THE OFFICE BUILDING OF THE FUTURE

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The Vision

EXECUTIVE SUMMARY

For millennia, mankind has continually sought to present and define their visions for the future world. One of its most striking and imaginative aspects is the portrayal of the built environment in its many varied forms.

The National Association of Industrial and Office Properties (NAIOP) hosted a national design competition in 2012 for The Office Building of the Future (OBF). This book represents the award winning submission and offers a vision of the future grounded in the pragmatic realities of the most accurate and latest building science data available, it is nearly limitless in its potential configurations and bound only by imagination.

PRINCIPLES

With the intent to present a fully resolved design concept for the OBF, a team of multi-disciplined professionals was invited to participate in a charrette to discuss and identify trends, advances and opportunities to consider for potential incorporation into the project's design. The conclusions were synthesized into three distinct principles that will drive the design of the OBF:

- Qualities: Its workplace will be healthful and conducive to employees' productivity and well-being, with qualities such as abundant natural light, access to fresh air, customizable work areas and greater collaborative spaces.
- Business Objectives: It will be economically viable and support the owner's business objectives with innovative design and construction, efficient floorplates and multipurpose spaces.
- Sustainability: It will be highly sustainable and responsive to its climate and site.

QUALITIES

Owners will require an innovative approach to attract and engage tenants. Defining the potential tenant of the future requires an understanding of contemporary workplace culture. Trends in speculative office development offer insights on how the diverse workforce of the future will interact and their expectations. The workforce will have greater expectations of their work environments. The OBF will provide greater access to daylight and natural ventilation, pleasant views, exterior green space, direct access to public transit, on-site parking for both vehicles and bicycles, and proximity to residential spaces.

The next-generation workspace will move away from dedicated offices and workstations and offer more free-flowing environments that blur the line between work and private life. Professionals will increasingly work remotely, and the office will be a place for collaboration, face-to-face encounters, knowledge sharing and team-building.

BUSINESS OBJECTIVES

A number of emerging and anticipated trends in office design will impact the design and construction of the OBF, directly impacting the owner's bottom line.

- Owners of the OBF will enjoy substantive economic and tenant satisfaction benefits as a result of working in an increasingly social, mobile and collaborative fashion referred to as "distributed work."
- Consistent lease depths of 45 feet will offer many advantages.
- Design and construction technologies will allow for thinner state-of-the-art integrated floor systems resulting in reduced floor-to-floor heights yet greater floor-to-ceiling heights.
- Work environments will continue to move away from dedicated offices and workstations and migrate towards more free-flowing environments.
- Flexible workspace will allow for cost-effective modifications, easy reconfigurations, and multi-functional capabilities to maximize real estate usage, create savings and minimize the risks of space dependency.

- Although they are often considered an amenity, personalized comfort controls at workstations will enhance office environment comfort and improve productivity.
- The Building Information Modeling (BIM) platform will facilitate seamless integration and coordination of design, engineering and construction, enabling faster and more economical delivery of projects.
- Shorter construction schedules will provide significant reductions in risk and project financing costs.

SUSTAINABILITY

The OBF incorporates an advanced system monitor to track, measure and display data about the building's performance to allow potential tenants to make informed decisions about their workplace and allow a high-performance building such as the OBF to stand out within a highly competitive real estate market.

MODULARITY

One of the most significant conclusions resulting from this study is that development of the OBF can be economically and efficiently achieved through an advanced system of modular building, with structural and enclosure units. An innovative system would offer the adaptability, efficiency and economy necessary to balance the owner's business objectives with the well-being and productivity of the tenants and the preservation of natural resources.

PROTOTYPE

Fine grain details of the OBF's building systems and logistics have been carefully considered in an effort to produce a new methodology of construction that is viable both in concept and in practice. The system is inherently flexible, able to accommodate a variety of building systems technology and be assembled into a range of building forms with a variety of architectural expression.

To balance the needs of both owner and tenant, it was determined that the floorplate offering the most flexibility would be 45 feet and the building would maintain a floor-to-floor height of 13 feet. To meet sustainability and user experience quality goals, the 45-foot wide floorplate includes operable windows on both sides of the lease depth, the necessary modular "kit of parts" being optimized for this architectural configuration. The precast elements are fabricated off-site in a factory setting where all of the building mechanical and electrical systems can be pre-fitted. As the building elements arrive on site, they are simply lifted off the delivery trucks and set directly in place, creating the final and completed floor assembly.

FLOOR MODULE

Constructed using precast concrete, the structural floor system of the OBF incorporates mechanical, electrical, communications, fire suppression and lighting systems into a single, integrated assembly measuring 45 by 10 feet.

WALL MODULE

The perimeter structure and facade of the OBF will be combined in the factory and delivered to the site as a complete single wall unit. The columns and spandrel beam that make up each structural bay (30 feet x 1 floor) are precast as continuous frames that are then in-filled with the latest technology in building fenestration.

MODULAR CORE

Instead of a mundane grouping of spaces relegated to the center of the floorplate, the core of the OBF is the heart of the building. The OBF expands the bracing system into a large open tube of precast concrete latticework, surrounding light-filled centralized atriums. Due to the system's inherent "plug & play" flexibility, it is intended that the independence of the structural core will allow for programmatic units to be added or replaced years after its completion, thereby allowing the building to be repurposed.

IDEAL OFFICE ARRANGEMENT

With significantly higher ceiling heights, the OBF will be filled with natural light and fresh air and respond to the specific needs of inhabitants. The OBF will be organized as a narrow building that maximizes light, air and views in and through both sides of the lease depth.

CASE STUDY: SEATTLE

To further develop and explore the OBF, the modular system was applied to a one million gross square foot, two-phased, mixed-use development. The city of Seattle was selected for the OBF as it is home to several significant high-tech corporations; it has a temperate climate; it has an active real estate and development community with a number of potential sites.   Additionally, as a participant in the Architect 2030 Challenge to achieve net zero energy and water use, Seattle offers a community that has long been a proponent of environmental stewardship and sustainability.

THE NEXT STEP

It is believed that the inherent success of the modular system can be achieved and implemented in nearly any location. The system's limitless adaptability of building program and scale as well as a faster construction schedule will offer clients greater agility in responding to volatile market demands. The system's design allows it to continually evolve and incorporate ever-changing technologies to realize the next generation of high-performance buildings.

The Future

PROLOGUE

Humankind has eternally been fascinated with the concept of its own future. Inherent in human ambition is the need to question the current standard and envision the next step. For millennia, we have imagined and depicted the forthcoming political, economic and physical landscape. Humans have continually sought to define their visions for the future world from early illuminated manuscript depictions of the doomed Tower of Babel to science fiction films of the last century.

Across this spectrum of media, one of its most striking and imaginative aspects is the portrayal of the built environment, both on earth and in space. Noted films offering distinctive visions of the future include Fritz Lang's *Metropolis* (1927), Woody Allen's *Sleeper* (1973) and Ridley Scott's *Blade Runner* (1982). Early television provided us with an animated, fantastical version of the future with Hanna-Barbera's *The Jetsons*. Hinting at the exciting possibilities of human achievement, *Popular Science* magazine captured the imagination of generations.

While themes of pervasive automation, servile robots and artificial intelligence are common throughout, the architecture of our cinematically conceived future is represented in many varied forms. From the gritty Los Angeles of *Blade Runner* and the authoritarian *Metropolis*, to the sleek modern and near-organic forms in *Sleeper* and *The Jetsons*, each portrays a unique visual and perhaps cautionary commentary on the perceived state of humanity.

Versions of the future have also appeared in significant advertising campaigns. General Motor's Futurama exhibition at the 1939 World's Fair in New York City depicted, perhaps all-too-realistically, an urban environment connected yet dominated by roads and automobiles.

The proposal for the OBF offers the next step. While the design is grounded in the pragmatic realities of the most accurate and latest data of building science available, it is nearly limitless in its potential configurations and bound only by imagination.

Photo: © CORBIS

Principles

"If you just follow Sadie, she'll show you the way out." [1]

"In a prosperous society, you really have only two assets: people - their creativity and skills - and the ecosystem around them. Both need to be carefully tended." [2]

1 Steiner, Peter. Cartoon. The New Yorker Collection. 8 July 2002: Online.

2 Lederhausen, Mats, as cited in Esty, D, & Winston A. (2006) Green to Gold. Hoboken, NJ: John Wiley & Sons. Page 32.

How Will The Future Workplace Be Different?

PRINCIPLES: THE WORKPLACE OF THE FUTURE

With the intent to present a fully resolved design concept, a team of multi-disciplined professionals was invited to participate in a charrette to discuss and identify trends, advances and opportunities for potential incorporation into the design of the OBF for the year 2030.

The team included Pickard Chilton, Design Architect; Magnusson Klemencic Associates, Structural and Civil Engineering; Atelier Ten, Sustainable Design; Cosentini Associates, MEP Engineering; IA (Interior Architects), Interior Planning; and Gilbane Building Company, Cost Estimating and Scheduling.

The charrette raised a number of critical questions and discussions resulting in a series of conclusions that would guide the design of the OBF. The conclusions were synthesized into three distinct principles that will drive the design of the OBF:

- The OBF's workplace will be healthful and conducive to employees' productivity and well-being with **qualities** such as abundant natural light, access to fresh air, customizable work areas and greater collaborative spaces.
- The OBF will be economically viable and support the owner's **business objectives** with innovative design and construction, efficient floorplates and multipurpose spaces.
- The OBF will be highly **sustainable** and responsive to its climate and site.

Photo: Ezra Stoller © Esto

Qualities

WORKPLACE TRENDS

In an increasingly competitive market, owners will require an innovative approach to attract and engage tenants. Defining the potential tenant of the future requires an understanding of contemporary workplace culture. Current trends in speculative office development offer insights on how the diverse workforce of the future will interact and their expectations for the office building.

THE WORKFORCE

As the newest members of the workforce will be "digital natives," their intuition to save time and work as quickly as possible will be inherent. They will drive the efficiency and speed of communication more than any previous generation, necessitating open floor plans and mobility within the office.[1] From 2006-2016, 93% of the growth in the labor force will be among workers ages 55 and over. This shift in the demographic composition of the workplace will result in employees who are more accustomed to multi-tasking from various locations as they seek greater work-life balance.[2] Across generations, the tenant of the future will be better informed about possibilities for the working environment, due to their constant connectivity.

THE WORKPLACE

The next-generation workplace will move away from dedicated offices and workstations and offer more free-flowing environments that help to blur the lines between work and private life. Professionals will increasingly work remotely and the office will begin to function as an anchoring physical location away from the digital realm. The office will be a place for collaboration, face-to-face encounters, knowledge-sharing and team-building.[3] Workers will go to the office for human interaction yet expect the comfort and personal atmosphere of one's own "living room." The OBF will become a collaboration center and house a variety of workspaces, including quiet "library" spaces, "cubbie" break out rooms and large formalized conference rooms.[4]

AMENITIES

The workforce will have greater expectations of the building in which their work environments reside. The design will provide greater access to daylight and natural ventilation, pleasant views, exterior green space, direct access to public transit, on-site parking for both vehicles and bicycles, and proximity to residential spaces. Numerous studies indicate that these attributes directly result in a more content and healthy workforce, thereby contributing to an increase in productivity.[5] Better working environments also serve to attract and retain top talent. As a result, certain features that may increase up-front design and construction costs are offset by the gains from increased employee productivity, comfort and well-being. Common amenities may include: on-site day care, fitness centers, cafés with healthy menu options, concierge services, communal collaboration and social areas as well as private work spaces, highly integrated technology and communication, and a flexible schedule. An engaged, healthy workforce is a productive and efficient workforce.

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1 Schmidt, Lucinda, and Hawkins, Peter. (July 15 2008) Children of the Tech Generation. The Sydney Morning Herald. http://www.smh.com/au/news/parenting/children-of-the-techrevolution/2008/07/15/121588.

2 Interior Architects Presentation of Qualifications: Workplace Trends (http://www.interiorarchitects.com).

3 Staniek, Bettina, and Claus, A. (September 2011) Typology of Organizational Forms of Offices. Detail Magazine. Page 1014.

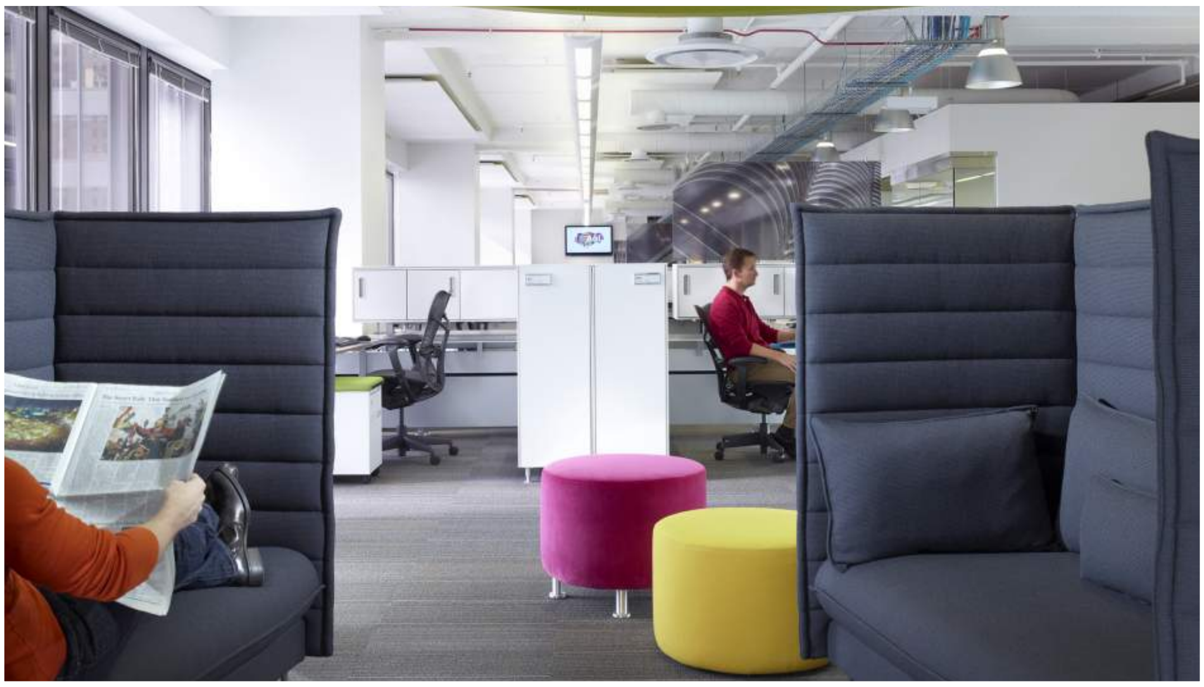
4 Blum, Andrew. (15 November 2011) Acting Like a Start-Up. Metropolis Magazine. http://www.metropolismag.com/cda/story.php?artid=4900.

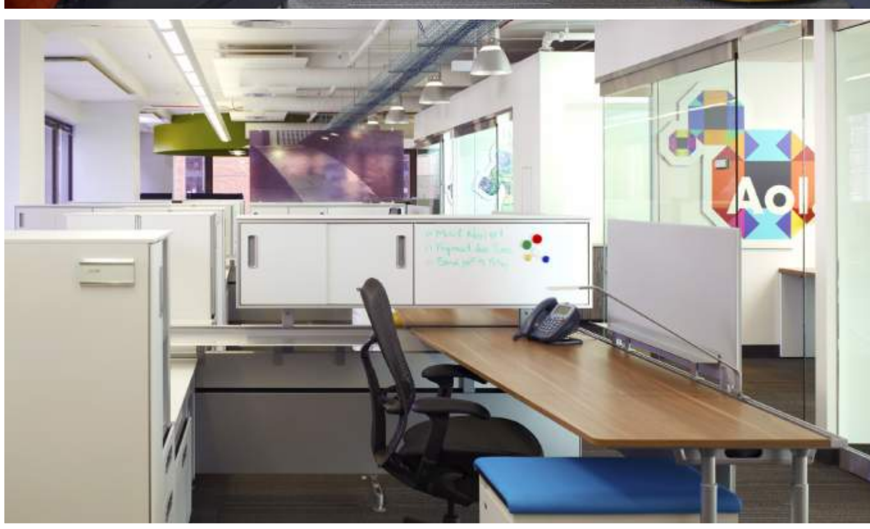
5 Romm, Joseph J. (1999) "Design for Workplace Productivity, Lockheed Building 157." Cool Companies: How the Best Businesses Boost Profits. Washington, DC: Island Press. Pages 92-94.

Photos: Takata, Sherman. Harmonic Lobby II San Jose. Takata, Sherman. T Mobile Pantry. Ooms, Frank. Mapquest Open Office. Barrett, Christopher. AOL Collaboration Chicago. Laignel, Eric. JWT Atlanta. Takata, Sherman. Expedia. Millman, Matthew. Young and Rubicam Studio. Merrick, Nick. Watermark Seattle. James, Phillip. Trip Advisor Conference Room. Wilson, Adrian. IA NY Conference Studio. Provided by IA Interior Architects.


harmonic

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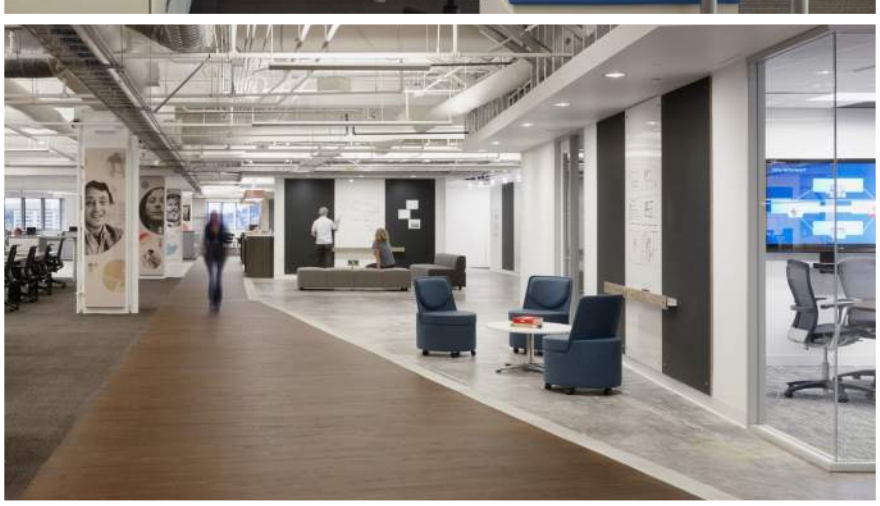
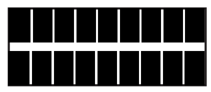
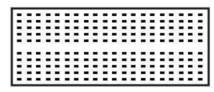
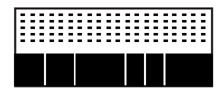
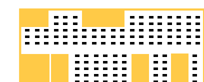


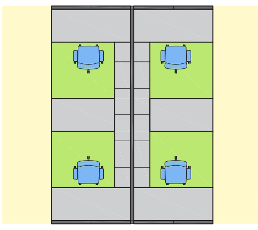


new york

	Cellular Offices	Open - Plan Offices	Group Offices	Reversible Offices
ORGANIZATIONAL TYPOLOGY				
Suitable For	noisy activities concentrated work independent work sensitive areas	communicative creative group work teamwork routine work	communicative process-oriented constant exchanges professional groupings	flexible layout investment concerns varying staff numbers varied tenancies
Average Workplace Needs Per Person	105 - 180 ft^2	130 - 160 ft^2	130 - 160 ft^2	85 - 160 ft^2
Typical Floor Depth	40 - 50 ft	65 - 130 ft	40 - 80 ft	45 - 50 ft
Natural Lighting (Proportion For All Workplaces)	100%	40%	75%	75 - 100%
Natural Ventilation (Proportion For All Workplaces)	100%	ca. 40%	ca. 75%	50 - 100%
Communication Level	low	high	high	concept dependent
Concentration Level	high	low	medium	concept dependent
Adaptability Of Workspace	medium	problematic	medium	concept dependent
Technical Flexibility	medium	high	medium	very high
Control Of Climatic Factors	individual	automatic	individual / automatic	individual / automatic

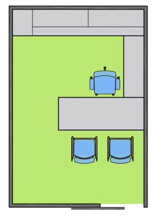
SELECTING THE IDEAL OFFICE ORGANIZATION

As referenced in the data above from the article by architects Bettina and Claus Staniek[1], the concept of the "reversible office" offers the flexibility for various office types to act as a single unit and to accommodate several types within not only one development, but on a single floorplate as well. It offers investors greater flexibility in developing a project without knowing the future occupant. As such, it is expected that the reversible form will prove to be the most economically viable office type in future commercial office markets.



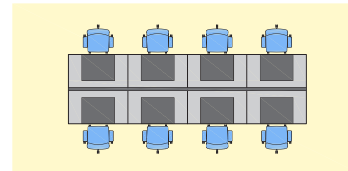
WORKSTATIONS

Private individual work space



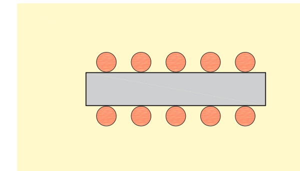
PRIVATE OFFICE

Enclosed individual work space



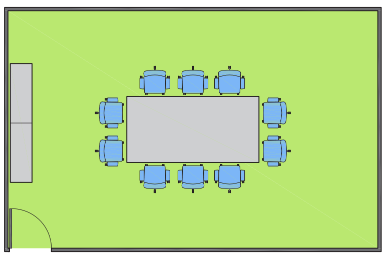
VISITOR WORKSTATIONS

Temporary workstations for employees and visitors



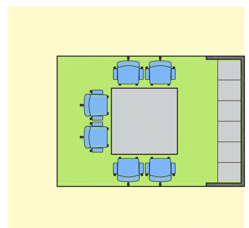
WIRELESS HUB

Raised counter with barstools for individual productivity



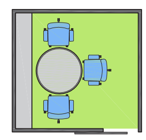
CONFERENCE ROOM

Enclosed space for meeting and collaborating



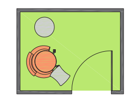
MEDIA REVIEW SPACE

Semi-open space with digital media projection capabilities



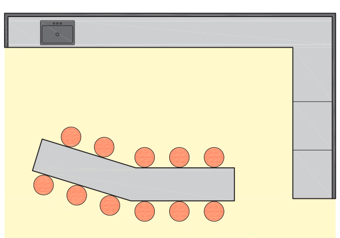
BREAKOUT ROOM

Enclosed space for teamwork



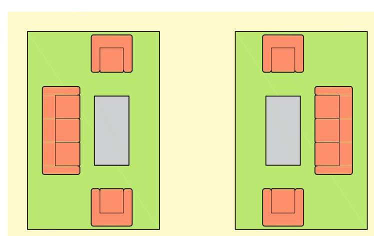
PRIVATE STUDY

Enclosed, single-occupant workspace, shared as needed



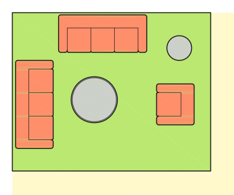
CAFE

Employee gathering space for eating and socializing



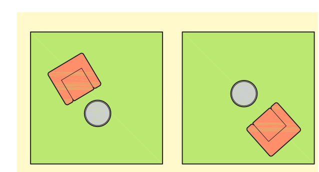
LOBBY

Reception area



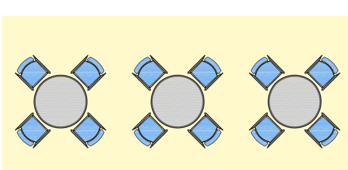
LOUNGE

Social relaxation space



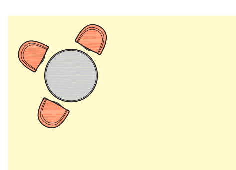
CASUAL FOYER

Quiet work space in an open environment



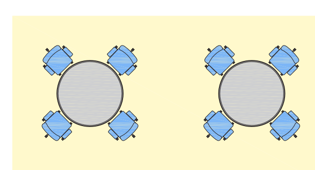
CLUB TABLES

Collaborative workspace in an open, active environment



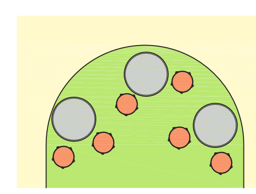
CAFE TABLES

Meeting space in a quiet, open environment



STRATEGY SPACE

Collaborative workspace in an open, active environment



SOCIAL CLUSTER

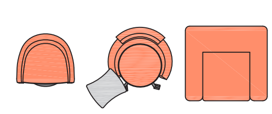
Open space for casual, impromptu discussions

MODULAR INTERIOR FIT-OUT

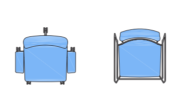
Companies will continue to leverage technology and their employees, and it is envisioned that "the office of the future" will become more about a place to gather and exchange ideas. A larger portion of floor area will be populated by various types of meeting spaces – each offering different tools, furniture settings and architectural features. Personal workspaces will still be available, too, although they will be fewer in number, more compact and moveable to easily accommodate organizational changes. Emerging technologies will allow media (2-D and soon 3-D) to come out of the shadows and into more open workspace.[2]

SEATING DIAGRAM KEY

Comfortable Seating



Office Seating



1 Staniek, Bettina, and Claus, A. (September 2011) Typology of Organizational Forms of Offices. Detail Magazine. Page 1014.
2 Gribbons, Mark. IA Interior Architects. Seattle, WA.

Business Objectives

DEVELOPMENT TRENDS AND METRICS

The design for the OBF will meet the owner's business objectives by providing a value-based yet high-performance architectural solution. A number of emerging trends in office design will impact the design and construction of the OBF.

DISTRIBUTED WORK

The average company pays between $12,000 and $15,000 per employee in annual facility cost, yet 30-40% of physical workspaces are vacant at any given moment on a regular business day. With technological advances that allow workers to truly work remotely, the significance and size of the office will diminish and work will be done in a variety of places. Technology will provide access and flexibility in time and space, and will also reduce travel and paper consumption.[6] Traffic jams cost Americans in urban areas an estimated 4.2 billion hours that flexible workers can convert into productive time.[1] By working in an increasingly social, mobile and collaborative fashion otherwise known as "distributed work," both owners and companies can enjoy a number of important financial and employee satisfaction benefits: substantive cost savings with an average 33% first-year cost avoidance over conventional workspace, with consistent savings thereafter; 7-12% greater space utilization than conventional spaces; and higher levels of employee satisfaction with about 65% of employees satisfied with the impact of distributed work programs on their individual performance and 80% satisfaction about their team performance.[2]

GREATER OCCUPANT DENSITY

Companies rebuilding or modifying their work environments with an eye on the next generation of workspace will continue to move away from dedicated offices and workstations. The current average occupancy density is 150-200 square feet of space per person, but industry wide it is continually trending downwards.[3] Cisco's implementation of a shared workspace resulted in substantial cost savings including: real estate rent: 37%; construction: 42%; workplace services: 37%; furniture: 50%; IT capital spend: 40%; cabling: 60%; and equipment room space: 50%.[4]

MAXIMIZING FLOORPLATES

Consistent lease depths of 45 feet offer many distinct advantages including: unobstructed and column-free floorplates, maximum flexibility and efficiency, access to natural light throughout, and customization of each floor for greater leasing capability.[5]

GREATER MODULARITY IN INTERIOR FIT-OUT

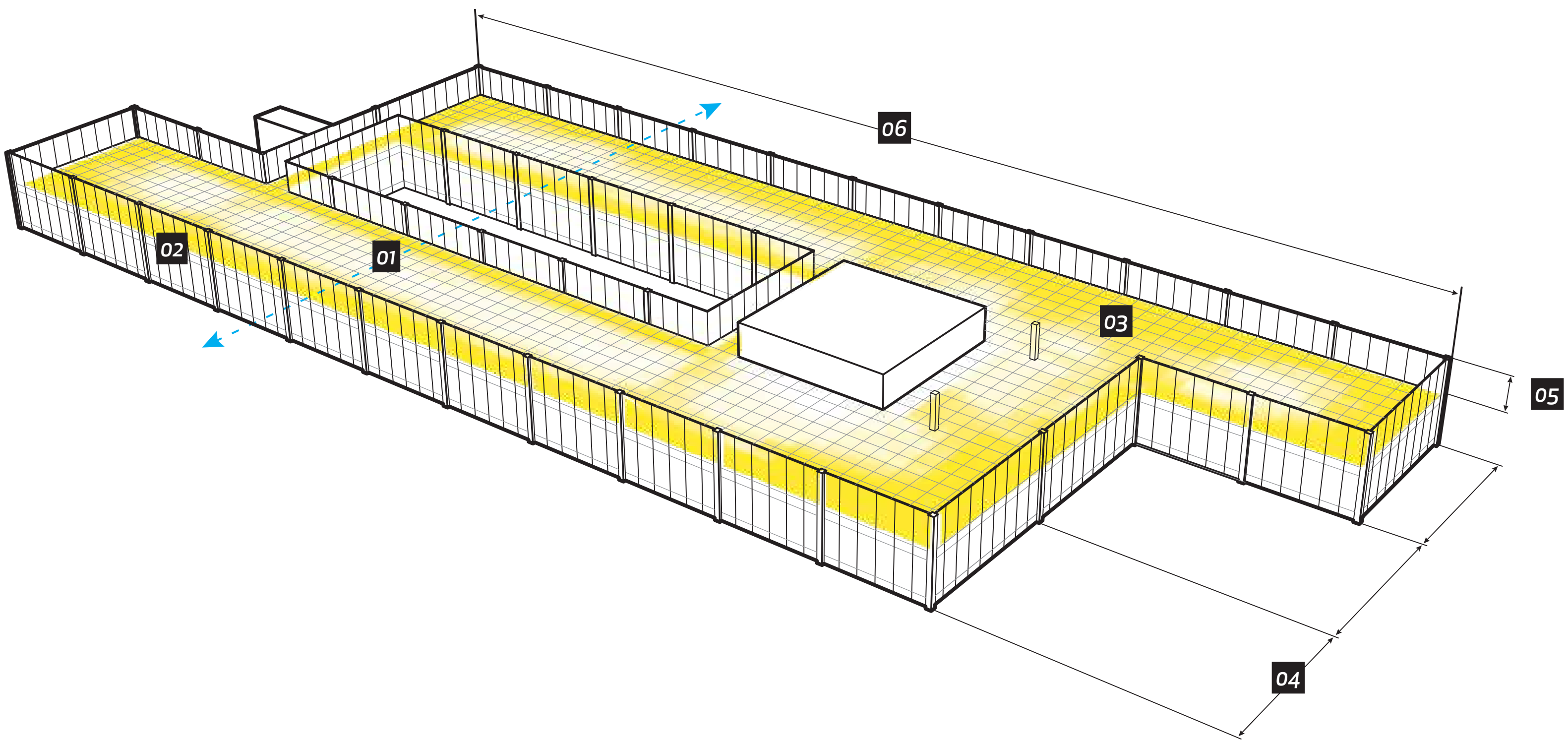
Flexible workspace that allows for cost-efficient modifications, easy reconfigurations, and multi-functional capabilities can maximize real estate usage, create savings and reduce the risks of space dependency.[6] In an effort to reduce its high churn rate, which was negatively impacting employee productivity, Hewlett-Packard developed a new universal flexible workplace plan with fewer space standards that facilitated frequent moves without major furniture reconfigurations. As a result, move time was reduced by an average of 73%, resulting in an estimated productivity savings of 48,000 to 72,000 hours per year.[7]

MINIMIZED CEILING CAVITY

Design and construction technologies are increasingly allowing for thinner state-of-the-art floor systems with integrated technologies. As a result, overall floor-to-floor heights are reduced proportionally throughout the entire structure, thereby reducing constructions costs. However, overall floor-to-ceiling heights will remain generous and allow for significant natural light and expansive views as appropriate.[5]

PERSONALIZED COMFORT CONTROLS

Although they are often considered an amenity, personalized comfort controls are increasingly provided at workstations to enhance office environment comfort and to improve productivity. These controls also contribute to reduced construction and energy costs.[8] West Bend Mutual Insurance provided personalized comfort controls at each individual workstation. As a result, productivity increased by 16% and gains paid for the workstations within 18 months; hot/cold complaints were virtually eliminated; and there was a sizable decrease in energy consumption resulting in lower utility costs.[7]



INTEGRATED DESIGN

As the Building Information Modeling (BIM) platform is increasingly adopted as an AEC industry standard, it too will facilitate integration and coordination of design, engineering and construction. It enables faster and more economical delivery of projects, although it does demand some initial effort in early project phases. Advantages of BIM over traditional delivery methods include greater precision and reliability; easier identification of inter-discipline conflicts; broader understanding of the project; more precise cost estimates and control; and, more secure data transfer. The University of Colorado was commissioned to compare two research facilities on their campus: a recently completed project that used traditional project delivery methods and a similarly sized project to be built using BIM. The results solidly affirmed BIM's advantages: there were 780 fewer RFIs, leading to a $585,000 savings just on the cost of administering RFIs alone. The project was also completed six months faster.[9]

FASTER CONSTRUCTION DELIVERY

Recent extremes experienced across real estate markets worldwide underscore how critical it is for clients to have the agility to quickly react to changing demands. Today investors must forecast a market's demand for office space years in advance of a project's expected completion. Projects conceived in prosperous times of growth may be completed in the midst of an economic downturn. Alternately, as markets begin to recover and surpluses of vacant space are absorbed, a race begins to be the first to the market with a new building. The ability to shorten the construction timeline will provide significant reductions in risk and reduce project financing costs. A reduced construction schedule also has financial benefits through construction management. A shorter schedule means fewer days that accrue general conditions costs. Efficient schedules equate to more effective use of labor, which is the largest percentage of the construction budget.[10]

01 Natural Ventilation

02 Optimal Facade Grid = 4 - 5 Ft

03 75% Of Floor Area Optimized For Daylight

04 Acceptable Floor Depth = 45 - 50 Ft

05 Minimum Clear Ceiling Height = 10 Ft

06 Bar Length To Be Determined By Need

1 Siegel, Seth, et al. (2009) "Why Change Now? Preparing for the Workplace of Tomorrow." Deloitte: Workplace Flexibility.
2 O'Neill, Michael, and Wymer, Tracy. (2011) The Metrics of Distributed Work. http://www.knoll.com/research/downloads/WP_DistributedWork.pdf.
3 Interior Architects Presentation of Qualifications: Workplace Trends http://www.interiorarchitects.com.
4 Cisco: Office Design Case Study: How Cisco Designed the Collaborative Connected Workplace Environment. http://www.cisco.com/web/about/ciscoitatwork/collaboration/connected_workplace_web.html.
5 Pesek, Judy. (19 May 2011) The Shifting Office Needs of Corporate America. Real Points. http://realpoints.dmagazine.com/2011/05/judy-pesek-the-shifting-office-needs-ofcorporate-america/.
6 Sargent, Kay. (June 2009) A Pivotal Shift; Leveraging for Advantage. http://www.interiorarchitects.com. Page 10.
7 Rice, James. (August 2002) Success Stories From the New Workplace. Building Operating Management. http://www.ardentcommercial.com/Data/FileManager/Documents/Best%20practices%20drawn%20from%20workplaces%20that%20work.pdf.
8 Napoli, Lisa. (15 February 1998) Earning It; Where Every Worker is Ruler of the Thermostat. The New York Times. http://www.nytimes.com/1998/02/15/business/earning-it-where-everyworker-is-ruler-of-the-thermostat.html?pagewanted=all&src=pm.
9 Autodesk: Mortenson Construction: http://usa.autodesk.com/adsk/servlet/item?id=13572250&linkID=10326920&siteID=123112.
10 Stukel, James. (September/October 2003) Cost Conscious Construction. Commercial Investment Real Estate Magazine. http://www.ccim.com/cire-magazine/articles/cost-conscious-construction.

Sustainability

OBF PERFORMANCE

The built environment in the United States will undergo drastic change in the methods of construction and rates of energy consumption as the focus of new development turns toward sustainable growth for future generations. Buildings alone account for over 40% of the nation's greenhouse gas emissions and energy consumption.[1] Their operation requires vast quantities of potable water, much of which is discharged into the public sewer system.

A sustainable lifestyle will be ingrained in the routine of office tenants in the future. From a young age, the next-generation workforce will innately understand the value of environmental stewardship. The identity of sustainability will not be limited to trendy green products and strict government regulations. It will naturally exist in the way workers live closer to the office, eliminating expensive commutes and utilizing local city amenities.[2] Sustainability goals will increasingly achieve a balance of social and fiscal growth within the limits of our natural environment. This is in keeping with the definition of sustainable development established by the Council for Local Environmental Initiatives: "Sustainable development delivers basic environmental, economic and social services to all without threatening the viability of the natural, built and social systems upon which these services depend."[3]

BUILDING PERFORMANCE

In the future, it is envisioned that data representing a buildings' impact on the environment will be readily available and displayed. Just as nutritional labels on food packaging provide standardized, easy to compare information that allows consumers to make informed decisions, similar metrics will be established for building performance and will be readily available and displayed. Although a number of rating systems exist today that are based on quantifiable improvements in building performance, the future measure of buildings will not be relative, but rather absolute.

The U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) Green Building Rating System is the most popularly implemented standard for the development of sustainable buildings and environments in the United States. The transformative and beneficial effect that the system has had on the North American building industry over the last decade is unparalleled. However, LEED is a frequently evolving system of points that encourages building design to follow a checklist which is ultimately arbitrary. By comparison, the Living Building Challenge (LBC) is a performance-based standard with mandatory targets (net-zero energy, net-zero water, zero toxins) requiring documented results. The LBC raises the sustainability standard but only bestows awards to a limited number of extreme buildings. Established in 2002 by architect Edward Mazria, the Architecture 2030 Challenge was created to eliminate fossil fuel emissions from energy sources such as natural gas, oil and coal-fired power plants from new buildings by the year 2030. The Challenge sets an ambitious precedence relative to energy consumption but the program does not address a building's total impact on water, materials and the natural environment.

While each of these programs promotes and encourages sustainable building design, none measure ongoing building performance nor address the aging stock of existing buildings. In the future, the standard system to quantify a building will track, monitor and measure building performance so that it is clear, informative and easily understood. The system will allow potential tenants to make informed decisions about their workplace, and it will allow a high-performance building such as the OBF to stand out within a highly competitive real estate market. The system will track real-time metrics, detailing consumption of water and energy, among other building attributes. With the aim of defining a new, more informative rating system, the OBF incorporates an advanced monitoring system to track, measure and display data about the building. In real time, the building's consumption metrics would be available to determine if the building is achieving its Net-Zero targets. Easily adaptable to both existing and new buildings, the monitoring system can serve as a simple visual graphic showing the systems annual performance through production and consumption. It may also be viewed as the heart of an interactive

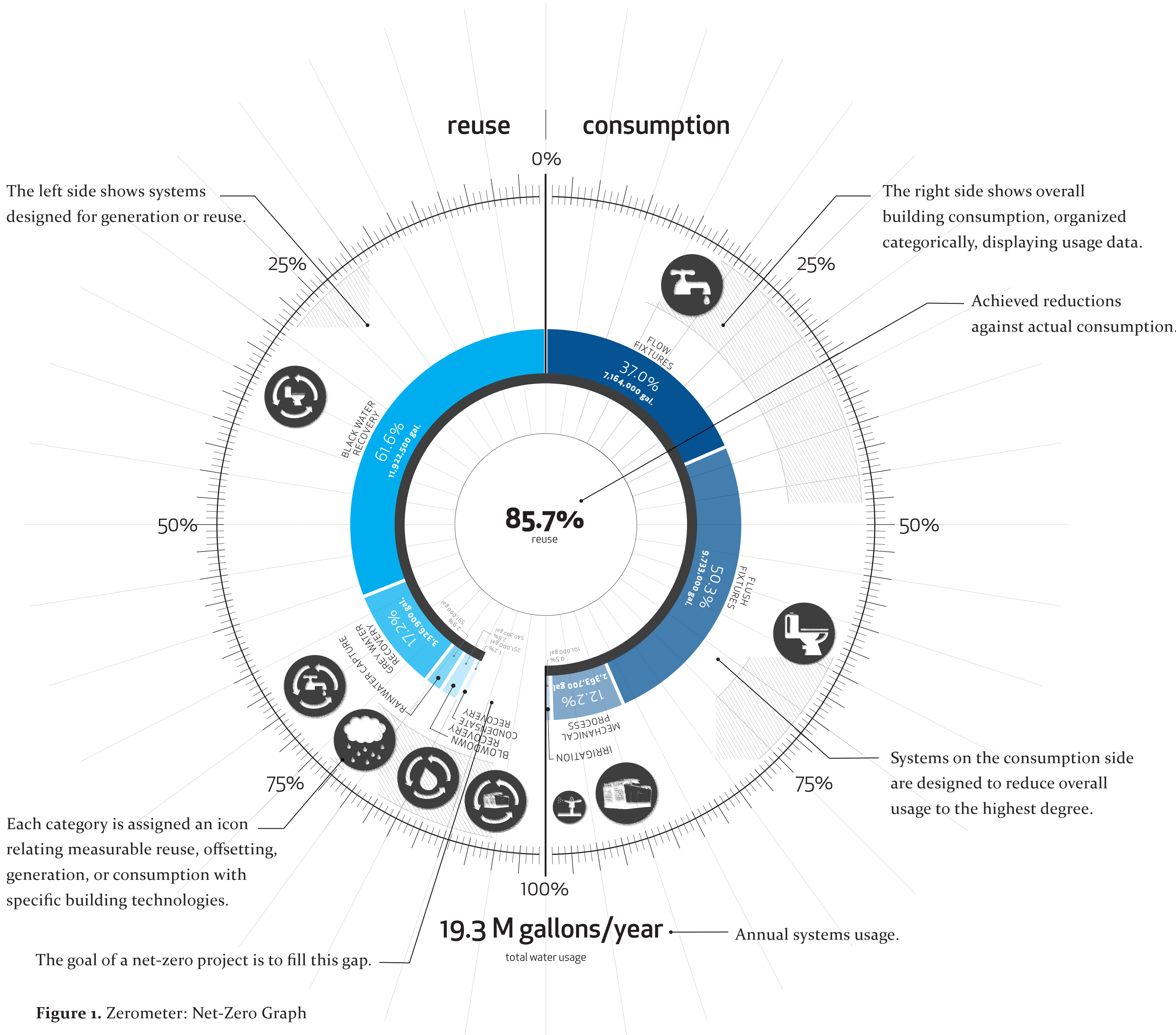


Figure 1. Zerometer: Net-Zero Graph

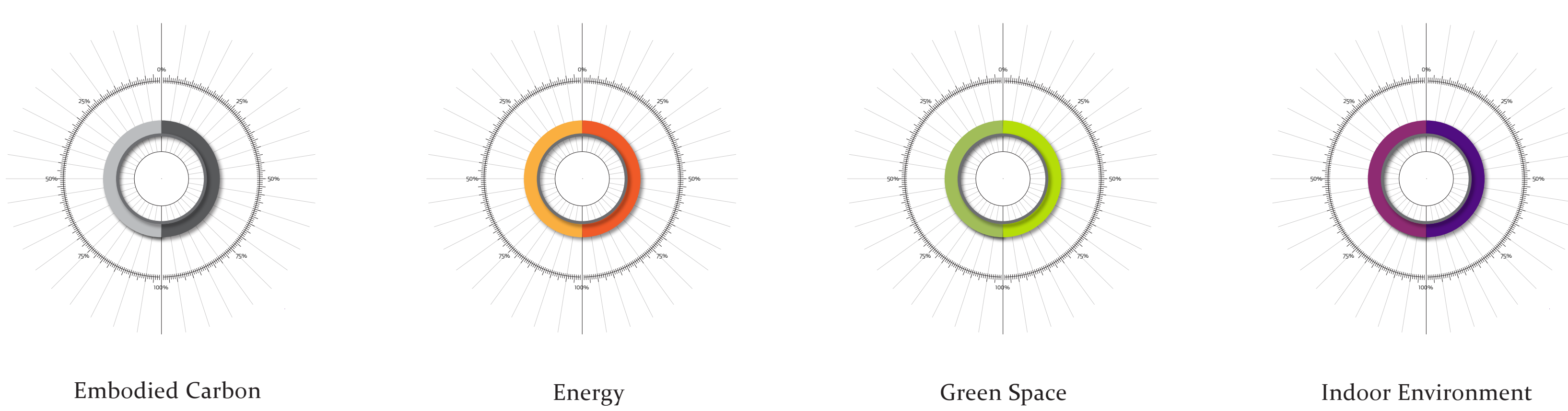


Figure 2. Measurable Sustainability Categories

building automation system, tracking live performance data and highlighting inefficiencies or failures in the systems. The circular graphics illustrate a number of key metrics including energy systems, water systems, green space impacts, carbon usage and more. The simplicity of the graphic allows it to be easily understood, rated and compared. It is intended to inform tenants and potential tenants of the effective efficiencies of the building.

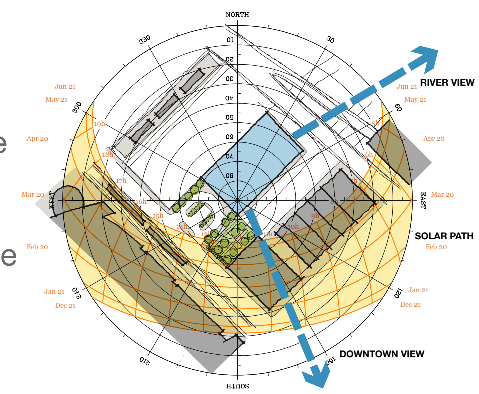
1 United Nations Environment Programme Sustainable Buildings and Climate Initiative. (2009) Buildings and Climate Change: Summary for decision-makers. Page 9.
2 Hellman, Jay. (May 1995) "The Virtual Office" Buildings/ Cities/ Suburbs. Urban Land. http://www.virtualadjacency.com/wp-content/uploads/2009/02/uli.pdf. Pages 54-55.
3 International Council for Local Environmental Initiatives. (1995) The Local Agenda 21 Planning Guide. Section 1.01. http://web.idrc.ca/openebooks/448-2/#page_5.

GREAT SITE

- located on edge of urban center
- near amenities like restaurants, shops
- near central business district
- near residential neighborhoods
- has access to city utilities
- connected to public transportation
- has access to bicycle networks
- is a previously developed site

SMART DESIGN

- locate masses for solar gain in cool climates
- shade direct summer sun
- orient for views
- capture prevailing breezes for ventilation
- create new green public space
- restore natural habitat with appropriate plants
- enhance pedestrian experience
- provide new amenities
- contribute to neighborhood improvement
- increase permeability of site
- cover parking

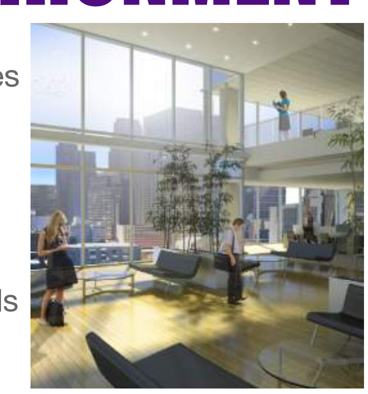


MATERIAL LIFE CYCLE

- evaluate material selections for carbon impacts
- review procurement to minimize GHG emissions
- minimize high-embodied energy materials
- emphasize regional, renewable selections
- prefer certified responsible products

INDOOR ENVIRONMENT

- design for daylighting
- manage daylight with shades
- maximize view access
- emphasize views of nature
- provide natural ventilation
- improve air filtration
- minimize pollutant sources
- avoid VOCs & toxic materials
- enhance occupant control
- design for thermal comfort



Photos: iStockphoto. Skyline. Street Car. Richard Eriksson. Bicycle Lanes. Paul Krueger.
Pioneer Square Totem Pole. Seattle Photographs. Wood Panels. Peter Aaron / OTTO.
BG Group Place Entrance. Peter Aaron / OTTO. Water Droplet. iStockphoto.
1180 Peachtree. Jonathan Hillyer. 300 North Lasalle. Peter Aaron / OTTO.

NET-ZERO ENERGY

- design curtain wall for maximum thermal resistance
- maximize insulation on opaque surfaces
- shade most exposed elevations from direct solar gain
- uses most efficient systems for heating & cooling
- employ energy recovery & mixed-mode ventilation
- heats water with solar energy
- generates electricity with photovoltaic panels

NET-ZERO WATER

- minimize flow, flush, irrigation & process water demands
- employ integrated water design approach
- harvest all possible water sources
- store & treat rainwater
- treat & recycle grey water & black water
- store, treat & recycle condensate blowdown

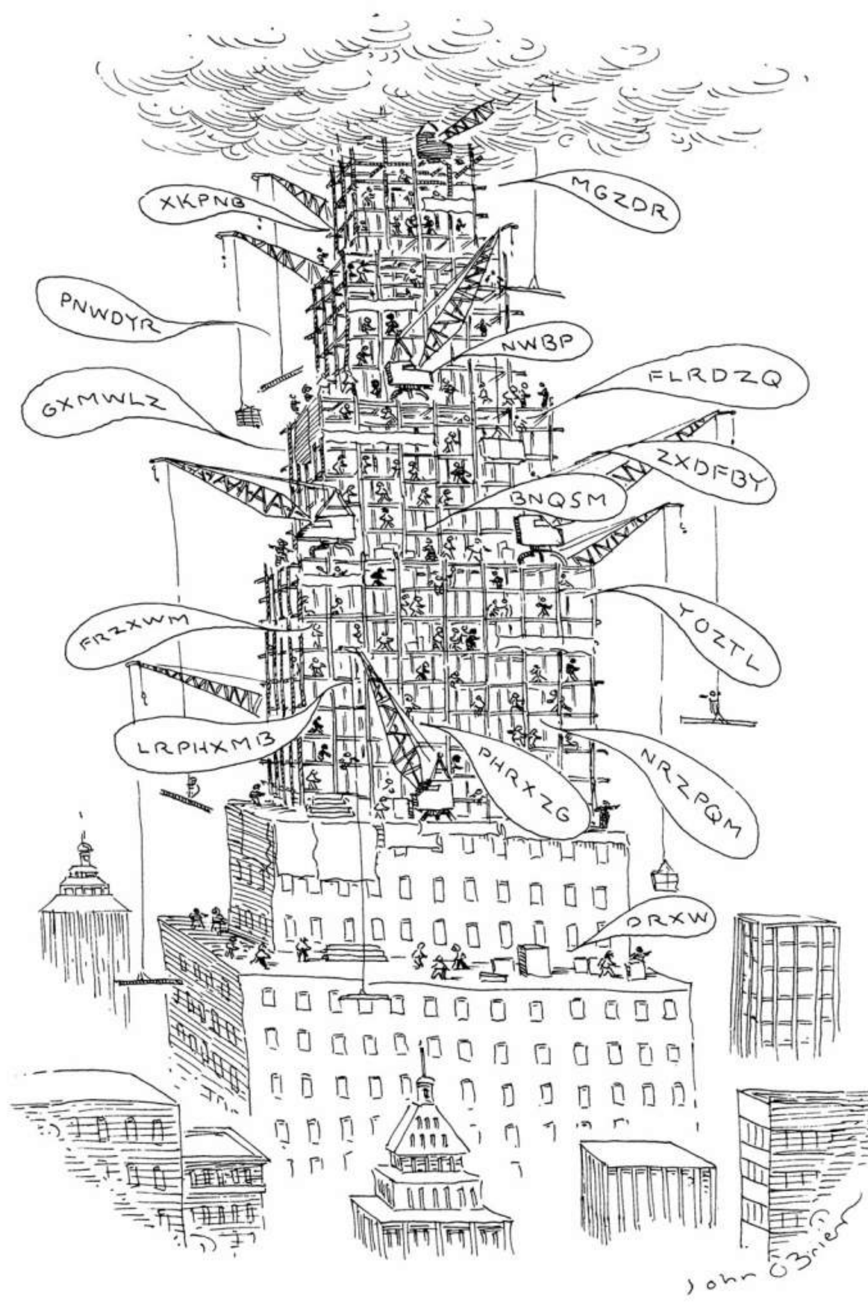
BUILD IT RIGHT

CERTIFY

VERIFY

MAINTAIN

Modularity


XKPNG
MGZDR
PNWDYR
NWBP
FLRDZQ
GXMWLZ
ZXDFBY
BNQSM
FRZXWM
YOZTL
LRPHXMB
PHRXZG
NRZPQM
ORXW

1

"The bottom line is that with modular construction you can get a facility built to the same local codes with construction quality as good as or better than a comparable site-built building in much less time. Additionally, the abbreviated construction schedule allows you to get a return on your investment sooner while minimizing the exposure to the risks commonly associated with protracted construction schedules." [2]

1 O'Brien, John. Cartoon. The New Yorker Collection. 06 February 1989: Online.
2 Modular Building Institute and the USGBC's LEED: Version 3.0 2009 Building Rating System.

How Will Construction Become More Efficient?

A SHIFT TOWARD MODULAR CONSTRUCTION

One of the most significant conclusions resulting from this study is that while the OBF will be unique, site specific and responsive to its climate and environment, its development can be efficiently achieved through an advanced system of modular building. An innovative modular system will offer the adaptability, efficiency and economy necessary to balance the owner's business objectives with the well-being and productivity of the tenants and the appropriate use of natural resources. Modular construction merges high-tech BIM and the simple concept that eliminating excess saves money.

QUALITIES

A modular system will support the goal of providing environments that are healthful and conducive to employees' productivity and well-being by providing aesthetic versatility; greater flexibility of the workplace; ability to repurpose spaces; durability; the integration of high-performance components and technologies; and improved indoor air quality. Interior planning flexibility can be incorporated into the design of the modular system to allow for the future conversion to residential use. As the dynamics of the real estate market shift, spaces could be repurposed to either retail or residential space to allow the OBF to be responsive to economic conditions.

