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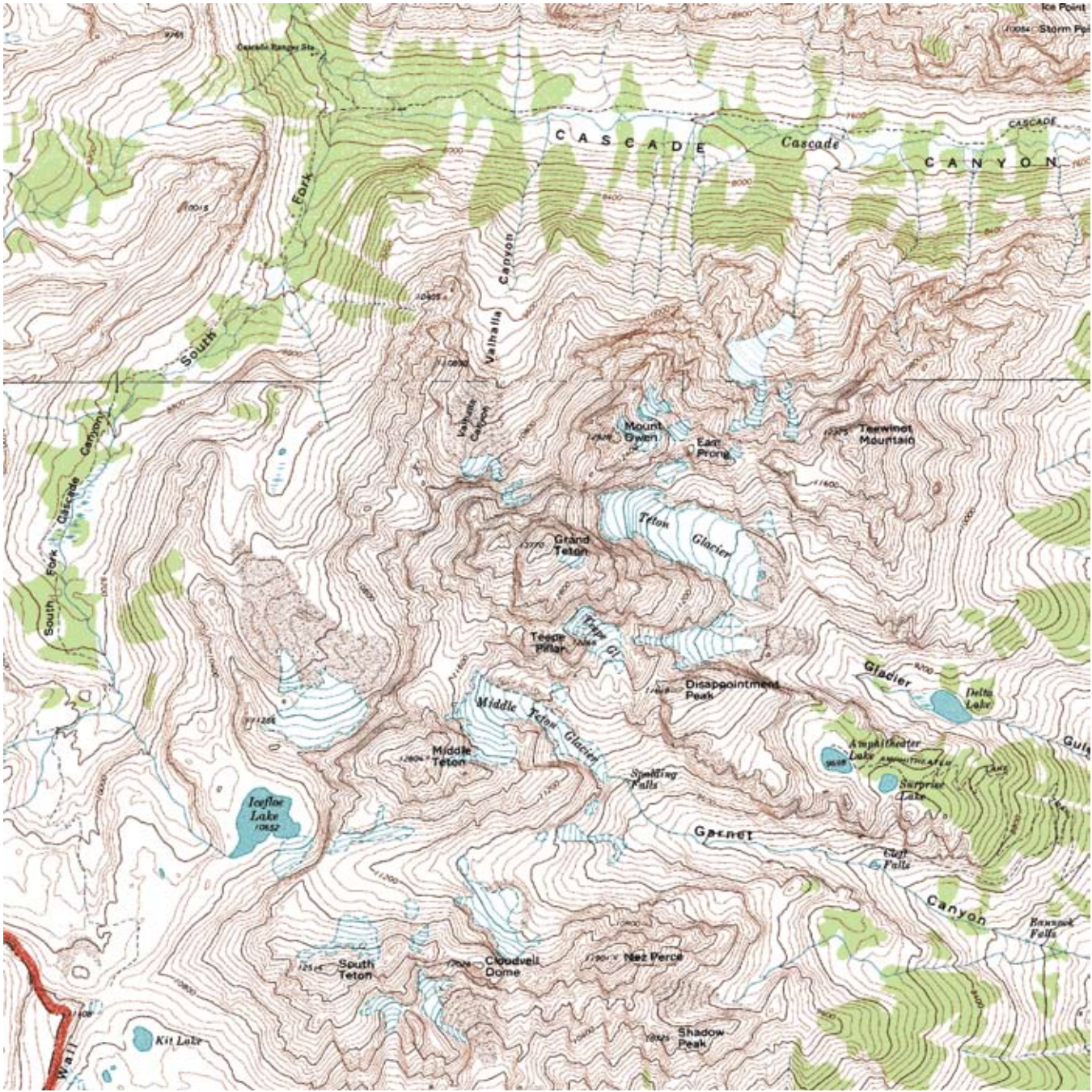
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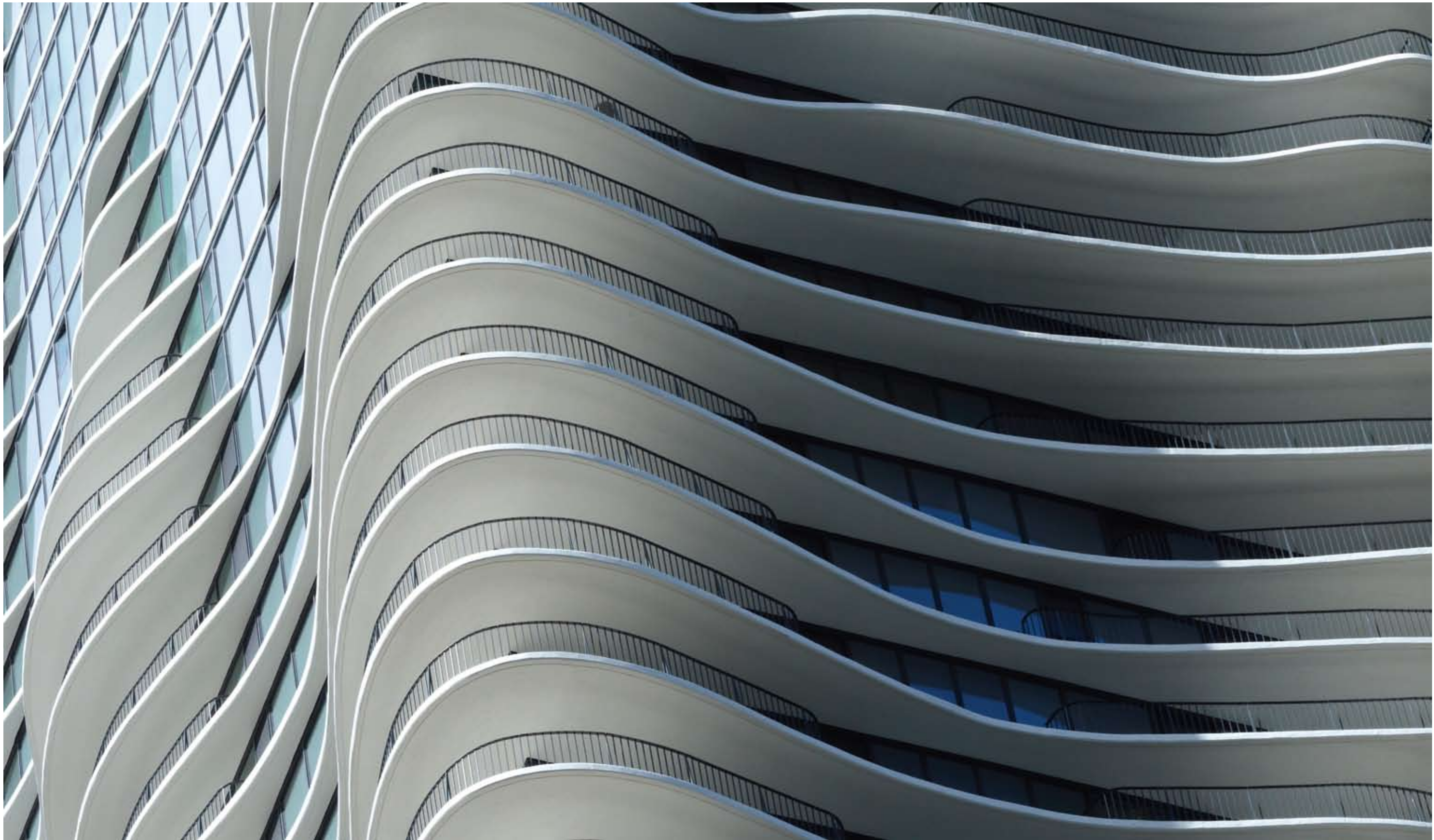
4.1 A topographic map of the Grand Teton Mountain Range delineates heights in small increments; each line represents an 80-foot vertical difference. In plan, one specific line creates an unbroken loop around the mountain. The loop-line changes as it follows a path, jaggedly tracing the ins and outs of a mountain's creases and smoothing out across its broad surfaces. Evenly and distantly spaced loops represent contours with smooth and shallow transitions between them, while tightly packed, irregular contours are steep slopes with deeply incised surfaces. A mountain's three-dimensional physical features are visible through this two-dimensional representation.

PROJECT

AQUA

Aqua is a mixed-use residential tower located at Lakeshore East, a development situated near Lake Michigan in downtown Chicago. Divided into a hotel, apartments, and condominiums, the tower rises 260 meters in height. Its two-story plinth includes retail, a hotel ballroom, commercial spaces, lobbies, and parking topped by a large roof garden. At street level the project connects pedestrians to a six-acre park with two large public stairs. Design for Aqua began in 2004.

OWNER/DEVELOPER: Magellan Development Group, NNP Residential LLC.
LOCATION: 225 N. Columbus Drive, Chicago, USA
SIZE: 1.9 million SF including parking
COMPLETION DATE: 2010





4.3 The Grand Tetons, seen from across a frozen lake, are a silhouette of peaks measured against the horizon. While the mountain range out-scales the height of a city skyline by orders of magnitude, both elicit a sense of wonder.

4.4 Tall buildings clustered in cities create the visual sensation of landscape. Together, buildings stand-in for landscape, especially when there is a noticeable lack of one nearby. From afar, both cities and mountains beckon as destinations of promise and opportunity.

(previous spread)
4.2 Aqua explores what can be achieved by constantly varying the tower's most prevalent structural element: its floor slabs. Slabs extending beyond the interior provide a strong connection between inside and outside by creating large outdoor terraces for people to occupy. Oblique vistas of the building form a virtual surface across the slab edges.

TOPOGRAPHIC TOWER

Aqua is one of the few tall buildings where people, perched on exterior terraces over the tower's full height, become a part of its facade, a part of its vertical community, and a part of the city simultaneously. It operates as a landscape—an inhabitable cliff. In its design we explored what other benefits topography had to offer the tall building typology.

Cities as Mountains

As is often observed, the skyline of a city creates the visual impression of a landscape. When clustered together, tall buildings make a city appear deceptively large—even on the scale of a mountain range. The variegated heights of buildings merge when viewed from a distance, despite the fact that their high and low points are not physically connected. After all, the city is an assembly of individual inhabitable vessels while a mountain range is a flowing, continuous mass of solid, impenetrable rock. But these visual associations do indicate that the city might play the role of surrogate for those who have left beloved mountainous locales for gritty urban ones. For others, the city's buildings stand-in for an imagined landscape, especially when there is a lack of three dimensions nearby. Cities in deserts (Vegas, Dubai), cities surrounded by water (Shanghai, Manhattan), and cities on plains (Chicago, Toronto) compensate for the environment's lack of variation with their own architectural diversity.

There is also a similarity in the way that cities and mountain ranges beckon, drawing people toward the prospect and potential they hold. Rising from a relentless horizontal, seemingly out of nowhere, the first sight of a city produces a thrilling sensation in much the same way as the first sight of a mountain range can. Both cities and mountains hold opportunity for incredible success or miserable failure. They represent destiny, as if the highs and lows of their peaks and valleys were a physical manifestation of life's fluctuations.

In addition to these shared visual and conceptual traits, both mountains and cities have in recent times become the sites of extreme physical adventure, with cities presenting challenges for high-risk recreation as fierce as those of the great outdoors (fig. 4.8). Parkour athletes test themselves by leaping between buildings and trains; urban adventurers scale cranes and unfinished towers, and crawl through tunnels. For many, the built environment has become so immense and mysterious that exploring it offers a physical, spiritual, and psychological reward equal to traversing the remote, craggy rock formations of natural terrains.

There is a known phenomenon among the urban adventure culture that the unsought-for places are usually the best. Popping open a random manhole for no real reason can lead one to an unexpected—and usually spectacular—find. So it was on this night. We had bailed on two prior endeavors and were heading back to the car when we passed over a hatch which was sort of in the middle of nowhere. As it rattled under our feet, Snail decided to go back and open it up. He went down and we closed the hatch above him and kept watch. A few seconds later he came back up and told us to come on down: it was a massive steam tunnel.

(Anonymous post, Nopromiseofsafety.com, April 21, 2010)

Topography in architecture can potentially heighten experience and excitement for all city dwellers, including those less intrepid than the urban adventure set. For the inhabitants of towers, it is the altitudinal view of the city that provides the thrill. Unencumbered views (also a feature of landscape) are the desire, but this wish can be at odds with the increasingly constructed urban center, where towers without neighbors are somewhat rare or short-lived. More typically, new towers must negotiate views between many existing buildings.

This held true for Aqua. Its site was located amid a cluster of existing buildings within the large, mixed-use development of Lakeshore East. Considering that views are a primary criterion for a residential high-rise, we took them as

4.5 A 1:20 physical model demonstrates that interesting views are possible. Taut strings representing sightlines correlate with views between the cracks of neighboring buildings and through the caverns of adjacent streets. Sightline strings are lines of desire connecting living spaces in the “hills” on the facade to specific landmarks.

