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ENVIRONMENTAL

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VIA CERTIFIED MAIL – RETURN RECEIPT REQUESTED

November 25, 2013

Mr. Thomas J. Hanlon, PE
Environmental Engineering Manager
Air Quality Program
Pennsylvania Department of Environmental Protection
Southcentral Regional Office
909 Elmerton Avenue
Harrisburg, Pennsylvania 17110-8200

Re: *R*equest for Meeting with PADEP and Comments on Revisions to Plan Approval Application No. 36-05158A
Perdue Grain & Oilseed LLC
1897 River Road
Marietta, Pennsylvania
Conoy Township, Lancaster County

Dear Mr. Hanlon:

At the request of our client, A & R Nissley, Inc. (Nissley Vineyards) we have reviewed the Revisions to Plan Approval Application No. 36-05158A (hereinafter referred to as the Revised Application) submitted by Perdue Grain & Oilseed LLC (hereinafter referred to as Perdue) for a soybean processing facility to the Pennsylvania Department of Environmental Protection (PADEP) on June 4, 2013. As a result of this review, we are providing the following comments/concerns to the PADEP for their consideration.

In addition, we are aware that the Department routinely meets with parties who have substantial concerns and objections to permit applications. Nissley has presented substantial comments and we request a one-on-one meeting with the Department to discuss our comments and Nissley's concerns. This is different than a public meeting at which the Department receives commentary and does not respond at that public meeting. Our hope is to engage the Department in a dialogue about Perdue's permit application. We had previously requested a meeting with the Department and were refused. **It was directly as a result of DEP's unreasonable refusal to meet with us that we were forced to request a meeting with EPA.** Our client's preference is to meet with DEP, not other agencies. Consequently, we request a meeting with the Department to discuss our client's concerns.

<u>Temperature Inversions</u>

Nissley Vineyards has contracted with Professor Richard D. Clark, Ph.D., Chair, Department of Earth Sciences at Millersville University to conduct a study of temperature inversions along the Susquehanna River centered on the location of the proposed Perdue facility. A copy of this study is provided in Attachment A. The results of this study indicate that temperature inversions occurred in this location on approximately 86 percent or 313 days in 2011, with a breakdown of the duration of the inversions as follows:

- No inversions: 52 days
- Short inversions (less than 4 hours): 293 inversions
- Medium length inversions (4 to 8 hours): 130 inversions
- Long inversions (9 hours or more): 96 inversions.

Note, the number of inversions exceeds 313 as more than one inversion and/or type of inversion occurred on multiple days. From the perspective of temperature, 2011 was an "average" year, so the number of inversions is what we would expect in an "average" temperature year. More inversions would be anticipated in a warmer year. These temperature inversions prevent air pollutants from dispersing and the study indicates that "areas immediately downwind of a pollution source can be significantly affected by deleterious air quality for long durations." There are concerns with air pollution in the area of the proposed Perdue facility including:

- Nonattainment with the 2008 8-hour Ozone Standard of 0.075 parts per million (ppm)
- Nonattainment with the 2006 $PM_{2.5}$ 24-hour Standard of 35 micrograms per cubic meter of air ($\mu g/m^3$) and $PM_{2.5}$ Annual Standard of 15 $\mu g/m^3$.

Due to the unique air characteristics in this area of the Susquehanna River as well as the fact that Perdue claims that the overall project will emit 208 tons of volatile organic compounds (VOCs), PADEP should request the following from Perdue:

- Information on how the source will not prevent or adversely affect the attainment or maintenance of ambient air quality standards in accordance with Title 25 of the Pennsylvania Code §127.12(a)(6).
- A plan of action for the reduction of emissions during each forecast level specified in 25 Pa. Code §137.3(1) thereby preventing the occurrence of an emergency due to the effects of the pollutants on the health of persons in accordance with 25 Pa. Code §127.12(a)(7).
- A plan for dealing with air pollution emergencies in accordance with 25 Pa. Code §127.12(a)(9).

The permit application should be withheld until Perdue adequately satisfies this important concern.

Ambient Impact Modeling

Perdue contracted with Environ International Corporation (Environ) to conduct dispersion modeling due to the potential health risks of hexane emission concerns. The cover letter of the modeling protocol indicates that Perdue is voluntarily conducting this assessment of the potential health risks associated with hexane from the proposed facility. However, the modeling performed by Perdue did not include ambient impact modeling of all emissions sources in the area including the proposed facility or modeling of VOC emissions.

Perdue calculates the facility-wide VOC emissions to be 208 tons. Perdue indicated in the Alternative Site Analysis (ASA) (Attachment I) that "the impact of the proposed plant on ozone formation in the surrounding region of Lancaster and York Counties is expected to be insignificant". However, Perdue has not conducted any ambient impact modeling on which to base this statement. The ASA includes information that VOCs react to produce "ozone," or "smog, …a regional air quality issue in much of the Northeastern United States, including in Southeastern Pennsylvania" as well as indicating that formation of ozone from VOCs forms over the course of "four (4) to six (6) hours or more" and that in this time period VOC emissions from the facility will have dispersed and will not cause ozone formation in Lancaster County.

As previously presented in this comment submittal, temperature inversions occur 313 of 365 days per year in the vicinity of the proposed facility in an "average" temperature year and these inversions prevent pollutants from dispersing. In addition, information maintained by PADEP (www.ahs2.dep.state.pa.us/aq-apps/aqpartners/code_red.asp) identifies that Ozone Action Days have been forecast in the southeast region of Pennsylvania since 2009 with warnings being issued to limit or curtail outdoor activity due to poor air quality. In an area where temperature inversions are known to occur, where ground level ozone results in Ozone Action Days being declared and the population being warned to limit or curtail outdoor activity, ambient impact modeling is necessary to ensure that new sources of 208 tons of VOC emissions will not further degrade the air quality in the vicinity of the facility.

As the application does not include ambient impact modeling, the application should be denied.

Air Dispersion Modeling and Health Risk Assessment

Perdue contracted with Environ to conduct dispersion modeling due to the potential health risks of hexane emission concerns. The following concerns were noted following a review of the report of these modeling results dated June 2013:

1. The maximum hourly rate used in the model was not specified in the report nor was it included in the data files obtained from PADEP of data used to perform the modeling. Therefore it is unclear if the modeling performed for acute

exposure was based on the maximum hourly rate of hexane emissions from the Perdue facility.

2. On page 28, Table 2 Structure Dimensions contains inaccurate building heights for the Extraction Building (18.59 meters) and Storage Tanks (18.31 meters). On the schematic drawing of the building profile that Perdue presented to the Conoy Township Zoning Hearing Board in March 2012 as Exhibit #2, the following elevations are listed:
    i. D - Grain Tank - 101 ft (equates to 30.78 meters)
    ii. F - Extraction Building - 90 ft (equates to 27.43 meters).

   As incorrect building heights were utilized in performing the modeling, the modeling should be re-run with the correct building heights.

As currently conducted, Perdue's modeling inaccurately models the dispersion of n-hexane emissions and it should be rejected.

Lowest Achievable Emission Rate (LAER) (Attachment H)

The LAER demonstration is provided in Attachment H. The LAER demonstration does not include any add-on control technology. All add-on control technologies identified were determined as technically infeasible with the exception of the use of a mineral oil scrubber on the main vent. However, not all of the reasons given that specific technology is technically infeasible are valid. Some of these reasons would be operational considerations or could be eliminated through the use of multiple technologies. For instance the use of mineral oil scrubber for the meal dryer vent and meal cooler vent is indicated as technically infeasible due to excess PM and low VOC concentrations. A regenerative thermal oxidizer (RTO) was rejected as technically infeasible but was identified as a potential control option in the Vegetable Oil NESHAP. These technologies should be further evaluated with the use of both PM control and condensing of VOCs. In addition, the use of a RTO is deemed not economically feasible. However, the cost of a specific technology is not a consideration under LAER. The LAER should be revised to evaluate all technologies that could be utilized and appropriate add-on VOC control technology specified for use at this facility.

Emergency Response/Safety

Nissley Vineyards has retained Mr. Frank Chiappetta, President and Explosives Application Engineer with Blasting Analysis International, Inc. (BAI) to evaluate the safety concerns associated with the proposed hexane ASTs. A copy of the BAI report is provided in Attachment B. The results of this study indicate an explosion of the hexane tanks would result in:

- High velocity fragments (shrapnel) impacting neighboring properties resulting in death or serious injury to anyone who was hit by it as well as serious property damage to any structures that it encountered
- Multiple fires wherever any burning shrapnel/debris landed

- The oil storage tank, which is situated only 40 ft away from the hexane storage tanks, most likely catching on fire and spewing out huge amounts of heavy smoke and toxic gases
- There is a large propane storage tank nearby on the adjacent Lancaster County Solid Waste Authority incinerator property. Depending on the mass and velocity of a projectile, it is possible to explode the propane tank on impact, causing another secondary large scale energetic explosion
- Airblast (concussion) would occur from the explosion that in itself would kill or seriously injure people and would also cause serious damage to nearby properties. The overpressure effect could result in the destruction of nearby buildings which could inflict injury or death to anyone inside or near the building(s). Because it is so close, it is expected that the incinerator complex would be seriously damaged from an explosion. In addition, BAI would expect windows in buildings as far as half a mile away to be blown out, which could also result in injury to anyone nearby.
- If there is a temperature inversion at the time of the explosion, the inversion layer will reflect the airblast energy back to ground elevation with a greater intensity .If there is an inversion at an appropriate height above the ground, with high-velocity directional winds, the inversion layer can be reflected back down to earth to break windows much farther away than half a mile with the possibility of a damage focal point 1 – 2 miles away. This is illustrated in the figure provided as Attachment C.
- If a hexane explosion occurred, the resultant fires would result in noxious fumes (as occurred at other soybean processing facilities). For example, some of the gasses often resulting from hexane explosions are oxides of nitrogen. Exposure to these gasses with concentrations of only 0.03 to 0.05% could be fatal 8 to 72 hours after exposure.

Due to safety concerns with the use of hexane at the facility, Perdue should be required to prepare an emergency response plan that will include immediate and direct notification of all neighbors--by Perdue--within a one mile radius of the proposed plant in Conoy Township, Pennsylvania. The plan should include a warning system to be implemented by Perdue to warn nearby residents immediately, rather than rely solely on the local emergency response units (most of whom are volunteers), because valuable time would be lost for nearby residents in deciding to evacuate immediately, or to seal their homes by closing all windows/doors and turning off their air conditioning units until the danger has passed. According to Perdue representatives, they plan to use the local emergency response units in dealing with such events. Perdue should take responsibility for this important aspect of emergency planning and response.

Alternative Site Analysis (ASA) (Attachment I)

The ASA submitted with the Revised Application has been significantly modified to and addresses some of the concerns raised in comments submitted April 2, 2013 to

PADEP on Perdue's Grain Elevator Site Analysis. However, the ASA submitted with the Revised Application still does not meet the requirements of 25 Pa. Code § 127.205(5) which states:

> *"…an analysis shall be conducted…..which demonstrates that the benefits of the proposed facility significantly outweigh the environmental and social costs imposed within this Commonwealth as a result of its location, construction or modification."*

The ASA does not provide a full comparison of the benefits as well as the environmental and social costs of the proposed facility versus the benefits as well as the environmental and social costs of the alternative sites evaluated. Due to this absence of a full comparison, the requisite information has not been provided to allow the impacted public or other decision-makers to make an informed decision.

