

Appendix I. Safety, Security, and Resiliency

The freight system is a complex network that is susceptible to natural disasters and human-caused events. Whether the result of natural processes, accidents, criminal activity or terrorism, freight system disruptions can have devastating consequences. California's economy is dependent on the strength, reliability, and resiliency of its freight sector. Disruptions may impact the economic health of individual companies, communities, regions, the State and nation. California needs to ensure that the freight transportation system prevents and minimizes negative impacts from such events and quickly recovers when they occur. California's freight system needs to be particularly adaptable so that emergency supplies can be transported and distributed when and where they are needed.

Emergency Support Functions

The State of California is prepared to respond quickly and effectively to large-scale safety and security events on a 24-hour basis. When an event or potential event is first detected, the California Office of Emergency Services (Cal OES) is activated to a level appropriate to the magnitude of the threat. All state agencies and volunteer organizations that comprise the State Emergency Response Team (SERT) are grouped into 18 Emergency Support Functions (ESF) to carry out coordination and completion of assigned missions¹. These functions represent specific response activities that are common to all disasters. Each ESF is comprised of one or more primary agencies serving as the lead and several other agencies and organizations providing support. The State-level ESF 1 activities support the coordination of transportation across various modes, including surface, maritime, railroad, aviation, and pipeline. The ESF 1 lead agency, CalSTA, has delegated to the CHP and Caltrans, the responsibility to provide expertise primarily for surface transportation, and has identified stakeholders from primary and supporting agencies to take the coordination lead for other modes of transportation². According to the State of California Emergency Plan, ESF 1 – Transportation, “assists in the management of transportation systems and infrastructure during domestic threats or in response to incidents.” ESF 1 also provides recommendations and subject matter expertise to Cal OES including ESF 1 preparedness, mitigation, response, and recovery.

Caltrans specific responsibilities directly related to ESF 1 activities:

- As the owner operator of the state highway system (SHS), has administrative orders to repair, maintain and operate the SHS during and following emergencies and disasters;
- Provide assessments of transportation infrastructure and traffic conditions;
- Assess damage to highway system and establish route priorities during recovery efforts;
- Operate as the liaison to the U.S. DOT and FHWA regarding the status of the SHS;
- Provide transportation policies and guidance as needed;
- Coordinate state agency plans, procedures and preparations for route recovery, traffic regulation and air transportation; and

- Develop routing and directions for the movement of incident victims out of an impacted area and for the delivery of necessary personnel and medical supplies to local medical facilities and shelters.

CHP specific surface transportation responsibilities:

- Act as the Director of the State Motor Transport Division during times of emergency;
- Perform tasks assigned in the California Emergency Resources Management Plans for transportation during times of a war emergency;
- Continue emergency traffic regulation and control procedures as required;
- Assist Caltrans with traffic route restoration;
- Provide police escorts on closed routes;
- Activate appropriate CHP Emergency Resource Centers to coordinate resources and ensure the timely dissemination of intelligence information;
- Secure routes, regulate traffic flow, and enforce safety standards for evacuation and re-entry into evacuated areas;
- Coordinate interstate highway movement on regulated routes with adjoining states;
- Establish highway safety regulations consistent with location, type and extent of emergency conditions; and
- Support Caltrans with traffic route re-establishment and continued emergency traffic regulation and control procedures as required.

Hazardous Materials Transport³

Industrial hazardous materials that are flammable, corrosive, toxic, explosive, or infectious play a vital role in the U.S. economy. They are used by industries from farming and mining to manufacturing and pharmaceuticals, and come in the form of raw materials, fertilizers, fuels, constituent parts, and other essential inputs. Of all hazardous materials, Toxic Inhalation Hazard (TIH) chemicals are among the most dangerous. Chlorine gas and anhydrous ammonia are the most common TIH chemicals; others include sulfur dioxide, ethylene oxide, hydrogen fluoride, and a variety of other products that are important manufacturing inputs. The potential consequences of a TIH release depend on the severity of the accident or event.

One widely discussed risk-mitigation proposal involves re-routing trains containing TIH tank car loads, for example, by choosing a route with less population exposure. TIH tank cars passing through major population centers were recognized as potential chemical weapons. Proponents of mandatory re-routing of TIH products argued that diverting trains around cities would place fewer people at risk of a terrorist attack and/ or collisions.

Many hazardous chemicals transported over long distances by rail, and for shorter distances by truck, may be particularly vulnerable to sabotage and disruption. At the federal level, the U.S. DOT and Transportation Security Administration (TSA) have sought to reduce the risk of terrorist attacks on freight. TSA worked with railroad carriers to implement a security program, the TIH Risk Reduction Program. TSA assumes that the risk of hazardous materials transport is directly proportional to the dwell time (the length of time that a rail car sits at a particular location), volume, and type of materials transported through densely populated areas. First

implemented in New Jersey and New York, the program seeks to establish secure storage areas for TIH materials and to expedite their movement through the system.

