Chapter 7
Capital Alternatives

Before transit services can be provided, a myriad of capital items are required. The capital items required for public transit service consist of vehicles, vehicle maintenance facilities, passenger amenities such as shelters and benches, and computer equipment. Indeed, many capital elements will be required to maintain and potentially expand EDCTA services over the coming years, as discussed below.

VEHICLE ALTERNATIVES

The size and types of EDCTA's fleet are presented in Table 32. A total of 26 revenue vehicles are eligible for replacement as of 2007 and an additional 14 will be eligible for replacement by the end of the planning period. Based on EDCTA's selection of the service alternatives presented in the previous chapter, a Capital Plan will be presented in a subsequent step of this study that will identify an appropriate vehicle acquisition schedule.

In FY 2006/07, the following prices are assumed for each type of bus currently used for the various services provided by EDCTA. These estimates do not assume the vehicles will use alternative fuel.

- DAR/Local Routes - The cost of a Type III 20 passenger bus, similar to those used by EDCTA for contracted social services and local route services, purchased through the state contract is $60,000. The design life of this vehicle is 5-years/150,000 miles. The cost of a Type IV van similar to those used for DAR is $40,000. The design life of this vehicle is 4 years or 100,000 miles.

- Commuter Routes – The medium heavy-duty Bluebird Excel buses that EDCTA currently uses for their commuter fleet will no longer be available. The only comparable types of buses being manufactured are heavy duty urban transit-style vehicles and over-the-road coaches. Transit vehicles designed for use in cities and urban areas typically have some rear facing seats with no reclining seats. Not only does this type of arrangement not suit a passenger with a commute time of one hour or more but it reduces the seating capacity of the vehicle. The FTA designated service life of a heavy-duty bus is 12 years or 500,000 miles, though it is likely that an over-the-road coach will last for 20 years. In comparison, a transit-style heavy duty bus may only last 15 years. Other transit systems with long distance commuter operations such as Placer County Transit, Fairfield/Suisun Transit, and San Joaquin RTD use over-the-road coaches. Yuba-Sutter Transit recently began a one month demonstration project using a Motor Coach Industries D 4500, 57 passenger vehicle. The cost of an over-the-road coach ranges from $500,000 to $550,000 whereas the cost of a heavy duty transit-style bus is $350,000 to $400,000. With the potentially longer life span, increased seating capacity and better rider amenities, the over-the-road coach is the best option for EDCTA.

Retired Van Donation Program

The EDCTA fleet currently includes 12 specialized transit vans which are used for DAR operations. FTA service life policy dictates that light-duty vehicles and specialized vans are eligible for replacement after 4 years or 100,000 miles. Two of these vans (# 9901 and # 9902) are designated backup vehicles and have logged over 180,000 miles each over 8 years of service. Four additional Chevy Vans (vehicles # 205, 206, 207, and 401) are currently eligible for replacement. Typically, retired vehicles are sold in the open market.

Recently, several transit agencies have implemented van grant programs to qualifying organizations in order to enhance local transportation options. As examples, Intercity Transit in Washington has donated retired vanpool vehicles to qualifying agencies, while Contra Costa Transit Authority has donated several paratransit vans to community based organizations. Contra Costa Transit Authority's "Community Connections Van Grant Program" is particularly applicable to El Dorado Transit. The program is multipurpose: dispose of old paratransit vans while providing community human service organizations the resources to offer transportation to clients who would otherwise ride the local ADA paratransit service. The following summarizes requirements associated with the Contra Costa Community Connections program:

- The recipient must be a local non-profit organization or government entity whose primary purpose is to serve the elderly and disabled.

- The organization must be able to provide at least 50 trips each month to ADA-eligible clients. During a two year provisional period, ADA passenger ridership data is recorded and reported monthly to Contra Costa Transit Authority, after which the organization is released from reporting requirements and the van is considered to be owned by the organization.

- Preference is given to organizations which have the greatest need for the vehicle, reliable funding sources, and could provide a large amount of trips to ADA-eligible clients.

- The community based organization must repaint the van so that it is no longer recognizable as a public transit vehicle.

Additionally, Contra Costa Transit Authority reimburses the van recipient for $10,000 of vehicle maintenance costs ($5,000 per year for two years) and provides free driver training.

Given the limited capacity of EDCTA's DAR service, donating retired EDCTA vans to social service agencies in the region could help to relieve demands on the system. Additionally, not all of El Dorado County residents and services are easy for DAR to serve. For example substance abuse programs in Georgetown are inaccessible by public transit, and the senior center in South County is served by transit once a week and by the Senior Shuttle once a month. Donating a van to organizations in outlying parts of the County may relieve the DAR system of longer, less cost-efficient trips.

Chapter 4 includes a review of human service agencies/organizations potential "program related" transit demand. The transit demand analysis indicated that there is significantly more transit demand from social service type of programs than passenger-trips being provided. El Dorado County Mental Health Services generates the greatest transit demand. The County already owns one van which provides approximately 40 trips per month for patients to the clinics and facilities in Placerville and occasionally for transport between Western El Dorado County and South Lake Tahoe. El Dorado County Senior Services also uses one van to transport approximately 140 seniors per month for shopping trips and to the Senior Nutrition Dining Centers.

In order to distribute a retired van equitably, EDCTA should implement an application and qualification process. Contra Costa Transit Authority requires that a van grant program recipient must be able to provide 50 ADA-eligible passengers trips per month. The recipient may provide trips for non ADA-eligible passengers as well. Not all organizations surveyed in El Dorado County solely deal with ADA-eligible persons. Some organizations are located in areas not currently served by DAR. Additionally, organizations who work with youth in the community have expressed interest in a van donation program. As EDCTA's DAR system is not limited to ADA-eligible individuals, it seems appropriate to broaden van donation eligibility to organizations who assist all types of transit dependent groups (disabled, elderly, youth, and low-income). In FY 2006/07, DAR provided on average 2,700 trips per month. If a high level of transit service were provided, most social service program categories listed in Table 40 generate transit demand significantly over 200 trips per month. This includes trips already provided on DAR and through the social service agencies. With this in mind, a reasonable eligibility requirement for a van grant donation program in El Dorado County would be 100 trips per month. In order to insure that the donated vans are put to good use, some sort of reporting requirements should be implemented for a period of at least one year. To minimize EDCTA's costs, the van recipient should be responsible for all vehicle maintenance but free driver training should be provided.

