GHG REDUCTION MEASURES TOOLBOX
FOR
INTERNAL USE IN
CALTRANS PROJECT DEVELOPMENT

Abstract

This document was developed by the Division of Environmental Analysis (Office of Environmental Management). It provides tools for consideration of greenhouse gas reduction measures and climate change adaptation measures that can be used at the project level (TPSIS, PID and PA&ED) and demonstrate that climate change has been considered in project development. Additionally, the lists of measures may be used as mitigation for CEQA significant impacts related to GHG emissions.

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Background

With the passage of Assembly Bill (AB) 32, The Global Warming Solutions Act of 2006, California embarked on a progressive approach to combat the anticipated effects of climate change. Goals for reducing greenhouse gas (GHG) emissions and preparing for the negative impacts of climate change such as extreme weather events, changes in precipitation, and wildfire cycles are at the forefront of many laws, executive orders, and policies across the state.

Executive Order (EO) B-30-15, signed by former Governor Jerry Brown, directs all state agencies, including Caltrans, to implement measures, pursuant to statutory authority, to achieve reductions of GHG emissions that contribute to the effort to meet the 2030 and 2050 statewide GHG reduction targets. Additionally, this EO directs Caltrans to consider future climate conditions in all investment decisions.

Senate Bill 1 Section 2030(e) directs Caltrans "To the extent deemed cost effective, and where feasible, in the context of both the project scope and the risk level for the asset due to global climate change to better adapt the asset to withstand the negative effects of climate change and make the asset more resilient to impacts such as fires, floods, and sea level rise."

California Environmental Quality Act (CEQA) regulations and guidelines Section 15064.4 require analysis and determination of significance of a proposed project's GHG emissions.

Caltrans considers and integrates climate change through GHG reduction and adaptation strategies into Departmental decisions and activities because of various progressive statewide policies, legislation, and executive orders. Caltrans promotes measures, practices, and business operations to minimize GHG emissions. Caltrans implements this by incorporating climate change mitigation, adaptation, and energy efficiency strategies into the design and maintenance of our transportation system.

How you should use this GHG Reduction Measures Toolbox

The following tables are intended to provide a resource to assist Project Development staff in the consideration and inclusion of greenhouse gas reduction measures from Project Nomination (TPSIS) Project Initiation (PID) through project approval and environmental document (PA&ED) and construction of capital projects for which Caltrans is the CEQA lead agency.

The list of reduction measures should be reviewed, and all applicable measures shall be incorporated into the proposed project to ensure consistency with the direction outlined in Caltrans *Interim Guidance: Determining CEQA Significance for Greenhouse Gas Emissions for Projects on the State Highway System (April 2019)*.

Measures to reduce construction-related GHG emissions **must be included in all projects**. Not all listed measures will be feasible or relevant to every project, but all feasible measures must be included for every project. Examples of general construction emissions reduction measures that can be incorporated are listed in Table 1, Project-Level Measures to Reduce GHG Emissions Related to Construction Activities. Some of these measures are best considered early in the project development process and should be discussed with the project development team (PDT) and the design engineer.

Operational emissions refer to petroleum use by vehicles on the state highway system. Measures to address operational emissions are best considered in the planning or early development of the proposed project. If GHG emissions have been determined to have a CEQA significant impact, additional measures must be incorporated. At the early planning stages capacity-increasing projects should be assumed to increase GHG emissions and should plan for additional minimization or mitigation measures. Table 2, Project-Level Measures to Reduce Operational GHG Emissions, provides a list of potential measures.

Table 3 provides project-level measures to address adaptation to changes in sea level rise, precipitation and flooding, wildfire, and temperature that will pose hazards to transportation projects and assets.

The following measures have been reviewed and accepted by a committee of Headquarters Project Development staff to ensure applicability and ability to implement for Caltrans projects. These tables are not intended to represent all conceivable measures that exist to reduce GHG emissions. These tables may be reviewed periodically and revised as new information and technologies become available. If measures are proposed outside the tables in the Toolbox, the PDT (including design and construction) shall be consulted in the District to ensure measures are biddable, buildable, and can be successfully implemented.

Key concepts to consider when developing GHG Reduction Measures

Measures in this toolbox have been incorporated from many sources, but all include some of the basic principles of sustainable transportation as described below. These terms are provided for context and background information.

