Types of Warehouses

Warehouse development comes in many shapes and sizes, each serving a specific role depending on the nature of the operations, and constraints of the supply chains they are supporting. Zoning should evolve to keep up with the changing variety of uses and trends (including definitions) as the differences could mean dramatically different impacts and outcomes, and whether a project is compatible with a site and beneficial to a community. Land use regulations should not simply lump "general industrial" or "warehouse" together, as different types can be profoundly different, entailing different impacts, which warrant greater specificity as to appropriate siting and design standards where permitted.

As such, it has never been more important that municipalities update and refine their planning and zoning regulations to differentiate among warehouse use types. This will ensure that local reviewing boards are equipped to adequately assess the extent to which a community's transportation network and land uses can handle the proposed level of intensity, traffic, and resultant impacts. Other impacts that can be assessed include infrastructure such as water, sewer, and municipal services (e.g., emergency services), which have the sustained capacity to meet demand over the lifetime of the project. For our purposes, the guidance largely focuses on various types of warehouse distribution facilities, their scale and intensity, and municipal, county, and regional considerations therein.

According to the **Geography of Transport Systems, 5th Edition**, warehouse distribution centers are a type of freight movement (e.g., logistics) facility that includes manufacturing, container and bulk terminals, and traditional warehouse storage facilities. A traditional warehouse is used for storing goods and materials in inventory for extended periods of time and releasing them on demand. They include multitenant facilities that are usually rented through short to medium-term leases.

The main difference between traditional and distribution warehouse functions relates to the time the inventory spends within a facility. The latter see much greater product loading and unloading flow velocity (usually less than a few days), especially at fulfillment centers, which deliver goods direct to customers within less than 48 hours in high throughput facilities. Warehouses may also include office, employee welfare, maintenance areas, as well as light manufacturing in the form of packaging, labeling, assembly, and returns, more typical of distribution functions. However, the space provided for these uses can be highly variable but is typically an insignificant portion of the overall building square footage.

Following recent updates to its **Trip Generation Manual, 11th Edition Supplement**, the **Institute of Traffic Engineers** (ITE) now lists six different categories of warehousing designations. For simplicity, these can be aggregated into three main types of distribution and fulfillment warehouses that are associated with today's e-commerce landscape and logistics (i.e., freight) infrastructure. Each is situated in a strategic location and carries out a somewhat distinct activity. They include

- Distribution facilities
- Fulfilment centers, and
- Last-mile fulfillment facilities or stations.

Keep in mind that this and other guidance is highly variable for specific types of warehousing uses as industry definitions, warehouse uses, and technology are constantly evolving and changing. There can be substantive variability within a single warehousing development based on type, intensity, and the potential for misclassification. In addition, some warehouse developments may have multiple warehousing use types within a single building or site. From the standpoint of a warehouse distribution center/facility's size, the following may be used:

- **Major Distribution center** – large-scale regional and/or interstate distribution facility having a minimum gross floor area from 500,000 to more than 1.5 million square feet.
- **Large Fulfillment center** – a large format regional fulfillment facility having a minimum gross floor area from 150,000 to more than 500,000 square feet. In this category, a medium-sized fulfillment center would average between 250,000 to 350,000 square feet.
- **Last-mile Fulfillment center** – a smaller local or area fulfillment center/facility or station that primarily serves local markets (roughly the same function as retail shopping centers) having a minimum gross floor area from 50,000 to more than 150,000 square feet. This category could include micro/small fulfillment centers of 3,000 to more than 25,000 square feet.

Warehouse distribution centers/facilities may be further characterized by the following attributes:

Major Distribution Centers tend to ship from wholesale or manufacturer, to businesses, or to fulfillment centers, and typically do not deliver to end-users (i.e., retailers and external customers). Distribution centers are typically larger than fulfillment centers, are located away from major consumer markets (population centers), and, are a complex transit hub for large quantities of bulk goods that generally do not require finishing or individual packing, as they are temporarily stored on palettes before being shipped.

