



Toward Sustainable Transportation Indicators for California



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**Toward
Sustainable Transportation Indicators
for California**

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16. Abstract Indicators are an increasingly popular way to present information about a community, region, or agency. As is true for most statistical measures, indicators are descriptive by their nature. This report focuses primarily on sustainable transportation indicators (STI). Despite the proliferation of indicators—and the proliferation of interest in indicators—there have been only very few and scattered attempts to develop comprehensive sustainability indicators for transportation systems. None have been built from the measures and indicators already collected by local and regional transportation agencies in California. This research addresses that gap, devising and testing sustainable transportation indicators that may be effective and practicable in California. In so doing, it builds on both recent research and practice in the U.S., Canada, and Europe. In addition to an extensive review of the literature, a two-stage survey of transportation professionals and several case studies (three in California plus one of Switzerland) are used to assess the current status of sustainable transportation indicators. The key conclusion is that while there is substantial interest in STI, and much data relevant to STI is being collected, more time and more collaboration between transportation agencies and citizen groups are needed before STIs will be embedded in the decision-making process of local transportation agencies.			
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EXECUTIVE SUMMARY

The focus of this study is on developing sustainable transportation indicators applicable to California surface transportation agencies, both planning and operating. This report presents the findings of a survey of transportation professionals regarding the relative importance of a list of potential indicators of sustainable transportation as well as several case studies of agencies involved with indicators of sustainability or sustainable transportation, to varying degrees. The report also discusses the development and use of sustainable transportation indicators.

DEFINITIONS

“Sustainable development” has been defined in various ways. The simplest statement of the best-known definition is:

...meeting the needs of the present without compromising the ability of future generations to meet their own needs, balancing and integrating a prosperous economy, a quality environment, and social equity... the “3 E’s” of sustainability.¹

By “sustainable transportation” we mean a transportation system that:

1. allows the basic access needs of individuals to be met safely and in a manner consistent with human and ecosystem health, and with equity within and between generations;
2. is affordable, operates efficiently, offers choice of transport mode, and supports a vibrant economy;
3. limits emissions and waste within the planet’s ability to absorb them, minimizes consumption of non-renewable resources, reuses and recycles its components, and minimizes the use of land and the production of noise.²

Indicators

Indicators are an increasingly popular way to present information about a community or region. Indicators are a way to summarize valuable data into an easily readable format. Indicators are used to clarify specific issues by presenting key data concisely.

Indicators have been an important part of governmental policy for decades. Only recently have indicators of sustainability and other measures of “quality of life” gained increasing attention.

Transportation indicators measure the transportation system. Sustainable transportation indicators are those that demonstrate the vital relationship between transportation networks and the ecology, economy, and society in which they are located and serve. This study defines sustainable transportation indicators (STIs) as *regularly updated performance measures that help transportation planners and managers take into account the full range of economic, social, and environmental impacts of their decisions* [emphasis added].

STUDY PURPOSE, METHOD AND RESULTS

Despite the proliferation of indicators—and the proliferation of interest in indicators—there have been only very few and scattered attempts to develop comprehensive sustainability indicators for transportation systems, and none that have built up from the measures and indicators already collected by local and regional transportation agencies in California. This research addresses this gap, seeking out and examining critically sustainable transportation indicators that may be effective and practicable in California. In so doing, it builds on both recent research and practice throughout the U.S., Canada and Europe.

The literature on “sustainable development,” “sustainable transportation,” and “sustainable transportation indicators” was reviewed as the basis for preparing a survey regarding an array of candidate sustainable transportation indicators. This survey was administered to a selection of transportation planning and program management professionals. In addition, several case studies of agency programs relating to sustainable development, transportation planning and operations, and the use of indicators were conducted, including review of their documents and interviews of agency staff and representatives.

Survey Results

A list of 31 promising transportation performance indicators gleaned from the literature are examined in this report (Table 1-1).

A survey was conducted to explore transportation professionals’ perceptions regarding sustainable transportation indicators. The results of the survey provide insights useful in developing performance indicators for local and regional transportation agencies. The survey was used to gain insight into how transportation agency directors and other key staff define sustainable transportation and view the importance of implementing sustainable transportation indicators.

Table 1-1 List of Possible Sustainable Transportation Performance Indicators³

Number	Indicator (definition)
1.	Percentage of household expenditures devoted to transportation, including direct expenditures on vehicles and fares and indirect expenditures, such as residential parking and taxes spent on transportation facilities
2.	Average amount of resident’s time devoted to non-discretionary travel
3.	Person miles traveled versus vehicle miles of travel
4.	Accessibility of non-drivers to employment centers and services
5.	Per capita land area paved for roads and parking facilities
6.	Quality of pedestrian and bicycle environment (e.g., the Pedestrian Environment factor used in Portland, Oregon’s regional transportation modeling)

Table 1-1 List of Possible Sustainable Transportation Performance Indicators³

Number	Indicator (definition)
7.	Quality of public transit service, including number of service hours, service frequency, average speed relative to automobile traffic speeds, safety, comfort (including number of standees during peak periods, number of bus shelters & other waiting facilities), availability of information, & integration with other modes
8.	Average number of major services (e.g. grocery, library, school, playing fields, etc.) within walking distance of residents, or average walking distance between residences and public services such as schools and retail centers
9.	Land use densities (residential) and intensities (commercial)
10.	Land use mix: e.g., proximity of residential, commercial & employment land uses
11.	Quality of delivery services (e.g., groceries)
12.	Quality of mobility services for residents with special mobility needs
13.	Affordability of public transit service by lower income residents (e.g., fares as a portion of lowest quintile income)
14.	Portion of residents with transit service within one-quarter mile
15.	Motor vehicle accident fatalities and accidents
16.	Per capita transportation energy consumption per vehicle mile and passenger mile, by mode
17.	Per capita transportation pollution emissions (air, water, noise) and share of total emissions
18.	Medical costs attributed to transportation, including care for injuries and pollution related diseases
19.	Portion of transportation-related costs paid by public funding
20.	Degree of residents' participation in transportation and land use decision-making
21.	Miles of facility by type (e.g., vehicular roadways, bikeway, busways, walkways)
22.	Per capita land area devoted to transportation facilities (including parking)
23.	Number of vehicles by type (including bicycles)
24.	Mode split (e.g. car, transit and non-motorized/low-power modes, walk) by trip purpose (e.g., work, shop, personal business, social, recreational)
25.	Average travel time and distance, by mode and purpose
26.	Freight transport by mode and type of goods
27.	Number of jobs and other regional features accessible within 30/45/60 minutes by mode from defined subareas
28.	investments in transportation infrastructure per capita and by mode
29.	Real change in passenger transport price paid by consumer by mode
30.	Real change in passenger transport cost incurred by supplier by mode

Table 1-1 List of Possible Sustainable Transportation Performance Indicators³

Number	Indicator (definition)
31.	Person hours lost to recurring congestion and traffic delays

The transportation professionals were asked how important they consider it that California transportation agencies actively develop and implement sustainable transportation indicators. Most respondents feel STIs are important to develop.

Responses Regarding Sustainable Transportation Indicators

“Mode Split by Trip Purpose” was the most frequently selected sustainable transportation indicator. Four other indicators also stood out as leading choices for STIs that provide good information from the standpoint of the transportation system overall:

1. Quality of pedestrian and bicycle environment (e.g., the Pedestrian Environment factor used in Portland, Oregon’s regional transportation modeling).
2. Quality of public transit service, including number of service hours, service frequency, average speed relative to automobile traffic speeds, safety, comfort (including number of standees during peak periods, number of bus shelters & other waiting facilities), availability of information, and integration with other modes.
3. Land use mix: e.g., proximity of residential, commercial & employment land uses.
4. Average travel time and distance, by mode and purpose.

About a third of the 31 sustainable transportation indicators were rarely chosen. We designated these as “orphan indicators”. The transportation professionals also offered other important and innovative sustainable transportation indicators not on the list.

Other Study Findings

1. Few U.S. communities and local transportation agencies have made significant progress toward development of comprehensive STI programs, despite the fact that many routinely collected transportation indicators are STIs in whole or in part.
2. STIs require a sustained community commitment to achieve success.
3. Sustainable programs and practices can occur without STIs being fully implemented. The process of developing them is itself beneficial and educational.
4. Sustainable transportation requires a holistic, multi-modal approach to community mobility, including pedestrian, bicycle, transit, and automobile use. In general, reduction in the use of the automobile is necessary.
5. Sustainable transportation also entails simultaneous inter-related planning for resource conservation, air quality, land use, housing, design, and other community conditions

related to mobility. Given these multiple dimensions, the number of STIs must be few if elected officials and other key decision makers are to grasp and apply them.

6. Sustainable transportation requires an interagency and inter-jurisdictional approach and cooperation among neighboring communities.
7. STIs, and sustainability in general, require community consensus and inclusion, together with a public education process to build a long-term constituency.
8. Community groups, whose volunteer activism has driven many local sustainability indicator movements, need to form alliances with local transportation agencies. The most effective activity for community groups with respect to STIs is to work to refine, improve, and publicize data that is already being collected by transportation agencies. They can also work to educate city councils, transportation agency boards and the general public/electorate on the importance of STIs.

The report also includes an extensive annotated bibliography.

OVERVIEW: SUSTAINABILITY AND TRANSPORTATION

BACKGROUND

This research project explores a variety of measures and indicators as tools for implementing sustainable local, regional and statewide transportation systems in California. The terms “performance measures” and “performance indicators” are often used interchangeably. As used in this discussion, a performance indicator is a performance measure with particular usefulness in policymaking—a measure that indicates a policy direction. The focus will be on developing performance indicators for local and regional government surface transportation agencies (both planning agencies and operating agencies). The results should be relevant for statewide transportation planning and the private sector as well.

Sustainability (which subsumes the related concept of Sustainable Development) represents an increasingly pervasive (some would say dominant) paradigm in many fields closely related to transportation, from urban and regional planning to global economic development theory and practice. Sustainability is clearly the dominant paradigm in the environmental movement, at all scales of analysis and action, from global to local.

While there are many definitions of sustainability, the simplest statement of the best-known definition is “*meeting current needs without jeopardizing the ability of future generations to meet their own needs*” [emphasis added].³ This definition has been broadened to include the integration and balancing of social, economic and environmental objectives so as to ensure the long-term viability of social, economic and natural systems. While the preservation of natural systems is often emphasized in the literature and in public debates about sustainability, sustainability is not mere environmentalism. The environment, the economy, and social equity are equally important aspects of sustainability.

Transportation has a major under-appreciated role to play in the pursuit of sustainability. According to the U.S. Department of Energy:

- Many communities have reached a crossroads. If they build a new highway, traffic will stop backing up—at least that’s the initial rationale. Citizens will stop calling to complain. Everyone presumably will be satisfied—for a while. This “solution,” however, is short-lived.
- When pavement is laid, more vehicles come. With more vehicles comes more smog. Automobiles are a major contributor to global warming. Their pollution also causes severe health problems for many. Traffic congestion, already costing us an estimated \$168 billion annually in lost productivity, is expected to triple in coming years, wasting more productivity and fuel and worsening our air quality.
- Our automobile habits have caused increasing dependency on oil imports, much of it coming from unstable parts of the world. In 1970, 23 percent of America’s petroleum was imported. Today, we import more than 54 percent of our petroleum

needs, and this number is estimated to reach more than 60 percent by 2010. The cost of oil imports to U.S. consumers totals some \$50 billion annually. And in addition to the cost of oil imports, the cost of productivity loss, and the cost of congestion, we must add other social costs of transportation, such as traffic deaths and injuries, and pollution.⁴

Sustainable transportation has much in common with Transportation Systems Management (TSM). The TSM philosophy recognizes that transport systems have carrying capacities that must be respected, because they are not easily nor cheaply expanded. This is also the philosophy of sustainable transportation.

Sustainability is still less central to transportation studies than it is to many allied fields, but change is evident. A search on the comprehensive (TRIS) database in 1990 revealed only two publications containing keyword variations of “sustainability,” a search in early 2001 revealed over 130, and a search on December 8, 2002 revealed just over 200. It is noteworthy that the majority of these citations was focused on transportation projects overseas, with Europe particularly well represented.

Performance measures and indicators have been in widespread use by many transportation firms and government transportation agencies for decades. Indicators are especially prevalent in the field of public transportation, which is understandable since local, state, and federal governments subsidize public transit, and each level of government requires documentation of performance against specified criteria and measures. Primary examples include transit Performance Audits performed under California’s Transportation Development Act (TDA), and the Federal Transit Administration’s (FTA) National Transit Database (formerly Section 15) performance reporting requirements, which are mandatory for all federally funded transit operations.

Performance indicators also have a long history in the development of highway systems. The concept of the cost-benefit ratio—a classic example of a performance indicator—has been a mainstay of highway planning for half a century.

While transportation measures in use today were not devised with sustainability in mind, all have a bearing on sustainability, and it is a fundamental premise of the proposed research that effective indicators will build on indicators already in use. The literature on indicators shows overwhelmingly that to be effective, indicators must be developed within an agency, not imposed from without.⁵

In the past decade, performance indicators for roadways have also taken a turn toward sustainability. Both the 1991 Intermodal Surface Transportation Efficiency Act (ISTEA) and its successor legislation, the Transportation Efficiency Act for the 21st Century (TEA-21), place a heavy emphasis on minimizing the impacts of transportation to human and natural environments—fundamental aspects of sustainability. The transportation legislation of the 1990s also emphasizes maintaining and maximizing the efficient use of existing transportation—another aspect of sustainability. Many performance measures have been devised to serve these ends. While many management systems and performance

indicators associated with the original ISTEA are no longer mandatory, many roadway agencies in California have developed and continue to refine management systems in which performance indicators play a key role.

The sustainability indicators movement also came of age in the 1990s. Entire communities, including large communities (in the U.S., Seattle, Washington is a well-known example) and even entire states (e.g., Minnesota and Hawaii) adopted sustainability indicator programs. The U.S. Department of Energy and the Environmental Protection Agency have been conducting workshops on the development of “Sustainable Community Indicators” for several years.⁶

THE FUNDAMENTAL ISSUE ADDRESSED IN THIS RESEARCH

Despite the proliferation of indicators—and the proliferation of interest in indicators—there have been only very few and scattered attempts to develop comprehensive sustainability indicator programs for transportation systems, and none that have built up from the measures and indicators already collected by local and regional transportation agencies in California. This research addresses this gap by seeking out and testing sustainable transportation indicators that may be effective and practicable in California. In so doing, it draws on both recent research and practice throughout the U.S., Canada and Europe.

Sustainability and Transportation

The remainder of this section concentrates on the definition of sustainability in terms of transportation, while the following chapter discusses the Sustainability Indicators movement as it applies to transportation planning and service delivery; the following section also defines the nature of sustainable transportation indicators (STIs) and defines a preliminary set of 31 STIs. The overall goal is to operationally define Sustainable Transportation Indicators in a historical context.

Neither of these chapters summarizes the full set of literature reviewed, which is contained in the Annotated Bibliography.

This discussion builds on the research team’s previous study.⁷ In that study it was found that statements of sustainable planning principles generally allocate a small and sometimes invisible role to transportation and transportation planning. Our previous study found that very few authors concerned with sustainability have focused on transportation planning. We now turn to three authors who were instrumental in developing our own definition of sustainable transportation, which is presented in the conclusion of this section.

Newman and Kenworthy

Longtime critics of automobile-oriented cities and automobile-oriented transportation planning, Newman and Kenworthy are best known for their global analysis of how major metropolitan areas of the world vary based on their urban form characteristics and consequent automobile use.⁸ While much of this thorough empirical research was well documented and well received, the two Australians were criticized for their implicit assumptions that urban form and transportation choices were subject to planning controls.⁹ In short, their global analysis was lacking in local prescription.

In *Sustainability and Cities: Overcoming Automobile Dependence*, Newman and Kenworthy attempt to set out specific local plan goals and polices for attaining simultaneously the two goals of the book's title (which, the authors argue, are very closely linked). Local transportation goals are defined as *indicators* that permit measurement of relative success:¹⁰

- Reduce car use per capita
- Increase transit, walk/bike and carpooling and decrease solo car use
- Reduce average commute to and from work
- Increase average speed of transit relative to cars
- Increase service kilometers/miles of transit relative to road provision
- Increase cost recovery on transit from fares
- Decrease parking spaces per 1,000 workers in central business district
- Increase kilometers/miles of separated cycleways

The authors note: “[the] problem with indicators... is that they are not always linked to a process that can lead to an improvement in the indicator.... They need to be tied into *policies and programs*...”.¹¹

Newman and Kenworthy devote most of their book to elaborating such policies and programs, but they distill their findings and arguments into five fundamental policies:

1. Traffic Calming—to *slow auto traffic* and create more urban humane environments better suited to other transportation modes
2. Quality transit, bicycling, and walking—to provide genuine options to the car
3. Urban Villages—to create multi-modal centers with mixed, dense land use that *reduce the need to travel* and that are linked to good transit
4. Growth management—to prevent urban sprawl and redirect development into urban villages
5. *Taxing* transportation better—to cover external costs and to use the revenues to help build a sustainable city based on the previous policies.¹²

Though broad, the scope of these policies is well within the ambit of California law and planning practice.

Domenic Spaethling

In *Sustainable Transportation: A New Paradigm?* Domenic Spaethling extends the Brundtland Commission definition to transportation.¹³ Sustainable transportation for Spaethling is a “transportation system that meets short and long term social, economic and environmental goals while incorporating technological, institutional and political considerations into the planning, programming, and implementation processes.”

Spaethling also suggests more prescriptive aspects of sustainable transportation. A sustainable transportation system should:

- Concentrate on moving people and goods rather than vehicles or avoiding movement altogether if telecommunications or changes in land use can substitute for present travel needs
- Increase market-based policies to encourage innovation in transportation operations and capture the full environmental and social cost of transportation
- Improve the efficiency of existing infrastructure through technical fixes in a multi-modal network
- Address public concerns regarding social equity in system design

Spaethling notes that in many ways these goals are reflected in U.S. federal transportation law. The Intermodal Surface Transportation Act of 1991 called for creation of “...a national Intermodal Transportation System that is economically efficient and environmentally sound, provides the foundation for the nation to compete in the global economy, and will move people and goods in an energy efficient manner.” The three basic components of sustainability are self-evident in this goal.

Finally, Spaethling outlines five basic steps to creating a sustainable transportation plan.

1. *Vision Plan*—determine the needs and goals of the affected population through surveys, visioning processes, sketch planning processes, informal brainstorming and public hearings.
2. *Identify Alternatives*—create alternatives that meet those goals and visions that surface as a result of the visioning process.
3. *Cost*—use full cost accounting to determine the true cost of each alternative, by internalizing the externalities into the capital and operations costs of the project. Then apply least cost planning guidelines to determine the least cost alternative that make the greatest mobility and access gains.
4. *Implement*—use an incremental approach to the implementation of transportation infrastructure and services. Use the least cost option first, and then continue to implement the more expensive options as the ability to pay increases and the mobility and access and needs increase. Implementation should be based on the ability of the users to pay for the service.
5. *Assess*—the use of the indicators is essential to quantifying the overall success or failure of the alternatives for the transportation system.

Todd Litman

In *Reinventing Transportation*, Litman begins this 1999 article with two telling statements:

“A sustainable economy is sensitive to economic, social and environmental constraints.”

“Sustainable transportation planning begins with a community’s strategic plan, which individual transportation decisions *must support*. It requires policies that *reward* individuals, agencies and communities... [emphasis added].”¹⁴

For Litman, transportation is a scarce and costly service to provide, and transportation policy must be built upon “constraints.” This is largely antithetical to the conventional method of building capacity to meet demand, and then providing facilities to users for free or with substantial subsidy. Litman also boldly states a truism found in every textbook on transportation, namely that most transportation is an intermediate means to an end, and not a good in itself. Litman forcefully asserts that transportation must be at the service of other elements of a community’s plan, which he identifies as land use, housing, noise, and conservation (air pollution). It is, in a word, subservient.

Litman is reacting to the fact that community transportation is too often conceptualized as the “infrastructure grid” that goes in first to support development later. It is often designed in isolation from other element policies. The field of transportation planning has been criticized for its technicality and isolation; in particular, from the land use and housing plan elements, whose policies are highly interactive with transportation.

Litman sharply distinguishes conventional transportation from sustainable transportation (see Table 2-1).¹⁵ For Litman, conventional planning defines and measures transportation primarily in terms of vehicle travel. It maximizes road and parking capacity to meet predicted traffic demand.

Sustainable transportation planning, by contrast, defines and measures transportation in terms of access; the ability of citizens in a community to access needs and wants. It uses economic analysis to determine optimal policies and investments based upon true market analysis, considering all externalities—including frequently overlooked environmental and social needs—in the cost/benefit assessment of transportation projects.

Litman emphasizes principles of transportation planning that echo principles of the New Urbanism. In that regard, they are not new. Current theory suggests that the proper planning context for transportation is compact growth, mixed-use development, higher densities around transportation nodes and corridors, and streets/thoroughfares that do not isolate residential areas from services and employment. Reducing speed and vehicle use in neighborhoods is a goal. Developing alternative transit is a goal. Cutting down vehicle usage is a major priority, and balancing the system with alternative transportation is the goal. The method is to re-work planning priorities so that non-vehicular transit modes can become competitive for transportation funds.

Table 2-1 Conventional vs. Sustainable Transportation Planning

	Conventional Planning	Sustainable Planning
Transportation	Defines and measures transportation primarily in terms of vehicle travel.	Defines and measures transportation in terms of access.
Objectives	Maximize road and parking capacity to meet predicted traffic demand.	Uses economic analysis to determine optimal policies and investments.
Public Involvement	Modest to moderate public involvement. Public is invited to comment at specific points in the planning process.	Moderate to high public involvement. Public is involved at many points in the planning process.
Facility Costs	Considers costs to a specific agency or level of government.	Considers all facility costs, including costs to other levels of government and costs to businesses (such as parking).
User Costs	Considers user time, vehicle operating costs, and fares or tolls.	Considers user time, vehicle operating and ownership costs, fares and tolls.
External Costs	May consider local air pollution costs.	Considers local and global air pollution, down-stream congestion, uncompensated accident damages, impacts on other road users, and other identified impacts.
Equity	Considers a limited range of equity issues. Addresses equity primarily by subsidizing transit.	Considers a wide range of equity issues. Favors transportation policies that improve access for non-drivers and disadvantaged populations.
Travel Demand	Defines travel demand based on existing user costs.	Defines travel demand as a function, based on various levels of user costs.
Generated Traffic/ Induced Travel	Ignores altogether, or may incorporate limited feedback into modeling.	Takes generated traffic into account in modeling and economic evaluation of alternative policies and investments.
Integration With Strategic Planning	Considers community land use plans as an input to transportation modeling.	Individual transportation decisions are selected to support community's strategic vision. Transportation decisions are recognized as having land use impacts.
Investment Policy	Based on existing funding mechanisms that target money by mode.	Least-cost planning allows resources to be used for the most cost-effective solution.

Table 2-1 Conventional vs. Sustainable Transportation Planning

	Conventional Planning	Sustainable Planning
Pricing	Road and parking facilities are free, or priced for cost recovery.	Road and parking facilities are priced for cost recovery and based on marginal costs to encourage economic efficiency.
Transportation Demand Management	Uses TDM only where increasing roadway or parking capacity is considered infeasible (i.e., large cities and central business districts).	Implements TDM wherever possible. Capacity expansion only occurs where TDM is not cost effective. Considers a wide range of TDM strategies.

Source: Litman, (2003), p8 (Table 1).

Litman's vision of sustainable transportation planning ranks as the best articulated and most operational. Litman's principles provide firm theoretical footings for the transportation criteria for plan evaluation. Perhaps the most relevant principle contained in this and other essays by Litman is his principle that individual transportation decisions, and the policies that guide decisions, should be subordinate to a community's strategic vision of the type of community it wants to become. Litman addresses "market distortion" and "bias" as fundamental distortions in the planning field. He gives a list of "biased transportation terms," and works to neutralize the language so that transportation policy is not unintentionally biased toward motor vehicle usage. Via such market distortion, he argues convincingly that we are overbuilding our transportation routes because our pricing for road and access is biased downward. Conventional transportation planning also assumes that all vehicle transportation time is equally valuable, when in fact, the value of travel time is known to vary with the traveler and the purpose of the trip. Litman also recognizes transportation policy decisions as having land use impacts that often far outweigh their direct transportation effects.

CONCLUSION: SUSTAINABLE TRANSPORTATION DEFINED

The Canadian Centre for Sustainable Transportation (CST) has adopted the following definition of Sustainable Transportation. A slightly amended version of this definition was adopted by the European Union (via the Council of Ministers of Transport and Communication) in April 2001, as the 15-nation European Union's formal definition of sustainable transport:¹⁶

A sustainable transportation system is one that:

- Allows the basic access needs of individuals to be met safely and in a manner consistent with human and ecosystem health, and with equity within and between generations.
- Is affordable, operates efficiently, offers choice of transport mode, and supports a vibrant economy.

- Limits emissions and waste within the planet's ability to absorb them, minimizes consumption of non-renewable resources, reuses and recycles its components, and minimizes the use of land and the production of noise.

This ranks as perhaps the most elegant, and is certainly the most officially accepted definition of sustainable transportation to date. It is a useful screening definition for assessing policies and indicators.

Lee developed a definition of sustainable transportation in 2002 based on five key principles. These were gleaned from the team's review of the literature and extensive dialogue and debate regarding these issues.¹⁷ The principles are presented in Table 2-2.

Table 2-2 Transportation Sustainability Principles

Principle A	Efficiently and equally serve (be subordinate to) the community's comprehensive economic, environmental and equity goals.
Principle B	Promote self-sustaining (financing) systems wherein users (benefactors) pay the full costs of system construction, operation and expansion.
Principle C	Promote and enhance more environmentally friendly transportation modes (essentially any modes other than single-occupant autos).
Principle D	Reduce use of and dependence on conventional automobiles.
Principle E	Reduce the need for travel in general.
Principle F	Make all transportation modes more environmentally sound, independent of attempts to change the market share of different modes.

In a similar manner, Table 2-3 presents the team-consensus view of what constitutes effective planning policy.

Table 2-3 Characteristics of Effective Transportation Policy

1.	Effective policy should be explicit and directive; if not mandatory, it should offer incentives that make it likely to be implemented.
2.	Effective policy should be clearly expressed, understandable and accessible to those who must implement it or are affected by it.
3.	Effective policy should be based on and make explicit reference to a substantial factual basis (e.g. a technical study, data base or model).
4.	Effective policy should be explicitly linked to performance standards or indicators enabling the policy's results to be monitored.

This principle-based definition is useful for more detailed assessment of transportation policies and programs, and was used in the screening of candidate indicators for this study.

To conclude, the literature of both sustainability and transport are streams of varying breadth and depth that have only recently begun to intermingle. The challenge for the research was to discover indicators that will lend tangibility to sustainable transportation and that can guide California transportation planners and managers toward more sustainable decision making.

Having posited a strong relationship between transportation and sustainability, in the next section, we turn to the concept of indicators. We will review the history of indicators, sustainability indicators, and the still quite brief history of sustainable transportation indicators.

THE DEVELOPMENT OF INDICATORS OF SUSTAINABILITY

Indicators are an increasingly popular way to present information about a community or region. In general, the term “indicator” refers to a statistical measure that implies, or “indicates,” a set of conclusions of greater significance than the measure itself. As is true for most statistical measures, indicators are descriptive by their nature. However, what is being described and how it is being described can significantly enhance our understanding of the subject.

This section describes the general composition of an indicator and why indicators are commonly used. Criteria for a high quality indicator are then set forth. An argument for the use of indicators as a means of quantifying the state of a transportation network is then set forth. Finally, a number of sustainable transportation indicators meeting the high quality criteria are set forth and recommended for continued use. Though this discussion focuses on transportation, many of the criteria, however, may be useful in establishing indicators for other important elements of a community or region.

WHAT ARE INDICATORS?

Most people use indicators as a normal part of their daily activities. Indicators serve as shortcuts that allow us to better understand the world around us. Indicators can be signs, symbols, pictures, and experiences. At times, these indicators may be difficult to describe and may not carry the same significance for all individuals. For this reason, it is generally useful to focus on those indicators that can be quantified.

Quantifiable indicators are the presentation of data that illustrate important changes over time. Indicators may measure a variety of factors in a community or region including, but not limited to, infrastructure adequacy, social equity, environmental quality, economic growth, and political inclusion.

Indicators are often included in reports for individuals in positions to influence policy direction. In private industry, indicators are often presented as part of the background material prior to determining the best course of action for a business. In the public arena, indicators are included in community and regional reports. Public policy decision makers are then able to use the information as a baseline against which future actions can be measured and hopefully adjust policy decisions to improve quality of life in the community or region. Transportation agencies often have a key role in the collection and use of indicators as well. Transportation agencies, however, are more likely to focus on more microscopic issues in the short-term as compared to community and regional planners.

Why Use Indicators?

Indicators are a way to summarize valuable data into an easily-readable format. In many cases, measuring and tracking the condition of a community or region requires analysis of large databases using complex statistical methods. A substantial amount of time and energy can be expended in gathering and interpreting the results. Many individuals either do not have the background in quantitative methods necessary to understand the complex statistics or do not have the time to consider the raw data. Indicators are used to clarify specific issues by presenting key data in a concise format.

Besides the time savings and general ease-of-use, indicators can be valuable decision making tools. To understand the value of indicators, it is necessary to think beyond the data being presented. An indicator should provide an empirical view of general trends. For example, a quality indicator can be used to establish baseline information from which change can be monitored. As long as the data in the indicator is repeatedly measured, the baseline information is then a valuable tool in determining whether progress is being made toward goals.

In this way, a quality indicator is a valuable tool. It creates a standard of information on which all parties can rely. Decision makers and stakeholders may turn to the information drawn from indicators to base negotiations and decisions regarding goals and actions. Constituents, stakeholders, and shareholders can use this information to grade the success, or failure, of decision makers. In this way, indicators can heighten accountability.

Criteria for Indicators: What Makes a Good Indicator?

A good indicator should be able to establish a base of information that can be used in the policy decision-making process. Decision making is difficult when participants draw different conclusions because each part has begun with a different set of assumptions regarding the current condition of a community or region. A high quality indicator should, at minimum, be able to dispel much of the dispute over information by establishing an empirical measure on which all parties can agree.

An indicator that establishes a generally accepted empirical measure may be referred to as a *descriptive* indicator. For example, traffic surveys may be used to establish the level of use of different transportation modes in a community, and all members may agree that the indicator is accurate. By contrast, *prescriptive* indicators not only describe reality, they measure the attainment of goals and the success of policy aimed at realizing goals. For example, if a community states that automobile driver trips should not exceed 50 percent, this is a prescriptive indicator. If the current traffic survey finds 60 percent of trips are auto driver trips, this is clear evidence that a community goal is not yet obtained. If the surveys indicate that five years earlier auto driver trips were 65 percent of all trips, this establishes that progress is being made toward the goal. Prescriptive indicators require members of a

community to agree on what the magnitude (or at minimum, the direction) the value of the indicator should take over time.

Indicators are intentionally designed to be shortcuts to greater understanding, and therefore inherently have some shortfalls; any summary statistic necessarily leaves out information about the reality being described. Nonetheless, good indicators are a useful, even necessary, part of public policy making.

Though indicators are as diverse as the community that creates them, good indicators have some commonalities. A good indicator should include most of the following general characteristics:

1. It reflects a fundamental element of community and regional well being.

Indicators are more than statistics. To have significance as an indicator, the data must measure factors that relate directly to community and regional well being. The correlation between community and regional well being and the indicator should be properly documented.

2. It is clear, understandable, and easy to communicate in concept.

Indicators should be clear to read and easily understood by an educated audience. It should not take a specialist to understand the significance of an indicator, given a brief explanation. A specialist, however, can be useful in interpreting the greater significance of an indicator of the long-term direction of quality of life in the community and region.

3. It has demonstrated value and importance to the community and region.

A quality indicator is one that is acceptable to a wide variety of audiences. Policy makers, in particular, must recognize its importance and be willing to acknowledge the conclusions drawn from it.

4. The data can be tracked consistently through statistical measurement at regular intervals.

Indicators should be more than one-time measurements. It is essential that the information can be tracked on a routine basis for comparison between time periods. In some cases a quality indicator may only have one year's measurements, such as when a new indicator is initiated. In this case, it is vital to establish that the indicator can and will be measured again on a regular basis.

5. The data should be timely.

The data collection process may entail substantial lag times. It is important that indicators provide information in time to take action. Furthermore, the ability of the

community, region, or agency decision-makers to trust data that is more than a year old decreases because current experiences may contradict the data presented.

6. It must be feasible to gather and analyze the data.

Measuring the data must be possible. Moreover, the questions asked must be answerable through a quantifiable means, while meeting the requirement to be clear and easily understandable.

7. The data comes from a reliable and trusted source.

Like most data, the statistical measurements presented in indicators must be based on a sound methodology. Where surveys or questionnaires are used, proper sampling methods must be used and responses must be statistically significant with a minimal degree of error. Using trusted sources with a well-documented methodology is essential.

8. The information should supplement common knowledge.

The data should measure things that people cannot measure for themselves. Which is to say, indicators should add to the knowledge base and not simply reconfirm it. Sometimes, however, it may be useful to validate and quantify commonly held assumptions; a community that thinks of itself as pedestrian-friendly may be surprised by its heavy reliance on cars.

9. The statistical measures should be appropriate in scale.

Data measurements need to be as specific as possible while still maintaining their ability to provide trend information. The focus of indicator data should not overgeneralize using the measurements of a single, small geographic region. Similarly, data for one demographic group should not be overgeneralized. On the other hand, over aggregating information in many instances will diminish its value for many policy-making decisions.

10. It indicates an outcome rather than an input.

Measurements of outcomes indicate the state of the factor being measured. Inputs measure what is being done to help the factor improve or deteriorate. For example, the number of laws passed providing transportation funding would *not* be a good indicator of transportation system conditions because it is an *input* into the amount of improvement being made on transportation systems. It is important that outcomes be measured to maintain the direct correlation between the indicator and community and regional well being.

With these characteristics of a good indicator in mind, we now turn to the history of indicators, and transportation's role in, and relation to, this larger history.

WHAT IS THE HISTORY OF INDICATORS?

Introduction

Indicators have been an important part of governmental policy for decades. The non-profit organization Redefining Progress points out that the Gross National Product (GNP), and later the Gross Domestic Product (GDP), have served as important barometers for assessing the state of the U.S. economy for decades. Since the 1960s, these indicators that measure “quality of life” have gained increasing attention. Indicators that attempt to measure progress of communities toward sustainability are an even more recent phenomenon.

Their recent publication *The Community Indicators Handbook, Redefining Progress* suggests that “it all started in 1985” in Jacksonville, Florida, when there was little interest or experience in developing and implementing comprehensive sets of indicators at any level of government.¹⁸ In that year, a report on *Life in Jacksonville: Quality Indicators for Progress* was issued by the Jacksonville Community Council, Incorporated (JCCI), a non-profit, citizen-based organization.¹⁹

The report contained data demonstrating historic patterns and current conditions related to the City’s quality of life including the economy, natural environment, public health and safety, recreation and culture, and mobility, among others. The purpose of the report was to provide a tool to promote a sustainable future for the community through public policy. Over the years a number of reports have been issued by JCCI covering about 82 measurable indicators, including a category called Mobility.

Example indicators related to transportation include the percentage of working people surveyed (by telephone) who report commuting times of 25 minutes or more, average number of daily seats available on flights through the Jacksonville International Airport, average weekday miles of Jacksonville Transportation Authority bus service, and average weekday ridership on the Skyway, among other measures. Moreover, members of various indicator task forces in the past have recommended additional indicators, which do not currently have available data. These include transportation-related measures such as the average number of rides provided weekly by the coordinated special-needs transportation system, and the number of Amtrak passengers going through the Jacksonville station annually.

The ongoing efforts of JCCI remain one of the leading examples of community-based sustainability indicators in the nation. It has served as a model for many other local community efforts to establish a sustainability indicator program. (See <http://www.jcci.org/newerhome.htm>).

Bruntland Sustainability and Agenda 21

Major influences in the development of sustainability indicators have been efforts of the United Nations to promote sustainable development, particularly the World Commission on Environment and Development (WCED or Brundtland Commission) and its report *Our Common Future*.²⁰ This report popularized the definition of sustainable development as “development which meets the needs of the present without endangering the ability of future generations to meet their own needs.”

The growing concern about the need for sustainable global development led to the United Nations Conference on Environment and Development, or Earth Summit, in 1992 at Rio de Janeiro, Brazil. A major result of the Earth Summit was the publication of *Agenda 21*, a plan of action to promote sustainability across the globe in the 21st century.²¹ A key component of *Agenda 21* was the need for accurate and timely information for decision making in order to bridge the data gap, in the form of indicators for sustainable development.²² Many nations adopted and attempted to implement the programs and actions of *Agenda 21*, including Australia, New Zealand, and many in Europe. A number of cities in the United States are committed to implementing *Agenda 21*, including Santa Monica, which is presented in this report as a case study.

U.S. Efforts

At the national level, initial interest in sustainable development appeared to be in response to the 1992 Earth Summit. The President’s Council on Sustainable Development (PCSD) was established in 1993 by the Clinton administration, which generated a series of documents related to sustainability. One of the PCSD recommendations resulted in the establishment of the U.S. Interagency Working Group on Sustainable Development Indicators (SDI Group). In 2001, the SDI Group published *Sustainable Development in the United States: An Experimental Set of Indicators*.²³

The report contained a wide range of information about indicators, with limited attention to transportation. The discussion about transportation focused on an indicator related to vehicle ownership, fuel consumption, and travel per capita. This indicator was deemed important because of the high rate of vehicle ownership, which was close to one vehicle per licensed driver, and the negative impact of heavier vehicles on fuel efficiency. It underscored the important role of transportation for economic production and distribution and for personal mobility. The indicator reflected an increase in both per capita motor vehicle registrations and annual miles traveled between 1960 and 1998.

The sustainability movement in the United States has not been strong, compared to other nations and local communities, especially in the development of sustainability indicators. In short, the interest in sustainability indicators in the United States has been limited, but

has exhibited some activity, especially beginning in the early 1990's. For the most part, U.S. activities have been independent of *Agenda 21*.

California

In California, the development and implementation of sustainability indicator programs has been limited. At the state level, the California Environmental Protection Agency recently published Environmental Protection Indicators for California (EPIC), which encompass a wide range of indicators. These are under the general categories of air quality, water, land, waste and materials management, pesticides, transboundary issues, environmental exposure impacts upon human health, and ecosystem health.

Transportation is listed under "background indicators," which "do not represent particular environmental issues in themselves, but provide information with which to interpret the meaning of various environmental indicators presented in this document."²⁴ The Governor's Office of Planning and Research (GOPR) released a draft of the General Plan Guidelines for public review and comment, which closed December 31, 2002. The draft document contains limited reference to sustainable development and appears to blend it with smart growth and new urbanism. There is brief mention of sustainability indicators with reference to the City of Pasadena's quality of life index.²⁵

Outside of Santa Monica and Santa Barbara, the only other local communities in the state to register indicator programs in the literature are Pasadena, San Francisco and San Mateo. However, the City of San Diego is initiating a Sustainable Community Program, which includes a Sustainable Community Indicators element and apparently is related to Mayor Dick Murphy's Ten Goals.

The Community Environmental Council of Santa Barbara (CEC) initiated a study of community sustainability indicators in the early 1990s to determine if there was a non-political approach to establish a framework for monitoring and protecting the quality of life for the Santa Barbara region. As a result, the CEC found only 40 state and local governments attempting to set up indicator programs.²⁶ In looking for model indicator programs for application to the South Coast region of Santa Barbara, the CEC held two workshops to discuss the experiences of other communities in developing sustainability indicators. The CEC ultimately issued a report, *Sustainable Community Indicators: Guideposts for Local Planning*, focusing on three communities: Seattle, Washington; Cambridge, Massachusetts; and Santa Monica, California.

Following publication of their report, the CEC decided to establish the Sustainability Indicators Program (SIP). The effort to establish an indicator program evolved from a perceived need to protect the quality of life in Santa Barbara. Recognizing the sharp political divisions in the community over issues related to development and environmental protection, it was paramount to the CEC leadership that a nonpolitical framework be

established. The framework reflected both the importance of the quality of life offered by Santa Barbara and the need for an economic conversion “as part of a defense-conversion plan to attract high-tech, high-paying jobs to the area.”²⁷

Early in the program, 30 community members from a variety of professions and organizations were interviewed to determine the number and range of indicators they would like to see included in the SIP. From about 300 potential indicators, the number was winnowed to 35. Subsequently, five Santa Barbara South Coast Community Indicator reports have been issued through 2002. During this time, the program became known as the Santa Barbara South Coast Community Indicators Project (SCCIP). Project support has expanded to include several county agencies, cities, non-profit foundations, and the University of California. Recent reports have focused on special topics, including housing affordability, non-profit organizations, public health, and healthy lifestyles. Indicators are divided into three basic categories: economic, environmental, and social.

Transportation-related indicators are organized under Environment as Mobility and include percentage of drive-alone commuters (declining), biking and walking (increasing), commute distances for South Coast employees (increasing), bus popularity (declining), and number of cars on highway 101 (increasing). The 2002 report contained new commuting data, using a Coastal Housing Partnership survey, illustrating the relationship between home-ownership and commuting time.²⁸ Only 4.58 percent of all South Coast residents can afford to buy a median priced home of \$699,950.²⁹

It remains unclear how the SCCIP will directly influence the development of sustainable community policy and implementation. The reports, and the process of obtaining and presenting indicator data, is guided by the mission statement “to involve the Santa Barbara South Coast community in developing and using social, environmental and economic indicators that will guide decisions towards continually improving our quality of life”.³⁰ There has been no documentation to date that the SCCIP has influenced planning policy in general, or transportation policy/programs in particular, within the South Coast Region. In this regard the SCCIP falls short of the example of the indicators program developed by Seattle in the 1990s.

Sustainable Seattle

Sustainable Seattle represents one of the best-known local community efforts to establish an index of sustainability indicators in the United States. In response to a 1990 conference held by the Global Tomorrow Coalition in Seattle, a group of interested people established the Sustainable Seattle Network and Civic Forum. This group sponsored a diverse civic panel of 150 community leaders to prepare a set of indicators to help “protect and improve our area’s long-term health and vitality by raising awareness of the links between economic prosperity, social equity, and environmental carrying capacity.” These indicators would serve “to educate ourselves and other citizens about the values, principles, and

practices of sustainability and to monitor the region's progress towards a more sustainable way of life." More than 200 people, investing over 2,500 hours of volunteer time, produced an initial set of 20 indicators, published as Indicators of Sustainability in 1993. The report contained 20 indicators, distributed under the categories of Environment, Population and Resources, Economy, and Culture and Society. Sustainable Seattle, also directly influenced the wording of many policies in the City's general plan, *Toward a Sustainable Seattle*.

The primary transportation-related indicator was Vehicle Miles Traveled and Fuel Consumption, which registered a slight decrease after decades of continuous increase.³¹ This particular indicator had "linkages" to a number of other indicators and conditions, including excessive use of non-renewable resources, pollution, loss of open space and wildlife habitat, decreased social health, and a declining sense of community. The report suggested that improvements could be gained through changing transportation modes (mass transit, walking, bicycling), increased affordable housing near work, and a stable population. Two additional reports were issued in 1995 and again in 1998, representing a total of 40 indicators.

Overall, the indicators suggested that Seattle was not trending toward sustainability. For example, in terms of Vehicle Miles Traveled and Fuel Consumption, the initial decline has been replaced by an increase in miles traveled and fuel consumed. After the 1998 report, this "cutting edge" non-profit organization experienced hard times. However, Sustainable Seattle has since regrouped and formed an alliance with the Cascadia Consultant Group (see www.sustainableseattle.org for more information).

