Alternatives Analysis Report

Appendix B

Review of Advanced Technology Options

Technical Memorandum

Metro

TECHNICAL MEMORANDUM

SR 710 Study – Review of Advanced Technology Options

PREPARED FOR:	Metro
COPY TO:	California Department of Transportation
PREPARED BY:	CH2M HILL Team
DATE:	September 22, 2012
PROJECT NUMBER:	428908

Introduction

This technical memorandum is a review of Advanced Technology options as part of the State Route 710 (SR 710) Alternatives Analyses. The SR 710 Alternatives Analyses has applied a process for development and screening of alternatives. The process included a preliminary screening to establish a preliminary set of 42 alternatives; an initial screening that resulted in an initial set of 12 remaining alternatives; and a secondary screening that resulted in alternatives for environmental review. An Advanced Technology Alternative was evaluated previously as part of the initial screening of 42 alternatives, and the results were presented in the memorandum to the Technical Advisory Committee (TAC): *SR 710 EIR/EIS – Draft Results of Initial Evaluation*, dated March 28, 2012. This topic was presented at the TAC meeting on April 4, 2012.

A total of 29 advanced technology options were considered during the preliminary screening as listed in Attachment 1. The conclusion that was reached from the initial evaluation was that the Advanced Technology Alternative did not perform well as a stand-alone alternative for meeting the project needs. The decision was made at that time to further review the advanced technology options to identify concepts that could be combined with the other alternatives to improve the performance of those alternatives. As a result of the initial screening, the following advanced technology options were identified for further evaluation during conceptual engineering:

- On-Line Electric Vehicles
- Inherently Low Emission Vehicles
- Dual-Mode Systems
- Vehicle Platooning

In addition to these options, Intelligent Transportation System (ITS) options were also considered in the preliminary screening of advanced technology options. The ITS technologies were included as part of the Transportation Systems Management/Transportation Demand Management (TSM/TDM) Alternative. Other advanced technology options, such as tolling/pricing technologies for application to highways, have also been identified for further consideration as listed in Attachment 1.

Assessment of Four Advanced Technology Options as part of the Secondary Screening

Included below is an assessment of the four advanced technology options that was conducted during the secondary screening and a recommendation regarding options to incorporate into the remaining alternatives.

On-Line Electric Vehicles

Online Electric Vehicles (OLEVs) use a new technology to supply power to electric vehicles. Instead of a conventional electric vehicle that requires a plug-in charge and a large battery for storage, the OLEV can pick up power from underground recharging strips imbedded in the roadway. The recharging strips have powerful magnets that provide a charge to the vehicle without any direct contact. Removing direct contact from the charging source prevents electrical shock hazards and is safe for pedestrians and other non-electric vehicles. The OLEV can be recharged while in motion, avoiding delays by having to stop or idle to recharge. The recharging strip only needs to be present along 20 percent of the vehicles' route, at locations such as bus stops, parking lots, and intersections. The OLEV battery is one-fifth the size of a conventional electric vehicle (EV) battery, which also makes the OLEV lighter and less expensive.

Currently one OLEV train is in operation at Seoul Grand Park in Gwacheon City, South Korea (Figures 1 and 2). The OLEV train consists of one engine and three passenger cars and travels along a 1.36-mile trackless route. The route contains four sections of power supply infrastructure that comprise 16 percent of the route's total distance. The Korean Advanced Institute of Science and Technology (KAIST) introduced an experimental bus route in 2011, with an eventual rollout of a commercial product by 2013. Nissan is also currently developing an experimental OLEV.

FIGURE 1 and 2. South Korea's OLEV train at Seoul's Grand Park (Source:http://www.csmonitor.com/World/2010/0312/Korea-OLEV-concept-vehicles-sees-the-future-and-it-s-magnets and http://www.ecofriend.org/entry/eco-cars-kaist-s-olev-an-electric-car-sans-batteries/)

