


# COMMUNITY GUIDE



## **High Cube and Automated Warehousing**

Updated January 2021



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This document serves as guidance to Lehigh and Northampton counties, the 62 municipalities of the Lehigh Valley, developers and community members, all of which have a vested interest in the impacts of high cube and automated warehousing on the health and well-being of the region. The LVPC is committed to supporting municipal governments and building collaboration between public and private partners to ensure the region's continued sustainability and resilience.

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In July 2017, Coca-Cola opened this 19-story, fully automated cold storage warehouse in Singapore. The built-in automation moves products nearly three times faster than traditional warehouses while using half of the land area. This international trend has the potential to bring positive and negative impacts to the Lehigh Valley.



Photos courtesy of CT-Technologies

# Introduction

## High Cube and Automated Warehousing

As the growth of e-commerce and one-day delivery makes the Lehigh Valley one of the fastest-growing freight corridors in the nation, companies are increasingly looking for ways to move goods through the region more efficiently. High cube and automated warehouses are the latest trend that carries the potential to bring positive and negative impacts to the region. This shift in how warehouses operate will push the limits of local codes and regulations and require careful consideration by municipal governments. However, there are several steps municipalities can take to better manage the location, size and look of this emerging development trend.

## What is High Cube and Automated Warehousing?

High cube and automated warehouses are differentiated from traditional warehouses because of their height, which to date, have been proposed up to 180 feet tall. They are highly automated, with newer warehouses being built for specific uses utilizing rack systems that also serve as the building's structure. The rack system is then wrapped with a metal skin that serves as the building's walls.

These tall structures typically integrate Automated Storage and Retrieval Systems (ASRS) to maximize storage space availability, and for the processing of goods in a more efficient manner than traditional human-manipulated storage movement systems. The intricate racking system increases the efficiency of goods moving into and out of these warehouses, with faster turnaround times for trucks, theoretically reducing the time a driver needs to stage or park.



High Cube Warehouses utilize automated storage and retrieval systems (ASRS) to move and retrieve goods. Photo Courtesy of Westphalia Technologies, INC.



Traditional warehouses utilize people operated forklifts to move goods. LVPC file photo.

# Potential Impacts

High cube and automated warehouses enable freight and distribution businesses to build massive warehouses that are as much as eight times the height of other warehouses in the region. By allowing companies to build higher, these automated structures need less physical land to develop, with their intricate racking systems moving both products and the trucks that deliver to them through the site more quickly. Less land being developed is potentially a positive outcome, leading to reduced pressure on farmland and open space. Increased efficiency within the warehousing industry is also likely to lead to increased economic productivity.

This emerging land use also has the potential for tremendous adverse impacts on the local and surrounding communities. Their high-tech automation means fewer jobs are created at the facility. Their height means drastic changes to landscapes in communities that have no other structures higher than three or four stories. These communities often do not have the emergency management service infrastructure necessary to serve structures of this scale, posing a threat to the public health, safety and welfare. While the efficiency of these facilities likely increases freight trips in and out of the site, the real impacts on traffic, and on the road and bridge infrastructure are not fully known because examples are not yet available to accurately assess trip generation. These factors will require proactive measures by municipal governments. Many of the impacts and recommendations detailed in this document could also apply to traditional warehouses and other industrial uses.

## Potential Effects of High Cube and Automated Warehouses

Possible Positive Outcomes	Possible Negative Outcomes
Development type may need less land per facility	Increased emergency management needs
Reduction of energy used for operations	Increased freight traffic
Reduction of customer wait times for goods	Increased wear and tear on roads and bridges
Reduction of customer returns and damage losses	Fewer jobs
May be located where adequate infrastructure exists to support development	Potential increased demand for broadband, electric, gas, water, and stormwater and sewer services
May include green and renewable infrastructure to offset environmental impacts of development	Decreased air quality due to freight traffic increases and truck idling
Compatible design may improve community skyline	Incompatible design could substantially harm community skyline

Locally, these vertical structures are being proposed for refrigerated and frozen storage and computer and electronics warehousing because their height allows them to be more energy efficient, reduce labor and product damage costs, and increase order accuracy and customer service. This design is also being proposed nationally and internationally for other types of warehousing, including dry goods and retail commodities.

Simultaneously with the development of new high cube warehouse facilities, traditional existing warehouses are redeveloping and retrofitting for automation as well. In these cases, the density of goods stored increases, potential for freight vehicle trips grows and the job roles for employees shift and decline.

With this increase in high cube warehousing and deployment of automated storage and retrieval systems, the Lehigh Valley's industrial economy has entered into its second phase of the 4th Industrial Revolution.

New construction of high cube and automated warehouses utilize the tall, intricate racking system for two purposes. The racks increase the efficiency of goods moving into and out of the warehouses, and serve as the building's support structure, before being wrapped in a metal covering that acts as the building's exterior walls. The racking system encompasses the entirety of the building's height. The completed building photo below offers a glimpse of comparison to the height of a traditional warehouse. Traditional warehouses, found broadly throughout the Lehigh Valley, typically don't exceed 50 feet, but the bottom photo shows how the 130-foot-tall building dwarfs the tractor-trailers at the first-floor bays.



The 130-foot-tall Americold Automated Storage and Retrieval System under construction in Rochelle, Illinois (above) and completed (below). Photos courtesy of Griffco Design/Build, Inc.





