Shifting Ground

Fluid futures of Mexico City

By

Lissette Andrea Forero

A thesis submitted to the Faculty of Graduate and Postdoctoral Affairs in partial fulfillment of the requirements for the degree of

Master of Architecture

In

Azrieli School of Architecture and Urbanism

Carleton University
Ottawa, Ontario

Shifting Ground

Fluid futures of Mexico City

Abstract

Mexico City is defined by its *aquafluxis;* a duality of abundance and scarcity, floods and droughts. Infrastructure and ground manipulations are at the heart of a complex relationship between a lacustrine environment and the city. This thesis seeks to probe notions of ground and water to explore [sub]natural realities and possibilities within the urban context of Mexico City.

The project takes a look at the historical, political, geographical and geological characteristics of the region, their impact on the urban development of the city and of ecological changes in the region. Drawings, maps and collages explore mythology, infrastructure and geology to speculate on *fluid* futures that re-conceptualize notions of inhabitation, water and ground.

Table of Contents

Acknowledgements

Thank you --

To my family, for their unwavering love and support. To my dad, for his encouragement, dedication, and willingness to always help me, especially with all things geology. To my mom, for her unwavering faith, love and sacrifice. To my sister, for keeping me company this past three years and lending me her ear every time I needed it. To my brother, for always brightening the days with his humor despite the distance.

To my advisor, Ozayr Saloojee, for his endless support, patience, encouragement, wisdom, and thought-provoking, insightful and inspiring comments and suggestions.

To the amazing and talented friends and colleagues with whom I've shared this journey. For the laughs, inspiration and advice. I'm grateful to have crossed paths with all of you, it has truly been a blessing.

List of Figures

List of Appendices

Introduction: Unstable Grounds

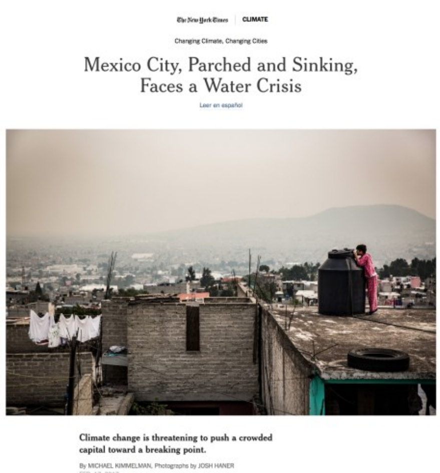


Figure 1. News articles chronicling the persistent floods and water scarcity in Mexico City.

Premise

> "Separating land from water on the Earth's surface is one of the most fundamental and enduring acts in the understanding and design of human habitation. The line with which this separation is imaged on maps, etched in the imagination and enforced on the ground with regulations and constructions has not only survive centuries of rains and storms to become a taken-for-granted presence; it has also been naturalized in the coastline, the river bank, and the water's edge [....] When people see flood, which is becoming an increasingly common event around the world, they see water transgressing this *line*"
>
> *Dilip Da Cuhna, Introduction to The Invention of Rivers*

Rapid urbanization and explosive growth have been a reality for much of Latin America since the beginning of the 20th century. Unsettled political contexts and increasing globalization have allowed industrialization and expanding capitalism perpetuate exploitation, mismanagement and an uneven spatial distribution of resources. As the world continues to urbanize, it is becoming more and more relevant to acknowledge and address the issues and conflicts that exist between urban centres, their surrounding hinterlands, ecosystems and resources.

Mexico City is one of the most populous cities in the world, ranking fifth in a 2018 report by the ONU.[1] Home to just over 21 million people, the 1675.5 km^2 urban footprint extends into its neighboring State of Mexico. As the city continues to grow, its issues and problems proliferate. *Water* is at the heart of many of these challenges and conflicts, and both *flooding* and *drought* are a recurring, increasing concern.

The first time I witnessed the city flooding was on a visit with my family in the early 2000's. I remember coming out of a restaurant. It was raining, hard. Water overflowed from the streets onto the sidewalks and people had to walk through ankle-high dark waters. The sound of rain and traffic was the background music to the chaos I saw in front of me. For *capitalinos,* however, it was just another day. Business as usual. While this would not be the last time I ever witnessed the city flooding, it left a long-lasting impression. How can a city so grand and *modern* have to deal with such a thing?

Mexico City is an urban environment defined by its *aquafluxis,* a duality of abundance and scarcity. It provides, as a consequence, a provocative set of conditions to explore and probe: the ways that designers, architects and planners might think about cities, concepts of 'nature' and 'landscape', the role that infrastructure plays in the design of the built environment and the importance of understanding the *ground* on which we build. It is time to rethink and redefine how the natural world and human habitation connect and impact one another at the urban scale, particularly at a time in which changing climate conditions bring forth fluctuating, unexpected weather phenomena that often exacerbates existing problems.

---

[1] "CDMX, La Quinta Ciudad Más Habitada En El Mundo: ONU." *Forbes Mexico*, last modified May 2018, http://www.forbes.com.mx/cdmx-la-quinta-ciudad-mas-habitada-en-el-mundo-onu/

This research explores the historical, geographical and geological characteristics of the region; how these have impacted the way the city has been built, how it has grown and the changing ecological conditions that characterize the cycles of *aquafluxis*. Mythology, infrastructure and geology play a key role in understanding and analyzing the relationship that exists between *water* and city and thus become the starting point to imagining a speculative, [sub]natural future for the city.

Waterscapes of the Mexican Central Basin: Geology and Geography

> "Mexico City's environmental history is also the history of the Basin of Mexico."
>
> *Matthew Vitz, City on a Lake, p. 13*

The anthropogenic landscape of Mexico City has always been, and continues to be, influenced by the geographic and geologic conditions of the region. Located at ~2250 meters above sea level, Mexico City sits within the Central Mexican basin and the Trans-Mexican Volcanic Belt. The hydrological region also encompasses the adjacent states of Estado de Mexico, Hidalgo, Tlaxcala and Mexico City[2] (Figure 2). The capital city is geographically delineated by the *Sierra de las Cruces range* on the west, the *Sierra Ajusco-Chichinautzin* range on the south and the *Sierra Nevada* on the east.

The region is characterized by a low-lying valley surrounded by mountains and volcanoes ranging from extinct, inactive, and active; and reaching heights of up to 5000 m (Figure 2). Geologically the basin used to naturally drain south towards the Cuernavaca basin,[3] but the volcanic and seismic formation of *Sierra Ajusco-Chichinautzin* to the south[4] transformed it into an endorheic basin.[5] Inwardly draining with active seismic and volcanic activity, the region is classified as a lacustrine environment and characterized by lacustrine clays, alluvial fills, basalts and andesites.[6] While volcanic rock can be porous and permeable in nature, these are mostly concentrated towards the mountain ranges, whereas the valley is characterized by more impermeable, lacustrine clays (Figure 3).

---

[2] According to an official document by the Secretaría de Recursos Hidráulicos, the basin is distributed in percentages as follows: 58.9% Estado de México, 20% Hidalgo, 4.9% Tlaxcala and 16.2% Mexico City proper. As such, political decisions regarding the management of water resources are shared by all four states. See Comisión Hidrológica de la Cuenca de México, *Breve Descripción de la Cuenca del Valle de México, sus Problemas Hidráulicos y Modo de Resolverlos.*

[3] Gutiérrez de MacGregor, María Teresa, and Jorge Gonzáles Sánchez. "Evolución Del Crecimiento Espacial de La Ciudad de México En Relación Con Las Regiones Geomorfológicas de La Cuenca de México." In *Geografía Para El Siglo XXI. Series Libros de Investigación, Núm. 7: Estudio Sobre Los Remanentes de Cuerpos de Agua En La Cuenca de México*, edited by Raúl Aguirre Gómez. Universidad Nacional Autónoma de México, 2010.

[4] It is estimated that the geologic formation of the mountain range took place during the upper tertiary and quaternary

[5] An endorheic basin is a closed basin, meaning there is no physical outlet for water to escape. Endorheic basins are inwardly draining and often result in the formation of lakes. See Benjamin Elisha. "Fluvial Landforms: What Is An Endorheic Basin?" WorldAtlas. https://www.worldatlas.com/articles/fluvial-landforms-what-is-an-endorheic-basin.html (accessed February 3, 2020).

[6] Council, National Research. Mexico City's Water Supply. Mexico City's Water Supply: Improving the Outlook for Sustainability. National Academies Press, 1995. https://doi.org/10.17226/4937.

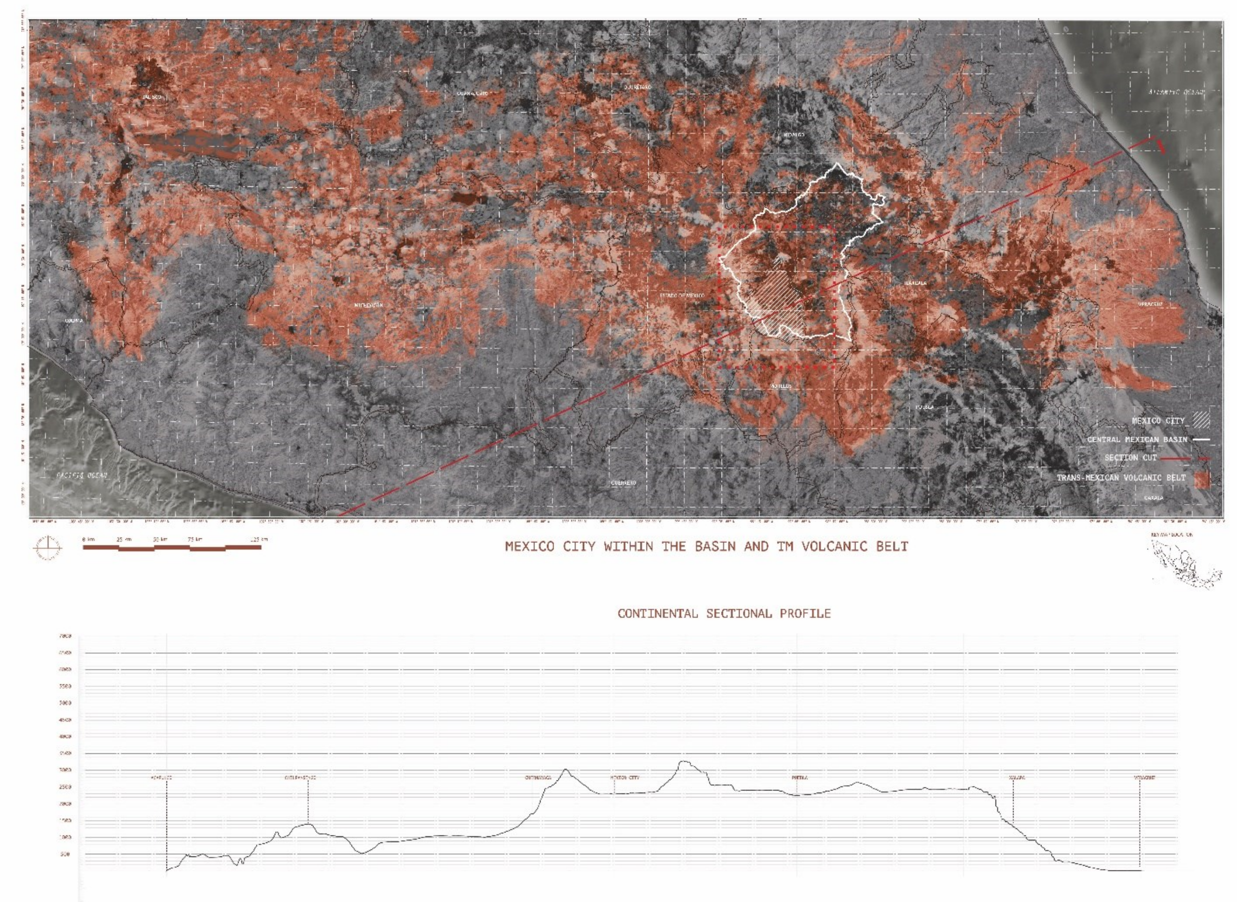


Figure 2. Geographic location and topographical conditions of Mexico City in relation to the rest of the country

These unique conditions transformed the basin into a rich waterscape environment. Eventually the different rivers fed by the volcanic icecaps and seasonal rains draining into the basin formed a grouping of lakes: Zumpango, Xaltocan, Texcoco, Xochimilco and Chalco.Topographically, Texcoco was the lowest point of the basin, which meant the other lakes, located higher up, drained down onto it. The nature of rivers and lakes in the basin was cyclical and fluctuated with climate and rain season. Precipitation only takes place during four to five months of the year, usually May-September,[7] and thus many of the rivers were torrential and seasonal, resulting in a fluctuating *boundary* for the lakes.[8] In addition to rivers and the lakes, the volcanic nature of the basin resulted in an abundant number of natural springs in the region, fed by rich underground aquifers, and were surrounded by lush forests, abounding with pine trees, *oyameles* (sacred fir), *ahuehutes* (bald cypress) and cedrus trees.[9] The basin was characterized by a water-rich

[7] CONAGUA. “Compendio Básico Del Agua: Gerencia Regional XIII, Aguas Del Valle de México y Sistema Cutzamala,” 2004.
[8] The five lakes were individual bodies of water when water levels dropped enough to separate them, otherwise they merged into one, single massive body of water that encompassed the entire lower portion of the valley.
[9] Comisión Hidrológica de la Cuenca de México, *Breve Descripción de la Cuenca del Valle de México, sus Problemas Hidráulicos y Modo de Resolverlos.*

environment ample with life. Most of the water has since dried out and the historical, liquid terrain of the now city is parched, dry, thirsty.

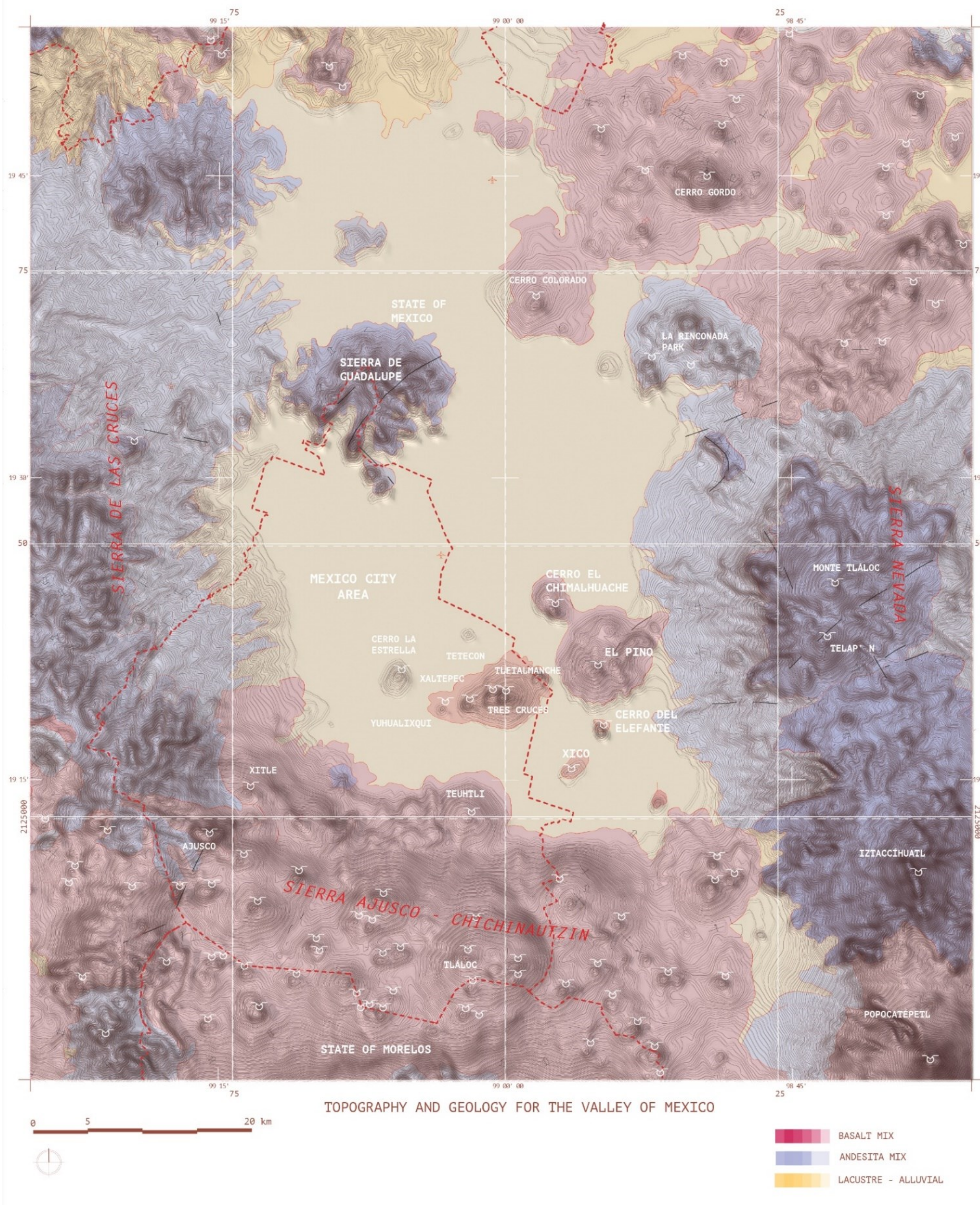


Figure 3. Topographical and Geological map for Mexico City

The Anthropogenic Landscape of the Americas

> "Natural environments, once modified by humans, may never regenerate themselves as such. The product of the collision between nature and culture, wherever it has occurred, is a *landscape*"
> William Balée and Clark Erickson, *Time, Complexity and Historical Ecology*

> "The concept of landscape is also closely tied with the evolution of human interactions with water"
> *Matthew Gandy, The Fabric of Space: Water, Modernity and the Urban Imagination*

Increased awareness of the impact human activity has on the environment has resulted in the inclusion of the *Anthropocene* as the next geological epoch in the time scale of the planet. The material culture of this new era is leaving behind vestiges and evidence of the temporally abrupt yet profoundly impactful changes and transformations taking place on the planet.[10]

Davis and Todd argue that in the Americas, the anthropocene began with the establishment of *Colonialism* and its Eurocentric, proto-capitalist logic of extraction and accumulation.[11] However, despite the Colonial agenda to change and transform the environment for the economic prosperity of the Imperia project, indigenous groups in the Americas had been transforming their surroundings for hundreds of years.[12] No 'natural' environment in the Americas has truly been untouched by human activities. Daniel Janzen argues that 'natural environments' have been historically produced "by human intentionality and ingenuity, creations imposed, built, managed and maintained by collective multigenerational knowledge and experience of Native Americans."[13] Through practices and techniques of *terraforming* land and environments were shaped for prosperous agricultural activities and successful urban centres.

Having developed their own set of *landscape* traditions, by the time of European arrival the *anthropogenic* landscape already was a form of built environment[14] in the Americas. A complex palimpsest of human activity *produced* over time, its spatial implications span generations[15] and encapsulate the connection between water, landscape and infrastructure. Based on Native ecological *epistemes*[16] and operating in temporal and historical contexts, landscapes have been intentionally designed, engineered and planned in advance; control and manipulation being the

---

[10] Davis, Heather, and Zoe Todd. "On the Importance of a Date, or Decolonizing the Anthropocene." *ACME* 16, no. 4 (2017).
[11] *Ibid.*
[12] See Charles Mann *1492: New Revelations of the Americas Before Columbus*.
[13] Daniel Janzen, *Gardenification of Nature* in Erickson, C. L. "*The Domesticated Landscape of the Bolivian Amazon".* See also, Daniel Janzen "*Gardenification of Wildland Nature and the Human Footprint".*
[14] Balée, William, and Clark L Erickson. "Time, Complexity and Historical Ecology." In Time and Complexity in Historical Ecology: Studies in the Neotropical Lowlands, edited by Clark L Erickson and William Balee, 1–17. New York: Columbia University Press, 2006.
[15] Graham, Elizabeth. "Built Environment". In Erickson, C.L. "*The Domesticated Landscapes of the Bolivian Amazon"*
[16] From the greek word Epistêmê, it translates as *knowledge.* The term is often in philosophical discourse with technê or *craft/art* as embodied by the paradigm of knowledge/practice. See Parry, Richard, "Episteme and Techne", *The Stanford Encyclopedia of Philosophy* (Summer 2020 Edition), Edward N. Zalta (ed.) Accessed May 2020, https://plato.stanford.edu/archives/sum2020/entries/episteme-techne/.

key strategies to regularize and delineate land.[17] Water is key for human survival and thus infrastructure has become the "technical and organizational domain that underpins the functional dynamics of [both, urban and rural space]."[18] The Americas have never been an empty wilderness. Domestication and cultural practices had already transformed the land into humanized environments for hundreds of years. The *anthropogenic landscape* had long existed by the time Colonial rule was established.[19]

---

[17] Erickson, Clark.L. "The Domesticated Landscapes of the Bolivian Amazon." In *Time and Complexity in Historical Ecology: Studies in the Neotropical Lowlands,* edited by Clark L. Erickson and William Balee, 279-310. Columbia University Press, 2006.https://doi.org/ISBN-231-50961-8 (electronic).
[18] Gandy, Matthew. "Introduction". In *The Fabric of Space: Water, Modernity and the Urban Imagination.* MIT Press, 2014.
[19] See Clark Erickson, *The Domesticated Landscapes of the Bolivian Amazon,* Bryan Davis, *Wider Horizons of American Landscape,* and William Denevan *The Pristine Myth: The Landscape of the Americas in 1492*.

Part I: From Water to Dust, 1300s - 1800s

Figure 4: (Top) Departure from Aztlán
Figure 5: (Bottom) The Foundation of Tenochtitlan

[1300s-1521] Quest for the Mythical City

Mexica *episteme*

Teotl: "Notion of a [the] sacred quality [of the natural world], with the idea that it could be physically manifested in some specific presence - a rainstorm, a lake, or a majestic mountain"
Barbara Mundy in Death of Aztec Tenochtitlan, the life of Mexico City p.28

In *The Order of Things,* Michel Foucault describes *episteme* as "[that which] defines the condition of possibly all knowledge, whether expressed in a theory or silently invested in practice [in any given culture at any given moment]."[20] The Mexica were by no means the first group of people to settle around the lakes of the basin. The area of Central Mexico had continuously been inhabited for hundreds of years and by the time the Mexica arrived different groups of people had settled around the edge of the lake and developed successful agricultural techniques. Changing ecological epistemes, however, have been at the centre of the environmental transformation of the basin in the last 700 years. As political, technological and cultural conditions changed so did the *epistemes* that defined the environmental relationship made.

Core to all Mexica philosophical, theological and ecological discourse is its mythology. It dictated their understanding of the universe, natural phenomena and their role as humans on this Earth. Duality and balance are key concepts that form, order and contextualize the structure of a Mexica world-view. Deities embodied naturally occurring phenomena and represented opposing, contrasting qualities, often in conflict or battle, to provide equilibrium.[21] Extremely spiritual and philosophical, all life force on earth is fluid and manifests as *teotl*; "eternally self-generating, constantly permeating and shaping the cosmos."[22]

The Mexica *episteme* is very much rooted in *teotl* and facilitated the Mexica to establish a deep understanding of basin hydrology and its dependent ecology. Such acknowledgement is expressed in the very nature of *Nahuatl* language. Descriptive and poetic, the act of giving names to places and things illustrates the sensible, intuitive relationship between mythology, land and people.[23]

---

[20] Foucault, Michel. *The Order of Things*. 2nd Edition. London: Routledge, 1970, 183. Accessed online February 2020, https://doi.org.proxy.bib.uottawa.ca/10.432/9781315660301.

[21] For example, there were two deities for water: Tláloc, god of rain and agriculture and his sister Chalchiutlicue, goddess of lakes and seas, and often associated with 'unruly' waters such as floods.

[22] Maffie, James. "Aztec Philosophy." *Internet Encyclopedia of Philosophy.* Accessed January 2020, https://www.iep.utm/edu.aztec/#SH2a.

