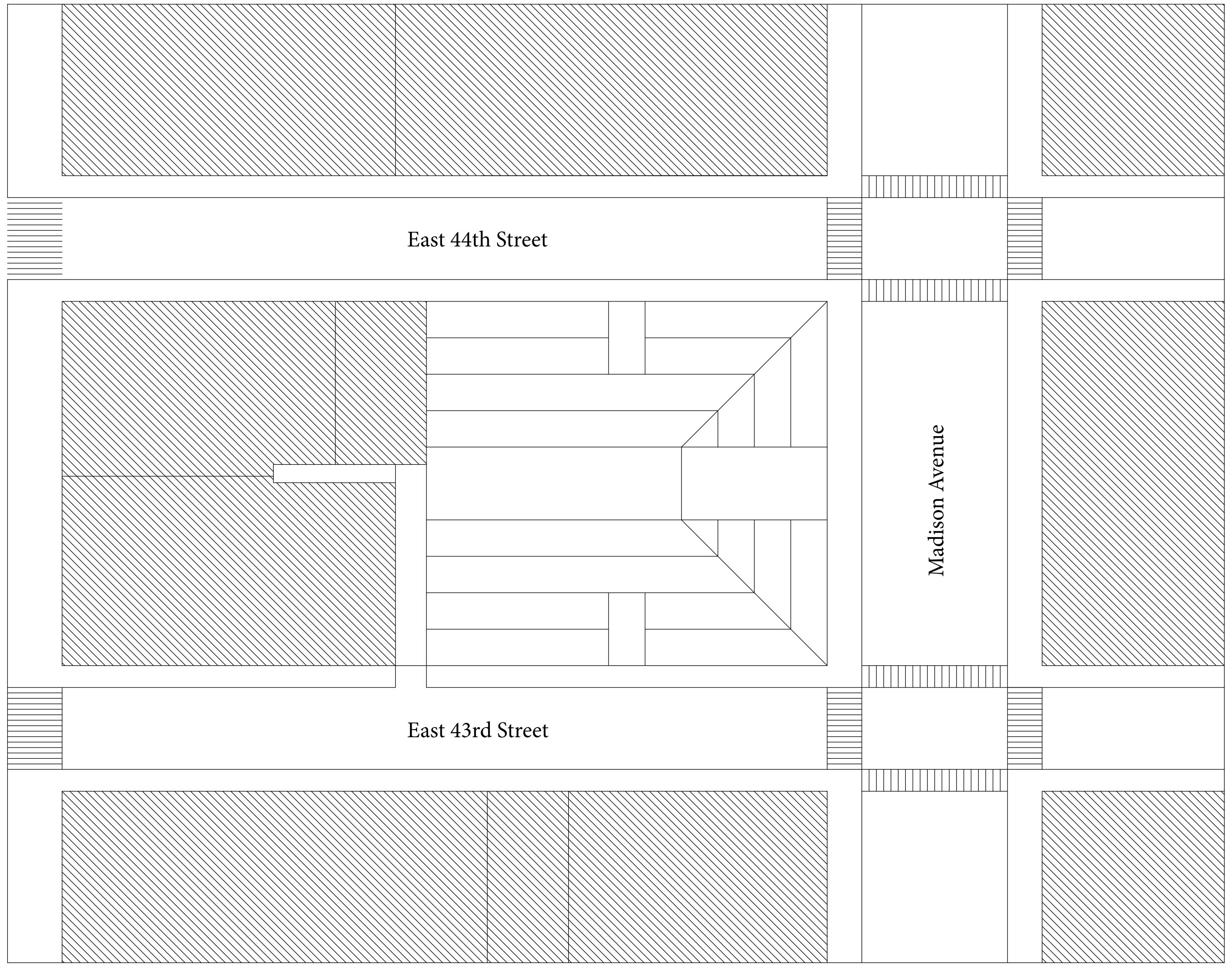






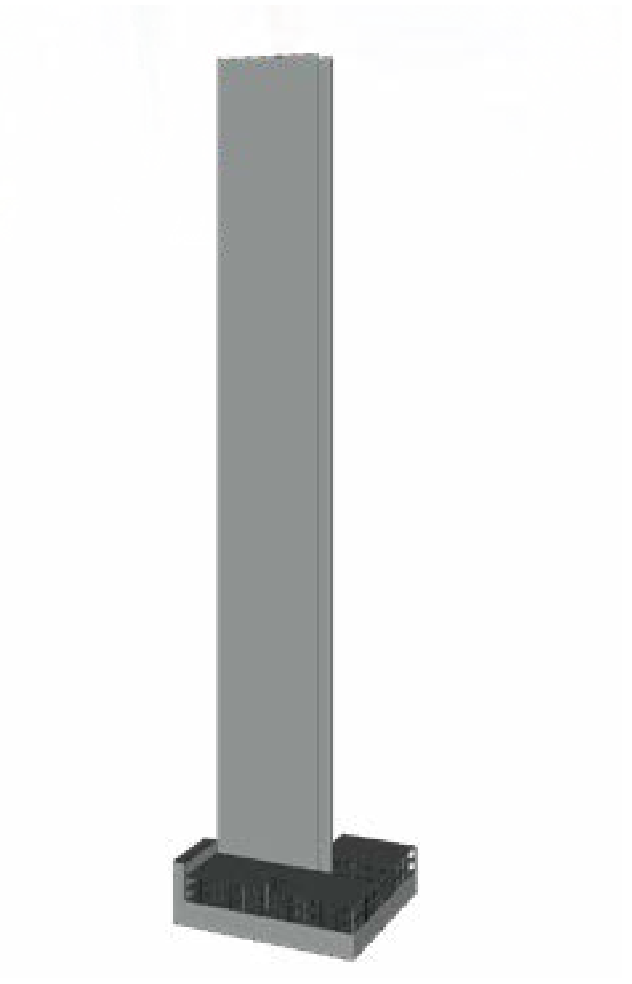
Project Development | Site Plan

Project Development | Block Plan

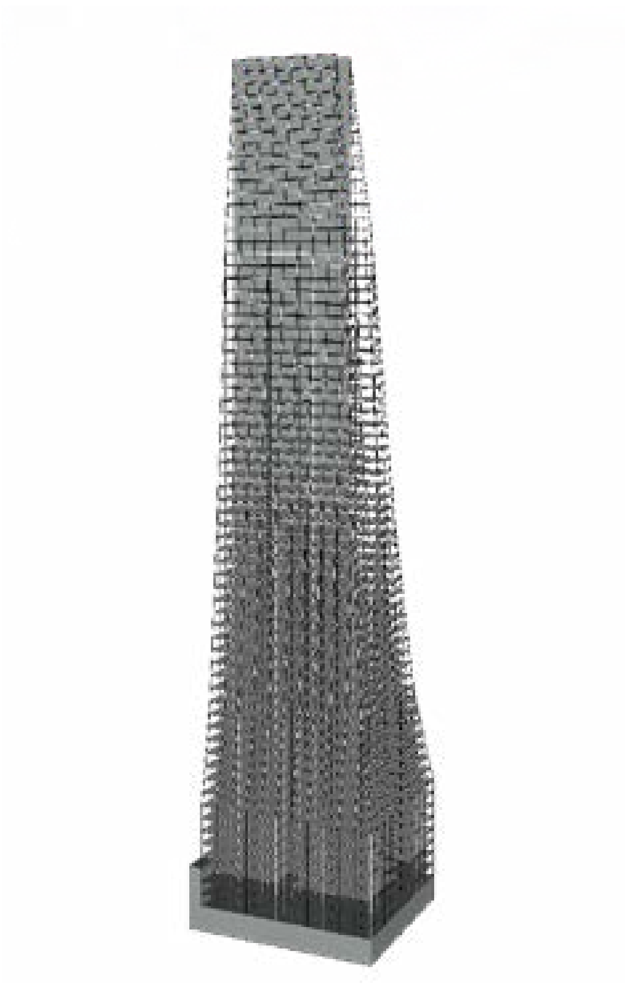


Project Development | Kit of Parts

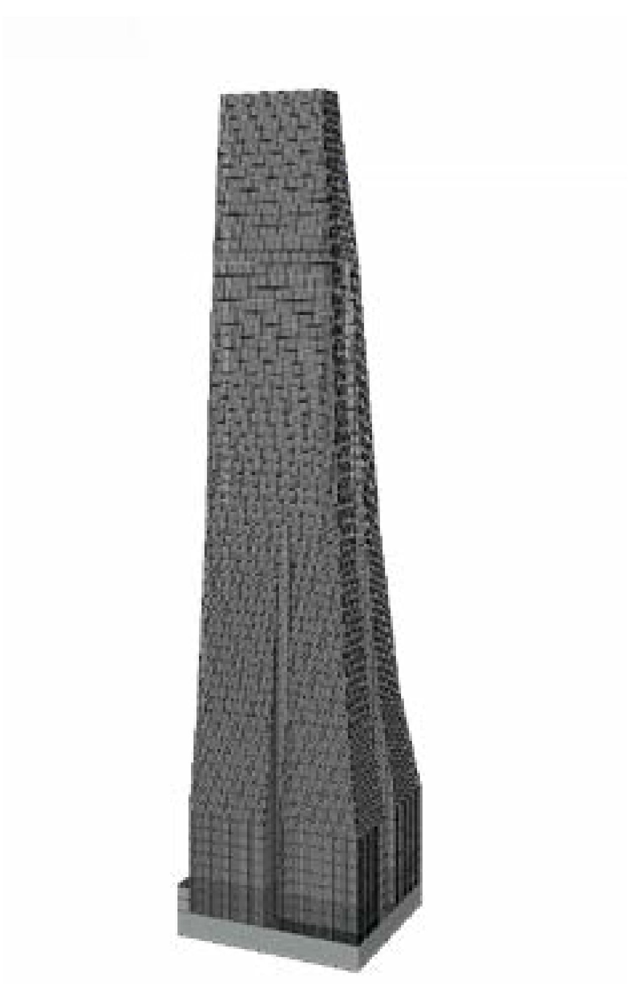
Base: Two basement floors and two ground floors constructed out of concrete



