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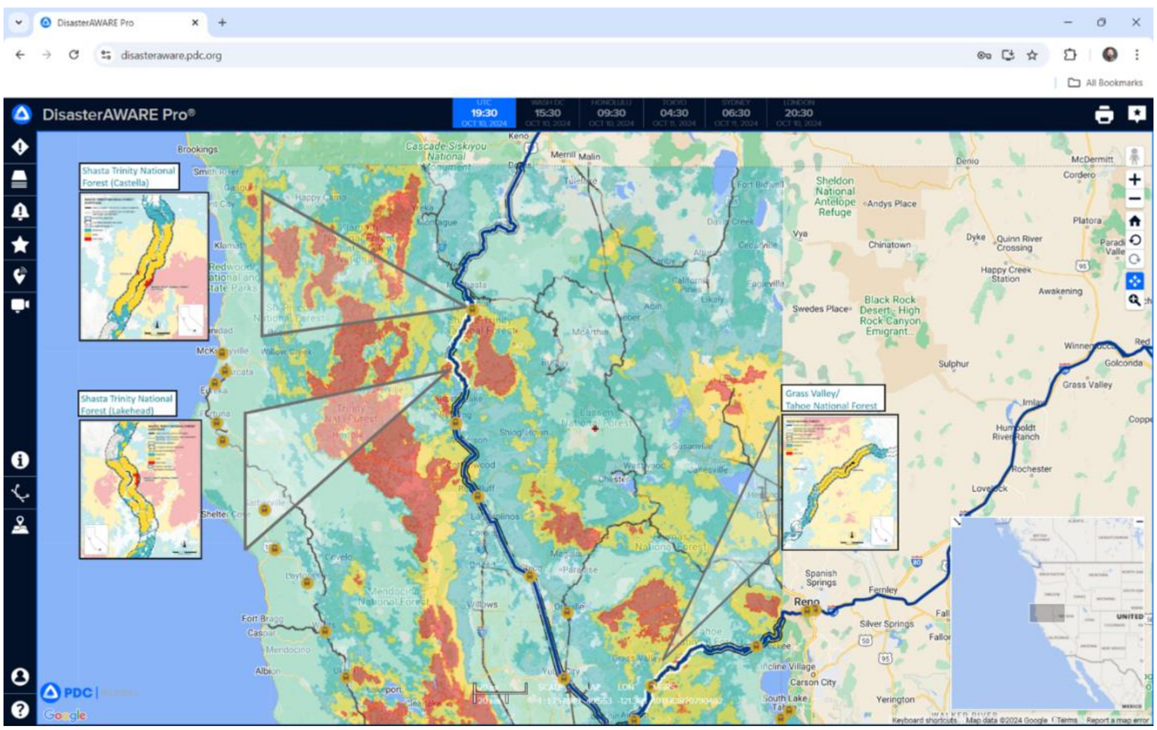
of Transportation
**Federal Railroad
Administration**

Office of Research,
Development and Technology
Washington, DC 20590

Enhancing Wildfire Resilience in the Rail Industry: Developing a Community Resilience Extreme Events Portal (CREEP)



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14. ABSTRACT

The Community Resilience Extreme Events Portal (CREEP) provides a centralized platform for accessing wildfire danger indices, critical asset locations, and vulnerability scores for rail segments. The project team developed a data-driven, indicator-based vulnerability assessment framework that defines vulnerability as a function of exposure, sensitivity, and adaptive capacity. To build this framework, the team selected publicly available datasets, prioritizing national datasets, whenever possible, to ensure transparency, reproducibility, and scalability. The portal allows users to analyze and visualize vulnerability across 1-kilometer segments of Class I freight and passenger rail lines in California, supporting planning and mitigation prioritization to help reduce rail-related fatalities, injuries, economic losses, and service disruptions caused by wildfire. To inform development, the team held three stakeholder working sessions with representatives from government agencies, rail operators, and research institutions. Participants provided feedback on data relevance and practical applications and emphasized the need for integration with existing systems and improved coverage for under-resourced regions. Stakeholders also suggested incorporating infrastructure material types, electrified rail risks, and scoring based on proximity or cargo type. The team integrated the vulnerability framework into Pacific Disaster Center's DisasterAWARE platform, allowing users to view the data driving the vulnerability assessment framework in combination with the entire

DisasterAWARE system, thereby improving coordination and decision-making capabilities, while simultaneously supporting the broader goal of building a more adaptive and resilient rail system.

15. SUBJECT TERMS
Wildfires, Rail transit

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
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METRIC/ENGLISH CONVERSION FACTORS

ENGLISH TO METRIC

LENGTH (APPROXIMATE)

1 inch (in)	=	2.5 centimeters (cm)
1 foot (ft)	=	30 centimeters (cm)
1 yard (yd)	=	0.9 meter (m)
1 mile (mi)	=	1.6 kilometers (km)

AREA (APPROXIMATE)

1 square inch (sq in, in^2)	=	6.5 square centimeters (cm^2)
1 square foot (sq ft, ft^2)	=	0.09 square meter (m^2)
1 square yard (sq yd, yd^2)	=	0.8 square meter (m^2)
1 square mile (sq mi, mi^2)	=	2.6 square kilometers (km^2)
1 acre = 0.4 hectare (he)	=	4,000 square meters (m^2)

MASS - WEIGHT (APPROXIMATE)

1 ounce (oz)	=	28 grams (gm)
1 pound (lb)	=	0.45 kilogram (kg)
1 short ton = 2,000 pounds (lb)	=	0.9 tonne (t)

VOLUME (APPROXIMATE)

1 teaspoon (tsp)	=	5 milliliters (ml)
1 tablespoon (tbsp)	=	15 milliliters (ml)
1 fluid ounce (fl oz)	=	30 milliliters (ml)
1 cup (c)	=	0.24 liter (l)
1 pint (pt)	=	0.47 liter (l)
1 quart (qt)	=	0.96 liter (l)
1 gallon (gal)	=	3.8 liters (l)
1 cubic foot (cu ft, ft^3)	=	0.03 cubic meter (m^3)
1 cubic yard (cu yd, yd^3)	=	0.76 cubic meter (m^3)

TEMPERATURE (EXACT)

[(x-32)(5/9)] °F = y °C

METRIC TO ENGLISH

LENGTH (APPROXIMATE)

1 millimeter (mm)	=	0.04 inch (in)
1 centimeter (cm)	=	0.4 inch (in)
1 meter (m)	=	3.3 feet (ft)
1 meter (m)	=	1.1 yards (yd)
1 kilometer (km)	=	0.6 mile (mi)

AREA (APPROXIMATE)

1 square centimeter (cm^2)	=	0.16 square inch (sq in, in^2)
1 square meter (m^2)	=	1.2 square yards (sq yd, yd^2)
1 square kilometer (km^2)	=	0.4 square mile (sq mi, mi^2)
10,000 square meters (m^2)	=	1 hectare (ha) = 2.5 acres

MASS - WEIGHT (APPROXIMATE)

1 gram (gm)	=	0.036 ounce (oz)
1 kilogram (kg)	=	2.2 pounds (lb)
1 tonne (t)	=	1,000 kilograms (kg)
	=	1.1 short tons

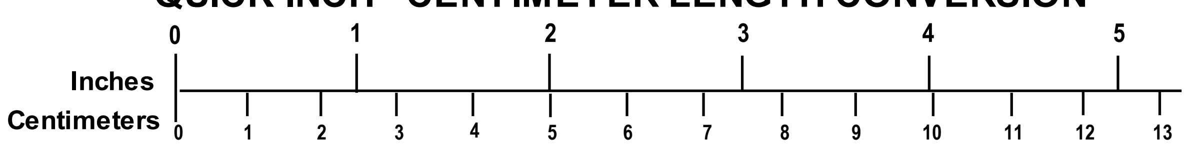
VOLUME (APPROXIMATE)

