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Crude Oil Transportation by Rail in Saratoga County, New York: Public Perceptions of Technological Risk, State Responses, and Policy

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U.S. rail shipments of crude oil grew by 5,091 percent from 2008 to 2014 due to increased production in the Bakken Shale Formation. Rail transportation of hazardous materials is not a new phenomenon; however, infrastructure in disrepair, coupled with the quantity and frequency of train cars not designed to haul crude oil and its volatility, and a community's means to manage accidents, presented a new technological risk. Rail infrastructure nationally needs repair - contributed to recent accidents - thus heightening the risk. While rail shipments peaked in 2014 and declined through 2019, communities along rail lines experience a heightened risk to safety, property, and the environment. The purpose of this qualitative research was to better understand the perceptions and awareness of Saratoga County residents and community influentials, as well as document policy responses. We conducted interviews, 419 surveys, Geographic Information System (GIS) mapping, and policy and archival data analysis. Data showed the public had a low level of knowledge about oil shipments and emergency management plans. We documented distrust in the federal government coupled with social amplification factors, resulting in a high level of perceived risk. We provide a suite of recommendations for improving communications, community preparedness, engagement, safety, and environmental protection.

KEY WORDS: Technological Risk, Risk Perception, Crude oil transportation by rail

摘要

鉴于巴肯页岩层的作业量增加, 美国原油铁路运输量从*2008*年到*2014*年增加了*5,091%*。用铁路运输有害物质已不是一件新鲜事; 然而, 失修的基础设施, 加上铁路车辆*(*设计目的并非运输原油*)*的数量、频率以及原油的挥发性, 和社区用于管理事故的途径, 共同呈现了一个新的技术风险。全国铁路基础设施需要维修—近几年曾造成事故—因此提高了风险。尽管铁路运输在*2014*年达到顶峰, 之后下降至*2019*年, 但铁路沿线的社区在安全、财产和环境方面经历的风险有所增加。该定性研究旨在更好地理解萨拉托加县居民及社区影响人物的感知和意识, 同时记录政策响应。我们进行了访谈、调研*(*参与人数为*419)*、地理信息系统*(GIS)*导图、政策及档案数据分析。数据表明, 公众对原油运输及应急管理方案的了解程度低。我们记录了*(*公众对*)*联邦政府的

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不信任以及社会放大因素， 这造成了高度的风险感知。我们就提升传播、社区预备、参与、安全以及环境保护提供了一系列建议。

关键词: 技术风险, 风险感知, 原油铁路运输

Resumen

Los envíos ferroviarios de petróleo crudo de EE. UU. Crecieron un 5,091 por ciento entre 2008 y 2014 debido al aumento de la producción en la Formación Bakken Shale. El transporte ferroviario de materiales peligrosos no es un fenómeno nuevo; sin embargo, la infraestructura en mal estado, junto con la cantidad y frecuencia de vagones de tren no diseñados para transportar petróleo crudo y su volatilidad, y los medios de una comunidad para manejar accidentes, presentaron un nuevo riesgo ecnológico. La infraestructura ferroviaria a nivel nacional necesita reparación, contribuido a accidentes recientes, lo que aumenta el riesgo. Si bien los envíos ferroviarios alcanzaron su punto máximo en 2014 y disminuyeron hasta 2019, las comunidades a lo largo de las líneas ferroviarias experimentan un mayor riesgo para la seguridad, la propiedad y el medio ambiente. El propósito de esta investigación cualitativa fue comprender mejor las percepciones y la conciencia de los residentes del Condado de Saratoga y los influyentes de la comunidad, así como documentar las respuestas de política. Realizamos entrevistas, 419 encuestas, mapeo del Sistema de Información Geográfica (SIG) y análisis de datos de política y archivo. Los datos mostraron que el público tenía un bajo nivel de conocimiento sobre los envíos de petróleo y los planes de manejo de emergencias. Documentamos la desconfianza en el gobierno federal junto con factores de amplificación social, lo que resulta en un alto nivel de riesgo percibido. Ofrecemos un conjunto de recomendaciones para mejorar las comunicaciones, la preparación de la comunidad, el compromiso, la seguridad y la protección del medio ambiente.

PALABRAS CLAVES: Riesgo ecnológico, Percepción del riesgo, Transporte de petróleo crudo por ferrocarril

Introduction

Since 2000, North America experienced a boom in crude oil production due to increased production from the Alberta tar sands in Canada, the Bakken Shale in North Dakota and Montana, and the Eagle Ford Basin in Texas. The development of new hydrofracturing (fracking) technology, combined with horizontal drilling allowed these formations to become more productive and accessible. From 2000 to 2003, yearly U.S. oil production via hydraulic fracturing doubled (Levi, 2013). Total production of crude oil in the United States was 9.43 million barrels per day in 2017, and in North Dakota, production rose from 98,000 barrels per day in 2005 to 1.1 million barrels per day in 2017 (Association of American Railroads, 2018).

These new sources of oil and gas fundamentally changed the U.S.' domestic oil production and energy outlook. In 2014, the U.S. surpassed Saudi Arabia and Russia as the world's leading producer of petroleum and natural gas, respectively. This growth of crude oil production caused a significant strain on oil

and gas transportation infrastructure, surpassing the capacity of pipelines to transport crude to domestic refineries on the East Coast and Gulf of Mexico (Clark, 2011; Covert & Kellogg, 2018). Oil production and refining companies increasingly turned to existing rail infrastructure to transport crude oil to refineries that pipelines could not access. Indeed, domestic rail shipments of crude oil grew from 9,500 train car loads in 2008 to 493,146 car loads in 2014—an increase of 5,091 percent (Association of American Railroads, 2018). Rail presents a riskier crude oil transportation method than pipelines.[1,2] Unfortunate derailments involving crude by rail have resulted in fires/explosions, environmental harm, property damage, and even fatalities, thus earning the nickname "bomb trains" from rail operators (Mason, 2018; Mikulka, 2019a).

The transportation of hazardous materials via rail is not a new phenomenon. However, much of the rail infrastructure in the United States is in disrepair and was not designed to handle the quantity and frequency of tanker cars or haul highly volatile crude oil (U.S. DOT, 2017). This creates risk for communities living near railways that are not fully appreciated or understood, which, in turn, can affect a community's means to prepare for, communicate, respond to, and manage accidents (derailments, spills, fires, and explosions). As crude transport increasingly stresses national infrastructure, it is important to understand the technological and social perceptions and risks associated with these changes.

Here, we present a case study from Saratoga County, New York (NY) located north of the Port of Albany, NY, both of which became part of the network to transport Bakken crude oil to NJ, PA, and DE refineries on the Eastern Seaboard in 2012 (Mouawad, 2014). At the height of the phenomenon, two trains carrying crude oil arrived daily to the Port of Albany where the oil was stored until rerouted to southern refineries. Each train carried 70 to 120 tank cars, which equated to 50,000 to 90,000 barrels (3 million gals.) of oil per day/train (Frittelli et al., 2014). The Canadian Pacific Railway (CP) originates in Vancouver, Canada and runs east across the southern part of Canada. From its easternmost point in Montreal, tracks run south through Saratoga County and the NY State Capital Region—Port of Albany (Figure 1). The Burlington Northern Santa Fe (BNSF) runs from North Dakota and connects to the Chessie-Seaboard Merger (CSX), running across NY to the Port of Albany (CSX is not located in Saratoga County; Riverkeeper, 2016; Figure 1). From the Port of Albany, CSX rail lines run south along the western side of the Hudson River (Figure 1). Both sets of railroad tracks are located close to Lake Champlain and the Mohawk and Hudson Rivers. Within Saratoga County, 35 schools and 26,432 residences are located within one-mile of CP.

The purpose of this qualitative research was to better understand community perceptions of risk and level of concern associated with crude oil transport via rail in Saratoga County. Our research also worked to better understand citizen and community influentials' level of awareness, engagement, and/or willingness to better prepare for crude oil transportation by rail. Insights gained through semi-structured interviews, online surveys, a geographic information system (GIS),

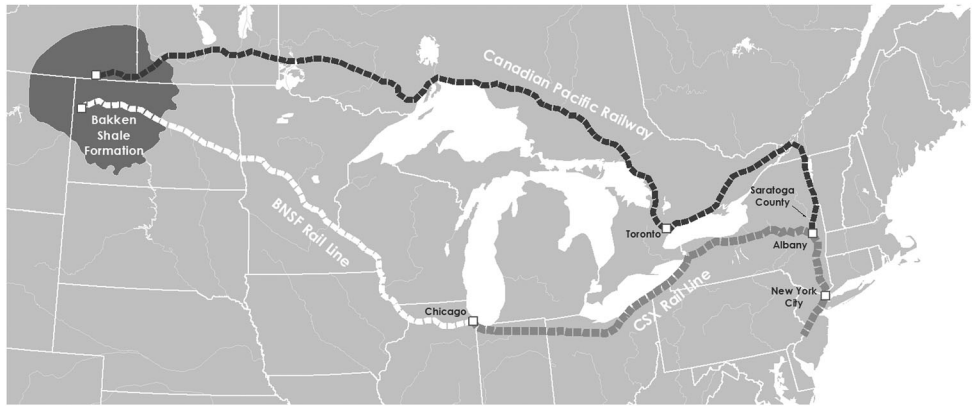

Figure 1. Crude Oil Transport Via Rail From the Bakken Shale Formation.
Sources: Energy Information Administration; BNSF; Canadian Pacific; CSX; Image by Charlie Bettigole.

archival data, and policy analysis resulted in a suite of recommendations to improve safety. The research questions guiding this effort included:

1. How do community influentials and the public perceive risk related to crude transport by rail in Saratoga County and NY State?
2. To what extent are community influentials and the public engaged in railway safety, disaster preparedness plans, and/or public education and outreach efforts, to address the risk of crude transport by rail?
3. In Saratoga County, what is the geographical extent of potential human and/or environmental impacts in the case of a derailment, spill, and/or fire/explosion?

