11 Barriers to Building Climate-Safe Infrastructure

AB 2800 stipulated, in Section 2 (c), that "[t]he Working Group shall consider and investigate, at a minimum, the following issues: (1) The current informational and institutional barriers to integrating projected climate change impacts into state infrastructure design." The topic of barriers was considered throughout the Climate-Safe Infrastructure Working Group's (CSIWG) deliberations and was also an integral part of the webinar series that supported the CSIWG's work.

In this Appendix, we summarize and discuss the barriers we have identified throughout this project. We list the full list of barriers that were discovered, organized by the stages in the adaptation process[312] (which are similar to the stages in an infrastructure lifecycle) and by type of barrier (for example, informational, institutional, financial etc.).

Adaptation Process		Types of Barriers			
Phase	**Stage**	**Informational**	**Capacity/skill**	**Attitudinal**	**Political**
Understanding	Just becoming aware of climate change risks	• Inconsistent risk information (FEMA vs. other flooding info) • Lack of knowledge who is unaware/uninformed so outreach can target those groups • Lack of a national or state climate information system	• Lack of attention to and knowledge about CC in general • General lack of systems perspective on CC risks to interrelated infrastructure	• Climate skepticism among engineers • Climate skepticism among decision-makers (and public) • Assumptions about the public • No leadership to shape public opinion • Lack of education • Perceived lack of urgency • Lack of motivation to get interested in and knowledgeable about CC risks and resilience • Culture does not value long-term thinking	• Declined federal leadership reduces importance • Greater need for state leadership on adaptation • Lack of leadership outside government
	Gathering info to better understand risks	• Lack of centralized data/ information repository • Demographic shifts variably well understood • Cascading and teleconnected impacts poorly understood • Compound risks only partially known • Lack of certain climate risk data • Env. response to CC only partially understood (e.g., SLR > coastal geomorphology, bathymetry) • Reduced federal investment in research funding to generate relevant information • Lack of dynamically updated, central data depository	• Lack of sufficient upfront engagement of scientists and engineers and planners to assess information needs • Lack of guidance/requirements on data • Lack of knowledge about global climate models • Social equity not a consideration from the start • Lack of requirement to prioritize CC > if capacity is limited > back-burner • Inappropriate use of scientific info (e.g. conflating precision with accuracy)	• Difficulty of moving from scenario approaches (top-down) to bottom-up approaches (RDM, scaling) • Initial impact assessments can be scary and overwhelming, thwarting commitment to a fuller assessment • Social equity typically not a consideration from the start • Designers not included from the start • Cultural heritage and historical resources and structures frequently ignored still in adaptation planning	• Lack of political will to look into issue • Challenging political climate • Lack of political backing of non-state-owned infrastructure owners (e.g., ports, airports) from state (executive or legislative side) in pushing to overcome federal barriers • Diverse political opinions about climate change can hinder regional collaboration
	Completed assessment of climate change risks	• Certain forward-looking science not available (e.g., precipitation data, development) or available but not useful • Methodological gaps • Lack of roadmap for identifying critical infrastructure/facilities in each sector • Scientific info not actionable • Use of rules of thumb vs. use of data • Floodplain mapping for state infrastructure is incomplete/ missing	• Lack of requirements for process of using data • Lack of systems thinking/ perspective • Lack of knowledge of what to do with CC information • Inadequate education of engineers on climate change and on range of professional skills for effective stakeholder engagement and multi-disciplinary team work • Lack of training on how to deal with uncertainty	• Skepticism of climate models • Inadequate public engagement in risk/vulnerability assessment	• Lack of political will to use forward-looking climate science • Lack of list of “choke points” in each infrastructure sector prevents issue rising as political priority

