Infrastructural Ecologies:

Converting the Abandoned Fisher Flourmill on Seattle's Harbor Island into an Aquaponic Food Production and Education Facility.

Sean Michael Kelly

A thesis submitted in partial fullfillment of the requirements for the degree of
Master of Architecture

University of Washington
2013

Committee:
Rick Mohler, Chair
David Strauss

Program Authorized to Offer Degree:
Department of Architecture

Dedicated to My Family– Thank you for your inexhaustable love and support.

ACKNOWLEDGEMENTS

First and foremost, I'd like to thank Rick Mohler and David Strauss (my thesis committee), for contributing their valuable time, expertise, design-input, encouragement, and guidance throughout this thesis process. Thank you especially for helping me to clarify my thoughts and intentions regarding this broad project.

Thank you to Kate Simonen for the structural crit and Dan Stettler for the design crit.

Thank you to the thesis jurors: Uwe Bergk (SRG Partnership), Rick Browning (AIA), Myer Harrell (Webber Thompson), and Gundula Proksch (UW) – you're engaging discussion and interest in the project during the final review was a sweet relief. Thank you also to Boris Srdar (NAC), Prentis Hale (SHED), and Mike Jobes (Miller Hull)– your input during the mid-review helped to focus the project.

Thank you to Jim Nokes for taking the time out of your busy schedule to show me around the Fisher Flourmill. Your extensive knowledge of its inner-workings and lore surrounding its abandonment continue to fascinate me. Have a great retirement!

Thank you to my friend and Master of Landscape Architecture student, Taj Hansen, for the smooth and thoughtful collaboration– It was the first, but hopefully not the last.

Thank you to all the other UW CBE faculty who have helped me to grow as a designer over these many years: Jen Dee, Charlie Anderson, Ken Oshima, Tristan Pagenkopf, Frank Ching, Dan Stettler, Judith Swain, Rob Peña, Chris Meek, Alex Anderson, Jim Nicholls, Nicole Huber, and Morten Vedelsbøl (The Royal Danish Academy).

And lastly, thank you to all my studio-mates for the motivation, laughter, and memories. Best of luck to you all!

CONTENTS

IMAGE REFERENCES

Break Image: “Mill at the Mouth of the Duwamish.” Sean Kelly. 2013

1 // Overview: “Cheadle Grain Elevator Demolition.” 2008. http://www.cheadlealberta.com/images/Grain_Elevator.jpg

Figure 1 (top-left): “Ogden Grain Elevator Demolition.” *Flickr*. 2011. http-//farm7.staticflickr.com/6157/6249594889_7ac59a18b8_z.jpg
Figure 2 (top-right): “Girard Point (Tidewater) Grain Elevator.” *Wordpress*. 2007. http://ruins.files.wordpress.com/2007/12/104_6633.jpg
Figure 3 (bottom-right): “Liverpool Grain Silo Demolition.” 2009. *Flickr*. http://www.flickr.com/photos/subutcher/3641212585/
Figure 4 (bottom-left): “Baron’s Grain Elevator Demolition.” Jaime Vedres. 2012. http://dailyphotodose.com/wp-content/uploads/2012/07/BaronsGrainElevator_01.jpg
Figure 5: “Bing Maps.” *Bing*. 2013. http://www.bing.com/maps

2 // Past “1875 Duwamish Bay Survey Map.” *The Burke Museum*. 2009. http://www.burkemuseum.org/waterlines/maps.html

Figure 6: “Historic Seattle Maps by Kroll.” *Kroll*. 2013. http://www.krollmap.com/id100.html
Figure 7: Base map courtesy of *Google*. 2013. maps.google.com
Figure 8: (top-left) “Harbor Island in 1910.” Museum of History and Industry. 2013. http://content.lib.washington.edu/cdm4/item_viewer.php?CISOROOT=/imlsmohai&CISOPTR=5199
(left-middle) “Dearborn Street Regrade.” Museum of History and Industry. 2013. http://upload.wikimedia.org/wikipedia/commons/thumb/5/5a/Seattle_-_Dearborn_St_regrade,_1912.gif/930px-Seattle_-_Dearborn_St_regrade,_1912.gif
(bottom-left) “Jackson Regrade.” Museum of History and Industry. 2013. http://content.lib.washington.edu/cdm4/item_viewer.php?CISOROOT=%2Fseattle&CISOPTR=578&DMSCALE=100&DMWIDTH=802&DMHEIGHT=606.72135416667&DMMODE=viewer&DMFULL=1&DMX=0&DMY=0&DMTEXT=&DMTHUMB=0&REC=1&DMROTATE=0&x=569&y=212
(bottom-middle) “Jackson Regrade.” Museum of History and Industry. 2013. http://pauldorpat.com/wp-content/uploads/2011/12/1-Weller-St.-Pipeline-lk-W.-WEB.jpg
(bottom-right) “Jackson Regrade.” Museum of History and Industry. 2011. http://pauldorpat.com/wp-content/uploads/2011/12/Jackson-regrade-THEN-mr.jpg
(top-right) “Jackson Street Regrade.” Museum of History and Industry. 2005. http://pauldorpat.com/wp-content/uploads/2010/03/5th-Lane-THEN-WEB.jpg
Figure 9: Base map courtesy of Google. 2013. maps.google.com
Figure 10: “The Fisher Flourmill circa 1912.” Museum of History and Industry. 2013
Figure 11: “Flour Packing, Storage, and Shipping.” Museum of History and Industry. 2013.
Figure 12: “Flour Packing, Storage, and Shipping.” Museum of History and Industry. 2013.
Figure 13: “Building Timeline.” Sean Kelly. 2013
Figure 14: “The mill’s current condition.” *Bing*. 2013. http://www.bing.com/maps
Figure 15: “Existing building with construction dates.” Sean Kelly. 2013.

3 // Present “Photo looking east towards the mill” *Sean Kelly*. 2013.

Figure 16: “Basement flooding.” Sean Kelly. 2013.
Figure 17: “Steel scrapping, photography , and graffitti.” Sean Kelly. 2013.
Figure 18: “The Flourmill’s local and regional connections.” Sean Kelly. 2013.

Figure 19: “The economic connection between Seattle’s Ports and the rest of the world.” Sean Kelly. 2013.
Figure 20: “The Mill’s Approach.” Sean Kelly. 2013.
Figure 21: “The approach and view from the Klickitat Avenue overpass.” Sean Kelly. 2013.

4 // Literature Review Main background for collage courtesy of “Etienne-Louis Boullée’s Cenotaph to Sir Isaac Newton.” 1784. http://www.bu.edu/av/ah/fall2008/ah382/lecture05/33.jpg.

Figure 22: “The City as an Egg.” Flickr. http://farm7.static.flickr.com/6135/6208380488_8947b0b7c7_b.jpg
Figure 23: “Pablo Picasso’s ‘Bull’s Head’. 1942.” http://tubulocity.com/wp-content/uploads/2012/03/picasso-1943-stierkopf-xl.jpg
Figure 24: “Sublime Roof Collapse in Mill’s 1&2.” Sean Kelly. 2013

5 // Comparing Processes

Figure 25: “Media Based Aquaponic System”:
(top-left) “Mediamatic IBC Vertical Aquaponics Farm.” Els Engel. 2012. http://elsengel.nl/portfolio/wp-content/uploads/aquaponics_3in1_V2.png
(top-right) “Media Based Technique Diagram.” January 12, 2013. http://neweraquaponics.files.wordpress.com/2013/01/aquabook11.jpg
(bottom-left) “Growbed Zones Diagram.” Aquaponics Australia. 2008. http://www.aquaponics.net.au/Images/GrowBedZones1.jpg
(bottom-middle) “Growbed.” 2013. http://www.truthistreason.net/wp-content/uploads/aquaponics_drbones.bmp
(bottom-right) “Lettucs Varietals.” AquaponicsUSA. .2013. http://aquaponicsusa.files.wordpress.com/2011/12/humble-seed-red-oak-and-blk-seeded-simpson.jpg
Figure 26: “Nutrient Film Technique (NFT) System”
(top) “NFT Diagram.” San Diego Hydroponics and Organics. 2013. http://sdhydroponics.com/resources/wp-content/uploads/2012/05/Screen-shot-2012-02-08-at-12.15.46-PM.png
(bottom-left) “Root Baskets.” Canna UK. 2013. http://www.canna-uk.com/sites/default/files/images/articles/default/articles-aquaponics_text_2.jpg
(bottom-middle) “Plant Removal” A. Joats. 2011. http://joatsblog.com/wp-content/uploads/2011/02/IMG_3275-Medium.jpg
(bottom-right) “Lettuce Varietals.” Backyard Aquaponics. 2013. http://www.backyardaquaponics.com/wp-content/uploads/2012/06/NFT-Small.jpg
Figure 27: “Raft-based System”:
(top) “Raft-Based System Diagram.” Microponics. 2013. http://www.microponics.net.au/wp-content/uploads/2010/05/Raft-System.jpg
(bottom-left) “Plant Start.” Portable Farms. 2012. screenshot from http://www.youtube.com/watch?v=mCCN4nq7BlQ
(bottom-middle) “Raft and Roots.” Blogspot. 2013. 4.bp.blogspot.com/-ZFIaZTl3KJE/Tg01h_TD-qI/AAAAAAAAC1E/btfbcuvBNNE/s1600/DSC04692.JPG
(bottom-right) “Raft Field.” San Diego Hydroponics and Organics. 2013. http://sdhydroponics.com/resources/wp-content/uploads/2012/05/aquaponics.jpg
Figure 28: “The Nitrogen Cycle.” Sean Kelly. 2013
Figure 29: “Amount of land area it would take to produce enough food to feed Seattle’s population.” Sean Kelly. 2013
Figure 30: “Tenochtitlan.” Mexicanlore. 2013. http://www.mexicolore.co.uk/images-3/382_02_2.jpg
Figure 31: “Chinampa’s Section Cut.” Midwest Permaculture. 2012. http://midwestpermaculture.com/wordpress/wp-content/uploads/2012/10/chinampasImage.jpg
Figure 32: “The Flour Milling Process.” Sean Kelly. 2013

6 // Design

Figure 33: “The Existing Building.” Sean Kelly. 2013.
Figure 34: “The Repurposed Building.” Sean Kelly. 2013.
Figure 35: “Locations of Seattle Pea Patches.” Sean Kelly. 2013.

6.1 // Designing the Function

6.2 // Designing the Experience

Figure 84: “Usage Diagram.” Interface Studio Architects. 2012. http://www.archdaily.com/142709/the-granary-interface-studio-architects/usage-diagram-dgk-all/
Figure 85: “Public Presence.” Interface Studio Architects. 2012. http://www.archdaily.com/142709/the-granary-interface-studio-architects/isa_granary_20th_street_panorama/
Figure 86: “Silos for Mushroom Growing.” Interface Studio Architects. 2012. http://www.archdaily.com/142709/the-granary-interface-studio-architects/isa_granary_silo_climbing_wall/
Figure 87: “Silos for Climbing.” Interface Studio Architects. 2012. http://www.archdaily.com/142709/the-granary-interface-studio-architects/isa_granary_silo_farm/
Figure 88: “Site: Before and After.” Weiss Manfredi Architects. 2007. http://www.weissmanfredi.com/project/seattle-art-museum-olympic-sculpture-park
Figure 89: “Walkway Over the Rails.” Weiss Manfredi Architects. 2007. http://www.weissmanfredi.com/project/seattle-art-museum-olympic-sculpture-park
Figure 90: “Site Diagrams.” Weiss Manfredi Architects. 2007. http://www.weissmanfredi.com/project/seattle-art-museum-olympic-sculpture-park
Figure 91: “Site Section.” Weiss Manfredi Architects. 2007. http://www.weissmanfredi.com/project/seattle-art-museum-olympic-sculpture-park
Figure 92: “Street Facade.” Weiss Manfredi Architects. 2007. http://www.weissmanfredi.com/project/seattle-art-museum-olympic-sculpture-park
Figure 93: “Pavilion at Dusk.” Weiss Manfredi Architects. 2007. http://www.weissmanfredi.com/project/seattle-art-museum-olympic-sculpture-park
Figure 94: “Pavilion Interior.” Weiss Manfredi Architects. 2007. http://www.weissmanfredi.com/project/seattle-art-museum-olympic-sculpture-park
Figure 95: “Historic Use.” Toronto Archives. 1890. http://www.arupconnect.com/2013/04/18/addressing-a-citys-modern-challenges-by-tapping-into-its-history/
Figure 96: “Reactivated Interior.” Diamond Schmitt Architects. 2012. http://ad009cdnb.archdaily.net/wp-content/uploads/2012/06/1338906011-brickworks-5-1000x664.jpg
Figure 97: “Existing Warehouse.” Diamond Schmitt Architects. 2012. http://ad009cdnb.archdaily.net/wp-content/uploads/2012/06/1338905908-brick-works-2.jpg
Figure 98: “Entry Plaza.” Diamond Schmitt Architects. 2012. http://www.csla-aapc.ca/sites/csla-aapc.ca/files/web-atlas/projects/Evergreen%20Brick%20Works%20Toronto,%20ON%203%20-%20Design%20-%20National%20Honour_0.jpg
Figure 99: “New Facade.” Diamond Schmitt Architects. 2012. http://www.dsai.ca/uploads/projects-main/BRICKWORKS-chimney-court-R1.jpg
Figure 100: “Installation in Courtyard.” WORK Architecture Company. http://farm4.staticflickr.com/3224/2816095783_a4f06e7c98_z.jpg
Figure 101: “Planting/Picking diagram.” WORK Architecture Company. 2008. http://ad009cdnb.archdaily.net/wp-content/uploads/2008/05/ps1-05-planting-strategy.jpg
Figure 102: “Planting Crops.” WORK Architecture Company. 2008. http://www.ourcitiesourselves.org/images/my_city/public_farm_1.jpg
Figure 103: “Tube Construction.” WORK Architecture Company. 2008. http://stephenbrammer.files.wordpress.com/2010/10/2587934961_0805a16148_o.jpg
Figure 104: “Finished Installation.” WORK Architecture Company. 2008. http://archrecord.construction.com/news/daily/archives/2010/12/101206moma_ps1_young_arch/18_2008_Public-Farm-One.jpg
Figure 105: “Urban Context.”Mithun Architects and Urban Planners. 2007. http://mithun.com/projects/project_detail/center_for_urban_agriculture/
Figure 106: “Primary Facades.” Mithun Architects and Urban Planners. 2007. http://mithun.com/projects/project_detail/center_for_urban_agriculture/
Figure 107: “Contextual Perspective from Street.”Mithun Architects and Urban Planners. 2007. http://mithun.com/projects/project_detail/center_for_urban_agriculture/
Figure 108: “Function Diagrams.” Mithun Architects and Urban Planners. 2007. http://mithun.com/projects/project_detail/center_for_urban_agriculture/
Figure 109: “Exploded Assembly Showing Reused Shipping Containers” Mithun Architects and Urban Planners. 2007. http://mithun.com/projects/project_detail/center_for_urban_agriculture/

Break Image: “Harbor Island with Mount Rainier.” Stuart Isset. 2013. www.isett.com/data/photos/319_1vigor_aerial_94.jpg


APL
MAERSK

1 // Overview

INTRODUCTION

"A designer is an emerging synthesis of artist, inventor, mechanic, objective economist, and evolutionary strategist."

-R. Buckminster Fuller

Factories and other obsolete urban-relics from the industrial-age have gradually become abandoned in cities worldwide. Once the bustling engines of economic development, intrinsically tied to the city's metabolism and strategically located along its harbors, railroads, and thoroughfares, the central and highly-valuable land these building's occupy often incentivize their demolition.

Finding clever ways to re-use these specialized buildings preserves our cities industrial heritage, while saving energy and materials that would otherwise be disposed of. So, as Seattle's manufacturing sector continues to shrink and information-technology begins to decentralize industry, how can architecture address these contemporary issues by reusing its underutilized infrastructure, all the while ecologically reviving the once-thriving estuary, now turned Superfund Site of Harbor Island?

Figures 1-4: Grain Elevator Demolitions

PROBLEM STATEMENT

This thesis explores ways in which highly specialized, yet technologically obsolete, buildings may be reprogrammed with contemporary uses by finding overlap between two-differing processes with coincident material flows and building forms. As the case-in-point, I propose converting the abandoned Fisher Flourmill, on Seattle's Harbor Island, into an aquaponic food-production and education facility with three primary goals:

1. To retain Seattle's industrial heritage by re-using and re-contextualizing its existing infrastructure.

2. To produce food locally, thereby reducing the disconnect between food-producer and consumer.

3. To reframe the interaction between the general public and the means of production that sustain us, since traditionally industrial processes have been removed from public view.

The study begins with a contextual analysis of the existing mill, showing its historic significance, connections (both locally and globally), and current conditions. Next, a forensic analysis of the existing flourmill's function is shown to inform the material and resource flows of its conversion into an aquaponics facility. And, lastly, its new operation is described from both a functional and experiential perspective.

There is also a collaborative component to this project– For his thesis project, Taj Hansen, a Master's of Landscape Architecture student at the University of Washington, has used the asphalt-capped and abandoned Lockheed Martin lot and BP tank farm to the north of the site to create a bioremediation testing ground and biofuel processing plant. While his project formulates a large scale plan, this project focuses on the building proper. The two designs are related through their material flows and site strategies.

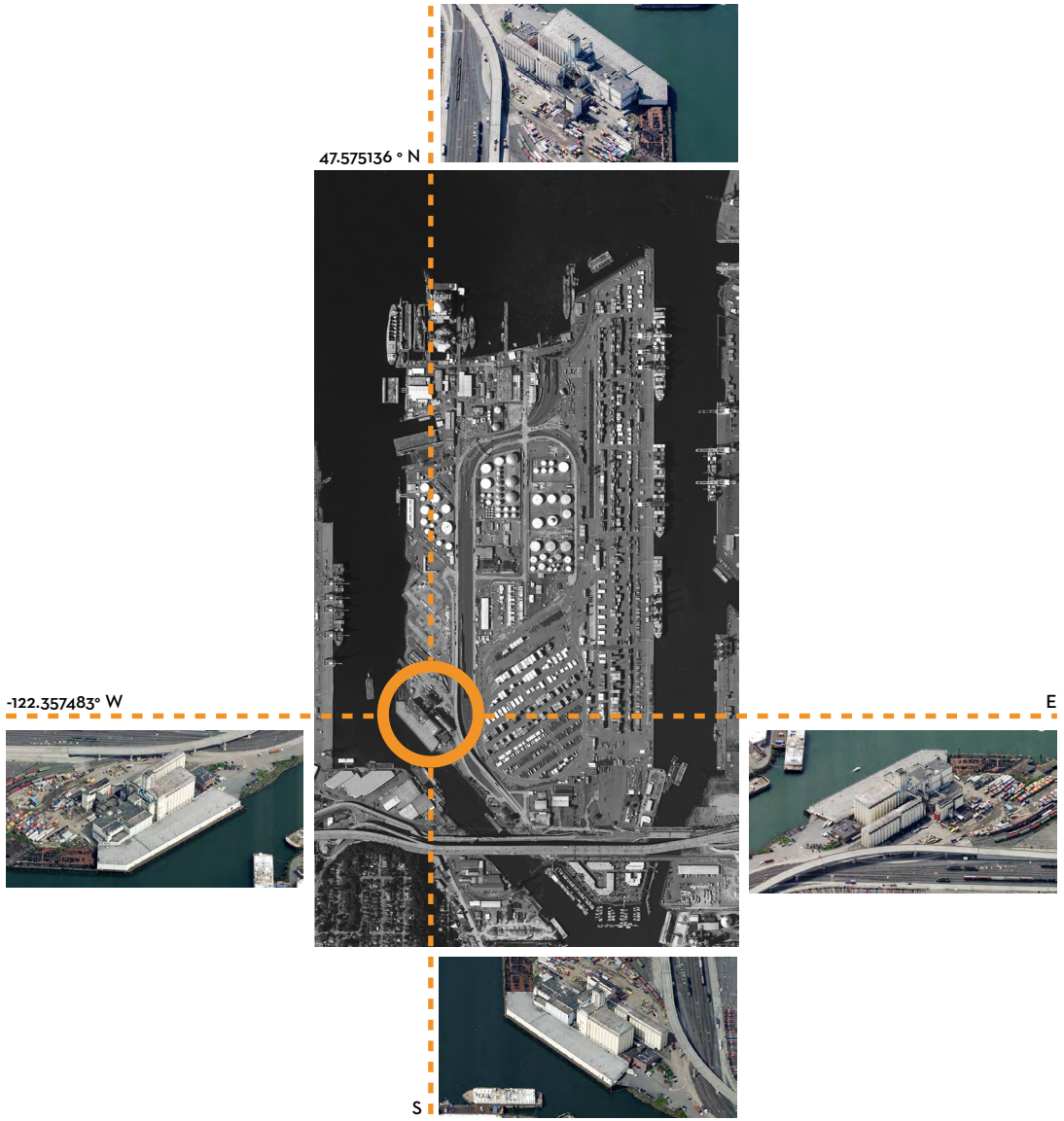


Figure 5: Fisher Flourmill's location on Harbor Island.

2 // Past


FOR EVERY PURPOSE
FISHERS BLENDFLOUR
WEST WATERWAY LUMBER C

HARBOR ISLAND'S HISTORY

Purely restorative "solutions" to Superfund Sites seek to remediate towards pre-societal/ecological conditions, but do not necessarily edify their historic social contexts. Within Harbor Island's contaminated ecosystem lies an amalgam of layered readings– a meta-nature echoing the cultural and environmental conditions present during subsequent periods of growth and decay. The Fisher Flourmill is a product of this ongoing process.

Centuries before the Industrial Revolution, the Duwamish River (Dx^{w}dəw in Lushootseed) was the lifeblood for Seattle's Native people, providing food, transportation, and an ecologically sound habitat for many indigenous species, including deer, elk, fowl, salmon, and clams. The lower-river was a flourishing estuary and riparian habitat winding 14 miles through 1,450 acres of intertidal mud and sand flats, 1,300 acres of estuary marsh, and 1,450 acres of forested wetland.[1] Floods and heavy rains were an integral part of this ecosystem's flux, causing the river to shift and redirect annually. This symbiotic lifestyle of the Duwamish people had been maintained since the 6th century. Until in 1851, when settlers, eager to "tame" this dynamic basin, drove them from their land. Seattle was incorporated in 1853, and the settling continued. When indigenous people backlashed in 1856, they were quickly dissuaded by US armed forces backed by the gunship Decatur.

Change quickly accelerated by 1890 when engineers introduced a sewage system sending waste, from the South Park and Georgetown settlements, into the river. To create more industrial land and to control the seasonal floods plaguing the area, engineers also decided to straighten the river *(fig. 6)*. When the Great Northern Railway arrived in 1893, redevelopment of the ports was accelerated. Beginning in 1905, the tidal flats at the mouth of the river were dredged, eventually deepening the river by 50 feet for a distance of 4.5 miles, to accommodate steamboats traveling as far as Kent.[2] And, major harbor developments continued throughout Seattle in anticipation of the Panama Canal's opening. Seattle was quickly becoming an international port furthered by a massive influx of prospectors headed north towards gold in the Klondike.

By 1909, 24 million cubic yards of dredged soil and spoils from the Jackson Hill and Dearborn Street regrades were combined to create Harbor Island *(fig. 7-9)*– the largest artificial island in the world (until 1938). It's 350 acres (expanding to 397 by 1967) located at the mouth of the Duwamish, would come to house a secondary lead-smelting plant, ship building and repair docks, bulk petroleum storage, metal fabrication shops, warehouses, laboratories, containerized cargo shipping areas, and the Fisher Flourmill.[3] Open for production in 1911, the same year as The Port of Seattle was founded, Harbor Island would help Washington to become the worlds largest locally controlled port system,[4] with Seattle and Tacoma comprising the second largest load center in the nation. As well, by forming The Port of Seattle, King County voter's regained democratic control over lands previously run by railroad and shipping monopolies.[5]

1 Duwamish Alive, Restore Our River. History. http://www.duwamishalive.org/history/ .Web. visited Feb. 2, 2013

2 Wilma, David. Straightening of Duwamish River Begins on October 14, 1913. History Link. Feb. 16, 2001. http://www.historylink.org/index.cfm?DisplayPage=output.cfm&File_Id=2986 .Web. visited Feb. 2, 2013.

3 Wikipedia.org. http://en.wikipedia.org/wiki/Harbor_Island .Web. visited Feb. 2, 2013

4 Washington State Department of transportation. http://www.wsdot.wa.gov/Freight/Marine.htm .Web. visited Feb. 2, 2013.

5 SeattleWaterfront.org. http://www.seattlewaterfront.org/history/. Web. visited Feb. 2, 2013

Figure 6: Reshaping Harbor Island and The Lower Duwamish River

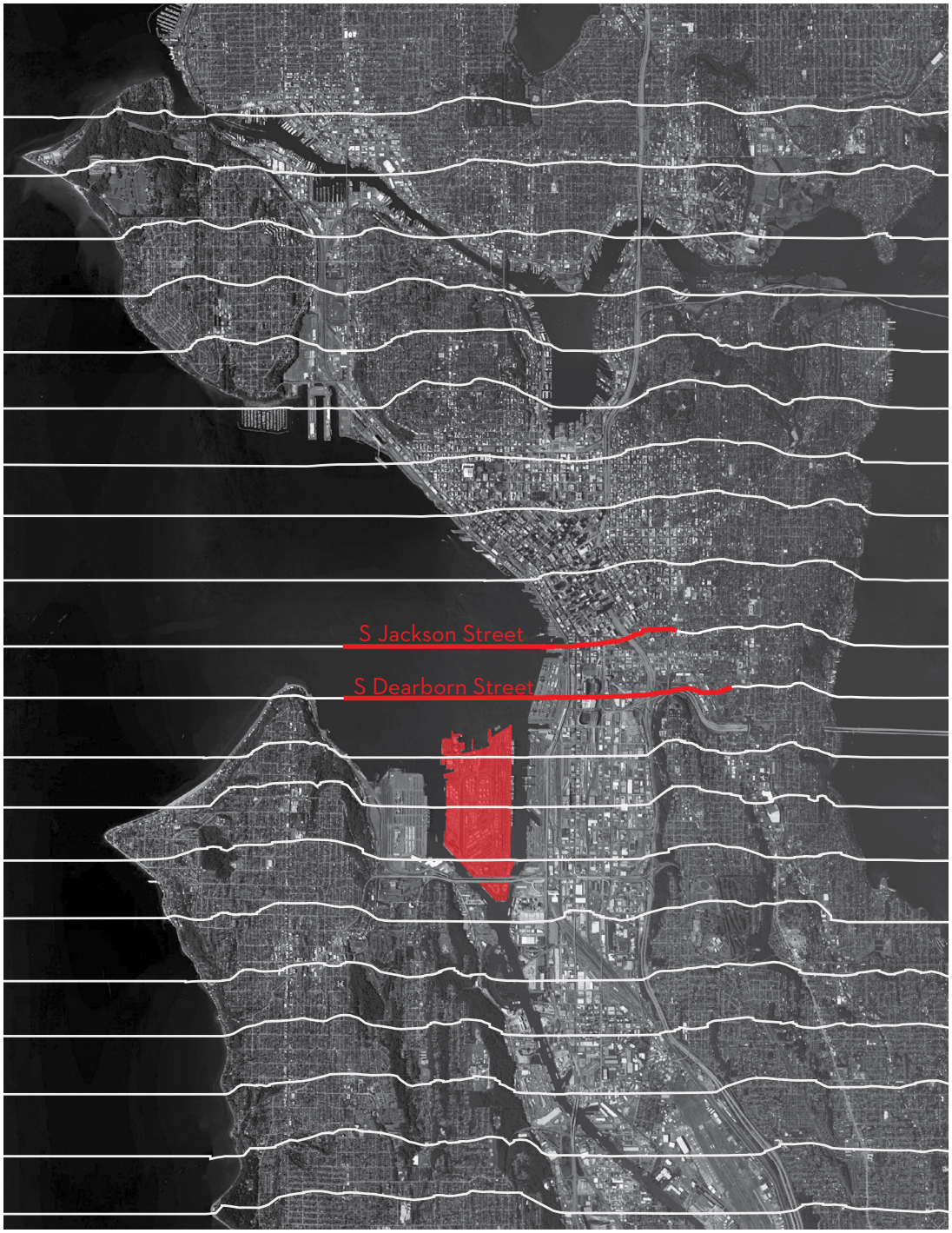


Figure 7: Harbor Island's resulting footprint

Figure 8: Seattle Regrades. (top-left) Harbor Island in 1910. (middle-left) Dearborn Street regrade. (top-right and bottom row) Jackson Street regrade.

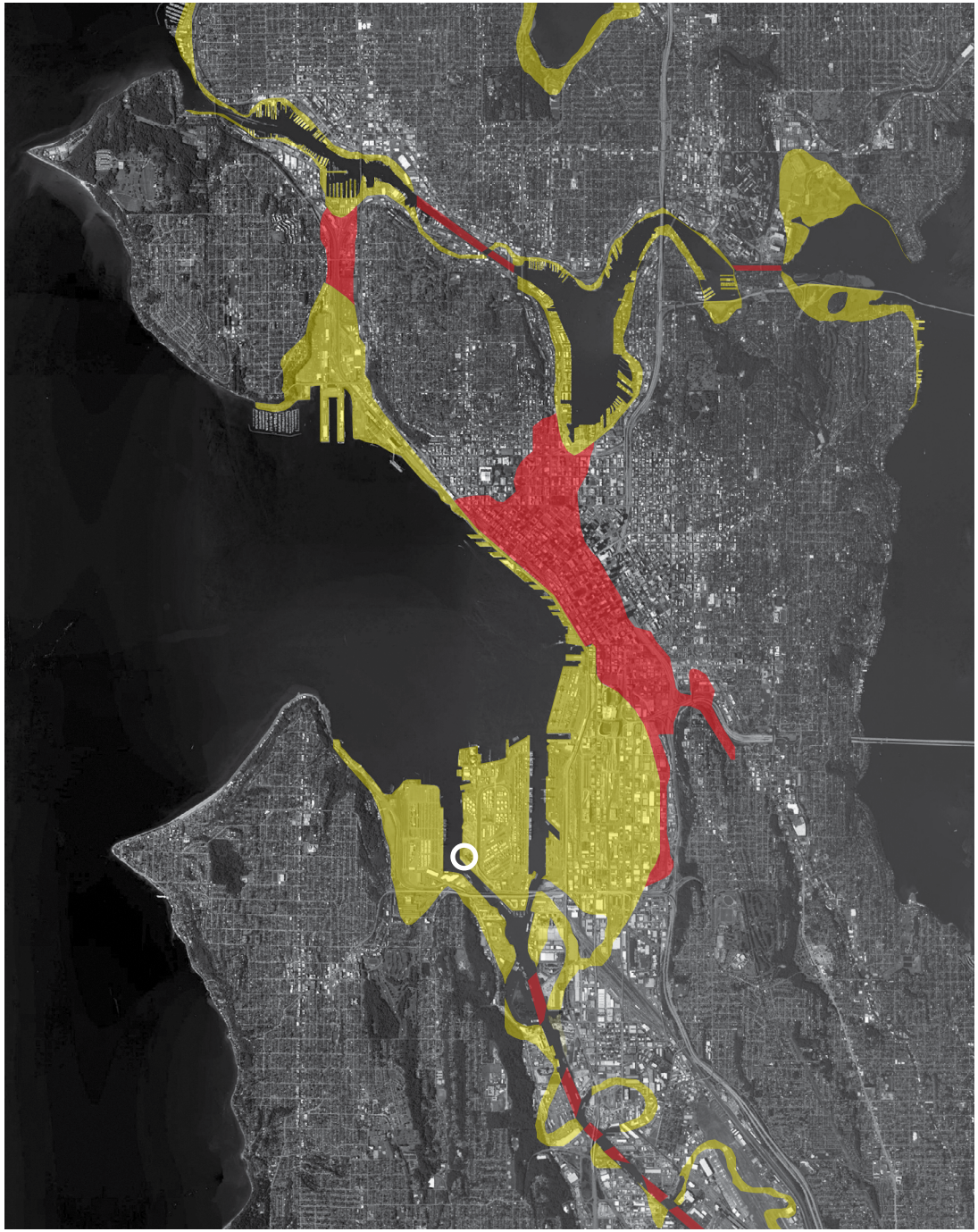


Figure 9: Cut (red) and Fill (yellow) land from early Seattle regrades with Fisher Floumill's location circled in white.

THE STORY OF O.D. FISHER, TITAN OF INDUSTRY

The story of the Fisher Flourmill *(fig. 10)* goes back much further than its construction in 1910. At the tail end of the 'Industrial Revolution,' in 1842, a poor boy named Oliver Williams Fisher entered this world through Ohio, only to dodge destitution by working in flour and saw mills from Ohio to Kentucky. By 1889, his hard work finally paid off when he founded a successful lumber company in Missouri, a land ripe with harvestable resources. The wealth accrued from this operation was re-invested in several timber operations in other states and his name soon became well known throughout Southern lumber circles— O.W. was certain his five sons, Daniel, Will, Wallace, Burr, and O.D. *(fig. 11)* would grow up with more opportunities than he had.[6]

The Fisher dynasty was born, and O.D. carried the torch well. He moved to Seattle in 1906, at the age of 31, enticed by the city's burgeoning downtown, abundance of natural resources, and important commercial shipping waypoint.[7]

> "According to business chroniclers of the era, as O.D. Fisher stood before Seattle's harbor he thought of the underdeveloped markets in the Far East, considered the rapidly growing population and trade along the Pacific Coast, and factored in the construction of the Panama Canal, then reportedly declared to his father, his brothers, and presumably anyone else in earshot, 'The markets of the entire world are before you.'" [8]

O.D.'s experience managing his families Belgrade, Montana flourmill, came in handy when he decided to open a mill of his own on Harbor Island. The Fisher Flourmill became the first building to open there, in 1910. It provided the base capital for many future business ventures, the most successful of which was KOMO broadcasting— started in 1926 and broadcasting from a small building on the southern portion of the site, the station became one of the first in the Pacific Northwest and was used, in part, to promote Fisher scones at fairs along the west coast. By the time of his death in 1967, he had established a diverse empire with three main branches: Communications, Real Estate, and Flour Production *(fig. 12)*.

Figure 10: The Fisher Fourmill circa 1912


Figure 11: OD Fisher

Figure 12: Flour Packing, Storage, and Shipping

6 American Lumberman, "The Personal History and Public and Business Achievements of One Hundred Eminent Lumbermen of the United States", Second Series, American Lumberman, Chicago, 1905-1906. http://www.ttarchive.com/Library/Biographies/Fisher_OW_AL.html .Web. visited Feb. 11, 2013

7 International Directory of Company Histories, Vol. 15. St. James Press, 1996. http://www.fundinguniverse.com/company-histories/fisher-companies-inc-history/ .Web. visited Feb. 11, 2013

8 ibid

THE BUILDING'S TIMELINE

The Fisher Flour Mill has expanded and contracted throughout its 98 years of operation, primarily based on market demands *(fig. 13 & 15)*. The following timeline delineates the building's progression:

1909- Harbor Island is constructed from 24 million cubic yards of fill dredged from the mouth of the Duwamish and delivered from the Jackson and Dearborn Street regrades.[9]

1910 (June)- Initial construction begins on the Northeastern 3x7 set of grain silos, mills 1&2, Package House 1, and Warehouse C

1911 (June)- The mills officially opens for production— 24 hours a day, 6 days a week. The $400,000 facility could grind 10,000 bushels (2,000 barrels) a day.[10]

1912 (November)- Dock Warehouse D

1913 (October)- Dock Warehouse A

1915- Scones began being sold at fairs along the west coast.

1916 (March)- The Southeastern 3x10 set of grain silos, Office Building, Transit House, Garage, Feed Mills 3-4-5, Wheat Cleaning, Rec. Dept. #2, Feed Mill Packer Room, Warehouse H, Warehouse B

1919 (December)- Garage Addition

1920 (July)- Dock Warehouse E

1926 (December)- The Radio Building was constructed to house what would later become KOMO-TV and eventually a communications empire.

1929 (March)- Western 6x10 set of grain silos, Square Storage, Motor Room, Rec. Dept. #3

1929 (April)- Dock Warehouse G,

1949 (April 13)- A 7.1-magnitude earthquake strikes Seattle, damaging the first Head House.

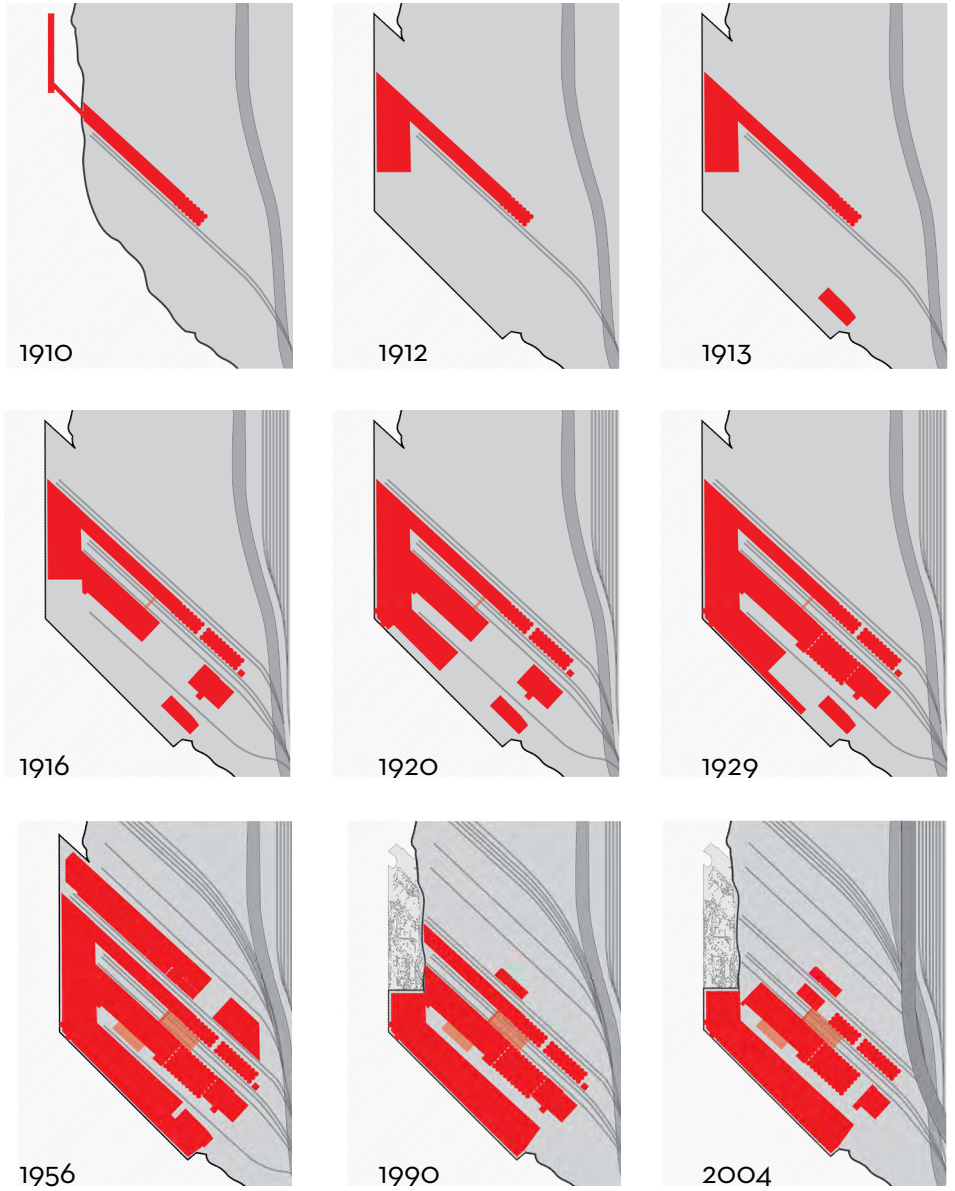


Figure 13: Building Timeline

9 Wikipedia. http://en.wikipedia.org/wiki/Harbor_Island .Web. visited Feb. 2, 2013

10 International Directory of Company Histories, Vol. 15. St. James Press, 1996. http://www.fundinguniverse.com/company-histories/fisher-companies-inc-history/ .Web. visited Feb. 11, 2013

1956 (June)- Warehouses 3 & 8-11, Buildings 6&7, Smaller Eastern-most Silos, Building 1 & 2, and Office 2

1990 (April)- Demolish Dock Warehouse D, Warehouses 8-11, and Building's 6 & 7, Dock Condemned.

Mid-90's– Klickatat Avenue overpass constructed.

2001 (Feb. 28)-A magnitude-6.8 earthquake rattles the Puget Sound and caused $1 billion in damage. Klickitat overpass constructed.

2001- Fisher Flour sells Mill to Pendelton for $31 million dollars

2002- Pendelton halts production at the mill and moves milling to their Blackfoot, Idaho Facility. Selling the 12.1 acre property to King County for $8.7 million dollars.

2004- Warehouses B & C Demolished

While the Fisher Flourmill is currently non-operational *(fig. 14)*, the west warehouse remains occupied by Puratos and Pendleton Flour, while Seattle Bulk Shipping Company occupies the southern brick building and eastern train yard.

King County, the current owner, plans to demolish the building in 2015 to use the space as a regional trash collection and sorting hub (once the Cedar Hills landfill is at capacity)– This is primarily due to the site's central location, its pre-contaminated nature, and its transportation access via water, road, and rail.

