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SAN FRANCISCO URBAN PARTNERSHIP AGREEMENT

NATIONAL EVALUATION: ENVIRONMENTAL DATA TEST PLAN

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SAN FRANCISCO
URBAN PARTNERSHIP AGREEMENT

NATIONAL EVALUATION:
ENVIRONMENTAL DATA TEST PLAN

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16. Abstract

This report presents the test plan for collecting and analyzing environmental data for the San Francisco Urban Partnership Agreement (UPA) under the United States Department of Transportation (U.S. DOT) UPA Program. The San Francisco UPA projects focus on reducing congestion by employing strategies consisting of combinations of tolling, transit, telecommuting/travel demand management (TDM), and technology, also known as the 4 Ts. The national evaluation focuses on the San Francisco UPA projects that deal with parking pricing in downtown San Francisco and supporting technology and telecommuting/TDM projects. The SF*park* parking pricing pilot will implement variable pricing in on-street and garage parking in selected parking zones. Information on parking availability and price will be available by phone, websites, and variable message signs. Outreach events for alternate commute programs will inform the public about the parking pricing and information projects. The Environmental Data Test Plan is based on the San Francisco UPA National Evaluation Plan. This test plan describes the environmental data sources, data availability, and possible risks associated with the data. The methods for analyzing the environmental data are discussed. The schedule and responsibilities for collecting, analyzing, and reporting the environmental analysis are presented.

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LIST OF ABBREVIATIONS

4Ts	Tolling, transit, telecommuting/travel demand management, and technology
ARB	Air Resources Board
CBA	Cost benefit analysis
CO	Carbon monoxide
CO_2	Carbon dioxide
CVO	Commercial vehicle operator
DMV	Department of Motor Vehicles
DOE	Department of Environment
EMFAC	EMission FACtor
FHWA	Federal Highway Administration
ISP	Information service provider
ITS	Intelligent transportation systems
MTC	Metropolitan Transportation Commission
NO_x	Nitrogen oxide (precursor to ozone)
Pb	Lead
PM	Particulate matter
PM_{10}	particulate matter 10 microns or less in diameter
$PM_{2.5}$	Particulate matter that is 2.5 micrometers in diameter and smaller
ROG	Reactive organic gases (precursor to ozone)
SFCTA	San Francisco County Transportation Authority
SFMTA	San Francisco Municipal Transportation Agency
SO_x	Oxides of sulfur
TDM	Travel demand management
UPA	Urban Partnership Agreement
U.S. DOT	United States Department of Transportation
VMT	Vehicle miles traveled
VT	Vehicle trips

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1.0 INTRODUCTION

This report presents the test plan for collecting and analyzing environmental data for the national evaluation of the San Francisco Urban Partnership Agreement (UPA) under the United States Department of Transportation (U.S. DOT) UPA program. The San Francisco UPA is one of several large field deployments around the United States that are receiving U.S. DOT funding and which are intended to demonstrate congestion pricing and supporting strategies. The San Francisco UPA national evaluation will address the four primary U.S. DOT UPA evaluation questions shown in Table 1-1.

Table 1-1. U.S. DOT National Evaluation "Objective Questions"

Objective Question #1	How much was congestion reduced in the area impacted by the implementation of the tolling, transit, technology, and telecommuting strategies? It is anticipated that congestion reduction could be measured by one of the following measures, and will vary by site and implementation strategy: • reductions in vehicle trips made during peak/congested periods; • reductions in travel times during peak/congested periods; • reductions in congestion delay during peak/congested periods; and • reductions in the duration of congested periods.
Objective Question #2	What are the associated impacts of implementing the congestion reduction strategies? It is anticipated that impacts will vary by site and that the following measures may be used: • increases in facility throughput during peak/congested periods; • increases in transit ridership during peak/congested periods; • modal shifts to transit and carpools/vanpools; • traveler behavior change (e.g., shifts in time of travel, mode, route, destination, or forgoing trips); • operational impacts on parallel systems/routes; • equity impacts; • environmental impacts; • impacts on goods movement; and • effects on businesses.
Objective Question #3	What are the non-technical success factors with respect to the impacts of outreach, political and community support, and institutional arrangements implemented to manage and guide the implementation?
Objective Question #4	What are the overall costs and benefits of the deployed set of strategies?

The questions shown in Table 1-1 will be addressed by carrying out the following ten "evaluation analyses" described in the San Francisco UPA National Evaluation Plan: congestion, pricing, telecommuting/travel demand management (TDM), technology, equity, environmental, goods movement, business impacts, non-technical success factors, and cost benefit. Each of these ten analyses relies upon various evaluation measures of effectiveness.

