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*Publication of this paper sponsored by Committee on Application of Economic Analysis to Transportation Problems.*

# Economics of a Unified Transportation Trust Fund

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The paper describes the pricing and investment rules that might be appropriate to a unified transportation trust fund and suggests that they could be based on the same criteria of profitability that are used in the private sector. The consequences of applying such rules to the U.S. transport sector are explored, and it is concluded that rail passenger transport and some waterway transport could be lost, but bus transport and rail freight services could benefit. The effect on air transport would be to divert traffic from the more congested airports to less congested ones. The effect on road transport could be a substantial rise in fuel taxes, especially on diesel fuel, and in the annual registration fees payable by vehicles that impose heavy axle loads on the road system. It is concluded that, if suitable pricing and investment criteria are introduced, a unified transportation trust fund would be unnecessary; if they are not, a unified transportation trust fund could be wasteful.

The Highway Trust Fund is due to expire in 1979, and a number of proposals have been made for alternative financing mechanisms for highways and other transport modes. One such proposal is for the establishment of a unified transportation trust fund (UTTF) that would be used to finance all transport modes (1). The main purpose of this paper is to discuss the economics of a UTTF, particularly the rules that it might follow for pricing and investment.

## CRITERIA FOR PRICING AND INVESTMENT RULES

A principal advantage of the UTTF, according to the Congressional Budget Office, is that it would "consolidate fiscal decisions for transportation as a whole and would permit better congressional coordination of modal financing" (1). It would also enable the U.S. Department of Transportation (DOT) "to better carry out the original purpose of integrating transportation programs" (2). Such integration implies that the same pricing and investment rules would apply to all modes supported by federal funds, so that the most economic solution can be developed for every need, irrespective of mode. Thus, a basic requirement of UTTF decision rules is that they can apply to all modes. A further requirement is that the rules should be applicable to transport activities in the private and public sectors. This is necessary to ensure that activities that can be carried out more eco-

nomically in the public sector are not carried out by the private sector and vice versa.

## PROFIT- AND BENEFIT-MAXIMIZING RULES

One of the main difficulties in the formulation of pricing and investment rules that would apply to all projects is that some modes, such as railroads, buses, and air carriers, provide services that are paid for by users, and investments in these modes can, in theory, be justified by the profits that they generate to the producers, without regard to the benefits enjoyed by the consumers. In a market economy, investments are typically justified in this way. On the other hand, facilities such as roads and waterways are generally regarded as free, and no charges are levied for use. Road and waterway projects are therefore generally assessed not by their profitability to their suppliers, but on the basis of cost/benefit analysis (CBA), which attempts to rank alternative schemes by comparing the benefits to society from each scheme with its costs to society. The private sector cannot function without profits and can only invest in projects that produce revenue in excess of expenditure. In contrast, the public sector can finance projects out of tax revenues and is not confined to revenue-raising projects. However, it should not be assumed that the benefits from revenue-producing projects go only to the suppliers: Laker's transatlantic air services produce substantial benefits to the consumer as well as profits to the airline.

Much of the effort that has gone into multimodal transportation planning has been directed at developing CBA to enable it to deal with revenue-producing, private sector projects, such as railroads, within the framework developed for the assessment of non-revenue-producing projects, such as roads. The method requires that total benefits to consumers, producers, and the general public be worked out for each project component and compared with the appropriate costs. The difficulty and ambiguity of such calculations enable poor projects to be justified on the basis of alleged social benefits. For example, according to Senator Domenici, the inability to measure the social demand for navigation projects leads to a

"slipshod analysis of whether new projects are needed or not" (3).

This paper attempts to sketch an alternative approach: to use private-sector, profit-to-the-producer, criteria for the evaluation of social projects, such as roads. In fact, most of the problems that arise from this approach will apply to roads, which are the most important transport components provided on a social rather than a financial basis (although roads have also been provided as revenue-producing projects by both private and public enterprise).

