Logistics and Pollution

The Effects of Light Pollution, Air Pollution, and Noise Pollution from Warehouses and Trucking.

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What are the impacts of light pollution, air, and noise pollution from warehouses and trucking terminals on the environment and surrounding communities? The multiple sources from warehouse and trucking terminals are important to consider both separately and together. Each type of pollution multiplies or amplifies the effects of the others. A perfect storm?

Consider Light Pollution from Warehouse and Trucking Terminals

First understand, light pollution is talking about an anthropogenic pollutant. The natural nighttime environment has plenty of light and with 2/3 of life on Earth dependent on nocturnal habitat and conditions, all artificial light is an unnatural pollutant, masking natural cues and disrupting the natural processes supporting the species that inhabit the night and their interaction with each other AND diurnal species. Natural nighttime light, from the Moon's phases, stars, and even galactic and zodiacal sources, is the zeitgeber or cue that nighttime species depend on for their daily and seasonal biological cues. Artificial Light at Night (ALAN) will have a negative effect on nocturnal species and the species that use the daily transitions from day to night and night to day.

- **Environmental Impact**: Disrupts nocturnal wildlife, affecting feeding, mating, and migration patterns. For example, artificial light can disorient birds, fish, and insects. ALAN desynchronizes the natural timings in nature.

- **Human Health**: Excessive nighttime lighting disrupts circadian rhythms, potentially causing sleep disorders, stress, and increased risk of chronic conditions like obesity or depression. ALAN links to chronic human conditions like diabetes, high blood pressure, cardio-vascular disease, and various cancers along with mental effects such as dementia and depression. While quantifying these maladies due to the light at night exposure is difficult, one can say chronic light at night and circadian disruption and desynchronization are strong components and contributors of these human maladies. If one has a genetic disposition to these chronic diseases, light at night exposure will raise one's risks even higher. For the elderly, with age compromised health, the risks are higher than generally stated as the data contains information from younger, more biologically resilient people.

- **Astronomical Effects**: Reduces visibility of stars and celestial bodies, hindering astronomical observations and research. Losing the view of the stars is also a colonial type oppression for indigenous people's and a loss of inspiration and wonder attracting young people to science and discovery. In addition, there is a loss of cultural identity and heritage and pride in what our ancestors accomplished.

- **Energy Waste**: Over-illumination along with ineffectively targeted and shielded lights that are not natural night sky friendly increases energy consumption and contributes to higher carbon emissions. Improperly designed and implemented lighting simply points light in the wrong direction and does not efficiently use the light to illuminate the task area. When light is wasted and not useful, energy and maintenance efforts are a waste of energy and effort. Using the right amount of illumination and constraining the reach of the lighting to where it's needed for the task at hand will *reduce* light pollution and light trespass while protecting the nighttime environment.

Consider Air Pollution from Warehouses and Trucking Terminals

- **Sources**: Diesel trucks, forklifts, and idling vehicles emit particulate matter (PM2.5, PM10), nitrogen oxides (NOx), volatile organic compounds (VOCs), and carbon monoxide (CO). For instance, last night, near warehouse complex near us, we passed a truck parked along a side

road waiting for entry to the warehouse complex with it's engine idling. While we have ordinances and laws not allowing this, they are not well observed and enforced.

- **Health Impacts**:
  - Respiratory issues (e.g., asthma, bronchitis) and cardiovascular diseases due to PM2.5 and NOx exposure.
  - Communities near terminals, often low-income or minority populations, face disproportionate health risks, including higher rates of cancer and premature death. In my area, warehouses and truck terminals are often moved out to the border of other municipalities. Some of the most prosperous and expensive neighborhoods end up right next to terminals. While recent research from California points to an environmental justice situation, I consider this, due to evidence in my area of Pennsylvania, to be a health impact for all peoples and especially rural townships along interstate highways. Older and elderly residents are more likely to have compromised health and will also be at a higher risk at a lower pollution level.

- **Environmental Impact**: Contributes to smog formation, acid rain, and climate change through greenhouse gas emissions. Especially in rural farming areas, this is a consideration for the agricultural community. Warehouse development in rural areas deeply alters the surrounding habitat which supports a wide range of wildlife and beneficial insects.

- **Data Point**: A 2021 study estimated that diesel truck emissions near warehouses contribute to thousands of premature deaths annually in the U.S., particularly in urban areas. This study quantifies the premature deaths in urban areas and rural areas would be lower because of a less dense population density. Nevertheless, premature deaths are not a desirable effect for any commercial business or any municipality and is certainly a reason to limit such development.

Consider Noise Pollution from Warehouses and Trucking Terminals

Like light pollution, noise pollution is an obvious yet underestimated type of pollution. Commercial interests often take priority over health and environmental concerns.

- **Sources**: Truck engines, loading/unloading activities, and warehouse operations generate constant noise, often exceeding 70-85 decibels. Increased traffic on roadways, especially on what was residential roadways and areas, impart a higher level of noise to what was a quiet setting.

- **Health Impacts**:
  - Chronic exposure to high noise levels which can cause hearing loss for workers not wearing hearing protection and low frequency rumble noise can travel long distances to residences. The noise from warehouses and especially trucking terminals can cause sleep disturbances to surrounding residential areas with all the accompanying health consequences.

- **Community Disruption**: Lowers quality of life in nearby areas, reducing property values and causing community dissatisfaction.

- **Wildlife Impact**: Disrupts animal communication and behavior, particularly for species reliant on sound for survival. Similar to effects on humans, noise pollution is a chronic environmental stressor to wildlife.

Mitigation Strategies for Light, Air, Noise Pollution

- **Light**: Use shielded, downward-directed LED lighting, implement motion sensors, and adhere to dark-sky guidelines. Use DarkSky International's Principles for Responsible Outdoor Lighting or DLC lighting principles along with guidance from the templates for municipal ordinances and statutes. Use DarkSky International or DLC approved lighting fixtures installed in a proper manner. Be careful of lighting devices lacking certification or ratings and watch for parameters such as CCT. For example, the exact same lighting device with a higher CCT may not be DarkSky International or DLC approved. Correct installation orientation and the proper light fixture for the specific place is critical to be DarkSky or DLC compliant. A general model for a site is far easier for distributors, designers and maintainers but will likely not meet the requirements and result in unexpected light pollution from the site. In addition, the wrong light placed improperly will result in a loss of visual acuity with a less efficient and a less safe work environment. It costs no more to implement lighting properly to benefit both residents and employees.

