Institute for Sustainable Solutions
PORTLAND STATE UNIVERSITY

Report for Oregon’s Fuel Tank Seismic Stability Program:
Environmental Justice, Laws, Policies, and Risk Minimization Best Practices

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Prepared For:

The Oregon Department of Environmental Quality's mission is to be a leader in restoring, maintaining, and enhancing the quality of Oregon's air, land, and water.

Prepared By:

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Table of Contents

List of Tables

List of Figures

Executive Summary

This report summarizes the Institute for Sustainable Solutions' (ISS) support of the Oregon Department of Environmental Quality's (DEQ) rulemaking efforts for Oregon's 2022 Senate Bill 1567 (SB1567). SB1567 provides the DEQ the authority to regulate large fuel facilities in Columbia, Lane, and Multnomah Counties and requires that those facilities conduct vulnerability assessments and implement mitigation plans to ensure safety at the facility in the event of a seismic event. The DEQ established the Fuel Tank Seismic Stability Program to conduct the rulemaking process and to maintain this regulatory oversight. In support of this rulemaking, ISS reviewed laws, policies, and best practices in seismic risk minimization at petrochemical facilities (Chapter 2); conducted an Environmental Justice (EJ) review (Chapter 3); and hosted a community resilience workshop which envisioned a pathway towards safe and thriving communities nearby large fuel facilities (Chapter 4). The report summarizes the results of these efforts and concludes with recommendations (Chapter 5) for DEQ's Fuel Tank Seismic Stability Program and other state agencies which we argue will improve statewide resilience and reduce threats to the public, property, and the environment stemming from seismic events and other natural disasters.

Law and Policy Review

Risk minimization at petroleum facilities involves a comprehensive risk management program that begins by assessing the risks of a facility. Once risks have been identified and possible release scenarios described, facilities can make targeted actions to reduce those risks to acceptable levels. Risk minimization actions include myriad engineering, operational, and response-oriented solutions.

In terms of prevention, risks posed by fuel facilities can be reduced through appropriate land-use planning along with operational and structural mitigation techniques. Operational mitigation techniques should include a "Safety Culture" and a Safety Management System at a facility which oversees risk-reduction operations and enables staff to report unsafe situations. Facilities can also adopt safer technologies and practices, such as reducing operating pressures. Structural mitigation techniques include facility design and layout decisions, improving the resilience of primary and secondary containment units, instituting early warning systems with automated shutdown technologies—as appropriate, and conducting the necessary repairs, upgrades, and maintenance to keep the facility at code requirements. All of which can reduce the likelihood and severity of releases.

Facilities can further minimize risk through preparedness efforts, especially relating to planning, training, capability development, and community outreach. Both on- and off-site emergency response plans should be maintained and exercised. Off-site response agencies must have sufficient information to prepare and drill their own response plans and to prepare the necessary response resources. Sufficient response resources should be maintained by the facility and relevant response agencies to handle the identified risk scenarios. Capabilities should be developed in other response areas including health and medical, mental health services, water infrastructure, communication infrastructure, evacuation capabilities, etc. Lastly, community members impacted or potentially impacted by a release "have a right to appropriate information," so they can "act appropriately should an accident occur" (Organization for Economic Co-operation and Development [OECD], 2003, p. 104).

Response and recovery actions should be carried out as quickly and efficiently as possible to reduce the impacts of a release and to enable a community to "build back better" following a disaster. The OECD (2003, 2015) encourages the thoughtful application of the Polluter Pays Principle to hold facilities responsible for a release financially accountable, which acts as a major incentive to ensure that facilities take all available risk minimization actions. To ensure the effective implementation or risk minimization actions, the relevant regulatory authorities should require and/or conduct intermittent audits and inspections conducted and reviewed by qualified professionals.

The best practices outlined in this review may or may not fall within the scope of Oregon's 2022 Senate Bill 1567 and may or may not be required by other laws and regulations already in place, additional review of the existing legal framework is merited.

Environmental Justice Review

The EJ review asked the following research questions research in Multnomah, Lane, and Columbia counties: (1) Who are the communities to consider as socially vulnerable to earthquake hazard impact due to the presence of fuel storage tanks? And (2) What are the various impacts and challenges on these communities due to the presence of fuel storage tanks? The review employed a combination of geospatial social vulnerability analysis, focus groups, and field visits.

In this study, a 4-mile buffer zone was established around fuel storage facilities to identify areas with increased hazard risks and to capture sensitive facilities (such as daycare centers, senior homes, and places of worship) located within that range. The researchers constructed an index based on social vulnerability indicators developed by Cutter et al. (2003) and commonly used by EPA and CDC, allowing for a systematic assessment of social vulnerability within the study area. Focus groups with residents in the study counties allowed the researchers to understand community perspectives related to the fuel storage facilities, and field visits provided an opportunity to collect on-site observations.

The EJ Review identified several key challenges. Multnomah County faces significant environmental justice challenges influenced by two key factors: the nature of exposure (e.g., size and diversity of population) to environmental risks, and the low level of preparedness nearby facilities (e.g., lack of local fire stations) to mitigate those risks. In Columbia County, the presence of fuel storage tanks poses a threat to a vulnerable population of older community members and valuable natural resources. In Lane County, minority and economically disadvantaged communities live near fuel terminals, which is compounded by higher rates of limited English proficiency potentially hindering awareness of the risks and appropriate response actions. Policy implications include comprehensive measures to address unequal environmental risks and burdens, such as improved preparedness, equitable access to resources, and targeted social and economic support for disadvantaged communities. This study encourages further engagement with diverse populations and collaboration with expert organizations to complement the DEQ’s work with oil handling terminals.

Fuel Terminal Community Resilience Workshop

ISS hosted a workshop to identify possible projects and funding sources which could improve the safety and resilience of communities who live nearby facilities regulated by SB1567. Held on August 7th, 2023, this workshop brought together representatives from state and local government, industry, the community, and other relevant experts. The scope of projects was confined to those actions that will improve community resilience and safety during the interim period before facility mitigation actions have been completed and which will contribute to reducing the residual risks that remain following facility mitigation operations. For a list of project ideas, suggestions for improving the quality of projects, possible funding sources, and project deep-dives, see Chapter 4.

From the conversation, the research team derived a four-phased, cyclical model for a community-centered approach to safety around large fuel facilities. Phase 1 includes fine-scale risk assessments and disaster scenario development which are used to develop response plans and protective action recommendations. Phase 2 involves capability developments that enable residents and first responders to carry out the protective action recommendations and response plans. Phase 3 is a widespread public education campaign intended to educate residents about protective action recommendations and ongoing safety efforts, such as indicating to residents where their evacuation routes are and when they should be used. Phase 4 includes reflecting on the successes and failures of the model, iterative improvements based on these lessons, and the dissemination of the lessons learned to other localities.

Recommendations for Improving Safety and Resilience

Based on the findings of this report, the Institute for Sustainable Solutions suggests the following actions be carried out. Although there may be overlapping roles, responsibilities, and activities for these recommendations, we have opted to group them into three categories indicating the recommended leading entity. Category 1 includes those actions which are or could be incorporated into the DEQ Fuel Tank Seismic Stability Program. Category 2 includes actions that other programs at the DEQ may be positioned to lead while coordinating with the Fuel

Tank Seismic Stability Program. Category 3 are those actions which may need other organizations to take the leading role. The following recommendations have been truncated for this executive summary, please see Chapter 5 for a more thorough description of each recommendation.

The research team argues that the implementation of these recommendations will promote environmental justice, public safety, and the well-being of all residents and employees in the vicinity of fuel storage facilities. Some of these recommendations may be either already required or in the process of implementation via existing authorities and laws. Other recommendations would require new legislation or funding. Chapter 5 includes a few notes on such efforts.

Category 1: Recommendations Related to the DEQ Fuel Tank Seismic Stability Program

1. Fuel facilities should be brought up to the highest possible code and safety requirements to reduce the chance of, and consequences of, a release, and all structural mitigation techniques, such as secondary containment units, should be built to withstand natural hazards that threaten to cause release.

2. Facilities and regulatory authorities should conduct periodic audits or inspections by qualified individuals to ensure that facilities meet codes and safety requirements.

3. Risk bonding or other forms of the Polluter Pays Principle should be applied to fuel facilities in Oregon, especially those who fail to meet the risk minimization requirements of the law, to ensure the financial burden of response and recovery actions following a spill does not fall on the public.

4. The DEQ Fuel Tank Seismic Stability Program should conduct public education on facility mitigation plans and the status of program activities.

5. Relationships between facility owners and operators, relevant regulatory agencies, first responders, and community members should be strengthened

to increase transparency and trust between interested parties.

6. The DEQ Fuel Tank Seismic Stability Program should be expanded to include all counties in Oregon, to include all hazards both human (e.g., terrorism) and natural, and to include other hazardous materials including extremely hazardous substances.

7. The DEQ Fuel Tank Seismic Stability Program should expand to regulate the seismic safety of transmission pipelines and associated system components, this should include transmission pipelines and components which cross the Oregon/Washington border and any other such pipeline in the State.

Category 2: Recommendations Potentially Led by Other DEQ Programs

8. Both on- and off-site response and recovery plans and capabilities should be developed based on possible release scenarios identified by fuel facilities.
    a. Response plans should coordinate the efforts of facility personnel along with personnel from all jurisdictions that may be impacted by a spill and should take the post-disaster context into account.
    b. Facilities should develop sufficient response resources to manage the risks identified in their release scenarios. Co-located facilities should explore the possibility of developing joint response capabilities.

9. The Oregon DEQ's Air Quality Program with support from the Oregon Health Authority and Oregon Department of Human Services should establish air quality monitors near fuel storage tanks using state-of-the-art tools to detect pollutants and to ensure the health, safety, and well-being of communities during standard facility operations and following a spill or natural disaster.

Category 3: Recommendations for Actions Led by Agencies External to the DEQ

10. All interested parties should work with the Oregon Department of Energy (ODOE) on their Energy Security Plan. Robust participation will improve the

quality and viability of this plan and future efforts. We recommend that ODOE develop near-term, mid-term, and long-term goals for Oregon's energy security alongside feasible implementation plans. Mid-term and long-term goals should guide the reduction of petroleum fuel usage stemming from decarbonization efforts in a way that maintains statewide energy resilience.

11. Emergency and public safety resources should be made available to the community. This includes establishing safe shelters, evacuation routes, alert and warning systems, and fire safety measures.

12. Facilities and relevant response agencies should engage local communities, including those who work in or nearby fuel facilities, to provide information about the risks at a facility as well as the appropriate personal protective actions to take in the event of a release.

Chapter 1: Introduction and Purpose

In 2022, the Oregon legislature passed Senate Bill 1567 (SB1567), which, grants the Oregon Department of Environmental Quality (DEQ) the authority to establish a program for seismic vulnerability assessment and mitigation at fuel terminals with a combined facility capacity of more than 2 million gallons of petroleum products in Columbia, Multnomah, and Lane counties. The law requires these facilities conduct seismic vulnerability assessments to understand the potential impacts of a Cascadia Subduction Zone Earthquake and to then create and enact mitigation plans to minimize the risks posed by their facility in the event of an earthquake. The Oregon DEQ began a rulemaking process to operationalize these requirements in September of 2022, at which time Portland State University's Institute for Sustainable Solutions (ISS) was brought on to provide support.

This report is the result of ISS's work to support the DEQ's rulemaking and program development process. Chapter 2 contains ISS's Law and Policy Review which was conducted to assist rule development. Chapter 3 contains ISS's Environmental Justice (EJ) review which highlights EJ challenges and community vulnerabilities for residents living nearby the fuel facilities subject to SB1567 as well as some consideration of the broader regional impacts that a catastrophic release at these facilities would have. Chapter 4 describes the outcomes of a workshop hosted by ISS which brought together local and state government agencies, industry representatives, community members, and subject matter experts to discuss projects and funding sources to advance safety and resilience in communities nearby large fuel facilities. The final chapter in this report, Chapter 5, offers the conclusions drawn from ISS's work and proposes recommendations to the Oregon DEQ and other public agencies who play a role in regulating fuel facilities and ensuring community safety.

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Portland State University and the Institute for Sustainable Solutions are in the heart of downtown Portland, Oregon in Multnomah County. We honor the Indigenous people on whose traditional and ancestral homelands we stand: the Multnomah, Kathlamet, Clackamas, Tumwater, Watlala bands of the Chinook, the Tualatin Kalapuya and many other indigenous nations of the Columbia River. It is important to acknowledge the ancestors of this place and to recognize that we are here because of the sacrifices forced upon them. In remembering these communities, we honor their legacy, their lives, and their descendants.

Chapter 2: Law and Policy Review for Risk Minimization Best Practices at Fuel Facilities

By: Luke Hanst

This Law and Policy Review investigates best practices and existing legal frameworks in disaster risk reduction at petroleum facilities, with an emphasis on seismic safety, in support of the Oregon Department of Environmental Quality's (DEQ) rulemaking process for the 2022 Oregon Senate Bill 1567 (SB1567). To this end, this Law and Policy Review uses a framework of international policy and academic research to identify risk minimization concepts and then demonstrates the application of these concepts in laws and rules from the United States and abroad. Due to this approach, some of the concepts examined may not be within the scope of SB1567 and may or may not be required by other laws affecting petroleum facilities in Oregon. Continued investigation of the overall legal framework within which Oregon's petroleum facilities operate is warranted to identify gaps in risk minimization efforts.

Each section of this Law and Policy Review reflects a critical component of risk minimization. This begins by describing the best practices in risk assessments at petroleum facilities, with the component parts of hazard assessments, vulnerability assessments, and off-site impact considerations. Then the four phases of disaster management (i.e., prevention, preparedness, response, and recovery) are used to describe risk minimization best practice concepts. Next, we describe Safety Management Systems, or organizational and policy structures that can be employed by facilities to uphold safety within their facilities and oversee changes to processes and infrastructure and go on to describe the external regulatory structures which can be instituted to ensure facilities meet safety standards (i.e., audits and inspections). This chapter concludes with a summary of these best practices.

Methods

National and international policy documents relating to safety and disaster resilience at petroleum facilities were collected via key word searches on Google, Google Scholar, and the Policy Commons database. These searches were supplemented by policies referenced in academic articles and laws, along with the application of a Bibliographic Search within the identified policy documents. It is unlikely that these methods resulted in a comprehensive collection of policy documents, as grey literature created by local governments or niche policy organizations is often poorly optimized for search engines or may not be available online. However, the author is confident that the policy documents collected from major national and international organizations which are available in English reflect the consensus on risk minimization best practices.

The above policy documents were then supplemented with select academic articles drawn from a systematic literature review conducted by the Institute for Sustainable Solutions for the Multnomah County report (publication forthcoming), *Risk of Earthquake-Induced Hazardous Materials Releases in Multnomah County, Oregon: Two Scenarios Examined*. That literature review synthesized decades of academic investigation into natural disaster triggered technological accidents, or Natechs, to identify the risks and challenges of earthquake-induced hazardous material releases. Pertinent articles from that literature review were selected by this report's author and used to describe and augment the best practices outlined in the identified policy documents.

The present report analyzed national and international laws which require petroleum facilities to improve safety and minimize risks relating to earthquakes—laws relating to natural disaster more generally were included when they contain exceptional examples of risk minimization or are widely referenced in policy and academic literature. The process for law identification included a Bibliographic Search in academic articles and policies, consultation with the DEQ Rulemaking Team, and informal outreach to international scholars. Following law identification, information about the laws was collected either from the text of the law itself, when available in English, or through secondary sources, such as journal articles or government presentations. For some countries or laws, no reliable sources of information could be identified in English and these laws did not receive continued analysis. Table 1 shows the laws for which sufficient information was identified in English to conduct an analysis.

Table 1: Laws Reviewed

Jurisdiction:	Hazard(s):	Regulation/ Regulating Body:	Document(s) Reviewed:
U.S. – California	Seismic & Environmental	California Accidental Release Prevention Program (CalARP)	California Code of Regulations, Title 19, Division 2, Chapter 4.5
U.S. – California	Seismic & Environmental	California Marine Oil Terminal Engineering & Maintenance Standards (MOTEMS)	California Building Code, Chapter 31F
U.S. – Texas	All	Texas Commission on Environmental Quality - Aboveground Storage Vessel Safety Program	Texas Administrative Code, Chapter 338
U.S. – Washington	Seismic & Environmental	Washington State Department of Ecology - Facility Oil Handling Standards (173-180 WAC)	Washington Administrative Code (WAC), Title 173, Chapter 173-180
European Union – Seveso Directive	All	European Union – Seveso-III Directive (Directive 2012/18/EU)	Seveso III Directive
European Union – German	Climate & Environmental	German Major Accident Ordinance – Technical Rules for Installation Safety 310	Krausmann et al. (2017)
European Union – Italy	All	D.Lgs. 105/2015	Marrazzo (2022) and Mazzini & Marrazzo (2021)
Japan	All	High Pressure Gas Safety Law, Fire Service Act, Act on the Prevention of Disasters in Petroleum Industrial Complexes, Basic Act for National Resilience, Building Standards Act	Introduction to the Building Standards Act, Presentation on the Act on the Prevention of Disasters in Petroleum Industrial Complexes, Krausmann & Cruz (2013)

For laws with sufficient information available in English, a two-part analysis was conducted. First, the text of the law or secondary source was used to create a Review Document which included a general overview of the law as well as information relating to key themes of interest to the ongoing DEQ rulemaking process. This phase of research was done in direct support of the rulemaking efforts and as such the focus of any one review differed from those preceding or following it depending on the DEQ's focus at the time the review was written. In particular, a review of offsite risk assessment requirements was drafted as a preliminary synthesis of policy, academic literature, and laws from California and Europe to address specific questions about what other jurisdictions require of petroleum facilities' engagement or interactions with nearby residents. Second, these Review Documents were reanalyzed during the drafting of this report to identify pertinent examples of best practices and to facilitate a general synthesis of policy, academic literature, and laws.

