1 March 2005

SR 520 Bridge Replacement and HOV Project Draft EIS

Appendix F

Energy

Discipline Report

Washington State Department of Transportation

Sound Transit

U.S. Department of Transportation Federal Highway Administration

SR 520 Bridge Replacement and HOV Project Draft EIS

Energy
Discipline Report

Prepared for

Washington State Department of Transportation
Federal Highway Administration
Sound Transit

Lead Author

CH2M HILL

Consultant Team

Parametrix, Inc.
CH2M HILL
Parsons Brinckerhoff
Michael Minor and Associates

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Acronyms and Abbreviations

Btu	British thermal unit
CEVP	cost estimating validation process
Draft EIS	Draft Environmental Impact Statement
MBtus	million British thermal units
mpg	miles per gallon
mph	miles per hour
VMT	vehicle miles traveled
WSDOT	Washington State Department of Transportation

Introduction

Why is energy considered in an EIS?

Project construction activities and the operation of vehicles on SR 520 consume large amounts of resources, particularly petroleum. This report estimates the amount of energy that would be consumed during construction of the project, and the amount of energy that would be consumed by vehicles operating within the project area under the No Build, 4-Lane, and 6-Lane Alternatives.

What are the key points of this report?

Based on data provided in the *Transportation Discipline Report*, contained in Appendix R of this EIS, operation of both the 4-Lane and 6-Lane Alternatives would consume less energy than the 2030 No Build Alternative. This conclusion results from the assumption that tolls would be charged for the build alternatives. Tolls are expected to result in fewer vehicle trips on SR 520 compared to the No Build Alternative.

Construction of the project would consume enough energy to meet the annual energy demands for 19,600 homes under the 4-Lane Alternative and 31,000 homes under the 6-Lane Alternative, respectively, for 9 years.

Exhibit 1. Project Vicinity Map

What are the project alternatives?

The SR 520 Bridge Replacement and HOV Project area comprises neighborhoods in Seattle from I-5 to the Lake Washington shore, Lake Washington, and Eastside communities and neighborhoods from the Lake Washington shore to 124th Avenue Northeast just east of I-405. Exhibit 1 shows the general location of the project. Neighborhoods and communities in the project area are:

- Seattle neighborhoods—Portage Bay/Roanoke, North Capitol Hill, Montlake, University District, Laurelhurst, and Madison Park
- Eastside communities and neighborhoods—Medina, Hunts Point, Clyde Hill, Yarrow Point, Kirkland (the Lakeview neighborhood), and Bellevue (the North Bellevue, Bridle Trails, and Bel-Red/Northup neighborhoods).

The SR 520 Bridge Replacement and HOV Project Draft EIS evaluates the following three alternatives and one option:

- No Build Alternative
- 4-Lane Alternative
  - Option with pontoons without capacity to carry future high capacity transit
- 6-Lane Alternative

Each of these alternatives is described below. For more information, see the *Description of Alternatives and Construction Techniques Report* contained in Appendix A of this EIS.

What is the No Build Alternative?

All EISs provide an alternative to assess what would happen to the environment in the future if nothing were done to solve the project's identified problem. This alternative, called the No Build Alternative, means that the existing highway would remain the same as it is today (Exhibit 2). The No Build Alternative provides the basis for measuring and comparing the effects of all of the project's build alternatives.

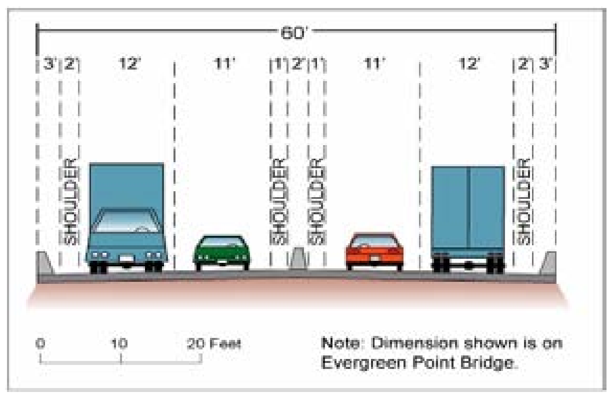


Exhibit 2. No Build Alternative

This project is unique because the existing SR 520 bridges may not remain intact through 2030, the project's design year. The fixed spans of the Portage Bay and Evergreen Point bridges are aging and are vulnerable to earthquakes; the floating portion of the Evergreen Point Bridge is vulnerable to wind and waves.