Perdue fails to grasp the detailed requirements of an ASA. An ASA is intended to be an exhaustive and thorough analysis of alternative sites, not a summary or conclusory statement. Each alternative site ought to be thoroughly evaluated. See Pennsylvania Trout v. DEP, 863 A.2d 93 (Pa. Commw. 2004). The evaluation cannot be a summary or a conclusion, but must be an exhaustive analysis of practical on-site and off-site alternatives. See, Pennsylvania Trout v. DEP, EHB Docket No. 2002-251-R (Adjudication, April 23, 2004), 2004 WL 1045408.

No information on benefits associated with any of the alternative sites evaluated is presented. In addition, the sole environmental and economic benefit for selection of the proposed site, as well as lack of further consideration for any of the alternative sites, is the availability of steam from the neighboring Lancaster County Solid Waste Authority (LCSWA). The ASA does not provide any information on the current use of the steam from the LCSWA or how use by Perdue at the proposed location would be more socially and environmentally beneficial than the current use of that steam.

Other benefits as well as environmental and social costs that should be considered, evaluated, and compared for the proposed site as well as alternative sites include public safety, air emissions and temperature inversions, and explosion hazards addressed in these comments.

The ASA report utterly fails to document that the benefits of the proposed facility significantly outweigh the environmental and social costs versus any of the potential alternative sites within the meaning of the regulations or the EHB's standard established in Pennsylvania Trout.

The ASA does not provide an analysis of the impact of increased traffic in the vicinity of the proposed location nor in the surrounding areas from which the soybeans will be shipped to the proposed grain elevator. A traffic study was conducted by Rettew on behalf of Perdue and dated June 5, 2012, which clearly shows that there will be a dramatic increase in vehicular traffic in the area. This is not discussed as a project impact which would be detrimental to the area. Perdue's proposed operation will introduce literally thousands of truck trips every week onto rural and local roads. Perdue's ASA summarily addresses traffic only in regard to the capacity of the LCSWMA driveway and is entirely inadequate. In addition, this traffic study was limited to traffic on Route 441 at the entrance to the proposed facility. However, "the proposed facility will receive, process, dry, store, and ship soybeans that are grown and harvested within Lancaster County and the surrounding region, consisting primarily of York, Berks, and Lebanon Counties and the states of New Jersey, New York, and Delaware."

As the proposed facility will only accept soybeans via truck, a study of the increase in truck traffic throughout the area from which soybeans will be shipped is warranted including specific modeling of the particulate matter less than 2.5 microns in diameter ($PM_{2.5}$) (a nonattainment pollutant in Lancaster County) and nitrous oxide emissions (a pre-cursor to ground level ozone (a nonattainment pollutant in Lancaster County)) along the entire Route 441 access route from Columbia, PA to Middletown, PA. In addition, an evaluation of the impact of the increased truck traffic on roadway infrastructure, specifically aging bridges in Lancaster County, which may result in the imposition of load limits, as well as the possibility of utilizing rail for shipments of raw materials to and finished products from the facility should be incorporated in the ASA.

The ASA indicates, "given the nature of the proposed facility's operations, other environmental impacts relating to water, waste, and land are expected to be minimal." The ASA fails to provide any details on these environmental impacts for the proposed facility or alternative sites nor is any analysis included to warrant selection of the proposed facility versus alternative sites based on these impacts.

The ASA discusses economic risks that Perdue is assuming in selecting the proposed location without mentioning or evaluating economic cost of the 8.75 million dollar grant to the Commonwealth of Pennsylvania or addressing the other social costs (i.e., degradation of air quality, public safety, and traffic). The ASA appears to give sole weight to Perdue's economic benefit at the expense of any other social or environmental costs.

As Perdue has failed to provide an alternative site analysis that demonstrates that the requirements have been met and from which an informed decision can be made, the Revised Application should be denied.

Best Available Technology (BAT) Analysis (Attachment J)

The BAT Analysis includes best management practices (BMPs) for grain handling. Many of these BMPs are qualitative in nature. Specific quantitative requirements for BMPs should be incorporated in addition to the qualitative BMPs as follows:

General Maintenance, Upkeep, and Repair:

- All grain handling and soybean processing operations will cease immediately if equipment or air pollution control equipment malfunctions occur that will result in excess emissions and will not be resumed until a remedy is implemented.
- Clean internal and external areas, including floors, roofs and decks, daily during operations to minimize dust to the atmosphere when the facility is receiving, transferring, or loading out grain.
- Clean the yard, ditches, and curbs daily during operations to minimize accumulation of grain, chaff, and grain dust.

Grain Handling Equipment:

- Grain handling equipment shall be cleaned daily, enclosed, or controlled to minimize visible dust emissions to the atmosphere when the equipment is being operated.

In addition, as Perdue indicates in the BAT that the Airlanco baghouses for control of particulate matter (PM) emissions from sources 201, 202, 206, 207, and 210 are guaranteed not to exceed 0.01 grains per dry standard cubic feet (gr/dscf) and this emission rate should be considered BAT for these sources as opposed to the emission rate of 0.04 gr/dscf in 25 Pa. Code §123.13(c)(1)(i).

Compliance Assurance Monitoring (CAM) Plan

The CAM Plan for "Flaking Rolls" should be modified to increase the frequency of checks for the PM monitoring device on page 3 of 5 as follows:

- Record the pressure differential hourly during source operation
- Check for visible emissions from the discharge from the cyclone stack once per shift during source operation.

Geologic Considerations

Specific geologic considerations identified in comments submitted November 26, 2012 to PADEP on Perdue's Site Specific Installation Permit (SSIP) Application and Spill Prevention Response (SPR) Plan and February 14, 2013 to the Susquehanna River Basin Commission (SRBC) on Perdue's Groundwater Withdrawal and Consumptive Use Application Pending/NOI #2012-071 and 2012-072 have not been addressed.

Within the Aquifer Test Report dated April 2012, it states that the Site is underlain by carbonate geology. A carbonate geology report, which was submitted to the Lancaster County Planning Commission (LCPC), identified a bedrock outcrop and sinkholes on site. The larger of the two sinkholes was measured to be 18-feet in diameter and 4-feet deep, which is large. Additionally, the aerial photographs that were reviewed identified a fracture trace onsite and the Kochanov map identified a closed depression. These karst geologic features are of concern; however, Perdue's Aquifer Test report only provides very general recommendations for sinkhole repair and no site specific recommendations for sinkhole repair are provided. We found that the Aquifer Test Report was superficial, generalized, not site-specific and inadequate for its purpose.

Within the SSIP Application, the Geologic Considerations state that the Site is underlain by carbonate geology; therefore, the permittee is required to include the methodology that will be used to stabilize the tank system's foundation. The carbonate geology report identified sinkholes on site which are of possible concern but only provides very general recommendations for sinkhole repair. No site specific recommendations for sinkhole repair are provided. The geotechnical report considers the karst geology in their foundation discussion but there is no discussion regarding potential problems during construction. The geotechnical report also indicates that the moisture contents of some of the soil samples were very high and could be a possible concern. Both reports should include more specific information on the karst geology at the Site including site specific recommendations for sinkhole repair, addressing problems during constructions and the high moisture content observed in some soil samples.
Considering the karst topography of the project area, the proximity to the Susquehanna River and the proximity to nearby neighbors who could be impacted by sinkholes, these reports are wholly inadequate.

Considering the additional groundwater withdrawal that is proposed, the on-lot septic system, and the general construction activities that will occur including the construction of two aboveground storage tanks (ASTs) that will contain 20,000 gallons each of hexane, there is a major concern that these activities will aggravate karst conditions present onsite resulting in new sinkhole development. When fully loaded, each hexane tank will contain 116,760 pounds of hexane. Coupled with the tare weight of the tanks, that will put significant stress on the karst terrain in itself. This concern is compounded by the fact that there are known fracture traces, closed depressions, bedrock outcrops, and sinkholes located and/or identified onsite.

These known conditions, coupled with the proposed activities could result in a situation in which the ASTs' foundations are compromised resulting in a hexane release. If the foundations were compromised and a release occurred, up to 40,000-gallons of hexane (a highly flammable substance with explosive vapors) would be released into a known karst environment. This release would most likely impact the Susquehanna River (both water quality and habitats) and groundwater in the area. Given that the municipality does not provide water to this area, many private water supply wells could be affected. In order to address private water supply wells, a search of the Pennsylvania Groundwater Information System (PaGWIS) was completed. However, this database is highly inaccurate and incomplete. It is understood that municipal water is not available in the vicinity of the Site and that all surrounding properties would contain their own private water supply well. Therefore, additional data should have been collected in order to verify that no additional water supply wells could be impacted from proposed

Site activities. Additionally, given that the hexane would likely migrate through sinkholes and other underground cavities, it would be nearly impossible to contain the release once it has entered the subsurface and would make for a difficult and costly remediation.

Perdue appears to rely on sinkhole repair which is entirely an after-the-fact remedy. They have not adequately documented how they will handle mitigation and prevention of collapse sinkholes in this karst terrain. A thorough geophysical analysis ought to be conducted of the entire tract to determine the likely location of underground voids and potential collapse sinkholes. That ought to be followed up with core drilling and a down-hole geophysical analysis to determine the location of voids, conduits and potential sinkholes. Once the tract has been thoroughly analyzed and the location of underground voids, conduits, sinkholes and potential sinkholes has been documented, then those voids, conduits, sinkholes and potential sinkholes ought to be mitigated with grout. Furthermore, a grout curtain or other appropriate mitigatory measure ought to be employed to prevent the further formation of new sinkholes. Finally, a structural engineer ought to be employed by Perdue and submit a report to the Department documenting how Perdue will construct facilities, some of which contain hazardous chemicals, in this karst environment.

While a sinkhole(s) opening might have an economic impact on Perdue, if it caused an explosion or release of hexane, that would have a huge adverse impact on neighbors, including Nissley.

Conclusion

The application submitted by Perdue is deficient and should be denied until important concerns related to adversely affecting the environment, public safety, and air quality have been adequately addressed.

Moreover, even if additional information was provided by Perdue, the emission of more than 208 tons of VOCs from this location including more than 104 tons of n-hexane emissions along with the storage of 40,000 gallons of hazardous hexane at this site is an environmental hazard, a safety hazard, and a public health hazard. The only way this facility would be acceptable would be if it eliminated the use of hexane.

If you have any questions regarding this submittal, I can be reached at (717) 399-9587 ext. 27.

Sincerely,

Susan M. Burkett, ASP
Principal Engineer, eCAP® Services

cc: Mr. Daniel Husted, PE, Chief, New Source Review Section, PADEP
Ms. Gerallyn Duke, New Source Review/PSD, U.S. EPA Region III

ATTACHMENT A

Temperature Inversion Report
Millersville University
Dated November 12, 2012

Millersville University
SEIZE THE OPPORTUNITY

P.O. Box 1002, Millersville, PA 17551-0302
Department of Earth Sciences
http://www.millersville.edu/esci
Phone: 717-872-3289
Fax: 717-871-4725

12 NOVEMBER 2012

Joel R. Burcat, Esquire
Saul Ewing LLP
Two North Second Street
Harrisburg, PA 17101

Dear Mr. Burcat,

You have requested that we evaluate the temperature inversions in Bainbridge for 2011. The analysis of 2011 Bainbridge, PA inversions is summarized in the following report. The following deliverables are submitted in accordance and compliance with our statement of work.