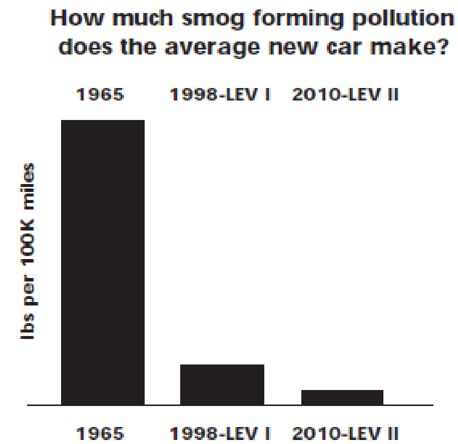
Application of OLEV technology could be used for any mode of transportation: automobiles, transit, and freight. However, the challenge is developing the matching technology for both the infrastructure and vehicles. The recharging strips would need to be integrated throughout the roadway infrastructure. Special electric vehicles with capability for recharging from the strips would be necessary to enable a system of OLEVs to function. The OLEV concept is not really a new means for providing additional mobility and access to meet the SR 710 Study needs. It is more a new means for power distribution to vehicles that could reduce local/regional emissions impacts due to transportation. The OLEV technology does not move people or therefore reduce congestion. Even if OLEV systems were installed throughout the study area, the same number and types of vehicles would still be required to meet travel demands. Because the OLEV concept requires unique modifications to the transportation infrastructure and special vehicles, this technology would not be practical for application in the SR 710 Study, except possibly along bus transit lines.

Inherently Low Emission Vehicles

To meet incremental reductions in emissions, the state of California has implemented the Low-Emission Vehicle (LEV) programs administered by the California Air Resources Board (CARB). The LEV requirement was adopted in 1990 and has been amended twice as vehicle emissions technology has evolved, and to meet stepped emissions goals.

The LEV amendments expand the level of emissions and the type of vehicles that must meet the standards. These standards are expected to reduce overall smog-forming emissions by 57 tons per day in the Los Angeles Basin alone.

Inherently Low-Emission Vehicles (ILEV) is a definition established specifically as part of the Clean Air Act Amendments which created the ILEV program. The Transportation Efficiency Act of the 21st Century (TEA-21) allowed states to authorize ILEVs to use high-occupancy vehicle (HOV) lanes without meeting the occupancy requirements. The United States Environmental Protection Agency administers the certification, labeling, and other regulatory provisions of the ILEV program and maintains an updated list of certified ILEVs on their website (http://www.epa.gov/otaq/cff.htm). This certification applied most broadly to hybrid vehicles; however, the category of low emission and energy-efficient vehicles also includes alternative fuel vehicles. Alternative fuel vehicles are vehicles that operate solely on methanol or other alcohols; a mixture of at least 85 percent methanol or other alcohols, natural gas, liquefied petroleum gas, hydrogen, coal derived liquid fuels, fuels derived from biological materials; or electricity. Recent and emerging technology has increased the number of not only automobiles but also light-duty trucks and transit that fit this category. Under these provisions states were also allowed to impose more stringent requirements in either fuel economy or emissions.



A new 1965 car produced about a ton of smog-forming hydrocarbons during 100,000 miles of driving. California's low-emission standards have cut that to around 50 pounds for the average 1998 car. LEV II would further reduce emissions from the average new 2010 car to approximately 10 pounds.

FIGURE 3 Emissions Reductions (Source: CARB, February, 1999)

CARB has further classified and defined ILEV into the following categories:

- Low-Emission Vehicles,
- Ultra-Low-Emission Vehicles (those that are 50 percent cleaner than average vehicles),
- Super-Ultra-Low-Emission Vehicles (SULEV) (90 percent cleaner than average),
- Partial Zero-Emission Vehicles (PZEV) (similar to SULEV, 15 year/150,000-mile warranty, and zero evaporative emissions as well as some advanced technology components) and
- Zero-Emission Vehicles (ZEV) (that have no emissions and are typically electric or hydrogen fuel cell vehicles).

Incentives offered through CARB to consumers for purchasing these LEVs include vehicle purchase rebates (Clean Vehicle Rebates) and use of HOV facilities as a single-occupant vehicle (SOV). The California Department of Motor Vehicles regulates LEVs that can use the HOV facilities as an SOV through the use of a color-coded program where stickers are attached to cars allowing them to use the HOV lanes. Three sticker categories were established for vehicles:

- Yellow, which were available to hybrids for HOV use until July 1, 2011,
- White, which are PZEV and Compressed Natural Gas (CNG). These stickers will expire on January 1, 2015
- Green (which is limited to only 40,000) meets the California Advanced Technology PZEV requirement (AT-PZEV).

