

# Designing for Wellness in Distribution Centers

By KSS Architects

*Produced in conjunction with*



## About NAIOP

NAIOP, the Commercial Real Estate Development Association, is the leading organization for developers, owners and related professionals in office, industrial, retail and mixed-use real estate. NAIOP comprises some 20,000 members in North America. NAIOP advances responsible commercial real estate development and advocates for effective public policy. For more information, visit [naiop.org](http://naiop.org).

The NAIOP Research Foundation was established in 2000 as a 501(c)(3) organization to support the work of individuals and organizations engaged in real estate development, investment and operations. The Foundation's core purpose is to provide information about how real properties, especially office, industrial and mixed-use properties, impact and benefit communities throughout North America. The initial funding for the Research Foundation was underwritten by NAIOP and its Founding Governors with an endowment established to support future research. For more information, visit [naiop.org/research-foundation](http://naiop.org/research-foundation).

## About KSS Architects

Through great architecture, KSS creates meaningful and lasting change that impacts their clients, their firm and their world. KSS Architects is an award-winning full-service architecture, planning and interior design firm with offices in New York, NY; Philadelphia, PA; and Princeton, NJ. Founded in 1983, KSS has grown to a team of 80 dedicated design professionals, eager to create built environments that stimulate the intersections of learning, commerce and community. They are passionate about guiding their clients through an innovative and collaborative design process to create impactful built environments that inspire and elevate the human experience.

The following individuals at KSS Architects coauthored this report: Ed Klimek, Jennie Himler, Bri Dazio, Tyler Park and David von Stappenbeck.

## About Branch Pattern

BranchPattern is a building consultancy dedicated to creating Better Built Environments®. Their team consists of professional engineers, registered architects, and building scientists that focus on implementing programs and solutions to optimize human experience and environmental stewardship. The firm provides broad expertise to support the sustainability goals of the commercial real estate industry throughout North America, South America and Europe.

The following individuals at Branch Pattern contributed to this report: Andres Rodriguez-Burns, Nate Maniktala and Marcel Harmon.

## Acknowledgments

The authors wish to acknowledge the contributions of the following individuals at NAIOP for their contributions to this report: Shawn Moura, Jacqueline Seibert and Jennifer LeFurgy.

## Disclaimer

This project is intended to provide information and insights to industry practitioners and does not constitute advice or recommendations. NAIOP disclaims any liability for actions taken as a result of this project and its findings.

# Contents

- Executive Summary ..... 3
- Introduction ..... 4
  - Wellness in Design ..... 4
  - Report Structure ..... 4
  - The Distribution Center Workplace..... 5
  - Analysis Framework..... 6
- Wellness Objectives ..... 6
  - 1. Promote Safety ..... 6
  - 2. Enhance Perceived Comfort ..... 7
  - 3. Reduce Body Strain ..... 8
  - 4. Encourage Proper Nutrition and Hydration..... 9
  - 5. Enhance Air Quality ..... 9
  - 6. Support Mental and Emotional Health ..... 10
  - 7. Instill Sense of Belonging..... 10
  - 8. Improve Access to Transportation and Vital Services ..... 10
- Design Recommendations ..... 11
  - General Building Prototype ..... 11
  - Site Context ..... 11
  - Remote Development Strategies ..... 12
  - Suburban Development Strategies ..... 12
  - Urban Development Strategies ..... 12
  - Site Entry..... 16
  - Shell Building Improvements ..... 16
  - Building Entry ..... 16
  - Large Break Spaces ..... 20
  - Medium Break Spaces..... 20
  - Small Break Spaces ..... 20
  - Transportation Lounge ..... 25
  - Workstation ..... 25
- Conclusion ..... 28
- Endnotes ..... 30

# Executive Summary

The rapid expansion of e-commerce over the past decade has reshaped industrial real estate and the nature of work within warehouses and distribution centers. Occupiers have invested in mechanization, automation and warehouse-management systems to maximize throughput. Despite that, distribution centers often require a large number of workers to process incoming shipments and outgoing orders. Growing competition for workers and increased awareness about workplace wellness have generated interest in design interventions that can make these centers healthier and more attractive work environments. Wellness features in industrial properties can contribute to market differentiation, increase employee retention, impact productivity and help meet environmental, social and governance (ESG) goals.

The NAIOP Research Foundation commissioned this report to offer design recommendations that improve occupant well-being. The authors conducted secondary research, observed conditions in existing distribution centers and interviewed occupants to collect information on key wellness concerns. They then drew from these findings to design a prototype distribution center with elements and features that contribute to a healthier and safer work environment.

Workers in distribution centers face conditions that are different from those in office buildings or retail centers. Industrial buildings can have variable indoor air temperatures and above-average levels of noise. Workers may engage in repetitive, strenuous work, and they are exposed to a range of conditions not found in other indoor environments. Due to typical distribution center locations, workers also often have limited access to nearby services and public transportation. The report recommends and illustrates a series of design interventions to address these conditions, including:

- Site layouts that improve pedestrian safety, provide space for public transit and ridesharing services, and provide access to green space.
- Shell improvements that improve thermal conditions, acoustic environments, air quality and lighting such as improved ventilation, destratification fans, skylights, acoustic treatments, high-performance lighting, and radiant heating and cooling elements.
- Workstations that provide ergonomic support, local conditioning and task-oriented lighting.
- Break spaces for distribution center employees and commercial truck drivers that facilitate restoration; provide access to nutrition, hydration and fresh air; protect workers from vehicles; and provide relief from the acoustic and thermal conditions of the distribution center interior.
- Space to host amenities that are not located in the surrounding area, such as day care and food services.

# Introduction

The global supply chain is in a period of rapid change. The COVID-19 pandemic accelerated e-commerce adoption, which had already reshaped industrial real estate in the preceding decade. Sales by nonstore retailers (a proxy measure of e-commerce sales) grew from \$751 billion in 2019 to \$1.28 trillion in 2022, as the share of nonstore retail sales grew from 13.9 percent to 18.1 percent of all retail sales over this period.<sup>1</sup> The expansion of e-commerce has entailed a corresponding expansion of the distribution center workforce. The Fourth Industrial Revolution, characterized by the digitalization and automation of production, is also reshaping distribution centers with the introduction of automated storage and retrieval systems, robots and advanced warehouse management systems.

Spaces for industry and logistics will need to adapt to the new industrial paradigm. Not long ago, most new industrial buildings in the U.S. were warehouses optimized for delivering goods to brick-and-mortar retail locations, and they were sited in exurban or rural locations outside major population centers. Over time, new development began to move closer to urban areas with the adoption of “just in time” efficiency, the expansion of e-commerce and increased consumer demand for fast delivery. Industrial development also began to integrate environmentally sustainable design with low-cost investments in energy efficiency in largely unoccupied and marginally conditioned spaces. However, as distribution centers simultaneously evolve to be more labor-intensive and mechanized, and face greater competition for workers, a different type of sustainability is becoming more important: human sustainability. This report focuses on how design interventions that promote human well-being can make distribution centers healthier work environments that will lower costs associated with worker illness and injury and help occupiers attract and retain workers.

## Wellness in Design

In 2014, the International WELL Building Institute (IWBI) introduced the WELL Building Standard. The WELL system draws from a knowledge base of how environmental conditions affect human health to derive a metric-driven approach to guide design decisions. At the time of its creation, WELL focused on commercial office design and expanded into other sectors including residential, education, restaurants, commercial kitchens and communities.<sup>2</sup> Fitwel, similar to the WELL standard, is administered by New York City’s Center for Active Design and was previously piloted by the Center for Disease Control and Prevention (CDC) and the General Services Administration (GSA). Fitwel has identified a range of strategies and building design interventions that can improve occupant health and well-being. The Center for Active Design recently published a report that provides guidance for the design of industrial space.<sup>3</sup>

The purpose of this report is not to replicate the work of WELL or Fitwel, but to build on their findings to make specific development and design recommendations, drawing from the authors’ extensive experience with related industrial projects.

## Report Structure

This report builds on contemporary models of industrial development. Its purpose is not to radically re-design the distribution center, but to offer solutions that can be readily implemented to transform distribution centers into better places for work. Eventually, new building forms will evolve as many of these conditions take hold. After outlining the general conditions of the industrial workplace and the problems they present for workers’ health and well-being, the report describes wellness objectives that can be addressed through improved design. It then describes the characteristics and components of a distribution center prototype that is based on contemporary development standards. The report then illustrates design strategies that meet specific wellness objectives and positively impact human health.

## The Distribution Center Workplace

Understanding the distribution center workplace begins with understanding the people who work there. The distribution center workforce recently experienced exponential growth, fueled by the rise of e-commerce and accelerated by the COVID-19 pandemic. While many Americans worked from home during the pandemic, transportation and warehouse employees were classified as “essential” and exempt from stay-at-home orders.<sup>4</sup> Despite the pandemic and an associated labor shortage, this sector grew significantly. As of January 2023, the warehousing and storage subsector employed 1.94 million workers, up from 1.30 million workers employed in January 2020.<sup>5</sup> This workforce fills a wide array of positions, from industrial truck and tractor operators (including forklift operators), hand laborers, shipping and receiving clerks, store clerks and order fillers, and managers. In the warehouse sector, the workforce works in shifts, typically three per day and including weekends. It is common for workers to log multiple 10-hour days, representing 41.6 percent of a worker’s day and time spent indoors.

The workplace built environment, where workers spend most of their active indoor time, has the potential to impact health positively or negatively, affecting both the worker and their productivity. Employers in the U.S. spend \$575 billion a year on costs associated with poor employee health, such as lost productivity due to absences and chronic health conditions, and injuries that result in workers’ compensation claims. These costs translate to 61 cents for every dollar spent on health benefits.<sup>6</sup>

E-commerce distribution centers are more labor-intensive than traditional retail distribution centers due to the greater variety of items stocked and larger number of orders shipped from a given location. Despite this increased dependence on labor, distribution center design continues to focus primarily on product storage and throughput.

According to the Bureau of Labor Statistics (BLS), there were 46 fatalities across the warehousing and storage subsector in 2021, up from 26 in 2018.<sup>7</sup> Incidence rates of nonfatal workplace injuries and illnesses (which control for number of employees and hours worked) in the transportation and warehousing industry were higher in 2021 than any other industry except agriculture, forestry, fishing and hunting. That year, the incidence rate for cases that resulted in workers missing days of work was higher in

transportation and warehousing than any other industry; 22.2 percent higher than in agriculture, the next closest industry; and 100 percent higher than the average for all private industry.<sup>8</sup> Workplace policies play an important role in reducing accidents and injuries in distribution centers, but effective human-centric design can also improve safety and worker well-being.

The authors spent time in distribution centers designed by KSS to identify issues associated with their environments. They interviewed occupiers in different industries to explore common workplace issues. In addition, the authors obtained access to the employees of a corporation engaged in the distribution of pharmaceutical products to conduct post-occupancy interviews. The following environmental conditions were observed at the pharmaceutical distribution center:

- **Noise:** Immediately upon entering the warehouse floor, there was a sensation of being part of a rapidly moving machine. The characteristic sound of the scanner set the pace of work. Conveyors and automation contributed to the constant noise.
- **Uniformity:** Except for equipment, there was minimal variation in color. Light levels were also high but uniform across the space. This contributed to minimal differentiation between places or activities. Wayfinding aids were also limited, save for a few signs.
- **Data:** Work monitoring acted as a driver of activity. Information about associate productivity was displayed on wrist devices and workstation screens.
- **Isolation:** Despite the presence of many associates on each warehouse floor, most worked alone. Fellow associates could only be seen from a distance and were focused on their own tasks.
- **Physicality:** Heavy lifting is not usually required in a pharmaceutical distribution center. However, many associates had to walk long distances, particularly near the loading dock. Workers who performed manual tasks made highly repetitive motions.
- **Identity:** Associates expressed a greater sense of purpose in the work they do than would be expected in a typical consumer goods distribution center. Handling products associated with people’s health reinforced a sense of belonging and satisfaction.

- **Dignity:** Associates conveyed a high level of pride in their work. Night shift workers felt a sense of value in getting products out to people for use the next day. Associates who worked in more secure areas also expressed satisfaction in the responsibilities associated with their level of clearance.
- **Community:** Despite the sense of isolation within the facility, people congregated and socialized at break times. There was a palpable sense of community among the group. Special events were occasionally scheduled to bring the team together.

These observations parallel the issues found in most distribution centers visited by the authors. In addition, work at other distribution centers involved heavy lifting, limited access to outdoor space, uneven access to natural light, and—in larger facilities—more isolation. Typically, provisions for personal environmental control and overall comfort (thermal comfort, indoor air quality, lighting quality, acoustics) are minimal.

## Analysis Framework

This study takes a holistic approach to design recommendations by focusing on wellness objectives that address a consistent set of issues found in contemporary distribution centers. Each objective can be addressed in the design of a distribution center and its specific components. This is consistent with the approach advocated by the WELL and Fitwell rating systems. WELL identifies 10 categories of human physiological needs: air, water, nourishment, light, movement, thermal comfort, sound, materials, mind and community. Fitwell focuses on “impact categories” with associated design strategies: impacts surrounding community health, reduces morbidity and absenteeism, supports social equity for vulnerable populations, instills feelings of well-being, enhances access to healthy foods, promotes occupant safety, and increases physical activity. This framework was used to guide the design recommendations and prototype starting on page 10.

# Wellness Objectives

This study is organized around key objectives that can be consistently pursued throughout a distribution center and its individual components. These are:

- |   |  |
|---|--|
|  Promote safety.                           |  Improve Access to Transportation and Vital Services. |
|  Encourage proper nutrition and hydration. |  Enhance air quality.                                 |
|  Support mental and emotional health.      |  Enhance perceived comfort: Acoustic.                 |
|  Instill a sense of belonging.             |  Enhance perceived comfort: Lighting.                 |
|  Reduce body strain.                       |  Enhance perceived comfort: Thermal control.          |

## 1. Promote Safety

Distribution centers can be dangerous, especially at the interface between people and equipment. Many safety provisions in distribution centers are aimed at preventing accidents involving forklifts and other moving vehicles. Strategies to prevent these accidents include separating traffic and introducing protective features.<sup>9</sup>

The pandemic has brought new awareness to the value of health safety measures. As essential workers in the early months of the pandemic, distribution center employees had to work with others in indoor settings. Incorporating health safety into design helps prepare distribution centers for future potential outbreaks while also reducing worker absenteeism due to illness from endemic diseases, such as the flu.