4.6 Named and rated navigable routes are desire-lines found on typical ski maps. Perspectival illustration of the slope is chosen over plan projection on ski maps in order to allow the detail of the paths to be shown simultaneously with the magnitude of the entire mountain range.

our starting point. It was clear that Aqua’s height would allow for ample views at the upper floors, but with its site wedged between hotels, office towers, and other residential high-rises, capturing views for the mid and lower levels would prove more difficult. This difficulty would only increase once the master plan was completed, as made evident by a physical model at 1:20 that accounted for existing and planned buildings.

Nevertheless, sightlines extending from a digital city model demonstrated that interesting and particular views from Aqua were possible between the cracks of adjacent buildings and down the street corridors to specific landmarks. Taut strings connected to the physical model were used to focus the general sightlines toward landmarks, while detailed digital models lent greater geometric precision to the experiment.

It was soon discovered that three-dimensional sculpting on all four sides of the tower yielded better view connections—giving Aqua, with its topographic surface turned upright, hill-like curves that offer unexpected sights around corners and through gaps, just as they do on land. The individual hills in early modeling were positioned strategically on the form to exploit this phenomenon. Rather than opting for generalized panoramas, it was instead preferred to create a specific response to the city, providing a set of determined links between the building and its site.

Translation

As with topographic maps that translate physical conditions into two-dimensional abstractions, the initial study models of the building were converted into two-dimensional, map-like drawings. Hills became articulated as contour lines: unbroken loops describing areas of similar projection. Abstracting dimensional information from the models into drawings gave an understanding of the continuity of the surface, where small, one-foot increments of change could be communicated. Mapping also revealed the connections between the building’s hills and valleys, and the steepness of these transitions (fig. 4.7). Four unique elevational maps emerged. Each drawing represents a different orientation: north, south, east, and west.

The next translation was made from the topographic elevation drawing to a new, three-dimensional model. This time, contours yielded a different result: instead of lines, they were converted to slices passing through the mass to produce a series of plates with individual outlines. These slices were interpreted as a series of slabs like strata in rock (fig. 4.10). Given the tools that connect our digital drawings to the builder’s lay-out tools, we knew that varying the slabs would be viable from a construction standpoint. Re-conceiving the tower as a form made up of many layers or strata created new rules for the design’s development.

Specificity & Difference

Modulation is achieved through extremely slight adjustments of the floor plates over the height of the tower. The slab edges are constantly changing, and no two are alike. Far from just creating a surface effect, these layers are integral to the building’s construction, as each slab is an essential part of the structure. Curved in plan, the slabs cantilever away from the face and outer column line of the building. Each cantilever is dependent on its own back-span and precise column location. With the cantilevers presenting the most difficult structural challenge (some extend up to 12 feet), certain parameters were put in place to determine their proper location and maximum size (fig. 4.14). In addition to views, solar-shading, apartment size, form and structure, accessibility, cost, and construction methods all played a role in their final design: seemingly ordinary criteria that came to life when applied to the slabs of Aqua, providing a set of variables that contributed to its overall shape.



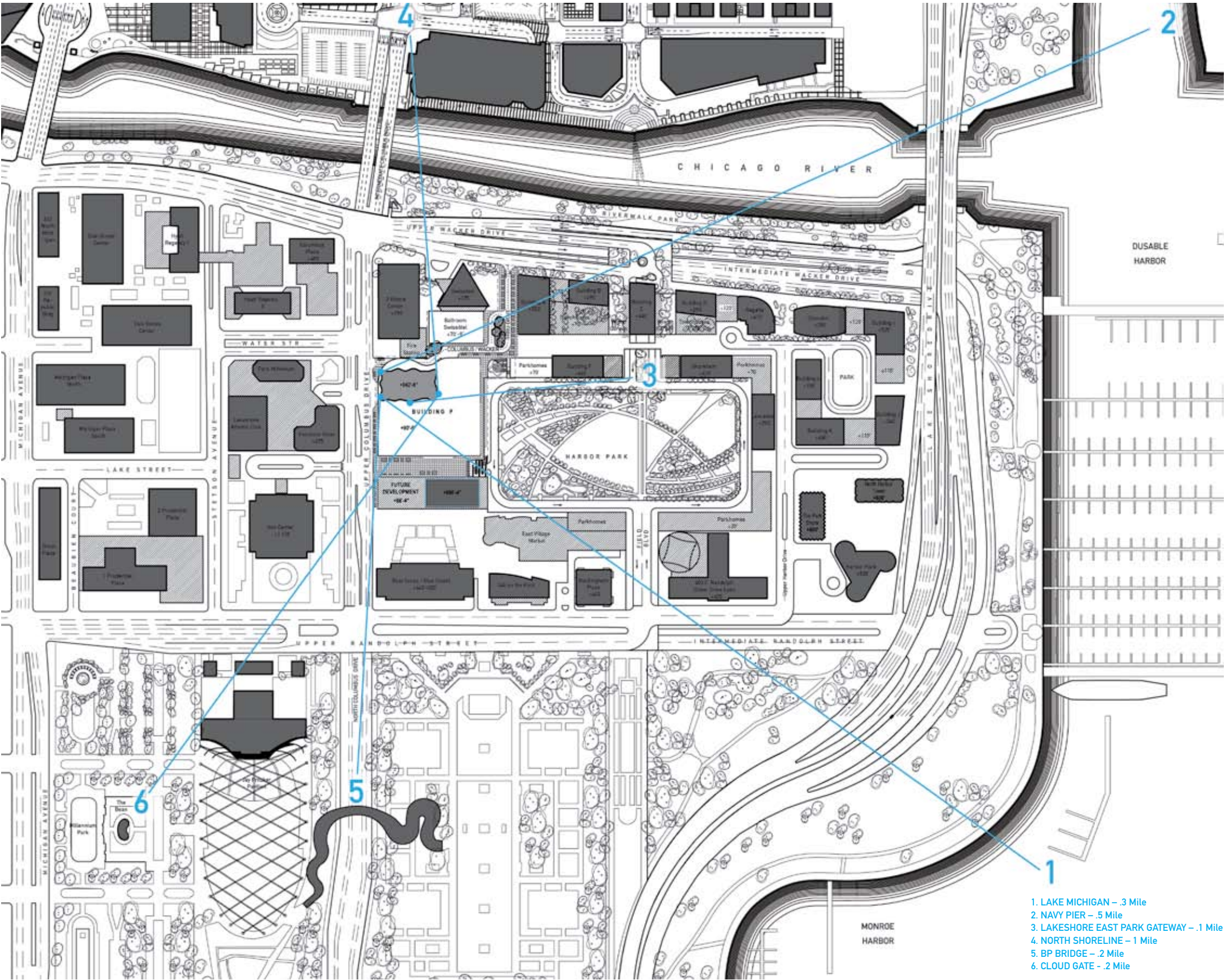
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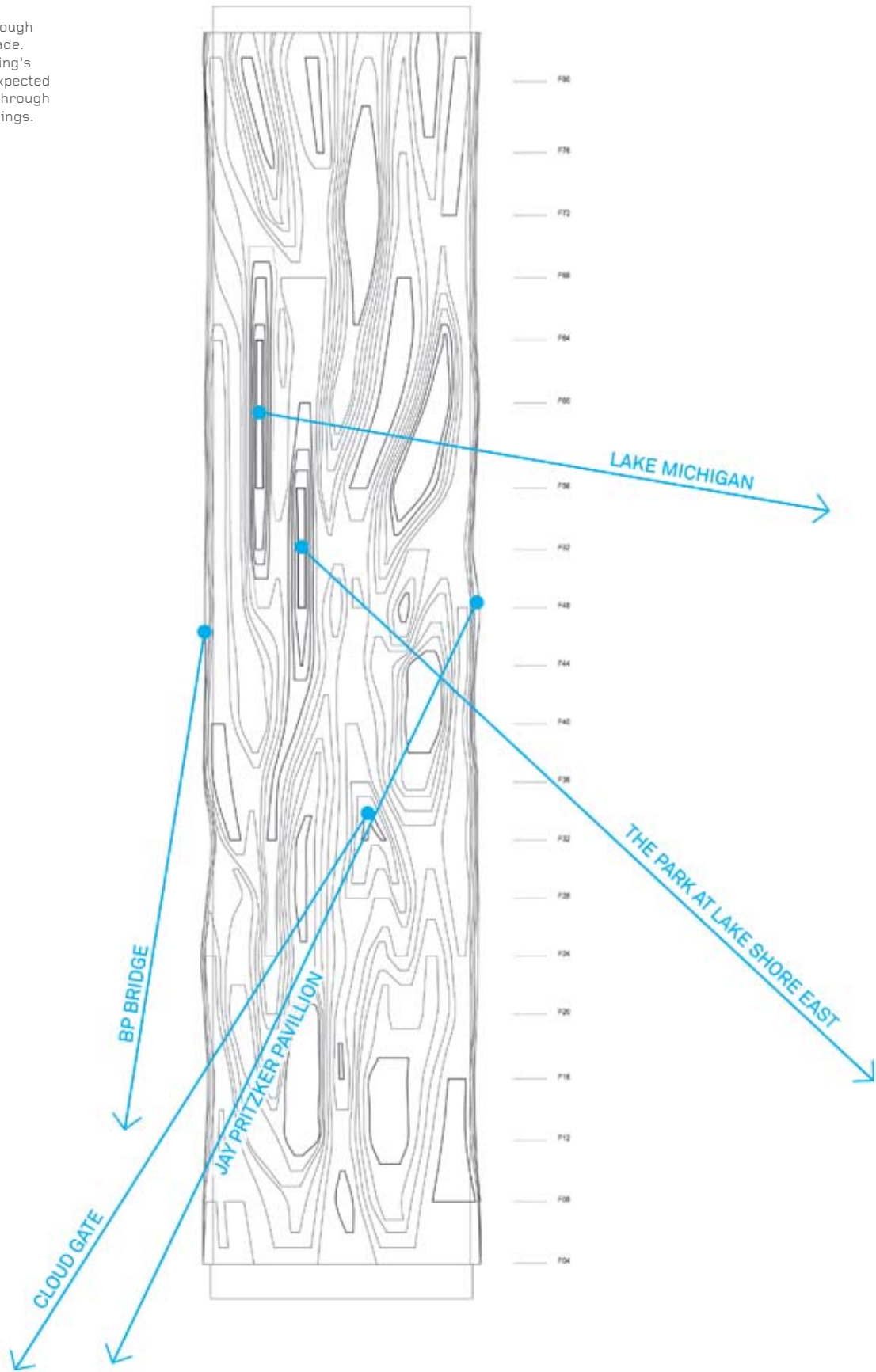
4.6

AQUA SITE PLAN

The site plan shows the existing and proposed buildings at Lakeshore East and the position of Building P (now Aqua) along Upper Columbus Drive. When all of the buildings are completed, a denser city fabric will surround the Park, and change access to views for the mid and lower levels of the tower. Strategically positioning hills, which extend out from the facade at different heights, enables views of surrounding Chicago landmarks between other buildings. A hill located on the tower's east side, for example, yields a view of the landmark sculpture Cloud Gate by Anish Kapoor, even though the sculpture is located to the southwest of the tower. Around the corner and between two neighbors, Aqua connects to Cloud Gate along view line #6 in the drawing. Rather than general panoramas, the hills create visually navigable routes that identify a specific city and cement a relationship between the building, its site, and a moment in time represented by the contemporary surroundings.



4.7 Specific connections to landmarks are achieved through sculpting the building's facade. "Hills" created on the building's vertical surfaces allow unexpected views around corners and through gaps between existing buildings.

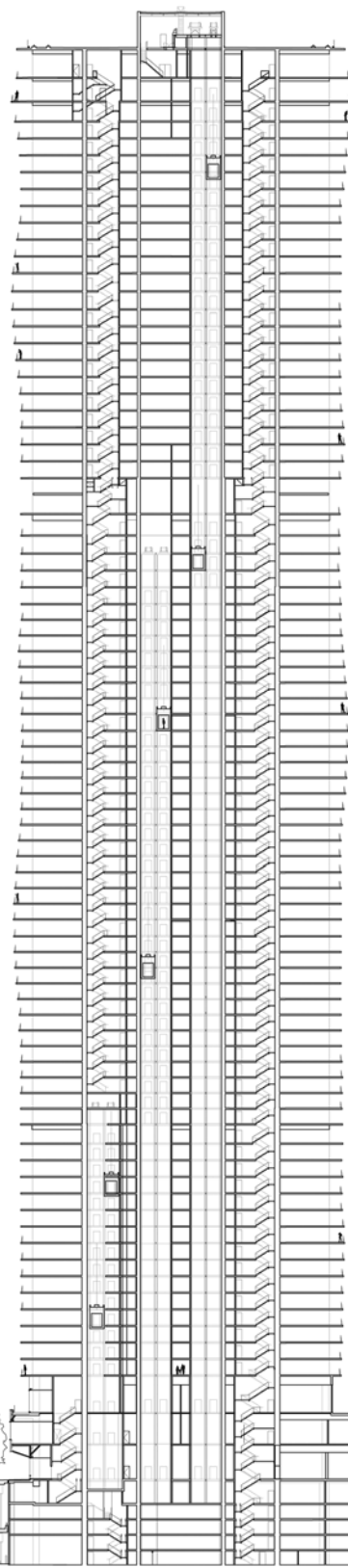


4.8 Urban adventurers exploring (clockwise from top left): a tunnel; the Greco-Roman temple atop 360 N Michigan Avenue; and Aqua's roof. Photos courtesy of Nopromiseofsafety.com

The design process exploited the opportunities presented by constantly varying the slabs. One of the greatest benefits of this approach are the large, unique outdoor terraces for people to occupy, from which oblique vistas across the building's exterior are possible. Parties, cook-outs, sunbathing, and reading on the terraces give vertical neighbors a chance to see and meet each other in a more comfortable situation than the elevator. Aqua's hilly surface gives residents outdoor access, while dually facilitating a relationship between occupants.