The literature below details the phenomenon of Bakken crude transportation via rail in the United States, the policies governing its transport, and research regarding technological risk perception. The following section also works to explain the economic,

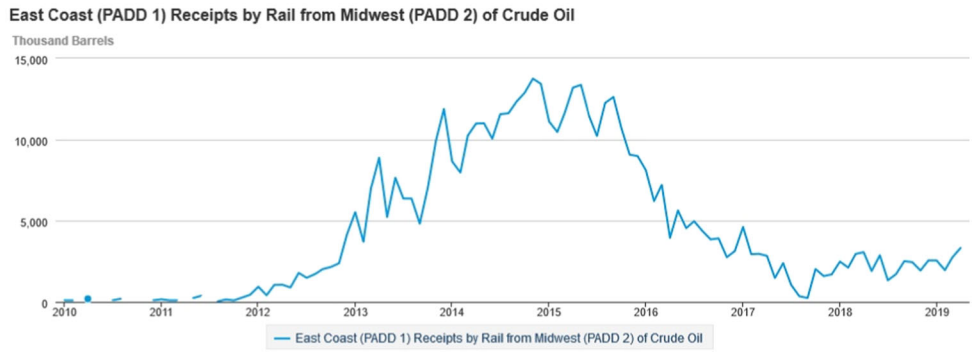

Figure 2. Bakken Crude by Rail to East Coast, 2010–2019.
Source: EIA (2019a).

environmental, and public health issues of crude transport by rail specific to Saratoga County.

The Nature of Crude Oil and Transportation Via Railways

The United States Energy Information Administration (EIA) defines crude oil as "a mixture of hydrocarbons that exists as a liquid in natural underground reservoirs and remains a liquid when brought to the surface" (EIA, 2015, p. 1). Bakken crude is considered "tight oil," which is "oil produced from petroleum-bearing formations with low permeability." It is also often referred to as sweet oil and "light tight oil." Light oil has a low density and "flows freely at room temperature" (Sandia National Laboratories, p. 2015). Bakken crude is traded as "North Dakota Light." There are two different types of crude oil being shipped through Saratoga County via rail: crude from the Bakken Shale and bitumen from the Canadian tar sands.

With the increase in domestic oil production, transport via rail increased approximately 5,000 percent between 2008 and 2015: 13,754 thousand barrels were transported from the Bakken to the east coast in November 2014 (EIA, 2019a; International Association of Emergency Managers [IAEM], 2015) (Figure 2). Compared with new pipeline construction, which is politically contentious and subjected to comprehensive federal and state permitting processes that involve public input as mandated by the National Environmental Policy Act (NEPA), etc., shipping crude by rail does not require (special) federal permits. The 2017 construction of the Dakota Access Pipeline and the 2019 proposed Liberty and Keystone XL pipelines are examples of such projects that had to comply with political and regulatory processes and were politically fraught. Further, railroad infrastructure was already in place and could be utilized immediately, and railroad companies were more willing than pipeline companies to enter into short-term contracts with oil companies to transport crude, offering flexibility in the rapidly changing oil market (Frittelli et al., 2014). Increased oil production in the United States, along with shifts in global oil production, caused the price of oil to greatly fluctuate. For instance, Bakken crude prices plummeted from a high of $126/barrel in June 2008 to $22.72 per barrel in February 2016 (EIA, 2019a).[3]

The June 2017 completion of the 1,172 mi. Dakota Access Pipeline–that begins in the Bakken formation in ND and continues through SD and IA to an oil terminal near Patoka, IL—greatly reduced the pipeline bottleneck, thus reducing the industry's reliance on rail. After June 2017, 78% of all Bakken crude was transported via pipeline, with 6,965 thousand barrels via southern CSX rail routes to East Coast refineries in NJ, DE, and PA, bypassing the Port of Albany and Saratoga County (EIA, 2019a). In April 2019, 3,322 thousand barrels of crude were transported via rail to the East Coast (EIA, 2019a); however, in June 2019 explosions at the Philadelphia Energy Solutions (PES) refinery (the largest on the East Coast) caused the refinery to permanently close. The refinery processed 335,000 b/d of crude, with the EIA (2019b) writing that supply chains utilizing pipelines will become more prevalent for other facilities.

Governing Agencies and Public Safety. A number of federal agencies govern crude oil shipments and railroad safety, but the Federal Railroad Administration (FRA) has primary jurisdiction over railroad safety. The FRA employs 500 federal railroad inspectors and 179 state inspectors (U.S. DOT, 2015). FRA regulates "the safety of track, grade crossings, rail equipment, operating practices, and movement of hazardous materials" (Frittelli et al., 2014, p. 14). FRA enforces regulations created by the Pipeline and Hazardous Materials Safety Administration (PHMSA). Incidents with crude oil transported via rail are handled by the National Transportation Safety Board (NTSB), the investigatory agency responsible for r*ecommending* changes to regulations and policies based on the circumstances surrounding past accidents (Burton & Stretesky, 2014). The NTSB is not required to take into account any economic costs when considering additional safety measures and it has no real regulatory authority. While the FRA collaborates with the NTSB and often agrees with their recommendations, new FRA regulations are implemented slowly (Frittelli et al., 2014).

To prepare for an oil spill or crude by rail accident the federal government provides leadership and support for preparatory actions as part of a multiagency National Response System. Within the National Response System are three main teams: the interagency team, the National Response Team, and the Regional Response Team. This interagency team is comprised of the Environmental Protection Agency (EPA), the Department of Transportation (U.S. DOT), and the Federal Emergency Management Agency (FEMA). The National Response Team is responsible for assessing states' preparedness for crude by rail accidents through discussions with state representatives to better understand state abilities to mitigate damages after a disaster (IAEM, 2015). In addition to acting as a support system for Regional Response Teams, the National Response Team has three primary responsibilities: to distribute information, plan for emergencies, and train for emergencies (EPA, 2016a). There are 13 Regional Response Teams, responsible for response, planning, training, and coordination associated with crude by rail disasters. This includes developing Area and Regional Contingency Plans, which delineate the responsibilities of government entities (EPA, 2016b).

In May 2014, the DOT released an emergency order that "required all railroads operating trains containing large amounts of Bakken crude oil to notify State Emergency Response Commissions about the operation of these trains through their states" (U.S. DOT, 2014, p. 1). "Large amounts" is defined as 1 million gallons or more, which is approximately 35 tank cars. In response to the Emergency Order, states claimed that the 1 million gallon reporting minimum was too high and did not allow them to identify at-risk communities to prepare for disasters (IAEM, 2015).

With the urging of NY Senator Schumer, and under the direction of NY Governor Cuomo, state agencies traveled to Washington D.C. in 2014 and petitioned the federal government for improved rail infrastructure design, safety, disaster prevention, and response (Schumer, 2015). Additionally, Governor Cuomo allocated funding for state

agencies to identify rail infrastructure in need of repair. These "Blitz" inspections by NYS Department of Transportation (NYSDOT) and the Department of Environmental Conservation (DEC) were implemented in February of 2014. Two initial inspections occurred at Kenyard Yard in Albany (owned by CP) and the other at the Frontier Rail Yard in Buffalo (owned by CSX), two of the most heavily used locations in NYS for crude by rail (Governor Andrew Cuomo, 2014). At the Kenyard Yard, the NYSDOT and FRA inspected 120 cars and found three defective wheels and three defective brake shoes. They also inspected two miles of rail tracks and 31 switches and found 36 defects, including loose rail joints, fasteners, and a broken joint bar, all of which were repaired immediately. At the Frontier Rail Yard, 198 cars, three locomotives, and one yard switcher was inspected. Two of the tank cars were found to have wheel and brake shoe defects. Additionally, they inspected four miles of track and 13 switches. The team found seven defects, including one broken rail (Governor Andrew Cuomo, 2015). In 2015, NY Senator Schumer publicly stated "We have all seen the result of oil train derailments in Lynchburg, Lac-Mégantic, and WV—we don't want to repeat that nightmare scenario in Upstate NY because of a faulty rail bridge that was simply overlooked in the inspection process." The NY blitz inspections did not occur after 2014, and they did not include bridges.[4] As of 2016, there was only one federal inspector for the 3,000 private train bridges in NY, who was also charged with inspecting bridges in 13 other states (Congressional Research Service, 2018).

In response to this upswing in crude by rail disasters, Governor Cuomo issued Executive Order 125 in January of 2014 directing state agencies to review safety procedures and Emergency Response Plans. In October of 2015, Governor Cuomo announced that 19 fire stations and hazardous waste management teams around NY would be provided with trailers containing 600 gallons of Class B foam to control crude oil fires. Saratoga County was equipped with a trailer in January 2016 (City of Saratoga Springs, 2016; Governor Andrew Cuomo, 2015). Additionally, Saratoga County Deputy Fire Coordinator, Nate King traveled to Pueblo, Colorado for a CP Rail sponsored Crude By Rail Emergency Response Training (Saratoga County Office of Emergency Services, 2016). That fall, NY State hosted a one-day workshop promoting the resources in the Transportation Rail Incident Preparedness & Response (TRIPR) Flammable Liquid Unit Train program. And in 2017, NY, CA, IL, MD, ME, and WA responded to an Advanced Notice of Proposed Rulemaking issued by the PHMSA (2017) asking for immediate action to limit vapor pressure – a driver of the oil's explosiveness and flammability—of less than 9.0 psi (New York Attorney General, 2017). As of this writing, the Trump Administration has yet to make a determination on this proposed rule.