A. Data Acquisition and Conditioning for Analysis

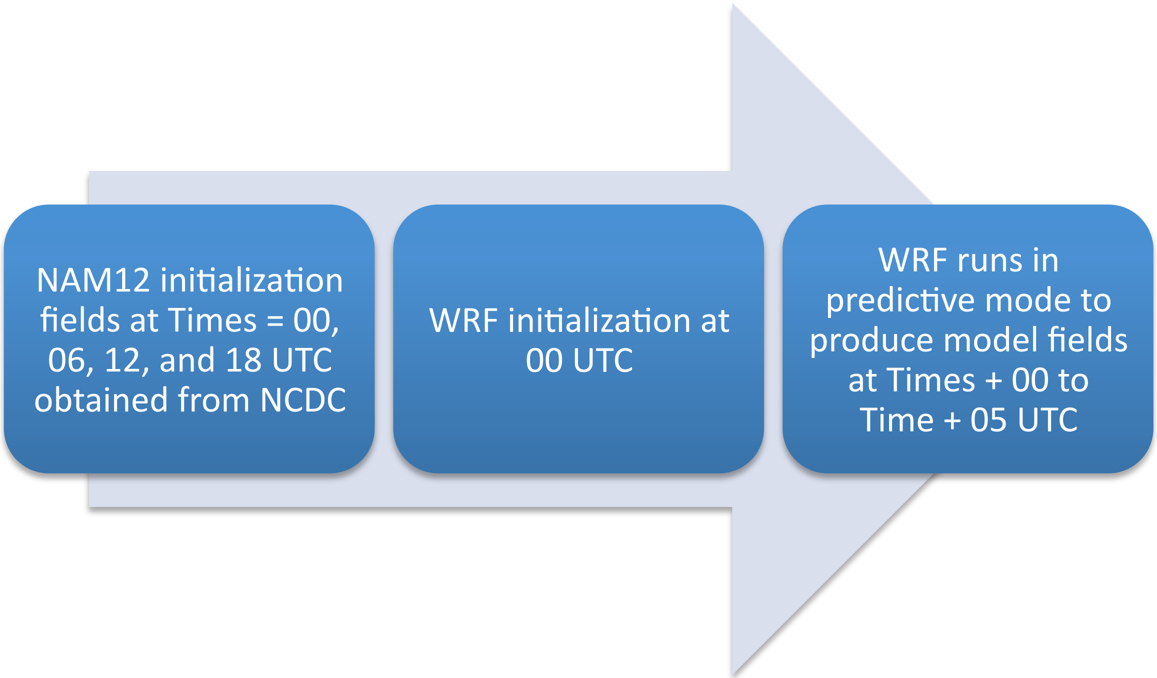
a. WRF model runs for 24 hours, 365 days in 2011 centered on Bainbridge, PA

i. North American Model – 12 km resolution (NAM12) model fields were obtained from the National Climatic Data Center (NCDC) for 00, 06, 12, and 18 UTC for each day in 2011, and used to initialize the Millersville Weather Research and Forecasting (WRF) numerical modeling system. Overall, 7.2 percent of the total annual hourly data are missing due to the unavailability of the NAM12 initialization fields from NCDC. Qualitative analysis allowed for a downward adjustment of 0.8 percent resulting in 6.4 percent of hourly data missing. Of the 8760 hours in 2011, we evaluated 8197 (93.4%) of total annual hours. The table below summarizes the missing data. (MS Excel spreadsheet, "**Missing_Bainbridge_Data_10-31-2012.xlsx**," refer to these missing data. We do not feel that these missing data significantly compromise our analysis or our results.

TABLE 1. Missing hours of model output per month

Month	Missing hours of data	Percentage of Monthly Total
Jan	0	0.0
Feb	24	3.6
Mar	224	30.1
Apr	146	20.3
May	7	0.9
Jun	102	14.2
Jul	6	0.8
Aug	54	7.3
Sep	0	0.0
Oct	0	0.0
Nov	0	0.0
Dec	0	0.0

ii. Following model initialization, the WRF model was employed in a predictive mode to create output files for each hour from Initialization time through initialization time + 5 hours. The workflow is represented by the following schematic.



iii. The result was to create 3-dimensional numerical output over the WRF domain from which the vertical profiles of temperature T, dew point temperature T_d, potential temperature θ, height z, and wind components u, v, could be extracted for Bainbridge, PA.

iv. The raw data from the WRF model were employed to construct graphic files of the vertical profiles of the meteorological variables listed in "c."

B. Working Definition of an Inversion

An inversion is a layer of atmosphere where the temperature increases with height, that is, it is "inverted" from the normal decrease with height most often seen in the troposphere. However, stable layers can be much deeper than inversion layers. A stable layer can be defined in several ways. For instance, when the temperature decreases with height by an amount that is less than the saturation adiabat, the layer is said to be stable with respect to moist adiabatic ascent, which in turn is stable with respect to dry adiabatic ascent. Another method for defining stability is to use the bulk Richardson number (BRN), where:

BRN = buoyancy acceleration/square of the wind shear

Or

$$BRN = \{ (g/\theta)\ \Delta\theta/\Delta Z \} / (\Delta U/\Delta Z)^2$$

where g = 9.81 ms^{-2}, θ is the potential temperature in Kelvin, Z is the height of the layer in meters and U is the wind in ms^{-1}. The Δ symbol represents the difference between the top of the stable layer and the surface; example $\Delta Z = Z_{top} - Z_{bottom}$ = thickness of the layer, $\Delta\theta$ represents the difference in potential temperature between the top and bottom, and $\Delta U/\Delta Z$ is the wind shear. The layer is considered stably stratified when the $BRN > BRN_{CRITICAL} = 0.25$. One may recognize the numerator as the square of the Brunt-Vaisala Frequency, N^2. The BRN has the advantage of considering instability, and by extension the generation of turbulence and mixing, in terms of both hydrostatic instability and mechanical instability, the latter due to shear. *In this analysis we use the formal definition of an inversion, a layer where temperature increases with height,* but we also provide additional information on the depth of the stable layer using the BRN.

Temperature inversions modeled at Bainbridge, PA ranged in duration from one hour to 19 hours. Short duration inversions have little consequence on air quality since they are often weak and easily disrupted by multiple atmospheric conditions. Medium duration (lasting 4-8 hours) and long duration (≥ 9 hours or extending from sunset to sunrise) can have a significant impact on air quality by trapping pollutants. Under these conditions, winds are usually calm or no more than a few meters per second. Consequently, area immediately downwind of a pollution source can be significantly affected by deleterious air quality for long durations – until mixing fumigates and replenishes the air. Low-lying areas such as valleys, where under clear sky conditions can be subject to strong and low-lived inversions, are particularly susceptible.

C. **Analysis of vertical profiles to determine the existence of inversions at Bainbridge, PA**

Our analysis took at two-pronged approach to determine the existence of an inversion for a particular vertical profile: i) a qualitative visual inspection of the profile image to determine the existence of the inversion and its depth; and ii) a quantitative analysis of the surface-based inversion based upon a computational analysis of the vertical temperature profile. In addition, the BRN was employed to determine the depth of the stable layer.

i) Qualitative determine of inversion frequency and depth based on visual inspection of each vertical profile was carried out for each of the 8197 hourly profiles. Each profile was visually inspected and a determination of existence (or not) of an inversion was made, along with an estimate of the height of the inversion. To pass the "inversion test," the inversion had to originate at the surface and the temperature had to increase with altitude. Upon meeting these criteria, the inversion was counted and an estimate of the depth of the inversion was recorded.

Table 2 shows a comparison of the two methods in determining monthly inversion frequency. The two methods differ by 5.4 percent. However, March and April had a significant number of missing vertical profiles, which resulted in the lower frequencies in those months.

Table 2: Comparison of evaluation methods

COMPARISON OF QUALITATIVE (VISUAL) AND QUANTITATIVE METHODS (COMPUTER PROGRAM) OF INVERSION DETERMINATION													
	JAN	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**TOTAL**
Quantitative Method	**241**	**227**	**137**	**111**	**223**	**255**	**294**	**230**	**232**	**202**	**176**	**131**	**2459**
Qualitative Method	**239**	**220**	**82***	**75***	**211**	**240**	**290**	**228**	**225**	**207**	**179**	**131**	**2327**

*Prior to conducting the quantitative approach, the data in successive hours before and after the missing data, which often included times from 00 – 05 UTC, were evaluated and where possible, were conservatively extrapolated based on best judgment. The resulting analysis led to the addition of 55 hours of inversions in March and 36 inversion-hours in April. If we eliminate March and April from the totals, the number of inversion-hours identified by the two different methods agrees within 1.8 percent.

ii) A quantitative numerical analysis of the Bainbridge data was conducted to determine the depth of the surface-based stable layer as well as the depth of the inversion; the former using the BRN method and the latter using the formal definition of an inversion.

We evaluated each hour of the 8197 total hours for the existence of an inversion. The following is a result of that analysis. This data can be found in "**Inversion_Summary_10-31-2012.xlsx**." Using BRN to identify stable layers, of which inversions are subsets, results in layers of greater depth than the depth of the inversions. This is discussed in greater detail later.

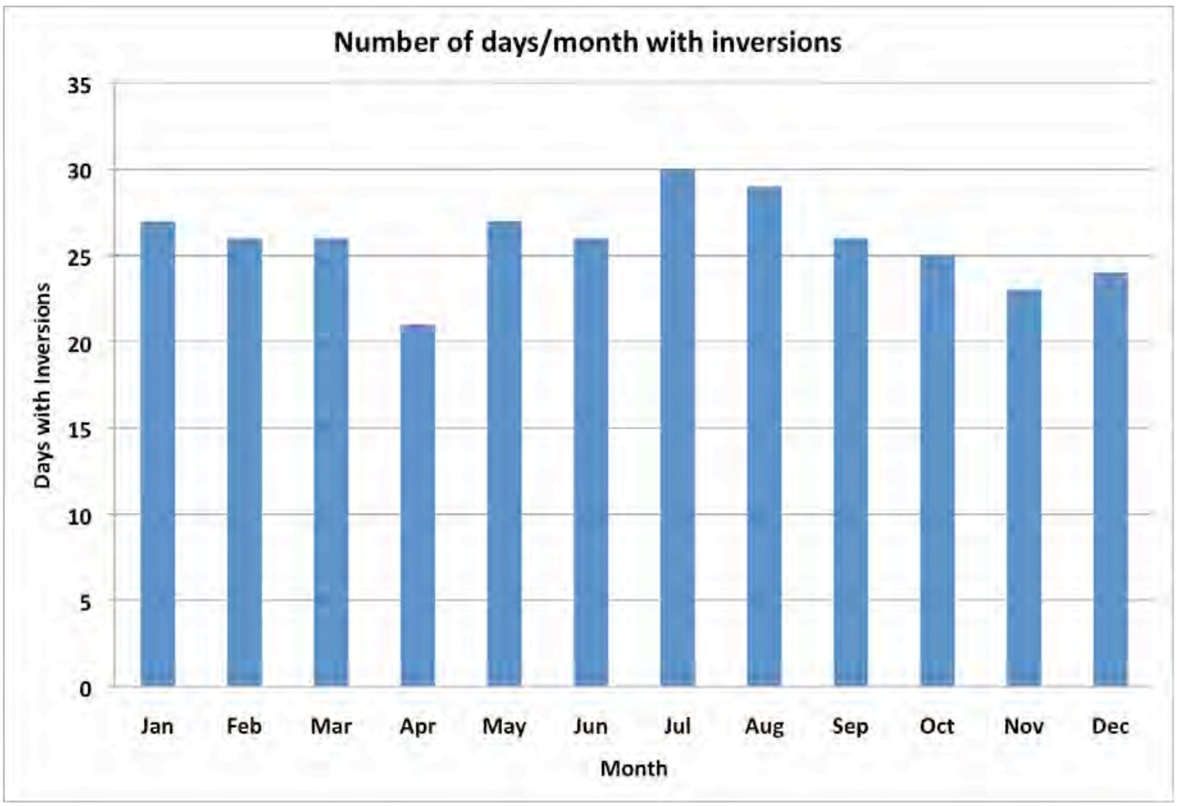


Figure 1: Number of days per month showing evidence of surface inversions; based on analysis of the bulk Richardson number.