"Test plans" are the evaluation planning documents that describe how specific data will be collected and processed to yield the evaluation measures of effectiveness required for the various analyses. Whereas evaluation analyses are categorized according to related evaluation questions

or types of impacts, for example all equity-related impacts are addressed in the equity analysis, test plans are categorized according to common data types or sources. For example, the Traffic System Data Test Plan collects and processes all of the traffic data required for the national evaluation. In addition to this Environmental Data Test Plan, the other nine test plans focus on the following types of data: traffic, parking, transit, telecommuting/travel demand management, traveler information, surveys and interviews, content analysis, cost benefit analysis (CBA), and exogenous factors.

The relationship between test plans and evaluation analyses is discussed in Section 1.2. In short, analyses describe the evaluation questions and hypotheses to be investigated and the test plans describe how the data and measures of effectiveness needed to support the evaluation will be collected and processed. Most test plans collect data and provide measures of effectiveness that will be used in multiple analyses and most analyses rely upon data and measures developed through several different test plans.

The remainder of this introduction chapter describes the San Francisco UPA deployments and elaborates on the relationship between test plans and evaluation analyses. The remainder of the report is divided into three sections. Chapter 2.0 presents the data sources, data availability, and risks associated with evaluating the environmental data elements of the San Francisco UPA. Chapter 3.0 describes the techniques that will be used to test the hypotheses and assess the measures of effectiveness in which environmental data are used. Chapter 4.0 presents the schedule and responsibilities for collecting and analyzing the environmental data.

1.1 The San Francisco UPA

San Francisco was selected by the U.S. DOT as an Urban Partner to implement projects aimed at reducing congestion based on four complementary strategies known as the 4Ts: tolling, transit, telecommuting/TDM, and technology. Under contract to the U.S. DOT, a national evaluation team led by Battelle is assessing the impacts of the projects in a comprehensive and systematic manner in San Francisco and other sites. The national evaluation will generate information and produce technology transfer materials to support deployment of the strategies in other metropolitan areas. The national evaluation will also generate findings for use in future Federal policy and program development related to mobility, congestion, and facility pricing.

The San Francisco local UPA partners for the national evaluation consist of three public agencies. Two of the partners represent the City of San Francisco--the San Francisco County Transportation Authority (SFCTA) and the San Francisco Municipal Transportation Agency (SFMTA). The third partner is the Metropolitan Transportation Commission (MTC), the metropolitan planning organization for the Bay Area.

The San Francisco projects are focused on reducing traffic congestion related to parking in downtown San Francisco. Intelligent transportation systems (ITS) technologies underlie many of the San Francisco UPA projects, including those utilizing parking sensors and real-time parking

information. The San Francisco UPA projects that will be evaluated[1] are described briefly below.

SF*park* Variable Pricing. SF*park* is the name given to the parking pricing system to be implemented by SFMTA. The primary goal of SF*park* is to use intelligent parking management technology and techniques, in particular demand-responsive pricing, to manage the on-street and off-street parking supply and demand. SFMTA expects this approach to increase parking availability, reduce the number and duration of vehicle trips (VT) and reduce double parking and, thereby, reduce congestion. The parking technologies to be tested include networked parking meters, parking occupancy sensors, and parking information systems. Pricing policies may change over the course of the evaluation period, as SF*park* managers adjust rates in response to demand. Some extensions in times of day/week that meters are operable are also possible pending SFMTA Board actions.