Organizations that are potential van grant recipients in Western El Dorado County include El Dorado County Mental Health, PAVES, Vision Coalition, El Dorado County Senior Shuttle Program, Family Connections, Headstart, and the Boys and Girls Club.

Alternative Fuels

To reduce pollution from mobile sources, the United States Environmental Protection Agency (EPA) has adopted a variety of regulations as required by the Clean Air Act Amendments (CAAA) of 1990. On February 24, 2005, the California Air Resources Board (CARB) adopted new emissions reduction regulations applicable to diesel or alternative fueled transit vehicles. According to the rule, on-road vehicles operated by a public transit agency that are less than 35 feet in length and 33,000 pounds Gross Vehicle Weight Rate (GVWR), but greater than 8,500 GVWR, powered by heavy-duty engines fueled by diesel or alternative fuel are considered *transit fleet vehicles* and are subject to the following requirements (CARB, 2007):

- The particulate matter emissions of the total transit fleet (excluding non-transit fleet vehicles such as gas-powered vehicles) as of January 1, 2005 is considered the baseline emissions measurement.

- By December 31, 2007, particulate matter emissions of total transit fleet vehicles had to be reduced by 40 percent from baseline and NOx emissions could be no more than 3.2 grams per brake horse-power hour (g/bhp-hr). By December 31, 2010, total particulate matter emissions of transit fleet vehicles must be reduced by 80 percent from baseline and NOx must be no more than 2.4 g/bhp-hr.

An *urban bus* is a passenger carrying vehicle owned or operated by a public transit agency, powered by a heavy heavy-duty engine, intended primarily for intra-city operation. Typically this includes buses 35 feet or longer and/or greater than 33,000 pounds gross vehicle weight rating (GVWR). CARB set different standards for urban buses:

- NOx emissions fleet average must be no more than 4.8 g/bhp-hr.

- Diesel-powered urban bus particulate matter emissions must be reduced by 85 percent or meet 0.01 g/bhp-hr times the total number of diesel-powered urban buses in the fleet.

If the transit agency chooses an alternative fuel path, at least 85 percent of urban bus purchases must be fueled by alternative fuel and particulate matter emissions need only be reduced by 60 percent from the 2002 baseline by 2007. The 85 percent reduction of particulate matter emissions will apply to transit agencies using alternative fuel in 2009.

A *commuter service bus* means a passenger-carrying vehicle powered by a heavy heavy-duty diesel engine that is not otherwise an urban bus and which operates on a fixed-route primarily during peak commute hours and that has no more than ten scheduled stops per day, excluding Park-and-Ride lots. A commuter service bus is subject to transit fleet vehicle rules.

There are 14 urban buses and 5 transit fleet vehicles in the EDCTA fleet. EDCTA is in the process of completing the retrofit of all diesel engines to meet the 0.01 g/bhp-hr particulate matter emissions standard. In order to develop a working concept of the different alternative fuels, their advantages and disadvantages, and their potential application for the EDCTA fleet, the following review of the eight relatively common alternative fuel technologies is presented below.

In addition, global climate change or "global warming" is a major environmental issue which needs to be acknowledged in planning documents. Climate change is caused by the release of greenhouse gases (GHG's) such as carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride into the atmosphere which traps heat and increases temperatures near the earth's surface. Forecasted, long-term consequences of climate change range from a rise in the sea-level to a significant loss of the Sierra snow pack. As a direct result of Assembly Bill (AB) 32, CARB has been charged with developing rules and regulations that will reduce GHG emissions in the State of California to 1990 levels by 2020. The "global" affect of each alternative fuel is also considered in the alternative fuel discussion.

Ultra Low Sulfur Diesel

Diesel-fueled engines have traditionally dominated the transit vehicle marketplace with their fuel efficiency and durability. From an air quality perspective, diesel engines have very low tailpipe emissions of CO and other organic gases. The concern from an air quality perspective, however, has been the emission rates of NOx and particulate matter.

Due to increasing environmental pressure to reduce the above emissions, the Environmental Protection Agency and CARB, has developed stringent NOx and particulate matter regulations as referenced above. The final Clean Air Amendments permit the use of clean diesel in urban buses, provided that the clean diesel engines meet the particulate matter standards imposed by the CARB. In partial response to the 1990 CAAA amendments for cleaner burning fuels and the continued development of the previously mentioned alternative fuels, the traditional diesel fuel engine has made great strides toward evolving with a cleaner burning particulate trap and catalytic converter technology. All 2007 and later model year buses will be designed to comply with CARB particulate matter and NOx emissions.

Ultra-Low Sulfur Diesel (ULSD) is diesel fuel with 15 parts per million (ppm) or lower sulfur content. This ultra-low sulfur content enables use of advanced emission control technologies such as particulate traps and catalytic converters on light-duty and heavy-duty diesel vehicles. Fuel with a higher sulfur fuel content can deactivate these devices and nullifies their emissions control benefits. The U.S. Environmental Protection Agency required 80% of the highway diesel fuel refined in or imported into the United States (100% in California) to be ULSD as of 2006. One hundred percent must be ULSD nationwide by 2010. Different requirements apply to non-highway diesel.

Methanol

Most of the methanol used commercially in the United States is manufactured from natural gas, making it economical to use. The tailpipe emissions of methanol are generally considered to be about half as reactive as an equal mass of emissions from gasoline or diesel fuel, promoting its use to reduce ozone in urban areas, such as Los Angeles. By volume, methanol has slightly more than half the energy content of diesel fuel and slightly more than half the energy content of gasoline. Due to the above characteristics, a methanol engine will consume a little over twice the volume of fuel per mile of service, as compared to a diesel engine.

Transit authorities in Los Angeles and Seattle have in the past retired their methanol programs due to the fuel's highly corrosive properties. Authorities from the Metropolitan Transportation Authority (MTA) cited that the buses are prone to costly mechanical repairs. Officials of the Seattle Metro eliminated their methanol demonstration program after a trial period of five years. Test results of the program indicated that severe engine malfunctions were experienced on the buses at 60,000 and 70,000 miles, largely attributed to the corrosive nature of the fuel.