Crude by rail presents a potential technological risk made more complex by the diversity of communities through which the trains travel (each with site-specific infrastructural, staging, public health and safety, and environmental protection challenges), and overlapping governance responsibilities. It is important to note that multiple states have relied upon (and pressured) federal agencies to better regulate and safely transport crude oil by rail. Case in point, former NY State Attorney General Schneiderman stated:

> We need to do whatever we can to reduce the dangers that crude oil shipments pose to communities across NY State…trains carrying millions of gallons of crude oil routinely travel through our cities and towns without any limit on its flammability and explosiveness—which makes crude oil more likely to catch fire and explode in train accidents. The federal government needs to close this extremely dangerous loophole, and ensure that residents of the communities in harm's way of oil trains receive the greatest possible protection (New York City Press Office, 2015).

And as communities across the U.S. (including Saratoga County) became thoroughfares for crude by rail, the NTSB recognized this threat in 2016, stating:

> Rail carriers that introduce hazardous materials into communities have burdened those communities with seeking out commodity flow information, in addition to maintaining trained personnel and appropriate resources, to enable them to respond to potential transportation mishaps. We have found that despite voluntary outreach and community awareness programs, such as the Transportation Community Awareness and Emergency Response program, many communities and emergency responders are unprepared to cope with derailments that involve fires fueled by crude oil (p. 1).

DOT-111 Train Car Regulations. Railways are constructed for all types of cargo and there are no specific *hazardous materials only* tracks; however, companies are upgrading container rail cars in order to reduce crude by rail accidents. The DOT-111 tank car was the standard for transporting crude, with the DOT establishing construction and safety standards. Rail operators are responsible for moving crude oil and maintaining the railroads and infrastructure but do not own the DOT-111 rail cars, nor do they own the crude that is shipped. Producers of the crude oil or refiners own the crude and are responsible for shipment, and either own or lease the cars. Entities therefore have different legal responsibilities in the supply chain (Pumphrey, Hyland, & Melton, 2014), and as such, there has been confusion after crude by rail accidents regarding responsibility for clean-up and fines. DOT-111s are "non-pressure" tank cars designed to carry a wide range of products including hazardous and nonhazardous materials. Each car holds 30,000 gallons (715 barrels) of oil (Frittelli et al., 2014). Pressurized tank cars have thicker shells and heads, metal jackets, and strong protective housings for top fittings. Tank cars can become overloaded when they exceed the maximum gross weight. This can cause axles to break or brakes to fail (Bentley, 2016). Policies regulating tank cars have mainly been reactive policies rather than regulatory (Burton & Egan, 2011). In 2015 the DOT announced the final rule to strengthen DOT-111 standards. The rule included a new, enhanced tank car design, a new braking system to reduce the severity of an accident and the "pile-up effect," new speed restrictions, and operational protocols to inform local government agencies (U.S. DOT, 2015). This rule included all

DOT-111s used in high-hazard flammable trains (HHFT) be removed from this service or retrofitted by 2025. The AAR estimates that it will cost between $20,000 and $40,000 to retrofit each individual DOT-111 car (Pumphrey et al., 2014). Despite the rule, Christopher A. Hart, Chairman of the National Transportation Safety Board (NTSB) stated at a 2016 press conference "Ten years is much too long. We have been lucky thus far that derailments involving flammable liquids in America have not yet occurred in a populated area, but an American version of Lac Mégantic could happen at any time" (NTSB, 2016a, p. 1). Canada phased into the newer models in November 2018 (Tate, 2018; U.S. DOT, 2016).

Crude Oil Properties and Regulation. While increased volumes of Bakken crude were transported via rail, we also note that many other common hazardous chemicals are also hauled by rail, including anhydrous ammonia, chlorine, liquefied petroleum gas, hydrochloric acid, and ethanol. After the 2013 Lac Mégantic, Quebec accident that caused 47 fatalities and destroyed buildings (crude oil with a psi of 9), "the U.S. Department of Transportation issued a safety alert warning that the type of crude oil being transported from the Bakken region may be more flammable than traditional heavy crude oil" (Billig, 2019; Frittelli et al., 2014). Two concerns regarding the properties of Bakken crude oil arose from rail accidents: flammability and volatility. Bakken crude has as a flashpoint of 73°F (North Dakota Petroleum Council, 2014) and an average Reid vapor pressure (RVP) of at least 8.75 psi (Andrews, 2014). In comparison, Louisiana Light Sweet has an RVP of 3.33 psi., and only Brent crude from the North Sea with a volatility at 6.17 psi compares to Bakken (Gold, 2014).

With safety as a rationale, the North Dakota Industrial Commission in December of 2014 adopted conditioning standards for the transport of Bakken crude oil, with a requirement that Bakken crude reach a limit of 13.7 psi before transportation from the state (PHMSA, 2020). In October 2019 attorney generals from NY, MD, NJ, and CA, sent a letter of support to the US PHMSA regarding a WA state law that sought to limit the volatility of Bakken crude transported via train through WA State, to a limit of 9 psi (Mikulka, 2019b). On May 15, 2020 the PHMSA ruled against the states and issued a "Notice Of Administrative Determination of Preemption" stating:

> PHMSA finds that the Hazardous Materials Transportation Act (HMTA) preempts Washington State's vapor pressure limit for crude oil loaded or unloaded from rail tank cars, for three reasons. First, the vapor pressure requirement constitutes a scheme for classifying a hazardous material that is not substantively the same as the HMR [Hazardous Materials Regulations]. Second, the vapor pressure requirement imposes requirements on the handling of a hazardous material that are not substantively the same as the requirements of the HMR. Third, PHMSA has determined that the vapor pressure requirement is an obstacle to accomplishing and carrying out the HMTA (PHMSA, 2020, P.1).

As a result, as of the time of this publication, the US PHMSA has not (i) mandated sampling and testing for measuring vapor pressure, (ii) set a federal vapor pressure standard, (iii) nor required conditioning of crude oil prior to transport.

Culmination of Risk: Crude by Rail Accidents

While not a comprehensive list, the culmination of risks associated with crude oil transport via rail caused 84 accidents/million barrels shipped,[5] some of which proved lethal, and were detrimental to waters and wildlife (Mason, 2018). While the probability of accidents is low, prior events highlight the risk and challenges with crude by rail shipments. In *Lac-Mégantic, Quebec Canada,* 63 cars derailed and exploded in the town's center, spilling close to 40,000 barrels of oil (PSI of 9), and killing 47 people (Transportation Safety Board of Canada, 2014). Mason (2018) estimated that damages exceeded $100,000,000 USD. In December 2013, 18 tank cars derailed in Casselton, North Dakota and spilled 450,000 gallons of crude (FEMA, 2015). No fatalities occurred but the accident caused $6.1 million in damage with farmland sustaining the most damage. In Lynchburg, Virginia, a 2014 derailment released ±30,000 gallons of crude into the James River (catching fire). The train was traveling 24 m/hr, and the NTSB determined the cause to be a broken rail. Total property damage was $1.2 million, not including environmental remediation fees (NTSB, 2016b). The 2016 Mosier, Oregon derailment of 16 cars was caused by at least one broken bolt holding the rail in place (Ridler, 2016). Despite the newer CPC-1232 cars equipped with an extra metal layer to reduce punctures/fires, and a psi vapor pressure of 9.2 (slightly higher than the crude oil that exploded in Lac Mégantic, Quebec), the Bakken crude burned and spilled about 30,000 gallons near the Columbia River (Nearing, 2016). No waterways were contaminated during the spill (EPA, 2019; Tate, 2018). After the accident, the NTSB (2016b) stated:

> High-hazard flammable train derailment is yet another example where the local emergency response community was ill-prepared to effectively respond to the derailment. The absence of a regulatory requirement for railroads to assist local emergency planning committees still leaves many communities unprepared to deal with releases of hazardous materials. As the organizations that introduce such hazards into communities, railroads must take a more active role to protect those communities from the consequences of railroad accidents involving hazardous materials. No railroad regulations currently require a community-level public railroad awareness program, as pipeline regulations do for that industry. Further, recent changes to the Association of American Railroads (AAR) circular OT-55-O to revise the Transportation Community Awareness and Emergency Response program include a requirement that AAR members provide bona fide emergency response agencies or planning groups with specific commodity flow information covering all hazardous commodities transported

> through communities for a 12-month period in rank order…we are concerned that many small communities do not know how to obtain this information, nor do they have the resources to look for it or understand what to do with it if they get it (p. 1).

Public Risk Perception of Crude by Rail

No peer reviewed literature exists on the public's perception of risk posed specifically by crude by rail. However, Kraus & Slovic (1988) explored "local" hazards, all within the same category of railroad collisions, noting that all railroad accidents are not (created or perceived) the same. They constructed 49 railroad accident scenarios that incorporated type of train, cargo (passengers, benign cargo (grain), and chemicals), type of accident (collisions, derailments), location of accident, and the cause of an accident. Authors found that "catastrophic potential, newness, and dread were found to be the three best predictors of perceived risk" (p. 454), and that trains hauling explosive chemicals near a city were perceived by the public to be on par with a nuclear reactor, with trains carrying nontoxic freight evoking little concern. They concluded that policymakers should understand the difference between the degree of public concern for ordinary train derailments and enhanced concern (and social disruption) for derailments involving chemicals.

