Emergency Preparedness Meeting
July 10, 2017
9:00 am

AGENDA

A. Introductions – Jim Scanlon

B. Update on the Sunoco pipeline – Jim Scanlon

a. Questions asked by the West Chester Area School District in letter dated December 29, 2016

b. Response by Sunoco Logistics

Q: Actual scaled drawings of maps indicating the pipeline and schools proximity to it.

A: Maps at a scale of less than 1:24,000 are generally not public information due to Homeland Security guidelines. However, we are providing detailed distances to the pipeline and valves on either side of the schools, as well as appropriately-scaled maps by municipalities (East Goshen, Westtown, West Whiteland townships and Chester County).

Q: Exact distance from the pipeline to the schools and the depth of the pipe at the closest location.
Q: Proximity of the closest shut off valves to the schools.

A: **Distance of Valves / Average Depth of Horizontal Directional Drill (HDD)**

Penn Wood Elementary, 1470 Johnny's Way, West Chester, Pa 19382 (Westtown Township, Chester County, PA)

Distance:
-Distance School is located off of Line: 3,105 feet (at its most direct point)
-Line Distance between Valves located to the North and South of the School: approximately 5.57 miles (between the 1st valve located north (Boot Road) and south (Duffers) of the school)
-Distance the school is located off-line to 1st Valve North (Boot Road): 4.49 Miles
-Distance the schools is located off-line to the 1st Valve South (Duffers): 1.14 Miles
Depth:
-Depth of HDD at this point: 132 feet

East Goshen Elementary, 800 North Chester Road, West Chester, Pa 19380 (East Goshen Township, Chester County, PA)

Distance:
-Distance School is located off of Line: 1,609 feet (at its most direct point)
-Line Distance between Valves located to the North and South of the school: approximately 5.569 Miles (between the 1st valve located north (Boot Road) and south (Duffers) of the school)
-Distance the school is located off-line to 1st Valve North (Boot Road): 2.16 Miles
-Distance the schools is located off-line to the 1st Valve South (Duffers): 3.57 Miles
Depth:
-Depth of HDD at this point: 75 feet

Exton Elementary School, 301 Hendricks Avenue, Exton, Pa 19341 (West Whiteland Township, Chester County, PA)

Distance:
-Distance School is located off of Line: 1,740 feet (at its most direct point)
-Line Distance between Valves located to the North and South of the School: approximately 2.5 Miles (between the 1st valve located north (Exton) and south (Boot Road) of the school)
-Distance the school is located off-line to 1st Valve North (Exton): 0.39 Miles
-Distance the schools is located off-line to the 1st Valve South (Boot Road): 2.44 Miles
Depth:
-Depth of HDD at this point: 50 feet

Q: Explanation of how a shut off valve works and how the safety system works to shut down the pipe?

A: The Mariner Pipeline Systems are monitored 24/7 by a qualified Pipeline Controller who has the specific authority to shut down any pipeline at any time if he/she believes there is the possibility of potential release. Even if data provided to the Controller by the SCADA (Supervisory Control and Data Acquisition) system is inconclusive, the Pipeline Controller has been trained to assume that a potential issue exists and they are to take action until it can be proved that a problem does not exist.

Additionally, the Mariner Pipeline Systems are equipped with a state-of-the-art automatic shutdown system called "ISACL." ISACL is an acronym for Inter-Site Auto-Close Logic, which is a PLC-based software system that actively monitors NGL pipeline pressures and automatically executes a pre-determined sequence of events when a potential release condition is detected. In general, activation of the ISCAL will automatically:

- Close the remote shutoff valve (also known as an Emergency Flow Restricting Device, or EFRD) at the affected location;
- Close the EFRD valve immediately upstream of the affected location;
- Close the EFRD valve immediately downstream of the affected location;
- Shut down all mid-line pump stations;
- Stops all flow of product into and out of the pipeline.

The automatic ISACL system initiates itself within seconds of detecting a potential issue. The Pipeline Controller can also shut down the pipeline manually at any time. Given the time to safely stop flow and physical time it takes for the mainline valves to close, a potential area of concern can be isolated in a matter of minutes.

Q: Copy of any safety analysis that Sunoco has conducted. Copy of any risk assessment conducted by Sunoco of a potential leak.

A: We are evaluating which data can be shared, keeping in mind Homeland Security guidelines but also the School District's emergency planning needs. We will meet with our third-party expert to consider if and in what form this information can be made available.

Q: Information regarding first responders' protocol in the event of a leak.

A: Sunoco Logistics trains with and shares a number of resources with first responders, as referenced on our website at http://www.sunocologistics.com/Environment-and-Safety/Emergency-Preparedness/78/.

We also conduct specific training for first responders at our terminals, valve sites and pump station facilities. Please note that the U.S. Department of Transportation's Emergency Response Guide No. 115 applies to both natural gas (methane) and natural gas liquids (propane, butane, ethane). The Emergency Response Guidebook is used by first responders across the country when dealing with incidents involving hazardous materials, and is incorporated into our training with local first responders.

c. Quest Consultants Pipeline Safety Analysis for Middletown Coalition for Community Safety – see handout

d. Accufacts Inc. Pipeline Safety Analysis for West Goshen Township – see handout

C. Communications protocol

a. Who notifies 911 of a problem?

b. How fast is information disseminated?

D. School evacuation plans - Sara Missett - flowchart handout

E. Hospital capacity for mass injuries – John Felicetti, Chester County Hospital Emergency Management Coordinator

F. Community evacuation plans – Questions to be answered:

1. In the event of a pipeline incident, how will a determination be made between shelter-in-place vs. evacuation of a school?

2. If students are evacuated, where exactly will they be taken? (Sunoco's recommended plan is that people self-evacuate on foot at least 1/2 mile and not use vehicles or cell phones since they are potential ignition sources) How will we ensure the safety of students evacuating on foot for this distance?

3. Will there be a system in place to account for each student prior to evacuation and at the designated evacuation location?

4. How will parents be reconnected with students? How will emergency responders prevent hundreds or thousands of parents from flocking to the school(s) to collect their child(ren)?

5. How will the District communicate with parents in the event of an emergency if cell phones are potential ignition sources?

6. How will the District prevent students from using cell phones during a pipeline emergency?

7. Is there contingency planning in place in case the local fire department (e.g. Greenhill Road) is itself incapacitated due to its close proximity to the pipeline?

8. How is the county going to clearly communicate the safety plan to parents, students, and the community so that everyone knows exactly what to do in the event of an emergency?

9. Do our emergency response teams have the capacity and resources to handle a leak of highly explosive gas? What is the plan if they are not able to enter an affected area for hours, if not days?