Ethanol

While not being as corrosive as methanol, the major use of ethanol is currently limited as an octane additive and oxygenate for gasoline. As such the same basic engine can be used with both diesel and ethanol fuel. According to Information Update, (Detroit Diesel Corporation, February 1992), the cost of ethanol is almost twice as much as that of methanol, making its use limited as a motor vehicle fuel. Aside from the fuel's economic drawbacks, ethanol produces lower carbon monoxide (CO) emission rates than gasoline, has a higher energy density than methanol, and has a lower toxicity than either methanol or gasoline. Ethanol's affect on greenhouse gases however depends on how the fuel is made. Ethanol produced from corn has life cycle GHG emissions about 15 percent less than gasoline vehicles. Ethanol produced from woody biomass (E-100) has GHG emissions 60 to 75 percent below conventional gasoline (excluding any impacts associated with land clearing).

Compressed Natural Gas (CNG)

Natural gas is a domestically produced alternative fuel and is readily available to end users through the utility infrastructure. The strength of CNG as an alternative fuel for transit buses is that it is generally less expensive per unit of energy than gasoline or diesel fuels. Per the October 2007 Clean Cities Alternative Fuel Price Report, the average price of CNG in the West Coast region was $2.60 per diesel gasoline equivalents compared to $3.21 per gallon of diesel gasoline. The fuel also has the potential to reduce NOx emissions and particulate matter when compared to diesel, although low sulfur diesel fuel used in conjunction with particulate matter traps can reduce particulate matter emissions by a similar amount. GHG emissions from CNG vehicles are approximately 15 percent to 20 percent lower than from gasoline vehicles, since natural gas has a lower carbon content per unit of energy than gasoline. However, CNG vehicles have about the same greenhouse gas emissions as diesel fuel vehicles, with lower CO_2 emissions offset by higher hydrocarbon emissions.

Many people – both inside and outside the transit industry – perceive CNG as the future fuel of choice. Others see CNG as a stop-gap measure that can be used to reduce vehicle emissions until other technologies (hydrogen fuel-cell or combustion-electric hybrid) are developed further. Indeed, the decision to pursue CNG comes down to the underlying goals of the agency considering alternative fuels, the local politics, the financial resources of the agency, and the commitment of decision-makers.

Historically, the weakness of CNG is its difficult storage requirements. CNG is stored in high pressure cylinders at pressures up to 3,000 pounds per square inch. The high weight, volume, and cost of the storage tanks for CNG have been a barrier to its commercialization as an alternative fuel. The recent development of lighter aluminum tanks, however, has reduced this disadvantage to some degree.

The advantages of a CNG bus are no visible pollution and quieter operation. The problems encountered with CNG include the inconsistent quality of local CNG supplies, limited range of CNG vehicles, and continued industry concerns regarding reliability.

According to the FTA report, *Transit Bus Life Cycle Cost and Year 2007 Emission Estimation*, a CNG bus costs between $25,000 to $50,000 more than a comparable diesel bus. This is due to the higher cost of the engine itself and the higher cost of the fuel tanks. In addition, the study cited that a CNG refueling station for an urban transit fleet costs between $320,000 and $7,400,000. Additional costs would be incurred to upgrade the new maintenance facility with required safety features and to provide emergency response equipment and training. These facility modification costs range from $500,000 to $15,000,000 for the urban transit agencies reviewed.

In a 1996 Department of Energy report, Pierce Transit (Tacoma, Washington) estimated that CNG engines are about 20 percent less efficient than diesel engines on a per gallon equivalency which reduces the range of CNG buses. CNG buses are described as having a driving range of about 300 miles (of course depending upon the capacity of the gas cylinders) compared to a little more than 400 miles for diesel buses. Typically, buses smaller than 35 feet in length are unable to accommodate enough fuel tanks to operate a full urban cycle service day without refueling.

The issue of reliability is surrounded by diverging viewpoints. In the same 1996 Department of Energy report, Pierce Transit noted no large difference in reliability between CNG- and diesel-powered buses. The main problem they encountered in the beginning of their CNG program was difficulty with the fuel control system – a problem they note has been resolved for the most part by advances in the technology and continued training of maintenance staff. Indeed, CNG technology is still saddled somewhat with the reliability problems that surfaced in the late 1980s when it was still very much in its infancy – especially when dual-fuel technology was still the state-of-the-art. The technology truly has come a long way since then, and reliability is seemingly much better.

However, in a 1999 report the Contra Costa County Transit Authority (CCCTA) noted that engine manufacturers encounter CNG-related warranty claims that are between 50 percent and 250 percent higher than their diesel counterparts. This may be a particular problem for agencies like EDCTA who are not located close to an CNG engine warranty provider. CCCTA also cited experience by BC Transit in British Columbia, Canada. BC Transit started a two year comparison of 25 1996 New Flyer CNG-powered buses and 25 1996 New Flyer diesel-powered buses, all with Detroit Diesel engines. Results for the CNG fleet were as follows: the roadcall rate was 4½ times higher, parts and labor costs were 132 percent higher, and overall maintenance costs were 61 percent higher. CCCTA has chosen to pursue “clean diesel” technology.

One of the major drawbacks for CNG use in El Dorado County is the lack of a nearby fueling station. The nearest CNG refueling stations to the EDCTA yard are the Placer County Public Works station in Auburn and a public fueling station in Rancho Cordova about 25 miles away. The EDCTA Park-and-Ride Master Plan lists a regional alternative fueling station near the Sacramento County/El Dorado County line south of US 50 and north of White Rock Road as capital improvement priority Number 8. The County Line Transit Facility project has been discussed preliminarily at a staff level between the City of Folsom, County of El Dorado and transit operators. Total costs of this project which include a Park-and-Ride facility are estimated at $5.4 million.

Liquefied Natural Gas (LNG)

To store more energy onboard a vehicle in a smaller volume, natural gas can be liquefied. At atmospheric pressure, LNG occupies only 1/600 the volume of natural gas in vapor form. One Gasoline Gallon Equivalent equals about 1.5 gallons of LNG. Because it must be kept at such cold temperatures, LNG is stored in double-wall, vacuum-insulated pressure vessels. LNG fuel systems typically are only used with heavy-duty vehicles. The potential advantages of the fuel lie in its economic considerations, where the fuel's processing costs are much less than that of the other gaseous fuels. LNG also has a greater potential to reduce NOx and HC emissions when compared to diesel and gasoline fuels. Currently, the biggest obstacles facing LNG are the lack of availability and its storage and handling facility requirements.