Limitations

Three general limitations are worthy of note for the Law and Policy Review. First, barriers relating to document access and language availability reduced the total data available to the research team. Because of this, there may be better representations of best practices, or novel approaches, relating to seismic stability at petroleum facilities that are not explored in this report. In particular, countries from Central and South America including Chile, Columbia, and Mexico, who face significant seismic risks and who have learned from recent earthquake disasters, are not included in this review because of a lack of documents available in English. Similarly, some key laws from Japan were not available in English and may have valuable concepts not included in this review. Despite this limitation, the research team believes a relative state of knowledge saturation was attained from the available documents, especially when supplemented by academic literature.

A second limitation is that laws were only evaluated based on their current versions, which may not necessarily be the ideal state. Existing laws may have gaps or challenges to implementation that are not apparent when evaluating only the law as it is written. It is possible that these gaps or barriers may be carried over into this report under the framing of best practices when the real-world application of the reviewed law does not meet the expectation of best practice. Some informal outreach was done with academics or experts from other countries. However, a systematic approach assessing the perspective of regulators and practitioners for each of the reviewed laws fell beyond the time constraints of this project. Such outreach is advisable both to learn from the strengths and weaknesses of similar laws and to advance the community of practice (i.e., a network of practitioners, experts, regulators among whom lessons can be shared and new ideas generated) for those working to address the risks of natural disasters induced hazardous materials releases at industrial facilities.

The third and final limitation for the Law and Policy Review stems from the exclusively external lens taken in the investigation. In this review, best practices are outlined and posed as recommendations for the DEQ and regulators of large petroleum facilities in Oregon. However, these best practices may already be required to greater or lesser degrees by existing laws. For example, the need for internal and external emergency response plans, and the content of these plans, is discussed at length in this report. Oregon's Community Right to Know and Protection Act supplements federal law to establish rules relating to these emergency response plans. We also know that these federal and state laws do not require that emergency response plans take the post-disaster context into account, which is a firm recommendation from academic literature (Necci et al., 2018) and international policy (Organization for Economic Cooperation and Development [OECD], 2015). We advise that an analysis be performed of the current regulatory framework for petroleum facilities in Oregon and combined with the best practices outlined in this report to understand where additional regulations are necessary to result in the lowest possible risk for Oregon's communities.

Risk Assessments

The first step to minimizing risk at a hazardous facility is to identify all the possible scenarios that could lead to an unintended release of hazardous materials (The United Nations Economic Commission for Europe [UNECE], 2015). UNECE (2015) posits that "hazard identification and risk assessments should be undertaken during all stages of the [facility's] life cycle," to guide the selection of equipment or design decisions to minimize risk and to assess and prepare for "unusual circumstances" (p. 13). In other words, facilities must assess the risks posed by their facilities, in terms of likelihood and severity, to enact changes to reduce these risks. Risk assessment methodologies are increasingly well studied and detailed descriptions are available elsewhere (e.g., Cozzani & Salzano, 2017; Necci & Krausmann, 2022).

Facilities should adopt "methodology for ongoing hazard identification, risk assessment and determination of necessary control measures for routine and non-routine activities" (UNECE, 2015, p. 13). Of note is the need for risk assessments for non-routine operations, as industrial facilities are particularly vulnerable to human, technical, or natural disasters during construction, maintenance, decommissioning, etc. as personnel are placed in unfamiliar circumstances and certain non-routine conditions may increase demand on fuel containment structures (Krausmann & Cruz, 2017). For example, during the magnitude 9 Tohoku earthquake in Japan, a significant petrochemical fire occurred at Tokyo Bay due to a series of technical and human errors during routine maintenance of a liquefied petroleum gas container (Krausmann & Cruz, 2017). The tank had been filled with water while undergoing an inspection, which increased the weight 1.8 times and surpassed the design requirements resulting in the tank's collapse during the earthquake, igniting nearby tanks and causing an explosion (ibid.). Human error further contributed to the conflagration as an LPG safety valve had been manually locked in the open position and was unreachable during the fire, continually feeding more fuel (ibid.). The consideration of such non-routine circumstances allows for the facility to design for and prepare for a more comprehensive collection of risk scenarios.

Scenarios should be developed to examine how natural disasters may cause a release along with the consequences of that release within the post-disaster context (Necci et al., 2018; Organization for Economic Cooperation and Development [OECD], 2015). These natural disaster scenarios—and the subsequent development of emergency response plans or other mitigation actions—should consider the post-disaster context including: the likely lack of external response resources, the possibility of multiple simultaneous releases at the same facility, widespread infrastructure damage, and damage to facility safety equipment (Krausmann, Cruz, & Salzano, 2017). Natural disaster risk assessments may be either probabilistic or deterministic (Necci & Krausmann, 2022). Deterministic approaches "identify a reference natural hazard scenario (e.g., credible worst-case, most likely) that is described through its intensity (e.g., peak ground acceleration)," whereas in the probabilistic approach, "the hazard description includes an estimate of its frequency based on historical records in addition to an intensity measure" (ibid., p. 10). In the deterministic approach a scenario or set of scenarios are developed whereas in the probabilistic approach a probability curve is established with the likelihood that a given intensity parameter will be equaled or exceeded in a reference time interval (ibid.). This information is then used to evaluate the vulnerability of a facility, i.e., the likelihood that the reference natural disaster or intensity measure would result in a hazardous materials release and how this release would occur.

During risk assessments, facilities should consider the consequences of a hazardous material release to both the public and the environment (OECD, 2003). To assist in disaster preparedness and risk mitigation, facilities should describe possible release scenarios and identify the "geographical zones where effects are likely to occur in the event of an accident" (OECD, 2015, p. 26). Geographic impact zones should indicate the populations and critical

Natural Hazards in Law, California's MOTEMS:

The MOTEMS program provides flexibility to facilities in the identification of seismic hazard scenarios without a loss of rigor.

Facilities must determine their seismic requirements based on Design Peak Ground Acceleration (DPGA), Design Spectral Acceleration, and Design Magnitude, which will include amplification effects and liquefaction assessments.

Probabilistic approaches to DPGA and Design Spectral Acceleration may be obtained from either the USGS US Seismic Design Maps tool using ASCE/SEI 41, or DPGA and Design Spectral Acceleration may be determined by a site-specific probabilistic seismic hazard analysis conducted by a qualified geotechnical engineer. MOTEMS defines the return period as 72 and 475 years for seismic assessments at the highest risk-tier facilities.

For a deterministic approach, the design earthquake may be selected as the largest earthquake magnitude associated with a critical seismic source, taken as the closest distance from the source to the facility site. If the largest earthquake magnitude is selected, it will be used for "all DPGA values for the site, irrespective of probability levels."

facilities that may be affected and who may need to make "decisions concerning evacuation, sheltering in place, or other actions to limit exposure" (ibid., 2015). Release scenarios, for both natural and non-natural disasters, should be identified and developed in consultation with experts as well as employees familiar with the hazardous processes (UNECE, 2015). People and communities affected by a release

Vulnerability Assessments in Law, the Seveso Directive:

The Seveso Directive requires member states of the European Union to submit Safety Reports as part of the Facilities' Major-Accident Prevention Policy (MAPP). These Safety Reports must include a "description of the possible major-accident scenarios and their probability or the conditions under which they occur," and this includes "a summary of the events which may play a role in triggering each of these scenarios." Both internal and external (e.g., seismic) sources of potential accidents must be considered. Internal causes of an accident may be, for example, human error, equipment malfunction, or corrosion. External sources which must be considered include domino effects and natural disasters. Once accident scenarios have been identified, facilities must evaluate and describe the consequences of these accidents through modeling, maps, etc., and review past "incidents with the same substances and processes used" to derive lessons learned and appropriate accident prevention measures.

In Italy's implementation of the Seveso Directive, risk analyses must evaluate the possible outcomes of an accident and the probability of such an accident occurring. This includes, for example, evaluating the likelihood of consequences of boiling liquid expanding vapor explosion (BLEVE), jet fires, flash fires, vapor cloud explosions, etc. (Mazzini & Marrazzo, 2021).

In Germany, facilities must abide the Technical Rules for Installation Safety (TRAS) which specify facilities' obligations under the Seveso Directive for a given natural or technical hazard source. Each of the TRAS rules defines the probabilities and intensities of the natural hazards which a facility must account for by defining the appropriate recurrence rates (e.g., 100-year flood event). Facilities must then conduct a hazard source identification which investigates the impacts of each hazard source on the facility site, both as a "single hazard" or in combination with other natural hazards (e.g., rain on snow event; Krausmann et al., 2017). Once the expected impacts to the site have been established, a risk analysis is conducted to examine how each "safety-relevant part" of the facility—which includes storage tanks, fire suppression systems, etc.—will be impacted in each hazard scenario. Then, the risk analysis considers the effects of the disaster scenario on the facility as a whole and evaluates for interactions between equipment failures as well as the simultaneous nature of damage to multiple facility components. This includes evaluating for the risk of a release larger than the single largest tank due to multiple tank failures, the limited availability of internal and external response resources, and the potential for domino effects within a facility and with nearby facilities.

"should have a role in the risk assessment process," which helps to build trust, maintain open communication, and ensures that the gravity of the risk is recognized (OECD, 2003, p. 39; UNECE, 2015). As risk assessments are carried out, external response agencies should be engaged and informed of information relevant to the development of their off-site response plans (United Nations Office for Disaster Risk Reduction [UNISDR], 2018).

Offsite Consequences in Law, CalARP:

CalARP requires that regulated facilities conduct an offsite consequence analysis for both a worst-case release scenario and at least one alternative release scenario, these must estimate the greatest distance from the facility to the release's endpoint and evaluate for the public and environmental receptors within that distance.

Worst-case scenarios estimate the distance traveled by hazardous materials based on the maximum possible quantity stored at a facility, considering administrative controls on this quantity, and then assumes an instantaneous spill which is contained by passive mitigation systems (i.e., secondary containment) only if those systems are assessed to be resilient to the incident which caused the release. CalARP requires flammable liquids and gasses be assessed for a worst-case vapor cloud explosion ten minutes after vaporization begins, and CalARP defines the atmospheric conditions to be used in this assessment.

Then, facilities must identify populations, facilities, and environments within the impacted zones and share this information with the regulatory authority. Based on the results of this modeling, facilities must consider passive and active mitigation systems that would reduce the risk of harm. Scholars note that while these scenarios derive from a natural disaster-induced release, the law does not require that the post-disaster context be considered for the consequence analyses or response planning, a shortcoming (Necci et al., 2018).

Following the determination of risks, owners and operators should pursue mitigation actions both on and off-site including maintaining "sufficient quantities of appropriate emergency medical supplies," engaging with external parties in the development of off-site emergency response plans, and engaging community leaders to "promote education of communities" who are at risk (Necci & Krausmann, 2022; OECD, 2003, p. 93, 94). Mitigation activities are described in greater detail throughout subsequent chapters.

Risk Minimization

Once facilities have conducted risk assessments that identify the possible sources of accidents, the likelihood of these accidents occurring, and the possible consequences of such accidents, efforts should turn to minimizing these risks of. This section first aims to define risk minimization and then examines risk minimization best practices for petrochemical facilities in each of the four phases of disaster management (i.e., prevention, preparedness, response, and recovery).

UNISDR (2018) defines disaster risk as the "potential loss of life, injury, destroyed or damaged assets which could occur to a system, society or a community" due to the combination of: a hazard(s); the potential exposure to this hazard; the vulnerability, both in terms of the likelihood of the disaster occurring and the presence of or lack of protections for people and environments at risk of exposure; and the capacity of a systems to respond and recovery from a disaster. (p. 17). Risk minimization therefore refers to all those efforts which reduce the severity or likelihood of a hazard, protect populations and environments from exposure should an accident occur, and enable sufficient response and recovery to protect lives, property, and the environment. In the laws and regulations reviewed in this report, risk minimization is operationalized in multiple ways, outlined in Table 2.

Countries and states differ in their prioritization of risk minimization. For example, CalARP requires that, "the facility owner or operator must implement [mitigation] recommendations unless the recommendation is based on factual errors or the recommendation is infeasible, however, a determination of infeasibility shall not be based solely on cost." Whereas the Washington Department of Ecology's "determination of best achievable protection" is guided by the following criteria: "the additional protection provided by the measure, the technological achievability of the measures, and the cost of the measures." This means that the Washington Department of Ecology is responsible for approving or denying cost-benefit arguments provided by facilities for why they opted not to conduct a particular mitigation action, whereas in California the regulatory authority's criteria prioritizes efficacy and feasibility regardless of financial cost.

Table 2: Risk minimization in reviewed laws.

Law / Regulation:	Definitions of Risk Minimization:
CalARP	CalARP requires that facilities and ongoing processes are made "safe" and comply with recognized and generally accepted good engineering practices (RAGAGEP).
MOTEMS	MOTEMS requires that potential oil spills and consequences "shall be mitigated by implementing appropriate designs using the best achievable technologies," and "residual risks are addressed by operational and administrative means."
WAC 173-180	WAC 173-180 sets minimum standards for equipment, operations, and design "to ensure **best achievable protection**," which is defined as "the highest level of protection that can be achieved through the use of the best achievable technology and those staffing levels, training procedures, and operational methods that provide the greatest degree of protection available."
Seveso Directive	The Seveso Directive assigns a "general obligation" to facilities to "prevent major accidents," "mitigate their consequences," and to "take recovery measures."
Seveso Directive, Italy	Italy's implementation of the Seveso Directive requires that hazardous facilities enact "all necessary measures to prevent major accidents and/or limit their consequences," (Marrazzo, 2022, p. 6).
Seveso Directive, Germany	The German Major Accident Ordinance requires that facilities take precautions to prevent accidents and limit their consequences "according to the state of the art in safety" (Krausmann et al., 2017).
Japan	The Basic Act for National Resilience "requires the adoption of comprehensive countermeasures to ensure that major industrial parks remain in operation following large earthquakes and tsunami" (Krausmann & Cruz, 2021, p. 13).

Prevention

Prevention is the first phase of disaster management and refers to efforts taken to reduce the likelihood of an incident occurring (OECD, 2003). Prevention efforts identified in the policies reviewed here can be categorized as land-use, operational, or structural mitigation measures.

An investigation of best practices in land-use planning for hazardous installations is beyond the scope of this review. However it is worth noting that land-use planning is widely accepted as critical to risk minimization (UN, 2015), and scholars are unanimous in their argument that the most effective mechanism to reduce Natech risk is through land-use planning (e.g., Young et al., 2004; Cruz et al., 2004; Necci et al., 2018; Steinberg et al., 2008; Suarez-Paba et al., 2019). Jurisdictions should avoid placing hazardous facilities in natural-disaster prone areas, and to the greatest degree possible, hazardous facilities should be geographically distanced from residents, vulnerable environments, and critical transportation routes and infrastructure (UNECE, 2015). Scholars also recognize that land-use regulations for pre-existing facilities can be prohibitively expensive or face significant social and political barriers (Cruz et al., 2017). If land-use planning is not an available risk reduction mechanism, facilities should use a combination of operational and infrastructure-based prevention measures to minimize risk.

Operational prevention measures are based in and stem from a "'Safety Culture' that is known and accepted throughout the enterprise" (OECD, 2003, p. 21). A Safety Culture "requires visible top-level commitment to safety in the enterprise, and the support and participation of all employees and their representatives" (ibid., pp. 21-22). A Safety Culture enables all employees to identify and report potentially risky situations to management with trust that the appropriate action will be taken to address this risk (ibid.). As part of a Safety Culture, it is important that roles and responsibilities for employees and managers are clearly defined, especially as they relate to process control and safety systems, and that these personnel are knowledgeable and trained appropriately to minimize the chance of human error and maximize the effectiveness of response operations (UNECE, 2015). The OECD (2003) recommends that a Safety Culture be supported by a Safety Management System that enables accountability and communication between all levels of facility personnel, management, and executives. Safety

Safety Culture in Japan:

Facilities in Japan must instate a Disaster Protection Manager and adopt disaster risk reduction policies and operational procedures including sufficient financial support, human resources, and employee complaint/problem reporting channels to enable those risk reduction efforts to operate effectively.

Management Systems can oversee a variety of risk-reduction operations such as auditing and inspections, managing change, quality assurance, and decommissioning as described later in this chapter.

Other operational prevention measures generally fall within the realm of inherently safer technologies and practices within the hazardous process. This can include minimizing the quantity of hazardous substances used or stored at a facility or replacing it with less hazardous substances, reducing operating pressures or temperatures, using simpler process, and installing back-up systems (OECD, 2003; UNISDR, 2018). Efforts should be made to locate chemicals that react with water away from flood risks or other water sources that could exacerbate a release (Necci et al., 2018). The likelihood of floating-roof tank failures can be decreased by reducing the quantity of material in a tank which lowers the total weight and provides more freeboard, which subsequently reduces the risk of liquid sloshing overtopping the tank walls (DOGAMI, 2012).