An ILEV option as a stand-alone alternative for the SR 710 Study would involve dedication the north-south highway and street network or developing new dedicated facilities specifically for ILEVs. Development of an exclusive ILEV alternative would require consideration of alternative fueling for both electric and hydrogen. Additional considerations of an all-ILEV alternative would also need to take into account longer-term evolution of emission standards to meet clean air requirements. As emission standards change demand will also fluctuate as consumers react to vehicle emission standards and entry restrictions. For example, in the future as more vehicles meet the standard, operation of the facility will be affected, reducing the incentive to purchase the vehicles.

LEV technology has application for all transportation modes: automobiles, transit, and trucks. The ILEV concept is a means to reduce the emission impacts due to transportation rather than a new technology to provide mobility or access. Promotion of ILEVs will more likely be accomplished through regional, state, or federal legislation rather than on specific projects. Depending upon the SR 710 study alternative that is selected, incentives or priorities may be given to users of ILEVs. Exempting ILEVs from highway HOV eligibility requirements for would require more total vehicles to support total travel demands.

Dual-Mode Systems

Dual-mode systems aim to combine the possibility of automated driving with the manual control by a driver. Where there is a requirement for the system to be in automated mode, the system ensures the most efficient use of space, while in other areas personal control is accommodated to ensure optimum freedom.

The concept of a dual-mode vehicle that will run on tram or train tracks and is also capable of driving on the road is being applied in the European AutoTram concept (Figure 4). The Autotram can be up to 36 meters long and can carry as many passengers as a streetcar while being as versatile as a bus. One of the key aspects of the Autotram is its flywheel energy storage system that facilitates a regenerative braking system and significantly cuts operating costs.

FIGURE 4. Dual-Mode AutoTram Concept (Source: http://www.advancedtransit.org)

The Adelaide O-Bahn Busway is a guided busway located in Adelaide, Australia (Figure 5). The O-Bahn – from the Latin omnibus ("for all people") and the German bahn (railway, as in S-Bahn and U-Bahn) – was conceived by Daimler-Benz to enable buses to avoid traffic congestion by sharing tram tunnels in the German city of Essen. The route was introduced in 1986 to service Adelaide's rapidly expanding northeastern suburbs, replacing an earlier plan for a tramway extension.

FIGURE 5. Dual-Mode Adelaide O-Bahn Busway (Source: http://www.abc.net.au/news/stories/2009.htm)

The O-bahn design is unique among public transport systems; busways typically use dedicated bus lanes or separate roadways, but the O-Bahn runs on specially built track, combining elements of both bus and rail systems. Adelaide's track is 12 kilometres (7.5 miles) long and includes one station and two interchanges.

Interchanges allow buses to enter and exit the busway and to continue on suburban routes, avoiding the need for passengers to change. Buses travel at a maximum speed of 100 kilometers per hour (62 miles per hour) along the track. The buses operate both on the track and on normal roadways; special guide wheels on the buses are used to keep the buses within the track.

The Dual-Mode concept could be applied to all modes- automobiles, transit, and freight, although the applications that have been implemented so far are only for transit. The advantages of the Dual Mode concept are the ability to control and optimize operations of the guideway (increase speed, capacity and improve safety) while in operation while also offering the flexibility of entering/departing the guideway at locations to enable access to areas beyond the guideway. The disadvantages of the dual-mode concept are that special infrastructure (guideway) and vehicles are required. The Dual-Mode concept would be impractical for application to all modes and highways and streets in the Study Area. If the Dual-Mode concept were to be applied to a Bus Rapid Transit (BRT) Alternative, the BRT line would need to be on exclusive, separate right-of-way.

Vehicle Platooning

Grouping vehicles into platoons is a method for increasing capacity of transportation systems. For highways, platooning can be accomplished using the Intelligent Transportation Systems technology known as automated highway systems. The purpose of using this technology is to increase traffic flow by reducing following distances and headway, thus allowing more vehicles to occupy a given stretch of road. The tight spacing of vehicles also provides aerodynamic benefits with less wind resistance to the vehicles in the platoon.

An example demonstration of this technology was applied as a prototype by the California Partners for Advanced Transit and Highways (PATH) program in 1997 along a portion of I-15 in San Diego, California (Figure 6). The PATH platooning demonstration used sensory technology in the vehicles that read passive, magnetic road markings, and used radar and inter-vehicle communications to form the platoons without intervention of drivers.