1 milliliter (ml)	=	0.03 fluid ounce (fl oz)
1 liter (l)	=	2.1 pints (pt)
1 liter (l)	=	1.06 quarts (qt)
1 liter (l)	=	0.26 gallon (gal)
1 cubic meter (m^3)	=	36 cubic feet (cu ft, ft^3)
1 cubic meter (m^3)	=	1.3 cubic yards (cu yd, yd^3)

TEMPERATURE (EXACT)

[(9/5) y + 32] °C = x °F

QUICK INCH - CENTIMETER LENGTH CONVERSION



QUICK FAHRENHEIT - CELSIUS TEMPERATURE CONVERSION

°F	-40°	-22°	-4°	14°	32°	50°	68°	86°	104°	122°	140°	158°	176°	194°	212°
°C	-40°	-30°	-20°	-10°	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°

For more exact and or other conversion factors, see NIST Miscellaneous Publication 286, Units of Weights and Measures. Price $2.50 SD Catalog No. C13 10286

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Executive Summary

The Community Resilience Extreme Events Portal (CREEP) is a centralized, data-driven, planning and mitigation prioritization support tool designed to enhance wildfire resilience across the rail sector. Led by the University of Hawaiʻi and the National Disaster Preparedness Training Center (NDPTC), in partnership with the Pacific Disaster Center (PDC) and Haley & Aldrich, Inc., the project is funded through the Federal Railroad Administration's Consolidated Rail Infrastructure and Safety Improvement (CRISI) Program and administered by the San Jose State University Research Foundation through the Mineta Transportation Institute. This technical report presents Phase I and Phase II of the CREEP project, which together describe a scalable vulnerability assessment framework that supports risk communication and mitigation prioritization for rail infrastructure exposed to wildfire.

Phase I, documented in Section 2 of this report, focused on foundational research, stakeholder engagement, and a proof-of-concept study. The project began with a comprehensive literature review of existing methodologies for assessing wildfire risk, infrastructure vulnerability, and wildfire resilience in the context of the rail system in the United States. This review informed the conceptual design of the CREEP vulnerability framework and guided the selection of publicly available datasets to ensure transparency, reproducibility, and scalability. The stakeholder engagement portion of Phase I involved three semi-structured interviews with rail operators from Amtrak, Norfolk Southern, and Canadian National Railway (CN), and participants provided feedback on data relevance, accuracy, and practical applications. The proof-of-concept study involved the development of a methodology for identifying segments of California railway that were particularly exposed to wildfire hazard. Five rail segments were identified as the most vulnerable in California and two were selected as the subject of case studies and further analysis in Phase II.

Phase II, described in Sections 3 through 5, focused on expanding the vulnerability assessment framework with additional indicators and integrating it into an operational platform. The framework (Section 3) defines vulnerability as a function of exposure, sensitivity, and adaptive capacity. Exposure primarily reflects proximity to wildfire-prone areas and human-caused ignition sources; sensitivity accounts for the presence and characteristics of rail assets such as bridges, rail grade crossings, and stations; and adaptive capacity represents redundancies in the network, if available, and emergency response capabilities, such as distance to the closest fire station. Each component is quantified using indicators derived from publicly available datasets, selected for national scalability and to reflect stakeholder feedback. To support targeted vulnerability scoring and prioritization of mitigation investments, rail lines were divided into 1-kilometer segments. The framework was then integrated into PDC's DisasterAWARE platform (Section 4), expanding its operational utility for stakeholders, as well as helping to support near real-time alerting, coordination, and decision-making. Finally, Section 5 presents a synthesis of additional stakeholder input gathered during three virtual working sessions and an online survey (available for reference in Appendix A), the results of which indicated the importance of data relevance and practical applications, emphasizing the need for integration with existing systems and improved coverage for under-resourced regions. Specific recommendations received from stakeholders include incorporating infrastructure material types, electrified rail risks, proximity to critical infrastructure, and cargo type.

Overall, CREEP is a strategic tool for improving wildfire resilience in the rail sector. By combining data-driven methodology, stakeholder engagement, and integration into DisasterAWARE, the project supports planning and mitigation prioritization in the face of increasing wildfire-related threats.

1. Introduction

The Community Resilience and Extreme Events Training and Research Program is led by the San Jose State University Research Foundation through the Mineta Transportation Institute. Funding for projects was provided by the Federal Railroad Administration (FRA) Consolidated Rail Infrastructure and Safety Improvement (CRISI) Program.

The University of Hawaiʻi and the National Disaster Preparedness Training Center (NDPTC), in partnership with Haley & Aldrich, Inc., and Pacific Disaster Center (PDC), leads the development of the Community Resilience Extreme Events Portal (CREEP).

The primary goal of the portal is to enhance planning and decision-making capabilities to reduce rail-associated fatalities, injuries, economic losses, and disruptions due to weather and other hazards.

The portal provides a centralized platform for data and knowledge sharing for stakeholders to improve early coordination, risk communications, and mitigation prioritization. The Portal hosts outputs from research on wildfire risk factors affecting railways, including relevant wildfire indices, critical rail asset locations, and vulnerability rankings that help communicate risk across the network.

1.1 Background

Phase I of the project included a literature review, engagement with stakeholders, and a proof-of-concept case study.

1.2 Literature Review

The purpose of the literature review was to assess the current state-of-the-art knowledge concerning wildfire risks to railways and the potential for wildfires to be ignited from railway operations. The literature review summarized datasets, models, and methods for evaluating wildfire risk, and documented mitigation and response measures used to enhance resilience. The review highlights the increasing frequency and intensity of wildfires in the western United States and discusses the vulnerabilities of railway infrastructure to wildfire impacts, including direct exposure and operational disruptions. The review concludes with recommendations for conducting vulnerability assessments and effective wildfire risk management strategies for railway systems.

1.3 Stakeholder Engagement

Interviews with rail industry stakeholders supplemented the literature review to inform the selection of datasets and models. Input was solicited regarding how the portal might best serve rail industry operational and risk managers and other rail stakeholders. A series of three semi-structured interviews were conducted virtually with representatives from Canadian National Railway, Amtrak, and Norfolk Southern. These discussions informed the development of a vulnerability assessment framework by providing insights into the sensitivity of rail assets (e.g., wood versus metal components), the potential reputational impacts of service disruptions in passenger rail, and the importance of accounting for financial impacts of wildfire-related hazards.

1.4 Proof-of-Concept Study

The last stage of Phase I was the development of a proof-of-concept study and framework for assessing rail vulnerability. This preliminary research helped identify critical rail segments across California with the greatest exposure to wildfire risk. Publicly available wildfire-related data, including burn probability, land cover, terrain slope, and a fire danger metric were used to identify five high-hazard segments of railway across California. Railway segments selected for analysis had to serve Class I freight, passenger rail, and be STRACTNET designated (STRACNET is a continuous rail line with over 41,000 miles of track in the United States that serves the Department of Defense), as these rail lines have higher traffic intensities, a greater potential for freight loss, and may be transporting hazardous materials. Five potential railway segments were identified based on the proximity of the track to areas of burn probability and the relative area for different classes of burn probability. Two segments were subsequently selected based on the total area classified as high and very high burn probability and the length of track exposed to very high burn probability. These segments were evaluated using land cover, slope, meteorological conditions, and adaptive capacity metrics. Heightened wildfire risk was found in these two segment areas due to complex terrain, meteorological conditions conducive to fire, and large extents of flammable vegetation. The data and methods tested in this study are replicable and scalable and represent initial work in developing a broader vulnerability assessment framework for assessing the exposure, sensitivity, and adaptive capacities of railways exposed to wildfire and other hazards at the state or regional level.