In 1999, the Washington State Department of Transportation (WSDOT) estimated the remaining service life of the Evergreen Point Bridge to be 20 to 25 years based on the existing structural integrity and the likelihood of severe windstorms. The floating portion of the Evergreen Point Bridge was originally designed for a sustained wind speed of 57.5 miles per hour (mph), and was rehabilitated in 1999 to withstand sustained winds of up to 77 mph. The current WSDOT design standard for bridges is to withstand a sustained wind speed of 92 mph. In order to bring the Evergreen Point Bridge up to current design standards to withstand at least 92 mph winds, the floating portion must be completely replaced.

The fixed structures of the Portage Bay and Evergreen Point bridges do not meet current seismic design standards because the bridge is supported on hollow-core piles. These hollow-core piles were not designed to withstand a large earthquake. They are difficult and cost prohibitive to retrofit to current seismic standards.

If nothing is done to replace the Portage Bay and Evergreen Point bridges, there is a high probability that both structures could fail and become unusable to the public before 2030. WSDOT cannot predict when or how these structures would fail, so it is difficult to determine the actual consequences of doing nothing. To illustrate what could happen, two scenarios representing the extremes of what is possible are evaluated as part of the No Build Alternative. These are the Continued Operation and Catastrophic Failure scenarios.

Under the Continued Operation Scenario, SR 520 would continue to operate as it does today as a 4-lane highway with nonstandard shoulders and without a bicycle/pedestrian path. No new facilities would be added and no existing facilities (including the unused R.H. Thompson Expressway Ramps near the Arboretum) would be removed. WSDOT would continue to maintain SR 520 as it does today. This scenario assumes the Portage Bay and Evergreen Point bridges would remain standing and functional through 2030. No catastrophic events (such as earthquakes or high winds) would be severe enough to cause major damage to the SR 520 bridges. This scenario is the baseline the EIS team used to compare the other alternatives.

In the Catastrophic Failure Scenario, both the Portage Bay and Evergreen Point bridges would be lost due to some type of catastrophic event. Although in a catastrophic event, one bridge might fail while the other stands, this Draft EIS assumes the worst-case scenario—that both bridges would fail. This scenario assumes that both bridges would be seriously damaged and would be unavailable for use by the public for an unspecified length of time.

What is the 4-Lane Alternative?

The 4-Lane Alternative would have four lanes (two general purpose lanes in each direction), the same number of lanes as today (Exhibit 3). SR 520 would be rebuilt from I-5 to Bellevue Way. Both the Portage Bay and Evergreen Point bridges would be replaced. The bridges over SR 520 would also be rebuilt. Roadway shoulders would meet current standards (4-foot inside shoulder and 10-foot outside shoulder). A 14-foot-wide bicycle/pedestrian path would be built along the north side of SR 520 through Montlake, across the Evergreen Point Bridge, and along the south side of SR 520 through Medina, Hunts Point, Clyde Hill, and Yarrow Point to 96th Avenue Northeast, connecting to Northeast Points Drive. Sound walls would be built along much of SR 520 in Seattle and the Eastside. This alternative also includes stormwater treatment and electronic toll collection.