- **Air**: Transition to electric or low-emission vehicles, enforce anti-idling policies, and install air quality monitoring systems surrounding warehousing and trucking facilities. Install logging monitors in nearby residential areas or sensitive natural areas to check pollution levels.

- **Noise**: Install sound barriers and optimize truck routes to avoid residential areas and environmentally sensitive areas. Schedule operations to minimize nighttime activity. Trees are a natural sound absorber so suburban/urban reforesting projects can be beneficial.

Limiting warehouse construction and operations in ecologically sensitive rural agricultural areas is obviously one of the best ways to limit the multi-pollution originating from the bloom of warehousing and trucking along rural sections of Interstate roadways. This can be accomplished through municipal and state ordinances and statutes. Raise awareness among municipalities of the consequences and the true cost which includes the health, environmental, and increased risk of losing productive farmland due to industrial spill or accident.

Consider Warehousing and Trucking Terminals in Pennsylvania's rural areas

In rural Pennsylvania, the impacts of light, air, and noise pollution from warehouses and trucking terminals are significant, though less studied compared to urban areas. What are warehousing's specific effects in rural locations.

Light Pollution

- **Environmental Impact**: Artificial lighting from warehouses and trucking terminals disrupt nocturnal wildlife, such as birds, bats, and amphibians, common in Pennsylvania's rural ecosystems. For example, light pollution can disorient migratory birds that rely on moonlight and starlight, causing them to stray into hazardous areas or collide with structures. Migrating birds are susceptible to redirection, disorientation, and light capture from bright commercial

site lighting. Aquatic species in ponds and streams, like fish and dragonflies, may mistake artificial light reflections for water, leading to disrupted breeding cycles and population declines. Aquatic habitats are extremely sensitive to artificial light at night. This affects Pennsylvania's ecosystems, including sport fishing in its waterways and effect the health of the local streams. Since wildlife has a higher population in rural areas, the impact on wildlife and supporting ecosystems is greater than in urban areas.

- **Human Impact**: Excessive nighttime lighting in rural areas, where natural darkness is expected, disrupts residents' circadian rhythms, potentially causing sleep disorders, stress, and related health issues. Rural communities near warehouses may experience intense skyglow, reducing visibility of stars and impacting cultural and recreational experiences like stargazing. Not only residents but also visitors seeking a rural setting and who bring an economic tourism boost to areas will be thwarted in their search for a natural rural setting. The consequence will be a loss of an economic boost from a renewable tourism resource, an economic loss for the community. With an aging population, less able to withstand biological effects, rural residents will experience greater health impacts and because of the lack of local medical facilities older residents will experience worse outcomes.

- **Context**: Rural Pennsylvania, with its historically dark skies, is particularly vulnerable to new warehouse developments introducing intense lighting. For instance, unshielded fixtures or 24/7 terminal operations exacerbate skyglow, which can extend miles beyond the immediate area.

Air Pollution

- **Sources**: Diesel trucks servicing warehouses and terminals emit high levels of particulate matter (PM2.5, PM10), nitrogen dioxide (NO2), and other pollutants. In rural Pennsylvania, where warehouses are increasingly built due to lower land costs where truck traffic significantly elevates local air pollution from norms. The extra nitrogen aggravates medical conditions like asthma. The extra truck traffic will also increase the levels of nitrogen washing in local watersheds. Identifying sources and reducing nitrogen washing into watersheds is the purpose of PA State MS4 mandates that are totally funded from local taxes or surcharges for municipal sewer and storm water authority funding.

- **Health Impacts**: Rural residents face increased risks of respiratory issues (e.g., asthma, bronchitis), cardiovascular diseases, and low birthweight due to diesel emissions. Normally warehousing is located at municipal borders. In urban areas, this corresponds with low-income and minority communities, sometimes present in rural areas, who are disproportionately affected, raising environmental justice concerns. This is not always the case in highly developed areas where high-end housing ends up adjacent to warehouse and trucking terminals. Since air pollution is not contained onsite, the air quality is compromised into all the surrounding area irregardless of the economic status. Again, in rural areas, older and elderly residents will experience degraded health from air pollutants.

- **Environmental Impact**: PM2.5 and NO2 contribute to smog and acid rain, degrading rural Pennsylvania's forests, streams, and farmland. Unlike urban areas, rural counties often have fewer air pollution sources, making warehouse-related emissions a significant local contributor. For example today, weather.com had a warning about PM2.5 and another app, AirVisual, listed PM2.5 at 2.7 times the level the WHO recommends as safe. EPA's AirNow.gov site is another source of information.

- **Data Point**: While specific Pennsylvania warehouse studies are limited, nationwide data suggest warehouses increase near-site NO2 by ~20%, with higher truck traffic correlating with greater pollution.

Noise Pollution

- **Sources**: Truck traffic, loading/unloading, and warehouse operations generate noise levels often exceeding 60-70 dBA in rural areas, where background noise is typically lower (e.g., 58.2 dBA). Heavy trucks can elevate noise by ~7% compared to baseline levels.

- **Health Impacts**: Chronic noise exposure in rural communities can cause sleep disturbances, stress, high blood pressure, and cognitive impairments, particularly in children. Low-frequency noise from trucks, which travels farther and penetrates walls, is especially disruptive in rural homes.

- **Wildlife Impact**: Noise disrupts communication and behavior in species like birds, amphibians, and mammals, common in Pennsylvania's rural areas. For example, birds may sing earlier or relocate due to noise, affecting mating and survival.

- **Context**: Rural Pennsylvania's quiet landscapes amplify the impact of warehouse noise, as residents are less accustomed to industrial sounds compared to urban areas. In the Cumberland Valley, the mountains on each side of the narrow valley can reflect noise back towards residential areas.

Specific Considerations for Rural Pennsylvania

- **Warehouse Growth**: The rise of e-commerce and giants like Amazon have led to warehouse proliferation and increased truck traffic in rural Pennsylvania, particularly along major highways like I-81 and I-78, due to proximity to urban markets, cheaper land, and lack of municipal ordinances and accompanying enforcement. Over the last few years, warehouse building has exploded, Central Pennsylvania and the I81 corridor has a higher concentration of warehouses and trucking than most other areas..

- **Environmental Justice**: While rural areas are less densely populated, rural communities near these facilities face disproportionate health risks from air and noise pollution, similar to urban patterns. Pennsylvania's older residents should be considered a vulnerable people group in this instance.

