Chapter 6
Capital Alternatives

This chapter provides a detailed description of the various fuel and fleet vehicle alternatives as well as other capital improvement options such as bus stop passenger amenities, bicycle/pedestrian facilities, and transfer center design elements and potential transfer center locations. Also included in this chapter is an overview of the advanced transit system technologies that have been developed such as automatic vehicle location (AVL) systems, demand responsive dispatching (DRD) capabilities, and automated transit information (ATI).

Transit Fleet

Folsom Stage Line's current fleet is a mix of various vehicle types and ages: six 45-seat Bluebird diesel coaches used to operate the downtown commuter service, three 31-seat Supreme diesel trolleys used to operate local fixed Route 10, six Ford cut-aways used to operate dial-a-ride service, and one Ford cut-away for the Butterfield light rail connector route. Spare vehicles include a 2000 Ford Econovan, a 1993 Ford Cutaway, and a 1992 Chevy Astro Van that is assigned to the Transit Supervisor. The total fleet consists of 18 active vehicles and one inactive Flxible bus that has been retired. The Ford Econovan is to be replaced by a Ford cut-away, and the Chevy Astrovan is to be replaced by a Ford Aerostar (five-passenger van). The review of the service alternatives presented in Chapter 5, and the selection of the service plan that the City decides to implement during the next five years, will determine the appropriate vehicle acquisition schedule. *Table 45* lists the fleet inventory (as of July 2005) and notes the vehicles year it was manufactured, odometer reading and condition as of February 2005, along with a potential year for replacing the vehicle.

Fleet Spare Ratio

In order to ensure system reliability, an adequate number of spare buses are required for each service mode. The transit industry does not have a uniform spare ratio, however, the Federal Transit Administration (FTA) will only fund replace or expansion buses if a 20 percent or lower spare ratio is maintained for fleets with 50 or more active peak vehicles. For fleets with fewer than 50 fixed-route vehicles, judgment must be applied to determine what is an excessive number of spare vehicles. Since Folsom Stage Line does not operate greater than 50 buses in peak service on any of its three modes (Fixed-Route, Dial-A-Ride and Commuter), the maximum 20 percent spare ratio is not a requirement but merely a guideline that can be used as a basis for evaluating Folsom Stage Line's fleet needs. Currently (July 2005), Folsom Stage Line has one spare diesel Bluebird coach for the downtown commuter service, one spare Supreme trolley for the fixed-route service, and one Ford cut-away for the dial-a-ride service. Lower spare ratios can generally be maintained if the following issues have been addressed:

- ***Average Age of the Fleet*** – the ability to regularly replace older vehicles with new vehicles increases the reliability of the fleet and reduces the maintenance effort required.

- ***Fleet Consistency*** – The uniformity of the fleet enables maintenance staff to standardize maintenance procedures and reduce parts inventories, which leads to reduced maintenance efforts.

- ***Maintenance Program*** – The efficiency and effectiveness of maintenance staff, as well as the relative importance within the organization of maintaining the fleet at a very high level, reduces the need for a large spare ratio. The ability to provide specialized and continuing training to maintenance staff also increases the effectiveness of the maintenance program. Mid-life refurbishment of the fleet also extends the life of vehicles and increases the reliability of the fleet.

TABLE 45: Folsom Stage Line Fleet Inventory (July 2005)

No.	Veh ID#	Year	Vehicle Description	Acc. Y/N	No. of WC	No. of Seats	Stand. Cap.	Serial or Vin No.	Odometer (Mileage)	Odometer Date	Vehicle Condition
1	418	1998	Bluebird QBRE3705 Coach, (Commuter)	Y	2	45	60	1BAGKB7A1WF082033	161,613	2/16/2005	Good
2	417	1998	Bluebird QBRE3705 Coach, (Commuter)	Y	2	45	60	1BAGKB7AWXF082032	169,573	2/16/2005	Good
3	419	1998	Bluebird QBRE3705 Coach, (Commuter)	Y	2	45	60	1BAGKB7A3WF082034	190,369	2/16/2005	Good
4	292	1995	Bluebird F112274 Coach (Commuter)	Y	2	45	60	1BAGKB7A4SF064538	208,834	2/9/2005	Fair
5	291	1995	Bluebird F112273 Coach (Commuter)	Y	2	45	60	1BAGKB7A2SF064537	211,481	2/9/2005	Fair
6	290	1995	Bluebird F112272 Coach (Commuter)	Y	2	45	60	1BAGKB7A0SF064536	244,375	2/15/2005	Fair
7	557	1999	Supreme Trolley (local Route 10)	Y	2	31	37	4UZ62FBA1XCF56760	54,937	2/9/2005	Good
8	554	1999	Supreme Trolley (local Route 10)	Y	2	31	37	4UZ62FAA1YCG01909	116,213	2/16/2005	Good
9	563	2000	Supreme Trolley (local Route 10)	Y	2	31	37	4UZAAUBV31CH76042	134,000	2/11/2005	Good
10	825	2004	Ford E-450 Cutaway (Dial-A-Ride)	Y	2	14	20	1FDXE455254HA19123	8,542	2/16/2005	Excellent
11	744	2004	Ford E-450 Cutaway (Dial-A-Ride)	Y	2	14	20	1FDXE45S63HB85223	26,183	2/16/2005	Excellent
12	743	2004	Ford E-450 Cutaway (Dial-A-Ride)	Y	2	14	20	1FDXE45S93HB18289	26,296	2/26/2005	Excellent
13	742	2004	Ford E-450 Cutaway (Dial-A-Ride)	Y	2	14	20	1FDXE45S73HB38119	28,635	2/16/2005	Excellent
14	741	2004	Ford E-450 Cutaway (Dial-A-Ride)	Y	2	14	20	1FDXE45S43HB85222	29,523	2/16/2005	Excellent
15	740	2004	Ford E-450 Cutaway (Dial-A-Ride)	Y	2	14	20	1FDXE45S53HB43268	34,432	2/9/2005	Excellent
16	258	1993	Ford Cut-away (spare)	Y	2	14	20	1FDKE30G1RHA14329	201,845	2/16/2005	Fair
17	527	2000	Ford Econovan	N	0	7	7	1FMRE11L0YHB04049	40,548	2/16/2005	Good
18	58	1992	Chevy Astro Van[1]	N	0	7	7	1GNDM15Z8NB167678	105,890	2/11/2005	Fair
INACTIVE VEHICLES											
*	259	1993	Flxible Bus					1GF5ERVK5PD104818	N/A		Retired

Footnotes:
[1]This vehicle is assigned to the Transit Supervisor.

Abbreviations:
Y/N = Y= Yes; N = No
Acc. = Accessible
No. of WC = No. of wheelchair positions
Stand. Cap. = Standing Capacity (without WC)

Source: Folsom Stage Line, Transit Division, July 2005

Fuel Alternatives

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. In addition, the California Air Resources Board (CARB) recently adopted a transit bus fleet rule that requires transit agencies to significantly reduce the tailpipe emissions of their fleet by 2015. Agencies are allowed to opt for either a "diesel path" or "alternative fuel path" to provide flexibility in determining their optimal fleet mix. In general, the requirements include:

- An in-use fleet average requirement for oxides of nitrogen (NO_X) that will encourage the retirement of the oldest, dirtiest diesel buses. This requires a minimum active fleet average of 4.8 grams per brake horsepower-hour (g/bhp-hr) of NO_X. This requirement is the same for either path (diesel or alternative fuel).

- A particulate matter (PM) retrofit requirement, with an emphasis on the dirtiest buses, to reduce diesel PM emissions. This requires that an after-treatment device that demonstrates 85 percent conversion efficiency be installed on engines that meet specified requirements. This requirement is the same for either path.