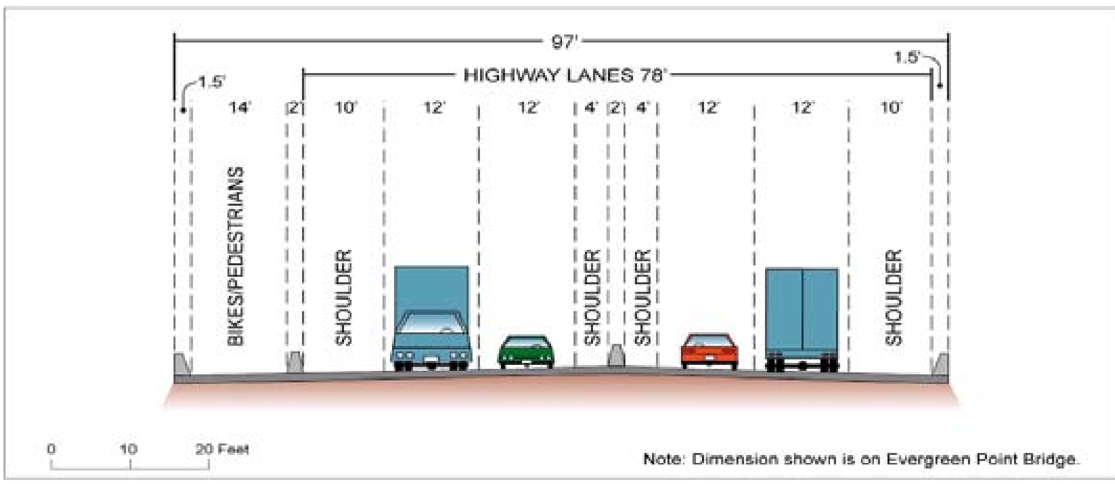


Exhibit 3. 4-Lane Alternative

The floating bridge pontoons of the Evergreen Point Bridge would be sized to carry future high-capacity transit. An option with smaller pontoons that could not carry future high-capacity transit is also analyzed. The alternative does not include high-capacity transit.

A bridge operations facility would be built underground beneath the east roadway approach to the bridge as part of the new bridge abutment. A dock to moor two boats for maintenance of the Evergreen Point Bridge would be located under the bridge on the east shore of Lake Washington.

A flexible transportation plan would promote alternative modes of travel and increase the efficiency of the system. Programs include intelligent transportation and technology, traffic systems management, vanpools and transit, education and promotion, and land use as demand management.

What is the 6-Lane Alternative?

The 6-Lane Alternative would include six lanes (two outer general purpose lanes and one inside HOV lane in each direction; Exhibit 4). SR 520 would be rebuilt from I-5 to 108th Avenue Northeast in Bellevue, with an auxiliary lane added on SR 520 eastbound east of I-405 to 124th Avenue Northeast. Both the Portage Bay and Evergreen Point bridges would be replaced. Bridges over SR 520 would also be rebuilt. Roadway shoulders would meet current standards (10-foot-wide inside shoulder and 10-foot-wide outside shoulder). A 14-foot-wide bicycle/pedestrian path would be built along the north side of SR 520 through Montlake, across the Evergreen Point Bridge, and along the south side of SR 520 through the Eastside to 96th Avenue Northeast, connecting to Northeast Points Drive. Sound walls would be built along much of SR 520 in Seattle and the Eastside. This alternative would also include stormwater treatment and electronic toll collection.

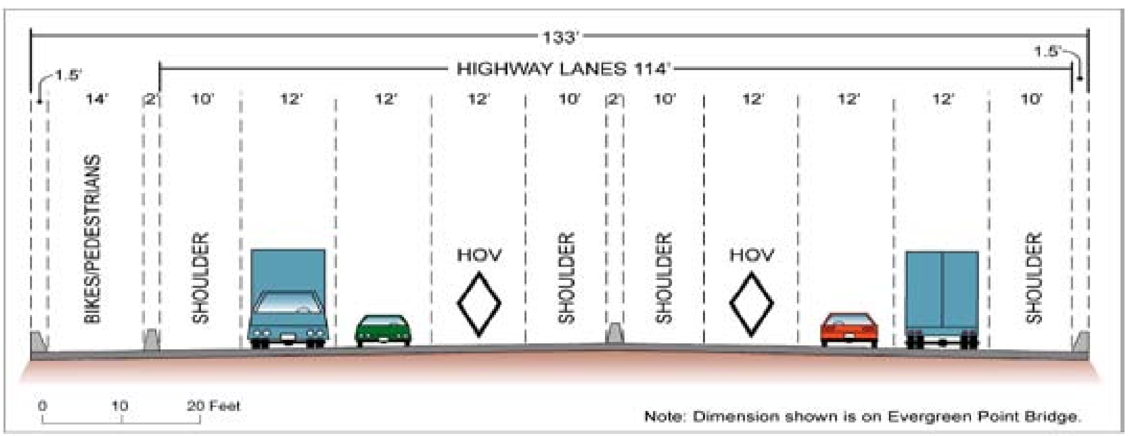


Exhibit 4. 6-Lane Alternative

This alternative would also add five 500-foot-long landscaped lids to be built across SR 520 to help reconnect communities. These communities are Roanoke, North Capitol Hill, Portage Bay, Montlake, Medina, Hunts Point, Clyde Hill, and Yarrow Point. The lids are located at 10th Avenue East and Delmar Drive East, Montlake Boulevard, Evergreen Point Road, 84th Avenue Northeast, and 92nd Avenue Northeast.

