Petition of PECO Energy Company for a finding of Necessity Pursuant to 53 P.S. Section 10618: That the situation of Two Buildings associated with a Gas Reliability Station in Marple Township, Delaware County Is Reasonably Necessary for the Convenience and Welfare of the Public Further Call-In Telephonic Evidentiary Hearing	Docket No. P-2021-3024328

Pages 1517 - 1728

Judge's Chambers
Piatt Place
301 5th Avenue
Pittsburgh, PA
July 22, 2021
Commencing at 11:11 a.m.

INDEX TO EXHIBITS
Docket No. P-2021-3024328
Hearing Date: July 22, 2021

NUMBER

PECO Energy Exhibit:

Statement 6-SR
Israni Surrebuttal
Testimony

Ms. Baker Exhibit:

Julie Baker Statement No. 4,
Dr. Ketyer's Direct Testimony

E.K. Exhibit 1, Dr. Ketyer's
Curriculum Vitae

JB-9, PDF and PowerPoint PECO Site
Recommendations

Uhlman Exhibit 8, Confidential PECO
Discovery Response 0025 and 0026
(CONFIDENTIAL)

Uhlman Exhibit 9, Confidential
Sound Study
(CONFIDENTIAL)

PECO ENERGY COMPANY

STATEMENT NO. 6-SR

BEFORE THE
PENNSYLVANIA PUBLIC UTILITY COMMISSION

PETITION OF PECO ENERGY COMPANY FOR A FINDING OF

NECESSITY

PURSUANT TO 53 P.S. § 10619

Docket No. P-2021-3024328

SURREBUTTAL TESTIMONY

WITNESS: MIKE ISRANI

SUBJECT: RESPONSE TO TESTIMONY AT PUBLIC INPUT HEARINGS AND OPPOSING PARTY TESTIMONY CONCERNING SAFETY OF GATE STATIONS AND THE NATURAL GAS RELIABILITY STATION

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SURREBUTTAL TESTIMONY OF MIKE ISRANI

I. INTRODUCTION

Q. Please state your name and business address.

A. My name is Mike Israni. My business address is Inamco Engineering, LLC, 9757 Sara Ann Court, Dublin, CA 94568.

Q. Mr. Israni, what is the purpose of your testimony?

A. I am providing expert testimony to respond to: (1) statements made at the Public Input Hearings on May 25 and May 26, 2021; and (2) Rebuttal and Direct Testimony regarding safety of the Natural Gas Reliability Station and Gate Stations. My testimony is based on my decades of cumulative training and experiences as a consultant in the natural gas pipeline industry and in past positions with the U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration ("PHMSA").

Q. What is your educational background related to your expert testimony?

A. I received a bachelor's degree in Mechanical Engineering from the University of Bombay, India in 1970. I also received a master's degree in Marine Engineering and Naval Architecture from the University of Michigan in 1978.

Q. What is your current profession?

A. I am the principal of Inamco Engineering, LLC, a consultancy in the areas of safe operations and maintenance activities of the natural gas and petroleum pipeline industry. I started consulting in 2017, after I retired from PHMSA in 2016.

Q. Please generally describe PHMSA's role in natural gas pipeline regulation.

A. PHMSA is the federal agency responsible for regulating and ensuring the safe and secure movement of hazardous materials to industry and consumers by all modes of transportation, including pipelines. All natural gas distribution pipelines, including PECO's natural gas system, must fully comply with the federal pipeline safety regulations. PHMSA's Office of Pipeline Safety ensures safety in the design, construction, operation, maintenance, and spill response planning of America's 2.6 million miles of natural gas and hazardous liquid transportation pipelines. Also, PHMSA's Office of Pipeline Safety monitors operator compliance through field inspections of pipeline facilities and construction projects, inspections of operator management systems, procedures, and processes, and incident investigations.

Q. How long were you employed with PHMSA, and could you please describe your role with PHMSA?

A. For twenty-two years, from 1994 to 2016, I served as the Senior Technical Advisor and Program Manager – Regulations and Standards for PHMSA. I reported directly to the Associate Administrator of the Office of Pipeline Safety. In that position, I was directly involved in the regulatory development, implementation, and oversight of natural gas and hazardous liquid pipeline systems and storage facilities, offshore pipelines, liquefied natural gas, and liquefied petroleum gas facilities. I was responsible for leading the development of most major regulations that were promulgated during my tenure with PHMSA related to natural gas and hazardous liquid pipelines, storage tanks, and liquified natural gas, and liquefied propane gas systems, most notably, risk-based regulations concerning pipeline integrity management, integrity verification processes, and safety management systems. I also developed pipeline safety advisory bulletins and guidance materials to assist the pipeline industry in complying with federal safety standards and national technical standards. During my tenure at PHMSA, I participated in numerous inspections of pipeline facilities and assisted in PHMSA enforcement cases. Finally, I represented PHMSA on various industry standards committees, including the Pipeline Standards Developing Organizations Coordinating Council (“PSDOCC”), the American Society of Mechanical Engineers B31.8 Committee (related to natural gas pipelines) and B31.8S Committee (related to natural gas integrity), the American Petroleum Institute (“API”) 1160 Committee (related to hazardous liquid integrity), and the National Fire Protection Association (“NFPA”) 59A Committee (related to liquified natural gas), and NFPA 58 and 59 Committees (related to propane gas).

Q. Did you author any federal regulations?

A. Yes. I authored the following regulations that were published in the Federal Register:

a. Integrity Management Program for Gas Distribution Pipelines; Final Rule (Dec 4, 2009)

b. Pipeline Integrity Management for Gas Transmission Pipelines; Final Rule (Dec 15, 2003)

c. Pipeline Integrity Management for Hazardous Liquid Pipeline; Final Rule (Dec 1, 2000)

d. Liquefied Natural Gas (LNG) Regulations - Final Rule (March 1, 2000)

e. Safety of Gas Transmission and Gathering Pipelines; NPRM (Apr 8-2016)

f. Safety of Hazardous Liquid Pipelines - NPRM (Oct 13, 2015); Final Rule (Oct 2019)

g. Excess Flow Valves in Gas Distribution Systems to Applications Other Than Single-Family Residences- Final Rule (Oct 14, 2016)

h. Safety Regulations for Rural Hazardous Liquid Low-Stress Lines - Final rule (Apr 26, 2011)

i. Breakout Tanks - Adoption of Consensus Standards - Final Rule (Apr 2, 1999)

Q. What other professional experiences do you have that involve pipeline safety?

A. Prior to my role with PHMSA, I was Chief of the Marine Engineering Branch with the United States Coast Guard ("USCG"), where I was in charge of regulations for pipelines, tanks, and machinery onboard ships and shore-based marine facilities under USCG's jurisdiction. Prior to my position with the USCG, I was employed with Avondale Industries from 1979 to 1985 as a Senior Engineer, where I worked in marine pipeline and storage tank design, construction, testing, operation and maintenance. Before Avondale Industries, I was a Chief Engineer, and previously a First and Second Engineer, for Tradax International Company, where I had overall responsibility for the operation and maintenance of machinery, pipeline systems, and storage tanks on several of the company's merchant ships.

Q. What other certifications or experiences further qualify you to provide your expert testimony?

A. I received a National Board Authorized Inspector Commission from the National Board of Boiler and Pressure Vessel Inspectors in Columbus, Ohio in 1993. Also, I served on the American Society of Mechanical Engineer's Accreditation Committee to evaluate Authorized Inspectors' performance in inspecting pipelines, pressure vessels, boilers, and heat exchangers. Finally, I received a Chief Engineer's License for Merchant Ships in 1976 from The Director General of Shipping, Mercantile Marine Department, India, which qualified me to work as Chief Engineer on any merchant ship under the International Maritime Organization Laws.

Q. Have you previously provided expert testimony?

A. Yes. I am currently involved in a case, *Marathon Pipeline Company, LLC et al. v. Louisville Gas & Electric Company et al.*, in Jefferson County, Kentucky, where I provided expert witness deposition testimony on behalf of Louisville Gas & Electric Company on May 7, 2021 regarding pipeline regulatory standards, compliance records, and enforcement cases involving Marathon Pipeline Company. Also, I served as a testifying expert for NuStar Pipeline Company in a lawsuit with Occidental Energy, Inc. My role involved providing advice, expert witness deposition testimony, and trial testimony relating to Nustar's liquid transmission pipeline's compliance with federal and state regulatory standards, best practices in pressure testing, in-line inspection data collection, risk modeling, integrity management, and operations and maintenance plans.

Q. What other expert consultancy experience do you have in pipeline systems siting safety regulation?

A. Through my current firm, Inamco Engineering, LLC, I have consulted on natural gas transmission pipeline projects for Energy Transfer Rover Pipeline, LLC in Michigan, Ohio and Pennsylvania in the areas of safety regulation, integrity management, and siting requirements. I also consulted on Kinder Morgan's Permian Highway Gas Pipeline Project in Texas for regulatory and standards compliance, integrity management in the potential impact areas, and siting requirements at the new construction sites. Additionally, I am currently consulting with Econometrica, Inc. in the analysis of regulations related to environmental and safety protections at offshore energy development facilities on the outer Continental Shelf.

Q. Mr. Israni, based upon your education, training, and experience, do you believe that you are capable for expressing an opinion to a reasonable degree of professional certainty as to the operations and safety of natural gas facilities, including PECO's proposed Natural Gas Reliability Station that is the subject of this proceeding, as well as PECO's other Gate Stations?

A. Yes, I do.

Q. Mr. Israni, are you sponsoring any exhibits?

A. Yes. I am sponsoring the following exhibits:

a. Exhibit MI-1 is prior Direct Testimony of Mr. Timothy Boyce from *Flynn, et al. v. Sunoco Pipeline L.P.*, Docket Nos. C-2018-3006116 and P-2018-3006117.

b. Exhibit MI-2 is a November 28, 2018 report by G2 Integrated Solutions submitted to Timothy A. Boyce, Director of DES and titled *Mariner East 2 Pipeline and Existing Adelphia Pipeline Risk Assessments*.

II. RESPONSE TO STATEMENTS FROM THE PUBLIC AND OPPOSING PARTY TESTIMONY CONCERNING SAFETY OF GATE STATIONS AND THE PROPOSED NATURAL GAS RELIABILITY STATION.

Q. Mr. Israni, at the four Public Input Hearings held in this matter, certain members of the public expressed safety concerns with PECO's proposed Natural Gas Reliability Station and other natural gas gate stations. This sentiment was likewise stated in the

testimonies of Mr. Boyce, Mr. Capuzzi, and Ms. Winters. Based on your expert experience, what is your opinion on the safety of these types of facilities?

A. Based on my industry experience, Gate Stations and Reliability Stations are extremely safe. This conclusion is supported by my review of PHMSA's publicly available safety records involving these types of facilities, which have quite exceptional safety records and pose little, if any, safety risk on the community.

Q. What information allows you to form this opinion?

A. First, natural gas pressure regulating facilities are subject to strict industry and regulatory standards and are common and necessary aspects of natural gas distribution systems. The purpose of these facilities is to reduce and stabilize the pressure of natural gas traveling through a natural gas system to ultimately reach end-use customers. For example, the smallest category of pressure regulating equipment in the natural gas industry are the common household natural gas meters found on the exterior or interior of households. This equipment decreases the pressure of natural gas traveling from the distribution system into the household. Larger categories of natural gas pressure reducing facilities include "Master Meter Facilities", which connect a transmission or distribution line to a multi-unit residential community, often associated with mobile home communities, where there are multiple customers. Also, and relevant here, are "Reliability Stations" and "Gate Stations", which like the "Master Meter Facilities", reduce and stabilize natural gas pressure from a higher-pressure transmission or distribution line to a lower-pressure distribution system. These facilities are commonly referred to in the industry as "Regulating Stations" because they are regulating natural gas pressure. The main difference between these types of facilities is the amount of pressure that needs to be reduced from a transmission line or distribution line that has higher pressure into a distribution network with lower pressure. Specific to this proceeding, to arrive at my opinion that Reliability Stations and Gate Stations are very safe, I reviewed several PHSMA Pipeline Safety-Flagged Incidents data sets dating from 1986 to 2020. This data is publicly available on PHMSA's website. These data sets include all situations that rise to the level of an incident that are reported to PHSMA directly from pipeline operators. Moreover, the data sets also include several pieces of information about the incidents, such as information about the equipment involved, the operator, whether there were any injuries, and an overall narrative of the incident. I analyzed the data sets for incidents that involved natural gas pressure regulating stations of an equivalent nature to that of PECO's Natural Gas Reliability Station, which would include "Gate Stations", "Reliability Stations", and "Master Meter Facilities." Following my review of the data, I prepared Table 1, set forth below, to demonstrate the results of my review:

Table 1. Regulating Stations Incidents: All gas distribution pipelines*

	Incident Count	Casualties	Injuries
1986 - 2003	2	0	3
2004 - 2009	8	0	0
2010 - 2020	19	0	1

- **the DOT database shows <u>not a single incident</u> has occurred at PECO's Regulating Stations between 1986 – 2020**
  (PHMSA's online Data is available from 1986)
- **Incident causes: Regulator assembly malfunction occurred 20 times; remaining incidents due to third-party damage to the facility.**

***All data taken from PHMSA DOT website at: https://www.phmsa.dot.gov/about-phmsa/offices/office-pipeline-safety** (last visited June 18, 2021)

Table 1 shows that from 1986 to 2020 there have only been twenty-nine incidents across the entire United States natural gas distribution network and only four injuries. Notable for this proceeding, PHMSA's records show that PECO's Gate Stations have not had a single incident during this time period.

Q. How does PHMSA define the term "incident"?

A. "Incident" is a defined term in 49 CFR 191.3, a federal pipeline regulation, which states:

> "Incident means any of the following events:
>
> (1) An event that involves a release of gas from a pipeline, gas from an underground natural gas storage facility, liquefied natural gas, liquefied petroleum gas, refrigerant gas, or gas from an LNG facility, and that results in one or more of the following consequences:
>
> (i) A death, or personal injury necessitating in-patient hospitalization;
>
> (ii) Estimated property damage of $50,000 or more, including the loss to the operator and others, or both, but excluding the cost of gas lost.
>
> (iii) Unintentional estimated gas loss of three million cubic feet or more.
>
> (2) An event that results in an emergency shutdown of an LNG facility.
>
> (3) An event that is significant in the judgment of the operator."

Q. How many Regulating Stations exist in the United States?

A. PHMSA's records do not have an exact count or inventory for Regulating Stations in the United States. However, one can easily estimate that the number is several thousand. There are over 1,400 natural gas distribution operators in the United States, which includes large operators, like PECO, and small gas distribution systems run by local municipalities. Each of these systems, particularly larger systems, likely operates several Regulating Stations, such as Gate Stations or Reliability Stations. Also, there are over 5,000 natural gas systems servicing mobile home parks, public housing projects, rental apartments and office complexes in the United States, which are likely operating one or more Master Meter Facilities. These Regulating Stations are common and necessary aspects of natural gas public utility infrastructure.

Q. Please summarize your conclusions based on Table 1.

A. Since 1986, out of thousands of Regulating Stations across the United States, there have only been twenty-nine "incidents" as defined by 49 CFR 191.3 involving Regulating Stations, and none occurred at any PECO Gate Stations.

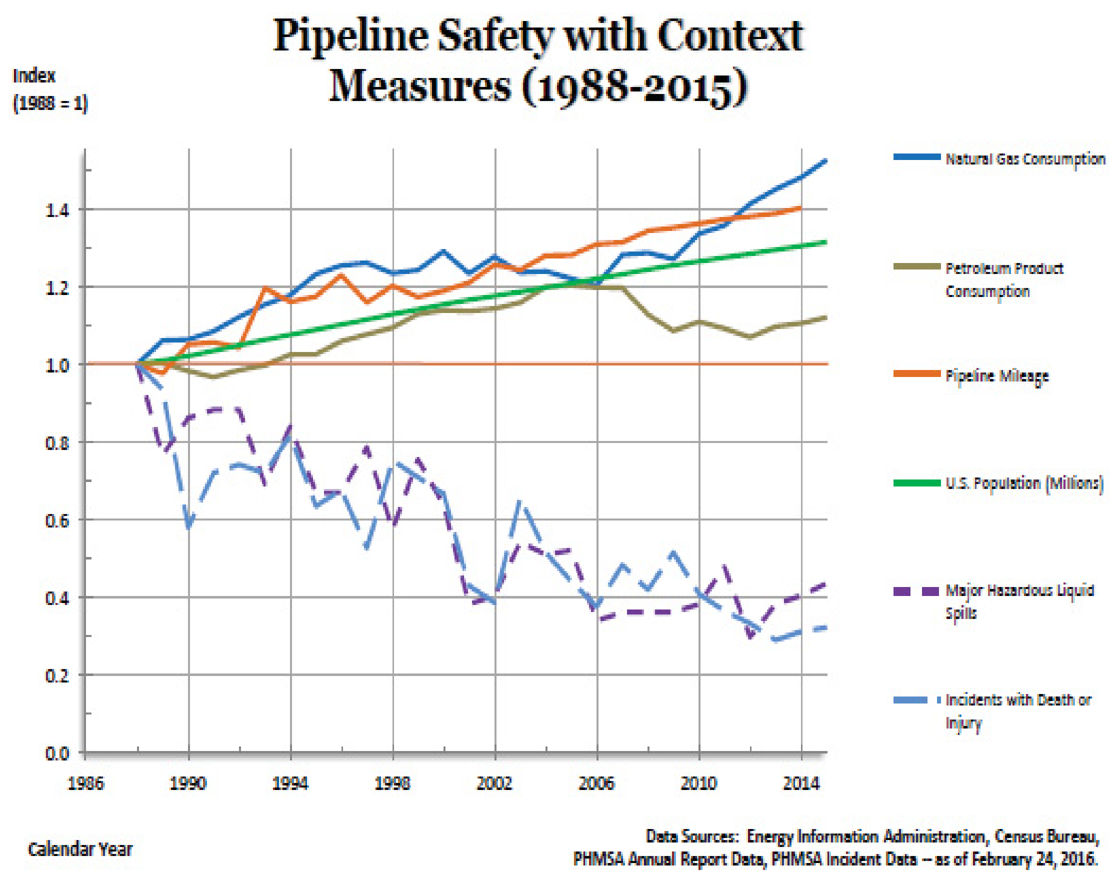
Q. From your perspective, are there any trends you can identify from reviewing PHSMA's incident records related to Regulating Stations?

A. Yes. The records demonstrate that the majority of these incidents are very minor. I reviewed information for each of the incidents identified in Table 1 and a majority of the incidents were related to valve malfunctioning or simple operational failure of valves not being fully closed during filter changes, which are not indicative of any type of safety situation. Also, of the twenty-nine incidents, there were only four reported injuries during the thirty-four-year timeframe, which indicates that these facilities are very safe to operators and the public.

Q. What is your opinion of the safety of Natural Gas Regulating Stations?

A. Based on my review of incident records involving Regulating Stations, my opinion is that Regulating Stations, including Gate Stations, Reliability Stations, and Master Meter Facilities, are a very safe aspect of natural gas distribution systems. Natural gas consumption has increased in the United States over time, and even with increased pipeline mileage and consumption, the death and injury rates from pipeline incidents have decreased as shown below in Figure 1., which is reflected in this Energy Information Administration chart:

FIGURE 1.



- ❖ Gas transmission and distribution pipeline serious incidents and average fatality count have been steadily declining according to PHMSA's database.
- ❖ http://www.nace-houston.org/images/NACE_10112016final.pdf

Additionally, to demonstrate the overall safety of natural gas pipelines, it is possible to compare the safety records of oil and gas pipelines to alternative modes of transportation for hazardous materials. Below is Table 2, which compares incident rates for various modes of hazardous materials transportation based on PHMSA's records:

Table 2. Comparison of Pipeline Incidents to Hazardous Materials Transportation by other Modes (2009-2018)*

Transportation Mode	Average Incidents Per Year
Road (HazMat Trucks)	14,592
Railway (HazMat Cargo)	637
Hazardous Liquid Pipelines (~160K miles)	149
Gas Transmission Pipelines (300K miles)	70
Gas Distribution Pipelines (2.2M miles)	70

*All data taken from PHMSA DOT website at: https://www.phmsa.dot.gov/about-phmsa/offices/office-pipeline-safety (last visited June 18, 2021)

* Hazmat Office Data https://www.phmsa.dot.gov/hazmat-program-management-data-and-statistics/data-operations/incident-statistics; Pipeline Office Data http://www.phmsa.dot.gov/pipeline

As Table 2. demonstrates, the average incident rate for all forms of pipelines, including natural gas distribution pipelines, is significantly lower compared with other modes of hazardous materials transportation.

Another comparison that can be made to demonstrate just how safe pipelines are is to compare annual accidental death rate data for various types of accidental deaths across the United States. Below is Table 3, which combines various sources of data to demonstrate different causes of average annual deaths in the United States:

Table 3. Nationwide Accidental Deaths and Injuries:

Type of Accident	Deaths	Injuries
Highway	37,501	2,424,000
Falls	29,600	
Work related	5,333	2,800,000
Fire, smoke	3,704	16,600
Drowning	3,700	
Poisoning	3,000	128,000
Railroad	751	9,070
Marine	700	3,231
Air	404	284
Transit rail	151	7,390
Floods	92	
Lightening	49	
Tornado	42	
Pipeline	10	49
Sources: Transportation Statistics Annual Rpt. 2017; www.bts.gov (2015); www.cdc.gov (2019); www.weather.gov (2019); www.stopdrowningnow.org (2019); www.bls.gov (2019); www.osha.gov		

There are approximately 550,000 miles of interstate gas and hazardous liquid pipelines across the United States and over 2.2 million miles of natural gas distribution pipelines in the United States, and with this vast infrastructure, there are an annual average of two accidental deaths involving natural gas transmission lines and eight for natural gas distribution lines. As you can see from Table 3, this annual rate is significantly less than other unlikely causes of accidental death, such as lighting strikes or tornados. Now, when you compare the incident record for Regulating Stations discussed above with the overall safety rate for natural gas distribution systems, Regulating Stations are even safer than the natural gas distribution system generally because there have only been twenty-nine reportable incidents, four injuries, and no casualties in the past 34 years across the entire United States. Again, none of those incidents occurred at PECO's Gate Stations.

Q. Mr. Israni, members of the public were also concerned about vandalism or sabotage occurring at gate stations. What do PHMSA's records show regarding past incidents of vandalism or sabotage at gate stations?

A. PHMSA's incident records reported no instances of vandalism or sabotage at any Regulating Stations. Also, Regulating Stations, and specifically Gate Stations, are typically surrounded by a security fence, and have buildings to house and protect the stations' equipment, so in order for someone to vandalize the equipment, they would need to make a great effort to cut or scale the fence, and then access the buildings, which are locked and both of which are remotely monitored by the utility, who would be able to report it to law enforcement.

Q. Members of the public stated that PECO's proposed Natural Gas Reliability Station should be located in an industrial location. Mr. Israni, from your experience, where are Regulating Stations typically located?

A. Regulating Stations can be located in residential, commercial, or industrial areas. The central purpose of Regulating Stations is to reduce the natural gas pressure from a larger main line, often transmission lines, before this natural gas is placed into the distribution system, so Regulating Stations are found where natural gas is needed to go into the distribution system, which is often in residential or commercial areas. Reliability Stations generally are used to lower pressure into distribution mains, which are mostly located in residential and commercial areas.

III. RESPONSE TO STATEMENTS AT PUBLIC INPUT HEARINGS CONCERNING PECO'S OPERATIONAL RECORD.

Q. Mr. Israni, what is your opinion of PECO's natural gas operational record?

A. In my opinion PECO's operations meet or exceed the federal and state standards for a natural gas system.

Q. What is the basis for your opinion?

A. I have reviewed PHMSA's records related to incidents involving PECO's Gate Stations and violation or enforcement actions against PECO. Based on this information, PECO has an excellent record among top natural gas distribution companies. For example, as previously discussed, PHMSA's records do not have a single incident related to PECO's Gate Stations. Also, below is Table 4 that I created based on PHMSA's records that identifies enforcement actions against PECO since 2002.

Table 4. PECO Energy Enforcement Cases*

Year	Corrective Action Order Cases	Notice of Probable Violation Cases	Notice of Amendment Cases	Warning Letter Cases	Notice of Proposed Safety Order Cases
2002	0	1	0	0	0
2003	0	0	0	0	0
2004	0	0	0	0	0
2005	0	0	0	0	0
2006	0	0	0	0	0
2007	0	0	0	0	0
2008	0	0	0	0	0
2009	0	0	0	0	0
2010	0	0	0	0	0
2011	0	0	0	0	0
2012	0	0	0	0	0
2013	0	0	0	0	0
2014	0	0	0	0	0
2015	0	0	0	0	0
2016	0	0	0	0	0
2017	0	0	0	0	0
2018	0	0	0	0	0
2019	0	0	0	0	0
2020	0	0	0	0	0
2021	0	0	0	0	0
Totals	**0**	**1**	**0**	**0**	**0**

*All data taken from PHMSA DOT website at: https://www.phmsa.dot.gov/pipeline/enforcement/enforcement-overview (last visited June 18, 2021)

As shown above on Table 4, PECO has only been involved in one action, occurring in 2002, with no other actions since. The records show that PHMSA issued a notice of probable violation for 49 CFR 191.5(a), which was a failure to give a telephonic notice of an incident at the earliest, practical moment. PECO conducted corrective actions, which PHSMA accepted, paid a fine to resolve the violation, and then PHMSA closed the case.

To be clear, this probable violation involved an administrative issue and did not involve any injury to persons or property.

Q. Based on this information, are you able to form an opinion of PECO's record compared with its industry peers?

A. Yes. Based on PHMSA's enforcement data, PECO has an excellent record among its industry peers.

Q. What is your opinion of PECO's ability to safely operate the proposed Natural Gas Reliability Station?

A. Based on my review of PHMSA's records related to Regulating Stations, knowledge of Regulating Station operations and requirements, experience within the industry, and review of PHMSA's enforcement records for PECO, my opinion is that PECO will be able to safely operate the proposed Natural Gas Reliability Station.

IV. RESPONSE TO TIM BOYCES' REBUTTAL TESTIMONY

Q. Mr. Israni, have you reviewed the Rebuttal Testimony of Mr. Tim Boyce in this proceeding?

A. Yes.

Q. On page 8 of Mr. Boyce's Rebuttal Testimony he states that his main concern relative to the risks associated with PECO's Natural Gas Reliability Station is "a release from the proposed facility, especially a delayed ignition accident, [which] is likely to affect a large area containing many people and a great deal of valuable property." Do you have a response to this comment?

A. Yes. Here, Mr. Boyce assumes that if a natural gas leak occurs at PECO's Natural Gas Reliability Station that it could lead to a delayed ignition that would affect a larger area. If a natural gas leak occurred outside of a Regulating Station's buildings, it would immediately rise into the air and not form a cloud because natural gas is lighter than ambient air. If a leak occurred within a Regulating Station's building, it would trigger a leak detection alarm, which is standard for Regulating Stations, and notify the Station's control system, which can remotely shut down the valves to prevent further gas leaks. Additionally, Regulating Station buildings have ventilation systems to release any natural gas in a controlled manner to the exterior to prevent a build-up of gas, which will dissipate into the atmosphere because, again, natural gas is lighter than air.

Q. Mr. Israni, do you share in Mr. Boyce's concern that a gas cloud could be formed by PECO's Natural Gas Reliability Station as stated throughout Mr. Boyce's Rebuttal Testimony, and specifically on page 11?

