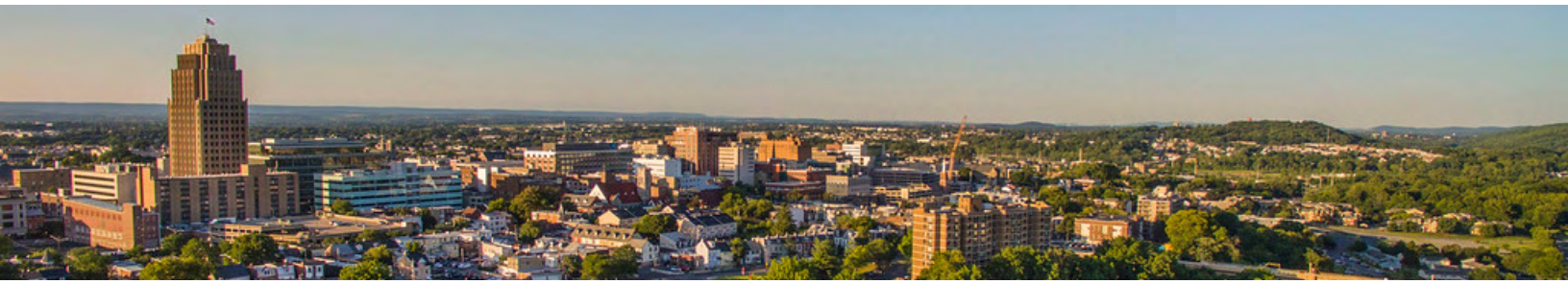
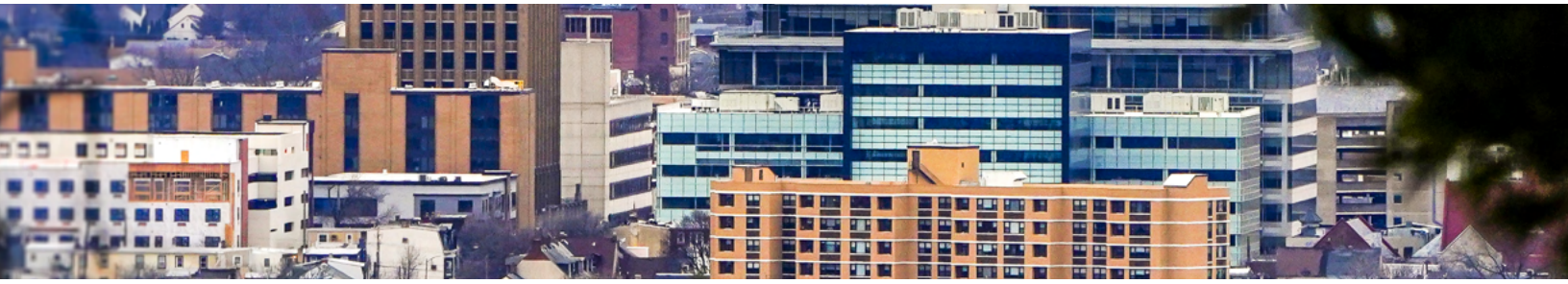
How Warehouse Growth & Modern Truck Traffic Are OVERWHELMING LEHIGH VALLEY ROADS

NEVER DESIGNED FOR IT. AND WHAT DRIVERS ARE GETTING WRONG.





HOW WAREHOUSE GROWTH &
TRUCK TRAFFIC ARE
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Credit: City of Seattle

Key Finding:

Most truck-related intersection conflicts are not random. They are the predictable result of road design and human misinterpretation.

The surge in warehouses has caused a truck traffic crisis in the Lehigh Valley, a growing reality frequently covered by local media, as exemplified by *Lehigh Valley News' Road Scholar* series.

The typical daily commute has changed in recent years. You're driving in the left lane of a four-lane local road approaching an intersection with a stoplight (one you have driven many times before). A tractor-trailer rolls up beside you in the right lane (which used to be rare). The truck prepares to turn right at the intersection, noses out, and starts a right turn that looks illegal because the truck is encroaching on your lane, until you realize the truck driver is doing the only thing physics allows: swinging wide and using more than one lane just to get through the corner.