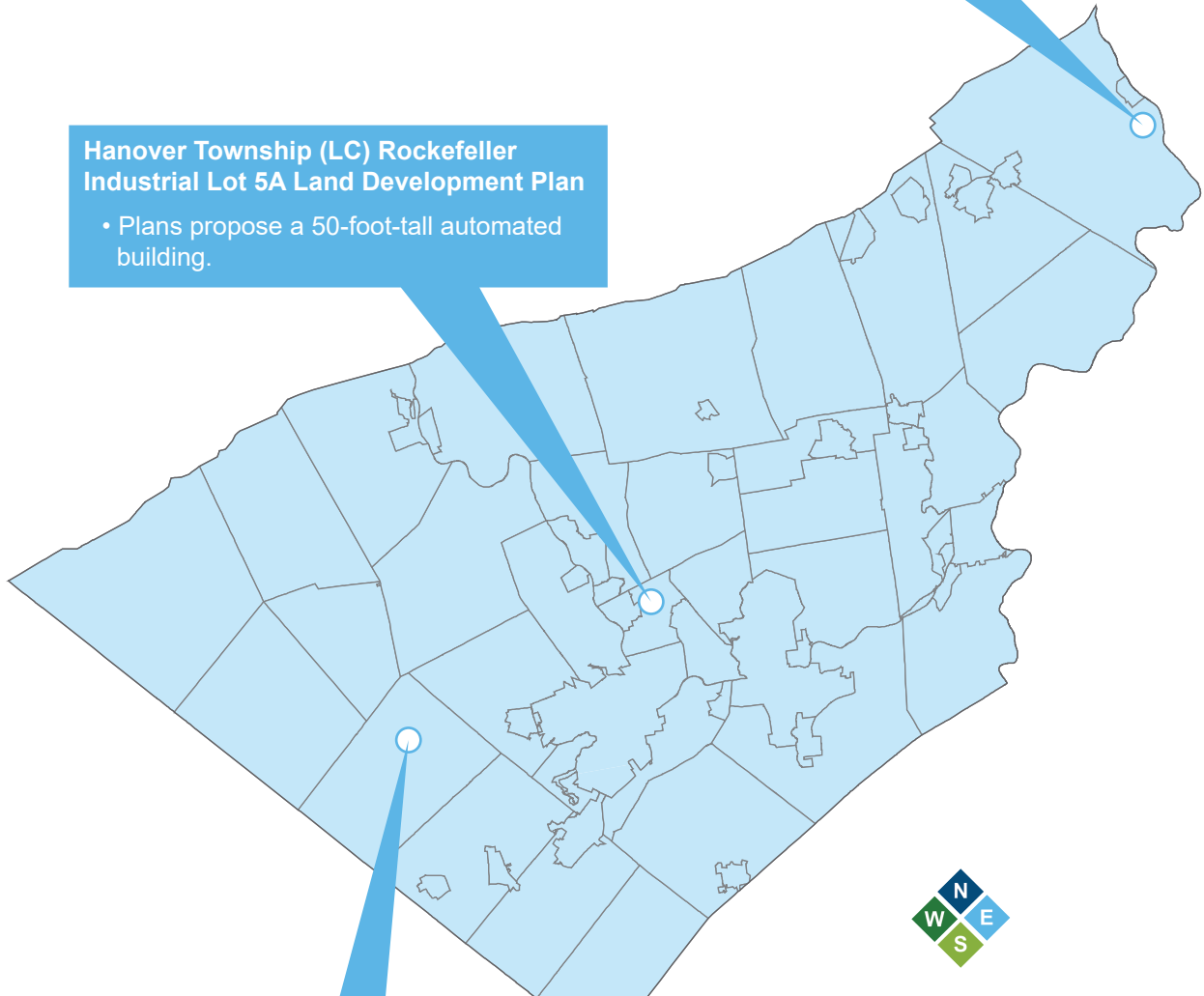
# Local Examples

**Upper Mount Bethel Township Proposed Ordinance Amendments**

- Ordinance proposal would allow for building heights of 100 feet by right, and 110 feet with conditional use approval.

**Hanover Township (LC) Rockefeller Industrial Lot 5A Land Development Plan**

- Plans propose a 50-foot-tall automated building.



**Upper Macungie (Americold) Zoning Ordinance Amendment**

- Original ordinance proposal would allow for buildings up to 140 feet in height.
- Ahead of the proposed ordinance amendment, the Upper Macungie Zoning Hearing Board allowed for a height variance up to 140 feet. The Upper Macungie Board of Supervisors appealed the decision and a Lehigh County Court judge overturned the zoning hearing board decision.

# Municipal Considerations

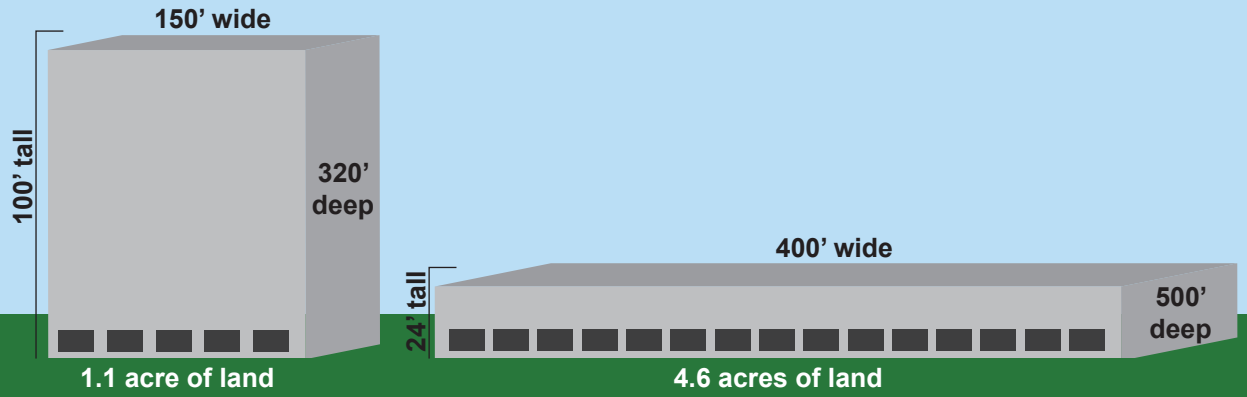
High cube and automated warehousing brings numerous implications that should be considered and planned for by local leaders in response to changing landscapes, safety and quality of life impacts. These considerations stem from the height of these development types, impacts on the workforce, reuse potential, transportation, water, sewer and stormwater system impacts and emergency services implications. Therefore, municipal considerations are wide-ranging, from traffic and transportation, to land use and zoning, to fire and police services.

As municipalities consider the most appropriate ways to address these uses between zoning, subdivision and land development or building code regulations, it's important to understand the three distinct manners in which they may emerge:

- **New construction, or greenfield development**, involves the construction of a facility at an undeveloped new location. In this situation, municipal regulatory controls are likely to have the greatest impact because zoning, land development and building codes all apply.
- **Redevelopment** is when a building or developed site is changed. Modifications are generally considered substantial when 50% or more of the building(s) and/or site are changed. This covers everything from a tower or major addition to an existing building, a large industrial use change that would markedly increase traffic but may not alter the structure of the existing building, or a complete removal of existing structures to build new. Municipal control in redevelopment will depend on the scale and extent of which a building and/or site is redeveloped. Zoning and building codes review will apply in all cases, however in major redevelopments local land development regulations should also apply.
- **Retrofit** of a facility for automated uses includes retention of the existing building and site, with interior renovations to accommodate the new use. Essentially, no volume changes to the existing building are proposed and alterations are largely, if not exclusively, internal. In these cases, municipal regulatory options are limited, with building codes likely the only management tool available, though there may be exceptions depending on the use categories defined in the zoning ordinance.

Volume is a vital consideration in high cube and automated warehousing because instead of the traditional model of storing goods on the ground floor, nearly all of the space within a high cube building is used for goods storage. While a 24-foot traditional warehouse is often shorter than a typical three-story home, a 100-foot high cube warehouse rivals the nine or ten stories found in Allentown's Lehigh County Courthouse or Easton's Alpha Building.

This 3D graphic illustrates the same 4.8 million cubic volume of space allocated in a high cube versus a traditional warehouse. The traditional warehouse is 200,000 square feet with a 24-foot ceiling height common in the Lehigh Valley, built over 4.6 acres of land, while the footprint of a 100-foot ceiling height high cube fits on 1.1 acre of land.



Municipal governments can be challenged in determining which rules and regulations apply as a result of the variety and scale of high cube and automated warehousing. It is easiest to think about the volume of a development as a measure of its impact on the community.

## Zoning Ordinance

- **New construction:** Requires zoning approval for appropriately locating the land use within a community and on the property itself.
- **Redevelopment:** Standards for zoning districts must be met, although a comprehensive review of the proposal in consideration of all standards within the zoning ordinance may only be required when a substantial change to the site is proposed, such as a change to the building footprint or land use. For example, the Americold cold storage facility in Upper Macungie Township is pre-existing, therefore, increasing the height scale of that existing use above the locally allowable limit has triggered a zoning review and subsequent height variance request.
- **Retrofit:** Least likely to trigger a zoning review, unless there are significant site improvements proposed simultaneously, because the use and building footprint are not typically changing. Though substantial changes in water, sewer, stormwater, electric, gas, transportation and emergency management services needs may require other reviews and permits beyond zoning. Specifically defining High Cube and Automated Warehouses in the zoning ordinance is extremely important here. A retrofit that changes the defined use of a facility will trigger a zoning review and enable the municipality to better assess the impacts of the proposal on the community.

In any of the three potential development scenarios, the land use must be permissible in the zoning district in which it is proposed. In all cases, a project cannot exceed maximum lot or building provisions standards outlined for the applicable zoning district.