The International Sustainability Indicators Network

Although the evolution of indicators has been modest to date, interest in this tool for sustainability continues to build, as illustrated by the creation of the International Sustainability Indicators Network (ISIN) in 2001. That year, the Rocky Mountain Institute sponsored a workshop entitled, "Indicators of Opportunity: Building Bridges to Policy Change and Action," and invited a small group of individuals with a wide range of experience but a uniform strong interest in the idea. Participants reviewed the current status of indicators, shared success stories, learned about new tools and approaches for applying indicators, and conducted a visioning effort. Out of the workshop, ISIN was born and held another workshop later that year in Massachusetts. An organization was established and a web site created which presents the following statement:

The International Sustainability Indicators Network is a member driven organization that provides people working on sustainability indicators with a method of communicating with and learning from each other. Through listserv discussions, virtual and in-person meetings, and special programs and

trainings, the Network facilitates shared learning and development among sustainability indicators practitioners and others (see <http://www.sustainabilityindicators.org/>).³²

ISIN promotes the use of indicators as a major means to mobilize increased support for sustainability at all scales, “from local neighborhoods to the global economy.” ISIN includes an advisory board, staff, and several work groups, including U.S. National Sustainability Indicators, Sprawl/Smart Growth Indicators, Indicators for Decision Making, Business, and Markets and Indicators. For example, the Sprawl/Smart Growth Indicators Work Group has the mission to examine how sustainable development and smart-growth concepts interact by learning about existing tools to measure the comprehensive effects of land-use decisions, and the development of indicators to assist communities to address urban sprawl (web site). The work group is attempting to develop a framework for indicators to monitor land-use management and smart growth, including the connection to transportation planning. A major meeting of ISIN was held in Toronto in March 2003, sponsored by the City of Toronto and Environment Canada.

Conclusions

To date, sustainability indicators have not generated the level of energy found in the new urbanism or smart-growth movements. However, interest in indicators is growing, albeit slowly. As the efforts of organizations such as Redefining Progress and the International Sustainability Indicators Network, among others, evolve, awareness of initiatives of local communities across the globe to develop and implement sustainability indicators will increase. Judith Innes of the University of California at Berkeley argues that effective indicators may require nearly ten years to be adequately established, as quoted by Trudi Lang in her article “Alternative ways to measure progress: How new indicators will impact on road management.”³³ Most local community indicator programs are less than 10 years old and have not established an adequate time frame for effective evaluation. In short, more history is needed before STIs can make history.

As the foregoing history indicates, transportation has played a surprisingly minor role in the sustainability indicators movement, and transportation indicators have been few-and-far-between. This is surprising, even astonishing, given transportation’s significant and growing impact on all aspects of sustainability.

Whatever the cause, there have been few projects that have attempted to define, measure, and monitor STI. The following section summarizes two pioneering efforts with these aims. The second study, by Canada’s Centre for Sustainable Transportation/LeCentre pour le transport durable (CST/CTD), represents the most ambitious and fruitful investigation of STIs in North America to date.

TWO RECENT SUSTAINABLE TRANSPORTATION INDICATOR PROJECTS

Sustainable Transportation: Conceptualization and Performance Measures

Josias Zietsman and Laurence R. Rilett develop sustainable transportation indicators for roadway projects and corridor-level planning in this technically exacting 2002 study. They duly note that there has been little quantitative research and/or implementation of sustainable transportation concepts. The main reasons for this are related to a lack of understanding of sustainable transportation. To address this problem, they develop a comprehensive definition based on Bruntland and compile a set of related performance measures that are typically employed in the evaluation of major transportation project plans. They then devise a framework on how to identify, quantify, and use performance measures for sustainable transportation in the transportation planning process. They test their proposed framework via analysis of the operations and impacts of two Houston, Texas freeway corridors.

Zietsman and Rilett's chosen performance measures (indicators) are conventional, mainly travel time—and its variability, economic costs—and pollution emissions. However, they do demonstrate how to make novel use of Automatic Vehicle Identification (AVI) data and the Transportation Analysis and Simulation System (TRANSIMS) model to obtain travel-related information at highly disaggregate levels. This information is used to quantify sustainable transportation performance measures at the individual level and levels of spatial and temporal disaggregation not previously possible. The AVI data, the TRANSIMS model, and a number of transportation environmental impact models are used to quantify the performance measures at various levels of aggregation.

The authors' performance measures based on disaggregate data can potentially provide richer results as compared to aggregate approaches. Furthermore, Zietsman and Rilett's disaggregate approach can be used to allocate responsibility for negative externalities and to assess sustainability-related impacts experienced by different user groups (e.g. is travel time reliability better or worse for bus riders compared to car drivers?). While focused on motorized travel, Zietsman and Rilett's work represents an important step toward integrating analysis of sustainability factors into the analysis of highway facilities and highway operations.

The CST Sustainable Transportation Performance Indicators (STPI) Project

The Sustainable Transportation Performance Indicator (STPI) Project was completed in December 2002 by the Centre for Sustainable Transportation. It produced a set of indicators that can be used to track progress towards (or away from) sustainable transportation in Canada.

Primary support was provided by Environment Canada and Transport Canada, with additional funding from two other federal departments: Industry Canada—whose stated mission is to foster a growing competitive, knowledge-based Canadian economy—and Natural Resources Canada—a department specializing in the sustainable development and use of natural resources, energy, minerals and metals, forests and earth sciences.

The project was conducted in three phases. Phase 1 was conducted early in 2000 and comprised a review of some relevant activities worldwide and identification of a long list of 84 potential STPI (see Table 3-1). Phase 2, conducted late in 2000, sought to confirm whether or not the project was moving in the right direction, and secured information about potential users of STPI and how the STPI might be used.

Phase 2 was organized around a workshop held in Toronto in November 2000. Two surveys were conducted in preparation for the workshop. One survey sought information from government officials, and others, as to potential users and uses of STPI. The other survey comprised a follow-up of respondents to the two Urban Transportation Indicators surveys initiated by the Urban Transportation Council of the Transportation Association of Canada and conducted during the 1990s. Reports on the surveys are included as two of the Phase 2 report's eight appendices. In short, Phase 2 helped frame Phase 3, which comprised the actual development of STPI.

Phase 3 involved the development of an initial set of 14 STPI. An additional 16 STPI were identified as development possibilities during the next three years, if resources can be made available. Another 14 STPI were identified as being desirable but requiring more than three years for development. The conclusion drawn from application of the initial STPI set is that some progress is being made; however, on balance, transportation in Canada is becoming less sustainable.

Selection and development of the Centre's initial STPI list was based on strict application of the following criteria:

Criterion 1. It should say something about sustainable transportation, as reflected by the CST definition (quoted at the conclusion of the first section of this report). Otherwise it should address one of seven policy questions adapted from the European Environmental Agency. [EEA is a branch of the EU whose Transport and Environment Reporting Mechanism (TERM) program has collected and reported environmentally important transportation indicators for EU member nations since 2000. Unfortunately, for the present study, TERM collects and reports data only at the national level.] Those seven policy questions ask:

1. Is the performance of the transport sector improving with respect to its adverse impacts on the environment and health?

2. Are land use urban forms or transportation systems changing to reduce transportation effort?
3. Are we increasing the efficiency of use of the current infrastructure and changing the infrastructure supply in sustainable ways?
4. Are patterns of expenditure by governments, businesses, and households (and the associated pricing systems) consistent with moving toward sustainability?
5. Is technology being used more in ways that make vehicle transportation systems and their utilization more sustainable?
6. How effectively are environmental management and monitoring tools being used to support policy and decision making toward sustainability?
7. Is transport activity changing in directions consistent with positive answers to the questions listed above?

Criterion 2. It should be time series data, so that changes in performance could be tracked over time.

Criterion 3. It should represent national (i.e. Canada-wide) information. Unfortunately, this focus means that development of local and regional indicators have been left for later research.

Criterion 4. It should come from a reputable and reliable source—in practice, this usually meant an agency of the Canadian federal government.

The Centre is seeking funds to continue work on the Sustainable Transportation Performance Indicators. Three avenues of future research are envisioned:

1. To maintain and enhance the initial set of STPI.
2. To develop some or all of the additional indicators identified for development over the next three years.
3. To conduct preparatory work for development of the additional indicators identified as requiring more than three years for development.

Although its focus remains at the national level, CST/CTD project represents excellent path-breaking research of great import to the future development of STI. The executive summary of the Phase 3 report is in Appendix A of this study. The entire series of reports may be downloaded from the CST/CTD project website:

<http://www.cstctd.org/CSTadobefiles/STPI%20Phase%203%20final%20report.pdf>

**Table 3-1 Initial Long List of Sustainable Transportation Performance Indicators
Compiled by the Centre for Sustainable Transportation**

Number	Indicator
1.	Toxic substances in urban air: benzene
2.	Global atmospheric concentration of greenhouse gases
3.	Greenhouse gas emissions from transportation
4.	Hourly average concentration of ozone in suburban areas and annual concentration (mean) of benzene in central urban areas
5.	Mean annual concentration of particulates in central urban areas
6.	Contribution to overall NO _x emissions in percent
7.	Contribution to the overall emission of VOCs
8.	Contribution to final energy consumption
9.	Mobile source emissions, for CO, NO _x and PM ₁₀
10.	Resident population exposure to local atmospheric concentrations of CO, NO _x and PM
11.	Black smoke emissions
12.	Lead emissions
13.	Nitrogen dioxide concentrations
14.	Methane (CH ₄) emissions; emissions of ozone-depleting substances
15.	Per-capita use of transportation energy
16.	Unit sales of cars and trucks
17.	Per capita gasoline consumption vs. urban density
18.	Arterial and expressway lane-km per 1000 capita in Existing Urbanized Area (EUA)
19.	Off-street parking spaces per employee in CBD
20.	Fuel use per person-trip in EUA
21.	Per capita automobile use
22.	Per capita land area paved for roads and parking facilities
23.	Length of railways and main roads
24.	Share of areas larger than 100 km ² not separated by motorways
25.	Percentage of reused or recycled parts of different types of end-of-life vehicles
26.	Annual new road construction
27.	Area of arable land use converted to road or rail reserve

**Table 3-1 Initial Long List of Sustainable Transportation Performance Indicators
Compiled by the Centre for Sustainable Transportation**

Number	Indicator
28.	Day and night time noise levels in residential, mixed, and industrial areas
29.	Change in vehicle fleet noise generation
30.	Gas and diesel fuel prices at the pump
31.	Fare box revenue/operating and maintenance budget
32.	Transport cost index
33.	Pricing and taxation
34.	Real changes in the cost of transport
35.	Portion of transportation-related costs paid by public funding
36.	GDP per unit of energy use
37.	Number of fatalities and injuries per year in transport
38.	Trips with two or more modes
39.	Average home/work trip distance in UA
40.	Quality of pedestrian and bicycle environment
41.	Quality of public transit service (hours of service, frequency, speed relative to auto, safety, comfort), integration with other modes
42.	Average number of major services within walking distance of residents and average distance (walking) between residences and public services
43.	Quality of delivery services
44.	Quality of mobility services for residents with special mobility needs
45.	Affordability of public transit service by lower income residents
46.	Length of public transport network (rail and buses)
47.	Proportion of traffic zones and trips served by a direct public transport connection; proportion of suburban traffic zones served by a direct public transport connection to the CBD
48.	Non-auto trips (percentage of urban trip not by automobile)
49.	High-occupancy-vehicle (HOV) lane-km per 100,000 capita in EUA
50.	Automobiles per capita in EUA
51.	Morning peak period transit seat-km per capita in EUA
52.	24-h transit seat-km per capita in EUA
53.	Morning peak period auto mode share to/from CBD (drivers and passengers)

**Table 3-1 Initial Long List of Sustainable Transportation Performance Indicators
Compiled by the Centre for Sustainable Transportation**

Number	Indicator
54.	Morning peak period auto mode share for EUA (drivers and passengers)
55.	24-h person trips per capita for EUA
56.	Annual transit rides per capita for EUA
57.	Traffic volumes of road, rail, air, sea (vehicle-kilometres)
58.	Total passenger and cargo turnover by air, ship, road, rail; mode shifts
59.	Percentage of urban journeys by mode of transport (excluding cycle/walk)
60.	Percentage of short urban journeys by mode of transport
61.	Percentage of inter-urban passenger trips by mode of transport
62.	Public transport route length/highway route length
63.	Vehicles
64.	Car use and total passenger travel
65.	Freight traffic
66.	Diesel locomotives available
67.	Aircraft departures
68.	Air passengers carried
69.	Air freight carried
70.	Index of specified transport emissions in relation to defined absorption capacity
71.	Index of specified transport wastes in relation to defined absorption capacity
72.	Index describing the rates of use of non-renewable materials in relation to the rates of growth of production of renewable replacements
73.	Index of the degree of reuse and recycling in relation to the amounts of potential waste from production and use.
74.	Index of the amount of land used for all transport purposes in relation to the total EUA
75.	Index of transport noise in relation to established critical levels for health impact
76.	Index of the extent to which lack of transport constrains the meeting of defined everyday needs

**Table 3-1 Initial Long List of Sustainable Transportation Performance Indicators
Compiled by the Centre for Sustainable Transportation**

Number	Indicator
77.	Index of the extent to which lack of transport constrains the meeting of the collective needs of society
78.	Index of the prevalence of transport-related diseases in humans
79.	Index of the extent to which transport contributes to social polarization
81.	Index of the availability of transport opportunities for moving people and freight
80.	Index of the actual or perceived quality of the transport system in relation to an accepted benchmark
82.	Index of the factor cost of transport in the production and distribution of goods and service
83.	Index of the number and intensity of the actions undertaken to change the trajectory of Canada's transport system from 'business as usual' to one consistent with attainment of sustainability
84.	Index describing the rates of use of renewable resources in relation to the rates of their regeneration

Source: CST/CTD (Phase One Report) Sustainable Transportation Performance Indicators Project: Brief Review of Some Relevant World-Wide Activity and Development of An Initial Long List of Indicators.

DEFINING SUSTAINABLE TRANSPORTATION INDICATORS

Transportation systems are a fundamental social need. Transportation systems are vitally linked to economic health in a number of ways. For example, successful transportation systems enable complementary goods, services and skills to be accessed, improving productivity and encouraging investment in businesses within a community or region. Truly efficient transportation systems minimize resource consumption needed for movement, and thus help maintain a healthy environment for residents and the encompassing ecosystem. With ongoing investment and a capable, willing labor force, a community or region is more likely to experience economic success.

Transportation systems are thus linked to not only the economic success of the community or region, but also to the overall quality of life. Where economic growth is experienced, the standard of living in a community or region rises. The importance of good transportation is sometimes better understood in the negative: where time is lost to

inefficient, inadequate and/or expensive transportation systems, less time can be spent at businesses, with family, or in leisure activities.

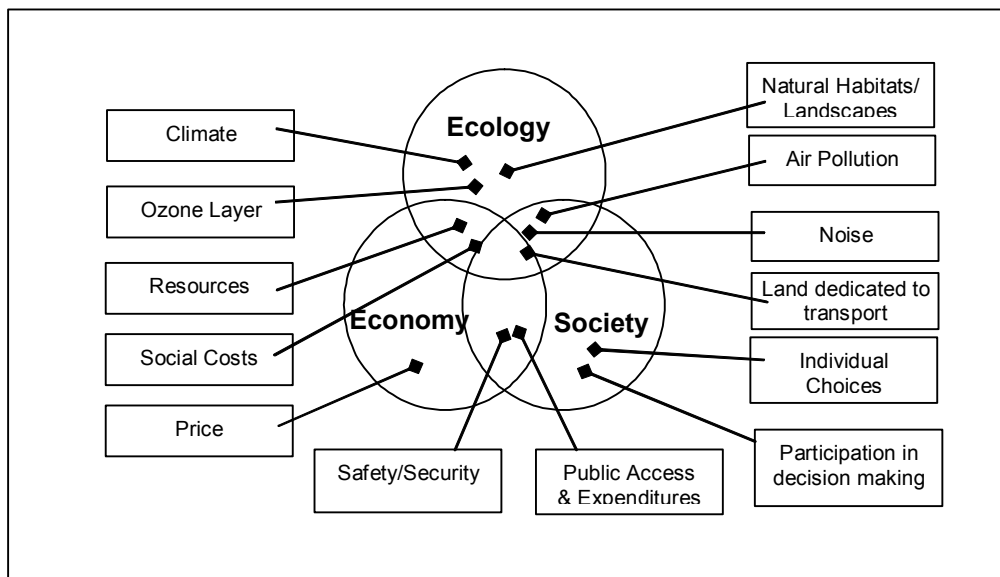
Quality of life is difficult to measure because it is difficult to quantify. However, as we come to understand and measure those elements that have a significant impact on our quality of life, we also learn that by improving those elements we can improve our overall quality of life. Transportation systems can be measured in a number of ways. These measures can then be used to better the quality of life in a community or region.

Transportation indicators measure the transportation system and its impacts, good and bad, upon the community it serves. For purposes of this study, sustainable transportation indicators (STIs) are defined as *regularly updated performance measures that help transportation planners and managers take into account the full range of economic, social and environmental impacts of their decisions* [emphasis added].

Indicators can measure transportation systems in a number of ways, with or without sustainability as an ultimate goal. They may differ greatly, yet to be effective they should be compiled and used in a similar manner. First, the meaning of the indicator and how (in general) it will be used must be agreed upon. How will it be used to evaluate the transportation system? How will it be used in decision making? If the indicator is intended as an indicator of sustainability, the question of how the indicator relates to sustainable development and sustainable activities must also be asked and answered.

Then, a baseline must be established from which to compare future measurements. Time series data often demonstrate current needs and give large clues into what problems may arise in the near future. Sustainable transportation indicators are those that demonstrate the vital relationship between transportation systems and the ecology, economy, and society in which they are located and serve (see Figure 3-1).

Using a variety of transportation indicators helps the community or region and its policy leaders understand the important link between their daily activities and the greater impact on the environment. Figure 3-2 illustrates several classes of transportation indicators. Sustainable transportation indicators are also an important way to help keep builders and operators of transportation systems accountable to users and affected non-users.



Source: Basler, E. et al. Measuring the Sustainability of Transport. National Research Programme 41:M3. Berne, Switzerland

Figure 3-1 The Relationship of Transportation to Ecology, Economy, and Society

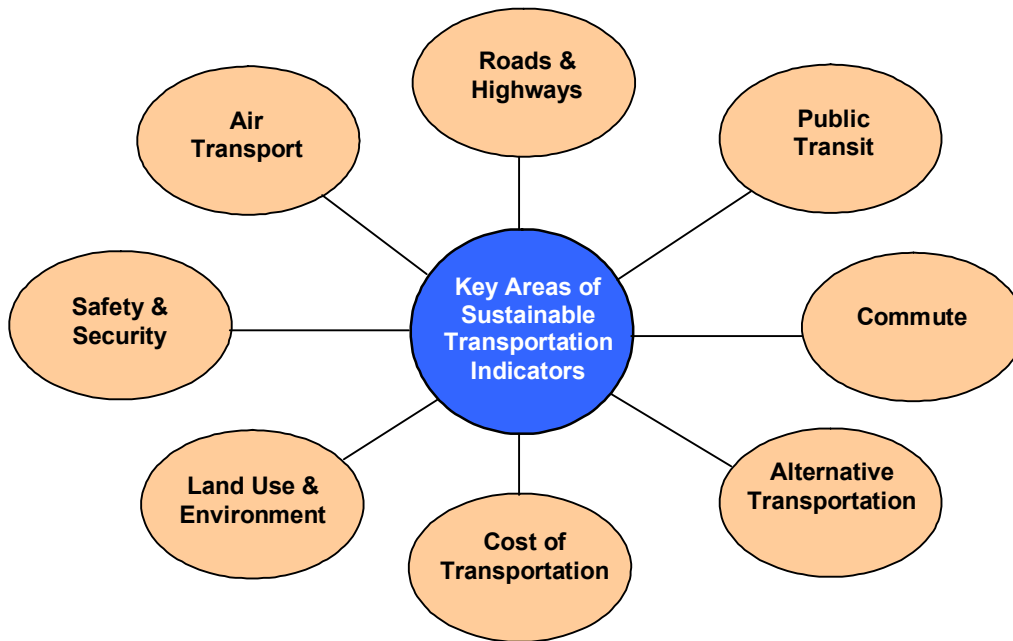
1. The Efficiency of the System
2. Changing Usage & Demand By Those Using the System
3. Maintenance Needs
4. Improvements or Declines in System Efficiency
5. Safety for Those Using the System and Those Living and Working in Proximity to the System
6. Impacts on the Environment
7. The Success of Specific Funding Projects in Reaching Their Goals
8. Helping in the Benefits-Cost Analysis of System Redesigns or Expansions

Source: Munroe Consulting, Inc.

Figure 3-2 Some Important Considerations for Measuring Transportation Systems

EXAMPLES OF SUSTAINABLE TRANSPORTATION INDICATORS – FOR USE BY LOCAL AND REGIONAL AGENCIES

Several examples of quality sustainable transportation indicators are given in this section. They are grouped into subcategories to provide for more coherent relationships, as shown in Figure 3-3.



Source: Munroe Consulting, Inc.

Figure 3-3 Key Areas of Sustainable Transportation Indicators

Roads and Highways

The most common transportation indicators used in the US are those that measure highway and roadway traffic. These measures come in a variety of forms. Listed below are a few examples, with descriptions of why each is important.

Waiting Times At Intersections With Traffic Signals

Waiting times at intersections are a key measure of overall delay on a roadway. Increased delays at intersections have the tendency to cause bottlenecks at high volume periods. Some drivers will also seek alternative routes through neighborhoods and other roads not designed for heavier vehicle volumes. The caution in using this indicator is that it may be read to always encourage larger roadways. A more complete interpretation of the indicator

would suggest that the entire transportation system in the community or region might need some adjustment and investment, not just the roadways.

Traffic Volume At Key Intersections And On Major Highways And Roadways

Most transportation congestion problems are caused by bottlenecks in the system. Intersections inherently are a bottleneck because there is a need for slowing, stopping, merging, and/or turning. Many times bends in the roadway, narrow overpasses, bridges, tunnels, etc., can have a similar effect on traffic movement. Understanding the capacity of a roadway or intersection and relating it to the volume attempting to pass through it helps create understanding about needed improvements.

Roadway Miles In Disrepair/Good-Repair

Roadway conditions measure the effectiveness of the transportation funding and implementation of planning in a community or region to maintain basic infrastructure. Low marks often indicate a deeper problem with the overall policy structure for on-going infrastructure spending. This indicator can also highlight the need for a reliable source of funding for maintenance work prior to building a new project.

Average Annual Vehicle Damage Due To Poor Roadway Conditions

This measure focuses attention on the cost of needed repairs to vehicles due to under funding infrastructure maintenance. This indicator can create a clear relationship between how money is spent indirectly on transportation issues. In this case, local residents may choose to avoid paying for needed infrastructure directly, instead paying similar costs in repairs on their personal vehicles. An example indicator at the state level is shown in Figure 3-4.

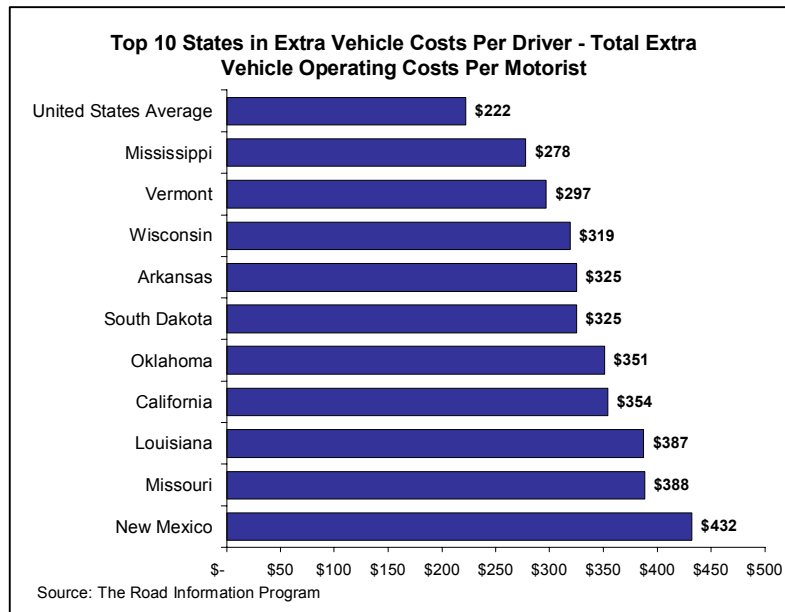


Figure 3-4 Example Chart From Extra Vehicle Operating Costs: What Motorists Pay to Drive on Roads in Need of Repair, *The Road Information Program*, April 2001

Public Transit

Public transit in general provides several benefits in a community, including less traffic congestion, less pollution, and less stress for commuters and drivers. Public transit entails multiple modes of transportation in many communities and each mode should be measured in some way to facilitate their management as an integrated system. The following lists public transit measures with a description of the importance of each.

Bus Ridership

This indicator helps assess whether current bus routes are matching the needs of the community or region by identifying more and less heavily traveled routes. Public transportation becomes more useful when one is able to travel more directly to key destinations. A caution in using this indicator is that not all less-frequently traveled bus routes should be interpreted as without utility. Public transit is also commissioned to help the less advantaged travel to medical facilities, business centers, and retail shops. In some cases, bus routes pass through neighborhoods expressly to meet this purpose.

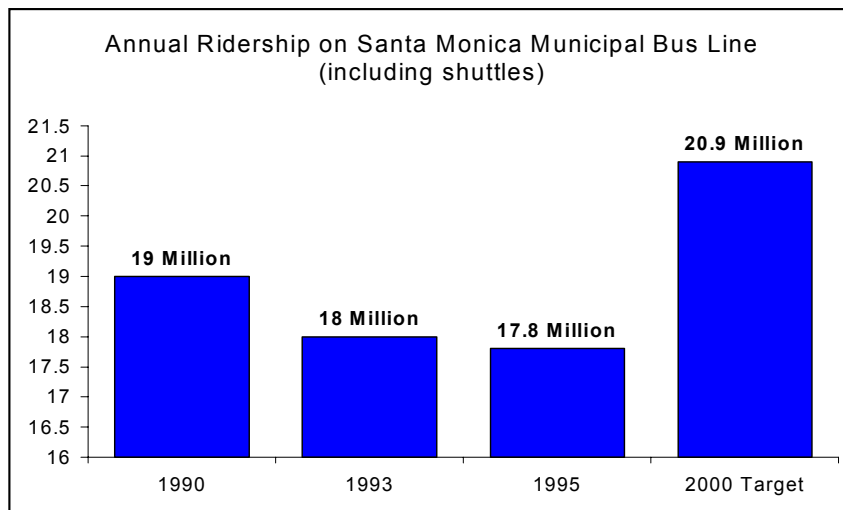


Figure 3-5 Example Chart from Santa Monica Sustainable City Program 1997

Regional Rail Ridership

Railways are ideal for moving a large number of people to large business and retail centers. When used efficiently, rail systems can significantly reduce vehicle volumes at peak periods along roadways, which means less commuter stress, less delay, and less pollution. An underutilized rail system should focus attention on what obstacles are discouraging its use. On the other hand, a heavily used railway may indicate a strong need for greater system capacity.

Regular ridership data systemwide (for both bus and rail, and any other available public transportation modes) should be collected at a fairly detailed level: route, time of day, and as much demographic data on users as possible. Detailed ridership data can be used to answer systemwide questions such as: “Is overall transit use rising relative to automobile use? Is the share of transit commuters increasing? How have fare changes affected ridership?”

Public Expenditure On Public Transit

Local and national governments regularly subsidize public transit. The subsidies are in place to encourage people to:

1. Avoid damaging the environment
2. Avoid greater expenditures on roadway infrastructure
3. Help less advantaged individuals move about the community

4. Support the development of higher-density urban areas and the economic social and environmental benefits of high-density urbanism.

Balancing the appropriate level of public investment and rider fees requires measuring how and where money is spent.

Commute Indicators

A community or region's transportation system is put under the most strain during commute times. For this reason, inadequacies are most apparent on a day-to-day basis during commute hours. When these delays in commute traffic occur, substantial negative impacts may result to the local economy, to individuals' sense of well being, and to the environment (particularly air quality).

Percent of the Commuting Population Taking Each Mode of Transportation to Work

Understanding proportional usage of transportation modes in a community or region is important for planning and funding maintenance and expansion programs. This measure is also key to marking progress in the changing behaviors of commuters over time.

Average Commuting Distance to Work by Place of Residence

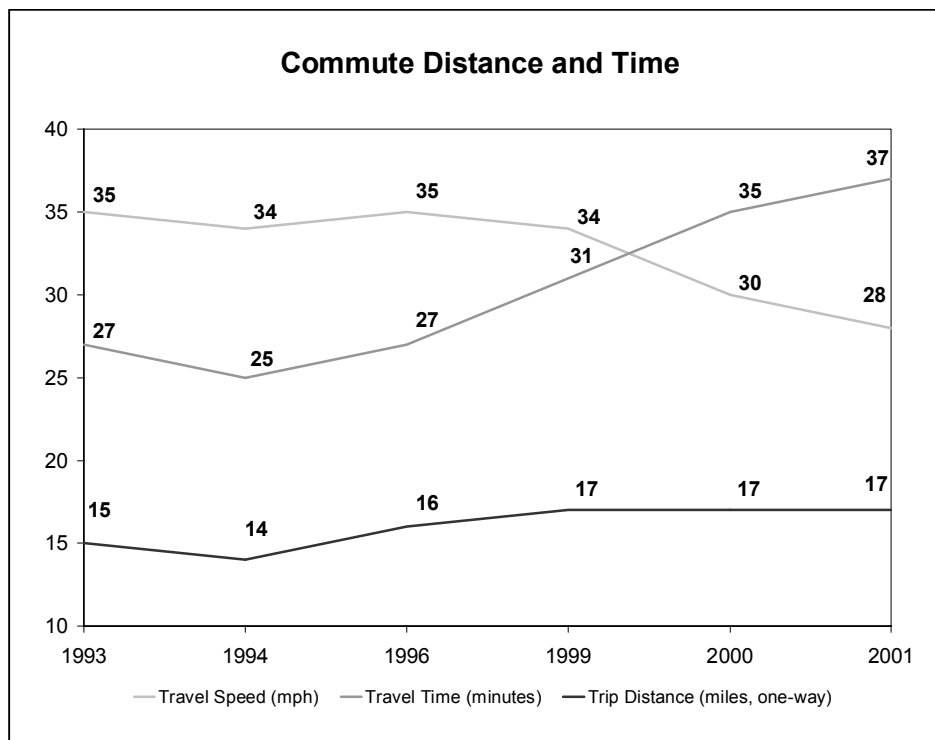
The relationship between place of residence and place of work is fundamental to the load that is put on a transportation system by commuters. It is important to measure how that distance is changing. Generally a policy of sustainability should work to shorten that distance and thereby reduce demand on a transportation system. Acknowledging this indicator also can help the general public understand the relationship between land-use planning and transportation planning. The closer housing is brought to major job centers, the shorter the commuter distance can be for workers, which also reduces the load on a transportation system.

Average Commuting Time to Work by Place of Residence

This indicator measures how much time residents in a community or region are devoting to reach their jobs. In many cases, longer commutes are the result of people choosing cheaper housing in outlying areas. Understanding this correlation enables better long-term planning for future transportation system expansions. It also may suggest the need for adjustments in land use planning in concert with transportation planning to bring affordable housing nearer to major job centers.

Figure 3-6 illustrates how the changing relationship between commute speed, travel time and distance can be presented. The example data indicates that over an eight-year period,

average commute times have generally increased, while speed has decreased and the average distance between home and work has gone up. Though the trend toward living further from work leveled off during the final three years, lower commute speeds meant that time spent commuting continued to climb.



**Figure 3-6 Example Chart from Commute Profile 2001:
A Survey of San Francisco Bay Area Commute Patterns**

Percent of People Who Live and Work within the City or Community

This measure shows the link between economic development and transportation planning. A favorable balance of jobs to adequate housing in a community or region decreases demand on transportation systems by allowing more people to walk, bike, or commute to work on local systems without adding demand on regional systems, especially highways.

Time Devoted to Non-Recreational Travel

This indicator is similar to measuring commute time, but also provides insight into travel for other necessary purposes, such as shopping, school and personal business activities. Together with the commute information, this indicator provides a fuller picture of overall demand placed on a transportation system in a community or region. This indicator also establishes how travel time consumed in necessary travel means less time for family, friends, community, and personal leisure.

Alternative Transportation

Vehicle transportation is the number one cause of air pollution through the use of fossil fuels for propulsion. Much pollution occurs from the start-up and cool-down of internal combustion engines, regardless of distance traveled. Under federal mandates, long term transportation planning must limit pollution. The successful use of alternative transportation methods is a key method for reducing transportation-related pollution.

Percent of Vehicles Powered by Renewable Energy Sources

Alternative fuels from renewable energy sources (such as methanol) and vehicles with alternative power plants (such as hybrid and pure electric cars) aid in the reduction of air pollution. Measuring the trend toward the use of vehicles based on alternative fuels and power systems marks the popularity of such vehicles and the amount of air pollution avoided. Where financial incentives have been applied to encourage the use of such vehicles, this indicator helps measure the success of the incentives in relation to the overall transportation load. Figure 3-7 illustrates how the City of Santa Monica has tracked its own success in switching to alternative fuel vehicles.

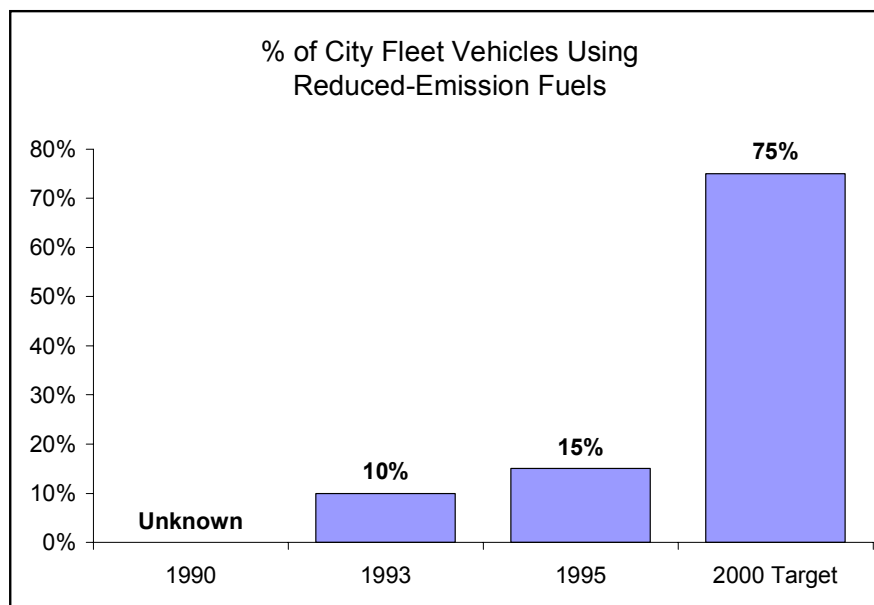


Figure 3-7 Example Chart from Santa Monica Sustainable City Program, 1997

Bike Route Miles as a Percent of Street Miles

This is one measure that indicates how well a community is promoting alternatives to vehicular travel. Designated bike routes make non-vehicular travel safer and thus more

viable for those who choose not to use a car. Extensions of this indicator could include level of use and quality of service for bicycle facility users along the bike routes.

Cost of Transportation

Travel within a community or region needs to be accomplished efficiently, both in terms of time and in terms of monetary cost. Some of these costs are paid directly by travelers, while others are paid indirectly through taxes.

Average Daily Costs of Transportation by Mode for Individuals

Monetary cost is an important consideration for many individuals when choosing their mode of travel. However, because the total cost is not borne solely at the moment that an individual uses a particular mode, it can be beneficial to total the costs associated with each mode. For example, while people consider the cost of gas in auto travel, they often do not include the cost of insurance, maintenance, repairs, taxes, and other fees. It is likely that some would change their mode of travel if they saw a reasonable alternative with lower cost. Causing such mode changes is the intent of the example shown in Figure 3-8.

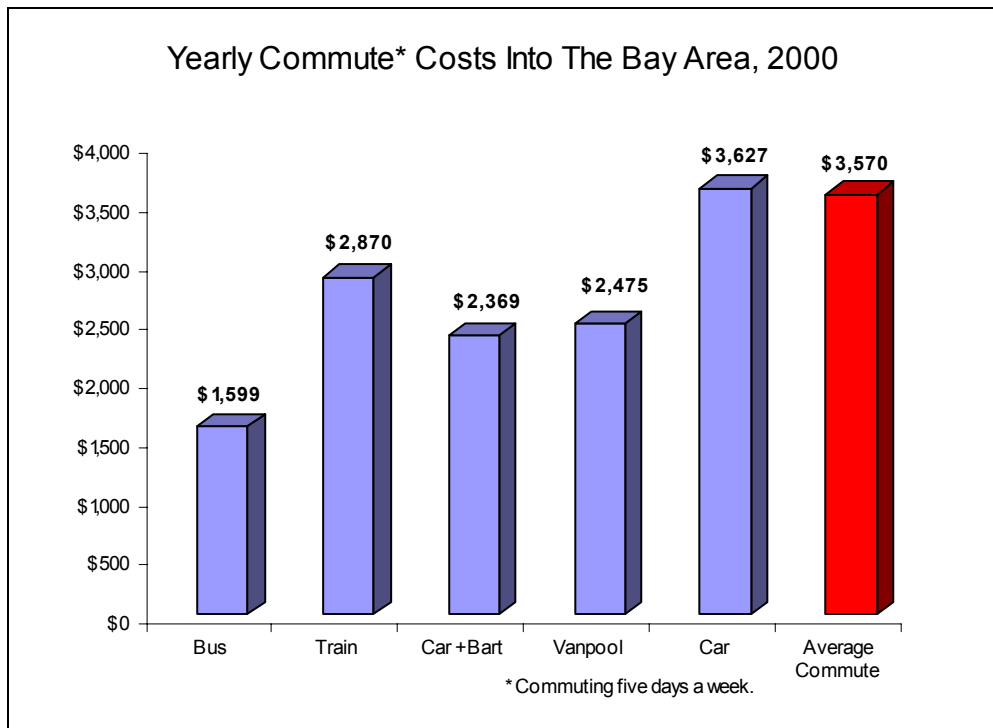


Figure 3-8 Example Chart from *Altamont Pass Commuter Survey, October 2000*, San Joaquin Partnership and San Joaquin Council of Governments

Total Average Cost of Transportation by Mode

It is difficult for the public to associate how much of their tax money subsidizes various modes of travel. Reporting the total average cost of transportation by mode (private expenditure and public subsidy) allows policy makers and the public to understand how much money must be spent to use and maintain a community's or region's transportation system.

Marginal Cost for Additional Volume by Mode

The previous indicator illustrates how money is currently being spent. Measuring the marginal cost (i.e., the cost of accommodating the new riders, including any necessary costs of system expansion) of additional volume in a transportation network provides insights useful while planning for future capacity. Often, the impact of one more person is negligible until full capacity is reached. Extending capacity for the next person is an expensive endeavor. To make wise decisions on the best use of public funds, it is important to understand where the systemwide capacity plateaus exist.

Environmental Impacts

Transportation systems invariably leave imprints and impacts on a community and a region. Pollution is often the most recognized environmental impact. The quantity of land dedicated to the use of transportation systems can also have substantial environmental impacts.

Quantity of Fugitive Dust Emissions (PM-10) Emitted from Roads

Daily travel causes much of the air pollution in a community or region. A substantial portion of that pollution is caused by dust emissions from roadways independent of vehicular emissions. Dust emissions have been linked to cases of chronic respiratory illnesses and asthma attacks. Measuring this indicator can help focus efforts on lowering these emissions.

Quantity of Vehicle Exhaust Emissions

(CO, NOX, VOC, SO², PM, Pb, CO², CH⁴, N²O, etc.)

Vehicle exhaust emissions are harmful to the environment and can be deadly to people and animals. Public programs that have focused attention on measuring these emissions and have provided viable travel alternatives that lower emissions levels have been proven effective in reducing these pollutants. On-going tracking as a transportation indicator helps keep the public and policy makers abreast of success (or failure) in reducing these dangerous gases.

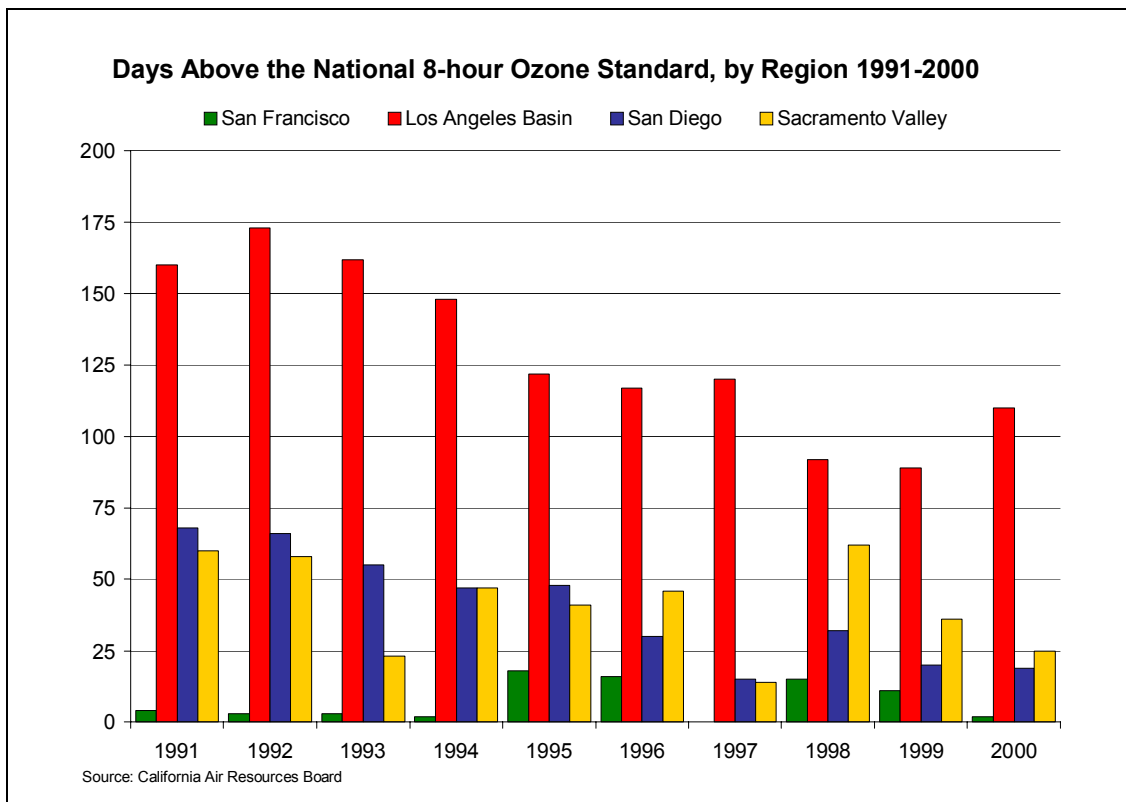


Figure 3-9 Example Chart from East Bay Indicators 2001, EDAB, May 2001

Number of Bad Air Days (National Standard & California State Standard) in the Region

Using the national or state standard in measuring bad air days is a convenient way to compare air quality between regions. More importantly, it shows air quality trends within the region and the efficacy of pollution abatement measures. While the state of California and the U.S. government have set particle standards, in general, a bad air day is one in which certain activities are restricted for many people due to respiratory dangers. While the public generally understands what smog is, it is helpful to have a qualified measure at which point a day is declared smoggy and is recorded as such.

Land Use Dedicated to Transport

Transportation systems take a substantial amount of space away from other primary (and revenue producing) uses in a community or region, including housing, agriculture, retail space, commercial space, and open space. The overall impact of the community or regional transportation system is in part the result of how much land area must be dedicated to its use. Furthermore, some transportation planning decisions are changed when land area considerations are taken into account. Ideally, communities should track

the total amount of land devoted to transportation by mode, including parking and other “off-network” land uses.

Safety and Security

The high speeds of travel and the large groups of people moving on the transportation systems inherently cause safety and security concerns. Keeping these risks to a minimum is an important part of transportation planning.

Traffic Casualties at Intersections

Intersections are inherently dangerous for travelers and a large percentage of all transportation injuries occur at intersections. Some intersections, however, are much worse than others due to their design. Visual distractions or impairments are often sources of danger. Tracking casualties at intersections focuses attention on the most dangerous and encourages responsible parties to make safety improvements. Figure 3-10 illustrates a summation of national data regarding intersection safety.