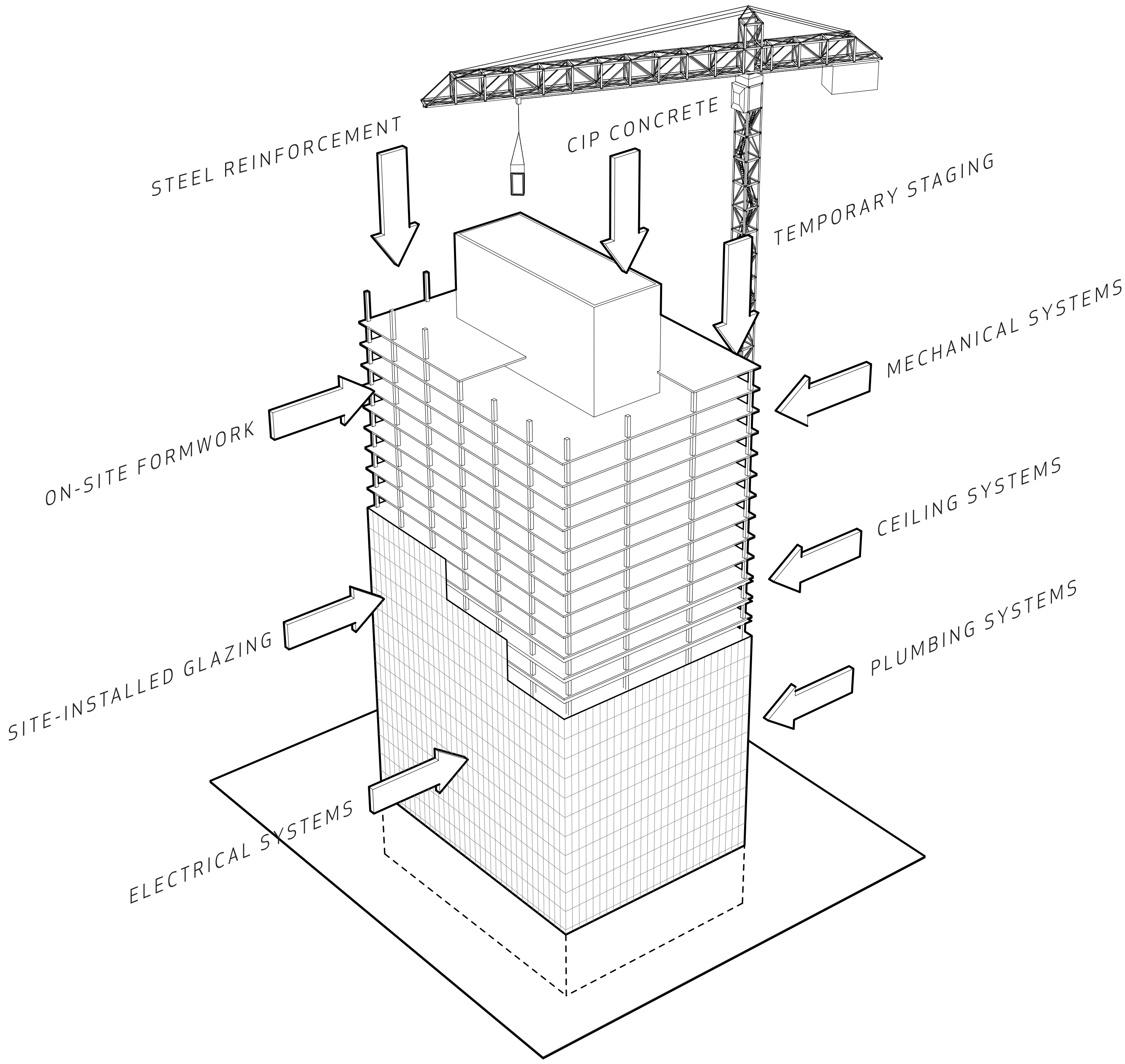
BUSINESS OBJECTIVES

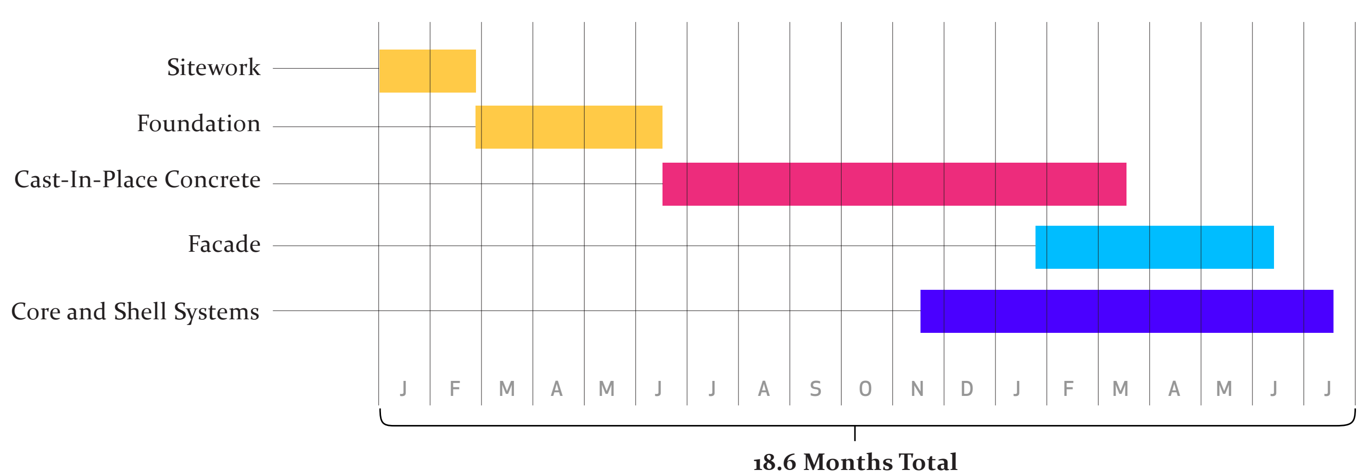
A modular building system offers significant economic advantages including shorter construction time (due to speed of erection, negligible weather delays, and increased structural efficiency) and greater cost control as a result of the following: a highly efficient manufacturing and construction process with an increased number of skilled workers, fewer subcontractors, and reduced overhead cost and material redundancy. The system allows for efficient off-site construction in controlled environments that offer greater tolerances and higher quality control. The components are sized to be easily transported by truck, delivered to the site and assembled by a smaller workforce. As units are shipped after being manufactured, they do not require a significant staging area on site prior to construction. With a faster construction period than the typical office building, the system will result in short- and long-term cost savings as well as earlier tenant occupancy.

SUSTAINABILITY

A modular building system would realize the goal of sustainable construction techniques and longevity for the OBF. During construction, the system offers greater resource consciousness with locally sourced and manufactured materials as well as the optimized use of these materials through the reduction of waste; reuse of molds and forms and incorporation of recycled components. The faster construction schedule will minimize neighborhood disturbance. The integration of high-performance mechanical systems will provide excellent comfort levels with a minimum amount of energy use over the life of the building.

Photo: Licensed from iStockphoto.com

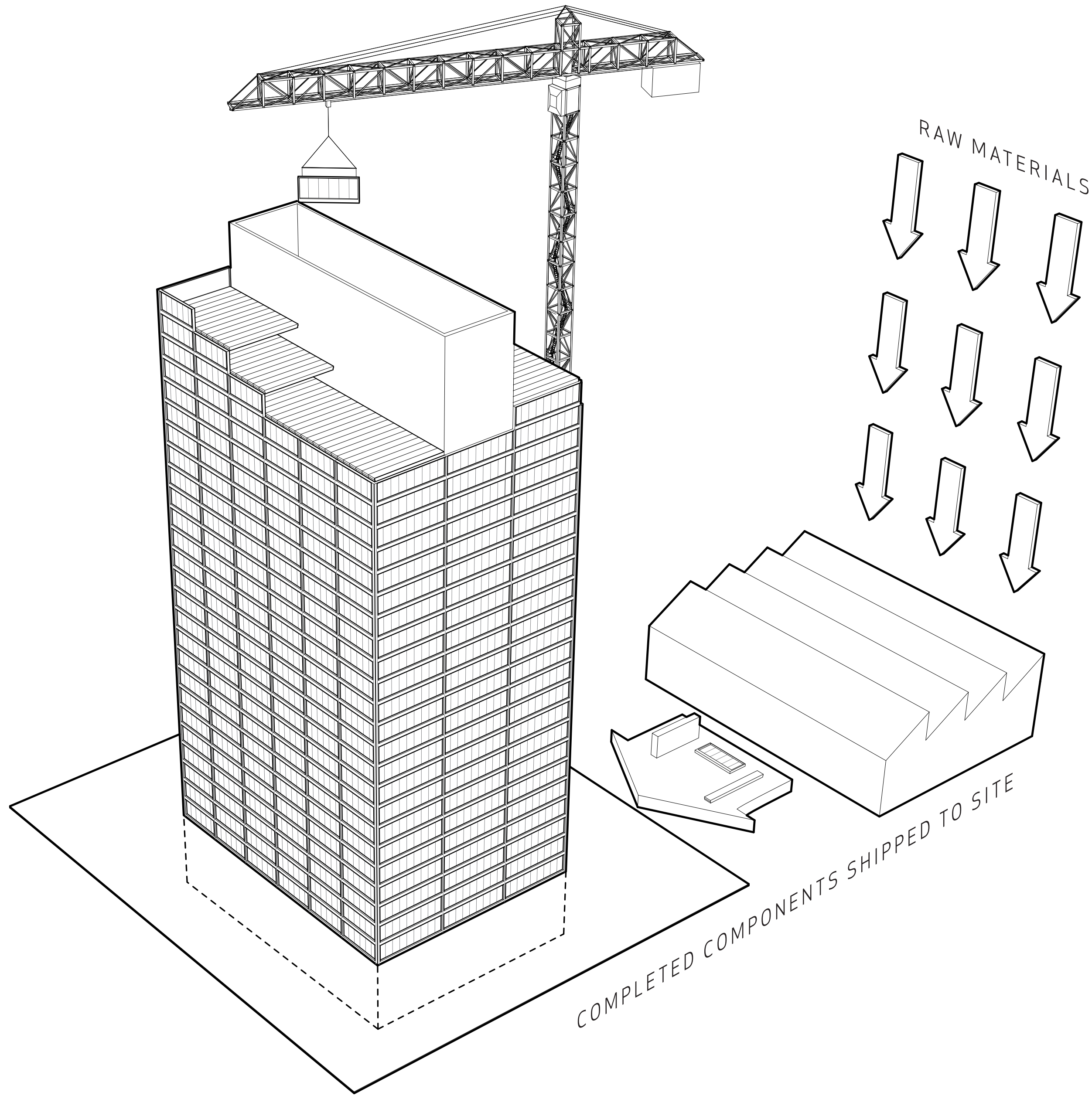


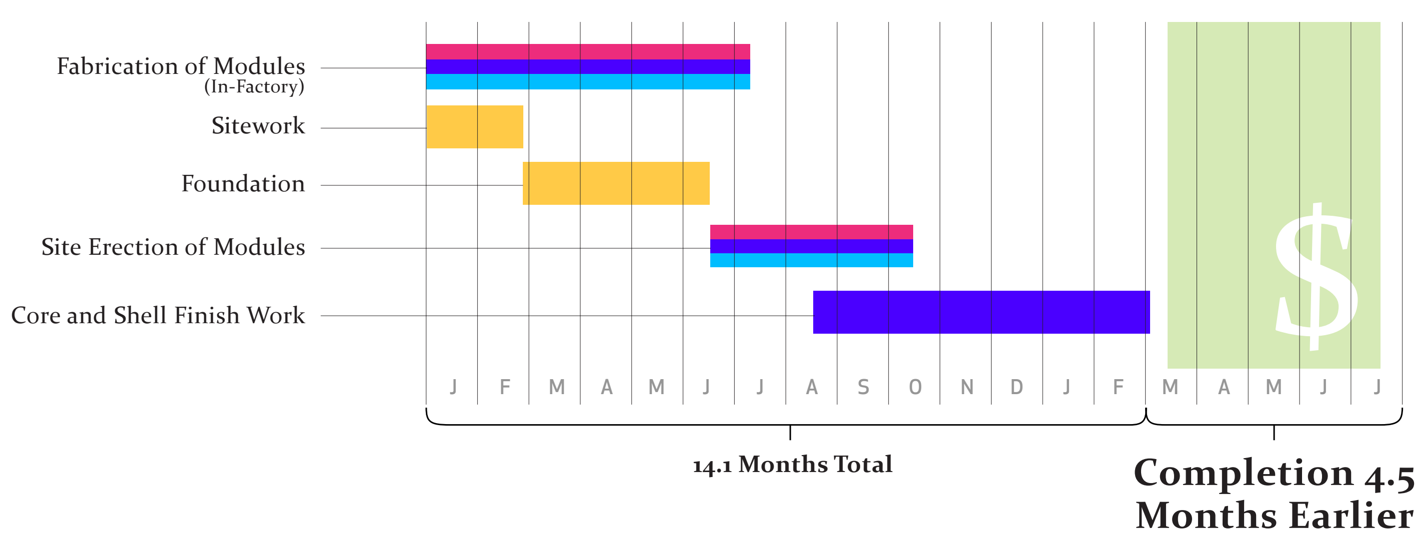


CONVENTIONAL ON-SITE CONSTRUCTION

A study of normative on-site construction technologies and timeframes yields a number of interesting conclusions when compared with modular in-factory fabrication. Many of these differences result from time spent erecting formwork, installing rebar, and waiting for concrete to cure. HVAC, plumbing, electrical, and other systems must be installed entirely and simultaneously on site, creating coordination issues and lengthening the construction timeline. The facade and exterior systems are installed incrementally. Overall, this conventional approach to building contains the following on-site risks:

- Weather delays
- Imprecise measurements
- Imprecise concrete mixtures
- More staging requirements
- More material waste
- More damaged material
- More community disturbance
- Costly unionized labor





MODULAR IN-FACTORY FABRICATION

A factory-fabricated approach enables a number of positive scenarios in which the building components can be constructed in a highly controlled environment. The building structure, facade, and systems are fabricated and assembled in the factory during the sitework and foundation phases, thus maximizing time efficiency. Time required for on-site systems and finish work is also reduced because modules are delivered from the factory with building systems pre-installed. A few in-factory benefits are as follows:

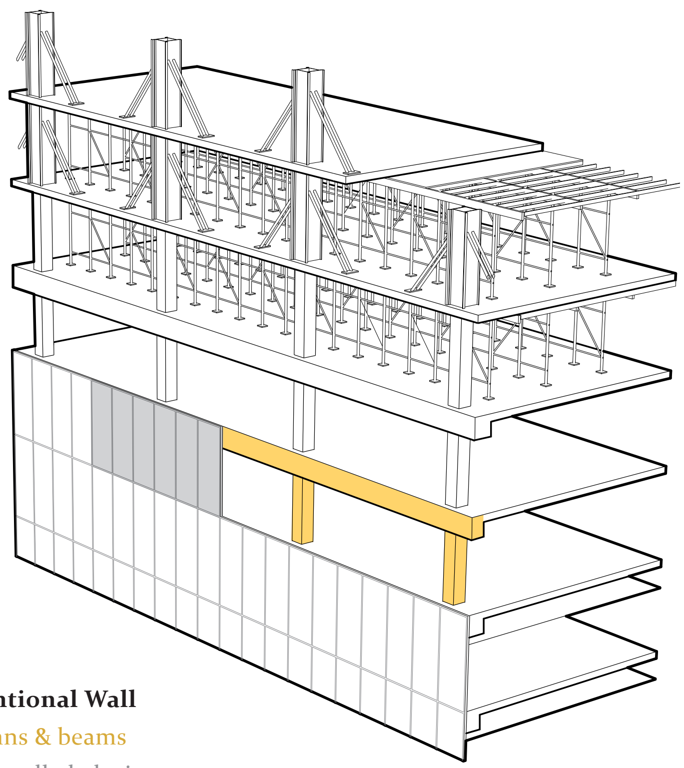
- Streamlined manufacturing process
- Constant access to necessary tools and equipment
- Easier management and quality control
- Ideal concrete curing environment
- Fewer subcontractors
- Less wasted material
- Fewer coordination issues
- Inexpensive storage of materials

Note: The calculations in these timelines have been prepared by Gilbane Building Company and are based on the *Base Building*, shown on pages 48-52. See Appendix page 154 for full breakdown.

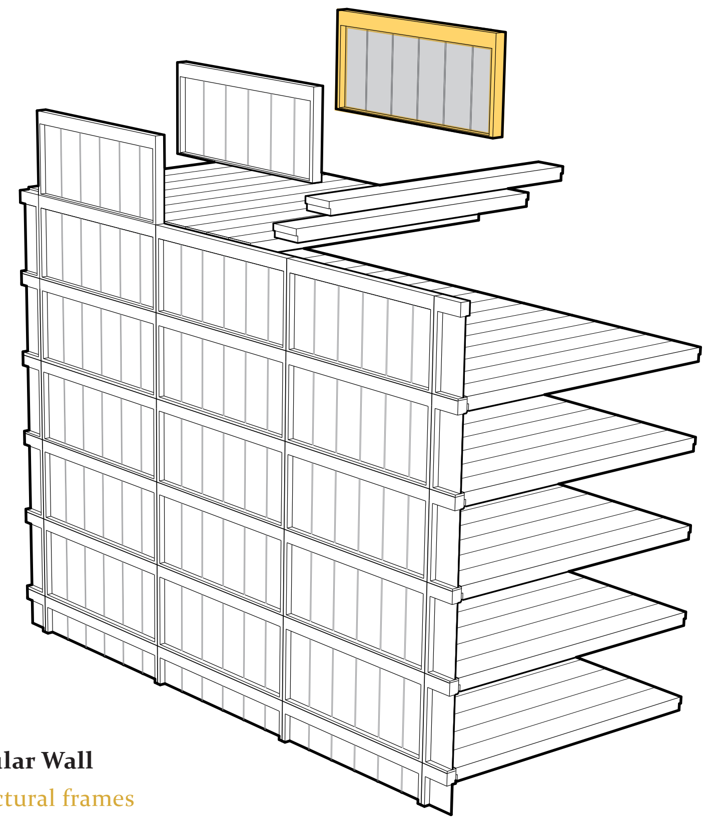
CONVENTIONAL SYSTEMS

MODULAR SYSTEMS

STRUCTURE & FACADE

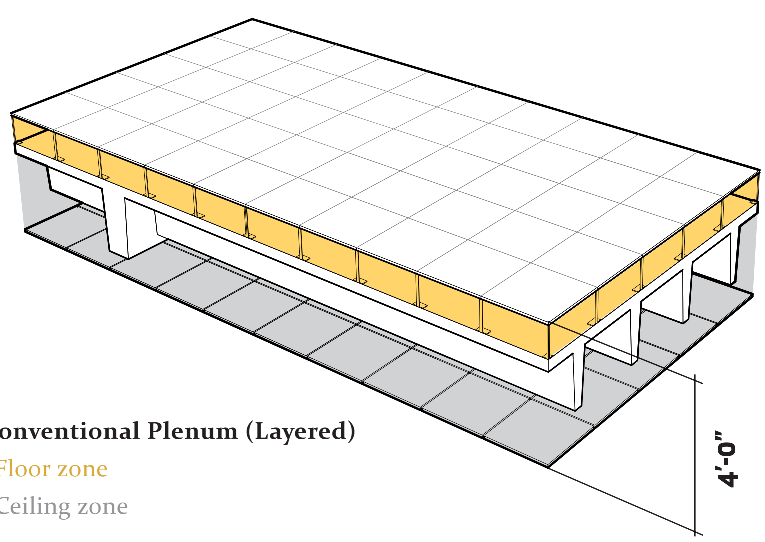


Conventional Wall
- Columns & beams
- Site-installed glazing

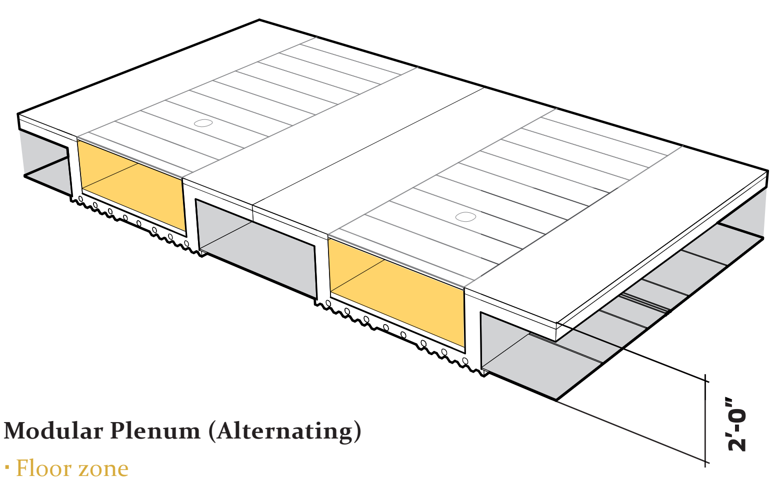


Modular Wall
- Structural frames
- Integrated glazing

FLOOR & CEILING

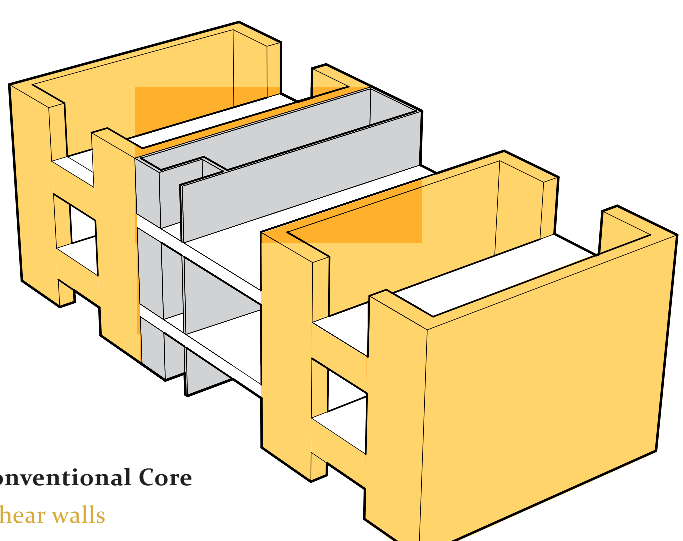


Conventional Plenum (Layered)
- Floor zone
- Ceiling zone

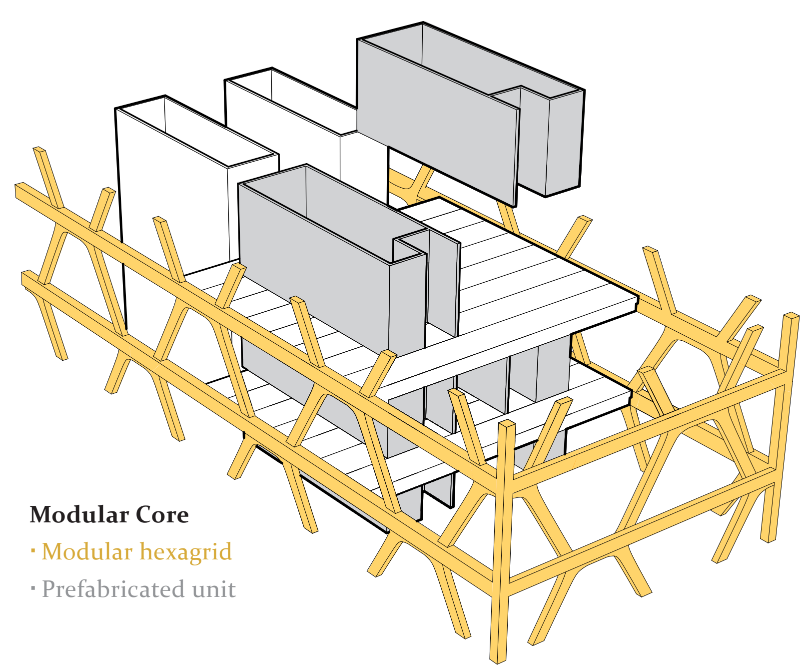


Modular Plenum (Alternating)
- Floor zone
- Ceiling zone

CORE

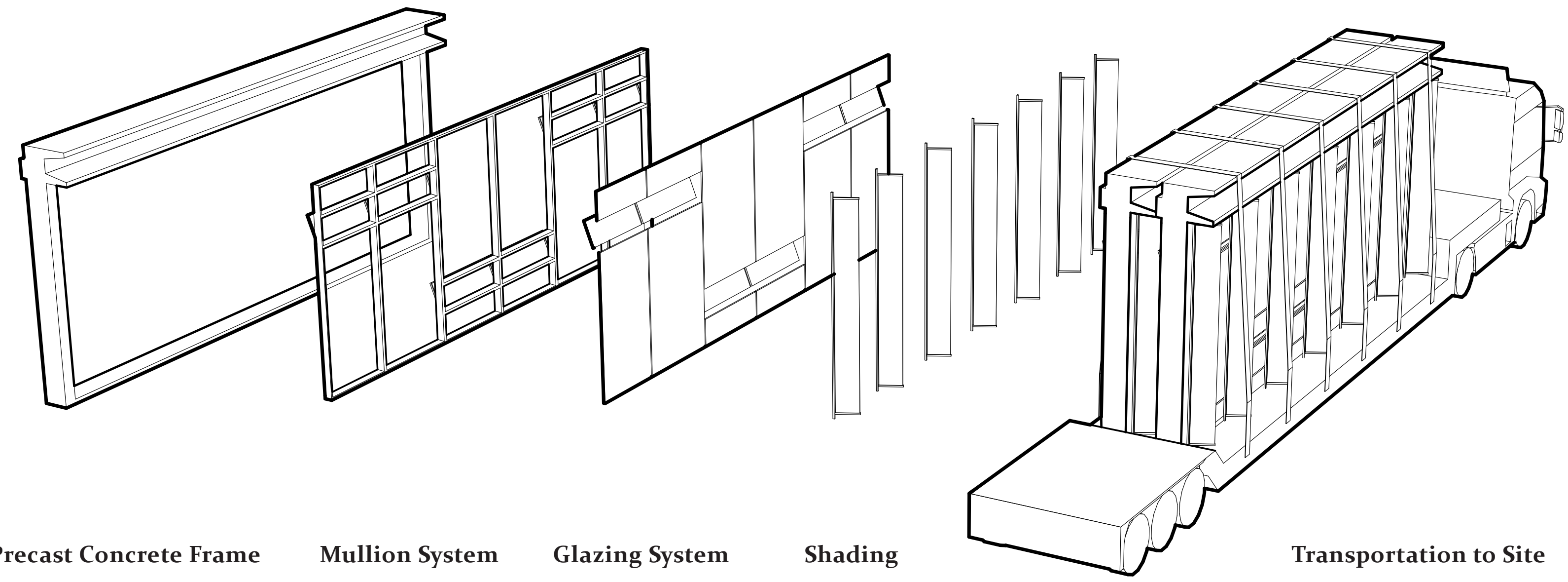


Conventional Core
- Shear walls
- Built in place

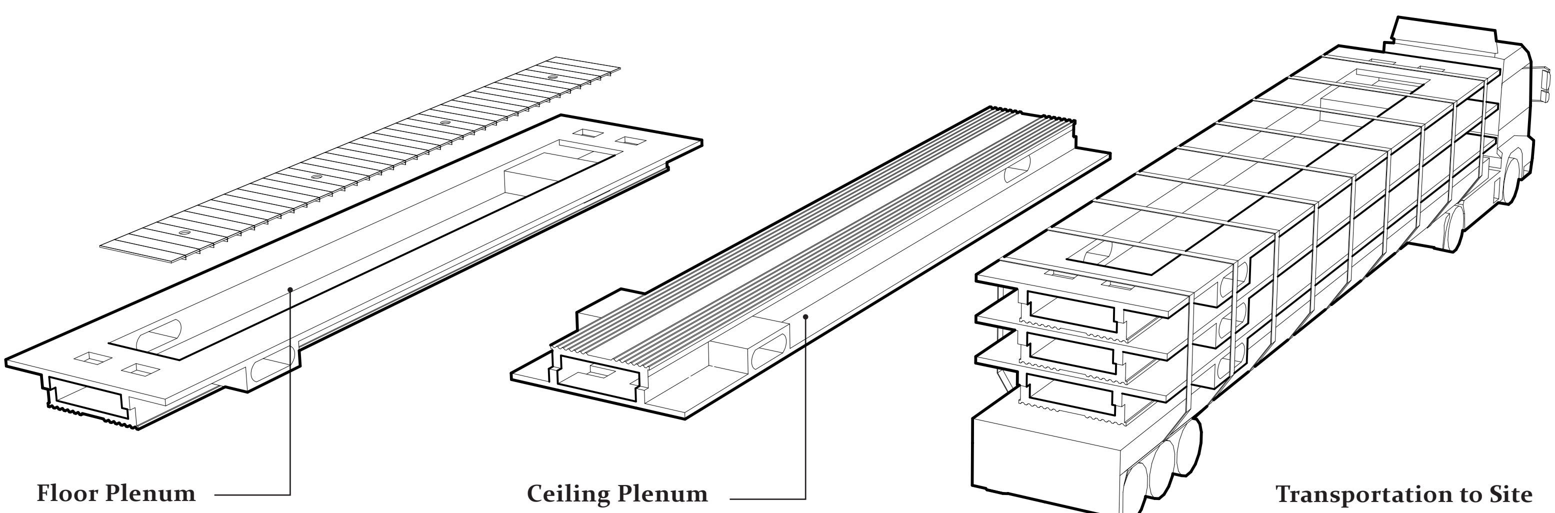


Modular Core
- Modular hexagrid
- Prefabricated unit

FACTORY ASSEMBLY



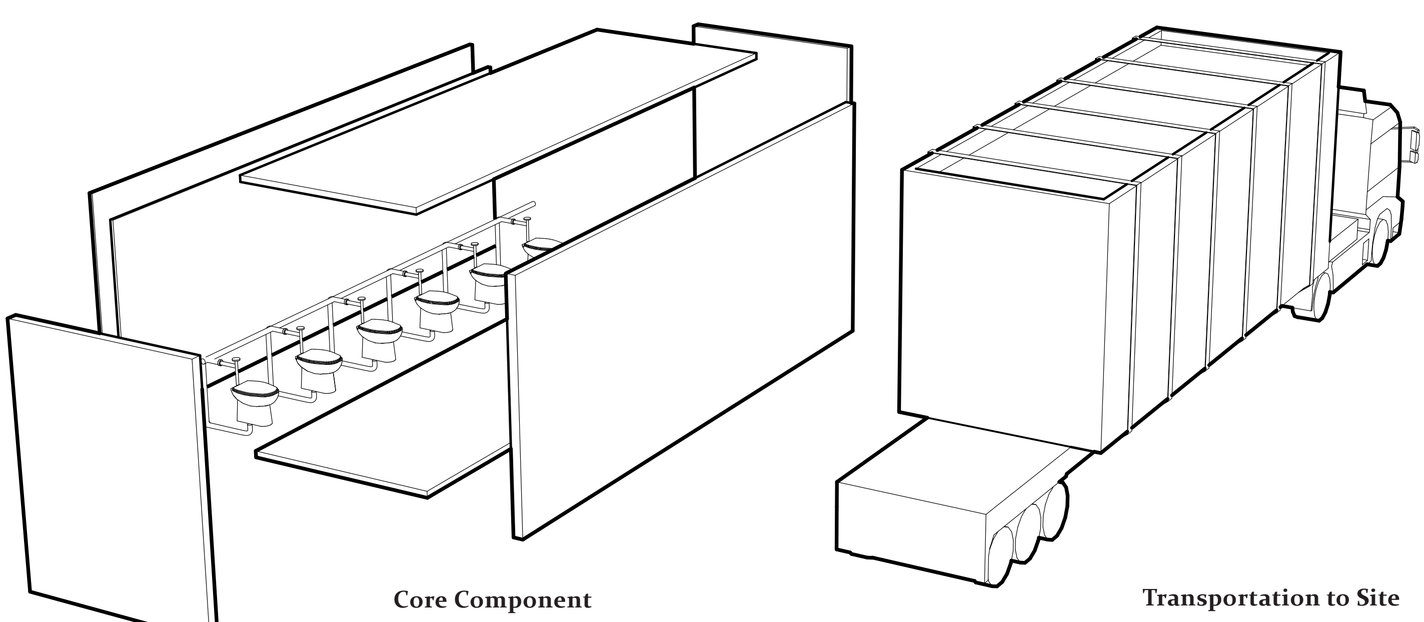
Precast Concrete Frame **Mullion System** **Glazing System** **Shading** **Transportation to Site**



Floor Plenum
- HVAC (supply air)
- Data & electrical

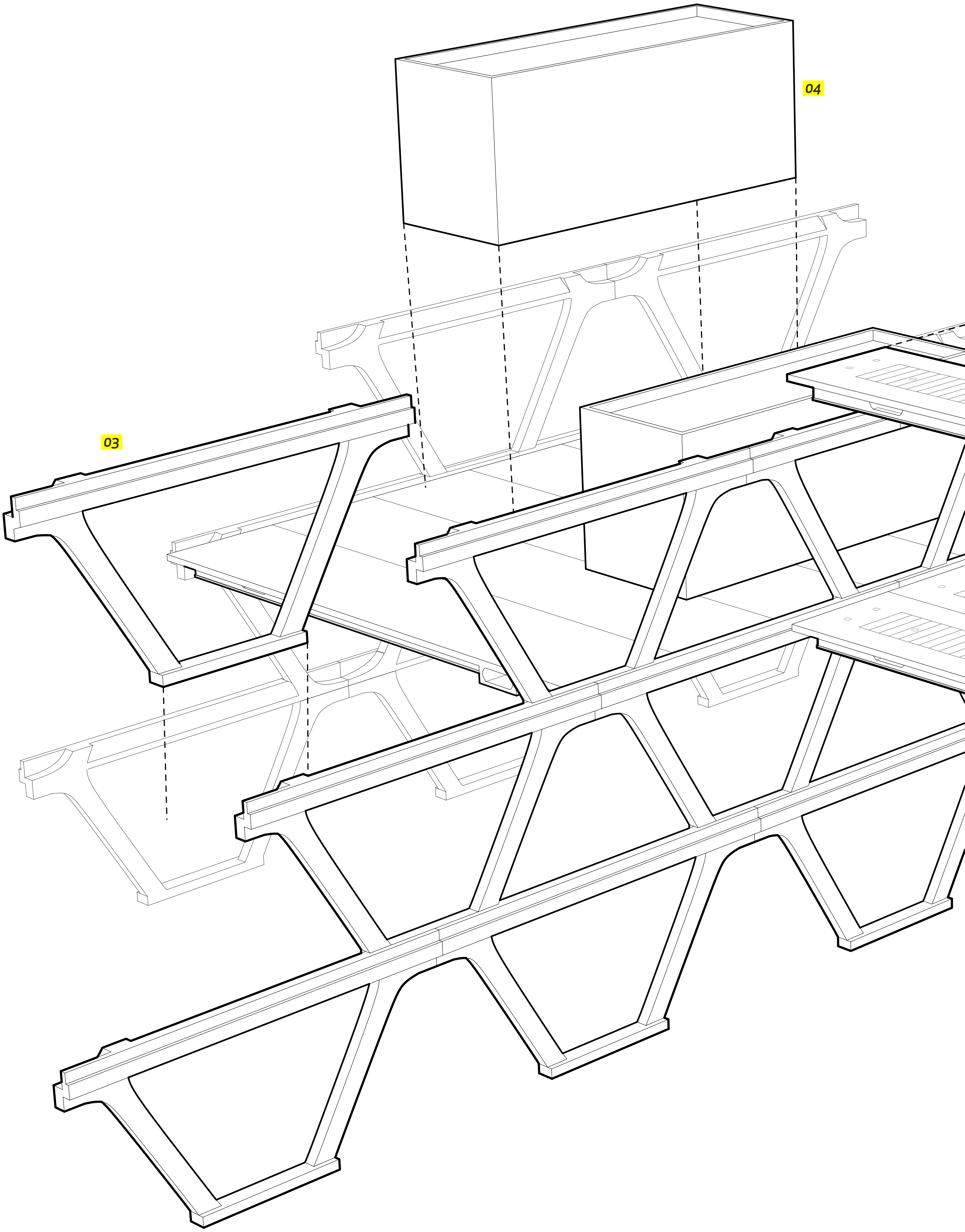
Ceiling Plenum
- HVAC (return air)
- Lighting & fire suppression

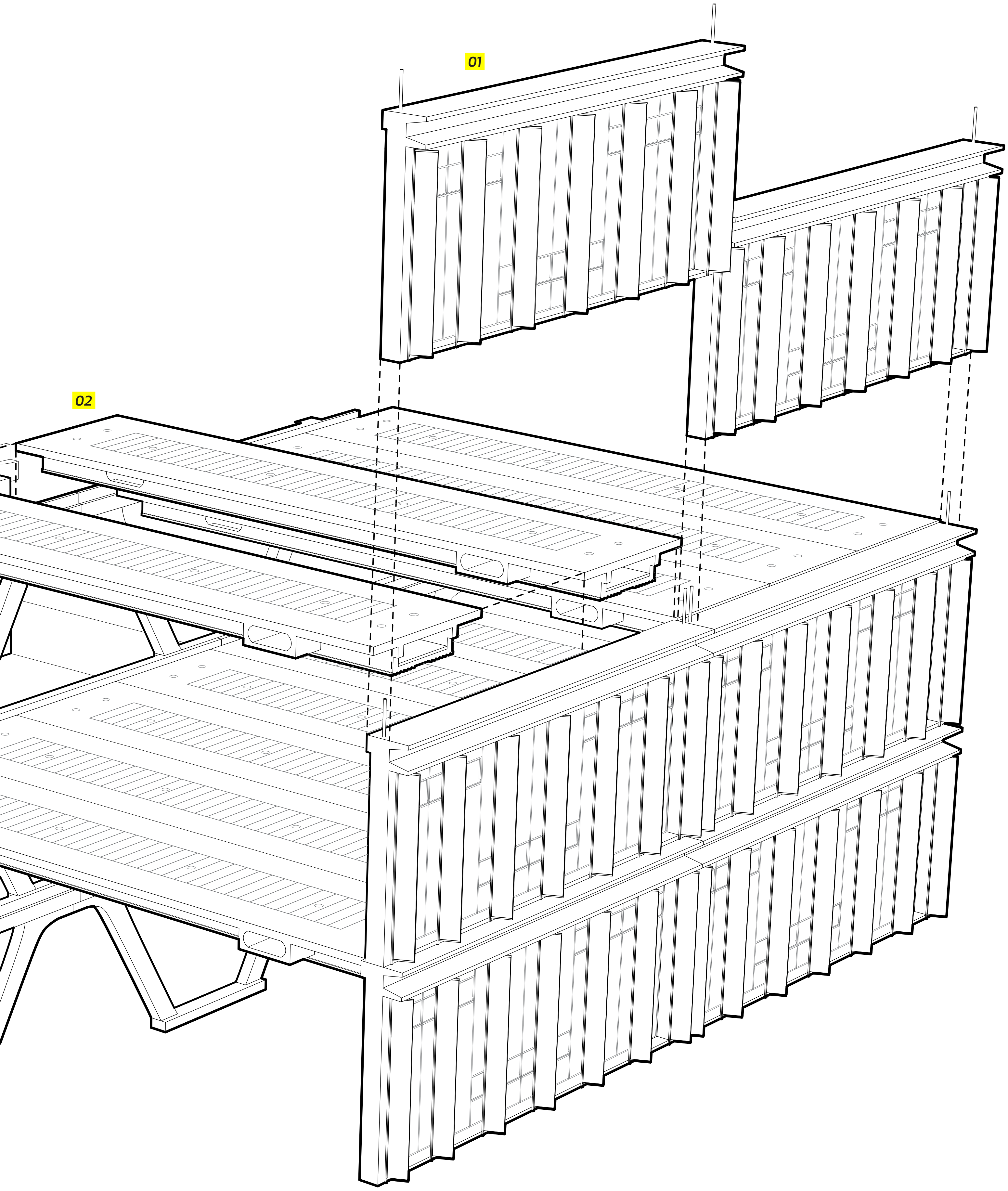
Transportation to Site



Core Component
- Restroom (shown), mechanical, stair, elevator, etc.

Transportation to Site


04
03



01 Wall Module

02 Floor Module

03 Core Structural Module

04 Core Systems Module

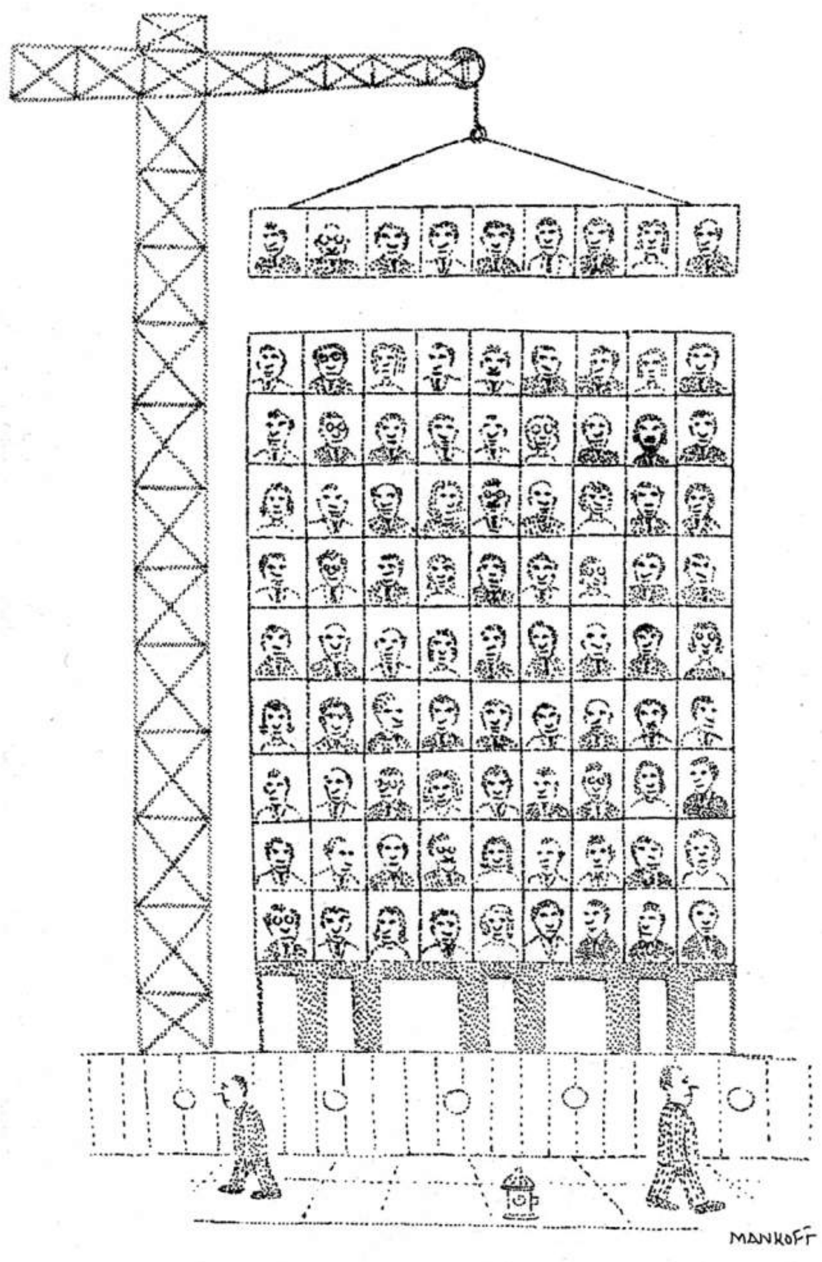
MODULAR ON-SITE ASSEMBLY

The assembly of the OBF reflects a high level of coordination, both in terms of schedule and cost. These benefits are reflective of a process that works from the beginning to leverage the most advanced technologies in the industry.

> ***"In summary, the prefabricated structure proved to have a 20% schedule and a 6.35% cost advantage as compared to a CIP structure."*** [1]

1 Adamowicz, Peter J. Gilbane Building Company. Glastonbury, CT.

Prototype


MANKOFF

"Ecology, Economy and Equity anchor a spectrum of value and at any level of scrutiny, each design decision has an impact on all three." [2]

1 Mankoff, Robert. Cartoon. The New Yorker Collection. 7 May 1979: Online.

2 McDonough, W, and Braungart, M. (2002) Design for the Triple Top Line: New Tools for Sustainable Commerce. Corporate Environmental Strategy. Vol. 9(3). Page 254.

What Is The Building Block Of The Future?

A PROTOTYPE FOR THE MODULAR OFFICE

Throughout the last century, numerous attempts were made to design and adapt modular building systems for commercial construction. These past designs have generally not proven to be viable because they did not align a strong original concept of modularization with the realities of building materials and construction processes. In the case of the OBF, the fine grain details of building systems and logistics have been carefully considered in an effort to produce a new methodology of construction that is feasible in both concept and practice. The wall, floor and core modules are viable both as components and as assemblies at the scale of an office floor and at the scale of the building. In addition to the logistical and technical advantages, the system is inherently flexible, able to accommodate a variety of building systems technology and capable of being assembled into a range of building forms with a variety of architectural expressions.

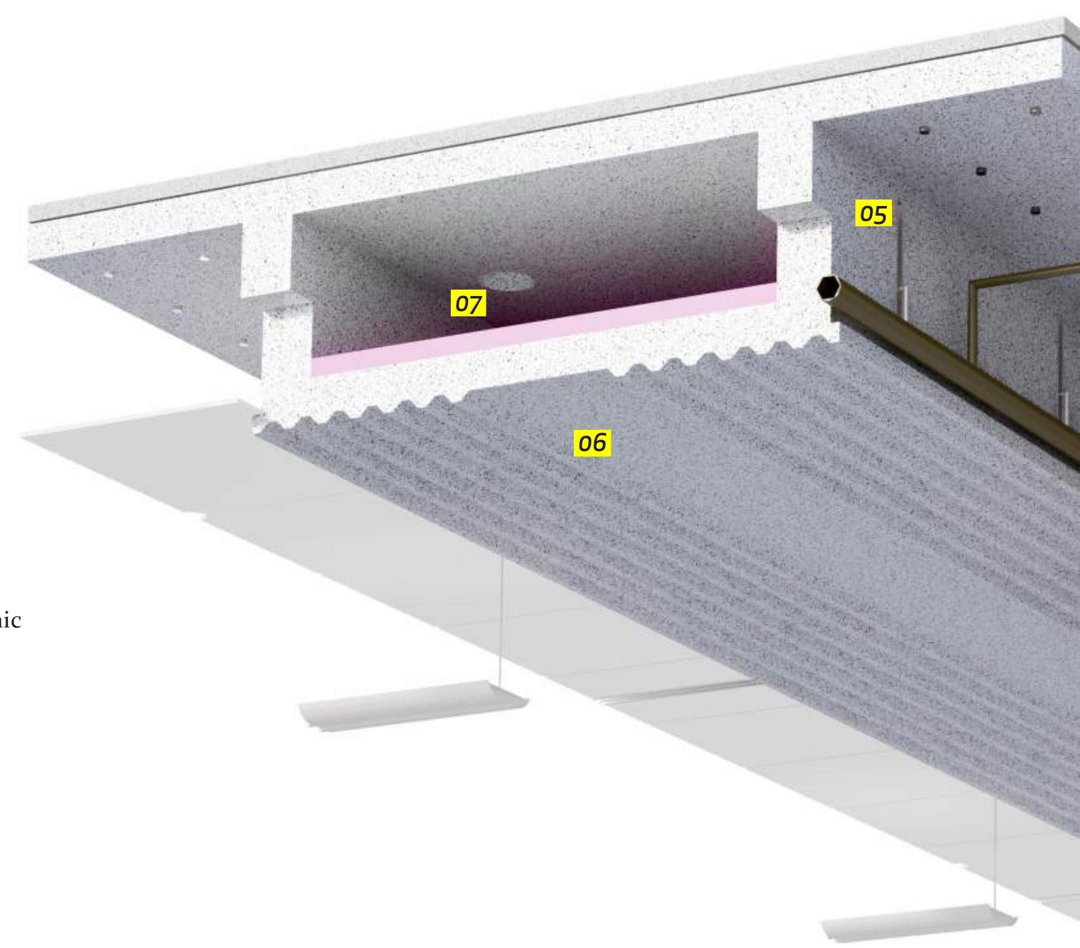
Every major component of the building assembly is considered for its potential disassembly into modular units that could be fabricated in a factory environment. A key parameter for each element is that it fit on a truck for delivery to the site. Precast concrete is used as the main structural component for the modular system as it offers the greatest flexibility and is widely available. Additionally, due to the anticipated availability of new higher-strength materials and mixtures that minimize or eliminate the use of Portland cement, it offers greater advantages in achieving the sustainable ambitions of the OBF. It should be noted that the modular system is designed to be assembled atop a typical office building foundation. It was concluded that, other than potential changes in the composition of concrete, in the foreseeable future there are likely to be few dramatic advances in below grade structures that significantly alter current methods. The modular system's innovative attributes occur as they rise above the ground plane.

To further balance the needs of both owner and tenant, consideration was given to define basic metrics such as the optimum lease depth and floor-to-floor height. It was determined that a 45-foot wide floorplate would offer the most flexibility, and that the unit design would maintain a floor-to-floor height of 13 feet. In order to meet goals of sustainability and quality it was assumed that this floorplate, with operable glazing on both sides, would be a basic formation of all building massing strategies, and thus the modular "kit of parts" is devised for its configuration.


THE ORIGINAL
TINKERTOY
WINDMILL
DOG
JET PLANE
LOG TRUCK

Floor Module

COORDINATED SYSTEMS



The structural floor module incorporates mechanical, electrical, communications, fire suppression and lighting systems into a single, integrated assembly. Constructed using precast concrete, structural sections measuring 45 feet by 10 feet span the width of the floorplate and are envisioned to be 24 inches deep, one-half of the traditional plenum depth. This savings in plenum depth is achieved by alternating the ceiling and floor cavities and interweaving them within the necessary structural depth. Incorporated within the precast concrete elements are hydronic cooling/heating loops to maintain proper building temperature, integral air highways to distribute supply and exhaust air, and a cast-in mounting system for electrical and communication routing.

The precast elements are fabricated off-site in a factory setting where all of the building mechanical and electrical systems can be pre-fitted. As the building elements arrive on site, they are simply lifted off the delivery trucks and set directly in place. A topping slab joins the individual components to create a continuous diaphragm and the necessary systems are connected.

01 Under-Floor Air Diffuser (Supply Air)

02 Accessible Raised Floor Panels

03 Integrated Supply Air Duct

04 Closed-Loop Chilled Beam System

05 Cast-In Unistrut Mounting System

06 High Strength 30-Foot Precast Floor Module

07 Chilled Beam Insulation

08 2-Inch Fine-Finish Topping Slab

09 Accessible Ceiling Panels

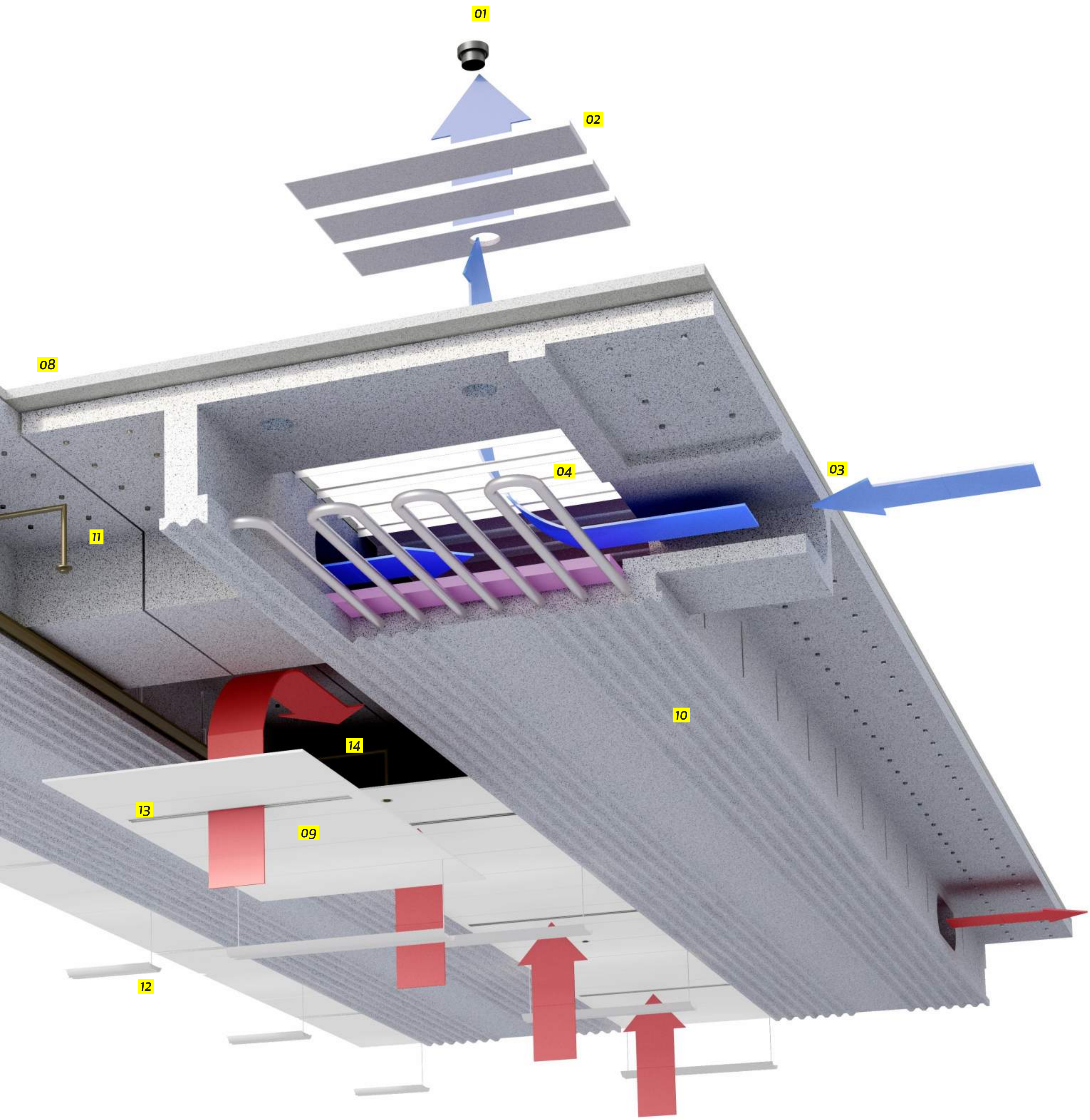
10 Acoustic Beam Underside

11 Integrated Accessible Utility Cavity

12 Sensored High-Efficiency Lighting

13 Return Air Diffuser

14 Integrated Return Air Plenum


01
02
08
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13
09
12

Wall Module

THE INTEGRATED FACADE

The convention in office building construction has long been to separate the structure and facade of the building perimeter into two distinct components, requiring two trades working on site and two steps in the construction process. For the OBF, the structure and facade is combined in the factory and delivered to the site as a complete single wall unit. As the perimeter columns and spandrel beams are being lowered into place, so also are the glazing, shading and facade systems—a clean, single-step process to erect a dried-in building. Measuring 30 feet by 1 foot, each structural bay's columns and spandrel beam are precast as continuous frames that are in-filled with the latest building fenestration technology: using high R-value materials, such as mullions made of pultruded fiber-reinforced polymer composites (FRP), which is fiberglass that has been formed into linear components to replace extruded aluminum, triple-pane glazing to minimize heating and cooling loads and translucent insulating panels using aerogel, interspersed to reduce loads. Solar radiation is blocked by large vertical shading devices and converted to electric energy with translucent amorphous silicon photovoltaic cells. In an effort to maximize the interior space planning, perimeter columns are shifted to the exterior of the wall—these external precast elements will be cast with integrated insulation to prevent thermal bridging to the interior.

01 High-Strength Precast Concrete Frame

02 Triple-Glazed High Efficiency Vision Zone

03 Pultruded Fiber-Reinforced Polymer Composite Mullion System

04 Translucent Fiberglass Panel With Aerogel Infill

05 Computer-Synchronized Operable Window For Airflow

06 Cast-In Structural Mounting Sleeve

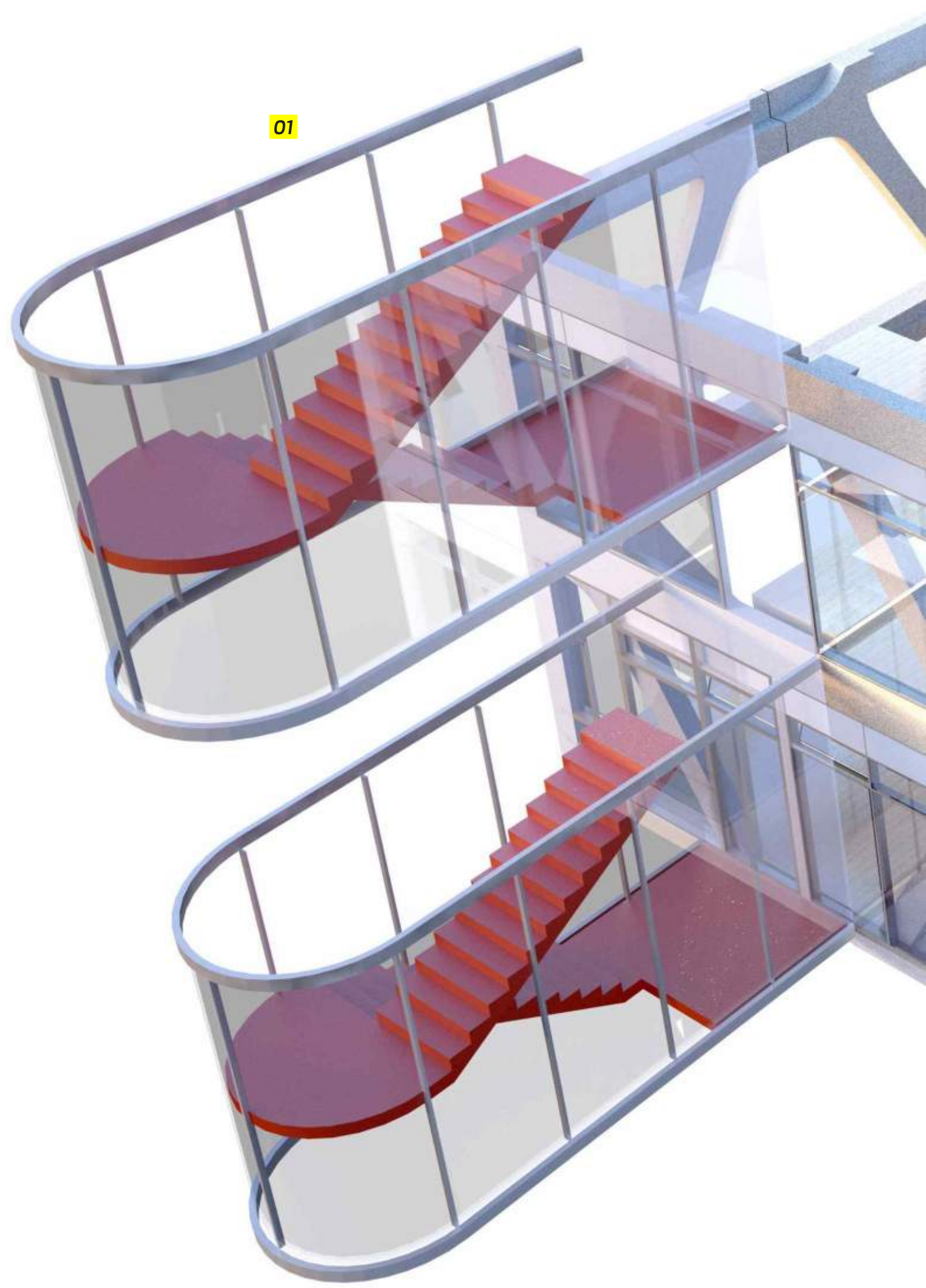
07 Photovoltaic-Integrated Vertical Sunshades


04
02
03
07
06
01
05

Central Core Module

RETHINKING THE CENTER

In a conventional office building, the core is typically a tightly packed conglomeration of large structural members for lateral support and utilitarian programmatic spaces, such as egress stairs, mechanical rooms and restrooms. It is generally treated as a necessary yet mundane grouping of spaces relegated to the center of the floorplate and obscured from natural light. The OBF will define a new paradigm, one that embraces the core as the heart of the building, a unifying open space. Rather than group all of the lateral bracing into a massive, solid concrete cluster at the building center, the OBF expands the bracing system into a large open tube of precast concrete latticework that surrounds a light-filled centralized atria. Because lateral loads are more broadly distributed, the assemblage is more structurally efficient and less material intensive. Stairs and elevator shafts are now independent of the structure and surrounded by natural light. Additionally, due to the system's inherent "plug & play" flexibility, it is intended that the independence of the structural core would allow for programmatic units such as mechanical rooms or elevators to be added or replaced at the discretion of the owner years after the completion of the initial project thereby allowing the building to be repurposed.