- **"Reducing[1]"** Includes processes that reduce the need for virgin paving and structural materials. Examples include soil stabilization methods to reduce the need for structural backfill or to reduce the required thickness of a new pavement or overlay; pavement preservation technologies that extend the life of existing pavements and reduce the need for new materials; bridge preservation technologies that extend the life of existing bridges and reduce the need for new structures and materials; retrofitting existing bridge structures to reduce the need for new structures and materials; or processes that incorporate existing pavement structures into new pavement structures ,such as crack-and-seat, to reduce the need for new materials and avoid the transportation of the existing used materials which would otherwise be removed from a project.

- **"Reusing"** is the reuse of a material or by-product from another industry for a new function in a transportation application. Examples of the beneficial use of industrial by-products include the incorporation of materials such as coal ash, fly ash, foundry sand, slag, asphalt shingles, construction and demolition materials, or other materials into a transportation project. These reused materials replace traditional materials with similar properties in specific applications. The reuse of these materials should assure that the engineering properties of the final product or mixture are equal to or better than those obtained from using traditional materials, and that their economic value is demonstrated in accordance with the FHWA Recycling Policy. Reused materials provide environmental benefit by reducing the unnecessary landfilling of these materials. With proper engineering, these materials can be successfully incorporated into transportation applications and provide economic value to our projects.

- **"Recycling"** is the use of old materials for a new and similar use in a transportation application, or the salvaging and reprocessing of previously used materials from other transportation applications into a new transportation project. Examples of recycling solutions include the incorporation of reclaimed asphalt pavement (RAP) and recycled concrete aggregate (RCA); cold-in-place recycling (CIR); hot-in-place recycling (HIR); and full depth reclamation (FDR). Also included are the salvage and recycling of aggregate, rock, asphalt, concrete, wood, metal (rebar, sign posts, signal poles, etc.), and other materials that have previously been used in other transportation applications and can be incorporated into a new project. Examples include the salvage and recycling of signposts,

[1] FHWA INVEST Sustainability Rating Tool https://www.sustainablehighways.org/122/project-development.html

signal poles, luminaries, rock or concrete used as rip-rap, and asphalt millings used as a shouldering material. For bridges, an example would be using recycled steel girders from a roadway bridge for a new pedestrian structure.

- **"Retrofit"** is defined as the addition of new features or technology to an older or existing facility. For example, a project would include retrofit components to reinforce structures to become more resistant and resilient to the forces of natural hazards and other environmental factors such as aging and weathering. It involves the consideration of changes in the mass, stiffness, damping, load path, and ductility of materials, as well as radical changes such as the introduction of energy absorbing dampers and base isolation systems.

Table 1: Project-Level Measures to Reduce GHG Emissions Related to Construction Activities

Note: All projects must incorporate measures to reduce GHG emissions related to construction activities.

Considered/ Included	Description
☐	Limit idling to 5 minutes for delivery and dump trucks and other diesel-powered equipment (with some exceptions).
☐	Schedule truck trips outside of peak morning and evening commute hours.
☐	Schedule longer-duration lane closures to reduce number of equipment mobilization efforts. (Combine with public information efforts for congested areas.)
☐	For improved fuel efficiency from construction equipment: • Maintain equipment in proper tune and working condition • Use right sized equipment for the job • Use equipment with new technologies
☐	Use alternative fuels such as renewable diesel for construction equipment.
☐	Use solar-powered construction equipment.
☐	Earthwork Balance: Reduce the need for transport of earthen materials by balancing cut and fill quantities. https://www.sustainablehighways.org/764/178/earthwork-balance.html
☐	Supplement existing construction environmental training with information on methods to reduce GHG emissions related to construction. https://www.sustainablehighways.org/122/project-development.html
☐	Use accelerated bridge construction (ABC) method. (Reduces construction windows, uses more precast elements that in turn reduce need for additional falsework, forms, bracing, etc.).
☐	Salvage rebar from demolished concrete and process waste to create usable fill.
☐	Maximize use of recycled materials (tire rubber for example).
☐	Salvage large removed trees for lumber or similar on-site beneficial uses other than standard wood-chipping. (Use in roadside landscape projects or green infrastructure components for example)
☐	Recycle existing project features on-site. (For example, MBGR, light standards, Sub-base Granular Material or native material that meets Caltrans specifications for incorporation into new work.)
☐	Reduce construction waste. For example, reuse or recycle construction and demolition waste (reduces consumption of raw materials, reducing waste and transportation to landfill; saves costs).
☐	Use recycled water or reduce consumption of potable water for construction.