FIGURE 6. Vehicle Platooning and Automated Highways, California PATH

More recent platooning technology development has moved toward autonomous intelligent vehicles without the requirement of building specialized infrastructure. Several vehicle manufacturers are developing autonomous cruise control system technologies for their vehicles (http://www.memagazine.org/May98). The Safe Road Trains for the Environment (SARTRE) Project is a project being demonstrated in Europe to investigate platooning on unmodified Roadways. This project has successfully demonstrated platooning in 2011 (http://www.bbc.co.uk/news/technology-12215915).

As noted in Attachment 1, ITS research is being sponsored by the United States Department of Transportation (USDOT) on a program called IntelliDrive. This program is to employ a system of wireless connectivity between vehicles and roadway infrastructure. The benefits that are being investigated include improved fuel efficiency, improved safety, and potentially reduced traffic congestion through distribution of information within the traffic network to improve routing of traffic. While no applications of IntelliDrive are currently in practice, USDOT expects to complete the majority of their research by 2013 and then begin to deploy the technologies that are ready.

While there is great potential for application of advanced technologies to achieved platooning of vehicles in highways, the technology is still under development. These technologies would have application to limited access facilities such as the freeway alternatives. However these technologies have not yet been fully demonstrated and implemented in actual, complex, urban conditions.

Conclusions Regarding Application of Advanced Technology Options

Attachment 1 to this memorandum includes details on some potential advanced technologies that will be considered later in project development for some of the build alternatives if they are selected. Also shown in the attachment are advanced technologies under the category of ITS, which were further evaluated as part of the TSM/TDM Alternative in the SR 710 Study Alternative Analyses. Examples of those technologies included Active Traffic Management and Traveler Information Systems.

In addition to these advanced technologies, the Los Angeles County Metropolitan Transportation Authority (Metro) and the California Department of Transportation (Caltrans) continuously review and apply appropriate advanced technologies as they become available and when demonstrations and tests show these technologies to be cost-effective. Examples include the full array of ITS technologies that are currently being applied to the regional highway and transit systems, the transit fare card payments systems, highway tolling technologies, and new lower emissions bus technologies (hybrids and compressed natural gas).

The table below summarizes the recommendations regarding the four advanced technologies that were evaluated during the secondary screening for the SR 710 Alternative Analyses. After evaluation of these four technologies, the conclusion has been reached that the four technologies evaluated below have limited application for the SR 710 alternatives. The Online Electric Vehicle and Vehicle Platooning technologies have not been demonstrated and tested to a level that they can be applied to the SR 710 Study. The Online Electric Vehicle and ILEV technologies do not reduce congestion or provide additional mobility. The Dual-Mode technology could be applied to BRT, although a fully exclusive right-of-way would be required. Some of these technologies will be dependent upon further development by manufacturers or State and Federal legislation.

TABLE 1
Recommendations Regarding Four Advanced Technologies

ID No. from Advanced Technology Attachment(*)	Technology Name and/or Description	Assessment Regarding Application of Technology Option for SR 710 Alternatives	Recommendations Regarding Options to Incorporate into Remaining Alternatives
1	Online Electric Vehicle Technology - electric power from roadway strips	This technology has been used on a limited application to power transit vehicles on exclusive guideways. Technology requires special modifications to infrastructure. Not practical for use on roadways unless this technology becomes the common technology that manufacturers incorporate for providing power to private vehicles. Does not reduce congestion or provide additional mobility.	Remove from further consideration in SR 710 Study.

TABLE 1
Recommendations Regarding Four Advanced Technologies

ID No. from Advanced Technology Attachment(*)	Technology Name and/or Description	Assessment Regarding Application of Technology Option for SR 710 Alternatives	Recommendations Regarding Options to Incorporate into Remaining Alternatives
5	Inherently Low-Emissions Vehicles – vehicles using battery electric, hydrogen fuel cells, or compressed/liquid natural gas	This is either a regional, state, or national policy decision to promote Inherently Low-Emissions Vehicles, or a market change where this becomes the predominant technology used for private vehicles. Does not reduce congestion or provide additional mobility.	Continue to apply low emissions technologies for transit vehicles within alternatives that are selected for further development and environmental review.
7	Dual-Mode Systems – similar to PRT systems except enabled to run manually off guideways	Technology requires special modifications to infrastructure. Not practical for use on roadways unless this technology becomes the common technology that manufacturers incorporate for providing power to private vehicles.	Will be considered later as part of a “hybrid” Bus Rapid Transit alternative if the BRT alignment is on an exclusive right-of-way.
8	Vehicle Platooning – automatic control of vehicles in platoons	This technology is still under development and is not ready for deployment. Not practical for use on roadways unless this technology becomes the common technology that manufacturers incorporate for providing automatic control of private vehicles.	Technology has potential and should be evaluated further as testing and demonstrations evolve. However this technology has not been yet been implemented in an actual, complex, urban condition and therefore cannot be confirmed and selected for application for the SR 710 Study.