- When items arrive at a port, they go to a break-bulk facility where massive quantities are broken down into smaller clusters for transport to regional locations at fulfillment centers.
- Generally located in or near the largest industrial markets and seaports across the U.S., such as Newark, NJ.
- Often aggregated at massive industrial sites with hundreds of warehouses close to major multi-modal hubs that can include shipping lines, rail lines, and extensive highway networks.
- Can be located an hour to 90 minutes away (i.e., within a 75-mile radius) from the port (e.g., Lehigh Valley along Rt. 78) and still be completely functional for the tenants.
- Access to regional rail and highway networks is key for these larger facilities, since their customers are usually other, smaller fulfillment centers.
- Performs transloading functions (aka. cross docking), whereby the consolidation, transferring and distribution of pallets, equipment, and other shipments are made between locations using more than one mode of transportation for manufacturers, wholesalers, or retailers.
- Includes cross-docking functions, whereby palletized freight (goods and materials) is moved across the distribution center to another truck to complete the rest of its journey. Characterized as having little or no storage function due to the perishable nature of many goods being shipped, such as food (including refrigeration and heated)
- Includes fabrication functions (e.g., sorting and packaging before final delivery).
- Includes break-bulk functions, whereby items that are shipped in bulk (e.g., unpackaged state) are divided into units for further shipment (i.e., palletized or completely broken down) so that a retailer, business, or fulfillment center can receive a smaller quantity to their exact specifications.

- Structures typically from 500,000 to more than 1.5 million square feet.
- Average clear building height is between 32 and 3.5 feet. According to the Commercial Real Estate Development Association (NAIOP), in newly constructed structures larger than 300,000 square feet, 32 feet clear is typical. In mega-sized distribution buildings, 36 feet is common, with clear heights rising past 40 feet in some cases.

Large Fulfillment Centers are a type of distribution center often solely dedicated to e-commerce supply chains that pick and pack incoming orders (i.e., items/parcels) from shelves for individual delivery in order to "fulfill" individual online orders. They are short-term storage-based (holding a very high range of goods) but also rely on a high level of throughput. Typically smaller than distribution centers and focus on quickly delivering goods to individual customers. They typically receive, pick, pack, kit, label, and deliver products to people's doorstep in delivery vans. They are situated closer to consumer markets so individual items can be delivered quickly to people's doorsteps.

- Typically located on the outskirts of major metro areas in regional locations, items can either be stored or sent directly to consumers.
- In major metropolitan areas, items stored in regional warehouses are typically sent to last-mile facilities, which are located close to consumer homes, enabling fast delivery to customers.
- There is a diverse user base for mid-size buildings, ranging from middle-mile support for national users to regional or local businesses serving local customers.
- Includes cross-docking functions, whereby palletized freight is moved across the distribution center to another truck to complete the rest of its journey. Characterized as having little or no storage function due to the perishable nature of many goods being shipped, such as food (including refrigeration and heated)
- Includes fabrication functions (e.g., sorting and packaging before final delivery).
- Includes cold storage and refrigeration functions, including large scale grocery cold chain distribution, whereby outbound loads are customized shipments bound to specific grocery stores. These deliveries are usually regional in scope, which corresponds to the market area of the distribution center.
- Includes break-bulk functions, whereby palletized freight or boxed goods are completely broken down so that a customer can receive a smaller quantity to their exact specifications.
- Includes high-cube automated fulfillment centers and associated facilities as described below.
- Structures typically from 150,000 to 500,000 sq. ft., with an average clear building height between 32 and 3.5 feet.

Last-mile Fulfillment Centers (or stations) are smaller fulfillment facilities serving the final leg of delivery rather than a literal measurement of distance. They serve either consumers, individual households (for online shopping), or the retail stores they shop at (for traditional retail).

- Typically located in urban and suburban infill areas.
- Primarily serve local markets with roughly the same function as retail shopping centers
- Locational impetus is to be near those customers, which can result in delivery vans/trucks traveling over local streets.
- Last mile delivery hubs may be smaller compared to distribution centers, but truck and van trips are high, as are the parking requirements necessary to accommodate hundreds of employees, delivery vans, and trucks, and require a larger parking lot (impervious surface) footprint than other warehouse operations.

- Higher sprinter van and truck trips warrant more direct access to the interstates and truck networks.
- Structures typically from 50,000 to more than 150,000 square feet.
- Includes micro-fulfillment centers (i.e., small fulfillment centers) with a footprint between 3,000 and 25,000 sq. ft., that are typically highly automated, run on a very small staff, and cater to the area they are in. Sometimes occupy sections of retail stores that handle last-mile fulfillment and delivery of products to customers.

High Cube and automated warehousing – an emerging trend in distribution

As available and ideally situated land in strategic locations becomes scarcer and more expensive to meet demand, distribution companies are increasingly embracing emerging technologies to move and store goods more efficiently. As a result, warehouse distribution facilities are changing to adapt to automation and reduction in available space by reducing footprints and modifying layouts and designs. These changes have taken the form of high cube and automated warehousing (HCW), which are differentiated from traditional warehouses because of their height.

