



Climate Change Impacts Across California Transportation

Other Reports in This Series



Summary

Climate change will have a number of serious impacts on California, including public health risks, damage to property and infrastructure, life-threatening events, and impaired natural resources. This report focuses on how a changing climate is affecting transportation infrastructure and key issues the Legislature faces in responding to those impacts. This is one of a series of reports summarizing how climate change will impact different sectors across California.

Climate change will impact transportation infrastructure in California in a number of ways. These include sea-level rise undermining coastal railways and bridges, intense storms causing mudslides and flooding of highways, and heatwaves leading to buckling and rutting of roads. Mainly, we find that some existing transportation infrastructure will need to be modified or relocated to remain useable, and that planning, construction, and maintenance processes will increasingly need to account for the effects of climate change to maintain the infrastructure's longevity. To respond to these impacts, the Legislature may want to consider whether it needs to modify how it funds, prioritizes, and plans transportation infrastructure, as well as what the state's role should be in supporting local development and implementation of climate adaptation projects. For example, given that the potential costs for climate adaptation far outstrip available funding, the Legislature likely will want to require transportation planning agencies to integrate climate resiliency into how they prioritize and select projects. Prioritization factors could include the immediacy of expected climate impacts, state ownership and responsibility, number of road users affected, public safety implications, and potential effects on surrounding land uses.

The Legislature also may want to require transportation planning agencies to prioritize funding for communities that face the greatest risk and have less capacity to address climate threats without state assistance. Additionally, the Legislature will want to consider which funding streams will be appropriate and sustainable to support climate-resilient transportation infrastructure. Climate adaptation projects can be expensive and difficult. However, in many cases, efforts that help to avoid future damages and costs could bring significant longer-term economic benefits for certain regions and the state compared to if they were not undertaken. Any new state initiatives should build on existing state efforts and funding, which include initial department- and agency-led work that is underway to assess and plan for climate change impacts.

Introduction

This report contains three primary sections: (1) the major ways climate hazards impact transportation infrastructure, (2) significant existing state-level efforts underway to address climate change impacts in the transportation sector, and (3) key questions for the Legislature to consider in response to these impacts. Given the complexity of the issues, this report does not contain explicit recommendations or a specific path forward; rather, it is intended as a framing document to help the Legislature adopt a “climate lens” across its decisions in the transportation policy area.

Because some degree of climate change already is occurring and more changes are inevitable, this document focuses primarily on how the Legislature can think about *responding* to resulting impacts. Of note, the state is also engaged in numerous efforts to *limit* the degree to which climate change occurs by enacting policies

and programs to reduce emissions of greenhouse gases (GHGs), such as by encouraging the adoption of zero-emission vehicles.

California Faces Five Major Climate Hazards. As discussed in depth in our companion report, *Climate Change Impacts Across California: Crosscutting Issues*, five major climate change hazards confront California. Specifically, increasing temperatures, a changing hydrology, and rising sea levels are leading to:

- Higher average temperatures and periods of extreme heat.
- More frequent and intense droughts.
- Increased risk of floods.
- More severe wildfires.
- Coastal flooding and erosion.

Major Climate Change Impacts on Transportation

In this section, we discuss the primary ways climate change impacts affect the transportation sector. As shown in **Figure 1**, not only will some existing transportation infrastructure need to be modified or relocated due to the effects of climate change, but transportation planning, construction, and maintenance also will need to increasingly account for the impacts of climate change.

Some Existing Transportation Infrastructure Requires Modification or Relocation to Remain Usable. As the climate changes, statewide transportation systems are already beginning to experience a range of impacts, such as sea-level rise undermining coastal railways and bridges, intense storms causing mudslides and flooding of highways, and heatwaves leading to buckling and rutting of roads. For the impacted roads, railways,

bridges, and ports to remain accessible, they will need to be modified or relocated. For example, to accommodate increased flooding, some roads need to be constructed with more drainage and certain railroads need to be diverted to higher ground. Implementing such changes will be costly.