While research has been conducted on risk perception of technological disasters and the impact of risk perception on public policy, none focus specifically on crude oil transportation via rail. Most of the existing literature pertaining to our research lies within the study of technological risk perception. The natural sciences quantitatively define risk estimation as a "probability distribution of adverse effects," (Renn, 2008, p. 374), but social contexts refer to risk as "the likelihood of an adverse effect resulting from an event or an activity, rather than an opportunity for desired outcomes" (Wachinger et al., 2010, p. 8). For technological hazards, risk perception models include risk as a fatal threat, risk as fate, risk as a test of strength, risk as a game of chance, and risk as an early warning (lurking danger) indicator (Renn, 2004). For the public, a risk managed and communicated by an untrustworthy source is perceived to be greater than the same risk controlled by a trustworthy source, with a "source" including a country, state, agency, or business (Covello & Sandman, 2001; Kuprianczyk, 2016). Fiorino (1990) further explained that individuals tend to define risk perception based on three variables: (i) previous experience with a similar disaster; (ii) an entity's assessment of potential risk; and (iii) an institution's acknowledgment of potential, as a product of the individual's respect for that institution. The context in which those risks are experienced determines one's risk perception rather than the probability or severity of the adverse effects caused by the risk (Renn, 2004). As for the context, hazardous materials like flammable gas/liquids shipped via rail might feel more familiar to the public than radioactive material, because of personal experiences with gas stoves and gasoline. As such, "management of familiar hazardous materials is perceived to have a lower risk than management of radioactive materials" (Kuprianczyk, 2016, p. 28). In a

similar vein, Slovik (1993) stated that "When we lack familiarity with a technology we are naturally suspicious of it and cautious in accepting its risks" (p. 185).

Risk perception of technological disasters within the discipline of environmental and social justice tends to focus on issues of race and class. Burton and Stretesky (2014) noted that while the environmental justice framework is applied to communities of color and low socioeconomic status, the risks posed by crude by rail differ from this paradigm. They argued that the risks associated with crude by rail and its environmental injustice follows "transportation corridors that may traverse low-income communities in urban areas and affluent communities in non-urban areas" (Burton & Stretesky, 2014, p. 85). Similarly, Saratoga County presents a complex case, with both extremely wealthy communities (with substantial access to political power) at risk, alongside impoverished areas of the County, and further down the line in the Port of Albany, where the Ezra Prentice public housing residents are on a daily basis directly exposed numerous threats associated with rail infrastructure.

Environmental health and public safety are constantly at odds with the economic incentives of potentially harmful activities, including transporting crude oil through endangered species habitat and state-designated environmental justice communities. Infamous technological disasters that attracted (and still receive) a high degree of media coverage (in the United States and globally)—such as the Bhopal gas tragedy (India), Love Canal (NY), the 1969 Santa Barbara (CA), 1989 Exxon Valdez (AK),[6] and 2010 Deepwater Horizon oil spills (USA), Fukushima Daiichi nuclear disaster (Japan), and Lac-Mégantic (Canada) crude-by-rail disaster—resulted in changes to regulations and policies to protect public health and the environment. Heightened media coverage (and elevated public awareness) of these catastrophic (rare) events can also act as "regulatory catalysts" (and a diversity of *secondary impacts*), which sometimes include civil society advocacy, social disorder, elected official, agency, and municipality legal action, political demands, and proposals for training, regulatory, and/or infrastructure improvements (Kahn, 2007; Slovik, 1993). These disasters, the heightened media coverage, and the legal/policy/regulatory/social outfall (a proliferation of impacts) is a phenomenon termed the "social amplification" of risk (Kasperson, et al., 1988). Additionally, according to Kuprianczyk (2016), as a result of social amplification, the public might perceive disasters to have a higher frequency than they actually do. Further, since these catastrophes are highly publicized for extended periods of time, the degree to which the public perceives technological risk varies by the *type* of hazard and material. For instance, the outcomes of future nuclear explosions (an unfamiliar material) possibly outweighs risks related to oil/gas hazards (familiar materials), thus influencing risk perception (in terms of frequency and severity).

> Interaction or involvement with Class 7 material [radioactive material] is perceived to have a high failure frequency. On the contrary, Class 3 material accidents, such as gas explosions or oil fires, are associated with a lower relative major failure frequency, and thus lower contribution to total risk from major failure (Kuprianczyk, 2016, p. 26).

Risk policy cannot be purely science-based nor purely value-based (Renn, 2004). Public perception of risk can help to inform public policy to the extent that it positively shifts the understanding of shared social risk (Beck, 1992). Public policy regarding technological risk needs to consider the question "how fair is safe enough" and "how safe is safe enough" (Rayner & Cantor, 1987). And the focus of policymaking should move from focusing on what is deemed unsafe, and instead focus on an acceptable way of determining the "desired safety and utility levels" (Renn, 2004, p. 411). Analyzing public risk perception is beneficial for policymakers; however, policy decisions must take into consideration the diversity of contextual circumstances within society, as well as the politics, perceptions, and preferences of policymakers themselves. For instance, Slovik (1993) posited that with an increased awareness (by society and government) that we have control over many risks, we may become "more frustrated and angered at those risks that we are not able to control, when exposures are imposed upon us involuntarily" (p. 185). As such, when creating public policy and regulations, conflicts often arise when risk professionals (at times) view the public's perception of risk as misguided, given their lack of technical/scientific knowledge (Fiorino, 1990; Slovik, 1993). However, there are multiple substantive and normative arguments against this technocratic orientation in favor of including the public's perception of risk in creating policies and regulations. Fiorino (1990) argued that there are three substantive arguments: (i) lay judgments about risk are as sound as experts, as they have knowledge of issues that experts may overlook; (ii) the public has sensitivity to contextualized social and political values that experts' models might not acknowledge; and (iii) the public may have a better ability to accommodate for uncertainty. A normative argument to include the public's perception of risk when crafting policy is that ignoring the public is simply incompatible with democratic ideals; disregarding the public's perception of technological risk, whether misguided or not, disenfranchises the public (Fiorino, 1990).

Methods

Study Site

Economy of Saratoga County. Saratoga County is a tourist destination for outdoor recreation, art, and music, mineral springs, historical sites, and includes the nation's first horse racetrack in Saratoga Springs. The agricultural industry is prominent; according to the Cornell Cooperative Extension (2014) there were 583 farms in Saratoga County in 2012, averaging 135 acres per farm, with a total of 78,849 acres in production. County farms produce annual sales volumes of $79.9 million in agricultural products with just under 50% of gross agricultural sales from the sale of milk. The County is also a high-tech business destination, with GlobalFoundries investing over $12 billion in a semiconductor plant and research and development center (Roberts, 2014). The median household income in Saratoga County is $70,581, higher than the median household income of NY State's $58,678 (U.S. Census Bureau, 2015). Saratoga County is expected

to have the highest growth rate in the NY Capital Region with 2050 projections indicating a population of 252,153 (CDRPC, 2020).

The Natural Environment, Protected Lands and Waters, and Endangered Species Transporting crude oil via rail poses unique threats to the natural environment in the event of an accidental spill and/or fire. CP Rail lines in Saratoga County are within one-mile of the Hudson and Mohawk Rivers. The tracks also cross these rivers twice, south of Saratoga County in Cohoes and Albany. The CP lines run through multiple watersheds in Saratoga County, including the Loughberry Lake watershed, the main drinking water source for the City of Saratoga Springs. This watershed sits upon deep glacial sand deposits that contain a significant aquifer close to the surface. Wetlands occupy 42,800 acres of Saratoga County, amounting to 8% of the total area of the county. While forested wetlands are the most abundant in the county, emergent wetlands, ponds, and shrub swamps are also common (Tiner, 2000).

The Karner blue butterfly is a federally protected endangered species that relies on protected lands and habitat (associated with the sand deposits mentioned previously) in Saratoga County, in the Wilton Wildlife Preserve and Park (WWPP, 2019). According to the NY DEC, the most intact populations of the Karner blue butterfly *nationwide* are in Saratoga County. CP rail lines run directly through the WWPP where Blue lupine (the host plant for the butterfly) thrives in the sandy soils. In the event of an oil spill the material would be difficult to remove from the soils, thus harming Blue lupine and/or the butterfly (New York State Department of Environmental Conservation [NYSDEC], 2019a; U.S. Fish and Wildlife Service, 2003). Downstream from Saratoga County the Shortnose sturgeon lives in the Hudson River between Manhattan and Troy, NY. The Shortnose sturgeon is listed as Endangered and fully protected by the Endangered Species Act (NYDEC, 2019c). Sturgeon have the potential to be impacted in the event of a crude oil spill from a railcar and/or oil barge.[7]

Instrumentation and Data Collection

The qualitative data for this research was triangulated through 419 online (Qualtrics) and in-person surveys, 16 semistructured interviews with members of the state and county government, emergency response planners, business and education community, community influentials, and archival analysis of county and municipality safety/fire commissioner online and printed resources (Creswell, 2013).[8] The survey consisted of 17 items, took 15 minutes to complete, was compatible with smart phones (or pencil/paper upon request), and collected a diversity of data on public knowledge, preferences, trust, political affiliation, attitudes, and perceptions. The instrument included one open-ended question, preference rankings, photo identification, slider bar percentage rankings, multiple choice, and yes/no questions (Creswell, 2013). The introductory *Informed Consent* form provided respondents with information about the purpose of the research, yet was phrased so as not to bias responses, and only described rail cargo broadly, and the need for a better understanding of the public's awareness and perceptions of rail shipments, emergency response plans, and community and environmental risks related to

rail shipments (it did not mention crude oil shipments). All survey respondents lived or worked in Saratoga County. Community organizations such as the League of Women Voters, Saratoga County Republican and Democratic Committees, PTAs, etc., voluntarily distributed the online survey via email and/or social media. Online surveys and paper and pencil surveys were completed at public festivals, farmers' markets, and libraries. All respondents were asked to provide their physical home address to allow for geo-coding and ArcGIS mapping in relation to proximity to railroad tracks, thus determining the relationship between respondents' awareness of crude by rail in relation to proximity to tracks.