The outcome of this work was presented at the Transportation Research Board's Annual Meeting in Washington D.C. in January 2025, at the Association for Environmental Health and Sciences Foundation 35th Annual West Coast Conference in March 2025 and was published in the peer-reviewed journal Transportation Research Interdisciplinary Perspectives in July 2025 (Kim et al., 2025).

1.5 Organization of the Report

1. Introduction
2. Vulnerability Assessment Framework
3. CREEP and Disaster AWARE Platform
4. Stakeholder Engagement
5. Summary and Conclusions
6. Appendix A
7. References
8. About the Authors

2. Vulnerability Assessment Framework

The Vulnerability Assessment Framework used in this project builds off other indicator-based vulnerability assessments, such as the U.S. Department of Transportation Vulnerability Assessment Scoring Tool (USDOT & FHWA, 2015), which is designed to help state departments and metropolitan planning organizations document and quantify the vulnerability of their transportation assets (Figure 1).

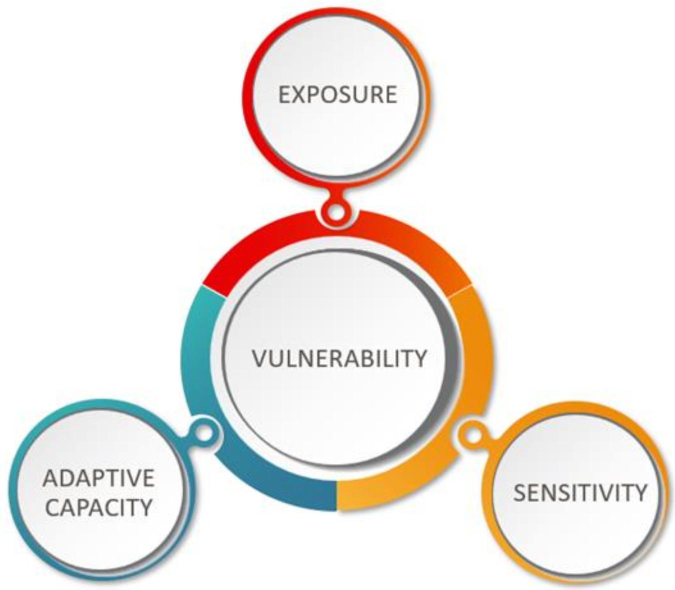

Figure 1. Vulnerability Assessment Framework

Within this framework, vulnerability is a function of exposure, sensitivity, and adaptive capacity (FHWA, 2018). Characteristics of the hazard stressors, transportation assets, operations, and larger built environment can serve as indicators of the rail's exposure, sensitivity, or adaptive capacity, and combined, can inform the vulnerability by producing relative vulnerability scores.

Exposure refers to the extent to which wildfire hazard overlaps with railroad infrastructure (or "values at risk"). Sensitivity refers to the characteristics of a system that influence the severity of the impacts when exposed. Adaptive Capacity refers to the ability of a system to adjust to potential damage, take advantage of opportunities, or respond to consequences.

Indicators were chosen—based on the literature reviewed, stakeholder input, data availability, and subject matter expertise—to represent each of the three components of the framework. Indicator values were calculated for each rail segment, standardized, weighted, and summed to get an overall component score. Weights are applied to the scores generated for the three components once more and added together to obtain a final overall vulnerability score for each segment.

2.1 Data and Data Sources

All datasets used in the framework are publicly available (Table 1). The datasets that represent adaptive capacity are available through California state agencies, including CAL FIRE and Caltrans, and thus contain information for the state of California only—all other datasets are available nationally.

Table 1. Data and Data Sources Used in Vulnerability Assessment Framework

Data	Source	Layer Name in Portal	Portal Layer Path (User Navigation)
		Exposure	
USFS Burn Probability (BP)	U.S. Forest Service (USFS)	Wildfire BP (California)	CREEP (Prototype)/Wildfire Risk Assessment for Railways
Wildland Urban Interface (WUI)	USFS	Wildland Urban Interface (WUI)	CREEP (Prototype)/Fire Risk
Campgrounds	USFS and Bureau of Land Management	Campgrounds (California)	CREEP (Prototype)/Fire Risk
		Sensitivity	
Railroad Bridges	U.S. Department of Transportation	Railroad Bridges (USA)	CREEP (Prototype)/Rail Infrastructure
Rail Grade Crossings	U.S. Department of Transportation	Rail Grade Crossings (USA)	CREEP (Prototype)/Rail Infrastructure
Amtrak Stations	U.S. Department of Transportation	Amtrak Stations (USA)	Regional Data / North America/ USA/ Infrastructure/ Transportation/ Railway
Freight Stations	U.S. Department of Transportation	Railway Freight Stations (California)	CREEP (Prototype)/Rail Infrastructure
		Adaptive Capacity	
Distance to Fire Stations	California Department of Forestry and Fire (CAL FIRE)	Fire Stations (USA)	USA/ Infrastructure/ Emergency Services

Data	Source	Layer Name in Portal	Portal Layer Path (User Navigation)
Kilometers of Road Network	California Department of Transportation (Caltrans)	Road Network (California)	CREEP (Prototype)/ Rail Infrastructure
Rail Tunnels	California Department of Transportation	Rail Tunnels (California)	CREEP (Prototype)/ Rail Infrastructure

2.2 Exposure

Exposure of rail line segments were determined using a 2 km buffer zone, which represents the average distance of ember travel (British Columbia Firesmart, n.d.). Exposure factors that may increase the risk of wildfire include continuous fuels available to burn, low fuel moisture content, steep slopes, high winds, extreme temperatures, human activity that could ignite a fire, and areas where human development closely intermixes with undeveloped wildlands, also known as the Wildland Urban Interface (WUI) (Table 2).

Exposure was determined using three datasets: USFS Burn Probability, presence of campgrounds, and total area of Wildfire Urban interface and intermix zone. These three datasets are publicly available and robustly account for the landscape, meteorological, and human drivers of wildfire. Burn probability (BP) was used as the only indicator of wildfire risk on the landscape to avoid issues related to spatial autocorrelation and erroneously attributing higher levels of exposure to rail lines through the use of multiple similar indices. WUI and Campgrounds represent the critical contribution of human-related risk factors to California's fire regime.

Table 2. Exposure Metrics

Metric	Methodology	Scaling/weights
Exposure (Component weight: 0.4)		
Burn Probability (BP)	Conservative Method: highest BP present within the 2 km buffer zone for any given rail segment is the final Burn Probability assigned to that rail segment.	Scaling: 1 = Low, 2 = Moderate, 3 = High, 4 = Very High 1 = 25, 2 = 50, 3 = 75, 4 = 100 Weight = 0.5
Wildland Urban Interface (WUI)	Total area designated interface and/or intermix within the 2 km buffer zone. Units: square km	Scaling: 0 to 100 using standardization (0 is the minimum WUI area amongst all segments, 100 is the maximum) Weight: 0.25

Metric	Methodology	Scaling/weights
Campgrounds	Total number of campgrounds located within the 2 km buffer zone. Units: # of campgrounds	Scaling: 0 to 100 using standardization (0 is the minimum number of campgrounds, 100 is the maximum) Weight: 0.25
Exposure Score: (BP × 0.5) + (WUI × 0.25) + (Campgrounds × 0.25)		

2.3 Burn Probability

The BP dataset by the USFS is a 30 m resolution national dataset that estimates probabilistic wildfire risk that can support national strategic wildfire planning (Figure 2). It incorporates several factors (fuels, slope, weather, etc.) that contribute to burn likelihood into a dynamic model. It represents the annual probability of wildfire burning in a specific location based on fuel distribution and moisture content, as well as slope and wind (Scott et al., 2024). The fire behavior model FlamMap is used to simulate tens of thousands of wildfires under a wide range of meteorological conditions; BP is determined at each grid cell based on these simulations. 'Very High' BP indicates an area that has the highest chance of burning (based on 2020 landscape conditions). BP scores for each segment were determined by the highest BP value present within the 2 km buffer zone. For example, if a Very High BP grid cell is located within the 2 km buffer zone for that segment, the BP score for that segment is Very High. The weight assigned to the BP indicator was 0.5 due to its robust representation of numerous wildfire exposure factors, such as slope, vegetation moisture, and vegetation type.