Figure 1 shows that the number of days in each month with at least one hour of inversion is relatively uniform. However, with addition analysis, we found that the characteristic of these inversions varies significantly from month to month.

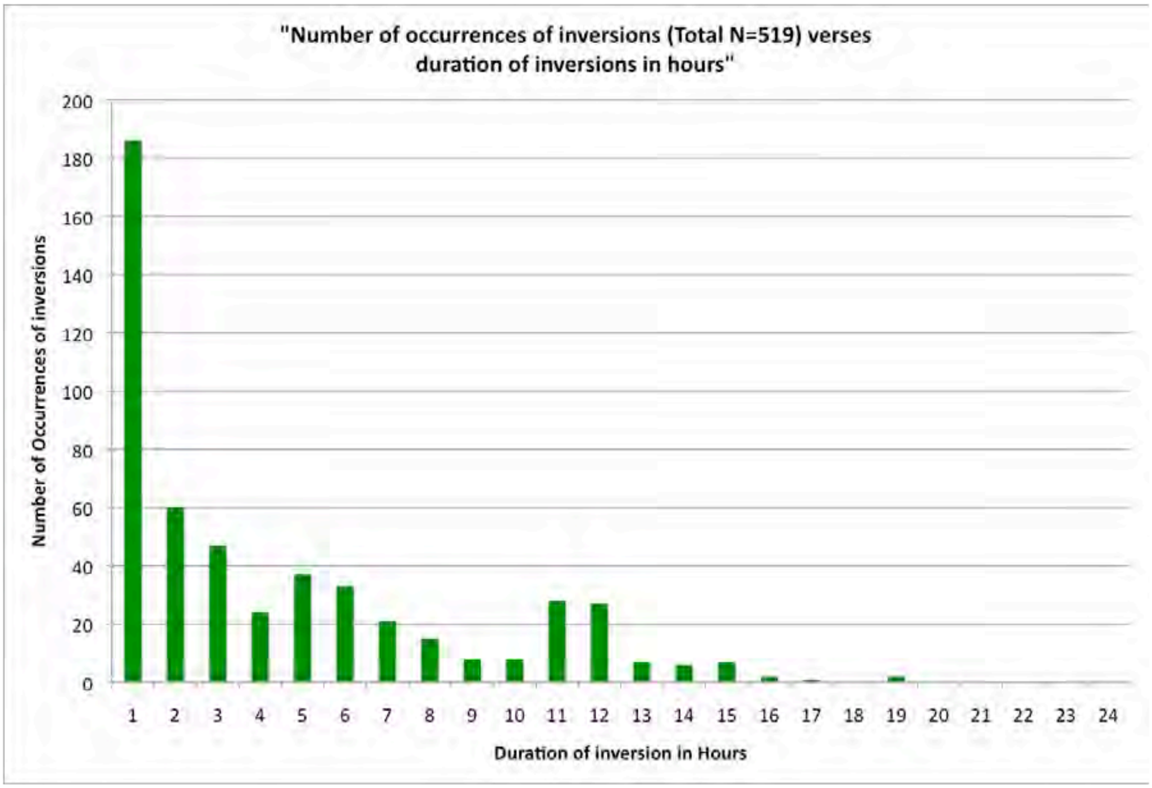


Figure 2a: The number of occurrences of inversions versus the duration of the inversion in hours. Based on a total of 519 inversions in Bainbridge, PA in 2011.

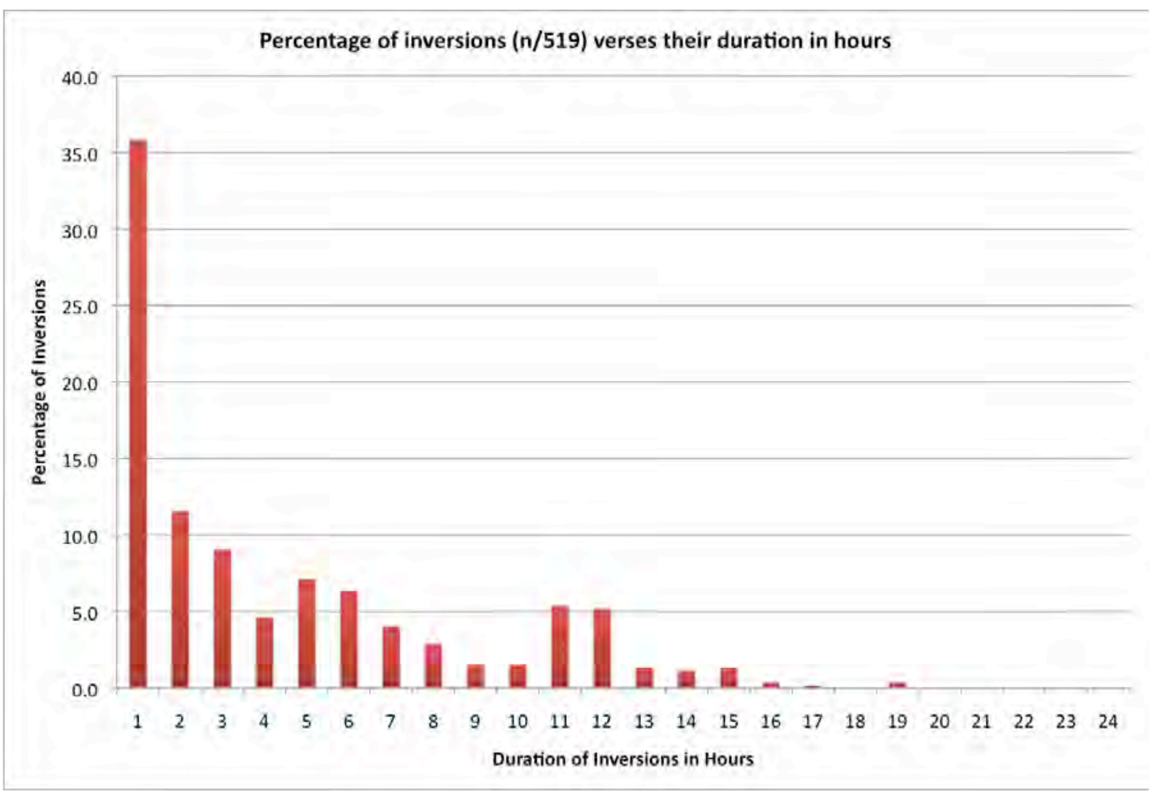


Figure 2b: Same as 2a except percentage of inversions versus their duration in hours. Based on a total of 519 inversion in Bainbridge, PA in 2011.

Figure 2a and 2b depict the number and percentage of occurrences of inversions as a function of their duration in hours. The inversions were classified according to the following categories:

- Short duration inversions lasting less than 4 hours (293 out of 519 or 56.5%)
- Medium duration inversions lasting between 4-8 hours (130 out of 519 or 25.0%)
- Long duration inversions lasting 9 hours or longer (96 out of 519 or 18.5%)

The distinction between medium duration and long duration at 8 to 9 hours is arbitrary. One could argue that an 8-hour inversion should be categorized as a long duration. The reason why the cut-off was made between 8-hour and 9-hour inversions is qualitatively justified by the distribution in Figures 2a and 2b where the modality changes. On the other hand, the distinction between short duration and medium duration between 3 and 4 hours is based more on the strength of the inversion and the characteristics of the stable layer.

In addition, the medium duration inversions were further subcategorized into those that occurred primarily in the evening hours (e.g. starting around 1900-2000 local time and referred to as medium-evening (ME)) and those that were primarily in the early morning hours after midnight local time (MM). Of these, 58/130 or 44.6% occurred were ME and 55.4% were MM.

Short duration (1-3 hours in length) and are either weak or quickly destroyed by vertical mixing or synoptic/meso-scale systems. They would contribute little to trapping pollutants and transporting them along stably stratified downwind streamlines.

The medium duration inversions have durations between 4-8 hours and can be bifurcated into those that occur primarily in the evening hours (44.6%) and those that occur in the early morning hours (55.4%). This distinction is probably related to the timely of clearing skies and radiational cooling. On a clear day, the inversion will develop rapidly around sunset. If it persists all night it will fall into the long duration category. If clouds encroach, or wind speed increases due to the approach of a synoptic or mesoscale weather system, the inversion will weaken or be destroyed. Conversely, on days with convective clouds, if often takes several hours after sunset for the clouds to dissipate, causing the inversion to form later.

Long duration inversions lasting 9 or more hours make up 18.5% of all inversions. These inversions are sustained long enough to allow appreciable downwind transport, and would exhibit stronger stability than short- or medium-duration counterparts. As such, they have the ability to trap pollutants in the near surface layer for longer periods. The medium-to-long duration inversions would typically occur on clear to partly cloudy nights with strong longwave radiative cooling and light to calm winds at the surface. These *radiation inversions* typically become established after sunset and persist until shortly after sunrise.

Figure 3 shows a summary of the medium and long duration inversions for each month in 2011. Note that no long duration inversions were recorded in the transition (and rainy) months of March and April. Inversions in general, and in particular long duration inversions, are more common in summer; peaking in July when the aloft winds are relatively light and large quasi-stationary air masses stall over the mid-Atlantic region.