Liquefied Petroleum Gas (LPG)

The advantages and disadvantages of LPG (commonly referred to as propane) are similar to those of natural gas. The advantage of LPG is that gasoline engines can be easily converted, due to its high heating and high octane characteristics. Propane vehicle power, acceleration, and cruising speed are similar to those of gasoline-powered vehicles. The range of dedicated gas-injection propane vehicles is generally less than gasoline vehicles because of the 25% lower energy content of propane and lower efficiency of gas-injection propane fuel systems. LPG is not as commonly used for transit vehicles in the United States as other alternative fuels.

Hybrid Electric

An emerging vehicle propulsion technology that has recently gained national interest are hybrid electric systems. Under this arrangement, battery-powered electric motors drive the wheels; the batteries are charged using a small internal combustion engine (diesel-, gasoline- or alternative-fueled) to power an electric generator. This arrangement provides near-zero emissions, as the engine operates within a very narrow and efficient operating range.

Operating costs for a hybrid electric system are typically lower in comparison to conventional diesel- or CNG powered arrangements due to greater fuel economy and reduced break wear (the batteries are also charged through regenerative breaking, which tends to slow the vehicle while it recoups energy). In addition, hybrid electric buses provide better acceleration and quieter operation than conventional internal combustion engine propulsion systems. Another benefit of hybrid electric technologies is that it does not require the large infrastructure investment that is required for CNG or LNG technologies. However, the average price of a 40-foot hybrid bus typically ranges from $450,000 - $550,000 when compared to $280,000 - $300,000 for a conventional diesel bus. In addition, conventional sealed-gel lead acid battery systems typically last only two to three years, and replacement units cost on the order of $25,000. Better battery technology currently exists that could extend battery life (i.e., nickel metal hydride), but this technology currently costs $35,000 to $45,000. Hybrid buses which use ultra-low sulfur diesel and particulate matter filters have 90 percent lower emissions than a conventional diesel bus. Hybrids have less GHG emissions than both conventional diesel and CNG buses.

Hybrid electric propulsion systems have been tested at several large transit programs, most notably at New York City Transit. The National Renewable Energy Laboratory prepared an evaluation of the benefits of 10 new CNG Orion VII buses and 10 new Orion VII hybrids used for New York City Transit. According to the report, hybrid maintenance costs were lower than the CNG buses, battery replacement rate for the hybrid vehicles was about 4.5 percent per year, brake repair costs were 79 percent lower on the hybrid buses than the CNG buses and the hybrids had fewer roadcalls. New York City Transit has since placed an order for an additional 500 hybrid buses. Other agencies which have tested hybrid technologies include Sunline Transit in Thousand Palms (California), the Los Angeles County Metropolitan Transportation Authority, the Orange County Transportation Authority, Omnitrans in San Bernadino, TriMet in Portland (Oregon), King County Metro Transit in Seattle, the Southeastern Pennsylvania Transportation Authority in Philadelphia, and New Jersey Transit.

Hybrid electric technology can be combined with various alternative fuel types such as bio-diesel or propane to increase emissions benefits. Full electric vehicles and hydrogen-powered buses are two other emerging technologies that are being tested by several transit agencies, although many experts consider these technologies to be on the leading edge of current understanding. Considerable research is still necessary regarding the life cycle costs and benefits of these technologies before they should be considered as viable options for small transit agencies.

Biodiesel Fuel

Biodiesel can be legally blended with petroleum diesel in any percentage. The percentages are designated as B20 for a blend containing 20% biodiesel and 80% petroleum diesel, B100 for 100% biodiesel, and so forth. B20 is the most common biodiesel blend in the United States and provides the benefits of biodiesel but avoids many of the cold-weather performance and material compatibility concerns associated with B100. B20 can be used in nearly all diesel equipment and is compatible with most storage and distribution equipment. Particulate matter, CO and Hydrocarbon emissions are reduced by B20 and significantly more by B100, however NOx emissions actually increase. The closest biodiesel fueling station to EDCTA is in Meyers, CA near South Lake Tahoe.

Summary

The *Transit Bus Life Cycle Cost and Year 2007 Emission Estimation* report concluded that ULSD or "clean diesel" buses are still the most economic technology, followed by buses fueled by B20 biodiesel. Fuel economy rated best among the hybrid buses but overall costs were offset by battery replacement costs. As for GHG emissions, the hybrid buses also outperformed the other alternative fuels followed by B20 diesel, ULSD and then CNG. In the short-term, continuing to follow the ULSD diesel path seems the most appropriate for EDCTA, especially considering EDCTA is in the process of completing the retrofit of all transit fleet vehicle and urban bus diesel engines to meet the 0.01 g/bhp-hr particulate matter emissions mandated by CARB. However EDCTA should remain open to the ideas of alternative fuels as technology progresses and alternative fuel infrastructure is built.

PASSENGER FACILITIES

The "street furniture" provided by the transit system is a key determinant of the system's attractiveness to both passengers and community residents. In addition, they increase the physical presence of the transit system in the community. Bus benches and shelters can play a large role in improving the overall image of a transit system and in improving the convenience of transit as a travel mode. More importantly, shelter is vital to those waiting for buses in harsh weather conditions. In addition, passengers could benefit by installing passenger amenities at major bus stops, particularly adjacent to regional shopping centers, medical facilities, and social service agency facilities.

Adequate shelters and benches are particularly important in attracting ridership among the non-transit-dependent population – those that have a car available as an alternative to the bus for their trip. Preference should be given to locations with a high proportion of elderly or disabled passengers and areas with a high number of daily boardings. Lighting and safety issues are equally important along major highways. Consideration of evening service should include an analysis of lighting needs at designated bus stops. This could range from overhead street lighting to a low power light to illuminate the passenger waiting area.

According to Tolar Manufacturing, who has most recently supplied EDCTA with passenger amenities, the approximate cost of a 13 foot metal shelter is $4,000. Another $550 can be added for a perforated metal 8 foot bench and an additional $550 would be required for a 30 gallon trash receptacle. Adding solar lighting to a shelter costs on of order of $1,500. While total costs including installation depends on site characteristics and the ability to use public works staff during off periods, total costs for a new shelter fall in the range of $8,000 to $10,000. Maintenance and repair of vandalism to bus benches and shelter is a very minor cost since they are designed to be very resistant to vandalism. As a result, cleaning and maintenance costs are minor.