Data Analysis and Limitations. Interviews were transcribed, coded, and analyzed utilizing quote charts, Type 1 tabulations, and descriptive narratives (Silverman, 2006). Respondent interview data from both the semistructured interviews and open-ended survey questions were coded for topical commonalities and deviant cases in responses (Creswell, 2013). We coded and mapped responses to each of these questions within one-mile and one half-mile of the tracks. These distances were based on the DOT's Emergency Response Guidebook; anything within one-mile of the tracks is in the potential impact zone in the event of a crude oil fire, and anything within one half-mile is in the evacuation zone (U.S. DOT, 2016). Further, we calculated the number of homes and schools, and area of farmland, protected lands, wetlands, and schools that are within one-mile and one half-mile of the tracks. For quantitative questions where answer represented contiguous variables, descriptive statistics were calculated in JMP Pro (v14). The effect of political party affiliation on respondent bias was calculated using JMP and Analysis of Variance (ANOVA) with a Tukey's HSD pairwise comparison.

In terms of limitations, while we made efforts to interview representatives from railroad companies and industry representatives, our requests were declined, and as such, we relied on secondary data from the railroad industry (Association of American Railroads), federal and state government agency reports, the Congressional Research Service, and peer reviewed research. We also experienced coverage error, or "a function of the mismatch between the target population and the frame population" (Couper, 2000, p. 467). While our target population included Saratoga County residents, those with internet access and smart phones were most likely to complete our survey. As such, we worked throughout the county to collect data via paper surveys at community events and libraries. Citizens lacking internet access are of a lower income bracket, older, or may be less educated than demographics with access to the Internet. It's possible that individuals who lack access to the internet are also those directly affected by the risks associated with crude by rail.

Results

Survey Data

Citizen Awareness of Crude by Rail in Saratoga County, Disaster Preparedness, and Emergency Planning. While 54% (217/401) of all respondents had seen a DOT-111 rail

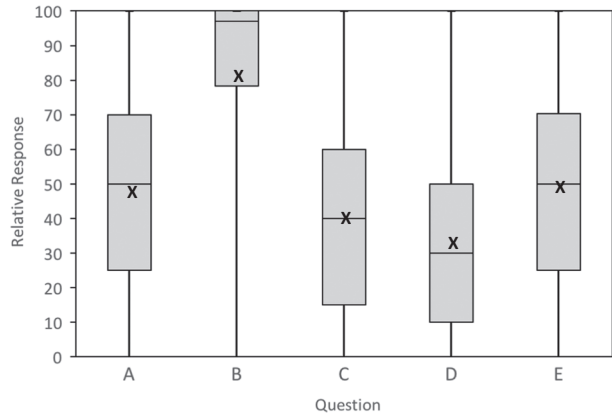

Figure 3. Box and Whisker Plots Showing the Max, Min, Q1, Median, Q3, and Mean (X) Response Values for Survey Questions A: How safe do you think it is to transport crude oil by rail with 100 being the safest?, B: How would you rate your level of support for creating or strengthening an emergency response plan for derailment/spill/explosion of oil trains in Saratoga County with 100 being the highest amount of support?, C: In relation to railway shipments of oil, to what extent do you trust the federal government to protect your safety, private property, and public health with 100 being the most trust?, D: In relation to railway shipments of oil, to what extent do you trust the federal government to protect the environment with 100 being the most trust?, and E: What is your willingness to involve yourself in any sort of action to improve safety measures for crude oil transportation by rail with 100 being the most willing?

car in Saratoga County, only 35% (142/401) of all respondents knew that crude oil was being transported via rail through the County. Respondent awareness of a formal Emergency Management Plan in the event of a crude by rail accident/fire was 11%, and only 15% were aware of what to do following a crude by rail accident/fire. In terms of respondents living closer to the tracks, 75% ($32/43^{9}$) of respondents living within the Potential Impact Zone had seen the tanker cars, yet only 11% (5/43) knew that crude oil was the material being transported. This lack of knowledge was similar to the low level of awareness of Emergency Response Plans: 86% of respondents living within the Potential Impact Zone did not know what to do in the event of an accident/fire. Overwhelmingly, 93% (372/400) of all respondents agreed that the local government should be responsible for ensuring public awareness of a crude by rail Emergency Response Plan. When asked on a scale of 0–100 "How safe do you think it is to transport crude oil by rail?", respondents averaged 47/100 (Figure 3a). We found a significant effect ($p < 0.05$) of party affiliation on provided responses. Although party affiliations included Independent, Green, Working Families, Libertarian, Other, and Choose Not to Say, the effect was driven by differences between Democrats and Republicans. Democrats felt it was less safe (LS mean = 41) than did Republicans (LS mean = 66). And when asked if they supported the creation and/or strengthening of a County Emergency Response Plan, respondents gave an average value of 82 on a scale of 0–100 (Figure 3b). Again party affiliation was a significant response effect ($p < 0.05$) driven by Republicans vs Democrats. Democrats were more enthusiastic about strengthening response plans (LS mean = 84) compared to Republicans (LS mean = 66).

Table 1. Citizen Priorities in Relation to Crude Oil Transport Via Rail, *Not* Grouped by Political Affiliation ($n = 381$)

	Most Important	Somewhat Important	Least Important	Total
Minimization of oil prices	8.4%	8.4%	83.2%	100%
Minimization of environmental impacts	37.27%	52.49%	10.24%	100%
Minimization of impacts to public health	54.33%	39.11%	6.56%	100%

Citizen Level of Governmental Trust and Engagement. Respondents had a low level of trust in the Federal Government regarding crude by rail transportation. In the following, 0 represents the least amount of trust for the Federal Government, with 100 the most. When asked to rate their level of trust in the Federal Government regarding protection of safety, private property, and public health in relation to crude by rail shipments, the average value was 40 out of 100 (Figure 3c). Similarly, respondents rated their level of trust in the Federal Government regarding protection of the environment in relation to crude by rail shipments, with the average response value 34 out of 100 (Figure 3d). When asked how willing they would be to engage themselves in any sort of action/communication to advocate for enhanced safety measures for crude by rail, the average value was 49 out of 100 (Figure 3). Party affiliation had no significant effect on response as all affiliations had highly varying responses with respect to trust in the federal government (Figure 3c,d).

Respondent Party Affiliation. As mentioned above, our data identified political affiliation and the relationship between political affiliation and respondents' opinions about crude by rail and policy. Broadly, 67% (262/393) of all respondents (regardless of political affiliation) stated they would support a

Table 2. Natural and Built Environment (Amenities) Located Within the Evacuation Zone and Potential Impact Zone

Type of Amenity	Potential Impact Zone One-Mile of CP	Half-Mile of CP Evacuation Zone
Residential property	17,990	8,442
Total value of residential property	$3.2 billion	$1.3 billion
Schools	22	13
DEC land	2.3 mi^2	2.2 mi^2
Farmland	15.3 mi^2	7.6 mi^2
Wilton Wildlife Preserve and Park (multiple dispersed plots)	90%	64%
Wetlands	24.6 mi^2	20.0 mi^2
Loughberry Lake	59%	
Loughberry Lake Watershed	38.60% (9.0 mi^2)	19.40% (4.6 mi^2)
Hudson River	13.5 mi^2	10.4 mi^2

Source: New York State Department of Taxation & Finance (2014).