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Phase	**Stage**	**Informational**	**Capacity/skill**	**Attitudinal**	**Political**
Planning	Brain-storming range of options	• Insufficient funding for strategic planning and regional coordination • Only limited funding options considered • Temporal misalignment of available funding programs (difficulty in combining sources)	• FEMA requirement to rebuild to pre-disaster design and function unless the prevalent local code is more progressive • NFIP exempts historical structures from flood protection requirements, thus undermining that risks are fully assessed, planned for and mitigated • Legislation often without technical input so can be ill-informed and needs to be corrected through procedural guidelines and regulation	• Limited technical assistance to date • Lack of long-term planning for facilities • Lack of partnerships, delayed coordination in G/NBI projects	
	Completed assessment of potential options	• Limits of existing CBA methods • Limited ability to value non-monetary risks and benefits • Cost effectiveness requirements of most options • Tradeoff: cost vs. risk • Perception/reality that jobs are at risk	• ADA may restrict certain options • Historic preservation (ditto) • Prevalent codes and standards • Design immunity only if following existing standards • Lack of clarity on liability for CC risks • Lack of incentives • Lack of policy guidance • No requirement to use life cycle assessment informed by CC	• Lack of process to value resilience • Limited (sometimes lacking) cross-jurisdictional coordination among local, state, federal entities • Zoning inflexibility can inhibit cross-sector coordination • Lengthy delays from assessments to implementation (up to 20 years)	• Greater difficulty of integrating CC considerations in retrofits of existing infrastructure than in new infrastructure
	Selected subset of adaptation options assessment of climate change risks	• Higher upfront cost of climate-resilient designs • Long-term funding uncertainty • Unfunded mandates • Restrictions on use of disaster funding • Discount rates devalue the future	• Tight connection between standards and professional liability (reinforces risk aversion, maintaining current practice, even if no longer best practice) • Lack of clarity on who is liable when deviating from existing standards	• Lack of forward-looking standards • Old backward-looking/static standards • Contradictory standards • Competing rating systems	

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Phase	**Stage**	**Informational**	**Capacity/skill**	**Attitudinal**	**Political**
Managing	Begun implementing options (design & construction)	• Insufficient or unclear funding sources for G/NBI and other infrastructure • Failure or inability to combine/ coordinate different funding sources/agencies • Cost escalation in construction undermines implementation of sustainability/ resilience measures	• Rating systems not adopted as code • Lack of technical standards to guide implementation • Lack of bid criteria • Unclear authority over multi-jurisdictional G/NBI projects • Too much flexibility in laws creates uncertainty for implementation; people are not willing to be the first to test legal limits • Inadequate implementation of codes and standards • Lack of code enforcement	• Need for partnerships to implement multi-jurisdictional projects (added workload and complexity) • Permitting delays • Loss of Community Redevelopment Authorities (loss of coordination, power) • Existing standards and guidelines too restrictive	• Industry lag time in adopting new practices
	Operating, maintaining and monitoring performance of actions	• Lack of money for longitudinal tracking/ monitoring • Lack of funding to implement evaluation	• Lack of accountability that repair/ replacement actually happens • Lack of technical standards to guide evaluation • Lack of requirement to evaluated projects for climate change	• Changes in building use • No process to evaluate evaluation • No process to assess/evaluate risk management process	• Need for more demonstration projects and monitoring of effectiveness
	Evaluating and reassessing options	• Difficulty of keeping infrastructure current and in state of good repair	• Lack of performance goals • Lack of professional standards/ standards of care • Lack of accountability (esp. long-term) • Disconnect of accountability of owner/developer from accountability of designer > becomes a public liability	• Competing rating systems (old, mandatory and newer, voluntary) • Externalization of certain consequences > ignores systemic consequences	

Political Barriers	Rec. 1 Climate Safe Path for All	Rec. 2 Fund Climate Science	Rec. 3 Engineering/ science interaction	Rec. 4 Pre-develop-ment	Rec. 5 Stakeholder Engagement	Rec. 6 Climate-cognizant standards	Rec. 7 Equitable finance + better economic tools	Rec. 8 Workforce Development	Rec. 9 Standing CSIWG	Rec. 10 Policy for project translation
Lack of federal political leadership on climate change in general, resulting in de-prioritization at best and unhelpful controversy at worst, as well as inadequate progress on federal infrastructure investment						✓			✓	✓
Against a background of politicized debate and near-term priorities absorbing limited funds, lack of political will to prioritize climate change and commit to climate preparedness and adaptation										
Lack of political will to address past legacies of institutional racism, neglect of certain communities and to redress those infrastructure inequities now								✓	✓	
Inability to generate public support for infrastructure investment, including to effectively communicate costs and benefits										
Lack of commitment to aspects of infrastructure operation and maintenance (e.g. monitoring) if they don't generate political benefits						✓		✓	✓	✓
Lack of support for novel infrastructure designs (e.g., green/ nature-based infrastructure)										