Operational Mitigation in Law, MOTEMS:

Potential oil spills and consequences "shall be mitigated by implementing appropriate designs using the best achievable technologies," and "residual risks are addressed by operational and administrative means." Specific operational or administrative measures are not specified.

On the structural mitigation side, risk minimization can include facility design and layout decisions or improvements, early warning systems, and the enforcement of code requirements including maintenance and repairs of aging equipment. Facility design and layout considerations can protect the lives of employees, reduce the chance or severity of a release, and minimize the risk of domino effects. Employees can be protected, and enabled to respond to incidents, by ensuring the safety of occupied buildings, especially control rooms, by locating them away from the source of the hazard, making them resistant to fire and explosions, and by providing uninterruptible power supplies (UNECE, 2015). In addition to strengthening and protecting existing buildings, facilities can provide safe refuges for employees to use during a fire or hazardous materials release and should ensure sufficient and resilient evacuation and fire access routes (UNECE, 2015).

Facility Layout Requirements in Japan's Legal Framework:

Petroleum facilities in Japan must abide layout requirements which ascribe minimum distances between zones in the industrial facilities (e.g., minimum distances between manufacturing, administrative, and storage zones). Each zone has requirements for fire access routes and vacant areas for staging firefighting operations. Facilities must install disaster protection equipment including multiple layers of secondary containment, outdoor water storage and distribution facilities, and emergency reporting equipment (i.e., emergency radios). Hazardous facilities must also install and operate the appropriate "equipment used for fire defense, a water supply for fire defense, and facilities necessary for fire extinguishing activities" (Fire Service Act).

The chance of a release and its severity can be reduced by multiple methods, first among them improving the design of the primary containment unit (UNISDR, 2018). In addition, facilities should have secondary containment systems designed to contain leaks, spills, and firefighting waters from traveling off-site or seeping into the ground (UNECE, 2015). This can also include an "increased number of barriers to prevent the release of hazardous substances, e.g., double encapsulation" (OECD, 2003, p. 43). The risk of domino effects can be reduced by ensuring safe separation distances between storage units, both on-site at a facility and between facilities (OECD, 2003). Fire protection and response equipment should be available with sufficient water supply and firefighting foam and should be located such that it will be accessible following a release and/or natural disaster (Krausmann & Cruz, 2017; OECD, 2003). It is critical that all such secondary containment and response equipment are constructed to withstand seismic events and other natural hazards (Krausmann & Cruz, 2017).

Early warning systems for natural disasters can reduce the risk of release and protect communities and employees, however there are limitations for early warning systems for earthquakes. Early warning systems, and alarm systems in general, allow employees and community members to enact protective measures prior to a disaster (UNECE, 2015). For earthquakes, warning times are likely to be too short for extensive measures to be taken. Krausmann et al. (2017) argue that early warning systems to prevent earthquake-induced hazardous material releases is "the most unfavorable" situation compared to other natural disasters as the warning times are very short, ranging from seconds to minutes, while valve closures or other preventative measures can take up to ten minutes to enact. There are additional limitations concerning the risk of false alarms and the integration of a facility's operating equipment with internet-based warning systems (Krausmann & Necci, 2021). Despite these limitations, earthquake early warning systems can provide valuable information to employees and residents living nearby petrochemical facilities to enable them to take protective action.

Lastly, facilities can prevent the risk of a release by meeting the appropriate building codes and industry practices in all aspects of a facility's design (UNECE, 2015). Identifying the appropriate building codes for facilities regulated by Senate Bill 1567 is the focus of engineering contractors working with the DEQ and is beyond the scope of this review. Once facilities have been brought up to code, it is critical that they establish programs for the "regular maintenance, inspection and testing of equipment" to ensure the facility continues to meet code and safety requirements (OECD, 2003, p. 55). It is important to consider that continued adaptation and facility upgrades may be required as new

Structural Mitigation Requirements in WAC 173-180:

New petroleum storage tanks in marine oil transfer facilities in Washington, and pre-existing storage tanks which will undergo upgrades and retrofits due the requirements of WAC 173-180, must include one or more of the following to "reduce risk from seismic events," including: "Flexible mechanical devises between storage tank and piping or sufficient piping flexibility to protect the tank and pipe connection and prevent the release of product; foundation driven pilings; anchored storage tanks; or other seismic protection measures proposed by the facility and approved by Ecology, as long as such protection measure equals or exceeds those required in this section."

Facilities are also required to locate storage tanks within secondary containment areas to prevent "discharged oil from entering waters of the state at any time during use of the tank system." Secondary containment areas must be capable of containing "100% of the capacity of the largest storage tank within the secondary containment area including sufficient freeboard for stormwater." These secondary containment areas "must be designed to withstand seismic forces."

Notably, oil transfer pipelines are encouraged to include "automatic emergency isolation shutoff valves that are triggered to close during seismic events."

hazard levels are adopted, and new prevention technologies or techniques become available.

Reducing the Risk of Domino Effects:

In general, the laws reviewed here as well as the academic literature, point to gaps in knowledge and practice for risk reduction relating to domino effects. Japan has struggled with continued occurrences of domino effects, including fires spreading between tanks and facilities, due to their proximity to one another which is exacerbated by the scarcity of lanc on which to construct petroleum facilities (Krausmann & Cruz, 2013).

The Seveso Directive has instituted some organizational requirements for reducing the risk of domino effects without specific structural or design layout mitigation techniques. Sevesc requires that facilities located together such "as to increase the likelihood of major accidents or aggravate their consequences… should cooperate in the exchange of information and in informing the public." This information is then used in the development of potential release scenarios which inform mitigation actions. Japan has instituted similar organizational requirements in the creation of unified response resources among co-located facilities, described further in the preparedness section of this chapter.

Preparedness

The risks posed by industrial facilities can be reduced through appropriate preparedness actions, many of which are intended to enable effective response should an incident occur. Primary among these are response planning, training, and exercising; ensuring sufficient response equipment and preparedness in relevant sectors; and community engagement and public communication.

Both on and off-site it is essential that relevant personnel have clearly defined roles and responsibilities and are sufficiently trained to respond to an incident (UNECE, 2015). Personnel preparedness, and the effectiveness of roles and responsibilities, is based on the joint planning and exercising of response operations. Recommendations generally hold that response plans should be based on two scenarios for each feasible release risk: a worst-case scenario, and a most-probable case scenario (OECD, 2003; 2015). These scenarios should elaborate the zones that are likely to be affected in each scenario and identify impacted communities, environments, and critical facilities (OECD, 2003).

Facilities should work alongside local jurisdictions to provide information about risks and possible release scenarios to enable off-site emergency planning (UNISDR, 2018). It is advisable that neighboring facilities coordinate response plans to control the risk of domino effects and maximize the effectiveness of response resources (Necci & Krausmann, 2022). For government agencies, neighboring jurisdictions should “inform each other of their emergency plans, endeavor to make such plans compatible, and where appropriate, should draw up joint off-site emergency plans” (UNECE, 2015, p. 6). Collaboration between neighboring jurisdictions is particularly important when the risks posed by a facility would cross jurisdictional lines, and in these cases joint response plans, mutual aid agreements, and joint response exercising are particularly useful (UNISDR, 2018).

Scholars note that to be effective emergency response plans must take the post-disaster context into account (OECD, 2015). Earthquakes impact a wide geographic region, and they tend to cause simultaneous hazardous materials releases, both within the same facility and across facilities in the impacted region (Girgin et al., 2019). At the same time, earthquakes may damage secondary containment or safety measures and overburden response resources (Krausmann et al., 2010; Necci et al., 2018). Earthquakes also damage communication

Off-Site Coordination and Response Planning in Law:

It is common for laws aiming to reduce risk of disasters at hazardous installations to require a facility to share emergency response plans and scenarios with the regulatory authority and the jurisdictional authorities responsible for assisting in or conducting disaster response operations.

The implementation of the Seveso Directive in Italy uses the review period during which the risk assessments and mitigation plans are approved to extract information from the report to assist with offsite emergency planning and land-use planning (Mazzini & Marrazzo, 2021).

CalARP requires regulated facilities to establish an emergency response program which coordinates with local response agencies before, during, and after an incident.

WAC 173-180 requires emergency response plans to be submitted to the Washington Department of Ecology as part of the facilities’ reports on vulnerability and mitigation plans. This information is presumably made available to relevant response agencies for off-site emergency response planning.

infrastructure (Krausmann & Cruz, 2013), water infrastructure (Cruz et al., 2004), transportation infrastructure (Krausmann et al., 2010), and medical response infrastructure (Girgin, 2011), all of which are critical to sufficient spill response operations. Combined, these variables have led well-established scholars to argue that facility response plans should assume that off-site response resources are unavailable and that facilities will need to provide their own resources and response procedures following an earthquake-induced release (Krausmann et al., 2017).

Facilities should establish, “individually or through bilateral or multilateral cooperation a minimum level of prepositioned response equipment commensurate with the identified risk” (UNISDR, 2018, p. 25). Regulators should ensure that response plans appropriately address risks and are paired with sufficient response resources, which can be further enforced through the development of minimum standards including the composition of response teams, allowable response strategies, and elaboration of minimum equipment requirements (UNISDR, 2018). The development of sufficient response resources and effective response plans is a joint responsibility of the facility and relevant external response agencies in the public and private sectors (UNISDR, 2018).

Response Capability Requirements in Law, Japan:

Japan’s Act on the Prevention of Disasters in Petroleum Industrial Complexes, requires facilities to establish an “extended, comprehensive, and integrated disaster risk reduction system” (Japan’s Extraordinary Disaster Management Office, 2017, p. 14.) Facilities must maintain a risk reduction plan, and co-located facilities must work together to “set up a private disaster protection organization” and provide it the “materials and equipment” necessary to respond to fire or spills at the industrial complex (ibid. p. 14). This joint disaster response organization must have sufficient response resources on-site including chemical fire response trucks with foam capabilities, a high-capacity foam storage and distribution system, long distance water-feed systems, oil booms, and oil recovery vessels.

Alongside firefighting and spill response equipment, capabilities and resilience should be developed in the following sectors to support disaster response and minimize risks to the population: medical infrastructure, mental health services and psychosocial support capabilities, communication infrastructure, community resources, water infrastructure, evacuation capabilities, and other critical facilities

(UN, 2015; UNISDR, 2018). Other novel technologies, such as the use of disposable drones to garner situational awareness following a natural disaster, should be investigated, and adopted as appropriate (Yumei Wang, verbal communication June 26, 2023).

Lastly, community members potentially impacted by releases at a facility "have a right to appropriate information," so they can be aware of the risks in their community and so they can "act appropriately should an accident occur" (OECD, 2003, p. 104). This information should include details about how the public will be informed about an incident, guidance on the actions to be taken and why they should be taken, sources of post-accident information, and points of contact to express concerns and learn more (OECD, 2003). Information should be provided to the community in a collaboration between facilities and relevant authorities, and this information should be provided to the public without their having to ask for it and in a format that is accessible for people with access and functional needs (e.g., multiple languages; OECD, 2003). UNECE (2015) further recommends that communities should play a role in the creation of off-site emergency plans.

Response & Recovery

Disaster response is the collection of actions taken to "minimize the adverse consequences to health, the environment and property," (OECD, 2003, p. 13). Effective response to an oil spill largely depends on "the existence of an exercised and tested contingency plan," which is based on "identified risk scenarios and matched to an appropriate response strategy and capability" (UNISDR, 2018, p. 25). Once an incident occurs, the response should be directed according to pre-determined scenarios as well as information available on the real release occurring which can be gathered by detection systems and appropriate modeling technologies (UNECE, 2015). Quick detection of spills and the subsequent modeling of spills enables employees, first responders, and community members to take the appropriate action. This can involve activating response operations, donning personal protective equipment, evacuating, or sheltering-in-place (UNECE, 2015). Elaboration of these actions is beyond the scope of this review.

Once response operations have concluded, follow-up to incidents including clean-up activities and incident investigation should proceed (OECD, 2003). Clean-up should aim to return the environment to baseline levels, and sufficient external monitoring efforts should be conducted to uphold accountability (UNECE, 2015). A complete review of clean-up procedures is beyond the scope of this review. The UNISDR (2018) argues that effective response and recovery, including clean-up actions, are essential for a community to "build back better" after a disaster. Further, the OECD (2003, 2015) calls for the application of the "Polluter Pays Principle," a form of risk-bonding, in which the organization or corporation who drew financial gains from the operation of a hazardous facility is held responsible for the financial costs of response and recovery operations at their facility.

The OECD (2003) argues that the Polluter Pays Principle acts as a "major incentive" for facilities to ensure that sufficient resources are available to recover from a disaster and "to do everything in their power to avoid such accidents" (2003, p. 127). However, the application of this principle following natural disasters is less straightforward compared to a purely human or technical cause of a hazardous material release especially if a facility met or exceeded the regulations and codes required of them (OECD, 2015). Additional interpretation of this principle within the context of the State of Oregon and Senate Bill 1567 is necessary.

Polluter Pays Principle in Law, CalARP:

Daily costs up to $25000 or $50000 (depending on the case) are incurred for owners and operators who fail to meet the requirements of CalARP, and the law holds operators liable for all costs associated with an emergency during the time that a facility fails to meet the law's requirements.

Safety Management Systems, Facility Oversight, and Retrofit Timelines

To ensure long-term safety in hazardous facilities, it is important that regulatory authorities and facilities collaborate to conduct intermittent inspections and audits. These inspections can identify vulnerabilities associated with corrosion and facility aging, ensure the implementation of proper maintenance, and confirm the facility continues to meet all the necessary safety requirements. The institution of safety management systems supports accountability and communication within an organization, and these systems can play a leading role in auditing and inspections, managing change, and overseeing decommissioning activities (OECD, 2003).

Audits and inspections should be performed regularly by qualified experts in collaboration with employees and managers, during these audits "efforts should be made to improve transparency… including making publicly available the relevant policies, programs, and outcomes," to help establish trust between parties (OECD, 2003, p. 58). The frequency and depth of audits and inspections should reflect the "hazard potential of the oil terminal; proximity to sensitive environments or communities; the age of the installation; aging of the equipment; historical accident and incident record of the terminal; and inspection records" (UNECE, 2015, p. 11). Safety management systems should ensure that internal inspections cover at least four asset categories including the primary containment systems, relevant infrastructure, process safeguards, and electrical control systems (UNECE, 2015). The results of these audits or inspections, particularly those carried out by internal facility teams, should then be reviewed by the appropriate regulatory authority and should be open for a public comment period. CalARP provides 45 days for public comment, and WAC 173-180 provides 30 days for public comment. It is also important that corrective actions are taken by facilities in a reasonable time. CalARP and MOTEMS, which are both long-standing laws that have since phased out pre-existing, non-conforming fuel facilities, provide 2.5 years and 4

MOTEM's Audit Requirements:

Terminals regulated by MOTEMS must undergo annual inspections, audits conducted at least every 4 years, and post-event inspections to ensure compliance with the building code. Audits and post-even inspections must be performed by a multidisciplinary team consisting of a: project manager, on-site team leader, structural inspection team, structural analyst, electrical inspection team, mechanical inspection team, corrosion specialist, geotechnical analyst, and representative(s) from the regulatory authority. The findings of the inspection team are then reviewed by a qualified professional to ensure quality assurance, and the regulatory authority may require peer review for advanced engineering analyses and design "by an external independent source to maintain the integrity of the process."

Audits and post-event inspections rate the facility according to multiple criteria, they then assign remedial action priorities and required follow-up actions. These audits result in a final report which includes an action implementation plan with a timeline for how these corrective actions will be completed before the next audit. These plans are reviewed by the regulatory authority prior to implementation. Then the facility submits updated "as-built" documentation.

years, respectively, for facilities to complete the necessary actions. WAC 173-180, which has newly established requirements for pre-existing, non-conforming facilities to come up to the appropriate codes, requires facilities to meet those codes within 10 years of by the next scheduled API Standard 570 inspection, whichever is later.

Managing change refers to oversight and quality assurance during both organizational changes and changes to hazardous processes and facility equipment to minimize risks. Effective management of change begins with environmental impact assessments as well as risk assessments to understand and track impacts to the environment and the increases or decreases in risks associated with changes to a facility (UNECE, 2015). Environmental impact assessments also allow the establishment of baseline conditions to serve as a target for cleanup and restoration once a site has been decommissioned (UNECE, 2015). During alterations to the infrastructure of a facility, it is critical that systems are in place to ensure the sufficient performance of contractors such that the results of construction meet the expectations of design requirements and manufacturer guidelines (UENCE, 2015).

Plan Review in Italy's Seveso Directive:

The Seveso Directive requires local authorities are to "ensure effective implementation and enforcement" through routine and non-routine inspections of facilities, which shall not be longer than one year apart for especially dangerous installations. In Italy, facility reports are evaluated by a Regional Technical Committee composed of representatives from the Fire Brigade and other national agencies with pertinent expertise. This committee confirms that facilities have taken adequate measures to prevent accidents, have sufficient means to limit the consequences of an accident "inside and outside the site," have provided accurate information in the safety report, and that facilities have made the appropriate information available to the public (Marrazzo, 2022).

Once construction of a new facility or alterations to a facility are complete audits should be performed to ensure that equipment and buildings meet "all applicable legal and technical standards and codes" (UNECE, 2015, p. 31). These audits, or "pre-start-up safety reviews," prevent failures resulting from faulty parts or materials, improper fabrication, and improper installation (ibid.). Both during the design and following construction of a facility component, facilities should enact the process of "reliability engineering" to evaluate "how long a system and its components can be operated safely before they should be taken out of service for maintenance or replacement" (UNECE, 2015, p. 32). The timelines established in this process then aid in the planning of inspection and maintenance intervals (ibid.).