Figure 14: The mill's current condition (looking west)

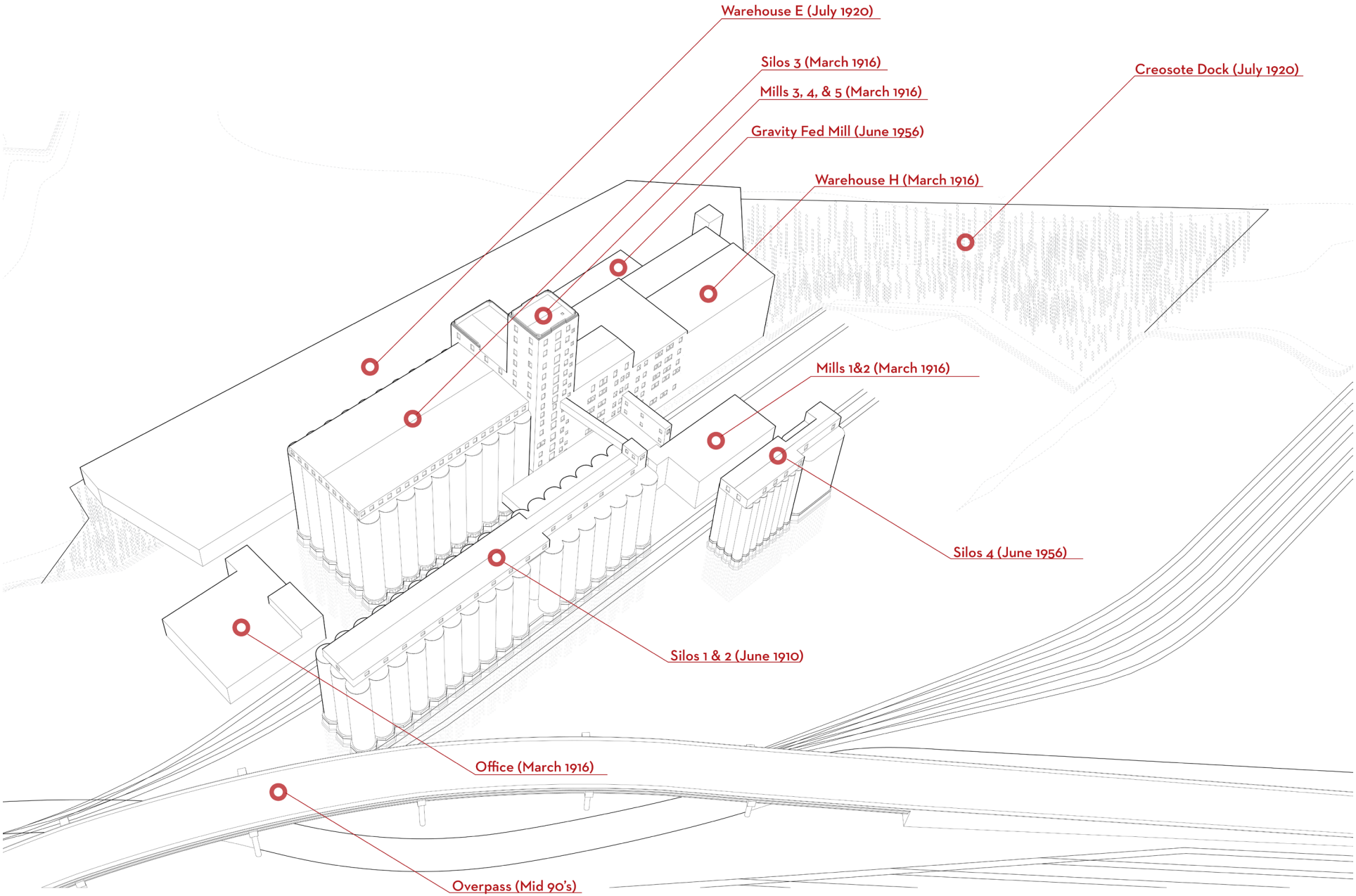


Figure 15: Existing buildings with construction dates

3 // Present

CURRENT CONDITIONS

Harbor Island is a seismically unstable liquefaction zone built atop a river delta— This became apparent during the 1949 and 2001 earthquakes as some sections of the island shifted by up to 16 inches, while muddy water purportedly erupted from the ground in a geyser-like fashion, up to a yard high in areas.[11] Later in 2001, it was deemed a Federal Superfund Site, mostly due to significant lead contamination in the soil. But, while the soil is relatively unstable and contaminated, the grain silos have stood strong through both earthquakes, because of their deep drilled-pier foundations.

Regarding the condition of the mill– The basement slab in Silo's 1-3 have cracked, so flood during high tides events *(fig. 16)*. Also, a large amount of asbestos material had to be abated from the facility before its sale in 2001.

There are no residences currently on the island, but 10,000 people live within one-mile of it.[12] Since the island is only used for industrial purposes, it typically clears-out at night when "blue-collar" workers leave. Besides these workers, the mills abandonment and remoteness attracts four other types of people— arsonists, metal scrappers, photographers, and graffiti writers *(fig. 17)*.[13] While the former two act like saprobes feeding on this decomposing building, the latter two are attracted by its creative potential. Most of the machinery in the complex has been ransacked by the steel scrappers, which recycle the precious metals for money. This has caused many contentious episodes. Jim Nokes, a 35 year employee of the Fisher Flourmill, recalls stories of scrappers being electrocuted after cutting live wires and booby traps being set up by both workers and scrappers in the form of cardboard being laid over floor openings.[14]

Regarding access and transportation, the site is at an important juncture both locally and globally— trains, commercial vehicles, and freight ships all converge at the Fisher Flourmill, as does marine life migrating up and down the Duwamish river *(fig. 18)*. As a gateway to the Pacific, the island has/had a strong connection with other port cities around the world *(fig. 19)*. In fact, during the great Russian famine of 1921 the mill sent entire ships loaded with flour to feed the starving people.

The building's breadth of connection is juxtaposed by it's relative inaccessibility. While it is a visually prominent feature along Seattle's industrial skyline, it's physically difficult to get to. This is mostly due to the large swaths of train tracks blanketing the island, which create multiple pedestrian barriers and very few entry points *(fig. 20)*. In the mid 90's the Klickatat Avenue overpass was constructed as an additive solution to this problem. Bending along the mills south end, the overpass became the main gateway to the islands west side *(fig. 21)*, making this western edge an island within an island.

Figure 16: Basement flooding

*For additional site photos see a Appendix A

Figure 17: Steel scrapping, photography , and graffiti

11 History Link.org. Harbor Island, at the time the world's largest artificial island, is completed in 1909. http://www.historylink.org/index.cfm?DisplayPage=output.cfm&file_id=3631 . Web. visited March 1, 2013

12 Weiser, Cathy. Harbor Island - Largest Artificial Island in the U.S. May 2010 http://www.legendsofamerica.com/wa-harborisland.html. Web. visited March 1, 2013

13 Form/Space Atelier. From Industry to Information. September 22, 2009. http://formspaceatelier.blogspot.com/2009/09/formspace-atelier-program-for-october.html .Web. visited March 2, 2013

14 Nokes, Jim. Personal interview. 3 Dec. 2012.

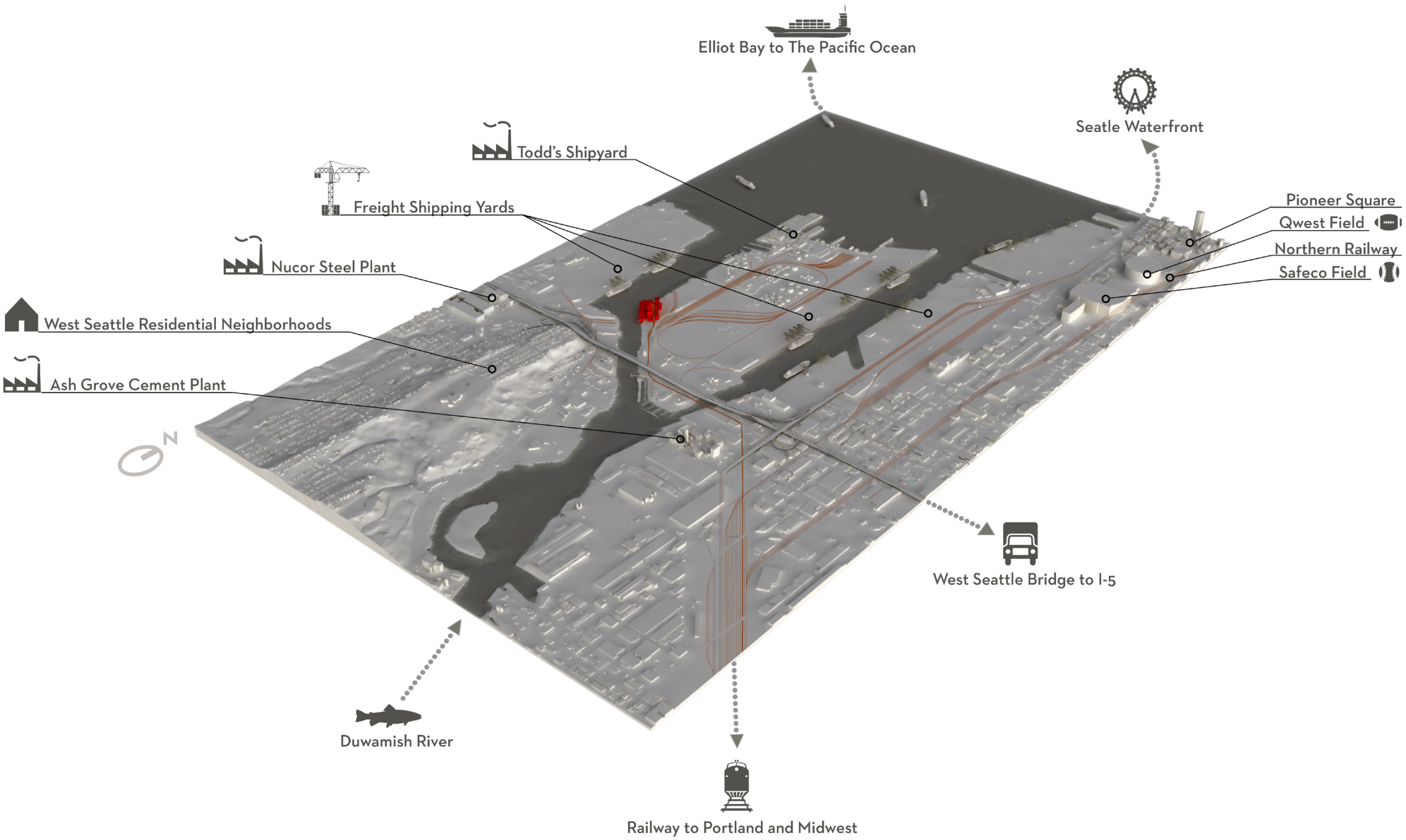


Figure 18: The Flourmill's local and regional connections.

2010 Net Vessel Trade by Country via Seattle Ports (in Millions of USD)

source: U.S. Dept. of Commerce, Bureau of Census

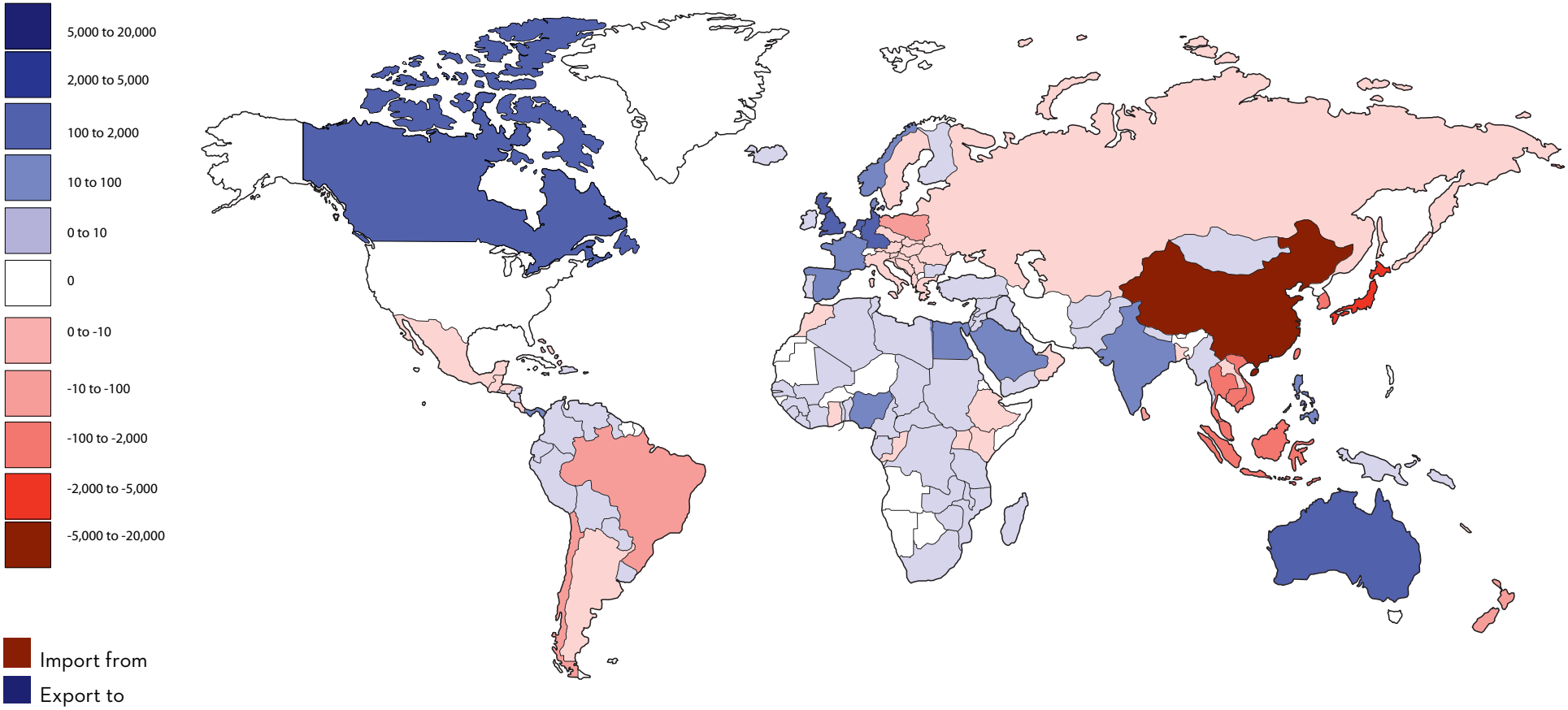


Figure 19: The economic connection between Seattle Ports and the rest of the world.

The Port of Seattle currently employs 1,650 employees across five operating divisions and 52 departments.[15] And, since ports play a critical role in our community by supplying jobs and affording more economic opportunities for local businesses, it is important to reactivate our abandoned waterfront spaces in order to increase their productivity. In 2010, The Port of Seattle was ranked 26th largest port in the US by tonnage (27th in imports, 13th in exports, 17th in foreign trade, and 54 in domestic trade).[16]

15 About the Port of Seattle. https://www.portseattle.org/JOBS/Pages/default.aspx .Web. visited March 2,2013.

16 American Association of Port Authorities. http://aapa.files.cms-plus.com/Statistics/2010%20U.S.%20PORT%20RANKINGS%20BY%20CARGO%20TONNAGE.pdf Web. visited March 2,2013.

Car Access

Pedestrian/Bike Access

Figure 20: The Mill's Approach– vehicles must drive over the tracks on Klickitat Avenue in order to re-approach the site from the north. While there's no crosswalk before the overpass, pedestrians can illegally cross the street and approach from the south.

Figure 21: The approach and view from the Klickitat Avenue overpass.

4 // Literature Review

DIGITAL DISLOCATIONS

The invisible flows of the city are becoming increasingly complex and intangible as technology continues to dematerialize the world around us– quickened communication and the virtualization of information now challenge architectures ability to frame reality. Its use-value has been brought into question yet again, and typological re-inventions may be necessary in order to adapt to our emerging information-based economy.

> "In the face of electronic communication, air travel, global financial markets, and the like, it would be a combination of naïveté and hubris to think that traditional architectural semiotics could any longer manage mass communication and perception."[17]

Architecture as a profession has become increasingly marginalized in post-modernity. And, the proliferation of information technology, as an innovative mechanism for organizing societal flows, has questioned physical space's efficacy in performing the same task. Thus, the new frontier in urban development deals less with formal production and more with the design of operational strategies involving multiple overlapping forces, which intrinsically underlie the "collective form"[18] of society.

> "The urban architect now needs to design the organizational systems of collective form and take on a significant role as a translator of the information revolution, as a decision maker, and as a system's architect... instead of remaining in our tidy discipline, we now maneuver within manifold worlds to simultaneously consider functional, political, financial, social, aesthetic, and ecological issues."[19]

The new architects of "collective form" in the information-age typically construct generative rule-systems with languages that initially evolve in the virtual world, but consequently manifests in the physical world. For instance, Dennis Ritchie (inventor of C, and Unix) and Linus Torvald (inventor of Linux) aren't "household names," nevertheless the open-source languages they've constructed run the New York Stock exchange, Cisco Systems, US Department of Defense, Industrial & Commercial Bank of China, and many other influential institutions world-wide. Being that Linux is a free-of-charge open source platform, it's also important to note the global shift in valuation toward participation and innovation rather than commoditization and proprietary ownership. Today, the rules of supply and demand, that governed the industrial age, have started to break down as information becomes transferred immaterially, making it infinitely reproducible. How can architecture adapt accordingly?

> "As we move from an economy dominated by technologies of production to an economy dominated by technologies of **re**production, the differences between things seem less significant than the potential sameness of images."[20]

Thus, appearance becomes less important than performance/use-value. This shift has ineffably changed the daily lives of people living within these technologically advanced culture– The Spanish sociologist, Manuel Castells, in *The Rise of the Network Society*, clearly describes this restructuring. He notes an increase in the amount of independent freelance workers able to sustain themselves within well-connected professional networks. Workers form partnerships on a job-by-job basis. What's more, this work can be performed globally now, due to the hastened speed of information– He calls this organization around global media a "culture of real virtuality,"[21] and the material foundation of this network society, "the space of flows and timeless time,"[22] implying the bifurcation of space and time as instant long-distance interactions becomes possible and ubiquitous.

This network society, especially in countries with larger [knowledge-based] service sectors like the United States, creates opportunities for locally-decentralized growth due to an increase in telecommuting (yet, it's important to note digital epicenters still exist regionally/culturally– e.g. Seattle). Systemic volatility based on the images heightened ability to sway value-judgments in the marketplace implies an increasingly speculative mindset towards the real valuation of currency, and a general individuation in management/labor relations.[23] Thus, the power structure in the network society becomes complex, decentralized/self-organizing/bottom-up, and smaller-scale/fine-grained, whereas the power structure in the industrial society was simpler, centralized/governed/top-down, and large-scale/course-grained (due to heightened efficiencies in 'economies-of-scale').

Since the various market forces and power structures present in society during the physical construction of cities invariably shape its architecture, it becomes possible to analyze historic-societal forces vicariously through their built works. Kevin Lynch was able to sum up his heuristic and empirical findings into three "Normative City Models"– The City of Faith, The City as a Machine, and The Ecological City. The latter two are the built manifestations of the industrial society, and network society, respectively.

In Recombinant Urbanism, David Grahame Shane describes how these two paradigms manifest themselves differently in the built environment. He states,

> "In the City as a Machine, actors attempt to create a rational city governed by simple rules, a city whose parts are matched to their functions and where the reliability, efficiency, and standardized mass-production of modern machinery can produce a new spatial environment for the greatest good of the greatest number at the least cost."[24]

Conversely,

> "In the organic or Ecological City, actors seek more individual control

over and customization of design, creating a more responsive and flexible design system that incorporates feedback from the bottom up."[25]

Shane finishes with an open-ended analysis of both models:

> "Design in the City as a Machine is essentially a Modernist project; design in the Organic or Ecological city, a post-modern project. But whether postmodernism constitutes a clean break with a now-defunct Modernist world-view, or joins in dialogue with an 'unfinished' Modernist project, is a question on which views differ."[26]

Cedric Price, in 1982, used an egg metaphor to articulate the attributes of Lynch's three city models (fig. 22). He describes the premodern city as a hard-boiled egg with the life-bearing and panoptic yolk at the core (served spaces), surrounded by the concentric albumen support structure (servant spaces), and encased by a defensive shell (city wall). In this premodern city there was a clear separation between town/country and servant/served spaces. Also, growth was gradual, and transportation was primarily by foot. Next, Price analogized the modernized cities of the industrial revolution as a fried egg where the chef had to first break the shell (wall) in order for the egg-white (suburban residences) to seep outward (sprawl). The formal and figurative centrality is maintained; yet greater distances between economic core and peripheral residences depend highly upon faster transport (cars, busses, trains, etc.). The city is separated into zones, made more homogenous and distant.

Lastly, the Ecological City was likened to a scrambled egg– The chef stirs up (heterogenizes) the privileged yolk adding milk (technology) to the mix, creating a polycentric and blended network. Smaller-scale heterogeneity becomes ubiquitous in this city model. Also, time and space can virtually disengage as information becomes transmitted more instantaneously. Lynch described ecological cities as autonomous and self-sufficient from each other– the cities contain individual spatial and social units, continually recycled materials, and a capability to self-repair. But, within that unit, it's spaces and people are highly dependent.

The current homogenization and segregation in the majority of Seattle's city fabric is a consequence of the Industrial Revolution's hyper valuation of efficiency through economies-of-scale– the prevalence of single-use zoning laws became one result of this, and automobile dependency, another. Yet, the novelty and hyper-productivity of the "city as machine," while impressive in scale, can become alienating and dehumanizing at the same time, especially when relentlessly applied throughout city sections. For example, the enormous shipping cranes that line Seattle's industrial ports become iconic signifiers of productivity. They compose Seattle's large commercial-gateway, while adding a bit of gritty-charm to the area. Though, the street-life at the foot of these cranes is non-existent, except for the blue-collar workers that operate the district. In short, its single-use (industrial) creates mono-culture (blue-collar worker).

> "If the sameness of use is shown candidly for what it is–sameness–it looks monotonous. Superficially, this monotony might be thought of as a sort of order, however dull. But aesthetically, it unfortunately also carries with it a deep disorder: the disorder of conveying no direction."[27]

The practice of Architecture must now adapt to a culture of rapid change and complex interactivity. As scales reduce towards this new Network/Ecological City paradigm, reincorporating food into our urban environment seems socially inevitable and economically viable, if not only in protest of the current large-scale-industrial food systems that disconnect urban-consumers from the abstract production and distribution channels that depend upon preservatives and high-energy refrigeration to decrease spoil-percentages in monocultural commodity-crops, then for the sake of increased food security, nutritional-value, reduced carbon emissions, and the elimination of ecologically harmful chemical-fertilizers. History has shown systems, both ecological and urban, to be most resilient and robust when diversely organized. And, as the Industrial Revolution has shown, diversity has become an after thought as multi-national corporations accumulate power enough to quench customs and traditions inherent in local trade markets around the globe in favor of efficiency-generating, be it indirectly, homogenization through globalization. For instance, half of the 35,000 items frequently stocked in US supermarkets are produced and distributed by only 10 multinational food and beverage corporations, whose boards of directors collectively hold 138 people (all with similar socio-economic backgrounds).[28] The success of this macro-scale industrial food system is contingent upon its invisibility through separation and it's ability to infuse homogenized products with an illusion of difference– this abstract system is the long-term byproduct of "The City as Machine," where profit takes priority over pride in product quality, as accountability is shifted towards appeasing stock-holder interests rather than the general publics. And, as our modern cities grow, so do the physical and mental distances separating people from their food supply.

Yet, within this emerging "network society" and its physical manifestation, the "ecological city," localized food production is becoming more possible. And, needless to say, food is one of the few human necessities that cannot become virtualized, nor sustained at a distance. It's currently a question of how we should proceed architecturally into this new frontier, especially considering the site's (Harbor Island's) high-profile location, both locally and globally. Since, ports become gateways for global commerce, proposing a building whose intention is to localize the exchange of agricultural products (albeit with the intention of sharing information about its methodologies, globally) exhibits a marked shift in the value system of global port cities like Seattle. The monumental presence of the existing Fisher Flourmill can become the pedestal for this new message– emphasizing a change in ethos both figuratively and formally– a new symbol of Seattle's push towards self-sufficiency, towards local "sustainability" and food security.

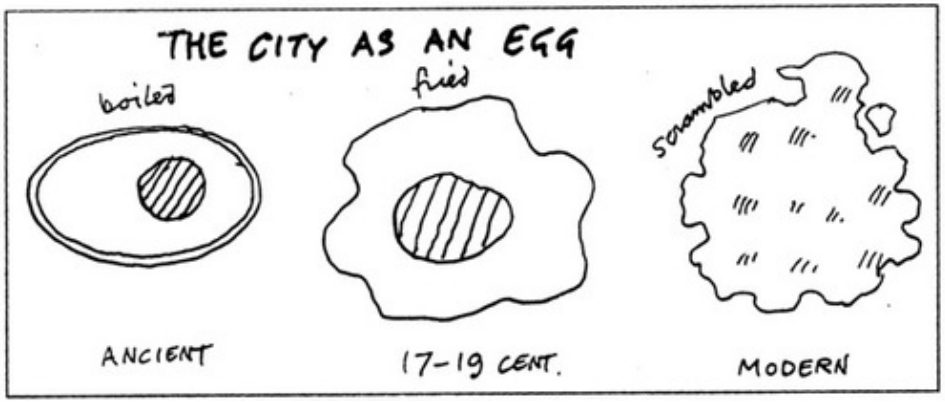


Figure 22: Cedric Price's "City as an Egg" metaphor.

17 Allen, Stan. Points + Lines: Diagrams and Projects for the City. New York: Princeton Architectural Press, 1999. Print. Pg. 5

18 Mayne, Thom, Stan Allen, and Thom Mayne. Combinatory Urbanism: The Complex Behavior of Collective Form. Culver City, CA: Stray Dog Café, 2011. Print. Pg. 29

19 Ibid. Pg. 38-39

20 Allen, Stan. Points + Lines: Diagrams and Projects for the City. New York: Princeton Architectural Press, 1999. Print. Pg. 14

21 Castells, Manuel. The Rise of the Network Society. Malden, Mass: Blackwell Publishers, 1996. Print. Pg.99-101

22 Ibid. Pg.406

23 Castells, Manuel. The Internet and Society. USC Annenberg: You Tube, Sept. 24 2008. http://www.youtube.com/watch?v=qrOABiFUd0g

24 Shane, David G. Recombinant Urbanism: Conceptual Modeling in Architecture, Urban Design, and City Theory. Chichester: Wiley-Academy, 2005. Print. Pg. 119

25 Ibid. Pg. 120

26 Ibid.

27 Jacobs, Jane. The Death and Life of Great American Cities. New York: Random House, 1961. Print. Pg. 223

28 Lyson, Thomas A., and Annalisa Lewis Raymer, Stalking the Wily Multinational: Power and Control in the US Food System, Agriculture and Human Values, October 19, 1999, Pg. 208

INFRASTRUCTURAL URBANISM

In 1920's America, a new form of architecture, not even designed by architects, emerged and began to influence the dominant European-theoretical-discourse. Grain silos, a form conceived and developed by engineers through economic and mathematical calculations, have been praised by modernists, since Gropius, Mendelsohn, and Corbu, for their technical clarity, material innovation, and use of mass, surface, and plan:

> "There exists a mass of work conceived in the new spirit; it is to be met with particularly in industrial production." – Le Corbusier [29]

If the grain elevator was praised for its form as a consequence of its function, then what would Corbu and others have said about the technologically outdated and abandoned elevators of the world? Would its form be monumentalized as the semiotic expression of a bygone age, as Aldo Rossi would have us infer? It seems unlikely, since early modernists praised these structures for their technological candor. In "Towards a New Architecture," Le Corbusier writes:

> "The tool is the direct and immediate expression of progress; it gives man essential assistance and essential freedom also. We throw the out-of-date tool on the scrap heap: the carbine, the culverin, the growler and the old locomotive. This action is a manifestation of health, of moral health, of morale also; it is not right that we should produce bad things because of a bad tool; nor is it right that we should waste our energy, our health and our courage because of a bad tool; it must be thrown away and replaced."[30]

The Fisher Flourmill, a tool in its own right, was abandoned as Pendelton Flour (the final owners of the mill) moved production to its Blackfoot, Idaho plant, which could mill flour more efficiently (with less energy and labor). But, Le Corbusier's quote seems rather careless, as it implies demolition for the sake of "health." But, of course, this writing predated our current "environmental crisis," where an assumption-of-finite-means has become imperative. Instead, a contemporary solution would suggest re-using the tools already at our disposal. It would suggest augmentation before replacement. Our technology will always require updating, but how can we update in a clever way? Le Corbusier's writing was emblematic of the machine-age, but not of post-modern ethics where history and context play a larger roll.

Besides a re-embracement of history, post-modernity was defined by regionalism, and the study of semiotic language (sometimes through ornament) as a counterpoint to the universality, purity, and perpetual newness of modernity. But, while language (it's meaning and image) has becomes an effective tool in thinking about architecture, Stan Allen has argued that its preoccupation has begun to marginalize the profession.

In, Points and Lines, Allen suggests a shift away from this representational model towards, what he has dubbed, "Infrastructural Urbanism"– an urbanism that embraces architecture's instrumentality as a scaffold for growth and decay based on (non-linear) time and contextual processes. That is, architecture's contextual adjacencies and self-organizing ability become paramount in efficiently transferring energy flows around the city. This anachronous proposition grounds architecture in the world of things and becomes a counterpoint to the ubiquitous virtuality underlying our modern network-society. As well, it brings use-value to the forefront and redefines architecture as a material practice that adopts the "grassroots" logic and bottom-up speed of the network society, but in the physical realm.

> "Material practices (ecology or engineering for example) are concerned with the behavior of large scale assemblages over time. They do not work primarily with images or meaning, or even with objects, but with performance: energy inputs and outputs, the calibration of force and resistance. They are less concerned with what things look like and more concerned with what they can do... [and] deploy an open catalog of techniques without preconceived formal ends."[31]

The open catalog of performative techniques Allen advocates has similar roots in the architectural-writings of Colin Rowe and the anthropological-writings of Claude Levi-Strauss. In Collage City, Colin Rowe and Fred Koetter advocate for colliding plans in the form of 'collage'; or more adequately 'bricolage' (a term borrowed from Claude Levi Strauss in The Savage Mind).

> "A 'bricoleur' is adept at performing a large number of diverse tasks; but unlike the engineer, he does not subordinate each of them to the availability of raw materials and tools conceived and procured for the purpose of the project. His universe of instruments is closed and the rules of his game are always to make do with 'whatever is at hand', that is to say with a set of tools and materials which is always finite and is also heterogeneous... Such elements are specialized up to a point, sufficiently for the 'bricoleur' not to the equipment and knowledge of all trades and professions, but not enough for each of them to have only one definite and determinate use. They represent a set of actual and possible relations; they are 'operators', but they can be used for any operations of the same type."[32]

More simply put,

> "The scientist and the 'bricoleur' are to be distinguished by the inverse functions which they assign to events and structures as means and ends, the scientist creating events... by means of structures and the 'bricoleur' creating structures by means of events."[33]

For example, Picasso's "Bull Head" made from a bicycle seat and handle bars (fig. 23),

is a perfect example of bricolage. And, it's corollary implication, using a bull's skull as a bike seat, seems also to be a useful appropriation. This exemplifies the mindset of the bricoleur as clever and resourceful, instead of myopic and reductive.

Rowe and Koetter's goal in Collage City (in Collision City and The Politics of 'Bricolage') is to convince the reader that there is not one "correct" or "true" way to build cities, but momentary consensuses and adaptability through democratic design debates:

> "For, surely, the job is that of making safe the city (and hence democracy) by large infusions of metaphor, analogical thinking, ambiguity; and, in the face of a prevailing scientism and conspicuous laissez-aller, it is just possible that these activities could provide the true Survival Through Design."[34]

Imposing master plans and homogenizing large swaths of city 'fabric' through large-scale demolition has proved detrimental to the health of many cities and its inhabitants. Such was the approach by many early-modernists, including Le Corbusier. Rather the industrial utopia/distopia that is Harbor Island maintains a unique and desirable character that could be built upon rather than torn down. It could become reactivated in phased successions by attracting a varied array of people through the introduction of new and different uses over time, all the while maintaining it's productive roots and industrial elements of monumental scale. The first of which could be an aquaponic food production facility, and not just because food is a necessity for all people, but because the abandoned flourmill's form could conveniently house this new function with less modifications than most abandoned buildings.

Figure 23: Pablo Picasso's "Bull's Head." 1942.

---

29 Le Corbusier. Towards a New Architecture. John Rodker Publishers, London, 1931. Pg. 3

30 Ibid. Pg. 13

31 Allen, Stan. Points + Lines: Diagrams and Projects for the City. New York: Princeton Architectural Press, 1999. Print. Pg. 52-53

32 Levi-Strauss, Claude. The Savage Mind. London. 1966: New York, 1969. Pg. 17

33 Ibid. Pg. 22

34 Rowe, Colin and Fred Koetter. Collage City. The MIT Press, Cambridge, Massachusetts, and London, England. Pg. 117

THE DECAYING SYMBOL

Why the fascination with grain elevators? While most know little regarding the internal functioning of these buildings, with their complex maze of pipes and conveyers, they seem drawn to the platonic, symbolic, and monumental-presence of these structures in the landscape, be it rural or urban.

> "It is this dual reading– as structure and monument– that provides common ground for a wide variety of enthusiasts. The grain elevator is at once engineering wonder– a gritty machine, functionally determined; a complex embodiment of the realities of the American systems of farm production and transportation; and a symbol, be it for the passing of the family farm, the death of urban waterfronts, or a lost, naïve modernism. The grain elevator is neither form, nor function, nor symbol. It is all three..." -Kevin Lippert[35]

The Fisher Flourmill's form was infrastructural by design, more of a machine than a building, yet its abandonment has transformed it into an "unintentional monument"– Alois Riegl's term for a monument who's didactic meaning was not determined by it's creator (as in an intentional monument), but by our modern cultural perceptions and retrospective memory.

In *The Modern Cult of Monuments* Riegl posits guidelines for intentional and unintentional monuments, as well as the relational dynamics between use-value, art-value, age-value, newness-value, and historical-value. While newness and age-value are naturally opposed, and art-value and historical-value intrinsically tied, the relationship between use-value and age-value is less defined, as is the subjective nature of art/historical-value. Today, the Fisher Flour Mill's use-value has been minimized in its abandonment, but it still contains significant age-value (relative to Seattle) and art-historical value based on early formal appraisals by well-respected 20th century modernists. Nevertheless, their art-historical appraisals were directly derived from the use-value of the grain silo. Absent its use, what really becomes of its art-historical value? By modifying the silos and refiguring/resurrecting their use-value, the architect concurrently alters its art-historical value.

Riegl notes that in the 19th century preservation tended towards full-restoration– washing away a monuments age to reinforce its transcendent and timeless meaning, reinstating its newness-value. But, it wasn't until the 20th century that preservationist's embraced age-value by welcoming decay *(fig. 24)*.

> "It is probably fair to say that ruins appear more picturesque the more advanced their state of decay: as decay progresses, age-value becomes less extensive, that is to say, evoked less and less by fewer and fewer remains, but is therefore all the more intensive in its impact on the beholder... From the standpoint of age-value, one need not worry about the eternal preservation of monuments... Age-value manifests itself immediately through visual perception and appeals directly to our emotions."[36]

JB Jackson, in The Necessity for Ruins, further elucidates the interconnection between art-historical-value and age-value by approaching it from a perspective that acknowledges decay as a precursor to transformation.

> "There has to be that interval of neglect, there has to be discontinuity; it is religiously and artistically essential. That is what I mean when I refer to the necessity for ruins: ruins provide the incentive for restoration, and for a return to origins. There has to be (in our new concept of history) an interim of death or rejection before there can be renewal and reform."[37]

In the case of The Fisher Flourmill, its origins derive from its utility, its use-value. It's art-historic and age-value became unintentional consequences of its inimitable form and economic-obsolescence, respectively. Regenerating its use-value through modification would recall the landmarks original aim, whilst instigating a process of renewal that could undoubtedly manifest lively and diverse urban conditions in this 'waiting land'– a term, coined by Kees Christiaanse of KCAP, describing ripe, yet vulnerable, post-industrial spaces located close to urban centers and in dire need of sensitive transformation methodologies. But, deciding whether to add or subtract from the abandoned mill can become a polemic decision– On the one hand, demolition requires a large amount of energy and wastefully disposes of the materials. On the other hand, it can clear the way for new growth, while reducing the risk of collapse (if the building is in disrepair). Again, we look to Riegl for guidance:

> "... use-value is indifferent to the treatment of a monument so long as the monument's existence is not affected and no concessions whatsoever are made to age-value. Only in cases where use-value is fraught with newness-value must consideration of age-value be even more tightly restricted... On the other hand, use-value may also require the destruction of a monument; for instance, if decay endangers human life."[38]

So, by using both additive and subtractive approaches, the use, age, and art-historical value of the re-purposed structure might be enriched. The Fisher Flourmill's iconic and historical form will remain noticeable, yet noticeably altered, thereby communicating it's historic and prospective uses simultaneously, evoking, through structural bricolage, a reassembled amalgam of historic fragments that may create powerful juxtapositions across seams of difference: new and old, heavy and light, inside and out, solid and void. At the same time, a sort of conceptual bricolage is taking place in the shifting relations between program, information, and use of the building-as traditionally intended versus newly repurposed.

> "Shifting relations of program, information, and use further extend

architecture's engagement with the invisible flows of the city. Architecture is already marked by complex relations of real to virtual. Only by creatively examining the role of the architect in these changing urban economies can architecture evolve the means to reengage the world." -Stan Allen[39]

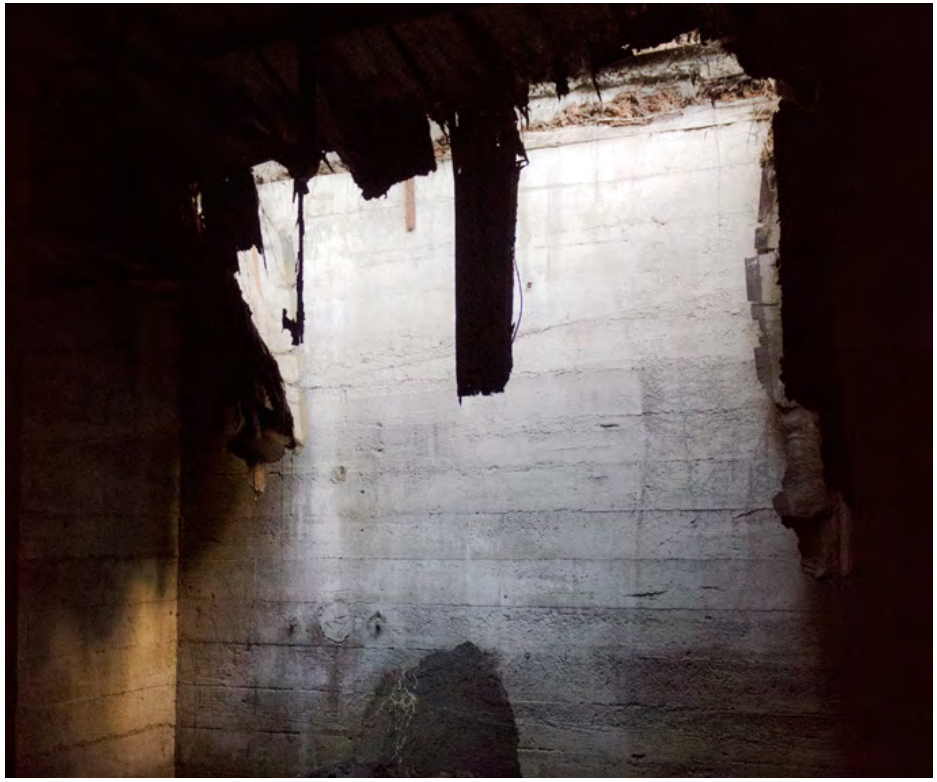


Figure 24: The sublime result of a roof collapse in Mill 1&2

35 Mahar-Keplinger, Lisa. Grain Elevators. New York, N.Y: Princeton Architectural Press, 1993. Print. Pg. 83

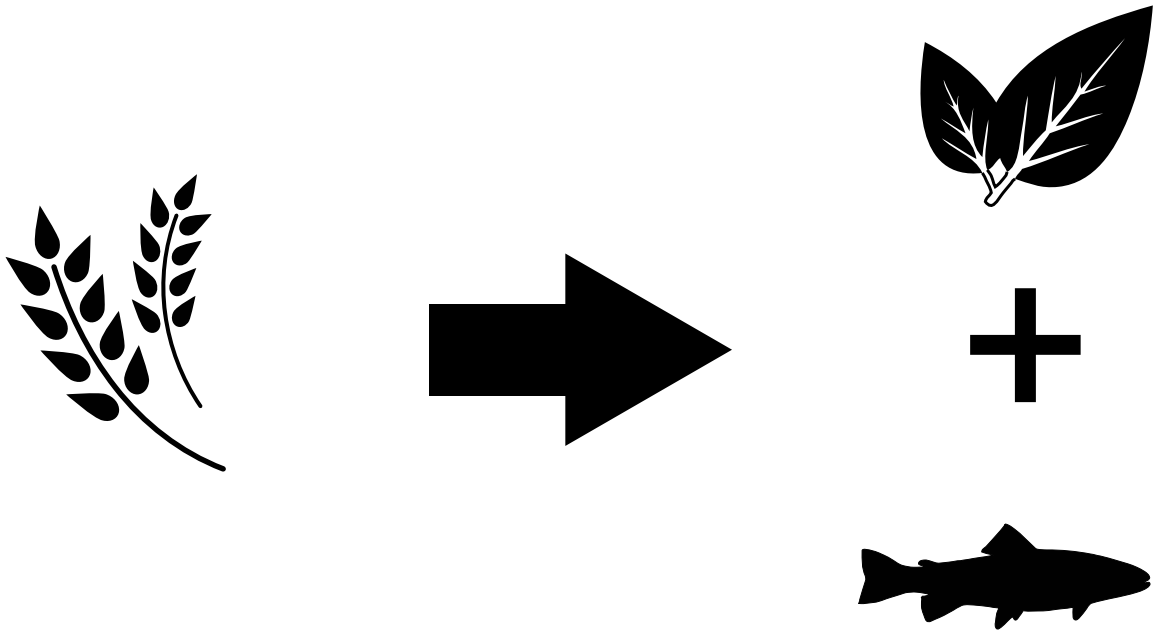
36 Riegl, Alois. The Modern Cult of Monuments: Its Character and Its Origin. Oppositions Reader: Selected Readings from a Journal for Ideas and Criticism in Architecture, 1973-1984. Hays, K M. New York: Princeton Architectural Press, 1998. Print. Pg. 621-651

37 Jackson, John B. The Necessity for Ruins, and Other Topics. Amherst: University of Massachusetts Press, 1980. Print. Pg. 102

38 Riegl, Alois. The Modern Cult of Monuments: Its Character and Its Origin. Oppositions Reader: Selected Readings from a Journal for Ideas and Criticism in Architecture, 1973-1984. Hays, K M. New York: Princeton Architectural Press, 1998. Print. Pg. 621-651

39 Allen, Stan. Points + Lines: Diagrams and Projects for the City. New York: Princeton Architectural Press, 1999. Print. Pg.16

5 // Comparing Processes



THE AQUAPONIC FOOD PRODUCTION PROCESS

I. What is Aquaponics?

"Aquaponics" is an agricultural term used to describe the synthesis of Hydroponic and Aquacultural growing techniques:

> Aquaculture: The cultivation of aquatic organisms (as fish or shellfish) especially for food and typically in controlled conditions.[40]

> Hydroponics: The growing of plants in nutrient solutions with or without an inert medium (as soil) to provide mechanical support.[41]

More specifically:

> "Aquaponics is the cultivation of fish and plants together in a constructed, re-circulating ecosystem utilizing natural bacterial cycles to convert fish waste to plant nutrients. This is an environmentally friendly, natural food-growing method that harnesses the best attributes of aquaculture and hydroponics without the need to discard any water or filtrate or add chemical fertilizer."[42]

There are three primary types of aquaponics systems:

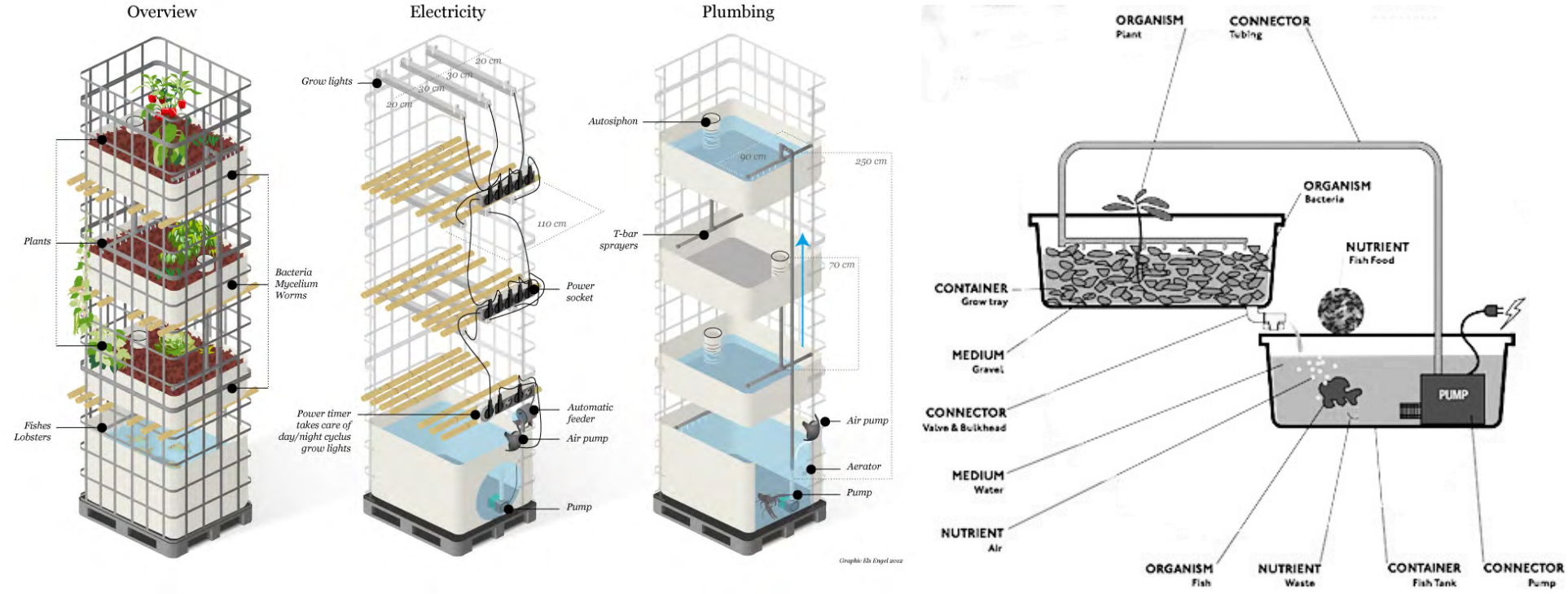
1. Media-Based (fig. 25)
2. Nutrient-Film Technique (fig. 26)
3. Raft (aka- Deep Water Culture) (fig. 27)

In Media-Based Aquaponic systems the growing beds become the filtration system for all the solid-waste products, versus the NFT and Raft systems, which use submerged plant roots to filter solids. The downside with these latter two systems concerns the eventually build up of solid waste on plant roots, which can starve them of oxygen if proper care is not taken. To avoid this problem the Raft-based systems need mineralization tanks, clarifying tanks, and degassing tanks to effectively filter solids, removing valuable nutrients in the process. Conversely, Media-based systems need little upkeep– there is no regular clean out of grow beds or fish tanks, just a high-pressure spraying of pipes and pumps to knock loose any additional solids every month. This minimal upkeep and the fact that Media-based systems are more flexible regarding which plants they can grow, makes it ideal for this project.