As extensions of the interior spaces, the slabs provide solar shading for the window wall, so that clear, low-e glass could be used for much of the building. But the variation also meant that some areas would be shaded more fully than others. Fine tuning the glazing to mitigate solar exposure was achieved through the introduction of reflective "pools": places on the facade where high-performance glass is introduced locally (fig. 4.15). Generated using sun angles, the figure of the pools is visible in the final design.

For pedestrians at street level, Aqua is a topographic tower that constantly changes as one moves around it. The form is sculptural when seen obliquely, from below, and resolves into a slender rectangle from further away. Its vertical landscape can be experienced from the public space at its base, from neighboring towers, and from its own terraces. Because it is not a two-dimensional elevation, or an immediately recognizable, cartoon-iconic shape (drill bit, Möbius strip, pagoda), it cannot be fully comprehended in an instant, thereby resisting any singular reading. The building aims to inspire exploration and asks if architecture can be more than shelter, inviting us to step out on its terraces and interact with the world around us. Its topography is formed with a great variety of peaks, valleys, and pools, resonating with landscape but redefining it by deploying it—for the first time—vertically.



1
0 100 200
EAST-WEST SECTION

4.9 The tower includes 14 levels of hotel, 40 levels of rental apartments and 27 levels of condominiums, reaching a height of 876 feet. Mixed use continues at the podium building, including residential lobbies, retail stores, restaurants, hotel ballrooms, and commercial space with a large outdoor garden on its roof. Aqua's plinth quietly navigates the site's complexity by spanning pre-existing elements, such as an electrical sub-station, and by aligning with existing infrastructure, including an adjacent three-level roadway. The plinth physically connects pedestrian areas with stairs and elevators linking street level to park level to lakefront, and beyond.

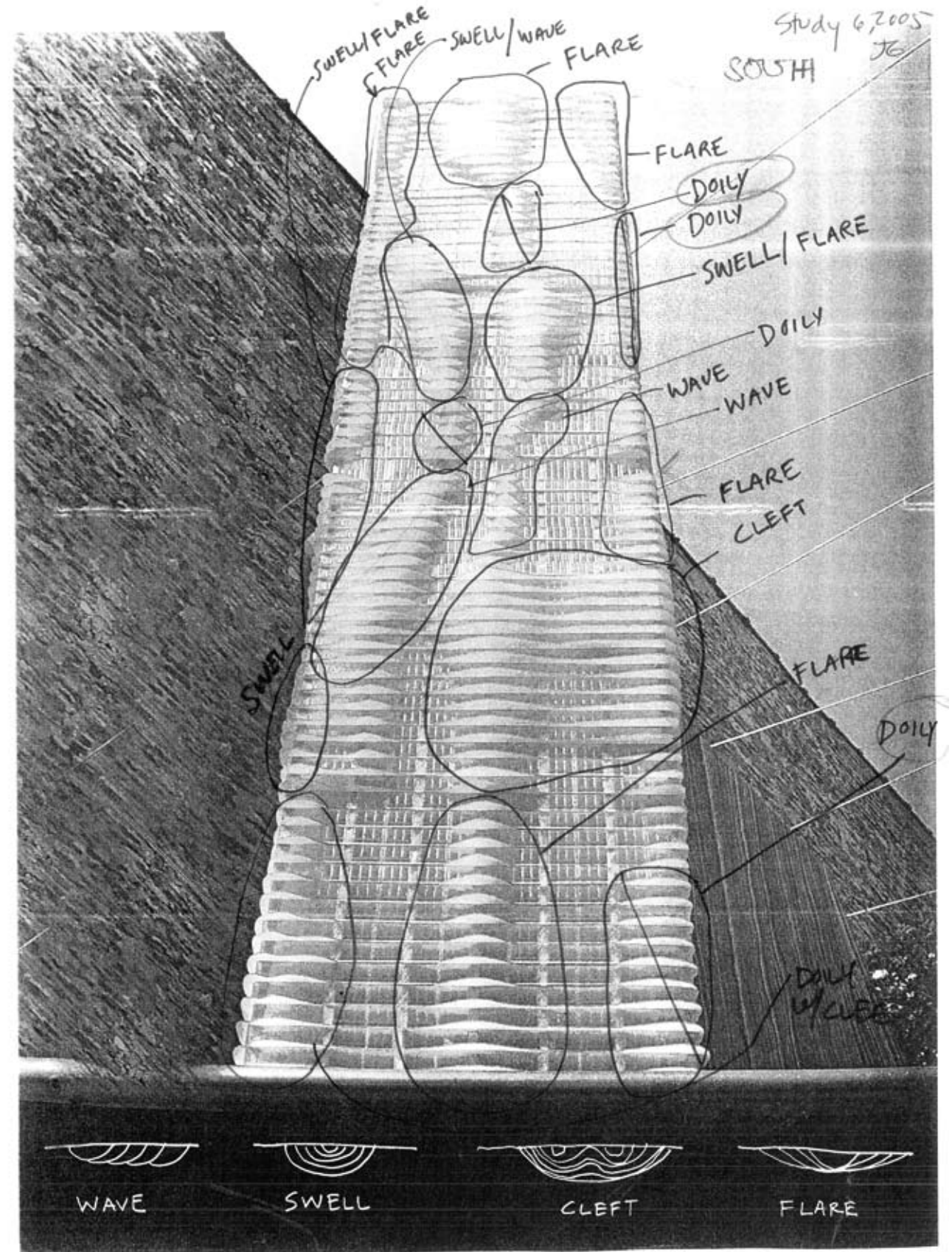
4.10 Unlike cartoon-iconic buildings, Aqua is difficult to draw. Instead of a single formal gesture, its form arises from the desire to make a facade that can be occupied. Here descriptive formal terms such as wave, swell, cleft, and flare are used to identify emerging patterns on the tower. Sketched over a photocopy of a model photograph, the terms refer to transitions in plan, section, and elevation patterns. A smoothing process of the form is accomplished with iterative digital and physical models, resulting in a sense of movement over the facade.

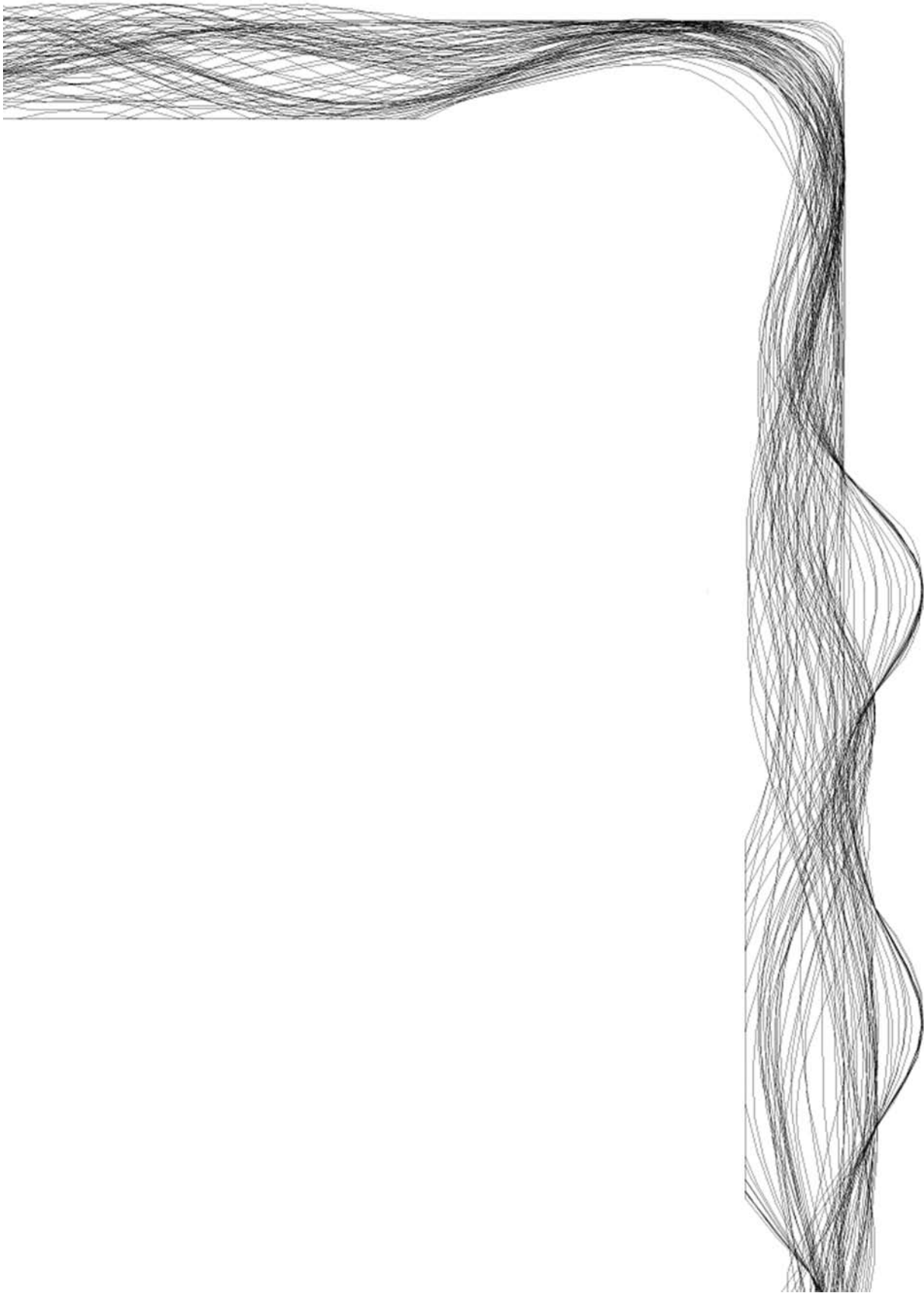
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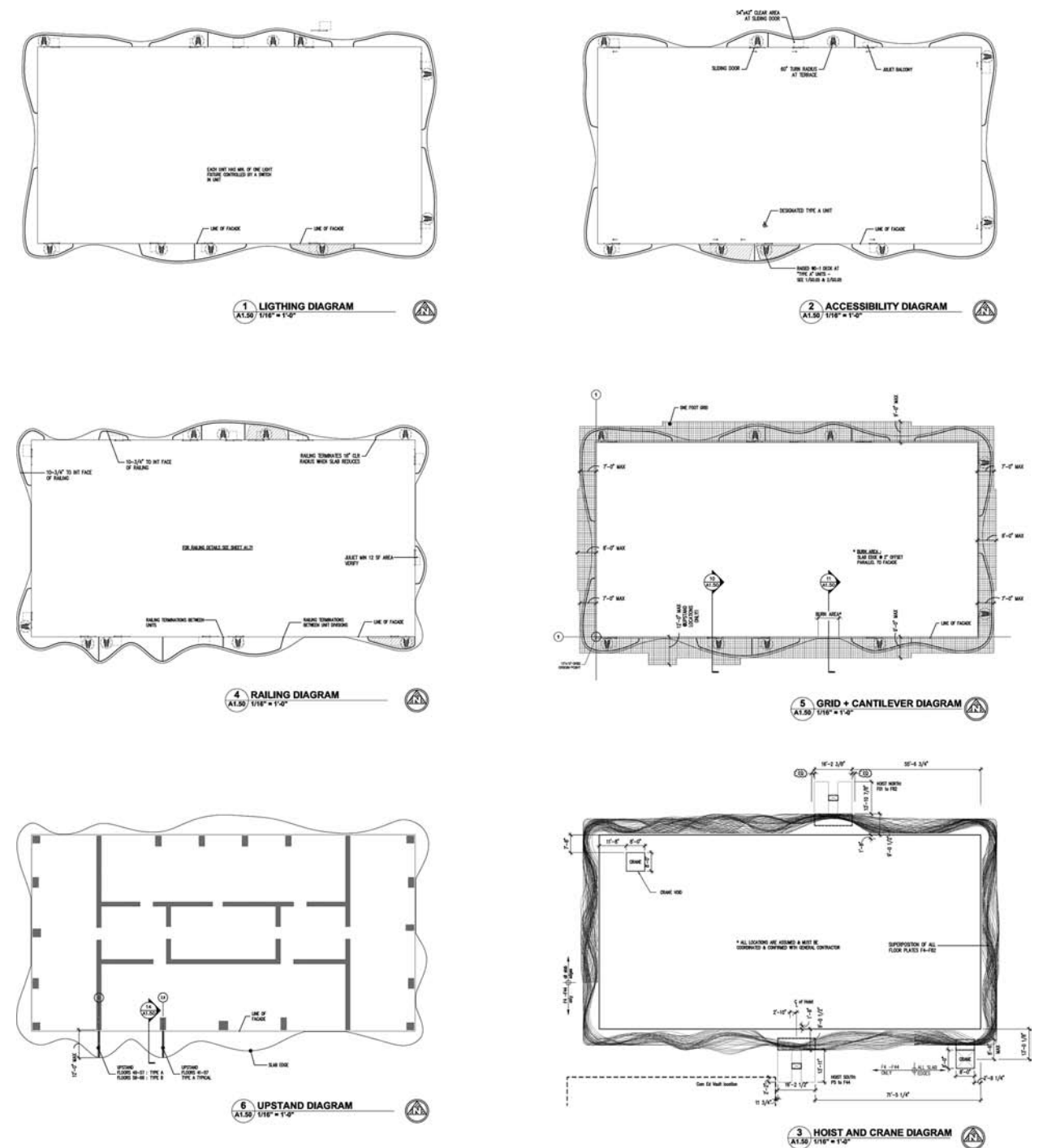
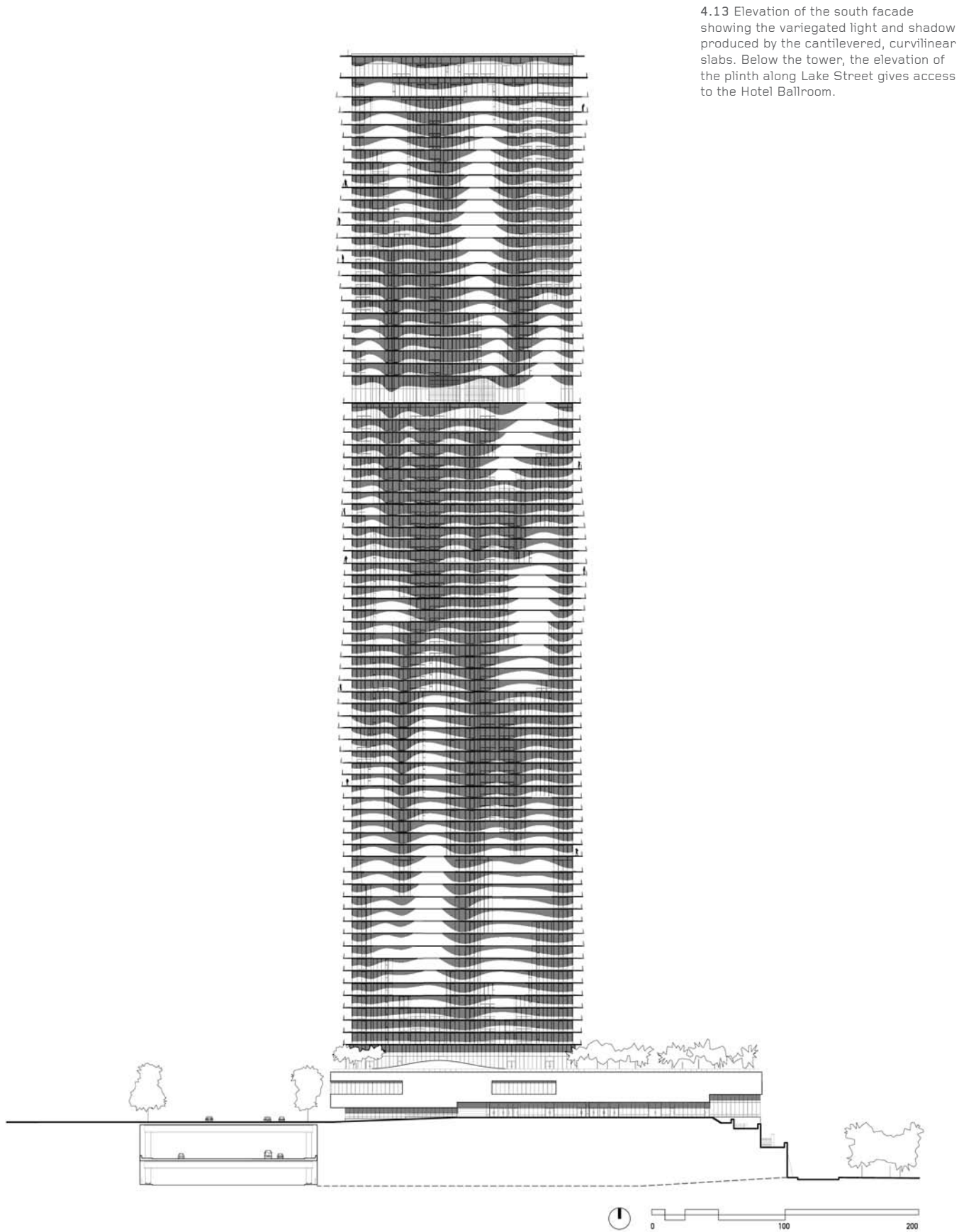
4.11 Partial overlay drawing showing all 82 floors. The plan of each floor varies slightly over the height of the tower.