The risk of disease transmission can be mitigated by building and operational measures, such as incorporating spaces that allow for the isolation of ill workers. Providing access to emergency health care provisions is important for both health safety and emergency preparedness. Design elements can also allow workers to protect themselves during severe weather events or other emergency situations.

Recent extreme weather events highlight the importance of emergency preparedness. Six workers died when a tornado destroyed an Illinois distribution center in 2021. Protecting employees from natural emergencies is a growing concern as the frequency of severe weather increases. Distribution centers are typically located in large open spaces, making them particularly vulnerable to severe weather.<sup>10</sup> Providing enclosed shelter locations and emergency exits at regular intervals within a building can help protect building occupants in the event of severe weather and other natural disasters.

As consumers have shifted toward ordering a broader range of goods online—a trend accelerated by the pandemic—demand has grown for storage and distribution spaces that can meet special environmental requirements. These include cold and freezer storage for food and pharmaceutical products. Demand for these spaces is only expected to expand. The overall market for cold chain services is projected to grow to \$21.3 billion globally in 2024, vs. \$15.7 billion in 2019.<sup>11</sup> Federal subsidies for microchip manufacturing will also increase demand for spaces that require their own special environmental conditions for manufacturing and distribution. Special design provisions include access to spaces for warming and temperature monitoring, as well as spaces for protective gear and first aid medical supplies.<sup>12</sup>

## 2. Enhance Perceived Comfort

### A. ENHANCE ACOUSTIC ENVIRONMENT

According to the CDC, 40 percent of workers in the transportation and warehousing industry are exposed to hazardous noise. As a result, 13 percent of those workers have difficulty hearing, 7 percent have tinnitus and 12 percent have hearing impairment.<sup>13</sup> Due to the volume of automation and equipment, warehouses are loud by nature. For example, an operating forklift can be as loud as 96 decibels.<sup>14</sup> While it may be difficult to reduce the noise at its source, interventions can provide protection.

To address noise concerns, the National Institute for Occupational Safety and Health (NIOSH) recommends the following hierarchy of noise risk control:<sup>15</sup>

1. Eliminate the noise (physically remove the hazard)
2. Buy quiet equipment and tools (replace the hazard)
3. Control the noise hazard (isolate people from the hazard)
4. Set exposure time limits (change the way people work)
5. PPE (protect workers with personal protective equipment)

While the first approach is the most effective, there are typically limits on what can be done. In a warehouse or distribution center setting, it is important to purchase noise-reducing equipment and tools. This could consist of using gearless conveyors instead of conventional ones, replacing high-speed fans with high-volume, low-speed fans, or using quieter electric forklifts (or forklifts with other noise-reducing features).

To control the noise hazard, acoustic curtains can be placed around loud equipment, and sound considerations can be taken into account when laying out the facility by separating the noisier areas or activities from the remaining spaces. Physical barriers to limit sound transmission may also be used to separate these areas from each other, along with supplemental sound-absorbing material and surfaces that prevent reverberation.

In addition to providing PPE, it may be necessary to set exposure time limits if other noise-risk-reduction measures are insufficient. Workers can separate themselves from noise in acoustically designed break spaces.

### B. ENHANCE THERMAL COMFORT

Large open volumes, coupled with large numbers of dock doors and thermal output from material handling equipment (MHE), make distribution systems difficult to condition to the same degree encountered in office environments. Moreover, many distribution centers are classified as “minimally conditioned” or even “semi-heated” spaces. These classifications provide minimal requirements for a building’s thermal envelope.

Broad-based strategies to improve thermal comfort include passive approaches such as optimizing building orientation, introducing sun control, introducing more reflective hardscapes and reducing their size to reduce heat island effects. Less passive systems such as the introduction



of cross-ventilation and destratification fans can improve perceived comfort, but they do not change air temperature. Direct strategies include the introduction of “micro-climates” with break areas designed for thermal refuge at key locations. Radiant systems for heating and cooling may be optimal in high-volume areas where core and shell infrastructure can enable localized climates.<sup>16</sup> Example solutions consist of radiant floor systems and radiant panels.<sup>17</sup> Occupants often find these more comfortable than convection-based systems. Radiant systems can be further augmented with digital systems that track employees to personalize conditioning and optimize energy efficiency.<sup>18</sup> In general, localized conditioning strategies provide the most opportunities for employee comfort and energy performance in large open distribution centers.

### C. ENHANCE LIGHTING QUALITY

Light, both artificial and natural, plays an important role in human physiological and psychological processes. Light exposure is critical to the effective functioning of the body’s circadian rhythm, and as a result, sleep quality.<sup>19</sup> Access to daylight and exposure to well-lit spaces can also improve mood,<sup>20</sup> increase productivity<sup>21</sup> and generally increase occupant satisfaction.<sup>22</sup> However, poorly controlled daylight or poorly designed electrical lighting systems that create glare or excessive contrast ratios within the visual field, or provide inadequate levels of illumination, can negatively impact health and productivity, as well as lead to safety issues in a warehouse or distribution center environment.

Strategies for providing a high-quality lighting experience within a warehouse or distribution center environment include varying combinations of the following:

- Electric lighting systems should be glare-free and provide adequate levels of illumination at the horizontal and vertical work planes in line with Illuminating Engineering Society recommendations.<sup>23</sup> Suspended fixtures should have some upward component. Daylighting control/dimming systems can be incorporated to save energy.
- Provide access to high-quality daylighting through some combination of skylights, clerestory windows and lower windows. Daylighting should be controlled through a combination of light shelves, louvers, blinds and/or shades. The blinds and shades (and louvers if adjustable) should be automated with local override capabilities and tied to the daylighting control system. If shades are used, consider a 1 percent or 3 percent open dark shade cloth.

- It is important that the combined daylighting/electric lighting system mimics the changing frequencies and intensities of daylight over the course of the day for optimal circadian health. The WELL Building Standard is a good resource for this.<sup>24</sup> Branch Pattern also provides detailed recommendations for optimizing lighting for shift workers whose schedules are out of alignment with the day/night cycle.<sup>25</sup>
- Provide furniture at workstations that allows associates to adjust the direction they are facing while working.
- When considering glare, contrast ratios and horizontal/vertical illumination levels should account for all primary locations where associates will be working and where they will be looking (e.g., loading/unloading via forklifts or working at multiple levels). Account for shadowing, along with the locations of clerestories and fixtures, within the visual field.
- Engage an engineering consultant, lighting designer and other experts as needed to provide the best contextual solution in an energy-efficient manner.

Enhancing perceived comfort requires regular monitoring and regular associate/employee feedback on their perception of environmental conditions (via interviews or surveys). In addition, wearable devices can measure the environment’s physiological impacts on worker health.

### 3. Reduce Body Strain

Distribution center workers are subject to body strains that are very different from those experienced by office workers. While office workers may require a greater degree of physical mobility to offset more sedentary work, distribution center workers need to offset the impacts of strenuous physical activity. Distribution center workers spend most of their time on their feet and frequently lift and carry objects. BLS data from 2022 reveal that on average, stockers and order fillers spent 91.9 percent of their time standing or walking, and 75 percent of these workers lifted or carried up to 50 pounds at a time.<sup>26</sup> Prolonged periods of standing are associated with increased discomfort, pain and stress on the body. According to the CDC, standing for long periods of time can contribute to low back pain, fatigue, leg swelling and discomfort, and can increase the risk of cardiovascular disease and pregnancy complications. It is recommended that individuals not stand for more than two hours continuously without some type of fatigue-reducing intervention.<sup>27</sup> The U.S. Occupational Safety and Health Administration (OSHA) has identified proper manual lifting and handling as a top concern for warehouse workers.<sup>28</sup>

Distribution center work is repetitive by nature and typically organized around production efficiency. Any task can cause physical and cognitive strains; when that task is prolonged or repetitive, the risk is elevated.<sup>29</sup>

Reducing bodily strain can be addressed by policies that limit exposure. However, design can also play a significant role by providing space for those policies to work. Overall strategies include reducing walking distances to break locations and providing spaces for physical rest, stretching and hydration. Specific workspaces can also be designed more ergonomically to accommodate sitting and appropriate environmental comfort to reduce physical stress.

#### 4. Encourage Proper Nutrition and Hydration

Access to proper nutrition and hydration is a significant issue in distribution centers. Because of zoning regulations, distribution centers are often far from essential services, grocery stores and restaurants. Internally, distribution centers typically have food service and cafeteria spaces, but workers may walk as much as a quarter mile to access those spaces on a limited break schedule. Shift schedules dictate that most workers need access to these facilities all at once. It is also common for cafeterias to offer few nutritious meal options. A poor diet during the workday can contribute to lost productivity due to malnutrition or excess weight and obesity.<sup>30</sup>

Strategies to improve nutrition and hydration focus on spatial proximity and providing access to nutritious food. Plumbing and drainage infrastructure should be laid out to allow for regularly spaced hydration stations that can be appropriately separated and safeguarded from traffic on the warehouse floor. Introducing multiple café spaces throughout a distribution center and varying their size allows workers to access them more frequently throughout a shift and spend less time walking to them. Providing spaces for catering, food trucks or a farmer's market can also increase access to a variety of fresh and local foods. Integrating nutrition information and education into these spaces can further enhance health outcomes.

#### 5. Enhance Air Quality

Carbon dioxide (CO<sub>2</sub>) levels are a common metric to evaluate a space's existing ventilation and whether additional ventilation is needed. High CO<sub>2</sub> levels can impair cognitive performance, as can Total Volatile Organic Compounds (TVOCs) and particulate matter.

Strategies for achieving good indoor air quality in a warehouse or distribution center environment include varying combinations of the following:

- Outdoor air (ventilation) levels at a minimum of 130 percent of the minimum recommended levels found in ASHRAE 62.1.<sup>31</sup> However, certain areas (such as loading docks) or situations (such as pandemic conditions) may require significantly greater ventilation rates. Systems and operations may need to be capable of achieving a higher rate of equivalent air changes per hour through layered additions of ventilation, exhaust, system filtration and portable air cleaners as the need arises.
- Increase air flow (and limit destratification) through a combination of mechanical exhaust (and/or operable clerestory windows), high-volume/low-speed ceiling fans (selecting rotation direction based on heating/cooling season and providing local controls where possible), large open doors and/or lower, operable windows. When possible, take advantage of the stack effect and/or prevailing wind conditions (taking exterior air quality into account).
- Building mechanical system filtration should be a minimum of MERV 13 (or equivalent).
- Where needed, supplement with a vortex dust collection system, portable/industrial air cleaners that use HEPA and carbon filters, and/or bag dust removers equipped with HEPA filters.
- Exhaust dumping points should not be near outside air intakes, doors or operable windows, or areas frequented by occupants. Outdoor truck-idling locations should not be positioned near these areas.
- Transition to electric forklifts.
- Supplement these measures by providing employees with respirators as needed. Select respirators that are effective against particulate matter, TVOCs, other harmful compounds and pathogens, and provide comfort and ease of communication.
- Engage an engineering consultant and other experts as needed to provide the best contextual solution in a sustainable and energy-efficient manner.

It is also important to regularly obtain employee feedback on air quality conditions (via interviews and/or surveys), periodically take air quality measurements, and continuously monitor air quality conditions (interior and exterior). In addition, wearable devices can potentially monitor employee biometrics affected by air quality. Working air-monitoring devices with audible alarms can also prevent carbon monoxide poisoning and should be tested regularly.<sup>32</sup>

## 6. Support Mental and Emotional Health

Employees are having to adapt to an increased volume of repetitive tasks and increasingly automated systems. Distribution centers are traditionally designed to optimize material flow, arranging operations and systems to achieve optimal efficiencies. Human employees can experience stress if their interactions with these operations and systems are not well thought out. The repetitive tasks associated with distribution center work can also contribute to mental fatigue, which can impact workers' mental and emotional health.

While operational policies and human-oriented planning are key to reducing worker stress and fatigue, design strategies can also have an impact. Placemaking and wayfinding are of increasing importance as distribution centers grow in size. These help to ground and orient employees. Design strategies that increase opportunities to encounter a natural environment can reduce the mental stress associated with working in a highly mechanized environment. Access to nature has clear benefits to physical, social and mental health.<sup>33</sup> Providing areas for board games and similar activities can offer opportunities for rest and provide cognitive stimulation that reduces mental fatigue.<sup>34</sup> Access to space for quiet mental rest can also reduce fatigue and improve cognitive function and mental health.<sup>35</sup>

Perceived comfort can be assessed through monitoring and regular employee feedback on perceived stress and strain (via interviews or surveys). In addition, wearable devices can measure the physiological effects of employee activity.

## 7. Instill Sense of Belonging

Creating a sense of belonging—encouraging people to feel empowered and connected to a company's culture—is a key element of workplace wellness.<sup>36</sup> But distribution centers are often associated with buildings and spaces that are generic and may lack an identifying aesthetic character. Furthermore, “associates” working within the distribution center are typically separated physically from “office” or other workers.

Design solutions that contribute to an employee's sense of belonging are rooted in an appropriate human-centered aesthetic. Purposeful belonging is never generic. Integrating equitably designed common spaces and

avoiding unnecessary gender segregation can foster a sense of common purpose. Design elements should also reflect local norms and employees' cultural diversity to make spaces more welcoming. Design and graphics that demonstrate how the distribution center serves the greater community can underscore how employees contribute to a common greater purpose.

## 8. Improve Access to Transportation and Vital Services

Due to their size, concerns about truck traffic and Euclidean zoning, distribution centers are often located in remote areas that are removed from residences and places where services are rendered. Demand for urban distribution and evolving approaches to land use planning have begun to change this condition, but it is likely to persist. As distribution centers grow more labor-intensive, a growing number of workers must commute longer distances. These longer commute times can reduce worker productivity and increase absenteeism.<sup>37</sup> After workers arrive at a distribution center, they are often far from services they need to access in their daily lives, such as day care centers, grocery stores and medical offices. Long commutes and a dearth of adjacent services can serve as obstacles to recruiting new employees and retaining them.

The most effective approach to providing access to transportation and vital services varies by location and density. In urban and suburban contexts, it may be possible to locate a new distribution center near public transportation or existing services. But for most large distribution centers located farther from population centers, the most direct approach is to introduce key services and amenities at the industrial park or within individual buildings.

