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# Hydraulic Fracturing and Public Health

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# Overview of America's Pipeline System

Rory Siegel. Fall 2015

## Introduction

Construction, placement, and maintenance of pipelines have become hot button political topics. To be an informed voter, citizens must understand the pipeline system spanning across the United States. The production of pipelines to transport the crude and refined products to meet the demand of our growing domestic energy resources has led to multiple national news stories. Oftentimes there is public backlash to proposed pipelines, which creates bias and bad information to come out from both sides of the issue. Knowing the improvements made and hazards yet to be solved in pipeline technology provides both short- and long-term perspectives on what kinds of public and environmental damages are caused by pipelines, and where pipelines should be placed. Not all locations are the same and an analysis of government and private practices will help readers make informed decisions for their own town and state. That being said, also understanding what the federal government does to regulate pipelines is important when voting for congressmen, senators, and the President.

Lehigh students will be making decisions such as these in the near future. Understanding our pipeline system, how it is expanded and developed, helps students think for themselves instead of being influenced by public opinion or corporate propaganda. Since Pennsylvania is a fracking hotspot, students who understand the environmental ramifications of continued support of the fracking industry, and by proxy the pipeline industry, will make better judgements on whether they want their own legislatures to enact similar policies. Lehigh students live all across the country and there is no right answer for any one location. However, being able to decide if the government has adequately protected both the interests of the public and the companies requires knowledge on the limits of the pipeline system.

The general public should also be interested in understanding the materials and methods used in the pipeline system. Pipelines affect people differently, depending on if they live in rural or urban areas, or if they are directly affected by possible water source contamination, among other things. People who have a basic understanding of where their energy comes from will be more informed voters, and can decide if the health and environmental impacts of pipelines are worth the energy they provide.

## Major Discussion

The Hanging Gardens of Babylon existed due to rudimentary pipelines carrying water from a far-off river. Since then, pipelines have become more common and less wonderful. The first American pipeline was built in 1859 and the network has since expanded to nearly 2.7 million miles of pipeline crossing the United States (Pipeline and Hazardous Materials Safety Administration [PHMSA], 2014a). Although pipelines are the safest method used to transport oil and natural gas (Seville, 2014), much is left to be desired. This report will cover the various types of pipelines, the methods and materials companies use to build pipelines, the role of stations, such as compressor stations, along pipeline paths, and the geographical significance of the American pipeline system.

## Pipeline Variations

Oil and natural gas pipelines are broken down into three main varieties. There are gathering pipelines, transmission pipelines, and distribution pipelines. Gathering pipelines are defined by the Pipeline and Hazardous Material Safety Administration, PHMSA, as pipelines which transport the product from the original source (PHMSA, 2011b). Transmission pipelines are used to bring large quantities of processed product to communities and large-volume users (Government Accountability Office [GAO], 2012). Distribution pipelines come from a station where a transmission pipeline has fed the desired product, and deliver the product to residential and commercial users (GAO, 2012).

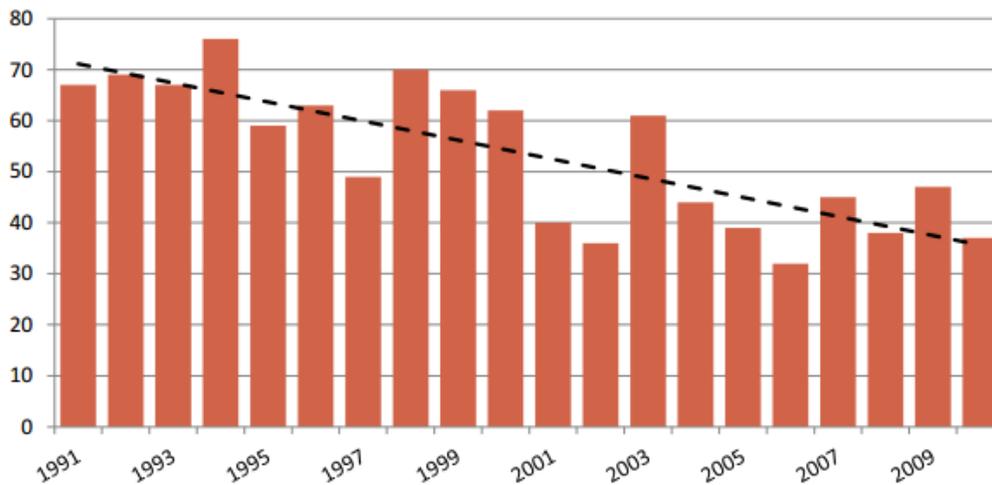


Figure 1 Pipeline incidents that involve death or injury since 1991 to 2011

Source: PHMSA, The State of the National Pipeline Infrastructure. (2011a). Retrieved December 9, 2015.

