



A Close Call and an Uncertain Future:

An assessment of the past,
present, and next steps for
Philadelphia's largest refinery

Brian Abernathy and Adam Thiel
November 2019



Message From The Co-Chairs

In the early morning hours of June 21, 2019, Philadelphia was rocked awake by a series of explosions at the large refinery site in South Philadelphia. Immediately afterward, as the scope of the incident became more widely known, many residents began to ask questions and express concerns over what happens beyond the refinery's fence line, what impacts the refinery has on public health and safety, and what will happen in the future – to the refinery, to the site, and for themselves.

For many reasons, the case of the Philadelphia Energy Solutions (PES) Refinery is not a typical example of a large employer closing its doors. The refinery has been a significant part of Philadelphia's economic landscape for more than 150 years, yet it remains a controversial one. Unlike most employers, the refinery sits at the intersection of many different public and private interests – many of which are inherently in conflict with one another – and the very presence of a large oil refinery in our City raises a series of valid questions:

- Is the existing refinery safe? What are the dangers and how are residents being protected?
- What will happen to the refinery workers? How can the existing jobs be saved or replaced?
- What is the economic impact to the City, to the state, and to the region of the refinery closing?
- Does a refinery, and all of the inherent risks associated with one, belong in the middle of such a densely populated area?
- How is the pollution from the site impacting communities? What is the relationship between the refinery and those communities?
- How does the refinery contribute to climate change or fit into the long-term future of energy?
- How economically sustainable is the refinery in the long term?
- How can/should the 1,300-acre site be used in the future?
- What are the current and future environmental dangers and risks on the site and how are they going to be addressed?

Due to both the very prominent public safety concerns that were heightened as a result of the incident on June 21st, as well as the intersection of so many different interests, having a public conversation and process to sort through these issues was of paramount importance. Mayor Kenney created a Refinery Advisory Group to organize a process that allowed City leaders to learn about the refinery from the points of view of all stakeholders, including from those most directly impacted by the refinery – nearby residents and PES employees. The Advisory Group process provided a way to make sure we learned as much as possible, and created the opportunity for concerned residents and interests to share their thoughts and concerns directly with the City.

This report provides a summary of the information, perspectives, and concerns that we heard through the Advisory Group process. It also provides factual context behind the history of the refinery, its positive and negative impacts, and clarifies the role of City government in defining the future of the site. The report also responds to some of the common questions that emerged throughout the Advisory Group process. Lastly, the report contains recommendations around a set of values for the future use of the site and specific operational recommendations for the City to implement as the future for the refinery site becomes clearer – whatever that future may be.

We have been clear throughout this process that we do not expect every stakeholder or interest to be fully satisfied with this process or this report. Finding consensus around how the site should be used in the future would be challenging in the most ideal circumstances. While the City has no direct control over this privately-owned site, which is in the midst of a bankruptcy proceeding, and we cannot dictate its future, we hope to influence the future of PES. We have attempted to conduct this process and write this report with clear eyes, active listening, and open minds so the City is best prepared for supporting and encouraging a future for the site that is cleaner, safer, and better for Philadelphians than it ever has been in the past.

Sincerely,

Brian Abernathy
Managing Director

Adam Thiel
Fire Commissioner and Director of Emergency Management

Table of Contents

- 4 About the Refinery Advisory Group
- 7 The Philadelphia Refinery
- 13 Benefits of Refinery
- 17 Costs of Refinery
- 24 The Incident of June 21st
- 27 Current Status
- 30 Potential Reuses
- 35 Next Steps Moving Forward
- 42 Conclusions
- 43 Acknowledgements
- 44 Sources

ABOUT THIS REPORT

This report is authored by the two co-chairs and based on many perspectives shared through the Advisory Group process. The report is intended to provide the public, other City officials, and other stakeholders with an overview of the issues surrounding the refinery and the information gathered through the work of the Refinery Advisory Group. The report concludes with a series of values statements intended to define the suggested conditions under which City officials should evaluate its approach to proposals for how the site may be used in the future. Though this report contains several recommendations for how City operations should be evaluated and strengthened in the future, as well as several recommended attributes and features that future owners of the site should consider implementing, it does not attempt to make any specific recommendation for how this privately-owned site should – or should not – be used in the future.

This report was drafted and reviewed by city staff and many of the cited reference materials are available at www.phila.gov/refinery. The report does not reflect the views of the Advisory Group as a whole or its individual members.

About The Refinery Advisory Group

Introduction and Background

On Friday, June 21st, 2019, at approximately 4:00 am, a major explosion rocked the Girard Point facility of the PES refinery complex in South Philadelphia. The explosion was heard and felt throughout the surrounding communities, and dramatic video footage of the incident was featured on national news – leading to a heightened level of public interest and concern regarding the refinery.

Thanks to the efforts of the PES fire brigade, the quick actions of the highly trained staff on duty at the refinery, and the Philadelphia Fire Department, the incident and its immediate impacts were contained on the refinery property without serious injuries to refinery workers, first responders, or community members. However, the incident raised serious questions and concerns in the minds of many regarding the refinery – particularly since another smaller and unrelated fire occurred at another portion of the refinery several weeks prior to June 21st.

The day of the explosion, Mayor James F. Kenney called upon Managing Director Brian Abernathy and Fire Commissioner and Director of Emergency Management Adam Thiel to convene a working group to evaluate the cause of and response to the incident with the intention of making recommendations about what could be improved moving forward.

Several days later, on June 26th, the leadership of PES announced their intention to cease operations at the refinery and market the complex for a sale. Following that announcement, City leadership refocused the working group on the future of the site. The Refinery Advisory Group was comprised of representatives from numerous constituencies and stakeholder groups affected by the refinery. Members were chosen to represent various stakeholder groups impacted by the refinery closure – business, community, labor, academic and environmental experts, and government officials – and conflicting points of view were encouraged.

Unlike many task forces or working groups organized by government, the charge of the Refinery Advisory Group was not to make recommendations or policy decisions as a group. Rather, the members were tasked with organizing the information-gathering

process – to bring forth subject matter experts and stakeholders who could present to City officials and the public on various issues that the City of Philadelphia should consider as the future of the refinery site comes into clearer focus.

This report represents a summary of the information that the City has learned through this process and outlines the values the City will apply to evaluate and respond to proposals for the future use of the refinery. The report also contains several recommendations from the perspective of the co-chairs for steps the City should take to improve its operations in the future.

The report draws heavily upon the information that members of the Advisory Group organized and presented to the City. Though a draft of the report was shared with the Advisory Group prior to its public release, this report represents the views of the City and not the views of the Advisory Group as a whole, or its individual members.

MISSION

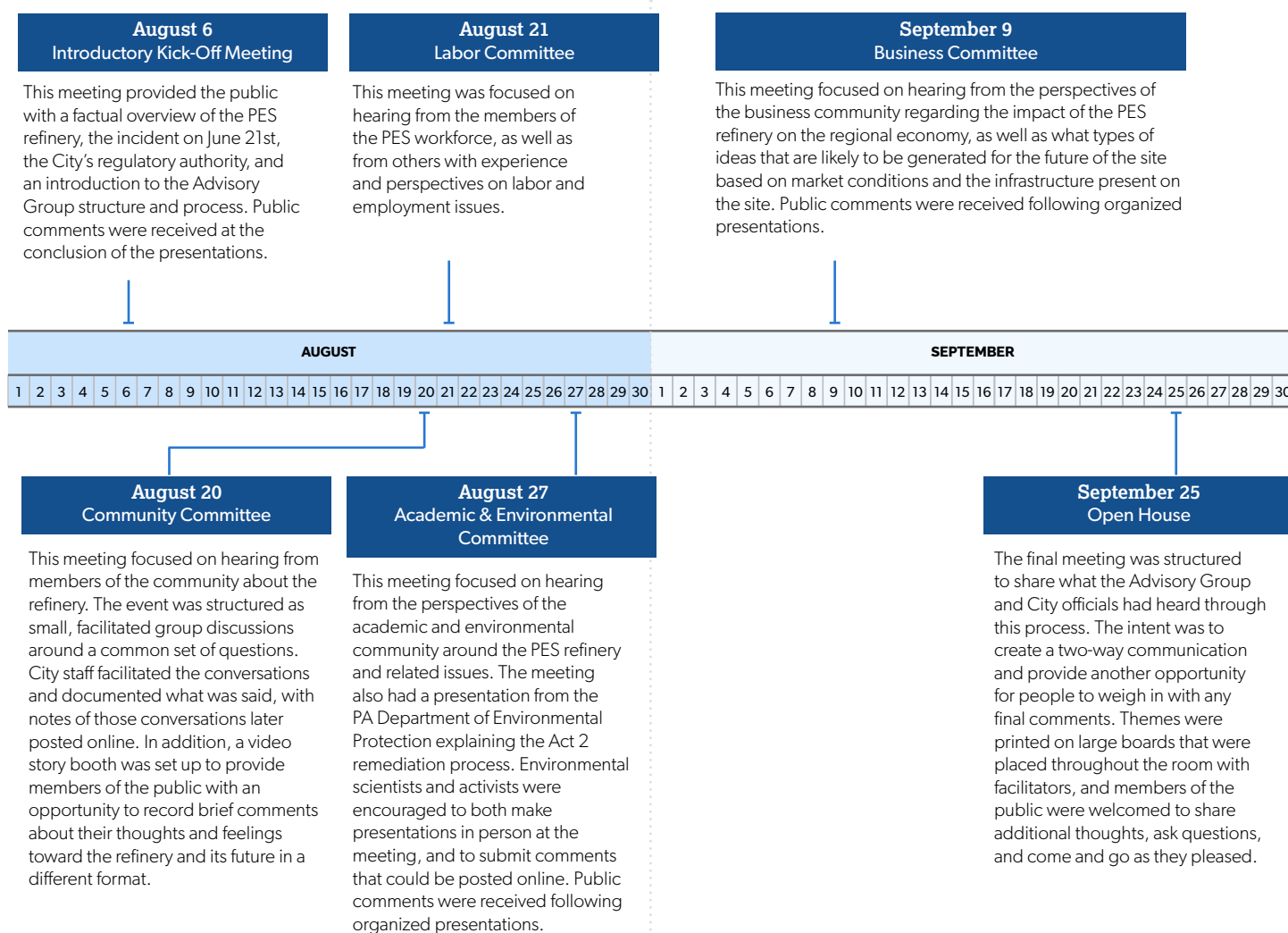
The Refinery Advisory Group assembled a group of stakeholders with diversity of experience, knowledge, and perspectives on the PES refinery site and its operations. The Advisory Group focused on:

- Providing data on how the announced potential closure of the PES facility will impact Philadelphia with respect to the economy, environment, and public health and safety.
- Providing input regarding the potential reactivation or reuse of the site, as well as understanding the obstacles, limitations, and role of the City in the process.
- Sharing ideas regarding uses for the site that are both economically feasible and positive for the City.
- Organizing, through a committee structure, feedback from members of different constituencies and the public in an effort to better inform City officials and members of the Advisory Group.

Process

The Advisory Group process was designed to be open, transparent, and informative. A series of public meetings were organized based on stakeholder group to encourage an orderly dialogue that would sort through the different perspectives around the refinery and its related issues. All meetings were held in a community-based location near the refinery complex (Preparatory Charter School – 25th and McKean Streets) after normal working hours. The meeting location was climate controlled, ADA accessible, reachable by transit or car, and could accommodate approximately 300 people.

A total of six meetings were held:



Public participation was encouraged and permitted at every meeting, and members of the public had multiple different avenues to participate. Some meetings permitted people to sign up and speak at a microphone in advance, and other meetings permitted people to speak at the end without pre-registration. People were also encouraged to submit written comments to the Advisory Group at refinery@phila.gov.

Meeting materials, including copies of presentations and written testimony, were posted online at www.phila.gov/refinery for any members of the public to access at any time. Most meetings were also filmed by the City and the videos were put online.

What We've Heard

Extensive comments were shared through the Advisory Group process and its six public meetings. More than 115 comments were received via story stations, public testimonies, and written feedback – plus extensive written testimony and remarks that were made available on the website.

Overall, most feedback fell into these topics:

- Health and safety of the surrounding community and workers
- Loss of jobs and economic impact
- Climate change, fossil fuels, and environmental sustainability
- The ideal future use(s) of the site
- Pollution and environmental conditions and cleanup
- The refinery's impact on, and relationship with, the surrounding community
- Outreach and communications between the community, refinery, and City

While there were many different perspectives and points of view shared, **most people seemed to agree on several things:**

- People should be kept safe and healthy. This includes the health of the community and the workers.
- There should be high-quality jobs and job training available for workers and community members.
- The site should be cleaned up and there should be ongoing monitoring.
- Residents and taxpayers should not bear the cost of remediation and cleanup.
- There should be better communication between management and workers, the land owner and the community, the City and the community, and between workers and residents.

People also had differing opinions on what should happen with the site:

- The site should never be a refinery again//The site should absolutely be a refinery again.
- The refinery is safe//The refinery is toxic and dangerous
- The site should have homes on it//The site should never have people living on it.

- The City should seize the property//The City should not seize the property
- The private sector should determine what happens at the site//The community should determine what happens at the site.
- Portions of the site should be made available for public use//The site should remain primarily a center for employment/private use.

Despite these different opinions, members of the public, including near neighbors and refinery workers, also seemed to agree on several **requests to guide the future of the refinery site:**

- Make equity central to use, development, hiring, and community engagement.
- Companies that caused pollution should pay for all damages and cleanup.
- New site management should:
 - Work to repair trust between workers and management
 - Improve working conditions and invest in modern and updated operations, including pollution controls.
 - Work cooperatively with unions and the workforce, including by taking employee suggestions on how to improve/modify/adjust operations.
 - Have a local hiring requirement from surrounding community.
 - Hold regular inspections and make the results publicly available.
 - Incorporate more environmentally friendly operations.
- The City should consider:
 - Being more involved in monitoring any future use proposals and operations at the site
 - Making sure a new owner is better capitalized and invested in long term success
 - Paying for security and testing if the site becomes vacant for an extended period of time.
 - Exploring re-zoning the land for another use(s)
 - Implementing stronger environmental regulations and compliance monitoring.
 - Banning or more strictly regulating certain hazardous materials.



The Philadelphia Refinery

Since the dawn of the industry in the mid-1800s, petroleum has been a significant part of Philadelphia's industrial economy.

Note: Throughout this report, references to "Philadelphia Energy Solutions" or "PES" are used to refer to issues specific to that corporate entity or refinery owner. For more general references to the refinery complex, the term "Philadelphia refinery" is used.

Background and History

Since the dawn of the industry in the mid-1800s, petroleum has been a significant part of Philadelphia's industrial economy. As the petroleum industry rapidly grew in the 1860s and subsequent decades, Philadelphia developed into one of the most significant early refining and storage hubs due to its location between the oil fields of Western Pennsylvania and consumer markets – both domestic and abroad. In the mid-19th century, petroleum storage and processing facilities were scattered throughout the industrial sections of Philadelphia. As the contamination risks and fire dangers of these operations quickly became evident, petroleum operations consolidated to more isolated locations in the southern parts of the City, away from residents and drinking water supplies and near railroads and wharves.¹

The refinery site on the lower Schuylkill River was first used for petroleum-related uses as far back as 1866, when the Atlantic Petroleum Storage Company built a complex to store and transport petroleum and its byproducts by taking advantage of the proximity of railroads and wharves. At the time, the surrounding neighborhoods were sparsely developed and much of the site was farmland or marshes along the tidal Schuylkill.

Shortly thereafter, refining operations began on the site, and Atlantic Refining quickly grew to become Philadelphia's largest employer by 1870. At this time, the most significant product made was lamp fuel since there were no other major consumer uses for the other byproducts from the refining process. The facility quickly became a leader in its field – by 1891, 50% of the world's lighting fuel and 35% of all U.S. petroleum exports came from the 360-acre refinery at Point Breeze.²

In the early part of the 20th century, additional petroleum activities developed in the area in response to growing demands for new products like gasoline and aviation fuel, and by the 1920s a terminal and second refinery were built nearby at Girard Point by Gulf Oil Company. These two neighboring refineries – Atlantic's Point Breeze refinery and Gulf Oil's Girard Point refinery – gradually expanded, increased their capacity, and changed corporate owners several times.

While the refinery site continued to expand, so did the surrounding neighborhoods. The farms and marshes that once surrounded the refinery site were developed with homes, streets, and highways. The Schuylkill Expressway and Platt Bridge were constructed through the area after World War II, transforming the area from an isolated industrial pocket to a major transportation crossroads. Public housing developments

The Philadelphia Refinery

were built near the refinery site, including directly across the highway from portions of it, by the Philadelphia Housing Authority and the federal government. Today, the refinery – which long predated its neighbors – is situated in the midst of a sprawling, densely populated area that is home to more than 113,000 people within 1 mile of the property’s fence line.³

Sunoco, which was a Philadelphia-headquartered oil company with deep roots in the region, purchased the Point Breeze refinery complex in 1988 and the Girard Point refinery complex in 1994, and operated the two refineries as one complex (the Philadelphia refinery) to produce mainly transportation fuels such as gasoline and diesel fuel, as well as heating fuels.⁴ Sunoco, in turn, distributed and sold these fuels through its own network of pipelines and retail gas stations. By jointly operating these refineries as one complex, Sunoco positioned its Philadelphia refinery to be the largest on the East Coast, with a capacity of 335,000 barrels per day.

Sunoco also connected the Philadelphia refinery to its other regional refineries – its original refinery in Marcus Hook, PA and its refinery in Eagle Point, NJ – by pipeline and configured the Point Breeze refinery to process the same light-sweet crude oil that its other regional refineries processed. Sunoco also built pipelines to connect its regional refineries to a crude oil importing terminal along the Delaware River near Fort Mifflin and the Philadelphia International Airport.⁵

As time went on, Sunoco faced difficulty with maintaining profitability in its refinery operations. While Sunoco made regular upgrades to equipment and technology, the refinery’s fundamental configuration remained comparatively unsophisticated and did not see major changes to allow it to process the cheaper, heavier crude oils that were entering the global market or deploy more expensive and complicated hydrocracking capabilities. As a result, the refinery had to rely on some of the world’s most expensive types of crude oils, which were primarily shipped to Philadelphia from West Africa, Venezuela, and other locations abroad. This put the refinery at a competitive disadvantage compared to refineries that had the types of technology in place that would allow them to process less expensive, heavier crude oils or the ability to turn multiple types of crude oils into a wider range of products.

Crude Oils and Oil Refineries

Crude Oil refers to the oil that is pumped from the ground before it is turned into refined products used by consumers.

Oil refineries are industrial plants that transform crude oil into a range of useful products, such as gasoline, diesel fuel, heating oils, asphalt, and other chemicals.

There are many different types of crude oils depending on the geology where the oil comes from. Crude oil is usually described by its **density** and its **sulfur content**. Crude oil can be “heavy” or “light” depending on its density, and “sour” or “sweet” depending on its sulfur content.

Generally, lighter and sweeter crude oils (less dense, lower sulfur) are more expensive but easier to extract, transport, and refine into consumer products like gasoline and other fuels. Heavy, sour crude oils are typically less expensive but are more difficult to extract, transport, and refine into consumer products.

Refineries are built to process specific types of crude oils. The Philadelphia refinery complex is built to process **light, sweet crude oil** and turn that oil primarily into motor fuels.