In one example of this approach, Patagonia distribution centers provide on-site childcare, the costs of which have been 91 percent recouped through tax benefits, increased employee retention and increased employee engagement.<sup>38</sup> Similar solutions can be deployed for other services such as grocery stores, storefronts and technical training schools.<sup>39</sup> To improve transportation access, developers or occupiers can partner with local transit agencies or private employee shuttle services to establish bus routes connecting distribution centers to nearby communities. Designated pickup and drop-off locations for ride-sharing services can also improve transportation access.

# Design Recommendations

## General Building Prototype

This report has adopted a distribution center prototype that demonstrates specific design strategies to achieve these wellness objectives. This prototype contains program elements that are found in most distribution centers. While most distribution centers do not contain all the components listed, many contain various combinations of them. The prototype does not represent any particular center, but an amalgamation of the most prevalent components at scales that are typically encountered. This study does not attempt to “re-imagine” the distribution center through the development of a prototype, but to work within the constraints of typical distribution centers so that recommendations can guide alterations to existing buildings as well as new development. As supply chains continue to evolve and distribution centers become more labor intensive, design standards for a typical distribution center may change, and this study may influence that change. However, this study’s design recommendations are intended to be immediately applicable to current development.

Many distribution building components are traditionally executed in two phases: an initial speculative phase, followed by a phase in which the building is adapted to the needs of a specific end user. As industrial development becomes increasingly complex, those boundaries are increasingly blurred. The prototype can inform both phases of building development, since it shapes the requirements for a building’s superstructure and infrastructure as well as the components of its ultimate design.

At a macro-level, the proposed prototype is 840,000 square feet in floor area. It is organized in a “double-loaded” configuration with speed bays of 60 feet on each of the long sides of the building. It is envisioned as a single-tenant building containing automated and non-automated functions. It includes semi-automated pick modules, manual pick modules, robotic mezzanines, workstations, laydown spaces, conveyance systems and racking areas. These have been organized into a footprint based upon typical uses but are intended to capture the broad spectrum of uses within a distribution center rather than the needs of a specific end user. The prototype also reflects issues associated with large-scale development. The design anticipates a “corner entry” condition typical of most distribution centers.

Wellness objectives are addressed in the following categories and program elements:

- 1.0 Site Context and Layout
- 2.0 Shell Building
- 3.0 Building Entry
- 4.0 Large Break Spaces
- 5.0 Medium Break Spaces
- 6.0 Small Break Spaces
- 7.0 Transportation Lounge
- 8.0 Workstations

Each contains specific strategies to promote employee well-being. While these are organized into program spaces to reflect the organization of typical buildings, the strategies associated with each space are intended to be adaptable to many conditions throughout the distribution center.

## Site Context

Wellness begins beyond the boundaries of the building and the site. Employees are impacted by such practical issues as daily commute times, the availability of public transportation and the proximity of services, especially good day care. Interviews with warehouse associates revealed that proximity to affordable day care was a key factor in recruitment and retention. These are issues of concern for any workforce. But distribution centers are typically located further from these kinds of services than most workplaces, as noted earlier. The developer, end user and local authorities can deploy multiple strategies to address the limitations associated with a distribution center’s location. These strategies vary based on where a center is located. Most distribution center locations fall into three categories: remote, suburban or urban.

## ■ Remote Development Strategies

Rural development is categorized less by surrounding uses such as agriculture and more by development and population density. The Census Bureau defines rural areas as not urban, with urbanization defined through a combination of population density and amount of land covered by buildings and infrastructure.<sup>40</sup> Areas with fewer than 500 people per square mile that are not adjacent to a denser population center are generally classified as rural.

Remote distribution centers are not adjacent to many dwellings and can be similarly far from services. These centers are often located in multiple-building industrial parks. Employee well-being can be enhanced in such settings by including additional uses and amenities adjacent to or within industrial parks. These include day care centers, park and recreation facilities, restaurant or food-truck locations, ride-share and shuttle facilities, and other amenities.

**KEY WELLNESS STRATEGY:** Introduce critical services to development such as day care, health care and food access that can serve industrial parks and surrounding areas.

## ■ Suburban Development Strategies

There are no standard definitions of suburban areas, but they are characterized by a predominance of single-family dwellings and higher rates of car commuting than in urban areas.<sup>41</sup> They are also characterized by planning and zoning decisions that have traditionally segregated land uses. Industrial uses are traditionally provided for in zones away from residential areas and commercial services. When combined with lower levels of transit infrastructure, this limits access to services for distribution center workers. However, with increased e-commerce activities, last-mile distribution, limited land resources and a higher demand for labor, distribution centers are increasingly being located closer to other uses in suburban communities.

Unlike wellness strategies for remote distribution centers that call for the introduction of services on-site, strategies for suburban distribution centers are focused on better integration with the local community. These include the creation of public open space, greater aesthetic development, walkable adjacencies, transit inclusion and the introduction of other supportive mixed-use components such as affordable housing.

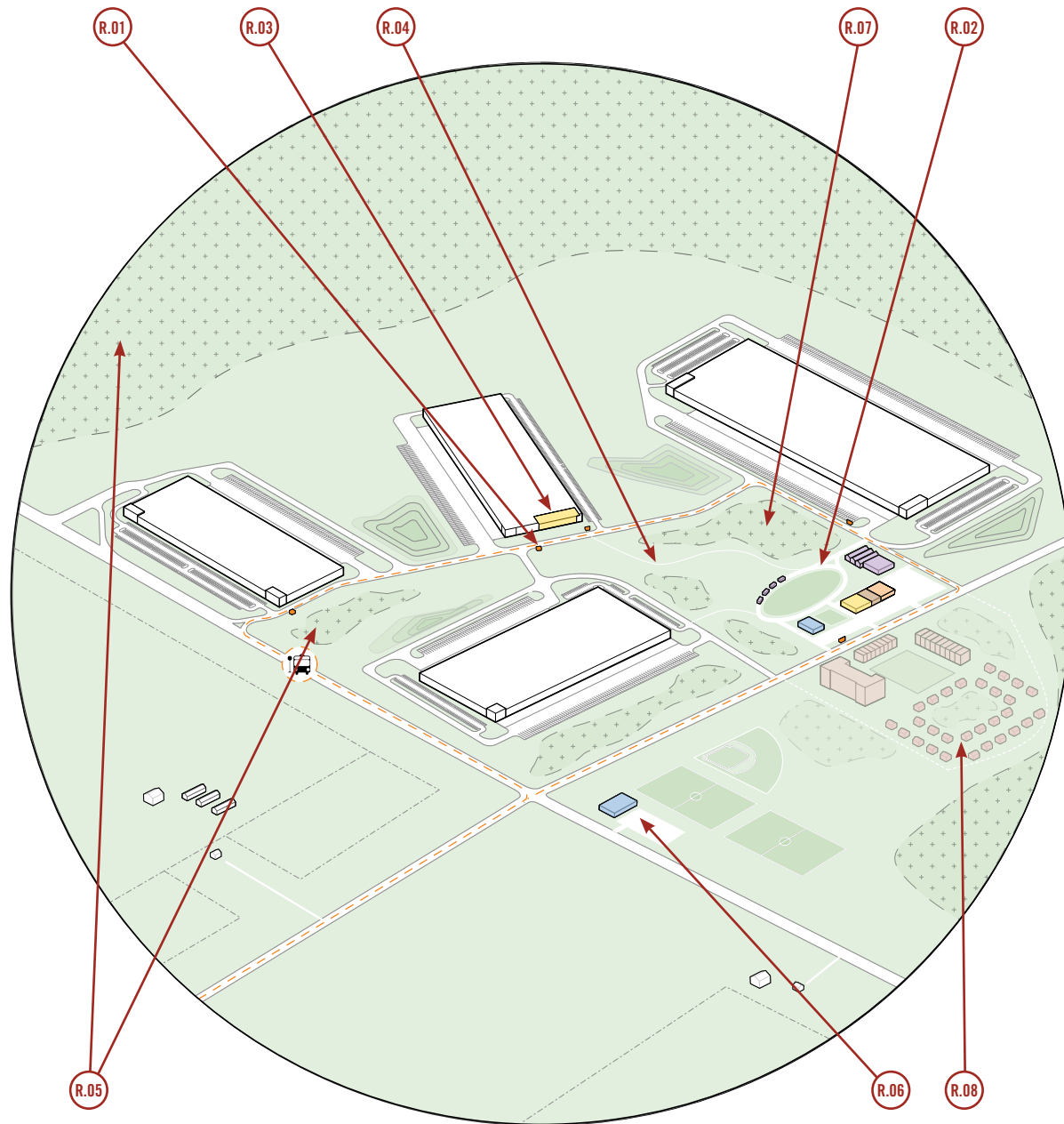
**KEY WELLNESS STRATEGY:** Development integration

## ■ Urban Development Strategies

The rise of e-commerce and last-mile distribution, along with changes in modes of delivery to smaller and electrified vehicles, has created new opportunities for urban industrial development. These occur at “infill” locations or at former industrial land tracts, including recent multistory development. Urban locations have the advantage of greater access to services and mass transit. However, many historic urban industrial tracts are subject to the conditions left over from old industry. These include environmental contamination, outdated infrastructure and adjacency to low-income neighborhoods. Urban industrial development presents opportunities to respond to the wellness and social concerns of both building occupants and adjacent communities. These include environmental restoration, improved public space (especially at waterfronts), mixed-use development, connecting to adjacent communities, and providing economic and human development opportunities.

**KEY WELLNESS STRATEGY:** Urban industrial integration

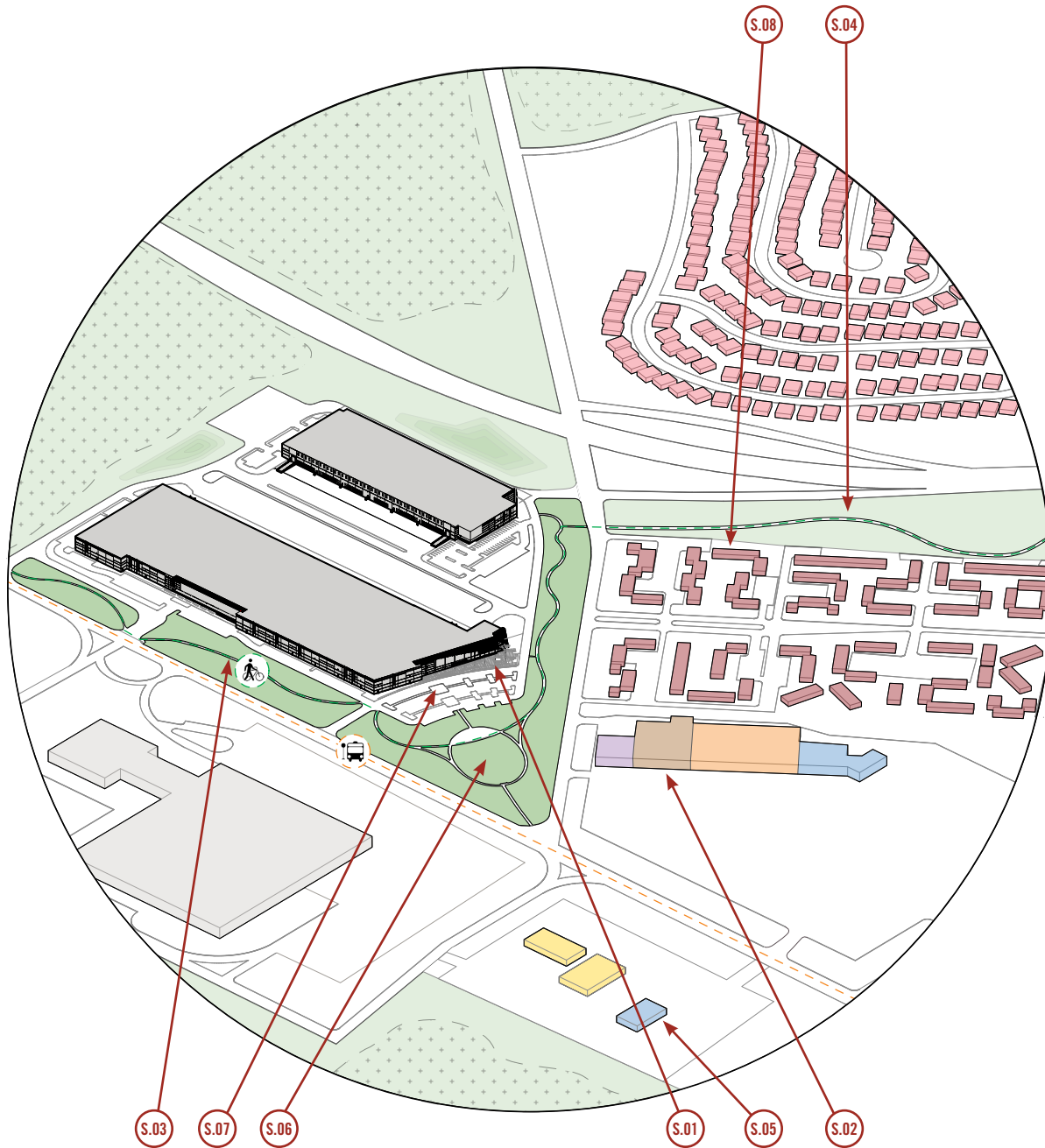
## Remote Development Strategies



TAG	STRATEGY	WELLNESS OBJECTIVE	SCOPE
R.01	Provide exterior entrance amenities such as drop-off/pickup spaces, benches and seating, public art, greenspace and pathfinding; and identify opportunities to improve connection to surrounding community.		<b>D</b>
R.02	Provide amenities including daycare, health care, and food access such as small grocery, restaurant or food-truck locations.		<b>D</b>
R.03	Provide on-site training facilities.		<b>D</b>
R.04	Provide walking paths and access to landscape features.		<b>D</b>
R.05	Preserve existing treelines and community access to open space and view corridors. Orient buildings and provide visual buffers to integrate the buildings into the landscape.		<b>D</b>
R.06	Provide or support adjacent parks, recreation facilities, cultural and civic engagement opportunities.		<b>D T</b>
R.07	Decrease hardscape to reduce heat island effect.		<b>D</b>
R.08	Support adjacent or on-site affordable housing opportunities.		<b>D T</b>