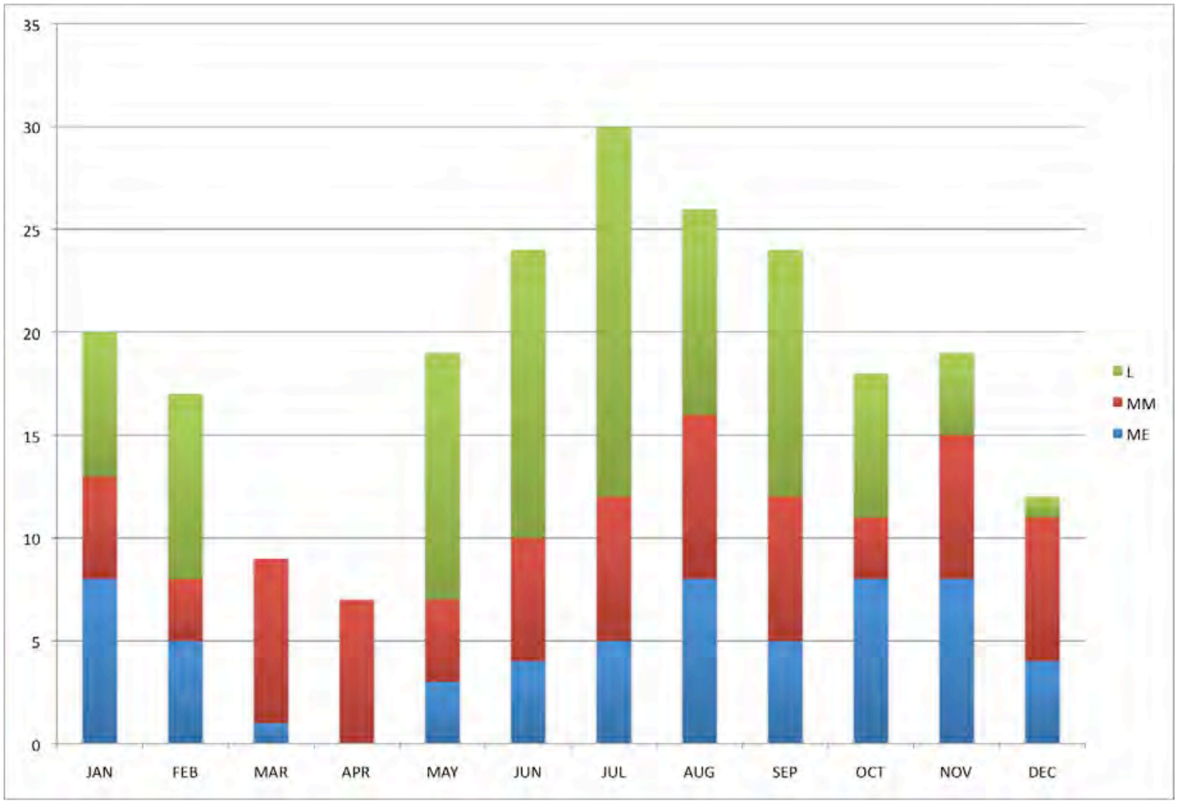


Figure 3: Distribution of Medium and Long duration inversions according to month in 2011. ME = inversions that occurred primarily in the evening; MM = early morning inversions starting after midnight; L = long duration inversions

The data were ranked according to the number of inversion-hours per month and the number of inversion-days per month. In 2011, Bainbridge had the greatest number of inversion-hours in mid-summer and mid-winter, followed by end of summer and end of winter. The least number of inversions is during the spring transition months of March and April, and in December. The spring transition in March and April is characterized by colder temperatures aloft and warmer surface temperatures leading to instability and mixing near the surface. Inversions cannot become established in a well-mixed surface layer. The consequence is the reduction in the number of surface inversions during the spring transition. Similarly, November and December are the winter transition seasons when the polar jet stream extends southward. Baroclinic waves (cold and warm fronts) migrate along the polar front and encroach on the mid-Atlantic region bringing higher surface wind speeds, and colder and progressive air masses, which tend to erode inversions or prohibit their formation. High pressure air masses in mid-summer and fall bring subsidence and clear sky conditions, which favor longwave radiative cooling and the development of extended radiation inversions. Table 3 and Table 4 show the months in 2011 ranked by the frequency of inversion-hours and inversion-days per month.

Table 3: Rank inversion-hour frequency by month

RANK ACCORDING TO INVERSION-HOURS PER MONTH		
RANK	Month	Total inv-hrs/month
1	JUL	294
2	JUN	255
3	JAN	241
4	SEP	232
5	AUG	230
6	FEB	227
7	MAY	223
8	OCT	202
9	NOV	176
10	MAR	137
11	DEC	131
12	APR	111

Table 4: Rank inversion-day frequency by month

RANK ACCORDING TO INVERSION-DAYS PER MONTH		
RANK	Month	Total inv-days/month
1	JUL	30
2	JUN	29
3	AUG	29
3	JAN	27
4	MAY	27
4	FEB	26
4	MAR	26
4	SEP	26
5	OCT	25
6	DEC	24
7	NOV	23
8	APR	21

The distribution of total inversions by month is given in Figure 4, and should be compared to Table 2, which is the same data ranked. Figure 4 illustrates that the majority of inversions-hours at Bainbridge are recorded during relatively stagnant weather conditions brought about by slowly moving, weakly progressive air masses moving across the mid-Atlantic region. This generally occurs in summer when the polar jet stream is situated over Canada, well north of the mid-Atlantic region, and the atmospheric condition often lacks strong gradients (i.e. barotropic atmosphere). Transition seasons, when the weather systems are more progressive and conditions are less favorable for the establishment of inversions, exhibit lower frequencies of inversions.

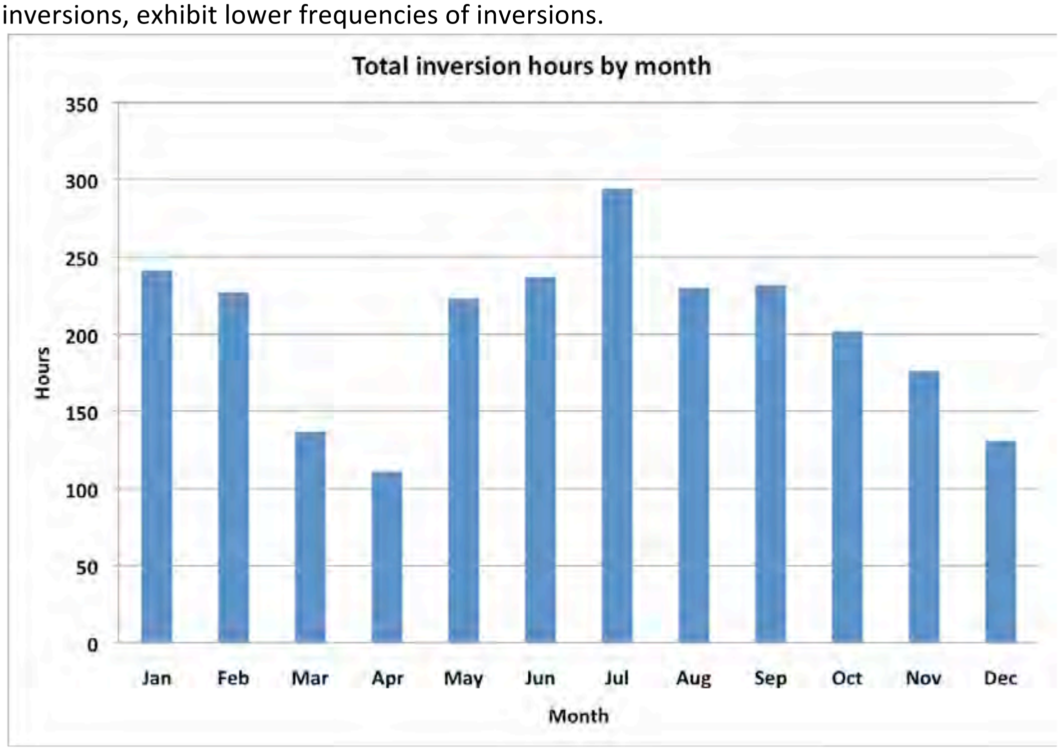


Figure 4: Total inversion-hours by month for 2011 in Bainbridge, PA

An interesting aspect of this analysis is the mean monthly depth of the surface-based stable layer as shown in Figure 5. While slow-moving high pressure air masses may bring clear to nearly clear sky conditions during summer and autumn, and in 2011 during mid-winter as well, the depth of the inversion is shallower in summer than in winter. Summertime in the mid-Atlantic region east of the Appalachian Mountains, under conditions of high pressure, may lead to a higher frequency of stable layers, but these conditions also lead to the development of the summertime nocturnal low-level jet (LLJ), which tends to occupy the layer immediately above the surface-based nocturnal inversion. In this region, the LLJ can exhibit wind speeds in excess of 18 m/s (36 kts) for sustained periods between sunset and sunrise. The consequence of the LLJ is to quell the growth of the nocturnal inversion and destroy the inversion early after sunrise. Thus, the same conditions that lead to strong radiative cooling at night and radiation inversions also leads to the development of LLJs that tend to suppress the vertical growth of the inversion and can cause mixing when Richardson numbers fall below critical due to excessive wind shear in the near surface layer. Conversely, even though the winter, spring, and autumn have fewer inversion-hours per month, the LLJs are weak or non-existent and the radiation inversions can growth to significant average depths.

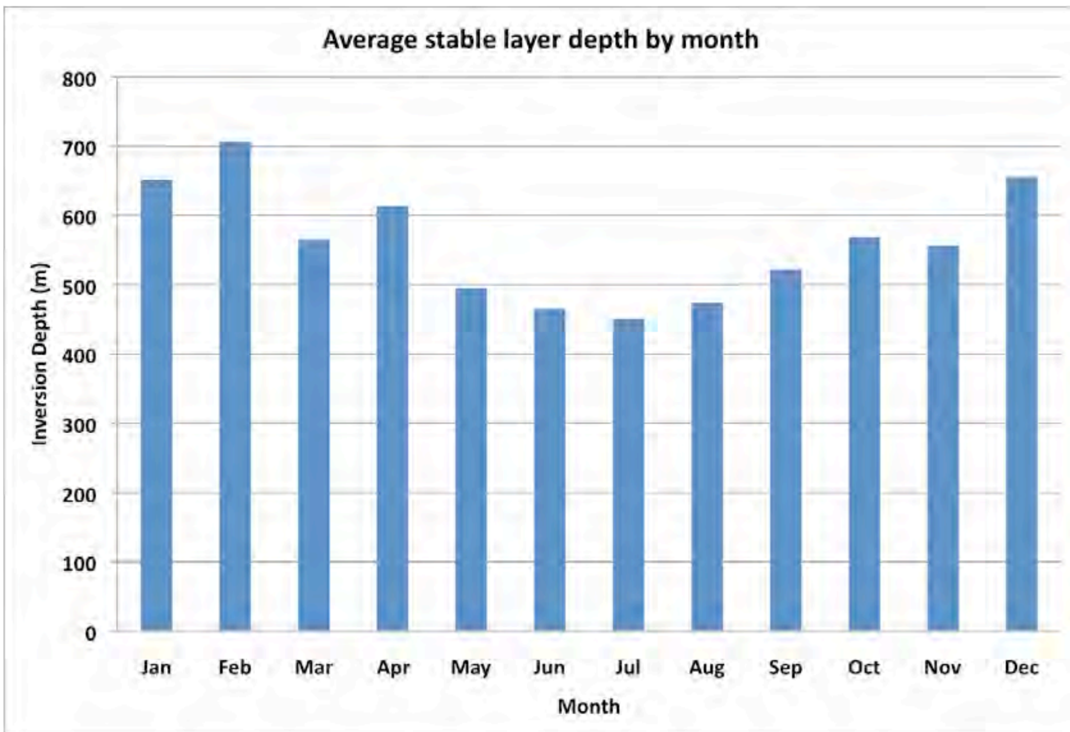


Figure 5: Average depth of the stable layer in meters by month as determined by the BRN method.