(*) ITS technology options from Attachment 1 were incorporated into the TSM/TSM Alternative. Other advanced technologies from Attachment 1 will be considered further during project development for alternatives during preliminary engineering. An example are the Pricing/Tolling technology options which will be evaluated for application on the Freeway Alternative.

Attachment 1 – List of Advanced Technologies Initially Considered for the SR 710 Study

This attachment shows the advanced technologies that were initially considered for application on the SR 710 Study. The table below describes 29 advanced technologies, as well as the mode(s) that the technology could apply to (auto, transit, and freight). The technologies are grouped into the following categories: Vehicle / Guideway Technologies (IDs 1 to 15), ITS Technologies (IDs 16 to 24), and Pricing / Tolling Technologies (IDs 25 to 29). Also included in the table is an assessment of the reasonability of each technology for application to the SR 710 for meeting the study needs.

Based upon the initial evaluation of these Advanced Technologies, the finding was that the Advanced Technology Alternative would not perform well as a stand-alone alternative for meeting the SR 710 needs. The technologies would potentially be supportive to other build alternatives that are being considered. A decision regarding the appropriate application of these technologies would generally be made later in the design development for alternatives. Advanced Technologies 1-Online Electric Vehicles, 5-Inherently Low-Emissions Vehicles, 7-Dual-Mode Systems, and 8-Vehicle Platooning were recommended for further consideration during the secondary screening for the SR 710 Alternatives Analyses. In addition to these technologies, others were identified as potential technologies that could be considered later in project development for application in certain modal alternatives if alternatives are selected. Some of the technologies listed below (in Table A1) were judged to have no application in the SR 710 study due to either not meeting the project needs or not being currently feasible.

TABLE A1
Evaluation of Advanced Technology Options During Initial Development of Alternatives

ID	Technology	Description	Mode(s)	Why Carried/Not Carried Forward
Vehicle / Guideway Technologies (IDs 1 to 15)				
1	Online Electric Vehicle (OLEV)	Instead of a conventional electric vehicle that requires a plug-in charge and a large battery for storage, OLEVs pick up power from underground recharging strips imbedded directly in the roadway.	Auto, Transit, Freight	Carry forward for further consideration in secondary screening.
2	Personal Rapid Transit (PRT)	Segregated guideway using small car-sized vehicles. Fully automated, with on-demand service.	Transit, Freight	Drop from further consideration; not applicable to this project.
3	Electric Freight Movement (CargoMovers, CargoRail)	Automated transport of cargo containers on a grade-separated elevated guideway. CargoMover: a redesigned, self-propelled, automated flatbed rail freight car with a payload of up to 60 tons. CargoRail: rubber-tired vehicles (Cargo Ferries) that move along an elevated guideway	Freight	Drop from further consideration; option does not support project needs; due to large infrastructure requirement is most suitable for point-to-point movement of large quantities of goods from a common origin to a common destination, which is not typical of goods movement through the study area; freight movement is not a primary need for this project.

TABLE A1
Evaluation of Advanced Technology Options During Initial Development of Alternatives