01 Modular Stair Section

02 Modular Wall Panel

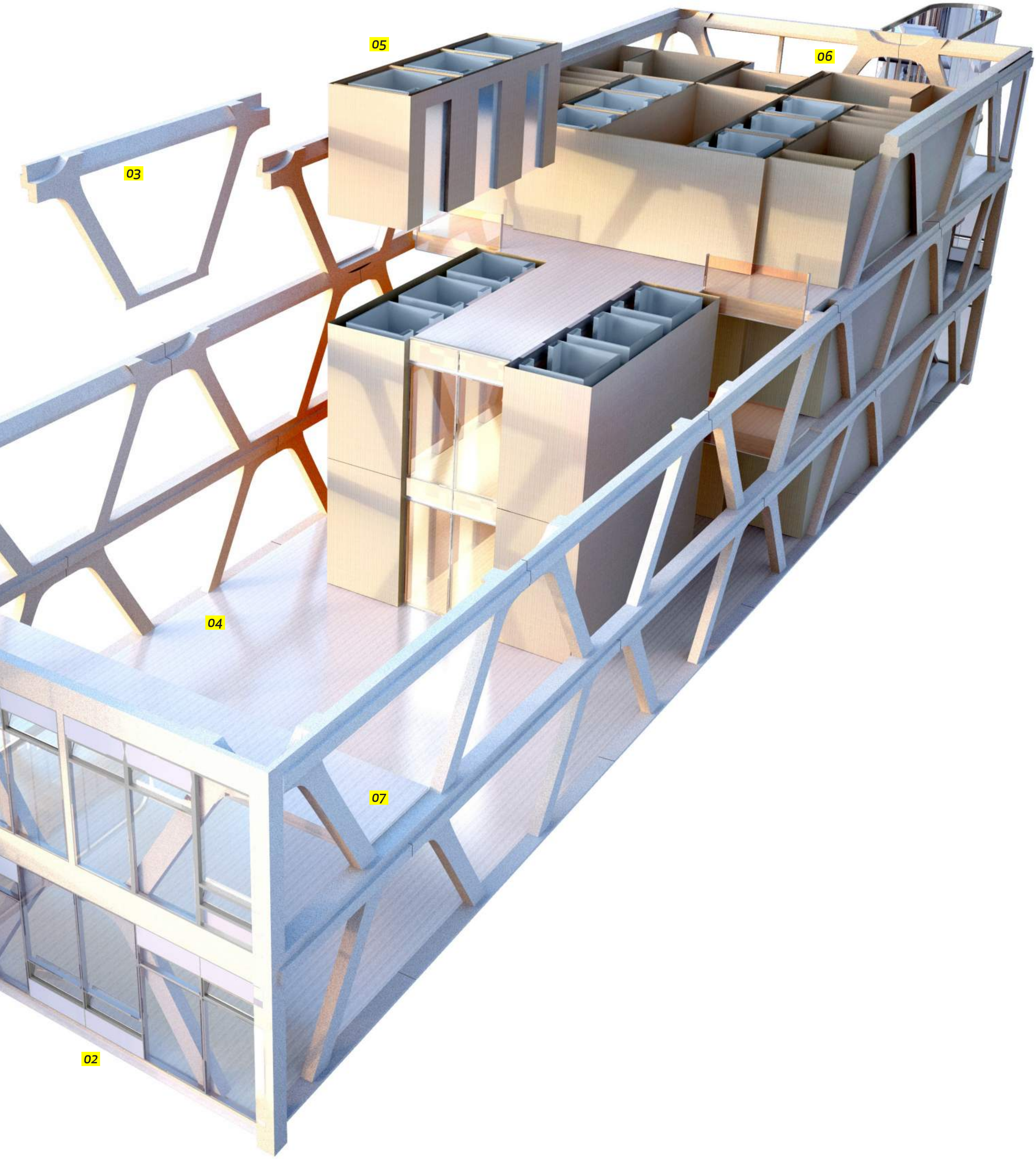
03 Shear Wall Diagrid Module

04 Floor System (Shown In Atrium Condition)

05 Elevator Module

06 Bathroom Module

07 Atrium Bridge Connection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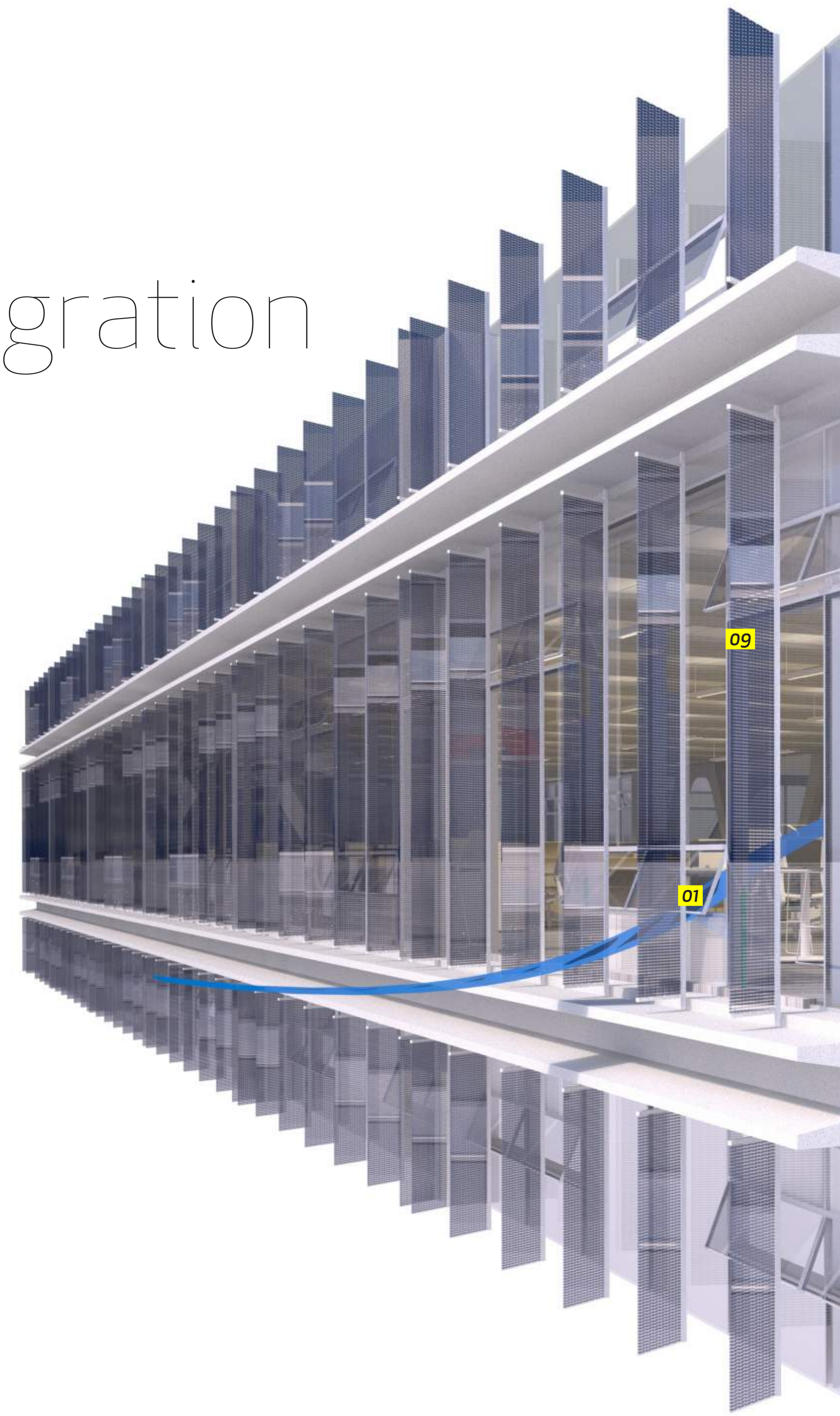
Systems Integration

THE HIGH-PERFORMANCE WORKPLACE

The OBF will be filled with natural light and fresh air and respond to the specific needs of each inhabitant. Its occupants will demand floorplates that allow democratic and universal access to the building perimeter. The OBF will be organized as a narrow building that maximizes light, air and views in and through both sides of the lease depth. With plenum spaces in the ceiling and floor deployed more efficiently, space is freed up to produce significantly higher ceiling heights. When natural ventilation is not possible, fresh air can be supplied though a matrix of small floor-mounted vents to provide each occupant the option to control local flow. Inconspicuous overhead radiant heating and cooling will efficiently maintain the proper temperature.



01 Cross Ventilation Across Building Floorplate

02 Fresh Air From Floor Vents

03 Exhaust Air Through Ceiling

04 Radiant Cooling/Heating From Exposed Concrete Ceiling

05 Task Lighting

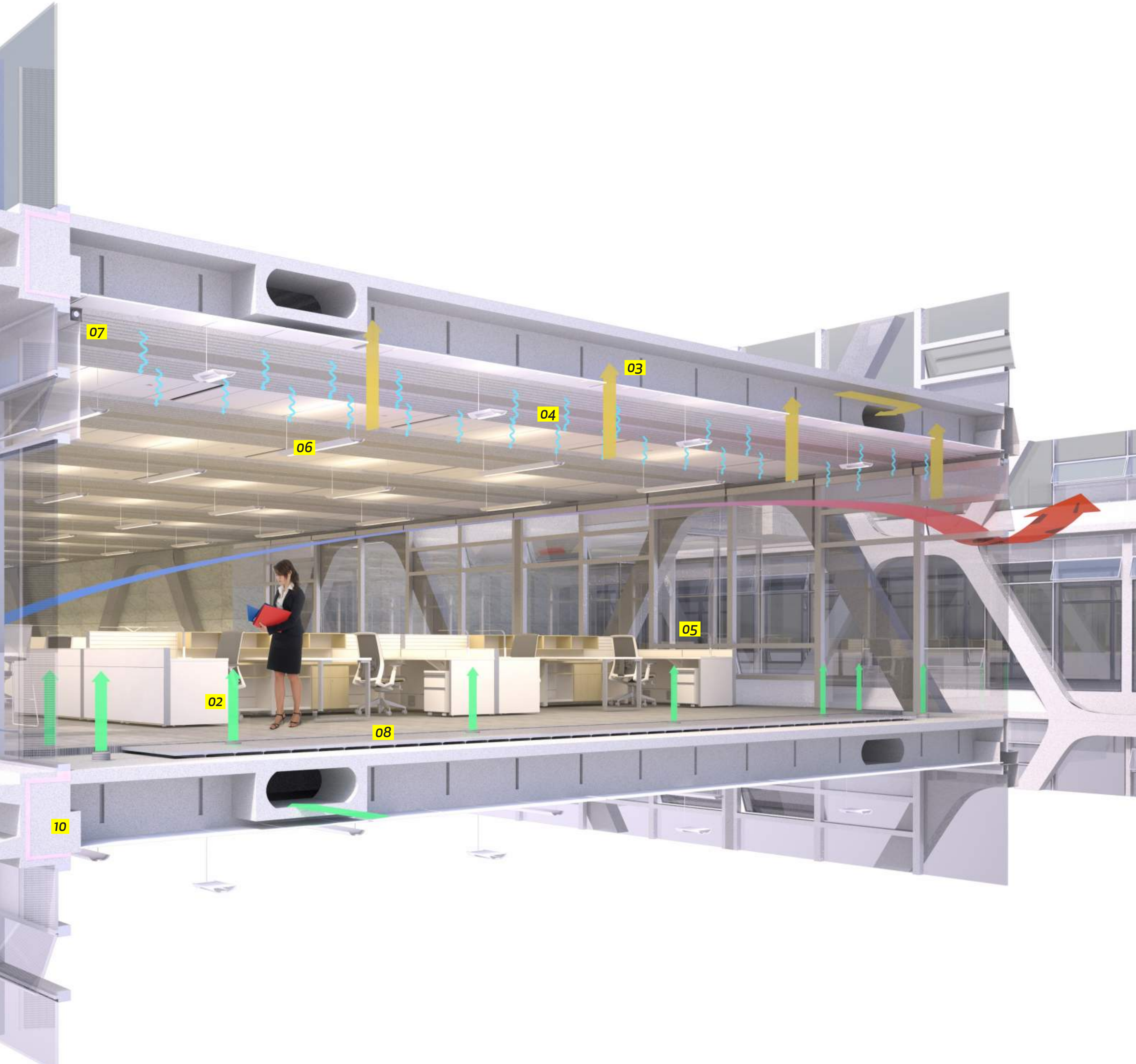
06 Dimmable Fluorescent Space Lighting

07 Roller Shades

08 Access To Floor Plenum

09 Vertical Solar Shades With BIPV Solar Collection

10 Cast-in Insulation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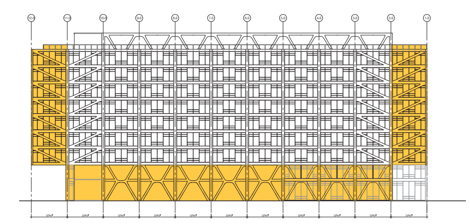
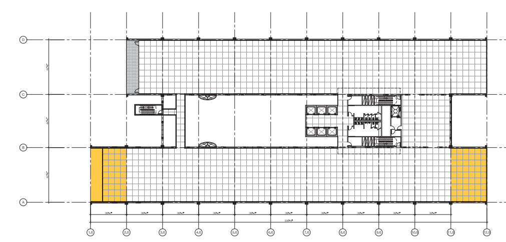
Cost Analysis



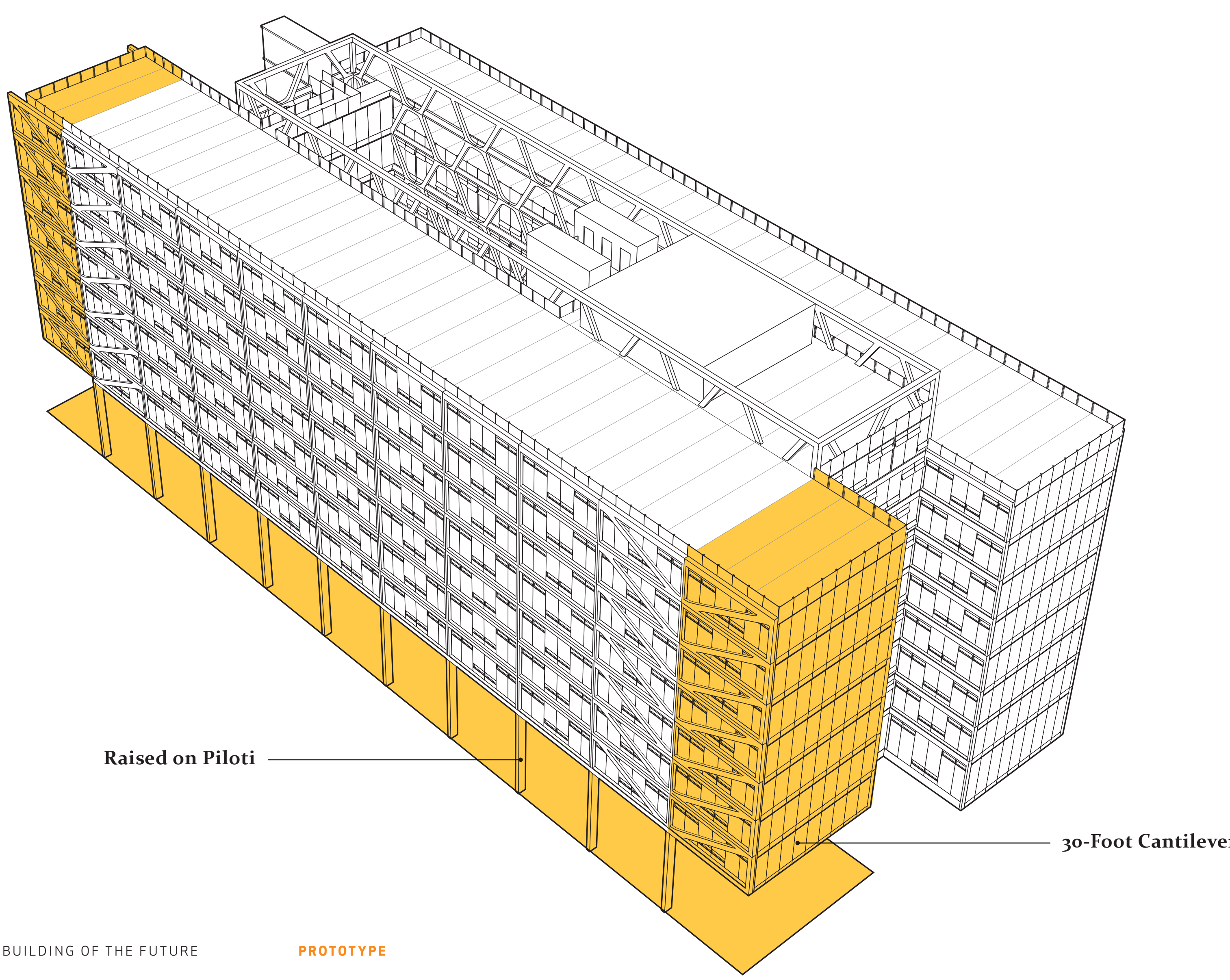


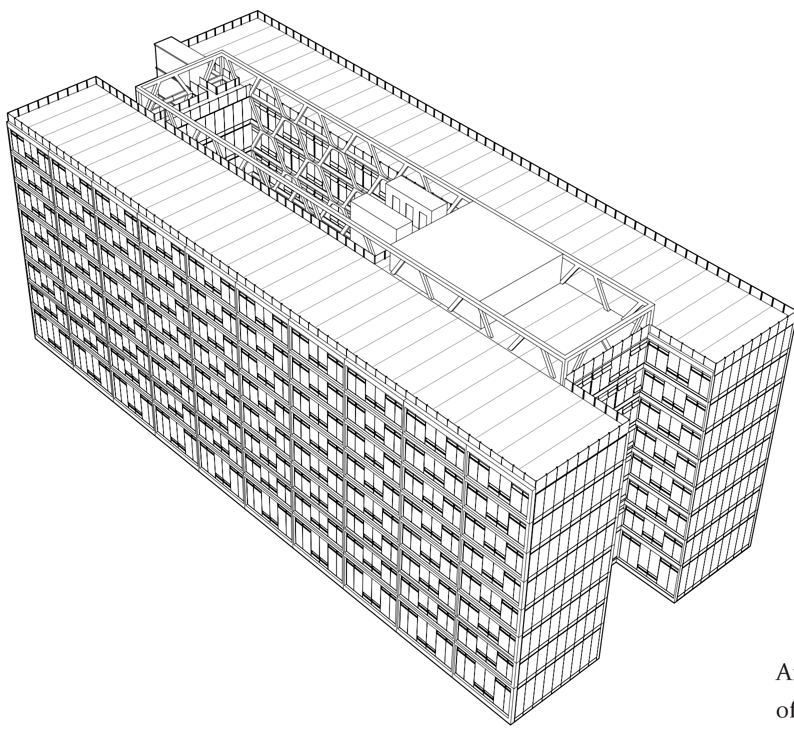
BASE BUILDING PRICING

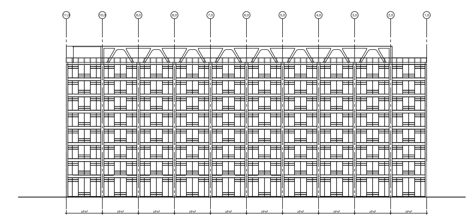
As a means to test the viability of the modular system, the units were assembled into a variety of building masses, one of which was chosen for detailed cost evaluation. This building design, called the "Base Building," was estimated under two distinct construction scenarios: (1) built using the modular system as described in the preceding pages, and (2) built using conventional construction techniques with a cast-in-place concrete structure.

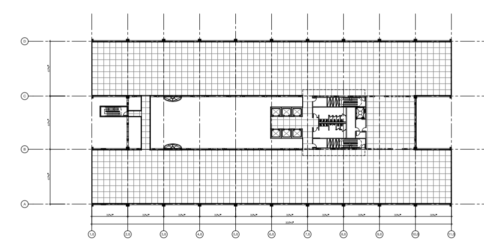
Pricing was provided for a base building comprising: two slipped office bars, core and open courtyard. The north office bar is raised on piloti, with two 30-foot cantilevers on the ends. Balconies are on alternating floors on the east facade. Yellow denotes modifications of the simplified base building, which is shown on the opposing page.

9 floors; 254,065 GSF; 32,940 GSF per typical floor



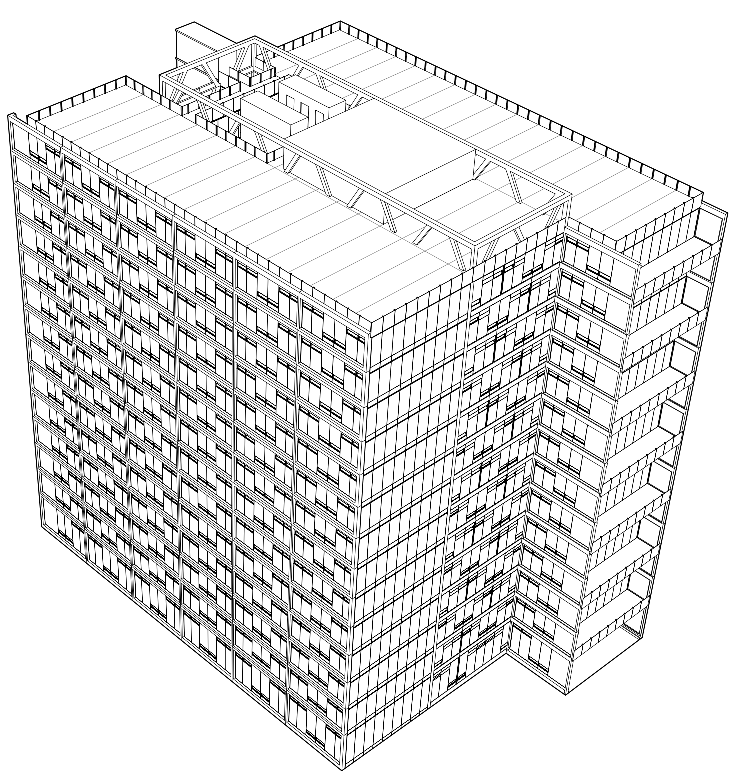


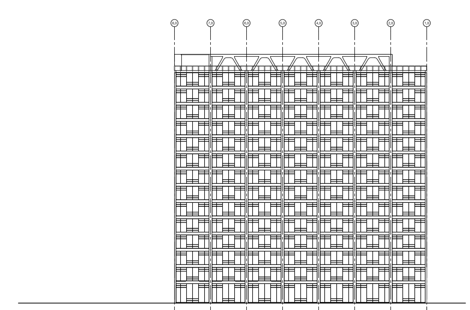


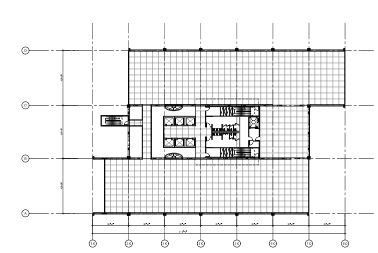


An alternative simplified base building comprising: two symmetrical office bars, core and open courtyard. The building is not raised nor cantilevered, and it does not have balconies.

8 floors; 259,920 GSF; 32,490 GSF per typical floor

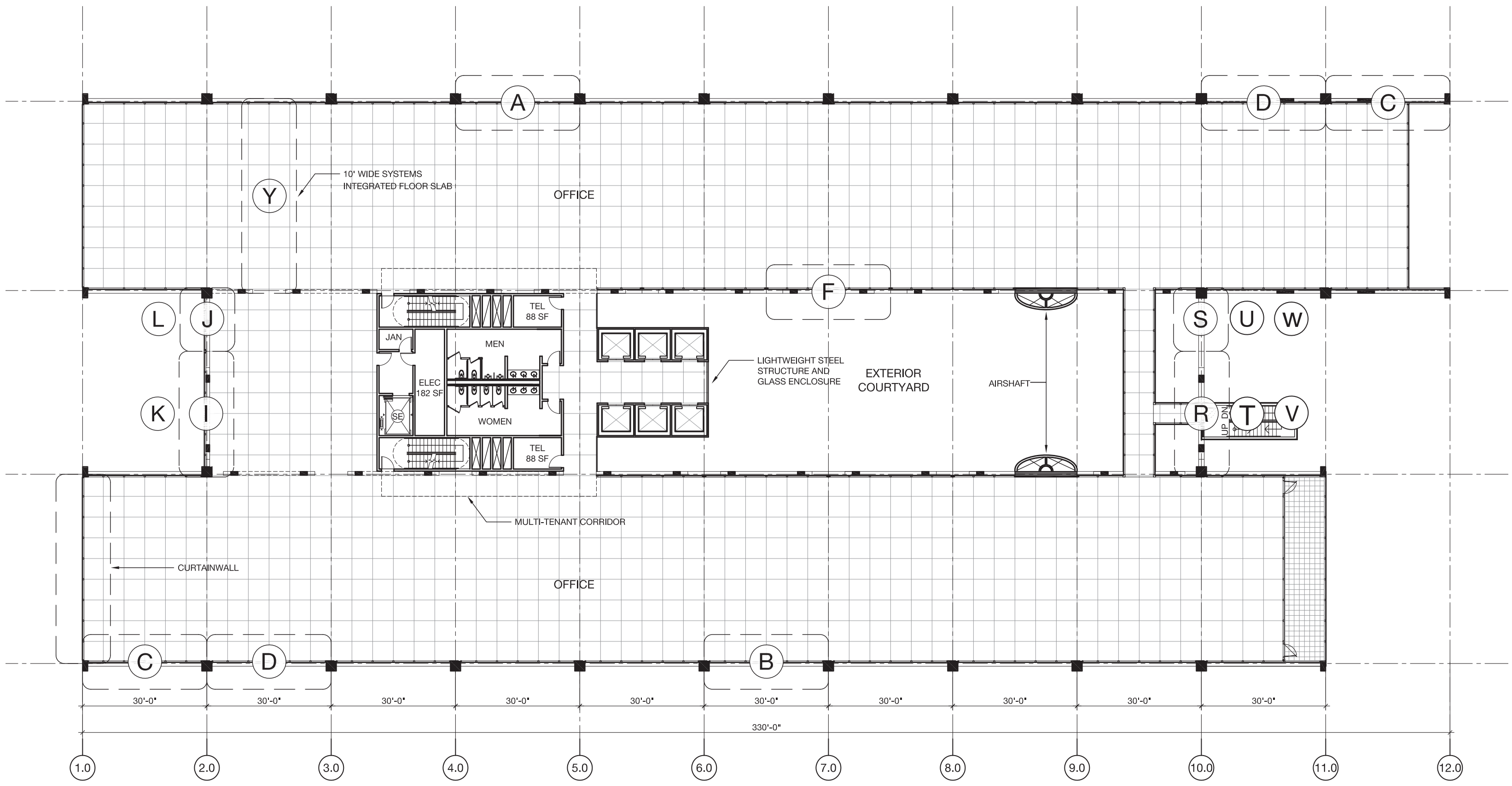






An alternative vertically extended base building comprising: two shortened, slipped office bars and core. The building is not raised nor cantilevered. Balconies are on east and west facades.

14 floors; 291,060 GSF; 20,790 GSF per typical floor



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10' WIDE SYSTEMS INTEGRATED FLOOR SLAB
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OFFICE
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L
J
S
U
W
TEL 88 SF
JAN
MEN
ELEC 182 SF
WOMEN
TEL 88 SF
K
I
LIGHTWEIGHT STEEL STRUCTURE AND GLASS ENCLOSURE
EXTERIOR COURTYARD
AIRSHAFT
R
T
V
MULTI-TENANT CORRIDOR
CURTAINWALL
OFFICE
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30'-0"
330'-0"
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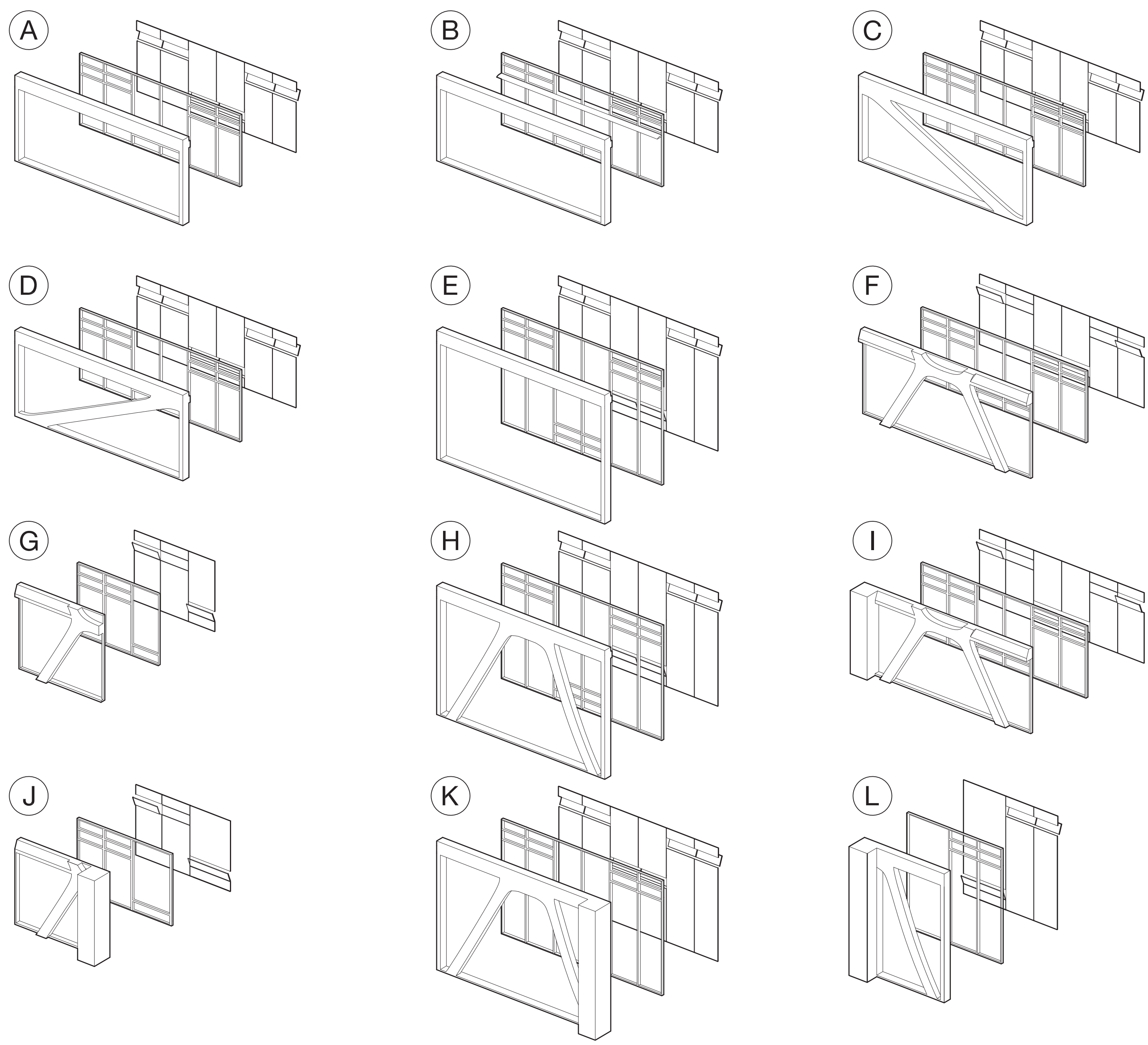

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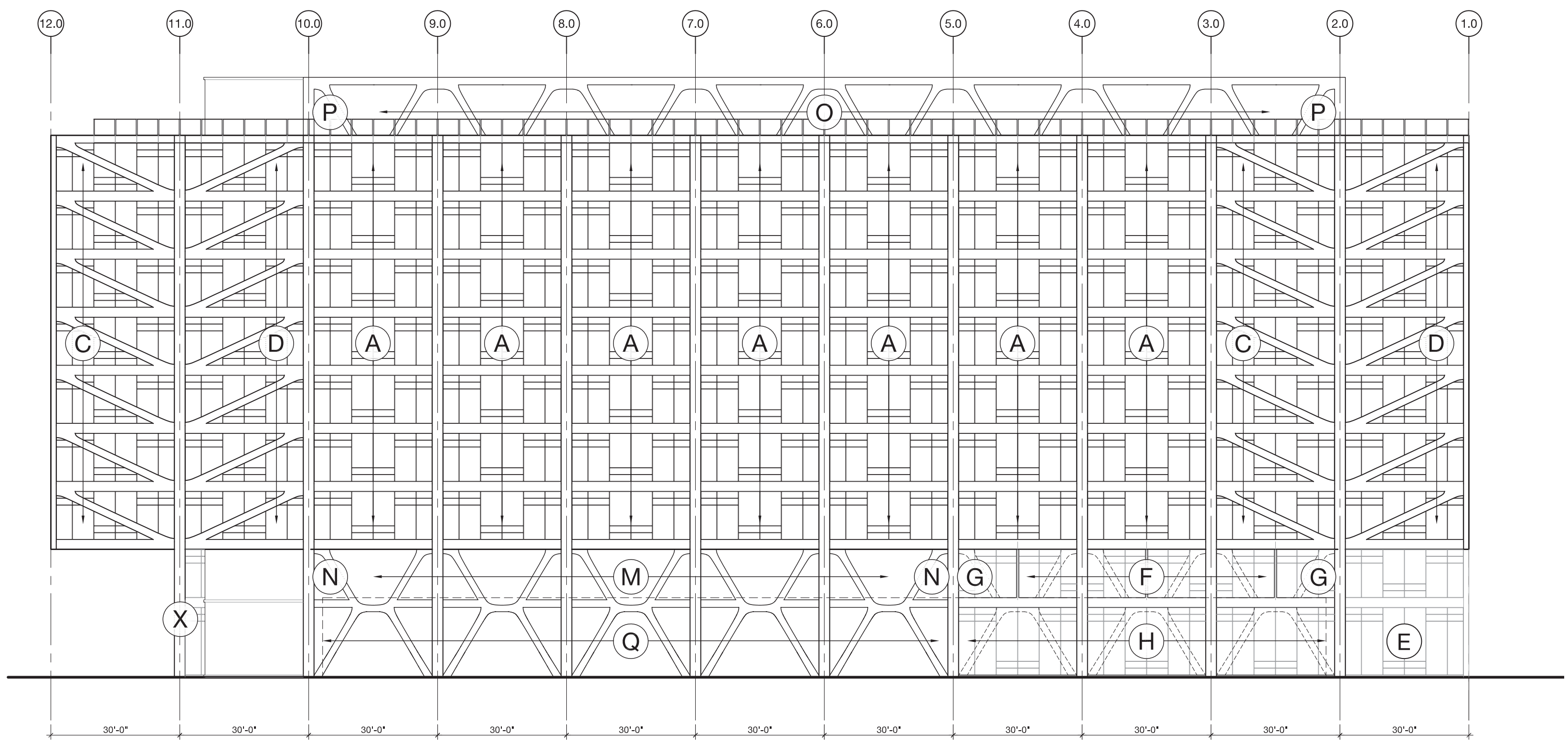
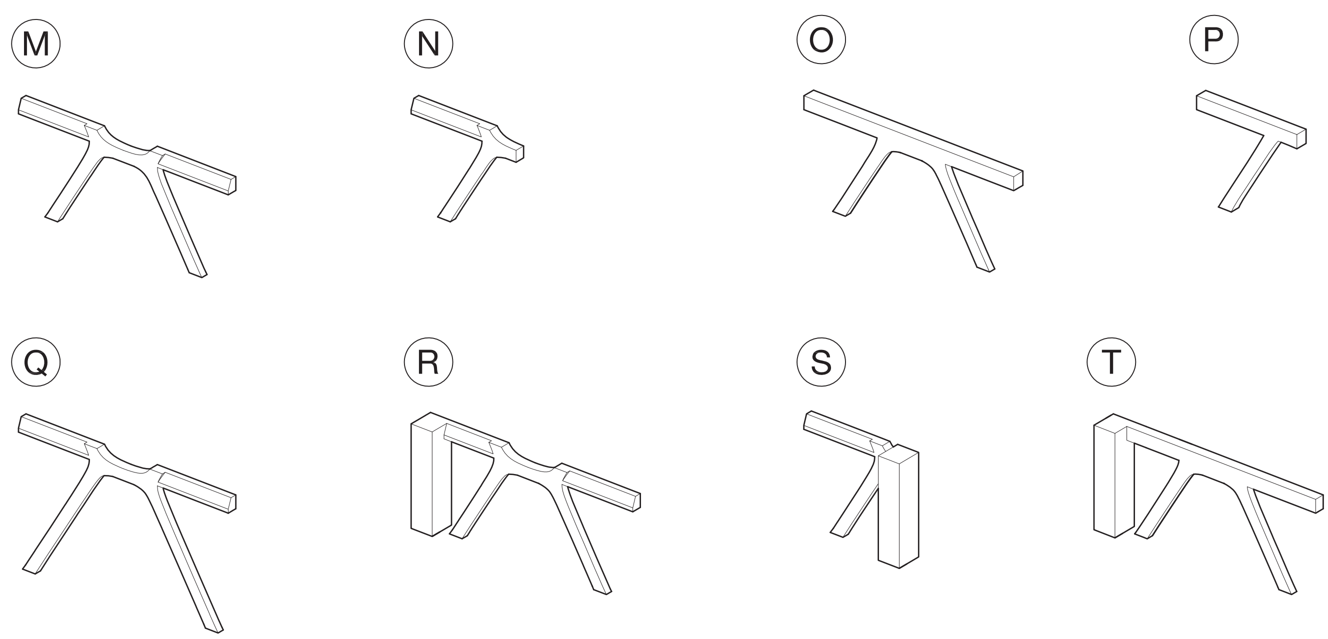
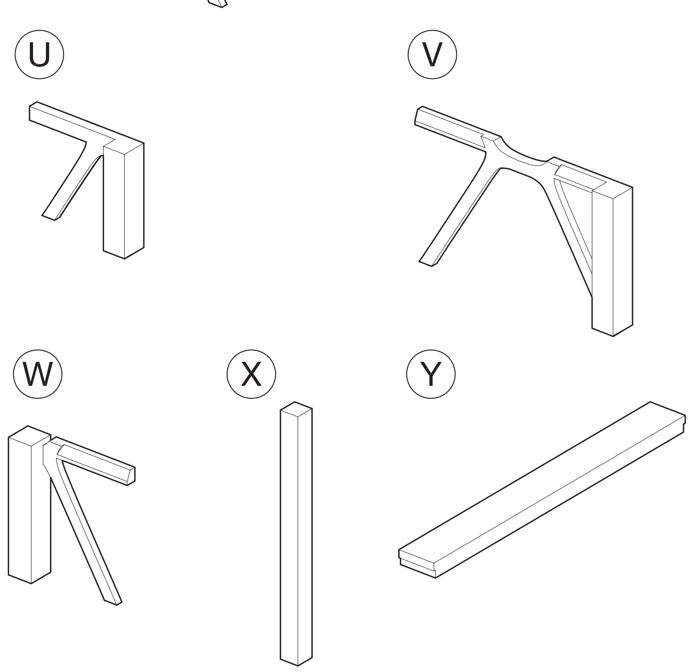






Detailed enumerations and drawings were provided to Gilbane Building Company to explain the modular composition of the design, several of which are represented on these pages. The cost analysis shows that the modular approach provides a 6.35% cost advantage, in addition to its significant improvement in the construction timeline. The total construction cost of the OBF prototype is $60.5 million at $233/GSF compared with the cast-in-place concrete which is $64.6 million at $248/GSF.

Note: For the complete cost estimate prepared by Gilbane Building Company See Appendix pages 154-155.


Blanchard St
ONE WAY
impark

Case Study

"Location, location, location." [1]

"Greater Seattle is considered to be near the forefront of using Smart Growth principles to combat urban sprawl in the United States." [2]

1 Kaplan, Bruce. Cartoon. The New Yorker Collection. 28 February 1994: Online.

2 Fox, David. (2010) Halting Urban Sprawl: Smart Growth in Vancouver and Seattle. 33 BC Int'l & Comp. L. Rev. 43.

Where Can This Be Realized?

TESTING THE MODULAR SYSTEM

To further explore the potential for the OBF, the modular system was applied to a one million gross square foot two-phased mixed-use development comprising a phase one office building of 247,010 gross square feet and a phase two office tower of 606,720 gross square feet and a phase two residential component of 46,800 gross square feet, all on top of 98,300 square feet of at grade restaurants, boutiques, a fitness center and office lobbies. A number of potential cities were considered as a test location for the OBF. However, the city of Seattle was selected for a number of reasons: it is home to several significant tech corporations such as Microsoft and Amazon and their educated workforces; it has a temperate climate; it has an active real estate and development community with a number of potential sites to consider for the OBF.

Additionally, as a participant in the Architecture 2030 Challenge to achieve net zero energy and water use, Seattle offers a community that has long been a proponent of environmental stewardship and sustainability. The Seattle 2030 district is proactive in this regard and has received significant support from city hall, corporations and local establishments as well as architects and designers. It has been widely embraced with many buildings and institutions within the district already successfully reaching established goals to ultimately achieve net zero years ahead of schedule. Climatic data suggested that Seattle would be an appropriate city for the workplace of the future. While overcast conditions are common, this data also suggested that Seattle would also provide ample opportunities for direct sunlight, and the city offers immediate access to both the ocean and the mountains, which are distinct advantages and amenities for the workers themselves.

WESTLAKE AND EIGHTH

Sited on an active and very prominent corner on the edge of the current business district, the design for the OBF is within Seattle's Denny Triangle Neighborhood at the corner of Westlake and Eighth Avenues. With the advantage of direct access to multiple modes of public transportation, its gently rising terrain offering views of the harbor. On an underdeveloped area north of downtown, the site is ideally located for future development. At ground level, the OBF will feature verdant and landscape spaces for the enjoyment of both the public and occupants themselves. It is expected to encourage pedestrian activity and be user-friendly with many employee amenities such as service retail, cafés and day care.

Photo, Opposing Page: iStockphoto.com

Figure 1. Surrounding Districts

Figure 2. Public Transportation

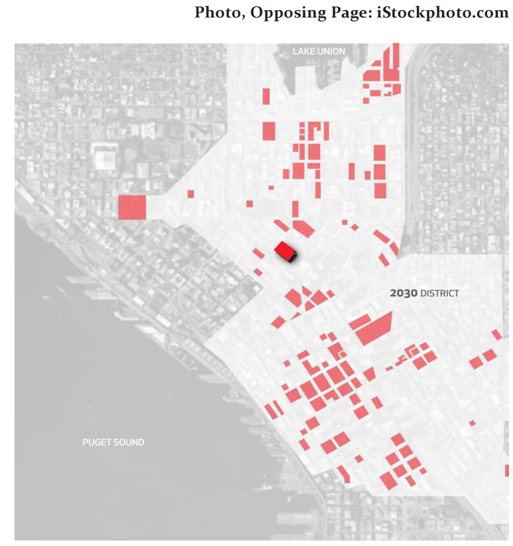


Figure 3. Seattle 2030 District

Seattle Year-Round

CLIMATE STUDY

The design of the OBF aspires to meaningful and deliberate reductions in the use of resources. This demands a response to the local environment and a detailed understanding of the specific climatic conditions.

Seattle sits on the edge of Puget Sound in the Pacific Northwest and enjoys a mild, if cool, rainforest climate. Average temperatures typically remain below the yellow comfort band shown in Figure 2; summer highs and winter averages suggest a need for supplemental heating and minimal cooling. Humidity is higher in winter yet less so in summer, indicating dampness in the cooler seasons and drier weather in the summer. This moderate temperature range suggests that natural ventilation is feasible but that the humidity must be addressed.

Natural ventilation, combined with direct solar gains on exposed thermal mass and with night purge ventilation, can expand the typical comfort range. Occupants have a greater tolerance for higher temperatures when windows are operable and appropriately shaded. Internal gain controls reduce cooling demand in summer.

Sky cover affects light levels and visual comfort inside buildings. In the cooler seasons, Seattle's skies are partly or fully overcast 80% - 90% of the time, while in the summer, skies are only 50% overcast (see Figure 3). As such, direct sun shading is only necessary in the summer but solar-dependent technologies such as photovoltaics will have limited effectiveness and applications in this instance.

Seattle's average monthly rainfall is consistently high for most of the year with an average total precipitation of 37.6 inches. Strategies to address this significant amount of precipitation include capturing rain water for building use and managing runoff during the wettest months.

Throughout the year, as shown in Figure 1, prevailing winds come primarily from the south; summer breezes favor the south and southeast, and autumn storms typically come from the northwest. Proper orientation of the OBF will direct this summer breeze through the building thereby enhancing natural ventilation strategies and reducing energy demand.

A solar path for Seattle illustrates that the summer sun altitude is high (65 degrees) at noon and travels from the northeast to the northwest. The winter sun is much lower (20 degrees) at midday and travels from southeast to southwest. The OBF's south-facing glazing will benefit from solar radiation in the winter, and shading west-facing windows will minimize overheating in the summer.

As indicated by the yellow and orange areas shown on Figure 4, summer offers the most solar energy available to the site. The purple (morning) and red (afternoon) shadows illustrate that there is negligible summer overshadowing from the adjacent buildings. This confirms that the OBF will be able to take full advantage of summer sun for available and anticipated clean solar technologies. Oriented sunshades will reduce heat loads on glass surfaces.

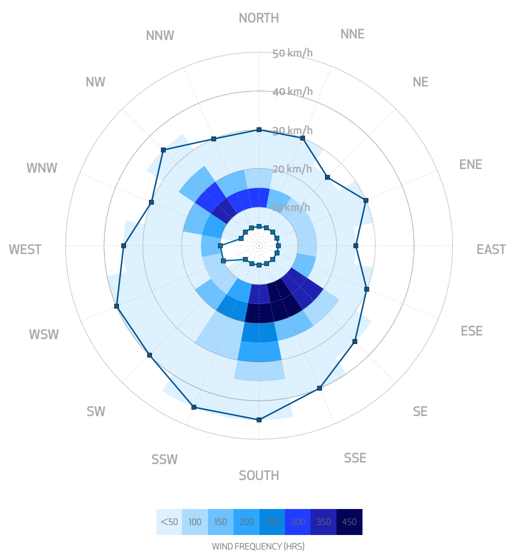


Figure 1. Prevailing Winds

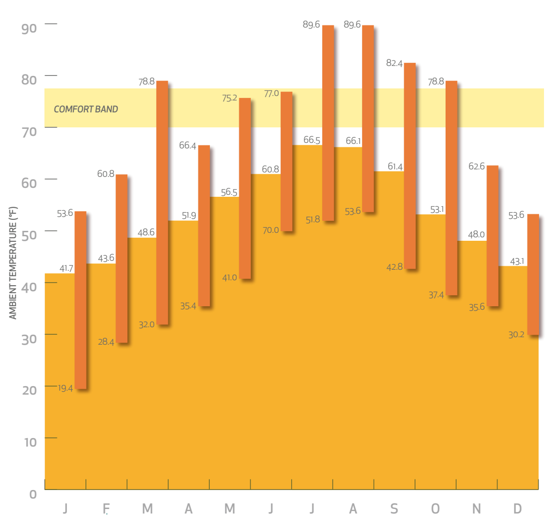


Figure 2. Ambient Temperatures

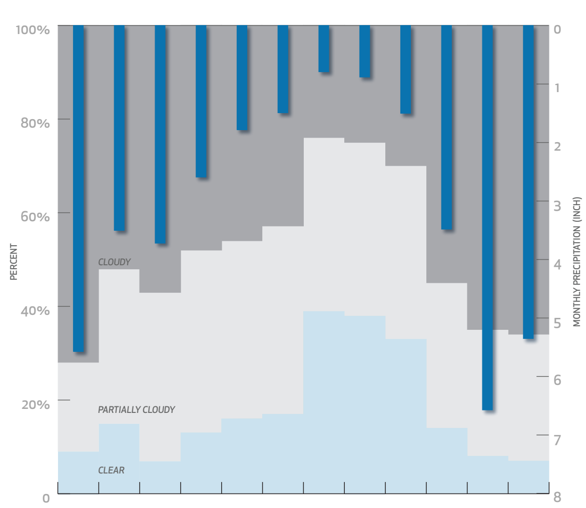


Figure 3. Precipitation & Cloud Cover

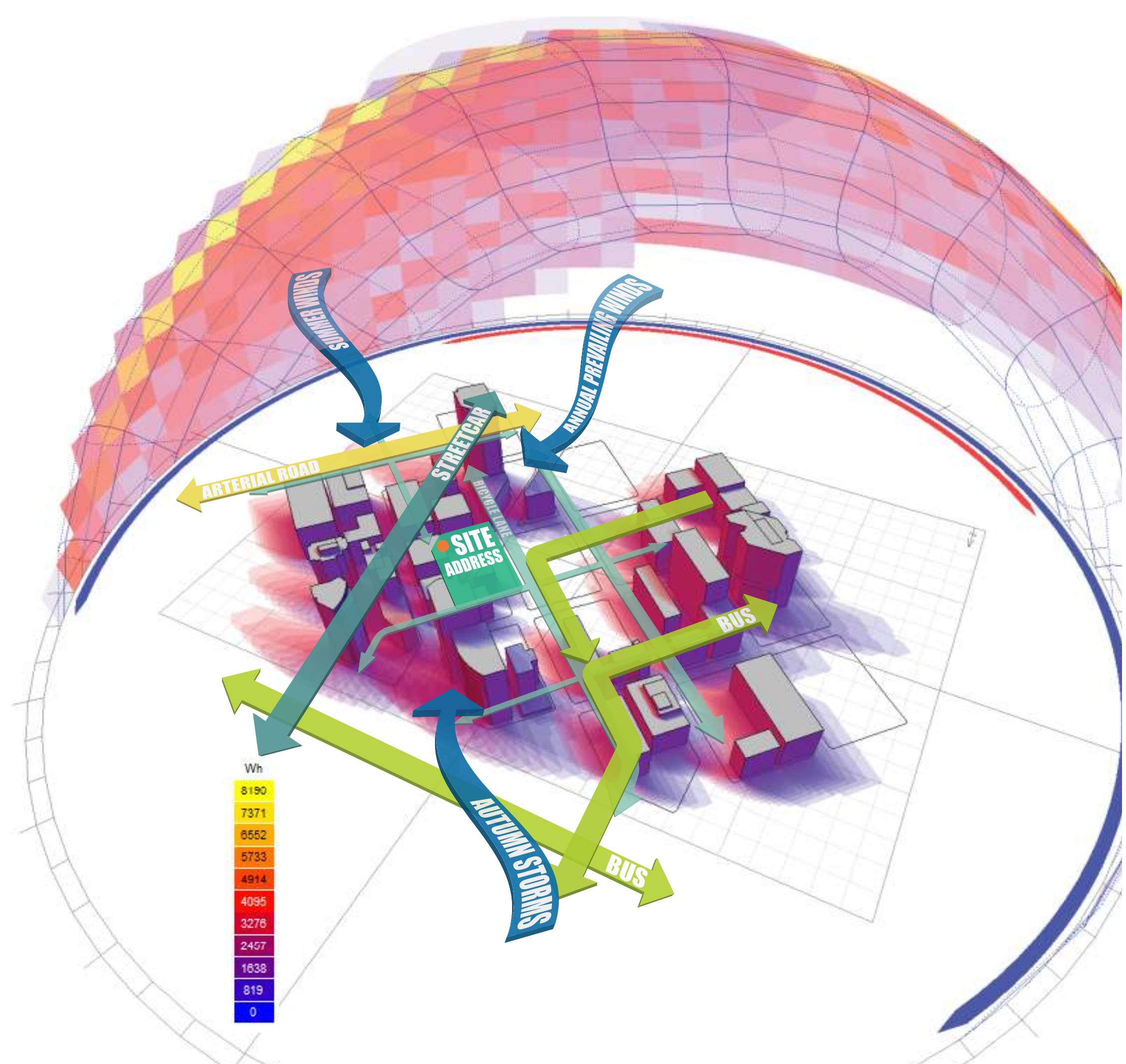


Figure 4. Overall Site Systems

Site-Specific

PROGRAM ORGANIZATION AND PHASING

While the OBF is conceived primarily as an office building, the programmatic composition will be increasingly mixed to be continually viable in future real estate markets. The current typologies of homogeneous office, residential and retail development will soon cede to more mixed-use programmatic strategies that integrate multiple uses to coincide and synergize with one another.