In addition to the determination of the depth of the stable layer, the depth of the inversion layer, using the strict definition of an inversion as one where the temperature increases with height, was also calculated. The criteria for this determination was similar to the BRN determination of the stable layer in that it first required the T(Z+1) > T(Z). Then the temperature of each layer was subject to the test the same test. The top of the inversion was recorded as the height where T no longer increased with height. The results, as might be expected, were lower inversion heights as shown in Figure 6.

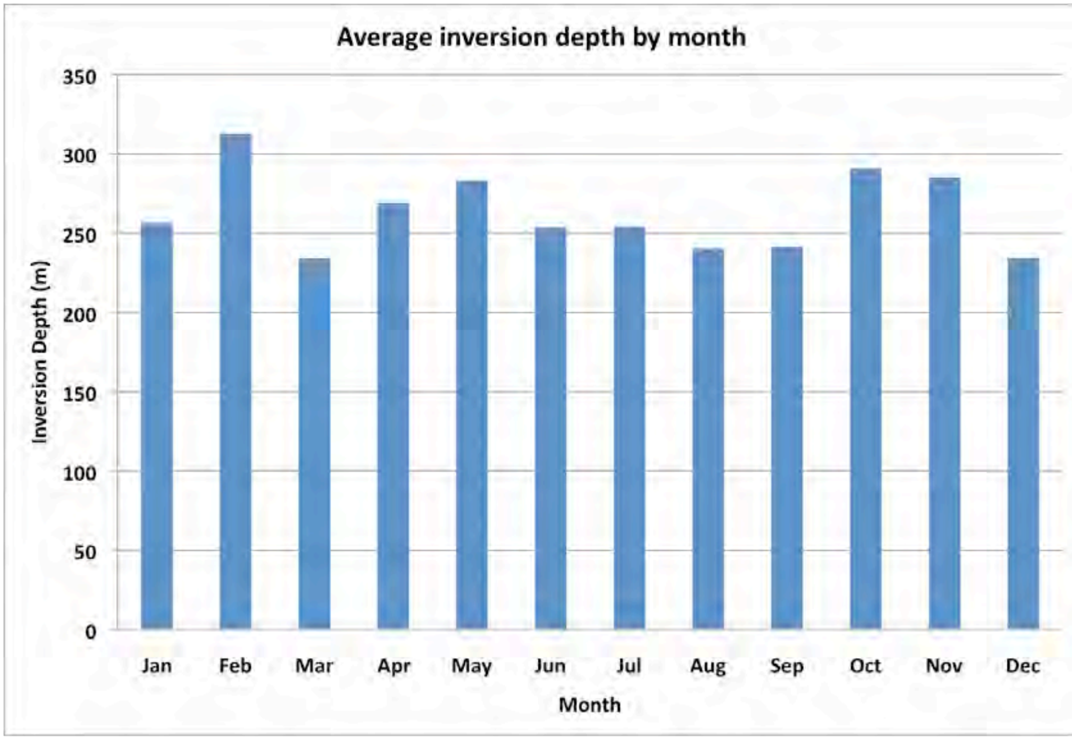


Figure 6: Average depth of inversions in meters

If Figures 3 and 6 are evaluated together, it is apparent that during the solar summer (May-September), and to a lesser degree in mid-winter (Jan-Feb), strong and long-duration inversions can develop that trap pollutants in layers generally less than 250 meters (~750 feet) above the surface.

Figure 7 illustrates the average inversion-hours per inversion day. For those days with inversions, mid-summer and mid-winter days exhibit the longest duration inversions. This can be understood by considering the meteorological conditions associated with mid-summer/winter months versus those of the transition seasons. Transition seasons are characterized by progressive systems, which on the average tend to disrupt inversions, whereas mid-summer/winter seasons are characterized by more stagnant and slowly moving air masses which tend to maintain atmospheric conditions longer. This is a caveat to this assessment. March and April are not only influence by progressive systems that shorten the inversion duration, but these months were noted for the largest amount of missing data, which would tend to diminish the average inversion hours even further. While it is true that March and April will undoubtedly have shorter-duration inversions owing to the meteorological conditions characteristic of transition seasons, they are partly affect but the bias in the larger frequency of missing data.

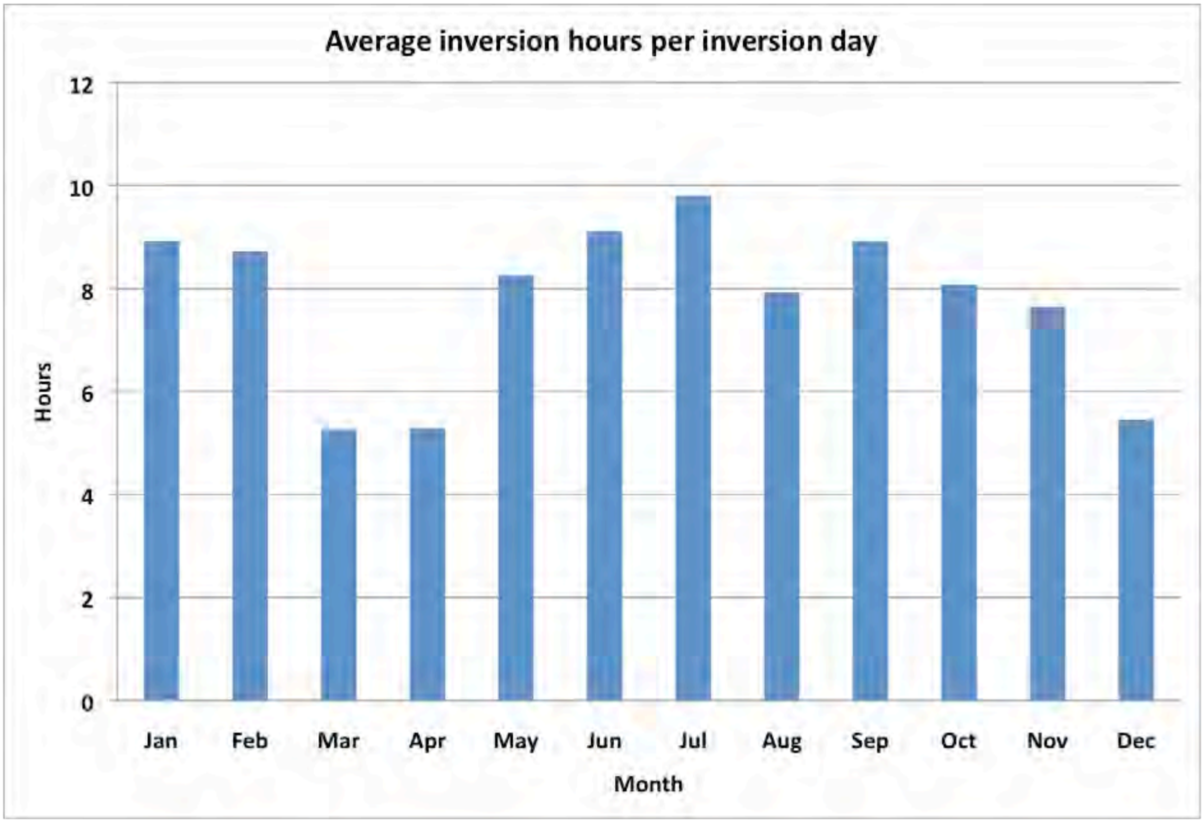


Figure 7: Average inversion-hours per inversion day for Bainbridge, PA 2011

D. Comparative analysis of Bainbridge 2011 to the 10-year and long-term historical (98 year) climatology.

Was 2011 a typical year for inversions in Bainbridge? The charge to this study was to qualitatively ascertain whether the conditions observed at Bainbridge in 2011 could be classified as 1) much below (MB), 2) below (B), 3) normal (N), 4) above (A), or 5) much above (MA), when compared to short and long-term climatology. Although the level of subjectively increases for an analysis of this type, it is possible to make qualitative judgments based on a comparison between Bainbridge, PA in 2011 using Millersville University 2011 as a surrogate, and 98 years of climate records archived at Millersville University. The data for this analysis can be found in "**Bainbridge_Climatological_Comparison_10-31-2012.xlsx**."

The convention used for the categorical ranking of temperature anomaly and precipitation is based on the accepted methods of the National Climatic Data Center and is given in Table 4.

Table 4: Categories of ranking of climatological data based on NCDC

Much Below (MB)	Below (B)	Normal (N)	Above (A)	Much Above (MA)
Less than -1.25 SD	Less than -0.5 SD	Between -0.5 SD and +0. 5 SD	Greater than +0.5 SD	Greater than +1.25 SD

Table 5: Comparison of 2011 <u>Temperature Anomaly</u> to long-term historical climate record and 10-year climate record. For the short-term (10-year) comparison, the numerical Z parameters are given as a measure of the deviation from the mean. Red font indicates those years when the 10-year does not match the 98-year long–term climate record.

Month	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2011 Compared to 98 year historical climate record	**B**	**N**	**N**	**A**	**A**	**A**	**MA**	**N**	**A**	**N**	**MA**	**MA**
2011 Compared to 2001-2010 climate record	**B -0.84**	**N 0.35**	**B -0.51**	**N 0.32**	**A 0.59**	**N -0.19**	**MA 1.30**	**MB -1.59**	**N -0.06**	**B -0.78**	**N 0.49**	**MA 1.30**

Table 6: Comparison of 2011 <u>Precipitation</u> to long-term historical climate record and 10-year climate record. For the short-term (10-year) comparison, the numerical Z parameters are given as a measure of the deviation from the mean. Red font indicates those years when the 10-year does not match the 98-year long–term climate record.

Month	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2011 Compared to 98 year historical climate record	**N**	**N**	**A**	**MA**	**N**	**N**	**B**	**MA**	**MA**	**N**	**N**	**N**
2011 Compared to 2001-2010 climate record	**N 0.15**	**N 0.06**	**MA 2.02**	**MA 2.15**	**N 0.46**	**N -0.42**	**B -0.85**	**MA 1.45**	**MA 2.14**	**N -0.13**	**A 0.72**	**N -0.21**

Attention should focus primarily on the comparison between 2011 and the 10-year climate record for both temperature anomaly and precipitation, since records indicate that there has been a trend toward slightly warmer and wetter in recent decades. When averaged over the 12 months of 2011 to obtain an annual categorical rank for the Z parameter, it suggests that for temperature, Z = 0.03, and for precipitation, Z = 0.63. Thus, comparing 2011 to the most recent decade would point to a nearly NORMAL year with respect to average temperature anomaly, and a wetter year in this geographical region (above normal (0.5 < **0.63** < 1.25 SD).