40 Merriam-Webster. http://www.merriam-webster.com/dictionary/aquaculture .Web. visited March 3,2013.

41 Merriam-Webster. http://www.merriam-webster.com/dictionary/hydroponics .Web. visited March 3, 2013.

42 Bernstein, Sylvia. Aquaponic Gardening: A Step-by-Step Guide to Raising Vegetables and Fish Together. Gabriola, BC: New Society Publishers, 2011. Print. Pg.1



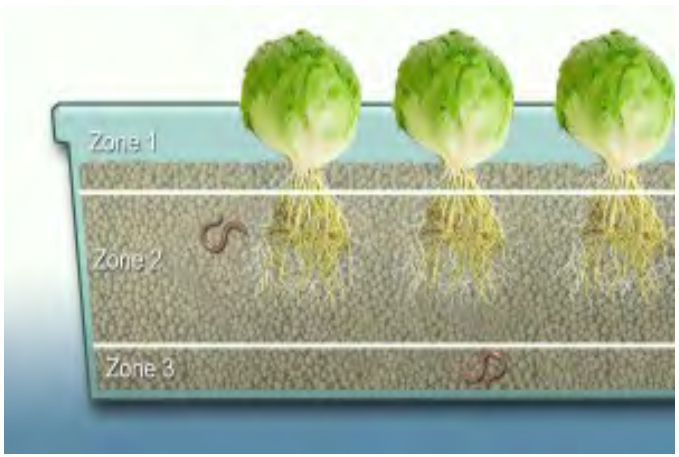


Figure 25: Media-Based Aquaponic System

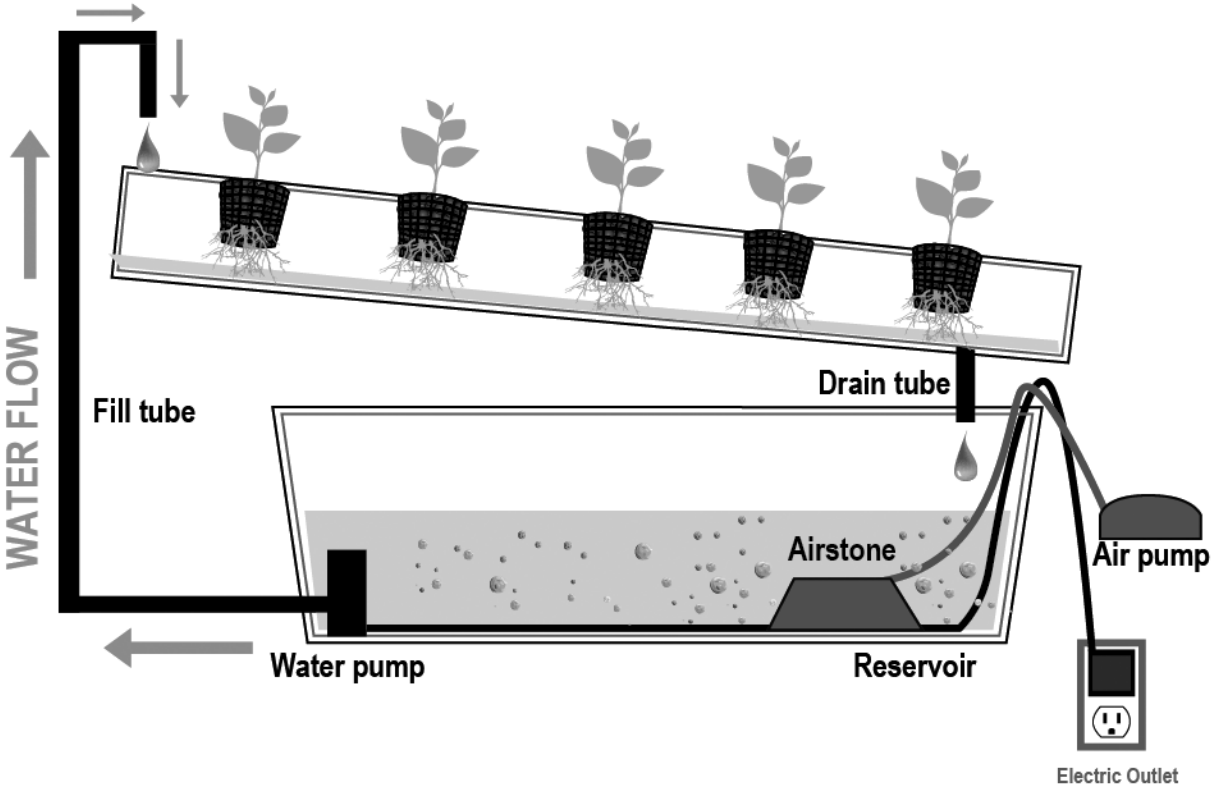
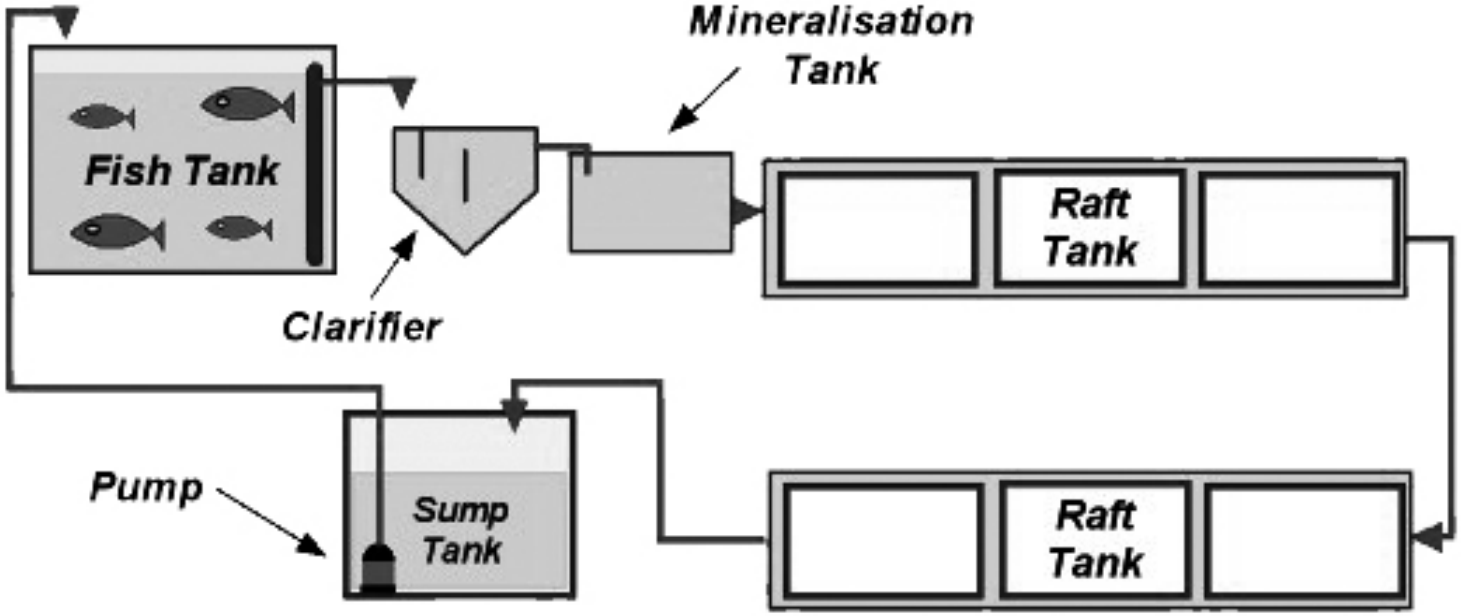


Figure 26: Nutrient Film Technique (NFT) System



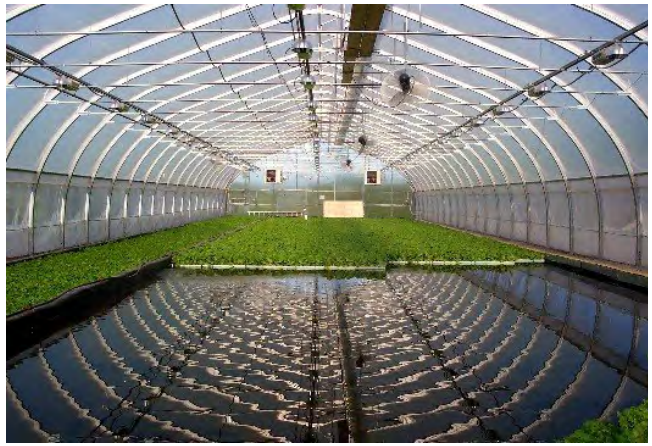


Figure 27: Raft-Based System

II. The Aquaponics Process

Fish feed, seeds, and sunlight are the only continuous inputs into an aquaponicssystem while fish, vegetables, and compost (from roots) are its outputs. The process is as follows:

A. Sequence of Introduction: Plants, Bacteria, Worms and Fish

1 The first step in setting up a self-regulating aquaponics system, begins with the introduction of plants into the Hydroton (lavarock) growth medium. The plants will first be first grown hydroponically, using a nutrient solution, until their root structures become mature enough to filter undesirables from the water.

2 Next, young fish are introduced to the system, which will simultaneously begin to cultivate the natural bacteria and worms within the constructed ecosystem. The Plants nutrition will still need to be supplemented hydroponically while the water is closely monitored to assure the PH levels don't become too acidic or alkaline for the fish to survive.

3 Once the fish, worms and micro organisms have matured enough to fertilize the plants, additional nutrients will no longer be necessary– The only input will be the fish food (Duckweed, Black Soldier Flys, or commercial Feed).

B. The Nitrogen Cycle (fig. 28)

4 Regardless of what aquaponics system you use (Media-based, Nutrient-Film Technique, Raft, or other), nitrogen is still fixed in the same way. First, the clean water is pumped into the fish tank, where it is aerated/ oxygenated and then dirtied by fish effluent.

5 Next, in raft systems ONLY, the excrement is pumped from the bottom of the tank to a clarifier tank, degassing tank, and mineralization tank; The clarifier allows the solids to settle, where it is subsequently removed as compost/fertilizer; The degassing tank removes gasses; In the mineralization tanks anaerobic bacteria (Nitrosomonas and Nitrobacter) fix the ammonia, first into nitrite, then into nitrate (plant fertilizer).

6 Conversely, in Media-based systems and NFT systems pump the unfiltered effluent up to the plant root systems where the microorganisms and worms fix the nitrogen in direct contact with plant roots. Red worms consume the solids in and around the Hydroton rocks and excrete waste that further fertilizes the plants.

7 The plants absorb the water and nutrients, and the clean water is sent back to the fish tanks. When the plants are ready to harvest they can be simply pulled out of their tray, in the case of raft and NFT systems, or from their continuous rock bed, in the case of media-based systems.

8 New plant "starts" are added after harvesting, as are young fish fry, and the process begins all over again.

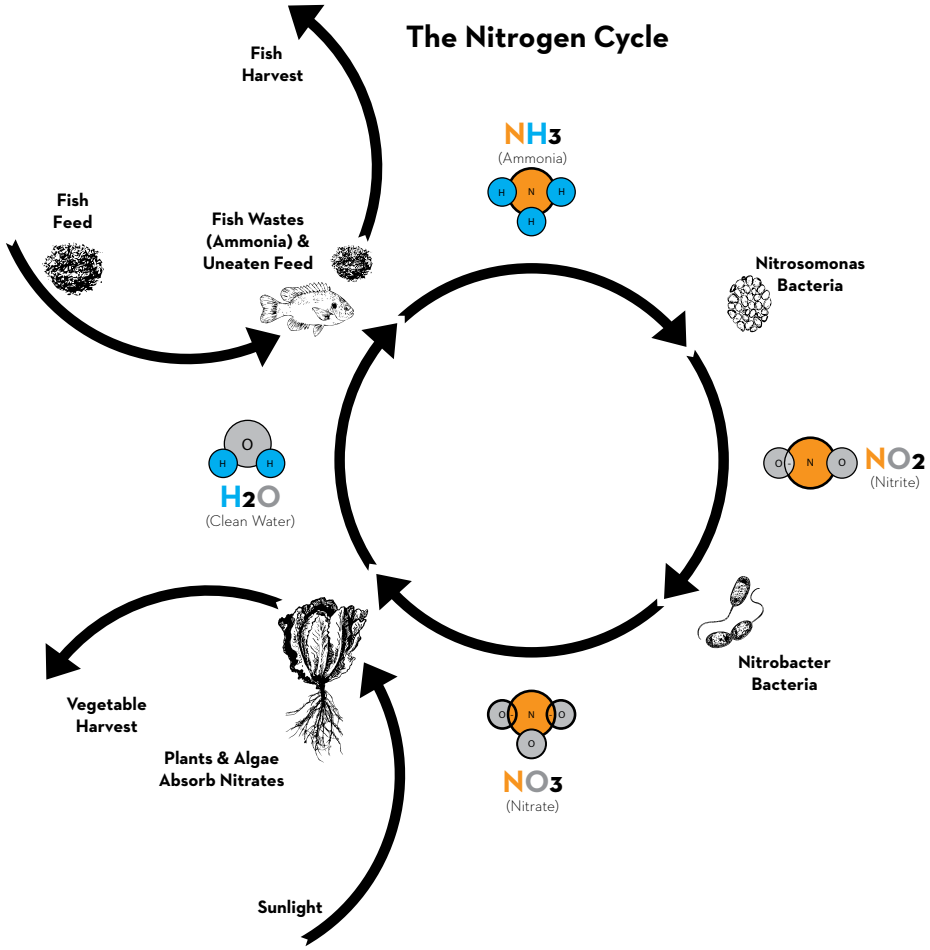


Figure 28: The Nitrogen Cycle

III. The Case for Aquaponic Food Production

With the world's population expected to increase from 7 to 9 billion in the next forty years, and with a large portion of the developing world still unable to sufficiently feed it's population, new methods of sustainable agriculture are needed now more than ever. According to a 2010 estimate by The World Wildlife Fund, the carrying capacity of Earth was reached around 1976.[43] So if mankind, especially in industrialized societies, doesn't find new methods of living more harmoniously within Earth's biosphere, we run the risk of decimating our species and every species we depend upon for survival. I believe, aquaponic agriculture can help to assuage these pressing issues. The following are some of the advantages and possible disadvantages of growing food aquaponically:

Advantages

1. Removes chemicals and fertilizer from the agricultural process, by re-using the fish excrement as a natural form of plant nutrition so that aquacultural solid-waste is disposed of responsibly and intelligently. This also means there is no need to purchase expensive chemical nutrients like those used in hydroponic food-production.

2. 90% of the water is saved by re-circulating it through a (mostly) closed-loop system. This reduces erosion and circumvents the water loss from evaporation, soil oversaturation, and seepage common in typical agriculture. Even in hydroponic systems the water may require flushing so that the correct nitrogen levels are maintained.

3. Aquaponic systems are more productive.

4. Aquaponic food is completely organic.

5. Growing foods in an urban environment brings production closer to the typical consumer. The result is a reduction in energy intensive transport, and an increase in food freshness.

6. The increased production capacity of aquaponic systems reduces the communities need for large amounts of rural cropland to sustain itself.

7. The plant roots and bacteria/worms act to reduce the pathogens that often plague aquacultural production systems.

8. Reduces our agricultural dependency on petroleum.

9. Reduces our need to over-fish the oceans or deforest land for agriculture. Currently, agriculture uses 60 times more land on Earth than both urban and suburban areas combined![44]

Disadvantages

1. The initial expense of purchasing housing, tanks, plumbing, pumps, aeration equipment, and grow beds.

2. The countless number of ways a system can be configured lends itself to varying results and conflicting research.

3. Some aquaponic systems can rely heavily on man-made energy, technological solutions, and environmental controls to properly recirculate the water and maintain proper water temperatures. Although, if water is allowed to flow downward as much as possible a highly energy efficient system is the result.

4. If redundancy isn't built into the design, there can be 'single points of failure,' such as electrical failure or pipe blockage, which can result in a complete loss of fish stock.

---

43 Bernstein, Sylvia. Aquaponic Gardening: A Step-by-Step Guide to Raising Vegetables and Fish Together. Gabriola, BC: New Society Publishers, 2011. Print. Pg.12.

44 Ibid. Pg.18

IV. Yields: Traditional Versus Aquaponic Farming

Aquaponic systems are far more productive than traditional agricultural and hydroponic operations. Like hydroponic systems, they grow within a controlled environment; so can produce the same crops year round while eliminating crop failure from pests, heavy drought, or drastic temperature fluctuations.

The amount of acreage required to adequately feed one person varies widely depending on the crop selection grown, climatic conditions (such as freeze/thaw cycles, rain, solar exposure, etc.), and the overall soil quality of the land in question. The Food and Agricultural Organization of the United Nations has performed extensive statistical analysis on the food security, arable land usage, and food production statistics surrounding traditional agriculture globally. In 1993,

> "The minimum amount of agricultural land necessary for sustainable food security, with a diversified diet similar to those of North America and Western Europe (hence including meat), is 0.5 of a hectare per person. This does not allow for any land degradation such as soil erosion, and it assumes adequate water supplies. Very few populous countries have more than an average of 0.25 of a hectare. It is realistic to suppose that the absolute minimum of arable land to support one person is a mere 0.07 of a hectare–and this assumes a largely vegetarian diet, no land degradation or water shortages, virtually no post-harvest waste, and farmers who know precisely when and how to plant, fertilize, irrigate, etc."[45] (FAO, 1993)

While aquaponic systems cannot produce root-crops (potatoes, carrots, etc.) efficiently or livestock, they are the most efficient producers of fish and leafy vegetables. Will Allen's company Growing Power, an urban permacultural operation, mixes aquaponic and traditional agriculture techniques to produce 1,000,000 lbs of produce and 10,000 lbs of fish annually on 3 acres of land.[46] That would feed about 500 people per year, which equates to roughly 260 SF in order to feed one person. On the loftier end of the claim-spectrum, Portable Farms claims only 25-30 SF of grow space is necessary to feed one adult year-round using their aquaponics system![47] With so many contributing factors, such as diet, climate, growing methods, etc., precision is difficult when estimating how much space it would take to feed a single person annually. But, the superior quality and efficiency of aquaponic food production makes it an ideal method of growing food in urban environments.

With 64,006 SF of grow bed area, this aquaponics facility could theoretically feed 2130-2560 people per year (using Portable Farms productivity estimates), and since a typical person spends about $2500 on food annually, a gross annual income of roughly 5.3 - 6.4 million dollars could be accrued before deducting labor and materials. The restaurant and educational components of the program would also bring in additional income. Although, the financial intricacies of this project are vast and full of contingencies, so cannot be considered reliable until further studies are undertaken- this would be a project in itself.

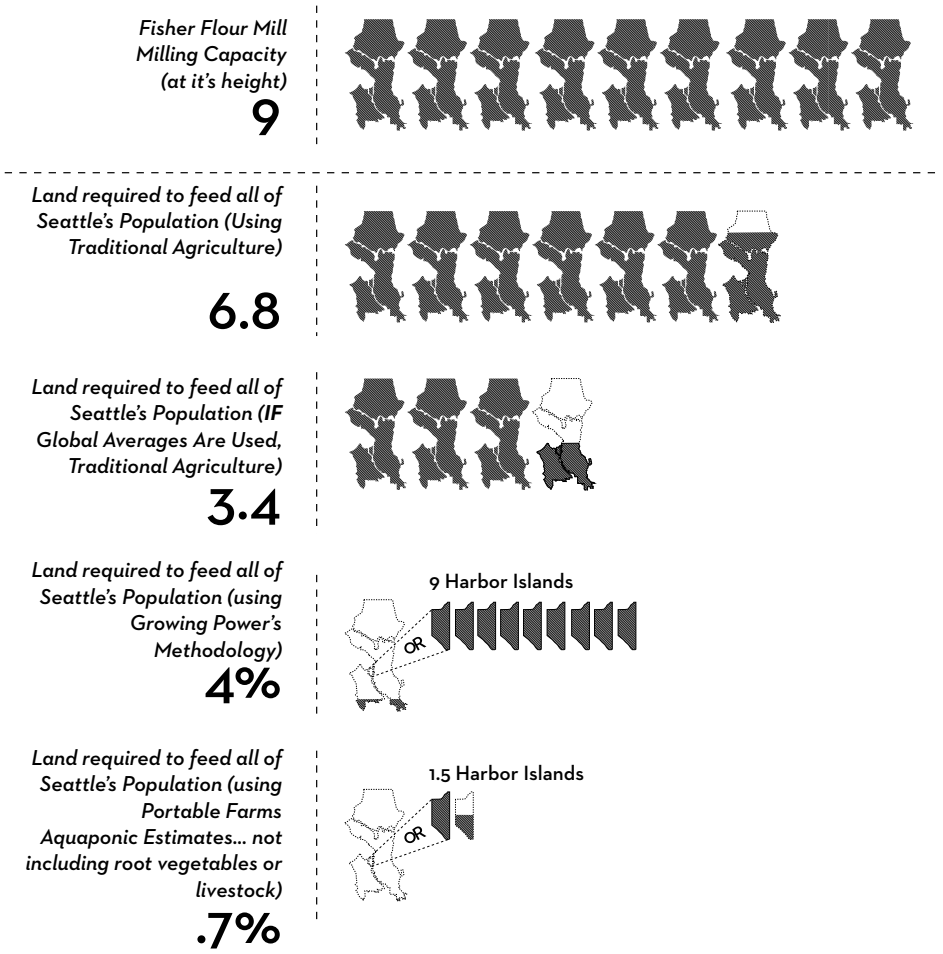


Figure 29: Amount of land area it would take to produce enough food to feed Seattle's population. *calculations shown in Appendix B

45 Soil Loss Accelerating Worldwide, Food and Agriculture Organization, Rome, Italy, 1993. http://www.iisc.ernet.in/currsci/feb25/articles16.htm .Web. visited March 14, 2013.

46 "1 MILLION pounds of Food on 3 acres. 10,000 fish 500 yards compost." http://www.youtube.com/watch?v=jV9CCxdkOng. You Tube, June 25, 2009. Web. March 13, 2013.

47 Davis, Colle and Phyllis. Portable Farms. Part 1: Sizing Your Aquaponics System. http://portablefarm.com/farm/2013/part-one-sizing-your-aquaponics-system/ . Web. March 13, 2013.

V. History of Aquaponics

The oldest known use of Aquaculture dates back to the Chinese in the fifth century BC. As well, the ancient Aztecs, Mayans, and Egyptians have all discovered and utilized the symbiotic relationship between fish and plants. The Aztecs developed "Chinampas," which were man-made floating islands on lake beds (fig. 30 & 31). When the fish waste settled to the bottom of the lakes, they would collect it to fertilize their maize, squash and other plants.

In 1733, German farmers began to gather fresh-water fish eggs, facilitated their fertilization, and raised them to maturity in natural lakes. And, most recently, completely constructed ecosystems have turned aquaculture into a calculate-able system, constantly re-circulating water in a closed environment. Unfortunately this form of aquaculture was capital intensive and tended to neglect important components of fish habitat–namely the incorporation of microorganisms, plants (which provide shade and water filtration), and the simulated geomorphology of lake beds (which provide a conducive habitat for spawning). Also, these re-circulating systems increased fish density along with their waste output (ammonia, uneaten food, and excrement), it has also brought into question the health of the fish produced.

Most recently, empirical studies performed at North Carolina State University, University of Virgin Islands[48], and the New Alchemy Institute have corroborated the lofty claims made by aquaponic farmers, regarding it's high productivity levels, nutritional values, minimal upkeep, and sustainability. The system has proven to be much healthier than hydroponics and aquaculture alone.

Figure 30: Tenochtitlan, a 14th century Mexican city that used chinampas to produce greater crop yields.

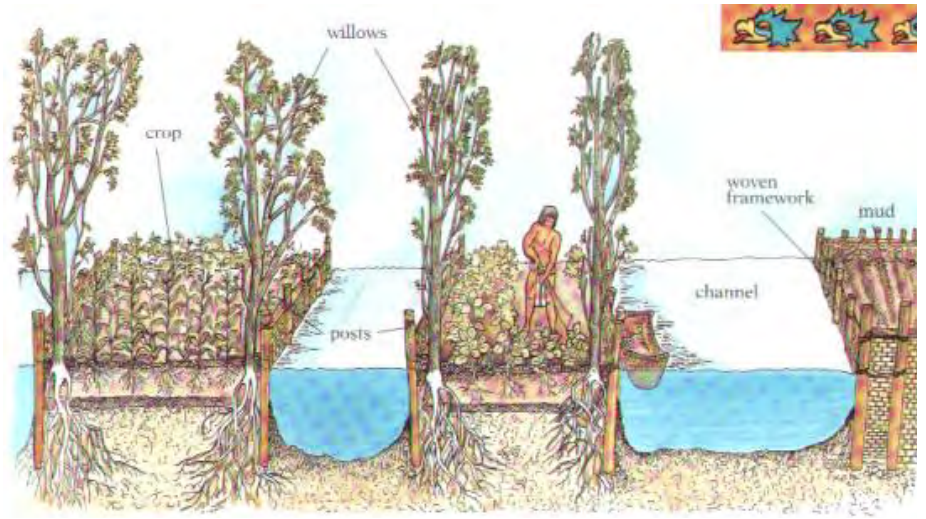


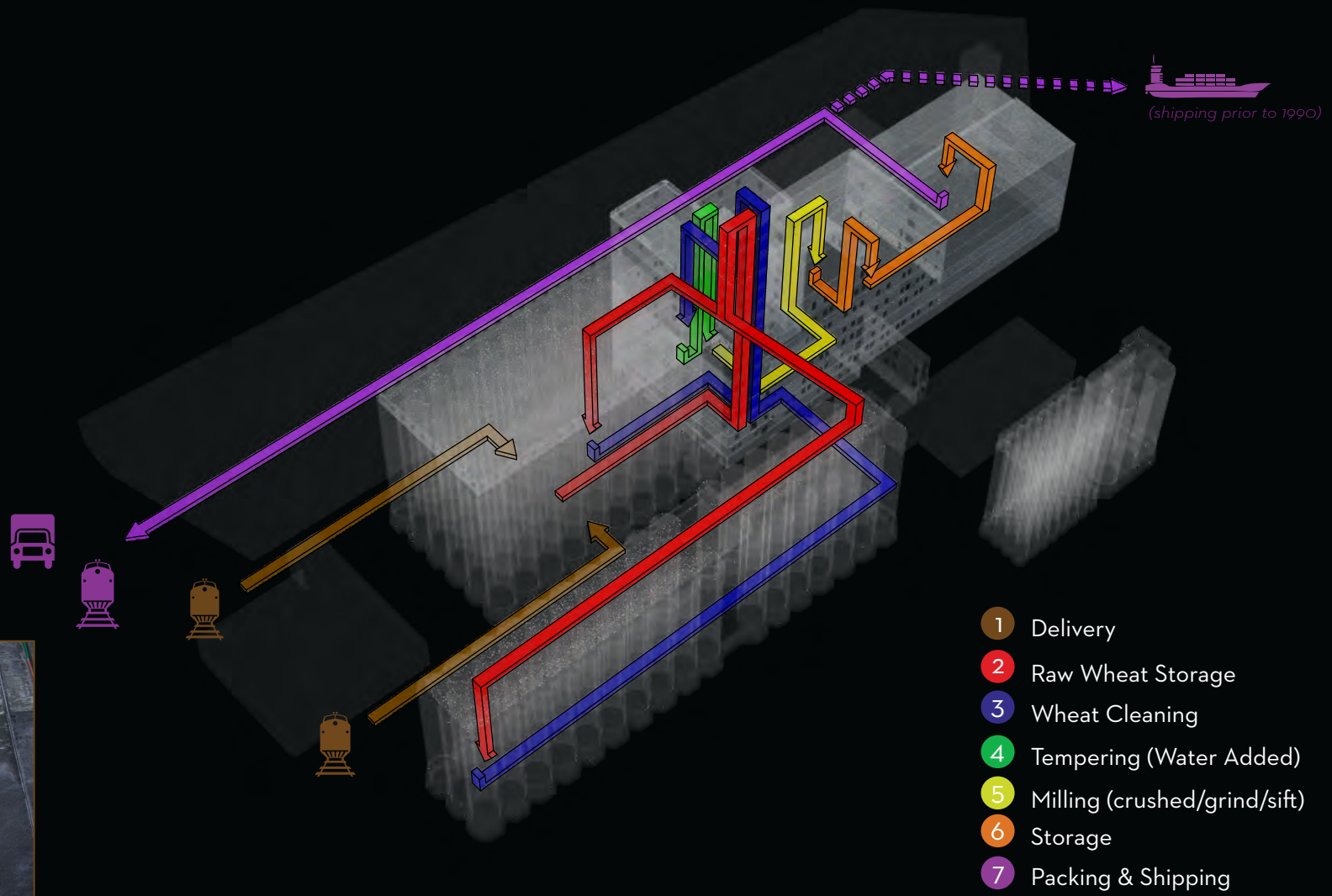
Figure 31: Section cut through a traditional Chinampa.

48 Rakocy, James E., Donald S. Bailey, Charlie Schultz, and Eric S. Thoman. "Update on Tilapia and Vegetable Production in the UVI Aquaponics System" University of the Virgin Islands Agricultural Experiment Station. http://ag.arizona.edu/azaqua/ista/ista6/ista6web/pdf/676.pdf. Web. March 13, 2013.

THE FLOUR MILLING PROCESS *(fig. 32)* *(for a material-flow diagram showing the machines used see Appendix D)*

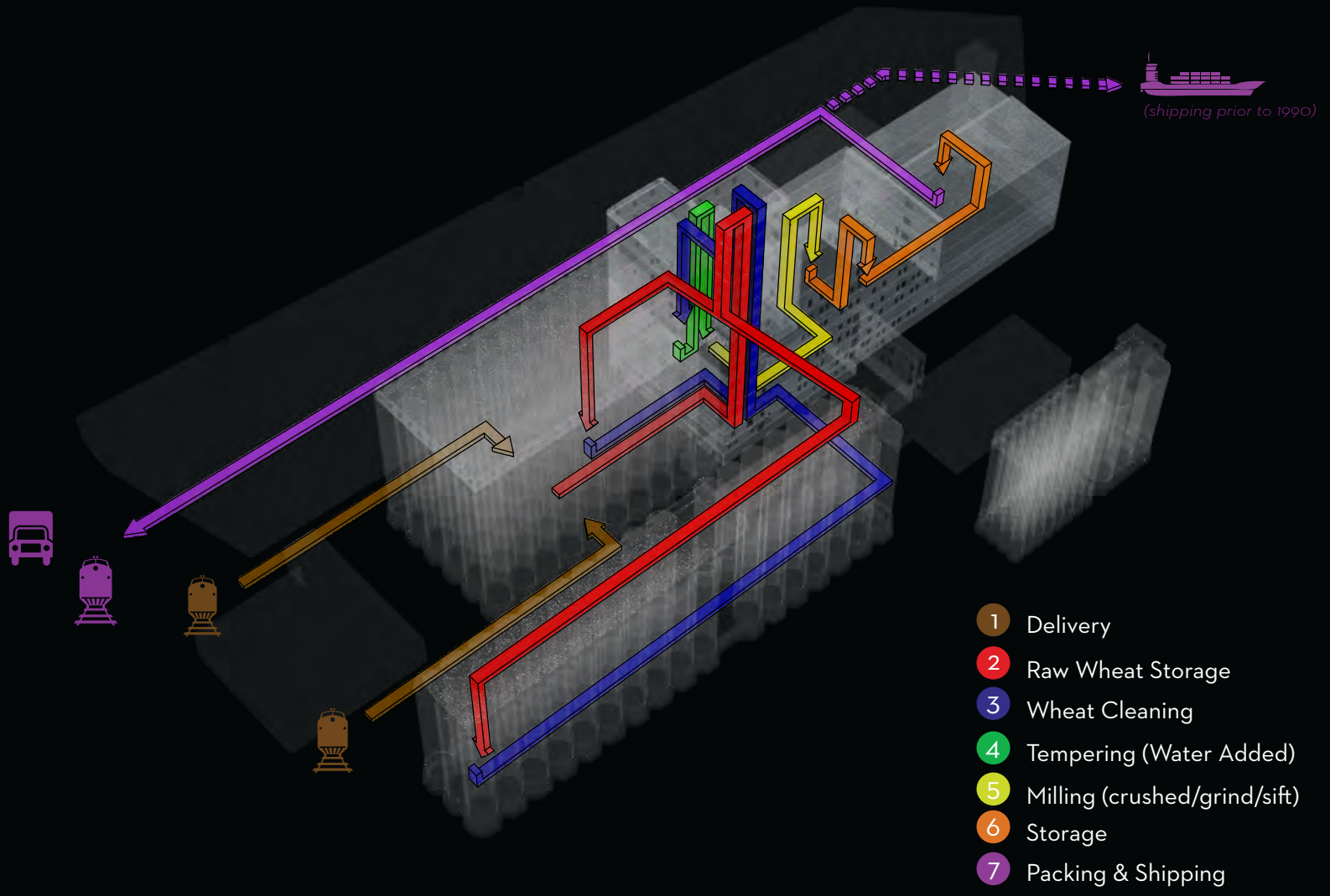
1. Delivery

A. Arrival: The wheat arrives at the flourmill via train, boat, or freight.
B. Analysis: Wheat is sampled and taken for physical and chemical analysis.
C. Grading: The wheat is given a grade based on kernal characteristics, including color, hardness/softness, and protein content.



2. Raw Wheat Storage

A. Storage: Once the wheat is graded it is loaded onto conveyers, located in the basement "pit" and taken up the grain elevator to the top of the headhouse before being sent back down to floor 10, where the grain is redirected to a series of conveyers on floors 9 and 8 which channel the wheat (using a "tripper") into their specified storage silos.



3. Wheat Cleaning/Purifying *(see Appendix C for existing drawings)*

A The wheat is taken from the bottom of the storage silos and is conveyed up to the top of the headhouse again.

B Scale: From the headhouse, the tripper on floor 9 sends the grain through a series of wheat cleaning instruments, the first of which is a scale (on floors 7 and 6) that measures and separates the wheat into smaller, more process-able, quantities.

C Separator: (on floor 5) Uses reciprocating screens to remove stones, sticks, and other foreign material.

D Aspirator: An aspirator (on floor 4) uses air currents to remove the lighter impurities.

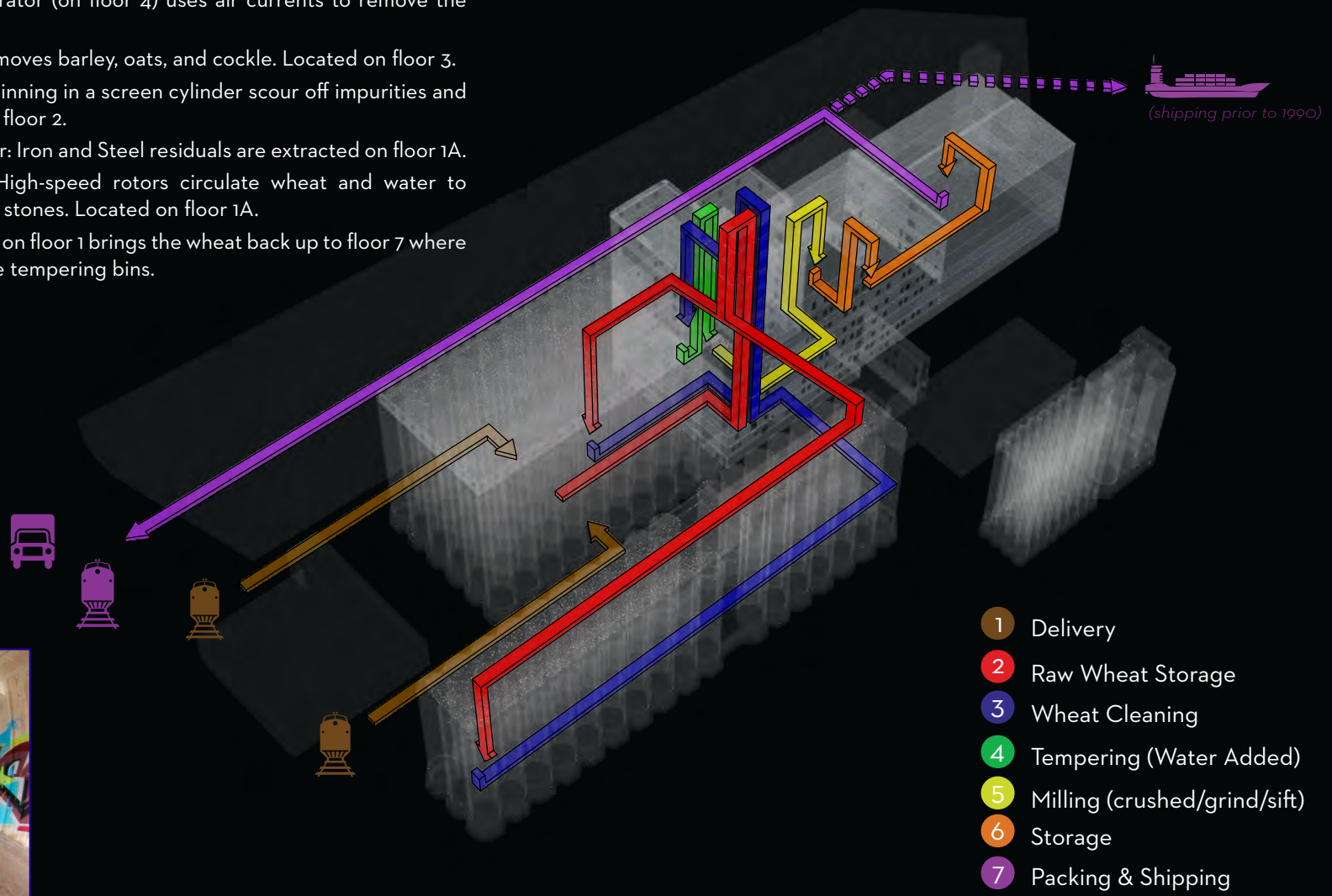
E Disc-Separator: Removes barley, oats, and cockle. Located on floor 3.

F Scourer: Beaters spinning in a screen cylinder scour off impurities and roughage. Located on floor 2.

G Magnetic Separator: Iron and Steel residuals are extracted on floor 1A.

H Washer Stoner: High-speed rotors circulate wheat and water to remove any additional stones. Located on floor 1A.

I The return conveyor on floor 1 brings the wheat back up to floor 7 where it is channeled into the tempering bins.