⁴In addition to gasoline, diesel, and heating fuels, the refinery produces and markets jet fuels, kerosene, propane, propylene, butane, cumene, and sulfur.

Philadelphia Energy Solutions Equity Ownership

(as of January 2018 - prior to first bankruptcy):

Equity Holder- Percentage of Equity Held

Carlyle Group
65.04%

Sunoco/ETP
(d.b.a. PES Equity Holdings)
32.52%

Current and former PES senior management
2.44%

Philadelphia Energy Solutions Operations:

335,000 barrel per day refining capacity; largest refinery on East Coast and 11th largest in U.S.

Typically produced:

Gasoline
45%

Distillate (diesel, fuel oils)
40%

Low-value products
(residual fuel, liquid petroleum gas, etc.)
12%

High-value petrochemicals
3%

Direct employees approximately
1,100

The Philadelphia Refinery

By 2009, Sunoco announced some significant changes to its business model and regional refining activities. In a time of softening demand and increased competition, the company closed its refinery in Eagle Point, NJ in 2010 to increase utilization of its other two refineries. By 2011, Sunoco announced that it would exit the refining business entirely and instead focus on logistics and retail, which were more profitable activities. At the time, Sunoco claimed that its northeast refinery operations cost the company \$772 million between 2009 and 2011 and that the company was unable to justify making the expensive capital investments needed to position the Philadelphia and Marcus Hook refineries to be more competitive and sustainable in the future. Sunoco announced its intention to shut down its last two refineries at Philadelphia and Marcus Hook by July 2012 if a new buyer could not be found. Sunoco was ultimately purchased in April 2012 by Energy Transfer Partners (ETP).⁶

The Marcus Hook facility was closed as a refinery and repurposed, using its strategic pipeline connections, geologic storage caverns, and location on the Delaware River to serve as a hub for storing and transporting natural gas liquids. Meanwhile, around July 2012, an entity called Philadelphia Energy Solutions (PES) was created to purchase the Philadelphia refinery and continue its operations.

The PES Era

A privately held company, Philadelphia Energy Solutions (PES) was created as a joint venture between Sunoco and the Carlyle Group, a large private equity firm. As part of the joint venture, Sunoco contributed its refinery assets and Carlyle contributed \$175 million in capital.

The creation of PES and its plan to continue operating the Philadelphia refinery received significant political backing at all levels of government, and public subsidies were provided to assist the company with modernizing its operations and preserving the existing jobs. The Commonwealth of Pennsylvania provided \$15 million over three years for refinery cracker equipment upgrades and a \$10 million grant for rail car unloading infrastructure to expand the refinery's ability to receive crude oil by train. The Commonwealth also provided tax relief through Keystone Opportunity Zone designations, the opportunity for tax exempt bonds, and a consent decree with the PA Department of Environmental Protection (PA DEP) to address outstanding air pollution violations at Sunoco's Marcus Hook refinery. As part of the transaction, PES was also protected from liability from historical environmental contamination at the site, and the liability for addressing that contamination remains with Sunoco.⁷

The Philadelphia Refinery

PES operated the Philadelphia refinery complex as an independent “merchant refinery” - meaning it bought crude oil and sold refined products on the market, rather than for affiliated businesses. Using its access to refined product logistics infrastructure, PES moved its products through the Northeast U.S. through pipeline connections to other cities and consumer markets, including Pittsburgh, western New York, and the New York Harbor. PES also had the capability of transporting finished products to market by barge or ship, by truck via the adjacent ETP-owned Belmont Rack, or by rail.⁸

Oil by Rail

Petroleum refining is a capital-intensive business that requires significant and ongoing investments to maintain safe and efficient operations. PES made significant capital investments to try to improve the refinery’s economic sustainability and reverse years of financial losses. The sale of the refinery to PES approximately coincided with the development of crude oil from domestic shale resources. This new domestic supply of light, sweet crude oil came from places like North Dakota’s Bakken region or the Permian basin in Texas. At the time, these newly economic oil fields were geographically isolated and lacked extensive or efficient pipeline connections to markets. As a result, the primary way to move this new crude supply from the well to customers was by train. Given how this “shut-in” supply was difficult to logistically deliver to market, this light, sweet crude oil traded at a substantial price discount relative to other comparable crudes. This discount made new oil shale supplies economically attractive, even with the significant price premium associated with shipping crude by rail.

Historically, the Philadelphia refinery relied almost exclusively on crude oil shipped across the Atlantic via marine vessels. These Atlantic-borne crudes often came from politically unstable countries and included costly shipping premiums. PES took advantage of new, discounted domestic oil supplies as an opportunity to enhance competitiveness. It constructed, with state support, an advanced \$130 million railyard to the north of the refinery that had the capability of offloading four 104-car unit trains each day – meaning that up to 280,000 barrels per day could come by rail from this less expensive source.⁹ However, moving large unit trains of oil through a dense metropolitan area on a regular basis was not without controversy or public concern. This was due in large part by the hazards exposed during an oil train accident and explosion in Quebec in 2013 that killed 47 people. In fact, an oil train derailed on the nearby Schuylkill River bridge that resulted in a tank car dangling over the river but, luckily, was resolved without incident.¹⁰

While Bakken crude (priced on the WTI exchange) was trading at a discount to imported oil (priced on the Brent exchange), PES did well financially – reporting \$156 million in positive net income for the first three quarters of 2014.¹¹ During this time, the company appeared to be on more solid financial footing. Its leaders publicly announced various initiatives to expand and enhance its operations.¹² PES issued initial public offering (IPO) paperwork with the SEC for its rail logistics business in September 2014, and for its refining and marketing business in February 2015.

The competitive edge provided to PES from access to less expensive domestic crude, however, would not last. Over time, pipelines like the Dakota Access pipeline were constructed that linked the Bakken oil fields to markets and refineries in other parts of the country, mainly in the Gulf Coast and Midwest. These pipelines allowed Bakken crude oil to move more cheaply and efficiently to those places and also lowered the “shut-in” Bakken crude discount. However, pipelines were not built to bring the Bakken crude oil to the Philadelphia region. In addition, the cost to move crude by rail was no longer affordable for PES when the huge Bakken crude discount was reduced. Therefore, PES and other regional refineries were forced to go back to relying on more costly Atlantic-borne crudes. In general, this dynamic served to benefit Gulf and Mid-Western refineries and harm refineries on the East Coast.

Concurrent with the above developments, in November 2014, the Organization of the Petroleum Exporting Countries (OPEC) made a pivotal decision to not cut crude oil production at a time when supplies were plentiful, and the prices were low – which resulted in international Brent crude prices plummeting from a weekly average of more than \$108 in 2013 to less than \$55 in 2017. As a result of these developments, the price discount that once existed for bringing trains of Bakken to Philadelphia, compared to buying light sweet crude oil on the global markets, shrank considerably and so too did PES’ competitive advantage.¹³

As these market dynamics unfolded, it made less economic sense to ship Bakken oil by rail to East Coast refineries. These shipments peaked in November 2014 at 13,754,000 barrels per month, and shrank to less than 3,000,000 barrels per month by 2017.¹⁴ PES and other East Coast refineries, therefore, became more dependent on traditional, more expensive imported crude oil deliveries by ship while their competitors in the Midwest and Gulf Coast gained greater access to less expensive domestic crude oil from new pipelines. Gulf and Mid-Western refineries also benefited from access to steeply discounted Canadian tar sand-based crudes. These heavy, sour crudes require more complex refining capabilities to process - capabilities that PES does not possess.

U.S. Renewable Fuel Standard

The U.S. Renewable Fuel Standard (RFS) program was created by Congress through the Energy Policy Act of 2005 and was amended thereafter. The law requires a portion of traditional petroleum-based transportation fuel to be replaced by certain volumes of renewable fuel (e.g. corn-based ethanol, biomass-based diesel) that deliver lifecycle greenhouse gas reductions. These volumes (called renewable volume obligations, or RVO) are set by law and updated through regulations.

Refineries and importers of petroleum fuels are required to comply with the RFS by either buying compliance credits (called renewable identification numbers, or RINs) through a market, or generating their own RINs by blending renewable fuels with traditional transportation fuels. These parties are required to obtain enough RINs to meet their annual RVO.¹⁵

In its January 2018 bankruptcy filing, PES attributed RFS compliance costs, loss of access to cheap domestic crude, and declining gross refining margins at the top three factors driving the company into insolvency. As a merchant refinery - meaning it relies on the market, not affiliated businesses to purchase feedstock and sell refined product - PES is less insulated from RIN market price volatility compared to its vertically integrated peers that generate RIN credits through affiliated businesses. And, RIN prices can be quite volatile. For example, in late 2017, prices for D3 RINs were trading near \$3.00 per credit, while by late 2019 credit prices were trading below \$1.00.¹⁶

Sunoco (via Energy Transfer Partners) operates the Belmont Rack, located at the Philadelphia refinery site near 26th Street and Passyunk Ave. The Belmont Rack generates significant RIN credits that accrue to Sunoco via its on-site blending operations. However, the PES refinery does not presently have the ability to blend renewable fuels and has relied mainly on purchasing RINs on the market to meet its RFS obligations. This strategy has cost PES a substantial amount of money when RIN prices were trading at high prices, from an annual cost of \$13 million in 2013 to an annual cost of \$218 million in 2017. At one point, total RFS compliance costs were twice PES' annual payroll and represented its second largest operating expense after crude oil. At the time of its first bankruptcy filing, PES owed \$350 million in additional RIN compliance obligations.¹⁷

Any future petroleum refining business at the Philadelphia refinery site will be obligated to comply with the RFS, absent the law's repeal or revision. Successfully managing RFS compliance costs to limit downside risk when credit prices are high may be one of several key factors in maintaining financially viable refinery operations.

Financial Challenges and First Bankruptcy

For a time in 2014 and early 2015, PES appeared to be on stronger financial footing and the company experienced positive net income. During this period, PES explored an initial public offering (IPO) for its rail yard logistics subsidiary, as well as a separate, larger IPO for the marketing and refining business. These transactions would have made the private venture, which was self-valued at more than \$1 billion in February 2015, publicly traded and would have raised additional capital from investors to enhance and expand operations. However, due in large part to both poor timing and broader energy market conditions, PES postponed the IPO in August 2015 and the company remained in private ownership.¹⁸

In large part due to the financial burdens caused by shrinking crude oil price advantages, increased compliance costs with the federal Renewable Fuel Standard (RFS), investor dividends, and significant debts incurred from investments made in capital infrastructure, PES began to face a worsening financial position. In June 2016, reports surfaced that PES was looking for a buyer, but none materialized. In July 2016, PES cut production by 10% due to low profit margins and shortly after implemented a series of cost cutting measures targeted toward employee benefits, staff buyouts, and layoffs. Moody's downgraded PES' debt in November 2016 and again the following year, from B1 to Ca.¹⁹

With a \$523 million term loan set to mature in April 2018, PES filed Chapter 11 Bankruptcy for the first time on January 21, 2018 with the goal of continuing operations while restructuring its financial obligations. At the time it filed the bankruptcy petition, PES was more than \$580 million in debt secured by its refinery business, plus more than \$97 million in debt secured by the affiliated rail yard logistics business. The company also owed significant tax liabilities.²⁰

The Chapter 11 process provided PES with some relief from its debt obligations, including more than \$200 million in outstanding RFS compliance costs, and allowed the company to raise \$260 million in new capital. Owners of approximately \$525 million in debt extended \$417 million of that debt until 2022 and exchanged the remaining obligations for 75 percent equity in PES. Through this process, PES was able to maintain refinery operations and two of the company's lenders - Credit Suisse Asset Management and Bardonia Hill Investment Partners (formerly Halcyon Capital Management) - became the largest shareholders.²¹

PES Equity Ownership

(after first bankruptcy)

Equity Holder- Percentage of Equity Held

Credit Suisse Asset Management	Bardin Hill Investment Partners
29.43%	26.71%
Carlyle PES LLC	PES Equity LLC
15.00%	7.43%
Third Point Loan LLC	Other Equity Holders (combined)
7.27%	14.16%

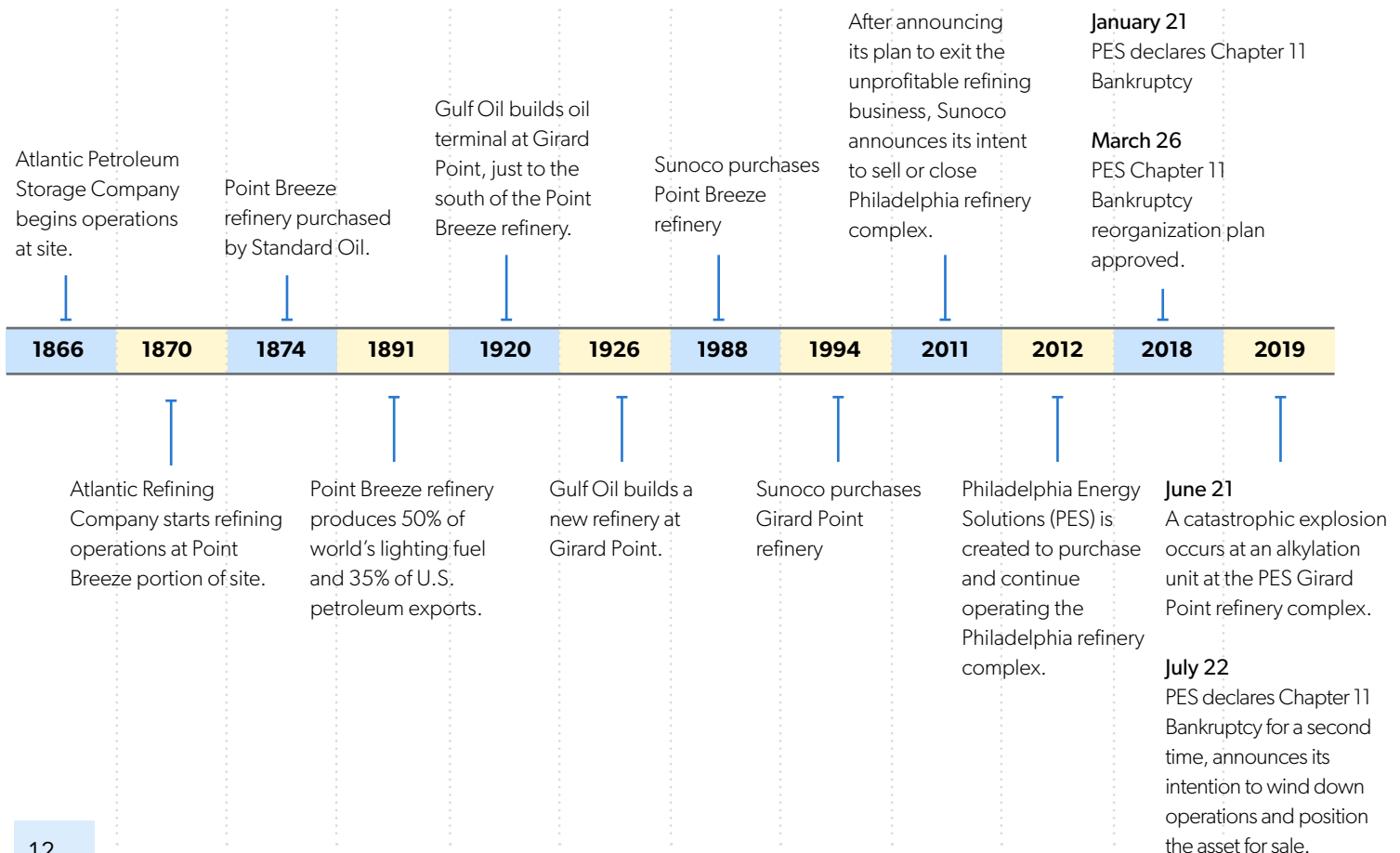
Source: List of Equity Security Holders, Filed July 21, 2019, In Re: PES Energy, Inc. Docket No. 19-11630, U.S. Bankruptcy Ct, Dist. DE.

However, questions arose over the long-term economic viability of PES to continue operating as it had been. Though the Chapter 11 process helped PES with restructuring and providing relief for some of its financial obligations, challenges remained.

Unless significant investments were made to improve PES' RFS compliance strategy, federal renewable energy policy changed significantly, feedstock costs declined, or refinery margins otherwise improved, the underlying structural and financial challenges facing PES would persist and at least one analysis anticipated a second bankruptcy filing in the future once the maturity date for more than \$417 million in restructured debt approached in 2022.²²

And then, on the morning of June 21st, 2019, a segment of elbow pipe at alkylation unit 433 at the Girard Point refinery complex that was installed in the early 1970s failed, leading to a catastrophic fire and explosion.

The Philadelphia Refinery: A Business History





Benefits Of The Refinery

Many government, labor, business, and political leaders rallied behind the need to “rescue” what was left of the refining industry due to its importance to the Philadelphia regional economy and its potential impact on gas prices

Throughout its long history and its chain of ownership, the oil refining industry has produced positive economic benefits to the City and to the region. However, around the time of the Great Recession and weaker demand, the region’s entire refining industry (which was comprised of 6 refineries at the time) was in economic trouble and its future looked grim. In 2009, Valero announced its intent to permanently close its large refinery in northern Delaware (which subsequently reopened under a new owner). That same year, Sunoco idled its Eagle Point, NJ refinery and later demolished it. In 2011, the ConocoPhillips refinery in Trainer, PA was idled (and later reopened under a new owner), and Sunoco announced its intention to fully transition out of the refining industry – threatening the future of its two remaining refineries in Marcus Hook and Philadelphia, PA. The sixth refinery, then operated by Valero in Paulsboro, NJ, was not seriously threatened with permanent closure, but it was purchased by a new operator in 2010.

In 2011, after several tumultuous years for the region’s refining industry and when Sunoco announced its intent to exit the refining business, many government, labor, business, and political leaders rallied behind the need to “rescue” what was left of the refining industry due to its importance to the Philadelphia regional economy and its potential impact on gas prices. These efforts, when viewed through the lens of trying to preserve jobs and economic activity at a time when the industry was contracting and the region was still continuing to recover from the Great Recession, were successful for a time – the Trainer refinery was purchased by a subsidiary of Delta Airlines and continues operations, the Marcus Hook refinery complex was repurposed to take advantage of its location and assets to serve as a natural gas liquids logistics and export facility, and the Philadelphia refinery was purchased by a new joint venture and continued to operate as a refinery.

As noted previously, the Philadelphia refinery – with state assistance – also developed new infrastructure such as the rail yard to try to enhance its competitive advantage in the years ahead. Thousands of highly paid, highly skilled, and difficult to replace jobs were preserved. For a time, the refinery appeared to be on stronger footing, and its leadership was encouraging the development of a regional “energy hub” to take advantage of the existing infrastructure, location advantages, and connections to the burgeoning Marcellus Shale natural gas field and position Philadelphia as a significant anchor of the energy industry once again. For many reasons, the vision of Philadelphia as an “energy hub” has not come to fruition – but numerous proposals to expand energy-related uses in proximity to the refinery have continued to emerge – including LNG, biofuels, and renewable natural gas.

“When the announcement came one year ago that this refinery was closing, the future seemed grim. By using imagination and a spirit of partnership, we found a solution.”