The last noteworthy contribution of a safety management system is in the management or oversight of decommissioning actions and subsequent cleanup operations. Procedures should be adopted to ensure the "safe shutdown, decommissioning and demolition of hazardous installations" to minimize possible risks incurred by the decommissioning process (OECD, 2003, p. 60). UNECE (2015) posits that oil terminals should be closed: "If the relevant conditions stated in the permit have been met and continued operations through lifetime extension are not justifiable from an economic viewpoint; At the substantiated request of the operator, after authorization of the competent authority; If the competent authority decides for obvious and justified reasons that it should close" (p. 57). It is advisable that new construction be "designed for decommissioning" to enable the safe deconstruction and removal of equipment (UNECE, 2015). Once a facility or component is decommissioned, the "oil terminal operator should assess the state of the soil, water and groundwater contamination by the hazardous substances used" and "compare this with the baseline conditions" (UNECE, 2015, p. 58). If significant environmental damage is detected, the oil terminal operator should conduct the appropriate cleanup and restoration activities aimed at returning to baseline conditions (ibid.).

Conclusion

In summary, the best practices for risk minimization at fuel facilities include a comprehensive risk management program which begins by assessing the risks of a facility, including its vulnerability to natural hazards and the potential consequences of a release. Once risks have been identified and possible release scenarios described, facilities can make targeted actions to reduce those risks to acceptable levels. Risk minimization is multifaceted with myriad potential engineering, operational, and response-oriented solutions. This review adopted the phases of the disaster management cycle to elaborate these solutions. The best practices outlined in this review may or may not fall within the scope of Oregon's 2022 Senate Bill 1567 and may or may not be required by other laws and regulations already in place, additional review of the existing legal framework is merited.

In terms of prevention, risks of hazardous installations can be reduced through appropriate land-use planning which locates facilities in areas with minimal natural hazard risks and distanced from residential areas and important environmental areas. When located in safe areas, or in situations where historical decisions prevent present-day land-use changes, facilities can adopt a variety of operational and structural mitigation techniques. Operational mitigation techniques begin with the adoption of a "Safety Culture" and implementation of a Safety Management System at a facility which enables staff to report unsafe situations and oversees risk-reduction operations. Facilities can also adopt safer technologies and practices, such as reducing operating pressure or providing sufficient free-board, and by reducing the quantity of hazardous materials at their facilities.

Structural mitigation techniques are numerous and include facility design and layout decisions, which can provide employees safety in the event of an accident, reduce the risk of domino effects, and enabling response operations through proper equipment placement and access routes. Additionally, improving the resilience of primary and secondary containment units, instituting early warning systems with automated shutdown technologies—as appropriate, and conducting the necessary repairs and maintenance to maintain the facility at code requirements can all reduce the risk of a release, and its severity should one occur.

Facilities can further minimize risk through preparedness efforts, especially relating to planning, training, capability development, and community outreach. Facilities should ensure they have the appropriate on-site emergency response plans, and that their employees are trained and drilled in the execution of these plans. These efforts should engage off-site response agencies to ensure they have sufficient information to prepare and drill their own response plans and to prepare the necessary response equipment. Facilities and response agencies should ensure that they have the appropriate level of response equipment available to handle the identified risk scenarios, and the determination of sufficient capabilities must account for the post-disaster context in which external response resources are limited, widespread infrastructure damage has occurred, and multiple simultaneous releases have taken place at one facility. Capabilities should also be developed in other response areas including health and medical, mental health services, water infrastructure, communication infrastructure, evacuation capabilities, etc. Lastly, international policies argue that community members impacted or potentially impacted by a release "have a right to appropriate information," so they can be aware of the risks in their community and so they can "act appropriately should an accident occur" (OECD, 2003, p. 104).

A comprehensive review of best practices in response and recovery fell beyond the scope of this review. It is worth noting that response and recovery actions should be carried out as quickly and efficiently as possible to reduce the impacts of a release and to enable a community to "build back better" following a disaster. The OECD (2003, 2015) encourages the thoughtful application of the Polluter Pays Principle to hold facilities responsible for a release financially accountable, which acts as a major incentive to ensure that facilities take all available risk minimization actions. This principle has challenges to its application in the context of natural disasters, especially if facilities meet or exceed the regulation and code requirements placed on them.

To ensure the effective implementation or risk minimization actions, the relevant regulatory authorities should require and/or conduct intermittent audits and inspections of the facility to ensure it meets the appropriate codes and safety requirements. These audits and inspections should be conducted and reviewed by qualified individuals. To help manage the process of audits and inspections, as well as other safety-related actions, facilities should adopt a Safety Management System. This system can conduct internal inspections, coordinate with external authorities in the reporting of these inspections, and ensure the identified corrective actions are taken. Safety Management Systems can also oversee organizational and structural changes at a facility to ensure quality and safety, and these systems can oversee and manage the appropriate decommission and cleanup actions at the end of a process or storage tank's lifecycle.

Chapter 3: Environmental Justice Review for Oregon's Fuel Tank Seismic Stability Program

By: Arun Pallathadka and Idowu Ajibade

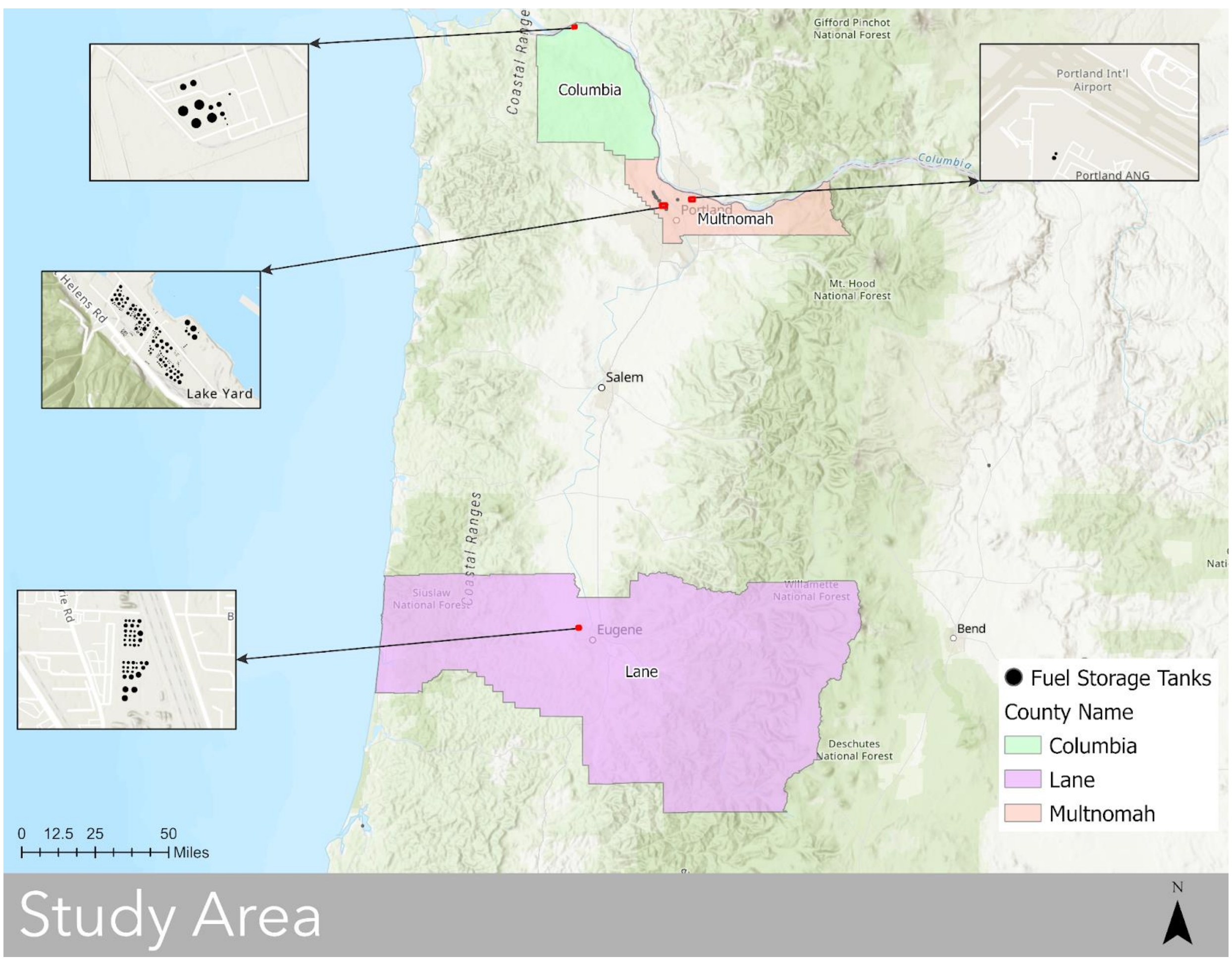
This chapter reports the key findings of the Institute for Sustainable Solutions' (ISS) Environmental Justice (EJ) review in support of the Oregon DEQ's rulemaking for Senate Bill 1567. The Oregon DEQ commissioned ISS to study the EJ issues associated with the seismic vulnerability of the large fuel terminals subject to Senate Bill 1567 in Columbia, Multnomah, and Lane counties (Figure 1). Conducted between December 2022 and April 2023, this study assessed some of the present-day impacts of the fuel facilities on neighboring communities and examined characteristics of community vulnerability to catastrophic disaster at these facilities. This chapter begins with a definition and brief history of environmental justice studies. Then we provide an overview of the history of environmental injustice in the study counties. The next section discusses the intentions, requirements and scope of this study. After this, the methods employed in the study are outlined, results are presented, and the chapter is concluded with a summary of key points and future research directions.

The United State Environmental Protection Agency (EPA) defines environmental justice as the fair treatment and meaningful involvement of all individuals, regardless of race, color, national origin, socio-economic status, in the development, implementation, and enforcement of environmental laws, regulations, and policies (EPA, 2020). EJ scholars and proponents recognize that marginalized and disadvantaged communities often bear a disproportionate burden of environmental hazards and pollution, while having limited access to environmental benefits and resources. In other words, environmental injustice places disproportionate social and health risks on people who are already the most vulnerable or susceptible to those risks (Clark, Millet, & Marshall, 2014).

Evidence of environmental injustice arose in the 1980s, when Black scholars, activists and families called attention to the existence, siting, and build-up of hazardous waste sites, landfills, industrial facilities in neighborhoods consisting of communities of color as well as in poor and immigrant neighborhoods (Bullard, 1990). Specifically, the 1987 United Church of Christ (UCC) study, *Toxic Wastes* *and Race in the United States* showed the relationship of race and socioeconomic class to contaminated waste sites across the U.S. The UCC's assessment revealed that three out of every five Black or Hispanic citizen lived near an "uncontrolled" hazardous waste site. Although the study found both race and class to be significant factors, the results suggested that race carried greater weight.

Over the following decades environmental justice has become an essential part of federal and state environmental policy. There has been some progress in addressing environmental injustices associated with the placement of industrial facilities but minoritized and low-income communities remain disproportionately exposed to these hazards (Kojola & Pellow, 2021; Mohai et al. 2009).

Figure 1. Study Counties and Fuel Facilities.



History of Environmental Injustice in the Study Areas

The history of environmental injustice in Columbia, Lane, and Multnomah counties can be categorized into three distinct phases. The first phase of environmental injustice occurred when Native American communities who inhabited the Columbia riverbank experienced displacement and livelihood dispossession, as their way of life centered around the sacred practice of salmon fishing were radically transformed. These communities had thrived for generations and relied on the abundant resources of the river for sustenance and cultural expression. However, in the late 19th and early 20th centuries, multiple displacements took place, forever altering their lives. The loss of their land had particularly far-reaching implications, disrupting physical connection to their ancestral territories and undermining their economic freedom, stability, and self-sufficiency (Pallathadka et al., 2023). Furthermore, the deprivation of fishing rights following the displacement dealt a severe blow to their cultural identity and spiritual practices (Northwest Power and Conservation Council, n.d).

The narratives passed down through generations of local communities shed light on the subsequent waves of injustice that have shaped the lands upon which the fuel sites now reside. In the early 20th century, as the use of automobiles became widespread, the need for fuel storage facilities expanded to cater to increasing demand. Along Highway 30 in Portland, for instance, several fuel storage tanks were constructed to supply gasoline and other petroleum products to the growing population and industries in the area (Stenvick, 2019). This coincided with the area's already established industrial community, which was home to diverse immigrant populations, including those from Eastern Europe and India (Lee, n.d.). The construction of fuel storage tanks has a significant social and demographic impact in the region. The displacement of numerous workers who were integral to the local community contributed to a second wave of environmental injustice. This displacement disrupted the vibrant social fabric and caused socio-economic challenges for affected individuals and the community.

In present-day there is a third wave of environmental injustices taking place relating to zoning, seismic risks, environmental degradation, and energy justice. Neighborhoods around fuel storage tanks in the study areas include socially disadvantaged and vulnerable populations, subject to the decisions made by powerful international corporations. Critics argue that the placement of fuel storage tanks in industrial zones disregards the presence of residential neighborhoods in the area. Despite the knowledge of residential zoning in the surrounding areas, these tanks are zoned and re-permitted for industrial purposes (Kavanaugh, 2022; Stenvick, 2019).

The local community has long been concerned about the potential risks posed by earthquakes, particularly because the fuel storage tanks are situated on seismically unstable soil which increases the risk of liquefaction-induced failures in the event of a Cascadia Subduction Zone (CSZ) Earthquake (Multnomah County, 2022). The State of Oregon's Critical Energy Infrastructure (CEI) Hub located in Portland, for example, threatens to release between 95 and 194 million gallons of petroleum products during a CSZ Earthquake, and because of the post-earthquake context it will be exceedingly difficult if not impossible to quickly begin containment procedures to mitigate the spill's impacts (Multnomah County, 2022).

The highest threats to life safety exist for employees working at or near the CEI Hub along with nearby residents, but the health impacts of a release will reach a much broader population in Multnomah County. These employees and residents are threatened by the possibility of fires both at the CEI Hub and Forest Park, exposure to toxic fumes from evaporating petrochemicals or other hazardous materials (ibid.). Light oils, like gasoline and jet fuel, will begin evaporating when exposed to the air, and the huge volumes anticipated to be released will result in plumes of toxic chemicals including "benzene, toluene, xylene, ethylbenzene, and others" (ibid., p. 49). On the other hand, oil fires at the CEI Hub will release smoke that carries other pollutants including "VOCs, NOx, sulfur dioxide, and particulate matter" (ibid., p. 49). It is likely that much of Portland, OR and Vancouver, WA, will experience unhealthy air quality from the evaporated gasoline and smoke (ibid.). Extreme environmental impacts along the Willamette and Columbia rivers are anticipated following a release of this size. While in-depth models of fuel distribution are not available, it is undoubtable that such a release will have severe consequences on sacred tribal lands and fisheries.

Additionally, there are energy justice implications resulting from the fuel shortages that are expected to follow a CSZ earthquake due to damage at the CEI Hub and other fuel facilities. This will have implications for energy justice, as certain communities or vulnerable populations will face greater barriers to accessing fuel for essential needs such as heating, transportation, and power generation. These disparities in access to fuel resources can exacerbate existing inequalities and disproportionately affect disadvantaged communities.

These examples highlight some of the challenges associated with fuel facilities in Oregon, all of which underscore the need for comprehensive planning, mitigation measures, and proactive action to address potential environmental injustices including spreading knowledge and equitable distribution of resources to address these problems effectively. Greater public safety and hazard mitigation should positively affect all the impacted, but in the public involvement and implementation of the DEQ's Fuel Tank Seismic Stability rules, the needs and concerns of vulnerable and historically underserved groups should be considered and elevated. Public safety and hazard mitigation measures should aim to positively impact all communities and social groups affected by environmental hazards while considering the principle of intersectionality, discussed further below.

Study Scope and Objectives

This study was framed within a limited scope of research due to the focus of the DEQ's rulemaking efforts, data availability constraints, and study time constraints. It was within our scope to investigate socially vulnerable populations using geospatial analysis and focus groups, to attempt to understand community concerns through focus groups, and to explore environmental injustice using geospatial analysis.

The social vulnerability component of this study aims to understand the community's perspective on fuel storage facilities and identify geographic areas of concern. To do this, we conducted geospatial regional and site-specific analyses in Columbia, Lane, and Multnomah counties, as well as field analysis and community discussions conducted through focus groups, described further in the methods section. However, before that investigation could begin, we had to address complexities which arise from the study context. Oregon's historical demographic composition, primarily consisting of a white population (74.8%, U.S. Census Bureau, 2021), poses complexities when considering racial-ethnic minorities in the context of racial equity. The relatively small proportion of racial-ethnic minorities presents challenges in summarizing intricate population variations, particularly when the variability does not conform to a statistically normal distribution. Consequently, adopting an intersectional perspective that acknowledges the multiple dimensions of inequality becomes crucial to comprehending environmental injustices in this context.