New Infrastructure Will Have Shorter Lifespans Unless Transportation Planning Increasingly Accounts for Effects of Climate Change. Transportation infrastructure is typically planned to withstand once-in-a-century weather events. As the climate changes and extreme weather events become more common, maintaining transportation infrastructure’s expected usable lifespan will quickly become infeasible unless it is developed to be resilient to more frequent and intense stressors. For example, this will involve

adopting higher design standards to ensure the longevity and safety of transportation infrastructure given more prevalent flood risks. These higher standards likely will require using more complex forecasting data, based not solely on historical flooding patterns, but also informed by changing and anticipated conditions.

Existing Materials Likely Will Not Meet the Demands of Changing Conditions.

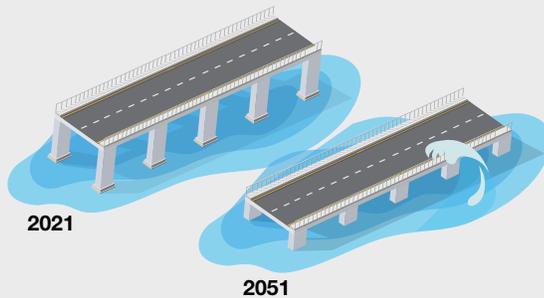
To adequately respond to extreme weather and climate-driven events such as heatwaves, flooding, and wildfires, transportation infrastructure needs to be stronger and more resilient to new stressors. Depending on the region, construction materials should change in response to the climate change threat that is most prevalent. For example, [research](#) suggests that a projected increase in average temperature of 4 degrees Fahrenheit over the next several decades will decrease the life expectancy of asphalt by 3 to 7 years for roads with a service life of about 20 years. As such, in areas where prolonged and extreme heatwaves are becoming more common, shifting to paving material that better reflects the sun may prolong the longevity of the roadways. In other regions where flooding and mudslides are becoming more frequent, roads likely will require more permeable materials.

Figure 1

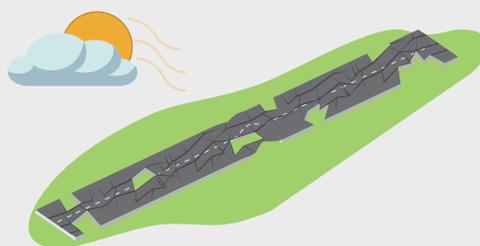
Key Ways in Which Transportation Infrastructure Is Impacted by Climate Change



Some existing transportation infrastructure requires modification or relocation to remain usable.



New infrastructure will have shorter lifespans unless transportation planning increasingly accounts for effects of climate change.



Existing materials likely will not meet the demands of changing conditions, and the maintenance needs of transportation infrastructure are changing.

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Maintenance Needs of Transportation Infrastructure Are Changing. To ensure the usable lifespan of transportation infrastructure is maximized, regular maintenance is essential. However, as the climate changes, the maintenance needs of different assets as well as the ability to work on transportation infrastructure are beginning to vary. For example, in areas that historically received a lot of snow, increasing

temperatures are reducing the need for snow removal work and extending the months of the year workers can complete work on various transportation infrastructure. Alternatively, extreme and prolonged heatwaves are beginning to damage roads through buckling and warping of pavement—requiring increased maintenance—as well as limiting the time maintenance workers can safely undertake projects during the day.

Significant Existing Efforts and Funding

The state has several existing efforts dedicated to addressing the climate change impacts on transportation infrastructure, including funding and research initiatives as well as department- and agency-led projects to assess climate-related vulnerabilities and plan for more climate-resilient transportation infrastructure. We highlight some of the most significant efforts below.

Chapter 5 of 2017 (SB 1, Beall) Provided \$20 Million for Climate Adaptation Planning Grants. Over three years, the California Department of Transportation (Caltrans) has awarded 61 grants on a competitive basis for local and regional entities to prepare for and reduce damage from climate change impacts on transportation infrastructure. Funded projects include vulnerability and needs assessments as well as regional climate adaptation plans.

Chapter 118 of 2016 (AB 2800, Quirk) Established the Climate-Safe Infrastructure Working Group. The Legislature directed the California Natural Resources Agency to convene a working group consisting of engineers, scientists, and architects to examine how to incorporate climate change impact data into state infrastructure planning, design, construction, operations, and maintenance. The working group **published** its findings in 2018.