PA GOVERNOR TOM CORBETT, SEPTEMBER 19, 2012.²³

Economic Impact

The Philadelphia region’s refining economy has contracted since the Great Recession, from six refineries operating in early 2009 to four a decade later. However, the remaining refineries have significant economic impacts, both locally and regionally. By their very nature, refineries have long and complicated supply chains and rely on a wide range of vendors and suppliers. Most of PES’ largest vendors by dollar value were engaged with shipping and logistics through railroads, pipelines, and water-borne commerce; construction contractors; engineering services; employee benefits; specialty equipment rentals; and chemical supplies. In August 2019, PES reported a preliminary estimate to the City that between January 2018 and June 2019, it paid its 40 largest regional vendors more than \$720 million.

The analysis also estimated that the PES refinery had a total economic impact to the City of Philadelphia of \$2.1 billion. The refinery supported a total 6,300 full-time jobs (including indirect and induced) in Philadelphia (7,650 in Pennsylvania) with a total annual compensation of \$600 million.

Furthermore, a customized tax model used by Econsult Solutions estimated that the PES refinery had a total annual tax impact to the City of Philadelphia of \$33.2 million, and a tax impact to the Commonwealth of Pennsylvania of \$30 million (while also accounting for the refinery’s KOZ status). This data was not based on actual tax data due to confidentiality issues.²⁴

The analysis was intended to estimate the impact from a typical year of steady-state operations at the refinery. It is important to note that the estimate was prepared using an economic forecasting model tailored to assess the refining industry in the Philadelphia region, and limited data sets were available. Nevertheless, the findings indicate that the PES refinery had a substantial impact on the region’s employment levels, tax base, and economic activity.

Modeled Economic Impact of PES

Average Annual Full-Time
Employees (including contractors)

1,950

Total Annual Employee
Compensation

\$237m

Total Annual Expenditures

\$1.1b

Through the Refinery Advisory Group process, Econsult Solutions was contracted to perform a preliminary analysis of the economic impacts of the refinery complex. That preliminary analysis estimated that in a typical year, PES was responsible for directly employing an average of 1,950 full-time employees with a total annual compensation of \$237 million and total annual expenditures of more than \$1 billion.

This report acknowledges that this analysis is limited in scope to the economic impact generated by PES in the form of employment, spending, tax payments, and relevant multipliers. It does not attempt to capture any costs that may be attributed, wholly or partially, to any negative externalities associated with the refinery such as adverse health impacts in adjacent communities. While these factors are important to consider, such an analysis is difficult to accurately quantify and attribute specifically to the refinery given the many other contributing factors in the area, the presence of other pollution sources, and the complexities associated with the long periods of exposure and long latency periods often associated with many of the health impacts often associated with industrial pollution.

Jobs

In addition to having a broad economic impact throughout the region, the refining industry has traditionally been a large employer of a highly skilled workforce. In January 2018, PES employed approximately 1,100 people²⁵ in a wide variety of occupations –

including but not limited to managers and corporate executives, refinery operators, rail car unloaders, tank field operators, laboratory technicians, scale operators, warehouse staff, mechanics, and skilled trades. As reported in *The Philadelphia Inquirer*, according to the Federal Reserve a Pennsylvania refinery worker earned approximately \$107,000 per year, on average.²⁶

While the direct employment numbers are certainly substantial, consideration must also be given to the large contracted workforce that would be employed at the refinery on a regular basis. While PES employed 1,100 to operate the plant and the company daily, hundreds of skilled building trades workers would also be on site frequently to perform construction and maintenance activities at various parts of the facility. According to Ryan O’Callaghan, former president of the United Steelworkers Local 10-1, contracted building trades employees worked more than 8 million hours in the previous six years at the Philadelphia refinery.²⁷

In early 2012, when the future of the entire regional refining industry was in question, Reuters reported that the Pennsylvania Department of Labor and Industry produced a study estimating that 18.3 jobs would be lost for each refinery job lost, and that the total economic loss for the affected communities would be more than \$566 million in state and local taxes. In the same time period, the Delaware County Daily Times reported that more than 36,000 jobs were in jeopardy due to the potential closures of the three Pennsylvania refineries at Marcus Hook, Trainer, and Philadelphia.²⁸ Preserving and protecting the jobs associated with the refining industry has long been a priority in the region. Due to the contraction of the East Coast refining industry over the last decade, many of these highly skilled, high quality jobs are difficult to replace within the region – forcing many displaced workers to relocate to other regions (e.g. Mid-West or Gulf Coast refining areas) or to change careers.

Current and former employees of PES attended every Refinery Advisory Group public meeting. Many spoke to personally express a tremendous sense of pride in the work they performed and emphasized the importance they placed on safety while operating the refinery. Many also expressed understandable frustration at the events that led up to the present day, including frustration toward various decisions made by corporate management. Many expressed a strong desire to have the

refinery quickly reopened so they could go back to work, while others expressed their concerns over what the future would mean for them and their families.

Domestic Energy Supply

For many years, the Philadelphia region was home to a substantial percentage of the East Coast’s limited oil refining capacity. Prior to the June 21st incident, PES operated 28% of the East Coast’s refining capacity. The three Pennsylvania refineries in operation ten years ago were responsible for operating approximately 50% of the East Coast’s refining capacity – leading to concern over the extent to which the region would become more dependent on imported fuel if all three facilities closed.²⁹ The strategic importance of the regional refining industry to the East Coast energy supply was cited as a significant concern when political figures rallied to rescue the refining industry at the beginning of this decade.

Although the Philadelphia refinery is home to a substantial percentage of the East Coast’s refining capacity, it was notable that no significant shortages of motor fuels were reported in the region following the closure of either the Philadelphia refinery or other regional refineries in recent years. This was likely due, in large part, to the region’s heavy dependence on, and the ready availability of fuels being imported into the region from other places, such as the Gulf Coast or refineries located abroad.

Although no critical fuel shortages or price spikes were reported at the time, it is worth noting that the East Coast is increasingly reliant on fuels that are refined in other places. PADD 1 – the federally designated region that encompasses the East Coast for fuel data collection purposes – is a net importer of petroleum fuels that are made elsewhere. According to the Energy Information Agency, the PADD 1 region consumes more transportation fuels than any other domestic region but has the refining capacity to meet just one fifth of the region’s consumption.³¹

Refining capacity in PADD 1 has declined as refineries have shuttered – from a high of 1,741,000 barrels per day in July 2004 to 889,000 barrels per day by August 2019 after PES idled its operations.³² Demand in PADD 1 for fuels has also decreased over time. In a similar period of time, total volume of all finished

“Philadelphia Energy Solutions can help the United States work its way back to energy-independence and economic pre-eminence.”

PA GOVERNOR TOM CORBETT, SEPTEMBER 19, 2012.³⁰

Benefits of the Refinery

petroleum products supplied to PADD 1 dropped from 6,731,000 barrels per day in January 2004 to 5,504,000 barrels per day by August 2019.³³

This deficit between the region's demand for fuels and limited refining capacity has traditionally been met by deliveries of refined fuels via pipelines and ships from the Gulf Coast or from abroad. However, this dynamic presents potential risks to the East Coast's fuel supply in the event of pipeline disruptions or severe weather events impacting shipping traffic or refining activities. This risk may be particularly acute in the Pennsylvania,

New Jersey, and New York regions that once had reliable access to transportation fuels from pipelines connected to the Philadelphia refineries. Now, these markets, like the rest of the East Coast, are more dependent on fuels being shipped from Gulf Coast pipelines or barges.

Given the multitude of factors involved, it is too early to tell what the ultimate impact of the Philadelphia refinery's closure may have on fuel prices or energy supplies in the East Coast more broadly or in the Philadelphia area specifically. However, this dynamic is worth paying close attention to moving forward.

What We've Heard

“The economic benefits of the refinery don't just pertain to the City of Philadelphia but throughout the whole Delaware Valley region...we have to do everything we can to get the refinery up and running again.”



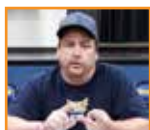
MARTIN W., AUGUST 6, 2019

“This is devastating. No one wins if we lose this refinery.”



JOHN B., AUGUST 6, 2019

“The Northeast is going to be devastated by the closing of the refinery.”



SHAWN T., AUGUST 20, 2019

“Our families depend on the health and welfare benefits and we are concerned about losing our healthcare and pension.”



DENNIS K., AUGUST 21, 2019

“As soon as you walk into PES, they tell you three things: Be safe, keep the products in the pipes, and take care of the community.”



TERRENCE F., AUGUST 21, 2019

“We are constantly worrying about safety and the environment – nonstop.”



BRANDON P., AUGUST 21, 2019

“The refinery is monitored daily, we have all kinds of equipment that tests the gases that come out of all equipment and monitors around the perimeter...”



BILL R., AUGUST 20, 2019

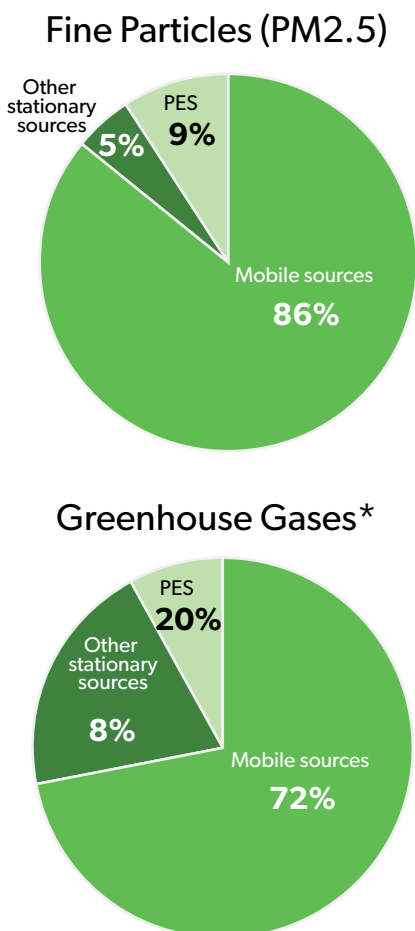
“We have an environmental department at PES that really looks out for others...nothing happens at PES without the proper permits.”



JIMMY M., AUGUST 20, 2019



Costs of the Refinery



*Including carbon dioxide, methane, and nitrous oxide

The refinery contributed many positive benefits to the Philadelphia region in the form of jobs, economic activity, tax revenue, and security and stability for the region's energy supply. However, the refinery also had significant negative impacts that must be considered, as well.

Air Pollution

Oil refineries, by their very nature, produce a variety of emissions from numerous processes. Distillation units, alkylation units, cracking units, pumps, boilers, heaters, flares, storage tanks, and other critical systems all generate different forms of air pollution. During steady state operations prior to June 21st, the Philadelphia refinery was the largest stationary source of air pollution in the city. According to the Department of Public Health, the refinery was estimated to be responsible for approximately 9% of the city's fine particle (PM2.5) emissions and 20% of greenhouse gas emissions.

Additionally, the refinery was the largest single emitter of toxic pollutants in Philadelphia. On average, the refinery has released 467,600 lbs. of air toxics annually since 2014. According to 2016 data from the EPA's Toxic Release Inventory, the 464,284 lbs. of toxic emissions attributed to the refinery represented 56.65% of total toxic emissions from larger sources in Philadelphia that year. These toxic emissions include benzene and other known carcinogens.³⁴

Types of Air Pollution

"Criteria Pollutants" are 6 common pollutants defined by the EPA that are mainly produced by combustion and are associated with poor air quality, heart and lung disease, and reduced life expectancy. These include particulate matter (PM2.5 and PM10), nitrogen dioxide, ozone, carbon monoxide, sulfur dioxide, and lead.

"Air Toxics" are chemicals that may have long-term risks for cancer or other serious health or environmental effects. These chemicals are typically released from industrial sources and include benzene, dioxin, and formaldehyde.

"Greenhouse Gases" are gases that contribute to climate change by absorbing and emitting radiant energy in the atmosphere. Many of these gases are naturally present, but the burning and development of fossil fuels are a major source of them. Examples include carbon dioxide, methane, and nitrous oxide.

Costs of the Refinery

The Philadelphia Department of Public Health, through its Air Management Services (AMS) division, administers and enforces local, state, and federal air pollution requirements as applicable to the refinery. This effort includes:

- Issuance of air pollution permits that provide for air pollution emission limits, work practice, record keeping, emissions testing, and air pollution monitoring requirements. These requirements include the siting of fence line air monitors for certain Criteria Pollutants.
- Routine inspections of the facility to ensure compliance with air pollution permits and attendant requirements. These inspections are often performed in conjunction with the EPA.
- Operation of a city-wide air pollution monitoring network that measures airborne concentrations of Criteria Pollutants.

Additionally, following a Consent Decree, PES operates air monitors along the fence line to measure particulate matter (PM_{2.5} and PM₁₀), ozone, sulfur dioxide, lead, carbon monoxide, nitrogen oxides, hydrogen sulfide, and benzene.³⁵

The refinery has a significant history of permit deviations. However, capital improvements and equipment upgrades have been made over the years to reduce emissions at the refinery. Since 2014, annual releases of air toxics from the refinery dropped by approximately 38% when compared to 2011-2013 figures.³⁶ Since PES took ownership of the facility in 2012, AMS has issued 7 Notices of Violation (NOVs) to the refinery for air pollution - about one every year.³⁷ The violations cited in these NOV's ranged in severity from minor odor or opacity events to emission limit exceedances from certain heaters, boilers, and other process equipment.³⁸ However, the number and severity of the violations in the NOVs were not serious enough to warrant closure of the refinery, or major infrastructure changes.

Air pollution from the refinery complex has been a source of concern in surrounding communities for a long time, and the refinery's prior owners faced lawsuits from community and environmental groups seeking to force changes to reduce pollution from the site. Concerns over pollution and its impacts on public health were a dominant theme raised by members of the public throughout the Advisory Group process.

While the data indicates that the refinery is a significant source of air pollution, including certain air toxics that are known to have adverse health impacts, it is not the only significant source of air pollution impacting nearby communities. For example, the largest source of Philadelphia's PM_{2.5} (86%) fine particle emissions is mobile sources, which includes exhaust from transportation vehicles. The neighborhoods nearest the refinery, in particular, are located in close proximity to major highways,

railroad lines, the Philadelphia International Airport, and port facilities - all of which are significant sources of PM_{2.5} and other forms of air pollution. At least one commenter claimed that the level of toxic air emissions in neighborhoods closer to the refinery have been, on average, higher than in the city overall.³⁹

However, 2014 EPA National Air Toxics Assessment (NATA) data indicates that the Respiratory Hazard Index (i.e. the likelihood that exposure to air toxics would lead to adverse, non-cancerous health effects) for these neighborhoods is among the lowest in the City.⁴⁰ The NATA data also indicates that cancer risk from exposure to air toxics in these neighborhoods is comparable to the cancer risk rates in Center City Philadelphia.⁴¹ Similarly, the City's air monitoring network measurements indicate that neighborhoods near the refinery, on average, have PM_{2.5} levels comparable to the citywide average.⁴²

Health Impacts

Concerns over the impacts of the refinery on public health were a dominant theme of the comments and feedback raised throughout the Advisory Group process. This concern was expressed by numerous members of the public, advocacy organizations, and academic experts at every public meeting hosted by the Advisory Group.

While it is well understood that pollution can negatively impact public health, it is difficult to attribute specific public health impacts to any specific industrial site when the public is also exposed to pollution (and other health risks) from other sources. According to the EPA, calculating the impact that exposure to air pollution has on people depends on many factors, such as the amount and type of pollution, the specific mixture of pollutants, exposure doses and durations, and individuals' susceptibilities to diseases.⁴³ Determining causation becomes even more complicated when considering that long latency periods often exist between the time of exposure and the onset of cancer and other health effects. However, data strongly suggests that Philadelphians suffer disproportionately adverse health effects, and many of these health effects are correlated to emissions like those generated from the refinery.⁴⁴

The National Cancer Institute estimates that Philadelphia has the highest cancer rate of any large city in the U.S. The data indicates that in Philadelphia, 541 of every 100,000 people will get cancer compared to 442 per 100,000 nationwide and 494 per 100,000 for Pennsylvania. Philadelphia has a higher rate of lung cancer and kidney cancer than the state average - and both cancers are linked to exposure to particulates and benzene. Additionally, Philadelphia has an asthma hospitalization rate three times higher than the state average, according to the PA Department of Health.⁴⁵

While there are many contributors to these health outcomes, exposure to volatile organic compounds and particulate emissions, over time, increase these risks to human health. These health impacts may include respiratory illness, cancer, and negative birth outcomes.

Though the City is not aware of any studies that have focused on the direct impact of this refinery on health, studies have been performed elsewhere that indicate the impact that air pollution from oil refineries can have on respiratory health impacts. According to testimony presented by members of the Drexel University School of Public Health, air pollutants such as nitrogen dioxide, PM_{2.5}, and sulfur dioxide have been associated with increased respiratory illnesses among people living near refineries.⁴⁶

In summary, it is clear that the refinery has been a significant source of air pollution in Philadelphia. It is also clear that exposure to certain air pollutants poses health risks, and that a reduction in air pollution can be expected to lead to better health outcomes. However, there are many other sources of air pollution that impact nearby communities, and many other communities within Philadelphia that are located a greater distance away from the refinery are exposed to similar levels of air pollution and associated health risks. Therefore, while a reduction in air emissions from the refinery site may help improve Philadelphia's air quality more generally, it is difficult to tie that reduction in refinery emissions directly to a reduction in the air pollution that impacts any specific community or population because there are other relevant risk factors and pollution sources involved.

In addition to considering the human toll caused by these factors, one must also consider the negative economic impacts caused by public health detriments when evaluating the full picture of economic benefits and costs of any large industrial facility. While this is an important consideration to make, due to limitations in data it was a calculation that was beyond the scope of this report.

Soil and Ground Water Pollution

While any petroleum-related land use is likely to have some level of pollution or contamination associated with it, the Philadelphia refinery site suffers from particularly extensive soil and ground water contamination due to its very long history of processing oils. For the site's first century of operations, virtually no environmental laws or regulations existed.

Liquid refinery products like gasoline are present on the groundwater in many areas beneath the site, and evidence suggests that these contaminants likely have migrated offsite – which may also potentially impact a drinking water aquifer used by New Jersey.

In the present day, the refinery complex has its own advanced wastewater treatment system on site to clean and process stormwater runoff on the site, which mitigates the flow of pollution into nearby waterways. However, the refinery is still responsible for more than 5,000 pounds of water pollution annually and historical contamination remains in the ground throughout the site.⁴⁷

Sunoco was mandated by consent order to clean up the soil and water on the site. Sunoco retains responsibility through its subsidiary, Evergreen Resources Management Operations, to remediate most of these liabilities. To fulfill this obligation and release itself from state and federal liability once the remediation work is completed, Sunoco entered the site into Pennsylvania's Act 2 voluntary remediation program. Sunoco's remediation plans call for the vast majority of the site to be remediated to a site-specific, non-residential standard. Sunoco's subsidiary, Evergreen, has funding in place to support the remediation work, which will take many years to complete.

Criticism and concerns have been raised over how the required Public Involvement Process (PIP) for the Act 2 plans was handled. Many argued that Evergreen did not hold the appropriate public meetings or make information available to the public as required by Act 2. In response to this criticism, the City of Philadelphia has requested that Evergreen create a new PIP and adhere to a longer time frame for accepting public comments. During the Advisory Group process, many expressed concern about current environmental conditions of the site and about Evergreen's intent to remediate the site based on a non-residential standard, with many advocating for a more stringent standard that would enable portions of the site to contain a wider range of activities than continued heavy industrial or commercial uses. However, under Act 2, the responsible party is permitted to remediate to a site-specific standard and there is no obligation to restore site conditions to what they were before a refinery was built.