4.12 Between the layers, the slab edges undulate from the column line of the building, providing a strong contrast with the gridded city beyond.

CONTOUR TYPES







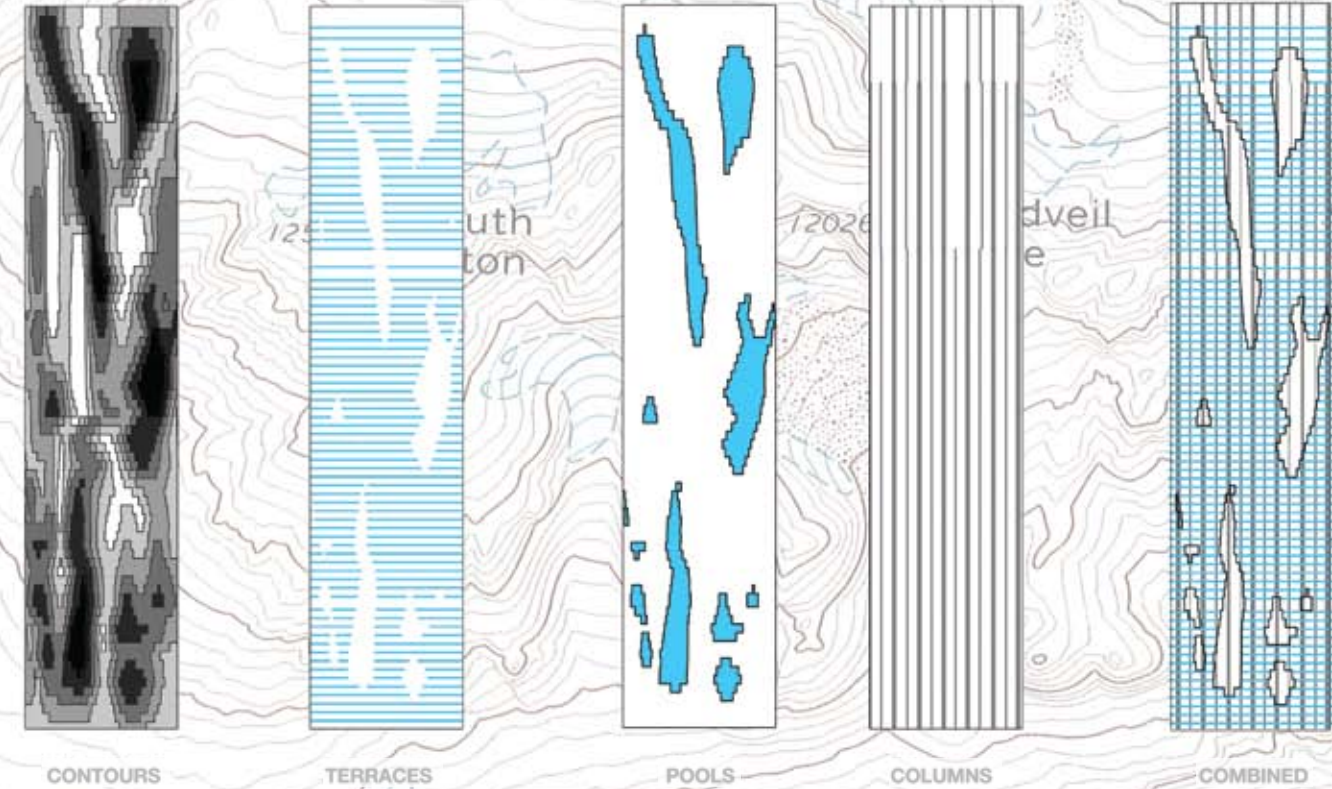
4.14 Structure and construction planning set up constraints for the varying floor slabs. The structural diagram outlines the location of the deepest and shallowest cantilevers allowable, while the construction diagram indicates crane and hoist locations to be accommodated. The unique floor slabs, in turn, parametrically cause variation in many other building elements. Handrails are particular to each slab, as are locations of sliding glass doors from living rooms to terraces. Door locations adjust in every apartment to coordinate with terrace size, living room furnishings, and accessibility.

POOLS

4.15 Where slabs provide shading, clear, low-emissivity glass is called for. Where they do not, a higher performing glass is introduced. The higher reflectivity responds to this specific condition, creating a series of "pools" on the facade.

4.16 Design is a result of the cumulative strategies and responses to specific conditions.

4.17 (page background) Lakes depicted on the topographic map set a clear horizontal datum. Pools on Aqua similarly set a vertical one: they indicate the line where glass performance must increase.



4.18 A sun study of the south elevation recording hours per day of solar radiation. Highlighted zones receive more than four hours of direct sunlight.

MARCH 21:
VERNAL EQUINOX

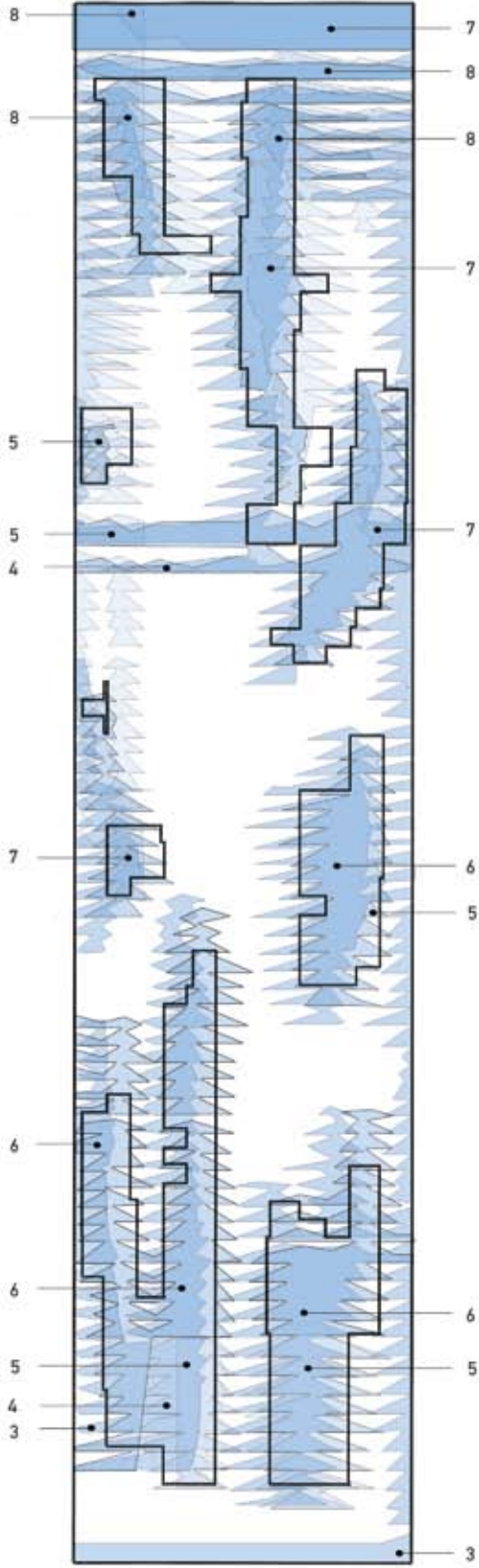
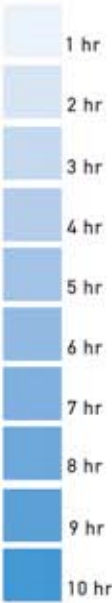
Sun is: 32 degrees above the horizon at 9:00 am
49 degrees above the horizon at noon

March 21 average temperature: 42 F

Average high in March 21: 52 F
Possibility of sunshine: 50%

Probability of April 21 at 65F or above: 20%

Highest record temperature: 77 F





Lynn Becker's writings on architecture have appeared in the *Chicago Reader*, *Harvard Design Magazine*, *Long Island Newsday*, *Metropolis Magazine*, and on his daily blog, *Architecture Chicago Plus*. Becker interviewed Aqua's developer and Architect of Record, Jim Loewenberg, during construction on the tower; Jim had this to say:

Jim Loewenberg: I've only had one job in my life, really. My father and my uncle were architects and engineers. When I graduated from MIT in 1957, I came to work for them. In 1980, I took over.