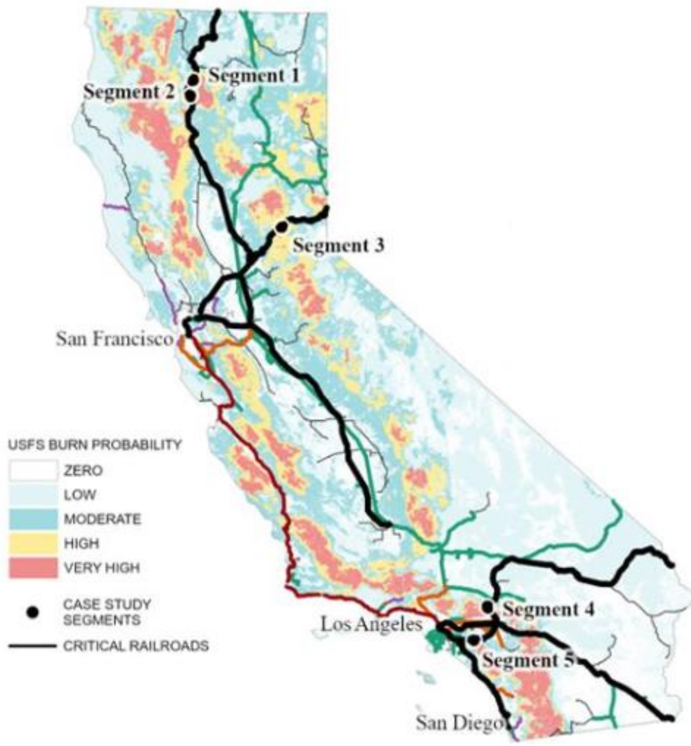

Figure 2 Burn Probability in California

2.4 Wildland Urban Interface

The WUI by the USFS was included as an indicator of exposure because these areas are more likely to experience wildfires due to human ignition than wildland, and wildfires pose a greater threat to lives and homes, are harder to fight, and cannot be allowed to burn the way they can in certain wildland areas (Radeloff et al., 2018). The WUI is represented as polygons with six categories of wildland urban areas, including high, medium, and low-density interface and intermix zones. WUI polygons are delineated based on percent vegetation (derived from the National Land Cover Database [NLCD]), and the number of housing units per square kilometer (Radeloff et al., 2023). The WUI is the zone of transition between wildland vegetation and human development. WUI values for each rail segment were determined by calculating the total area of designated interface (defined as the high-density development adjacent to undeveloped wildland vegetation) and/or intermix (defined as the lower-density housing mingled with undeveloped wildland vegetation) within the 2 km buffer zone. The WUI exposure indicator uses the total area within the 2 km buffer zone rather than a binary yes or no system to avoid overestimating wildfire risk in urban areas. The weight applied to the WUI indicator was 0.25.

2.5 Campgrounds

The Campgrounds dataset was generated by the USFS and the Bureau of Land Management (BLM), represents the spatial distribution of USFS and BLM designated campgrounds, and is displayed as point data. Campgrounds were chosen as an indicator of exposure because 84% of wildfires are human-caused and approximately 5% of those are caused by campfires (Daley, 2017). The value for the Campgrounds indicator was determined by calculating the total number of campgrounds located within each rail segment's 2 km buffer zone, and the weight applied to the Campgrounds indicator was 0.25.

2.6 Sensitivity

Rail infrastructure is sensitive to wildfire due to the use of wooden materials in bridges and ties, and metal components that may warp when exposed to extreme heat. Rail assets, such as rail grade crossings and passenger and freight stations, are also sensitive to wildfire due to the presence of electrical equipment and the potential for wildfire-related impacts to passenger safety, delays, and disruptions, which may result in cascading financial and/or reputational impacts (Table 3). While active fires directly threaten rail infrastructure, the risk of new wildfires igniting increases with high rail traffic, hot engines, braking, exhaust components, and electrified railways. Interviews with stakeholders corroborated the findings from the literature that indicated each asset type was sensitive to wildfire; thus each indicator was assigned an equal weight of 0.25.

Table 3 Sensitivity Metrics

Metric	Methodology	Scaling/weights
Sensitivity (Component weight: 0.3)		
Railroad Bridges	Total number of bridges located along the rail segment. Units: Number of railroad bridges	Scaling: 0-100 using standardization (0 is the minimum number of bridges, 100 is the maximum) Weight: 0.25
Rail Grade Crossings	Total number of railroad grade crossings located along the rail segment. Units: Number of railroad grade crossings	Same as above
Freight Station	Total number of freight stations located along the rail segment. Units: Number of freight station locations	Same as above
Amtrak Stations	Total number of Amtrak stations located along the rail segment. Units: Number of Amtrak station locations	Same as above
Sensitivity Score: (Railroad Bridges × 0.25) + (Rail Grade Crossings × 0.25) + (Freight Stations × 0.25) + (Amtrak Stations × 0.25)		

2.6.1 Railroad Bridges

The Railroad Bridges dataset was generated by USDOT and was included as an indicator of sensitivity because bridges are generally more expensive to replace than rail; the speed to recover from damage to bridges along a segment of rail may therefore be longer than segments without bridges and could lead to delays, the need to reroute, and longer periods of lost productivity. It provides the location of railroad bridges, defined by the Code of Federal Regulations (49 CFR Part 237) as "any structure with a deck, regardless of length, which supports one or more railroad tracks, or any other undergrade structure with an individual span length of 10 feet or more located at such a depth that is affected by live load" (USDOT, 2022c). The Railroad Bridges value was determined by calculating the total number of bridges located within the 2 km buffer zone of each segment, and the weight applied to the indicator was 0.25.

2.6.2 Rail Grade Crossings

The Rail Grade Crossings dataset was generated by USDOT. Rail grade crossings were included as an indicator of sensitivity because grade crossings are sensitive to wildfire due to the presence of electrical equipment. The dataset provides the locations of rail grade crossings, defined as intersections where a railway crosses a railroad at grade (USDOT, 2022b). The Rail Grade Crossing value for each rail segment was determined by calculating the total number of railroad grade crossings located within the 2 km buffer zone of each segment, and the weight applied to the indicator was 0.25.

2.6.3 Freight Stations

The Freight Stations dataset was generated by USDOT. Freight stations are railway stations that are used primarily for loading and unloading goods. Freight stations were included as an indicator of sensitivity because interruptions to freight transport can delay deliveries, increase transportation costs, and disrupt supply chains, affecting businesses and industries that rely on rail transport. This data layer provides locations of freight stations (USDOT, 2022a). The Freight Stations value for each rail segment was determined by calculating the total number of freight stations located within the 2 km buffer zone of each segment, and the weight applied to the indicator was 0.25.

2.6.4 Amtrak Stations

The Amtrak Stations dataset was generated by USDOT. Amtrak stations are railway stations that are used for intercity railroad passenger terminals in the United States (USDOT, 2022). Amtrak Stations were included as an indicator of sensitivity because wildfires can disrupt passenger rail service, causing delays and cancellations for passengers, which result in logistical and economic impacts, as well as impacts to reputation. Wildfire-related impacts to Amtrak stations may have cascading financial and reputational effects depending on the duration of the disruption, magnitude of changes to travel times, and ability of Amtrak to reroute. The Amtrak Stations value for each rail segment was determined by calculating the total number of Amtrak stations located within the 2 km buffer zone of each segment, and the weight applied to this indicator was 0.25.