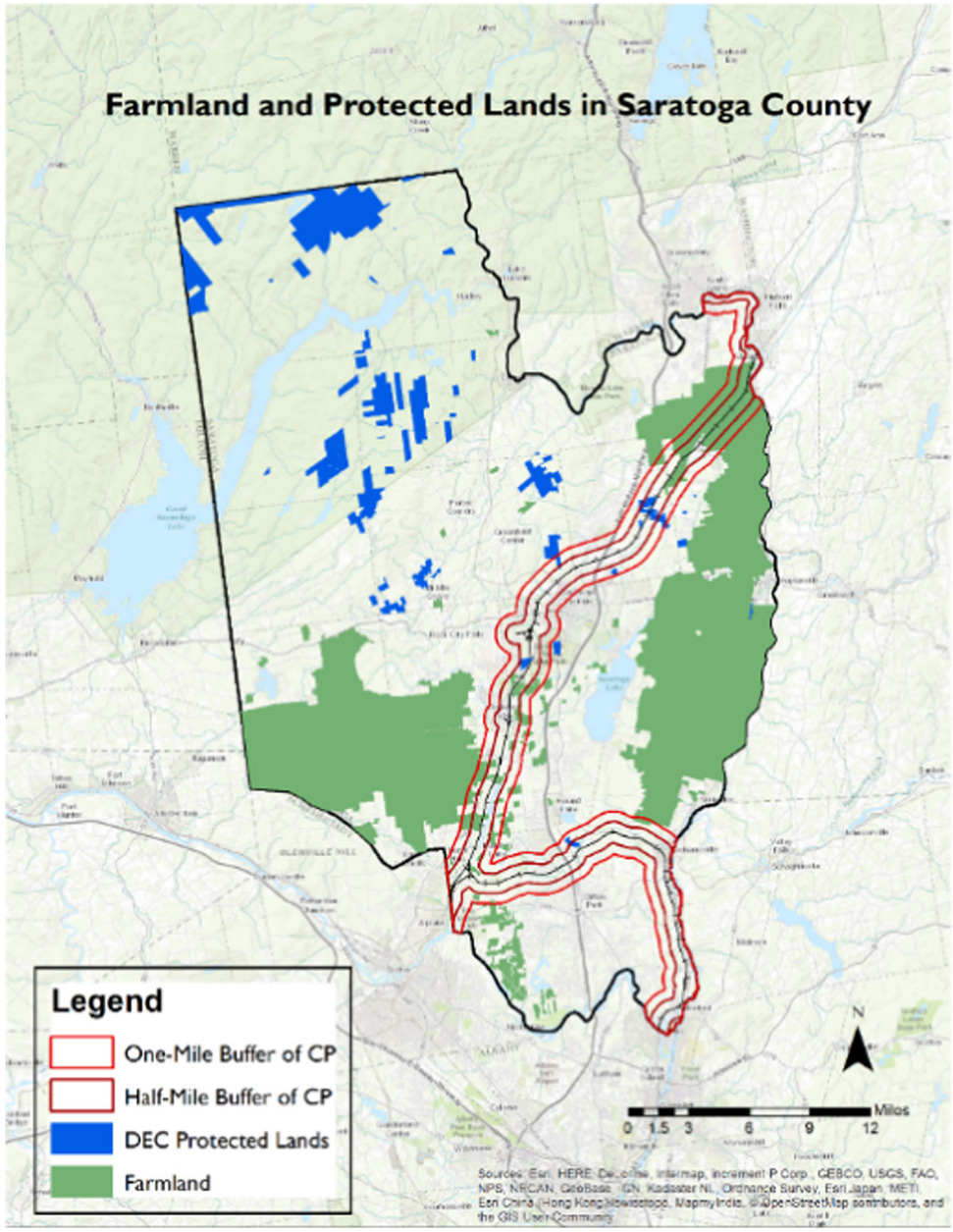

Figure 4. Map of Farmland and DEC lands in Saratoga County, in Relation to Crude by Rail Route. *Sources:* Cornell Institute for Resource Information Science (2016); NYSDEC (2008); USDA Economic Research Service (2012).

statewide ban on crude by rail transport through NY State until all tracks, railroad beds, and rail cars were inspected and repaired. In relation to political affiliation, 80% of Democrats, 43% of Republicans, and 60% of Independents supported this policy intervention.

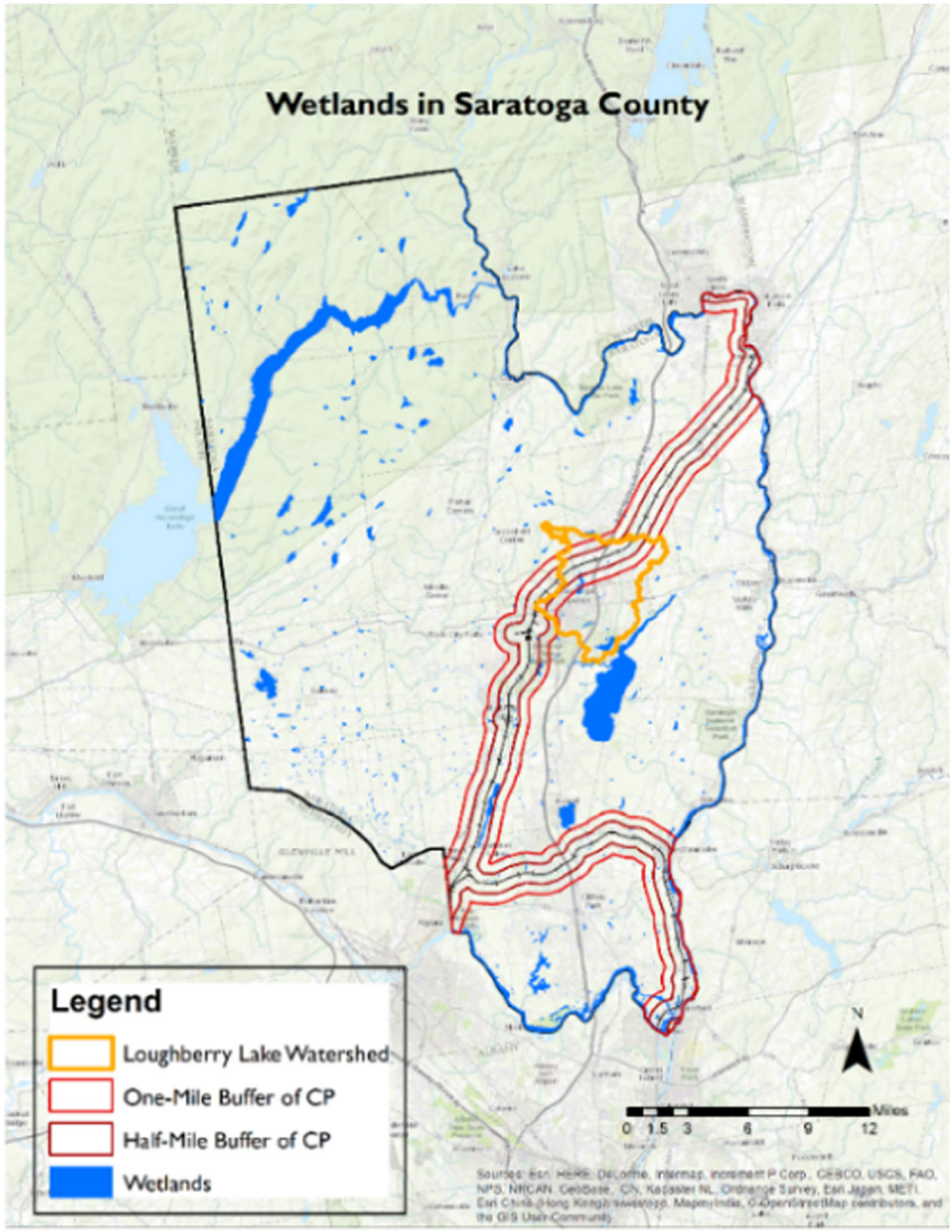

Figure 5. Map of Wetlands in Saratoga County, in Relation to Crude by Rail Route.
Source: USDA Geospatial Gateway (2016)

Respondents were asked to rank the priority of the following factors in relation to crude oil transport via rail: minimization of oil prices; minimization of environmental impacts; and minimization of impacts to public health. Ranking options included "Most Important," "Somewhat Important," and "Least Important." Regardless of political affiliation, 54.33% ranked minimization of impacts to public health as most important,

Table 3. Community Influential Semistructured Interview Respondents

Name	Title	Affiliation
Michael Piccirillo	Superintendent	Saratoga Springs School District
Two anonymous Saratoga County employees		Saratoga County
Kirsten Anderson	Engineering Geologist	NY State Department of Environmental Conservation—Geographic Response Plan
Dennis Pokrzywka	Co-Chair, Local Emergency Management Committee	Town of Ballston, NY
Maria Trabka	Executive Director	Saratoga PLAN
Bill Boehmke	Chair, Climate & Energy Committee	Sustainable Saratoga
Larissa Leibmann	Clean and Safe Energy Campaign Attorney	Waterkeeper Alliance
Loretta Greenholtz	Academic Safety Officer, Office of Environmental Health and Safety	Skidmore College
Scott Kellogg, Ph.D.	Educational Director Sustainability Advisory Committee	Radix Ecological Center City of Albany, NY
Louise Golub	President	League of Women Voters
Brian Fredericks	Labor Student Alliance Founder & Skidmore College Divestment Taskforce Appointee	Skidmore College

37.27% ranked minimization of environmental impacts as most important, and 8.4% ranked minimization of oil prices as most important (Table 1). Among all three parties, minimization of oil prices ranked the lowest in priority, with 20% of Republicans stating this as the highest priority (10% of Independents and 4% of Democrats). Among all three parties, Minimization of Environmental Impacts was the second highest in priority, with Democrats leading at 46% (37% of Republicans and 20% of Independents). Highest in priority among all three parties was minimization of impacts to public health, with 60% of Independents ranking this as the most important (54% of Republicans and 51% of Democrats).

Geographical Information System Data Points

As mentioned above, the CP runs through populated areas of Saratoga County, as well as farmlands, watersheds, lands protected by the DEC, and habitat for the federally listed Karner blue butterfly. In Table 2 and Figures 4 and 5, we detail the locations, quantities, and (some) values for these properties and public amenities, located within the Potential Impact and Evacuation Zones.

Semistructured Interview Data

Through 16 semistructured interviews with citizens and community influentials - elected and appointed individuals with influence over environmental protection, public health and safety policies, regulations, and emergency response planning

(Table 3)—we documented risk perception and concerns regarding crude by rail in Saratoga County.

Knowledge and Concern Regarding Crude by Rail. Semi-structured interviews with community influentials showed that respondents had a clear knowledge of the issue, as well as a concern for students, public safety, and the environment, due to the frequency of crude oil shipments and proximity to schools. As noted above, 13 schools are within the Evacuation Zone, with Skidmore College (depending on location) 500–3,000 ft. from the tracks (2,650 students and 1,080 faculty and staff). And, as noted by the Superintendent of the Saratoga Springs School District: "Actually, the oil trains go right by Maple Ave. Middle School on a daily basis [370 ft. from the tracks]. Also, the tracks are pretty close to Dorothy Nolan Elementary School…even the high school, the tracks are not that far from here" (M. Piccirillo, 2016, personal communication). Greenholtz, the Academic Safety Officer at the Office of Environmental Health and Safety at Skidmore College, and author of the College's Crude by Rail Response Plan (2016) explained:

> We average about one-and-a-half to two trains a day, albeit when those trains come through they can have well over 100 cars on a train. So if there were an issue, it would be devastating, without question. But the likelihood of an accident happening is low (2016, personal communication).