#### OBJECTIVES OF A UTTF

The three most important objectives for a UTTF might be

1. In the short run, to encourage transport users to pay the costs incurred in the use and provision of existing transport facilities;
2. In the long run, to encourage renewal or expansion of transport facilities for which users are prepared to pay and the contraction of facilities for which users are not prepared to pay; and
3. At all times, to provide a financial mechanism to enable the providers of transport facilities to supply the services that transport users require and are prepared to pay for.

The provision of services for which users are not prepared to pay is not included as a UTTF objective because such provision usually implies the transfer of resources from some classes of people to others. For example, proponents of rail transport would like to see rail transit systems supported by taxes on highway use, regardless of the wishes of the highway users. But an important characteristic of the 800 or so U.S. governmental trust funds is that the money paid in is eventually expended in the interests of the contributors. Decisions that involve the transfer of resources from one group to another are essentially political and should, therefore, be dealt with by the appropriate political processes.

#### Basis of Pricing and Investment Rules

The conventional way of dealing with transportation pricing is to set a definition of costs and base prices on them. Typically, analysts look at different kinds of costs, such as maintenance, traffic control, signaling, and capital expenditure, and assess prices to different classes of user by a cost allocation that seems reasonable. This approach suffers from the disadvantage that there is often no unique way of allocating common costs (such as the entrance hall to an apartment block) between different users. This paper will therefore attempt an alternative approach used in competitive markets: Prices are determined not by costs, but by demand—by what the market will bear. If, at market-determined prices, an asset earns a surplus of revenue over expenditure, this is taken by the decision maker as a signal that the asset should be renewed, expanded, or duplicated. (For example, if revenues from competitively determined rail fares are just sufficient to cover crew and fuel costs, the service would be run until the rolling stock wears out; if the revenues are sufficient to cover replacement of rolling stock, the service would be continued until the track wears out; if the revenues are large enough to finance the renewal of track, the track is renewed; if a profit remains after all expenditure over and above the minimum required to attract capital into the industry, expansion of the whole system

would be indicated.) If an asset makes a loss under prices determined by competitive markets, this is taken as a signal that the asset should not be renewed unless a case is made to do so for reasons not connected with transport.

#### The Pricing Rule

The objective of efficient transport pricing is to ensure that every user of transport facilities meets his or her share of the costs associated with use, no more and no less. Only in this way can one assure that the extra cost entailed in the production of a little more travel is balanced by the extra satisfaction obtained from it. Two separate elements comprise the costs associated with the use of transport facilities:

1. Direct costs—costs imposed as a result of resources directly consumed in making the transport facility available (e.g., wages, fuel, wear and tear, and atmospheric pollution).
2. Congestion costs—costs imposed by users on one another, when the demand for a service at the price charged exceeds the available supply. These costs arise out of scarcity, which, in principle, enables additional charges to be levied for the use of the scarce facility. In this sense, congestion costs arise because of underpricing (i.e., because sufficient rents are not charged for the use of scarce resources).

A system of efficiency prices, under which users are charged the costs that arise out of their travel, including a rent to ensure that the demand for scarce facilities is tailored to the available supply, can be called user-cost pricing. The appropriate price can be called the user-cost price (UCP).

Where there is no congestion, the UCP will consist only of direct costs (i.e., of the value of the resources directly consumed as a result of the provision of the good or service in question). Under a rational economic system, no service would be provided unless users pay at least the direct costs; for if direct costs are not explicitly met, each additional unit of service provided is more likely to reduce society's assets than to increase them. If, when direct costs are charged, the demand for the facility exceeds capacity so that potential users have to queue up, the UCP includes an additional element to balance supply and demand. The UCP is therefore not equivalent to cost in the popular sense of the word. For example, the appropriate charge for the use of a parking meter may exceed the direct cost of supervision and cash collection. But, failure to collect the scarcity rent element of the UCP for street parking would result in inefficient pricing in the sense that the pricing system would do little to allocate the limited number of parking spaces to the most urgent uses nor would it encourage the provision of off-street parking at economic prices.