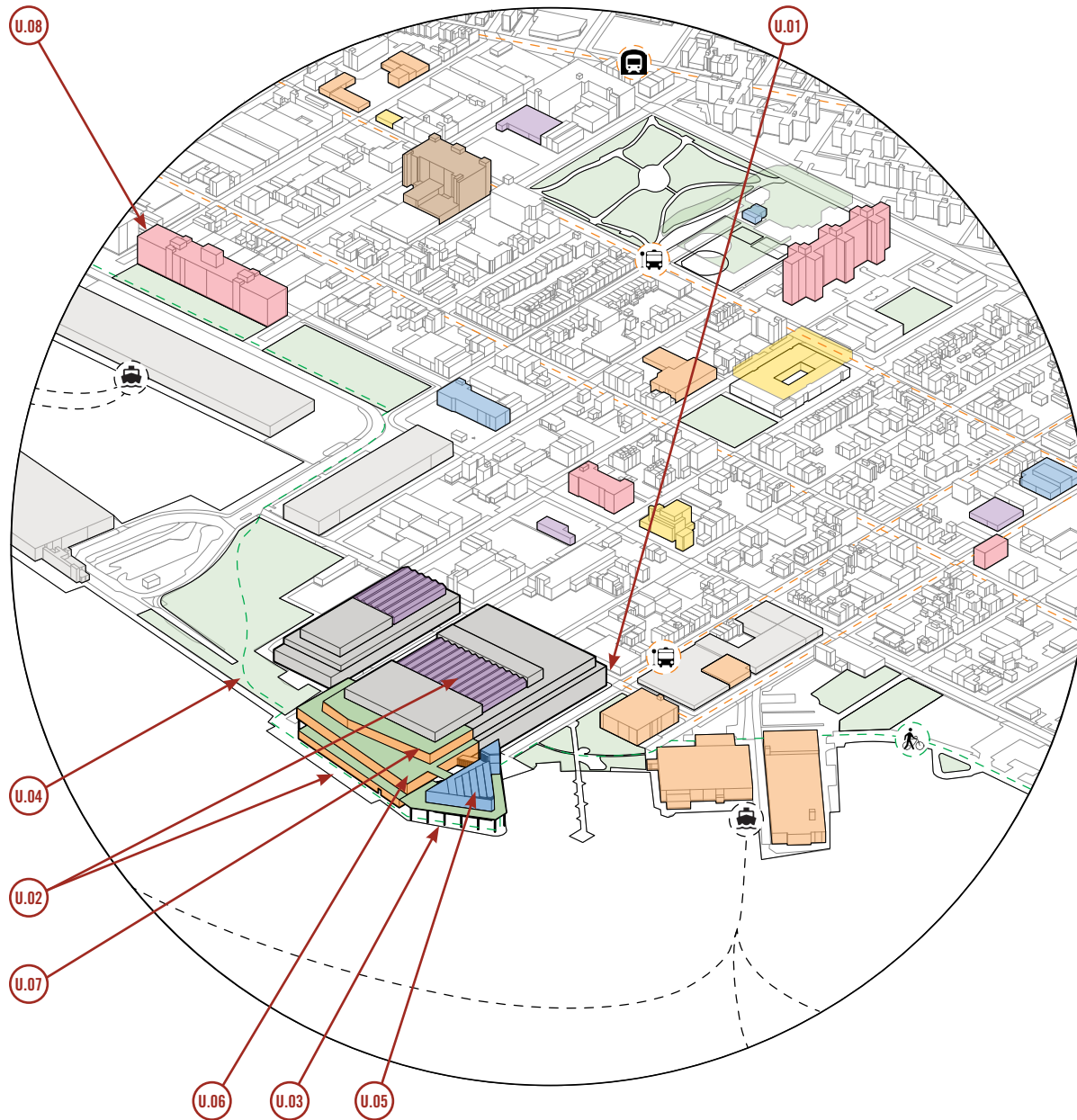
Scope Key: **D** = Developer, **T** = Tenant

## Suburban Development Strategies



TAG	STRATEGY	WELLNESS OBJECTIVE	SCOPE
S.01	Provide exterior entrance amenities such as drop-off/pickup spaces, benches and seating, public art, greenspace and pathfinding; and identify opportunities to improve connection to surrounding community.		<b>D</b>
S.02	Provide amenities including daycare, health care, and food access such as small grocery, restaurant or food-truck locations.	  	<b>D</b>
S.03	Provide walking paths and access to landscape features.		<b>D</b>
S.04	Provide or connect to existing community-accessible open space and view corridors.		<b>D</b>
S.05	Provide or support adjacent parks, recreation facilities, cultural and civic engagement opportunities.		<b>D T</b>
S.06	Provide large-scale accessible green space.		<b>D</b>
S.07	Decrease hardscape to reduce heat island effect.		<b>D</b>
S.08	Support adjacent or on-site affordable housing opportunities.		<b>D T</b>

## Urban Development Strategies



TAG	STRATEGY	WELLNESS OBJECTIVE	SCOPE
U.01	Provide exterior entrance amenities such as drop-off/pickup spaces, benches and seating, public art, greenspace and pathfinding; identify opportunities to improve connection to surrounding community.		<b>D</b>
U.02	Provide amenities including daycare, health care and food access such as small grocery, restaurant or food-truck locations.		<b>D</b>
U.03	Provide walking paths and access to landscape features.		<b>D</b>
U.04	Provide, revitalize or connect to existing or future planned community-accessible open space and view corridors.		<b>D</b>
U.05	Provide, revitalize or support adjacent parks, recreation facilities, cultural and civic engagement opportunities.		<b>D T</b>
U.06	Provide large-scale accessible green space.		<b>D</b>
U.07	Decrease hardscape to reduce heat island effect.		<b>D</b>
U.08	Support adjacent or on-site affordable housing opportunities.		<b>D T</b>



## ■ Site Entry

The exterior of the distribution center is as important to its operations as its interior. Here, goods are transferred to and from tractor trailers, and in the case of more local distribution, box trucks, vans and other small vehicles. The ability for that movement to happen quickly and efficiently is central to a distribution center's success, underscoring the importance of loading, truck transportation and storage in site design. Yet the site also provides for employee arrival and interconnectivity with the surrounding community and infrastructure. The large scale of distribution center sites offers unique opportunities to arrange open spaces to benefit employees.

The prototype maintains the key elements that allow the efficient transfer of goods and vehicle movement. Building on this basic function, it arranges open space to improve employee safety and well-being. To promote safety, truck entrances and exits are made distinct from employee entrances and exits, through clear organization, separation and sight lines. The building entrance is oriented away from loading and truck areas and separated from them by green space and screens to make the area more inviting and limit pedestrian exposure to exhaust fumes. Drop-off areas are included near the building entrance to accommodate cars, vans and the potential inclusion of mass transit. Pedestrian and bike access is provided. Large open green spaces designated for stormwater management include adjacent exercise areas and walking paths that are interconnected to break spaces and building entrances. Since up to 40 percent of truck drivers are accompanied by pets to alleviate the loneliness of travel,<sup>42</sup> the prototype provides space for secure areas to walk pets.

**KEY WELLNESS STRATEGY:** Additional emphasis on employee outdoor activities, separation of human and trucking activities to promote safety, and arrangement of natural open space for employee benefit.

## ■ Shell Building Improvements

The traditional distribution center shell building is based upon “minimally conditioned” or “semi-heated” models that must meet only limited thermal performance criteria. With a shell designed for the secure storage of goods, little access to daylight is provided. Internal infrastructure offers minimal access to plumbing, and lighting is limited to maximize energy efficiency.

In addition to accommodating the program elements described below, improvements to the prototype's base building include passive environmental enhancement such as orientation, sun control and reflective or limited hardscape to reduce heat island effects. Semi-passive strategies include ventilation, destratification fans, perimeter glazing and skylights, and interior acoustic treatments at perimeter walls. Infrastructure improvements include additional plumbing infrastructure, high-performance lighting, and service to accommodate radiant heating and cooling elements. Control systems should accommodate occupant-centric environmental controls.

**KEY WELLNESS STRATEGY:** Install improved passive/active environmental control infrastructure, infrastructure for wellness interventions, infrastructure for micro-environments/occupant controls.

## ■ Building Entry

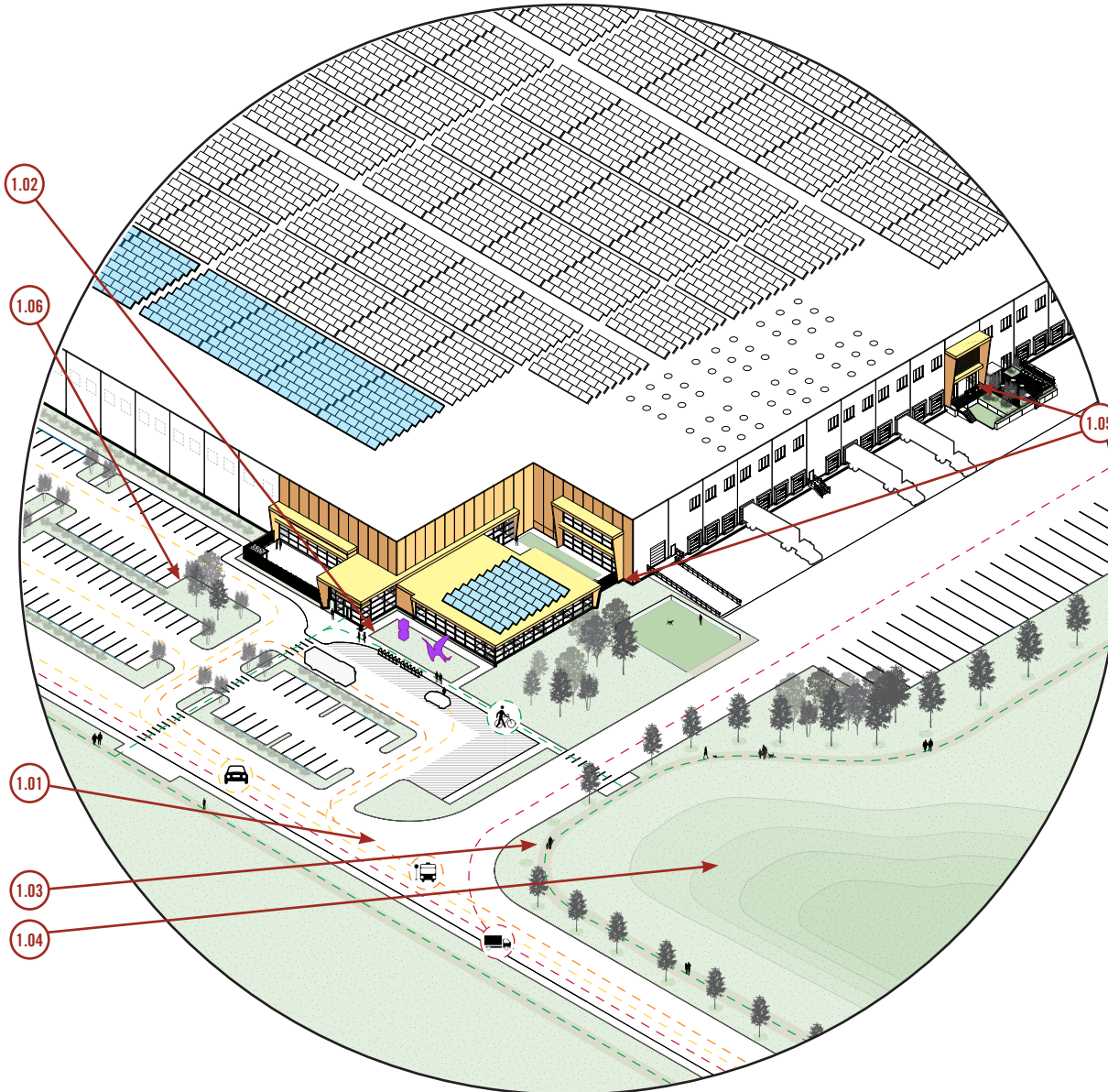
The distribution center entrance is a place of transition and arrival. Here, the occupant transitions from the outside to the inside, from non-work to work, and from open to more mechanized environments. There is an opportunity to make those transitions gradual, welcoming and healthful. It is a point of security and a location where amenities and services are often provided. It is also the space where any office functions are typically located.







The prototype envisions a 16,000-square-foot entrance. Programmatically, it contains entry/drop-off, security reception, locker space, large restrooms, break space, outdoor space, office space and transition space. Several wellness improvements have been introduced, including a health suite that includes a rapid screening point, safe separation spaces (when needed), and emergency care spaces. The entrance is designed to allow for free-flowing, open circulation and is non-hierarchical, with open locker arrangements. An environmental transition allows for a change of scale, a transition between natural and artificial light, and an acoustical and thermal transition. Air connectivity and separation is addressed as needed.

**KEY WELLNESS STRATEGY:** Improved environmental transition from the outside to the distribution center environment, including provisions for health screening and safety.