<u>10 Most Dangerous Intersections</u>		
1. <u>Pembroke Pines, Fla.</u>	Flamingo Rd. and Pines Blvd.	<u>Map it!</u>
2. <u>Philadelphia, Penn.</u>	Red Lion Rd. and Roosevelt Blvd.	<u>Map it!</u>
3. <u>Philadelphia, Penn.</u>	Grant Ave. and Roosevelt Blvd.	<u>Map it!</u>
4. <u>Phoenix, Ariz.</u>	7 th St. and Bell Rd.	<u>Map it!</u>
5. <u>Tulsa, Okla.</u>	51 st St. and Memorial Dr.	<u>Map it!</u>
6. <u>Tulsa, Okla.</u>	71 st St. and Memorial Dr.	<u>Map it!</u>
7. <u>Phoenix, Ariz.</u>	19 th Ave. and Northern Ave.	<u>Map it!</u>
8. <u>Frisco, Tex.</u>	State Highway 121 and Preston Rd.	<u>Map it!</u>
9. <u>Metairie, La.</u>	Clearview Pkwy and Veterans Memorial Blvd.	<u>Map it!</u>
10. <u>Sacramento, Calif.</u>	Fair Oaks Blvd. and Howe Ave.	<u>Map it!</u>

Note: The maps from the report were interactive and are not included in this example.

Figure 3-10 Example Chart from State Farm “Dangerous Intersections” Project

Source: www.statefarm.com, (accessed 2001)

Traffic Casualties on Highways

The high speeds of travel on highways makes them inherently dangerous. Some sections of a highway become more dangerous, such as merging lanes, bends, hills, or blind curves. Tracking the casualties along the more dangerous sections of highways focuses attention on them and encourages responsible parties to make safety improvements.

Criminal Offenses on Public Transportation

Public transportation systems are designed to carry a large volume of travelers. Large groups of people have a tendency to attract individuals with criminal intents. The public will often try to avoid public transportation areas where they do not feel their person or their property are safe. Measuring the number of criminal offenses in key public transportation areas encourages corrective actions (and thus increased security) and promotes those areas that have a history of safety. Public awareness of safety measures and of an acceptable level of safety performance promotes use of the system.

Air Travel

The great increase in air travel has resulted in airports becoming key elements of a region's transportation infrastructure and key nodes of congestion for the surface transportation system. Airports also receive substantial public subsidy and are expected to perform with safety and efficiency.

Passenger Traffic at Commercial Service Airports

Passenger volume is an important consideration when contemplating expansion plans or other transportation changes that would affect the ability of passengers to use the airport. An example of this measure is shown in Figure 3-11.

Air Freight at Commercial Service Airports

Like most other modes of travel, air travel has become an important way to move cargo. The volume of airfreight passing through an airport changes the need that the airport will have for runways and other facilities. Furthermore, those airports that process large volumes of airfreight must also have an adequate ground transportation network to move the freight into and out of the airport. Regional transportation planning and land-use planning efforts must consider the dynamic needs of airports in making their decisions.

Coastal Californian communities with ports might develop similar tracking indicators for water-borne freight.

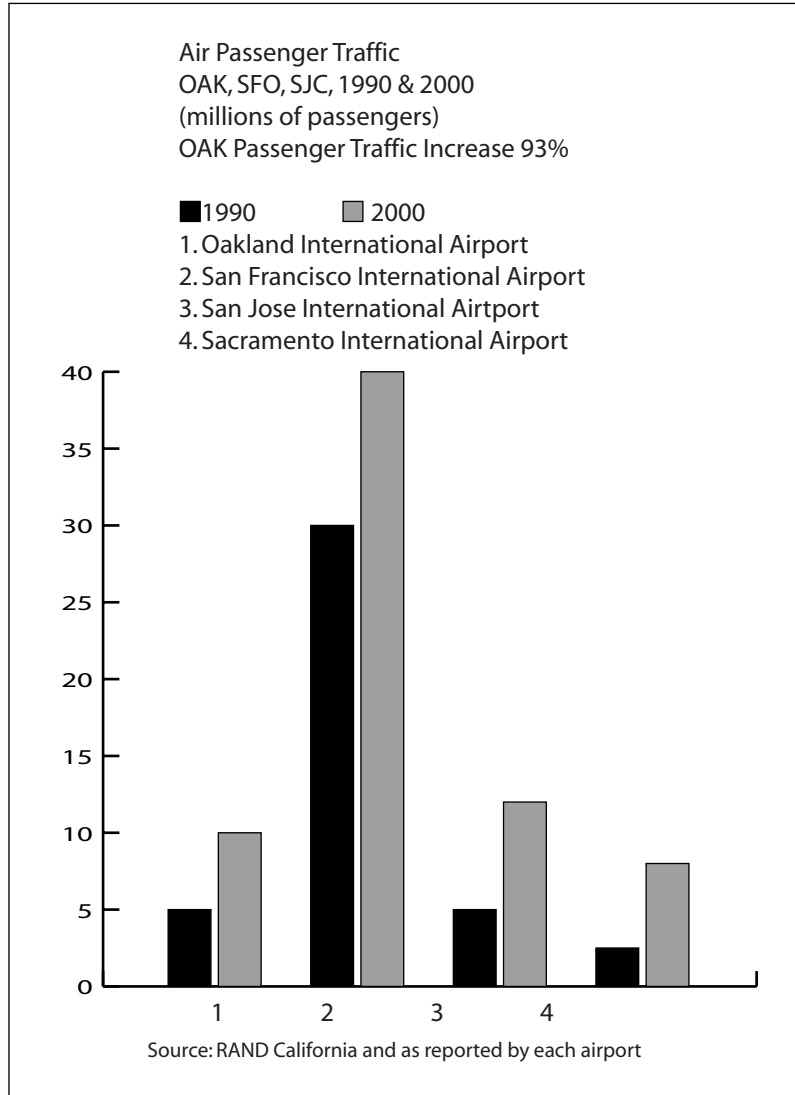


Figure 3-11 Example Chart from East Bay Indicators

SURVEY OF TRANSPORTATION PROFESSIONALS REGARDING SUSTAINABLE TRANSPORTATION INDICATORS

SURVEY RATIONALE AND METHOD

Ultimately, California's transportation systems are planned and run by professionals with considerable education, training, and experience. The understanding, attitudes, and perceptions of these professionals will have an important effect on the implementation of sustainable transportation indicators. A survey was chosen as the best method for better understanding the perceptions of transportation professionals regarding sustainable transportation indicators (as the basis for developing STIs for California's surface transportation agencies). The survey results provide insights useful for developing performance indicators for local and regional transportation agencies.

An initial "screening" survey was administered during January and February 2002. This survey was intended to simply identify transportation professionals with interest in and knowledge of sustainability and indicators. More than 2,000 email addresses were obtained through the Institute of Transportation Engineers from rosters for a variety of ITE Councils (interest groups within ITE), including the following:

- Pedestrian and Bicycle Council
- Public Agency Council
- Transit Council
- Transportation Consultants Council
- Transportation Education Council
- Transportation Planning Council

This initial survey asked respondents to provide names and e-mail contacts for persons and transportation agencies that are knowledgeable about or have implemented Sustainable Transportation Indicators, using the definition of STI presented in Chapter Two of this study:

Sustainable Transportation Indicators are regularly updated performance measures that help transportation planners and managers take into account the full range of economic, social and environmental impacts of their decisions.

The recipients were informed that the responses to this initial survey would be used to compile a contact list for a more detailed survey concerning development and implementation of STIs.

The focus of the overall study is on developing STIs for *California* surface transportation agencies (both planning and operating). Thus, it was important to reach California's transportation professionals. Inspection of the ITE mailing list indicated that, although its members span the globe, California transportation agencies of all types were well represented, except in the area of transit agency staff. Thus the ITE mailing lists were augmented with roughly 35 e-mail addresses for representatives of California transit agencies who are American Public Transit Association (APTA) members.

Although California was well represented, neither the initial survey nor the longer follow-up survey was limited to California agencies. It seemed prudent to keep the second survey open to others as well, since it was clear from the literature review that much important work was being done beyond the boundaries of California or even the U.S. As the preceding chapters have indicated, Canada and Europe may properly be considered worldwide leaders in the development of STIs.

A longer, in-depth survey was developed for distribution to 230 transportation professionals nationwide and a few abroad, mainly in Canada. This list is essentially all persons who were identified, or who self-identified themselves, in the initial survey as interested and/or knowledgeable about sustainability and transportation indicators.

The second, more elaborate survey was used to gather insight into how transportation agency directors and other key staff define sustainable transportation and view the importance of implementing sustainable transportation indicators. It also asked them to judge the relevance of sustainable transportation indicators that currently have been implemented or recommended for use.

The second survey, like the first, was administered electronically via the World Wide Web during June 2002 with invitations to participate sent by e-mail. The survey was sent to 230 transportation professionals identified in the course of the screening survey. Eighty-one responded, representing a 35 percent response rate.

Table 4-1 lists some of the agencies and consulting companies that responded to the survey by the end of June 2002. Just under half of the respondents were California based, or agencies that did substantial work in California. In general, the respondents are representative of the diversity of California's agencies and transportation consulting firms. The text of the web-based survey instrument is contained in Appendix B.

Table 4-1 Agencies and Consultants Responding to the Sustainable Transportation Indicators Survey (Partial listing - not all respondents provided data)

Associate Project Manager, Nelson\Nygaard Consulting Associates	Planning Manager, Regional Transportation Commission of Southern Nevada	Transportation Planner, City of Menlo Park
Deputy Director, Traffic Engineering, City of San Diego	Housing/Redevelopment Director, City of Menlo Park	Professor, Cal Poly
Transportation Planner, Santa Clara Valley Transportation Authority	Vice President, HNTB Corporation	Transportation Planner, WilsonMiller, Inc.
Principal Transportation Engineer, City of LA DOT	Transportation Planner, SRF Consulting Group, Inc.	Manager, Transportation Planning and Design Regional Municipality of Durham
Transportation Engineer, Michigan DOT Planning Bureau	Executive Director, Surface Transportation Policy Project	Strategic Development Manager, Southern California Regional Rail Authority
President, Higgins Associates	Executive Director, League of Michigan Bicyclists	Owner, Brooks & Associates
Sr. Transportation Planner, Presidio Trust	Principal Transportation Planner, Science Applications International Corporation (SAIC)	Transportation Planner, Florida DOT
Research Associate, Pennsylvania Transportation Institute	Senior Associate, Fehr & Peers	Principal, Architecture 21
Transportation Planner, Olmsted County Planning Department	Associate, Cambridge Systematics, Inc.	Transportation Planner, Public Works Department
Transportation Planning Mgr., Los Angeles County Metropolitan Transportation Authority	Professor, Senior Conservation Fellow, Cal. State Univ., Hayward, Sierra Club	Transportation Engineering Manager, City of Kent, WA
Community Planner, Boulevard Transportation Group	Planning Specialist, Florida Dept of Transportation, District 4	Project Manager, Los Angeles MTA
Principal, Weston Pringle & Associates	Urban Planner, NCTCOG	—

SURVEY RESULTS

The survey results show that an overwhelming majority of respondents support the concept of sustainable transportation systems and related indicators. This underscores the importance of developing and monitoring sustainable transportation indicators as part of California agencies' future transportation plans.

Defining Sustainable Transportation

Respondents were asked (question 3) whether they agreed with the Canadian CTI/CTD definition of sustainable transportation (which, as noted earlier, has been adopted by the European Union as well):

“A sustainable transportation system is one that:

Allows the basic access needs of individuals to be met safely and in a manner consistent with human and ecosystem health, and with equity within and between generations;

Is affordable, operates efficiently, offers choice of transport mode, and supports a vibrant economy; and,

Limits emissions and waste within the planet's ability to absorb them, minimizes consumption of non-renewable resources, reuses and recycles its components, and minimizes the use of land and the production of noise.”

Of the 81 respondents, 74 agreed or strongly agreed with this definition.

The same proportion agreed that, “a Sustainable Transportation system should help realize a community's economic, environmental and equity goals and that a Sustainable Transportation system actively promotes and enhances more environmentally friendly transportation modes.”

More than 75 percent of respondents agreed or strongly agreed with the statement: "Sustainable Transportation systems reduce use of and dependence on conventional automobiles and Sustainable Transportation should focus on making all transportation modes more environmentally sound" (question 4).

The transportation professionals were asked how important they consider it that California transportation agencies actively develop and implement Sustainable Transportation Indicators. Nearly four out of five view the development and implementation of sustainable transportation indicators as an “important” or “very important” tool that will help transportation planners and managers take into account the full range of economic, social and environmental impacts of their decisions (question 5).

Candidate Sustainable Transportation Indicators

With the STI definitions, selection criteria, and examples discussed in the previous section in mind, the research team compiled the following list of 31 indicators. Neither exhaustive nor definitive, the list does reflect 31 robust STIs that have all been either critiqued in the academic and professional literature, or have been incorporated into an STI program in the real world. This list became an important component of a survey of transportation professionals.

The survey asked the respondents their opinion of the 31 STIs identified in the literature review (and shown below in Table 4-2). The transportation professionals were asked to select the five most important STIs of the list of 31, from two perspectives. First, they were asked to choose from the overall standpoint of the surface transportation system; and second from the standpoint of their own transportation agency. We present the results of the “overall” perspective first.

Table 4-2 List of Possible Sustainable Transportation Performance Indicators for Survey

Indicator Number	Indicator (definition)
1.	Percentage of household expenditures devoted to transportation, including direct expenditures on vehicles and fares and indirect expenditures, such as residential parking and taxes spent on transportation facilities
2.	Average amount of resident's time devoted to non-discretionary travel
3.	Person miles traveled versus vehicle miles of travel
4.	Accessibility of non-drivers to employment centers and services
5.	Per capita land area paved for roads and parking facilities
6.	Quality of pedestrian and bicycle environment, e.g., the Pedestrian Environment factor used in Portland, Oregon's regional transportation modeling
7.	Quality of public transit service, including number of service hours, service frequency, average speed relative to automobile traffic speeds, safety, comfort (including number of standees during peak periods, number of bus shelters and other waiting facilities), availability of information, and integration with other modes
8.	Average number of major services, e.g. grocery, library, school, playing fields, etc., within walking distance of residents, or average walking distance between residences and public services such as schools and retail centers
9.	Land use densities (residential) and intensities (commercial)
10.	Land use mix, e.g., proximity of residential, commercial, and employment land uses

Indicator Number	Indicator (definition)
11.	Quality of delivery services, e.g., groceries
12.	Quality of mobility services for residents with special mobility needs
13.	Affordability of public transit service by lower income residents, e.g., fares as a portion of lowest quintile income
14.	Portion of residents with transit service within one-quarter mile
15.	Motor vehicle accident fatalities and accidents
16.	Per capita transportation energy consumption per vehicle mile and passenger mile, by mode
17.	Per capita transportation pollution emissions (air, water, noise) and share of total emissions
18.	Medical costs attributed to transportation, including care for injuries and pollution related diseases
19.	Portion of transportation-related costs paid by public funding
20.	Degree of residents' participation in transportation and land use decision-making
21.	Miles of facility by type, e.g., vehicular roadways, bikeway, busways, walkways
22.	Per capita land area devoted to transportation facilities including parking
23.	Number of vehicles by type including bicycles
24.	Mode split (e.g. car, transit and non-motorized/low-power modes, walk) by trip purpose (e.g., work, shop, personal business, social, recreational)
25.	Average travel time and distance, by mode and purpose
26.	Freight transport by mode and type of goods
27.	Number of jobs and other regional attractions accessible within 30/45/60 minutes by mode from defined subareas
28.	Investments in transportation infrastructure per capita and by mode
29.	Real change in passenger transport price paid by consumer by mode
30.	Real change in passenger transport cost incurred by supplier by mode
31.	Person hours lost to recurring congestion and traffic delays

Sources: Derived from Litman, (1999); TERM (2001); CST (2002); and others.

Rating of Most Important Overall Sustainable Transportation Indicators

Mode split by trip purpose was the most frequently selected STI. Thirty five percent of the transportation professionals selected "Mode split by trip purpose" as one of their top five STIs from an "overall" standpoint—i.e., that of the transportation system as a whole.

Four other indicators also received high ratings for overall STIs: more than 25 percent of respondents chose these as an overall transportation sustainability indicator:

1. Quality of pedestrian and bicycle environment, e.g., the Pedestrian Environment factor used in Portland, Oregon's regional transportation modeling (indicator 6)
2. Quality of public transit service, including number of service hours, service frequency, average speed relative to automobile traffic speeds, safety, comfort (including number of standees during peak periods, number of bus shelters and other waiting facilities), availability of information, and integration with other modes (indicator 7)
3. Land-use mix, e.g., proximity of residential, commercial and employment land uses (indicator 10)
4. Average travel time and distance, by mode and purpose (indicator 25)

Other Indicators Rated as Somewhat Important

Less popular, but still the choice of at least 16 percent of the transportation professionals were these indicators of overall transportation sustainability:

1. Per capita land area paved for roads and parking facilities (indicator 5)
2. Average number of major services (e.g. grocery, library, school, playing fields, etc.) within walking distance of residents, or average walking distance between residences and public services such as schools and retail centers (indicator 8)
3. Land-use residential densities and commercial intensities (indicator 9)
4. Affordability of public transit service by lower income residents, e.g., fares as a portion of lowest quintile income (indicator 13)
5. Portion of residents with transit service within one-quarter mile (indicator 14)
6. Per capita transportation energy consumption per vehicle mile and passenger mile, by mode (indicator 16)
7. Person-hours lost to recurring congestion and traffic delays (indicator 31)

Results by Agency Type

As might be expected, transportation professionals working at different types of agencies had different perspectives on what constituted a good overall STI. We now turn to an analysis of the choices made by professionals at the three types of agencies of most interest to this study: regional planning agencies (planners), street and highway managers, and transit agency managers.

Regional Transportation Planners' Ratings

Five or more of 16 transportation planners responding to the survey (31 percent or more) selected the following as an Indicator of Overall Transportation Sustainability.

Indicator of Overall Transportation Sustainability

1. Quality of pedestrian and bicycle environment (e.g., the Pedestrian Environment factor used in Portland, Oregon's regional transportation modeling) (indicator 6)
2. Quality of public transit service, including number of service hours, service frequency, average speed relative to automobile traffic speeds, safety, comfort (including number of standees during peak periods, number of bus shelters and other waiting facilities), availability of information, and integration with other modes (indicator 7)
3. Land-use mix: e.g., proximity of residential, commercial and employment land uses (indicator 10)
4. Per capita transportation energy consumption per vehicle mile and passenger mile by mode (indicator 16)
5. Per capita transportation pollution emissions (air, water, noise) and share of total emissions (indicator 17)
6. Mode split (e.g. car, transit and non-motorized/low-power modes, walk) by trip purpose (e.g., work, shop, personal business, social, recreational) (indicator 24)
7. Average travel time and distance, by mode and purpose (indicator 25)

Indicators Selected as Relevant to Transportation Planning Agencies

Thirty one percent or more of the 16 transportation planners surveyed selected the following Indicators of Transportation Sustainability as relevant to transportation planning agencies:

1. Portion of transportation-related costs paid by public funding (indicator 19)
2. Investments in transportation infrastructure per capita and by mode (indicator 28)

Street and Highway Managers' Ratings

At least five of the 18 street and highway managers responding (28 percent) pointed to the following as Indicators of Overall Transportation Sustainability.

Indicators of Overall Transportation Sustainability

1. Quality of pedestrian and bicycle environment (e.g., the Pedestrian Environment factor used in Portland, Oregon's regional transportation modeling) (indicator 6)
2. Quality of public transit service, including number of service hours, service frequency, average speed relative to automobile traffic speeds, safety, comfort (including number of standees during peak periods, number of bus shelters & other waiting facilities), availability of information, and integration with other modes (indicator 7)
3. Average number of major services (e.g. grocery, library, school, playing fields, etc.) within walking distance of residents, or average walking distance between residences and public services such as schools and retail centers (indicator 8)
4. Land-use mix: e.g., proximity of residential, commercial and employment land uses (indicator 10)
5. Mode split (e.g. car, transit and non-motorized/low-power modes, walk) by trip purpose (e.g., work, shop, personal business, social, recreational) (indicator 24)

Indicators of Transportation Sustainability Rated as Important

And at least 28 per cent of the 18 street and highway managers surveyed named the following Indicators of Transportation Sustainability as important to the street and road management agency:

1. Person-miles traveled versus vehicle miles of travel (indicator 3)
2. Land-use densities (residential) and intensities (commercial) (indicator 9)
3. Land-use mix: e.g., proximity of residential, commercial & employment land uses (indicator 10)
4. Portion of residents with transit service within one-quarter mile (indicator 14)
5. Motor vehicle accident fatalities and accidents (indicator 15)
6. Miles of facility by type, e.g., vehicular roadways, bikeway, busways, walkways (indicator 21)
7. Average travel time and distance, by mode and purpose (indicator 25)
8. Person-hours lost to recurring congestion and traffic delays (indicator 31)

These results indicate that street and highway manager respondents place more emphasis on safety and the physical infrastructure compared to other respondents.

Transit Managers' Ratings

At least two of the five transit managers responding to the survey listed the following as Indicators of Overall Transportation Sustainability.

Indicators of Overall Transportation Sustainability

1. Quality of public transit service, including number of service hours, service frequency, average speed relative to automobile traffic speeds, safety, comfort (including number of standees during peak periods, number of bus shelters & other waiting facilities), availability of information, & integration with other modes (indicator 7)
2. Portion of residents with transit service within one-quarter mile (indicator 14) Land use mix: e.g., proximity of residential, commercial & employment land uses (indicator 10)
3. Per capita transportation energy consumption per vehicle mile and passenger mile, by mode (indicator 16)
4. Person hours lost to recurring congestion and traffic delays (indicator 31)

Indicators of Transportation Sustainability Rated as Important

Two of the five transit managers surveyed also identified the following as important to the transit agency:

1. Quality of public transit service, including number of service hours, service frequency, average speed relative to automobile traffic speeds, safety, comfort (including number of standees during peak periods, number of bus shelters & other waiting facilities), availability of information, & integration with other modes (indicator 7)
2. Land-use densities (residential) and intensities (commercial) (indicator 9)
3. Portion of residents with transit service within one-quarter mile (indicator 14)
4. Motor vehicle accident fatalities and accidents (indicator 15)
5. Per capita transportation energy consumption per vehicle mile and passenger mile, by mode (indicator 16)
6. Portion of transportation-related costs paid by public funding (indicator 19)
7. Mode split (e.g. car, transit and non-motorized/low-power modes, walk) by trip purpose (e.g., work, shop, personal business, social, recreational) (indicator 24)
8. Average travel time and distance, by mode and purpose (indicator 25)
9. Real change in passenger transport cost incurred by supplier by mode (indicator 30)

The small number of transit managers was somewhat disappointing, and merits a comment. An interview with one transit manager who did not respond suggests that transit agency staff may suffer from “indicator overload” due to the need to file multiple indicator reports to various funding and stakeholder groups.

Orphan Indicators

Out of the list of 31 Sustainable Transportation Indicators, some were rarely chosen as important indicators. Fewer than eight respondents (i.e., less than ten percent of the total respondents) chose the following 16 indicators as good overall STIs.

Rarely Favored Indicators

1. Percentage of household expenditures devoted to transportation, including direct expenditures on vehicles and fares, and indirect expenditures, such as residential parking and taxes spent on transportation facilities (indicator 1)
2. Average amount of residents’ time devoted to non-discretionary travel (indicator 2)
3. Accessibility of non-drivers to employment centers and services (indicator 4)
4. Quality of delivery services (e.g., groceries) (indicator 11)
5. Quality of mobility services for residents with special mobility needs (indicator 12)
6. Motor vehicle accident fatalities and accidents (indicator 15)
7. Medical costs attributed to transportation, including care for injuries and pollution related diseases (indicator 18)
8. Portion of transportation-related costs paid by public funding (indicator 19)
9. Degree of residents’ participation in transportation and land use decision-making (indicator 20)
10. Miles of facility by type, e.g., vehicular roadways, bikeway, busways, walkways (indicator 21)
11. Number of vehicles by type including bicycles (indicator 23)
12. Freight transport by mode and type of goods (indicator 26)
13. Number of jobs and other regional accessible within 30/45/60 minutes by mode from defined subareas (indicator 27)
14. Investments in transportation infrastructure per capita and by mode (indicator 28)
15. Real change in passenger transport *price* paid by consumer by mode (indicator 29)
16. Real change in passenger transport *cost* incurred by supplier by mode (indicator 30)

Least Favored Indicators

Focusing on Sustainable Transportation Indicators relevant from the perspective of the respondents' agencies, many STIs indicators were rarely selected. The following STIs were endorsed as important agency-level indicators by fewer than five of the 81 total respondents:

1. Accessibility of non-drivers to employment centers and services (indicator 4)
2. Quality of delivery services, e.g., groceries (indicator 11)
3. Quality of mobility services for residents with special mobility needs (indicator 12)
4. Affordability of public transit service by lower income residents, e.g., fares as a portion of lowest quintile income (indicator 13)
5. Medical costs attributed to transportation, including care for injuries and pollution related diseases (indicator 18)
6. Degree of residents' participation in transportation and land use decision-making (indicator 20)
7. Per capita land area devoted to transportation facilities including parking (indicator 22)
8. Number of vehicles by type (including bicycles) (indicator 23)
9. Freight transport by mode and type of goods (indicator 26)
10. Number of jobs and other regional attractions accessible within 30/45/60 minutes by mode from defined subareas (indicator 27)
11. Investments in transportation infrastructure per capita and by mode (indicator 28)
12. Real change in passenger transport *cost* incurred by supplier by mode (indicator 30)

Examining the first of the two lists of rarely chosen or “orphan” indicators, one may conclude that “cross-cutting” STIs, which require information from more than one agency, are the indicators passed over by the respondents.

Examining the second of the two lists, the least chosen agency-level indicators, one may conclude again that “cross-cutting” STIs, which require information from more than one agency, are the indicators passed over by the respondents. Moreover, indicators that are far-removed from the day-to-day concerns of transportation planning and service delivery organizations are on the orphan list. Qualities of delivery services are overlooked because neither planning nor street departments nor transit operators operate delivery services, even though all benefit from efficient delivery systems.

Looking at an orphan of more gravity, it would be hard to think of an indicator more important, in human terms, than total medical costs attributed to transportation (i.e., including care for injuries and pollution related diseases). But transportation agencies are generally only responsible for medical costs that can be directly ascribed to misconduct of their agency mission.

Sadly, more than a decade after passage of ISTEA, the degree of residents' participation in transportation and land-use decision making is not viewed as worth tracking by very many transportation professionals from either an overall or an agency perspective. This willingness to discount public opinion may merely reflect bad experiences from drawn-out public hearings. However, taken at face value, it suggests that recent rhetoric and research on the importance of public input and customer focus is not resonating with transportation professionals.

DETAILED SUMMARY OF RESPONSES

Following is a detailed summary of the transportation professionals' responses to the survey questions. The survey results have been summarized in both a tabular and bar chart format. This is followed by an analysis of responses to an open-ended request for additional sustainable transportation indicators and for comments on sustainable transportation indicators.

Question 1 asked: **What is the primary function of your agency?**

Choice	Count	Percent
Street and highway management	18	22.2
Public Transit Operations	5	6.2
Transportation Planning Agency	16	19.8
Transportation Consulting	22	27.2
Other	20	24.7

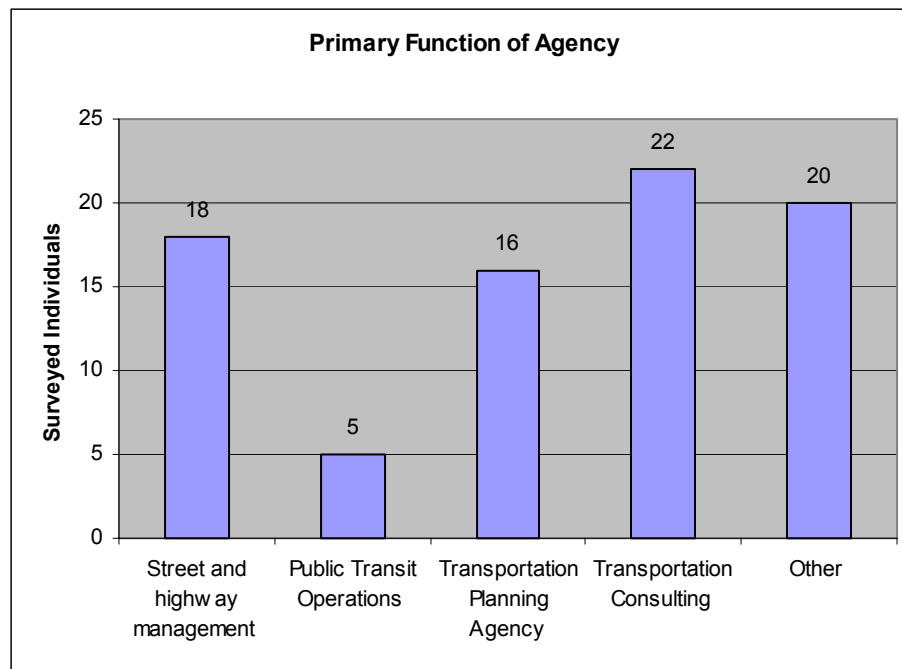
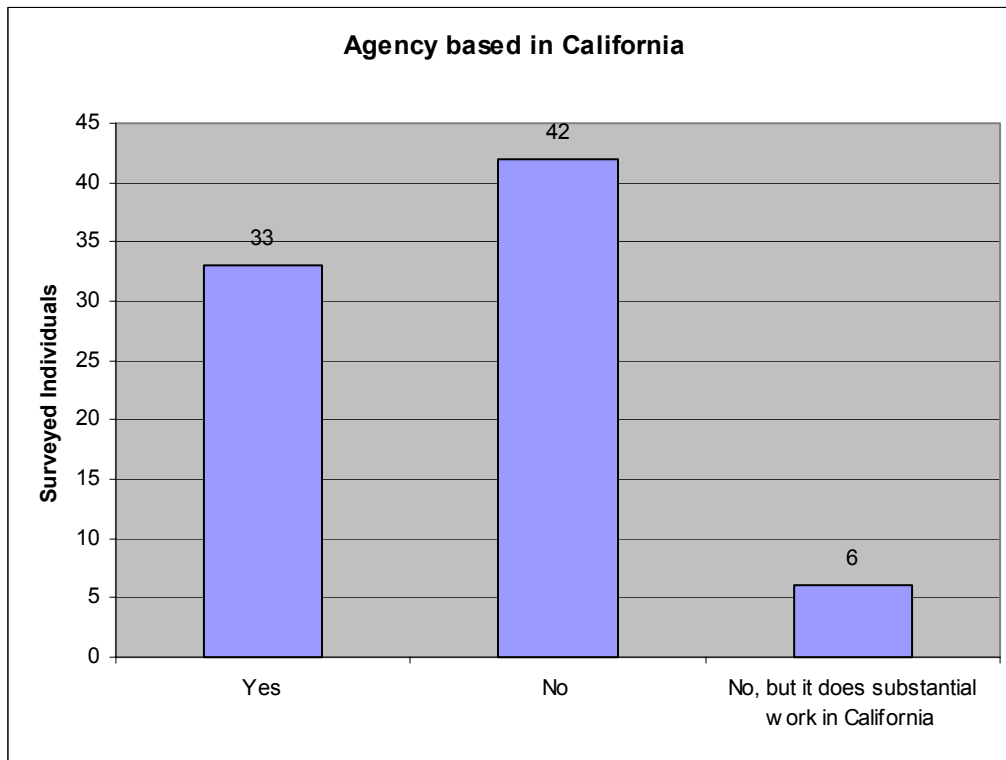


Figure 4-1 Survey Results–Primary Function of Agency

Question 2: Is your Agency based in California?

Choice	Count	Percent
Yes	33	40.8
No	42	51.9
No, but it does substantial work in California	6	7.4

**Figure 4-2 Survey Results—California-based Participants**

Question 3: Please indicate the overall degree to which you agree with this definition?

The Canadian Centre for Sustainable Transportation (CST/CTD) adopted the following definition of Sustainable Transportation. A sustainable transportation system is one that:

Allows the basic access needs of individuals to be met safely and in a manner consistent with human and ecosystem health, and with equity within and between generations.

Is affordable, operates efficiently, offers choice of transport mode, and supports a vibrant economy.

Limits emissions and waste within the planet's ability to absorb them, minimizes consumption of non-renewable resources, reuses and recycles its components, and minimizes the use of land and the production of noise.³⁴

Choice	Count	Percent
Strongly Agree	30	37.0
Agree	44	54.3
Neutral	7	8.6
Disagree	0	0.0
Strongly Disagree	0	0.0

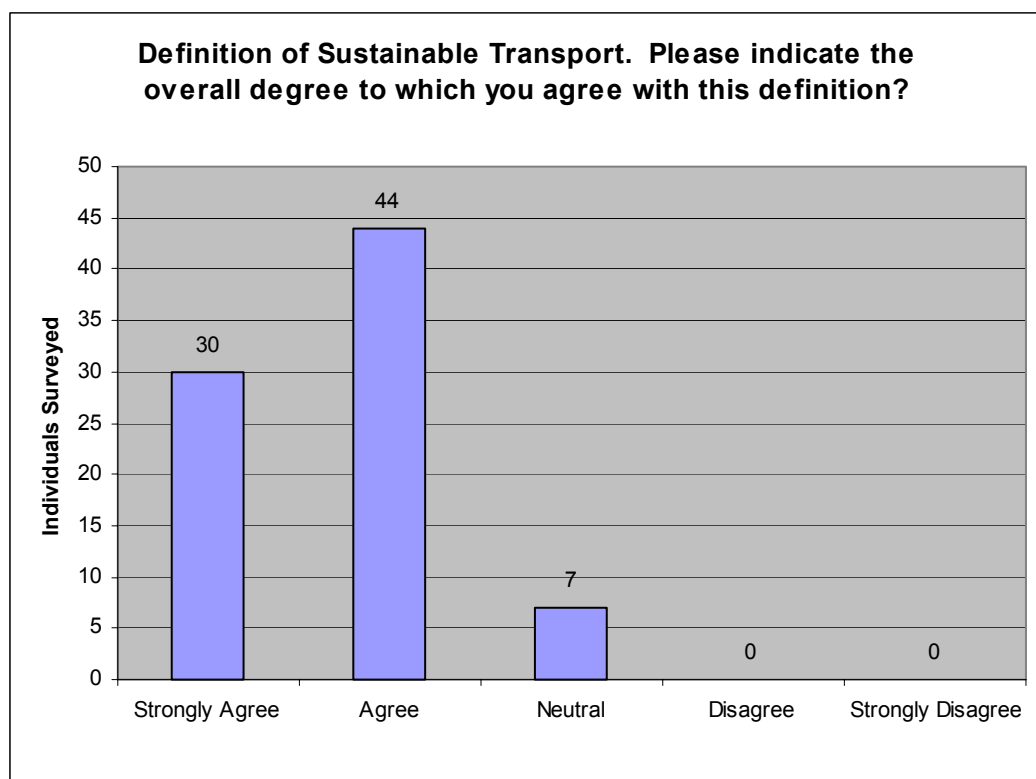


Figure 4-3 Survey Results–Sustainable Transportation Definition

Question 4: **Please indicate the degree to which you agree with the following statements:**

- a) A Sustainable Transportation system should help realize a community's economic, environmental and equity goals.

Choice	Count	Percent
Strongly Agree	45	55.6
Agree	31	38.3
Neutral	5	6.2
Disagree	0	0.0
Strongly Disagree	0	0.0

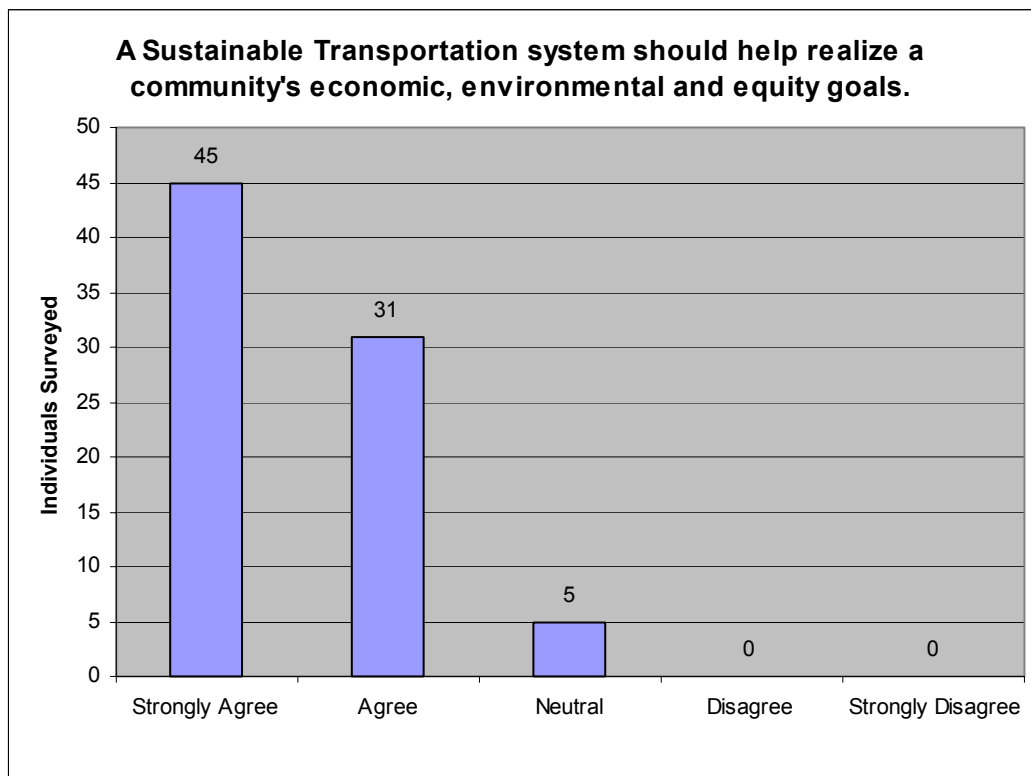


Figure 4-4 Survey Results–a) Realizing Economic, Environment and Equity Goals

- b) A Sustainable Transportation system entails a self-sustaining (financing) system wherein users (benefactors) pay the full costs of system construction, operation, and expansion.

Choice	Count	Percent
Strongly Agree	0	0.0
Agree	23	32.4
Neutral	22	31.0
Disagree	19	26.8
Strongly Disagree	7	9.9

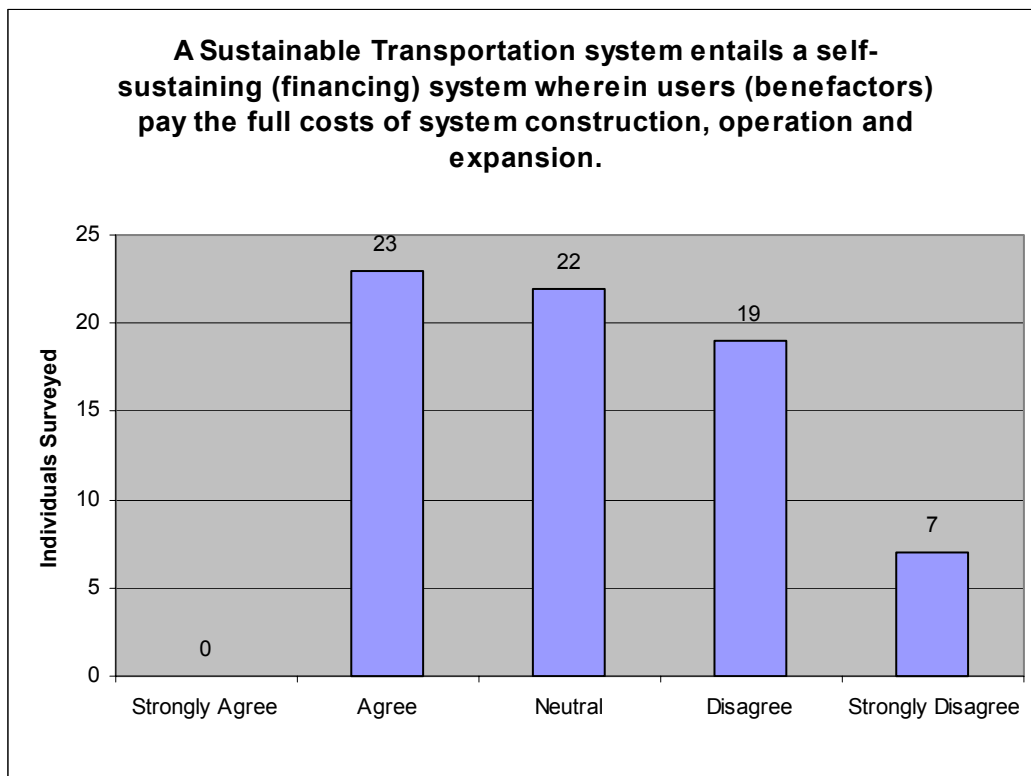


Figure 4-5 Survey Results b)–Financing a Sustainable Transportation System

- c) A Sustainable Transportation system actively promotes and enhances more environmentally friendly transportation modes.

Choice	Count	Percent
Strongly Agree	46	56.8
Agree	29	35.8
Neutral	4	4.9
Disagree	2	2.5
Strongly Disagree	0	0.0

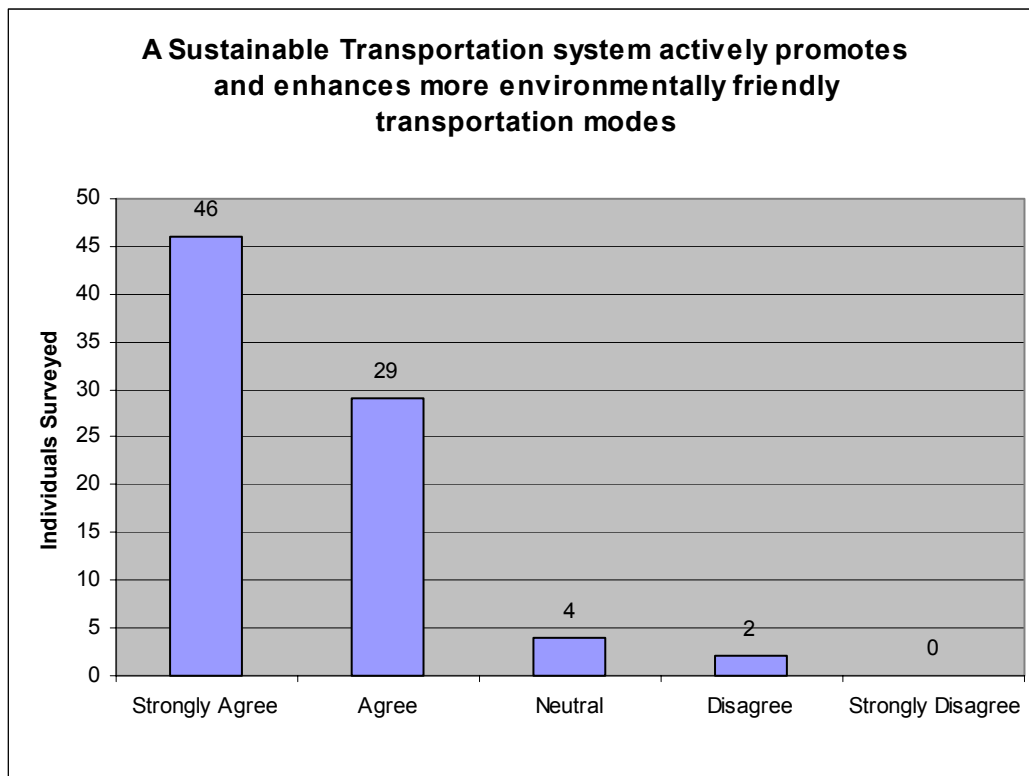


Figure 4-6 Survey Results c)–Promoting Environmentally Friendly Transportation

- d) Sustainable Transportation systems reduce use of and dependence on conventional automobiles.