Intersectionality recognizes that individuals and communities experience multiple intersecting forms of oppression and privilege based on race, gender, socioeconomic status, and other social identities (Crenshaw, 1990; 2017). This means that decision-making processes must include representatives from marginalized communities who may be disproportionately impacted by the potential seismic event. By recognizing the interplay between race, class, and other factors, a more comprehensive understanding of the complex challenges faced can be attained (McKane et al. 2018). Thus, the scope of intersectionality requires researchers to consider communities beyond just race alone. The Environmental Protection Agency (EPA) acknowledges this critical aspect and advises incorporating a range of socioeconomic indicators to effectively address environmental justice concerns (EPA, 2020). This approach finds support in various research studies that underline the significance of considering multiple dimensions of inequality in the analysis of environmental disparities (Cutter, 2003; Collins et al., 2018; Grineski et al., 2017). By adopting a broader framework that encompasses socioeconomic factors alongside race, we can gain a more inclusive and nuanced understanding of environmental justice and work towards equitable outcomes.

Other important populations, impacts or risks, and research areas fell outside of our scope but are deserving of future attention. These include fuel facility impacts and risks to downstream environments, tribal communities, fisheries; unhoused populations; and industrial workers. Examining the communities threatened by fires which could spread from facilities into such places as Portland’s Forest Park, was beyond our scope. Nor did we examine the impacts or threats stemming from possible toxic plumes and/or reduced air quality from evaporating petrochemicals and petrochemical fires which could occur following a release. And finally, we did not examine the risks posed to communities throughout Oregon by possible fuel shortages following an earthquake. Although these items fall beyond our current scope, they unquestionably align with the broader public interest and warrant consideration through future research.

Methods

To build an environmental justice and social vulnerability framework for the present study, we ask the following questions: (1) Who are the communities to consider as socially vulnerable to earthquake hazard impact due to the presence of fuel storage tanks? And (2) What are the various impacts and challenges on these communities due to the presence of fuel storage tanks? Based on the history and present-day circumstances in our study areas, we identified and categorized the following populations as relevant to this review:

- Those who are at risk and environmentally overburdened:
  - Those who live near the fuel terminals face higher life safety risk due to a potential seismic disaster and secondary effects (e.g., unhealthy air quality, fire, exposure to hazardous materials, etc.).
  - Those who rely on natural resources that will be impacted directly by a disaster in the area, especially Indigenous communities and people who fish from the river, use the river for agriculture, recreation, etc.
- Those populations who are underserved:
  - Groups with less political voice (racial minorities, children, people living in poverty, immigrants, etc.).
  - Groups who will be more impacted by a disaster (people with access and functional needs, limited English, houseless individuals, etc.).
- Those who are economically distressed:
  - Those without resources to prepare, mitigate, recover, or move away from the danger, such as:

    - Those who lack the financial capacity to purchase resources to adapt to a statewide fuel shortage following a disaster.
    - Those who are unable to afford seismic resilience improvements to their homes or businesses.
  - Those local and small businesses whose industries and customers would be interrupted by lack of access to Highway 30 (e.g., Linnton), fuel shortages, the destruction of property, etc.

Once we identified and defined some of the populations of interest, the research team undertook an approach comprising three key components: geospatial analysis, focus group discussions, and field observation. Geospatial analysis served as the foundation of the study, providing an initial understanding of the distribution and spatial patterns of fuel storage tanks. However, it became evident that the available geospatial datasets lacked the necessary granularity to capture the finer-scale vulnerabilities present in the study area. Consequently, focus group meetings with residents and field trips were integrated into this research approach.

Geospatial analysis conducted in this study employed a social vulnerability index (SoVI) approach, originally developed by Susan Cutter (Table 3; Cutter et al., 2003). Cutter et al. (2003) defined social vulnerability as, "the susceptibility of given social groups to the deleterious effects of environmental or technological hazards, as well as to the stress resulting from social, economic, and political factors." Major government agencies at the federal level (E.g., CDC, EPA) have adopted the SoVI framework to gain insights into environmental justice concerns, and its applicability has been demonstrated through several independent studies conducted in the field (Collins et al., 2018; Grineski et al., 2017).

In this study, a social vulnerability index was built based on the relationship of each variable to vulnerability, which could be either positive or negative (Table 3). By using this model, the study identified areas with high social vulnerability so that emergency management strategies can be developed to mitigate potential impacts on these communities.

Table 3. Social Vulnerability Indicators Used in EJ Review

Variable:	**Vulnerability Rationale:**	**Used by:**
Population density (+)	Require more resources prior to, during, and after a hazard event	Cutter (2003)
% Population > 65 years of age (+)	Require more assistance during and after a hazard event	CDC, EPA
% Non-White Population (+)	Have less ability to recover after a disaster due to lack of resources	CDC, EPA
% Population with no high school diploma (+)	Have less access to information and resources	CDC, EPA
% Housing units occupied by renters (+)	Have less resources to recover after a hazard event	CDC, Ma and Smith (2020)
Median Household Income (US$) (-)	Have less resources before, during, and after a hazard event	CDC, EPA
% Households with limited English (+)	Require more assistance/outreach before, during, and after a hazard event	CDC, EPA

We selected census block groups (CBGs) as our unit of analysis because they are the smallest geographic unit for which the Census Bureau publishes data. The Census Bureau defines a census block group (CBG) as a geographic area that generally contains between 600 and 3,000 people. All the social vulnerability variable data was sourced from the American Community Survey of 2020 (U.S. Census Bureau, 2021). The variables used in this study are listed in Table 3 with corresponding vulnerability rationale. To facilitate the analysis, the variables were normalized using a standard min-max normalization technique (Equations 1 and 2), ensuring that all variables were transformed to a standardized range of 0 to 1 before they were combined (Chang et al. 2021). The quantile classification method was then used to classify the normalized values into four distinct categories: “low,” “medium,” “high,” and “very high.” The ranking was based on the normalized values falling within the defined ranges of 0-25%, 25-50%, 50-75%, and 75-100%, respectively. The normalized and ranked values for all variables were then combined to determine the overall vulnerability.

Equation 1: $x' = (x - \min(x)) / (\max(x) - \min(x))$
(Eq 1 used for positive relationship with vulnerability, see Table 3)

Equation 2: $x' = (\max(x) - x) / (\max(x) - \min(x))$
(Eq 2 used for negative relationship with vulnerability, see Table 3)

where:

x is the original value of the variable
x' is the normalized value of the variable
min(x) is the minimum value of x in the dataset
max(x) is the maximum value of x in the dataset
This formula scales the variable x to a range between 0 and 1, where 0 represents the minimum value and 1 represents the maximum value in the dataset.

As part of the study, we examined a selection of hazardous material incidents (Table 4). Based on this analysis, a radius of 4 miles from the hazardous materials source was deemed appropriate to indicate the highest-risk area (Hinzen, 2007; Lam & Culbertson, 2014; Murthy, 2014). Within this radius, certain facilities of significance from a social vulnerability or emergency management standpoint were identified. To emphasize the potential heightened risk in this area, it was referred to as the "increased hazard risk area." The study identified specific facilities within this area (Tables 5, 6, & 7) that could inform emergency management strategies and help mitigate potential impacts on the communities located within the designated buffer zone. It is important to note that this buffer zone should not be misconstrued as an absolute boundary or a predetermined marker. The term "increased hazard risk area" (4-mile buffer zone) is used to underscore the seriousness of the issue within a reasonable radius. It should be regarded as a starting point for further exploration of this issue.

Table 4. Defining an Increased Hazard Risk Area

Incident:	Major Impact Radius:	Reference:
Toxic Train Accident in Raymond, Minnesota	0.5 mile	Yan, Burnside, Nilsen, & Alvarado, 2023
Toxic Train Accident in East Palestine, Ohio	1 - 2 miles	Ohio Governor’s Office, 2023
Gas leak in Bhopal, India	4.5 miles	Murthy, 2014
Fuel tank explosion in London, UK	3 miles	Hinzen, 2007
Wildland/Urban fires in California, USA	1.5 miles	Radeloff et al. 2005
Aliso Canyon Gas Leak	3 miles	Los Angeles County Department of Public Health, 2016
San Juanico disaster	3 - 4 miles	Arturson, 1987
Beirut explosion	6 miles	Wagner & Petras, 2020

In addition to the geospatial analysis, the research team conducted focus group discussions with community members in all three counties. Prior to community outreach, the focus group component of the study was approved by the institutional review board of Portland State University. The research team allocated four weeks to conducting outreach and hosting virtual focus group sessions using Zoom. Prior to the focus group meetings, participants were asked to complete a pre-focus group questionnaire in which they shared their perspectives on various topics related to fuel storage tanks in their community, including awareness, perceived risks, and other relevant aspects. This information was then used to guide the focus group discussions.

Out of the initial pool of over sixty people who expressed interest in participating in the focus group, only nine individuals ultimately met the eligibility criteria and scheduling availability to be included in the study. Most of those interested did not live in the study areas or did not attend their scheduled focus group session. This selection process ensured that participants aligned with the specific criteria outlined for the research, which included filling out designated Google Forms, providing basic details such as their name, address, phone number, and email. This was to ensure compliance with Portland State University's requirements for the disbursement of compensation ($50 per participant) to the participants. These details were also collected to ensure that participants resided within the target community and to maintain the integrity of the research findings. In addition to the selection process, several responses submitted online were curated to ensure accuracy and relevance to the study's objectives.

The research team conducted a total of three visits to the fuel storage facilities located in Multnomah (along Highway 30 in the community of Linnton) and Columbia Counties (In Quincy, near Clatskanie). Unfortunately, due to time constraints associated with researchers’ schedule, the planned visit to Lane County fuel storage facilities could not take place, although residents from Lane County participated in the focus group. The visits to Multnomah and Columbia Counties provided valuable opportunities for the research team to directly interact with members of the public and contextualize their opinion and experiences through firsthand observations on-site.

During the field visits, several concerns emerged that may not have been easily identifiable through computer-based geo-spatial analysis or within the limited setting of a focus group. These concerns highlighted major environmental issues that could potentially have negative impacts on the community. The field visits allowed the research team to witness and gather evidence about a broad set of concerns and potential socio-environmental impacts, further emphasizing their significance and the need for appropriate attention and action.

Methodological Limitations

Our study is a pilot assessment of the EJ implications of fuel storage and seismic risks, it is by no means a comprehensive evaluation of the challenges facing communities living near fuel terminals in Multnomah, Lane, and Columbia counties. For example, the use of census block groups, while the finest available scale for census data, only provides a summarized view of vulnerability, potentially overlooking finer-scale vulnerabilities. To gain a more accurate understanding of the situation and guide appropriate interventions, a comprehensive review should address these limitations and incorporate more detailed data.

There are broader issues not captured as part of the study's methodology due to a lack of available data. For instance, we did not delve into the downstream environmental impacts on the river, which could affect tribal communities. New data and models need to be developed to understand the impact on tribal communities regionally. Additionally, the study did not cover plume models, which could travel several miles in different directions and have an impact on marginalized communities. We also did not include data of unhoused population and warehouse workers in the social vulnerability model, the data for both could not be secured within the timeframe, and we also considered the ethical issues of including data on a constantly changing population. Another significant limitation is that focus groups were only available for a brief period, which may have hindered broader participation.

Study Results: Multnomah County

Multnomah County is situated in the northwestern part of the state. It covers an area of approximately 466 square miles (1,207Km2) and is bordered by the Columbia River to the north, Clackamas County to the south and east, and Washington County to the west (Multnomah County, 2023). The county extends from the urban center of Portland to rural areas in the east. As of 2021, Multnomah County has an estimated population of 803,377 making it the most populous county in Oregon (U.S Census Bureau, 2021). Multnomah County's demography consists of White (78.1%), Hispanic (12.9%), Asian (8.3%), Blacks or Africans alone (6.2%), Native Americans (1.5%). As of 2022, the median household income was $76,290. However, about 12% of families live in poverty (US Census Bureau, 2022). Economically, Multnomah County is diverse with sectors such as technology, healthcare, education, manufacturing, retail, and tourism contributing to its growth. The county's location in the Portland metropolitan area provides access to a range of employment opportunities and a thriving business environment.

The bulk of fuel storage tanks (~ 496) in Multnomah County are situated along Highway 30 and Columbia River, near the community of Linnton, in a historically industrial belt. A small number of tanks (~ 10) are situated across the Willamette River near the University of Portland and Portland International Airport. These are within urban centers and close to major waterways. Portland's industrial belts have a long history of disinvestment and signs of urban decay, especially considering the shift from manufacturing facilities to fuel storage tanks in these communities. Safety concerns have arisen due to the liquefaction potential of the soil beneath the tanks, and community members have been advocating for a relocation of these tanks to ensure a safe environment.

Geospatial Analysis and Field Trips to Multnomah County

The census block groups (CBGs) that are located between multiple fuel facilities, especially those directly adjacent to industrial areas in northwest Portland and the Portland airport, are of particular concern. These CBGs find themselves situated between multiple fuel storage facilities, and within them, numerous socially vulnerable neighborhoods can be found. Within the social vulnerability index, the variables that trigger high vulnerability around these sites are age, language, poverty, race, and ethnicity. Over 300,000 people live in the increased hazard risk area (4-mile buffer), which constitutes roughly 21% of the combined population of Multnomah and Washington counties. There is also a significant density of sensitive facilities (over 25% of all such facilities in the county) such as day care centers and places of worship (e.g., church, temple) are located within the increased hazard risk area (Table 5).

Figure 2. Social Vulnerability in Multnomah and Washington Counties

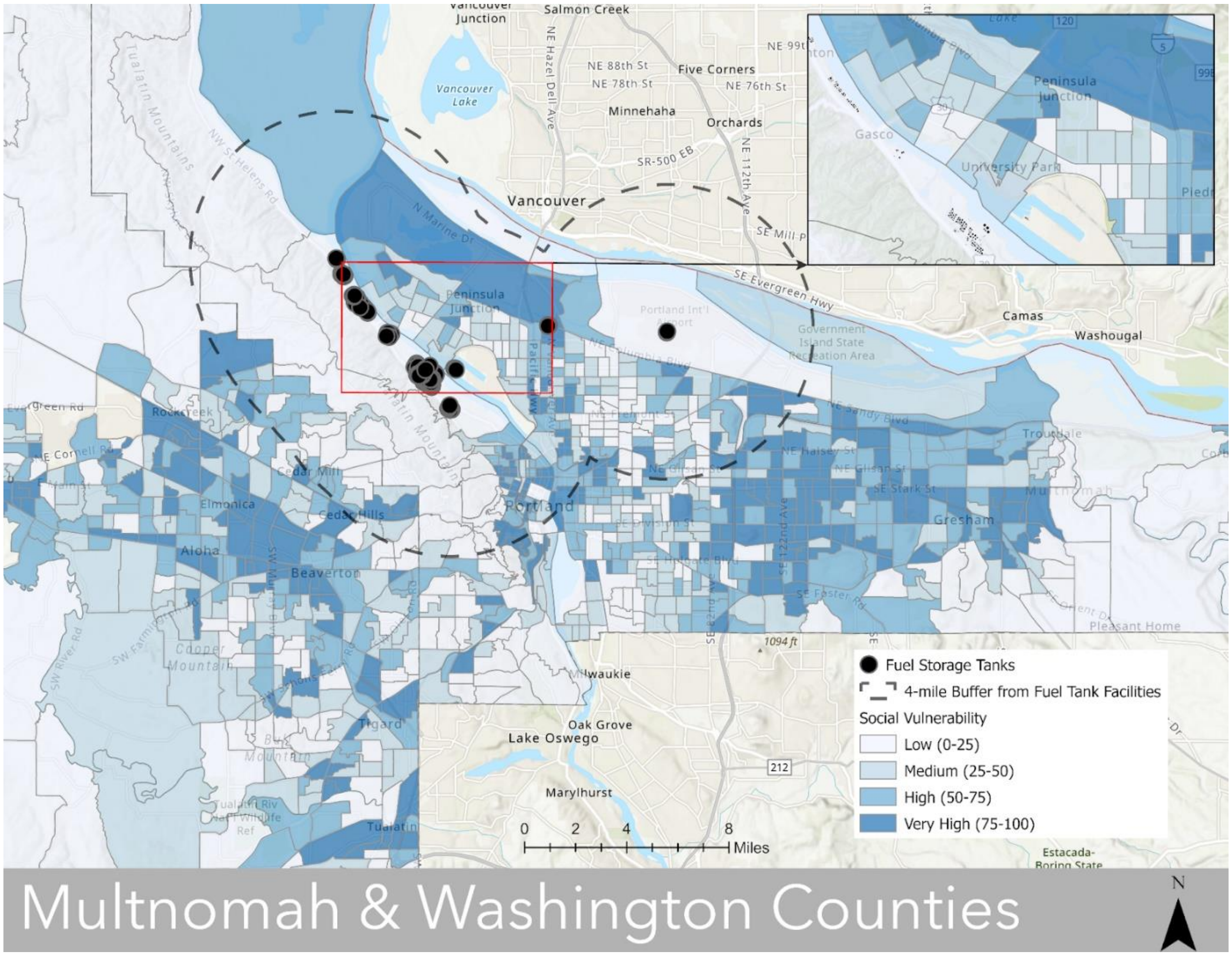


Table 5. Sensitive Facilities to Consider Within 4-mile Buffer in Multnomah and Washington Counties

Facility type:	Total within the 4-mile buffer:	Total within the county:	Data source:
Community centers	19	293	Metro via PSU
Daycare centers	237	732	HIFLD
Hospitals	10	16	HIFLD
Places of worship	332	1,025	HIFLD
Public schools	195	733	HIFLD

Senior homes/Nursing homes	34	186	HIFLD
Supermarkets	59	156	Portland Open Data

Focus Group Discussions in Multnomah County

During the discussions, participants from Portland expressed significant concerns regarding two main issues involving the fuel storage tanks: air pollution and seismic safety. Air pollution was a primary concern, with participants highlighting the potential negative impacts on their health and the well-being of the community. Additionally, participants expressed apprehension about the seismic safety of the fuel storage tanks, given the risk of liquefaction of the underlying soil where the tanks are located.