Gathering pipelines have garnered the most controversy from groups worried about the pipeline industry expanding out of control. In some sense, groups have a reason to worry. Ninety percent of gathering pipelines are defined as “Class 1,” the lowest classification of four. Class 1 pipelines are unregulated by the PHMSA because, in the case of failure, they are deemed to be “low-risk” to human life (Seville, 2014). Class 1 gathering lines, defined as less than 11 human-residency buildings per mile, are allowed to reach 72% of their stress level, the theoretical maximum amount of product flow a pipeline can handle, and have no federal laws that regard factors such as proximity to those houses and mandatory reporting of accidents along those lines. The most important accolade in the pipeline industry’s history is that transporting hazardous liquids, natural gas, and oil via pipeline is the safest method in terms of total injuries and lives lost compared to road or rail transportation (Seville, 2014). Due to economics and regulations, whenever possible, pipelines are better built in rural, low-population areas with very little risk of causing injury to humans. These factors and others such as better procedures and materials have cut pipeline-related casualties by over 50% since 1991 to 2011 (PHMSA, 2011a).

## Industry Material and Procedure – Wrought Iron

The drop in casualties can be attributed to two factors. First, the methods companies use to replace their old, corroded pipelines are becoming safer for workers. Second, as the pipeline industry becomes more profitable, more money is being spent on research and development into the construction of safer pipelines. In the past, pipelines were constructed out of low carbon, iron-based metals, which are corrodible. Pipeline built and placed in the 1950s and 60s accounts for approximately 50% of the total pipeline infrastructure (PHMSA, 2011a). According to a report by the US Department of Transportation, 24% of hazardous liquid pipeline system incidents are the result of corrosion (PHMSA, 2011a). The most failure-prone material used in active pipelines is wrought iron. State and federal incentives have brought the amount of wrought iron in America's pipeline system down significantly. Wrought iron, which remains in only 2.3% (PHMSA, 2014b) of active main pipelines, but still account for 10.2% of incidents along gas distribution mains, is four times as likely to fail as the rest of the pipeline