Choice	Count	Percent
Strongly Agree	39	48.8
Agree	24	30.0
Neutral	10	12.5
Disagree	7	8.8
Strongly Disagree	0	0.0

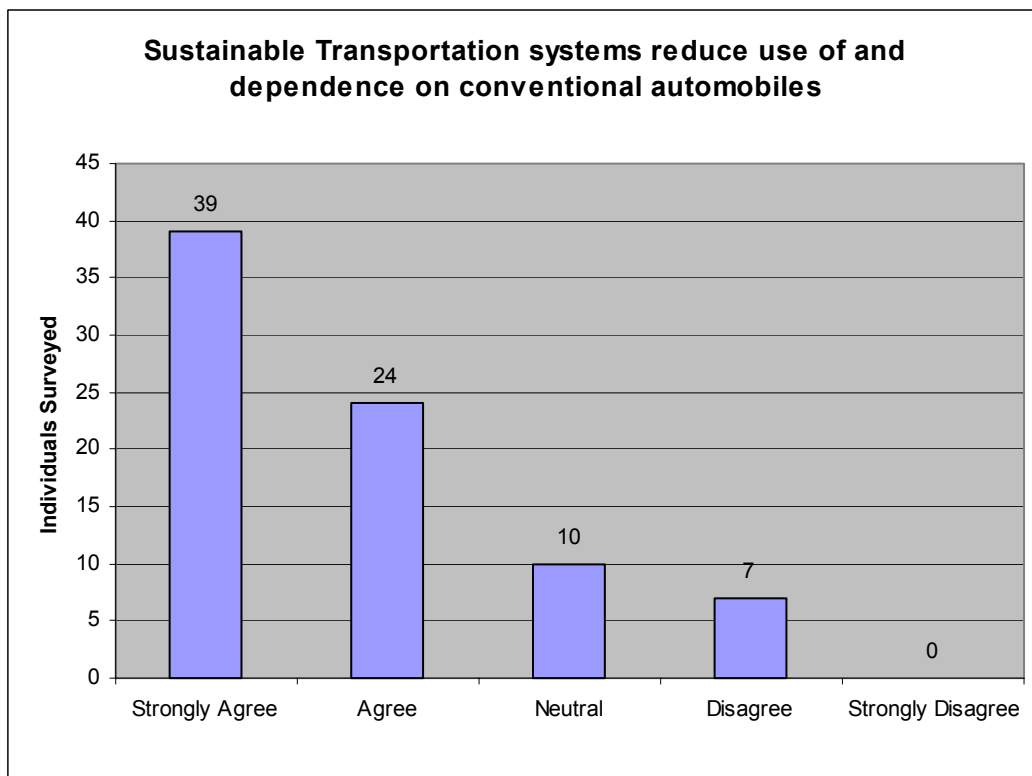


Figure 4-7 Survey Results d)–Reducing Automobile Use

e) A Sustainable Transportation system entails less overall (per capita) travel.

Choice	Count	Percent
Strongly Agree	14	17.5
Agree	23	28.8
Neutral	22	27.5
Disagree	16	20.0
Strongly Disagree	5	6.3

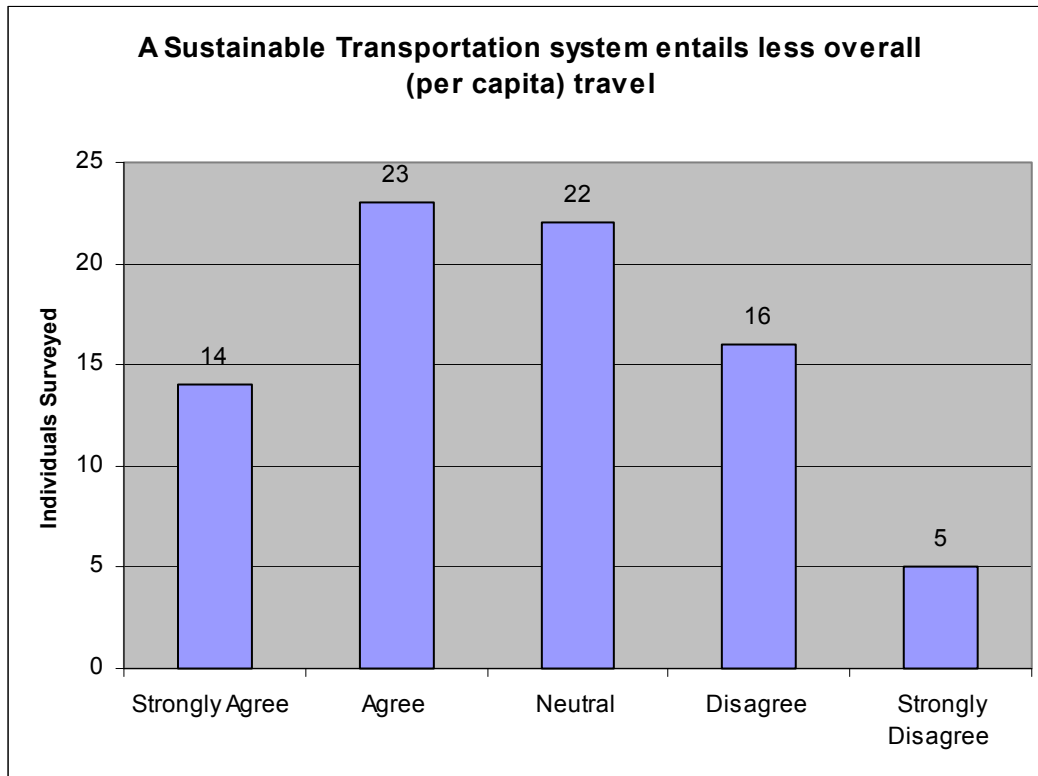


Figure 4-8 Survey Results e)–Reducing Per Capita Travel

f) Sustainable Transportation should focus on making all transportation modes more environmentally sound.

Choice	Count	Percent
Strongly Agree	35	43.8
Agree	35	43.8
Neutral	3	3.8
Disagree	3	3.8
Strongly Disagree	4	5.0

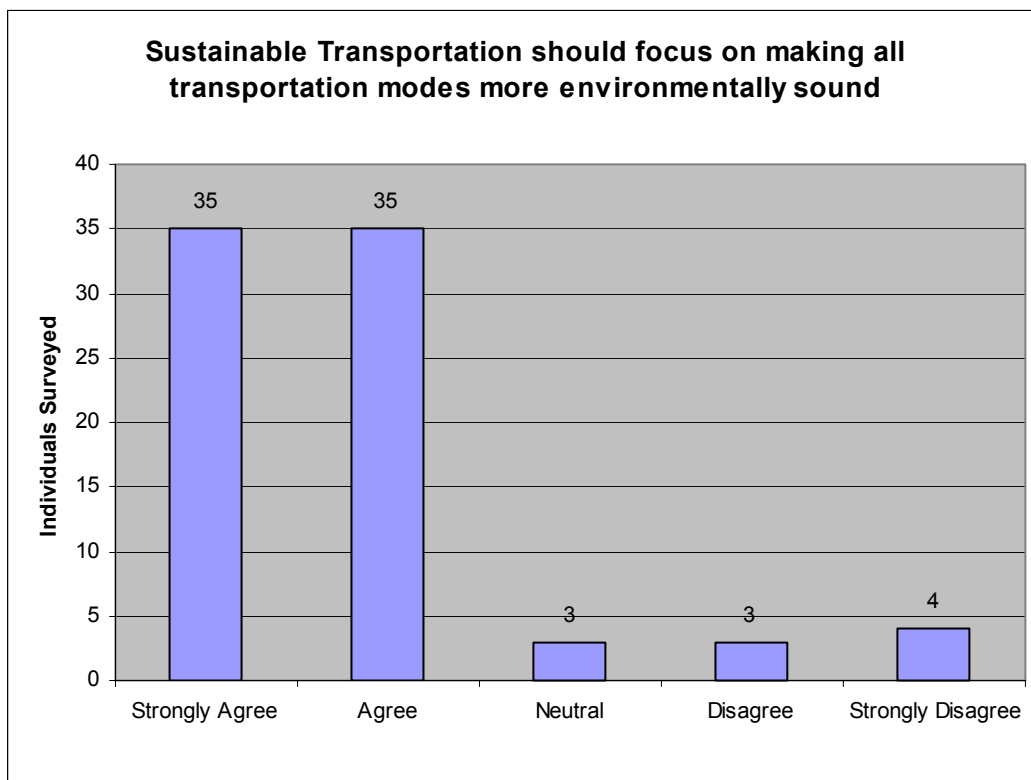


Figure 4-9 Survey Results f)–Environmentally Sound Transportation Modes

Question 5: Sustainable Transportation Indicators may be defined as follows:

Sustainable Transportation Indicators are regularly updated performance measures that help transportation planners and managers take into account the full range of economic, social and environmental impacts of their decisions.

In your opinion, how important is it that California transportation agencies actively develop and implement Sustainable Transportation Indicators?

Choice	Count	Percent
Very Important	30	38.0
Important	33	41.8
Somewhat Important	8	10.1
Not that Important	8	10.1

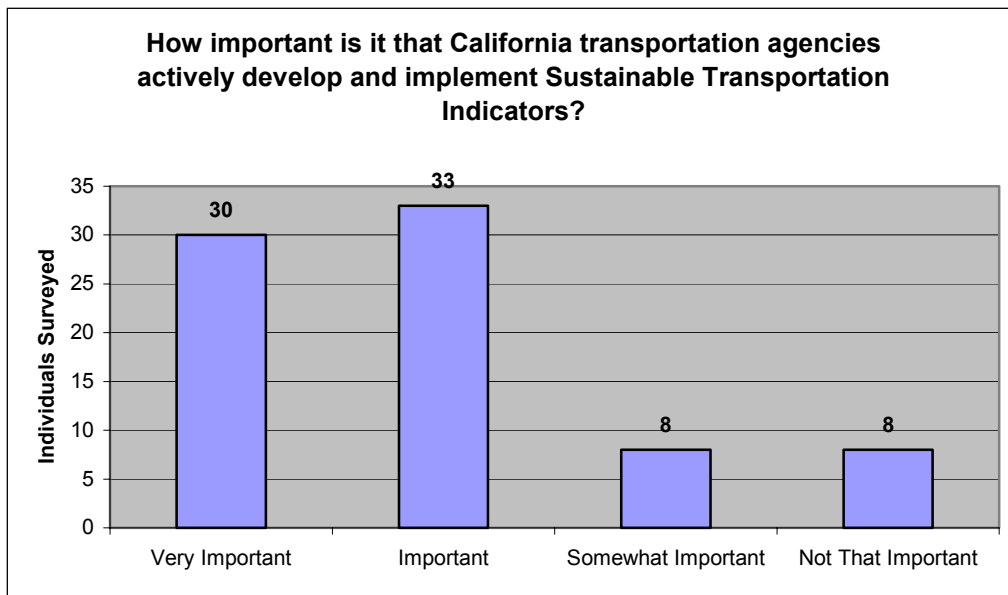


Figure 4-10 Survey Results–Importance of Sustainable Transportation Indicators

For questions 6-10, please list what you consider to be the five most important STIs from the standpoint of surface transportation overall. You do NOT need to rank the five indicators you choose. Choose from the list below (please use ID [number] from list).

For each of your five chosen indicators, please indicate your assessment of the ease of compiling and updating the data needed to calculate the STI on a regular basis using the following scale:

- Easy–data is routinely collected and available
- Moderately difficult–data could be collected and made available with some effort
- Difficult–data not available and a major effort would be needed to collect it

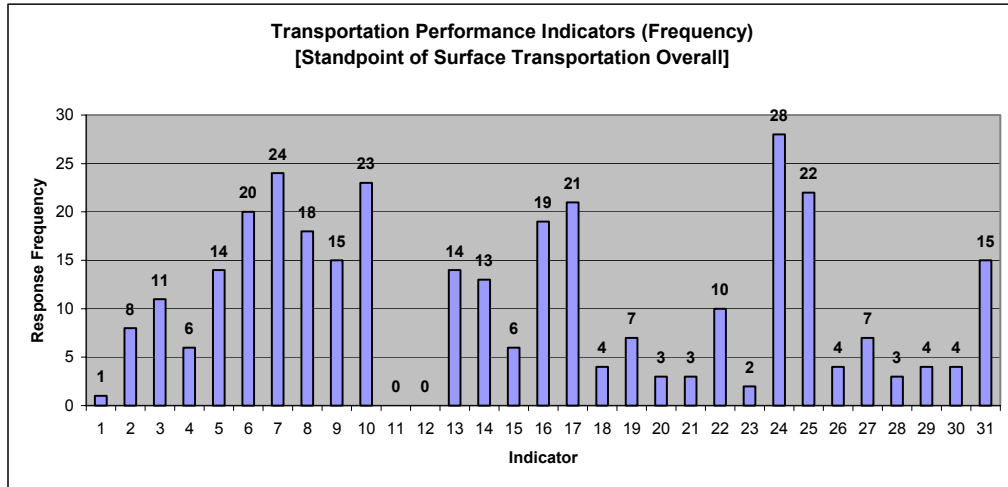


Figure 4-11 Survey Results–Transportation Performance Indicators: Standpoint of Surface Transportation Overall

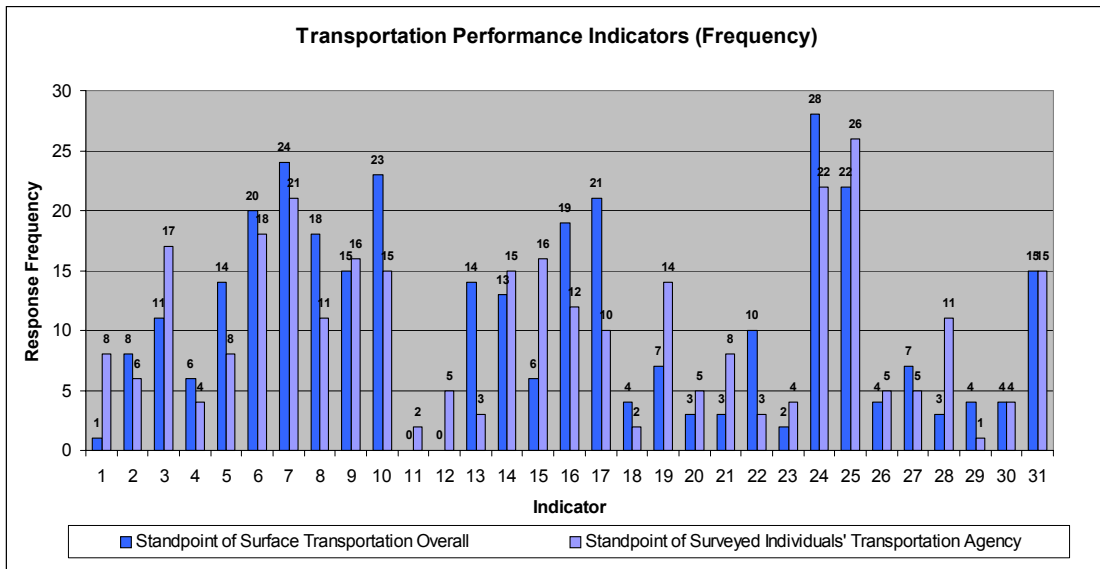
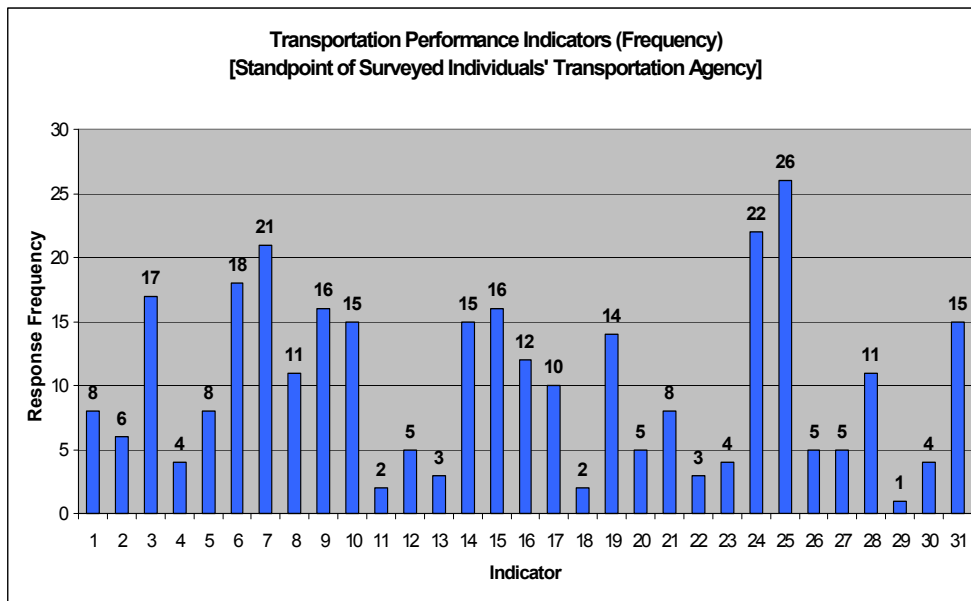


Figure 4-12 Survey Results–Transportation Performance Indicators Comparison

For questions 11-15, please list what you consider to be the five most important STIs from the standpoint of your transportation agency. Again, you do NOT need to rank the five indicators you choose. Use the list above.

Again, for each of the five indicators, please indicate your assessment of the ease of compiling and updating the data needed to calculate the STI on a regular basis using the following scale:

- Easy—data is routinely collected and available
- Moderately difficult—data could be collected and made available with some effort
- Difficult—data not available and a major effort would be needed to collect it



**Figure 4-13 Survey Results—Transportation Performance Indicators:
Standpoint of Surveyed Individuals' Transportation Agency**

Primary Function: Public Transportation Operations

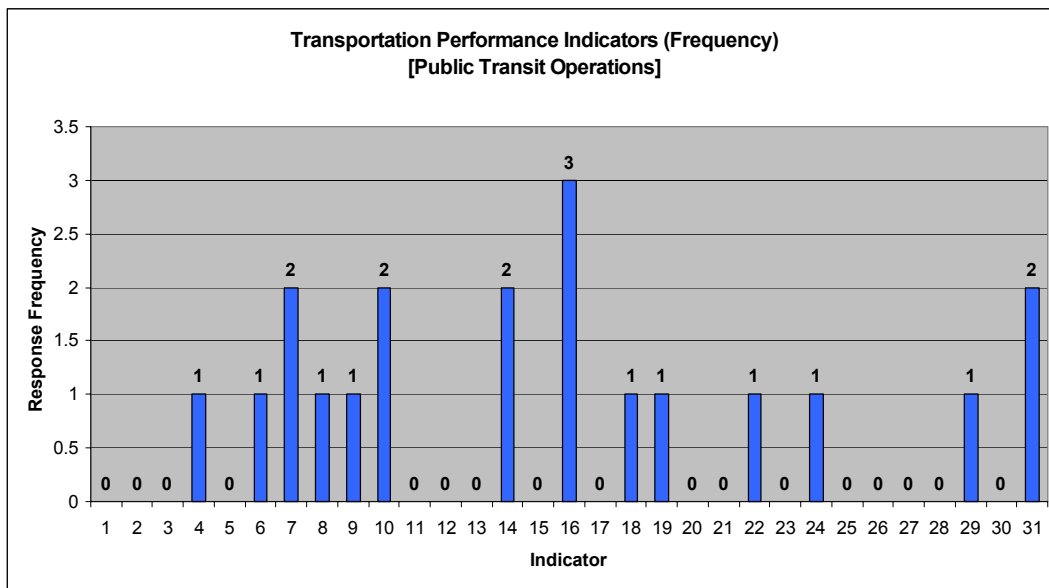


Figure 4-14 Survey Results–Transportation Performance Indicators: Public Transit Operations

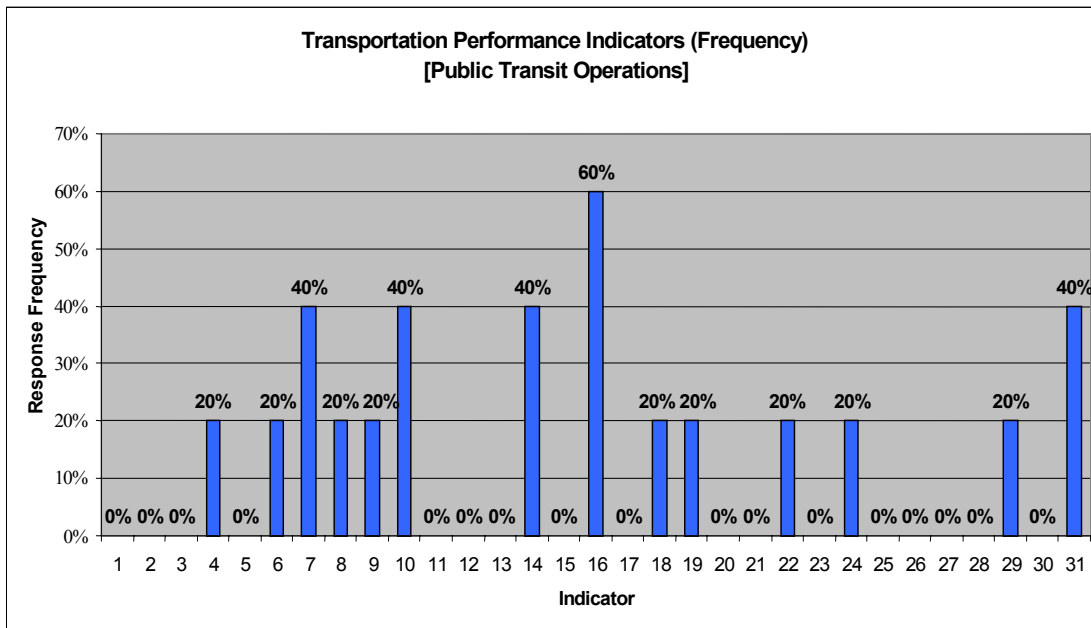


Figure 4-15 Survey Results–Transportation Performance Indicators: Public Transit Operations (%)

Primary Function: Street and Highway Management

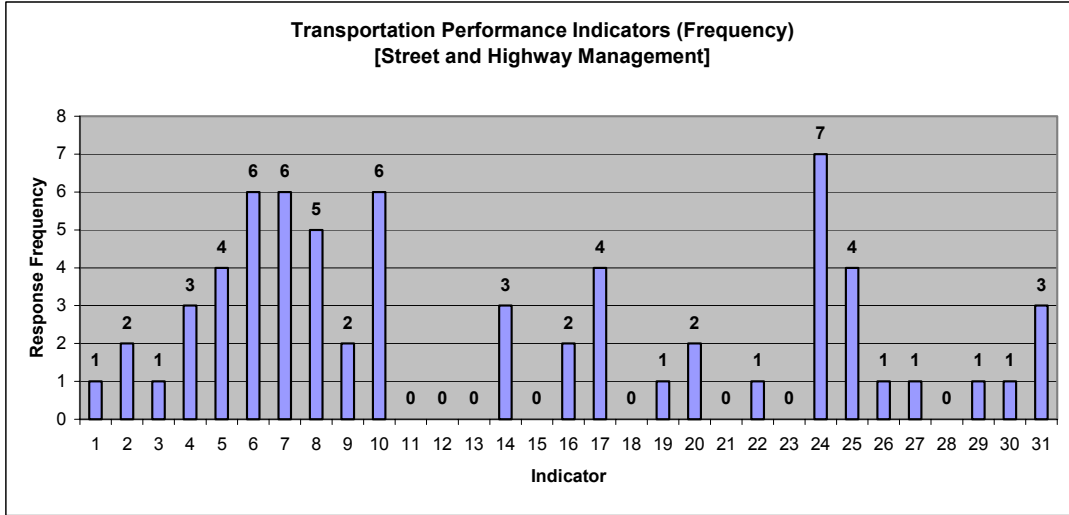


Figure 4-16 Survey Results–Transportation Performance Indicators: Street and Highway Management

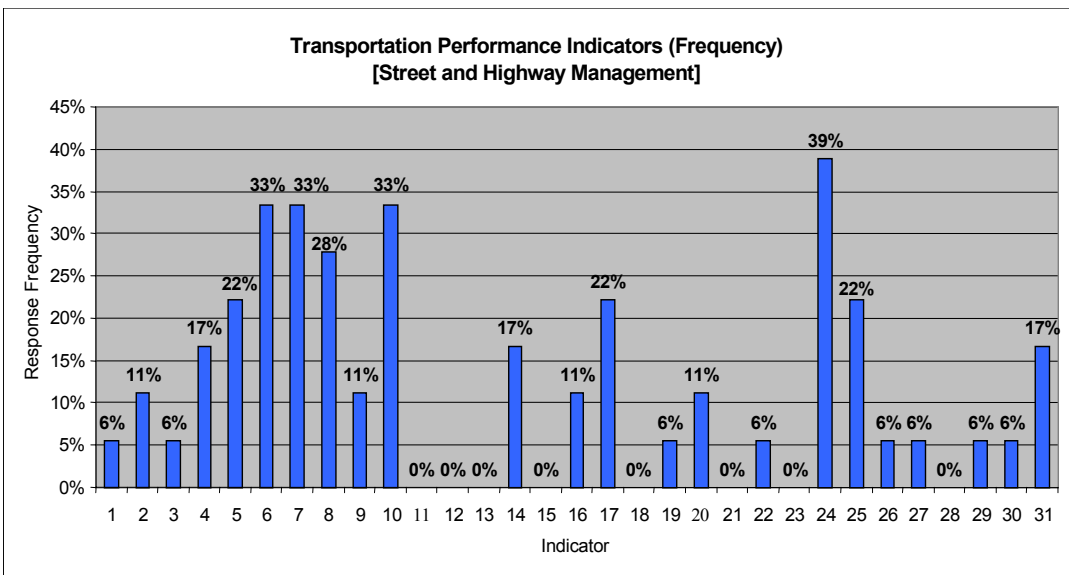


Figure 4-17 Survey Results–Transportation Performance Indicators: Street and Highway Management (%)

Primary Function: Transportation Consulting

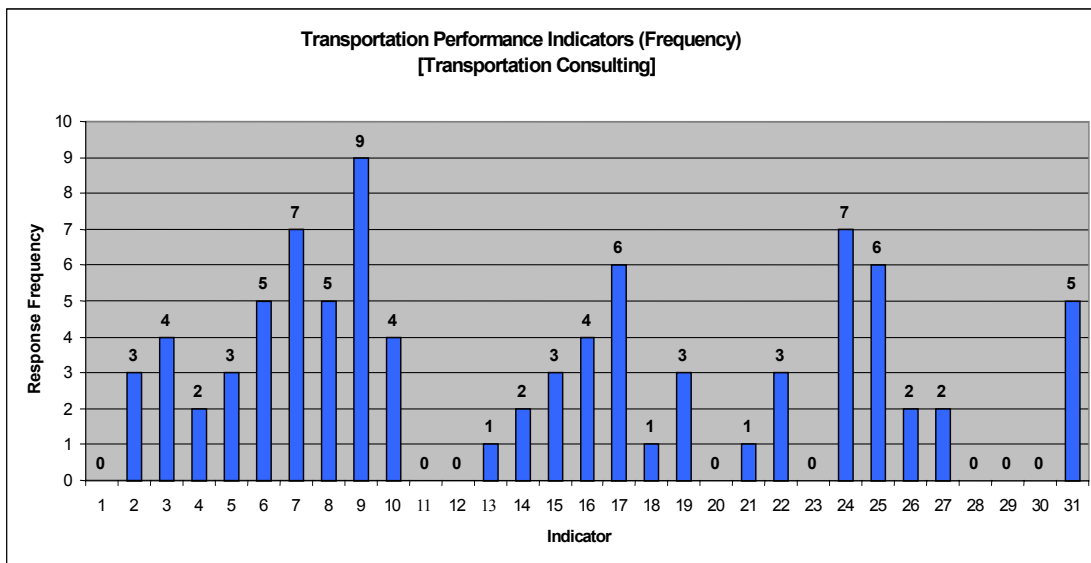


Figure 4-18 Survey Results–Transportation Performance Indicators: Transportation Consulting

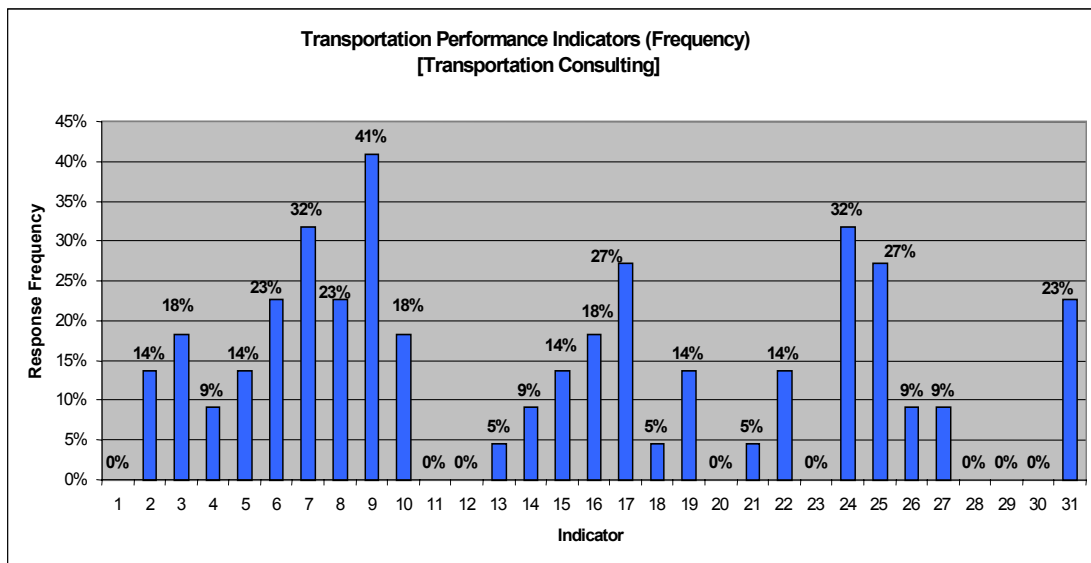


Figure 4-19 Survey Results–Transportation Performance Indicators: Transportation Consulting (%)

Primary Function: Transportation Planning Agency

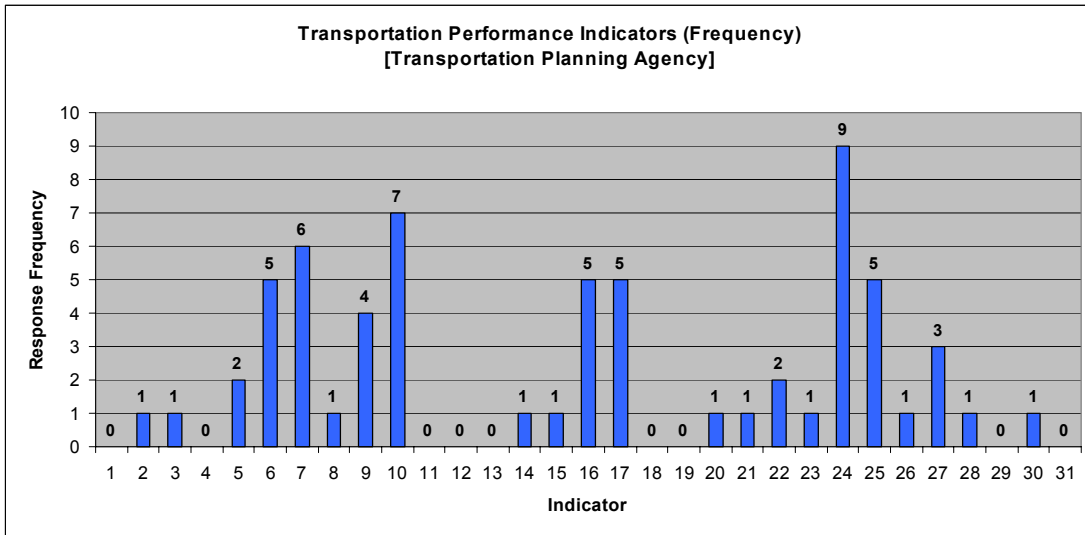


Figure 4-20 Survey Results–Transportation Performance Indicators: Transportation Planning Agency

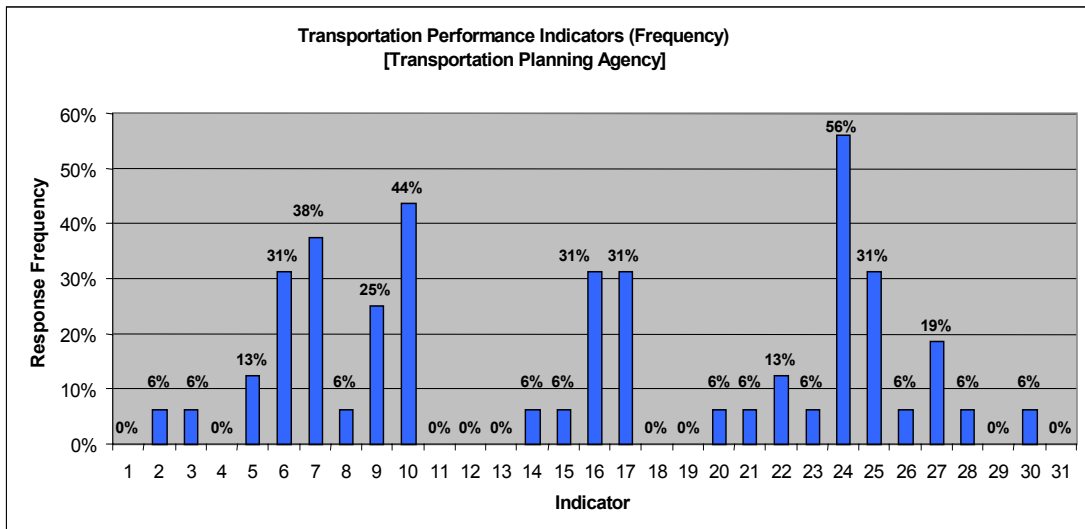


Figure 4-21 Survey Results–Transportation Performance Indicators: Transportation Planning Agency (%)

Primary Function: Other

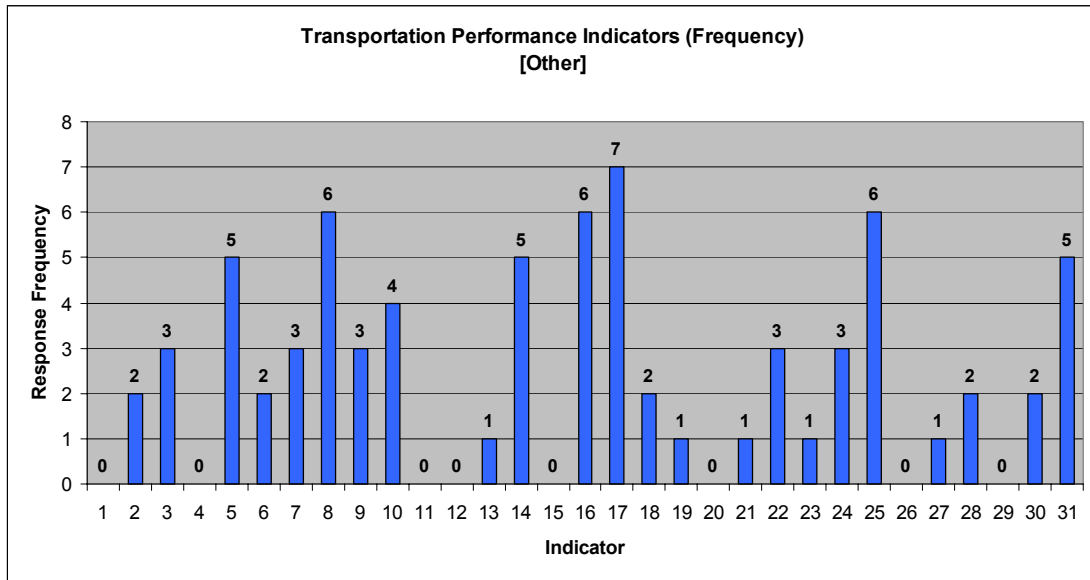


Figure 4-22 Survey Results–Transportation Performance Indicators: Other

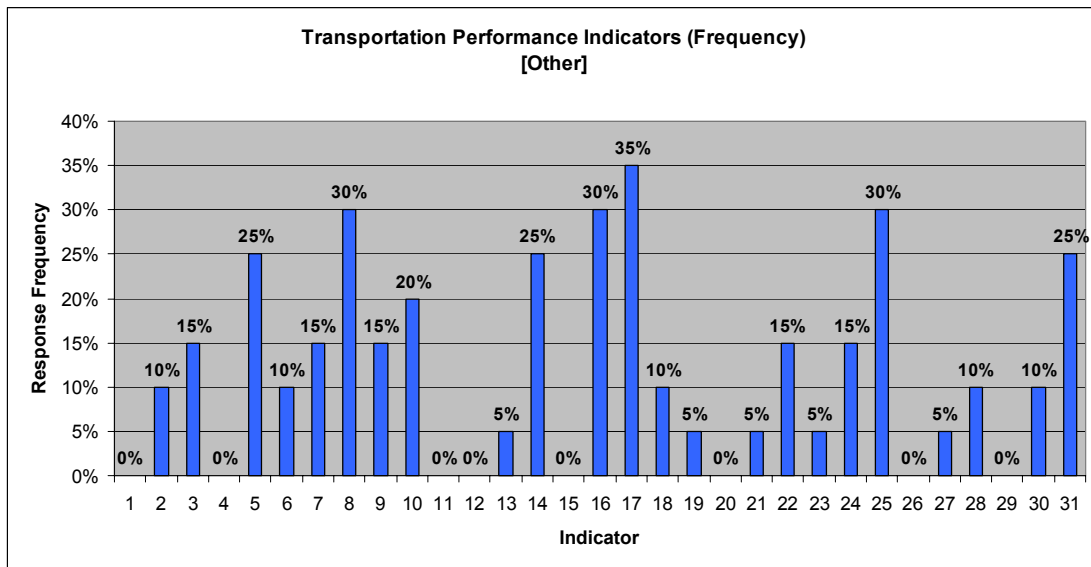


Figure 4-23 Survey Results–Transportation Performance Indicators: Other (%)

California-Based Agencies

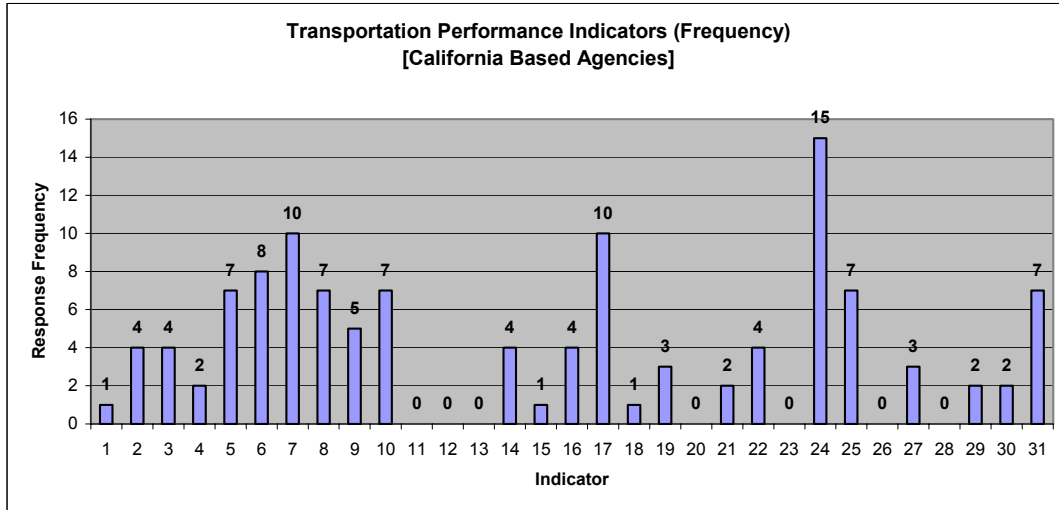


Figure 4-24 Survey Results–Transportation Performance Indicators: California-Based Agencies

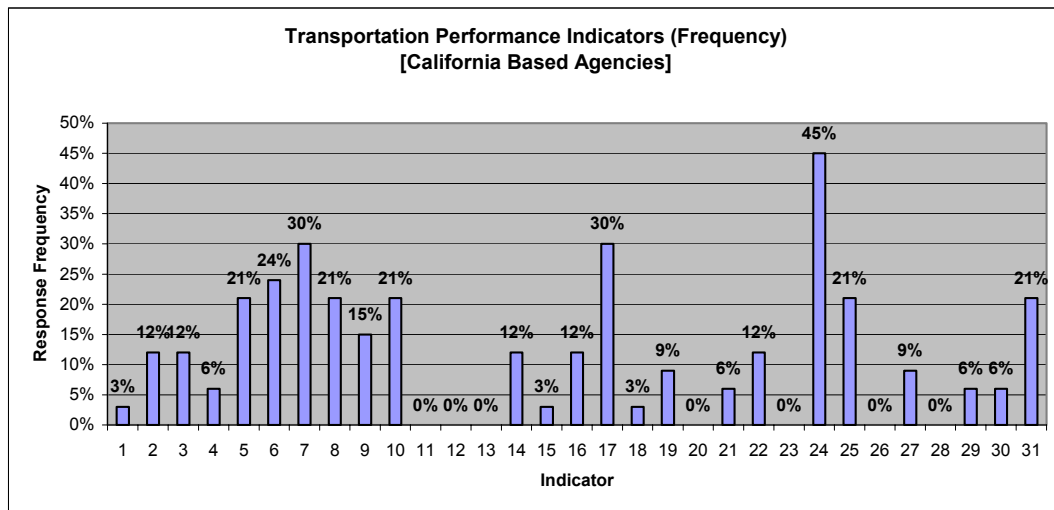


Figure 4-25 Survey Results–Transportation Performance Indicators: California-Based Agencies (%)

Nominations for Other Important Sustainable Transportation Indicators

The second to last question (question 16) invited agency directors and transportation professionals to nominate other important Sustainable Transportation Indicators. A total of 38 open-ended responses were made.

A. Costs

1. Medical and other costs related to all crashes/accidents, including bike, pedestrian, and motor vehicle
2. Cost of intra-urban freight movement (including emissions, time, dollars)
3. Life cycle: cost person delay – but assess delay for all users, not just vehicles
4. Actual cost of transportation mode including all subsidies both government and private to each mode; include road, gas, vehicle, environmental and other government subsidies; then show cost per mile
5. Cost Effectiveness and Capacities of Transit alternatives
6. Portion of auto environmental externality costs including carbon loading paid directly by users; portion of federal auto-related costs including military, tax incentives, and other subsidies paid directly by users
7. Sustainable local and state revenues for all transportation modes
8. Indicators that reveal the hidden costs of driving or transportation in general – parking, tolls, insurance, gas taxes, etc.

B. Modal Indicators

1. Trips saved by telecommuting
2. Number of trips that are on time for reliability
3. Availability of a Carshare Club
4. Capacity number per mode, like a seat-mile or something similar
5. Available options of sustainable transportation means for residents to take
6. Number of per capita trips per year on public transportation
7. Vehicle miles of travel per capita
8. Ability of the chosen mode of transport to carry larger loads, i.e. 6 bags of groceries, baby strollers; can be easy access to low-floor transit vehicles by persons using strollers, or grocery trolleys
9. Connectivity of modes
10. Number of inter-modal facilities; ability of pedestrians including persons w/disabilities to access transit stops/centers; and for them to get where they want to go by transit
11. Measure of route choice availability

C. Human Factors

1. Portion of residents within a one-quarter mile of direct transit service to the major employment areas (CBD, etc.)
2. Person capacity—assessing traditional intersection and roadway LOS in terms of their abilities to move people rather than cars (take into account vehicle occupancies and non-motorized users)
3. Crash rate and fatality rate (per population)
4. Efficiency of transportation operations and maintenance (cost per population)
5. Degree of peaking of traffic on roadways
6. The type of energy consumption (renewable or not), not just quantity
7. Road centerline miles per capita
8. Bike-pedestrian facility miles per capita
9. Barriers to physical activity such as biking and walking
10. Something about TDM program support
11. Use of raw materials for transportation facilities on a per capita basis
12. Land use, urban form, and density control may be included in the list; more intensive land uses by creating compact city; some development control allowing high densities land uses along and within the major corridor; encouraging mixed use and dual occupation
13. Do-ability: projects that can be completed in a timely fashion because they are able to meet current standards; land is easily obtained; permits for environmental controls easy etc.
14. "Feeling" of safety for pedestrians/bikes
15. Reducing Housing cost with parking Maximum and Car Sharing
16. Improving Transit through Phasing to a goal of Exclusive Transit way
17. Effects of TDM on change in travel habits; the roles played in travel choice by personal safety, traffic safety, and culture
18. Level of congestion and VMT
19. Walking routes to schools and the impact of school zones on traffic flow

Comments Regarding Sustainable Transportation Indicators

The final question (17) invited agency directors and transportation professionals to comment about Sustainability Transportation Indicators. A total of 17 responses were received.