ID	Technology	Description	Mode(s)	Why Carried/Not Carried Forward
4	Electrified Freight Railways	Electric powered freight rail system, with overhead wires, a third rail, or on-board energy storage device that powers the locomotives. Reduce emissions, noise, and fuel spills.	Freight	Drop from further consideration; option does not support project needs; due to large infrastructure requirement is most suitable for point-to-point movement of large quantities of goods from a common origin to a common destination, which is not typical of goods movement through the study area; freight movement is not a primary need for this project.
5	Inherently Low-Emission Vehicles	Vehicle that is certified as a zero-emissions vehicle (100 percent battery electric, hydrogen fuel cell, compressed natural gas, liquid natural gas, or liquefied petroleum gas)	Auto, Transit, Freight	Carry forward for further consideration in secondary screening.
6	Maglev (magnetic levitated vehicles)	Transportation system that uses magnetic levitation to suspend, guide, and propel vehicles using magnets. Low emissions and high speeds are possible. Freight application of maglev: Electric Cargo Conveyer System	Transit, Freight	Drop from further consideration; this technology applies to longer corridors where there is enough distance to allow operations to reach higher speeds, also high use of energy versus benefits for this project application.
7	Dual-Mode Systems (guideway and manual)	Individual vehicles on a fixed guideway, with manual or auto control. Vehicles manually driven when off-guideway. Other designs where cars ride on moving platforms	Transit, Freight	Carry forward for further consideration in secondary screening.
8	Vehicle Platooning / Road Trains	Automatic control of vehicles in multiple-vehicle train on the roadway. Join/leave train in manual mode.	Auto, Transit, Freight	Carry forward for further consideration in secondary screening.
9	Automated Guided Vehicles (AGVs)	Driverless vehicles navigated and controlled by a computerized system. AGVs have been successfully used in manufacturing plants, warehouses, airports, and other facilities, and for automated transport of various goods	Auto, Transit, Freight	Drop from further consideration; option not fully demonstrated and may not be cost-effective
10	Vehicle Guidance & Precision Docking	Automate precise positioning of vehicles at loading/unloading areas. Has been applied to Bus Rapid Transit at median running stations to speed up docking at near-level platforms	Transit, Freight	Will be considered later as part of a Bus Rapid Transit operation if Bus Rapid Transit alternatives are selected for further development and environmental review.

TABLE A1
Evaluation of Advanced Technology Options During Initial Development of Alternatives

ID	Technology	Description	Mode(s)	Why Carried/Not Carried Forward
11	Bus Lane with Intermittent Priority (BLIMP)	Utilizes dynamic lane assignment to designate an exclusive bus lane on a temporary, bus-actuated basis. Temporary lane is designated via overhead variable message signs and in-ground dynamic lane markings	Transit	Drop from further consideration; option not fully demonstrated and may not be cost-effective.
12	Rail Direct to Port Docks	Transporting goods by rail directly to port docks, to minimize truck trips, lower emissions and increase safety.	Freight	Drop from further consideration; option does not support project needs; San Pedro Ports are implementing more on-dock rail facilities. Destinations of freight moved by these systems are south and east of study area, so even further expansion would not have substantial effect on traffic in the study area; freight movement is not a primary need for this project.
13	Tunnel with Conveyor Belt	Transporting goods via use of tunnel and a conveyor belt	Freight	Drop from further consideration; option does not support project needs; due to large infrastructure requirement is most suitable for point-to-point movement of large quantities of goods from a common origin to a common destination, which is not typical of goods movement through the study area; freight movement is not a primary need for this project.
14	IntelliDrive	USDOT initiative to advance technology and create interoperable connectivity among vehicles, infrastructure, and passengers' wireless devices to produce safety, mobility, and environmental benefits. Inter-vehicle communications system of wireless connectivity between vehicles and roadway infrastructure.	Auto, Transit, Freight	This technology is the same as Advanced Technology 8- Vehicle Platooning and will be evaluated further during Concept Engineering.

TABLE A1
Evaluation of Advanced Technology Options During Initial Development of Alternatives