Dangers Posed by Hazardous Chemicals

Oil refineries, by their very nature, contain many different hazardous chemicals – often in large quantities. These risks are magnified by the dangers posed by processing large quantities of highly flammable or explosive materials in close proximity to those other chemicals. Risks to public health and safety are magnified by conducting refining activities in densely populated areas.

The Philadelphia refinery complex has suffered from large fires throughout its history – some of which ended with fatal consequences. The refinery has a dedicated fire brigade that is specially trained to respond to emergency issues and works closely with the Philadelphia Fire Department. But nevertheless, fires can and do occur – and they pose a particularly high risk in a refinery setting.

Costs of the Refinery

While risks can be managed and precautions taken, risks can be minimized and planned for but never truly eliminated. According to the U.S. Chemical Safety and Hazard Investigation Board (CSB), the bulk hydrogen fluoride (HF) used at PES contained an additive intended to reduce its volatility in the event of a release.⁴⁸ However, this additive, while significantly slowing the evaporation/volatilization of the HF if released, could not totally eliminate the risk of a release caused by a large explosion nearby, as the events of June 21st demonstrated.

Regardless of how well the workforce is trained, and how many safety precautions are in place, something could always go wrong at a large industrial site like a refinery. And when hazardous chemicals are in close proximity to highly flammable liquids, in the center of an urban area, the potential consequences are even higher.

Urban Context

The geographic context in which the Philadelphia refinery is situated is far from ideal in many ways. While the site has many positive benefits to the refinery due to its infrastructure and access to road, rail, and water transport, it sits amid one of the most densely populated parts of the U.S.

When the refinery site was first used for petroleum production, it had few neighbors – and the area along the lower Schuylkill was specifically used for petroleum production to isolate the city from the dangers to the public and waterways. Over time, however, the city grew around the refinery and now more than 113,000 people live within 1 mile of its fence line, and more than 1 million people live within a 7-mile radius.⁴⁹ Residential encroachment near the refinery site occurred decades ago, at a time when it was not uncommon for homes to be built directly across the street from polluting industries. This development occurred before zoning laws or comprehensive development plans came into practice and would not be encouraged today.

However, although the refinery came to the site first, the reality in recent decades is that many of the communities located closest to the refinery, which are most directly impacted by air pollution and other negative external factors, are disproportionately populated by lower income populations and communities of color - many of whom did not choose to reside in close proximity to an oil refinery or have the means to relocate. While many middle- and upper middle-class neighborhoods are located within one mile of the fence line, there are also large public housing developments and historically disadvantaged neighborhoods located in the same proximity. This dynamic raises obvious concerns around environmental justice and

disproportionate impacts on low-income people who have fewer choices about where to live, and these concerns were repeatedly raised by the public during Advisory Group meetings.

Population within 1 mile of refinery fence line

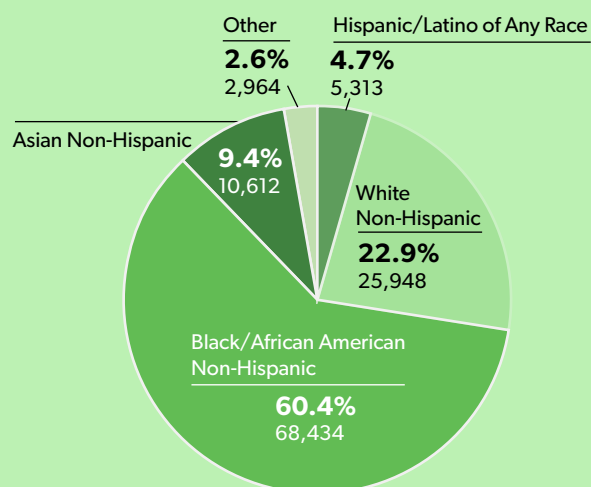
Total population (2018 est)

113,271

Total \$ of households

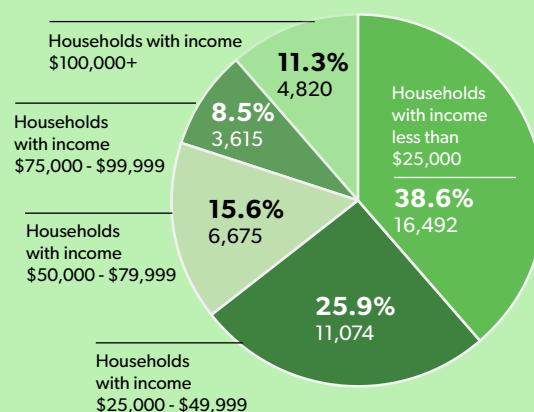
42,676

Racial Demographics



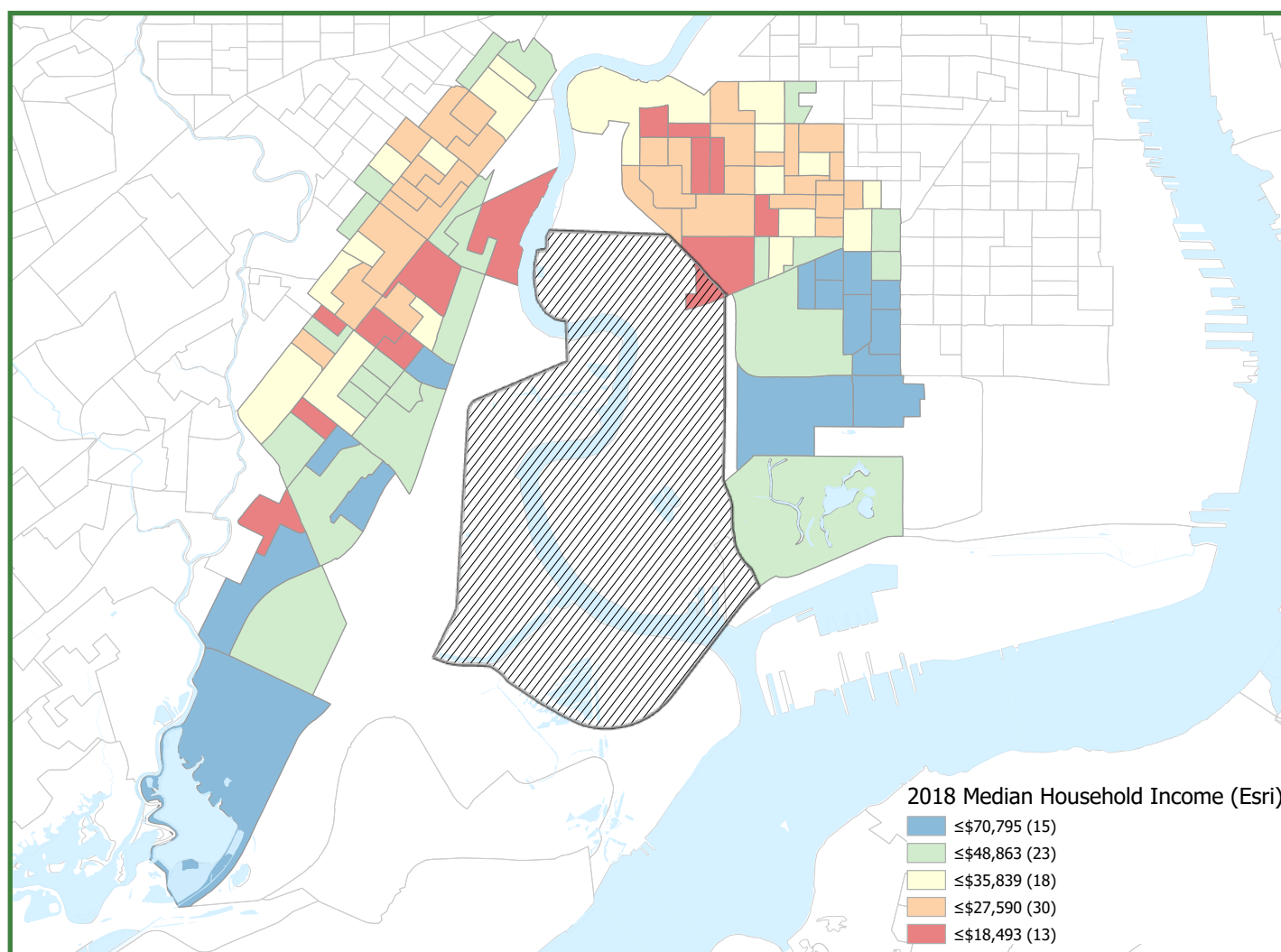
Number of Households by Household Income Range

Range of average household income levels by census block
\$14,880 - \$114,821



Source: 2018 demographic estimates from Esri "Popular Demographics in the United States" data set, updated July 1, 2019.

Median Household Income Within 1 Mile of Refinery



Additionally, the presence of the refinery has negative impacts on the perception that many visitors have of Philadelphia. For much of the refinery's history, Philadelphia was a bustling hub of dirty, heavy manufacturing industry that took advantage of the City's access to ports, rail, markets, and workers. In recent decades, however, as heavy industries industry declined, Philadelphia has experienced a rebirth fueled by economic sectors that rely more heavily on the service economy, tourism, hospitality, higher education, and other non-industrial sectors. Major highways and the Philadelphia International Airport were built, putting the sprawling refinery's location near a primary gateway to the City. As Philadelphia has tried to transform its economy from post-industrial decline to an attractive and competitive place to do business in the modern economy, concerns were raised by some through the Advisory Group process as to whether the site should continue to be seen as an anchor to the traditional, regionally declining petroleum economy or whether it should be used to position Philadelphia as a hub of economic rebirth and exemplify the creation and development of energy jobs of the future.

Climate Change/Environmental Concerns

Concerns over the broader environmental impact of oil refineries were also frequently raised throughout the Advisory Group process.

The fossil fuel industry is a well-known contributor to carbon dioxide and other greenhouse gas emissions. According to the EPA and as reported by Christina Simeone, the PES refinery was the 8th largest emitter of greenhouse gases in Pennsylvania and the largest, by far, in Philadelphia. As of 2014, the refinery emitted between 2.9 and 3.2 million metric tons of carbon dioxide equivalent annually.⁵⁰

Mainstream scientists have increasingly sounded the alarm over the need to reduce carbon emissions in order to have a meaningful impact on the threats posed by climate change. The most recent report from the International Panel on Climate Change indicates that worldwide carbon emissions must be slashed by 2030 before the impacts of climate change

Costs of the Refinery

become irreversible. The City of Philadelphia has recognized the importance of reducing global carbon emissions in order to mitigate the impacts of climate change, and Mayor Kenney committed to upholding the commitments of the Paris climate agreement at the local level and reduce Philadelphia's carbon emissions between 26 and 28 percent by 2025, with a long-term goal of 80% reductions by 2050.

Many have advocated for a moratorium on fossil fuel development and an increased focus on adopting and developing clean energy technologies that reduce consumption of fossil fuels. These concerns were voiced throughout the Advisory Group process, along with broader calls to use the closure of the PES refinery as an opportunity to highlight the potential to retrain displaced petroleum workers for jobs in the green economy.

What We've Heard

“We are living in fear...I just want my family to live.”



SONYA S., AUGUST 20, 2019

“It's a sad day when people can't work, but it's also sad when you lose family members and you know when your doctors tell you it's because of the fossil fuels at the refinery....”



SYLVIA B., AUGUST 20, 2019

“I am extremely concerned about the hydrogen fluoride stored on-site.”



KATHERINE R., AUGUST 6, 2019

It is worth noting that although an end to refining activities at this specific location may help with reducing the City's carbon emissions and meeting its long-term climate goals, this impact must be balanced against the reality that fossil fuel development continues to increase in other parts of the world – including in areas that do not have the same level of environmental regulations. Ultimately, reducing consumption of fossil fuels and increasing the adoption of cleaner technologies will have a more significant and lasting impact on lowering carbon emissions than shuttering one refinery.

Specific to the PES refinery, climate change also poses tangible risk to significant portions of the site. Due to its low elevation and location along a tidal waterway, portions of the site are vulnerable to increased flooding risks due to sea level rise – a topic discussed in greater detail later in this report.

“The closure of the PES refinery represents a major improvement to air quality, public health, and quality of life in Philadelphia and would remove the city's single largest industrial contributor of greenhouse gases.”



MATT W., AUGUST 6, 2019

“The City should use any influence it has to transform this site into something that serves the clean energy economy rather than something that impedes it.”



MARK S., AUGUST 27, 2019

“It is time to demand that labor leaders start rapidly preparing members for the transition off of fossil fuels because it is coming, and we all need you to be ready.”



TAMMY M., AUGUST 21, 2019

“South Philly is the best neighborhood for several reasons, except for the air pollution...we have had so much tragedy in South Philly due to asthma.”



VIRGINIA H., AUGUST 6, 2019

“I got involved with Philly Thrive because we as an organization believe that everyone has the right to breathe clean air.”



MARK C., AUGUST 20, 2019

“I believe Philadelphia wants this land for non-polluting, non-fossil fuel purposes...given what we know about climate change, it would be highly irresponsible for the land to be used to process fossil fuels again.”



WALTER T., AUGUST 27, 2019

“Overall fossil fuels have been a good thing, but we know that too much of a good thing can be lethal...and fossil fuels are now lethal.”



CHERYL P., SEPTEMBER 9, 2019

“While transitioning from petroleum as the source of our carbon-based chemicals poses a great challenge, it also presents a tremendous opportunity for a sustainable and prosperous future.”



NADINE G., AUGUST 27, 2019

“The fact is, we don’t need the refinery. Philadelphia has an opportunity to be a clean, green city.”



PAMELA G., SEPTEMBER 9, 2019

“We have all benefited from a fossil fuel economy, both here in Philadelphia and around the world, but these cheap fuels have come with a disastrous cost.”



AUDRA W., AUGUST 6, 2019

“In the area where the refinery is, South Philadelphia has the highest cancer rates, highest childhood asthma rates...”



CAROL H., AUGUST 20, 2019



The Incident on June 21st

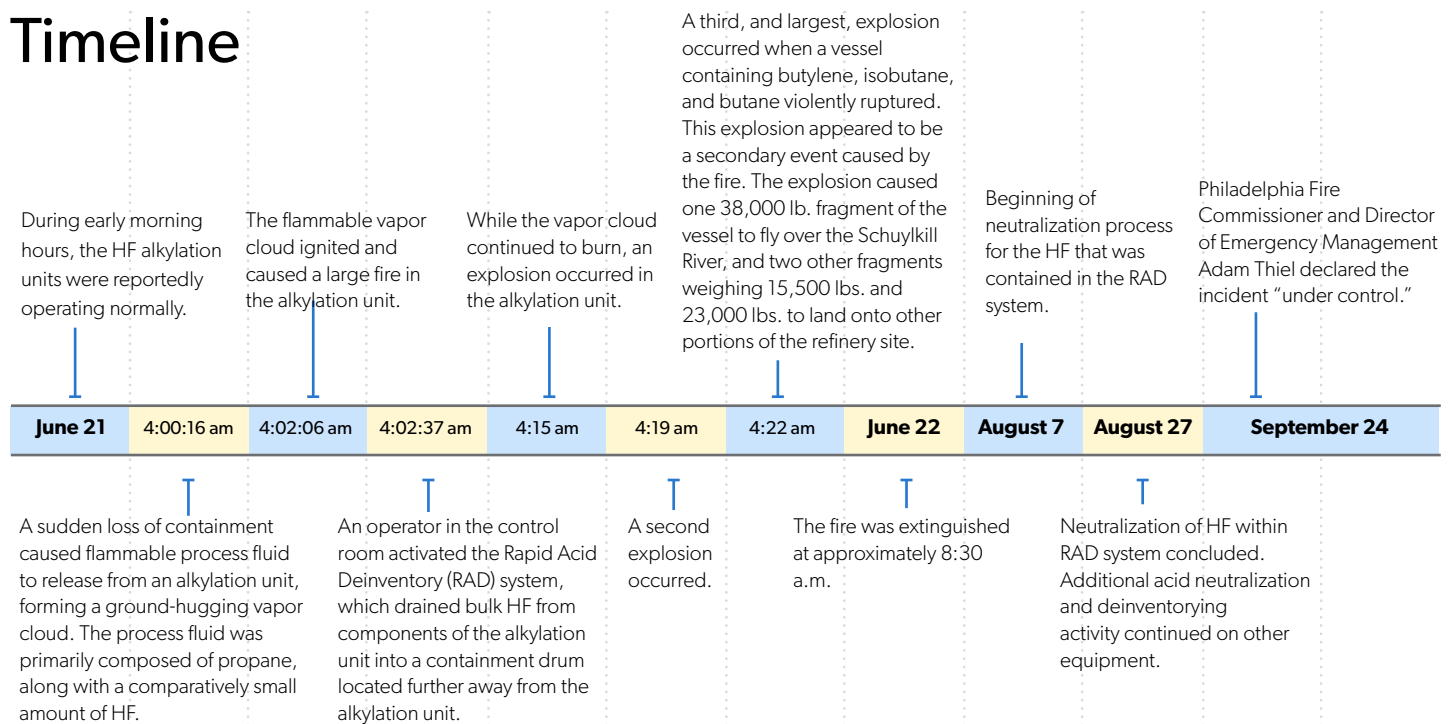
At the time this report was written, multiple investigations into the incident were ongoing. Until those investigations are thoroughly conducted and concluded, it is impossible to have a full and complete understanding of what led up to the catastrophic explosions that occurred on June 21st. However, in the months since June 21st, City officials have gathered a basic set of preliminary, underlying facts surrounding the incident.

What Happened

According to preliminary findings released by the U.S. Chemical Safety and Hazard Investigation Board (CSB), the alkylation units appeared to be operating normally at the Girard Point refinery complex. Then, at approximately 4:00 am, a leak suddenly occurred that led to highly flammable process liquid escaping from the pipes of the alkylation unit and forming a vapor cloud near ground level. This vapor cloud, which was primarily comprised of propane with a low concentration of HF - was visible on security camera footage. Very shortly after the leak began, the vapor cloud ignited and caused a large fire.

PES employees manning a control room quickly stepped into action and activated a Rapid Acid De-inventory (RAD) system that was installed previously by Sunoco to rapidly drain the HF in the unit and safely contain it in the event of an emergency. More than 96 percent of the HF known to be on site at the unit was safely and successfully evacuated from the immediate vicinity of the fire and contained in the RAD drum.

Timeline



(Source: "Factual Update – Fire and Explosions at Philadelphia Energy Solutions Refinery." U.S. Chemical Safety and Hazard Investigation Board. October 16, 2019.)

Seven minutes after the control room operator activated the RAD system, the ongoing fire caused the first in a series of three explosions in the alkylation unit. The third and largest explosion occurred seven minutes after the first one, when a vessel containing butylene, isobutane, and butane violently ruptured. According to the CSB, this explosion appeared to be a secondary event caused by the fire. This explosion produced an enormous fireball that was widely portrayed in the media and was powerful enough to send a 38,000 lb. fragment of the vessel across the Schuylkill River (a distance of approximately 2,100 feet) and other large fragments to crash down on other parts of the refinery site.⁵¹

The fire was extinguished the following morning on Saturday, June 22nd. Thankfully, nobody was killed or seriously injured as a result of the fire or explosions. According to the CSB, five workers experienced minor injuries during the incident and response and neither the CSB nor the City of Philadelphia are aware of any offsite or onsite health impacts from any HF release.⁵²

Potential Cause

As noted previously in this report, it is impossible to have a full and complete understanding of what led to the incident on June 21st until all pending investigations have been thoroughly concluded. At the time this report was written, these investigations remained ongoing.