[23] The Nahuatl language has a very descriptive way of naming places and things. It is often straightforward and direct; relating to the geographic, geologic and water qualities of the places it represents. For example, *tlatelli* means 'earth mound'; *Ajusco* means 'place of water springs'; *Cauhtlapan* means 'on the earth where there are trees'; *Iztapalapa* means 'in the river of white flagstone'.' *Tlatelolco* means 'on the islet'; *Xochimilco* means 'place where the

There was no greater manifestation of *teotl* than the rich waterscape found in the basin at the time the Mexica arrived. Within the Mexica *episteme* the basin was a reflection of their own spatial perception of their mythic place of origin in *Aztlan*, which became a template for the new city of Tenochtitlan.[24] (Figure 3 and 4) Water was *the* key element in how spaces were produced, the strategies employed to do so, and the survival and prosperity of the region. The *altepetl* ('water hill') became the ideal conceptual and physical space to inhabit.[25] Such a mindset would see the development of ingenious strategies and infrastructure to successfully manage the fluctuating waters of the lakes, in effect, establishing the first wave of human intervention in the basin and *ground* level from which all future decisions would arise.

flowers grow'. See N.A., *"Anexo C: Toponimia y Geotecnia en el Valle de Mexico"* y N.A, "*Anexo D: Caracterización detallada de 30 tlateles prehispánicos"* for a more extensive list of examples that detail the relationship between language, naming, mythology, *teotl*, and landscape and how they help understand the way Mexicas saw their environment and their relationship to it.

[24] *Aztlan*, the mythical place of origin for the Mexica people is portrayed as a place surrounded by water. The founding of Tenochtitlan sees the city being founded on the convergence of 4 types of waters in the middle of the lake, an echo of the same conditions that characterized *Aztlan*.

[25]The religious and social importance of water as a source of life; and mountains as a geographical and spatial marker, and a symbolic space for their gods and ancestors became the political and social marker of independent city-states. Barbara Mundy expands further on the application of Lefbvres's production of space to Tenochtitlan, the way in which spaces in the city were created and how the act of *producing* space changed as the city transition from a Mexica space to a colonial space characterized by the Spanish *traza* (where Spaniards inhabited) and the rest of the city where the remaining indigenous population lived. See Barbara Mundy, *Death of Aztec Tenochtitlan, The Life of Mexico City.* 1st ed., Austin, Texas: University of Texas Press, 2015.

Figure 6.. (Top) The goddess Chalchiutlicue
Figure 7. (Bottom) Tenochtitlan c. 1537-1555. Mexica map illustrating their view and understanding of their fluid landscape.

Infrastructure of *Fluidity*

"It was the sacrifice of Chalchiutlicue that made the foundation of the city possible [..] it was the taming of the lakes in the fifteenth century that allowed the city to survive"
Barbara Mundy in *Death of Aztec Tenochtitlan, the life of Mexico City, p.49*

When Tenochtitlan was established in 1343, the Mexicas became aware of the abundance of water in their surroundings, its fluctuating nature and the risks they presented.[26] Employing methods of 'land reclamation,' the Mexica utilized mud from the lake bed to raise and create inhabitable *ground* 2 m above the level of lake Texcoco (the lowest point).[27] Water canals became their streets and canoes their method of transportation. The region, however, was a flood zone and as the city began to be built and grow its *limits* became as fluid as the lakes'. Lake Texcoco (a saltwater lake) was associated with the goddess Chalhuitlicue and was the most unruly of the lakes (Figure 5), becoming, as a result, a major threat to the city.[28]

Although much of the pre-conquest infrastructure has since disappeared (whether destroyed or appropriated and changed during colonial times), Figure 6 helps to paint a picture of what the basin looked like by the time Europeans arrived. The Mexicas were very much aware of the spatial relationships of the different rivers/streams in the region (seen as blue lines extending out into the landscape), and successfully learned how to *hold* water for their own advantage and developed, in turn, a sophisticated water management system in the basin. Through *calzadas* (causeways), *albarradones* (dams), aqueducts, storage tanks and canals, the Mexica transformed the look and balance of the region.

Earthworks

Causeways (shown as brown lines in Figure 6) were earthen constructions linked by bridges and had openings for the movement of canoes. They connected Tenochtitlan to land and major towns on the edges of the lakes and functioned as major throughways; some even performed double functions as open air aqueducts, carrying fresh drinking water into the city (shown as blue and brown lines in Figure 6). In addition, some of these causeways also served as dams, separating the lakes and providing operable gates to control the flow of water into lower lying lakes.

---

[26] The fluctuating nature of the lakes in the basin meant that during abundant rain seasons the five lakes would become one large interconnected lake, known as *Lake of the Moon*. When the levels decreased again the lakes would once again separate, only connected to each other with canals.

[27] The Mexicas would impale sticks on the ground, tie them together with woven reeds and fill the space with mud from the lakebed. This method would also be implemented in the construction of *chinampa* to successfully cultivate food and flowers. See Coe, Michael D. "The Chinampas of Mexico." *Scientific American* 211, no.1 (1964): 90-00.

[28] Because Lake Texcoco was the lowest point of the basin, all the rivers and lakes drained into it. Tenochtitlan was established within the expanse of its lakebed at ~2 m above the water level of the time. Xochimilco,Chalco, and Xaltocan were -3 meters higher than both Texcoco and Tenochtitlan, while Zumpango rose ~6m above Texcoco. In addition, the southern lakes were freshwater lakes, fed mostly by springs and rivers from the west and south; Zumpango, Xaltocan, and Texcoco were brackish water lakes due to minerals carried into the water from surrounding mountains north and east.

he fluctuating and shifting nature of the water meant that Lake Texcoco kept intruding into the city, often overflowing onto agricultural land. After a major flood in 1449, the *tlatoani* (ruler/king) of Tenochtitlan asked help from Texcoco's *tlatoani*, Nezahualcoyotl*,* to build a dam that would finally conquer the unruly Texcoco. The *albarradón de Nezahualcoyotl* (Nezahualcoyotol's dam) not only helped protect the city from overflowing salty waters of Lake Texcoco, it would help desalinate part of the lake and create a fresh water lagoon (Laguna de Mexico) onto which *chinamperia* expanded (Figure 8).

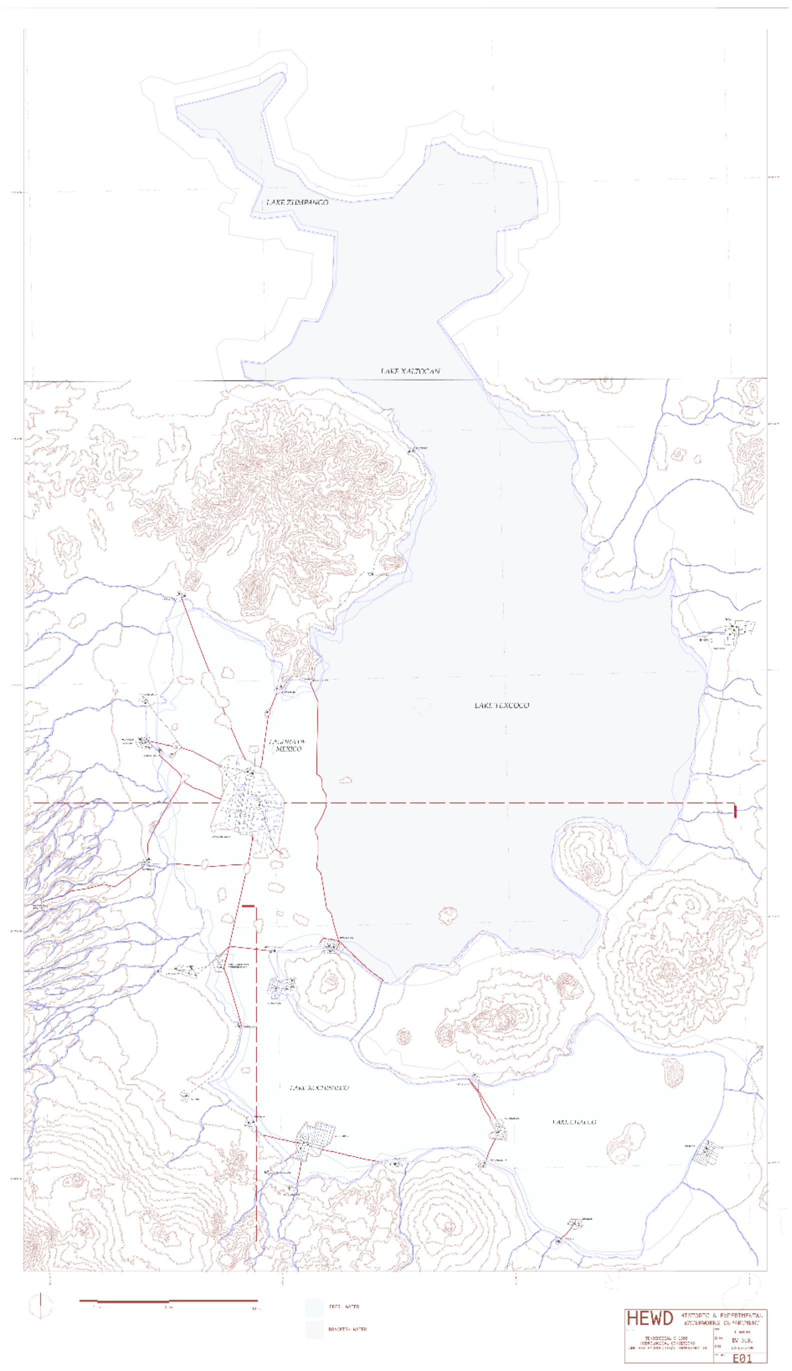


Figure 8. Map of Old Tenochtitlan c.1500

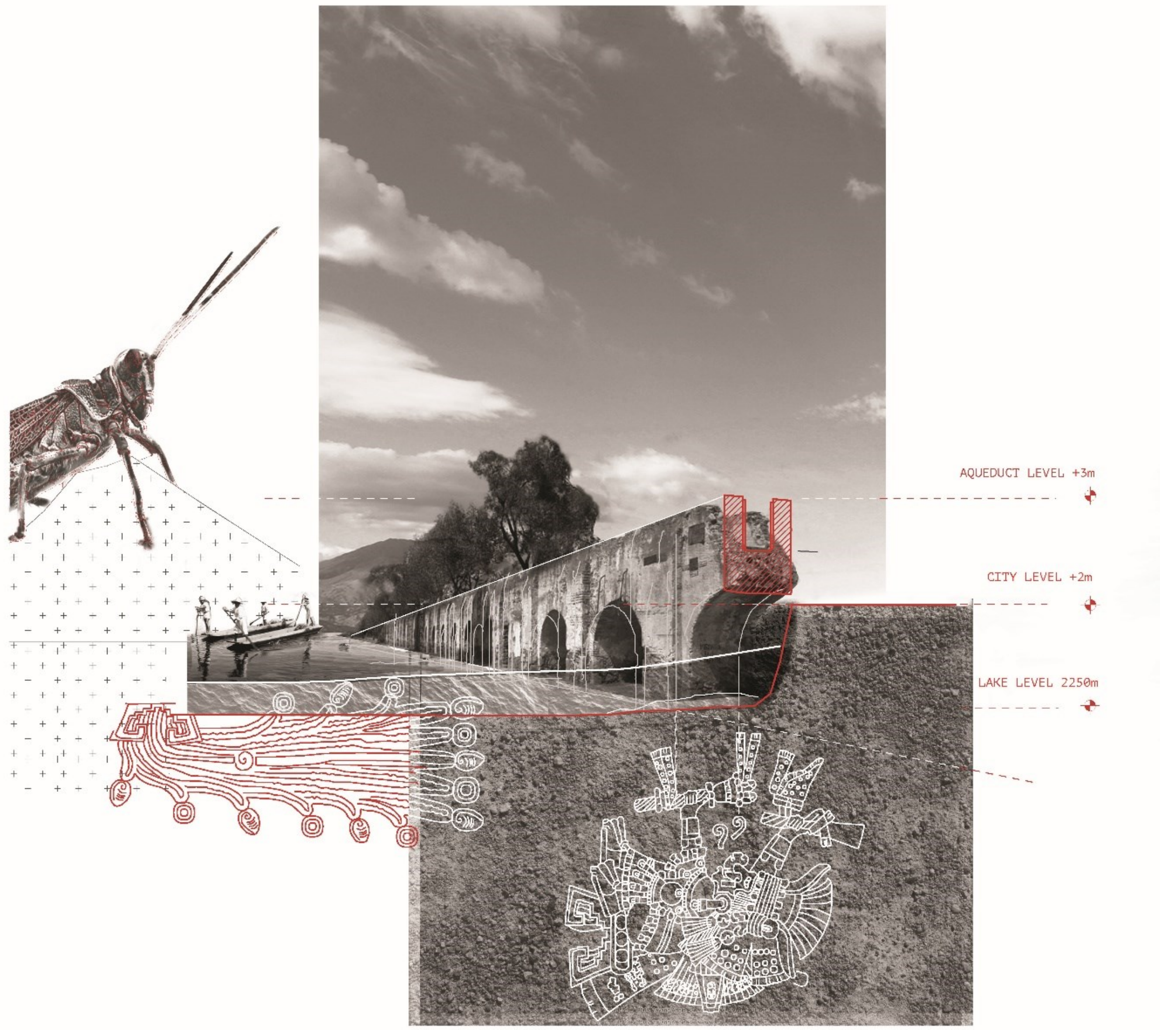


Figure 9. Collage that illustrates the relationship between *ground* and infrastructure. How it help to navigate the shifts by 'sacrificing' Chalchihuitlicue.

Chinampas

A ‘native land-reclamation’[29] strategy, chinampas are long and narrow artificial plots of land surrounded by water on at least three sides[30] (Figure 9). Described by German geographer as ‘reclamation through drainage’,[31] they are designed to *capture* moisture at the root level. Chinampas are created by carving out canals and *mucking* [32] sediment from the lakebed to raise ‘land’ above water level. Both sediment and mud provided organic-rich soil for agriculture. For structural integrity, while retaining porosity and seepage for irrigation the sides of the small plots were held in place by posts with vines and branches woven between them or by planting willow trees at the edges of the plots[33] (see Figure 10).

Figure 10. Modern day chinampas in Xochimilco. They are the only remaining example of the spatial characteristics of the fluid waterscape that once dominated the region.

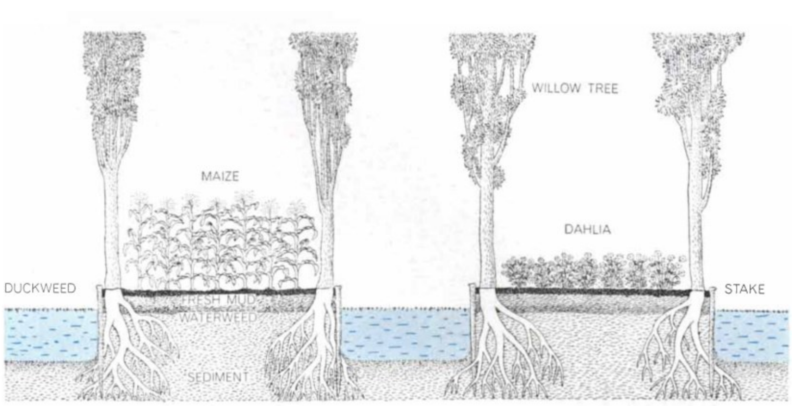


Figure 11. Cross section of chinampas and canals. It details its construction and relationship between water and soil.

---

[29] Armillas, Pedro. “Gardens on Swamps.” *Science, New Series* 174, no. 4010 (1971): 653.
[30] Coe, “The Chinampas of Mexico.”, 90.
[31] *Ibid.* 93.
[32] Mucking consisted of scooping mud and spreading it over the chinampa. Armillas, Pedro. “Gardens on Swamps.”, 653.
[33] Coe, Michael D. “The Chinampas of Mexico.”, 93.

[1521 - 1800s] Quest for the Hygienic City

Colonial and 19th century *epistemes*

"Colonialism was always about changing the land, transforming the earth itself"
Heather Davis and Zoe Todd. On the Importance of a Date, or Decolonizing the Anthropocene

"Europeans colonized the Americas with .. visions of former places but without the sight to appreciate the environment and cultures they were colonizing"
Berry and Jackson, 1994 in Andrew Sluyter, Colonialism and Landscape: Postcolonial Theory and Applications

The arrival of the *conquistadores* to Mexico brought about radical reconceptualizations and physical changes to the environment. What Narchi and Canabal Cristiani call *'subtle tyranny'*, the introduction of Spaniard views on land and water as fixed elements began to erode 'traditional ecological knowledge'[34] that saw them as *fluid*[35]. Notions of private property were introduced, in which the communal land practices of the Mexica were replaced by *individuals* (colonizers) who saw themselves as 'legitimate [owners]' of the land, with 'rights to [fully exploit and transform their surroundings]'[36]. This became evident with the division of land in *encomiendas*[37] after the fall of Tenochtitlan and later on through land grabs that characterized *haciendas*.

In addition, capitalist schemes of extraction required a new conceptualization of the relationship between man, land and water to suit European methods of pastoral economic production - livestock and grain production[38]. Rooted in mercantile capitalism, a shift in socio-political power saw the establishment of a class system in which the Spanish elite would eventually dominate. This meant that flooding became a *problem*. It was a risk to the accumulated wealth represented by property and land (in the form of rentiers and agricultural production) and a health threat to city-dwellers.

The protection of the city as a political symbol of Crown power, the economic gains it represented, and wellbeing of its citizens became *the* priority. As seasonal flooding continue to afflict the city[39], particularly the urban *elite*, the focus shifted from *containing* to *draining* water. The second wave

---

34 Traditional ecological knowledge is a cognitive system made up of knowledge, practices, behaviours, and beliefs by which local populations internalize the structure and ecological functioning of the geographic zone from which they get natural resources to fulfill their needs. See Narchi, Nemer E.. and Beatriz Canabal Cristiani. "Subtle Tyranny: Divergent Constructions of Nature and the Erosion of Traditional Ecological Knowledge in Xochimilco." *Latin American Perspectives* 42, no. 5 (2015): 92, https:// doi.org/10.1177/0094582x15585118.

35 See Candiani, Vera S. *Dreaming of Dry Land: Environmental Transformation in Colonial Mexico City.* Stanford University Press, 2014 https://doi.org/10.11126/stanford/9780804788052.001.0001.

36 Nemer and Canabal Cristiani, "Subtle Tyranny: Divergent Constructions of Nature and the Erosion of Traditional Ecological Knowledge in Xochimilco.", 91.

37 An eoncomienda consisted of a crown grant to a conquistador/soldier of a specific amount of Indigenous labour in the area. They could extract tribute and although it was not a land grant it afforded colonizers to control land inhabited by Indigenous Mexiccans. "Encomienda". Encyclopedia Britannica. Accessed May 2020. https://www.britannica/com/topic/encomienda.

38 Candiani, *Dreaming of Dry Land: Environmental Transformation in Colonial Mexico City,* 32

39 There was a particularly devastating flood in 1629 that lasted 5 years.

of intervention in the basin consolidated the Spanish state[40], perforated the basin for the first time and began the process of *desiccation* that would permanently alter the hydrology of the region. Dry land would no longer be a dream.

The political and economically driven agenda of drainage, together with the continuous expansion of capitalistic urbanization[41] carried on after the fall of colonial rule and the rise of an *Independent* Republic. The land-water-city relationship continued to be defined by the rigid, fixed views inherited from Spanish rule, but now the newly established government had to find a way to address the city-hinterland dynamic. Still relying on pre-Hispanic traditions and the *fluid* nature of land and water for economic activities and sustenance, 19th century environmental *episteme* became a technocratic rule centered around *sanitation*.

This not only altered the relationship of the city to its surrounding lakes, but also the spatial qualities of the city itself. Growing urban expansion and concern for urban health meant canals and rivers became undesirable. Their water, fouled by human waste, drained into Lake Texcoco and transformed it into a fetid environment[42]. Eradication or concealment became a tool in the process of *drainage* and slowly started to eliminate water from the inner spaces of the city. Sanctioned through political ideologies and regularization, infrastructure and manipulation of the landscape and water allowed the government to consolidate power and dictate the *urban environmental imaginary*[43]. Sanitation efforts continued the narrative and materiality of *desiccation* in the basin, becoming the third major human intervention, the second perforation in the basin and the beginning of radical shifts in notions of *ground*. Dry land started to become the norm.

---

[40] Candiani, *Dreaming of Dry Land: Environmental Transformation in Colonial Mexico City,* 47.

[41] Vitz, Matthew. *A City on a Lake: Urban Political Ecology and The Growth of Mexico City.* Duke University Press, 10.

[42] Candiani, *Dreaming of Dry Land: Environmental Transformation in Colonial Mexico City*.

[43] Matthew Vitz explains in detail the role urban sanitation had in interlocking city and hinterland in an environmental discourse. The *urban environmental imaginary* was a set of suppositions about the city's environment and its relationship with the hinterland. It originated during Spanish rule and was carried on by a group of professional *elites*, usually scientists and engineers. Vitz, *A City on a Lake: Urban Political Ecology and The Growth of Mexico City,* 20.

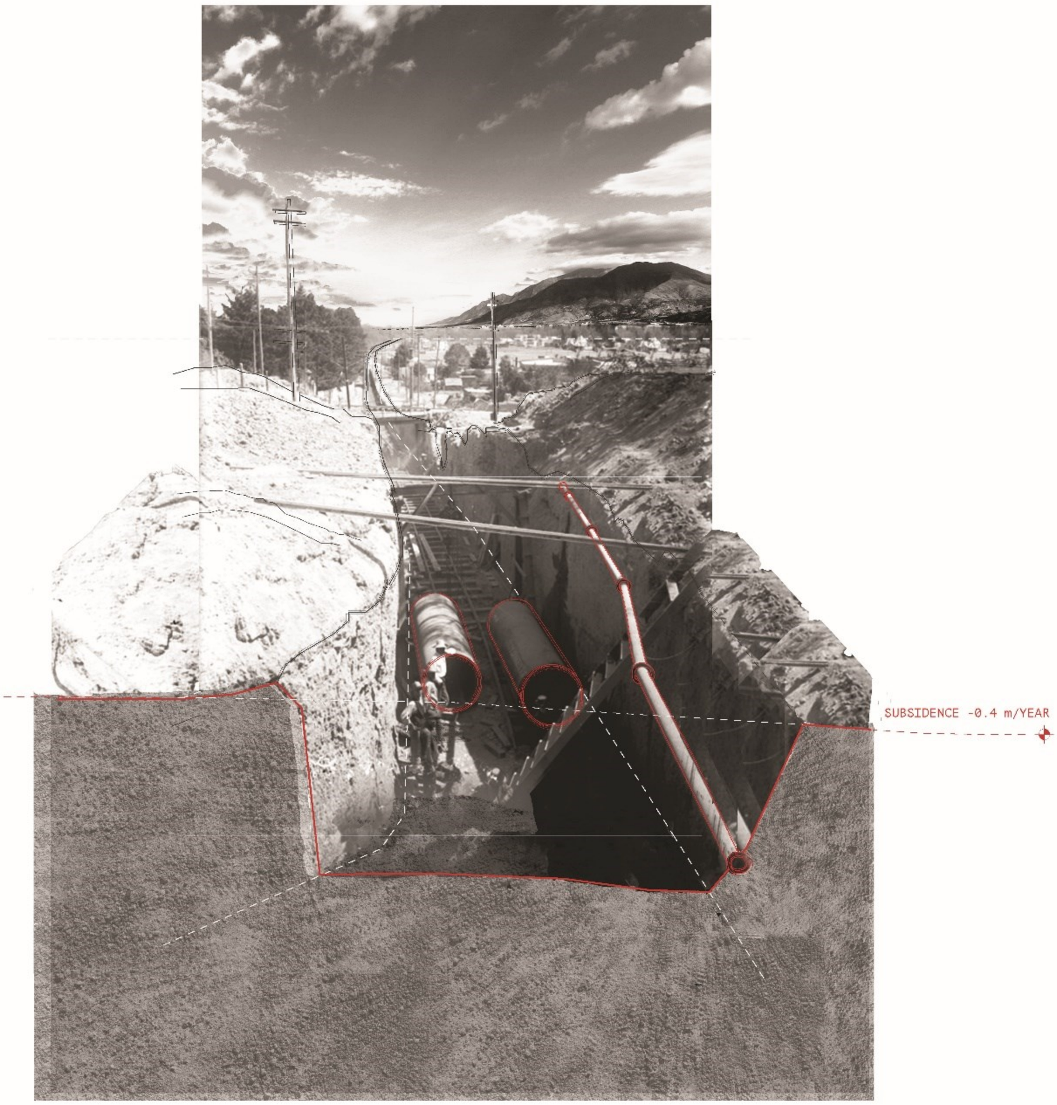
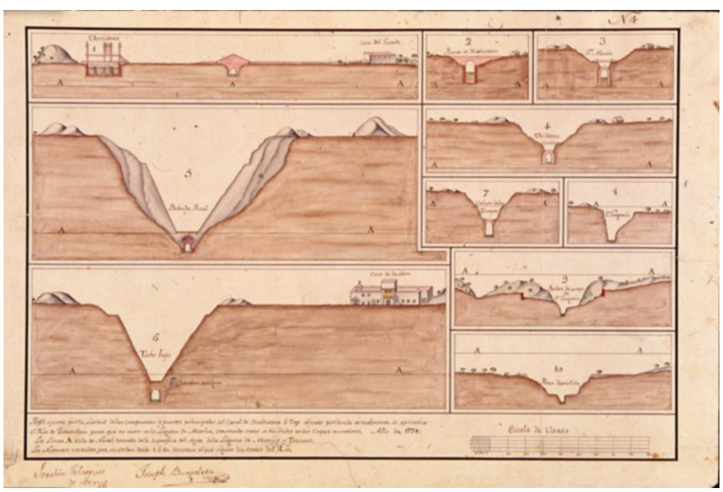


Figure 12. Collage that shows the extent in which the *ground* was intervened and manipulated for the purpose of *desiccating* the landscape. Water was pushed underground and concealed to reveal a ‘cleaner’, dry landscape.