Legal/Regulatory Barriers	Rec. 1 Climate Safe Path for All	Rec. 2 Fund Climate Science	Rec. 3 Engineering/ science interaction	Rec. 4 Pre-develop-ment	Rec. 5 Stakeholder Engagement	Rec. 6 Climate-cognizant standards	Rec. 7 Equitable finance + better economic tools	Rec. 8 Workforce Develop-ment	Rec. 9 Standing CSIWG	Rec. 10 Policy for project translation
Lack of policy guidance on what to plan for and how				✓		✓			✓	✓
Lack of rules and regulations that would foster/require consideration of climate change (e.g., no requirement to assess exposure to climate change; no requirement to use certain data, no requirement to do a life cycle assessment)										
Lack of design criteria, standards, performance goals/targets and guidelines for inclusion of climate change in infrastructure design, implementation, monitoring and evaluation						✓		✓	✓	✓
Lack of professional standards of care										
Lack of regulatory incentives (e.g., accelerated permitting)						✓		✓	✓	✓
Rating systems are not adopted as code (i.e. don't have regulatory power)										
Lack of code enforcement, including exemptions after disaster or in other special circumstances, and lack of accountability for inadequate designs or maintenance								✓	✓	✓

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Unclear jurisdiction where infra-structure crosses jurisdictional lines (including the possibility that different jurisdictions have different priorities, capacities and needs)						✓			✓	✓
Different or even contradictory standards and risk assessment ap-proaches (e.g., FEMA's recognition of certified levees only; NFIP's exemp-tion of historical buildings from flood protection requirements even in high-hazard zones)										
Existing laws and regulations that could or have already been experienced as limiting the consideration of climate change, even if infrastructure owners have been willing to do so						✓			✓	✓

Institutional Barriers	Rec. 1 Climate Safe Path for All	Rec. 2 Fund Climate Science	Rec. 3 Engineering/ science interaction	Rec. 4 Pre-develop-ment	Rec. 5 Stakeholder Engagement	Rec. 6 Climate-cognizant standards	Rec. 7 Equitable finance + better economic tools	Rec. 8 Workforce Develop-ment	Rec. 9 Standing CSIWG	Rec. 10 Policy for project translation
Differences in planning time horizons across levels of government or types of infrastructure				✓	✓			✓	✓	✓
General lack of longer-term planning										
Lengthy time from initiation to complete implementation of infrastructure projects (up to 20 years), (e.g. due to lengthy reviews and permitting)				✓		✓			✓	
Lack of processes for comprehensive valuation, evaluation, assessing the quality of risk assessment, risk management or evaluation approaches										
Competing rating systems (mandatory, voluntary) and competing standards (backward-looking/static standards, forward-looking standards)						✓			✓	
Externalization of certain consequences from systemic assessment										

Informational and Knowledge Barriers	Rec. 1 Climate Safe Path for All	Rec. 2 Fund Climate Science	Rec. 3 Engineering/ science interaction	Rec. 4 Pre-develop-ment	Rec. 5 Stakeholder Engagement	Rec. 6 Climate-cognizant standards	Rec. 7 Equitable finance + better economic tools	Rec. 8 Workforce Develop-ment	Rec. 9 Standing CSIWG	Rec. 10 Policy for project translation
Lack of knowledge and understanding in certain areas, requiring more research (e.g., in methods, adaptive design, trade-offs, value/benefits of resilient design) or cross-disciplinary education on existing knowledge							✓		✓	
Lack of investment in certain types of research and monitoring (e.g., no benchmarks, no M&E hence no understanding of performance; lack of metrics)										
Existing knowledge and approaches are contested (i.e. experts do not agree on what is most credible or reliable); as a result, practitioners avoid new/contested approaches or rely on outdated information and methods						✓		✓	✓	✓
Lack of information in usable/ actionable/standardized formats (including incomplete or missing information, inconsistent information or information is not available at the right temporal/spatial scale)										
Lack of (easy) access to information either because the data is proprietary, help by individual researchers or not in a centralized repository										
Lack of guidance on, and familiarity with, how to use data/information/ tools/methods appropriately										