10. What role does the school district have if a leak occurs off school hours?

G. Next steps

West Chester Area School District

Educating and inspiring students to achieve their personal best

Dr. James R. Scanlon, Superintendent of Schools

December 29, 2016

Sent via First Class USPS and email to: JFMCGINN@sunocoinc.com

Mr. Joseph McGinn, Senior Manager, Public Affairs
Sunoco Logistics-*Mariner East Pipeline Project* 525
525 Fritztown Road
Sinking Spring PA 19608

Dear Mr. McGinn,

I am writing to express my concern about the construction of the Mariner East 2 pipeline running through Thornbury, West Goshen, East Goshen, and West Whiteland Townships. It is my understanding that the pipeline will be used to transport natural gas such as propane, butane and methane from the Marcellus Shale region to the Marcus Hook refinery. The products remain under high pressure to be transported as a liquid. However, if the pipe was to leak, the liquid would convert immediately to an extremely combustible gas.

Three of our elementary schools (Penn Wood, East Goshen, and Exton) are within 1500 feet of this proposed pipeline. While we have evacuation plans in place in the event of a gas leak, I am concerned about the construction of the line, particularly safety measures being put in place to ensure safety of our children and families in these school areas.

I understand that some municipalities have passed ordinances to add safety measures regarding pipeline construction for new residential areas. An ordinance in West Goshen Township requires automatic shutoff valves in the event of detected gas leak.

Please let me know if the plans include these automatic shutoff valves in the pipeline in areas where it runs near schools. If not, I respectfully request that they be included in the plans to ensure safety of our children once the pipeline is completed. I can be reached at 484-266-1018 or on my cell phone at 484-883-0648.

Thanks for your time and attention to the safety of our students and families. I look forward to hearing from you.

Sincerely,

James R Scanlon

James R. Scanlon, Ed D
Superintendent of Schools

emailed to:

Cc: West Chester Area SD Board of School Directors
Superintendent Administrative Cabinet
Dr. Terri-Lynne Alston, Principal Exton ES
Mr. Dennis Brown, Principal, East Goshen ES
Mrs. Ellen Gacomis, Principal, Penn Wood ES

Representative Elect Carolyn Comitta
Senator Andy Dinniman
Senator Tom Killion

Mr. Rick Smith, East Goshen Twp. Manager
Mr. Mike Cotter, West Chester Borough Manager
Mr. Casey Lalonde, West Goshen Twp. Manager
Mr. Rob Pingar, Westtown Township Manager
Ms. Judy Lizza, Thornbury Township-Chester County Manager
Mr. Jeffrey T. Seagraves, Thornbury Township-Delaware County Manager

Governor Tom Wolf -FAXED
Mr. Donald Zoladkiewicz, Community Liaison (Eastern PA), Sunoco Logistics

Accufacts Inc.
"Clear Knowledge in the Over Information Age"

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kuprewicz@comcast.net

Date: January 6, 2017

To: Mr. Casey LaLonde
Township Manager
West Goshen Township
1025 Paoli Pike
West Chester, PA 19380-4699

Re: Accufacts Report on Mariner East 2 Expansion Project Affecting West Goshen Township

1. Introduction

Accufacts Inc. ("Accufacts") was asked to assist West Goshen Township ("Township") in evaluating an additional Sunoco Pipeline L.P. ("Sunoco") pipeline project identified as the Mariner 2 East Expansion Project. The Mariner East 2 Expansion Project is a proposal to install a new 20-inch, high MOP liquid transmission pipeline operating across the Township that will carry highly volatile liquids, or HVLs (propane and butane), eastward.[1] This project is for a new pipeline that supplements movement of NGLs eastward out of the Utica and Marcellus shale gas regions in Ohio and western Pennsylvania, respectively.

Accufacts provides specialized technical and safety expertise in pipeline siting, design, operation/maintenance, and regulatory requirements, especially as it relates to HVLs, a category of liquids given special definition and mention in the federal pipeline safety regulations because of their unique hazards.[2] Based on over forty years of experience, Accufacts utilized a similar approach in producing an analysis for the Township for the original Mariner East Project, an earlier conversion of an 8-inch existing vintage pipeline to

[1] Maximum Operating Pressure, or MOP, a term defined in federal pipeline safety regulations 49CFR§195.2, "means the maximum pressure at which a pipeline or segment of a pipeline may be normally operated under this part."
[2] 49CFR§195.2 Definitions.

Road across the Township in or in close proximity to the existing 8-inch Mariner East Pipeline right-of-way ("ROW"). Because of the requests to horizontal directional drill ("HDD") certain road crossings, two segments, or over ninety percent of the 20-inch pipeline located within the Township, will be installed utilizing HDD that will be performed in sequence (one HDD downstream of the other). The rest (slightly over two hundred feet of pipeline) between the HDDs will utilize conventional open cut trenching pipe installation. The connecting pipe between the two HDD pulls will incorporate an above ground remotely operated valve at Boot Road within the Township (at Milepost, "MP," approximately MP 344 on the new 20-inch pipeline). Spanning the Township, the nearest upstream/downstream remotely operated valves on the 20-inch will be at the upstream Eagle pump station (~MP 335) and at Middletown Road (~MP 350), respectively. A manual valve is located at approximately MP 341.

HDD entails installing pipe below ground utilizing directional drilling techniques from the surface at two locations spanning a site. HDD involves first directional drilling from the surface a small diameter pilot bore hole and then performing subsequent reaming passes that can be either in one or both directions, that allow the original directional pilot hole to be expanded in diameter via successive reaming passes, expanding the hole diameter depending on the soil conditions. The final directional drill reaming pass must be larger than the pipe to be installed. Pipe is eventually pulled through the final bore with a mixture of mud/bentonite to reduce friction and pulling forces that could possibly damage the pipe or its coating during the final pull. Depending on various parameters, to avoid pipe kinking, etc., the arc of the bore and pipe curvature will place the pipe fairly deep along most of the span, as pipe can only be made to bend or deflect along a limited curve, depending on such factors as pipe diameter, thickness, strength, etc.

HDD technology has been utilized for over forty years with considerable advances in directional drilling for larger pipeline diameters with greater span lengths, as well as bore location guidance, having been especially improved in the last twenty years. The HDD installation of a 20-inch pipeline should not be overly challenging provided the pipeline operator has worked with the Township and other infrastructure agencies such as gas companies that might be near the HDD, to assure there are no other underground structures that might interfere with the HDD, or that might hinder the future safe operation of the pipeline (e.g., via cathodic protection, or CP, stray current interference). One advantage of routing pipeline under roadways is that, if placed at proper depths and suitably evaluated by the pipeline operator, third party surface threat activities that could impact the pipeline are significantly reduced as compared to a more conventional pipeline right-of-way utilizing open cut trenching. Proper depth below grade in this location will also be important to assure protection of the pipe during its operation. Accufacts is well experienced in the various advantages of pipeline installation under roadways in areas of

In addition, a critical inspection related to nondestructive testing (i.e., x-ray, gamma ray, or ultrasonic inspection) of girth welds, the welds joining pipe segments together during construction, is important. Federal minimum liquid transmission pipeline safety regulations require that "During construction, at least 10 percent of the girth welds made by each welder during each welding day must be nondestructively tested over the entire circumference of the weld."[5] For various reasons, there have been a series of girth weld failures on new pipelines as well as many older pipelines. Since hydrotesting does not truly test the quality of girth welds, I believe that during pipeline construction, especially for HVL pipelines, a pipeline operator should nondestructively test all girth welds and many pipeline operators do so, and retain certain inspection records for the life of the pipeline. Sunoco will nondestructively test all girth welds on the Mariner East 2 Expansion Project, prudently exceeding federal minimum pipeline safety regulations in this important area.

