ACTIVE TRANSPORTATION PROGRAM

CYCLE 1

APPLICATION
Part 1
(Includes Sections I, V, VI, VII, VIII & XI)

Please read the Application Instructions at
http://www.dot.ca.gov/hq/LocalPrograms/atp/index.html
prior to filling out this application

Project name:	Fresno State - Barstow Avenue Bikeways

For Caltrans use only: ____TAP _____STP____RTP ____SRTS ____SRTS-NI ____SHA
____DAC ____Non-DAC ____Plan

Table of Contents

I. GENERAL INFORMATION

Project name: Fresno State - Barstow Avenue Bikeways

(fill out all of the fields below)

1. APPLICANT (Agency name, address and zip code) California State University, Fresno (state agency)	2. PROJECT FUNDING ATP funds Requested $ 872,000.00
3. APPLICANT CONTACT (Name, title, e-mail, phone #) Cynthis Teniente-Matson, (559)278-2083, cmatson@csufresno.edu	Matching Funds (If Applicable) $ 113,000.00 Other Project funds $ 1,090,000.00 TOTAL PROJECT COST $ 2,075,000.00
4. APPLICANT CONTACT (Address & zip code) Fresno State, Haak Administrative Center, 5200 N. Barton Avenue, MS ML52, Fresno, CA 93740	5. PROJECT COUNTY(IES): Fresno County (MPO)
6. CALTRANS DISTRICT #- Click Drop down menu below District 6	7. Application # 1 of 1 (in order of agency priority)

Area Description:

8. Large Metropolitan Planning Organization (MPO)- Select your" MPO" or "Other" from the drop down menu>	COFCG Fresno Coucil of Governments
9. If "Other" was selected for #8- select your MPO or RTPA from the drop down menu>	
10. Urbanized Area (UZA) population (pop.)- Select your UZA pop. from drop down menu>	Within a Large MPO (Pop > 200,000)

Master Agreements (MAs):

11. ☐ Yes, the applicant has a FEDERAL MA with Caltrans.
12. ☐ Yes, the applicant has a STATE MA with Caltrans.

13. If the applicant does not have an MA. Do you meet the Master Agreement requirements? Yes ☒ No ☐
The Applicant MUST be able to enter into MAs with Caltrans

Partner Information:

14. Partner Name*:	15. Partner Type
16. Contact Information (Name, phone # & e-mail)	17. Contact Address & zip code

☐ Click here if the project has more than one partner; attach the remaining partner information on a separate page

*If another entity agrees to assume responsibility for the ongoing operations and maintenance of the facility, documentation of the agreement must be submitted with the application, and a copy of the Memorandum of Understanding or Interagency Agreement between the parties must be submitted with the request for allocation.

Project Type: (Select only one)

18. Infrastructure (IF) ☒ 19. Non-Infrastructure (NI) ☐ 20. Combined (IF & NI) ☐

Project name: Fresno State - Barstow Avenue Bikeways

I. GENERAL INFORMATION-continued

Sub-Project Type (Select all that apply)

21. ☐ Develop a Plan in a Disadvantaged Community (select the type(s) of plan(s) to be developed)
    ☐ Bicycle Plan ☐ Safe Routes to School Plan ☐ Pedestrian Plan
    ☐ Active Transportation Plan

    (If applying for an Active Transportation Plan- check any of the following plans that your agency already has):
    ☐ Bike plan ☐ Pedestrian plan ☐ Safe Routes to School plan ☐ ATP plan

22. ☒ Bicycle and/or Pedestrian infrastructure
    Bicycle only: ☐ Class I ☒ Class II ☐ Class III
    Ped/Other: ☐ Sidewalk ☐ Crossing Improvement ☐ Multi-use facility

    Other:

23. ☐ Non-Infrastructure (Non SRTS)

24. ☐ Recreational Trails*- ☐ Trail ☐ Acquisition

    ***Please see additional Recreational Trails instructions before proceeding**

25. ☐ Safe routes to school- ☐ Infrastructure ☐ Non-Infrastructure

If SRTS is selected, provide the following information

26. SCHOOL NAME & ADDRESS:
27. SCHOOL DISTRICT NAME & ADDRESS:

28. County-District-School Code (CDS)	29. Total Student Enrollment	30. Percentage of students eligible for free or reduced meal programs **
31. Percentage of students that currently walk or bike to school	32. Approximate # of students living along school route proposed for improvement	33. Project distance from primary or middle school

**Refer to the California Department of Education website: http://www.cde.ca.gov/ds/sh/cw/filesafdc.asp

☐ Click here if the project involves more than one school; attach the remaining school information including school official signature and person to contact, if different, on a separate page

II. PROJECT INFORMATION

1. **Project Location** Fresno State - Barstow Avenue Bikeways

2. **Project Coordinates** Latitude -- +36.815806 (Decimal degrees) Longitude -- - 36.815806 (Decimal degrees)

3. **Project Description** - The completed Barstow Avenue Bikeways will run from Cedar Avenue to Chestnut Avenue (1 mile - Fresno State northern perimeter) to connect the bikeway systems of the cities of Fresno and Clovis. The western end of the proposed Barstow Avenue Bikeways connects with an existing City of Fresno bike trail that extends 2 miles to Blackstone Avenue, and the eastern end connects with the City of Clovis Bike Trail that extends 1.7 miles to Harvard Avenue/Sierra Vista Elementary School. To complete the project is to complete the longest west-east bikeway in the City of Fresno, along three of Fresno's four major job centers (the clusters on Blackstone Avenue, Shaw Avenue, and Fresno State). The Barstow Avenue Bikeways will also connect the longest north-south trails in Fresno (running along Cedar Avenue and First Avenue), and the city of Clovis plans to extend its Barstow Avenue bikeway from Harvard Avenue to Clovis Avenue, which will be the longest and major north-south bikeway in Clovis. The Fresno State Barstow Avenue Bikeways close a prominent gap between the bikeway systems of two adjacent municipal jurisdictions, and in doing so transform the university from a major barrier into a major access route for commuter bicycling. The construction of the Barstow Avenue Bikeways is a **high impact** improvement in **connectivity, safety,** and **access** for commuter bicyclists in the adjacent cities of Fresno and Clovis and for the university's 20,000-plus students, faculty, and staff. The proposed Bikeways also provide a **qualitative improvement** to its location (a major activity center in the City of Fresno) that has heavy stop and go traffic and, not infrequently, terrible congestion; the significant vehicle idling produces a disproportionate amount of pollutants. Finally, the project is **shovel-ready**.

   Funding is requested for the three phases (3, 4, and 5) that run along the entire north side of Barstow, from Cedar to Chestnut, for two reasons. First, it is cost effective to complete all three phases at once, resulting in savings of $219,000[1] for construction costs (plus time savings). Second, these phases are the most dangerous because vehicle lanes now utilize the entire curb-to-curb width in certain sections (see also Section III. "Need for Project").

4. **Project Status**

   ►Entire Barstow Avenue Bikeways (5 Phases) - Phase 1 is under construction with funding from the San Joaquin Valley Air Pollution Control District and is on schedule for completion at the end of May 2014.

   ►The **concept plans** for the entire Bikeways have been completed ($25,000). The Bikeways were outlined in five discrete, usable phases to accommodate incremental

[1] The construction costs for the phases if funded separately are $526,400 (Phase 3); $432,600 (Phase 4); and $573,000 (Phase 5), totaling $1,532,000. The construction costs when combining all three phases is $1,313,000 (saving $219,000).

funding and construction along the busy route if necessary (see "Project Timeline" in attachments). Phasing of the project was determined by selecting segments along Barstow Avenue wherein proper vehicular and bicycle traffic flow could be maintained at the termination points of each phase of construction. The phases could be constructed in any order.

►Fresno State also resolved a **right of way** issue by a land trade. Fresno State gave up its Bullard/Willow right-of-way to allow connection of Fresno and Clovis bikeways via Barstow Avenue. Willow Avenue is the divider between the City of Clovis and City of Fresno. The Willow Avenue right of way to the City of Fresno was recorded 5-23-13. The Willow Avenue right of way to the City of Clovis was recorded 6-7-13. The value of the land trade can be calculated using the most recent appraisal done for Fresno State (Campus Pointe, 2001): 117,846 SF x $5 SF = $589,230.

► Fresno State is committing another $360,500 for land use dedicated to the entire Barstow Avenue Bikeways. For Phases 3, 4, and 5 only, land use is an estimated 13,700 SF x $5 SF = $68,500.

►A final and significant leveraged resource committed by Fresno State is **20-year maintenance** of the bike lanes.

►**CEQA status**: The project is a retrofit of an existing road. The scope is architecturally insignificant and does not merit a CEQA review. Upon award, Fresno State will file a Notice of Categorical Exemption.

III. SCREENING CRITERIA

1. Demonstrated Needs of the Applicant

A. Need for the project. No safe route exists for cyclists to enter the University from its northern perimeter (or its southern perimeter, Shaw Avenue), the two longest and heavily trafficked perimeters of the rectangular campus. Studies for Fresno State's *Campus Master Plan* found that 47% of all traffic enters the university from Barstow Avenue, an aging and narrow urban road (see "Traffic Study" in attachments). Traffic management and safety (cars, bicycles, walkers) are pressing issues for Barstow Avenue. Funding is requested for Phases 3, 4, and 5 as these are particularly dangerous for the University's thousands of students, faculty, and staff, as well as commuter bicyclists in cities of Fresno and Clovis. Either vehicle lanes take up the entire curb-to-curb width or the existing bike lane and road are too narrow for safety. Phase 3 runs along the north side of Barstow Avenue from Cedar Avenue to the Westerly End of Parking Lot Q. Particularly dangerous in Phase 3 is the intersection of Cedar Avenue and Barstow Avenue which lacks both a bike lane and a vehicle right turn lane. Phase 4 continues along the north side of Barstow Avenue from the Westerly End of Parking Lot Q to the Viticulture Building. This phase is dangerous due to two heavily trafficked entrances/exits from Parking Lot Q. Phase 5 then continues along the north side of Barstow Avenue from the Viticulture Building to Chestnut Avenue. The "Accident Report" (see attachments) provides the number of reportable accidents in recent years only; it does not include accidents never reported, plus the many "near misses." The photographs (see attachments) show the conditions which encourage the many near misses.

B. Need for funding. The project to build bikeways requires major work on an aged, narrow urban street, resulting in a price tag that is far beyond the means of a public university like Fresno State. Fresno State also sits in the San Joaquin Valley, whose economic and air quality challenges are grim. Building these bikeways is about social justice on every level: for our students (over 50% of whom are Pell grant recipients) and for the larger community whose population is majority-minority and whose socio-economic status has lagged behind the state's for decades. Adjacent to the university are four Environmental Justice areas and two disadvantaged neighborhoods—Sierra Madre and El Dorado Park—and the latter's zip code has been ranked among the poorest in California. The university is also a heavily-trafficked activity center for the City, and a significant amount of vehicle idling occurs all day, producing a disproportionate amount of pollutants for the neighborhood. In recent years, Fresno State met the challenge of balancing its budget even with all the radical cuts (exceeding 20%) made in recent years to the California State University system because of the economic downturn that hit hard the State of California. The university is poised to move forward with a stable funding base now established with moderate increasing state funds on the horizon, but these funds will be applied to maintain the quality of teaching in the classrooms and to address the large amount of deferred maintenance of the physical campus that took place during the economic downturn. The University will have to rely on aggressive pursuit of external funding to make its physical campus a model of a premiere Hispanic-Serving Institution.

C. Consistency with Regional Transportation Plan (100 words or less)
The Fresno Council of Government's RTP (2014) "includes a notable increase in the regional active transportation network for walking and bicycling" (p. 4-25). The gap that the Barstow Avenue Bikeways would close is labelled on the Fresno COG's "Bikeway Systems Map" (see attachments) The Environmental Justice Areas bordering the university are labelled on the Fresno COG's "EJA" map (also in attachments).

IV. NARRATIVE QUESTIONS

1. POTENTIAL FOR INCREASED WALKING AND BICYCLING, ESPECIALLY AMONG STUDENTS, INCLUDING THE IDENTIFICATION OF WALKING AND BICYCLING ROUTES TO AND FROM SCHOOLS, TRANSIT FACILITIES, COMMUNITY CENTERS, EMPLOYMENT CENTERS, AND OTHER DESTINATIONS; AND INCLUDING INCREASING AND IMPROVING CONNECTIVITY AND MOBILITY OF NON-MOTORIZED USERS. *(0-30 POINTS)*

A. Describe how your project encourages increased walking and bicycling, especially among students.

The Barstow Avenue Bikeways (the "Bikeways") will be part of California State University, Fresno, home to a total of 23,060 students and 2,191 employees (Fall 2013) and seated in one of the densest activity centers in the Fresno-Clovis Metropolitan Area. Barstow Avenue is part of the backbone of the circulation system of the University, being the northern one-mile leg of the rectangular perimeter whose three other borders are Shaw Avenue (south), Cedar Avenue (west), and Chestnut Avenue (east). Barstow Avenue connects the two main west-east thoroughfares of the university perimeter as it runs from Cedar Avenue to Chestnut Avenue. However, Barstow is an older, narrow street with no room for bike lanes at certain points. It is dangerous for cyclists. The new Barstow Avenue Bikeways would offer students, faculty, and staff a safe alternate mode of transportation. In doing so, the Bikeways would provide students, faculty, and staff with increased access to the "Bike n' Bus" program of Fresno Area Express (FAX) operating in the Fresno-Clovis metropolitan area. A total of four bus routes (#9, #10, #28, and #38) run along the university's perimeters (see attachments).

The university's being seated in an activity center also means that the Bikeways would increase access to major education, employment, shopping, and recreational sites for the populations in two adjacent jurisdictions. The Bikeways would complete a critical connector between the Fresno and Clovis bikeway systems. Construction of the Bikeways would transform the avenue from a one-mile obstacle into a one-mile gateway for commuter bicyclists. The Bikeways fill a gap in the longest west-east bikeway in the City of Fresno that goes through three of Fresno's four major job centers—the clusters on Blackstone Avenue, Shaw Avenue, and Fresno State. These dense job and activity centers are the sites of major bus routes, whose "Bike n' Bus" program further boosts the accessibility and practicality of bike travel. According to the U.S. Census, the 2012 estimate for the City of Fresno's population was 505,882 and the City of Clovis' population was 98,632, for a total of 604,515 for the Fresno-Clovis metropolitan area.

B. Describe the number and type of possible users and their destinations, and the anticipated percentage increase in users upon completion of your project. Data collection methods should be described.

In Spring 2009, the University surveyed the entire student body (then approximately 22,000) on parking and traffic conditions, with a total of 2,712 responding (12.3%). Of the respondents, 18% indicated that they were dissatisfied or very dissatisfied with bike routes *to* campus and 11.9% indicated that they were satisfied or very satisfied. For bike routes *on* campus, 18.7% indicated that they were dissatisfied or very dissatisfied and 13.7% indicated that they were satisfied or very satisfied. That the great majority selected either "didn't know" or "neutral" suggests that the lack of biking infrastructure renders invisible and/or inconsequential the minimal and inadequate facilities available. The point is salient as the largest category of students (24.6%) identified "convenience/ flexibility" as determining their choice to use alternate transportation to vehicles. The once honored tradition of students, faculty, and staff biking to campus has long evaporated with the deteriorating and/or increasingly congested transportation infrastructure: those walking, biking, or skateboarding to campus has sunk to a steady low of 7%. The data from the survey indicate the extent to which the situation could be turned around however. For example, only 16.7% of bike users indicated that they use their bike as primary transportation to the campus while 50.9% do so rarely. But 46.2% of bike users indicated that they would probably or definitely use improved bike facilities, with another 24.8% giving a neutral, open-ended response. An additional 15.4% of *non*-bike users indicated that they would probably or definitely use improved bike facilities, with another 19.1% giving a neutral, open-ended response. Finally, 38.9% indicated that they would like to see biking parking lockers and showers included in new parking structures. Improved biking facilities are critical to re-creating a 'critical mass' of bikers that would re-establish biking as part of the campus culture, making the activity highly visible to all passers-by on the heavily trafficked routes lining the university.

A new survey is scheduled for Fall semester 2014, and two years post-completion of the Barstow Avenue Bikeways, a follow up survey will be administered. The two-year window will allow time for media announcements, visible daily use, new high impact signing along the route, and so on, to take effect and increase use levels from the 2009 and 2014 surveys.

The U.S. Census – American Community Survey report, "Commuting in the U.S.: 2009," notes that several of the top metro areas for bicycling to work have at least one large college or university with a high percentage of college-aged students (pg. 10). Fresno State is a commuter university, and the concentration of people on a weekday can easily exceed 25,000. Approximately 10% (2,500 students) live within 1.5 miles of campus; 25% (~5,000 students) live within five miles; and 50% (~10,000 students) live within 10 miles (see "Campus Master Plan - Student Resident Locations" in attachments). This means that large numbers could commute by bicycle or by Fresno's Public Transportation (FAX) Bike n' Bus program if provided with a safe and convenient route. Student enrollment will continue to climb. Fresno State's current Campus Master Plan (2008) presents a "Projection of Student Headcount for Space Planning Purposes." The University anticipates a projected increase in student headcount to 31,001 (Class of 2030). Over 2,000 employees (faculty, managers, and staff) serve our current student population. Fresno State also houses University High School, with 400 students, plus its own faculty and staff. Due to the University's concentrated population, surrounding it are many businesses serving University clientele, and contributing to a steady stream of employees coming to the area. Many of these employees (e.g., restaurant workers) are on the lower end of the wage scale, making them good candidates for commuter bicycling.

Finally, the disadvantaged neighborhoods/Environmental Justice areas bordering the university have concentrations of lower socio-economic and minority populations, who are prime candidates for commuter bicycling (see also Question 6). "Commuting in the United States: 2009" also noted that minority/disadvantaged populations have the highest reliance on public transportation: "The percentage of Hispanic and non-Hispanic Asian workers who drove alone did not exceed 70 percent" (pg. 5), and those who live and work in a metro area have the "highest public transportation usage rate, at 10.9 percent" (pg. 6). The Barstow Bikeways project also offers these stakeholders increased access to Fresno's "Bike n' Bus" program, and it does so for newly linked bikeways along three major job centers.

Finally, the mode share data on the cities of Fresno and Clovis from the American Community Survey was consulted but cannot be broadly applied to the university. Fresno State is a community-within-a-community (the Fresno-Clovis metropolitan area) that has a disproportionately high share of prime candidates (students) for bicycling. Fresno State's population is simply not representative of the general population. However, one point bears mention: the five-year (2008-2012) ACS mode share data indicates the extent to which the City of Fresno is a 'car culture,' with .008% bicycling to work; .0019 walking to work; and 2% taking the bus to work (and not all of those use the Bike n' Bus program). The City of Clovis has even smaller percentages for those biking (.004%), walking (.014%), or taking the bus to work (.005%). Clearly, the need is great to create the infrastructure for alternative transportation and develop the culture to use and appreciate it. This is all the more reason to encourage and eventually entrench a culture of bicycling in the immediate generations of students at Fresno State, who are prime candidates for change.

C. Describe how this project improves walking and bicycling routes to and from, connects to, or is part of a school or school facility, transit facility, community center, employment center, state or national trail system, points of interest, and/or park.

Not only are the Bikeways part of a large, commuter university but also due to the university's concentrated population, surrounding it are many businesses and organizations. The total number of number of these (restaurants; convenience stores; nonprofit organizations; retail stores; religious organizations; shopping centers; arena) and their clientele are significant. Two deserve note:
► Save Mart Center is a 16,000-plus capacity multi-purpose arena that hosts major sports, entertainment, and business conferences for the region.
► Campus Pointe is a development with a 14-screen cinema, shopping center, restaurants, mixed use housing, and office space.
Finally, the campus is open access. The Bikeways will be highly visible active transportation at a well-visited university that is an environmental leader for the region.

D. Describe how this project increases and/or improves connectivity, removes a barrier to mobility and/or closes a gap in a non-motorized facility.

The Bikeways project addresses a critical flaw in the regional bikeway system. The plan to create and update bikeways along both sides of Barstow Avenue between Cedar and Chestnut Avenues would transform the Fresno State campus from a major barrier to commuter-oriented bicycling into a major access route. The Bikeways running along Barstow Avenue (university owned) would complete a crucial link in the bikeway systems of the adjacent municipal jurisdictions of Fresno and Clovis. The western end of the 1-mile Barstow Avenue bikeways would connect with an existing City of Fresno bike trail that extends two miles to Blackstone Avenue, and the eastern end would connect with the City of Clovis Bike Trail that extends 1.7 miles to Harvard Avenue/ Sierra Vista Elementary School. This project would complete the longest west-east bikeway in the City of Fresno (along three of Fresno's four major job centers—the clusters on Blackstone Avenue, Shaw Avenue, and Fresno State). Moreover, the Barstow Avenue Bikeways will connect the longest north-south trails in Fresno (running along Cedar Avenue and First Avenue). Clovis plans to extend its Barstow Avenue bikeway from Harvard Avenue to Clovis Avenue, which will be the longest and major north-south bikeway in Clovis. In sum, the Fresno State Barstow Avenue Bikeways will provide significantly increased connectivity and so access to major education, employment, shopping, and recreational sites for the populations in two adjacent cities.

2. **POTENTIAL FOR REDUCING THE NUMBER AND/OR RATE OF PEDESTRIAN AND BICYCLIST FATALITIES AND INJURIES, INCLUDING THE IDENTIFICATION OF SAFETY HAZARDS FOR PEDESTRIANS AND BICYCLISTS.** *(0-25 POINTS)*

A. Describe the potential of the project to reduce pedestrian and/or bicycle injuries or fatalities.

The Bikeways phases for which we are requesting funding either have no bike lanes in some parts because vehicle traffic takes up the entire width of the road or the existing bike lane and road are too narrow for safety. The result is that bicyclists are on the road 'mixed' with cars, on the sidewalk 'mixed' with pedestrians, or 'mixing' in and out of both cars and pedestrians. The accident report from Fresno State's Police Department indicates 14 reportable injuries during a five-year span (2008-2013) (see attachments). The report does not include injuries from accidents in which the bicyclists and/or pedestrians picked themselves up, dusted themselves off, and pedaled or walked home—perhaps to discover injuries later. This scenario would be exacerbated among a population that is young and coming from a lower socioeconomic background. The report also does not include the many near misses.

Note: The entire Barstow Avenue Bikeways will incorporate the following minimum standards: (1) Minimum bike lane width of 5' (7' where adjacent to concrete curb and gutter); (2) Minimum width of combination bikeway and pedestrian walk to be 12'; and (3) Minimum vehicular traffic lane width of 11' (12' desirable wherever practicable). Appropriate pavement striping, markings, and signing will determined during detailed design of the project, and will conform to the recommendations and standards included in the publication entitled "Bikeway Planning and Design" as prepared by the California Department of Transportation, July 1990 (or latest edition).

B. Describe if/how your project will achieve any or all of the following [safety measure listed]:

► Addresses inadequate bicycle facilities, crosswalks or sidewalks
Widening the road either to create bike lanes where none exist or to widen existing bike lanes that are too narrow addresses woefully inadequate bicycle facilities. In the process of creating a bike lane at the northeast corner of Cedar and Barstow Avenues, a right turn lane will also be added, increasing safety to both bicyclists and vehicle drivers at that crowded corner (the entrance point of 30% of all traffic into the university).

► Addresses inadequate traffic control devices
Along the entire length of the Barstow Avenue Bikeways, pavement striping, markings, and signing will be important features. These features, like the Bikeways itself, will conform to Caltrans' standards for bike lanes. Signage will especially be high impact along the entire Bikeways, with signing such as "Bike/Pedestrian Crossing—Do Not Block" to allow staging of vehicles at intersections without impeding use of the bikeway/pedestrian crossing.

► Eliminates behaviors that lead to collisions
Creating the bike lanes creates a designated space for bicyclists. This eliminates behavior that leads to collisions because bicyclists have a safe lane to ride in: they no longer are forced to mingle directly with vehicle traffic, with pedestrian traffic (an equal source of accidents), or (worse) to mingle with both, darting in and off the sidewalks and roads as spaces disappears or become available, dodging cars and walkers as necessary.

► Improves sight distance and visibility
Creating bike lanes were none existed increases the visibility of bicyclists (compared to their sometimes being mingled with pedestrians on the sidewalk, then darting out to cross the road or to avoid a pedestrian). The bike lanes along the length of Barstow Avenue increases the sight distance related to bicyclists: bicyclists in the lanes now

have clear sight of the street and its traffic; cars travelling parallel to the bike lanes now have clear sight of bicyclists; and pedestrians walking parallel are now separate from bicyclist and have clear sight of them also. (Please see photos that illustrate current conditions in attachments.)

►Improves compliance with local traffic laws

Creating bike lanes were none existed or the existing lane and road are too narrow for safety improves compliance with local traffic laws as bicyclists will now be riding in new or widened bike lanes, and riding in the right direction. The lack of bike lanes now results in students riding hither and thither, be it on the wrong side of the street or on the sidewalks. The increased and high impact signage, coupled with the clearly demarcated bike lanes, will also prompt bicyclists and vehicle drivers to be mindful of local laws as they apply to sharing the road.

►Reduces speed or volume of motor vehicles

The increased visibility of bicyclists, the clearly demarcated lanes, and the high impact signage will both prompt vehicle drivers to be more mindful of local laws about bicycling and to reduce their speed and be cautious: they need to share the road.

C. Describe the location's history of events and the source(s) of data used (e.g. collision reports, community observation, surveys, audits) if data is not available include a description of safety hazard(s) and photos.

An accident report from the Fresno State Police Department can be found in the attachments. In the five-year span from 2008-2013, there were 14 reportable accidents involving bicyclists, pedestrians, and vehicles along the crowded and chaotic route.

To add to the Police Department's accident report, first-hand testimonies (i.e., complaints) from students and vehicle drivers report many "near misses." The environment contributing to these "near misses" is seen in the photos included in the attachments. Anecdotal information also includes scenarios of students who fit the description above of having an accident, getting up and dusting off, and then pedaling home, sometimes with an injury.

3. PUBLIC PARTICIPATION and PLANNING *(0-15 POINTS)*

A. Describe the community based public participation process that culminated in the project proposal or plan, such as noticed meetings/public hearings, consultation with stakeholders, etc.

The project proposal for the Barstow Avenue Bikeways is the result of a series of coordinated efforts. First, a series of over 80 meetings was held with the campus community to arrive at the current Campus Master Plan (January 2008). The Campus Master Plan Coordinating Committee guides the future growth and development at Fresno State and includes members from all divisions of the university (Academic Affairs, Auxiliary, Facilities & Management, Athletics, Communications, President's Committee on Disabilities, Student Government, and more). Both Campus and Community Participation are encouraged. The proceedings (e.g., agendas, minutes) are available online to the public not only for viewing but also for comment.

The Campus Master Plan Coordinating Committee collaborates with the standing Campus Planning Committee, charged with coordinating, developing, and implementing the Campus Master Plan. The Campus Planning Committee regularly works with the City of Fresno and County of Fresno Planning Commissions on matters related to campus development, zoning in areas surrounding the university, streets and highways leading to and from the campus, and other matters as appropriate. The Vice President for Administration oversees these campus planning bodies and efforts, and its office handles business matters, such as obtaining the right of way for the Barstow Avenue Bikeways via a land trade (2013), with the cities of Fresno and Clovis.

Regarding broad community support, Fresno State faculty members are active in environmental initiatives. A cadre recently secured a "Campus as a Living Lab" grant from the CSU Chancellor's Office to institute a series of "green bag" lunches devoted to environmental education and discussion, in collaboration with Fresno State's Plant Ops team. Faculty members participate in grants to transform the physical campus and its practices whenever possible; for example, a faculty member will take charge of EV education for the campus and the general community as part of the grant award from the California Environmental Commission to build the Valley's first major EV Charging Station on campus.

Support is consistent across the university. The Fresno State Police Department's Campus Bike Program is one modest example, and it runs an annual bike helmet giveaway to the first 25 students who register their bikes. The university is right now investing in bike barns, having completed one bike barn in student housing that has significantly reduced bike theft and provided better infrastructure to bicyclists. Two more bike barns are scheduled for installation this summer to encourage ridership by offering secure storage.

The university prides itself on demonstrating environmental leadership for the San Joaquin Valley. Support for the Bikeways is strong and campus-wide.

B. Describe the local participation process that resulted in the identification and prioritization of the project:

In addition to the open process and committee work described above, the university developed and administered the survey to the entire student body that covered bicycle use (2009) (see answer to Question 1.B). The university was already committed to building the Barstow Avenue Bikeways for compelling traffic, safety, and environmental leadership reasons, but the positive response from students on the survey indicating that they would use new or improved bicycle facilities influenced the university's decision to install the new bike barns and to include bike racks and changing/showering facilities in new parking garages.

C. Is the project cost over $1 Million? Y/N **N - $872,000**

If Yes- is the project Prioritized in an adopted city or county bicycle transportation plan, pedestrian plan, safe routes to school plan, active transportation plan, trail plan, circulation element of a general plan, or other publicly approved plan that incorporated elements of an active transportation plan? Y/N **N/A**

4. COST EFFECTIVENESS *(0-10 POINTS)*

A. Describe the alternatives that were considered. Discuss the relative costs and benefits of all the alternatives and explain why the nominated one was chosen.

The university is seated and had no real 'alternatives.' An 'alternative' might have been neither to fund the Concept Plans for the Bikeways nor to press forward with securing funding to build them. In short, to do nothing was the main 'alternative' (and not acceptable to the university leadership and community). An 'alternative' route was also not realistic: Shaw Avenue is the closest parallel route/other west-east perimeter, and it is a congested thoroughfare with 90,000-plus average daily traffic. No bike lanes are permitted on that dangerous thoroughfare.