- **Ecosystem Sensitivity**: Pennsylvania's rural areas, home to diverse wildlife and waterways, are particularly sensitive to light and noise disruptions, which can cascade through food chains, affecting species like fish, birds, and insects.

Limitations and Further Research: Data specific to rural Pennsylvania is sparse. Nationwide studies, like those from the Environmental Defense Fund, suggest significant impacts, but *local air and noise monitoring* is needed to quantify effects. Shouldn't this be a requirement?

Connecting the increase of particulate and gases pollution to an increase in light pollution and skyglow levels.

In rural Pennsylvania, the different types of pollution from warehouses and trucking terminals can interact, amplifying light pollution effects.

Connection Between Particulate/Gaseous Pollution and Light Pollution/Skyglow

- **Particulate Matter (PM2.5, PM10) and Skyglow**: Fine particulate matter from diesel trucks and warehouse operations (e.g., dust from loading/unloading) scatters artificial light in the atmosphere. This scattering enhances skyglow, making the night sky brighter and reducing star visibility and overwhelming natural night brightness levels. In rural Pennsylvania, where baseline light pollution is low, PM2.5 from increased truck traffic, like in Cumberland County (e.g., along I-81 or I-78) can significantly worsen skyglow, especially near warehouse clusters. Studies suggest that areas with high PM2.5 levels can see skyglow intensity increase by up to 20% compared to cleaner air conditions.

- **Gaseous Pollutants (NOx, VOCs) and Light Scattering**: Nitrogen oxides (NOx) and volatile organic compounds (VOCs) from truck emissions contribute to smog and haze formation. These aerosols scatter light, intensifying skyglow and reducing the clarity of the night sky. In rural areas, where natural darkness is a valued feature, this effect is particularly noticeable, degrading both the aesthetic quality of the night sky and astronomical observations. While people question astronomical observations, it must be considered that astro-tourism brings income to rural areas and can be an economic boon with a renewable resource in rural areas with dark natural night skies. The inability to see the natural night sky should be considered a warning sign, like the canary in the coal mine cliche.

- **Mechanism**: Particulates and gases act as light-scattering particles, trapping and redistributing artificial light from warehouse lighting. This creates a diffuse glow that extends beyond the immediate facility, impacting rural communities and wildlife habitats. For example, bats and nocturnal birds, common in Pennsylvania's rural ecosystems, may experience disrupted navigation due to this enhanced skyglow. Skyglow's reach is much farther than one would think, as it is affecting biodiversity and normal species and species-to-species function in surrounding areas far from the visible skyglow dome. This would extend into Michaux State Forest and State Parks on both sides of the Cumberland Valley and the Appalachian Trail Corridor and other Pennsylvania conservancies.

Quantitative Insight

- While specific data for rural Pennsylvania is limited, a 2021 study on urban light pollution noted that areas with high PM2.5 concentrations (e.g., 10-15 μg/m^3 above background levels) can increase skyglow radiance by 10-20%. Warehouses and trucking terminals in rural areas, contributing ~20% higher NO2 and PM2.5), likely produce comparable effects, especially during high-traffic periods or winter inversions when pollutants accumulate.

Impacts Specific to Rural Pennsylvania

- **Wildlife**: Enhanced skyglow from pollutant-light interactions disrupts species like migratory birds and amphibians, which rely on dark skies for navigation and reproduction. This is critical in rural Pennsylvania's forests and wetlands. The health of aquatic and riparian

habitat will also be affected with night sky luminosity overwhelming the key zeitgeber of the Moon's phases. Rural areas are a haven for migrating birds with shelter and food. Light pollution alters migration routes and attracts birds away from their normal migration paths and the services they provide there. Bird density is also increased creating a situation where pathogens are passed at a greater frequency and infection risk of domestic flocks is raised.

- **Human Experience**: Residents in areas like the Lehigh Valley or near the I-81 Corridor report reduced star visibility due to new warehouse developments, likely exacerbated by particulate-driven skyglow. This affects quality of life along with cultural and recreational activities like stargazing.

- **Environmental Justice**: Rural communities near warehouses, often with limited resources to advocate for mitigation, face compounded effects from air and light pollution, worsening health, environmental inequities, and quality of life for residents.

Mitigation Strategies for Air, Light, and Noise Pollution

- **Reduce Emissions**: Transition to electric trucks and enforce anti-idling policies to lower PM2.5 and NOx, reducing skyglow-enhancing aerosols. This will most likely take decades to come to fruition. Increased warehouse automation and robotics will most likely reduce the workforce in the warehouse before self-driving trucks eliminate drivers. This will be a gradual change which is already underway. Warehouse power and heating is another source of emissions to consider.

- **Light Management**: Use shielded, low-intensity LED lights and dimming schedules to minimize the light available for scattering by pollutants. Use DarkSky International lighting principles.

- **Monitoring**: Deploy air and light pollution sensors near rural warehouses and in nearby residential areas to quantify interactions and inform policy, such as Pennsylvania adopting stricter warehouse emission rules. Nearby residents should also have their health monitored to identify known and new human health concerns caused by warehouse and trucking industry operations.

Air pollution and light pollution are connected. In fact, not only does air pollution increase skyglow levels but light pollution causes an increase in air pollution as air pollution molecules and particles are broken down by light and into gases that have adverse effects on humans, such as ozone.

Air pollution and light pollution are interconnected in a two-way relationship. In rural Pennsylvania, where warehouses and trucking terminals are increasing, this interplay has notable implications. Air pollution exacerbates skyglow and light pollution can, in turn, worsen air pollution through photochemical reactions.

Air Pollution Increasing Skyglow

- **Mechanism**: Particulate matter (PM2.5, PM10) and gaseous pollutants (e.g., nitrogen oxides [NOx], volatile organic compounds [VOCs]) from diesel trucks and warehouse activities scatter artificial light in the atmosphere. These particles act as reflectors, diffusing light from warehouse floodlights, road lighting, and truck headlights, which intensifies skyglow. In rural Pennsylvania, where natural darkness is prevalent, this effect is pronounced, as even small

increases in PM2.5 (e.g., 10-15 μg/m³ from truck traffic) can boost skyglow radiance by 10-20%, according to urban studies adaptable to rural settings.