In contrast with the scale of more traditionally designed warehouses and distribution centers seen in both Pennsylvania and New Jersey over the past decade, HCW construction is literally taking the industry to new heights, with some built as high as 180 feet tall nationwide. Instead of the standard model of storing goods on one ground floor, nearly all the space within a HCW is dedicated to the rapid storage and removal of goods. HCW's are highly automated, with sophisticated racking and forklift retrieval systems designed to reduce human labor while dramatically increasing vertical storage capacity (i.e., project density), loading, and unloading speeds. The resultant efficiencies translate to more trucks moving a much greater number of products onto roadways.

- A HCW Distribution Center is typically a very large shell building commonly constructed using steel framed and/or other concrete tilt-up techniques with a minimum gross floor area of 200,000 square feet, a ceiling height of 32 feet or more (can be as high as 10-to-14 stories in height), a minimum dock-door ratio of 1 door per 10,000 square feet.
- Primarily used for the storage and/or consolidation of manufactured goods (and to a lesser extent, raw materials) prior to their distribution to retail locations or other warehouses. It has a high level of on-site automation and logistics management, which enable highly efficient processing of goods.
- Characterized by a small employment count due to a high level of automation, and truck activities frequently outside of the peak hour of the adjacent street system.
- Related types of HCW's include high-cube transload and short-term storage warehouses, high-cube parcel hub warehouses, and high-cube cold storage warehouses.
- A short-term HCW is a distribution facility often with custom/special features built into the structure for the movement of large volumes of freight with only short-term storage of products.
- High-cube parcel (i.e., fulfillment) hub warehouses typically serve as a regional and local freight-forwarder facility for time sensitive shipments via airfreight and ground carriers, while high-cube cold storage warehouses entail substantial temperature-controlled environments for frozen food and other perishable products such as bulk raw produce.
- A typical 1-million-square-foot warehouse has an average daily traffic rate of 1,740 trips, whereas

a HCW of the same floor area has 8,180 vehicle trips per day — nearly 5 times as much.

- Whereas a typical large warehouse may have a building footprint between 150,000-to-500,000-square feet with a 40-feet ceiling height (shorter than an average 3-story home), a high cube warehouse can be 10-to-14 stories (a story generally being 14 feet) – potentially four times the height of a typical warehouse. Therefore, square footage may not be the best predictor of traffic generation. Source: **Lehigh Valley Planning Commission: Community Guide: High Cube & Automated Warehousing**

While HCW building design has the potential to reduce unwanted land consumption (if only at the site-specific level) and provide greater opportunities for a reduced carbon footprint and the retention of existing green infrastructure and habitat, the success of any strategy using density to reduce a specific uses' overall footprint, ultimately depends on the broader land-use policies in place. While HCW design offers a compelling opportunity to consume less land, municipal officials and planners should weigh the project-specific benefits against the potential for significant adverse impacts on community character, viewsheds, air quality, health, safety, and the transportation network.

In addition to concerns for heavy truck traffic that higher product volume capacities can generate, height will also present challenges for emergency services personnel who will need special training and expensive equipment. This is particularly concerning in instances where high cube towers are proposed in suburban and rural areas where police, fire, ambulance, and emergency medical services may be limited, underfunded, or volunteer-based agencies not equipped to respond to a multi-story emergency. The height of the structure, the construction materials used, and what is stored in the warehouse are critical to ensuring that workers are safe and that emergency services can adequately respond safely. At the same time, accommodating such facilities in appropriate industrial locations with similarly sized building heights, or where offsetting elevation changes exist in the immediate landscape, in tandem with direct highway access, can mitigate impacts and conflicts, while providing an appropriate fit for a locally desired project or land use that might not otherwise work in other locations.

When reviewing projects that may be above three stories in height, the consideration for these services becomes especially critical. Larger, taller, and high-powered (potential electrical, hazardous materials risks) automated facilities can pose serious risks to the community and emergency personnel and should not be permitted unless it can be demonstrated that there are adequately trained and equipped personnel and services to respond to emergency situations. Emergency services impact statements should be required in the form of a questionnaire for applicants to submit as part of the site plan review process. Likewise, establishing a municipal public safety or emergency services committee, including review by the local OEM, fire, and police departments, should be considered to facilitate enhanced communication and coordination between emergency response organizations affected by a development proposal.

Highly automated facilities can be expected to have substantial impacts on the local and regional workforce as robotics technology and trends towards its application in new and retrofitted facilities continue to expand, municipalities should carefully assess potential employment impacts (e.g., more high tech jobs) from HCW proposals. Given these special needs and concerns, HCW uses above 150,000 gross square feet may be more appropriate where permitted a conditional use in tandem with permitted uses that otherwise limit building height and size among other standards utilized to limit the scale and intensity of uses