Capacity/skill barriers	Rec. 1 Climate Safe Path for All	Rec. 2 Fund Climate Science	Rec. 3 Engineering/ science interaction	Rec. 4 Pre-develop-ment	Rec. 5 Stakeholder Engagement	Rec. 6 Climate-cognizant standards	Rec. 7 Equitable finance + better economic tools	Rec. 8 Workforce Develop-ment	Rec. 9 Standing CSIWG	Rec. 10 Policy for project translation
Inadequate/narrow/siloed disciplinary or sectoral perspectives on what are in fact systemic, interconnected challenges										
Widespread lack of engagement of scientists and engineers on climate change issues										
Lack of training in and guidance on assessing and interpreting uncertainty and making decisions under uncertainty										
Lack of skills and staff capacity in tracking performance, assessing non-monetary benefits										
Insufficient capability of translating policy and guidance into standards and codes										
Lack of sufficient knowledge about climate change, climate models and lack of expertise in or guidance on how to appropriately use climate data										
Lack of awareness of/education about resilient, adaptive and sustainable designs (including green/ nature-based infrastructure options)										
Lack of training in and guidance on effective stakeholder engagement and other professional skills										
Lack of awareness, familiarity and skill in considering social equity issues in infrastructure planning and decision-making from the start										

Attitidunal Barriers	Rec. 1 Climate Safe Path for All	Rec. 2 Fund Climate Science	Rec. 3 Engineering/ science interaction	Rec. 4 Pre-develop-ment	Rec. 5 Stakeholder Engagement	Rec. 6 Climate-cognizant standards	Rec. 7 Equitable finance + better economic tools	Rec. 8 Workforce Develop-ment	Rec. 9 Standing CSIWG	Rec. 10 Policy for project translation
Abiding skepticism of global climate models and sometimes even the reality of climate change										
Lack of acceptance of citizen science as valuable input to monitoring performance										
Neglect of social equity as a central concern, integrated from the start of infrastructure planning										
Perceived incompatibility of green/ nature-based infrastructure with prevailing professional norms										
Strict adherence to established professional norms resulting in resistance to innovation and experimentation										
Premature narrowing of the range of options considered due to assumptions about their public acceptance										
Lack of leadership and related, a pervasive lack of urgency about climate change and lack of commitment to invest in infrastructure										
Culturally prevalent attitudes that do not favor long-term thinking.										
Lack of willingness to pay for resilience (resulting from the above-mentioned attitudes)										
Lack of trust among stakeholders partly due to divergent values and priorities, partly due to past experience										
Varying levels of risk aversion/risk tolerance										

Financial Barriers	Rec. 1 Climate Safe Path for All	Rec. 2 Fund Climate Science	Rec. 3 Engineering/ science interaction	Rec. 4 Pre-develop-ment	Rec. 5 Stakeholder Engagement	Rec. 6 Climate-cognizant standards	Rec. 7 Equitable finance + better economic tools	Rec. 8 Workforce Develop-ment	Rec. 9 Standing CSIWG	Rec. 10 Policy for project translation
Lack of funding for every stage in the infrastructure lifecycle, including inadequate resources for infrastructure-related research, strategic planning, building infrastructure in general and green/nature-based infrastructure in particular; difficulty of keeping infrastructure in state of good repair (high maintenance costs); and lack of funding for monitoring systems and long-term, ongoing data collection										
Higher upfront cost, particularly of climate-resilient infrastructure										
Long-term funding uncertainty										
Limited funding options available or considered										
Lack of coordination among funding agencies; inability to coordinate or combine funding sources and types due to disconnected timing or other factors; and lack of funding for coordination										
Unfunded mandates										
Lack of monetary incentives to plan for climate change										
Restrictions on use of funds (e.g., disaster recovery funding) or constraining eligibility criteria										
High discount rates that devalue the future										
Difficulties related to valuing risks and benefits and thus with making the economic case for infrastructure investment										

Other Barriers	Rec. 1 Climate Safe Path for All as Policy	Rec. 2 Fund climate science assess-ments	Rec. 3 Engineering/ science interaction	Rec. 4 Better pre-develop-ment	Rec. 5 Stakeholder engagement	Rec. 6 Climate-cognizant standards + governance	Rec. 7 Equitable finance + better economic tools	Rec. 8 Workforce development	Rec. 9 Standing CSIWG	Rec. 10 Policy for project translation
Until recently, lack of a catastrophic weather-related events of the magnitude of Hurricanes Katrina (2005), Sandy (2012) or Maria (2017) in California to generate sufficient media, public and political attention and support for action (recent drought, wildfires, landslides and flooding may raise sufficient awareness)					✓					
Physical limitations related to existing infrastructure (i.e., greater difficulty of integrating climate change considerations in retrofits than in new infrastructure)										
Industry lag time in adopting new practices in design and construction				✓	✓	✓				✓
A general lack of demonstration projects, including monitoring of their effectiveness										