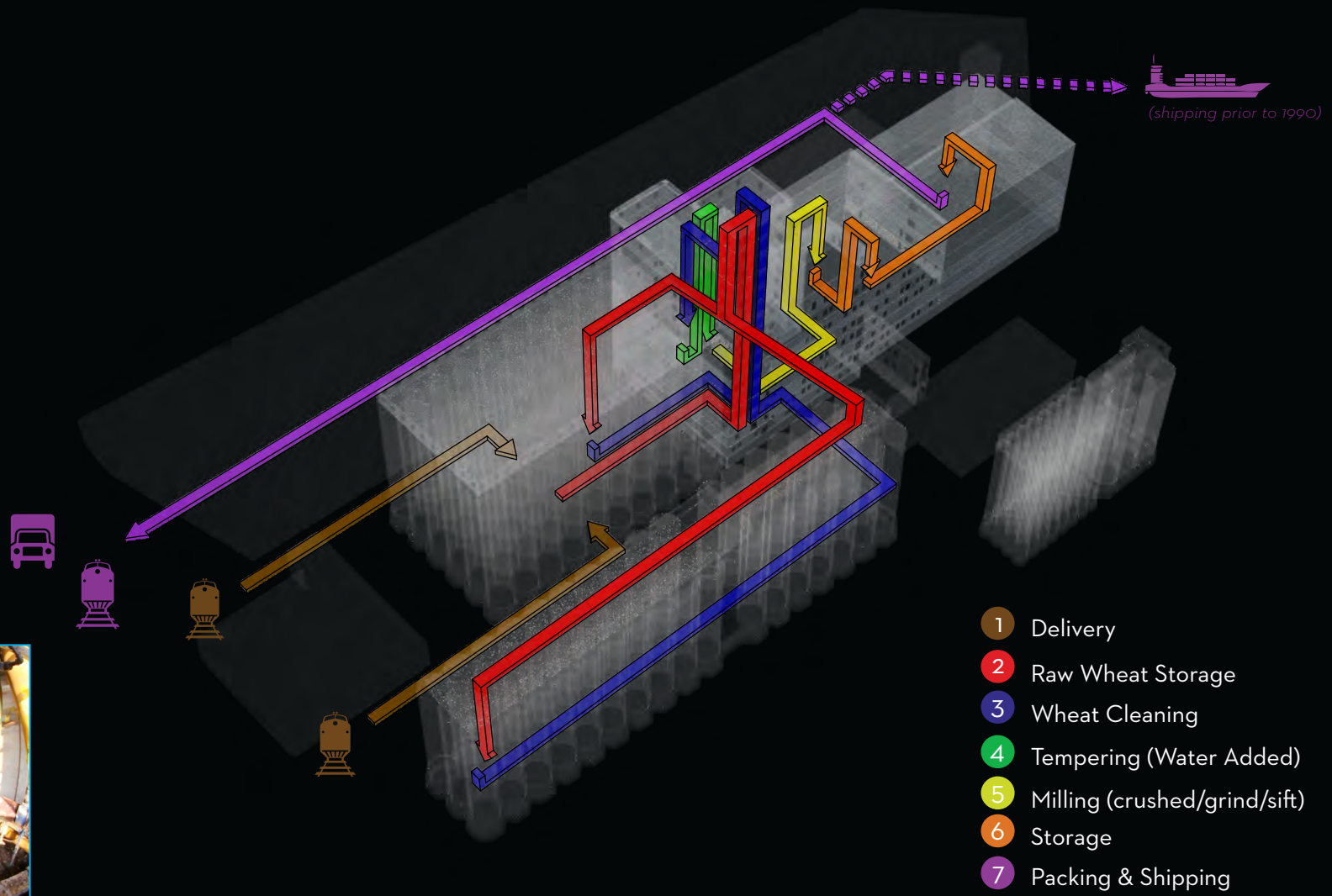
4. Wheat Tempering/Preparing

A Tempering: Water is added to the bins, located on floors 6 to 1, soaking the cleaned wheat for approximately 30 days in a process known as tempering. This loosens the exterior bran; making it easier to separate it from the interior endosperm and germ during grinding.

B Blending: Various tempered wheat's are blended to create specific types of flour.

C Impact Scourer: Unsound wheat is removed from the blend.

D Grinding Bin: Grindable wheat is directed into grinding bins on the first floor.



5. Milling

A First Break: The blend is suctioned from the first floor bins to the second floor of the mill, where corrugated rolling pins break the wheat.

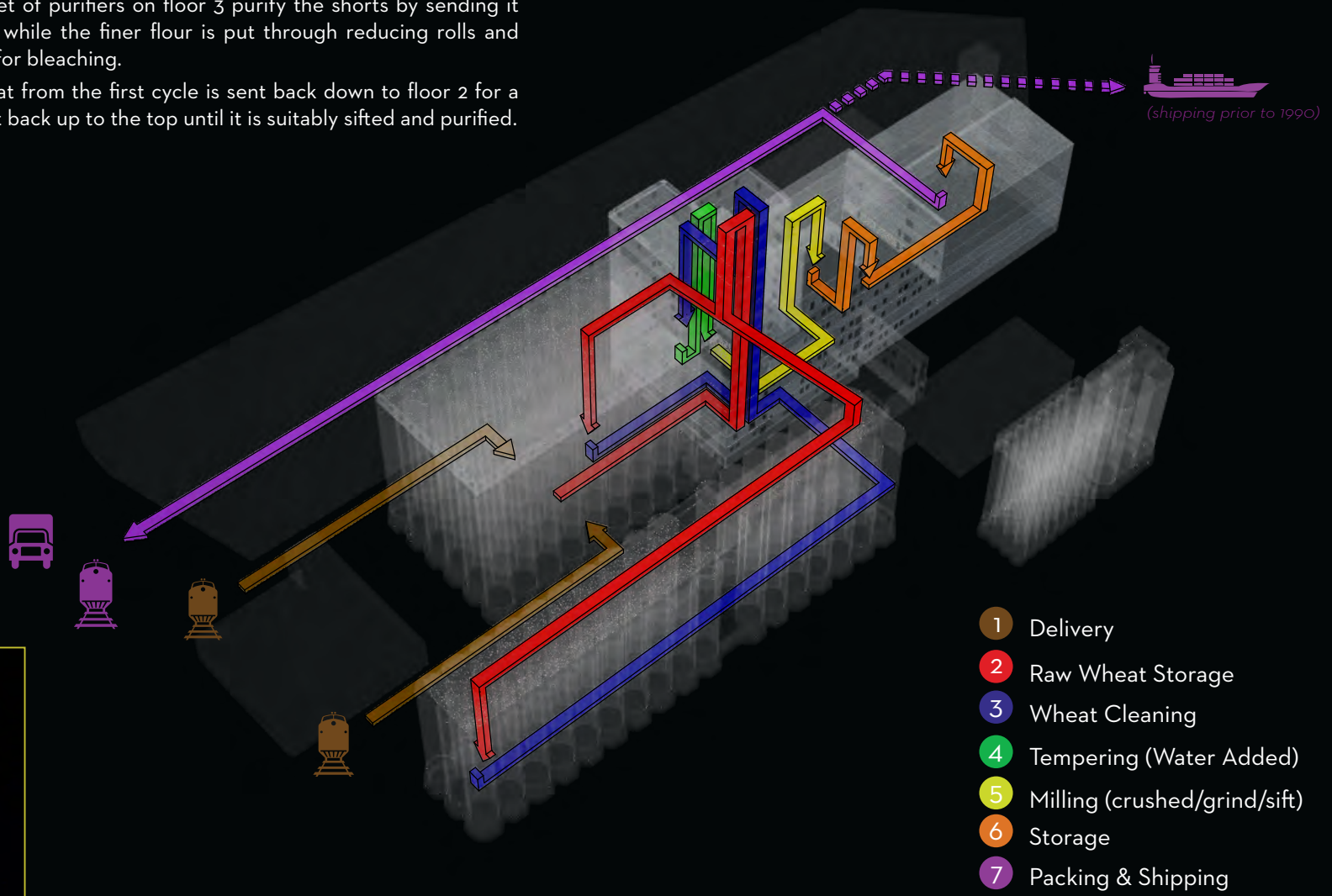
B Sifter: The wheat is suctioned up to the sixth floor where it is sifted through successively finer screens.

C Purifier: The sifted wheat moves down to purifiers on floor 5 where the bran and middlings are separated.

D Sifter: Another round of sifters on floor 4 separate the "shorts" from the flour and suction it into different purifiers.

E Purifier: Another set of purifiers on floor 3 purify the shorts by sending it through germ rollers, while the finer flour is put through reducing rolls and sifters until it is ready for bleaching.

F The unbroken wheat from the first cycle is sent back down to floor 2 for a second break and sent back up to the top until it is suitably sifted and purified.

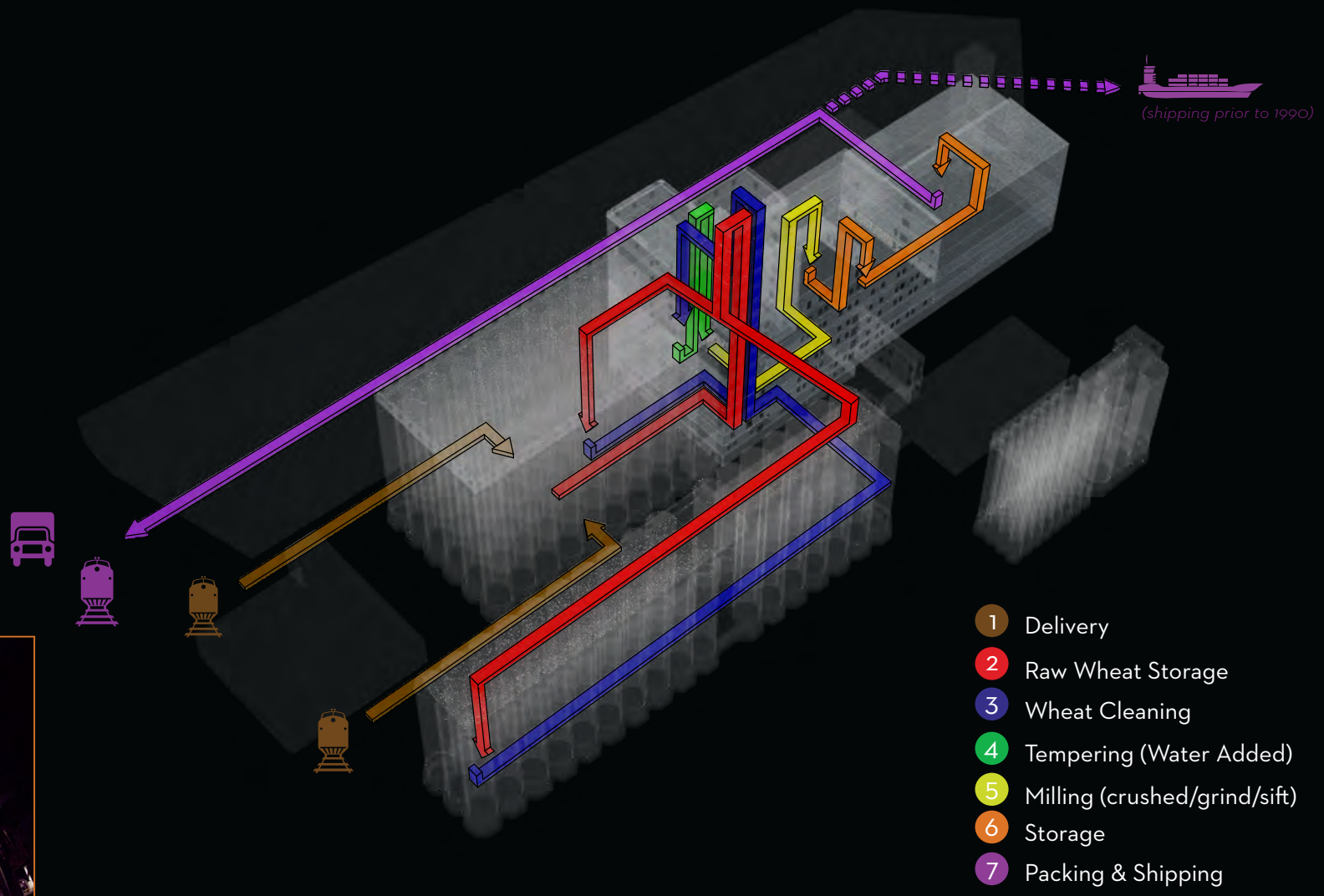


6. Storage

A Bleaching: Small amounts of bleaching and oxidizing agents are added to the flour after milling.

B Bulk Storage: The flour is moved to different silo's in 'Warehouse H' where it's stored in an lightproof/temperature controlled building.

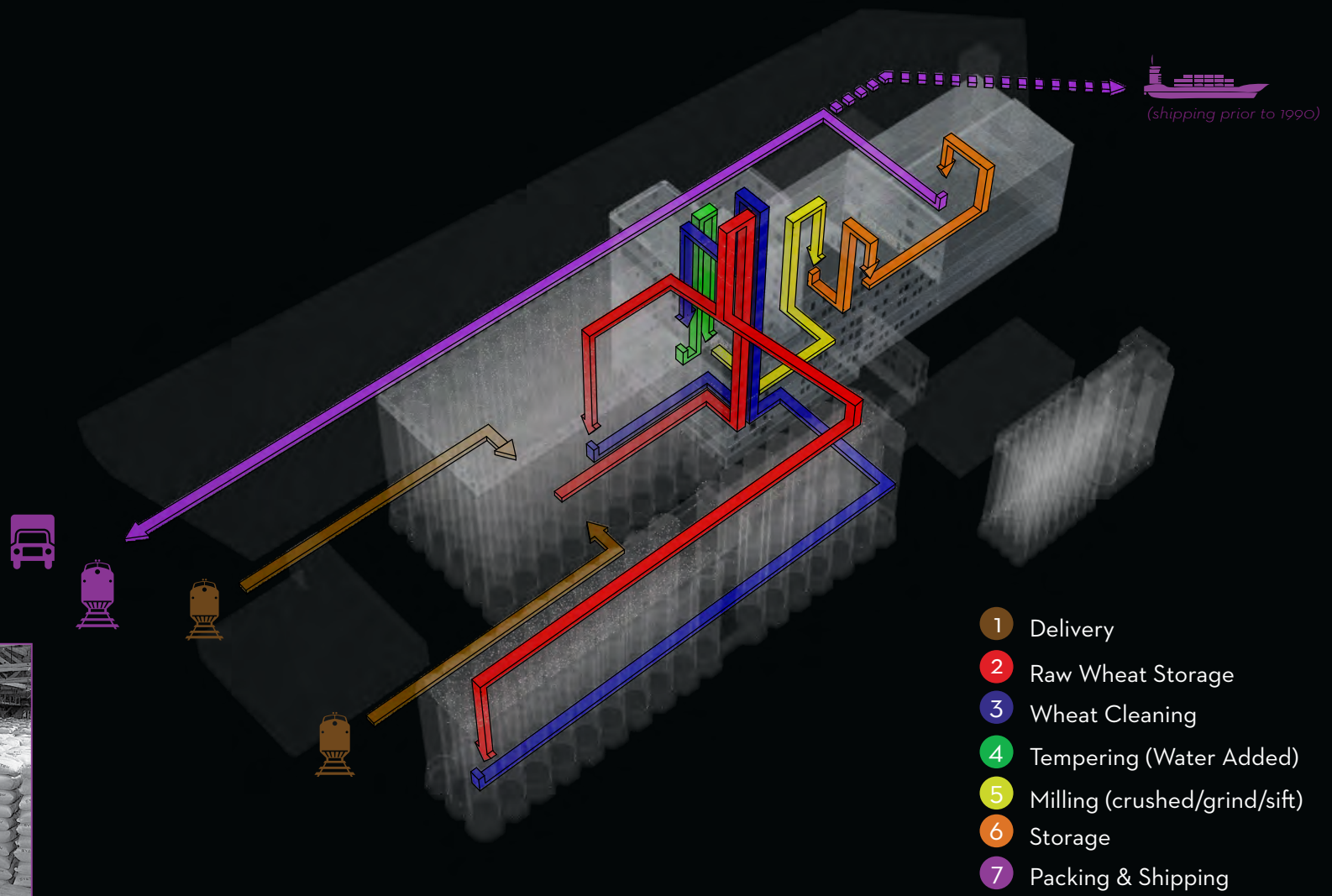
C Enriching: The flour is taken out of the silos and enriched with thiamine, niacin, riboflavin, and iron.



7. Packing & Shipping

A Sacked: The flour is packed into cloth bags of differing sizes (25, 50, and 100 lbs).

B Bulk Delivery: the flour bags are delivered to bakeries by truck, rail, or sent abroad by ship (prior to the 1990's).



6 // Design

PROGRAM

Traditionally, we (the public) have been separated from the means-of-production that sustain us. Large-scale industrial agricultural operations have made reductions in food-quality unapparent to most consumers. Converting the Fisher Flourmill (a monofunctional food-processing facility) *(fig. 33)* into an aquaponic food-production and education facility seeks to remove this separation by rethinking the interaction between private, semi-private, and public program to create a sort of mixed-use factory *(fig. 34)*. The building will become a teaching tool, informing the public about the efficiency and quality of aquaponic food production. Borrowing from the pea-patch-garden model, local volunteers will be the primary tenders of the aquaponic "plots." The faculty will also serve as production staff assuring that the health of the fish and vegetables are maintained.

The three main programmatic elements include:

1. Aquaponic Food Production Space:
    - Greenhouse Space *(64,006 sf)*
    - Fish Rearing tanks *(110,557 sf)*
    - Support/Utility spaces
        - Seed Storage
        - Harvest Floor
        - Composting Room
        - Fish Processing
    - Material Storage
    - Packing and Shipping/Delivery

2. Educational Facilities:
    - Dormatories (w/ bathrooms & kitchen)
    - Auditorium
    - Meeting Rooms
    - Faculty Offices

3. Public Program:
    - New Experiential Walkway Cut Through Bins
    - Observation Decks
    - Restaurant
    - Seed Gallery
    - Market
    - Bathrooms

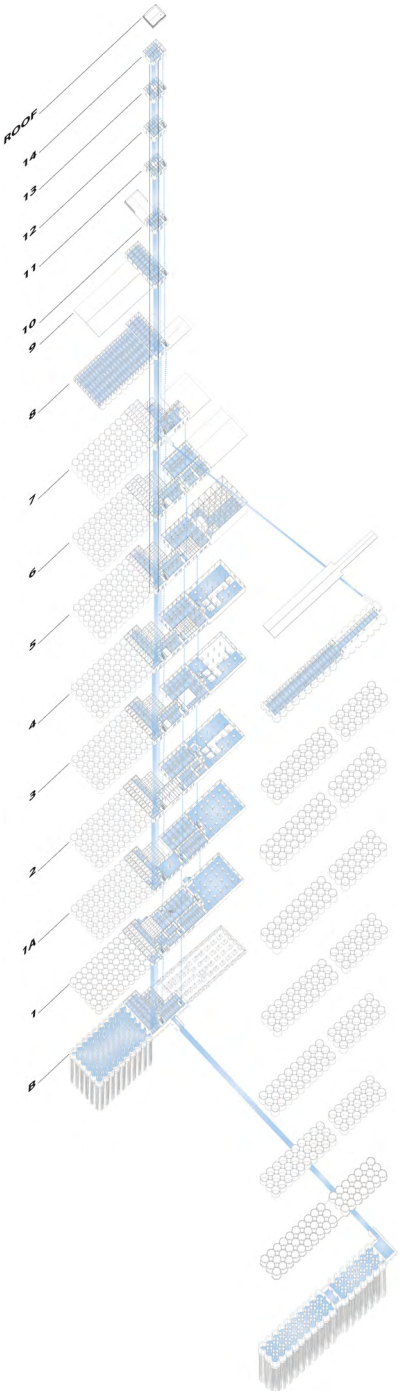


Figure 33: The Existing Building (mono-functional) *(See Appendix E for enlarged image)*

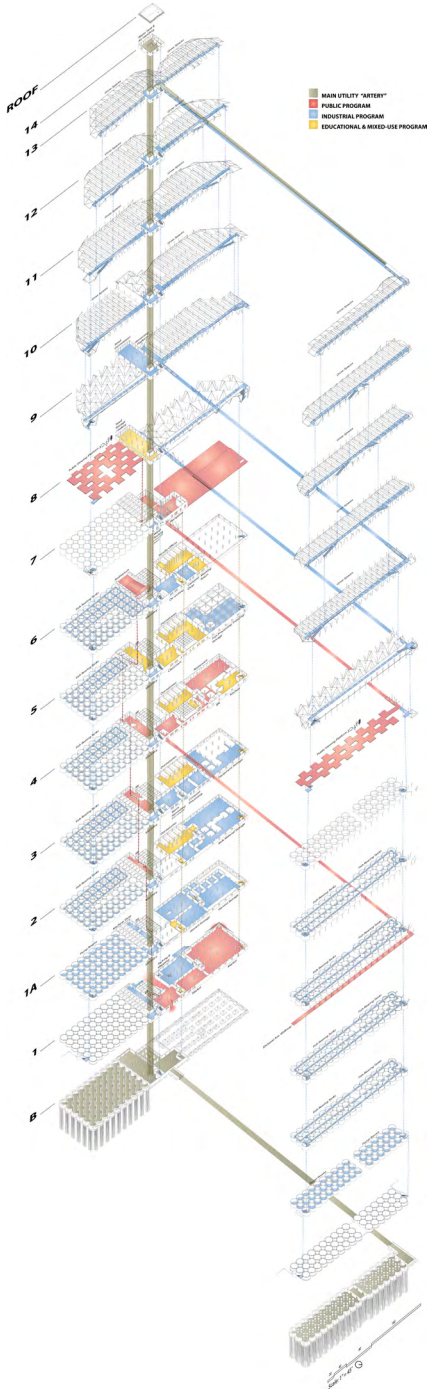


Figure 34: The Repurposed Building (multi-functional) *(See Appendix F for enlarged image) *beams and joists hidden for clarity*

SEATTLE PEA PATCHES

Residential neighborhoods logically contain the majority of pea patches in the city *(fig. 35)*. 12.4 tons of food from these pea patches are donated to local food banks annually. While Harbor Island is located in the heart of Seattle's industrial landscape (2 miles from the closest pea patch), this proposal would be a different type of pea-patch– Capable of growing food all hours of the day, this building could produce roughly 2,000 tons of food annually, some of which could also be donated.

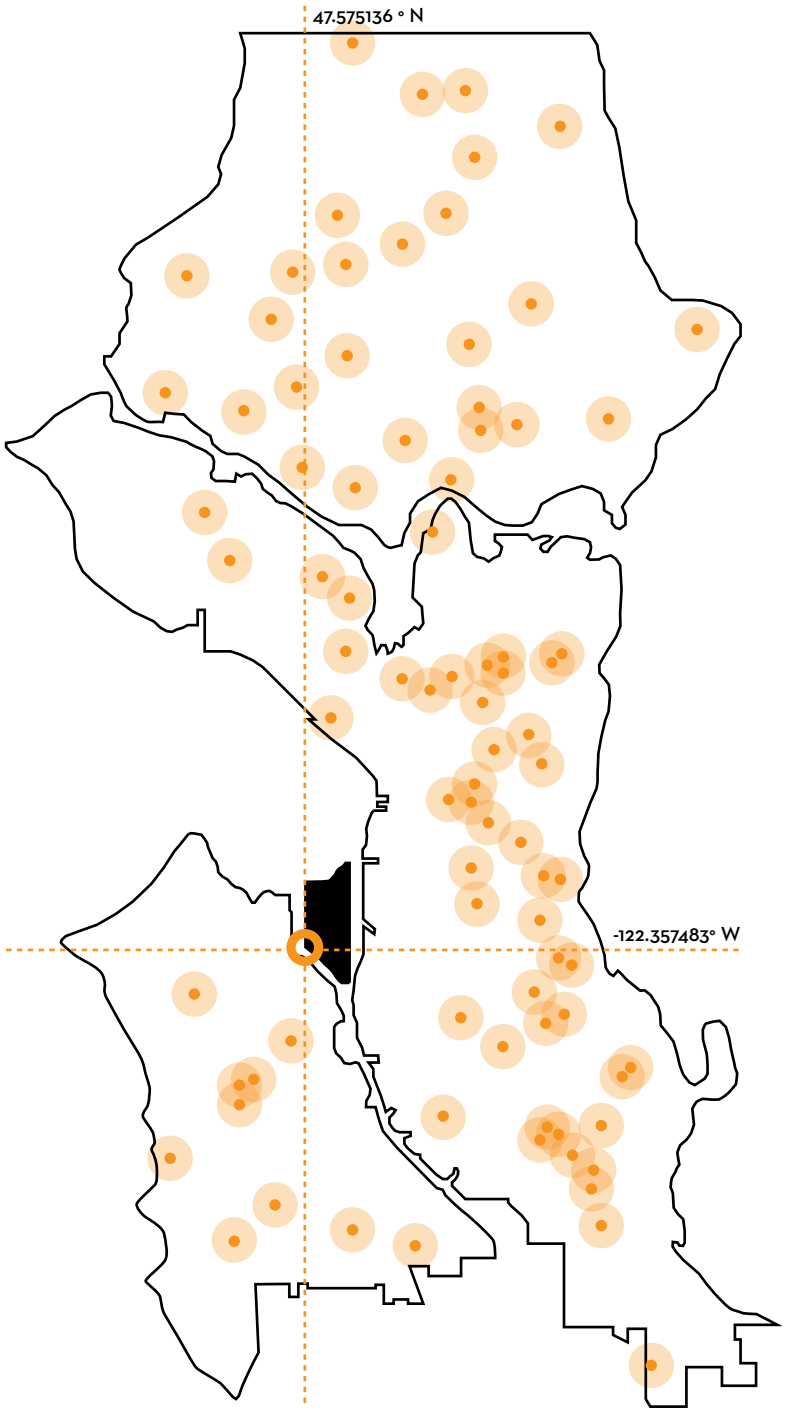
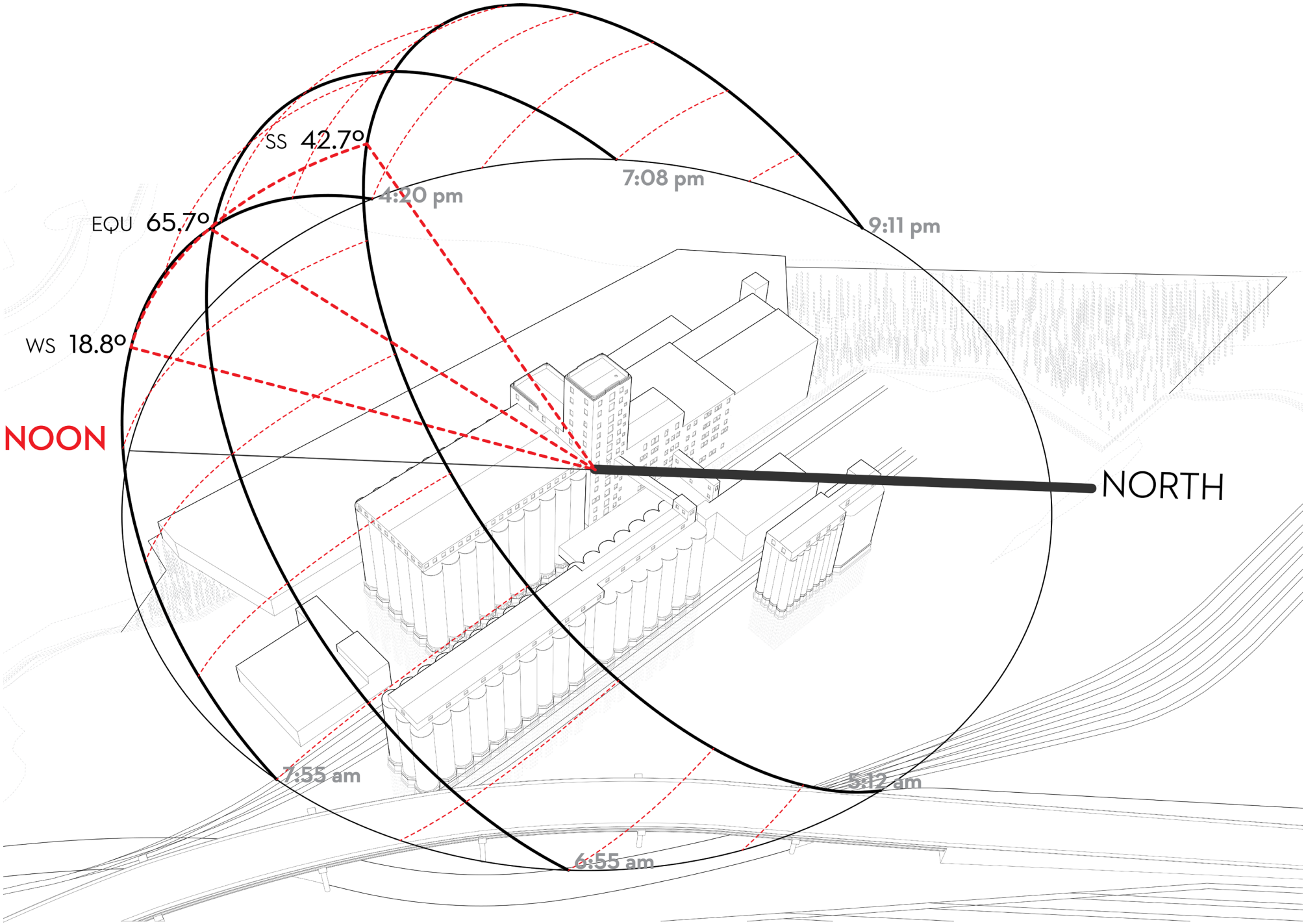


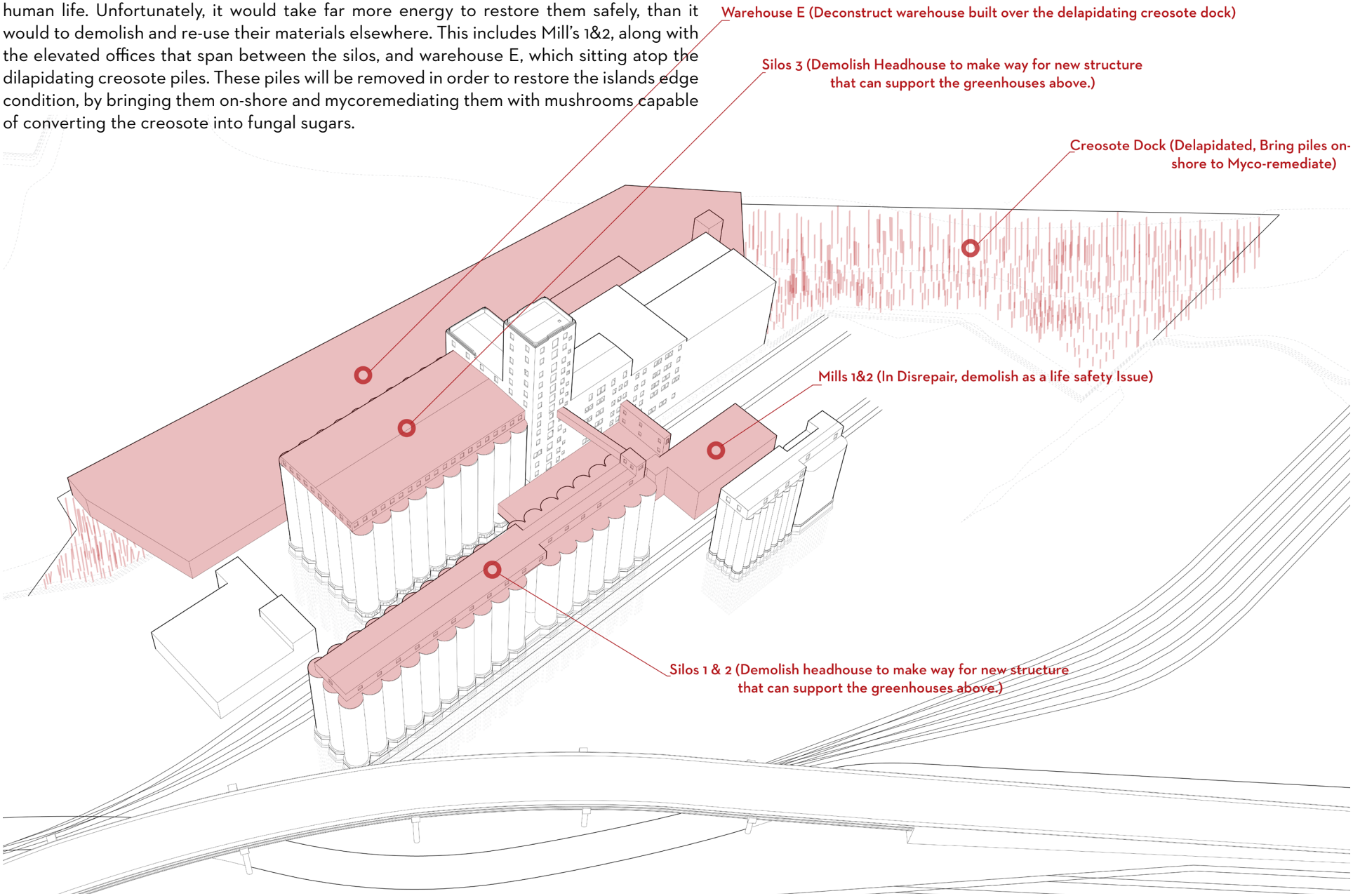
Figure 35: Location of Seattle Pea Patches *(with 5 minute walking circles shown in light-orange)*

SOLAR ACCESS *(fig. 36)*

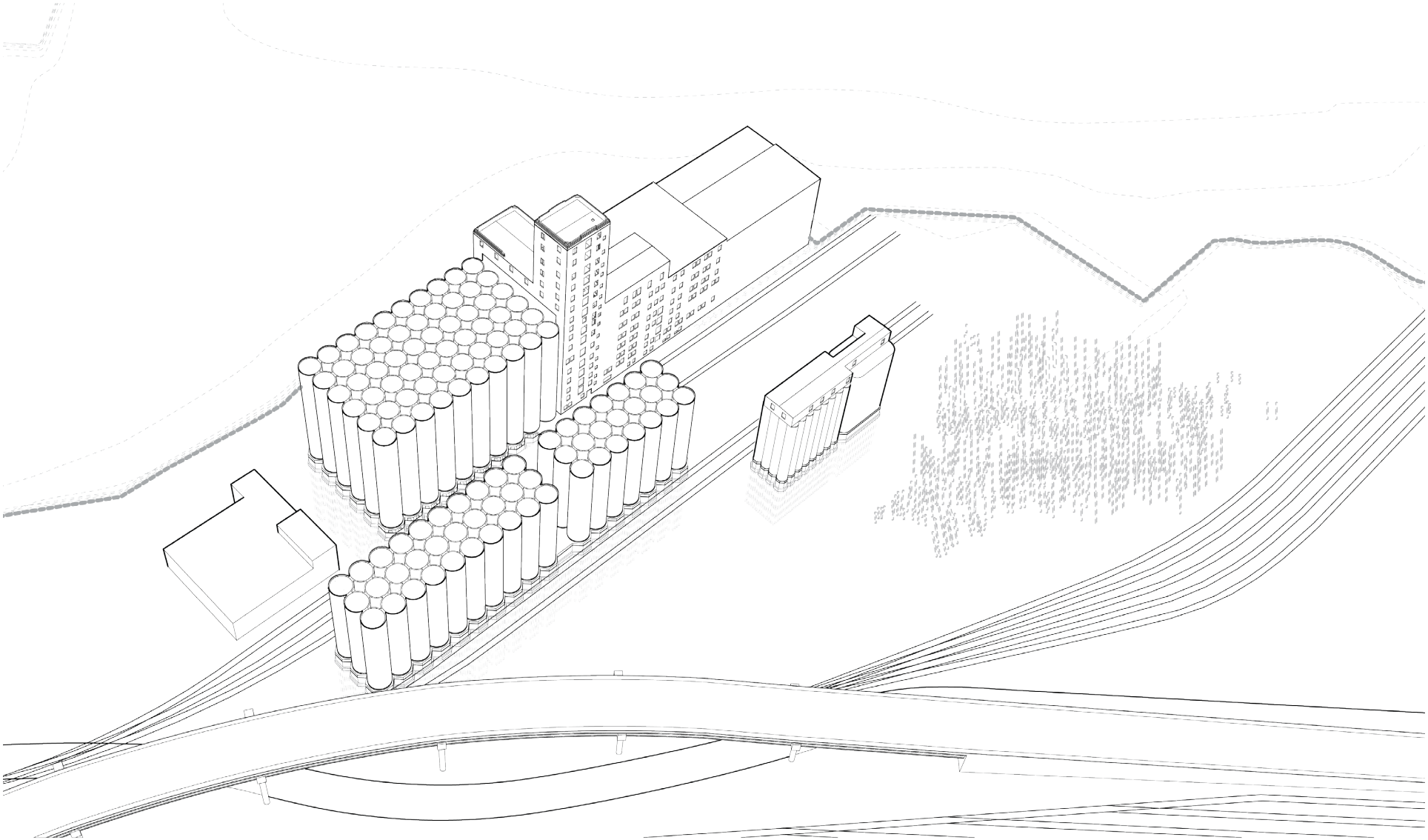


DEMOLITION AND DECONSTRUCTION *(fig. 37)*

Removing, rather than reusing, any existing building is a contentious decision, especially in a project seeking to repurpose as much of the existing infrastructure as possible. In this case, several of the building's on-site are in such disrepair they pose a threat to human life. Unfortunately, it would take far more energy to restore them safely, than it would to demolish and re-use their materials elsewhere. This includes Mill's 1&2, along with the elevated offices that span between the silos, and warehouse E, which sitting atop the dilapidating creosote piles. These piles will be removed in order to restore the islands edge condition, by bringing them on-shore and mycoremediating them with mushrooms capable of converting the creosote into fungal sugars.



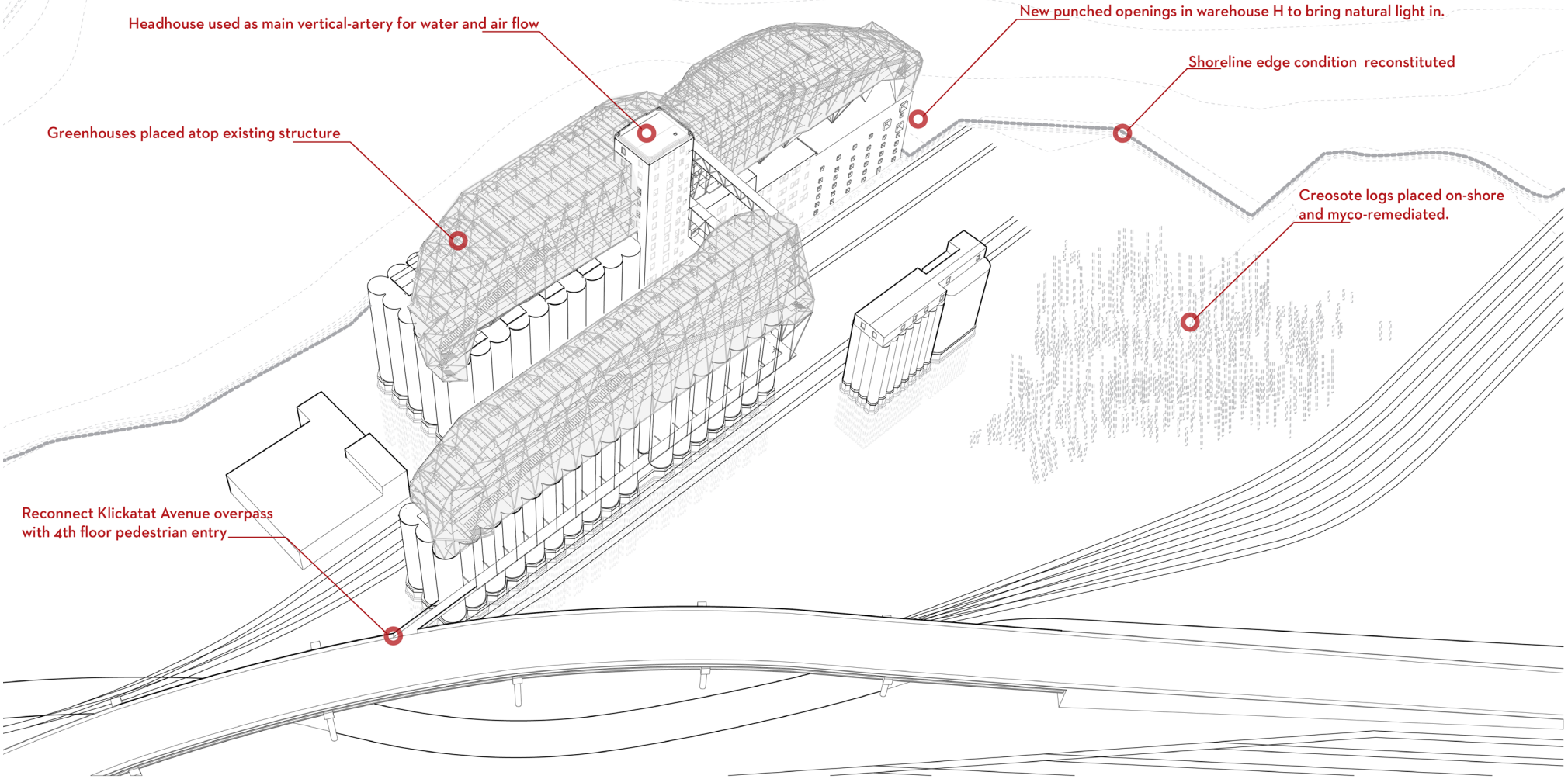
THE REMAINING "RUINS" *(fig. 38)*



REPURPOSED BUILDING WITH ADDITION *(fig. 39)*

After studying the logic of the existing mill, it follows that the aquaponics facility should also be gravity fed, using the headhouse as it's main artery to circulate systems and materials through the building. The greenhouses placed atop the existing structure become the most visible element and a communicator of the buildings new use.

A pedestrian walkway is proposed on floor 4, in order to reconnect the Klickatat Avenue overpass with the repurposed building.



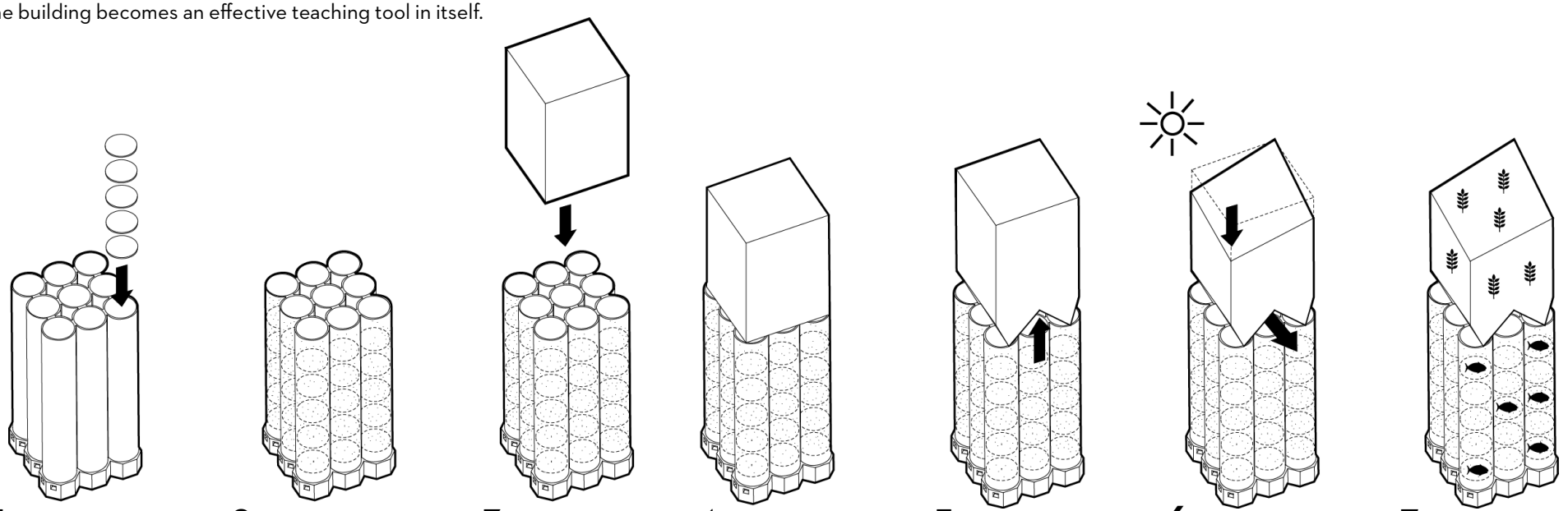
6.1 // Designing the Function

FORM FINDING *(fig. 40)*

Beginning without any preconceived notion of what the building might look like, it's formal qualities arose from the technical requirements of an aquaponics facility, from the structural preconditions of the existing structure, and from environmental requirements.