Rail Freight

California has increased state-level oversight of rail freight and strengthened the regulation of railroad security. In addition to its role enforcing federal rail safety regulations, the California Public Utilities Commission (CPUC) is developing the capacity to improve rail security. The CPUC was charged with enforcing the provisions of AB 3023 requiring railroad operators to conduct risk assessments of their facilities and to develop and implement infrastructure protection programs. CPUC has more than 40 federally certified inspectors who are authorized to issue security enforcement recommendations under the auspices of federal law. Additionally, California actively seeks to bring State-level knowledge regarding rail safety and security to short line rail carriers that may not have the resources to establish robust safety and security programs on their own.

Positive Train Control Program

Positive Train Control (PTC) systems are integrated command, control, communications, and information systems for controlling train movements with safety, security, precision, and efficiency. PTC systems improve railroad safety by significantly reducing the probability of collisions between trains, casualties to railway workers, damage to equipment, and overspeed accidents. The system can recognize a threat of collision or accident and slow or stop a train automatically to avoid the incident. The National Transportation Safety Board (NTSB) has named PTC as one of its "most-wanted" initiatives for national transportation safety. The Rail Safety Improvement Act of 2008 required all Class I railroads (the largest) and intercity passenger and commuter railroads to implement a PTC system on mainline track that carry passengers or TIH materials by December 31, 2015. Currently PTC is completely implemented in all Class I railroads in California.

Trucks

Trucks can weigh more than 30 times more than passenger vehicles and requires more stopping distance, especially when loaded. When involved in a collision, the size and weight of large trucks increase the severity of impact when a passenger vehicle is involved. Furthermore, truck crashes are more likely to result in severe injuries or fatalities than those involving only passenger cars. For example, between 2013 to 2017, the number of collisions involving trucks increased by 23 percent. Also, during this period, statewide truck VMT increased by 15 percent, followed by an overall increase in the number of collisions per one million VMT. However, commercial truck collisions resulting in no injury or death increased only by 4 percent and injuries by 24 percent, though the number of commercial truck collisions resulting in a fatality decreased by 8 percent.

Another safety concern is distracted driving and driver inattention. A distraction is anything that diverts the driver's attention from his or her primary tasks of navigating the vehicle and

responding to critical events. According to an in-cab driving study of commercial truck drivers by the Virginia Technical Institute, the most dangerous distraction observed was texting. Truck drivers who texted while driving had 23 times the risk of being involved in a crash or a near crash incident. However, texting and phone calls are not the only distractions. Others may include eating, drinking, grooming, handling in-vehicle navigation systems, and conversating with passengers.

The FMCSA and the PHMSA have published rules specifically prohibiting interstate truck drivers, bus drivers, and drivers who transport quantities of “placards”, which are large amount of hazardous materials, from texting or using hand-held mobile phones while operating their vehicles. The joint rules are the latest actions by the U.S.DOT to end distracted driving. Violations can result in fines and/or driver disqualifications and will impact a motor carrier’s and/or driver’s Safety Measurement System results.

With new electronic logging device rules, the monitoring of drivers’ adherence to the hours of service rules will become more rigorous because computer programs will be tracking the driving and work activity of truck drivers. The California Trucking Association (CTA) has a long history of supporting truck safety initiatives, such as banning radar detectors, prohibiting the use of mobile phones while driving, and administering mandatory drug and alcohol testing. CTA is now calling for several additional safety improvements, such as mandatory use of devices to limit maximum truck speed and a national clearinghouse to track positive drug and alcohol test results and refusals to test.

Commercial Vehicle Enforcement

The CHP provides safety oversight of approximately 8.5 million commercial vehicles. Currently, there are 54 commercial vehicle enforcement facilities (CVEF) located throughout the State. The CHP has jurisdictional authority over the CVEFs and maintains responsibility for commercial enforcement.

CHP mobile road enforcement units are used within their eight divisions throughout California’s highways and county roadways (county roadways are often not necessarily seen as commercially traveled routes). The CHP conducts over 500,000 inspections annually in accordance with the California Vehicle Safety Alliance standards set forth in the North American Standard Out-of-Service Criteria. The CHP also provides off-highway enforcement utilizing the Motor Carrier Safety Unit, which includes over 300 non-uniformed motor carrier specialists assigned to one of the eight state field divisions.

The CHP and Caltrans are the State agencies designated by the Governor’s Office as the certifying officials for size and weight regulations and enforcement. The CHP is the primary agency responsible for the enforcement of size and weight statutes and regulations, pursuant to the California Vehicle Code (CVC) and Title 13, California Code of Regulations.