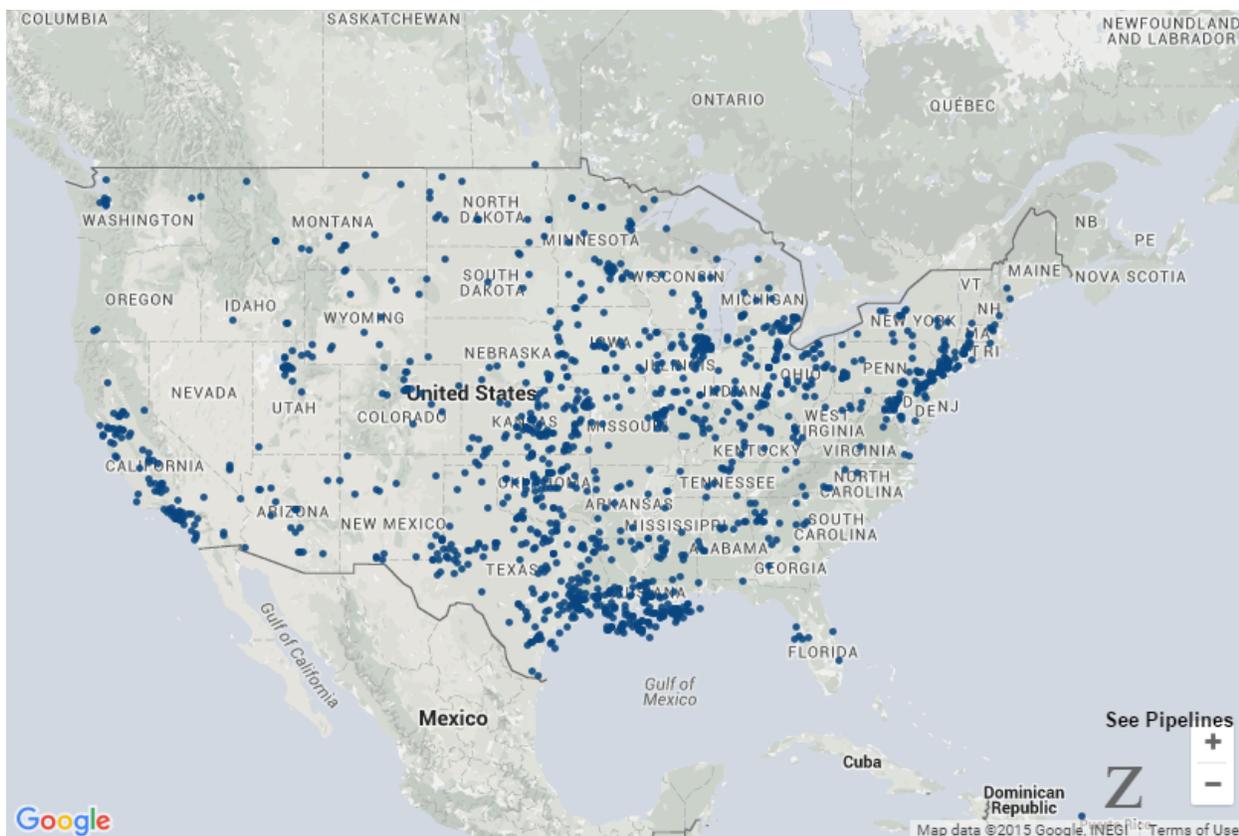


Figure 2 A map of the United States overlaid with all of the pipeline failures regulated as "significant incidents" by the PHMSA since 1986 to Nov. 15, 2012.

Sources: Map by Google Maps, overlay by Lena Groeger with ProPublica

system, and in the case of failure, is over twice as likely to cause a fatality or injury (PHMSA, 2014b).

While no company constructs new pipeline made of wrought iron, one dangerous possibility for the future of wrought iron pipelines is to reactivate them without replacing their material. Tennessee Gas Pipeline Co. has proposed to repurpose a wrought iron pipeline which was partly laid in 1940 (Bruggers, 2014). Tennessee Gas Pipeline Co. wants to use this pipeline to carry natural gas liquids from a fracking well. Both the federal PHMSA and the local residents are against this repurpose. The pipeline is within 200 feet of citizens' houses and travels over the Dix River and nearby caves, a major problem if a leak were to occur, because both landforms connect to the local water supply (Bruggers, 2014). The concern is based on histories of repurposed pipelines failing, such as a 20-year-old pipeline which spilled 20,000 barrels of crude oil over a North Dakota wheat field (Tackett, 2013). The failure, a hole a quarter-inch in diameter, was likely caused by the pipeline rusting over and corroding due to the age of the pipeline.

### **Industry Material and Procedure – New Material**

Newly implanted pipelines are made of plastic or steel. Plastic is the primary material used for underground natural gas transportation to limit corrosion, to which metal is prone (Underground, 2015). Due to thermodynamic fluid mechanics favoring the transportation of fluid at the same viscosity, the thermal benefits of steel make it the primary material used for pipelines carrying liquids (Thermodynamics, 1992). The industry standard for steel pipelines is steel grade X70, an iron alloy. Occasionally, either X60 or X80 will be used. The grade refers to the pressure in pounds per square inch (psi) the steel can withstand before becoming stressed and deformed. X60 withstands up to 60,000 psi, X70 up to 70,000 psi, etc. (White, 2012). The new alloys are not impervious to fatigue and eventual failure from exposure to compounds such as hydrogen gas, sulfur dioxide, and carbon dioxide (Drexler, et al., 2013, Xiang, et al., 2013), but compared to wrought iron are vast improvements.