A. No, I do not. As I stated, the properties of natural gas do not permit for a natural gas cloud as described by Mr. Boyce to be formed from a leak. Natural gas is lighter than air and disperses into the atmosphere. From my experience at PHMSA, I have never heard of or been involved with a situation where a natural gas leak from a Regulating Station caused a cloud. Other, *very different*, types of hazardous materials releases can form a "cloud", but those materials are dissimilar from what Mr. Boyce is suggesting about natural gas. For example, releases from *liquified* natural gas (LNG) facilities—which is not the same as the natural gas coming into PECO's Reliability Station—may form a visible vapor cloud that disperses as it is released due to it being at extremely supercooled temperatures. Another very different chemical substance, liquified petroleum gas (LPG), is denser than air when leaked and can form a cloud, but this is not the same as natural gas, nor does LPG share the same properties as natural gas.

Q. Mr. Israni, are you familiar with any other testimony of Mr. Boyce related to distinctions between natural gas and other forms of petroleum products?

A. Yes. I am familiar with prior Direct Testimony of Timothy Boyce that was submitted into evidence before the Pennsylvania Public Utility Commission, in *Flynn, et al. v. Sunoco Pipeline L.P.*, Docket Nos. C-2018-3006116 and P-2018-3006117, which I am providing here as Exhibit MI-1.

Q. What were Mr. Boyce's comments on the differences between natural gas and other forms on hazardous materials transported through pipelines?

A. In comments pertaining to natural gas, Mr. Boyce stated on page 4, lines 11 through 18, that "Methane is lighter than air, so natural gas tends to dissipate upon release to the atmosphere." Later, with regards to other petroleum products, Mr. Boyce states that "[h]ighly volatile liquids by contrast, if released to the atmosphere, transform rapidly into colorless odorless gas. This is heavier than air, so it ends to concentrate near the ground and can flow along it downwind and downhill into low-lying areas."

Q. What are your observations in comparing Mr. Boyce's testimony in the *Flynn et al. v. Sunoco Pipeline L.P.* case with his testimony in this proceeding?

A. In the *Flynn et al. v. Sunoco Pipeline L.P.* proceeding, Mr. Boyce has a correct understanding on the properties of natural gas, *i.e.* that it is lighter than air and would dissipate into the atmosphere and a correct understanding on the properties of natural gas liquids, in that those substances are heavier than air and when released can form a cloud. In this PECO proceeding, however, Mr. Boyce does not correctly describe the properties of natural gas that would be released during a leak from PECO's proposed Natural Gas

Reliability Station. No gas cloud as described by Mr. Boyce in the PECO proceeding would be formed from a leak from PECO's proposed Natural Gas Reliability Station.

Q. On page 6 of Mr. Boyce's Testimony, he states that he is familiar with risk assessments for releases from natural gas facilities. Are you familiar with any risk assessments conducted for other natural gas facilities in Delaware County?

A. Yes. I am familiar with a November 28, 2018 document drafted by G2 Integrated Solutions, titled, Mariner East 2 Pipeline and Existing Adelphia Pipeline Risk Assessments, submitted to Timothy A. Boyce, Director of Department of Emergency Services of Delaware County, a copy of which is submitted here as Exhibit MI-2 ("G2 Risk Assessment").

Q. Please generally describe the purpose and findings from the G2 Risk Assessment, specific to natural gas facilities.

A. G2 conducted a quantitative risk assessment on behalf of Delaware County for a proposed 20-inch natural gas liquids ("NGL")[1] pipeline, known as Mariner East 2, and an 18-inch proposed natural gas pipeline, known as the Adelphia Pipeline. G2's methodology for the quantitative risk assessment was provided on page 6 of the G2 Risk Assessment, which stated that G2 would: (1) establish study context; (2) define the releases and accident events to be assessed; (3) determine accident event frequency; (4) determine magnitude of the harmful consequence and impact; (5) calculate individual risk results; and (6) compare individual risk results to other common risk sources. G2 concluded that individual fatality risk levels estimated for both the Mariner East 2 Pipeline and the Adelphia Pipeline fall

[1] NGLs are hydrocarbons "in the same family of molecules as natural gas and crude oil, composed exclusively of carbon and hydrogen. Ethane, propane, butane, isobutane, and pentane are all NGLs." U.S. Energy Information Administration, https://www.eia.gov/todayinenergy/detail.php?id=5930.

within or below the range of other common risk sources such as traffic accidents, house fires, or falls from stairs.

Q. Do you agree with G2's methodology and conclusions in the G2 Risk Assessment?

A. Yes, I do. I agree that the risks posed by natural gas facilities are extremely low and these facilities are very safe.

Q. How do the analyses and conclusions of the G2 Risk Assessment affect your opinion of the risks related to Regulating Stations, such as Gate Stations, or PECO's proposed Natural Gas Reliability Station?

A. The G2 Risk Assessment supports my opinion that Regulating Stations are very safe, including PECO's Gate Stations. Also, the G2 Risk Assessment supports my opinion that PECO will be able to safely operate the proposed Natural Gas Reliability Station. The G2 Risk Assessment concluded that the risks for the natural gas Adelphia Pipeline are incredibly low, even lower than the low level of risks associated with the NGL Mariner East 2 Pipeline. The Adelphia Pipeline was described as an 18-inch natural gas pipeline with an operating pressure of 1,083 psig[2], and based on my understanding of PECO's Natural Gas Reliability Station, the inlet main will be a 12-inch natural gas main with a MAOP of 525 psi and an anticipated operating inlet pressure of 200 psi, which are much lower compared with the Adelphia Pipeline. Based on the lower pressure, smaller infrastructure, and from my review of the PHMSA records involving incidents at Gate Stations, you can easily determine that the risks associated with the Natural Gas Reliability Station would be much lower than the risks associated with the Adelphia Pipeline, which

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[2] PSIG is known as "pound-force per square inch Gauge" Pressure. This term is used for PSI in relation to atmospheric pressure. PSIG and PSI are interchangeable nomenclature in the pipeline industry when discussing line pressure. The G2 Risk Assessment uses the term PSIG for Adelphia and Mariner East 2 pipeline pressure.

G2 described as being equivalent to the risks associated with household fires or falling down a flight of stairs.

Q. What does the G2 Risk Assessment state with regards to a natural gas delayed ignition?

A. Page 33 of the G2 Risk Assessment discusses delayed ignition with respect to the natural gas Adelphia Pipeline. The document states that natural gas delayed ignitions have reduced discharge rates and smaller consequences. In fact, it states specifically, the "greater the ignition delay, the greater the discharge is reduced and the smaller the consequence."

Q. Do you agree with G2's statement with regards to delayed ignition events involving natural gas releases?

A. Yes. As natural gas is lighter than air, therefore it does not concentrate near the ground when released. A delayed ignition event reduces the likelihood of ignition because the natural gas continues to rise and mix with air and that reduces the methane concentration to levels that are not within a flammable range.

Q. On page 13 of Mr. Boyce's Rebuttal Testimony in this proceeding, in response to a question regarding his specific concerns about the delayed ignition of a gas cloud, Mr. Boyce states "[t]hat is a worst-case scenario." How does this statement compare with the G2 Risk Assessment or your knowledge of the natural gas industry?

A. This statement is not supported by the G2 Risk Assessment as stated previously and is not supported by my knowledge and experience in the natural gas industry. Natural gas releases dissipate into the atmosphere very quickly. Any release from the Natural Gas Reliability Station would dissipate into the atmosphere very quickly and reduce the likelihood of ignition.

Q. On page 8 of Mr. Boyce's Rebuttal Testimony, Mr. Boyce states that the 2020 Department of Transportation Emergency Response Guidebook suggests an "impact zone" of at least 800 meters/half a mile in the event of a delayed ignition. Could you please comment on Mr. Boyce's Testimony?

A. The 2020 Department of Transportation Emergency Response Guidebook does not provide a potential impact radius on people or property from a pipeline failure. The Guidebook provides evacuation ranges. Evacuation ranges and impact ranges are different concepts. The Department of Transportation Guidebook provides for an evacuation range of 100 meters as an immediate precautionary measure for hazardous materials releases and provides for larger evacuation distances depending on the type or extent of hazardous release or fire.

Department of Transportation regulation 49 C.F.R. § 192.903, defines the term "potential impact radius" (PIR) to mean the radius of a circle within which the potential failure of a pipeline could have significant impact on people or property. The Department of Transportation regulation provides the following equation to calculate PIR: $r = 0.69 *$ square root $(p * d^2)$. In this equation, r is the potential impact radius (ft), p is the maximum allowable operating pressure (MAOP) in the pipeline segment in pounds per square inch (psi), and d is the pipeline diameter in inches.

I have reviewed PECO's Direct Testimony of Mr. Timothy Flanagan, PECO Energy Company Statement No. 4, and Mr. Flanagan states on page 4, line 3 that the natural gas MAOP for the 12-inch main connected to the Natural Gas Reliability Station is 525 psi, and that the pressure arriving at the Station is anticipated to be less than 200 psi. Using the Department of Transportation equation of a 12-inch pipe diameter main, and a pressure of

525 psi, in the extremely unlikely scenario of a serious incident at the Natural Gas Reliability Station, the PIR is 190 feet, not 800 meters/half-mile as Mr. Boyce states[3], but in actuality the pressure arriving at the Natural Gas Reliability Station will be only 200 psi, which would result in a PIR of 117 feet.[4]

V. RESPONSE TO JIM CAPUZZI'S REBUTTAL TESTIMONY

Q. Mr. Israni, have you reviewed the Direct Testimony of Jim Capuzzi in this proceeding?

A. Yes.

Q. Mr. Capuzzi expresses concern on page 4, lines 2-3, of his Rebuttal Testimony that there is no guarantee that PECO will be onsite at the Natural Gas Reliability Station within one hour if a leak occurs. Do you share this same concern?

A. No. As I understand from PECO Energy Company Statement No. 4-SR, PECO's response record, PECO responds to 99.9% of odor calls within an hour, and PECO ranks in the first decile for Percent First Responder Calls Under One-Hour for the last 13 years among similar gas utilities per industry benchmarking.

Additionally, the Department of Transportation regulations, 49 C.F.R. §§ 192.721 and 192.723, require operators to conduct periodic patrols and leak surveys of their systems. Further, a December 10, 2012 *PHMSA Leak Detection Study Final Report,* conducted by Kiefner & Associates, Inc. (available at https://www.phmsa.dot.gov/sites/phmsa.dot.gov/files/docs/technical-resources/pipeline/16691/leak-detection-study.pdf, last visited 07/08/2021) found that hazardous liquid pipeline operators responded to incidents within an hour 88% of the time, demonstrating that operators across the country respond to

[3] 0.69 * square root $(525 * 12^2) = 190$

[4] 0.69 * square root $(200 * 122) = 117$

incidents within a one-hour timeframe a very high percentage of the time, and PECO's odor response time record far exceeds that national rate.

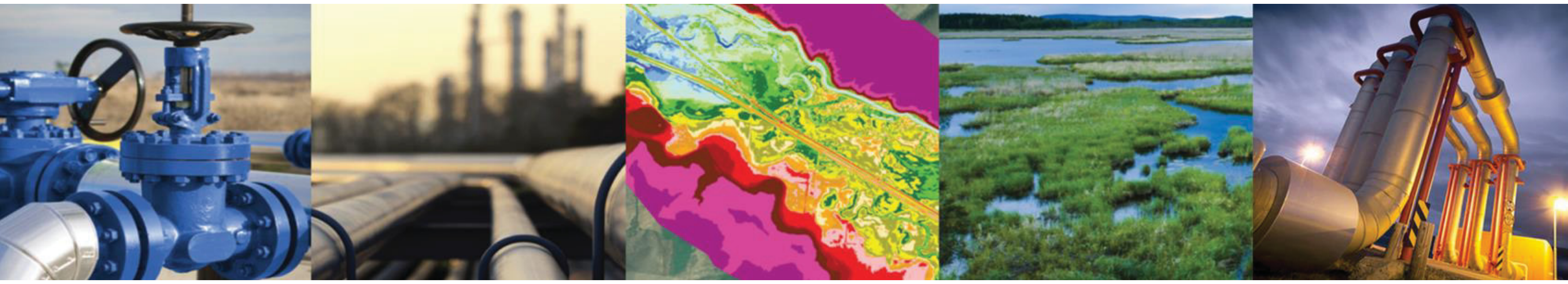
VII. CONCLUSION

Q. Does this conclude your Surrebuttal Testimony?

A. Yes, it does.

MI – 1
Omitted

MI – 2



Mariner East 2 Pipeline and Existing Adelphia Pipeline Risk Assessments

Submitted on: November 28, 2018
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1.1	11/02/2018	R. Mancik	C. Phillips	J. F. Kill	Issue for Client Review
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About G2-IS

G2 Integrated Solutions (G2-IS) delivers expertise to pipeline operators, utility companies, and other energy stakeholders in seven specialized service disciplines:

- Asset Integrity
- Engineering
- Regulatory and Strategic Consulting
- Geospatial
- Field Assurance
- Programmatic Management Solutions
- Software & Technology

We provide asset life cycle solutions that help manage risk, assure compliance, and optimize performance. G2-IS is committed to maintaining a safe and incident-free working environment for our people and our customers, and to sound environmental stewardship. We work within controlled management systems that achieve continual improvement and assure reliable delivery of high quality products, services and outcomes.

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1.0 EXECUTIVE SUMMARY

Residents of Delaware County, Pennsylvania desire to better understand the risks associated with the operation of the Mariner East 2 pipeline and the converted Adelphia pipeline. In response to public discussions, this risk assessment was undertaken to estimate the level of individual risk to those people located within the County of Delaware from either the Mariner East 2 pipeline or the converted Adelphia pipeline and then compare to other common sources of risk experienced by the general population.

The Mariner East 2 pipeline and Adelphia pipeline quantitative risk assessments were executed in a systematic process in which potential accident events were identified, the associated consequence and likelihood of such events were determined, and the risk measures estimated. The risk measure calculated for each of the pipelines is individual fatality risk, which is the measure of the likelihood of an individual suffering a fatal injury, as the result of an accident event, in a period of a year.

The concluding intent of these risk assessments was to present a comparison of the Mariner East 2 pipeline and Adelphia pipeline estimated individual fatality risk levels against other individual fatality risk levels from common sources. This comparative evaluation establishes an improved perspective when interpreting the meaning of the pipeline individual fatality risks.

It was concluded that the individual fatality risk levels estimated for both the Mariner East 2 pipeline and the Adelphia pipeline fall within a range of other common risk sources such as traffic accident, house fire, or fall from stairs.

2.0 INTRODUCTION

Residents of Delaware County, Pennsylvania desire to better understand the risks associated with the operation of the Mariner East 2 pipeline and the converted Adelphia pipeline. In response to public discussions, the Delaware County Council would like to estimate the level of individual risk to those people located within the County of Delaware from either the Mariner East 2 pipeline or the converted Adelphia pipeline, and compare these risk results to other common sources of risk experienced by the general population.

The County of Delaware has contracted G2 Integrated Solutions to undertake the following two tasks:

- An independent risk assessment of the event of an accidental release located within Delaware County from the Mariner East 2 pipeline
- An independent risk assessment of the event of an accidental release located within Delaware County from the converted existing Adelphia pipeline

This document provides the results of these risk assessments.

2.1 Objectives

The specific objectives of the Mariner East 2 pipeline and Adelphia pipeline risk assessments were to:

- Calculate the individual fatality risk as a function of distance from the pipeline route and generate a risk transect
- Compare the level of individual fatality risk to other common risk sources

2.2 Scope of Work

The following sections detail the scope of work for the Mariner East 2 pipeline and Adelphia pipeline risk assessments.

The risk measure calculated for each of the pipelines is individual fatality risk ("individual risk"), which is the measure of the likelihood of an individual suffering a fatal injury, as the result of a hazardous accident event, in a period of a year. Such a risk measure is preferred because it can be compared to readily available statistics.

2.2.1 Mariner East 2 Pipeline Risk Assessment

The scope of the Mariner East 2 pipeline risk assessment is for the quantification of individual fatality risk to the Delaware County public residing and working nearby the future 20-inch natural gas liquid (NGL) transmission pipeline. The physical scope of work is an accidental release from the body of the Mariner East 2 pipeline segment located within the Delaware County boundaries.

The following items are excluded from the Mariner East 2 pipeline risk assessment scope of work:

- Associated pipeline equipment such as meters, pumps, valves, compressors, etc.
- Escalation events resulting from an initiating event from the Mariner East 2 pipeline
- Other pipelines connected to, or nearby, the Mariner East 2 pipeline
- Societal fatality risk calculation

2.2.2 Adelphia Pipeline Risk Assessment

The scope of the Adelphia pipeline risk assessment is for the quantification of individual fatality risk to the Delaware County public residing and working nearby the existing 18-inch natural gas transmission pipeline. The physical scope of work is an accidental release from the body of the existing Adelphia pipeline segment located within the Delaware County boundaries.

The following items are excluded from the existing Adelphia pipeline risk assessment scope of work:

- Associated pipeline equipment such as meters, pumps, valves, compressors, etc.
- Escalation events resulting from an initiating event from the existing Adelphia pipeline
- Other pipelines connected to, or nearby, the existing 18-inch Adelphia pipeline
- Societal fatality risk calculation

3.0 DEFINITIONS

Release Event	An accidental loss of containment from the pipeline via a pinhole, leak, or rupture.
Accident Event	A hypothetical event, such as a jet fire, flash fire, or explosion, that results from a pipeline release.
Accident Event Frequency	A measure of how often a hypothetical accident event could occur. For pipelines, the accident event frequency is measured on an annual per mile basis (i.e., per mile-year).
Accident Event Consequence	The potential harmful effect of an accident event, such as jet fire thermal radiation, flash fire, or explosion overpressure.
Atmospheric Condition	The condition of the atmosphere in terms of both Pasquill stability class (e.g., stable "F" or neutral "D") and wind speed.
Individual Fatality Risk	Individual fatality risk is the annual chance an individual will suffer a fatal level of harm due to hazards to which they are exposed.
Societal Fatality Risk	Societal fatality risk is the annual chance that a specified number of people will suffer a fatal level of harm due to hazards to which they are exposed.
Full Bore Release	A full bore release is the equivalent to a complete severing of the pipeline diameter resulting in discharge from pipe on both sides of the rupture point. The equivalent can occur by a large longitudinal rip or tear – complete severing is not required. Note that PHMSA uses the term "rupture" for full bore and any size longitudinal rip or tear, and then details the size of the longitudinal rip or tear.
Jet Fire	A directional flame resulting from the combustion of a fuel continuously released.
Flash Fire	A fire resulting in a rapidly spreading flame front; characterized by short duration and without damaging explosion overpressure.

Vapor Cloud	A region or volume containing a vaporized fuel in flammable concentrations; below a certain concentration, the cloud is not flammable.
Vapor Cloud Explosion	A vapor cloud that expands so rapidly, such as from a spreading flame front, as to result in a damaging overpressure or shockwave.

4.0 METHOD

A quantitative risk assessment is a systematic process in which hazards from an activity or operation are identified, and the consequence and likelihood of potential accidental events are estimated.

The following approach was executed for the Mariner East 2 pipeline and the Adelphia pipeline quantitative risk assessments:

1. Establish study context
2. Define the releases and accident events to be assessed
3. Determine accident event frequency
4. Determine magnitude of the harmful consequence and impact
5. Calculate individual risk results
6. Compare individual risk results to other common risk sources

5.0 STUDY CONTEXT

The descriptions and operating conditions of both the Mariner East 2 and Adelphia pipelines as assessed in this report are taken from publicly available sources. Where specific information needed for this assessment is not detailed in the publicly available sources, conservative interpretation of the available information and/or judgement is used to provide the necessary basis for the risk assessment. Such specific information may be used only indirectly in the analysis; for example: the depth of cover.

Table 1 is a summary of the Mariner East 2 pipeline information used as the basis of the risk assessment.

Table 2 is a summary of the Adelphia pipeline information used as the basis of the risk assessment.

Table 1: Mariner East 2 Pipeline Risk Assessment Basis

Item	As Assessed	Comment
Pipeline diameter	20 inches	Reference [2]
Total pipeline length	306 miles	Reference [2]
Commodity transported	Natural gas liquids	Reference [3]
Commodity composition	Propane	Assumption: Mariner East 2 pipeline to carry propane or butane, batched and not mixed [2]. The pipeline is anticipated to carry primarily propane [4]. Thus, propane is the representative single component for the Mariner East 2 risk assessment.
Operating pressure	1,480 psig	Reference [2]
Operating temperature	12.5°C (54.5°F)	Assumed to be same as the average outdoor air temperature. Average outdoor air temperature from Reference [22].
Flowrate	275,000 barrels/day (258 kg/s)	Reference [4]
Emergency flow restriction devices	2 located in Delaware County	Both automated and manual valves will be located along the pipeline route. Two emergency flow restriction devices (EFRD) will be located in Delaware County [2]. For the purposes of consequence modeling, this risk assessment will assume that the 2 EFRDs located in Delaware County will isolate a volume equivalent to 8 miles of a 20-inch pipeline within 15 minutes.
Isolated length	8 miles	Reference [2] Approximate distance between the EFRD valves located in Delaware County.

Item	As Assessed	Comment
Isolation time	15 minutes	Reference [1] Sensing devices along the pipeline send data every 15 seconds to 15 minutes.
Depth of cover	4 feet	Reference [8]
Pipeline route surroundings in Delaware County	Varies from urban to suburban. Mixed residential and commercial land use.	Google Maps, Google Earth
Atmospheric condition	D-4.5 m/s	D-4.5 m/s is the neutral atmospheric condition in this risk assessment. Atmospheric stability class "D" is the dominating atmospheric condition based on published fractions. [9]. 4.5 m/s average wind speed from Reference [22].
	F-1.5 m/s	F-1.5 m/s is the stable atmospheric condition in this risk assessment. It represents the allocation of both atmospheric classes "F" (i.e., stable) and "E" (i.e., slightly stable) and the lowest wind speed category used in Purple Book for "F" and "E" stability conditions [9]. Stable wind conditions tend to have much greater dispersion distances than average wind conditions.

Table 2: Adelphia Pipeline Risk Assessment Basis

Item	As Assessed	Comment
Pipeline diameter	18 inches	Reference [6]
Pipeline length (overall)	84 miles	Reference [6]
Commodity transported	Natural gas	Reference [6], [7]
Commodity composition	Methane	Simplification: Natural gas is primarily methane. Methane is used as the representative single component for this risk assessment.
Operating pressure	1,083 psig	Reference [6]
Operating temperature	12.5°C (54.5°F)	Reference [22]
Flowrate	250 MMSCFD (58.8 kg/s)	Reference [6]
Isolated length	N/A	While natural gas pipelines typically are equipped with emergency isolation capability, such capability does not factor into the consequence modeling approach used for this risk assessment. See Section 8.1 for details.
Isolation time	N/A	See Section 8.1 for details.
Depth of cover	4 feet	Assumption: 4 feet of cover is considered typical.
Pipeline route surroundings in Delaware County	Varies from urban to suburban. Mixed residential and commercial land use.	Google Maps, Google Earth

Item	As Assessed	Comment
Atmospheric condition	D-4.5 m/s	D-4.5 m/s is the neutral atmospheric condition in this risk assessment. Atmospheric stability class "D" is the dominating atmospheric condition based on published fractions [9]. 4.5 m/s average wind speed from Reference [22].

6.0 DEFINE RELEASE AND ACCIDENT EVENTS

This study considers the loss of containment, or unwanted releases, from the pipeline body and assesses the potential events and associated impact on individuals exposed within the potential consequence zones. This section defines the loss of containment characteristics, accident event frequencies, and potential associated consequences.

The defined characteristics of a loss of containment, or release event, include:

- Release hole-size
- Release location
- Release orientation

The following accident event frequencies, associated consequences, and impacts were considered:

- Jet fires resulting in harmful thermal radiation levels
- Flash fire resulting in harmful thermal radiation levels
- Vapor cloud explosion resulting in harmful overpressures

6.1 Release Hole-Size

Loss of containment hole-sizes can range from full bore ruptures to pinhole punctures. For this risk assessment, the following two hole-sizes were considered:

- Full bore rupture
- 50 mm equivalent hole (i.e., approximately two inches)

As specified in the "Guidelines for Quantitative Risk Assessment" (widely referred to as the "Purple Book") [9], simplifying the potential range of pipeline release hole-sizes to two (2) representative hole-sizes is sufficient for calculating risk and is consistent with pipeline release scenarios.

A full bore rupture event is when the pipeline body is completely severed (sometimes called "guillotine" break) or has a longitudinal split or crack with a large area. In such an event, the resulting discharge comes from both the portion of the pipeline upstream of the rupture point and the portion downstream of the rupture point. Such releases are characterized by a massive, but a rapidly decreasing discharge rate.

A 50 mm equivalent hole represents an event with a much smaller discharge rate. Such releases are characterized by discharge rates that do not decrease appreciably over the time periods relevant to quantitative risk assessments. Although such events might range from tiny pinhole leaks to leaks considerably larger than 50 mm, 50 mm is selected to represent the range of possible leaks.

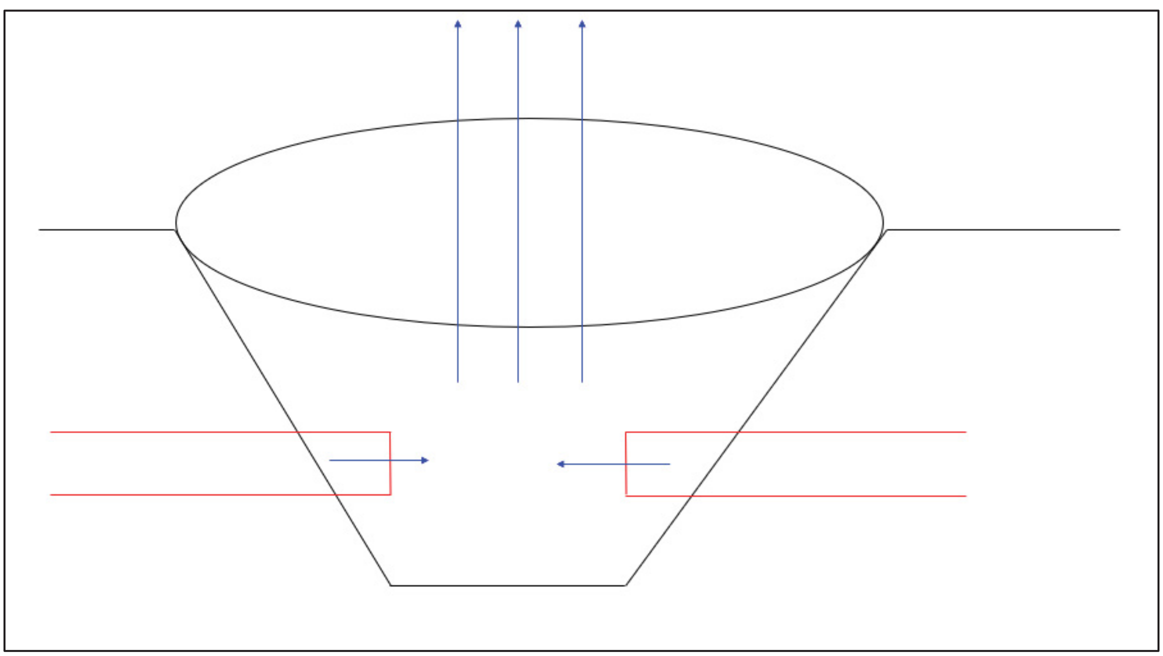
6.2 Release Location and Release Orientation

For the objectives of these risk assessments, only below-ground, shallow depth, pipeline body release locations are considered.