Truck Weight Limits

California follows federal law by placing weight limits on trucks to protect pavement and bridges from damage and excessive wear and tear. Truck weight is also a major factor in the severity of truck-passenger vehicle incidents. Heavier trucks and trucks carrying loads exceeding maximum weight limits can be more difficult for the driver to control because they require increased stopping distance, have an increased potential to roll due to a higher center of gravity, generate higher speeds when traveling downhill, and have decreased steering capability, especially at higher speeds.

Table I.1 shows a summary of the CVC weight limits. (Note: The information in this table is paraphrased for brevity. Refer to CVC Weight Sections 35550 – 35558 for more detailed information.)⁴

Table I.1. California Vehicle Code (CVC) Related to Vehicle Weight

Unit	Maximum Weight
Vehicle Combination Gross Weight	80,000 pounds
Single Axle	20,000 pounds
Axle Group: less than 8'-6" (8-feet-6-inches) between outer axles	34,000 pounds
Axle Group: 8'-6" (8-feet-6-inches) or more between outer axles	Varies by distance between axle groups
Source: California Vehicle Code Weight Sections 35550 – 35558	

Caltrans often receives requests to increase truck (or axle) weight limits, or to implement programs that would collect additional fees for compensation of overweight loads. There are several reasons for these requests. Hauling larger loads with fewer trucks can help industries reduce transportation costs and increase efficiency. Competition and changing market conditions puts pressure on freight-dependent industries to lower costs in an effort to provide greater efficiencies and increases in service quality. Transportation costs and flexibility for load size can have a significant effect on economic sustainability, particularly for heavy bulk commodities and highly priced sensitive goods, such as agriculture, lumber and timber, and construction materials. It is paramount to the economic vitality of California that it maintains an efficient freight transportation system and support freight-dependent industries. It is also vital that decision makers and the public understand the trade-offs between economic benefits with increased infrastructure and safety costs that occur when increasing load limits.

To support cleaner truck technologies California passed AB 2061 in 2018. To the extent expressly authorized by federal law, the bill authorized a near-zero-emission vehicle or a zero-emission vehicle, as defined in subdivisions (c) and (d) of Section 44258 of the Health and Safety Code, to exceed the weight limits on the power unit by up to 2,000 pounds⁵.

Truck Parking

The demand for commercial vehicle parking far exceeds the supplied capacity in California. When originally conceived, public rest areas were meant to be temporary rest areas for short-term safety breaks for the traveling public. As the trucking industry expanded, these rest areas began to serve as long-term, overnight parking for long-haul commercial vehicle operators, thereby contributing to overcrowding. The lack of availability for truck parking is not just an issue for truck drivers who struggle to secure parking but also for neighborhoods adjacent to freight facilities such as ports, intermodal facilities, warehouse and distribution centers, and manufacturing. These neighborhood streets, empty lots, and business parking lots are used as truck parking when highway rest areas are full or closed. Besides creating safety hazards, neighborhoods frequently must contend with noise, smell, vibration, degradation of air quality, loss of viewshed, and disruption to community cohesion.

Because of the limits on stays in public facilities, parking space shortages, and HOS regulations, truck drivers have few alternatives. Parking underneath overpasses, on roadway access ramps or roadway shoulders are typically unauthorized and pose safety risks for the driver and other users of the highway or road. Accelerating quickly enough to merge into the traffic stream from a parked position on the side of the road is particularly challenging for truck drivers. Additionally, errant vehicles may stray into these areas and strike parked commercial vehicles. Privately owned truck stops are also not plentiful and are frequently filled to capacity, therefore, they are not always available to provide long-term parking. A lack of facilities can influence which route is taken based on the availability of amenities, whether the trip is a long or short haul, the time of day, and the need for staging areas. Just-in-time delivery scheduling and “rolling warehouse logistics” put even greater demand on drivers and on truck parking facilities.

Drug and Alcohol Prevention

The CHP continues to work closely with the trucking industry to educate and reduce impaired driving and to maintain the highest level of compliance. The goal of the program is to ensure all motor carriers located in the state are inspected for continued compliance with state and federal drug and alcohol testing requirements. These inspections are necessary in the continued efforts to reduce the number of impaired drivers on the road.

Air Freight

Freight Security

As with its passenger counterpart, the airline freight industry is pressured to comply with stringent security requirements. As part of the 9/11 Commission Act of 2007, Congress requires all cargo transported in the holds of passenger airplanes originating in the U.S. to be screened at a level commensurate with passenger luggage. Since 2010, TSA regulations mandates the screening of all cargo before it is to be loaded and carried by air both within the U.S. and

internationally. The deadline to meet this mandate was August 3, 2010 and TSA is charged with enforcing it thereafter.