## Subdivision and Land Development Ordinance

- **New construction:** New developments require a subdivision and land development plan, enabling a community to more comprehensively assess impacts of the proposal. The provisions of the municipal subdivision and land development ordinance are applicable for new projects, including general impact and improvements provisions. The Pennsylvania Municipalities Planning Code specifically requires that, at a minimum, development plans outline “any subdivision, all covenants relating to use, location and bulk of buildings and other structures, intensity of use or density of development, streets, ways and parking facilities, common open space and public facilities.” [Act of 1968, P.L.805, No.247 as reenacted and amended, Article 1§107. Definitions].
- **Redevelopment:** The municipal subdivision and land development ordinance typically only applies if the proposal substantially changes the site or the building. Again, the Pennsylvania Municipalities Planning Code gives broad power to the municipal government to decide whether to process a redevelopment plan as a retrofit or a development proposal. Specifically, the state law broadly outlines:
  - “(1) The improvement of one lot or two or more contiguous lots, tracts or parcels of land for any purpose involving:
    - (i) a group of two or more residential or non-residential buildings, whether proposed initially or cumulatively, or a single non-residential building on a lot or lots regardless of the number of occupants or tenure; or
    - (ii) the division or allocation of land or space, whether initially or cumulatively, between or among two or more existing or prospective occupants by means of, or for the purpose of streets, common areas, leaseholds, condominiums, building groups or other features.” [Act of 1968, P.L.805, No.247 as reenacted and amended, Article 1§107. Definitions].
- **Retrofit:** May or may not require a land development plan based on the intensity, timing, character and cumulative nature of what is being proposed.

This table provides a quick reference for which municipal tools are most applicable to each development scenario:

### Local Regulatory Authority: What Tools Apply and Where

Development Type	Zoning Ordinance	Subdivision and Land Development Ordinance	Building Codes
New Construction	Yes	Yes	Yes
Redevelopment	Situational <ul style="list-style-type: none"> <li>• Change of use</li> <li>• Site improvement qualifying as land development (as defined by the MPC)</li> </ul>	Situational <ul style="list-style-type: none"> <li>• Over 50% change to building or site</li> </ul>	Yes
Retrofit	Situational <ul style="list-style-type: none"> <li>• Change of use</li> </ul>	Unlikely	Yes

### Building Codes

In cases of redevelopment and retrofit where only building codes apply, municipalities should establish a process by which they can adequately determine the same use-related information that would otherwise be provided in a zoning or subdivision and land development review. The Pennsylvania Universal Construction Code is a statewide standard, applicable in all development scenarios that a municipality cannot supersede. However, the building code review process contains opportunities to implement alternative tools to help assess impacts of a development. An assessment form, for example, may provide a municipality with information relating to impacts to emergency services, transportation infrastructure, the economy and the environment.

# Land Use and Zoning Implications

Municipalities and the development community should work together to identify and address the potential impacts of high cube and automated warehousing, as municipalities amend their zoning ordinances and subdivision and land development ordinances to reflect these emerging and rapidly evolving uses. High cube and automated warehousing can happen anywhere, from new construction on former agricultural fields, to redevelopment of existing retail properties, to retrofit of existing buildings. When evaluating these different development approaches, municipalities should consider the tools at their disposal in the form of zoning ordinances, subdivision and land development ordinances, and building codes, that can assist in planning for an increase in these uses, while mitigating adverse community impacts.

The following sections provide specific considerations for communities when assessing potential impacts—positive, negative or neutral—of high cube and automated warehousing:

## Permitting and Review/Approval Process

Municipalities looking to regulate high cube and automated warehousing in their zoning ordinances should consider a number of zoning specific factors, including refining industrial use types, as high cube and automated warehousing uses require specific definitions and regulations.

### Zoning Districts

Zoning district locations are critically important for matching the intensity of land use with locations that minimize impacts and provide the best outcomes for municipalities. Generally, locating these uses in existing industrial parks and in urban areas with proximity to major arterial roads and highways will mitigate conflicts between area residents and commercial vehicles. Municipalities must balance their needs between matching building form and scale, to matching transportation demands, to appropriate infrastructure. Locating a high cube or automated warehouse in an urban area with similar building heights may be appropriate for the landscape, but traffic generated by the use may also be detrimental to the street network. Conversely, matching the use and scale of development to appropriate infrastructure may result in an inconsistent building form if there are no existing buildings of the same scale.

### Special Exceptions and Conditional Use

Municipalities should consider allowing these as special exceptions or conditional uses, rather than uses permitted by right, to allow thorough understanding of project specifics and resulting impacts of the proposed use.

**“Special exceptions and conditional uses are usually reserved for those land uses that will have a significant impact on the zoning district or the whole community, or for those uses that necessitate additional safeguards. Common examples of such uses include, but are not limited to, landfills, warehouse and distribution facilities, telecommunications towers, etc. These additional safeguards take the form of specific standards and criteria stated in the zoning ordinance. The applicant for a special exception or conditional use must demonstrate compliance with the specific standards and criteria stated in the zoning ordinance.”**  
- Pennsylvania Department of Community and Economic Development, Planning Series 07

Municipalities should position themselves for developing the best projects in the interest of their community by periodically reviewing and amending ordinances to reflect modern or emerging development trends like high cube and automated warehouses. Subdivision and land development ordinance amendments should be made to require an impact analysis for these specific types of uses. Analyses should consider not only traffic impacts but economic impacts, such as job creation, as well as environmental impacts, including but not limited to viewshed analysis and environmental impact evaluations. Studies of this nature allow communities to make more informed decisions on land development proposals, especially related to public safety.

## Sketch Plans

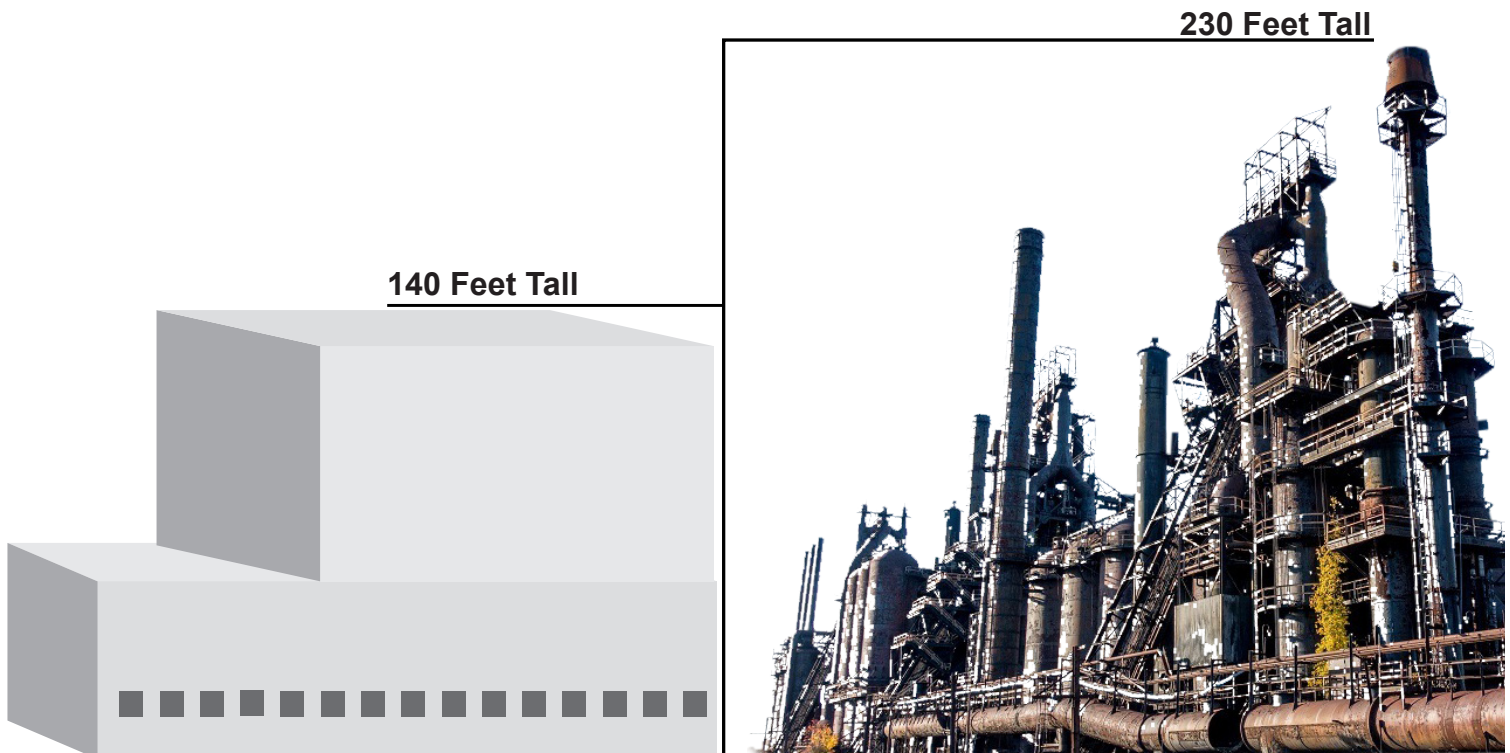
One tool used to facilitate conversations between a municipality and developer is a sketch plan. A sketch plan submittal and review requirement is designed to provide developers an opportunity to informally discuss project intentions with municipalities. The plan is reviewed for general scope and layout, conformity with applicable municipal requirements and the local comprehensive plan, as well as for conditions which might affect the implementation of the development. Incorporating a sketch plan requirement in the subdivision and land development ordinance will enable public and private collaboration to ensure the project is designed to fit the fabric of a community, while also respecting property rights. Municipalities may also choose to require that the sketch plan be reviewed by the LVPC. This is recommended, as it allows for review of consistency with *FutureLV: The Regional Plan*, and provides an opportunity for a municipality to receive additional recommendations for improving upon the proposal.