Since the silo's cylindrical shape best supports the heavy load of water, it makes sense to stack the fish tanks vertically within them, connecting the circulation of water, fish, and people through openings in the silo walls.

Putting the greenhouses on top and inviting the public to occupy the space between, where the aquaponics process can be best understood through observation, the building becomes an effective teaching tool in itself.



1 *fish tank platforms added to silos.*

2 *small punctures bring light in*

3 *greenhouse placed atop existing building.*

4 *new structure aligned with existing grid.*

5 *bottom of greenhouse lifted triangularly (for lateral support), creating public space between to observe fish below and plants above.*

6 *plant beds tier, maximizing sun exposure.*

7 *plants and fish added to the system at ~ 1:1 ratio*

FORM FINDING

The tectonic language of the addition reflects the flow of materials through the building (i.e.- water, air, sunlight). The required flow rate of water through the system generates the 1:10 greenhouse ramp slopes (shown in fig. 42 & 43).

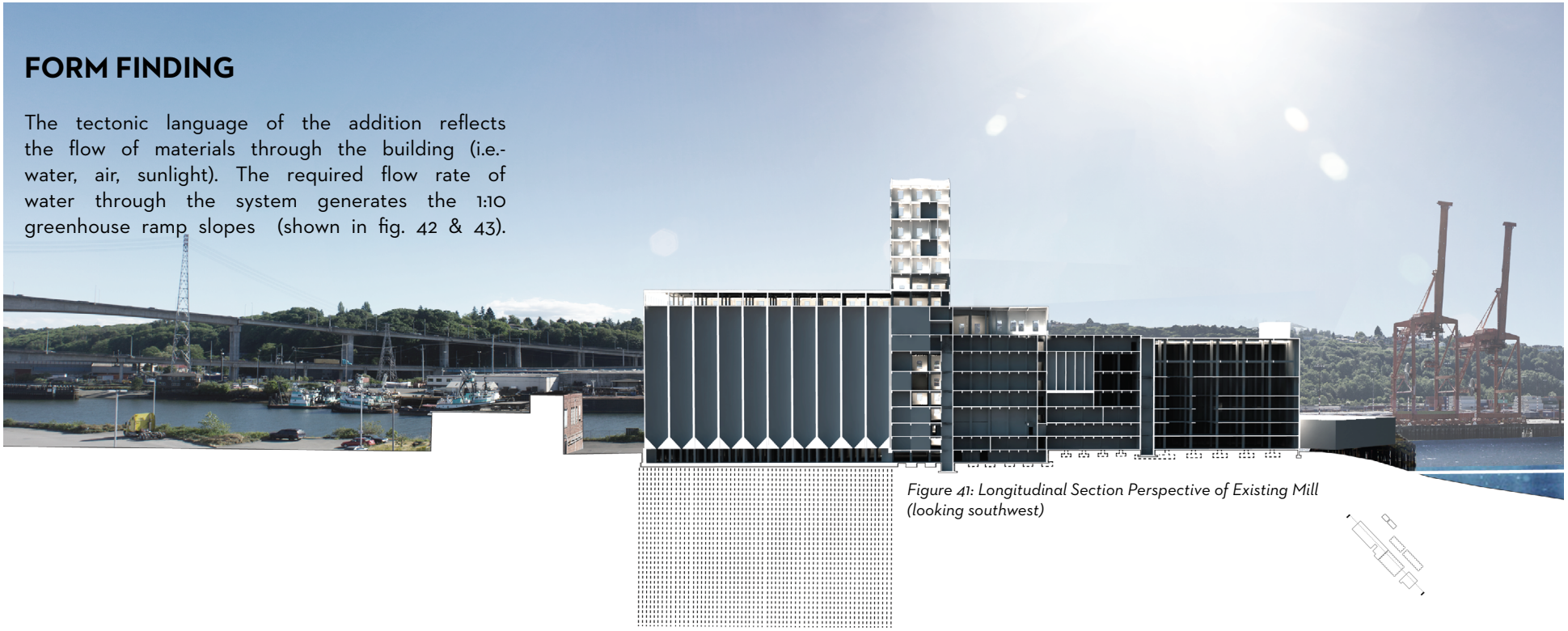


Figure 41: Longitudinal Section Perspective of Existing Mill (looking southwest)

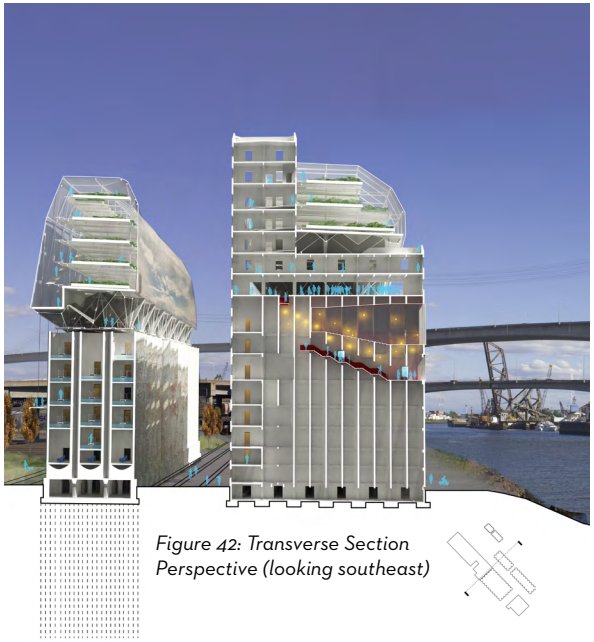


Figure 42: Transverse Section Perspective (looking southeast)

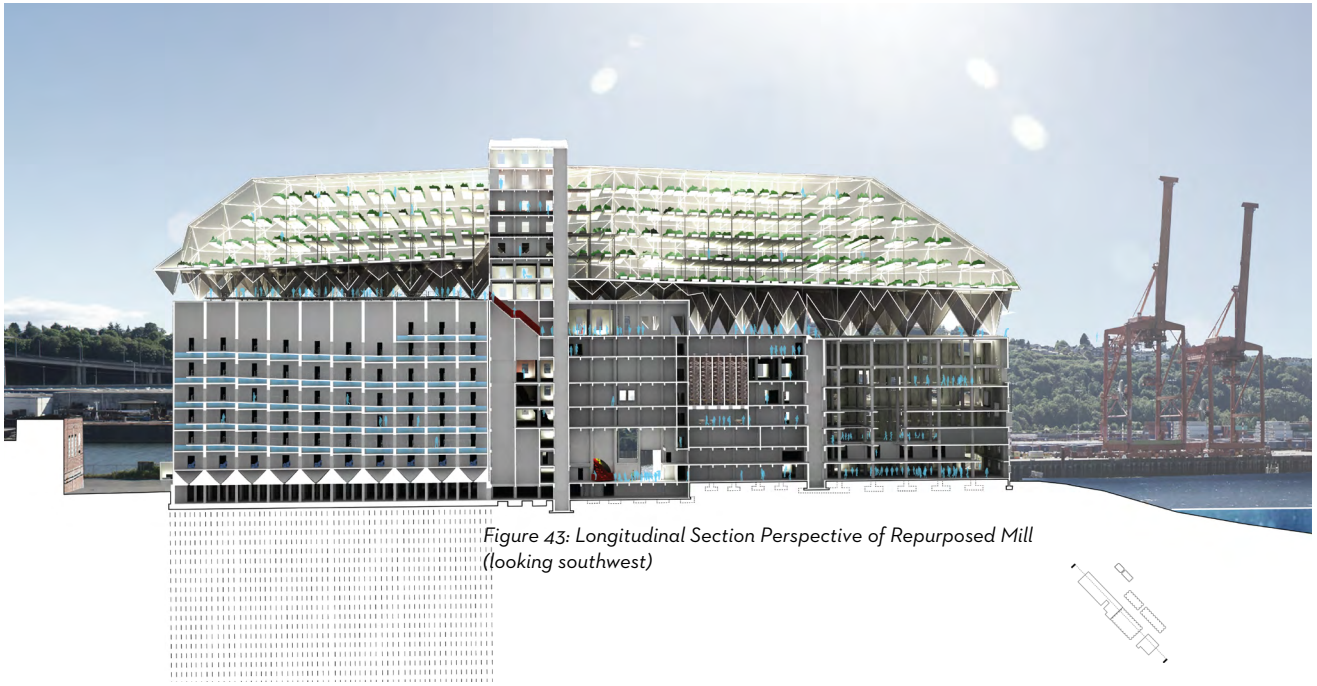
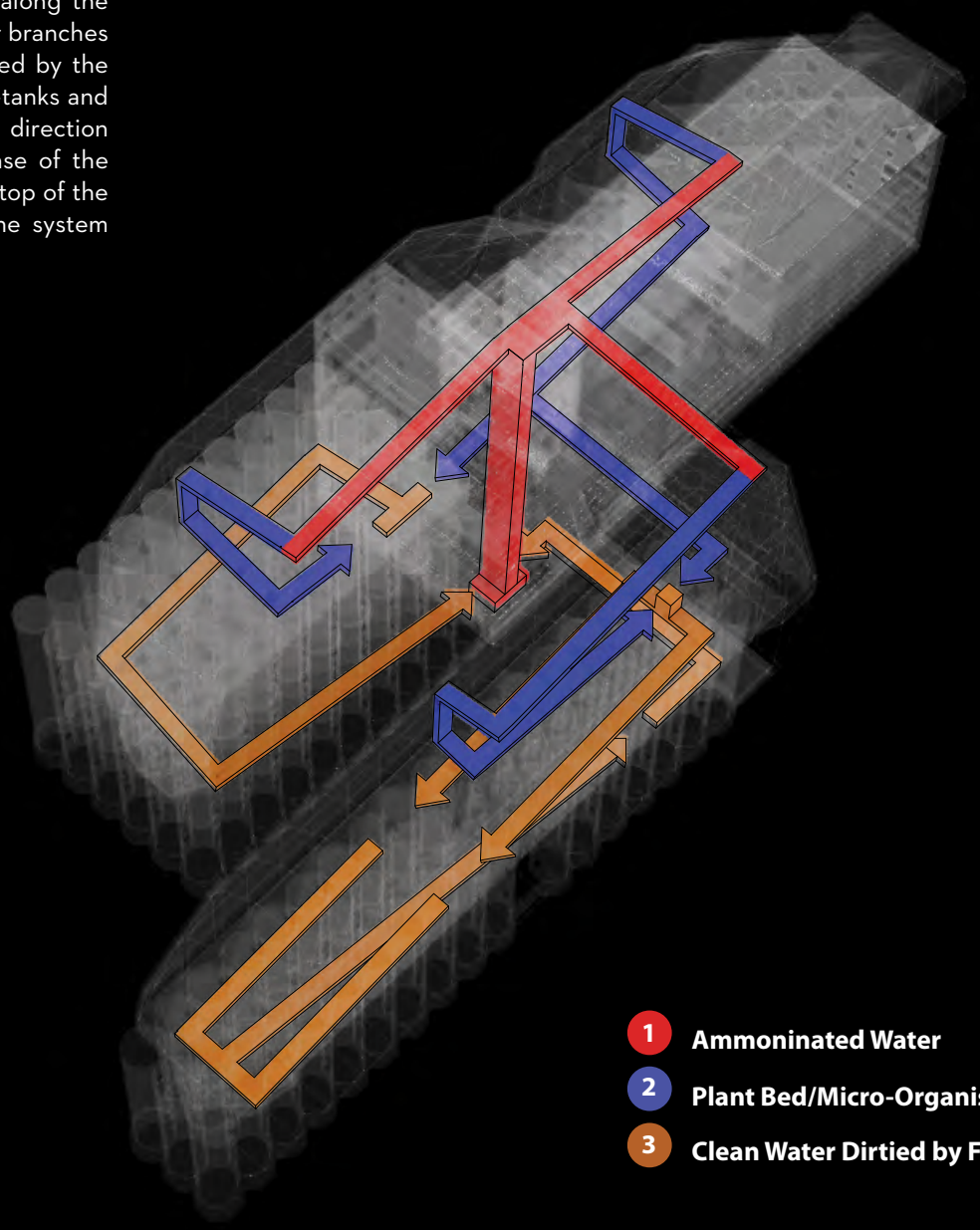


Figure 43: Longitudinal Section Perspective of Repurposed Mill (looking southwest)

WATER FLOW *(fig. 44)*

From the top of the headhouse, the ammoniated water moves down the “circulation spine” along the northeastern edge of the building. The water branches off into the planting beds where it is cleaned by the plants. Once clean, it is fed into the silo-fish-tanks and is dirtied as it moves downward in a spiral direction back to the pump room (located at the base of the silos). Next, the water is pumped back up to top of the headhouse where it recirculates through the system again.



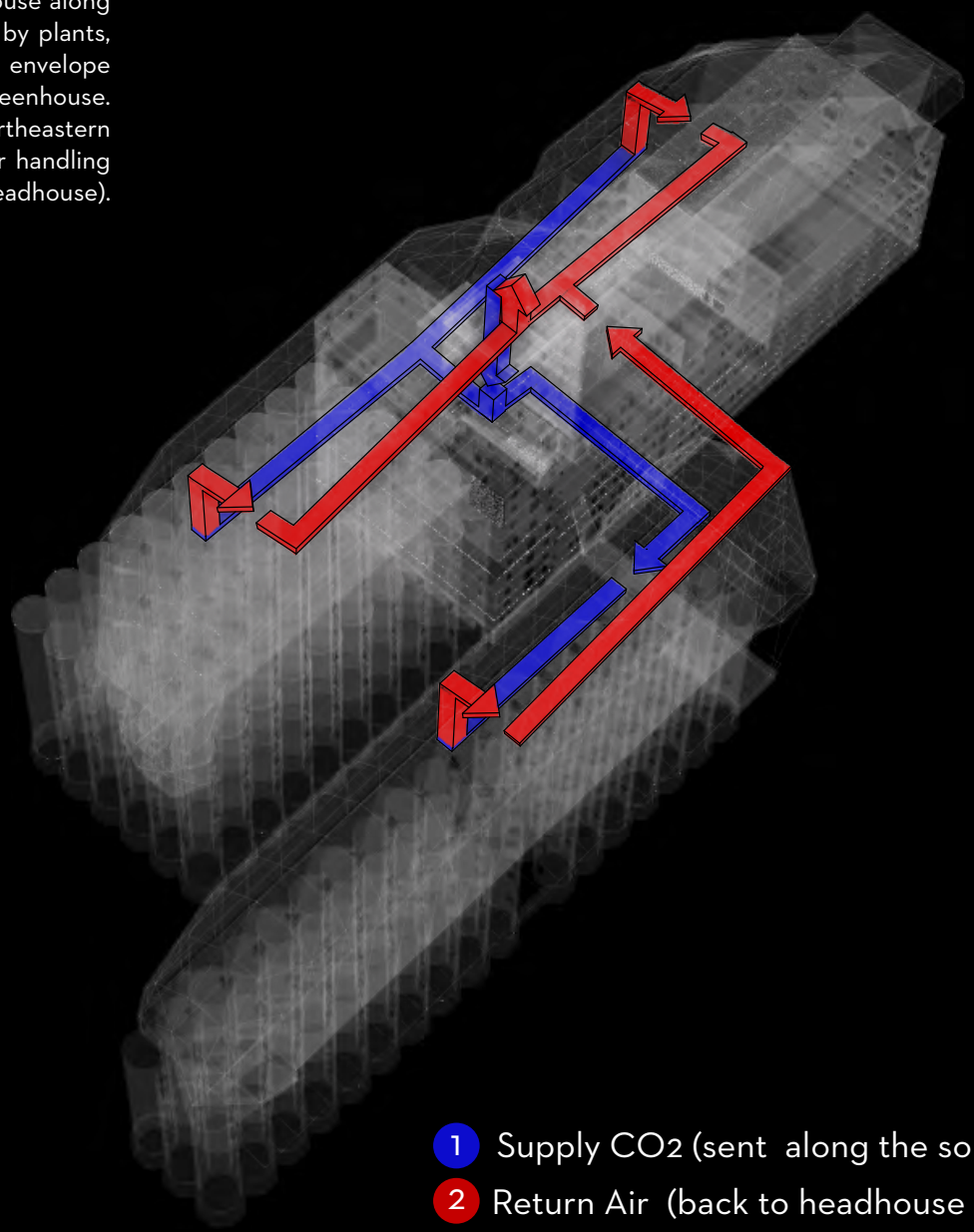
1 **Ammoninated Water**

2 **Plant Bed/Micro-Organism Filtration**

3 **Clean Water Dirtied by Fish**

GREENHOUSE VENTILATION *(fig. 45)*

Moving in the opposite direction of the water, the supply CO_2 enters from the bottom of the greenhouse along the southern-end. As it is photosynthesized by plants, oxygen (the byproduct) is heated by the envelope causing it to rise up through the top of the greenhouse. Next, it's pumped back along the northeastern "circulation spine" of the structure to the air handling unit (located on the 14th floor of the headhouse).

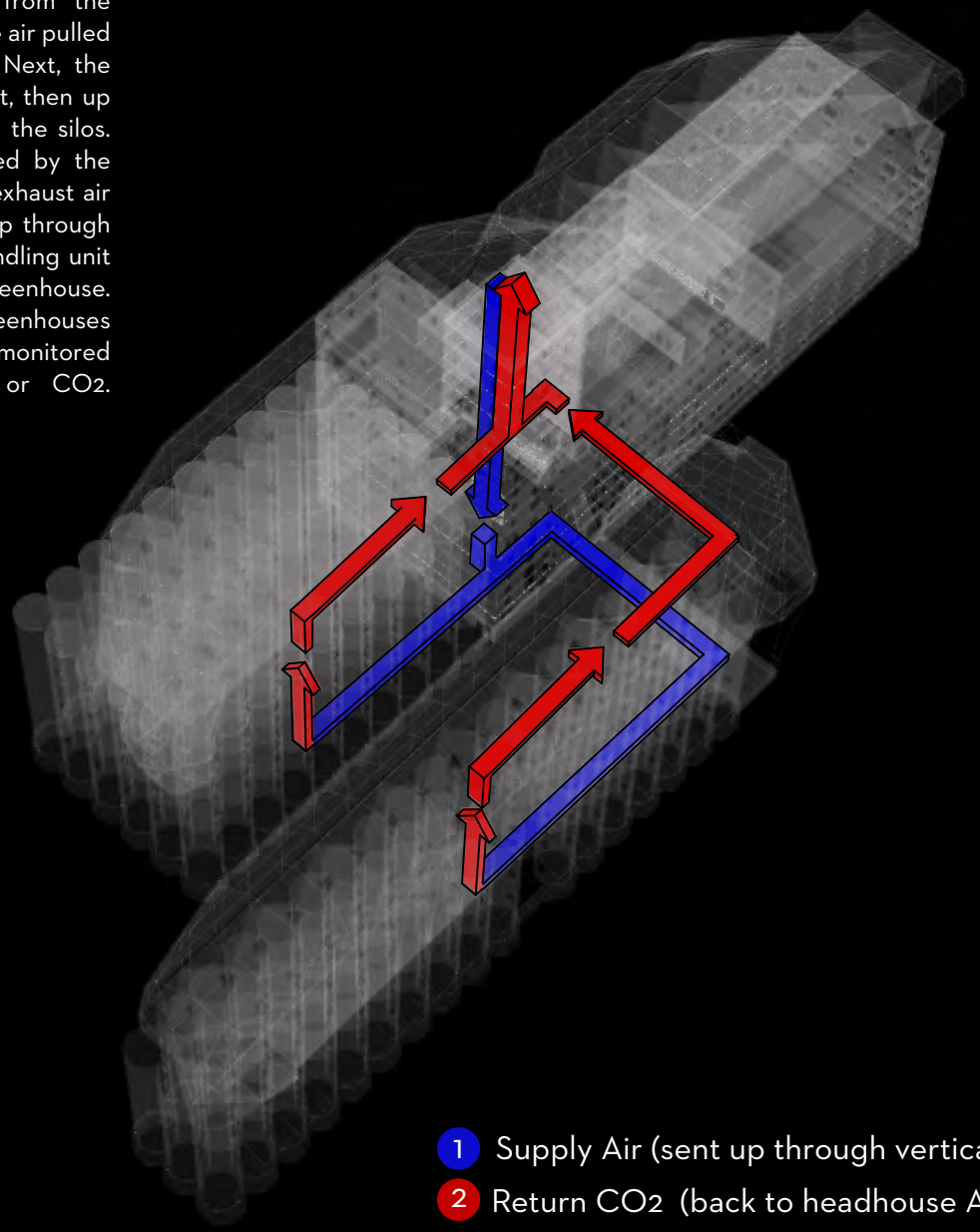


1 Supply CO_2 (sent along the southern-end of the greenhouse)

2 Return Air (back to headhouse AHU)

SILO TANK VENTILATION *(fig. 46)*

The fish tanks (stacked within the existing silos) are supplied with fresh air deriving mostly from the greenhouses, but is supplemented by outside air pulled through the air handling unit on floor 14. Next, the fresh air is sent down through the basement, then up through the vertical plenum space between the silos. Once pumped into the silos and respirated by the fish and people occupying the tank rooms, exhaust air (with CO_2 as the byproduct) is sent back up through the vertical plenum, then back to the air handling unit where it can be recirculated back into the greenhouse. By centralizing the air-handling of both the greenhouses and fish tanks, air levels can be easily monitored and supplemented with either oxygen or CO_2.



1 Supply Air (sent up through vertical silo “plenums”)

2 Return CO_2 (back to headhouse AHU)

THE INTEGRATED SYSTEM *(fig. 47)*

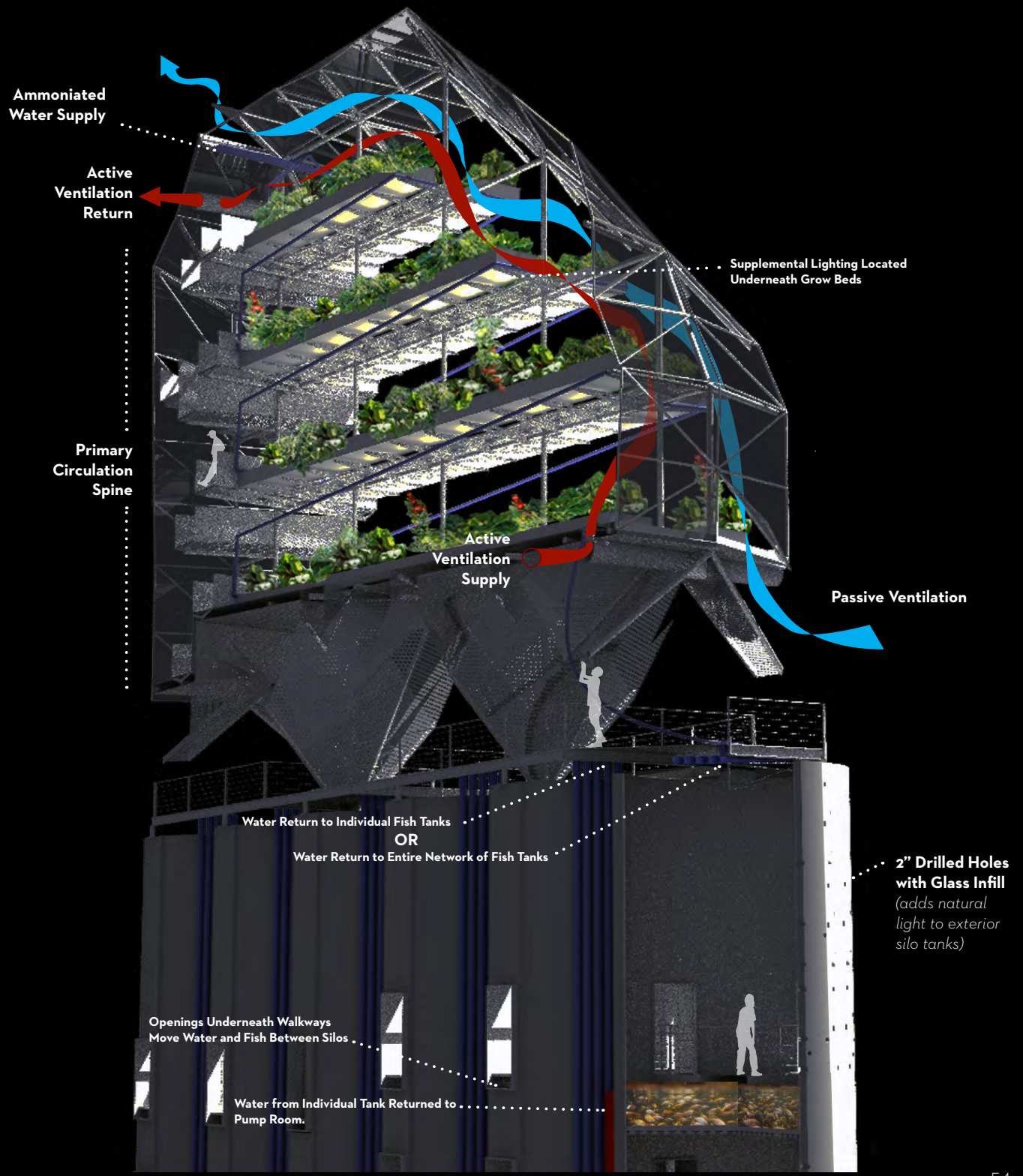
The grow beds tier, bringing light deeper into the structure while also creating a high pressure air-zone at the top of the enclosure which pulls air up through the skin when the operable windows are open. When the façade is closed, air is pumped through the bottom of the southeastern edge and returns through the top of the Northeastern "circulation spine". Both people and resources circulate along this northeastern side of the structure, minimizing structure along the more-important southwestern side.

The exterior shell is also designed to laterally resist shear forces which minimizes any overshadowing that may be caused from laterally bracing within the enclosure.

Supply water enters from the top of the structure. Once the ammoniated water reaches the end of the first bed, it's pumped back into the top of the bed below until it reaches the end of the bottom bed. Here, the water exits the grow area through openings in the floor. That water is then pumped directly into either the isolated fish tank(s) below or is sent back to the main water tank (on floor 7 of the headhouse) where it circulates through all the fish tanks (globally) from the beginning.

A continuous walkway cuts through openings in the silo tank walls. As people move along the top of the this walkway, fish can swim through the opening below. This opening, allowing for the fish to swim between the silos, can also be closed off in case a more closed ecosystem is desired between the plant beds above and the tank in question. Once the water is dirtied within the isolated tank, it can be sent back to the pump room through a drain pipe running back down the vertical-plenum.

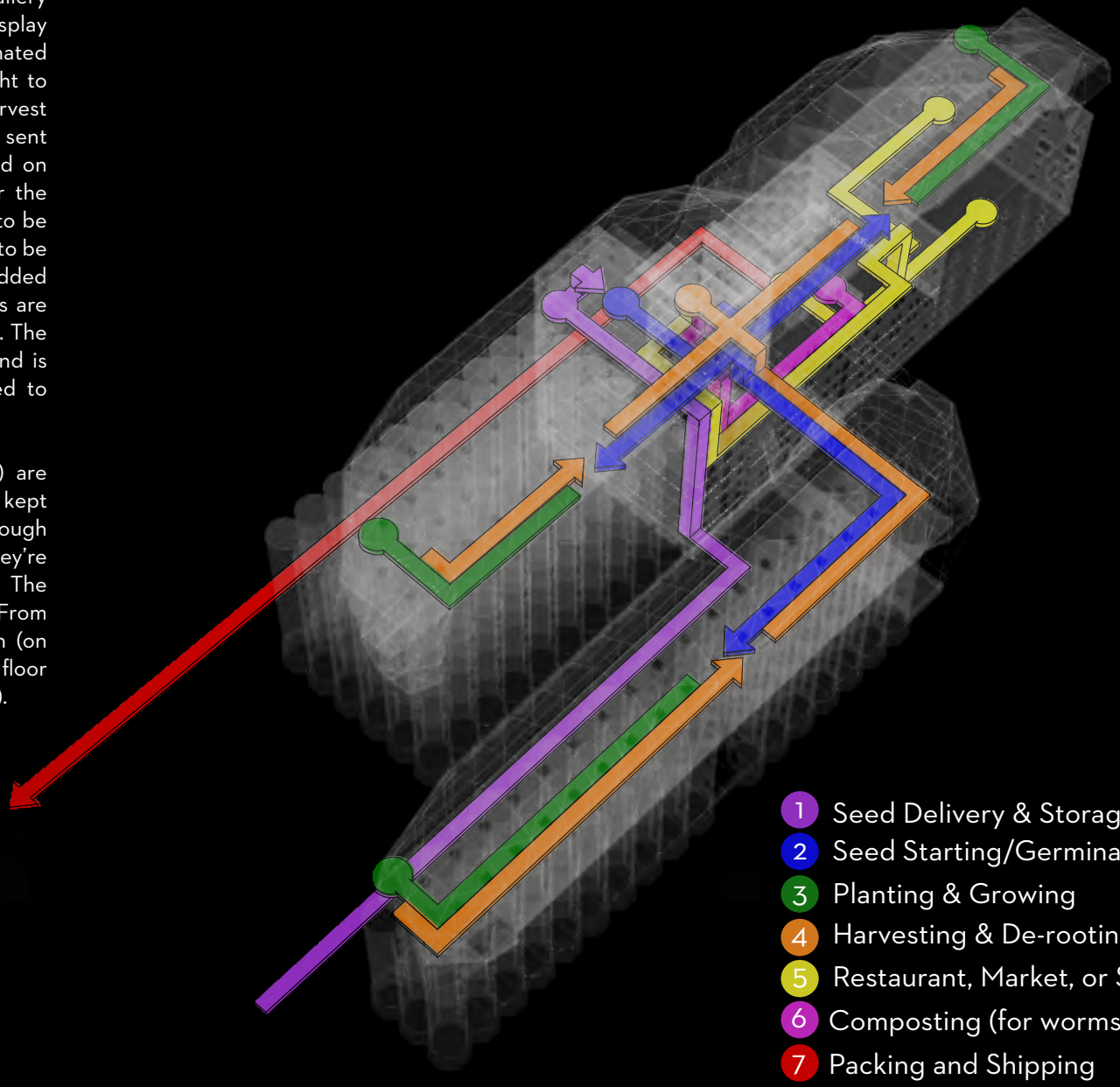
Arranging a system that can both isolate and include the fish within the whole system, creates resilience. If something catastrophic were to occur in a tank, such as disease, it could be quickly isolated before spreading. Also, separation is necessary to control fish populations, since in aquaculture males and females are generally kept separate



FOOD PRODUCTION PROCESS *(fig. 48)*

The flow of food through the system starts with a seed delivery up to floor 8, Here, in the seed storage/gallery people can view different heirloom seeds on display before they're brought up to floor 9 to be germinated (usually 1 week). Once germinated, they're brought to the grow beds until they're mature enough to harvest (approximately 2-3 months). Once mature, they're sent to the harvesting platform before being derooted on floor 6. The vegetables are then taken to either the restaurant to be served on floor 4, to the market to be sold on floor 1, or to the shipping and packing area to be delivered elsewhere. As for the roots, they are added to the compost bins where worms and soldier flys are raised, to feed the fish and fertilize the plant beds. The finished compost is used to make compost tea and is brought back into the landscape, where it's used to bioremediate the soil.

The fish (Tilapia, Yellow Perch, and Barramundi) are raised within the silo tanks. Fish fry are initially kept in separated tanks until they are mature enough to swim with the larger fish. Once mature, they're caught with a net from the walkways above. The catch is then taken to floor 5 to be processed. From there the fish meat is either sent to the kitchen (on floor 4), is froze and packed for delivery (on floor 1), or is sent to the market to be sold (on floor 1).



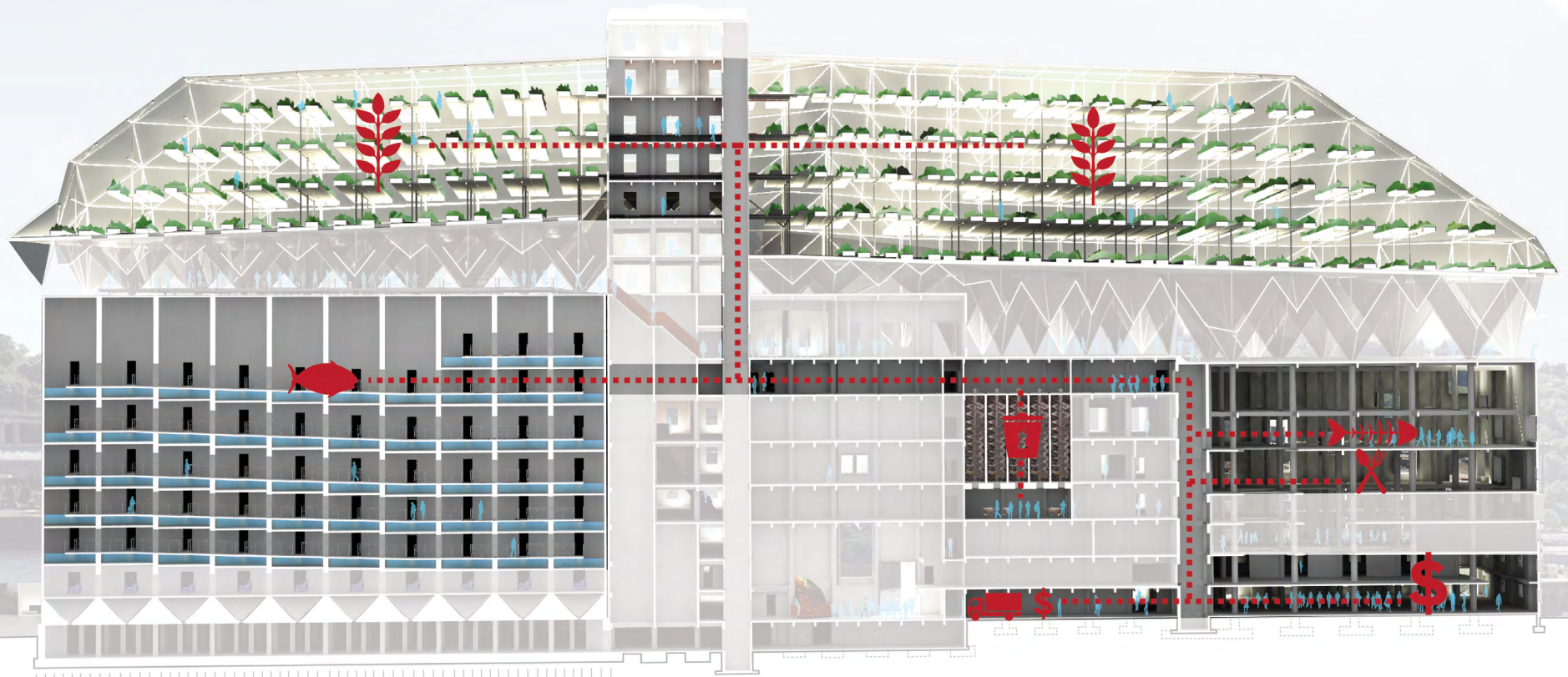
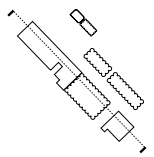


Figure 49: Longitudinal section perspective showing the flow of vegetables and fish through the system. (looking southwest)



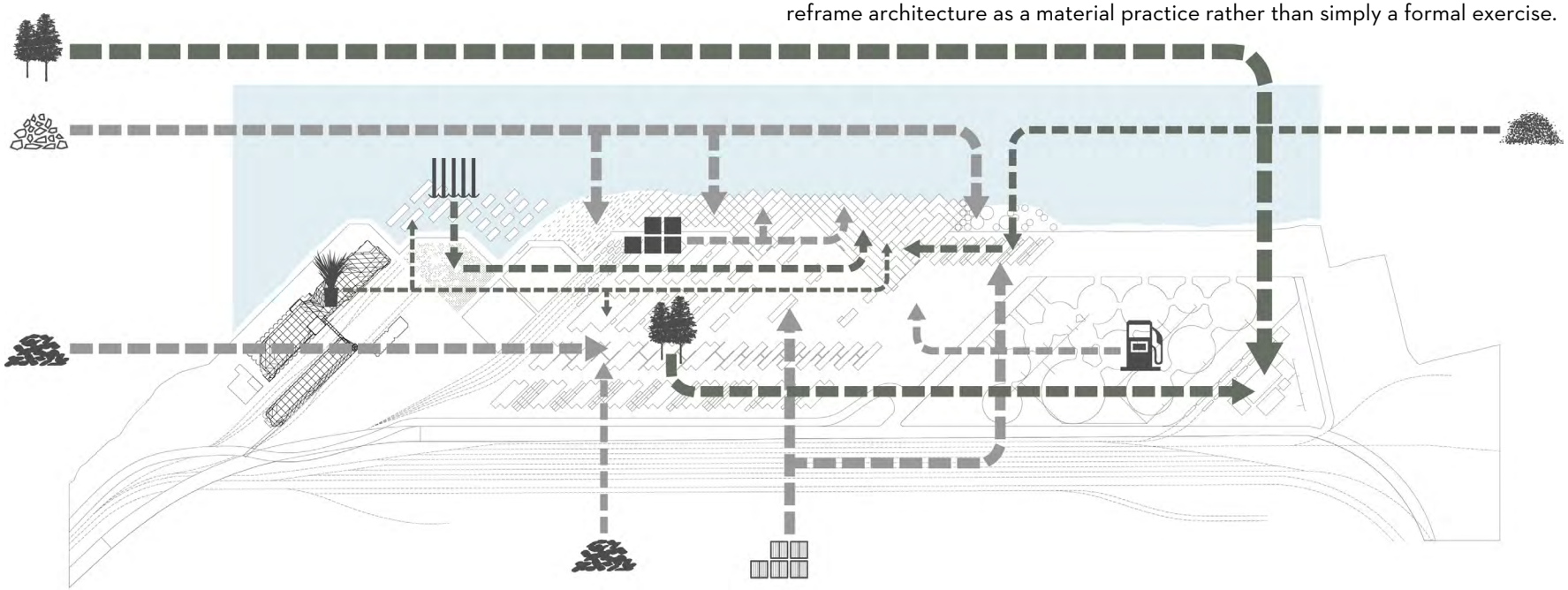
SITE MATERIAL FLOWS *(fig. 50)*

The interconnection between the building and its surrounding post-industrial landscape is an important component of this design proposal. The flow of materials and energy, while more closed in an aquaponic system, is still dependant upon inputs (fish feed, light, etc.) and a place to send outputs (compost, excess food, etc.). I have collaborated with Taj Hansen, a Master of Landscape Architecture thesis student at the University of Washington, to find the material flow overlaps between our two projects in order to strengthen the tactics used in each.

His project proposes creating a landscape of experimentation that would use successive planting species to bioremediate the capped, contaminated, and abandoned Lockheed Martin site just north of my site, while also creating a shoreline enhancement strategy to aid fish migration *(fig. 51)* along the western edge of Harbor Island. As well, the BP tank farm holding the northern end of his site will be converted into a biofuel refinery *(fig. 54)* capable of converting woody debri into usable energy.

My project would provide his with plant starts and compost, while his project would bioremediate the surrounding soil and pull the creosote logs, from the dilapidated dock, on shore in order to inoculate them with mushrooms capable of breaking down the harmful toxins *(fig. 52)*.

Combining our planning efforts early in the design process, has benefited both projects in very symbiotic ways. Together, they become greater than the sum of their parts and reframe architecture as a material practice rather than simply a formal exercise.



Biotic Material Flows

Industrial Material Flows

Local and regional waste biomass and phytoremediation transferred to biofuel refinery for processing

Phytoremediation and shoreline plant starts supplied by aquaponics facility

Ethanol fuel produced from biomass processing and supplied on-site at existing fueling station

Locally sourced ecology blocks used for construction of habitat shelf system

Locally sourced shipping containers used for modular shelters and planter boxes

Creosote pilings mycoremediated then used as large woody debris in habitat shelf system

East Waterway sediment phytoremediated and then supplied to habitat shelf system

Local and regional industrial waste materials stockpiled at material yard for public use

Waste concrete from viaduct removal and building demolition used for construction of gabion reef structures and habitat islands

Figure 52: Mycoremediation "forest"

Figure 51: Shoreline shelf system

Figure 53: Phytoremediation plots

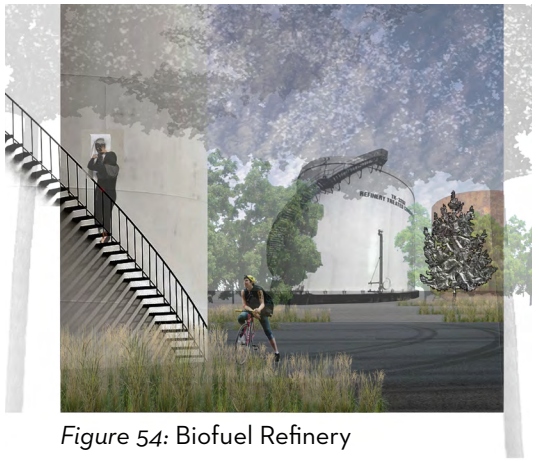


Figure 54: Biofuel Refinery

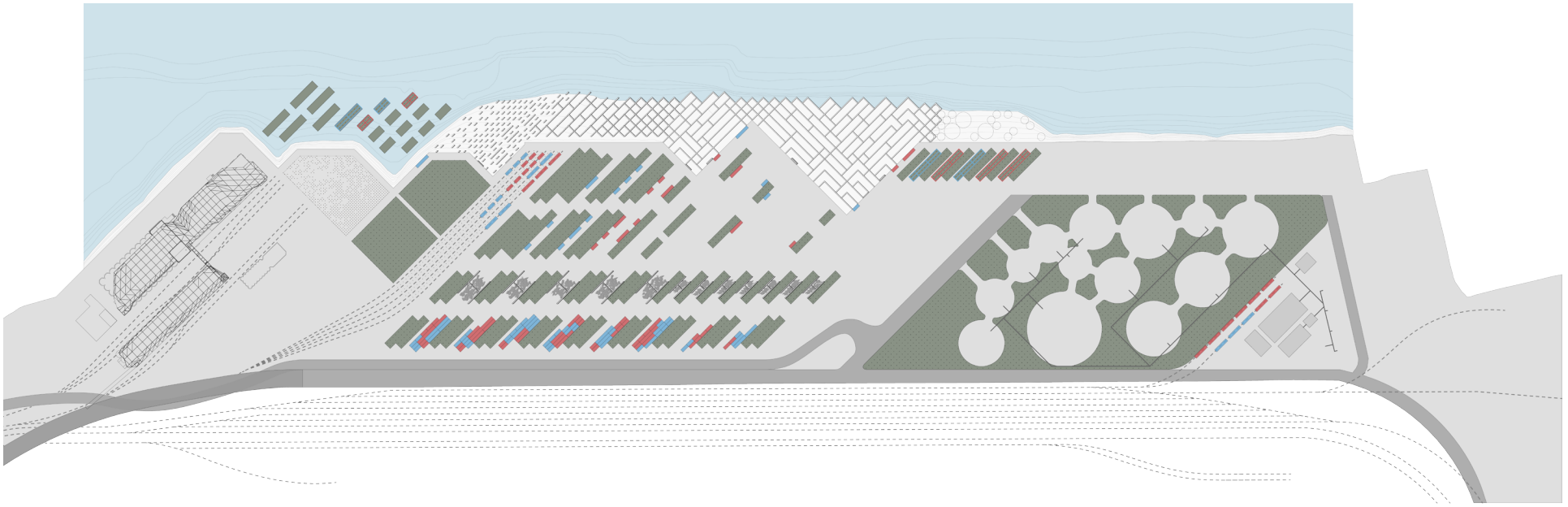


Figure 55: Site Plan

6.2 // Designing the Experience

PRIVATE AND SEMI-PRIVATE CIRCULATION

Informing the public about this new production process involves making new circulation schemes through the existing structure thereby physically, but not visually, separating public, semi-public, and, private circulation.