2c) No pump station for the 20-inch is required nor located within the Township.

Because of pipeline hydraulics associated with the greater pipe diameter, the 20-inch pipeline will not require a pump station within the Township. The last upstream pump station on the 20-inch system is located some miles upstream of the Township and can supply flow to the pipeline's final destination in the Twin Oaks (Marcus Hook) facility. A new remotely operated emergency flow mainline pipeline shutdown valve operated via the central control room will, however, be installed within the Township just east of US Highway 202 on a portion of the pipeline installed by conventional installation (between the HDDs).

3) <u>Operation of the proposed Mariner East 2 Expansion 20-inch Pipeline affecting the Township.</u>

Components of the pipeline other than the mainline pipe in the Township play an important role in the operation of the HVL pipeline as it could affect the Township. These include: 1) upstream pump stations and mainline pipe beyond the Township, 2) certain mainline valves and their actuation, and 3) to a lesser extent, the elevation profile of the pipeline. Many of the main issues identified below were discussed in detail in Accufacts' report on the original Mariner East Project.[6] While I run the risk of repeating myself, the following major issues that were important for the original Mariner East project are just as, if not more, important, for the new 20-inch pipeline:

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[5] 49CFR§195.234 Weld: Nondestructive testing.

[6] Accufacts Inc., "Accufacts Report on Mariner East Project Affecting West Goshen Township," March 6, 2015.

shutdown and isolation, including pump station isolation and remote mainline valve closure, following a special required sequence. Information provided by Sunoco indicates a rational and progressive approach in trying to achieve pipeline rupture release detection with automated shutdown response without excessive false alarms.

To complement the automatic shutdown system focused on possible larger pipeline releases, the pipeline will also incorporate a separate non-automatic "leak detection" software package that is intended to assist the control room operator in identifying possible pipeline leaks as well as rupture. To further enhance the effectiveness of this software leak detection system, the pipeline is to be normally operated liquid full, or non-slack line. This separate leak monitoring approach requires the control room operator to interpret presented information of a possible release in a special format, decide if a possible release indication is real, and manually initiate a system-wide shutdown if warranted. This second leak detection monitoring system relies on control room operator intervention, but is intended to supplement the automatic shutdown intended for larger releases.

3d) The Critical Role of the Control Room Operator

While pipeline automation plays an important role in controlling and monitoring certain aspects of a pipeline operation, and can play a timely safety role in automatically shutting down and isolating a pipeline system, the control room operator nonetheless still serves an important function in pipeline operation. The control room operator is responsible for managing various operating parameters, as well as monitoring and responding to various computer signals, including responding to alarms, in their hierarchy of importance. A well designed computer system that initiates certain actions such as automatic shutdown and mainline valve closure can react faster than a human monitoring various aspects of a pipeline system. Such complexity should not override the ability of the control room operator to initiate a shutdown if he feels it is warranted.

It is further worth noting that Accufacts has investigated several liquid pipeline ruptures where a control room operator decision to shut down a pipeline was delayed while supervisory authority was sought to approve such a shutdown, increasing response time. Sunoco has incorporated a procedure that gives the control room operator direct authority to shut down and isolate a pipeline without supervisory approval if a release is suspected. Restart of the pipeline under such circumstances, requires approval that follows a procedure meant to verify a release has not occurred. Accufacts views these procedures as a positive and prudent control room practice.

technologies have a high degree of reliability for the general corrosion and possible limited third party damage that might occur in this location. The Township can serve as a proactive agent in assisting the pipeline in avoiding certain threats, such as foreign crossing activities along the pipeline right-of-way that might interfere with the pipeline's safe operation over time, or the safe operation of other infrastructure in these locations that the pipeline might interfere with (such as CP stray current interference).

5) Accufacts' Conclusions

As discussed above, the federal minimum hydrotesting requirements should be appropriate for assuring new pipe integrity for the 20-inch pipeline given that Sunoco protocols are in place to avoid cracking threats as discussed above. Proper communication among parties should also permit the two HDDs for the Mariner 2 East Expansion Project 20-inch pipeline to occur within the Township without endangering existing infrastructure, including the existing 8-inch Mariner East pipeline currently in operation. Accufacts finds that Sunoco exceeds federal girth weld inspection requirements by requiring that all girth welds be 100% radiologically inspected. Such nondestructive inspection during construction provides the gold standard in assessing girth weld integrity as current ILI smart pig technology is not yet capable of reliably assessing girth welds as well as radiological field assessments during construction.

It is also Accufacts' opinion that Sunoco, on the 20-inch Mariner East 2 Expansion pipeline segment that could affect the Township, is exceeding federal pipeline safety regulations in utilizing additional integrity management approaches, prudent pump station design, mainline valve placement and actuation, pipeline monitoring, as well as control room procedures, automatic release detection safety systems, and emergency notification protocols that reflect the level of respect that transporting HVL should require in a prudent pipeline operation. While these efforts cannot guarantee prevention of a release, they reflect a safety attitude that applies up to date steps to avoid a release and respect for the consequences a material release could produce, especially rupture. Accufacts concludes that the Mariner East 2 Expansion Project meets or exceeds the prudent technical approaches commensurate with the safe transportation of HVL.

Richard B. Kuprewicz

Richard B. Kuprewicz,
President,
Accufacts Inc.

MIDDLETOWN COALITION FOR COMMUNITY SAFETY

HAZARD CALCULATIONS FOR SUNOCO'S MARINER EAST II PIPELINE
EXECUTIVE SUMMARY

The Middletown Coalition for Community Safety retained industry-respected Quest Consultants Inc. to perform hazard calculations associated with accidental releases from the proposed Mariner East II (ME2) pipeline. This pipeline is intended to transport so-called "natural gas liquids" (NGLs), including ethane, propane, butane, or mixtures of these, from eastern Ohio and western Pennsylvania to the Marcus Hook Industrial Complex. NGLs are hydrocarbons that can be transported under high pressure as liquids, but which will return to a heavier-than-air gaseous state at ambient conditions. Because of the hazardous properties of this family of materials, Including their extreme flammability, loss of containment events can be a source of harm to humans.

No government agency has, so far, exercised siting authority with respect to this pipeline. And Sunoco has chosen a route through the heart of densely populated suburban Philadelphia, in close proximity to many residences, schools and businesses. Thus, the intent of this analysis was to answer the question:

What is the public safety risk from the pipeline?

Quest Consultants used advanced simulation software to model plausible worst case effects from a leak of the proposed ME2 pipeline. The simulation focused on Glenwood Elementary School in Middletown Township, about 650 feet from the proposed ME2 route, with a population of over 450 students. The Quest consequences analysis assumes a rupture near Glenwood Elementary, about 35 miles downstream from the closest pumping station, accounting for pressure drop over that distance.