Where congestion is heavy and persistent, as in city centers, the UCP congestion or rent element could be substantial. Calculations made by Mohring (4) suggest that, under the conditions prevailing on traffic arteries in Minneapolis and St. Paul, the UCP could exceed 40 cents/vehicle-km (66 cents/vehicle mile) in peak periods, and 20 cents/vehicle-km (33 cents/vehicle mile) in the off-peak. Imposition of such charges would yield substantial financial surpluses, which, according to Mohring, "suggest that road expansion might well yield substantial benefits."

## The Investment Rule

It is therefore apparent that, if transport charges were based on the UCP, in the short run the total revenues earned by providers of transport facilities would not necessarily equal the total costs. Some facilities would make profits while others have losses. In the private sector of the economy, investment resources tend to flow to those industries and uses that make profits and to avoid those that have losses. Investment in profitable industries tends to increase capacity and reduce the rates of profit; however, disinvestment in loss-making industries tends to cut out their least-profitable elements and thus increase profits. In theory, this process continues until all industries yield a normal return on investment. If these investment rules were applied to transport facilities, given constant returns to scale, they too would be expanded or contracted until each element yielded normal profits. Furthermore, Mohring (4) and others have demonstrated that, given constant returns to scale, each component of a cost-minimizing transportation system would stand on its own feet, and such a system would require neither subsidies from society at large nor from one mode to another. Thus, imposition of user cost pricing would not only induce travelers to select travel modes that minimize total travel costs but would also generate funds required for capital investment.

From the national point of view, an initial assumption of constant return to scale is unlikely to lead to serious error. Where scale economies or diseconomies are shown to be important, the investment rule can, if appropriate, be adjusted so as to encourage investment where there are systemwide economies of scale and to discourage it where increased size leads to external diseconomies.

Economic efficiency does not require only that a complete transport enterprise should be profitable. In theory, each and every segment should, at equilibrium, earn normal profits (5). For the efficient or equitable allocation of resources, there is no special virtue in users of one bus line subsidizing the users of another or in off-peak passengers subsidizing peak users. But there are practical limits to the extent to which it is possible to vary prices, in the private as well as in the public sector.

## APPLICATION TO UNITED STATES TRANSPORT SECTOR

Before these ideas are applied to selected elements of the United States transport sector, some preliminary general points should be made:

1. The requirement that direct costs be paid by users implies that the UTTF would be primarily concerned with financing infrastructure. The payment of direct costs of transport services by users should, by definition, provide adequate revenues to finance the operating and maintenance costs for all modes. The prime function of the UTTF should be the collection of charges to finance the roads, railroads, and other indivisibles of the transport system. It could do so by combining the criterion of financial profitability with the imposition of prices for the use of infrastructure as close as practicable to the UCPs.

2. To avoid waste and misallocation of resources, all significant elements have to be debited to the project under consideration and valued at the highest prices obtainable in alternative uses. For example, this point applies to land and to the use of government personnel, such as members of the Army Corps of Engineers.

3. The application of the UCP is of special interest

in cities, where it would involve the imposition of additional charges for the use of congested roads. The economic, technical, and political problems of imposing such charges have been discussed extensively elsewhere (6); therefore, this paper will confine itself to the inter-urban elements of the United States transport sector. However, the pricing and investment framework described here for application outside United States cities would be entirely consistent with the application of UCPs within them.

## Railroads

On economic and financial grounds, a railroad can charge what the market will bear and base its investment program on the replacement or duplication of assets that earn an acceptable profit under a system of market-determined prices. Joy, when chief economist to the British Railways Board, asserted that British railways followed just such a market-based pricing policy (7):

In future, investment will be made only in assets which convey existing traffics at a long-run marginal cost which is covered by their respective revenues, or in assets for new traffics which meet the same criterion. The use of market-based prices will provide a clear indication of the opportunities for profitable investment in replacement or capacity-increasing assets.