B. Calculate the ratio of the benefits of the project relative to both the total project cost and funds requested.

Benefits aligned with ATP goals from the completion of the Barstow Avenue Bikeways include the following:

1. Increased safety for commuter bicyclists, both students and general population, from completion of Bikeways on a well trafficked route with either no bike lane in sections or existing bike lane and road that are narrow in other sections;
2. Increase mobility and access for commuter bicyclists, both students and general population, from completing a gap between two major bikeway systems;
3. Increase in the proportion of bicycling trips from the provision of newly safe, convenient, and congenial Bikeways;
4. Advance regional efforts to achieve greenhouse gas reductions by allowing increased student and commuter bicycling, especially in an area with a huge amount of daily traffic and significant vehicle idling;
5. Enhances public health by allowing for increased bicycling, especially being part of Fresno State's larger "Healthy U" campaign;
6. All of above benefits extend to disadvantaged neighborhoods/Environmental Justice areas immediately bordering the university (see EJ Areas map in attachments);
7. Benefits a broad spectrum of users, including not only bicyclists (students; work commuter bicyclists; low income and/or Hispanic workers; leisure bicyclists), but also pedestrians, who will be able to walk on sidewalks now dedicated to their exclusive use.

The injuries listed in the Fresno State Police's Department accident report (see Question 2) indicate the safety gained from building the bikeways, as do the calculations using the World Health Organizations HEAT tool and data from Hall et al's study of South Coast and San Joaquin Valley air pollution (see Question 5). Important here is quantifying the GHG emissions reductions, and Fresno State requested an analysis from the environmental consulting firm, FirstCarbon Solutions (FCS):

"FCS prepared cost-effectiveness estimates for criteria pollutants reactive organic gases (ROG), oxides of nitrogen (NOx), particulate matter less than 10 micrometers (PM10), and particulate matter less than 2.5 micrometers (PM2.5). FCS also prepared a cost-effectiveness estimate for greenhouse gases (GHG) to determine the project's benefits for reducing climate change impacts.

The analysis first estimates reductions in vehicle trips and miles traveled that will result from the construction of the Barstow Bikeway project. The analysis is based on the California Air Resources Board (ARB) 2005 document "Methods to find Cost-Effectiveness of Funding Air Quality Projects." The trip reductions are based on the amount of vehicle traffic that currently exists on roadways serving the campus and fractions of trips that are expected to be diverted to bike trips due to the new bikeway. The vehicle trip estimates for the local road segments were obtained from data published by the Fresno Council of Governments. The ARB method adjusts the bicycle trip rate based on factors including climate, the size of the urban area, and the number of activity centers that are expected to attract bike trips. The analysis uses the default 1.8 mile bike trip length to account for shorter trips taken by most bicyclists. The results of the analysis show an anticipated reduction of 122,030 daily vehicle trips and 219,654 vehicle miles traveled (VMT). *(For detailed modeling results and references, see attachments.)*

The next step of the analysis is to estimate emission reductions that would result from the reductions in vehicle trips and miles traveled. For criteria pollutants, the analysis used emission factors compiled by ARB in its 2005 guidance document described above. ARB provided emission rates in grams per mile for ROG, NOx, PM10, and PM2.5. The emissions rates are multiplied by the reduced vehicle trips and miles traveled to obtain an estimate of emission reductions in pounds per year. To estimate greenhouse gas emission reductions, the analysis used ARB's EMFAC 2011 emission model to determine current emission factors for carbon dioxide (CO_2) for light duty cars and trucks. EMFAC provides emission rates in grams per mile for running emissions and grams per day for vehicle starting emissions. The emission rates are multiplied by the same daily trips and VMT used in the criteria pollutant estimate for the greenhouse gas emission reduction estimate.

The final step of the analysis is to determine the cost effectiveness of the project based on each funding source and overall total funding from all sources. The cost-effectiveness is reported in dollars per pound of total pollutants reduced for criteria pollutants and in dollars per metric ton of CO_2 for greenhouse gases. The results of the analysis are presented below:

Criteria Pollutant Cost-Effectiveness (CE)				
	Funding ($)	**Amortized ($/yr)**	**Emissions Reductions**	**CE $/lb**
ATP Funding	872,000	69,760	415	**168**
CMAQ Funding	590,000	47,200	415	**114**
Local (CSUF)	613,000	49,040	415	**118**
Total Funding	2,075,000	166,000	415	**400**
Reduction in Kilograms/day		0.52		

Greenhouse Gas Cost-Effectiveness (CE)				
	Funding ($)	**Amortized ($/yr)**	**Emissions Reductions**	**CE ($/lb)**
ATP Funding	872,000	69,760	99.9	**698**
CMAQ Funding	590,000	47,200	99.9	**472**
Local (CSUF)	613,000	49,040	99.9	**491**
Total Funding	2,075,000	166,000	99.9	**1662**

To summarize, the project will result in a cost-effectiveness of **$168** per pound of criteria pollutant reduction based on Alternative Transportation Project (ATP) funding and **$400** per pound of criteria pollutant reduction accounting for total project funding. The cost-effectiveness of greenhouse gas reduction are **$698** per metric ton of CO_2 based on ATP funding and **$1,662** for total project funding."

5. IMPROVED PUBLIC HEALTH *(0-10 points)*

A. Describe how the project will improve public health, i.e. through the targeting of populations who have a high risk factor for obesity, physical inactivity, asthma, or other health issues.

Fresno State occupies a site that ranks high in both disadvantaged populations and poor air quality. Poor air quality is one of the most pressing issues for the region, and it exists on the neighborhood, city, and regional level. Completing the Bikeways in a neighborhood with very heavy traffic and vehicle idling will make a contribution to reducing pollution. Current rates for asthma in Fresno County exceed those for the state. For adults, 13% have asthma in Fresno County vs. 7.7% in the state, and for children and teens, 15.7% have asthma in Fresno County vs. 10.1% for the state (see California "Health Profiles" in attachments).

The extent of the poor air quality in our area is indicated by the American Lung Association sample of 277 metropolitan areas and subsequent rating of the top 25 polluted cities in America.[2] For ozone pollution, five of the six top cities are in the Central Valley. For short-term particle pollution, four of the five top cities are in the Valley. For year round particle pollution, six of the seven top cities are in the Central Valley. Fresno is on all three lists: the City holds second place for the most polluted city for short-term particle pollution; third place as the most polluted city for year round particle pollution; and fourth place for high ozone days.

Hall et al's study, *The Benefits of Meeting Federal Clean Air Standards in the South Coast and San Joaquin Valley Air Basins* (November 2008), applied the Regional Human Exposure Model (REHEX) and reported on the particularly detrimental situation in the two air basins, plus the socioeconomic demographics related to exposure. Ozone levels typically exceed during warmer months, and PM2.5 typically exceeds during the cooler fall and winter months, so there is no "clean" season in the San Joaquin Valley. The risk of exposure is highest by region, due to the unique geography of the San Joaquin Valley. 100% of the population of Fresno County is exposed to annual PM2.5 concentrations exceeding federal standards. Age and race and ethnicity play a part in the extent of exposure. "Children under the age of 5 are exposed to unhealthful ozone concentrations on more days than adults" (85) and "Blacks and Hispanics experience somewhat more frequent exposures to elevated levels of PM2.5 than non-Hispanic whites do" (3). Hispanics in the SJV receive "disproportionately more exposures than other racial or ethnic groups" (24): as the concentrations of PM2.5 increase, so does exposure of Hispanics. Whites and Hispanics receive 100% exposure annually to PM2.5 greater than 12 ug/m^3, but for exposure greater than 15ug/m^3, whites receive 61% annually vs. Hispanics who receive 72% exposure. For exposure greater than 18 ug/m^3, whites receive 29% annually vs. Hispanics who receive 34% exposure (35).

[2] http://www.stateoftheair.org/2013/city-rankings/most-polluted-cities.html

The health effects from exposure to air pollution also result in a high price for residents of the San Joaquin Valley: "...the cost of air pollution is more than $1,600 per person per year, which translates into a total of nearly $6 billion in savings if federal ozone and PM2.5 standards" are met (5). On the "Impact Charts" representing the distribution of adverse health effects and the economic benefits of remedying the situation, Fresno ranks 1st as paying the highest price (6-7; 81-83; 85). The documented health effects include both infant and premature adult mortality, plus events such as nonfatal heart attacks and conditions such as chronic bronchitis and asthma. The related consequences from these health effects include school absenteeism and work loss days. The report notes there is no measure for the "value of avoiding the pain and anxiety caused by the underlying condition" (58-75). The report concludes that while progress has been made, achieving the health-based standards "will be very difficult" for the San Joaquin Valley (11), and that difficulty will only increase with the growth in population and parallel growth in vehicle traffic and the economy (86). The summary on the study's results of attaining federal levels for air quality include this excerpt:

> "In the SJVAB, the overall benefits of attaining the NAAQS are dominated by premature mortality.... Across the SJVAB, over 800 people are estimated to avoid premature death annually, accounting only for the effect of PM2.5 and only for the population aged 30 and older. With a value for each life of $6.63 million, this effect alone offers a benefit of attainment of over $5 billion each year" (77).

The air quality in the San Joaquin Valley has improved since 2004. Many challenges remain, however, and current reports from organizations such as the American Lung Association show that the San Joaquin Valley's ratings have not improved. Air quality is of urgent importance.

Hall et al's study emphasis on reduced premature mortality as a core benefit from improved air quality merited a calculation in the World Health Organization's "Health Economic Assessment Tool" (HEAT). The HEAT tool, however, is set up for "population level" assessment (e.g., of municipalities) and not higher education campuses whose populations are stable but not representative of the general population. HEAT makes clear that it is designed for the general population aged 20-64. Fresno State's population would be predominantly in the lower end and partly below it. Fresno State's population would align with the HEAT tool by not including children, very young adults, or older people (who would be retired). Fresno State's population would also largely fall within the dose per day (1.5 hours given that most students live within 1-10 miles of the campus, that faculty and staff who live farther out in the surrounding towns would not be among the commuter bicyclists, etc.; see also "Campus Master Plan: Student Residence" in attachments).

Given that estimates had to be used, but also that the university's population is stable, the calculation was based on a single point of time (two-plus years after the bikeways are built). The single point of time meant entering a set of numbers from one conservative estimate whereas the "before and after an intervention" method would have meant entering sets of numbers from two conservative estimates. Not only would the number of estimates have doubled, but HEAT itself cautions: "Data to estimate the proportion of newly induced cycling is rarely available." The data entered therefore consisted of one set of conservative estimates based whenever possible on numbers available, e.g., from Fresno State's 2009 survey of students, the mode share data on the cities of Fresno and Clovis from the U.S. Census.

Fresno State - Barstow Avenue Bikeways	
Frame: 2 Years Post-Completion of Bikeways (1-mile connector, plus major public university location	
Fresno State Students - 7% of 23,060 (total head count in Fall 2013) = 1614. Fresno State 2009 survey of entire study body showed that 7% bicycle, walk, or skateboard to campus, and that is an all-time low. Given the improvements in safety, connectivity, and visibility from the Bikeways, it was considered reasonable to aim for 7% of the student body bicycling.	1614
Fresno State Faculty & Staff - 2% of 2,191 = 40. Given the cadre of environmental leaders in this population and their activity levels, being in prime adulthood, it was considered reasonable to aim for 2% cycling.	40
Commuter Bicyclists - Fresno State is seated in one of the four densest job and activity centers of the Fresno-Clovis metropolitan area. It was considered reasonable to include 5% of commuter bicyclists identified in the mode share data of the U.S. Census' American Community Survey: 2008-2012. 5% x 4,400 [.008 of approximately 500,000 (City of Fresno) = 4,000 and .004 of 100,000 (City of Clovis) = 400].	220
Regular Sports and/or Leisure Bicyclists - 2.5% of Commuter Bicyclists. No data was available. The estimate remained conservative though a good number of people bicycle for enjoyment compared to those who bicycle to work.	110
Total Cyclists	*1984*
Average Distance: 4 miles. Conservative estimate of bicycling an average of 2 miles (20 minutes) each way (see "Campus Master Plan: Student Residence" in attachments).	4
Annual Days: 120. This is a conservative estimate, based on 4 days per week x 30 weeks (2 semesters of 15 weeks). This is an average for all parties: students and faculty (some of whom bicycle year round due to summer session); commuters who bicycle 5 days per week year round; sports and leisure bicyclists who regularly exercise or enjoy the activity.	120
WHO - HEAT Results	
Average distance cycled per person per year in km	772
This level of cycling is likely to lead to a reduction in the risk of mortality of	15%
Total number of individuals regularly doing this amount of cycling	1984

6. BENEFIT TO DISADVANTAGED COMMUNITIES *(0-10 points)*

A. I. Is the project located in a disadvantaged community? Y/N N

II. Does the project significantly benefit a disadvantaged community? Y/N | Y |

a. Which criteria does the project meet? — Median household income for the community benefited by the project: Using the five-year American Community Survey, U.S. Census Tract 54.03 (that holds more than one severely disadvantaged neighborhood) has a median household income of $21,037, a little less than 35% of the State of California median household income of $61,400).

B. Describe how the project demonstrates a clear benefit to a disadvantaged community and what percentage of the project funding will benefit that community, for projects using the school based criteria describe specifically the school students and community will benefit.

Census Tract 54.03 contains El Dorado Park, a severely disadvantaged neighborhood adjacent to the university. The university/surrounding activity center generate significant traffic congestion and vehicle idling, which produces a disproportionate amount of pollutants. This local concentration of pollutants affects those living close by, including residents in El Dorado Park. (In fact, there are a total of four Environmental Justice Areas bordering the university—see map in attachments.) No percentage of the project falls geographically within El Dorado Park and so no funding is targeted for that disadvantaged community: the prime benefit is improved air quality. The Bikeways, like other university catalytic projects such as the EV charging station, provide immediate air quality improvements to the campus and bordering neighborhoods, in addition to moving forward culture change in the San Joaquin Valley.

The access of El Dorado Park residents, and all others, is daily: the campus is open. Local teenagers play Frisbee on our green lawns and thousands of school children visit and picnic in Fresno State's O'Neill Park each year. Or, Fresno State's Associated Students, Inc. (student government) frequently partner with the local anchor organizations in El Dorado Park like the Boys and Girls Club to sponsor field trips. One such trip is walking along the Barstow Avenue route to the University's Farm Market. Such access fulfills an acute need, for El Dorado Park is an isolated neighborhood: poor urban planning resulted in there being only two modes of egress/ingress into the neighborhood.

A final note is that the same way that the U.S. Census mode share data for the cities of Fresno and Clovis does not clearly represent the university community (see Question 1.B), the disadvantaged community data which is both valid and reliable cannot be applied to the university community (for obvious and correct reasons). Yet, Fresno State holds two need-based U.S. Department of Education Minority-Serving Institution designations: Hispanic-Serving Institution and Asian American, Native American, and Pacific Islander-Serving Institution. The most recent (2012) unduplicated head count of degree students who received Title IV need-based assistance (Federal Pell Grant, Federal College Work Study, Federal Perkins Loan, or Federal Supplemental Educational) totaled 15,681.

7. **USE OF CALIFORNIA CONSERVATION CORPS (CCC) OR A CERTIFIED COMMUNITY CONSERVATION CORPS** *(0 to -5 points)*

A. The applicant has coordinated with the CCC to identify how a state conservation corps can be a partner of the project. Y/N **N/A**

B. The applicant has coordinated with a representative from the California Association of Local Conservation Corps (CALCC) to identify how a certified community conservation corps can be a partner of the project. Y/N **Y**

a. Name, e-mail, and phone # of the person contacted and the date the information was submitted to them – Contacted Mr. Shawn Riggins, Director, Fresno EOC Local Conservation Corps/YouthBuild Fresno, who delegated task to Salvatore Terry, General Manager, Local Conservation Corps, Fresno Economic Opportunities Commission. 1805 E. California Avenue, Fresno, CA 93706. shawn.riggins@fresnoeoc.org. T (559) 264-1048. F (559) 264-1004. Cell (559)994-5453. Date submitted: 22 April 2014.

C. The applicant intends to utilize the CCC or a certified community conservation corps on all items where participation is indicated? Y/N **Y**

I have coordinated with a representative of the CALCC; and the following are project items that they are qualified to partner on:

1. Grubbing and clearing
2. Demo of existing concrete and A/C
3. Grading and compacting
4. Forming on grade
5. Placing and finishing ready-mix concrete
6. Installation of ADA domes

(See also Conservation Corps letter in attachments.)

8. **APPLICANT'S PERFORMANCE ON PAST GRANTS** *(0 to -10 points)*

A. Describe any of your agency's ATP type grant failures during the past 5 years, and what changes your agency will take in order to deliver this project.

Fresno State has no past grant experience with ATP but has performed satisfactorily on similar grants. The university just completed Phase I of the Barstow Avenue Bikeways with funding from the San Joaquin Air Valley Pollution Control District. The university in general performs satisfactorily (or above) on approximately $35 million in externally-funded projects annually. Also, Fresno State operates a full construction program including staff and contract expertise in engineering and architecture that starts from preliminary/schematic design through construction documents, bid phase, award, and construction to include inspection and code compliance. In the next 4 months, Fresno State will break ground on 3 building projects that total over $80 million in cost.

Project name: Fresno State - Barstow Avenue Bikeways

V. PROJECT PROGRAMMING REQUEST

Applicant must complete a Project Programming Request (PPR) and attach it as part of this application. The PPR and can be found at http://www.dot.ca.gov/hq/transprog/allocation/ppr_new_projects_9-12-13.xls

PPR Instructions can be found at http://www.dot.ca.gov/hq/transprog/ocip/2012stip.htm

Notes:

- Fund No. 1 must represent ATP funding being requested for program years 2014/2015 and 2015/2016 only.
- Non-infrastructure project funding must be identified as Con and indicated as "Non-infrastructure" in the Notes box of the Proposed Cost and Proposed Funding tables.
- Match funds must be identified as such in the Proposed Funding tables.

STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION

PROJECT PROGRAMMING REQUEST

DTP-0001 (Revised July 2013)

General Instructions

☑ New Project				**Date:**	5/20/14
District	**EA**	**Project ID**	**PPNO**	**MPO ID**	**TCRP No.**
06					

County	**Route/Corridor**	**PM Bk**	**PM Ahd**	**Project Sponsor/Lead Agency**	
FRE	Barstow Avenue			California State University, Fresno ("Fresno State")	
				MPO	**Element**
				COFCG	Local Assistance

Project Manager/Contact	**Phone**	**E-mail Address**
VP Cynthia Matson	278-2083	cmatson@csufresno.edu

Project Title

Fresno State - Barstow Avenue Bikeways

Location, Project Limits, Description, Scope of Work ☐ See page 2

[Within City of Fresno] - Construct bike lane on north side of Barstow Avenue (university owned) from Cedar Avenue to Chestnut Avenue. 1 mile. Includes widening road and new vehicle right turn lane at northeast corner of Barstow and Cedar Avenues.

☐ Includes ADA Improvements ☑ Includes Bike/Ped Improvements

Component	**Implementing Agency**
PA&ED	Fresno State
PS&E	Fresno State
Right of Way	Fresno State
Construction	Fresno State

Purpose and Need ☐ See page 2

Completes gap between bikeway systems of two adjacent municipal jurisdictions (cities of Fresno and Clovis). Creates safe active/alternate transportation route for university's 20,000-plus students, faculty, and staff, plus commuter bicyclists. Offers safe active/alternate transportation route for a university that holds two need-based U.S. Department of Education Minority-Serving Institutions designations: Hispanic-Serving Institution and Asian American, Native American, and Pacific Islander-Serving Institution. Route is currently dangerous: either there are no bike lanes (vehicle traffic takes up entire width of Barstow Avenue) or bike land and road are narrow.

Project Benefits ☐ See page 2

IMPROVED SAFETY: In some parts, no bike lanes exist because vehicle traffic takes up entire width of street. INCREASED RIDERSHIP: Completing link between two major bikeways enables commuter bicycling, of students and general population. IMPROVED AIR QUALITY: University area is heavily traffic with congestion; resulting vehicle idling produces disproportionate amount of pollutants.

☑ Supports Sustainable Communities Strategy (SCS) Goals ☑ Reduces Greenhouse Gas Emissions

Project Milestone			**Proposed**
Project Study Report Approved			
Begin Environmental (PA&ED) Phase			
Circulate Draft Environmental Document	**Document Type**	CE	12/01/14
Draft Project Report			
End Environmental Phase (PA&ED Milestone)			
Begin Design (PS&E) Phase			
End Design Phase (Ready to List for Advertisement Milestone)			
Begin Right of Way Phase			
End Right of Way Phase (Right of Way Certification Milestone)			
Begin Construction Phase (Contract Award Milestone)			12/01/14
End Construction Phase (Construction Contract Acceptance Milestone)			11/30/15
Begin Closeout Phase			12/01/15
End Closeout Phase (Closeout Report)			11/30/17

Project name:	Fresno State - Barstow Avenue Bikeways

VI. ADDITIONAL INFORMATION

Only fill in those fields that are applicable to your project

FUNDING SUMMARY

ATP Funds being requested by Phase (to the nearest $1000)	**Amount**
PE Phase (includes PA&ED and PS&E)	$ 222,000
Right-of-Way Phase	$
Construction Phase-Infrastructure	$ 650,000
Construction Phase-Non-infrastructure	$
Total for ALL Phases	**$** 872,000

All Non-ATP fund types on this project* (to the nearest $1000)	**Amount**
Fresno State - 11.47% cash match for ATP 313.000	$ 113,000
Fresno State - 68.000 land use (phases 3 +4 +5)	$ 68,000
Fresno State - 63.000 construction mgmt	$ 63,000
Fresno State - Prior (concept plans, right of way)	$ 369,000
CMAQ - 550 Con and 40 PS&E	$ 590,000
	$

*Must indicate which funds are matching

Total Project Cost	$ 2,075,000
Project is Fully Funded	Yes

ATP Work Specific Funding Breakdown (to the nearest $1000)	**Amount**
Request for funding a Plan	$
Request for Safe Routes to Schools Infrastructure work	$
Request for Safe Routes to Schools Non-Infrastructure work	$
Request for other Non-Infrastructure work (non-SRTS)	$
Request for Recreational Trails work	$

ALLOCATION/AUTHORIZATION REQUESTS SCHEDULE

	Proposed Allocation Date	Proposed Authorization (E-76) Date
PA&ED or E&P		
PS&E	12/01/2014	01/01/2015
Right-of-Way		
Construction	12/01/2014	01/01/2015

All project costs MUST be accounted for on this form, including elements of the overall project that will be, or have been funded by other sources.

Project name: Fresno State - Barstow Avenue Bikeways

VII. NON-INFRASTRUCTURE SCHEDULE INFORMATION

Start Date	End Date	Task/Deliverables

Project name: Fresno State - Barstow Avenue Bikeways

VIII. APPLICATION SIGNATURES

Applicant: The undersigned affirms that the statements contained in the application package are true and complete to the best of their knowledge.

Signature: [signature] Date: 5/20/14
Name: Dr. Thomas McClanahan Phone: (559)278-0840
Title: Associate Vice President, ORSP e-mail: tommcc@csufresno.edu

Local Agency Official (City Engineer or Public Works Director): The undersigned affirms that the statements contained in the application package are true and complete to the best of their knowledge.

Signature: ______ Date: ______
Name: ______ Phone: ______
Title: ______ e-mail: ______

School Official: The undersigned affirms that the school(s) benefited by this application is not on a school closure list.

Signature: ______ Date: ______
Name: ______ Phone: ______
Title: ______ e-mail: ______

Person to contact for questions:

Name: Phone: ______
Title: e-mail: ______

Caltrans District Traffic Operations Office Approval*
If the application's project proposes improvements on a freeway or state highway that affects the safety or operations of the facility, it is required that the proposed improvements be reviewed by the district traffic operations office and either a letter of support or acknowledgement from the traffic operations office be attached (_) or the signature of the traffic personnel be secured below.

Signature: ______ Date: ______
Name: ______ Phone: ______
Title: ______ e-mail: ______

*Contact the District Local Assistance Engineer (DLAE) for the project to get Caltrans Traffic Ops contact information. DLAE contact information can be found at http://www.dot.ca.gov/hq/LocalPrograms/dlae.htm

Project name: Fresno State - Barstow Avenue Bikeways

VIII. ADDITIONAL APPLICATION ATTACHMENTS

Check all attachments included with this application.

- ☒ Vicinity/Location Map- **REQUIRED for all IF Projects**
  - ☒ North Arrow
  - ☒ Label street names and highway route numbers
  - ☒ Scale

- ☒ Photos and/or Video of Existing Location- **REQUIRED for all IF Projects**
  - ☒ Minimum of one labeled color photo of the existing project location
  - ☒ Minimum photo size 3 x 5 inches
  - ☐ Optional video and/or time-lapse

- ☒ Preliminary Plans- **REQUIRED for Construction phase only**
  - ☒ Must include a north arrow
  - ☒ Label the scale of the drawing
  - ☒ Typical Cross sections where applicable with property or right-of-way lines
  - ☒ Label street names, highway route numbers and easements

- ☒ Detailed Engineer's Estimate- **REQUIRED for Construction phase only**
  - ☒ Estimate must be true and accurate. Applicant is responsible for verifying costs prior to submittal
  - ☒ Must show a breakdown of all bid items by unit and cost. Lump Sum may only be used per industry standards
  - ☒ Must identify all items that ATP will be funding
  - ☒ Contingency is limited to 10% of funds being requested
  - ☒ Evaluation required under the ATP guidelines is not a reimbursable item

- ☐ Documentation of the partnering maintenance agreement- Required with the application if an entity, other than the applicant, is going to assume responsibility for the operation and maintenance of the facility

- ☐ Documentation of the partnering implementation agreement-Required with the application if an entity, other than the applicant, is going to implement the project.

- ☐ Letters of Support from Caltrans (Required for projects on the State Highway System(SHS))

- ☐ Digital copy of or an online link to an approved plan (bicycle, pedestrian, safe routes to school, active transportation, general, recreation, trails, city/county or regional master plan(s), technical studies, and/or environmental studies (with environmental commitment record or list of mitigation measures), if applicable. Include/highlight portions that are applicable to the proposed project.

- ☒ Documentation of the public participation process (required)

- ☐ Letter of Support from impacted school- when the school isn't the applicant or partner on the application (required)

- ☒ Additional documentation, letters of support, etc (optional)

Additional Attachments – List

(1) Vicinity/Location Map: Fresno COG Bikeway System (N arrow; scale; labels)
(2) Photographs of existing location
(3) Preliminary Plans: Blair, Church, & Flynn Concept Plans (N arrow; scale; labels)
(4) Detailed Engineer's Estimate: Alan Mok Engineers
(5) Documentation of Public Participation Process
(6) Accident Report (Fresno State Police Department)
(7) FirstCarbon Solutions: Detailed Modelling Results and References (Criteria Pollution Cost Effective Analysis and GHG Emission Reduction and Cost Effective Calculations), and MPO's Regional Traffic Monitoring Report
(8) Fresno COG – Environmental Justice Areas map
(9) Fresno State – Project Timeline
(10) Fresno State – *Campus Master Plan* excerpt: Barstow Avenue Traffic Study
(11) Fresno State – *Campus Master Plan* excerpt: Student Residence Location
(12) Fresno Area Express (FAX) Bus Routes Map
(13) Documentation of Matching Funds
  a) Fresno State Vice President of Administration: Letter of Commitment
  b) Notification from Fresno Council of Government of recommended CMAQ funding
(14) Documentation – Qualified Community Conservation Corps commitment to participate, with specific tasks identified
(15) Studies Cited in Narrative Questions: Q1-8
  c) "Commuting in the United States: 2009." American Community Survey Reports (Sept 2011).
  d) UCLA Center for Health Policy Research. 2011-2012 Health Profiles: Adults / Child and Teen
  e) Hall, Jane et al. *The Benefits of Meeting Federal Clean Air Standards in the South Coast and San Joaquin Valley Air Basins* (Nov 2008).

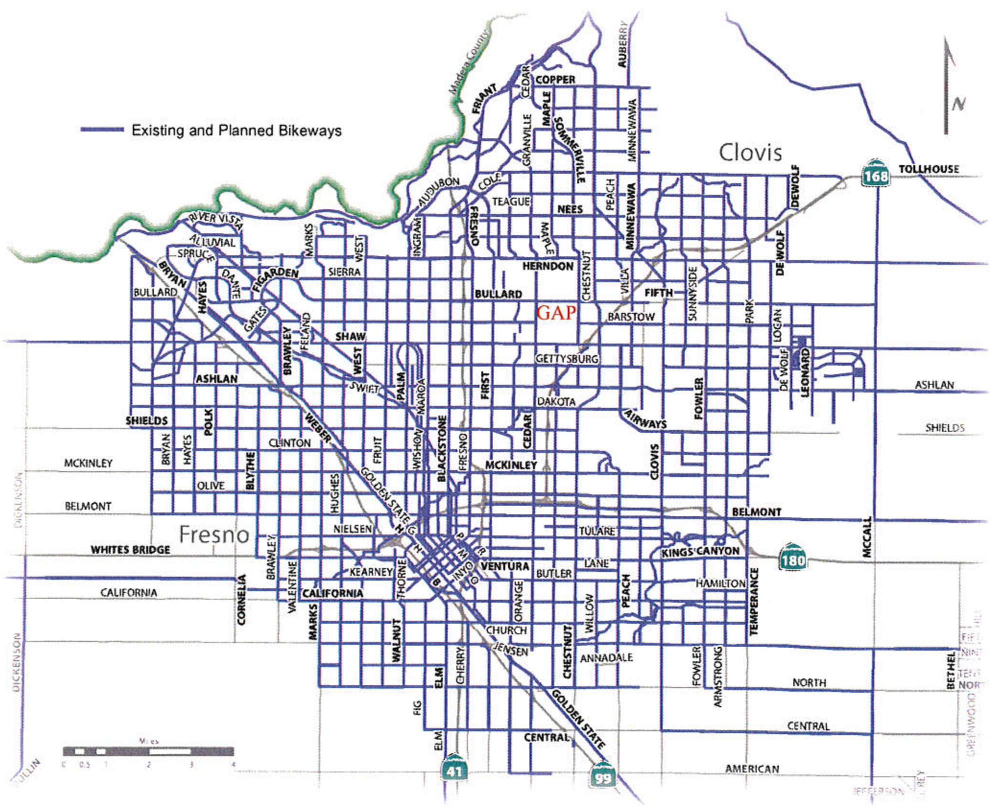
Vicinity/Location Map - Fresno COG Bikeway System (below) w/ "GAP" labelled

neighborhoods, mix land uses, and provide a variety of transportation choices" among many others. Within the 2007/08 – 2026/27 Measure "C" Program, 4% of funding is allocated to pedestrian/trails/bicycle facilities subprograms while fully 24% of funding is allocated to the Regional Public Transit Program, including the Public Transit Agencies Subprogram (19.66%), the Farmworker/Car/Van Pools Subprogram (1.16%), the New Technology Reserve Subprogram (2.10%) and the ADA/Seniors/Paratransit Subprogram (0.79%), among others. In addition, the 2011 RTP included new policy regarding Complete Streets and policy enhancements suggested by the Fresno County Department of Public Health that emphasize walking, bicycling, and transit for reasons of health and well-being. Policy and funding are finally coming together to establish an achievable, not just theoretical, relationship between transit and bicycling/pedestrian infrastructure.