EDCTA will be provided with 15 new bus shelters with no capital or maintenance cost through an advertising agreement with Lamar Transit Advertising. The following locations are proposed as the sites of new bus shelters to be funded by Lamar:

- 1004 Fowler Way, Placerville
- 1266 Broadway, Placerville
- Future Cameron Park Community Center
- Mother Lode Drive and South Shingle Springs Drive (near Gold Harvey Market)
- Mother Lode Drive and South Shingle Springs Drive (near Family Chevrolet)
- Cold Springs Road Site 1 (Cold Springs Dental)
- Cold Springs Road Site 2 (DMV)
- Marshall Medical Building, Palmer Drive, Cameron Park
- Cimarron Road and La Canada, Cameron Park
- Pleasant Valley and Oro
- Northeast corner of Pony Express Transit and Sanders Drive
- Northeast corner of Carson and Larson Road
- Corner of Broadway and Pointview Drive, Placerville
- Tentative location at US 50/Coloma Road (EDCA Lifeskills)

All new passenger amenities should comply with the design standards referenced in the *El Dorado Transit Authority Transit Design Manual* (LSC Transportation Consultants, Inc., 2007).

Local Routes

EDCTA has made great strides over the past five years in implementing additional passenger facilities. A total of 19 shelters and 15 additional benches are currently provided in the local route service area. In order to comply with the Service Quality Goals proposed in Chapter 5, shelters should be constructed at the following local route bus stops. These locations are not included as part of the shelter agreement with Lamar.

- Old City Hall
- Child Development (FLC)
- Raley’s (Placerville Dr.)
- Safeway (Cameron Park Place)
- Placerville Senior Center (existing bench)
- Pleasant Valley/Church Street
- Union Mine High School

Additionally benches should be placed at the following local route bus stops:

- Placerville Post Office
- M.O.R.E.
- Gold Country Inn
- Lake Oaks/Patterson

The approximate total cost of attaining the passenger amenity standard for the local routes is $72,200.

Park-and-Ride Lots

The *US 50 Corridor Transit Plan* (LSC Transportation Consultants, 2006) reviewed existing and future parking demand at the El Dorado County Park-and-Ride lots created by future commute patterns and new light rail services. By 2010 approximately 60 additional spaces will be required to meet demand at the El Dorado Hills Park-and-Ride and 34 additional spaces would be required at the Cameron Park lot and 172 spaces. All other El Dorado County Park-and-Ride lots were found to be large enough to accommodate future demand. By 2027, an estimated 172 spaces will be required in El Dorado Hills and 74 spaces in Cameron Park. The *El Dorado County Transit Authority Park-and-Ride Master Plan*, completed by Dokken Engineering in 2007, indicated the following top five priority capital improvements with possible construction dates before 2012:

- **Bass Lake Road Multi-Modal Facility** – The 200 space Park-and-Ride facility is a condition of development in the Bass Lake Hills Specific Plan. The developer is required to acquire a site and construct 100 parking spaces. EDCTA will need to provide funding for the remaining 100 spaces, however mitigation fees received from other developers in the area could be used to fund this project. The lot will be located east of the El Dorado Hills lot and west of the Cambridge Park-and-Ride and will satisfy short-term parking demand associated with the Cameron Park and El Dorado Hills Park-and-Ride lots.

- **Ponderosa Park-and-Ride Facility** – Reconstruction of the driveway and loading area is required to allow transit buses to pickup passengers in the lot instead of roadside. Caltrans SHOPP Minor B funding has been designated for this project.

- **Placerville Multi-Modal Station** – The plan includes the expansion of the parking area to 130 spaces from 55 spaces.

- **Central Transit Transfer Center** – This center will act as a transfer facility for SAC-MED as well as include some Park-and-Ride capacity. It will be located adjacent to EDCTA's operations and management center in Diamond Springs.

- **Missouri Flat Road Park-and-Ride –** This project would replace the interim Missouri Flat Road bus transfer facility with an improved transfer station and 25 passenger Park-and-Ride lot in a new location. Unfortunately, finding an available suitable location has become a challenge.

In order to comply with the Service Quality Goals proposed in Chapter 5, the following Park-and-Ride lots shelters should be constructed at these Park-and-Ride lots:

- **Ponderosa Park-and-Ride** – A shelter and information kiosk is included in the Park-and-Ride capital improvement program and will be funded by Caltrans.

- **Rodeo Road Park-and-Ride** – This facility is owned by El Dorado County.

- **El Dorado County Fairgrounds Park-and-Ride** – This facility is owned by the County Fair Association.

Adequate lighting is important for safety and security at Park-and-Ride lots as EDCTA commuter routes have many scheduled stops during non-daylight hours. Therefore, the approximate cost of two shelters with benches, trash can and solar lighting is $13,200.

Bicycle/Pedestrian Facilities

At one end of their trip or the other, virtually all transit passengers also travel on foot or on bicycle as part of their trip. A key element of a successful transit system, therefore, is a convenient system of sidewalks and bikeways serving the transit stops. Additionally, by promoting non-motorized forms of transportation, EDCTA can help to reduce greenhouse gas emissions and other air pollutants. EDCTA should continue to work with the planning and public works departments of El Dorado County and the other jurisdictions in the region to review construction plans and schedule priorities for pedestrian and bicycle improvements to best coordinate with transit passenger needs. Generally, all local route and commuter buses should have bike racks and this is the case with EDCTA. Only four EDCTA cutaway vehicles do not have bike racks and these buses are primarily used for the contracted social services route rather than general public services. In FY 2005/06, EDCTA received a BTA grant to replace 2-bike racks with 3-bike racks on all buses. Unfortunately the 3-bike racks are not structurally compatible with El Dorado Transit's Type VII buses.

Bicycle racks for bike parking should be provided at bus stops where there is the potential for a high level of patrons access by bike, such as near educational facilities. Elements to consider when improving bicycle facilities at transit stops include:

- **Location** – Bicycle parking and storage should be conveniently located near the bus shelter/passenger loading area but away from the main flow of pedestrian traffic so there is no conflict. They should also be placed in an area where few street crossing are required. Constructing bicycle parking facilities at a bus stop where cyclists often lock their bikes to sign posts or utility poles can enhance the appeal of the transit stop.

- **Security** – Commuting cyclists require long-term bike storage and therefore require higher security at the parking facility. One option is bicycle "cages" which provide security for the bicycle while allowing security personnel to see the contents of the cage. Unless a bike cage is geared towards a specific office park or college campus, this type of bicycle parking tends to be vulnerable to theft. Bicycle lockers are another secure option. For shorter-term bike storage, providing a sturdy bike rack, ensuring that the area is clear of hazards and obstacles, and providing lighting if night time use is anticipated are good practice.