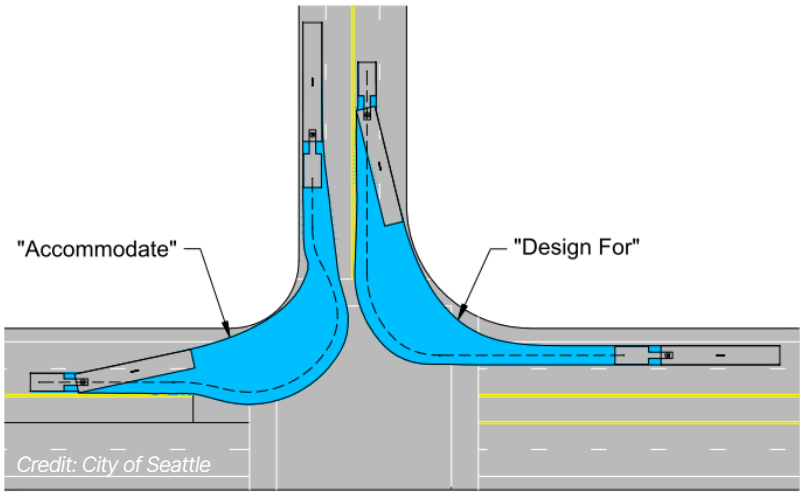
That "wide swing" is an untold story of truck safety in the Lehigh Valley. The region approved **48.1-million square-feet of industrial/warehouse development** between 2015 and 2024. Truck counts on key corridors have surged. On Route 22 just east of MacArthur Road, *PennDOT counts show trucks more than doubled, increasing from 5,593/day (2014) to 13,268/day (2024).* Trucks are increasingly showing up on local arterial and collector roads as freight moves between expressways and warehouse sites. Congestion and crash clusters are the new norm. And certain intersections are particularly dangerous now, because of the confluence of two concepts that don't get enough public attention: what civil engineers call "design-vehicle mismatch" and what traffic safety officials call "driver misperception."

LEGACY DESIGN: VEHICLE MISMATCH AND MODERN TRUCK TURNING RISK

Certain intersections present elevated crash risk today because their **geometry no longer matches the turning characteristics of the vehicles** that routinely use them. In transportation engineering, this condition is best described as a design vehicle mismatch, where intersection curb return radii, lane widths, and channelization were developed for smaller historical design vehicles and do not adequately accommodate the way in which modern 53-foot semitrailers and other large trucks execute a turn.

Modern intersection design in the United States is governed by the principles set forth in A Policy on Geometric Design of Highways and Streets, which requires engineers to select an appropriate design vehicle and ensure the intersection accommodates that vehicle's turning path (American Association of State Highway and Transportation Officials).

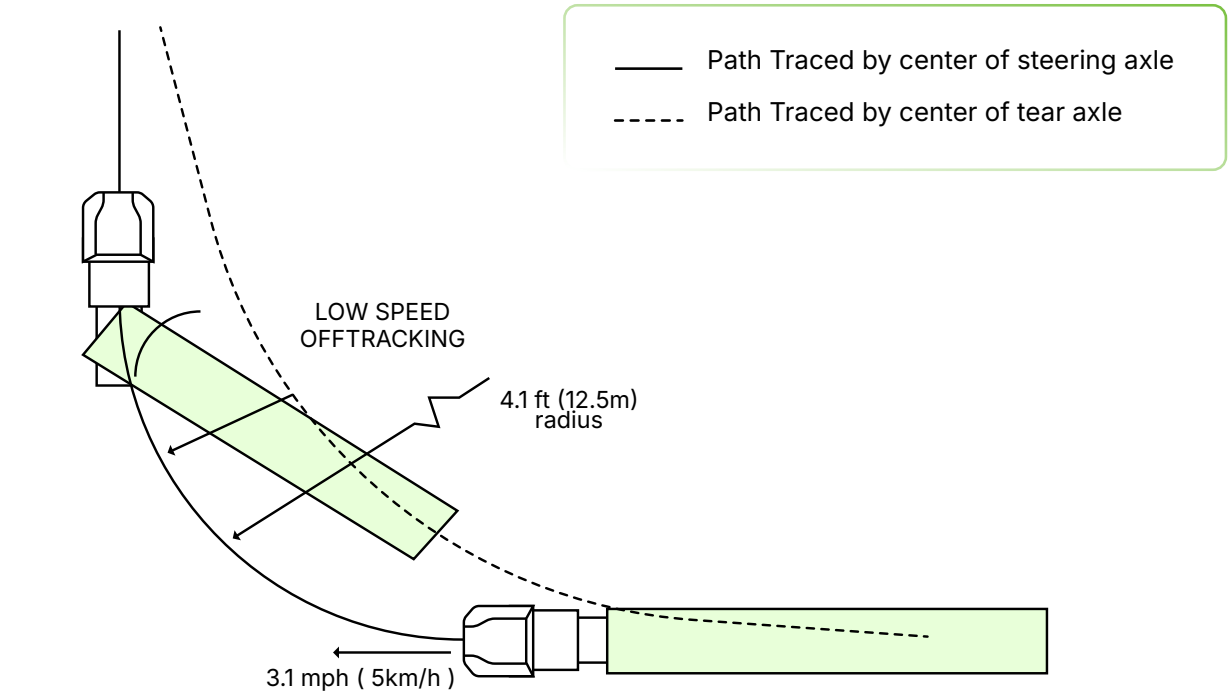
Lehigh Valley intersections were not improperly designed when constructed; rather, the functional **demands placed on them have changed** as large-scale warehouse development and increased tractor-trailer volumes have altered the traffic composition beyond the anticipated vehicles and freights of the original road designs.