Emergency preparedness of residents and neighborhoods emerged as another significant concern, with participants emphasizing the need for comprehensive emergency plans and preparedness measures. Additionally, participants expressed apprehension regarding the age and structural integrity of the fuel storage tanks themselves, suggesting that either removal or upgrading to modern safety standards should be considered.

Participants also noted the vulnerability of immigrant and people of color industrial workers who may be employed in nearby warehouses, emphasizing the importance of enhancing public awareness through education and training. Participants agreed this may be ensured through communicating the associated risks to local warehouse operators and businesses, who may then be able to provide appropriate materials and training to their employees, and also come up with appropriate emergency plans.

Participants voiced their concerns regarding ongoing air quality issues related to the fuel storage tanks. They emphasized the significance of implementing effective monitoring systems and ensuring transparent reporting on the tanks' status and the disclosure of their contents. All the participants called for regular monitoring to ensure the well-being of the community. Participants also highlighted the need for enhanced safety standards within the fuel storage facilities, particularly relating to fire prevention and containment of fuel spills.

Study Results: Lane County

Lane County is situated in the western part of Oregon and covers a range of geographical features, including coastal areas, mountains, forests, and fertile valleys. The area is approximately 4,553 square miles (11,794 square kilometers) and is bordered by the Pacific Ocean to the west, Benton County to the north, Linn County to the east, and Douglas County to the south (Griffin-Valade, 2020). The seat of Lane County is Eugene, one of the largest cities in the county. Eugene serves as a cultural, educational, and economic hub for the region. Lane County has an estimated population of 382,353, making it the fourth most populous county in Oregon (U.S Census Bureau, 2022). The demography of Lane County consists of White (88.6%), Hispanic (10.1%), Asian (3.2%), American Indian (1.6%), Black or African American (1.3%), (1.6%) and two or more races (5%).

Like Multnomah County, Lane County has a diverse economy with sectors such as education, healthcare, technology, manufacturing, agriculture, and outdoor recreation playing significant roles. The presence of the University of Oregon and Oregon State University contributes to the region's educational and research activities. The county's natural beauty, including the Oregon Coast, Willamette National Forest, and recreational opportunities along the McKenzie River, attract tourists and support the local tourism industry (Griffin-Valade, 2017).

Lane county hosts several fuel storage tanks (~ 42) all located by the Union Pacific railroad and Prairie Road, northwest of the city of Eugene. These tanks are in a semi-industrial area but are situated very close to residences and some local parks.

Geospatial Analysis and Field Trips to Lane County

The area around the fuel storage facility exhibits high social vulnerability, and it is the only county among the three study counties where a greater proportion of socially vulnerable neighborhoods (n = 28) were found within the 4-mile radius compared to outside of it (Figure 3). Among the variables used in creating the social vulnerability index, the proportion of racial and ethnic minorities was particularly high (27%) within the increased hazard risk area surrounding the fuel storage tank site. The increased hazard risk area here also contained over 90,000 people, which constitutes 23% of all of Lane county's population. Over 25% of all daycare centers, senior homes, and places of worship in the County were also located within the increased hazard risk area (Table 6). The scheduled visit to Lane County did not take place because of time limitations tied to the researchers' schedule.

Figure 3. Social Vulnerability in Lane County

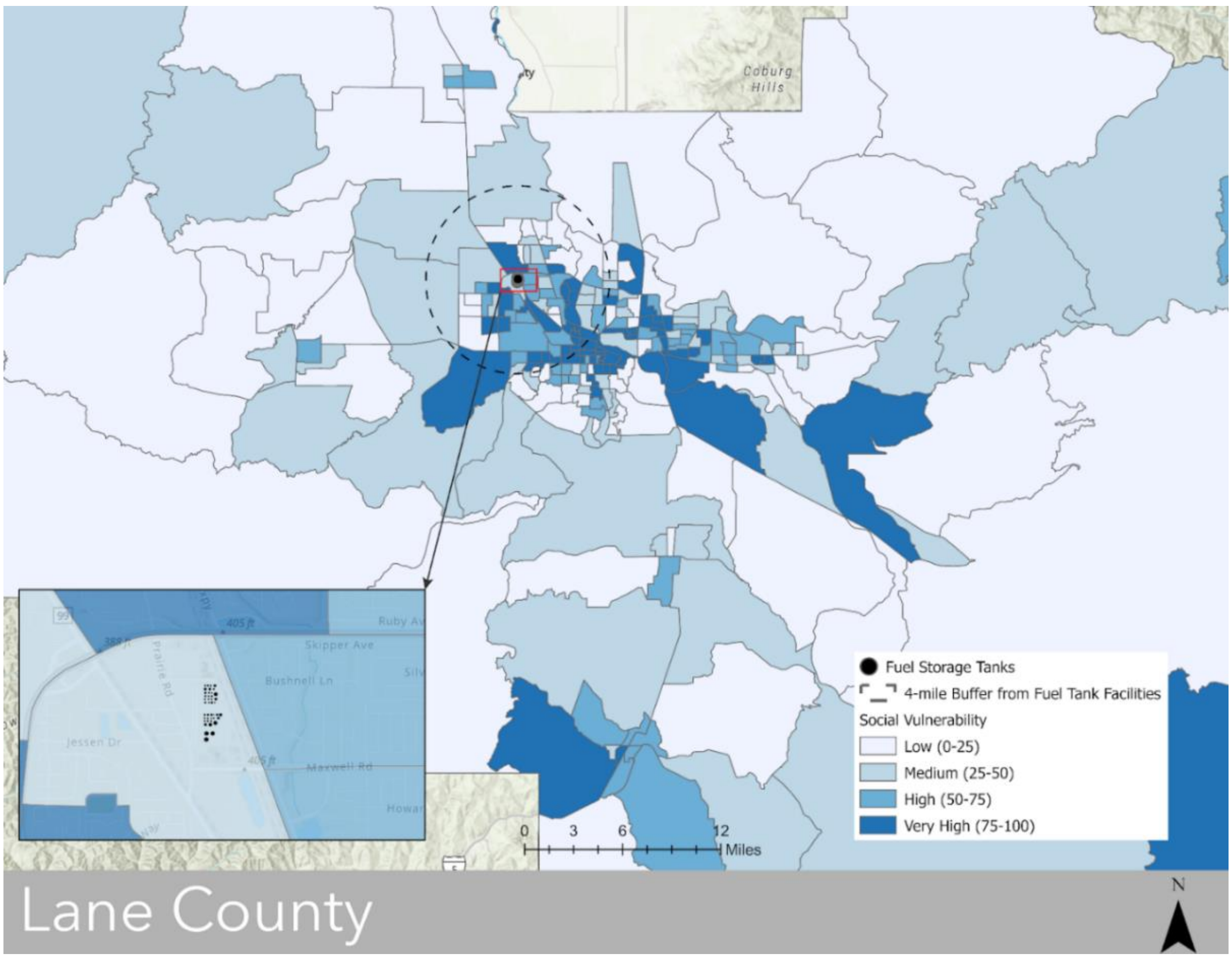


Table 6. Sensitive Facilities to Consider Within 4-mile Buffer in Lane County

Facility type:	Total within the 4-mile buffer:	Total within the county:	Data source:
Community centers	NA	NA	NA
Daycare centers	47	154	HIFLD
Hospitals	0	6	HIFLD
Places of worship	80	299	HIFLD
Public schools	27	117	HIFLD
Senior homes/Nursing homes	15	53	HIFLD

Focus Group Discussions in Lane County

Like the observations in the other two study counties, participants in Lane County expressed concerns regarding emergency preparedness and public safety communication. They emphasized the importance of comprehensive public education initiatives to ensure that residents, particularly those living near the fuel storage tanks, are well-informed and prepared for any potential emergencies. Participants highlighted the need for increased availability of resources to support the community in emergency situations. They stressed the importance of ensuring that adequate resources, such as emergency response services, are readily accessible to residents, particularly in areas with higher vulnerability. While there was mention of communities of color during the discussions, participants had limited information to share on this aspect. However, the overall sentiment expressed by participants underlined the importance of equitable access to resources and services for all residents. Overall, the concerns raised by participants in this area echoed the need for enhanced emergency preparedness measures, improved public safety communication, and increased resources to support residents, particularly those living near the fuel storage tanks.

Study Results: Columbia County

Columbia County is situated in the northwest part of Oregon. It was the 16th county created in Oregon and is among the 3 smallest counties in the region (SOS, 2017). Geographically, it covers an area of approximately 688 square miles (1,783 square kilometers) and is bordered by the Columbia River to the north, Multnomah County to the east, Washington County to the south, and Clatsop County to the west. The county features diverse landscapes, including forests, rolling hills, and portions of the Oregon Coast Range. Columbia County is estimated to have a population of 53,000 people (US, Census Bureau). The population density is relatively low compared to neighboring counties, which contributes to the County's rural and small-town atmosphere. The communities in the area include St. Helens, Rainier, Scappoose, Quincy, and Vernonia. These towns offer a range of amenities, including schools, parks, and local businesses, while maintaining a close-knit community feel. Historically, Columbia County's economy was primarily based on logging, fishing, and manufacturing industries. However, over the years, the economy has diversified, and sectors such as healthcare, retail, education, and services have grown. The Columbia River plays a significant role in the county's geography and recreation. It provides opportunities for boating, fishing, and other water-based activities. The river also serves as a transportation route and has historically played a vital role in the region's economy (Lang, 2021).

The fuel storage tanks (~ 4) in Columbia County are situated to the north of Quincy, a small agricultural town that is positioned approximately 4 miles north of Clatskanie, an incorporated city with a population of around 1,700 residents. These tanks are located near the convergence of the Columbia River and local dikes and sloughs, forming a natural watershed for nearby communities. The surrounding access roads leading to the fuel storage tanks are narrow and not designed to accommodate large truck movements. Clatskanie, the largest community near the fuel tanks, was established by Oregon Trail pioneers and relies heavily on occupations related to logging, farming, and fishing. Like numerous communities in Oregon, a significant portion of its population consists of elderly individuals, comprising almost one third of the total. Additionally, approximately one fourth of the population falls below the poverty line. The area boasts abundant water resources, attracting migratory birds and offering opportunities to observe numerous eagles.

Geospatial Analysis and Field Trips to Columbia County

Within Columbia County, the census block groups (CBGs) surrounding the fuel storage tanks exhibited higher social vulnerability (Figure 4). Nearly 5,000 people live in the surrounding CBGs, which constitutes 1/10th of the county's population. During the field trip, the researchers identified three major issues. The lack of information and preparedness was apparent among residents. During interactions with the research team, a common concern expressed by everyone was the location of the fuel storage tanks in proximity to towns with limited access to essential services such as hospitals or emergency services. This geographical factor raised apprehensions among the community members. As a significant number of the population is elderly, there was a strong concern for the health implications of a release at the fuel facility. Some also expressed concern about potential vandalism, given the secrecy around the conditions of the tanks themselves. Two small business owners expressed concern about the loss of natural watershed in the event of a spill. No participants attended the focus group discussion planned for this county.

Figure 4. Social Vulnerability in Columbia County

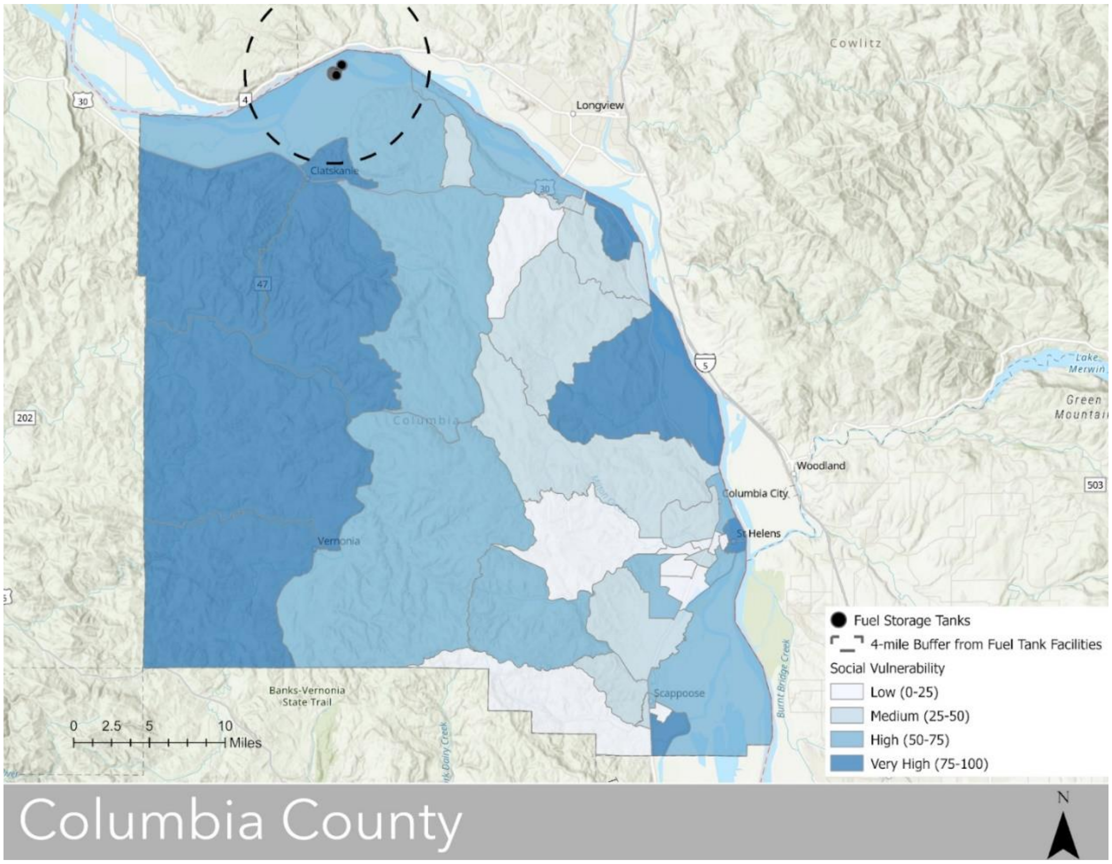


Table 7. Sensitive Facilities to Consider Within 4-mile Buffer in Columbia County

Facility type:	Total within the 4-mile buffer:	Total within the county:	Data source:
Community Centers	NA	NA	NA
Daycare centers	0	23	HIFLD
Hospitals	0	0	HIFLD
Places of worship	0	40	HIFLD
Public schools	0	24	HIFLD
Senior/Nursing Homes	0	7	HIFLD

Conclusions and Future Study Directions

The issue of environmental justice encompasses various social and economic barriers that result in hardships and reduced quality of life for communities facing environmental injustices compared to those that are economically, racially, politically, and socially privileged. In this study, we assessed social vulnerability to potential earthquake impacts in communities located near large fuel terminals in three Oregon counties.

Multnomah County, the most populous county in Oregon, bears the greatest burden. One might expect that due to the county's population size, human capital, civic engagement, and social innovation would lead to better preparedness; however, this is not the case. The environmental injustice consequences here are particularly complex, with many neighborhoods experiencing multiple forms of challenges and a high burden of exposure to fuel storage tanks and air pollution. The lack of a fire station and reliable air quality monitoring near the fuel terminals in Multnomah County raises significant concerns for the surrounding communities, as highlighted in focus group discussions.

Columbia County, a farming community with access to valuable natural watersheds, is home to fuel storage tanks that risk its abundant natural resources. Its smaller population, high social vulnerability due to lower household incomes, a significant elderly population, and geographic isolation compared to locations in Multnomah and Lane further emphasize these challenges, as highlighted in focus group discussions. Moreover, the area serves as a habitat for migratory birds, including Canada Geese and endangered species of American Eagles, and the absence of a clear ecological mitigation plan endangers the flora and fauna. The potential risks of earthquakes, spills, or accidents amplifies the urgency of addressing this issue.

Meanwhile, in Eugene, located in Lane County, communities consisting of racial and ethnic minorities and economically disadvantaged individuals reside in close proximity to the fuel terminals. Additionally, there are communities in the area where English is not their primary language, potentially resulting in limited awareness of the situation.

Policy implications for environmental justice arising from these findings include the need for comprehensive measures to address the unequal distribution of environmental risks and burdens. State-wide strategies to address these inequities should include improved preparedness and safety measures, knowledge and awareness among disadvantaged groups, equitable access to fire stations and air quality monitoring, and targeted outreach and support for minority communities, underserved communities, and those with limited language proficiency. Other disaster management efforts will further improve safety and reduce the unequal distribution of risk in these counties, including: maintaining an early warning systems that can detect seismic activity and provide advance alerts to the population; conducting drills and exercises to familiarize communities with proper evacuation procedures and emergency response plans; and strengthening critical infrastructure such as hospitals, power plants, dams, and bridges to withstand seismic forces. Earthquake preparedness is a shared responsibility involving governments, communities, individuals, and organizations. By implementing these measures and promoting a culture of safety, the impact of earthquakes can be significantly reduced, lives can be saved, and we can work towards reducing the high burden of exposure for communities living near fuel terminals.