- **Type of rack** – Bicycle racks vary from the old fashion type which only holds the wheel of the bicycle to "wave" racks where the bike frame can be locked in one location and the inverted "U" rack where the bike frame can be locked to the rack in multiple locations. Racks can be made out of square or rounded metal piping and hold anywhere from 2 to 14 bicycles. The square metal piping is more resistant to theft.

Bicycle rack bike parking costs can range from $100 for a 2 bike setup to $500 for a 10 bike rack. Bike locker costs range from $1,300 to $3,000 depending on the type of material used and locking mechanism.

ADVANCED PUBLIC TRANSIT SYSTEM TECHNOLOGIES

Recent advances in communication and communication technologies have impacted all segments of modern society, and have found new applications in the transit industry. These technologies have come to be known as Advanced Public Transportation Systems (APTS). For purposes of the EDCTA environment, there are three promising technologies within the APTS umbrella that have been developed over recent years: Automatic Vehicle Location (AVL) systems, Mobile Data Terminals (MDT), and Electronic Fare Management Systems.

APTS Currently in Use at EDCTA

Currently EDCTA employs Zonar Electronic Vehicle Inspection Report Technology for the primary purpose of fleet maintenance management. "Tags" are placed at important inspection points on each vehicle. During daily vehicle inspections, each driver places a hand-held reader near each tag and keys in the condition of that part of the vehicle. After the inspection is complete, the reader is returned to a vehicle mount inside the bus where the data is transmitted wirelessly to maintenance and operations staff. This technology improves operational efficiency by allowing managers to be informed of potential maintenance issues in a timely manner. The Zonar system also ensures that pre-trip vehicle inspections are properly performed. Packaged with EDCTA's Zonar technology is a GPS system which allows transit supervisors to remotely pinpoint the route and stops of each bus and receive in-route information such as vehicle speeds and excessive idling. Although vehicle on-time performance can be monitored using the Zonar system, maintenance related issues are the primary focus of this technology.

EDCTA also employs Trapeze Computer Aided Dispatch (CAD) software which incorporates transit route, schedules, demand response trip orders, and vehicle assignments to allow dispatchers to more efficiently schedule and dispatch trip requests.

Automatic Vehicle Location (AVL)

Originally developed in the trucking and package delivery industries, AVL has increasingly found application within transit services. AVL employs in-vehicle transponders and a central geographic mapping system using geo-positioning satellites to locate, track, and monitor vehicles. The central computer system automatically or manually (by the dispatcher) polls one or more vehicles. The polled vehicle transmits the longitudinal and latitudinal coordinates, time/date and other information if available (such as riders on board, etcetera) back to the central computer. The dispatcher knows the vehicle's location based on triangulation of the signals received from the global positioning satellites. A computer screen in the dispatch office displays a map indicating vehicle location, with an accuracy of plus or minus four feet. This map can also display direction of travel and on-time status (a different color for vehicles operating behind schedule, for example). Another potential benefit of AVL is increased emergency response in case of an accident or security threat.

A number of rural and small urban transit systems have implemented AVL systems. Examples include Boone County Transportation System (Iowa), Belle Urban System (Racine, Wisconsin), Blacksburg Transit (Virginia), Dakota Area Resources & Transportation for Seniors (Minnesota), Cape Code Regional Transit Authority (Massachusetts), and Flagler County Transit (Florida). The extent to which each has incorporated these systems into a system-wide APTS program varies according to the complexity of each transit system[1]. From 2001 to 2005 the Wisconsin Department of Transportation surveyed several small to medium sized transit agencies before and after implementation of AVL systems. The results were summarized in the *Evaluation of User Impacts of Transit Automatic Vehicle Location System in Medium and Small Size Transit Systems*. One important finding of this research was that the implementation of AVL improved on-time performance by 36 percent in some cases.

According to the Federal Transit Administration, the average cost of a baseline AVL system including on-board GPS, vehicle tracking integrated with operations control center dispatching and security systems is $315,000. When combined with other technologies or processes, AVL can deliver increased benefits in the areas of fleet management, systems planning, safety and security, traveler information, fare payment, and data collection. Introduction of an AVL system is often the first step in a more comprehensive APTS implementation.

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[1] FHWA-RD-98-146, U.S. Department of Transportation.

Pros and Cons for EDCTA: The complexity of the local transit services makes efficient connections between services very important. The availability of AVL would be a great help to dispatchers in directing efficient connections between various EDCTA services (particularly for connections between the local routes at Missouri Flat). With the aging of the population, demand for demand response services is likely to continue to grow. Implementation of AVL technology into the EDCTA's existing CAD program would be extremely useful in maximizing the efficiency of demand-response services, particularly with regard to service to the more outlying portions of the EDCTA service area. It also is likely that a state-of-the-art AVL system would increase on-time performance, by providing transit supervisors more monitoring tools. The significant benefit of AVL for EDCTA would stem from combining the system with other technologies such as MDTs or Automatic Passenger Counters (APC) so that passenger boarding and alighting data by stop could be obtained. On the downside, implementing all these technologies is expensive, requires careful research as to which systems are compatible, and may not be worth the financial input. As with all the APTS discussed later in this section, there are the additional costs of maintaining and operating AVL that potentially outweigh the benefits. Studies have shown that the primary benefit of AVL is to improve on-time performance. Unless on-time performance becomes a major issue at EDCTA, the financial impacts of AVL technology are likely to outweigh the benefits.

Mobile Data Terminals

Mobile Data Terminals (MDTs) are a form of on-board communication technology between transit drivers and operations staff. Using a text format transmitted via radio/cell phone, dispatch messages, vehicle location, passenger counts, engine performance, mileage, and other information is directly communicated to the transit agency office. MDTs can effectively replace paper manifests and allow for easier and more thorough analysis of route performance. Additionally, MDTs limit frustration and time when radio messages between dispatchers and drivers become inaudible and require repeating.

This form of technology can be particularly efficient when paired with other ITS systems such as electronic fare payment, CAD and scheduling, automatic passenger counters, and AVL. An MDT/CAD combination allows dispatchers to make optimal changes to itineraries when necessary and to automatically communicate updated information to drivers. Communication systems can also be integrated with AVL systems to provide real-time location data with every communication exchange. This information can be transmitted in voice or text form.