1. "Difficult to say what indicators should be without reference to a community's objectives; indicators should reflect objectives, not be considered in isolation."
2. "They are the right approach, but it's difficult to determine which are the true measures; they should be somewhat aligned with agency/community objectives and incorporated into corporate/community report carding."
3. "Sounds heavily oriented toward the environment and certain interest groups, and less broad-based and less oriented toward what the public demand is."
4. "Our Transportation Element of the General Plan speaks about sustainability in terms of quality of life issues for neighborhoods; residential neighborhood impacts in terms of congestion/speeding and parking impacts seems to be of biggest concern to the average citizen."
5. "I put 'disagree' with importance of making ALL transportation modes environmentally sound, because you can get the same benefit by reducing the use of the mode that is environmentally unsound."
6. "There is a good deal of research that has already been done on STIs; what is needed now is a way to operationalize them, such as using GIS for ones with spatial elements."
7. "Transportation access allows urbanization; the indicators listed in this survey measure things like how "efficient" the transportation system is (saves traveler time, cost, etc.); also how 'efficient' the land use pattern is (more dense vs. less dense)."
8. "An Index-like indicator that summarizes all the cost incurred and benefits gained either from transportation investments or from a transportation activity per capita, would be useful for decision makers as well as for every resident."
9. "Most of the STIs you chose to offer as choices would require some type of household survey or specialized data gathering effort: things no agency could afford to do often enough to make them valuable statistics."
10. "Many of these are very moderately difficult to difficult to obtain; we need to find some real indicators that are easy to quantify."
11. "I have trouble with the 'social' aspect of these STIs; seems a very Canadian/European way of thinking; yes, we have social programs that help the lowest

economic people, but the U.S. seems to be moving away from these types of programs.”

12. “High-level STIs (that is, those used in discussions with elected officials and for public awareness purposes) should be as simple and concrete as possible (no abstruse abstractions); at the next level, they should be straightforward and mode specific.”
13. “Ease of transportation is important; if it is easier to take transit than to drive, the congestion on the highway or lack of parking contributes to the choice of transit and a more sustainable transportation system.”
14. “Something to consider for the definition of Sustainable Transport; it is designed and operated with the user in mind – and accounts for the interactions of the transportation infrastructure with users and the environment; it minimizes uncertainty.”
15. “It is interesting to see that other jurisdictions are trying to examine how best to prioritize the allocation of scarce resources in the Transportation area. Virginia DOT is currently examining an update to its 2020 Plan in co-operation with local jurisdictions.”
16. “As a retired traffic engineer I believe we pay too much attention towards congestion and its relief; congestion could mean viability and activity that we all desire; therefore, Sustainability should foster Pedestrian Friendly TODs.”
17. “I think all STIs are of equal importance, I would like to see most of them incorporated in the sustainability indicators.”

CASE STUDIES OF SUSTAINABLE TRANSPORTATION INDICATORS

THE CASE FOR CASE STUDIES

The survey was supplemented by telephone interviews with staff at transportation agencies in California where survey data and other intelligence revealed special interest in sustainable transportation indicators. These surveys were preparatory to the conduct of full case studies. The case studies were intended to flesh out the findings of the survey, the literature review, and provide more details about the origin and evolution of indicator programs and progress toward STI.

As noted in the previous sections, notions of sustainable transportation and corresponding indicators are still developing. While communities around the globe attempt in different ways to better integrate transport systems within the environments in which they are embedded and which they serve, no truly comprehensive model of sustainable transportation planning has yet emerged. Hence, there is a need for exploratory research, and for use of methods appropriate to such research. Case studies may be viewed as a *comprehensive* exploratory research technique. For Robert Yin “a case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between the phenomenon and the context are not clear.”³⁵ Robert Stake hits upon the fundamental rationale for case studies:

We study a case when it itself is of particular interest. We look for the detail of interaction with its contexts. Case study is the study of the particularity and complexity of a single case, coming to understand its activity within important circumstances.³⁶

The Selected Case Studies

Each of the case studies presented here entailed field visits to agencies that have successfully begun the implementation of sustainable transportation indicators. While the initial intent was to choose cases where exemplary performance indicators are in place, the surveys and interviews suggested that no California agency has fully implemented STIs. The case studies represent a variety of transportation agencies. An important purpose of these interviews was to identify factors that can enhance acceptance of sustainable transportation indicators.

Four case studies of key agencies within their agency and jurisdictional settings were conducted:

1. Santa Monica
2. San Francisco Bay Area (Oakland Focus)
3. San Luis Obispo City and Region
4. Switzerland

Each of the case studies is unique, and their uniqueness is one reason why the jurisdiction was selected. For example, Santa Monica is a California city that has been exemplary in developing sustainability programs for several years. The San Francisco Bay Area is a region of great urban diversity with a full range of transportation options. San Luis Obispo is a small city with relatively slow growth, but with its regional context it offers a full range of growth and planning issues.

Because of a dearth of fully developed STI programs in the U.S., a decision was made to examine a European case, Switzerland, for more mature STI programs. Switzerland has designed transportation programs along principles of sustainability at the federal and local governmental levels.

While each of the cases is unique, each illuminates the development of STIs. The discussion of the cases focuses on concepts and lessons that have real potential for successful application to other California local transportation agencies.

CASE STUDY: CITY OF SANTA MONICA

Santa Monica was selected as a case study because of the city's explicit and continued commitment to sustainable development and sustainability principles. This was highlighted from the perspective of comprehensive planning in an earlier MTI study.³⁷

Introduction

The city's commitment to sustainability began from inside their government structure, initially focusing on environmental programs and operational procedures that the city could directly implement. The Santa Monica Sustainable City Program has contributed to the ongoing update of two elements of the city's General Plan: Conservation and Circulation. When these two elements are adopted, the end result could be the evolution of a complete general plan update, element by element, over time. The Circulation Element update could then provide the long-term policy guidance for the current effort to establish an expanded sustainability indicators program for the city.

Santa Monica has been an important "beach community" in the Los Angeles basin since it was founded in 1875 (incorporated in 1886). The city's population is approximately 84,000. Although Santa Monica has been mostly built out since the 1950s, it has been experiencing significant in-fill and redevelopment in several commercial and industrial areas, while remaining a major residential suburb of the larger metropolitan region. Santa Monica's desire for sustainability is problematic given the regional, metropolitan context of the city. However, Santa Monica serves as a global leader in the evolving sustainability movement, especially at the local community level.

In 1992, the Task Force on the Environment was established by the city council in response to *Agenda 21*, the blueprint for creating sustainable communities, born out of the United Nations sponsored Rio Summit held the same year. The result of the work by the task force, city staff, and others was adoption of the Santa Monica Sustainable City

Program (SCP) by the city council in 1994. The SCP was envisioned “as a way to create the basis for a more sustainable way of life both locally and globally through the safeguarding and enhancing of our resources and by preventing harm to the natural environment and human health... that our impact on the natural environment must not jeopardize the prospects of future generations.”³⁸

Goals and Targets

The original SCP was based upon four main goal areas, including: Resource Conservation; Transportation; Pollution Prevention and Public Health Protection; and Community and Economic Development. Each contains a set of goals and targets. For example, Transportation includes the following goals:

1. Maximize the use of alternative forms of transportation, including walking, bicycling, public transit and carpools/ridesharing,
2. Develop innovative traffic policies that reduce negative impacts from vehicles,
3. Limit pavement area to the minimum necessary,
4. Implement work schedules that reduce the number of employee commute days,
5. Advocate for the regional development of public transportation systems.

Initial targets include increased ridership on the local bus system, and improved average vehicle ridership for all employers with more than 50 employees.

Previous Findings Compared

Implementation of the SCP requires assessment on how the city is doing in achieving the targets through the publication of periodic progress reports, which also contain sustainability indicators. Previous progress reports were issued in 1996 and 1999. The current “2002 Status Report” presents a number of findings for the previous decade, including:

1. Annual ridership on Santa Monica’s Big Blue Bus increased by 17 percent between 1990 and 2000. The Big Blue Bus was ranked the number one urban transit system in the United States in 1998 and 1999.
2. Average vehicle ridership for employees of companies in Santa Monica with more than 50 employees increased from 1.13 persons per vehicle in 1993 to 1.39 in 2000.
3. The percentage of city fleet vehicles operating on reduced emission fuels (natural gas and electricity) has increased from 10 percent in 1993 to 70 percent in 2000.³⁹

Other illustrative findings of interest provided by the 2002 Status Report, include:

1. The total percentage of solid waste diverted from the landfill has increased from 13.8 percent in 1990 to 55 percent in 2000.

2. Citywide water usage was reduced by 6.3 percent between 1990 and 2000.
3. Citywide greenhouse gas emissions were reduced by 5.2 percent between 1990 and 1997.
4. Santa Monica has developed one of the most successful and comprehensive environmentally-based preferable purchasing programs in the United States.
5. The number of publicly assisted affordable housing units in the city increased by 47 percent between 1990 and 1998.
6. Streetscape renovations to improve pedestrian safety and neighborhood quality are underway along Pico Boulevard.⁴⁰

Moreover, the Downtown Transit Mall is intended to enhance the city's transit and pedestrian experience, beautify downtown, and improve traffic flows along Broadway and Santa Monica Boulevard, among other objectives. Also, the Downtown Transit Mall provides a dedicated transit lane for buses, wider sidewalks, additional trees, and new street furnishings and lighting.

Updating the Santa Monica Sustainable City Program

The Santa Monica Sustainable City Program (SCP) has been undergoing a comprehensive update process during the past year, including revised goals, indicators, and targets. As part of the update process, the city created the Sustainable City Working Group (SCWG), which includes elected and appointed officials, representatives of the business community, community organizations, and city staff. The update expands the SCP goals and indicators, including revised indicator targets for 2010, which were developed by SCWG.

The SCP Update is supported by nine guiding principles to encourage “effective and sustainable decisions.”⁴¹ The existing and proposed guiding principles include these.

1. The concept of sustainability guides city policy.
2. Protection, preservation, and restoration of the natural environment is a high priority of the city.
3. Environmental quality, economic health, and social equity are mutually dependent.
4. All decisions have implications to the long-term sustainability of Santa Monica.
5. Community awareness, responsibility, participation and education are key elements of a sustainable community.
6. Santa Monica recognizes its linkage with the regional, national, and global community.
7. Those sustainability issues most important to the community will be addressed first, and the most cost-effective programs and policies will be selected.
8. The city is committed to procurement decisions which minimize negative environmental and social impacts.
9. Cross-sector partnerships are necessary to achieve sustainable goals.

Once adopted, the SCP will be implemented through an advisory Sustainable City Steering Committee (SCSC). The SCSC will include representatives from five City Council-appointed groups: Planning Commission, Housing Commission, Recreation and Parks Commission, Social Services Commission, and the Task Force on the Environment. Additional members from other community groups will be added over time. Additionally, there will be an interdepartmental Sustainable City Implementation Group, made up of City staff who will work together and provide support to the SCSC. Within one year after adoption of the SCP, the SCSC and staff Implementation Group will report to the City Council with a set of baseline indicators and implementation strategy. An indicators report will be updated every two years and presented to the City Council.

The update process began in July 2001. There were a series of community meetings held to receive recommendations for revising and creating new goals, indicators, and targets. In addition to the previous goal areas identified, four new areas include Economic Development, Open Space and Land Use, Civic Participation, and Human Dignity.

Transportation Goals

In terms of transportation, the proposed goals include:

1. Creation of a multi-modal transportation system that minimizes and, where possible, eliminates pollution and motor vehicle congestion while ensuring safe mobility and access for all without compromising our ability to protect public health and safety.
2. Facilitation of a reduction in automobile dependency in favor of affordable alternative, sustainable modes of travel.

Goals Related to Transportation

Goals for other areas related to transportation include:

1. Transformation of land use/transportation planning and policies to create compact, mixed-use projects, forming urban villages designed to maximize affordable housing and encourage walking, bicycling and the use of existing and future public transit systems (Open Space and Land Use).
2. Businesses, organizations and local government agencies within Santa Monica continue to increase the efficiency of their use of resources through the adoption of sustainable business practices (Economic Development).
3. Significant decrease in overall community consumption, specifically the consumption of non-local, non-renewable, non-recyclable, and non-recycled material, water, and energy and fuels (Resource Conservation).

Each set of goals is represented by specific indicators, including “System Level” indicators, measuring community-wide conditions, and “Program Level” indicators, measuring performance of specific city or other institutional policies. For example, the indicators related to the SCP transportation goals are represented by the Table 5-1.

Table 5-1 Santa Monica Sustainable City Program Indicators

System Level Indicators	Program Level Indicators
Modal split (number of trips by type) (link with Open Space/Land Use)	Annual ridership on Santa Monica Municipal Bus Lines (link with Open Space/Land Use)
Number or percent of residents who have taken utilitarian trips using sustainable forms of transportation (bus, walk, bike, etc.) in the past week (link with Open Space/Land Use)	Percent of City fleet vehicles using alternative fuels
Number or percent of residents who perceive that the city's alternative modes of transportation meet their needs (link with Open Space/Land Use)	Number of signalized intersections with unacceptable motor vehicle congestion (LOS D, E or F) during peak hours
Avg. number of vehicles per person (of driving age) by car type (i.e.; ZEV, SULEV, ULEV)	Number of bicycle and pedestrian collisions involving vehicles (link with Open Space/Land Use)
	Average emergency response times for public safety vehicles <ul style="list-style-type: none"> – Police – Fire
	Locally classified streets that exceed City thresholds for traffic level

Source: City of Santa Monica, Sustainable City Program Update: Public Review Draft (July 22, 2002)

Recognizing that many of the eight goals and 64 indicators represent several areas of sustainability, a Goal/Indicator Matrix has been prepared. The matrix demonstrates the linkages between the goals and indicators. For example, the 10 Transportation indicators represent 19 linkages to goals outside of Transportation, especially Open Space and Land Use, Economic Development, Environmental Health, and Resource Conservation.

The indicator portion of the SCP update is an important component, as represented by the fact that the city has contracted with Maureen Hart to prepare both the indicators and revised targets for 2010. Hart is one of the most respected and knowledgeable experts on sustainability indicators in the United States, and is one of the founders of the International Sustainability Indicators Network (ISIN), a rapidly growing organization of professionals, academics, and community leaders committed to the development and application of indicators. In an interview for this study, Hart stressed that indicators designed to merely shore up a report are a waste of time. She argued that indicators serve to raise awareness, inform decisions, or measure progress, but rarely do all three.⁴² Santa

Monica seems committed to the long-term development of an indicator framework that collectively does all three.

By December 2002, public review of the SCP update had been completed and was under final review by the city's Task Force on the Environment, which will forward the document to the city council for final action. The city council was expected to take final action in January 2003.

Interview with Dean Kubani

Dean Kubani is the Sustainable City Program Coordinator for Santa Monica. He is well known in the sustainability movement, from global to local levels. His commitment to sustainability is becoming legendary, but he emphasizes that the commitment to a sustainable Santa Monica is a community-wide effort.

Kubani credits the city's Task Force on the Environment for getting the SCP started and keeping it evolving. As a member of the city's Public Works Department, Kubani's job is to keep the fire of sustainability alive inside the senior staff of city government, among other city officials. Interestingly, Kubani credits Craig Perkins, the city Public Works Director, as a major contributing force in Santa Monica's sustainability effort. Both the community and the city council provide the support to keep sustainability a priority. According to Kubani, five of the seven city council members, including the mayor, are advocates of Santa Monica's sustainability movement.

As a matter of policy, the city encourages Kubani to work with other communities in exchanging ideas and experiences about sustainable communities. Numerous groups from around the globe visit Santa Monica to learn more about their programs; for more information, see <http://santa-monica.org/environment/policy>.

The city supports Kubani's active participation as a founding member of the International Sustainability Indicators Network (ISIN). (For more information about ISIN, see <http://www.sustainabilityindicators.org/news/News.html>).

Given his network, Kubani has been a significant contributor in providing information and contacts for this study. For example, one of the indicator efforts he most respects is that of Jacksonville, Florida, and the work of David Swain (for more information, see <http://www.jcci.org/qol/qol.htm>).

The Quality of Life in Jacksonville: Indicators for Progress 2001, published by Jacksonville Community Council, Inc., contains a number of sections, including "Mobility." Kubani observes that although Santa Monica's program is strongly supported by both the municipal government and the community, Jacksonville is challenged by the fact that support for sustainability indicators is coming from a community base outside of city government. The challenge for Jacksonville is influencing city policy to incorporate indicators into their political decision-making process.

In responding to how indicators can be used as a sustainability management system, Kubani's point is simple: connect indicators to the local government's budget process, based upon performance. Sustainability indicators can be part of the budgetary framework, especially if the city manager (or county administrative officer) is supportive. Indicators can help departments save money, in addition to improving a community's quality of life. Santa Monica's budgetary process has traditionally contained annual performance indicators for the various departments. Since the original adoption of the SCP a number of performance indicators have become sustainability oriented.

For example, the Environmental and Public Works Management Department has a number of budget performance measures, including graffiti removal, tons of catch-basin debris prevented from entering Santa Monica Bay, and percentage of vehicles operating on reduced emission fuels since adoption of the SCP. The department also may set a target of how many gallons of water will be saved during the next budget year, and may establish a target to reduce wastewater by 15% during a certain period of time. Although meeting such targets may not themselves generate current budgetary savings for the Department, achieving the targets ultimately could save the city \$9 million by eliminating the need to expand sewage treatment facilities.

Thus, indicators can be used both to monitor whether sustainability targets are achieved and, indirectly, how the city can save service costs. Through the budgetary process the city can encourage departments to achieve sustainability goals and targets through funding incentives and hold them accountable for achieving the defined targets; alternately, they may determine that more funding may be required to improve sustainability performance because the department does not have adequate resources to meet the targets. This would be especially true if a department had achieved positive results with limited funding, and it can be reasonably assured that increased funding would improve performance for a specific goal, indicator, and target.

It is important that department heads and city staff are informed, and or involved; they also need to be committed to the idea of indicators as an incentive and not a (threatening) stick. Initially in Santa Monica, most department heads were hesitant because they did not want to be measured by a framework they did not fully comprehend. Kubani points out that any program as unconventional as the SCP and its indicators must entail a long process of building professional relationships, based upon trust and mutual respect. After several years, city staff started to "get it" in terms of what the SCP was trying to accomplish. Fortunately, most departments were already collecting the information needed, so that progress toward indicators followed on quite rapidly. Kubani reports that the director of transportation management has been very cooperative in providing information critical to assessing the circulation needs of the city. Kubani's experience clearly indicates that it is critical to keep city departments informed and involved in the program.

Kubani also offers some basic observations about the merits of using descriptive and prescriptive indicators. Descriptive indicators are educational and can serve as a report card on the state of the community's quality of life. Descriptive indicators are valuable in

raising awareness, but may not serve as instruments of change in the long run. Kubani views prescriptive indicators as important connectors to policies and targets, and guide policy. Prescriptive indicators can be important tools for policy documents, such as the pending Circulation and Conservation element updates of the 1984 General Plan.

Regarding the role of national and state governments in promoting sustainability, Kubani suggests that it is vital to provide reliable data that is useful to local governments. Kubani also believes that third party (government or non-profit) certification for sustainable products would be invaluable. If local governments had dependable information, the purchasing of sustainable products and services would be simplified, and less expensive. If local governments (“community marketing”) knew which green businesses provided sustainable products and services, purchasing would be more efficient and economical.

Lessons Learned

This brief overview of Santa Monica’s efforts to achieve community sustainability barely touches the surface of their achievements and progress to date. Reflecting the commitment of the Task Force on the Environment, city staff, and city council, Sustainable City Program Coordinator Dean Kubani has represented Santa Monica with both enthusiasm and talent in promoting the city’s efforts to create a sustainable community.

As presented in a previous Mineta Transportation Institute study (*The California General Plan Process and Sustainable Transportation Planning*, MTI Report 01-18, Dr. Richard Lee), Santa Monica is demonstrating that the creation and application of sustainable principles can occur independent of the state-mandated General Plan process, though the pending Conservation and Circulation elements updates of the 1984 General Plan will add a formal plan framework.⁴³ Moreover, the city’s commitment to sustainability continues with the current efforts to update their Sustainable City Program, especially in the development and application of sustainability indicators.

It is unfortunate that the public review draft of the California General Plan Guidelines contains little toward the application of sustainable planning principles or indicators (see http://www.opr.ca.gov/localplanning/PDFs/GPG_2002.pdf). It appears that communities like Santa Monica, serving as “islands of sustainability,” will be providing the leadership as a “bottom up” example for other local governments to follow. Santa Monica and its commitment to sustainability and sustainable transportation can be characterized as *focused* and, at the risk of sounding redundant, *sustained*.

CASE STUDY: SAN FRANCISCO BAY AREA

Nine counties, 90 cities, and over seven million residents comprise the vast region of the San Francisco Bay Area.

Introduction

There have been several notable regional efforts to promote and implement sustainable development, the most recent and ambitious being the Smart Growth Strategy/Regional Livability Footprint Project, which:

...began in 1999, when the Bay Area's five regional agencies – those responsible for transportation planning, environmental protection and regional planning – came together to promote and nurture seeds of “smart growth” that were cropping up throughout the region. At the same time, the Bay Area Alliance for Sustainable Development, a coalition of 40 organizations representing business, the environment, social equity and government, embarked on an ambitious effort to develop public consensus and support for a “regional livability footprint”, that is, a preferred land-use pattern that could direct the Bay Area toward a more sustainable future.⁴⁴

The joint effort entailed thousands of hours of effort from a diverse set of elected officials other community leaders and planners, as well as more than 2,000 citizens who participated in planning workshops held throughout the Bay Area issued its final report in 2002. The final report notes that the Smart Growth Strategy/Regional Livability Footprint Project intends to be more than just a hypothetical planning exercise; it “aims to change the underlying fiscal and regulatory structure that is at the root of current growth patterns.” This implementation effort is only beginning, and the Smart Growth Strategy/Regional Livability Footprint Project promises to be a major force for local planning for sustainable urban development. Another move toward implementation began with the launch of a regional sustainability indicator report in January 2003, which includes two transportation indicators, commuter mode split and vehicle miles traveled.⁴⁵

Cognizant of this and other larger regional sustainability projects, the Bay Area case study team sought out noteworthy examples of movement toward STI in three types of transportation agencies with functions of interest in this study:

1. The Metropolitan Transportation Commission (MTC), the regional transportation planning agency (which plans and channels federal and state funds for all major transport infrastructure in the region; MTC was a partner in the Smart Growth Strategy/Regional Livability Footprint Project),
2. The Bay Area Rapid Transit District (BART, the most expansive transit system in the Bay Area, the transit agency providing the main alternative to auto use for longer trips in four counties: San Francisco, Alameda, Contra Costa, and San Mateo),
3. The City of Oakland Sustainable Development Initiative and its Public Works Department's Sustainable Design Guide.

The investigation entailed examination of important planning documents supplemented with interviews with key staff. While there is no comprehensive STI program in the Bay Area, there are ongoing and emergent transportation indicator programs that include STIs and otherwise address sustainable transportation issues.

MTC Documents Addressing Regional Transportation Indicators

Four MTC documents were studied, including:

1. *Statistical Summary of Bay Area Transit Operators: Fiscal Years 1995-96 Through 1999-2000*,
2. *2001 Regional Transportation Plan*,
3. *Final Environmental Impact Report for the 2001 Regional Transportation Plan*,
4. *Performance Measures Report for the 2001 Regional Transportation Plan for the San Francisco Bay Area*.

Statistical Summary of Bay Area Transit Operators

The first regional transportation indicator document examined (and the only document not directly related to MTC's Regional Transportation Plan) was the *Statistical Summary of Bay Area Transit Operators: Fiscal Years 1995-96 Through 1999-2000*, which is prepared by the Metropolitan Transportation Commission Programming and Allocations Sections. This publication is produced annually by the MTC and includes a summary of financial and operating information for the 16 largest public transit agencies in the nine-county San Francisco Bay Area. The publication is designed to allow quick access to in-depth information about the major transit operators. It includes the information most requested by transit operators, agencies, consultants, academic and industry researchers, elected officials, and professionals in government.

The data included are from reliable sources: a.) the audited figures from past fiscal years taken directly from the MTC Regional Reporting System, b.) the Federal Transit Administration National Transit Database Reports, or c.) from data obtained via direct correspondence with the transit agencies. The fact that the indicators reported are required by federal law means that other regions with multiple transit operators could create such a reporting mechanism fairly easily.

The report is a compact document (44 pages in the 2001 edition reviewed) and has other "user-friendly" attributes as well. It is available on-line at MTC's website (www.mtc.ca.gov). Another helpful aspect of the report is a page containing definitions and explanations of key transit terms and entities. Each of the 16 transit agencies is profiled, accompanied by a regional map showing each of the transit operators' routes. The operator profile consists of a basic one-page introduction to the agency, including the organization type, operational information, inter-operator coordination, and passenger breakdown by fare category or mode, and fare structure. Following each profile are tables that contain operator-specific financial and operating data for fiscal years 1995-96 through 1999-00, for each transit mode operated (including paratransit). All data is actual, audited data (no future estimates are given).

The performance measures reported are used by MTC and by the transit operators themselves to monitor progress toward their own and MTC's policy goals and objectives.

The formulas used to calculate the measure, and the underlying performance concepts are described.

The following six performance measurements are presented in detail:

1. Operating cost per revenue-vehicle hour, measuring cost efficiency,
2. Operating cost per passenger, measuring cost effectiveness,
3. Passengers per revenue-vehicle hour, measuring service effectiveness,
4. Passengers per revenue-vehicle mile, measuring service effectiveness,
5. Revenue-vehicle hours per employee, measuring labor efficiency,
6. Ratio of fares received to total operating cost (farebox recovery) measuring cost efficiency.

In sum, the document represents an excellent reporting format for transit indicators. Although the indicators are focused on economic variables and do not cover the full range of sustainability issues, the format could easily be expanded to cover environmental and social equity indicators.

The MTC Regional Transportation Plan

The team also examined the MTC Regional Transportation Plan (RTP). Regional Transportation Plans are the fundamental long range (20-25 year) plans for California's metropolitan regions (since the advent of ISTEA in 1991). The RTP represents the transportation policy and action statement of the Metropolitan Transportation Commission for how to approach the region's transportation needs over the next 25 years. MTC is required by law to update the RTP at least every three years using the latest projection of population and employment growth and estimates of future transportation funding levels. Specifically, the team reviewed the *2001 Regional Transportation Plan* and the associated *Final Environmental Impact Report*.⁴⁶

The RTP Environmental Impact Report (EIR), which is mandated by both federal and state law, focuses primarily on regional impacts, but it also addresses transportation corridor impacts for a number of the environmental impact areas. This approach reflects the organization of the 2001 RTP, which presents information and transportation investments in a corridor format. MTC has defined 15 multi-modal travel corridors in the 2001 RTP in recognition of their primacy as determinants of regional travel patterns. As a program level EIR, individual project impacts are not addressed unless they are found to be regionally significant.

The Regional Transportation Plan Environmental Impact Report identifies three types of impacts:

1. Short-term impacts,
2. Long-term impacts,
3. Cumulative impacts.

Indicators

The following list of impacts and their corresponding mitigation measures were compiled for this EIR, and their respective significance after mitigation is reported:

1. Transportation impacts (average travel time, auto accessibility to jobs, increases in vehicle miles traveled and changes in Level of Service, etc.),
2. Air Quality (emissions impacts for CO, ROG, and NOx),
3. Energy consumption,
4. Geology and Seismicity (Seismic events),
5. Biological Resources (wetlands, aquatic resources, sensitive communities),
6. Water Resources (water quality, drainage patterns),
7. Visual Resources (affecting rural/open space areas, blocking views),
8. Noise (noise impact on surrounding areas),
9. Cultural resources (historic preservation),
10. Population, housing and social environment (residential and business displacement or relocation, disruption or division of a community and its facilities),
11. Land Use (conversion of resource lands, including prime agricultural lands, mines).

The environmental assessment of the proposed 2001 RTP is measured against, or fulfills the requirements of the California Environmental Quality Act (CEQA). In accordance with CEQA, the 2001 RTP EIR identifies regional effects of the implementation of projects, which could follow adoption of the 2001 RTP. The assessment of future travel activity and use of the transportation system are based on the most recent land use assumptions and growth projections of the Association of Bay Area Governments (ABAG).

Rationale for Indicator

These are based solely on the requirements of CEQA and the expectations of reviewers of the RTP; it is designed to inform decision-makers, responsible and trustee agencies, and the general public of the proposed 2001 RTP and the range of potential environmental impacts that could result from its implementation.

In short, the RTP and its EIR address many aspects of sustainability. Both documents are regularly updated, though not annually (the RTP is generally updated every two to three years). The RTP EIR is limited to reporting indicators of environmental impacts as required under CEQA. However, with the 2001 RTP, a companion report was developed which potentially represents a substantial first step toward making the RTP process a true Sustainable Transportation Indicators program.

Performance Measures Report for the 2001 Regional Transportation Plan

Unlike the RTP EIR, the *Performance Measures Report for the 2001 Regional Transportation Plan for the San Francisco Bay Area* is a new feature of the 2001 Regional Transportation Plan. In this publication, MTC pursues the development of performance measures with three purposes in mind:

1. To define quantifiable performance measures for long range transportation planning,
2. To test the efficacy of the measures by analyzing three alternative long-term transportation investment strategies described in the RTP Draft Environmental Impact Report (DEIR),
3. To develop suggestions for improving the use of performance measures in future RTPs.

MTC states in this report that it has shifted its emphasis in measures of performance to measure and reflect on “outcomes” versus “outputs” (i.e., the number of new lane miles of roadway provided is an output, whereas the travel time savings for the customer is an outcome). The emphasis is now more customer-oriented, as well as a more holistic view of the system.

The Performance Measures Report is organized into four chapters.

1. Chapter One provides an overview of the RTP and the process used to develop the RTP performance measures.
2. Chapter Two provides general descriptions of the measures themselves.
3. Chapter Three summarizes the results of the performance analysis; the report notes that subsequent work may be needed to revise or refine the measures.
4. Chapter Four provides observations and suggestions for consideration in future work.

There are also several appendices: Appendix A contains tables showing the detailed results of the analysis for all measures in the report.

Stakeholders' Objectives

A Working Group of stakeholders, representing environmental and business interests as well as transportation specialists, met six times in early 2001 to begin the development of the indicators. The Working Group defined the following objectives:

- Steer investment decisions to optimize transportation results, equity, and protection of the environment
- Steer decisions to efficient transportation and enhanced livability while minimizing pollution and habitat loss

The Working Group also described six desirable characteristics of measures or indicators.

1. Measures should incorporate economic valuation.
2. Individual measures should support multiple goals.

3. Measures should apply to management of both supply and demand.
4. Measures should look at access and choice, not just corridor mobility.
5. A variety of measures are needed to reflect diversity of Bay Area.
6. Avoid ambiguous measures.

Ultimately, the goals of the RTP were the basis of the performance measures selected for testing. The 2001 RTP identifies six broad goals; these goals, and their corresponding performance measures, are listed below. Italicized performance measures are similar to STIs identified in previous chapters.

1. Mobility of people and freight. Associated performance measures are:
 - a. Travel time: aggregate travel time and travel time distribution (average, median, and 90th percentile travel times) between selected geographic origins and destinations,
 - b. Accessibility to jobs and shopping opportunities.
2. Safety. Performance measure: no measures are included. The report concludes that it is difficult to assess impacts of future RTP investments on safety for different travel modes given available modeling tools.
3. Economic Vitality. Performance measures are:
 - a. Accessibility of region's workforce to employers,
 - b. Economic efficiency of transportation investments (value of travel time as well as user costs and public expenditures).
4. Community Vitality. Performance measures are:
 - a. Population and employment within walking distance of transit intermodal/rail stations,
 - b. Use of walking to access transit.
5. The Environment. Performance measure is: air quality and global warming – vehicle emissions.
6. Equity. Performance measures are a comparison of changes in:
 - a. Travel time (aggregate, median, 90th percentile),
 - b. Accessibility to jobs,
 - c. Transit travel time from target communities to major job centers for low-income and minority communities relative to other communities.

While performance measures were devised for all six goals, in this initial document only the measures for two goals were actually evaluated: Goal 1) mobility of people and freight, and Goal 3) economic vitality made the short list of RTP goals identified for measurement via indicators.

For “Mobility of people and freight” the performance measures are: accessibility to shopping opportunities based on a threshold number of retail jobs; and person trips in the peak period. For “Economic Vitality,” the performance measures are: economic efficiency measured as net discounted benefits, accounting for the value of travel time as well as user costs and public expenditures; and the inclusion of safety and air quality costs and benefits in the calculation above (to be conducted by interested Working Group members).

Overall, the MTC RTP Indicator initiative is a very encouraging, if preliminary, development. All of the indicators investigated by MTC and the indicator Working Group depend upon computer-based transportation modeling for measurement. This limitation has its merit in that there is a common data base for all indicators; it is problematic in that not all indicators can be reliably modeled.

Similarly, the new emphasis on customer-orientation is also positive, yet somewhat ambiguous from the standpoint of sustainability. Customers are likely to be more concerned with having their personal travel needs met than they are with larger environmental, economic and social issues. Ultimately, the issue becomes one of an expanded notion of the customer, in order for transportation to include all who bear its costs and effects, not just travelers. Customer education—i.e., making travelers more aware of the costs and impacts of their travel choices—also looms as a need.

State Mandated Transportation Performance Measurement (Senate Bill 1492)

Senate Bill 1492 was passed and signed by the governor in September 2002. This legislation requires MTC to establish performance measurement criteria for the purpose of evaluating transportation *projects* for inclusion in the 2004 regional transportation plan (RTP). This is a change from the previous practice of evaluating the RTP as a whole.

Specifically, this new law:

1. Requires the establishment of project and corridor level performance measurement criteria by no later than July 1, 2003 to evaluate all new transportation projects and programs as "Track One" investments in the 2002 RTP.
2. Specifies that the performance measures shall apply to proposed projects, and the impact those projects will have on their respective corridors.
3. Directs that the performance measurements be utilized to evaluate and prioritize alternative transportation investments in order to meet the goals and objectives for each corridor in the 2004 RTP.
4. Directs that goals and measurable objectives be adopted for planning delineated corridors and sub-corridors, provided that they are compatible and consistent with the performance measures as described in item 3, above.

5. Provides that any costs associated with this measure shall be paid solely from the existing share of funds that are available for regional planning and programming. (MTC is authorized to use up to 3 percent of local sales tax revenues for transportation planning and programming purposes.)

According to the Senate Appropriations Committee Analysis, this measure would likely result in local costs of \$100,000 to MTC for establishing performance criteria and goals.

Interestingly, elements of this bill are very similar to SB 473 (also sponsored by Senator Don Perata), which previously was approved by the legislature, but ultimately vetoed by the governor. In addition to performance measures, SB 473 would have required MTC to adopt a master plan for commuter rail corridors and express bus service, and several other tasks. The governor's veto message highlighted concerns regarding mandated state costs associated with the tasks established by the bill.

MTC staff interviewed for this study expressed the same concern; while corridor and project level indicators are desirable in theory, the fact that this is an unfunded mandate undercuts the level of effort that can be put into the development and implementation of the new indicators. As of December 2002, the specifics of these new indicators were yet to be determined. MTC staff were planning to include the newly required corridor and project evaluations in the 2004 RTP so that system, corridor and project level indicators will all be contained in a single document.

BART Documents Addressing Transit System Indicators

The Bay Area Rapid Transit District is the most expansive transit system in the San Francisco Bay Area in terms of its service area. It provides long-haul rail service to four central Bay Area counties (San Francisco, Alameda, Contra Costa, and San Mateo). It is governed by a nine-member board of directors elected by districts.

BART currently has 95 miles of rail lines in four Bay Area counties. BART has 39 stations (12 surface, 13 aerial and 14 subway stations including four combination BART and MUNI Metro stations in downtown San Francisco). An 8.7-mile, four station extension to San Francisco International Airport and Millbrae opened in 2003. The Millbrae station gives BART a direct interface with Caltrain commuter rail service; BART already has direct connections to most other Bay Area transit operators. BART thus may be considered the backbone of regional transit in the region. BART also provides parking (generally) free of charge at many stations. The total number of parking spaces provided system wide is 42,230.

On the basis of discussions with staff at BART and MTC, two major documents were selected for this analysis of BART's use of indicators. These documents are:

1. *San Francisco/Bay Area Rapid Transit: Annual Report (2001)*,
2. *The San Francisco/Bay Area Rapid Transit: Strategic Plan (1999)*.

BART 2001 Annual Report

This document is approximately 24 pages long and contains the following sub-reports:

1. Message from the General Manager of BART,
2. Letter from Pricewaterhouse Coopers LLP (outside auditors),
3. Balance Sheet,
4. Revenues & Expenses,
5. Changes in Fund Equity,
6. Cash Flows,
7. Notes to Financial Statements,
8. Sources & Uses of Operating & Capital Funds,
9. Performance Highlights,
10. Average Weekday Trips & On-Time Performance.

BART Annual Report Methodology

The methods applied in this document pertain specifically to the outside auditor's evaluation and accounting methods for balance sheets, related statements of revenues and expenses, statements in changes in fund equity, and statements of cash flows in all material respects for the purpose of determining the financial position of BART.

The financial statements compare year-ends of June 30, 2000 with June 30, 2001.

1. Assets: total assets were compared, year-to-year (with assets increased for year-end 2001).
2. Liabilities and Fund Equity: total liabilities and fund equity were compared, year-to-year (with an increase for year-end 2001).
3. Revenues and Expenses were compared, year-to-year (with a significant increase for year-end 2001).
4. Changes in Fund Equity were compared, year-to-year (with an increase in total fund equity for year-end 2001).
5. Cash Flow Statements were compared, year-to-year (with an increase in cash and cash equivalents, end of year 2001).

Indicators Presented in the BART Annual Report

Indicators pertain to "Sources and Uses of Operating Funds" for fiscal year 2001: Sources of funds include: passenger fares (49.5 percent), transactions and use sales tax (33.31 percent), property tax (3.95 percent) and other (investment income, operating revenue). Uses of funds include: maintenance (31.42 percent), transportation (23.31 percent),

general and administrative (20.96 percent), police services (5.8 percent), and other (capital designation, construction & engineering).

Indicators also pertain to sources and uses of capital funds; sources of funds include: federal (49.95 percent), local (3.77 percent), state (3.9 percent) and district (42.38 percent). Uses of funds (expenditures) include: construction (67.57 percent), equipment (30.49 percent), studies & other (1.94 percent).

The chosen indicators are financial. As in most audit-based corporate annual reports, the indicators pertain to financial conditions and factors of the BART system. Interviews also discerned that financial indicators are indicators that most concern BART senior staff and BART directors.

The report does include other indicators in the section titled “Performance Highlights for Fiscal Year 2001 vs. 2000.” These highlights are categorized as: Rail Ridership (broken down into nine sub-categories: annual passenger trips, average weekday trips, average trip length, annual passenger miles, daily train on-time performance, system utilization, end of period ratios: peak patronage and off-peak patronage); Operations (broken down into three sub-categories: annual revenue car miles, passenger accidents/million passenger trips, passenger crimes/million passenger trips); and Financial (broken down into nine sub-categories: net passenger revenue, other operating revenue (excluding net change in fair value of investments), total operating revenue, net operating expense (excluding depreciation), system farebox ratio (net passenger revenue/net operating expense), net rail passenger revenue/passenger mile, rail operating cost/passenger mile, net average rail passenger fare including FastPass.

Two graphics are presented to show: a.) On-Time Performance on a monthly basis for Fiscal Year 2000 versus Fiscal Year 2001, and b.) Average Weekday Trips on a monthly basis for Fiscal Year 2000 versus Fiscal Year 2001.

The Bay Area Rapid Transit Strategic Plan

In 1996, BART’s Board of Directors launched an effort to develop a new strategic plan to guide BART into the 21st century. Development of this plan included data analysis, assessment of past trends and future projections, and considerable input from BART’s stakeholders including employees and customers. This plan was ratified and adopted by the Board in 1999. The document is relatively compact (approximately 40 pages) and contains the following sections:

1. Message from the BART Board of Directors,
2. Background,
3. Organization Mission & Vision,
4. Strategy Focus Areas:
 - a. The BART Customer Experience,
 - b. Building Partnerships for Support,

- c. Transit Travel Demand,
- d. Land use and Quality of Life,
- e. People of BART,
- f. Physical Infrastructure,
- g. Financial Health.

BART looked at indicators and issues including a fast-growing need for system rehabilitation, shifts in regional growth patterns that affect transit priorities, changing customer expectations, and new funding dynamics. The BART plan focuses on seven key issues (listed in the following underlined headings) and identifies goals, objectives, and strategies for achieving results in each area.

BART Customer Experience–Goals/Objectives:

1. Improve customer satisfaction by maintaining performance standards and providing quality customer service. Objective: continue measuring and improving customer satisfaction with BART services (through surveys); continue measuring and improving on core service attributes.
2. Maximize regional transit access, convenience, and ease of use through effective coordination among transit providers. Objective: improve customers' rating of "timeliness of bus connections;" improve intermodal transit time competitiveness relative to the automobile for trips that serve major destinations; increase transit ridership and revenue by increasing convenience; develop proactive, productive partnerships with at least one or two other transit providers per year to integrate fares, schedules, services, and information.

Building Partnerships for Support–Goals/Objectives:

1. BART will be viewed by stakeholders as a credible, trustworthy steward of the system, focused on improving value to riders and communities. Objective: regular, periodic customer surveys; taxpayer votes for endorsing BART initiatives; ratio of positive to negative customer feedback will improve regarding BART services.
2. BART will encourage and consider public input as integral to sound, balanced policy development and decision-making, and make deliberate, disciplined decisions in the best interests of the people it serves. Objective: have in place decision-making process that obtains public feedback about pending key decisions; establish criteria for defining adequate public input for board policy development and review–focus groups, customer forums; actively communicate with riders and residents about key BART decisions and initiatives.
3. Bay Area residents will value and take pride in BART as an integral part of their communities. Objective: assess the degree to which the public values and takes pride

in BART as an integral part of their communities through a survey-based measurement system to track public opinion over time and set measurable goals against which to gauge progress.

4. Key elected officials, opinion leaders, and decision makers will understand and actively support transit needs and initiatives. Objective: BART will be sought out to participate in regional decision-making forums; voters will endorse transit initiatives; legislators will sponsor and support transit initiatives.

Transit Travel Demand–Goals/Objectives:

1. BART will work to understand changing transit demand patterns and be prepared to respond to them, and will work proactively to influence travel demand trends in the region that support transit ridership. Objective: produce biennial reports on the requirements of new and changing market dynamics to better understand the potential impacts of: a.) major public infrastructure investments and b.) transportation pricing policies—by tracking regional growth and activity patterns to identify existing and emerging markets that could be served by BART; track major infrastructure investments and determine those investments that best support public transit.
2. Optimize the use of existing capacity. Objective: increase off-peak, reverse commute, and intra-suburban travel by improving physical and institutional linkages to concentrations of employment or other activities and increasing rider awareness of off-peak, etc. destinations.
3. Encourage and facilitate improved access to and from BART stations by all modes. Objective: achieve a 10 percent shift in access mode splits, reducing the percentage of parked single-occupancy vehicles, relative to access by all other modes, by the year 2002; maintain station throughput capacity to meet growth of demand.

Land Use and Quality of Life–Goals/Objectives:

BART will close gaps in regional rail services between major populations and employment centers and/or corridors. Objectives: in conjunction with development of the MTC's RTP, at least once every four years identify corridors with the most significant transportation needs and establish partnerships to develop consensus on major transit investments, such as BART or other rail, busways, etc.; within the first two years, identify one or two key corridors, and establish partnerships among the respective key agencies and decision-makers to achieve consensus regarding rail service enhancement strategies.

1. In partnership with the communities it serves, BART's properties will be used in ways that first *maximize transit ridership* and then *balance transit-oriented development goals with community desires* [emphasis added]. Objectives: coordinate comprehensive planning and assessment of transit-oriented development at BART stations in concert with local communities; develop and implement a support structure to ensure that all new development at BART stations be transit-oriented.