As a solution to bottlenecks experienced at airports, which further impacts the global supply chain due to the complex screening processes for both passenger and cargo packages, TSA devised the Certified Cargo Screening Program (CCSP).⁶ Under the CCSP, shippers, freight forwarders, logistics services providers, indirect air carriers, independent cargo screening firms, and air carriers can screen cargo via a secure chain of custody and pass it along where it can go directly onto the aircraft without undergoing additional screening. This approach effectively creates a distributed screening network, allowing screening to be performed at the most cost-effective point in the supply chain and mitigating the impact on system performance, thereby expediting the flow of commerce. The CCSP is a flexible, voluntary program specifically designed to allow shippers with unique requirements to find the approach that best meets their needs. The CCSP requires airlines, freight forwarders, and shippers to assume the costs of these security measures and to establish a secure air freight transport chain.

NextGen

The Next Generation Air Transportation System (NextGen) modernization of the U.S. air traffic system is due for implementation across the country in stages between 2007 and 2025. NextGen aims to transform America's air traffic control system from a ground-based system to a satellite-based system. Global Positioning System (GPS) technology will be used to shorten routes, save time and fuel, reduce traffic delays, increase capacity, and permit controllers to monitor and manage aircraft with greater safety margins. Planes will be able to fly closer together, take more direct routes, and avoid delays caused by airport "stacking" as planes wait for an open runway.

The FAA is undertaking a wide-ranging transformation of the entire U.S. air transportation system through the NextGen program, which is developed to reduce gridlock both in the sky and at the airports. In 2017, FAA published an Implementation Plan Update, including a summary of accomplishments and the NextGen priorities annual plan through 2019. The NextGen Integration Working Groups successfully completed 52 commitments in fiscal year 2017, advancing operational improvements to the National Airspace System (NAS) in all areas. In February 2017, the NAC chairman proposed that the NAC focus on implementing NextGen in the Northeast Corridor, recognizing that making continuous improvements to the system in the Northeast Corridor operationally benefits the entire U.S. aviation system. Although this national effort focuses more on flight improvement across NAS, operational improvements provide benefits to the air cargo industry as well.

Maritime Freight

The maritime industry has always placed a high priority on security. Terrorism, weapons and drug smuggling, customs duty evasion, and piracy have been among the chief safety concerns. The international dimensions of the shipping industry, the large number of maritime ports, the vast fleet of global shipping, the range of products carried in vessels, and the difficulty of

detection has made the issue of security in shipping a persistent concern. For ports, vulnerabilities can range in levels of exploitation and severity from both land and water. Recently, more scrutiny from customs officials has focused on identifying illicit and/or dangerous cargoes within containers. All containers imported to U.S. seaports are scanned through radiation portal monitors (RPM) prior to leaving a marine terminal on trucks or rail cars. Other selected containers are also scanned or manually inspected by U.S. Customs and Border Protection (CBP) based on their assessment of risk or by random selection. The United States Coast Guard (USCG) inspects cargoes and containers for compliance with the Federal Hazardous Materials Transportation Law (FHMTL) and the International Safe Container Act of 1977 (ISCA) (46 U.S.C. §80501-80509). Regulations implementing the FHMTL are codified in 49 C.F.R. §107-180. Regulations implementing the ISCA can be found in 49 C.F.R. §450-453. The Coast Guard inspects containers of general cargo to ensure hazardous materials are being shipped legally. Undeclared hazardous material shipments are a leading cause of transportation incidents.

The USCG also has responsibility for the Transportation Worker Identification Credential (TWIC) program. The TWIC program was developed following the legislative provision of the Maritime Transportation Security Act (2002, 2010) and the Security and Accountability for Every Port Act of 2006. The TWIC identification card is a tamper-resistant credential that contains biometric information about the holder, rendering the card useless to anyone other than the rightful owner.

Vessel Safety and Security

The Maritime Transportation Security Act of 2002 (P.L. 107-295) was designed to protect the nation's ports and waterways from terrorist attacks. The basic elements of this legislation were adopted by the International Maritime Organization (IMO) in 2002 as the International Ship and Port Security code (ISPS). There are three important features of these interventions. First is the requirement for an Automated Identity System (AIS) to be fitted on all vessels from 300 gross tonnage and upward. The AIS requires vessels to have a permanently marked and visible identity number, and there must be a record maintained of its flag, port of registry, and address of the registered owner. Second, each port must undertake a security assessment of its assets and facilities, quantifying the effects of damages caused. The port must then evaluate the risks to its physical security, communication systems, and utilities. Lastly, all cargoes destined for the U.S. must receive customs clearance prior to the departure of the ship. It is proposed that biometric identification for seafarers are implemented and that a national database of sailors be maintained.