MDTs can also be used to assist with the efficiency of systems planning and fleet management. A MDT-AVL system combination can gather data and link the operations data to the transit agency's Geographic Information System (GIS) to be analyzed for long-term planning and service adjustments. This data could include real-time ridership figures generated by another technology, Automatic Passenger Counters (APC) that can be used by for long-range service planning or in the short-term by operations supervisors to add vehicles when demand outpaces the current in-transit capacity. Transit vehicles and their communications systems can be installed with a dedicated channel for emergency response. MDTs can include a pre-programmed emergency message that when integrated with AVL technologies can help provide location and pertinent information about a distressed vehicle. In addition, a silent alarm or CCTV camera video feed from a transit vehicle or transit facility to the operations or security center can be employed.

According to *TCRP Synthesis Report 70* (2007), which documents a survey of transit agencies who employ MDT technologies, 39 percent of respondents use MDT to monitor on-time performance. The exact cost of an MDT is difficult to determine without going through the procurement process, and the price is very dependent on the number of units ordered the features available. According to the TCRP survey, MDTs cost on the order of $1,000 to $4,000 per unit. Installation of the MDT units cost roughly

$500-$1,000 per unit. Transit agencies reported that annual maintenance is on average $200 per unit. In addition to the initial capital costs, MDT manufacturers may charge monthly or annual fees for technical support. Each driver will need to be trained on the MDT, which can take up to 8 hours per driver.

Pros and Cons for EDCTA: The primary purpose of the MDT technology is to facilitate communication between drivers and dispatchers. When interfaced with CAD software, MDTs would increase communications efficiency particularly for the EDCTA DAR vans which use cell phones to communicate. Currently, EDCTA does not automatically collect on-time performance data, though the Zonar system has the capability to generate reports that will assist in this department. With MDTs, EDCTA would be able to more effectively and efficiently compile standard transit performance measures such as passengers per vehicle service mile, passengers per vehicle service hour and on-time performance. Particularly, determining the performance of the Cameron Park, Diamond Springs and Folsom Lake College routes individually could be facilitated through the combination of MDTs and AVL. Case studies with MDTs in rural transit systems have shown that some regions attempting to implement MDTs were unable to do so due to an inadequate radio communications networks. EDCTA staff have indicated that there are "dead zones" in some areas of the County and radio conflicts in portions of downtown Sacramento. More in depth research would be required to confirm that a good data communications network could be established encompassing all of the EDCTA service area.

Electronic Fare Management System

A transit systems fare management system encompasses the receptacle for depositing passenger fares and fare media. Currently EDCTA uses standard manual fareboxes with a flip door. As for fare media, EDCTA uses plastic monthly and lifetime passes and paper transfers, Sac RT transfers and scrip tickets. Advanced fare systems are currently available that can make change, accept credit/debit cards, track passenger boarding activity by route, run and stop, speed the passenger boarding process, and greatly reduce the time and cost associated with collection of fares, tracking of fare data, and accounting.

There are three types of electronic fare media:

- **Bar Coded Cards** – Similar to technology employed in the retail industry, each bar coded ticket is labeled with specific data about the rider and fare. A bar code reader/scanner for each vehicle and costs on the order of $1,000 each. The base system which includes a computer and printer costs around $4,500. This is a relatively low cost method for transit systems to implement electronic fare media, automatically record trips, and generate operations and billing invoices.

- **Magnetic Stripe Cards -** These cards are paper or plastic tickets with a magnetic stripe for storing information. As an example, the BART system in the Bay Area uses paper magnetic farecards. There are two basic types: read-only swipe cards and read-write stored value cards. Read-only cards allow for automatic determination of the validity of an unlimited-ride pass. Read-write cards used in conjunction with a Ticket Processing Unit (TPU) can determine the validity of a multi-ride card or stored value card and deduct the necessary ride or value. Some units are able to print the remaining value on the card. Read-write cards can also be encoded with the information needed to serve as an "electronic transfer slip." An "electronic purse" is another function of the magnetic stripe, where the stored value on the card can also be used to make small purchases from cooperating merchants.

- **Smart Cards -** A smart card is a type of fare medium that resembles a credit card with an embedded computer chip. Two types of smart cards exist: contact and contactless "proximity" cards. Contact cards must be physically swiped or fed through a card reader, whereas, contactless cards only need to be held within an inch or two of the card reader allowing for a speedier processing time. In fact, contactless cards do not even need to be removed from a wallet or purse to function properly. A contactless smart card system potentially has lower maintenance costs because there are no moving parts needed to push the card through. In addition to the capabilities of the magnetic farecards, smart cards offer greater data processing capabilities and there is a move toward potential joint arrangements between the transit and banking industries using smart cards.

The farebox is the center of a fare management system. An electronic farebox generally includes the following features:

- Magnetic swipe pass reader
- Passenger display
- Integration with passenger processing
- Interface with smart cards
- A ticket processing unit which can read and re-encode magnetic tickets or smart cards, or issue a magnetic transfer, daypass, or other agreed-upon document from an internal supply of blank unencoded stock
- Electronic cashbox door lock
- Silent alarm

More advanced electronic fareboxes include some or all of these additional features:

- Validate coins and bills and return those that are not acceptable to the system
- Accept, validate and, if necessary, re-encode magnetic thin card fare documents
- Optionally accept and process credit cards and Employer ID cards
- Print, encode, and issue a magnetic transfer, daypass, or other agreed-upon documents from an internal supply of blank unencoded stock
- Provide change (or an electronic "change card" for future use) for fare overpayment
- Optional interface to destination/next stop electronic signs/audio enunciator system, GPS, passenger counters, and CAD/AVL systems
- Driver control unit
- High security dual port cashbox with built-in electronic identification system

<u>Pros and Cons for EDCTA</u>: The primary advantage of an electronic farebox for EDCTA would be the data management possibilities. An electronic farebox can record the number of boarding passengers by type, total passes, stored value cards, etc. Route/Run summary reports can be initiated by the driver using the driver keypad to create a record that summarizes all fare transactions since the last route/run request. Stored ride/stored value cards could be an alternative to multiple ticket booklets. Passengers could purchase either 10-ride, 20-ride, and 40-ride passes or a specified dollar amount worth of rides. These passes would be magnetic-striped farecards or smart cards, originally encoded by a ticket printing and encoding machine and typically sold off the bus. Electronic fareboxes can also issue and process transfers automatically. Another benefit of electronic fareboxes is that they could streamline the ticket purchase process for social service agencies. Some electronic fareboxes have the capability to accept "post billing period passes" for different programs. Using a ticket printing encoding machine, a batch of pre-encoded tickets valid for a specified period of time (say, one year) could be delivered to the various social service agencies and distributed to the clients. When the ticket is inserted into the magnetic card reader, the farebox reads the ticket and records the serial number, time of use, bus, and route. This data is then uploaded to the data system so an invoice report for the Social Service agencies can be generated.