- Low-sulfur diesel fuel must be used by all transit agencies by July 1, 2006 (this deadline was July 1, 2002 for agencies operating 20 or more urban buses). Low-sulfur diesel will reduce PM, though it is projected to cost an additional five to ten cents more per gallon. Use of low-sulfur fuel is required for both paths, though it is more important for agencies choosing the diesel path, since most existing after-treatment technologies require low-sulfur fuel to operate efficiently and reliably. Folsom Stage Line is currently meeting this requirement. Large transit agencies (greater than 200 urban buses) that choose the diesel path are required to procure three zero-emission buses by July 1, 2003, and use them in service for a minimum of one year.

- Beginning in 2008, large transit agencies that choose the diesel path must ensure that at least 15 percent of its annual bus purchases are zero-emission buses. This requirement is delayed until 2010 for agencies that choose the alternative fuel path.

Both paths provide approximately the same NO_X emission reductions over the lifetime of the fleet rule, though the alternative fuel path will provide greater PM reductions. A number of reporting requirements were also imposed as part of this rule. Folsom Stage Line has selected the diesel path.

Diesel Fuel

Diesel-fueled engines have traditionally dominated the transit vehicle marketplace with their fuel efficiency and durability. While diesel engines have very low tailpipe emissions of CO and other organic gases, the concern from an air quality perspective has been the emission rates of NO_X and PM. Due to increasing environmental pressure to reduce the above emissions, the Environmental Protection Agency, collaborating with the American Public Transit Association, has developed stringent NO_X and PM regulations. The final CAAA permit the use of clean diesel in urban buses, provided that the clean diesel engines meet the PM standards imposed by the CAAA. 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. Since the CAAA imposed regulations, diesel engine manufacturers have been successful in lowering NO_X and PM tailpipe emissions by employing in-cylinder control techniques. Similarly important is that manufacturers have maintained the fuel's economy.

Alternative Fuels

In order to develop a working concept of the different alternative fuels, their advantages and disadvantages, and their potential application for the Folsom Stage Line fleet, following is an overview of the different alternative fuels.

Ethanol

Ethanol is a clear, colorless liquid that is made up of a group of chemical compounds whose molecules contain a hydroxyl group bonded to a carbon atom. 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. While not being as corrosive as methanol, the major use of ethanol is currently limited as an octane additive and oxygenate for gasoline.

The CAAA of 1990 mandated the sale of oxygenated fuels in areas with unhealthy levels of carbon monoxide. Since that time, there has been strong demand for ethanol as an oxygenate blended with gasoline. Blends of at least 85% ethanol are considered alternative fuels under the Energy Policy Act of 1992 (EPAct). In the United States each year, approximately 2 billion gallons are added to gasoline to increase octane and improve the emissions quality of gasoline.

Methanol

Methanol is an alcohol fuel – methane with one hydrogen molecule replaced by a hydroxyl radical. Today most of the world's methanol is produced by a process using natural gas as a feedstock. However, the ability to produce methanol from non-petroleum feedstocks such as coal or biomass is of interest for reducing petroleum imports. 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. As engine fuels, ethanol and methanol have similar chemical and physical characteristics.

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, over recent years, retired their methanol programs, due to the fuel’s highly corrosive properties. After spending $102 million since 1989 on methanol buses, Los Angeles County Transit officials declared their methanol anti-pollution program a failure. Authorities from the Metropolitan Transit Authority (MTA) cited that the buses are prone to costly mechanical repairs. Officials of 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.

Compressed Natural Gas (CNG)

Natural gas is a mixture of relatively unreactive hydrocarbons, mainly methane, and is produced either from gas wells or in conjunction with crude oil production. The interest in natural gas as an alternative fuel stems mainly from its clean burning qualities, its domestic resource base, and its commercial availability to end-users. Because of the gaseous nature of this fuel, it must be stored onboard a vehicle in either a compressed gaseous state (CNG) or in a liquefied state (LNG).

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, although the gap in price has closed considerably over the past two years. The fuel also has the potential to reduce NO_X emissions and PM when compared to diesel. However, CNG engines still emit higher concentrations of HC and CO than recent diesel engines – two greenhouse gases that contribute to global warming.

It is widely perceived – both inside and outside the transit industry – that CNG is the future transit fuel of choice. However, others see CNG as a stop-gap measure that can be used to reduce vehicle emissions until other technologies (e.g. hydrogen fuel-cell or combustion-electric hybrid) are further developed. 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 problems. CNG is stored in high-pressure cylinders at pressures up to 3,600 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.

A new 40-foot CNG bus costs $350,000–$375,000 – that is about 30 percent more than a comparable diesel bus. This is due to the higher cost of the engine itself and the higher cost of fuel tanks. A CNG refueling facility with capacity for a fleet of 20 to 40 buses would probably cost in the range of $1.5 million - $2 million. Economies of scale could be realized if a fueling facility was shared with other CNG vehicle users; however, the initial capital outlays would be more, depending upon the ultimate capacity of the facility. Additional costs would also be incurred to equip the new facility with required safety features and to provide emergency response equipment and training.

The Yolo County Transportation District (YCTD) currently (Summer 2005) has a contract with Pinnacle to build a CNG refueling station, which includes two compressor skids, for about $1.4 million. Each compressor is capable of outputting about 7 therms a minute. At about 2.6 miles per therm, it would take 100 therms or 14 minutes to pump 260 miles worth of fuel; if both compressors are running at the same time, it would only take seven minutes to fill a bus. YCTD also paid PG&E about $65,000 to bring a bigger transformer and a natural gas line onto their property. After the station is up and running, YCTD will pay Pinnacle an ongoing fee per therm for maintaining the CNG station. There are a few hidden costs that would likely drive the costs up for other agencies such as costs related to the natural gas pressure at the inlet. YCTD is starting with 190 psi and is also using three existing vessels for storing natural gas as well as two existing CNG dispensers. An additional $200,000 would probably be needed to cover those costs (about $60,000 for two dispensers and another $75,000-$100,000) for fuel storage vessels, plus a contingency to cover concrete and steel prices going up.

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. Typically, buses smaller than 35 feet in length are unable to accommodate enough fuel tanks to operate 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 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 59 percent and 250 percent higher than their diesel counterparts. This may be a particular problem for agencies that are not located close to a 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 road call rate was 4.5 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.

Liquefied Natural Gas (LNG)

LNG has only recently received attention as an alternative fuel. The potential advantages of the fuel lie in its economic considerations, where the fuel's processing costs are much less than that of other gaseous fuels. LNG also has a greater potential to reduce NO_X 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)

Liquefied Petroleum Gas (LPG), commonly referred to as propane, is produced in the extraction of heavier liquids from natural gas, and as a by-product in petroleum refining. Presently, LPG supply exceeds the demand in most petroleum-refining countries, so the price is low compared to other hydrocarbons. Depending on the locale, however, the additional costs of storing and transporting LPG may more than offset this advantage.

Propane (LPG) is widely used in smaller vehicles, but so far comparatively rarely in full-sized transit buses that are using CNG more frequently in this category. Engine technology for LPG vehicles is very similar to that of natural gas vehicles. Power, acceleration, payload, and cruise speed are similar, but propane buses are less fuel-efficient than diesel buses, and hence their driving range is somewhat lower than for comparable vehicles. As with CNG buses, LPG engines, which are also spark-ignited, can be stoichiometric or lean burn, the latter being the more promising option. LPG is slightly heavier than air that means that LPG-gas coming out from a leakage may store up in spaces where the gas becomes highly explosive.

The advantages and disadvantages of LPG 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. LPG is also well established in its transit fleet applications. The disadvantage of the fuel is in the engine performance of transit vehicles using the fuel – the conversion of a gasoline engine to LPG will usually cause a 10 to 15 percent power loss.