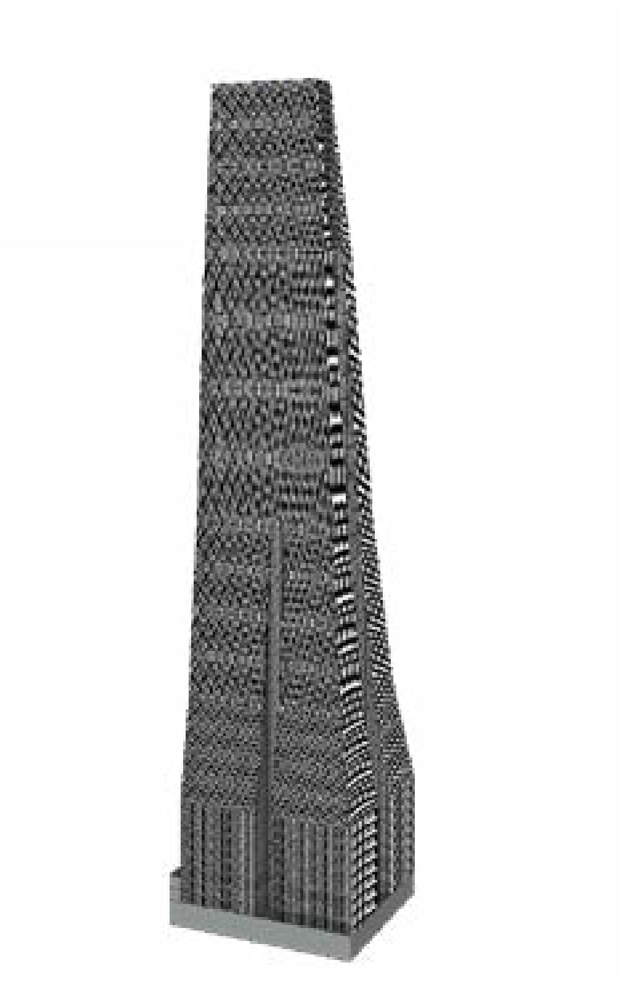
Core: 140'x40' concrete core rises at the centr of the building (includes lifts, stairs, mech. shafts)



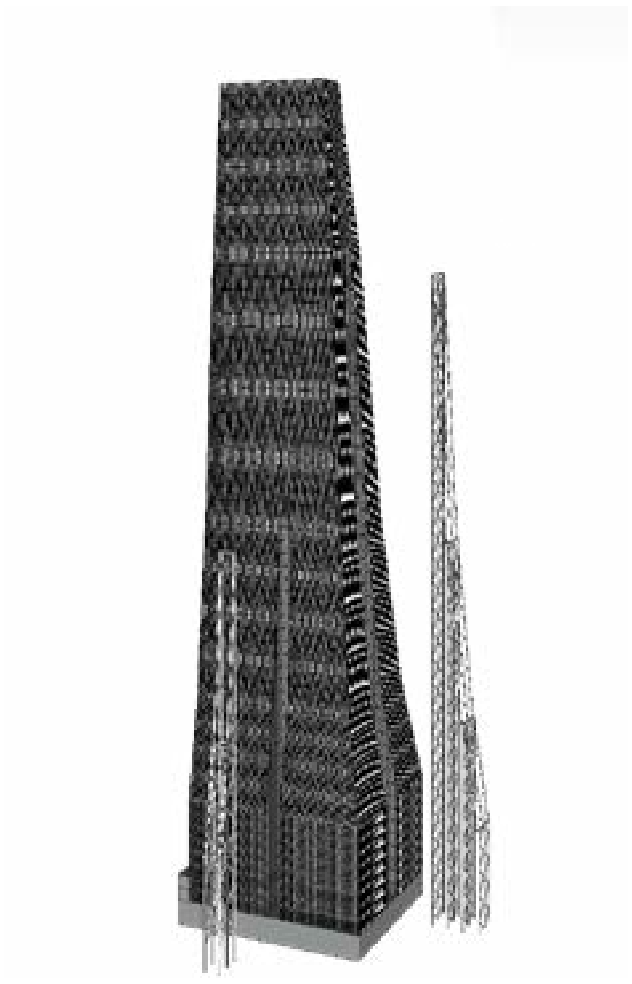
Timber Frame: structural system, floor plates and concrete pads (CLT and NLT combination)