Goals for the development of bicycle and pedestrian transportation in Fresno County are as follows:

- **Planning** - The recognition and integration of bicycling and walking as valid and healthy transportation modes in transportation planning activities.
- **Physical Facilities** - Safe, convenient, and continuous routes for bicyclists and pedestrians of all types that interface with and complement a multimodal transportation system.
- **Safety and Education** - Improved bicycle and pedestrian safety through education and enforcement.
- **Encouragement** - Increased acceptance of bicycling both as a legitimate transportation mode on public roads and highways and as a transportation mode that is a viable alternative to the automobile.
- **Implementation** - Increased development of the regional bikeways system, related facilities, and pedestrian facilities by maximizing funding opportunities.

Figure 5-15: Bikeway System - Metro Area



Existing System Inventory

Pedestrian facilities are not typically regional in function. Rather, they are essentially site-specific and local, and hold particular importance in community design and redesign in working toward a more livable environment. Alternatively, bicycle facilities can be regional in function. The planned bikeways regional system is shown in Figures 5-15 and 5-16. The plan calls for community routes and routes which link communities and provide access to activity centers, including major commercial and employment centers, major recreational sites, and schools. All of the cities in the County and the County itself have planned bikeway facilities, although limited available funding has had an impact on their construction. Nevertheless, local agencies continue to add to the inventory of completed

Photographs: Site of Barstow Avenue Bikeways

Intersection of Barstow Avenue (north side) and Cedar Avenue; no bike lane and no vehicle turn lane

Long shot: No existing bike lane/path on north side of Barstow Avenue

Bicyclists on Barstow Avenue (north side; heading toward Cedar Avenue)

Traffic at intersection of Barstow Avenue and Cedar Avenue (east to west perspective)

Vehicle, bicycle, and pedestrian traffic on Barstow Avenue (north side)

Bicyclist on Barstow Avenue between entrances/exits for Parking Lot Q entrance

Bicyclists and Pedestrians on Barstow Avenue at Parking Lot Q

Constant stream of traffic entering and exiting Parking Lot Q

Traffic at intersections of Barstow Avenue w/ Parking Lot Q (north side) and w/ Campus Drive (south side)

Steady stream of traffic exiting Parking Lot Q onto Barstow Avenue

Collage: Bicyclists on north side of Barstow Avenue (20-minute window; illustrative sample only)

Explanatory Note: Photographs of Bike Commuters on Shaw Avenue (southern leg of Fresno State perimeter).

Below are samples of photographs, two taken during 15-minute windows on Shaw Avenue at Fresno State. Not all photographs taking during each 15-minute window are included in the samples below. Only illustrative ones are included. Also, additional shots were missed due to the heavy traffic, i.e., a car, van, or truck passed by the bicyclist.

The photographs are meant to illustrate a critical point about calculating greenhouse gas emissions reduction for (1) a heavily-trafficked route (Shaw Avenue) with traffic in excess of the typical cap of 30,000 Average Daily Traffic (ADT) and for (2) the route (Barstow Avenue) parallel to a proposed bike lane.

(1) The logic of the 30,000 ADT cap is that crowded routes with many runners, walkers, moms with strollers, dogs with long leashes, etc., are a disincentive that serious bike commuters would not want to deal with. This logic is absolutely true: no bike commuter wants to deal with these things. Where the logic cannot be applied realistically is when that crowded route is a perimeter for a major and public university, especially one with many low income students for whom bicycling and using the FAX Bike N Bus program are the most economical and sometimes only realistic means of travelling to get their education. Moreover, the "disincentives" of runners, moms with strollers, dogs on long leashes, and on, are not present on this heavily trafficked avenue bordering the university. The photos on the following pages illustrate the pedestrian and bike commuter traffic consists mainly of the university population and surrounding businesses population.

Shaw Avenue has actual daily traffic in excess of 90,000. One can argue that Shaw Avenue presents more than a disincentive for bike commuters: it presents a dangerous route. Yet, the photographs illustrate the steady stream of bike commuters taking this route to access their public university. The lack of a central and safe route (the proposed Barstow Avenue Bikeways) compounds the matter because it prohibits development of a ridership culture and its complementary education about safe routes and practices. In the photographs below, one sees a norm of bike commuters with no helmets, not riding in the right direction, not walking across major intersections, riding side by side, having long hair unclipped, plus cars stopping in the cross lanes, and so on. Perhaps partly in the minds of these bike commuters is this insight—none of it really matters: all routes into the university are dangerous.[1]

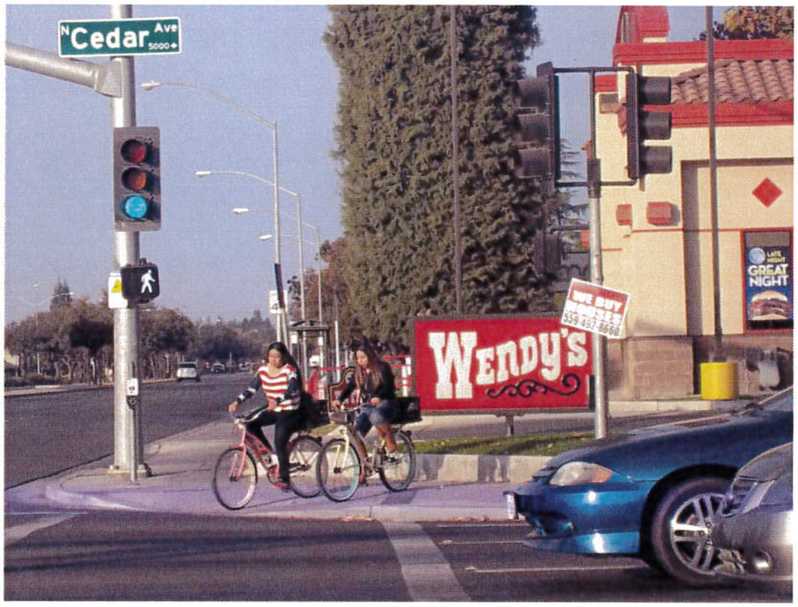
The photographs illustrate that the number of bike commuters on the perimeter corridor of Fresno State is a steadier stream than often seen on the miles of bike lanes throughout the City and County. They deserve **safety**. For those not yet daring enough to commute to Fresno State by bicycle, they deserve **access**.

(2) The logic of calculating the GHG emissions reduction based on the parallel road is also valid except when applied to the perimeter of a major university in an urban setting. I present an anecdotal illustration about vehicle drivers and Shaw Avenue. I myself drive down Cedar Avenue and across Shaw Avenue to enter the university every morning. The reason is that Shaw Avenue offers much better driving conditions that the narrow and old Barstow Avenue. When a safe bicycling route and ridership cultures exists at Fresno State, I will begin bicycle commuting to the university. My vehicle traffic will be taken off of Shaw Avenue (*not* Barstow Avenue). Given the current driving conditions, one argues reasonably that a chunk of vehicle traffic will be taken off of Shaw Avenue as well as Barstow Avenue by the construction of the Barstow Avenue Bikeways.

---

[1] Fresno State's Traffic Department runs a Campus Bike Program including safety education and incentives such as helmet giveaways on first come basis for registering bikes: http://www.fresnostate.edu/adminserv/police/transportation/bike/index.html.

<u>15-minute window *sampling only* #1 (A.M.)—Shaw and Cedar Avenues</u>:



Two student bicyclists ride across Shaw Avenue toward the university.

Two student bicyclists coming down Cedar Avenue (west side) and riding across to Shaw Avenue to enter the university.

Two bicyclists riding down Cedar Avenue (east side) and onto Shaw Avenue to enter the university.

Yet another in the steady stream of bicyclists riding through traffic at major intersection of Cedar and Shaw Avenues and proceeding onto Shaw Avenue to reach university.

Bicyclist riding near one of multiple bus stops at major intersections with Shaw Avenue at university; student bicyclists are not infrequently seen embarking and debarking from the FAX Bike N Bus—and heading toward Shaw Avenue.

Bicyclist riding across Shaw Avenue in front of car stopped in cross lane.

Bicyclist on Shaw Avenue swerved onto dirt strip to avoid pedestrian.

Bicyclist riding down sidewalk on Shaw Avenue toward university.

Yet one more student bicyclist out of more not included in this sampling at busy intersection.

15-minute window *sampling only* #2 (Midday)—Shaw and Cedar Avenues:

Bicyclist leaving university at midday, biking down Shaw Avenue

Another in the steady stream of bicyclists leaving midday

Ditto….

Bicyclist cruising down Shaw Avenue

These two shots of the same red-hooded bicyclist illustrate the bicyclist route of coming down (or up) Cedar Avenue and then riding down Shaw Avenue to enter the university

Bicyclist in grey t-shirt had come down Shaw Avenue to Cedar, crossed to opposite side of Shaw Avenue, then continued riding down Shaw Avenue

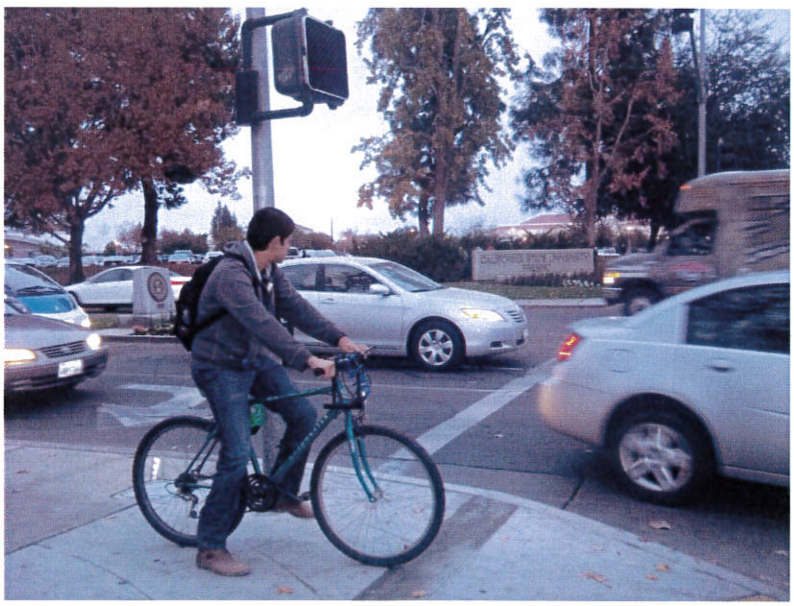
Simply two more bicyclists (riding opposite directions) at Cedar and Shaw Avenues

Bicyclist among pedestrians midday (most students)

...yet two more bicyclists midday at site

This final "midday" page illustrates yet more bicyclists out of the stream….

Final *sampling* #3—End of Day @ Shaw and Maple Avenues:



End of day photographs taken at Maple Avenue and Shaw Avenue to illustrate steady flow of bicyclists in and out of multiple university entrances/exits on Shaw Avenue

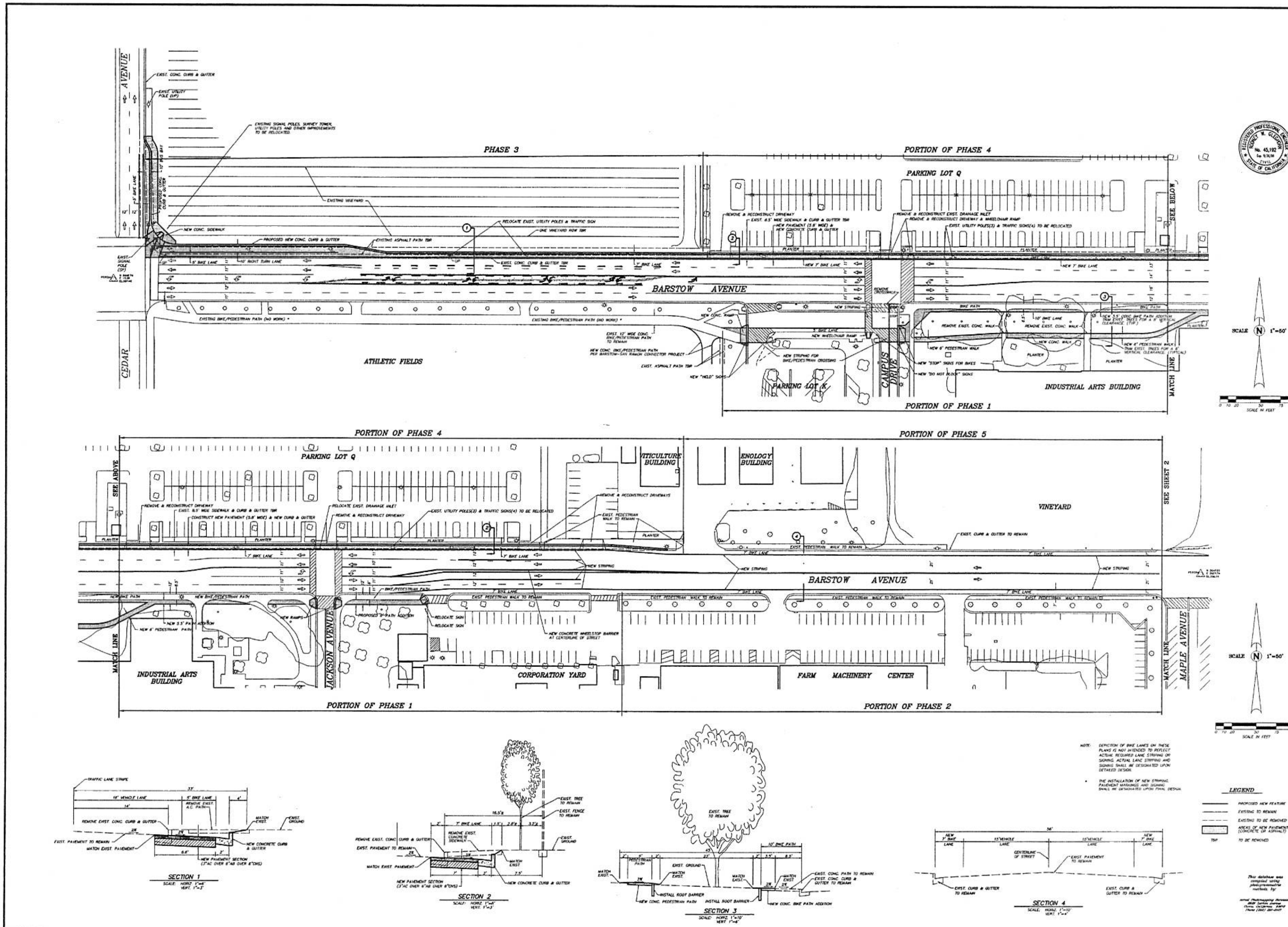
Two photographs show bicyclist (grey sweatshirt, green backpack) heading out Maple Avenue exit of university, crossing Shaw Avenue, and riding east down Shaw Avenue. In bottom photograph, bicyclist seen whizzing by Sequoia Textbooks store (red roof).

Two photographs show bicyclist (black sweatshirt, black backpack) heading out Maple Avenue exit of university, crossing Shaw Avenue, and riding west down Shaw Avenue. In bottom photograph, bicyclist seen by red tail light in front of silver car.

Photographs below are a quick collage of bike commuters….

More in the collage of bicyclists heading home….

Finally, at end of day, a bicyclist spotted wearing a helmet….



CALIFORNIA STATE UNIVERSITY, FRESNO

PROPOSED BARSTOW AVENUE BIKEWAYS

CONCEPTUAL PLAN
CEDAR TO CHESTNUT AVENUES

DESIGN ENGINEER: RODNEY W. GLEGHORN RCE NO. 43,192

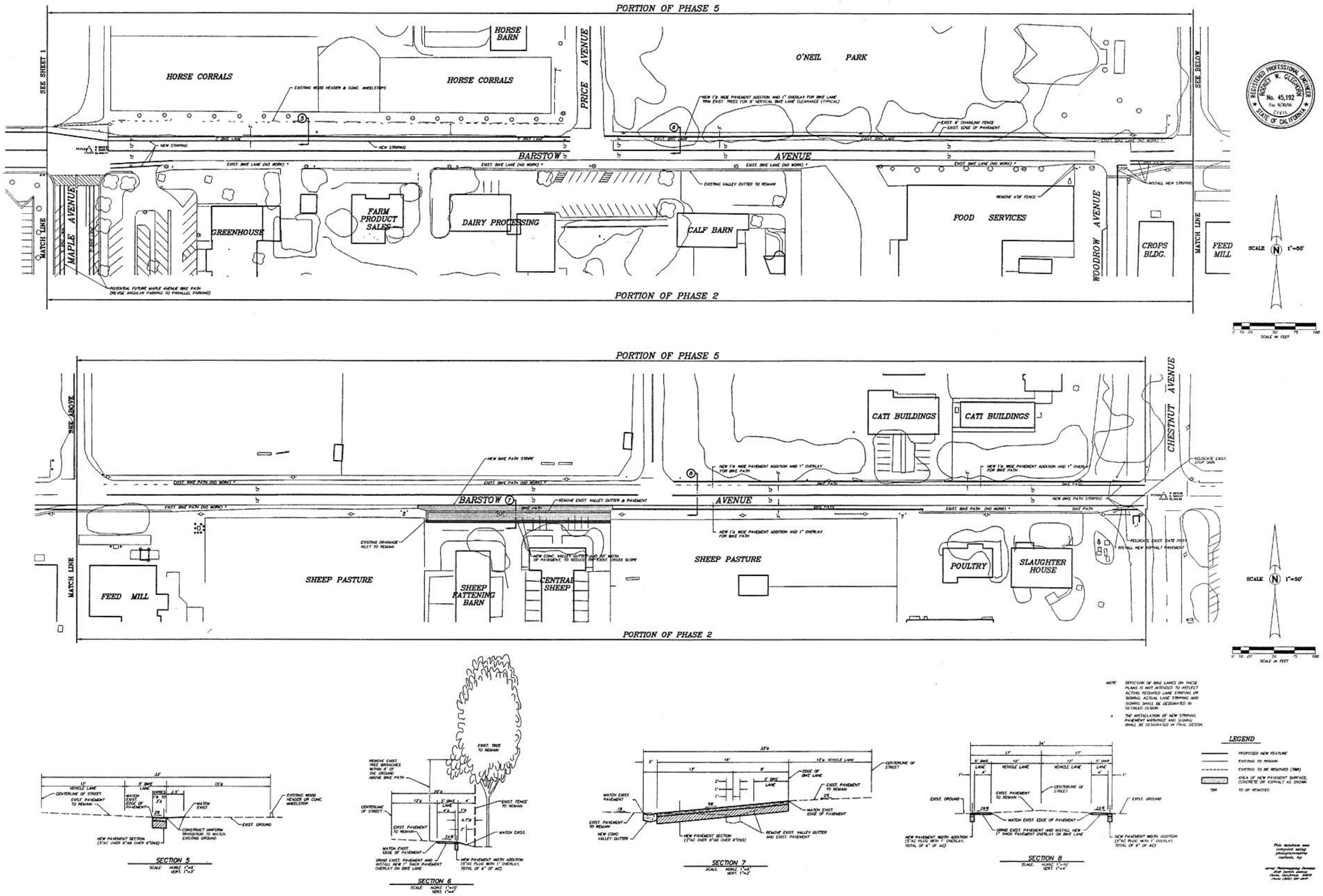
DATE: 3-24-06

REVISIONS:

Blair, Church & Flynn

DRAWING NUMBER

SHEET 1 of 2 SHEETS



Blair, Church & Flynn
CONSULTING ENGINEERS

REGISTERED PROFESSIONAL ENGINEER
RODNEY W. GLEGHORN
No. 45,192
CIVIL
STATE OF CALIFORNIA

CONCEPTUAL PLAN
CEDAR TO CHESTNUT AVENUES

DESIGN ENGINEER: RODNEY W. GLEGHORN RCE NO. 45,192
DATE: 3-24-06
REVISIONS:

CALIFORNIA STATE UNIVERSITY, FRESNO
PROPOSED BARSTOW AVENUE BIKEWAYS

DRAWING NUMBER

SHEET 2 OF 2 SHEETS

May 19, 2014

CALIFORNIA STATE UNIVERSITY, FRESNO

BARSTOW AVENUE BICYCLE PATH
UPDATED PRELIMINARY ESTIMATE OF PROJECT CONSTRUCTION COST
CONCEPTUAL PLAN

ENR CONSTRUCTION COST INDEX = 7,630

SUMMARY OF ESTIMATED PROJECT CONSTRUCTION COST

Phase 3 - North side of Barstow Avenue from Cedar Avenue to the westerly end of Parking Lot Q	**$407,000.00**
Phase 4 - North side of Barstow Avenue from the westerly end of Parking Lot Q to the Viticulture Building	**$333,000.00**
Phase 5 - North side of Barstow Avenue from the Viticulture Building to Chestnut Avenue	**$573,000.00**
Survey, Engineering, Inspection, Testing and Adminstrtaion	**$262,000.00**
Total Estimated Project Construction Cost	**$1,575,000.00**

PHASE 3: North Side of Barstow Avenue from Cedar Avenue to the Westerly End of Parking Lot Q

ITEM NO.	DESCRIPTION	ESTIMATED QUANTITY			UNIT ESTIMATE		EXTENSION
1	Mobilization and Traffic Control	1	LS	@	$15,000.00	=	$15,000.00
2	Clearing and Grubbing	1	LS	@	$30,000.00	=	$30,000.00
3	Earthwork	800	CY	@	$100.00	=	$80,000.00
4	Traffic Signal Modifications	1	LS	@	$60,000.00	=	$60,000.00
5	Utility Pole Relocations	3	EA	@	$15,000.00	=	$45,000.00
6	Concrete Curb and Gutter	800	LF	@	$25.00	=	$20,000.00
7	Concrete Walks and Ramps	5,600	SF	@	$6.00		$33,600.00
8	Traffic Striping, Markings and Signing	1	LS	@	$8,000.00		$8,000.00
9	3" AC on 6" AB Pavement Section	10,500	SF	@	$4.00		$42,000.00
10	Temporary AC Transition to Phase 4	1	LS	@	$3,000.00		$3,000.00
11	Miscellaneous Facilities and Operations	1	LS	@	$33,400.00		$33,400.00
					SUBTOTAL		$370,000.00
					CONTINGENCIES (10%+/-)		$37,000.00
					TOTAL		**$407,000.00**

IASE 4: North Side of Barstow Avenue from the Westerly End of Parking Lot Q to the Viticulture Buildi

1	Mobilization and Traffic Control	1	LS	@	$15,000.00	=	$15,000.00
2	Clearing and Grubbing	1	LS	@	$40,000.00	=	$40,000.00
3	Earthwork	400	CY	@	$100.00	=	$40,000.00
4	Utility Pole Relocations	6	EA	@	$15,000.00	=	$90,000.00
5	Concrete Curb and Gutter	1,240	LF	@	$25.00	=	$31,000.00
6	Concrete Walks and Ramps	8,750	SF	@	$6.00	=	$5,250.00
7	Concrete Driveway	1,500	SF	@	$8.00	=	$12,000.00
8	Traffic Striping, Markings and Signing	1	LS	@	$6,000.00	=	$6,000.00
9	3" AC on 6" AB Pavement Section	8,700	SF	@	$4.00	=	$34,800.00
10	Temporary AC Transition to Phase 3	1	LS	@	$1,000.00	=	$1,000.00
11	Miscellaneous Facilities and Operations	1	LS	@	$27,950.00	=	$27,950.00
					SUBTOTAL		$303,000.00
					CONTINGENCIES (10% +/-		$30,000.00
					TOTAL		**$333,000.00**

PHASE 5: North Side of Barstow Avenue from the Viticulture Building to Chestnut Avenue

ITEM NO.	DESCRIPTION	ESTIMATED QUANTITY			UNIT ESTIMATE		EXTENSION
1	Mobilization and Traffic Control	1	LS	@	$5,000.00	=	$5,000.00
2	Clearing and Grubbing	1	LS	@	$20,000.00	=	$20,000.00
3	Earthwork	500	CY	@	$100.00	=	$50,000.00
4	Utilities Pole Relocation	10	EA	@	$15,000.00	=	$150,000.00
2	Concrete Curb and Gutter	2,500	LF	@	$25.00	=	$62,500.00
3	Concrete Sidewalk and Ramp	15,000	SF	@	$6.00	=	$90,000.00
4	Traffic Striping, Markings and Signing	1	LS	@	$5,000.00	=	$5,000.00
5	3" AC on 6" AB Pavement Section	18,000	SF	@	$4.00	=	$72,000.00
3	5" AC Pavement Plug and 1" Overlay	1,250	LF	@	$15.00	=	$18,750.00
4	Miscellaneous Facilities and Operations	1	LS	@	$47,750.00		$47,750.00
					SUBTOTAL		$521,000.00
					CONTINGENCIES (10% +/-)		$52,000.00
					TOTAL		**$573,000.00**

Alan Mok Engineering

SBE, UDBE

Alan Mok, P.E., P.L.S., LEED AP, QSD
Principal Engineer

Frederick W. Wong, P.E.
Senior Project Manager

Edward M. Wong, P.E.
Senior Project Manager

Chad R. Blau, P.L.S.
Land Surveyer

May 19, 2014

AME File No. 213-0246

Ms. Amy Armstrong
Parking Administrator
California State University, Fresno
Traffic Operations
2311 East Barstow Avenue M/S PO14
Fresno, CA 93740-8004

Subject: Professional Services Proposal
Design for Barstow Avenue Bikeway, Phase 3, 4 & 5

Dear Amy,

As per your request, we have evaluated our cost for providing civil engineering services for the subject project. Please accept this letter as our proposal to you for the work.

Project Background

It is our understanding that the University is planning to construct a bikeway on Barstow Avenue at the campus and you would like us to provide civil engineering services for the project. This proposal is for phases 3, 4 & 5.

Scope of Work

1. Conduct topographic survey and utilities search of the work area.
2. Preparation of topographic survey map.
3. Preparation of construction documents for demolition, site, grading and drainage improvements, and landscape and irrigation modification.
4. Coordinate with utility companies to relocate power pole.
5. Preparation of SWPPP.
6. Submit and obtain approval from local agencies.

7415 N. Palm Avenue, Ste 101
Fresno, CA 93711
Tel 559-432-6879
Fax 559-432-6897
www.alanmokengineering.com

7. Meeting with the University staff as well as coordinating with consultants during the bidding and construction phases.
8. Provide bidding services – attend pre-bid conference and bid opening, issue addendum(s) as needed, evaluate bid results with the University.
9. Provide construction services – attend pre-construction meeting, provide periodic construction review, respond to contractor's RFI(s), prepare change order(s) as needed, process contractor's payment request(s) and attend final punch list meeting
10. Provide Testing, Inspection and Construction Administration service

Proposed Fee

We estimate the construction cost to be approximately **$1,313,000** for completing phases 3, 4 and 5 together, resulting in a reduction of overall time and construction costs and propose to provide engineering services for a lump sum amount of **$262,000.00**

We appreciate you considering Alan Mok Engineering as a member of your project team and look forward to working with you. Please call if you have any questions.

Best Regards,

ALAN MOK ENGINEERING

Alan K. Mok

Alan Mok
Principal

FRESNO STATE Discovery. Diversity. Distinction.

Go

Campus Master Plan

DIVISION OF ADMINISTRATIVE SERVICES

Campus & Community Participation

This website is designed to answer questions about the Campus Master Plan and encourage community participation in its development. The ideas of students, staff, faculty, alumni, parents, and community members will help ensure the value of Master Plan projects. Fresno State is committed to ensuring broad representation and participation in the master planning process from within the university, its community and its various stakeholder groups. I encourage you to check back often for the latest Master Plan developments and to contact us at masterplan@csufresno.edu with your thoughts.

Cynthia Teniente-Matson
Vice President for Administration
and Chief Financial Officer
California State University, Fresno

Campus Master Plan
5241 N. Maple Avenue M/S TA 52
Fresno, CA 93740
P 559.278.2083
F 559.278.2928

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Last Updated Dec 24, 2013

Consultation

Ten-Year Projections

A series of over 80 meetings was held with Deans, departments and other constituencies throughout the university to establish the plans and intentions of each for the next ten years. One important purpose of these meetings was to discover the aspirations as well as the more finite intentions of each group, so that a comprehensive view of facilities needs for the whole campus could be constructed. This was aligned with the community and social aspects of the university, and with academics. Attraction and retention of quality faculty and students are important, as is the goal of producing well-rounded students with capabilities that reach beyond their academic credentials.

A ten year period was selected because that period is short enough for realistic speculation, yet long enough to enable key projects to be identified, programmed, funded, designed, constructed and occupied.

The challenge of leaping ten years into the future was easier for some than for others, and inevitably, scenarios included a lot of detail about current facilities needs, and a certain number of unrealistic demands. However, all colleges and departments rose to the challenge, identifying current trends and making informed estimates of future needs. Expected increases in research and inter-disciplinary programs gave rise to many of the facilities improvement requests, but there were other recurrent themes too, such as the need for spaces for collegial interaction among students, faculty and staff. The program of requested facilities needs appears later in this document. A list of the meetings from which they were derived appears in the Appendix, and notes on each meeting are included in a technical appendix.