Amending both the zoning code and subdivision and land development ordinances with these provisions allows a developer, in a site development or redevelopment scenario, or an end-user, in the case of a building retrofit, to understand community needs and vice versa. This allows communities to consider industrial sector needs related to goals outlined in the comprehensive plan, empowering communities to facilitate discussion among residents, stakeholders, appointed officials, elected representatives and developers and facility end users. Ultimately, this leads to more sustainable and resilient businesses and communities.

## Height and Viewshed

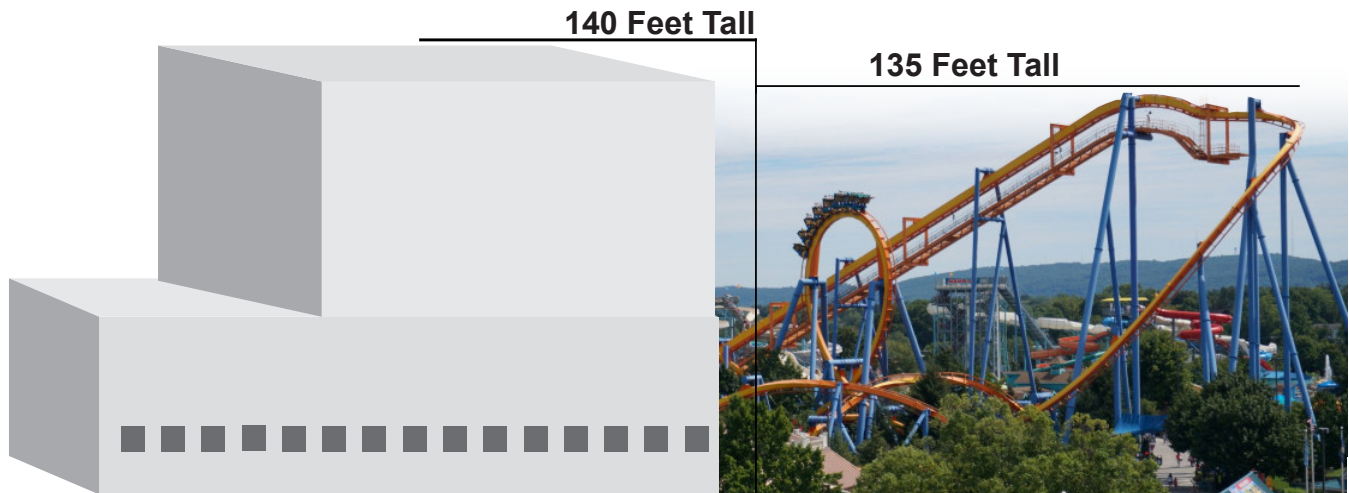
In consideration of the larger region, there is a possibility of significant changes to the landscape created by tall industrial buildings, lacking architectural features, potentially visible from miles away. These projects set unique standards for warehouse height, resulting in significant visual impacts across the region. Building architecture and articulation standards should be considered to support community character.

This substantial building height could not only change the character of the municipality where it is proposed, but of neighboring communities and even the region. Permissible building heights should take into account distance to adjacent buildings and property lines to avoid impacts to emergency access and changes in neighborhood character—both critical to safety and to the tax base. Topography and tall structures nearby are also considerations for viewshed impacts. For example, a 100-foot-tall high cube warehouse may not have a negative impact in a location with other tall buildings or high hills or mountains.



Height of high cube warehouse compared to Bethlehem Steel Blast Furnaces

On the other hand, high cube warehousing could have a sharp effect if the heights of buildings nearby or topography are out of scale with the proposed tall structure. In these cases, the high cube warehouse becomes the “landmark” or the dominate feature in the landscape. In communities and neighborhoods with lower height buildings and flatter topography, taller structures will have more of an impact.



Height of high cube warehouse compared to Talon rollercoaster at Dorney Park

The contrast between these two points of reference is created by the topography and character of the communities in which they are located, and underscores the importance of municipal height and viewshed consideration.

Communities should amend subdivision and land development and zoning ordinances to require viewshed information and analyses to assess the potential impacts, both positive and negative, where high cube and automated warehousing is proposed. Appropriateness of these taller structures in environments that can accommodate their impacts to the landscape, such as in existing industrial parks, with similarly tall buildings and where substantial elevation changes exist in the surrounding landscape should be considered.

### Airport-Related Height and Use Restrictions

An important consideration municipalities must make in allowing for high cube and automated warehousing are Federal Aviation Authority (FAA) height restrictions related to airports. These regulations are reinforced through Pennsylvania Act 164 of 1984, the Airport Hazard Zoning Law.

Height restrictions exist to ensure obstructions, such as buildings and signs, are not constructed in airspace associated with airport approaches. They are mandated through both the state and federal governments and should be reflected in municipal ordinances through airport overlay zoning. The FAA identifies surface zones, which are associated with aircraft approaches to airports and have varying degrees of height restrictions depending upon the type of aircraft utilizing the airport, approach paths and topography, among other things. These height restrictions must be considered when municipalities are implementing zoning ordinance changes.

Regionally, the Lehigh-Northampton Airport Authority oversees Lehigh Valley International Airport, Queen City Municipal Airport and Braden Airpark. Half of all municipalities in the Lehigh Valley are within one or more surface zones. As many municipalities are experiencing the pressure of industrial growth, coordination with the Lehigh-Northampton Airport Authority and implementation of standards that do not allow for obstructions in airspace is vital.

Use restrictions are also a consideration for municipalities that are within surface zones. The permissibility of industrial uses is not of concern outright, but detailed assessment should be made into the proposed materials used, stored or manufactured at facilities within the surface zones to ensure no site-specific hazards are presented. Limitations or outright prohibition should be made to the extent and intensity of hazardous materials stored or utilized at high cube and automated warehouses to mitigate impacts of a disaster, should one occur.