Future research endeavors should continue engage populations residing near the fuel storage facilities. In addition, collaborating with organizations known for their expertise in developing fine-scale risk factors for flooding and fire risk, such as First Street Foundation, can prove beneficial in assessing and mitigating the risks associated with earthquakes and fuel storage sites. Such collaborations can enhance research efforts and contribute to the development of more effective strategies that prioritize environmental justice. The integration of more detailed data and collaborative partnerships with expert organizations will improve our understanding of the situation, allowing for targeted interventions and policies that address the specific needs and vulnerabilities of communities affected by environmental injustices. By taking these steps, we can work towards creating more equitable and resilient communities, ensuring that environmental justice is at the forefront of decision-making processes. Future studies should also consider strategies for land restoration and remediation. Such research should address the allocation of access rights to the land. In making these decisions, special consideration should be given to populations and communities that have disproportionately suffered from environmental injustice.

Chapter 4: Fuel Terminal Seismic Stability Workshop

By: Luke Hanst

This chapter conveys the outcomes of a workshop hosted on August 7th, 2023, by the Institute for Sustainable Solutions (ISS) intended to advance the Institute's regional resilience goals while generating information that we hope will be useful to the Oregon DEQ's implementation efforts relating to Senate Bill 1567. The scope of the workshop was confined to actions that will improve community resilience and safety during the interim period before facility mitigation actions have been completed and which will contribute to reducing the residual risks that remain following facility mitigation operations. In total, 30 people attended the workshop including representatives from state and local government agencies, industry representatives, community members and advocates, and other relevant experts (Table 8).

The workshop was composed of three primary components: a project brainstorm in which breakout groups were asked to list any ideas they had which could potentially improve community safety and reduce residual risks; a full-group discussion on criteria or elements which make for good, fundable projects; and a project deep-dive session in which breakout groups were asked to select high-priority projects and elaborate on key elements (e.g., possible funding sources). This chapter describes the outcomes of these three workshop components, provides additional information on possible project funding sources, and then concludes with a brief synthesis of workshop ideas into a four-phased program which could be used to advance resilience and education in communities adjacent to fuel facilities.

It is important to note that the workshop used four breakout groups of roughly 7 people each with differing compositions of participant backgrounds and expertise. The project ideas listed below are not separated by breakout group due to significant overlap which would cause undue repetition, therefore these ideas should not be taken to represent a consensus among the participants, rather they are a potential starting point. The bulk of participants, especially among community members, are local to Multnomah County and as such discussion most often focused on the specific infrastructure surrounding Portland's Critical Energy Infrastructure Hub. Where possible, project ideas have been translated to be theoretically applicable in any county across the State. In some instances, such translation was not deemed feasible. Finally, the projects listed in this chapter face the same limitation as the broader report in that identified safety mechanisms may already be in place or in the process of being established. When possible, we have noted such existing safety mechanisms, but additional review of the existing conditions is merited prior to the advancement of any project idea.

Community Investment Project Ideas

In small groups, participants were asked to list any and all ideas they had in response to the following questions:

- What should we invest in now to make the community safer and more prepared for an earthquake?
- What should we invest in to minimize residual risks following facility seismic mitigation actions?

Based on these questions, the following project ideas were generated. They were then categorized after the workshop for ease and clarity. These ideas were not vetted nor were they prioritized and should be considered only the first draft of an inclusive brainstorming session.

Situational Awareness and Public Communication:

- Hazard scenarios should be developed which identify all realistic release scenarios and the natural hazard conditions under which they could occur, to be used for response planning, the identification of protective action recommendations, and for the development of appropriate capabilities.
- Public education campaigns should be undertaken which inform the public of the risk scenarios, the appropriate protective actions to be taken, and the safety measures in place both inside and near to facilities.
    - Community tours were proposed as a possible form of community education in which community members and others are educated about a location’s history, risks, appropriate protective actions, and ongoing safety efforts. These tours could reflect the ongoing “Family

Safety Days" taking place at other petrochemical facilities to increase transparency and trust between interested parties.

- Public notification systems should be expanded and improved, including the addition of redundant systems, such that residents can be informed of an ongoing disaster and the appropriate protective action they should take.
- The ShakeAlert® Earthquake Early Warning (EEW) System and other early warning systems should be integrated into fuel facilities and into the whole community.

Fire Control Measures:

- Fire control measures inside of and nearby facilities should be developed to reduce the risk of fires spreading within facilities and/or leaving facility boundaries.
- Additional wildfire detection cameras should be installed in communities to enable situational awareness following a natural disaster, especially in high-risk areas (e.g., Portland's Forest Park). Fire protection agencies should also be trained in how to operate these cameras.
    - The University of Oregon, PG&E, and the Oregon Department of Forestry run complementary camera systems that could be used.
- Wildfire breaks should be established between facilities and areas of concern, and fire fuel reduction operations should be carried out to reduce the risk of fire within those areas.
- Programs such as Firewise USA should be supported and shared with residents and businesses in high-risk areas to enable localized fire mitigation actions.

First Responder Capability Development:

- Response plans should be developed for all identified hazard scenarios and should emphasize support for people with access and functional needs.
    - Recovery and clean-up plans are a critical component in ensuring the community can return to their homes and rebuild their communities following a disaster.

    - **Note:** Facilities are currently required to maintain Spill Prevention, Control and Countermeasure Plans and Facility Response Plans that will, when implemented, provide the best achievable protection.
- Drills and training should be conducted regularly and should include all relevant response parties, residents or community leaders, and facility personnel.
- Sufficient response equipment should be pre-positioned along resilient transportation routes to enable timely response actions.
    - This should include oil catchment equipment or other such technology to stop the flow of oil into or down rivers and waterways.
- First responders, especially firefighters and hazardous material response teams, should carry out regular walk-throughs and training at fuel facilities.
- Awareness should be developed of facilities' fire suppression systems and hazardous materials response team capabilities.
- Mechanism for accessing and distributing fuel from fuel tanks without grid electricity or internet connection should be established to enable broader response and recovery actions.
- Relationships and capabilities should be developed among agencies involved in post-disaster vapors and toxics monitoring.
- Relevant response agencies at the federal level should be informed of disaster scenarios and prepared to participate in response operations, especially for large spill risk areas.

Fuel Facility Improvements:

- Facilities should ensure sufficient firefighting water and foam supplies are located on site and should be located in areas which will be accessible following natural disasters and hazardous materials releases.
- Onsite generators should be installed to enable water and foam pumping capabilities, as well as to enable gathering fuel from fuel facilities to enable response and recovery actions.
- The best possible spill control measures should be implemented, including sufficient and resilient secondary containment units to minimize the risks of

fuel releases moving beyond the bounds of a facility into residential or environmental areas.

  - **Note:** fuel facilities are required to meet the standards set by the American Petroleum Institute (e.g., API-650) for tank design, operation, maintenance, and inspection for new constructions, and pre-existing constructions will be required to meet the rules established by the Oregon DEQ in response to Senate Bill 1567.

- Facilities should implement automated emergency shutdown technologies, and, where feasible, connect these automated shutdown systems to the ShakeAlert EEW System or other such early warning technologies.
  - **Note:** Facilities currently have the capability to monitor facility systems remotely and enact remote shutdown operations to enable timely response to detected leaks. It is unclear how these systems or the operators required to control them will fair during an earthquake or other natural disaster.

Infrastructure Development:

- Transportation routes which can serve for evacuations and response operations should be identified and developed to ensure they are resilient to natural disasters and will be sufficient for the required transportation volume.
- Evacuation routes should be established and should:
  - Include multiple ways in and out of an area to support evacuations during multiple disaster scenarios.
  - Include redundant routes in case of unexpected conditions.
  - Be resilient to earthquakes and other natural disasters.
  - Include clear visual markers or indicators.
  - Support people with access and functional needs, and support multimodal transportation.
  - Include resilient muster points with pre-positioned water, food, and medical supplies for evacuees.

- Critical bridges, overpasses, etc. should be seismically reinforced to mitigate geographic islanding, or the isolation of different communities and regions from one another.
- Other critical facilities should be reinforced and equipped to provide support following disasters such as hospitals and schools.
- Other sources of fires (e.g., household natural gas lines) and hazardous materials releases should be assessed and undergo risk minimization actions to maximize community safety following a seismic event.
- Resilience Hubs should be supported in these communities which can:
  - Serve as a gathering point for communities at all times and especially during and following disasters.
  - Distribute information, resources, and minor medical assistance to residents during disasters.
  - Serve as heating, cooling, and clean air shelters during disasters, and the potential for such a facility to serve for shelter-in-place during a hazardous materials release should be investigated and supported.
  - Otherwise fulfill community needs in support of a thriving community.

Project Criteria Development and Possible Funding Sources

Following the project brainstorming session, participants were brought back into a full-group and asked: What qualities make the best projects? The research team provided a few examples to begin the discussion, such as: projects can be realistically implemented, interested parties can agree on the need, they benefit community members now or in multifaceted ways, there are potential funding sources. Based on these prompts, the workshop participants contributed to the following list of variables which may improve the quality of a project. It should be noted that this list is not exhaustive nor context specific.

- Good projects center equity and are either led by, or have significant participation from, the communities they are trying to serve. This includes:
  - Engaging and integrating community perspectives and voices early on in project development and throughout the project's implementation to

    ensure that the unique needs and perspective of each community are respected.
  - Emphasizing support for those who are most vulnerable.
  - Recognizing historical and contemporary injustices and alleviating resultant inequities. This is particularly relevant for communities of color and tribal nations.
  - Building on enduring community relationships and investing in people and their relationships.
  - Respecting the rights of nature and promoting access to the environment among community members.
- Projects are improved by:
  - Addressing multiple hazards simultaneously.
  - Providing mutual benefits to communities and other interested parties both during non-disaster times and during disasters. In other words, they benefit communities now, and they provide myriad benefits.
- Pragmatic projects:
  - Can be realistically implemented and fulfill a known and shared need among interested parties.
  - Serve a broader regional perspective alongside the local community needs.
  - Implement evidence-based approaches, avoid anecdotal approaches, and are built on models with past successes.
  - Align with available funding sources.
  - Are implementable in multiple jurisdictions or counties.
  - Adopt a realistic but satisfactory timeline for implementation.

Following the conclusion of this full-group discussion and prior to the project deep dive section, participants were provided with a list of possible project funding sources identified by the research team. Again, this list should not be considered comprehensive, nor should the information provided for each grant be considered sufficient or exhaustive of the program requirements or focus areas.

- Oregon Department of Environmental Quality’s Supplemental Environmental Projects grant program:
    - DEQ allows for violators to pay up to 80% of the civil penalty to a Supplemental Environmental Project to offset a violation fee.
    - The project must benefit the environment or public health in Oregon, which can include aiding in environmental emergency preparedness.

- FEMA Hazard Mitigation Assistance Grants
    - Building Resilient Infrastructures and Communities
        - Closes yearly in January, applications go from the State of Oregon to FEMA, Oregon then allocates subawards.
        - 75%/25% cost share
        - Supports:
            - System-based mitigation
            - Hazard mitigation planning or contributions to existing plans
            - Building Codes
            - Generally addressing risks to natural disasters as described in the Mitigation Action Portfolio
    - Pre-Disaster Mitigation Grant Program
        - Provides fundings to State Governments to reduce the risk of natural hazards and to reduce “reliance on federal funding from future disasters”
        - 75%/25% cost share
        - Notice of Funding Opportunity
        - Deadline for Oregon’s application: April 14, 2023

- Oregon Hazard Mitigation Assistance
    - Oregon’s application window for subawards to the FEMA Hazard Mitigation Assistance Grants
    - Closes yearly in the first quarter.

  - Projects can include a range of topics relating to pre-disaster mitigation of infrastructure and capability development.
  - Nonprofits can apply in some cases; local and county governments can apply for all eligible topics.

- Oregon Emergency Management Performance Grant Program
  - Applications run throughout the fiscal year.
  - Provides funds to the City of Portland and Multnomah County to support a comprehensive emergency preparedness system for all hazards. Largely through planning, exercises, and training.

- Homeland Security Grant Program
  - State Homeland Security Program (SHSP)
    - Applications open through June 15, 2023
    - 20% cost matching from local government
    - Supports capabilities to prevent, prepare for, protect against, and respond to acts of terrorism.
      - Including equipment, training, retrofits of existing structures, generator installation, new construction, communication equipment, other.
  - Urban Area Security Initiative (UASI)
    - Applications open through the Regional Disaster Preparedness Organization (historically) open in the first quarter. Applications must be submitted within 30 days of the NOFO.
    - Help to address the planning, organization, equipment, training, and exercise needs of high-threat, high-density Urban Areas, and to assist these areas in building and sustaining capabilities to prevent, protect against, mitigate, respond to, and recover from threats or acts of terrorism.

- State of Oregon Nonprofit Security Grant Program
    - 501(c)(3) nonprofits can apply for funds, must register by March 1 and submit applications by April 1.
    - Focuses on enabling nonprofits to prevent, protect against, respond to, and recover from terrorist attacks while generally readying the nation for catastrophic disasters.

- State Preparedness and Incident Response Equipment (SPIRE) Grant Program
    - Provides equipment to local government for emergency preparedness. Funds the purchasing and distribution of equipment, including vehicles and other property, to be used during an emergency.

- United States Environmental Protection Agency
    - Environmental And Climate Justice Program (ECJ Program)
        - $2.8 Trillion available until September 30, 2026, grant periods up to three years
        - Grants must be a partnership between a Tribe, Local Gov., or University and a CBO, just a CBO, or a partnership of CBOs
        - Eligible Program Types:
            - "Community-led air and other pollution monitoring, prevention, and mediation…
            - Investments in low- and zero emission and resilient technologies and related infrastructure and workforce development that help reduce greenhouse gas [and other pollutants]"
            - "Mitigating climate and health risks from urban heat islands, extreme heat, wood heater emissions, and wildfire events"
            - "Climate resiliency and adaptation"
            - "Reducing indoor toxics and indoor air pollution"

- "Facilitating engagement of disadvantaged communities in State and Federal advisory groups, workshops, rulemakings, and other public processes"

- The Environmental Justice Collaborative Problem-Solving Cooperative Agreement Program
  - Community-based nonprofits or a partnership of community-based nonprofits are eligible to apply.
  - Previous Deadline April 14, 2023
  - 50 awards at $500,000
  - 33 awards for small (<5 employee) nonprofits, $150,000
  - "EPA is soliciting applications for projects that support community-based nonprofit organizations (CBOs) in their collaboration with other stakeholders (e.g., local businesses and industry, local government, medical service providers, academia, etc.) to develop solutions that significantly address environmental or public health issue(s) in communities disproportionately burdened by environmental harms."
- The Environmental Justice Government-to-Government Program
  - States or local governments are eligible, and must be partnered with CBO.
  - State awards: 20 awards, $1 million over 3 years
  - Tribal governments: 20 awards, $1 million over 3 years
  - Local Governments: 20 awards, $1 million over 3 years
  - April 14th, 2023 deadline.
  - Supports government activities that improve environmental and/or public health in communities disproportionately burdened by environmental harms.
  - "Model EJG2G programs should leverage existing resources to develop processes or tools that integrate environmental justice considerations into governmental decision-making at all levels."
- Environmental Justice Small Grants Program
  - Ran in 2022, no round in 2023

        - Supplied 1500 CBOs with awards up to $100,000
        - "The program is designed to help communities understand and address exposure to multiple environmental harms and risks."

- National Science Foundation Research Grants (Examples)
    - Disaster Resilience Research Grants
        - Historical Proposals Due: August 19, 2022
        - 8-12 awards between $200k-$400k
        - "Call for research proposals to advance fundamental knowledge [or methods] related to disaster resilience."
        - Pertains to hydrometeorological, fires, earthquakes, and multi-hazard disasters. Can focus on structures, lifelines, households, communities, jurisdictions.
    - Engineering for Civil Infrastructure
        - Full proposals accepted anytime.
        - Funding subject to availability and proposal quality (past awards range from $100k to $4M)
        - "Supports fundamental research in infrastructure materials and architectural, geotechnical and structural engineering."

- Portland Clean Energy Community Benefits Fund (PCEF)
    - PCEF Mini Grants
        - A quarterly grant opportunity offering up to $5,000 for activities that align with PCEF goals of advancing racial and social justice while addressing climate change. Mini grants can fund a wide range of activities, including grant writing support, small projects, events, and training. While organizations of all sizes are eligible to apply, priority will be given to small organizations that reflect and are led by PCEF priority communities.
        - Previous deadline April 1, 2023
    - Community Responsive Grants
        - Next RFP expected soon after August 2023

        - Expected application period of 45-60 days
        - Prioritizes historically underserved communities
        - The grants will be allocated according to the priorities and actions outlined in the upcoming 5-year Climate Investment Plans, "Prioritizing carbon reduction projects that advance racial and social justice… strategic initiatives that are aligned with the City's broader climate action efforts."

- <u>Oregon Community Foundation</u>
    - <u>Community Grant Program</u>
        - 2023 spring applications were due May 4th
        - Prioritizes work that clearly addresses community-identified needs in support of disproportionately impacted populations.
        - Spring cycles are available to "small rural organizations, culturally specific organizations, and organizations specific to populations who have experienced significant bias and/or discrimination."
        - Fall cycles are available for "capacity-building, programs/projects and capital funding requests. They are open to any Oregon-focused organization that did not receive a 2022 Community Grant for capacity-building, capital or project support"

- <u>Pacific Power Community Foundation Grants</u>
    - Grants up to $10k are accepted on regular yearly cycles.
    - The June deadline includes projects considering community resilience.