- **Impact in Rural Pennsylvania**: Areas like the Lehigh Valley or along I-81, with growing warehouse clusters, see increased truck traffic (contributing ~20% higher). This elevates local PM2.5 and NOx, amplifying skyglow and reducing star visibility, which disrupts both human quality of life (e.g., stargazing) and nocturnal wildlife (e.g., bats, migratory birds) in Pennsylvania's rural ecosystems.

Light Pollution Contributing to Air Pollution

- **Photochemical Reactions**: Artificial light, especially ultraviolet (UV) or blue-spectrum light from warehouse LEDs, can trigger photochemical reactions in the atmosphere. These reactions break down air pollution molecules, such as VOCs and NOx, into secondary pollutants like ozone (O3) and secondary organic aerosols (SOAs).
    - **Ozone Formation**: UV light catalyzes reactions between NOx and VOCs, producing ground-level ozone, a harmful pollutant that irritates lungs, exacerbates asthma, and contributes to cardiovascular issues. In rural Pennsylvania, where baseline ozone is lower than urban areas, warehouse lighting can locally elevate ozone levels, especially during warm months when photochemical activity peaks.
    - **Secondary Aerosols**: Photolysis of VOCs under artificial light forms SOAs, which are fine particulates (PM2.5) that further degrade air quality and contribute to haze and skyglow.
- **Health Impacts**: Ozone and SOAs increase respiratory and cardiovascular risks for rural residents near warehouses. Communities in areas like Franklin or Cumberland Counties, near trucking corridors, may face disproportionate exposure, raising environmental justice concerns.
- **Environmental Impact**: Ozone harms vegetation, including crops and forests in rural Pennsylvania, reducing agricultural yields and ecosystem health. For example, ozone exposure can decrease soybean or corn yields by 5-15% in affected areas.

Bidirectional Feedback Loop

- **Air to Light**: PM2.5 and gases scatter light, worsening skyglow.
- **Light to Air**: Artificial light drives photochemical reactions, increasing ozone and PM2.5, which then further scatter light, creating a feedback loop that amplifies both pollution types.
- **Rural Context**: In rural Pennsylvania, this cycle is particularly disruptive because low baseline pollution levels make incremental increases more noticeable. Warehouses along highways (e.g., I-78) introduce both light and air pollutants, intensifying this loop in otherwise pristine areas.

Data and Evidence

- While specific studies on rural Pennsylvania are limited, broader research supports this interaction. A 2020 study on urban light pollution noted that high PM2.5 levels correlate with up to 20% increased skyglow, a trend likely applicable to rural warehouse zones. Conversely, photochemical studies show artificial lighting can increase local ozone by 5-10 ppb in high-NOx environments, relevant to trucking terminals.

- Local news stories highlight community concerns in rural Pennsylvania about warehouse development and related truck traffic and VIIRS satellite sensed light pollution maps show the extent of light pollution around warehouse and trucking facilities.

Mitigation Strategies for Rural Pennsylvania

- **Reduce Air Pollution**: Shift to electric trucks, enforce anti-idling policies, and plant vegetative buffers to trap particulates, reducing skyglow-enhancing aerosols. Unfortunately, increased truck traffic on adjacent Interstate highways and local roads will deliver a significant pollution load if diesel trucks are used. The shift to electric trucks will not be an instantaneous event.

- **Control Light Pollution**: Use DarkSky International Principles, information from Design Lights Consortium and other like organizations to light responsibly. Use lighting designers who are vetted on designing lighting in ecologically and agricultural settings. Not any designer will do.

- **Monitoring and Policy**: Install air and light pollution monitors near rural warehouses to quantify the feedback loop. Pennsylvania could adopt regulations like California's Warehouse Indirect Source Rule to limit emissions and require dark-sky-compliant lighting. https://www.aqmd.gov/docs/default-source/planning/fbmsm-docs/waire-program-overview-factsheet.pdf

- **Community Advocacy**: Rural residents can push for zoning laws to distance warehouses from homes and sensitive ecosystems, reducing all warehouse pollution types. Be aware that watershed pollution can leak into the local aquifer and streams, and show up in residential wells that are not usually monitored, especially in the rural Pennsylvania setting.

- **Limit Warehouse Development in Rural Areas** by proper zoning and land use. Provide funding for farmland preservation and nature conservancies. Create natural buffer zones.

What Else Are We Missing?

Synergy of Pollutants

While water pollution is a large concern for warehouse development, it has not yet been mentioned here. Water pollution alone is worth another report. In writing this report I came to the realization that Air, Noise, and Light Pollution are synergistic, meaning the sum of effects is more than the individual parts. Effects from the pollutants combine in ways to increase the impact and toxicity of the individual pollutants. This holds true with water pollution, joining the 'gang' of pollutants and increasing the impact of the other three in increasing chronic stress and load throughout the environment and increasing the effects of the pollutants, as they work together, to degrade human health and well-being in multiple ways at once. MNPs are a another pollutant lacking scientific study and water treatments can actually make this pollutant more deadly.

Pollution's Effects on Pennsylvania's Rural Residents

One of the research papers studied effects due to warehousing in California. The study speaks of people in poverty and low income urban areas being the unjustly affected people groups from warehouse and trucking facilities.

In Pennsylvania's rural areas, it is more the older and elderly residents who undoubtedly bear the disproportionate brunt from warehouse/trucking industry sourced pollutants. They are an equal poster child for environmental injustice and a vulnerable people group. Demographic data show rural communities often have a higher proportion of of elderly in their populations than urban areas, with younger generations moving to suburbs and urban areas for jobs.

Why are older people more susceptible and vulnerable to warehouse and trucking industry sourced pollutants?

Older people have less biological headroom than younger people due to age related health declines. Their immune systems have a reduced capacity to handle biological stressors. Respiratory and Cardio-Vascular conditions like asthma and COPD and high blood pressure are more prevalent in older populations. Water pollutants can contribute to cancer risks and reduced kidney function lowers people's ability to process and rid the body of toxins. Older adults' circadian systems are more fragile than younger people and this can worsen cognitive decline and aggravate mental health problems. These effects are amplified when multiple stressors affect people simultaneously.

In addition, rural areas of Pennsylvania have limited healthcare access requiring people travel to more populated areas for good healthcare. Rural elderly may also have lower incomes and less access to water or air filtration. Pollution or other health related declines can increase social isolation making mental health and physical health even worse.