Special Considerations

Some principles emerged from the meetings held with many of the groups whose members have different experiences and perspectives on the campus. For example, conflicts between vehicles and those on foot should not occur in the campus core, and should be reduced to a minimum elsewhere. There are some places on campus that accurately portray the spirit of this university, but there are many that need to be greatly improved. Similarly, the campus landscape is exceptional in places, but lacks coherence and consistency overall. These and many more issues emerged and were addressed in the framework plans and other analysis detailed later in this document.

Campus Master Plan
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Campus Master Plan

DIVISION OF ADMINISTRATIVE SERVICES

Committee & Members

The Campus Master Plan Coordinating Committee endeavors to create a framework for future growth and development at Fresno State. This framework responds to the institution's mission, goals, the Strategic Plan for Excellence III - 2006-2011, and our programmatic needs by enhancing the physical environment, and facilities of the campus.

The Master Plan provides a timeframe and order that best accomplishes the goals of the Master Plan by looking at both short- and long-range needs of the campus. When fully implemented, the Master Plan will provide for the University an attractive campus that promotes intellectual and social interchange between student, faculty, staff and the surrounding community in line with the University's plan for the *New California*.

Michael Botwin	Chair, Academic Senate Executive
Deborah S. Adishian-Astone	Executive Director, Auxiliary Services
Mark Aydelotte	Past Associate Vice President for University Communications
Shirley Armbruster	Interim Assistant Vice President for University Communications
Thomas Boeh	Director of Athletics
Robert Boyd	Associate Vice President, Facilities Management
Doug Hensler	Dean, Craig School of Business
Kathy Johnson	Associate Director, Facilities Planning
James S. Kus	Chair, FACEL
Jody Hironaka-Juteau	Past Chair, President's Committee on Disabilities
Craig Miner	Past Chair, President's Committee on Disabilities
Paul Ogden	Chair, President's Committee on Disabilities
Juan Pablo Moncayo	President, Associated Students
Jennifer Reimer	Past President, Associated Students
Kenneth Shipley	Associate Provost
Ganesan Srinivasan	Director, Agricultural Operations
Cynthia Teniente-Matson	Vice President for Administration
Julie Tone	SBC California
Robin Tricoli	Strategic Planning Consultant
Bernard Vinovrski	Associate Vice President, Enrollment Services
Dave Moll	Assistant Vice President for Risk Management and Sustainability

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Administrative Services

Campus Planning Committee

The Campus Planning Committee is an administrative committee, the primary function of which is to assist the President in the coordination, development and control of a long-range plan for the physical development of the campus as defined by the campus Master Plan, within a framework established by the Trustees of The California State University.

The committee serves in an advisory capacity in relation to the following:

- Development and maintenance of a long-range plan for the physical development of the campus.
- Selection of sites for each new building and other physical facilities on the campus.
- Review the work of the architects and engineers during the preliminary drawing phase.
- Review and make recommendations on the five-year and other long-range building programs.
- Work with city and county planning commissions on matters related to campus development, zoning in areas surrounding the university, streets and highways leading to and from the campus, and other matters.
- Study and review the areas delegated to it by the University President.

Minutes

- August 25, 2011
- October 13, 2011
- November 10, 2011
- February 14, 2012
- April 17, 2012
- May 31, 2012
- June 12, 2012
- July 12, 2012
- August 24, 2012
- September 27, 2012
- November 20, 2012
- January 15, 2013

Division of Administrative Services
Harold H. Haak-Administrative Center
5200 N. Barton Ave. M/S ML52
Fresno, CA 93740
P 559.278.2083
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Last Updated Dec 24, 2013

Campus Bike Program

ATTENTION all current and future riders:

We are having a bicycle helmet giveaway from now until August 22, 2013 (first day of fall semester). Students who register their bicycles on campus are automatically entered to win 1 of 25 free helmets!

Why Ride a Bicycle?

Riding a bicycle is one of many efficient means of transportation, especially for college students. It provides numerous benefits to you and everyone around you.

Benefits:

- Save the cost of a parking permit
- Save the expense of gasoline
- Help reduce air pollution
- Help reduce traffic congestion

Fresno State Police Department
2311 E Barstow Ave MS PO 14
Fresno, CA 93740
P 559.278.8400
F 559.278.7788

Last Updated Dec 24, 2013

Fresno State 2008-2013 (September) — Pedestrian and Bicycle Involved Accidents
Barstow Avenue *Only* (site of proposed bikeways)

Case #	Date	Time	Location	Speed Limit	Minor Injuries	Major Injuries	Fatal Injuries	DUI Involved	Caused By Juve?	Party Involved	Primary Collision Factor
08-258	4/2/2008	1555	2280 E BARSTOW AVE	25			0	F	F	Veh vs. Bike	21650.1 V.C.
08-895	10/6/2008	1554	JACKSON/BARSTOW	25	1	0	0	F	F	Veh vs. Bike	VC 21200/22450(a)
08-1036	10/31/2008	1910	E SHAW AVE/N CEDAR AVE		1	0	0	F	F	Veh vs. Ped	21650.1 VC
08-1215	12/10/2008	1836	E BARSTOW AVE/N CHESTNUT AVE	15	1		0	F	F	Veh vs. Ped	CVC 21803(a)
08-1242	12/15/2008	843	E BARSTOW AVE/N CAMPUS DR	25	1		0	F	F	Veh vs. Ped	VC 22350
09-588	5/21/2009	600	N CHESTNUT AVE/E BARSTOW AVE	25	1	0	0	F	F	Veh vs. Ped	Unsafe Backing
09-626	5/29/2009	1525	2257 E BARSTOW AVE	25	1		0	F	F	Veh vs. Bike	VC 21650.1
09-979	8/28/2009	1355	2360 E BARSTOW AVE	25	0	0	0	F	F	Veh vs. Bike	VC 21804
10-198	2/8/2010	1845	E BARSTOW AVE/N JACKSON AVE	25	0	1	0	F	F	Veh vs. Ped	21950(a) CVC
10-228	2/12/2010	1500	E BARSTOW AVE/N CHESTNUT AVE	15	1	0	0	F	F	Veh vs. Ped	22100(a)(3)
10-270	2/23/2010	810	2353 E BARSTOW AVE	25			0	F	F	Veh vs. Bike	21650.1 VC
10-646	4/28/2010	1930	E BARSTOW AVE/N CHESTNUT AVE	15	1		0	F	F	Veh vs. Bike	CVC 21800(a)
10-1036	7/16/2010	1023	5260 N JACKSON AVE	10	0	0	0	F	F	Bike ran into veh bumper	22350
10-1507	10/6/2010	1930	5275 N JACKSON AVE	25	1		0	F	F	Golf cart vs. Ped	Unsafe speed
10-1508	10/7/2010	1216	2280 E BARSTOW AVE	25	0	0	0	F	F	Veh vs. Bike	CVC 21650.1
10-1907	12/14/2010	1722	1794 E BARSTOW AVE	40	1	0	0	F	F	Veh vs. Ped	21453(b)
11-295	2/25/2011	1135	N JACKSON AVE/E BARSTOW AVE	25	0	0	0	F	F	Veh vs. Ped	Pedestrian
11-1649	10/28/2011	1045	2201 E BARSTOW AVE	10	1	0	0	F	F	Veh vs. Bike	Riding wrong direction
11-1675	11/1/2011	845	N CHESTNUT AVE/E BARSTOW AVE	15	1	0	0	F	F	Veh vs. Bike	CVC 21461(a)
13-422	5/1/2013	1750	E BARSTOW AVE/N JACKSON AVE	25	1		0	F	F	Veh vs. Ped	VC 21950(a)
13-909	9/16/2013	1100	E BARSTOW AVE/N JACKSON AVE	25	1	0	0	F	F	Veh vs. Ped	VC 21950(a)

Barstow Avenue Bikeways Project
Prepared by First Carbon Solutions/Michael Brandman Associates (FCS/MBA)

ADT	92,728	Fresno COG Trip Counts for Shaw Avenue and Barstow Ave* *(footnote)*
Days	329	Revised based on local climate (10% of days will be bad weather)
Annual Trips	30,507,512	
Adj Factor	0.001	City over 250k <1 mile
Activity Center	0.003	7 activity sites within 1/4 mile
Adj + Activity	0.004	
ADT Reduced	122,030	Trips/year
Bike Trip Length	1.8	Default
VMT Reduced	219,654	VMT/year

Segment	**Trip Counts**
Barstow E	6238
Barstow W	6238
Shaw E	40126
Shaw W	40126
Total	92728

Annual Emission Reductions

	Trip End EF (g/veh/day)	**ADT/Year**	**Emissions grams/year**	**Emissions in Lbs**
ROG	0.521	122,030	63578	140
Nox	0.189	122,030	23064	51
PM10	0.004	122,030	488	1
PM2.5	0.004	122,030	488	1
				193

	Auto VMT Factors (g/mi)	**VMT/Year**	**Emissions grams/year**	**Emissions in Lbs**
ROG	0.132	219,654	28994	64
Nox	0.146	219,654	32069	71
PM10	0.093	219,654	20428	45
PM2.5	0.087	219,654	19110	42
				222

Total Emission Reduction (Trip End and VMT) 415

Cost Effectiveness Calculation

Capital Recovery Factor 0.08 Rate for 15 year amortization

Criteria Pollutant Cost-Effectiveness (CE)

	Funding ($)	**Amortized ($/yr)**	**Emissions Reductions**	**CE $/lb**
ATP Funding	872,000	69,760	415	**168**
CMAQ Funding	590,000	47,200	415	**114**
Local (CSUF)	613,000	49,040	415	**118**
Total Funding	2,075,000	166,000	415	**400**

Reduction in Kilograms/day **0.52**

**The "Methods to Find Cost Effectiveness of Funding Air Quality Projects" (May 2005) provided a detailed example of the cost effective calculations for Bicycle Facilites (pages 29-33). The note on page 31 clarifies why actual vehicle trips should be used for bikeways: "Because ADT represents vehicles passing a single point, it may neglect vehicles that travel only a short distance on the corridor, and, as a result, underestimate total vehicle trips. Therefore, the number of vehicles diverted to bicycles may be underestimated by this method. If actual vehicle trips in the corridor are known, this number should be used in place of ADT." The Air Quality Services Manager for FCS/MBA replicated the State of California ARB's Air Quality Cost-Effectiveness Calculations Methodology in this spreadsheet to be able to show the Actual Daily Traffic and so represent the university's actual situation. Also please see map on next page with university perimeter and bike route(s), w/ clarification, plus photographs in attachment of site and commuter bicyclists.*

Greenhouse Gas Emission Reductions and Cost-Effectiveness Calculations for CSUF Barstow Bikeways Project

EMFAC2011 Emission Rates
Region Type: County
Region: Fresno
Calendar Year: 2014
Season: Annual
Vehicle Classification: EMFAC2011 Categories

Region	CalYr	Season	Veh_Class	Fuel	MdlYr	Speed	Population	VMT	Trips	CO2_RUNEX(Pavley I+LCFS)	CO2_STREX(Pavley I+LCFS)
						(miles/hr)	(vehicles)	(miles/day)	(trips/day)	(gms/mile)	(gms/vehicle/day)
Fresno	2014	Annual	LDA	GAS	Aggregated	Aggregated	262,733	11,121,649	1,654,616	291.854651	418.2129833
Fresno	2014	Annual	LDA	DSL	Aggregated	Aggregated	772	30,187	4,545	318.7776818	0
Fresno	2014	Annual	LDT1	GAS	Aggregated	Aggregated	40,926	1,617,117	248,426	341.4715334	470.1787115
Fresno	2014	Annual	LDT1	DSL	Aggregated	Aggregated	54	1,934	287	323.9423309	0
Fresno	2014	Annual	LDT2	GAS	Aggregated	Aggregated	96,972	4,120,543	608,183	414.4123727	584.5609308
Fresno	2014	Annual	LDT2	DSL	Aggregated	Aggregated	47	1,950	271	328.1322578	0

Fresno County Fleet Mix for Light Duty Vehicles

	Fleet Fraction
LDA	0.44214
LDT1	0.064191
LDT2	0.163446

Source: CalEEMod 2011 version 2.2

Greenhouse Gas Emission Reduction Calculations

		Population (vehicles)	Combined Fleet Fraction	Fraction by Fuel	Weighted Average Fraction	Trips Reduced per Year	CO2 STREX (gms/vehicle/day)	Start Emissions (lbs/yr)	Start Emissions (Tons/Yr)	VMT Reduced per Year	CO2 RUNEX (gms/mile)	Running Emissions (lbs/year)	Running Emissions (tons/yr)	Total Emission Savings (Tons/Year)	Total Emission Savings MTCO2/yr
LDA	GAS	262,733	0.44214	0.440844125	0.658195376	122,030	418.2	36994.2	18.5	219654	291.855	92940.4	46.5		
LDA	DSL	772	0.44214	0.001295875	0.001934786	122,030	0.0	0.0	0.0	219654	318.778	298.4	0.1		
LDT1	GAS	40,926	0.064191	0.064107166	0.095714195	122,030	470.2	6048.1	3.0	219654	341.472	15813.0	7.9		
LDT1	DSL	54	0.064191	8.38339E-05	0.000125167	122,030	0.0	0.0	0.0	219654	323.942	19.6	0.0		
LDT2	GAS	96,972	0.163446	0.163367648	0.243913494	122,030	584.6	19162.2	9.6	219654	414.412	48904.8	24.5		
LDT2	DSL	47	0.163446	7.83516E-05	0.000116982	122,030	0.0	0.0	0.0	219654	328.132	18.6	0.0		
				0.669777	1			62204.5	31.1			157994.9	79.0	110.1	99.9

Start emissions divided by 2 to account for trips entering and leaving the campus by the same vehicle on the same day.
Trips and VMT from Criteria Pollutant tab

Greenhouse Gas Cost-Effectiveness (CE)

	Funding ($)	Amortized ($)/Year	Emissions Reductions (MTCO2/yr)	CE ($/MTCO2)
ATP Funding	872,000	69,760	99.9	**698**
CMAQ Funding	590,000	47,200	99.9	**472**
Local (CSUF)	613,000	49,040	99.9	**491**
Total Funding	2,075,000	166,000	99.9	**1662**

Project Funding and Costs from CSUF Cost Estimates

Fresno County
Regional Traffic Monitoring Report

Prepared for
Fresno Council of Governments

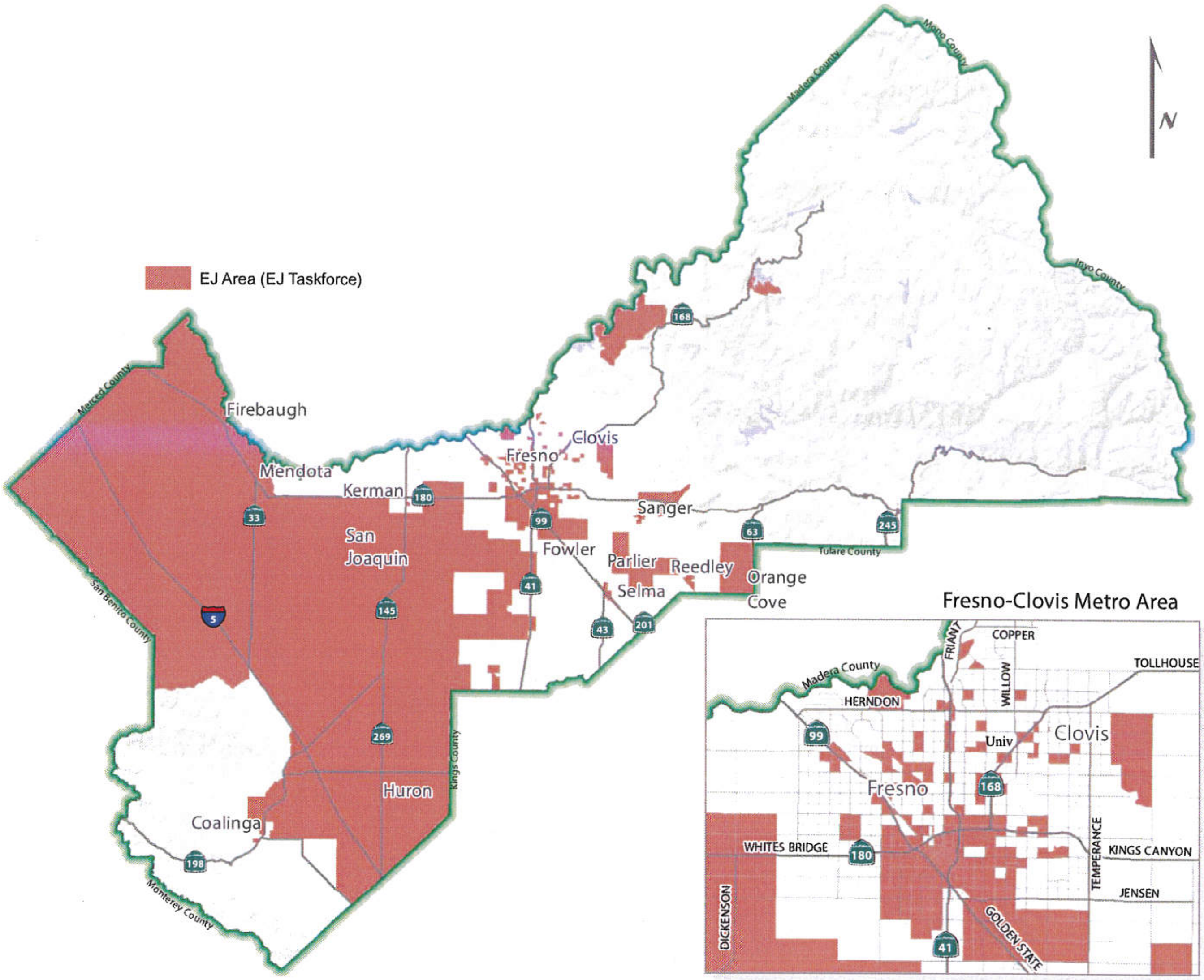
Prepared By:

omni·means
ENGINEERS·PLANNERS

Road Segment Name		Cross Sreet Name	Raw Traffic Count Data 2005	2006	2007	2008	2009
ASHLAN		E/O CORNELIA		25,931			
ASHLAN	EB	E/O MINNEWAWA	10,478				
ASHLAN	WB	E/O MINNEWAWA	10,309				
ASHLAN	WB	E/O POLK	6,630				
ASHLAN		E/O POLK		6,630			
ASHLAN	WB	E/O QUAIL LAKE	1,719				
ASHLAN	EB	E/O QUAIL LAKE	1,663				
ASHLAN	EB	E/O SUNNYSIDE	7,508				
ASHLAN	WB	E/O WEBER	3,1201				
ASHLAN		E/O WEBER		31,201			
ASHLAN	WB	W/O BLACKSTONE	21,353				
ASHLAN		W/O BLACKSTONE		21,353			
ASHLAN	WB	W/O CLOVIS	10,806				
ASHLAN	EB	W/O FRUIT	28,224				
ASHLAN		W/O FRUIT		28,224			
ASHLAN	EB	W/O POLK	2,619				
ASHLAN		W/O POLK		2,619			
ASHLAN	EB	W/O QUAIL LAKE	1,987				
ASHLAN	WB	W/O QUAIL LAKE	1,880				
ASHLAN	EB	W/O SUNNYSIDE	7,052				
ASHLAN	EB	W/O WEST	23,176				
ASHLAN		W/O WEST		23,176			
AUBERRY	EB	SE/O JOSE BASIN	710				
AUBERRY	WB	SE/O JOSE BASIN	748				
AUDUBON	EB	E/O FRIANT	10,453				
AUDUBON		E/O FRIANT		10,453			
B ST	EB	N/O MONO	3,232				
B ST		N/O MONO		3,232			
BARSTOW	WB	E/O CHESTNUT	6,238				
BARSTOW		E/O CHESTNUT		6,238			
BARSTOW	NB	E/O FORKNER	9,112				
BARSTOW		E/O FORKNER		9,112			
BARSTOW	EB	E/O FRUIT	5,556				
BARSTOW	SB	E/O GRANTLAND	700				

Road Segment Name	Cross Sreet Name	Raw Traffic Count Data 2005	2006	2007	2008	2009
SAN DIEGO	N/O ADAMS	169				
SAN DIEGO	N/O ADAMS	195				
SAN PABLO	N/O FALLBROOK	5,453				
SAN PABLO	N/O FALLBROOK		5,453			
SANTA FE	N/O HERNDON	2,712				
SANTA FE	N/O HERNDON		2,712			
SANTA FE	S/O PALO ALTO	9,397				
SANTA FE	S/O PALO ALTO		9,397			
SANTA FE	W/O FIGARDEN	9,856				
SANTA FE	W/O FIGARDEN		9,856			
SHAIN	W/O BRYANT	190				
SHAIN	W/O BRYANT	142				
SHAIN	W/O FOLSOM	404				
SHAIN	W/O FOLSOM	278				
SHAW	E/O GRANTLAND	4,023				
SHAW	E/O GRANTLAND	4,210				
SHAW	E/O ACADEMY	658				
SHAW	E/O ACADEMY	764				
SHAW	E/O CEDAR	40,126				
SHAW	E/O CEDAR		40,126			
SHAW	E/O FIRST	43,883				
SHAW	E/O FIRST		43,883			
SHAW	E/O FRUIT	48,457				
SHAW	E/O FRUIT		48,457			
SHAW	E/O MARKS	43,568				
SHAW	E/O MARKS		43,568			
SHAW	E/O MAROA	49,516				
SHAW	E/O MAROA		49,516			
SHAW	E/O MC CALL	3,177				
SHAW	E/O MC CALL	3,177				
SHAW	E/O PALM	41,608				
SHAW	E/O PALM		41,608			
SHAW	E/O WISHON	22,758				
SHAW	W/O ACADEMY	1685				

Figure 3-6: Environmental Justice Areas (EJ-TF)



PROJECT TIME LINE
The project is shovel-ready, with a complete conceptual plan and project report by Blair, Church & Flynn Consulting Engineers of Clovis, CA and updated cost estimates from Alan Mok Engineering. Any phase will be fully operational within one year from the execution date of an agreement. The project was segregated into five discrete, usable phases to accommodate incremental funding and construction along the busy route if necessary. Phasing of the project was determined by selecting segments along Barstow Avenue wherein proper vehicular and bicycle traffic flow could be maintained at the termination points of each phase of construction. The phases shown could be constructed in any order, to accommodate timely constraints.

CONSTRUCTION TIMELINE				
Phases	**Quantitative Milestones**	**Tasks for Milestones**	**Timeline**	**Summary Const. Budget**
1 – One	South Side of Barstow Avenue from Parking Lot K to the Corporation Yard Entrance	• Mobilization & Traffic Control • Clearing & grubbing • Earth work • Concrete paths & ramps • Traffic striping, markings, & signings • Root barrier & appurtenances • Construction Mgmt (dedicated project management)	60 days (2013-2014)	$149,800 (Under construction: $132,844 in Air District funds + $16,956 in Fresno State Cost Share)
2 – Two	South Side of Barstow Avenue from the Corporation Yard Entrance to Chestnut Avenue	• Mobilization & Traffic Control • Clearing & grubbing • Earth work • Concrete valley gutter • Traffic striping, markings, & signings • 3" AC on 6" AB Pavement Section • 5" AC Pavement Plug and 1" Overlay • Construction Mgmt (dedicated project management)	30 days (2015-2016)	$114,800 (Planned annual application to Air District w/ Fresno State Cost Share)
ATP Request applied toward Phases 3 + 4 + 5 (entire North Side). Combining the three phases results in an overall reduction of construction time and costs.				
3 –	North side of	• Mobilization & Traffic	90 days –	$407,000

Three	Barstow Avenue from Cedar Avenue to the westerly end of Parking Lot Q	Control • Clearing & grubbing • Earth work • Traffic Signal Modification • Utility pole relocations • Concrete curb & gutter • Concrete walks & ramps • Concrete gutter @ return • Traffic striping, signings, and markings • 3" AC on 6" AB Pavement Section • Temporary AC Transition to Phase 4 • Misc. Facilities & Operations	60 days + 30 days for PG&E to relocate utility poles (2014-2015)	(Blended sources: ATP, CMAQ, + Fresno State Cost Share)
4 – Four	North side of Barstow Avenue from the westerly end of Parking Lot Q to the Viticulture Building	• Mobilization & Traffic Control • Clearing & grubbing • Earth work • Utility pole relocations • Concrete curb & gutter • Concrete walks and ramps • Concrete driveway • Traffic striping, markings, & signings • 3" AC on 6" AB Pavement Section • Temporary AC Transition to Phase 3 • Misc. Facilities & Operations	90 days – 60 days + 30 days for PG&E to relocate utility poles (2014-2015)	$333,000 (Blended sources: ATP, CMAQ, + Fresno State Cost Share)
5 – Five	North side of Barstow Avenue from the Viticulture Building to Chestnut Avenue	• Mobilization & Traffic Control • Clearing & grubbing • Earth work • Utilities Pole Relocation • Concrete curb and gutter • Concrete sidewalk and ramp • Traffic striping, markings, & signings • 3" AC on 6" AB Pavement Section	60 days – 30 days + 30 days for PG&E to relocate utility poles (2014-2015)	$573,000 (Blended sources: ATP, CMAQ, + Fresno State Cost Share)

		• 5" AC Pavement Plug and 1" Overlay • Misc. Facilities & Operations		
Phases 3 - 5	(Entire north side of Barstow Avenue from Cedar Avenue to Chestnut Avenue)	Alan Mok Engineering – surveying, engineering, inspection, testing, and administration	2014-2015	$262,000

3. ACCESS AND CIRCULATION

The overall campus access and circulation were evaluated with specific attention given to the control of traffic flow along Barstow Avenue and Chestnut Avenue. The campus consists of the area bounded by SR 168/Willow Avenue to the east, Bullard Avenue to the north, Cedar Avenue to the west and Shaw Avenue to the south. In addition, the campus is bisected by Barstow Avenue east-west, and Chestnut Avenue north-south. These major arterials provide the primary access and circulation to and within the campus. The Barstow Avenue/Chestnut Avenue corridors, particularly the Barstow corridor, introduce an unwanted component of through traffic to the vehicular activity center of the university.

To understand the magnitude of the interaction between the university and the adjacent community a series of traffic counting techniques were utilized; first to understand the magnitude of the access points, and second to evaluate the interference through traffic presents along Barstow Avenue between Cedar Avenue and Chestnut Avenue. Access to and from the campus was determined through peak hour counts along the entry corridors and major access points. The results are tabulated on Table 12.

TABLE 12
CAMPUS PORTALS - PERCENT ENTERING & EXITING TRAFFIC

	AM	PM	Overall
Barstow West @ Cedar	29%	31%	30%
Barstow East @ Chestnut	12%	22%	17%
Barton @ Shaw	13%	15%	14%
Maple @ Shaw	22%	11%	17%
Woodrow @ Shaw	19%	17%	18%
Matoian @ Chestnut	3%	1%	2%
N. Pkg Acc@ Chestnut	3%	2%	2%
	100%	100%	100%

FIGURE 18
CAMPUS ACCESS – PORTALS

The importance of Barstow as a campus roadway is evident in that 47% of all campus traffic enters through this access corridor. Plant facilities, campus police and the single largest parking field (Lot "Q") all access through Barstow Avenue. While Shaw Avenue is also a major access and the primary window to the university, Barstow is the backdoor where services and deliveries are focused. The next evaluation was to determine the magnitude of the through traffic component along Barstow Avenue, the traffic traversing between Fresno and Clovis without a destination within the Campus. An origin-destination study was undertaken for three periods during the day, morning, mid-day and evening. The results were surprising in that the use of the Barstow corridor for non-campus activities is extremely small, from a low of 5.9% in the morning eastbound to a high of 16.9% in the evening westbound.

FIGURE 19
BARSTOW AVENUE – NONE UNIVERSITY TRAFFIC

Barstow Avenue

CSU Fresno owns the roadway

Develop a Series of roundabouts at key intersections

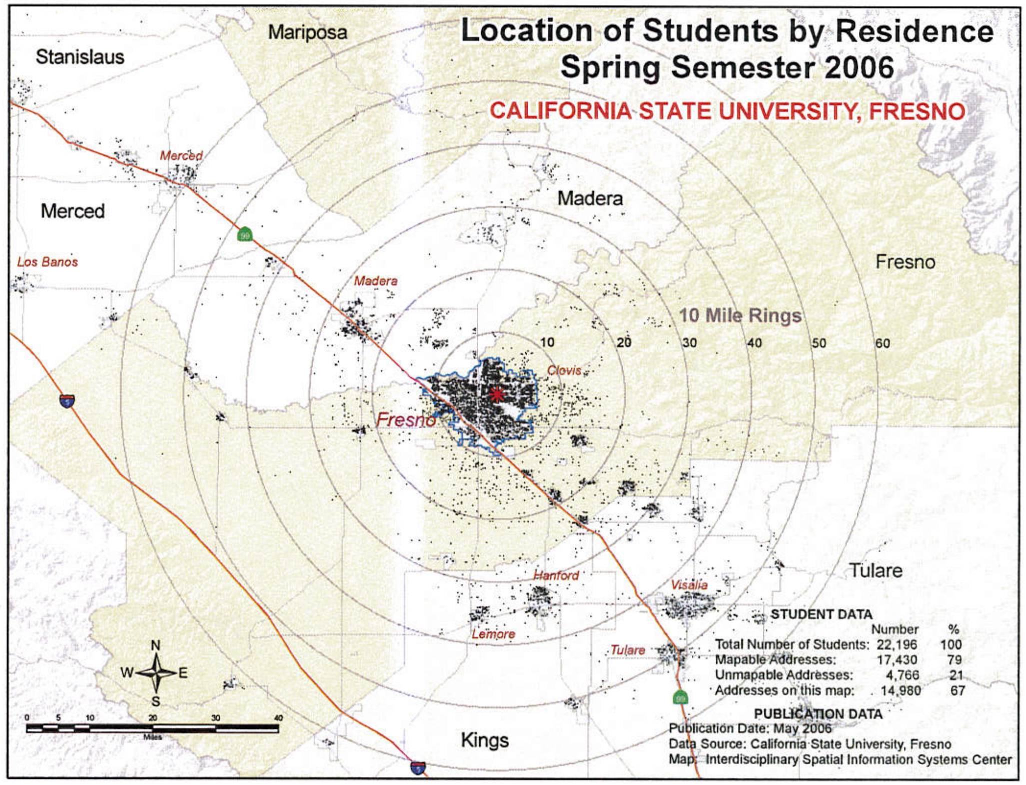
Roundabouts Provide adequate capacity, improve safety, and calm the traffic through the campus

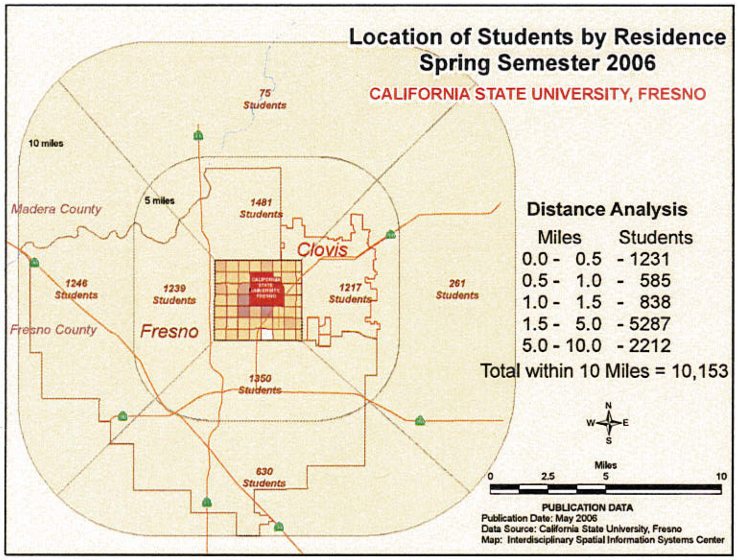
The bottom line is that Barstow Avenue is a university owned roadway which service primarily university traffic, over 90% in the morning and 80-90% the rest of the day.