Infrastructure of *Dessication*

Túnel (tunnel) de Huehuetoca/ Tajo (trench) de Nochistongo

At an elevation +6 m above Lake Texcoco, Colonial elites identified Zumpango and Xaltocan (+3 m above Texcoco) as the major contributors to the disastrous floods afflicting the city[44]. Envisioned by cosmologist Enrique Martinez the tunnel was set to traverse through the northwest mountains of the basins until it joined the Tula River. The aim of the project was to drain the dangerous waters of the Cuautitlan River, preventing its waters from feeding into Lake Zumpango and Xaltocan, and eventually draining the lakes. Construction began in 1607 and although promising at first, issues with the soil[45] in the tunnel resulted in erosion and collapse. Water-borne silt also presented a challenge, often becoming a barrier for the free flow of water and decreasing the depth of the tunnel by sedimentation. In 1629, the city suffered a catastrophic flood that lasted 5 years. An eventual decision was made to open up the tunnel and transform it into a trench. The *tajo* took 150 years to complete and involved extensive *manual* labour to excavate ~ 16 million m^3 of earth. The varying topography of the region saw a drastic re-manipulation and changes to its profile, always mindful of the elevation the bed of the tunnel had in relation to the lakes it was supposed to drain (see Figure #). The project was successful in starting the process of *desiccation* by restricting the amount of water discharged from the northern lakes into Lake Texcoco.



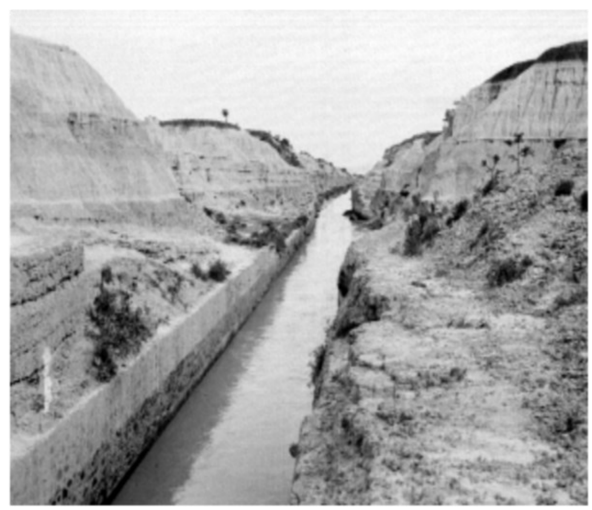


Figure 13. (Left) Cross sections along the length of the Nochistongo tunnel. Shows how the profile changed and shifted in relation to Lake Texcoco as it moves across the landscape.
Figure 14. (Right) View of the completed transformation from tunnel to open trench.

---

[44] Candiani, *Dreaming of Dry Land: Environmental Transformation in Colonial Mexico City*, 16.

[45] *Ibid*. The geologic characteristics of the soil in the basin presented several challenges. The clay soil had a high water content and the volcanic rock (*tepate*) was the major source of soil instability, being particularly vulnerable to erosion.

Túnel de Tequixquiac and Gran Canal de Desagüe

Continuous floods and increasing concerns with wastewater furthered the *desiccation* agenda. In 1857 Lake Texcoco began to be drained. Envisioned by engineers Luis Espinoza and Francisco de Garay, the 50km drainage canal ran from the northeast corner of the city in San Lazaro north to Lake Zumpango. There, a second tunnel, 11 km long, pierced the basin until it reached the town of Tequixquiac. The canal and tunnel once again changed the profile of the basin, manipulating the ground with new depths of up to 100m[46]. In addition, the large-scale project implemented a dam with operable doors to control the flow of the canal (see Figure#), becoming an engineering and architectural marvel of the time. The canal still operates to this day but has lost efficiency due to subsidence.

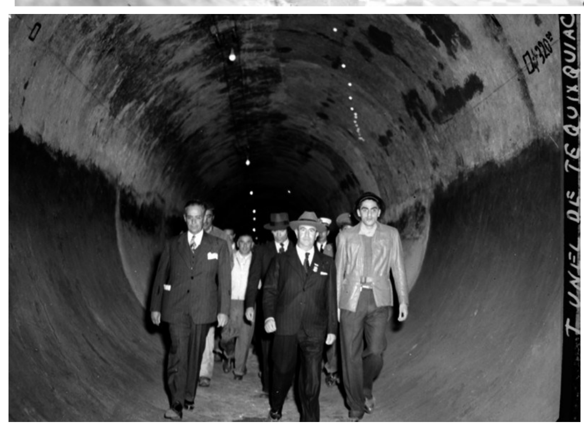


Figure 15. (Top Left) View of the canal's *compuerta* (gate) during construction.
Figure 16. (Top Right) Public access and view of the canal's compuerta (gate) on inauguration day.
Figure 17. (Bottom Right) View of the completed Tequixquiac tunnel
Figure 18. (Bottom Right) Government Officials inspecting the Tequixquiac tunnel. It demonstrates the larger scale of intervention that began to take place in the basin.

---

[46]Legorreta, L." Más Siglos, Más Túneles... y Más inundaciones En la Ciudad de México. Hacia el Cuarto Centenario de la Edificación de Túneles en la Ciudad.*"* In *Innovación Tecnológica, Cultura, y Gestión Del Agua*, edited by Delia Contreras Monter, Eugenio Gómez Reyes, Graciela Carrillo González, and Lilia Rodríguez Tapia, Primera ed., 231-41. Ciudad de México: Miguel Ánge, Porrúa, 2009.

Sewage Systems: the beginning of the end for urban rivers

Under the direction of engineer Roberto Gayol the first comprehensive sewage network in the city began. Collectors, lateral pipes and street sewers began to be implemented across the city.[47] The sewage system worked in tandem with the *Gran Canal* to evacuate both wastewater and stormwater from the city. Pipelines could go from 30 to 50 m below *ground* and also required extensive excavation. As the city began to grow, the sewage system expanded required size and depth upgrades in turn.

Figure 19. Sanitation efforts. Installation of sewage systems across the city.

Figure 20. (Left) Canal de La Viga. Popular canal connecting southern communities to the city. It was used as leisure and to transport goods into the city.
Figure 21. (Right) Sanitation efforts. Garita de la Vega after as it was drained to build a road in its place.

---

[47] Vitz, *A City on a Lake: Urban Political Ecology and the Growth of Mexico City*, 20.

Part II: From Dust to Concrete, 1900s - 2000s

Figure 22. (Top) Cyclists crossing across the dry, barren and dusty Texcoco lakebed.
Figure 23. (Bottom) View of a flooded street in 1950.

[1900s] Quest for the Modern City

20th Century *episteme*

"The transition towards 'modern water' [took place] throughout the industrialized world by the end of the 19th century [..]"
Jeffrey Banister and Stacie Widdifield, The Debut of 'Modern Water' in early 20th century Mexico City: The Xochimilco Potable Waterworks

"The material connections with water remain pivotal to the transformation of 'first nature' under the rationalizing impulse of modernity"
Matthew Gandy, Introduction in The Fabric of Space: Water, Modernity and the Urban Imagination

By the turn of the century, a political consolidation of a Mexican nation ruled over a partly drained and dry basin. The break from pre-Hispanic *fluid* water-land relationships into a *fixed*, *rigid* and *economically* driven commodification of both land and water would deepen, setting the stage for a future era of difficult water policy and relations in the basin. Despite previous *drainage* efforts, floods still afflicted the city. Backed by a group of urban and scientific *elite* that echoed the Colonial-era concerns of *salubrity* and flood *protection, desiccation* prevailed[48].

Within the changing social milieu of *modernism* and the technocratic *urban environmental imaginary,* infrastructure became the governmental strategy to consolidate power as a political entity, centralize control over the country's natural resources (especially water) and establish Mexico City as a cosmopolitan centre on the global scale. The scientific elite at the helm of political decisions furthered the rigid division of land and water, embracing 'rational and capitalistic' uses of nature. Industry, manufacturing and large-scale agriculture claimed land and water resources of the basin, taking precedence over the last remaining Indigenes[49]. Land speculation and urbanization fueled by a capitalist economy created a further need for *sanitation* and flood prevention. Infrastructure became the backbone of urban spatial growth *and* spatial inequalities[50].

---

[48] Matthew Vitz argues that despite scholarship suggesting desiccation to be the *only* strategy, there were also 'paladins of a healthy lacustrine environment such as an American lieutenant and doctors José Lobato and Río de la Loza' and 'champions of lake restoration' such as engineer Manual Balbontín and doctor Ladislao de Belina. (Vitz, *A City on a Lake: Urban Political Ecology and The Growth of Mexico City,* 32). Notions of continuing to manage water in the basin rather than draining it were not new. The ideas of these techno elites echoed Flemish Military engineer Adrian Boot's 1614 proposal of flood control and management. Utilizing strategies similar to those used in the Lower Countries (now The Netherlands), Boot argued for the economical and ecological benefits and advantages of keeping the lakes and *gathering* water rather than draining it. However, his proposal was refused by Mexican elites since it did not serve their economic interests of protecting rentier property. (See Candiani, *Dreaming of Dry Land: Environmental Transformation in Colonial Mexico City*)

[49] The shrinking of the lakes also saw a decline in the economic advantages they could gather from what remained *fluid* in the basin. Farming, fishing, hunting, capturing birds, and gathering of plants became increasingly difficult.

[50] A big revolutionary and post-revolutionary agenda consisted in providing people, particular lower classes and Indegens access to land ("*Tierra y Libertad"* and the Reforma Agraria) and thus water. Reestablishing the 'rights' to these resources in the hinterland was a big motivation in the decision to take part in a series of *Obras Publicas* (Public Works) across the country. Unfortunately, clear objectives on paper did not often materialize spatially, and if they did, tended to favour those with means (economically and socially). See Vitz, *A City on a Lake: Urban Political Ecology and The Growth of Mexico City.*

In addition, by this point in time, the city was not only grappling with continuous *excess* flood waters, but also with *insufficient* fresh water to meet the increasing demand of its growing population and economic activities. By 1853, existing aqueducts became insufficient. Artesian wells were dug around the city, tapping into the underground city's aquifer[51]. Perhaps unknowingly, in pumping underground water, the city introduced a new player into the water-land dynamics that impact flooding: *subsidence*[52]. By the end of the 1940s, civil engineer and UNAM director Nabor Carrillo openly called to attention the interconnectedness between pumping water and soil compaction. He noted that since the 1890s the city had slowly been sinking. Additionally, deeper well excavation since the 1930s had further accelerated uneven subsidence throughout the city[53], placing the level of the city below that of Lake Texcoco[54]. Once again, large-scale infrastructure allowed for the 'careful construction' of the spatial relationship city-water-and people had. Tapping into water far outside the city, *concealment* became the method of control to try and quench the thirst of the city[55].

Unfortunately, the unforeseen urban and population explosion that has taken place since the 1940s has transformed the environment of the basin on a scale like never before. In the name of salubrity, three new perforations to the basin have resulted in *the* largest scale sanitation and provision schemes in the basin to date. All to no avail.

---

[51] Candiani, *Dreaming of Dry Land: Environmental Transformation in Colonial Mexico City,* 319. Artesian wells reached a depth of up to 150 m.

[52] *Ibid*. Since Tenochtitlan was founded and grew out of infill, notions of *compaction* were not new. As early as the 1630s people had already observed heavy stone buildings sinking. Placed atop clay soils, the Mexica (and later Spanish) platforms on which the city sat had been compacting the lakebed for years. As water began to be removed via desiccation and wells, the soil and aquifers faced lower rates of recharge and loss of moisture. The loss of hydrostatic pressure within the aquifer began to further compact the granular molecules of both the clay and more porous sediments on which the aquifer sat, resulting in *subsidence*.

[53] Differential subsidence can be attributed to the infill techniques and practices that took place after Colonial rule was established. The Mexica city of Tenochtitlan utilized a 12m thick platform with a stone foundation to support the weight of buildings and people. However, after Spaniards gained control of the city, as the city expanded new infill took place at the edges of the pre-Hispanic city. The problem was that the thickness and materials of new platforms deferred from the original used by the Mexica. As such, the compression exerted by these newer infills varied from that of the older platform. For this reason, as soils were being compressed unevenly and water began to be extracted, the different infills began to subside at different rates. Deeper wells, often for 'public' use reached a depth of up to 500 m.

[54] With an initial elevation difference of +2 m, Mexico City sat above Lake Texcoco (the lowest point in the basin). By the end of the 1940s it is estimated the heart of the city had sunk to ~-9 m.
Increased sedimentation by the 19th century was also a major cause for the elevated *ground* of Lake Texcoco. Silt deposits reduced the Lake's depth and holding capacity and brought it closer to the surface level of the city. As such, water coming from rivers west of the basin into Lake Mexico could not drain into Texcoco. The risk of water being trapped in the city increased as sedimentation increased.

[55] Sewage and potable water networks are particularly vulnerable to subsidence. Continued subsidence and earthquakes have resulted in fractures and fissures. Leaks, reduced or all together changed slopes, have led to systems becoming inefficient, often requiring pumping to work. It is estimated that about ~33% of potable water is lost to leaks.

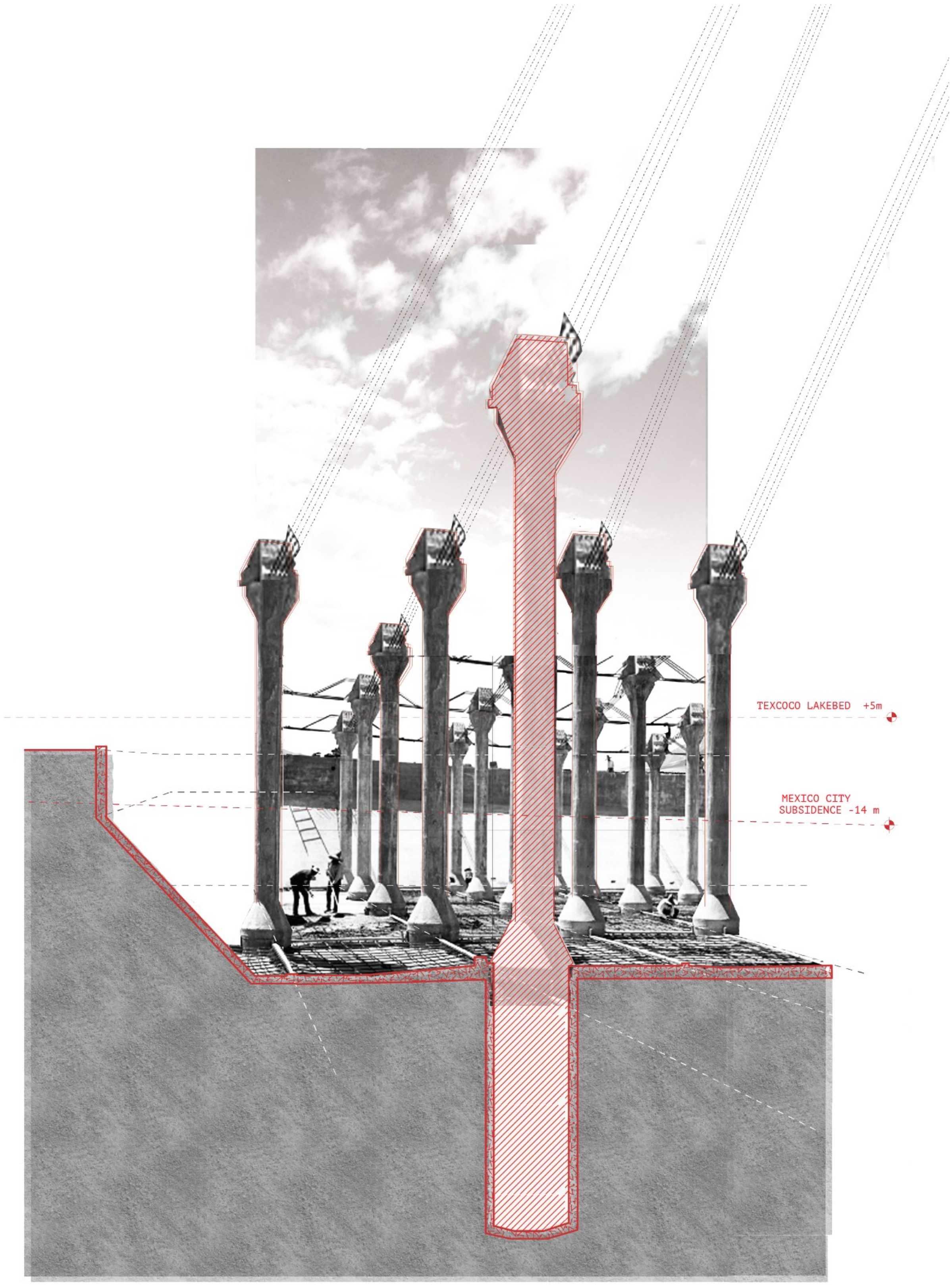


Figure 24. Collage illustrating the construction of a massive water supply tank. By this point the scale of manipulation and intervention had increased in order to meet the demands of an urban giant. Infrastructure became another layer within the shifting *ground-scape* of the city.

Infrastructure of ‘*modernity’*

“Water lies at the intersection of landscape and infrastructure, crossing between visible and invisible domains of urban space”
Matthew Gandy, Introduction in *The Fabric of Space: Water, Modernity and the Urban Imagination*

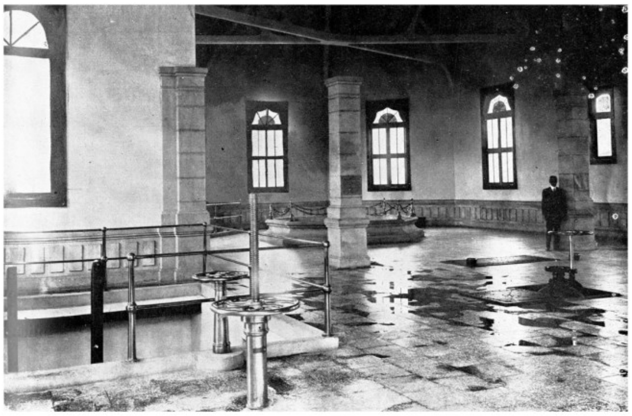
“Hydraulic megaprojects [were] one of the major indices of modern water [...] built to simultaneously address major urban water provision and hygiene problems, and to demonstrate the *advent of modernity* in their respective metropoles”
Jeffrey *Banister and Stacie Widdifield, The Debut of ‘Modern Water’ in early 20th century Mexico City: The Xochimilco Potable Waterworks*

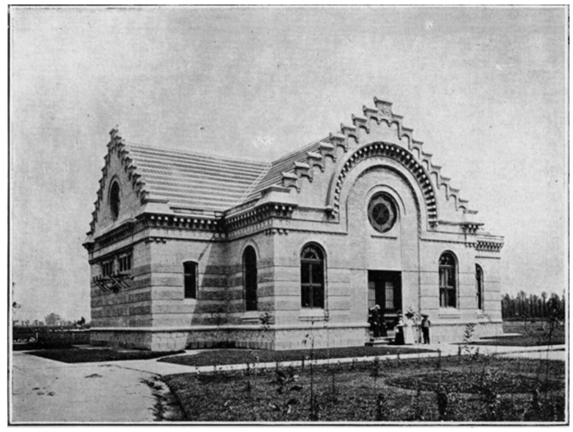
Xochimilco Aqueduct

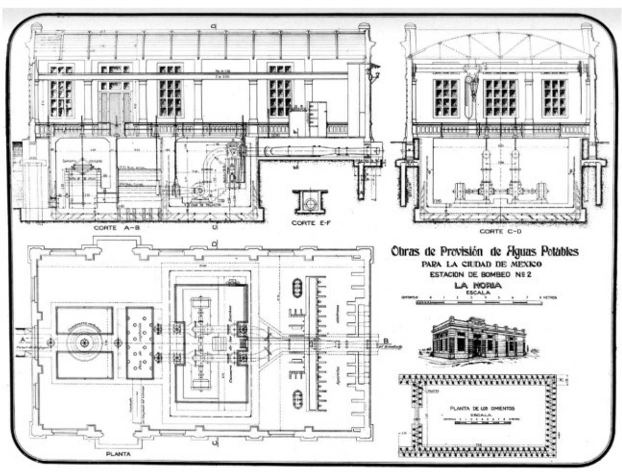
At the beginning of the 20th century the need for potable water had increased just as rapidly as the urban population. Known for their abundant freshwater springs, the southern region of Lake Xochimilco became the government appointed new supplier. The project began in 1903 and marked the ‘debut of modern water’[56] in Mexico City. Reducing the complexity of water down to simply *nature*, the technocracy employed infrastructure to exert control and finalize the conceptual divide between water and land that had begun in colonial times. Driven underground, water was abstracted and made ‘legible’ by allocating specific and controlled spatial instances for its use[57].
The project is peculiar in that it has a definite architectural expression that still survives to this day. Exquisite architectural detail was put into the design and construction of the pump houses (Figure 27-28). More than a political symbol, architecture becomes an infrastructural tool to establish ‘domain’ over water, both visually and conceptually. The architecture of the pump houses and storage tanks engaged with the *subterranean*, creating a separate architectural space for water (Figure 25 and Figure 29). The constructed experience of potable water further solidified the rigid separation of land and water, setting the stage for the future strategies.

---

[56] See Banister, Jeffrey M., and Stacie G. Widdifield. “The Debut of ‘modern Water’ in Early 20th Century Mexico City: The Xochimilco Potable Waterworks.” *Journal of Historical Geography* 46 (2014): 36–52. https://doi.org/10.1016/j.jhg.2014.09.005.
[57] *Ibid.* 38, 44







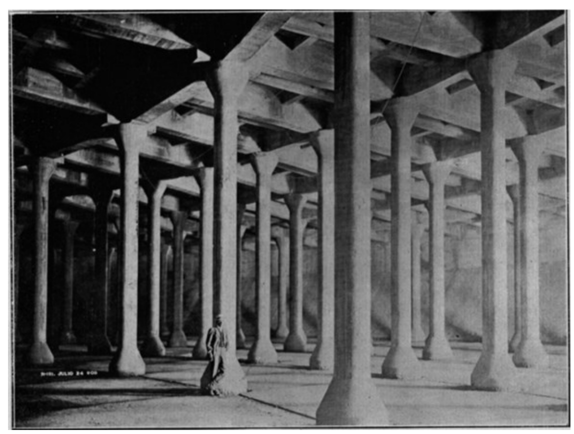


Figure 25. (Top Left) Interior of the Pump House at Nativitas.
Figure 26. (Top Right) Pump House at Nativitas
Figure 27. (Bottom Left) Plans and Sections of the Pump House at Nativitas
Figure 28. (Bottom Right) Interior of a distribution tank. Visitor standing next to the pillar gives a sense of the spatial scale this underground tank possessed.