Key takeaways from Quest's consequences analysis:

- Immediate ignition can produce a fireball with a blast radius up to 1,100 feet with no notice.
- Delayed ignition can produce a heavier-than-air combustible vapor cloud that can migrate up to 1,800 feet in 3 minutes. Ignition would result in a fire event that traces back to the leak.
- All ignited gas scenarios end in a jet fire that will continue until the pipeline is fully purged.

Risk assessment necessarily includes an analysis of probability. Such an analysis was carried out following a methodology published by Wenxing Zhou, Ph.D., Department of Civil and Environmental Engineering at Western University. (Lam and Zhou, 2016). Using Sunoco-reported mileage and incident data, the analysis predicts a leak once every seven months per 300-mile length of Sunoco-operated pipeline. This statistical prediction has been validated on Sunoco's roughly 300-mile long Mariner East I pipeline, on which Sunoco reported two separate leaks during 2016. For the 25 miles of proposed ME2 pipeline in Chester and Delaware Counties, the analysis predicts one leak every 7.5 years.

In terms of consequences and probability, Sunoco's proposed ME2 pipeline poses a critical and enduring public safety risk to our region. Now that this risk has been objectively identified, prudent public policy requires that this risk must be mitigated before it causes unprecedented catastrophe.

The Middletown Coalition for Community Safety is a nonpartisan, fact-based, grassroots organization of concerned Pennsylvanians. Despite its name, the Coalition stretches across our Commonwealth. Our mission is to unite people through education and to encourage our elected officials to make informed policy decisions for the safety and well-being of our communities.

To learn more, please visit www.middletowncoalition.org

QUEST
CONSULTANTS INC.®

Hazard Calculations for the Mariner East II Pipeline

Mr. Seth Kovnat
Middletown Township
Delaware County, PA

Revision 2
March 7, 2017

Dear Mr. Kovnat:

Quest Consultants Inc. was retained to perform a series of hazard calculations associated with accidental releases from the proposed Mariner East II (ME2) Pipeline. This pipeline intends to transport natural gas liquids (NGLs), which include ethane, propane, butane, or mixtures of these, from eastern Ohio and western Pennsylvania to the Marcus Hook Industrial Complex in southeastern Pennsylvania.

NGL materials are hydrocarbons (fuels or chemical feedstocks) that are transported as liquids under pressure, but will return to a gaseous state at ambient conditions. Due to this nature, and because of this family of materials' flammability, loss of containment events involving NGLs can be a source of harm to humans. Thus, the intent of this analysis was to answer the question:

What can happen in the event of a release from the pipeline?

A set of consequence analysis calculations were performed to evaluate such a scenario. To conduct this analysis, several steps are required to properly define the problem.

Step 1: Define what types of hazards exist due to NGL pipeline failures. Those failures may include:

- Exposure to a flash fire (ignition of a flammable vapor cloud - slow moving flame)
- Exposure to overpressure following a vapor cloud explosion (VCE) (ignition of a dispersed, flammable vapor cloud in a congested or confined region)
- Exposure to thermal radiation from a jet fire (ignition followed by a continuous fire)

Because the hydrocarbons that will be transported in the ME2 pipeline are not expected to include any acutely toxic materials, the flammable hazards listed above define the potential impacts following releases from the pipeline (all the materials to be transported are flammable). In areas very close to the release point, there is an asphyxiation hazard, but the extents of this zone are much smaller than the flammable hazards discussed later in this report. The "explosion" overpressure (pressure above atmospheric pressure) that may be associated with the initial pipeline failure is rarely a hazard to people. While it certainly will

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be an audible event, any damaging pressure wave associated with the pipeline failure is highly localized. The hazards listed above will have greater extents than the initial release of energy from the pipeline.

Step 2: Define the analysis parameters.

The 20-inch diameter, buried pipeline will be constructed from API 5LX65 steel[1], with a wall thickness of 0.375 inches. As with most accident scenarios, there are many variables that can influence the potential size of the impacts of such an event. Some of the potential variables that could influence the size of the impacts of a pipeline release are listed in Table 1. Also listed in the table is Quest's evaluation of the influence that variable has on the hazardous consequences associated with a release from the ME2 pipeline.

Table 1
Pipeline Consequence Analysis Variables

Variable	Potential Range	Importance within Analysis	Applied to This Analysis
Transported Material	Ethane, propane, butane, NGL mixtures	Moderate	Ethane
Material Temperature	Approximately 40°F – 80°F	Moderate	60°F
Material Pressure	Highest: MOP, 1500 psi[2] Lowest: 500-600 psi (depends on material transported and distance between pumping stations)	High	MOP (1,500 psi) and Typical (850 psi)
Normal Flow in Pipeline	Zero to 450,00 barrels per day (275,000 bpd in initial operation)	Low to Moderate	275,00 bbl/day
Release magnitude (as hole size)	Largest: pipeline rupture Intermediate: puncture (1-2" diameter hole) Smallest: pinhole leak	High	Pipeline Rupture
Release orientation	Between vertical and near horizontal	Moderate	Near horizontal
Release location	Anywhere along the pipeline; closer to a pumping station results in a higher pressure at the failure location	Moderate	Within Middletown Township
Atmospheric conditions	Wind speed: low (5 mph) to high (25 mph); Atmospheric stability: very stable to unstable	High	Low wind/stable and Average conditions
Ambient conditions	Temperature: -20°F to 100°F Relative humidity: 5% to 100 %	Low	Average annual conditions: 56°F, 64% r.h.

As demonstrated in Table 1, there is a set of conditions that are assumed for, or applied to, the consequence modeling for this pipeline. A summary of the scenarios that are being modeled would be described as:

- The ME2 pipeline is assumed to suffer a catastrophic rupture within Middletown Township
- The ME2 pipeline is assumed to be transporting ethane,
- The rupture occurs at one of two operating conditions:

[1] http://sxlpipelineprojects.com/projects/mariner-east/mariner-east-faq/
[2] Assumed based on emergency response information for the Mariner 1 pipeline: http://www.sunocologistics.com /SiteData/docs/PipelineLP/6ecbe6bdd2ee06ae/Pipeline%20LPG%20Response%20-%20MERO-ME-.pdf

  - when the nearest pump station (35 miles upstream[3]) is operating at a discharge pressure equal to the MOP – 1,500 psi – with the nominal flow rate of 275,000 bbl/day
  - when the nearest pump station is operating at a more typical discharge pressure of 850 psi, with a flow rate of 275,000 bbl/day
- The rupture creates a crater, and the jet of released ethane leaves the crater at the minimum angle of 19° upward from horizontal[4]
- The jet of ethane is aligned with the direction of the wind, creating the maximum downwind hazard
- The rupture occurs during one of two atmospheric conditions[5]:
  - Low winds, with a stable atmosphere (typically around sunrise), characterized by 2 m/s (4.5 mph) winds and Pasquill-Gifford "F" stability
  - Average conditions – breezy winds and neutrally stable atmosphere, characterized by 5 m/s (11 mph) winds and Pasquill-Gifford "D" stability

The set of parameters that includes a rupture during MOP operation and stable atmospheric conditions describes what can be called worst-case conditions. This scenario will then describe what ***might*** happen if all the conditions and parameters are aligned to produce the worst (largest) impacts, and as such, it provides a credible upper limit to the potential impact areas following a pipeline rupture. This analysis does not address the probability or likelihood of any of the events described in this report. There are many potential events that would create impact areas (hazard zones) smaller than the worst-case scenario.