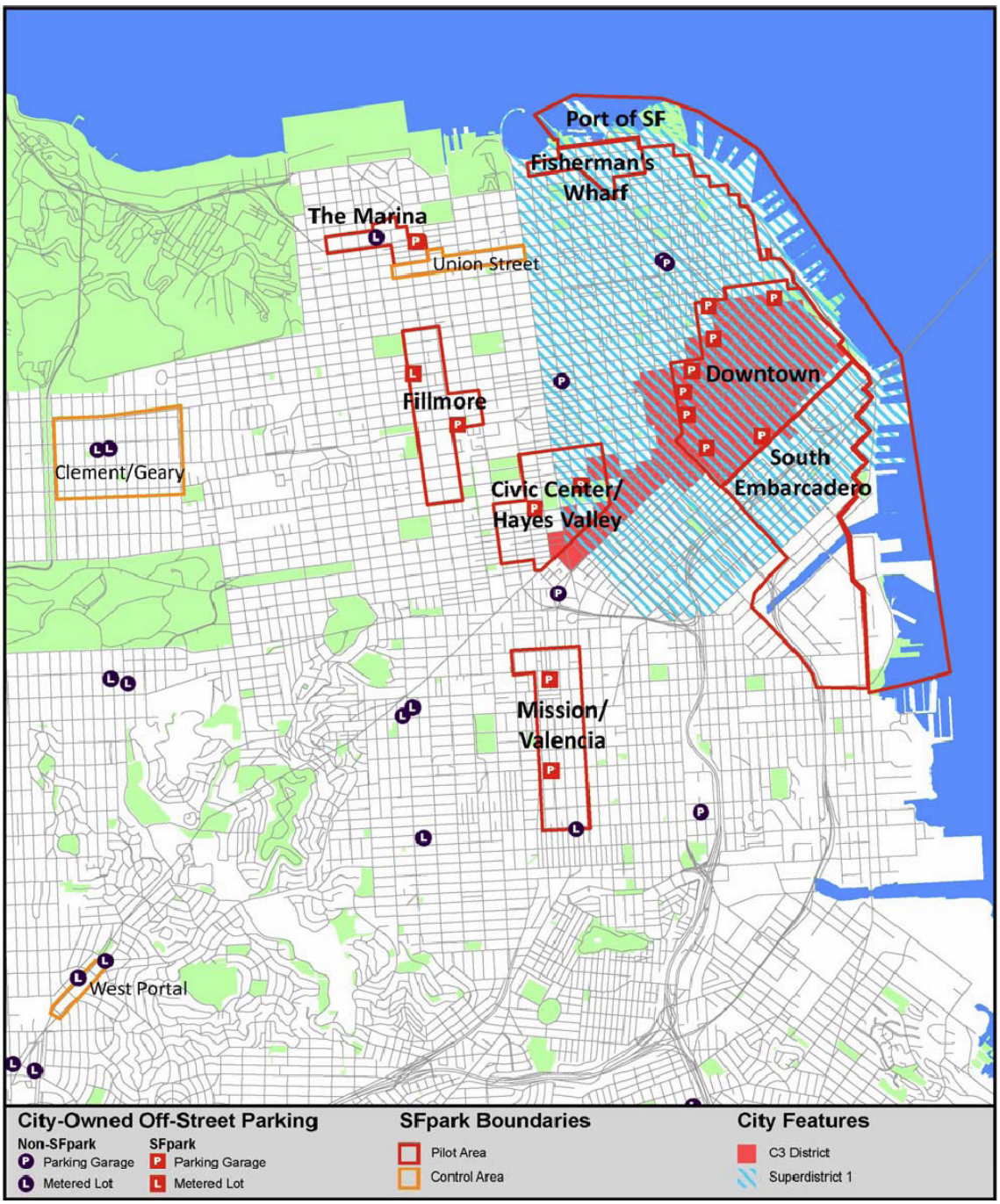
The pilot areas for SF*park* are highlighted in red (or dark lines) in Figure 1-1. The new system will consist of approximately 6,000 metered on-street parking spaces (about one-quarter of the city's total supply) and 12,250 parking spaces in fourteen city-operated garages and one lot. Control areas, highlighted in yellow (or light lines) in Figure 1-1, will be equipped with traffic sensors for monitoring use of the parking supply where variable pricing is not implemented.

To assist travelers in making choices about parking pre-trip and en-route, SFMTA will disseminate parking information in various ways. Strategically placed variable message signs[2] will show parking availability in city-operated garages, and parking availability and pricing information will also be displayed on SFMTA's website and by text messaging to mobile devices.

511 Upgrades. The 511 phone and website in the San Francisco Bay Area, operated by MTC, is one of the most advanced in the country, including a variety of multi-modal information. However, at the present time, the parking information on 511 is limited to static information about park and ride lots and rail stations (on the web) and airport parking (on the phone). The planned upgrades will provide parking space availability and pricing information for selected parking facilities in downtown San Francisco by 511 phone and web and by information service providers (ISPs) in the region who receive a feed of 511 data from MTC. MTC will receive a real-time data feed of parking availability for parking garages managed by SFMTA and pricing data for those SFMTA garages, lots, and on-street parking. The user interfaces on 511 phone and website will be enhanced to disseminate the parking information to 511 customers.

[1] The Clipper[SM] electronic payment card (formerly known as TransLink®) that was to be piloted for parking payment at five SFMTA garages was removed from the national evaluation owing to uncertainty about when it would be deployed.