2.7 Adaptive Capacity

Adaptive Capacity refers to the ability of rail systems to respond and adapt during an event. This may include fire prevention strategies, early warning systems, redundancies, and community preparedness. Indicators identified to represent adaptive capacity include distance to fire stations, total road network area, and the presence of rail tunnels. The proximity of fire stations to individual rail segments and the total distance of the road network may result in faster response times and easier accessibility to critical points along the fire's perimeter. The presence of rail tunnels increases vulnerability due to the high cost of repairs, difficulty of rerouting, and the cascading effects of a single disruption. Interviews with stakeholders corroborated the findings from the literature, confirming that the following indicators accurately reflect the adaptive capacities of rail segments. Thus, each indicator was assigned an equal weight of 0.3.

Table 4 Adaptive Capacity Metrics

Metric	**Methodology**	**Scaling/weights**
Adaptive Capacity (Component weight: 0.3)		
Proximity to fire stations	Distance to the closest fire station from any point along the rail segment. Units: km	Scaling: 0-100 using standardization (100 is the maximum distance to a fire station, 0 is the minimum distance) Weight: 0.3
Kilometers of road	Total kilometers of road network within the 2 km buffer zone of the rail segment. Units: km	Scaling: 0-100 using standardization (0 is the maximum amount of road network, 100 is the minimum) Weight: 0.3
Rail Tunnel Locations	Presence of rail tunnel along segment Units: yes/no	Scaling: No = 0, Yes = 100 Weight = 0.3
Adaptive Capacity Score: (Fire Stations × 0.3) + (Km of Road × 0.3) + (Tunnel Locations × 0.3) Overall Vulnerability = (Exposure × 0.4) + (Sensitivity × 0.3) + (Adaptive Capacity × 0.3)		

2.7.1 Proximity to Fire Stations

The Proximity to Fire Stations dataset is a product of CAL FIRE and represents the locations of fire stations. Proximity to fire stations was included as an indicator of adaptive capacity because fire stations in proximity to rail segments or assets may result in a faster response time and more available fire suppression resources. Proximity to fire stations values were determined by calculating the distance (in km) to the closest fire station from any point along the rail segment, and the weight applied to the indicator was 0.3.

2.7.2 Kilometers of Roads

The kilometers of road network dataset is a product of the CalTrans AllRoads Linear Referencing System and provides the locations of roads in California. Kilometers of road network were included as an indicator of adaptive capacity because a greater road network in proximity to the rail segment may signify a greater capacity for rapid emergency response, and potentially more access points for fire suppression. Kilometers of road network values were determined by calculating the total km of road network within the 2 km buffer zone of the rail segment, and the weight applied to the indicator was 0.3.

2.7.3 California Rail Tunnel Locations

The Rail Tunnel dataset is a product of Caltrans and provides the locations of rail tunnels in the state of California. Rail tunnels were included as an indicator of adaptive capacity because, similarly to bridges, tunnels are more expensive to repair and, in many cases, there are few options for rerouting trains, so one tunnel disruption could have ripple effects and have impacts on schedules and routes. Rail segments that contain a tunnel were assigned a "yes" (e.g., a score of 100), while rail segments that did not have a tunnel were assigned "no" (e.g., a score of 0). A score of 100 will increase the adaptive capacity component score as well as the overall vulnerability score (e.g., the rail segment is more vulnerable), while a score of 0 will have no effect. The weight applied to the indicator was 0.3.

2.8 Segmentation

Class I freight and passenger rail lines were segmented at approximately 1 km increments. All metrics, except for the presence of tunnels, were calculated within a 2 km buffer zone surrounding each segment, while only tunnels located along the rail segment were assessed. This approach was selected because a sensitive asset (e.g., bridge, crossing, station) within the 2 km buffer zone may be located near a high wildfire-risk area even if the rail segment itself is farther away. In these cases, a nearby fire could threaten both the asset and the surrounding rail infrastructure. Using the full buffer zone therefore provides a more realistic assessment of potential wildfire exposure. This method may be adjusted within the framework based on updated information or further stakeholder input.

2.9 Scaling and Weighting

Individual values for each indicator were calculated at each rail segment and transformed to fit within a scale of 0-100 using min-max normalization, where zi is the scaled value, xi is the value for each segment, and *max(x)* and *min(x)* are the maximum and minimum values across all segments (Equation 1).

$$z_i = (x_i - \min(x)) / (\max(x) - \min(x)) \times 100 \qquad \text{(Equation 1)}$$

Minimum and maximum values were determined using all rail segments, such that a scaled value of 0 is equal to the minimum value and 100 to the maximum value.

The method for applying normalized values to rail segments for the BP indicator varied from the other indicators of exposure. Raw BP values ranged from 0.000008 (lowest) to 0.12895 (highest). Higher values indicate a higher likelihood of fire. BP thresholds for low, moderate, high, and very high were derived for the entire state of California from the cumulative distribution of BPs for 20%-45% (low), 45%-75% (moderate), 75%-90% (high), and >90% (very high) percentile groupings. To scale BP categories on a 0-100 scale, low BP was assigned a 25, moderate BP a 50, high BP a 75, and very high BP a 100.

In addition, the kilometers of road network indicator used an inverted scale of 100-0 so that the ultimate vulnerability score is lower for a segment with a high total length of road network.

The presence of tunnels uses a yes or no option (yes = 100, no = 0), so vulnerability will increase with the presence of a tunnel.

Weights were assigned to each component of the framework (e.g., exposure, sensitivity, and adaptive capacity) based on expert judgement and scientific literature. Each overall component of the framework was assigned a weight, 0.4 for exposure and 0.3 for sensitivity and adaptive capacity, respectively. Exposure was weighted more heavily because environment, vegetation, landscape, and human factors are understood to be the leading factors of wildfire risk. Each indicator is also assigned a weight, ranging from 0.25 to 0.5, with BP being most heavily weighted. Weights will be continually re-assessed following interviews with stakeholders, are easily adjustable in the model, and may be modified following input and feedback from the Federal Railroad Administration (FRA).

3. CREEP and DisasterAWARE Platform

3.1 Platform

To host the CREEP, the project made use of the PDC's DisasterAWARE multi-hazard decision support application. DisasterAWARE is a global alerting platform that integrates source data for a variety of natural and human-caused hazards, including wildfires, and supports stakeholder input with the ability to directly post data and information products to the portal. As an Information Portal, DisasterAWARE provides a user-driven view of current hazards and related data in geographic and graphic visualizations at local, state, regional, and national levels, allowing for near-real-time risk analysis.

DisasterAWARE is a free-to-use, multi-hazard monitoring platform developed and continuously operated for more than 20 years by PDC to support disaster management decision-making. DisasterAWARE provides real-time alerting for 28 natural, biological, and human-caused hazards worldwide, and a suite of advanced situational awareness tools, including the patented Smart Alert technology. DisasterAWARE allows users to monitor hazards around the globe and to quickly assess potential threats to people, property, or critical assets in near-real time. More than 70 countries and tens of thousands of disaster managers and humanitarian assistance practitioners use DisasterAWARE to make disaster management decisions each day. A publicly available mobile app, Disaster Alert, has been downloaded by more than 4 million users.

3.2 Integrating the Vulnerability Assessment Framework

The various project data, including those supporting risk assessment and visualization, were configured within the platform to allow users to geospatially visualize the final output of the vulnerability framework (Section 3.1). Along with other project data, the platform functions as a portal for the wildfire/rail community — both for those who prepare and analyze and those who utilize these resources to make management and operational decisions. When users enter the portal using a "bookmark" or customized view, they see Rail Network Lines in California along with their level of wildfire risk and exposure, as indicated by the red (for the highest risk) and orange colors (Figure 3).