Municipalities must also consider that they are likely at increased liability should an emergency event occur without these mandated restrictions in place. While municipalities move to adopt standards in response to the emergence of high cube and automated warehousing, they should utilize the opportunity to incorporate provisions reflective of their proximity to the Lehigh Valley's airports and related surface zones.

## Emergency Response

Structures of this scale and height pose a need for thorough evaluation of services provided by fire companies, police forces and emergency medical operations. These considerations are especially important for those entities that rely on volunteers, have equipment that can only serve lower height buildings, and organizations that lack specific emergency response training for larger, taller and high-powered (potential electrical, hazardous materials risks) facilities. Communities should evaluate the equipment required to mitigate emergency situations and engage service organizations in conversations about capital equipment needs, training and resources necessary to serve these facilities. Simultaneously with the development or use alteration or change, communities need to understand the fiscal impact and ultimate pressure on the tax base.

### Emergency Services Impact Statement

Municipal subdivision and land development ordinances should be amended to reflect standards that consider the equipment and capital needs of emergency service operations. The best way to do this is to involve emergency management personnel including police, fire and ambulance services, in the application review process. Emergency services impact statements, which could be in the form of a questionnaire included with the zoning or subdivision and land development application, should be developed and codified for high cube and automated warehousing proposals. This is especially vital to the success of service provisions to existing facilities that are retrofitted to accommodate these emerging technologies. Impacts evaluated in association with existing facilities should consider not only those on the surrounding community but also on the project site, such as reviews of parking, drive aisle, fire lane and staging adequacy.

In many ways, use changes or expansions should almost be treated like a new development proposal by the local government. This doesn't necessarily mean that a full land development application is required, though it could, depending on the extent of the proposal. In some cases, a municipality may simply require a building permit to retrofit a structure. However, if traffic could double, the types of materials stored is changing, volume of goods warehoused is substantially increasing, or amount or type of energy being used to operate a facility is changed, then emergency response needs will change.

### Public Safety Committees

In order to facilitate communication and coordination between emergency response organizations affected by a development proposal, it is recommended that municipalities establish a 'public safety' or 'emergency services' committee. As appropriate, based on entities providing service in a particular municipality, the committee should be comprised of local police, state highway patrol, fire companies, ambulance services, municipal public works departments, and appointed municipal residents. This committee would afford an early opportunity for engagement and review of the potential impacts of a plan on the general health, safety and welfare of a community.

A committee of this sort would further allow for emergency services, such as fire departments, to coordinate anticipated emergency response and planning for future service to a proposed high cube or automated warehouse, and ensure that the most accurate data is included in the *Lehigh Valley Hazard Mitigation Plan*. It is important for first responders to have knowledge of the internal structure of a building, any operations that may hinder or complicate emergency response and inner workings of a proposed facility, including any hazardous material situations particularly involving automation or stored goods. The location of areas accessible to employees is also important to planning for future public safety needs, especially in high cube and automated warehouses where employees are not generally located within the structure above the typical first floor height.



## Economic Impacts

The LVPC recommends that municipalities incorporate requirements for the economic study and assessment of development impacts into their subdivision and land development ordinances. Proactive municipal provisions will ensure that a community is not required to bear full responsibility for costs associated with a proposed development.

Changes in development patterns and community character associated with high cube and automated warehousing pose potential impacts to property values, for example, by reducing market interest in buying a home near a facility that has high rates of ongoing daily traffic, noise generation, or a blocked viewshed. Considerations of all possible economic impacts to the region, municipality and residents compels a partnership between the public and private sectors to ensure the long-term viability and success of these facilities. The use of cost-benefit analysis in planning, development and infrastructure decisions is vital to quantify potential impacts.

In addition to considering the amount of tax revenue a community may receive, it is important to assess potential costs to ensure:

- Public safety officials have the training and equipment needed to service a facility
- Public works and engineering departments have funding to add new infrastructure and maintain existing roads and bridges affected by new traffic and changing mobility patterns
- Transit has adequate facilities and funding to support emerging and changing transit needs

Ultimately, if workers cannot get to their jobs because of poor system quality or congested infrastructure and a lack of public safety, businesses will struggle, tax revenue will decline and the potential economic benefits of a high cube or automated warehouse will decline.



**Cargill Cooler DRY Automated Storage and Retrieval System – 103 feet – Sidney, Ohio. Photo courtesy of Griffco Design/Build, Inc.**

Job creation and retention is a major consideration and should be integral to any negotiations between municipalities and developers or end users. Municipalities can account for economic impacts of both new and existing facilities by including high cube and automated warehouses as a special exception or conditional use in their zoning ordinances as a mechanism to allow for municipal negotiation through the development review and approval process.

Counties, school districts and municipalities should consider ways to ensure a return on investment in terms of tax revenue compared to local costs associated with service of these facilities. Monitoring industrial occupancy and vacancy is also important to maintaining jobs and the tax base, and ensuring that development is as additive to the community and region as possible. Creating a database of building and property actions allows local governments to monitor use and allows municipalities, counties and the region to get in front of major changes. This allows for incentives for redevelopment; changes in employment density, transit ridership, and emergency response needs; and other impacts to be managed in the best interests of all segments of the community.

## Reusability

High cube warehousing and related industrial land uses are often built with the intent of leasing to companies based upon agreed timeframes for property rental. By leasing a property, a company does not need to commit to the additional expenses and responsibilities of long-term property ownership. At the end of a contract the leaseholder will either need to renegotiate an agreement or may be free to vacate the warehouse or industrial space. This can, in turn, create the need to redevelop or renovate such structures to attract new leaseholders.

An industrial development analysis by CBRE Group, a national commercial real estate services and investment firm, identifies the Lehigh Valley as a key region for assessment in the Interstates I-78/I-81 Corridor. Analysis from the second financial quarter in 2020 has identified several trends in the supply of industrial space for leasing that may impact the long-term viability for high cube and automated warehousing. As speculation and the supply of industrial space throughout the Lehigh Valley region has increased, the long-term usage of these structures should be considered.

The “persistent demand” for industrial space is indicative of the need to prepare for change. CBRE notes that both third-party logistics companies, e-commerce, retailers and food and beverage manufacturers are the primary sub-markets leasing industrial facilities. Space that has been vacant for several quarters was beginning to fill as a result of the stay-at-home order, which halted new construction in the spring and early summer. The Lehigh Valley, in particular, has the lowest industrial vacancy and corresponding highest contract rents in the I-78/I-81 Corridor. As the land available for industrial development declines, inventory declines and consumer demand for products and services purchased online increases, proposals for high cube and automated warehousing will only increase.

Municipalities should strive to understand the existing development trends to best plan for a healthy supply of various land use needs. Permitting too much industrial space, or any type of land use for that matter, may create an oversaturated market, and lead to high vacancy rates or a need to constantly revitalize existing structures. The technology used in high cube and automated warehouses is often built with a dual-purpose of serving as the support structure for the building frame as well as facilitating goods movement. These structures, particularly in instances of new construction, are often built to serve a specific tenant. Municipal plans and ordinances should encourage flexibility to support reusability and long-term marketability of these facilities, as the specificity of building design may reduce opportunities for reuse if the tenant vacates.

**Below is a warehouse in the City of Allentown proposed for redevelopment into apartment units in 2020. The structural building frame lends itself to a variety of reuse options that would not be available for structures built to consist only of automation technology.**



LVPC file photo

## Workforce

Approximately 10% of the region's workforce, 31,795 Lehigh Valley employees, is in the transportation and warehousing industry (Lehigh Valley Workforce Development Area Profile, October 2020). Highly-automated facilities are bound to have substantial impacts on the local and regional workforce, with the distinct possibility of requiring fewer employees. This could result in fewer jobs available to people with minimal education and younger workers with little work experience. It's a concern for many communities as the potential loss of regional warehousing jobs to robotics technology occurs simultaneously with the ongoing decline of retail positions. Scott Anderson, director of Amazon Robotics Fulfillment, said in a 2019 statement that it's possible that existing facilities will convert to high automation within the next 10 years (Gizmodo), and a 2020 report from the National Bureau of Economic Research indicates that companies are likely to move even faster towards automation investments as a result of the COVID-19 Pandemic.