[2] The deployment of the variable message sign has been delayed to December 2011, placing them several months behind the other UPA projects. Rather than delay evaluation of the rest of the projects, the decision was made not to include them in the national evaluation.



San Francisco Municipal Transportation Agency, used with permission.

Figure 1-1. SF*park* Pilot and Control Zones

Expansion of San Francisco Telecommuting and Alternate Commute Programs. Under the direction of the SFCTA, the telecommuting and alternate commute programs will be undertaken by the City of San Francisco's Department of the Environment (DOE). In support of the SF*park* and 511 enhancements, DOE and SFCTA plans include three activities: promotion of SF*park* at DOE outreach events and promotion of 511 enhancements at outreach events. Through the outreach efforts, downtown workers will be better informed about the UPA initiatives and can better use the parking, bike-sharing and information resources available to them.

Schedule for the San Francisco UPA Projects. The projects to be evaluated will go into operation between in late-2010 and mid-year 2011. SFMTA will be implementing variable pricing in SF*park* zones in early 2011. At that time real-time parking information will become available via SFMTA's website and text messaging and the MTC 511 phone system. In late 2011 parking information will be available on the 511 website. As the SFMTA and MTC projects are deployed, SFCTA will conduct its expanded outreach and alternate commute program.

1.2 San Francisco UPA National Evaluation Plan and the Use of Environmental Data

Table 1-2 shows which of the various San Francisco UPA test plans will contribute data to each of the evaluation analyses. The "flow" between test plans is "one way" in the sense that test plans feed data and measures to the analyses rather than the reverse. The solid circles show where data from a given test plan constitutes a major input to an analysis; the open circles show where data from a given test plan constitutes a supporting input to an analysis. Data from the Environmental Data Test Plan will be used equity, environmental, and cost benefit analyses. Table 1-3 presents the environmental data elements and the measures of effectiveness and the hypotheses/questions the environmental data will be used to evaluate.

Table 1-2. Relationship Among Test Plans and Evaluation Analysis

San Francisco UPA Test Plans	Congestion Analysis	Pricing Analysis	Telecommuting/ TDM Analysis	Technology Analysis	Equity Analysis	Environmental Analysis	Goods Movement Analysis	Business Impact Analysis	Non-Technical Success Factors Analysis	Cost Benefit Analysis
Traffic System Data Test Plan	●				○		○			○
Parking Data Test Plan		●		○	○	○	●	○		
Transit System Data Test Plan	○	●				○				○
Telecommuting/TDM Data Test Plan			●							
Traveler Information Data Test Plan				●						
Surveys and Interviews Test Plan	●	●	●	●	●	○		○	●	○
Environmental Data Test Plan					○	●				○
Content Analysis Test Plan									●	
Cost Benefit Analysis Test Plan										●
Exogenous Factors Test Plan	○	○	○	○	○	○	○	○	○	○

● — Test Plan Data Constitute a Major Input to the Evaluation Analysis

○ — Test Plan Data Constitute a Supporting Input to the Evaluation Analysis

Table 1-3. Environmental Data Test Plan Data Elements Use in Testing Evaluation Hypotheses/Questions

Environmental Data Element	Measures of Effectiveness	Hypotheses/Questions*
1. Emission factors for criteria and greenhouse gases from EMFAC2010	• Reductions in emissions due to VMT reductions • Reductions in idling emissions • Reductions in emissions due to increases in speed due to decreased congestion • Socio-economic and geographic distribution of environmental impacts	• SFEnv-1 • SFEquity-3 • SFCBA-1
2. Fuel consumption factors from EMFAC2010	• Reduction in energy use through increased transit, decreased VMT and increased speeds (decreased congestion)	• SFEnv-3 • SFCBA-1

*An explanation of these acronyms can be found in Appendix A, which contains a compilation of the hypotheses/questions for all the analysis areas from the San Francisco UPA National Evaluation Plan.

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2.0 DATA SOURCES, AVAILABILITY, AND RISKS

This chapter identifies the sources of environmental data and discusses the availability of those data and any potential risks associated with collecting and processing them for use in the evaluation. Table 2-1 summarizes the data requirements for the Environmental Data Test Plan.