## Site Entry

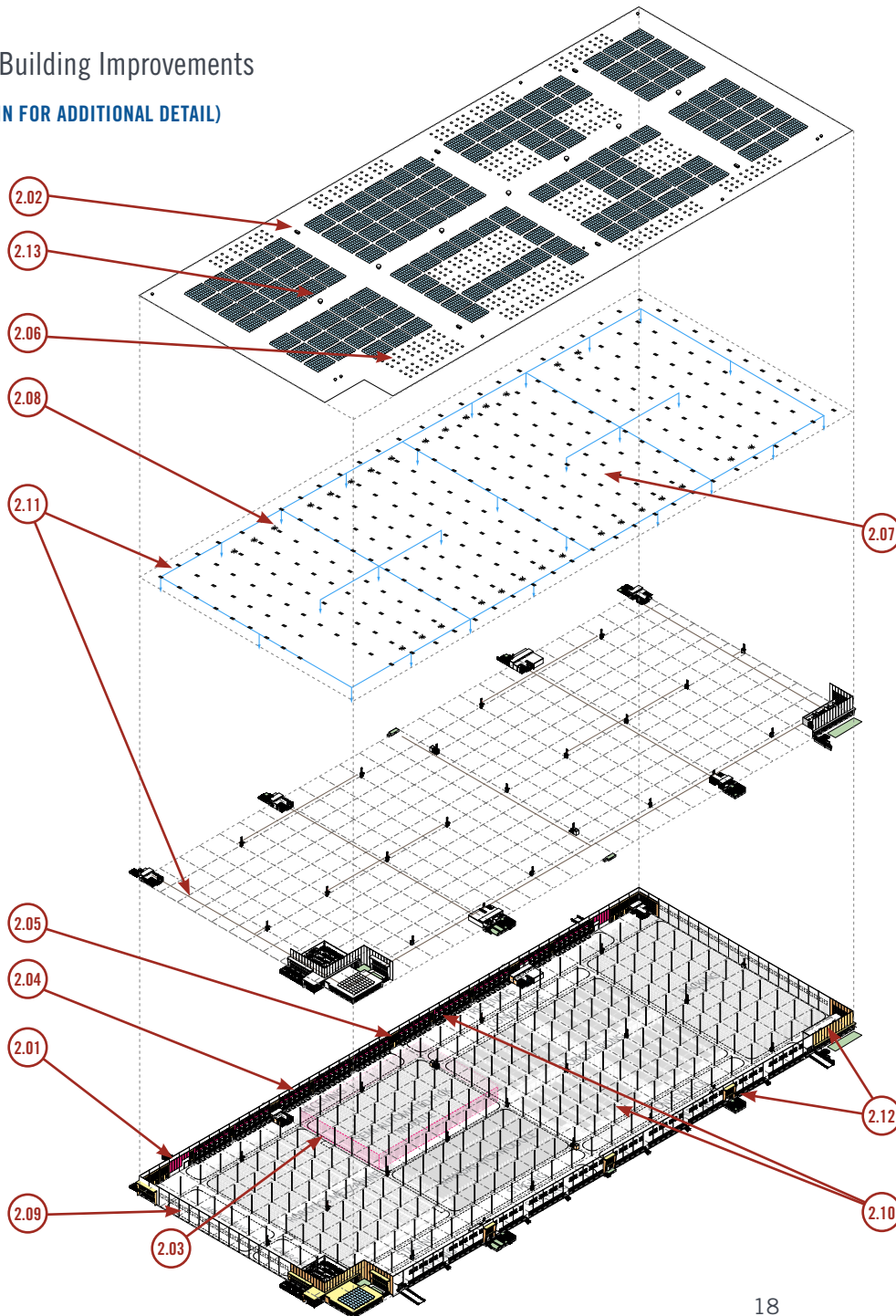
(ZOOM IN FOR ADDITIONAL DETAIL)



TAG	STRATEGY	WELLNESS OBJECTIVE	SCOPE
1.01	Segregate pedestrian, car and truck traffic.		<b>D</b>
1.02	Provide exterior entrance amenities such as drop-off/pickup spaces, benches and seating, public art, greenspace and pathfinding; identify opportunities to improve connection to surrounding community.		<b>D</b>
1.03	Provide walking paths and access to landscape features.		<b>D</b>
1.04	Provide community access to open space.		<b>D</b>
1.05	Provide large-scale accessible green space.		<b>D</b>
1.06	Decrease hardscape to reduce heat island effect.		<b>D</b>

## Shell Building Improvements

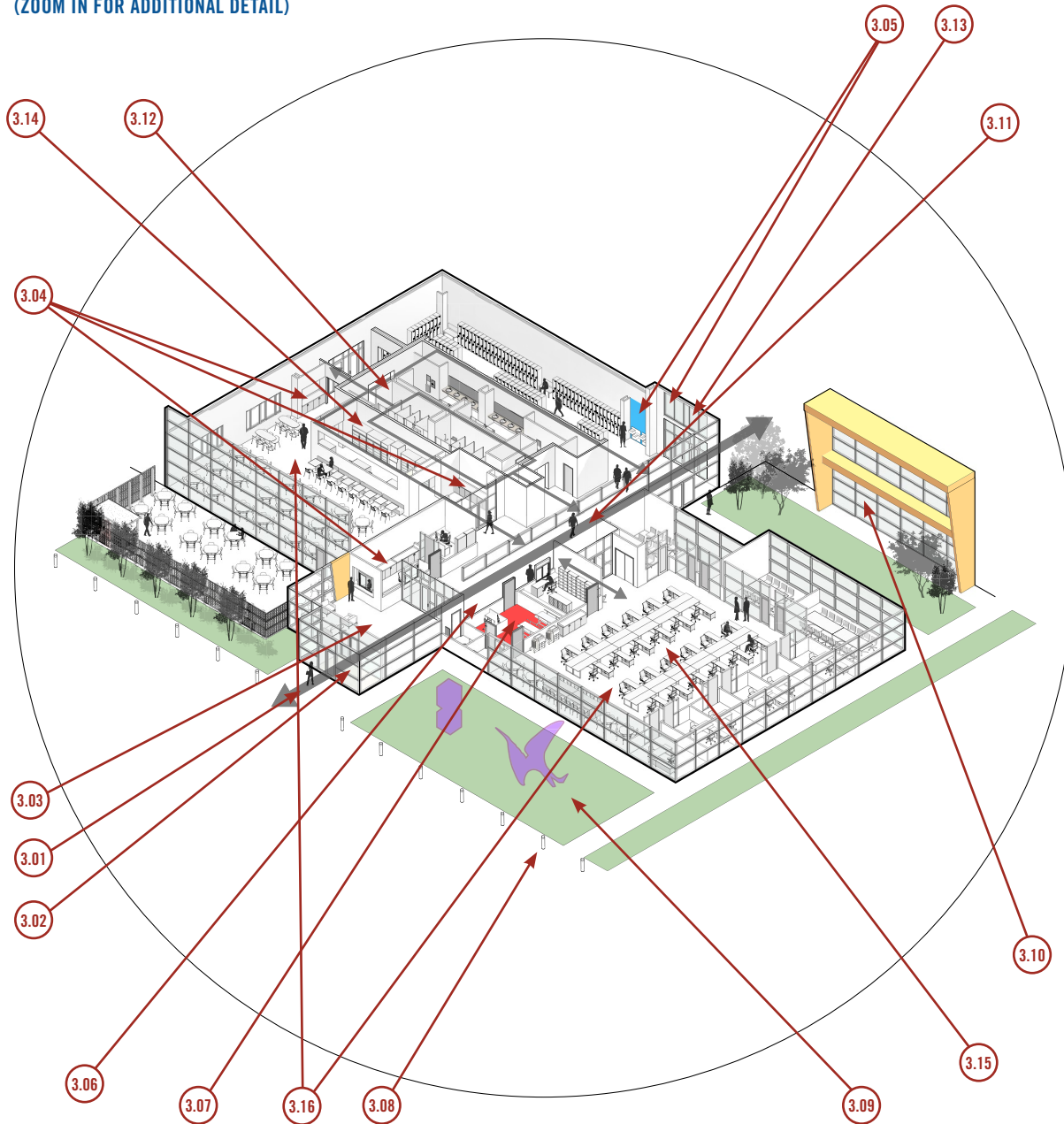
(ZOOM IN FOR ADDITIONAL DETAIL)



TAG	STRATEGY	WELLNESS OBJECTIVE	SCOPE
2.01	Perimeter acoustic deck/wall treatment.		<b>T</b> <b>D</b>
2.02	Provide MERV-13 or equal filtration and, where needed, supplement with vortex dust collection and HEPA filters.		<b>D</b>
2.03	Provide noise-isolating acoustic curtains at MHE systems.		<b>D</b>
2.04	Provide clerestory windows, 6 x 6 ft. min, 10-12 ft. o.c., especially at laydown spaces.		<b>T</b>
2.05	Provide eye-level, intermittent exterior glazing.		<b>T</b> <b>D</b>
2.06	Provide skylights/daylight tubes.		<b>D</b>
2.07	Provide non-glare, high-performance lighting with color/output control for circadian rhythm/shift work adjustment.		<b>T</b> <b>D</b>
2.08	Provide passive/active ventilation to increase air quality and provide passive conditioning.		<b>D</b>
2.09	Provide thermal envelope equivalent of occupied space.		<b>D</b>
2.10	Provide controlled radiant heating/cooling at regularly occupied distribution center space.		<b>D</b>
2.11	Provide more extensive plumbing network to serve additional break spaces.		<b>D</b>
2.12	Introduce biophilic elements.		<b>T</b> <b>D</b>
2.13	Provide occupant-centric environmental control system.		<b>T</b> <b>D</b>

## Building Entry

(ZOOM IN FOR ADDITIONAL DETAIL)



TAG	STRATEGY	WELLNESS OBJECTIVE	SCOPE
3.01	Provide single main entrance for all building occupants.		T D
3.02	Provide walk-off mats 10 ft long in the primary direction of travel to capture soil, dirt and debris.		T D
3.03	Provide vestibules or entryway systems that extend 10 ft minimum in the direction of travel.		T D
3.04	Provide handwashing and sanitizing stations.		T
3.05	Include mobile and fixed wayfinding signage and graphics.		T D
3.06	Design path of travel to allow health screening option.		T D
3.07	Create isolation spaces for symptomatic associates (one permanent space for temporary isolation).		T D
3.08	Install uniform exterior lighting at all entrances.		D
3.09	Create large-scale accessible green space.		D
3.10	Create large-scale views to exterior greenspace.		D
3.11	Create clear and direct line of travel, minimum 10 ft wide.		T D
3.12	"Airport"-style restrooms with unimpeded and non-touch entry/exit; include non-gender-specific facilities.		T D
3.13	Provide environmental transition space (thermal, light, acoustics, scale).		T D
3.14	Provide café space with nutritional options, min. 20 sf. per person.		T D
3.15	Provide fully conditioned amenity/office space with MERV-13 minimum filtration, outdoor air and CO2 monitoring systems.		T D
3.16	Provide dimmable and tunable LED lighting system with integrated daylight control for general use and to meet shift workers' circadian rhythm needs.		T D

## ■ Large Break Spaces

The physical and mental stresses that distribution center workers encounter differ from those in an office environment and can be more extreme. The typical distribution center only provides for large break facilities in a single location, making them mostly inaccessible during short break periods. The prototype envisages several large break spaces to create more opportunities for rest and social engagement. These are located at the “laydown” spaces where significant exertion occurs, which is typically far from the main building entrance. They are incorporated into the loading docks in a modular arrangement. Each large break space includes restrooms, hydration stations, a health screening area, mother’s rooms, communication spaces, eating spaces, dock door openings infilled with storefront glazing, ergonomic seating and relaxation space, stretching area, game space, and modular exterior space that can be incorporated into loading dock space. Environments are conditioned, with access to daylight and nature/biophilic elements, while providing sufficient air and acoustic separation from loading dock spaces. Each large break space also provides enclosed shelter in place and an emergency exit to protect occupants during natural disasters. Large break spaces are recommended at intervals of no more than 400 feet.

**KEY WELLNESS STRATEGY:** Provide a comprehensive break space that offers rest from physical and mental exertion, offers a physical location for building community among associates, and is distributed to allow associates to make the most of regularly scheduled work breaks.

## ■ Medium Break Spaces

Provided at more frequent intervals, these spaces are designed for brief restorative rest and to remove workers from temporary environmental stress. Each space includes access to hydration, a single toilet, protection from distribution-center machinery and access to emergency communication. Using radiant systems, it provides localized temperature relief, while acoustic material and a pink noise system provide localized acoustic relief. Air separation and air cleaning is provided as needed to provide relief from contaminants in surrounding areas. The space is designed to be readily visible, and it should provide wayfinding elements and space for branded design elements that promote a sense of inclusion. Medium break spaces are recommended at intervals of no more than 200 feet.

**KEY WELLNESS STRATEGY:** Provide a microenvironment for temporary relief from environmental stress.

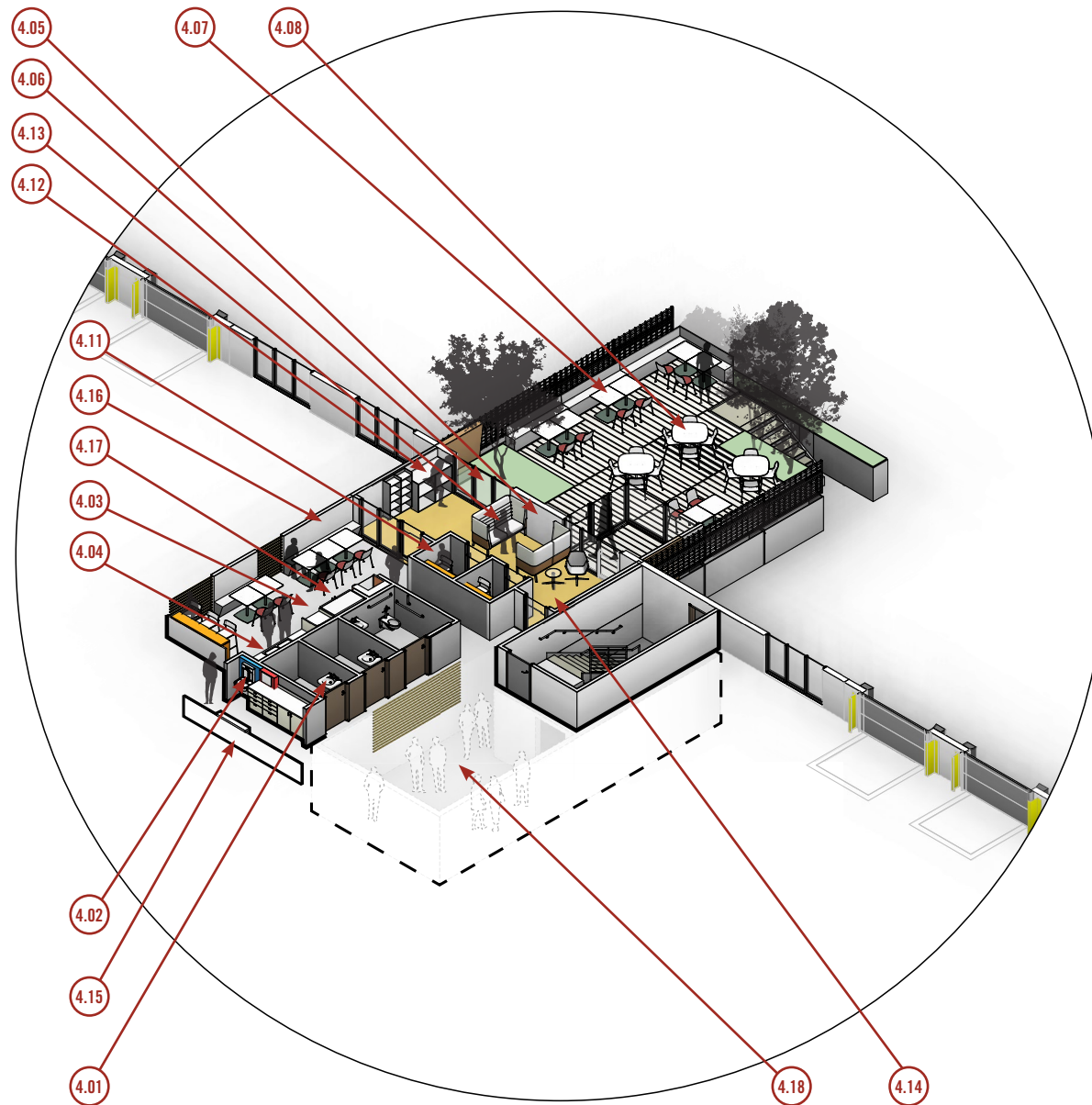
## ■ Small Break Spaces

Designed to be incorporated readily into MHE systems, with an example located at a rack end, these break spaces are intended for brief rest and hydration, with a space for seating and protection from distribution vehicles. Design elements are scaled to an individual worker. Small break spaces are recommended at intervals of no more than 125 feet.