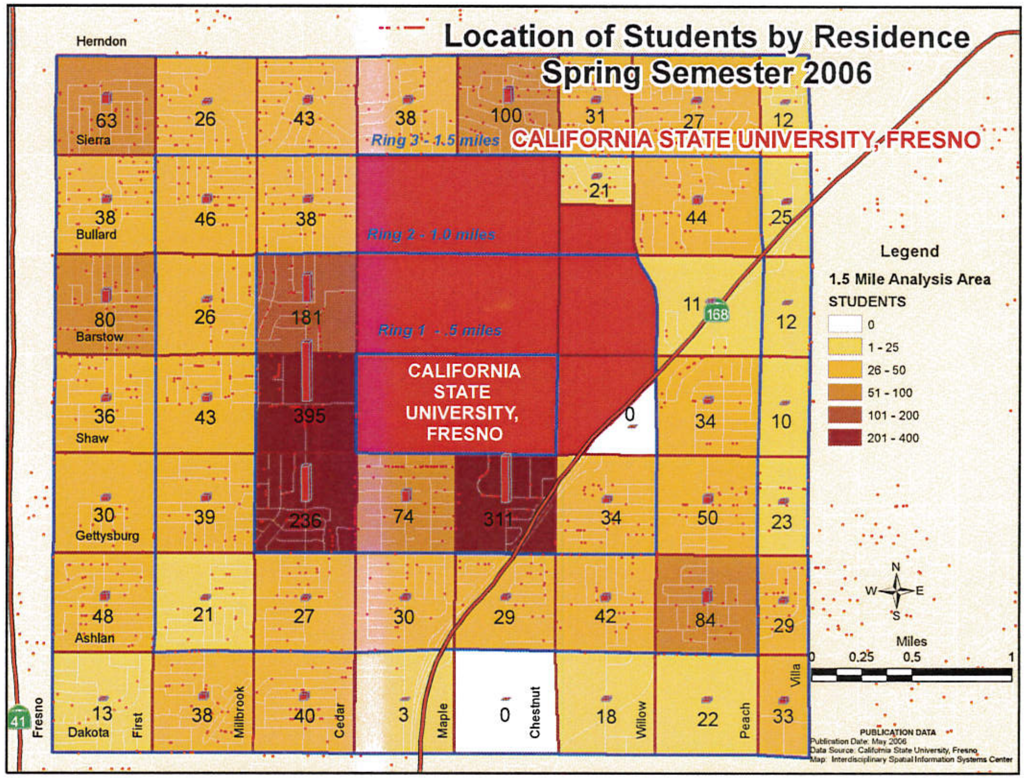
Traffic management along Barstow between Cedar and Chestnut is primarily via a series of all-way stops. These stops were likely installed for traffic calming purposes, to control the rate of flow through the campus. However, these stop controls now create severe congestion through the university, necessitating the use of police personnel to manually over-ride the stop sign requirements during peak periods. This is magnified during events at the Save Mart Center and Bulldog Stadium, where personnel are required to man these locations to prevent gridlock.

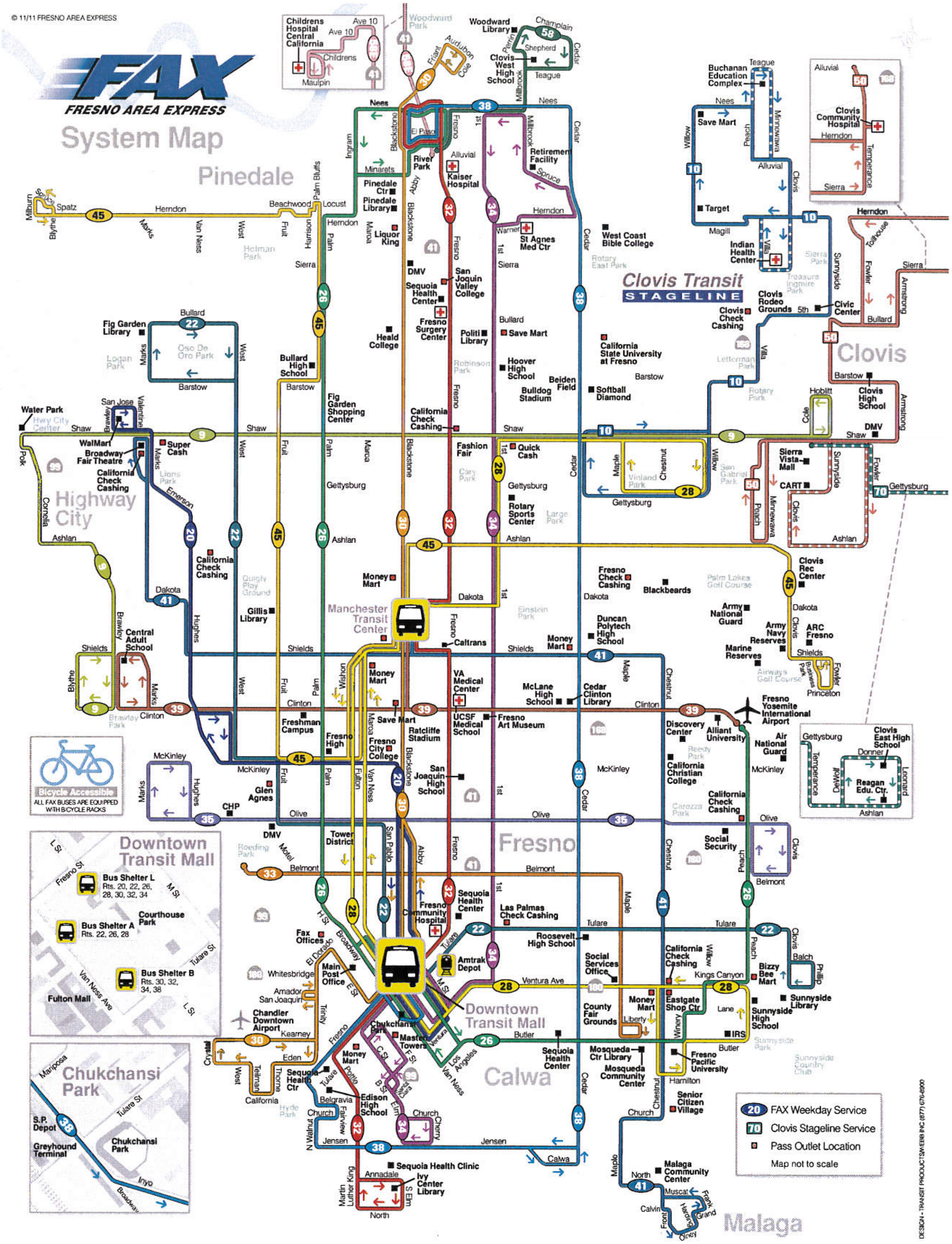
Student Resident Locations

Large numbers of students live within walking and bicycling distance of the campus. Many more could be persuaded to use those modes rather than driving if there were safe and congenial routes for them to use.
Many more would use transit if it could be made more convenient and affordable. Programs to encourage students, faculty and staff to get to and from campus by some means other than driving alone are a priority. The costs of such programs can be off-set by savings in reduced numbers of parking spaces to be constructed on campus. A secondary benefit would be reduction of congestion during peak arrival and departure times at the campus.




Location of Students by Residence
Spring Semester 2006
CALIFORNIA STATE UNIVERSITY, FRESNO
75 Students
10 miles
5 miles
Madera County
Fresno County
1246 Students
1239 Students
1481 Students
Clovis
1217 Students
261 Students
Fresno
1350 Students
630 Students
Distance Analysis
Miles Students
0.0 - 0.5 - 1231
0.5 - 1.0 - 585
1.0 - 1.5 - 838
1.5 - 5.0 - 5287
5.0 - 10.0 - 2212
Total within 10 Miles = 10,153
Miles
0 2.5 5 10
PUBLICATION DATA
Publication Date: May 2006
Data Source: California State University, Fresno
Map: Interdisciplinary Spatial Information Systems Center


Location of Students by Residence
Spring Semester 2006
CALIFORNIA STATE UNIVERSITY, FRESNO
Herndon
Sierra
Bullard
Barstow
Shaw
Gettysburg
Ashlan
Dakota
Fresno
First
Millbrook
Cedar
Maple
Chestnut
Willow
Peach
Villa
Ring 3 - 1.5 miles
Ring 2 - 1.0 miles
Ring 1 - .5 miles
CALIFORNIA STATE UNIVERSITY, FRESNO
63 26 43 38 100 31 27 12
38 46 38 21 44 25
80 26 181 11 12
36 43 395 0 34 10
30 39 236 74 311 34 50 23
48 21 27 30 29 42 84 29
13 38 40 3 0 18 22 33
Legend
1.5 Mile Analysis Area
STUDENTS
0
1 - 25
26 - 50
51 - 100
101 - 200
201 - 400
Miles
0 0.25 0.5 1
PUBLICATION DATA
Publication Date: May 2006
Data Source: California State University, Fresno
Map: Interdisciplinary Spatial Information Systems Center


© 11/11 FRESNO AREA EXPRESS
FAX
FRESNO AREA EXPRESS
System Map
Pinedale
Highway City
Clovis
Fresno
Calwa
Malaga
Clovis Transit
STAGELINE
Manchester Transit Center
Downtown Transit Mall
Bus Shelter L
Rts. 20, 22, 26, 28, 30, 32, 34
Bus Shelter A
Rts. 22, 26, 28
Bus Shelter B
Rts. 30, 32, 34, 38
Courthouse Park
Fulton Mall
Chukchansi Park
S.P. Depot
Greyhound Terminal
Bicycle Accessible
ALL FAX BUSES ARE EQUIPPED WITH BICYCLE RACKS
Childrens Hospital Central California
Woodward Library
Clovis West High School
Retirement Facility
Kaiser Hospital
River Park
St Agnes Med Ctr
West Coast Bible College
San Joaquin Valley College
Sequoia Health Center
Fresno Surgery Center
Politi Library
Save Mart
Hoover High School
Bulldog Stadium
Beiden Field
California State University at Fresno
Softball Diamond
Fig Garden Library
Bullard High School
Fig Garden Shopping Center
Heald College
Fashion Fair
Quick Cash
Rotary Sports Center
Super Cash
WalMart
Broadway Fair Theatre
Water Park
Gillis Library
Money Mart
Caltrans
Central Adult School
VA Medical Center
UCSF Medical School
Fresno Art Museum
McLane High School
Cedar Clinton Library
Duncan Polytech High School
Blackbeards
Army National Guard
Army Navy Reserves
Marine Reserves
ARC Fresno
Clovis Rec Center
Fresno Yosemite International Airport
Air National Guard
Alliant University
Discovery Center
California Christian College
Clovis East High School
Reagan Edu. Ctr.
Freshman Campus
Fresno High
Fresno City College
Ratcliffe Stadium
San Joaquin High School
Glen Agnes
CHP
DMV
Tower District
Social Security
Fresno Community Hospital
Sequoia Health Center
Las Palmas Check Cashing
Roosevelt High School
Social Services Office
Amtrak Depot
Fax Offices
Main Post Office
Chandler Downtown Airport
County Fair Grounds
Eastgate Shop Ctr
Sunnyside High School
Sunnyside Library
IRS
Bizzy Bee Mart
Fresno Pacific University
Mosqueda Ctr Library
Mosqueda Community Center
Senior Citizen Village
Edison High School
Sequoia Health Clinic
Ivy Center Library
Malaga Community Center
Buchanan Education Complex
Indian Health Center
Target
Clovis Rodeo Grounds
Civic Center
Clovis Community Hospital
Clovis High School
Sierra Vista Mall
CART
20 FAX Weekday Service
70 Clovis Stageline Service
Pass Outlet Location
Map not to scale

FRESNO STATE

Discovery. Diversity. Distinction.

May 19, 2014

Ms. Teresa McWilliam, Program Manager
Active Transportation Program
Department of Transportation
Division of Local Assistance
P.O. Box 942874, MS-1
Sacramento, CA 94274-0001

Dear Ms. McWilliam:

I am pleased to submit the Barstow Avenue Bikeways application for funding from the Active Transportation Program. I will direct all staff to carry out the Barstow Avenue Bikeways project in a timely manner. The Barstow Avenue Bikeways project will meet or exceed delivery schedules.

The University will maintain the completed Barstow Avenue Bikeways for a minimum of 20 years and will commit $113,000, the required 11.47% cash match for total funding ($985,000).

We have successfully pursued external funding for one phase of the proposed Barstow Avenue Bikeways, securing an award from the San Joaquin Valley Air Pollution Control District's Remove II program. We have also been notified by the Fresno Council of Governments that the Barstow Avenue Bikeways have been recommended for a CMAQ grant award. ATP funding will be a valuable contribution to allow us to complete the entire Barstow Avenue Bikeways.

When the Barstow Avenue Bikeways are ready for use, the University will be transformed from a major barrier into a major access route for commuter bicycling throughout the cities of Fresno and Clovis.

I am authorized to commit the resources of the University to this project.

Sincerely,

Cynthia Matson

Cynthia Teniente-Matson, Ed.D.
Vice President for Administration and Chief Financial Officer

Office of the Vice President for Administration
California State University, Fresno • Harold H. Haak Administrative Center • Henry Madden Library
5200 North Barton Ave. M/S ML52 • Fresno, California 93740-8014

P 559.278.2083 **F** 559.278.2928

Zimbra **gharootunian@csufresno.edu**

CMAQ Scoring Committee Recommendations

From : Lauren Dawson <LDawson@fresnocog.org> Wed, May 14, 2014 02:51 PM
Subject : CMAQ Scoring Committee Recommendations 1 attachment
To : Lauren Dawson <LDawson@fresnocog.org>

Good Afternoon,

Attached to this email is the list of projects recommended for funding by the 2013-14 CMAQ Scoring Committee.

The 2013-14 CMAQ Scoring Committee met on April 28, 2014 and selected the projects to recommend for funding. We received over $42 million in requests for funding with $18,547,495 in available funds.

The Programming Sub-Committee met on May 1, 2014 to decide whether to utilize toll credit funding or use the standard local match. It was the committee's decision to use local match funds.

The recommended list of projects was presented to the Transportation Technical Committee (TTC) and the Policy Advisory Committee (PAC) on Friday 5/9/2014. Both committees approved the list and recommended that the Fresno COG Policy Board approve the Scoring Committees list of projects to be funded at the 5/29/2014 meeting.

Selected projects will be programmed into the 2015 FTIP.

Should you have any questions, please call.

Regards,

Lauren Dawson
Senior Regional Planner

Fresno Council of Governments
2035 Tulare St. #201
Fresno, CA 93721
559-233-4148 ext. 217
www.fresnocog.org

2013 CMAQ Call for Projects

Funding Recommendations ($18,547,495 Available)

Applicant	Project Limits	CMAQ Funding Requested	Total Project Cost	Recommended $	Cumulative $
Cost Effective Category					
*Fresno Unified School District	Purchase 4 CNG School Buses (Requested 7)	$1,198,085	$1,409,513	$684,620	$684,620
City of Fresno	Purchase 2 CNG Street Sweepers	$711,200	$803,300	$711,200	$1,395,820
*Kings Canyon Unified School District	Purchase 4 CNG School Buses (Requested 8)	$1,438,864	$1,624,000	$719,432	$2,115,252
*Clovis Unified School District	Purchase 2 CNG School Buses (Requested 5)	$1,062,360	$1,200,000	$424,944	$2,540,196
*Southwest Transportation Agency	Purchase 2 CNG School Buses (Requested 5)	$1,062,360	$1,200,000	$424,944	$2,965,140
*Central Unified School District	5 New Alternative Fuels Low Emission School Buses (2)	$812,457	$917,719	$324,982	$3,290,122
City of Coalinga	Dirt Alley's Paving Phase 1	$305,606	$345,200	$305,606	$3,595,728
City of San Joaquin	Puchase one CNG Street Sweeper	$287,722	$325,000	$287,722	$3,883,450
*Parlier Unified School District	1 School Bus Replacement	$157,973	$178,440	$157,973	$4,041,423
*Raisin City Elementary School District	CNG Conversion of Light Truck	$7,082	$8,000	$7,082	$4,048,505
Fresno County	Adams Avenue Shoulder Improvements from Cherry to Clovis	$1,161,547	$1,312,039	$1,161,547	$5,210,052
*Parlier Unified School District	1 School Bus Replacement	$157,973	$178,440	$157,973	$5,368,025
Fresno County	Panoche Road Shoulder Improvements from SR33 to San Benito	$537,116	$606,707	$537,116	$5,905,141
Fresno County	Kamm Avenue Shoulder Improvements from SR145 to Jameson	$1,555,859	$1,757,438	$1,555,859	$7,461,000
All Other Categories (Non-Cost Effective)					
City of Fresno	ITS Herndon Avenue from Golden State to Willow Avenue	$1,150,900	$1,300,000	$1,150,900	$8,611,900
City of Fresno-FAX	Increase Bus Stop Frequencies on Shaw Avenue to 15-minutes (NO BUSES)	$7,082,400	$8,000,000	$4,426,400	$13,038,300
*Fresno State	Barstow Avenue Bikeways from Cedar Avenue to CSUF Viticulture Building	$590,672	$2,382,030	$590,672	$13,628,972
City of Fresno	ITS Shaw Avenue from SR99 to SR41	$398,400	$450,000	$398,400	$14,027,372
City of Mendota	Derrick and Oller Roundabout	$650,000	$1,500,000	$650,000	$14,677,372
Fresno COG	Operating Support for a Fresno to Yosemite Shuttle Service	$2,832,860	$3,200,000	$2,692,527	$17,369,899
City of Sanger	Operating Support for a Fresno to Sequoia-Kings Canyon National Parks Shuttle Service	$462,127	$522,000	$462,127	$17,832,026
City of Clovis	Alluvial and Temperance Roundabout	$715,469	$808,166	$715,469	$18,547,495
**Denotes non-member agency*					

Fresno Economic Opportunities Commission

May 14, 2014

CALTRANS
Division of Local Assistance, MS-1
Office of Active Transportation
And Special Projects
PO Box 942874
Sacramento, CA 94274-0001

Subject: Fresno Local Conservation Corps Support for Fresno State ATP Project

Please find this Letter of Interest in partnering with Fresno State on their Barstow Avenue Bikeways ATP project application. The Fresno Economic Opportunities Commission (EOC) Local Conservation Corps (LCC) recently celebrated its 20th anniversary and has the capability to perform the following work on this project:

The LCC will perform the following:

- Grubbing and clearing
- Demo of existing Concrete and A/C
- Grading and compacting
- Forming on grade
- Placing and finishing ready-mix concrete
- Installation of ADA domes

The LCC will not perform the following:

- Obtain any Permits
- Engineering
- Planning
- Inspections or testing
- Utilities
- Traffic signal modifications
- Signage
- Striping or markings
- A/C paving
- Surveying or staking locations of work

If you have any questions regarding our participation in this project, please feel free to contact LCC Director, Shawn Riggins, at (559) 264-1048.

Sincerely,

Brian Angus
Chief Executive Officer

community Action PARTNERSHIP

Commuting in the United States: 2009

American Community Survey Reports

Issued September 2011

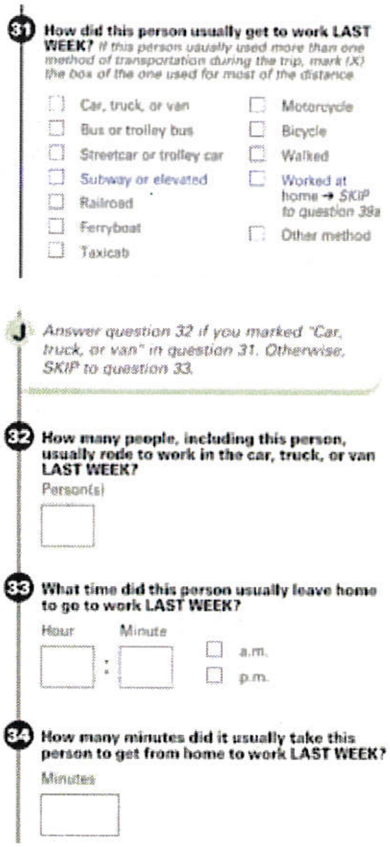
ACS-15

By
Brian McKenzie
and
Melanie Rapino

This report describes patterns of commuting for the nation and metropolitan statistical areas (metro areas) based on the 2009 American Community Survey (ACS).[1] In the United States, commutes make up less than 20 percent of all trips taken, but play a unique role within the mix of overall trips by determining peak travel demand across transportation systems.[2] Federal, state, and local policymakers use the ACS to guide decisions about how to allocate limited public resources devoted to transportation. Planners use ACS commuting data to guide transportation improvement strategies, predict future travel demand, and gauge the amount of pressure placed on transportation infrastructure.

The ACS is an ongoing survey conducted annually by the U.S. Census Bureau that captures changes in the socioeconomic, housing, and demographic characteristics of communities across the United States and Puerto Rico.[3] The ACS questions with populations of 65,000 or greater, estimates are available annually. For selected geographies with populations of 20,000 or greater, combined 3-year estimates are available. For the smallest geographic areas, the Census Bureau released 5-year estimates for the first time in December 2010. These estimates are based on data collected between 2005 and 2009. Workers are civilians and members of the Armed Forces, 16 years and over, who were at work the previous week. Persons on vacation or not at work the prior week are not included.

Figure 1.
Reproduction of the Questions on Commuting From the 2009 American Community Survey



31 **How did this person usually get to work LAST WEEK?** *If this person usually used more than one method of transportation during the trip, mark (X) the box of the one used for most of the distance*

- ☐ Car, truck, or van
- ☐ Bus or trolley bus
- ☐ Streetcar or trolley car
- ☐ Subway or elevated
- ☐ Railroad
- ☐ Ferryboat
- ☐ Taxicab
- ☐ Motorcycle
- ☐ Bicycle
- ☐ Walked
- ☐ Worked at home → *SKIP to question 39a*
- ☐ Other method

J *Answer question 32 if you marked "Car, truck, or van" in question 31. Otherwise, SKIP to question 33.*

32 **How many people, including this person, usually rode to work in the car, truck, or van LAST WEEK?**

Person(s)

33 **What time did this person usually leave home to go to work LAST WEEK?**

Hour : Minute ☐ a.m. ☐ p.m.

34 **How many minutes did it usually take this person to get from home to work LAST WEEK?**

Minutes

Source: U.S. Census Bureau, 2009 American Community Survey questionnaire.

[1] This report discusses data for the United States, including the 50 states and the District of Columbia, but not the Commonwealth of Puerto Rico. For more information on metropolitan statistical areas, please see <www.whitehouse.gov/omb/assets/omb/bulletins/fy2009/09-01.pdf>.

[2] Summary of Travel Trends: 2009 National Household Travel Survey. 2011. Technical Report No. FHWA-PL-11-022. <http://nhts.ornl.gov/publications.shtml>.

[3] The ACS uses a series of monthly samples to produce annual estimates. Detailed questions that previously appeared on the decennial census long form are now included in the ACS, and the decennial census now simply produces a count of the nation's population and a snapshot of its most basic demographic characteristics. The annual sampling rate for the ACS is about 2.5 percent of all housing units and includes residents living in group quarters. Five years of ACS data collection are necessary to achieve a cumulative sample large enough to ensure respondent confidentiality for smaller communities and for small geographies such as census tracts or block groups. For larger geographies, specifically those

U.S. Department of Commerce
Economics and Statistics Administration
U.S. CENSUS BUREAU

related to travel focus solely on commuting and do not ask about leisure travel or other nonwork trips. This report discusses commuting characteristics for workers 16 years and over who were employed during the week prior to the ACS reference week and did not work at home.

Respondents answer questions about where they work, what time they leave home for work, the means of transportation used to get there, the number of workers riding in a car, truck, or van, and how long it takes to travel to work. A reproduction of these questions can be found in Figure 1. The central topics of each section of this report are based on these commuting questions.

For each commuting attribute, findings are presented at the national and metro area levels for a variety of population characteristics such as sex, race, ethnicity, and workplace location.[4] A set of more detailed tables associated with each commuting attribute is available for download through links provided throughout the report.

Commuting highlights from the 2009 ACS are:

- Over three-quarters of the nation's workers drove alone to work.
- Workers took an average of 25.1 minutes to get to work.

[4] The estimates in this report (which may be shown in text, figures, and tables) are based on responses from a sample of the population and may differ from actual values because of sampling variability or other factors. As a result, apparent differences between the estimates for two or more groups may not be statistically significant. All comparative statements have undergone statistical testing and are significant at the 90 percent confidence level unless otherwise noted.

Table 1.
Means of Transportation, Time Leaving Home, and Travel Time to Work: 2009

(Numbers in thousands. For information on confidentiality protection, sampling error, nonsampling error, and definitions, see *www.census.gov/acs/www/*)

Characteristic	Total workers	Percent distribution	Margin of error[1] (±)
Means of Transportation to Work[2]			
Car, truck, or van	119,393	86.1	0.1
Drove alone	105,476	76.1	0.1
Carpooled	13,917	10.0	0.1
Public transportation	6,922	5.0	–
Bus or trolley bus	3,673	2.7	–
Streetcar or trolley car	89	0.1	–
Subway or elevated	2,372	1.7	–
Railroad	750	0.5	–
Ferryboat	37	0.0	–
Taxicab	157	0.1	–
Motorcycle	294	0.2	–
Bicycle	766	0.6	–
Walked	3,966	2.9	–
Other means	1,176	0.8	–
Worked at home	5,918	4.3	–
Time Leaving Home to Go to Work[3]			
12:00 a.m. to 4:59 a.m.	5,209	3.8	–
5:00 a.m. to 5:29 a.m.	4,647	3.4	–
5:30 a.m. to 5:59 a.m.	6,420	4.6	–
6:00 a.m. to 6:29 a.m.	11,408	8.2	–
6:30 a.m. to 6:59 a.m.	13,620	9.8	–
7:00 a.m. to 7:29 a.m.	19,536	14.1	–
7:30 a.m. to 7:59 a.m.	17,686	12.8	0.1
8:00 a.m. to 8:29 a.m.	14,565	10.5	0.1
8:30 a.m. to 8:59 a.m.	7,425	5.4	–
9:00 a.m. to 9:59 a.m.	8,287	6.0	–
10:00 a.m. to 10:59 a.m.	3,705	2.7	–
11:00 a.m. to 11:59 a.m.	1,747	1.3	–
12:00 p.m. to 3:59 p.m.	9,270	6.7	–
4:00 p.m. to 11:59 p.m.	9,150	6.6	–
Travel Time to Work[3]			
Less than 10 minutes	18,565	13.4	0.1
10 to 14 minutes	19,328	13.9	0.1
15 to 19 minutes	20,775	15.0	0.1
20 to 24 minutes	19,559	14.1	0.1
25 to 29 minutes	8,040	5.8	–
30 to 34 minutes	17,874	12.9	–
35 to 44 minutes	8,321	6.0	–
45 to 59 minutes	9,834	7.1	–
60 to 89 minutes	7,160	5.2	–
90 or more minutes	3,218	2.3	–
Mean travel time to work (minutes)	25.1	–	0.1

– Represents or rounds to zero.

[1] This number, when added to or subtracted from the estimate, represents the 90 percent confidence interval around the estimate.

[2] Workers 16 years and over.

[3] Workers 16 years and over who did not work at home.

Note: Because of sampling error, the estimates in this table may not be significantly different from one another.

Source: U.S. Census Bureau, American Community Survey, 2009.