Table 2-1. Environmental Data Summary

Data Element	Location	Data Granularity	Data Collection Frequency	Data Reporting Frequency	Responsible Agency (Data Source)
1. Emission factors for criteria and greenhouse gases from EMFAC2010	San Francisco County	Grams per mile and second by vehicle type, speed	EMFAC model runs on request	On request in 2011	MTC
2. Fuel consumption factors from EMFAC2010	San Francisco County	Fuel consumption per mile by speed and vehicle type[3]	EMFAC model runs on request	On request in 2011	MTC

2.1 Data Sources

The source of data for the emission and fuel consumption factors is the EMFAC (EMission FACtor) model, which produces estimates of pollutants from motor vehicles, as required for California. These emission factors are modeled emission rates expressed in grams per mile of travel. They are highly granular; rates are expressed for every possible class of vehicles from motorcycles to line haul trucks, and in 2.5 mph increments, as emission rates vary significantly by travel speed.

The environmental analysis will utilize changes in travel speeds and miles travelled in the parking pilot areas, multiplied by the appropriate emission factors, to estimate changes in emissions and energy use resulting from SF*park*, as described in the data analysis Section 3.0. Data used to measures changes in travel speeds and VMT (from searching for parking) is described in the Parking Data Test Plan.

EMFAC 2010 estimates of fuel consumption per mile for the San Francisco Bay Area will be used to estimate energy savings from SP*park* based on changes in VMT and speed and associated changes in fuel use.

The EMFAC model is developed by the California Air Resources Board (ARB). The model calculates emission rates from all motor vehicles, such as passenger cars to heavy-duty trucks, operating on highways, freeways and local roads in California. In the EMFAC model, the emission rates are multiplied with vehicle activity data provided by the regional transportation agencies to calculate the statewide or regional emission inventories.

[3] Vehicle type includes fuel type, vehicle technology (e.g., standard, hybrid, alternative fuel), and vehicle size (e.g., bus, motorcycle, passenger car, delivery vehicle).

The model calculates emission factors and emission inventories for the following primary pollutants:

- Reactive organic gases (ROG) (an ozone precursor)
- Carbon monoxide (CO)
- Nitrogen oxides (NO_x) (an ozone precursor)
- Carbon dioxide (CO_2)
- Particulate matter (PM) for total suspended particulate, particulate matter 10 microns or less in diameter (PM_{10}), and particulate matter 2.5 microns or less in diameter ($PM_{2.5}$)
- Fuel consumption
- Oxides of sulfur (SO_x); and
- Lead (Pb).

The emissions to be analyzed in the UPA evaluation will include a subset of those available from EMFAC, namely, ROG and NO_x (ozone precursors), $PM_{2.5}$ and CO_2, the most common indicators associated with VMT changes, and fuel consumption.

Emission factors are estimated for a given year based on the vehicle fleet mix, technology types and age distribution. "Vehicle fleet" refers to all the motor vehicles operating on roads in California, or in this case, the Bay Area, as fleet mix is locality specific. The fleet is broken into 13 categories called classes (for example passenger cars, motorcycles, buses, line haul trucks, etc.). These classes are based on the type of vehicle, but they also take weight class and fuel type (i.e., gas, diesel, or electric) into account. The number of vehicles in each class is based on an analysis of Department of Motor Vehicles (DMV) registration data. These vary by calendar year and geographic area, so the make-up of the vehicle fleet is dependent on the calendar year and geographic area (e.g., Bay Area versus Los Angeles).

The end result of running EMFAC are, for a given year such as 2010 or 2012, emission rates in grams per mile of travel (or fuel burned), at speeds from 2.5 to 65 mph. The fact that emission rates differ at different speeds is vital to estimating the effects of measures such as parking pricing or other pricing measures which can reduce congestion levels.

Generally speaking, emission rates are extremely high at low speeds and gradually drop as speeds increase, reaching a minimum at around 45 – 50 mph.[4] Therefore, even if VMT remains constant, if it is traveled at, say, 15 mph prior to the implementation of a pricing project and rises to 20 mph after implementation, emissions will drop substantially. If the speed increase is also accompanied by a decrease in VMT then emissions will drop even more.

[4] For light duty gasoline autos and for ROG, NO_x, CO_2 and $PM_{2.5}$ at least. Different technology types, fuels and pollutants respond differently to speeds.

2.2 Data Availability

Emission factors for San Francisco County in 2010, 2011 and 2012 will be provided by MTC upon request to the national evaluation team. MTC expects to use the EMFAC2010 model for San Francisco County.[5] Emission factors for motorcycles, light duty cars and trucks, as well as potentially for small commercial trucks will be provided by speed. However if data are available that indicate that any of the parking pilot areas have a different mix of vehicles than for the county as a whole, adjustments to the emission rates for those parking areas will also be considered. The national evaluation team will provide to MTC the observed parking and traffic data measured in the Parking Data Test Plan for MTC to use to estimate associated changes in VMT and speed. If the roadway sensor data in the Traffic Data Test Plan is able to provide data on fleet mix, that information will be provided as well. In order to estimate emission reductions, the VMT will be multiplied by emission factors at the appropriate before and after speeds.