**KEY WELLNESS STRATEGY:** Provide ready access to hydration and brief rest from walking and exertion.

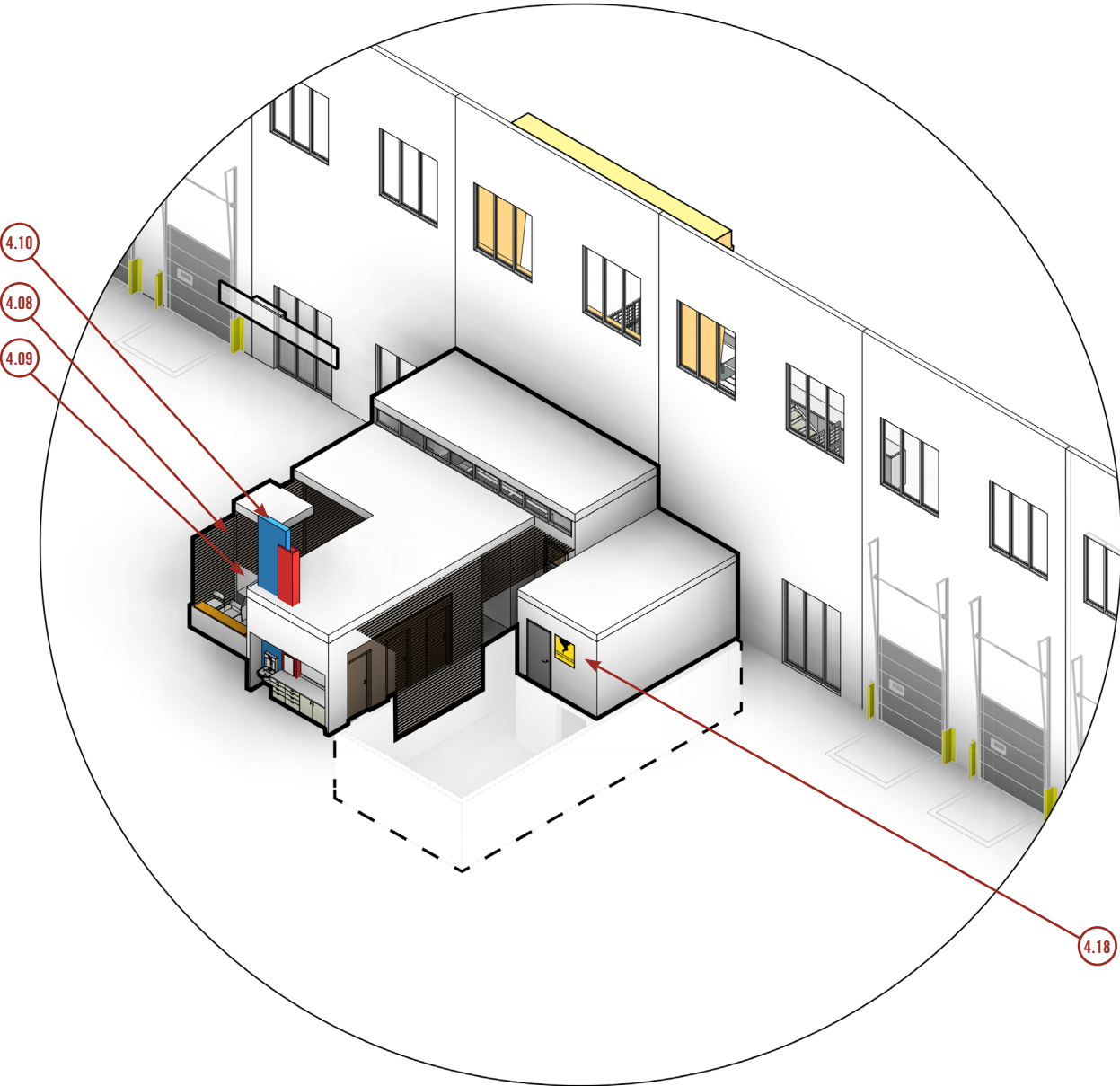
## Large Break Spaces: Section

(ZOOM IN FOR ADDITIONAL DETAIL)



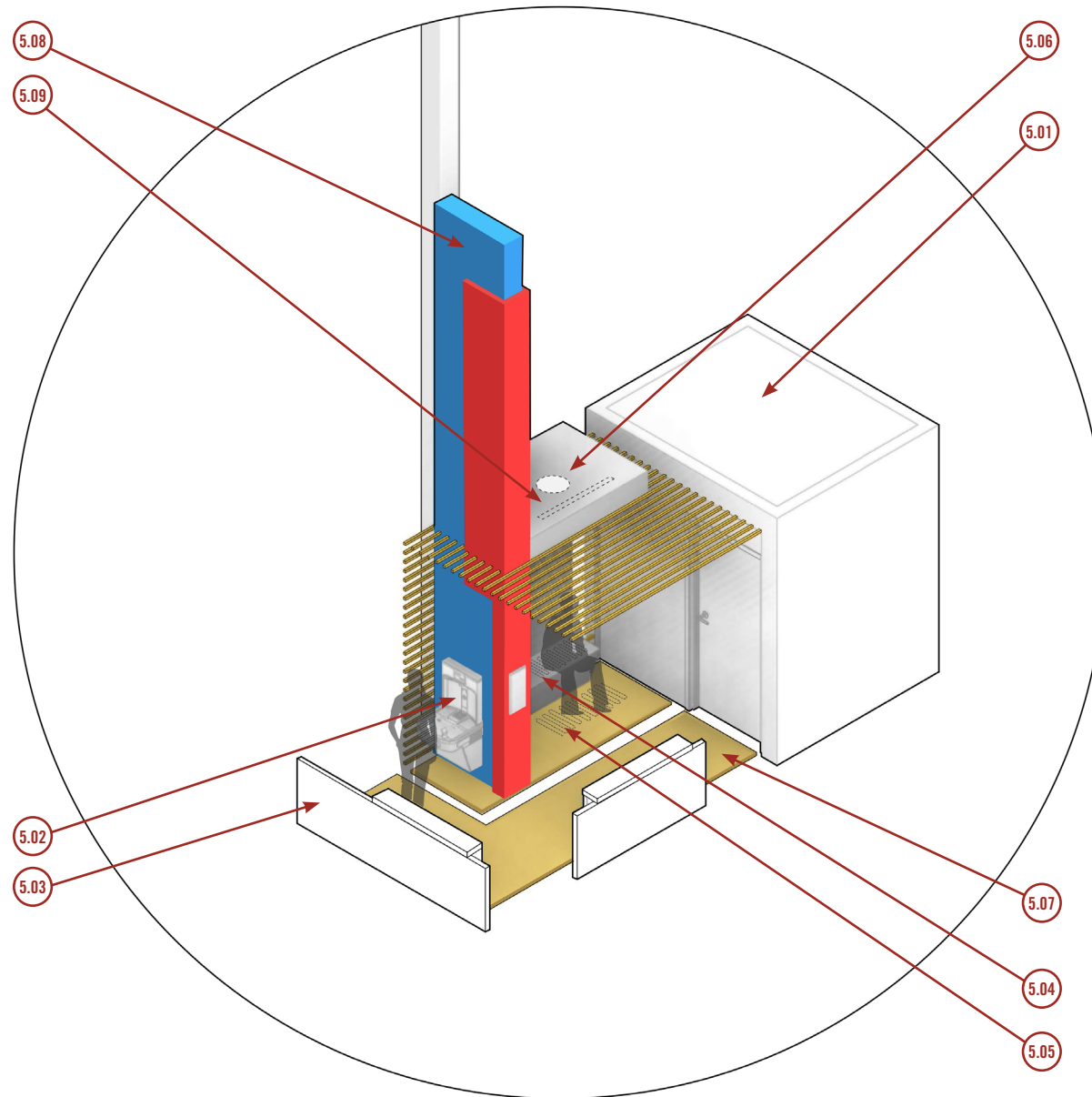
TAG	STRATEGY	WELLNESS OBJECTIVE	SCOPE
4.01	Three single-use ADA restrooms (general restroom spacing one per 200 ft).		<b>T</b> <b>D</b>
4.02	First aid and hydration stations (general spacing one per 125 ft).		<b>T</b> <b>D</b>
4.03	Provide café space with nutritional options, min. 20 sf. per person.		<b>T</b> <b>D</b>
4.04	Provide handwashing and sanitizing stations.		<b>T</b>
4.05	Provide fully conditioned amenity/office space with MERV-13 minimum filtration, outdoor air and CO2 monitoring systems.		<b>T</b> <b>D</b>
4.06	Provide access to natural light and views through exterior windows equipped with daylight control with manual overrides.		<b>T</b> <b>D</b>
4.07	Provide access to secured outdoor environments, minimum 1,000 sf.		<b>T</b> <b>D</b>
4.08	Provide access to ergonomically scaled space with biophilic materiality.		<b>T</b> <b>D</b>
4.11	Provide access to communications (internet, etc.).		<b>T</b> <b>D</b>
4.12	Provide space for rest from physical exertion, including rest and stretching opportunities.		<b>T</b> <b>D</b>
4.13	Provide space for rest from repetitive mental stress including provisions for games, reading, etc.		<b>T</b> <b>D</b>
4.14	Provide ergonomically soft flooring materials.		<b>T</b> <b>D</b>
4.15	Provide safety barriers.		<b>T</b> <b>D</b>
4.16	Provide sound isolation from adjacent distribution space, utilizing high-STC-rated partitions, acoustic absorptive material, and potential pink noise generator.		<b>T</b> <b>D</b>
4.17	Provide dimmable and tunable LED lighting system with integrated daylight control for general use and to meet shift workers' circadian rhythm needs.		<b>T</b> <b>D</b>
4.18	Provide enclosed shelter in place with emergency egress.		<b>T</b> <b>D</b>

### Large Break Spaces: Axon



TAG	STRATEGY	WELLNESS OBJECTIVE	SCOPE
4.08	Provide access to ergonomically scaled space with biophilic materiality.		<b>T</b> <b>D</b>
4.09	Provide transparency between break areas and distribution center space.		<b>T</b> <b>D</b>
4.10	Provide wayfinding and identity elements.		<b>T</b> <b>D</b>
4.18	Provide enclosed shelter in place with emergency egress.		<b>T</b> <b>D</b>

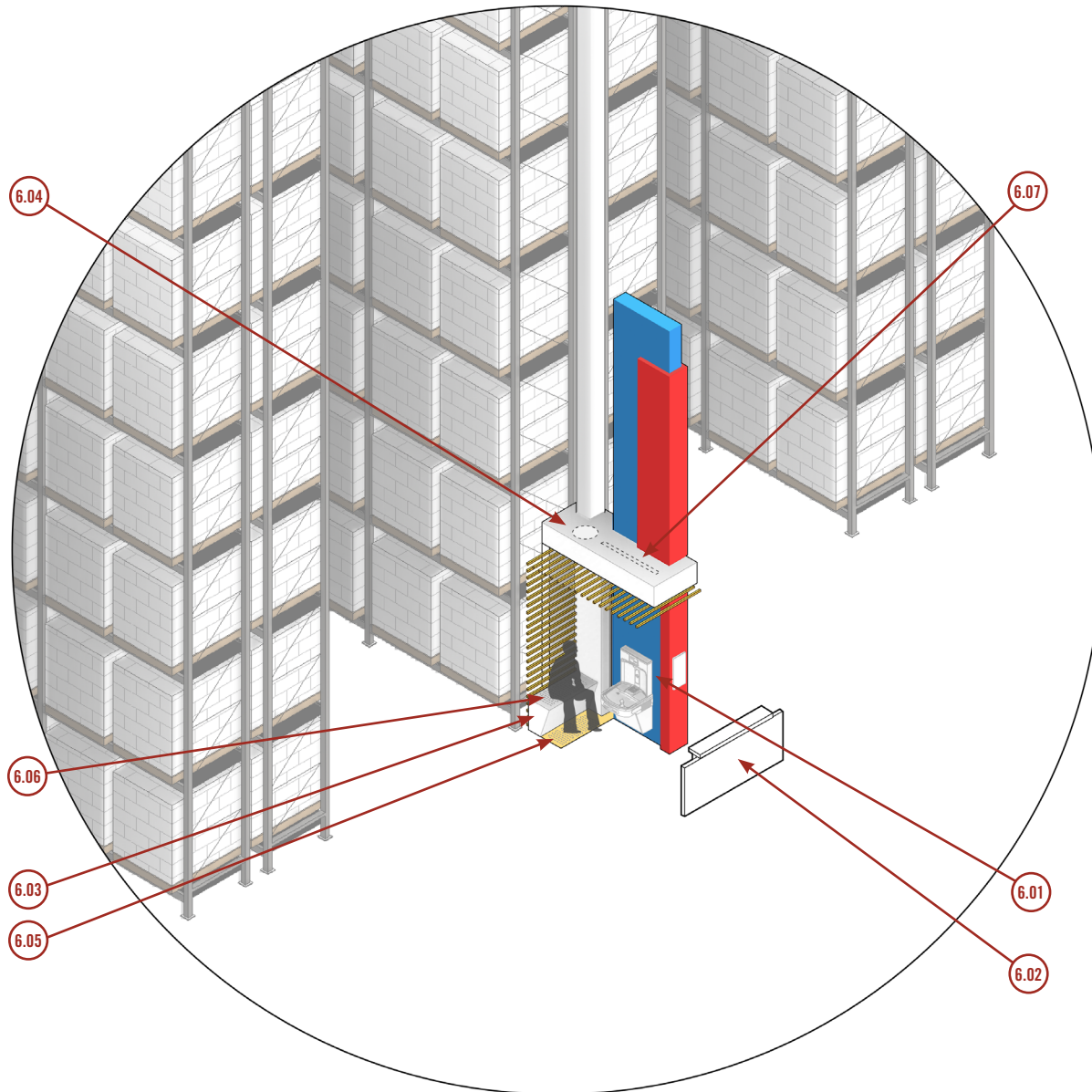
## Medium Break Spaces



TAG	STRATEGY	WELLNESS OBJECTIVE	SCOPE
5.01	Single ADA restroom (general restroom spacing one per 200 ft).		<b>T</b> <b>D</b>
5.02	First aid and hydration stations (general spacing one per 125 ft).		<b>T</b> <b>D</b>
5.03	Provide safety barriers.		<b>T</b> <b>D</b>
5.04	Provide bench seating.		<b>T</b> <b>D</b>
5.05	Provide locally controlled radiant heating/cooling with occupant control. Provide local ventilation with HEPA filtration and air quality monitoring.		<b>T</b> <b>D</b>
5.06	Provide sound isolation from adjacent distribution space, utilizing acoustic absorptive material and potential pink noise generator.		<b>T</b> <b>D</b>
5.07	Provide ergonomically soft flooring materials.		<b>T</b> <b>D</b>
5.08	Provide wayfinding and identity elements scaled to distribution center environment.		<b>T</b> <b>D</b>
5.09	Provide dimmable and tunable LED lighting system with integrated daylight control for general use and to meet shift workers' circadian rhythm needs.		<b>T</b> <b>D</b>