The ISPS code is being implemented in ports around the world. Without certification, a foreign port would have difficulty in trading with the U.S. Thus, it is becoming a factor in a port's competitiveness. The need to comply with ISPS has become an urgent issue in ports of various cargo volumes around the world. The costs of securing sites, undertaking risk assessments, and monitoring ships all represent an additional cost of doing business without any commercial return. U.S. ports have been able to tap funding from the Department of Homeland Security, but foreign ports must comply or else risk the loss of business. In 2008, legislation in the U.S.

required that all containers being shipped to the U.S. undergo screening. Foreign ports will be expected to purchase gamma-ray and x-ray scanners, and undertake screening of all U.S.-bound containers, regardless of the degree of the security threat. This is a further financial and operational cost for foreign ports to comply with. Security has become an additional element in determining competitive advantage.

Land Ports of Entry Freight

Border Safety and Security

California and Mexico share over 130 miles of international border. The border is a vital economic gateway for international trade and a key contributor to the economic well-being of both countries. Under the auspices of the Department of Homeland Security, the U.S. Customs and Border Protection (CBP) safeguards the U.S. - Mexico Border. Its top priority is “keeping terrorists and their weapons out of the U.S. while facilitating lawful international travel and trade.” Regarding to freight, the CBP’s primary responsibility is to “safeguard America’s borders thereby protecting the public from dangerous people and materials while enhancing the Nation’s global economic competitiveness by enabling legitimate trade and travel.”

The CBP creates and implements programs using sophisticated technologies, and trains personnel to help achieve the goals of securing U.S. ports and borders while supporting and expediting trade. Initiated after 9/11, the Free and Secure Trade (FAST) Program is a commercial clearance program for known low-risk shipments entering the U.S. from Mexico and Canada. FAST allows for expedited processing for commercial carriers who have completed background checks and certain eligibility requirements.

C-TPAT is a voluntary government and business initiative intended to build cooperative relationships that strengthen and improve the overall international supply chain and U.S. border security. Nationwide, there are over 78,000 commercial drivers enrolled in the program and 10,000 companies worldwide are certified under C-TPAT. FAST membership is \$50 U.S. or Canadian currency and covers five years. One of the key benefits of enrollment for carriers is access to dedicated lanes in transborder shipments which allow for greater processing speed and overall efficiency. For the U.S., Mexico, and Canada, the program helps to support supply chain security while promoting economic prosperity.

In 2016, the U.S. CPB announced the full implementation of Automated Commercial Environment (ACE). As the platform that enables the United States’ Single Window, ACE provides a single, centralized access point for the trade community to connect with CBP and its Partner Government Agencies. ACE is the system of record by which electronic trade transactions are conducted and recorded by CBP. ACE has streamlined collection and improved enforcement. With the ACE cargo processing system, trade transactions are more efficient, standardized, simplified, less costly, and more predictable for importers and exporters.

CBP has also been working to design a government-wide ‘trusted trader’ partnership program that would integrate CBP’s C-TPAT and the Importer Self-Assessment with other U.S. government trusted trader programs. In July 2016, CBP published the draft “Trusted Trader

Strategy Framework” whose objective is to co-create a strategy in terms and practice, one which acknowledges the significant commitment of partnership between the U.S. government and trade, in global trade and security. The Trusted Trader framework begins with a foundation of security and continues through current certified membership in C-TPAT baseline of engagement. This Trusted Trader pilot program was announced on June 16, 2014 in Federal Register 79FN13992 and transforms the existing Importer Self-Assessment program into the new Trade Compliance Program, which provides importers and exporters a platform to achieve an integrated partnership for security and compliance. The pilot program has since been continued and expanded. In January 2018, CBP, the Trusted Trader Subcommittee members, and the Trusted Trader Pilot participants met in Long Beach, California.

Freight Transportation Resiliency

“Freight resiliency” is the ability for the freight system to quickly detect, absorb, and recover from disruptions and return to normal operating levels. These disruptions can range in severity and scale, and from small-scale events with a localized impact (such as a power outage at a distribution center), to large events with far-reaching effects (such as earthquakes, mudslides, or terrorist attacks). The ability of a system to rebound depends on many factors, including: the structure of the specific freight system (manufacturing, shipping, processing, delivery), personnel training, transportation redundancies (such as having multiple options, modes, or routes), and public and private actions taken to preserve or restore service in case of a disaster or disruption.