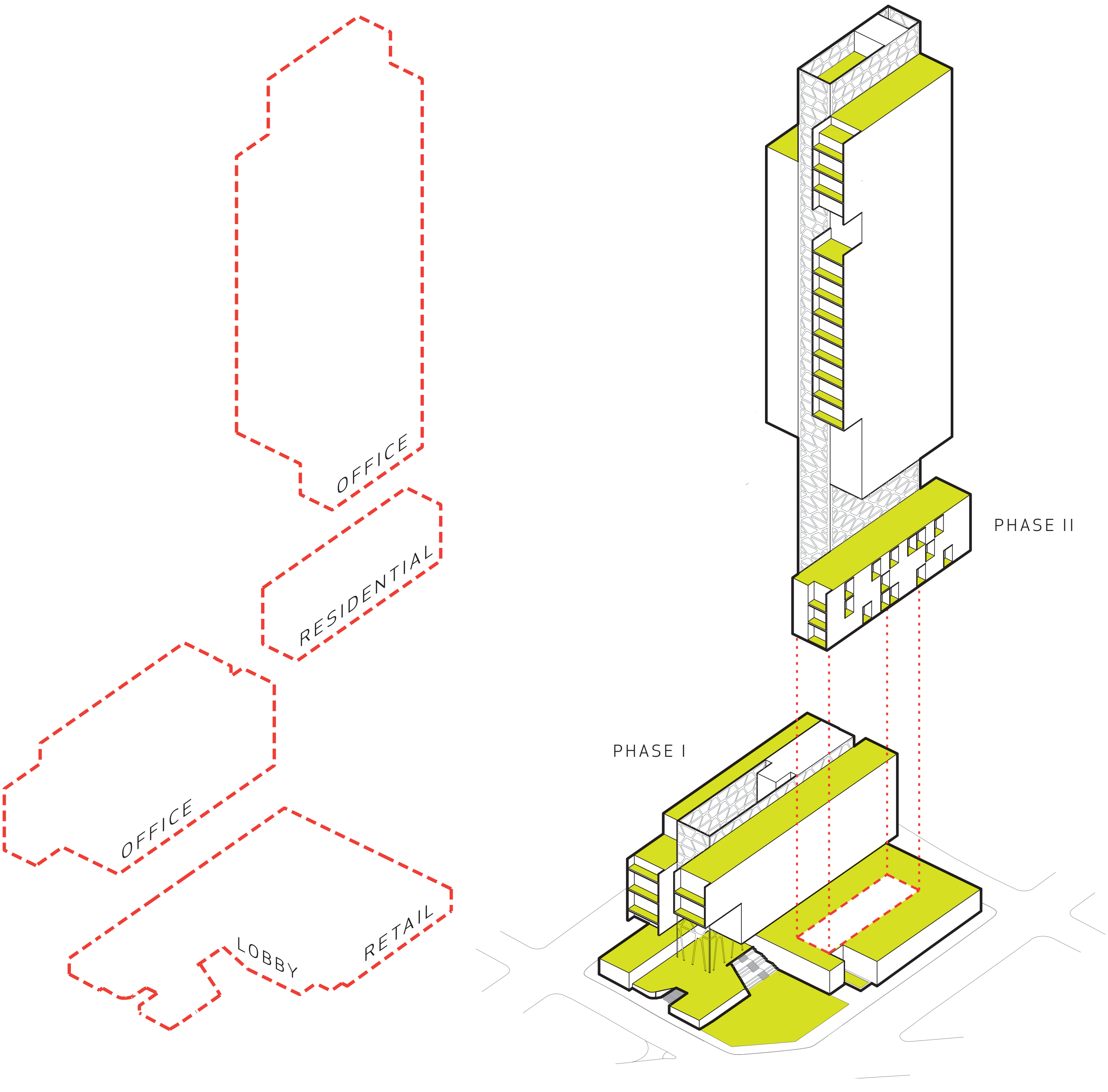
There are many synergies between the three primary urban program types. Office and residential spaces, for example, would typically be leased at lower rates if at ground level, while retail space benefits greatly from street level exposure. Offices experience peak parking loads early to mid-day on weekdays; retail parking generally peaks on weekends and holidays; and, residential requires most parking in evenings and overnight. Such a configuration allows for significant overlap in reducing overall parking requirements.

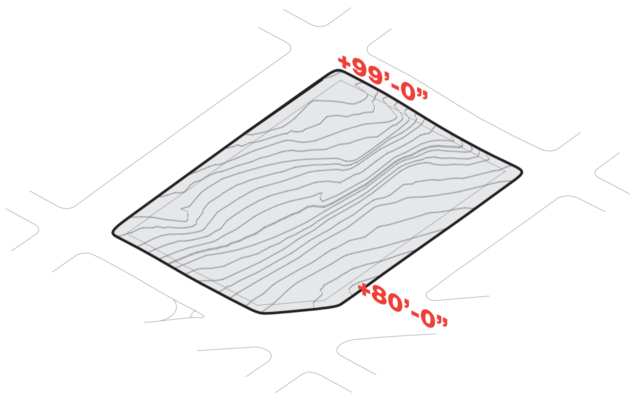
The OBF will achieve a successful programmatic balance with retail throughout the ground floor, four stories of parking below-grade similar to adjacent sites and a six-story residential building along the northeast side of the site. At ground level, a multi-level landscaped urban park will serve both building inhabitants and the general public. Supported by piloti, the office building will appear to float above the park to allow light and air to freely penetrate the site.

In an effort to minimize development risk and maximize flexibly to respond to market demands, the OBF is designed as a two phase development using the office prototype typology. Phase one is envisioned as a mid-rise office building comprising two low bars of eight and nine stories, unified by an open diagrid core, atop below-grade parking and ground level retail. In response to the "live work play" concept of living and socializing near where you work, phase two completes the development with a low-rise residential bar as well as an office tower component of two high bars attached to the high-rise core to form a 32-story office tower.

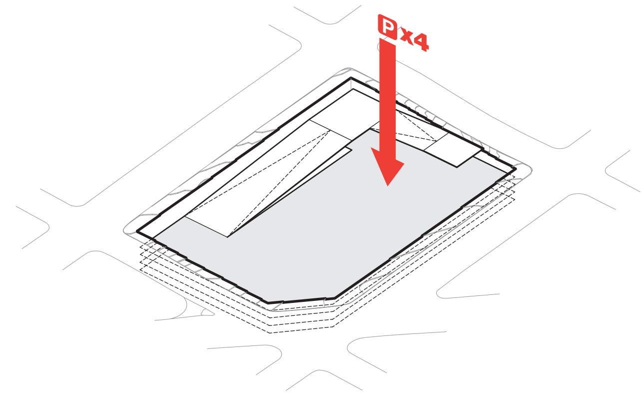
The minimal tower footprint is achieved by cantilevering the two high bars of offices off of the central core. One tower office bar cantilevers over the phase one office below taking advantage of air rights that were not fully realized in the initial build-out; the other cantilevers over the residential bar, allowing it to remain structurally independent and on its own column grid.

Offering dramatic views of the harbor, the verticality of the overall mixed-use development is in direct response to its current location in the periphery of this burgeoning downtown district and to the anticipated increase in development of larger scale buildings.

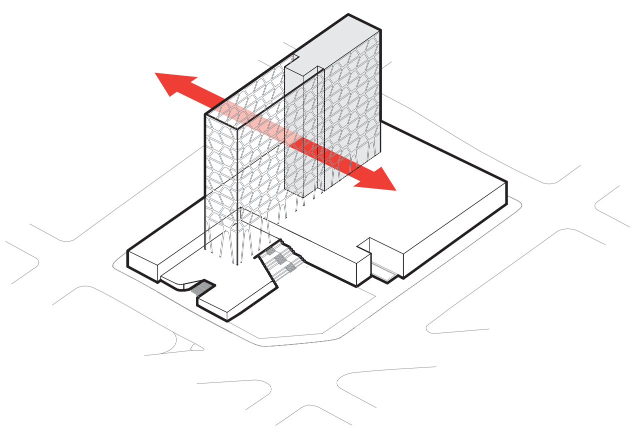

OFFICE
RESIDENTIAL
OFFICE
LOBBY
RETAIL
PHASE II
PHASE I



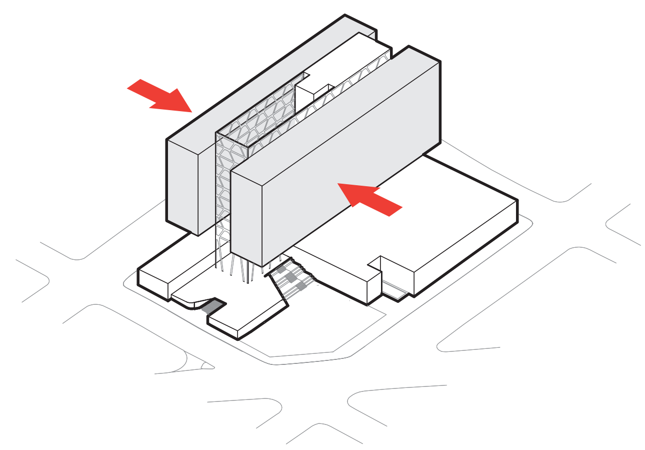
01 START: SITE



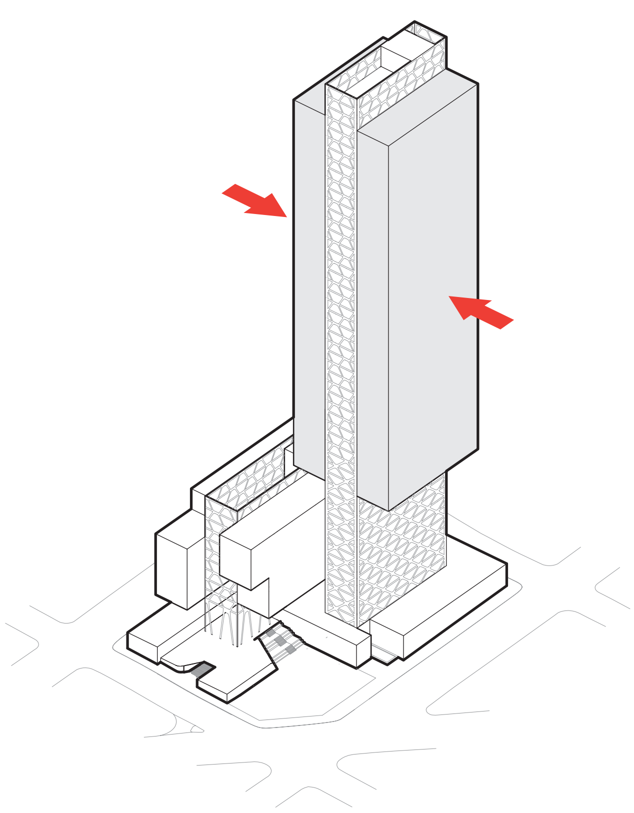
02 DEPRESS: PARKING



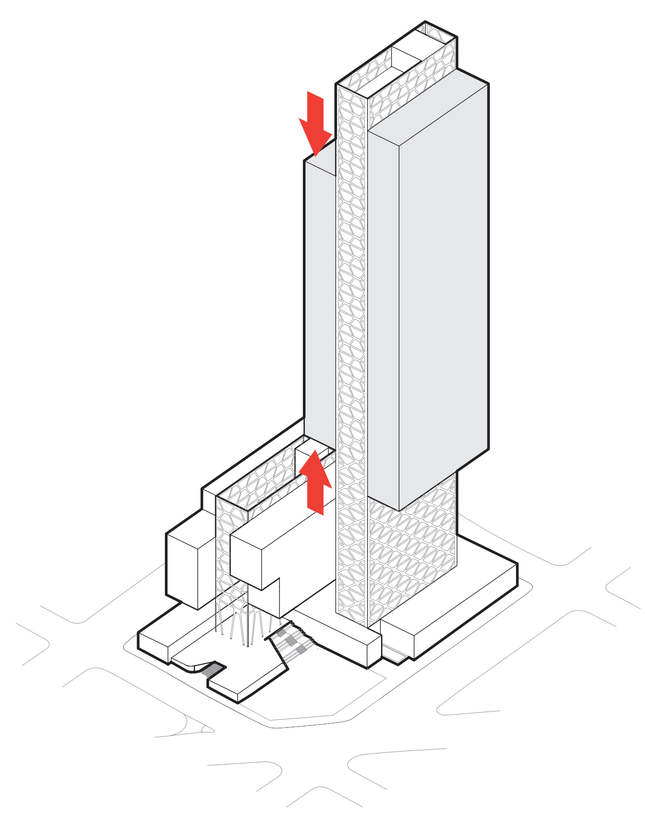
05 ORIENT: LOW-RISE CORE



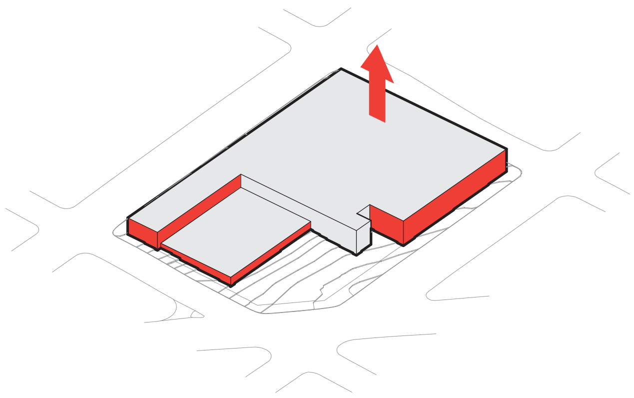
06 POSITION: LOW-RISE OFFICE BARS



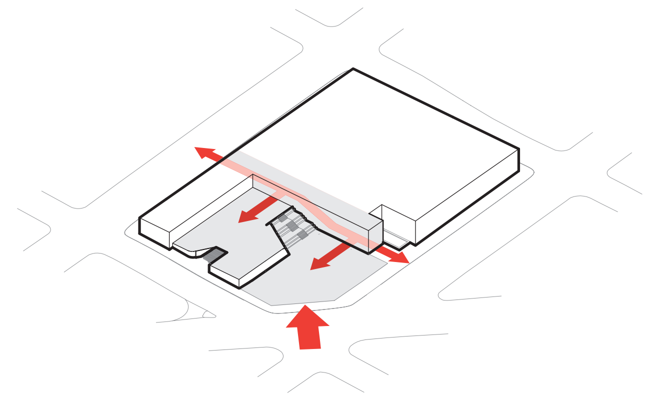
09 POSITION: TOWER OFFICE BARS



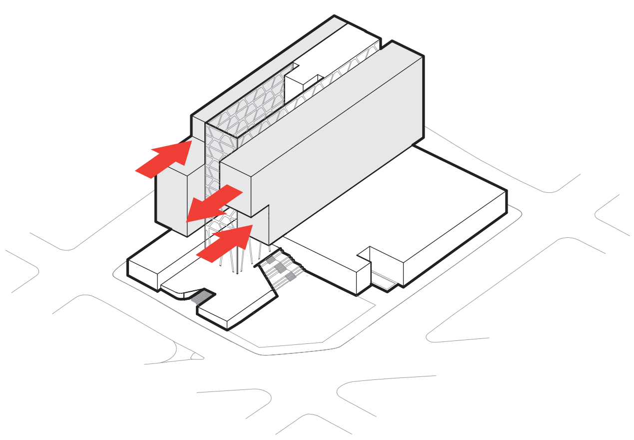
10 SLIDE: TOWER OFFICE MASSING



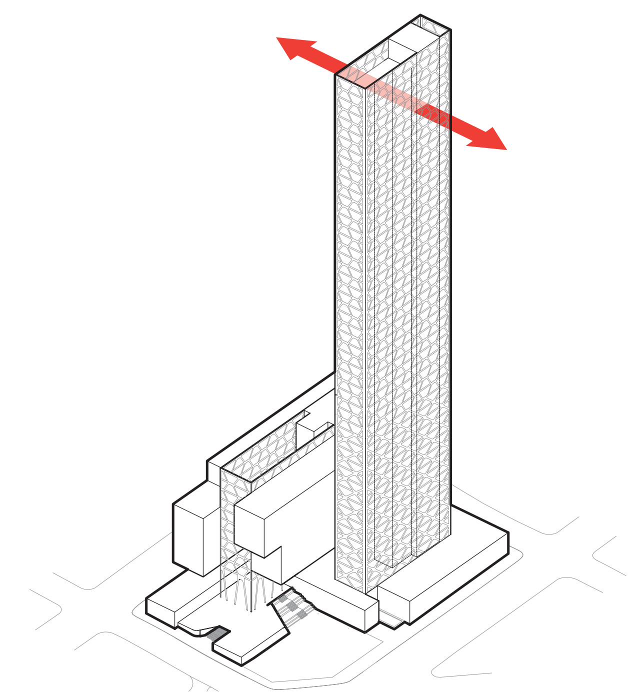
03 LIFT + ACTIVATE: GROUND PLANE



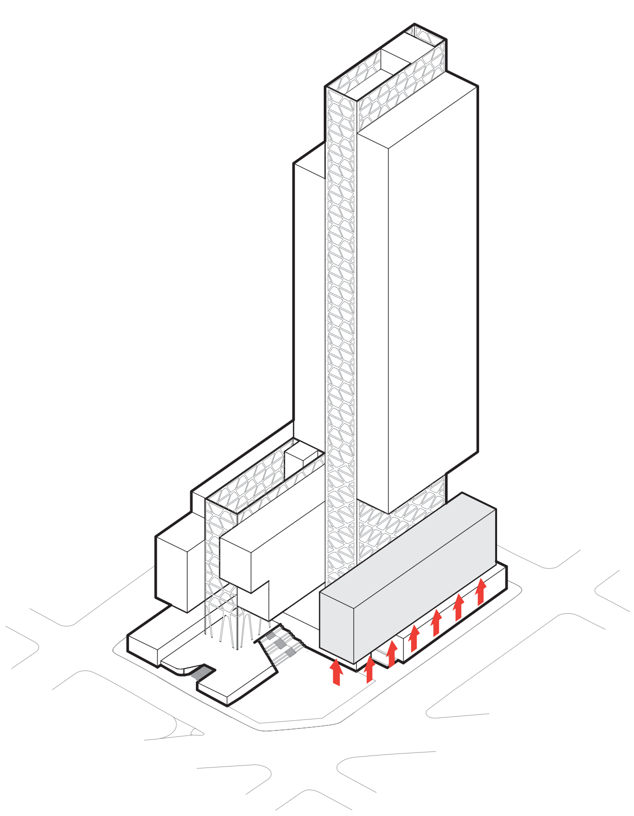
04 CONNECT + ENGAGE: ENTRY



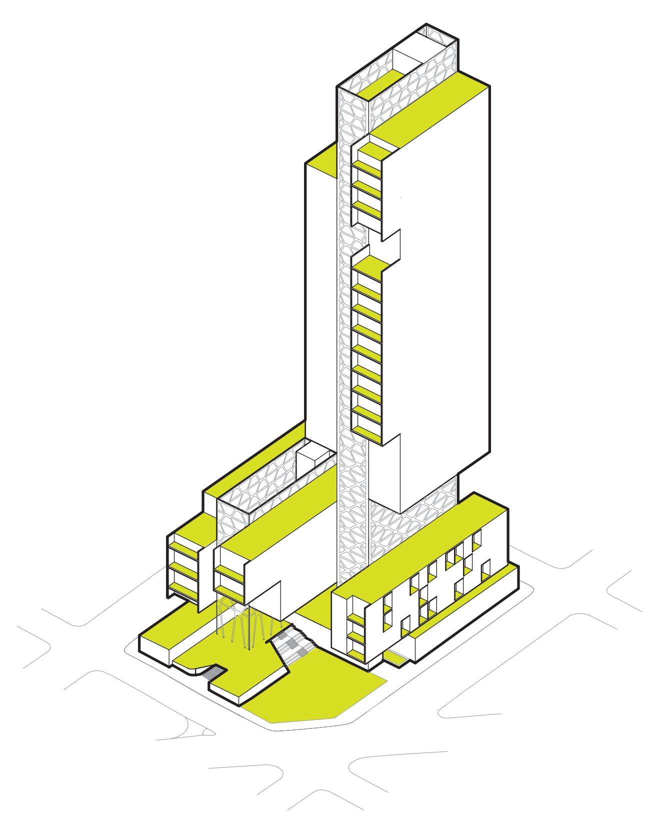
07 SLIDE: LOW-RISE OFFICE MASSING



08 ORIENT: TOWER CORE



11 FLOAT: RESIDENTIAL BAR



12 GREEN: OPEN SPACE

Putting It All Together

IMPLEMENTATION

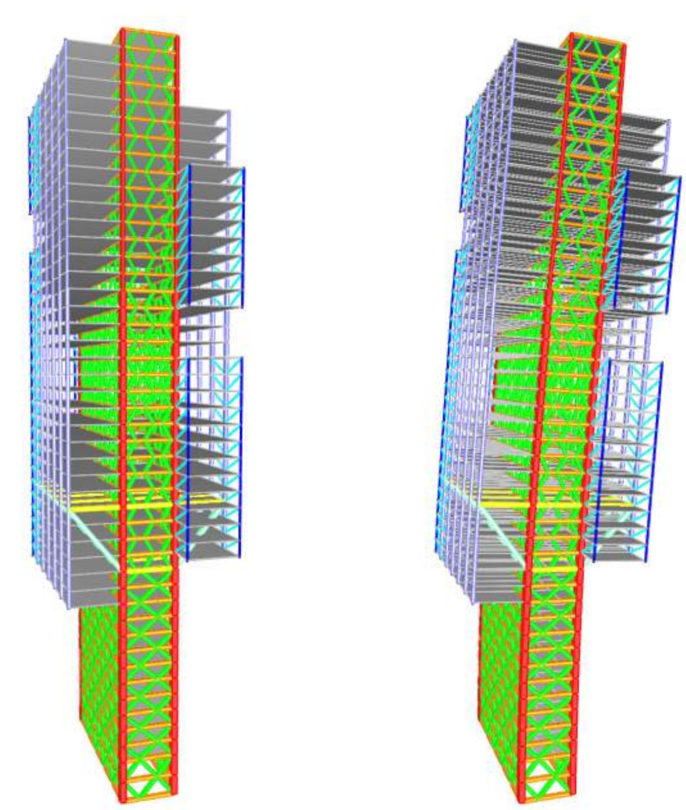
On-site assembly of the OBF will be a rapid culmination of a process that began, and largely took place, in a controlled factory environment. As modules are assembled to create dynamic spaces, and spaces assembled to form an elegant building, a new icon will be an innovative addition to Seattle's dynamic skyline.

The OBF will represent healthier work environments for office inhabitants, responsible use of natural resources, and a secure financial investment for owners. The city will be proud of its new monument to progress. Tenants will readily lease space in a building that they know will promote employee productivity and well-being.

BUILDING STRUCTURE

It is expected that the OBF will have a useful life spanning many decades into the future. Careful consideration has been given to ensure its durability and longevity, through the trauma of potential natural disasters, particularly in a city with significant seismic activity. As the modules of the OBF are lowered into place, they are structurally fused together by weld points and NMB sleeves—a specially designed coupling system that effectively unites two abutting reinforcing bars from separate precast units into a continuous reinforced concrete member.

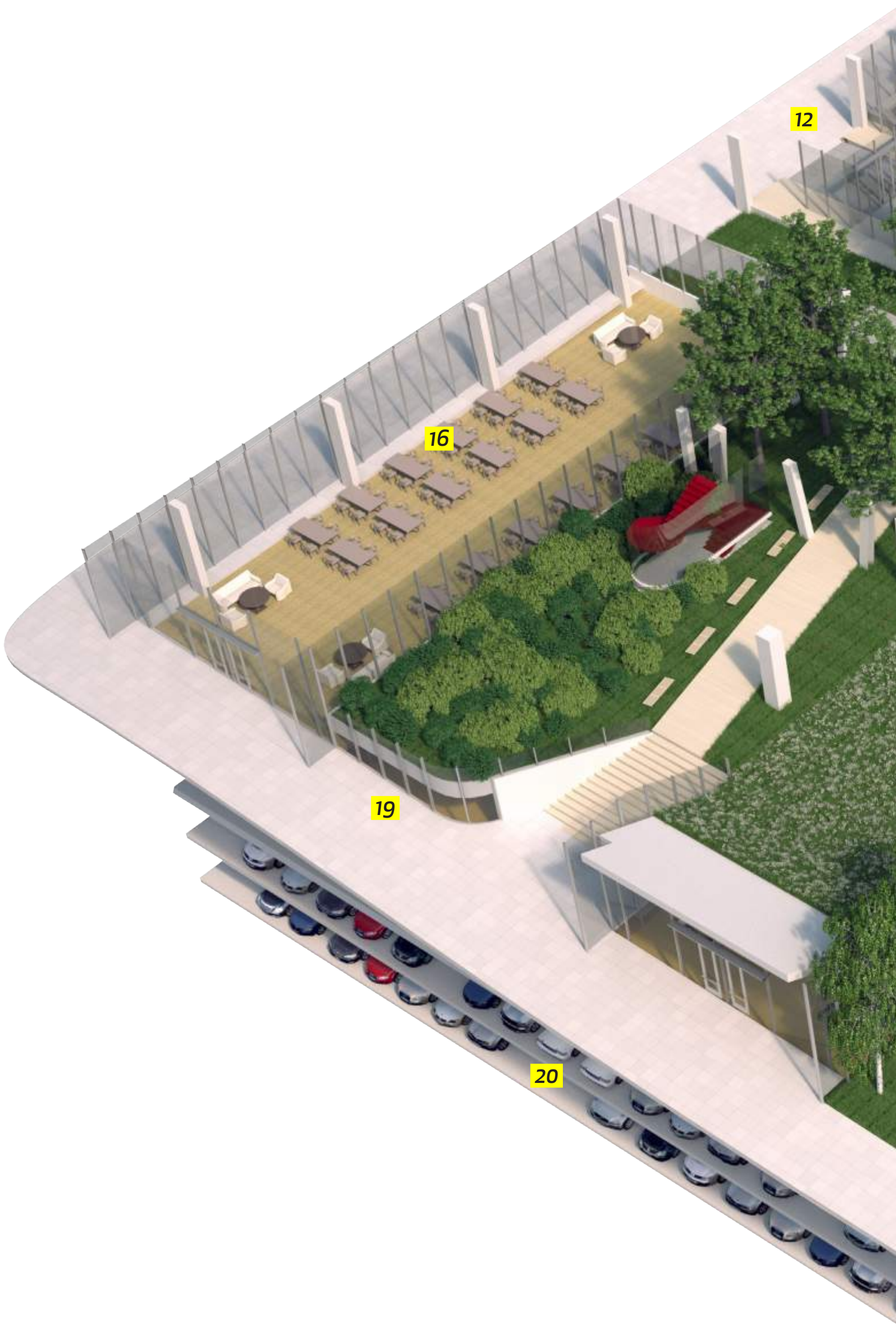
In the high-rise office tower, lateral loads will be resisted by a "core-only" approach, in which a central diagrid tube will resist both moment and shear forces. Structural analysis confirms that, through the modules' use of high-strength materials, this structural configuration is more than sufficient to keep tower deflection within acceptable limits. It is anticipated that in the near future, higher strength concrete and reinforcing steel will become more economical and widely available, therefore 10 ksi concrete and 100 ksi steel were the assumed materials for the structural testing of the OBF. The core-only structural model of the tower is fully expressed in the building form, by transferring perimeter vertical loads to the core at the bottom of the office bars, and allowing the core to stand alone for the bottom third of the office building.



Ground Level

VIBRANT AND DIVERSE CIRCULATORY NETWORK

The design of the OBF begins at ground level, with an integrated network of architectural elements and circulation patterns. The ground level serves as the catalyst by which existing vehicular and pedestrian connections are emphasized and expanded. Movement between the two office lobbies and bicycle and car parking are enlivened with street level amenities such as retail and restaurants, along with diverse and open green spaces. The ground level acts as the site-specific anchor for the creation of the OBF's distinctive architectural identity.



01	Café	*11*	Living Machine Water Treatment
02	Loading Dock	*12*	7th Avenue Entry
03	Central Plant	*13*	Through-Block Promenade
04	Boutique Retail	*14*	8th Avenue Entry
05	Bar & Lounge	*15*	Low-rise Courtyard
06	Bistro	*16*	Coffee Shop
07	Low-rise Lobby	*17*	Terrace
08	Tower Lobby	*18*	Entry Garden
09	Residential Lobby	*19*	Fitness Center & Bike Storage
10	Green Wall	*20*	Below-Grade Parking

Figure 1. Retail & Green Spaces

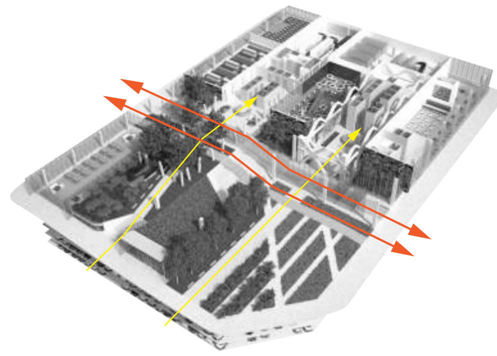


Figure 2. Pedestrian Circulation

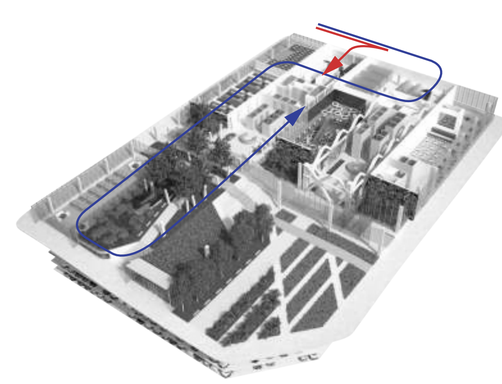
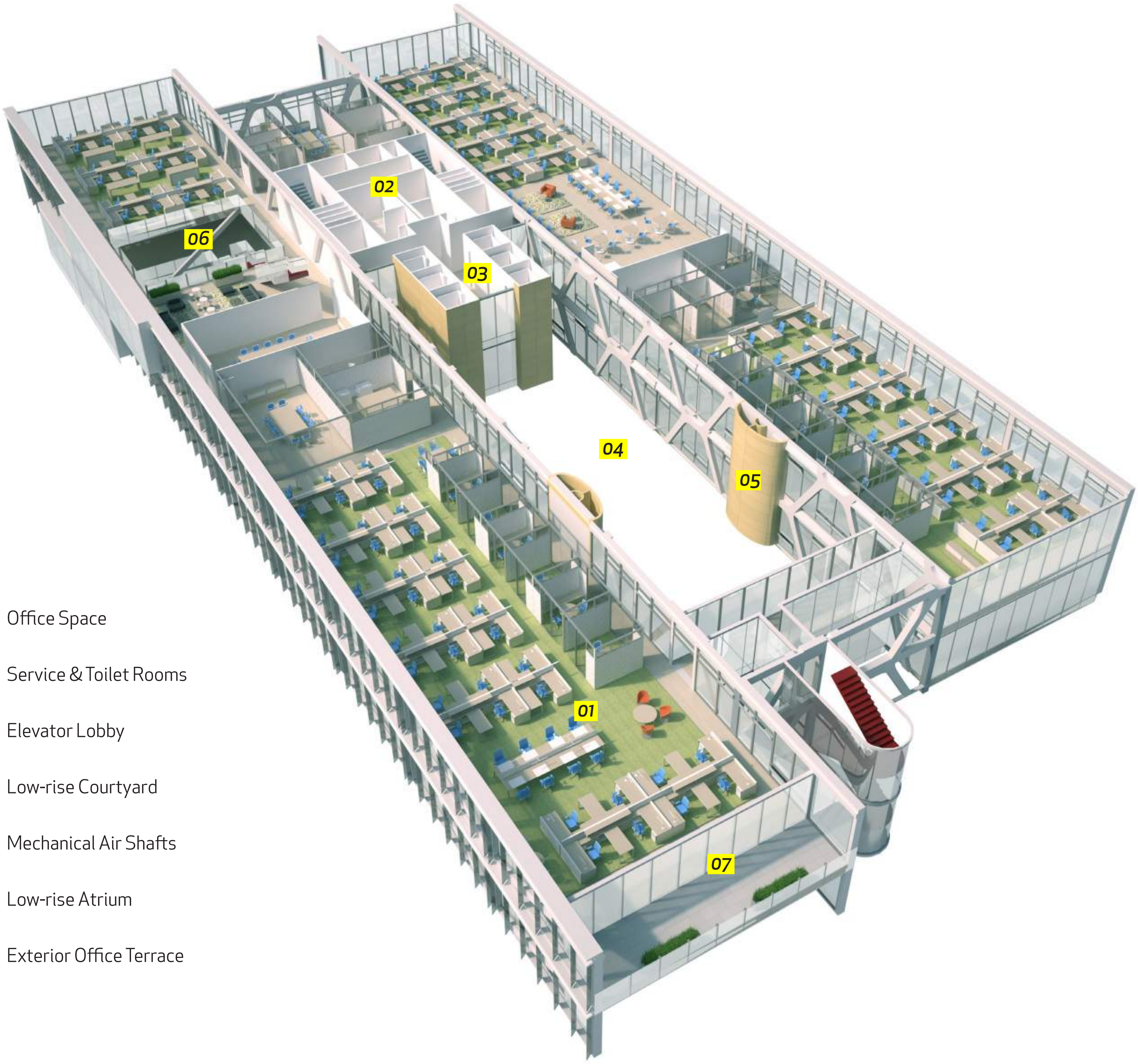


Figure 3. Vehicular Circulation

Low-Rise Office Level

NATURALLY VENTILATED AND DAY-LIT LOW-RISE OFFICE SPACE



01 Office Space

02 Service & Toilet Rooms

03 Elevator Lobby

04 Low-rise Courtyard

05 Mechanical Air Shafts

06 Low-rise Atrium

07 Exterior Office Terrace

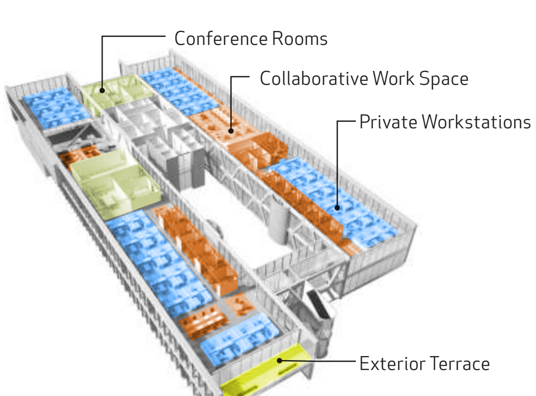


Figure 1. Single-Tenant Floor

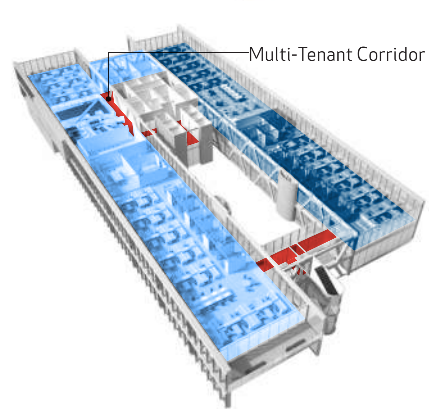


Figure 2. Two-Tenant Floor

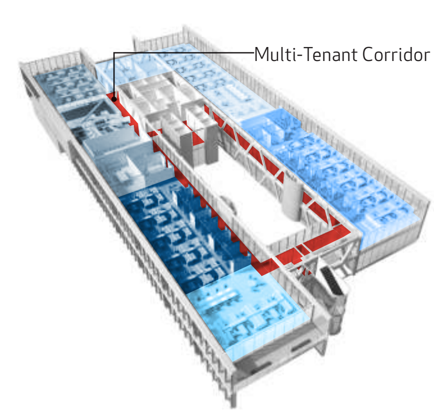
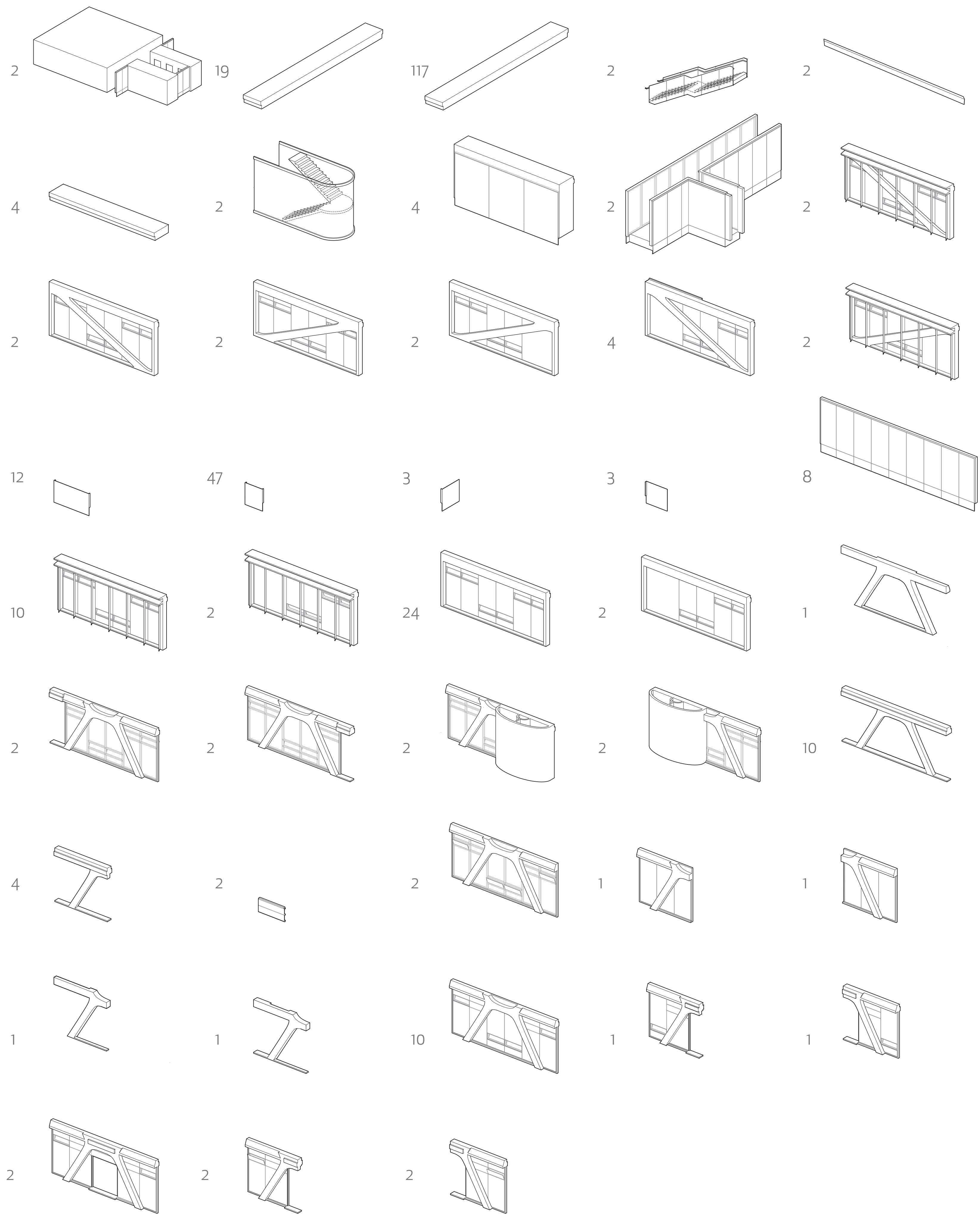


Figure 3. Multi-Tenant Floor

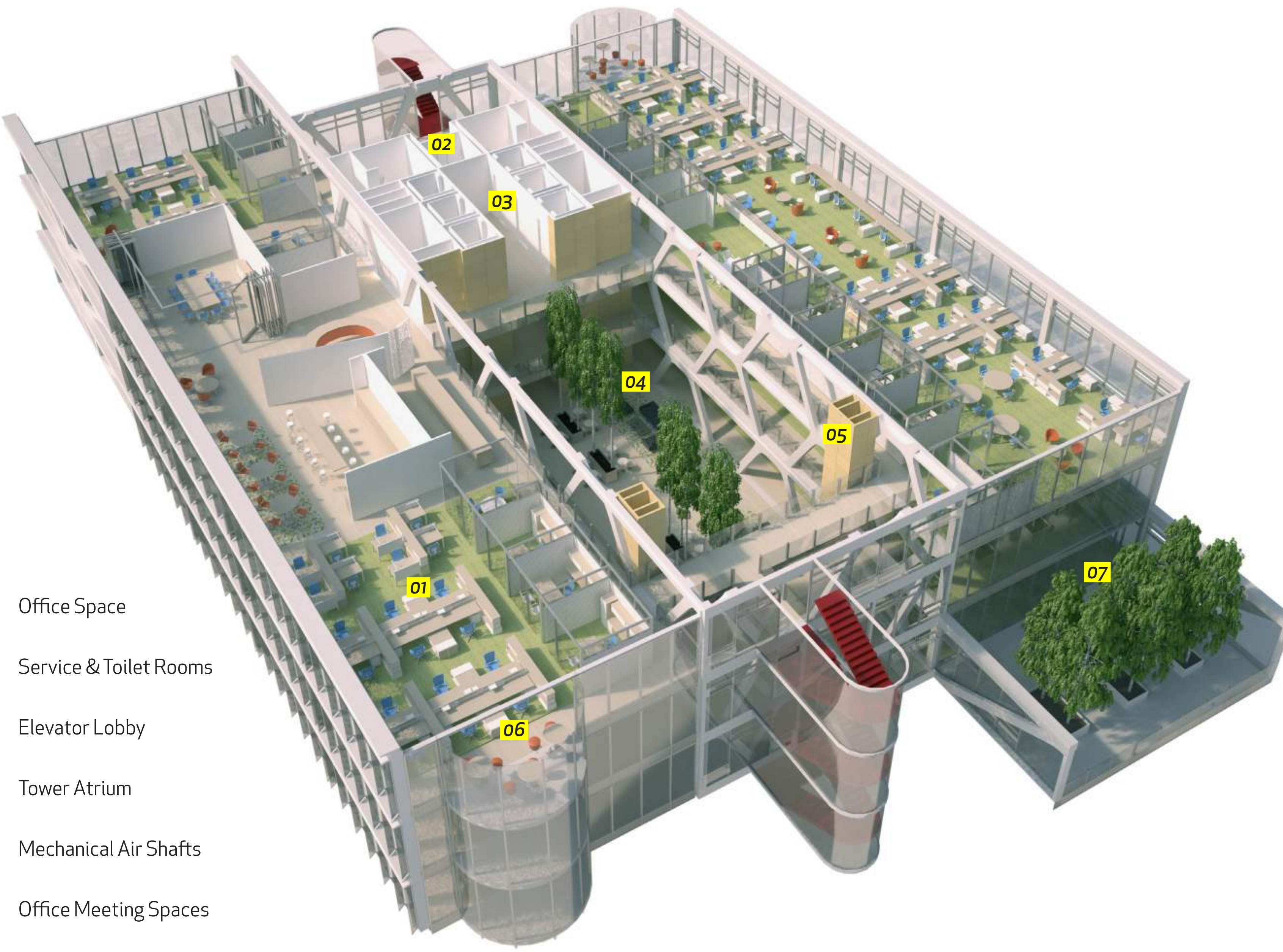


Note: Interior planning by IA; systems furniture design by Haworth; additional furniture by Pear Workplace Solutions, shown on opposing page.

Note: The numbers associated with building components represent assembly totals for two low-rise office floors, as shown on opposing page.

Tower Office Level

NATURALLY VENTILATED AND DAY-LIT HIGH-RISE OFFICE SPACE



01 Office Space

02 Service & Toilet Rooms

03 Elevator Lobby

04 Tower Atrium

05 Mechanical Air Shafts

06 Office Meeting Spaces

07 Exterior Office Terrace

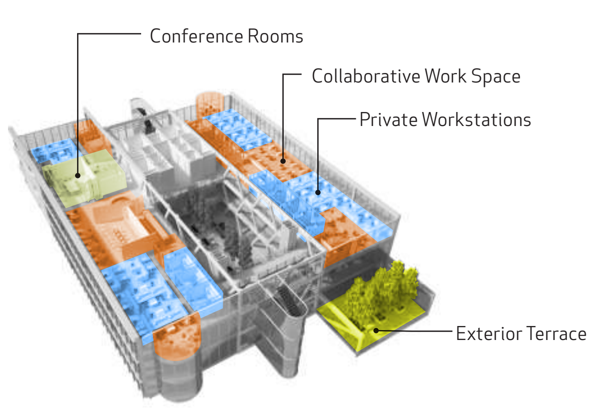


Figure 1. Single-Tenant Floor

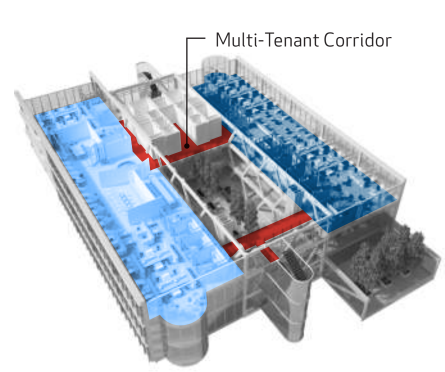


Figure 2. Two-Tenant Floor

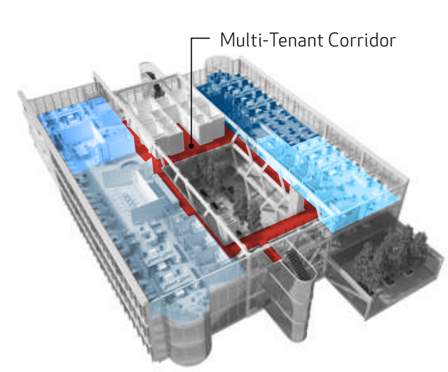
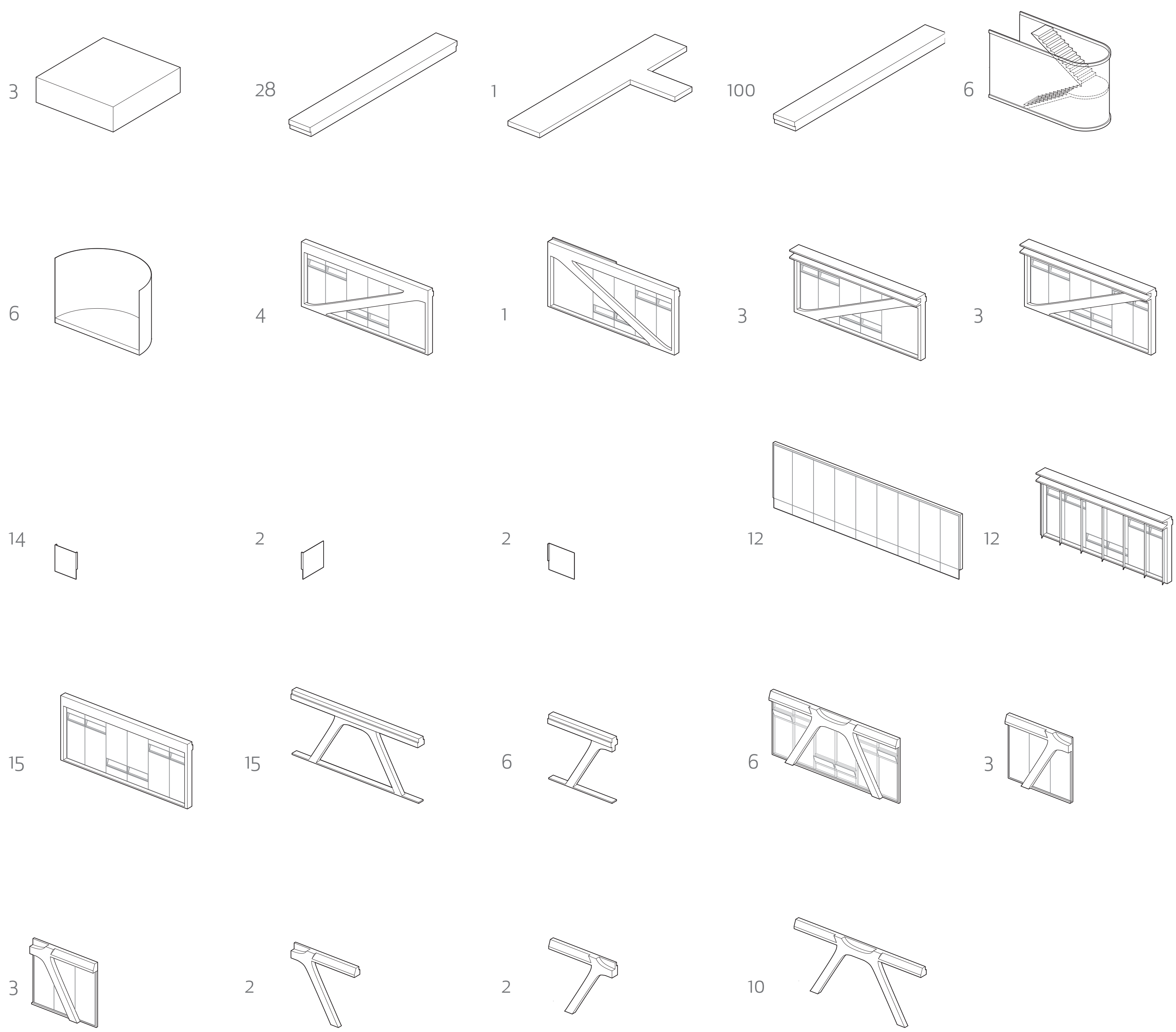


Figure 3. Multi-Tenant Floor



Note: Interior planning by IA; systems furniture design by Haworth; additional furniture by Pear Workplace Solutions, shown on opposing page.

Note: The numbers associated with building components represent assembly totals for three tower office floors, as shown on opposing page.

Building Ecosystems

THE PHYSIOLOGY OF THE OFFICE BUILDING OF THE FUTURE

More than just another hermetically sealed, inanimate building in the skyline, the OBF will interact with the world around it and the inhabitants within it. Capitalizing on energy from the sun and water from rain, manipulating wind energy for cooling and ventilation, and converting excess urban CO_2 into oxygen are just a few yet significant ways that the OBF takes action as a responsible steward of limited resources. Office workers will enjoy and benefit from access to natural ventilation and light, as well as the architecturally spectacular office atria, enticing stairs to traverse between levels, and landscaped exterior terraces.

01 Cross Ventilation Across Building Floorplate

02 Convective Flow of Natural Ventilation

03 Central Office Atrium Space

04 Green Sky Terrace

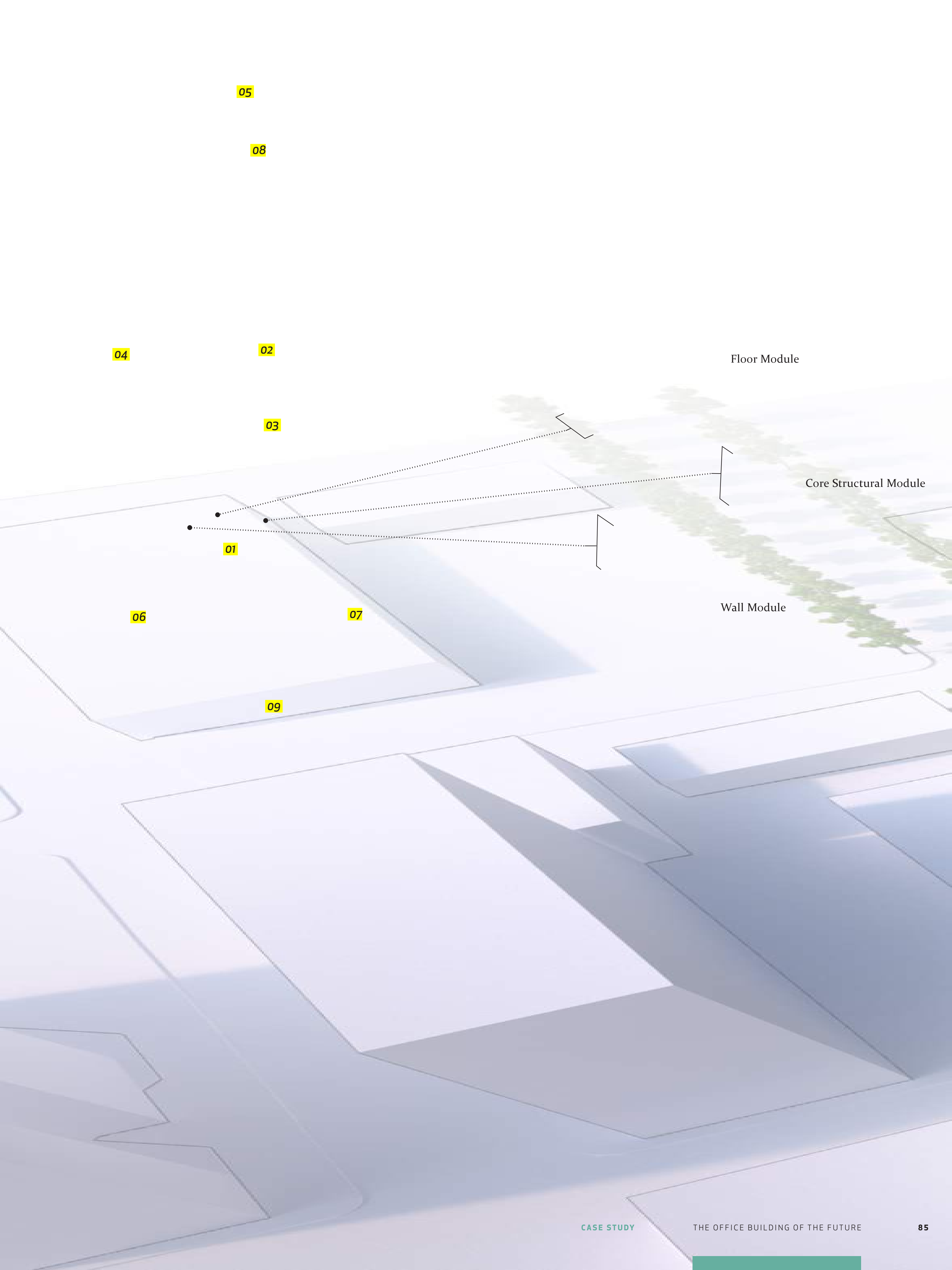
05 Rooftop Solar Collection

06 Facade Solar Energy Collection

07 Communicating Stairs

08 Mechanical Penthouse

09 Office Amenity Node


05
08
04
02
Floor Module
03
Core Structural Module
01
06
07
Wall Module
09

Net-Zero Energy

SYSTEM READINGS

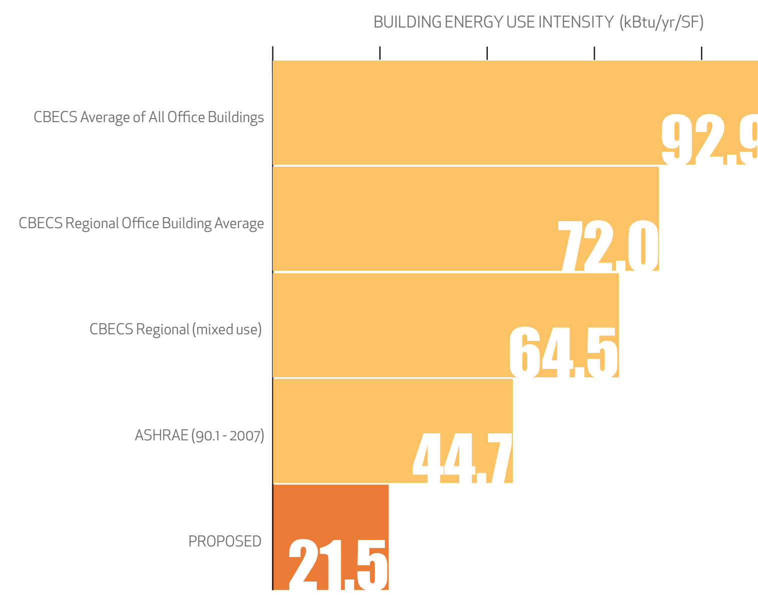


Figure 1. Energy Use Intensity Comparison

The Office of the Future will be a net-zero energy building; a high performance building that balances energy needs with on-site and off-site renewable energy. Narrow floorplates and high performance facades allow for use of passive seasonal strategies including natural ventilation and daylighting, which decrease building energy consumption and operating costs while increasing occupant satisfaction. Radiant heating and cooling systems and efficient lighting coupled with smart monitoring and increased occupant controls provide building users with greater influence over their individual environments and thus greater comfort and productivity. Supplemental ventilation, supplied through the floor and controlled by CO_2 sensors, ensures optimum indoor air quality when exterior conditions do not permit open windows. Heat recovery ventilators capture waste exhaust heat and use it to precondition fresh air intake, further reducing energy demand. Well-designed stairways and floors connected across atrium spaces encourage greater collaboration and activity among the occupants while lowering the need for short elevator trips.

In addition to efficient systems, renewable energy technologies take advantage of resources available on the site. Solar hot water collection is a proven means of heating water even in temperate climates; the OBF will reduce energy requirements for domestic hot water by 50%, almost 5% of the building's total energy demand. With the best commercially-available photovoltaic panel available today located on the roofs of the low-rise and tower, the OBF will generate 1.4% of its annual electricity needs. Thin film photovoltaic cells laminated into glass sunshades and skylight glass act as both shading device and electricity generator, producing just under 1% of the building's energy needs. These building-integrated photovoltaics (BIPV) are made of amorphous silicon and perform well under conditions where conventional photovoltaics do not, such as cloudy days and on vertical surfaces. Diversifying solar energy collection technology makes the OBF more productive over the course of a year and in atypical weather conditions. Improvements in photovoltaic technology in the future will allow the OBF to outperform current estimates.

Large buildings often have greater energy needs than can be met with on-site technologies, even in extreme conditions of efficiency and generation. Thus, selecting electricity supplied from responsible, renewable sources has an ongoing benefit for a building's environmental footprint. Purchasing renewable energy from off-site sources is typically more cost-effective than building on-site capacity, due to economies of scale and optimal site selection for the power plant.