Given a shallow depth of cover, a gas or two-phase flashing liquid release from a buried pipeline can result in the formation of a crater at the release location. The crater has the effect of directing the resulting discharge into an upwards direction with a reduced velocity, as compared to a free jet. Such effects can greatly alter the impact of the resulting consequence at ground level.

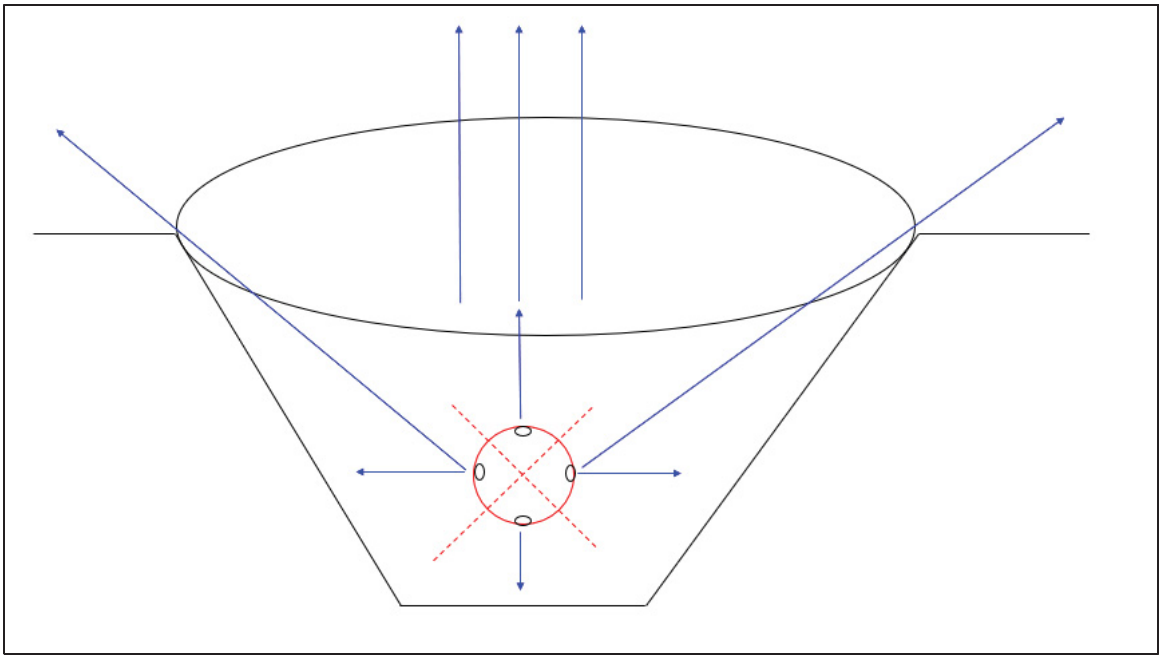
Figure 1 is a simplified diagram that illustrates the release orientation of a full bore release, with a shallow depth of cover. The discharge comes from both upstream and downstream portions of the ruptured pipeline. The two flows impinge on each other, form a crater, and exit the crater in a vertical orientation.

Figure 1: Full Bore Release Orientation



For the 50 mm hole-size, the release location can be anywhere around the pipeline body. For releases located near the top or bottom of the pipe, the release orientation will be nearly vertical as caused by the walls of the resulting crater. For releases located near the side of the pipeline body, the release orientation will be some angle closer to horizontal when exiting the crater. Figure 2 is a simplified diagram that illustrates the release orientation of a 50 mm hole-size release.

Figure 2: 50 mm Release Orientation



6.3 Accident Event Frequencies

After defining the release characteristics, the frequency of the associated potential accident events (i.e., jet fire, explosion, etc.) were determined. PHMSA historical data was used to estimate the frequency of an initiating release event for the Mariner East 2 pipeline and the Adelphia pipeline.

Event tree diagrams were then used to model and examine the potential accident event frequencies based on pathways from the initiating release event. The initiating release event starts at the left side of the tree and is followed by the occurrence, or not, of subsequent events and continues until the consequential outcome, or accident event, is reached. The frequency of each evaluated accident event is determined by multiplying the initiating release event frequency and the probabilities assigned to each of the subsequent events along the relevant pathway.

The event trees specific to the Mariner East 2 pipeline risk assessment and the Adelphia pipeline risk assessment are discussed in Section 7.0 and Section 8.0, respectively.

6.4 Accident Event Consequences

For the purposes of quantitative risk assessment, accident event consequence refers to the potential physical effects from pipeline loss of containment events. For this risk assessment, the accident event consequences relevant to the risk assessment of the Mariner East 2 and Adelphia pipelines are:

- Discharge rate
- Ignition
- Jet fire thermal radiation
- Flash fire thermal radiation
- Vapor cloud explosion overpressure

Each of these has specific meanings and relevant characteristics as applied within a quantitative risk assessment, which are described in the following sections.

The consequence modeling was performed using the DNV GL Phast software package.

6.4.1 Discharge Rate

In determining individual risk levels, the discharge rate, rather than the total quantity released, establishes the magnitude of the harmful consequence assessed. The discharge rate is based on the release hole-size and the pipeline operating parameters.

For the 50 mm release hole-size used in this risk assessment, the discharge rate is less than the normal pipeline flowrate, and is, therefore, nearly constant for over an hour, even with emergency isolation.

For a full bore rupture release, the initial discharge rate will be much greater than the normal pipeline flowrate but will decrease rapidly over time. The location of the rupture along the pipeline, the location of upstream and downstream isolation valves, and the isolation time for stopping the incoming flow may influence the discharge rate as a function of time.

The DNV GL Phast consequence modeling software was used to calculate the discharge rate over time for each of the two hole-sizes considered, based on the pipeline diameter, operating pressure, pipeline length, and isolation valve locations.

6.4.2 Ignition

A release of flammable material from a pipeline could result in the following ignition scenarios:

- Not ignite
- Ignite immediately
- Ignite after some time delay

Ignition of released flammable contents of a pipeline can potentially result in a jet fire, flash fire, or explosion.

Ignition sources for such accident events may be remote from the pipeline, in the form of open flames, electrical equipment, motorized vehicles, and other heat or spark sources. Additionally, the release event itself or electrostatic ignition sources near the release location can also be a source of ignition.

6.4.3 Jet Fire Thermal Radiation

A jet fire results from either the immediate or delayed ignition of a release of pressurized flammable gas. The resulting jet fire produces thermal radiation that can harm people directly by causing burns to people exposed over time or indirectly by starting secondary fires.

The thermal radiation level reaching a given point is largely determined by the:

- Size of the resulting flame (i.e., the larger the flame, the greater the distance to a given thermal radiation level)
- Composition of the fuel

It should be noted that the composition of the materials involved in the subject pipelines has an effect that is secondary compared to the flame size.

A jet fire from an ignited buried pipeline release will be oriented upwards as a result of the crater formed, with a near vertical flame tilting downwind. This flame tilt has the net effect of “shifting” the thermal radiation consequence zone downwind. Because the flame shift downwind is minimal, assessing the event at varying wind speeds was not warranted and, therefore, an average wind speed is used in this risk assessment for jet fire thermal radiation.

The modeling software also accounts for the effects the crater has on the momentum of the resulting jet, which can influence the thermal radiation footprint.

6.4.4 Flash Fire Thermal Radiation

If there is sufficient ignition delay to allow the release of pressurized flammable gas to disperse and form a flammable cloud, a flash fire results once the flammable cloud is ignited. Unlike a jet fire, a flash fire has a short duration but may be followed by a jet fire.

Although capable of starting secondary fires, in a quantitative risk assessment the harmful impact of a flash fire is simplified by limiting harm only to people directly exposed outdoors. The consequence zone of a flash fire is taken as equivalent to the area of the flammable cloud.

6.4.5 Vapor Cloud Explosion Overpressure

A vapor cloud explosion results in a shockwave, measured as an overpressure, that can cause harm directly to persons exposed outdoors, or indirectly to persons indoors by causing damage or collapse of buildings or structures. If the overpressure is sufficient to cause harm it is referred to as a damaging overpressure. At some low overpressure, there is insufficient energy to cause significant harm.

It should be noted that in common language usage, outside of risk assessment, the term "explosion" is often used rather loosely to describe any large ignited release of highly flammable gas or liquid. Such terminology use may make no distinction between jet fire, flash fire, or damaging vapor cloud explosion. Written material using the term outside of a quantitative risk assessment context should be interpreted accordingly.

6.5 Accident Event Impact

The accident event impact effects of the harmful accident event consequences described in Section 6.4 are needed to estimate an individual risk. For each of the consequence types, a vulnerability to an exposed person is applied. The vulnerability can be described as the fatality fraction of those persons exposed.

The vulnerability values used in this risk assessment are taken from the Purple Book [9] and are summarized in the following sections.

6.5.1 Jet Fire Thermal Radiation

For jet fire thermal radiation, the vulnerability varies with the thermal radiation level. For this risk assessment, the thermal radiation levels are divided into four ranges and an average vulnerability is applied to each range. The value of the vulnerability for each range is calculated from the radiation level and exposure time relationship published in the Purple Book [9], using a maximum of a 20-second exposure time. The 20-second maximum exposure time is also stipulated in the Purple Book [9].

Table 3 summarizes the vulnerability values applied in this risk assessment to people directly exposed (i.e., outdoors) to jet fire thermal radiation consequence.

Table 3: Jet Fire Thermal Radiation Vulnerability, Persons Outdoors

Consequence Level	Fatality Vulnerability	Basis
Greater than 35 kW/m^2	1.0	20 second exposure to unprotected skin
18 kW/m^2 to 35 kW/m^2	0.69	20 second exposure to unprotected skin
12.5 kW/m^2 to 18 kW/m^2	0.23	20 second exposure to unprotected skin
9.46 kW/m^2 to 12.5 kW/m^2	0.04	20 second exposure to unprotected skin
Less than 9.46 kW/m^2	0	20 second exposure to unprotected skin

People inside buildings are mostly shielded from direct exposure to thermal radiation. However, being present in a building does not eliminate vulnerability to thermal radiation, such as if the thermal radiation results in the building catching fire. The Purple Book stipulates an indoor vulnerability of 1.0 for jet fire thermal radiation levels greater than 35 kW/m^2 and zero for levels less than 35 kW/m^2, as summarized in Table 4 [9].

Table 4: Jet Fire Thermal Radiation Vulnerability, Persons Indoors

Consequence Level	Fatality Vulnerability	Basis
Greater than 35 kW/m^2	1.0	Assumes buildings are set on fire
Less than 35 kW/m^2	0	Below building ignition threshold

6.5.2 Flash Fire Thermal Radiation

For flash fire thermal radiation, the harmful impact is assumed not to vary by radiation level nor exposure time, because flash fires have very short durations (See Table 5). The Purple Book stipulates an outdoor vulnerability of 1.0 for persons in the flash fire flame envelope and zero for persons outside the flame envelope [9]. The Purple Book further stipulates that the flash fire flame envelope is equal to the flammable cloud footprint (the lower flammable level concentration contour) at the time of ignition [9].

Persons inside buildings are assumed to not be vulnerable to flash fire. The rationale for this simplification is not discussed in the Purple Book [9]; however, can be presumed to be related to the very short durations of flash fires. Persons inside buildings are likely able to escape after the flash fire, even if the building catches fire.

Table 5: Flash Fire Thermal Radiation Vulnerability

Consequence Level	Fatality Vulnerability	Basis
Inside LFL Cloud, Outdoors	1.0	Inside flash fire flame envelope
Inside LFL Cloud, Indoors	0	Inside flash fire flame envelope
Outside LFL Cloud, Outdoors or Indoors	0	Outside flash fire flame envelope

6.5.3 Vapor Cloud Explosion Overpressure

The Purple Book provides both indoor and outdoor vulnerabilities for vapor cloud explosion overpressure (See Table 6 and Table 7) [9]. The Purple Book [9] does not cite a specific basis or rationale for these vulnerabilities, however the Purple Book often cites the related Green Book [10]. The Green Book describes in detail the impact on humans of exposure to toxic substances, heat radiation, and overpressure [10].

Table 6: Vapor Cloud Explosion Vulnerability, Persons Outdoors

Consequence Level	Fatality Vulnerability	Basis
Overpressure greater than 4.35 psig (0.3 bar)	1.0	Not provided[1]
Overpressure less than 4.35 psig (0.3 bar)	0	Not provided[1]
[1] The Purple Book does not provide a basis for the vulnerability values provided. See Section 6.5.3.		

Table 7: Vapor Cloud Explosion Vulnerability, Persons Indoors

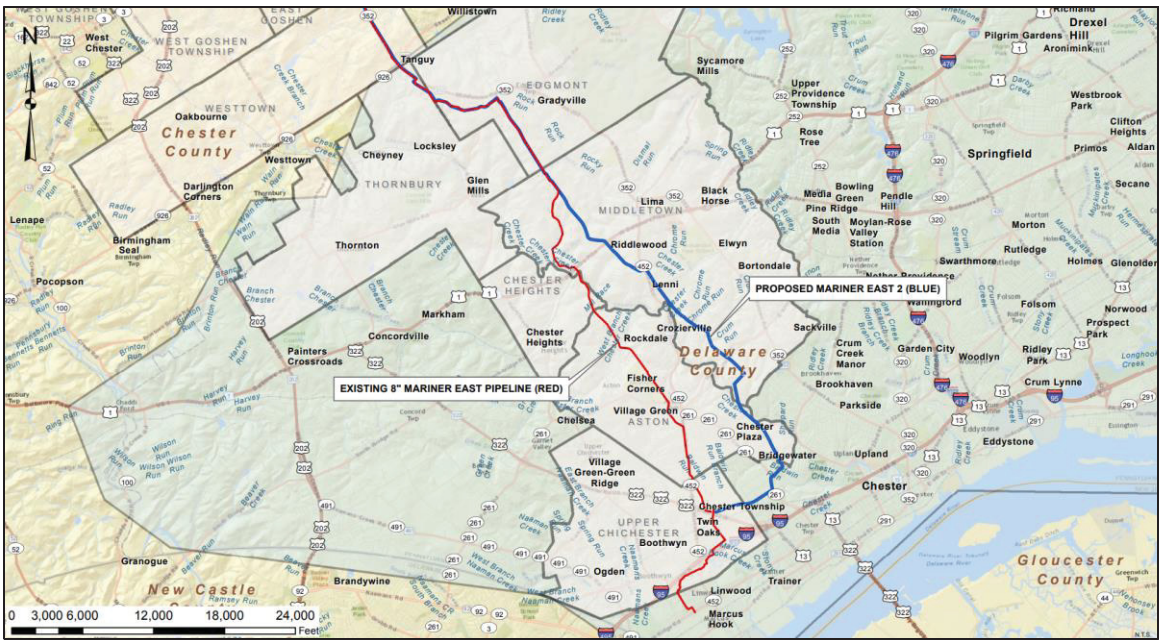
Consequence Level	Fatality Vulnerability	Basis
Overpressure greater than 4.35 psig (0.3 bar)	1.0	Not provided[1]
Overpressure greater than 1.45 psig (0.1 bar) but less than 4.35 psig (0.3 bar)	0.025	Not provided[1]
Overpressure less than 1.45 psig (0.1 bar)	0	Not provided[1]

[1] The Purple Book does not provide a basis for the vulnerability values provided. See Section 6.5.3.

7.0 MARINER EAST 2 PIPELINE RISK ASSESSMENT

The Mariner East 2 pipeline is an expansion of the existing Mariner East pipeline system and will transport NGLs from Ohio and the Pittsburgh area to the Marcus Hook facility for both domestic distribution and export. Mariner East 2 will be a 20-inch diameter pipeline with an initial transporting capacity of approximately 275,000 barrels per day of NGLs. The high-pressure pipeline will tunnel beneath 17 counties with a length of approximately 11.4 miles through Delaware County, Pennsylvania. Figure 3 shows the proposed route for the Mariner East 2 pipeline.

Figure 3: Proposed Route of Mariner East 2 Pipeline through Delaware County [11]



The following sections describe the risk assessment details specific to the Mariner East 2 pipeline.

7.1 Accident Event Consequence

The Mariner East 2 pipeline is modelled as pure propane to determine the accident event consequences. Upon release, liquid propane vaporizes to a dense gas, and, if not ignited immediately, the vaporized propane disperses downwind as a low-to-the-ground flammable cloud. After the pipeline is isolated and the content has leaked out, the flammable cloud will decrease in size until it is no longer at flammable concentrations.

For the purposes of this risk assessment, the dynamic nature of the Mariner East 2 pipeline accident event and associated consequences was reflected by considering two wind speed-stability conditions and dividing the event into three ignition periods.

The size of flammable cloud that is passively dispersing can vary considerably depending on the wind speed and atmospheric stability, which also varies.

The dispersing flammable cloud could ignite at any point in time and the time of ignition, with respect to the changing size of the flammable cloud means that the resulting consequence can vary greatly. If ignited early, the size of the flammable cloud will be small and jet fire thermal radiation will be the dominant harmful effect. A delayed ignition will result in a smaller jet fire due to the reducing discharge rate.

If ignition is delayed, the size of the flammable cloud means that a flash fire or vapor cloud explosion will occur, with the size of the flash fire or explosion increasing with increasing ignition delay, up to the maximum extent of dispersion. Additionally, at some delayed time, the effect of the flash fire or explosion will be greater than the effect of the delayed jet fire and will dominate the harmful effect.

For the full bore release event the following consequence outputs are contained in Appendix A:

- Release (i.e., discharge rate versus time)
- Jet fire thermal radiation footprint
- Side view of the early and late flammable cloud dispersion
- Early and late dispersion footprint of the flammable cloud (used for early and late flash fire consequence)
- Early and late vapor cloud explosion overpressure footprint

For the 50 mm release event the following consequence outputs are contained in Appendix A:

- Release (i.e., discharge rate versus time)
- Jet fire thermal radiation footprint
- Side view of the early and late flammable cloud dispersion

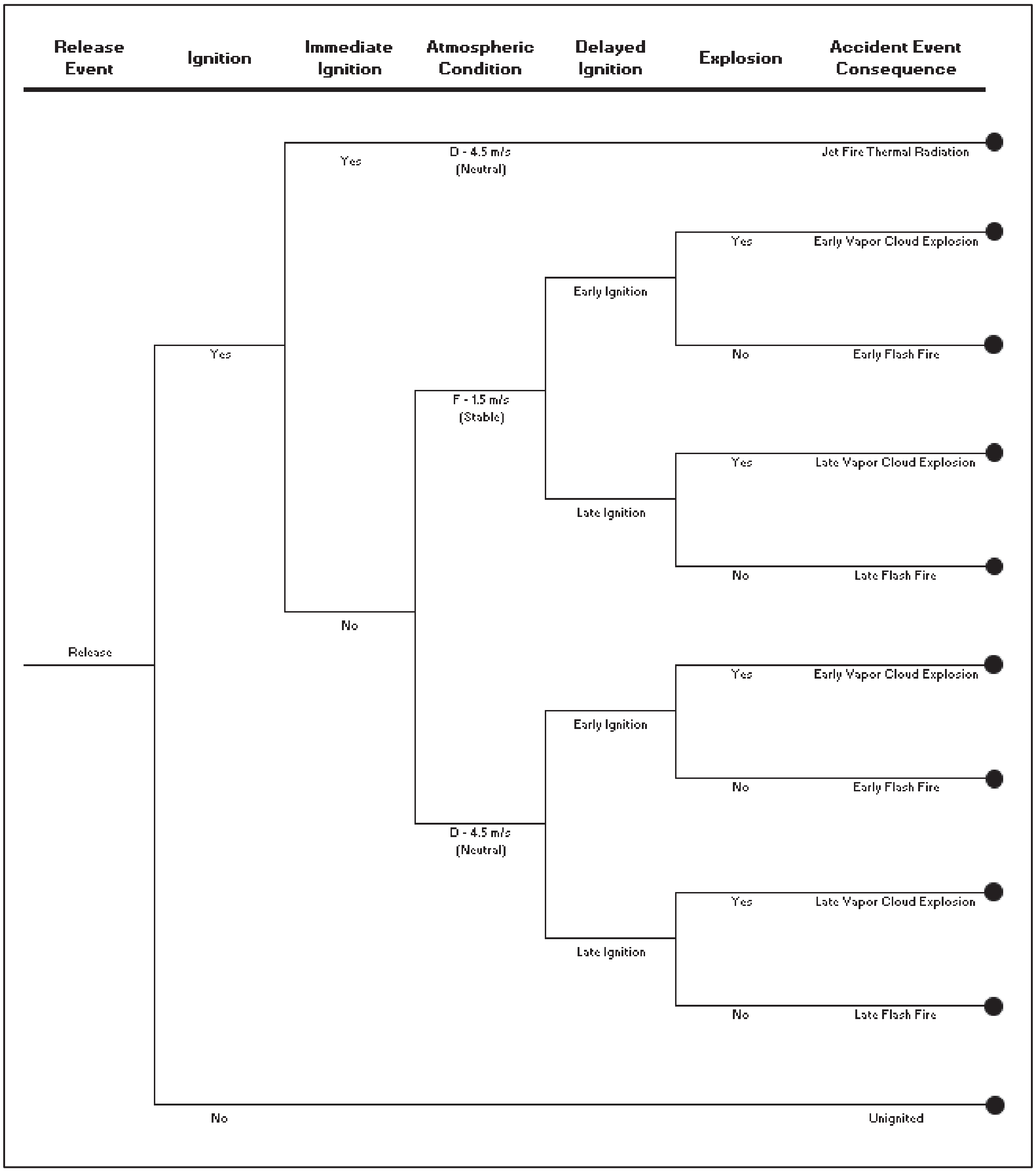
It should be noted that the side view flammable cloud dispersion figures for a 50 mm release event illustrate an upward dispersion, away from ignition sources and people, such that flash fire and vapor cloud explosion events do not contribute to the individual fatality risk level, if they were to occur.

For the purposes of this risk assessment, the following ruleset was defined:

- Assume immediate ignition and use the initial discharge rate (the average rate of the first 20 seconds of discharge) for jet fire thermal radiation consequence.
- Assume an intermediate ignition delay to represent an early flash fire or an early explosion of the expanding flammable cloud. The ignition delay is such that the flammable cloud would not have reached the maximum extent possible before ignition occurs (chosen to be approximately halfway to the maximum extent). Also, the discharge rate will have fallen to a point where the jet fire thermal effects will be smaller than the flash fire or explosion effects.
- Assume a longer ignition delay to represent a late flash fire or late explosion. The ignition delay is long enough that the expanding flammable cloud would have reached the steady-state, maximum extent. Again, the discharge rate will have fallen to a point where the jet fire thermal effects will be smaller than the flash fire or explosion effects.
- For jet fire thermal radiation consequence, only the overall average wind speed and neutral atmospheric stability is used (D – 4.5 m/s).
- For early and late flash fire or explosion, two wind speed and atmospheric stability combinations are used:
  - Overall average wind speed and neutral atmospheric stability
  - A worst-case condition reflecting a stable atmosphere (F – 1.5 m/s)

Figure 4 presents the event tree used to examine a chronological series of subsequent events and finally the frequency of consequential outcomes, or potential accident events resulting from a Mariner East 2 pipeline release. Additionally, the above rulesets are illustrated in the event tree shown in Figure 4. The branch probabilities used for each event tree branch in the risk summation is described in Section 7.2.

Figure 4: Mariner East 2 Pipeline Risk Assessment Event Tree



7.2 Accident Event Frequencies

The following subsections detail the release frequencies and conditional probabilities used in the Mariner East 2 pipeline risk assessment. Note that all values are taken directly from, or utilize common, published risk assessment references, including the Purple Book. The purpose of the Purple Book is to provide common starting points to facilitate obtaining verifiable, reproducible, and comparable quantitative risk assessment results [9].

7.2.1 Release Frequencies

A Mariner East 2 pipeline full bore release frequency was derived from the following available data sets:

1. PHMSA incident report statistics from hazardous liquid transmission pipelines for the period from 2002 through mid-2018 [11][14]
2. PHMSA hazardous liquid transmission pipeline mileage statistics [15]

The PHMSA incident and mileage data were refined, or filtered, to include the following relevant information:

- Highly volatile liquid (HVL) full bore release incidents
- Pipelines of diameter 12-inch and greater, to represent the 20-inch diameter Mariner East 2 pipeline
- Below-ground HVL transmission pipeline mileage

It should be noted that even though PHMSA details NGL pipeline incidents, PHMSA does not detail the mileage of NGL pipelines. Therefore, obtaining release frequencies specific to NGL pipelines is not possible using only the PHMSA data.

The filtering resulted in the following relevant historical data:

- Six HVL full bore release incidents
- 253,371 mile-years of HVL pipeline (12-inch or greater diameter)

Based on this data, an HVL pipeline full bore release frequency of 2.4E-05 incidents per mile-years (1.5E-05 incidents per km-years), was calculated.

The full bore release frequency value derived from PHMSA data compares well to that for a generic pipeline located in a dedicated route given in the Purple Book [9] (note that the pipeline diameter is not specified in the Purple Book values). The Purple Book value of 7E-06 incidents per km-year for full bore rupture is only a factor of 2 lower than the value derived from the PHMSA data.

Additionally, the Purple Book states that the release frequencies for pipelines located in a dedicated route are lower than other pipelines because of extra preventative measures [9]. The PHMSA data includes all pipelines and, according to the Purple Book, should be expected to be higher than full bore release frequency for pipelines located only in a dedicated route.

In determining a Mariner East 2 pipeline 50 mm release frequency, the estimated Mariner East 2 pipeline full bore release frequency was multiplied by a factor of 2.5 to result in a

50 mm release frequency of 5.9E-05 incidents per mile-years (3.7E-05 incidents per km-years). The 2.5 multiplying factor is taken from International Association of Oil and Gas Producers (OGP) recommended distribution of non-full bore hole sizes and full bore hole sizes for onshore oil pipelines [18].

Details of the PHMSA HVL incident and mileage data filtering and frequency calculations are provided in Appendix C.

7.2.2 Ignition Probability

OGP published ignition probability look-up correlations, which relate ignition probabilities to discharge rates for typical scenarios, were used in determining an overall (total) ignition probability given a release [19].

Specifically, Ignition Probability Correlation Number 3 was used as it is applicable for releases of flammable gases, vapor, or liquids significantly above their normal boiling point from onshore cross-country pipelines running through industrial or urban areas (many ignition sources as opposed to a rural area which would have sparse ignitions sources). This correlation is considered appropriate because the Mariner East 2 pipeline is transporting NGL, a liquid significantly above its normal boiling point, and the pipeline route through Delaware County can be described as urban. The values published for Ignition Probability Correlation Number 3 are provided in Table 8.

Table 8: OGP Published Ignition Probability Correlation #3 [19]

Discharge Rate (kg/s)	Ignition Probability
0.1	0.0010
0.2	0.0017
0.5	0.0033
1.0	0.0056
2.0	0.0095
5.0	0.0188
10	0.0316
20	0.0532
50	0.1057
100	0.1778

Discharge Rate (kg/s)	Ignition Probability
200	0.2991
500	0.5946
1000	1.0000
Ignition Probability Correlation #3: Flammable gases, vapor, or liquids significantly above their normal boiling point from onshore cross-country pipelines running through industrial or urban areas.	