Cased rivers

The modern ideal of visual separation was also applied to the remaining open rivers within the city. Infrastructure provided the means to 'control' water within the city, in some instances creating 'open space' for other uses such as parks or the subway (Figure 30). Encased in concrete the rivers are utilized as sewage, carrying away both waster and rainwater. Within the city, water is hidden and forgotten, just another layer in the shifting reality of urban growth under economic modernization.

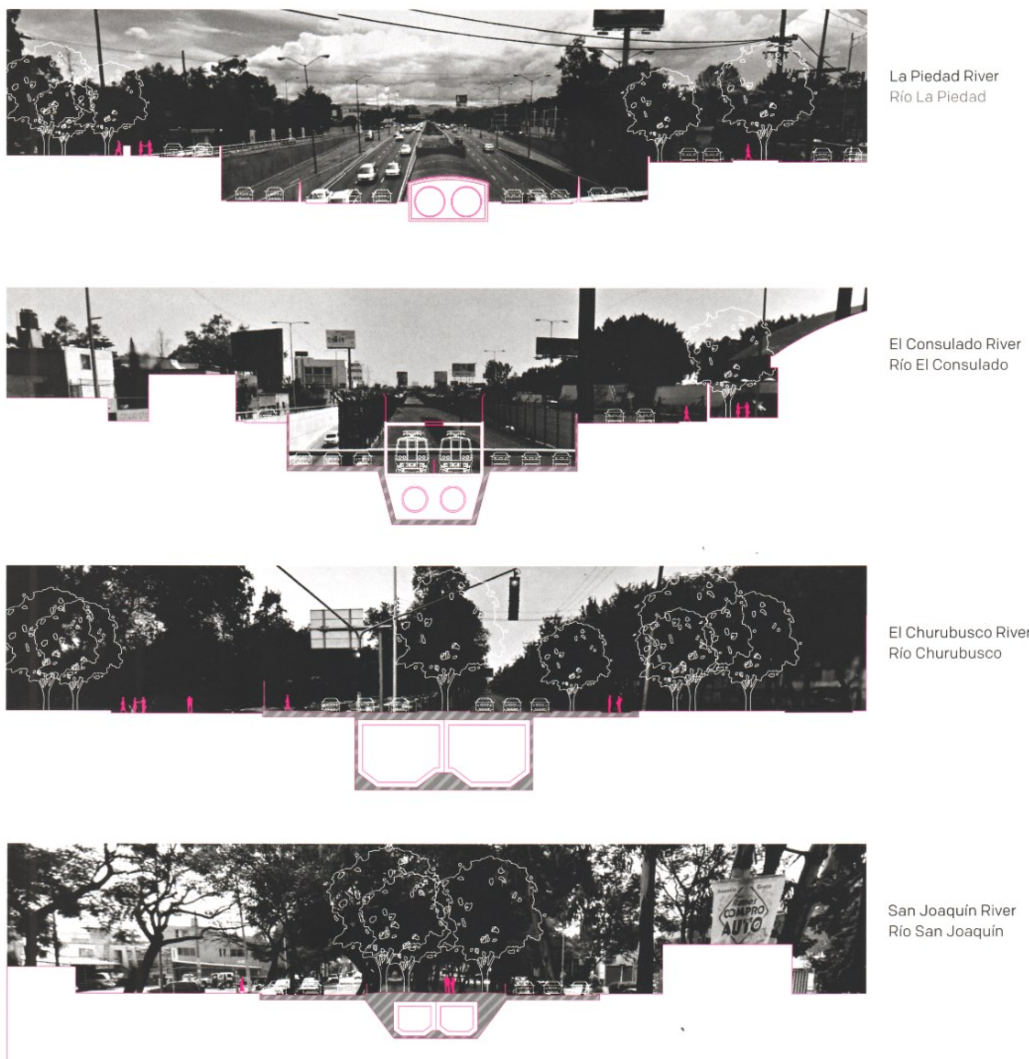


Figure 29. Sectional cuts along four cased rivers in the city. The drawings demonstrate how water exists underground in relation to the varying levels of *ground* that exit in the city.

Drenaje Profundo: Emisor Central, Interceptor Central and Interceptor Oriente

By the mid-20th century the rate of subsidence in the city had left the previous Gran Canal inefficient. As the ground sank, the slope of the canal was reversed and while the lakes had all but dissapeared floods were still a problem. Despite putting pumping statinos in place along the Gran Canal to help move water out a severe storm in 1950 (Figure 24) saw the need for more.

The *Drenaje Profundo* (Deep drainage) saw the implementation of the largets intervention in the basin to date. Reaching a maximum depth of about ~240 m (Figure 32), two collector tunnels (Interceptor Central and Oriente) expand across the city and connect into the *Emisor Central*, a 6.5 m diameter tunnel that carries the water out of the city and into the Gulf of Mexico (Figure 31). Similar to the Gran Canal, the tunnel cuts through the shifting geology and topography of the ground, creating a new spatial domain for water.

In 2019, a new tunnel (Tunel Emisor Oriental) was completed. Adding another layer to the efforts made to desiccate the basin and creating yet another way to continue the rigid separation of land and water.

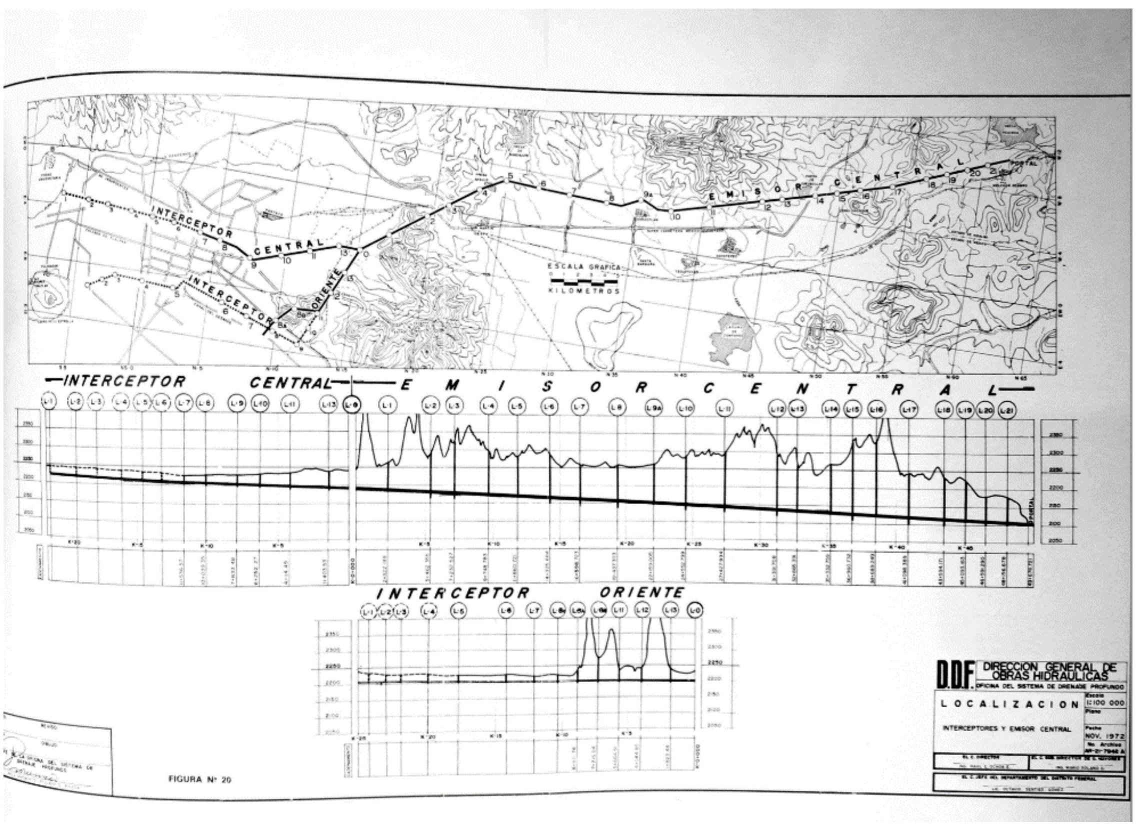


Figure 30. (Top) Sectional profile that shows the relationship between ground and depth of the drainage system.

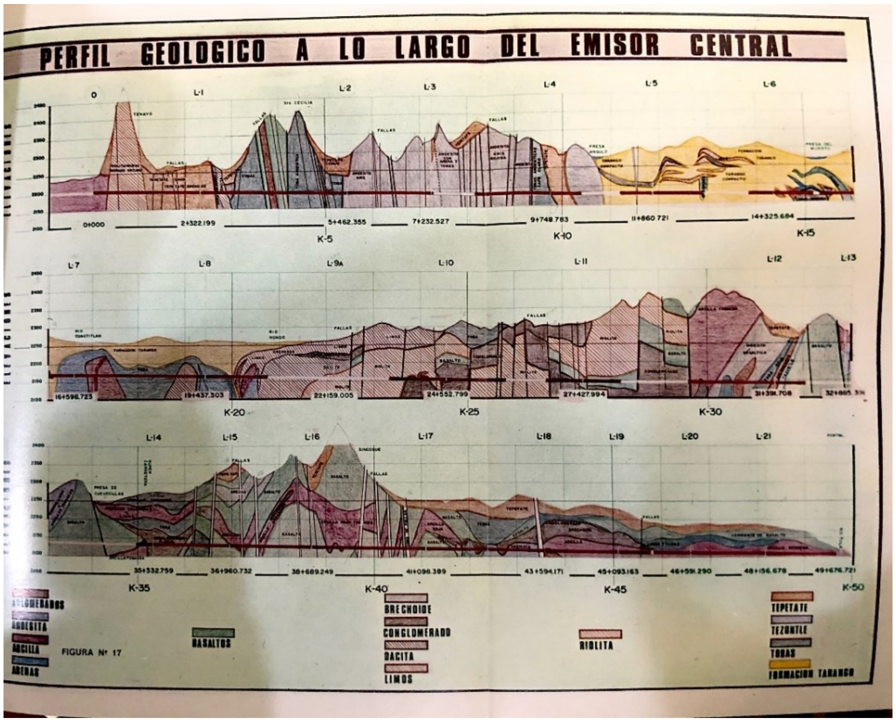


Figure 31. (Bottom) Sectional profile that shows the relationship between geology and depth for the drainage system.

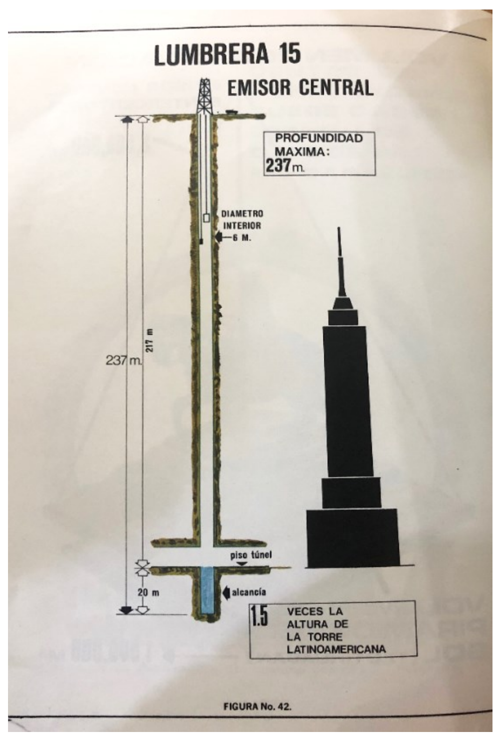


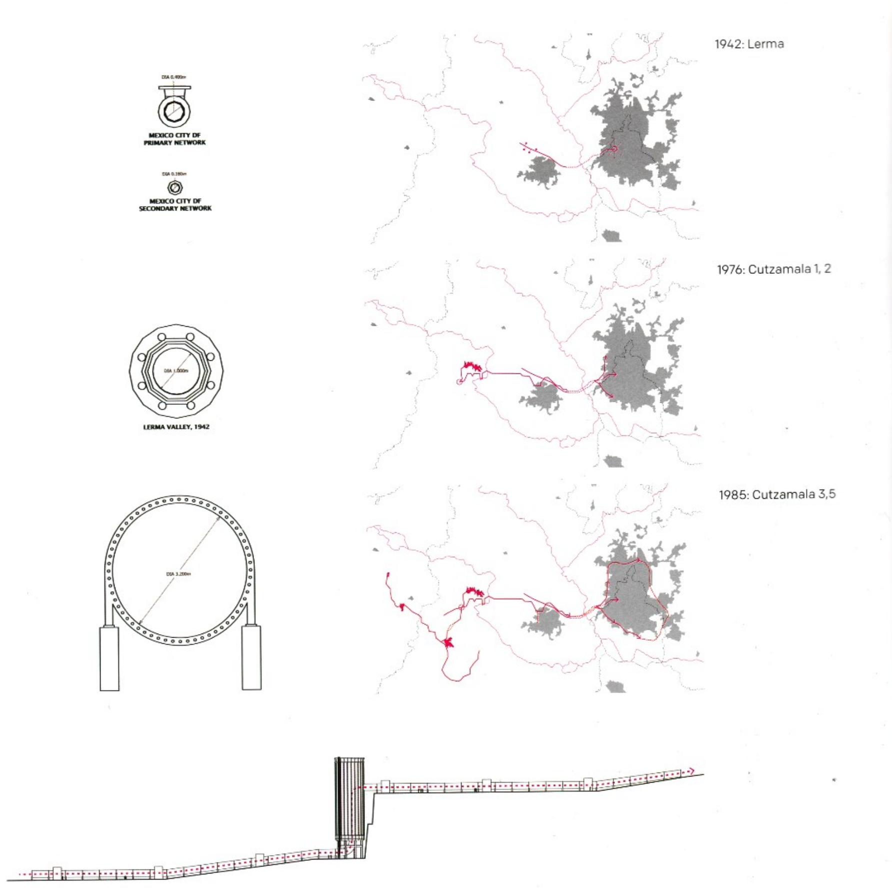
Figure 32. Illustrative posters showing the scale of the project. (Left) The width and height of the tunnel can fit a full-size military statue. (Right) The maximum depth reached (237m) is compared to the Latinamerican tower for scale.

Lerma and Cutzamala systems

The rapid urban expansion has led to a scarcity of potable water in the city. Distribution and access are highly spatial and continually contested; residents more often than not rely on pipas (water trucks) to supply their needs. After the spring waters feeding the Xochimilco aqueduct dried up and aquifers were being depleted faster than they could recharge the government acknowledge the need to find new fresh water sources. The solution: tap adjacent basins.

Three separate projects have put in place to collect, transport and distribute fresh water from the adjacent Lerma-Cutzamala basin. Begun in the 1940s, the Lerma system saw the implementation of pipes, pumps, and dams to utilize capture and utilize the waters of the Lerma river. Like the drainage efforts, the system engages across shifting topography and geology, moving water into the city. However, as urban and economic growth continue to expand so did the need to bring more water from the vicinities. By the 1970s, a new system was put in place, this time the reach extended onto the state of Michoacán, in order to tap the waters of the Cutzamala river (Figure 34).

The scale of the projects has increased in magnitude as the need for water becomes more urgent in the city. The modern idea of *invisible* aimed to provide a controlled supply of water for the city. The reality, however, is far from that.



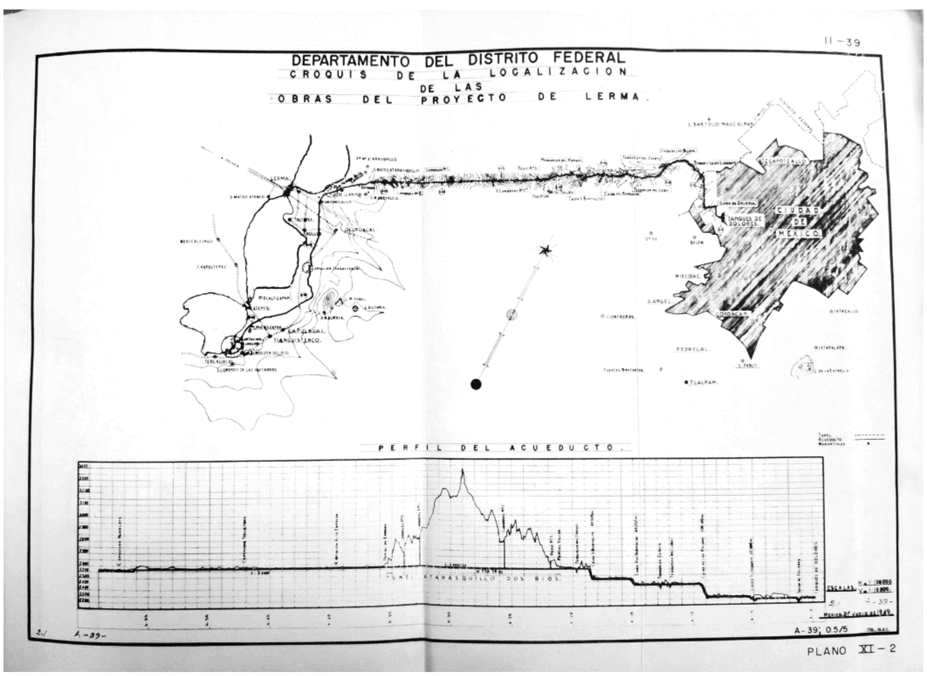


Figure 33: (Top) Evolution of the water supply system for Mexico City. Greater The system is reaching farther into adjacent basins and has increased in scale in an attempt to manage demand.
Figure 34. (Bottom) Location and sectional profile of the Lerma aqueduct. Water and infrastructure engage and navigate across shifting elevations and soil conditions.

Figure 35. Existing urban conditions. Automobile infrastructure and urban development dominate. Spatial movement across the city is experience within several *shifts* of the ground plane.

[2000s] Quest for the Ecological City

Desiccated City

“Mexico City is a palimpsest of infrastructures, urban design, physical transformation, and settlement patterns [...] Urbanization has operated on multiple spatial scales, spanning the city and its hinterland”
Matthew Vitz, City on a Lake, p.8

“The production of nature, including water infrastructure, has facilitated the expansionary impetus of capitalist urbanization”
Matthew Gady, Introduction in *The Fabric of Space: Water, Modernity and the Urban Imagination*

By the end of the 20th century, Mexico City was an urban monster. Between the 1960s and the 2000s, its urban population grew from 5.1 million to just over 18 million[58]. Dry land, as envisioned by the colonial elite, *is* the reality. The waterscape of times past is a mere ghost in the spatial fabric of the city. What once was free running water across the landscape is now the daily flow of traffic and city life. The city has taken over.

As the urban footprint of the city grew by 336.5 % in seven decades[59], infrastructure has once again led the way to reconceptualized notions of *ground*, *water* and *land*. Battling for space in the tightly packed city, soaring highways expand across the city and underground tunnels pierce the earth beneath. As you move across the city horizontally, you also *fluidly* move across it vertically. Water is gone. More than that, water and land have been replaced by asphalt and concrete. The only evidence of the *fluid* past of the region are the few remaining vestiges of the lakes: Zumpango to the north, Xochimilco and Chalco to the south and the dry, vacant lakebed of Lake Texcoco to the east. *Flooding* and *drought,* however, remained, and increase in frequency and severity[60].

Despite the extensive infrastructure put in place[61], overexploited aquifers and further *subsidence*[62] have resulted in a consistently flawed water management system of cracks, leaks and inefficiencies (Figure #). Water is still highly contested and its spatial distribution continues to be highly unequal. Growing concerns of climate change put a larger emphasis on the unsustainability

---

[58] Gutiérrez de MacGregor, María Teresa, “Evolución del crecimiento espacial de la Ciudad de México en relación con las regiones geomorfológicas de la Cuenca de México.” In *Geografía Para El Siglo XXI. Series Libros de Investigación, Núm. 7: Estudio Sobre Los Remanentes de Cuerpos de Agua En La Cuenca de México, edited by Raúl Aguirre Gómez, 15–39. Universidad Nacional Autónoma de México, 2010.*

[59] *Ibid*. The approximate urban footprint area of the city in the 1960s was 383.8 km^2, by the year 2000 the urban area covered 1675.5 km^2.

[60] Lankao, Patricia Romero. “Water in Mexico City: What Will Climate Change Bring to Its History of Water-Related Hazards and Vulnerabilities?” *Environment and Urbanization 22, no. 1 (April 2010)*: 157–78. https://doi.org/10.1177/0956247809362636.

[61] In 2018 a fifth perforation in the basin was completed. *Túnel Emisor Central* is the newest deep drainage tunnel built. The 62.4 km tunnel will join the existing *Drenaje Profundo* and aim to serve 20 million people.

[62] It is estimated that some parts of the city to date have sunk ~12 m below Lake Texcoco.

of the existing “draft-and-pump” strategy and the fragility and uncertainty of water in the city. Alternatives are needed.

Up to this date, efforts have been made to ‘mediate’ the impact that rapid environmental change has had on the basin and the city. However, deeply rooted and prevailing *technocratic* ideas still prevail. Urban growth and hydraulic infrastructure are intricately intertwined and interconnected to the soil, trees and water of the region[63]. What is the role of architecture in this terrain?

Figure 36. Overflowing waters on a section of Viaducto Miguel Aleman (a cased river that serves as sewage) during a storm. Infrastructure cannot keep up and is failing.

[63]Vitz, A *City on a Lake: Urban Political Ecology and the Growth of Mexico City,* 49, 108.

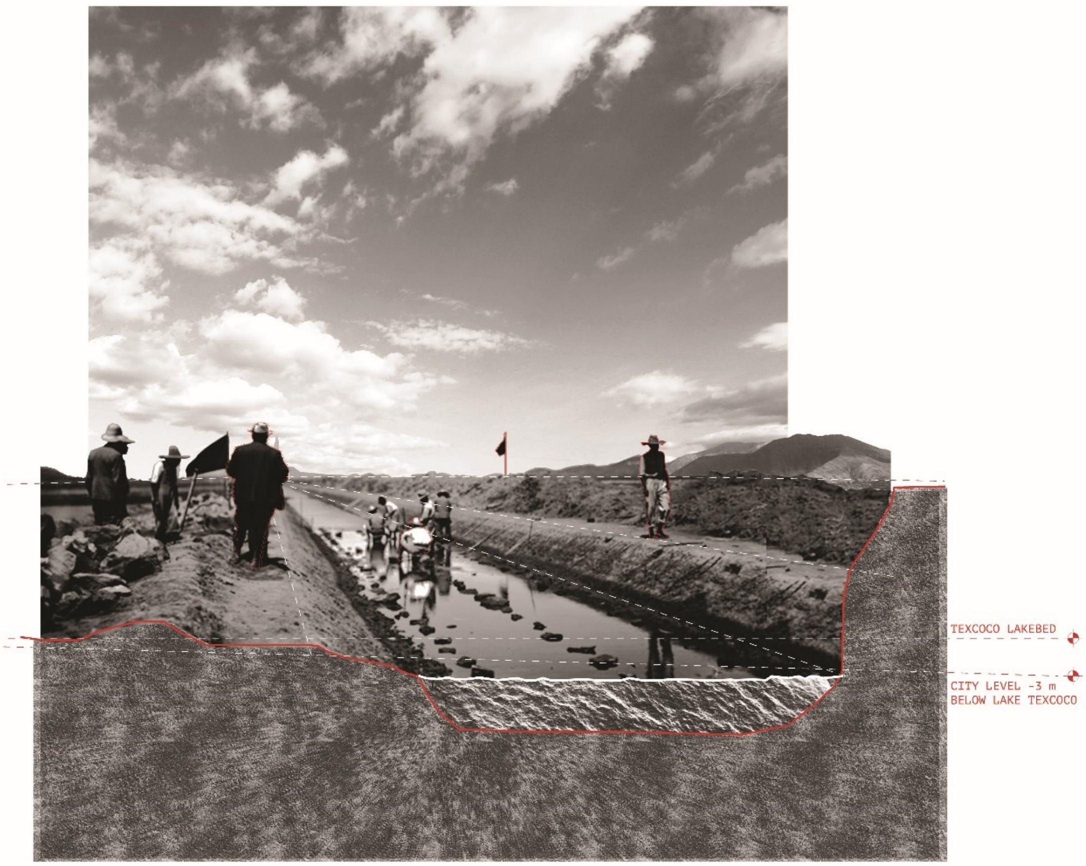


Figure 37. Collage illustrating early attempts to intervene and manipulated the Texcoco lakebed to 'reclaim' it. Challenging due to the conditions of the ground, several attempts have been made throughout history. At this point in history the relationship between city and lake has shifted, and the city finds itself at more than 5 meters below the lake.