Such a strategy could only be considered by a rail system, such as British Railways, that is free of economic regulation and able to decide what to carry, how to carry it, and at what price. Freedom from economic regulation for U.S. railroads would require major changes in the powers and activities of the Interstate Commerce Commission (ICC).

The requirement that all direct costs be covered is likely to endanger the future of intercity rail passenger service, which is now provided almost exclusively by the National Railroad Passenger Corporation (Amtrak). Amtrak's ridership has risen by an average of 8 percent/year since its establishment in May 1971, but the taxpayer subsidy has risen from \$40 million to \$500 million/year and is estimated to reach \$1 billion/year by 1984 (8). None of Amtrak's 41 routes covers its operating costs, but its services weaken those provided (on an economic basis) by the intercity bus industry. The technical characteristics of a train make it slower than an airplane and costlier than a bus; therefore, it is difficult to see an economic future for passenger train services in the United States.

On the other hand, some rail freight services, for example in the Southern, Union Pacific, and Santa Fe Railroads, generate revenues that are reported to exceed total costs. Application of the proposed criteria, coupled with freedom from ICC regulation, would enable such companies to expand profitable services and phase out the unprofitable ones.

## Air Transport

Commercial air services in the United States have some flexibility in setting their rates with the objectives of filling their seats and covering their costs. They also have the option of varying the frequency of their services. The industry recovers 99 percent of its costs from fares (9); the balance is accounted for by a portion of the Federal Aviation Administration's (FAA's) expenditure and a 5 percent subsidy to local-services air carriers (8). The FAA finances air traffic control facilities in the United States, for which it gets reimbursed by an 8 percent tax on air tickets paid into the Airport and Airways Trust Fund. Neither the FAA nor individual airports levy increased landing charges at

Table 1. Disbursement for U.S. highways in 1976.

Expense	Disbursements (\$000 000 000s)						Total
	Federal	State	Total Federal and State	County and Township	Municipality	Total County, Township, and Municipality	
Capital outlays	0.375	10.580	10.955	1.470	1.870	3.340	14.295
Interest on debt	-	0.896	0.896	0.093	0.235	0.328	1.224
Debt retirement	-	0.920	0.920	0.170	0.440	0.610	1.530
Total	0.375	12.396	12.771	1.773	2.545	4.278	17.049
Operating expenses							
Maintenance	0.098	3.165	3.263	2.520	2.100	4.620	7.883
Administration	0.260	1.237	1.497	0.350	0.370	0.720	2.217
Law enforcement	-	1.424	1.424	0.205	1.000	1.205	2.629
Total	0.358	5.826	6.184	3.075	3.470	6.545	12.729
Total	0.733	18.222	18.955	4.808	6.015	10.823	29.778

hours of peak congestion to ration demand and finance expansion. For this reason, and also because of the undercharging of general aviation (e.g., noncommercial flying), American airports could benefit from applying user-cost pricing to their operations. This would have the effect of diverting traffic from congested airports to uncongested ones.

#### Water Transport

The inland waterborne transportation industry has been characterized by heavy governmental expenditure and the absence of waterway user charges, in accordance with the principle that "navigable water . . . shall be . . . forever free . . . without any tax, impost, or duty" (Northwest Ordinance, Art. 4, 1787). In the fiscal years 1965-1974, more than \$3.2 billion (current dollars) was spent by the U.S. Army Corps of Engineers on the construction of shallow-draft navigation projects. State and local governments provided lands, rights-of-way, and river-port facilities, such as docks, warehouses, and elevators. A DOT study calculated that, if present trends continue, the U.S. taxpayer would pay \$1 billion in 1990 to enable the domestic marine industry to increase its revenues by \$21 million and to reduce the revenues of other transport modes by \$60 million (10, p. 119).

The effect of subsidized waterway rates on other transport modes illustrates the need to apply uniform pricing and regulatory principles to all transport modes (11).