As one of the largest employment sectors in the Lehigh Valley, changes in the number of warehousing jobs resulting from the trend toward automation should be closely monitored by municipalities, counties and the Lehigh Valley Workforce Investment Board. However, there is currently no data to confirm that rapidly increasing automation will result in massive layoffs in the near future. Reports by the University of California Berkeley Labor Center and Harvard Business Review suggest that automation is more so changing the day-to-day functions of existing jobs.

### Assessing Employment Impacts

Communities should assess potential employment impacts related to new development, redevelopment and retrofit projects. Public and private partnerships should be formed to ensure that developers are advising municipal governments of job creation and loss, or overall change, as a measure of impact to a community. Subdivision and land development ordinances should include provisions for economic impact statements with these types of proposals that specifically address impacts to a community's workforce. For building retrofits, where the subdivision and land development ordinance is not applicable, municipalities should consider the implementation of assessment forms with required zoning applications. These assessment forms should collect pertinent information, such as expected change in employee volume and traffic generation, so that municipalities can appropriately plan for shifts in municipal service needs.

## Sustainability and Design

Incorporating sustainable building practices and design provides immense benefits to the community and developer. Utilizing renewable resources or employing sustainable design increases asset value, and decreases operational costs for the user through energy, water, maintenance and waste savings. Additionally, stormwater management benefits are generated through overall green infrastructure design.

As communities implement sustainable building practices, the benefit of reduced building footprint through increased building height should be considered. Increased 'vertical' impact is likely to result in the need for less land to develop these facilities and will result in reduced pressure on greenfield development, helping to sustain the Valley's limited natural resources. Building retrofits for automated warehousing are also supportive of the environment in this way.



**Geneva II Warehouse in Charlotte, NC.**

**Photo courtesy of Shelco LLC.**



**Prologis Park 33 Building 1 (above) in Lower Nazareth Township utilizes energy-efficient lighting. Prologis Park 33 Building 2 (below) utilized recycled and locally sourced materials for construction.**

**Photos courtesy of Mowery**

Developers should also consider the benefits of incorporating sustainability into designs, as green building has become an increasingly popular and widespread practice that can enhance business reputation in the industry. Warehousing and distribution developers such as Prologis are pushing the envelope in this area.

Although a relatively new land use, the nature of high cube and automated warehouses to be highly efficient opens them to many sustainable opportunities to reduce development pressure and lessen their carbon footprint. Developers or end-users can initiate these energy cost savings by installing solar panels or energy-efficient light fixtures.

Municipalities can incentivize the inclusion of renewable energy systems and energy-conserving building design in their subdivision and land development ordinances, per the Pennsylvania Municipalities Planning Code (MPC) Section 503(6). For example, offering a density bonus when meeting sustainability thresholds can benefit the developer and the community by offsetting the associated costs of sustainable systems over the long-term, while lessening impacts of the development on the environment.

For greenfield and redevelopment sites, aesthetic features such as building form and shape, as well as minimum percentage of window area per building wall, would supplement these sustainable design recommendations and reduce the visual impact of the building's height. Standards for building form and shape should address wall and roof scale to break up one's line of sight. For instance, municipalities could require columns on building walls to break up the monotony of a flat wall. Minimum window requirements should ensure adequate visibility into and out of spaces accessible to employees and the creation of the appearance of windows, through building wall design, in storage areas.

Allowing high cube and automated warehouses as a special exception or conditional use supports the ability to secure minimum architectural standards. In addition to building form, architectural standards can also involve a variation of colors on building walls to reduce the perception of a 'white box', all of which can be negotiated through the special exception or conditional use process.

## Community Collaboration

Establishing a process that enables and encourages community feedback on proposals helps build trust between local governments, residents and the private sector, educates the community on the legally applicable process, and ultimately results in better projects that are more suitable to community needs and desires.

It is in the private sector's best interest to have an understanding of a community's goals and objectives. For instance, a public open house allows residents to visualize what the project may look like early in the planning process. This can garner community support and understanding, and can serve to address or mitigate concerns that may not otherwise be raised until substantial investment has already been made in the project design. These community engagement opportunities provide a platform for resident voices to be heard prior to any formal review and informs developers of potential historical issues within the area, such as road flooding. It also allows resident desires, such as a walking trail or buffering beyond what the subdivision and land development ordinance requires, to be considered.

In addition to internal meetings held between a municipality and developer, pre-submission meetings can involve the other community partners, such as the LVPC, Lehigh and Northampton Transportation Authority (LANTA) and the Lehigh Valley Workforce Investment Board. Pre-submission meetings are highly encouraged because they offer parties the opportunity to provide higher-level insight into regional implications and consider a holistic approach to development, transit accessibility and sourcing workers once the project is completed.

## Traffic Impacts

Changes to existing traffic patterns, especially truck traffic, is a principal concern of most communities. The LVPC encourages that any special exception or conditional use, and particularly any warehouse use, include a traffic impact study. Traffic impact studies are reports that estimate the changes that are likely to occur to the overall transportation network near the land development project based upon access needs, projected trip generation of traffic and potential effects to congestion along access roads.

### Traffic Impact Studies and Trip Generation

Traffic impact study requirements are established within a municipality's subdivision and land development ordinance. A traffic impact study is another tool used to assess the ramifications of a development, inform of future transportation constraints and enable a community to plan the best possible project outcome. Transportation impacts specifically related to high cube and automated warehousing are not fully known and are changing rapidly, therefore such scrutiny should be taken for these types of land uses.

Traditional and high cube warehouse land uses are each estimated by a separate traffic trip generation rate by the Institute of Traffic Engineers (ITE) Trip Generation Manual, 10th Edition. The ITE Manual is the engineering standard for calculating estimates of vehicle trip generated by developments. There is a relatively small volume of study information available in the high cube warehouse land use database. The database relies primarily on floor area, while there is a stronger correlation between vehicle trips and building gross square footage in regard to high cube warehousing. Gross building storage square footage is currently not available in the ITE Trip Generation manuals.

The ITE manual calculates traffic based only on gross floor area, a reflection of traditional warehouse footprints, which may not necessarily reflect the impacts of structures with storage capacity of 100 vertical feet or more. In essence, by measuring only floor area ITE treats a 24-foot-tall building with a floor area of 200,000 square feet the same as it treats a 100-foot-tall building with 200,000 square feet of floor area. In reality, the 100-foot-tall high cube or automated warehouse building is akin to stacking four traditional warehouses on top of each other.