### **Pressure stations**

Pistons are more efficient but require electrical energy. The beginning and end of pipelines are the most likely to experience large changes in pressure, so they are constructed in areas where electrical energy can be used to power the high-power pistons. In areas with low pressure changes, gas-powered centrifugal stations are preferred. Centrifugal pressure stations are equipped to generate their own power and therefore can be utilized in remote areas (White, 2012). Remote pressure stations can be ran automatically or connected to a trio of stations where the middle station is manned and controls all three. Pressure stations can cause damage to the public d environment. In 1999, a manually controlled pumping station failed to alleviate a pressure buildup caused by upstream pressure. The computer system failed resulting in 237,000 gallons spilled into a nearby lake unknown to any operators, eventually causing a massive explosion with multiple fatalities (McClary, 2003). Environmental concerns over compression stations extend further than catastrophes. Two large ecological concerns are over

the noise pollution and exhaust fumes (White, 2012). Although not usually considered serious, noise pollution disturbs natural wildlife, and is created during the construction of the pressure stations and long after by the pressure stations themselves. Effects range from changes to the amount of plant life to disturbances in mating calls and disruption of the food chain (Parry, 2012). Mufflers have been put in place to minimize the noise pollution, but are unable to

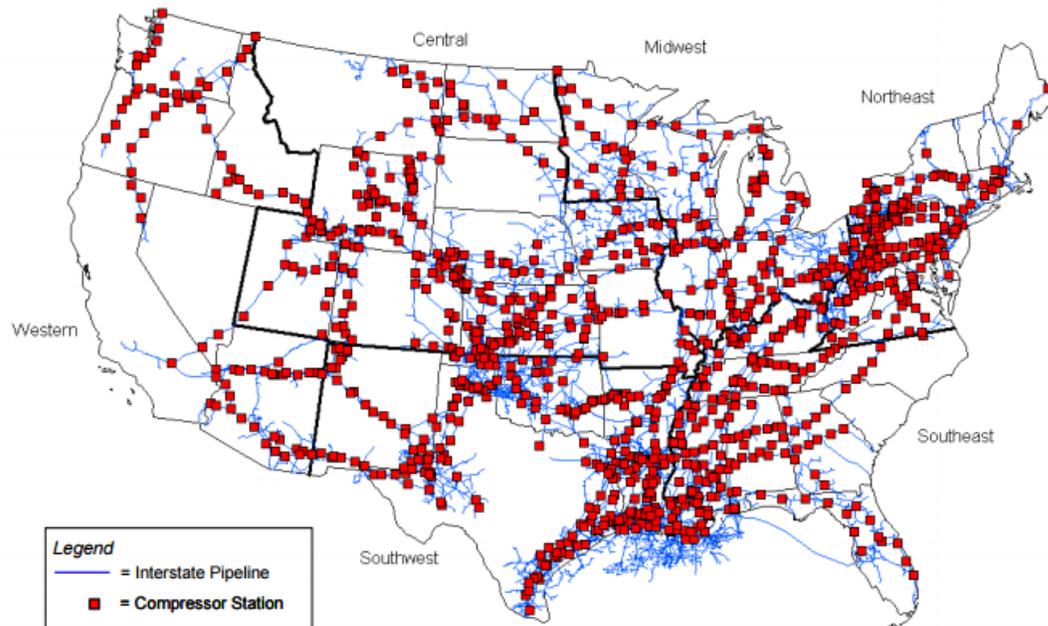


Figure 3 Numerous compressor stations located along the pipeline system. Regions are split up geographically, and areas of concentration are accurate to areas producing large volumes of natural gas.

Source: Energy Information Administration. (2009) *Natural Gas Compressor Stations on the Interstate Pipeline Network: Developments since 1996*. Retrieved December 9, 2015.

completely drown out the stations (White, 2012).

## Geography of the United States Pipeline System

The Gulf of Mexico and surrounding states from Texas to Alabama play a major role in the pipeline infrastructure of America. Very little crude oil is extracted from the Northeast. The largest source of the domestic crude oil produced is along the western shore of the Gulf of Mexico, which provides 16-17% of annual domestic crude oil production as well as 51% of U.S. natural gas processing plant capacity. For these reasons, this area is critical to understanding United States energy.