Railroads are frequently prevented from raising rates on "captive" traffic to a point where they can earn a reasonable return on total investment on the grounds that such rates would be unreasonably high and therefore unlawful. . . . Water carriers raise or lower rates in response to market conditions; railroads are compelled by law to provide service only at published prices. This amounts to forcing a railroad to give traffic to its competitor, who responds to market conditions in a way rail carriers cannot respond and receives subsidies rail carriers do not receive. . . . User charges and increased rail pricing freedom would lower transportation costs to society and encourage a more equitable distribution of resources within the transportation system.

#### Intercity Buses

According to DOT, "The bus industry is unique because transportation is provided by private companies which receive neither direct subsidies nor tax exemptions" (10, p. 151). Intercity buses pay federal, state, and local taxes that exceed by more than 25 percent their fair share for the use of public roads (10, p. 166). They serve 15 000 places, provide their own terminals, carry more passengers (340 million in 1976, compared to 220 million carried by air and 18 million by Amtrak) than any other mode at the lowest cost [3 cents/passenger-

km (5 cents/passenger mile) compared to 5 cents/passenger-km (8 cents/passenger mile) by air and 9 cents/passenger-km (15 cents/passenger mile) by Amtrak], and have the lowest fuel consumption [(30.6 passenger-km/L (116 passenger miles/gal) in 1976 compared to Amtrak's 11.6 passenger-km/L (44 passenger miles/gal)] (12).

Despite its many advantages, the intercity bus is losing ground to more costly and speedier modes, such as air and private automobile transport. It also has to compete with the heavily subsidized Amtrak rail services. The typical Amtrak trip of 364 km (226 miles) costs Amtrak \$44. Of this, the passenger pays \$16, and the taxpayers pay \$28. But, the same journey by bus would cost the passenger \$17 and the taxpayer nothing (8). Taxpayers are thus made to pay Amtrak a subsidy that enables it to undercut a more efficient competitor in the same way that the provision of free waterways enables the water carriers to undercut some railroad freight operations.

The introduction of user-cost pricing for all transport modes would have little direct effect on intercity bus services, as they already base their pricing and investment policies on commercial principles consistent with user-cost pricing. The indirect results could be considerable: user-cost pricing could (a) increase the costs of operating private automobiles and (b) reduce the services of Amtrak. Intercity buses would stand to benefit from both effects.

#### Roads

Figures published by the Federal Highway Administration (13) form the basis of Table 1. The table shows that, in 1976, federal and state expenditure on roads (i.e., all expenditure other than by counties, townships, and municipalities) amounted to about \$19 billion, of which about one-third was spent on maintenance, police, and administration of the current system to make it available for public use; two-thirds were expended on constructing and expanding the network. The table below breaks down the expenses by highway length (1 vehicle-km = 0.62 vehicle mile).

U.S. Highway	Federal and State	County, Township, and Municipality	Total
Vehicle kilometers (000 000 000s)	1015.23	1252.58	2267.81
Expenditure per vehicle kilometer (\$)			
Capital	1.26	0.34	0.75
Operating	0.61	0.52	0.56
Total	1.87	0.86	1.31

These total outlays, when divided by the 1015 billion vehicle-km (631 billion vehicle miles) of estimated rural travel, amount to 1.9 cents/vehicle-km (3 cents/vehicle mile); 0.6 cent/vehicle-km (1 cent/vehicle mile) to operate the existing system and 1.3 cents/vehicle-km (2 cents/vehicle mile) to construct and expand it. If all roads (urban and rural) and all travel in the United States were considered, the expenditure per unit travel would average 0.6 cent/vehicle-km (1 cent/vehicle mile) on operation of the existing system and 0.7 cent/vehicle-km (1.2 cents/vehicle mile) on construction and expansion of it.