Infrastructure of Reclamation?

National Parks: Forestry and Conservation efforts

By the 19th century, the *technocratic* elite had already acknowledged the interconnectedness of the city and its hinterland, particularly, the connection between water, vegetation, soil and flooding. An early champion of the forestry and conservation effort, Miguel Angel de Quevedo brought to the front the importance that forested land had in retaining water, preventing soil erosion and facilitating natural recharge of the underground aquifers. Keeping these lands forested was key.

Figure 38. Architect and engineer, Miguel Angel de Quevedo. Known as the *Apóstol del Arbol* (Tree Apostle) for his conservation efforts.

Implementation of conservation and forestry ideas furthered the *hygienic* narrative and its associated infrastructure. It placed large expanses of land under government control and put differing social and economical interests of *land* and *water* in direct conflict. Unfortunately, the formation of 34 National Parks during the *Cardenismo*[64] simply forged a new 'socio spatial hierarchy' around the use of resources and made no difference in preventing the city from taking over. This struggle continues even today in the Xochimilco area, where informal settlements are slowly encroaching into existing *Ajusco National Park* land[65].

64 Named after the presidential tenure of Lázaro Cárdenas (1934-1940)

65 See Jill Wigle's "The 'graying' of 'Green' Zones: Spatial Governance and Irregular Settlement in Xochimilco, Mexico City." and "The ' Xochimilco Model' for Managing Irregular Settlements in Conservation Land in Mexico City."

Figure 39. (Left) Cumbres del Ajusco National Park. One of the many protected areas and parks south of the city.
Figure 40. (Right) Los Dinamos National Park. Another protected area and park located southwest of the city.

Texcoco Project

Desiccation of Lake Texcoco freed up dry land for urban settlers. Along with dryness, however, it also freed up *dust.* The loss of moisture in the saline clay lakebed resulted in a parched surface prone to cracking, *tolvaneras* (Figure 34) (dust storms) began to afflict the city. Efforts to offset these effects began in the 1910s. Engineer Mariano Barragán spearheaded the first unsuccessful effort to fertilize and reforest the lakebed. The toxic salinity of the soil left his efforts unfruitful[66]. In the 1920s, engineer Alberto Carreño, together with others urban thinkers and engineers, proposed a second afforestation project using salt resistant plants: *hylophytes* (Figure 35). This project, however, never fully materialized and was also unsuccessful.[67].

[66] Vitz, A *City on a Lake,* 138
[67] *Ibid.* 155

Figure 41. (Left). A *Tolvanera* (dust storm) in the city.A result of the desiccated, parched lakebed.45
Figure 42. (Right) Master Plan for the Texcoco Project as envisioned. Emphasis was on successfully planting and reforestation of the lakebed

By the 1930s, government officials saw *reclamation* as the strategy to address the persistent dust storms. Within the changing social environment of *Cardenismo*, the project aimed to utilize lakebed land for agriculture; an attempt to reconcile urban development with changing rural conditions. Intervention was extensive: digging canals, diverting water, washing the soils. However, by 1937 375 hectares of land were under cultivation[68]. Unfortunately, by this point the extensive reach of hydraulic infrastructure in the basin resulted in yet again, conflicting social and agricultural interests over *water.* The Texcoco reclamation efforts came to an end.

It was not until the 1960s when engineer Nabor Carrillo proposed the creation of an artificial reservoir. Recycling wastewater, the reservoir aimed to end the *tolvaneras* (dust storms) (Figure 35), avoid flooding and help to conserve water. Although not the entire vision of his project, by the 1980s *Lago Nabor Carrillo* and three other artificial Lakes were implemented[69]. It has helped alleviate the dust storms, yet the rest of the lakebed still sits empty and barren.

[68] Vitz, A *City on a Lake,* 161
[69] *Ibid*. 230-232

Figure 43. (Top Left) Texcoco reclamation project. Men working to prepare the soil on Texcoco lakebed for agriculture. The process required 'washing' the soil and leveling the terrain to eliminate the minerals that made it highly alkaline.
Figure 44. (Top Right) Partial aerial view of Lake Nabor Carrillo.
Figure 45. (Bottom Left) View from Lake Nabor Carrillo. Iztaccíhuatl and Popocatépetl can be seen at the back.

Xochimilco Ecological Park

Subsidence also impacted Xochimilco, it was sinking and drying. Unlike Texcoco, the government did not have legal hold over the land, and the tightly knit communities around Xochimilco fought back. Emboldened by land reform and the nationalization of water, residents formed the Lake Xochimilco Conservation. The efforts only obtained a small success in preserving the waterscape needed for *chinamperia*[70]. *Capitalinos* recognized the cultural importance of the region and since the 1920s, it became a local tourist destination. Unfortunately, changing economic conditions and urban growth, topped with desiccation have left only a small portion of the lake alive.

In 1987 UNESCO designated Xochimilco as a World Heritage Site. In 1993 Mario Schjetan completed the Xochimilco Ecological Park. A multi-scalar project, the park 'restored' a ~300

[70] Vitz, A *City on a Lake,* 146-148. In the 1930s the Churubusco river was diverted to remedy decreasing water levels in Xochimilco canals. However, by the end of the 1950s the government began to artificially inject the canals with treated wastewater (205-206)

hectares of waterscape environment[71]. Described as a 'working landscape'[72], the project incorporates a series of interconnected infrastructure to manage and reintroduce water into the park. Reservoirs, wetlands, canals, an artificial lake and water tower are used to retain stormwater, regulate water levels, collect water runoff and pump water back into the aquifer[73]. The park has been a big success in rehabilitating environmental conditions of the lacustrine environment and *chinamperia*. It has provided the city with open space and allowed traditional economies of agriculture to thrive. Schjetnan's work is a 'consolidation of design with infrastructural needs' that highlights the performative interconnectedness, indeterminacy and flux of metropolitan landscapes[74].

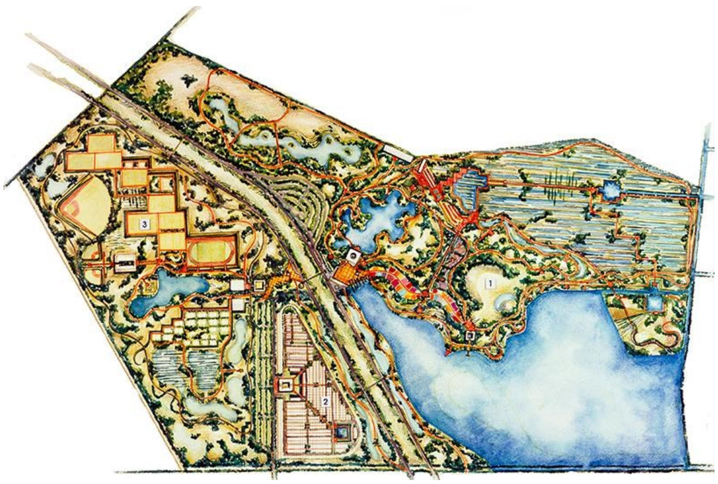


Figure 46. (Left) Master Plan for Xochimilco Ecological Park. 1. Cultural and Recreational Area, 2. Flower Market, 3. Sport and Natural Park
Figure 47. (Right) View of the Lake showing aqueduct bringing recycled water onto the site. In the back we see the water tower located in the entrance plaza.

[71] The park sought to restore canals and chinampa lands that had been affected by sedimentation and desiccation. Beardsley, John. *Mario Schjetnan: Landscape, Architecture and Urbanism*. 1st ed. Washington, D.C.: Spacemaker Press, 2007; 14.
[72] *Ibid*. 41
[73] *Ibid.* 40.
[74] *Ibid.* 21.

Return to the Lacustrine City? - *Ciudad Futura, Parque Ecológico de Texcoco, Parque Canal de Desagüe*

As issues with water continue to exacerbate in the city (seasonal flooding and scarcity of potable water), there is a strong argument to 'bring back' Lake Texcoco. However, ideas of reinstating and keeping part of the lake as a regulatory body of water are not new. Dating back to engineer Manuel Balbotin and doctor Ladislao de Belina, part of the lake was always envisioned to remain a *lake*. Even engineer Mariano Barragán's subsequent reclamation efforts did not seek to not fully desiccate the lake. However, the engineer Luis Careaga's critique of fertilization efforts brought forward, again, arguments for the regeneration of the lake and its lacustrine environment[75]. Unfortunately, the technocratic and political hold on the lakes was too deep. In light of increasing concerns with climate change and water stability in the city, ideas of *restoration* are coming forth again.

In his 1997 proposal *Ciudad Futura* (Future City), architect Alberto Kalach put forth a vision of a reinstated lacustrine landscape on the dried-up lakebed. Infrastructure-centric, the project sought to take advantage of the hydraulic infrastructure in the city to bring water *back* into the lake rather than *away*. In addition, the project incorporated housing, parks and an airport into the program. Ambitious, the project envisioned a slow incorporation of city and water, a new form of fluid urbanism[76].

Figure 48. (Top Left) Visualizations of the proposed Ciudad Futura. View of the Mexico-Texcoco highway.
Figure 49. (Top Right) Visualization of the proposed Ciudad Futura. View from the Airport.

[75] Vitz, A *City on a Lake: Urban Political Ecology and the Growth of Mexico City,*155.

[76] León, Teodoro González de, Alberto Kalach, and Juan Cordero. *México. CIUDAD FUTURA*. Edited by Alberto Kalach. Daido, 2010. Web access, December 2019, https://www.kalach.com/ciudad-futura..

Figure 50. Visualization of the proposed Ciudad Futura. View of edge condition where lake meets existing urban fabric.

Kalach's project may not have been fulfilled, but the ideas behind the project have taken a new form. Architect Iñaki Echeverria put forth another, similar project: *Parque Ecológico de Texcoco* (Texcoco Ecological Park). Combining public space, infrastructure, 'nature' and culture Echeverria seeks to reclaim the lake as a '*cultural ecology* (Figures 41-43)'. Green infrastructure also places a big role in allowing to harness stormwater runoff, create wetlands, replenish aquifers while providing open recreational space in the city[77]. The project seems to be openly backed by the government, and as of now the plan is to finally implement it.

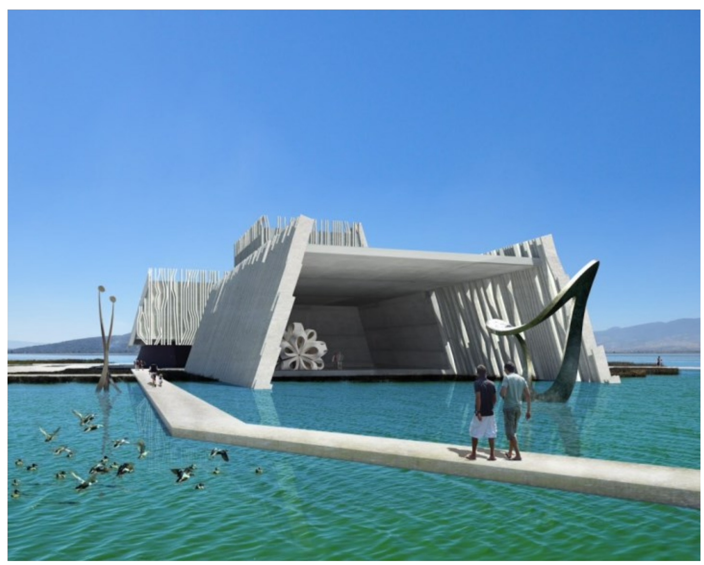


Figure 51. (Left) Visualizations for the proposed Texcoco Ecological Park. Perspective view overlooking Lake Nabor Carrillo.
Figure 52. (Right) Visualization for the proposed Texcoco Ecological Park. Infrastructure and program set amidst the waterscape.

[77] Biasco, Paul. "Mexico City is Proposing to Build one of the World's Largest Urban Parks". *Smithsonian Magazine*, last modified February 2020,https://www.smithsonianmag.com/travel/mexico-city-proposing-build-one-worlds-largests-urban-parks-180974179..

Figure 53. (Bottom Left) Visualization for the proposed Texcoco Ecological Park. Infrastructure is distributed across the waterscape to harness energy.

In addition, Mexico City's government has also made an effort to take back some of the spaces in the city taken by the hydraulic infrastructural projects of the 19th century. In January 2020, the *Parque Lineal Gran Canal* was inaugurated. Providing recreational and public space the park takes over a portion of the *Gran Canal* that was encased underground in 2006. A multipurpose project, the extension of green areas and rainwater harvesting (24 wells were drilled in placed) seeks to alleviate some strain from alluvial precipitation and repurpose water on the site[78]. This park in addition to other proposals such as the *Canal Nacional* and *Río La Piedad*, represent a new negotiation between *water* and *urban land* in current day Mexico City. Once again, infrastructure is at the heart of it. For architect Loreta Castro Reguera, however, these solutions are 'naïve' and lack an understanding of the sewage system, seasonal rain and geology of the region[79].

Figure 54. Aerial view of the recently opened lineal park *Parque Lineal Gran Canal*. The park 'reclaims' back part of the canal. However, water and land are still ruled by a *fixed* and *rigid* relationship.

---

[78] Redaccion CP. "Abren al Público Primera Etapa del Parque Lineal Gran Canal." *Chilango*, last modified January 2020, https://www.chilango.com/noticias/parque-lineal-gran-canal/..

[79] Reguera Castro, Loreta."Waterways in Mexico City." In ***Between Geometry and Geography,*** edited by Felipe Correa and Carlos Garciavelez Alfaro, 1st ed., 246-53. Applied Research and Design Publishing, 2014.

Part III: From Concrete to Unsettled, c. 2150

Quest for the [sub]Natural City

> "The theory of subnature [...] supports the notion that architecture and the environment are produced simultaneously"
> David Gissen, Introduction to *Subnature*

As ideas are put on the table to help address the current conditions the city face, they still echo the *technocratic* epistemes of the past. However, current proposals of 'reclamation' fall short, often employed to "re-established a specific class-based idea of the city."[80] As *aquafluxus* are expected to worsen a new reconceptualization of water, land and the environment is needed. In his book, *Subnature*, David Guissen argues that the environment is "composed of subnatures: threatening, uncontrollable, and primitive forms of nature[81] produced by "social, political and architectural processes and concepts."[82] This is certainly the case about the current spatial conditions of Mexico City and its constant battle with increasing floods. This thesis argues that reconceptualizing the current environmental episteme through the framework of the *subnatural* is how notions of *ground, water* and *infrastructure* can begin to be unsettled.

Unsettling *ground*: Material testing

In a certain way overlooked, water and geology are intricately intertwined; their relationship shifting as land was excavated, manipulated and dried. Once inhabiting above ground, water was forced underground, while simultaneously forcibly pushed out. The geological conditions and reality of the basin must be re-engaged to imagine how architecture and infrastructure can begin to be more *fluid.*

Notions of ground and how it behaves when interacting with water were explored by building small scale 'strata' Porosity and permeability of materials was tested to understand a bit more the way in which ground hand hold water. In addition, ideas of pressure were also tested by looking at material traces left on a piece of paper when pressure was applied once the material was saturated in water. (Figure 56).

A good initial exploration, it was not pursued any further, since the reality of soil quality and conditions is harder to replicate and analyze in this context. It did however inspired a different approach: how manipulation of soil and water can result in the creation of new *ground*. This second set of exploration was pursued by building an 8-layer geological model.

---

[80] Gissen, David. *Subnature: Architecture's Other Environments*. Laurie Manfra (ed.) .1st ed. New York: Princeton Architectural Press, 2009. 24.
[81] *Ibid.* 21-22.
[82] *Ibid.* 210-211.

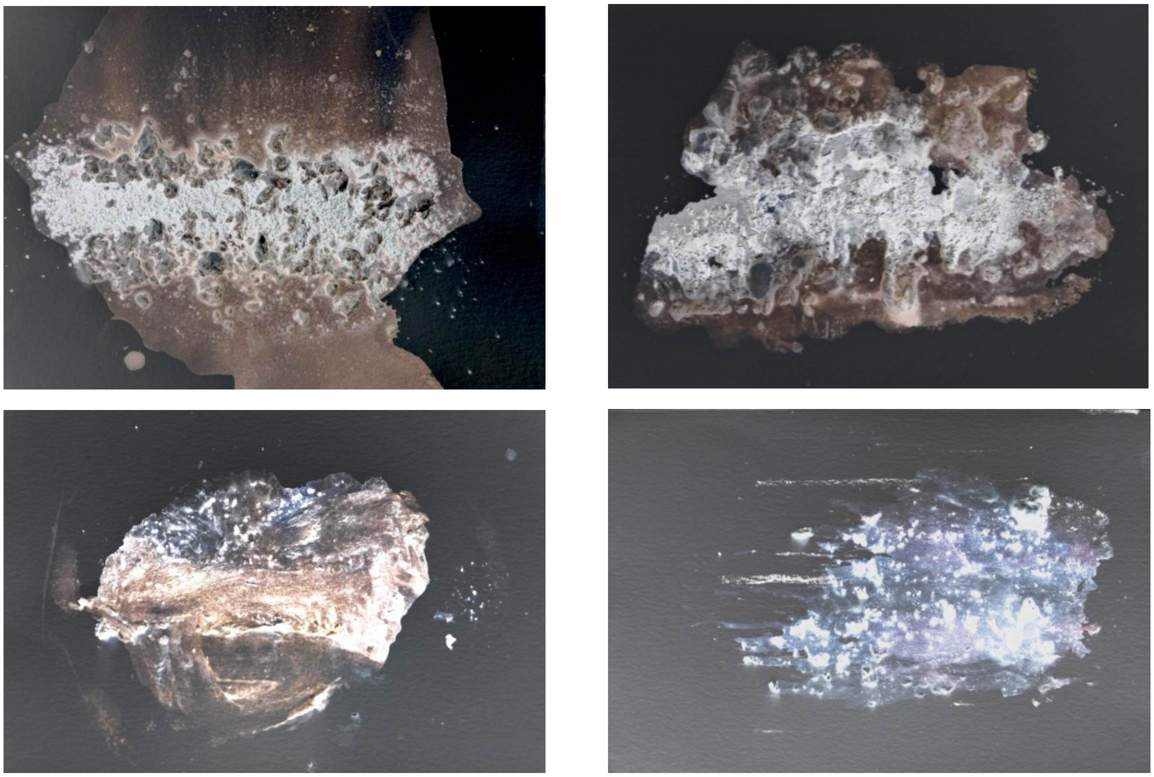
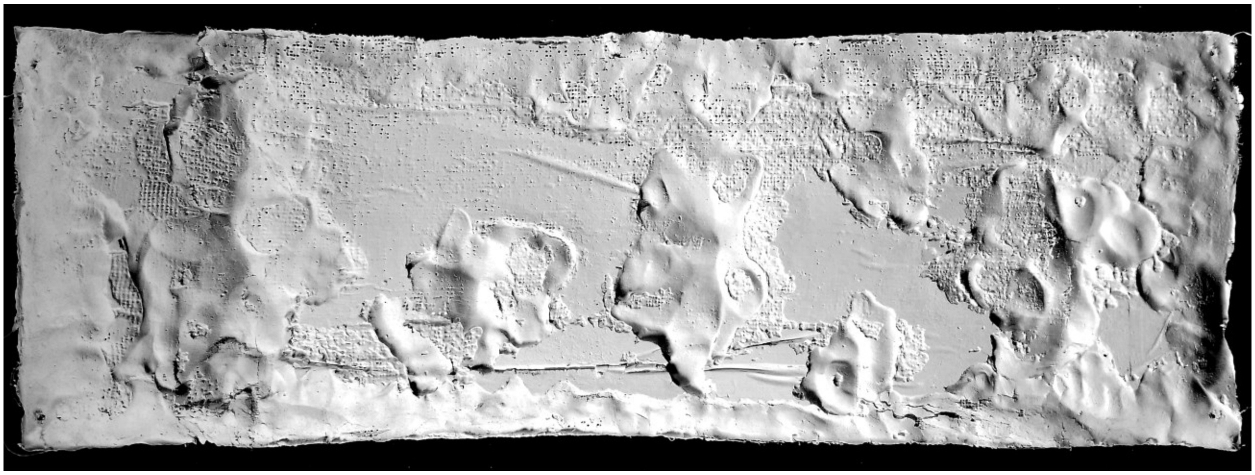


Figure 55. Material tests. Notions of permeability, porosity and pressure were explored.

Each layer of the model was built individually by manually shaping the terrain and overlaying wet plaster strips on top. The final results of each layer were determined by the physical shape created, how much water was on the strips at the moment of construction and how this water pooled and dried up. In an effort to recreate the natural way geological strata is created, each layer was built upon the previous one by adding, removing or shifting the previous arrangements.

The textural results of the layers provided interesting spatial qualities that were explored in photography (Figures 57, 59, 61), providing a glimpse of *subterranean* spatial conditions in which architecture could intervene to create inhabitable spaces for both water and man (Figure 61). The method in which the model was created aimed to probe the way in which human actions have altered the environment, this time in a larger spatial context and inspired the creation of imaginary landscape (Figure 58 and 60). By drawing out the resulting ground created it was attempted to create possible subnatural realities of fluidity onto which infrastructure and architecture could be deployed.



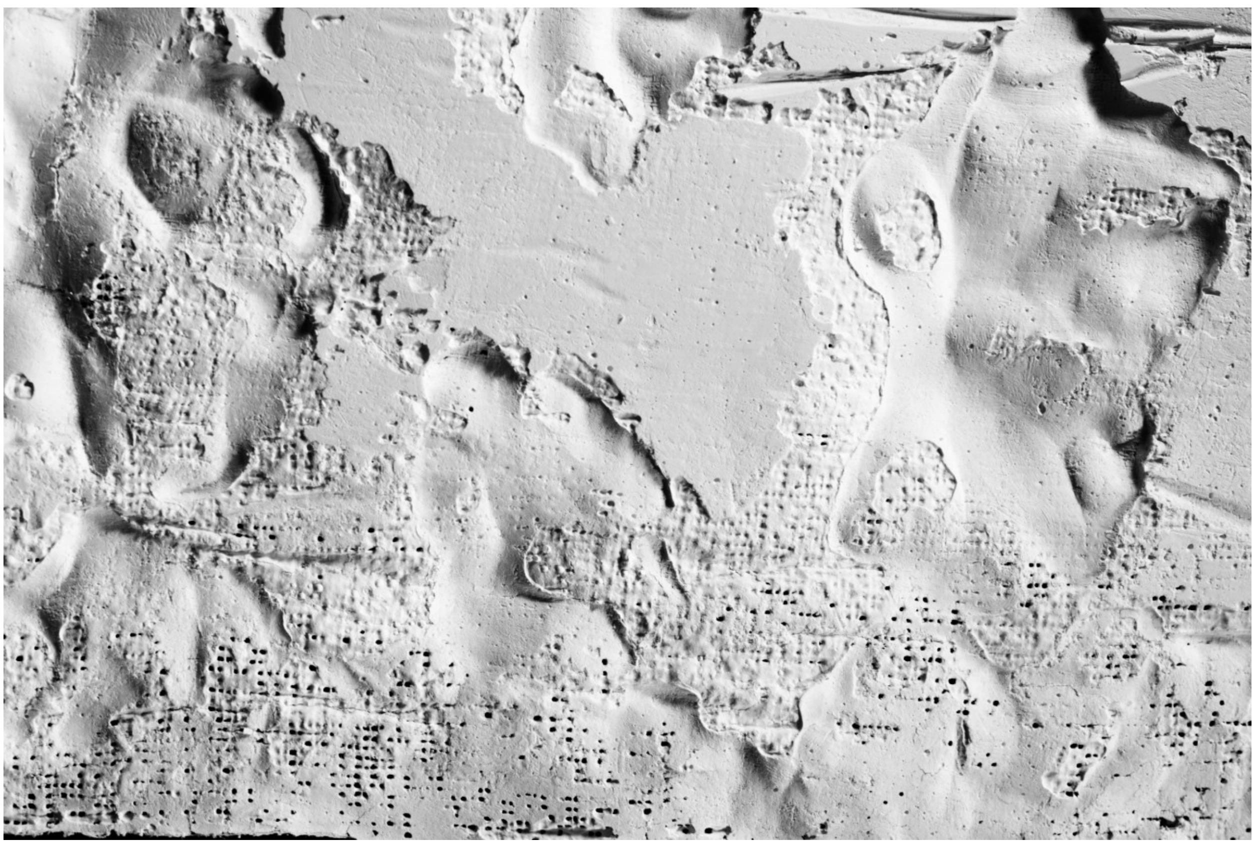


Figure 56. Material tests for Imagined landscapes. (Top) Geological layer built by manipulating ‘ground’. (Bottom) Close up.