Cladding: Building clad in metal curtain wall system

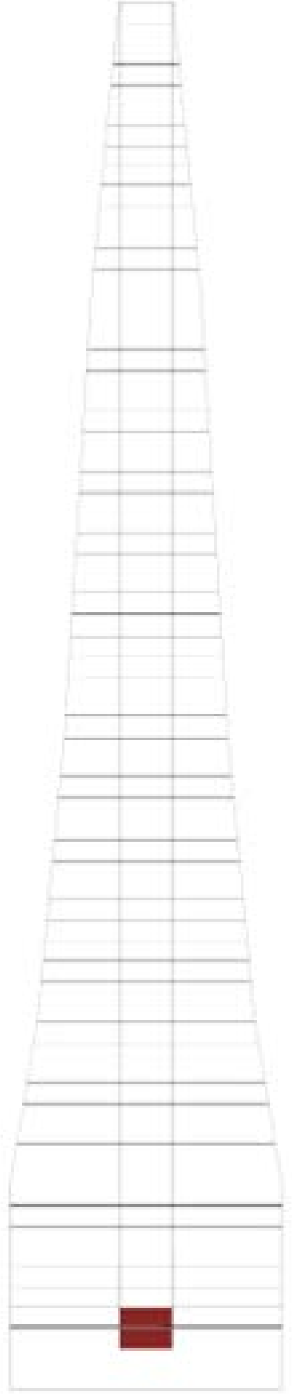


Diagrid: Building clad in timber diagrid system

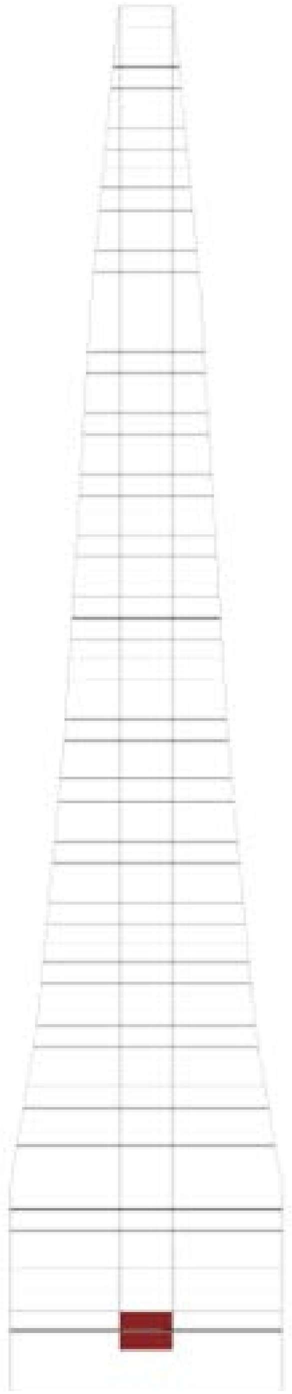


Dia-Frame: four Insets to receive timber dia-frames

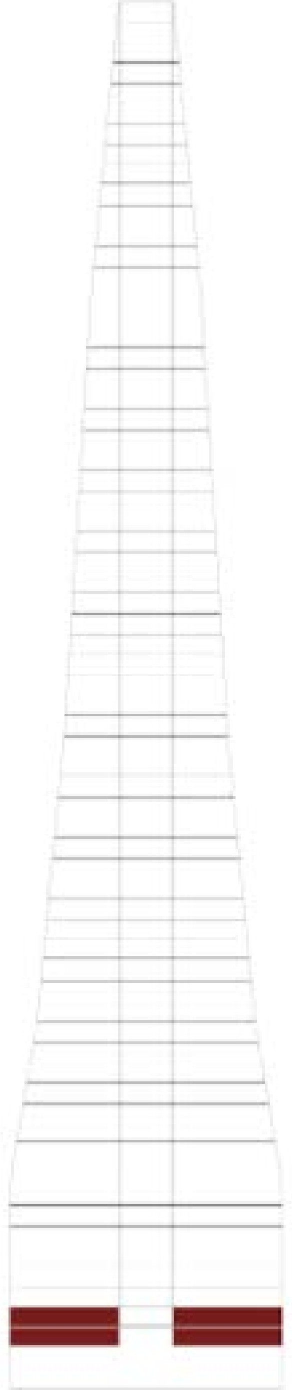
Lobby | Commercial

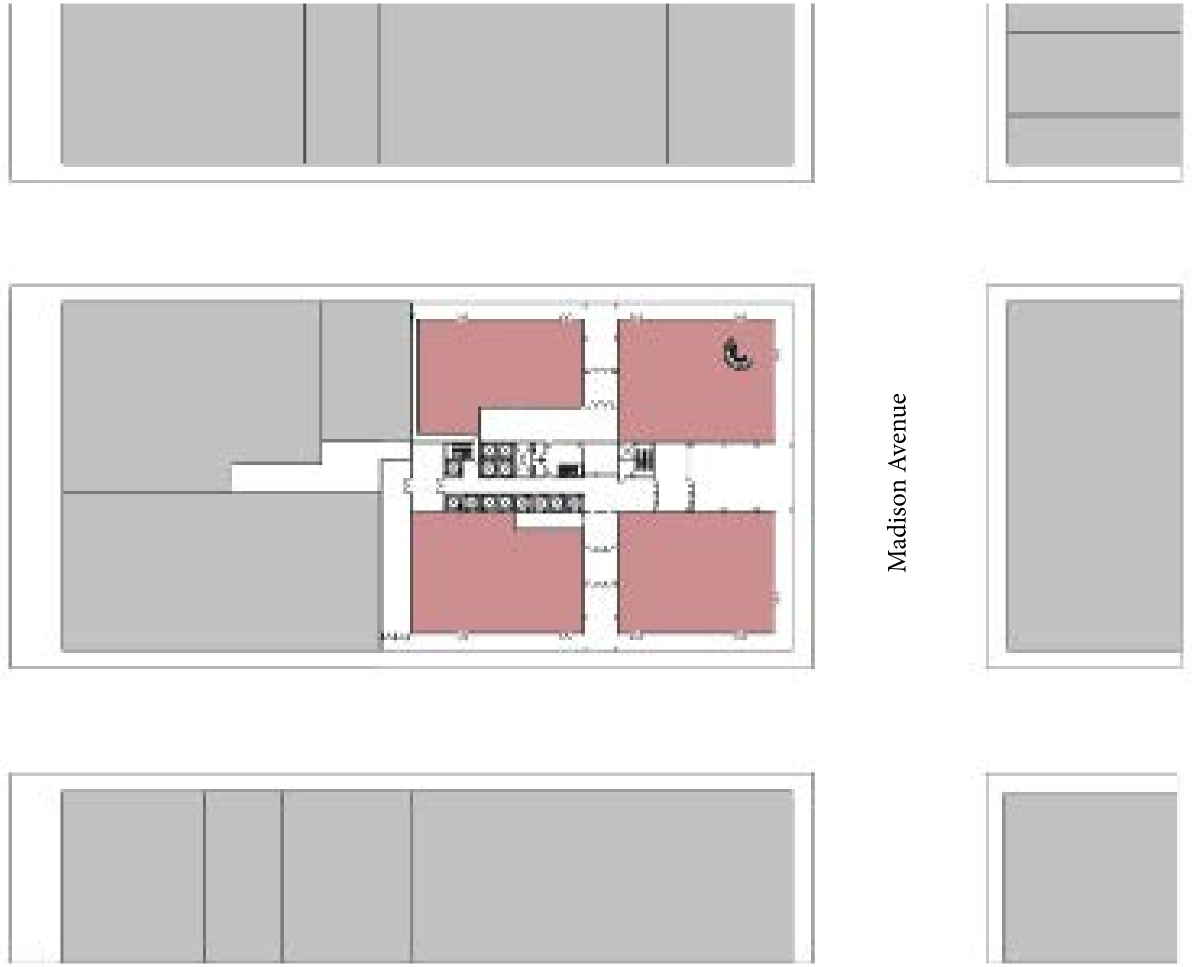


Lobby | Residential

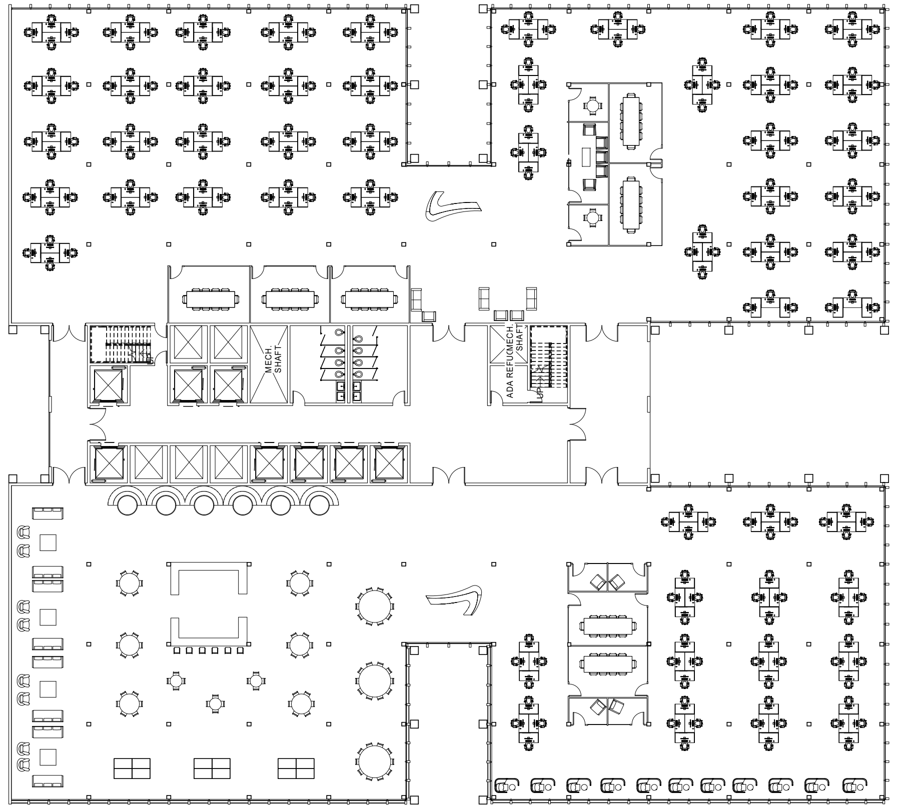


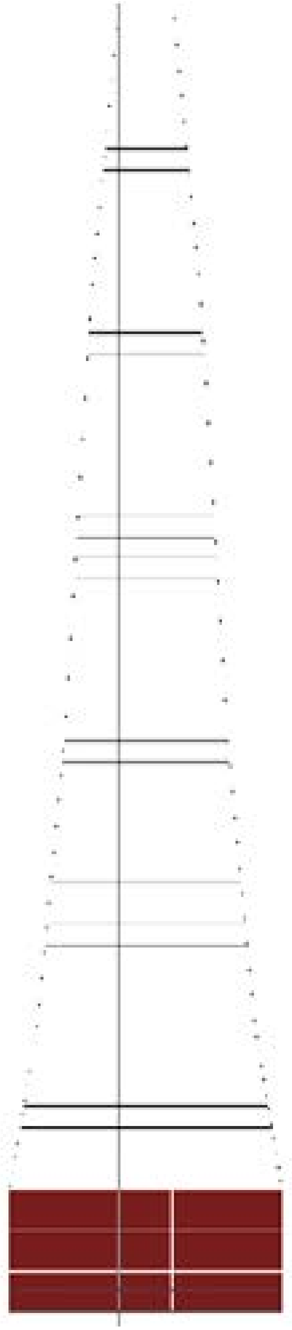
Commercial | Retail Spaces



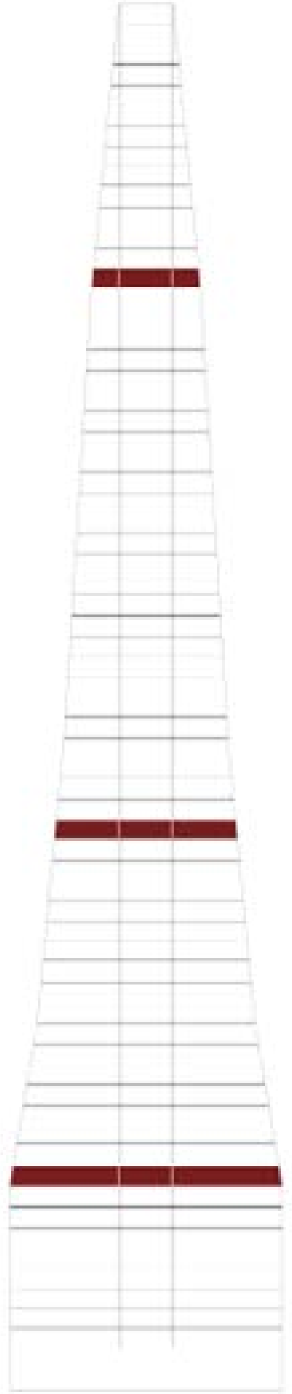


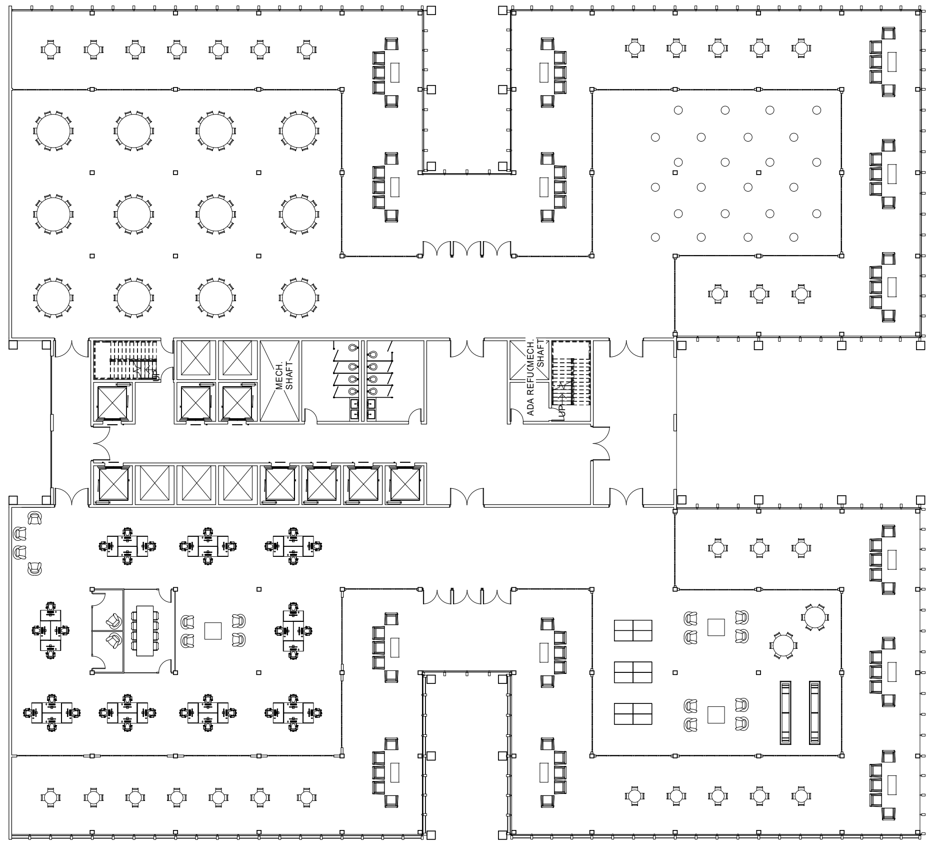
Commercial | Collaborative Work Space:



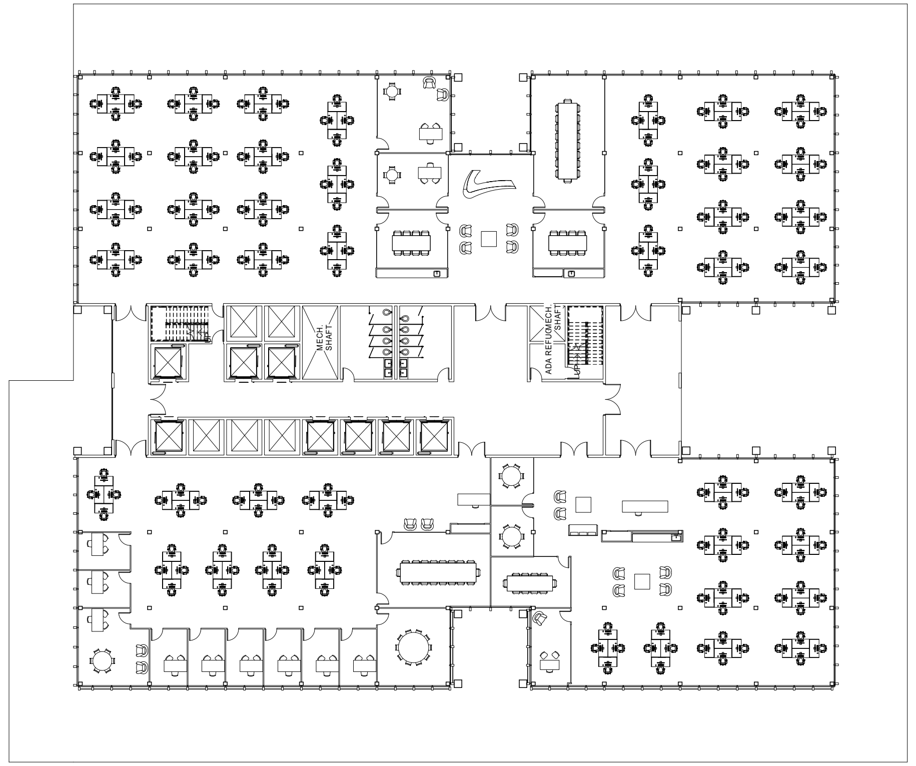


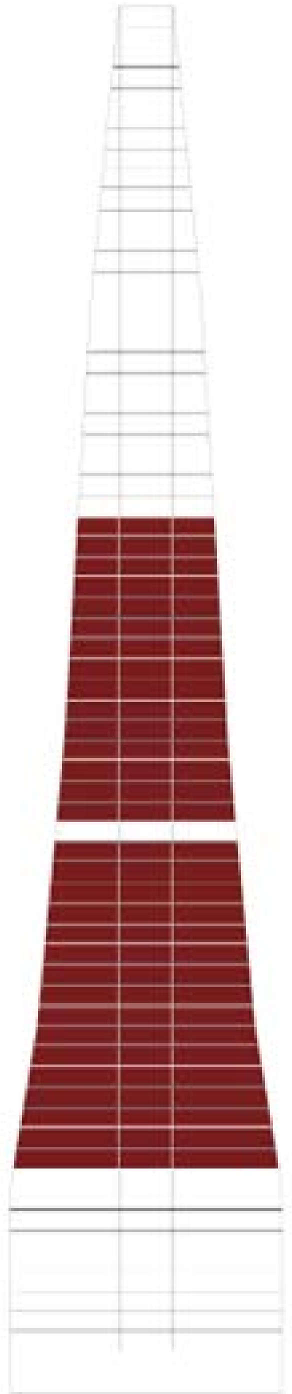
Public | Community Amenity Spaces



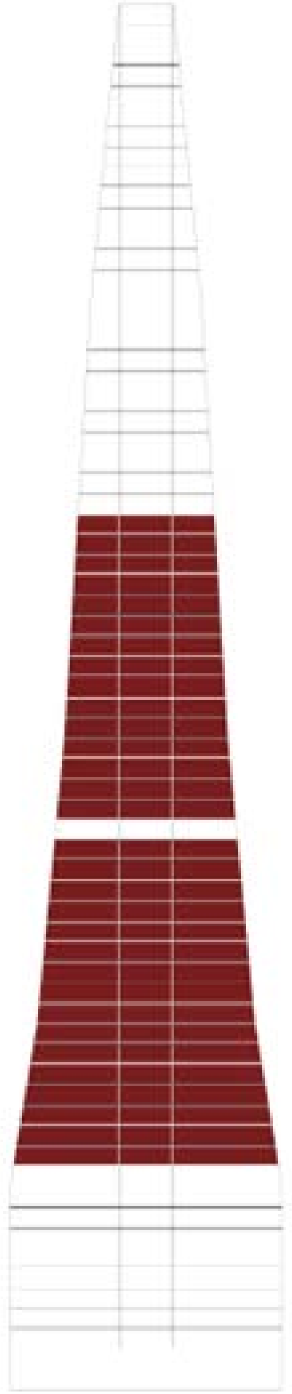


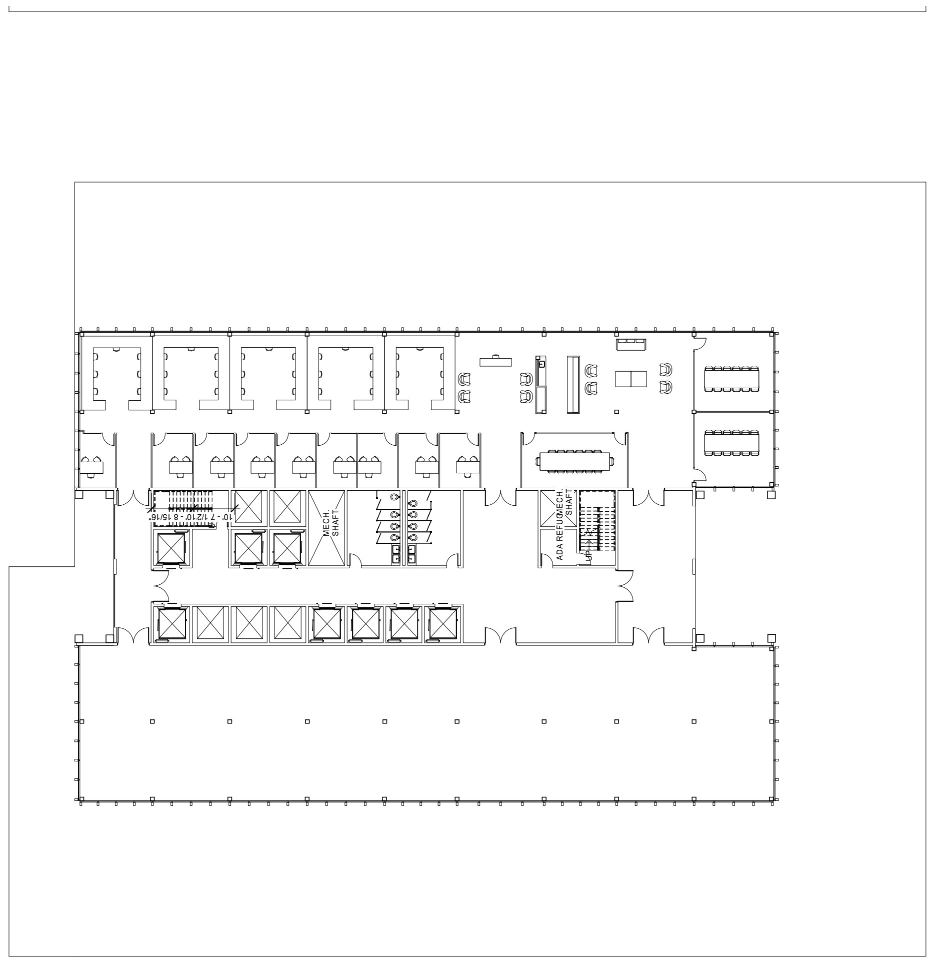
Commercial | Office Space

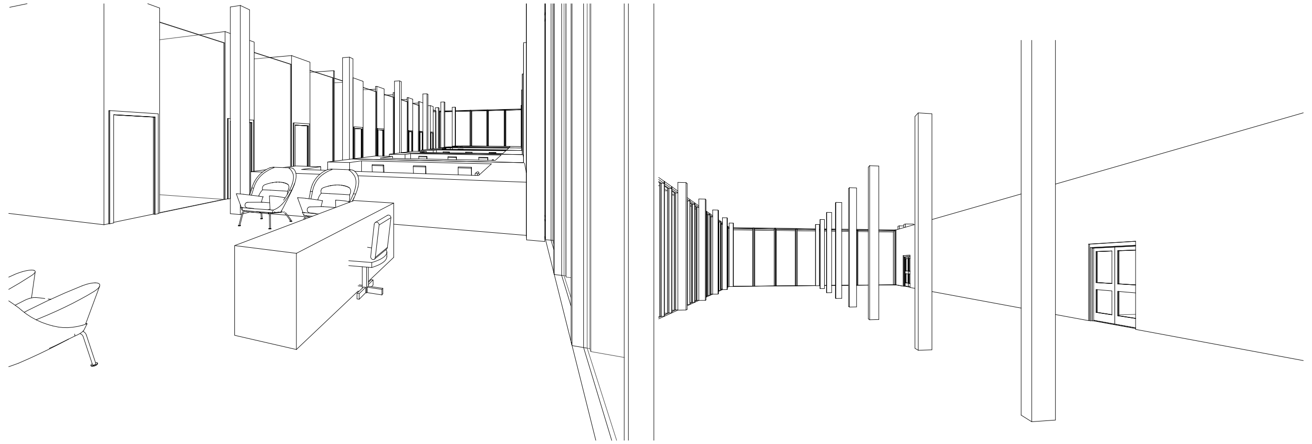




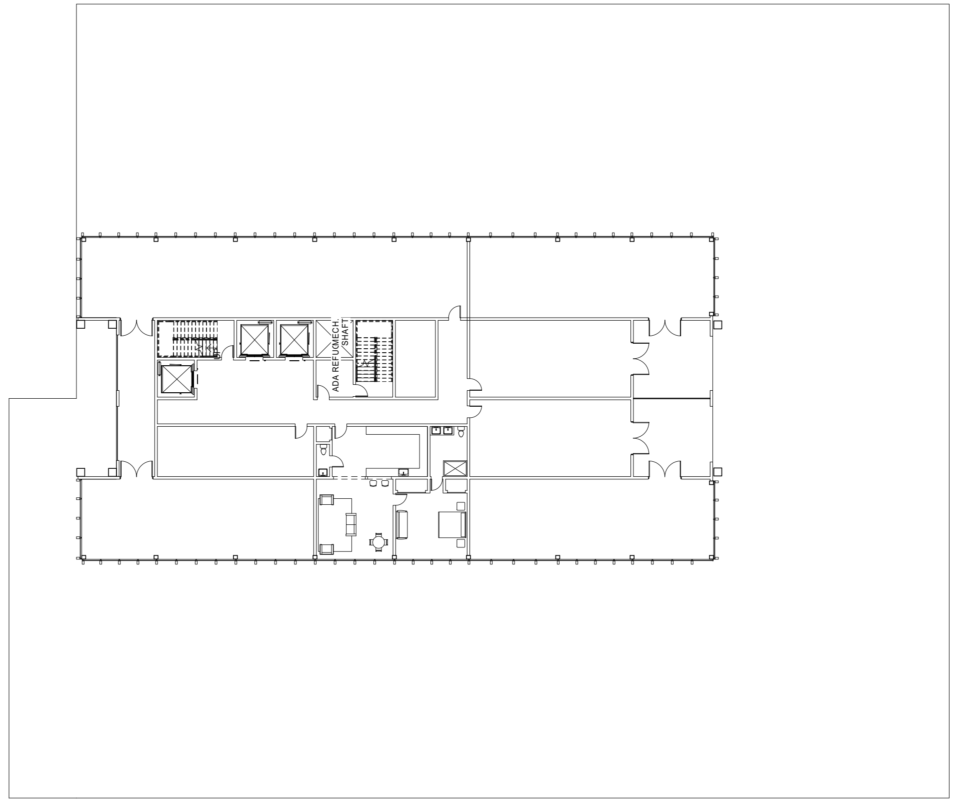
Commercial | Office Space:

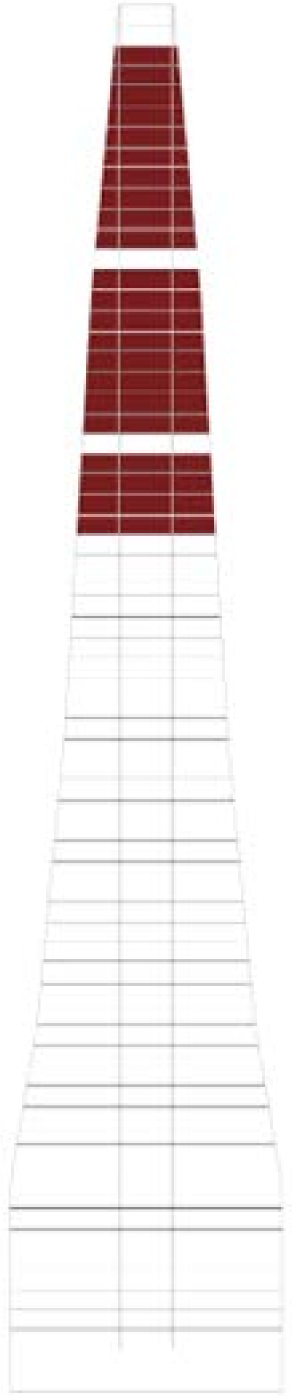






Residential | Apartments





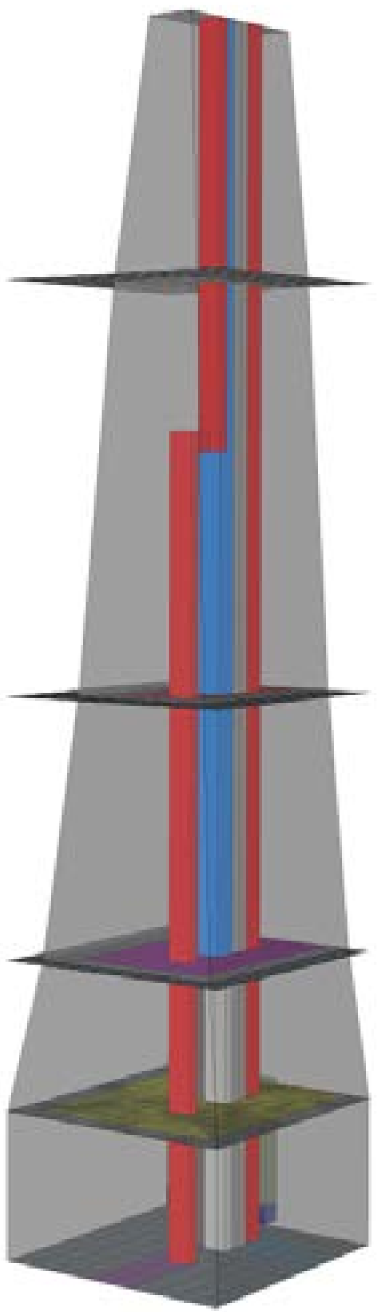
Mechanical

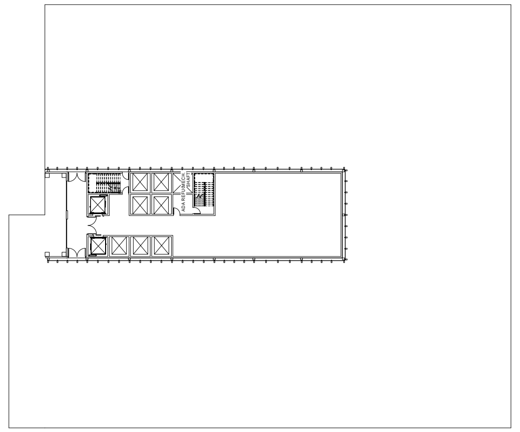
Designing the tower always related to the vertical circulation, the safest routes as well as ensuring there is ample service for all of the buildings requirements. To ensure privacy of residents – a bold move to privatize a significant portion of the ground level for the residents. Additionally, a considerable amount of time in planning for the emergency egress stairs was also thought out, ensuring that the stairs actually tapered back – deeper into the core as the building thins out at its peak.

Red: Fire Stairs

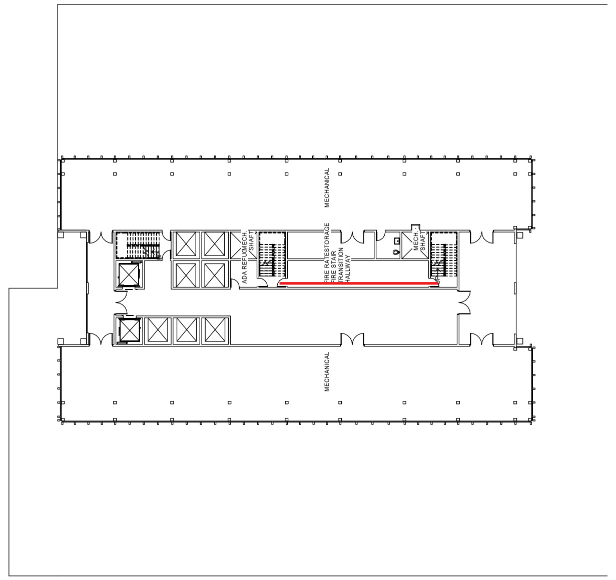
Blue: Mechanical Shafts:

White: Elevators – 10'x10' – the maximum required by code and each set has a dedicated route to ensure prime access and delivery.