2. In partnership with the communities BART serves, promote transit ridership and enhance the quality of life by encouraging and supporting transit-oriented development within walking distance of BART stations. Objectives: coordinate comprehensive planning and assessment of transit-oriented development around BART stations in concert with local communities; develop and implement a support structure to enable BART to advocate and educate for transit-oriented development near BART stations; establish an approach for BART station area planning to connect with planning efforts in local communities adjacent to BART.

People of BART–Goals/Objectives:

1. BART will create a welcoming and supportive working environment for all employees. Objectives: develop and establish performance measures, including: job satisfaction, attendance, and knowledge of organizational values; BART’s workforce will reflect the diversity of communities within service area; have a mechanism in place to facilitate ongoing dialogue within the organization, through annual employee surveys which include tracking of job satisfaction; employee training and orientation, etc.
2. BART will have an organizational culture that respects, values, and empowers employees and puts customers first, and will seek to improve working relationships within BART and between BART and the people and communities it serves. Objectives: mechanisms in place that give each employee tools and information needed; establish benchmarks.
3. Attract, train, retain and provide job enrichment and career growth to a dedicated and competent workforce. Objectives: have education and development plan in place for each employee; have specific benchmarks in place to measure employee satisfaction.

Physical Infrastructure–Goals/Objectives:

1. Make annual investments in maintenance and repair of physical infrastructure sufficient to support safety, cleanliness, reliability, train performance, and customer friendliness. Objectives: establish yearly performance goals that measure service delivery, reliability, and cleanliness of BART’s physical plant and support systems; confirm that performance goals reflect customer service satisfaction measured by the customer service survey.
2. Meet demands of BART customers and assure the long-term viability of BART by continuously re-investing in aging infrastructure so as to maintain its functional value. Objectives: develop sound fiscal programs to replace, renovate, and modernize the existing plant, systems, and rolling stock; update annually, an infrastructure investment program to address: seismic upgrade of all BART owned structures, revenue vehicle rehabilitation, systems upgrades, station rehabilitation, and support facilities expansion; yearly re-evaluation of Capital Improvement Plan, based upon District needs and funding allocations.

3. Insure that infrastructure and maintenance capacity supports the planned level of service. At the same time, provide the infrastructure flexibility to support the planned level of service. Objectives: periodically analyze the levels of service quality to be maintained and balance with planned expansion; identify and annually evaluate and prioritize flexibility improvements that will uphold service quality while demand increases – determine system operational flexibility needs, standards and priorities and incorporate a system flexibility assessment in all financial planning; develop the cost benefit analyses needed to support operational flexibility.

Financial Health–Goals/Objectives:

1. BART will remain a transit service that is competitive in terms of value (i.e., quality for price) for the people served by BART. Objectives: increase the number of people who perceive BART to be a good value for their money to 60 percent of customer satisfaction survey respondents; hold the annual increase in operating costs per passenger mile at or below the rate of inflation.
2. BART will maintain and improve the stability of its financial base. Objectives: maintain the operating ratio at or above 60 percent; preserve existing dedicated funding sources; maintain prudent reserves.
3. BART will work with regional transit partners to advocate for funding needed first to sustain existing transit services and infrastructure reinvestment, and then to pursue prudent expansion. Objectives: preserve and expand the amount of funding available in the region to sustain existing levels of transit service and infrastructure reinvestment; obtain new funding for prudent expansion of transit service within the region.
4. BART’s financial choices will be guided by prudent fiscal policies and reliable, useful revenue and expense forecasts and plans. Objectives: maintain and improve BART’s credit rating to minimize borrowing costs and maintain its reputation for sound fiscal management.

These indicators are intended to reflect BART’s mission and vision: to provide safe, clean, reliable and customer-friendly rapid transit service and to be both an effective leader and partner in efforts to improve “seamless” delivery of public transportation services.

BART’s Strategic Plan, System Needs, and System Expansion

Interview with Roy Nakadegawa , BART Director, District 3

Roy Nakadegawa believes it is his and other BART directors’ prime responsibility to administer the rail transit system in a sound, rational, planned, coordinated and cost effective manner. Mr. Nakadegawa believes the general public expects public funds be spent in a cost effective manner that benefits the whole community, rich and poor alike.

For him, a transit system administered in the described manner is the very essence of sustainable transportation.

Mr. Nakadegawa believes that in the Strategic Plan (which he notes was adopted only after eight months of study and public outreach meetings) the BART Board has a plan that provides a clear direction toward cost-effectiveness. Its goals and objectives offer a solid basis for agency-level STIs. It offers a policy foundation for BART to do what Mr. Nakadegawa believes BART should have begun doing long ago, that is, emphasizing non-auto access to BART by charging for parking and augmenting access via local transit, foot, bike, and other shared and non-motorized modes.

The Strategic Plan emphasizes systems maintenance, but does not command external funding sources. Mr. Nakadegawa notes that BART is a 30-year-old system in need of extensive refurbishment but lacks the estimated more than \$2 billion to undertake such changes. For example, BART needs to complete a \$1 billion seismic retrofit (a 2002 bond issue for this failed).

In a similar vein, the Strategic Plan emphasizes multimodal, interagency, and interjurisdictional planning, but this does not make these approaches the norm. Mr. Nakadegawa notes that proposed BART expansion projects such as the \$2 billion San Jose BART Extension (SJX) are politically popular, garnering support from state and federal legislators as well as voters (who approved a bond issue in 2000 to partly fund it). But he notes that the SJX was developed outside both BART's Strategic Planning process and the MTC RTP process. Based on available studies, Mr. Nakadegawa believes that SJX will be much more expensive than other viable alternatives; moreover, he argues that alternative modes such as commuter rail could provide better access to Santa Clara County and be implemented in a much shorter timeframe than the ten years estimated for SJX.

The foregoing issues are endemic impediments to sustainable transportation planning. To an extent, new and highly visible major projects will always command more attention from elected officials and the electorate than maintenance and incremental, but cost-effective enhancements to access and mobility. On a more positive note, it may be that the many sustainable transportation goals and related indicators contained in the BART Strategic Plan simply need time to diffuse into and saturate the political process.

City of Oakland Public Works Department

The Oakland City Council adopted a Sustainable Development Initiative (SDI) in late 1998, the same year that the city first elected Jerry Brown as its mayor. Brown ran in no small part on a platform of making Oakland a sustainable city. The Sustainable Development Initiative included a mandate to develop guidelines and criteria for sustainable development that could be applied to new development in the city.

A technical group of public works and community development staff worked with a consultant for more than a year to develop guidelines. The Oakland Sustainable Design Guide (more properly, guidelines) is based on work conducted by the University of

Minnesota. Initially the guidelines are only being applied to city-funded projects, facilities, and activities. More details are posted at the City of Oakland website (see <http://www.oaklandpw.com>).

The guidelines encourage use of non-motorized and public transportation, as well as new developments. Most of the guidelines focus on site selection and preparation, water, energy, indoor environmental quality and human factors, materials selection with recycled content or health considerations, waste and recycling. The guidelines give the following weight to transportation and other components of a development project that have sustainability implications.

**Table 5-2 Project Evaluation Guidelines (weighted),
City of Oakland Sustainable Development Initiative**

Category	Weight
Transportation	8%
Site Characteristics	13%
Water Use	8%
Energy Use	23%
Interior Environment and Human Factors	20%
Materials	15%
Waste	13%

City staff note that these weights are not final and may be changed. Though it could be argued that transportation deserves a higher weighting, the fact remains that transportation is only one aspect of development with which public works and community development departments must be concerned.

The development guidelines represent the major implementation accomplishment of the SDI to date. While this might seem scant progress, Carol Misseldine, who worked as consultant to Public Works on the SDI, sees a slowly growing groundswell of support. While sustainable transportation is only one aspect of sustainable development, and sustainable development is a new concept to public works departments, there is a clear trend. Public works staff are being asked to promote sustainability by more and more constituents, from city councilors to common citizens. The expressed political commitment of Oakland's leaders, together with Oakland's status within the region as an older, denser city at the hub of the regional transit system (BART), make progress toward STI probable, if not inevitable.

As can be seen in other case studies, it takes time for sustainability principles and STIs to permeate local development discussions, but there is some evidence that, given enough time, they will become increasingly embedded in such discussions and resulting decisions.

CASE STUDY: SAN LUIS OBISPO REGION AND CITY

San Luis Obispo is the name of a city, a county and a region on the Pacific coast mid-way between Los Angeles and San Francisco.

Introduction

In contrast to the highly metropolitan multi-county region that is the San Francisco Bay Area, the region of San Luis Obispo is coterminous with the county boundaries. The total population of the county and its seven incorporated cities was just under 250,000 in 2000. The city of San Luis Obispo, the county seat, is the most populous city; it had 45,000 full-time residents in 2000.

This case study focuses on STIs in relation to two regional planning agencies and their “flagship” plans:

1. San Luis Obispo Council of Governments (SLOCOG) and its *Regional Transportation Plan* (which, like MTC in the San Francisco Bay Area, plans and channels funds for all major transport infrastructure in the region),
2. Regional Sustainability Indicators Project developed by the San Luis Obispo Foundation for Community Design.

As with the Bay Area case study, the San Luis Obispo investigation entailed examination of important planning documents supplemented with interviews with key agency staff. As in the Bay Area case, there is no comprehensive STI program. However, the programs studied include STIs and otherwise address sustainable transportation issues. Members of the Public Works Department of the City of San Luis Obispo were also interviewed for insight into current and potential use of STI for local transportation (Public Works manages both the street plus the city’s 20-bus transit system).

SLOGOG RTP and other Regional Efforts

The key document examined was San Luis Obispo Council of Governments Regional Transportation Planning Agency’s *2001–Regional Transportation Plan*. This was supplemented by an interview with SLOCOG Deputy Director Steve Devencenzi in August 2002, plus regular attendance at the SLOCOG’s Citizens’ Advisory Committee and inspection of SLOCOG’s agenda packet throughout calendar year 2002.

The SLOCOG RTP

There are 10 overall objectives of the RTP, intended to guide the implementation of the transportation planning and programming process for the overall transportation system. They are:

1. Intermodal Transportation: develop, improve and maintain a comprehensive, integrated, intermodal transportation system that allows convenient, flexible and efficient use of all transportation alternatives to substantially reduce the rate of growth in vehicle trips and vehicle miles traveled and increase the use of alternative transportation modes.

2. Interjurisdictional and Public/Private Partnerships: increase opportunities for partnerships between public agencies, local jurisdictions, and private enterprise in the development of a comprehensive and integrated intermodal transportation system.
3. Environmental Enhancement & Protection: establish, maintain, and improve transportation systems in a manner that avoids or minimizes significant negative impacts to the environment and provides funding for the enhancement of associated transportation facilities.
4. Energy Conservation: maintain and improve the transportation system in a manner that minimizes energy requirements through the planning, programming, and implementation of services, facilities, and land use configurations that conserve energy.
5. Land Use and Transportation Coordination: maintain and improve the regional transportation system in a manner that can reasonably support anticipated development in local jurisdictions' general plans with projected resources in a manner consistent with achievement of "livable communities."
6. Public Safety: maintain and improve the regional transportation system in a manner that emphasizes public safety in all modes of transport.
7. Plan Consistency: maintain and improve the regional transportation system in a manner that is consistent with local, regional, state, and federal plans together with applicable design, construction, maintenance and financing standards, policies and guidelines.
8. Public Participation: provide adequate opportunities for public input in the evaluation and implementation of transportation system improvements.
9. Visual Enhancement: maintain and enhance aesthetic experiences along transportation corridors and surrounding landscapes.
10. Economic Competitiveness: make cost effective transportation investments in a manner that promotes sustainable economic growth and improves the movement of goods, people, information, and services throughout the region, including the provision of telecommunications and telecommuting.

Indicators

The following key areas have been outlined in terms of their basic goals, efforts, key issues, and alternatives, as well as the outlook, forecast and vision for the various transportation modes and issues:

1. Transportation Demand Management (TDM): growth in number and size of Park and Ride lots throughout county; capital amenities to improve public mass transportation (i.e., transit pull-outs, bus benches and shelters, bicycle racks and lockers, actuated signals, and development of multimodal centers, intercity rail and air travel facilities); reduction in the need to drive; expansion of alternative transportation opportunities.

2. Transportation System Management (TSM): application of funds to address system-wide needs, especially for underdeveloped transit, bike and pedestrian networks; operational improvements; add a requirement for alternative mode enhancements to be included as part of various operational improvement projects; develop operational improvement strategies for identified transportation network components; establish performance objectives to evaluate the effectiveness of TSM objectives.
3. Intelligent Transportation Systems (ITS): apply funds to establish and maintain the required networks; establish standards to ensure compatibility of systems on a regional basis; establish performance criteria that include quantitative and qualitative measures of component effectiveness.
4. Public Transit: create a truly rider-friendly transit service; integrate fully with other modes of transportation (highway, rail, air, bicycle, etc.); create a modal shift by actively promoting transit use as an alternative to the single occupant vehicle through education, the news media, schedule distribution, coordinated marketing, newsletters and public appearances; attain stability and adequate funding for both transit capital and operations; facilitate transit friendly development throughout the region.
5. Railroad Transportation: create an increase in passenger train reliability, travel speed, and frequencies; facilitate and support safe, commercially feasible, economically viable, and efficient movement of passengers and goods throughout the region, with minimal adverse impact on the population, the infrastructure, and the environment.
6. State Highways: Caltrans establishes priority categories to address the state highway system. The programming of projects by Caltrans must compete with projects from within all of District 5 and then with other projects from around the state. The need for planned improvements continues to exceed the projected funding, based on existing revenue sources. Prior to construction of major capacity expansions on the 101 corridor such as additional through lanes, there will be efforts to: construct operational improvements; develop effective system demand management programs; provide attractive and timely alternative modes of travel; improve alternative routes and local frontage roads; and, improve local interchanges while recognizing the need for the ultimate 6-lane highway configuration.
7. Routes of Regional Significance: The following performance criteria are used to assist in the ranking process when evaluating requests for Regional Transportation Improvement Program (RTIP) funding and Regional State Highway Account (RSHA) funding for projects on these routes:
 - a. Safety/Congestion Relief/ Level of Service–Traffic Volumes,
 - b. Functional Classification–Population of areas directly served,
 - c. Local Funding contribution/available funding–Roadway condition,
 - d. Contribution to intermodal system connectivity–economic benefits,

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- e. Directness of Connection (between communities, regional facilities, and state routes)–Regional Equity Consistency with RTP, local plans, and other relevant planning documents–environmental impacts,
 - f. Cost effectiveness–Need and overall significance.
8. Non-Motorized Transportation: provide a safe and efficient regional bikeway system that promotes bicycling as a means to decrease auto-dependency, air and noise pollution, and traffic congestion; provide safe, convenient, and conducive environs for pedestrians to promote walking as a transportation mode in itself and to provide connections between other modes. About 50 percent of trips have an average trip length/distance considered short enough so that biking is a viable option; Urban development is also considered, as the historical downtowns within the county are more conducive to walking/biking and alternative transportation options.
 9. Aeronautic and Port Facilities: maintain SLO County Regional Airport as the primary airport for the county, while establishing the Paso Robles Municipal Airport as the primary airport for the North County area; provide highest funding to projects that mitigate existing safety deficiencies, provide for other safety upgrades, and to maintain aviation facilities. Port facilities are limited in SLO County; Port San Luis is a small Harbor District concerned primarily with fishing vessels, recreational boating, and the development and operation of waterfront facilities.
 10. Maintenance of Transportation Infrastructure: jurisdictions need to provide increases in funding for road maintenance and rehabilitation; jurisdictions need to carry out a pavement management program focused on preventative maintenance while also carrying out more extensive rehabilitation projects on the most seriously deteriorated roadway segments. Monitoring of transit, rail, bike, pedestrian and equestrian facilities to assure the maintenance of safe, attractive, and efficient transportation networks.
 11. Land Use and Community Livability: enhance economic vitality, environmental sustainability, community identity, and accessibility to basic human services within and between communities of the region. Reduce travel times and trips by encouraging local jurisdictions to include appropriate measures in their general plans that will provide affordable housing and employment opportunities within each planning sub-region; change the fiscal relationships and tax distribution mechanisms between the state and local agencies to provide adequate funding that will allow, support, and encourage good land use and development practices; develop a strategy and forum for jurisdictions to identify planning and design standards they can implement to offer an array of travel choices, improved access, and flexible travel alternatives within and between the communities in the region; support implementation of land use strategies that limit automobile-oriented zoning and develop and promote pedestrian scale communities; support planning and retrofitting of community environments to be pedestrian- and transit-friendly and encouraging local jurisdictions to establish and maintain a mix of transit, bicycle, and pedestrian access choices; fund project scope studies and projects that benefit the transportation system while maintaining a sense of

community; review and comment on major local land development proposals, encouraging livable community design concepts; encourage and assist jurisdictions in providing expedited permit processing, and other incentives to encourage projects that contribute to pedestrian and transit friendly community design; develop a library of livability concepts, plans, standards, and successful project examples to be used as a resource by member jurisdiction and local developers.

To summarize, the SLOCOG RTP contains many goals and objectives that promote transportation sustainability, and contains several promising indicators. A major shortcoming of any RTP-based indicators is the fact that these massive planning documents are only updated every three years (and due to fiscal constraints, SLOCOG did not update its RTP for a six-year period prior to 2001).

Based on the example of MTC and SLOCOG, the RTP process appears capable of identifying and granting official status to many STIs. These regional transportation-planning agencies use their RTPs as a basis for planning and ultimately funding future transportation projects. But other, more accessible and more frequently updated documents are needed to raise awareness and acceptance of STIs.

San Luis Obispo's Community Indicators Project

This project parallels the Sustainable Seattle project described in the history of indicators presented before. In many ways, San Luis Obispo's Community Indicators Project is typical in its origins, structure and results. For these reasons, and the fact that the study team has long followed this particular process, this project is examined in detail.

In 1994, a collection of non-profit agencies formed the San Luis Obispo County Foundation for Community Design (FCD). Key personnel from community development organizations, as well as representatives of public health, education, and local government comprise the board of the non-profit FCD organization. The FCD conducted extensive surveys and public meetings over a two-year period to obtain opinions regarding county residents' visions for the future of their local communities and the county as a whole. The surveys and summits queried residents about environmental, social and economic issues, i.e., all the major components of sustainability. Based on this community outreach effort, a set of six "visions" or goals for the future was established. A subgroup known as the Community Indicators Roundtable (CIR) set about to define indicators that would be able to show progress towards the six visions/goals.

Members of the CIR spent hundreds of hours defining and refining a set of indicators, which were published in February 1998 in a document titled: *Compact: A Guide for Future Planning*. This document described the group's indicators and the reasoning behind them. CIR members sought suggestions for appropriate indicators from both experts and regular citizens with an interest in the issues. Only indicators meeting the following seven criteria were adopted: ⁴⁷

1. Clearly related to the specific vision being measured,

2. Statistically measurable,
3. Logically defensible,
4. Understandable to the public,
5. Relevant to our geographical area and comparable to other communities,
6. A true measure of outcomes,
7. Positive rather than negative.

Published Vision Statements

Based on the above processes and criteria, the following goals and associated indicators were devised and reported.⁴⁸ In this summary, all indicators, not only those indicators that have a direct relationship with transportation, are described in detail; this gives the reader a sense of the relatively minor role transportation indicators play. Although the visions are not prioritized, Roman numerals have been added to this summary for the sake of clarity:

Vision I: Growth is carefully planned and managed. Indicators associated with this vision are as follows:

1. Population Change,
2. Agricultural Land Preserves,
3. Air Quality measures the number of days per year that are below state mandated clean air standards. The rationale given for this indicator is that clean air is essential to building and maintaining healthy communities. The overall quality of the air we breathe is fundamental to the health and welfare of a community. Air quality is affected by all economic, environmental, and social decisions. Since transportation is the major source of ozone, this is, in part, an STI.
4. Water Quality indicates the health of the county's natural water resources. Rationale for this indicator is that clean water is essential to building and maintaining healthy communities. Similar to air quality, clean water is fundamental to the health and welfare of our communities.
5. Water Usage measures the daily per capita usage of water by homes and businesses.

Vision II: All children are ensured a high-quality education. The indicators associated with education quality are these.

1. College Preparation and Placement measures the math and language competency levels of local high school students who enroll at Cuesta Community College.
2. High School Graduation measures the percentage of students who complete public high school.
3. Continuing Education measures the percentage of students who intend to pursue further academic studies at college or vocational trade schools.

4. Student Participation in Work Experience Opportunities measures the participation by school district of students enrolled in work experience, Regional Occupational Program (ROP), and school-to-work courses.
5. Ethnic Diversity in Schools measures ethnic population by school district.
6. Physical Fitness measures the performance levels of 7th grade students on four standard physical fitness tests.
7. Educational Performance Levels measure the achievement of students in grades three, five, and eight in areas of English, math and language arts.
8. Youth Development Programs and Participation identifies the availability of youth development programs throughout San Luis Obispo County.

Vision III: The economy emphasizes clean industry, prosperous agriculture and flourishing tourism; it provides a variety of employment opportunities with livable wages and offers affordable housing alternatives. Indicators for this vision are as follows.

1. The Unemployment Rate measures the percentage of the labor force in the county that is unemployed.
2. Real Per Capita Income measures average income of residents in the region.
3. Non-farm Employment in San Luis Obispo County Areas measures the number of wage and salary jobs in non-agricultural establishments by geographical area in San Luis Obispo County.
4. Total Agricultural Production Value measures the sum total of all crops and livestock products originating in San Luis Obispo County.
5. Crop Value Per Harvested Acre measures the efficient utilization of farmland over time.
6. Number of Proprietors measures proprietors or self-employed persons in San Luis Obispo County.
7. Business Sentiment measures the vitality of the local economy by direct survey of local business leaders in SLO County.
8. Total Visitor Expenditures in SLO County measures the impact of tourism on the County economy.
9. Housing Affordability Index measures the ability of SLO County residents to afford housing through home ownership.
10. Average Permit Time for New Commercial Projects measures the number of days a municipality takes to review, evaluate, and authorize permits for new commercial or industrial developments, or large renovations of commercial and industrial buildings.

Vision IV: Crime is controlled so that people continue to have a sense of security and safety in their communities. Associated indicators are:

1. Adult and Juvenile Arrests measure the per capita rate of adult and juvenile felony arrests.

2. Incidence of Domestic Disturbance measures the number of child abuse reports, domestic violence calls, and spousal abuse arrests.
3. Incidence of Juvenile Offenders measures the incidence of juvenile offenses by areas of the county.

Vision V: Open space is preserved and enhanced as a rich resource of recreational and tourism opportunities. Indicators for this vision are as follows.

1. Miles of Public Trails measures the miles of multi-use public trails countywide. Rationale for indicator: multi-use trail access offers a variety of enhanced recreational opportunities for walkers, hikers, cyclists, and equestrians. Access to public trails contributes to the mental and physical health of county residents. This is in part a STI.
2. Acres of Public Land measures publicly owned lands, parks, and recreation facilities.
3. Total Incorporated Land Area indicates the change in acreage within the seven incorporated cities.
4. Soil Erosion indicates current efforts to monitor and prevent soil erosion and sedimentation.

Vision VI: County and local governments respond to identified community needs and actively seek and encourage community input in planning and decision making. Associated indicators are these.

1. Voter Participation measures the percentage of eligible voters that are registered and the percentage of registered voters that vote.
2. Civic Involvement and Access measures opportunities for civic involvement and public information made available to residents who want to participate in the public policy decision process.
3. Subsidized Child Care Services measures requests for government subsidized childcare and enrollment.

Year 2000 Update—And Shifts

The FCD released a second publication, titled *Compact: A Guide for Future Planning, Foundation for Community Design of the County of San Luis Obispo*, in April 2000. At this point in time, the FCD merged with a group concerned mainly with community health issues known as Action for Healthy Communities. Responsibility for the indicators project was henceforth with Action for Healthy Communities.

The six Visions/Goals are described differently, but are essentially the same. A total of 49 indicators (up from 33) are now reported, although data is not available for some of the indicators, including the two new STIs (alternative transportation use and alternative fuel vehicles). Most of the new indicators reflect public health issues—in other words, they reflect the principle concerns of Action for Healthy Communities.

Vision I: Growth is carefully planned and managed: growth is carefully planned and managed without sacrificing the natural beauty and health of the environment. Indicators for this vision are:

1. Air Quality,
2. Job-Workers Ratio,
3. Growth Patterns. This indicator reports whether new development is occurring inside or outside of the URLs (Urban Reserve Lines). It would be the ratio of the number of new housing units approved or built inside the URLs relative to the number built outside the URLs of the county.
4. Alternative Transportation tracks the use of alternative transportation, as measured by increases in transit, vanpool, and carpool ridership. The stated rationale for this new indicator: the increasing use of conventional gasoline-powered vehicles is one of the chief contributors to declining air quality. No data is presented for this indicator, which is clearly an STI.
5. Alternative-Fuel Vehicles is another new indicator that would measure the number of alternative-fuel vehicles in use in the county as a percentage of all vehicles registered in the county. The rationale for this indicator is that increasing the use of alternative-fuel vehicles can have a direct benefit by reducing gasoline engine emissions. No data is presented for this indicator, which is clearly an STI. CTD notes it would be desirable for separate indicators to be developed for privately and publicly owned vehicles.
6. Urban Resource Capacity reports whether communities in the county have enough infrastructure capacity to support expected growth.
7. Energy Use monitors the amount of energy the county uses annually in the residential, commercial, and industrial sectors.
8. Water Use tracks the efficiency of water use in the county. The amount used per residence and per business would be tracked for each major water system in the county, and for agricultural irrigation.
9. Water Quality reports water quality separately for streams, reservoirs, aquifers, and wetlands.

Vision II: Education and youth development: all children are ensured a high-quality education and activities are created to nurture youth development and encourage pride and involvement in their communities. Related indicators include these.

1. Student Educational Performance Levels measures the achievement level of SLO County students in grades 3, 5, 7, and 10 in math and language using standardized achievement tests.
2. Academic Performance Index (API) ranks California public schools based on the achievement level of their students.

3. College Preparation and Placement measures the language and math skills of SLO County high school students who enroll at Cuesta College. More local high school students continue their education at Cuesta College than any other institution.
4. High School Dropout Rate measures the percentage of students who drop out before completing four years of high school.
5. Physical Fitness measures the physical fitness of elementary and high school students. It reports the results of a test of five types of physical ability that is administered to fifth, seventh, and ninth graders statewide.
6. Students Feel Safe at School is an indicator that reports how safe SLO County students feel when they are in school.
7. Continuing Education Beyond High School measures the percentage of recent high school graduates who are continuing their formal education, either at a college, vocational school, or in the military.
8. Prepared for Employment measures how well local high school graduates are prepared for employment. Measurements are provided on criteria developed by the U.S. Department of Labor (SCANS).

Vision III: The economy emphasizes clean industry, prosperous agriculture, and flourishing tourism; it provides a variety of employment opportunities with livable wages and offers affordable housing alternatives. Indicators associated with this vision are:

1. Housing Affordability reports the percentage of homes sold that a family with an average income could afford to buy.
2. Crop Value Per Harvested Acre measures how much revenue is produced by each acre of farmland. Crop Value Per Harvested Acre is the ratio of total farm sales (excluding livestock) to the number of harvested (crop) acres.
3. Per Capita Retail Sales reports the average number of dollars spent each year in retail stores, on a per resident basis.
4. Hotel and Motel Revenues measures how much money is spent on overnight lodging in hotels, motels, and campgrounds in SLO County.
5. Personal Income tracks the average income of people in SLO County.

Vision IV: Public Safety: crime is controlled so that people continue to have a sense of security and safety in their communities. Associated indicators are the following.

1. Violent and Property Crimes measures the number of violent crimes and property crimes reported in SLO County.
2. Perception of Safety reports how safe county residents actually feel, apart from police-based crime statistics indicators.
3. Children Feel Safe in the Neighborhood reports on children's perception of their sense of security where they live.

4. Crimes Committed with Guns indicates how often guns are used in committing crimes in SLO County.
5. Domestic Violence monitors the level of domestic violence in the county. Two measures, the number of domestic violence-related calls for assistance and the number of arrests for domestic violence, provide the data.
6. Juvenile Criminal Activity measures the number of juveniles who are apprehended in connection with any type of crime, from minor offenses to felonies.
7. Gang Prevalence reports number of gangs and gang members in SLO County.
8. Nuisance Complaints measures the level of activities (noisy neighbors, loose dogs, or abandoned cars) that fall short of being crimes but are still annoying to residents).
9. Crime in Schools reports the number of crimes that take place on public elementary, middle, and high school grounds.
10. Perception of Gangs as a Community Problem reports on how concerned the community is about gangs.
11. Number of Child Abuse Reports indicates the level of child abuse in SLO County. More specifically, it reports the number of investigated reports, which includes both emergency and non-emergency responses.
12. Juvenile DUI Arrests measures the number of juveniles arrested for driving under the influence of alcohol.
13. Juvenile Drug Arrests measures the number of juveniles who have been arrested for misdemeanor and felony drug offenses.
14. Alcohol Related Accidents reports the number of vehicle accidents resulting in deaths or injuries where alcohol was involved.
15. Number of Hate Crime Victims enumerates the number of people who have been the target of a hate crime.
16. Perception of Gun Violence as a Community Problem measures the number of county residents who are concerned about gun violence.
17. Feel Hate Crimes are a Problem reports on the public's perception of the level of such crimes in the county.
18. Feel Substance Abuse is a Problem examines how concerned residents are about substance abuse in the community.
19. DUI Arrests measures the number of DUI arrests made by the CHP in SLO County. Rationale for this indicator is to show one of the risks of driving in the county, as well as how effective the Highway Patrol is in locating and apprehending drunk drivers. This may be considered, at least, a partial STI.

Vision V: Open space is preserved and enhanced as a rich resource of recreational and tourism opportunities. Indicators associated with this vision are as follows.

1. Open Space Inventory measures the county's open space resources, in acres, including the assignment of acres to categories indicating the likelihood that they will continue to be included in the open space inventory or converted to some non-open space use. For the purpose of monitoring the status of these lands, all open space acreage will be assigned to one of five categories: permanently protected, temporarily protected, pristine/unprotected, threatened or converted to development.
2. Irrigated Acres shows the numbers of acres of SLO County farmland that are irrigated and harvested.
3. Agricultural Resources indicator creates an inventory of agricultural resources differentiated by soil category (Class I, Class II, etc.). Acres would be designated as: permanently protected, Williamson Act (temporarily protected), threatened (subdivided, changed to non-agricultural land use category) or, converted to development. Biotic Census indicator uses an annual count of specific "indicator" species, both animals and plants, as a measure of how well the natural habitat in the county is faring.

Vision VI: Government: county and local governments respond to identified community needs and actively seek and encourage community input in planning and decision making. Associated indicators are the following.

1. Customer Service Index measures the customer service skills of front line employees in local government agencies.
2. Public Access and Information measures how well government agencies provide opportunities for residents to learn about, and be involved in, the decision-making process.
3. Voter Participation measures percentage of voting-age population that actually votes.

The 2001 Update

There was a third update and revision of the SLO Indicators project in 2001 in a document titled: *Report Card: Action for Healthy Communities*. In this iteration, there are seven adopted community goals, and the predominance of public health goals and indicators is quite evident. Although the number of Visions/Goals is increased to seven, the number of indicators reported is reduced to 14, as shown in the following:

1. Meeting Basic Needs Action Goal is measured by two indicators: those going without basic necessities, and school meals program.
2. Social Environment Action Goal is measured by two indicators: voter participation, and discrimination.
3. Education Action Goal is measured by two indicators: preparation for employment, and high school dropout rates.
4. Natural Environment Action Goal is measured by two indicators: traffic volumes (on 21 key county road segments) and energy use.

5. Health Issues Action Goal is measured by four indicators: teen tobacco use, teen alcohol abuse, physical health, and access to health care.
6. Public Safety Issues Action Goal is measured by two indicators: juvenile criminal activity and adult safety perceptions.
7. Economic Issues Action Goal is measured by two indicators: housing affordability and personal income.

For the first time, a wholly transportation-related indicator with actual data is reported (traffic volumes on 21 county road segments). Unfortunately, the air and water pollution indicators and the alternative transportation indicators, which had no data in the prior report, are no longer mentioned. As in other comprehensive community indicator programs, transportation indicators are infrequent relative to transportation's importance to sustainability, as measured by the transportation sector's use of fossil fuels, and its status as the major source of air and noise pollution and accidental death in the U.S.

The change in indicators in the three reports published on the San Luis Obispo project is understandable given the shift in sponsorship to a public health-focused collective. Yet, as impressive as the San Luis Obispo's Community Indicators Project has been throughout its five-year existence, the "indicator shift" just described underscores the limitations of a volunteer-base indicator program. While broad-base citizen support is an essential ingredient if sustainability indicators are going to affect public policy and public policy-makers, relying on volunteerism to collect and report indicator values is likely to lead to wide variability among indicators collected as well as gaps in the collection and reporting of results.

City of San Luis Obispo Bi-Annual Mode Choice Survey—A Small But Real Achievement

In interviews with Public Works staff in San Luis Obispo and elsewhere, much interest but little implementation was found. In the words of one long-time city public works employee, "local government has many mandated functions, but research and collection of STIs is, unfortunately, not one of them."

Nonetheless, the city of San Luis Obispo offers a small but significant example of a successful STI program: a bi-annual transportation survey. The survey is focused on citizens' choice of transportation modes, and the factors influencing their choice.

The survey is mandated by the city's 1994 General Plan. Every two years approximately 3,500 questionnaires are distributed, and just fewer than 1,000 were returned in the 2001 survey year. The process is well established and accepted and the quality and neutrality of the data is also established. As an indication of acceptance, both advocates for and opponents to bike facility expansion have cited data from the survey in arguments before the city council.

This biannual random sample survey is supplemented via traffic counts in the off years. The city also conducts a survey of the city's utility subscribers. This does not produce as representative a sample, since renters are underrepresented, but it provides evidence of

trends and opinions regarding transportation choices of a substantial segment of the population.

SWITZERLAND CASE STUDY

As it was not easy to find and document good examples of fully developed STI programs in California, or even the U.S., the project team decided to look to Europe and especially Switzerland for more mature STI programs. To reiterate, indicators of sustainability may be subdivided into the three “E’s,” namely Ecology, Economy, and Equity (or social justice), but the program as a whole cannot be deemed sustainable unless all three programs are evident. The author of this case study has been very active in planning for sustainable mobility in Europe, and he is the co-owner of two planning firms in Zurich.

Introduction

By way of background, Switzerland had a population in 2000 of 7,200,000 (roughly the same as the nine-county San Francisco Bay Area) with a land area of about 16,000 square miles (slightly more than twice the size of the Bay Area). The nation is multi-ethnic, including German-, French-, Italian-, and Romansch-speaking communities comprising 20 cantons and 6 half-cantons. It also has a substantial foreign-born population (about 15 percent).

Organization of Economic Co-Operation and Development (OECD) and Europe

In the year 2000, the Organization of Economic Co-Operation and Development (OECD) published the report “Environmentally Sustainable Transport.” However, no indicators were given at that time. The European COST C8 Committee is working on indicators and has proposed nine transportation indicators out of a total of 49 sustainability indicators (shown in Appendix C of that document and this report).⁵⁰

Three addresses of researchers in Germany are also given in the COST C8 document. The most interesting case is in the state Bundesland of Baden Wuerttemberg, where a university compiled the indicators for the whole state in the year 2000. The report is available from the state government.

Switzerland: Non-governmental Organizations

Several worldwide organizations and publishers headquartered in Switzerland use the popular sustainability indicator called the *Ecological Footprint*, “co-invented” by the Swiss Dr. Mathis Wackernagel, currently professor at the Center for Sustainability of the University of Anahuac de Xalapa in Veracruz, Mexico. The indicator is described on the web site of the organization “Redefining Progress (Redefining Progress, 2002).” Every visitor of the site can quickly approximate his personal ecological footprint, which is quite an experience, even if one has to estimate some input parameters. Average westerners find that mobility can make up 60 percent of their ecological footprint, and that they are living

considerably beyond the carrying capacity of the planet. About half of the sub-indicators in the test deal with personal mobility, namely the estimated use of public transportation, motorbike, car, bicycle, and airplane, gasoline use of motorcycle and car, and driving solo.

The headquarters of The World Business Council for Sustainable Development (WBCSD) are in Geneva. The Council does extensive research on mobility, mostly through researchers from MIT. It has produced a worldwide inventory report, *Mobility 2001*. Although this association of 150 members consists mainly of worldwide car manufacturers and gasoline producers, it actively seeks dialogue with representatives from alternative transportation. It was very active at the UN conference of Johannesburg 2002.

The headquarters of the Alliance for Global Sustainability (AGS) can be found in Zurich near the Swiss Federal Institute of Technology. The Alliance conducts research in sustainability and is also active in mobility research. It consists of the following universities.⁵¹

- Swiss Federal Institute of Technology (ETH)
- The Massachusetts Institute of Technology (MIT)
- The University of Tokyo
- Chalmers University of Technology, Sweden

Also in Zurich are the headquarters of the Organization of Ecologically Sensitive Firms (OEBU) with more than 100 Swiss members of small and very large industries. The organization has been issuing guidelines for sustainability measurement for 15 years.

Switzerland: Federal Level

Since the 1980s, Swiss governments on all levels have periodically published *Reports about the State of the Environment*.⁵²

Institutional Framework

At least three federal agencies, 8 “states” called cantons, and 17 cities and communities participated with approximately 180 reports.⁵³

In 1999, the Swiss citizens voted in a new constitution, which places a heavy weight on sustainability in many articles, especially in Article 73. The Swiss National Exposition from March to October 2002 featured a very popular “Sustainability Pavilion.” Visitors could fill out a form directed to the President of the Swiss Confederation specifying their wishes for a sustainable Switzerland.

Therefore, all levels of the *federal government* are now obliged by law to consider not only one of the “E’s,” but all three “E’s” of sustainability, and to give each *equal weight*. Indicators were developed by several federal agencies and are currently being coordinated. These indicators are already used to evaluate federal transportation projects, such as the freeway network and specific projects in transportation corridors.

On a lower level are the *cantons*, and several of them are developing their own indicators. The leaders appear to be the cantons of Basel-Land, Basel-Stadt and Geneva. Geneva already has indicators in its cantonal constitution.

Based on research by the ORL-Institute at the Swiss Federal Institute of Technology in Zurich, *cities* are now also developing their own sets of indicators. The leader appears to be Zurich, often cited as “the most energy efficient city in the world.” In 2001, the Mineta Transportation Institute published a comprehensive report entitled *Implementation of Zurich’s Transit Priority Program* (MTI Report 01-13, Andrew Nash), which highlights Zurich’s approach to sustainability.⁵⁴

Private industry was always strong in economic reporting and in the 1980s started to produce periodic environmental statements, which in recent years were supplemented by social impact statements (Sozialverträglichkeitsberichte). There is no legal mandate for the latter types of reports, but it is the ethical code to produce them for the public, as done, for example, by Schmidheiny Group, Baer Cheese Industries, the Credit Suisse and the Zuercher Kantonbank. In many respects, private industry is often ahead of government regulators concerning sustainability. This gives industry an edge in the competition on the world markets. Several organizations exist to produce guidelines for sustainability actions and reporting, which also cover mobility.⁵⁵

Trends

Interviews were conducted with key persons, government officials, professors, and consultants during the years 2001 and 2002 by phone or personal visit to Europe. The slogan among many leaders is “do the right thing first, sustainability statistics can come later.” Many politicians report that they are not willing to look at more than 15 indicators. Often, they base their decision not on numbers, but on the small print at the bottom of the page. However, politicians clearly want to see two questions answered:

Was our mandated strategy implemented? If yes, did we reach our objective?

On a global level, these questions were also asked at the UN Conference on Sustainability in Johannesburg in 2002, looking back to the first such conference in Rio de Janeiro in 1992. As in Johannesburg, the answers to these questions are not simple in Switzerland. While there are definitely impressive sustainability successes, not everything is perfect in Switzerland. Only 83 of the 3,000 Swiss communities have seriously implemented *Agenda 21* of the Conference of Rio. Despite tough zoning legislation, a considerable amount of urban sprawl has occurred. And despite excellent public transportation, car traffic continues to grow, at least outside city limits.

National Research Programme 41 “Transport and Environment”

This multimillion-dollar program lasted for several years and produced among others, Project C5, *Measuring the Sustainability of Transport*, where Economy, Ecology, and Society were divided into 13 criteria with a total of 25 measurable indicators (see

Appendix D). This research was published in 1998. The last documents of this research program were published in spring 2001. Most subsequent research and governmental implementation is based on this work.⁵⁶

Swiss Association of Transportation Engineers' (SVI) "Sustainability Rose"

The Swiss Association of Transportation Engineers does practice-oriented research paid by the federal government. The report *Sustainability and Coexistence in Road Planning* of 2001 shows an easy to understand graphic method for comparison of before and after conditions for seven projects on high volume arterials in delicate downtowns or village centers. Context sensitive design was applied in all of them. The results for two towns are shown in Figures 5-1 and 5-2.

Such "Sustainability Roses" present indicator data in a radial pattern resembling a compass rose. One set of data dots connected by lines shows the value of the sustainability measures prior to the project. The second set of connected dots shows the value of the sustainability measures after the project. The dots representing indicator values are arranged on a scale ranging from -2 (worst condition) to +2 (optimum condition). When indicators are displayed in this manner, it is easy to track both overall improvement or worsening and changes in individual indicators.

The first example is the Seftigenstrasse in Wabern near Berne. This is a show project of high public involvement and sensitive design. The second project is the Bernstrasse leading to the historic old town of Murten, Canton of Berne. The larger dots in the graph show the situation *before* the project was built. The smaller dots represent the sustainability indicator *after* the project was built. In order to make the before/after comparison easy, the relative value of the "after" reference was always set to zero. Therefore a positive number for the larger dots mean that the project has improved the situation. A negative number means that the project is worse than the situation before and in relation to the particular indicator. The size of the surface between before and after shows the total improvement based on the 14 indicators used. The project in Wabern evidently resulted in a bigger overall improvement than the one in Murten, but both are positive achievements. Both projects are "negative" concerning the indicator "costs," because evidently construction costs something.