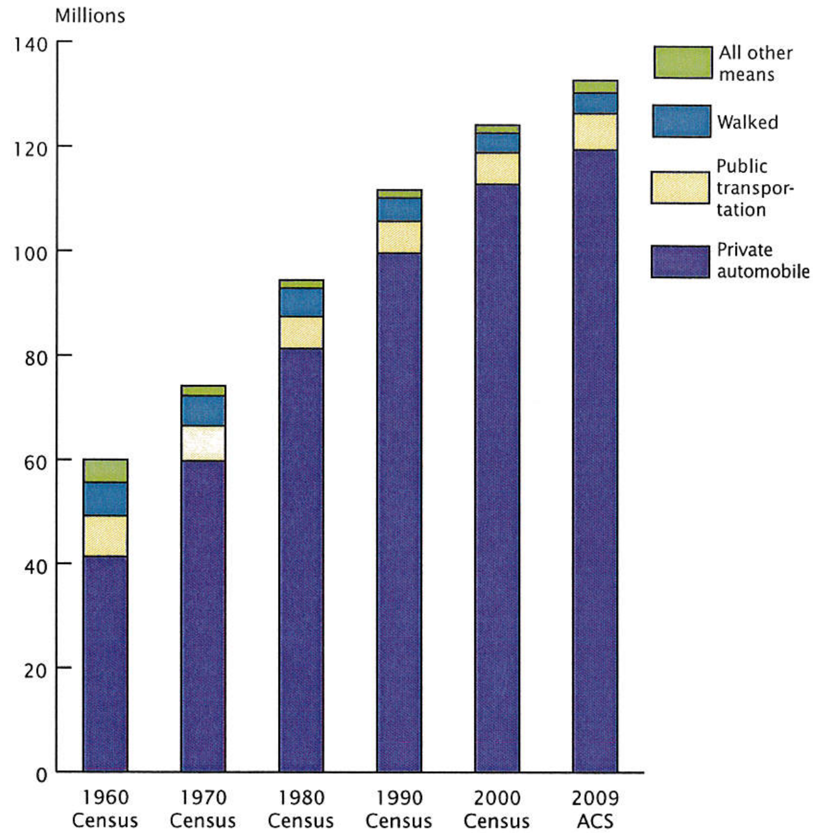
- Hispanic workers carpooled at a rate of 16.4 percent, compared with 9.5 percent for non-Hispanic workers.
- The rate of public transportation usage among the foreign-born population was 10.8 percent, more than twice that of the native-born population, at 4.1 percent.
- Suburban workers drove alone at a rate of 81.5 percent, compared with 72.1 percent for workers living inside of a principal city.
- The New York-Northern New Jersey-Long Island, NY-NJ-PA Metro Area had the longest average commute, at 34.6 minutes.
- The 10 metro areas with the shortest average commute times have populations of fewer than 300,000 people.

As communities change, the information collected in the ACS provides timely and relevant data upon which transportation planning decisions may be made. A major advantage of the ACS is its rich array of sociodemographic information. The ability to link information about commuting to sociodemographic characteristics and geography allows planners to forecast local peak travel demand and address unmet transportation needs more accurately.

A NATIONAL COMMUTING OVERVIEW FOR 2009

Table 1 shows that, among workers 16 years and over, 86.1 percent commuted in a car, truck, or van in 2009, and 76.1 percent drove to work alone. About 5 percent of workers commuted by public transportation, and about 3 percent walked to work. All other transportation modes were used by less than 1 percent of workers who did not work at home.

Figure 2.
Means of Transportation: 1960 to 2009
(Workers 16 years and over. For information on confidentiality protection, sampling error, nonsampling error, and definitions, see *www.census.gov/acs/www/*)



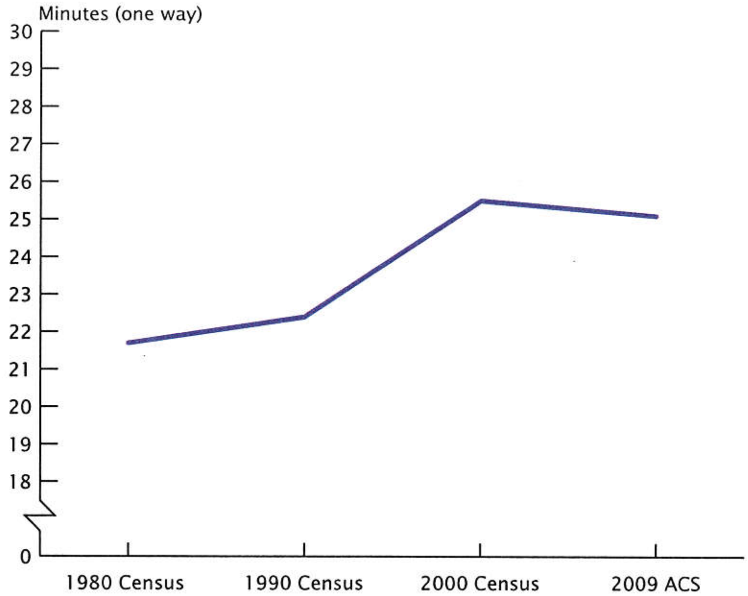
Sources: U.S. Census Bureau, Decennial Census, 1960, 1970, 1980, 1990, 2000; U.S. Census Bureau, American Community Survey, 2009.

The private automobile's dominance among travel modes used for the commute represents a long-standing pattern. The 1960 Census was the first to include questions specifically related to commuting. Figure 2 shows that the number of workers who commuted by private automobile increased continuously between 1960 and 2009, from about 41 million to about 120 million.[5]

Information about when workers leave their homes for work plays an integral role in the regional transportation planning process by contributing to an understanding of traffic flow patterns on the nation's roads and public transportation infrastructure. Table 1 shows that over half of the nation's workers left their homes for work between 6:00 a.m. and 8:59 a.m. The 30-minute period with the highest percentage of departures (14.1 percent) occurred between 7:00 a.m. and 7:29 a.m. Less than 25 percent of the nation's workers left for work between 9:00 a.m. and 11:59 p.m.

[5] Figure 2 includes workers 16 years and over. All subsequent tables and figures include workers 16 years and over who did not work at home.

Figure 3.
Average Travel Time for Workers: 1980 to 2009
(Workers 16 years and over. For information on confidentiality protection, sampling error, nonsampling error, and definitions, see *www.census.gov/acs/www/*)



Sources: U.S. Census Bureau, Decennial Census 1980, 1990, 2000; U.S. Census Bureau, American Community Survey, 2009.

Figure 3 shows mean travel time since 1980, the first year the census collected travel-time information. The mean travel time for workers was just under 22 minutes in 1980, then increased between 1980 and 2000 to about 25 minutes, where it remained in 2009. Just over 2 percent of workers took 90 minutes or more to get to work in 2009 (see Table 1). The questionnaires prior to Census 2000 permitted respondents to mark no more than two digits for their travel time, limiting reported travel time to 99 minutes. Three digits were made available in the Census 2000 questionnaire, which allowed results to show a greater range of extremely long commutes.

The amount of time workers spend commuting is an important indicator of shifts in the spatial distribution of workers' residences and their places of work. Travel-time shifts may also provide insight into other important community characteristics such as changes in workforce participation rates and shifts in the availability and usage of different transportation modes.

Table 1 provides a broad overview of key commuting patterns in the United States, but commuting patterns vary considerably across geographic scales and population subsets. Subsequent sections of this report illustrate these variations, beginning with a focus on differences in means of transportation across groups and regions.

MEANS OF TRANSPORTATION TO WORK

The 2009 ACS question related to means of transportation asked respondents in the workforce, "How did this person usually get to work LAST WEEK?" (see Figure 1, Question 31). Although commutes may involve multiple transportation modes (for example, driving to a train station and then taking a train), respondents are restricted to indicating the single travel mode used for the longest distance. Tracking changes in the distribution of means of transportation to work is important to the regional planning process for gauging the utility of transportation policy and budget decisions. This information also contributes to understanding unmet commuting needs for local populations, integral for addressing policy concerns related to mobility.

The characteristics of the communities to and from which workers commute have a great deal of influence on commuting choices, including the means of transportation used. For example, automobile congestion and the quality and availability of public transportation, sidewalks, and bicycle routes influence the relative utility and attractiveness of different transportation modes. These characteristics may vary considerably across and within places, especially when contrasting principal cities and suburbs.[6] This section takes a closer look at differences in how people get to work across several socioeconomic characteristics.[7]

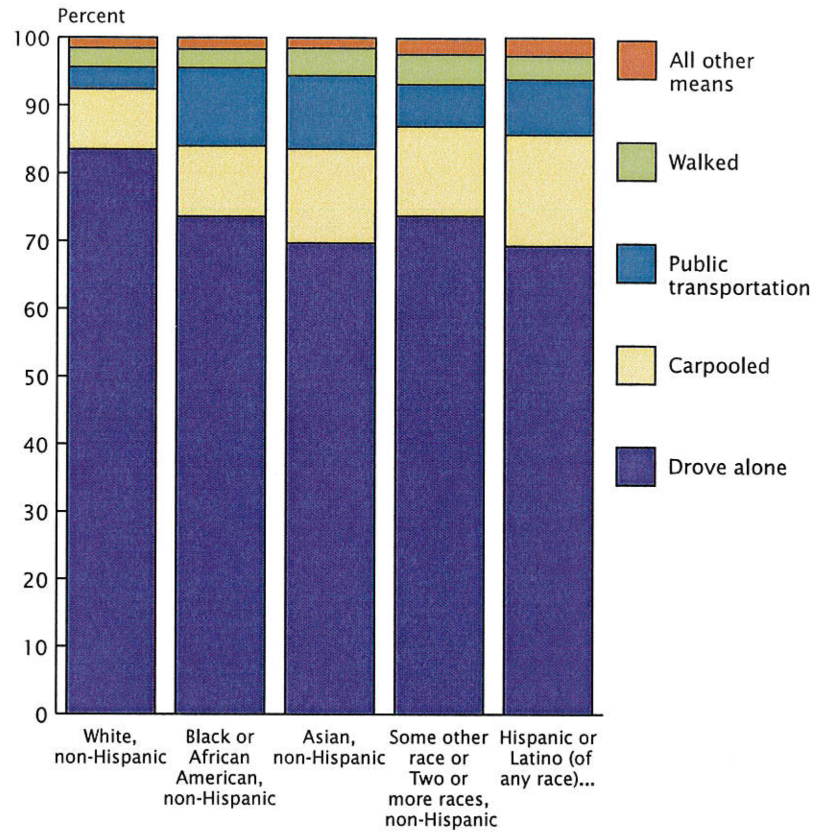
[6] For more information about the definition of principal city, see the U.S. Office of Management and Budget document entitled "Update of Statistical Area Definitions and Guidance on Their Uses" at <www.whitehouse.gov/omb/assets/bulletins/b10-02.pdf>.

[7] Much of the information presented in this section comes from Supplemental Table A, Means of Transportation by Selected Characteristics: 2009, accessible online at <www.census.gov/hhes/commuting/>. This table presents the means of transportation for the work commute by several social, economic, and housing characteristics.

Racial/Ethnic Differences

The percentage of non-Hispanic White workers who drove alone to work (83.5 percent) was about 10 percentage points higher than that of any other racial or ethnic group (see Figure 4).[8] The percentage of Hispanic and non-Hispanic Asian workers who drove alone did not exceed 70 percent. The comparatively low rate of Hispanic workers who drove alone was accompanied by a carpooling rate of 16.4 percent, notably higher than that of any other racial or ethnic group. Non-Hispanic Black workers had the highest rate of public transportation usage at 11.5 percent, more than three times higher than that of non-Hispanic White workers, at 3.2 percent. The rate of walking to work varied little across race and Hispanic origin groups, ranging between 2.8 and 4.4 percent.

Figure 4.
Means of Transportation by Race and Hispanic Origin: 2009
(Workers 16 years and over. For information on confidentiality protection, sampling error, nonsampling error, and definitions, see *www.census.gov/acs/www/*)



Source: U.S. Census Bureau, American Community Survey, 2009.

Foreign-Born and Native-Born Differences

Figure 5 shows differences in commuting mode by nativity. The foreign-born population carpooled at a rate of 16.0 percent, compared with 9.4 percent for the native-born population.[9] The rate of public transportation usage among the foreign-born population was more than twice that of the native-born population (10.8 percent compared to 4.1 percent, respectively). Higher rates of carpooling and public transit usage among the foreign born may reflect differences between the foreign-born and native-born populations in sociodemographic characteristics related to travel behavior. For example, in 2009 the foreign-born population was more likely than the native-born population to live in families with incomes at or below the poverty level and in households with no available vehicle.[10]

How Home and Work Characteristics Affect the Commute

The percentage of workers living in renter-occupied units who commuted to work by public transportation (9.9 percent) was more than three times higher than that of workers in owner-occupied units

[8] Federal surveys now give respondents the option of reporting more than one race. Therefore, two basic ways of defining a race group are possible. A group such as Asian may be defined as those who reported Asian and no other race (the race-alone or single-race concept) or as those who reported Asian regardless of whether they also reported another race (the race-alone-or-in-combination concept). The body of this report (text, figures, and tables) shows data using the first approach (race alone). Use of the single-race population does not imply that it is the preferred method of presenting or analyzing data. The Census Bureau uses a variety of approaches. For further information, see the Census 2000 Brief *Overview of Race and Hispanic Origin: 2000* (C2KBR/01-1) at <www.census.gov/population/www/cen2000/briefs.html>. This report may refer to the White-alone population as White, the Black-alone population as Black, the Asian-alone population as Asian, and the White-alone-non-Hispanic population as White, non-Hispanic. Because Hispanics may be any race, data in this report for Hispanics overlap with data for racial groups.

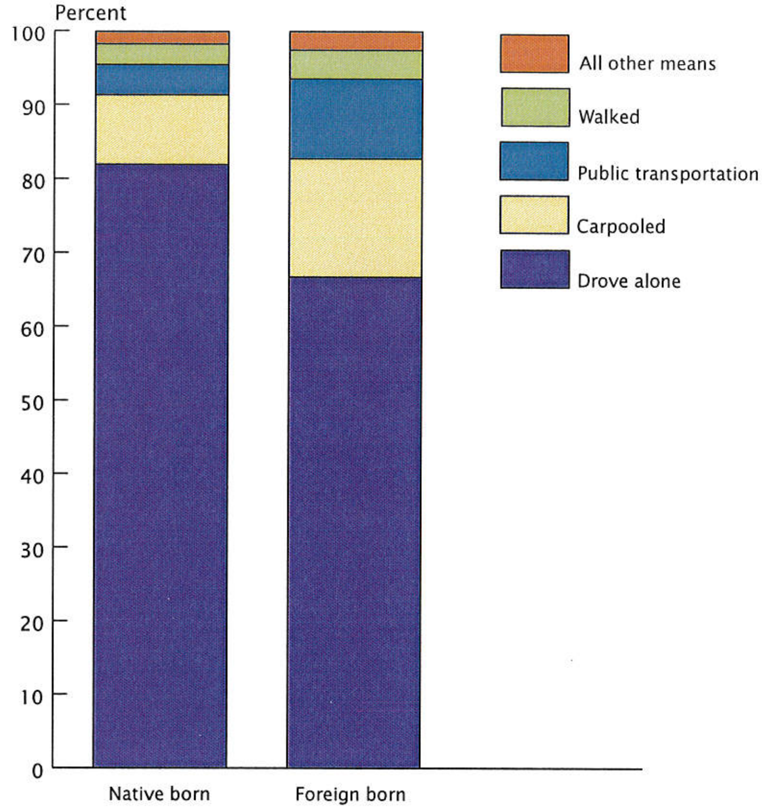
[9] "Native" or "native-born" includes people born in the United States, Puerto Rico, or U.S. Island Areas, or people born abroad of an American parent or parents.

[10] See Table S0501 from the 2009 ACS data on American FactFinder at <http://factfinder.census.gov>.

Figure 5.

Means of Transportation by Nativity: 2009

(Percent distribution of workers 16 years and over. For information on confidentiality protection, sampling error, nonsampling error, and definitions, see *www.census.gov/acs/www/*)



Source: U.S. Census Bureau, American Community Survey, 2009.

(3.1 percent). At 46.7 percent, the percentage of workers living in noninstitutionalized group quarters, including (but not limited to) those living in college or university student housing, military barracks, and group homes walked to work at a rate considerably higher than any other group.[11]

[11] See Supplemental Table A, Means of Transportation by Selected Characteristics: 2009, at <www.census.gov/hhes/commuting/>.

There were notable differences in mode choice between workers residing in the suburbs and those living in the city (see Table 2). Suburban workers (those who lived in a metropolitan area and outside of a principal city) drove alone at a rate of 81.5 percent, compared with 72.1 percent for workers who lived inside of a principal city. Respondents who lived inside of a principal city in a metro area walked to work at a rate of 4.4 percent, higher than that of workers who lived outside of a principal city in a metro area or outside of any metro area. Workers who lived in a principal city and worked in the metro area of residence had the highest public transportation usage rate, at 10.9 percent.

A Closer Look at Public Transportation

In several regions, transportation-planning efforts aimed at relieving congestion and increasing mobility have shifted from strategies that favor road-building to those that favor multimodal solutions. Investment in new and existing public transportation infrastructure has played a crucial role in this effort.

At the national level, 5 percent of commuters used public transportation in 2009, but public transportation represents the second most common means of transportation after the private automobile. "Public transportation" includes bus, trolley, streetcar, subway, elevated rail, railroad, or ferry. Although these modes collectively account for only a small portion of the nation's overall commutes, they play prominent transportation roles within several of the nation's largest metro areas.

Figure 6 shows workers who commuted by any form of public transportation in the 50 largest metro areas in 2009.[12] The rate of public transportation usage was less than the national average of 5 percent for many of these metro areas, illustrating the concentration of public transportation trips among a handful of the nation's large and densely populated

[12] The 50 most populous metropolitan statistical areas are based on population estimates as of July 1, 2009.

Table 2.

Place of Work by Means of Transportation for Metropolitan Statistical Area Level: 2009

(Numbers in thousands. For information on confidentiality protection, sampling error, nonsampling error, and definitions, see *www.census.gov/acs/www/)*

Metropolitan statistical area level		Drove alone		Carpooled		Public transportation		Walked		All other means	
	Total	Percent	Margin of error[1] (±)	Percent	Margin of error[1] (±)	Percent	Margin of error[1] (±)	Percent	Margin of error[1] (±)	Percent	Margin of error[1] (±)
Workers who lived inside principal city in metro area[2]	44,239	72.1	0.1	10.5	0.1	10.6	0.1	4.4	0.1	2.4	–
Worked inside metro area of residence	41,838	72.0	0.1	10.2	0.1	10.9	0.1	4.6	0.1	2.3	–
Worked inside different metro area	1,914	75.7	0.5	14.1	0.4	4.9	0.3	1.6	0.1	3.7	0.3
Worked outside any metro area[3]	486	68.7	1.3	16.0	1.1	8.2	0.8	2.9	0.4	4.2	0.5
Workers who lived outside principal city in metro area[2]	43,164	81.5	0.1	10.3	0.1	3.9	–	2.6	–	1.6	–
Worked inside metro area of residence	36,684	81.5	0.1	9.9	0.1	4.2	0.1	2.9	0.1	1.4	–
Worked inside different metro area	5,108	82.0	0.3	11.8	0.3	2.6	0.1	1.0	0.1	2.6	0.1
Worked outside any metro area[3]	1,372	81.5	0.5	13.2	0.5	1.0	0.2	1.6	0.2	2.7	0.2
Workers who lived outside any metro area[2, 3]	45,271	84.8	0.1	10.7	0.1	1.2	–	1.9	–	1.4	–
Worked in metro area	3,147	83.9	0.3	13.4	0.3	0.6	0.1	0.6	0.1	1.6	0.1
Worked outside any metro area[3]	42,123	84.9	0.1	10.5	0.1	1.2	–	2.0	–	1.4	–

– Represents or rounds to zero.

[1] This number, when added to or subtracted from the estimate, represents the 90 percent confidence interval around the estimate.

[2] Workers 16 years and over who did not work at home.

[3] Outside any metropolitan statistical areas includes micropolitan statistical areas.

Note: Because of sampling error, the estimates in this table may not be significantly different from one another.

Source: U.S. Census Bureau, American Community Survey, 2009.

regions. The New York-Northern New Jersey-Long Island, NY-NJ-PA Metro Area had the highest percentage of workers who commuted by public transportation (30.5 percent), followed by the San Francisco-Oakland-Fremont, CA (14.6 percent), and the Washington-Arlington-Alexandria, DC-VA-MD-WV (14.1 percent) Metro Areas.

Figure 7 shows the percentage of workers who commuted by public transportation for all 366 metro areas in 2009. The percentage of public transportation commuters exceeded 10 percent in only five metro areas in 2009.[13] Although public transportation usage is generally higher in large metro areas, several relatively small metro areas with large universities also showed comparatively high rates of public transportation usage. For example, Ithaca, NY, and Ames, IA, had public transportation usage rates of 6.9 and 6.1 percent, respectively.

In several large metro areas, subway or elevated rail systems are integral components of the overall regional transportation system. The highest rate of subway or elevated rail commuting in 2009 occurred in the New York-Northern New Jersey-Long Island, NY-NJ-PA Metro Area, where about 19 percent of all workers used one of these modes, followed by the Washington-Arlington-Alexandria, DC-VA-MD-WV, and Boston-Cambridge-Quincy, MA-NH Metro Areas, at 8.4 and 6.3 percent, respectively.[14]

Commuting by Bicycle and Walking

Creating new infrastructure and altering existing infrastructure to accommodate bicycling and walking has become a goal for several metropolitan planning organizations across the United States.[15] Tables 3 and 4 show the 10 metro areas with the highest percentage of workers who commuted by bicycle and walked in 2009. Due

[13] For the following metro areas, the percentage of workers who commuted by public transportation in 2009 exceeded and was statistically different from 10 percent: New York-Northern New Jersey-Long Island, NY-NJ-PA; San Francisco-Oakland-Fremont, CA; Boston-Cambridge-Quincy, MA-NH; and Chicago-Naperville-Joliet, IL-IN-WI.

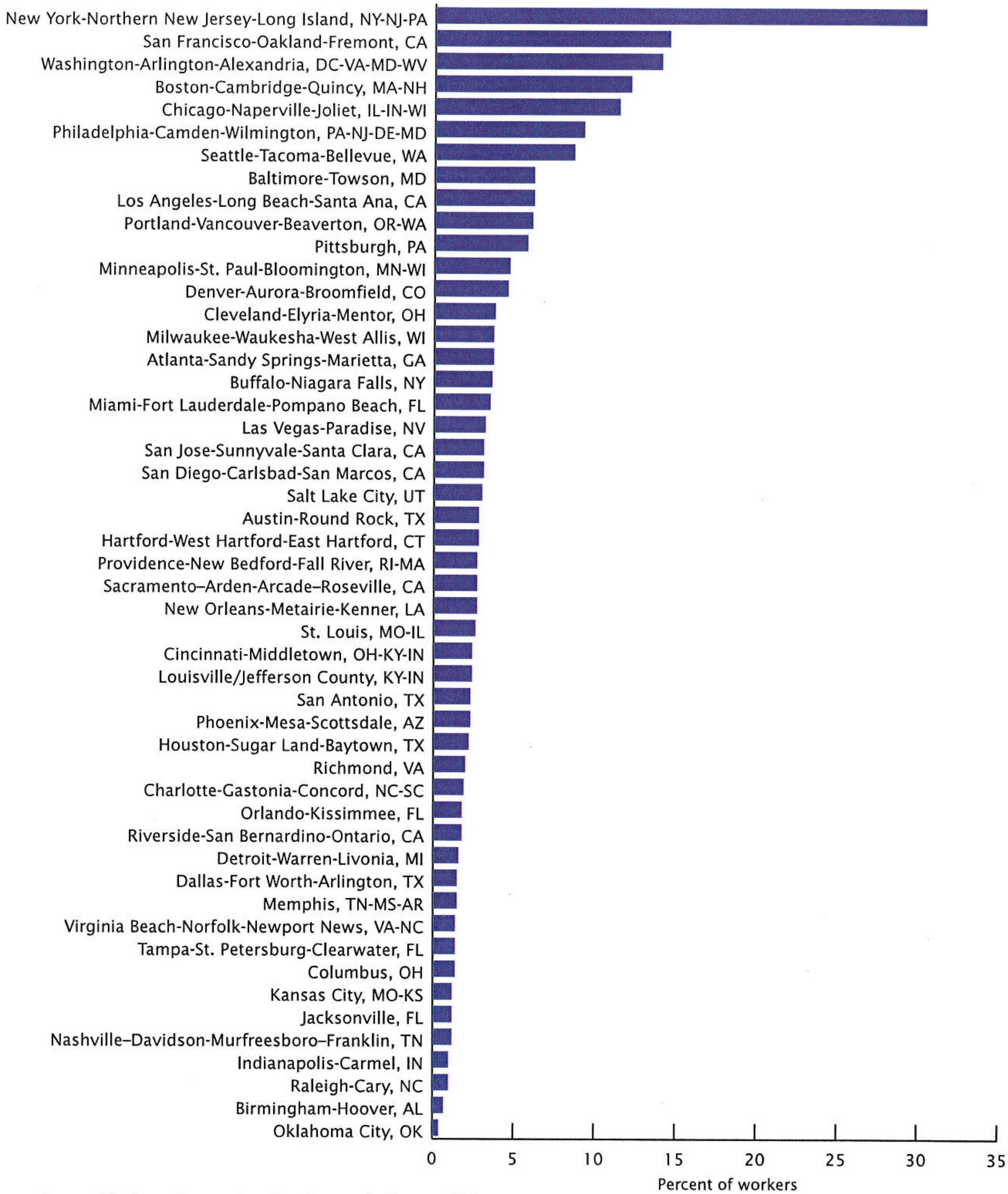
[14] See Table B08006 from the 2009 ACS data on American FactFinder at <http://factfinder.census.gov>.

[15] For example, the Cities for Cycling Program is a project of the National Association of City Transportation Officials that focuses on gathering and disseminating information about best practices for implementing bicycle-friendly infrastructure at the local level.

Figure 6.

Public Transportation Usage for the 50 Largest Metropolitan Statistical Areas: 2009

(Workers 16 years and over. For information on confidentiality protection, sampling error, nonsampling error, and definitions, see *www.census.gov/acs/www/*)

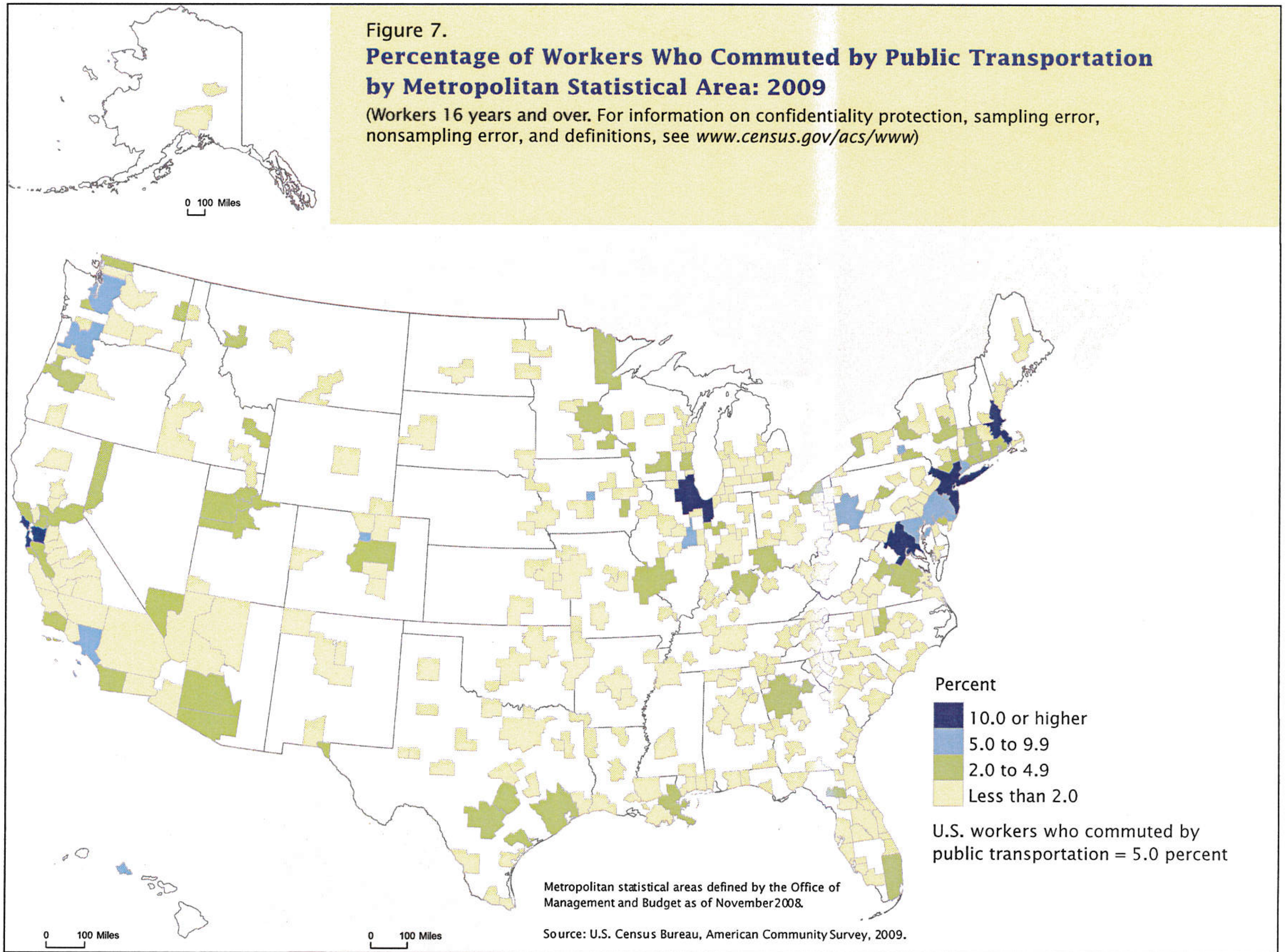


Source: U.S. Census Bureau, American Community Survey, 2009.

Figure 7.

Percentage of Workers Who Commuted by Public Transportation by Metropolitan Statistical Area: 2009

(Workers 16 years and over. For information on confidentiality protection, sampling error, nonsampling error, and definitions, see *www.census.gov/acs/www*)



Metropolitan statistical areas defined by the Office of Management and Budget as of November 2008.

Source: U.S. Census Bureau, American Community Survey, 2009.

Table 3.