However, preliminary findings and factual releases made by the CSB, as well as industry alerts released by PES, indicate that a ruptured 8-inch, 90-degree pipe elbow appears to be what led to the process fluid release that led to the fire and explosions that occurred that day.

The process fluid running through the pipe circuit where the failure occurred was highly flammable and corrosive – comprised of approximately 95% propane, 2.5% HF, and 2.8% other hydrocarbons. The pipe circuit appears to have been installed in the early 1970s and both the elbow that failed, as well as the adjacent elbow that did not fail, featured the same stamp indicating that both pieces were constructed to meet the same ASTM A234 WPB material specification.⁵³

The pipe circuit was routinely tested using ultrasonic technology at specific locations to monitor the thickness of the pipe. These designated testing locations were referred to as “condition monitoring locations” (CML). According to industry protocols, these pipes were subject to “retirement” when they corroded to less than 0.180 inches in thickness.⁵⁴

The Incident of June 21st

While there were numerous CMLs located on this pipe circuit, the specific elbow pipe that failed did not have a CML. Therefore, while the thickness of the pipe circuit was regularly monitored in other locations, the thickness of this specific elbow pipe was not regularly monitored.

According to the CSB, recent PES inspection data from 2018 indicated that the thickness measured at nearby CMLs on the pipe circuit (including pipe segments immediately adjacent to the elbow joint that failed) were well within acceptable standards. For example, measurements taken at multiple nearby CMLs on the same pipe circuit reported thicknesses of more than 0.300 inches in 2018. According to an industry alert from PES, the thickness measured on the elbow pipe immediately adjacent to the failed elbow measured 0.311 inches. At the time the pipes were first installed, their thickness was 0.322 inches. – indicating relatively low corrosion rates over more than 40 years in service.⁵⁵

However, after the incident on July 21st, it was discovered that the minimum thickness of the unmonitored elbow that failed was just 0.012 inches – just 7% of the minimum acceptable thickness level of 0.180 inches and less than the thickness of a credit card.⁵⁶

The ruptured elbow pipe and an adjacent elbow both featured the same material specification stamps, and are believed to have been installed in the same time period. One could conclude, therefore, that the pipe segments should have been made of the same alloy and would therefore be subject to similar corrosion levels over time. However, following the incident, testing indicated that the ruptured elbow had a different chemical composition than the adjacent elbow.⁵⁷

The ASTM A234 WPB material specification in effect when the pipes were installed did not contain specified maximum content levels for nickel or copper. In 1995, these standards were revised to include a maximum nickel content of 0.40% and maximum copper content of 0.40%. Following the incident, tests revealed that the pipe elbow that failed contained a 1.74% nickel content and a 0.84% copper content – well in excess of the revised 1995 specifications – while an adjacent pipe elbow that remained intact and showed far less corrosion had a nickel content of less than 0.01% and a copper content of 0.02%. The chemical composition of both the ruptured elbow and the adjacent elbow were within the allowable maximum standards (including the 1995 revised standards) for all other elements.⁵⁸

Since investigations are ongoing, no final, comprehensive analysis, conclusions or recommendations have been rendered regarding the full range of factors that contributed to the incident. However, these preliminary facts and findings suggest that this specific elbow joint was not made of the same chemical composition as the other pipe segments on the circuit, the

The Incident of June 21st

elbow joint that failed contained higher levels of nickel and copper than updated standards would permit, and these higher levels of nickel and copper likely contributed to an accelerated rate of corrosion beyond what was measured or anticipated for the rest of the pipe circuit.⁵⁹

Upon discovery of these underlying facts regarding the different chemical composition of the failed pipe, PES management distributed an industry alert disclosing these known facts and recommending that other “refiners with HF alkylation facilities should consider conducting a one-time thickness measurement on all installed piping components in spooled sections of carbon steel piping systems in HF acid service, possibly including positive material identification, to determine whether accelerated localized corrosion is occurring.”⁶⁰

Immediate Aftermath

Though the fire was extinguished the following day, significant hazards remained present on the site and the extent of those hazards was not fully known for some time. Due to this uncertainty, personnel from the Philadelphia Fire Department and the Office of Emergency Management - assisted by multiple state and federal agencies - remained on site 24 x 7 for more than three months following the incident to ensure public health and safety. During this time, a primary focus of Philadelphia’s first responders was to ensure that the HF that remained on site in the RAD system was stable, contained, and safely monitored until it was successfully neutralized.

The leak of process fluid, fire, and series of explosions were substantial and caused a significant release of hydrocarbons from the refinery’s pipes and processing systems. As reported by the CSB, PES estimated that approximately 676,000 pounds of hydrocarbons were released during the event and 608,000 pounds of those were combusted during the fire and explosions.

Although the vast majority of the HF that PES estimated to be on site was safely and successfully contained in the RAD system, a comparatively small quantity of HF was present in a low concentration in some of the process equipment and pipes that failed during the incident. As a result, some quantities of HF were released into the atmosphere. According to the CSB, PES estimated that 5,239 lbs. of HF were released from the piping and equipment. Some of this release (approximately 1,968 lbs.) was contained by a water spray safety system within the alkylation unit and drained to the refinery’s wastewater treatment plant, where it was processed. The remaining 3,271 lbs. were not contained by either the RAD system or the water spray and was released into the atmosphere.⁶¹

While the release of any quantity of HF is cause for serious concern, it is important to note that neither City officials nor federal agencies have identified any known offsite or onsite health impacts from the release:

- First responders and refinery employees working in close proximity to the site of the incident did not report any adverse health effects that would suggest they were exposed to any significant quantity of HF.
- No air monitors are known by the City to have reliably recorded elevated HF levels. Though one portable air monitor deployed by the City’s Department of Public Health after the explosion recorded an elevated HF reading, this reading was confirmed to be a “false positive” due to the meter being improperly calibrated. No other monitors are known to have recorded elevated HF levels migrating off the property, and neither did any air monitors located downwind of the site of the incident.
- Air modeling performed by the Federal Emergency Management Agency’s Interagency Modeling and Atmospheric Assessment Center (IMAAC), based on the actual timeline of the incident and the known weather conditions on site at the time, indicates with high confidence that the vapor cloud that leaked out of the alkylation unit could not have traveled a far enough distance from the site of the leak prior to ignition to have crossed the facility perimeter and posed an external threat to surrounding communities. Furthermore, the subsequent fire and explosions likely had a significant effect with dissipating and diluting any remaining HF to concentrations well below levels that would cause health effects.⁶²

On September 24th, following the successful neutralization of the HF contained in the RAD system and the complete restoration of the air monitoring network on the PES site, the incident was declared “under control” by Commissioner Thiel. By making this declaration, the Commissioner communicated that any remaining hazards on the site were understood and believed to be safely contained to the immediate vicinity of the incident. Once the incident was declared under control, PFD and OEM ended its 24 x 7 staff presence at the PES facility and remained in frequent communication with the leadership of PES and other responding and investigating agencies. The total costs incurred by the City for all work related to responding to the refinery incident and its aftermath since June 21st totaled approximately \$1.9 million.



Current Status

The City of Philadelphia has entered an appearance in the bankruptcy proceeding in order to remain informed and involved in the process as it unfolds.

Present Conditions

The explosions on June 21st seriously damaged the 433 Alkylation Unit and caused PES to stop refining operations at the Girard Point refinery complex. PES continued to operate the neighboring Point Breeze portion of the facility, which was not directly affected by the fire or explosions, until August when the last of the crude oil stored on site was refined. Though PES is no longer refining crude oil and has laid off the majority of its workforce, the company has maintained a small caretaker crew on duty at the refinery to monitor conditions, operate and maintain core systems, safely store and remove millions of gallons of liquids and gases that were still on site, and ensure that the complex remains safe and in a condition that will allow the plant to be restarted in the future following the outcome of the bankruptcy process.

Second Bankruptcy Filing

A month after the incident on June 21st, PES filed for Chapter 11 bankruptcy on July 21st for the second time in two years. The filing followed the announcement that PES intended to end refining operations without a restart date planned. However, by filing under Chapter 11, rather than Chapter 7, the company indicated its initial intent to restructure its operations and debts, rather than dissolve and sell the assets to satisfy creditors as would occur through Chapter 7.

The company's lenders also agreed to provide up to \$100 million in additional financing to operate the company, wind down refinery operations, and position the assets for a sale or restart while the bankruptcy process unfolded. As reported, PES had an insurance policy on its facility that could provide up to \$1 billion for property damage and \$250 million for loss of business.⁶³

It was widely reported in the news media that PES was soliciting expressions of interest and bids for entities wishing to purchase the refinery assets. As of November 10th, media reports indicated that 15 potential bidders expressed written indications of interest in acquiring the site.⁶⁴ However, it remains to be seen what types of businesses emerge offering viable, credible proposals for the site's future and those details will not be known until formal bids are submitted and the bankruptcy auction, if any, takes place.

The City of Philadelphia has entered an appearance in the bankruptcy proceeding in order to remain informed and involved in the process as it unfolds. On November 14th, 2019, the Bankruptcy Court approved a process for the sale of PES' assets. An auction of said assets is currently scheduled for January 17, 2019. If competing bids are received and the auction is held, representatives of the City of Philadelphia will attend and shall consult with PES on the bidders' proposed future use and

Current Status

development of the site as appropriate. However, the City is just one of many parties in the proceeding and while it is likely that the City will be able to exert some influence over aspects of the site's future through this process, the City will not be able to dictate who buys the site.

Broader Economic Challenges

Long before the events of June 21st, the PES refinery was facing significant financial challenges. While some of these financial challenges were internal due to the restrictive financial and legal arrangements that existed between the PES refinery operation, related subsidiaries, and creditors, many of the challenges were external, structural challenges that would be difficult for any similar independent merchant refinery operator to compete against.

Crude Oil Economics

As noted previously in this report, the Philadelphia refinery complex is built to process light, sweet crude oil and produce mainly fuels. Unless very substantial capital investments are made, the refinery cannot process less expensive crude oils that have higher sulfur content, or produce a wider range of other marketable petrochemical products.

The Philadelphia refinery features a state-of-the-art oil train offloading facility, which allowed it to benefit from less expensive Bakken crude oil for a period of time. At the time this railyard was built by PES, numerous other refineries in the region – including Monroe Energy in Trainer, PA and PBF Energy in Delaware City, DE, were also developing the rail infrastructure to import crude from domestic sources by rail.

However, as noted by the U.S. Energy Information Agency, the economics of crude-by-rail depend heavily on the relationship between prices of domestic and international crude oils. The discount that once existed between Bakken crude and imported crude has diminished over time and so has the attractiveness of bringing Bakken crude to Philadelphia by train. Meanwhile, new crude oil pipelines have been built to connect the Bakken region with other regions like the Midwest and Gulf Coast – allowing refineries in those regions to tap into this crude oil source without paying the cost premium involved with shipping crude by rail to the East Coast, where these pipelines do not exist. Thus, Bakken by rail shipments to the East Coast have declined substantially from a peak in late 2014.⁶⁵

In summary, the Philadelphia refinery no longer received the level of financial advantage it once did from bringing crude by train and had to rely more on expensive crude imported internationally. Meanwhile, the refinery had to continue to pay predetermined contractual fees to its rail yard subsidiary regardless of the volume of train traffic moving through the yard.⁶⁶

For the existing refinery complex to be on stronger financial footing for the long term, future operators would have to consider whether it makes economic sense to either make the capital improvements necessary to process less expensive crude oils; consider whether there are new opportunities to bring light, sweet crude oil to the facility at a discount to the international import market; and consider other options to lower the operating costs and improve the production efficiency of the refinery.

Risks to Customer Base

In addition to experiencing financial challenges from crude oil markets, the Philadelphia refinery is facing challenges from losing access to portions of its traditional customer base.

Laurel Pipeline:

The Philadelphia refinery complex is connected to major consumer markets in the East Coast through a series of pipelines. These pipelines allow finished products to efficiently travel to where they are consumed. One of these pipelines – the 350-mile Laurel Pipeline, owned by Buckeye Partners – allowed the Philadelphia refinery, as well as other regional refineries and importers with East Coast fuel terminals, to ship fuels westward to markets in Western Pennsylvania. At one point, PES claimed that 20% of its total production traveled to the Pittsburgh area through this pipeline.⁶⁷

Since at least 2016, however, Buckeye has sought to reverse the direction of portions of the Laurel Pipeline to allow growing Midwest refineries greater access to Pennsylvania markets at the expense of East Coast refineries. Shortly after the incident on June 21st and the announced closure of PES, Buckeye reached a settlement with refiners and retailers to reverse portions of the pipeline and allow Midwest refineries to ship fuels east through the pipeline as far as Altoona, PA. The settlement allows for bi-directional traffic between Pittsburgh and Altoona until the end of 2024, after which Buckeye could permanently switch the flow and end east-to-west traffic at Altoona.

However, the settlement also contains language that if pipeline shipments from PES or a successor fall off after 2022, then the agreement would no longer apply through 2024 and Buckeye could petition to use the pipeline exclusively to ship fuels from west to east into Central Pennsylvania.⁶⁸

Should these terms and conditions continue into the future, and if the flow direction on the Laurel Pipeline is permanently shifted to supply Central and Western Pennsylvania markets with fuels produced in the Midwest, the Philadelphia refinery and other East Coast refineries will face a significant loss of customer base at the expense of rivals in other regions – further hindering their ability to be competitive and economically viable under their current business models.

Changing Maritime Fuel Standards:

Changing environmental regulations regarding residual fuels also pose a risk to a portion of the refinery's traditional customer base. Commercial shipping vessels have traditionally consumed large quantities of heavy fuels that are produced as byproducts of the distillation process. Many of these fuels, such as Number 6 bunker oil, have high sulfur content and generate significant emissions when burned.

Beginning in January 2020, the International Maritime Organization will mandate that most vessels convert to burning lower sulfur fuels (or implementing expensive environmental control systems). Whereas the current standards permit fuels with a sulfur content as high as 3.5%, the new standards require fuels to have a sulfur content of 0.5% or less. These new standards are expected to reduce SOx emissions from global shipping by up to 77% annually.⁶⁹

While positive for environmental health, the adoption of this new fuel standard will cause notable disruption in the fuel supply system. Refineries, including the Philadelphia refinery, will have to adapt to the new standards by implementing new technologies and making significant capital investments to reduce the sulfur content in the fuels they produce for this segment of the market or risk losing access to it.

RIN Issue Still Unresolved

As noted previously in this report, the federal Renewable Fuels Standard (RFS) placed a substantial financial cost on the Philadelphia refinery. PES' strategy for complying with the RFS by purchasing RINs on the market cost the company a total of \$832 million over a six-year period between 2012 and 2017 and represented the second largest operating cost to PES by the time it filed for bankruptcy for the first time in 2018.⁷⁰

Absent any changes to federal policy, the cost of compliance with the RFS may fluctuate from being manageable to deleterious, for any future operator of the Philadelphia refinery site as it is currently configured. However, there are potential paths forward for a future refinery operator to comply with the RFS while reducing these operating costs. For example, PES (or a future refinery operator) could acquire Sunoco's blending

facilities at the Belmont Rack, or enter into strategic partnerships with other renewable fuel producers and blenders. Indeed, prior to the incident on June 21st, PES was actively exploring partnerships to develop a \$120 million renewable energy plant at the refinery site that would convert food waste into biogas, which PES would then purchase. This arrangement would have assisted PES with meeting its RFS obligations without having to rely on purchasing as many RINs on the open market in order to do so.⁷¹

A wide range of options like these exist for a refinery operator to be able to lower its RIN costs and improve compliance with the RFS, but those options require sufficient capital, time, and strategic partnerships to develop.

Waning Demand for Gasoline

In addition to potentially losing access to much of its traditional customer base due to pipeline reversals, the Philadelphia refinery faces long term challenges due to projected declines in demand for certain fuels in the years ahead.

According to IHS Markit, demand for gasoline is anticipated to peak around 2020 due in large part to increased fuel efficiency and wider use of electric/hybrid vehicles. These declines in demand are expected to pressure U.S. refiners to cut production, and East Coast refiners are expected to feel particular pressure due to their comparatively higher operating costs and competition from other supply sources, such as refineries located in other regions or overseas. IHS anticipates that East Coast refinery capacity utilization – following a decade of capacity contractions from refinery closures – will continue to decline, from near 90% in 2018 to 30% by 2050.⁷² Additionally, there has been a steady decline in the demand for home heating oil, which was also produced by the refinery.

This report does not attempt to present a thorough financial analysis into the viability of the refinery's business model, nor does the City have access to PES' internal financial data. However, based on these (and other) underlying economic conditions, legitimate questions can be raised as to how economically viable the existing Philadelphia refinery would be in the long term unless substantial and costly upgrades are made to make the plant more efficient to operate and to diversify its business model into different lines of crude oil feedstocks, consumer products, and renewable fuel production capabilities.



Potential Reuses

While the City of Philadelphia does not have direct control over the future of the refinery site, it does have some tools it can use to exert limited influence over what happens.

Powers of the City

Throughout the Advisory Group process, City officials have explained the **limitations** upon the role of City government in determining the future of the refinery site:

- **The refinery site is privately owned and controlled.**
As a result, the City has no legal authority to tell the owner whether to sell some or all of its property, who to sell it to, or what to do with it. Virtually all of the refinery site is zoned I-3 Heavy Industrial, which allows a full range of industrial uses with the fewest restrictions of any industrial zoning district.⁷³
- **Zoning changes cannot prohibit a future refinery or mandate a change of use for the site – at least in the short term.** The site has been in use as a refinery for more than 100 years, and petroleum-related uses long pre-date the existence of Philadelphia's zoning laws. As a result, the existing land uses are "grandfathered" in and are allowed to continue in the future. If the property were to be re-zoned in the future to prohibit a refinery or other heavy industry, existing uses would be permitted to continue as "nonconforming uses" – which are uses that were legal prior to the adoption of a zoning ordinance that would render the uses illegal. Under Pennsylvania and Philadelphia law, nonconforming uses may generally continue to operate (and often expand) until the nonconforming use is "abandoned" at the site – regardless of whether the ownership or tenancy of the property changes.⁷⁴

Determining whether a nonconforming use has been sufficiently "abandoned" to no longer be grandfathered in is fact specific. In Philadelphia, this requires that the nonconforming use be "discontinued" for more than 3 consecutive years. The law also requires that for the use to be considered "discontinued" for any period of time, there must be evidence that the owner or lessee no longer intends to use the property for that purpose. This evidence may include the owner removing improvements necessary to support that use, modifying the property to make it unsuitable for that use, allowing required permits or licenses to lapse, or failing to pay taxes related to the nonconforming use. Maintaining necessary licenses, making improvements to the property to accommodate the use even when it is not actively operating, and efforts to market the property for that use during the time when it was not actively operating may all be evidence to prove that the use has not, in fact, been discontinued.⁷⁵

- **The refinery site is involved in a bankruptcy proceeding.** While in bankruptcy, PES retains control of its operations and assets. PES has a fiduciary duty to maximize the value of those assets for the benefit of its creditors. PES is currently engaged in a sale and auction process. Who will ultimately be the successful bidder will determine the near-term future for the site. Any sale must be approved by the U.S. Bankruptcy Court in Delaware. The Court is likely to approve the sale if it finds it reflects a reasonable exercise of PES' business judgment. The City, although actively involved in the case, is one of many creditors and interested parties and is not in a position to dictate what should happen to PES or to its site – or whether PES should continue as a refinery or sell any of its assets to any specific party. The future of both PES and its assets will ultimately be decided through the bankruptcy process and by the range of viable bids and offers that surface through that process.
- **Eminent Domain is not a viable near-term option.** Upon learning about the limitations of the City's role in this process, some have suggested that the City could exert greater control and influence over the future of the site by condemning it using the power of eminent domain. The City and Philadelphia Redevelopment Authority can take title to private property, via eminent domain, through a process known as condemnation. Such takings of private property can only be done for specified public purposes. However, such takings do come with significant costs.