In addition to the parameters discussed above, there are also certain aspects of the modeling software that produce a conservative result, or contribute to the upper limit described by the worst-case scenario.

- The areas surrounding the pipeline were assumed to be flat (free of significant obstacles or terrain features), which maximizes the travel of a flammable vapor cloud
- No obstacles maximizes the impact of thermal radiation for fires by eliminating shielding
- Atmospheric conditions including wind speed and wind direction are assumed to be constant throughout the event, which maximizes the extent (the size of the impact area) of a flammable vapor cloud and thermal radiation

Finally, the annual average air temperature and relative humidity were applied to the study (alternate conditions would not significantly alter the results presented below).

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[3] http://files.dep.state.pa.us/ProgramIntegration/PA%20Pipeline%20Portal/MarinerEastII/Berks/08%20-%20Location%20Map/BerksCo_USGS.pdf

[4] The choice of 19° upward from horizontal is based on a study completed by the Health and Safety Executive (HSE). In the HSE study *Comparison of Risks from Carbon Dioxide and Natural Gas Pipelines*, Research Report 749, 2009, a review of pipeline crater sizes and release angles was made and the 19° value was defined as the average escape angle for jets from a ruptured pipeline.

[5] Atmospheric stability is defined by the Pasquill Gifford rating scale of A through F. The most unstable atmosphere is characterized by stability class A. Stability A would correspond to an atmospheric condition characterized by strong solar radiation and moderate winds. This combination allows for rapid fluctuations in the air and thus greater mixing of the released gas with time. Stability D is characterized by partial to full cloud cover during both daytime and nighttime. The atmospheric turbulence is not as great during D conditions as during A conditions; thus, the gas will not mix as quickly with the surrounding atmosphere. Stability D is often considered as representative of "average" conditions. Stability F corresponds to the most stable atmospheric conditions. Stability F generally occurs during the early morning hours before sunrise (thus, no solar radiation) and under low winds. The combination of low winds and lack of solar heating allows for an atmosphere which appears calm or still and thus restricts the mixing ability of a released gas. Modeling the releases under low winds and F stability generally results in the longest downwind dispersion distances.

Step 3: Define how the extent of the impacts are measured in the modeling.

The hazards defined in Step 1 must be defined by a certain level of impact. In this study, a common level of impact, equivalent to *serious injury*[6], was selected for each hazard type.

- Exposure to a flash fire – dispersion of flammable vapors with the maximum extent of the vapor cloud defined by the lower flammable limit (LFL) of ethane (3% in air)
- Exposure to explosion overpressure – 1.0 psi overpressure
- Exposure to jet fire thermal radiation – 1,600 Btu/hr-ft^2 for up to a 40-second exposure

For an individual within the zone defined as a flash fire (defined by the extent of the LFL), there would be direct exposure to flames, with the potential vulnerability of secondary fires. For individuals outside the flash fire zone, the radiant impact is minimal due to the duration of the fire.

1.0 psi overpressure is a level that may cause damage to buildings or shattering of glass, which could lead to injuries of building occupants. In open areas, 1.0 psi is not capable of inflicting any serious injury.

1,600 Btu/hr-ft^2 thermal radiation corresponds to 2nd degree burns for a 30-40 second exposure. This assumes that a person is exposed to this level of thermal radiation for the entire exposure time and does not seek shelter or move away from the flame.

Each hazard calculation was made to define the maximum extent of the above hazardous level. When performing site-specific consequence analysis studies, the ability to accurately model the release, dilution, and dispersion of gases and aerosols is important if an accurate assessment of potential exposure is to be attained. For this reason, Quest uses a modeling package, CANARY by Quest, that contains a set of complex models that calculate release conditions, initial dilution of the vapor (dependent upon the release characteristics), and the subsequent dispersion of the vapor introduced into the atmosphere. The models contain algorithms that account for thermodynamics, mixture behavior, transient release rates, gas cloud density relative to air, initial velocity of the released gas, and heat transfer effects from the surrounding atmosphere and the substrate. The release and dispersion models contained in the QuestFOCUS package (the predecessor to CANARY by Quest) were reviewed in a United States Environmental Protection Agency (EPA) sponsored study [TRC, 1991][7] and an American Petroleum Institute (API) study [Hanna, Strimaitis, and Chang, 1991][8]. In both studies, the QuestFOCUS software was evaluated on technical merit (appropriateness of models for specific applications) and on model predictions for specific releases. One conclusion drawn by both studies was that the dispersion software tended to overpredict the extent of the gas cloud travel, thus resulting in too large a cloud when compared to the test data (i.e., a conservative approach).

A study prepared for the Minerals Management Service [Chang, et al.,1998][9] reviewed models for use in modeling routine and accidental releases of flammable and toxic gases. CANARY by Quest received the

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[6] Impact levels taken from 40 CFR Part 68 – United States Environmental Protection Agency (EPA) risk Management Plan (RMP), 1996.

[7] TRC (1991), *Evaluation of Dense Gas Simulation Models*. Prepared for the U.S. Environmental Protection Agency by TRC Environmental Consultants, Inc., East Hartford, Connecticut 06108, EPA Contract No. 68-02-4399, May, 1991.

[8] Hanna, S. R., D. G. Strimaitis, and J. C. Chang (1991), *Hazard Response Modeling Uncertainty (A Quantitative Method), Volume II, Evaluation of Commonly-Used Hazardous Gas Dispersion Models*. Study cosponsored by the Air Force Engineering and Services Center, Tyndall Air Force Base, Florida, and the American Petroleum Institute; performed by Sigma Research Corporation, Westford, Massachusetts, September, 1991.

[9] Chang, Joseph C., Mark E. Fernau, Joseph S. Scire, and David G. Strimaitis (1998), *A Critical Review of Four Types of Air Quality Models Pertinent to MMS Regulatory and Environmental Assessment Missions*. Mineral Management Service, Gulf of Mexico OCS Region, U.S. Department of the Interior, New Orleans, November, 1998.

highest possible ranking in the science and credibility areas. In addition, the report recommends CANARY by Quest for use when evaluating toxic and flammable gas releases. Specific models contained in the CANARY by Quest software package have also been extensively reviewed.

CANARY also contains a model for jet fire radiation. The model accounts for release rate, release orientation, material composition, target height relative to the flame, target distance from the flame, atmospheric attenuation (humidity), wind speed, and atmospheric temperature. The jet fire model is based on information in the public domain (published literature) and has been validated with experimental data.