Applying this correlation to the 20-inch Mariner East 2 pipeline discharge rates, for the two (2) hole-sizes, results in the following ignition probabilities:

- 50 mm release @ 3.4 kg/s, ignition probability = 0.01384 (interpolated)
- Full bore release @ 1586 kg/s (average of first 20 seconds), ignition probability = 1.0

Note that these are total ignition probabilities and do not indicate the timing of ignition.

7.2.3 Immediate Ignition

For the conditional probability of immediate ignition (given ignition) the Purple Book specifies a value of 0.3 for rupture of a liquefied flammable gas, buried cross-country pipeline [9].

The Purple Book does not detail the time delay criteria used to define "immediate" ignition. However, in the Mariner East 2 pipeline risk assessment, "immediate" is used as a differentiating factor between the jet fire and flash fire/explosion accident event consequences. Given that it takes some time for a dense flammable cloud to disperse passively downwind, the relevant time frame for "immediate" ignition in this risk assessment is roughly about one minute or less.

Note that in the case of an NGL release, a risk assessment using an immediate ignition probability that is lower than the delayed ignition probability produces more conservative results because the lower immediate ignition probability puts more emphasis on the effects of a delayed flash fire or explosion.

7.2.4 Atmospheric Condition

As a reference, the meteorological condition distribution of several locations in the Netherlands, as published in the Purple Book, was reviewed. The published fractions of stable and slightly stable atmospheric conditions added together result in a probability value slightly lower than 0.2.

Based on this information a conditional probability of a stable ("worst case") atmospheric condition was set at 0.25 in this risk assessment. The use of a higher value is to be conservative and accommodate uncertainty of the differences between the Netherlands locations and eastern Pennsylvania.

7.2.5 Ignition Delay

As discussed in Section 7.1, the Mariner East 2 pipeline risk assessment divides the delayed ignition effects into two periods:

- An intermediate (or early) delay, where the flammable cloud ignites before the maximum, steady-state size is reached resulting in an early flash fire or early vapor cloud explosion.
- A long (or late) delay (for late flash fire, or late explosion), where the flammable cloud reaches a maximum, steady-state size resulting in a worst case late flash fire or late vapor cloud explosion.

For the purposes of this risk assessment, the conditional probability that the ignition delay is late is set at 0.1 resulting in an early ignition conditional probability of 0.9. This is a conservative simplification that is justified by the argument that in a populated, urban area such as Delaware County, a dispersing flammable NGL cloud is more likely to ignite sooner rather than later due to the likely presence of numerous ignition sources.

Furthermore, to support the validity of this argument, the probability of early delayed ignition was checked using the model presented in Appendix 4.A of the Purple Book [9]. The inputs to this model are the area of the flammable cloud, the time interval the cloud is exposed over the ignition sources, and the effectiveness of the ignition sources.

Using the early flash fire flammable cloud area with a corresponding exposure time, and an ignition effectiveness based on the overall population density of Delaware County, the Purple Book delayed ignition model predicts a probability of ignition of 1.0 for the smaller, early flammable cloud. This supports that it is unlikely for a cloud to reach the maximum size before igniting in such an urban area.

To be conservative, the late ignition conditional probability is not set to zero, as suggested by the Purple Book delayed ignition model argument. A value of 0.1 is used in this risk assessment, which reflects that 10% of the delayed ignition events are assumed to have a late ignition, versus an early ignition, and result in the flammable clouds reaching the maximum, steady-state size before igniting.

7.2.6 Vapor Cloud Explosion

This Mariner East 2 pipeline risk assessment assumes that a vapor cloud explosion is a viable accident event given the combination of a propane flammable fuel source, a ground hugging flammable cloud, and some likely congestion near the pipeline. Thus, a suitable event tree branch probability split between a flash fire outcome and a vapor cloud explosion outcome is required.

This risk assessment uses a simple 0.6 flash fire/0.4 vapor cloud explosion split, as suggested by the Purple Book [9], for both the early ignition scenario and the late ignition scenario.

7.3 Individual Risk Results

The Mariner East 2 pipeline accident event consequences (Section 7.1), accident event frequencies (Section 7.2), and defined accident event impacts (Section 6.5) are combined to produce outdoor and indoor individual risk results. The individual risk results are then plotted on a grid to produce transects showing individual risk levels as a function of distance from the pipeline route. Separate risk transects for outdoor and indoor locations are provided, since different impact rulesets are used for the two location types (Section 6.5).

Note that the individual risk transects reflect an individual's continuous presence (i.e., 24-hours per day, 7-days per week) at a select location. This assumption is consistent with common quantitative risk assessment methodology; the continuous presence at a select location reflects a most exposed individual and, therefore, represents a maximum individual risk level.

The outdoor and indoor individual risk transects are shown in Figure 5 and Figure 6. Note that distance from the pipeline are expressed in meters.

Figure 5: 20-inch Mariner East 2 Pipeline, Outdoor Individual Risk Transect

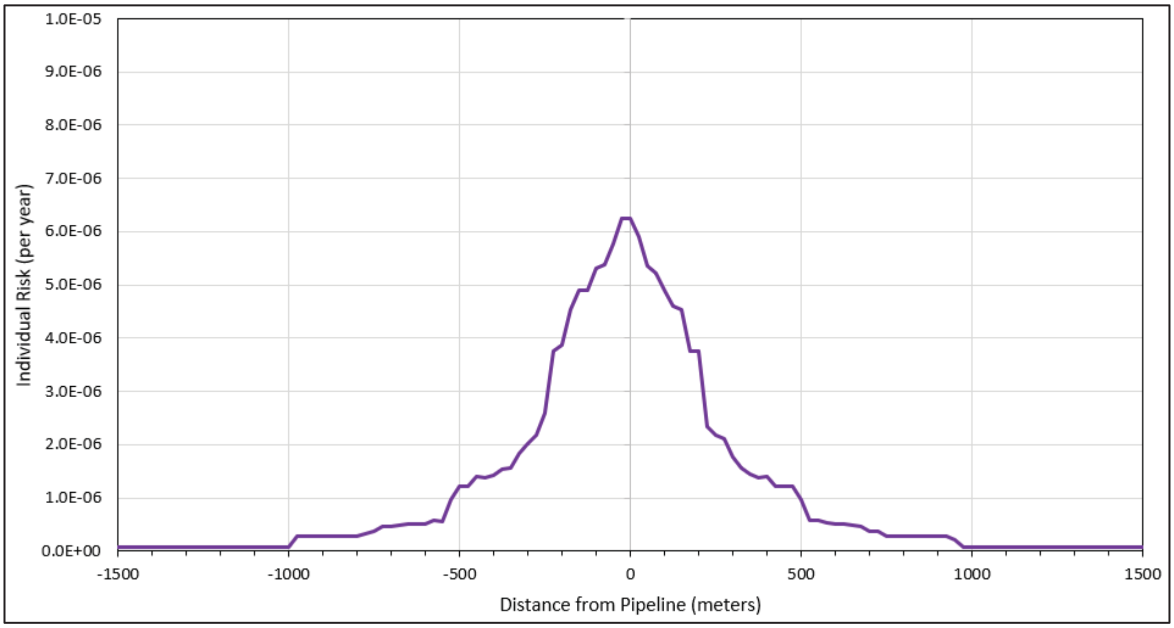
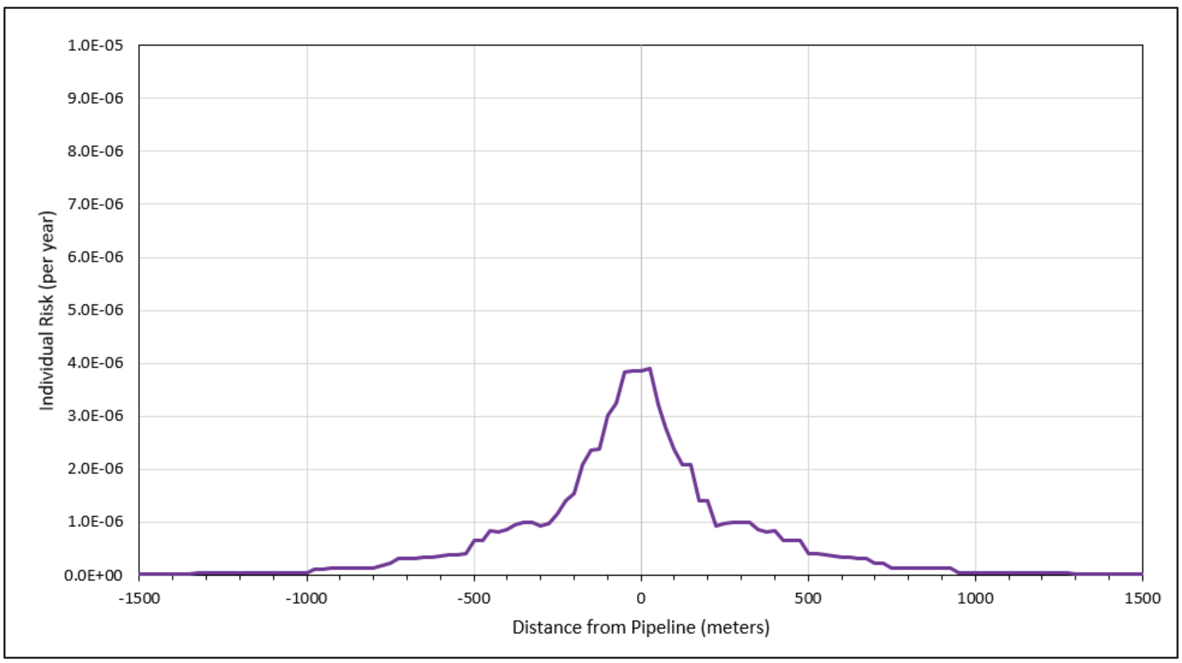


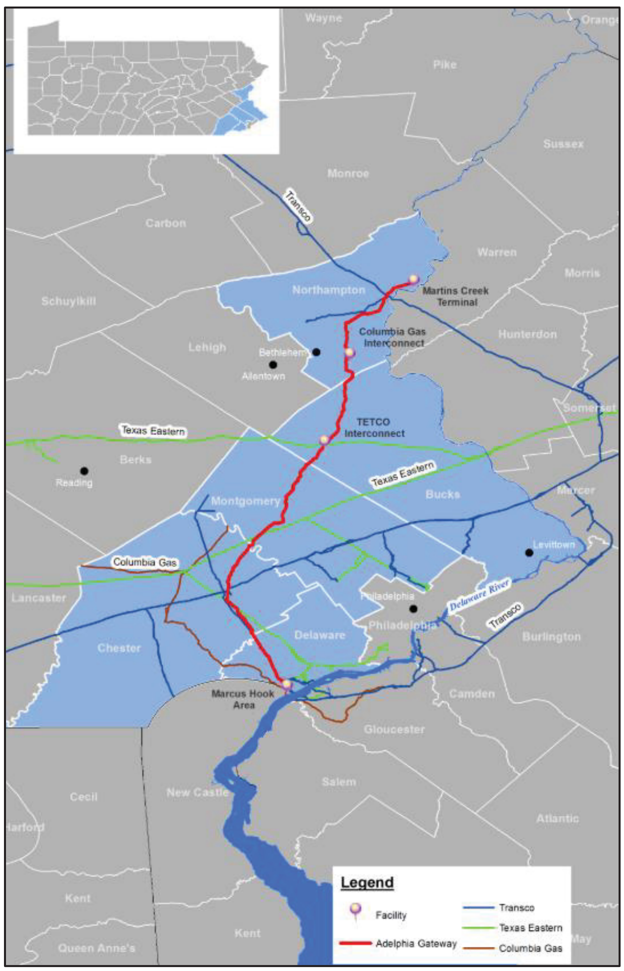
Figure 6: 20-inch Mariner East 2 Pipeline, Indoor Individual Risk Transect



8.0 ADELPHIA PIPELINE RISK ASSESSMENT

The existing Adelphia pipeline is an 84-mile pipeline that runs through five Pennsylvania counties, including Delaware County, and was originally constructed to transport oil from Marcus Hook to Martins Creek, Pennsylvania. In 1996, the northern 34 miles of the Adelphia pipeline was converted to transport natural gas. The remaining 50 miles of existing Adelphia pipeline is planned to be converted to transport natural gas, of which approximately 12 miles traverses Delaware County. Figure 7 shows the route of the existing Adelphia pipeline.

Figure 7: Route of Existing Adelphia Pipeline [12]

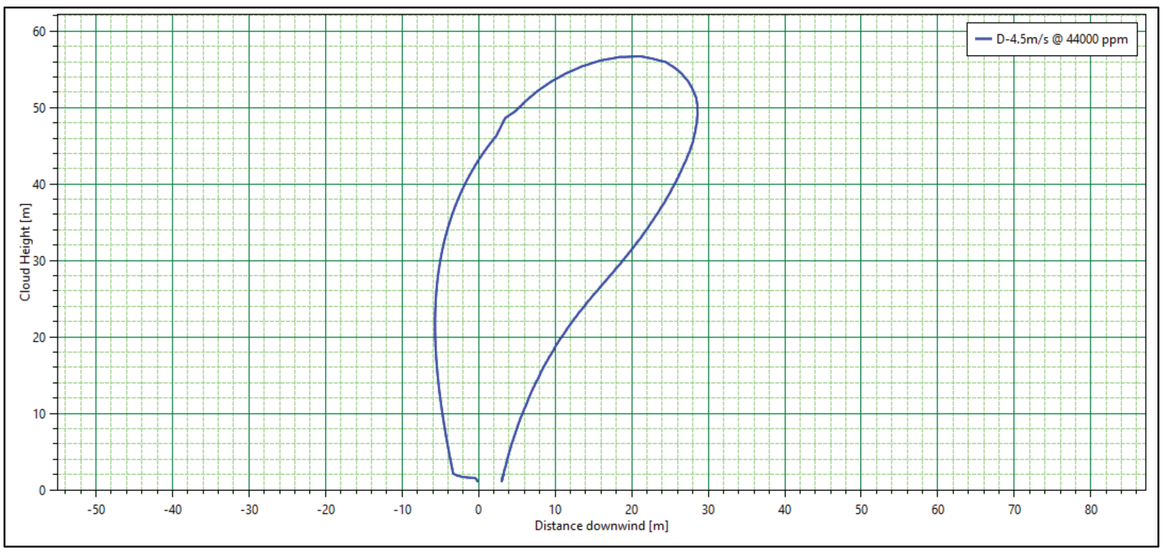


The following sections describes the risk assessment details specific to the Adelphia pipeline.

8.1 Accident Event Consequences

The Adelphia natural gas pipeline is modeled as pure methane to determine the accident event consequences. Upon release, the gas rapidly mixes with air to concentrations below the lower flammable limit. This rapid dilution combined with the vertical orientation of the resulting flammable cloud, caused by a combination of the effects of the crater and the buoyancy of the released gas, results in a small flammable gas cloud footprint near the ground level. This is illustrated in Figure 8 with a side view plot of the flammable vapor cloud from a full bore release.

Figure 8: Side View of Flammable Cloud from Full Bore Adelphia Pipeline Release



The two key implications of the nearly vertical flammable vapor cloud from a natural gas release from a buried pipeline are:

1. A flash fire impact would be negligible since near the ground level only the immediate vicinity of the release (just a few square meters) is within the flash fire envelope.
2. A vapor cloud explosion is very unlikely because, with natural gas, the confinement or congestion needed within the cloud (See Section 6.5) is unlikely to be present immediately above the transmission pipeline.

For these reasons, the Adelphia pipeline risk assessment only considers jet fire thermal radiation consequences and excludes the minimal contributions of flash fire thermal radiation and vapor cloud explosion overpressure consequences to the pipeline risk estimations.

For the full bore release event the following consequence outputs are contained in Appendix B:

- Release (i.e., discharge rate versus time)
- Jet fire thermal radiation footprint
- Side view of the flammable cloud dispersion

For the 50 mm release event the following consequence outputs are contained in Appendix B:

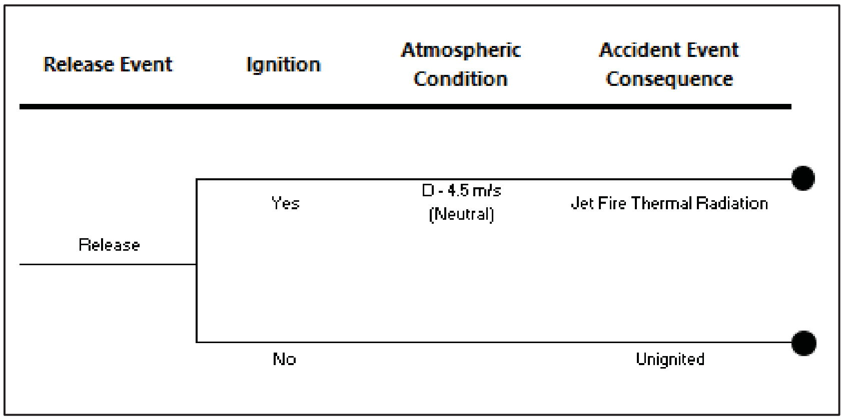
- Jet fire thermal radiation footprint
- Side view of the flammable cloud dispersion

The approach for this risk assessment is to assume that if the release ignites, it is ignited immediately, and the initial discharge rate is used for thermal radiation consequence. This ruleset is a conservative simplification. In reality, the ignition could be delayed. If delayed, then the discharge rate will have reduced and the jet fire thermal radiation consequence will be smaller. The greater the ignition delay, the greater the discharge is reduced and the smaller the consequence.

The Purple Book references for “immediate” ignition probability do not provide criteria of what time frame constitutes “immediate” ignition. However, it could be interpreted to be as quickly as only a few seconds, if not instantaneous. This could leave “non-immediate” ignition thermal radiation consequence similar in magnitude to “immediate” ignition thermal radiation consequence. This justifies simply using the initial discharge rate for jet fire thermal consequence without applying an immediate ignition conditional probability.

The consequence rulesets described above are illustrated in the event tree shown in Figure 9. The release event frequency and probabilities used for each event tree branch in the risk summation is described in Section 8.2.

Figure 9: Adelphia Pipeline Risk Assessment Event Tree



8.2 Accident Event Frequencies

The following subsections detail the release frequencies and conditional probabilities used in the Adelphia pipeline risk assessment. Note that all values are taken directly from, or utilize common, published risk assessment references, including the Purple Book. The purpose of the Purple Book is to provide common starting points to facilitate obtaining verifiable, reproducible, and comparable quantitative risk assessment results [9].

8.2.1 Release Frequencies

An Adelphia pipeline full bore release frequency was derived from the following available data sets:

1. PHMSA incident report statistics from natural gas transmission pipelines for the period from 2007 through mid-2018 [16].
2. PHMSA natural gas transmission pipeline mileage statistics [17].

The PHMSA incident and mileage data were refined, or filtered, to include the following relevant information:

- Natural gas full bore release incidents
- Pipelines of diameters greater than 10-inches but less than 28-inches to represent the 18-inch diameter Adelphia pipeline
- Below-ground natural gas transmission pipeline mileage

The filtering resulted in the following relevant historical data:

- 128 full bore release incidents
- 2,214,615 mile-years of natural gas pipeline (10-inch to 28-inch diameter range)

Based on this data, a natural gas pipeline full bore release frequency is 5.8E-05 incidents per mile-years (3.6E-05 incidents per km-years) was calculated.

The full bore release frequency value derived from PHMSA data compares reasonably well to that given in the Purple Book [9] for a generic pipeline located in a dedicated route (note that the pipeline diameter is not specified in the Purple Book values). The Purple Book value of 7E-06 incidents per km-year for full bore rupture is 5 times lower than the value derived from the PHMSA data. The Purple Book value reflects pipelines located "in a dedicated route", whereas the PHMSA data is for all pipelines.

The Purple Book states that the release frequencies for pipelines located in a dedicated route are lower than other pipelines because of extra preventative measures [9]. Additionally, the PHMSA data includes all pipelines and so could be expected to be higher than pipelines located only in a dedicated route.

In determining an Adelphia pipeline 50 mm release frequency, the estimated Adelphia pipeline full bore release frequency was multiplied by a factor of 6 to result in a 50 mm release frequency of 3.5E-04 incidents per mile-years (2.2E-04 incidents per km-years). The multiplying factor of 6 is taken from OGP recommended distribution of non-full bore hole sizes and full bore hole sizes for onshore gas pipelines [18].

Details of the PHMSA natural gas incident and mileage data filtering and frequency calculation are provided in Appendix D.

8.2.2 Ignition Probability

OGP published ignition probability look-up correlations, which relate ignition probabilities to discharge rates for typical scenarios, were used in determining an overall (total) ignition probability given a release [19].

Specifically, Ignition Probability Correlation Number 3 was used as it is applicable for releases of flammable gases, vapor, or liquids significantly above their normal boiling point from onshore cross-country pipelines running through industrial or urban areas. This correlation is considered appropriate because the Adelphia pipeline is transporting natural gas and the pipeline route through Delaware County can be described as urban (many ignition sources as opposed to a rural area which would have sparse ignitions sources). The values published for Correlation Number 3 are shown in Table 9.

Table 9: OGP Published Ignition Probability Correlation #3 [19]

Discharge Rate (kg/s)	Ignition Probability
0.1	0.0010
0.2	0.0017
0.5	0.0033
1.0	0.0056
2.0	0.0095
5.0	0.0188
10	0.0316
20	0.0532
50	0.1057
100	0.1778
200	0.2991
500	0.5946
1000	1.0000
Ignition Probability Correlation #3: Flammable gases, vapor, or liquids significantly above their normal boiling point from onshore cross-country pipelines running through industrial or urban areas.	

Applying this correlation to the 18-inch Adelphia pipeline discharge rates, for the two (2) hole-sizes, results in the following ignition probabilities:

- 50 mm release @ 8.8 kg/s (nominally 10 kg/s), ignition probability = 0.0316
- Full bore release @ 434 kg/s (average of first 20 seconds, nominally 500 kg/s), ignition probability = 0.5946

8.3 Individual Risk Results

The Adelphia pipeline accident event frequencies (Section 8.2), accident event consequences Section 8.1), and defined accident event impacts (Section 6.5) are combined to produce outdoor and indoor individual risk results. The individual risk results are then plotted on a grid to produce transects showing individual risk levels as a function of distance from the pipeline route. Separate risk transects for outdoor and indoor locations are provided, since different impact rulesets are used for the two location types (Section 6.5).

Note that the individual risk transects reflect an individual's continuous presence (i.e., 24-hours per day, 7-days per week) at a select location. This assumption is consistent with common quantitative risk assessment methodology; the continuous presence at a select location reflects a most exposed individual and, therefore, represents a maximum individual risk level.

The outdoor and indoor individual risk transects are shown in Figure 10 and Figure 11. Note that distance from the pipeline is expressed in meters.

Figure 10: 18-inch Adelphia Pipeline, Outdoor Individual Risk Transect

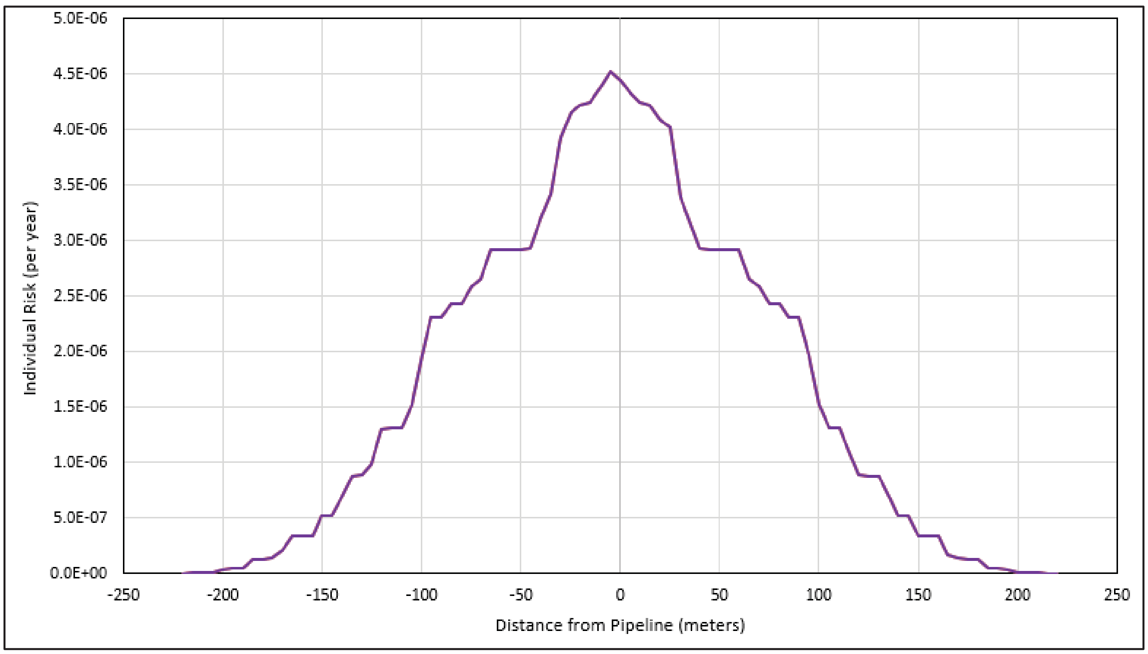
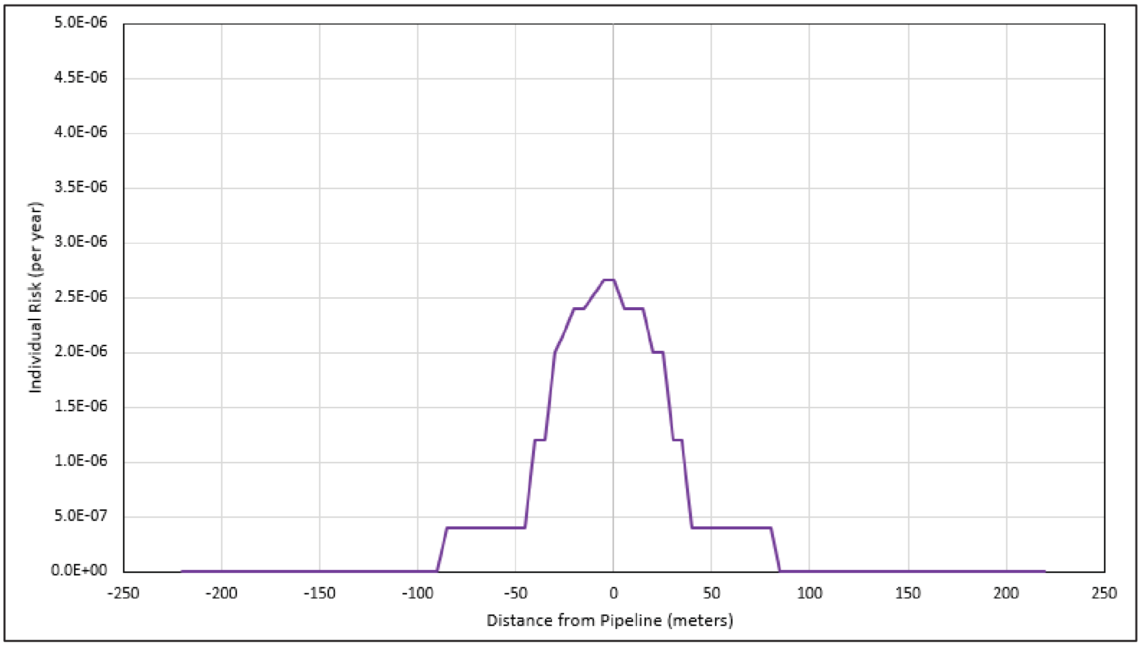


Figure 11: 18-inch Adelphia Pipeline, Indoor Individual Risk



9.0 COMMON INDIVIDUAL RISK SOURCES

Table 10 provides a list of common risk sources and corresponding published individual risk levels derived from United States fatality statistics [20]. The one-year odds of dying, as a result of a select cause, is the total population of the United States divided by the number of deaths in one year that occurred in the United States, in relation to a select cause. The individual risk level equates to the inverse of the one-year odds.