First, the City and Redevelopment Authority must compensate the owner of any property that is to be condemned by paying the owner fair market value. Second, in condemning property, the City and Redevelopment Authority would inherit liability for the clean-up of any environmental contamination that exists on any property that is condemned. Both of these issues would be subject to lengthy and time consuming litigation, and the total process would likely cost taxpayers hundreds of millions of dollars (or more) - funds that the City does not have available for this purpose.

Though the City does not have direct control over the future of the refinery site, it does have some tools it can use to exert limited influence over what happens there in the future:

- **Economic Incentives.** Much of the refinery site is enrolled in Pennsylvania's Keystone Opportunity Zone (KOZ) program, which is designed to encourage business activity and investment at specific sites that are abandoned, vacant, or underutilized. Properties and businesses located within KOZs pay little to no state and local business taxes for a defined period of time. KOZ designations can be authorized for up to 10 years, although sites that remain vacant or underutilized may be extended through a similar

approval process to new KOZs. The KOZ designation covering most of the refinery site was approved by the State in November 2013 for a 10-year period beginning January 2014 through December 2023. As a condition of the City's KOZ application for portions of the refinery site, PES entered into a Payment in Lieu of Taxes (PILOT) Agreement for the 10-year term of the KOZ. That PILOT payment is set at 110% of the real estate taxes (approximately \$1.25 million annually) that would be due if the site had not received KOZ designation. The City may submit an application to the State seeking extension of KOZ benefits subject to authorization for specific parcels by both City Council via legislation and the School District of Philadelphia Board of Education via resolution. Applications are submitted to the PA Department of Community and Economic Development for consideration. Any extension of KOZ benefits would be conditioned upon continuance of the PILOT agreement.

While the KOZ program is the most robust incentive program at the City's disposal, the City also has a range of additional discretionary economic development incentives it can use to encourage business growth and development within the City, including Tax Increment Financing (TIF) or grants and forgivable loans. These programs can be utilized to encourage business activities that align with the City's values and vision.

- **Infrastructure Assistance.** Much of the 1,300-acre refinery site currently exists as large tracts of privately-owned land that are fenced off with relatively few connections to the City's roadway or infrastructure network. If the future of the site is conducive to a range of activities, it is likely that parcels of the site may either require subdivision or the construction of additional infrastructure like streets, water, sewer, or river access to improve connectivity to the rest of the City. Should this situation occur, the City could leverage its infrastructure to help support the development of uses that support the City's values and vision. Should the City decline to assist with building this type of infrastructure, the onus to provide it would be on the property owner.
- **Targeted Assistance for Specific Initiatives.** The City may also be able to exert influence to encourage certain uses on the site in a more targeted way than offering tax breaks or building roads. For example, the City has substantial purchasing power that could be leveraged to encourage the development of green energy. The City, therefore, could enter into a power purchase agreement to encourage the development of solar or wind energy on portions of the site, or agree to purchase biofuels for use in municipal vehicles. The City can also offer targeted workforce development assistance through its partner agencies like Philadelphia Works to ensure that future users of the site have access to the trained workforce they require.

Environmental Remediation Issues

As previously noted, the site's long history in the petroleum industry has led to substantial environmental contamination in the soil and ground water throughout the site. These conditions will significantly influence the range of activities that are viable or safe on the site.

The site is enrolled in Pennsylvania's Act 2 voluntary remediation program, which is administered by the PA Department of Environmental Protection. Under the terms of the sale of the refinery to PES, Sunoco retained liability for dealing with legacy contamination that occurred before the sale in 2012. PES, in turn, is responsible for any contamination that occurred under its ownership. Sunoco created a subsidiary, Evergreen Resource Management Operations, to address these legacy contamination issues with funding identified to perform the work.⁷⁶

Remediation plans for the site's 11 areas of interest are in various stages of development, and the actual remediation work will take many years to complete. However, current plans call for most of the refinery site to be remediated to a site-specific non-residential standard based on the site's current and long-standing use as a heavy industrial site. Various technical reports and environmental assessments that have been developed so far in the Act 2 process are available online at <https://phillyrefinerycleanup.info> and can otherwise be reviewed at PA DEP's Southeast Regional office in Norristown.⁷⁷

While the existence of a responsible entity with funds available to deal with legacy environmental issues may be an advantage for encouraging expressions of interest in the site moving forward, these existing conditions also limit what is possible on the site in the years ahead. Unless it is decided, and deemed technically feasible, to clean portions of the site to a higher standard, the site will likely remain in use primarily for industrial or commercial purposes in the years ahead.

What the Future Might Look Like

Though the history and underlying facts around the refinery and its site are complex, the site has advantages that, if maximized, can ensure that it is used in a way that adds value to the Philadelphia region for many years to come.

Throughout the Advisory Group process, many stepped forward with ideas for what they would like to see happen on the site and what they would absolutely not like to see happen. The opinions and suggestions were wide ranging in their vision as well as their level of economic feasibility. Many agreed, however, that the site should at least be put to some form of productive use.

It is worth noting that the refinery site, at more than 1,300 acres, presents a tremendous opportunity to host a range of uses. There are no other developable sites available in the City that come close to this size. In 2013, the Philadelphia Industrial Development Corporation, Philadelphia City Planning Commission, and the Commerce Department released a master plan for the Lower Schuylkill that envisioned much of the existing refinery site to be utilized to support the energy industry's growth and diversification. The plan also called for nearby areas to be utilized to support innovation and logistics due to critical links to highways, railroads, ports, airports, and close proximity to Center City. Regardless of which activities are situated there, the existing attributes of the site strongly suggest that the area would be an ideal place to anchor a large and regionally significant center of employment.⁷⁸

Site Assets

The following existing assets are likely to make the site attractive for certain future uses:

- **Excellent, high quality industrial infrastructure that is difficult to find elsewhere.** The site contains a significant amount of petroleum processing equipment, storage facilities, connections to interstate pipelines, and related infrastructure. Industrial-scale utilities, including a wastewater treatment plant, rail facilities, and port access, are also present.
- **Strategic location.** The site sits at the crossroads of two interstate highways and a short drive to Philadelphia International Airport and the City's major seaport facilities. Much of the site also contains frontage along the tidal portion of the Schuylkill River, which is navigable. Pipelines connect the site to shipping terminals on both the Delaware and Schuylkill Rivers, enabling liquid products to be easily transported between land and sea.
- **Favorable existing zoning.** The site's I-3 zoning designation is the City's most permissible industrial zoning category and permits a wide range of industrial uses with minimal restrictions.
- **Access to a large supply of skilled labor.** The Philadelphia region is home to an enormous workforce, including skilled trades labor and an existing workforce that is well trained in refinery and heavy industrial operations due to the industry's long history in the region.

Site Liabilities and Uncertainties

The site also has some attributes that may hinder or complicate redevelopment opportunities:

- **Legacy soil and groundwater contamination will limit future uses.** The Act 2 remediation process will take many years and, at the time of this report, will not remediate conditions to a level that will support non-commercial development. While future owners of the site will not be responsible for remediating this contamination, the existing conditions will limit future development to industrial and commercial uses and may complicate the construction and engineering methods required to build new structures on the site.
- **The extent of the fire damage and condition of the processing equipment.** While PES had an insurance policy for the unit that was damaged on June 21st, the ongoing investigations into the incident and the insurance claims process will complicate how quickly the Girard Point facility could be brought back online. Additionally, the refinery facility has an extensive amount of infrastructure that, while maintained over the years, has not been upgraded to the most state of the art technologies due to a lack of investment from recent operators. These factors may influence the viability of any proposals to restart refining operations in that portion of the facility and encourage a different use or range of uses in that part of the site.
- **Flood risk.** Sea levels are projected to rise in future years due to climate change, and many moderate scenario projections from NOAA suggest that large portions of the refinery site in the vicinity of the Schuylkill River Tank Farm and Girard Point will experience more frequent and severe flooding events in the years ahead. Future development must take these risks into consideration when planning what to build, where to build it, and how to build it.
- **Urban location.** While proximity to a large population center may be advantageous for certain uses, it poses complications for any contemplated uses that involve dangerous chemicals, emissions, or other activities that may pose unacceptable risk levels to the surrounding community. Future users of the site must be mindful of how proposals for the site will be received by and interface with the surrounding community.
- **Pervasive infrastructure on site.** While the presence of abundant industrial infrastructure may be advantageous for certain uses, it may also complicate or delay the development of other, non-refinery uses on portions of the site.

Likely Potential Uses

Through the Advisory Group process, IHS MarkIt was consulted to provide a market analysis to better inform officials about the range of possibilities that are likely to emerge for the refinery site. Preliminary findings were presented in a public meeting of the Advisory Group on September 9th. Based on an assessment of overall market conditions, conditions of the site itself, and prior experience with similar industrial reuse projects elsewhere, the two entities determined that the following uses were likely to express interest in the site:

- **Continued petroleum processing.** It is likely that some, or all, of the site could be viably maintained for some type of petroleum processing – whether that includes refining or primarily storage and logistics activities. It is important to note that the Point Breeze portion of the refinery was unaffected by the incident on June 21st and could be restarted with minimal effort – and all the necessary infrastructure to run a refinery is already in place – but whether doing so would be an attractive or profitable option remains a question. However, based on the overall market forecasts and structural issues outlined in this report, it is unlikely that the full, 335,000 barrel/day refinery could be profitably operated in the same manner in the long term unless substantial investments are made to change its business model. To remain competitive in the long run, the refinery would need to be configured to process a wider range of lower cost crude oils, produce a wider range of consumer products, and (absent changes to federal regulations) develop renewable production or blending capabilities to lower its RFS compliance costs. While these investments are not impossible to make, it remains a question as to whether any companies or investors are willing to step forward and contribute the capital needed to make it happen.
- **Alternative energy.** The site has many pipelines, storage tanks, and processing equipment which would make it an attractive location to produce biofuels or other forms of renewable energy. The massive footprint of the site leaves abundant room to accommodate solar generation throughout the site without conflicting with the development of other uses. Interest may emerge to take advantage of the site's direct port access for wind turbine manufacturing, as well. The site's industrial character may also be attractive for resource recovery uses, such as tire distillation, syn-gas production, and organic and municipal waste processing and recycling.

- **Natural Gas Liquids.** Existing energy-related infrastructure may make the site attractive for petrochemical industries that need access to ethane and propane.
- **Petrochemical.** Existing infrastructure may also support industries centered on the production of ethylene, plastics, polypropylene, chemicals, and plastics recycling activity.
- **Manufacturing, warehousing, logistics, and distribution.** The existing zoning, site size, and easy connections to highways, railroads, port, airport, and customers make the site an attractive location for manufacturing activity, warehouses, port activities, and firms that are focused on storing items and moving them to market.

Examples from Elsewhere

Many other large industrial sites have been repurposed to support the next generation of economic activity, and some of these examples may help predict what the site may look like in the future:

Marcus Hook, PA: Former Sunoco oil refinery repurposed into the Marcus Hook Industrial Complex and Keystone Industrial Port Complex. Serves as a Natural Gas Liquids hub, where products from the Marcellus Shale region arrive by pipeline and are shipped to consumer markets, including through export.

Paramount, CA: Former refinery converted to produce renewable diesel and jet fuels.

Le Mede, France: Former refinery now includes a biofuel refinery, an 8-megawatt solar farm, a petrochemical plant, a logistics and storage hub, and a training center.

Dartmouth, Nova Scotia: Refinery that closed in 2013 was converted into a marine terminal operation.

Shell Haven, England: Refinery closed in 1999, was redeveloped into a container port, business center, and storage/distribution facilities.

Sparrows Point, MD: Former steel plant is currently being redeveloped for logistics and manufacturing.

Who Ultimately Decides?

Given the current trajectory of the bankruptcy proceeding, it is likely that the short-term future of the refinery site will be decided when the Bankruptcy Court approves a sale to the successful bidder for the refinery's assets. However, there are several key factors that will influence the long-term fate of the site, which are outside the control of either the Bankruptcy Court or the City of Philadelphia:

- What does the site's owner want to do? Both the current owner and the future owner.
- What activities and projects can the market justify? What is profitable?
- Future owners must have the resources needed to execute their vision.
- Future uses must find ways to be compatible with the existing site conditions – the site's advantages, as well as its disadvantages.
- What is the cost involved in making any necessary infrastructure changes to upgrade facilities, change systems to allow different uses, or remove systems?

Given the current trajectory of the bankruptcy proceeding, it is likely that the short-term future of the refinery site will be decided when the Bankruptcy Court approves a sale to the successful bidder.



Next Steps/ Moving Forward

Through this Advisory Group process, City officials have learned a lot about how different groups of people feel about the refinery site

Guiding Values

Through this Advisory Group process, City officials have learned a lot about how different groups of people feel about the refinery site and what they would like to see for its future. At this point, nobody truly knows what the future will specifically look like in the short or long term – those proposals will emerge through the ongoing bankruptcy process. However, based on what we have heard and learned throughout this process, we can define and put forth a series of values that can shape how, and under what conditions, the City responds to future ideas and proposals for the site.

Based on what was learned since June 21st and through the Advisory Group process, the City should favor and encourage a future for the refinery site that:

1. Puts the public's safety as a top priority. Risks and hazards to the public should be minimized to the greatest extent possible in every aspect of how the site is used.
2. Has a more positive impact on public health and the environment than the status quo ever had. Air, soil, and groundwater pollution from the site should be minimized and remediated and operations should be more environmentally friendly than ever before.
3. Provides significant long-term economic benefit to Philadelphia and its residents, including through high quality, family sustaining jobs. The site should be put to a productive use that is financially viable and creates high quality employment opportunities.
4. Provides direct community investment and engages meaningfully with surrounding communities. Future users should work collaboratively with surrounding neighborhoods to ensure that there is openness, transparency, trust, and positive impacts across the fence line – including through community benefits agreements or targeted job training or hiring initiatives. Future users should listen and respond to community concerns.
5. Provides for diverse uses/activities on the 1,300+ acre site. Regardless of how it is used in the future, the site is large enough to accommodate more than one use. The site's size should be utilized to support as many economically, socially, and environmentally positive activities as possible.

Though the City lacks direct power over determining the future of the site, the City will likely be able to exert some level of influence over specific aspects of the site's future - whatever that future may be. For example, there may be economic incentives, infrastructure enhancements, or other resources that the City

may be called upon to provide for the site in the years ahead to assist with its future development. To what extent the City responds to any such requests should be determined by whether, and to what extent, the future uses support the values set forth by the City.

These five values respond to the major concerns and incorporate the common themes that emerged from every stakeholder group throughout this process, and can help ensure that the City responds to whatever future proposals emerge for the site in a manner that will further the public interest – of making sure that the site, first and foremost, is cleaner and safer than it was in the past while still making positive contributions to Philadelphia and its residents.

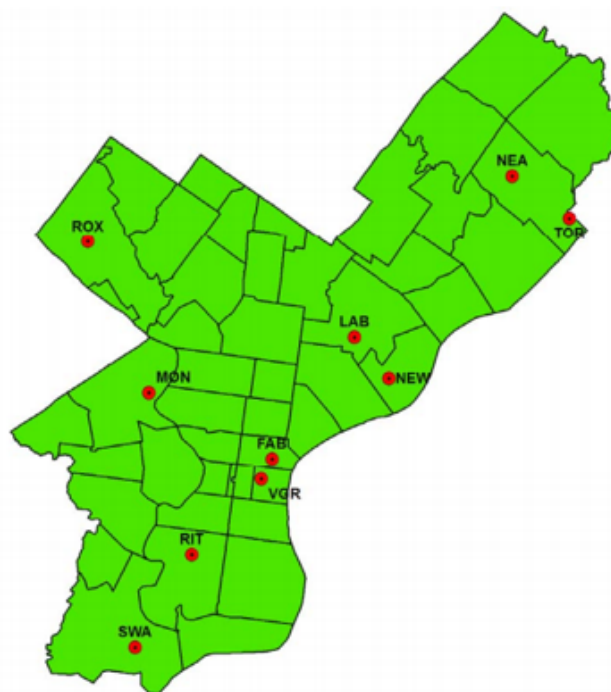
Specific Recommendations

While the City is not using this report or process to make recommendations for what the future use or uses of the site should or should not be, the information gathered through this process and after the events of June 21st have helped to highlight some specific areas where the City can make improvements to its operations and regulations. Feedback received through the Advisory Group process has also helped define some specific recommendations that the City, as well as the future occupants of the site, should consider regarding how the site could be positioned to improve its impact on the environment and surrounding community – regardless of what the future range of uses will be on the site.

Review Air Monitoring Capabilities

The City of Philadelphia, through the Department of Public Health's Air Management Services division (AMS), administers and enforces air pollution regulations within City limits. AMS operates and maintains a network of 10 stationary air monitoring stations located throughout the City. Each monitoring station is configured to measure a different series of pollutants. This monitoring network is designed to present a comprehensive, citywide view of air pollution levels.