## Small Break Spaces



TAG	STRATEGY	WELLNESS OBJECTIVE	SCOPE
6.01	First aid and hydration stations (general spacing one per 125 ft).		T D
6.02	Provide safety barriers.		T D
6.03	Provide bench seating.		T D
6.04	Provide sound isolation from adjacent distribution space, utilizing acoustic absorptive material and potential pink noise generator.		T D
6.05	Provide ergonomically soft flooring materials.		T D
6.06	Provide locally controlled radiant heating/cooling with occupancy control.		T D
6.07	Provide dimmable and tunable LED lighting system with integrated daylight control for general use and to meet shift workers' circadian rhythm needs.		T D

## ■ Transportation Lounge

Many supply chain workers, particularly truck and delivery van drivers, work primarily outside of distribution centers. The expansion of e-commerce has contributed to growth in the number of workers engaged in local delivery and long-range trucking. As noted earlier, roadway and site design should provide for the safe passage and loading of vehicles, as well as safe pedestrian crossings. In addition to these safety concerns, distribution center design can address the unique wellness needs of transportation workers. These workers—particularly long-haul truckers—face daily challenges accessing restrooms, food and hydration; overcoming fatigue; finding places to sleep; and finding opportunities for social interaction. The prototype’s trucker lounge provides for toilet rooms, meal access, hydration, stretching and exercise space to reduce physical fatigue, places of rest to reduce mental fatigue, spaces for social engagement, semi-private communication space, and exterior access to a modular outdoor green space.

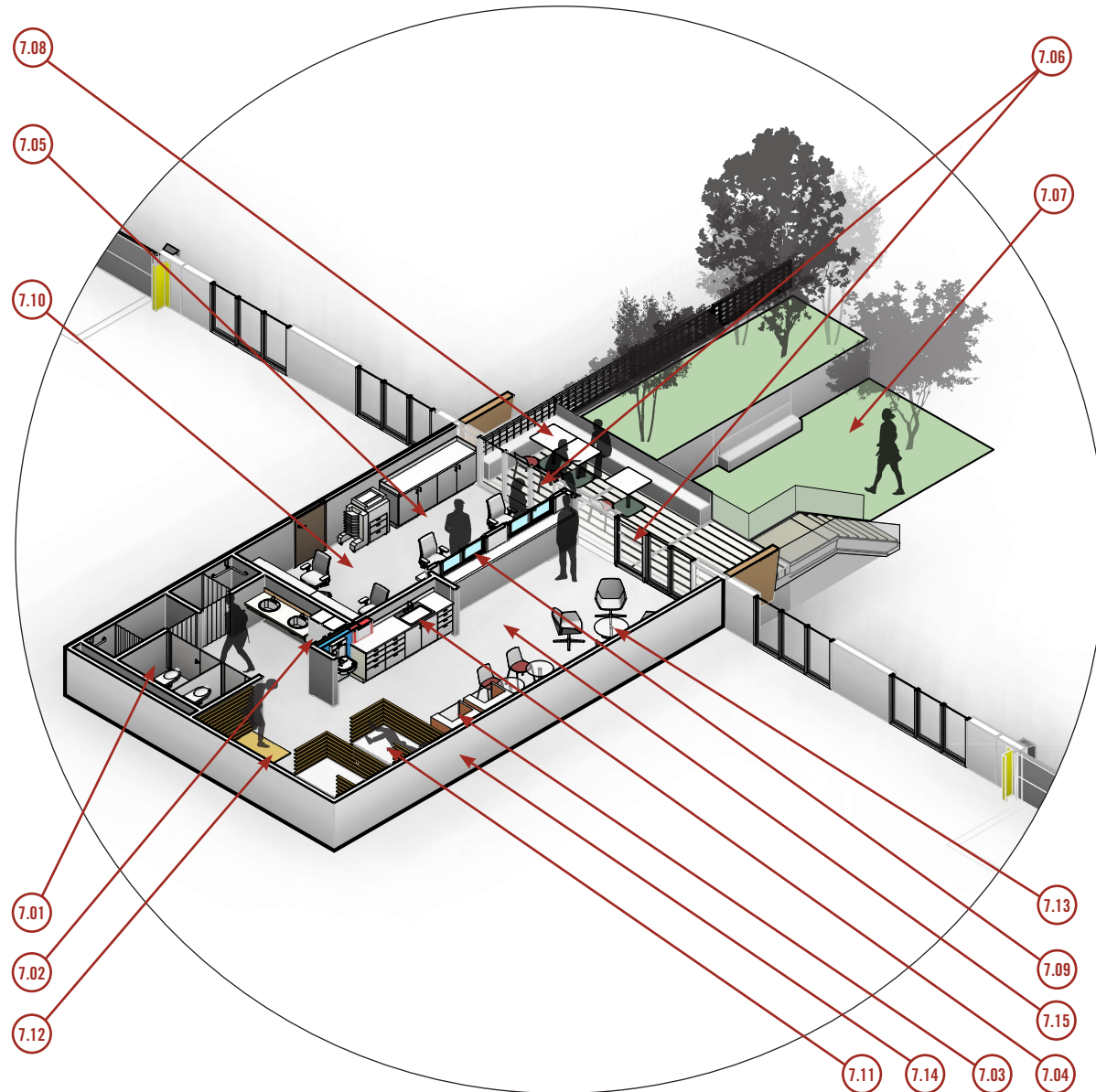
**KEY WELLNESS STRATEGY:** Provide space to reduce fatigue, access services and socialize.

## ■ Workstation

While much of the work activity in a distribution center involves the movement of goods internally via forklift or vehicle loading and unloading, work increasingly involves smaller “piecework.” This may require searching and sorting for small piece orders, placing material within MHE, and organizing specific orders. These activities often occur alongside or in conjunction with automation systems that produce noise and heat. In addition to the improvements recommended to the base building to improve the general work environment, localized interventions are also needed. The prototype’s workstations provide adaptable configurations that are optimized to smaller-scale work. The workstations’ design includes scaler elements, local conditioning, task-oriented lighting, noise reduction and ergonomic elements—such as floor treatments and furniture-like adaptations—to improve health and safety outcomes.

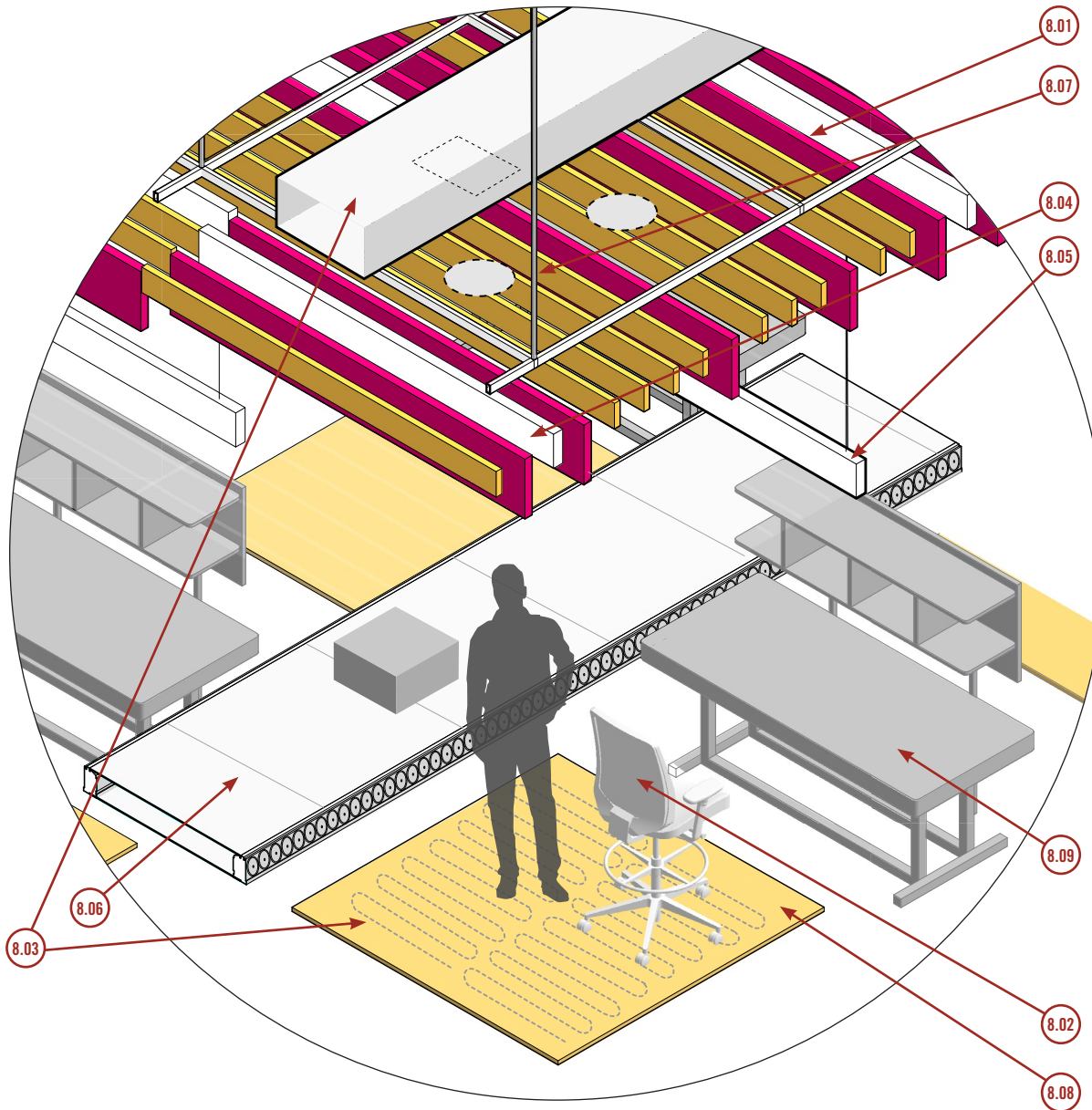
**KEY WELLNESS STRATEGY:** Adapt workstations to a human scale and tasks performed; provide localized environmental improvements.

## Transportation Lounge



TAG	STRATEGY	WELLNESS OBJECTIVE	SCOPE
7.01	Provide two single-use ADA toilet rooms with showers.		T D
7.02	Provide secure locker space.		T D
7.03	Provide café space with nutritional options, min. 20 sf. per person.		T D
7.04	Provide handwashing and sanitizing stations.		T D
7.05	Provide fully conditioned amenity/office space with MERV-13 minimum filtration, outdoor air and CO2 monitoring systems.		T
7.06	Provide access to natural light and views through exterior windows equipped with daylight control with manual overrides.		T D
7.07	Provide access to secured outdoor environments, minimum 500 sf.		T D
7.08	Provide access to ergonomically scaled space with biophilic materiality.		T D
7.09	Provide visual security.		T D
7.10	Provide access to communications (internet, etc.).		T D
7.11	Provide access to sleep stations.		T D
7.12	Provide space for rest from physical exertion, including rest and stretching opportunities.		T D
7.13	Provide space for rest from repetitive mental stress, including provisions for games, reading, etc.		T D
7.14	Provide sound isolation from adjacent distribution space, utilizing high-STC-rated partitions, acoustic absorptive material and potential pink noise generator.		T D
7.15	Provide dimmable and tunable LED lighting system with integrated daylight control for general use and to meet shift workers' circadian rhythm needs.		T D

## Workstation



TAG	STRATEGY	WELLNESS OBJECTIVE	SCOPE
8.01	Provide acoustic deck/cloud treatment at open work areas.		T
8.02	Provide ergonomic adjustable seating.		T D
8.03	Provide locally controlled radiant heating/cooling with occupant control.		T D
8.04	Provide dimmable and tunable LED lighting system with integrated daylight control for general use and to meet shift workers' circadian rhythm needs.		T D
8.05	Task lighting.		T
8.06	Low-noise MHE equipment.		T
8.07	Provide sound isolation from adjacent distribution space, utilizing acoustic absorptive material and potential pink noise generator.		T D
8.08	Provide ergonomically soft flooring materials.		T D
8.09	Provide access to ergonomically scaled space with biophilic materiality.		T D

# Conclusion

In the context of a rapidly changing economy, the distribution center has evolved from a warehouse to an active workplace, often employing associates by the hundreds if not thousands. Distribution centers have traditionally been designed for the efficient movement of goods, rather than human occupancy, contributing to conditions that can affect occupant well-being. These can also erode an employer's bottom line by contributing to high turnover rates and hindering recruitment in an increasingly labor-intensive industry.

A new approach to distribution center design can address these problems by focusing greater attention on providing a healthy work environment for the humans occupying these centers. Significant improvements can be made within the current design paradigm, ranging from basic shell and infrastructure improvements to the introduction of key program elements. Developers seeking to compete for the highest-quality tenants can differentiate themselves by partnering closely with occupiers to deliver improved spaces for human work.