Hydrogen

The simplest and lightest fuel is hydrogen gas. Hydrogen is in a gaseous state at atmospheric pressure and ambient temperatures. Hydrogen may contain low levels of carbon monoxide and carbon dioxide, depending on the source. Hydrogen is being explored for use in combustion engines and fuel cell electric vehicles. On a volumetric basis, the energy density of hydrogen is very low under ambient conditions. This presents greater transportation and storage hurdles than for liquid fuels. Storage systems being developed include compressed hydrogen, liquid hydrogen, and physical or chemical bonding between hydrogen and a storage material (e.g. metal hydrides).

The ability to create hydrogen from a variety of resources and its clean-burning properties make it a desirable alternative fuel. Although there is no significant transportation distribution system currently for hydrogen transportation use, hydrogen can be transported and delivered for early market penetration using the established hydrogen infrastructure; for significant market penetration, the infrastructure will need further development.

Hydrogen will play an important role in developing sustainable transportation in the United States, because in the future it may be produced in virtually unlimited quantities using renewable resources. Hydrogen has been used effectively in a number of internal combustion engine vehicles as pure hydrogen mixed with natural gas. In addition, hydrogen is used in a growing number of demonstration fuel cell vehicles. Hydrogen and oxygen from air fed into a proton exchange membrane (PEM) fuel cell "stack" produce enough electricity to power an electric automobile, without producing harmful emissions.

Hybrid Electric

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

Hybrid electric propulsion systems are currently being tested at several large transit properties, most notably New York City Transit. This agency has been testing pre-production 40-foot hybrid electric buses since 1999 with generally positive results. New York City Transit currently has another 325 Orion VII hybrids on order. The following California transit agencies are also testing hybrid technologies: Elk Grove Transit, Long Beach Transit, Los Angeles County Metropolitan Transportation Authority, Omnitrans in San Bernadino, Orange County Transportation Authority, and Sunline Transit in Thousand Palms. Other agencies testing hybrid electric buses include: King County Metro Transit in Seattle, New Jersey Transit, Southeastern Pennsylvania Transportation Authority in Philadelphia, and TriMet in Portland (Oregon).

According to a report in the January 2003 edition of *Metro Magazine*, maintenance costs for a hybrid electric system are typically lower in comparison to conventional diesel- or CNG-powered vehicles, due to greater fuel economy and reduced brake wear. The batteries are also charged through regenerative braking, 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 a large infrastructure investment that is required for CNG or LNG technologies. However, the cost of a full-size heavy-duty hybrid gasoline electric bus is approximately $550,000 – that is about $200,000 more than a comparable CNG powered bus and more than double the cost of a comparable diesel fueled vehicle. In addition, conventional sealed-gel lead acid battery systems typically only last two to three years, and replacement units cost on the order of $10,000 to $15,000. Better battery technology currently exists that could extend battery life (e.g. nickel metal hydride), but this technology currently costs several times that of lead-acid batteries.

A few years ago, Roseville Transit expanded its CNG fueling facility by adding a second compressor, a few storage tanks, and slow fill dispensers to its corporation yard, for a total cost of over $300,000. Presently, Roseville Transit can fuel a maximum of twelve buses using slow fill at night. It can also be used to fast fill a few buses during the day, if needed. Roseville Transit’s Transportation Manager, Mike Wixon, provided the following insights from their recent experience:

- If possible, use oil-free compressors to avoid oil in the CNG.
- Have back-up systems for the compressors.
- Emergency shut off switches need to have a quick re-set capability.
- Identify exactly how the buses will park and fuel.
- If fast fill is needed for up to 40 buses, one behind the other, locate the fill station near an existing high volume/pressure natural gas line (you can only fuel as much as the existing natural gas supply line will allow).
- A fast fill system will likely cost more than a slow fill system.
- If other vehicles will be using the facility, identify a best guess estimate of the number and type of vehicles that will use it and how much volume of fuel each vehicle will need on a daily basis. This will help determine if the supply line has enough volume to even allow an expansion.
- Consult with the City's sewer and water treatment electronic technicians for the fueling system maintenance, since they are likely to be most familiar with the use of compressors and electronics similar to a CNG station.
- The garage will need to be set up to work on CNG buses – add costs to retrofit and/or expand the fleet maintenance building.
- CNG vehicles will have higher maintenance costs;
- CNG buses are now burning leaner, which means that the amount of fly-oil in the CNG must be very low or it will cause a lot of problems in the engine and fuel delivery systems--do not buy DDC series 50G engines!

Terry Bassett, Executive Director for the Yolo County Transportation District (YCTD) estimated the cost difference (including purchase price plus fuel costs over a 12-year useful life) of a new gasoline hybrid coach to be more than 35 percent of a comparable CNG bus as shown in *Table 46.* Unless there is a savings of more than $200,000 in maintenance costs over 12 years, hybrid gasoline/electric buses are still more expensive to operate than CNG buses. The cost difference to purchase seven or eight new hybrid buses would pay for a CNG station.

TABLE 46: Gasoline Hybrid versus CNG Bus Cost Comparison

	Gasoline Hybrid	CNG
Total Miles	500,000	500,000
Miles per Gallon	5.00	3.65
Price Per Gallon Equivalent	$ 2.30	$ 1.59
Total Gallons Consumed	100,000	136,986
Total Fuel Costs	$ 230,000	$ 218,438
Bus Purchase	$ 550,000	$ 357,000
12-year cost *(excludes maintenance)*	**$ 780,000**	**$ 575,438**
Cost Difference	$ 204,562	
	35.5%	

Notes:
CNG = $1.12 per therm x 1.34 efficiency rating

Source: Terry Bassett, Executive Director, YCTD, July 2005

Alternative Fuels Summary

Full electric vehicles and hydrogen-powered buses are 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.

Barring conversion to alternative fuels, a number of steps can be taken to substantially reduce the air quality impacts of diesel-fueled transit buses. Various transit systems have been successful in reducing PM emissions through the application of “clean-diesel” technology. The utilization of a low sulfur fuel has proven to reduce the average annual PM emissions of a transit coach from 935 pounds to 260-300 pounds – roughly a 70 percent reduction. In addition, installation of an electronically controlled fuel injection system and specially designed transmission has dropped emission levels by 120 pounds of PM annually, for a total reduction in emissions of 87 percent. This technology is currently in use on Roseville Transit’s fleet of 1998 and newer diesel buses, all of which use a Ford-Navistar Powerstroke, Detroit Diesel, or Cummins C-Series diesel engine. The City of Folsom uses clean air technology with both the gas and diesel vehicles using electronic fuel controls, and the diesel vehicles also utilize ultra-low sulfur diesel fuel.

Folsom Stage Line should remain open to the ideas of alternative fuels. However, the agency would have a greater impact on local air quality through the purchase of new diesel equipment with “clean-diesel” standards that meet CARB requirements. To pursue this route, Folsom Stage Line would replace the worst polluting vehicles from the existing fleet, as they are due for retirement.

CNG Fueling Facility Alternatives

CNG is the most common alternative fuel in use by transit fleets today. Funding assistance is available through the Sacramento Metropolitan Air Quality Management District (SMAQMD), Congestion Mitigation Air Quality (CMAQ) funds and the Sacramento Emergency Clean Air and Transportation (SECAT) program for CNG fueled vehicles. There are several nearby transit operators that utilize CNG fueled vehicle (Sacramento Regional Transit District, Yolo County Transportation District) that can offer their expertise and experience. The following section summarizes background on local operators’ experiences and planning considerations for the City should it wish to assess the feasibility of converting its transit fleet to an alternative fuel. For purpose of this discussion, the alternative fuel being considered is compressed natural gas (CNG).