Note that the values in Table 10 are shown in the order of decreasing risk level (i.e., highest risk to lowest) and range from approximately 1.2E-04 per year (motor vehicle accident fatalities) to 1.1E-07 per year (lightning fatalities).

Table 10: Odds of Death in the United States by Selected Cause, 2016

Cause of Death [20]	Number of Deaths (2016) [20]	One-Year Odds[1] [20]	Individual Risk (per year)[2]
Motor vehicle accident	40,327	8,013	1.2E-04
Assault by firearm	14,415	22,416	4.5E-05
Exposure to smoke, fire, flames	2,730	118,362	8.4E-06
Falls from stairs or steps	2,344	137,853	7.3E-06
Swimming pool	780	414,266	2.4E-06
Firearm accident	300	1,077,092	9.3E-07
Hurricane, tornado, blizzard, storm	66	4,895,871	2.0E-07
Lightning	36	8,975,764	1.1E-07

[1] Values are based on total U.S. population and not on a number of activity participants.

[2] Calculated based on one-year odds and rounded to the nearest decimal.

Source Insurance Information Institute
https://www.iii.org/fact-statistic/facts-statistics-mortality-risk

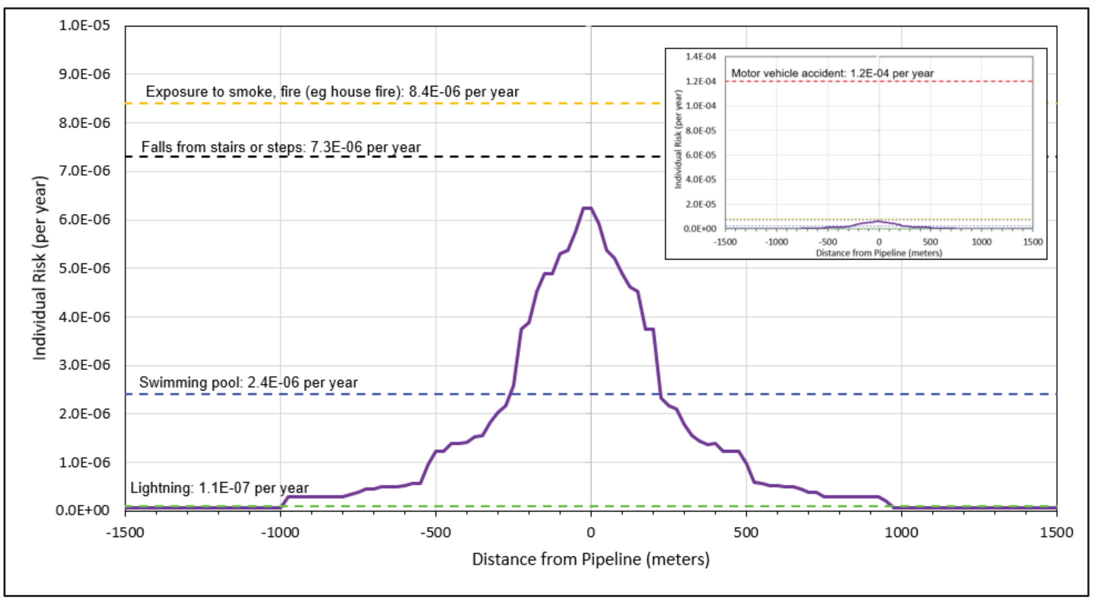
10.0 CONCLUSIONS

The final objective of these assessments was to present a comparison of the Mariner East 2 pipeline and Adelphia pipeline estimated individual risk levels against other individual risk levels from common sources. This is done in order to establish an improved perspective when interpreting the meaning of the individual fatality risks.

Figure 12 presents such comparisons using the resulting outdoor individual risk transect for the Mariner East 2 pipeline together with several common risk sources presented in Section 9.0.

Note that the plot contains an inset figure using a compressed risk axis to accommodate the 1.2E-04 per year motor vehicle accident individual risk value, which would otherwise be off the scale of the main plot (i.e., greater than 1.0E-05 per year).

Figure 12: Mariner East 2 Outdoor Individual Risk versus Common Risk Sources



The following are examples of how to interpret the above Mariner East 2 pipeline comparative plot:

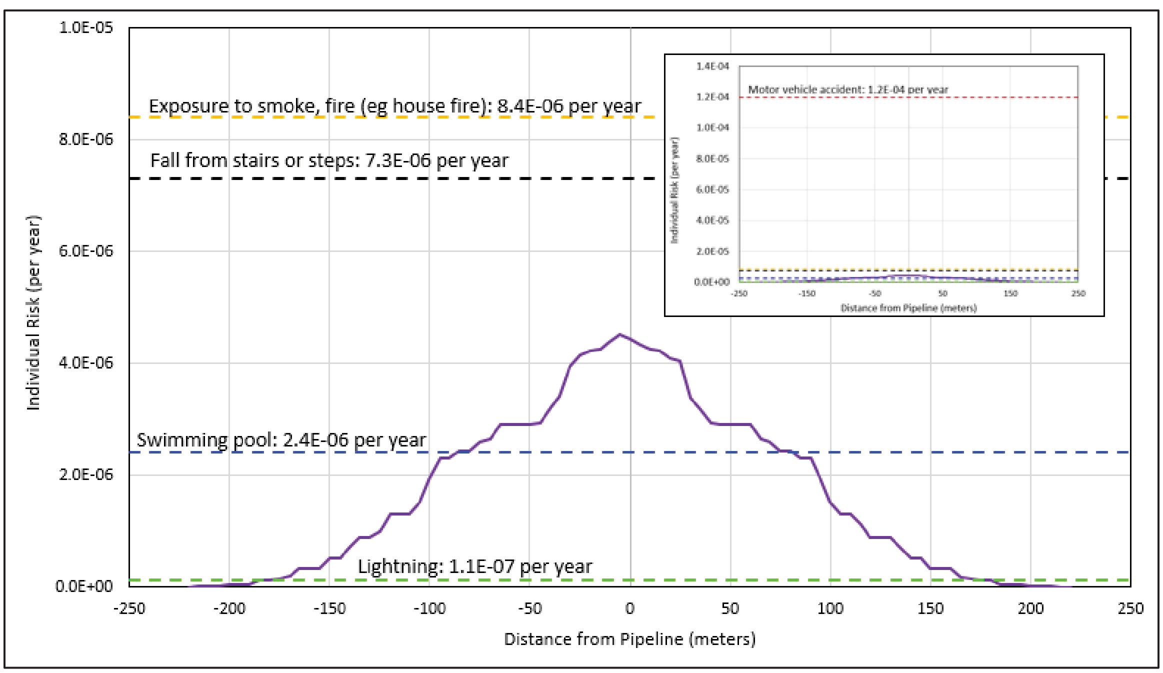
- The average person's annual exposure to a fatal traffic accident (1.2E-04 per year) is approximately 20 times greater than that of the annual individual risk level (6.2E-06 per year, or odds of 1 in 161,290) of a person present 24 hours per day, 7 days per week at a zero distance from the Mariner East 2 pipeline route (i.e., on the centerline).

- The average person's exposure to fatal house fires (8.4E-06 per year) is approximately 35% greater than that of the individual risk level (6.2E-06 per year, or odds of 1 in 161,290) of a person present 24 hours per day, 7 days per week at a zero distance from the Mariner East 2 pipeline route (i.e., on the centerline).
- The average person's exposure to a fatal fall from stairs (7.3E-06 per year) is approximately 20% greater than that of the individual risk level (6.2E-06 per year, or odds of 1 in 161,290) of a person present 24 hours per day, 7 days per week at a zero distance from the Mariner East 2 pipeline route (i.e., on the centerline).

Figure 13 presents such comparisons using the resulting outdoor individual risk transect for the Adelphia pipeline together with several common risk sources presented in Section 9.0.

Note that the plot contains an inset figure using a compressed risk axis to accommodate the 1.2E-04 per year motor vehicle accident individual risk value, which would otherwise be off the scale of the main plot (i.e., greater than 1.0E-05 per year).

Figure 13: Adelphia Outdoor Individual Risk versus Common Risk Sources



The following are examples of how to interpret the above Adelphia pipeline comparative plot:

- The average person's exposure to a fatal traffic accident (1.2E-04 per year) is approximately 27 times greater than that of the individual risk level (4.5E-06 per year, or odds of 1 in 222,222) of a person present 24 hours per day, 7 days per week at a zero distance from the Adelphia pipeline route (i.e., on the centerline).
- The average person's exposure to fatal house fires (8.4E-06 per year) is approximately 2 times greater than that of the individual risk level (4.5E-06 per year, or odds of 1 in 222,222) of a person present 24 hours per day, 7 days per week at a zero distance from the Adelphia pipeline route (i.e., on the centerline).
- The average person's exposure to a fatal fall from stairs (7.3E-06 per year) is approximately 60% greater than that of the individual risk level (4.5E-06 per year, or odds of 1 in 222,222) of a person present 24 hours per day, 7 days per week at a zero distance from the Adelphia pipeline route (i.e., on the centerline).

In conclusion, based on the figures above, it can be stated that the individual risk levels estimated for both the Mariner East 2 pipeline and the Adelphia pipeline fall within a range of other common risk sources.

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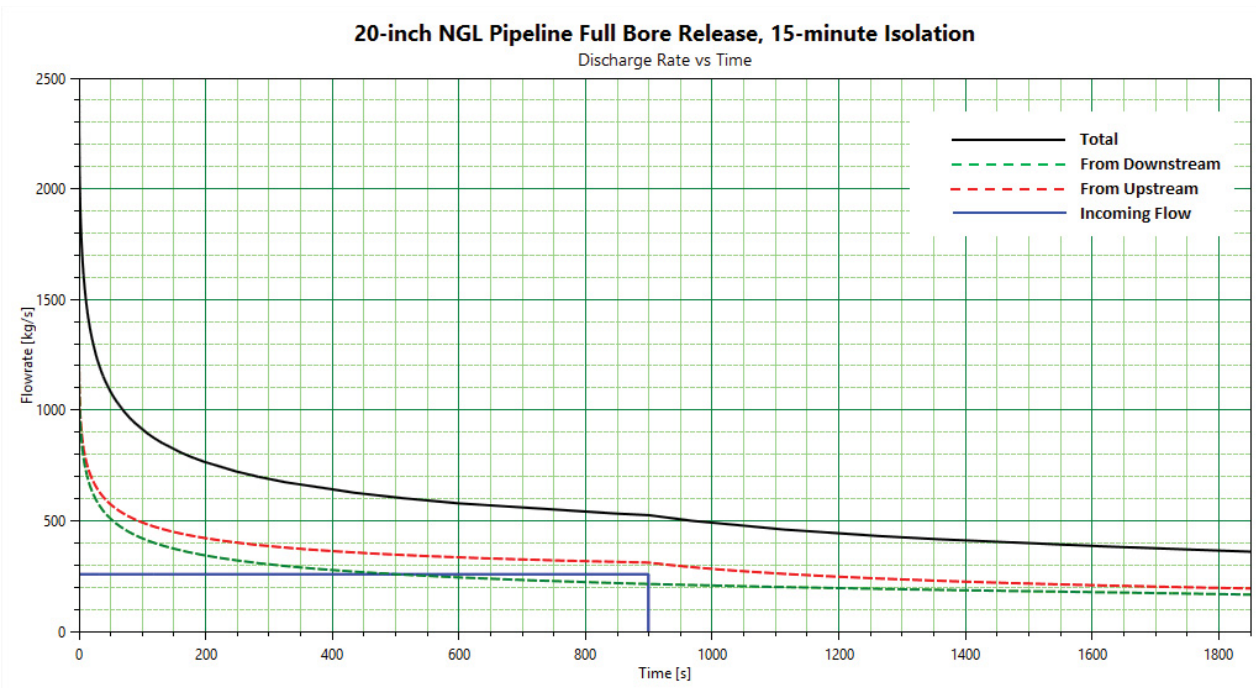
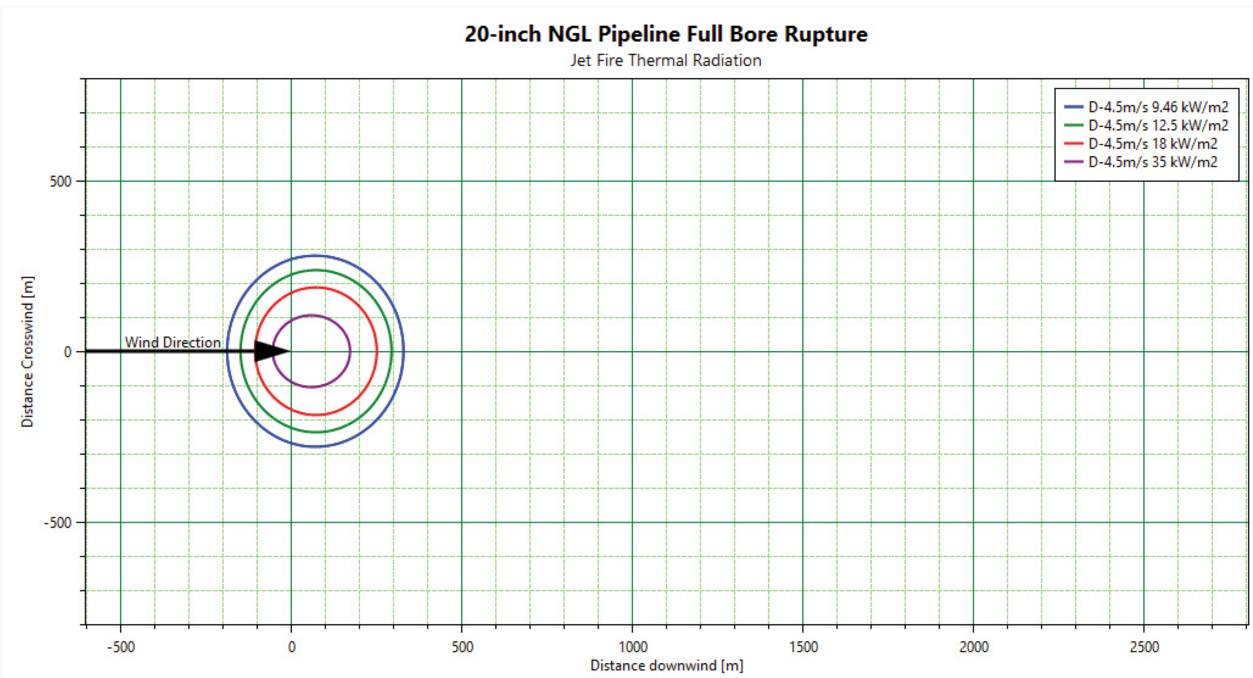
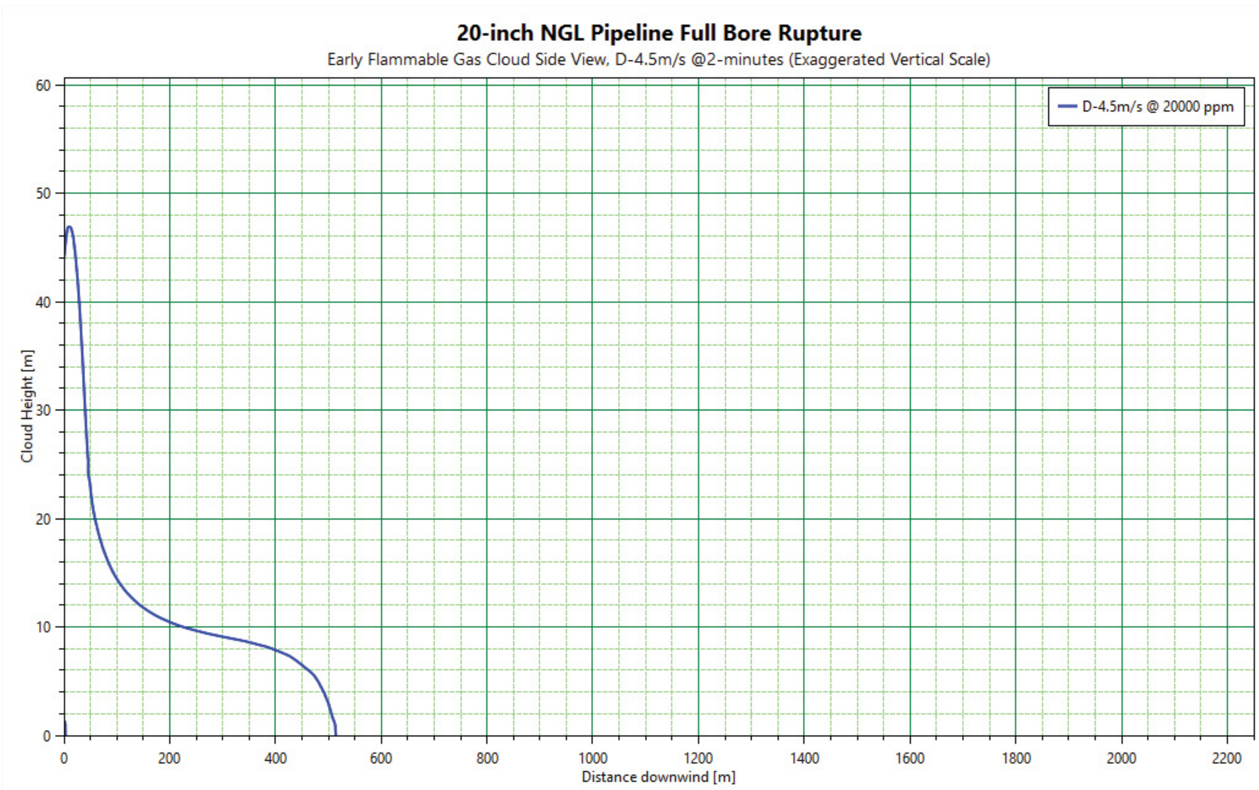
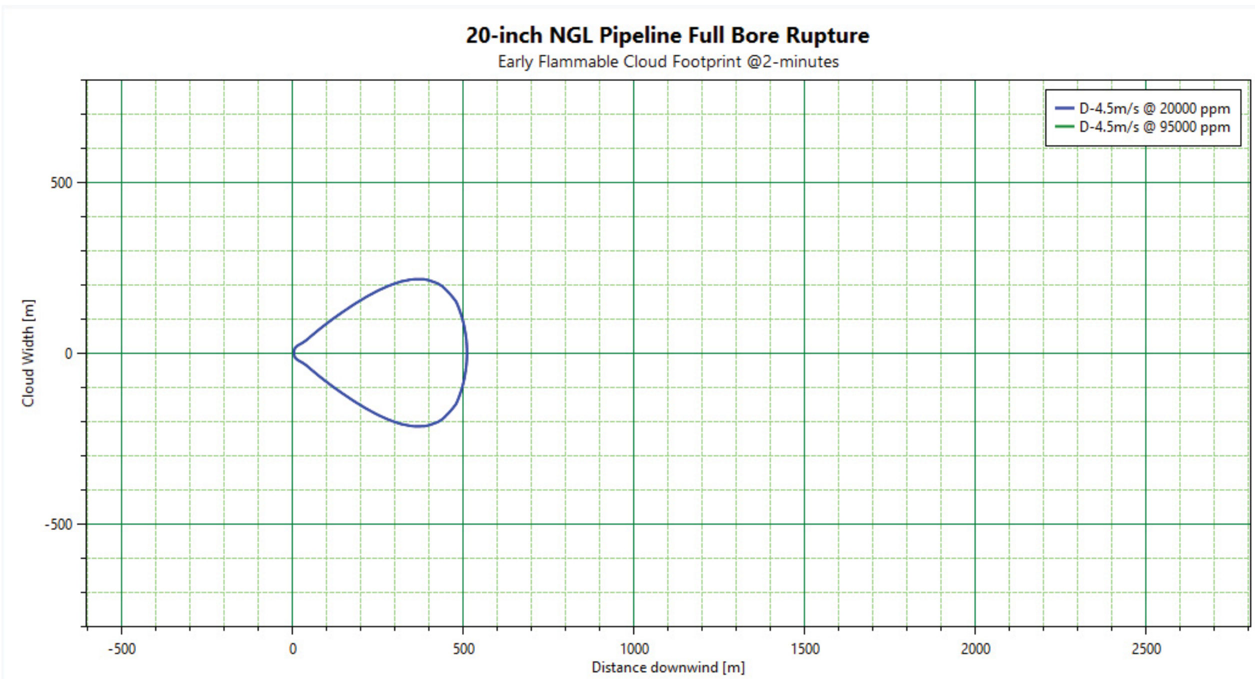
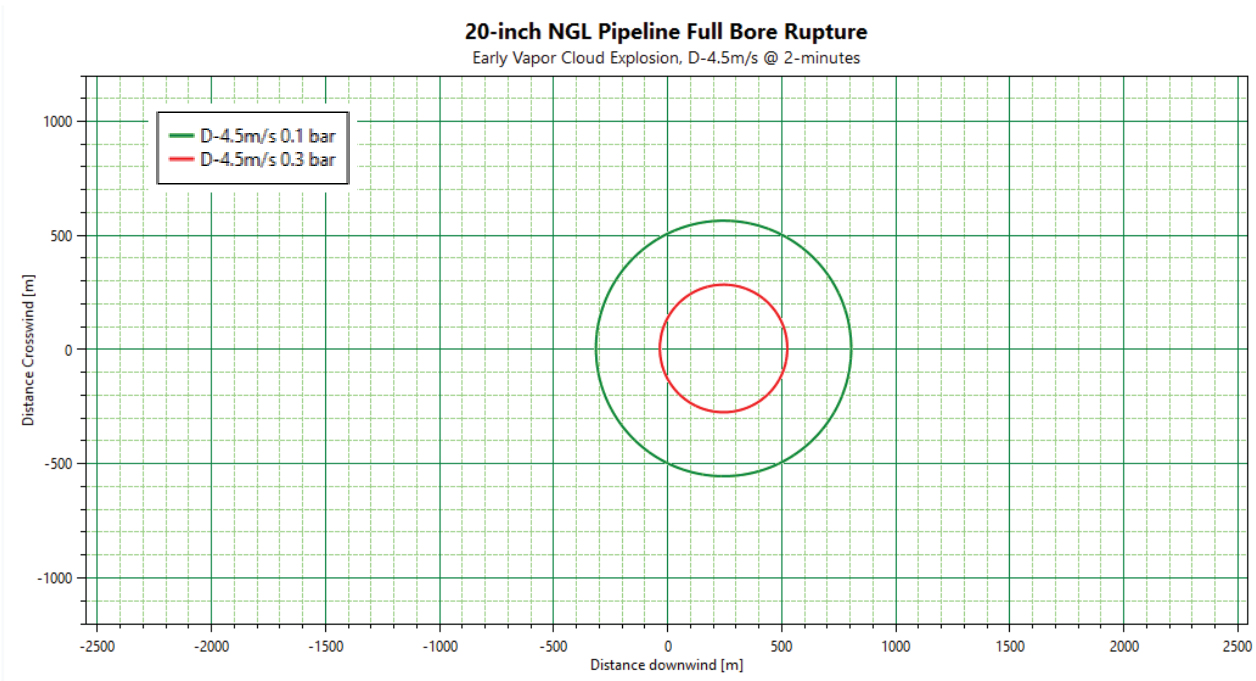
APPENDIX A: MARINER EAST 2 PIPELINE CONSEQUENCE PLOTS

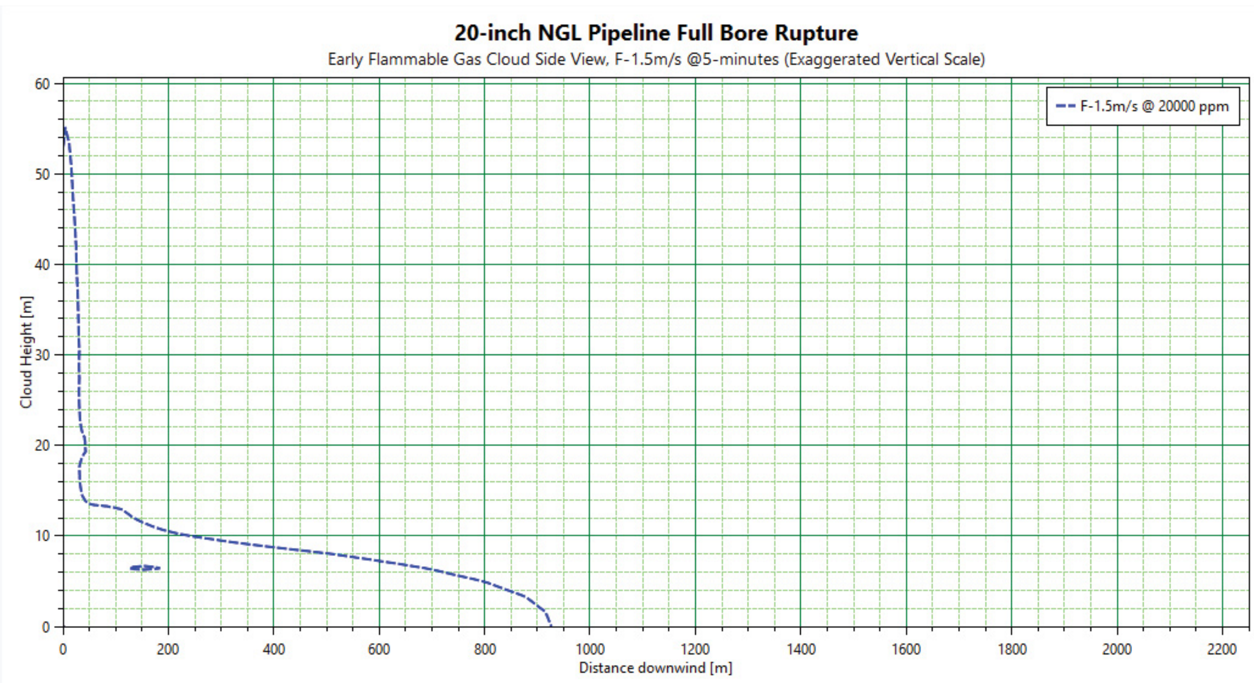

20-inch NGL Pipeline Full Bore Release, 15-minute Isolation
Discharge Rate vs Time
Total
From Downstream
From Upstream
Incoming Flow
Flowrate [kg/s]
Time [s]
0
500
1000
1500
2000
2500
200
400
600
800
1000
1200
1400
1600
1800