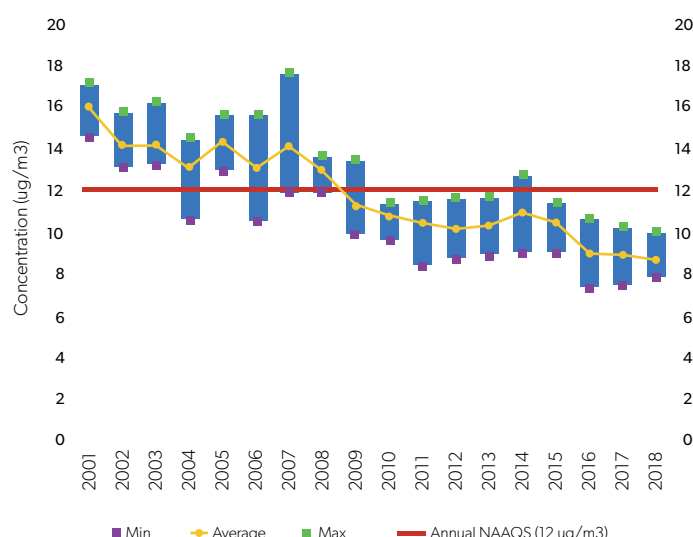
Philadelphia Air Monitoring Network as of July 1, 2019



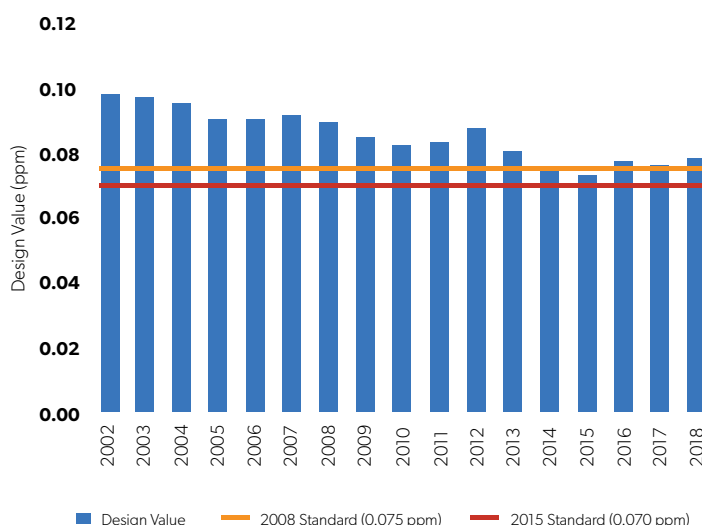
			Parameter															
AQS Site Code	AMS Site Address	CO	SO ₂	Ozone	NO ₂	NO _x /NO	PM ₁₀	PM _{2.5}	Speciated PM _{2.5}	PM Coarse	Black Carbon / Ultrafine PM	Carbonyls	PAMS VOC	BaP	TSP Metals (Ba, Cr, Mn, Ni, As, Cd, Pb)	Toxics TO15	MET	AMS Site
421010004	LAB 1501 E. Locoming St			X														LAB
421010014	ROX Eva & Dearnley Sts											X					X	ROX
421010024	NEA Grant Ave & Ashton Rd			X														NEA
421010048	NEW 2861 Lew is St	X	X	X	X	X	X	X	X	X		X	X				X	NEW
421010055	RT 24th & Ritner Sts		X					X	X			X			X		X	RT
421010057	FAB 3rd & Spring Garden Sts							X										FAB
421010063	SWA 8200 Enterprise Ave											X					X	SWA
421010075	TOR 4901 Grant Ave & James St	X			X			X										TOR
421010076	MON I-76 & Montgomery Drive	X			X			X			X			X	X		X	MON
	VGR 6th & Arch Sts			X				X									X	VGR

Overall, Philadelphia's air quality has improved significantly over the years as various environmental standards were tightened, use of cleaner fuel sources expanded, and heavy industry declined. Since the start of the 21st Century, the average annual PM_{2.5} levels have declined in the city by nearly 50% and ozone levels, while still higher than the recently lowered federal air quality standard, have also declined significantly.

Trends in Annual PM_{2.5} (Fine Particles)



Trends in Yearly Ozone Ozone Design Value at NEA



However, despite this progress, the City has room to improve the monitoring of air quality to ensure that the City is better prepared to quickly identify hazards and protect people from them. Accordingly, the City should:

- Ensure that if the refinery site remains in use as a refinery or other heavy industry that generates emissions, then the site should be required to have a robust air monitoring network that provides data to City officials. The monitoring should include measurements of any hazards posed specifically by the operations of the site.
- Evaluate whether it is feasible to make the data from the City's air monitoring network available, in real time, to the public and government officials to otherwise enhance the city's response to air pollution incidents and releases.
- Review the locations of the City's current air monitors to determine if they continue to be appropriately located and configured to provide a comprehensive picture of air quality in the City as required by EPA.
- Determine whether existing air monitors that are part of the City's air monitoring network can detect/monitor specific hazardous chemicals, like HF, that are being used in the various industrial facilities that would pose a particular risk to public health if they are released in significant quantities. Steps should be taken to enhance air monitoring capability, where appropriate, to monitor for specific known risks near specific sites.

Increased Oversight of Hydrofluoric Acid (HF) and Other Chemicals

The City of Philadelphia and the CSB are unaware of any offsite or onsite health impacts reported from the HF release that occurred from the incident on June 21st.⁷⁹

According to air modeling performed by IMAAC, there is no indication that any significant quantity of HF crossed the refinery's property line, and no evidence to suggest that any members of the public, PES personnel, or emergency responders were exposed to hazardous HF levels.⁸⁰

However, the incident on June 21st and subsequent releases of information and news coverage drew renewed, widespread attention to both the dangers of HF and the presence of large quantities of HF at oil refineries throughout the nation.

What is HF?

Hydrofluoric Acid (HF) is the term commonly used to refer to hydrogen fluoride that is dissolved in water. Hydrogen fluoride can also exist as a colorless gas or as a fuming liquid.

According to the Centers for Disease Control and Prevention (CDC), HF poses an immediate danger to human life and health at concentrations of 30 parts per million (ppm).

When HF comes into contact with skin, it penetrates the skin and damages deep tissue layers and bone – and fatalities have been reported from HF skin exposure to as little as 2.5% of body surface area. If inhaled, HF can damage lung tissue and cause swelling and fluid accumulation in the lungs that can become fatal.

HF has the potential to form a vapor cloud that travels close to the ground. In the event of an outdoor release of HF, recommended precautions involve limiting exposure by either sheltering in place indoors or evacuating the area if doing so does not create an exposure risk.⁸¹

Nationwide, more than 40 refineries – including the Girard Point portion of the PES refinery, as well as nearby refineries in Trainer, PA and Paulsboro, NJ – use HF as a catalyst during the alkylation process. The other dominant technology in use by refineries for this activity utilizes sulfuric acid, which is used in the Point Breeze refinery complex.⁸² The two technologies are not interchangeable without substantial capital investment, and alkylation units designed to use sulfuric acid as a catalyst generally require much larger quantities of sulfuric acid to be purchased and delivered to the site than HF units.⁸³ Sulfuric acid is often considered a less significant hazard to surrounding communities due to its tendency to form a liquid (not a vapor cloud) when released. However, exposure to sulfuric acid can still cause many health effects at concentrated levels, including damage to eyes, skin, teeth, and lungs – and can be fatal.⁸⁴ Refineries utilizing sulfuric acid often require a much greater volume and frequency of shipping traffic than HF, leading to a heightened risk of accidents during transportation.

According to the CSB, the bulk HF used at PES contained an additive intended to reduce its volatility in the event of a release.⁸⁵ The PES refinery was also equipped with a rapid acid de-inventorying (RAD) and water deluge systems to further manage risks and dangers associated with HF. These critical

safety systems were installed by Sunoco years before the incident and were put to the test on June 21st. Had those systems not been in place, it is likely that the outcomes from the incident would have been far worse.

Despite its known hazards to human health, HF is commonly used in industrial applications – though typically in much smaller quantities and/or lower concentrations. However, its use at oil refineries poses a particularly significant risk since refineries tend to have large quantities of HF on site and that by their very nature oil refineries are vulnerable to fires, explosions, and other failures that may lead to large releases and catastrophic exposure to this dangerous chemical.

Between February 18th, 2015 and June 21st, 2019, three U.S. refineries experienced catastrophic incidents that threatened significant releases of HF – at Torrance, CA., Superior, WI., and Philadelphia. Following the first two incidents, in April 2019 the CSB called upon the EPA to review studies it performed in 1993 to determine whether existing refinery risk management plans were sufficient to prevent HF releases, as well as determine whether there are other commercially viable technologies that refineries can use in the alkylation process that are inherently safer than HF.⁸⁶

In addition to the concerns raised by the CSB, organized labor has advocated for the adoption of safer technologies in the refining industry. Though there have been no known fatalities caused by an HF release in the U.S., minor releases of HF have occurred numerous times and have resulted in serious injuries to refinery workers. In 2009, a release of 22 pounds of HF at the Philadelphia refinery sent 13 workers to the hospital.⁸⁷ The United Steelworkers has raised concerns over the dangers posed by HF and what the union has felt are shortcomings in refinery safety systems and procedures, and has advocated that the industry end the use of HF and replace it with safer alternatives.⁸⁸

Though a declining number of U.S. refineries use HF, it remains in widespread use in the refining industry – including at numerous refineries that are located in densely populated areas. As reported in *The Philadelphia Inquirer*, a risk management plan filed by PES with federal regulators in 2017 suggested that in a “worst case” scenario at the Philadelphia refinery involving the loss of 71 tons of HF, a gas cloud could travel up to seven miles in 10 minutes – a radius that is home to 1.1 million residents in Pennsylvania and New Jersey.⁸⁹

Moving forward, the City should closely evaluate its legal abilities to further regulate HF (and other hazardous chemicals) in a way that minimizes the level of risks posed to surrounding communities. The focus of review should center on the chemicals and concentrations that pose the greatest risks to health and are

subject to Risk Management Plan requirements under the Clean Air Act. Under existing federal laws, the EPA and OSHA have the authority to enact regulations restricting or prohibiting the use of HF in oil refineries.⁹⁰ A petition calling for a ban on HF use in oil refineries was under consideration by EPA.⁹¹ That petition was denied as facially incomplete on November 12, 2019. It is not currently known if the petition will be corrected and resubmitted. However, neither the EPA, OSHA, nor any other federal regulatory agencies have enacted further restrictions on the use of HF despite being urged to do so by numerous advocacy groups.

In the absence of explicit federal or state regulation of HF use, any regulation of HF by the City would be performed via either an amendment to The Philadelphia Code by City Council, or as a regulation promulgated by the City's Air Pollution Control Board.⁹² It is important to note that while the refinery complex is the largest user of HF within City limits, it is not the only user – and its application in other uses may not pose the same level of risks as a refinery. For example, the other identified users in the City have much smaller quantities and concentrations of HF on premises and have fewer risk factors present in their operations that might lead to an accidental release.

The City should closely and carefully consider a regulatory framework for HF and other hazardous chemicals that first and foremost minimizes risks to the public. In doing so, it is important to understand the full range of current users of these chemicals, the context in which they are used, the availability and feasibility of safer alternatives, and the full range of strategies that can be used to minimize any exposure risk to these chemicals (as well as the limitations of those strategies). For these and other reasons, if the City did decide to further regulate HF it would seem most appropriate to do so through the City Council legislative process.

Review HazMat Response Capabilities

In addition to exploring additional regulations around HF and other hazardous materials, the City should carefully and critically review its existing planning and response capabilities around hazardous materials more broadly. Prior to the incident on June 21st, the Philadelphia Fire Department's (PFD) Hazmat Task Force operated using two separate fire companies. This task force was staffed by personnel from an engine (foam pumper), a ladder, and a hazmat laboratory and extinguishing agent, with 9 personnel trained and available to respond to hazardous materials incidents.

The PES incident highlighted a gap in the PFD's ability to handle multiple hazmat incidents simultaneously – an issue the Department has run into on multiple occasions even before the PES incident. The engine and ladder assigned to the Hazmat Task Force could be responding to a fire when a hazmat incident occurred, which would lengthen response times as they disengage the fire and respond to the hazmat incident or vice-versa. With the long-term response needed for the refinery incident, the Department had to adapt, standing up the hazmat unit to be on-site at all times until the incident was put “under control” months later. During and following the incident, the Hazmat Task Force operated as a stand-alone unit, able to respond to hazmat incidents without the worry of being tied up with a fire-related event. These changes ensure that the residents who are served by a fire suppression resource (Engine 60 and Ladder 19) will not lose that capability when these units are committed to a hazmat response.

While the PES site is the largest and most public example of a heavy industrial site that uses toxic chemicals, many other locations in Philadelphia have dangerous chemicals on site. The City should carefully review its hazardous materials response and its capacity to respond to multiple, simultaneous events. Additionally, an analysis of the Office of Emergency Management's hazardous material planning is appropriate. This analysis should include a focus on ensuring that public education and awareness in communities near sites with hazardous material risks is effective so people are better prepared and more familiar with the precautions they should take in the event of an incident.

Improve Environmental Impacts of the Site

Regardless of what the future use or range of uses will be for the refinery site, steps should be taken to encourage the site to have a more positive impact on the environment than it has in the past.

Develop Clean and Renewable Energy:

A consistent theme raised by the public through the Advisory Group process was a desire to see the large site utilized to encourage the development of clean and renewable energy. While the range and scope of those ideas varied, given the sheer size of the site it is highly probable that some level of this technology can play a significant role – even without displacing any existing uses.

Next Steps/Moving Forward

According to a preliminary concept provided to the City by Solar States based on satellite images and parcel sizes, the footprint of the existing refinery complex will likely be able to accommodate a solar power system in excess of 34 megawatts - enough to power 34,000 homes - utilizing roofs and parcels that are currently unoccupied by tanks or structures. Potential may also exist in certain areas to support wind energy – and numerous ideas surfaced through the Advisory Group process to utilize the site’s large footprint and immediate access to a tidal waterway to manufacture components for offshore wind generation since many of these components are too large to efficiently transport on land.

Regardless of the specific use of the refinery site in the future, attention should be paid to encourage the development of clean and renewable energy to the greatest extent possible. Such technology can take advantage of the sheer size of the site, can be adapted to be compatible with a range of uses, and can position the site to once again be on the cutting edge of energy technology similar to when it was first developed in the 1860s.

Enhanced Pollution Control:

The City should evaluate its existing air pollution regulatory framework to ensure that regulations are effectively enforced to ensure public health and safety. Many of AMS’ regulatory powers are delegated to the City of Philadelphia from state and federal agencies, and AMS’ role is primarily aimed at inspection and enforcement. However, City leaders should evaluate whether, and how, these activities can be further strengthened within the existing legal framework.

Continued Wastewater Treatment Activities:

The refinery site currently operates its own wastewater treatment facility to convey, clean, and process stormwater from the overall site. This treatment system is critically important to reducing the flow of pollutants into nearby waterways and preventing those pollutants from entering the City’s infrastructure. Additionally, Sunoco installed and operates systems to pump and treat groundwater contamination. The future of the site should include plans to continue operations of both treatment systems to ensure that the site’s pollutants can continue to be safely contained and treated on-site, thereby minimizing impacts on rivers and City systems.

Plan for Climate Resilience

The sprawling refinery site is directly adjacent to the Schuylkill River just upstream from where it enters the Delaware River. Both rivers are tidal and commercially navigable to the Atlantic Ocean. The refinery site is generally very low in elevation and, prior to being industrially developed, was home to extensive tidal marshes. These attributes make the site vulnerable to flooding and sea level rise.

According to projections by the U.S. National Oceanographic and Atmospheric Administration (NOAA), portions of the refinery site are currently vulnerable to minor flooding during extreme high tides – particularly the areas near Girard Point and west of the Schuylkill River. In a future scenario with mean higher high water (MHHW) increasing by just 2 feet over current levels, portions of the tank farm west of the Schuylkill River become inundated. Increases of 3 feet over current levels are projected to significantly inundate large portions of the Girard Point section of the refinery – with flooding risks and impacts increasing with projected sea level increases.⁹³

Future uses of the refinery site – regardless of what those uses are – must seriously plan for these scenarios when determining what types of infrastructure should be built, as well as where and how that infrastructure should be built on the site to minimize risks posed by flooding. Careful attention should also be paid throughout the environmental remediation process on the site to ensure that soil and groundwater contaminants are addressed in a way that minimizes the risks of contaminants migrating off-site in the event of more frequent and more severe flooding events. If the site remains in use as a refinery, existing infrastructure and operations should be evaluated and adjusted (if necessary) to ensure that more severe and frequent flooding events do not result in environmental damage.

More broadly, the City should develop a more robust planning effort to ensure that development citywide occurs with climate resiliency in mind. Many of Philadelphia’s prime development sites exist along waterways- including, for example, areas in Manayunk, near Penn’s Landing, and the Navy Yard. Despite the risks posed by flooding events in many of these sites, developers continue to pursue projects in these areas and these projects are often based on current conditions rather than on future projections for weather patterns decades in the future and beyond today’s financial horizon. Risks posed by future conditions, however, must be more thoughtfully considered and centrally coordinated in the present to ensure that the safety and resiliency of the building’s future occupants are protected many years after the current project developers are gone. Further regulations on development in the floodplain, therefore, should be developed that are based on future projections for both sea

level rise and increased flooding events caused by precipitation. These regulations must consider, at a minimum, methods to mitigate the impacts of more frequent and severe flooding events on structures and their occupants. Regulations should also consider mitigating any existing environmental hazards on a site to ensure that increased flooding events do not worsen those conditions. Development standards should also prioritize energy efficiency and other technologies to ensure that buildings are minimizing their negative impacts on the climate while also being more resilient to withstand anticipated impacts at the local level.

Landscaping, Beautification, and Public Amenities

Though the refinery complex has a heavily industrial character, it also sits at a major crossroads and point of entry to Philadelphia. Travelers heading to and from Philadelphia International Airport and the sports complex pass directly by the refinery complex on adjacent streets and highways, and travel over much of the complex on elevated bridges that carry Philadelphia's two major interstate highways high above the Schuylkill River. Additionally, tens of thousands of residents live near the refinery and are subject to frequent odors and emissions coming from the facility.

Refineries and heavy industrial sites are inherently difficult neighbors. However, the negative impacts associated with these types of uses can be softened through some strategic investments to green and beautify the landscape in places where visitors and residents interface with the fence line.

Philadelphia has long been conscious of the negative image that these conditions may portray to visitors to the City. Since 1989, the Pennsylvania Horticultural Society has worked with government agencies and adjacent railroad and refinery operators to improve landscaping along the 26th Street corridor – a major travel thoroughfare between the Airport and Center City. Native trees, grasses, and wildflowers were lushly planted to soften the edges between pavement, chain link fence, and tank farms. The existing conditions around the site provide many more opportunities to further pursue and enhance this beautification model. The City should strongly encourage future owners of the refinery to continue pursuing – and enhancing – these efforts to improve how the site interacts with surrounding communities, as well as improve how the site is perceived and viewed by Philadelphia's residents and visitors.

Additionally, public enhancements can be made along portions of the refinery site that adjoin the Schuylkill River. In recent years, the Schuylkill River Development Corporation has built and extended a trail along the river with significant public and private financial support. This trail is very heavily used and allows the public to travel from Christian Street to beyond Valley Forge along active and abandoned rail lines, as well as along structures built over the water. Subsequent phases of the trail project are either under construction or in development and would extend the trail south of its current terminus at Christian Street and across the Schuylkill River to Bartram's Garden.

South of Bartram's Garden, much of the Schuylkill waterfront on both sides of the river is part of the refinery complex. While this portion of the river has a heavily industrial character, much of this property is under-utilized by refinery operations and is off-limits to the public. The Lower Schuylkill Master Plan released in 2013 anticipated the southerly extension of the trail along the western edge of the river, near the existing tank farm, toward Fort Mifflin. Future uses and owners of the refinery site should consider providing easements or access along the river to accommodate these planned future extensions of the trail southward – which would greatly enhance the accessibility and connectivity of this valued public amenity.



Conclusion

Through the Advisory Group process, City officials have gathered a wide range of information and perspectives on the refinery site from many different stakeholders. Though the near-term future of the site is not known at the time of this report's publication, the information gathered through this process has helped both the public and City officials to better understand the underlying issues and concerns regarding the site. This information, as well as the values and recommendations contained in this report that were shaped by this information, will be utilized to help City decision makers evaluate and appropriately respond to the full range of possible uses that emerge for the site. These values will also better define the conditions through which the City and other public entities should approach and evaluate proposals for the site's future, to ensure that those uses support the broader public interest and lead to a future that is cleaner, safer, and healthier than our past.