Step 4: Evaluate consequence modeling results.

When the consequence modeling is conducted for the scenarios described above, the following worst-case results can be described:

IF the pipe were to rupture in Middletown Township, and **IF** the pipeline were operating at 1,500 psi while transporting ethane, and **IF** the release were oriented near to horizontal in the direction of the wind, and **IF** there are few obstructions to vapor cloud dispersion, and **IF** the weather conditions were 5 mph winds and stable atmosphere,

the flammable vapor cloud could extend up to 1,800 feet from the pipeline.

This describes the worst-case consequences for the pipeline – the impact that reaches the farthest distance from a pipeline rupture. Other potential scenarios create smaller hazard zones. For example, **IF** the pipe were to rupture in Middletown Township, and **IF** the pipeline were operating at 1,500 psi while transporting ethane, and **IF** the weather conditions are 11 mph winds and neutrally stable air,

the flammable vapor cloud could extend up to 250 feet from the pipeline.

This result is a much smaller impact area, simply because the atmospheric conditions tend to mix (dilute) the released material faster, resulting in a shorter downwind distance to the vapor dispersion hazard zone.

Similar to the above evaluations, the remaining pipeline conditions and hazard types can be evaluated. The results of such an evaluation are summarized in Table 2.

Table 2
Modeling Results for a Rupture of ME2 Pipeline when Transporting Ethane

Pipeline Pump Station Discharge Pressure	Weather Conditions	Approximate Maximum Downwind Distance [feet] to		
		Immediate Ignition: Serious Burns from a Jet Fire	Delayed Ignition: Flammable Vapor Cloud (time to reach this distance)	Delayed Ignition: Serious Burns from a Jet Fire
1,500 psig	5 mph/stable	1,100	1,800 (about 3 minutes)	700
	11 mph/neutral	1,050	250 (less than 20 seconds)	675
850 psig	5 mph winds, stable atmosphere	825	1,350 (about 3 minutes)	600
	11 mph winds, neutral atmosphere	775	200 (less than 20 seconds)	575

As demonstrated in Table 2, there is little effect of the weather conditions on jet fires. However, the wind speed and atmospheric stability have a significant effect on the dispersion of flammable vapors.

The impacts presented in Table 2 are maximum downwind distances. Figure 1 demonstrates the hazard footprint and vulnerability zones associated with a flash fire hazard associated with a rupture of the pipeline when operating at high pressure, during low winds/stable conditions (the "worst-case" event).

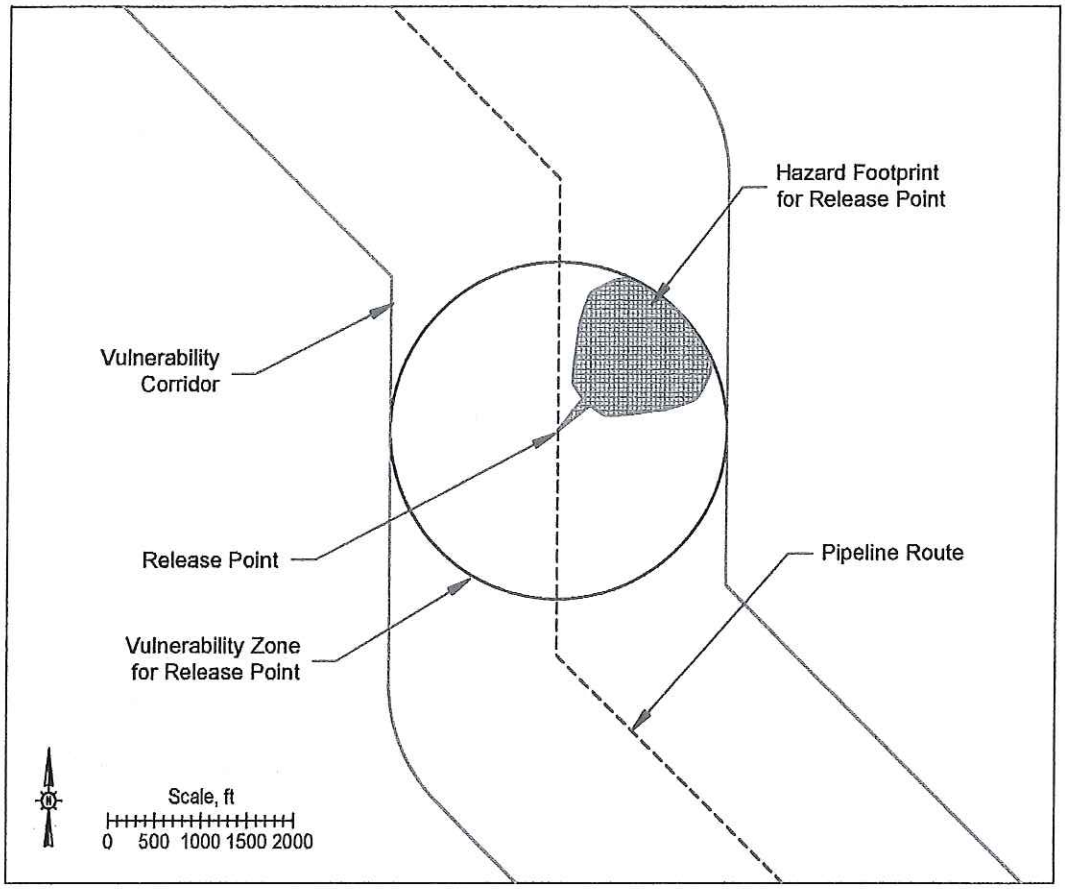


Figure 1
Flash Fire Hazard Footprint and Vulnerability Zones
Following a Rupture of the Mariner East 2 Pipeline; Operating at High Pressure (MOP);
Weather Conditions of 5 mph Southwest Winds and Stable Atmosphere

As seen in Figure 1, the specific accident scenario creates a hazard footprint. As the wind direction varies, the hazard footprint defines a vulnerability zone. When that vulnerability zone is moved along the pipeline, it creates a vulnerability corridor. For any one accidental release scenario, only a hazard footprint can affect persons around the release point.

All There are several things to remember about these results:

- These results are largely directional. This means that all of the impacts could be (for example) to the northeast of the pipeline rupture (given a southwest wind) and other areas around the rupture site

could be unaffected (see Figure 1).

- The modeling in this study assumes no obstructions and a "flat earth" for vapor dispersion. For fire radiation, no accounting for shielding due to objects (trees, buildings, etc.) is given. Thus, the results are expected to be conservative.
- The results presented above all occur within the first few minutes after the pipeline rupture. The hazard distances will be continuously shrinking as the pressure in the pipeline and the available inventory are diminishing. For example, the jet fire hazard distance in Table 2 decays from a maximum of about 1,100 feet (immediate ignition) to 700 feet (delayed ignition) within 2 minutes. At later times, the hazard distance will be even smaller.
- The pressure in the pipeline is constantly decaying after any release event. To demonstrate this, consider the following (as predicted by the release model in CANARY):
    - For the high pressure (1,500 psig) case, the pressure at the rupture location (35 miles downstream of the pump station) is about 1,200 psig before the rupture occurs. After two minutes, the pressure at the rupture location is about 45 psig.
    - For the typical pressure (850 psig) case, the pressure at the rupture location (35 miles downstream of the pump station) is about 575 psig before the rupture occurs. After two minutes, the pressure at the rupture location is about 30 psig.
- Due to the above factors, the results presented in Table 2 are the worst-case, first-few-minutes hazards that might be experienced by persons near the pipeline rupture site.