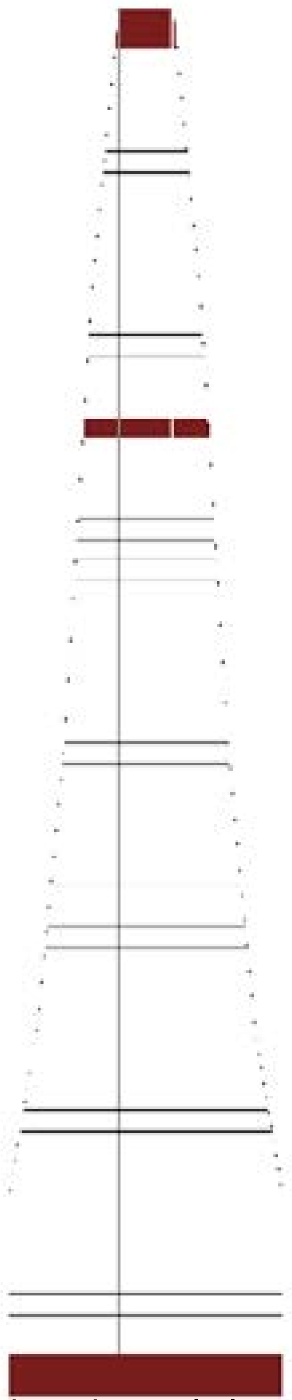


66th Floor: Utility Room

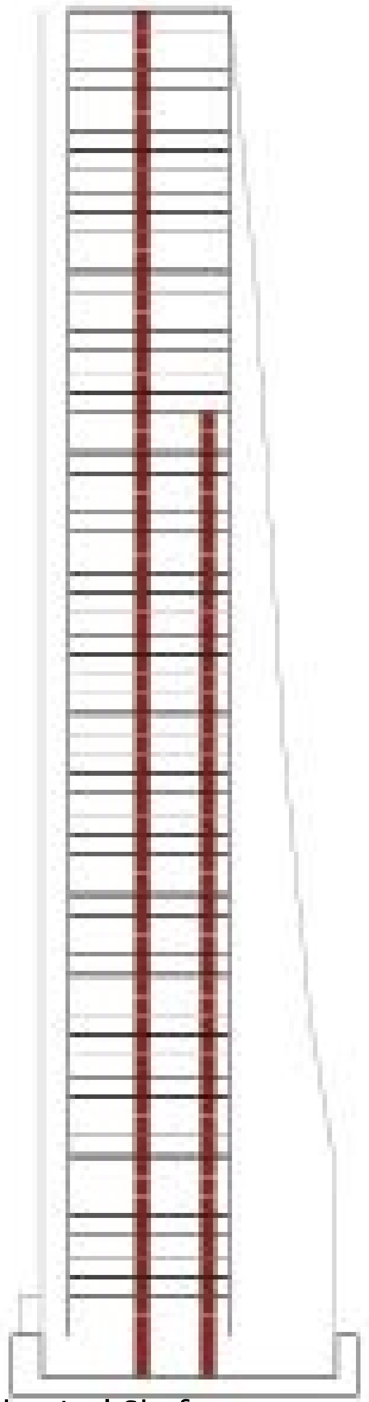


45th Floor: Utility Room & Fire Stair Switch

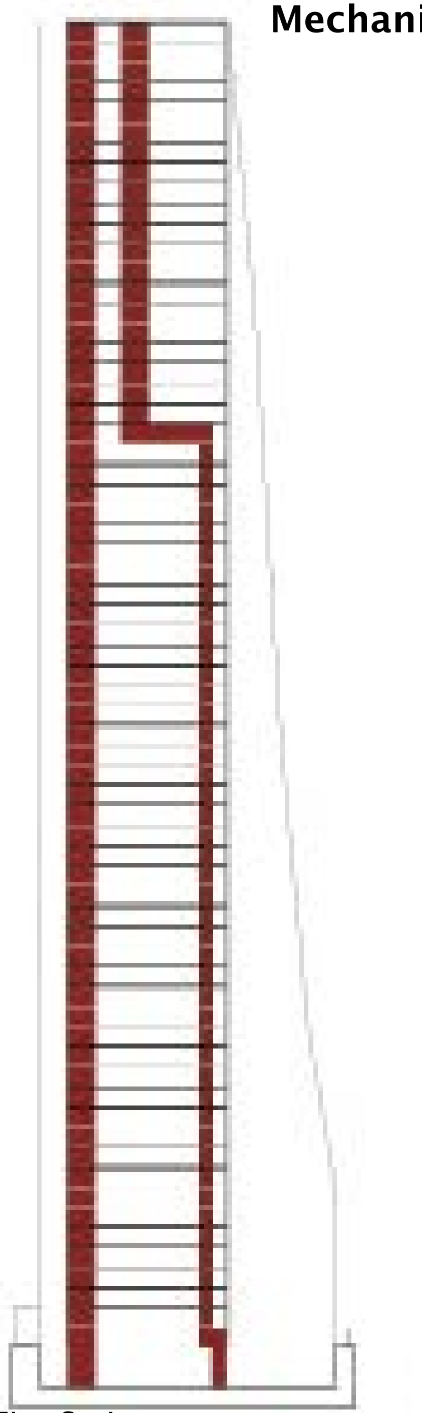
Mechanical



Designated Mechanical Floors