Considered/ Included	Description
☐	Salvage or move buildings instead of demolishing. https://www.sustainablehighways.org/764/177/recycle-materials.html
☐	Select pavement materials that lower the rolling resistance of highway surfaces as much as possible while still maintaining design and safety standards.
☐	Specify Long-Life Pavement. Minimize life-cycle costs by designing long-lasting pavement structures. Consider future climate conditions in decisions. (For example, areas that are expected to experience increased temperatures and extreme heat days may have different pavement needs than areas expecting more frequent freezing temperatures) https://www.sustainablehighways.org/764/179/long-life-pavement.html
☐	Use permeable pavements to reduce "urban heat islands." The void structure of pervious concrete acts as insulation and prevents the pavement from storing heat that would otherwise raise air temperatures (resulting in a greater use of air conditioning in nearby buildings). http://blog.nwf.org/2009/12/permeable-concrete-reduces-emissions
☐	Specify cold in-place recycling. This pavement rehabilitation treatment is used on low traffic-volume, Hot Mix Asphalt (HMA) pavements to extend the pavement service life and to recycle natural resources. The treatment also reduces emissions and energy use associated with processing and hauling these materials. https://www.dot.ny.gov/programs/climate-change/activities
☐	Produce HMA using warm mix technology. https://www.fhwa.dot.gov/pavement/asphalt/wma.cfm
☐	Replace lighting with ultra-reflective sign materials that are illuminated by headlights to reduce energy used by electric lighting.

Table 2: Project-Level Measures to Reduce Operational GHG Emissions (emissions generated by use of the state highway system)

Considered/ Included	Description
☐	Measures to reduce Vehicle Miles Travelled (VMT).
☐	Measures listed in the applicable EIR prepared for the RTP/SCS that have been identified to reduce GHG emissions or to reduce VMT.
☐	Measures to improve energy efficiency.
☐	Use water-efficient technologies for landscaping, building operations, etc. such as drought-tolerant landscaping, drip irrigation with moisture sensors, and water-saving fixtures such as low-flow toilets in structures.
☐	Complete Streets components that make non-auto modes of transportation more attractive.
☐	Measures to support multi modal transportation that will offset project climate impacts: additional Park & Ride lots, bike lockers, bus-only lanes.
☐	Install solar power source to supply power to highway facility components or buildings.
☐	Maximize use of solar cells for point-of-use energy source. Give consideration to compatibility with existing structures.
☐	Installation of zero-emission vehicle (ZEV) infrastructure (e.g., electric vehicle charging stations).
☐	Select project features that minimize the need for irrigation and nonnative plants.
☐	Install urban planting/vegetation, especially canopy trees, to reduce “heat island” effects.
☐	Include project features that maximize planting of native tree species.
☐	Incorporate native plants and vegetation to the project design. Replace more vegetation than was removed to increase carbon sequestration.
☐	Avoid an ultimate (new trees at projected maturity) net loss of tree canopy within the project limits through a combination of preservation and new planting. Trees sequester carbon and provide cooling shade. • Replace removed trees at a minimum 1 to 1 ratio. • If overall available planting area has been reduced, compensate for trees lost with trees either nearby or off-site.
☐	Include landscaping components such as mulch and compost application to improve carbon sequestration rates in soils and reduce organic waste.
☐	Include mulch application around new and existing plants to retain soil moisture.