The results presented in Table 2 do not include the potential impacts due to VCEs. This is due to the assumption of flat, unobstructed terrain (giving the largest vapor dispersion distances), which leaves no confinement or congestion that may produce damaging levels of overpressure. If a VCE involving ethane were to occur in a mostly open area, the overpressure is approximately 0.4 psi, which is not high enough to cause serious injuries to people or to damage to buildings.

If a release from the pipeline is not ignited immediately and the flammable vapors are contained within a confined or congested area (a forested area for example), there is the potential to produce damaging levels of overpressure greater than 1.0 psi. However, this becomes a very site- and dispersion-specific explosion scenario that is beyond the scope of this work. To put the hazard in perspective, the maximum extent of a flammable vapor cloud (dispersing in open terrain) is generally greater than or equal to the potential impacts from a VCE when there is confinement or congestion within the reach of the flammable vapor. Thus, the area that is vulnerable to a hazard following a pipeline release is reasonably represented by the flammable dispersion scenario that defines the flash fire impact.

This report was intended to describe the potential impacts of a small number of possible pipeline failure scenarios. The results described here are subject to change if further information concerning the pipeline is provided or any of the stated release parameters are changed.

MIDDLETOWN COALITION FOR COMMUNITY SAFETY

Sunoco Leak Probability Analysis

A leak probability analysis has been performed using data obtained from the federal Pipeline and Hazardous Materials Safety Administration (PHMSA). Leaks are reported to PHMSA by the pipeline operator.

Data Sourcing

For this analysis, hazardous liquid leak data specific to Sunoco Inc. and Sunoco Pipeline L.P. were isolated in order to obtain a Sunoco-specific leak rate, and to determine how often to statistically expect a leak on a Sunoco-operated hazardous liquids pipeline of a given length. Ten years of Sunoco-reported leak and mileage data are shown in Table 1.

Table 1: Sunoco-Reported Incident and Mileage Data (2006 to 2016)

Company	Year	Number of Incidents (Leaks)[1]	Property Damage	Gross Barrels Spilled (Hazardous Liquids)	Pipeline Mileage[2,3]
Sunoco Inc.	2006	1	$5,000	-	42
Sunoco Pipeline L.P.		28	$957,179	1,423	3,959
Sunoco Inc.	2007	-	-	-	42
Sunoco Pipeline L.P.		25	$4,462,834	2,696	3,958
Sunoco Inc.	2008	1	$4,170,000	120	33
Sunoco Pipeline L.P.		23	$2,274,784	577	4,449
Sunoco Inc.	2009	1	$40,000	320	32
Sunoco Pipeline L.P.		23	$2,282,837	5,041	4,448
Sunoco Inc.	2010	2	$101,000	1,700	33
Sunoco Pipeline L.P.		26	$1,571,302	324	4,920
Sunoco Inc.	2011	-	-	-	26
Sunoco Pipeline L.P.		21	$1,789,272	1,537	4,654
Sunoco Inc.	2012	-	-	-	26
Sunoco Pipeline L.P.		25	$19,734,998	2,142	4,672
Sunoco Pipeline L.P.	2013	36	$8,165,845	1,863	4,658
Sunoco Pipeline L.P.	2014	19	$1,270,649	505	5,371
Sunoco Pipeline L.P.	2015	31	$4,914,145	1,346	6,173
Sunoco Pipeline L.P.	2016	19[4]	$6,091,657	10,128	6,173

[1] PHMSA Pipeline Operator Information: https://primis.phmsa.dot.gov/comm/reports/operator/Operatorlist.html?nocache=8260#

[2] Hazardous liquid pipeline mileage data, 2004 to 2009: www.phmsa.dot.gov/staticfiles/PHMSA/DownloadableFiles/Pipeline2data/annual_hazardous_liquid_2004_2009.zip

[3] Hazardous liquid pipeline mileage data, 2010 to present: www.phmsa.dot.gov/staticfiles/PHMSA/DownloadableFiles/Pipeline2data/annual_hazardous_liquid_2010_present.zip

[4] Data from 2016 are incomplete as of March 2017. Partial year shown.

MIDDLETOWN COALITION FOR COMMUNITY SAFETY

Methodology

Probability was assessed using a methodology published by Wenxing Zhou, Ph.D., Department of Civil and Environmental Engineering, Western University, in the International Journal of Pressure Vessels and Piping on June 14, 2016[5].

The methodology establishes an average expected leak rate, expressed as leaks per mile per year. This average leak rate is based on the number of reported leaks each year, factoring in the total operational pipeline mileage each year.

This particular methodology is operator-specific and therefore accurately accounts for Sunoco's highest-in-the-industry total leak rate. While it was technically possible to adjust for Sunoco's history of federal and state enforcement actions, no attempt was made to do so. The methodology combines various pipeline features, and subsequently calculates a greater than likely leak rate when considering only buried segments; however, it also under-predicts the leak rate where only above ground facilities (i.e. block valve sites and pumping stations) are considered. For the Mariner East set of pipelines, Sunoco has proposed numerous valve sites and other above ground facilities in residential and other High Consequence Areas (HCAs), within the potential blast zone of many schools, residences and businesses. Under these circumstances, the methodology is applicable to the overall proposed pipeline length.

It is also useful to observe that, industry-wide, large hazardous liquids leaks in HCAs have been increasing *per mile of pipeline* for many years, as presented in Figure 1.[6]