Another unmentioned effect is that older and elderly people tend to have paid off their mortgages and their largest form of equity is held in their properties. While this asset is not easily accessible it remains their largest possession of value and it is for use in their old age or as a valuable possession to be passed to children as inheritance. Large warehouse and logistics centers reduce property values in the area surrounding the warehouse in some cases by 10-15% or more. This is a significant loss of value for retired people in any setting but especially so in rural areas where people own their homes and the difference in real estate values would be a significant loss that can't be made up on fixed incomes.

Conclusions:

This section also includes related revelations from the Questions section.

Light pollution from Warehousing and Trucking Terminals effects both the environment and human health and well-being. Light pollution lowers the quality of life and well-being of surrounding residents along with degrading the surrounding ecosystems. Home and property values in the vicinity will lose value.

Air pollution from warehousing and trucking terminals is a significant quality of life and health impactor, adding to respiratory and other chronic health concerns. Air pollution is a well known and studied pollutant and the human health toll is already well known. The lack of air quality monitors in such a warehouse/trucking dense area is troubling.

Noise Pollution from warehousing and trucking terminals effect peoples' quality of sleep, adding to stress and mental issues. Like light pollution, this is an 'invisible', not well documented and studied pollutant.

The unmentioned pollutant, Water Pollution, from warehousing and trucking terminals can infiltrate well water and watersheds and streams. This is a threat to the water supply for humans, livestock, and irrigation.

MNPs are a serious health risk and a lack of scientific study exists. Standard water treatment and, in rural areas, nitrates, can increase MNPs ability to absorb and carry lethal pollutants like heavy metals and deliver them like mRNA to biologically sensitive points in the human body. Currently, municipal water is not being filtered for MNPs.

MNPs are not included in MS4 and stormwater plans are incapable of preventing warehouse sourced MNPs from entering the environment and the human habitat. Stormwater mitigation is pumping MNPs into water sources while increasing the capabilities of the particles to carry harmful substances.

The synergistic effect of all these pollutants, sourced from warehousing and trucking, working together, is greater than the individual pollutant's effects when added together. Each of the pollutants amplifies the effects of the others and increases the biological risk above any of the pollutants by itself. The multi-vector impacts of pollutants together overwhelm peoples' resilience or ability to recover and amplifies the biological effects even further.

These pollutants often have a higher cost and impact on older and elderly residents in rural areas because of heath conditions in an aging population. Rural areas in Pennsylvania have a larger population of elderly and aging in place people. Aging people have reduced biological resilience making them more vulnerable to pollutants. In addition, the availability of medical care is less than urban areas, making rural residents at more at risk for physical and mental health disease.

Home values can lose 10-15% within a couple miles of the facility causing a loss of equity in home and property values for aging populations.

Increased truck traffic on interstates and local roads surrounding the trucking facilities raise the danger of accidents because of sheer numbers of vehicles on roads. Our roads are not designed to handle the traffic load and the complexity caused by the increased number of vehicles on the roadway. The sheer weight of trucks increase the danger when compared with cars in vehicle accidents and especially pedestrian-vehicle accidents in residential areas. While speed is the critical factor, the weight of trucks is so much greater than cars so fatalities involving trucks-cars-pedestrians will occur at a much lower speed.

Warehouses and transportation of hazardous materials pose an existential risk to farmland and food production, which is a critical asset to Pennsylvania.

Excavation in historically agricultural areas pose the risk of residual banned pesticides and herbicides being released from lower layers of soil and finding their way into water supplies and becoming airborne. This is a risk during construction and an ongoing risk.

Municipalities and emergency response do not have an on-demand source of information on warehouse contents. This raises the danger to first responders and the rights of residents to know if hazardous materials or their components are being stored in their municipality. Currently, this is only an annual report. Current logistics systems contain the data but a system

to share the data on-demand does not exist. The proliferation and density of warehouses in our area require a better solution to protect residents and first responders.

Additional Questions and Thoughts:

This section contains partially researched ideas and concerns applicable to this discussion. Placing large warehouses and related facilities on former agricultural land raises many questions and concerns. Whether they have been addressed or not, these questions raise additional valid concerns, not in the preceding sections, that require answers. Economic boon often leads to a rush to profit without thoughtfully weighing the concerns. Other people working specifically in this field of environmental sciences will have a much deeper knowledge of the concerns with warehouse proliferation in our area.

Warehouses radically altering the natural topology of rural areas with a rapid increase in impervious surface area along with the usual runoff control artifacts like swales and catch basins. These make a perfect breeding ground to increase populations of undesirable insets such as black flies and mosquitos while removing desirable habitat for the insect predators like bats, birds, and predator insects and driving insectivores away with light and noise pollution. This unnaturally increases unwanted insect populations and decreases natural insect control altering the natural biodiversity of the surrounding area. Are native trees and shrubs used? What can be done to counter-balance these landscape changes and the pressure on the local species and biodiversity that makes the rural area unique and worth conserving.

What is an acceptable number or density of warehouse and trucking facilities that an area can bear before the land and the people can no longer absorb the effects? Should baseline studies be done first before additional facilities are added? How do we know additional facilities and their support businesses won't stress communities and habitats beyond what they can bear? Would a warehouse moratorium in Cumberland Country and other areas be appropriate until these baseline studies and analysis be done? Is current planning to focused on single locales rather than the aggregate effect in an area?

Non-native CDL drivers bring an added danger to the local roadways and the interstates. Will warehouse companies avoid the use of non-native CDL drivers?

Simply put, commercial enterprises with environmental impacts such as air, water, noise and light pollution will affect the aging population more deeply causing a greater negative impact than expected as aging biology can't respond as well to environmental pollutant stressors. Like the previous comments on the warehouse effect on the surrounding landscape, what is the plan to help the aging community with the additional health stressors brought into the local surrounding communities by the warehouse facilities?

Home values for local residents can lose 10-15% within a couple miles of the facility causing a loss of equity in home and property values at a critical time of life for aging populations. Is anything being done to compensate residents for this loss?

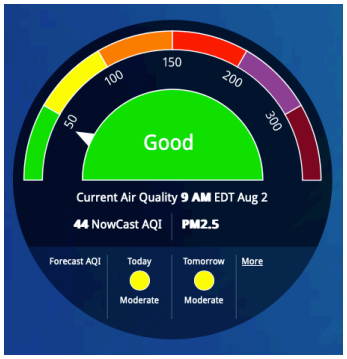
Does crime follow trucking, warehousing, and associated businesses? Yes, trends show this to be true. Middlesex Township and the outcome of the Miracle Mile is a great example. Does West Penn have their own police and the bandwidth to handle the additional crime load. Do other agencies, such as fire companies, have the bandwidth and capability to handle the extra

workload to support the warehouses? Who is funding the increase in capability? Is any special equipment required for emergency services?