- <u>Portland General Electric Community Grants</u>
    - Online application for 501(c)(3) nonprofits.

Project Deep-Dives

Once participants had discussed the qualities of a good project and been provided with the list of possible funding sources, they were asked to return to their breakout groups to complete the Project Deep Dive activity. This activity involved selecting one project from their brainstorming list (or more if time allowed) and developing details that align with the criteria (i.e., discussing why it is a good project or how it could be strengthened), identifying interested parties in the implementation of a project, identifying potential funding sources, and indicating key barriers to project implementation and success. The following projects were examined by participants (of note, some project deep dives did not generate information beyond that included in the above project brainstorming section and are not included here):

- ShakeAlert / Public Notification Systems
    - Warning systems could be established in important community locations, such as school and hospital paging systems or through fire department radio systems. In addition to delivering alerts that warn people to take protective action, the ShakeAlert EEW System could also trigger automated actions that improve response capabilities, such as automatically opening fire station apparatus bay doors upon earthquake detection to enable rapid egress.
    - Other mechanisms to warn people to take protective actions such as sirens could be established, which can reach people who do not have cell phone access.
    - Sirens connected to the ShakeAlert EEW System could deliver alerts for other hazards including hazardous materials releases or wildfires in addition to earthquake early warning alerts.
    - Such a system would require regular testing and training within the community to ensure appropriate response.
    - Possible Funding Sources:
        - BRIC or the Homeland Security Grant Program could be used to help purchase and install sirens in key locations.

  - Other important collaborators or interested parties:
    - Everbridge (a system used to communicate about and during emergencies within organizations).
    - Local cities and counties.
    - People with access and functional needs.
    - NGOs, community organization, activism groups, etc.

- Public Education Campaigns
  - Increase public awareness of the risks identified for a given locality and the appropriate protective action recommendations.
  - Foster community relationships among individuals and with other community organizations to enable support systems among disaster survivors.
  - Include the history of the area, such as that of its Indigenous populations and communities of color, to minimize erasure and enable actions to support populations bearing generational iniquities.
  - Be distributed through diverse channels and emphasize individual and community level distribution, this may include:
    - Information provided to homebuyers or renters prior to home purchasing or the signing of rental agreements.
    - Childhood education in schools and other programs.
    - Discussion and outreach from Community Emergency Response Teams.
    - Educational outreach to teachers or other employees in community-oriented facilities.
    - Other community organizations, farmers markets, county fairs, etc.
  - Inform residents of preparedness actions including:
    - What an individual or household can do to prepare for disasters such as developing evacuation plans, collecting shelter-in-place materials, or signing up for early warning systems such as OR-Alert and apps powered by the ShakeAlert EEW System.

    - How individuals can contribute to disaster risk reduction efforts through volunteering or other means.
  - Be accessible to people with access and functional needs including being available in all relevant languages and made available to houseless individuals.
  - Share information about ongoing mitigation plan implementation and other actions being carried out by facilities and other public agencies which are improving community safety.
  - <u>Possible Funding Sources:</u>
    - PCEF
    - Industry partners
    - Existing programs or personnel in local government.
    - State funding and technical assistance grants.
    - Environmental Justice Small Grants Program
  - <u>Other important collaborators or interested parties:</u>
    - Landlords and real estate agents
    - Neighborhood associations
    - Industry representatives
    - Educators
    - State Agencies
    - Local Emergency Planning Committees (LEPCs)
    - Local city and county governments
    - Neighborhood Emergency Teams / Community Emergency Response Teams
    - Other volunteer groups

- <u>Community Tours</u>
  - Participants outlined an integrated public education program using a guided tour model.
  - These tours should include information about the risks present in a location as well as what to do during a disaster, where to go for resources or assistance, and what the community and other parties

are doing to improve safety.

- Such tours could include:
  - A tour of fuel facilities, similar to their ongoing Family Safety Day programs, which point out safety systems within facilities.
  - Pertinent community locations and their history, such as resilience hubs, environmental landmarks, etc.
  - Exhibits discussing the history of a location and its people, maps of the historical community and its development over time, especially as it relates to the establishment of fuel facilities.
  - Other educational activities, such as:
    - Water quality or air quality testing for kids and families.
  - Lifecycle drawings and explorations to represent the journey of, for example, a petrochemical.
- <u>Possible Funding Sources:</u>
  - Not discussed.
- <u>Other Interested Parties:</u>
  - Not discussed.

Model for Facilitating Community Resilience

Stemming from the workshop's conversation, the research team deduced a four-phased, cyclical model for a community-centered approach to safety around large fuel facilities. The concerns of this approach are foremost the safety and resilience of residents and employees who live and work in or near the fuel facilities and face the highest life safety risks should a disaster occur. Following life safety concerns, this model then prioritizes response and recovery capabilities to reduce the harm caused to people, property, and the environment in the event of a disaster.

Phase 1 includes in-depth and fine-scale risk assessments and disaster scenario development. The State of Oregon's efforts to map tsunami risks on the Oregon Coast is an ideal example of the level of detail required for these scenarios. Scenarios should account for all hazards that pose a significant threat to a community, and should include:

- The anticipated effects of natural disasters on the built environment.
- The possibility of hazardous materials releases and/or fires in fuel facilities.
- Possible releases of other extremely hazardous substances from fuel facilities and from nearby industrial areas.
- The myriad atmospheric conditions which could influence the severity of a disaster and the distribution of hazardous materials.
- The identification of locations which are likely to be safe to serve as muster points of shelter locations.

The aim of these scenarios is to understand the specific conditions within a neighborhood or community, which may relate to local geography, topography, built environments, etc., such that specific instructions can be provided down to the household level. These scenarios are then used to determine a matrix of protective action recommendations that residents and employees can enact to protect themselves, which may include, for example, evacuation routes or shelter-in-place guidelines.

Once scenarios have been identified and protective action recommendations determined, Phase 2 begins in earnest with the development of the appropriate capabilities to enable residents and first responders to carry out the protective action recommendations. For example, if residents are told the most appropriate response for them under given wind conditions is to carry out an evacuation, then it is essential that resilient and accessible evacuation routes are available to them. Further, it is critical that the appropriate technologies are in place such that residents can determine for themselves which actions they should choose from the response matrix, or such that first responders can communicate them during a disaster.

Once possible disaster scenarios have been developed and the matrix of protective action recommendations defined, the work of public education and outreach can begin alongside the infrastructure and response development of Phase 2. The core objectives for Phase 3 is to inform the public of the appropriate protective action to carry out in given disaster scenarios as well as the infrastructure in place to support those actions (e.g., evacuation routes). These campaigns are also an opportunity to inform the public about efforts carried out by public agencies and industries to improve safety, thereby increasing transparency and trust among parties. It is important that such education is ongoing to inform new residents and to reinforce the campaign's messages. Further, the information shared over time should reflect changes in the risk scenarios, response capabilities, or protective action recommendations.

Phase 4 includes reflecting on the successes and failures of the model, iterative improvements based on these lessons, and the dissemination of the lessons learned. In other words, as the cycle of scenario development, capability development, and public education carries forward, those involved should reflect on the successes and challenges of the model's implementation and attempt to improve it accordingly while sharing its capabilities with others.

Table 8. Workshop Participant Directory

Name:	Organization:
Antonio Machado	Western State Petroleum Association
Beth Gilden	Institute for Sustainable Solutions
Bobby Cochran	Portland State University, Oregon Consensus
Bonnie McKinlay	Rumble on the River Community Forums
Bryan Profit	Portland Fire and Rescue
Courtney Duke	Portland Bureau of Transportation
Della Graham	Haley & Aldrich, Inc.
Edward Jones	Linnton Neighborhood Association (NA)
Jeff Rubin	Disaster Preparedness Expert
Jonna Papaefthimiou	Office of Gov. Tina Kotek
Kelly Missett	ShakeAlert Regional Coordinator
Luke Hanst	Institute for Sustainable Solutions
Mark Johnston	Oregon State Fire Marshal
Max Woods	Oregon Department of Energy
Mike Kortenhof	Oregon Department of Environmental Quality
Nancy Hiser	Linnton NA: Tank the Tanks, Fuel Tank Safety
Nikki Mandell	Mt. Tabor Neighborhood Assoc.
Paula Dougherty	Linnton Neighborhood Assoc.
Rachel Springer	PSU Sociology PhD
Ralph Cohen	Ralph M Cohen Consultancy, Professional Engineers of Oregon
Rica Perez	Institute for Sustainable Solutions
Sarah Taylor	Braided River Campaign and Portland Harbor Coalition
Shawn Looney	Linnton Neighborhood Association; Tank the Tanks
Sophia Steele	Western States Petroleum Association
Sterling Stokes	Portland Harbor Community Coalition
Svetlana Lazarev	Oregon Department of Environmental Quality
Tiffany Brown	Oregon Seismic Safety Policy Advisory Commission
Tom Sicilia	Oregon Department of Energy
Yumei Wang	Institute for Sustainable Solutions

Chapter 5: Recommendations for Improving Safety and Community Resilience

By: Luke Hanst, Arun Pallathadka, and Idowu Ajibade

Based on the findings of this report's Environmental Justice (EJ) Review and the Review of Laws and Policies, the Institute for Sustainable Solutions suggests the following actions be carried out, either by the Oregon Department of Environmental Quality or other appropriate regulatory agencies. These recommendations aim to address the various concerns raised by members of the DEQ's Rules Advisory Committee, input from public members as part of the rulemaking process, the EJ focus group participants, and the community-at-large. The implementation of these recommendations will promote environmental justice, public safety, and the well-being of all residents and employees in the vicinity of fuel storage facilities. Some of these recommendations may be either already required or in the process of implementation via existing authorities and laws, we have provided a few notes on such efforts when possible.

Although there may be overlapping roles, responsibilities, and activities for these recommendations, we have opted to group them into three categories indicating the recommended leading entity. Category 1 includes those actions which are or could be incorporated into the DEQ Fuel Tank Seismic Stability Program. Category 2 includes actions that other programs at the DEQ may be positioned to lead while coordinating with the Fuel Tank Seismic Stability Program. Category 3 are those actions which may need other organizations to take the leading role.

Category 1: DEQ Fuel Tank Seismic Stability Program Recommendations

1. Fuel facilities should be brought up to the highest possible code and safety requirements to reduce the chance of and consequences of a release. This should involve the adoption of all feasible risk minimization actions, both operational and structural. It is important that all structural mitigation techniques, such as secondary containment units, are built to withstand natural hazards that threaten to cause release.

Note: The DEQ program is addressing this recommendation and is conforming with the intent of the 2022 SB1567 language by recommending the highest possible code requirements to minimize risk focused on safety concerns.

2. Facilities and regulatory authorities should conduct periodic audits or inspections of hazardous installations to ensure that they meet the required codes and safety requirements, and that the appropriate corrective actions are taken. Further, the results of audits or inspections, along with any reports relating to facility safety, including hazard assessments, vulnerability assessments, and consequences analyses should all be created and reviewed by qualified individuals and undergo an independent peer review process.

   Note: The DEQ Fuel Tank Seismic Stability Program has recommended inspections as part of activities associated with Fuel Facilities' mitigation plan implementation under Oregon's 2022 SB1567.

3. Risk bonding or other forms of the Polluter Pays Principle should be applied to fuel facilities in Oregon, especially those who fail to meet the risk minimization requirements of the law, to ensure the financial burden of response and recovery actions following a spill does not fall on the public. This is related to existing provisions for, or limits on, responsible party liability. The responsible parties should be held accountable for harm to public health and the environment caused by their operations.

   Note: The DEQ Fuel Tank Seismic Stability Program is aware of this form of financial risk management. Additional research to develop options and legislation may be warranted.

4. The DEQ Fuel Tank Seismic Stability Program should conduct public education on the approved facility mitigation plans and the status of program activities. These activities should include information on the residual risks,

both on-site and off-site, that will remain after mitigation activities are completed. Education should emphasize socially vulnerable populations and sensitive facilities, such as schools and senior living centers. Education should include:

   a. Information about the appropriate personal protective action residents should enact in the event of a spill.
   b. Information about the possible health effects of exposure and the appropriate medical response.
   c. Information about where residents can go to learn more before a disaster, and where they can expect to go following a disaster to receive aid.
   d. Information about ShakeAlert, an earthquake early warning system.

5. Efforts should be made to strengthen relationships between facility owners and operators, relevant regulatory agencies, first responders, and community members to increase transparency and trust between interested parties. Ongoing forums such as Local Emergency Planning Committee Meetings could serve as the basis for such efforts.

6. The DEQ Fuel Tank Seismic Stability Program should be expanded to include all counties in Oregon, to include all hazards both human (e.g., terrorism) and natural, and to include other hazardous materials including extremely hazardous substances. Mitigation actions should also include improved security measures to prevent unauthorized access, vandalism, or potential threats to public safety

   Note: This may involve multiple jurisdictions, such as organizations involved with risks from terrorism, safety, and security. Additional authority via legislation would also be necessary to expand the scope of the program to match this need.

7. The DEQ Fuel Tank Seismic Stability Program should expand to regulate the seismic safety of transmission pipelines and associated system components regulated by the United States Department of Transportation's Pipeline and Hazardous Materials Safety Administrated and by the Oregon Public Utility Commission. This should include transmission pipelines and components which cross the Oregon/Washington border on Columbia River and any other such pipeline in the State. Protection of these transmission pipelines will enable comprehensive fuel safety during a seismic event which will reduce threats to the public, property, and the environment.

Category 2: Recommendations Potentially Led by Other DEQ Programs

8. Both on- and off-site response and recovery plans and capabilities should be developed based on possible release scenarios developed by fuel facilities. These response plans should coordinate the efforts of facility personnel along with personnel from all jurisdictions that may be impacted by a spill and should be developed with consultation from local community members. It is critical that these response plans take the post-disaster context into account and examine how an earthquake (or other natural disaster) will impact internal and external response capabilities and access. In areas with insufficient risk information available (e.g., models of downstream fuel dispersion) additional research should be conducted.

   Facilities should develop sufficient response resources to manage the risks identified in their release scenarios. Co-located facilities should explore the possibility of developing joint response capabilities. This may include utilizing drones and similar newer technologies for situational awareness. Response equipment should be placed in locations that are resilient to natural disasters and will be accessible following a simultaneous natural disaster and hazardous materials releases.

   Note: Both the US Environmental Protection Agency and the Oregon DEQ have spill prevention programs that involve response and recovery plans, and national oil spill teams are aware of the risks posed by Oregon's Critical Energy Infrastructure Hub. However, improved awareness and coordination between national spill response teams, the United State Coast Guard, the US EPA, local and state response agencies, and others is necessary to ensure an effective coordinated response.

9. The Oregon DEQ's Air Quality Program with support from the Oregon Health Authority and Oregon Department of Human Services should establish air quality monitors near fuel storage tanks using state-of-the-art tools to detect pollutants and to ensure the health, safety, and well-being of communities during standard facility operations and following a spill or natural disaster. This will help protect communities by providing information to regulators and facilities about necessary corrective actions. Additionally, following a disaster these air quality monitors can aid in situational awareness to identify impacted locations and communities to guide response efforts.

Category 3: Recommendations for Actions Led by External Parties

10. All interested parties should work with the Oregon Department of Energy (ODOE) on their Energy Security Plan and related efforts. The Energy Security Plan, mandated by Oregon 2022 Senate Bill 1567, will "identify risks to electricity, liquid fuel, and natural gas/propane systems, and propose ways to mitigate those risks" (State of Oregon, n.d.). Robust participation from industry, community members, public agencies, and others will improve the quality and viability of this plan and future efforts. We recommend that ODOE develop near-term, mid-term, and long-term goals for Oregon's energy security alongside feasible implementation plans. Mid-term and long-term goals should guide the reduction of petroleum fuel usage stemming from decarbonization efforts in a way that maintains statewide energy resilience.

11. Emergency and public safety resources should be made available to the community through the coordinated efforts of public and private

organizations. This includes establishing safe shelters, evacuation routes, alert and warning systems, and fire safety measures.

a. Special attention should be given to providing resources for the elderly population, including access to breathing supplies and improved healthcare facilities.
b. ShakeAlert, and other early warning system tools (such as ALERT Wildfire), should be researched and integrated by facilities as well as developed for the immediate neighbors and community.
c. A comprehensive plan for emergency sheltering and support services during and after disasters should be developed.
d. Resilience should be developed at sensitive community facilities including daycare centers, hospitals, schools, and other large gathering places in the areas around fuel facilities. This may include improved air filtration systems, fire prevention measures, seismically resilient evacuation routes, etc.

12. Facilities and relevant response agencies should engage local communities, including those who work in or nearby fuel facilities, to provide information about the risks at a facility as well as the appropriate personal protective actions to take in the event of a release.
    a. Materials and information should be provided in and accessible format and in languages other than English.
    b. The potential risks should be communicated to the unhoused population who may choose to camp near the fuel storage tanks. Reasonable efforts should be made to relocate them to safer areas and to provide necessary support.
    c. Sensitive community facilities in the area should be informed about the potential risks associated with fuel facilities and the appropriate response actions in the event of a release. These community facilities should be supported to develop comprehensive emergency plans that include provisions for potential relocation in case of emergencies.

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