Without a convenient, reliable source of fuel, a transit fleet cannot operate effectively or efficiently. Presently, the nearest CNG fueling facility to the City of Folsom’s corporation yard is the Folsom Cordova Unified School District’s (FCUSD) bus facility located in Rancho Cordova, which is operating at near capacity. If the City of Folsom decides to pursue the CNG fueling alternative in the future, there are a couple of fueling facility options as described below.

1) **The City could build its own CNG fueling facility.** Given the size of Folsom Stage Line’s active fleet (currently 18 vehicles) and that it will not likely expand significantly, with plans to eliminate downtown commuter service when light rail is operational, this option is not justified unless the entire City fleet of garbage trucks, police cars, etc. converted to CNG. In addition, the City could provide a public facility and sell CNG to other entities (e.g. El Dorado Transit, school districts). Sonoma County Transit installed a new CNG fueling facility in its yard in Santa Rosa, which cost about $2 million (1999 dollars) including all associated upgrades to its facility. Yolo County Transportation District (YCTD) is currently building a CNG fueling station for about $1.4 million. Because they are smaller volume operators, Sonoma County Transit and YCTD have not and do not expect to realize significant savings in fuel costs with a switch to CNG. However, Sacramento Regional Transit District (RT) does save on fuel costs because it’s CNG active fleet of over 250 buses are 100 percent CNG.

2) **The City could contract with a provider to install and maintain a compression unit and provide the CNG.** No up-front capital investment is needed; however, new CNG-fueled vehicles must be purchased, and a multiple-year contract for the compression/fueling unit is required with a minimum annual purchase. The units are designed for commercial fleet, small transit, and paratransit operations that need eight to 80 gallons per fueling.

Vehicles and Maintenance

Use of CNG fuel by Folsom Stage Line would require conversion of the existing fleet of vehicles to CNG fueling, replacement of diesel buses with new CNG-fueled vehicles, or a combination of the above. Sonoma County, YCTD, and RT all recommend against conversion of existing vehicles to CNG fuel because diesel vehicles are not designed to handle the load of CNG fuel tanks. Purchase of new vehicles is certainly a possibility, depending on funding availability (see below), and represents the preferred option since vehicles would be designed and built specifically for CNG-fueled operation and would be under full warranty.

There are a number of reliable CNG-fueled vehicle types and sizes available (with the exception of small, cutaway type vans like the vehicles Folsom Stage Line operates in local dial-a-ride service now). However, CNG-fueled vehicles have a higher initial purchase price than diesel-fueled vehicles. The experience of local transit operators indicates that there is little difference between the maintenance costs for diesel and CNG fueled vehicles. Comparisons are usually made between older diesel coaches and newer CNG vehicles, however, so the results are not conclusive. An initial capital outlay is also required to upgrade maintenance facilities to comply with CNG safety requirements (e.g. ventilation, emergency power shut-off, leak detection equipment).

Possible Funding Sources

As an operator in the Sacramento Urbanized Area the City of Folsom is eligible to compete for a share of the FTA Section 5307 formula funds available to the urbanized area. These funds can be used for capital projects, including bus purchase, ADA services and for preventive maintenance expenses. These funds are available on a competitive basis. The Sacramento Metropolitan Air Quality Management District (SMAQMD) has funding programs available to assist with the extra incremental capital costs associated with the purchase of CNG-fueled large transit coaches (not the small vehicles used for dial-a-ride service). SMAQMD would also be able to assist with applications for other funding sources such as the Congestion Management and Air Quality (CMAQ) and the Sacramento Emergency Clean Air and Transportation (SECAT) programs. A Federal congressional earmark of funds for a fueling facility and/or vehicles is also a possibility for Folsom. The City has been successful in the recent past with acquiring such earmarks for purchases of commuter buses. Transportation Development Act (TDA) funds could be used for the required local match for federally funded purchases.

Summary of Planning Considerations

- Cost of a new CNG fueling facility would be $1.5-2 million. Since the cost to purchase the fuel is largely dependent on volume, such as investment makes sense for Folsom only if the vehicles served could be expanded to include not only the transit fleet but the entire fleet of City vehicles, school district buses, possibly El Dorado Transit's buses, or other private or public parties.

- The cost of CNG increases significantly (making it uncompetitive with diesel) when the fueling facility is owned by another entity due to the fact that this third party must recoup its capital costs as part of the fueling charges.

- Conversion of existing diesel-powered vehicles to CNG is considered too risky and expensive. New, reliable CNG-fueled vehicles are available particularly for operations using heavy-duty 35-foot to 40-foot transit coaches. According to the transit vehicle procurement officer for Caltrans, cut-away vehicles, such as those used by Folsom for its local dial-a-ride service, are not currently being made with CNG-fueling equipment. Cutaway vehicles that were previously manufactured with CNG fuel systems have had reliability issues, and are not recommended.

- Financial assistance that would fully fund CNG-fueled vehicle purchases and the investment in a CNG fueling facility is not currently available. Some assistance covering the additional costs associated with purchasing CNG-fueled vehicles is available, and there is some potential for CMAQ/SECAT grant funds, FTA 5307 formula funds, FTA 5309 bus discretionary funds, and/or congressional earmarks.

Fleet Vehicle Alternatives

Low-Floor Buses

Low-floor transit coaches are becoming the "standard" for urban fixed-route transit services around the country. For instance, Sacramento Regional Transit District, Valley Transit Authority, Livermore-Amador Valley Transit Authority, and Modesto Area Express are examples of transit systems in northern California that are transitioning to low-floor buses. In comparison to the typical floor height of approximately 30 inches, low-floor buses require passengers to climb to only approximately 12 inches in height. In addition, low-floor buses typically use a simple fold-out ramp system to assist persons with mobility limitations in boarding the bus – negating the need for a hydraulically-actuated lift system. The benefits of low-floor buses are that passengers typically find them more comfortable, and boarding and deboarding times are reduced, thus, reducing dwell times and improving on-time performance.

The primary disadvantage of low-floor buses is that there are fewer seats than in a standard high-floor bus of similar length. For example, Bluebird, one of the world's leading bus manufacturers, makes a 35-foot low-floor bus (Ultra LF™) that seats up to 30 passengers whereas Bluebird's comparable 35-foot high floor bus (XCEL102) seats up to 38 to 40 passengers. Both models can accommodate up to two wheelchairs; however, each wheelchair takes the space of three seats. A Bluebird Ultra LF and XCEL102 each cost about $230,000 - $240,000 (excluding sales tax). The comparable cost is due to the difference in the wheelchair lift equipment. The low-floor bus is equipped with a simple, fold-out ramp whereas the two-step bus has a more expensive hydraulic lift. Finally, low-floor buses are typically 102 inches wide, in comparison to the 96-inch width of the existing Folsom Stage Line buses. Operating a wider bus could be a problem in areas with particularly narrow streets (e.g. Historic Folsom). Copies of brochures for each of these Bluebird buses are included in *Appendix L.*

Registering Fareboxes

Two types of registering fareboxes currently exist: (1) validating fareboxes and (2) non-registering fareboxes. Both types register (e.g., count) money and tokens inserted for payment of fares. A validating farebox, however, uses modern electronic methods to verify that the coins and bills inserted are valid. In addition, validating fareboxes seek to accurately determine the value and denomination of the coins and bills. A standard non-validating registering farebox uses simple mechanical methods to identify coins and bills and makes no attempt to identify or reject invalid or counterfeit currency. For coins, only the diameter is measured to determine value. For bills, registering fareboxes measure the length and count every bill within 10 percent of the length of a dollar as a $1.00 bill. Bill denominations are not distinguished. In short, validating fareboxes provide increased security and accuracy over traditional electro-mechanical non-validating fareboxes.