The floating bridge pontoons of the Evergreen Point Bridge would be sized to carry future high-capacity transit. The alternative does not include high-capacity transit.

A bridge operations facility would be built underground beneath the east roadway approach to the bridge as part of the new bridge abutment. A dock to moor two boats and maintain the Evergreen Point Bridge would be located under the bridge on the east shore of Lake Washington.

A flexible transportation plan would promote alternative modes of travel and increase the efficiency of the system. Programs would include intelligent transportation and technology, traffic systems management, vanpools and transit, education and promotion, and land use as demand management.

Affected Environment

What information was used to estimate energy use?

The energy discipline team calculated how much energy would be used under the proposed project based on vehicle miles traveled (VMT) estimates presented in the *Transportation Discipline Report*, which is contained in Appendix R of this EIS. The discipline team derived the amount of fuel efficiency (gallons per mile) from information prepared by the U.S. Department of Energy and the U.S. Environmental Protection Agency. The Energy Information Administration and the Washington State Department of Community, Trade, and Economic Development provided energy consumption information for the State of Washington.

The project area for the energy and the transportation analyses are the same; see the *Transportation Discipline Report* for more information.

What are the existing energy use characteristics of the project area?

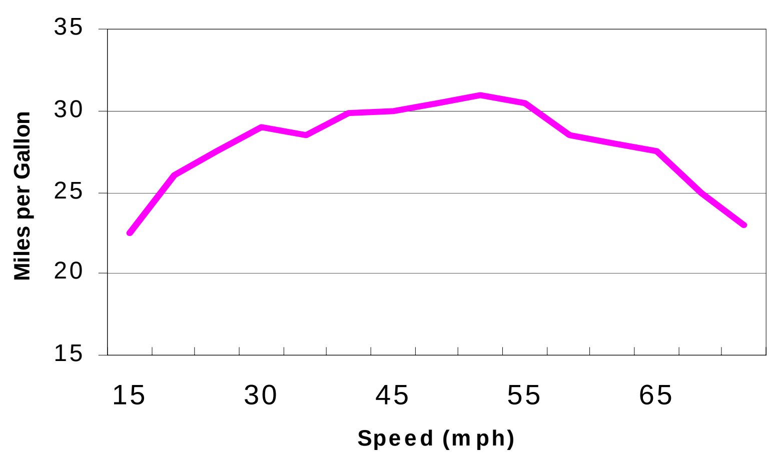
This report discusses the existing energy use characteristics at both the state level and the project level. Because detailed information about energy use in the project area is not available, the discipline team used the state-level trends to help determine energy consumption at the local level.

According to the Energy Information Administration, Washington state consumed over 2,173 trillion British thermal units (Btus) of energy in 2000, enough energy to meet the needs of nearly 24 million households. Petroleum use accounted for nearly 40 percent of the state's total energy consumption, and motor vehicles consumed over 2.63 billion gallons of gasoline (U.S. Department of Energy 2000).

Per capita vehicle travel in Washington has grown by 50 percent since 1970. In recent years, the increasing popularity of pickups, vans, and sport utility vehicles has reduced new vehicle fuel efficiency. Although Washington's economy is becoming less energy intensive because of improved technology and productivity increases, the state's overall energy consumption is expected to grow because of growth in population, jobs, and demand for vehicle travel (CTED 2002).

The SR 520 corridor is heavily used and frequently congested with traffic because it is one of only two crossings that serve the commuters and other travelers across Lake Washington. The congestion level indicates that the available roadway capacity is fully used and traffic is being forced to operate at lower speeds and with limited maneuverability. See the *Transportation Discipline Report* for a more detailed explanation of current traffic congestion.

Traffic congestion reduces fuel efficiency. Excessive idling and stop-and-go traffic conditions substantially reduce fuel economy compared to free-flow conditions. Exhibit 5 presents the average miles per gallon (mpg) for vehicles traveling at speeds between 15 and 75 miles per hour



Source: U.S. Department of Energy and U.S. Environmental Protection Agency (2004).