Measuring a building's Energy Use Intensity (EUI), the annual energy consumption per square foot, allows a simple comparison between buildings of different size. The Commercial Buildings Energy Consumption Survey (CBECS) shows that the average EUI of all American office buildings is 92.9 kBtus per square foot, while the Pacific Northwest average is 72.0 kBtus/SF and a typical mixed-use office building in Washington State performs at a slightly improved 64.5 kBtus/SF. To meet the current standard ASHRAE, the OBF must achieve at least 44.7 kBtus/SF. Combining passive design and equipment efficiency in the OBF will result in a 77% reduction in EUI compared with the national average, and will exceed the current EUI benchmark for the Seattle 2030 District.

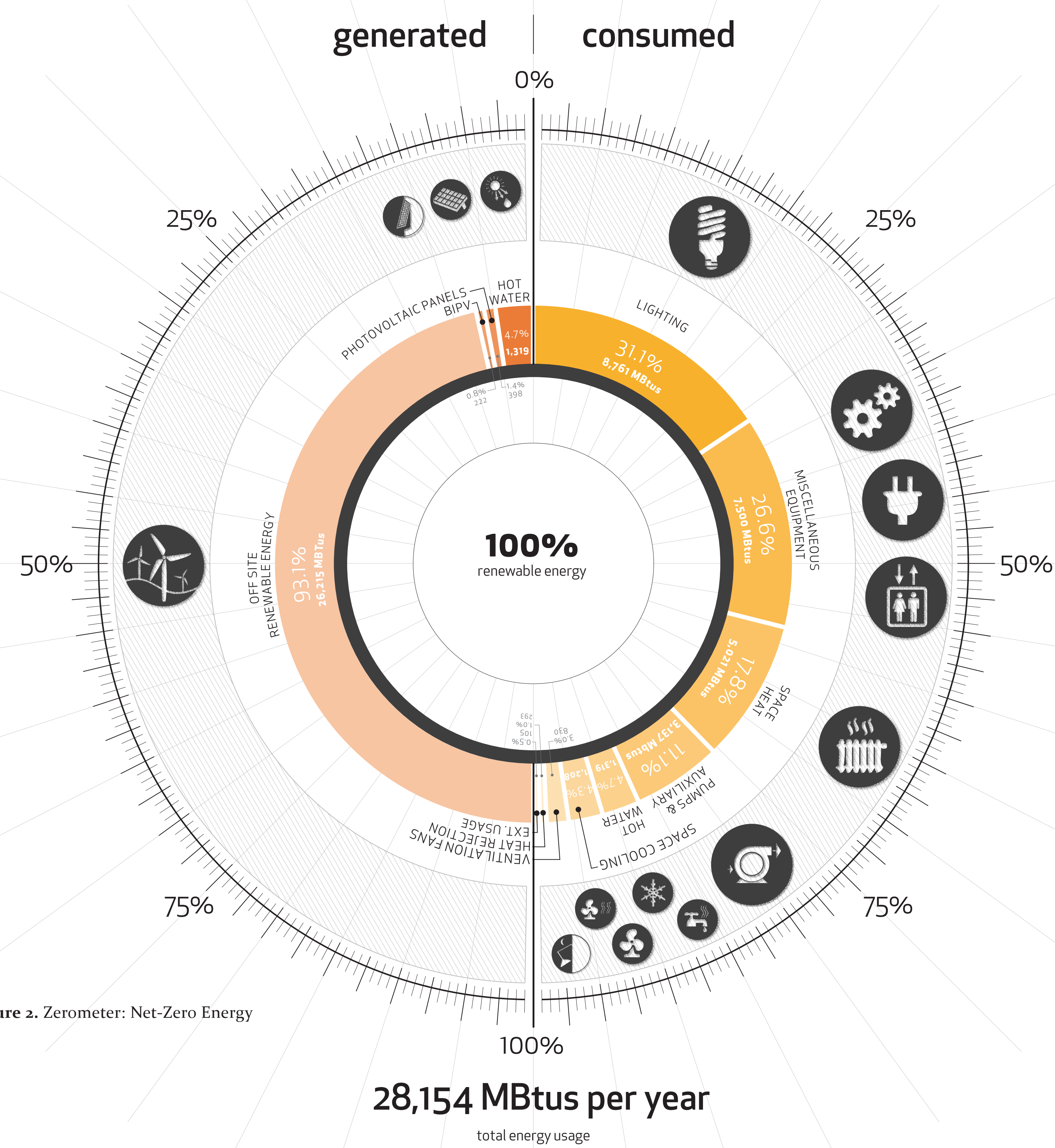


Figure 2. Zerometer: Net-Zero Energy

Strategies

ENERGY STRATEGIES

PASSIVE DESIGN STRATEGIES

- Atriums enhance stack effect
- Sun shades manage summer solar gain
- Thermal mass creates a thermal flywheel effect
- Night flushing cools the thermal mass
- Operable windows provide natural ventilation
- Daylight access reduces artificial lighting

HIGH PERFORMANCE ENVELOPE

- Triple-glazed low-e Krypton filled curtain wall glass: U-value as low as 0.12[1]
- Translucent Aerogel panels: U-value 0.05
- Fiberglass curtain wall framing: U-value 0.05[2] (vs. 0.65 for mechanically fastened aluminum curtain wall)[3]
- Continuous insulation avoids thermal breaks
- Green roof: cools by evapotranspiration and increases summer thermal resistance

HIGH EFFICIENCY HEATING & COOLING

- Radiant heating and cooling decouples conditioning from ventilation
- Geothermal exchange heating and cooling plant
- High efficiency magnetic bearing chillers
- High efficiency hot water condensing boiler plant; option to connect to Seattle Steam District Energy
- Cooling towers for one third of cooling (peak) load only

MIXED-MODE EFFICIENT VENTILATION

- Displacement ventilation with fresh air rising from floor
- Demand-control ventilation controls that supply fresh air when CO_2 is too high
- Energy recovery enthalpy wheels with dehumidification condition fresh air intake with heat from exhaust air

EFFICIENT LIGHTING

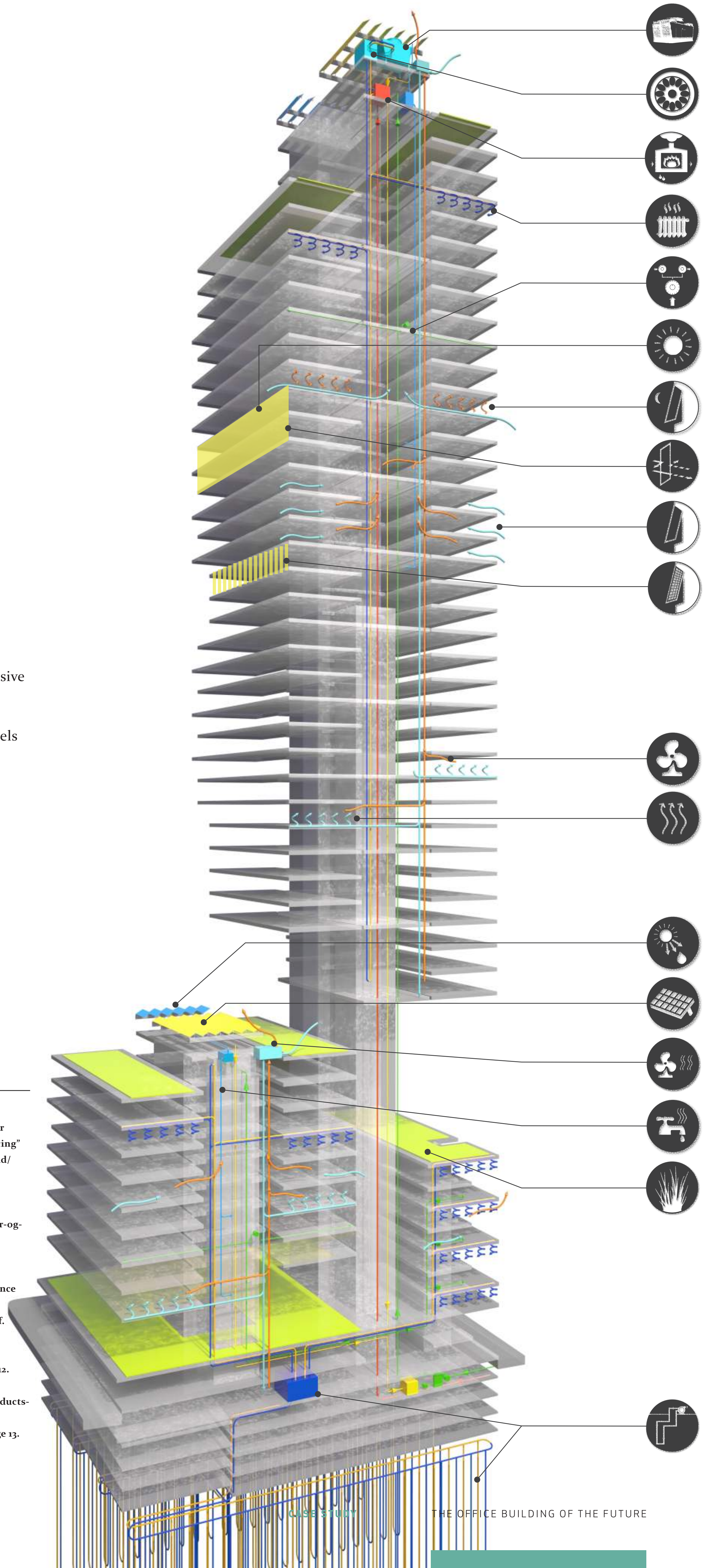
- Daylighting reduces need for artificial lighting
- Daylight sensors and dimming controls provide necessary light in varying light conditions
- Automatic interior roller shades provide glare control
- Efficient direct/indirect T5 fluorescent fixtures or LED fixtures

VERTICAL TRANSPORTATION

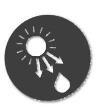
- Open stairs increase physical activity of occupants and reduce elevator demand
- Efficient new elevator belt technology can reduce energy by up to 50%; adding a regeneration drive that recaptures energy lost in braking can save an additional 25%[4]

OCCUPANT BEHAVIOR

- Tenant sub-metering incentivizes and encourages tenant efficiency
- Online building energy management systems provide real-time feedback to encourage better energy usage
- Tenant plug load reductions encourage more efficient equipment
- Task lighting encouraged to reduce general illumination



RENEWABLE ENERGY HARVEST



- Solar hot water (thermal) collectors are inexpensive and highly efficient

- Conventional monocrystalline photovoltaic panels with 20% conversion efficiency offer the highest production per square foot on roofs[5]

- Amorphous silicon building-integrated photovoltaics offer the most production in conditions with diffused lighting and vertical surfaces[6]

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1 United Nations Environment Programme Sustainable Buildings and Climate Initiative. (2009) Buildings and Climate Change: Summary for Decision-makers. Page 9; "Center-of-Glass U-factor (IP) vs. Glass Spacing" Spectra gasses WESTLab http://www.spectragases.com/content/upload/AssetMgmt/technical%20data/IP%20U-factor%20(colour).pdf. Accessed 11 May 2012.

2 Fiberline. "Typical Thermal Properties for Fiberline GRP Profiles." http://www.fiberline.com/vinduer-doere-facader/profiler-til-vinduer-og-doere-/tekniske-egenskaber/termiskeegenskaber/typical-thermal-properties-fiberlin. Accessed 11 May 2012.

3 Carbary, Lawrence, and Albery, Fiby. (2007) "A Thermal Modeling Comparison of Typical Curtainwall Glazing Systems." Glass Performance Days. Dow Corning. http://www.dowcorning.com/content/publishedlit/thermal_modeling_comparison_Carbary_GPD_2007.pdf. Accessed 11 May 2012.

4 "Leading to a Green Future" Otis Elevator Company http://www.otisgen2.com/gen2_adv/green.shtml. Accessed 12 May 2012.

5 Sunpower Corporation. "The Most Powerful Solar Panels for Your Business." http://us.sunpowercorp.com/small-medium-business/products-services/solar-panels/. Accessed 11 May 2012.

6 Onyx Solar. (2011) "Building Integrated Photovoltaics." Brochure. Page 13.

Net-Zero Water

SYSTEM READINGS

Until recently, concerns about water consumption in buildings focused primarily on improving fixture efficiency and reducing irrigation demand. Costs for municipal water supply and sewage discharge have rapidly escalated due to limits of existing infrastructure and growth. The OBF will adopt a comprehensive approach to efficiently manage all of its water resources.

For much of the year, Seattle receives significant precipitation and the OBF will collect the rain from its roofs and direct it to a cistern along with condensate and blowdown collected from the HVAC system for reuse throughout the building and landscape. Green roofs and landscaping will absorb a portion of the rainwater, create micro-habitats, and help to mitigate the urban heat island effect. These features will improve the local microclimate with increased evapotranspiration and reduced runoff loads on the City's over-taxed combined storm-water and sewer system, particularly in storm events.

An onsite "Living Machine" mimics the natural filtration capabilities of tidal wetlands with a series of lushly planted tanks and concealed cisterns, producing reusable though non-potable water from waste water. A reverse-osmosis plant will further purify this output, making it fully potable water. The onsite blackwater treatment and its associated water reuse strategies will reduce demand for city-supplied water by 86%, waste water outflow by 95%, and runoff by at least 50%. Payback on the increased capital cost of onsite infrastructure is estimated to be achieved in as little as 4 years.

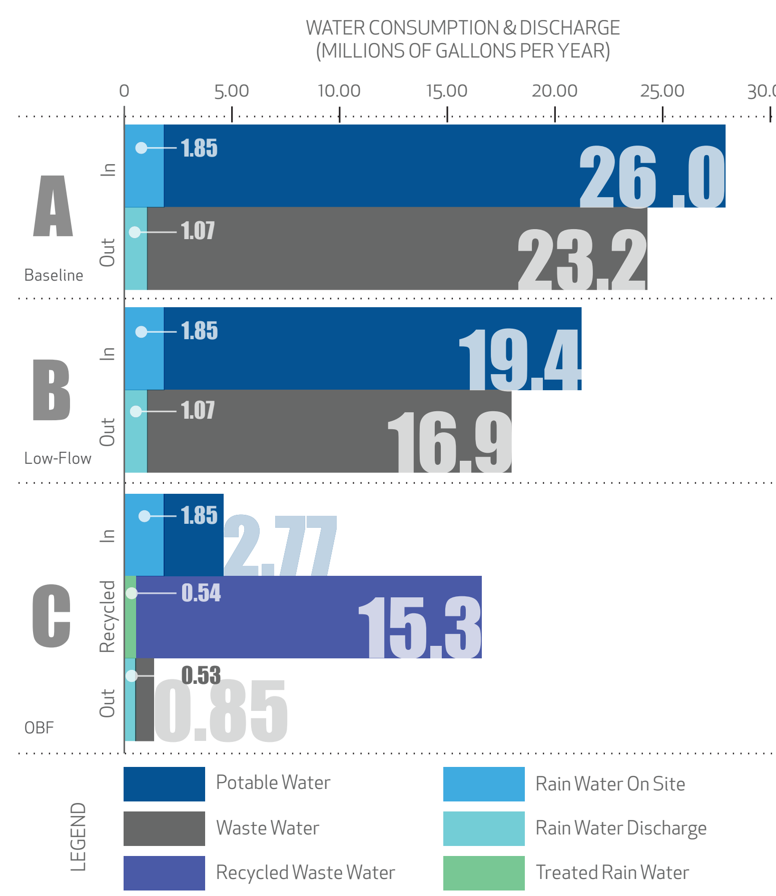


Figure 1. Water Use Comparison

A comparable building consumes as much as 26 million gallons of potable water per year with medium-flow fixtures (A). The use of low-flow fixtures reduces potable demand by 26% allowing waste water outflow to be reduced by 27% from 23.2 million to 16.9 million gallons (B). The dramatic balancing of water flows in the design of the OBF reduces potable water use to 2.77 million gallons (C), 11% of the baseline. Waste water output drops to 845,000 gallons (3.7% of the baseline) due to the recycling of 15.3 million gallons of water annually.

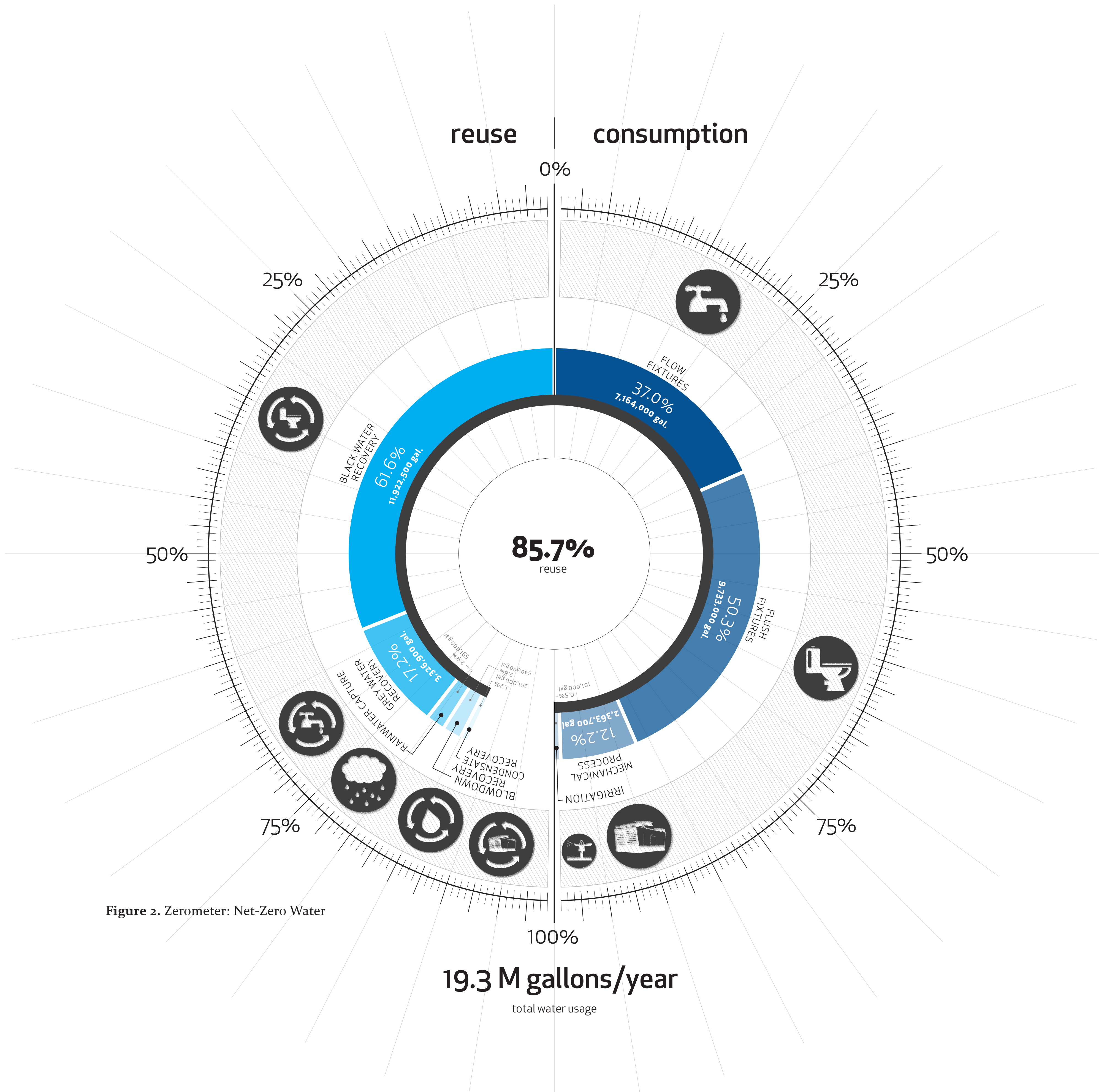


Figure 2. Zerometer: Net-Zero Water

Strategies

WATER STRATEGIES

HIGH-EFFICIENCY WATER FIXTURES

- Watersense-approved faucets, showers and toilets assure quality and reduced consumption
- Motion-activated and auto shut-off fixtures reduce demand and waste

RAIN WATER COLLECTION & STORAGE

- Collection from all surfaces, including roofs, green roofs and site
- 1,300-cubic-foot cistern sized for cost-effectiveness

EFFICIENT LANDSCAPE IRRIGATION

- Efficient and effective drip irrigation method
- Drought-tolerant landscaping minimizes irrigation needs

MECHANICAL PROCESS WATER COLLECTION & STORAGE

- Reduction of cooling tower blow down and condensate water flows (these can account for 40% of a building's water demand)
- 13,800 cubic foot cistern captures a large volume of water to vastly reduce demand and waste

WASTE WATER COLLECTION

- Managing grey water and black water flows together is more cost effective than managing separately

LIVING MACHINE

- A low-energy system for treating all waste water on site, and includes the following:
  - Settling tank for equalizing flow and settling solids;
  - Control system to manage flow and monitor performance and quality;
  - Wetlands installations located inside or outside for removal of nutrients and particulate -- this is the visible, odorless portion of the system;
  - Disinfection system to kill any remaining pathogens[1]

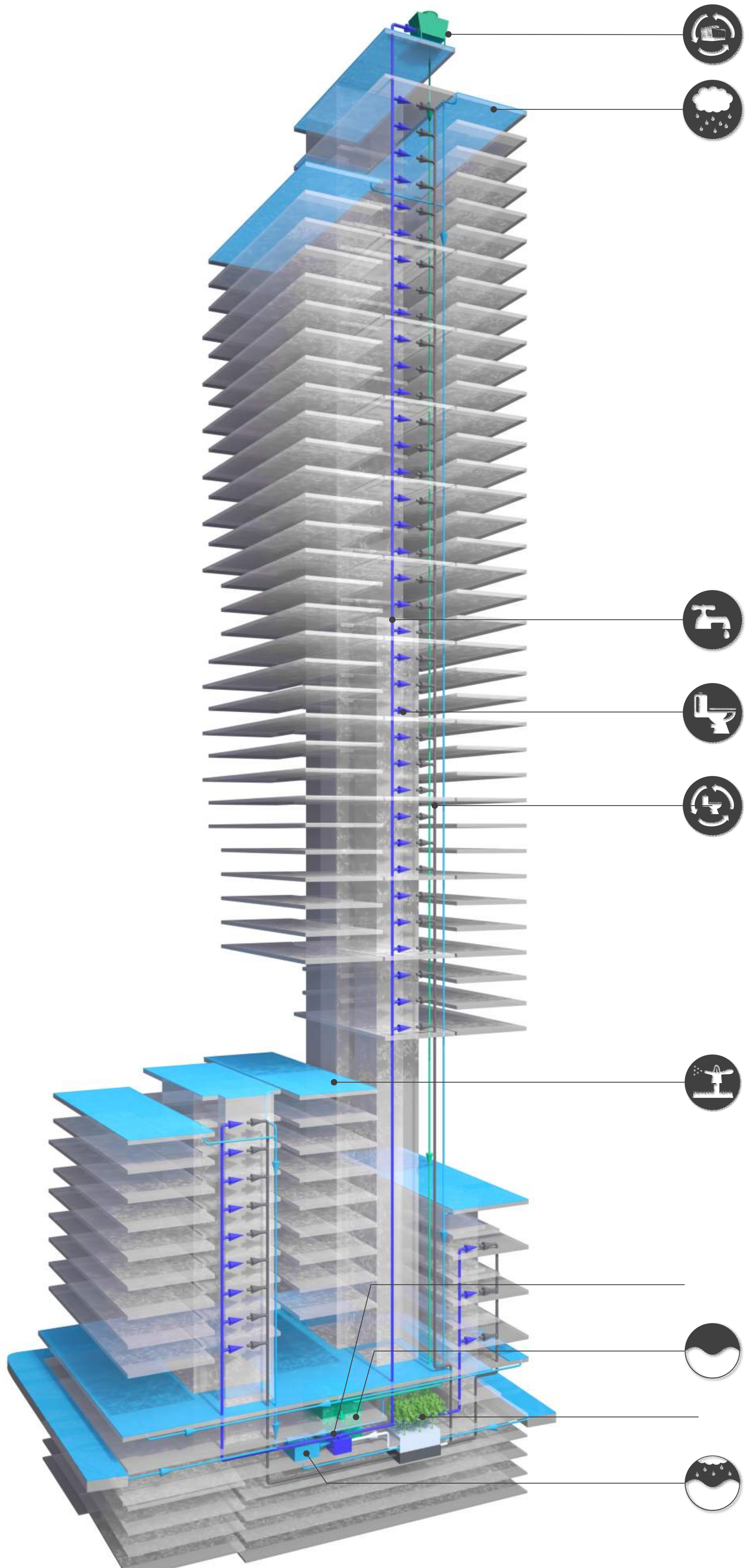
REVERSE-OSMOSIS PLANT

- For final purification of Living Machine output as well as collected effluents to produce potable water

REUSE OF COLLECTED & TREATED WATER

- System meets 86% of potable water needs
- Drastic reduction in city water and sewer services substantially reduces utility costs
- Tenants are charged for water services provided by the owner through on-site water collection and recycling services
- Payback on systems in as little as 4 years[2]

1 Worrell Water. "How It Works." Living Machine (R). www.livingmachines.com/about/how_it_Works. Accessed 11 May 2012.
1 Gagnes, Drew. "Water Resources Narrative." Magnusson Klemencic Associates.



Net-Zero Embodied Carbon

EMBODIED CARBON REDUCTION

The term, "embodied carbon emissions" describes the energy used to make a material or product. The Architecture 2030 Material Challenge notes that for a conventional house, it takes about 15 years for its operational energy consumption to exceed the energy used for its construction.[1] The OBF will include defined strategies to reduce the carbon footprint of its component materials.

Determining the embodied carbon of a project is more challenging than operational energy modeling because the necessary information is limited or not published. Due to the lack of specific data, the embodied-carbon strategy will not be based on attaining an absolute carbon number. The strategy will focus on making more informed choices during the design and material procurement process by considering relevant comparative data. Two major strategies to be employed in reducing the embodied carbon within the structure include use of Cement Reduction Concrete (reducing the amount of Portland cement used in concrete, since manufacture of Portland cement accounts for 2% of all greenhouse gas emissions in the United States)[2] and Carbon Accounting Specifications (requiring embodied carbon reporting through project specifications and using the carbon footprint of a material as one of the decision-making metrics for design and material procurement). Carbon Accounting will be commonplace within the next decade as Life Cycle Analysis increases as a focus in new construction.

As a means to offset resource consumption, the selected site trees will absorb 913 tons of CO_2 over 30 years. The Tree Carbon Calculator established by the US Forest Service provides carbon sequestration information for specific species of trees. The species are grouped for appropriateness in the major climate regions of the United States. As with energy consumption, the carbon footprint of a large building is difficult to offset within urban property lines, so a considerate owner will offset the remaining material impact of the building by supporting forest restoration efforts either regionally or internationally.

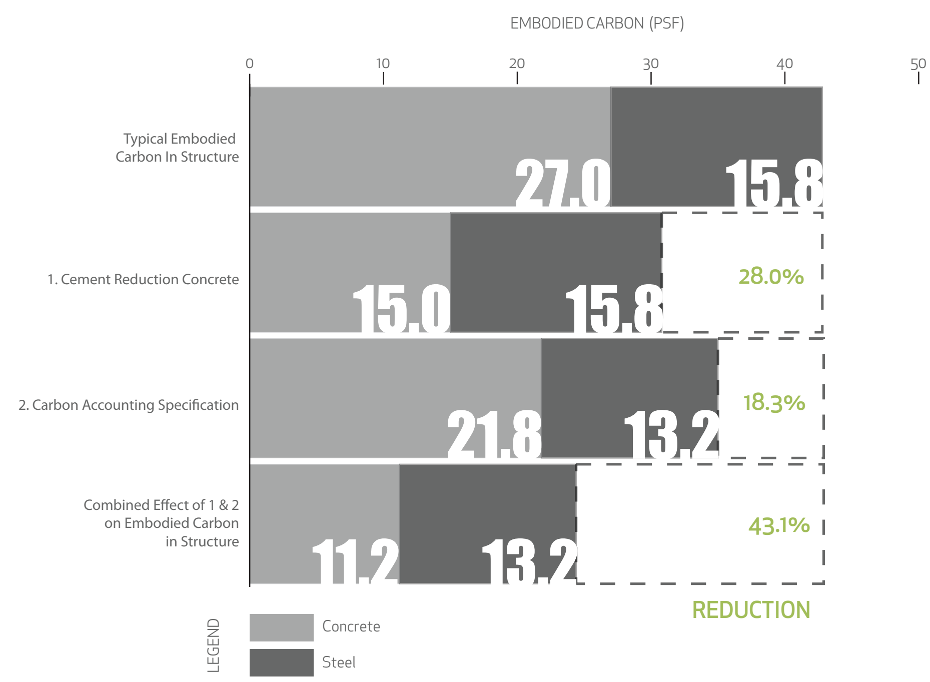


Figure 1. Embodied Carbon Reduction Strategies

Individually, each strategy has a measurable effect on carbon emissions: the Cement Reduction Concrete reduces embodied carbon by 28.0%, and the Carbon Accounting Specification allows for a 18.3% drop. In combination, the two strategies account for a 43.1% reduction in the embodied carbon of the structure, for a total decrease of 12.2 thousand tons of CO_2 emissions.

1 Architecture 2030 Materials. http://architecture2030.org/2030_challenge/products.

2 "Carbon Footprint of Portland Cement Shrinks" Environmental Building News. 1 July 2011. http://www.buildinggreen.com/auth/article.cfm/2011/6/29/Carbon-Footprint-of-Portland-Cement-Shrinks/.

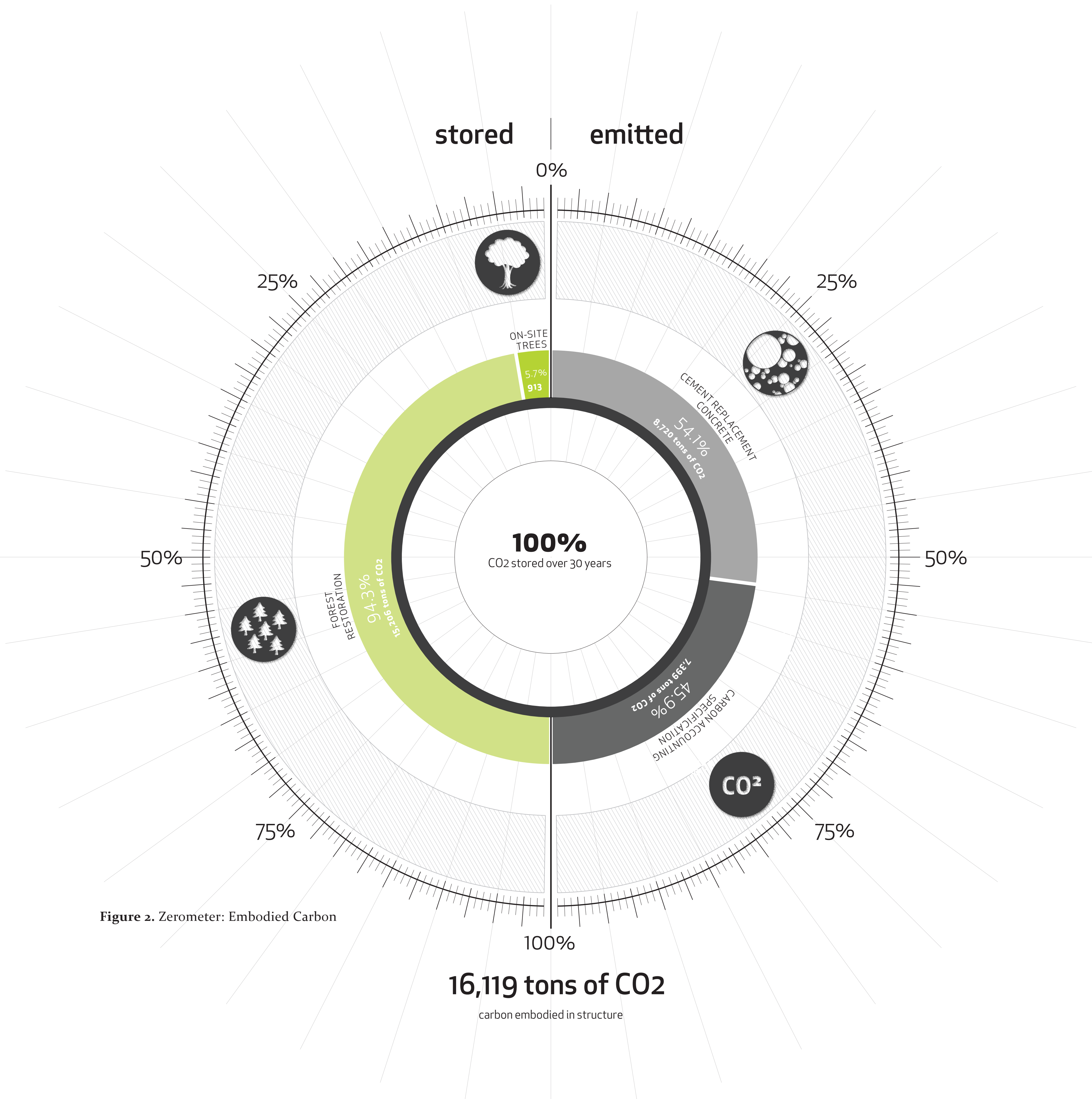


Figure 2. Zerometer: Embodied Carbon

Strategies

EMBODIED CARBON STRATEGIES

CEMENT REDUCTION CONCRETE

The manufacture of Portland cement accounts for 2% of all greenhouse gas emissions in the US.[2] Substituting Cement Reduction Concrete reduces or eliminates the use of Portland cement.

- High fly-ash or slag mix used as partial Portland cement replacement
- Both are byproducts of other industrial processes (burning coal, smelting steel) that exhibit cementitious properties when combined with calcium hydroxide
- Slag improves the durability and quality of concrete, increases its strength, and extends its service life, as well as making the concrete whiter and more resistant to chemical attack[3]
- Slag can replace Portland cement at a 1:1 ratio and can reduce the CO_2 emissions of cement by up to 65%

CARBON ACCOUNTING SPECIFICATIONS

Carbon Accounting Specifications require embodied carbon reporting through project specifications and using a material's carbon footprint as one of the project's decision-making metrics for design and material procurement such as:

Steel Rebar

- 80-90% recycled content
- Milled within Seattle city limits
- Produced during non-peak electrical load periods with electric hydropower generated by Seattle City Light

Precast Concrete

- Factory-produced building components reduce waste and improve quality
- Precasting easily responds to embodied carbon accounting requirements in project specifications

Fiberglass Curtain Wall Mullions

- Pultruded fiberglass reinforced polymer composite curtain wall structure
- Reduces embodied carbon by 55% to 78% compared with 40% recycled or all virgin aluminum (respectively)[4]
- Much higher thermal resistance versus aluminum; improves energy performance
- Higher strength than aluminum; uses less material for same structural requirements
- Has same thermal expansion and contraction rate as glass, for a more resilient system[5]

Locally Extracted and Manufactured Materials

- Highly favor products extracted and manufactured within 50 miles of site
- Favor products extracted and manufactured within 500 miles of site

Oyster Shells

- A byproduct of Seattle oyster farming, shells can be used as an aggregate replacement in roof pavers and landscape paving
- Historically used in making tabby concrete

Cradle-to-Cradle Certified Materials (e.g. glass)

- A voluntary certification of a product based on its impact on humans and the environment; reusability; energy used in manufacturing; water usage; output quality in manufacturing; and the manufacturer's social responsibility towards customers and employees

Alternative Transportation

- Favor transport by barge or train when products must be shipped from outside the region

Manufacture with Renewable Energy

- Favor products manufactured with renewable energy

Plant Trees on Site

- Urban trees reduce the urban heat island effect, shade buildings thus reducing energy consumption and absorb various air pollutants[6]
- A Coast Live Oak shade tree will have absorbed 11,619 pounds of CO_2 after 40 years[6]
- A Kwanzan Cherry, an ornamental tree, will have absorbed 16,318 pounds of CO_2 after 40 years[6]

Plant Trees Off-site

- Restoring clear-cut forests can potentially absorb up to 2.3 tons of CO_2 per year[7]
- Over 30 years, an acre of trees can absorb 69 tons of CO_2
- Forest restoration charities plant trees at a cost of $1/tree

1 Architecture 2030 Materials. http://architecture2030.org/2030_challenge/products.

2 "Carbon Footprint of Portland Cement Shrinks" Environmental Building News, 1 July 2011. http://www.buildinggreen.com/auth/article.cfm/2011/6/29/Carbon-Footprint-of-Portland-Cement-Shrinks/.

3 "Sustainable Cement." Construct Ireland. 19 April 2007. http://constructireland.ie/Vol-a-Issue-12/Articles/Sustainable-Building-Technology/-The-EcoFriendly-Durable-Low-Energy-Alternative-to-OPC.html.

4 Daniel, Ryszard A. (March 2003)"Environmental Considerations to Structural Material Selections for a Bridge." European Bridge Engineering Conference. Lightweight Bridge Decks. Rotterdam.

5 Kragh, Mikkel. (2008) "Innovative Facade Technology Based on Pultruded Fibre-Reinforced Polymer Composites." Research Review. Arup. Pages 37-39.

6 Urban Forests and Climate Change. "UEP Tree Carbon Calculator." USDA Forest Service. www.fs.fed.us/ccrc/topics/urban-forests/ctcc. Accessed 7 May 2012.

7 US EPA. "Representative Carbon Sequestration Rates and Saturation Periods for Key Agricultural & Forestry Practices." www.epa.gov/sequestration/rates.html. Accessed 7 May 2012.

The Future

"Someday I hope to have a whole complex of caves." [1]

"Many newly successful cities on the global stage – such as Shenzhen and Dubai – have sought to make themselves attractive to businesses based on price and infrastructure subsidies. Those competitive advantages can work in the short term, but they tend to be transitory. For cities to have sustained success, they must compete for the grand prize: intellectual capital and talent." [2]

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1 Cotham, Frank. Cartoon. The New Yorker Collection. 11 February 2002: Online.
2 Bloomberg, Michael. (March 2012) "Cities must be cool, creative and in control." Financial Times.

When Will It Begin?

EPILOGUE: THE MODEL FOR CHANGE

It is expected that the OBF will fully satisfy the business objectives of its client and provide an attractive and healthful environment for its inhabitants. Attributes contributing to the success of the modular system include a high level of sustainable design and stewardship of limited natural resources; concern for the quality of life for inhabitants; and the careful management of schedule and budgets. The system's limitless adaptability in terms of building program and scale as well as a faster construction schedule will offer owners greater agility in responding to volatile market demands.

HOW DOES IT CHANGE IF BUILT IN OTHER CITIES?

It is believed that this success is inherent to the modular system and that it can be achieved and implemented in nearly any location worldwide. To suit each potential site's unique climatic conditions, the individual elements of the modular units, such as the glazing in the wall panels, can be easily adapted for warmer or colder environments. The modular system can easily accommodate local and unique zoning requirements. Additionally, the system is designed to not only respond to its specific location but to take advantage of it as well. For example, photovoltaic panels can easily be incorporated in south-facing wall modules to further facilitate achieving net-zero energy targets.

WHAT DO WE DO WHEN TECHNOLOGY CHANGES?

One the greatest attributes of the OBF modular system can be further customized within each unit. This allows for on-demand rapid integration of technological advances in both materials and systems while modules are in production. As envisioned by the design team, the OBF has the ability to continually evolve and accommodate humanity's drive to innovate. What suits and serves its occupants in 2030 can be replaced by future tenants who have grasped the imaginings of 2030 and realized them as the novel and unanticipated technologies of the high-performance buildings of their time.

Photo: NASA. (http://www.decodedscience.com/wp-content/uploads/2012/05/) EarthfromSpace.jpg.

Team Profiles

PICKARD CHILTON

Jon Pickard FAIA, RIBA, Principal

Pickard Chilton delivers master planning and architectural design services to clients worldwide. Throughout their careers, the firm's principals—Jon Pickard FAIA, William Chilton FAIA and Anthony Markese AIA—have led the design of some of the world's most significant and recognized buildings.

Projects include corporate headquarters, commercial office towers, mixed-use complexes, healthcare facilities and academic centers. In all of the firm's work, it endeavors to bring unexpected value to its clients through excellence in service and design. The firm has completed or is currently designing projects for clients worldwide with a construction value of more than $12.0 billion.

Its buildings are noted for their people-oriented spaces as well as their distinctive modern forms that establish memorable identities, becoming new landmarks.

The firm's principals collaborate on the design of each project, supported by a close-knit staff of architects and designers that strives for more than architectural excellence. The goal, with every project, is to create an engaging environment that fully satisfies the clients' ambitions while exceeding the expectations of those who live, visit and work in and around the firm's projects.

For all projects, the firm collaborates with experienced Architects of Record to meet the unique needs of each client. This ensures that clients have access to the most highly qualified professionals for all aspects of design, project management, building technology and construction administration.

The firm practices from its New Haven, Connecticut, studio located on the town green across from Yale University.

Jon Pickard has been recognized internationally for his achievements in architecture. He has designed or collaborated in the design of some of the world's most recognized buildings, including such prominent projects as the ExxonMobil Office Complex in Houston, Texas; the Devon Energy Headquarters in Oklahoma City, Oklahoma; The Atrium (LEED Gold), a luxury residential tower in Dubai, UAE; 1180 Peachtree (LEED Gold) in Atlanta, Georgia; 300 North LaSalle (LEED Gold) in downtown Chicago, Illinois; the CalPERS Headquarters Complex (LEED Gold), in Sacramento, California, for the nation's largest pension fund; Wells Fargo Financial Headquarters in Des Moines, Iowa; ConocoPhillips Headquarters West Campus expansion in Houston, Texas; the US Environmental Protection Agency Headquarters (LEED Gold) near Washington, DC; and Four Seasons Place in Kuala Lumpur, Malaysia.

Prior to the founding of Pickard Chilton, he collaborated with Cesar Pelli in the design of numerous landmark and award-winning projects, including two of the largest commercial developments ever built: the World Financial Center in New York and Kuala Lumpur City Centre in Kuala Lumpur, a development that includes the Dewan Filharmonik, Malaysia's National Symphony Hall, and two of the world's tallest buildings, the Petronas Towers.

Jon Pickard received his Bachelor of Arts in Architecture from Iowa State University and his Master of Architecture from the Yale School of Architecture. Iowa State University awarded him its Design Achievement Award (1989) for distinguished contributions to the arts and the Christian Petersen Design Award (2007). In conjunction with William Chilton, he is co-recipient of the 2011 Iowa State University Distinguished Alumni Award, the highest honor given to alumni by the University. The Gerald D. Hines College of Architecture at the University of Houston recognized Jon Pickard as its 2006 Honoree. He regularly serves as a visiting critic at Yale University and has led an advanced design studio at Iowa State University. He has lectured extensively at academic institutions including Rice University, Louisiana State University, Iowa State University and Harvard University. He currently serves on the Yale School of Architecture Dean's Council.

William D. Chilton FAIA, RIBA, Principal

William Chilton has directed projects for leading corporate and institutional clients worldwide including the world headquarters for Eaton Corporation in Cleveland, Ohio; the ExxonMobil Office Complex in Houston, Texas; Devon Energy Headquarters in Oklahoma City, Oklahoma; 900 New York Avenue (LEED Gold) in Washington, DC; Four Seasons Place in Kuala Lumpur, Malaysia; Emory University Hospital Midtown and Conservatory in Atlanta, Georgia; the US Environmental Protection Agency Headquarters (LEED Gold) near Washington, DC; The Atrium, a luxury residential tower in Dubai, UAE; AIM Corporate Headquarters in Houston, Texas; California Green, a mixed-use development in Irvine, California, and CalPERS Headquarters Complex (LEED Gold) in Sacramento, California.

Prior to the founding of Pickard Chilton, he was Ellerbe Becket's President of Architecture and collaborated on such notable buildings as the Science Museum of Minnesota and Kingdom Centre in Riyadh, Saudi Arabia, which, when completed, was the tallest mixed-use complex in Europe and the Middle East. The Art Institute of Chicago selected the project for its international exhibition, Skyscrapers: The New Millennium.

William Chilton received his Bachelor of Arts in Architecture from Iowa State University and Master of Architecture from the University of Minnesota. Iowa State University recognized him with its Design Achievement Award (1995) for distinguished contributions to the arts and the Christian Petersen Design Award (2007), the highest award given by the College of Design. In conjunction with Jon Pickard, he is co-recipient of the 2011 Iowa State University Distinguished Alumni Award, the highest honor given to alumni by the University. He is actively involved in teaching, serving in Spring 2010 as Professor in Practice at the University of Minnesota College of Design. He has been a visiting critic at Oklahoma State University and has lectured at Iowa State University, Yale University and a broad range of professional associations including the AIA and Urban Land Institute (ULI). He is a member of ULI serving on the 2007 and 2008 juries for the ULI Gerald D. Hines Student Urban Design Competition and serves on the Design Futures Council Executive Board. He is past chair of the Architecture Advisory Council of the College of Design at Iowa State University and currently serves on the Advisory Board of the College of Design at the University of Minnesota.

Anthony J. Markese AIA, RIBA, LEED AP, Principal

Anthony Markese has design leadership experience on prominent projects around the world for a broad range of higher education, institutional and commercial clients. He has collaborated on the design of a variety of prominent projects, including the ExxonMobil Office Complex in Houston, Texas; 900 New York Avenue (LEED Gold) in Washington, DC; California Green (LEED Gold), a mixed-use development in Irvine, California; 300 North LaSalle (LEED Gold), and River Point (LEED Gold), both in downtown Chicago, Illinois; the CalPERS Headquarters Complex (LEED Gold), in Sacramento, California, for the nation's largest public pension fund; the Colgate University Case Library and Center for Information Technology; the Duke University Basketball Practice Facility; and ER One, a state-of-the-art medical emergency response facility in Washington, DC.

Prior to Pickard Chilton, he was a Senior Associate and Design Team Leader with Cesar Pelli & Associates where, during a distinguished fifteen-year period, he collaborated on the design of the award-winning Terminal at the Reagan Washington National Airport; JP Morgan Chase in downtown San Francisco, and the Biwako Hotel and Entertainment Complex on Lake Biwa, Japan. He also collaborated on the design of the Rock Biomedical Research Laboratory at the Mission Bay campus of the University of California San Francisco as well as several projects for Duke University including the Athletic Precinct Master Plan, the Wilson Student Recreation Center, and Schwartz/Butters Hall.

Anthony Markese is a US Green Building Council LEED-accredited professional. He received a Bachelor of Science in Architecture from the University of Illinois and a Master of Architecture from the Yale School of Architecture. In addition to his professional accomplishments, he has lectured and taught design studios at Yale University, Oklahoma State University and the University of Texas at Austin and other universities.

MAGNUSSON KLEMENCIC ASSOCIATES

Ron Klemencic, PE, SE, President

Magnusson Klemencic Associates (MKA) provides structural and civil engineering services worldwide, with $73 billion worth of projects in 47 states and 48 countries, and individual projects in excess of $2 billion. The firm, headquartered in Seattle with offices in Chicago, Shanghai and Riyadh, was founded 88 years ago and has a staff of 145. MKA provides engineering services to architects, owners, developers and contractors with enhanced expertise in seismic engineering, wind engineering, vibration engineering, building renovation, sustainable designs and blast protection.

MKA's engineers are organized into specialist groups, with each group focused on a particular facility type. Their Office Building Specialist Group has designed campuses up to 40 acres and vertical and stacked configurations up to 112 stories tall. The firm's 80-year history of office building design includes more than 430 office projects, with repeat designs for world-class organizations. They have designed 35 award-winning office projects in the last 10 years and are recognized pioneers in the development of performance-based seismic design for high-rises.

The most significant professional recognition by engineering peers is the annual American Council of Engineering Companies' National Engineering Excellence Program. MKA has been presented with a national ACEC award each of the last 15 consecutive years and 24 times in the last 26 years – three times more than any competitor structural engineering firm in the United States. During that time, MKA has received ACEC's "Grand Conceptor" award three times, recognizing the firm for designing the top engineering project in the nation.

Ron Klemencic is President of MKA and one of the firm's most senior structural engineering talents. He has 24 years of design experience, accrued after receiving his Bachelor of Science from Purdue in 1985 and his Master of Science from UC Berkeley in 1986. Mr. Klemencic takes a hands-on approach to projects, serving as Principal-in-Charge or Concept Designer for $5.2 billion worth of projects in the last five years alone. He has designed projects in 22 states and 20 countries and leads the firm's Office Building Specialist Group.

Mr. Klemencic is known locally and internationally for his creativity and "big picture" approach, which translates into a unique ability to consistently produce cost-effective, innovative designs. Developers, architects and contractors alike have come to rely on his focus on value, and he has on-going relationships with many of those well-known in the industry.

He was named 2008 Structural Engineer of the Year by the Structural Design of Tall and Special Buildings Journal, and he was also a 2008 Top 25 Engineering News Record Newsmaker for his work advancing Performance-Based Seismic Design. He is Past 5-year Chairman of the Council on Tall Buildings and serves on the Board of Directors of the American Concrete Institute and the Charles Pankow Foundation, as well as a myriad of other technical committees.

ATELIER TEN

Paul Stoller, LEED AP BD+C, Director, New York

Atelier Ten is a collaborative, interdisciplinary and innovative firm of environmental design consultants and lighting designers focused on delivering sustainability to the planned and built environment. The team's background in architecture, engineering, lighting design, environmental studies and urban design translates into a profound respect for architectural design and urbanism with an enthusiasm for working with emerging designers and established firms. The firm's core objective is to meet the needs of their clients by developing well-integrated buildings with simple systems that work with natural laws of physics to increase comfort, reduce energy consumption and contribute back to the greater environment.

Atelier Ten believe passionately in delivering a legacy of positive change. By recognizing and analyzing opportunities for improving energy efficiency, water conservation, material resources and carbon emissions reductions, the firm provides integrated, full-service consulting on environmental design, building systems performance analysis, lighting and daylighting design, benchmarking, sustainable master planning and inter-related services. Their broad and worldwide portfolio spans from the tallest LEED Gold Office building in the United States to the world's largest thermal labyrinth at Federation Square in Australia, to hundreds of award-winning projects and LEED certified buildings.

An international firm, Atelier Ten provides a seamless, integrated service, marked by accessibility, reliability and efficiency at every level. Founded in 1990 in London by a team of progressive engineers, they have since expanded, with offices in New York, New Haven, San Francisco, Glasgow and Abu Dhabi.

Mr. Stoller is a director of Atelier Ten and the leader of its global benchmarking practice. He is recognized internationally for environmental planning and design consulting work on large-scale campus, community and urban projects. His recent work includes two LEED Platinum rated academic buildings, the tallest LEED project in the United States, the sustainability framework for a major urban medical campus and a carbon-neutral airport terminal.

He currently teaches core courses on environmental design and building services at the Yale School of Architecture. Mr. Stoller also serves as a visiting lecturer at the Rural Studio at Auburn University and frequently speaks on environmental design and building performance modeling at architecture schools and conferences. He is a LEED Accredited Design Professional, and holds a Bachelor of Science and a Masters of Arts in architectural history from the University of Wisconsin and a Masters of Architecture from Yale University.

COSENTINI ASSOCIATES

Douglas Mass, PE, LEED AP, President

Cosentini Associates was established in 1952 to provide consulting services in the mechanical and electrical engineering disciplines. As one of the largest and most respected consulting engineering firms in the country, Cosentini provides the following engineering services: HVAC, electrical power, fire protection, plumbing, mission critical, telecommunications, security, audiovisual, specialty lighting, energy conservation and LEED design/facilitation, code consulting and fire engineering, commissioning and construction services.

Cosentini's practice employs over 300 professionals across ten offices worldwide. Working closely with leading architects, the firm has participated in the design of the world's most innovative and celebrated buildings. In 1999, Cosentini greatly expanded its resources by joining Tetra Tech, Inc., a nationwide alliance of more than 330 offices specializing in engineering design, construction management, resource management and infrastructure, telecommunications support services, applied science and management consulting.

Cosentini is proud of its many years of work in engineering energy-efficient, environmentally conscious designs and of its portfolio of "firsts" in these areas. Cosentini employs over 75 LEED Accredited Professionals and its portfolio includes over 50 LEED certified projects and over 70 projects anticipating LEED certification.

One particularly unique aspect of Cosentini's engineering practice is the firm's ability to offer its clients a fully integrated set of services. This integration of services assures its clients that the coordination of all engineering and information technologies trades is both seamless and expedient.

Douglas C. Mass, PE, LEED AP, President of Cosentini Associates, is an internationally recognized leader in the global design and construction industry – largely as a result of his expertise as a mechanical engineer, his commitment to design innovation, and a long list of world-renowned projects designed by equally renowned architects. Mr. Mass's work in the area of sustainable design has earned him an international reputation for developing building systems that are energy efficient, ensure occupant comfort and promote the preservation of our environment.

Mr. Mass's career spans over 30 years and includes many pioneering achievements such as his design of the first sustainable high-rise office building in Manhattan and the first LEED Gold residential high-rise in the country. Mr. Mass is also well-known for his pioneering applications of underfloor delivery systems – including the first corporate headquarters in the United States to incorporate this technology as well as subsequent advances .

Mr. Mass has participated in the engineering of many of the world's most prestigious projects including the Guggenheim Museum in Bilbao, Spain; Shanghai Center - a LEED Gold targeted, 2000-foot tower that will be the tallest in China; and a major new federal office building complex in San Juan, PR (to be LEED Silver). Under his direction, Cosentini has engineered over 50 projects to have obtained LEED certification and over 100 that anticipate LEED certification.

Mr. Mass's dedication to the education of future engineers and architects is evident in his service as an adjunct professor at Columbia University's School of Architecture and at his alma mater, Brown University, where he earned a Bachelor of Science in Mechanical Engineering. He has authored several articles and lectured extensively on sustainable design and underfloor air system design.

Larry W. King, AIA, NCARB

IA Interior Architects is the first global architectural firm focused exclusively on interior architecture, workplace strategies and design. The firm's mission is to translate its clients' goals, brand and culture into high-performance, visually compelling and sustainable environments. Their innovative design solutions, built around people, processes and business drivers, contribute to their clients' success. IA's diverse and talented professionals – the firm's most important asset – extend their expertise and achieve personal success in the creative and entrepreneurial culture.

IA Interior Architects was founded in 1984 in Los Angeles and has since grown to offices in 13 metropolitan cities across the United States, including Atlanta, Boston, Chicago, Dallas, Denver, Los Angeles, New York, Orange County, Raleigh, San Francisco, Seattle, Silicon Valley and Washington, DC. IA's global office network includes London and Tokyo with over 60 affiliate locations across Europe, South America, Latin America, Australia, the Middle East, Africa and Asia Pacific.

Larry King has over 40 years of experience in architecture, strategic design, planning and corporate general management. He is a comprehensive resource for the structuring and implementation of long-term occupancy strategies as well as design solutions requiring sensitivity to client goals.

Mr. King founded IA's Chicago office and has been Managing Principal of both the New York and Chicago offices prior to his relocation as Managing Principal of the Denver office in 2004.

Prior to joining IA, he worked for sixteen years at Gensler's Denver office where he served as Managing Principal. Mr. King also served as Chief Executive Officer for the national offices of a Fortune 50 financial services company, PHH Environments, and a partner at Perkins & Will.

As an architectural graduate of Kansas State University, he is NCARB-certified and is a registered architect in 33 states. He is a participating member of the American Institute of Architects (AIA) and past Vice President of the Denver AIA Chapter, Urban Land Institute (ULI) Executive Council Colorado Chapter, Corenet Rocky Mountain Chapter Board of Directors, a member of International Facilities Managers Association (IFMA) and The Economic Club of Chicago. He is currently a board member of Heartland Alliance, Harrington College of Design, Denver Art Museum Design Council, and Kansas State University Foundation and the College of Architecture, and a frequent speaker and panelist.

GILBANE BUILDING COMPANY

Gilbane is a leading international building firm, providing total facility-related solutions—from state-of-the-art sustainable buildings to the latest applications in construction technology – for clients in a variety of market segments. Founded in 1873 and the nation's fifth oldest builder, Gilbane is still a privately held, family-run company. As part of the firm's culture of client advocacy, it delivers projects on time, on budget, safely and efficiently while providing added value with innovative approaches.

Its core values – integrity, teamwork, tough-mindedness, dedication to excellence, loyalty and discipline – are at the heart of Gilbane's lasting success. Although the challenges of today's built environment are increasingly complex, the firm's philosophy is simple: employ the best people to deliver the best experience for its clients.