Many companies contribute to the massive amounts of energy provided via the Gulf of Mexico. One such, Boardwalk Pipeline Partners, a natural gas-focused company, is the parent of many subsidiary companies which each perform a specific task, from collection to refinement to distribution of natural gas. Boardwalk Pipeline Partners owns distribution networks expanding from Texas to Ohio, and provides for numerous other pipelines which reach even

further (Boardwalk Pipeline Partners, 2015). With 14,190 miles of pipeline, Boardwalk Pipeline Partners is just a small fraction of the total infrastructure emerging from the Gulf of Mexico.

The concentration of so many pipelines has not been good for communities around the Gulf of Mexico. Not only are spills more common in the area, the spills also tend to be larger. The environmental factors are still not fully explored, but a report from 1983 was already concerned by the oil spills which were occurring and threatening local wildlife (U.S. Minerals Management Service, 1983). Today, over 400 species are listed as at risk due to the 2010 BP Deepwater oil spill. (Heimbuch, 2011)

### **The Future of Pipelines in America**

Pipelines are not going away soon. Statistically speaking, oil and natural gas pipelines are the safest method of transportation for these critical resources. However, just because they're the safest does not mean they should be exempt from oversight. The lack of regulation over gathering lines is quickly becoming an issue that requires action before the increased size and stress on unregulated pipelines causes permanent damage to people's livelihoods or the environment. The processes in which pipelines are created have become safer over time, but there is still more to be done. Using materials that will degrade slower, and replacing, not repurposing, pipelines will save companies from massive legal and damage control costs down the road. Sometimes, subsidiary sections of pipelines such as pressure stations add to the pollution; companies need to take approaches to not just limit the oil and natural gas released into the ecosystem, but also the other chemicals released by the tools used. The Gulf of Mexico is a powerhouse in producing domestic energy, but at the cost of one of the United States' most beautiful and irreplaceable regions.

Energy companies should be investing heavily into the research and development of pipelines. The most important fact to keep in mind, despite all the downsides, is pipelines provide the safest method of transporting natural gas and oil around the country. Many of these issues and disasters mentioned in this report can be prevented by regular updates to the pipeline infrastructure. Debbie Hersman, the head of the National Transport Safety Board, told National Public Radio, "I will tell you, 100 percent of the [pipeline] accidents that we've investigated were completely preventable" (Shogren, 2013). The challenge is getting companies to go out of their way to prevent them.

### **Interview with Samya Lutz.**

Ms. Lutz received her Bachelor of the Arts degree from Western Washington University and her Masters in Planning from the University of British Columbia. She is certified with the American Institute of Certified Planners, and at the time of the interview worked as the Outreach Coordinator for the Pipeline Safety Trust, a group dedicated to informing the public on issues involving pipeline safety and regulation. The interview was conducted by email.

*Q: First off, I'd like to ask a little about yourself! When did you first get involved with the Pipeline Safety Trust? How about pipelines in general? Would you say that learning more about pipelines has made you more or less concerned about the way they are managed?*

A: I joined the Pipeline Safety Trust about 2.5 years ago, with no background in oil and gas transportation. They hired me to help with land use technical assistance to communities across the country, and it's been a steep learning curve to understand the jurisdictional layers of authority when it comes to regulating pipelines. I do sometimes feel as if we are working in the dark ages when it comes to this topic, as many thousands of miles of pipelines in the US are still completely unregulated.

*Q: Which programs that the Pipeline Safety Trust are working on, such as the annual pipeline safety conference or publishing the "Transparency of Pipeline Information," do you wish more people knew about? I found myself on the Pipeline Safety Trust's website often during my research, and I'm still finding entire sections I haven't looked at yet. Maybe you have a favorite?*

A: I personally like the sections on [land use planning near pipelines](#) and the [Local Government Guide to Pipelines](#) as well as the section on [how folks can get more involved in commenting](#) on various federal rulemaking activities. We find that many people really appreciate our [briefing papers](#) to help with basic understanding of various pipeline topics.