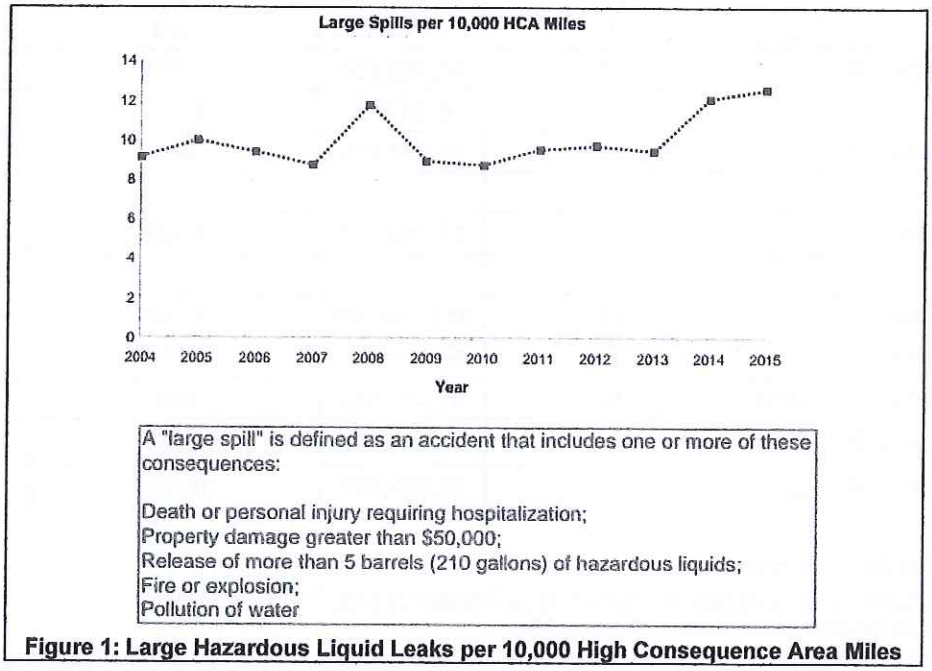


Figure 1: Large Hazardous Liquid Leaks per 10,000 High Consequence Area Miles

[5] Statistical analyses of incidents on onshore gas transmission pipelines based on PHMSA database by Chio Lam, Assistant Engineer, and Wenxing Zhou, Associate Professor. Published in *International Journal of Pressure Vessels and Piping*, June 14, 2016. *See* www.middletowncoalition.org/pipelineleakprobability.

[6] PHMSA Integrity Management Data: https://hip.phmsa.dot.gov/analyticsSOAP/saw.dll?PortalPages.

Probability Results

The data in Table 1 were used to determine Sunoco leaks per mile for the ten-year period beginning in 2006. This actual leak rate per mile of Sunoco-operated pipeline is presented in Table 2.

Table 2: Sunoco-Specific Leak Rate per Mile (2006 to 2016)

Year	Annual Incidents (Sunoco Inc. and Sunoco Pipeline L.P.)	Pipeline Mileage	Leaks per Mile
2006	29	4,001	0.00725
2007	25	4,000	0.00625
2008	24	4,482	0.00536
2009	24	4,480	0.00536
2010	28	4,953	0.00565
2011	21	4,680	0.00449
2012	25	4,697	0.00532
2013	36	4,658	0.00773
2014	19	5,371	0.00354
2015	31	6,173	0.00502
2016	19	6,173	0.00308[7]
10 YEAR AVERAGE:			**0.00537 PER YEAR**

Leak Rate Implications

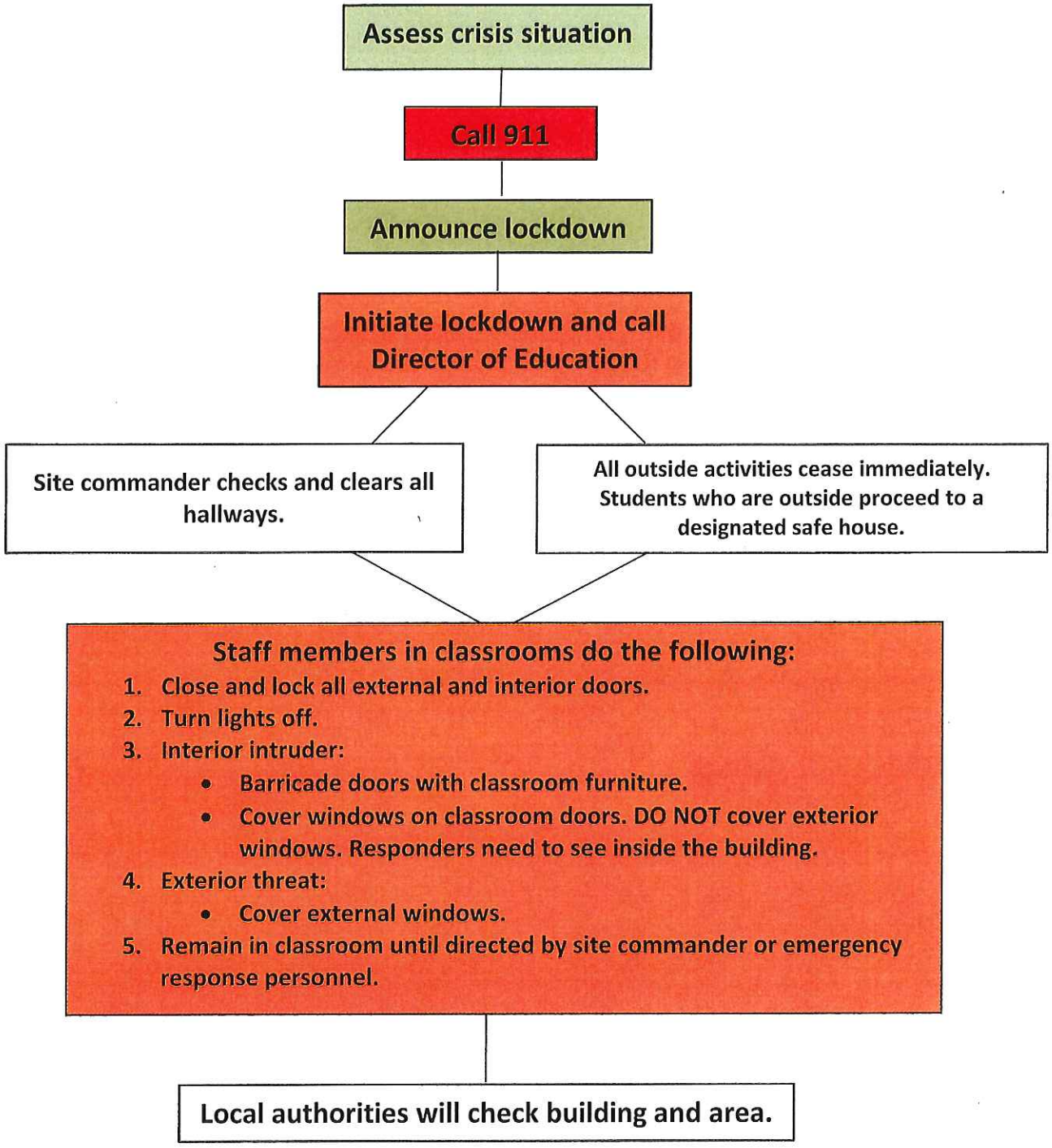
Each proposed Mariner East pipeline is approximately 300 miles long. With the average leak rate of .00537 leaks per year per mile, the statistical leak frequency for each 300-mile length of pipeline is **one leak every 7.5 months**.

Because Sunoco proposes to operate three Mariner East pipelines along essentially the same 300 mile route, it is estimated that a leak will occur along the shared route **once every 2.5 months**.

For the 25 miles of proposed ME2 pipeline in Chester and Delaware Counties, the analysis predicts **one leak every 7.5 years**. For the proposed route in Delaware County alone (11.4 miles) the analysis predicts **one leak each 16.5 years**.

[7] Data from 2016 are incomplete as of March 2017. Partial year shown.

CRISIS SITUATION PROCEDURES FLOWCHART



The West Chester Area School District
2017 - 2018