Oddly, in Pennsylvania, especially along the I81 Corridor south of Harrisburg, only one AirNow monitoring stations exists near Middlesex. In the area where all the warehouses are springing up in rural areas, no monitors exist all the way to the Maryland border. This literally means, no idea exists about the current level of air pollution due to warehousing and trucking and no idea of how additional sites would effect the health of people and the environment in this rural area. Shouldn't we at least know where we are currently at before we build more warehouses and supporting facilities and introduce even more air pollution to this area? Are rural areas and the damage inflicted by this type industry invisible because we don't look?

https://gispub.epa.gov/airnow/?contours=none&monitors=ozonepm&xmin=-8709082.128756467&xmax=-8509734.35898865&ymin=4797030.319104659&ymax=4914896.216720446

In Mechanicsburg, on a pretty good day, we are flirting with a not so good PM2.5 level. Is there headroom to absorb more PM2.5 from warehousing and trucking?



Microplastics and nanoplastic pollution is an additional topic to research in relation to warehouses and trucking, especially in the I81 corridor where the sites and amount of truck traffic has exploded due to proximity to I81 and easy to obtain rural land. Warehousing extensively uses plastic packaging and trucking heavily contributes to microplastic release into the environment through tire wear (on the highway and onsite) are combined they become a major source of the micro/nanoplastics pollution into the environment. Plastic in landfills are an additional major source of this type of pollution and warehouses produce a lot of plastic refuse that will likely end up in local landfills. Landfills are a major pathway of this degraded plastics pollutant into drinking water sources. Runoff from roads and impervious surfaces also carries the plastic pollutants into streams and aquifers. Currently, water companies do not treat for micro and nanoplastics so we are all drinking it. Isn't this a serious health problem with long term consequences. Once in the area aquifer, rural well water is at risk. Do we know what levels in the area water sources is now? Before we add more? While monitoring is good, once it's found, it's too late. According to our water company, they know it is in our municipal water sources now. It is expensive to filter and requires new facilities to be built. This is a topic to explore in the future. What is one of the largest pollution sources of micro/nano plastics? TWP - tire wear particles…. TWP also becomes airborne and becomes major contributor to PM2.5 and PM10 particles. We are drinking AND breathing in micro/nano plastics. As warehousing and trucking are major contributors, do we know the thresholds?

Nano and Microplastics FAQ PA DEP, https://www.pa.gov/content/dam/copapwp-pagov/en/health/documents/topics/documents/environmental-health/Nano- and Microplastics fact sheet.pdf

A very serious question to ask, are the contents of the warehouse and the roadways leading to it, have a control by state and local government? In other words, can dangerous or hazardous materials, either in complete form or parts, be transported to or stored at the warehouse without agreement and awareness of the local municipality and even the community? Shouldn't local governments and especially fire departments have a total awareness of such hazards stored within their communities in case of fires or spills at the site? Since emergency responders would be called into action on the interstates, even hazardous materials being transported through should be reported so lives are not put into jeopardy during accidents. Is there a system connection from warehouse logistics data to PA 911 where-by first responders would have the information they need before going to an incident? Could a state-wide AI assisted system be developed to do this?

While I don't have insight to state and county planning, I do have insight into municipal planning. All the permitting and plan approval is done at a site level, perhaps at a single warehouse level. This is not a wholistic way to operate. To truly grasp the ecological weight and the human health concerns in an area due to warehousing, the aggregate effect of ALL the warehouses need to be considered. How else would we know we have reached saturation of a certain industry and its effects on the local communities? Would state or local governments allow an industry with known pollutants cluster multiple industrial sites in an area and only approve plans and permits on a singular basis? Surely, this is not a functional methodology but it sure seems from the explosion of warehouses in our region that this is the current method. Are state and county planners considering this or is this a blind spot? Do they plan in a wholistic view manner?

If any of these facilities, either from willful negligence or failure to operate properly, will the true owners and investors be held liable for spills or even a superfund type cleanup of long-term fouling of the environment? Will it be the local government and the communities and the taxpayers who would be left with the bill, as in so many cases in the past? This question has a historic basis for Pennsylvania, in that this situation has happened time and again. The companies responsible for the pollution and despoilment disappear but the hidden owners, investors and families are not held responsible for what happened. Is this the case for warehousing and trucking in Pennsylvania?

What is the possibility of these facilities being abandoned and turning into brownfield recovery sites. Other warehouse clusters ion Pennsylvania have exhibited this outcome. Are there sufficient bonds being posted by the developers to cover the cost of recovery?

DDT and other persistent organic pollutants (POPs) may persist in the lower levels of soil in agricultural areas and could be disturbed by warehouse construction. These compounds resist degradation and tend to accumulate in soil. In general, excavation can release these compounds which are toxic to workers, surrounding communities and ecosystems. Site assessments, soil testing and remediation are critical before heavy construction in areas with a history of heavy pesticide use like rural agricultural areas.

Some of these are:

Chlordane: Broad spectrum insecticide used on crops 1940's-1980's. Highly persistent with half-life of 15 years and residues can remain in deeper soil for decades. With construction,

chlordane dust can be released into the air and water. Its toxicity and potential for bioaccumulation poses a risk.

Dieldrin and Aldrin: Insecticides used on crops like corn from the 1950's - 1970's. Aldrin breaks down into dieldrin. Persistent with a half-life of 5-25 years in soil, its compounds bind strongly with soil particles and can persist in deeper layers. Excavation may mobilize these highly toxic compounds. They are classified as POPs by the Stockholm Convention on Persistent Organic Pollutants. I'm not sure the US has signed but not ratified this UNEP Global Treaty, and participates as an observer. Even so, these compounds are still a very valid concern relating to use or re-release due to heavy construction.

Heptachlor: Insecticide for soil insects, widely used until the 1980's. Half-life 0.5 to 3 years but can accumulate in deeper soil and persist for up to 15 years. Excavation can release the toxic compounds into the air, water, and into nearby ecosystems.

Toxaphene: Insecticide used on crops from the 1940's - 1980's. Half-life in soil is from 1 to 14 years, with some residues detectable in deeper soil levels due to low microbial activity. It's complex mixture of chlorinated compounds can be released during ground disturbance and pose risks due to its carcinogenicity.