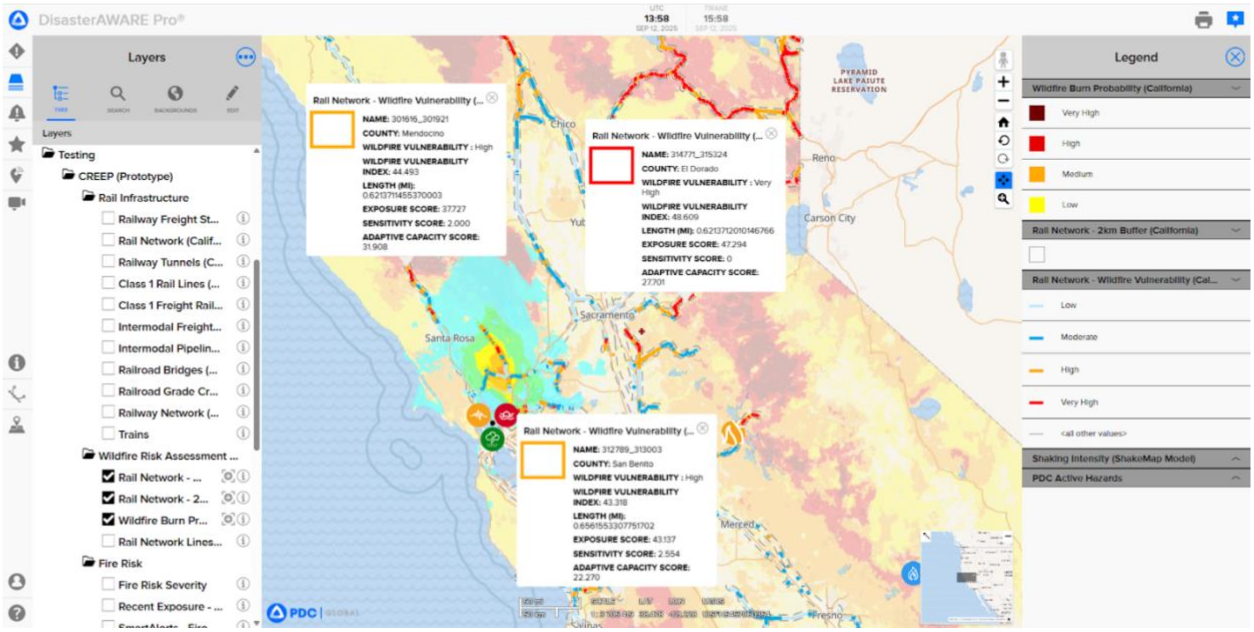

Figure 3 Community Resilience Extreme Events Portal (CREEP)

Portal users can click on each rail segment and see its name and location, its Overall Vulnerability Score, its component scores, and its length in miles. Other operational-critical data including but not limited to weather data, population density, and infrastructure (e.g., tunnels, bridges, stations, freight yards, etc.) can be visualized in the context of the rail segments.

3.3 Leveraging DisasterAWARE capabilities for CREEP users

The integration of the Vulnerability Assessment Framework into DisasterAWARE included creation of data layers from the individual source datasets used in the framework (Table 1). These layers have been integrated into the portal and are accessible to its users for visualization and further analysis. Additionally, portal users can create views of a selected area showing the rail network with vulnerability, the 2 km buffer, and other relevant portal layers to create a "Bookmark" that captures that configuration and can then be shared with other portal users to have a shared, common view into the portal.

Additionally, a Wildfire Risk model "hazard" was prototyped to provide alerts of potential wildfire threat, allowing portal users to further leverage DisasterAWARE functionality for hazards, including alert notification for user-selected regions as well as for user-provided assets (Figure 4).

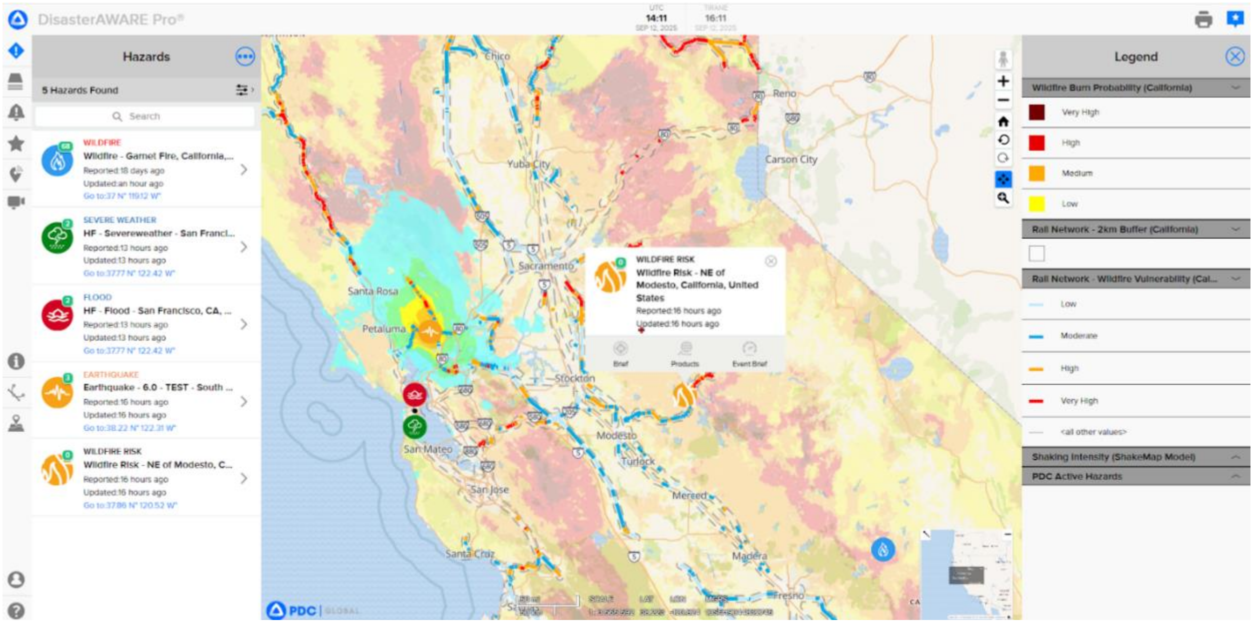

Figure 4 Near Real-time Wildfire Risk Events for Rail

The prototype Wildfire Risk hazard, based on a combination of the Fire Weather Index (FWI) and the Wildfire Suppression Difficulty Index, was created to provide a realistic — but not necessarily definitive — real-time threat to further demonstrate the power of the portal for operational uses within stakeholder agencies. These datasets (Table 5) are also available to portal users as layers.

Table 5 Data Layers Associate with Prototype Wildfire Risk Hazard

Data	Source	Layer Name in Portal	Portal Layer Path
Wildfire Suppression Difficulty Index (SDI)	USFS	Wildfire SDI (USA)	CREEP (Prototype)/Fire Risk
Fire Weather Index (FWI)	Copernicus	Wildfire Weather Index	CREEP (Prototype)/Fire Risk

Portal users may configure DisasterAWARE's Smart Alert feature to provide email, SMS, and on-screen notifications for the high-risk fire alerts in addition to receiving alerts and updates for current, active wildfires and other hazards such as flooding and landslides. This feature allows rail network operators to securely configure their assets (e.g., rail segments, stations, yards, bridges) within Smart Alert to receive notifications of potential extreme risks to their network and take proactive measures accordingly.

4. Stakeholder Engagement

4.1 Working Sessions

The working sessions were a key tool for engaging stakeholders in the evaluation and refinement of the CREEP. The purpose of these sessions was to gather direct feedback on the portal's methodology, functionality, and potential applications, as well as identify use cases and opportunities for improvement. For example, participants provided insights on data relevance, regional applicability, and operational needs. The sessions also helped clarify priorities and set expectations, ensuring that the portal is developed to support real-world needs. Feedback from these sessions will inform future updates to the portal and guide the development of the framework for potential broader adoption.