A year of nearly normal temperatures qualitatively implies that 2011 would likely have a typical number of inversions compared to the years in the most recent decade on average. On the other hand, above normal precipitation in 2011 implies wetter surface cover (soil and subsoil) on average, and the addition of soil moisture changes the near surface radiative and thermodynamic characteristics in a complicated way. Air above a wet surface will have higher relative humidity and a greater potential for fog formation. When water vapor condenses to form fog and latent heat is released to the near-surface air, the result is to slow the nocturnal decrease in temperature thereby slowing the formation of an inversion or weakening the strength of an existing inversion. Additionally, if a fog forms, fog-top net radiative cooling creates negative buoyancy forces that tend to mix the layer, further weakening the strength of an inversion to preventing it from forming altogether. Rain (snow) tends to destroy inversions. A saturated layer of air will exhibit a lapse rate that follows the saturation adiabat, which is a decrease in temperature of between 3.5-6.5 C/km in the low layers of the atmosphere. Moreover, weather systems associated with rain events are typically mid-Atlantic cyclonic low-pressure systems, which are regions of convergence, ascending motion, and adiabatic cooling, none of which is conducive to sustaining inversions or enabling their development in the first place. March and April 2011 exhibited precipitation in amounts MUCH ABOVE NORMAL, suggesting that the development of inversions during those months would diminish as a result. **Both total inversion hours (Figure 3) and average inversion hours per inversion day (Figure 6) show March and April as having fewer inversions and shorter-duration inversions, which could be a result of increased precipitation in 2011 during those months. The take-away is that years with normal to below normal precipitation could see a higher frequency of inversions due to the reduced amount of moisture/water in the atmosphere/soil.**

4. Project Summary

A. All raw data files will be stored on a Millersville server and may be transferred to another server at any time. These files include: 1) textual output from the WRF model and 2) images of vertical profiles over Bainbridge, PA for each hour of data that was available from NCDC.
B. 8179 hourly vertical profiles were evaluated for the existence of inversions. 6.4 percent of the data were available for analysis
C. The total number of inversion-hours per year = 2459/8760 = 28.07%
D. The total number of days per year with at least one hour of inversion = 313
E. The number of days in 2011 in Bainbridge having inversions with durations of less than 4 hours was 56.5%; 25.0% had durations of 4-8 hours; 18.5% had long durations of 9 hours or more.
F. Stronger inversions last longer unless synoptic or mesoscale systems displace the atmospheric condition that establishes them. Long lasting inversions, in this analysis those that are medium or long duration, have the potential to trap pollutants for that duration near the surface; calm to light winds will prevent significant transport in strong inversions causing pollutant concentrations to become elevated in the vicinity of the source, especially when the source stack is short and confined within the depth of the inversion.
G. Using the Millersville University climate archive (1914-2011), it was determined that 2011 was normal in temperature in comparison of the decade from 2001-2010 and would likely have a frequency of inversions typical of other years based on temperature alone; precipitation was above normal in 2011 compared to 2001-2010, in March and April, and could have contributed to the fewer inversions observed during these months

Sincerely,

Richard D. Clark, Ph.D.
Chair, Department of Earth Sciences

ATTACHMENT B

Safety Concerns Report
Blasting Analysis, Inc.
Dated September 7, 2012

Blasting Analysis International, Inc.

Explosives-Seismic-Mining
(Engineers & Specialists)

371 Daniel Street
Allentown, Pennsylvania USA 18104-8509

(610) 530-7415 • Fax (610) 395-5552
Email: blastinganalysis@rcn.com

September 7, 2012

The Honorable Gina Mariani
Chair
Conoy Township Board of Supervisors
211 Falmouth Road
Bainbridge, PA 17502

Re: Serious Safety Concerns Regarding Perdue's Proposed Grain and Oilseed, LLC – Soybean Processing Plant, Conoy Township

Dear Ms. Mariani,

Introduction

I have been retained to provide advice on behalf of A&R Nissley, Inc. (Nissley Vineyards) regarding the explosion hazard from the proposed Perdue Grain and Oilseed, LLC – Soybean Processing Plant, Conoy Township.

I have an extensive background in explosives and blasting. I am the President and Explosives Applications Engineer with Blasting Analysis International, Inc. (BAI). With BAI, I have worked on major projects, including the first expansion and deepening of the Panama Canal between 1994 and 2002. I am one of four authors in the textbook entitled "Explosives and Rock Blasting" and received the Distinguished Service Award from the International Society of Explosives Engineers in 1990 for my "outstanding technical contribution to the mining/explosive industry". I hold a Bachelor's and a Master's degree in mining engineering from Queen's University (Canada), with a specialty in blasting and explosives applications.

Nissley Vineyards owns property opposite the proposed plant on Pa. Route 441 (River Road). That property is only 1,030 feet from the proposed location of Perdue's hexane tanks. The Nissley property currently is used for agriculture and it has employees and tenants who work that property. Also, there is always the possibility that the property may someday be used for some development purpose.

I have some serious concerns regarding the safety of nearby homeowners, travelers, employees and businesses should an accidental explosion occur at the Perdue facilities in terms of shrapnel, fire and toxic fumes. It is our understanding that the Perdue plant will be storing hexane in two adjacent storage tanks, each holding 20,000 gallons for a total of 40,000 gallons, and that the plant will be using 30,000 gallons of hexane at any one time in the process (we have been told by Perdue that there will be a maximum of 40,000 gallons on site at any one time). Hexane is highly explosive and even facilities using hexane that have been well-maintained have suffered from catastrophic explosions.

I met with a number of Perdue representatives on June 15, 2012 to discuss these concerns. Although the Perdue representatives have promised to get back to us, no information has been provided to date regarding their explosion hazard assessments, emergency plans or standard operating procedures to protect nearby residential homeowners, travelers (on River Road) and businesses, in the event of an accidental explosion.

Recent Soybean Manufacturing Plant Explosions Using Hexane

Unfortunately, explosions in the manufacturing of soybean oil using hexane are not uncommon.

- In 2003 a soybean manufacturing plant using hexane owned by AG Processing Inc. exploded in Sioux City, Iowa, injuring eight employees, with three of the injuries being critical. *Sources – Nuteva Newsletter. August 29, 2003, and Associated Press, August 30, 2003.*

- Hexane explosions have occurred in Italy, Mexico (200 dead) and South Africa. *Source – "Soy Protein Use in Natural Foods Bathed in Toxic Solvent Hexane", Natural News, May 20, 2009.*

- Explosions in which hexane was implicated also have occurred at the Minnesota Soybean Processors plant (May, 2009), a plant in Formosa Brazil (March, 2009), Arkansas Ricelands Food Plant (2006), Ag Processing Inc. plant (2003), Canadian CanAmera Foods plant (2002), and Indiana Central Soya plant (1994). *Source – "Organic Versus Conventional Soy", Alexis Bayer, Organic consumers Association, July 1, 2009.*

Generally speaking, the causes for explosions at soybean processing plants are from heat sources such as open flames, hexane spillages, and inadequate supervisor/employee training.

Case History of Damages, Injuries and Deaths Caused by a Massive Chemical Explosion

A very well documented hydroxylamine plant explosion, which occurred in the Lehigh Valley, PA during 1999, provides a clear example of what can be expected in the surrounding community from a massive chemical explosion. While hexane is not the same as hydroxylamine, for comparison of an explosion they are very similar.

It was believed a hydroxylamine tank holding 9,000 gallons exploded during the distilling process from a nearby hot plate or Bunsen burner. Since the density of hydroxylamine is 1.21 g/cc and the density of hexane is 0.66 g/cc, the 9,000 gallon tank of hydroxylamine would be more or less equivalent to a hexane explosion of approximately 18,000 gallons. The Purdue plant in contrast will be using up to 30,000 gallons of hexane in their process, or housing up to 40,000 gallons of hexane in their two storage tanks. Thus, a hexane explosion from the proposed Perdue plant will be much more devastating than what occurred at the hydroxylamine plant explosion.

Some important observations in the aftermath of the hydroxylamine plant explosion were:

- Facility was a two-story steel and concrete structure with a 40,000 square foot area.
- Explosion left a 4 foot crater on cement floor.
- Blew out 3 @ 25 feet concrete containment walls, which collapsed the building.
- 5 fatalities, plus 14 serious injuries.
- Explosion sent metal studs, concrete pieces and insulation several hundred yards in all directions.
- Some debris (insulation) was found up to 5 miles away.
- Explosion was heard up to 10 miles away.
- Windows were blown out in nearby office buildings.
- Force caused cracks in wall of adjacent building, which was located 100 yards away.
- Explosion broke windshields and caved roofs on at least 30 cars in the parking lot.
- Many windows in nearby homes were shattered.

Source No. 1 – "The Explosion at Concept Sciences: Hazards of Hydroxlamine". U.S. Chemical and Hazard Investigative Board, Case Study No. 1999-13-C-PA, March, 2002.

Source No. 2 - "Five Workers Killed in Pennsylvania Chemical Plant", Paul Scherrer, International Committee of the Fourth International, February 24, 1999.

Safe Distances for Chemical (Reactive) Explosions

Figure 1 illustrates a plan view of the proposed Purdue plant property perimeter, approximate location of the two 20,000 gallon storage tanks, and distances to various points of concern in the event of an accidental explosion.

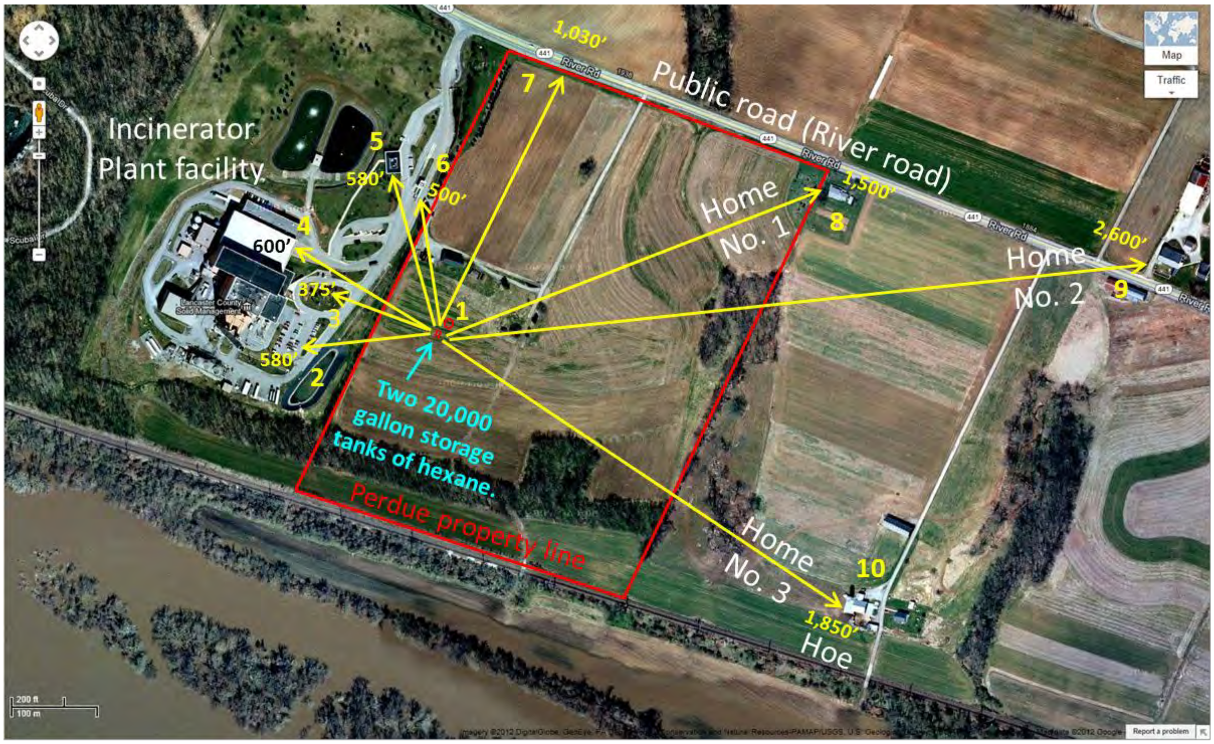


Figure 1 – Plan view of the Purdue property perimeter, two 20,000 hexane storage tanks, and points of concern regarding an accidental explosion.