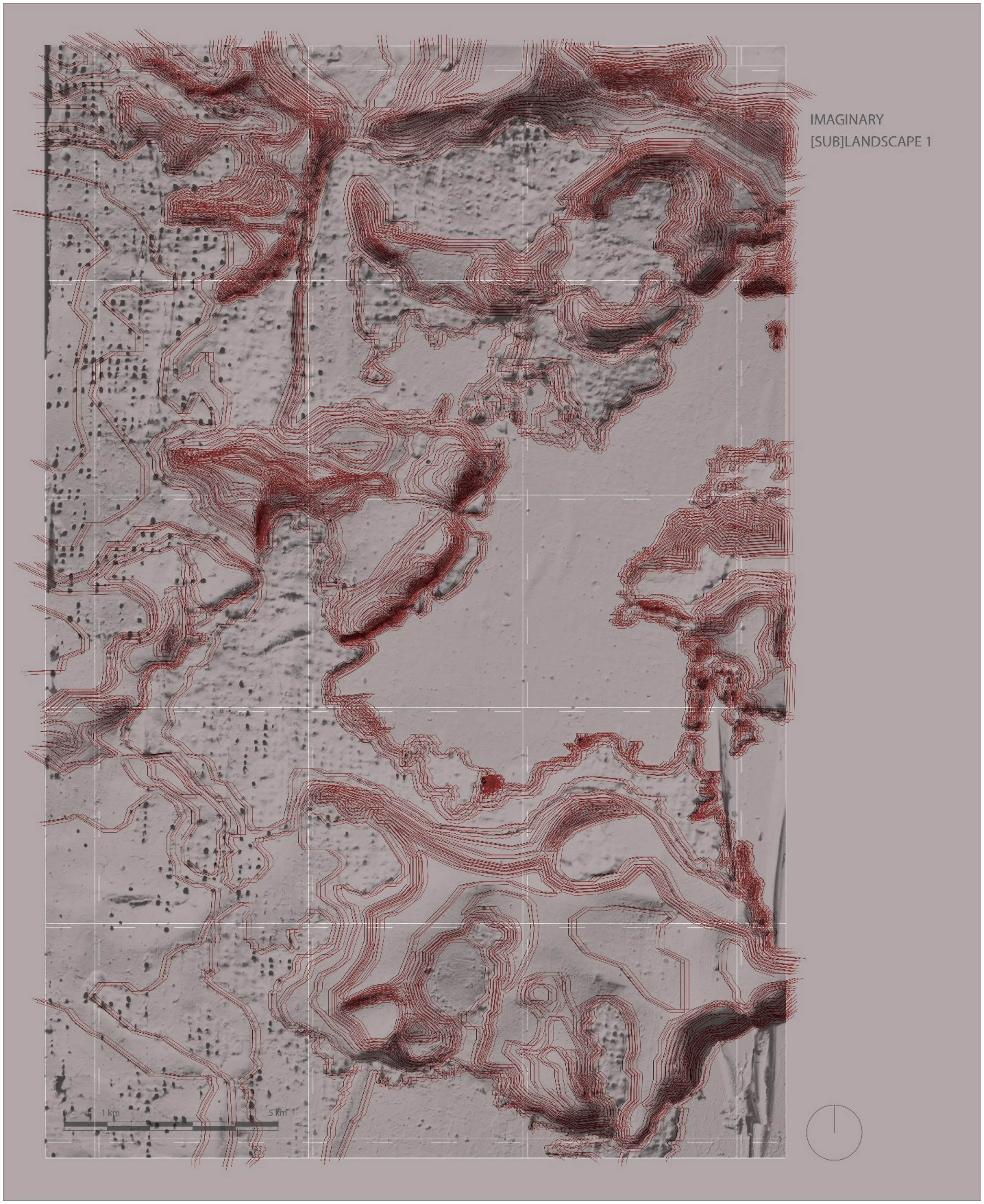


Figure 57. Imaginary landscape from material exploration seen in Figure 56.

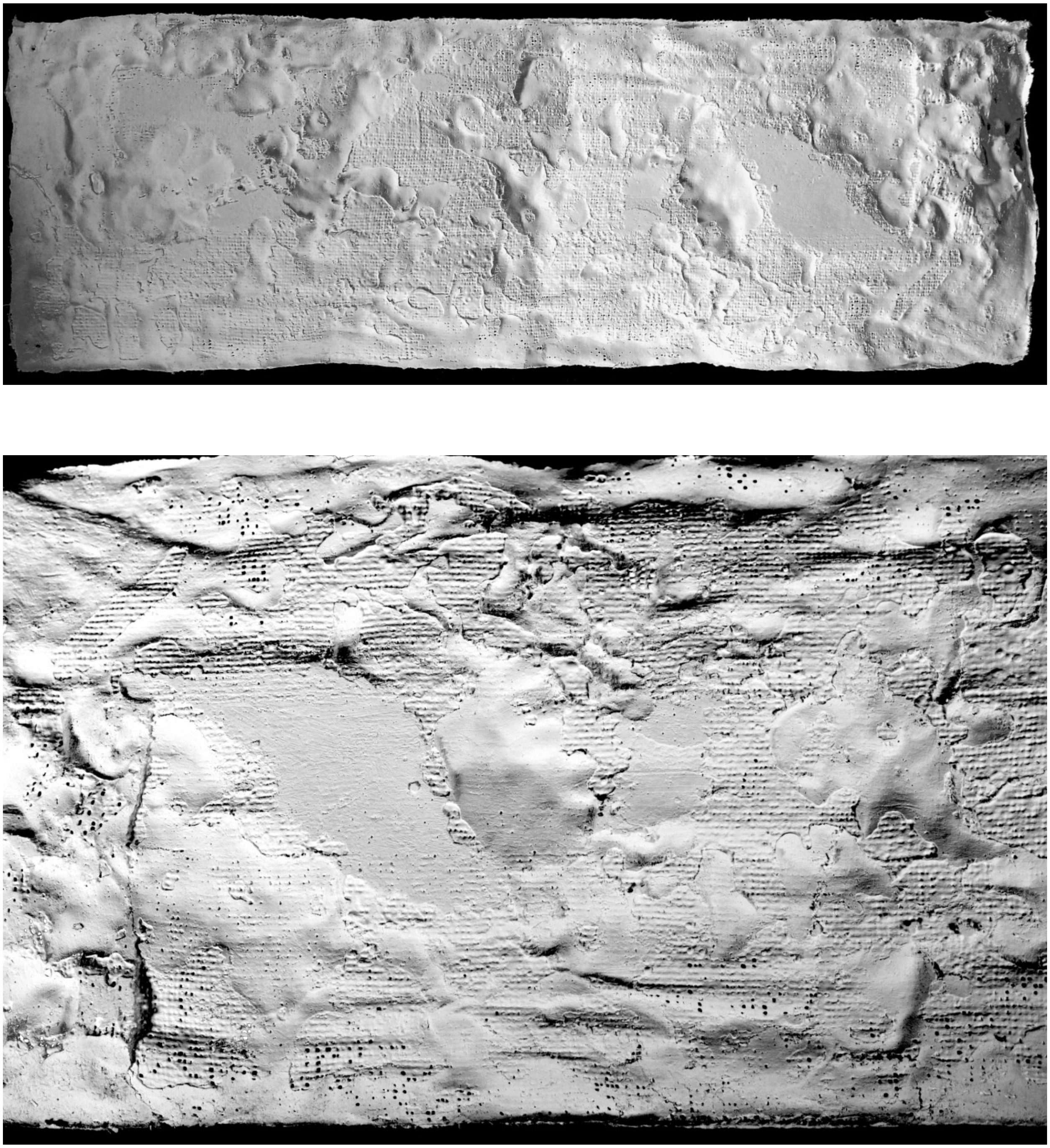


Figure 58. Material tests for Imagined landscapes. (Top) Geological layer built by manipulating ‘ground’. (Bottom) Close up.

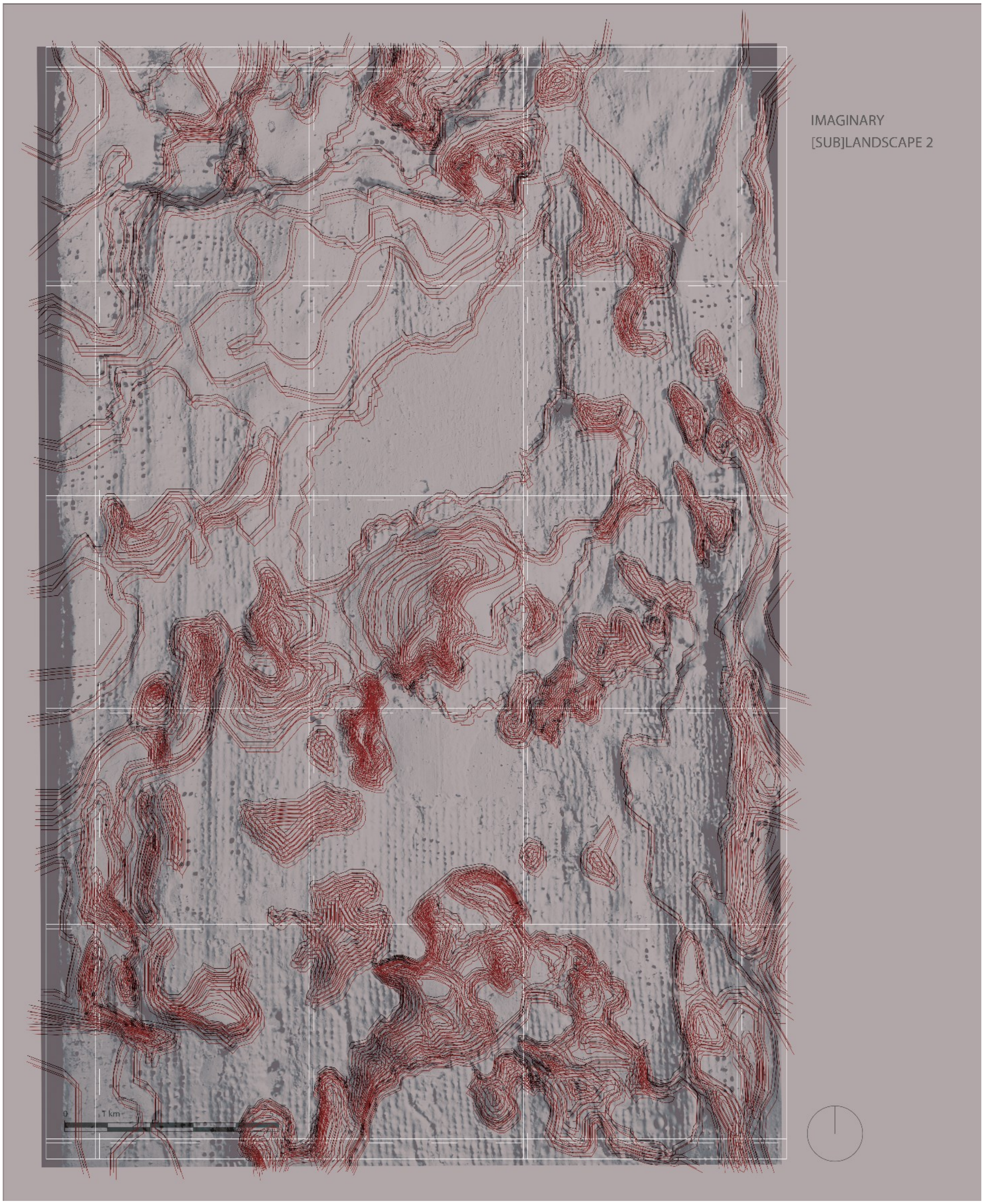


Figure 59. Imaginary landscape from material exploration seen in Figure 58.

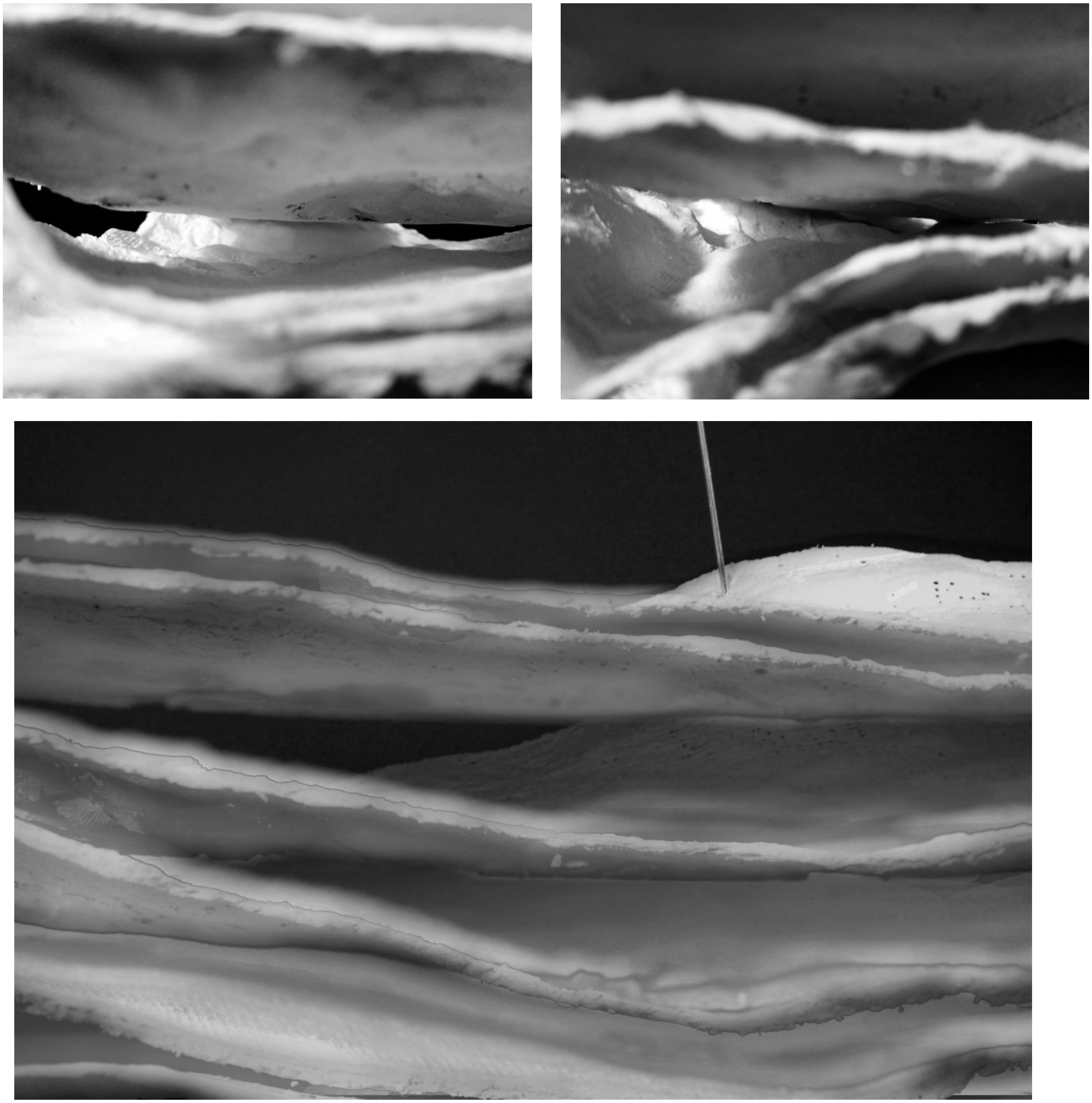


Figure 60. Material tests for Imagined landscapes. Close up of interior spaces exploring the relationship of strata, *ground* and inhabitation.

Unsettling Infrastructure

Documenting the infrastructural history of the region through historical photographs demonstrated the extent of scale and potential spatial qualities they possessed. Three categories were identified based on use: Water Provision, Water Management and Water Supply; an atlas began to take form (Figure 62). Many of the photographs found recorded the construction process of several infrastructural projects. What made these photographs interesting was that they provide a glimpse of the way ground and scale were manipulated.

Further study of the photographs demonstrated that the material language of existing infrastructure could be probed to explore its potential qualities. Designed and constructed with the intention of controlling water, ideas of human inhabitation within this infrastructure began to be questioned.

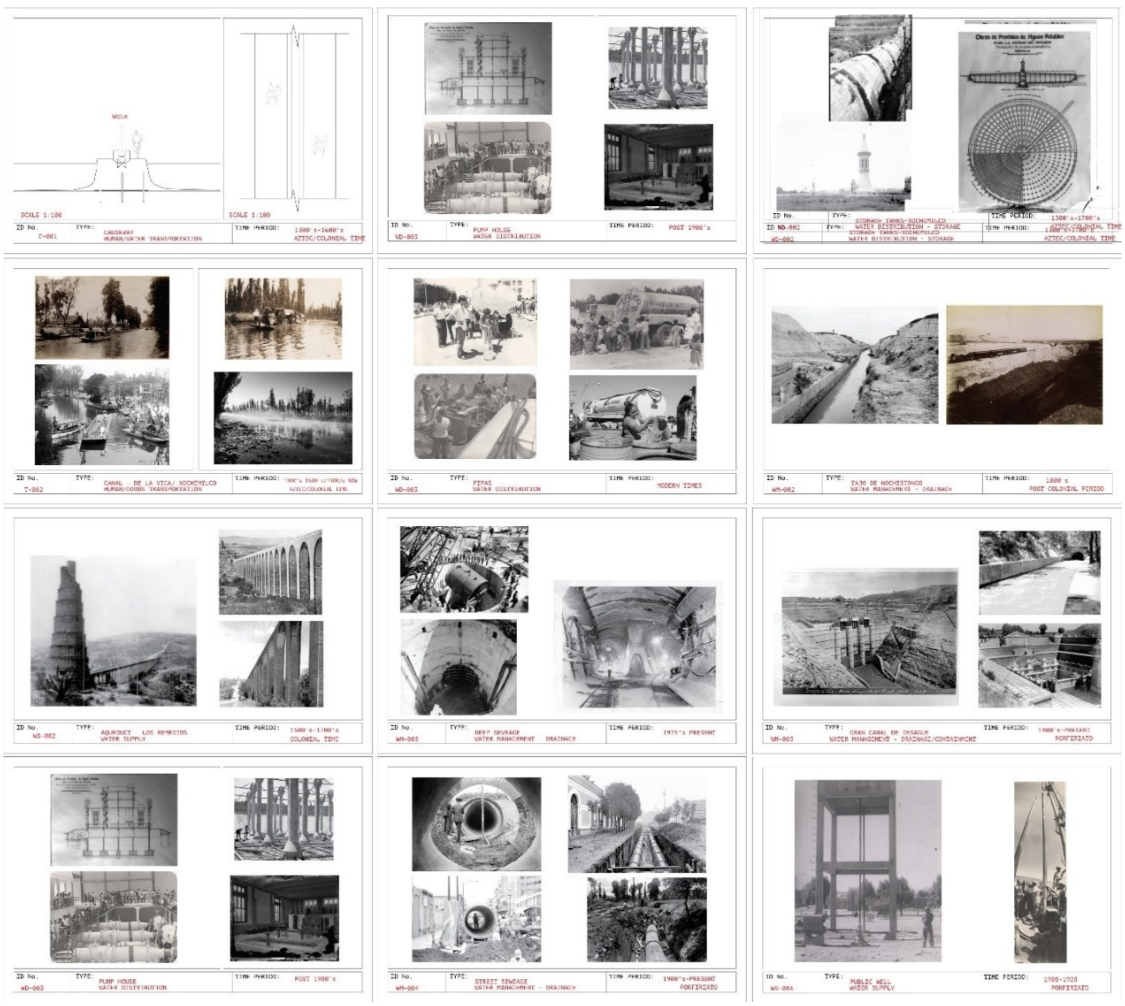


Figure 61. Infrastructure ‘atlas’. Representation of the spatial implementation of infrastructure according to use/purpose.

Photographs were employed as a starting point to play and manipulate scale and ground to imagine the *subterranean* could be inhabited by both *water* and *people*. Keeping in mind that *fluidity* is an important factor driving the exploration spaces begin to be conceptualllized as *shifting*. Depending on the amount of water being held spaces appear or dissapear as water levels rise or fall (Figure 63)

An important aspect of this exploration was that scale becema a key element in how spaces are reimagined. For example, Figure 64 employs a combination of elements from Figure 63, modifying scale to create monumental qualities that help define and identify the *fluid* spaces where both water and people can coexists.