Credit: City of Seattle

Semi-trucks don't turn like cars. They "offtrack."

At low speed, the trailer's rear wheels cut inside the path of the front wheels, closer to the curb. The *Federal Highway Administration (FHWA) calls this "low-speed offtracking,"* and it means that the big rig must make a wider turn to leave extra space so as to not strike the curb or anything sitting on the curb. **Wider turns mean encroaching into extra lanes.**



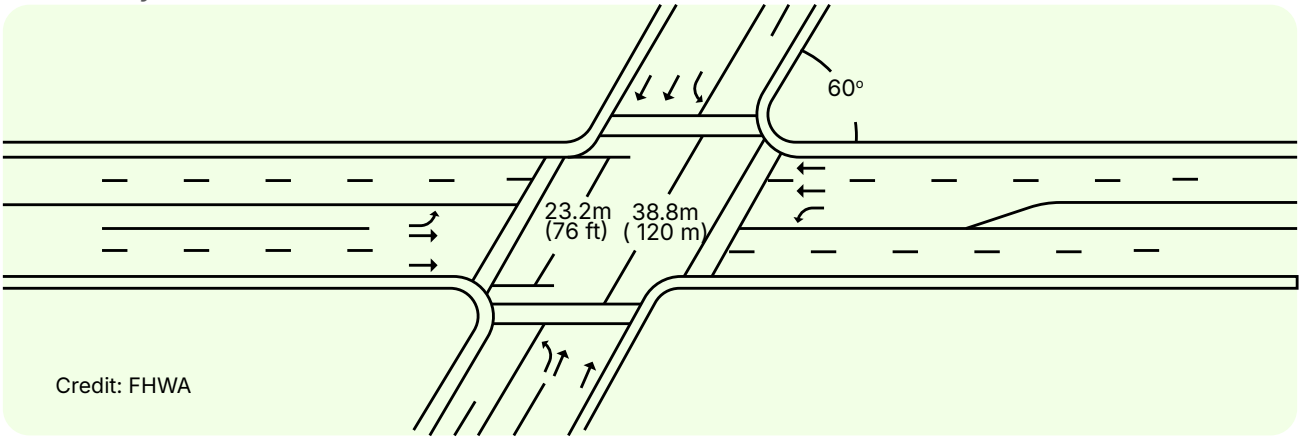
Credit: FHWA

A roadway geometry analysis published by the *FHWA* quantified low-speed turning behavior for a standard 53-foot semitrailer as a baseline comparison: Under a 90-degree right-hand turn with a 42-foot radius at approximately 3 mph, the trailer exhibited *16.1 feet of offtracking and required a 24.1-foot swept path,* effectively occupying the width of two standard travel lanes.

In plain terms: even when a truck driver makes a slow, careful right turn, the trailer naturally cuts toward the curb, forcing the front of the truck to swing wide into the next lane so the trailer can clear the corner. The result is that, for a moment, the truck and trailer together need about as much space as **two full traffic lanes,** even though nothing about the maneuver appears aggressive or out of control.

Driver Misperception

This is where driver perception error, a recognized category in traffic safety research, becomes relevant. Human drivers rely on prior experience with passenger vehicles when interpreting roadway movements. When a tractor-trailer initiates a wide entry into a turn to compensate for trailer off-tracking, that maneuver can appear to create an opening alongside the truck. At that moment, some motorists make a gap acceptance decision, concluding, incorrectly, that there is sufficient time and space to pass through what they perceive to be an available gap. Because the truck's trailer will track inward during the turn, that decision often results in the passenger vehicle moving into the truck's swept path envelope, which is the predictable **physical area the trailer must occupy to complete the maneuver**. The conflict, therefore, is not random; it arises from a misinterpretation of geometry and vehicle dynamics.



Credit: FHWA

Even where an intersection is redesigned to better accommodate large trucks, perception-based gap acceptance errors can still occur, because the visual cue of a wide swing continues to invite misjudgment independent of whether the geometry technically meets design standards.

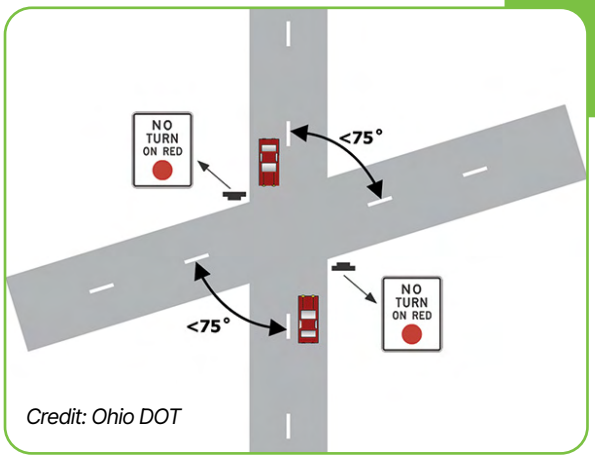
Driver misperception remains a persistent and central safety challenge in intersection conflicts involving large trucks. Precise archival records detailing the original design-vehicle assumptions for specific Lehigh Valley intersections, including whether they were configured to accommodate the largest of tractor trailers using our Lehigh Valley warehouses, were not reviewed for this article. Even assuming that certain intersections were originally designed to accommodate larger combination vehicles operating in today's freight environment, the interaction between truck turning dynamics and human perception would still present risk, because visual misinterpretation of wide turning maneuvers can occur independent of whether the underlying geometry technically satisfies contemporary design criteria.