The emission factors will be transmitted by the MTC air quality analysis staff in the form of EMFAC output tables and will include emissions (g/mi) by speed category and fuel consumption by vehicle class and speed. The table will be provided in electronic form and hard copy to the national evaluation team.

2.3 Potential Risks

There is minimal risk associated with obtaining emission factors from MTC. The generation of emission factors is a routine function for air quality staff, and preliminary discussions with key staff indicate that the factors will be generated upon request with minimal delay. The only potential delay could be in MTC transitioning to using EMFAC2010, but MTC did not cite this as an issue in previous discussions. Thus, it is expected that EMFAC2010 will be available in time for use by the national evaluation team in late 2011. If this is not the case then EMFAC2007 will be used.

There is some risk in the use of data from other test plans, such as the Parking Data Test Plan. As described in section 3.0, the environmental and energy analyses depend on this data just as much as upon the emission factors. There is significant risk to the environmental and energy analyses, if the parking data does not result in needed outputs such as miles of travel by vehicles searching for parking spaces and the speeds at which they search. This risk necessitates coordination between the test plans and the careful review of local data collection and analysis plans.

[5] The EMFAC model will be used to generate emission factors in 2011. Currently, the EMFAC 2007 model is being used, but it is expected that EMAC2010 will be completed by the time emission factors for the UPA project are required.

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3.0 DATA ANALYSIS

The before and after analysis of emissions and fuel consumption will be performed using the emission factors and fuel consumption rates for pre- and post-parking pricing implementation periods in combination with data from the test plans for traffic, parking, transit, and surveys. The primary data required for the environmental and energy analysis are changes in speed, VMT, mode and modeled emission rates and fuel consumed per mile of travel. Exogenous factors will be addressed through the use of control areas that will be used to assess "natural" changes in VMT or speeds as compared to the pilot areas.

The environmental analysis will address air quality and energy impacts. The analysis approach, outlined in the National Evaluation Framework, measures changes in traffic volumes in terms of VMT and congestion in terms of speed, and then applies speed-appropriate emission factors for each pollutant. This approach is consistent with the approaches used in other projects affecting travel behavior through pricing. Methodologies recommended by the EPA and state agencies for evaluating pricing and, more generally, any measures affecting travel behavior, specify identifying changes in miles of travel and speeds as the primary inputs for estimating emission reductions and changes in energy use. The analysis approach recommended here is consistent with these methodologies.

Measures such as parking pricing can directly reduce vehicle miles travelled (VMT) through the disincentive of the higher parking prices, reduced parking search time due to demand-responsive pricing, and indirectly through encouraging shifts to alternative travel modes such as transit, walking, bicycling, or carpooling. Transit ridership could increase if travelers perceive faster, more reliable travel times on transit resulting from less traffic impedance from cars searching for parking. Likewise, speed changes result from reductions in traffic along affected routes. It is intuitive that reductions in VMT would reduce emissions and fuel consumption. However, changes in travel speed also can reduce emissions. In fact, changes in speed could result in emission decreases that outweigh those associated with VMT reductions. Emission rates per mile drop as speeds increase, up to about 50 mph. Therefore, a mile traveled at a congested speed such as 5 mph causes much higher emissions than a mile travelled at a speed of 10 or 15 mph. In addition, more fuel is consumed per mile of travel at low speeds than at higher speeds. As such, the accuracy and reliability of the speed data, generated from the parking analysis (as described in the Parking Data Test Plan) is crucial to the environmental analysis.

The air quality impacts will be analyzed using two primary sources of "observed" data (to be used with the emission and energy factors to calculate impacts): parking search time data (from search time surveys) and parking turnover rates from parking sensors. Transit ridership data (from the Transit System Data Test Plan) will also be used to assess potential VMT reductions from transit ridership increases., and data from the visitor/shopper survey (Surveys and Interviews Test Plan) will help to confirm whether transit ridership increases are occurring as a result of the changes in parking pricing. In addition, the Parking Data Test Plan will document changes in the amount of idling vehicles due to double parking, but the data are not expected to be sufficient for emissions analysis and will be used only qualitatively.