Endrin: Insecticide and rodenticide used on crops. Half-life 2 to 12 years, with residues lingering in deeper anaerobic soil layers. If disturbed by excavation, this compound is highly toxic to aquatic life and humans if it reaches water sources, streams, or riparian areas.

Lindane: Insecticide for crops, livestock, and seed treatment. Used from 1940's - 2000's. Half-life in solid is from months to 6 years. In deeper, low-oxygen soil layers it can persist longer due to slower degradation. Soil disturbance can release lindane residues which are toxic and can contaminate groundwater.

Additional notes on this question: The U.S. has banned or restricted many POPs listed under the convention (DDT, chlordane, dieldrin) through DPA regulations under the Toxic Substances Control Act and the Federal Insecticide, Fungicide, and Rodenticide Act.

Two Pennsylvania Superfund sites with agricultural context:

Boarhead Farms (Pennsylvania): In this case, improper storage and disposal of hazardous materials, including pesticides, contaminated groundwater, surface water, and residential wells, leading to a fish kill and the site's inclusion on the National Priorities List (NPL) in 1989.

Crossley Farm (Pennsylvania): Drums containing liquid waste, potentially including pesticides, were disposed of at this farm, resulting in the contamination of residential wells nearby.

Farmers' Mutual Cooperative (Iowa): This site, an agricultural supply and service business, handled bulk fertilizer and pesticides. Investigations revealed pesticide and carbon tetrachloride contamination in groundwater, impacting nearby municipal wells.

Kem-Pest Laboratories (Missouri): This former pesticide formulation plant disposed of pesticide waste in a lagoon, leading to the contamination of surface soil, drainage paths, and groundwater with pesticides like chlordane, aldrin, endrin, and heptachlor.

While economic boon, jobs, increased tax revenues, and infrastructure upgrades are marketed as a plus for warehouses and trucking, it is forecast that most warehouse jobs will be replaced

by automation by 2030 and so the jobs, which are good source of income, will be lost. Depending on a one crop (warehousing) situation is not a good strategy and similar to rural places in California in the EPA's Environmental Justice Study, Environmental Resource Guide, will end up with no jobs, a ruined and polluted landscape, requiring remediation and recovery help from federal and state entities (taxpayers). All the infrastructure upgrades are for supporting the warehouses and trucking facilities not for residents.

Specific to our area, a concern would be the invisibility of rural communities (especially in our region) to social and environmental justice outcomes.

The growth of e-commerce, which most of participate in, is at the foundation of all the warehouse development. Will it continue, will companies find more economical methods and locations for logistics?

TWP accounts for 30% of MNPs?

With no current plans for MNPs remediation in drinking water, is storm water and runoff filtered for MNPs before being released into local streams? Storm water release without remediation will exacerbate the MNPs situation in streams.

Currently, municipalities treating their water may make matters worse as chemicals used for drinking water alter the MNPs particles which allows them to absorb dangerous pollutants and heavy metals.

Planning blind spot: Why would you put an industrial site with the potential to pollute aquifers and soil with agricultural ending pollutants? This is a food producing region. Tainting an aquifer or streams or an occurrence of a toxic spill may end the possibility of growing food or dairy production in an area surrounding a warehouse or warehouse cluster. Isn't food production a critical industry we should wisely protect? Are planners missing this?

Stories like this are a concerning since they happened very near an agricultural area, like ours and impacted food production:
1. Sherwin-Williams Paint Warehouse fire (1987 Dayton, OH). https://www.daytondailynews.com/news/when-massive-sherwin-williams-warehouse-blaze-threatened-the-area-drinking-water/n5M2dlGcTxvdm5iM38dPvM/
2. West Fertilizer Company Explosion in 2013, West Texas, is another.
3. The January 2025 fire at Moss Point was not a warehouse but a lithium battery storage plant, where energy was stored. One of California's largest wetlands and , air and soil were contaminated by the fire. https://insideclimatenews.org/news/01022025/moss-landing-battery-fire-contamination-health-fears/

Do we know what is being stored or will be stored at the warehouses all around us?

Nitrates in storm water runoff or streams alter MNPs and increase their environmental impact.

While not a direct source pollutant, the issue of the number of trucks and related traffic added to existing traffic is a concern. Truck % is higher than average around the warehouse/terminal exits. It appears the last PADOT traffic study was done in **2022?** With planned warehouses included, added approximately 9 to 12 new warehouses. Each warehouse contributes approximately 500-1000 trips a day, not including peripheral related traffic. Information I found on I81 puts the designed maximum traffic load at 30,000 to 50,000 vehicles per day with a

approximately 15% trucks. In 2022, especially in certain areas, like Carlisle and Chambersburg, the daily average is about 55,000 vehicles with a truck ratio of about 30%, exceeding the design limits of the Interstate highway. This was why the speed limit was dropped to 55mph? Each new warehouse adds 2 to 5% to the AADT (Annual Average Daily Traffic). Three new warehouses would push the AADT towards 60,000 AADT with spikes well above that average at certain times of the day. Speed limits were lowered from Mechanicsburg to past Carlisle but many trucks and cars regularly exceed the 55mph speed limit.

Personal experience shows the I81 on-ramps around Middlesex and Carlisle are becoming increasingly dangerous with long lines of trucks filling both lanes of the highway, leaving little room for merging or any mistakes. Just a reminder here how much more deadly a car-truck collision is. It is the mass disparity between the truck and the car that adds to the force involved. NHTSA data indicates the fatality rate is 2 to 3 times higher than non-truck crashes at similar speeds.

In general and especially if traffic gridlock or an accident blocks traffic, Ritner Highway (Rt 11) would pick up an increase of truck traffic, sending truck traffic through rural residential areas with all the consequences previously mentioned.

Research shows 6 to 9 new warehouses were added since the 2022 data was gathered. At 500 to 1000 trucks daily, this would add 3000-9000 trucks daily, not counting peripheral traffic. 55,000 + 9,000 + 3000…. Three more warehouses could potentially take the AADT towards 70,000, way over the design limit.