Considered/ Included	Description
☐	Include green infrastructure (planted areas such as swales and sidewalk planting areas) to treat storm water and facilitate infiltration on-site. Green infrastructure uses less raw material as compared to “gray” storm water treatment facilities (concrete, steel, plastic etc.), and has other livability and sustainability co-benefits. Local infiltration also reduces energy costs related to conveying and treating storm water through municipal systems.
☐	Select the project alternative that minimizes disturbance of undeveloped land.
☐	Design and install long-life pavement structures to minimize life-cycle costs. Consider future climate conditions in decisions. (E.g., areas that are expected to experience increased temperatures and extreme heat days may have different pavement needs than areas expecting more frequent freezing temperatures.)
☐	Incorporation of permeable pavements to reduce urban heat islands. The void structure of pervious concrete acts as insulation and prevents the pavement from storing heat that would otherwise raise air temperatures (resulting in a greater use of air conditioning in nearby buildings).
☐	Alternatives with balanced earthwork are desirable; reduces import/export of fill. Design goal of a balanced projected within 10%.
☐	Alternatives that match existing grade as much as possible are preferred; reduces earthwork.
☐	Balance alternatives against competing environmental constraints. (For example, a longer alignment may have a reduced overall impact on biological resources but increase VMT and GHG emissions.)
☐	Conduct workshops/advertising to promote use of mass transportation and carpooling.
☐	Conduct webinars or workshops with the public to improve awareness of inefficient driving habits and how to reduce individual climate change impacts.
☐	Incorporate infrastructure electrification into project design (e.g., electric vehicle charging; charging for electric bikes).
☐	Implement intelligent transportation systems and TDM elements to smooth traffic flow and increase system efficiency.

Considered/ Included	Description
☐	Implement Arterial Traffic Management Strategies: • Modify arterial roadways to allow more efficient bus operation, including bus lanes and signal priority/preemption where necessary. • Signal Synchronization: ○ Expand signal timing programs where emissions reduction benefits can be demonstrated, including maintenance of the synchronization system, and will coordinate with adjoining jurisdictions as needed to optimize transit operation while maintaining a free flow of traffic. • Coordinate controlled intersections so that traffic moves more efficiently through congested areas. • Where traffic signals or streetlights are installed, require the use of Light Emitting Diode (LED) technology or similar energy-efficient technology. Create an interconnected transportation system that allows a shift in travel from private passenger vehicles to alternative modes, including public transit, ride sharing, car sharing, bicycling, and walking.

Table 3: Project-Level Measures for Adaptation to Sea-Level Rise, Precipitation and Flooding, Wildfire, and Temperature Changes, and other climate change effects

Note: measures denoted with a * may not be applicable in the coastal zone. Consult with district coastal liaison.

Considered/ Included	Description
☐	Establish setbacks/buffers from areas identified as vulnerable to climate stressors (Wildfire, Sea-level Rise, etc.)
☐	Raise elevation
☐	Elevate mechanical/electrical equipment
☐	Retreat/Relocate
☐	Build/raise levee (engineered flood protection) *
☐	Construct floodwall (engineered flood protection) *
☐	Create berm
☐	Increase maintenance at flooding hotspots
☐	Use corrosion-resistant materials
☐	Retrofit/make waterproof
☐	Construct low-water crossings
☐	Create/restore/enhance wetlands
☐	Beach nourishment
☐	Improve drainage
☐	Construct shoreline armoring (engineered shore protection) *
☐	Build causeway
☐	Modify standards for the design, location, and construction of infrastructure to account for areas potentially subject to storm surge, sea level rise, and more frequent flooding.
☐	Include measures outlined in regional or local climate adaptation plans. For example: **Sacramento Region Transportation Climate Adaptation Plan (SACOG CAP)** http://www.sacog.org/sites/main/files/file-attachments/fullplanwithappendices.pdf
☐	Specify thermal zinc spray coating for steel corrosion retrofits in existing or newly identified splash zones (more viable retrofit option).
☐	Flooding: To minimize damage from the various chemical reactions …, constituent materials should be appropriately selected for the local conditions and projected exposure to increased temperatures and moisture.[5] (SACOG CAP, Appendix B, Flooding) (5 Willway et al. 2008. The effects of climate change on highway pavements and how to minimize them: Technical report.)

Considered/ Included	Description
☐	Green Infrastructure: wetlands restoration in coastal zone to mitigate storm surge exacerbated by SLR. Fund as a mitigation measure.
☐	Improve drainage systems to adapt to localized flooding risks.
☐	Stabilize slopes to lower chances of landslide on slopes at-risk from more frequent or intense wildfire and precipitation. (SACOG CAP, App. C)
☐	Permeable Pavement: Improve flow control and quality of storm water runoff through use of permeable pavement technologies. https://www.sustainablehighways.org/122/project-development.html (also see information in the INVEST tools ratings system for Materials, C38, Permeable pavements also reduce "urban heat islands")