All projects are based on analysis of sub-indicators based on extensive measurements or in-depth surveys of public opinion. The researchers concluded that their extended checklist is easy to follow, and that the seven projects indicate that context sensitive redevelopment of thoroughfares can be done with relatively little effort.⁵⁷

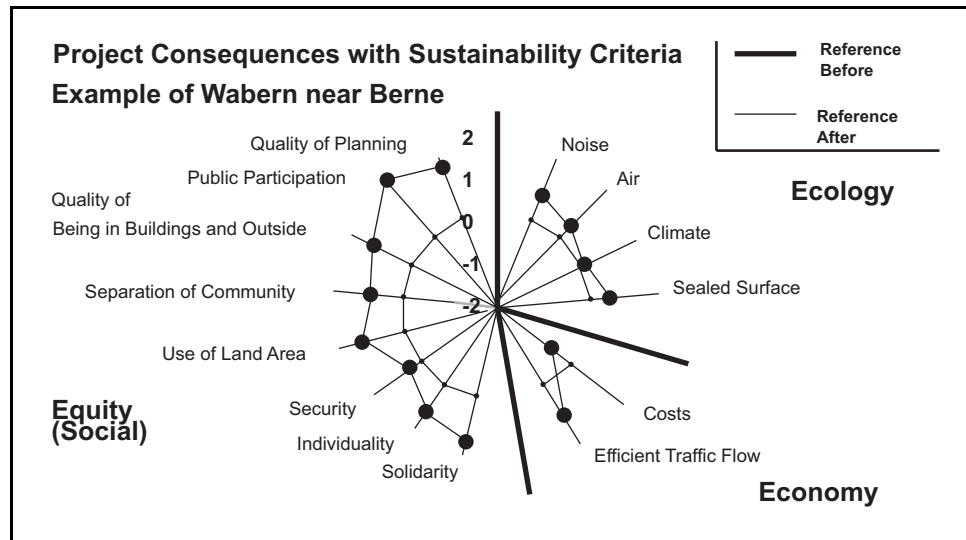


Figure 5-1 Example of Sustainability Rose Chart: Wabern Road Project

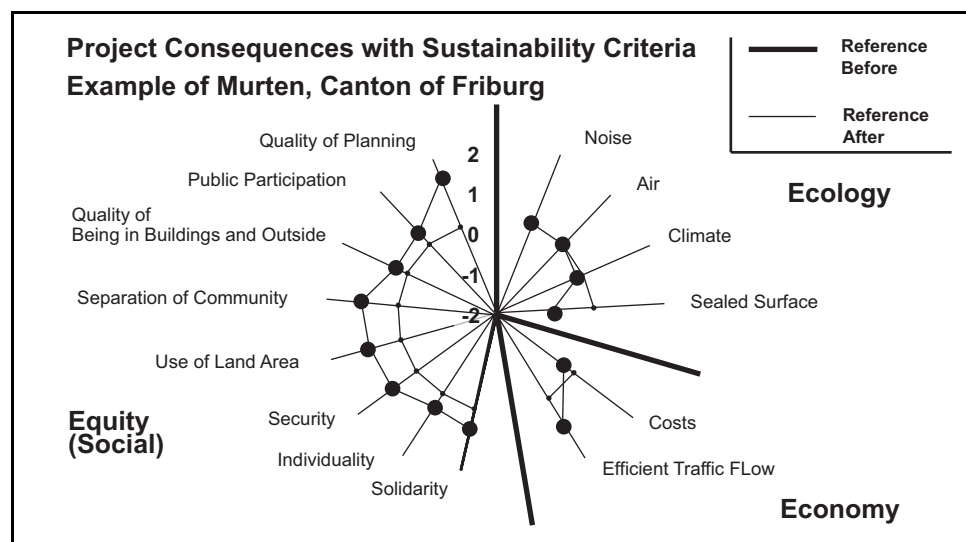


Figure 5-2 Example of Sustainability Rose Chart: Murten Road Project

New Indicator List for Communal and Cantonal Road Planning and Projects

The report, *Sustainability in Road Traffic*, delivers a new indicator list, which will likely become the Swiss standard for communal and cantonal planning. The list contains a total of 38 indicators, whereof 25 are measurable and the remaining 13 are qualitative only. The indicator tables for Ecology, Economy, and Society are divided into goals, objectives, indicators, units, and remarks.

The goals, objectives, and indicators were translated into English and are shown in the first part of Appendix E.

Future Research

In 2002, the federal government mandated the SVI association to produce two more reports in connection with sustainability in transportation; the first one is dealing with economy and the other treating society.

The MONET Project

The Swiss Federal Office for Spatial Development is the leader in developing national indicators of sustainability, and together with other federal offices, has documented the MONET project, which is based on the government's *Sustainable Development Strategy 2002*. The project was presented at the World Summit of Sustainable Development (Rio+10) in Johannesburg 2002.

Their sustainability indicator list is based on twenty objectives leading to twenty-six separate topics with nearly two hundred indicators covering the three "E's." The topic "Mobility" contains ten indicators. Indirectly connected with "Mobility" are three topics:

1. "Air," with 6 indicators,
2. "Climate," with 4 indicators, and
3. "Energy," with 7 indicators.

Some of the indicators are works in progress, and for others the historical development is shown. For most indicators, the charts indicate deterioration, improvement, or no significant change in the situation.

Appendix F contains the indicators for mobility, air, climate, and energy taken from the MONET website.⁵⁸

The NISTRA Project

The Federal Office of Roads has developed an indicator set for five federal transportation projects, mainly freeways, state roads, and a freeway tunnel. This is based mostly on the abovementioned new indicator list for communal and cantonal road planning and projects. Currently, plans are made to analyze the sustainability of operating and maintenance concepts, and also of speed limits and road pricing. Projects for rail will be analyzed as well.⁵⁹ Similar projects are underway in the cantonal public works departments. In Zurich, for example, a project for a tunnel under the lake is analyzed using this approach.

Switzerland: City Of Zurich

Zurich's sustainability team is directly attached to the mayor's office. The team's set of indicators was expected to be made a citywide ordinance in the first half of the year 2003. The city's sustainability report covering the years 1985–2001 was in draft form at the time of this study. A popular brochure about mobility and sustainability was distributed. For

certain activity sectors, like mobility, the City Council has already issued orders to the administration, including a mandatory “EEE Strategy Conformity Check.”

Draft Sustainability Report 1985-2001 (Nachhaltigkeitsbericht)

The final report may contain 21 indicators with only one indicator called “Environmentally Friendly Mobility.” This indicator will probably be measured through a number connected with alternative transportation. However, other indicators will indirectly touch on mobility, like “Global Warming,” “Air,” “Noise,” and “Sealing of Surfaces.”⁶⁰

Public Information Brochure “Mobility is Culture” (Mobilitaet ist Kultur)

In July 2002, the city council of Zurich decided to inform the public about a new philosophy of mobility in the brochure *Mobilitaet ist Kultur*. Under the eight new rules, number one is “Sustainability.” Other rules deal with “Conformity to the Strategy of the Council” concerning sustainability and “Project Controlling.” There is an excellent website containing a traffic simulation for interested citizens.⁶¹

The Checklist for Conformity with the Strategy of Sustainability (Strategiekonformitaetspruefung)

The city council published the above checklist in May 2002 mandating the administration to analyze any project in connection with mobility according to the three “E’s” of sustainability. No indicators are directly measured, but the examiner must give points from -2 to +2. The societal dimension, the economic dimension, and the ecological dimension each contain seven indicators, which leads to a total of 21 indicators. For each indicator the following is given:

1. Detailed question to ask
2. Detailed evaluation criteria
3. Detailed instruction about evaluation points

This is similar to the “Initial Environmental Checklist” in the California Environmental Quality Act (CEQA), but in addition to environmental factors, the list contains indicators of economy and society as documented in Appendix G.⁶²

CONCLUSIONS FROM THE CASE STUDIES

The acceptance of sustainability appears to be higher in Europe than in the U.S. With this goes a more widespread use of indicators and actions in response to indicators. In Europe, and especially in Switzerland, the essential idea of “sustainability” has been around for decades and is now anchored in the minds of most government employees. Switzerland follows a path of “compassionate capitalism,” preferring actions to excessive indicator bureaucracy. Full standardization of indicator sets may never come—and may not even be desirable—as goals, and objectives, and the particular project vary from place to place and

agency to agency. The very direct Swiss democracy insures that government quickly applies citizen's wishes.

Giving the three "E's" of sustainability *equal* weight is now a constitutional requirement for all federal agencies in Switzerland, and this is now being reflected in STIs and more importantly in actions. Focusing on Economy, the sustainability "E" most often overlooked, there is evidence that sustainable transportation pays its way: thanks to Switzerland's policies and excellent public transport system developed over many years, the average Swiss family spends only 10 percent of their annual budget on transportation. In the U.S., an average family spends about 20 percent.

While Switzerland emerges as the most exemplary of the case studies, there are many good sustainable transportation policies, many exemplary STIs, and numerous lessons to be drawn from each of the case studies. Though by no means complete, Santa Monica is demonstrating that the creation and application of sustainable principles can occur in a California city. In the San Francisco Bay Area, the Metropolitan Transportation Commission (MTC) and the Bay Area Rapid Transit District (BART) have devised useful indicators in high-profile planning documents, which if updated regularly and kept in the public eye, should begin to steer major transportation investment decisions toward sustainability; Oakland's Sustainable Development Guide represents a preliminary but real step toward implementation at the municipal level, as does the City of San Luis Obispo's biannual modal split survey. At the regional level, both the volunteer-driven San Luis Obispo Community Indicators Project and SLOCOG's Regional Transportation Plan contain sustainability indicators in abundance; more coordination and consistency between these efforts could result in an effective regional STI program.

The next section summarizes the primary lessons based on the entire research project.

OBSERVATIONS AND RECOMMENDATIONS

SUMMING UP

Most people use indicators as a normal part of their daily activities. Indicators can be signs, symbols, pictures, or experiences. Quantifiable indicators are the presentation of valuable data that illustrate changes over time. Indicators may measure a variety of factors in a community or region including, but not limited to, infrastructure adequacy, progress toward social equity, environmental quality, economic growth, and political inclusion.

This research project has explored indicators as a tool for implementing sustainable development, with particular emphasis on indicators to measure the sustainability of transportation systems at the local level. As described in the first two chapters, the concepts of sustainability and sustainable transportation have been evolving for many years, and continue to evolve.

The concept of sustainable transportation, like its parent concept of sustainability, is vast, complex, and difficult to fully define. It is nonetheless a coherent concept. It implies a commitment to transportation indicators (as well as plans, policies, and technologies) that point the way toward reducing transportation's role as a major consumer of non-renewable resources, and as a major contributor to air, water, and noise pollution, while still providing access to employment, services and recreation, and support for genuine economic development.

The most salient observations and recommendations emerging from this study are:

1. STIs require a sustained community commitment to achieve success.
2. Sustainable transportation programs and practices can occur without STIs being fully implemented.
3. The process of developing STIs is itself beneficial and educational.
4. Sustainable transportation requires a holistic, intermodal approach to community mobility, including pedestrian, bicycle, transit, and automobile use. In general, reduction in the use of the automobile is necessary. STIs must reflect this intermodalism.
5. Sustainable transportation also entails simultaneous inter-related planning for resource conservation, air quality, land use, housing, design, and other community conditions related to mobility. STIs should ideally relate to other, non-transportation indicators of sustainability.
6. Sustainable transportation requires an interagency and inter-jurisdictional approach and cooperation among neighboring communities.
7. Community groups, whose volunteer activism has driven many local sustainability indicator movements, need to form alliances with local transportation agencies. The most effective activity for community groups with respect to STI is to work to refine,

improve, and publicize data that is already being collected by transportation agencies. They can also work to educate city councils, transportation agency boards, and the general public/electorate on the importance of STI.

In sum, STIs and sustainability in general are very worthy goals, but they are also large-scale and long-term goals, requiring a community consensus that in turn requires a public education process to build a long-term constituency.

Review of international experience underscores the long-term nature of STI development, but also offers long-term hope. In general, Europe (where resource limitations are more palpable and alternative transportation is more mainstream) has made greater progress in the development of sustainable transportation concepts and indicators. Scandinavian countries with their strong socialistic traditions put a heavy weight on equity for many decades. Since the 1980s, these countries may be said to have added ecology while also paying more attention to the economy.

The European Union has implemented the Transportation and Environmental Reporting Mechanism, or TERM, which has tracked more than 30 environmental STIs since 2000. Although TERM is a substantial achievement, it is concerned only with national level indicators (e.g. total transport-generated pollutant emissions), which, as yet, are not collected and reported locally. The link to policy and action is largely advisory for the moment, and many feel the EU tends to be bureaucratic, often collecting more statistics than appear needed.

Canada clearly leads the U.S. in the investigation of the nature, purposes, and means of implementation for STI programs. The work of the Centre for Sustainable Transportation, (discussed in the first section and Appendix A of this study) and the Victoria Transportation Institute (directed by Todd Litman, whose work is discussed in the first section) is to be applauded and emulated. However, to date, there has not been widespread implementation of STI at the local level in Canada.

In the U.S., wider use of sustainability indicators should ideally result from more pressure from citizens for a changed legal framework, and not from bureaucratic fiat. Such citizen pressure may grow with the realization that reduced pollution and energy costs ultimately reduce strain on household and governmental budgets. As noted in the Switzerland case study, the average Swiss family spends only 10 percent of their annual budget on transportation. In the U.S., an average family spends more than 20 percent on transportation. The American federal transportation budget allocates less than 20 percent to public transportation, while the Swiss budget allocates over half. It should be noted that California has several positive exceptions of communities where much more than 20 percent of the total transportation budget is expended on public transportation.

Other Findings

Other more specific study findings and observations include:

1. A good indicator is: a) relevant, b) clear, c) reliable, and d) regularly updated.
2. There is agreement that the number of STIs that decision-makers can handle is limited; in this sense, less is more.
3. While the case studies found no perfect STI program, there are many STIs and instructive examples in each case study.
4. The case studies and the literature both strongly suggest that building local support for STI programs is far more important and fruitful than searching for an ideal STI template.
5. Transportation tends to be somewhat marginalized in large-scale, citizen-based Community Indicator Programs. Transportation tends to be reduced to one or, at most, a few indicators; some citizen-selected indicators can be hard to measure or interpret.
6. STI development takes time, more than a single elective term of office, or even two terms (the maximum under the California term limits law). Such long-term pervasive issues are not generally the type of issue that local elections hinge upon. Sustainability advocates must respond to this fact, perhaps by focusing on the nearer term benefits and usefulness of STIs.
7. While effective transit service is intrinsically sustainable, STI can indicate whether it is more or less so (three persons in a low-emissions vehicle may well be more sustainable than a bus with few passengers).
8. There should be more dissemination and use of good STIs such as the indicators required of transit operators by the federal National Transit Database and California's Transit Development Act reporting requirements.
9. The performance of a single transit operator is not as important as the total regional mode split.
10. A good place to start is with the Regional Transportation Plan (RTP) and other routinely produced documents, such as short-range and long-range transit plans. If the document is done in compliance with ISTE/TEA-21, there will be sustainable transportation goals, objectives, and even indicators in it (and most California RTPs do appear to comply with TEA-21).
11. The role of citizen groups should be oversight, not data collection. Citizen groups should make sure that the data is collected, regularly updated, put into meaningful terms, and published and publicized appropriately.

SURVEY FINDINGS

Overall, the 81 transportation professionals responding to the longer survey think that STIs are important to develop, and they concur with the Centre for Sustainable Transportation and European Union definition of sustainable transportation, i.e.: a transportation system that:

1. Allows the basic access needs of individuals to be met safely and in a manner consistent with human and ecosystem health, and with equity within and between generations.
2. Is affordable, operates efficiently, offers choice of transport mode, and supports a vibrant economy.
3. Limits emissions and waste within the planet's ability to absorb them, minimizes consumption of non-renewable resources, reuses and recycles its components, and minimizes the use of land and the production of noise.⁶³

The transportation professionals surveyed are divided on whether sustainable transportation means either cutting transportation subsidies or less travel. They commented extensively on 31 STI presented to them, and suggested many more. Different types of agency staff responded differently. Some good “cross-cutting” STIs appear to be underrated by transportation professionals because, although relevant to sustainable transportation, they are too remote from the day-to-day business of local transportation providers. Adopting and developing databases for such “orphan” indicators represents an important potential role for state and federal governments.

Principles for Prioritizing STIs

Different modes of transportation operate most effectively at different scales. New technology and pricing schemes influence choices and expectations of mobility over time. This report is concerned mainly with STIs for local communities and local transportation agencies; we conclude that it is germane for local STIs to emphasize local, low-impact travel modes as the best choice for the many short trips made in urban areas.

A recent article in the Institute of Transportation Engineers *ITE Journal* (April 2000) outlines possible local transportation characteristics of “responsible growth” (ITE’s preferred term for smart or sustainable growth) with an extensive list that includes “a balanced system of transportation modes, in *priority order*” [emphasis added]:⁶⁴

1. Walk
2. Bike
3. Transit
4. Goods and Service movement vehicles
5. Multi-occupant vehicles (presumably favoring those with lower emissions)
6. Single-occupant vehicles (again, presumably favoring those with lower emissions)

We concur with this prioritization, and have elaborated the ITE recommendation only with the parenthetical remarks emphasizing low-emissions vehicles. STIs should track progress toward optimizing use of lower impact modes. There must be positive encouragement for shifting people to more environmentally friendly modes, and not merely shifting of motor traffic. STIs should measure the effectiveness of facilities for pedestrian, bikes and similar modes with the same exactitude as vehicular movements and congestion are measured and

gauged. Measuring the mobility and accessibility of people (rather than vehicles) should be the first and foremost goal of STIs.

Sustainability indicators, STI and Curriculum Development

In response to the discovery midway through this study that STI and sustainability indicators in general have not advanced to the level anticipated, it was determined that action, not just research, was necessary.

At the beginning of Fall Quarter 2002 at the California Polytechnic State University, San Luis Obispo, the City and Regional Planning instructor for CRP 336 (Regional and Environmental Planning Foundations) presented to the 20 class members an idea for the course project: community sustainability indicators.

Subsequently, the class focused on the creation of a web site dedicated to indicators. Recognizing that a ten-week quarter has limitations on a project that represents about 30 percent of the course program, it was decided that the fundamental goal would be to establish the framework for a web site that would expand each time CRP 336 was offered (Fall Quarter). Also, individual students would be encouraged to do an independent studies assignment (CRP 400) or senior project (CRP 461, 462) that would also contribute to building the web site over time.

The web site is on line at <http://suntzu.larc.calpoly.edu/crp/indicators/index2.html>, and initially used a similar web site maintained by the Environmental Studies Program at the University of California at Santa Barbara as a guide. (Much inspiration was drawn from the work of Maureen Hart, the author of the textbook used in the course.) The UCSB web site is available at: <http://www.es.ucsb.edu/proj/135Bindicators>. A long-term goal is to link the two web sites. It is intended that the Cal Poly web site will build from the work completed to date on San Luis Obispo sustainability indicators, as discussed in the Case Study in the previous section.

Future student efforts in developing sustainability indicators will be related to the community through coordination with the San Luis Obispo County Community Foundation, especially Executive Director Janice Fong Wolf. Also, it is proposed that the class web site contain a set of sustainability indicators for the Cal Poly campus (this being coordinated with Linda Dalton, Ph.D., AICP, Vice Provost of Institutional Planning).

In addition to community and campus indicators, the web site will highlight transportation indicators, including such topics as current research, “best-of” transportation indicators, public transportation case studies, future of transportation indicators, and links to transportation indicators. The current web site should be viewed as a “rough draft,” with much refinement and expansion to follow. However, it should be noted that the class members devoted significant effort to prepare information for the web site, especially the two class web masters, Christopher Jordan and Jason Rogers.

CONCLUSION

The pursuit of sustainable transportation and sustainable transportation indicators practices is ongoing in California. This report serves as a beginning point, an initial argument for sustainable transportation indicators as an important and viable component of transportation planning. It will be important to build on the growing number of successful experiences in California.

To date, sustainability indicators have not generated the level of energy that surrounds the new urbanism or smart growth movement, and full-fledged STI programs are virtually non-existent. Nevertheless, there is a clear need for better measurement and reporting of both the goals and results of sustainable transportation policy at transportation agencies at the local and regional level. The lack of fully-realized STI programs should not be viewed as a lack of success so much as a lack of history. Most local community indicator programs are less than 10 years old and have not established an adequate time frame for effective evaluation, nor even to become fully embedded in agency policies and local decision making.

Interest in indicators remains strong, and even appears to be growing. The efforts of organizations such as Redefining Progress and the International Sustainability Indicators Network are increasing the awareness of initiatives of local communities across the globe; this will likely lead more communities and transportation agencies to develop and implement sustainability indicators. As noted in the “history of indicators” section in the second chapter, ISIN promotes the use of indicators as a major means to mobilize increased support for sustainability at all scales, “from local neighborhoods to the global economy.” Also, it appears likely that federal and state programs will increasingly contain mandates for STIs in an effort to secure more effective use of limited funds.

At the state level, California currently does not appear prepared to redirect the economic, environmental and social forces that it influences toward transportation sustainability. Local initiatives—“islands of sustainability” like Santa Monica—together with informational networks such as ISIN will be the major source of ideas and inspiration for other local governments for the foreseeable future.

Another challenge is the need to look at sustainability multi-dimensionally, i.e., as a three-legged stool. As important as is transportation, the economic, environmental, and social equity concerns of sustainability encompass far more. The stage on which sustainable transportation indicators must perform is vast. Integrating STIs with other non-transportation measures of sustainability will not be easy, but it must be pursued.

We have noted repeatedly that sustainable transportation indicators are a long-term proposition. Fortunately, regional transportation plans also have a future horizon of 20-25 years, which makes them good planning instruments for implementing sustainability. City and county general plans also have a 20-25 year time horizon in California, so there is, at least, a chance for synchronization as with comprehensive community planning and sustainability.

APPENDIX A: REPORT ON PHASE 3 OF THE STPI PROJECT (Centre for Sustainable Transportation, Canada)

EXECUTIVE SUMMARY

Sustainable development has become a global mission. Sustainable transportation is the expression of sustainable development in the transport sector. Achievement of sustainable transportation will require understanding of what is to be achieved. The Centre for Sustainable Transportation has contributed towards such understanding by developing a widely used vision and definition of sustainable transportation. Achievement will also require a means of determining whether progress is being made towards sustainable transportation. The Centre undertook the Sustainable Transportation Performance Indicators (STPI) project to provide such a means of assessing progress. The STPI project has been conducted in three phases.

Phase 1 comprised a review of relevant activity worldwide, and development and assessment of a list of potential STPI based on the review. Phase 2 sought to confirm whether or not the project was moving in the right direction, and to secure information about potential users of STPI and how the STPI might be used. Phase 3 has involved the actual development of STPI.

After consideration of several options, development of STPI was conducted within a version of the framework developed by the European Environment Agency for its Transport and Environment Reporting Mechanism (TERM) process. The framework comprises seven topics each with a policy-oriented question, set out in the left-hand column of Table—[A-1]. STPI were developed to help answer as many as possible of these seven questions. The Centre's definition was used to help ensure that the developed STPI were relevant to assessing progress towards sustainable transportation.

The primary exercise has concerned development of an initial set of STPI, listed by topic in the second column of Table—[A-1]. The initial set comprises 14 STPI, with responses to six of the seven questions each being provided by between one and four indicators. (An indicator could not be developed at this time for the seventh question.)

Development of the initial set of STPI involved conservative application of four criteria to numerous variables that might qualify to serve as STPI or as bases for STPI. The four criteria were (i) the variable should concern sustainable transportation, as elaborated in CST's definition, or provide a clear answer to one of the seven policy questions, or both; (ii) it should be a time series, so that information would be provided on changes in performance; (iii) to the extent possible, it should represent all of Canada; and (iv) it should come from what the project team considers to be a reputable and reliable source, usually a federal government source for Canada-wide data.

In some cases, an indicator comprised a qualifying variable, in raw or normalized form. In other cases, indices were constructed from several variables. For example, Indicator 3 in the initial set of STPI is an emissions index, constructed from four variables concerning

emissions from transport of carbon monoxide, sulphur dioxide, nitrogen oxides, and volatile organic compounds. This was done in part to avoid the overrepresentation of transport emissions in the initial indicator set that would have occurred if each type of emission had been represented separately.

The initial set of STPI can be seen at a glance in Figure—[A-1]. Each indicator was constructed so that a falling graph indicates progress towards sustainable transportation and a rising graph indicates the opposite. There are both rising and falling graphs. Some progress is being made, but on balance transportation in Canada is becoming less sustainable.

Development of further STPI is proposed. The third column Table—[A-1] lists shorter-term additions to the initial set of STPI that could be developed within three years, i.e., by the end of 2005. The final column in Table—[A-1] lists longer-term additions that would require more than three years for development. As well, the initial set of STPI could be enhanced by adding more or better data points and in some cases by enriching indices. An example of such enrichment would be addition of information about emissions of breathable particulates to the index of emissions of air pollutants from road transport (Indicator 3).

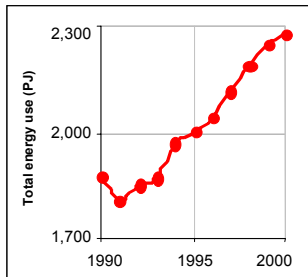
A major challenge encountered in developing the initial set of Sustainable Transportation Performance Indicators has been the lack of data relevant to and of sufficient quality for the development of such indicators. The Centre hopes that this report, as well as providing the means to track progress towards sustainable transportation, will also serve to stimulate production of better data on Canadian transport systems.

Table A-1 Initial set of STPI as Related to Framework Topics and Questions, with Proposed Short-term and Longer-term Additions

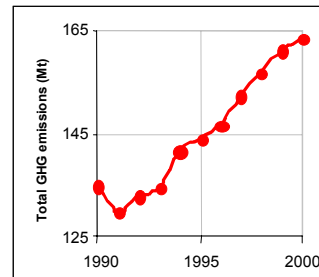
Framework Topic and Question	Initial Set of STPI	Shorter-term Additions	Longer-term Additions
1. Environmental and health consequences of transport <i>Is the performance of the transport sector improving in respect of its adverse impacts on environment and health?</i>	1. Use of fossil fuel energy for all transport 2. Greenhouse gas emissions from all transport 3. Index of emissions of air pollutants from road transport 4. Index of incidence of road injuries and fatalities	Air quality Waste from road transport Discharges into water Land use for transport Proximity of infrastructure to sensitive areas and ecosystem fragmentation	Noise Effects on human health Effects on ecosystem health

Framework Topic and Question	Initial Set of STPI	Shorter-term Additions	Longer-term Additions
<p>2. Transport activity</p> <p><i>Is transport activity changing in directions consistent with positive answers to the other questions?</i></p>	<p>5. Total motorized movement of people</p> <p>6. Total motorized movement of freight</p> <p>7. Share of passenger travel <i>not</i> by land-based public transport</p> <p>8. Movement of light-duty passenger vehicles</p>	<p>Utilization of passenger vehicles</p> <p>Urban automobile vehicle-kilometres</p> <p>Travel by non-motorized modes in urban areas</p> <p>Journey-to-work mode shares</p>	<p>Urban and intercity person-kilometres</p> <p>Freight modal participation</p> <p>Utilization of freight vehicles</p>
<p>3. Land use, urban form and accessibility</p> <p><i>Are land use, urban form, and transportation systems changing so as to reduce transportation effort?</i></p>	<p>9. Urban land use per capita</p>	<p>Urban land use by size class and zone</p> <p>Employment density by CMA, and urban size class and zone</p> <p>Mixed use (percent walking to work; ratio of jobs to employed labour force)</p>	<p>Share of urban population and jobs served by transit</p> <p>Share of population and employment growth on already-urbanized lands</p> <p>Travel and modal split by urban zone</p>
<p>4. Supply of transport infrastructure & services</p> <p><i>Are we increasing the efficiency of use of current infrastructure & changing the infrastructure supply in sustainable ways?</i></p>	<p>10. Length of paved roads</p>	<p>Length of sustainable infrastructure</p> <p>Transit seat-kilometres per capita</p>	<p>Congestion index</p>
<p>5. Transportation expenditures & pricing</p> <p><i>Are the patterns of expenditure by governments, businesses, and households, and the associated pricing systems, consistent with moving towards sustainability?</i></p>	<p>11. Index of relative household transport costs</p> <p>12. Index of the relative cost of urban transit</p>	<p>Percent of net government transport expenditures spent on ground-based public transportation</p> <p>Transport-related user charges</p>	<p>Expenditures by businesses on transportation</p>
<p>6. Technology adoption</p> <p><i>Is technology being used more in ways that make vehicle transport systems and their utilization more sustainable?</i></p>	<p>13. Index of energy intensity of cars & trucks</p> <p>14. Index of emissions intensity of the road-vehicle fleet</p>	<p>Percent of alternative fuel vehicles in the fleet</p> <p>Percent of passenger-km and tonne-km fuelled from renewable energy</p>	<p>Percent of labour force regularly telecommuting</p>
<p>7. Implementation and monitoring</p> <p><i>How effectively are environmental management and monitoring tools being used to support policy- and decision-making towards sustainability?</i></p>		<p>Number of sustainable transport indicators regularly updated and widely reported</p> <p>Public support for initiatives to achieve sustainable transportation</p>	<p>Number of CMAs where planning and delivery of transport and related land use matters have a single authority</p>

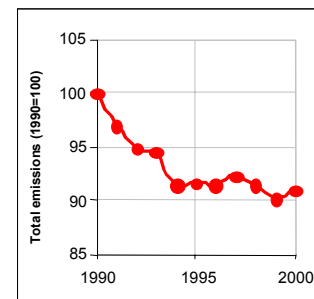
1. Use of fossil fuel energy for all transport



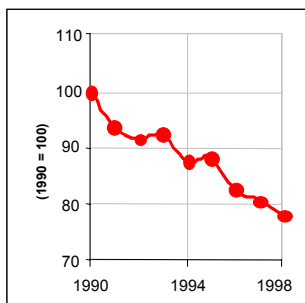
2. Greenhouse gas emissions for all transport



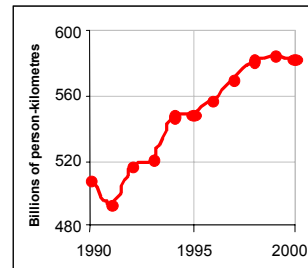
3. Index of emissions of air pollutants from road transport



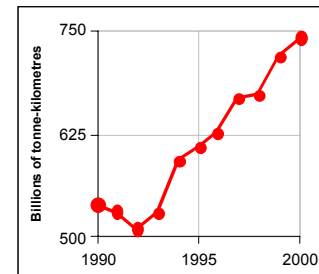
4. Index of incidence of road fatalities and injuries



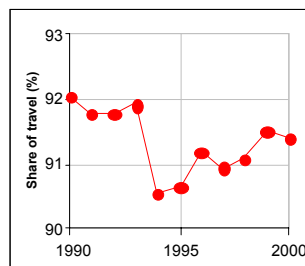
5. Total motorized movement of people



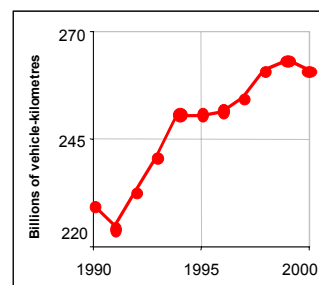
6. Total motorized movement of freight



7. Share of motorized movement of people *not* by land-based public transport



8. Movement of light-duty passenger vehicles



9. Urban land use per capita

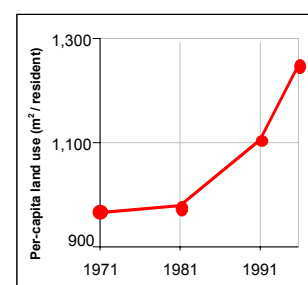
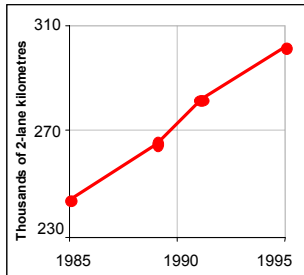
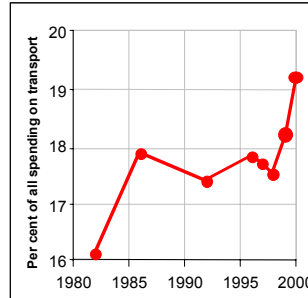


Figure A-1 The 14 Indicators in the Initial Set of STPI

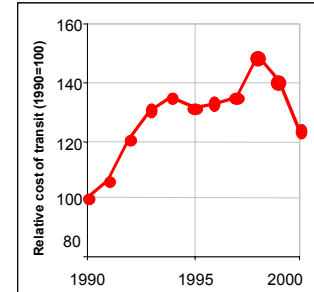
10. Length of paved roads



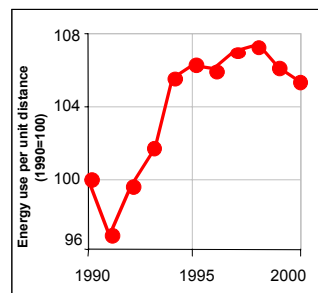
11. Index of relative household transport costs



12. Index of the relative cost of urban transit



13. Index of the energy intensity of cars and trucks



14. Index of the emissions intensity of road vehicle fleet

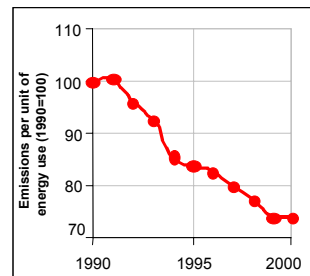


Figure A-1: The 14 Indicators in the Initial Set of STPI (continued)

APPENDIX B: SURVEY – SUSTAINABLE TRANSPORTATION INDICATORS

This appendix presents the introductory letter and on-line Survey Form for the Mineta Transportation Institute study of Sustainable Transportation Indicators.

INTRODUCTORY LETTER

Dear Transportation Professional:

We hope you can respond to this survey within two weeks. Your cooperation is greatly appreciated and will greatly enhance the overall results of the research.

The Cal Poly team thanks you in advance for sharing your knowledge. If you have any comments regarding the survey or the overall study, please contact

Dr. Richard Lee, AICP
City and Regional Planning Department
California Polytechnic State University
San Luis Obispo, CA 93407

OR

Kris Szlakowski, Research Associate

SURVEY FORM

YOUR CONTACT INFO (All individual responses will be confidential)

Name.

Title.

Agency.

Phone.

Email.

1. What is the primary function of your agency (choose one)?

- Street and highway management
- Public Transit Operations
- Transportation Planning Agency
- Transportation Consulting
- Other

2. Is your Agency based in California?

- Yes
- No
- No, but it does substantial work in California

3. Definition of Sustainable Transport

The Canadian Centre for Sustainable Transportation (CST/CTD) has adopted the following definition of Sustainable Transportation. In April 2001, a slightly amended version of this definition was adopted by the European Union (via their Council of Ministers of Transport and Communication) as the 15-nation European Union's formal definition of sustainable transport (CST, *Guidance Document*, 2002, 4-5),

A sustainable transportation system is one that:

- Allows the basic access needs of individuals to be met safely and in a manner consistent with human and ecosystem health, and with equity within and between generations.
- Is affordable, operates efficiently, offers choice of transport mode, and supports a vibrant economy.
- Limits emissions and waste within the planet's ability to absorb them, minimizes consumption of non-renewable resources, reuses and recycles its components, and minimizes the use of land and the production of noise.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Please indicate the overall degree to which you agree with this definition.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

4. Please indicate the degree to which you agree with the following statements.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
A Sustainable Transportation system should help realize a community's economic, environmental and equity goals.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
A Sustainable Transportation system entails a self-sustaining (financing) system wherein users (benefactors) pay the full costs of system construction, operation and expansion.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
A Sustainable Transportation system actively promotes and enhances more environmentally friendly transportation modes.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sustainable Transportation systems reduce use of and dependence on conventional automobiles.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
A Sustainable Transportation system entails less overall (per capita) travel.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sustainable Transportation should focus on making all transportation modes more environmentally sound.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

5. Sustainable Transportation Indicators

Sustainable Transportation Indicators may be defined as follows:

Sustainable Transportation Indicators are regularly updated performance measures that help transportation planners and managers take into account the full range of economic, social and environmental impacts of their decisions.

	Very Important	Important	Somewhat Important	Not that Important
In your opinion, how important is it that California transportation agencies actively develop and implement Sustainable Transportation Indicators?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

For questions 6-10 below, please list what you consider to be the most important five (5) STIs from the standpoint of surface transportation overall. You do NOT need to rank your five indicators you choose. Choose from the list below (please use ID# from list).

For each of your five chosen indicators, please indicate your assessment of the ease of compiling and updating the data needed to calculate the STI on a regular basis using the following scale:

- Easy—data is routinely collected and available
- Moderately difficult—data could be collected and made available with some effort
- Difficult—data not available, and a major effort would be needed to collect it

LIST OF POSSIBLE TRANSPORTATION PERFORMANCE INDICATORS

(Derived from Litman, 1999, TERM 2001, and CST 2002 and other sources)

1. Percentage of household expenditures devoted to transportation, including direct expenditures on vehicles and fares and indirect expenditures, such as residential parking and taxes spent on transportation facilities
2. Average amount of resident's time devoted to non-discretionary travel
3. Person miles traveled versus vehicle miles of travel
4. Accessibility of non-drivers to employment centers and services
5. Per capita land area paved for roads and parking facilities
6. Quality of pedestrian and bicycle environment (e.g., the Pedestrian Environment factor used in Portland, Oregon's regional transportation modeling)
7. Quality of public transit service, including number of service hours, service frequency, average speed relative to automobile traffic speeds, safety, comfort (including number of standees during peak periods, number of bus shelters & other waiting facilities), availability of information, & integration with other modes
8. Average number of major services (e.g. grocery, library, school, playing fields, etc.) within walking distance of residents, or average walking distance between residences and public services such as schools and retail centers
9. Land use densities (residential) and intensities (commercial)
10. Land use mix: e.g., proximity of residential, commercial & employment land uses
11. Quality of delivery services (e.g., groceries)
12. Quality of mobility services for residents with special mobility needs
13. Affordability of public transit service by lower income residents (e.g., fares as a portion of lowest quintile income)

14. Portion of residents with transit service within one-quarter mile
15. Motor vehicle accident fatalities and accidents
16. Per capita transportation energy consumption per vehicle mile and passenger mile, by mode
17. Per capita transportation pollution emissions (air, water, noise) and share of total emissions
18. Medical costs attributed to transportation, including care for injuries and pollution related diseases
19. Portion of transportation-related costs paid by public funding
20. Degree of residents’ participation in transportation and land use decision-making
21. Miles of facility by type (e.g., vehicular roadways, bikeway, busways, walkways)
22. Per capita land area devoted to transportation facilities (including parking)
23. Number of vehicles by type (including bicycles)
24. Mode split (e.g. car, transit and non-motorized/low-power modes, walk) by trip purpose (e.g., work, shop, personal business, social, recreational)
25. Average travel time and distance, by mode and purpose
26. Freight transport by mode and type of goods
27. Number of jobs and other regional attractions accessible within 30/45/60 minutes by mode from defined subareas
28. Investments in transportation infrastructure per capita and by mode
29. Real change in passenger transport *price* paid by consumer by mode
30. Real change in passenger transport *cost* incurred by supplier by mode
31. Person hours lost to recurring congestion and traffic delays

6a.

Indicator ID#	
---------------	--

6b.

	Easy	Moderately difficult	Difficult
Rating	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

7a.

Indicator ID#	<input type="text"/>
---------------	----------------------

7b.

	Easy	Moderately difficult	Difficult
Rating	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

8a.

Indicator ID#	<input type="text"/>
---------------	----------------------

8b.

	Easy	Moderately difficult	Difficult
Rating	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

9a.

Indicator ID#	<input type="text"/>
---------------	----------------------

9b.

	Easy	Moderately difficult	Difficult
Rating	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

10a.

Indicator ID#	<input type="text"/>
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10b.

	Easy	Moderately difficult	Difficult
Rating	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

For questions 11-15, please list what you consider to be the most important five (5) STIs from the standpoint of YOUR transportation agency. Again, you do NOT need to rank your five indicators you choose. Use the list above.

Again, for each of the five indicators, please indicate your assessment of the ease of compiling and updating the data needed calculate the STI on a regular basis using the following scale:

- Easy–data is routinely collected and available
- Moderately difficult–data could be collected and made available with some effort
- Difficult–data not available, and a major effort would be needed to collect it

11a.

Indicator ID#	<input type="text"/>
---------------	----------------------

11b.

	Easy	Moderately difficult	Difficult
Rating	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

12a.

Indicator ID#	<input type="text"/>
---------------	----------------------

12b.

	Easy	Moderately difficult	Difficult
Rating	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

13a.

Indicator ID#	<input type="text"/>
---------------	----------------------

13b.

	Easy	Moderately difficult	Difficult
Rating	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

14a.

Indicator ID#	<input type="text"/>
---------------	----------------------

14b.

	Easy	Moderately difficult	Difficult
Rating	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

15a.

Indicator ID#	<input type="text"/>
----------------------	----------------------

15b.

	Easy	Moderately difficult	Difficult
Rating	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

16. Please feel free to nominate other important STIs not listed above.

<input type="text"/>

17. If you have any other comments about STIs in general, we would appreciate them.

<input type="text"/>

Thank you very much for your time and interest!

For more information on the research project and the Mineta Transportation Institute, go to:

<http://transweb.sjsu.edu/RPD2106.htm>

APPENDIX C: EUROPE COST C8 COMMITTEE

Draft Indicator List of June 2002: Nine Transportation Indicators out of 49 Total

Explanation of key concepts and data employed (transportation indicators in bold)

Pre-selected indicators

No.	Indicator name	Field	Meaning and use
1	Length of courses	Environment	Gives an idea of the extension and seriousness of courses
2	Weight of waste in the streets	Environment	Gives an idea of environmental education of the city
3	Weight of waste in the streets per capita	Environment	Gives an idea of environmental education per capita
4	Quantity (Qty) of available courses	Environment	Provides information on the scope of courses offered
5	Qty of courses given	Environment	Provides information on the quality of courses offered
6	Qty of special courses	Environment	Provides information on courses on special matters
7	Qty of courses taken	Environment	Furnishes information about the interest for these courses
8	Qty of citizens committees	Socio-economics-env	Gives information on citizens' commitment
9	Qty of proposals received	Socio-economics-env	Gives information on citizens' participation
10	Qty of committee meetings	Socio-economics-env	Gives information on citizens in municipal affairs
11	Use of bikes	Infrastructure	Provides information on key alt. mode of transport
12	Percentage of rural land taken	Environment	Provides information of city growth
13	Percentage of lots in compliance	Environment	Provides information on compliance with municipal bylaws
14	Qty of penalties for no compliance	Municipal admin	Provides information of enforcement action
15	Qty of technical regulations	Municipal admin	Provides information on technical aspects
16	Percentage of research activities	Environment	Furnishes data on time/funds devoted to research
17	Qty of funds in each area	Environment	Gives information about allocation of funds
18	Persons per room	Social-economics	Information about promiscuity
19	Average size family	Social-economics	Gives information on density
20	Persons per dwelling	Social-economics	Gives information on social status
21	Qty of acres in compliance	Social	Gives information on compliance of regulations

No.	Indicator name	Field	Meaning and use
22	Population	Social	Its trends indicates growth
23	Percentage of dwellings without	Social	Indicates lack of enforcement proper documentation
24	Qty of local municipal offices	Municipal admin	Shows decentralization of municipal offices
25	Qty of paperwork reassigned	Municipal admin	Shows reengineering of municipal administration circuits
26	Qty of dwellings built	Social	Furnishes information about the construction activity
27	Soil occupation coefficient	Social	Information on density
28	Presence in cultural events	Social	Informs about people culture
29	Food system	Social	Describes the chain of food distribution
30	Destination of family income	Social	Describes allocation of income
31	Percentage of visitors over past year	Economics	Shows tourism
32	Qty of annual visitors	Economics	Indicates trends in tourism
33	Qty of visiting people out site of residence	Economics	Indicates floating population in a city
34	Transient population	Economics	Indicates the city importance as a transportation hub
35	Qty of people interested in ecotourism	Economics	Shows environmental culture
36	Demand for night recreation places	Economics	Indicates preferences, especially from young people
37	Public transportation control	Social-economics	Indicates public input on public transportation
38	Number of accidents	Social-economics	Gives an indication of street safety
39	Transportation costs	Social-economics	Related with social issues
40	Funds invested in public transportation	Social-economics	Shows how the City Hall considers transportation a priority
41	Transportation cost to user	Social-economics	Social cost
42	Actual income	Social-economics	Shows a basic social aspect
43	Quantity of passengers	Social-economics	Indicates use of population of public transit
44	Actual income (by mode)	Social-economics	Show discrimination in costs
45	Km. traveled by route	Social-economics	Informs about length of transportation routes
46	Percentage of private investment	Economics	Depicts private interest and potential of the city
47	Progress percentage per program	Economics	Indicates rate of advance of projects
48	Total surface built	Social	Shows an economic trend
49	Percentage of compliance with norms	Social	Indicates degree of enforcement

APPENDIX D: SWISS NATIONAL RESEARCH PROGRAMME 41, PROJECT C

Proposed Sustainability Indicators for the Transport Sector (Project Summary p.5, 1998)

Criteria	Indicators
Climate	Emissions of greenhouse gases [t CO ₂ -equivalent/a]
Ozone Layer	Emissions of ozone layer destroying agents [t CFC R11-equivalent/a]
Air Pollution	Air pollution in residential areas (NO ₂ , O ₃ , PM ₁₀) [% of excessively affected people] NO _x emissions [t/a] VOC emissions [t/a]
Noise	Noise levels in residential areas [% of excessively affected people] Noise levels in protected and recreational areas [% of excessively affected areas]
Natural Habitats / Landscapes	Unfragmented areas [distribution of frequencies by size]
Resources	Consumption of fossil fuels [J/a] Energy intensity [J/Pkm; J/tkm] Proportion of renewable fuels [%]
Social Costs	Coverage of operating costs [%] Amount of external damage costs [CHF/a]
Price	Corrected prices of specific transport services [CHF/Pkm; CHF/tkm]
Solidarity	Public expenditures for selected beneficiaries [CHF/inhabitant.a] Access to regional centers by public transportation [% of communities; % of population]
Safety / Security	Traffic casualties (safety) [deaths and injuries/a] Crimes (security) [criminal offenses in public transportation areas/a]
Settlements / Areas	Area occupied by transport system [km ²] Share of transport system in total settlement area [%]
Participation	Satisfaction with participation opportunities [qualitative]
Individuality	(no suitable indicator found)

APPENDIX E: NEWEST INDICATOR LIST FOR COMMUNAL AND CANTONAL ROAD PLANNING AND PROJECTS

According to research project 2002 *Nachhaltigkeit im Verkehr*, by the Swiss Association of Transportation Engineers, based on pages 23-25. (English Summary Translation)

1. Ecological Criteria (Total Of 11 Indicators)

Goals:

- 1a) Reduction of environmental impacts to a level, which is not harmful in the long run
- 1b) Reduction of use of energy

Objectives:

- 10. Lower emissions of air pollutants
- 11. Lower emissions of Green House gases
- 12. Minimize soil loss and degradation
- 13. Minimize impact on natural landscapes and habitats
- 14. Preservation of watersheds and water resources
- 15. Promote energy efficiency

Indicators:

- 101. NO_x - Emissions
- 102. PM₁₀ - Emissions
- 103. VOC - Emissions
- 111. CO₂ -Emissions
- 121. Sealed Surfaces
- 122. Volume of land fills needed
- 131. Impact on habitats
- 132. Impacts during building phase
- 133. Change of landscape
- 144. Impacts on watersheds and water resources
- 151. Use of energy

2. Economical Criteria (total of 14 indicators)

Goals:

- 2a) Promotion of economic development
- 2b) Efficient transportation infrastructure
- 2c) Optimal use of economic means

Objectives:

- 20. Access to transportation infrastructure
- 21. Strengthening the quality of the economy
- 22. Efficient traffic flow
- 23. Driving and walking comfort
- 24. Economical use of vehicles
- 25. Economical construction and use of transportation infrastructure

Indicators:

- 201. Access to main roads
- 211. Potential for industrial development
- 221. Travel time in the area of the traffic model

Indicators (continued):

- 222. Saved reserve travel time
- 231. Driving on congested roads
- 232. Smoothness of the drive including pedestrians at intersections
- 233. Entering and exiting main roads
- 241. Fixed costs in truck traffic
- 242. Variable costs in all cars
- 243. Internal benefits of new traffic
- 251. Building costs
- 252. Operating and maintenance cost
- 253. Possibility of phasing new construction
- 254. Risk in cost investment

3. *Societal Criteria (total of 13 indicators)*

Goals:

- 3a) Human health
- 3b) Co-existence of transportation users
- 3c) Quality of life and housing
- 3d) Promotion of regional equity of development

Objectives:

- 30. Traffic safety
- 31. Minimize noise and air pollution
- 32. Enhance tolerance among road users
- 33. High degree of sense of place
- 34. Limitation of urban sprawl
- 35. Enhance accessibility to settlements
- 36. Degree of implementation of Regional Planning vision

Indicators:

- 301. Traffic accidents
- 311. Air pollution by NO₂ and PM10
- 312. Noise pollution from traffic in residential area
- 313. Noise pollution from traffic in potential residential areas
- 314. Noise pollution from traffic in environmentally protected and recreational areas
- 321. Separating effect of traffic on pedestrians
- 322. Street is well suited for bicycle traffic
- 331. Use of the street right of way for other purposes possible
- 331. Traffic reduction in residential areas
- 341. Induced traffic
- 351. Change of accessibilities
- 352. Accessibility of destinations by public transit on the road
- 361. Degree of adhering to Regional Plan

APPENDIX F: MONET, AUGUST 2002
EXCERPT FROM THE SUSTAINABILITY LIST OF THE
SWISS FEDERAL OFFICE OF SPATIAL DEVELOPMENT

Showing the ten direct mobility indicators and the indicators for air, climate, and energy.