Three working sessions were held during the week of July 28, 2025. Each session ran for approximately one hour and had a range in the number of attendees, from two to seven people. In total, fifteen stakeholders from a variety of organizations and institutions attended, including the Federal Railroad Administration, California Governor's Office of Emergency Services, Caltrans, and the Canadian National Railway Company (Table 6). Stakeholders emphasized the importance of communicating return on investment for mitigation activities, integrating maintenance and infrastructure risks, and improving data coverage for under-resourced regions (e.g., remote rail corridors in areas with limited infrastructure and/or emergency response capabilities). Several participants suggested including bridge material types to better inform sensitivity; electrified infrastructure risks; unhoused encampment data due to the potential for human-caused fires; and criticality scoring for infrastructure based on proximity and cargo type (e.g., hazardous materials, passengers). Others mentioned opportunities for collaboration, including presenting at the Railroad Environmental Conference and connecting with additional industry partners. Overall, the sessions helped validate the portal's approach and identified specific areas for refinement to better support wildfire resilience in the rail sector.

Table 6 Working Session Participant List

Name	Title / Position	Organization / Institution
Stuart Gluck	Director, Officer of Industry Data and Economic Analysis	Federal Railroad Administration
Charlotte Love	Engineer, Climate and Hydrological Scientist	Federal Railroad Administration
Emily Grenzke	Director of Data Analysis and GIS Division	Federal Railroad Administration
Nathan DiPillo	Critical Infrastructure Protection Unit, State Threat Assessment Center, Homeland Security Division	California Governor's Office of Emergency Services
Glen Rudner	Consultant / Instructor	GDR Consulting LLC
Alex Kenefick	Division of Rail, Integration and Network Planning	California Department of Transportation

Name	Title / Position	Organization / Institution
Simranjeet Kaur	Division of Rail	California Department of Transportation
Amir Alemi	Division of Rail	California Department of Transportation
Monty Armstrong	Fire Prevention Officer	Canadian National Railway Company (CN)
Sarah Fulton	Senior Manager, Climate Change	Canadian National Railway Company (CN)
Harry Teng	Transportation Center Railroad Program	University of Nevada, Las Vegas
Hilary K. Nixon	Deputy Director	Mineta Transportation Institute, San Jose State University
Brandon-Dean Morris	General Manager	Association of American Railroads, Security and Emergency Response Training Center
Devin Sprinkle	Assistant Vice President	Environment, Hazardous Materials, and Climate Change, Associate of American Railroads
Brian M. Staes		Oregon State University

4.2 Survey

The primary goal of the stakeholder survey was to gather feedback on the methodology and functionality of the CREEP. Specifically, the survey sought to identify gaps or limitations in the portal's data layers and user interface, and understand how different organizations might apply the tool to support decision-making and mitigation planning. Participants also had the opportunity to make suggestions for future enhancements, such as the integration of new data sources and operational features.

The research team sent a follow-up survey to the fifteen participants in the working sessions and received two survey responses. Survey responses indicated support for the portal's current features and an interest in expanding its operational utility. Participant number one, who works for a federal agency, emphasized the value of strategic tools, such as vulnerability ratings and sensitivity layers, over tactical alerting functions, and suggested that historical wildfire impact data, including infrastructure damage and operational shutdowns, could be used to evaluate the correlation between real world events and high hazard areas. This respondent found all existing layers relevant and ranked exposure, BP, rail grade crossings, and fire stations as the most important within their respective categories of vulnerability assessment framework component (e.g., exposure) and component indicator (e.g., BP). Survey participant number two, who works as a consultant for emergency services and the rail industry, found all the indicators useful and highlighted the potential for the portal to improve interoperability between internal and external stakeholders during large-scale incidents. They recommended improving interactivity with ground-based units via mobile platforms, and increasing the frequency of weather updates, particularly wind speed and direction. They ranked sensitivity, WUI, railroad bridges, and road network as the most important in their respective categories. Both respondents expressed interest in using the portal to fill gaps in emergency coordination and planning, with one noting that the rail industry may not fully understand the capabilities of fire services and the National Incident Management System (NIMS) and Incident Command System (ICS) protocols. Overall, survey responses reinforced a desire for the portal to evolve beyond planning and mitigation into a more dynamic, operational tool that supports real-time monitoring and coordination.

5. Summary and Conclusions

The CREEP project was developed to address the growing need for wildfire resilience in the rail sector. The project team established a scalable, data-driven framework for assessing vulnerability across rail infrastructure.

Phase I of the project focused on foundational research, stakeholder engagement, and a proof-of-concept study. A comprehensive literature review identified existing methodologies and data sources relevant to wildfire risk and infrastructure vulnerability, guiding the conceptual design of the framework. Stakeholder input gathered through a series of three semi-structured interviews provided insights into data relevance and practical applications. The proof-of-concept study demonstrated the feasibility of applying the framework to California's Class I freight and passenger rail network through the development of a methodology to identify high-hazard segments of railway based primarily on proximity to high probability burn zones.

Building on this foundation, Phase II focused on the development of the vulnerability assessment framework and its integration into an operational platform. Vulnerability was defined as a function of exposure, sensitivity, and adaptive capacity, with each component quantified using an indicator approach with the use of publicly available, nationally scalable datasets. The segmentation methodology enabled the relative comparison of vulnerability across a network, as well as the prioritization of mitigation investments on a rail segment scale. Integration into the PDC's DisasterAWARE platform made the framework accessible and allowed for the demonstration of its practical applications to stakeholders. Additional stakeholder feedback in Phase II emphasized the importance of data relevance, the need for integration with existing systems, and improved coverage for under-resourced regions. Participants ranked exposure, BP, sensitivity, WUI, and critical infrastructure layers as most important. Specific recommendations for improving the portal include incorporating infrastructure material types, electrified rail risk, and cargo type, in addition to real-time weather monitoring (such as wind speed and direction) and improved coordination with rail operators.

The CREEP project delivered a stakeholder-informed tool for improving wildfire resilience in the rail sector. By combining data-driven methodology with stakeholder engagement and integration into DisasterAWARE, the project supports risk communication and strategic mitigation prioritization. Future work may focus on expanding geographic coverage, refining metrics, providing more resources for remote rail corridors in areas with limited infrastructure and/or emergency response capabilities, and deepening integration with industry systems.

6. Appendix A

Community Resilience Extreme Events Portal Follow-Up Survey

Portal Functionality and User Experience

9. Which Type of organization do you represent?
    A. Rail company
    B. Local/State Agency
    C. Federal Agency
    D. CRISI Research Community
    E. Other
10. Which features or tools within the portal did you find most useful or relevant to your experience with wildfire or related risk during the session? Consider features like exposure or sensitivity layers, vulnerability ratings, other supporting map layers, or hazard monitoring and alerting.
11. What improvements would you suggest to make the portal more effective? Think about layout, navigation, clarity of outputs, or accessibility.
12. Are there specific types of data or visualizations you would like to see to make the portal more applicable to your work? Think about datasets, real-time dynamic updates, or additional map layers.

Data, Indicators and Methodology

13. The following table presents the three components of the Vulnerability Assessment Framework and their relevant indicators. Exposure refers to the spatial overlap of assets and hazards (e.g. any rail asset in a location that could be impacted wildfire is exposed). Sensitivity refers to the physical characteristics of an asset that make it more susceptible to the damaging effects of wildfire. Adaptive capacity refers to the programs, policies, and activities that may reduce the risk of wildfire. Do you consider the data sources and indicators used in the portal relevant and reliable for assessing wildfire-related risks to rail infrastructure? Select yes or no.