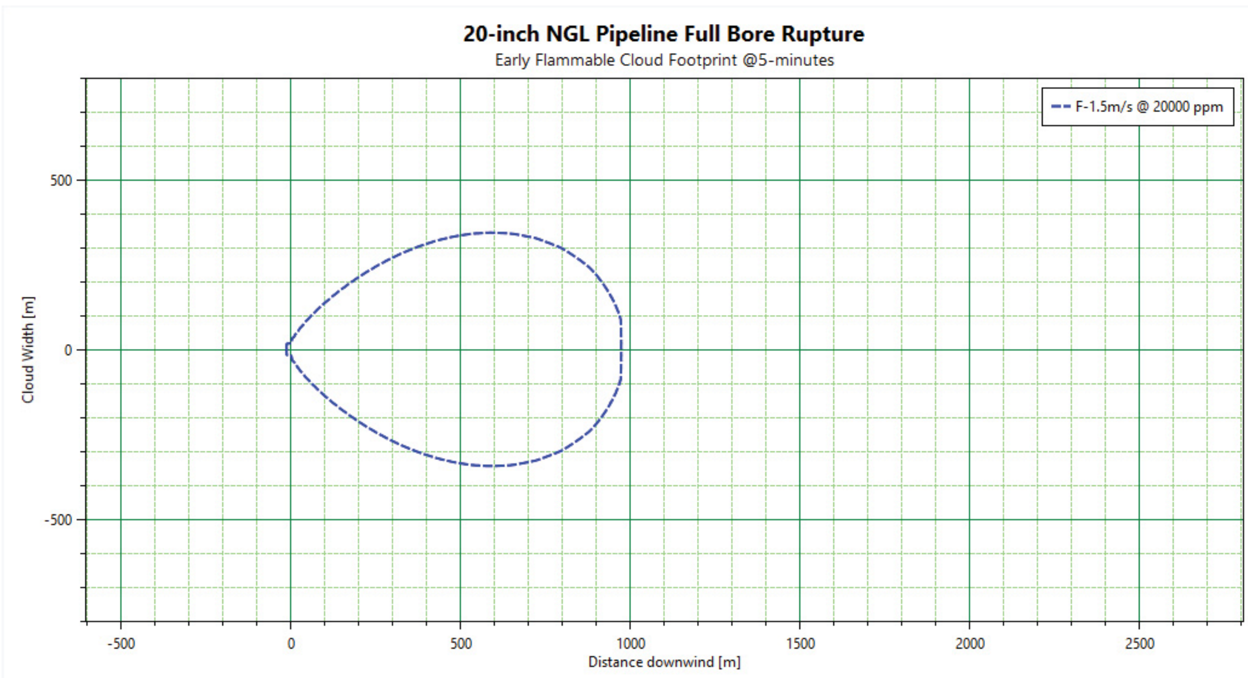

20-inch NGL Pipeline Full Bore Rupture
Jet Fire Thermal Radiation
D-4.5m/s 9.46 kW/m2
D-4.5m/s 12.5 kW/m2
D-4.5m/s 18 kW/m2
D-4.5m/s 35 kW/m2
Wind Direction
Distance Crosswind [m]
500
0
-500
-500
0
500
1000
1500
2000
2500
Distance downwind [m]

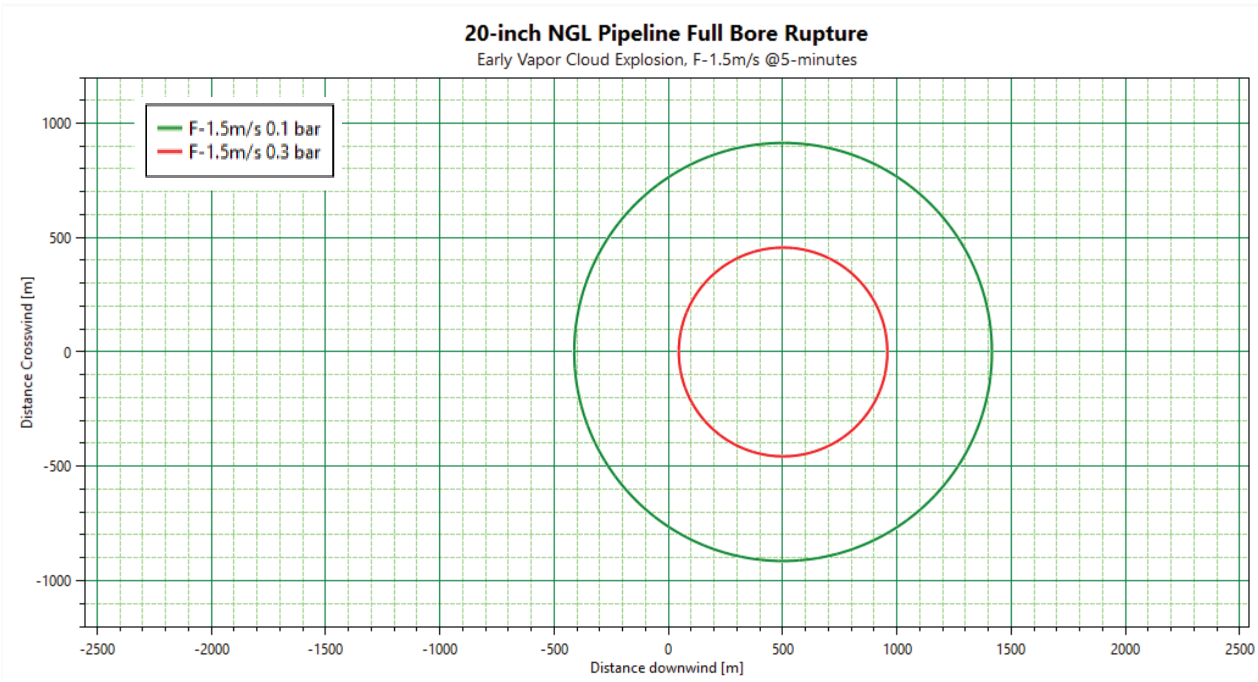

20-inch NGL Pipeline Full Bore Rupture
Early Flammable Gas Cloud Side View, D-4.5m/s @2-minutes (Exaggerated Vertical Scale)
D-4.5m/s @ 20000 ppm
Cloud Height [m]
Distance downwind [m]
0
10
20
30
40
50
60
200
400
600
800
1000
1200
1400
1600
1800
2000
2200

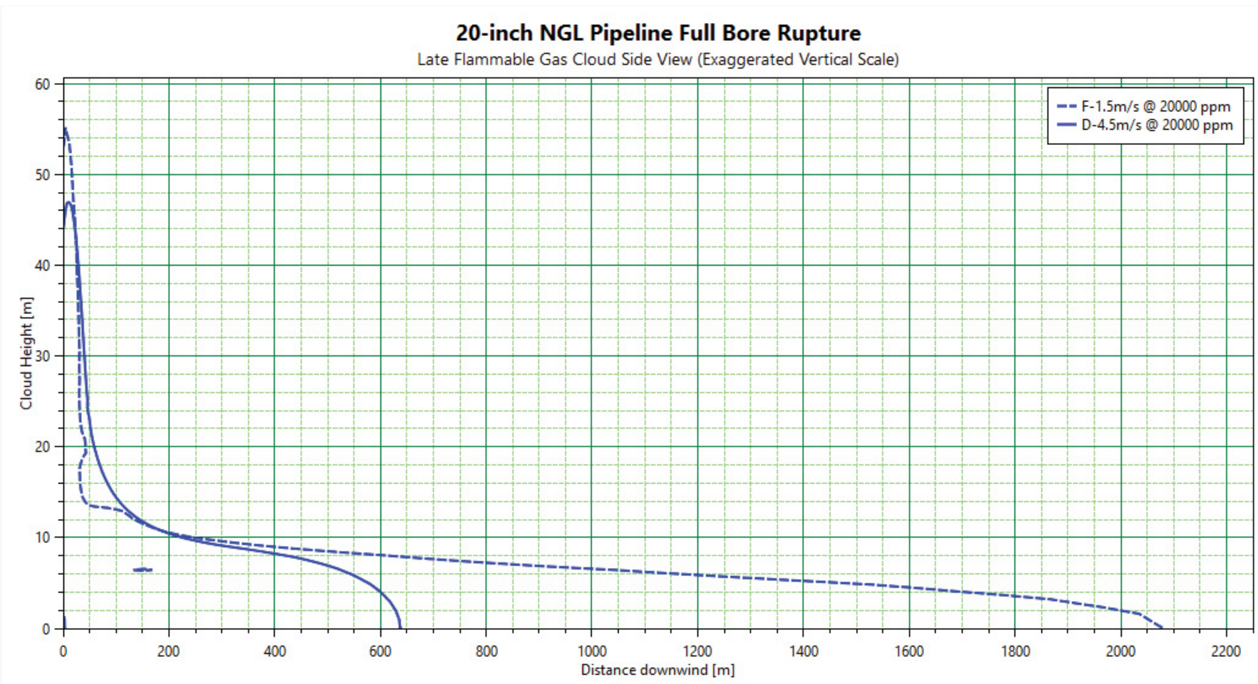

20-inch NGL Pipeline Full Bore Rupture
Early Flammable Cloud Footprint @2-minutes
D-4.5m/s @ 20000 ppm
D-4.5m/s @ 95000 ppm
500
0
-500
Cloud Width [m]
-500
0
500
1000
1500
2000
2500
Distance downwind [m]

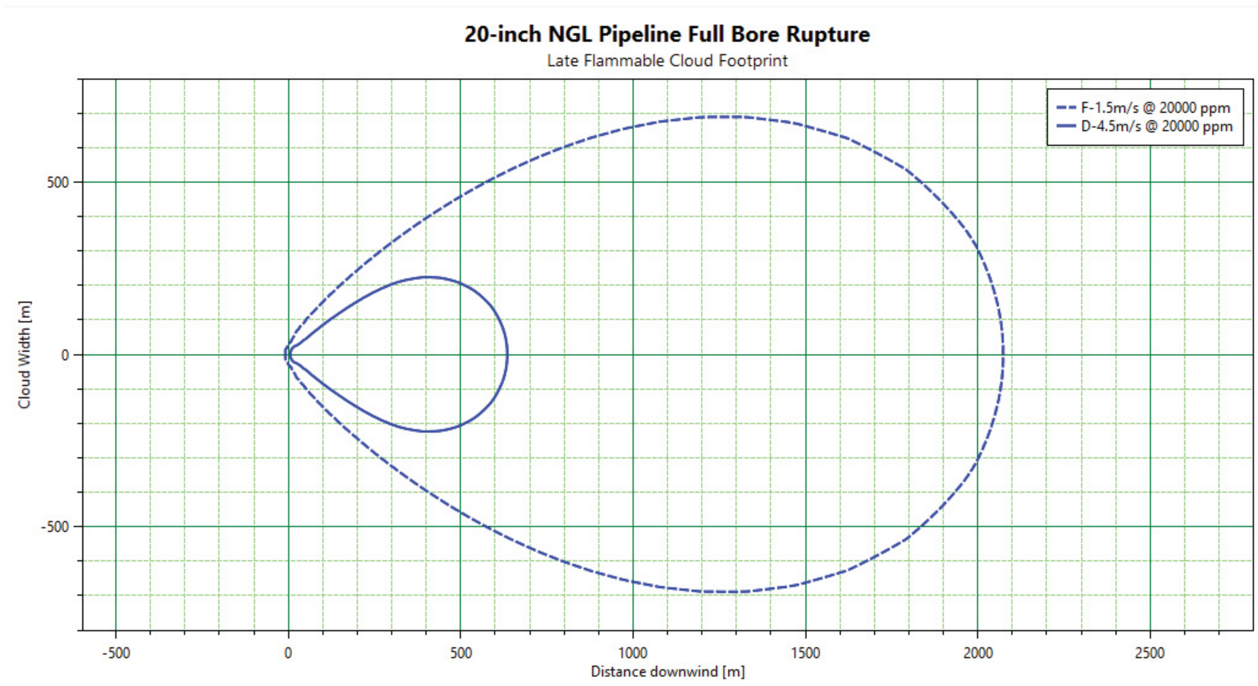

20-inch NGL Pipeline Full Bore Rupture
Early Vapor Cloud Explosion, D-4.5m/s @ 2-minutes
D-4.5m/s 0.1 bar
D-4.5m/s 0.3 bar
Distance Crosswind [m]
1000
500
0
-500
-1000
-2500
-2000
-1500
-1000
-500
0
500
1000
1500
2000
2500
Distance downwind [m]

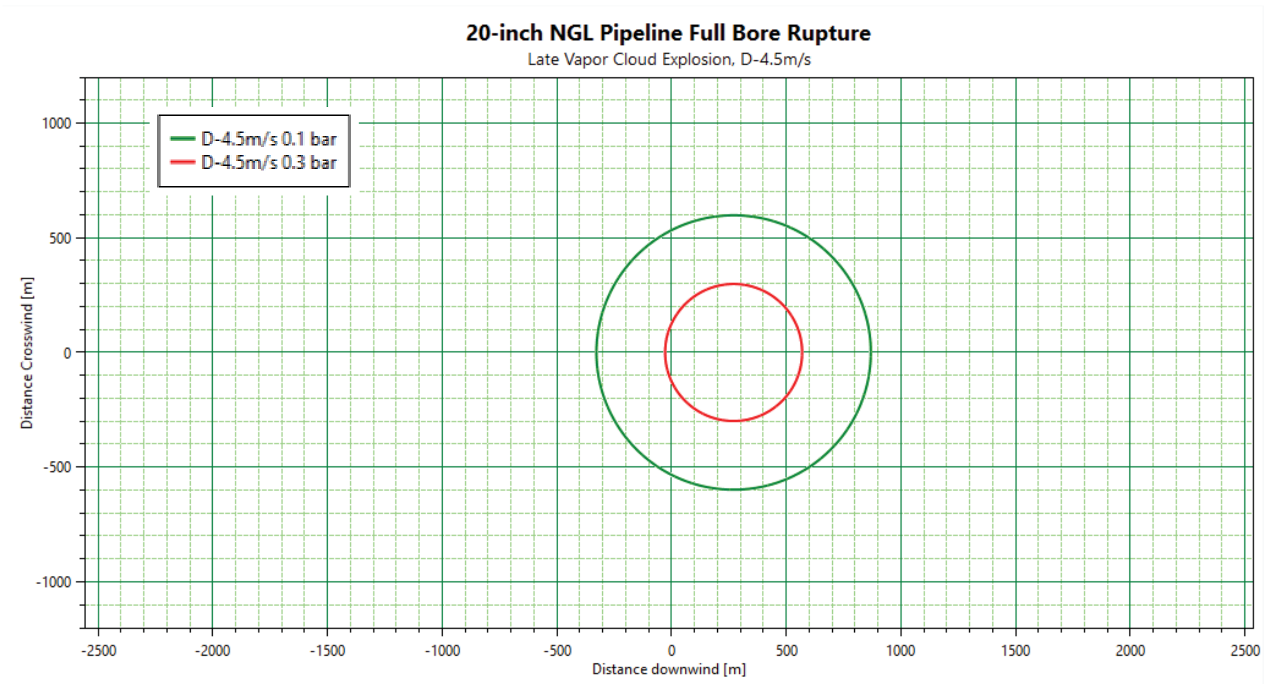

20-inch NGL Pipeline Full Bore Rupture
Early Flammable Gas Cloud Side View, F-1.5m/s @5-minutes (Exaggerated Vertical Scale)
F-1.5m/s @ 20000 ppm
Cloud Height [m]
Distance downwind [m]
0
10
20
30
40
50
60
200
400
600
800
1000
1200
1400
1600
1800
2000
2200

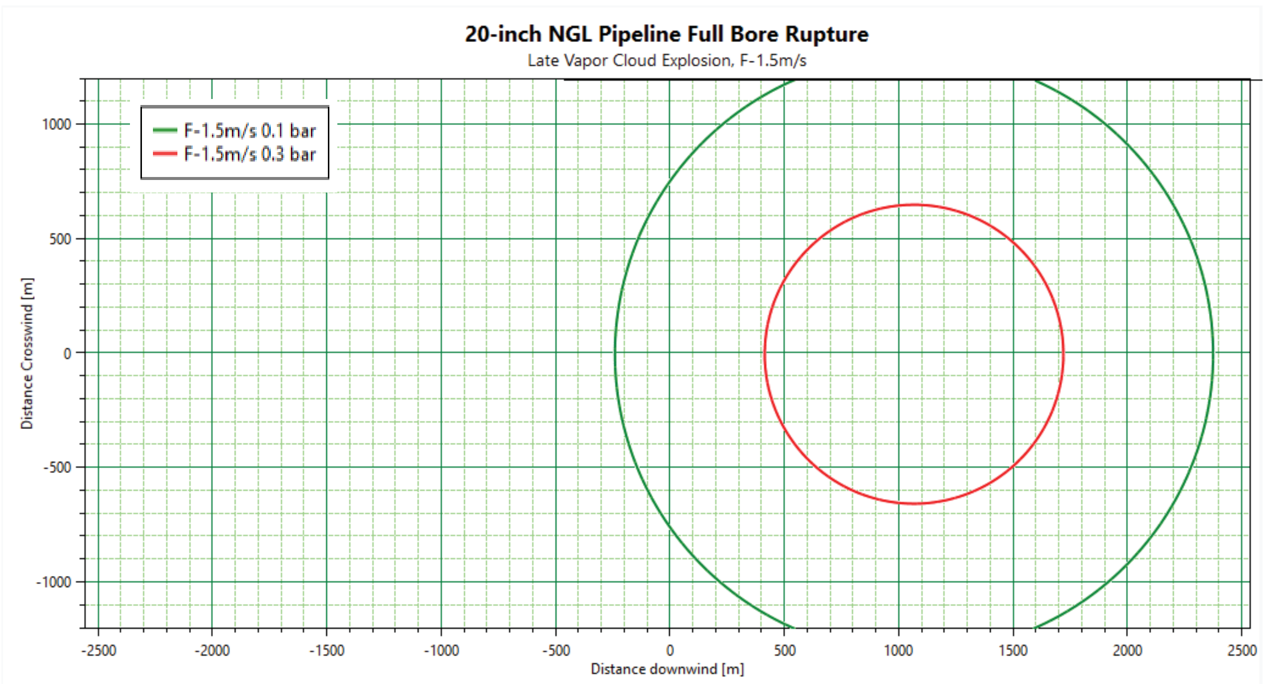

20-inch NGL Pipeline Full Bore Rupture
Early Flammable Cloud Footprint @5-minutes
F-1.5m/s @ 20000 ppm
Cloud Width [m]
500
0
-500
-500
0
500
1000
1500
2000
2500
Distance downwind [m]

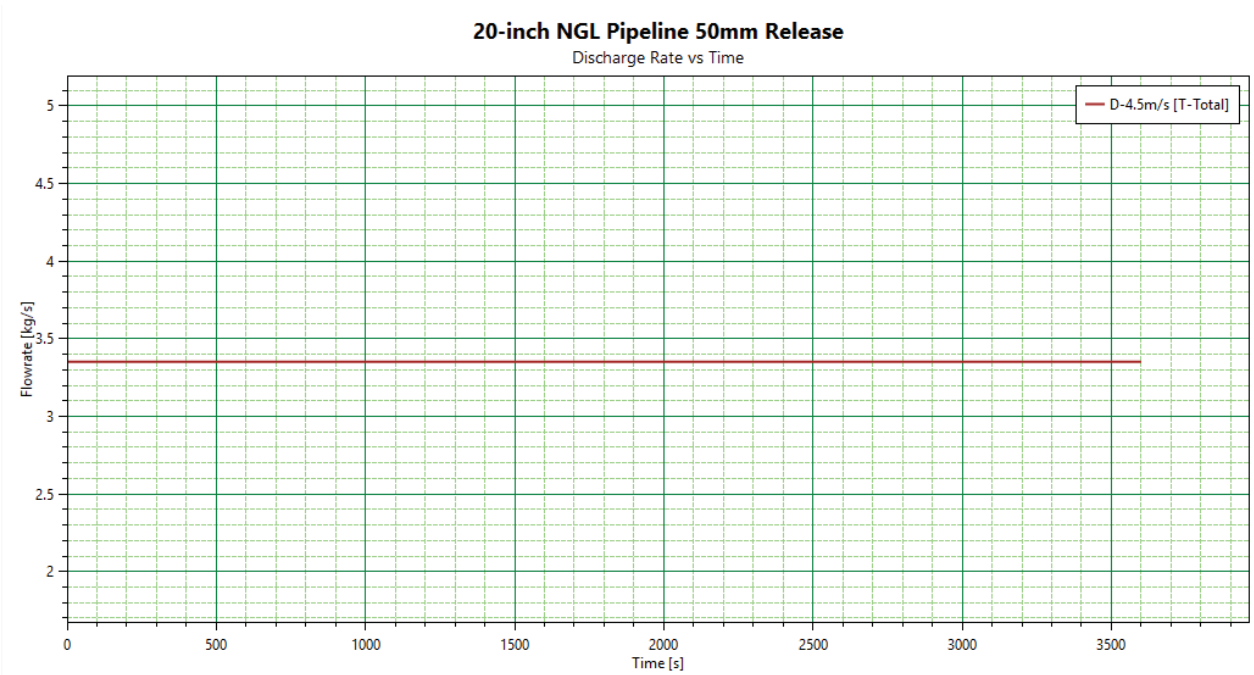

20-inch NGL Pipeline Full Bore Rupture
Early Vapor Cloud Explosion, F-1.5m/s @5-minutes
F-1.5m/s 0.1 bar
F-1.5m/s 0.3 bar
Distance Crosswind [m]
Distance downwind [m]
1000
500
0
-500
-1000
-2500
-2000
-1500
-1000
-500
0
500
1000
1500
2000
2500

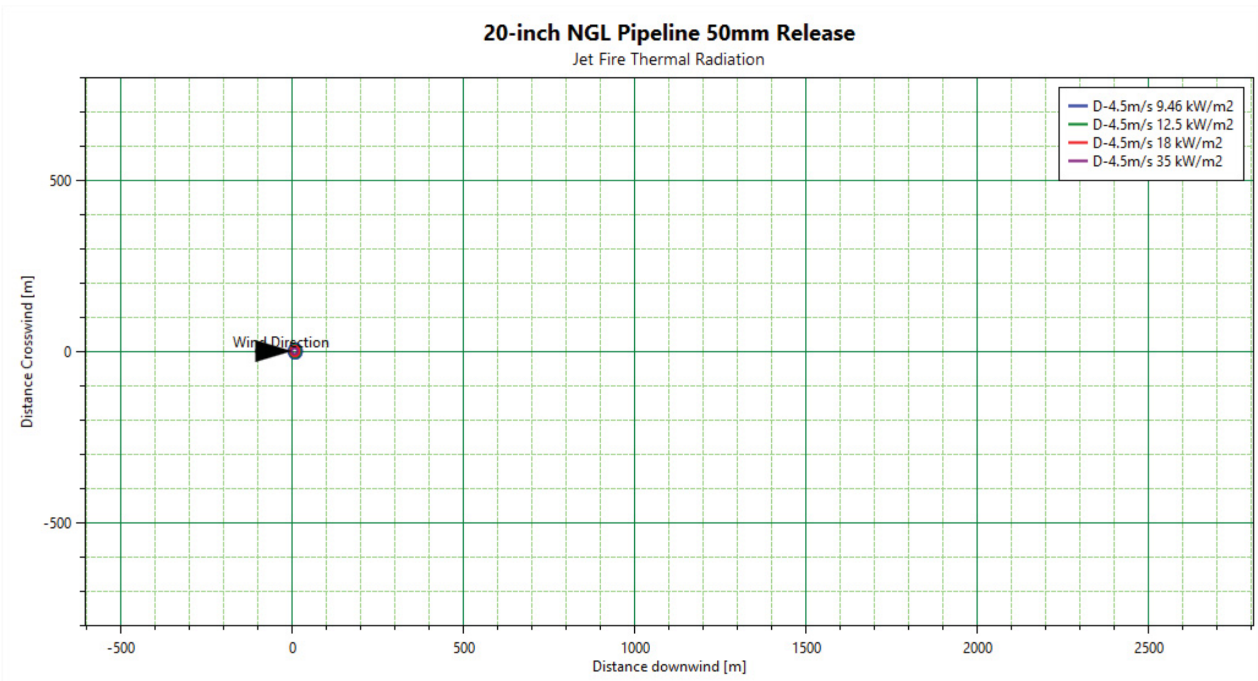

20-inch NGL Pipeline Full Bore Rupture
Late Flammable Gas Cloud Side View (Exaggerated Vertical Scale)
F-1.5m/s @ 20000 ppm
D-4.5m/s @ 20000 ppm
Cloud Height [m]
Distance downwind [m]
0
10
20
30
40
50
60
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200

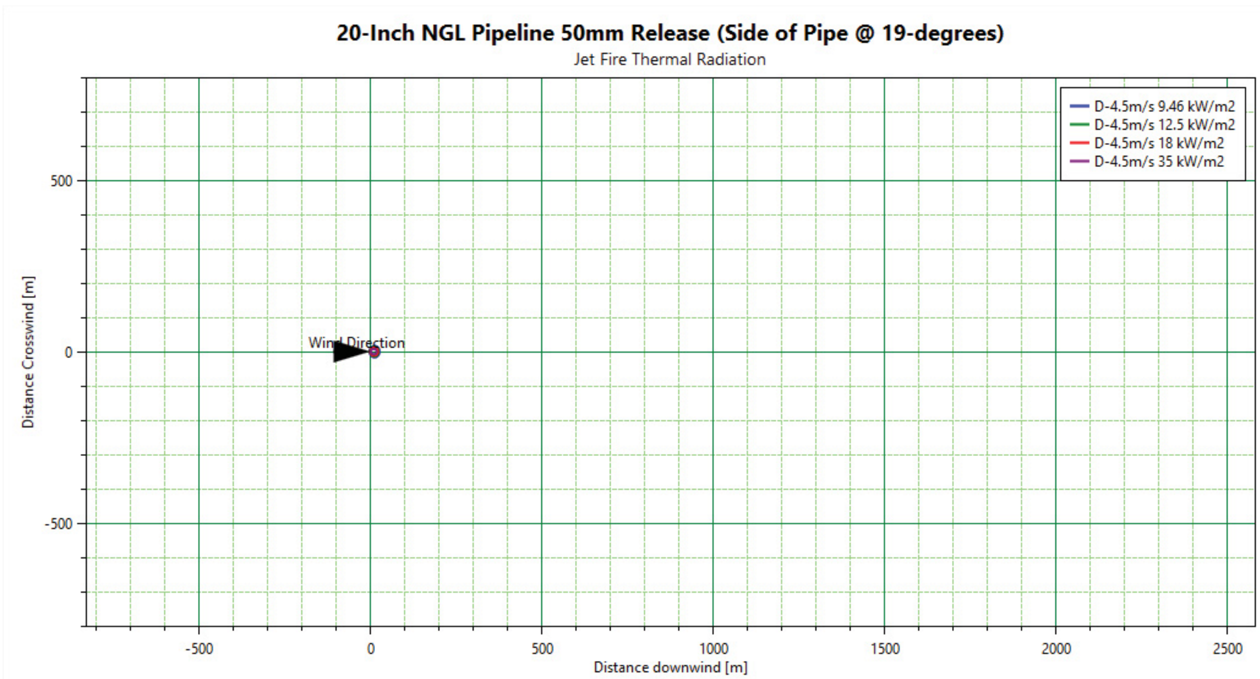

20-inch NGL Pipeline Full Bore Rupture
Late Flammable Cloud Footprint
F-1.5m/s @ 20000 ppm
D-4.5m/s @ 20000 ppm
Cloud Width [m]
500
0
-500
-500
0
500
1000
1500
2000
2500
Distance downwind [m]