*Q: One of the statistics I kept on coming across from multiple "pipeline information" groups was that 90% of gathering pipelines are unregulated by the PHMSA. How concerning is this number, after taking into account state-by-state regulations and internal regulations the pipeline companies might impose on themselves?*

A: The only state that regulates gathering lines in any substantive way is Ohio. Two years ago at our conference, PHMSA deputy associate administrator Linda Daugherty said "What keeps me up at night? Gathering lines," when she was interviewed between sessions. (You can see some of her perspective by watching her speak [here](#)). We really don't know what that percentage is, because we don't know where and how many gathering lines there are. In the recently published notice of proposed rulemaking on the Safety of Hazardous Liquid Pipelines, PHMSA proposed to add gathering lines to the pipelines for which operators are required to submit annual and incident reports, which at least would give us a start to understanding the extent of this issue. Years ago, gathering lines were small diameter, low pressure pipelines that did not appear to cause much of a risk; but today gathering lines can be 42" diameter very high pressure lines that aren't any different in their risk profile from transmission pipelines. There is no reason for them to be exempt. See below this message for a forwarded news article from Dec 6 giving an example of an incident that occurred this year on one of these gathering lines.

*Q: The PHMSA also puts out a lot of information, much of which is referenced on the Pipeline Safety Trust's website. Do you see the Pipeline Safety Trust's role toward to PHMSA as more of a partner in distributing information, a watchdog to make sure the PHMSA is properly doing its job, somewhere in between, or completely separate in your roles and functions?*

A: When Federal District Judge Rothstein agreed to a portion of the criminal penalties from the Bellingham pipeline tragedy going to start the Pipeline Safety Trust, she said “No industry polices itself very well... there is going to be the Trust.... They need to be listened to, they need to make a difference, because they’re the ones that will be the watchdogs.” Regulators are different than watchdogs; they’re supposed to make sure industry follows the rules, but unfortunately the rules do not prevent people from being killed or the environment from being polluted by oil and gas pipeline incidents that occur when those products are no longer contained as they’re supposed to be. We certainly appreciate that PHMSA has done a lot to make some of their information and data much more accessible to the public in the past few years.

To learn more about the Pipeline Safety Trust and their mission, visit [www.pstrust.org](http://www.pstrust.org). Although Ms. Lutz no longer works at the Pipeline Safety Trust, Rebecca Craven can be contacted at [rebecca@pstrust.org](mailto:rebecca@pstrust.org) for any questions relating to the Pipeline Safety Trust.

### **Important Contributors to America’s Pipeline System**

**The Pipeline and Hazardous Materials Safety Administration (PHMSA)** – Part of the US Department of Transportation, it provides the most extensive coverage of any government organization regarding pipelines. The many roles of the PHMSA include, but are not limited to: establish and enforce national pipeline regulations and policies, conduct research to be made available for the public, educate the public and first responders of handling pipeline failure, and protect the environment. They watch over private companies and receive reports on pipeline incidents when their regulations require companies to send in said reports. If a report shows that the company might be guilty of breaking a regulation, a PHMSA inspector will be sent out to determine if the company did anything wrong, and will give out citations or fines accordingly. Information on pipelines and hazardous liquids is distributed through their website. To contact the PHMSA, visit [www.phmsa.dot.gov](http://www.phmsa.dot.gov) or email [phmsa.pipelinesafety@dot.gov](mailto:phmsa.pipelinesafety@dot.gov) for information related to pipelines.

**Pipeline and Gas Journal** – Provides a resource for the peer-review and publishing of new reports on a variety of topics. Papers can range from in-depth looks into new materials being used for the construction of pipelines, new types of pressure stations, improvements to leak detection technology, information about public and environmental impacts of proposed pipelines, and updates on the current happenings around areas traversed by high amounts of pipelines such as the Marcellus Shale or Gulf Coast. The publisher of the Pipeline and Gas Journal, Oliver Klinger, can be contacted at [oklinger@oildom.com](mailto:oklinger@oildom.com).

**U.S. Energy Information Administration (EIA)** – Provides independent statistics and analysis of every energy source being used in the United States, including petroleum and natural gas. They provide both short- and long-term outlooks on US energy; what kinds of energy are being used today, what kinds of energy will be used in a year, and what kinds of energy will be used in a

decade and further from now. The EIA provides graphics to go along with their statistical analysis. Graphics can be used to supplement information about the locations of energy production, refinement, or situations such as petroleum spills and natural gas leaks. The EIA also explores domestic issues such as energy used during travel seasons. The EIA can be contacted for general information at [InfoCtr@eia.gov](mailto:InfoCtr@eia.gov) or their automated information line, (202) 586-8800.