Folsom Stage Line currently uses non-registering, "inspection plate" fareboxes that feature a display window for the driver to verify the cash paid. These fareboxes are only installed on the cut-away vehicles used to operate the dial-a-ride service. However, this technology is susceptible to fare fraud, as drivers cannot easily discern between valid coins and "plugs." In addition, this technology requires more staff time to count the cash fares and verify receipts against ridership records. There are no fareboxes installed on the Bluebird coaches used to operate the downtown commuter service. Commuter passengers paying fares with cash or script hand their fare to the bus driver who puts the money or script in a zippered pouch. This fare collection method is highly susceptible to fare fraud, since the honesty of the drivers cannot be monitored. With both of these methods, the bus drivers are supposed to record each boarding passenger and fare payment method on a daily ridecheck sheet, which is also susceptible to record-keeping errors. Finally, as new transit data technologies emerge, it will be important to link fare and passenger load information into the overall data management program. As such, it is reasonable for Folsom Stage Line to consider implementation of registering fareboxes.

Technological advancements in fare collection systems indicate that there will be more use of non-cash payments (e.g. stored value cards) in the future. However, cash fares will continue to be an important fare media. There will always be exception transactions (e.g. first time or infrequent riders, tourists, passengers who have lost or forgotten their passes, tickets or “smart cards”) that the need for cash payment will never go away. A registering farebox should be considered a component which will co-exist with other fare collection components, data radios, passenger counters, GPS systems, headsigns, audible stop announcement systems, and possible electronic entertainment and advertising systems to be developed in the coming years. At some time in the future, it’s critical for the success of the program, to install fareboxes in all the revenue vehicles. For the short-term, purchase of basis fareboxes compatible with the fareboxes in the dial-a-ride vehicles. In the future, the City may want to consider more technologically advanced fare collection equipment. The upcoming SACOG Universal Fare Card Feasibility Study may inform the City of the type of fare collection they may wish to purchase if a universal pass is implemented within the SACOG region.

Finally, as many different transit agencies currently operate in the Sacramento urbanized area, it is a regional goal in the future to be able to accept and properly process stored value cards issued by other operators and properly account for their use. This would require a high level of interagency cooperation but would allow the sharing of data between different agencies. Implementing registering fareboxes with an open communication technology that allows integration with other data processing technologies would be an important consideration.

SACOG was recently (November 2004) awarded a transportation planning grant to conduct a “Universal Transit Fare Card Feasibility Study” for the six-county SACOG region. SACOG is currently (August 2005) in the process of preparing a Request for Proposal (RFP) to select a consultant to conduct the study. A small working group comprised of members from SACOG’s Transit Coordinating Committee (TCC), of which Folsom Stage Line is a member, is being formed to provide input into hr RFP. The Sacramento Regional Transit District (RT) is very interested in developing a fare media that could be used on multiply transit systems such as Folsom Stage Line. With RT’s light rail system extending into Folsom, a single fare media that could be used on both systems would provide customers of both transit systems with added convenience.

On-Board Security Systems

According to Folsom Stage Line staff, there is occasionally a need to address behavior problems on the fixed-route buses, particularly loud and abusive language by teen-age riders. One technology that has been implemented by transit and school bus agencies across the country is the use of on-board surveillance cameras. The leading technology uses a digital recording system that can simultaneously record several cameras at once. The Logan Transit District in Logan, Utah, recently implemented a system that records activity in the rear of the bus (which is particularly difficult for the driver to monitor), the entrance and exit stairways, and the driver’s area. The system also includes voice-recording abilities. This system costs approximately $2,000 per bus, plus approximately $2,500 for software and hardware needed at the operations base for transferring and storing the data. In addition to monitoring passenger behavior, recent technological advancements allow agencies to monitor driver actions, such as brake and throttle use, engine idling time and brake retarder use. Activity is monitored from a central base using radio frequency transmission, which is particularly useful for security purposes.

Other Capital Improvements

Bus Stop Passenger Amenities

The "street furniture" provided by a transit operation is an important component 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 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 a vital need for passengers waiting for buses in inclement (e.g. rain, wind, sun, heat) weather conditions. It is recommended that benches be provided at every stop with an average of five or more boarding per day. The benefit to riders in terms of comfort, and the benefit to the transit system in terms of satisfied riders, should more than offset the expense of the program. It is recommended that Folsom Stage Line should work closely with developers to plan passenger amenities and other transit-friendly features during the development phase of a project. Adequate shelters and benches are particularly important in attracting ridership among the non-transit-dependent population – those who have cars available as an alternative to the bus for their trips. Preference should be given to locations with a high proportion of elderly or disabled passengers and areas with a high number of daily boardings. Many regional transit agencies have had benches provided by advertising firms at no cost to the agency.

Lighting and safety issues are especially important if evening service is provided. An analysis of lighting needs at designated high activity bus stops should be conducted to determine the appropriate lighting needs (e.g. overhead street lighting, low power light) to illuminate the passenger waiting area.

The cost of modern glass and steel shelters averages approximately $8,000 including installation for most areas, and appropriate transit benches range from $350 for a recycled plastic bench to $550 for a vinyl-clad "stretched" steel bench, not including installation. Recycled plastic benches are a good alternative since they are virtually maintenance-free, are harder to vandalize, and have a longer life span than traditional concrete or wood benches. As a result, cleaning, maintenance and repair costs are typically minor.

Signed Stops

Folsom Stage Line only picks up and drops off passengers at signed bus stops. A comprehensive bus stop signage program would provide a number of benefits to the Folsom Stage Line system:

- Signs provide a "presence" on the street when the bus is not present, heightening the system's identity and greatly increasing awareness of the system among residents who are not regular passengers.

- Signed stops can make the service easier to use for the first-time transit rider, particularly if provided with the transit information number and/or route schedule.

- Signed stops can be placed in accordance with traffic engineering judgment to assure adequate driver sight distance and to maximize pedestrian safety. As a result, the presence of signed stops can reduce a transit system's potential liability in the event of an accident.

- It is important that each stop have a unique identification number in order to improve the stop maintenance program and to integrate with the region's trip planning system. SACOG and the Sacramento Regional Transit District (RT) are currently working on a Web-based transit trip planning tool that will allow transit riders with the six-county SACOG region to create individual trip itineraries that may involve transfers between connecting transit systems.

All scheduled stops should be signed. Additional stops should be designated on all of the fixed routes to be able to enforce a policy of serving only signed stops.

Bicycle/Pedestrian Facilities

At one end of the trip or the other, virtually all transit passengers also travel on foot or on bicycle (or wheelchair) as part of their transit trip. A key element of a successful transit system, therefore, is a convenient system of sidewalks and bikeways serving the transit stops. The City of Folsom has over 22 miles of bike trails.. Bike storage lockers will be installed at the Glenn light rail station, and there are plans to install bike lockers at the Iron Point and Historic Folsom light rail stations at some time in the future. The City may also consider installing bike lockers at other park-n-ride facilities. It would be useful for Folsom Stage Line to work with other city departments to review construction plans and scheduling priorities for pedestrian and bicycle improvements to best coordinate with transit passengers' needs.

Bicycle Racks on Buses

The concept of bicycle carrier racks on public buses has gained widespread acceptance over recent years, particularly in smaller transit systems, and has proved popular in all cases. Folsom Stage Line has racks that can carry up to two bicycles mounted on the front of all revenue vehicles. Most of the Sacramento region's transit operators have bicycle carrier racks installed on their bus fleets. An estimated cost per rack, including mounting brackets, is about $700. SportWorks, one of the leading manufacturers of bicycle carrier racks, is now making a rack that can carry up to three bicycles. An estimated cost for a three-position rack is in the range of $850 to $900. Installation on the front of the bus is recommended, as this location has proven to be substantially safer than a rear-mounted rack. It is recommended that Folsom Stage Line continue to equip revenue vehicles with front mounted bike carrier racks.