Peter Adamowicz, Vice President

Mr. Peter Adamowicz, Vice President, is Gilbane's Connecticut District Chief Estimator. In this role, he oversees all activities in the state, with focus on customer satisfaction, quality, training and adherence to policies and procedures. Mr. Adamowicz also provides strategic direction as Gilbane continues its commitment to growth in Connecticut. He has worked on projects for clients in different market sectors, including the State of Connecticut, University of Connecticut, Fairfield University, Bayer Inc., Pfizer Inc. and several municipalities statewide.

With 32 years of construction, 18 at Gilbane, Mr. Adamowicz is a seasoned estimator. He has extensive estimating and budget development experience on advanced research projects that is supported with a well-developed understanding of local and regional market prices. As estimating executive, he coordinates with a team of in-house mechanical, civil and electrical estimators to prepare detailed estimates.

Mr. Adamowicz received an Associate of Science degree in Building Construction Technology from Wentworth Institute of Technology and an Associate of Science degree in Civil Engineering from Northeastern University.


FORM
ASSEMBLY

Appendices

Appendix 1 | Floor Plans

PICKARD CHILTON

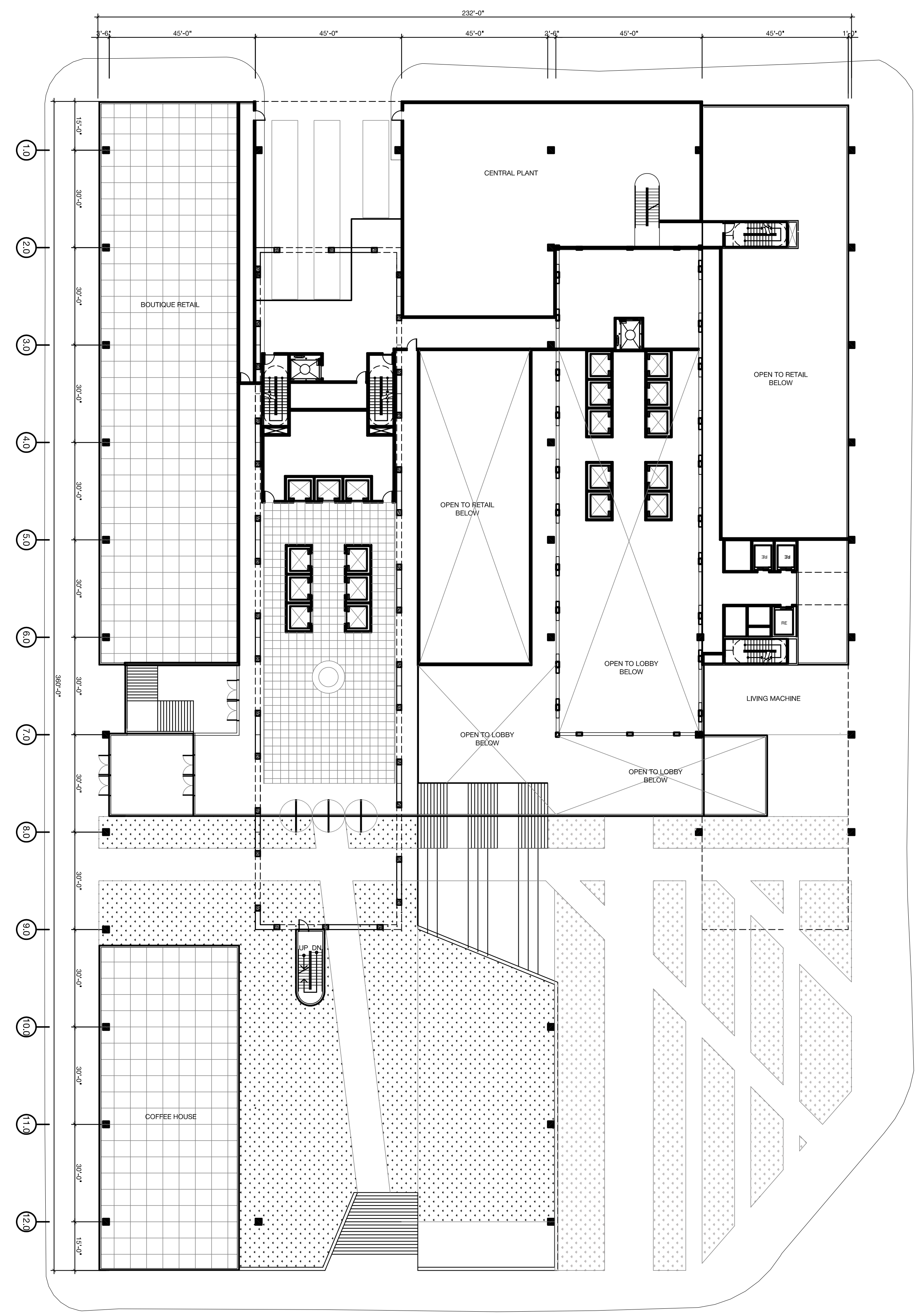


Figure 1. Ground Level 02 Plan

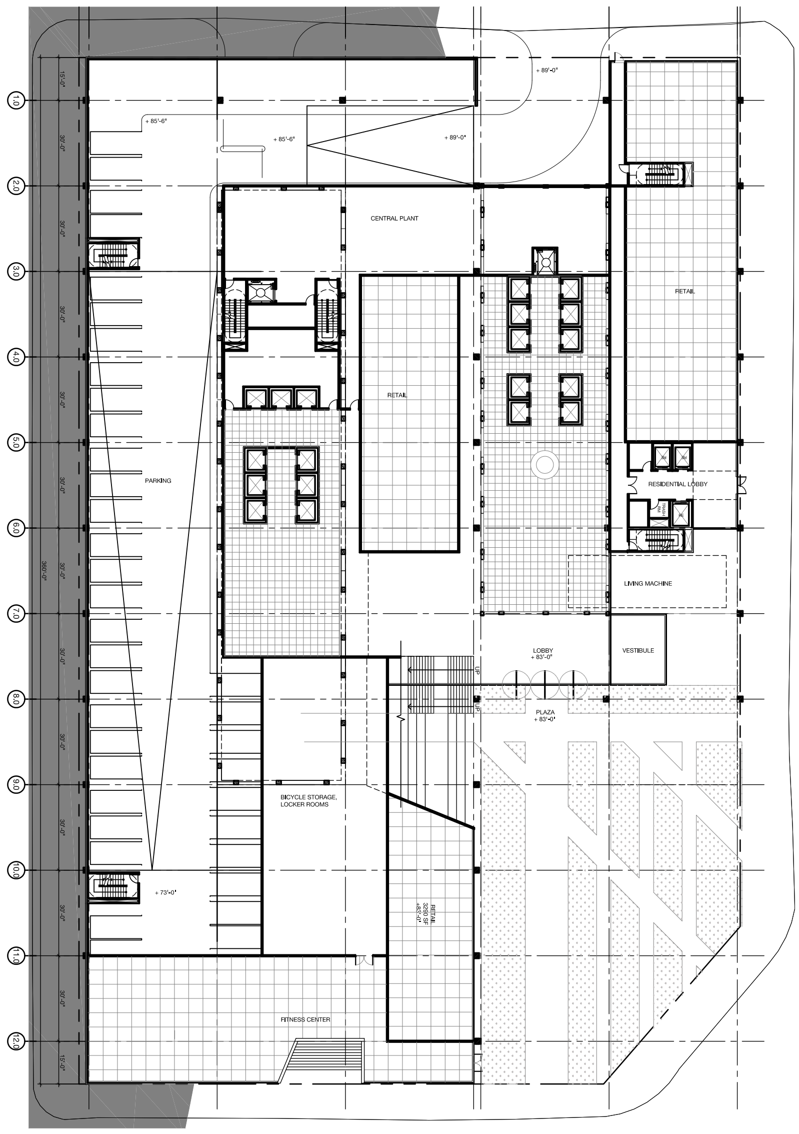


Figure 02. Ground Level 01 Plan

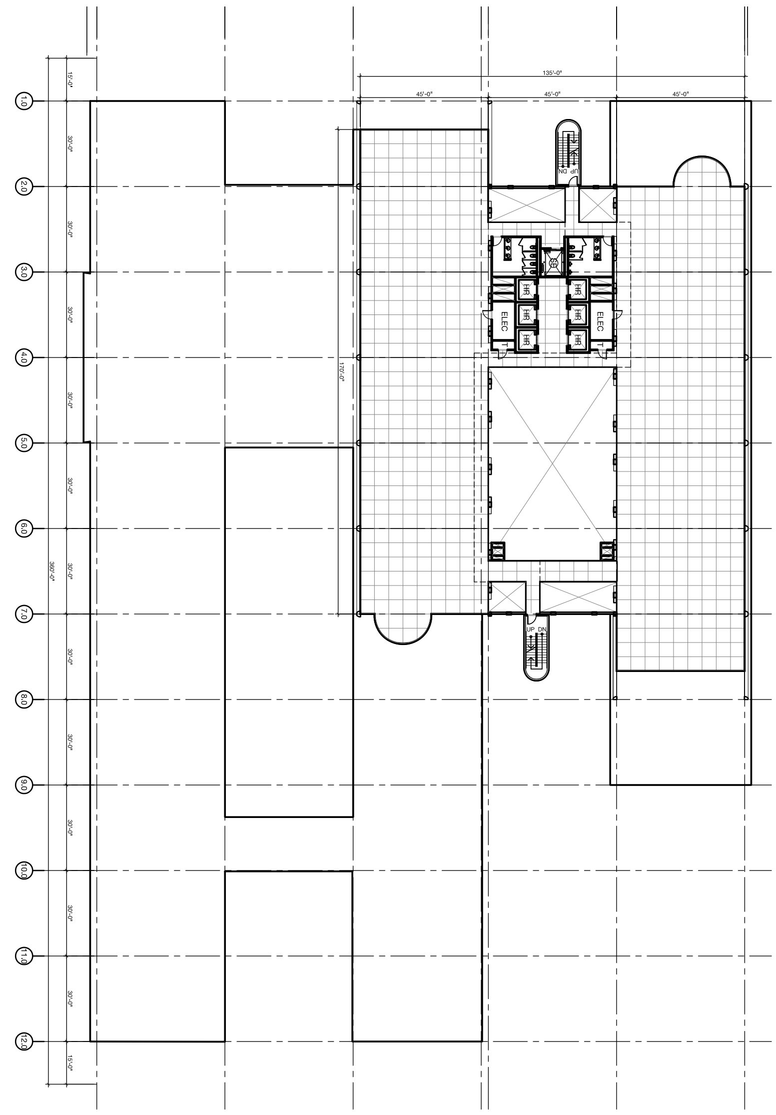


Figure 03. High-Rise Tower Level Plan

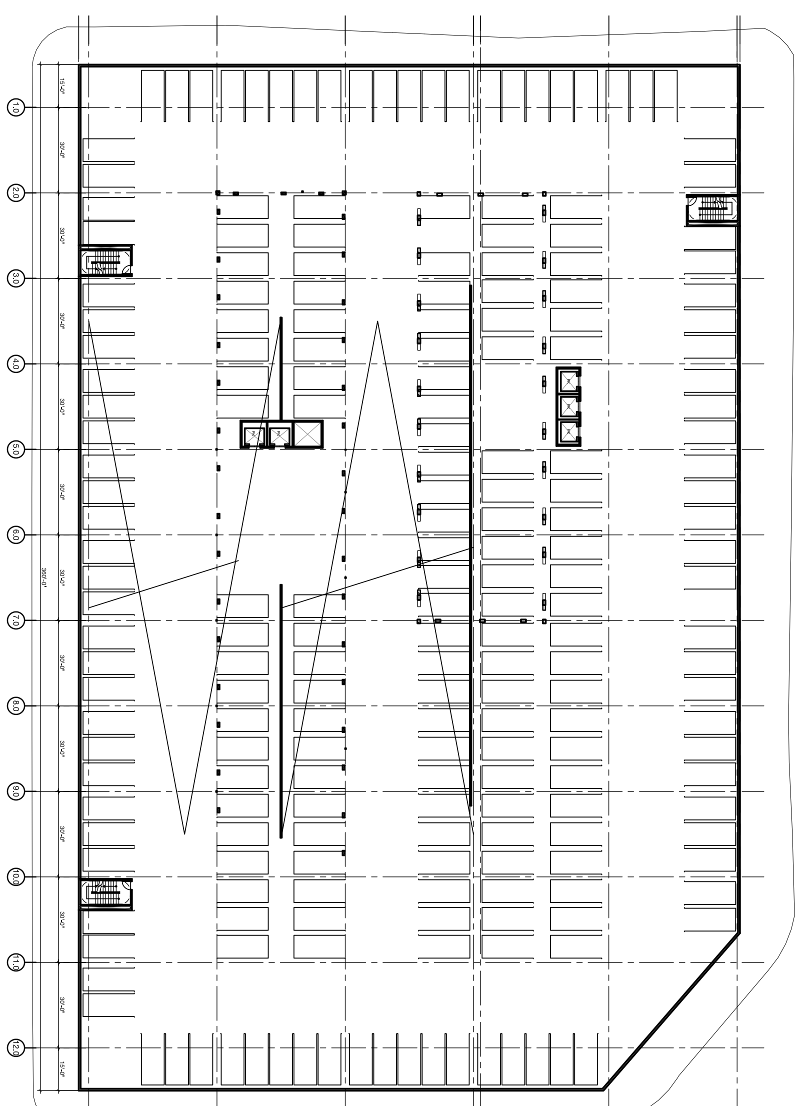


Figure 04. Parking Level 01 Plan

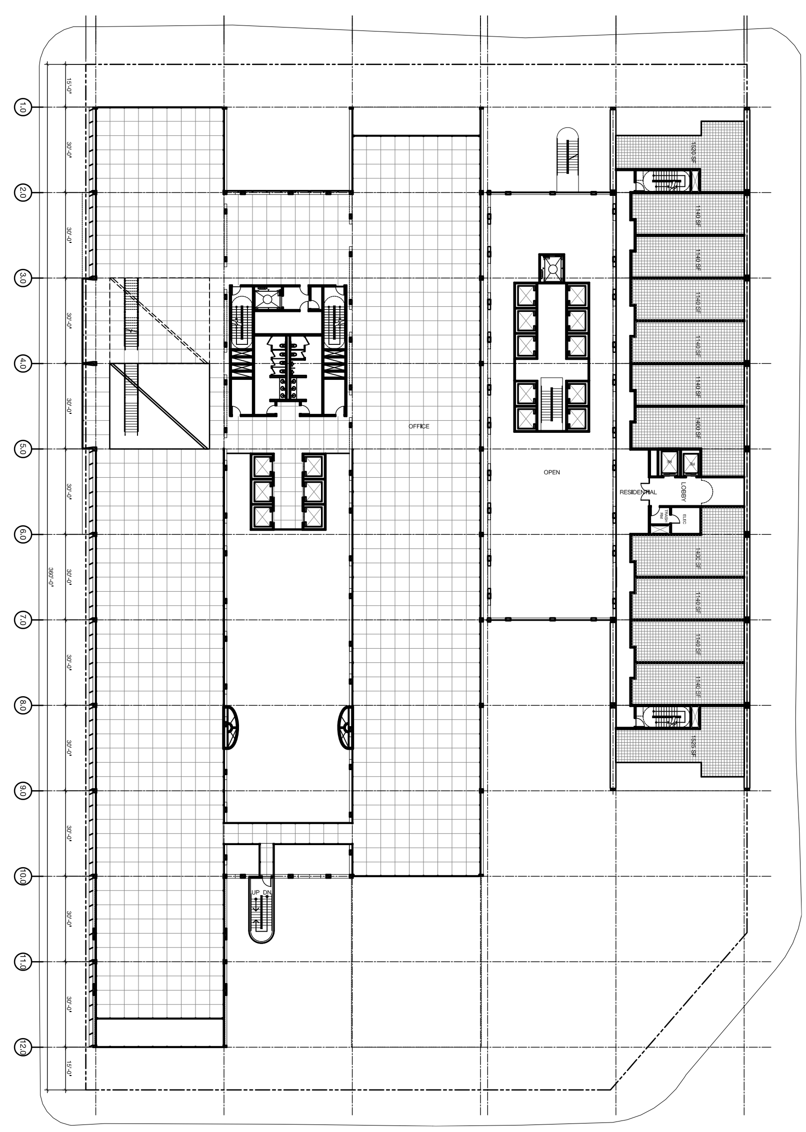


Figure 05. Typical Low-Rise Level / Residential Plan

Appendix 2 | Structure

MAGNUSSON KLEMENCIC ASSOCIATES

FLOOR FRAMING - TRADITIONAL APPROACH

Most office buildings today are constructed of 5" – 6" thick concrete slabs supported by composite metal deck. This decking material is in turn supported by structural steel beams, typically 18" – 21" deep, spanning from the core to the perimeter of the building. Spray-on fire protection is applied to complete the structural floor assembly. Mechanical, electrical, communications, fire suppression, lighting and ceiling systems are "layered" below the structure to complete the overall building plenum construction. The result of this layering approach is an overall plenum depth of approximately 48". In some markets, cast-in-place reinforced concrete or post-tensioned concrete systems are used if local conditions support these systems as being more economical. However, the overall approach to the layering of the building plenum is largely the same. Plenum depths of 42" – 48" remain common.

FLOOR FRAMING - WHAT'S NEW?

A new structural floor system is envisioned for the OBF which incorporates mechanical, electrical, communications, fire suppression and lighting systems into a single, integrated assembly. Constructed using precast concrete, structural sections spanning the width of the floorplate are envisioned to be 24" deep, one-half of the traditional plenum depth. Incorporated within the precast concrete elements are hydronic cooling loops providing the building cooling system, integral air highways to distribute supply and exhaust air, and pre-fabricated raceways for electrical and communication routing. The precast elements are fabricated off-site in a factory setting where all of the building's mechanical and electrical systems can be pre-fitted. As the building elements arrive on site, they are simply and easily lifted off the delivery trucks and set directly in place creating the final and completed floor assembly. Speed of construction is significantly enhanced.

Improvements offered by the Integral Pre-Cast Concrete Floor System include:

- Integral construction of structural, mechanical and electrical systems reduces the necessary floor to floor height, saving significant construction costs.
- Pre-assembly of the various building systems reduces on-site construction time and labor, as well as substantially reducing construction material waste.

- Speed of erection of the precast elements improves upon traditional steel construction.
- Spray-on fire protection is eliminated, resulting in a cleaner environment requiring little, if any, maintenance.

COLUMNS - TRADITIONAL APPROACH

Perimeter columns are commonly located as close to the exterior wall as possible to minimize their impact on internal office space planning. Columns are typically coated with spray-on fire protection and then surrounded by metal stud and drywall furring.

COLUMNS - WHAT'S NEW?

Columns supporting the OBF are envisioned to exist outside the perimeter wall of the building, completely eliminating any internal space-planning encumbrances. Columns are constructed of precast concrete with integral insulation to eliminate thermal cold-bridging. Similar to the precast floor elements, the precast concrete columns are fabricated in a factory setting and simply lifted into place upon arrival at the site. There is no additional spray-on fire protection nor any additional furring, saving cost and time during on-site assembly.

Improvements offered by the Precast Concrete Insulated Columns include:

- Positioning the column outside of the exterior wall eliminates all office space planning encumbrances.
- Integral insulation eliminates thermal cold bridging.
- Speed of construction is improved over traditional steel construction through the elimination of additional finishes.

SEISMIC AND WIND BRACING - TRADITIONAL APPROACH

Bracing systems for most office buildings include some arrangement of concrete shear walls or braces around a central core. While this approach is quite efficient, significant challenges occur for mechanical or electrical systems that must penetrate these walls. In addition, if multiple levels of below grade parking are included, the walls prove to be burdensome on the efficiency of the garage. Finally, the thick shear walls or heavy bracing offer little flexibility for future technologies or building modifications.

SEISMIC AND WIND BRACING - WHAT'S NEW?

A bracing system organized around the perimeter of the internal atria and/or light-wells provides an even more efficient method of bracing the building. Instead of concentrating the lateral load resistance in a small central core, the resistance is more broadly distributed reducing demands on the structural pieces as well as the building's foundation. The result is smaller structural elements and the elimination of thick concrete shear walls or heavy steel bracing.

Precast concrete diagonal elements provide an openness of the structural frame that allows natural light to penetrate the office spaces. With no concrete shear walls or heavy steel bracing, the elevators, stairs and shafts are also open to natural light. Future flexibility for the incorporation of new technologies or building modifications is also enabled.

Superior quality control, fast and efficient assembly, the elimination of spray-on fire protection and the reduction of on-site waste materials are additional benefits of this system.

As the distributed diagonal bracing system penetrates the sub-structure, parking can be more readily and efficiently planned. The encumbrances invoked by traditional concrete shear walls are eliminated.

Improvements offered by the Precast Concrete Diagonal Bracing System include:

- The well-distributed system reduces demands on the structural elements resulting in smaller, less costly pieces.
- Natural light is able to penetrate all areas of the floorplate.
- Elevators, stairs and shafts are no longer "captured" within heavy structural elements allowing for the easy incorporation of future technologies or building modifications.
- Below grade parking can be more efficiently planned as thick shear walls or heavy bracing is eliminated.

MATERIALS - TRADITIONAL APPROACH

Traditional building materials include cement-based concrete with strengths of 4,000 – 8,000 psi, reinforcing steel with a yield strength of 60 ksi, and structural steel sections with a yield strength of 50 ksi.

MATERIALS - WHAT'S NEW?

Higher-strength materials and concretes that minimize or eliminate the use of Portland cement are envisioned. The production of Portland cement is one of the most energy-intensive manufacturing processes on the planet. The embodied carbon content of Portland cement concrete is the single largest use of carbon in the construction of any building. Cement replacement products, including Alkalai Activated Cement (AAC), promise to dramatically reduce the amount of embodied carbon in building construction. Coupled with the use of higher-strength reinforcing steel, 100 ksi and up, the overall cost of materials and the labor to install them will be drastically reduced.

Improvements offered by new materials include:

- The reduction or elimination of Portland cement concrete through the use of cement replacement materials or Alkali Activated Cements (AACs) will dramatically reduce embodied carbon content of building construction.
- High-strength reinforcing steel (100 ksi and greater) will reduce the overall quantity of material and the labor required to install it.

Appendix 3 | Water

MAGNUSSON KLEMENCIC ASSOCIATES

Note: The figures for this article appear on pages 124-127.

EXECUTIVE SUMMARY

The design proposal includes a high-performance, integrated approach to meeting the water resources needs of the OBF. From top to bottom, a suite of sustainable interventions will contribute to creating a building with an extremely small water footprint (a building with a very low impact on its community's precious water resources), serving as model for 21st century building design.

As shown in Figure 1, rainwater that lands on the building's low roofs will be soaked up and evaporated by green roofs; rainwater from the building's high roofs will be collected in a cistern for reuse within the project; condensate and blowdown from the project's HVAC system will also be harvested for reuse within the project and sewage will be treated on site in a Living Machine which outputs clean, reusable water. These reclaimed waters will be used for irrigation, toilet flushing and the HVAC system's cooling tower.

Together these measures provide habitat, reduce the local urban heat island affect and improve the local hydrologic cycle via increased evaporation and reduce the demand on the city's overtaxed combined sewer system. In addition, the on-site sewage treatment and water reuse strategies will significantly reduce the facility's total cost of water resources by reducing demand on city-provided water and sewer utilities, with the increased capital cost of on-site strategies being paid back through utility bill savings in as little as 4 years.

INTRODUCTION

For the past 100 years, Seattle, like many urban areas across the country, has dealt with water-related utilities in three distinct "silos," whereby a city's drinking water supply, sewage treatment and storm water management needs have all been met with separate, centralized systems, with little regard to economic or environmental benefits that could be derived by leveraging synergies between these three water "resources." Figure 2 depicts this approach.

This conventional approach led to the development of mega, centralized water and sewage treatment plants whose charge has been to meet the needs of an entire city in more or less a single location, albeit separately for water and sewage. The one common overlap that developed in many cities was the convenience of collecting nuisance storm water runoff together with sewage and treating this combined waste water at a centralized sewage treatment plant. This so-called "combined sewer" approach has proven to be a false synergy due to the inability of these systems to adequately handle the combined load, even in modest storms, leading to combined sewage overflowing to rivers, lakes, etc. Billions of dollars are required to retrofit existing combined sewer networks with the proper infrastructure to preclude combined sewer overflows (CSOs), billions that city coffers simply do not have. Moreover, the means to fund these major improvements is manifested in skyrocketing water and sewer utility rates. As a result, the conventional approach has proven to be both environmentally and economically unsustainable.

An example of the increased awareness of urban water resource issues is the sheer number of storm water management goals that architects and engineers designing building projects are juggling as they brainstorm sustainable strategies for new projects across the country. Quite often local code requirements for storm water detention are not the only goals considered with LEED, the Sustainable Sites Initiative, a new federal standard and other goals beyond local code often considered in an effort to show a greater contribution to improving watershed health.

Figure 3 summarizes the amount of storage required to manage the runoff from the facility as required to comply with a variety of binding and voluntary criteria. The project will certainly comply with local code and may choose to over comply with code to achieve one of the higher order goals. However, rather than just building a holding tank to achieve storm water goals, we are proposing an integrated water design approach that will achieve required (or desired) storm water reductions through reuse of water resources within the project.

An integrated water design approach bucks the conventional silo approach to water resources engineering. As shown in Figure 4, this approach considers all the water needs or "demands" of a project and compares them to all the possible water "supplies" available at the project site (e.g. an irrigation demand could be supplied by rain landing on a roof or the toilet flushing water demand could be supplied by water that is collected from sinks, then cleansed and recycled). Numerous optional pairings of supplies and demands can be compared against one another from an initial capital cost as well as a long-term operations and maintenance cost perspective to determine the most cost effective and environmentally responsible strategies that should be considered for the project. In short, this approach often yields more "decentralized" water resource solutions that reduce the water and sewer utility bills and redirects those monies to pay for on-site systems and their long-term operations and maintenance.

The remainder of this narrative summarizes the existing water resource situation at the project site and recommends a sustainable water resource alternative to continuing with the status quo.

EXISTING WATER RESOURCES AT PROJECT SITE

The first step in analyzing the sustainability of optional water resources approaches is to gain an understanding of the current, conventional situation by performing a baseline water resources audit.

The project site is served by conventional city public infrastructure; the site is surrounded by combined storm water and sewer infrastructure.

This means that every drop of rain that lands on the site is conveyed to the waste water treatment plant and treated as sewage. Figure 5 provides the regional context for the existing centralized municipal treatment facilities. This map helps one understand the origin of clean city water and the destination for combined sewage.

EXISTING WATER RESOURCES SUMMARY

Figure 6 indicates the basic water, sewer and storm drainage supplies/demands for the building when fully leased, based on the proposed program and proposed HVAC approach for the building. In 2012, those water resources would cost the building tenants $377,000. When projected out over 30 years at current escalation rates for those utilities, those same resources will cost $13,971,000 in 2042 (for a total 30-year cumulative cost of $113,407,000). These are costs borne by the building tenants and paid to the city utility companies via the building landlord.

SUSTAINABLE WATER RESOURCE ASSESSMENTS

The assessment of alternative sustainable water resource strategies begins with breaking the overall water resources into their constituent parts. This is shown in Figure 7. The sustainable water analyses then are simply a study of the alternative use of one supply for one demand, considering the initial capital cost of on-site infrastructure and long-term operations and maintenance cost associated with each pairing. In these scenarios, the building tenants would still be charged market (or potentially sub-market) utility rates by the landlord, which the landlord would then use to pay off the initial capital investment and annual operations and maintenance. The landlord in effect becomes a private utility district. Figure 8 shows a comparative life-cycle cost analysis of alternative sustainable water resource strategies, while Figure 9 graphs these against one another over a 30 year period. In Figure 9, portions of a given curve that are above the zero line (or baseline) are costs that are greater than business as usual and portions of a curve that are below the zero line are cost savings over baseline.

The various scenarios reveal some interesting findings such as:

- Rainwater for irrigation only while having a low capital cost has a very long payback horizon and a low potable use reduction.
- Payback horizons become medium when flush demand is added but potable use reductions remain small.
- Adding both mechanical harvests and demands to the scenarios further improves payback horizons but potable use reductions remain on the low side.
- Adding greywater harvesting pushes potable use reductions into double digits and brings payback horizon into single digit.
- Replacing greywater with blackwater treatment (in the form of a Living Machine as described below) finally yields high potable use reductions and low payback horizons. Scenario 17 (which leverages rainwater, mechanical condensate, cooling tower blowdown and blackwater treatment reclaimed water for irrigation, toilet flushing and cooling tower make-up water) would reduce dependence on city water by 60%, would cost $1,182,000 to implement, would pay back that initial investment in only 6 years and would save $65,237,578 over 30 years.

CONCLUSIONS AND RECOMMENDATION

The analysis is clear that only scenarios that provide on-site sewage treatment yield enough reclaimed water to make a big impact in potable water purchase from the city (and consequently only these contribute greatly to unburdening the city's combined sewer system). Of those, scenario 17 provides the greatest potable water use reduction short of scenario 18, which includes treating to drinking water standard. Scenario 15 is similar to 17 in most every comparison category, on the one hand showing the relatively small benefit to situation that is derived by adding mechanical harvests to the equation, but on the other hand showing the small amount of initial investment required to capture all possible on-site water resources.

As noted, scenario 17 leverages all facility-generated water supplies for all water demands except potable water for drinking, hand washing etc. In this scenario, potable water needs would be met by purchasing water from the city. While this is a noteworthy scenario, one can simply add a reverse osmosis plant to the downstream end of the Living Machine, and its reclaimed water can be treated to federally mandated drinking water standard. It seems appropriate that an OBF should achieve the level of self-sufficiency so we recommend scenario 18.

It is important to note that even in scenario 18, this building is not 100% self-sufficient relative to water resources. This is because the building will contain a cooling tower that releases a large amount of water to the atmosphere as it does its job to cool water within the HVAC system. This evaporated water is not recapturable so is lost to the in-building water resources systems. This is why scenario 18 only achieves an 86% reduction in potable water use since 14% of the total building water need is lost via the cooling tower.

In addition to the water savings, unburdening of the combined sewer and long-term cost savings benefits described above, the OBF, will showcase the type of 21st century decentralized infrastructure needed to enable continued development in our nation's urban centers without the need for more mega treatment plants.

BLACK WATER TREATMENT OVERVIEW

Some of the preceding analyses rely on the use of on-site sewage treatment as the means to turn waste water into reusable water. This analysis assumed that this would be carried out in a Living Machine. A Living Machine treats waste water by running it through containers filled with stones whose biofilm interacts with the waste water and cleanses it. Plants topping each container provide final polishing of the water. These systems use small scale pumps to move the waste water from chamber to chamber and require a modest amount of electrical energy to operate. For this project we estimate that the Living Machine will require approximately 1,750 square feet of space with chambers that are 7 feet deep.

The Living Machine is becoming more and more widely used at the individual building scale for on-site sewage treatment due to its small size, low energy requirements and aesthetics.

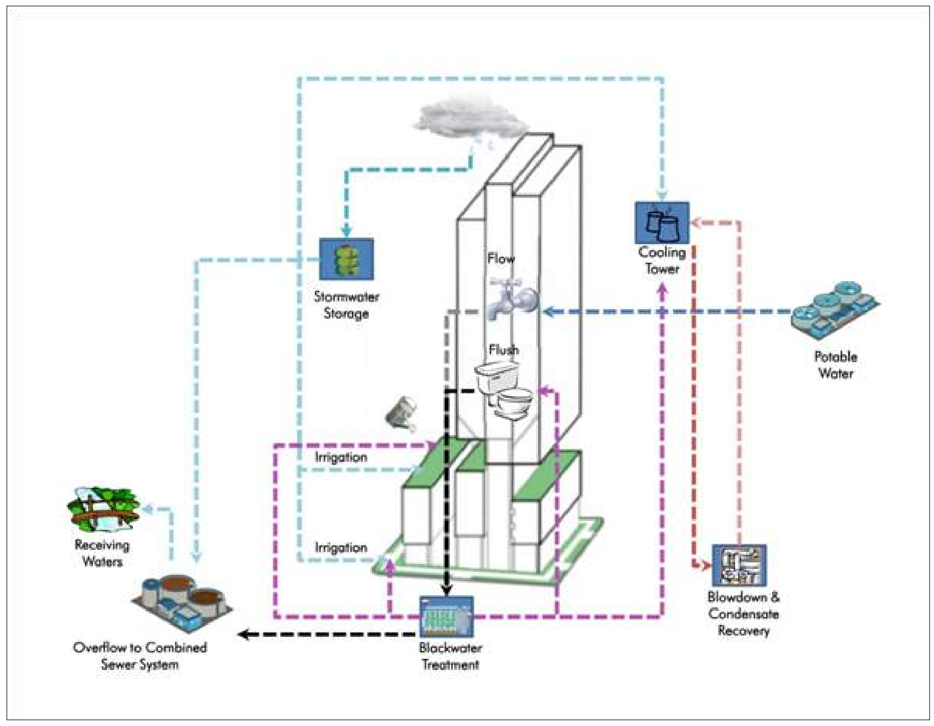


Figure 1. Schematic of Sustainable Water Resource Interventions

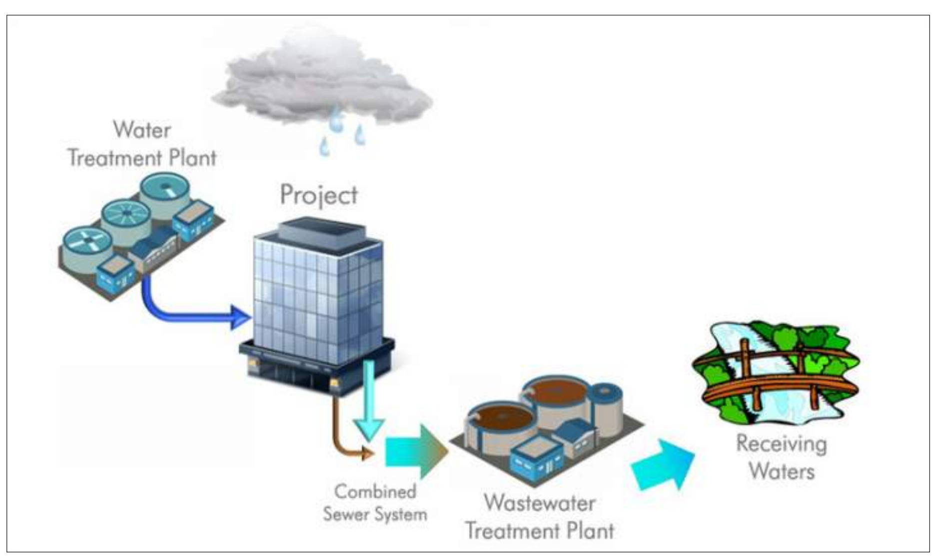


Figure 2. Conventional Water Resources Approach

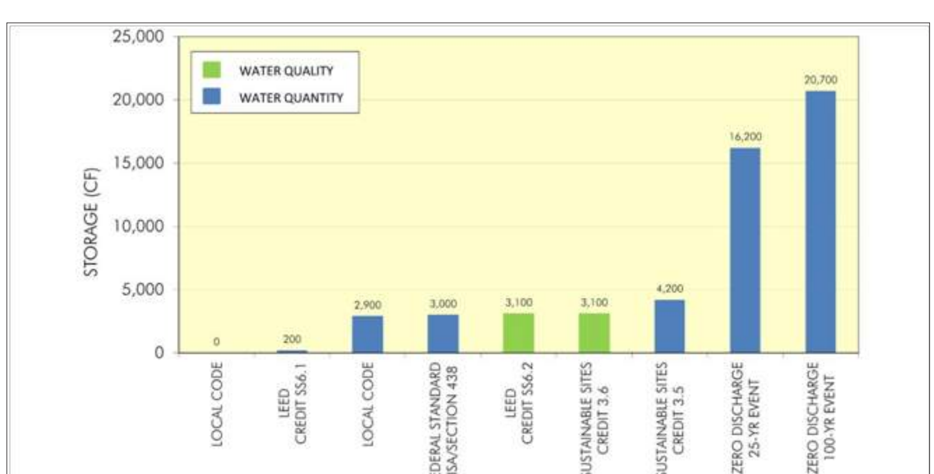


Figure 3. Alternative storm water management goals comparing local code with other prevalent standards.

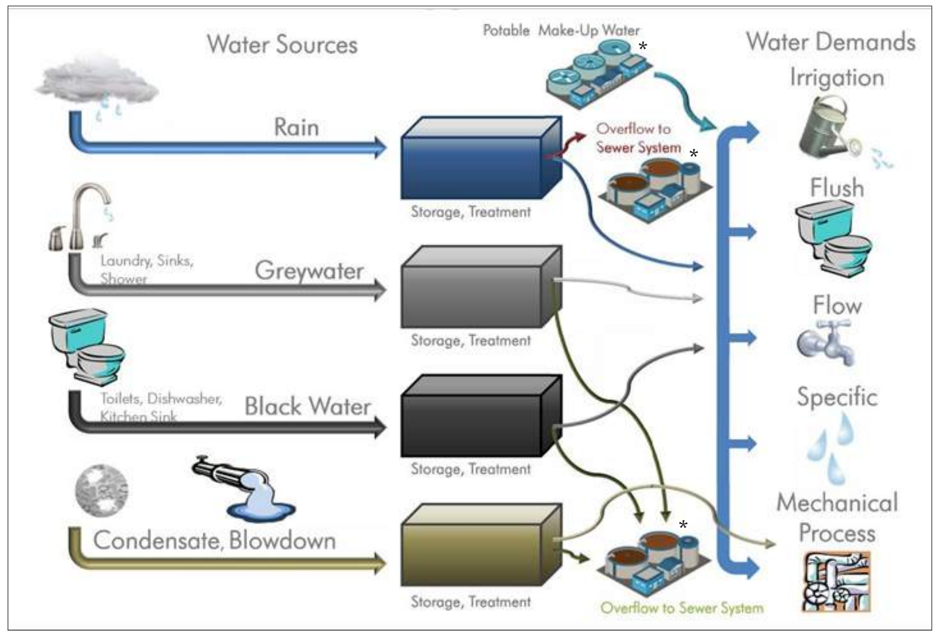


Figure 4. Integrated Water Design Approach

* Tracey Saxby, Integrated & Application Network, University of Maryland Center for Environmental Science

Figure 5. Regional Water Resource Points of Origin and Termination

Background Image © 2012 Google Earth

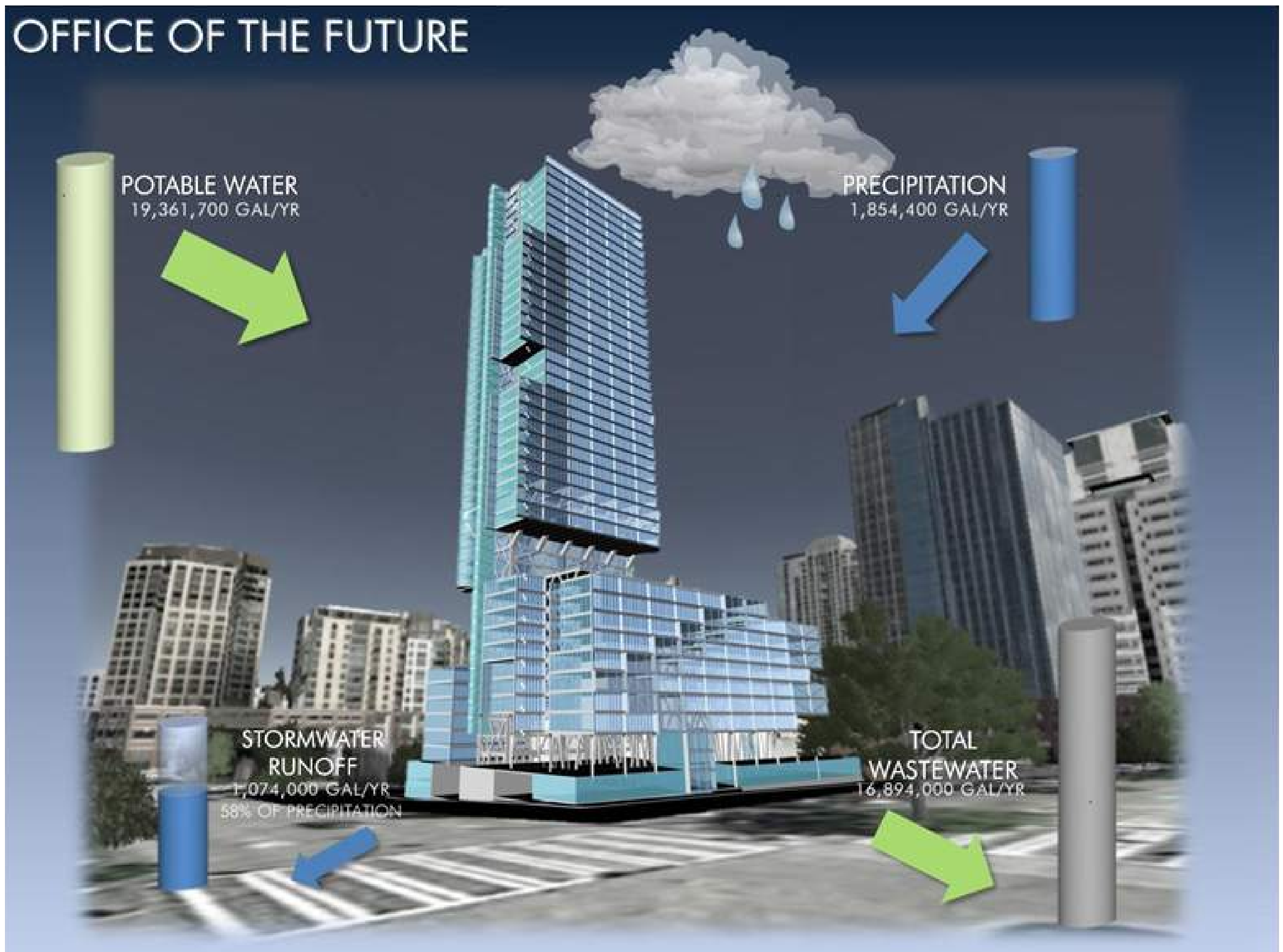


Figure 6. Baseline Project Water Resources Profile

Background Image © 2012 Google Earth

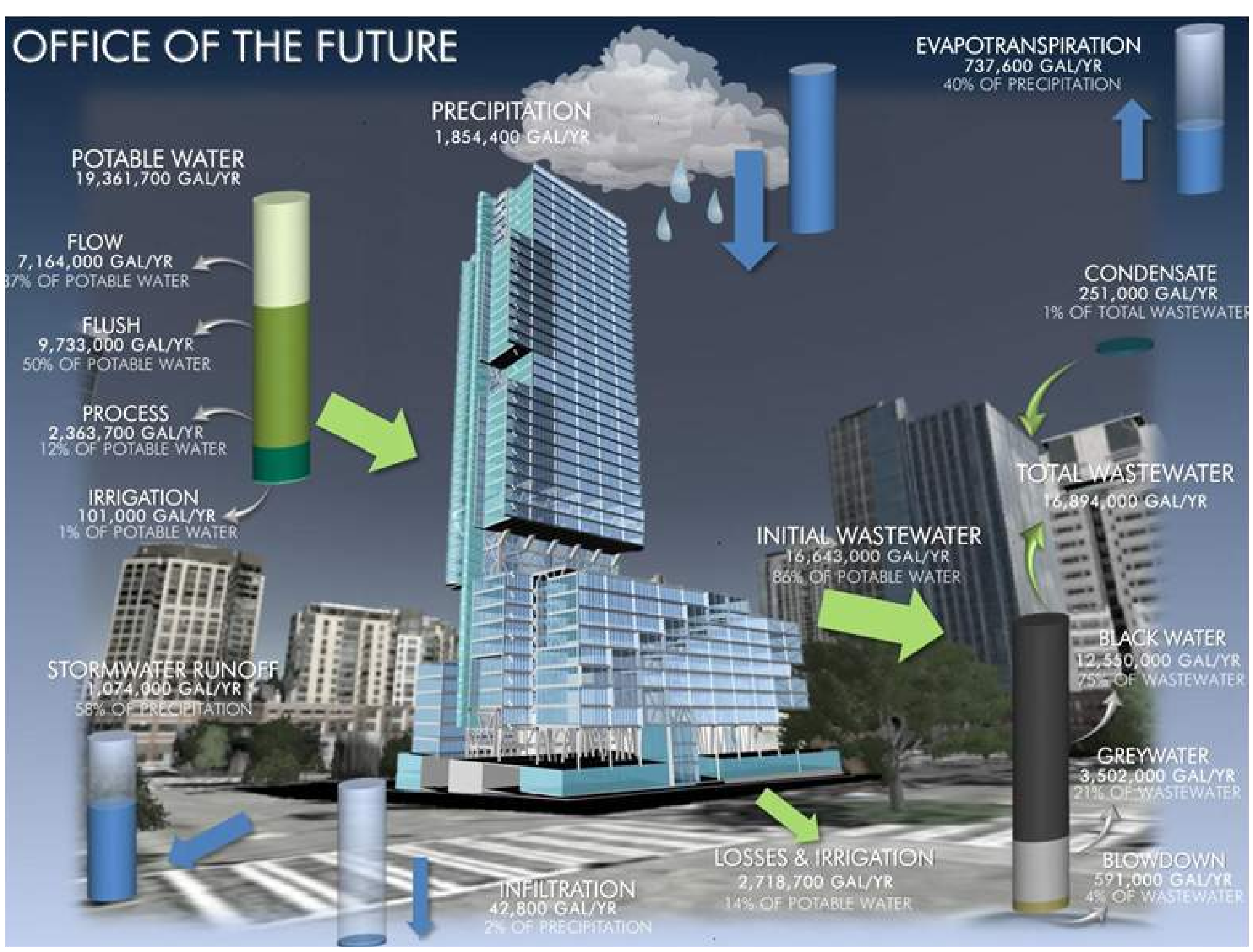


Figure 7. Detailed Breakdown of Water Resources Constituents

Background Image © 2012 Google Earth

Scenario	Harvest	Reuse Demand	Potable Use Reduction	First Cost	Payback (years)	30 Year Cost Savings
1	Rainwater	Irrigation	0%	$35,610	24	$88,125
2	Rainwater	Irrigation, Flush	4%	$248,200	11	$4,428,516
3	Rainwater	Irrigation, Mechanical	0%	$56,450	23	$164,159
4	Rain, Condensate	Irrigation, Mechanical	1%	$61,450	21	$941,783
5	Rain, Condensate	Irrigation, Flush, Mechanical	5%	$237,000	13	$4,982,981
6	Rain, Condensate, Blowdown	Irrigation, Mechanical	4%	$93,210	9	$4,421,348
7	Rain, Condensate, Blowdown	Irrigation, Flush, Mechanical	8%	$268,800	9	$8,464,531
8	Rain, Greywater	Irrigation, Flush	21%	$427,000	6	$23,267,452
9	Rain, Greywater	Irrigation, Mechanical	3%	$194,400	25	$901,924
10	Rain, Grey, Condensate	Irrigation, Mechanical	5%	$215,900	20	$2,357,453
11	Rain, Grey and Condensate	Irrigation, Flush, Mechanical	22%	$450,900	6	$24,726,832
12	Rain, Grey, Condensate, Blowdown	Irrigation, Flush, Mechanical	25%	$515,500	6	$28,133,091
13	Rain, Black Water	Irrigation, Flush	51%	$1,087,000	6	$54,071,214
14	Rain, Black Water	Irrigation, Mechanical	12%	$965,900	27	$1,901,605
15	Rain, Black Water	Irrigation, Flush, Mechanical	55%	$1,087,000	6	$60,432,141
16	Rain, Black, Condensate	Irrigation, Flush, Mechanical	57%	$1,097,000	5	$61,917,882
17	Rain, Black, Condensate ,Blowdown	Irrigation, Flush, Mechanical	60%	$1,182,000	6	$65,237,578
18	Rain, Black, Condensate, Blowdown	Irrigation, Flush, Mechanical, Potable	86%	$1,143,000	4	$99,977,737

Figure 8. Life-Cycle Cost Analysis Table

Figure 9. Life-Cycle Cost Analysis Comparison Curves

Appendix 4 | Embodied Carbon

MAGNUSSON KLEMENCIC ASSOCIATES

CARBON AS A DECISION-MAKING METRIC

Carbon, like money, is a tool we can use for making informed decisions. Next to water, it is certainly one of the sustainability metrics receiving the most attention.

The Architecture 2030 Material Challenge has insightfully highlighted that, for traditional construction, it takes approximately 15 years of building operations before the operational carbon of energy surpasses the embodied carbon to construct (Figure 1). Where renewable and low-carbon energy exists, such as hydropower, nuclear, or other renewable energy sources, the operational carbon of energy will take even longer to surpass the embodied carbon to construct.

What this clearly shows either way is that it can be a mistake to focus on only energy. Short-lifespan developments, especially considering the infrastructure requirements that go into and around them, can easily be some of the most nonsustainable construction created, regardless of whether a carbon-neutral energy use is achieved for the building.

For this purpose, the project will utilize Performance-Based Seismic Design (PBSD) standards to both specifically meet a 100+ year building design life and to consider the serviceable building performance in a 50% probability in 30 year earthquake, with a no damage building objective. This PBSD analysis will reduce the building's financial risk due to earthquake damage during it's useful life. It will also reduce the amortized yearly equivalent embodied carbon footprint of the building by allowing for an extended longevity and by reducing its renovation repair requirements due to damage following an earthquake, which it will likely see one or more times during its life.

Embodied carbon modeling and reduction strategies will also be used as part of the design and material procurement process for the project specifications and construction.

Clarifying a project's embodied carbon is much harder than operational energy carbon modeling. However, taking a page from macro-economics, the embodied-carbon focus will not be on attaining absolute carbon numbers. The goal will be to use this metric for making more informed choices during the design and material procurement process. It will consider comparative data, with enough relevance to make informed decisions without looking at absolutes. For this project, embodied carbon reporting for structural materials for the Seattle market were studied for the major construction materials of the structure. What was found was the ability to vary the structural carbon footprint by as much as 50% simply by making commodity material supply choices that favored the cost comparable but lower carbon footprint suppliers. This was most evident in the procurement options for rebar and concrete.

When comparing two concrete suppliers active in the Seattle downtown market, one of the suppliers receives their cement via a direct pneumatic pipe from a cement production plant within the Seattle city limits. That plant produced the majority of its energy needs from on-site cogeneration, with raw materials being shipped in by barge. The second concrete supplier received 50% of their cement from China.

When comparing two rebar suppliers active in the Seattle downtown market, one receives their bar stock from a mill located within the Seattle city limits, utilized 80-90% recycled steel in the production of their bar, and electrical hydro-power purchased from Seattle City Light. The plant operations work around non-peak electrical demands to reduce overload on the Seattle City Light grid. The second supplier's rebar supply was shipped in from the Mid-West region of the United States, with the majority of the energy used to produce the bar coming from coal-fired generation.

What was found was that even when material quantities and costs appear to be the same, there can be a significant difference in the carbon footprint for these structural building materials that historically have very high energy production requirements.

Embodied carbon comparative modeling was studied by MKA, using their internally developed C-Tool program. With material quantities defined by their optimized design process, MKA then specifically tracked project-specific material supply chain options with a cradle-to-project gate consideration.

The attached summary report for looking at the tower and varying the concrete material supply chain shows a 39% reduction to the structural embodied carbon footprint is possible without a significant change to the project costs or building systems. Further reduction strategies were also considered that brought the full embodied carbon reduction potential to 50%.

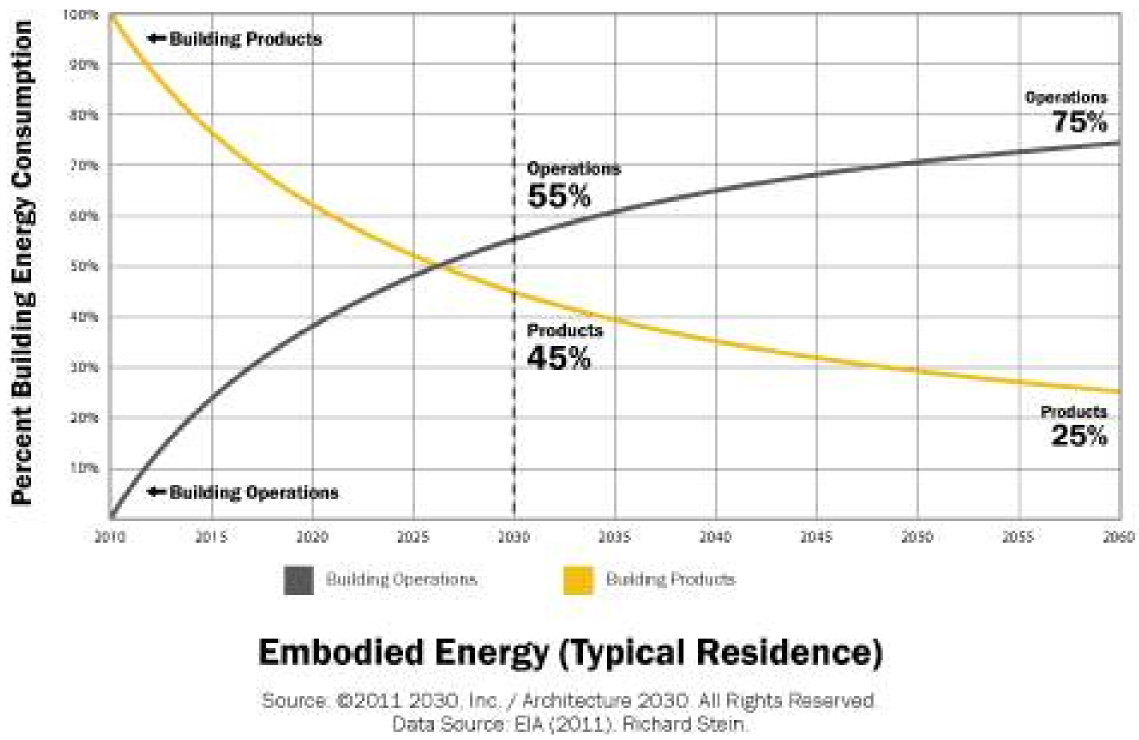


Figure 1. Embodied Energy: Building Operations vs. Building Products

EMBODIED CARBON REPORT

MAGNUSSON KLEMENCIC ASSOCIATES

PROJECT NAIOP Office Building
SCENARIO Concrete

LOCATION SEATTLE, WA
CLIENT MKA

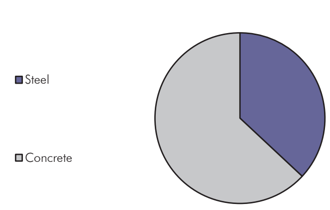
MATERIAL QUANTITIES — GRAND TOTAL: 169.2 (PSF)

Building System	Steel	Concrete	Timber	Masonry	subtotal
Roof	-	-	-	-	-
Floor	4.4	93.8	-	-	98.2
Lateral	5.5	33.0	-	-	38.5
Columns	2.0	8.0	-	-	10.0
Footing / Fndt'n.	1.5	20.0	-	-	21.5
General	1.0	-	-	-	1.0
TOTAL	14.4	154.8	-	-	169.2

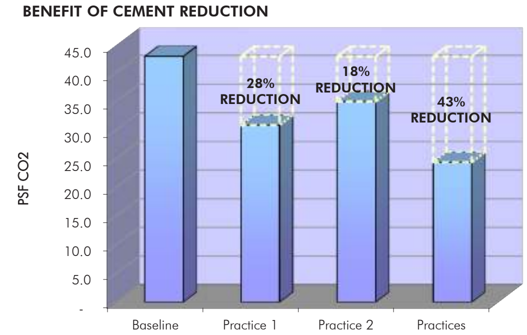
EMBODIED CARBON — GRAND TOTAL: 42.9 (PSF)

Material	Baseline	Practice 1	Practice 2	Practices 1 + 2
Steel	15.8	15.8	13.2	13.2
Concrete	27.0	15.0	21.8	11.2
Timber	-	-	-	-
Masonry	-	-	-	-
TOTAL	42.9	30.9	35.0	24.4
CO2 Reduction	0.0%	28.0%	18.3%	43.1%

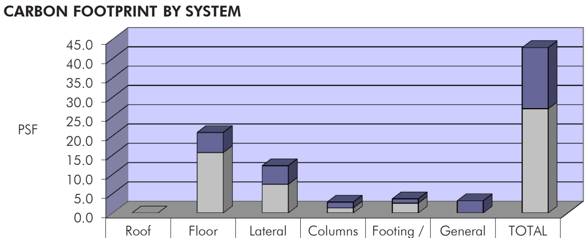
EMBODIED CARBON, PSF



BENEFIT OF CEMENT REDUCTION



CARBON FOOTPRINT BY SYSTEM



	Roof	Floor	Lateral	Columns	Footing / Fndt'n.	General	TOTAL
Steel	0.0	5.2	4.8	1.5	1.1	3.2	15.8
Concrete	0.0	15.7	7.5	1.3	2.6	0.0	27.0
Timber	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Masonry	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Figure 2. Embodied Carbon Report, Magnusson Klemencic Associates

Appendix 5 | Passive Design

ATELIER TEN

With the ever-changing demand and technology of the office environment, the standard model of the 21st century office as we know it must evolve to accommodate the needs of the OBF. Overall, the OBF epitomizes adaptability for ever changing demand in building program type, while respecting the embodied footprint of building resources and materials. The OBF will be an energy efficient building with responsible site design that improves indoor environment quality, enhances productivity and encourages healthy behavior for occupants. Narrow floorplates and high-performance facades allow for use of passive seasonal strategies, natural ventilation and daylighting that ultimately decrease building energy consumption and operating costs while increasing occupant satisfaction. Efficient radiant building systems and efficient lighting coupled with smart controls and increased occupant control provide building users with a stronger connection to their environment. Well-designed stairways and floors connected across atrium spaces encourage greater participation and activity from the occupants while low-emitting materials improve indoor air quality, enhancing occupant health and overall productivity. A holistic approach for both indoor and outdoor environments will create an engaging and productive work environment while minimizing energy impacts and above all, satisfying occupant needs.