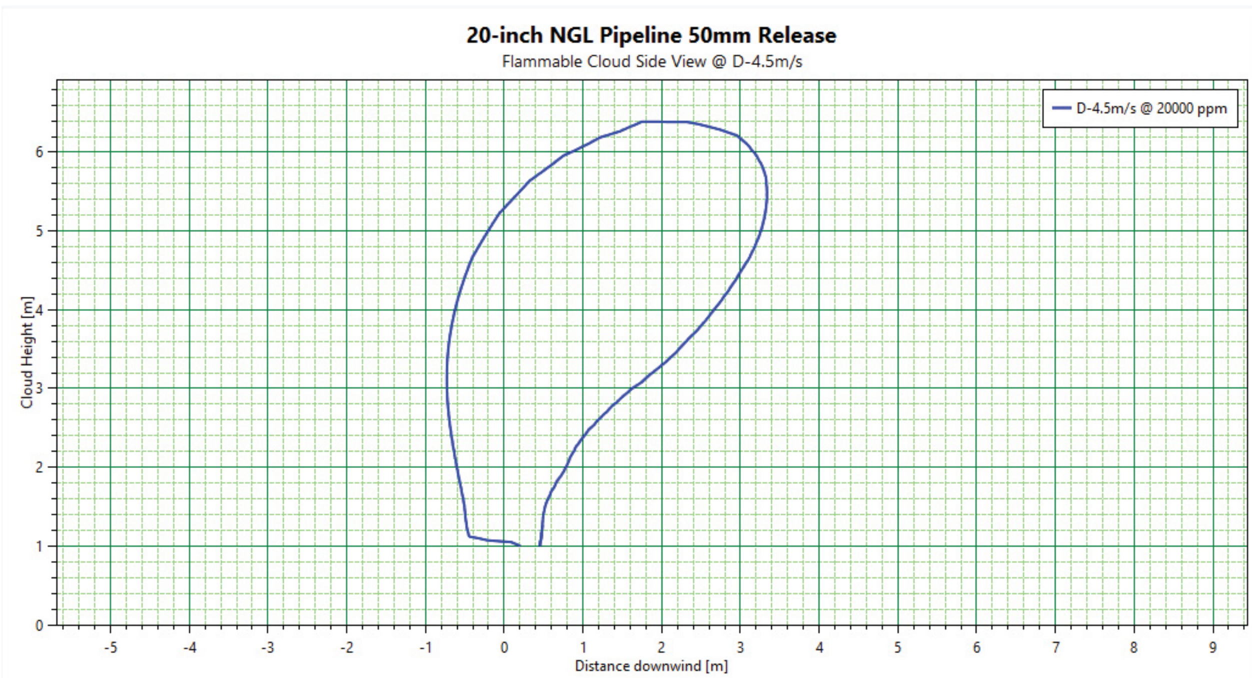

20-inch NGL Pipeline Full Bore Rupture
Late Vapor Cloud Explosion, D-4.5m/s
D-4.5m/s 0.1 bar
D-4.5m/s 0.3 bar
Distance Crosswind [m]
Distance downwind [m]
1000
500
0
-500
-1000
-2500
-2000
-1500
-1000
-500
0
500
1000
1500
2000
2500

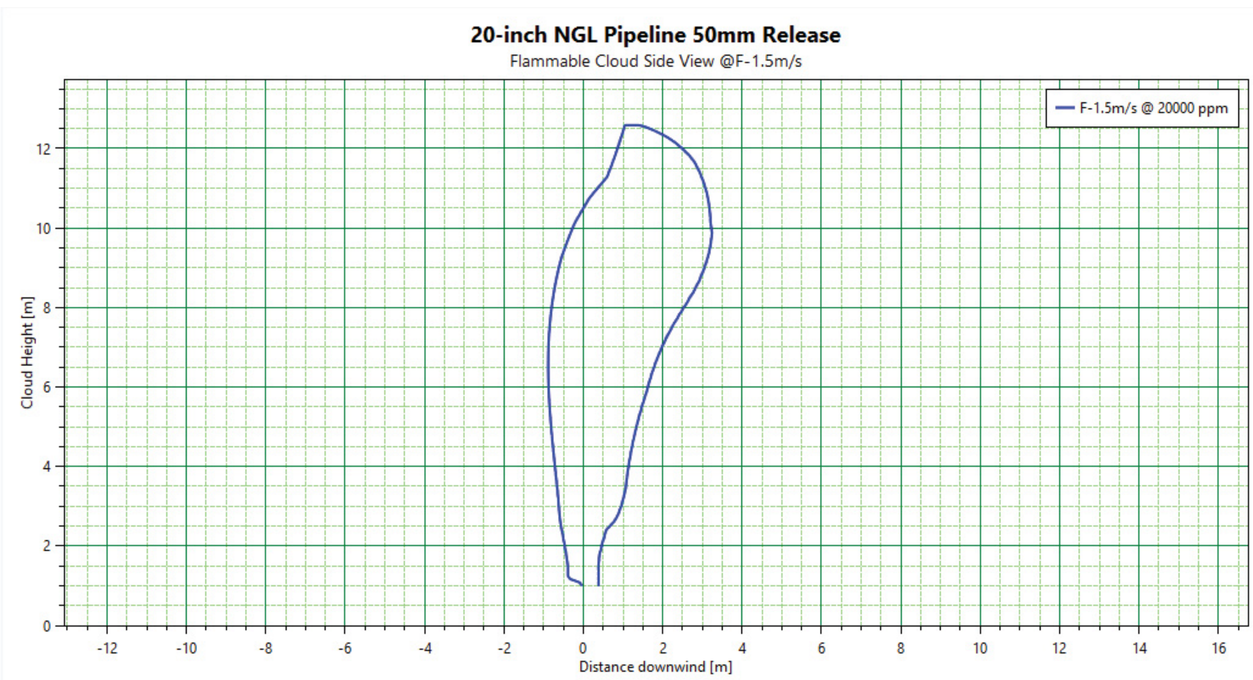

20-inch NGL Pipeline Full Bore Rupture
Late Vapor Cloud Explosion, F-1.5m/s
F-1.5m/s 0.1 bar
F-1.5m/s 0.3 bar
Distance Crosswind [m]
1000
500
0
-500
-1000
-2500
-2000
-1500
-1000
-500
0
500
1000
1500
2000
2500
Distance downwind [m]

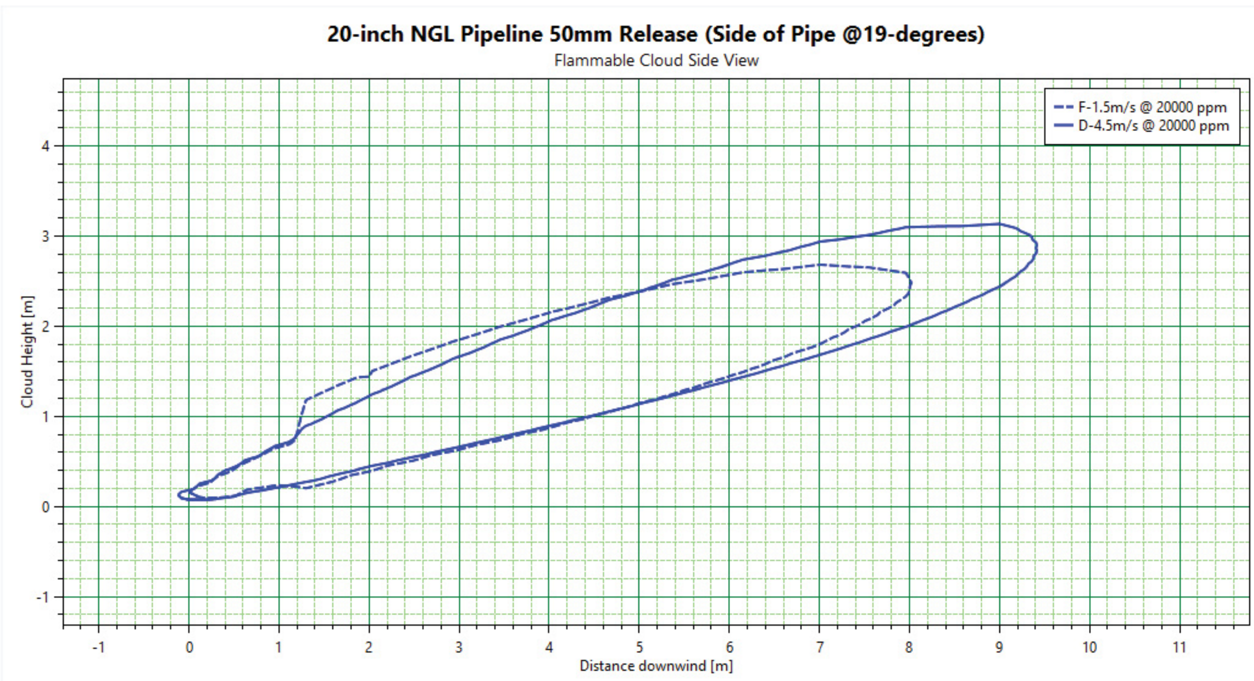

20-inch NGL Pipeline 50mm Release
Discharge Rate vs Time
D-4.5m/s [T-Total]
Flowrate [kg/s]
Time [s]
5
4.5
4
3.5
3
2.5
2
0
500
1000
1500
2000
2500
3000
3500


20-inch NGL Pipeline 50mm Release
Jet Fire Thermal Radiation
D-4.5m/s 9.46 kW/m2
D-4.5m/s 12.5 kW/m2
D-4.5m/s 18 kW/m2
D-4.5m/s 35 kW/m2
Wind Direction
Distance Crosswind [m]
500
0
-500
-500
0
500
1000
1500
2000
2500
Distance downwind [m]

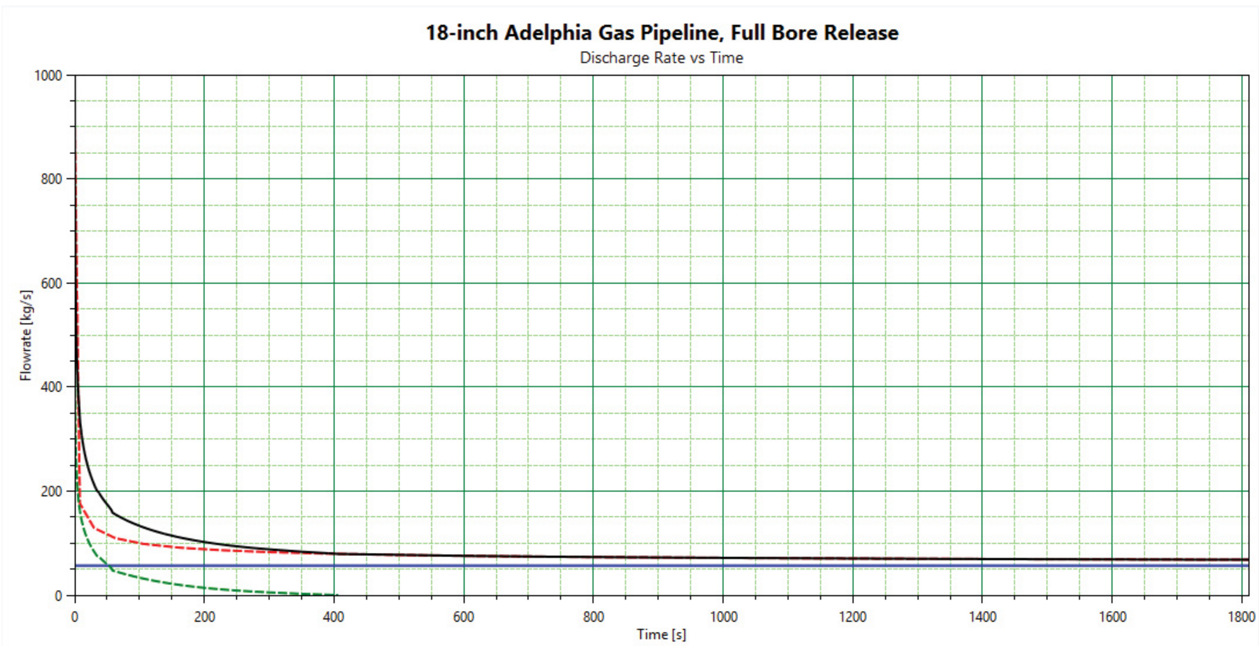

20-Inch NGL Pipeline 50mm Release (Side of Pipe @ 19-degrees)
Jet Fire Thermal Radiation
D-4.5m/s 9.46 kW/m2
D-4.5m/s 12.5 kW/m2
D-4.5m/s 18 kW/m2
D-4.5m/s 35 kW/m2
Wind Direction
Distance Crosswind [m]
Distance downwind [m]
500
0
-500
-500
0
500
1000
1500
2000
2500

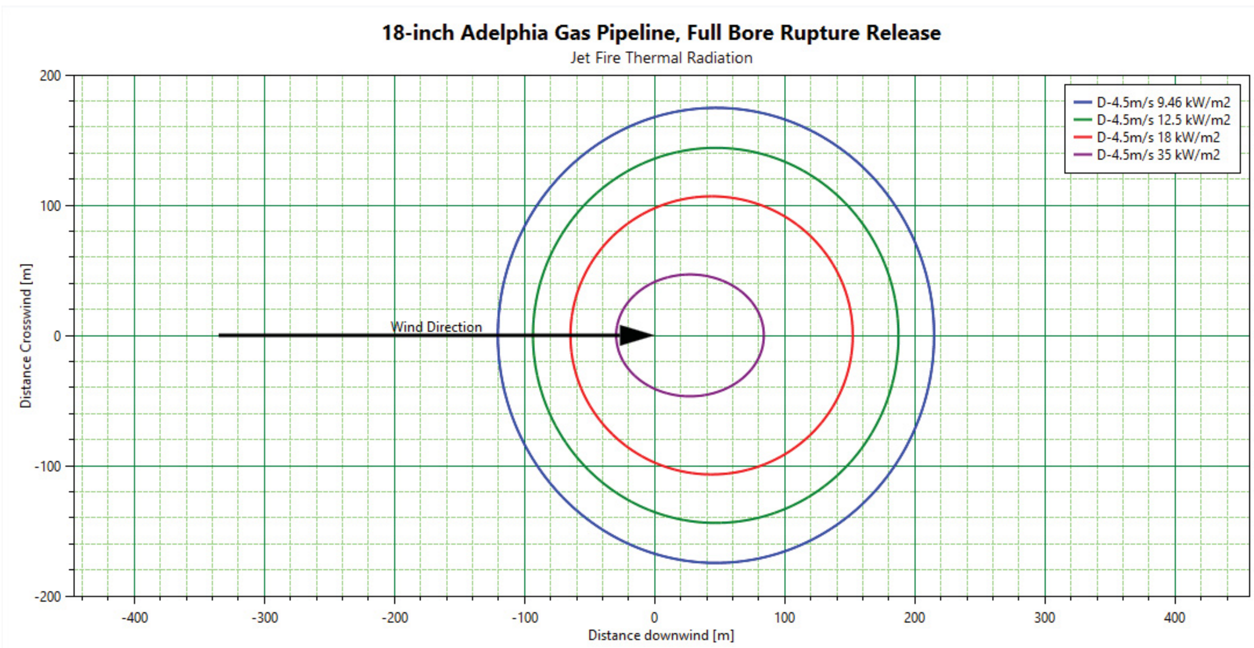

20-inch NGL Pipeline 50mm Release
Flammable Cloud Side View @ D-4.5m/s
D-4.5m/s @ 20000 ppm
Cloud Height [m]
Distance downwind [m]
0
1
2
3
4
5
6
-5
-4
-3
-2
-1
0
1
2
3
4
5
6
7
8
9

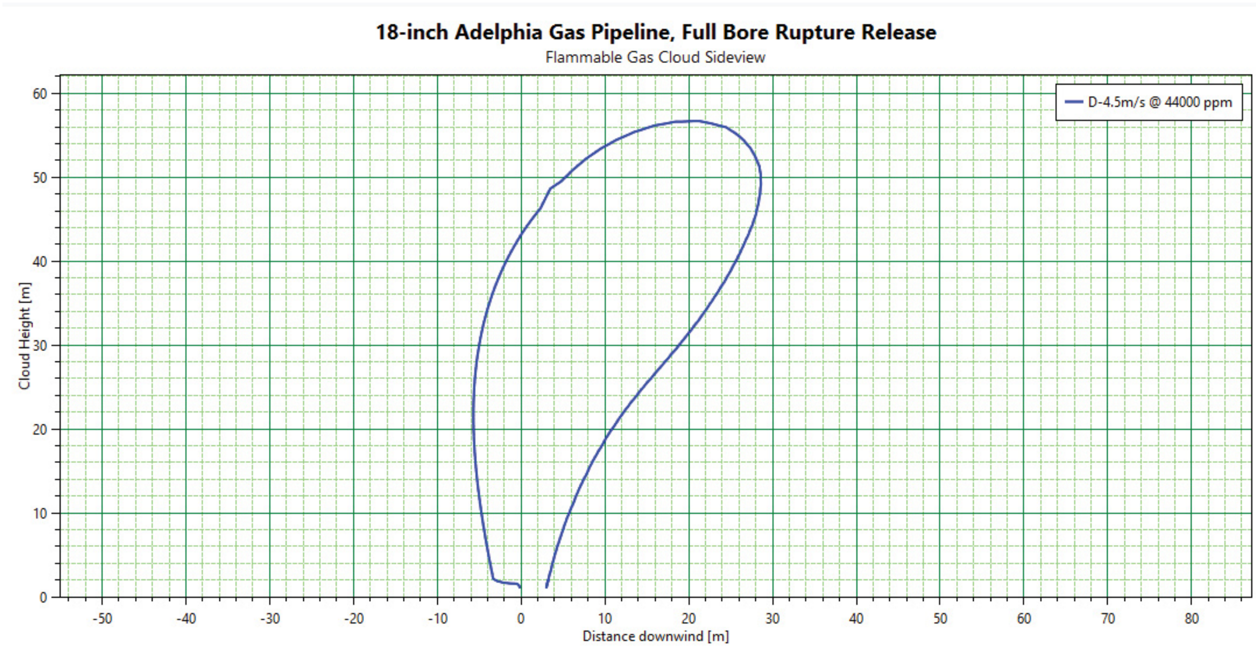

20-inch NGL Pipeline 50mm Release
Flammable Cloud Side View @F-1.5m/s
F-1.5m/s @ 20000 ppm
Cloud Height [m]
Distance downwind [m]
0
2
4
6
8
10
12
-12
-10
-8
-6
-4
-2
0
2
4
6
8
10
12
14
16

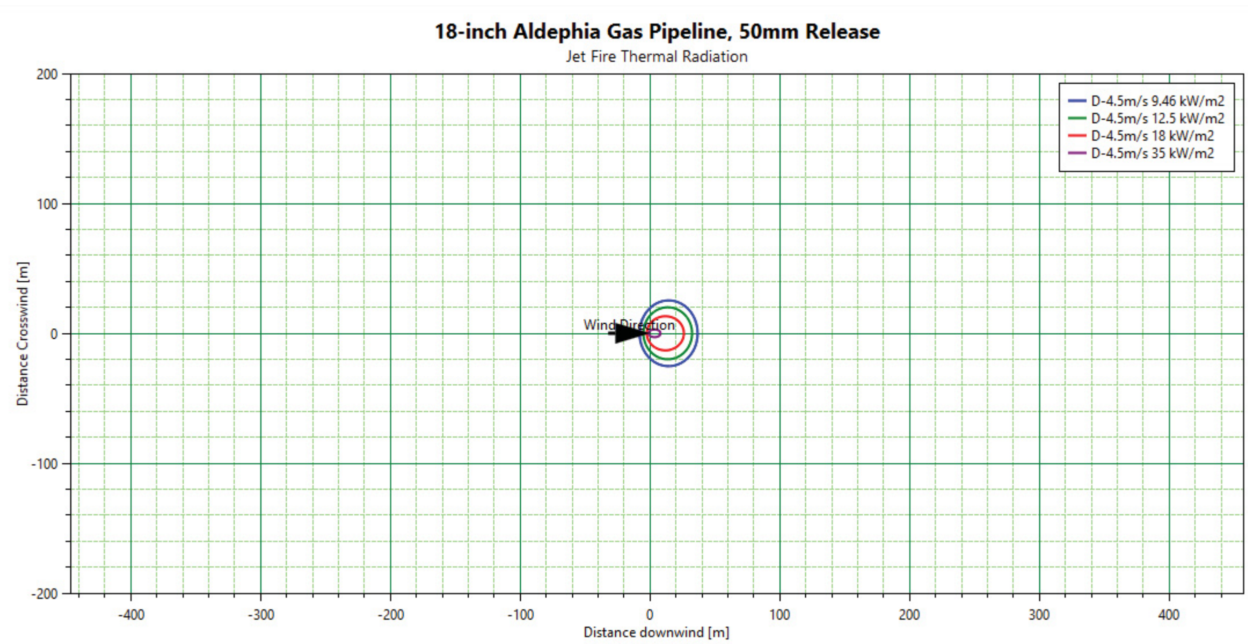

20-inch NGL Pipeline 50mm Release (Side of Pipe @19-degrees)
Flammable Cloud Side View
F-1.5m/s @ 20000 ppm
D-4.5m/s @ 20000 ppm
Cloud Height [m]
Distance downwind [m]
4
3
2
1
0
-1
-1
0
1
2
3
4
5
6
7
8
9
10
11

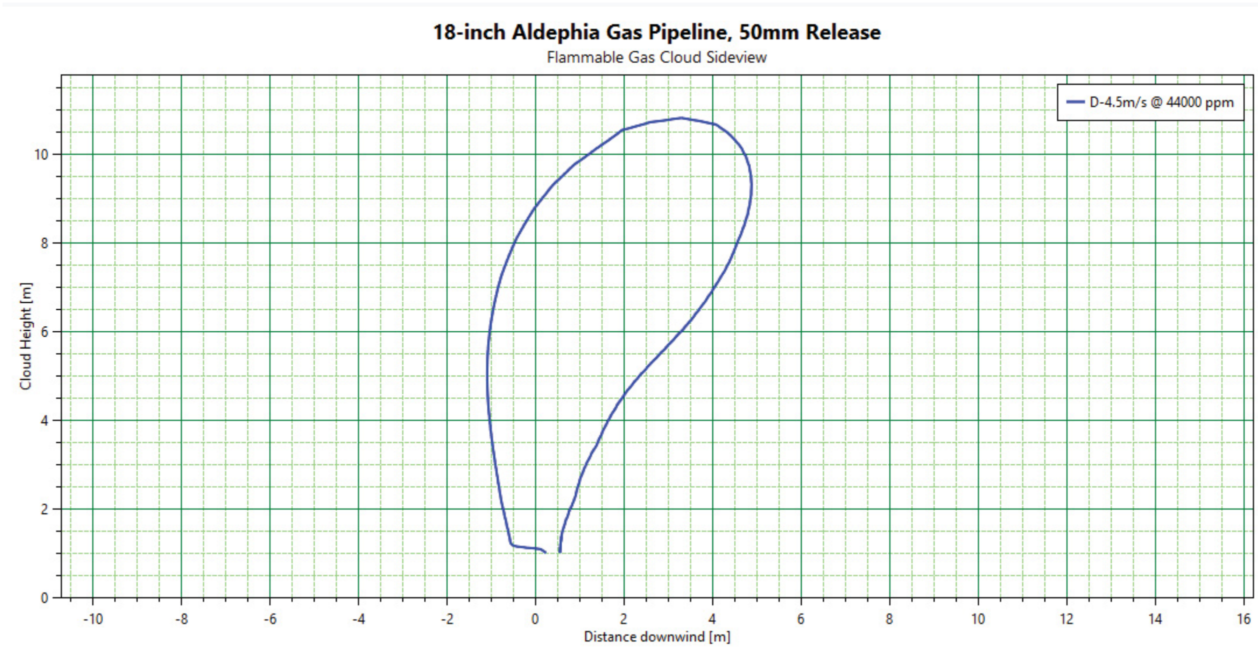
APPENDIX B: ADELPHIA PIPELINE CONSEQUENCE PLOTS


18-inch Adelphia Gas Pipeline, Full Bore Release
Discharge Rate vs Time
Flowrate [kg/s]
Time [s]
0
200
400
600
800
1000
1200
1400
1600
1800


18-inch Adelphia Gas Pipeline, Full Bore Rupture Release
Jet Fire Thermal Radiation
D-4.5m/s 9.46 kW/m2
D-4.5m/s 12.5 kW/m2
D-4.5m/s 18 kW/m2
D-4.5m/s 35 kW/m2
Wind Direction
Distance Crosswind [m]
Distance downwind [m]
200
100
0
-100
-200
-400
-300
-200
-100
0
100
200
300
400


18-inch Adelphia Gas Pipeline, Full Bore Rupture Release
Flammable Gas Cloud Sideview
D-4.5m/s @ 44000 ppm
Cloud Height [m]
Distance downwind [m]
60
50
40
30
20
10
0
-50
-40
-30
-20
-10
0
10
20
30
40
50
60
70
80


18-inch Aldephia Gas Pipeline, 50mm Release
Jet Fire Thermal Radiation
D-4.5m/s 9.46 kW/m2
D-4.5m/s 12.5 kW/m2
D-4.5m/s 18 kW/m2
D-4.5m/s 35 kW/m2
Wind Direction
Distance Crosswind [m]
Distance downwind [m]
200
100
0
-100
-200
-400
-300
-200
-100
0
100
200
300
400


18-inch Aldephia Gas Pipeline, 50mm Release
Flammable Gas Cloud Sideview
D-4.5m/s @ 44000 ppm
Cloud Height [m]
Distance downwind [m]
0
2
4
6
8
10
-10
-8
-6
-4
-2
0
2
4
6
8
10
12
14
16

APPENDIX C: PHMSA HVL TRANSMISSION PIPELINE STATISTICS

Summary HVL Onshore Below Ground Pipeline Mileage, 2002 to Mid 2018 (inclusive)

Year	Diameter Less than 12-inch (mile-years)	Diameter 12-inch or greater (mile-years)	All Diameter Sizes (mile-years)	Comment
2002	41,135	10,621	51,757	Assume to be similar to 2004
2003	41,135	10,621	51,757	Assume to be similar to 2004
2004	41,135	10,621	51,757	
2005	40,236	10,970	51,207	
2006	41,090	11,442	52,532	
2007	42,485	11,896	54,382	
2008	43,794	13,231	57,024	
2009	43,667	13,565	57,233	
2010	43,887	14,090	57,977	
2011	44,178	14,401	58,578	
2012	44,154	15,684	59,839	
2013	44,445	18,321	62,766	
2014	45,585	20,208	65,793	
2015	46,500	21,169	67,670	
2016	46,473	22,385	68,858	
2017	46,037	22,763	68,799	
Mid 2018*	23,018	11,381	34,400	Assume 2018 similar to 2017 and prorate*
Total	**718,956**	**253,371**	**972,328**	

* Count only half of 2018 to align with incidents used

HVL Onshore Below Ground Pipeline Incident Frequency

Diameter	Number of Full Bore LoC Incidents 2002 to Mid 2018 (inclusive)	Full Bore LoC Incidents Frequency (LoC incidents/mile-year)
Less than 12-inch	22	3.1E-05
12-inch or greater	6	2.4E-05
All Diameter Sizes	**28**	**2.88E-05**

APPENDIX D: PHMSA NATURAL GAS TRANSMISSION PIPELINE STATISTICS

Summary Natural Gas Onshore Below Ground Pipeline Mileage, 2002 to 2017 (inclusive)

Year	Diameter 10-inches and less (mile-years)	Diameter Over 10-inches thru 28-inches (mile-years)	Diameter Over 28-inches (mile-years)	All Diameter Sizes (mile-years)	Comment
2002	93,339	135,496	67,013	295,849	
2003	88,242	138,374	68,333	294,949	
2004	88,409	137,564	70,882	296,855	
2005	89,295	133,985	68,716	291,996	
2006	86,887	136,430	70,329	293,646	
2007	89,576	134,039	71,136	294,751	
2008	88,530	135,070	73,617	297,217	
2009	86,379	135,952	76,527	298,857	
2010	89,264	134,793	75,307	299,364	
2011	88,255	132,434	79,035	299,723	
2012	86,670	133,155	78,830	298,654	
2013	86,150	133,015	79,228	298,392	
2014	85,586	132,746	79,583	297,915	
2015	85,994	132,060	79,279	297,333	
2016	85,286	131,766	79,866	296,918	
2017	84,273	131,823	81,474	297,570	
2018	42,136	65,912	40,737	148,785	Extrapolated 2017 mileage and prorated for the 6 months of 2018. This was done to match the incident data range 2002-2018 (half year)
Total	**1,444,269**	**2,214,615**	**1,239,890**	**4,898,775**	

Natural Gas Onshore Below Ground Pipeline Incident Frequency

Diameter	Number of Full Bore LoC Incidents 2002 to mid-2018 (inclusive)	Full Bore LoC Incidents Frequency (LoC incidents/mile-year)	Small to Large LoC Incident Frequency* (LoC incidents/mile-year)
10-inches and less	47	3.3E-05	8.1E-05
Over 10-inches thru 28-inches	128	5.8E-05	1.4E-04
Over 28-inches	37	3.0E-05	7.5E-05
All Diameter Sizes	212	4.3E-05	1.1E-04

* Assumed 50mm frequency to be 2.5X Full Bore Frequency, per OGP recommendation distribution for onshore oil pipelines

TESTIMONY REGARDING PROPOSED
PECO "NATURAL GAS RELIABILITY PROJECT"
MARPLE TOWNSHIP, PA

I. Introduction

My name is Dr. Edward Ketyer. I reside at 102 Meadowvue Court in Venetia, PA (Washington County). I am a medical doctor (M.D., Northwestern University School of Medicine 1987). I am a pediatrician who retired from patient care after 26 wonderful years in a busy primary care pediatric office. Until my retirement I was a Clinical Assistant Professor of Pediatrics in the Department of Pediatrics at the University of Pittsburgh School of Medicine.