Park-and-Ride Facilities

The analysis of commuter transit demand provided in Chapter 3 underscores the growing long-term demand for commuter services. This growing demand will inevitably result in a substantial increase in park-and-ride parking demand. This growth can be experienced for either an expansion in Folsom Stage Line commuter bus service or for vanpool services (though vanpool parking demand can be expected to be more dispersed than that for bus service). As the residential growth along the Highway 50 corridor continues, traffic will continue to get more congested, increasing the demand for alternative transportation options such as carpooling and vanpooling.

In light of these factors, it will be important for park-and-ride facilities to be appropriately sized to the commuter services provided. There will be park-and-ride lots at each of the three new Folsom light stations: (1) Historic Folsom – 88 (minimum) or 108 (maximum) spaces, (2) Iron Point – 214 spaces (143 in the new north lot and 71 in the existing south lot), and (3) Glenn – 184 spaces. Other potential locations for a park-and-ride facility are: (1) at the intersection of Blue Ravine Road, East Natoma Street, and Green Valley Road; (2) on East Natoma Street near the planned access road for the new bridge to be built over the American River south of the current Folsom Dam Road bridge, and (3) at the U.S. Highway 50 interchange at East Bidwell Street/Scott Road.

Transfer Center Design Elements

A transfer center should be designated to encourage and expedite the transfer to buses of users of other modes of transportation, as well as the transfer of passengers from one bus route to another. Transfer points should have amenities to make the use of the facilities more pleasant. Amenities that may prove useful at such a facility in Folsom could include the following:

- ***Bus Shelters and Benches*** – Shelters should be designed to provide the opportunity for protection from winds and rain in three directions, as well as shade protection from strong, low-angle sun exposure near the end of the day. Seating should also be provided.

- ***Lighting*** – The area should be well lit, to enhance the safety and personal security of waiting passengers. The lighting requirements will depend on the layout of the facility.

- ***Bicycle Racks and/or Bicycle Lockers*** – Bicycle parking and storage should be located near the bus shelter/passenger area.

- ***Landscaping*** – Landscaping will make the facility more attractive to both current and potential users. Landscaping should be placed where it will not interfere with the safety and personal security of the passengers. Generally, landscaping should be focused on the entrances to and the perimeter of the site. When placing landscaping in the passenger waiting area, it is important that the landscaping not interfere with the ability of the waiting passengers to see around it.

It would not currently be economically feasible to provide a transfer point with climate-controlled indoor waiting space and restrooms. While these amenities would be a benefit to passengers, they would incur additional staffing costs by requiring on-site staffing for security reasons and cleaning services.

Important factors to consider when designing a transfer center include the following:

- ***Provision of Adequate Land Area*** – In addition to providing space for passenger loading and bus bays, a transfer point should also accommodate vehicle circulation, interior space, and any setbacks required by local regulation, and landscaping.

- ***Vehicle Access*** – Given the high number of transit vehicle movements through a passenger facility over the course of the day, safe and efficient transit access to and from adjacent arterial streets is a crucial consideration. Delays to transit vehicles (such as the unprotected left turn movements onto busy streets) can cause substantial delay to the entire transit system. Vehicle travel paths must also be carefully designed to minimize conflict with pedestrians.

- ***ADA Compliant Access –*** The transfer center should meet all the requirements to be ADA compliant (e.g. wheelchair access, signage).

- ***Environmental Impact*** – Transit passenger facilities should also be designed to avoid or minimize any potential negative impact of their construction or operation. Any significant impacts associated with a facility will require mitigation, which can often become a large proportion of the total project cost.

These potential impacts can include the following:

- Noise (particularly with respect to nearby residential land uses)
- Air Quality
- Water Quality
- Ecologically Sensitive Areas
- Endangered Species
- Wetlands
- Flooding
- Aesthetics
- Displacement of Existing Land Uses
- Historic Properties/Parklands
- Land Use/Local Plan
- Parking
- Safety/Security
- Traffic

For proper system-wide bus circulation, buses should be able to enter the transfer center from all major street directions. The location should, if possible, facilitate left hand turns from one-way streets and right-hand turns from two-way streets for safer movement. Circulation into the site should separate automobile and bus traffic to ease access for both. When feasible, access points should be a minimum of 150 feet from the centerline of the nearest intersection to avoid traffic conflicts. Two access points located on different streets should be provided to the facility whenever possible. Vehicle and pedestrian access should be designed to minimize conflict between buses and pedestrians.

In addition to passenger loading bays, it is often beneficial to provide at least one parking location for an out-of-service transit bus. This can allow one vehicle to be traded out for another without affecting traffic flow around the center. Parking for transit operations staff and for drivers stopping for transit information should also be considered.

Potential Transfer Center Locations

Current Riley Street and Main/Madison Transfer Points

Currently, Folsom Stage Line has two transfer points on the fixed-route line, one on Riley Street between Glenn Drive and Wales Drive, and one on Main Avenue at Madison Avenue in Orangevale. The Main/Madison transfer point is an RT bus stop with a covered shelter and bench. The Riley Street transfer point has a bus shelter on the north side of Riley in front of the Folsom Central shopping center, and a bus shelter on the south side of Riley in front of the Folsom Aquatic Center. The southbound stop at the Aquatic Center has the most passenger activity on the local fixed Route 10. Its central location within the Folsom area makes it a logical location for passengers to transfer between routes and services. This stop is also located on a segment of Riley Street that has some of the heaviest traffic in the city. While there are shelters at both of these stops, there currently are no bus turn-outs which means that the buses stop in the right-hand traffic lane. Since the proposed service plan recommends maintaining this stop as a central transfer point for Folsom's fixed-route bus network, it is also recommended that the City consider modifying the curb on both sides to have bus turn-outs. Also, curbside space should be reserved for a minimum of three vehicles at one time.

Folsom Lake College

Another potential transfer location is at Folsom Lake College (FLC). With FLC enrollment projected to nearly double from 6,400 in 2004 to 12,000 students by 2010, and parking limited, the college administration has expressed it's support of Folsom's transit services. To encourage FLC students to take the bus, FLC administrative management have expressed interest in having Folsom buses enter the campus from Scholar Way, stop in front of the main building, and loop around the adjacent parking lot. There is currently a cement area near the flagpole that a bus shelter could potentially be located. It is recommended that the City work with the college administration to install a bus shelter and to ensure that the bus loop around the parking lot is has adequate clearance for the bus turns, and that the curb is painted red for no parking, and that the no parking is enforced.

Historic Rail Block Multi-Modal Plaza

The City of Folsom will be breaking ground this Summer (2005) on the construction of a multi-modal, mixed-use development plaza located on the Historic Rail Block, a triangular-shaped area between Sutter, Leidesdorff and Reading streets. The new plaza, designed to be a gateway to historic Folsom, will serve a mix of transportation uses for light rail passengers, bicyclists, pedestrians and tourists. The Plaza will have bicycle racks and lockers on the Leidesdorff Lid, bus turnouts on Leidesdorff Street, automobile turnouts on Reading Street, benches and shade trees. The Plaza will be conveniently located adjacent to the new Historic Folsom light rail station. The multi-million dollar project is partially funded with a FTA earmark. It is recommended that the Transit Division staff work closely with the other City departments working on this project to ensure that the bus turnouts are properly located and meet the bus vehicle specifications.