In my father's day—in the 20s—they would do 12-story buildings. Those were huge buildings. I've been joking for the last few months that my 20-story building used to be a big building. Now, we're doing Aqua. Aqua is 87 stories when you count the five stories below street level.

Aqua is part of the Lakeshore East development, the genesis of which is that my partner, Joel Carlins, and I decided that we wanted to build over at Superior Place, and we partnered with Charles E. Smith and Company out of Washington, very large residential developers who specialize in in-town locations and high-rise buildings. They were looking to expand their national footprint and Chicago was one of their targets.

They said, "We really like Chicago. It's been very good to us. And we like you guys. Let's do some more business together." I said, "There's a huge piece of property that's been sitting vacant, the remnants of the old Illinois Central yard." Smith's success in Washington was that they bought a railroad yard between the Pentagon and the White House. They built a development called Crystal City over this old railroad yard. It was tremendously successful.

The parallels between Lakeshore East and Crystal City were very apparent to me, and so we approached Smith. Then we started to try and buy the large piece of land. It took us quite a while because the owner, Metropolitan Structures, was totally a rudderless ship. The land was owned by Metropolitan and the remnants of the old Illinois Central Railroad Company, which had become PepsiAmerica. It was a totally misplaced asset on their balance sheet and nobody was looking at it.

So we got the land, and now we had to figure out what to do with it. It was designated as an office building PUD (Planned Urban Development). But we didn't want to build 14 million sf of offices and the city didn't want to build 14 million sf of offices. We wanted to do residential. That was our forte.

The plan had included a deck to bring the whole thing up to the level of upper Columbus. It would have cost \$100 million to build—totally uneconomical. We had Skidmore, Owings & Merrill come in and redesign the site plan. We put the park down on natural grade—a great idea and it reduced the infrastructure cost from \$100 million to \$17 million. It made it a buildable project.

Nobody can really sit and predict the market ten years in advance, and so as a part of the master plan, there were buildings of all sizes and scopes. The idea was to give us flexibility. The basic parameters were that it would be a mixed-use community, because it offered us a variety of product. We didn't want to be competing with ourselves with multiples of the same type of building. That's always been our mantra.

So we did a 207-unit condominium, and we did a 550-unit rental building, and two others. Then we came to the Aqua site, which is huge. The floor area ratio would allow us to build out to 1,200,000 sf. So now we violate all our rules. You don't want to build condominiums—it's too many. You don't want to build a rental, because now you're talking about one thousand apartments in a single building.

We decided to try something that's never been done here. We'll build a single building that's got multiple housing uses. We think this is a great hotel site, close to Millennium Park, close to the Loop and all the attractions here.

Economies of scale become magnified in apartments, so the bigger you can build them, the better. The next thing we know is who rents. I've been doing rental apartments for fifty years. I can sit here and put a shovel in the ground for a building and tell you pretty much what the demographics will be. Two-thirds of the people are going to be young adults, between 20–25, first job. Of that, 65 percent are going to be single, and 65 percent are going to be female, working in a Loop professional services firm. Sarbanes-Oxley was the greatest thing that ever happened to the rental market, because it's forced all these accounting firms to double and triple their staff. We get a lot of lawyers, young kids coming out of law school. They get relatively high pay, so they're high-income earners. They're single. They want to live close to work.

So we design our products to meet those people. We're very heavy on one-bedroom and studio apartments. We know we can get all the features in, and average around 820 sf across all units, about 1,000 sf grossed up. We know that our master bedroom, we like to go between 11 and 12 feet wide, so our sweet spot is 11 ½ feet wide. Why is it 11 ½ feet wide? Well, the bed is 6 feet. You got a dresser over here that's 24 inches, and that leaves you three feet between the bed and the dresser. If it gets much smaller than that, it gets too cramped.

The length of the bedroom we can go as low as 14 feet, but we like to go 16 feet. And how do you get to that? Well, you always work off of a king-sized bed. If you can get that in, you can get any bed in. A king-sized bed is about 6' x 6', maybe 72" x 75". Then you want to put a little nightstand on either side. That's 18", and you'd like 2' clearance. Also, you have to remember: two steps to daylight. That's a favorite saying of mine. From the door, to the time you can look out a window, in any room—I don't care what room it is—if you have to take much more than two steps, it's bad. Because the pop or "wow factor" is putting in a window and having them look out the window. They forget the size of the room. It opens it up. I have always maintained that the average renter in a high-rise building never looks above the third floor. He sees the building at street level. He doesn't look at the details above the third floor. It's more important that the apartment is a livable space. Critics hate me, but I have always said the inside is much more important to him than the outside. And the fact of the matter is that some of my ugliest buildings, in the critics' minds, are some of the most successful buildings.

The view is very important. That's marketing. We sell it. I'm a proponent of balconies, don't get me wrong, but balconies are the most useless thing. They're expensive to do, probably about \$2,500 to \$3,000 each. Why do people want a balcony? Well, he or she pictures themselves coming home from work. The partner of their choice hands them a martini, and they go and sit on the balcony. It's a concept that sells. But the guy who fantasizes

about his balcony, what does he do? He winds up putting his \$3,000 bicycle on the balcony because he doesn't want to leave it in the storage room down in the basement where it will get stolen.

Anything over 12 stories is too high, okay? Somewhere around 10, 12 stories you can still relate to the ground. You can see what's going on in Millennium Park. You're part of the action. After that, you don't really see the ground unless you walk up to the window and look straight down. Anything over that is ego. Height sells, but there isn't a hell of a lot of difference between the 40th floor and the 70th floor.

I decided early on that I would do a couple of buildings at Lakeshore East, to get it started, and then we would start bringing in the top architects to try different things, different housing techniques. I was looking for architects that would give me a wow factor, and I brought Jeanne in. We paid something extra for good design and it was worth it. It brings identification in the marketplace.

In Jeanne's design for Aqua, the slabs move in and out, and I bought into it immediately. I thought it was a great idea. But the thing that made it really great is the way she did it. I was able to convince myself, and then eventually the contractors, that this is not something you have to worry about. It's going to be really a basic, simple building. It may take you one man-day extra per floor to do it, to make the curves work, but once we got past that point in discussing that with the contractor, we were able to bring them on board and do it, relatively speaking, as an economical building.

I always like the general contractor to be the guy who pours the concrete, because the guy who pours concrete on a job sets the pace. And we like to have the same mechanical guys, the same electrical guys. We want them to understand what we need and the way we need it done and we don't want to have to listen to their tale of woe about how they didn't anticipate something. We want them to know going in what they have to deliver, to control costs, and control productivity. We buy tough, but the guys know that they're going to get a fair shake from us.

We start on the marketing as soon as we have a firm-enough handle on costs. The last thing you want to do is go out and sell something you can't afford to build. The banks say they won't open a loan with less than 50 percent of the units sold. We say we don't want to open a loan with less than 75 percent sold. When we opened the construction loan for Aqua, we were 87–88 percent sold. You run scared all the time. And you should, until it's completely sold.

How does a project wind down? With a condominium, when we deliver the last unit and turn over the board to the homeowners, we're totally out of it. We're gone. With rentals, we have a management company that comes in to run it. We always keep the point at which we want to sell in the back of our minds. There are guys in the office building market that buy a building, hold it for six months, eight months, and then flip it. We like to hold them somewhere around eight years. We're building a portfolio.

I'm a great believer in the master architect theory. The architect is really a functionary of a building process and really shouldn't—he does not manage—the process. He's just another consultant on a long list of consultants. And the architect in his traditional role has abdicated his responsibility. Go back to the time of the Middle Ages, and the guy who designed Chartres Cathedral, he told the bricklayer where to put the damn stone, you know? He told this guy to do that. He was responsible.

S/GA



4.19 Glossy "splash" pages of the Aqua sales brochure





ENGINEERING AQUA

RON KLEMENCIC, Structural Engineer, Magnusson Klemencic Associates, Seattle, WA

Undulating Slabs

The most visible aspect of architecture merged with structure is found in Aqua's undulating slab edges. Maximizing views while providing unique balcony conditions for each unit requires the floor slab to cantilever as much as 12 feet, compared to the typical 6-foot standard balcony found on most tall buildings. To accomplish this gravity-defying feat, the structural design combined a unique column arrangement and state-of-the-art analysis techniques with requirements for a specific construction methodology.

Typical floor slabs in high-rise residential towers span 20 to 24 feet, with cantilever balconies of 6 feet. The thickness of these floor slabs is traditionally targeted at L/35, or 8" (22 ft x 12" per ft/35). Aqua capitalizes on a larger column spacing of 28 feet. Combining the larger bay sizes with the increased support offered by the larger columns (30" x 50" on average) required to support the 80 floors of weight allowed the slabs to cantilever 12 feet with a skinny 9-inch-thick slab. State-of-the-art finite-element computer modeling was employed to analyze and design the more than 70 unique floor slab conditions.

Pivotal to the design of the floor slabs is the forming method used to construct them. Typical construction methods utilize wood formwork supported by multiple levels of shoring below to temporarily carry the weight of the wet concrete. These construction loads can be greater than any loading the slabs will experience throughout the life of the building.

For Aqua, a unique formwork system was utilized which supports the weight of the wet concrete on steel trusses, which are in turn supported directly from the building columns. As such, the weight of the wet concrete is transferred directly into the vertical supports, eliminating the heaviest loading condition for the floor slabs. This direct transfer of loading enabled a slab design considered more aggressive than normal.

Bracing Against the Wind

Next to gravity, the most demanding effects considered in the design of tall buildings are those associated with wind forces. For most buildings, providing enough strength to resist these forces is relatively simple. Of greater concern is the sway of a tower and the resulting impact on occupant comfort.

Aqua combines traditional concrete shear walls with outrigger and belt walls strategically located throughout the tower's height to effectively manage the building's motion. Two shear walls and a central concrete core extend from the tower's

foundation to the roof. Outrigger walls are provided at Levels 55 through 58 and 81 through 82, with supplementary belt walls between Levels 57 and 58. The purpose of the outriggers and belt walls is to activate all of the columns in the tower in resisting sway, thus effectively and efficiently distributing the wind loads. Similar to outriggers on a canoe or the support ski poles offer a skier, the outrigger and belt walls effectively broaden the "stance" of the building, improving overall stability.

Detailed wind tunnel studies were completed to confirm the performance of the structure under high winds. During the testing, it was discovered that the undulating slab edges disrupted or "confused" the flow of wind around the tower, effectively reducing the wind demands. Initially, it was thought that a supplemental tuned mass damping system might be required to appropriately manage the effects of the wind. The detailed wind tunnel studies confirmed the effectiveness of the structural design, and a supplemental damping system was not required.

Foundations

Unseen but critical to the support of the tower are the foundations. The enormous concentration of loading from the 88 supported floor slabs over the tower's relatively small footprint required a unique foundation design which tested the limits of any previously constructed in Chicago.

Typically, high-rise buildings in Chicago are supported on belled caissons bearing on Chicago's hard pan, which is located some 70 feet below grade. Average bearing pressures of 40 to 50 ksf are considered normal. Applying these "norms" to Aqua resulted in an overlapping geometry of caisson bells, yielding these standard construction techniques implausible.

Instead, 100-foot-deep rock caissons were designed with average bearing pressures of 500 ksf (ten times normal). The caissons varied in diameter from 5 to 10 feet, were constructed using 9,000-psi concrete, and were firmly socketed 6 feet into solid underlying bedrock. The load-carrying capacity of the rock caissons was confirmed using an Osterberg Load Cell Test, which proved that more-than-adequate safety margins exist in the tower's foundation design.