The existing circulation is used for private and semi-private program- the head house stairs are used by faculty workers and members of the farming co-op as private circulation, while the existing mill and warehouse stairs *(fig. 56)* are used primarily by visiting students and faculty.

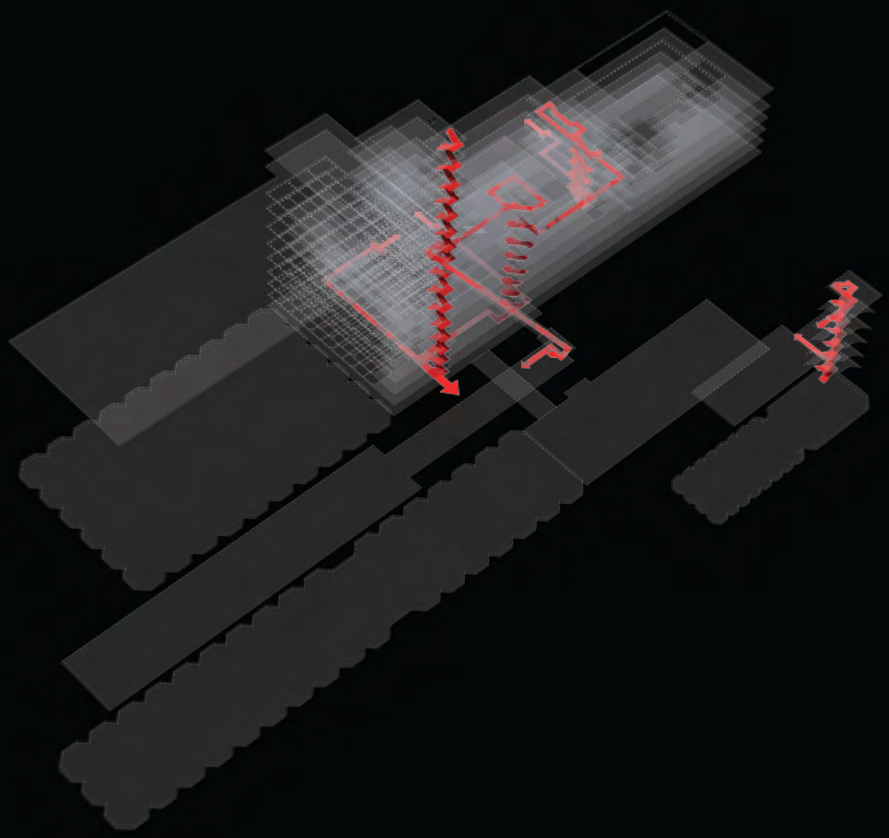


Figure 56: Existing circulation diagram

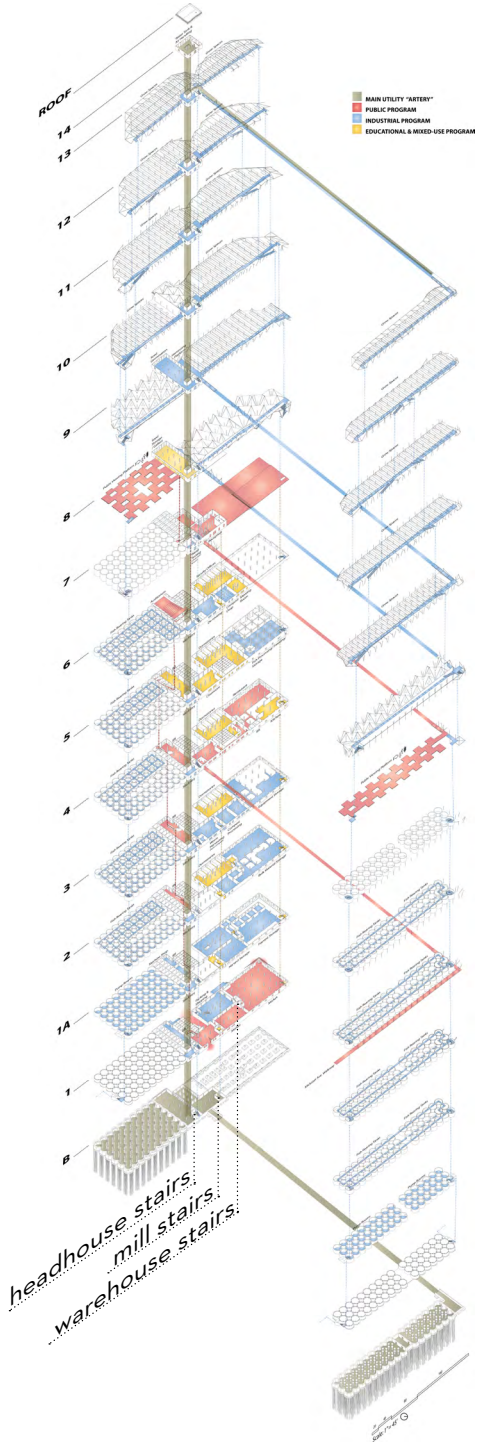


Figure 57: Exploded axonometric, showing vertical circulation

NEW PUBLIC CIRCULATION

Since, understanding the inner workings of this building (past and present) at a glance is extremely difficult, the new public circulation proposes cutting *(fig. 58)* through the existing vertical bins *(fig. 59)* (due south) to educate experientially as people move through the existing spaces to see how they have been repurposed.

Figure 58: Building cut by Gordon Matta Clark

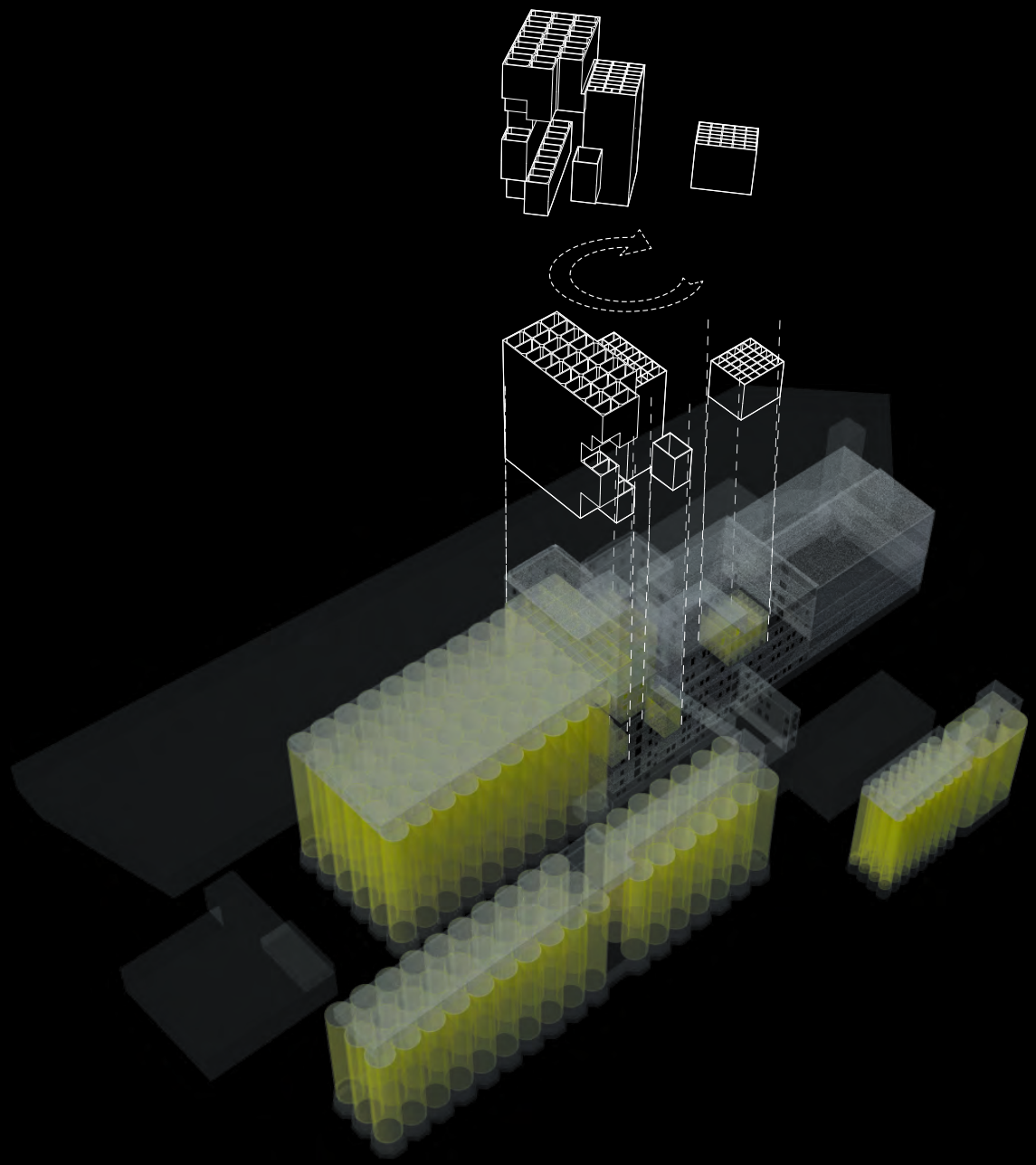


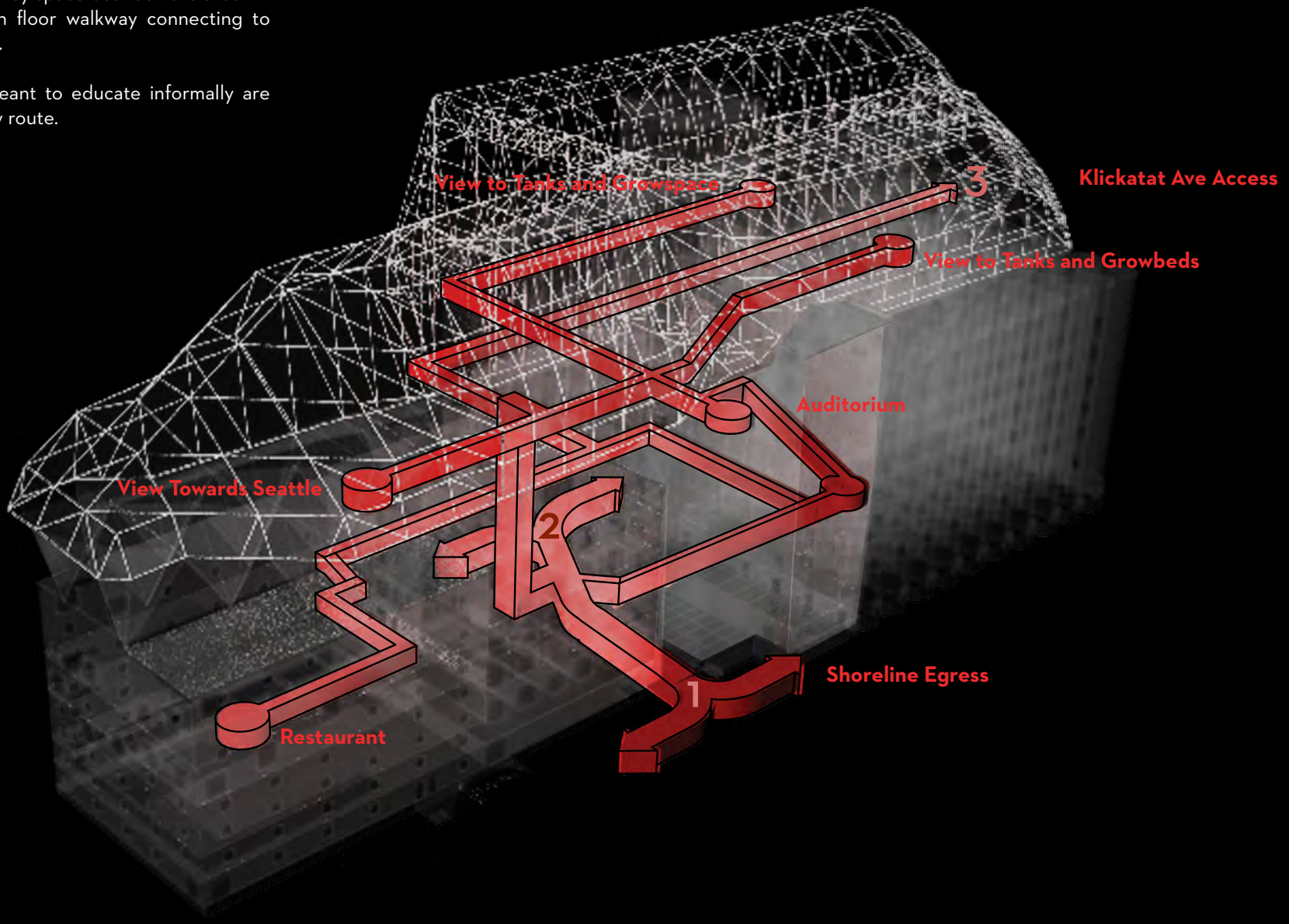
Figure 59: Existing Verical Spaces

NEW PUBLIC CIRCULATION *(fig. 60)*

The entry and exit points for the public circulation scheme occur in three places:

1 Along the waterfront.
2 Through the alley space between the silos.
3 On the fourth floor walkway connecting to Klickitat Avenue.

Experiential nodes meant to educate informally are located along this new route.



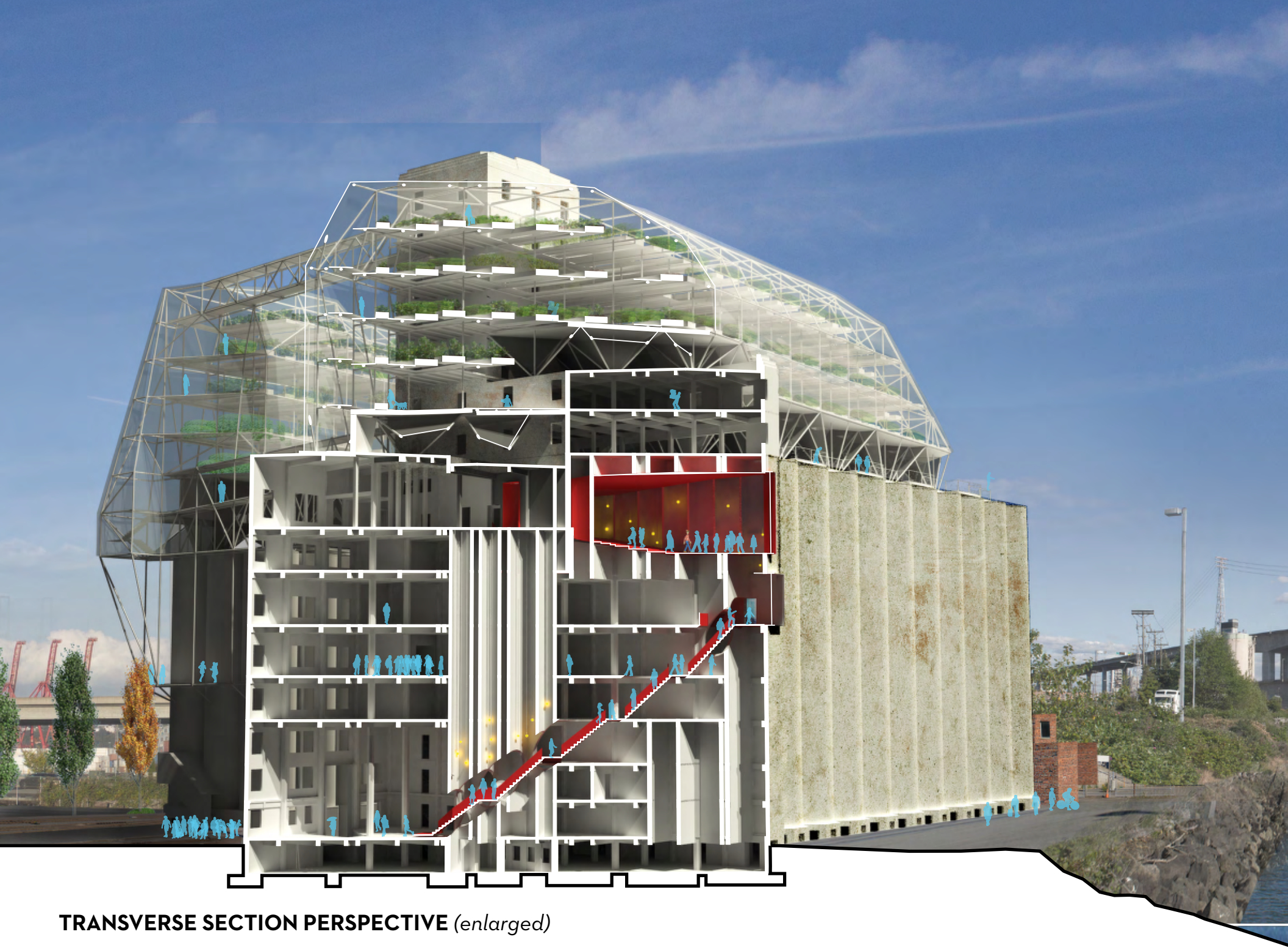
MAIN ENTRY LOBBY *(fig. 61)*

As you enter into the main triple-height lobby space on the ground level, you see the new stair cutting obliquely through the old temper bins.

TRANSVERSE SECTION PERSPECTIVE *(looking East)* *(fig. 62)*

The public circulation route begins at the entry lobby, and cuts up through the temper bins. This new route is also accessible from the 4th floor Klickitat Avenue entry.

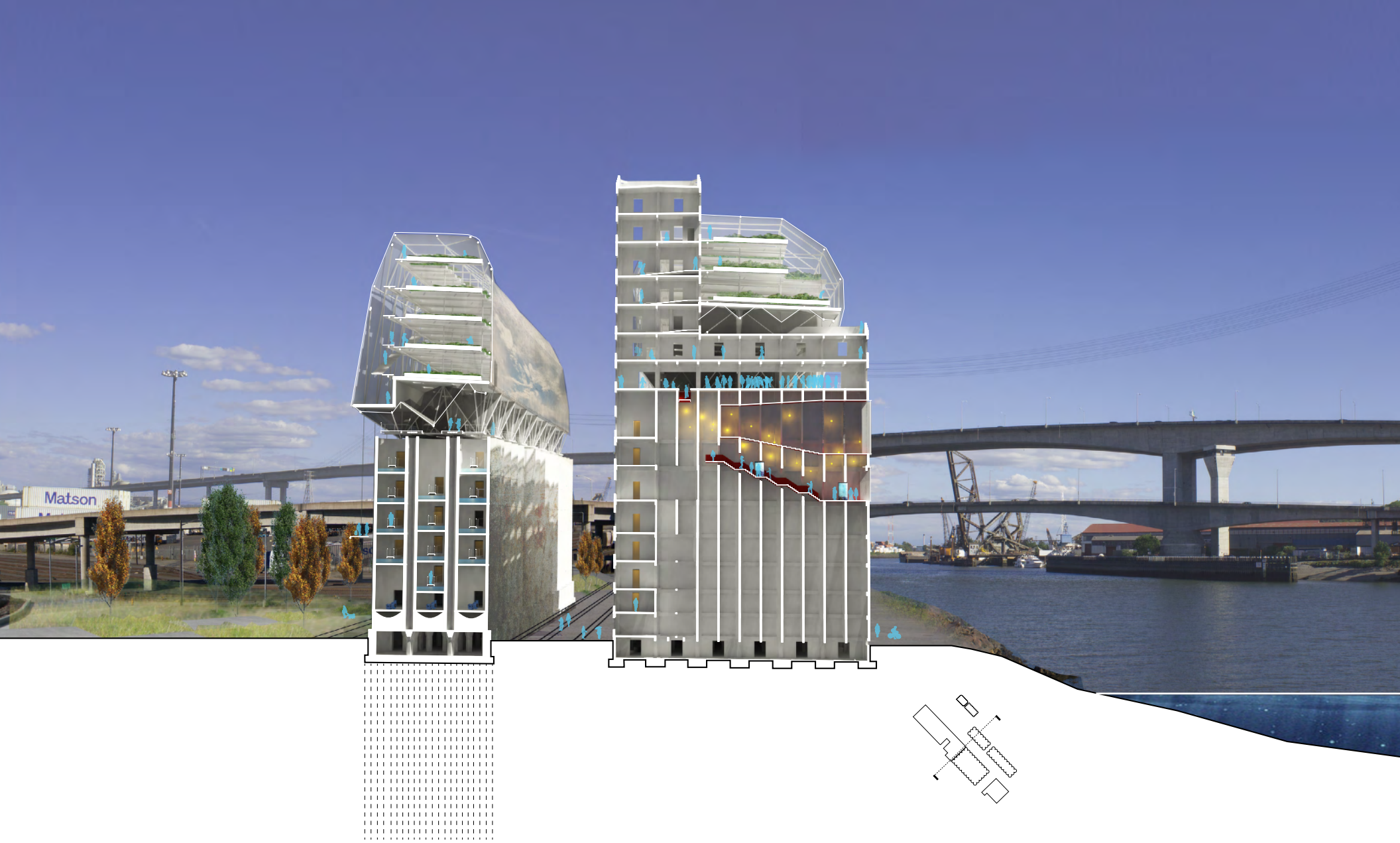
In the landscape the mycoremediation “forest” and Poplar trees begin to bioaccumulate the soil contaminants.



TRANSVERSE SECTION PERSPECTIVE *(enlarged)*

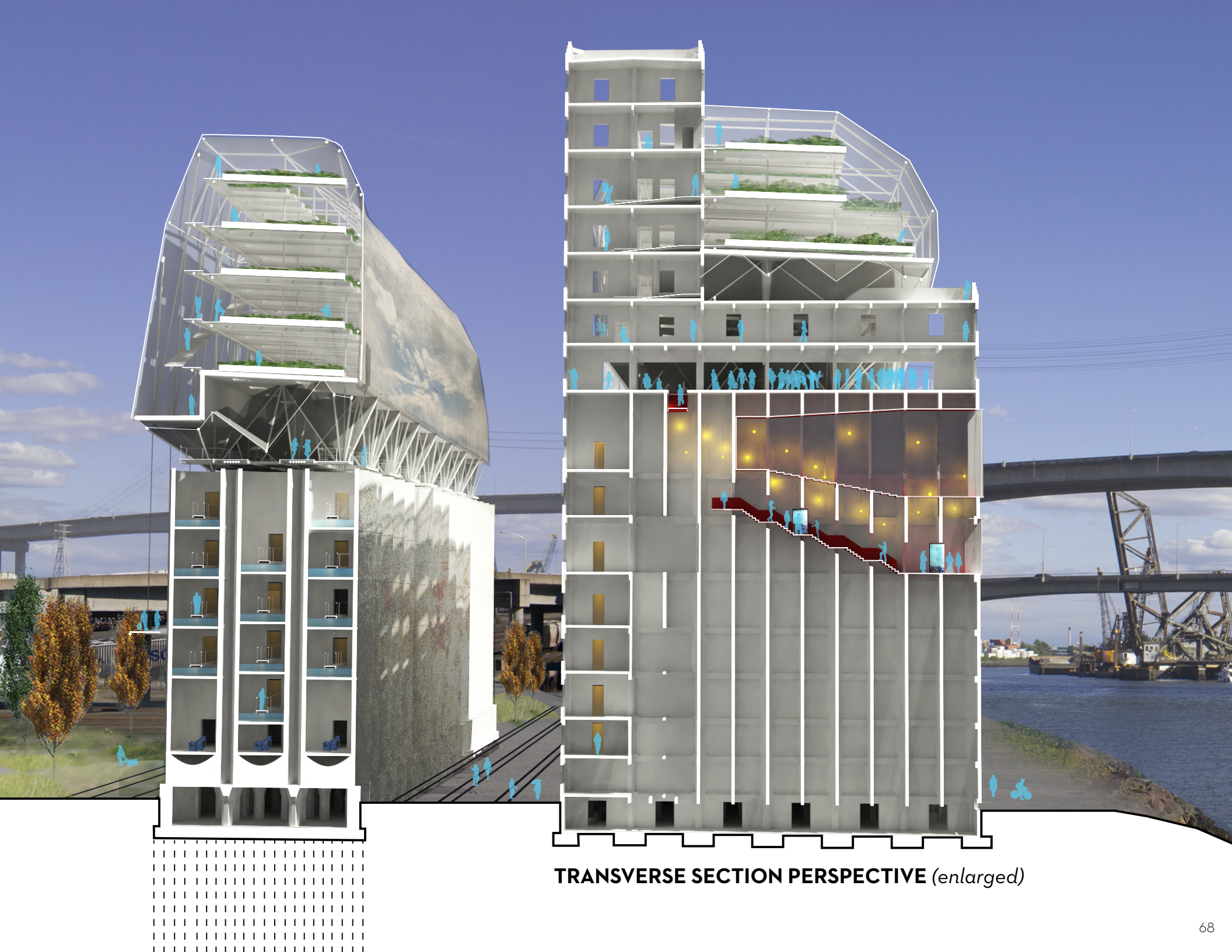
VIEW UP THROUGH THE TEMPER BINS *(fig. 63)*

Walking up the new stairs directly south, hanging lights illuminate the grand height of the temper bins, adding dynamic quality to a space once packed with saturated wheat.



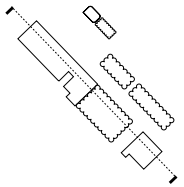
TRANSVERSE SECTION PERSPECTIVE *(looking southeast)* *(fig. 64)*

As you reach the bend at the top of the stair, and turn back into the building you discover the first viewing platform into the fish-rearing silo.



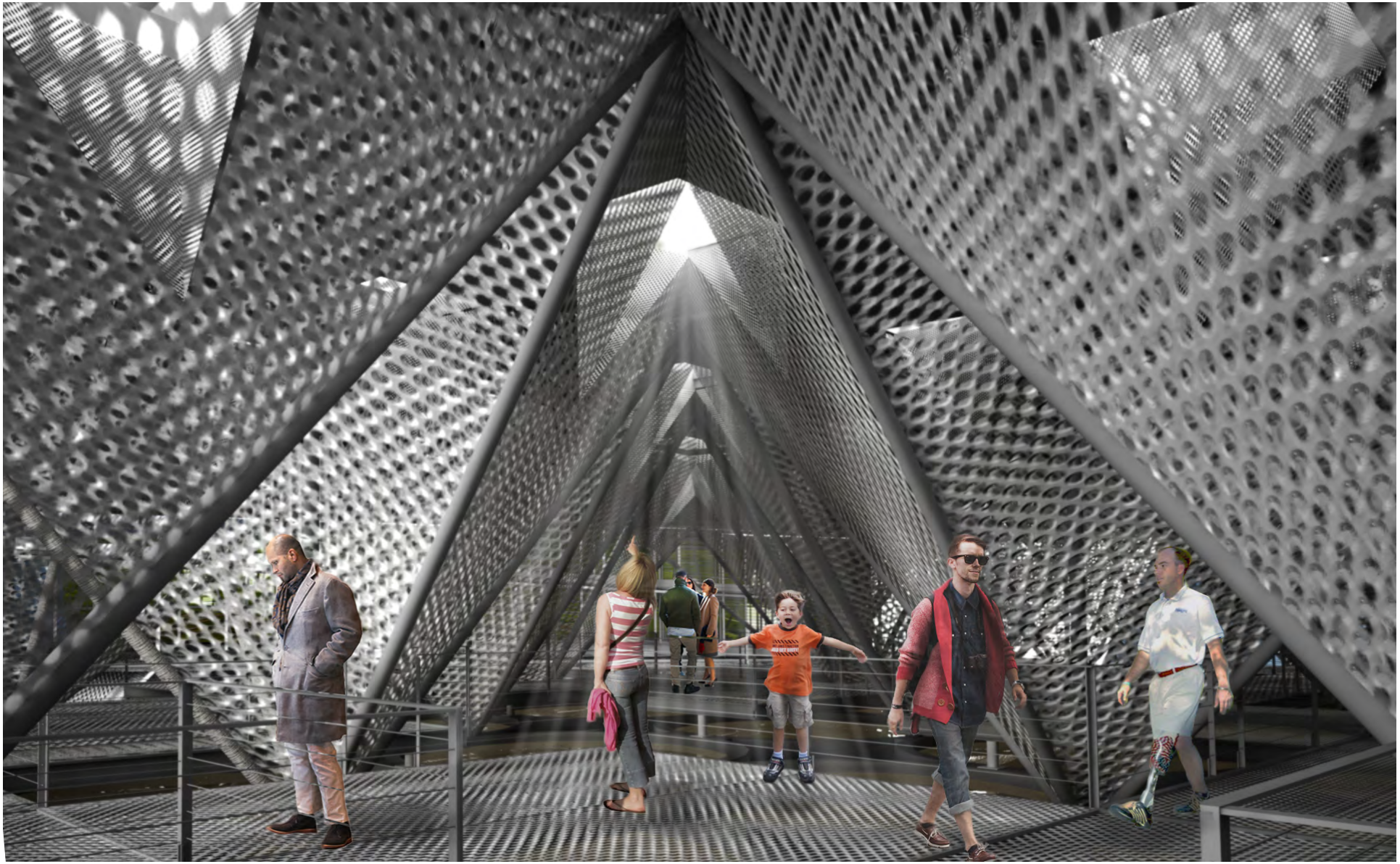
TRANSVERSE SECTION PERSPECTIVE *(enlarged)*

VIEW INTO THE FISH REARING SILOS *(fig. 65)*



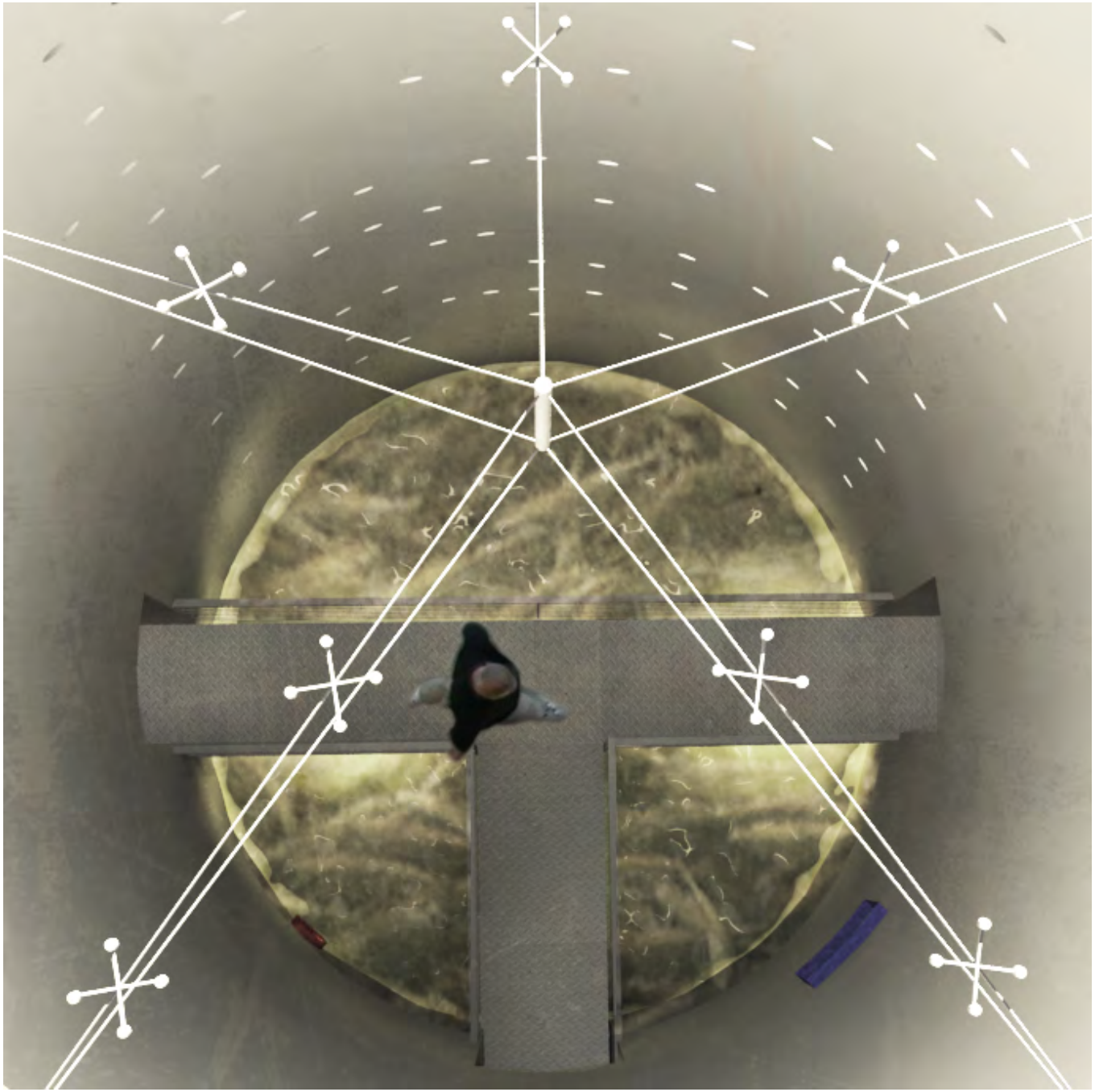
LONGITUDINAL SECTION PERSPECTIVE *(looking southwest)* *(fig. 66)*

As you reach the top of the stairs on level 7 you can enter the auditorium from the reception area (shown in the previous two transverse sections) or move up the last flight of stairs towards the viewing platform (located in the "triangulated" space above the silo-fish-tanks and below the greenhouses).



VIEWING PLATFORM *(fig. 67)*

From the viewing platforms, located above each of the silo tanks, visitors can observe the fish swimming below and the plants growing above (through openings in the greenhouse floor).



VIEW DOWN INTO A SILO FISH TANK *(fig. 68)*

VIEW ALONG THE GREENHOUSES CIRCULATION SPINE *(fig. 69)*

VIEW FROM THE NORTHEASTERN VIEWING PLATFORM *(fig. 70)*

VIEW FROM THE SW SPOKANE STREET BRIDGE *(showing the mouth of the Duwamish River)* *(fig. 71)*

NIGHTTIME PERSPECTIVE FROM WEST SEATTLE *(fig. 72)*

7 // Concluding Remarks

ON THE DESIGN

In the words of Kevin Lippert,

> "The grain elevator is neither form, nor function, nor symbol. It is all three..."

Similarly, The Fisher Flourmill's conversion into an aquaponic food production and education facility is, at once, functional and symbolic. But, at all scales it is reconnective, seeking to remove barriers. Its function, locally, is to reduce the disconnection between food producers and consumers by incorporating agriculture back into the city-scape, as well as public consciousness back into the food-production process. Its function, globally, is to communicate the efficiency and quality of aquaponic-food-production, while also showing that these highly specialized and abandoned factories, common in post-industrial cities, can be cleverly repurposed rather than demolished. As the early drivers of economic development, they most eloquently tell the story of how a city manifests, and become "unintentional monuments" displaying a city's fossilized value-system to future generations.

Using the "bottom-up" logic of our emerging "Network Society," as understood by Manual Castells, it seems natural to use the pea-patch model as an operational prototype for the aquaponics facility. This way the building functions inclusively rather than exclusively. Focusing primarily on performance requirements and material inputs/outputs, the building's technical requirements instruct its form once the programmatic adjacencies are understood. The resulting design emerges from these constraints, becoming less formal and more instrumental in the process– an approach coincident with industrial architecture's valuation of usefulness over aesthetics (a more subjective measure). But, that's not to say the aesthetic experience is unimportant. Rather, the experience of moving through the spaces, old and new, make the, otherwise abstract, processes, of building-as-flourmill and building-as-aquaponics-facility, tangible. Light becomes the evocator, illuminating these obscure internal spaces along with their aged surfaces. As well, it communicates the building's food-growing capabilities at night, redefining the industiral skyline in the process. In short, this proposal reimagines an ecology served by infrastructure rather than one subserviant to it, thereby reconstituting humanity's role as planetary steward.

ON THE FINAL REVIEW

The discussion during the final review was engaging. Several questions were brought up relating to the financial viability and productivity of an aquaponics facility of this scale. The research I found relating to aquaponic food production, while new and emerging, showed astonishing results regarding its productivity and food quality. It would be wise to wait and see how many more farmers can substantiate these lofty productivity/quality claims before proceeding with a project of this magnitude, but I am convinced that this project would be a smart long-term investment for a city like Seattle. Also, while aquaponic food production can produce a large amount of leafy-vegetables and fish protein, grains and other dietary requirements would need to be provided elsewhere.

With only 9 weeks to design and produce the presentation, I had to narrow the focus of the project to the more technical aspects of the building proper. Of course, this was understood by the reviewers when they questioned how the building might fit into a larger scale urban-food-distribution-network, or possibly a local-tourism-route (by boat). While I had primarily focused on the inner-workings of the existing building, I wasn't able to research and diagram how the building might fit into a new regional-food-network or design the surround site to accommodate water entry. But, fortunately, the delivery infrastructure already exists on-site from the buildings days as a flourmill– it's well-connected to rail lines, roads, and water. If I had more time I would have continued to develop the more schematic elements of the program such as the restaurant, marketplace, and student dormitories.

There are a lot of unknowns when working with an existing building, too. The greatest concern is structural– while there weren't any questions regarding the structural integrity of the existing building being able to support the addition, I'm sure it may have cross some peoples minds. While I designed the new structure to follow the load-paths of the existing building, it's questionable whether the foundation below the existing mill and warehouse could support the greenhouse addition on-top. In-depth structural tests would be required in order to calculate how much additional structure the existing building could support. Also, the seismic upgrades and energy efficiency requirement commonly involved in performing a renovation would inevitably change the dimension and composition of the existing interior walls.

Appendix A // Additional Site Photos

Figure 73: The In-between Spaces. A: space between silos, B: northern side of silos, C: silo tops, D: parked train, E: north end of silo 1&2 from mill 1&2 roof, F: headhouse from mill 1&2 roof, G: conveyer from silos 4 to mill.

Figure 74: Interior Spaces. A: vertical plenum between silos, B: mill 1&2 roof collapse, C: hallway from mill 1&2 to new mill, D&E: warehouse h with metal silos removed.

Figure 75: Pipes connect spaces. A: pipes into silos 1&2, B: floor 5 of mill area, C: headhouse grain conveyer ducts ("main vertical artery"), D: water tanks above tempering bins, E: water tanks.

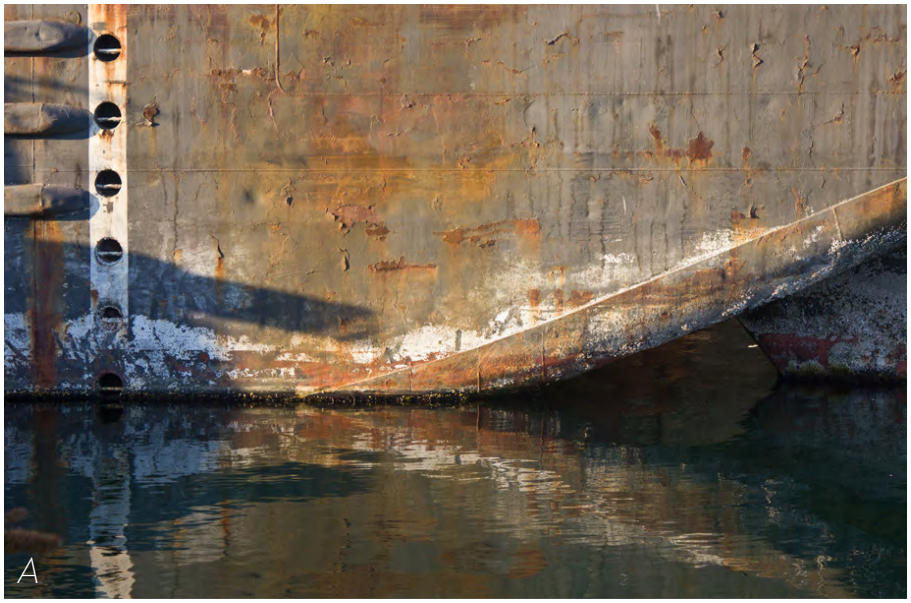


Figure 76: Materiality. A: Boat parked adjacent to the mill, B: Mill 1&2 basement, C: Mill 1&2 basement collapse, D: Mushroom growing on creosote soaked railroad tie.