ID	Technology	Description	Mode(s)	Why Carried/Not Carried Forward
15	Emerging Technologies in Sustainable Transportation	Variety of emerging highway-based technologies that promote sustainable transportation, including: biofuels-based pavements, carbon-neutral roadways, glass highways, green cement, hydrogen highways, pavement heat exchangers, resin-based pavement, solar highways, green streets, and complete streets.	Auto, Transit, Freight	Does not address project needs; consider as part of development of infrastructure for build alternatives.
Intelligent Transportation System Technologies (IDs 16 to 24)				
16	Incident Management	Automated or video-based incident detection, incident verification, incident response with enhanced GPS capabilities, service patrols, towing arrangements.	Auto, Transit, Freight	Will be considered later as part of new freeway segments if freeway alternatives are selected for further development and environmental review.
17	Traveler Information	Real-time, multimodal information via phone, radio, television, internet, and in-vehicle; vehicle detection systems; vehicle speed data collection; changeable message signs with dynamic rerouting.	Auto, Transit, Freight	Carry forward arterial street system applications of Vehicle Detection Systems, Speed Data Collection, and Changeable Message Signs as part of the TSM/TDM Alternative in the next level of evaluation.
18	Active Traffic Management (ATM) - Arterials	Traffic control signal systems synchronization, adaptive control along selected arterials, transit signal priority, emergency vehicle pre-emption.	Auto, Transit, Freight	Carry forward Traffic Signal Synchronization and Transit Signal Priority as part of the TSM/TDM Alternative in the next level of evaluation.
19	Ramp Management	Ramp metering, ramp closures, special use treatments, junction control, ramp terminal treatments.	Auto, Transit, Freight	Will be considered later as part of new freeway segments if freeway alternatives are selected for further development and environmental review.
20	Active Traffic Management (ATM) - Freeways	Ability to dynamically manage recurrent and nonrecurrent congestion based on prevailing traffic conditions. ATM strategies include variable speed displays, lane control signals, hard shoulder running, queue warning, and junction control. Speed Harmonization: Stabilize the speed distribution such that differences between the highest and lowest vehicle speeds are minimized.	Auto, Transit, Freight	Will be considered later as part of new freeway segments if freeway tunnel alternatives are selected for further development and environmental review.

TABLE A1
Evaluation of Advanced Technology Options During Initial Development of Alternatives

ID	Technology	Description	Mode(s)	Why Carried/Not Carried Forward
21	Commercial Vehicle Operations (CVO)	Automated vehicle identification (AVI), automated vehicle classification (AVC), electronic credentialing, truck safety inspection, driver credential verification, mainline screening of commercial vehicles, commercial vehicle information systems & networks (CVISN), and weigh-in-motion (WIM).	Freight	Drop from further consideration; option does not support project needs; freight movement is not a primary need for this project.
22	Integrated Corridor Management (ICM)	Operational coordination of multiple transportation networks and cross-network connections comprising a corridor, and the coordination of institutions responsible for corridor mobility. Includes communications between transportation management centers (TMCs).	Auto, Transit, Freight	Will be considered later as part of new freeway segments if freeway alternatives are selected for further development and environmental review.
23	Special Event, Weather and Work Zone Management	Highway and weather information systems (visibility, precipitation, pavement condition), coordination with convention centers and sports complexes, contingency and evacuation planning, work zone strategies.	Auto, Transit, Freight	Will be considered later as part of new freeway segments if freeway alternatives are selected for further development and environmental review.
24	Vehicle Tracking Systems	Use of global positioning systems (GPS) to track vehicle locations in real time.	Auto, Transit, Freight	Drop from further consideration; option does not support project needs.
Pricing / Tolling Technologies (IDs 25 to 29)				
25	Managed Lanes with Pricing	Strategies designed to improve roadway performance, improve travel speeds and reliability, and generate revenue through roadway pricing. Includes express lanes, high-occupancy toll (HOT) lanes, and toll roads. Can incorporate express bus and bus rapid transit services.	Auto, Transit, Freight	Will be considered later as part of new freeway segments if freeway alternatives are selected for further development and environmental review.
26	Dynamic Pricing/ Tolling Strategies	Consider number of lanes, segment length, toll rates by time of day, occupancy requirements, exemptions, access control, toll technologies, public-private partnerships.	Auto, Transit, Freight	Will be considered later as part of new freeway segments if freeway alternatives are selected for further development and environmental review.

TABLE A1
Evaluation of Advanced Technology Options During Initial Development of Alternatives

ID	Technology	Description	Mode(s)	Why Carried/Not Carried Forward
27	Vehicle Miles Traveled (VMT) Road User Pricing Systems	Fees based on number of VMT, measured using GPS-based technology. Fee rates could vary based on geography, time of day, and/or vehicle type.	Auto, Transit, Freight	Drop from further consideration; this technology has not yet been demonstrated.
28	Cordon or Area Pricing	Fees charged to drivers who enter or cross a designated cordon boundary or drive in a particular area, such as a central business district. Used to manage congestion, generate revenue, and encourage alternative travel modes.	Auto, Transit, Freight	Drop from further consideration on this project; this option is being considered for the downtown Los Angeles area in the Southern California Association of Governments Regional Transportation Plan.
29	Variable Parking Pricing	Vary parking rates based on day of week, time of day, and/or real-time parking utilization. Used to manage parking demand and encourage alternative travel modes.	Auto, Transit, Freight	Drop from further consideration; not applicable to this project.