While most community influentials were pragmatic about the low likelihood of an accident/fire/explosion, they still expressed concerns. For instance, an employee of the Saratoga County government who wished to remain anonymous stated:

> It's getting a lot of publicity because of the recent accidents, and there's been a lot of train derailments that involve a wide variety of chemicals. But once the issues with the crude oil trains started, I think that's when people started paying attention to what was on the cars. I understand that people are concerned if they live right by the rail (anonymous, 2019, personal communication).

More nuanced public health threats involved degraded air quality due to off-gassing during the staging of crude oil. Greenholtz and Kellogg made it clear that while affluent and underprivileged communities alike are at risk in the event of a derailment, communities with the least political capital are disproportionately affected by transportation planning and policies. This risk receives less attention, yet has equal weight in light of impacts to environmental justice communities, including those in Albany's South End.

> There are segments of the population that are really sensitive to this. Many people don't know there are tons of oil moving past the Saratoga County schools that their children attend, and transported and stored in lower-income, politically underrepresented communities in Albany. Within, and

> even just outside of Saratoga County, the input of these communities is rarely solicited, and when it is, it's tokenized and disregarded (Fredricks, 2016, personal communication).

This is similar to what respondents explained in open-ended survey responses; they didn't feel empowered to engage with this issue due to low self-efficacy, further compounded by those who indicated a distrust of the local and federal government to inform citizens about crude by rail shipments, and the potential risks to public safety and the environment. When citizens lack influence to change the outcomes of the situation—whether that outcome is related to meaningful Emergency Management Plans or the creation of new regulations and practices to make infrastructure and the industry safer—it represents a flaw in both technological risk management and policy/governance that acquiesces an inappropriate usage of railroads in close proximity to schools, homes, etc. According to Liebmann, who worked on the Waterkeeper Clean and Safe Energy Campaign:

> Community members are not really sure how often these trains are coming, they're not really sure what's in the trains, they just know that there's a chance that something could go horribly wrong, and they can't do much about it. Because even if local officials are responsive to their concerns, there's only so much that local officials can do. Mostly it's up to the federal government…it's just the way the law is structured (2016, personal communication).

While it is the responsibility of federal agencies to mandate broad (nationwide) improvements in rail and car infrastructure, thus improving the safety of crude by rail, municipal, county, and state governments have the authority to pass ordinances (with limited mandates), power to pressure (and lobby) for stronger federal policies, and ability to apply for funding used for training, equipment, and the creation site-specific Emergency Management Plans (in the case of NY State, they are called Inland Geographic Response Plans—GRP[10]). Further, local governments also have the authority to educate the public about crude by rail shipments in their communities, as well as readiness to communicate and implement the GRPs.

But with so many stakeholders it is difficult for citizens to understand how the issue should be addressed. Kellogg elaborated on these complexities in relation to the Port of Albany, where Bakken crude, after leaving Saratoga County, is stored 100 ft. from the Ezra Prentice public housing in Albany's South End:

> The City of Albany does not own the Port of Albany. There's a multi-member coalition that governs the Port, but ultimately this is a federal issue, because the tracks are federal. Albany County Executive McCoy was in favor of trying to pass a county-wide moratorium on oil shipments, or provisions having to do with the way oil is treated there. He's a former

> fireman who's particularly concerned about the dangers (2016, personal communication).

Regulation, Prevention, and Preparedness. None of our respondents supported a ban on shipments of crude oil through NY State due to economic impacts, given the state and nation's dependence on fossil fuels. Additionally, they expressed low confidence in the viability of a ban and uncertainty regarding the broader outcomes of such an action. While the Superintendent of Schools, anonymous Saratoga County employees, and Co-Chair of the Town of Ballston Emergency Management Committee all agreed that crude by rail accidents posed threats to public health and safety, they were all aware of the political complexity of supporting a ban on crude by rail in the County. As Kellogg explained "It's a really contentious issue, and it's ongoing. It's also politically complicated because of all the multiple layers of government that are involved" (2016, personal communication).

When asked about how to improve public safety, we found that some community influentials were more focused on the *prevention* of an accident, others more focused on appropriate *reactions* (preparedness) for an accident, and those who valued both. Superintendent Piccirillo discussed his concern for protecting public safety and was most concerned with individual student and staff actions in the unlikely event of an emergency. Piccirillo understood his ability to directly control the extent to which schoolchildren and teachers are prepared to act in relation to Emergency Management Plans, by organizing fire drills and actions to take in the event of an accident.

Students and employees of Skidmore College who work and sleep in buildings adjacent to the CP tracks expressed their interest regarding the factors that contributed to prior crude by rail accidents, how to create and/or implement broader policies to make the industry safer, and how disasters can be prevented. While one employee we interviewed suggested that the first step should be to repair faulty rail infrastructure (nationwide), another employee noted the outdated nature of society's reliance on fossil fuel infrastructure: "Any economic activity that destroys the environment is counterproductive and shouldn't happen, doesn't need to happen, especially in the energy sector, when there are so many alternatives to oil."

Interviewees Pokrzywka and Greenholtz focused on both prevention *and* preparedness as strategies; outdated rail cars should be replaced or retrofitted, and broken rail infrastructure should be repaired. In our 2016 interview with Pokrzywka he discussed avoidance methodology, and advocated for more comprehensive Emergency Management Plans—similar to the 2018 NY State DEC map-based, location-specific "Geographic Response Plans"—which use GIS, and are updated every 3 years. He stated that the plans needed to be site specific for each County:

> The issue covers both humans and the environment, so then we must ask ourselves "What if there is a big wreck…what are our protection priorities, and what are those factors that we want to look at?" But right now, in our current Emergency Management Plan…can you tell me where the water

> intakes are for this lake, or where the eagle nest is? (2016, personal communication).

Liebmann expanded upon these concerns noting the need for planning and remediation efforts to address the longer-term consequences of a crude by rail disaster:

> In a report about the Lac-Mégantic disaster, the Canadian government found an increase in the frequency of deformities in fish. Their study is interesting as it shows not just short-term effects. An oil spill will impact water quality immediately and longer-term, potentially affecting potable water for human consumption, as well as impacts to wildlife…impacts that will continue for years (2016, personal communication).

NY State ultimately responded (and paid for) the DEC's 2018/2019 creation of 25 GRPs, and the training of 25 counties to bolster the safety of communities and the environment in the face of this new technological risk (NYSDEC, 2019b). These newly released GRPs outline response strategies for the protection of inland resources, identify sensitive environmental resources, booming strategies, and "identify the locations [and phone numbers] of sensitive human receptors (e.g., schools, daycare centers, assisted living centers, etc.), critical infrastructure, and suppression assets" (NYSDEC, 2017, p. 1). Saratoga County's GRP was finalized and made available by the DEC online to the public in 2018. During our semistructured interview with the DEC, Anderson stated:

> We [DEC] established "Steering Committees" with the assistance of county emergency management to create the GRPs. These steering committees consisted of local first responders, Department of Public Works workers, utility workers, and other local, state, and federal response agencies. Once created, the data we captured and the final created products all go back into the hands of the county EMs [Emergency Management] and all those who attended these Steering Committees. It is then up to the county and first response agencies to distribute the plans to their public. Some counties post them on their county websites or make them available through the emergency management office and at fire houses. DEC does make all of our plans publicly available through our GRP Webpage and online map-viewer (2019, personal communication).

Discussion

Potential Risk Reduction Solutions and the Ongoing Intersection of Citizen Action, State Funded Response Policies, and Federal Policy

Based on our 419 survey results we found that the public had a low level of knowledge about the existence of crude oil rail shipments moving through Saratoga

County (as low as 11% for those living closest to the tracks), despite the fact that the deadliest crude by rail disaster (Lac-Mégantic) was highly publicized and occurred only three years prior to our research (and was located within ±320 mi. of their homes). Community influentials we spoke with confirmed the public's lack of knowledge, and also acknowledged the potential threats to public health and safety, and the environment. Despite the NY State Division of Homeland Security and Emergency Service's development of a strategic and tactical guide for fire departments for the immediate aftermath of an accident (in order to strengthen emergency preparedness in response to a crude by rail accident) (Hauer, 2014), most of our public survey respondents were unaware of Emergency Management Plans and actions to take during a crude by rail accident.

Our data showed that most respondents believed it was the local government's responsibility to make sure the public was aware of an Emergency Response Plan, possibly due to their stated low levels of trust in the federal government (in relation to crude by rail; Figure 3) to protect public safety and health, private property, and the environment. The majority of semistructured interviews with community influentials reflected these same sentiments of distrust, as did the documented actions of NY Governor Cuomo and the Attorney General of NY, various NY elected officials, Governor Inslee of WA State, and three Attorney Generals from MD, NJ, and CA. As described by Covello & Sandman (2001) and Kuprianczyk (2016), this lack of trust was likely related to a risk managed and communicated by a source that was perceived to be untrustworthy, which was possibly also reflected (in survey responses) in the public's stated low degree of confidence in the federal government's ability to regulate and safely transport crude oil by rail (Figure 3). And while management of a familiar hazardous material (oil) might hypothetically result in a lower risk perception among community influentials and the public (Kuprianczyk, 2016; Slovik, 1993), the high level of distrust of the federal government that we documented, coupled with various social amplification factors—Lac Mégantic's high death rate, expansive media coverage of nationwide derailments, widespread use of the term "bomb trains," and a vocal civil society—resulted in a high level of perceived risk. Our findings further paralleled those of Kraus & Slovic (1988) who found that the practice of using trains to haul explosive chemicals near a city (population center) is often perceived by the public as a risky endeavor. However, we also found political affiliation affected perceptions of perceived risk, the need to reform/create policies to make shipments safer, and preferences for the creation and/or strengthening of Emergency Response Plans.