Hexane weighs approximately 5.6 lbs/gal. Thus, one of the 20,000 gallon storage tanks would weigh approximately 112,000 lbs. Based on the Perdue layout of the plant facilities dated February 29, 2012, the two 20,000 gallon tanks show a separation distance of only 5 feet. Because these tanks are in the open, they would be considered as being unbarricaded and more likely one would cause a sympathetic explosion of the other if one of the tanks exploded.

According to the IME (Institute Makers of Explosives) in Publication No. 2, "The American Table of Distances for Storage of Explosive Materials", June, 1991, the hexane tanks should be separated by a minimum distance of 430 feet, to eliminate a sympathetic explosion if one of the hexane storage tanks exploded. In the case of only a 5 foot separation, it is a certainty that if one of the 20,000 gallon hexane tanks exploded, the second 20,000 gallon tank would also explode.

Tables 1 and 2 list the minimum safe distances recommended by the IME for a 20,000 and 40,000 gallon hexane explosion, respectively.

Table 1 - For a 20,000 Gallon Hexane Explosion

Structure or Area of Concern	Minimum Safe Distance
Inhabited Buildings (Homes, Businesses and Plants).	2,000 ft.
*Public Highways With Less Than 3,000 Vehicles per Day.	1,120 ft.

Table 2 - For a 40,000 Gallon Hexane Explosion

Structure or Area of Concern	Minimum Safe Distance
Inhabited Buildings (Homes, Businesses and Plants).	2,155 ft.
*Public Highways With Less Than 3,000 Vehicles per Day.	1,300 ft.

**Public highway means any public street, public alley or public road.*

The main difference between an explosive detonation and a hexane explosion is the degree of small fragments created at the source. I would expect that the explosion effects regarding how far the fragments or shrapnel are thrown would be similar.

In reference to Figure 1, the main points of public concern around the hexane storage tanks are listed in Table 3.

Table 3 – Applies to a 20,000 to 40,000 Gallon Hexane Explosion

Point No.	Description	Current Distance From Hexane Storage Tanks
1	Oil storage tank.	40 ft.
2	Parking lot.	580 ft.
3	Parking lot.	375 ft.
4	Main incinerator building.	600 ft.
5	Inhabited office building.	580 ft.
6	Inhabited office building.	500 ft.
7	Public road (River road).	1,030 ft.
8	Residential home No. 1.	1,500 ft.
9	Residential home No. 2.	2,600 ft.
10	Residential home No. 3.	1,850 ft.

The distances coded in red in Table 3 designate unsafe distances from the hexane storage tanks. Note that even if the two 20,000 gallon hexane storage tanks were separated by a safe distance of 430 ft., a single 20,000 gallon hexane tank explosion could still result in serious injuries, death and/or property damage to the nearby public.

The minimum safe distance to cover all points of concern from a 20,000 to 30,000 gallon hexane explosion is 2,000 ft. The minimum safe distance to cover all points of concern from a 40,000 gallon hexane explosion is 2,155 ft.

Opinions Regarding the Effects of an Explosion of Hexane

In the event of an accidental hexane explosion, I would expect the following consequences:

1. High velocity fragments (shrapnel) will be thrown in all directions. If there were an explosion of the fully loaded hexane storage tanks, shrapnel would be formed from the tanks themselves. If the soybean processing plant (loaded with 30,000 gallons of hexane) were to explode, the plant container and building itself would become shrapnel that would be thrown a similar distance. The shrapnel alone from such an explosion would have disastrous consequences. This shrapnel would be projected to Route 441 and beyond, to the neighboring homes and to the incinerator complex. The shrapnel would cause death or serious injury to anyone who was hit by it. In addition, the shrapnel would cause serious property damage to any structures that it encountered.

2. Multiple fires would be expected wherever any burning shrapnel/debris fell on.

3. The oil storage tank, which is situated only 40 ft. away from the hexane storage tanks, would most likely catch on fire and spew out huge amounts of heavy smoke and toxic gases.

4. BAI understands that there is a large propane storage tank nearby on the adjacent incinerator property. Depending on the mass and velocity of a projectile, it is also possible to explode the propane tank on impact, causing another secondary large scale energetic explosion.

5. Airblast (concussion) would occur from the explosion that in itself would kill or seriously injure people and would also cause serious damage to nearby properties. The overpressure effect could result in the destruction of nearby buildings which could inflict injury or death to anyone inside or near the building(s). Because it is so close, I would expect that the incinerator complex would be seriously damaged from an explosion. In

addition, I would expect windows in buildings as far as half a mile away to be blown out, which could also result in injury to anyone nearby.

6. If a hexane explosion occurred, I would expect the explosion to set off fires giving off noxious deadly fumes (as occurred at other soybean processing facilities). For example, some of the gasses often resulting from hexane explosions are oxides of nitrogen. Exposure to these gasses with concentrations of only 0.03 to 0.05% could be fatal 8 to 72 hours after exposure.

Recommendations

In view of the serious potential dangers to the public, BAI makes the following recommendations:

1. Perdue should perform a full explosion hazard assessment before proceeding with their plans, and to make their findings available to the public.

2. An emergency response plan needs to be prepared by Perdue that will include immediate and direct notification of all neighbors within a one mile radius of the plant. The plan should include a warning system to be implemented by Perdue to warn nearby residents <u>immediately</u>, rather than rely solely on the local emergency response units, because valuable time would be lost for nearby residents in deciding to evacuate immediately, or to seal their homes by closing all windows/doors and turning off their A/C units until the danger has passed. According to Perdue representatives, they plan to use the local emergency response units in dealing with such events. As of June 15, 2012, Perdue was <u>not</u> planning to directly notify neighbors in the event of any emergency at the plant. Instead, they were planning to rely on local authorities. It is not clear how and/or when nearby neighbors would be warned of the dangers and precious time would be lost while Perdue communicated with the emergency responders who would then have to communicate with the community. Perdue should take responsibility for this important aspect of planning.

3. Conoy Township and Lancaster County need to update both their emergency plans and training for emergency responders to deal with a potential explosion hazard from the Perdue facility.

4. If Perdue cannot satisfy the minimum safe distances to all points of concern, the options would be to either bury the two 20,000 gallon storage tanks and the process section of the plant which requires the use of 30,000 gallons of hexane, or to relocate the entire plant facilities elsewhere.

Sincerely,

R. Frank Chiappetta
Explosives Applications Engineer
BLASTING ANALYSIS INTERNATIONAL
Explosives, Seismic & Mining Specialists

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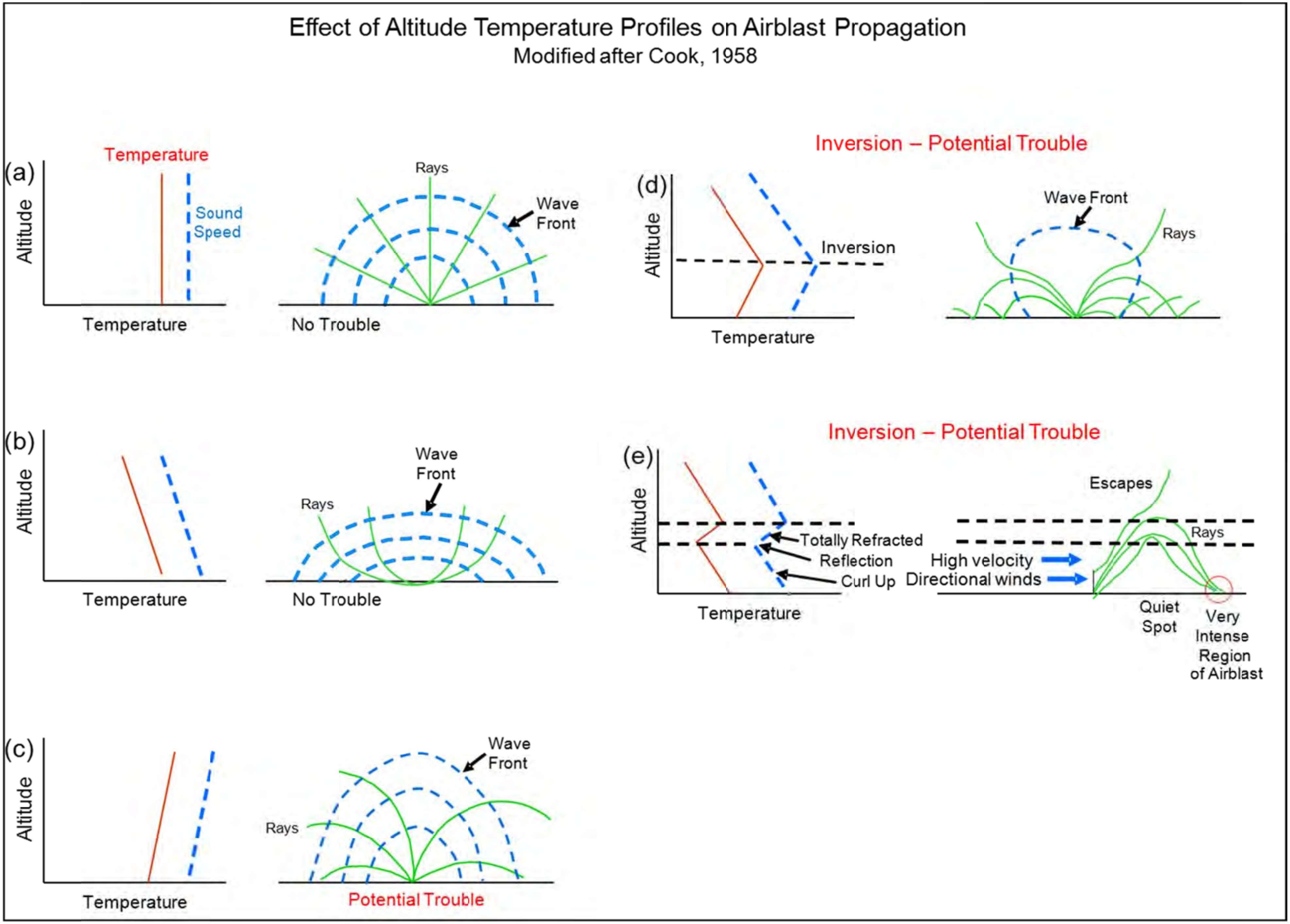
ATTACHMENT C

Figure
Effect of Altitude Temperature Profile on Airblast Propagation


Effect of Altitude Temperature Profiles on Airblast Propagation
Modified after Cook, 1958
(a)
Altitude
Temperature
Sound Speed
Temperature
Rays
Wave Front
No Trouble
(b)
Altitude
Temperature
Wave Front
Rays
No Trouble
(c)
Altitude
Temperature
Wave Front
Rays
Potential Trouble
Inversion – Potential Trouble
(d)
Altitude
Inversion
Temperature
Wave Front
Rays
Inversion – Potential Trouble
(e)
Altitude
Totally Refracted
Reflection
Curl Up
Temperature
Escapes
Rays
High velocity
Directional winds
Quiet Spot
Very Intense Region of Airblast