I am still employed by Allegheny Health Network as their Social Media Medical Advisor for the AHN Pediatric Institute (AHN Pediatrics - Pediatric Alliance). I am proud to be the editor and principle writer for *The PediaBlog* (www.thepediablog.com), a blog centered around pediatric topics of interest for parents and caretakers, with posts published every day since August 2012.

I remain a member of the Pennsylvania Medical Society and the Allegheny County Medical Society.

I am also a member of the American Academy of Pediatrics and the AAP Council on Environmental Health and Climate Change (COEHCC).

Since 2015, I have been a medical advisor for SWPA Environmental Health Project — a non-profit, evidence-based, public health organization dedicated to assisting residents reduce their health risks objectively associated with living near shale gas (unconventional) oil and gas operations in Pennsylvania's Marcellus Shale region and other areas in the U.S.

I am a board member and President-elect of Physicians for Social Responsibility, a statewide non-profit environmental health advocacy organization helping doctors and other health care providers and the public learn about health risks objectively associated with shale gas development and climate change, in addition to other topics of national and global importance. I also serve on the steering committee of Concerned Health Professionals of Pennsylvania, a group of physicians and nurses who understand that there is no safe way to frack.

I am a Co-Chair of the Education and Outreach Workgroup of the Cancer and Environment Network of Southwestern Pennsylvania.

Finally, I am a member of the Climate Reality Project Leadership Corps. and Climate Reality Pittsburgh & SWPA Chapter.

I was asked to present this testimony from residents living in Marple Township who are opposed to this fracked gas project. I will limit this testimony to the potential and expected harms to the health of residents living nearby, and to children attending an elementary school less than 500 feet away from the proposed site.

I am not an engineer, so I will not discuss in any detail the nature of the building being proposed or its function to supply consumers with natural gas. Nor am I a city planner, so, although this project doesn't seem advisable, I will not opine about the wisdom or foolishness associated with siting a large fracked gas facility such as this one into close proximity to residential and commercial properties, residents and schoolchildren, except to consider the threat to public health and safety this facility represents.

I am a pediatrician by training. I take care of children and advise their parents on how to care for them and protect them from harm and disease. This is my area of expertise. From a pediatric health and safety standpoint, siting PECO's "Natural Gas Reliability Project" at the intersection of two busy roads, in close proximity to homes, retail businesses, and an elementary school is unwise. It is dangerous. It exposes children and their families to harmful emissions from burning natural gas, noise, and light pollution, and it compromises public safety due to the potential for inadvertant leaks and explosions that can occur accidently or during periods of maintenance at the facility.

As a pediatrician, a father, and an advocate for urgent solutions to the climate crisis, I believe I am within my area of expertise to say that the PECO "Natural Gas Reliability Project" should not be approved at this or any site. Climate change is an immediate threat to the health of children and the adults who love them. This is an objective statement. Any project that involves burning even more fossil fuels than before, even natural gas, is inconsistent with solving the climate crisis. In fact, allowing this project to proceed would ignore the scope, the severity, and the urgency of the climate crisis — a local, regional, national, and global emergency which is very much happening today. In fact, partly because of Pennsylvania's long history of extracting fossil fuels (today, mostly by the rapid expansion of fracking), climate change is accelerating. Last month, the International Energy Agency (IEA) declared that investment in, and new development of, all fossil fuel infrastructure, including natural gas, must end immediately in order to fully decarbonize by 2050 and limit global average warming to 1.5 degrees Celsius, which is the consensus value of climate scientists everywhere, recorded in the Intergovernmental Panel on Climate Change Special Report (2018), and the minimum goal of the Paris Climate Agreement.

This makes the PECO “Natural Gas Reliability Station” not only an unwise project, it is an irresponsible and amoral one. Expanding customers’ reliance on natural gas will require even more expansion of drilling and fracking in the Marcellus Shale, negatively impacting the health of safety of people living near it. I live in Washington County, which is the most heavily fracked county in Pennsylvania. While fracking has brought a number of jobs, it has brought with it a dangerous amount of pollution to the air, water, and soil that we all share. It has negatively impacted the health of adults and children living nearby.

I have personally witnessed some of the health harms people have suffered and continue to suffer as a result of leaving nearby fracking wells, pipelines, and compressor stations. Many of their stories were heard by the 43rd Statewide Investigating Grand Jury that last year reported on many industry and regulatory failures to protect Pennsylvania residents from harm.

Fracking is dirty and dangerous. It scars the landscape, damaging and degrading the environment. It pollutes the air and water — precious resources that are supposed to be protected by Article I Section 27 of the Pennsylvania Constitution for all PA residents, and for generations to come. Objectively, fracking makes people sick. The Compendium of Scientific, Medical, and Media Findings Demonstrating Risks and Harms of Fracking (Unconventional Gas and Oil Extraction) Seventh Edition, published by Concerned Health Professionals of New York and Physicians for Social Responsibility now contains in excess of 2,000 peer-reviewed studies, government investigations, and media reports. The medical experts conclude that “fracking cannot operate without threating public health directly, or without imperiling climate stability upon which public health depends.”

Let’s take a look at how this gate station, which PECO disingenuously calls a “natural gas reliability station,” will adversely impact public health and safety.

II. Public health and safety threats and potential impacts from PECO Gate Station

A. Air pollution

Burning methane (CH4) generates specific physical and chemical byproducts that must be released into the atmosphere in order for efficient combustion to occur. While the PECO website offers very little information about what activities will actually be going on at the site in Marple Township, my understanding is that six large methane-fired “heaters” operating alone or in combination will produce large enough volumes of emissions to produce health symptoms in adults and children living, shopping, and learning nearby.

The emissions produced by burning natural gas are by and large invisible due to the size and physical properties of each component. Each component of the air pollution generated by burning natural gas has very significant health risks potentially associated with it. There is no safe level of exposure to any component of pollution resulting from natural gas combustion. We know that even small amounts of exposure, even when brief, can produce significant health signs and symptoms that can affect quality of life for some and increase the risk of poor health outcomes for everyone.

The natural gas industry tells consumers that natural gas burns cleaner than coal and oil. While that's generally true — for example, burning methane results is significantly less particulate matter pollution compared with coal and oil — it's like putting a filter on a cigarette and saying that it too is cleaner. Yes, there are fewer particles and the filter captures some dangerous tar and other substances, but no doctor is going to reassure their patient that it is safe to smoke it.

We also know that invisible particles, smelly vapors, and chemicals that constitute modern air pollution caused mostly from burning fossil fuels like natural gas can impair fertility, complicate pregnancies, and lead to poor birth outcomes. Birth defects and developmental delays caused by some components of toxic air pollution lead to lifelong health burdens for young children, for their families, and for society. ADHD, learning disabilities, and even the development of autism have been associated with air pollution exposure during pregnancy. Lung cancer, bladder cancer, and other types of adult and childhood cancers are linked to air pollution, which impacts practically every organ system in the body — not just the lungs, but also the heart and brain, the liver and kidneys. Adults with chronic obstructive pulmonary diseases (COPD) and other chronic lung diseases, heart disease, and children with asthma have worse symptoms and sicker days when air quality is not good. Recent research describes the links between air pollution and the development of obesity, type 2 diabetes, dementia, anxiety, depression and other forms of mental illness. And it is now estimated that nearly 9 million people worldwide die prematurely each year as a result of air pollution, and that includes hundreds of thousands of Americans.

1. Fine and ultrafine particulate matter (PM 2.5 and smaller; PM 2.5 refers to particles 2.5 micrometers and smaller — for perspective, about thirty 2.5 micron particles laid side by side would equal the width of a human hair).

The cradle-to-grave health impacts caused by breathing air polluted with microscopic fine and ultrafine particles are well-known after decades of occupational and community-level, peer-reviewed, epidemiological research. As I mentioned above, researchers have linked PM 2.5 pollution with impaired fertility, miscarriage, and poor birth outcomes such as low birth weight, small-for-gestational age newborns, and prematurity — each of which carry lifelong health burdens for children, their families, and society. Breathing air contaminated with PM 2.5

exacerbates lung symptoms in children and adults with asthma and other chronic lung diseases. PM 2.5 is a potent contributor to the development of cardiovascular and cerebrovascular disease (i.e. heart attacks and strokes). PM 2.5 is a known carcinogen, causing lung cancer and bladder cancer, and is associated with other types of cancer in adults.

Many people tolerate particulate matter pollution to some degree, even if they experience relatively mild health symptoms impacting the eyes (burning and redness), ears (middle ear infections in children), nose (burning, rhinitis, sneezing, nosebleeds), and throat (irritation and soreness). Breathing PM 2.5 causes headaches in some people and sinus problems in others. But let me be clear: there is no safe level of PM 2.5 exposure because even small exposures (even those under EPA or WHO standards) can still result in noticeable health symptoms.

2. Volatile organic compounds (benzene and formaldehyde are two examples).

Burning fossil fuels, including natural gas, produces VOCs like benzene. Benzene as an airborne pollutant can cause mild symptoms of toxicity — dizziness, headache, and nausea, for example — and more extreme symptoms such as tremors, confusion, and unconsciousness with high levels of exposure. Benzene is a known carcinogen, causing cancer in children and adults. Fossil fuel combustion (which includes natural gas) results in emissions of other harmful VOCs potentially leading to serious health concerns, including toluene (permanent neurological damage), ethylbenzene and xylene (ENT and neurotoxicity), and formaldehyde (ENT and lung irritant, human carcinogen).

3. Nitrogen oxides (NOx)

Nitrogen oxide is produced abundantly wherever fossil fuels and natural gas are combusted. Nitrogen oxide combines with VOCs in the presence of sunlight and heat to produce ground level ozone, also known as smog. Ozone adversely impacts every person's lung function. It has been shown to stunt lung function growth in infants and young children. Whether one is young or old, rich or poor, active or sedentary, everyone's lung function is diminished on days when ozone levels are high.

4. Carbon monoxide (CO)

Carbon monoxide is toxic to every human if exposure is high enough. Depending on the level and duration of exposure, carbon monoxide can cause symptoms as mild as headaches, dizziness, and nausea, to more severe symptoms like hallucinations and loss of consciousness, and death.

5. Carbon dioxide (CO2)

Burning methane produces about 50% less CO_2 than coal per energy equivalent. On a planet facing a climate emergency, with all the methane being fracked and burned, that is still a lot of greenhouse gas emissions. CO_2 from the burning of fossil fuels, including fossil gas, is the principle greenhouse gas responsible for causing the climate crisis. Climate change is adversely impacting the health and safety of children and adults around the world right now. It is a health threat to every child on the planet today, and will be a threat for generations to come until humans decide to abruptly stop using fossil fuels.

6. Sulfur dioxide (SO_2)

Burning methane results in less sulfur dioxide pollution compared with burning coal and oil, but as I alluded to earlier, "less" does not mean "none." SO_2 in low amounts can cause upper and lower respiratory irritation; higher exposures can lead to difficulty breathing and death from respiratory failure and cardiac arrest.

7. Radon gas

Natural gas slated to flow through the Marple Township Natural Gas Gate Station comes from the highly radioactive Marcellus Shale. Radioactivity is a major health threat from upstream and downstream sources in the shale gas supply chain, beginning at the wellhead and continuing on to consumers' stovetops and furnaces.
Radon gas has been shown to be one of these radioactive threats. Radon is the second-leading cause of lung cancer behind tobacco smoke.

8. Methane (from incomplete combustion, intentional venting, and unintentional leaks).

Large volumes of methane leak inadvertently and are vented and flared intentionally into the atmosphere throughout every phase of natural gas extraction (conventional and especially unconventional shale gas development), transportation/transmission, delivery, and consumption. Methane is an extremely potent greenhouse gas, trapping heat in the atmosphere 86 times more effectively compared with CO_2 over a 20-year time period. Methane leaks abundantly from fracked gas infrastructure — from gas wells to pipelines to compressor stations to processing facilities to gate stations and metering stations to homes and businesses. Any greenhouse gas savings achieved by burning natural gas instead of coal is instead squandered by allowing methane to carelessly escape from natural gas infrastructure.

B. Noise and light pollution

Noise pollution and light pollution from the proposed Marple Township gate station will potentially result in additional adverse health impacts, especially mental health. Both types of pollution have been shown to interfere with healthy, restful, restorative sleep in residents living nearby loud and bright industrial sites. Cognition may be impacted from chronic exposure to loud background noise, creating a disadvantage for students who wish to learn efficiently and working adults who wish to be productive on the job.

I would like to pause and note here that any human who witnesses environmental degradation and destruction (as this project represents to anyone seeing the big picture) generally experiences a negative impact on their mental health. And this is especially true in children.

C. Vehicular traffic

The proposed PECO Gate Station in Marple Township is sited on the corner of a busy intersection. The surrounding homes, school, and businesses already generate abundant car, truck, and school bus traffic. In the event of anticipated vehicular accidents, an evacuation plan for the neighboring community, school, and businesses must be created, made public, and updated as local conditions/development change.

D. Explosions and fires

It is well known that pipelines can leak and spill. They can shift in the ground and slip into sinkholes. Over time, pipelines rust and corrode. Pipeline accidents and explosions can destroy homes and property, and they can maim and kill people. There are multiple examples of each of these incidents involving pipelines in Pennsylvania. The proposed Gate Station in Marple Township is essentially a part of the pipeline infrastructure. Because natural gas will enter and exit the facility, and because the pipelines are expected to undergo physical stress due to cooling and heating, the Gate Station will plausibly be subjected to any and all of these potentially catastrophic events. Residents, businesses, and the parents of schoolchildren must be warned ahead of time of the potential threats this facility presents to the health and safety of all community members.

It is my understanding that first responders will not be allowed to respond to an incident or accident occurring at the site unless PECO first determines whether they are needed. This doesn't sound like a good idea. Properly trained police, firefighters, and EMS personnel should be able to respond immediately to any dangerous incident in the community. If true, the public will need to be educated about why PECO thinks this is an advisable emergency protocol.

III. Summary

The proposed PECO Gate Station facility will bring increased risks to public health and safety. Burning natural gas to operate the plant will produce an array of chemicals and particles — smog-forming VOCs and nitrogen oxides that make breathing difficult, cancer-causing fine particulate matter and possibly radon gas, climate-destroying greenhouse gases — emitted into the atmosphere where they will be invisible to the eye even as they do their very grave damage to health and well-being.

Some health symptoms may be felt immediately by some residents living in the neighborhood, workers and customers occupying businesses in close proximity, and elementary students attending school within 500 feet of the facility. The odors and noise coming from the site could reasonably be expected to interfere with students' learning, especially those who struggle in school with learning differences and attention issues like ADHD. In addition to acute exposures to toxic air emissions, cumulative exposures can cause serious health problems, particularly in women who are pregnant, and in children who may not develop chronic heart and respiratory disorders or cancer until years and even decades have passed after exposure.

It is predictable that the air pollution, noise and light pollution, the added vehicular traffic, and knowing of the possibility of an industrial accident at the site are likely to generate stress in the population of adults and children living in proximity to the facility. Stress is a side effect of living near fossil fuel infrastructure and other industrial facilities and has been shown to exacerbate mental health conditions such as anxiety and depression. Chronic stress also helps contribute to the development of chronic medical conditions.

PECO's plan to build and operate a natural gas gate station in such a densely developed, highly populated, high-traffic area is inherently dangerous to people living, working, shopping, and learning nearby. An operational gate station at this site will subject children and adults to toxic air pollution that will not pause and cannot be avoided. Threats to health and safety due to the nature of natural gas's extremely flammable and explosive physical properties will only add to the public health and safety risk people will face every day.

There are alternatives to natural gas. There are no alternatives to clean air. This PECO gate station in this location should not be built. The risk to health and safety is far too high. Building and operating it on this site is irresponsible and unnecessary. In my opinion, as a pediatrician, a father, and a fellow traveler on this planet, I believe this plan should be abandoned.

IV. More Resources:

The Compendium of Scientific, Medical, and Media Findings Demonstrating Risks and Harms of Fracking (Unconventional Gas and Oil Extraction) Seventh Edition

PubChem (NIH, National Library of Medicine, National Center for Biotechnology information)

Southwest Pennsylvania Environmental Health Project

Physicians for Social Responsibility Pennsylvania

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June 11, 2021

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EDUCATION: Undergraduate: University of Vermont 1978-1982
Burlington, VT. (Grad. 5/82 — B.A. Zoology)

Medical School: Far Eastern University 1982-1985
Manila, Philippines

Medical School: Northwestern University 1985-1987
Chicago, IL. (Grad. May 1987 — M.D.)

POST GRADUATE TRAINING: Pediatrics Resident - Children's Hospital of Pittsburgh
1987-1990.

PEDIATRIC PRACTICE: Pediatric Alliance, PC (www.pediatricalliance.com),
— Primary care pediatric practitioner — Chartiers/McMurray Division — 1990-2016 (retired).

— Editor and principle writer, *The PediaBlog* 2012-present (www.thepediablog.com)

— Social Media Medical Advisor, AHN Pediatrics — Pediatric Alliance — May 2018-present.

ACADEMIC POSITIONS: University of Pittsburgh School of Medicine
Department of Pediatrics

— Clinical Instructor of Pediatrics - 1990-1995.
— Clinical Assistant Professor of Pediatrics - 1996-2017.

BOARD CERTIFICATION: American Board of Pediatrics – Initial Certification - 1990
Recertification - 2004, 2011 "Retired in Good Standing" (2017)

PENNSYLVANIA LICENSE: MD-045079E ("Active-Retired")

FORMER HOSPITAL STAFF AFFILIATIONS:

Children's Hospital of Pittsburgh
3705 Fifth Avenue
Pittsburgh, PA. 15213-2583

Magee-Womens Hospital
300 Halket Street
Pittsburgh, PA. 15213-3180

St. Clair Hospital
1000 Bower Hill Road
Pittsburgh, PA. 15243-1899

ORGANIZATION MEMBERSHIPS:

— American Academy of Pediatrics (AAP), Fellow
— AAP - Pennsylvania Chapter - 1990-present.
— AAP - Council on Environmental Health - 2013-present.
— Pennsylvania Medical Society
— Allegheny County Medical Society
— Physicians for Social Responsibility Pennsylvania (2017-present; Board member and current President-elect)
— Climate Reality Project Leadership Corps. (Pittsbugh 2017)

COMMITTEES:

Pediatric Alliance, P.C.
— President, Board of Directors – 1997-2004.
— Member, Board of Directors — 1996-2016.
— Member, EMR Committee (Electronic Medical Records) — 2006-2016.
— AHN Pediatrics - Pediatric Alliance Social Media Committee — 2017- present.

Children's Hospital of Pittsburgh:

— Children's Health Network (CHN) – Board of Directors - 1995-1996

— Teaching and Education/Residency Curriculum Committee - 1995-97

Magee Women's Hospital:

— Magee Physician Hospital Organization – Board of Directors, MPHO - 1994-1996

— Membership Committee, MPHO - 1994-1996

— Strategic Planning Committee, MPHO - 1994-1996

St. Clair Hospital:

— Infection Control Committee - 1990-1992

— Pediatric Quality Improvement Committee (QIT) — 1993-2014

— Executive Committee (Department Chair) - 2010-2012

CONSULTING: Southwest Pennsylvania Environmental Health Project (SWPA-EHP) - 2015-present.

www.environmentalhealthproject.org.

(Updated: 05/20//21)

MARPLE SAFETY COALITION

Recommendations for Appropriate Sites in Marple for Proposed PECO Natural Gas Reliability Station

https://www.facebook.com/groups/stoppeco

Appropriate Site Locations

Points on Map	Address	Zoning District	Distance from Lawrence Road Intersection	Description
A, B	861 Sussex Boulevard, Broomall	I - Industrial	1.3m	DELCO Transfer Site #3
C	401 Parkway Dr, Broomall	I - Industrial	.81m	Oversized Parking Area
D	825 Reed Road, Broomall	INS - Institutional	.38m	Don Guanella Property
E	1797 Sproul Road, Broomall	INS - Institutional	.41m	Saints Peter and Paul Cemetery
F	10-20 Lawrence Road Broomall	B1 – Business	1.4m	PennDOT Salt Shed and Crozer-Keystone Remote Parking Lot
X	2090 Sproul Road, Broomall	N- Neighborhood Center	.44m	Lot bordered on three sides by residences

Key Points:

- All sites are within 2 miles of Lawrence Road and Sproul intersection
- All sites (**except proposed site**) are adjacent to non-residential zoning districts.

Appropriate Site Owner Contact Information

Points on Map	Address	Zoning District	Description	Property Owner	Property Owner Contact Info
A, B	861 Sussex Boulevard Broomall	I – Industrial	DELCO Transfer Site # 3	Delco Solid Waste Authority CEO: Joseph W. Vasturia	(610) 892-9620
C	401 Parkway Drive	I – Industrial	Oversized Parking Area	Amazing Creations LLC. & HD Realty Holdings LP	700 Old Marple Rd. Springfield, PA 19064/ PO Box 12, Wallingford, PA 19086
D	825 Reed Road, Broomall	INS – Institutional	Don Guanella Property	ARCHDIOCESE OF PHILADELPHIA Director of Property Services: Deacon Thomas Croke	(215) 587-3560 tcroke@archphila.org
E	1797 Sproul Road, Broomall	INS – Institutional	Cemetery	PHILA CATHOLIC CEMETERIES LLC	(484) 200-8321 or (844) 451-9614
F	10-20 Lawrence Road, Broomall	B1 – Business	PennDOT Salt Shed/ Remote Parking Lot	PennDOT/ Prospect Medical Holdings	PennDOT Engineer (610) 205-6787 Prospect Medical (800) 254-3258
X	2090 Sproul Road, Broomall	N- Neighborhood Center	Lot bordered on 3 sides by residences	Frank Facciolo	(610) 356-7800

Map Sites A - E

A
B
C
D
E
Map
Google
Imagery ©2021 Maxar Technologies, U.S. Geological Survey, USDA Farm Service Agency, Map data ©2021 Google
United States
Terms
Send feedback
500 ft

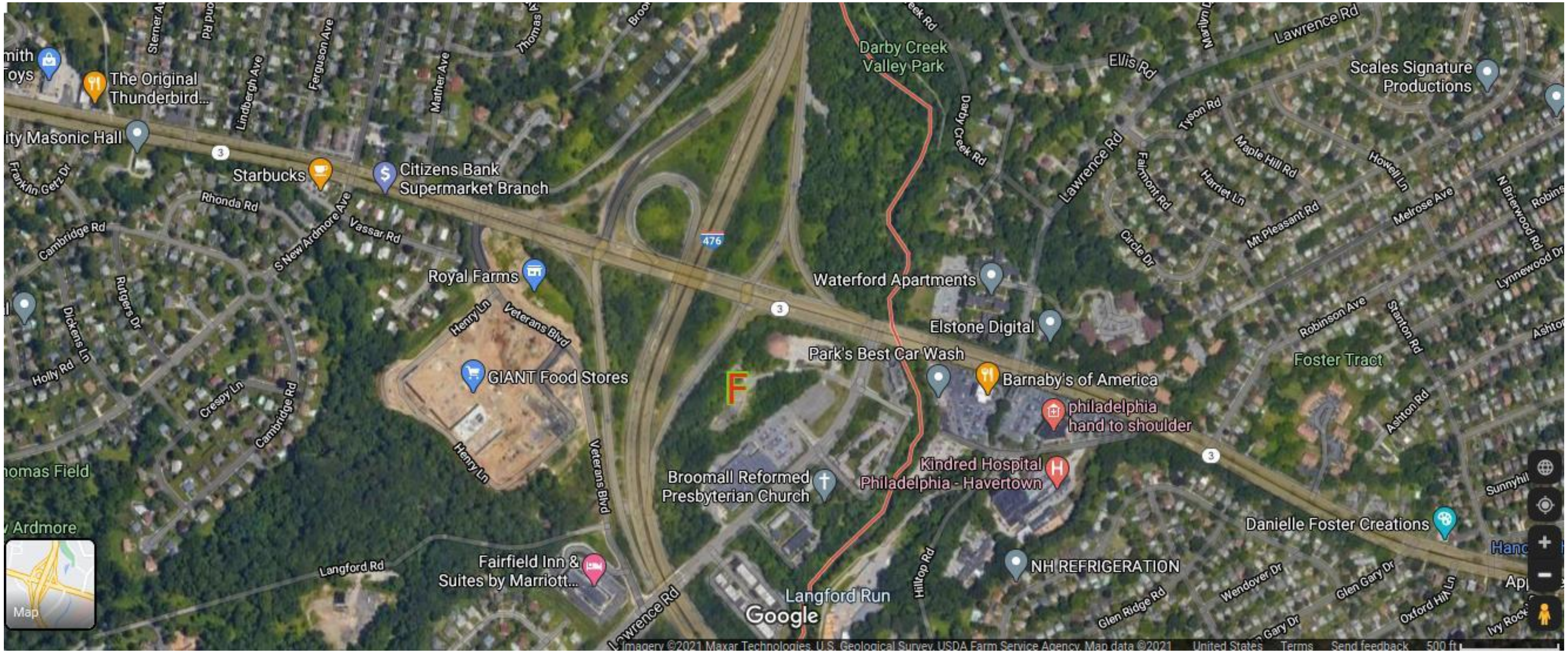
Map Site A & B - DELCO Transfer Site #3

861 Sussex Blvd., Broomall, PA

Map Site C - Oversized Parking Area
401 Parkway Dr, Broomall, PA

Map Site F - Penn Dot Salt Shed & Remote Parking Lot

10- 20 Lawrence Road, Broomall, PA



Map Site F - Penn Dot Salt Shed & Remote Parking Lot

10- 20 Lawrence Road, Broomall, PA

Looking E from 476
Northbound exit ramp

View looking North toward Rte. 3

View looking W toward Rte. 476