## Trip Generation Example

For the purposes of this example, every land use category in ITE in regard to warehousing was calculated with a base assumption of a structure of 1,000,000 square feet gross floor area

Land Use Category	Description	250,000 SF (GFA)		250,000 SF (GFA)		1,000,000 SF (GFA)	
		Total Trips	Truck Trips	Total Trips	Truck Trips	Total Trips	Truck Trips
Land Use 150: Warehousing	A warehouse is primarily devoted to the storage of materials.	435	150	870	300	1,740	600
Land Use 154: High-Cube Transload and Short-Term Storage Warehouse	Buildings that have a primary function of consolidation and distribution of pallet loads (or larger) for manufacturers, wholesalers, or retailers. They typically have little storage duration, high throughput, and are high-efficient facilities.	350	55	700	110	1,400	220
Land Use 155: High-Cube Fulfillment Warehouse	A facility characterized by a significant storage function and direct distribution of e-commerce product to end users. These facilities typically handle smaller packages and quantities than other types of HCWs and often contain multiple mezzanine levels.	<b>Sort Warehouse</b> 1,610      48		<b>Sort Warehouse</b> 3,220      95		<b>Sort Warehouse</b> 6,440      190	
	<b>Sub-Categories of Land Use 155</b> <b>Sort Warehouse:</b> Fulfillment center that ships out smaller items, requiring extensive manual sorting. <b>Non-Sort Warehouse:</b> Fulfillment center that ships large box items that are processed primarily with automation.	<b>Non-Sort Warehouse</b> 453      58		<b>Non-Sort Warehouse</b> 905      115		<b>Non-Sort Warehouse</b> 1,810      230	
Land Use 156: High-Cube Parcel Warehouse	Warehouses that typically serve as regional and local freight forwarder facilities for time sensitive shipments via airfreight and ground carriers. These sites also often include truck maintenance, wash or fueling facilities.	1,158	145	2,315	290	4,630	580
Land Use 157: High-Cube Cold Storage Warehouse	Facilities typified by temperature-controlled environments for frozen food or other perishable products.	530	188	1,060	375	2,120	750

Careful consideration is necessary to develop policies regarding a 'warehouse built on top of a warehouse'. As these uses appear it may mean radical changes in trip generation calculations. The goods stored and moved are available in far greater quantities when stored vertically rather than in traditional warehouses, making assumptions of transportation impacts a complicated endeavor. The limited data available for cold storage facilities produce acceptable levels of accuracy for vehicle trip estimates. However, vehicle trip generation rates based on data collected in recent years are higher than those derived from data collected at least 10 years ago. It is recommended that further investigation be made into the existing data and that additional data be collected.

In the meantime, it is anticipated that industrial developers and engineers will utilize the ITE Trip Generation Manual to calculate vehicle trips and level of service changes to the roadway system. It is critically important to note that bridge sufficiency ratings, pavement quality and maintenance, transit connections, air quality impacts, among other key questions should be addressed as part of a transportation impact statement. Some of these factors have standardized data available to assess impacts, like the ITE Manual and PennDOT traffic safety data, but other impacts are more localized, like bridge condition assessments or the ability of a road to withstand higher frequency and higher weight vehicles without falling apart. Proximity to housing, hospitals, elder care facilities and schools can have impacts as well. These may be negative, such as lowered air quality, or positive like infrastructure already built to standards that support more intense uses. Transportation Impact Statement requirements should accommodate the variety of scenarios that can arise when development is proposed.

As automation makes loading and unloading of trucks more efficient, it is likely that truck turnaround time may be faster as well, enabling a higher usage of the transportation network than traditional warehousing.

Challenges have been noted, but opportunities also exist. Higher intensity uses can be clustered to target costly infrastructure improvements to limited areas, reducing upfront and long-term maintenance costs, as one example. Also, high cube and automated warehousing, in and of itself, is a significant technological achievement. This increase in efficiency and advancement can be carried beyond the building's interior and to the parking areas through electric charging stations for tractor-trailers and solar powering for the building's operation, as well as supporting automated traffic signal corridors key to reducing congestion and air pollution and enhancing emergency management services delivery. Again, each development or redevelopment will have unique needs, as will the seamless integration of that facility into the community. Holistically approaching issues and needs through traffic impact assessments can support facility and community success.

This 68-foot-tall Prologis facility in Seattle features a highway-style ramp network that enables tractor-trailers to dock at two levels of bays, potentially doubling truck traffic at the building. These increased impacts are something for the Lehigh Valley region to consider. Locations with substantial industrial development near highway interchanges, near the Lehigh Valley International Airport or along major freight corridors should prepare for highly intensive facilities as industrial land becomes more limited



Photo courtesy of Prologis

### **Truck Routes and Access**

The scoping of a traffic impact study should identify all transportation impacts, including vehicular, truck, pedestrian, multimodal and transit access. The scope of the traffic impact study should scrutinize the planned truck routes, particularly between the project location and the closest highway or interstate because the trucks utilizing these facilities will ultimately want to connect to a highway. It is critical to plan and identify the best logical and capable truck route to access these high classification roadways, to minimize tractor-trailer impacts on local roads. Improvements to potential conflict points along these routes may be negotiated between the developer, municipality and Pennsylvania Department of Transportation (PennDOT), which will ultimately make a project more accessible to tenants and users. Traffic impact studies should also consider on-site needs, including parking and insufficient infrastructure capacity.

### **Tractor-Trailer and Driver Amenities**

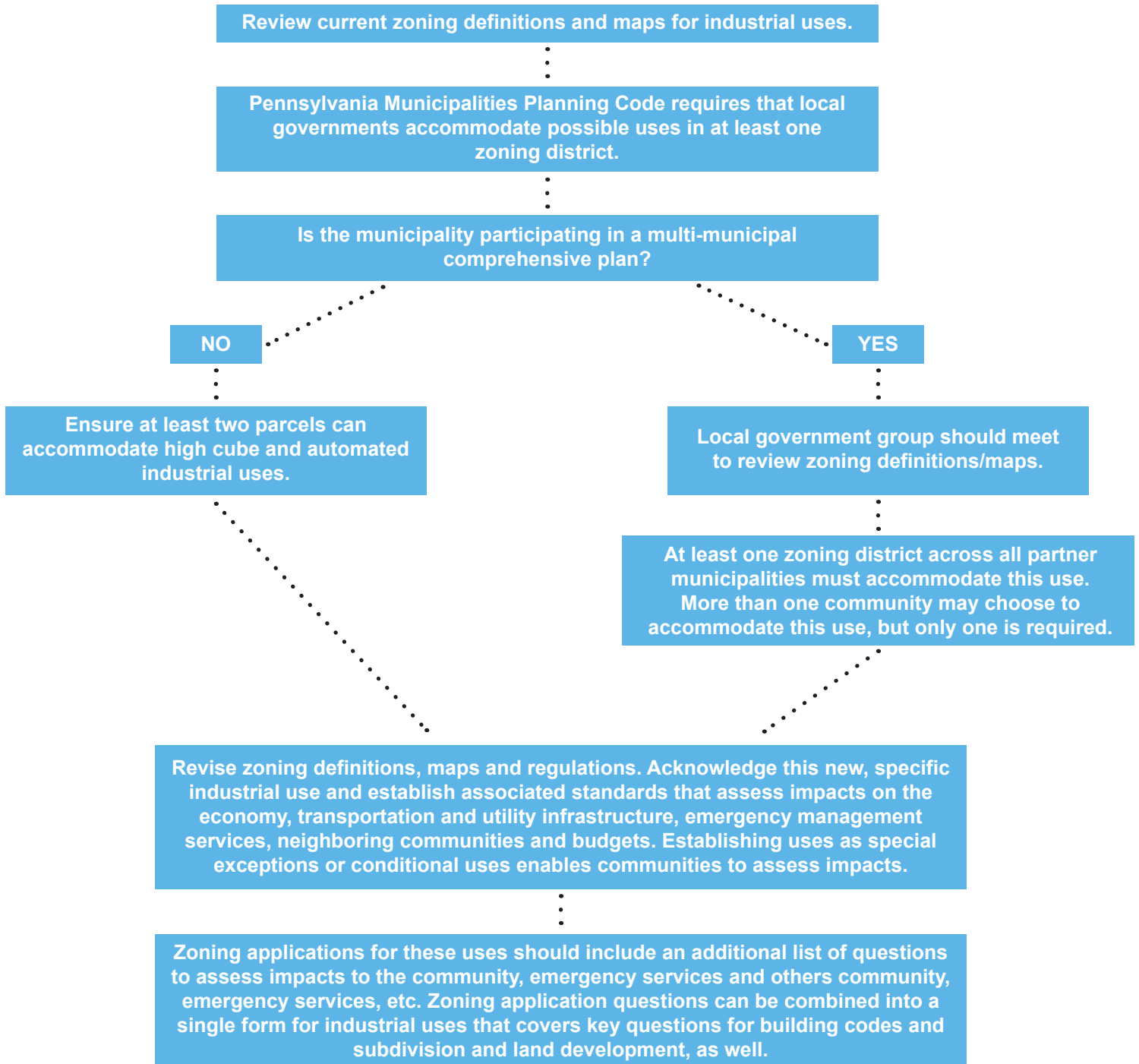
Minimum truck parking and queuing requirements at facilities, along with driver amenities, should be included within the subdivision and land development ordinance. This recommendation also involves access opportunities, such as gated facilities, to ensure that trucks are not queuing along the roadway but rather internal to the site.