Assuming an average fuel consumption of 6.38 km/L (15 miles/gal), these figures suggest that a tax of 4 cents/L (15 cents/gal) [equivalent to 0.6 cent/vehicle-km (1 cent/vehicle mile)] would be roughly equivalent to the element of the UCP payable to administer and operate the existing highway system. This tax would be somewhat higher than existing fuel taxes, which consist of the 1.1 cents/L (4 cents/gal) federal tax and state taxes ranging from 1.3 to 2.9 cents/L (5 to 11 cents/gal), but an increase in fuel tax would be consistent with the administration's energy policy. The tax on diesel fuel would have to be substantially higher than that on gasoline if it is to be used as a method of charging for roads, because of the low fuel consumption of diesel-engined vehicles.

The costs of constructing and expanding the road system, assuming for the moment that 1976 expenditure was optimal, would have required at least a further 5.3 cents/L (20 cents/gal) tax on rural road use, if the fuel tax were considered an appropriate source of funds for capital investment. However, because a considerable proportion of highway construction costs is due to the effects of heavily loaded axles, a tax on commercial vehicles would seem a more appropriate source of funds, particularly if it could be varied in proportion to pavement damage caused, which is reckoned to be proportional to the fourth power of the axle load (e.g., a 4-Mg axle load damages a road 16 times as much as does a 2-Mg axle load). If all the \$17 049 billion of capital expenditure were charged to the nation's 1976 population of 28 197 900 commercial vehicles (13), the annual tax on each truck and bus would average \$605; if the capital expenditure were charged entirely as an annual tax payable by the nation's total 1976 population of 143 538 500 vehicles (13), the average annual tax per vehicle would be \$119.

The purpose of these arithmetic exercises is not to recommend a particular combination of taxes but to indicate that there appears to be no insuperable difficulty in devising a tax structure that would enable all road users to be charged the total cost of U.S. roads. However, two problems remain:

1. Any charging system that relies on taxes on fuel and vehicle parts, supplemented by annual registration fees, would involve a considerable degree of averaging and would not meet the test of being a market-determined price, based on what the market would bear.
2. The use of such taxes would tell us nothing about the optimal size of road networks, nor whether they should be expanded or contracted, as the profits from any road system could be arbitrarily increased by the taxes.

Tolls can, and are, being used to charge for many roads (particularly for costly sections such as bridges), and the toll-road industry is, in fact, developing new pricing methods to enable charges to be assessed against moving vehicles (6, pp. 15-20). However, a considerable amount of averaging has to be accepted as a fact of life.

The diseconomies of averaging are particularly evident in the absence of charges for the use of congested urban streets, but the absence of road pricing need not prevent improvements in the financing of other elements of the transport system. Tax rates on road use already vary from state to state.

Extremes of underinvestment in road networks can be avoided by allowing private suppliers to build new road sections and to be reimbursed from the fuel and other taxes earned on their roads. The appropriate amounts could be determined by traffic counts and could replace or supplement tolls. Overinvestment would be more difficult to deal with, particularly if associated with high taxes and poor planning, but a vigilant and educated electorate would tend to exert its influence to cut taxes and improve planning.

#### OTHER SOURCES OF FINANCE

The UTTF need not, of course, be the sole source of finance for transport infrastructure. There would always be room for grants from public or other agencies to finance unprofitable services. But such grants should be deliberately and specifically voted by appropriate political levels. There would be no advantages (and many disadvantages) in giving the UTTF powers to switch funds from profit-making to loss-making concerns. There is no reason in equity why users of profitable transport services should be made to subsidize unprofitable ones.

Nor is there any reason for the UTTF to monopolize the financing of profitable transport projects. Other public or private agencies could be allowed (even encouraged) to finance and operate roads, railways, and ports, but it would be desirable that similar pricing and investment rules be used throughout the U.S. transport sector.