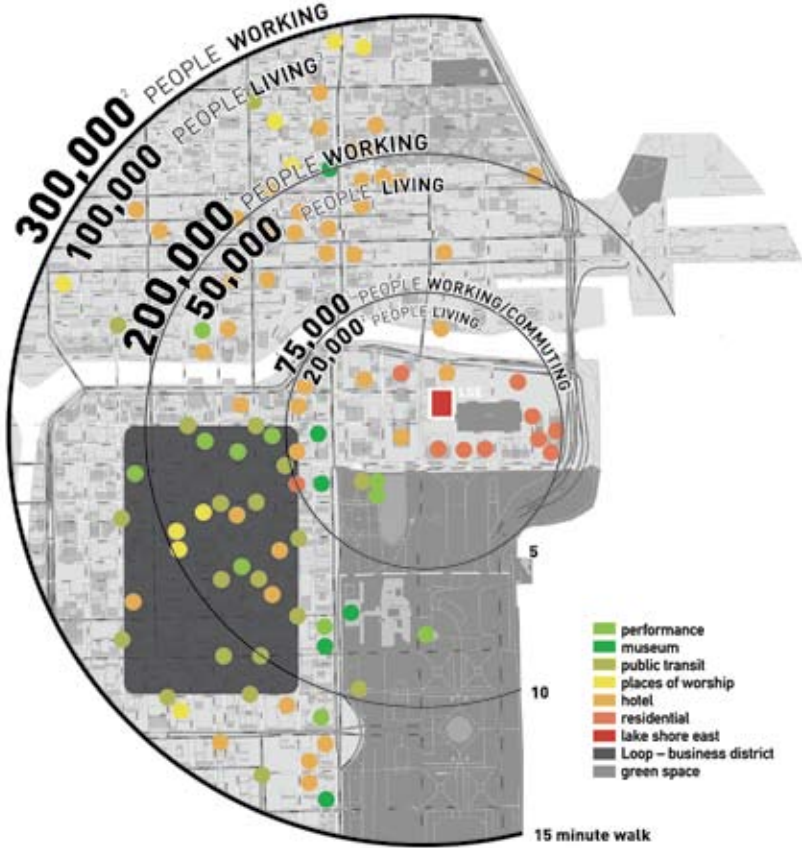
The commercial objectives of building a tower combined with the physical forces of gravity and wind have a great influence on building, but the most memorable tall buildings are the result of a thoughtful, sometimes poetic, duet played by the architect and structural engineer.

S/G/A

MEASURES OF DENSITY

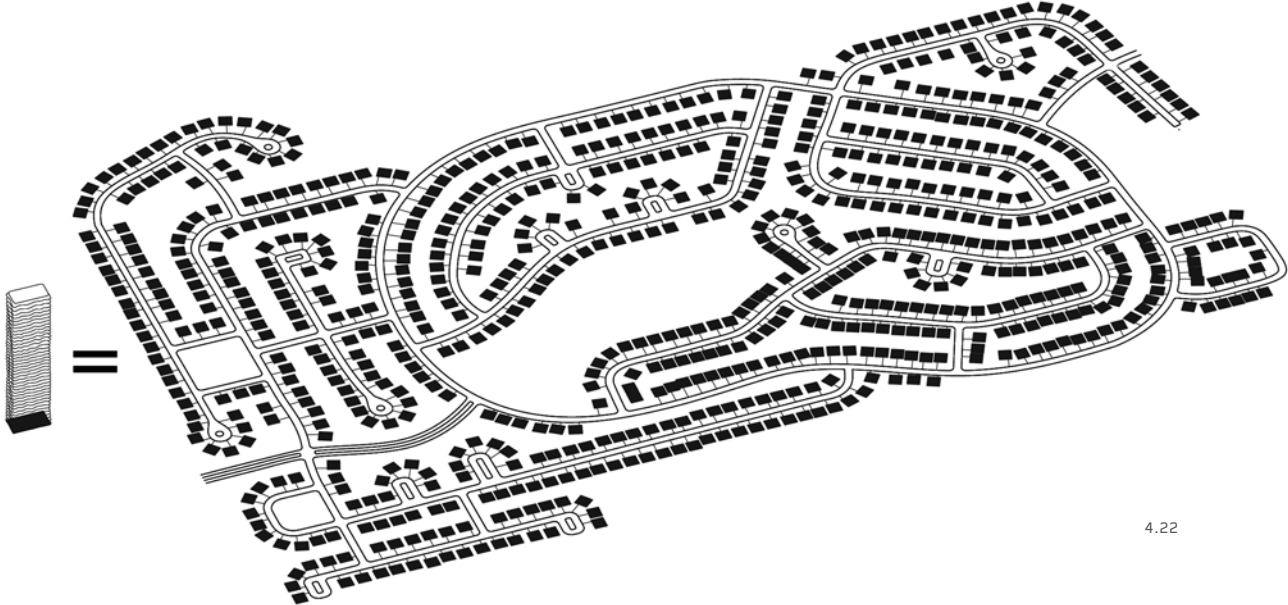
4.20 Urban dwellers benefit from density. A greater number of residents in proximity to employment brings cultural, recreational, educational, and mobility options within walking distance. Aqua Tower at Lake Shore East situates 738 new households minutes from the activities of everyday life, reducing reliance on driving.

4.21 In the city center, walking, taking a subway ride, or a minimal drive is all that is necessary to connect people to a high concentration of jobs. A compact city that locates residential dwellings near job density minimizes travel distances and commuting time, and thus reduces consumption of fossil fuels.



4.20

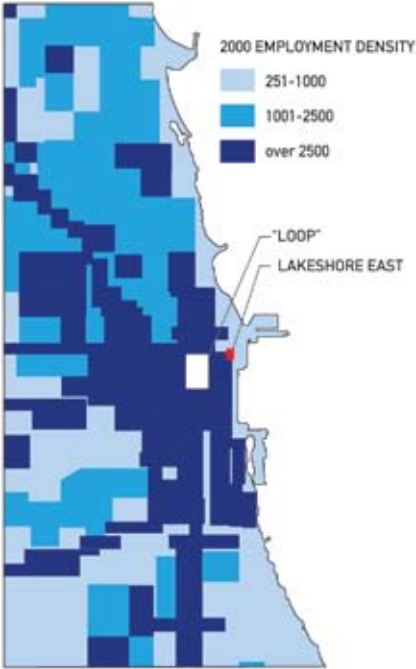
TALL VS. SPRAWL



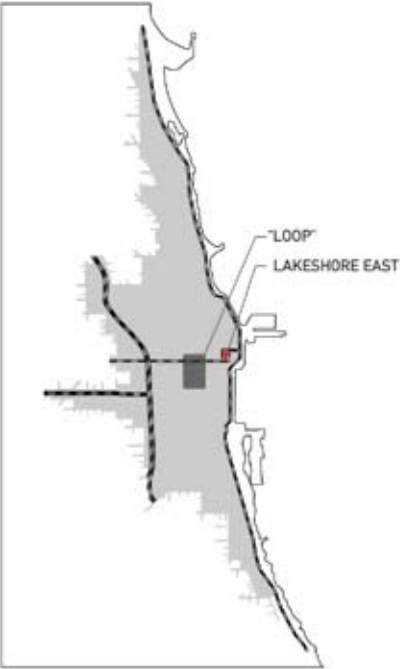
4.22

4.21

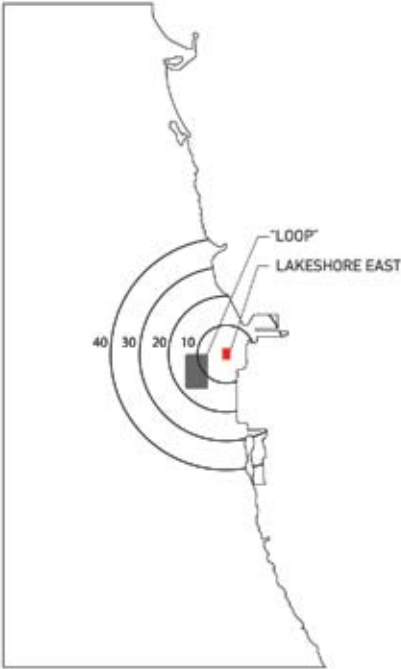
JOB DENSITY



10-MINUTE DRIVE



WALKING TIME (MINUTES)



4.23

4.22 Land-use Comparison: Density can be measured in households per acre. Aqua holds 738 households on .32 acres yielding a density measure of 2036 households per acre. A typical suburb would need 333 acres to accommodate the same number of households: approximately one thousand times more land.

4.23 Carbon Comparison: The metric tonnage of CO₂ produced by a household is directly related to the density of the settlement in which the household is located. For example, a typical household located in Aqua would produce 1.9 tons of carbon per year. A typical household in the suburb above would produce 14 tons of carbon per year. At seven times the size, the suburb leaves a Sasquatch-sized carbon footprint. Source: Center for Neighborhood Technology.

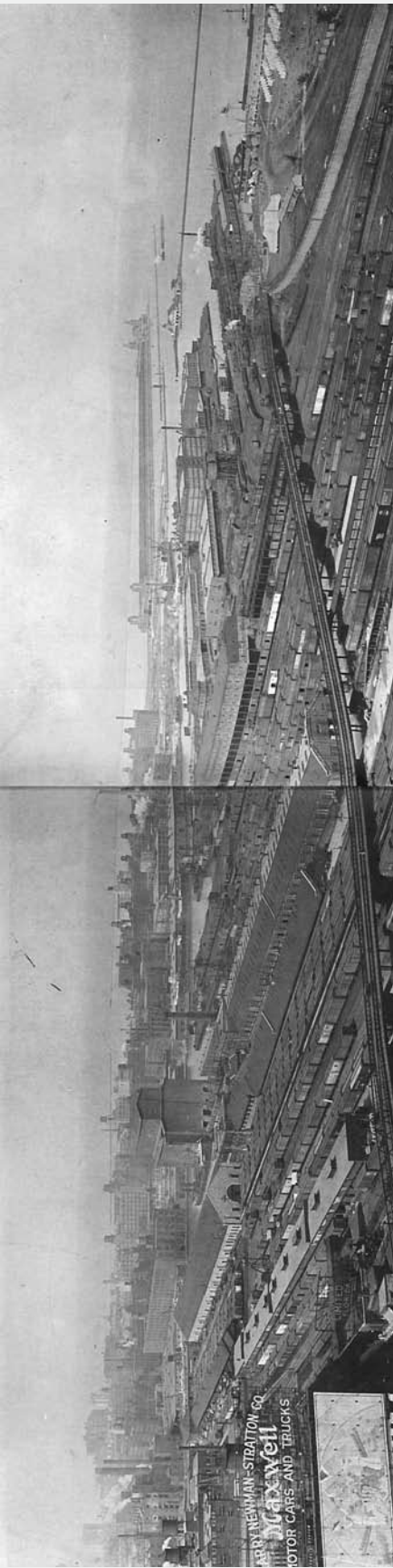


4.24 In 1857, a pre-fire “Birds-Eye View of Chicago” shows the Illinois Central Railroad along the lakefront. Its trestles define the shore solely as a railway corridor. The stretch of water between the city and the trestle would later be filled to become Grant Park. Reproduced by permission of the Chicago History Museum. ICHI-05658.

A LIFE *of* HARD TIMES: THE BOULDER’S STORY

DISCOVERED BY A BACKHOE DURING WORK
ON FOUNDATIONS FOR THE AQUA TOWER,
THE BOULDER’S EPIC JOURNEY WAS ABOUT TO
COME TO AN ABRUPT AND DEFINITIVE END.

RIPPED AWAY FROM ITS STABLE BEDROCK
IN CANADA, THE BOULDER WAS SENT ON
A FORCED ROLL TO THE UNITED STATES
15,000 YEARS AGO.





The boulder arrived via the Laurentide Glacier express, which moved approximately one to two feet per year on a trip that lasted over 10,000 years. After riding this head of ice as far south as Indiana, it reversed direction and moved north as the Laurentide receded.

On its way back to Canada on this harrowing journey, it happened upon Chicago. Its first indignity upon entering the city was to arrive on the muddy bottom side of a giant melting sheet of ice. It experienced not only dirt, but excruciating forces as the weight of the ice ground the boulder against hard earth. New scratches were added to its already scarred visage, a testament to its origin and to the long trip this rock had endured.

Unfortunately, the boulder never made it back to Canada. It was left behind as the glacier melted and receded to form Lake Michigan. At least it was not alone. It was deserted in Chicago along with many other chunks of Wisconsin and Minnesota. In fact, so many rocks were stranded in the Midwest that the area became nicknamed the “boulder belt.”

Time, though, was good to the boulder’s intactness and general state of being. It did what boulders do best for years and years: absolutely nothing. Enveloped by earth and dust, it remained buried fairly close to the earth’s surface. It had no need or inclination to move. Others were not as lucky. When they were encountered by farmer’s plows in the 1800s, they were frequently dug up and broken down to serve as fences, land markers, or even as part of a dam. Things were quiet for the Canadian boulder, however, even during the devastating fire of 1871. Located at the intersection of Michigan and Monroe Avenues, in the center of the fire’s destruction, the rock’s igneous composition was oblivious to what was, compared to its own life experience, a minor level of heat.