Exhibit 5. Average Automobile Fuel Consumption Rate

(mph). As shown on the graph, fuel efficiency is greatest when vehicles are traveling between 45 and 55 mph. Because of the current conditions in the corridor, there are many times throughout the day when the corridor is congested and vehicles are operating at inefficient speeds.

The traffic analysis in the *Transportation Discipline Report* describes the existing energy use characteristics of the project area, including daily VMT and the average speed of vehicles operating along the SR 520 corridor. The daily traffic numbers include vehicles traveling in both directions on a single corridor during a 24-hour period. The Puget Sound Region experiences nearly 3.1 million VMT every day over its freeways and arterials; most of these miles are freeway miles.

Today, SR 520 has become congested in both directions during the a.m. and p.m. peak periods because of a steady increase in daily traffic volumes and because the peak period travel times are longer. The p.m. peak period traffic accounts for nearly 24 percent of the total daily volume of traffic.

Because of traffic congestion, the average travel speed of vehicles driving in the project area is 34 mph. At that rate of speed, nearly 33.6 million gallons of fuel are consumed by vehicles in the project area each year. Exhibit 6 shows the formula used to convert the annual VMT into gallons and million Btus (MBtus). The result is approximately 4.65 million MBtus of energy consumed per year in the project area.

Exhibit 6. Existing Fuel Consumption in the Project Area

Alternative	Annual VMT (millions) [a]	Average Speed (mph) [b]	Fuel Consumption Rate (mpg) [c]	Gallons/Year (millions)	MBtus (millions)[d]
Existing Conditions	1,053	34	28.3	37.2	4.65

Source: *Transportation Discipline Report*; U.S. Department of Energy and U.S. Environmental Protection Agency (2004).

[a] An annualization factor of 345 (Adury pers. comm. 2004) was used to convert daily VMT to annual VMT.

[b] Average speed from *Transportation Discipline Report*.

[c] Fuel consumption rate (mpg) was estimated by interpolating U.S. Department of Energy data presented in Exhibit 4.

[d] 1 gallon of gasoline = 0.125 MBtus.

According to a Residential Energy Consumption Survey conducted by the U.S. Department of Energy in 2001, the average U.S. household consumed approximately 92.2 MBtus of energy annually. Thus, the existing annual energy consumed by vehicles operating in the project area is roughly equivalent to the annual energy use of approximately 50,500 households.

Potential Effects of the Project

What methods were used to evaluate the project's potential effects?

The energy discipline team estimated operational effects by calculating the total number of gallons of fuel consumed under each alternative. The team then estimated the vehicle fuel consumption for each alternative by applying the fuel consumption rates presented in Exhibit 7 to the VMT and average speed data reported in the *Transportation Discipline Report*.

Exhibit 7. Fuel Consumption Estimates in the Project Area by Alternative

Alternative	Annual VMT (millions) [a]	Average Speed (mph) [b]	Fuel Consumption Rate (mpg) [c]	Gallons/Year (millions)	% Change versus No Build 2030	MBtus (millions) [d]
No Build – 2030	1,315	29	28.7	45.8	0.0%	5.73
4-Lane – 2030	1,241	33	28.7	43.2	-5.7%	5.40
6-Lane – 2030	1,257	30	29.0	43.3	-5.4%	5.42

Source: *Transportation Discipline Report;* U.S. Department of Energy and U.S. Environmental Protection Agency (2004).

[a] An annualization factor of 345 was used to convert daily VMT to annual VMT.

[b] Average speed from the *Transportation Discipline Report*.

[c] Fuel consumption rate (mpg) was estimated by interpolating U.S. Department of Energy data presented in Exhibit 5.

[d] 1 gallon of gasoline = 0.125 MBtus

During project construction, energy would be consumed during the mining and production of construction materials and when transporting materials to the site. Operating and maintaining construction equipment would also consume resources. Construction-related effects were estimated by applying a highway construction energy factor to the total cost of each of the build alternatives.

How would the project permanently affect energy use?

This report bases its analysis of the direct effects on energy on projected year 2030 corridor traffic volumes and total VMT. Traffic volumes and average speeds for each alternative were obtained from the *Transportation Discipline Report*. Annual VMT was calculated by multiplying a factor of 345 days per year by daily VMT for the project area. Exhibit 7 presents estimates of annual fuel consumption during operation for each of the alternatives.