From a practical perspective, tractor-trailers are making these turns on an everyday basis and we've all experienced it at intersections and accommodated the large truck once in a while. As a driver we just make room for and respect the truck so it can complete its turn. But **as frequency increases, natural human behavior tends toward less patience** for frequent wide turns, further contributing to intersections becoming daily conflict zones.

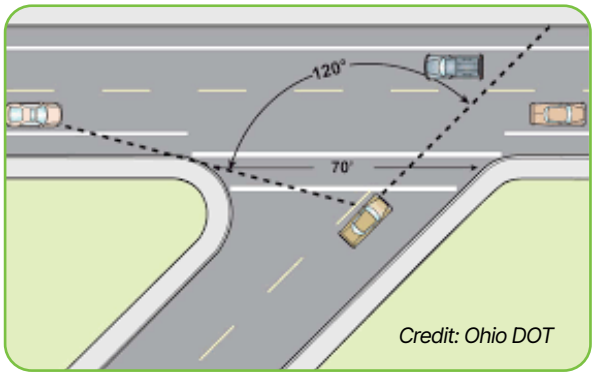
Skewed intersections make the problem worse

A skewed intersection is one where roads meet at an angle other than near-90-degrees (often 60–75 degrees, sometimes less). For example, instead of making a traditional right turn, the driver is cutting hard as if at the point of a triangle.

From a safety and operations standpoint, skew matters because it **changes geometry, timing, and visibility all at once,** and those effects compound when trucks are involved.



Credit: Ohio DOT



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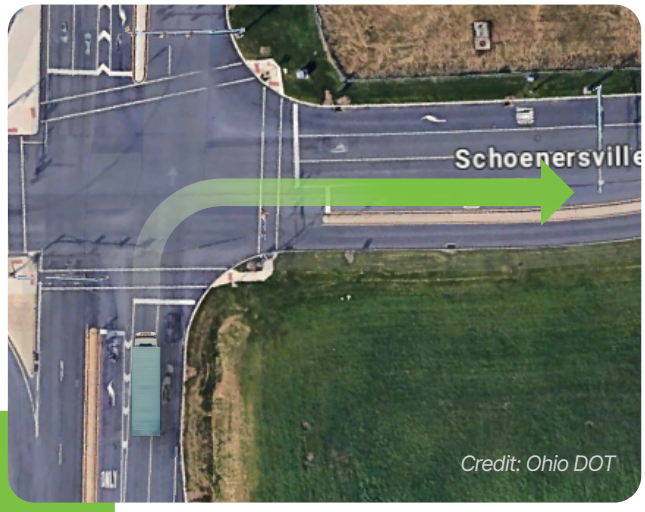


Credit: Ohio DOT

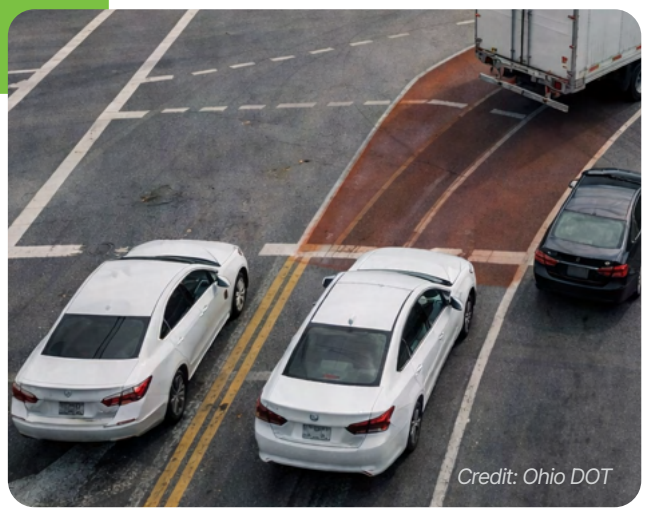
At a near-90° intersection:

- Vehicle paths cross quickly
- Exposure time is short
- Turning paths are more predictable.

At a skewed intersection:

- Crossing distances are longer
- Vehicles occupy the intersection for more time
- Turning movements overlap with through movements for longer distances.


Credit: Ohio DOT


Credit: Ohio DOT

For trucks, that means:

- Longer time spent blocking lanes while completing a turn
- More opportunity for cars to arrive beside or behind the truck mid-maneuver.