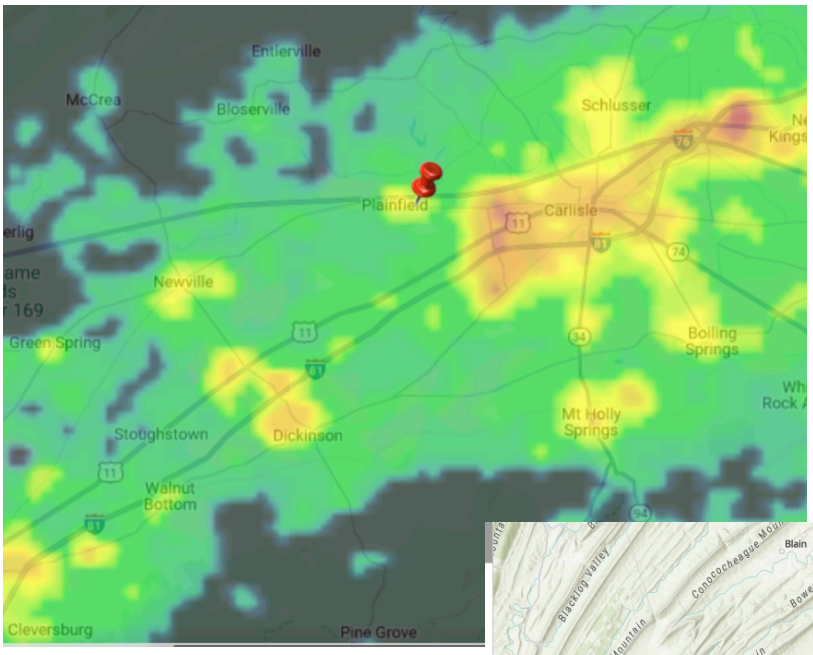
A summary of the last four paragraphs is that the I81 Corridor in South Central PA is already at saturation or greater with peak times well over road design limits using 2022 data. The 6-9 warehouses since 2022 have pushed the AADT even further past road design limits. Three new warehouses would add 1500-3000 trucks a day to that total. We could expect increased crash fatalities with the majority of deaths coming from drivers and passengers in cars due to the weight disparity ratio between trucks and cars. Expect additional traffic on local roads as a bypass to I81 traffic or cut-through warehouse to warehouse traffic. Commonsense would dictate no additional traffic adds until after infrastructure can support it. The cost of lost lives added to the true cost of the warehouse project?

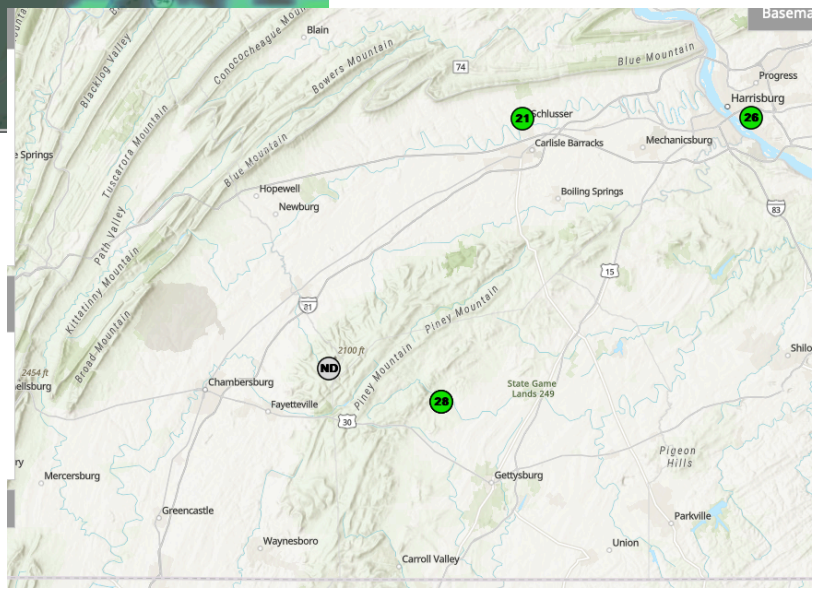
Not sure how to phrase this so stream of thought… Many valid concerns exist. Many are not properly studied and solutions found. People assume agencies like EPA and DEP are taking care of us but that is not true, even if the intent of the agency is to do so. Residents raise valid questions that are not addressed. Agencies have their focus yet there is no wholistic, consolidated entity to understand the impact of large projects and the impact of a specific project aggregated with other similar projects in an area. Residents are losing something of value and are not being compensated for it, plus they end up paying for improvements when, in this case commercial interests like warehouses, break existing infrastructure and require roads and power and utilities to be upgraded. If residents and a municipality are selling something of great value, their resources and quality of life, then they should expect to be compensated properly for it. If the aforementioned risks and degradation of their properties are a concern, solutions and agreements need to be in place BEFORE a project gets to design and definitely before it goes to construction. Once at that stage, everything is already lost and cannot be restored (Once a water source is contaminated, once a rural community's ambiance, once a vista gone, or people's health harmed, you're not getting it back). A rural community's life and surroundings is worth extremely more than even most of the residents understand. Don't sell yourself short. Remember Issac, Easau and Jacob and their story in Genesis 27.

Addendum:

Light Pollution Map showing the level of light pollution in the local I81 Corridor and the effect of warehouse and trucking facilities in Middlesex Township, Carlisle, south to Shippensburg. The map also shows the ecologically sensitive areas to the north and south, where naturally dark night skies are a valuable and required resource for the health of the local environment.

The second map is from AirNow.gov, the EPA Air Quality Monitors, showing only one monitor near Middlesex, PA along the I81 Corridor. None in the area of heavy warehouse development and none along the rest of 81, all the way to the PA/MD Border.





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Pesticide Control Acts: State pesticide control acts, such as the Pennsylvania Pesticide Control Act of 1973, regulate pesticide use, storage, and disposal within the state, which can affect development projects on land with a history of pesticide use.

Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA): FIFRA regulates the registration, labeling, and use of pesticides, aiming to prevent unreasonable adverse effects on human health and the environment. Its provisions can indirectly influence development on contaminated land by influencing how certain pesticides are managed and the associated risks.

Due diligence and site assessments

- Phase I and Phase II Environmental Site Assessments (ESAs): Conducting a Phase I ESA is generally required before developing on potentially contaminated land, especially for commercial properties and those seeking financing. This non-intrusive assessment involves reviewing historical property usage, regulatory records, and conducting a site inspection to identify Recognized Environmental Conditions (RECs), which indicate potential contamination.

- Phase II ESA: If a Phase I ESA identifies RECs, a more comprehensive Phase II ESA may be necessary to confirm and quantify the presence and extent of contamination through soil, groundwater, and potentially vapor sampling. The findings of Phase II ESAs inform the need for remediation and help developers make informed decisions about site development.