Resilience in the state’s freight system is needed for California to meet its growing needs for efficient freight mobility, as well as to help meet challenges presented by California’s changing climate. Without resiliency, infrastructure will be subjected to faster deterioration due to extreme weather events. The public will be faced with increases in system disruptions, and private enterprises may lose competitiveness. The 2018 update to California’s Fourth Climate Change Assessment has shown a dramatic shift in California’s climate future that will affect people, the natural landscape, and infrastructure.⁷ **Table I.2** shows the key findings from the Fourth Climate Change Assessment for statewide climate trends that are expected to occur between 2050 and 2100. Effects on freight are added to this summary table to illustrate potential outcomes because of these changing climate conditions.

Table I.2. Key Findings Adapted from California’s Fourth Climate Change Assessment to Include Potential Impacts to Freight Systems

Climate Stressor	Future Change	Impacts to Freight
Temperature	By 2100: 5.6°-8.8° increase in daily temperature	Increase in daily temperatures can lead to hotter warehouses and damage to truck tires and engines. Workers will need more protections from overheating (e.g., access to air conditioning, more frequent breaks, and shorter shifts).
Water	By 2050: Water supply from snowpack is projected to decline by two-thirds	Agricultural shortages could arise from the limited water supply, which would change patterns of freight from California’s Central Valley to more reliance on food imports from other countries.
Wildfire	By 2100: Average land area burnt will increase by 77%	Road closures from damaged highways could result in freight trucks needing to be rerouted to other highways that may be further away, thus increasing delivery and shipping costs and times.
Sea Level Rise	<p>By 2100:</p> <ul style="list-style-type: none"> • 31%-67% of Southern California beaches may completely erode • \$17.69 billion worth of residential and commercial buildings could be inundated statewide • The number of highway miles exposed to coastal flooding will triple 	<p>Inundation could cause relocation of container yards, commercial buildings, and warehousing, especially those found in coastal areas that have not implemented adaptation measures.</p> <p>Flooding of highways will lead to road closures which could affect the trucking industry.</p>
Source: California’s Fourth Climate Change Assessment		

The projected changes in California’s climate highlight the need for transportation systems to be resilient and quickly regain “business as usual” operations despite changing circumstances. System disruptions are almost impossible to predict with accuracy because they can stem from many sources and have many different types of impacts. This highlights the need for the freight system to be flexible and be able to swiftly recover from shocks. **Table I.3** shows disruption events and possible corresponding freight impacts to illustrate unpredictability the freight system faces.

The wildfires that now occur nearly year-round in California are recent examples highlighting the need for resiliency. From 2017 to 2019, California experienced some of the most devastating fires in its history, whether in terms of acres burned, structures destroyed, or lives lost. These fire events interrupted freight rail and roadway mobility and closed freight-related businesses. The interruptions, though necessary to save lives and speed up emergency crew movements, impede freight movements and shipments of goods, both perishable and shelf-stable. The rate of natural disasters is predicted to increase due to California's changing climate.

Table I.3. Event Types and Possible System Failures

Disruption Source	Event Type	Possible System Failures
Climate Change	Wildfires	<ul style="list-style-type: none"> • Downed powerlines • Road closures • Damage to infrastructure
	Increased Tornado/Hurricane Strength	<ul style="list-style-type: none"> • Downed powerlines • Damaged or destroyed buildings • Inaccessible roads
	Sea Level Rise/Storm Surge	<ul style="list-style-type: none"> • Flooding • Salt water intrusion and corrosion of electronic systems • Damage to rail, highway, seaport, airport infrastructure
	Intense Precipitation	<ul style="list-style-type: none"> • Flooding • Low visibility • Washout of roads and rail substrates
	High Winds	<ul style="list-style-type: none"> • Downed power lines • Vehicles blown off roadways or overturned • Increased threats to bridges • Delays to air freight flights
	Increased Temperatures	<ul style="list-style-type: none"> • Vehicles overheating • Tire blowouts • Rail track expansion and buckling • Thermal expansion of bridge joints
	Cliff Retreat	<ul style="list-style-type: none"> • Unstable roadways • Inaccessible roads • Loss of connectivity between cities
Geophysical	Tsunamis	<ul style="list-style-type: none"> • Flooding • Saltwater intrusion and corrosion
	Earthquakes and surface rupture	<ul style="list-style-type: none"> • Uneven pavements • Downed powerlines and communications
	Sinkholes	<ul style="list-style-type: none"> • Unstable roadways