This is why *Federal Highway Administration* guidance consistently notes that near-right-angle intersections are the safest geometry, and that severe *skew creates operational and safety problems that often require mitigation.*

Skewed intersections didn't become more dangerous overnight. As warehouse traffic increases, their **weaknesses are exposed more often.** The longer trucks occupy the intersection, the more time their wide turning paths present a conflict, and the harder it is for other drivers to judge gaps and anticipate movements. In a region like the Lehigh Valley, where many arterial roads *predate modern design standards, skewed intersections turn routine truck movements into recurring conflict points.*

TRUCK-CRITICAL ROAD DESIGN FEATURES ARE MISSING OR STRAINED IN THE LEHIGH VALLEY

The Lehigh Valley does not lack engineering knowledge about how to design intersections for trucks. What it lacks, by history and circumstance, is consistent incorporation of truck-critical features across a road network that was *largely built before modern freight volumes existed.*

Tight curb radii and limited turning aprons

The term "radii" simply refers to the plural of radius in the context of turning: the curved distance that a vehicle's wheels follow when it makes a turn, like tracing part of a circle on the road.

Many arterial and collector-road intersections in the Valley were designed for:

- Passenger vehicles
- Farm equipment
- Occasional industrial trucks; not frequent 53-foot semitrailers.

Curb return radii at older intersections are often **too tight to allow trucks** to turn without encroaching into adjacent lanes or shoulders. While a single truck can usually complete the maneuver slowly, frequent truck turns make lane borrowing **routine rather than exceptional**, increasing the likelihood that a passenger vehicle will be alongside a truck during a wide turn.

What can be done about the tight curb radii? **Truck aprons** - mountable paved areas designed to accommodate large vehicles' turning paths and reduce offtracking conflicts - are a recognized design treatment to **help long trucks navigate intersections.** Though on many state and locally maintained corridors in the Lehigh Valley - including key freight feeders such as Routes 22, 309, and 33 - *freight infrastructure planning documents* identify a need for **intersection and corridor upgrades,** implying that present accommodations are inconsistent or under-provided relative to current truck volumes.

Credit: Ohio DOT

Certain intersections are more difficult for big trucks to navigate.

EXAMPLES OF "TRUCK-CONFLICT HOTSPOT" INTERSECTIONS ACROSS THE LEHIGH VALLEY

Understanding the mechanisms of the way tractor-trailers turn matters in part because fatal truck crashes are often not "truck-only" events. The *National Highway Traffic Safety Administration reports* that **80%** of large trucks involved in fatal crashes are in **multi-vehicle crashes.** And in Pennsylvania, *PennDOT's 2022 crash report* notes that crashes involving heavy trucks and fatal injury crashes were the highest in the last five years (as of 2022).

Following are only a few examples of intersections repeatedly flagged in reporting, planning discussions, and crash databases in Lehigh and Northampton Counties:

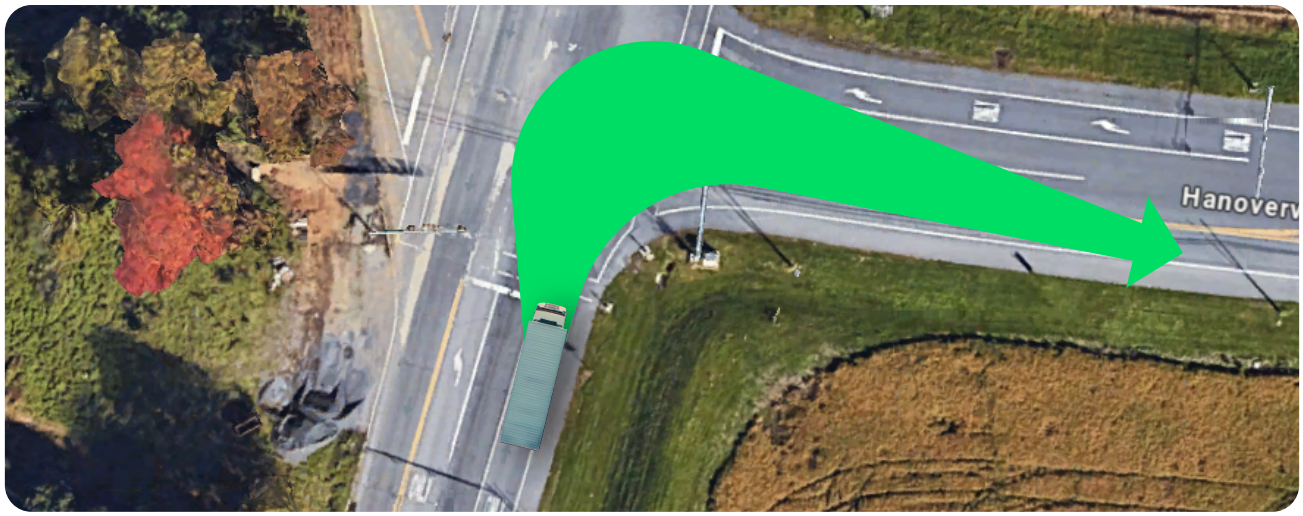
Airport Road (Hanover Twp. corridor)

LehighValleyNews reports about *2,270 big rigs per day on Airport Road* (between City Line and Grove) as of early 2025, up from 901/day in 2013 on that segment. Airport Road now functions less like a local collector and more like a freight access spine, serving multiple warehouse and logistics facilities. The safety issue here isn't speed or volume by itself. It's the **frequency** of low-speed truck turning movements on geometry that leaves little margin for error.