This study offers actionable findings that also serve as a basis for future innovations that follow the same human-centered principles. They set the stage for the evolution of distribution centers as they become more embedded in local communities and more attentive to the needs of the people working within them. Achieving the goal of a wellness-focused distribution center will require effort from developers, designers and occupiers and—most importantly—input from workers themselves. Establishing a meaningful dialog between all these parties will be critical to paving the way to a more sustainable, equitable and successful supply chain.

## Recent NAIOP Research Foundation-Funded Research

### Available at [naiop.org/research](https://naiop.org/research)

Office Space Demand Forecast, Second Quarter 2023

Industrial Space Demand Forecast, First Quarter 2023

Economic Impacts of Commercial Real Estate, 2023 U.S. Edition

Office Space Demand Forecast, Fourth Quarter 2022

The Role of Data Analytics in Commercial Real Estate Siting, Design and Valuation Decisions (2022)

Sustainable Brownfield Redevelopment (2022)

Economic Impacts of Commercial Real Estate in Canada, 2022 Edition

Industrial Space Demand Forecast, Third Quarter 2022

New Places and New Spaces for E-commerce Distribution (2022)

Findings from the Development Approvals Index (2022)

Seeing Past the Pandemic: Industrial Demand and U.S. Seaports (2022)

New Uses for Office Buildings: Life Science, Medical and Multifamily Conversions (2022)

How the Other Half Builds: Small-Scale Development in Tertiary Markets (2021)

A Two-Dimensional Approach to Evaluating Commercial Real Estate Markets (2021)

An Overview of Emerging Construction Technologies (2021)

The Development Approvals Index: A New Tool to Evaluate Local Approvals Processes (2021)

© 2023 NAIOP Research Foundation

There are many ways to give to the Foundation and support projects and initiatives that advance the commercial real estate industry. If you would like to contribute to the Foundation, please contact Bennett Gray, vice president, National Forums and NAIOP Research Foundation, at 703-904-7100, ext. 168, or [gray@naiop.org](mailto:gray@naiop.org).

For information about the Foundation's research, please contact Jennifer LeFurgy, PhD, executive director, NAIOP Research Foundation at 703-904-7100, ext. 125, or [lefurgy@naiop.org](mailto:lefurgy@naiop.org).

# Endnotes

- <sup>1</sup> U.S. Census Bureau, “Advance Monthly Sales for Retail and Food Services,” news release and monthly retail trade report, January 18, 2023, <https://www.census.gov/retail/sales.html>.
- <sup>2</sup> Prologis Park Tacoma became the first WELL-certified logistics facility in 2018, but the standard has not been widely applied to industrial buildings. See Prologis, “Prologis Park Tacoma is World’s First WELL-Certified Logistics Real Estate Property,” November 28, 2018, <https://www.prologis.com/news-research/articles/prologis-park-tacoma-worlds-first-well-certified-logistics-real-estate>.
- <sup>3</sup> Center for Active Design and Quadreal, “A Better Box, Optimizing Industrial Spaces for Employee Health and Wellness,” 2021, <https://www.fitwel.org/industrial-spaces>.
- <sup>4</sup> U.S. Department of Homeland Security Cybersecurity and Infrastructure Security Agency, “Guidance on the Essential Critical Infrastructure Workforce: Ensuring Community and National Resilience in COVID-19 Response,” April 17, 2020, [https://www.911.gov/assets/CISA\\_Guidance\\_on\\_Essential\\_Critical\\_Infrastructure\\_Workers\\_Apr\\_2020.pdf](https://www.911.gov/assets/CISA_Guidance_on_Essential_Critical_Infrastructure_Workers_Apr_2020.pdf).
- <sup>5</sup> Bureau of Labor Statistics, “Warehousing and Storage: NAICS 493,” <https://www.bls.gov/iag/tgs/iag493.htm>.
- <sup>6</sup> Bruce Jaspen, “Poor Worker Health Costs U.S. Employers \$575 Billion a Year,” *Forbes*, December 8, 2020, <https://www.forbes.com/sites/brucejaspen/2020/12/08/poor-worker-health-costs-us-employers-575-billion-a-year/>.
- <sup>7</sup> Bureau of Labor Statistics, “Warehousing and Storage.”
- <sup>8</sup> Bureau of Labor Statistics, “Employer-Reported Workplace Injuries and Illnesses—2021,” news release, November 9, 2022, <https://www.bls.gov/news.release/pdf/osh.pdf>.
- <sup>9</sup> Charles G. Oakes, “Bollard: Non-Crash and Non-Attack-Resistant Models,” *Whole Building Design Guide*, September 2, 2016, <https://www.wbdg.org/resources/bollard-non-crash-and-non-attack-resistant-models>.
- <sup>10</sup> Jeanne Whalen and Rachel Lerman, “Anguish and Gratitude As Tornado Slashed Through Amazon Warehouse,” *The Washington Post*, December 15, 2021, <https://www.washingtonpost.com/technology/2021/12/15/amazon-warehouse-collapse-tornado/>.
- <sup>11</sup> “2020 Biopharma Cold Chain Sourcebook Forecasts a \$17.2-Billion Logistics Market,” *Pharmaceutical Commerce*, April 27, 2020, <https://www.pharmaceuticalcommerce.com/view/2020-biopharma-cold-chain-sourcebook-forecasts-a-17-2-billion-logistics-market>.
- <sup>12</sup> Daniel Wake, “Cold Fact,” *NFPA Journal*, March 1, 2019, <https://www.nfpa.org/News-and-Research/Publications-and-media/NFPA-Journal/2019/March-April-2019/Features/Cold-Storage-Safety>; Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, “Cold Stress,” June 6, 2018, <https://www.cdc.gov/niosh/topics/coldstress/>; Brenda Jacklitsch and Diana Ceballos, “Preventing Cold-Related Illness, Injury, and Death Among Workers,” Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2019-113, September 2019, <https://doi.org/10.26616/NIOSH PUB2019113>.
- <sup>13</sup> Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, “Transportation, Warehousing and Utilities (TWU) Statistics,” November 11, 2021, <https://www.cdc.gov/niosh/topics/ohl/transportation.html>.
- <sup>14</sup> “Workplace Hearing Loss at Epidemic Levels,” *Industrial Safety & Hygiene News*, May 3, 2018, <https://www.ishn.com/articles/108580-workplace-hearing-loss-at-epidemic-levels>.
- <sup>15</sup> Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, “Noise and Hearing Loss,” January 23, 2023, <https://www.cdc.gov/niosh/topics/noise/noise.html>.
- <sup>16</sup> U.S. Department of Energy, “Radiant Cooling,” <https://www.energy.gov/energysaver/radiant-cooling>.
- <sup>17</sup> George Youngvorst, “Growing Demand for Warehouses Is Fertile Ground for Radiant Heating,” *Plumbing & Mechanical*, May 20, 2021, <https://www.pmmag.com/articles/103581-growing-demand-for-warehouses-is-fertile-ground-for-radiant-heating>; Kristen White, “Radiant Installation Features Huge Time Savings,” *Plumbing & Mechanical*, November 18, 2021, <https://www.pmmag.com/articles/103917-radiant-installation-features-huge-time-savings>; Kim Bliss, “How Prefabricated Radiant Panels are Revolutionizing Commercial Construction,” *Plumbing & Mechanical*, May 5, 2022, <https://www.pmmag.com/articles/104194-how-prefabricated-radiant-panels-are-revolutionizing-commercial-construction>.
- <sup>18</sup> Michal Veselý and Wim Zeiler, “Personalized Conditioning and Its Impact on Thermal Comfort and Energy Performance—A Review,” *Renewable and Sustainable Energy Reviews* 34 (June 2014): 401-408, <https://doi.org/10.1016/j.rser.2014.03.024>.
- <sup>19</sup> Anthea Court, “The Effects of Exposure to Natural Light in the Workplace on the Health and Productivity of Office Workers: A Systemic Review Protocol,” *JBL Library of Systematic Reviews* 8, no. 16 (June 2010): 1-19, <https://doi.org/10.11124/jbisrir-2010-574>; American Academy of Sleep Medicine, “Circadian Rhythm Sleep Disorders,” 2008, <https://aasm.org/resources/factsheets/crsd.pdf>.

- <sup>20</sup> Anna Wirz-Justice, Francesco Benedetti, and Michael Terman, *Chronotherapeutics for Affective Disorders*, 2<sup>nd</sup> ed. (Basel: Karger, 2013).
- <sup>21</sup> Jo Phipps-Nelson et al., “Daytime Exposure to Bright Light, as Compared to Dim Light, Decreases Sleepiness and Improves Psychomotor Vigilance Performance,” *Sleep* 26, no. 6 (September, 2003): 695:700, <https://doi.org/10.1093/sleep/26.6.695>.
- <sup>22</sup> Mustafa Kemal Alimoglu and Levent Donmez, “Daylight Exposure and the Other Predictors of Burnout Among Nurses in a University Hospital,” *International Journal of Nursing Studies* 42, no. 5 (July 2005): 549-555, <https://doi.org/10.1016/j.ijnurstu.2004.09.001>.
- <sup>23</sup> Illuminating Engineering Society, ANSI/IES RP1-20, *Recommended Practice: Lighting Office Spaces* (New York: Illuminating Engineering Society, 2020).
- <sup>24</sup> International WELL Building Institute, “Circadian Lighting Design,” <https://standard.wellcertified.com/light/circadian-lighting-design>.
- <sup>25</sup> Marcel Harmon, “Getting the Light Right for Shift Workers,” Branch Pattern Perspectives, <https://branchpattern.com/shift-work-lighting/>.
- <sup>26</sup> U.S. Bureau of Labor Statistics, “Occupational Requirements Survey,” <https://www.bls.gov/ors/>.
- <sup>27</sup> Thomas R. Waters and Robert B. Dick, “Evidence of Health Risks Associated with Prolonged Standing at Work and Intervention Effectiveness,” *Rehabilitation Nursing* 40, no. 3 (May 2015): 148-165, <https://doi.org/10.1002/rnj.166>.
- <sup>28</sup> Occupational Safety and Health Administration, “OSHA Pocket Guide.”
- <sup>29</sup> Alexander L. Cohen et al., “Elements of Ergonomics Programs: A Primer Based on Workplace valuations of Musculoskeletal Disorders,” U.S. Department of Health and Human Services Public Health Service and the Centers for Disease Control and Prevention National Institute for Occupational Safety and Health, March 1997, <http://www.ergo2.amisco.org/CDC%20PDF/Elements%20of%20Ergonomics.pdf>.
- <sup>30</sup> Christopher Wanjek, *Food at Work: Workplace Solutions for Malnutrition, Obesity and Chronic Diseases* (Geneva: International Labour Organization, 2005).
- <sup>31</sup> ASHRAE, “ANSI/ASHRAE Standard 62.1-2022, Ventilation and Acceptable Indoor Air Quality,” 2022, <https://www.ashrae.org/technical-resources/bookstore/standards-62-1-62-2>.
- <sup>32</sup> James A. Raub et al., “Carbon Monoxide Poisoning—a Public Health Perspective,” *Toxicology* 145, no. 1 (April 7, 2000): 1-14, [https://doi.org/10.1016/S0300-483X\(99\)00217-6](https://doi.org/10.1016/S0300-483X(99)00217-6).
- <sup>33</sup> University of Pennsylvania School of Medicine, “Access to nature requires attention when addressing community health needs,” *ScienceDaily*, July 9, 2020, <https://www.sciencedaily.com/releases/2020/07/200709085312.htm>.
- <sup>34</sup> Lisa Quintiliani, Signe Poulsen, and Glorian Sorensen, “Healthy Eating Strategies in the Workplace,” *International Journal of Workplace Health Management* 3, no. 3 (September 28, 2010): 182-196, <https://doi.org/10.1108/17538351011078929>.
- <sup>35</sup> Marianna Virtanen et al., “Long Working Hours and Cognitive Function: The Whitehall II Study,” *American Journal of Epidemiology* 169, no. 5 (March 1, 2009): 596-605, <https://doi.org/10.1093/aje/kwn382>.
- <sup>36</sup> Kate Lister, “What’s Good for People? Moving From Wellness to Well-Being,” Knoll, 2014, [https://www.knoll.com/document/1353003180652/Well\\_Being\\_wp.pdf](https://www.knoll.com/document/1353003180652/Well_Being_wp.pdf).
- <sup>37</sup> John Sullivan, “How Commute Issues Can Dramatically Impact Employee Retention,” TLNT, April 21, 2015, <https://www.tlnt.com/how-commute-issues-can-dramatically-impact-employee-retention/>.
- <sup>38</sup> Heather Balogh Rochfort, “The Case for Onsite Childcare,” *Outside Business Journal*, November 15, 2019, <https://www.outsideonline.com/business-journal/issues/the-case-for-onsite-childcare/>.
- <sup>39</sup> Distribution centers can also look to health and wellness programs provided by companies in other industries, including those active in rural areas. For example, The Wonderful Company, a food and beverage company based in California’s Central Valley, provides on-site gyms, offers workers exercise classes and healthy snacks, and provides a mobile clinic to serve remote locations. See The Wonderful Company, “Social Responsibility: Health & Wellness,” <https://www.wonderful.com/social-responsibility/health-wellness/>.
- <sup>40</sup> Michael Ratcliffe, et al., “Defining Rural at the U.S. Census Bureau,” Report Number ACSGEO-1, U.S. Census Bureau, December 8, 2016, <https://www.census.gov/library/publications/2016/acs/acsgeo-1.html>.
- <sup>41</sup> Whitney Airgood-Obyrcki, Bernadette Hanlon, and Shannon Rieger, “Delineate the U.S. Suburb: An Examination of How Different Definitions of the Suburbs Matter,” *Journal of Urban Affairs* 43, no. 9 (April 3, 2020): 1263-1284, <https://doi.org/10.1080/07352166.2020.1727294>.
- <sup>42</sup> Jim Motavalli, “‘The Traveling Zoo’: Life on the Road, With Pets at Their Side,” *The New York Times*, April 29, 2021, <https://www.nytimes.com/2021/04/29/business/truckers-pets.html>.





**We're Shaping the Future**

2355 Dulles Corner Boulevard, Suite 750  
Herndon, VA 20171-3034

703-904-7100  
[naiop.org/research-foundation](http://naiop.org/research-foundation)