#### CONCLUSION

Given the sources of funds described and clear pricing and investment rules, it is possible to envisage a UTTF that would collect revenues that broadly reflect economic user charges in the transport sector and use the revenues to provide any element of transport infrastructure that is likely to be profitable in the financial sense. However, if the recommended pricing and investment rules were followed, there would be no obvious advantage of a UTTF over the existing funding methods. On the other hand, a UTTF not bound by strict investment and pricing criteria would have considerable potential for the misallocation of resources that are scarce. On balance, there seems to be a stronger case for the adoption of investment standards or criteria for publicly financed projects than for the establishment of a UTTF.

#### ACKNOWLEDGMENT

Thanks are due to Anthony Churchill, Ron Cooke, Charles Dale, Damian Kulash, Herbert Mohring, Ali Sevin, David Starkie, Floyd Thiel, and Alan Walters for their comments and suggestions, and to Betty Easter for editing the draft, but neither they, nor the World Bank, necessarily endorse the assumptions, data, or conclusions presented in this paper.

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*Publication of this paper sponsored by Committee on Application of Economic Analysis to Transportation Problems.*

# Institutional Factors in the Implementation of Automobile-Restrictive Measures

## Part 1: Implementation Experience with Transportation Air Quality Measures in the Denver, Colorado, Urban Area

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In recent years, Denver's high altitude, topography, rapid growth, and heavy reliance on the automobile have combined to cause a severe air pollution problem. According to the Colorado Air Pollution Control Commission, the principal cause of the pollution is the use of motor vehicles. The Denver region developed an air quality plan that was submitted to the U.S. Environmental Protection Agency as part of the state implementation plan for air quality. The Denver element of the plan relies on strategies that reduce emissions at the tailpipe rather than strategies to restrict automobile use. Several institutional and attitudinal factors played a role in determining that automobile-restriction measures were not acceptable: (a) the no-problem syndrome, (b) the no-solution syndrome, (c) lack of public acceptance, (d) possibility of unequal burdens, (e) changing economic impacts, (f) agency priorities, and (g) difficulty in resolving conflicts. As the Denver region moves from planning to implementation of air quality strategies, it will be important for the state to transcend parochial political interests and take the difficult stands necessary. The state must also be careful not to make decisions in a vacuum. Ascertaining the public's opinion on air quality strategies will be critical to their successful planning and implementation.

Denver is known for its attractive environment and healthy climate. In recent years, however, Denver's high altitude, topography, rapid growth, and heavy reliance on the automobile have combined to give the "Mile-High City" a severe air pollution problem. The Denver region is currently experiencing frequent violations of the National Ambient Air Quality Standards (NAAQS) for carbon monoxide, ozone, nitrogen dioxide, and suspended particulate matter. For example, in 1977 the second highest recorded 8-h average carbon monoxide concentration was 120 percent greater than the 8-h carbon

monoxide standard [22.8 mg/m<sup>3</sup> (19.8 ppm) versus 10.4 mg/m<sup>3</sup> (9 ppm)].

According to the Colorado Air Pollution Control Commission (APCC) the principal cause of the pollutants is the use of motor vehicles. The commission estimates that vehicular sources account for 93 percent of the carbon monoxide emissions, 85 percent of hydrocarbon emissions (which are a primary precursor to ozone), 75 percent of particulate emissions, and 37 percent of nitrogen oxides. For three of the four standards, automobile use is the primary cause of the violations (1, pp. 11-20).

States in which there are areas that do not now meet the NAAQS must prepare revised state implementation plans (SIPs) that will ensure compliance with the air quality standards by December 31, 1982. Under certain circumstances, attainment of the standards for carbon monoxide and ozone may be extended to December 31, 1987. These revised SIPs must be submitted to the U.S. Environmental Protection Agency (EPA) by January 1, 1979. If the plans do not demonstrate the required compliance to EPA's satisfaction, severe sanctions on federally funded highway, sewer, and other construction can be imposed on the states and local governments.

### DEVELOPMENT OF THE COLORADO SIP

Final responsibility for development of the Colorado plan rested with the APCC, an independent body appointed by the governor with the consent of the senate.