At many Airport Road intersections, curb radii and lane alignment were designed for cars and occasional trucks. When a 53-foot semitrailer turns right or left from Airport Road into an access drive or cross street, the trailer's rear wheels naturally cut toward the curb. To keep the trailer from striking the curb or roadside objects, the tractor must swing outward, often occupying part or all of the adjacent lane.

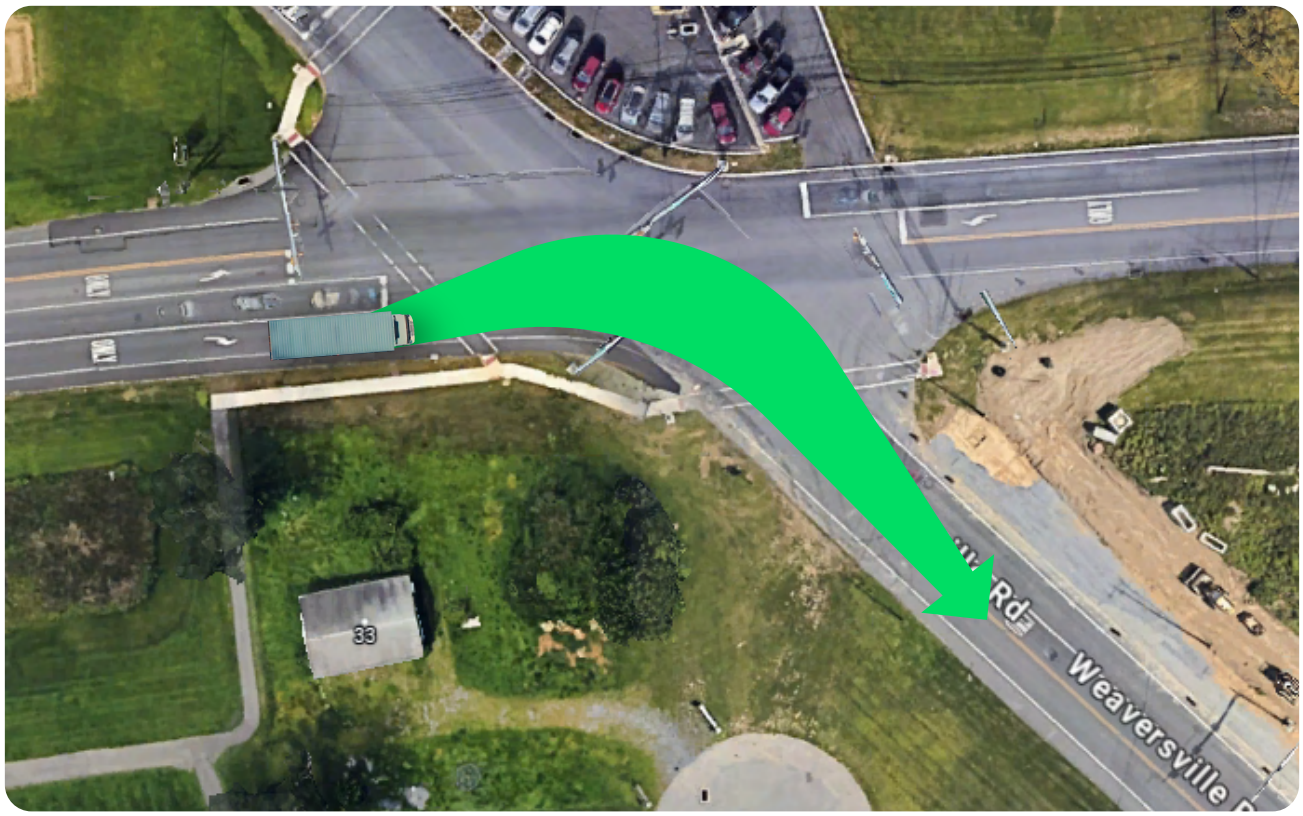
Because these turns happen repeatedly throughout the day, Airport Road spends long stretches of time in a "wide-turn condition," where the **lane next to turning trucks is not reliably available** (even if pavement markings suggest otherwise).