Caltrans Has Engaged in Climate Change Vulnerability and Adaptation Planning Efforts. In 2019, Caltrans assessed the state highway system for climate change impacts, identifying segments of the system vulnerable to impacts such as precipitation, temperature, wildfire, storm surge, and sea-level rise. Using the findings from these vulnerability **assessments**, Caltrans **evaluated** the at-risk segments of the state highway system and studied the potential adaptation solutions. In addition to these district-specific efforts, Caltrans is incorporating climate resiliency into statewide action as well. For example, it is currently **updating** its statewide guidance on incorporating sea-level rise into its project development and delivery processes. Although the department has begun to engage in vulnerability assessment and adaptation planning, its efforts to ensure climate change is incorporated into project implementation processes are in the beginning stages.

California State Transportation Agency (CalSTA) Developed Climate Action Plan for Transportation Infrastructure. In response to Executive Order N-19-19, which called for CalSTA to leverage discretionary state transportation funds to reduce GHG emissions in the transportation sector and adapt to climate change, CalSTA developed ten guiding principles to leverage state transportation dollars to meet

the state's climate, health, and social equity goals. In July 2021, CalSTA adopted the final version of the *Climate Action Plan for Transportation*

Infrastructure. However, additional work is needed to ensure the agency implements these principles in allocating state transportation funds.

Key Issues for Legislative Consideration

Given the impacts of climate change on transportation, the state has an important role in ensuring the state's highway system and bridges—as well as local streets and roads—remain functional by incorporating necessary changes in planning, construction, and maintenance processes. Below, we provide several key questions for the Legislature to consider, including issues regarding funding, prioritization, and planning for the adaptation of transportation infrastructure, as well as the state's role in local development and implementation of such climate adaptation projects. We also summarize these issues in **Figure 2**.

How Do the Merits of Preparing for Changing Conditions Compare With the Consequences of Failing to Prepare?

Climate adaptation projects can be expensive and difficult. However, in many cases, efforts that

help to avoid future damages and costs could bring significant longer-term economic benefits for certain regions and the state compared to if they were not undertaken. For example, a national **study** found that \$1 of federal spending on pre-disaster mitigation projects for infrastructure yielded savings of \$6 in disaster recovery costs. In assessing the merits of climate adaptation proposals, the Legislature will want to ensure that transportation planning agencies also consider the costs of inaction to climate change—specifically, comparing up-front costs against the potential savings that adaptation projects could achieve over time. For instance, such an analysis should compare the potential cumulative costs of repeatedly rebuilding an erosion-prone stretch of highway to those associated with relocating it to a more stable location.

Figure 2

Climate Change Impacts on Transportation: Key Issues for Legislative Consideration

- ✓ How do the merits of preparing for changing conditions compare with the consequences of failing to prepare?
- ✓ How can the state avoid working at cross purposes with climate resiliency?
- ✓ How can the state incorporate climate change impacts into transportation infrastructure processes?
- ✓ How can the state support local development of climate-resilient transportation infrastructure?
- ✓ How should the state prioritize adaptation funding and projects?
- ✓ Which funding streams will be appropriate and sustainable to support climate-resilient transportation infrastructure?
- ✓ How can the transportation sector reduce greenhouse gas emissions and thereby potentially lessen the extent of climate change impacts?

How Can the State Avoid Working at Cross-Purposes With Climate Resiliency?

The state will want to avoid adopting policies or undertaking projects that might inadvertently make it more difficult to effectively adapt to the impacts of climate change. For example, if the state were to explore using new road construction materials that rely on recycled materials to meet one set of sustainability objectives, it would want to ensure such materials do not also significantly amplify heat and worsen the impacts of increasing temperatures. To avoid such unintended consequences, the Legislature will want to use a climate lens in considering new policies and projects along with other potential policy goals.

How Can the State Incorporate Climate Change Impacts Into Transportation Infrastructure Processes?