U.S. Highway 50 and East Bidwell/Scott Road Interchange

Another location that has potential for a transfer center is at the U.S. Highway 50 interchange at East Bidwell/Scott Road. Since there are current plans for a park-and-ride facility to be built on the north side of East Bidwell Street at Iron Point Road, this would be a good location for a transfer point between Folsom Stage Line and the El Dorado County Transit Authority. It will also warrant heightened communication and coordination between the two service providers and development of a transfer agreement and possibly a universal fare. As Folsom and its neighboring city, El Dorado Hills, continue to expand with more residential development and work sites, there is potential future demand for transit service between Folsom and El Dorado Hills. The development over time of a “pulse” system will also add additional transit activity. Ease of access for commuter and fixed-route buses to and from U.S. Highway 50 will be a critical element in the success of this potential transfer point.

Facilities

Vehicle Maintenance Facility

Maintenance is performed on Folsom Stage Line vehicles by the City of Folsom’s Fleet Maintenance Department. The Fleet Maintenance Facility is currently located in the City of Folsom’s corporation yard located at the west end of Leidesdorff Street near Folsom’s Historic District. To conduct proper preventative maintenance procedures, adequate facilities are required. While these facilities may not need to be new, they do need to accommodate adequate parts storage, meet safety requirements, and provide necessary equipment, facilities, and room for maintenance activities. Functional areas should be located in an efficient and safe proximity to each other. Presently, the existing fleet maintenance facility is adequate for the City of Folsom’s current fleet. However, there have been on-going discussions to relocate the City’s corporation yard. While it is not an actual capital project, there is some speculation that it could become an active project sometime in the next five years. If this project does move forward, the Transit Division should be included in the facility planning.

Adequate transit operations and maintenance facilities should be provided for the following functions:

- A vehicle maintenance area, providing three general maintenance bays
- A bus service island, with a service lane including a bus washing facility (vehicle inspection will be done in the general maintenance bays, as opposed to a separate area)

- A separate welding shop, constructed to OSHA standards
- A tire repair area with cage
- Bulk storage space
- Separate parts storage space (including tires)
- A battery storage room
- A fare revenue room, located on the bus service line
- A radio/dispatching area, assuming room for the AVL/real-time dispatching equipment and personnel
- A drivers'/mechanics' room, serving as both a locker area and as a lunch room
- Administrative employee office space
- A multi-purpose room of 150 square feet, which would be used as a training/meeting room
- Transit vehicle parking
- Employee and visitor parking

Ideally, the facility layout should provide for separate vehicular movements by mode (transit vehicles versus private automobiles). Transit vehicle circulation should be in a single direction for safety and space considerations. A service lane bypass should be included to maintain efficient through-flow of transit vehicles, thus avoiding the potential bottleneck of the service line. Transit vehicle parking should be provided in a stacked configuration to conserve space, while providing for easy pull-out maneuvers.

With recent changes in federal regulations regarding hazardous waste contamination, a thorough review of relevant environmental regulations is warranted prior to serious consideration of obtaining an alternative facility site. Prior to legal site acquisition proceedings, it is strongly recommended that an environmental inspection and assessment be obtained by the City of Folsom on any site it is seriously considering. Responsibility for cleaning up environmental contamination conveys with ownership of land. The cost of cleanup is often extremely expensive; it is not uncommon for the cost of cleanup to exceed the land and project costs combined.

Bus Wash System

In general, there are two types of wash systems appropriate for small bus programs: a drive-through system and a gantry-type system. A drive-through system is typically designed for transit systems that operate 30 or more buses daily and uses a relatively low amount of water. The bus proceeds slowly through the wash system, in which rotating wash brushes and water/soap nozzles are positioned in a stationary frame. In a gantry-type system, the bus parks in the wash bay and the wash system proceeds back-and-forth over the bus. This system is commonly used for washing automobiles, as it uses sensors to position the brushes and/or nozzles to wash the vehicle. Both of these types of systems are generally able to wash a greater variety of vehicles.

Given the fleet size and types of vehicles used by Folsom Stage Line, a gantry-type wash system is appropriate, which is the type of system used to wash the City of Folsom's total fleet of vehicles. The current system was refurbished in the spring of 2004, is in good condition, and the City does not have any plans to replace the system in the next five years.

If the City decides to build a new corporation yard, it may want to consider partnering with another transportation provider (e.g. Folsom-Cordova Unified School District or El Dorado Transit) on construction of a new drive-through bus wash facility. A drive-through system typically only requires two to three minutes to wash a full-size bus, in comparison to four to five minutes with a gantry-type system. Over time, this reduction in staff time (and in water usage) could help pay for the additional $35,000 to $40,000 required for a drive-through system. Partnering with Folsom's Solid Waste Division might not be cost effective, as transit buses and trucks may not be able to use the same system, due to differing sizes and make-ups of the vehicles. This is particularly problematic for bobtail or tractor-trailer vehicles, as the drive-through systems do not do a good job washing the space between the cab and the cargo box. The extra staff time needed to manually wash this area could more than use up the savings accrued from a drive-through system. In addition, garbage trucks are generally dirty, which can cause the wash system to perform badly when washing a bus.

Computer Facilities

Each of the Transit Division administrative staff has a computer that is networked with the City's computer system and has Internet access. There are a total of six Compaq PC's that were purchased and installed within the past year (2004). The transit office also has five Hewlett Packard color printers (four deskjets and one laserjet.) The software applications installed include: Microsoft Office (e.g., Word, Excel), Microsoft Outlook e-mail. The PC's will probably need to be upgraded in about three years, and the printers should likely not need to be replaced for at least five years.

Demand-response scheduling and dispatching software could improve the efficiency of the dial-a-ride service. Folsom Stage Line tried to use a demand-response software application called "RouteMatch," but have found it unsuitable, and are no longer using it. RouteMatch will be replaced with Trapeze Lite within the next year (2006). This software should have the ability to maintain client records. The minimum amount of information, which should be maintained in the database, includes the client's name, address, identification number, classification according to disability or specialized need, and billing information. The program should also have the capability to provide weekly, monthly, and annual reports of ridership by agency. The software should also have the ability to prepare daily vehicle schedules. The vehicle schedules should incorporate subscription trips, group trips, and demand-responsive requests, which are received the day before travel is desired. Preparation of vehicle schedules may be accomplished using a fully-automated system or software, which assists the dispatcher in preparing vehicle schedules.

The number of paratransit vehicles operated by Folsom Stage Line can easily be scheduled either manually or by using a software package that assists the scheduler. Paratransit systems with as many as 40 vehicles have found that scheduling assistance is more efficient than a fully-automated system. However, as computer capabilities increase and software is developed to take advantage of the enhanced capabilities, it may become more effective to use a fully-automated scheduling system.

Advanced Transit System Technologies

Recent advances in communication technologies have impacted all segments of modern society and have slowly found new applications in the transit industry. These technologies have come to be known as Advanced Public Transportation Systems (APTS). For purposes of the Folsom Stage Line environment, there are three promising APTS technologies that have been developed over recent years: (1) Automatic Vehicle Location (AVL) systems, (2) Demand Responsive Dispatching (DRD) capabilities, and (3) Automated Transit Information (ATI) systems.

Automatic Vehicle Location

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 of day, date, and other information if available (e.g. number of passengers on board) 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 50 feet. This map can also display direction of travel, on-time status (e.g. a different color for vehicles operating behind schedule) and potentially, the number of passengers on board.