In one specific instance, *public planning documents* for the Hanoverville Road intersection describe **repeated contact** between heavy vehicles and overhead signal equipment, leading to recommendations to raise signal heads to meet PennDOT clearance standards. That type of recommendation only appears when turning and approach movements are **physically incompatible with existing infrastructure.**



PA 329 (Nor-Bath Boulevard) & Weaversville / Howertown Road

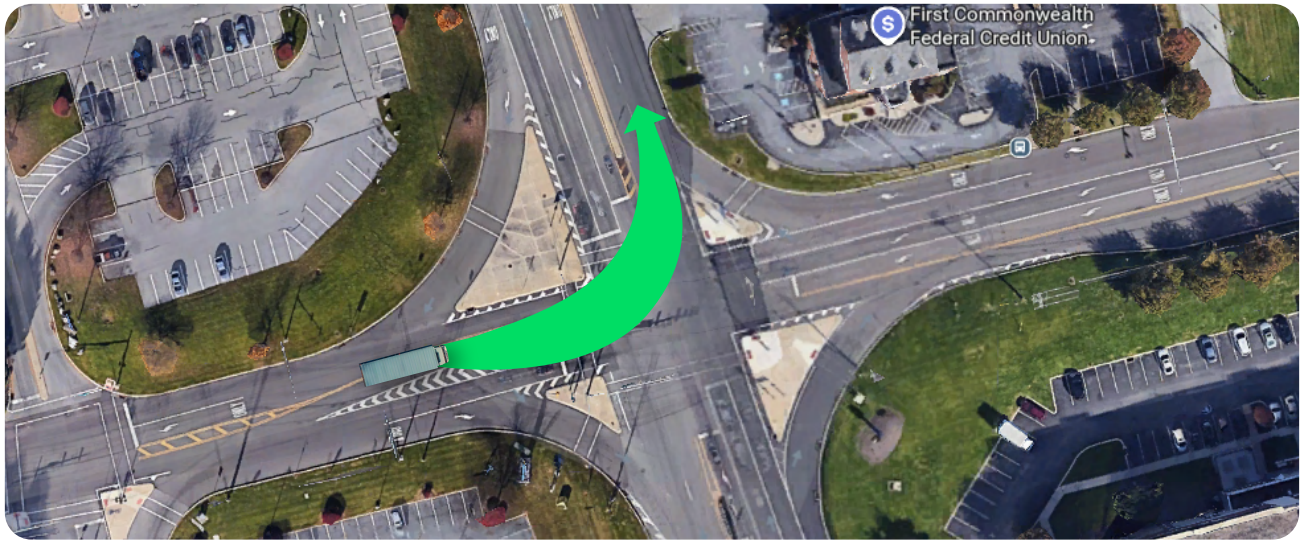
Regional freight and transportation planning documents identify PA 329 (Nor-Bath Boulevard) as part of the area's recommended truck route network, serving warehouse, distribution, and industrial traffic north of the airport. Specifically, the *Lehigh Valley International Airport Area Freight Study* states "[a]t the southern extent of Weaversville Road, the roadway features challenging geometry for trucks." Those same plans recommend special routing and alignment solutions for truck traffic near Weaversville and Howertown Roads, including reserving space for new connections or realignments, rather than relying solely on the existing intersection layout.



The need for those recommendations reflects the reality that current truck turning movements must operate within roadway geometry and adjacent land uses that were **not designed for frequent tractor-trailer turns.** As a result, trucks approaching or leaving PA 329 often need to set up wide for turns, temporarily using more than one lane to complete a maneuver safely.

Route 100 & Tilghman Street (Upper Macungie Township)

This intersection in Upper Macungie Township sits at the heart of one of the Valley's most intense warehouse growth corridors and has been called "one of the worst intersections in the township" *by its planning commission*. Route 100 functions as a major collector for truck traffic from nearby industrial parks, and warehouse deliveries have been linked to sharp increases in **heavy-truck turning counts** along the corridor. Lehigh Valley Planning Commission data show truck counts on Route 100 have grown substantially in recent years as local industrial acreage expanded, contributing to **increased turning volumes** at intersections such as Tilghman Street.



From a geometry perspective, trucks turning from Route 100 into commercial and industrial access points must negotiate curb returns and lane alignments originally designed for lighter, passenger-vehicle traffic. Discussing a proposed gas station to this intersection, Upper Macungie Township Planning Commission Chairman Charles Deprill said "*[t]hose driveways were designed in 2004 and 2005. It's now 2026*." When semitrailers execute these turns repeatedly throughout the day, the trailer's off-tracking can demand space that the intersection's curb and lane geometry do not reliably provide under design assumptions, leading to encroachment into adjacent travel lanes and **increasing conflict risk** at the moment of the turn. FHWA design guidance notes that insufficient provision for turning paths of design vehicles can result in operational problems, including encroachment and increased crash potential.

Union Boulevard / Irving Street / Airport Road (Allentown)

Allentown's Safe Streets for All Action Plan (February 2025) identifies the intersection of Union Boulevard, Irving Street, and Airport Road as a high-injury location. The plan describes it as a **five-legged, skewed intersection** carrying substantial daily traffic and experiencing multiple serious and fatal crashes, including pedestrian incidents.