PASSIVE SOLAR HEATING

Atria Orientation - During cooler months, glazed openings of atriums with direct solar exposure will benefit from solar gains. Heat losses through the envelope can be balanced or overcome by direct solar gains through the glazing on the southeast or southwest orientations.

PASSIVE COOLING

Direct Solar Shading, Thermal Mass, Night Flushing - Solid, thermally massive floor slabs reduce the heating load at night and the cooling load during occupied hours by storing thermal energy to buffer temperature swings. Thermal mass helps enhance occupant comfort by moderating temperature conditions. Solar gains during peak summer months are absorbed by the floor slab. During warmer months, operable windows can be opened in the evening to draw cool night air into the building and exhaust warmer air out of higher-level openings.

NATURAL VENTILATION

Operable Windows, Orientation, Narrow Floorplates - Buildings with natural ventilation – a strategy in which the thermal environment is regulated primarily by opening and closing windows – tend to have lower energy consumption and increased occupant satisfaction because occupants take an active role in managing the thermal conditions. The building's orientation will move prevailing wind from the southeast through courtyards. Atriums and courtyards can aid in cross-ventilation from the surrounding floor areas to mitigate some of the irregularity inherent in one-sided natural ventilation. The inclusion of a building management system to operate windows for night cooling can help the building cope with summer heat gains. For the 3-level atriums in the tower, the height of the spaces can be used to draw air from the surrounding spaces and flush it out the building at the bottom or top levels of the local atrium. Similarly, the atriums can work in reverse, facilitating air movement to the surrounding spaces and through their facades. Inclusion of a mechanical heat recovery system in the atrium exhaust may reduce overall energy use.

DAYLIGHTING

Narrow Floorplates, Orientation - Good quality daylighting is vital to a low energy OBF. Once a building's heat losses and gains have been controlled, the next big consumer of energy is the building's electrical lighting. It is important that the daylight in the office and residential areas is as even as possible to minimize contrast and relative brightness so that the darkest areas do not act as a benchmark level for people to switch on electrical lighting. Reduced floorplate depths allow for more even distribution of sufficient daylight levels, while the external shading helps minimize solar heat gains and excessive perimeter light levels through the southeast and southwest facing facades. Courtyard openings allow a greater portion of the usable floor area to have direct daylight access and help bring light down to lower pedestrian levels for enhanced experience and comfort.

VERTICAL TRANSPORTATION

Encourage Stair Use By Making Attractive, Super-Efficient Elevators - Research has shown that improvements in building design and operation have measurable impacts on occupant physical activity, and are important, alongside neighborhood design, for reducing the health problems associated with physical inactivity. Designing buildings that encourage physical activity is particularly important in locales such as Seattle, where inclement weather necessitates physical activity to be conducted indoors during much of the year. The OBF is not only energy efficient, but promotes a healthy indoor environment that enhances physical well-being.

Stairways are designed to be easily accessible, visible, safe, and most of all, attractive to occupants. By encouraging physical activity, good stairway design can help reduce sick-leave by half for employees, leading to increased productivity for tenants. Local stairways will group multiple levels to encourage use as an alternative to 1-3 level elevator rides. In addition, local elevator stops will discharge passengers on central levels where they can take stairways to adjacent floors. In addition to health benefits, greater use of stairs helps minimize the use of elevators and has the potential to decrease energy consumption. Elevators routinely account for 3-10% of a building's energy use. Therefore, improving the efficiency of the elevators contributes to significant energy reductions.

Appendix 6 | Energy

ATELIER TEN

HIGH PERFORMANCE ENVELOPE

Facade and Roof - The envelope for the OBF will consist of high-performance materials for increased building performance and enhanced occupant comfort. High-performance IGUs will help reduce solar heat gains during cooling seasons and heat losses during colder months. The well insulated facade will minimize radiant thermal comfort effects for occupants directly adjacent to the facade during winter months. During the warmer months, external shading will minimize direct solar gains and peak illuminance levels along the perimeter, which can otherwise be troublesome for occupants adjacent to the facade.

The lower roof portion will be vegetated green roof, which will add insulation to the built-up roof below. All other higher roof areas where glare is not a concern from above will be well insulated and finished with a highly reflective material to reduce urban heat island effects.

LIGHTING

Controls, Efficient Fixtures, Task Lighting, Etc. - Artificial lighting typically accounts for a large portion of a building's energy use. The integration of daylighting and artificial lighting schemes is an important aspect of a sustainable lighting scheme for the future office building. Effective use of daylight is a critical first step toward reducing the demand for artificial lighting. In addition to energy savings, providing the right amount of full spectrum light through daylighting provides visual comfort to occupants and can improve productivity and well-being.

Ensuring that daylighting strategies are paired with the efficient and appropriate use of artificial lighting will help tenants reduce energy use and operational costs. With daylight dimming, photosensor controls automatically reduce the output and energy consumption of artificial light fixtures when daylight is available. Compared with on/off controls, dimming controls generally increase energy savings and extend lamp life. In addition, occupancy sensors can be used to auto-control lighting and mechanical systems when spaces are unoccupied.

Apparent enhanced comfort also relies on occupant control. Lighting controls and switches should be available in all multi-occupant spaces, and individual lighting controls and/or task lighting should be provided for all individual workspaces.

PLUG LOADS

Tenant Side Reduction Strategies - Ultimately, the tenant behavior determines the plug loads of the building. Tenant plug load reduction strategies could include off-hour power shut down of personal computers. Limiting the hours that equipment is on will have a direct reduction in energy use. Lower ambient light levels will allow display screen brightness to be reduced without compromising visual acuity, meanwhile reducing power consumption. Similarly, residential occupants should minimize or eliminate the use of electrical lighting, electronics and appliances during unoccupied or idle times.

RENEWABLES

Climate change and fossil fuel use are currently some of the most pressing and widely publicized environmental issues. While all of the environmental impacts of energy production and use should be considered, greenhouse gas emissions' contribution to climate change is a critical global concern. Integrating on-site renewable energy sources into a project is an additional measure that will enhance the design of a sustainable building. A high-performance envelope first reduces heating and cooling loads, while appropriate conditioning and energy systems efficiently meet the building's energy demand. Renewable technologies then work with the building's energy systems to help meet demand in a carbon-free way. A mix of on-site renewable energy systems can also increase the reliability and redundancy of the project's energy supply. Selecting appropriate on-site renewable energy technologies for a project depends on what works reliably with the climate and site location and what matches up well with the building demand. The capital cost of each technology is also an important consideration.

SOLAR HOT WATER

On Roof - A solar hot water system can be installed on the rooftop to harness solar energy to connect to the building's domestic hot water supply. This can be done as a closed loop system, where a secondary water (or glycol) loop exchanges heat with the supply water. The combination of office and residential program helps achieve a more stable hot water demand, which can be supplemented by a backup heating source when solar energy is insufficient.

BUILDING INTEGRATED PHOTOVOLTAICS

On Facade Sun-Shades - Photovoltaic (PV) cells convert solar energy directly into electrical energy that can be used to meet building power requirements, or can be sold back to the utility company when surplus power is generated. Increasing efficiencies of PVs and physical material advances show promise for building integrated photovoltaics. The OBF will utilize solar shading devices that double as photovoltaic solar panels. The southwest and southeast orientations would be the best candidates for solar shade integrated photovoltaics, while roof area is reserved for solar hot water panels and green roof space for enhanced views to look down upon. The embedded photovoltaic components will block unwanted direct solar gains on the glazed facade and turn it into usable energy for the building.

Appendix 7 | Climate Study

ATELIER TEN

Any design that attempts to respond to the local environmental condition must be based on a close analysis of that climate. The degree to which the building needs to provide shelter and how the requirements for shelter change over the day and year directly influence the optimal design of the building and its systems. Critical climate factors are air temperature, humidity and solar radiation.

The following section of this study graphs annual weather data for Seattle, Washington. Statistically average data are used, which have been compiled over a long time span so that no abnormal weather is included.

Ambient Temperatures

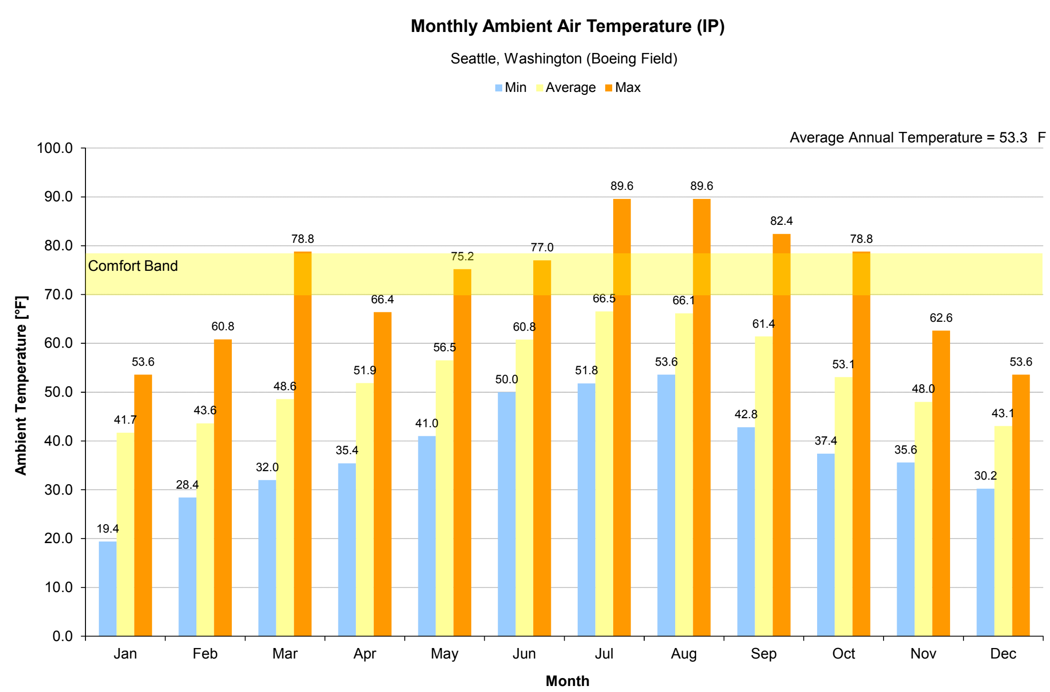
The graph on the top right shows the minimum, maximum and average temperatures for each month in a statistically average year. The maximum temperatures are roughly near the comfort band (68-80°F) for the majority of the year, while average temperatures are more often below the comfort band. This indicates that Seattle is a moderate to cool climate. The hottest period of the year is the summer months of July to September, when maximum temperatures are near 90°F and average temperatures are below the comfort band. Minimum temperatures in the late spring and early autumn fall to 35°F. Minimum temperatures in winter can be as low as 19°F, showing that heating will be required during the winter months. The average temperature for this statistically average year is 53.3°F.

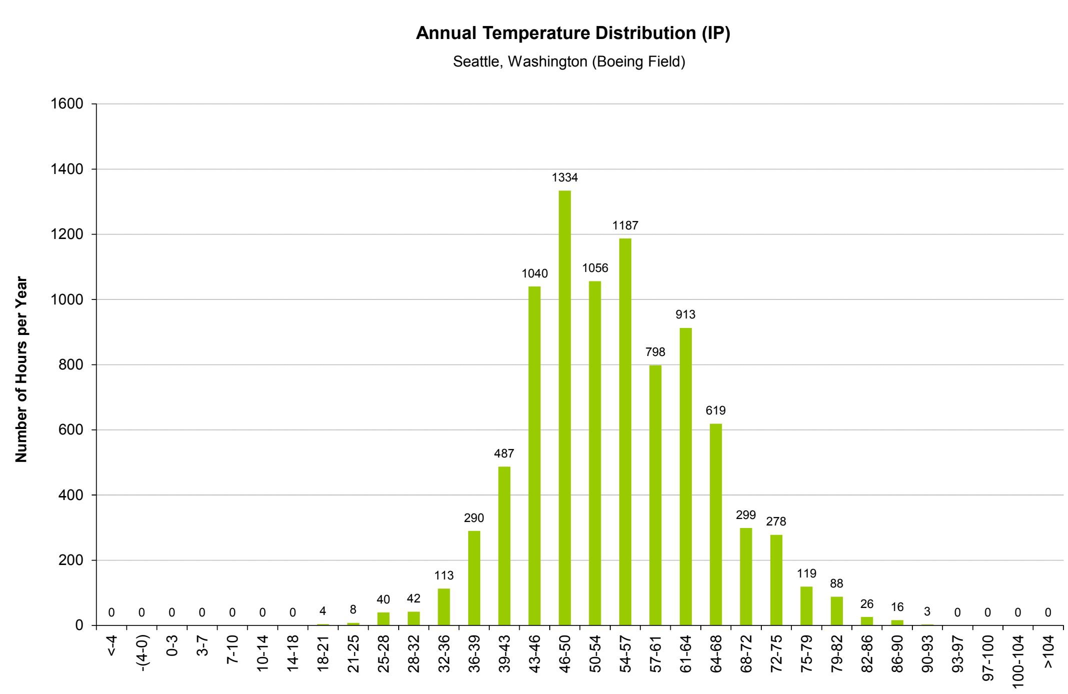
Temperature Frequencies

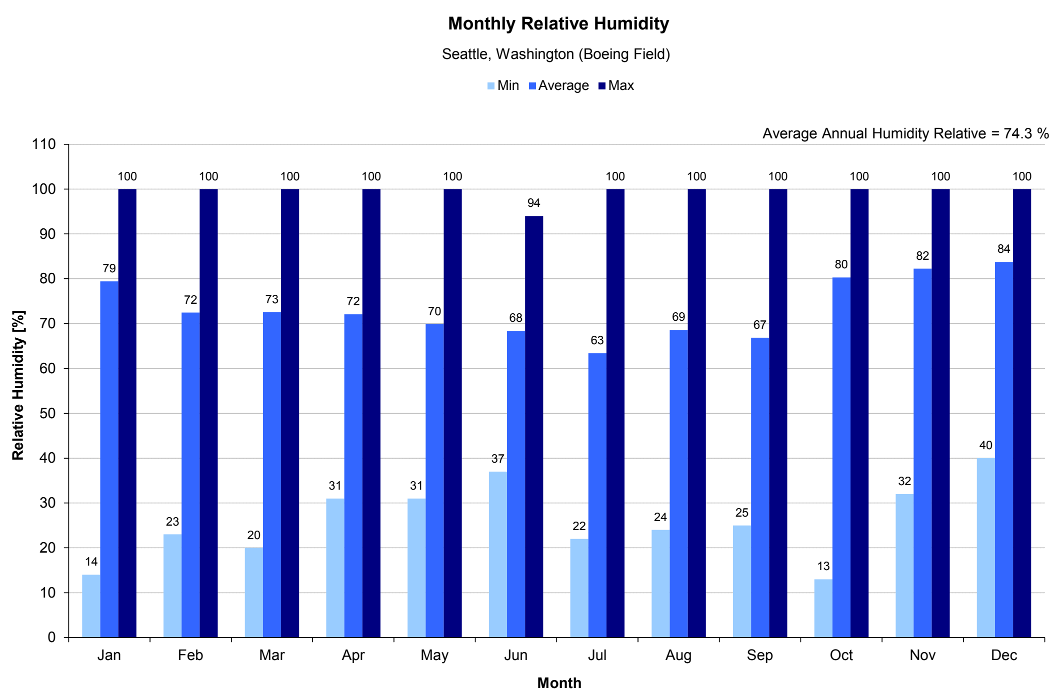
Another way of looking at annual temperature distribution is to chart annual temperature frequency. The graph of Annual Temperature Distribution shows that out of 8,760 hours in a year, 133 hours, or 1.5% of the time, are above 80°F and therefore warmer than the comfort zone. 7,931 hours, or 90.5% of the time, are below 68°F and thus require heating, indicating that this is a heating dominated climate. The temperature drops below freezing for 94 hours per year, or 1% of the time, showing that this climate is more moderate without extreme cold. For 696 hours annually, or 8% of the time, the weather is in the comfort zone without any conditioning.

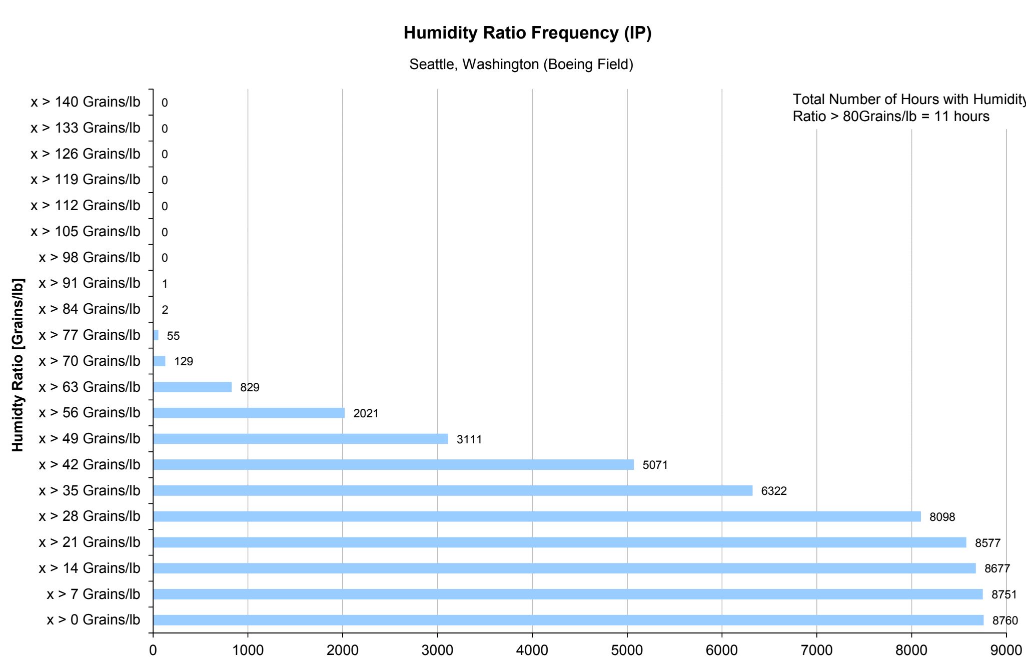
Humidity Frequencies

Thermal comfort is not only affected by air temperature, but also by the amount of humidity in the air. The graph of monthly relative humidity shows that the average relative humidity is typically 65-85%. The high relative humidity should be considered when weighing effective passive strategies.



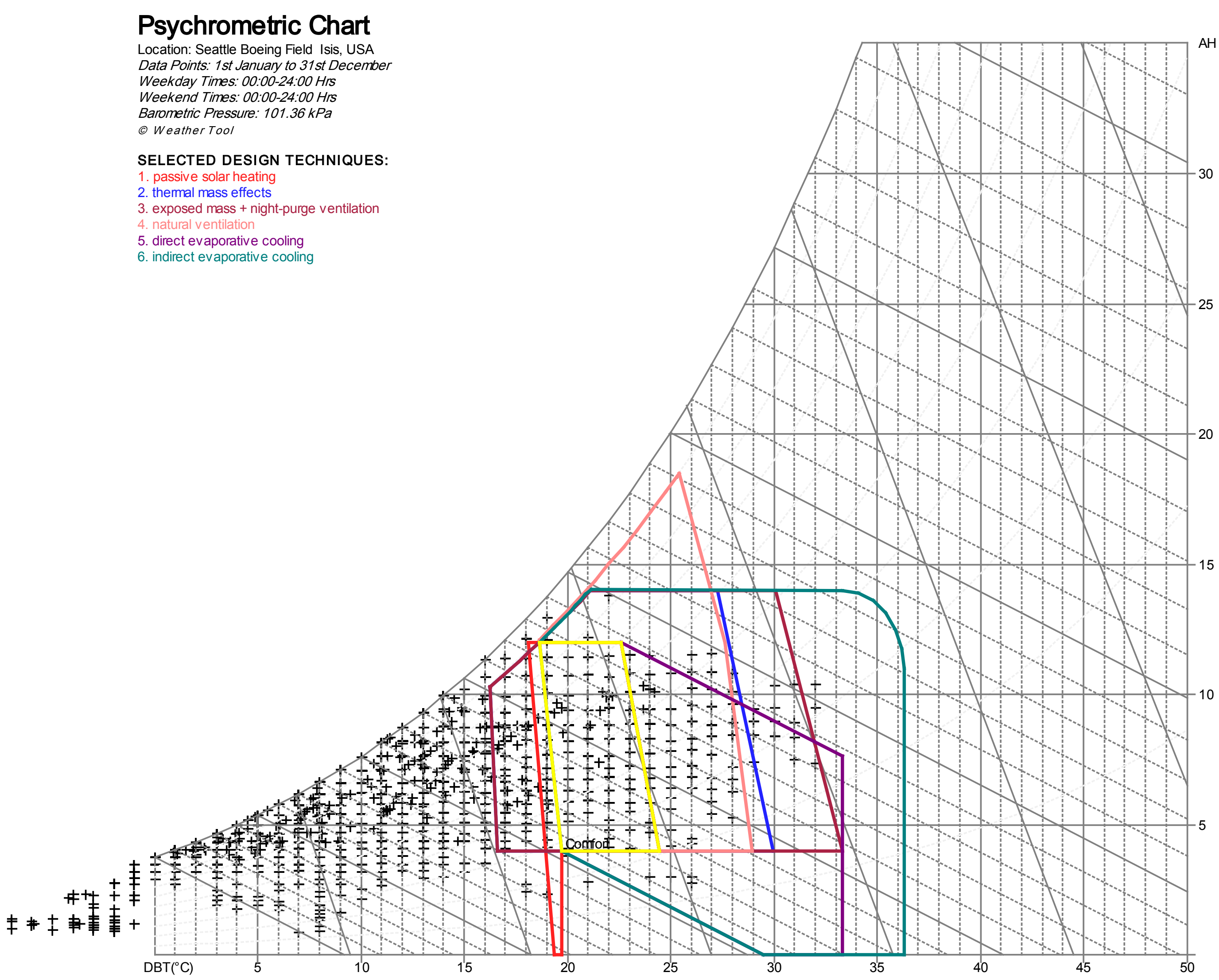



Monthly Relative Humidity
Seattle, Washington (Boeing Field)
Min
Average
Max
Average Annual Humidity Relative = 74.3 %
Relative Humidity [%]
Month
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Humidity Ratio Frequency (IP)
Seattle, Washington (Boeing Field)
Total Number of Hours with Humidity Ratio > 80Grains/lb = 11 hours
Humidty Ratio [Grains/lb]
Hours Per Year

Appendix 7 | Climate Study

ATELIER TEN



Passive Conditioning Potential

In a first attempt to evaluate the potential of various passive space conditioning strategies, the Psychrometric Chart graph expands the comfort zone to account for the effects of measures such as solar heating through direct solar gains and thermal mass. Given exposed mass with night-purge ventilation, the comfort range can be expanded so that almost all points warmer than the initial comfort range are now within this expanded comfort zone. This indicates that summertime comfort may be achieved with no mechanical air conditioning, as long as solar and internal gains are controlled. Direct solar gains do little to expand the comfort zone while exposed mass with night-purge ventilation can further expand the comfort zone into the lower temperature areas, though mechanical heating will still be required.

Psychrometric Chart

Since humidity and temperature both affect comfort, they should be analyzed simultaneously. The psychrometric chart displays the relationship between dry bulb air temperature (x-axis) and humidity (y-axis). The range of temperatures and humidities that most people consider comfortable is outlined in yellow.

The annual weather data for this site, plotted on the psychrometric chart, show that absolute humidity is low, seldom rising above the level of 12.0 g/kg or 80 grains/lb. Meanwhile, the relative humidity falls close to the saturation point during much of the year. Most of the data points fall to the left of the comfort zone, indicating a need for heating. A smaller number fall to the right of the comfort zone, indicating that temperatures are above a comfortable level for a short time of the year.

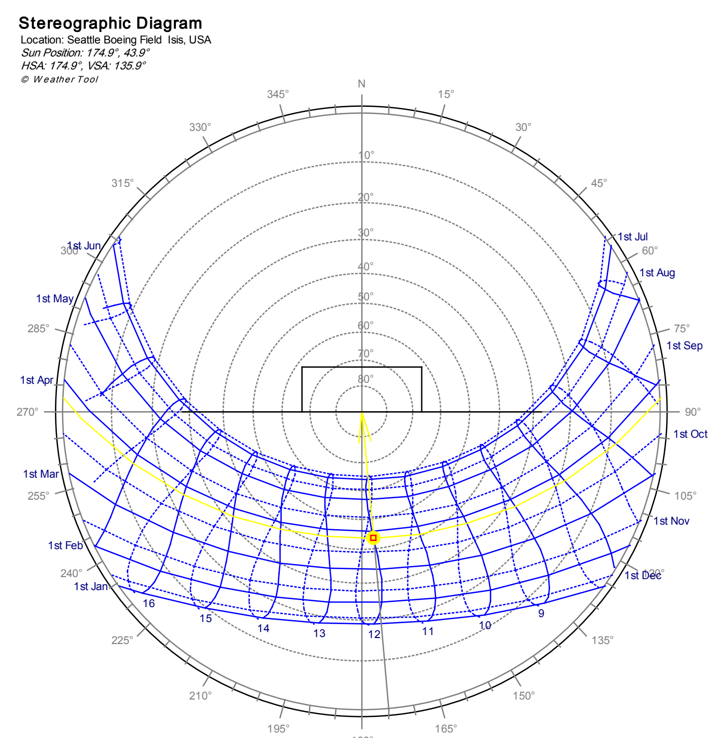
Solar Path Diagram

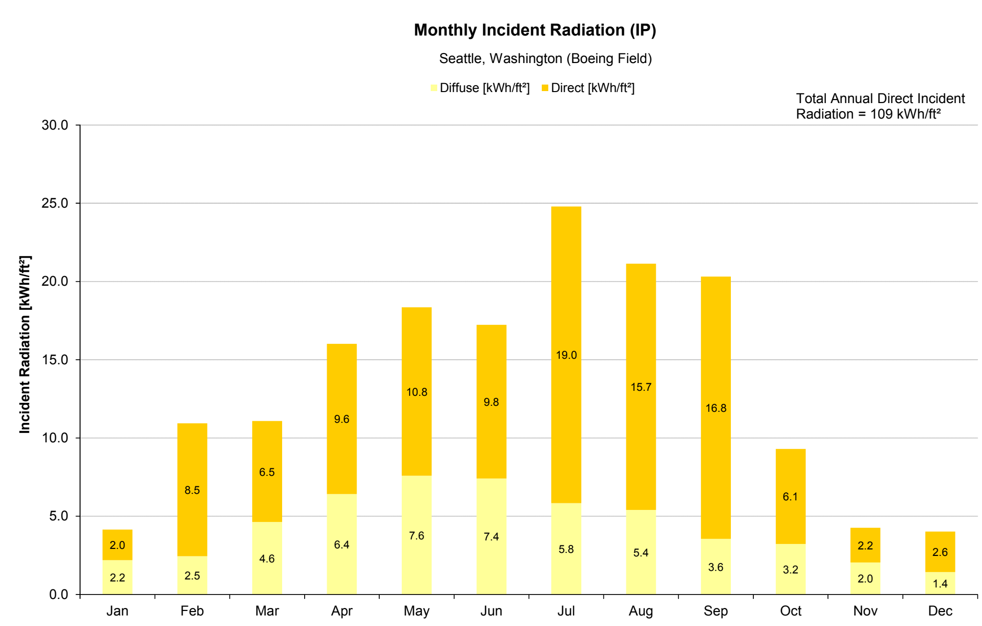
Heating and cooling requirements are greatly influenced by the amount of solar radiation available. Solar heat gain can beneficially offset heating requirements in one season while detrimentally increasing cooling requirements in another. The amount of solar heat gain within a space depends on the size and orientation of openings in relation to the position of the sun. A sun path diagram maps the movement of the sun by plotting solar azimuth (compass direction) and altitude (vertical sun angle) throughout the year. The sun path diagram for Seattle shows that in summer months the sun is high in the sky (altitude of 65°) at noon, and in mornings and evenings comes from the northeast and northwest respectively. In the winter the sun has a low altitude (altitude of 20° at noon) and travels during the day from southeast to southwest. This means that south-facing windows are well positioned to collect solar radiation in the winter. Minimizing windows to the east and west will help avoid overheating in summer.

Incident Radiation

While the solar path diagram is a useful tool to analyze the direction of incident solar radiation, it does not allow for an evaluation of the intensity of this radiation. Cumulative incident solar radiation analysis determines the amount of solar energy on a specific surface and how that energy is distributed on that surface.

The amount of solar radiation is influenced by cloud cover and other atmospheric factors. In the graph on the bottom right, available incident solar radiation is plotted by intensity (y-axis) for each month of the year (x-axis). The data shows that the highest amount of direct horizontal solar incident radiation is available during the late spring and summer months.





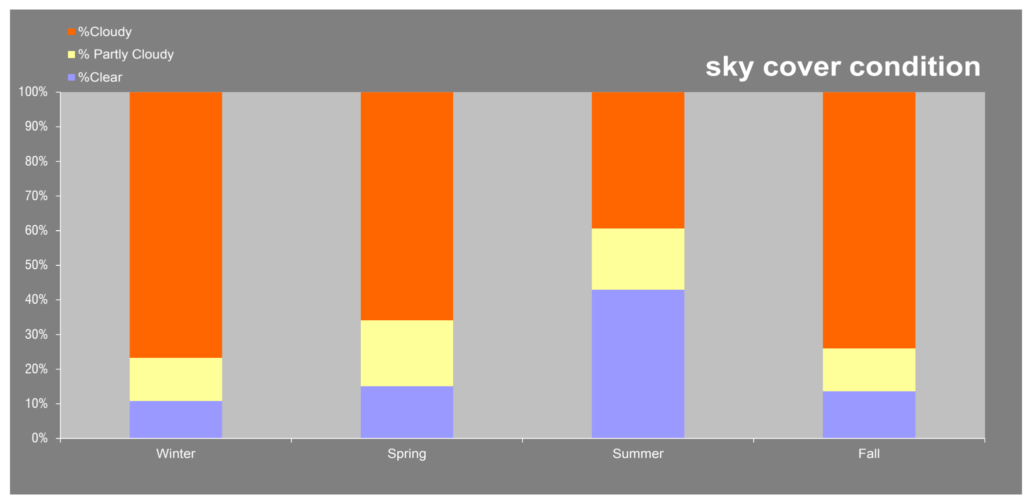
Appendix 7 | Climate Study

ATELIER TEN

Sky Cover Analysis

The sky condition affects both the light levels and visual comfort inside the office area. Therefore, Atelier Ten analyzed the sky cover condition. The results showed that the sky conditions in Seattle are fairly consistent on average throughout the year. It is cloudy and partly cloudy for approximately 80-90% during the winter, spring, and fall months, with overcast conditions for 50% of the summer. This indicates that controlling direct radiation is only a concern in the summer.

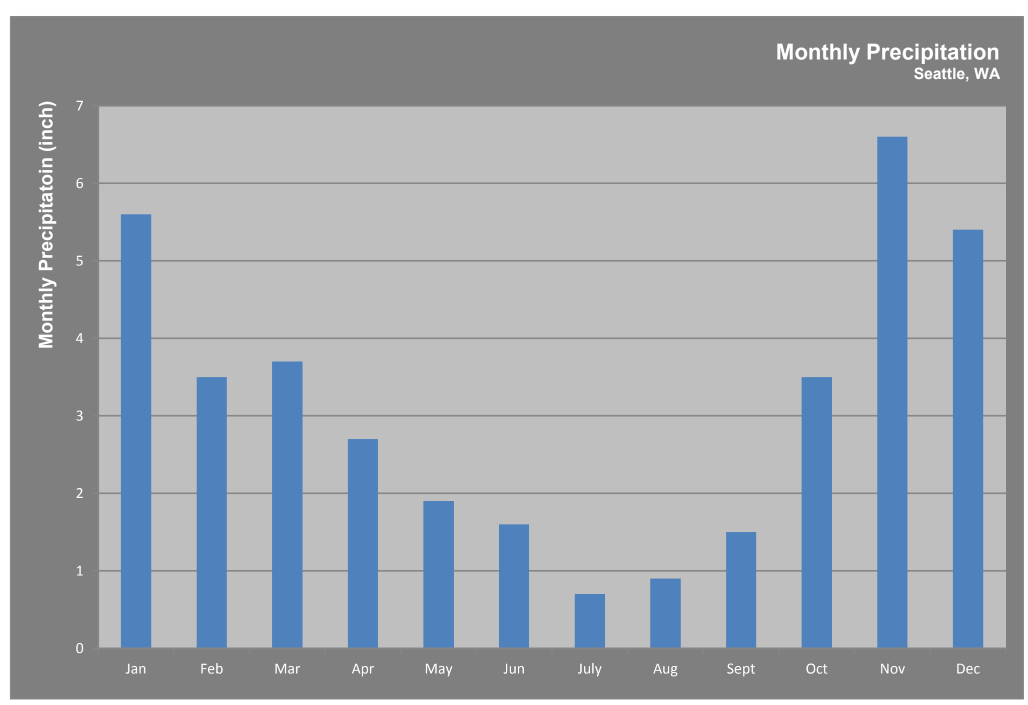
The high percentage of time that is partially cloudy and cloudy will reduce the effectiveness of renewable solar technologies such as photovoltaics or solar hot water collectors for domestic hot water.

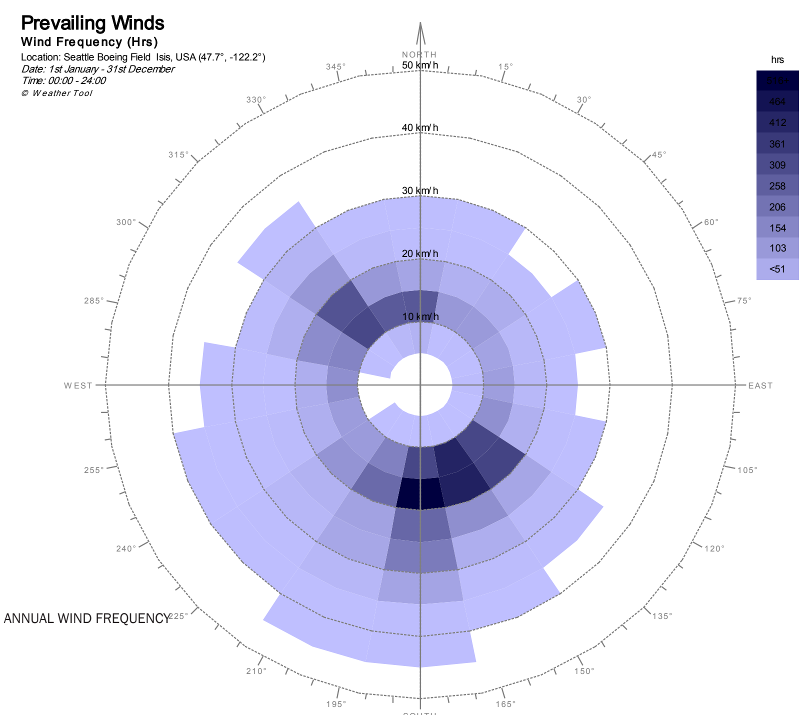


Monthly Precipitation

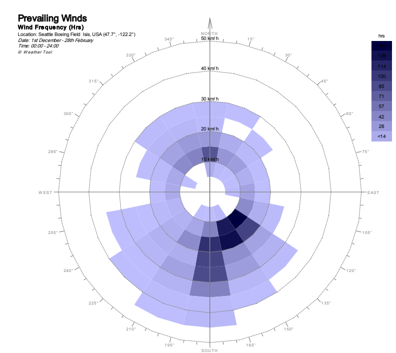
The monthly precipitation graph shows that the monthly average precipitation is moderately high in Seattle. While the amount of rainfall remains consistently low between June and September, the rainfall during the winter, spring, and fall is fairly high. At a total precipitation of approximately 37.6 inches, there is a significant amount of rain for the majority of the year, peaking at 6.6 inches in November.

The moderate amount of precipitation indicates that strategies to reduce peak stormwater runoff may be used. Strategies such as stormwater capture and infiltration techniques such as pervious pavement and bioswales could be employed. Stormwater could also be captured and used on-site for toilet flushing, irrigation, and maintenance.

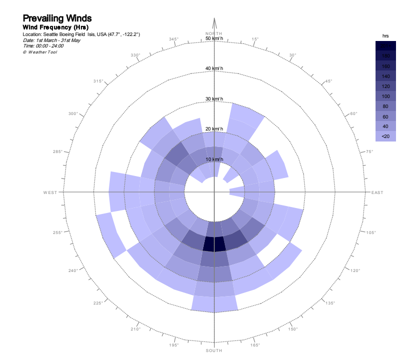




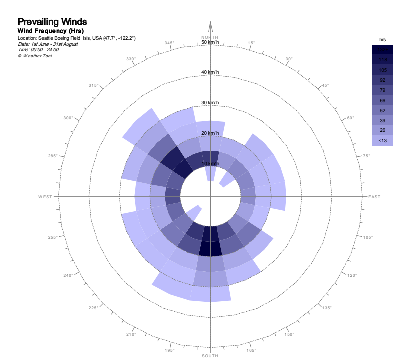
ANNUAL WIND FREQUENCY



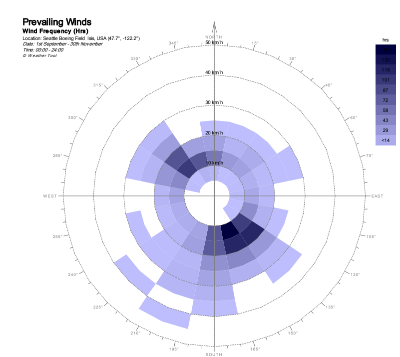
WINTER WIND FREQUENCY



SPRING WIND FREQUENCY



SUMMER WIND FREQUENCY



AUTUMN WIND FREQUENCY

Wind Patterns

A map of annual wind speed and direction indicates that the highest velocity of wind (areas at the outer region of the graph) and the prevailing wind direction (the darker areas) are from the south. While the weather information is taken near Seattle at Boeing Field, wind occurrences on a particular site are often affected by local obstructions. Thus, the available wind data should be considered as indicative of general trends only.

Seasonal wind distribution charts show that south winds are dominant in winter and spring. In summer and fall, the winds shift between the southeast and northwest.

Natural ventilation could be used from late spring to early fall to take advantage of the consistent south wind. Open spaces can be strategically placed in order to help facilitate this and increase occupant comfort.

Appendix 8 | Calculations

MAGNUSSON KLEMENCIC ASSOCIATES - WATER
ATELIER TEN - ENERGY
PICKARD CHILTON - CARBON, RENEWABLE ENERGY

Relative Water Study

Baseline & Upgraded Water	Gallons/year
Baseline In	26,048,000
Baseline out	23,204,000
Upgraded Potable Water Input	19,361,7000
Upgraded Waste Water Output	16,894,000
Precipitation	1,854,400
Stormwater Runoff	1,074,000
Upgraded Waste Water + runoff	17,968,000

Proposed Water Use Reduction	Gallons/year	% Reduction
Proposed Potable Water Input	2,772,595	85.7%
Proposed Waste Water Output (excluding run-off)	844,700	95.0%
Precipitation	1,854,400	NA
Proposed Runoff	534,000	50.3%
Proposed Waste Water Output + runoff	1,378,700	92.3%

Absolute Water Study

Water Consumption	Gallons/year	% of Consumption
Flow	7,164,000	37.0%
Flush	9,733,000	50.3%
Mechanical Process	2,363,700	12.2%
Irrigation	101,000	0.5%
Total Consumption	19,361,700	

Recovered Water Supply	Gallons/year	Efficiency	Final Gal/Yr	% of Consumption
Rainwater recovery	1,074,000	Storage	540,300	2.8%
Condensate recovery	251,000	95%	238,450	1.2%
Blowdown recovery	591,000	95%	561,450	2.9%
Greywater recovery	3,502,000	95%	3,326,900	17.2%
Blackwater recovery	12,550,000	95%	11,922,500	61.6%
Total Recovered Supply	17,968,000		16,589,600	85.7%
Net difference Consumption versus recapture			1,393,700	14.3%

Embodied Carbon

Total Building Area	1,321,238 sf	Material Quantities, total concrete & steel weight /sf			169.2 lbs/sf
Embodied Carbon (CO_2) per SF	Concrete	Steel	Combined	Difference	
Baseline	27.0	15.8	42.8		
Practice 1 (CCMs)	15.0	15.8	30.8	12	
Practice 2 (LCA specifications)	21.8	13.2	35.0	7.9	
Practices 1 + 2, total	13.2	11.2	24.4	18.5	
Total Embodied Carbon after Reductions	117,440,342	14,797,866	32,238,207	lbs of CO_2	
for 1,321,238 sf	8,720.2	7,398.9	16,119.1	tons, imperial	
	54.1%	45.9%			
			Tons CO_2 Absorbed		
Street and building trees on site (120 total; 28 big leaf maple, 92 cherry)*			913	5.7%	
Remainder to be offset offsite			15,206.1	94.3%	
Carbon sequestration from reforestation (restoring clear-cut forest)					
Assuming Douglas fir forest at 2.1 metric tons/acre/year			2.31	ton (US)/acre/year	
30-year time span			69.42	tons/ acre	
Acres to absorb carbon emissions due to building structure over 30 years			219.04	acres	
Estimated cost of restoring forest at cost of 1$ per tree and 450 trees per acre			$98,550.00		

*Carbon Absorption Rate of Trees estimated with Tree Carbon Calculator Tool from USDA Forest Service	Per Tree (lbs)	Pounds	Tons
Coast Live Oak (28), planted on site at 10 years maturity, total carbon absorbed after 30 years (at age 40):	11,618.90	325,329	163
Kwanzan Cherry (92), planted on site at 10 years maturity, total carbon absorbed after 30 years (at age 40)	16,319.40	1,501,385	751

Energy Usage

ASHRAE 90.1 2007 Proposed

Space Cooling	5,276	1,208	4.29%
Heat Rejection	82	105	0.37%
Space Heat	14,098	5,021	17.83%
Hot Water	2,658	1,319	4.68%
Ventilation Fans	3,409	830	2.95%
Pumps & Aux.	5,320	3,137	11.14%
Exterior Usage	273	273	0.97%
Misc.Equip.	14,876	7,500	26.64%
Area Lights	12,662	8,761	31.12%
Total	58,654	28,154	MBtus

GENERATION

Solar Hot Water	0	1,319	4.68%
Conventional Solar Array	0	397.5*	1.41%
BIPV	0	222.2*	0.79%
Off-Site Generation	0	26,215	93.11%
		28,154	

MBtus

*Source: PVWatts.com Solar Energy Calculator

Appendix 9 | MEP

COSENTINI ASSOCIATES

1.1 HVAC SYSTEMS

A. ENVIRONMENTAL GOALS

1. The MEP systems for the project will be designed to achieve the following environmental goals:
   - a. Energy-efficient design including high-quality and high-efficiency equipment.
   - b. A superior workplace environment that will provide high-quality thermal comfort, visual comfort and lighting of the space. The systems will allow for individual control of each occupant's environment including HVAC/temperature control and lighting control.
   - c. A modular-based MEP system that is integrated with building structural and architectural systems. The modular-based system will result in reduced construction schedule, reduced material usage, increased flexibility and the ability to deconstruct the building and re-use materials at the end of the building's useful life.
   - d. A Building Automation System incorporating control strategies to minimize energy consumption while maintaining user comfort and system reliability. The system will have the ability to monitor energy usage from each type of system and each energy conservation measure to assist the tenant in controlling both energy usage and energy cost.
   - e. Use of durable, high-quality, and environmentally safe building materials.
   - f. No use of ozone-depleting substances such as CFC's and halons.
   - g. Maintenance of high indoor air quality environment.
     - 1) Air quality standards as defined by ASHRAE Standard 62 will be maintained or exceeded. Outdoor air quantities introduced at each air handling unit will be continuously monitored to ensure compliance. Ventilation effectiveness will be in accordance with ASHRAE 127, using under-floor air diffusers.
     - 2) High-efficiency air filtration will be utilized in air handling units serving occupied areas.
     - 3) Air handling units will be provided with IAQ features such as fully drainable stainless steel cooling coil drain pans, stainless steel casing construction for all airside surfaces in cooling coil section, double wall construction, high-efficiency fans, variable frequency drives and cleanable "air side" surfaces to ensure that proper environmental conditions can be maintained.
     - 4) Outside air systems to be provided with U.V. lighting at cooling coils.
     - 5) On each floor of building, quantity of outside air and general exhaust/spill air will be continuously monitored to ensure that as outside air quantities are varied as population changes, (based on CO_2 demand control ventilation) proper floor pressurization can be maintained. A variable volume box or variable speed fan will be provided at each general exhaust connection that will be interlocked with outside air VAV box via BMS to ensure that such pressurization will be maintained.
     - 6) Provide a flexible work environment where changes to the layout of the space can be performed with minimal demolition and re-construction. This will reduce construction waste and allow conservation of material resources through re-use of existing system components.

B. GENERAL – PRE-CAST PLANK MEP SERVICES DISTRIBUTION SYSTEM

1. The HVAC system will be designed to advance the environmental goals listed above. Heating and cooling for the building will be produced by an advanced energy-efficient geothermal exchange cooling and heating plant for phase 1 of the project. Phase 2 of the project will be a chiller/heater plant, high-efficiency magnetic bearing chillers and a high-efficiency hot water condensing boiler plant.
2. Conditioning of the occupied spaces will come from a radiant cooling and heating system combined with a displacement ventilation system. The distribution system for these systems will be integrated into the structural pre-cast plank system. The pre-cast plank will have an upper slab and lower slab forming alternating upper and lower distribution pathways.
   - a. The hydronic radiant cooling and heating system will be integrated into the lower slab. The upper air pathway shall be utilized to supply ventilation air up through the floor utilizing swirl type diffusers. This pathway shall be sealed utilizing raised floor type floor tiles. The lower pathways will be utilized to distribute power, chilled and hot water piping to supply the radiant system and supplemental cooling fan coil units, sprinkler piping and telecommunications wiring. Ventilation air will be supplied by central ventilation air handling units with enthalpy wheels for dehumidification and energy recovery.
3. The upper pathways within the planks will be connected by a duct crossing through the lower pathways to allow supply air to distribute horizontally between adjacent planks. This horizontal pathway will become the supply air main. The top of the upper cavity will be sealed utilizing access floor type tiles. Diffusers will be located in these tiles to supply air to the space.
4. Multiple pre-cast ducts crossing through the upper cavity will allow electrical, telecommunications, fire sprinkler and return air to distribute horizontally between adjacent planks. Sprinklers, lights and return air openings will be placed in the ceiling tile that encloses the lower cavity of the system. A grid of knock out locations will be provided on a 5-foot grid in the top of the lower cavity for installation of floor boxes for power and telecommunications.

C. MEP SYSTEM BENEFITS

1. This system will have the following benefits consistent with the environmental goals listed above.
   a. Reduced energy consumption
      1) High-efficiency geothermal cooling system will provide cooling water for the radiant system and heat rejection for the ground source chiller/ heater serving phase 1.
      2) High-efficiency magnetic bearing chillers and condensing boilers.
      3) Reduced energy usage due to higher chilled water temperatures of the radiant system.
      4) Reduced fan transport energy by utilizing radiant cooling and low-velocity displacement ventilation system.
      5) The integration of the radiant cooling and heating system with the building structure will allow use of the building's thermal mass and can take advantage of this thermal storage effect during natural ventilation and night purge cycles.
   b. Increased thermal comfort
      1) Increased thermal comfort because conditioned ventilation air is supplied at the level of the occupants and will stratify upwards using natural convection currents (in lieu of forcing air down through the warm stratified air layer at the ceiling).
      2) Increased thermal comfort due to radiant cooling effect.
      3) Increased thermal comfort due to individual control that the system allows. Each occupant is provided with an adjustable diffuser that will allow control of the temperature in the individual's space.
   c. Increased indoor air quality
      1) Increased indoor air quality because outdoor air is delivered through the system directly into the occupied zone allowing for full ventilation effectiveness.

D. CODE REQUIREMENTS

1. Materials, equipment and systems installed shall meet all pertinent requirements of all authorities having jurisdiction and local codes.

E. SYSTEM PERFORMANCE CRITERIA

1. Cooling/Heating Design Criteria Used to Size All Base Building Heating and Air Conditioning Equipment serving Tenant Floors
   a. Summer
      1) Outdoor - 82°F D.B. - 66°F W.B. (68°F W.B. for cooling tower)
      2) Indoor - 75°F D.B. - 50% R.H.
   b. Winter
      1) Outdoor - 24°F DB
      2) Indoor - 72°F DB
      3) Population: 7 people per 1000 sq. ft. useable area for office occupancy; (per ASHRAE STD 62).
   c. Ventilation - The greater of 20 cfm per person or 30% greater than ASHRAE Std. 62-2007.
   d. Sun Control - use of automatic blinds for solar control.
   e. Tenant Lighting and Power
      1) Base building units - all floors-cooling for 3.5 W/sq. ft. useable area (in addition, units are sized for ventilation and perimeter solar and transmission loads).
   f. Retail Lighting and Power (fit out by tenant)
      1) Capped condenser water connections will be provided to accommodate cooling for 20W/ sq.ft. of useable retail area (30W/sq.ft. of power provided overall). Tenant will provide air handling unit to serve this space.
   g. Note - The base building outside air ventilation riser and fan systems will be sized to include an excess air supply to support special high-density population areas. An allocation of 15% excess air shall be provided.
      1) The base building outside air will be filtered, cooled and dehumidified in the summer and heated in the winter.

F. ACOUSTICAL CRITERIA

1. Within 10' of fan room: NC 40
2. Beyond 10' of fan room: NC 35

G. AIR FILTRATION AND INDOOR AIR QUALITY FEATURES

1. Outside air units - MERV 13
2. Re-circulating units - MERV 13
3. Efficiency determined by ASHRAE 52.2
4. In the low-rise portion of the building and the high-rise portion of the building, four general exhaust/spill air risers are available for tenant usage for areas such as copy and printing rooms. These risers will also be used for emergency air purge to remove harmful or noxious fumes from a chemical (e.g. cleaners and solvents) spill and to purge the space for removal of volatile organic compounds (VOCs) off gassed during tenant fit out.
5. Construction indoor air quality shall be maintained as per the SMACNA Construction IAQ Guidelines.

1.2 MECHANICAL SYSTEMS DESCRIPTION

A. BUILDING CENTRAL PLANT DESIGN

1. Building Phasing
   a. This building will be constructed in two phases: the low rise portion of the building will be Phase 1 and the high-rise tower will be Phase 2. Each phase shall be served by its own central heating and cooling equipment.
2. Phase I Cooling and Heating Plant
   a. Geothermal System (radiant cooling and condenser water)
      1) The Phase 1 central plant will utilize a geothermal exchange system for heating and cooling. A closed loop system of approximately 600 tons will reject or reclaim heat from the ground surrounding the building. The system will consist of approximately 200 vertical closed loop wells each with a depth of 500 ft. The condenser water from this geo-exchange system will be delivered to a heat exchanger in the Phase 1 central plant.
      2) HDPE piping will be used for the geothermal loopfield including wells and horizontal piping.
      3) Two water loops will be created on the secondary side of the heat exchangers. The first loop will be utilized as chilled water for the radiant cooling system. This water

Appendix 9 | MEP

COSENTINI ASSOCIATES

can be fed directly to the radiant system at a temperature of 57°F-60°F and thus can be utilized without additional compressor energy.

4) The other loop will supply secondary condenser water to the geothermal chiller/heater heat pumps that will generate chilled and hot water for the building's outdoor air system and radiant heating usage.

5) Multiple pumps shall be provided for the primary geothermal condenser water loop including one stand-by pump. All pumps, piping valves and appurtenances shall be provided for the geothermal condenser water system.

b. Phase 1 Refrigeration Plant - Geothermal chiller/heater plant.

1) Phase 1 will have an electric centrifugal geothermal heat pump to produce chilled and hot water for supply to the building's mechanical systems. The central chilled water plant will be sized for the Phase 1 low-rise office building. The central chiller/heater heat pumps will be sized for 600 tons and will provide 42°F chilled water to the ventilation air handling units. In addition, this lower temperature chilled water will supply supplemental cooling to fan coil units serving conference rooms and other densely occupied areas and other miscellaneous air handling units and will also be available for other tenant supplementary cooling requirements.

2) These chiller type heat pumps will also supply additional cooling to the higher water temperature radiant cooling system during any minimal hours in which the geothermal system cannot produce the proper temperature chilled water directly.

3) Redundant condenser water and chilled water pumps shall be provided. Pumps shall be piped to headers to allow multiple pump and chiller configurations.

4) The Phase 1 plant shall be provided with (2) - 300 ton electric high-efficiency centrifugal heat pumps. The plant shall also include two 300-ton heat exchangers to separate the glycol in the geothermal loop from the direct radiant cooling loop and from the heat pump condenser water loop. Chilled water distribution to the building will be delivered via two service chilled water pumps for the radiant cooling loop and two service chilled water pumps for the cooling coil loop. One stand-by pump will be provided for use by both systems. All pumps will be provided with variable frequency drives to allow for efficient chilled water delivery to the building from partial to full load.

c. Phase 1 Heating Plant

1) The central geothermal heat pumps utilized for cooling will also produce hot water for heating usage.

2) A condensing boiler plant will provide additional heating requirements when the heat pumps are unable to produce enough hot water to meet the building load requirements. This plant will be a modular system with a total capacity of 100 BHP.

3) A hot water distribution system with all pumps, valves and appurtenances will be provided.

4) Hot water pumping system will include a primary/secondary distribution with one primary pump provided for each heat pump and boiler (with one (1) common stand-by on a vfd). Two secondary systems will be provided: one to serve the perimeter radiant heating panels and one to serve the air handling systems including the ventilation air units. Each secondary system will have two (2) service pumps and one stand-by pump. Consideration will be given to utilize common standbys if piping layouts permit a cost effective alternate. All pumps shall be provided with inverter drives.

5) For office areas, perimeter heating will be provided by the radiant ceiling system serving the perimeter zones.

3. Phase 2 Cooling and Heating Plant

a. Phase 2 will consist of a high-rise office tower and a 6-story residential component. The office component and the residential component will have differing occupancy schedules and peak loads. This load diversification will allow for sharing of capacity and reduction in the size of the plant.

b. Phase 2 Refrigeration Plant

1) The central refrigeration plant serving the Phase 2 portion of the building will produce chilled water to supply the building radiant cooling system, the ventilation air handling units and tenant supplemental fan coil units. The plant shall consist of three (3) magnetic bearing flooded condenser chillers for high efficiency operation. Each chiller will have a capacity of 400 tons. The equipment shall have ultra-high part load efficiencies and an intelligent plant controller to minimize energy usage during operation.