The environmental and energy analyses will be performed to evaluate the hypotheses related to improving air quality and transit use, and reducing energy use. For example, the evaluation will assess whether SF*park* improved air quality by reducing parking search times, which might be caused by reductions in overall VMT from fewer miles spent "cruising" for parking. The evaluation will be based upon the method outlined in chapter 14 of the book "The High Cost of Free Parking" by Donald Shoup.[6] This method requires data that can be collected using the park-and-visit method developed by Britain's Road Research Laboratory and applied by Shoup and his research assistants to a 15 block neighborhood commercial district in the Los Angeles area. The Shoup team used bicycles in the study so as not to influence the results; as Shoup points out, most drivers hunting for a parking spot will try to avoid following other cars which appear to be doing the same thing. Bicycles do not influence other drivers in that manner. In the neighborhood Shoup studied, bicycles were easily able to keep up with motor vehicles, thus making estimates of the speed of travel easily observable.

The SF*park* neighborhoods, with the possible exception of the Port of San Francisco, are expected to have slow speeds, similar to the Los Angeles study, due to pedestrian traffic, stop signs, stop lights, and cross or turning traffic. However, this issue is explored in the Parking Data Test Plan. Neighborhood-level speed data by time of day will be reviewed to determine whether and which neighborhoods might experience vehicular speeds that are faster than bicycle speeds. In such neighborhoods a chase car or floating car survey will be used to provide calibration data to adjust the bicycle speeds to vehicular speeds.

The data required from the parking data collection includes:

- the number of metered spaces
- the average search time (in minutes)
- the parking turnover rate per parking meter (i.e., the number of cars at each meter per unit of time; for example between 5 pm and 6 pm 1.3 cars park at meters on average in a given parking pricing implementation zone)
- the average speed (in lieu of directly measured distance from cyclometers on the bicycles).

These data will be used to estimate the total VMT caused by cruising for parking and the average speeds of travel for each of the pilot parking areas. While the parking analysis will focus on changes in average parking search time as a key performance measure, the environmental analysis needs to consider the total impact on travel (VMT) in order to assess air quality impacts.

In Shoup's methodology, the distance travelled while cruising (measured by odometers on the bicycles times the turnover rate of the meters) is multiplied by the number of meters to obtain the total cruising distance for a given time period. However, as per SFMTA's parking survey plan, distance and speed will be calculated by analysts using the addresses and times notated by the bicyclists for the parking spaces they find. This has been determined by SFMTA to be preferable to utilizing odometers on the bicycles. The statistical reliability of air quality and fuel

[6] Donald Shoup, The High Cost of Free Parking, Chicago: Planners Press, 2005.

estimates will be largely dependent on the accuracy of the parking search time data collection method and statistical significance of the estimates of change in parking search times and speeds.

The emission factors and fuel use factors, when multiplied by the changes in VMT and speed documented in the parking survey will produce changes in emissions to quantify the measures of effectiveness described in Section 1, Table 1-2:

- Reductions in emissions due to VMT reductions
- Reductions in idling emissions (if feasible)
- Reductions in emissions due to increases in speed due to decreased congestion; and
- Reductions in energy use due to decreased fuel use

Supplemental data may include mode shift from the Transit System Data Test Plan or the Surveys and Interviews Test Plan. Mode shifts to transit in particular may occur, as parking prices increase and bus travel time decreases due to decreased congestion, thereby making transit a more attractive alternative than driving. An increase in transit ridership could be used as a qualitative estimate of reductions in emissions; in order for it to be used in a quantitative manner, the regional average trip length of the transit riders would be used.

Finally, the environmental data analysis must support both the equity and cost-benefit analysis to address the hypotheses related to these evaluation issues. The primary means of assessing the equity implications of air quality and energy impacts is to determine whether these impacts are disproportionally distributed by socioeconomic strata (e.g., income, ethnicity, age, etc.) or geography. The environmental analysis will supply emission and fuel consumption findings for each study area to the equity analysis in order to apply socioeconomic characteristics from each parking district to derive any differential impacts on key groups. In terms of the cost-benefit analysis, changes in emissions and fuel consumption will be monetized in order to assess their contribution to the benefits of the project and its attendant elements. The estimated air quality and energy impacts will serve as input to the cost benefit analysis and will be used to calibrate the regional model for estimating and monetizing the long-term benefits of the UPA projects.