The February 2025 Action Plan highlights several contributing design characteristics, including wide turning radii, long and angled pedestrian crossings with worn markings, excessive roadway width, and visibility concerns related to sight distance. The intersection also functions as a **junction of commercial, residential, and transit activity,** increasing the number of conflict points between vehicles and pedestrians.

Its irregular geometry and expansive footprint create overlapping movements that are not present at a typical four-corner intersection. The skewed layout can make **judging vehicle paths, speeds, and crossing** distances more difficult for both drivers and pedestrians.

WHAT DRIVERS CAN DO: HOW TO ANTICIPATE TRUCK TURNS

You don't need to be Neo in the Matrix to anticipate truck movements. Even vague geometric awareness can bring **sharper decision-making.**

The practical, commuter-minded takeaway: don't just watch traffic, **watch the geometry.** At intersections with tight curb radii, trucks don't have the option to "hug the corner" the way cars do. The trick for drivers is learning to **spot the early signals** that a wide turn is coming before the truck actually moves into another lane.

Watch the truck's front wheels; they tell the truth first

Turn signals can be misleading. The front wheels are not. If you see a truck's front wheels angled outward before the turn, or positioned closer to the center line than you'd expect, that's a sign the driver is setting up a wide turn to protect the trailer from clipping the curb.

Driver rule: If the front wheels aren't lined up with the curb, the truck will need extra space. Experienced truck drivers report that they will intentionally position their vehicle across both lanes as they approach a turn in order to signal following motorists not to attempt a pass on either side.

Notice how far forward the truck stops at the line

At tight corners, truck drivers often pull forward farther than a car would before beginning a turn to straighten the trailer as much as possible and reduce how sharply it will cut toward the curb.

Driver rule: If a truck is stopped well ahead of the stop line or slightly angled, it's a cue that the turn will not stay within one lane. Give them space and don't crowd the stop line.

Look at the curb: tight corners force wide swings

You don't need to measure anything. Just glance at the corner. Is there a short, sharp curb? No rounded apron? Sidewalk or grass immediately behind the curb? Those are all signs of a small curb radius.

Driver rule: The tighter the corner looks to you, the wider the truck has to turn. If the corner looks too tight for a truck, assume the truck will need your lane until it proves otherwise.

If the truck pauses mid-turn, it's not hesitating; it's protecting space

At tight corners, truck drivers may slow dramatically, pause briefly, or "creep" through the turn. That's often because they're ensuring the trailer clears the curb, monitoring for traffic beside them, and/or adjusting the swing angle.

Driver rule: Don't assume the truck is yielding and try to slip past. Recognize the truck is managing its turning envelope and wait it out. The 10 seconds isn't worth a side-swipe.

Respect the gap (No passing on the inside)

When trucks swing wide, it may appear that you have an opportunity to sneak by. Resist the urge to channel your inner Andretti. Attempting to pass creates danger for you and others.

Driver rule: Never try to pass a turning truck on the inside.

Defensive positioning

More trucks mean more drivers. Do not rely on them all to see you. At intersections with heavy truck traffic or warehouse driveways, leaving one extra car length gives you reaction time in case the truck needs more space than expected.

Driver rule: Stay out of their blind spots. Do not pull up into the space alongside a truck that is preparing to turn.

Do NOT rely on

- **Painted lane lines (they don't change truck physics)**
- **Turn signals alone**
- **Thinking "the trailer hasn't crossed the line yet"**

The reality is even the safest of truck drivers will be bound by the laws of physics and geometry when executing turns on our Lehigh Valley roads, many of which are not designed for the amount of truck traffic currently traversing them. Even if a truck driver is not being as safe as the law demands, we as educated drivers can often avoid tragedy by being vigilant for ourselves and our families. And while we drive defensively today, ultimately, the Lehigh Valley's infrastructure must catch up to the reality of modern freight volumes.

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Frank Santini is a personal injury attorney and public safety researcher whose work focuses on accident causation, roadway safety, and emerging transportation risks, as well as toxic chemicals. He is the founder of Santini Personal Injury & Car Accident Law, a firm representing injury victims in matters involving motor vehicle crashes, commercial trucking collisions, catastrophic injuries, and other negligence-related cases.

Santini is a graduate of **Muhlenberg College** in Allentown, Pennsylvania, and **Stetson University College of Law**, where he graduated **first in his class among full-time students**. His work often combines legal analysis with investigation into the structural and behavioral causes of accidents.
In addition to litigation, Santini conducts independent safety research through Santini Research, examining topics such as tractor trailer accidents, e-bike crash risks, and other emerging public safety issues affecting communities in regions such as the Lehigh Valley.

He is the author of a published article in the **American Bar Association's Law Practice Management Journal** and has participated in dozens of speaking engagements throughout the country. Beyond his legal work, Santini is involved in community and charitable initiatives that support local organizations and families in need such as the Autism Society Lehigh Valley and Family Connection of Easton. His work often bridges legal analysis, public safety research, and community engagement to better understand and communicate the factors that contribute to preventable injuries.