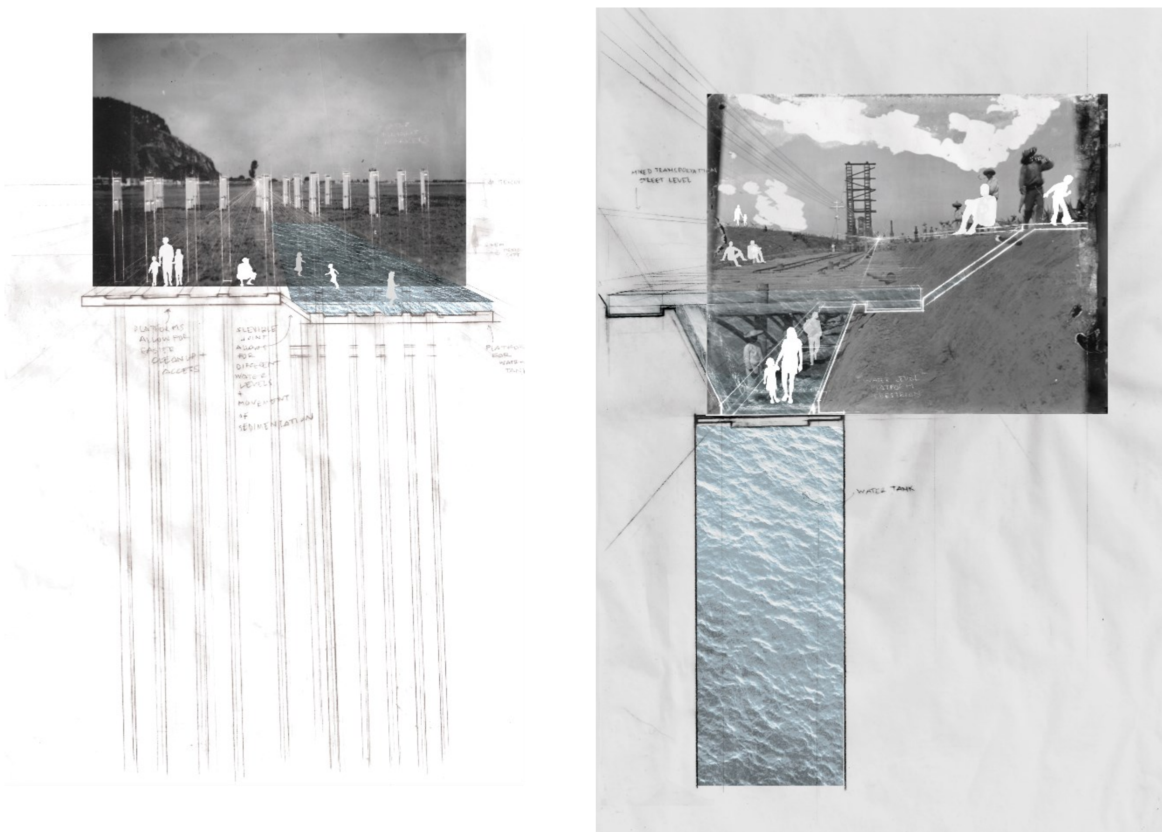


Figure 62. Sketch and photographs collages that begin to explore the role of scale in reimagining infrastructure and its spatial manifestation

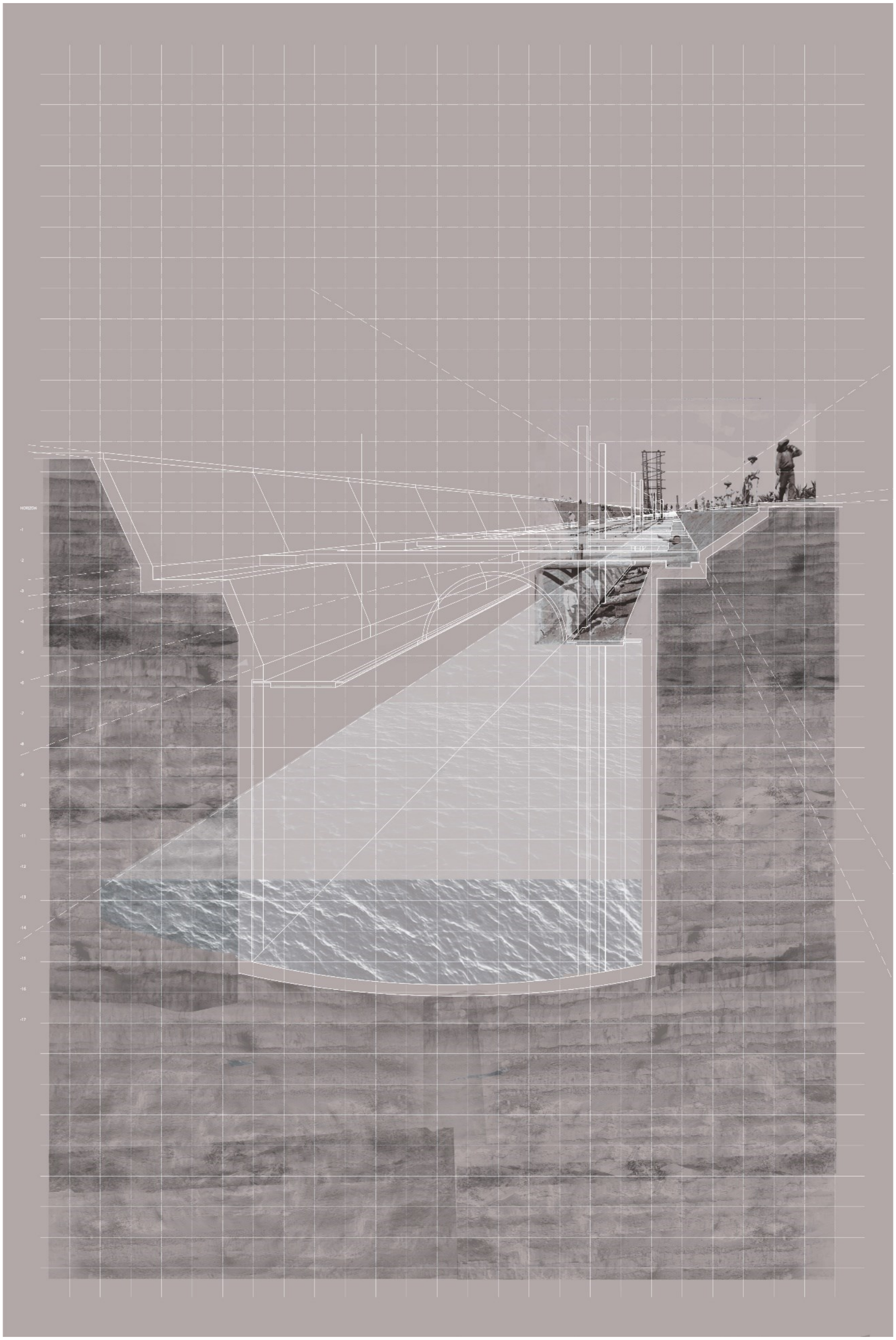


Figure 63. Collage that further explores spatial characteristics of infrastructure, ground and water to probe a more *fluid* dynamic.

Speculative [sub]Narratives

Storytelling is chosen as a tool to further explore ideas of *ground,* infrastructure and inhabitation by projecting 130 years into the future. Critically engaging with the depth of socio-cultural, geological, geographical and built history that has, and continues to, shape the physical landscape of the city, the exploration seeks to unsettle the *rigidness* of the 'ground' and imagine a future urban *fluidity.* Through maps and collages existing Infrastructural language and form become the starting point to engage the subterranean and probe ideas of *scale* and *habitation*, utilizing the familiar to re-conceptualize the water-land dynamic once more.

Water, as embodied by the goddess Chalchihuitlicue, is the main protagonist. Believed to have been casted away and banished from its realm, she has in actuality laid dormant. Observing from the sidelines, awaiting her time to return. Her old realm, the Texcoco lakebed, becomes the contested site between Chalchihiitlicue and *The Architect*, a representative of the government. Through the lens of the *subnatural*, the resulting architecture attempts to mend the disconnect between city and water; reintroducing Chalchihuitlicue as a key player in the production of *fluid* landscapes.

Narrative: The return of Chalchihuitlicue

Rain. As far as the eye could see. The city had not seen rain like this for hundreds of years. Heavy. Relentless. Punishing in its intensity.

Just as quickly as water descended upon the city, it began to pool. Dry land began to disappear as the city began to be submerged by the rising waters. Looking for higher ground we moved towards a section of the Anillo Periferico (ring road) high above the city. People were making their way to safety as rain continued to pour.

The turbulent waters overtook the horizon, reclaiming the barren Texcoco lakebed with ferocious intensity. As I stood captivated by the sheer power on display I looked over to the mountains. Popocatepetl and Iztaccihatil were hidden behind the wet curtain of rain, but as it poured the once absent Chalchihuitlicue began to emerge on the horizon. Awakening from her long slumber she has come back to claim back the parched land she once ruled.

It seemed the reign of dry land had come to an end.

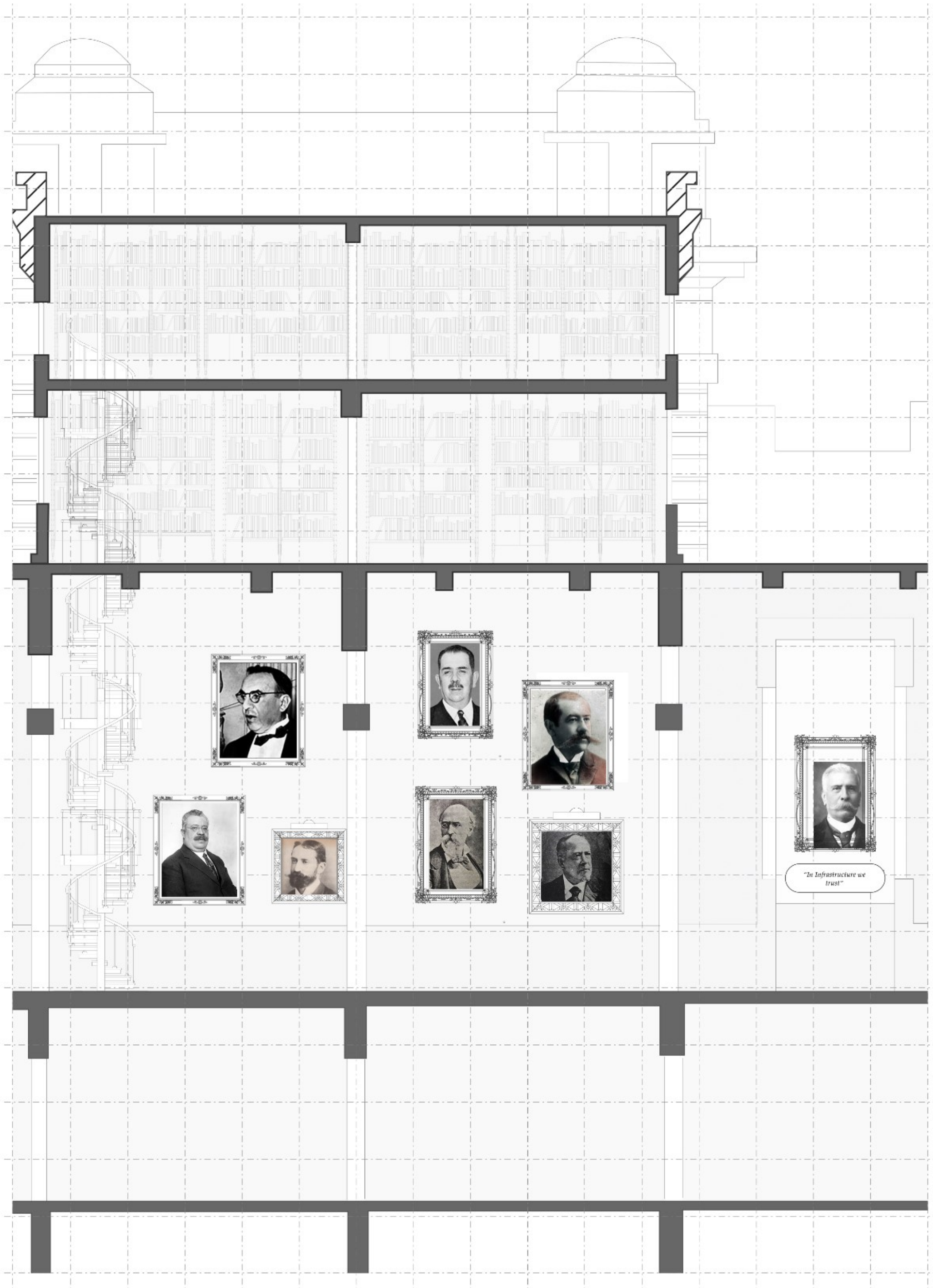
AS RAIN POURED THE ONCE ABSENT CHALCHIHUITLICUE BEGAN TO EMERGE ON THE HORIZON.
SHE CAME TO CLAIM BACK THE PARCHED LAND IT ONCE RULED

Narrative: Rise of the [sub]Architect

I stood looking at the building in front of me: Pump house no.1; an engineer wonder of its time, the space now stood as a historical token of the great advancements the city has done to dominate over water and create dry land. Flooded and wet, the reality of the city is a direct contradiction.

The interior of the space was a spatial reflection of the mentality that has dominated the approach to water and land: divided, rigid, and glorifying *techno-egineering*. As I moved along the main hall towards the *Ingeniero's* (engineer) office the faces of the men that shaped the water-land relationships of the region were proudly on display. The knowledge of its past hidden and forgotten, waiting to be rediscovered in the archives of old times.

'*In infrastructure we trust'* read the plaque on the wall above the Ingeniero's desk. As I sat in the office facing Chalchihuitlicue it was clear water was here to stay and infrastructure was no longer enough. It was time for change.



"IN INFRASTRUCTURE WE TRUST" READ THE PLAQUE.
IT WAS NO LONGER ENOUGH, IT WAS TIME FOR CHANGE.

Dawn of the [sub]altepetl

As I dove deep into the archives of old times, the historical, social, political, and geographical complexity of Mexico City proved to be a challenging reality. The breadth of information a bit overwhelming to process. It became evident that while engineered landscapes was the underground reality for how water that reality needed to be challenged.

It was clear that the Mexica saw landscape as a technological tool for the management of water, whether it was to redirect, retain or control how water flowed or pooled. The understanding of a shifting *ground* to accommodate water slowly eroded to the rigid, hyper-engineer reality of today. The modern, Haussmann-inspired vision of a clean, hyper-engineered city has drained water to the point that it has not only physically transformed the land, it also depleted its cultural importance with the city and the people. While turning back the clock is a naïve assumption, it is time to reconsider that *ground* is not a fixed notion and *fluidity* should be part of the vocabulary when addressing the way architecture interacts with land.

The idea of the *[sub]altepetl* seeks to bring back that cultural connection between people and water. Once conceived as the source of water and symbol for the spatial ideal to inhabit, the *[sub]altepetl* aims to engage the terrain in a way that allows for *fluid* spaces in which water can be captured and held, facilitated by *shifting* grounds that allow water to fluctuate as needed. Keeping in mind that landscapes are produced as a result of cultural and social impact people and nature, the *subnatural* offers an opportunity to reimagine how the old Texcoco lakebed can be inhabited once again, allowing for the simultaneous production of culturally significant and engineered spaces that facilitate the treatment, storage of water while facilitating an active intervention to begin recharging the overexploited aquifer.

Post-Script Conclusions

The thesis in no way sought to provide a concrete answer to the current reality of *aquafluxus* in Mexico City, it sought to engage with ideas of *ground* as they relate to architecture within a urban context. Scale was an important factor that proved difficult in asserting design decisions. However, it also provided the means to question the impact design can have in rethinking how architecture and design can play a role in the way environments are produced to better include water and *fluidity*.

From the scope of the historical and social context of the issue it became clear that design teams should have a wider breath of disciplines collaborating in the design process. It seems as architects we often take for granted the reality of the *ground* on which architecture stands on and intervenes. The Texcoco lakebed offers an opportunity to test out different approaches to city design and architecture, putting importance on *what* kind of grounds architects are to intervene, *how* design should be intervening to best preserve existing cultural and ecological conditions, *in which ways* inhabitation can take place within a shifting landscape, and *what* a shifting landscape looks like.

This thesis does not have the answers to this questions, merely the curiosity of them, and hopes it inspires discussion among design professional, government and the general public to begin thinking about ground, water and people in different ways.

Appendix

The following appendix contains additional images and illustrations that document contextual information and process work for the thesis that were not included within the main text but are relevant.

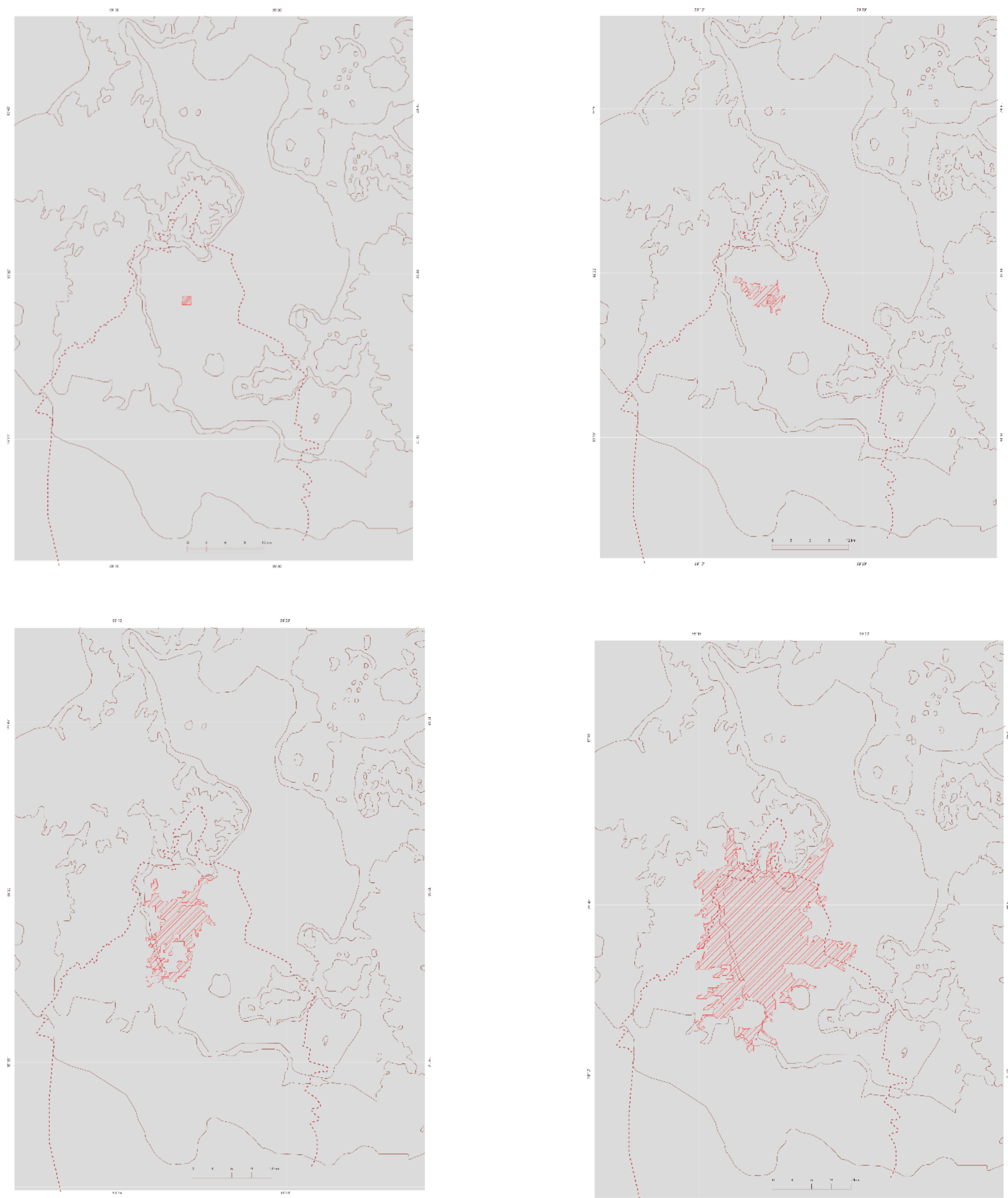


Figure 66. Mexico City's urban growth. *Top Left:* c.1500; *Top Right:* c. 1900; *Bottom Left:* c.1930; *Bottom Right:* c.1960

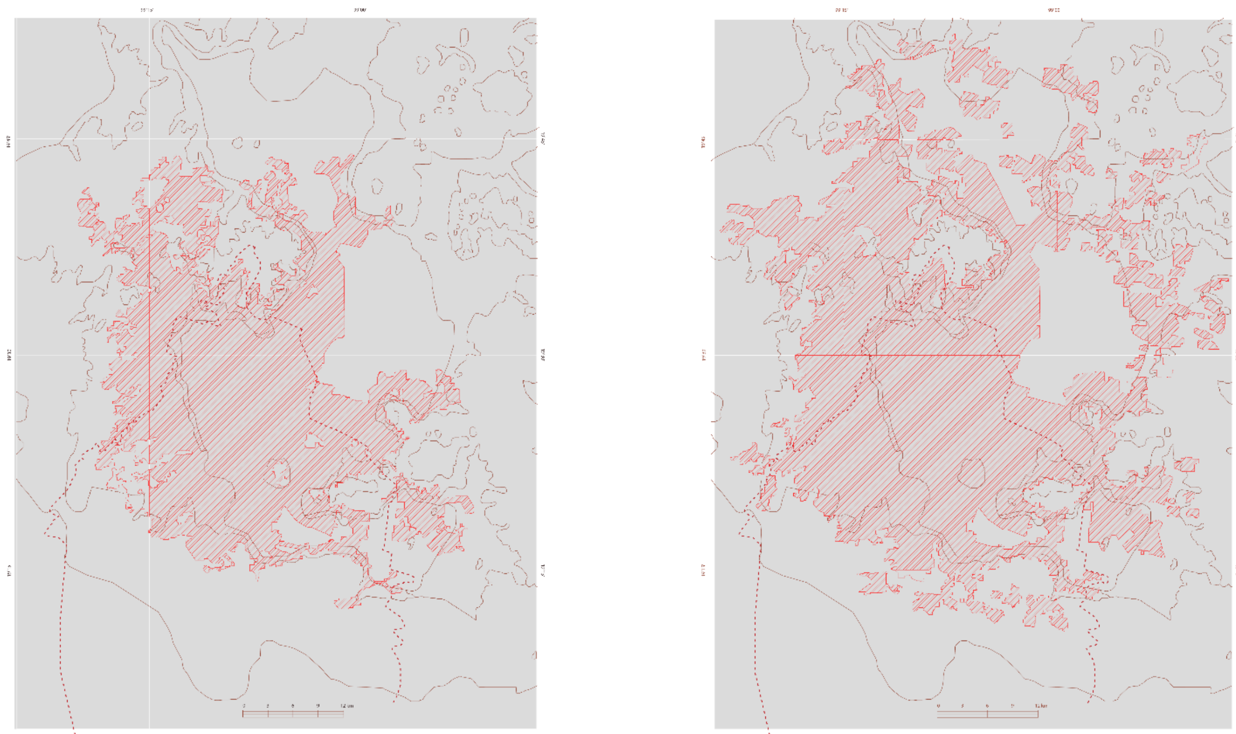


Figure 67. Mexico City’s urban growth. *Top Left:* c.1990; *Top Right:* c.2000;

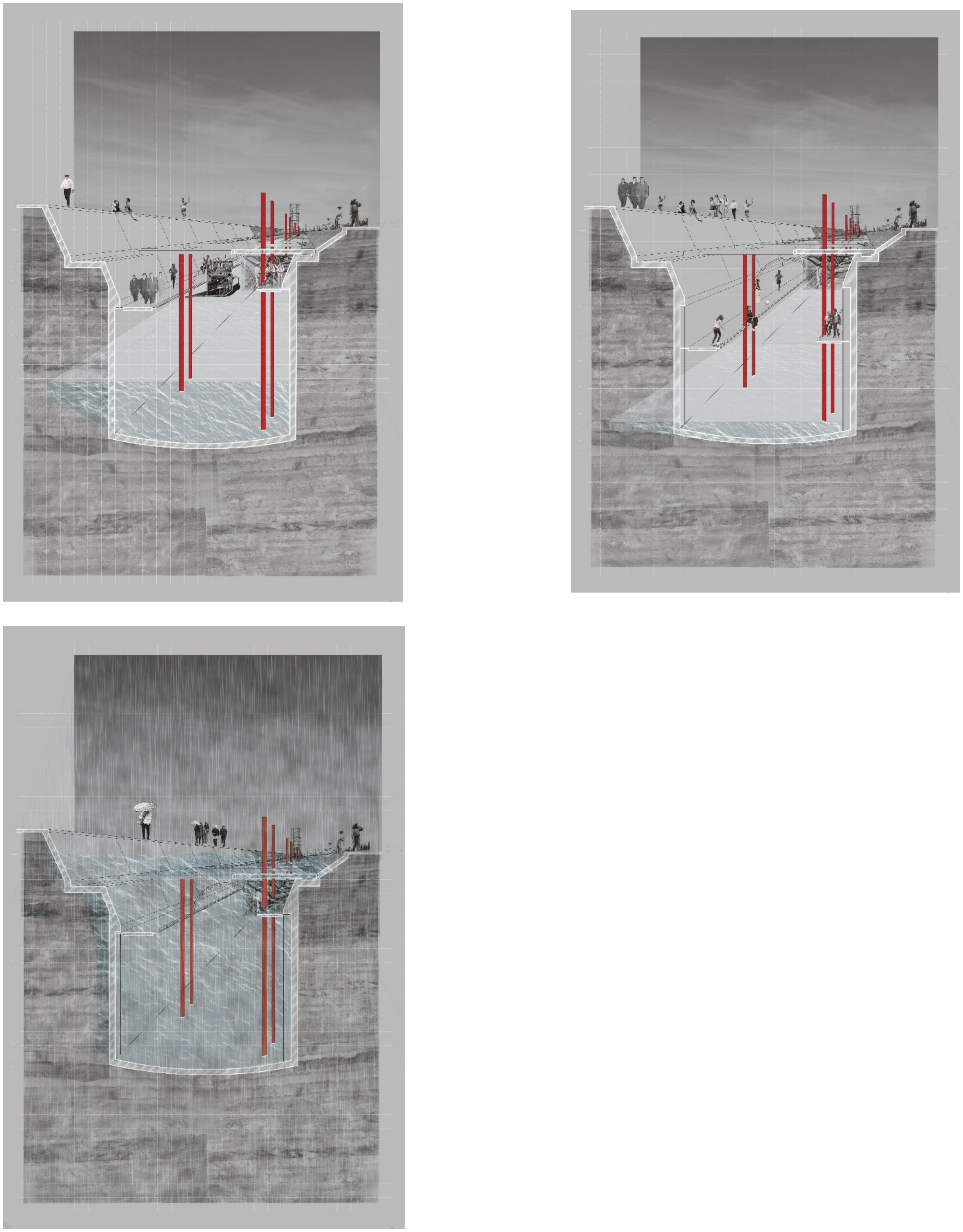


Figure 68. Visualization of three spatial conditions at different water levels. An experimentation of representation that dramatized existing conditions unintendedly.