Acknowledgments

Co-Chairs Brian Abernathy and Adam Thiel are grateful for the support of many who made the work of the Refinery Advisory Group possible. Special thanks to the members of the Advisory Group who dedicated their time and energy to make sure that the perspectives of all key stakeholders – including those most directly impacted by the refinery and the aftermath of the incident - were brought forward and heard. The Co-Chairs also extend their thanks and appreciation to Preparatory Charter School for graciously accommodating and hosting the public meetings.

In addition, the Co-Chairs wish to express gratitude to the dedicated workers of the PES refinery and emergency responders who went above and beyond the call of duty to protect the health and safety of the public during the incident on June 21st and the weeks following. These skilled and well-trained individuals quickly stepped forward in a moment of crisis and successfully contained hazards and minimized risks and dangers to the surrounding communities. Unfortunately, many of these heroes received layoff notices as a result of the incident and will face challenges finding similar employment opportunities elsewhere in the region.

Finally, Co-Chairs Abernathy and Thiel extend their thanks and appreciation to the members of the public who attended the 6 public meetings of the Advisory Group, as well as those who shared their thoughts and perspectives with the City throughout this process.

Members of the Refinery Advisory Group

Co-Chairs

Brian Abernathy

Managing Director, City of Philadelphia

Adam Thiel

Fire Commissioner and Director of
Emergency Management, City of
Philadelphia

Government Members

Harold Epps

Director of Commerce, City of Philadelphia

Anne Fadullon

Director of Planning and Development, City
of Philadelphia

Dr. Thomas Farley

Health Commissioner, City of Philadelphia

Christine Knapp

Director of Sustainability, City of Philadelphia

Rich Lazer

Deputy Mayor for Labor, City of Philadelphia

Patrick Patterson

Southeast Regional Director, Pennsylvania
Department of Environmental Protection

Sam Robinson

Deputy Chief of Staff, Office of the Governor

Aliyah Stanger

Southeast Regional Director, Pennsylvania
Department of Community and Economic
Development

Business Members

Anne Bovaird Nevins

Chief Strategy and Communications Officer,
Philadelphia Industrial Development
Corporation

Matt Cabrey

Executive Director, Select Greater
Philadelphia

Ed Hazzouri

Chairman, Hazzouri and Associates LLC

Denis O'Brien

Senior Executive Vice President, Exelon
Utilities

Anna Shipp

Executive Director, Sustainable Business
Network of Greater Philadelphia

Jerry Sweeney

Chairman, Philadelphia Regional Port
Authority

Craig White

President and CEO, Philadelphia Gas Works

Academic and Environmental Members

Peter DeCarlo

Associate Professor, Drexel University

Mark Alan Hughes

Founding Faculty Director, Kleinman Center
for Energy Policy, University of Pennsylvania

Christina Simeone

PhD Student, Colorado School of Mines/
National Renewable Energy Laboratory

Community Members

Jody Della Barba

Girard Estates Area Residents

Otis Bullock, Jr.

Diversified Community Services

Donna Henry

Southwest CDC

Shawn Jalosinski

Sports Complex Special Services District

Anton Moore

Unity in the Community

Irene Russell

Friends of Stinger Square

Claudia Sherrod

Point Breeze Civic Leader

Ethel Wise

Wilson Park Resident Council

Labor and Employment Members

Mark Lynch

International Brotherhood of Electrical
Workers

Ryan O'Callaghan

United Steelworkers Local 10-1

Jim Snell

Steamfitters Local 420

Tony Wigglesworth

Philadelphia Area Labor Management
Committee

Advisory Group Staff

Javon Davis

Assistant Deputy Commissioner, Philadelphia
Fire Department

Patrick O'Neill

Divisional Deputy City Solicitor, City of
Philadelphia Law Department

Christopher Rupe

Deputy Managing Director, City of
Philadelphia Managing Director's Office

Sources

¹Simeone, Christina. "Beyond Bankruptcy: The Outlook for Philadelphia's Neighborhood Refinery." Kleinman Center for Energy Policy, University of Pennsylvania, September 2018, p. 8, <https://kleinmanenergy.upenn.edu/paper/beyond-bankruptcy/>; Hein, Carola. "Refineries (Oil)," The Encyclopedia of Greater Philadelphia, 2016, <https://philadelphiaencyclopedia.org/archive/refineries-oil/>

²Ibid.

³2018 demographic estimates from Esri "Popular Demographics in the United States" data set, updated July 1, 2019.

⁴In addition to gasoline, diesel, and heating fuels, the refinery produces and markets jet fuels, kerosene, propane, propylene, butane, cumene, and sulfur.

⁵Simeone 8

⁶Simeone 9

⁷Simeone 9

⁸Simeone 9-10

⁹Simeone 10; Declaration of Jeffrey S. Stein, Chief Restructuring Officer of the Debtors, in Support of Chapter 11 Petitions and First Day Motions at Exhibit B, In re PES Holdings, LLC, et al.: Case No. 19-11626 (Bankr. D. Del. July 21, 2019), Docket No. 32.

¹⁰Warner, Dave. "Train hauling crude oil derails on Philadelphia bridge." Reuters, January 20, 2014. <https://www.reuters.com/article/us-usa-derailment-pennsylvania/train-hauling-crude-oil-derails-on-philadelphia-bridge-idUSBREA0J1GO20140120>

¹¹Simeone 10

¹²Renshaw, Jarrett. "PES to begin operating benzene terminal in Nov." Reuters, October 21, 2014. <https://www.reuters.com/article/refinery-philadelphia-benzene-idUSL2N0SG15K20141021>

¹³Simeone 11

¹⁴U.S. Energy Information Administration. East Coast (PADD 1) Receipts by Rail from Midwest (PADD 2) of Crude Oil. https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=ESM_EPCO_RAIL_R10-R20_MBBL&f=M

¹⁵U.S. Environmental Protection Agency. Overview for Renewable Fuel Standard. <https://www.epa.gov/renewable-fuel-standard-program/overview-renewable-fuel-standard>

¹⁶U.S. Environmental Protection Agency. RIN Trades and Price Information. <https://www.epa.gov/fuels-registration-reporting-and-compliance-help/rin-trades-and-price-information>

¹⁷Simeone 12

¹⁸Simeone 10-11.

¹⁹Simeone 11

²⁰Simeone 11

²¹Maykuth, Andrew. "Court approves Philadelphia Energy Solutions' bankruptcy plan." The Philadelphia Inquirer, March 26, 2018. <https://www.inquirer.com/philly/business/energy/us-bankruptcy-court-philadelphia-energy-solutions-plan-20180326.html>

²²Simeone 5

²³Pennsylvania Office of the Governor. "Pennsylvania Governor Corbett Speaks During Philadelphia Energy Solutions Celebration." Press Release, September 19, 2012. <https://www.pnwswire.com/news-releases/pennsylvania-governor-corbett-speaks-during-philadelphia-energy-solutions-celebration-170336936.html>

²⁴"Preliminary Analysis of the Economic Impacts of the PES Refining Complex." Econsult Solutions, September 9, 2019.

²⁵Simeone 9

²⁶"Philadelphia is strong enough to overcome the closures of Hahnemann and the refinery. It has to." The Philadelphia Inquirer, June 30, 2019. <https://www.inquirer.com/opinion/editorials/hahnemann-hospital-refinery-philadelphia-energy-solutions-pes-closing-jobs-20190630.html>

²⁷"Philadelphia refinery owner files for bankruptcy again." Delaware County Daily Times, July 23, 2019. https://www.delcotimes.com/business/philly-refinery-owner-files-for-bankruptcy-again/article_9245dd16-aca6-11e9-acac-531974dbfe4a.html

²⁸McGurty, Janet. "Pennsylvania sees bigger toll from refinery closings." Reuters, March 13, 2012. <https://www.reuters.com/article/pennsylvania-economy-refineries/update-1-pennsylvania-sees-bigger-toll-from-refinery-closings-usw-idUSL2E8DHH920120313>.

²⁹Ibid.

³⁰Pennsylvania Office of the Governor. "Pennsylvania Governor Corbett Speaks During Philadelphia Energy Solutions Celebration." Press Release, September 19, 2012. <https://www.pnwswire.com/news-releases/pennsylvania-governor-corbett-speaks-during-philadelphia-energy-solutions-celebration-170336936.html>

³¹U.S. Energy Information Administration. East Coast and Gulf Coast Transportation Fuels Markets. February 3, 2016. <https://www.eia.gov/analysis/transportationfuels/padd1n3/>

³²U.S. Energy Information Administration. East Coast (PADD 1) Operable Crude Oil Distillation Capacity. Accessed November 6, 2019. <https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=MOCLEP12&f=M>

³³U.S. Energy Information Administration. East Coast (PADD 1) Product Supplied of Finished Petroleum Products. Accessed November 6, 2019. <https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=MTPUPP12&f=M>

³⁴U.S. Environmental Protection Agency. ECHO - PES Energy Solutions, Air Toxic Release Inventory (2014-2018). <https://echo.epa.gov/air-pollutant-report?fid=110000336994>

³⁵Philadelphia Department of Public Health. "Air Quality Monitoring in Philadelphia." Presentation from August 27, 2019 Refinery Advisory Group meeting.

³⁶U.S. Environmental Protection Agency. ECHO - PES Energy Solutions, Air Toxic Release Inventory (2011-2018). <https://echo.epa.gov/air-pollutant-report?fid=110000336994>

³⁷City of Philadelphia AMS NOVs Dated July 29, 2013; October 29, 2014; April 23, 2015; May 14, 2015; September 29, 2016; March 20, 2018; and August 20, 2019.

³⁸City of Philadelphia AMS NOVs Dated July 29, 2013; October 29, 2014; April 23, 2015; May 14, 2015; September 29, 2016; March 20, 2018; and August 20, 2019.

³⁹Testimony of Dr. Marilyn Howarth before the Refinery Advisory Group. August 27, 2019.

⁴⁰U.S. Environmental Protection Agency. EPA Environmental Justice Mapper, 2014 NATA Respiratory Hazard Index, <https://ejscreen.epa.gov/mapper/>

⁴¹U.S. Environmental protection Agency. EPA Environmental Justice Mapper, 2014 NATA Cancer Risk, <https://ejscreen.epa.gov/mapper/>

⁴²Philadelphia Department of Public Health. "Air Quality Monitoring in Philadelphia." Presentation from August 27, 2019 Refinery Advisory Group meeting.

⁴³U.S. Environmental Protection Administration. Outdoor Air Quality. <https://www.epa.gov/report-environment/outdoor-air-quality>

⁴⁴Testimony of Dr. Marilyn Howarth before the Refinery Advisory Group. August 27, 2019.

⁴⁵Ibid.

⁴⁶Auchincloss, Amy, et al. "Statement on the Health Effects of Refineries and Implications for the S. Philadelphia Refinery." October 28, 2019.

⁴⁷Simeone 36-37

⁴⁸U.S. Chemical Safety and Hazard Investigation Board. "Factual Update: Fire and Explosions at Philadelphia Energy Solutions Refinery," October 16, 2019, p. 1.

⁴⁹2018 demographic estimates from Esri "Popular Demographics in the United States" data set, updated July 1, 2019; Maykuth, Andrew. "S. Philly refinery blast released 5,000 pounds of a deadly chemical, federal investigators say." The Philadelphia Inquirer, October 16, 2019. <https://www.inquirer.com/business/deadly-chemicals-philly-refinery-explosion-fire-new-findings-20191016.html>

⁵⁰Simeone 37

⁵¹Maykuth, Andrew. "S. Philly refinery blast released 5,000 pounds of a deadly chemical, federal investigators say." The Philadelphia Inquirer, October 16, 2019. <https://www.inquirer.com/business/deadly-chemicals-philly-refinery-explosion-fire-new-findings-20191016.html>

⁵²U.S. Chemical Safety and Hazard Investigation Board. "Factual Update: Fire and Explosions at Philadelphia Energy Solutions Refinery," October 16, 2019, p. 7.

⁵³Ibid.

⁵⁴U.S. Chemical Safety and Hazard Investigation Board. "Factual Update: Fire and Explosions at Philadelphia Energy Solutions Refinery," p. 9.

⁵⁵Philadelphia Energy Solutions. Industry Alert – HF Alkylation Corrosion.

⁵⁶U.S. Chemical Safety and Hazard Investigation Board. "Factual Update: Fire and Explosions at Philadelphia Energy Solutions Refinery," p. 9.

⁵⁷U.S. Chemical Safety and Hazard Investigation Board. "Factual Update: Fire and Explosions at Philadelphia Energy Solutions Refinery," p. 10.

⁵⁸*Ibid.*

⁵⁹U.S. Chemical Safety and Hazard Investigation Board. "Factual Update: Fire and Explosions at Philadelphia Energy Solutions Refinery," p. 9.

⁶⁰Philadelphia Energy Solutions. Industry Alert – HF Alkylation Corrosion.

⁶¹U.S. Chemical Safety and Hazard Investigation Board. "Factual Update: Fire and Explosions at Philadelphia Energy Solutions Refinery," p. 7.

⁶²IMAAC Technical Operations Hub. "Potential Off-Site Hazard from Hydrogen Fluoride Releases from PES Facility, 21 Jun 2019." October 21, 2019.

⁶³Kearney, Laila and Jarrett Renshaw. "Philadelphia Energy Solutions files for bankruptcy after refinery fire." Reuters, July 22, 2019. <https://www.reuters.com/article/us-pes-bankruptcy/philadelphia-energy-solutions-files-for-bankruptcy-after-refinery-fire-idUSKCN1UH009>

⁶⁴Maykuth, Andrew. "Bankrupt Philly refinery gets interest from 15 potential bidders; aims for a January auction." The Philadelphia Inquirer, November 10, 2019. <https://www.inquirer.com/business/bankrupt-philadelphia-energy-solutions-refinery-sets-sale-auction-procedure-20191110.html>

⁶⁵U.S. Energy Information Administration. Crude-by-rail volumes to the East Coast are declining. August 3, 2016. <https://www.eia.gov/todayinenergy/detail.php?id=27352>

⁶⁶Simeone 26

⁶⁷Simeone 33.

⁶⁸Maykuth, Andrew. "Philly refinery closure paves the way for pipeline settlement. Midwestern refiners win, for now." The Philadelphia Inquirer, August 1, 2019. <https://www.inquirer.com/business/buckeye-laurel-gasoline-pipeline-will-allow-midwestern-refiner-ship-pennsylvania-20190801.html>; Seltzer, Alan M. "Joint Petition for Approval of Settlement." Pennsylvania Public Utility Commission, July 31, 2019. <http://www.puc.state.pa.us/pcdocs/1630028.pdf>

⁶⁹International Maritime Organization. Sulphur 2020 - Cutting Sulfur Oxide Emissions. <http://www.imo.org/en/MediaCentre/HotTopics/Pages/Sulphur-2020.aspx>

⁷⁰Simeone 12

⁷¹Jaramillo, Catalina. "Mixed review for a \$120M renewable energy plant at Philly refinery." WHYY/StateImpact, September 7, 2018. <https://stateimpact.npr.org/pennsylvania/2018/09/07/mixed-reviews-for-a-120m-renewable-energy-plant-at-philly-refinery/>; Maykuth, Andrew. "Philly refiner plans \$120M plant to convert food scraps to fuel for trucks and buses." The Philadelphia Inquirer, August 28, 2018. <https://www.inquirer.com/philly/business/energy/philadelphia-energy-solutions-food-waste-digester-methane-gas-fuel-20180828.html>

⁷²Hopkins, Phil. "Market Insights - PES Refinery Complex." IHS MarkIt presentation to the Refinery Advisory Group, September 9, 2019.

⁷³Philadelphia Code Section 14-602(5)

⁷⁴Philadelphia Code Section 14-305. See also Metzger v. Bensalem Tp. Zoning Hearing Bd., 165 Pa. Cmwlth. 351 (1994).

⁷⁵Philadelphia Code Section 14-305(5)

⁷⁶Consent Order and Agreement By and Between PADEP, Sunoco, and PES, Dated August 14, 2012.

⁷⁷*Id.*

⁷⁸Philadelphia Industrial Development Corporation. "The Lower Schuylkill Master Plan: Executive Summary" https://www.pidcphila.com/images/uploads/resource_library/LSMP_ExecSummary.pdf

⁷⁹U.S. Chemical Safety and Hazard Investigation Board. "Factual Update: Fire and Explosions at Philadelphia Energy Solutions Refinery," p. 7.

⁸⁰IMAAC Technical Operations Hub. "Potential Off-Site Hazard from Hydrogen Fluoride Releases from PES Facility, 21 Jun 2019." October 21, 2019.

⁸¹U.S. Environmental Protection Agency. Facts About Hydrogen Fluoride (Hydrofluoric Acid). <https://emergency.cdc.gov/agent/hydrofluoricacid/basics/facts.asp>

⁸²Other alkylation technologies, such as ionic liquids alkylation technologies and solid acid catalysts, are under development and have the potential to serve as alternatives to HF or sulfuric acid. However, these emerging technologies are not currently in widespread use in U.S. refineries. See Alkylation Technology Study – Final Report, Prepared by Norton Engineering for the South Coast Air Quality Management District, Dated September 9, 2016. <http://www.aqmd.gov/docs/default-source/permitting/alkylation-technology-study-final-report.pdf>.

⁸³Maykuth, Andrew. "'It looked like Armageddon': Refinery fire puts focus on toxic chemical." The Philadelphia Inquirer, June 22, 2019. <https://www.inquirer.com/news/philadelphia-refinery-fire-explosion-cause-20190622.html>

⁸⁴Centers for Disease Control and Prevention. Sulfuric Acid. <https://www.cdc.gov/niosh/topics/sulfuric-acid/default.html>

⁸⁵U.S. Chemical Safety and Hazard Investigation Board. "Factual Update: Fire and Explosions at Philadelphia Energy Solutions Refinery," p. 1.

⁸⁶U.S. Chemical Safety and Hazard Investigation Board. Letter from K.M. Kulinowski to EPA Administrator Andrew Wheeler, April 23, 2019. https://www.csb.gov/assets/1/6/letter_to_epa_4.23.2019.pdf

⁸⁷Maykuth, Andrew. "Deadly acid poses a safety issue for Sunoco." The Philadelphia Inquirer, September 23, 2009. https://www.inquirer.com/philly/business/20090923_Deadly_acid_poses_a_safety_issue_for_Sunoco.html

⁸⁸United Steelworkers. "A Risk Too Great: Hydrofluoric Acid in U.S. Refineries." <http://assets.usw.org/resources/hse/pdf/A-Risk-Too-Great.pdf>

⁸⁹Maykuth, Andrew. "'It looked like Armageddon': Refinery fire puts focus on toxic chemical." The Philadelphia Inquirer, June 22, 2019. <https://www.inquirer.com/news/philadelphia-refinery-fire-explosion-cause-20190622.html>

⁹⁰See Toxic Substances Control Act, 15 U.S.C. Sec. 2601 et. seq.; Occupational Safety and Health Act, 29 U.S.C. Sec. 651 et. seq.

⁹¹Public Employees for Environmental Responsibility TSCA Sec. 21 Petition to Ban HF in Refineries, Dated August 7, 2019. https://www.epa.gov/sites/production/files/2019-08/documents/hydrofluoric_acid_rulemaking_petition.pdf

⁹²See Philadelphia Code Sections 3-302(2)(a)-(d).

⁹³National Oceanographic and Atmospheric Administration. Sea Level Rise Viewer. <https://coast.noaa.gov/digitalcoast/tools/slr.html>