Municipal standards should also require or incentivize electrical hookups within truck parking areas, both for trucks and for refrigeration trailer units in which goods are transported. Electric-diesel hybrid refrigeration trailer units are becoming more common. The availability of hookups will mitigate the impacts of diesel-run units on the neighboring area and regional air quality.

Impacts to the origin and destination of goods, as well as staging and parking concerning the commodity flows to logistics of freight, are anticipated to change. Driven by continual e-commerce demand, it is likely that regulation of these uses will require ongoing evolution to maintain the service expectations of citizens. Direct attention by both PennDOT and municipal officials should focus on monitoring traffic generation and its impact on the Lehigh Valley transportation network. The true changes to both state of good repair and existing conditions present an ongoing issue, and the growing demand on the transportation network will require continued assessment on both a case-by-case and global basis.

# High Cube and Automated Warehousing: Municipal Considerations for Updating Standards

Serving as a 'to do list' for what and how a municipality should consider making updates to local zoning codes, this chart should be used in conjunction with the detailed information provided in the High Cube and Automated Warehouse Guidance Document. Municipalities should follow a similar process when proposing updates to subdivision and land development ordinances and/or other municipal procedures and codes.





# Zoning Codes Must Consider Regulations for:

## Location

Location has a big impact on whether a land use is appropriate for that community.

### ADEQUATE ROAD, BRIDGE AND TRANSIT INFRASTRUCTURE

Where can transportation-intensive high cube or automated uses operate without adversely affecting infrastructure?

### FREIGHT ROUTES AND CORRIDORS

Where are there designated freight routes that can accommodate higher frequency and higher weight vehicles?

### QUALITY OF LIFE

Where will the 24-hour operational potential of these uses have the least impact on residential, medical, educational, recreational and other uses that's value is inherently connected to lower noise, emergency access and high air quality?

### EMERGENCY MANAGEMENT SERVICES ACCESS

Can emergency management services, including fire, police and ambulance, access high cube and automated warehouse use locations effectively?

Is there an established emergency service delivery corridor providing traffic signal preemption to these uses from police, fire and ambulance facilities and hospitals? Do traffic signals need to be upgraded in order to ensure corridors are established?

Do local emergency response agencies have adequate staffing and equipment to handle any emergency at tall or very large buildings with 24-hour operations, and as the scale of industrial facilities and multi-tenant developments grow?

Is there water capacity and conveyance infrastructure, including adequately sized pipes and fire hydrants, to fight a fire should one occur?

## Volume

Volume considers not only the building footprint, but the height and dimensions that allow more goods to be stored.

### COMMUNITY CHARACTER

What impacts does the building volume have on the community's existing character?

Consider assessing not just the front, rear and side yard setbacks, but also maximum height and size limitations.

### VIEWSHED

What is visible to and from these facilities?

Consider impacts to residential; protected open space; historic and cultural sites; parks or recreational lands; farmland; other businesses; schools; hospitals; continuing care facilities; emergency management facilities; and other types of uses.

### PROPERTY VALUES

Will property values decline in a specific neighborhood(s) or other land use or group affect municipal revenue and therefore make it more challenging for the delivery of governmental services, including but not limited to, road and bridge maintenance, sewer, water and stormwater infrastructure maintenance, police, fire and ambulatory needs?

Will a specific neighborhood(s) or other land use or group be directly affected? Will those specific neighborhoods(s) or other land use or group see a decline in the value of their property(ies)?

### QUALITY OF LIFE

What impact could an individual high cube or automated warehouse, or grouping of industrial facilities, have on the quality of life of the community?

# Conclusion

The true impacts of high cube and automated warehousing uses are yet to be fully determined. These emerging land uses pose both positive and adverse impacts to a community's transportation network, economy, municipal budget, character and viewshed. Municipalities have an interest in protecting the health, safety and general welfare of their residents through regulation of these types of warehousing. The manner and approach to regulating these land uses are based upon whether the plan is for a new construction project, redevelopment of an existing lot or renovation to an existing structure.

Municipalities are encouraged to begin early in planning for this evolving land use. The most desirable outcomes benefiting communities are achievable by leveraging proper regulations in the subdivision and land development ordinance, zoning ordinance and building codes. These tools serve to assess the real impacts of a proposal, identify appropriate locations for development and ensure the prevention of additional costs to a community. Further, they serve to support the long-term success of a development.

Continually assessing the effectiveness of subdivision and land development ordinances and zoning ordinances allows a municipality to remain abreast of rapidly evolving development and industry trends, such as high cube and automated warehousing. Engaging with the private sector, relevant municipal departments, public safety organizations and residents early and often in the planning process facilitates widespread and comprehensive understanding of overall needs, resulting in the best possible outcome for all parties.

Be proactive. Install new regulations now, before they arrive.



148-foot Americold High Cube warehouse in Atlanta, Ga. Photo courtesy of Griffco Design/Build, Inc.

# Resources

## Project Examples

<https://www.wibw.com/content/news/Frito-Lay-one-step-closer-to-building-new-warehouse-486523091.html>

<https://www.westfaliausa.com/resources/case-studies/organic-valley>

<https://www.prologis.com/industrial-logistics-warehouse-space/washington/seattle/prologis-georgetown-crossroads>

[https://www.gcca.org/system/files/coldfactmagazine/0584\\_GCCA%20ColdFacts%20CEBA%20Insert%202019\\_V6\\_lowres.pdf](https://www.gcca.org/system/files/coldfactmagazine/0584_GCCA%20ColdFacts%20CEBA%20Insert%202019_V6_lowres.pdf)

<https://rsmowery.com/project/prologis-warehouse-park-33-building-1/>

## Land Use and Zoning

<https://dced.pa.gov/download/planning-series-07-special-exceptions-conditional-uses-variances/>

Lower Macungie Township Zoning Example: Specific Criteria for Warehouse, Wholesale, Storage, or Distribution uses: <https://ecode360.com/34785641>

## Economic Impacts and Incentives

<https://www.easternlandpa.com/listings/parcel-9northampton/LERTA.pdf>

<https://www.nber.org/papers/w27249.pdf>

<https://www.itprotoday.com/artificial-intelligence/us-recession-will-automation-help-or-hurt-recovery>

<https://laborcenter.berkeley.edu/future-of-warehouse-work/>

<https://hbr.org/2015/06/robots-seem-to-be-improving-productivity-not-costing-jobs>

## Workforce

<https://gizmodo.com/fully-automated-warehouses-are-a-decade-away-amazon-sa-1834459784>

## Reusability

CBRE Marketview, Pennsylvania I-78/I-81 Corridor Industrial, Q1 2020, Market fundamentals remain strong amid speculative development starts, 2020, [www.cbre.com/researchgateway](http://www.cbre.com/researchgateway).

## Sustainability

<https://www.prologis.com/sustainable-industrial-real-estate/environmental-stewardship/LEED-certification?title=&page=0>

## Traffic Impacts

<https://www.ite.org/pub/?id=a3e6679a%2De3a8%2Dbf38%2D7f29%2D2961becdd498>



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