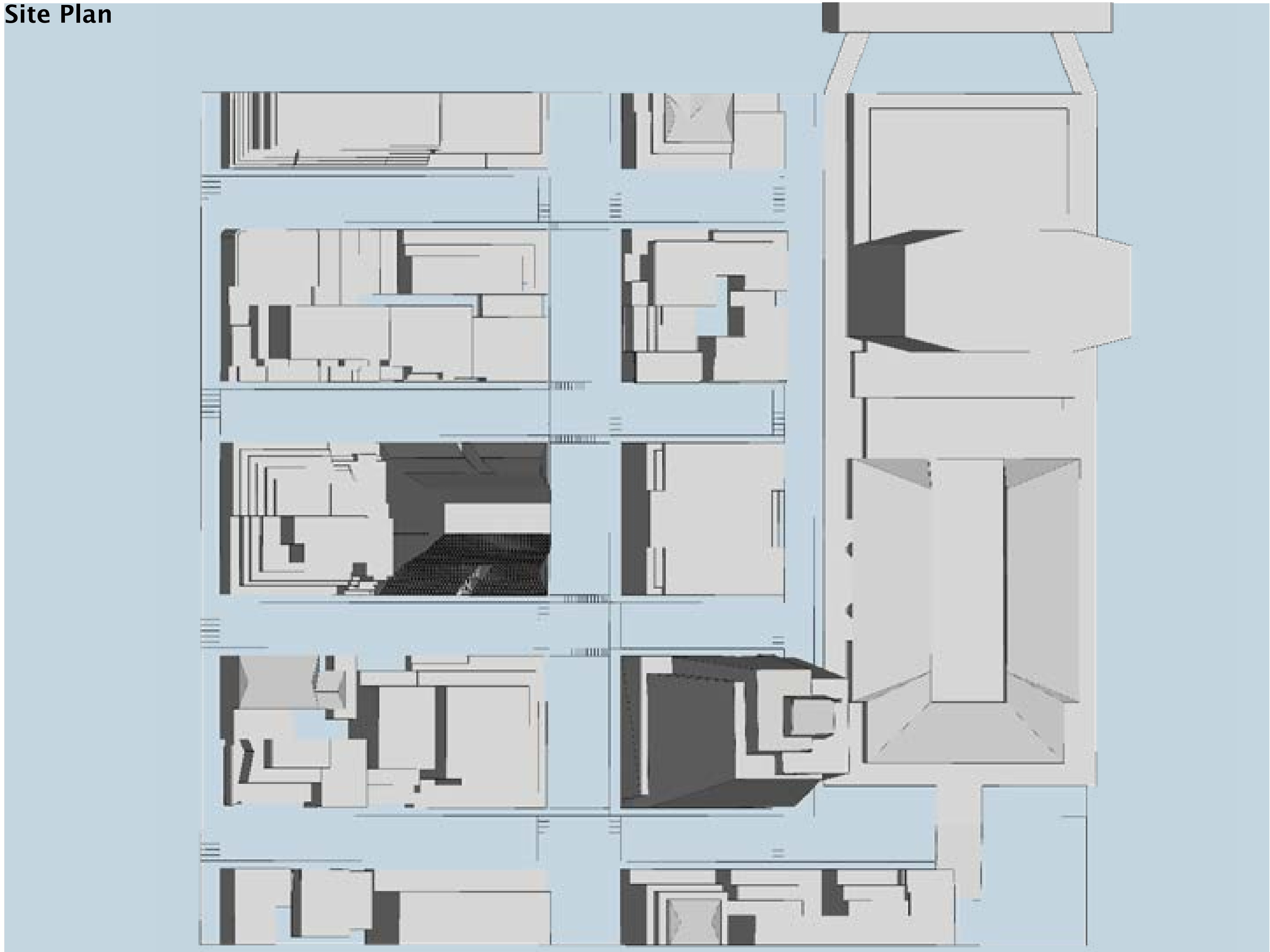


Mechanical Shafts

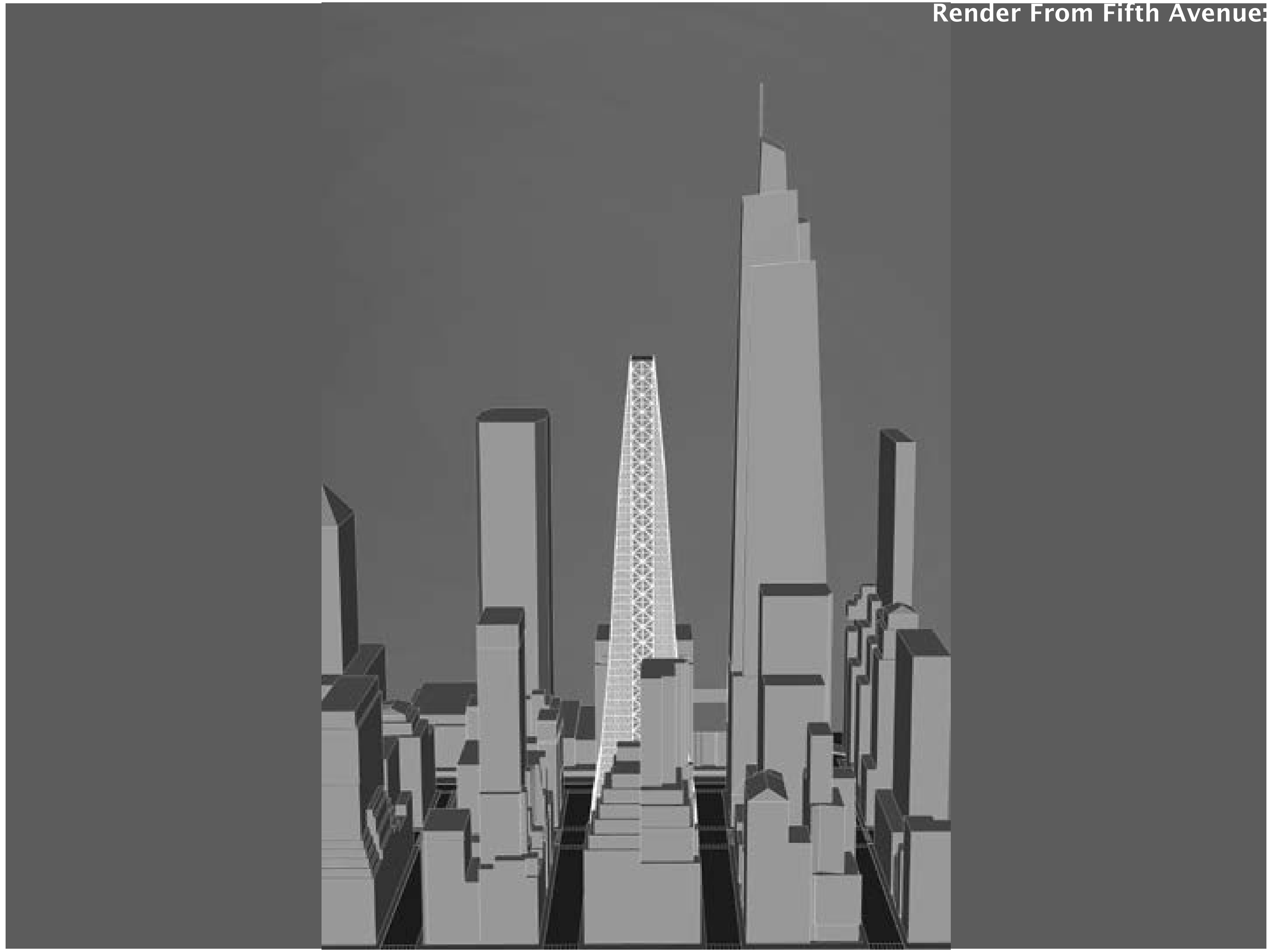


Fire Stairs

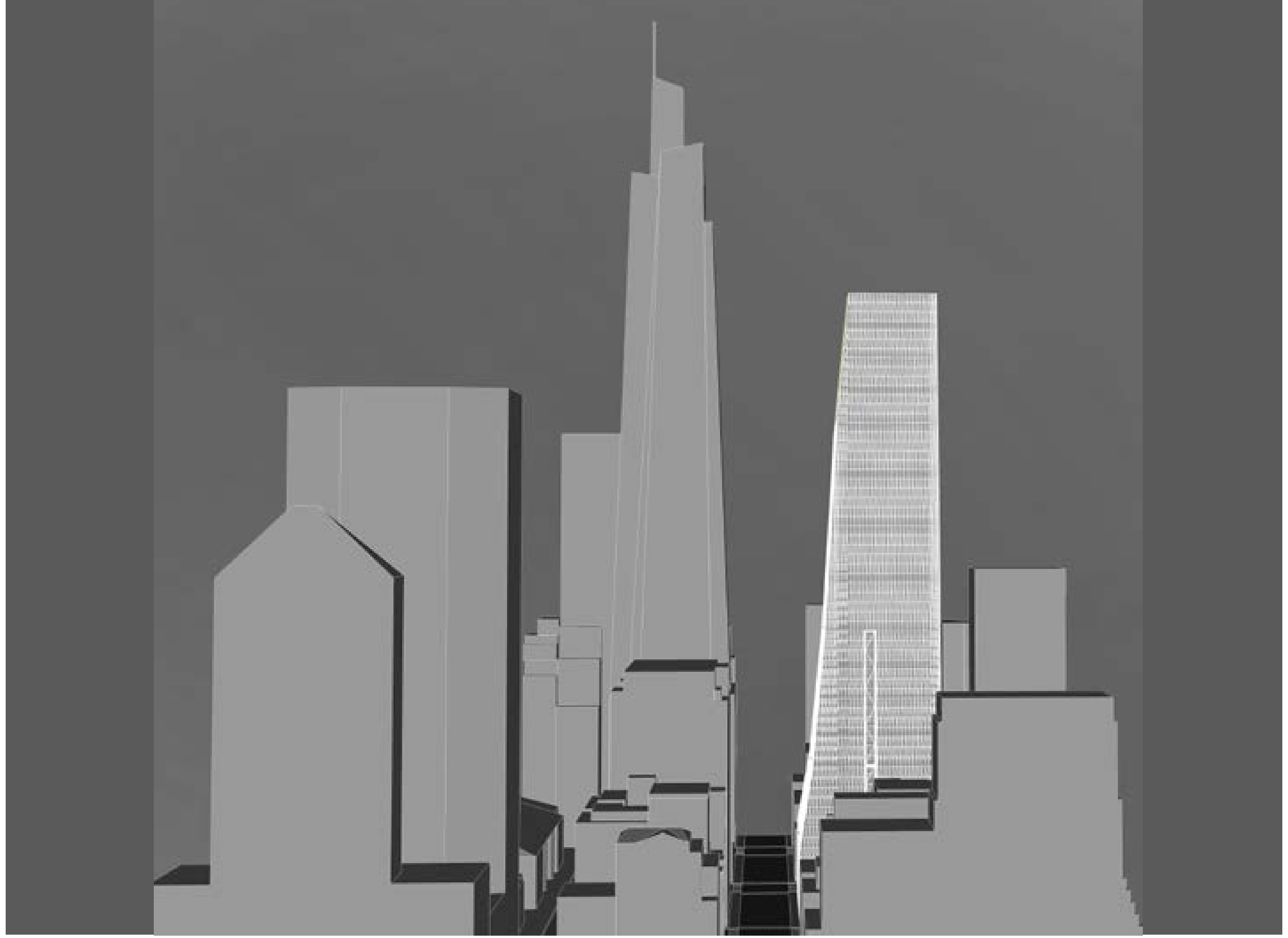
Site Plan



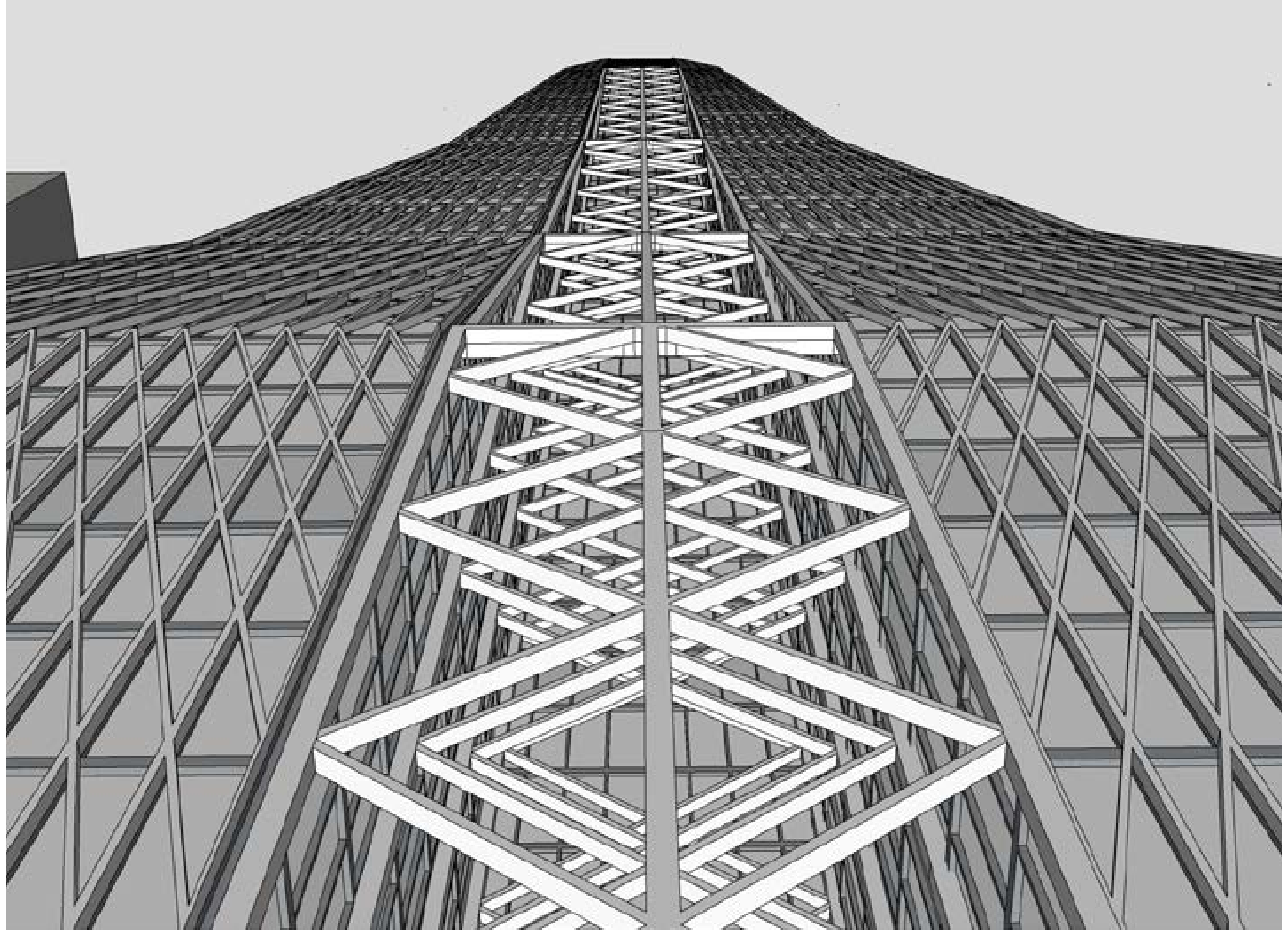
Render From Fifth Avenue:



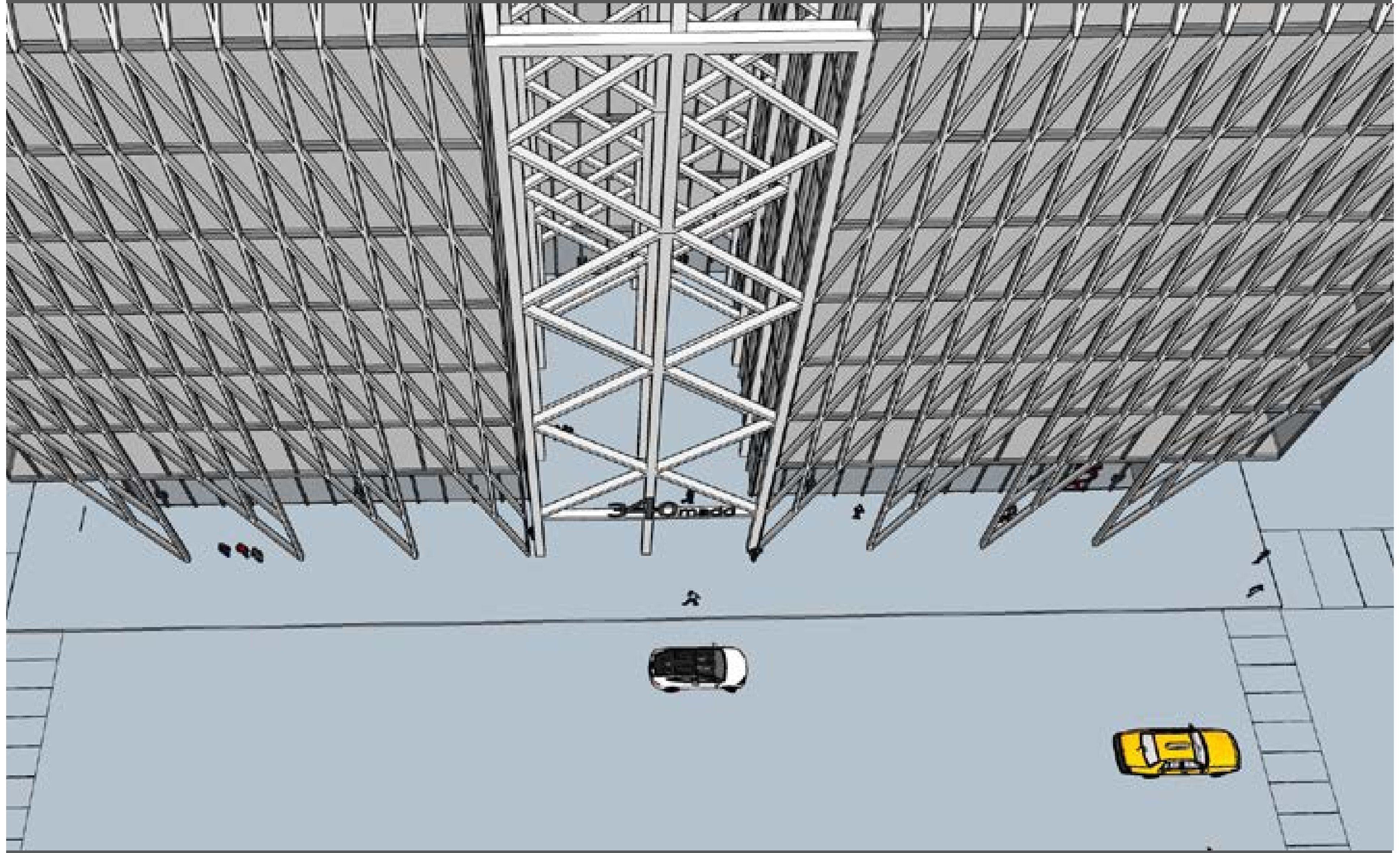
Render From 45th Street



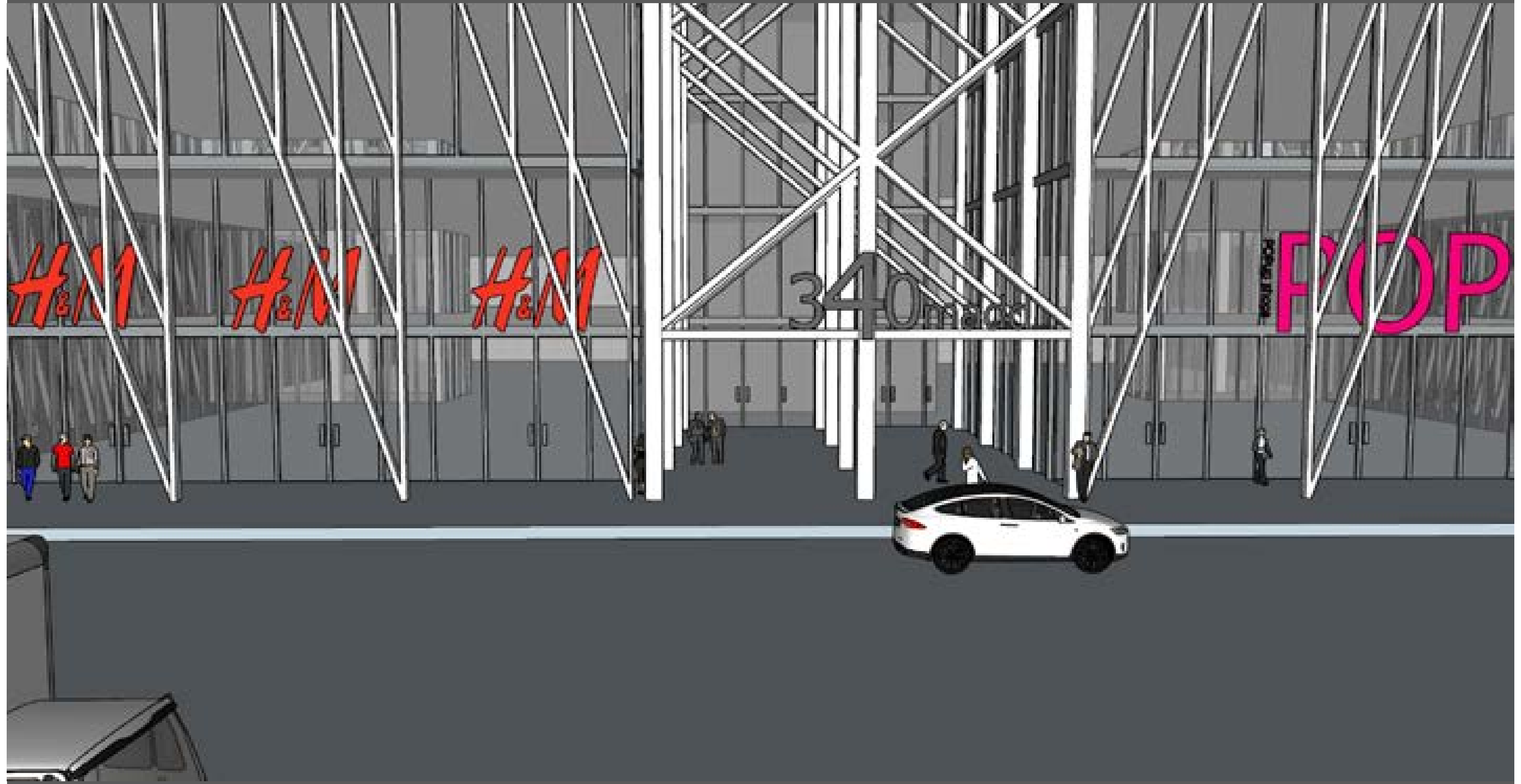
Render From Maddison Avenue Looking Up



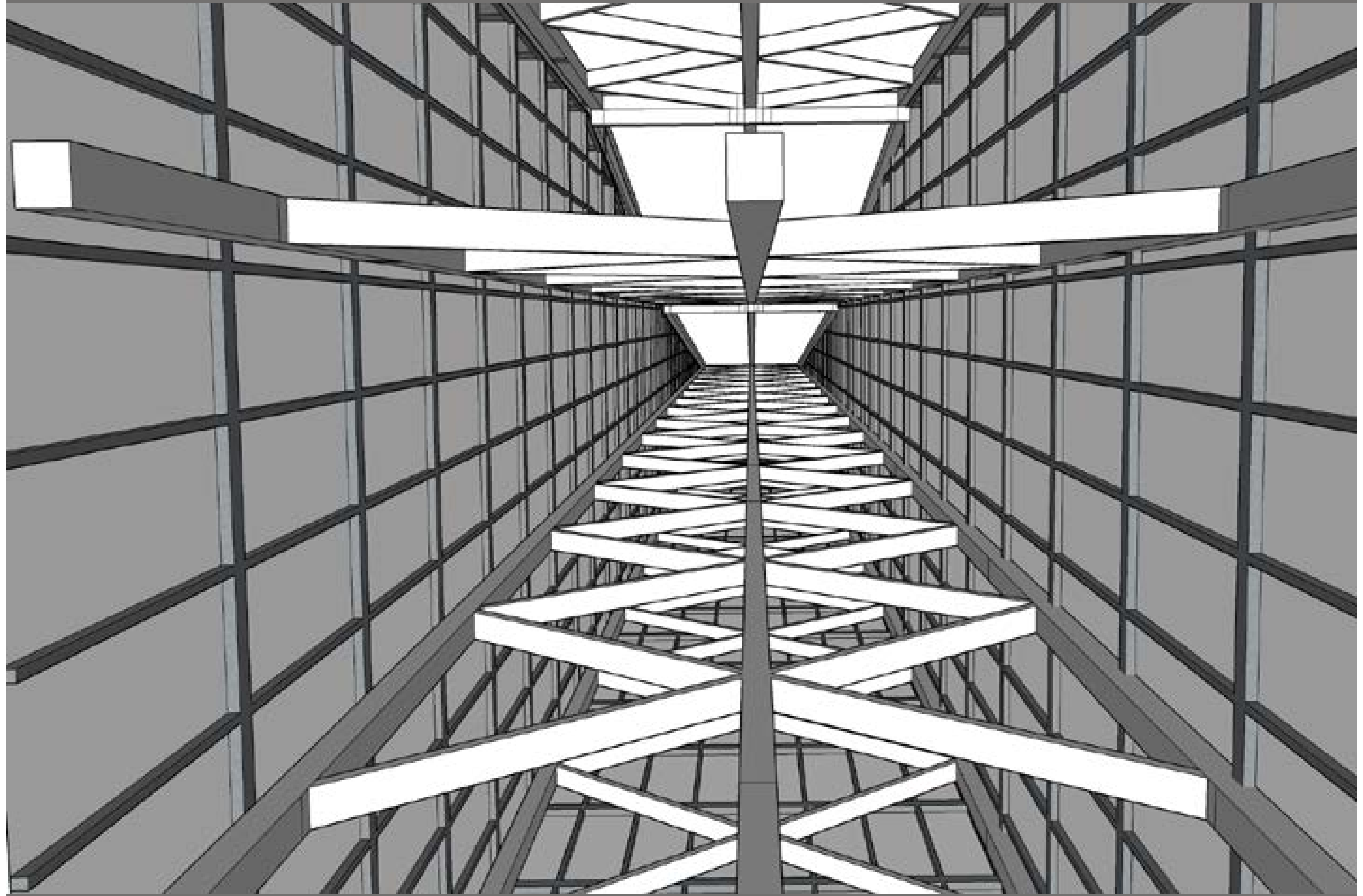
Render From Maddison Avenue Looking Down



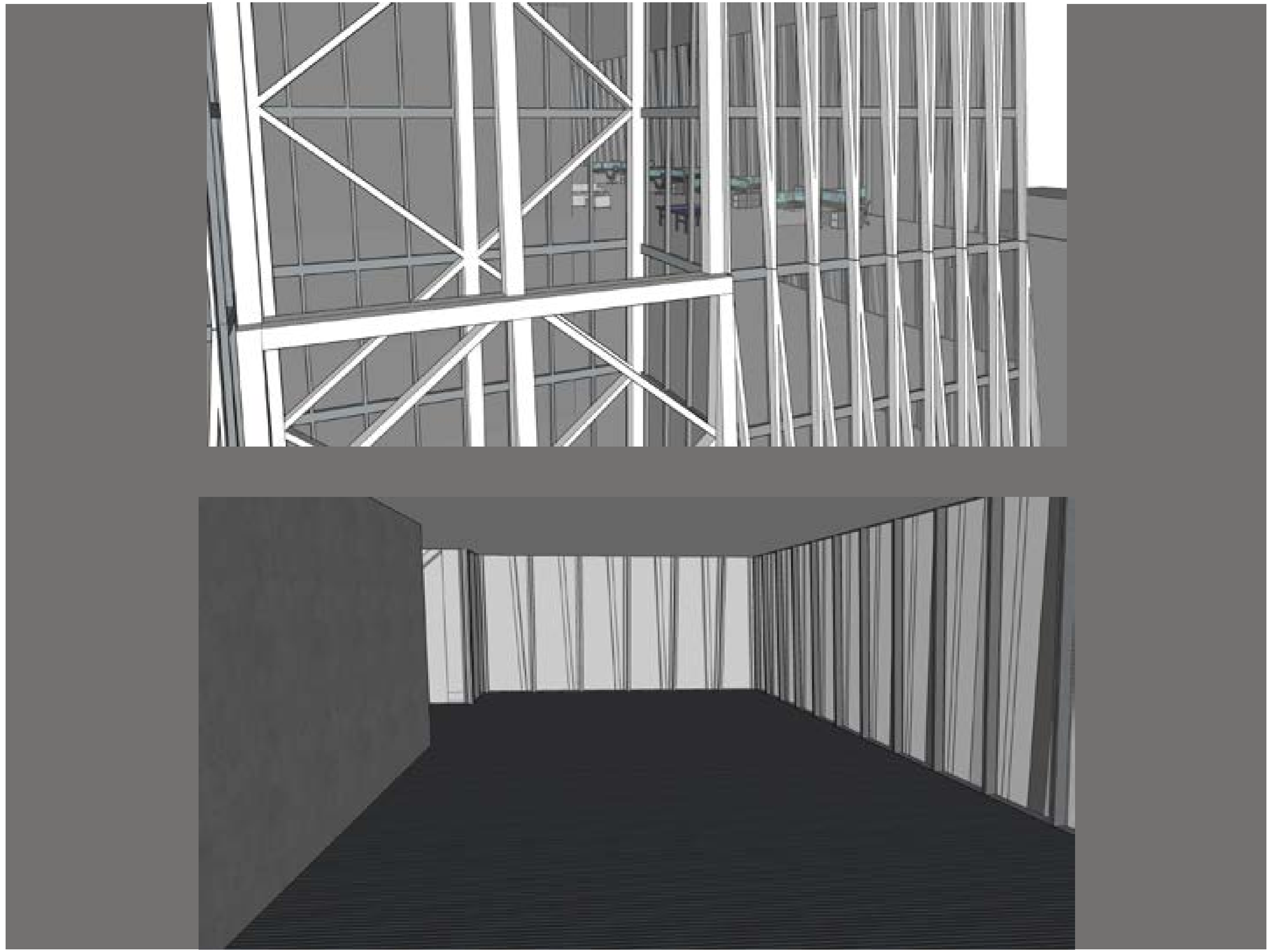
Render of Maddison Avenue Street Front Entry



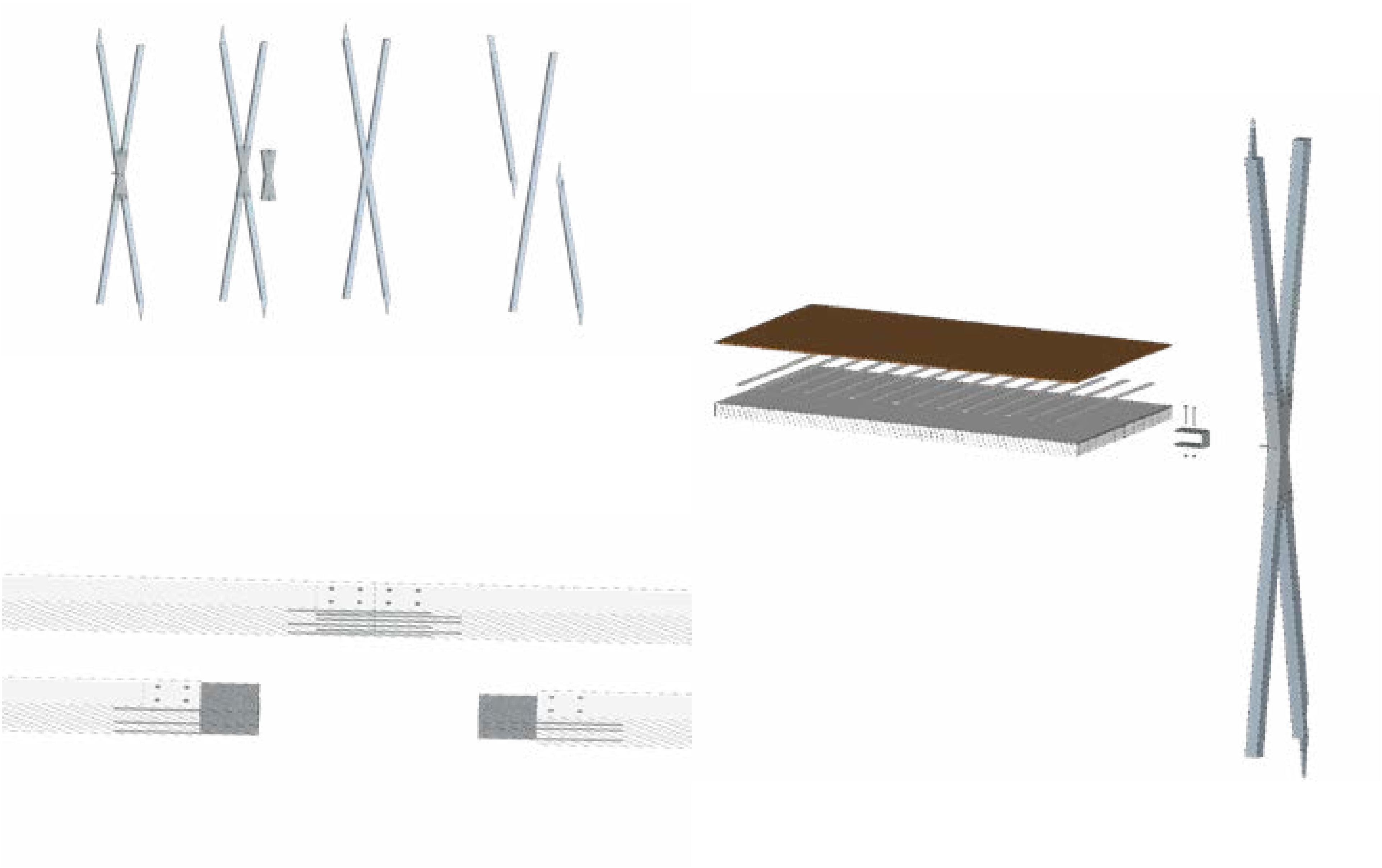
Render Looking up at Diaframe from Maddison Avenue Entry



Render of Maddison Avenue and 44th Street Streetscape



Construction Details



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