From both the surveys and interview data, and the more recent reactions (and actions) by the State of NY, we found a disconnect between federal agency regulations and (in)action (i.e.,: reluctance to adopt vapor pressure limits for crude oil), and the heightened need to communicate with communities. While our survey and interview respondents were less inclined to engage themselves in actions to advocate for enhanced safety measures for crude by rail, a broad coalition of citizens and state and national civil society organizations—including the environmental justice/climate justice movement and NY State Nurses Association—have engaged in social mobilization, civil disobedience, and demonstrations, and lobbied their elected officials to address and remedy the diversity of risks to public health and the environment.[11] The resulting

social amplification, and the repeated use of the term "bomb trains," was but one strategy for gaining political advantage and swaying public opinion. Further, it was apparent that a diversity of elected officials (NY Governor Cuomo, WA Governor Inslee, NY Senator Schumer, etc.), and civil society have continuously highlighted the risks presented by crude by rail. Potentially, crude by rail represents yet another facet of the broader fossil fuel infrastructure/industry that (in their opinion) needs to be reformed in order to mitigate anthropogenic caused climate change through a "just transition" to renewable energy sources (which many consider safer for communities and the climate). This scenario is similar to what was described by Kasperson et al. (1988), that "Risk issues enter into the political agenda of social and political groups" (p. 185). As such, the social alignment factors within this case of social amplification may possibly be affecting risk perception by the public, as well as the level of support for policies related to the fossil fuel industry. For instance, within our respondents, 67% stated they would support a statewide ban on crude by rail transport through NY State until all tracks, railroad beds, and rail cars are inspected and repaired, regardless of political affiliation, although Democrats were about twice as supportive (compared to Republicans). Again, as described by Kasperson et al. (1988), social amplifications of risk resulted in behavioral responses, which, in our case ultimately resulted in secondary impacts: "stigmatization of a risk manager; political demands; changes in training, education, or required qualifications of emergency response personnel; social disorder (protests and arrests); changes in risk monitoring and regulation; and erosion of public trust" (p. 182).

While NY State and Saratoga County have taken action to reduce risk and be better prepared for a crude by rail accident, there are significant limitations placed on any state or municipal agency/official that wants to engage in risk governance and *regulate* crude by rail; the federal government maintains the exclusive power to regulate railroads, protected by the Commerce Clause in the Constitution. Congress has passed multiple laws enhancing this power, including the Interstate Commerce Commission Termination Act of 1995. Additionally, the U.S. DOT adopted a rule stating that any regulation or law passed by a state that attempts to "limit or prohibit the use of a rail line…for the transportation of hazardous materials…is prohibited" (Gerrard & McTiernan, 2015, p. 1). As such, the FRA ultimately decides on rail safety regulations, while (as our research found) states (like NY, CA, WA, OR, MD, etc.) are relegated to self-funded infrastructure inspections and D.C. lobbying efforts, and local governments (like Saratoga County) are burdened with first response/emergency preparedness, prevention, and public education. This tiered disaster management regime (as realized nationwide) is inefficient, as different costs and benefits of risk management across levels of government places the burden (costs and responsibilities) on state, county, local governments, and taxpayers (Lyles, Berke, & Smith, 2014; McEntire, 2007).

Recommendations

In light of our findings, we propose the following recommendations, which can be implemented and funded through state legislation similar to that of Oregon's HB

2209 (June 29, 2019). Oregon's bill requires railroads that own or operate high-hazard train routes to have oil spill contingency plans that have been approved by the OR State Department of Environmental Quality. The bill establishes fees on railroads that fund the work of state agencies to prepare for oil moving throughout the state and holds rail oil transporters more accountable for the costs associated with training, equipment, and the development of site-specific Emergency Management Plans (Schick, 2019).

Strengthen Statewide Public Engagement and Awareness Efforts

Participatory GIS (PGIS) could be employed to engage community members and provide input on issues where their voices would otherwise not be heard (Hawthorne, 2005). By implementing PGIS, residents living in areas who have first-hand knowledge of bridge deterioration and broken railroad infrastructure are given the opportunity to enhance "expert" data, and can base their perception of risk and future behaviors beyond reports from external agencies (including railroad companies) (Hawthorne, 2005).

Information about crude by rail shipments, as well as appropriate public response (evacuation routes) should be communicated (sent in the mail) to homes, schools, etc. within the Potential Impact Zone (NYS GRPs already identify addresses of these human receptors). This communication presents a financial burden to county agencies and municipalities, and thus should be communicated (and paid for) by rail companies. Enhanced public awareness and response to a risk is a necessary next step if counties and municipalities want community members to be adequately prepared. Fire departments offer public information sessions, the ability to sign up for Code Red—Community Notification Enrollment (a reverse 911 system for phones), and citizens can join a Community Emergency Response Team (CERT) or Citizen Corps, thus providing basic education and training for residents to learn how to be safer from the threats of disasters. While crude by rail shipments have recently ended in NY State, the phenomenon could potentially see a resurgence based on supply, refinery demand, and/or pipeline capacity. Covert & Kellogg (2018) posited that the (sometimes) higher prices of Bakken Crude in 2019 ($61.00/barrel) may make crude by rail shipments worth the higher cost, yet this remains to be realized (EIA, 2019a). Current lack of demand due to the Covid-19 pandemic suggests that such demand is some time in the future, providing time for the federal government to implement new reforms.

Enhanced Railroad Infrastructure Inspections and Repairs

While NY State took action to inspect rail infrastructure, no Blitz inspections have occurred since 2014, and should now be expanded with greater frequency to review hundreds of more miles of rail (on foot). Heavier duty bolts should be used

in curved sections of tracks, as Union Pacific cited one or more broken bolts as the cause of the 2016 Mosier, Oregon derailment and fire (Schick & Conrad, 2016). Additionally, more federal inspectors should be hired to inspect privately owned railroad bridges, and in addition to manually checking rails on foot, automated flaw detection equipment should be considered for more rapidly inspecting greater distances of tracks.

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NOTES

[1]On October 29, 2019 the Keystone Pipeline spilled 383,000 gallons of crude oil into a North Dakota wetland. In 2017, the same pipeline spilled more than 400,000 gallons onto South Dakota agricultural land (Knowles, 2019).

[2]According to the Association of American Railroads (2020), "more than 99.999% of all hazmat moved by rail reaches its destination without a release caused by an incident" (p. 1).

[3]The cost of transporting oil by rail is $5 to $10 per barrel higher than pipelines, yet was still profitable despite the overall lower cost of Bakken (Frittelli et al., 2014).

[4]On July 5, 2018, two 30-ton pieces of non-load-bearing concrete fell off the Onondaga St. Bridge in Syracuse, owned by the New York, Susquehanna & Western Railway (Congressional Research Service, 2018).

[5]For the period July 2010–July 2016 (Mason, 2018).

[6]For instance, as a result of the 1989 Exxon Valdez oil spill (AK), the Oil Pollution Act of 1990 amended the Clean Water Act, requiring tankers (ships) to be constructed with double hulls to prevent oil spills. The Act also established a trust fund financed by a tax on oil to clean up spills when the responsible party is incapable or unwilling to do so (EPA, 2020).

[7]In December 2012, during its maiden voyage from the Port of Albany the oil tanker Stena Primorsk grounded near Bethlehem, NY. None of the 12 million gallons of crude spilled, despite a 13-foot gash in the hull; an inner hull remained intact (Stevens, 2015).

[8]The college Institutional Review Board approved all data collection and respondent *Informed Consent* forms, and standard research protocols were followed in the development of the survey instrument, data collection and analysis, and reporting of results.

[9]The total number of respondents living within the potential impact zone is likely underrepresented in our data, as not all respondents voluntarily provided us with their home addresses.

[10]NYS Inland GRPs can be found online at https://nysdec.maps.arcgis.com/apps/webappviewer/index.html?id=6606cf0fc1b14c4f9a9364126ec006aa

[11]In 2015 the NY State Nurses Association staged a rally and "die-in" during their annual convention to commemorate the Lac Mégantic disaster, and later protested in 2016 at the Port of Albany, calling for more stringent safety standards related to crude by rail shipments (New York State Nurses Association, 2020).

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Appendix A: List of Acronyms and Abbreviations

AAR	Association of American Railroads
BNSF	Burlington Northern Santa Fe
CERT	Community Emergency Response Team
CA	California
CP	Canadian Pacific Railway
CPC	Casualty Prevention Circular
CSX	Chessie-Seaboard Merger
DEC	Department of Environmental Conservation
DOT	Department of Transportation
EIA	Energy Information Administration
EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Agency
FRA	Federal Railroad Administration
GIS	Geographic Information System
GRP	Inland Geographic Response Plans
HMR	Hazardous Materials Regulations
HMTA	Hazardous Materials Transportation Act
MD	Maryland

NEPA	National Environmental Policy Act
NTSB	National Transportation Safety Board
NJ	New Jersey
NY	New York
OR	Oregon
PES	Philadelphia Energy Solutions
PGIS	Participatory Geographic Information System
PHMSA	Pipeline and Hazardous Materials Safety Administration
PSI	Pound Per Square Inch
PTA	Parent Teacher Association
RVP	Reid Vapor Pressure
TRIPR	Transportation Rail Incident Preparedness & Response
WA	Washington
WWPP	Wilton Wildlife Preserve and Park