It was during the aftermath of the fire when all hell broke loose for the boulder. By 1870, the city’s population exploded to ten times its size only two decades earlier. Chicago embarked on a massive building campaign that utterly transformed its surface, its shoreline and everything below grade. A new type of foundation system called grillage developed in 1881 that made tall buildings possible despite the mucky soil underfoot. Boulders were dug up and moved aside to make way for architecture.

There were several success stories such as that of the so-called “Guthrie boulder” that made it big after being discovered along the shore of Lake Michigan. In 1912, the Guthrie boulder was the center of a parade through the streets of Chicago as it was transported to a new home in Washington Park on the South Side. To this day, it has been able to sit contentedly doing nothing, while monumentalizing Samuel Guthrie, the inventor of chloroform.

Not many stories end happily for these ancient rocks. The Canadian boulder was unearthed to make way for an encyclopedia company’s new building. Wrenched from the earth by a crew of fifty men digging by hand, it was levered onto a skid and nudged north across the street to what would become Grant Park. From this precarious position, exposed and potentially obstructing the park’s progress, it was clear that the boulder’s fate was in play. The city ordered the encyclopedia company to remove the boulder from its land.

In 1921, the boulder was rolled north along Michigan Avenue to the western edge of a railroad terminus. This site was slightly more secure because buildings were unlikely to be constructed along the railroad’s gritty edges. Grime-covered and surrounded by a swirl of activity, the boulder sat still

for a brief forty years. As train transport was replaced by truck transport in the 1950s, railroads ceased operations, sold their land and pulled up track. The land’s availability led to the 1960 construction of a new commercial development on the site. The boulder’s storied past was irrelevant to the men who were assigned to clear the site for construction for the Illinois Center project. To them, the boulder was simply an obstruction to be removed. Unlike the Guthrie boulder, which was elevated to “monument” status, the Canadian boulder was essentially banished. The contractors tried rolling it into the lake, but after the first few hundred feet of rolling, they simply abandoned the effort and left it for dead east of Columbus Drive.

There were humiliations at this location to be sure; curiously, the rock became an attractive pissoir for drunks, as the multilevel roadway built up around it gave the space the qualities of an underpass. One highlight, however, was the giant yellow peace sign tattooed on its surface in 1964.

In 1977, while making way for their new substation, a utility company was ordered by city officials to dispose of the boulder. After analyzing the cost of removal, the utility company decided to dig a hole and bury the rock underground next door. Safely out of sight and out of mind, it wasn’t until 2005, during site preparation for a new mixed-use residential tower called Aqua, that the boulder was rediscovered. Its remaining days were numbered, as it was sitting squarely on the future location of one of Aqua’s largest caissons. Among other things dug up from alongside the Canadian boulder were some wood piles from a former pier, shoring from the former lake edge and strands of iron rail track. All of this detritus had to come out to make way for foundations.

In the future, perhaps someone will value a rock like this one more highly. They might try to save an old rock as a memorial to geologic history. They might think to place it in a museum, in a park, or on a podium in the city. One day, people might even consider it holy and come to worship near it. On this day, though, the end came quickly and unceremoniously. With the help of jackhammers and bull-dozers, the aged boulder that had traveled so far on a river of ice was converted to an ordinary pile of gravel and dust to fill the sub-surface of a mundane driveway.

SOVA

4.25 (page 171, on fold) A view of the Illinois Central Railroad terminus and yard shows its prime real estate on Chicago’s lakefront circa 1915. The Peristyle at Grant Park’s northern edge is visible in the lower left-hand corner and the future Aqua site is in the center of the photograph.

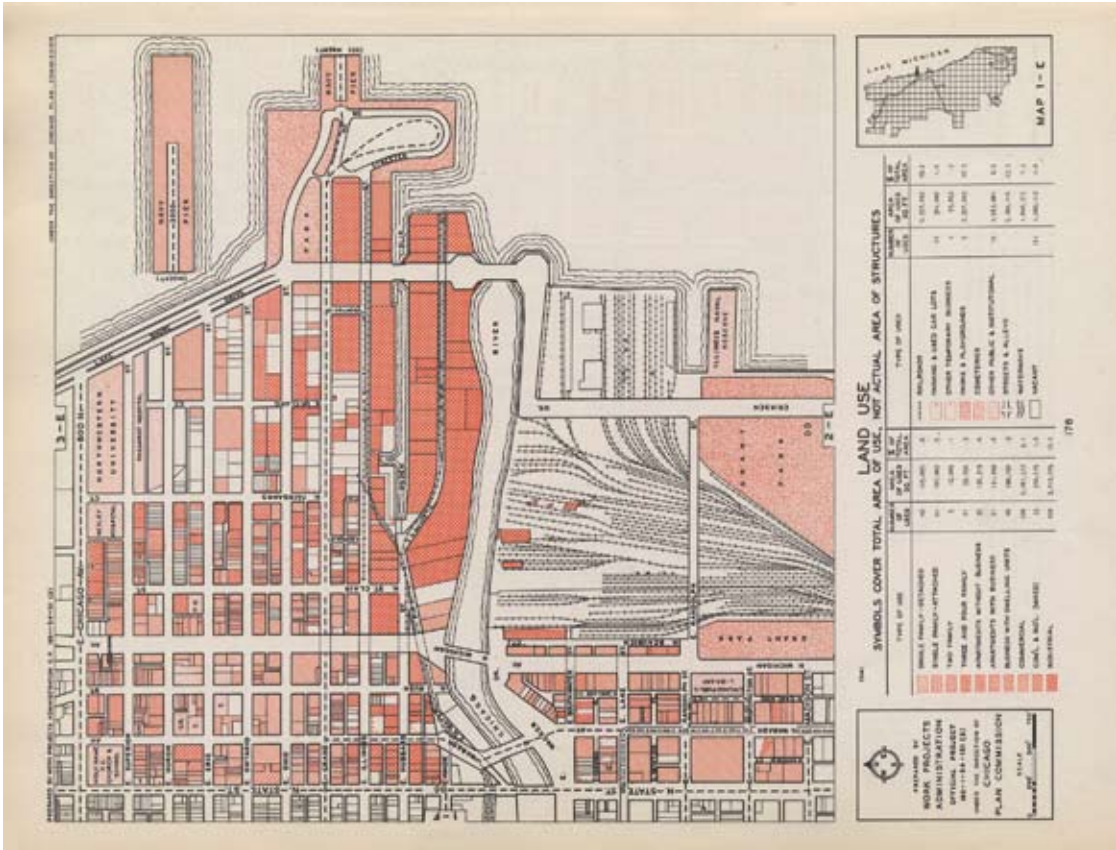
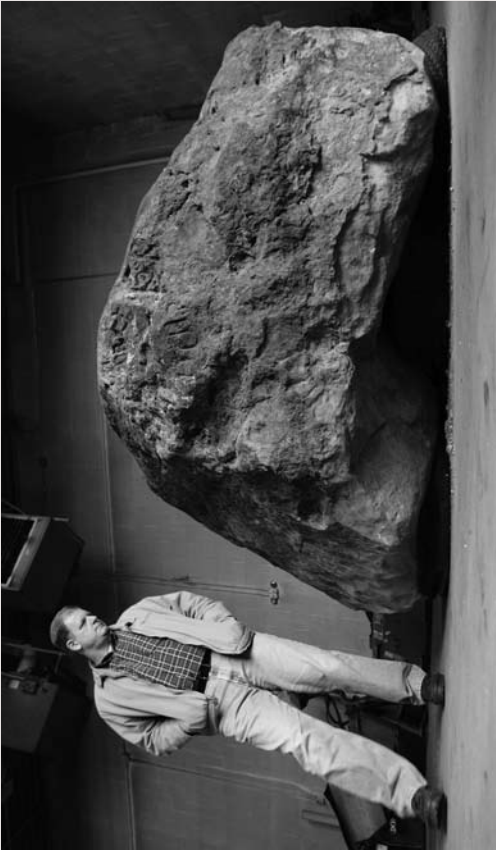
4.26 (page 172, below fold) A 1904 photograph shows a man standing next to the Guthrie Boulder on Michigan Avenue. The boulder was found during building excavation work and later converted to a monument for a physician who discovered chloroform, Samuel Guthrie. It was paraded down the major street to its new home in Jackson Park. Photograph by the Chicago Daily News reproduced by permission of the Chicago History Museum. DN-0003261

4.27 (page 172, lower) A boulder that has long been present in local lore was rolled into Kentucky’s portion of the Ohio River over a hundred years ago. In 2008 Steve Schaffer, an Ohio historian, removed the “Graffiti Boulder” from the river and brought it to Portsmouth, Ohio garage, sparking a border dispute between the two states over its rightful owner.

4.28 A 1935 Works Progress Administration (WPA) map showing the relationship between the Illinois Central Railroad terminus and the Chicago River to the north and Lake Michigan to the east. When the Railroad ceased operations, many of the tracks and other detritus were simply buried below grade. Reproduced by permission of the Chicago History Museum. ICHI-38518.



BOULDERS IN THE NEWS 1904: The excavated glacial “Guthrie Boulder” (above) is prepared to be moved to Jackson Park as a monument. 2008: the submerged “Graffiti Boulder” (below) became the center of a border dispute between Kentucky and Ohio when it was removed from the Ohio River.



MATERIAL REPORT: MAPS
REVEALING INVISIBLE STRATA

We tend to think of maps as ultimate authorities: as unimpeachable references that give us the answers and settle debates. The best maps are those which deliver information straightforwardly, without unnecessary additions or flourishes. These achieve a seamless graphic elegance—almost an omniscience—that allows their users to grasp concepts without noticing their communication.

But however easy it is to think of maps as infallible, they are often commissioned by people with an agenda, and as such are the result of multiple subjective choices regarding content and medium. The making of maps for political advantage, for example, is an age-old game of chess in which natural resources or constituent voters are the pawns. Perhaps the most famously manipulated voting district map dates from 1812. Redistricted to benefit Elbridge Gerry, the incumbent governor of Massachusetts, this map of Essex County inspired a political cartoonist to redraw it as a clawed, lizard-like creature and title it “The Gerry-Mander” (after Governor Gerry + salamander). The name inexplicably stuck, and today “gerrymandering” continues to be a common concept in world politics—for map-making continues to be recognized as an important tool in political power play.

Some maps, however, are so powerful they can transcend the sometimes narrow motives of their commissioners. William Smith’s Great Strata-Map of 1815 is one of these. More than a factual regurgitation, it is a work of personal observations, bold imagination, a strong aesthetic sense, and—once in a while—a wild guess. Now known as the first geologic map of Great Britain ever drawn, the map began as a passionate side project for Smith, who traveled throughout early nineteenth-century Britain as a surveyor and drainage engineer financed by various coal mine owners. While inspecting mines and charting the best courses for coal canals, Smith (who had since childhood been fascinated by all things geologic) took the opportunity to observe cross sections of the earth like no one else before him. Here he recognized distinct layers of different types of soil and rock, and came to hypothesize that they had somehow been “set down,” one on top of the other. More importantly, he came to realize that these layers, which he chose to term “strata,” were arranged in the same way all across Britain. By paying attention to what was previously underground and unseen, he had discovered a larger pattern.

It was in making the decision to map this pattern that Smith’s observations took on their greatest importance. Looking for the clearest way to differentiate between strata too similar in color and other qualities to be recognized by their rock and soil makeup, he discovered that fossils—which he had collected

since he was a boy—were the key to distinguishing which strata were which. Those fossils abundant in one layer, Smith found, could be completely absent from the next. Additionally, each stratum contained its own unique fossil combination which remained its identifying characteristic throughout the whole country. These careful observations led him to posit an idea previously unthinkable in its heresy: that the creation and seemingly random location of fossils were not in fact the product of Noah’s flood—that instead their whereabouts were regular and corresponded with other geologic phenomena. The world was much, much older than previously imagined.

Smith’s 1815 map of “England and Wales with part of Scotland” makes the reality of these rock and fossil patterns, as well as their greater implications for science (and, eventually, for turning the Christian worldview on its head), beautifully clear. Originally printed in fifteen sections to total a size of more than eight feet by six feet, the map is hand-colored in twenty-two different shades of ochre, umber, rust, gray, blue and green, each corresponding to a unique, age-defined stratum. It is startlingly accurate: a fact that is all the more surprising when it’s considered that Smith was never formally trained in cartography. Instead he developed his graphic techniques through a long and painstaking process of trial and error, eventually settling on the medium and methods that most effectively enabled him to communicate the invisible complexity of the underworld. Displayed in such a masterful way, his observations have since profoundly changed the way humans understand the history of the earth and our place within it—most famously, in its use by Charles Darwin as part of his theory of natural selection, as well as in the realms of continental drift and climate change.