<u>Drawbacks of the electronic farebox include</u>: delays associated with difficulty feeding magnetic fare cards through the machine, particularly if the card is wet, additional maintenance required and, of course, the cost. Depending on the type of unit, an electronic farebox (without the capability to interface with smart cards) may cost around $14,000 per unit. If magnetic fare media is used an additional $17,000

would be required for each ticket printing/encoding machine purchased. (Costs associated with smart cards are discussed below). Implementation of an electronic fare management system may also require modification of the cash counting office to accommodate larger cashboxes and the installation and maintenance of fareboxes.

Universal Fare Card for Sacramento Region

In 2007, the SACOG conducted a study to determine the feasibility of a universal fare card for the 14 transit agencies which serve the greater Sacramento region. The study recommends implementing the following strategies:

- A regional contactless smart card that would be accepted by all transit agencies. The card would be reusable and passengers should be able to add value to the card at retail outlets and agency offices or link the smart card directly to a bank account.

- The following equipment would need to be installed in each transit agency vehicle: MDTs, smart card readers (this could be interfaced with an electronic validating farebox, a stand-alone unit mounted to the vehicle or a hand-held device) and wireless communications system that can upload/download data between the smart card reader and a yard-based computer.

- In order to issue the smart cards and process transactions, each transit agency would need to be equipped with a smart card printer/encoder, digital camera (for ID photos), and a credit/debit card processor.

- Retail outlets for transit passes and tickets would need to be outfit with a point of sale terminal for the regional smart card.

- A central manager or "regional center" would be required to assist with the reconciliation of revenues between the various transit agencies, purchase of materials, system maintenance and parts inventory, customer service and employee training and on-going support. Either one of the participating agencies or an independent third party could fill this role.

- A central website would be established and maintained by the central manager. The website would perform the following functions:

    - Purchase of a new smart card
    - Register a new or existing smart card
    - One-time reload of a smart card, using a credit card for payment (reload to be performed automatically by smart card reader on bus or rail system within 48 hours)
    - Set up automatic reload ("autoload") of smart card by registering card and linking it to a credit card or bank account
    - Review status, history and remaining value of an individual's registered smart card; revise autoload parameters
    - Report lost, stolen or destroyed smart card to hotlist it and request a replacement
    - For administrators of employer-based transit benefit programs, manage and review smart card accounts of employer and participating employees

- Provide answers to frequently asked questions (FAQs) and contact information for customer assistance and service

Implementation of a regional smart card would provide multiple benefits for passengers and transit agencies:

- The primary benefit to the El Dorado County passenger is that a "seamless" transit trip could be provided from Placerville to Sacramento on EDCTA, light rail, and other transit services as only one type of fare media would be required for the whole trip.

- Employers or social service agencies that currently purchase transit passes for employees would be able to purchase a block of limited use pre-encoded smart cards and be billed electronically for actual trips periodically.

- In addition to only needing one card to access all transit systems in the Sacramento region, the regional smart card provides the passenger with multiple fare payment options. Value can be added to smart cards at retail outlets, an automated phone system or through the website. Additionally the passenger can set up a recurring autoload account that automatically adds value to the card based upon criteria set by the individual.

- Data tracking possibilities such as summary reports of fare types (passes, transfers, disabled riders, social service client, student etc.) would be helpful to operations management and reduce the need for driver data compilation.

The Feasibility Study estimates that the entire project will cost $8.2 million (including 20% contingency) to implement. This number will fluctuate depending on the number of agencies involved and type of equipment purchased. In addition to capital costs, the annual cost of collecting and processing fares increases in the range of $1.5 - $2.0 million for the region overall, after adjusting for expected reductions in lost revenue due to an electronic system and less fare abuse. Although each agency will see a decrease in their in-house expenses and an improvement in revenues, these reductions do not offset the costs associated with the new regional center.

Proposition 1B funding has been secured by SACOG to cover initial capital costs for all participating agencies. Project implementation is planned to begin in FY 2009-2010. Transit staff recommended that EDCTA participate in the initial procurement and implementation of equipment for 26 commuter routes vehicles only with possible procurement of equipment for the remaining fixed-route vehicles in the future. EDCTA staff estimate the capital costs of the project to be $282,000, or $10,850 per vehicle. Annual operating costs incurred by the project will run about $36,000 per year.

Solar Energy Arrays

Many public entities have integrated alternative technologies such as solar power into their facilities and operations. The City of Vacaville has installed solar arrays on the City Hall and at the Bella Vista Park-and-Ride lot which produces electricity for city electric powered vehicles. In sunny California, large buildings or structures such as a covered bus parking or maintenance facility would provide a good location for solar panels. The EDCTA yard receives abundant sun and could be outfit with covered parking and solar panels in order to reduce the agency's carbon footprint.

Advantages of APTS for El Dorado County Transit Authority

- EDCTA appears to be on track to implement smart card readers for the commuter services, and electronic fareboxes will not provide significantly greater data collection/processing options than smart card readers. As this is seen as the primary benefit of an electronic farebox for EDCTA, the cost of implementing electronic fareboxes does not outweigh the benefits. The remainder of the EDCTA system is not of sufficient size to make electronic fareboxes cost-effective.

- MDTs offer enhanced communication and transit performance tracking tools on top of smart card reader benefits that would be helpful for EDCTA at a smaller cost than electronic fareboxes. This technology would be particularly useful in managing the local routes to improve efficiency and on-time performance.

- Future procurement of AVL and GIS systems to assist EDCTA with long-term planning and operations management of DAR system could be beneficial in the long-term, particularly as AVL becomes more widely used in rural transit systems and costs are reduced.

As the system grows in response to growth in the community, or as the cost and dependability of these technologies improves, EDCTA should carefully consider further investment in APTS systems as a means of improving service quality while also increasing service effectiveness.