Top Ten Metro Areas for Commutes to Work by Bicycle: 2009

(Numbers in thousands. For information on confidentiality protection, sampling error, nonsampling error, and definitions, see *www.census.gov/acs/www/)*

Metropolitan statistical area	Commuted by bicycle[1]	
	Percent	Margin of error[2] (±)
Corvallis, OR	9.3	3.1
Eugene-Springfield, OR	6.0	1.2
Fort Collins-Loveland, CO	5.6	2.1
Boulder, CO	5.4	1.2
Missoula, MT	5.0	1.8
Santa Barbara-Santa Maria-Goleta, CA	4.0	0.9
Gainesville, FL	3.3	1.2
Logan, UT-ID	3.3	1.4
Chico, CA	3.0	1.2
Bellingham, WA	3.0	1.3

[1] Workers 16 years and over.

[2] This number, when added to or subtracted from the estimate, represents the 90 percent confidence interval around the estimate.

Note: Because of sampling error, the estimates in this table may not be significantly different from one another.

Source: U.S. Census Bureau, American Community Survey, 2009.

Table 4.

Top Ten Metro Areas for Commutes to Work by Walking: 2009

(Numbers in thousands. For information on confidentiality protection, sampling error, nonsampling error, and definitions, see *www.census.gov/acs/www/)*

Metropolitan statistical area	Walked to work[1]	
	Percent	Margin of error[2] (±)
Ithaca, NY	15.1	3.2
Corvallis, OR	11.2	3.0
Ames, IA	10.4	2.9
Champaign-Urbana, IL	9.0	1.5
Manhattan, KS	8.5	2.4
Ocean City, NJ	8.4	2.9
Iowa City, IA	8.2	1.4
Hinesville-Fort Stewart, GA	8.2	5.1
Jacksonville, NC	8.1	3.0
State College, PA	8.0	2.0

[1] Workers 16 years and over.

[2] This number, when added to or subtracted from the estimate, represents the 90 percent confidence interval around the estimate.

Note: Because of sampling error, the estimates in this table may not be significantly different from one another.

Source: U.S. Census Bureau, American Community Survey, 2009.

to relatively small sample sizes for estimates, the margins of error for both the top biking metro areas and the top walking metro areas tend to be large and, as a result, estimates for some metro areas may not be statistically different from others on the list.

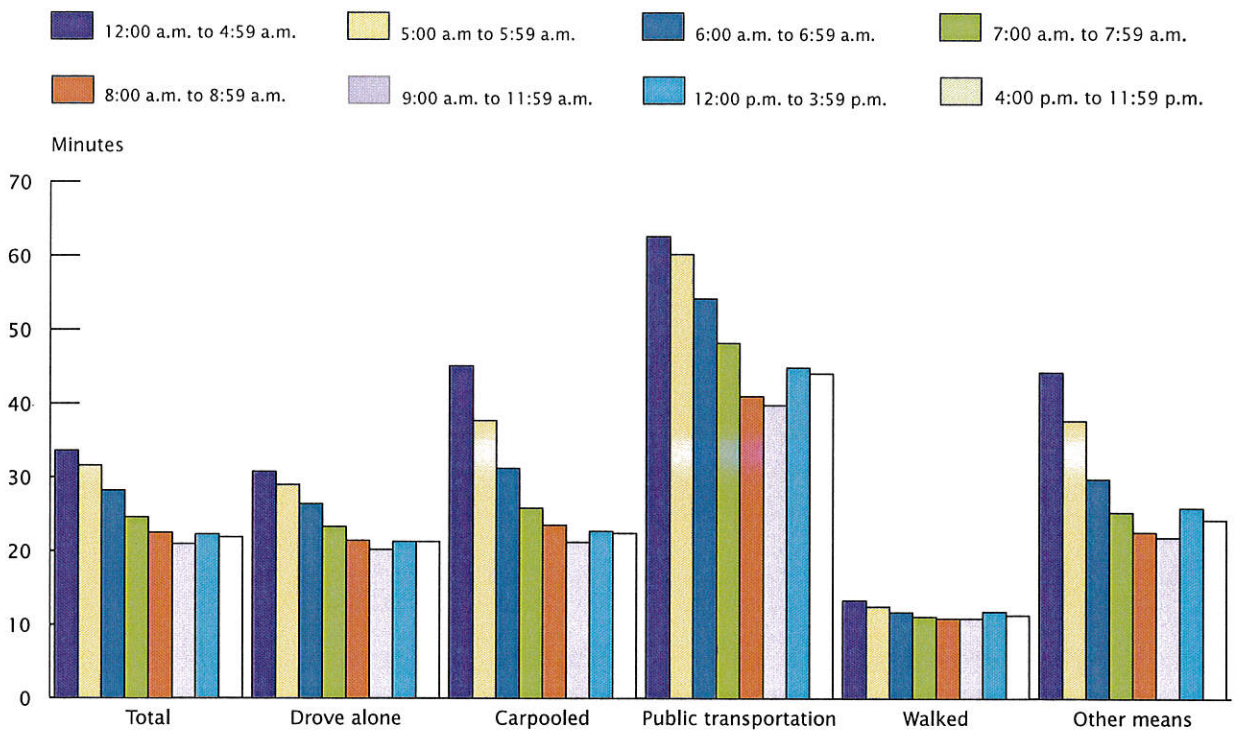
Some common characteristics stand out among the metro areas featured in Tables 3 and 4. Each metro area had a population of less than 500,000 in 2009. Several were also home to at least one large college or university and had high proportions of college-aged students. For example, 18- to 24-year-olds accounted for about 17 percent of the population of the Missoula, MT Metro Area in 2009, and about 25 percent of the population of the Corvallis, OR Metro Area, compared with about 10 percent in this age category for the nation (not shown).[16] Corvallis is the only metro area to appear on both the bicycle and walking lists. Oregon is also notable because the Portland-Vancouver-Beaverton, OR-WA Metro Area, with a bicycle commuting rate of 2.3 percent, was the only metro area with a population of over 1 million with a bicycle commuting rate of at least 2 percent.

[16] See Table S0101 from the 2009 ACS data on American FactFinder at <http://factfinder.census.gov>.

Figure 8.

Mean Travel Time by Means of Transportation by Time of Departure

(Workers 16 years and over. For information on confidentiality protection, sampling error, nonsampling error, and definitions, see *www.census.gov/acs/www/*)



Source: U.S. Census Bureau, American Community Survey, 2009.

TIME OF DEPARTURE FOR WORK

Information about when workers leave for work plays an integral role in the regional transportation planning process, especially by contributing to an understanding of congestion patterns on the nation's roads and public transportation infrastructure. Table 1 suggests that the volume of commuter travel occurring on the nation's transportation infrastructure varies considerably during a typical day.

The majority of all U.S. workers depart in the morning, but there are important differences in the distribution of departures across sociodemographic subgroups, means of transportation, and subsequent mean travel time. The following section highlights these differences.[17]

[17] See Supplemental Table B, Time of Departure to Work by Selected Characteristics: 2009, at <www.census.gov/hhes/commuting/>.

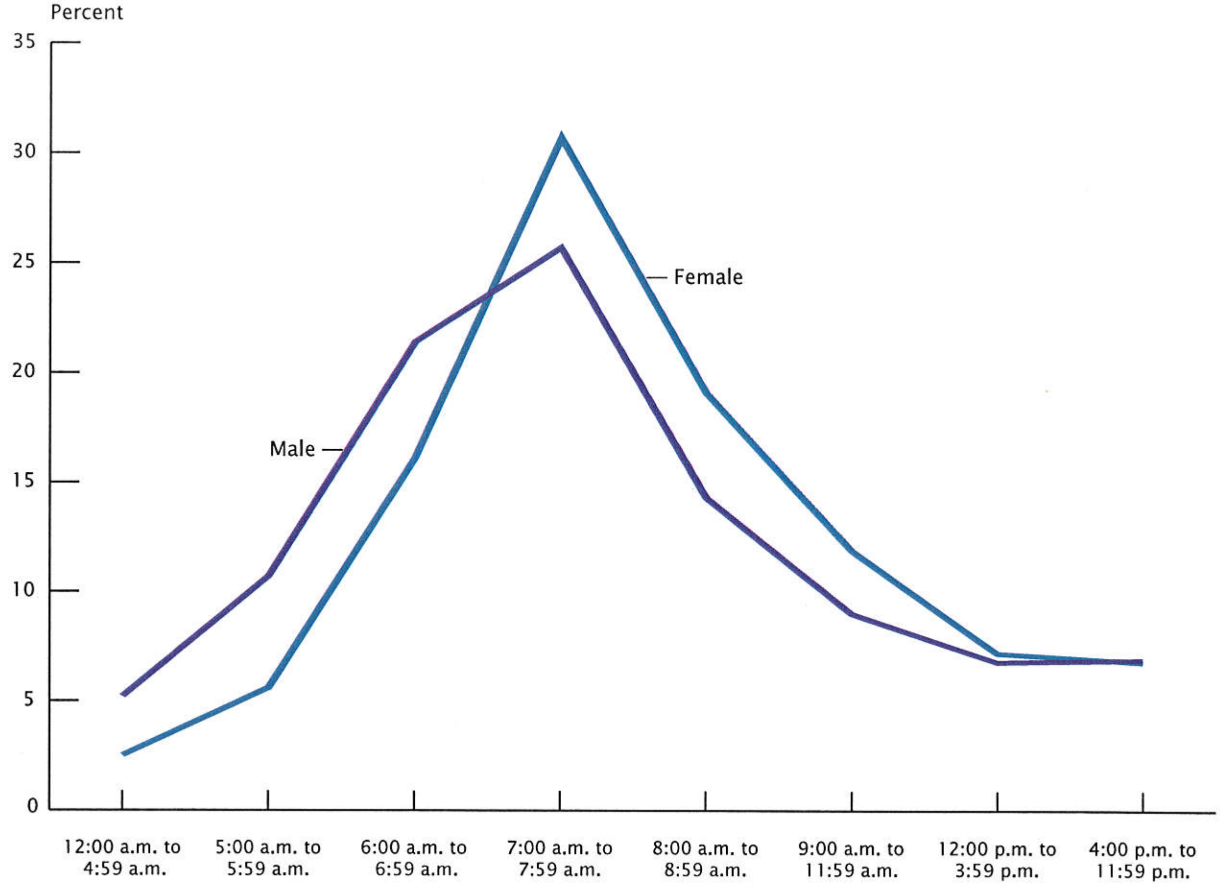
Mean Travel Time by Time of Departure and by Means of Transportation

Figure 8 shows mean travel time by time of departure and means of transportation for the United States in 2009. The longest average travel times were associated with early-morning departures, and travel time decreased as the morning progresses. This trend suggests that many workers who depart for work relatively early may do so to compensate for long work commutes.

Figure 9.

Time of Departure by Sex of Worker: 2009

(Workers 16 years and over. For information on confidentiality protection, sampling error, nonsampling error, and definitions, see *www.census.gov/acs/www/*)



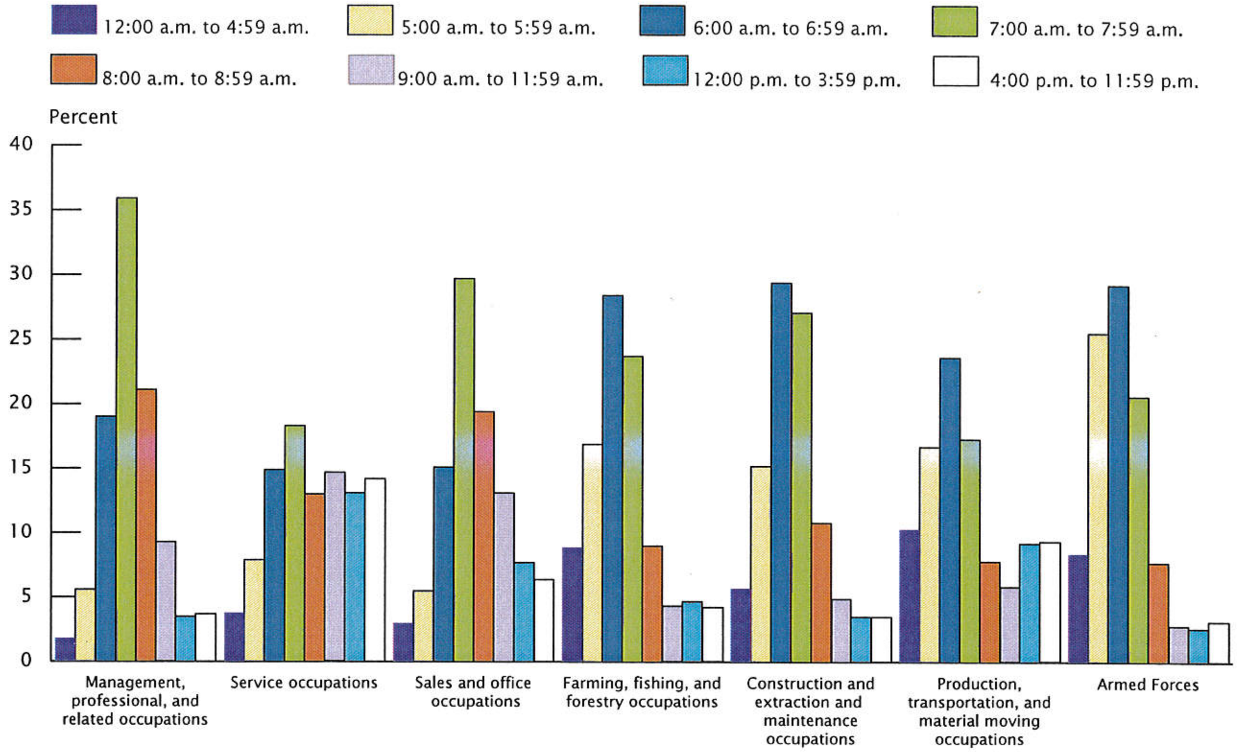
Source: U.S. Census Bureau, American Community Survey, 2009.

Those who relied on public transportation had the longest commutes across all departure-time categories, especially in the earliest departure categories. Compared with all other modes, workers who walked to work had the shortest mean travel time for every departure-time category. Workers who carpooled took longer to get to work than those who drove alone. This difference was largest for the 12:00 a.m. to 4:59 a.m. period, where mean travel time for carpool commuters was 45.1 minutes, compared with 30.8 minutes for workers who drove alone.

Men Left for Work Earlier Than Women

The most common time of departure for both male and female workers was between 7:00 a.m. and 7:59 a.m. Male workers were more likely to leave for work before 7:00 a.m. than their female counterparts. Almost 40 percent of men left before 7:00 a.m., compared with less than 25 percent of women (see Figure 9). All departure time categories from 7:00 a.m. through 3:59 p.m. included a greater percentage of women than men.

Figure 10.
Time of Departure by Occupation: 2009
(Workers 16 years and over. For information on confidentiality protection, sampling error, nonsampling error, and definitions, see *www.census.gov/acs/www/*)



Source: U.S. Census Bureau, American Community Survey, 2009.

Departure Times Varied by Occupation

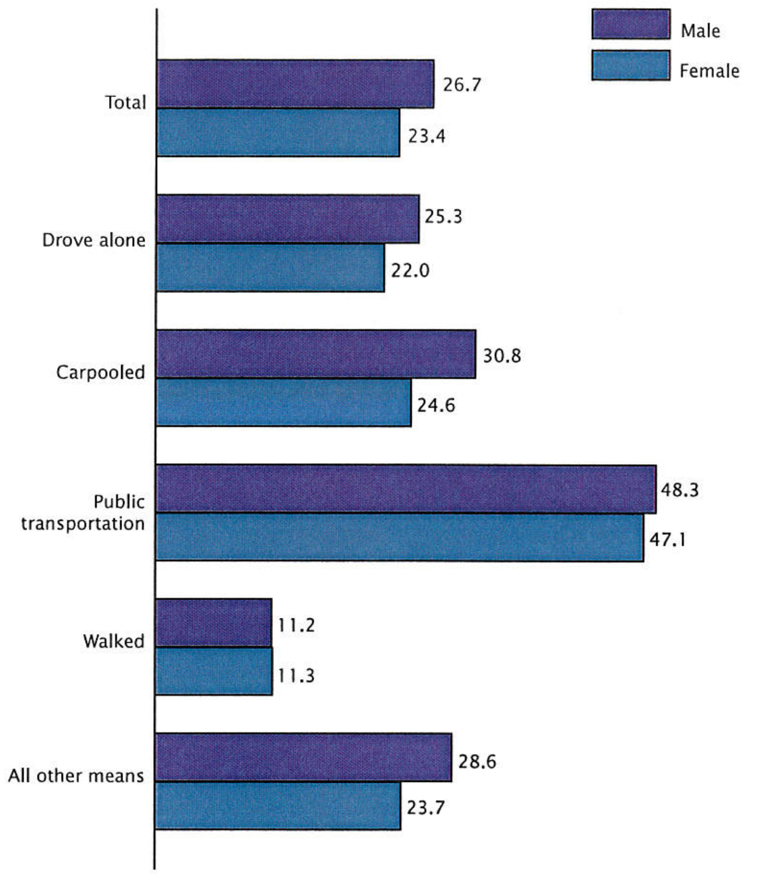
Figure 10 shows that at 10.5 percent, workers in production, transportation, and material moving occupations were more likely to depart for work between 12:00 a.m. and 4:59 a.m. than any other occupational category. At 1.9 percent, those in managerial, professional, and related occupations had the lowest percentage of departures between 12:00 a.m. and 4:59 a.m. Over one third of all workers in management, professional, and related occupations left for work between 7:00 a.m. and 8:00 a.m. Departures for service workers were more evenly distributed across the day compared with other occupation categories. For service workers, no time of departure category exceeded 20 percent.

TRAVEL TIME TO WORK

The ACS asks respondents in the workforce how many minutes it usually takes them to get from home to work (see Figure 1, Question 34). Changes in average commuting times at the community level may reflect several factors working in concert, including changes in the community's population and infrastructure, as well as shifts in regional labor market patterns. As communities change, the ACS provides an important tool for understanding the social and economic forces that influence travel time. The 2009 ACS reveals that average commute times in large metro areas were generally longer than those in smaller metro areas and that commute times also varied across sociodemographic characteristics, as discussed in this section.[18]

[18] Unless otherwise stated, the travel-time information provided in subsequent sections is based on Supplemental Table C, Mean Travel Time to Work by Means of Transportation and Selected Characteristics: 2009, available online at <www.census.gov/hhes/commuting/>.

Figure 11.
Mean Travel Time and Means of Transportation by Sex: 2009
(In minutes. Workers 16 years and over. For information on confidentiality protection, sampling error, nonsampling error, and definitions, see *www.census.gov/acs/www/*)



Source: U.S. Census Bureau, American Community Survey, 2009.

Men Took Longer to Get to Work Than Women

Overall, the mean travel time for male workers was significantly longer than for female workers (see Figure 11). Men took an average of 26.7 minutes to get to work, compared with 23.4 minutes for women. For all transportation modes except walking, the mean travel time for women was significantly shorter than it was for men.

For both male and female workers, the average travel time for workers who commuted by public transportation was over 20 minutes longer than that of their counterparts who drove alone.

Demographic Variation in Travel Time

Figure 12 shows mean travel time by race and Hispanic origin. Non-Hispanic White workers had the shortest mean travel times for the categories of walking and driving alone. Non-Hispanic Black workers who commuted to work by public transportation had the longest average travel time, at 50.0 minutes, although this is not statistically different from that of workers of some other race or two or more races. Non-Hispanic Black workers also had the longest average walking travel time, at about 14 minutes. Hispanic or Latino workers had the longest mean travel time when carpooling (29.0 minutes), but the shortest mean travel time for public transportation usage (46.0 minutes).

For all workers combined, public transportation commuters averaged over 20 minutes longer getting to work than those who drove alone.[19] Mean travel time also varied by nativity status. The average travel time for foreign-born workers was 28.1 minutes, compared with 24.9 minutes for native-born workers.

Average Commute Time Across Metro Areas and Their Components

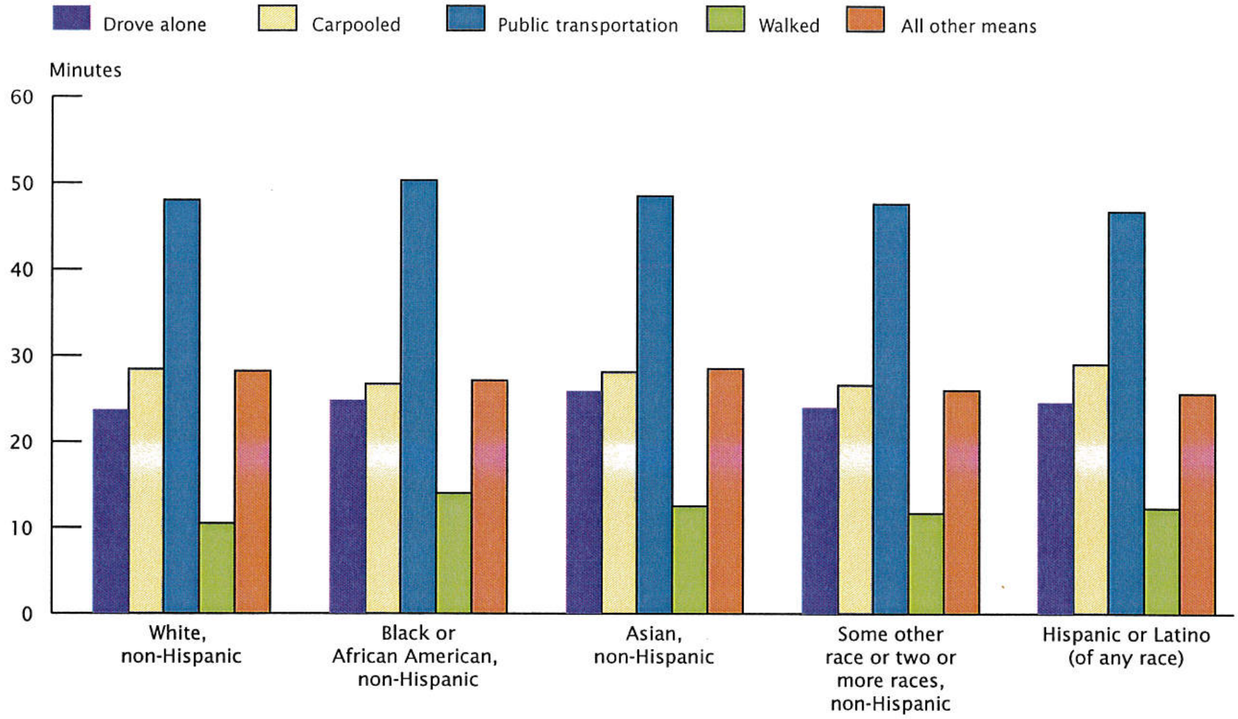
Table 5 presents mean travel time for workers who lived in metropolitan areas for different commute types. For example, workers who lived in a metro area and worked outside any metro area had the longest average commute times, at 43.4 minutes, followed by workers who lived outside a principal city (in a metropolitan area) and worked inside a principal city, who traveled an average of 30.4 minutes. For each home-to-work trip combination, public transportation commuters had the longest mean travel

[19] See Supplemental Table C, Mean Travel Time to Work by Means of Transportation and Selected Characteristics: 2009, at <www.census.gov/hhes/commuting/>.

Figure 12.

Mean Travel Time by Race and Hispanic Origin: 2009

(Workers 16 years and over. For information on confidentiality protection, sampling error, nonsampling error, and definitions, see *www.census.gov/acs/www/*)



Source: U.S. Census Bureau, American Community Survey, 2009.

time, while walkers had the shortest. Workers who took public transportation, lived in a metro area, and worked outside any metro area had the longest average commute time at 71.1 minutes. Workers who walked to work and lived and worked in a metro area, but outside of a principal city, had the shortest mean travel time, at 9.6 minutes.

Table 6 provides ranked lists of the metropolitan statistical areas with the shortest and longest commutes. Metropolitan area size has a considerable bearing on mean travel time. The 10 metro areas with the shortest mean travel times have populations of fewer than 300,000 people. The Great Falls, MT Metro Area had the shortest mean travel time at 14.2 minutes, although this estimate was not statistically different from that of three other metro areas.[20]

Among the 10 metro areas with the longest travel times, several are among the nation's most populous. For example, the New York-Northern New Jersey-Long Island NY-NJ-PA Metro Area had the longest average travel time at 34.6 minutes, followed by the Washington-Arlington-Alexandria, DC-VA-MD-WV Metro Area, with an average travel time of 33.4 minutes.

Also among the 10 metro areas with the longest commutes are several smaller metro areas located near a much larger one. For example, the Poughkeepsie-Newburgh-Middletown, NY Metro Area had the third-longest average commute time at 32.2 minutes, which was influenced by a substantial percentage of its residents commuting to the New York-Northern New Jersey-Long Island NY-NJ-PA Metro Area.[21] Figure 13 shows the variation in mean travel time across metro areas in 2009.

[20] The travel-time estimate for the Great Falls, MT Metro Area is not statistically different from Lewiston, ID-WA; Grand Forks, ND-MN; and Cheyenne, WY.

[21] The travel-time estimate for the Poughkeepsie-Newburgh-Middletown, NY Metro Area is not statistically different from Bremerton-Silverdale, WA.

Table 5.
Means of Transportation and Mean Travel Time to Work for Workers Living in Metro Areas: 2009

(Travel time to work is in minutes. For information on confidentiality protection, sampling error, nonsampling error, and definitions, see *www.census.gov/acs/www/)*

Place	Total		Drove alone		Carpooled		Public transportation		Walked		All other means	
	Mean travel time	Margin of error[1] (±)	Mean travel time	Margin of error[1] (±)	Mean travel time	Margin of error[1] (±)	Mean travel time	Margin of error[1] (±)	Mean travel time	Margin of error[1] (±)	Mean travel time	Margin of error[1] (±)
Workers 16 years and over who did not work at home	**25.7**	**–**	**24.2**	**–**	**28.0**	**0.1**	**47.8**	**0.2**	**11.9**	**0.1**	**27.5**	**0.4**
Lived and worked inside same metro area	24.2	–	22.7	–	25.7	0.1	47.0	0.2	12.0	0.1	22.6	0.4
Lived and worked inside same principal city	21.1	0.1	17.6	0.1	20.8	0.2	42.5	0.2	13.0	0.2	19.4	0.4
Lived and worked inside different principal cities	28.6	0.2	26.5	0.2	29.4	0.5	49.9	0.7	16.5	1.5	29.1	1.4
Lived inside principal city, worked outside principal city	26.1	0.1	24.4	0.1	27.9	0.3	53.3	0.9	16.1	1.0	27.2	1.5
Lived outside principal city, worked inside principal city	30.4	0.1	28.2	0.1	32.0	0.2	57.8	0.4	16.7	1.4	30.9	1.0
Lived and worked outside principal city	21.9	0.1	21.7	0.1	24.3	0.2	42.9	0.8	9.6	0.2	21.4	0.6
Lived in metro area and worked outside metro area	43.4	0.2	41.2	0.2	49.7	0.7	71.1	1.3	11.0	0.7	62.0	1.8

– Represents or rounds to zero.
[1] This number, when added to or subtracted from the estimate, represents the 90 percent confidence interval around the estimate.
Note: Because of sampling error, the estimates in this table may not be significantly different from one another.
Source: U.S. Census Bureau, American Community Survey, 2009.