No Build Alternative

Under the No Build Alternative's Continued Operation Scenario, the annual VMT for the project area is forecast to be approximately 1.32 billion miles in 2030. This annual VMT is expected to be higher than either of the build alternatives because the tolls that would be assessed under the build alternatives would reduce the number of vehicles using the Evergreen Point Bridge. Vehicles operating in the project area would consume about 45.8 million gallons of fuel per year, or 5.73 million MBtus of energy. The energy consumed by vehicles under this alternative would meet the energy needs of an estimated 62,100 households.

Under the Catastrophic Failure Scenario, the regional VMT would increase as traffic would be diverted to other routes that connect Seattle to the Eastside. Because a failure of the bridges would reduce the number of crossing points, congestion would likely increase in the region, resulting in slower average speeds on the region's freeways and arterials. On average, use of these alternative routes would result in longer trips as well. The increased congestion and longer trip lengths would cause vehicles to operate inefficiently and would likely result in a substantial increase in the consumption of fuel when compared to the other alternatives.

4-Lane Alternative

In 2030, the 4-Lane Alternative is projected to result in 1.24 billion VMT in the project area. Vehicles are forecast to travel at an average speed of 33 mph and to consume an estimated 43.2 million gallons of fuel, which is approximately 5.7 percent less than the 2030 No Build Alternative. The 4-Lane Alternative is expected to have the lowest energy consumption of any of the alternatives; fuel would consume approximately 5.40 million MBtus of energy, enough to meet the annual energy needs of approximately 58,600 households.

6-Lane Alternative

In 2030, the 6-Lane Alternative is projected to result in 1.26 billion VMT in the project area. The average speed would be 30 mph, and vehicles would consume 34.3 million gallons of fuel, a reduction of 5.4 percent when compared to the No Build Alternative. The fuel used in the 6-Lane Alternative would consume 5.42 million MBtus of energy, enough to meet the annual energy needs of approximately 58,700 households.

How would project construction temporarily affect energy use?

During construction of the project, energy would be consumed during the mining and production of construction materials and when transporting materials and equipment to the site. Operating construction equipment and providing construction lighting would also consume energy resources. The amount of energy used during the construction of a project would be roughly proportional to the size of the project.

For this analysis, the energy discipline team estimated energy consumption during construction by applying a construction energy consumption factor to the total project costs. Energy consumption calculations reported in this analysis are for the entire construction period. The California Department of Transportation derived energy consumption factors for different roadway facilities in the 1983 report *Energy and Transportation Systems*; these are still widely used in the industry today. For this analysis, the energy consumption factors for urban freeway, bridge, and interchange were used to estimate the energy consumed during the project. The consumption factors were reported in MBtus per thousand dollars of construction spending.

The discipline team used a 90 percent risk cost, which was estimated during WSDOT's Cost Estimating Validation Process (CEVP), to calculate energy consumption during the construction period. The total construction cost estimate is $1.64 billion for the 4-Lane Alternative and $2.41 billion for the 6-Lane Alternative. Construction costs were then allocated between roadway, bridge, and interchange structures. Cost estimates are in 2011 dollars and represent the mid-point of expenditure for the project.

Exhibit 8 presents total energy consumption for construction of the build alternatives. The energy consumed during construction would be spread out over the entire construction period. The 4-Lane Alternative would consume approximately 16.2 million MBtus, and the 6-Lane Alternative would consume approximately 25.7 million MBtus. This amount of energy would meet the annual energy demands of

19,600 homes and 31,000 homes under the 4-Lane and 6-Lane Alternatives, respectively, for 9 years.

Exhibit 8. Total Energy Consumption During Construction

Alternative	Construction Cost (2011 Dollars in millions)	Mbtus (millions)
4-Lane	$1.64	16.2
6-Lane	$2.41	25.7

Notes: Construction costs reflect the estimated mid-point of expenditure for the project.
A 90 percent risk cost was used to estimate construction energy consumption.

Mitigation

No operational mitigation measures are anticipated because each of the build alternatives results in net savings in energy consumption when compared to the No Build Alternative. Construction plans should make every attempt to minimize roadway congestion and should adhere to construction practices that encourage efficient energy use, such as limiting idling equipment, encouraging construction workers to carpool, and locating staging areas near work sites.

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