Caltrans should not only implement the adaptation solutions identified in its priorities reports (discussed above), but also continuously incorporate updated vulnerability assessments into future planning processes. Given that the time frame for developing transportation infrastructure is quite lengthy, how can the Legislature ensure up-to-date information on climate change impacts will be considered throughout the transportation planning, construction, and maintenance processes at Caltrans and the California Transportation Commission? How can the Legislature ensure that planning agencies' intentions to incorporate the effects of climate change into their processes manifest into effective action and implementation? How can the Legislature ensure that state transportation projects will be resilient, long-lasting, and a worthwhile investment of state funds? Should the Legislature play a greater role in establishing climate resilience goals and overseeing their implementation into transportation infrastructure processes?

How Can the State Support Local Development of Climate Resilient Transportation Infrastructure?

In addition to the climate adaptation of the state highway system, local and regional entities—such as transit agencies, cities and counties, regional planning organizations, and port authorities—will need to assess, plan, and implement strategies to make their transportation infrastructure more climate resilient. Policy levers the Legislature can consider include financial incentives for and technical assistance of adaptation planning efforts, directing safety and design standards to incorporate climate change impacts, removing administrative barriers to implementing climate adaptation projects, and directing state agencies to facilitate collaboration with local and regional entities on developing climate resilient transportation infrastructure projects. The Legislature can consider additional ways to ensure all local and regional entities are making progress towards climate adaptation, such as through setting goals and accountability measures.

How Should the State Prioritize Adaptation Funding and Projects?

Given that the potential costs for climate adaptation far outstrip available funding, the Legislature likely will want to require transportation planning agencies to integrate climate resiliency into how they prioritize and select projects. Prioritization factors could include the immediacy of expected climate impact, state ownership and responsibility, number of road users affected, public safety implications, and potential effects on surrounding land uses. In addition, the impacts of climate change will not be uniform across communities in California, and not all communities will be equally prepared and resourced to implement climate adaptation projects. As such, the Legislature may want to require transportation planning agencies to prioritize funding for communities that face the greatest risk and have less capacity to address climate threats without state assistance.

Which Funding Streams Will Be Appropriate and Sustainable to Support Climate-Resilient Transportation Infrastructure?

The costs associated with adapting the state transportation system to withstand the impacts of climate change likely will be greater than current expenditure levels for developing and maintaining transportation infrastructure. Furthermore, as vehicles become more efficient, gas tax revenues—which currently represent the primary source of state funds for transportation projects—may not provide as much funding for future efforts. Depending on the project, alternative funding sources such as the General Fund, federal funds, or other special funds could also be options to support climate resilience. For example, given that the state is receiving a significant influx of one-time federal funds for transportation infrastructure, the Legislature could consider dedicating some of these funds specifically for climate adaptation

projects. Additionally, the Legislature may want to consider developing new sources of funding, such as road charges where drivers pay for road maintenance based on the miles they drive (as explored by a pilot study established via Chapter 835 of 2014 [SB 1077, DeSaulnier]).

How Can the Transportation Sector Reduce GHG Emissions and Thereby Potentially Lessen the Extent of Climate Change Impacts?

As the largest contributor to California's GHG emissions, the transportation sector plays a significant role in the state's climate change mitigation efforts. To help minimize climate impacts, the Legislature will want to continue to explore how it can encourage the development of transportation infrastructure that promotes more efficient transit modes and reduces overall GHG emissions. Additionally, as it considers various transportation proposals, the Legislature will want to be mindful of the degree to which they might increase or decrease GHG emissions.

Conclusion

Climate change will have increasingly severe impacts on transportation infrastructure due to extreme heat, flooding, wildfires, and sea-level rise. Adequately addressing these impacts will be challenging, but the state can take actionable steps now to prepare, such as by better incorporating the impacts of climate change into its transportation funding, planning, construction, and maintenance processes.

The consequences of inaction will be severe and worsen over time, as the hazards of climate change become increasingly extreme. To ensure state and local transportation infrastructure continues to be functional and safe despite the growing threats posed by climate change, building upon and accelerating existing climate adaptation efforts will be critical.

LAO Publications

This report was prepared by Eunice Roh and Rachel Ehlers, and reviewed by Anthony Simbol. The Legislative Analyst's Office (LAO) is a nonpartisan office that provides fiscal and policy information and advice to the Legislature.

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