**Boardwalk Pipeline Partners** – One of many companies that is involved in the collection, refinement, and transportation of natural gas and liquid products. According to their website, they own and operate 14,190 miles of natural gas pipelines. Boardwalk Pipeline Partners' headquarters is located in Houston, Texas. It operates six subsidiary companies: Texas Gas Transmission, LLC, Gulf South Pipeline Companies, LP, Gulf Crossing Pipeline Company, LLC, Boardwalk Field Services, LLC, Boardwalk Louisiana Midstream, LLC, and Boardwalk Petrochemical Pipeline, LLC. They connect directly from the Gulf of Mexico to the Northeast, and from there also distribute natural gas and liquid to unaffiliated companies. The numbers for Boardwalk Pipeline Partners primary facilities are (731) 479-8000 (Houston, TX) or (270) 926-8686 (Owensboro, KY)

**Pipeline Safety Coalition (PSC)** – A Pennsylvania based nonprofit, the Pipeline Safety Coalition is focused on providing unbiased information to increase public participation in the pipeline planning and building process. The PSC website provides subheadings for landowners and community members to visit and learn more about land rights and what recourse they might have in the event of a leak or other incident. As a Pennsylvania based group, the PSC focuses on Marcellus Shale gas and other active sections of Pennsylvania. The primary focus of the PSC is to act as a mediator between the public and pipeline companies, providing information on both the benefits and potential hazards of pipelines. The Pipeline Safety Coalition can be contacted through a form submission on their website, or by telephone at (484) 340-0648.

### **For More Information**

350.org – An environmentally focused website that often takes the negative side on proposed pipelines, such as the Keystone XL, Energy East, and Tar Sands pipelines. 350.org often attempts to get public attention on topics such as pipeline construction, and create public backlash against these projects. Under individual topics, 350.org distributes information usually promoting their cause, and can be a great resource in finding pro-environmentalist information on a certain topic.

PennEnergy.com – A company that focuses on relaying news about most sources of energy, including fracking and pipelines. The PennEnergy website aggregates content from multiple facets under the PennWell Petroleum brand. Information ranging from financial reports to statistics to the vanguard of energy research are reported on the website. Users can sign up for multiple newsletters distributed via email to stay up to date on information pertaining to their specific interests.

Treehugger.com – Another environmentally focused website. Treehugger.com distributes reports on environmental topics. Reports advocating against pipelines often appear on the

front page of Treehugger.com, especially when a high-profile pipeline has been proposed. Although they are sometimes involved with grassroots protests, their website's focus is to report news on topics such as green technology, transportation, or energy. They also provide casual reading such as recipes or lifestyle stories. Readers looking for a liberal perspective on pipelines and other environmental issues should utilize Treehugger.com

Npms.phmsa.dot.gov – The National Pipeline Mapping System, a website ran by the PHMSA that gives approximate locations for pipelines. Although regular users are limited to viewing a single county at a time due to safety precautions, the ability to see how pipelines transverse your local area is important to understanding the magnitude of miles the pipeline system runs across the United States. Information is presented clearly, and allows users to select multiple parameters to display at a time.

Topics.nytimes.com/top/reference/timestopics/subjects/k/keystone\_pipeline – A breakdown on the Keystone Pipeline, one of the more well-known proposed pipelines in America. The New York Times uses this page to give readers ease of access to articles pertaining to the Keystone Pipeline and pipelines in general. This website is good for understanding and keeping track of the politics that occur when pipelines are proposed. The New York Times tends to lean left, but the nature of news articles means a minimal bias is presented.

Exxonmobilpipeline.com – Although the website is not the easiest to navigate, ExxonMobil, a company that utilizes the pipeline system to transport multiple products including petroleum and natural gas liquids, uses this space to present information pertaining to how they try to limit pipeline-related accidents. Most of the links in Exxon Mobil's website are self-reported documents. If you are looking for a balance of information for the environmentally heavy websites listed above, ExxonMobil and other pipeline-utilizing companies use websites like these to distribute their side of issue.

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