2) The central refrigeration plant will have a primary secondary pumping system with one primary pump for each chiller plus one stand-by. There will be two secondary distribution loops. One will provide water at a supply temperature of 57°F-60°F for use in the radiant cooling system. The other secondary distribution loop will deliver chilled water at a supply temperature of 42°F to supply the cooling coils in the ventilation air handling units and tenant fan coil units for densely occupied spaces and for other miscellaneous air handling units. Each secondary loop shall have two service pumps and one stand-by pump.

3) The chillers will reject heat to the building condenser water system.

c. Phase 2: Heating Plant A heating plant utilizing high-efficiency low emissions condensing-type boilers shall be provided. The heating plant will be located in the mechanical penthouse at the top of the tower. The condensing boiler shall be a modular system with a total capacity of 190 bhp. Boiler pumping system will include a primary/secondary distribution with one primary pump provided per boiler (with one (1) common stand-by) and two (2) secondary systems each with a primary pump stand-by. Consideration will be given to utilize common standbys if piping layouts permit a cost effective alternative. A secondary system will be provided for the office tower heating requirements, as well as for retail and building common area heating requirements. The hot water risers serving the office tower shall be piped in a reverse-return configuration. All pumps shall be provided with inverter drives.

d. Condenser Water System

1) The central condenser water system consisting of three (3) 500-ton cooling tower cells, will serve the Phase 2 high-rise tower's cooling needs including the base building chiller plant and tenant supplemental loads. The system will include (3) dedicated condenser water pumps (one (1) stand-by) to feed the chiller plant as well as supplemental condenser water for special office. The condenser water system will be available 24 hours per day, year-round for special tenant use. The rooftop evaporative cooling towers will be winterized. At office floors 2-1/2" valved outlets will be provided for tenant connection to their supplemental cooling units.

2) Cooling tower fans and condenser water pumps will be provided with variable frequency drives to maximize energy efficiency. Pumps will respond to the actual system load based on flow and pressure. Pumps will be selected automatically via the BMS for both daytime and nighttime load conditions.

B. CENTRAL VENTILATION AIR HANDLING UNITS

1. Central air handling units will condition ventilation air (100% outdoor air) for delivery to the office space through a displacement ventilation system.
2. Each of the central ventilation units will be provided with an enthalpy wheel heat recovery section that will perform both sensible and latent heat recovery. The latent heat recovery will allow for partial dehumidification of the outdoor air without the use of compressor energy.
3. Four units will be located on the roof of the low-rise to serve the low-rise office space, with each unit serving a quadrant of the floor. Each of the units will have a capacity of approximately 25,000 cfm.
4. The Phase 2 tower will be served by eight units each with a capacity of approximately 25,000 cfm. Four units will located on the roof of the tower building and four units will be located on the roof of the low-rise feeding into the tower.
5. Each unit will be have an outdoor air and exhaust air pathway and will be provided with supply fan, exhaust fan, MERV 13 filters, electrostatic type filters, cooling coil, enthalpy wheel section, heating coil, IAQ type drain pan and cooling coil ultraviolet light system.

a. Each ventilation AHU will be provided with variable frequency drives for the supply and return fans to allow the use of a demand control ventilation sequence to reduce energy usage.

6. These units will supply conditioned outdoor air to a riser that will deliver air to the structural plank air duct system on each floor.

C. OFFICE AIR CONDITIONING

1. Typical office floors will be conditioned by the combination of a structural slab integrated radiant cooling and heating system and a displacement ventilation system.
2. Radiant Cooling and Heating System

a. The slab integrated radiant cooling system will consist of a system of cross linked polyethylene (PEX) piping installed in the bottom section of the slab panels. Chilled or hot water will circulate through this piping to heat or cool the slab section that will become a radiant body. During cooling, this will absorb heat from occupants and other surfaces. During heating, occupants and cold surfaces in the space will absorb heat from the radiant panel. The piping within each panel will have modular connections at the panel end to allow for connection to adjoining panels or to the chilled or hot water supply and return mains.

b. The radiant piping within the slab is supplied by the chilled and hot water supply and return mains that run along the core of the building. The pipe mains serve as a manifold and one radiant loop will be provided for each control zone. An automatic control valve controlled by a thermostat will be used at each connection to control the temperature of the radiant panel to maintain comfort conditions.

1) The panels serving the perimeter spaces will be supplied with both hot and chilled water. Each zone will have a hot and a chilled water control valve tied to a thermostat to select heating or cooling and control the amount of water supplied to the panels. Maximum perimeter zone size will be 900 sq. ft.

2) The panels serving the interior space will be supplied with chilled water only. Maximum control zones in the interior space will be 1500 s.f.

c. The radiant panels will provide energy-efficient, quiet and comfortable cooling and heating.

1) Efficiency is increased by allowing the building to utilize the thermal mass of the structure for thermal storage effect and to take advantage of natural ventilation and night purge cycles. It will also allow the building to take advantage of the thermal mass of the structure.

3. Office Floor Ventilation

a. Conditioned ventilation air will be supplied into the upper cavity of the office floor plank system from each of the risers. The planks will have a connecting air pathway that crosses through the lower cavity and connects the supply air pathway to adjacent planks. This creates a duct to allow supply air to get to all planks in the quadrant. Air will travel through the plank system at a low velocity (maximum of 450 fpm) to reduce fan energy usage and maintain space acoustics.

b. The upper cavity of the plank system will be enclosed on top with access tiles. Underfloor air swirl diffusers will be placed within these tiles and will supply air to the office space above.

1) Each occupant will have a swirl diffuser located adjacent to their workstation. The diffuser shall allow for each user to reduce the air volume provided to their space to allow for individual control.

c. Demand Control Ventilation: The system will have the ability to reduce air volume supplied to the space based upon space occupancy as determined by space CO_2 levels. The base building BMS shall have the demand control ventilation control sequence that will react to tenant-installed CO_2 sensors. Enthalpy/ dewpoint sensors will override the demand control ventilation sequence to ensure that space humidity set points are not exceeded.

4. Conference Rooms and Other High-Density Spaces

a. A supplemental chilled water main will be provided running parallel to the core of each floor. This system will be extended through the lower cavity of the structural planks to supply fan coil units to serve conference rooms and other high-density spaces that will require more cooling than is available from the radiant and displacement ventilation systems.

5. Tenant Supplemental Cooling

a. Tenant supplemental cooling will be provided by the condenser water and building chilled water system.

D. MISCELLANEOUS AIR SYSTEMS

1. The building lobby will receive conditioned air from a dedicated constant volume (inverter drive will be provided for summer/ winter adjustments and balancing) chilled water air handling unit. In addition the lobby unit will be provided with unit-mounted heating coils to allow lobby pressurization in winter time to offset building stack effect. A dedicated return fan will be provided to allow for lobby exhaust and to support pressurization requirements. The lobby AC unit will derive outdoor air directly from a perimeter louver to allow for independent 24x7 operation, without the use of building ventilation systems. Unit will be supplied with integral direct digital automatic controls including sensors, controllers and processors to support all local AC functions.

a. Building lobby entrances will be provided with dedicated H&V units supplying air at or near entrance doors. Electric matt heaters shall be provided at concierge desk.

2. Retail areas of the building will be provided with capped valved outlets for condenser or chilled water for cooling and hot water for heating, as well as louvers and/or ductwork tap extended from louvers for exhaust and outdoor air intake requirements. .

3. Toilet exhaust will be provided for the men's and women's toilets. The toilet exhaust system will be sized to exhaust 2 cfm/ sq. ft. from each base building toilet room as well as an additional allowance of 10% to allow special tenant toilets to be added.

4. A general exhaust/relief air system will be provided. General exhaust will be used for relief air at all times the outside air system is energized, and tenant can connect special spaces to this system such as reproduction rooms, pantries, etc. A variable volume exhaust box will be provided and tracked with the outdoor air supply. This system will be exhausted through the heat recovery ventilation air handling units.

a. This system will also be utilized for emergency purge cycle during an indoor air quality event such as a chemical spill on the floor.

E. BUILDING MANAGEMENT SYSTEM

1. A direct digital control Automatic Temperature Control and Alarm System will be provided with electric (electronic) actuators for dampers and control valves. The system is designed to accommodate fan coil units with D.D.C. controls and space sensors, as part of tenant installation. The system will be designed for control optimized starting and stopping of all air conditioning and heating systems, cooling tower fans, pumps, etc. System will provide status of equipment that is started and stopped, and will provide alarms for critical areas and equipment for the building.

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IA INTERIOR ARCHITECTS

A PIVOTAL SHIFT; LEVERAGING FOR ADVANTAGE

Timing is everything. Power lies in knowing that the moment has come—a pivotal shift that profoundly affects the present and will define the future. The current global financial crisis has forced such a moment and caused an accelerated pace of change that promises huge opportunity for those who understand its significance early on. Trends cautiously eyed by some and enthusiastically embraced by others in recent years will come into their own, reshape the way we work and live, and support a variety of agendas—economic, demographic, social, creative, and technological. By necessity, the workplace will be rethought, reconfigured, and rebuilt to greater advantage and profitability. Smart companies and corporate real estate (CRE) decision makers who understand the implications for their portfolio, workforce, and bottom line will plan tactically and leverage opportunities for a bright future well ahead of the curve.

Lost revenue and massive layoffs have taken their tolls on CRE portfolios. Recent vacancy rates have accelerated. What was once an asset has become a liability as workspace becomes under used or simply not used at all. Although each company's position is unique and some firms continue to expand, the pressure to maximize shareholder value, increase productivity, and squeeze additional savings out of corporate portfolios remains. With leaner budgets and fewer resources many firms must do more with less to realize profits, pursue innovation, and support a vibrant business culture. Trends and realities that have long pushed against the traditional workplace subtly and not so subtly will now be acknowledged, evaluated, and adapted to reshape the workspace and the way we work for immediate and future benefit.

With real estate costs typically the second largest item on the expense sheet, right after labor, smart companies will assess their workspace and business goals from every possible angle to take advantage of coming changes. To use a metaphor: a hurricane has severely damaged the old house and immediate action is required to make it livable again. There's no point in just patching it up and hoping it stays together through the next trauma. This is the time to rebuild, plan for, or implement all those innovative and ultimately cost saving features that must be dealt with anyway if the house is to meet construction standards and serve well into the future.

Despite great uncertainty about the Obama administration's priorities and what they will bring, change is certain. Most companies, now in a holding pattern likely to continue well into 2010, will work to reestablish their assets and seek smart but controlled growth after the dust settles. They will strive to avoid financial risk and over-commitment by consolidating their real estate holdings and remain cautious with a sharp eye on shifting priorities to stay competitive. Success will depend on flexibility and a holistic approach. Comprehensive strategic planning that identifies options, opportunities, and obstacles from every aspect of the workplace must be implemented for quick maneuvering with tactical cunning to adjust, change course, and take advantage of sudden opportunities as they arise.

What are the factors and realities that companies need to understand and leverage to cut their losses, rethink the workplace, plan strategically, and profit? What changes must be made and why? How do companies successfully determine and control the appropriate action for their unique situation?

TODAY: THE WORKSPACE AND THE WORKFORCE

A workplace reduced in size and staff as a direct result of the global financial crunch must provide new efficiencies for a smaller staff that works smarter to keep up the company's momentum and profitability. Multi-tasking—already on the rise as technology enables employees at all levels to do more for themselves—will be front and center. Employers will look to knowledge workers with a range of skills to tackle a variety of business challenges. The workspace will need to support many skill sets and multifunctional capabilities with ease and agility.

The workforce, now distinctly multigenerational, represents an unprecedented diversity of work styles and mind-sets that signal a pronounced social shift involving four generations: Veterans (pre 1944); Baby Boomers (1944-1964); Gen Xers (1964-1984); and Millennials (1978-1995). Moreover, there is a gender shift. For the first time in history, more women than men are graduating from college each year in the United States with career expectations, and more women are migrating here in search of career opportunities. These shifts in the demographic composition of the workplace will result in employees who are more accustomed to multi-tasking from various locations as they seek greater work-life balance.

The Veterans, now mostly retired or moving into retirement, play a diminished role in the workplace by virtue of their dwindling numbers. Yet their legacy—traditional hierarchical work style, respect for authority, work as a duty, fixed hours, retirement benefits—is still a factor in the workplace. This leaves the Baby Boomers, Gen Xers and Millennials as the key players. Although many of the Baby Boomers are looking towards retirement, some anticipate another 20 years in the workforce. The Gen Xers, the smallest in size of the three generations, will move into management as the Baby Boomers retire, and the first wave of Millennials, the youngest group, are just beginning to let their influence and impact be known.

Gen Xers, the original latch-key kids of working and often divorced parents, are, by necessity, independent and self-reliant. Believing that their parents "lived to work," they intend to "work to live" and were the

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first to demand a work to live environment, inaugurating the work-life balance initiatives corporations are having to address more often today. Pragmatic and flexible, they are not impressed with structured work hours and have a casual approach to authority. They are tech-savvy—one could easily say that this generation was at the forefront of the technology revolution—and equate the office with a connection to resources. Although they tend to focus on self-advancement and change goals to suit that end, collaboration is important to them. As the Baby Boomers move into the first stages of retirement, this generation is moving into management and key leadership roles.

The Millennials, true children of the digital age, have an intuitive feel for technology and multitask by nature. As masters of instant communication and social networking, they are natural collaborators, prefer to work in teams, readily share information, seek feedback, and want to participate in decision-making.

They also expect to customize their work life just like they customize their world at every turn—from websites, to cars and clothing. They intend to shape their job, their hours, and workspace to fit their life and for personal fulfillment. They are committed to a work-life balance. The Millennials will build a greener planet (sustainability is not an option for hem, it is a cause, a given) and give back to the community with a social consciousness. But they are willing to work hard. A more meaningful role or entrepreneurial opportunity in the workplace is a key driver among the Millennials. According to Kelly Services' international workplace survey, 51 percent of those surveyed are prepared to accept a lower wage if their work contributes to something more important or meaningful.

Growing up against a background of faltering corporate accountability, failing social commitment, and increasing global terrorism, younger workers have seen whole companies evaporate along with their grandparents' pension, and just witnessed the stunning collapse of multiple corporations long considered impregnable pillars of the free market. Not surprisingly, the corporate ladder with its promises, restrictions, tarnished credibility, and way of working holds little attraction for them.

On the other hand, the Baby Boomers have been through tough times before, but nothing like this. Conditioned by the benefits and liabilities of corporate life and a structured workplace, fixed hours, and a private, standard-issue cube or office, they are coping with their own disillusionment and, in many cases, significant personal financial loss. They will now postpone retirement, at least for a while, to stay in the workforce, rebuild their assets, and preserve their legacy. Some may move towards a soft retirement within 18 months of recovery and strike a balance between work and personal time to become the largest distributive workforce to date. A flexible work structure in a multi-tasking environment will remain a challenge for many and technology will continue to be an acquired skill. However, the emphasis Gen Xers and Millennials place on collaboration creates an opportunity for cross mentoring that allows Baby Boomers to advise and pass on their valuable knowledge and experience, and in turn benefit from their younger colleagues' innovative, technology-driven, and fresh approach to the workplace. Plus, a sustainable environment with natural light and improved air quality along with ergonomic features will contribute to their health and well-being.

GOING FORWARD: DESIGN; GLOBALIZATION; SUSTAINABILITY; INFRASTRUCTURE/SECURITY; PLANNING

How will the design and use of the workspace impact CRE and create solutions that meet everyone's varying needs and expectations? Companies building or modifying their work environments with an eye on the next generation of workspace will continue to move away from dedicated offices and workstations. More free-flowing environments will blur the lines between work and private life. We've done a great job bringing the office into the home, but will now bring elements of the home into the office. The office will become a collaboration center, the "living room" of the company. Informal seating areas that emulate living areas, or, as at home, dedicated rooms to support specific tasks, will be increasingly common corporate interiors. These features will give employees a sense of ease and comfort and help create work-life balance. Large expanses of open workstations will convert to more cellular areas that address the privacy and acoustical concerns traditional open plans don't effectively address.

The term "office" as we know it—the primary place where you go to do work—will become obsolete. It will be a place for collaboration, face to face encounters, knowledge sharing and bonding to build company culture. Joe Wallace, CEO, Preferred Group, says, "Workers don't want dedicated office space at all. They just want a place where they can go." Creating attractive, energizing, and engaging spaces to foster interaction will convert the office to a hub, offering a variety of different spaces customized to meet specific needs, as well as multiple options for quick discussions and decision making, like stand-up, on–the-go meeting spots to complement the lounge furniture already a feature of the office. Changeable panel heights, workspace configuration options, and automated sit-to-stand work surfaces will allow workers to further customize the space they use.

With technological advances that allow workers to truly work remotely—anywhere, anytime, with swift and secure access to networks and a faster process for scanning documents into the system—the significance and size of the office will diminish and work will be done in a variety of places including the home, client touchdowns and community centers. Technology will provide access and flexibility in time and space, and will also reduce travel and paper consumption.

Research shows that workspace is empty on average 50-60 percent of the time; we are spending all those real estate dollars for space that is underutilized. But a flexible workspace that allows for cost-efficient modifications, easy reconfigurations, and multi-functional capabilities can maximize real estate usage, create savings, and reduce the risks of space dependency. Flexibility will also free up space for enhanced amenities that younger workers expect, including fitness centers, social areas, cafés with healthy menu options, concierge services, and quiet zones—perks that all generations, in fact, can appreciate. Joe Wallace notes, "We think quality of their experience in the office is resonant. These are knowledge workers…it's going to put a premium on energizing places to work. People respond to better quality environments."

Many employees struggling with the current economy see working from home as a career limiting disadvantage. As a result, an increasing number of mobility workers are coming into the office with the belief that they must be seen and physically present to demonstrate their diverse skills sets and value. This is a temporary anomaly, even though management has historically opposed working off-site on the premise that one can't measure the productivity of a worker who is not in the office. But just because it's not possible to see someone doesn't mean they aren't productive or that they can't be managed. There are too many factors in support of working remotely to stem the tide of this trend and, as Tom Doherty, a principal at WB Engineers | Consultants PLLC notes, "Change is going to continue to accelerate, but peoples' effectiveness will be measured by how they manage relationships and connectivity." Going forward, working remotely will be fundamental to the workplace. The nature of each employee's work and management's skill in determining what is needed for the firm to do business and meet its goals will determine the required mix of remote work and time at the office for each employee.

Future of Work, a research program focused on enhancing both individual and organizational productivity while reducing the cost of workforce support (www.thefutureofwork.net), has identified the following potential work distribution: 40 percent in corporate environment; 30 percent at home; and 30 percent in other locations (such as community-based centers). As the role of the office changes, community-based centers that offer the complete services of an office but are located close to residential areas will expand in response to the increased need to reduce real estate costs (which may be tied to commuter costs, see below) and provide greater flexibility, more work-life balance, reduced carbon emissions and commute times. These community-based centers will also allow even small companies and independent consultants to enjoy the services, staff and facilities available to larger corporations without the cost. Temporary office space businesses like Regus are creating "variable office space" facilities that support an organization's needs but charge by the hour to provide the ultimate flexibility in CRE without long-term leases and the problem of capacity issues.

WHAT ABOUT GLOBALIZATION?

A significant number of U.S. companies have expanded their business into other markets worldwide. In the near term that expansion will slow in response to reduced consumption brought on by the global recession and the social and political pressures to increase hiring domestically as opposed to abroad. An additional factor is the anticipated reduction in overseas tax credits. However, this is a temporary slowdown and globalized services will increase for the long term. Companies will take a more strategic approach focused on better cost value from planning guidelines, and broader based purchasing programs that are also flexible to local cultural needs and building standards.

HOW WILL SUSTAINABILITY IMPACT REAL ESTATE NEEDS?

Legislation and a socially-conscious younger generation are pushing the sustainable movement, even though the rough economy may slow its progress. The introduction of stimulus funding for energy efficiency will not only be a tremendous force toward getting us back on track in many arenas (specifically the federal portfolio), it will also catapult us forward. The American Recovery and Reinvestment Plan (ARRP) alone allocates $6.7 billion to the renovation and repair of federal buildings, with a focus on increasing energy efficiency and conservation and an emphasis on the adaptation of existing buildings and their infrastructure.

The current administration has set the goal of reducing greenhouse gas emissions 80 percent by 2050 and introduced the possibility of environmental legislation to control and offset emissions. With this legislation, organizations will be asked to report emissions from their facilities and from their employees' and suppliers' commutes. Corporations will be held accountable for their share of the carbon footprint and required to either eliminate it or pay for its offset. They will, however, find that reducing commuting time will offer another benefit: increased productivity. For example, the average commute in Washington, DC, is 30 minutes, which equates to 60 minutes of lost production time every day per worker, or 250 hours annually–more than six weeks of time that could be used for work is spent on the road. And that same commute creates emissions annually that companies will be charged for. Consider the following information from the U.S.Census Bureau and the International Facility Management Association.

- Average commuter = 24.4 miles at $.55 a mile = $13.42 each way per driver for a total of $6,722.50 annually;
- Add in the average parking cost per car of $2,880 annually;
- Add lost production time of 250 hours spent on the road at the average hourly rate of $24.25 (based on the national average income of $50,233.00) = $6,037.62.

Then add in the cost for real estate:

- Average square feet per person is 200 x average rent of $30 per RSF + average operating cost of $10 per RSF = $8,000 annually;
- Plus the average cost of furniture and IT per employee of $5,000 annually. (Sources: www.census.gov and www.ifma.com)

At these rates for an employee to come to the office every day costs an annual average of $28,640.12 in real estate expense, lost production time and commute cost. Now add in the cost to offset emissions which are typically calculated in five different categories: building energy use, data center energy use, fleet vehicles, employee travel, and employee commutes.

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With these considerations in mind, companies will look for ways to revamp their infrastructure to yield greater energy efficiency and will seek options to reduce commute times, limit their real estate holdings and improve sustainability—especially if given incentives to do so. By employing conservation and smart design practices for the use of space (telecommuting, hoteling, creating hubs and engagement centers, client touchdowns, community centers, etc.), they will be able to reduce their carbon emissions and defray the cost of offsets. To calculate an individual's or organization's carbon footprint visit www.terrapass.com.

Nevertheless, the current state of the economy will temporarily slow the push toward sustainable initiatives as companies that want to be green find themselves unwilling or unable to undertake that task at this time. There is also the expectation that sustainability will be woven into design and construction costs, just as the Americans with Disabilities Act (ADA) was after its initial year of implementation. The impact of implementing sustainable initiatives will diminish as the design industry works to seamlessly integrate sustainable solutions into standard design practices, as it has integrated code and ADA compliance.

WHAT ABOUT INFRASTRUCTURE AND DISASTER PREPAREDNESS?

Going forward, companies will have to consider the needs of an aging inventory of physical properties neglected for the past two decades for a variety of reasons: a shift in focus to ADA compliance; the need for building security; and the current economic crisis. Even if a space is leased and the responsibility falls to the building owner, few tenants will want to occupy a space during an infrastructure upgrade which is typically an invasive process that disrupts the workplace.

Because there are so many available properties, many companies may choose to relocate rather than take on the challenge to modernize. They might also consider third market or satellite locations which will allow them to spread their knowledge base, increase security, and reduce operating costs. In addition, an increasing number of companies now realize the need to go beyond just creating secure buildings. The events of the past decade—9/11, Hurricane Katrina, and the current economic downturn—have shown that the real threat to continued operations is a lack of preparedness for natural and man made disasters. Developing contingency plans to sustain business in the event of a disaster will become a priority that affects real estate.

Being prepared must ensure the survival of people, but going a step further with proper contingency planning will ensure the continuity of operations. Initiatives proposed by the U.S. Department of Homeland Security's Ready Campaign include the following:

- Assess your company's functions on both internal and external levels. Which staff, materials, procedures, and equipment are completely necessary to keep the business operating?
- Identify your suppliers, shippers, resources and other businesses you must interact with on a daily basis; keep a list with contact details in an emergency supply kit and at an off-site location.
- Develop a continuity of operations plan should your place of business become inaccessible.
- Plan for payroll continuity.
- Define crisis management procedures and individual responsibilities in advance.
- Review your emergency plans annually.

WHAT ABOUT PLANNING AND THE CRE TEAM?

To make informed decisions that minimize loss and maximize profits, a company needs to know where it stands, even if it's on shaky ground; understand its goals or targets; identify opportunities and obstacles; allow for maneuverability without penalty; and chart a course with an appropriate contingency plan(s) for swift action and execution when an opportunity presents itself. Tactical plans carefully thought through and appropriately vetted will allow companies to take advantage of anticipated and unexpected windows of opportunity. According to Jane Kuehn, Senior Project Manager, Computer Sciences Corporation, "There's a greater level of scrutiny and lots more discussion and validation. And that's good. We're reinventing our process." Organizations that are over-extended will need to focus on stability and reduced risk, but others will have a chance to capitalize on the unusual opportunities the current market is creating.

The importance of real estate will increase and the role of the CRE team will change. As emphasis is placed on real estate solutions the importance of the team will be elevated. More and more CRE teams will consolidate their services and operations into a global management team with guidelines and pre-negotiated contracts for goods and services that eliminate reinventing the wheel and provide speed to market solutions. CRE teams—historically in a service-providing mode—will likely be asked to change their mission. Going forward, they will regulate and control real estate for cost savings, appropriate workplace diversity and innovation, consistency, and accountability.

EVALUATION PROCESSES: ADJUSTMENTS FOR ADVANTAGE

What changes must be made, and why? How does a firm determine the appropriate action for its unique situation? Since real estate costs are a big item on the expense sheet, a company must understand both its current situation and where it needs—and wants—to be. An assessment of the overall portfolio, space utilization (including workflow), space requirements, current costs, and business goals is a prerequisite.

A holistic approach is essential. It's important to remain open to the many possible avenues that could lead to a positive result for the organization's use of real estate, resources, and facilities. Every aspect of the infrastructure, all workplace requirements, and human requirements should be considered without a bias for any one specific agenda. A professional strategist, whether internal to the organization or brought in from the outside, should be engaged as a partner and team member. A strategist will be uniquely sensitive to the interconnectedness of diverse factors that impact business success and will have the experience to recognize hidden costs savings and options often missed. By analyzing every aspect of a business, beginning with its overall business goals, human resources, technology, human capital, management, workflow, real estate, and communication, a strategist can advise the right approach and steps a company should take to move towards greater effectiveness and success. Using a holistic approach will help the team identify new ways to manage, allocate, and design space, improve operations, mitigate potential risks, enhance the organization's culture, and provide overall cost savings.

Advanced portfolio planning combined with comprehensive strategic planning allows an organization to identify the right time to make tactical changes for the greatest results with the least investment. Significant portfolio occurrences, such as lease expirations, staff relocations or consolidations, energy upgrades, and building infrastructure renovations, may be the ideal trigger points to initiate additional needed workplace modifications. By anticipating and aligning these events, companies can minimize work disruption and build positive staff support for change.

A knowledgeable team with the right tools and a careful process is required for this undertaking. Regardless of the approach an organization takes to planning, consider these steps for a positive and successful result:

- Know or determine the company's goals—from the short term to the long term and realistically assess where it stands today.
- Outline what approaches might work for the company's business and culture, and what kind of results to expect.
- Socialize the planning effort. Let staff contribute input and help them understand the options being considered.
- Formulate guidelines for a long-term plan, defining the points where tactical change can occur.
- Measure actual changes for effectiveness when they occur.
- Revisit the plan to make adjustments as market, business, and other factors change.

CONCLUSION

An irrevocable shift of historical magnitude, a pivotal change, has occurred. Like all significant change it comes at a moment preceded by a combination of elements, precursors that make the timing inevitable. The multiple factors—economic, technological, demographic and cultural—now shaping the workplace have been working towards this moment for quite a while and will continue their work going forward. The workplace will be distributed among locations remote and near; accessible and flexible in time and space; collaborative and interactive; customizable and easily reconfigurable; innovative and competitive; sustainable, healthful and work-life oriented; non-hierarchical; and certainly profitable. It will perform as it has never performed before, but there will be growing pains as the shift proceeds. The implications are readily apparent. Smart companies will recognize this compelling opportunity to rebuild and reposition the workplace for optimum performance and gain. Acting wisely with a carefully honed tactical approach such organizations will lead the evolution towards a new way of working.

Appendix 11 | Workplace Trends

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DEMOGRAPHICS

Age and the Economy

- 93% of the growth in the labor force from 2006-2016 will be among workers ages 55+.
- 54% of workers ages 65+ say the main reason they work is that they want to remain active and engaged.
- 63% of workers ages 50-61 say they might have to push back expected retirement date because of current economic conditions.
- 59% of respondents say they prefer a job that offers better security over higher pay but less stability.

GENDER

- For the first time in history, more women than men are graduating from colleges each year.
- Women tend to need more work-life balance.
- Women tend to manage more by consensus and team building.
- Women tend to relate more through personal experiences and interconnections.

MAJORITY MINORITY SOCIETY

- Multinationals are migrating to the United States seeking opportunities and a large percentage of them are women.
- Cultural diversity brings a new depth of understanding regarding global issues and varies cultures into the work place.
- Diversity fosters global connections.

US TRENDS

- Drive to reduce space, operating costs; improve flexibility, sustainability
- Ratio of offices / workstations 20/80 or 30/70 high end fewer, smaller private offices
- Modular systems carry power and data in lieu of raised floor, trend is leaning towards raised floor
- Trending towards more modularity and flexibility to reduce renovation costs
- Average targeted USF per person 150 - 200 SF/P industry wide– trending downwards.
- Demand for collaborative space increasing
- Virtual teams, global hours, work anywhere, anytime.

EMEA TRENDS

- High rent, limited space, drives higher floor densities.
- Lower office to work station ratios.
- Raised floors installed by landlords.
- Homogeneous layout; increased flexibility, less churn, less disruption.
- Chasing 130 sf/12 sq m occupancy density.
- Workstation size reduced (36 sf/3.6 sq m).
- Benching concept with mobile pedestals and seats added or removed as growth fluctuates.
- Tech-savvy.

POTENTIAL WORKPLACE OBJECTIVES

- Flexible workplace environments supporting practice group interaction and mobility.
- Intelligent workplace space management concepts accommodating growth dynamics.
- Forward-thinking operational infrastructure accommodating enhanced access to information technology.
- Integrated, flexible and scaleable “smart common areas” enhancing meeting and collaboration opportunities.
- Flexible and stable “smart” furniture solutions supporting dynamic space use.

Workplace solutions should be scalable, flexible and tailored to the specific requirements of the specific implementation solution. A related system of quantifiable and measurable benefits that may also be important include:

QUALITATIVE BENEFITS

- Dynamic practice group flexibility and mobility.
- More effective in-office time for leadership and their teams.
- Improved workplace culture and employee retention.
- Improved workplace productivity and efficiency.
- Key organizational engagement supported by a cultural migration to the client’s “Smart Space” philosophies.

QUANTITATIVE BENEFITS

- Improved real estate ROI– return on investment measured through reduced occupancy costs.
- Reduced real estate requirement per FTE measured through space utilization metrics.
- Enhanced office space utilization measured through reduced real estate cost per square foot.
- Financial Analysis supporting reduced real estate costs and enhanced office space utilization.

Veterans:	**Gen X:**
1900-1945	1965-1980
GI Generation	Latchkey generation
Silent Generation	Entrepreneurial
Duty First	Work / life balance
Live to work	Self reliant
By the book	Question authority
Loyal	Working for money
Great Faith in Institution	What's in it for me
Rank - Status - Authority	Want instant gratification
Baby Boomers:	**Millennials:**
1946-1964	1980-2000
Get it Done	Work to deadlines
Whatever it Takes	Technology rules
Live to Work	Connected 24/7
Action Oriented	Global Network
Competitive	Work Anywhere
Recognition	Multi-taskers
Consumers	Cultural diverse
They are what they do	What are you doing for me?
leader oriented	Team oriented

Appendix 12 | Cost Estimation

GILBANE BUILDING COMPANY

EXECUTIVE SUMMARY

Building More Than Buildings®

CostAdvisor©

EXECUTIVE SUMMARY

Project:Pickard Chilton Office Building of the Future Scenario: Cast-In-Place Concrete

Project Date:5/1/2012 9:31:55 AM Project Type:Corporate

Location:	CT - New Haven	**Architect:**	Pickard Chilton
Report Date:	05/10/2012	**COE Representative:**	Adamowicz
Owner:	Speculative	**Gilbane Estimator:**	erz
Program Manager:	Gilbane	**Gilbane:**	

Preconstruction Start Date: 05/01/2012 **Construction Start Date:** 05/21/2013 **Construction End Date:** 08/21/2014

CONCEPTUAL MODEL COST SUMMARY

	SF	Cost	Cost/BGSF
New Construction Fit-Out:	260,000	$35,477,815	$136.45
Renovation:	0	$0	$0.00
Total new / Reno Fit-Out (BGSF):	260,000	$35,477,815	$136.45
New Construction Core and Shell:		$29,099,953	$111.92
Building Construction Total:		$64,577,768	$248.38
Sitework and Building Demolition:		$0	$0.00
Total Conceptual Model Cost:		$64,577,768	$248.38
Construction Escalation to midpoint of construction:	0.00 %	$0	included in cost

SOFT COST SUMMARY

	Soft Costs Total	#Error
Soft Cost Escalation to three months prior to end of construction:	$0	included in cost

Project Total Cost: $64,577,768 $248.38

Report created on: 5/10/2012

*All information contained herein is designed to provide assistance and advice and does NOT constitute an estimate or promise of price.

Gilbane

CONSTRUCTION COST SUMMARY (BY PROGRAM)

Building More Than Buildings®

CostAdvisor©

CONSTRUCTION COST SUMMARY (BY PROGRAM)

Project:Pickard Chilton Office Building of the Future Scenario:Cast-In-Place Concrete

Project Date:5/1/2012 9:31:55 AM Project Type:Corporate

whole building	NewArea	RenoArea	Int BOD	Fit-out $/ft	Reno $/ft	New Fit-out $	Reno Fit-out $	C and S $	Total Cost	Cost/BGSF
MEP Rooms, Shafts, El Closets Complete	10,100	0	B	$118	$0	$1,194,991	$0	$1,130,421	$2,325,412	$230
Admin Complete	16,000	0	B	$179	$0	$2,864,491	$0	$1,790,766	$4,655,258	$291
General Offices Complete	200,000	0	B	$132	$0	$26,465,409	$0	$22,384,579	$48,849,988	$244
Stair Finishes total all floors	4,700	0	B	$70	$0	$329,261	$0	$526,038	$855,298	$182
Toilet rooms complete	6,000	0	B	$258	$0	$1,550,562	$0	$671,537	$2,222,099	$370
Circulation Complete	11,400	0	B	$125	$0	$1,419,791	$0	$1,275,921	$2,695,712	$236
Retail Space	11,800	0	A	$140	$0	$1,653,310	$0	$1,320,690	$2,974,000	$252
Totals for program:	**260,000**	**0**				**$35,477,815**	**$0**	**$29,099,953**	**$64,577,768**	

New Fit-out Total Cost:	$35,477,815	260,000	**Core and Shell Total Cost:**	$29,099,953
Reno Fit-out Total Cost:	$0	0	**Core and Shell Cost/SqFt:**	$112
Total Area All Buildings:		260,000	**Building Cost All Buildings:**	$64,577,768

Report created on: 5/10/2012

*All information contained herein is designed to provide assistance and advice and does NOT constitute an estimate or promise of price.

Gilbane

CORE AND SHELL MODEL BY SECTION

Building More Than Buildings®

CostAdvisor©

CORE AND SHELL MODEL BY SECTION

Project:Pickard Chilton Office Building of the Future Scenario:Cast-In-Place Concrete

Project Date:5/1/2012 9:31:55 AM Project Type:Corporate

Building Summary

Building Gross SqFt:	260,001	**Building Structure SqFt:**	260,000
Building Footprint SqFt:	28,889	**Roof Area**	28,889
		Escalation:	0.00 %
Total Cost/GSF:	$111.92	**Core And Shell Total:**	$29,099,953

Section: whole building

Building Classification:	#Error	**Number of Stories:**	9
Exterior Skin (SqFt):	149,257	**Building Height:**	117
Building Perimeter (LFt):	1,276	**Exterior Skin : BGSF Ratio:**	57 %
% Exposed Perimeter:	100.00 %	**Section BGSF:**	260,001.00

Exterior Skin	Lump Sum	Cost / Wall SF
Section Exterior Skin Cost (149257)		

Report created on: 5/10/2012

*All information contained herein is designed to provide assistance and advice and does NOT constitute an estimate or promise of price.

Gilbane

CORE AND SHELL MODEL BY SECTION

Building More Than Buildings®

Foundations	Lump Sum	Cost / TotalBuildingFootprint
8000cy Excv/Bkfl, Excavation (28889)	$255,780	$8.85
Foundation System, Foundation System (28889)	$862,077	$29.84
8" SOG, Slab on Grade System (28889)	$246,308	$8.53
Totals:	**$1,364,164**	**$47.22**

Superstructure	Lump Sum	Cost / TotalBuildingStructureSquareFeet
CIP Conc Structure Complete , Type of Superstructure (260001)	$11,638,035	$44.76
Not Required, Spray-on Fireproofing (260001)	$0	
Totals:	**$11,638,035**	**$44.76**

Roofing	Lump Sum	Cost / TotalBuildingFootprint
Flat Adhered Membrane, Type of Roof (28889)	$615,769	$21.32
Green Roof Premium 14000sf, Type of Roof (28889)	$298,410	$10.33
Totals:	**$914,179**	**$31.64**

Conveying Systems	Lump Sum	Cost / TotalBuildingStructureSquareFeet
18 flights Metal Pan - Conc fill, Access / Egress Pathways (260001)	$287,753	$1.11
Service Elevator 10 stops, Elevators & Escalators (260001)	$319,725	$1.23
Public Elevators 6 = 54 stops, Elevators & Escalators (260001)	$1,055,093	$4.06
Totals:	**$1,662,570**	**$6.39**

Exterior Closure	Lump Sum	Cost / TotalExteriorSkinSquareFeet
Window Systems 100% @ $85, Exterior Skin (149257)	$13,521,005	$90.59
Totals:	**$13,521,005**	**$90.59**

Note : The numbers in the braces indicate SquareFeet of Exteroir Skin.

Report created on: 5/10/2012

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EXECUTIVE SUMMARY

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CostAdvisor©

EXECUTIVE SUMMARY

Project:Pickard Chilton Office Building of the Future — Scenario: Modular Base Case

Project Date:5/1/2012 9:31:55 AM — Project Type:Corporate

Location:	CT - New Haven	**Architect:**	Pickard Chilton
Report Date:	05/10/2012	**COE Representative:**	Adamowicz
Owner:	Speculative	**Gilbane Estimator:**	erz
Program Manager:	Gilbane	**Gilbane:**	

Preconstruction Start Date: 05/01/2012 **Construction Start Date:** 05/21/2013 **Construction End Date:** 08/21/2014

CONCEPTUAL MODEL COST SUMMARY

	SF	Cost	Cost/BGSF
New Construction Fit-Out:	260,000	$32,252,559	$124.05
Renovation:	0	$0	$0.00
Total new / Reno Fit-Out (BGSF):	260,000	$32,252,559	$124.05
New Construction Core and Shell:		$28,345,323	$109.02
Building Construction Total:		$60,597,882	$233.07
Sitework and Building Demolition:		$0	$0.00
Total Conceptual Model Cost:		$60,597,882	$233.07
Construction Escalation to midpoint of construction:	0.00 %	$0	included in cost

SOFT COST SUMMARY

	Soft Costs Total	#Error
Soft Cost Escalation to three months prior to end of construction:	$0	included in cost
Project Total Cost:	$60,597,882	$233.07

Report created on: 5/10/2012

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CONSTRUCTION COST SUMMARY (BY PROGRAM)

Building More Than Buildings®

CostAdvisor©

CONSTRUCTION COST SUMMARY (BY PROGRAM)

Project:Pickard Chilton Office Building of the Future — Scenario:Modular Base Case

Project Date:5/1/2012 9:31:55 AM — Project Type:Corporate

whole building	NewArea	RenoArea	Int BOD	Fit-out $/ft	Reno $/ft	New Fit-out $	Reno Fit-out $	C and S $	Total Cost	Cost/BGSF
Admin Complete	16,000	0	B	$163	$0	$2,604,083	$0	$1,744,328	$4,348,411	$272
Circulation Complete	11,400	0	B	$113	$0	$1,290,719	$0	$1,242,833	$2,533,553	$222
MEP Rooms, Shafts, El Closets Complete	10,100	0	B	$108	$0	$1,086,355	$0	$1,101,107	$2,187,462	$217
General Offices Complete	200,000	0	B	$120	$0	$24,059,463	$0	$21,804,095	$45,863,557	$229
Stair Finishes total all floors	4,700	0	B	$64	$0	$299,328	$0	$512,396	$811,724	$173
Toilet rooms complete	6,000	0	B	$235	$0	$1,409,601	$0	$654,123	$2,063,724	$344
Retail Space	11,800	0	A	$127	$0	$1,503,009	$0	$1,286,442	$2,789,450	$236
Totals for program:	260,000	0				$32,252,559	$0	$28,345,323	$60,597,882	

New Fit-out Total Cost:	$32,252,559	260,000	Core and Shell Total Cost:	$28,345,323
Reno Fit-out Total Cost:	$0	0	Core and Shell Cost/SqFt:	$109
Total Area All Buildings:		260,000	Building Cost All Buildings:	$60,597,882

Report created on: 5/10/2012

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CORE AND SHELL MODEL BY SECTION

Building More Than Buildings®

CostAdvisor©

CORE AND SHELL MODEL BY SECTION

Project:Pickard Chilton Office of the Future — Scenario: Modular Base Case

Project Date:5/1/2012 9:31:55 AM — Project Type:Corporate

Building Summary

Building Gross SqFt:	260,001	**Building Structure SqFt:**	260,000
Building Footprint SqFt:	28,889	**Roof Area**	28,889
		Escalation:	0.00 %
Total Cost/GSF:	$109.02	**Core And Shell Total:**	$28,345,323

Section: whole building

Building Classification:	I	**Number of Stories:**	9
Exterior Skin (SqFt):	149,257	**Building Height:**	117
Building Perimeter (LFt):	1,276	**Exterior Skin : BGSF Ratio:**	57 %
% Exposed Perimeter:	100.00 %	**Section BGSF:**	260,001.00

Exterior Skin	Lump Sum	Cost / Wall SF
Section Exterior Skin Cost (149257)	$0	$0.00

Report created on: 5/10/2012

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Gilbane

CORE AND SHELL MODEL BY SECTION

Building More Than Buildings®

Foundations	Lump Sum	Cost / TotalBuildingFootprint
8000cy Excv/Bkfl, Excavation (28889)	$255,780	$8.85
Foundation System, Foundation System (28889)	$923,654	$31.97
8" SOG, Slab on Grade System (28889)	$246,308	$8.53
Totals:	**$1,425,741**	**$49.35**

Superstructure	Lump Sum	Cost / TotalBuildingStructureSquareFeet
Precast Modular Structure Complete, Type of Superstructure (260001)	$12,469,323	$47.96
Topping Slab@ $3/sf 231,000sf, Type of Superstructure (260001)	$738,565	$2.84
Totals:	**$13,207,888**	**$50.80**

Roofing	Lump Sum	Cost / TotalBuildingFootprint
Flat Adhered roof membrane , Type of Roof (28889)	$615,769	$21.32
Green Roof Premium 14000sf, Type of Roof (28889)	$298,410	$10.33
Totals:	**$914,179**	**$31.64**

Conveying Systems	Lump Sum	Cost / TotalBuildingStructureSquareFeet
18 flights Metal Pan - Conc fill, Access / Egress Pathways (260001)	$287,753	$1.11
Service Elevator 10 stops, Elevators & Escalators (260001)	$319,725	$1.23
Public Elevators 6 = 54 stops, Elevators & Escalators (260001)	$1,055,093	$4.06
Totals:	**$1,662,570**	**$6.39**

Exterior Closure	Lump Sum	Cost / TotalExteriorSkinSquareFeet
Window Systems 100% @ $70, Exterior Skin (149257)	$11,134,945	$74.60
Totals:	**$11,134,945**	**$74.60**

Note : The numbers in the braces indicate SquareFeet of Exteroir Skin.

Report created on: 5/10/2012

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Appendix 12 | Cost Estimation

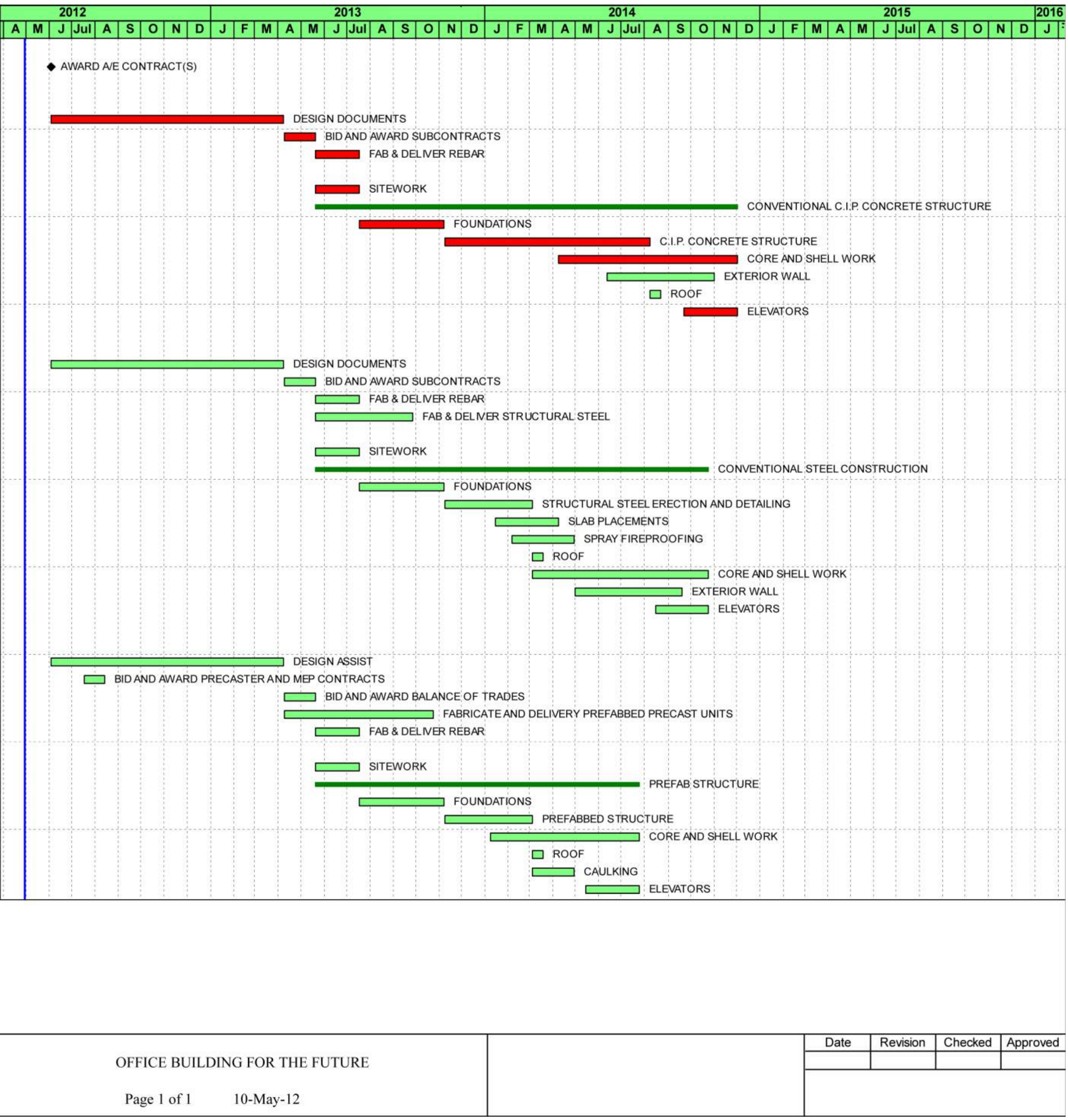
GILBANE BUILDING COMPANY

Activity ID	Activity Name	Orig Dur	Rem Dur	ES	EF
	OFFICE BUILDING OF THE FUTURE				
4000	AWARD A/E CONTRACT(S)	0	0	04-Jun-12*	
CONVENTIONAL CIP CONCRETE CONSTRUCTION					
PROCUREMENT					
4010	DESIGN DOCUMENTS	216	216	04-Jun-12	08-Apr-13
4110	BID AND AWARD SUBCONTRACTS	30	30	09-Apr-13	20-May-13
4200	FAB & DELIVER REBAR	40	40	21-May-13	17-Jul-13
CONSTRUCTION					
4120	SITEWORK	40	40	21-May-13	17-Jul-13
3956	CONVENTIONAL C.I.P. CONCRETE STRUCTURE	390	390	21-May-13	01-Dec-14
4030	FOUNDATIONS	80	80	18-Jul-13	07-Nov-13
4040	C.I.P. CONCRETE STRUCTURE	190	190	08-Nov-13	07-Aug-14
4090	CORE AND SHELL WORK	165	165	09-Apr-14	01-Dec-14
4080	EXTERIOR WALL	100	100	12-Jun-14	31-Oct-14
4070	ROOF	10	10	08-Aug-14	21-Aug-14
4100	ELEVATORS	50	50	22-Sep-14	01-Dec-14
CONVENTIONAL STEEL CONSTRUCTION					
PROCUREMENT					
4260	DESIGN DOCUMENTS	216	216	04-Jun-12	08-Apr-13
4350	BID AND AWARD SUBCONTRACTS	30	30	09-Apr-13	20-May-13
4360	FAB & DELIVER REBAR	40	40	21-May-13	17-Jul-13
4370	FAB & DELIVER STRUCTURAL STEEL	90	90	21-May-13	26-Sep-13
CONSTRUCTION					
4380	SITEWORK	40	40	21-May-13	17-Jul-13
4390	CONVENTIONAL STEEL CONSTRUCTION	365	365	21-May-13	24-Oct-14
4270	FOUNDATIONS	80	80	18-Jul-13	07-Nov-13
4280	STRUCTURAL STEEL ERECTION AND DETAILING	80	80	08-Nov-13	04-Mar-14
4290	SLAB PLACEMENTS	60	60	15-Jan-14	08-Apr-14
4300	SPRAY FIREPROOFING	60	60	05-Feb-14	29-Apr-14
4310	ROOF	10	10	05-Mar-14	18-Mar-14
4330	CORE AND SHELL WORK	165	165	05-Mar-14	24-Oct-14
4320	EXTERIOR WALL	100	100	30-Apr-14	19-Sep-14
4340	ELEVATORS	50	50	15-Aug-14	24-Oct-14
PREFAB OFFICE BUILDING OF THE FUTURE					
PROCUREMENT					
4020	DESIGN ASSIST	216	216	04-Jun-12	08-Apr-13
4190	BID AND AWARD PRECASTER AND MEP CONTRACTS	20	20	17-Jul-12	13-Aug-12
4180	BID AND AWARD BALANCE OF TRADES	30	30	09-Apr-13	20-May-13
4230	FABRICATE AND DELIVERY PREFABBED PRECAST UNITS	140	140	09-Apr-13	24-Oct-13
4220	FAB & DELIVER REBAR	40	40	21-May-13	17-Jul-13
CONSTRUCTION					
4130	SITEWORK	40	40	21-May-13	17-Jul-13
3966	PREFAB STRUCTURE	300	300	21-May-13	24-Jul-14
4140	FOUNDATIONS	80	80	18-Jul-13	07-Nov-13
4240	PREFABBED STRUCTURE	80	80	08-Nov-13	04-Mar-14
4150	CORE AND SHELL WORK	140	140	08-Jan-14	24-Jul-14
4160	ROOF	10	10	05-Mar-14	18-Mar-14
4250	CAULKING	40	40	05-Mar-14	29-Apr-14
4170	ELEVATORS	50	50	14-May-14	24-Jul-14

Data Date - 30-Apr-12

Run Date - 10-May-12

Remaining Level of Effort	Remainin...
Actual Level of Effort	Critical R...
Actual Work	◆ Milestone


2012
2013
2014
2015
2016
A M J Jul A S O N D J F M A M J Jul A S O N D J F M A M J Jul A S O N D J F M A M J Jul A S O N D J
AWARD A/E CONTRACT(S)
DESIGN DOCUMENTS
BID AND AWARD SUBCONTRACTS
FAB & DELIVER REBAR
SITEWORK
CONVENTIONAL C.I.P. CONCRETE STRUCTURE
FOUNDATIONS
C.I.P. CONCRETE STRUCTURE
CORE AND SHELL WORK
EXTERIOR WALL
ROOF
ELEVATORS
DESIGN DOCUMENTS
BID AND AWARD SUBCONTRACTS
FAB & DELIVER REBAR
FAB & DELIVER STRUCTURAL STEEL
SITEWORK
CONVENTIONAL STEEL CONSTRUCTION
FOUNDATIONS
STRUCTURAL STEEL ERECTION AND DETAILING
SLAB PLACEMENTS
SPRAY FIREPROOFING
ROOF
CORE AND SHELL WORK
EXTERIOR WALL
ELEVATORS
DESIGN ASSIST
BID AND AWARD PRECASTER AND MEP CONTRACTS
BID AND AWARD BALANCE OF TRADES
FABRICATE AND DELIVERY PREFABBED PRECAST UNITS
FAB & DELIVER REBAR
SITEWORK
PREFAB STRUCTURE
FOUNDATIONS
PREFABBED STRUCTURE
CORE AND SHELL WORK
ROOF
CAULKING
ELEVATORS
OFFICE BUILDING FOR THE FUTURE
Page 1 of 1
10-May-12
Date
Revision
Checked
Approved

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NET-ZERO WATER ?
Design Process
UNDERSTAND WATER CONTEXT
Research and understand opportunities & limitations of microclimate
Determine what infrastructure serves building site
Identify site water sources
Identify where water goes, including waste water and storm water
REDUCE WATER DEMAND
Reduce potable water demand
Low-flow faucets, fixtures
No potable water for toilets, urinals, cooling towers, radiant floors, heat pumps, laundry
No potable water for irrigation, exterior maintenance
Drought-tolerant planting
DIVERSIFY & MANAGE SOURCES
Capture gray water
Treat and use for non-potable uses
Capture rainwater
Use for non-potable uses
Treat and use for drinking water
Store for dry season use
Allow excess to infiltrate and replenish ground water
LOW FLOW EVERYTHING.
RAINWATER COLLECTION
ROOF COLLECTION
FACADE COLLECTION ?
RAINWATER TREATMENT FOR DRINKING
GREY WATER TREATMENT
BLACKWATER TREATMENT
CARBON NEUTRAL MATERIALS ?
Design Process
MATERIAL SELECTION CONSIDERATIONS
Regionally appropriate/sourced
Sustainable sources
Renewable or rapidly renewable source
Carbon sequestration
Low-embodied energy
Low life cycle costs
Non-toxic
Reusability
Recycleability
Biodegradability
LIFE CYCLE ASSESSMENT
WOOD
LIFE CYCLE TOWER Concept
LIFE CYCLE TOWER Austria
STADHAUS, London
49 weeks
STADHAUS, London


& MANAGE OUTPUT
ckwater generation
g toilets
site water treatment
retention and settling
treatment
treatment
ROOF
FEDERAL BUILDING
COMPOST TREATMENT
MICRO TURBINES IN VERT COLLECTION FOR ENERGY PRODUCTION
515,000 SF BUILDING
15,000 SF URBAN PLAZA
8,250 SF OPEN SPACE
5,500 SF PUBLIC ATRIUM
82,200 SF SITE
53,450 SF NOT PUBLIC
35% OF SITE AREA PUBLIC
CIRS INFORMATION
Located on university campus
Site Area: 2 008 m² | 21,614 SF
Building Area: 5 675 m² | 61,085 SF
4 stories, with 1 story auditorium
Program: "Living Laboratory" - interdisciplinary research facility including offices, labs, auditorium, atrium and café
$37 million construction budget ($606/SF)
CIRS ENVELOPE STRATEGIES
Window / wall ratio: 48%
Extra insulation: R30 walls, R60 roof
Target average envelope R value: R20
Green roof on auditorium
LANDSCAPE PLAN