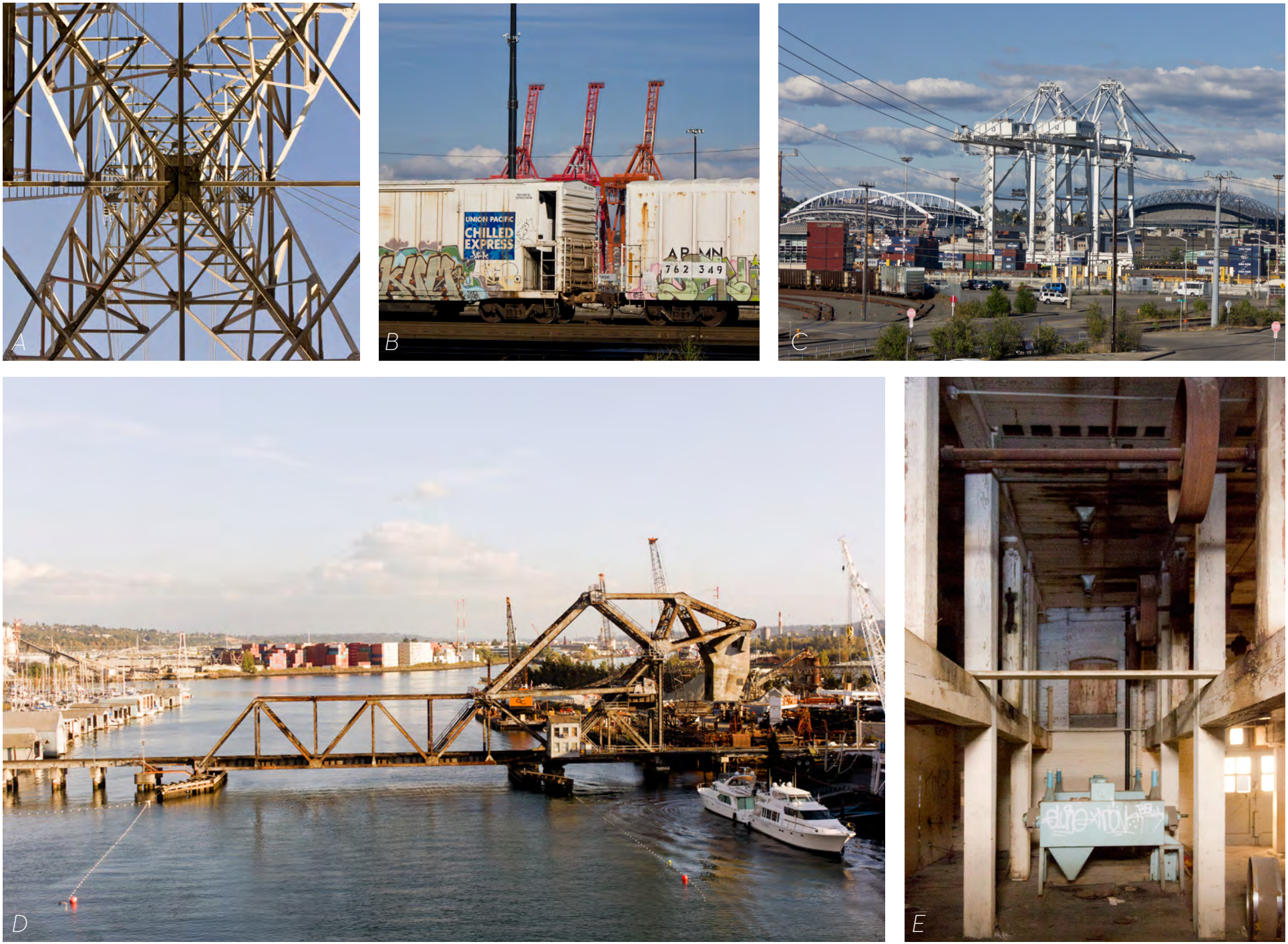


Figure 77: Tectonic Context. A: Electrical tower B: Trains and cranes, C: Crains and stadiums, D: Railroad bridge E: Wood beams inside Mills 1&2

Appendix B // Productivity Calculations

Fisher Flour Mill Milling Capacity (at it's height)

9

Land required to feed all of Seattle's Population (Using Traditional Agriculture)

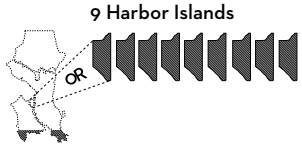
6.8

Land required to feed all of Seattle's Population (IF Global Averages Are Used, Traditional Agriculture)

3.4

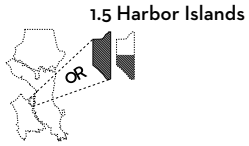
Land required to feed all of Seattle's Population (using Growing Power's Methodology)

4%



Land required to feed all of Seattle's Population (using Portable Farms Aquaponic Estimates... not including root vegetables or livestock)

.7%



Fisher Flour Mills Annual Wheat Milling
9 Seattles = 1,277.5 sq. miles of wheat
15,000 barrels of flour per day
2,9400,00 lbs of flour per day

Annual Flour production
3.5 square miles of wheat milled into flour per day
=15,000 barrels of flour milled per day

Seattle is 142.5 square miles or 91,200 Acres
Seattle's population (inner-city) = 620,778 ppl
6.81 Seattle's to feed the population
3.5 sq miles of wheat x 365 days annually = 1277.5 sq. miles annually
So the FFM mills 8.96 Seattles worth of wheat into flour.
Aprox. 1,241,556,000 lbs of food consumed by all of Seattle's people Annually (assuming apporx. 2,000 lbs/person/year according to http://www.inspirationgreen.com/index.php?q=food-consumption-in-america.html)

Annual Aquaponics production

Portable Farms
A 90 foot by 120 foot unit=
60,000 vegetables per year
23,000 lbs of fish per year
Claims 10,000sf warehouse can feed 240 people= that's 42 sf for one person per year! (source: www.portablefarms.com)
They even claim that 25 sf of growspace can feed a person for an entire year! (source: http://www.youtube.com/watch?v=mCCN4nq7BlQ)
620,778 x 42 = 26,072,676 SF aka 599 Acres to feed all of Seattle... which is about .7% of Seattle's Total Land Area
Since Harbor Island is 407 Acres, it would take 1.47 Harbor Islands to feed all of Seattle Aquaponically.

Growing Power
1,000,000 lbs of produce and 10,000 lbs of fish on 3 acres of land annually
1,010,000 lbs/year / 2000 lbs/person/year = around 500 people fed per year on 3 acres of land? (source: http://www.youtube.com/watch?v=jV9CCxdkOng)
about 3724 Acres to feed all of Seattle using Growing Powers methods... that's only about 4% of Seattle's Total Land Area

Amount of Food Consumed by One Person Annually

Average American consumes 2000 lbs of food per year
1 persons body weight in food per month
2700 calories per day
1 acre per person Annually for a balanced diet (generally accepted estimate for American diet)
But, the World Bank Estimates it takes .5 Acres (.2 Hectares) to feed one person annually

Figure 78: Productivity Calculations

Appendix C // Drawings of Harbor Island and Existing Flourmill

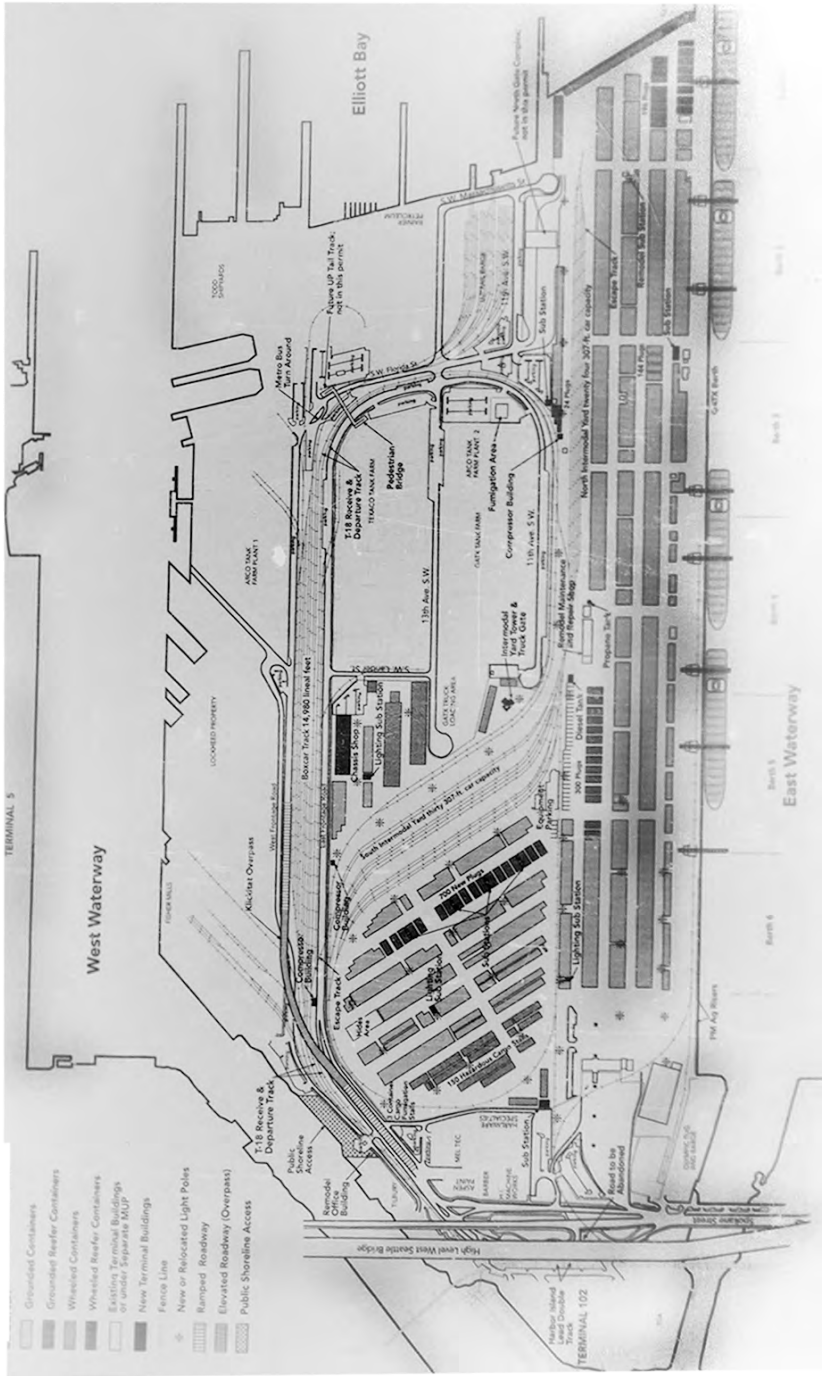


Figure 79: Harbor Island Site Map

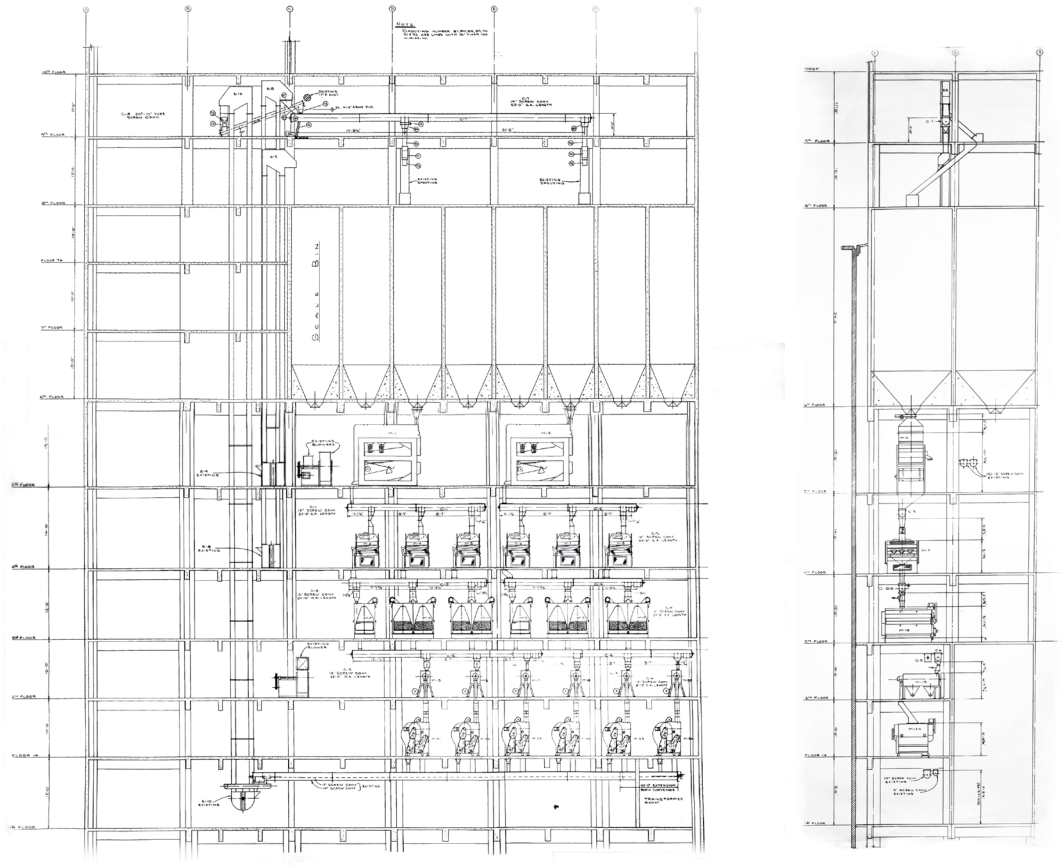
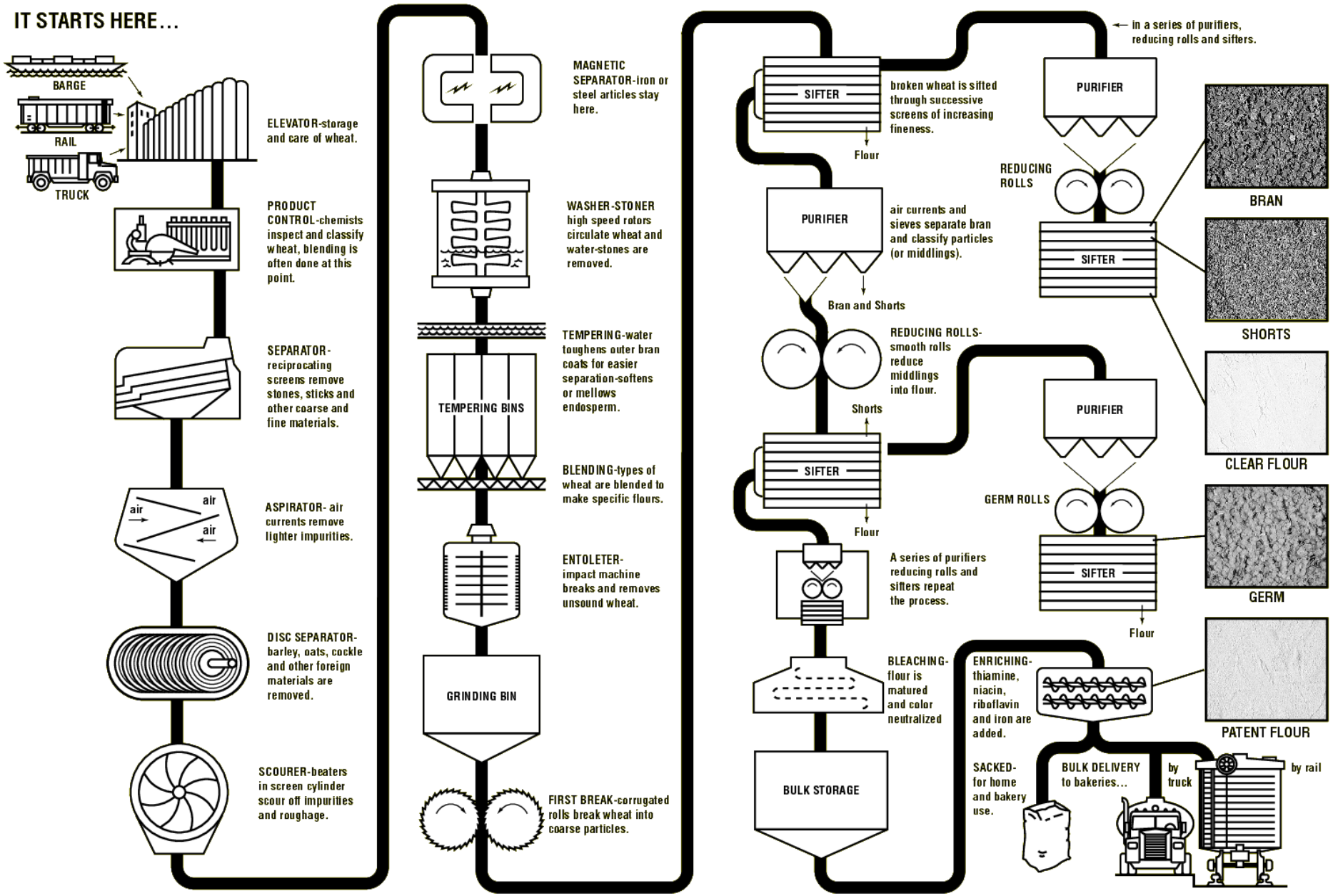


Figure 80: Wheat Cleaning Plant

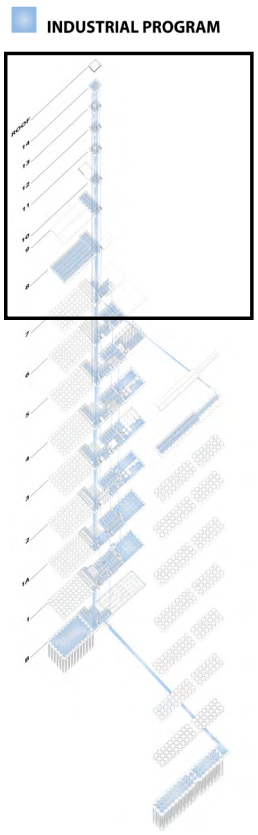
Appendix D // Flourmilling



NOTE: This chart is greatly simplified. The sequence, number and complexity of different operations vary in different mills.

Figure 81 : Diagram of the flourmilling process showing the machines used.