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4.0 SCHEDULE AND RESPONSIBILITIES

MTC will be responsible for providing EMFAC2010 emission factors for 2010, 2011, and 2012 for criteria and greenhouse gas pollutants (ROG, NO_x, $PM_{2.5}$, and CO_2). The EMFAC output by speed and vehicle class will be requested by the national evaluation team. In late 2011 the evaluation team will specify needed pollutants, speed classifications, and fleet mix variables in order to derive the most appropriate and accurate emissions factors. In addition, the emission factor tables will include fuel consumption by vehicle class and speed (standard in EMFAC).

The national evaluation team will analyze the data and report on the findings following the one-year operation of SF*park*.

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APPENDIX A – COMPILATION OF HYPOTHESIS/QUESTIONS FROM THE SAN FRANCISCO UPA NATIONAL EVALUATION PLAN

Evaluation Analysis	Hypothesis/ Question Number	Hypothesis/Question
Congestion	SFCong-1	The deployment of SF*park* and the 511 improvements will reduce traffic congestion on selected travel routes in the downtown area.
	SFCong-2	The public will perceive that congestion has been reduced.
Pricing	SFPricing-1	Parking pricing will increase parking availability.
	SFPricing-2	Parking pricing will lead to reduced search time and variability.
	SFPricing-3	Parking pricing will reduce double parking.
	SFPricing-4	Parking pricing will shorten the duration of the average on-street parking session.
	SFPricing-5	Parking pricing will improve reliability and speed of public transit.
	SFPricing-6	Parking pricing will cause a shift to other routes, modes, and other parking garages.
Telecommuting/ TDM	SFTele/TDM-1	TDM events will increase the demand for information about SF*park* and 511 enhancements.
	SFTele/TDM-2	SF*park* and 511 enhancements will increase effectiveness of TDM program.
	SFTele/TDM-3	Distribution of UPA-related information at events will influence parking program awareness and behavior change.
Technology	SFTech-1	Implementing advance parking technology will improve agency ability to manage parking.
	SFTech-2	Improving the dissemination of parking information via 511 phone, websites, and text messaging, will reduce parking search times.

Evaluation Analysis	Hypothesis/ Question Number	Hypothesis/Question
Equity	SFEquity-1	What are the direct social effects (parking fees, travel times, adaptation costs) for various transportation system user groups?
	SFEquity-2	What is the spatial distribution of aggregate out-of-pocket and inconvenience costs, and travel-time and mobility benefits?
	SFEquity-3	Are there any differential impacts on certain socioeconomic groups?
	SFEquity-4	How does reinvestment of parking pricing revenues impact various transportation system users?
Environmental	SFEnv-1	SF*park* will improve air quality by reducing parking search times and shifting trips from car to transit.
	SFEnv-2	The public will perceive an improvement in air quality resulting from SF*park.*
	SFEnv-3	SF*park* will reduce fuel consumption by reducing parking search times and shifting trips from car to transit.
Goods Movement	SFGoods-1	Commercial vehicle operator (CVO) double parking will decrease in the SF*park* areas.
	SFGoods-2	CVO double parking fines will decrease in the SF*park* areas.
	SFGoods-3	Parking availability, including loading and freight zones, will increase in the SF*park* areas.
	SFGoods-4	Travel times will decrease in the SF*park* areas for CVOs and other vehicles.
Business	SFBusiness-1	Sales will increase in the SF*park* areas.
	SFBusiness-2	Overall travel to access retail and similar businesses will increase in the SF*park* areas.

Evaluation Analysis	Hypothesis/ Question Number	Hypothesis/Question
Non-Technical	SFNonTech-1	What role did factors related to “people” play in the success of the deployment? People (sponsors, champions, policy entrepreneurs, neutral conveners)
	SFNonTech-2	What role did factors related to “process” play in the success of the deployment? Process (forums including stakeholder outreach, meetings, alignment of policy ideas with favorable politics, and agreement on nature of the problem).
	SFNonTech-3	What role did factors related to “structures” play in the success of the deployment? Structures (networks, connections and partnerships, concentration of power and decision-making authority, conflict-management mechanisms, communications strategies, supportive rules and procedures).
	SFNonTech-4	What role did factors related to “media” play in the success of the deployment? Media (media coverage, public education).
	SFNonTech-5	What role did factors related to “competencies” play in the success of the deployment? Competencies (cutting across the preceding areas: persuasion, getting grants, doing research, technical/technological competencies; ability to be policy entrepreneurs; knowing how to use markets).
	SFNonTech-6	Does the public support the UPA strategies as effective and appropriate ways to reduce congestion?
Cost Benefit	SFCBA-1	What is the net benefit (benefits minus costs) of the UPA strategies?

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