	Landslides (mass movement)	<ul style="list-style-type: none"> • Inaccessible roads • Debris clogging tunnel passages
	Volcanic Eruptions	<ul style="list-style-type: none"> • Inaccessible roads
Human Activity	Accidents	<ul style="list-style-type: none"> • Traffic congestion • Closed roads
	Communications Failures	<ul style="list-style-type: none"> • GPS failures • Telephone failures
	Cyber Attacks	<ul style="list-style-type: none"> • Disrupted distribution operations
	Terrorism	<ul style="list-style-type: none"> • Destroyed infrastructure • Closed roads
	Economic Collapse	<ul style="list-style-type: none"> • Disrupted freight operations
	Protests/Boycotts	<ul style="list-style-type: none"> • Disrupted freight operations • Inaccessible distribution centers <ul style="list-style-type: none"> • Closed roads • Goods unable to be sold
Source: California’s Fourth Climate Change Assessment		

The rapid development of e-commerce, economic globalization, just-in-time production, and logistics and supply chain systems over the past decades have led to a significant need for efficient and effective management of freight movements. Businesses and consumers have become increasingly dependent on the freight transport system to deliver their goods on time, because increasingly, far less inventory is stored in regional warehouses and stores. Freight movement in the U.S. has increased dramatically over the past 20 years. Highway vehicle miles traveled grew by approximately 98 percent; however, the highway network expanded less than 5 percent between 1980 and 2007. Significantly more freight is being moved on the same relative number of lane miles, which results in increased delays from higher traffic volumes and more maintenance needs on the road network.

Disruptive, weather-related events have increased dramatically over time. Individuals, businesses, industries, and public sector government agencies are not immune to sudden events that disrupt normal daily activities. Trucking companies, rail carriers, infrastructure managers, and terminal and port operators must invest to prevent or mitigate the effects of disasters. Whether attributable to acts of nature, human error, mechanical failure, or intentional disruptions, identification of future threats and plans for the ability to quickly respond to them is needed.

Due to increased goods movement activity, it is imperative for the freight system to be equipped to handle climate, environmental, human, and geophysical events. While it is difficult to predict when an event may occur, it is important for the system, as well as both the public and private sectors, to be prepared for its eventuality. Failure to adapt can be disastrous to individuals, businesses, governments, and the economy.

Importance of Resiliency in Freight

Effects to a Non-Resilient System

The impacts to a freight system unprepared for climate resiliency have far-reaching consequences outside of private industry profit margins. Disruptions in freight movements can mean freight industry workers are unable to reach their jobs, thus experiencing a loss in wages. Agricultural crops can decline in quality or even spoil if trucks are delayed between farms and distribution points. Delays in shipping products to consumers could have disastrous consequences, such as diabetic patients not receiving their insulin shipments on time, or that stores not stocked with goods necessary for helping residents weather a severe storm event.

Local, regional, state, and federal governments can be severely affected fiscally if the freight system is not adequately prepared for a major climate, human, or geophysical event. Ignoring the need for repairs, retrofitting, or adaptation measures could accelerate the failure of vital infrastructure, thereby substantially increasing the costs to repair after an event more than proactively maintaining it.

Benefits of a Resilient System

A freight system that has been successfully adapted to the upcoming climate changes will be better suited to quickly recover from disaster events, thus saving time, money, and lives. Private industries and public agencies can ensure a resilient system by adapting infrastructure to withstand greater shifts in climate.

Public incentives are available to private businesses, such as rebates for installing solar infrastructure, which helps the state more quickly adopt climate adaptation measures, thus increasing California's resilience to energy demands. Solar infrastructure can safeguard a business to ensure refrigeration systems can still run, even in power outages, which will prevent inventory from spoiling. Other public measures, such as increasing funding for elevating bridges over bodies of water to accommodate increases in precipitation or sea level rise, identifying areas prone to rockslides or mudslides and fortifying the area to protect the roadways and traveling public, or by communicating road closures and openings quickly so that truckers and delivery trucks can get back on their regular routes are examples of ways California can increase resiliency for the freight system.

Accommodating disruptions within the freight transportation system often needs a variety of measures. Reliable freight transportation is a prerequisite for an efficient supply chain. As ground transportation systems have become more congested and less able to accommodate shifting demands, improving resilience of the transportation system itself becomes a priority.

Two important points should be taken from this section:

- Public-private relationships are integral to building and supporting a resilient system.
- Communication is critical to saving lives in case of a catastrophe.

Current Efforts

Private Sector

The Burlington Northern Santa Fe (BNSF) rail line publicly releases its yearly “Corporate Responsibility and Sustainability Report,” which outlines the continuing efforts to, “enhance safety, including efforts to reduce energy consumption and carbon emissions with more sustainable operations.”⁸ As a rail operator that carries more than 40 percent of America’s freight and as North America’s second largest freight railroad network operating over 32,500 miles of track, BNSF has been striving to ensure its operations are resilient. The largest concern for BNSF is the event of a hazardous waste spill. The company operates under “Common Carriage” responsibilities, meaning that it is required to make reasonable accommodations for the transportation of any hazardous material or commodity. In 2017, BNSF carried over 1.3 million customer hazmat shipments across its network. To reduce the risk of accidents, BNSF uses, “wayside detectors, track inspections, reduced speeds, positive train control, and stronger tank cars.” Crude oil and ethanol are among the hazardous materials BNSF transports, and BNSF requires that trains travel no faster than 50 miles per hour (mph), with speeds under 35 mph in areas with 100,000 or greater inhabitants.