Appendix E // The Existing Building *(from the roof to floor)*



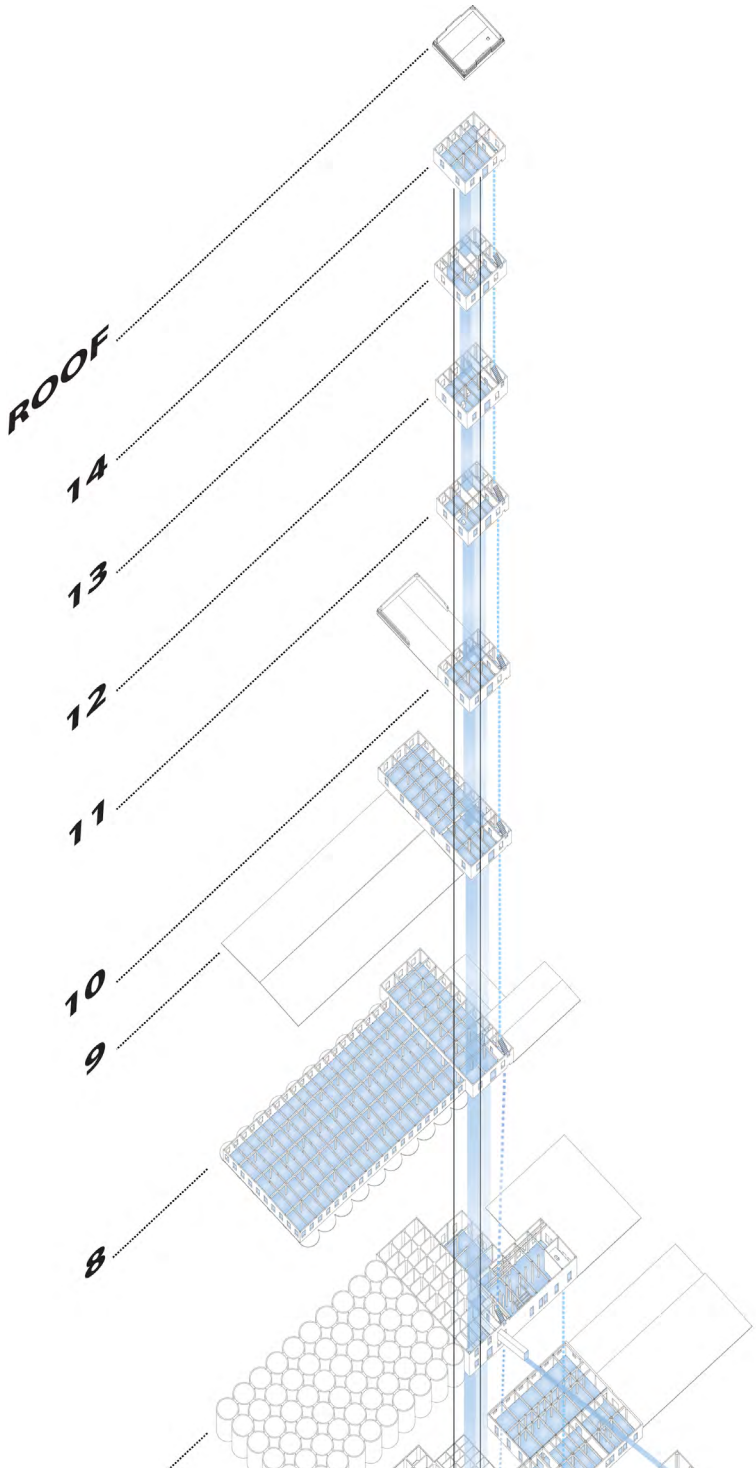


Figure 82: Existing Building

Appendix E // The Existing Building *(from floor 8 to floor 4)*

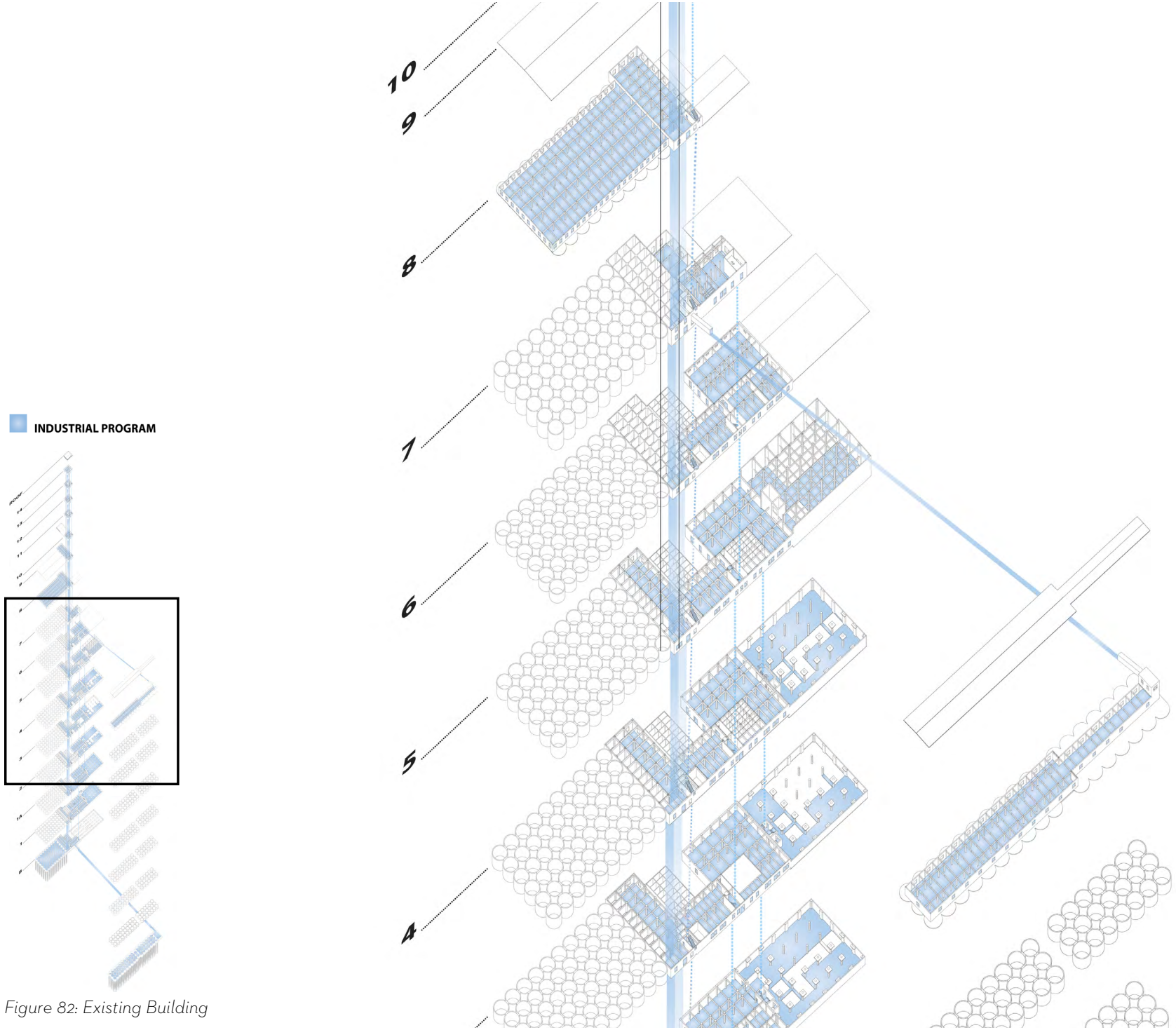


Figure 82: Existing Building

Appendix E // The Existing Building *(from floor 4 to floor 1)*

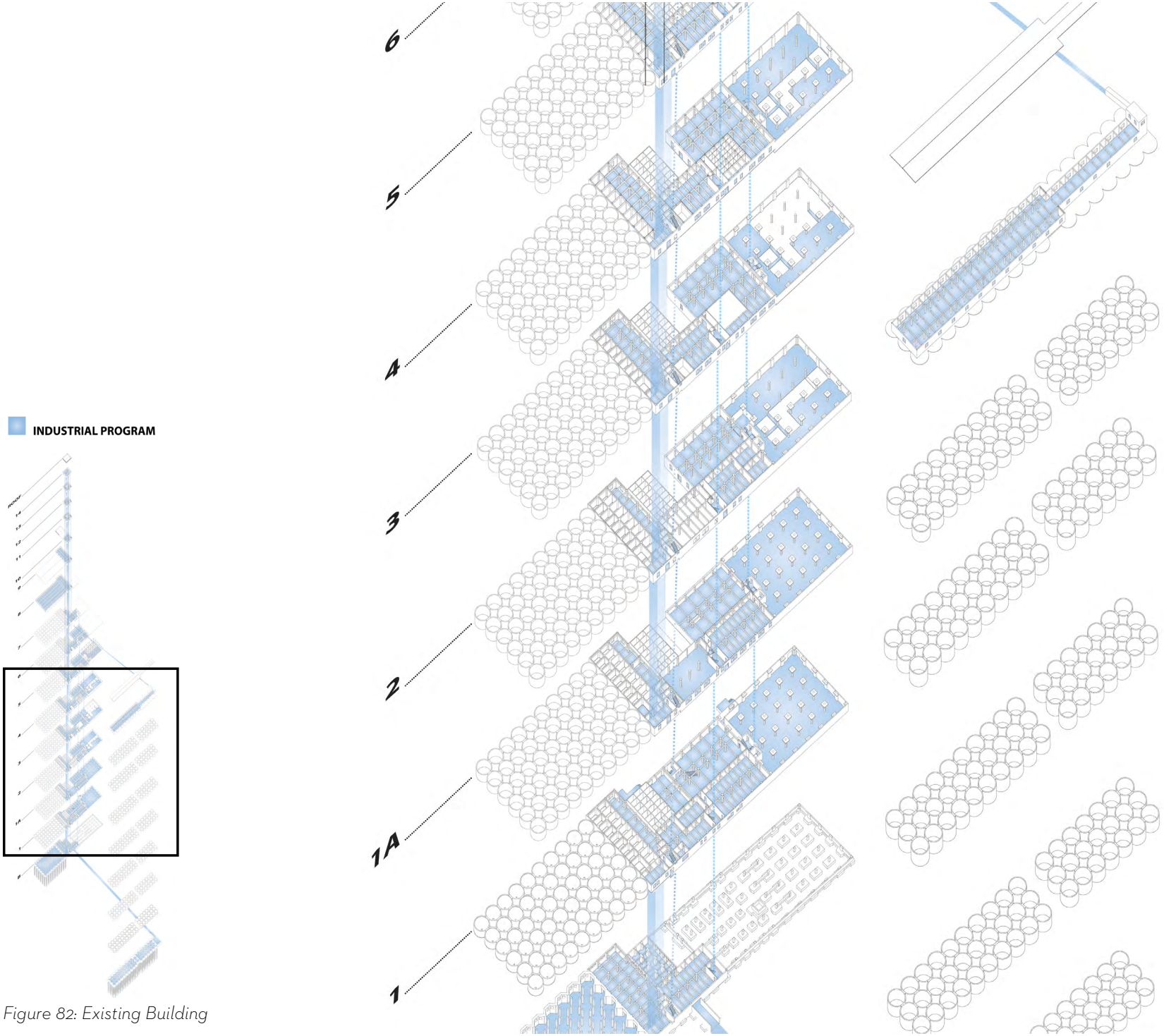


Figure 82: Existing Building

Appendix E // The Existing Building *(from floor 1 to foundation)*

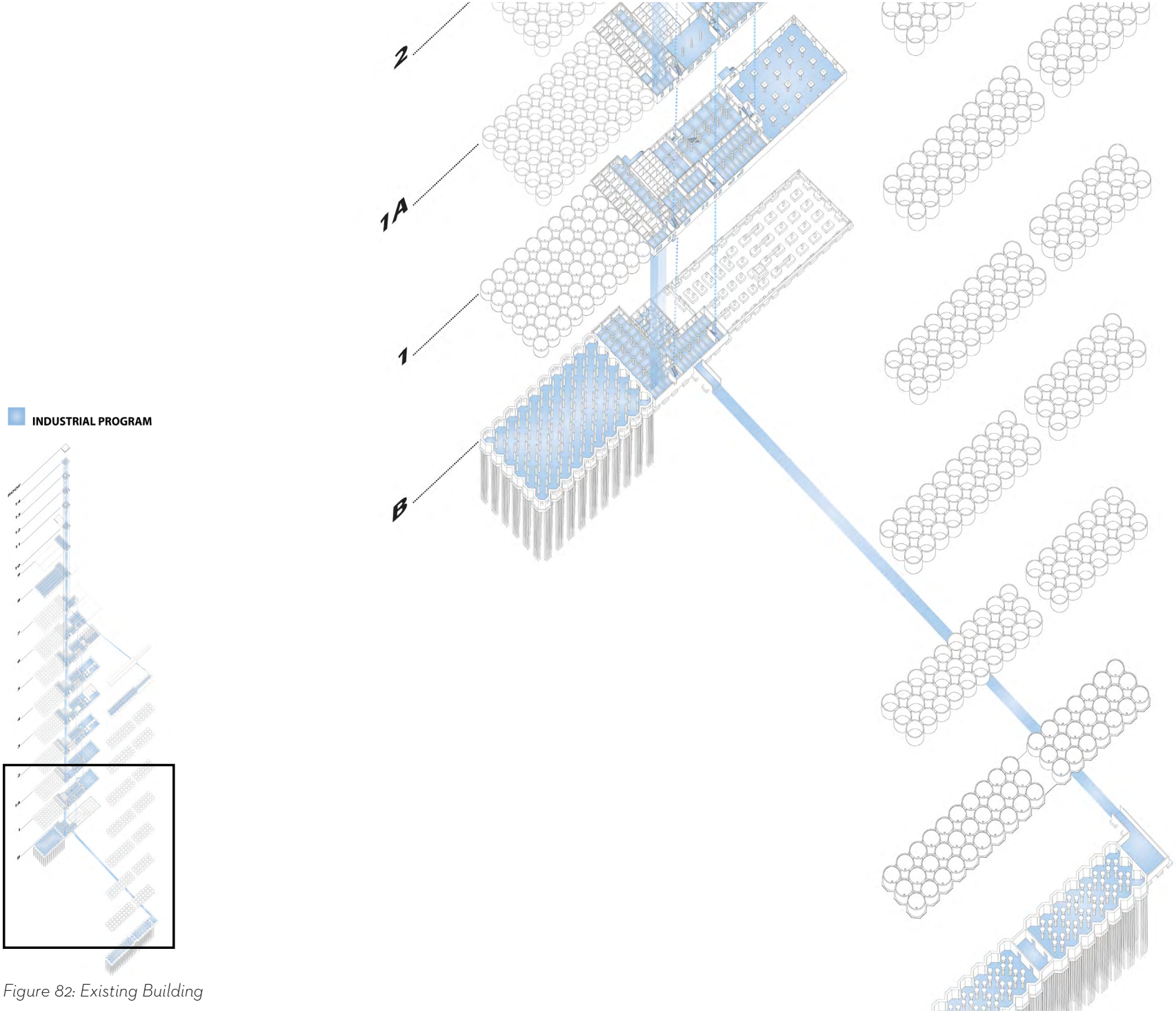


Figure 82: Existing Building

Appendix E // The Existing Building *(from floor B to foundation)*

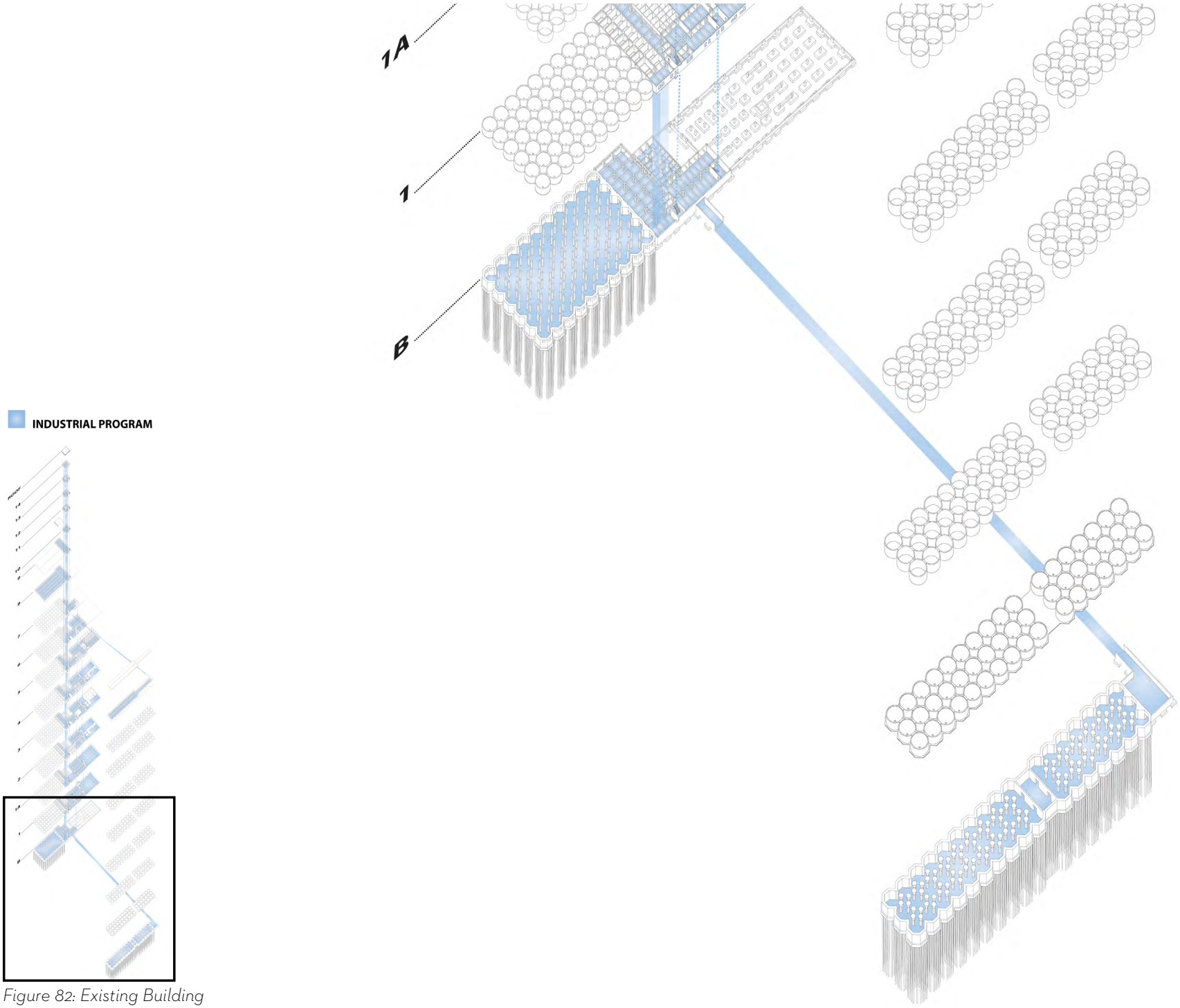


Figure 82: Existing Building

Appendix F // The Repurposed Building *(from the roof to floor 9)*

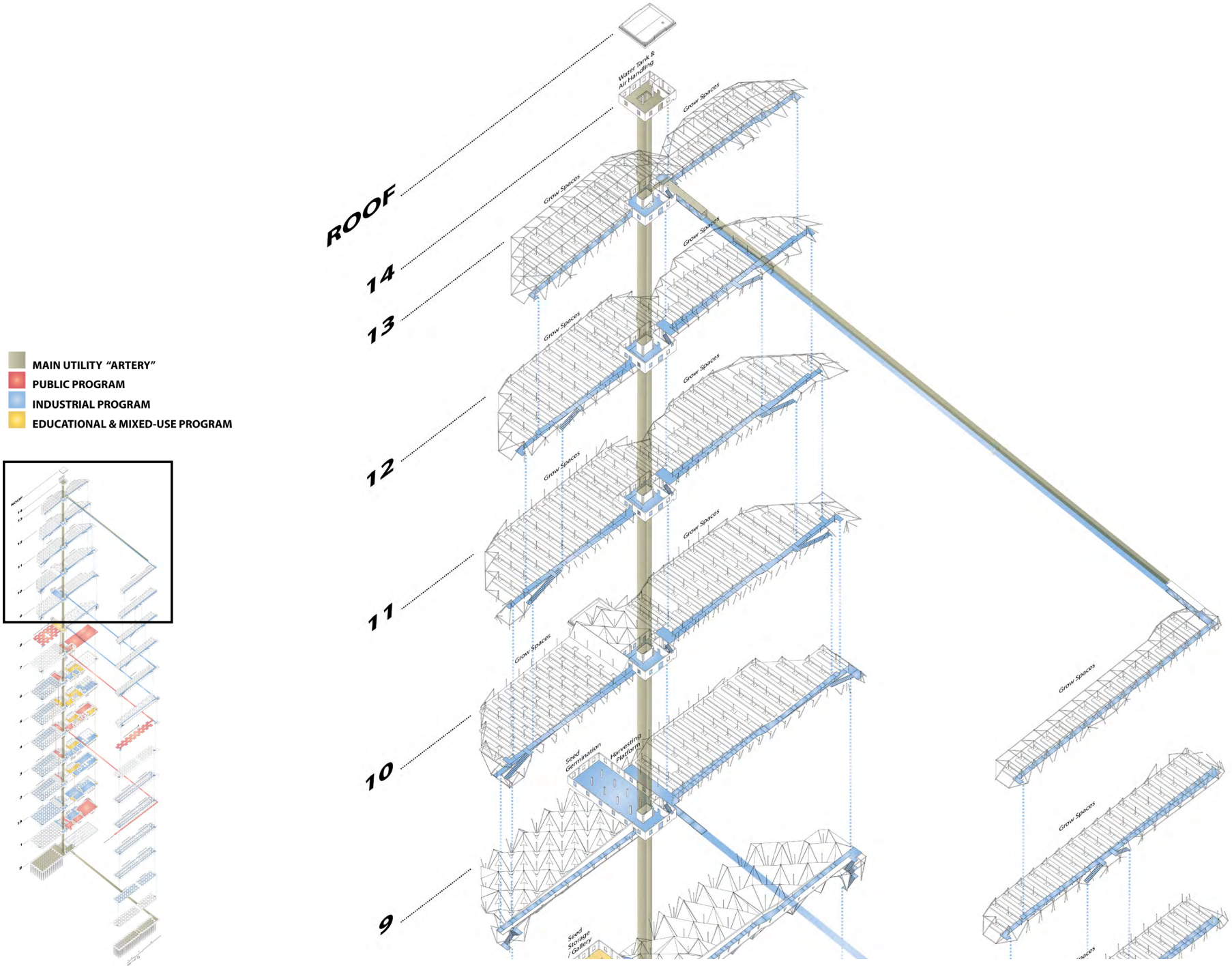


Figure 83: Repurposed Building

Appendix F // The Repurposed Building *(from floor 9 to floor 5)*

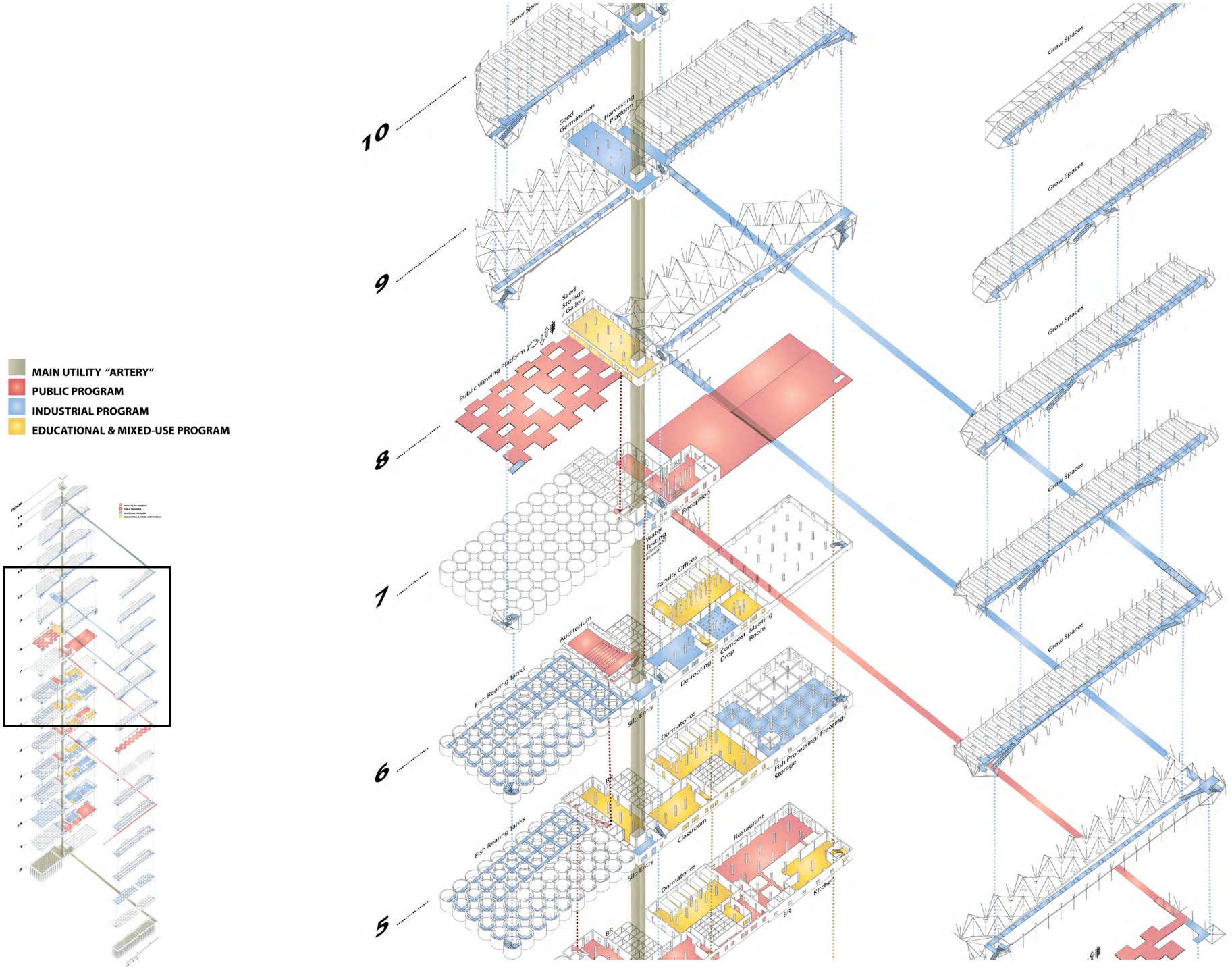


Figure 83: Repurposed Building

Appendix F // The Repurposed Building *(from floor 5 to floor 1A)*

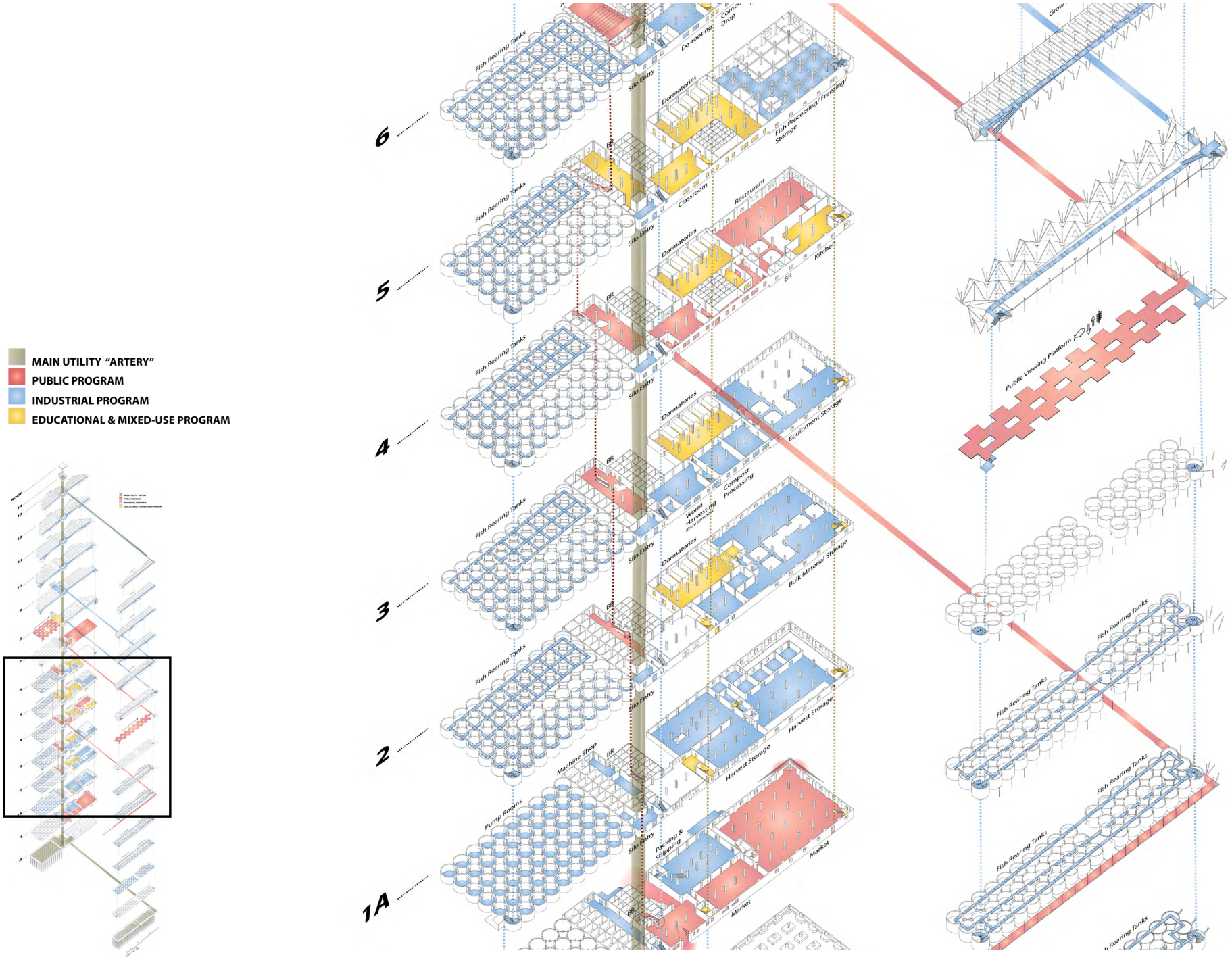


Figure 83: Repurposed Building

Appendix F // The Repurposed Building *(from floor 1A to foundation)*

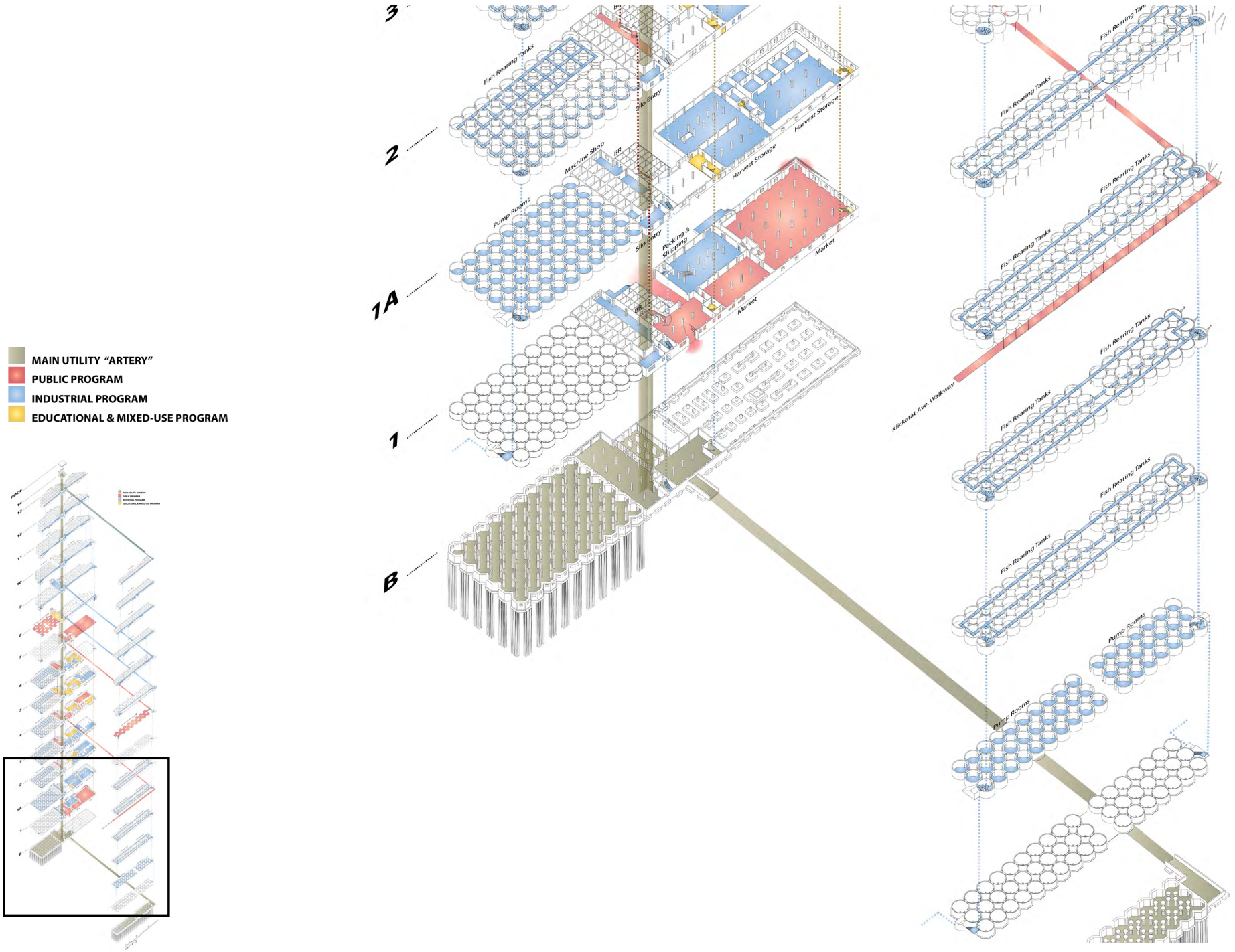


Figure 83: Repurposed Building

Appendix F // The Repurposed Building *(from floor 1A to foundation)*

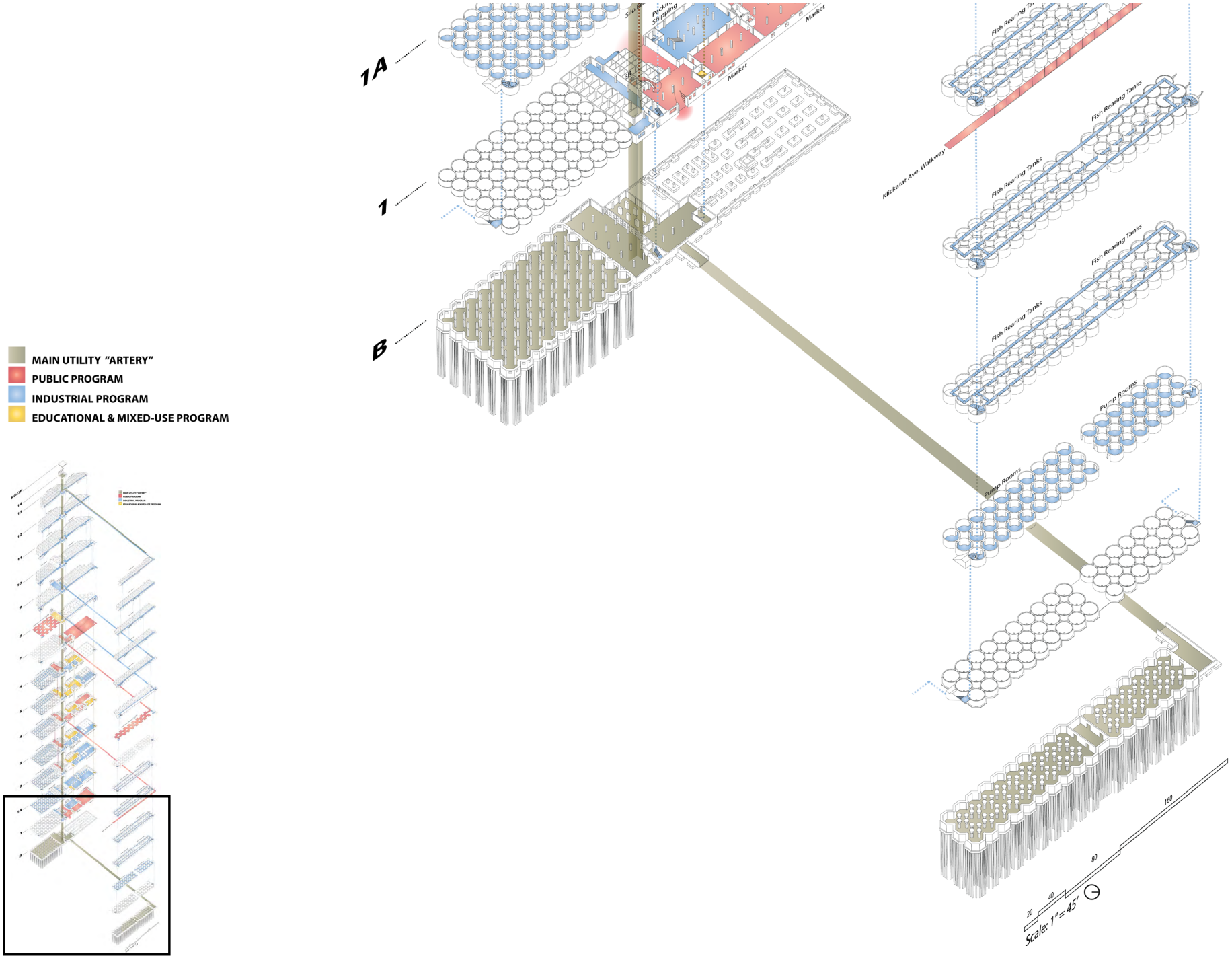


Figure 83: Repurposed Building

Appendix G // Case Studies

I. The Granary, Interface Studio Architects

The conceptual proposal by Interface Studio converts an old grain silo in Philadelphia into a mixed-use residential project. An engineering analysis showed the existing structure as capable of supporting a considerable overbuild.[49] So, 14 stories of residential apartments would be constructed atop the existing silo's with the first floor used for retail. While the existing silos proved to difficult to convert to residences or offices, the architects proposed a handful of alternative uses– passive air-cooling/warming chambers, rainwater and grey-water collection chambers, climbing walls, micro-galleries, hydroponic farms, and several other possibilities.

Their approach shows how an abandoned and difficult-to-reuse industrial building (due to it's specific use) can be repurposed in unexpected ways, thereby reviving the cultural value of the structure rather then simply treating it as a museum piece.

Figure 85: Public Presence

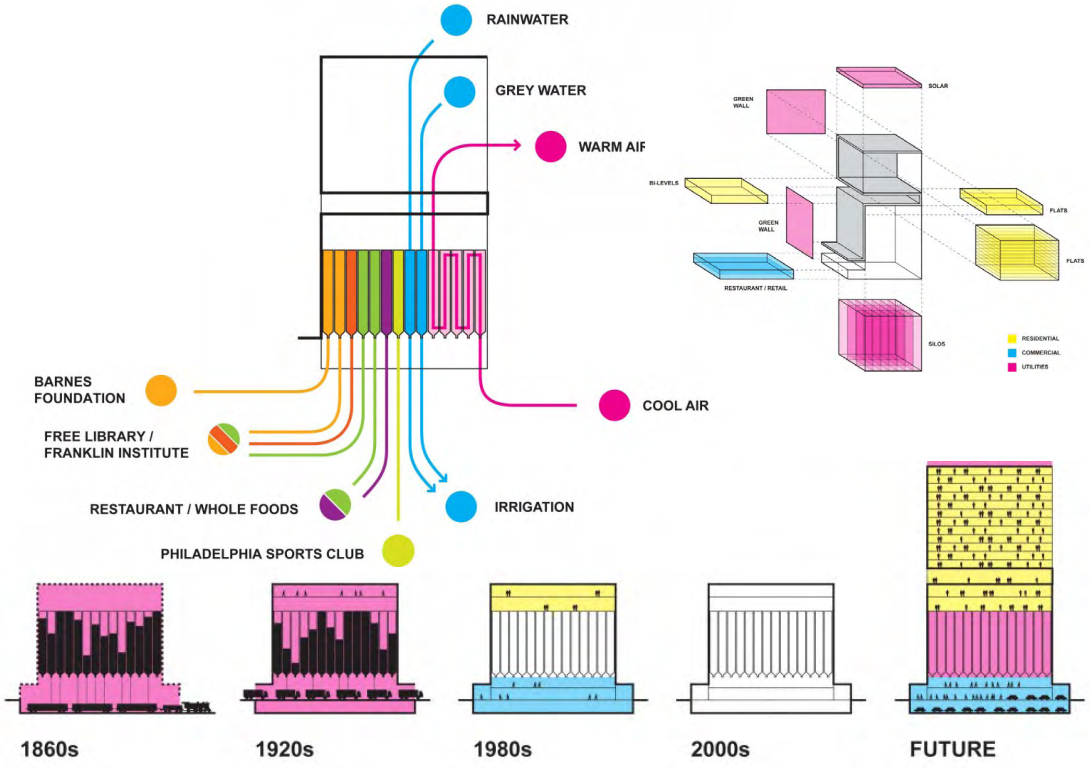


Figure 84: Use Timeline

Figure 86: Silos for Mushroom Growing

Figure 87: Silos for Climbing

49 Furuto, Alison. The Granary / Interface Studio Architects. Arch Daily. June 11, 2011. http://www.archdaily.com/142709/the-granary-interface-studio-architects/. Web. March 17, 2013.

II. The Olympic Sculpture Park, Weiss/Manfredi Architects

The Olympic Sculpture Park is located on a plot of post-industrial land along the Seattle Waterfront. The site's constraints were transformed into creative opportunities by Weiss/Manfredi during the design of the Park; The railroad and main arterial that split the site into three distinct plots were married by a continuous, angular, zig-zagging bridge/paths, of which, the exhibition-building becomes an extension, unifying site, topography, and program; the contaminated soil on-site was stripped and remediated off-site; and lastly, the crumbling seawall was repaired, adding to it a rubble shelf to help assist Salmon in safe migration.

The use of Mechanically Stabilized Earth was both an economic and seismic decision, since it is significantly less costly than reinforced concrete retaining walls, piles, or piling caps associated with traditional retaining wall construction.[50]

Video Link: http://vimeo.com/37620337

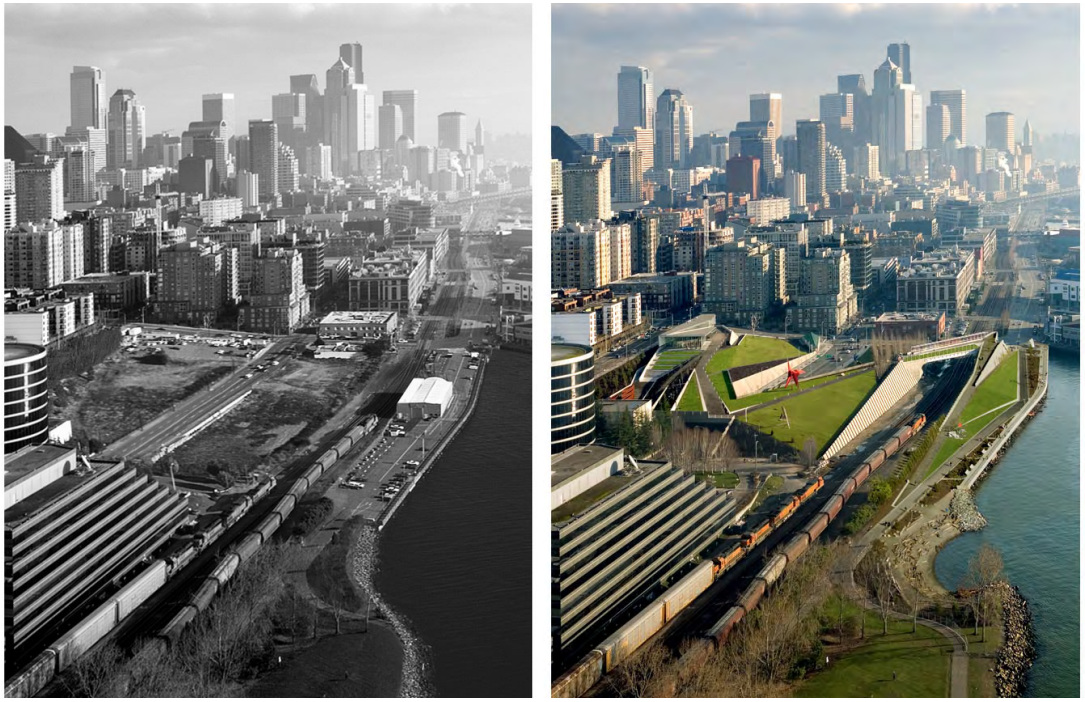


Figure 88: Site: Before and After

Figure 89: Walkway Over the Rails

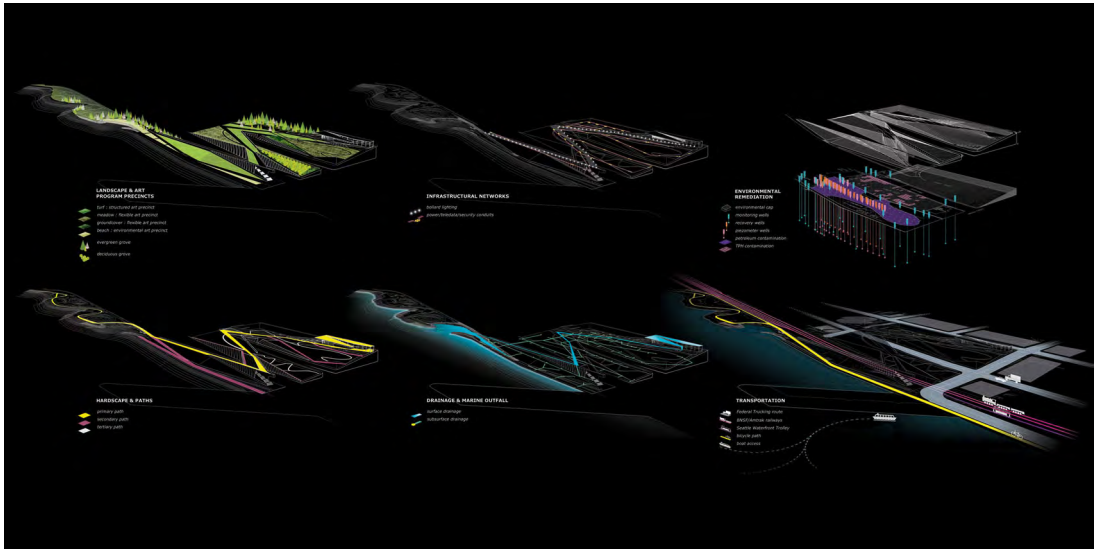
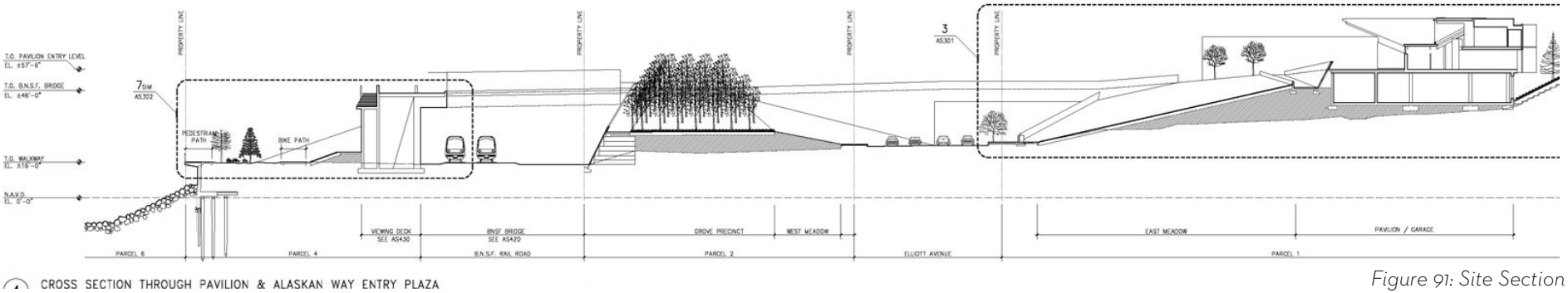


Figure 90: Site Diagrams

50 Margolis, Liat, and Alexander Robinson. Living Systems: Innovative Materials and Technologies for Landscape Architecture. a Basel: Birkhäuser, 2007. Print. Pg. 38



CROSS SECTION THROUGH PAVILION & ALASKAN WAY ENTRY PLAZA

Figure 91: Site Section

Figure 92: Street Facade

Figure 93: Pavilion at Dusk

Figure 94: Pavilion Interior

III. Evergreen Brick Works, Du Toit Allsopp Hillier, Diamond + Schmitt, Era Architects, Claude Cormier Architectes Paysagistes, Evergreen, and The Toronto and Region Conservation Authority.

In 1994, after the factories and quarry closed, this site was incorporated into Toronto's park system and subsequently turned into productive green space– the new programming incorporated a nursery, visitors center, farmers market, play areas (for children), and 110,000 sf of vegetable gardens and nursery to teach locals about urban agriculture.

Due to dilapidated conditions, some of the original building's could not be reused, but their materials were, instead, stockpiled for re-use in future construction projects.

The only addition to the complex was a multifunctional teaching/office building designed by Diamond and Schmitt Architects, intended to be an "idea's incubator." Its most distinct feature is the façade wall, composed of window boxes where tenants can grow plants in a sort of "vertical wetland," filtering rainwater in the process.

Figure 95: Historic Use

Figure 96: Reactivated Interior

Figure 97: Existing Warehouse

Figure 98: Entry Plaza

Figure 99: New Facade

IV. Public Farm 1 MoMA Installation, WORK Architecture Company

Built in the courtyard of New York's Museum of Modern Art during the summer of 2008, this installation was a prototype for creating a dense and agriculturally productive urban space that could be replicate-able almost anywhere, including underutilized rooftops or derelict urban spaces.

Cardboard tubes were used for the primary structure, because of their lateral strength, and compost ability once the installation was over. The underside of the elevated structure became a loosely programmed pavilion.

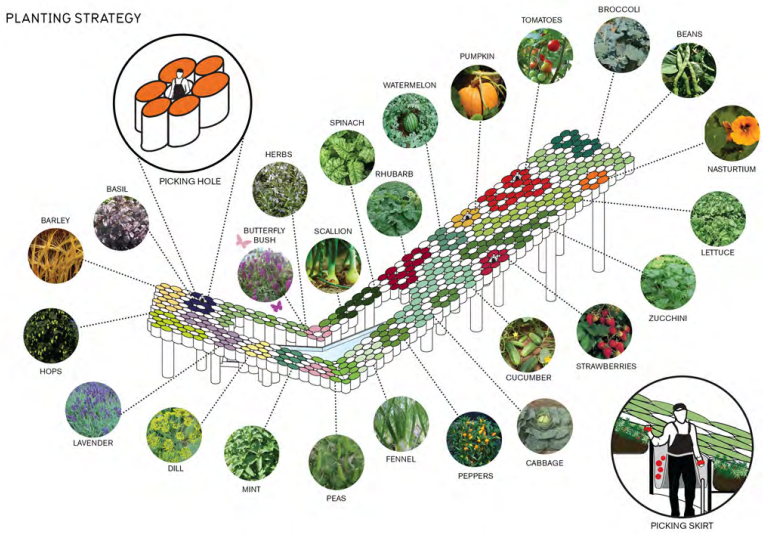


Figure 101: Planting/Picking Diagram

Figure 102: Planting Crops

Figure 103: Tube Construction

Figure 100: Installation in Courtyard

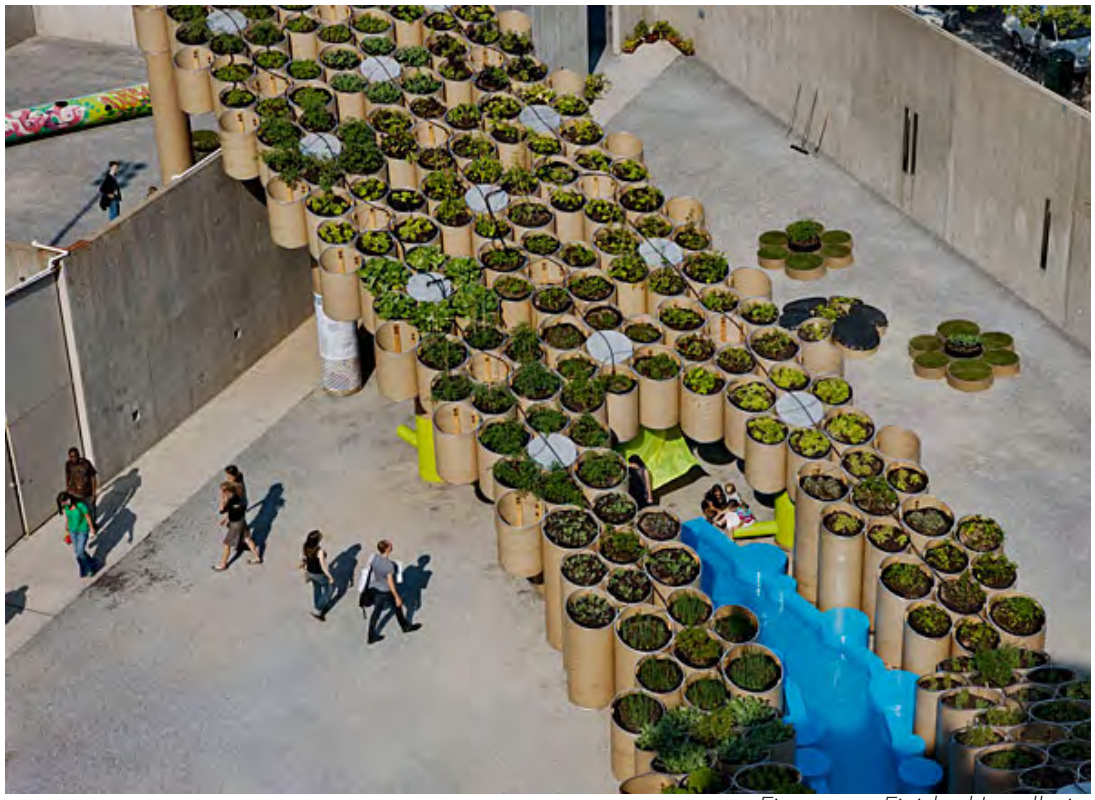


Figure 104: Finished Installation

V. Center for Urban Agriculture, Mithun Architects, Planners, and Designers.

Mithun's imaginative project for Seattle's Denny Triangle, designed (but not yet built) as a net zero building, won the "Best in Show" award in the 2007 Living Future Competition (organized by Cascadia Green Building Council). It contains eighteen stories of residential units, made of recycled shipping containers, a restaurant, educational laboratory, chicken farm, and plant/tree nurseries.

Much of the building is dedicated to the accumulation of water and solar energy landing on-site, including the southern façade of the building, which blankets the shipping containers in a variegated array of photovoltaic panels.

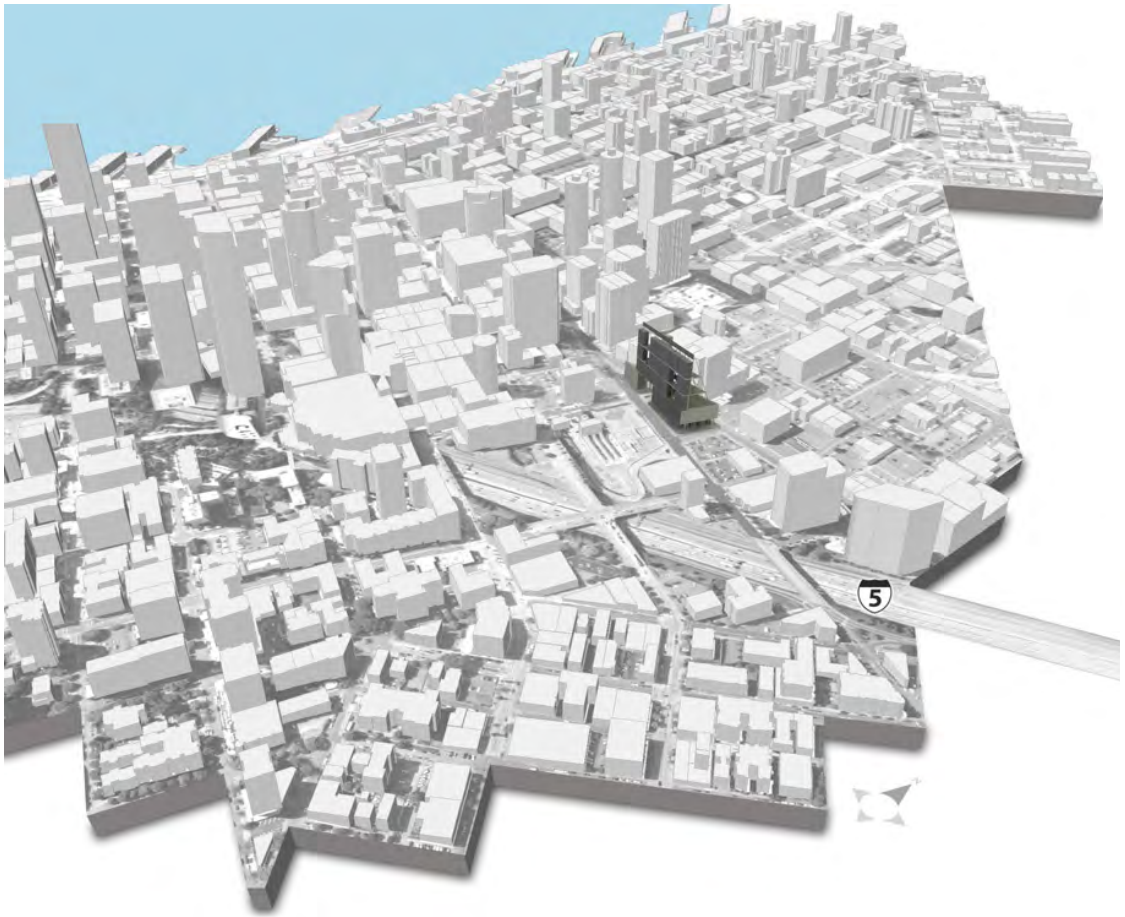
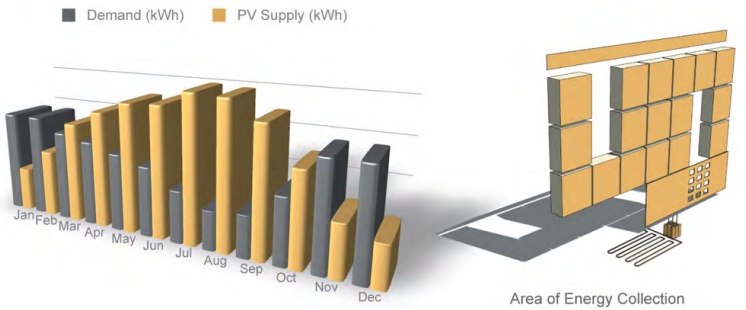
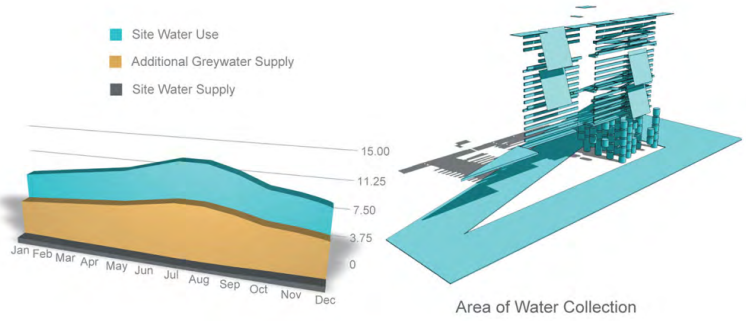
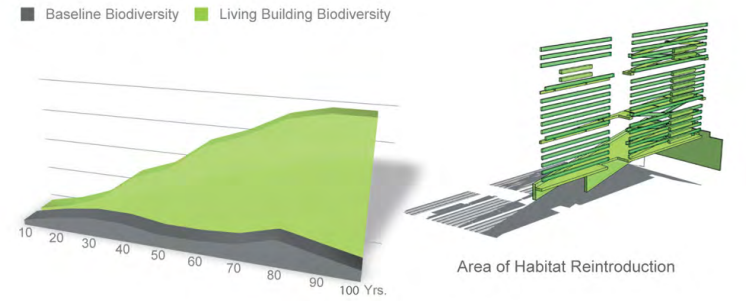


Figure 105: Urban Context

Figure 106: Primary Facades (south above, north below)







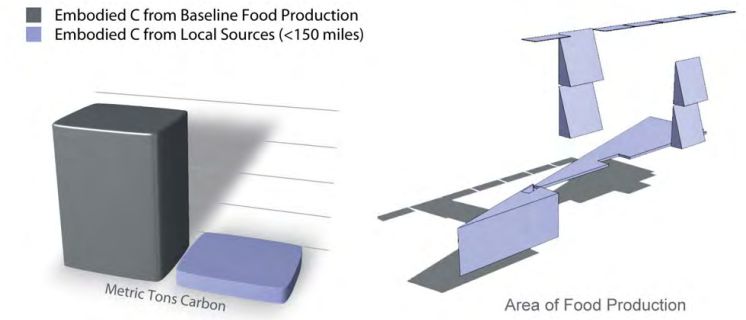


Figure 108: Function Diagrams

Figure 107: Contextual Perspectives from Street

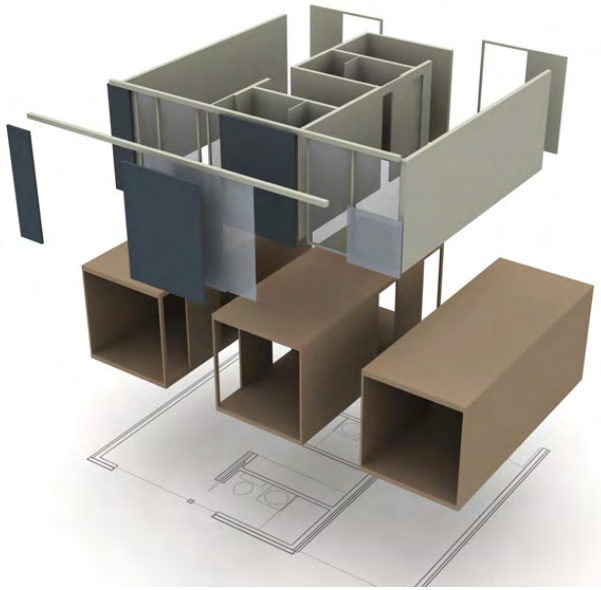


Figure 109: Exploded Assembly Showing Reused Shipping containers

BIBLIOGRAPHY

"1 MILLION pounds of Food on 3 acres. 10,000 fish 500 yards compost." http://www.youtube.com/watch?v=jV9CCxdkOng. You Tube, June 25, 2009. Web. Visited March 13, 2013.

About the Port of Seattle. https://www.portseattle.org/JOBS/Pages/default.aspx .Web. Visited March 2,2013.

Allen, Stan. Points + Lines: Diagrams and Projects for the City. New York: Princeton Architectural Press, 1999. Print.

American Association of Port Authorities. http://aapa.files.cms-plus.com/Statistics/2010%20U.S.%20PORT%20RANKINGS%20BY%20CARGO%20TONNAGE.pdf Web. Visited March 2,2013.

American Lumberman, "The Personal History and Public and Business Achievements of One Hundred Eminent Lumbermen of the United States", Second Series, American Lumberman, Chicago, 1905-1906. http://www.ttarchive.com/Library/Biographies/Fisher_OW_AL.html .Web. Visited Feb. 11, 2013.

Bernstein, Sylvia. Aquaponic Gardening: A Step-by-Step Guide to Raising Vegetables and Fish Together. Gabriola, BC: New Society Publishers, 2011. Print.

Castells, Manuel. The Internet and Society. USC Annenberg: You Tube, Sept. 24 2008. http://www.youtube.com/watch?v=qrOABiFUd0g

Castells, Manuel. The Rise of the Network Society. Malden, Mass: Blackwell Publishers, 1996. Print.

Davis, Colle and Phyllis. Portable Farms. Part 1: Sizing Your Aquaponics System. http://portablefarm.com/farm/2013/part-one-sizing-your-aquaponics-system/ . Web. Visited March 13, 2013.

Duwamish Alive, Restore Our River. History. http://www.duwamishalive.org/history/ .Web. Visited Feb. 2, 2013.

Form/Space Atelier. From Industry to Information. September 22, 2009. http://formspaceatelier.blogspot.com/2009/09/formspace-atelier-program-for-october.html .Web. Visited March 2, 2013.

Furuto, Alison. The Granary / Interface Studio Architects. Arch Daily. June 11, 2011. http://www.archdaily.com/142709/the-granary-interface-studio-architects/. Web. Visited March 17, 2013.

Hansen, Taj. 2013. Landscape of Experimentation: Pioneering and Succession on Harbor Island. MLARCH thesis, University of Washington College of Built Environment. Seattle, WA.

History Link. Harbor Island, at the time the world's largest artificial island, is completed in 1909. http://www.historylink.org/index.cfm?DisplayPage=output.cfm&file_id=3631 . Web. Visited March 1, 2013.

International Directory of Company Histories, Vol. 15. St. James Press, 1996. http://www.fundinguniverse.com/company-histories/fisher-companies-inc-history/ .Web. Visited Feb. 11, 2013.

Jackson, John B. The Necessity for Ruins, and Other Topics. Amherst: University of Massachusetts Press, 1980. Print.

Jacobs, Jane. The Death and Life of Great American Cities. New York: Random House, 1961. Print.

Le Corbusier. Towards a New Architecture. John Rodker Publishers, London, 1931.

Levi-Strauss, Claude. The Savage Mind. London. 1966: New York, 1969.

Lyson, Thomas A., and Annalisa Lewis Raymer, Stalking the Wily Multinational: Power and Control in the US Food System, Agriculture and Human Values, October 19, 1999.

Mahar-Keplinger, Lisa. Grain Elevators. New York, N.Y: Princeton Architectural Press, 1993. Print.

Margolis, Liat, and Alexander Robinson. Living Systems: Innovative Materials and Technologies for Landscape Architecture. a Basel: Birkhäuser, 2007. Print.

Mayne, Thom, and Stan Allen. Combinatory Urbanism: The Complex Behavior of Collective Form. Culver City, CA: Stray Dog Café, 2011. Print.

Merriam-Webster. http://www.merriam-webster.com/dictionary/aquaculture .Web. Visited March 3,2013.

Merriam-Webster. http://www.merriam-webster.com/dictionary/hydroponics .Web. Visited March 3, 2013.

Nokes, Jim. Personal interview. 3 Dec. 2012.

Rakocy, James E., Donald S. Bailey, Charlie Schultz, and Eric S. Thoman. "Update on Tilapia and Vegetable Production in the UVI Aquaponics System" University of the Virgin Islands Agricultural Experiment Station. http://ag.arizona.edu/azaqua/ista/ista6/ista6web/pdf/676.pdf. Web. Visited March 13, 2013.

Riegl, Alois. The Modern Cult of Monuments: Its Character and Its Origin. Oppositions Reader: Selected Readings from a Journal for Ideas and Criticism in Architecture, 1973-1984. Hays, K M. New York: Princeton Architectural Press, 1998. Print.

Rowe, Colin and Fred Koetter. Collage City. The MIT Press, Cambridge, Massachusetts, and London, England.

SeattleWaterfront.org. http://www.seattlewaterfront.org/history/. Web. Visited Feb. 2, 2013.

Shane, David G. Recombinant Urbanism: Conceptual Modeling in Architecture, Urban Design, and City Theory. Chichester: Wiley-Academy, 2005. Print.

Soil Loss Accelerating Worldwide, Food and Agriculture Organization, Rome, Italy, 1993. http://www.iisc.ernet.in/currsci/feb25/articles16.htm .Web. Visited March 14, 2013.

Washington State Department of Transportation. http://www.wsdot.wa.gov/Freight/Marine.htm .Web. Visited Feb. 2, 2013.

Weiser, Cathy. Harbor Island - Largest Artificial Island in the U.S. May 2010 http://www.legendsofamerica.com/wa-harborisland.html. Web. Visited March 1, 2013.

Wikipedia. http://en.wikipedia.org/wiki/Harbor_Island. Web. Visited Feb. 2, 2013.

Wilma, David. Straightening of Duwamish River Begins on October 14, 1913. History Link. Feb. 16, 2001. http://www.historylink.org/index.cfm?DisplayPage=output.cfm&File_Id=2986 .Web. Visited Feb. 2, 2013.


"THE END"