Early transit AVL systems relied on electronic "signposts" consisting of monitors placed throughout the transit system that could detect and report to the central computer the passage of a specific vehicle. Between signposts, vehicle location could only be estimated based upon the schedule. This strategy proved to be cumbersome (as route changes would require modifications of the signposts) and not adequate for demand-response services. Later systems attempted to use LORAN-C radio receivers; this system, however, is often susceptible to electromagnetic interference. In recent years, however, the development of relatively low-cost Global Positioning System (GPS) technologies using satellite triangulation to identify location has largely replaced these other technologies.

The Regional Transportation District in the Denver area implemented an AVL system for 833 fixed-route buses, as well as 66 supervisor vehicles, at an estimated cost of $10,400,000. The Dallas Area Rapid Transit System is installing an AVL system for a total of 844 buses, 216 commuter coaches, 245 demand-response vans, and 300 supervisor vehicles. Similar systems have been installed in the following locations: Chicago, Baltimore, Rochester, and Portland.

AVL technologies open up a range of additional services and benefits:

- The Americans with Disabilities Act requires transit systems to provide voice announcements prior to major transit stops, to allow the visually impaired to more easily use transit services. Drivers, who are often more than busy coping with traffic congestion, find it difficult to consistently provide these announcements. With AVL, vehicle location and direction of travel can be used to trigger a computer processor on a transit vehicle to automatically make a synthesized announcement and also potentially to display a message inside the vehicle. This can also be potentially beneficial to alert visitors of major attractions along the fixed routes.

- An important benefit in larger urban systems is the ability for drivers to trigger a silent alarm, which automatically dispatches police to a bus. The response time to criminal activity on a bus is greatly reduced.

- The ability to identify vehicle location in "real time" is critical to the success of any advanced technology transit service, particularly along routes with relatively low service frequency.

- Finally, automatic passenger counters (APC) record passenger activity by bus stop and time of day. The cost of this technology has decreased substantially over the past several years, equating to $1,000 to $1,200 per bus if installed at the same time the AVL system is installed. This type of technology would allow Folsom Stage line staff to better assess ridership patterns at key busy stops.

It is apparent from the substantial growth that has occurred throughout the greater Sacramento region in recent years, and the spreading out of commute trip patterns, like spokes on a wheel, that the effective coordination among regional transit operators will be a critical element in the efficient operation of future transit services in the City of Folsom study area. The implementation of AVL technologies would enable dispatching and customer service transit staff to effectively coordinate transfers between inter-agency buses.

It is recommended that Folsom Stage Line maintain on-going communications with it's neighboring transit operators (e.g. El Dorado Transit, Elk Grove Transit, Roseville Transit, Sacramento Regional Transit) to keep abreast of the efforts by other transit providers to implement these technologies, and to ascertain any joint procurement opportunities that could result in capital savings for Folsom Stage Line.

Traffic Signal Preemption

Traffic signal preemption technologies provide additional signal "green time" as buses approach traffic signals. The bus can either be equipped with an on-board device that sends out a "notification" signal that extends a set distance in front of the vehicle, or the bus is tracked by a centrally-located AVL system. The intersection controller must be equipped with the hardware and software that will allow for real-time modification of signal timing to better accommodate the approaching bus. Many transit systems operating along congested roadways have found this technology provides a substantial benefit, as buses can operate over shorter schedules and the amount of recovery time provided in the schedules to accommodate traffic signal delays can be reduced. As a result, the capital and maintenance costs associated with the preemption system can, under specific conditions, be more than offset by operational cost savings. The Sacramento Regional Transit District (RT) is utilizing this technology along the Stockton Boulevard corridor with it's enhanced bus line, and is working with Sacramento County to implement this technology along the Watt Avenue corridor.

Rather than always providing buses with a green signal, these systems simply extend the length of green time up to a predetermined limit as buses approach the signal. They are designed to not unduly impact overall traffic delays. This option could potentially be used for all buses or be limited to those buses operating behind schedule or those carrying relatively high passenger loads. A nearby system of similar size that has invested in such a program is Napa VINE transit service, which implemented an AVL system on the entire 18-vehicle fleet in 1995 (including signal preemption when routes are behind schedule). This system is credited with improving on-time performance and cutting operating costs. A traffic signal priority system has also been successfully implemented as part of Portland's AVL system. A similar system may be beneficial for Folsom Stage Line, particularly along the Blue Ravine and Iron Point corridors.

Demand Responsive Dispatching

Demand Response Dispatching (DRD) technologies use the computing speed of modern computers to match incoming ride requests with available vehicle capacity to most efficiently assign vehicles to serve passenger requests. This can be a very demanding computer task, as the number of potential combinations of passenger assignments to even a small fleet of vehicles can be extremely large; the computer must assess the time required under each potential assignment within a few seconds, taking into consideration the travel time impacts on passengers already aboard the vehicles, as well as the potential for transfers.

Because the demand is constantly changing with new ride requests and rides being completed, the system must continually readjust the optimum utilization of the fleet vehicles. How the system knows to assign a ride request to a particular vehicle is based on several factors (e.g. vehicle location, vehicle load, vehicle destination, and caller location and destination). The system may also consider specific needs of the current passengers if the system is programmed to do so. Ride requests can be generated from a number of sources, including phone requests (either using a human operator or through a voice mail system), a "touch pad" at specific transit stops, or specialized touch pads at important trip generators (e.g. social service facilities or lodging properties).

A variety of software packages have been developed to allow "real-time" dispatching to varying degrees. With names such as "ParaMatch™," "Easy Rides®," "MIDAS-PT," "ParaLogic," and "PASS," many of these systems have been designed for demand response systems for elderly persons and persons with disabilities. The LTD in Logan implemented EasyRides® for its Call-A-Ride and Lifeline services and provides a good example of the benefits of DRD technologies for a small transit agency.

Some of these dispatching programs allow data to be relayed to the driver via radio frequency communications to a liquid crystal display text screen mounted next to the dashboard, commonly called mobile data terminals (MDTs). This data is continually updated to display the driver's next several pickup and delivery points. If MDTs are implemented, local officials should ensure that the dispatch programs communicate appropriately with these units.

Automated Transit Information

Once AVL and DRD technologies are put in place, it is a relatively straightforward process to automatically provide passengers with "real-time" information regarding transit services. Provided with vehicle location, vehicle travel speed, and the passenger's desired service point, a computer can readily estimate the number of minutes before service is actually provided. This information can be disseminated in a number of ways:

- Automated phone systems can be used to provide information. Transit passengers in the Ottawa (Ontario) area, for example, can call Ottawa-Carlton Transit, punch in their bus stop number and desired route, and be provided with the next several service times at their stop.

- Video terminals placed in transit centers and shopping malls are also used to provide "real time" arrival and departure times in Halifax, Nova Scotia and Broward County, Florida. A similar system is currently installed at various locations around Anaheim, California (including the Anaheim Stadium and the Hilton Hotel), providing real-time traffic congestion information. Overseas, real-time information is already widely provided in Stockholm, Sweden and Osnabruck, Germany.

Potential Applications for Folsom Stage Line

A number of factors indicate that the innovations in transit technologies have a high potential for successful application at Folsom Stage Line.

- The extension of RT's light rail service into Folsom makes efficient connections between services very important. The availability of AVL would be a great help to dispatchers directing efficient connections between Folsom Stage Line buses and RT's light rail line. The importance of this information may well grow in the future, as increasing congestion along the transit routes reduces schedule reliability.

- With an aging of the population, demand for demand-response services is expected to grow. AVL and MDT technology would be extremely useful in maximizing the efficiency of demand-response services.

At present, experience at other similar-sized transit services indicates that Folsom Stage Line's current services are not quite at the "critical mass" at which APTS technologies can be cost-effective. As the system grows in response to growth in the community, or as the cost and dependability of these technologies improve, Folsom Stage Line should carefully consider an investment in APTS systems as a means of improving service quality while also increasing service effectiveness.