Union Pacific Railroad (UPRR), the largest railroad operator in the U.S. after BNSF, is also concerned with the human element of potential disruptions. A 2016 report published by UPRR, the “2016 Building America Report - A Report to Communities on Our Social, Environmental, and Economic Sustainability Progress,” addresses a variety of concerns the company faces during its day-to-day operations, such as environmental health, employee and customer safety, and resource management. UPRR, similar to BNSF, is also highly concerned with hazardous material transportation safety. The UPRR report stresses emergency response trainings for first responders, UPRR employees, and volunteers.

By offering paid employee training on safety procedures while transporting hazardous materials, BNSF and UPRR set an example of how private responsibility is taking the lead to benefit public well-being. Employee, volunteer, and first responder training directly increases resiliency in an emergency, because well-organized and orchestrated disaster relief actions can improve responds to events and improve situation assessments. Also, the practice of using new technology, stronger equipment, and reductions in train speeds reduces the vulnerability of the freight system from accidents that can contribute to spills, destruction of property, injuries, or deaths.

Public Sector

Caltrans has concluded statewide vulnerability assessments to learn the extent to which the SHS will be affected by a changing climate by horizon years 2025, 2055, and 2085. These vulnerability assessments explore how rising temperatures, sea level rise, storm surge, and rates of wildfire may impact the SHS. The outcomes of these vulnerability assessments will lead each of the 12 Caltrans districts to develop their own Climate Adaptation Strategy. These strategies are intended to guide decisions to address the vulnerable areas of highways, with the aim to develop design changes to help protect users from potential hazards.

Caltrans has administered the Climate Adaptation Planning Grants for three fiscal years (2017-2020). These grants, totaling \$20 million, are funded through SB 1, a transportation funding bill passed by the California legislature and backed by voters in 2018. Adaptation Planning Grants aim to advance climate planning on California's transportation infrastructure, including roads, railways (public railways that both private and public rail lines use), bikeways, trails, transit lines, bridges, bus terminals, seaports, and airports.

The Climate Adaptation Grants awarded to regional and local governments within California are helping communities plan for improvements to their transportation infrastructure in the face of increased extreme heat events, precipitation, drought, storm surges, sea level rise, and wildfires due to climate change. To date, over 40 planning grants have been awarded, empowering communities throughout California to safeguard their transportation systems against disruptions caused by a changing climate. Findings from these plans aid local, regional, and state efforts of increasing climate and system resiliency while decreasing vulnerabilities regardless of source type. These efforts ensure that the freight system (and by extension California's economy), environment, and residents are resilient to any disasters that may disrupt normal life.

Endnotes

- ¹ State of California. “State of California Emergency Plan” CalOES, October 1, 2017.
- ² State of California. “California Emergency Support Function 1 Transportation Annex.” CalOES, October 2013.
<https://www.caloes.ca.gov/PlanningPreparednessSite/Documents/01%20Executive%20Summary%20Transportation.pdf>
- ³ “Hazardous Materials: Enhancing Rail Transportation Security for Toxic Inhalation Hazard Materials.” *Federal Register*, 16 Aug. 2004,
<https://www.federalregister.gov/documents/2004/08/16/04-18705/hazardous-materials-enhancing-rail-transportation-security-for-toxic-inhalation-hazard-materials>.
- ⁴ “Code Section Group.” Codes Display Text,
https://leginfo.legislature.ca.gov/faces/codes_displayText.xhtml?lawCode=VEH&division=15.&title=&part=&chapter=5.&article=1.
- ⁵ Caltrans. “Near-Zero-Emission and Zero-Emission Vehicles.” Caltrans.
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- ⁶ Government Publishing Office. “Title 49- Transportation.” *Code of Federal Regulations*, 1 Oct. 2017, <https://www.govinfo.gov/content/pkg/CFR-2017-title49-vol9/xml/CFR-2017-title49-vol9-part1549.xml>.
- ⁷ California’s Fourth Climate Change Assessment. State of California. 2018.
<http://climateassessment.ca.gov/state/overview/>
- ⁸ BNSF Railway. *Corporate Responsibility and Sustainability Report*. BNSF Railway, 2017,
<https://www.bnsf.com/in-the-community/environment/pdf/sustainability-report-2017.pdf>.