Bibliography

Books and Articles

Armillas, Pedro. “Gardens on Swamps.” *Science, New Series* 174, no. 4010 (1971): 653–61. http://www.jstore.org/stable/1733739.

Balee, William, and Clark L Erickson. “Time, Complexity and Historical Ecology.” In *Time and Complexity in Historical Ecology: Studies in the Neotropical Lowlands*, edited by Clark L Erickson and William Balée, 1–17. New York: Columbia University Press, 2006.

Banister, Jeffrey M., and Stacie G. Widdifield. “The Debut of ‘modern Water’ in Early 20th Century Mexico City: The Xochimilco Potable Waterworks.” *Journal of Historical Geography* 46 (2014): 36–52. https://doi.org/10.1016/j.jhg.2014.09.005.

Beardsley, John. *Mario Schjetnan, Landscape, Architecture, and Urbanism*. 1st ed. Washington, D.C.: Spacemaker Press, 2007.

Bernárdez de la Granja, Maria del Carmen. “Acueducto de Xochimilco.” *Villes En Parallèle* 45, no. 1 (2018): 202–34. https://doi.org/10.3406/vilpa.2012.1494.

Burian, Edward R. “Contemporary Mexico City: Recycled Sites, Regenerative Landscapes, and Revaluated Post-Industrial Enclaves.” *Perspecta: Re_Urbanism: Transforming Capitals* 39 (2007): 121–35. https://doi.org/10.1016/0003-6870(75)90022-8.

Candiani, Vera S. *Dreaming of Dry Land:Environmental Transformation in Colonial Mexico City*. Stanford University Press, 2014. https://doi.org/10.1126/stanford/9780804788052.001.0001.

Davis, B. “Wider Horizons of American Landscape.” *Landscape Journal* 34, no. 1 (2015): 79–96. https://doi.org/10.3368/lj.34.1.79.

Davis, Heather, and Zoe Todd. “On the Importance of a Date,or Decolonizing the Anthropocene.” *ACME* 16, no. 4 (2017): 761–80.

Denevan, William M. “The Pristine Myth: The Landscape of the Americas in 1492.” *Annals of the Association of American Geographers* 82, no. 3 (1992): 369–85. http://www.jstor.org/stable/2563351.

Erickson, Clark L. “The Domesticated Landscapes of the Bolivian Amazon.” In *Time and Complexity in Historical Ecology: Studies in the Neotropical Lowlands*, edited by Clark L Erickson and William Balee, 279–310. Columbia University Press, 2006. https://doi.org/ISBN 0–231–50961–8 (electronic).

Evans, Susan Toby. “Aztec Royal Pleasure Parks: Conspicuous Consumption and Elite Status Rivalry.” *Studies in the History of Gardens and Designed Landscapes* 20, no. 3 (2000): 206–28. https://doi.org/10.1080/14601176.2000.10435621.

Foucault, Michel. *The Order of Things*. 2nd ed. London: Routledge, 1970. https://doi.org.proxy.bib/uottawa.ca/10.4324/9781315660301.

Fox, David J. “Man-Water Relationships in Metropolitan Mexico.” *Geographical Review* 55, no. 4 (1965): 523–45. https://www.jstore.org/stable/212413.

Gandy, Matthew. “Introduction.” In *The Fabric of Space: Water, Modernity, and the Urban Imagination*, 1–26. MIT Press, 2014. https://doi.org/10.7551/mitpress/8313.001.0001.

Gissen, David. “Puddles.” In *Subnature: Architecture’s Other Environments*, edited by Laurie Manfra, 1st ed., 100–117. New York: Princeton Architectural Press, 2009.

Gutiérrez de MacGregor, María Teresa, and Jorge Gonzáles Sánchez. “Evolución Del Crecimiento Espacial de La Ciudad de México En Relación Con Las Regiones Geomorfológicas de La Cuenca de México.” In *Geografía Para El Siglo XXI. Series Libros de Investigación, Núm. 7: Estudio Sobre Los Remanentes de Cuerpos de Agua En La Cuenca de México*, edited by Raúl Aguirre Gómez, 15–39. Universidad Nacional Autónoma de México, 2010.

Hagan, Susannah. *Ecological Urbanism: The Nature of the City*. New York: Routledge, 2015.

Lacroix, Jorge Gurría. *El Desagüe Del Valle de México Durante La Época Novohispana*. Primera edición. Ciudad de México: Universidad Nacional Autónoma de México, 1978.

Lankao, Patricia Romero. “Water in Mexico City: What Will Climate Change Bring to Its History of Water-Related Hazards and Vulnerabilities?” *Environment and Urbanization* 22, no. 1 (April 2010): 157–78. https://doi.org/10.1177/0956247809362636.

Leatherbarrow, David. “Between Soil and Sky, or Cultural Memory and Invention in Contemporary Latin American Landscapes.” In *New Latin American Landscape Architecture*, edited by Monica Gili, Miquel Adria, Moises Puente, and Anna Puyuelo, 4–10. Barcelona: Gustavo Gili, 2009.

Legorreta, Jorge. “Más Siglos, Más Túneles... y Más Inundaciones En La Ciudad de México. Hacia El Cuarto Centenario de La Edificación de Túneles En La Ciudad.” In *Innovación Tecnológica, Cultura, y Gestión Del Agua*, edited by Delia Contreras Monter, Eugenio Gómez Reyes, Graciela Carrillo González, and Lilia Rodríguez Tapia, Primera ed., 231–41. Ciudad de México: Miguel Ángel Porrúa, 2009.

Mann, Charles C. *1491: New Revelations of the Americas Before Columbus*. 1st ed. New York N.Y.: Alfred A. Knopf, 2005.

Mann, Charles C. *1943: Uncovering the World Columbus Created*. 1st ed. New York N.Y.: Alfred A. Knopf, 2011.

Maudslay, Alfred P. “The Valley of Mexico.” *The Geographical Journal* 48, no. 1 (1916): 11–23. https://www.jstore.org/stable/1779321..

Mundy, Barbara E. *The Death of Aztec Tenochtitlan, The Life of Mexico City*. 1st ed. Austin, Texas: University of Texas Press, 2015.

Narchi, Nemer E., and Beatriz Canabal Cristiani. “Subtle Tyranny: Divergent Constructions of Nature and the Erosion of Traditional Ecological Knowledge in Xochimilco.” *Latin American Perspectives* 42, no. 5 (2015): 90–108. https://doi.org/10.1177/0094582x15585118.

Reguera, Loreta Castro. “Waterways in Mexico City.” In *Between Geometry and Geography*, edited by Felipe Correa and Carlos Garciavelez Alfaro, 1st ed., 246–53. Applied Research and Design Publishing, 2014.

Ruiz, Sonia Lombardo de. “El Desarrollo Urbano de México-Tenochtitlan.” *Historia Mexicana* 22, no. 2 (1972): 121–41. http://www.jstor.org/stable/25135336.

Sluyter, Andrew. *Colonialism and Landscape: Postcolonial Theory and Applications*. Boston: Rowman & Littlefield Publishers, Inc., 2002.

Vitz, Matthew. *A City on a Lake: Urban Political Ecology and the Growth of Mexico City*. Durham: Duke University Press, 2018.

Waldheim, Charles. “Landscape Urbanism: A Genealogy.” *Praxis: Journal of Writing Building*, no. 4 (2002): 10–17.

Wigle, Jill. “The ‘graying’ of ‘Green’ Zones: Spatial Governance and Irregular Settlement in Xochimilco, Mexico City.” *International Journal of Urban and Regional Research* 38, no. 2 (March 2014): 573–89. https://doi.org/10.1111/1468-2427.12019.

Wigle, Jill. “The ‘ Xochimilco Model’ for Managing Irregular Settlements in Conservation Land in Mexico City.” *Cities* 27, no. 5 (October 2010): 337–47. https://doi.org/10.1016/j.cities.2010.04.003.

Websites

Biasco, Paul. “Mexico City Is Proposing to Build One of the World’s Largest Urban Parks.” Smithsonian Magazine, last modified February 2020, https://www.smithsonianmag.com/travel/mexico-city-proposing-worlds-largest-urban-parks-180974179.

“CDMX, La Quinta Ciudad Más Habitada En El Mundo: ONU.” *Forbes Mexico*, last modified May 2018, https://www.forbes.com/mx/cdmx-la-quinta-ciudad-mas-habitada-en-el-mundo-onu/.

Maffie, James. “Aztec Philosophy.” *Internet Encyclopedia of Philosophy.* Accessed January 2020, https://www.iep.utm/edu/aztec/#SH2a.

Parry, Richard, "Episteme and Techne", *The Stanford Encyclopedia of Philosophy* (Summer 2020 Edition), Edward N. Zalta (ed.), accessed May 2020, https://plato.stanford.edu/archives/sum2020/entreis/episteme-techne.

Redaccion CP. “Abren al Público Primera Etapa del Parque Lineal Gran Canal.” *Chilango*, last modified January 19, 2020, https://www.chilango.com/noticias/parque-lineal-gran-canal.

Image Sources

Figure 1. Top Left: Cuartoscuro. Digital Image. 2018. El Sol de México. Accessed December 2019. https://www.elsoldemexico.com.mx/metropoli/entre-inundaciones-desde-2016-se-eleva-cifra-en-cdmx-1907886.html
Top Right:
Middle Left: Noticieros Televisa. Digital Image. 2019. Noticieros Televisa. https://noticieros.televisa.com/ultimas-noticias/lluvias-ciudad-mexico-inundaciones-afectaciones-alcaldias/
Middle Right: Digital Image. 2019. La Verdad. Accessed January 2020. https://laverdadnoticias.com/mexico/Fuertes-lluvias-causa-inundaciones-de-casi-un-metro-de-altura-en-la-Ciudad-de-Mexico-20190619-0171.html
Bottom Left: Haner, Josh. 2017. The New York Times. https://www.nytimes.com/interactive/2017/02/17/world/americas/mexico-city-sinking.html
Bottom Right: Cuartoscuro. Digital Image. 2019. El Sol de México. Accessed January 2020. https://www.excelsior.com.mx/comunidad/atiende-iztapalapa-escasez-de-agua-y-urge-a-aumentar-suministro/1357152.

Figure 2. Adapted from Humbort, Alexander von. “Tableau physique de la pente Occidental du Plateau de la Nouvelle Espagne.” 1807. David Rumsey Map Collection. Accessed July 2019.

Figure 4. Unknown Creator. “Departure from Aztlán.Tira de la Peregrinación, ca. 1530.” Biblioteca Nacional de Antropología e Historia. In *The Death of Aztec Tenochtitlan, The Life of Mexico City*. Austin, Texas: University of Texas Press, 2015, 26.

Figure 5. Unknown Creator.“The Foundation of Tenochtitlan.” Codex Mendoza, fol. 2r, ca. 1542. Bodleian Libraries, University of Oxford. In *The Death of Aztec Tenochtitlan, The Life of Mexico City*. Austin, Texas: University of Texas Press, 2015, 4.

Figure 6. Adapted from Unknown Creator. “Chalchihuitlicue with Ritual Objects and Surrounding Thirteen-day Calendar*.”* Codex Borbonicus, p.5, ca. 1525. In *The Death of Aztec Tenochtitlan, The Life of Mexico City*. Austin, Texas: University of Texas Press, 2015, 44.

Figure 7. Unknown Creator. “Map of Santa Cruz, ca. 1537-1555.” Library of Congress, World Digital Library. Accessed January 2020. https://www.wdl.org/en/item/503/.

Figure 10. (Left) Santiago Arau. “Xochimilco.” November 17, 2017. Accessed October 2019, https://www.instagram.com/p/BbVuOt1BTgH/
(Right) Santiago Arau.”Amanecer Invernal en Xochimilco.” February 15, 2017. Accessed October 2019, https://www.instagram.com/p/BQjdh6ig7yj/.

Figure 11. Adapted fromCoe, Michael D. “The Chinampas of Mexico.” *Scientific American* 211, no. 1 (1964): 94. http://www.jstore.org/stable/10.2307/25931564.

Figure 13. Joaquín Velázquez de León. “Projection of the Level of Lake Texcoco on the Open Trench.” Archivo General de la Nación - México, Fomento Desagüe, vol.3, f.9. Adapted from Candiani, Vera S. *Dreaming of Dry Land:Environmental Transformation in Colonial Mexico City*. Standford University Press, 2014. Accessed February 2020, https://scholar-princeton-edu.proxy.bib.uottawa.ca/sites/default/files/Figure%206.8%20web.pdf

Figure 14. Hugo Brehme. “Canal en el Tajo de Nochistongo.” 1935. Mediateca Instituto Nacional de Antropología e Historia (INAH). Accessed November 2019, https://mediateca.inah.gob.mx/islandora_74/islandora/object/fotografia%3A328596

Figure 15. Casasola. “Presa y compuerta del túnel, en el Gran Canal de Desagüe del Valle de Mexico.” 1800s. Secretaria de Cultura: Mexicana. Repositorio del Patrimonio Cultural de México. Accessed November 2019, https://mexicana.cultura.gob.mx/es/repositorio/detalle?id=_suri:FOTOTECA:TransObject:5bc7d7737a8a0222ef1108c3

Figure 16. Casasola. “Compuerta del Gran Canal en la Lumbrera Número Uno.” 1897. Secretaria de Cultura: Mexicana, Repositorio del Patrimonio Cultural de México. Accessed, November 2019, https://mexicana.cultura.gob.mx/es/repositorio/detalle?id=_suri:FOTOTECA:TransObject:5bc7d5af7a8a0222ef0be8f8

Figure 17. Casasola. “Tajo de Tequixquiac, contigua el desembarcadero del túnel.” 1945-1950. Secretaria de Cultura: Mexicana, Repositorio del Patrimonio Cultural de México. Accessed November 2019, https://mexicana.cultura.gob.mx/es/repositorio/detalle?id=_suri:FOTOTECA:TransObject:5bc7d7757a8a0222ef110e96

Figure 18. Casasola. Manuel Ávila Camacho e ingenieros inspeccionando el Túnel de Tequixqiac. 1946. Mediateca Instituto Nacional de Antropología e Historia (INAH). Accessed April 2020, https://mediateca.inah.gob.mx/islandora_74/islandora/object/fotografia%3A75502

Figure 19. (Left) Casasola. “Obras de Saneamiento en una Calle, Construcción de Drenaje.” Secretaria de Cultura: Mexicana, Repositorio del Patrimonio Cultural de México. Accessed November 2019, https://mexicana.cultura.gob.mx/es/repositorio/detalle?id=_suri:FOTOTECA:TransObject:5bc7d7bb7a8a0222ef11c57b.
(Middle) Casasola. “Obras de un Acueducto de la Ciudad de México.” Early 1900s. Secretaria de Cultura: Mexicana, Repositorio del Patrimonio Cultural de México. Accessed November 2019, https://mexicana.cultura.gob.mx/es/repositorio/detalle?id=_suri:FOTOTECA:TransObject:5bc7d6077a8a0222ef0d1c79
(Right) Casasola. “Construcción de Drenaje en una Calle.” 1928. Secretaria de Cultura: Mexicana, Repositorio del Patrimonio Cultural de México. Accessed November 2019, https://mexicana.cultura.gob.mx/es/repositorio/detalle?id=_suri:FOTOTECA:TransObject:5bc7d7bb7a8a0222ef11c2c0

Figure 20. (Left) El Paseo y la Garita de La Viga: Navegando en barco de vapor, 1850-1890. Accessed online November 2019. http://www.mexicomaxico.org/Viga/LaVigaGarita.htm

Figure 21. (Right) El Paseo y la Garita de La Viga: Navegando en barco de vapor, 1850-1890. Accessed online November 2019. http://www.mexicomaxico.org/Viga/LaVigaGarita.htm

Figure 22. . Mediateca Instituto Nacional de Antropología e Historia (INAH). Accessed January 2020. https://mediateca.inah.gob.mx/islandora_74/

Figure 23. Algunas Fotografias (muy antiguas) que cambiaron para siempre la Ciudad de Mexico. Accessed online November 2019. https://mxcity.mx/2015/07/asi-se-vio-la-ciudad-de-mexico-inundacion-de-1950-fotos/

Figure 25. (Top Left) “Interior of the Pump House at Nativitas.” In M. Marroquín y Rivera, Memoria Descriptiva de las Obras de Provisión de Aguas Potables para la Ciudad de México México, 1914. Adapted from Banister, Jeffrey M., and Stacie G. Widdifield. “The Debut of ‘modern Water’ in Early 20th Century Mexico City: The Xochimilco Potable Waterworks.” *Journal of Historical Geography* 46 (2014): 48. https://doi.org/10.1016/j.jhg.2014.09.005.

Figure 26. (Top Right) “Photograph of the Pump House at Nativitas with visitors.” In M. Marroquín y Rivera, Memoria Descriptiva de las Obras de Provisión de Aguas Potables para la Ciudad de México México, 1914. Adapted from Banister, Jeffrey M., and Stacie G. Widdifield. “The Debut of ‘modern Water’ in Early 20th Century Mexico City: The Xochimilco Potable Waterworks.” *Journal of Historical Geography* 46 (2014): 49. https://doi.org/10.1016/j.jhg.2014.09.005.

Figure 27. (Bottom Left) “Plan of the Pump House at Nativitas.” In M. Marroquín y Rivera, Memoria Descriptiva de las Obras de Provisión de Aguas Potables para la Ciudad de México México, 1914. Adapted from Banister, Jeffrey M., and Stacie G. Widdifield. “The Debut of ‘modern Water’ in Early 20th Century Mexico City: The Xochimilco Potable Waterworks.” *Journal of Historical Geography* 46 (2014): 47. https://doi.org/10.1016/j.jhg.2014.09.005.

Figure 28. (Bottom Right) “Photograph of Distribution Tank with visitors.” In M. Marroquín y Rivera, Memoria Descriptiva de las Obras de Provisión de Aguas Potables para la Ciudad de México México, 1914. Adapted from Banister, Jeffrey M., and Stacie G. Widdifield. “The Debut of ‘modern Water’ in Early 20th Century Mexico City: The Xochimilco Potable Waterworks.” *Journal of Historical Geography* 46 (2014): 51. https://doi.org/10.1016/j.jhg.2014.09.005.

Figure 29. Adapted from Correa F. and Carlos Garciavelez Alfaro *Between Geometry and Geography*. p. 276

Figure 30. Dirección General de Obras Hidráulicas. "Localización Interceptor y Emisor Central." In Sistema de Drenaje Profundo. Mexico City, 1975, plate 20

Figure 31. Dirección General de Obras Hidráulicas. "Perfil Geológico a lo largo del Emisor Central." In Sistema de Drenaje Profundo. Mexico City, 1975, plate 17

Figure 32. (Left) Dirección General de Obras Hidráulicas. "Sección de Excavación del Emisor Central." In Sistema de Drenaje Profundo. Mexico City, 1975, plate 40

(Right) Dirección General de Obras Hidráulicas. "Lumbrera 15 Emisor Central." In Sistema de Drenaje Profundo. Mexico City, 1975, plate 42

Figure 33. Adapted from Correa F. and Carlos Garciavelez Alfaro *Between Geometry and Geography*. p. 264

Figure 34. Comisión Hidrológica de la Cuenca de México, Secretaría de Recursos Hidráulicos. "Croquis de la Localización de las Obras del Proyecto de Lerma." In Hidrología de la Cuenca del Valle de México. Vol. VII, no.11. Mexico City, 1964, Plan XI-2

Figure 35. Images taken by the author. February 2020.

Figure 36. Loreta Castro. Miguel Aleman Viaduct during a storm. Adapted from Correa F. and Carlos Garciavelez Alfaro *Between Geometry and Geography*. p. 251

Figure 38. Radio México Internacional. Accessed May 2020, https://www.imer.mx/rmi/el-apostol-que-era-mas-que-una-avenida/.

Figure 39. Parque Nacional Cumbres del Ajusco. *Secretaria de Turismo CDMX*. Accessed May 2020. http://cdmxtravel.com/es/lugares/parque-nacional-cumbres-del-ajusco.html

Figure 40. Parque Nacional Los Dinamos. *Secretaria de Turismo CDMX.* Accessed May 2020. http://cdmxtravel.com/es/lugares/parque-nacional-los-dinamos.html

Figure 41. Pinterest. Accessed January 2020, https://www.pinterest.ca/pin/840132505464014239/

Figure 42. (Left) Casasola. “Proyecto de Forestación del Lago de Texcoco.” Secretaria de Cultura: Mexicana, Repositorio del Patrimonio Cultural de México. Accessed November 2019, https://mediateca.inah.gob.mx/islandora_74/islandora/object/fotografia%3A108066.

Figure 43. (Top Left) Casasola. “Hombres Trabajan en las Obras Hidráulicas del Vaso de Texcoco.” 1930. Instituto Nacional de Antropología e Historia (INAH).Accessed October 2019, https://mediateca.inah.gob.mx/islandora_74/islandora/object/fotografia%3A9853

Figure 44. (Top Right) Excelsior. Accessed April 2020, https://www.excelsior.com.mx/expresiones/2015/04/13/1018443#imagen-1.

Figure 45. (Bottom Left) MXCity: Guía Insider. Accessed April 2020, https://mxcity.mx/2019/04/parque-ecologico-lago-de-texcoco-un-paraiso-en-lo-que-iba-a-ser-un-aeropuerto/.

Figure 46. Mario Schjetnan.”Xochimilco Project Master Plan.” Grupo de Diseño Urbano, 1993. Accessed January 2020, http://gdu.com.mx/gdu/portfolio/parque-ecologico-xochimilco/.

Figure 47. Parque Ecológico de Xochimilco. Grupo de Diseño Urbano, 1993. Accessed January 2020, http://gdu.com.mx/gdu/portfolio/parque-ecologico-xochimilco/.

Figure 48. (Top Left) Alberto Kalachi. “Calzada México-Texcoco.” In *México. Ciudad Futura*. México City: Daido, 2010. Accessed Novembre, 2019. https://www.kalach.com/ciudad-futura.

Figure 49. (Top Right) Alberto Kalachi. “El Nuevo Aeropuerto.” In *México. Ciudad Futura.* México CIty: Daido, 2010. Accessed November 2019, https://www.kalach.com/ciudad-futura.

Figure 50. (Bottom Left) Alberto Kalachi. “Desarrollo al Borde del Lago.” In *México. Ciudad Futura.* México City: Daido, 2010. Accessed November 2019, https://www.kalach.com/ciudad-futura.

Figure 51. Architizer. Accessed February 2020, https://architizer.com/idea/201149/.

Figure 52. Renders courtesy of Iñaqui Echeverria. Arquitour. Accessed February 2020, http://www.arquitour.com/parque-ecologico-lago-de-texcoco-inaki-echeverria/2012/05/.

Figure 53. Renders courtesy of Iñaqui Echeverria. Arquitour. Accessed February 2020, http://www.arquitour.com/parque-ecologico-lago-de-texcoco-inaki-echeverria/2012/05/.

Figure 54. @julioc_moreno. LANetwork. Accessed March 2020, https://la.network/ciudad-de-mexico-entrego-primera-etapa-del-parque-lineal-gran-canal/.