The story of Smith’s map has great relevance for the realm of architecture, too, where maps, diagrams and plans are key tools for conveying information. As in any other kind of map-making, the creation of these architectural drawings involves many subjective choices about what to include or leave out—choices that may relate to the client’s specific economic or political intentions for a project. As Smith proved with his work for the coal mine owners, however, faithfully fulfilling a client’s needs and exploring one’s own interests and convictions are not mutually exclusive. Part of the role of the professional is to deploy all of one’s skill, previous experiences, and powers of observation toward an issue, while still maintaining an open mind. When observing, researching, and intelligently synthesizing visual information in this way, architects have the power to elevate data above purely pragmatic purposes, opening the door for discoveries on a grander scale and beyond the confines of professional boundaries.

S/G/A

4.29 William Smith's revolutionary map, formally titled "William Smith's delineation of the strata of England and Wales with part of Scotland; exhibiting the collieries and mines, the marshes and fen lands originally overflowed by the sea, and the varieties of soil according to the variations in the substrata, illustrated by the most descriptive names." © NERC 2008



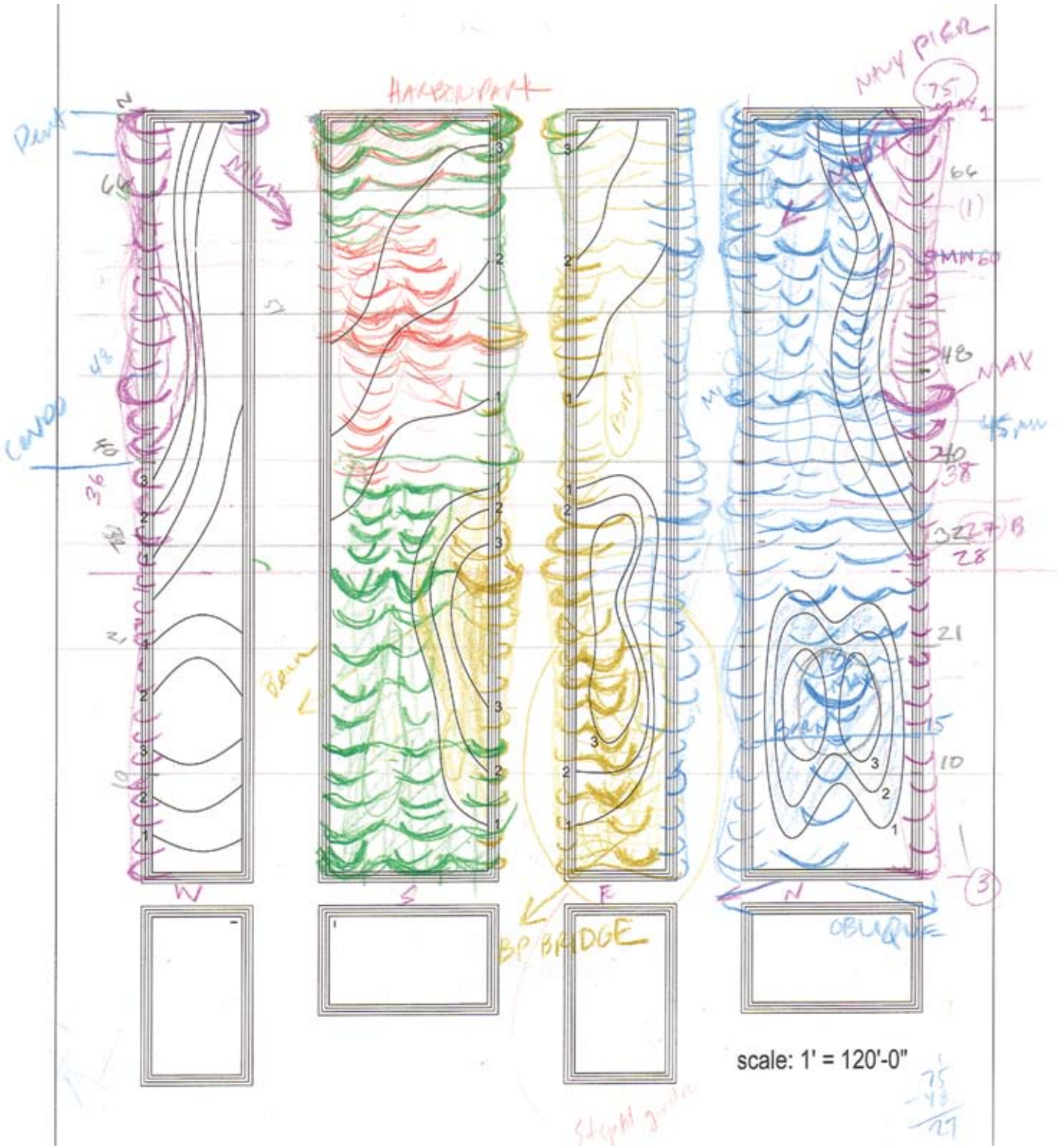
Griffith, Elmer C. The Rise and Development of the Gerry-mander. 1907. Reprint. New York: Arno Press, 1974.
Winchester, Simon. The Map That Changed the World: William Smith and the Birth of Modern Geology. New York: HarperCollins, 2001.

BIBLIOGRAPHY



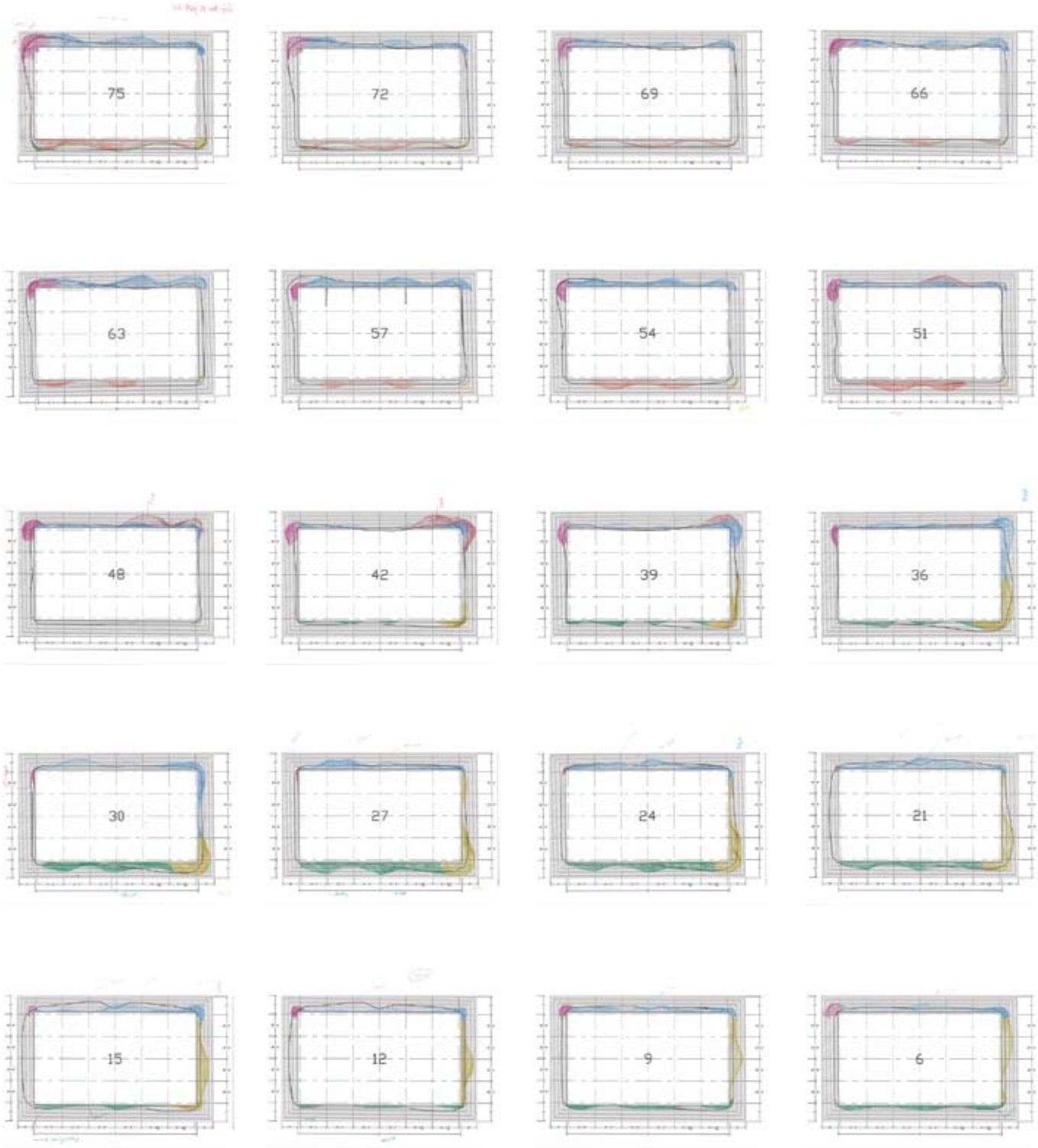
Photograph courtesy of Jim Martinez.

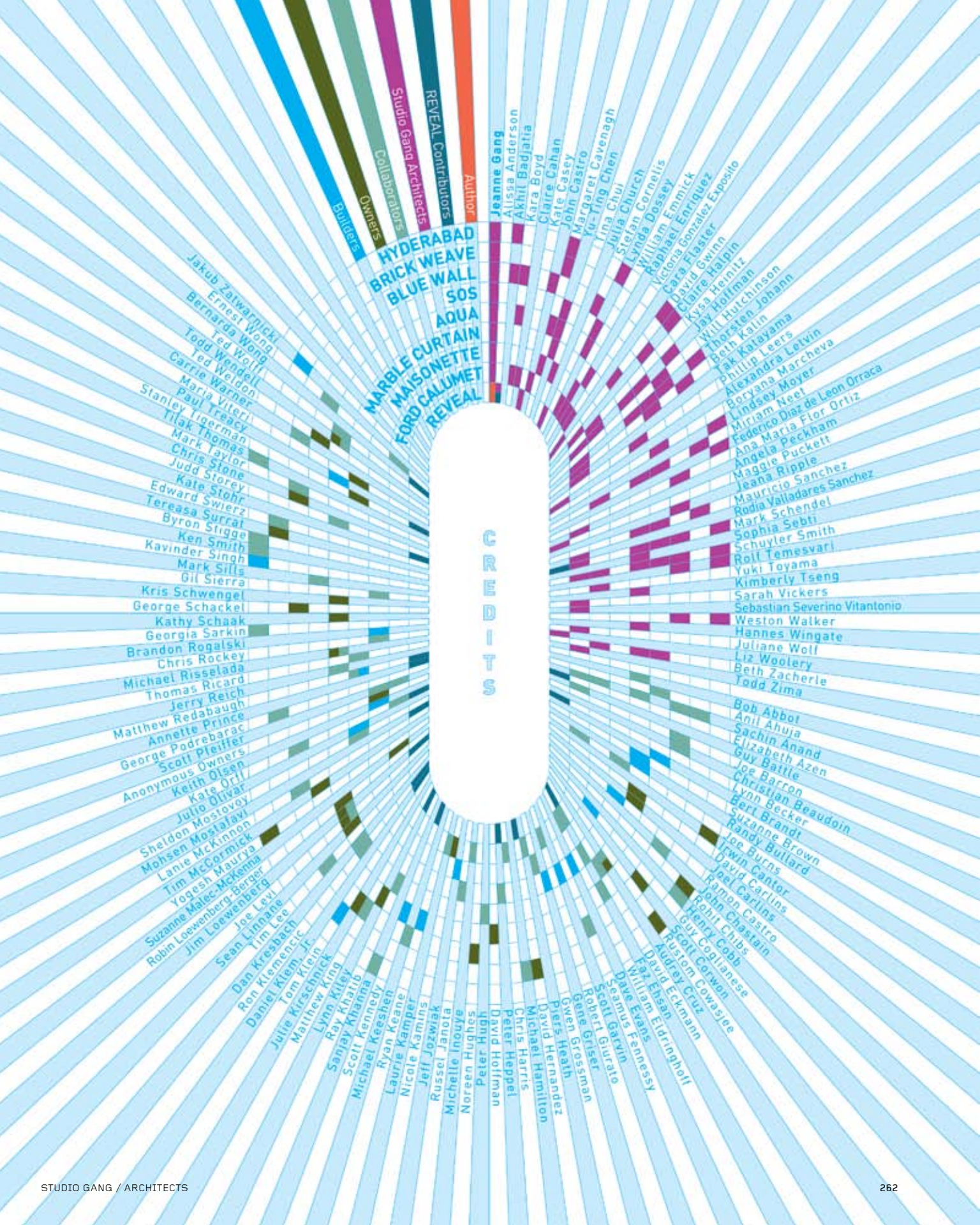




Overlay drawing studying the convergence of view targets with slab delineation

Hand sketches created for every third floor to track the migration of waves in the plan





ACKNOWLEDGMENTS

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Aqua

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