Component/Indicator	Yes	No
Exposure – Burn Probability		
Exposure – WUI		
Exposure – Campgrounds		
Sensitivity – Railroad Bridges		
Sensitivity – Rail Grade Crossings		
Sensitivity – Freight Stations		
Sensitivity – Amtrak Stations		
Adaptive Capacity – Fire Stations		
Adaptive Capacity – Road Network		
Adaptive Capacity – Railroad Tunnels		

14. What additional data sources and indicators do you think would add value to the Exposure component of the framework?
15. What additional data sources and indicators do you think would add value to the Sensitivity component of the framework?

1. What additional data sources and indicators do you think would add value to the Adaptive Capacity component of the framework?

2. Please provide any comments you have about question 5.

3. The Vulnerability Assessment Framework assigns separate weights to each overall component and each individual indicator. Rank the following components in order of greatest (top) to least (bottom) importance.

   A. Exposure

   B. Sensitivity

   C. Adaptive Capacity

4. The Vulnerability Assessment Framework assigns separate weights to each overall component and each individual indicator. Rank the following indicators of Exposure in order of greatest (top) to least (bottom) importance.

   A. Burn Probability

   B. Wildland Urban Interface

   C. Campgrounds

5. The Vulnerability Assessment Framework assigns separate weights to each overall component and each individual indicator. Rank the following indicators of Sensitivity in order of greatest (top) to least (bottom) importance.

   A. Railroad Bridges

   B. Rail Grade Crossings

   C. Amtrak Stations

   D. Freight Stations

6. The Vulnerability Assessment Framework assigns separate weights to each overall component and each individual indicator. Rank the following indicators of Adaptive Capacity in order of greatest (top) to least (bottom) importance.

   A. Fire Stations

   B. Road Network

   C. Railroad Tunnels

7. Please provide any comments you have about your responses to questions 7-10.

Risk Mitigation

8. What region are you primarily located in (e.g. northwest, south, southwest)?

9. Which Mitigation strategies do you believe are most effective for increasing rail in your region? (Select all that apply).

    A. Vegetation Management

    B. Detection/alert/warning systems

    C. Infrastructure Hardening

    D. Emergency Response Coordinator

    E. Community Engagement

    F. Other

10. What additional tools or features would help you better communicate risk and mitigation strategies with internal or external stakeholders? Consider monitoring and reporting tools, exportable visuals, or summary dashboards.

Application and Integration

11. How likely are you to use the portal in your own work or decision-making processes? (Scale of 1-10).

12. Why? (Question 18).

13. How likely are you to incorporate the portal into your organization's planning, maintenance, or emergency response workflows?

14. Why? (Question 20).

15. What workforce training and development needs are required to build capacity around improving wildfire preparedness and risk assessment for the railroad industry?

Strategic Value and Collaboration

16. How helpful is the portal in supporting coordination or communication with other agencies or departments during extreme events? (Scale of 1-10).

17. Why (Question 23).

18. To what extent do you believe the portal can help reduce safety risks such as derailments, loss of life, or infrastructure damage due to extreme events?

19. Why? (Question 25).
20. How useful is the portal in helping you understand and plan for climate-related risks that affect rail infrastructure?
21. Why? (Question 27).

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8. About the Authors

Karl Kim

Dr. Karl Kim is a professor at the University of Hawaii, Department of Urban and Regional Planning, who has over 40 years of experience in transportation safety and security, and disaster and risk management. Dr. Kim is Executive Director of the National Disaster Preparedness Training Center (NDPTC), a member of the National Domestic Preparedness Consortium (NDPC), FEMA's premier training provider. NDPTC is a FEMA training center authorized to develop and deliver nationwide disaster preparedness, mitigation, and recovery training. Dr. Kim is the Editor-in-Chief of the Transportation Research Interdisciplinary Perspectives, Associate Editor of Transportation Research, Part D, Transport and Environment, and formally the Editor-in-Chief of Accident and Prevention journals. Dr. Kim serves on several committees of the Transportation Research Board and was elected to the Board of the North American Alliance of Hazards and Disaster Research Institutes (NAAHDRI). Dr. Kim is also director of the University of Hawaii's University Transportation Center (UTC), which is a member of the Pacific Southwest Region (PSR) University Transportation Center. Dr. Kim and the University of Hawaii are members of the Center for Surface Transportation Testing and Academic Research (C-STTAR) consortium. This consortium of eight (8) universities and academic research centers was established to provide expertise in research focus areas across all modes of surface transportation to support the Federal Railroad Administration's Transportation Technology Center's (TTC) growth initiatives.

Daniele Spirandelli

Dr. Daniele Spirandelli is an environmental planner with over 20 years of experience leading teams in engineering, science, and planning, including 10 years focused on vulnerability assessments for transportation and utilities across the Pacific Northwest, California, and Hawaiʻi. She is currently leading a hazard vulnerability assessment for coastal transportation infrastructure in the State of Washington to identify areas for nature-based solutions to mitigate risks. Previously, as faculty at Hawaiʻi Sea Grant College and the University of Hawaiʻi, she created tools and strategies for sea level rise resilience with local communities and agencies. During her PhD work at the University of Washington's Urban Ecology Research Lab, she conducted regional studies, including her dissertation: a comprehensive, 10-county empirical analysis of land use, infrastructure, land cover change, and habitat impacts. Dr. Spirandelli is an active educator and collaborator on adaptation and resilience.

David Rother

Dr. David Rother is a dedicated wildfire resilience consultant with two years of professional experience in the field. He is currently working on a vulnerability assessment of rail systems to wildfire and is developing a web portal to help the Federal Railway Association, railroads, and communities reduce risks. During his PhD work at San Diego State University and the University of California, Santa Barbara, he conducted research on the effects of wildfire on energy balance, the influence of burn severity on post-fire vegetation recovery, and the impacts of extreme fire weather. Dr. Rother has extensive knowledge of the drivers of wildfire activity, and has years of experience managing, processing, and analyzing geospatial datasets and utilizing tools to understand wildfire.

Michelle Toner

Ms. Michelle Toner is a licensed GIS Professional (GISP) with more than eight years of experience managing spatial data and visualizing spatial information related to emergency management, environmental remediation, and resilience. She specialized in complex hazard assessments at the intersection of risk and infrastructure systems. She develops web mapping products, presentation graphics, and report figures to illustrate specific assets and hazard vulnerabilities. Michelle leverages existing spatial information and develops spatial data with clients; she also contributes to the development of complex spatially driven indicators for vulnerability analysis and reporting.

Eric Yamashita

Dr. Eric Yamashita has more than 35 years of experience in applying geospatial and remote sensing technologies and data products, and implementing and integrating information technology systems into organizations. Mr. Yamashita is the Associate Director of Technology and Innovation of the National Disaster Preparedness Training Center (NDPTC) at the University of Hawaii. Mr. Yamashita has over 50 peer-reviewed publications in the application of spatial science, transportation safety, disaster risk assessment, and urban transportation planning.

Chris Chiesa

Mr. Chiesa has more than 35 years of experience developing and managing enterprise applications of space-based and geospatial information technologies, and has been actively involved in disaster management activities around the globe for the past two decades. As the Director of Early Warning Solutions at the Pacific Disaster Center, he has helped to deliver DisasterAWARE-based systems to a number of countries as well as build skills and capacity for the operational use of the PDC-hosted DisasterAWARE Pro platform for many more partner organizations. In 2002, PDC received the prestigious Sasakawa Award from the United Nations for the Center’s DisasterAWARE platform and its work on a multi-hazard risk reduction approach.

Greg Hampe

Mr. Hampe developed enterprise software and systems for over 20 years with the American Red Cross Disaster Response and Biomedical groups. Having also spent several years as an Assistant Professor of Information Systems and Operations Management at George Mason University's Costello College of Business, including serving as Academic Director for two graduate programs, he then joined the Pacific Disaster Center as part of the Applied Science team to enhance and expand the DisasterAWARE platform. During his time with PDC, he has worked closely with Chris Chiesa and a variety of global projects, including a partnership with NASA on implementing global flood and landslide hazards.