No.	Name <i>(In italics: Indicators that are not yet able to be compiled)</i>	Reference to postulates of sustainable development As per pages 6-7
11.7	Investment as a percentage of GDP	10a
11.8	Duty-free import quota	10b
11.9	Corruption	10b
11.10	Market share of products from fair trade	14a, 12b
11.11	Proportion of ODA provided to help build trade capacity	6a
11.12	<i>Capital stock</i>	10a
12	Domestic markets	
12.1	Level of prices	9a
12.2	Share of market in GDP	9a
12.3	Environment-related taxes	9b
12.4	Greening of the tax system	9c
12.5	<i>Degree of internalisation of external costs of fossil fuels</i>	9b
12.6	<i>Degree of regulation of markets</i>	9a, c
12.7	<i>Subsidies harmful to the environment</i>	9b
12.8	<i>Environment-related subsidies</i>	9b, c
13	Employment	
13.1	Unemployment rate	13
13.2	Contentment with work	13, 13a
13.3	Proportion of people of working age who are employed	13
13.4	Job creation	13
13.5	Working poor	13, 2c
13.6	Ratio of average female wage to male wage	4a, b
13.7	Vertical segregation in the labour market by sex	4a, b
13.8	Time spent in paid labour and household and family work by sex	4a, b
14	Research, development and technology	
14.1	Patent applications	10a-c
14.2	Number of researchers in relation to the total workforce	10a-c
14.3	Expenditure on research and development	9, 10
15	Production	
15.1	GDP (cyclically adjusted)	10a
15.2	Cultivated land	10a
15.3	Net investments	10a
15.4	Final energy consumption in the industrial and services sector	12a
13.4	Job creation	10a
11.6	Labour productivity	10a
15.5	Energy efficiency in the industrial and services sector	12a
15.6	Organic farming	12a
11.12	<i>Capital stock</i>	10a
15.7	<i>Material efficiency of economy</i>	12a

No.	Name <i>(In italics: Indicators that are not yet able to be compiled)</i>	Reference to postulates of sustainable development As per pages 6-7
16	Consumption	
16.1	Consumer spending (adjusted for purchasing power)	2a
11.10	Market share of fair-trade products	12b
16.2	Market share of <<bio>> products	12b
16.3	Environment-related levies	9b, 12b
16.4	<i>Market share of non-food goods with ecolabels</i>	12b
17	Mobility	
17.1	Performance of passenger traffic	2a, 10a, 16
17.2	Share of public transport and human-powered mobility in total passenger traffic	10a, 12a, b 16, 17
17.3	Performance of goods traffic	10a, 12a, 16
17.4	Proportion of terrestrial transport of goods by rail	10a, 11a 12a, b, 16, 17
17.5	Number of landings / distance covered by passenger air transport	10a, b, 16, 17
17.6	Number of households disposing of at least one car	10a, 16, 17
17.7	Accessibility of public transport	4b, 4c, 12a, 16
17.8	Final energy consumption of traffic	12a, 12b, 16, 17
17.9	Tonne-kilometres or passenger kilometres as a percentage of GDP	12a, 12b, 16, 17
17.10	Total costs of traffic	9b
18	Materials, wastes and impacts	
18.1	Population exposed to noise	2b
18.2	Heavy-metal contamination of sewage sludge	15a, 17b
18.3	Radioactive waste stocks	15a, 17b
18.4	Generation of household waste	12a, b
18.5	Generation of hazardous waste	12a, b, 17b
18.6	Waste recycling	12a, b, 16a, b
18.7	Non-ionising radiation	2b
19	Soil	
19.1	Heavy-metal contamination	17b, 18c
19.2	Contamination with PAH (polycyclic aromatic hydrocarbons)	17b, 18c
19.3	Arable land	10a, 16a
19.4	Pollutants input into the soil	17b, 18a, c
19.5	<i>Soil compaction</i>	16a, b
19.6	<i>Risk of soil erosion</i>	16a, b
20	Water	
20.1	Household water use	2a, 16a, 19
20.2	Nitrate concentrations in groundwater	17a
20.3	Phosphorous concentrations in lakes	17a
20.4	Public expenditure on wastewater treatment	12a, b, 17a, b
20.5	Space requirement of flowing waters	18a, b, 20
21	Air	
21.2	Population exposed to excessive emissions	2b
21.3	Concentration of nitrogen dioxides	17a
21.4	Concentration of ozone	2b, 17a, 18c
21.5	Concentration of inhalable fine particles	2b, 17a
21.6	Emissions of NO _x , NH ₃ and VOC ₅	17a
21.7	Consumption of fossil fuels	16b

No.	Name <i>(In italics: Indicators that are not yet able to be compiled)</i>	Reference to postulates of sustainable development As per pages 6-7
22	Climate	
22.1	Annual mean temperature in Switzerland	18c, 19
22.2	Emission of greenhouse gases	17a, 18c, 19
22.3	Carbon-dioxide efficiency of traffic	17a, 18c, 19, 12a, b
22.4	Carbon-dioxide efficiency of economy	17a, 18c, 19, 12a, b
23	Land Use	
23.1	Settled area	2a, 16b, 20
15.2	Cultivated land	2a, 15a, 16b, 20
23.2	Landscape diversity	20
23.3	Expansion of settled area	2a, 16b, 19, 20
23.4	Extent of utilization	2a, 16b
23.5	Area Identified for settlement	2a, 16b
23.6	<i>Urban sprawl</i>	16b, 20
24	Biodiversity	
24.1	Species diversity	18a, 19, 20
24.2	Net change in the threatened status of species	18a, 19, 20
24.3	Diversity of habitats	18a, 19, 20
24.4	Livestock races and agricultural plant varieties	18a, 19, 20
24.5	Protected areas	16b, 19
24.5	Ecological balance areas	18a
25	Energy	
25.1	Useful energy consumption	2a, 16a, b, 17a
25.2	Output of power stations	2a, 10a
25.3	Final energy consumption	2a, 16a, b, 17a
25.4	Energy efficiency of economy	12a, 16a, b, 17a
25.5	Share of consumption of renewable energy resources	16a, b
25.6	Buildings that meet the <<Minergie>> low-energy standard	12c
25.7	<i>Grey energy</i>	2a, 16a, b, 17a
26	Forests	
26.1	Forest area	2a, 15a, b
26.2	Naturalness of forests	18a, 19
26.3	Condition of protective forest	2a, b, 3b
26.4	Wood harvesting intensity	16a
26.5	Subsidies for forestry	10d

**APPENDIX G: CITY OF ZURICH
SUSTAINABILITY CONFORMITY TEST
AS MANDATED FOR MOBILITY PROJECTS
IN SPRING 2002**

Summary of Main Topics (Each topic gets from –2 to +2 points)

1. *Societal Dimension, “Gesellschaftliche Dimension”*

- G1 Quality of dwellings and their surroundings
- G2 Connection between dwellings and their surroundings
- G3 Attractiveness of neighborhood centers and of the CBD
- G4 Traffic safety
- G5 Personal security
- G6 Access for everybody
- G7 Public participation/Individuality

2. *Economical Dimension, “Wirtschaftliche Dimension”*

- W1 True costs and understanding of costs
- W2 Competitiveness
- W3 Adequate access
- W4 Capacity of the mobility infrastructure
- W5 Efficiency of freight traffic
- W6 Reliability
- W7 Comfort

3. *Ecological Dimension, “Oekologische Dimension”*

- U1 Energy efficiency of the transportation system
- U2 Greenhouse gas emissions
- U3 Air pollution
- U4 Traffic noise emissions
- U5 Protection of habitats
- U6 Ecological networking
- U7 Use of surfaces and sealing of soil

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ABBREVIATIONS AND ACRONYMS

ABAG	Association of Bay Area Governments
AGS	Alliance for Global Sustainability
API	Academic Performance Index
APTA	American Public Transportation Association
AVI	Automatic Vehicle Identification
BART	Bay Area Rapid Transit
CBD	Central Business District
CEC	Community Environmental Council
CEQA	California Environmental Quality Act
CIR	Community Indicators Roundtable
CST/CTD	Canadian Centre for Sustainable Transportation/LeCentre pour le transport durable
DEIR	Draft Environmental Impact Report
EEA	European Environmental Agency
EIR	Environmental Impact Report
ETH	Swiss Federal Institute of Technology
EU	European Union
EUA	Existing Urbanized Area
FCD	Foundation for Community Design (San Luis Obispo County)
GDP	Gross Domestic Product
FTA	Federal Transit Administration
IISD	International Institute for Sustainable Development
ISIN	International Sustainability indicators Network
ISTEA	1991 Intermodal Surface Transportation Efficiency Act
ITE	Institute of Transportation Engineers
ITS	Intelligent Transportation System
JCCI	Jacksonville Community Council, Inc.
LITA	Local Index of Transit Availability
LLP	Limited Liability Partnership
LOS	Level of Service
MIT	Massachusetts Institute of Technology
MONET Project	A two-year investigation into mathematical web services funded by the European Commission as part of the Information Society Technologies (IST) Programme of the Fifth Framework
MTA	Metropolitan Transportation Authority
MTC	Metropolitan Transportation Commission

NCTCOG	North Central Texas Council of Governments
NISTRA Project	Nachhaltigkeit–Indikatoren fuer strasseninfrastrukturprojekte (Sustainability Indicators for street infrastructure projects)
OECD	Organization of Economic Cooperation and Development
PM-10	An air quality standard enacted by the U.S. EPA referring to airborne particles with a diameter of 10 micrometers or less
RSHA	Regional State Highway Account
RTIP	Regional Transportation Improvement Program
RTP	Regional Transportation Plan
RTPA	Regional Transportation Planning Agency
SAIC	Science Applications International Corporation
SCAG	Southern California Association of Governments
SCANS	Secretary's Commission on Achieving Necessary Skills
SCP	Sustainable City Program
SCSC	Sustainable City Steering Committee
SCWG	Sustainable City Working Group
SDI	Sustainable Development Indicators
SJX	San Jose BART Extension
SLOCOG	San Luis Obispo Council of Governments
SCCIP	Santa Barbara South Coast Community Indicators Project
STI	Sustainable Transportation Indicator
STPI	Sustainable Transportation Performance Indicators
SULEV	Super-Ultra Low Emissions Vehicle
SVI	Swiss Association of Transportation Engineers
TDA	Transportation Development Act
TDM	Transportation Demand Management
TEA-21	Transportation Efficiency Act for the 21 st Century
TERM	Transportation and Environmental Reporting Mechanism
TOD	Transit-Oriented Development
TRANSIMS	Transportation Analysis and Simulation System
TRIS	Transportation Research Information Services
TSM	Transportation Systems Management
VMT	Vehicle Miles Traveled
WBCSD	World Business Council for Sustainable Development
ZEV	Zero Emissions Vehicle

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- An extensive literature review on California's General Plan process, the nature of sustainability and sustainable transportation, and criteria and evaluation methods for plans
- Detailed analysis and scoring of policies from 26 exemplary General Plans against criteria designed to measure both transport sustainability and plan quality
- In-depth case studies of the General Plan process in seven diverse California communities
- Key informant interviews

The results of these several lines of analysis and inquiry were synthesized into a series of observations, conclusions and recommendations. Chief among these are the desirability of encouraging more frequent General Plan updates, the need for greater emphasis on implementation of plan policies, and the need for and utility of educational and outreach efforts aimed at enhancing the proliferation of General Plan policies that promote more sustainable transportation systems at the local level.

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This report presents the preliminary findings and recommendations of the 1992 performance audit of the Citywide Dial-A-Ride system. The purpose is to conduct an independent evaluation, and to provide management and policy makers with practical recommendations for transit improvement. Five performance indicators, specific to financial health, are addressed.

Newman, P. & Kenworthy, J. 2001. "Transportation energy in global cities: sustainable transportation comes in from the cold?" *Natural Resources Forum*. 25(2): 91-107.

This paper shows that cities with significant sustainable transportation system have reduced cost on road construction, maintenance, fewer road accidents and less air pollution. Electric rail technology; Indicator of transit cost recovery; Gross Regional Product spent on transportation; Greenhouse gas reduction strategies; Move to re-urbanization.

Pratt, R. & Lomax, T. (n.d.). "Performance Measures for Multimodal Transportation Systems." *Transportation Research Record*. 1518: 85-93.

This article discusses transportation systems analyses and their changing role as the decision context for improvement projects. It includes a discussion of performance measures including definitions, calculation procedures, and data required for each measure. It does not specifically mention sustainability.

Roberts, D. 2001. *Institutions for Transportation Operations*.

Provides an overview of the institutional and organizational arrangements that have been created in many parts of the country that have been in the vanguard of ITS (Intelligent Transportation Systems) and operations activities. Sustainability ultimately will require a continuing, reliable, predictable funding base and probably establishment of a more formal structure beyond a partnership based upon intergovernmental agreement.

This packet summarizes the workshop that discussed sustainability indicators. Website references are provided for specific city and other regional projects (i.e. Santa Monica and New Jersey). "Healthy Mountain Communities" specifically mentions transportation. Rocky Mountain Institute. 2001. *RMI Indicators Workshop Proceedings*.

San Francisco Bay Area Rapid Transit District. 2001. *On Course for the 21st Century, Annual Report*.

This is an audit-generated financial year-end report; therefore the indicators pertain to financial conditions and factors of the BART system. The report also includes “Performance Highlights for Fiscal Year 2001 vs. 2000). These highlights are categorized as: Rail Ridership; Operations; and Financial measures.

San Francisco Bay Area Rapid Transit District. 1999. *BART Strategic Plan: A New Era of Partnership*.

BART’s examination of issues and indicators including: a fast-growing need for system rehabilitation, shifts in regional growth patterns that affect transit priorities, changing customer expectations, and new funding dynamics. Development of this plan included data analysis, assessment of past trends and future projections, and considerable input from BART’s stakeholders including employees and customers.

San Francisco County Transportation Authority. 2001. *Congestion Management Program, 2001*.

Performance Measures in this study include: Roadway Level of Service (LOS); Transit Coverage/Routing; Transit Frequency; and Interoperation Coordination, as well as multimodal performance elements and performance measures.

San Francisco Bay Area Metropolitan Transportation Commission. 2001. *Performance Measures Report for the 2001 Regional Transportation Plan for the San Francisco Bay Area*.

The 2001 RTP identifies six broad goals, and their corresponding Performance Measures including Mobility, Economic Vitality, Community Vitality, the Environment, and Equity. It includes reasoning as to how and why these goals were selected.

San Francisco Bay Area Metropolitan Transportation Commission. 2001. “Appendix B: Detailed Methodologies for Performance Measures, and Appendix C: Performance Measures Working Group Meeting Summaries.” *Performance Measures Report for the 2001 Regional Transportation Plan for the San Francisco Bay Area*.

Examines methodologies employed to measure five specific performance measures: Mobility, Economic Vitality, Community Vitality, Environment, and Equity in Appendix B. Appendix C provides detailed meeting summaries of six separate Performance Measures working group meetings.

San Francisco Bay Area Metropolitan Transportation Commission Programming & Allocations Section. 2001. *Statistical Summary of Bay Area Transit Operators, Fiscal Years 1995-96 through 1999-2000*.

This report is a summary of financial and operating information for the 16 largest public transit agencies in the nine-county San Francisco Bay Area. Six performance measurements, their individual formulas, and their corresponding

performance concepts were specifically examined, specifically with regard to cost, labor, and service efficiency.

Schuman, R. 2001. *Summary of Transportation Operations Data Issues*. PBS&J.

This paper discusses the importance of data collection for the surface transportation industry. As more transportation agencies move aggressively toward system operations and performance measurement, the need for comprehensive quality data becomes imperative.

Smith, E., Watkins, B. & Carlisle, J. 2000. *Santa Barbara South Coast Community Indicators 2000*. Santa Barbara, CA: Regents of University of California.

The report documents the social, environmental, and economic factors of Santa Barbara's South Coast community through the collection and analysis of various indicators including mobility (pages 26, 27).

Southern California Association of Governments (SCAG). 2001. *Regional Transportation Plan*.

SCAG RTP document covering these eight indicators: mobility, accessibility, environment, reliability, safety, equity/environmental justice, geographic equity, cost-effectiveness. The SCAG Regional Goals have been updated to emphasize sub-regional and market-based approaches to improved mobility.

Southern California Association of Governments (SCAG). 1996. *Region Transportation Performance Indicators Technical Report*. Updated, March 1999.

SCAG's performance indicators seek to capture the important relationships between transportation and a diversity of public policy concerns. The performance-based approach both satisfies various provisions of federal and state mandates and is a means to selecting the most effective transportation system investments. The goal is to improve long-range investment decisions involving significant monies in order to develop a transportation system that better serves the needs of individual communities and the region as a whole. Nine performance indicators are examined.

Sussman, J. 2001. *Transportation Operations: An Organizational and Institutional Perspective*. Massachusetts Institute of Technology, MA: Civil and Environmental Engineering and Engineering Systems.

Paper intends to identify and discuss important ideas, relating to transportation operations and the associated institutional and funding changes, so as to contribute to the informed debate leading up to TEA-21 re-authorization. The following indicators of sustainability are mentioned: mobility, environment, access, safety/health, equity, affordability, efficiency, multi-modal, and supports vibrant economy.

TC Committee 6F-22. 1982. *Measuring Transit System Productivity and Performance*. 52(11).

This article summarizes the activities of the Institute of Transportation Engineer's Committee 6F-22, which undertook a study of performance indicators used by transit operators, local and regional planning agencies, and state and local governments. The specific objectives of the study were to: (1) identify performance measures of performance indicators considered most useful by the transit operators and state and provincial transportation agencies, (2) identify how the measures are utilized by different sectors of the transit community, and (3) identify the methods for assembling the required data.

U.S. Department of Transportation Bureau of Transportation Statistics. 2001. *List of Indicators & Page Reference*.

Indicator topics include safety, mobility, economic growth, human and natural environment, and national security. No mention of sustainability, but much basic data that could be used to establish baseline national levels for many sustainable transportation indicators.

United States Environmental Protection Agency. 1996. *Indicators of the Environmental Impacts of Transportation: Highway, Rail, Aviation, and Maritime Transport*.

Discusses transportation and its impacts on the natural environment; however it does not mention "sustainability" in particular. Includes four modes of transportation (highway, rail, aviation, and maritime) and their environmental effects, appropriate indicator selection including their limitations and uses, and extensive lists of indicators, most which have relevance for sustainability, issues, though from a modal rather than a community perspective.

United Way San Luis Obispo. 2001. *2001 Report Card, Action for Healthy Communities*.

Discusses seven adopted goals of the San Luis Obispo community for working towards a more healthy community. Traffic volume is mentioned relative to a goal oriented around "natural environment."

Walter, F., ed. 2001. *Sustainable Mobility: Contributions of NRP 41 Transport and Environment*. Berne, Switzerland: NRP.

This report discusses efforts in Switzerland to influence sustainable transport policy through project NRP 41. It includes three dimensions of sustainability (environment, economy, and society) and diagram of evaluation criteria for sustainable transport (indicators). Diagram p. 9.

World Commission on Environment and Development (WCED; also known as the Brundtland Commission). *Our common future*. New York: Oxford University Press, 1987.

This report established the most well-known definition of sustainable development:

Humanity has the ability to make development sustainable - to ensure that *it meets the needs of the present without compromising the ability of future generations to meet their own needs...* Thus sustainable development can only be pursued if population size and growth are in harmony with the changing productive potential of the ecosystem. Yet in the end, sustainable development is not a fixed state of harmony, but rather *a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are made consistent with future as well as present needs* (page 8).

Our Common Future also outlines seven objectives of sustainable development, with implications for, but no specific direction regarding transportation systems.

WEB SITES

Alliance for Global Sustainability. Available from World Wide Web:
<http://www.Globalsustainability.org>

Alberta Trends Report. Available from World Wide Web:
<http://www.peoplepatternsconsulting.com/albertareport.htm>
This report describes the trends in 51 indicators over 40 years in Alberta. The relevant Indicators (Transit Operators, Planning Agencies): Public Infrastructure, transportation expenditures, commuting time, auto crashes, oil and gas reserve, and air quality emissions.

Alberta GPI Blueprint Report. Available from World Wide Web: http://collection.nlc-bnc.ca/100/200/300/pembina_institute/alberta_gpi_blueprint/GPI_Blueprint.PDF
This report describes the methodology and background for the GPI accounting framework.

Assessing Sustainable Development: Principles in Practice. Available from World Wide Web: <http://iisd1.iisd.ca/pdf/bellagio.pdf>
This document contains principles that serve as guidelines for the whole of the assessment process including the choice and design of indicators, their interpretation, and communication of the results. They are intended for use in starting and improving assessment activities of community groups, non-government organizations, corporations, national governments, and international institutions.

Atkisson, A. & Green, S. 2000. Legacy 2000: Healthy Community Initiative of Greater Orlando. Available from World Wide Web:
http://www.hciflorida.org/Legacy_2000.html

Indicators designed for the evaluation of Orlando area (Orange County, Florida); includes basic transportation indicator.

Bossel, Hartmut. Indicators for Sustainable Development: Theory, Method, Applications. Available from World Wide Web:
<http://iisd.ca/measure/displayintro.asp>

Dr. Bossel shows that we need indicators for sustainable development that provide reliable information about the natural, physical and social world in which we live, and on which our survival and quality of life depend. He illustrates that popular indicators like the gross domestic product are inadequate, as they inform us only about monetary flows and not about the state of the environment, the destruction of resources or the quality of life.

He summarizes a systems approach for finding indicators of sustainable development, and applies this approach to finding indicator sets for communities, states, countries and the world. He shares the theoretical foundations, the implementation procedure and the practical experience, providing several complete lists of indicators of sustainable development for different regions.

Boulder County Civic Forum. Available from World Wide Web:
<http://www.bococivicforum.org/indicators/index.html>

This project discusses community indicators and the process Boulder County followed in developing 34 indicators for community areas including people, environment, economy, culture & society. Transportation and transit related indicators are found predominately in the environmental area and people areas. The relevant Indicators monitored are Air Quality, Watershed Water Quality, Automobile Registrations, Vehicle Miles Traveled (VMT), and Transit Use.

Centre for Sustainable Transportation, The. Available from World Wide Web:
<http://www.cstctd.org/CSTcurrentprojects.htm>

This Canadian organization's web site discusses the Sustainable Transportation Performance Indicators Project (STPI), which concluded at the end of 2002. In the first two phases, the center reviewed worldwide activities in a search for potential STPIs and potential STPI users. A report from both the first and second phases of this project is located on the website including indicator lists and descriptions. The Phase One report is "Sustainable Transportation Performance Indicators Project: Brief Review of Some Relevant World-Wide Activity and Development of An Initial Long List of Indicators." The Phase Two report is the "Potential Users and Uses of Sustainable Transportation Performance (STPI) Indicators." Phase Three entailed the initial development of national-level indicators. Because of its relevance to this research, the executive summary of the Phase Three report has been included in Appendix A of this report.

Center of Excellence for Sustainable Development. Available from World Wide Web:
<http://www.sustainable.doe.gov>

The website discusses measurement of sustainability through indicators and provides links to communities with sustainability indicator projects and/or reports. Many of the links are not active, and some reports are “purchase” only.

City of Santa Monica. Available from World Wide Web:

<http://www.ci.santa-monica.ca.us/environment/policy/indicators.htm>

Lists three sustainable transportation related indicators, other sustainability indicators, and the data collected for the city of Santa Monica. Includes discussion of indicators and why the task force and project were created. The relevant Indicators are annual ridership on city bus line, average vehicle ridership of city employers with over 50 employees, and percent of city fleet vehicles using reduced-emission fuels.

City of Winnipeg Quality of Life Indicators, Plan Winnipeg. Available from World Wide Web: <http://www.iisd.org/measure/cw.htm>

This document seeks to establish a measurement system for quality of life and outlines the process used to identify the key quality of life issues and identifies key indicators.

Community Initiatives. Available from World Wide Web:

<http://www.communityinitiatives.com>

Community Initiatives assists organizations with building sustainable communities, developing community indicators, and focusing on human well being as a foundation for promoting positive change.

Hardi, P., Barg, S. & Hodge, T. 1997. Measuring Sustainable Development: A Review of Current Practice. International Institute for Sustainable Development. Available from World Wide Web: <http://strategis.ic.gc.ca/SSG/ra01575e.html>

This review is an inventory of accomplishments in sustainable development. The first two chapters review the standard concepts of sustainable development and measurement, including indicators as measurement tools. The third chapter offers practical examples of ongoing measurement work. It includes a worldwide survey of measurement projects and applied indicator sets. The details of the indicator sets they use are presented in Appendix A. While the third chapter is a practical survey of existing projects, the fourth chapter offers a conceptual guide. It orients the reader among the various frameworks and models that define the purpose, focus and scope of the practical cases. It also highlights methodological problems to be solved. Finally, it briefly summarizes the present achievements and existing limitations of measurement programs. The fifth chapter ties measurement to the decision-making process. It clarifies the role of measurement in an integrated management system and analyzes the processes in which indicators are selected and measurement is implemented. Finally, the sixth chapter provides practical guidelines for assessing progress toward sustainable development.

Healthy Mountain Communities. 1996. Healthy Community Indicators: A tool for sustainable development in the Roaring Fork and Colorado River valleys. Available from World Wide Web:
<http://www.hmccolorado.org/2000report/96Report.htm>

The web page outlines the reason for evaluating a community's sustainability and the overall health of the region over a period of time. Lists and describes indicators, including traffic and transportation indicators. Future indicators are listed and explained because there are desired measurements they were unable to obtain but that are valuable to understanding the sustainability of a community. Those mentioned that are related to transportation include commute time and jobs to worker ratio.

International Institute of Sustainable Development. Available from World Wide Web:
<http://www.iisd.org/educate/learn/measures.htm>

This site discusses indicators, their uses, and indicator selection criteria. Relevant Indicators (Planning agencies & Transit operators): road traffic, climate change, vehicle miles and fuel consumption, highway congestion.

Jacksonville Community Council Incorporated. Available from World Wide Web: <http://www.jcci.org/newhome.htm>

A website dedicated to community improvement projects in Jacksonville, Florida; including mobility indicators used to evaluate this community. The relevant indicators are percentage of working people surveyed who report commuting times of 25 minutes or less (telephone survey), average number of seats available daily on flights through Jacksonville International Airport, destinations served by direct flights to and from Jacksonville International Airport, total airline passengers flying in or out of the Jacksonville International Airport, average weekday ridership on Jacksonville Transportation Authority buses per 1,000 people, average weekday miles of Jacksonville Transportation Authority bus service, percentage of JTA bus headways within 30 minutes during peak hours and 60 minutes during nonpeak hours, and average weekday ridership on the Skyway.

Local Index of Transit Availability (L.I.T.A). Available from World Wide Web:
http://www.lgc.org/freepub/land_use/lita/lita_manual.html

The Local Index of Transit Availability (LITA) is a system for rating transit service intensity, or transit availability, in various parts of a metropolitan area. LITA scores are intended to be useful to transit service planners as well as local land use planners and policymakers, allowing them to see where transit service is most intense and aiding them in developing appropriate land use plans and policies for areas with high, medium and low transit availability. In areas where ordinances require minimum roadway levels of service for new development, which often has the effect of pushing new development to peripheral areas poorly served by transit, LITA scores can provide an additional point of reference for land use decisions.

Minnesota Planning. Minnesota Milestones. 1998. Available from World Wide Web:

<http://www.mnplan.state.mn.us/mm/index.html>

Indicators and an assessment of Minnesota's Communities; includes transportation related indicators in three of four areas of concern including Economy, Community & Democracy, Environment. The relevant indicators were the number of regularly scheduled intercontinental flights from the Minneapolis-St. Paul International Airport, energy use per person, transportation for people with disabilities, regional disparity in unemployment, unrestricted highways, urban home values, freeway congestion, energy use per person, renewable energy sources, vehicle miles, and air pollutants.

NASA. NASA headquarters/Interagency Working Group on Sustainable Development Indicators Web Site:

This site contains the SDI Inventory, which is an inventory of indicators already selected and developed by various international and national organizations, such as the United Nations and the President's Council on Sustainable Development. The SDI Group selected the Proposed 1997 SDI from the SDI Inventory. This inventory includes a number of sustainable transportation indicators and transportation-related indicators.

<http://www.hq.nasa.gov/iwgsdi/Welcome.html>

The relevant indicators were Contaminants in Biota (432), Energy Consumption Per Capita (158), Greenhouse Climate Response Index (215), Greenhouse Gas Emissions (141), Groundwater Contamination (353), Materials Use per Capita (429), Ozone Depleting Substances (329), and Water Quality Index (446).

New Jersey Future. 1999. 1999 Sustainable State Project Report, Living with the Future in Mind, New Jersey. Available from World Wide Web:

<http://www.njfuture.org/HTMLSrc/SSR/GoalsAndIndicators.html>

They include goals for sustainability including efficient transportation and land use indicators. The relevant indicators (City/County) are need for road and bridge repairs, vehicle miles traveled, workplace transportation options, and traffic fatalities.

Pembina Institute for Appropriate Development. Available from World Wide Web:

www.pembina.org/green/gpi

This website is home to the Alberta Genuine Progress Indicators Project which has assessed the condition of 51 economic, social and environmental indicators from 1961 to 1999.

Redefining Progress. Available from World Wide Web:

<http://www.rprogress.org/projects/gpi/>

Discussion of General Progress Indicator and Gross Domestic Produce, how GPI is defined, including the latest GPI report. The relevant indicators (Planning Agencies) are GPI.

Rothblatt, D. & Colman, S. August 2001. Best Practices in Developing Regional Transportation Plans. MTI Report 01-10. Mineta Transportation Institute. Available at: <http://transweb.sjsu.edu/pubs.htm>.

The purpose of this study is to compare Metropolitan Planning Organization (MPO) Regional Transportation Plans (RTP) and planning processes within selected regions of California. A total of 17 MPOs were included to provide a balance of geographic location, growth rate, transit orientation, size, density, and air quality conformity status. The MPOs' planning processes and documentation were compared in terms of the past history and current progress in regional transportation planning, approaches toward addressing the transportation impacts of land-use decisions, methods and degree of citizen involvement in the process, the project evaluation process used, and the databases available in each MPO to support evaluation. It discusses qualities of a good regional plan, though not explicitly in terms of sustainability or sustainable transportation indicators.

Second Nature: Education for Sustainability. Available from World Wide Web:

www.secondnature.org

Second Nature is an educational non-profit whose primary goal is to advance human and ecological well being. It works specifically with colleges and universities by helping them transform into institutions that teach and practice the concept of sustainability. This website provides database information of sustainable resources and other websites. No indicators were listed.

Silicon Valley Environmental Partnership. Available from World Wide Web:

www.svep.org

This is a website dedicated to the joint venture of Silicon Valley Network, a non-profit organization dealing with environmentally sound business and community practices. The relevant indicators (monitoring) were vehicle miles traveled, air quality, commute modes, carbon emissions, MTBE, and fuel leaks.

Sustainable Measures. Available from World Wide Web:

www.sustainablemeasures.com

This sustainable measures website describes sustainability indicators, including what qualities make a good indicator, and how to develop good indicators. Relevant indicators were not listed.

Ten Steps to Sustainability. (n.d.). *Center for Excellence for Sustainable Development*. Available from World Wide Web:

<http://www.sustainable.doe.gov/management/tensteps/html>

The sixth step to launching a sustainable community initiative is to develop sustainability indicators. This guide lists four website references including "Sustainable Measures," "Redefining Progress Community Indicators Network," "Livable Communities Website," and "Compendium of SD Indicator Initiatives."

Urban Quality Indicators. Available from World Wide Web:

people.mn.mediaone.net/cyoakam/index/html

This is a newsletter dedicated to sharing information on efforts to measure the quality, health and sustainability of communities in North America. The relevant indicators (transit operators) are the average hours stuck in traffic.

Victoria Transport Policy Institute. Available from World Wide Web: www.vtppi.org

This comprehensive alternative transportation website includes a list of Transportation Demand Management Strategies with text descriptions and links to articles discussion for each strategy. Relevant indicators useful to evaluate transportation sustainability are identified as including: average amount of residents time devoted to non-recreational travel; per capita automobile use (annual miles or kilometers of travel); ability of non-drivers to reach employment centers and services; per capita land area paved for roads and parking facilities; quality of pedestrian and bicycle environment; quality of public transit service, including number of service hours, service frequency, average speed relative to automobile traffic speeds, safety, comfort, availability of information, and integration with other modes; average number of major services within walking distance of residents, or average walking distance between residences and public services such as schools and retail centers; land use mix; quality of delivery services; quality of mobility services for residents with special mobility needs; affordability of public transit service by lower income residents; portion of residents with transit service within 1/2 kilometer; motor vehicle accident fatalities and accidents; per capita transportation energy consumption; per capita transportation pollution; medical costs attributed to transportation.

OTHER WORKS CONSULTED

Association of Bay Area Governments. 2002. *Smart Growth Strategy/Regional Livability Footprint Project: Shaping the Future of the Nine-County Bay Area – Final Report*. Oakland. October.

Bay Area Alliance for Sustainable Communities. 2003. *State of the Bay Area, A Regional Report*. January.

Billheimer, J. and McNally, J. *Altamont Pass Commuter Survey. The San Joaquin Council of Governments and The San Joaquin Partnership*. October 2000.

Booz, Allen & Hamilton Inc. 2000. *Transportation System Performance Measures Report*. Caltrans.

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- Swiss Transport Research Conference. 2002 Report 47/99. *Nachhaltigkeit im Verkehr; Kriterien fuer kommunale und kantonale Strassenverkehrsplanungen und-projekte*. Zurich, Switzerland.

The Road Information Program. April 2001. *Extra Vehicle Operating Costs: What Motorists Pay to Drive on Roads in Need of Repair.*

Urban Development in Zurich. 2002. <http://www.stadtentwicklung-zuerich.ch>

U.S. Department of Transportation Bureau of Transportation Statistics. March 2001. *List of Indicators & Page Reference.*

World Business Council for Sustainable Development. 2001. *Mobility 2001.* Available from World Wide Web: <http://www.wbcds.org>

Zietsman, Josias and Rilett, Laurence. 2002. *Sustainable Transportation: Conceptualization and Performance Measures.* Texas Transportation Institute, The Texas A&M University System.

CASE STUDIES INTERVIEWS

Dean Kubani, City of Santa Monica Sustainable City Program Coordinator, Environmental Programs Division (September 2002)

Maureen Hart, President, Sustainable Measures (September 2002)

Doug Kimsey, Senior Transportation Planner/Analyst, San Francisco Bay Area Metropolitan Transportation Commission

Lisa Klein, Senior Transportation Planner/Analyst, San Francisco Bay Area Metropolitan Transportation Commission

Roy Nakadegawa, Bay Area Rapid Transit District Director, District 3, August 2002

Carol Misseldine, Sustainability Consultant, City of Oakland Public Works Department, August 2002

Steve Devencenzi, Deputy Director, San Luis Obispo Council of Governments, August 2002.

Terry Sanville, Senior Transportation Planner, City of San Luis Obispo Public Works Department, August 2002

Tim Bochum, Deputy Director, City of San Luis Obispo Public Works Department, August 2002

John Taylor, San Luis Obispo Community Indicators Roundtable, October 2002

ABOUT THE AUTHORS

Dr. Richard W. Lee

Principal Investigator and author Dr. Richard W. Lee, AICP, lives in Berkeley, California. He has researched, consulted, and taught courses on urban and regional transportation issues for more than two decades. For the duration of this project he was on the faculty of City and Regional Planning at California Polytechnic University at San Luis Obispo (Cal Poly). He holds a B.A. in History from Carleton College, as well as a M.S. in Transportation Engineering, a Master of City Planning and a Ph.D. in City and Regional Planning from the University of California, Berkeley.

Dr. Lee is a member of the American Institute of Certified Planners, American Planning Association, and the Chartered Institute of Transport. He has also served as a Senior Lecturer and Manager for the Graduate Diploma in Transport Planning Program, School of Resource and Environmental Planning, Massey University, New Zealand (1995-1998).

Paul Wack, MPA, AICP

Research Associate Paul Wack, AICP, is an Associate Professor of City and Regional Planning at California Polytechnic University at San Luis Obispo (Cal Poly). He holds a B.A. degree in geography from San Fernando Valley State College, a M.A. in Urban Geography/Urban Studies from California State University, Northridge, and a Master of Public Administration (with planning management emphasis) from the University of Southern California. He is a member of the American Institute of Certified Planners, and has served on the Santa Barbara County Planning Commission.

Eugene Jud, FITE

Research Associate Eugene Jud is on the faculty of the Civil and Environmental Engineering Department at California Polytechnic University at San Luis Obispo (Cal Poly). He holds a M.A. in Transportation Engineering from the Swiss Federal Institute of Technology (1961) and a M.A. in Environmental Sciences from the University of Zurich, Switzerland (1991). He is the owner of Jud Consultants, California, (www.judcons.com) and co-owner of Planungsbuero Jud AG, Zurich (www.jud-ag.ch). He is a Fellow of the Institute of Transportation Engineers, a member of the American Planning Association, and a member of several Swiss professional organizations. He is a licensed civil engineer in all European countries, and he worked as a transportation advisor for the United Nations Development Program for two years. He produced over 100 reports in the fields of data collection and analysis for environmental and transportation studies, planning for sustainable mobility, modeling, master plans and design studies. These include EIRs, neighborhood traffic management studies and reports on bicycle and pedestrian planning and Travel Demand Management, as well as public facilitation.

Tapan Munroe

Dr. Tapan Munroe is President of Munroe Consulting, Inc. (www.tapanmunroe.com). He received his Ph.D. in Economics from the University of Colorado. His awards and honors include the University of Colorado fellowship and membership in Phi Kappa Phi and Omicron Delta Epsilon. He is also a graduate of the Executive Training Program of the University of Chicago. Dr. Munroe has been a visiting scholar at the Massachusetts Institute of Technology, the University of Augsburg in West Germany, and Stanford University. He has also taught at the University of the Pacific in Stockton, California, and the University of California, Berkeley.

Dr. Munroe is well known in the U.S. for his economic and policy analysis consulting and advisory work. He has served as the President of the National Association of Business Economists (Bay Area chapter), a member of the National Petroleum Council Task Force on Oil Prices, and the quarterly Chair of the Commonwealth Club of California. Dr. Munroe is a past Chairman of the Economics Committee, Edison Electric Institute in Washington, D.C. He is a member of the University of California President's Board on Science & Innovation.

John Anguiano

John Anguiano has a Bachelor of Arts in Public Policy from Stanford University. He worked for Munroe Consulting Inc. as the Research Manager working on projects for the California State University system, Pacific Gas & Electric, Economic Development Alliance for Business, and the Cisco Learning Institute, among many other corporate, non-profit, and government clients.

Mr. Anguiano is an MBA candidate at the University of Texas for May 2004. He has been asked to provide professional comment on smart development and transportation issues for the *San Jose Mercury News*, San Jose, California.

Trevor Keith

Mr. Trevor Keith joined Crawford Multari Clark Associates as a graduate from the Master of City and Regional Planning Program at the California Polytechnic University at San Luis Obispo (Cal Poly). While attending Cal Poly, Mr. Keith worked as an intern for Crawford Multari Clark Associates on projects including the City of Ventura Comprehensive Plan Update, the Los Osos Habitat Conservation Plan, Atascadero General Plan EIR, and conducted a habitat assessment of Los Osos for the Los Osos Community Services District. At Cal Poly, he was a top performer, earning numerous awards and scholarships, including a California Planning Foundation Scholarship and the Herbert Collins Scholarship.

Mr. Keith received his Bachelor of Science degree in Ecology and Systematic Biology from Cal Poly in San Luis Obispo. During his undergraduate program, Mr. Keith worked at the County of San Luis Obispo in the environmental division and researched the nesting preference of the Snowy Plover for the Morro Coast Audubon Society. Mr. Keith is a member of the Association of Environmental Professionals, Congress for the New Urbanism and the California Chapter of the American Planning Association.

PEER REVIEW

San José State University and the MTI Board of Trustees have agreed upon a peer review process required for all research published by MTI. The purpose of the review process is to ensure that the results presented are based on a professionally acceptable research protocol.

Research projects begin with the approval of a scope of work by the sponsoring entities, with in-process reviews by the MTI Research Director and the project sponsor. Periodic progress reports are provided to the MTI Research Director and the Research Associates Policy Oversight Committee (RAPOC). Review of the draft research product is conducted by the Research Committee of the Board of Trustees and may include invited critiques from other professionals in the subject field. The review is based on the professional propriety of the research methodology.

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