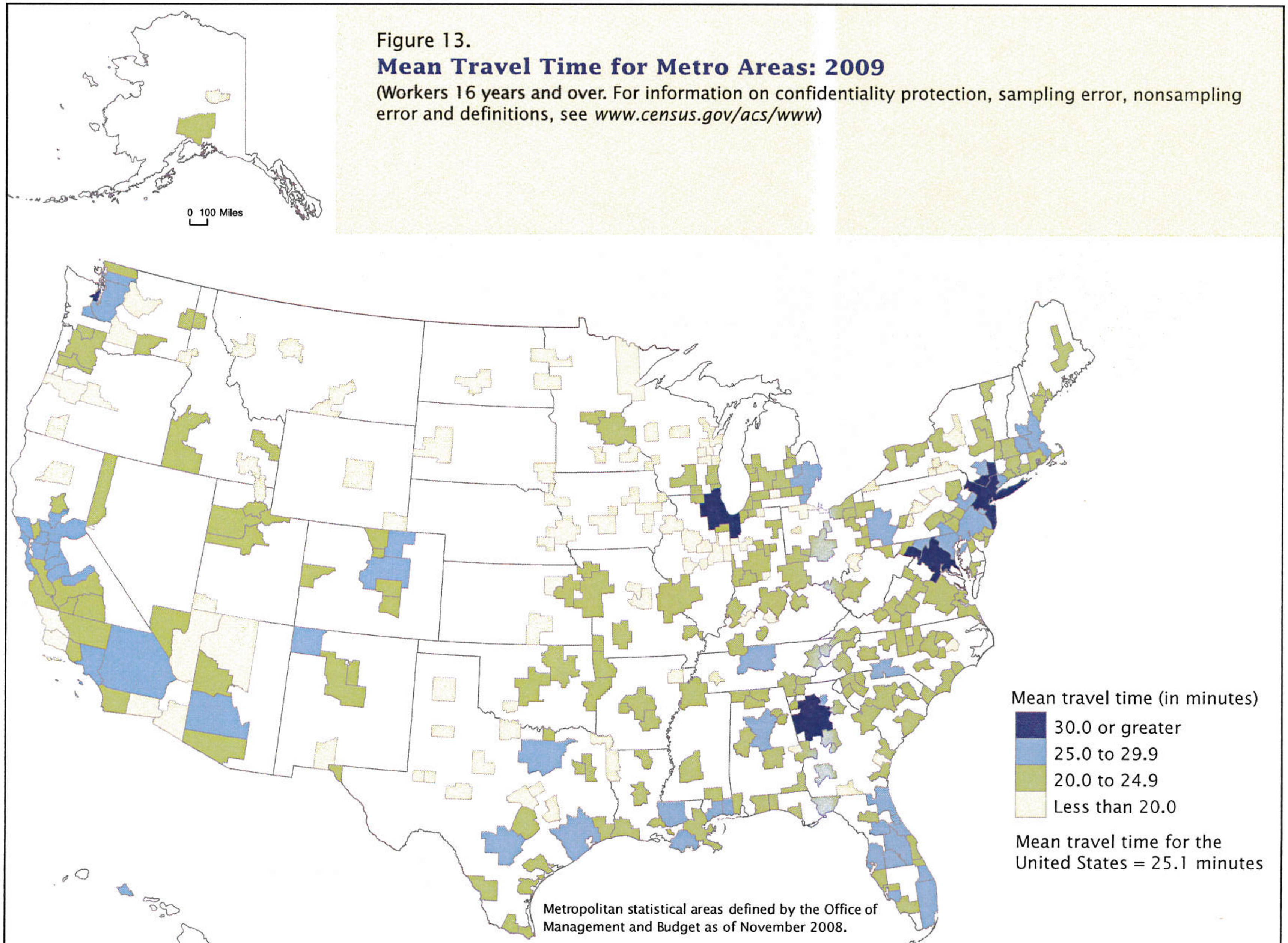
Table 6.
Metro Areas With the Longest and Shortest Commutes: 2009

(In minutes. For information on confidentiality protection, sampling error, nonsampling error, and definitions, see *www.census.gov/acs/www/)*

Metropolitan statistical area	Mean travel time to work[1]	Margin of error[2] (±)
Ten Longest Commutes		
New York-Northern New Jersey-Long Island, NY-NJ-PA	34.6	0.1
Washington-Arlington-Alexandria, DC-VA-MD-WV	33.4	0.3
Poughkeepsie-Newburgh-Middletown, NY	32.2	1.0
Bremerton-Silverdale, WA	30.8	1.4
Chicago-Naperville-Joliet, IL-IN-WI[3]	30.7	0.2
Winchester, VA-WV	30.3	2.1
Atlanta-Sandy Springs-Marietta, GA	30.1	0.3
Riverside-San Bernardino-Ontario, CA	30.0	0.4
Stockton, CA	29.8	1.2
Baltimore-Towson, MD	29.7	0.3
Ten Shortest Commutes		
Great Falls, MT	14.2	0.8
Lewiston, ID-WA	14.7	1.5
Grand Forks, ND-MN	15.1	1.1
Lubbock, TX	15.5	0.8
Missoula, MT	15.8	1.0
San Angelo, TX	15.9	1.3
Cheyenne, WY	15.9	1.8
Midland, TX	16.0	0.7
Lawton, OK	16.0	0.8
Decatur, IL	16.5	0.9

[1] Workers 16 years and over who did not work at home.
[2] This number, when added to or subtracted from the estimate, represents the 90 percent confidence interval around the estimate.
[3] The mean travel time for workers in the San Juan-Caguas-Guaynabo, Puerto Rico metropolitan area was 30.8 minutes, the fifth highest among metropolitan areas in the United States and its territories.
Note: Because of sampling error, the estimates in this table may not be significantly different from one another.
Source: U.S. Census Bureau, American Community Survey, 2009.

Figure 13.
Mean Travel Time for Metro Areas: 2009
(Workers 16 years and over. For information on confidentiality protection, sampling error, nonsampling error and definitions, see *www.census.gov/acs/www*)



Source: U.S. Census Bureau, American Community Survey, 2009.

SUMMARY

Commuting in the United States is dominated by private automobile travel, as is evidenced by the large proportion (86.1 percent) of workers 16 years and over who commuted by car, truck, or van in 2009. About three-quarters of workers drove to work alone in that year. The dominance of the automobile at the national level should not obscure the considerable variation in modal usage across geographic areas. This report highlights metro areas with comparatively high usages of transportation modes other than the private automobile.

Several smaller metropolitan areas have high proportions of workers who commute by walking or bicycle, and transit commuters are concentrated within a small number of large metropolitan areas. Differences in average travel times also vary geographically. The metro areas with the shortest travel times tend to have smaller populations, while the longest commutes are associated with the nation's largest metro areas.

Some of the most striking categorical differences in commuting behavior are found among characteristics associated with race, ethnicity, and sex. For example, non-Hispanic White workers drove alone at a rate of about 10 percentage points higher than that of any other racial or ethnic group. Hispanic workers carpooled at a rate much higher than non-Hispanic workers. And non-Hispanic Black workers who commuted by public transportation had the longest average travel time. Regardless of transportation mode (with the exception of walking), women generally had shorter travel times and later commutes than men.

Changes in the socioeconomic and demographic landscapes of communities are accompanied by changes in commuting patterns. Timely information about commuting patterns enables planners and policy makers to make informed decisions about investment in the nation's infrastructure, enables researchers to identify unmet transportation needs, and provides the tools necessary for working toward more efficient and equitable transportation solutions.

ADDITIONAL SOURCES FOR COMMUTING DATA

Additional ACS information related to the work commute or place of work is available on the Census Bureau's American FactFinder Web site at <http://factfinder.census.gov>. American FactFinder allows users to view data for several sociodemographic characteristics at various geographies.

The National Household Travel Survey (NHTS) is the nation's largest survey focusing specifically on travel. It collects household data on daily trips and is not limited to the commute. The NHTS provides a valuable contribution to understanding national-level travel patterns. More information about the NHTS can be found at <http://nhts.ornl.gov/>.

Several special tabulations related to commuting are available from the Census Transportation Planning Products (CTPP). The CTPP is a collaborative effort among the U.S. Census Bureau and several transportation-related agencies to produce a set of tabulations designed for transportation planners. The CTPP contains residence data summarizing worker and household characteristics, place of work data summarizing worker characteristics, and commuting flow data. The most recent CTPP tabulations are based on the ACS 3-year data from 2006 to 2008. Visit <http://ctpp.transportation.org> to access CTPP data.

The Longitudinal Employer-Household Dynamics (LEHD) dataset relates where people live to where they work using quarterly census of employment and wages (ES-202) data derived from reports filed by all employers subject to unemployment compensation laws. LEHD is a project of the Census Bureau that combines federal and state administrative data on employers and employees with the rich array of sociodemographic information from decennial censuses and the ACS. The LEHD dataset potentially provides an alternative source of place of work and flow data because it is built from administrative records, not the ACS survey. More information about LEHD can be found at <http://lehd.did.census.gov/led/>.

SOURCE OF THE DATA AND ACCURACY OF THE ESTIMATES

The American Community Survey

Many of the findings presented in this report were based on the American Community Survey (ACS) data collected in 2009. These data were based on the population living in either households or group quarters (which include correctional facilities, nursing homes, college dormitories, group homes, and overnight shelters) that were included in the ACS sample. The U.S. Census Bureau is both the sponsor and the collector of the American Community Survey. The 2009 ACS is based on a sample of just under 3 million housing unit addresses and a separate sample of just under 200 thousand people living in group quarters. ACS figures are estimates based on this sample and approximate the actual figures that would have been obtained by interviewing the entire household and group quarters populations using the same methodology. The estimates from the 2009 ACS sample may also differ from estimate based on other survey samples of housing units and group quarters and the people living within those housing units and group quarters.

SAMPLING AND NONSAMPLING ERROR

Sampling error occurs when the characteristics of a sample are measured instead of those of the entire population (as from a census). Note that sample-based estimates will vary depending on the particular sample selected from the population, but all attempt to approximate the actual figures. Measures of the magnitude of sampling error reflect the variation in the estimates over all possible samples that could have been selected from the population using the same sampling, data collection, and processing methods. Estimates of the magnitude of sampling errors are provided in the form of margins of error for all key ACS estimates included in this report. The Census Bureau recommends that data users incorporate this information into their analyses, as sampling error in survey estimates could impact the conclusions drawn from the results. All comparative statements in this report have undergone statistical testing, and comparisons are significant at the 90 percent confidence level unless noted otherwise. This means the 90 percent confidence interval for the difference between the estimates being compared does not include zero. In addition to sampling error, nonsampling errors may be introduced during any phase of data collection or processing. For example, operations such as editing, reviewing, or keying data from questionnaires may introduce error into the estimates. The primary source of nonsampling error and the processes instituted to control error in the 2009 ACS are described in further detail in the 2009 ACS Accuracy of the Data document (see Web link below). Title 13, U.S. Code, Section 9, prohibits the Census Bureau from publishing results from which the identity of an individual survey respondent could be determined. For more information on how the Census Bureau protects the confidentiality of data, see the 2009 ACS Accuracy of the Data document, available at <www.census.gov/acs/www/Downloads/data_documentation/Accuracy/ACS_Accuracy_of_Data_2009.pdf>.

FOR MORE INFORMATION

Further information from the 2009 ACS is available on the Census Bureau's Web site, at <www.census.gov/acs/www/>.

Measures of ACS quality—including sample size and number of interviews, response and nonresponse rates, coverage rates, and item allocation rates—are available at <www.census.gov/acs/www/methodology/methodology_main/>. For more information about commuting, go to the U.S. Census Bureau's Commuting (Journey to Work) Web site, at <www.census.gov/hhes/commuting/>.

CONTACT

Contact U.S. Census Bureau Customer Services Center at 1-800-923-8282 (toll free) or visit <ask.census.gov> for further information.

SUGGESTED CITATION

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UCLA CENTER FOR HEALTH POLICY RESEARCH

ADULTS 2011-2012 HEALTH PROFILES

Fresno County

This County Health Profile provides data on key health topics for the 650,000 adults (age 18 and over) in Fresno County. Estimates are based on the 2011-2012 California Health Interview Survey (CHIS).[1]

Demographics[2]	County(%)	State(%)
Age 18-64	85.0	84.2
Age 65 and over	15.0	15.8
White	37.3	43.5
Latino	46.3	34.2
Asian	9.0	13.9
Black	4.8	5.6
Other race[3]	2.6	2.8
Adults with income less than 200% FPL[4]	46.7	35.9

	County		California	
Access and Utilization	%	(95% CI)	%	(95% CI)
Uninsured all or part year (age 18-64)	27.1	(22.0 - 32.3)	26.6	(25.7 - 27.4)
Employment-based insurance, all year (age 18-64)	39.1	(33.3 - 44.9)	50.6*	(49.7 - 51.5)
Medi-Cal or Healthy Families, all year (age 18-64)	24.9	(18.7 - 31.0)	11.6*	(11.0 - 12.2)
Other coverage, all year (age 18-64)[5]	8.9	(5.6 - 12.3)	11.3	(10.7 - 11.8)
No usual source of health care[6]	23.0	(17.9 - 28.0)	17.6*	(16.9 - 18.2)
Delayed getting prescription drugs or medical services in past year	17.4	(13.8 - 21.0)	21.5*	(20.9 - 22.2)
Health Outcomes				
Serious psychological distress in the past year[7]	9.4	(6.2 - 12.5)	7.9	(7.5 - 8.4)
Fair or poor health (age-adjusted)[8]	25.0	(20.3 - 30.4)	19.4*	(18.7 - 20.0)
Current asthma[9]	13.0	(9.3 - 16.7)	7.7*	(7.3 - 8.1)
Ever diagnosed with diabetes[10]	8.5	(6.1 - 10.8)	8.4	(7.9 - 8.8)
Obese[11]	30.0	(25.3 - 34.7)	24.8*	(24.1 - 25.5)
Ever diagnosed with high blood pressure	29.7	(25.1 - 34.3)	27.3	(26.6 - 27.9)
Health Behaviors				
Engaged in regular walking in the past week[12]	32.6	(27.0 - 38.2)	33.3	(32.5 - 34.1)
Ate fruits and vegetables 3 or more times yesterday[13]	26.9	(21.9 - 32.0)	27.2	(26.5 - 27.9)
Current smoker[14]	15.5	(11.6 - 19.3)	13.8	(13.2 - 14.3)
Binge drinking[15]	27.0	(22.4 - 31.6)	31.1	(30.3 - 31.8)
Other Factors				
Food insecure[16]	22.4	(17.5 - 27.4)	14.9*	(14.3 - 15.6)
Limited English proficiency[17]	30.9	(25.2 - 36.7)	26.9	(26.2 - 27.7)

* Statistically significant difference between county and state at $p<0.05$

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Notes

[1] To obtain a representative sample, 42,935 adults in California were randomly selected to participate in CHIS 2011-2012.

[2] Racial and ethnic categories are based on the Office of Management and Budget (OMB) definitions used in the 2010 Census. For more information, see: *2010 Census Briefs*, issued March 2011. Retrieved August 26, 2013: http://www.census.gov/prod/cen2010/briefs/c2010br-02.pdf.

[3] Other race includes Native Hawaiian, Pacific Islander, American Indian, Alaska Natives, any other race and two or more races.

[4] FPL is the Federal Poverty Level. Poverty estimates for CHIS 2011-2012 have been weighted to the Current Population Survey and

[5] Other coverage includes: 1) Individually purchased private coverage; 2) Other public coverage that is not Medi-Cal or Healthy Families, such as AIM or MRMIP; and 3) Any combination of insurance types during the past year without a period of uninsurance.

[6] Usual source of care excludes emergency department and urgent care visits.

[7] Serious Psychological Distress (SPD) is often used as a proxy measure for severe mental illness in a population. Adult respondents were asked 6 questions, known as the "Kessler 6", to assess symptoms of distress during a 30-day period in the past year.

[8] Age-adjusted to U.S. Standard Population in 2000.

[9] Defined as ever diagnosed with asthma and reporting current asthma or an asthma attack/episode in the past year.

[10] Excludes ever been diagnosed with gestational diabetes. Estimates were not age-adjusted because age-adjustment did not produce meaningfully different estimates.

[11] Defined as body mass index (weight [kg] / height [m^2]) greater than or equal to 30.0.

[12] Defined as those who reported at least 150 minutes of walking for transportation or leisure in the past week.

[13] Excludes consumption of fruit juice and fried potatoes.

[14] Defined as having smoked at least 100 cigarettes in entire lifetime and currently smokes everyday or some days.

[15] Defined as consuming four or more alcoholic drinks on one or more occasion for women and five or more drinks on one or more occasion for men at any point in the past year.

[16] Defined as adults who had difficulty reliably putting food on the table in the past year. The question assumes that adults who are above 200% of the federal poverty level are food secure.

[17] Defined as adults who speak English less than very well out of the entire population. The question was asked only of those who speak a language other than English at home.

UCLA CENTER FOR HEALTH POLICY RESEARCH

The California Endowment

CHIS california health interview survey

The UCLA Center for Health Policy Research is one of the nation's leading health policy research centers and the premier source of health-related information on Californians.

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The California Health Interview Survey (CHIS) is the nation's largest state health survey and one of the largest health surveys in the United States. Learn more at: www.askchis.com

CHILD AND TEEN 2011-2012 HEALTH PROFILES

Fresno County

This County Health Profile provides data on key health indicators for the 275,000 children and teens (age 17 and under) in Fresno County. Estimates are based on the 2011-2012 California Health Interview Survey (CHIS).[1]

Demographics[2]	County (%)	California (%)
Age 0-11	66.8	65.8
Age 12-17	33.2	34.2
White	19.9	27.3
Latino	62.4	51.4
Asian	5.8	10.6
Black	6.4	5.5
Other race[3]	5.4	5.2
Adults living with children, with income less than 200% FPL[4]	60.7	45.1

	County		California	
Access and Utilization	%	(95% CI)	%	(95% CI)
Uninsured all or part year (age 0-17)	11.0	(7.3 - 14.8)	7.7	(6.7 - 8.6)
Employment-based insurance, all year (age 0-17)	36.1	(32.2 - 40.0)	45.1*	(43.3 - 47.0)
Medi-Cal or Healthy Families, all year (age 0-17)	49.9	(43.4 - 56.5)	40.5*	(38.5 - 42.4)
No usual source of health care (age 0-17)[5]	4.7	(2.8 - 6.6)	8.8*	(7.8 - 9.8)
Health Outcomes				
Current asthma (age 0-17)[6]	15.7	(11.4 - 20.1)	10.1*	(9.0 - 11.3)
Overweight for age (age 2-11)[7]	13.4	(9.1 - 17.8)	13.6	(11.8 - 15.3)
Overweight or obese (age 12-17)[8]	33.9	(26.0 - 41.9)	32.4	(29.5 - 35.3)
Health Behaviors				
Engaged in regular physical activity in the last week (age 5-17)[9]	22.5	(17.8 - 27.3)	20.8	(19.1 - 22.5)
Had fast food at least twice in last week (age 2-17)	44.1	(38.9 - 49.4)	37.2*	(35.4 - 39.0)
Had 5 or more servings of fruits and vegetables yesterday (age 2-17)[10]	27.1	(22.5 - 31.6)	26.6	(25.0 - 28.3)
Had 1 or more servings of soda or sugary drinks yesterday (age 2-11)[11]	36.7	(28.2 - 45.1)	27.0*	(24.9 - 29.1)
Had 1 or more servings of soda or sugary drinks yesterday (age 12-17)[11]	77.7	(70.7 - 84.8)	64.7*	(61.9 - 67.6)
Had flu vaccination in the past year (6 months - 11 years)	45.0	(38.0 - 52.0)	50.0	(47.7 - 52.2)
Visited a dentist in the past year (age 2-17)	88.1	(84.6 - 91.6)	87.8	(86.5 - 89.1)
Households with children (age 0-17) where smoking is permitted[12]	1.1	(0.5 - 1.7)	1.3	(1.1 - 1.5)
Other Factors				
Food insecure (adults living with children)[13]	14.8	(10.0 - 19.7)	8.4*	(7.9 - 9.0)
Family member reads to child everyday (age 0-5)	59.8	(54.0 - 65.7)	62.2	(59.1 - 65.2)

* Statistically significant difference between county and state at $p<0.05$

View all Health Profiles: www.healthpolicy.ucla.edu/healthprofiles

Notes

[1] With the exception of age, race/ethnicity, FPL, and state level estimates, the estimates for the Child and Teen County Health Profiles were produced employing Small Area Estimation (SAE). SAE is a statistical modeling method used to produce estimates for small geographic areas or population groups that are not otherwise directly available from the survey sample.

[2] Racial and ethnic categories are based on the Office of Management and Budget (OMB) definitions used in the 2010 Census. For more information, see *2010 Census Briefs,* issued March 2011. Retrieved August 26, 2013: http://www.census.gov/prod/cen2010/briefs/c2010br-02.pdf.

[3] Other Race includes Native Hawaiian, Pacific Islander, American Indian, Alaska Natives, any other race and two or more races.

[4] FPL is the Federal Poverty Level.

[5] Usual source of care excludes emergency department and urgent care visits.

[6] Defined as ever diagnosed with asthma, and reporting current asthma or asthma symptoms in the past year.

[7] Defined as the proportion of children (age 2-11) whose weight for age is at or above the 85th percentile based on gender specific Centers for Disease Control and Prevention weight guidelines.

[8] Defined as the proportion of teens (age 12-17) whose body mass index (kg/m^2) is at or above the 85th percentile on gender and age specific Centers for Disease Control and Prevention BMI guidelines.

[9] Defined as those who engaged in at least one hour of physical activity daily during the last week, excluding physical education.

[10] Excludes consumption of fruit juice and fried potatoes.

[11] Defined as drinking one or more glasses or cans of non-diet soda, sweetened sports drinks or energy drinks yesterday.

[12] Defined as households with children where smoking is allowed some days or every day among all households.

[13] Defined as adults with children who had difficulty reliably putting food on the table in the past year. The question assumes that adults with children who are above 200% of the federal poverty level are food secure.

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The Benefits

of Meeting Federal Clean Air Standards in the South Coast and San Joaquin Valley Air Basins

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EXECUTIVE SUMMARY

Overview

There has long been a tug-of-war about the cost of protecting public health by reducing life-threatening pollution. A central objective of this study is to assess the cost of the status quo, and the health and related economic benefits that will result from achieving the federal ozone and $PM_{2.5}$ standards in the South Coast and San Joaquin Valley air basins.

Both the federal government and California have set health-based air quality standards for ozone and fine particle ($PM_{2.5}$) pollution because there is wide concurrence that these pollutants pose a serious risk to health. Ozone pollution's effect ranges from premature death to school absences and hospitalizations, to symptoms that limit normal daily activity. Exposure to fine particles is tied to a range of effects from premature death and the onset of chronic bronchitis to loss of work days and respiratory symptoms.

Despite the widespread consensus on the danger of these pollutants and the necessity of the health-based standards, the South Coast and San Joaquin Valley air basins of California have air pollution levels that are among the worst in the country. The South Coast Air Basin (SoCAB), which includes Los Angeles, Orange, Riverside and San Bernardino counties, is classified by the U. S. Environmental Protection Agency (EPA) as an extreme nonattainment area for ozone. The San Joaquin Valley Air Basin (SJVAB) also is designated an extreme nonattainment area for ozone. Both air basins are classified as serious nonattainment areas for $PM_{2.5}$. While promising reductions in some pollutants have been achieved, levels of ozone and fine particulate matter remain high.

Between 2005 and 2007 ambient ozone levels in the San Joaquin Valley exceeded the health-based 8-hour National Ambient Air Quality Standard (NAAQS) on from 112 to 139 days a year, while in the South Coast Air Basin exceedances occurred on from 115 to 120 days. Ozone levels are typically elevated in the warmer months, so this suggests that air is unhealthful on most summer days in these regions. Not only is the standard frequently exceeded, but between 2005 and 2007 the maximum 8-hour concentration was significantly above the standard. While ozone levels in much of California have fallen steadily over a period of years, progress in the San Joaquin Valley has been slower than in other major air basins.

To meet the maximum 24-hour standard, fine particulate levels must fall by more than 50%, and annual average concentrations must fall by nearly 30%. These health-based standards will be very difficult to achieve.

Health Findings:
Some Residents More at Risk, but Nearly Everyone is Exposed

Almost every resident of the South Coast Air Basin and San Joaquin Valley Air Basin regularly experiences air pollution levels known to harm health and to increase the risk of early death. Specifically, from 2005 through 2007, each person was on average exposed to unhealthful levels of ozone on nearly 20 and more than 30 days a year in the South Coast and San Joaquin Valley, respectively. In Kern County, this rises to over 50 days each year, and in Riverside and San Bernardino Counties, nearly 50. In the San Joaquin Valley 66% of the population is exposed to health-endangering annual average levels of $PM_{2.5}$. In the South Coast, this averages over 64%, and in the most populated county – Los Angeles – it is 75%.

Because ozone exceedances typically occur during the warmer months (April through September), and the exceedances of the 24-hour $PM_{2.5}$ standard typically occur in the fall and winter months, there is essentially no "clean" season in either air basin.

These exposures translate directly into poorer health and an elevated risk to every resident exposed, but the adverse impacts of air pollution are not distributed equally. Residents of Fresno, Kern, Kings and Tulare Counties experience significantly more days when the $PM_{2.5}$ standard is exceeded than residents of other counties in the San Joaquin Valley, as do residents of San Bernardino and Riverside Counties, compared to the neighboring counties in the South Coast Air Basin. Tulare County also joins Fresno, Kern, Riverside and San Bernardino in being well above their basin averages for the number of days of exposure above the ozone standards. Children under the age of 5 are exposed to unhealthful ozone concentrations on more days than adults. Blacks and Hispanics experience somewhat more frequent exposures to elevated levels of $PM_{2.5}$ than non-Hispanic whites do. These disadvantaged groups all stand to gain relatively more from successful pollution reduction efforts.

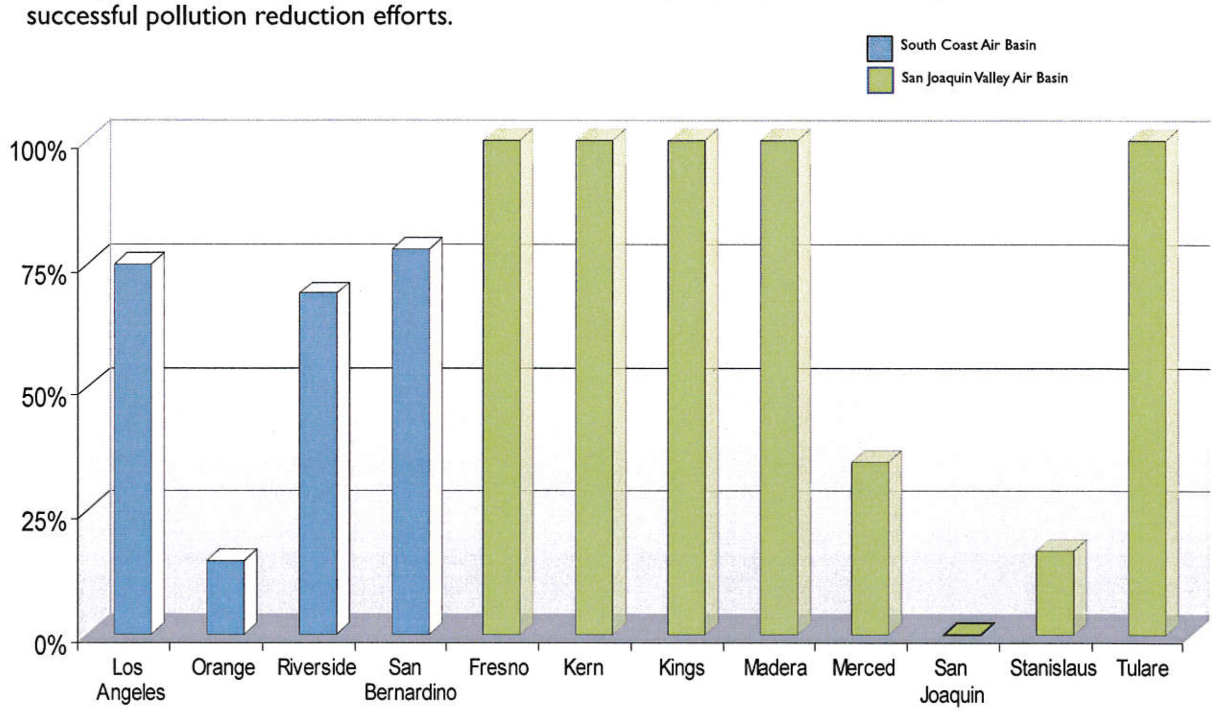

Figure E-1. Percent of the population exposed to $PM_{2.5}$ concentrations above the average annual federal standard (15 µg/m³) in 2005-2007 by county.

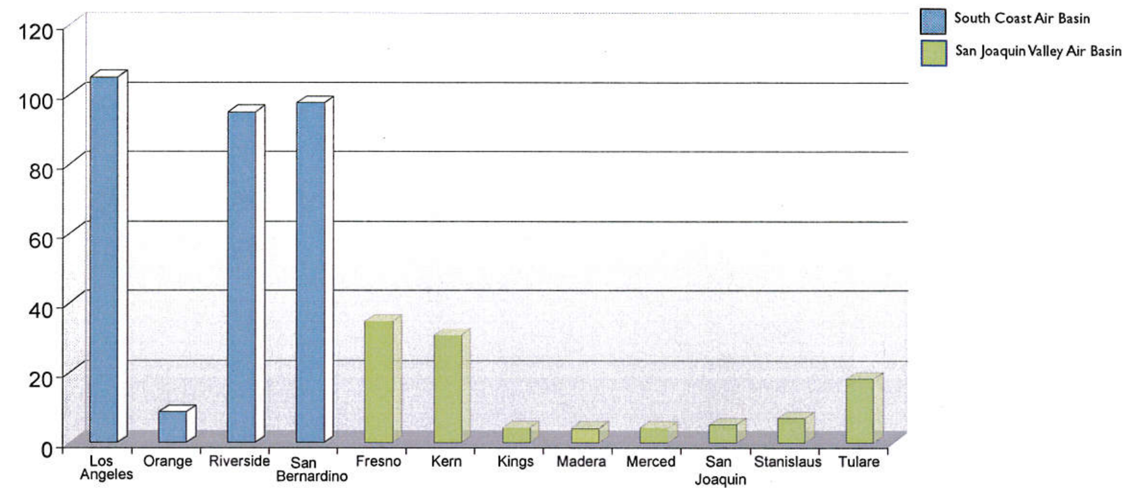

Figure E-2. Person-days per year residents are exposed to ozone concentrations above the 8-hr maximum federal standard (75 ppb) in 2005-2007 by county.

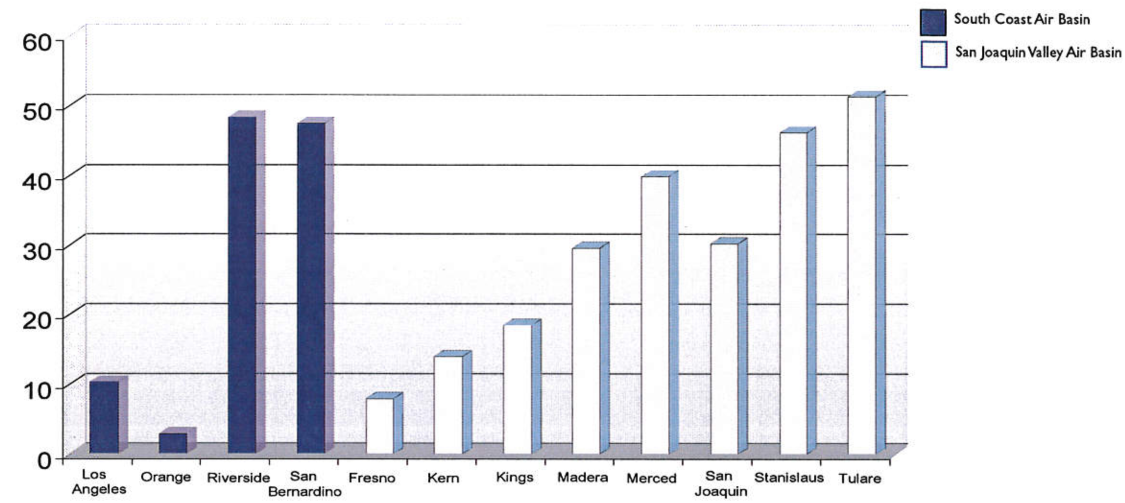

Figure E-3. Average days per year residents are exposed to ozone concentrations above the 8-hr maximum federal standard (75 ppb) in 2005-2007 by county.

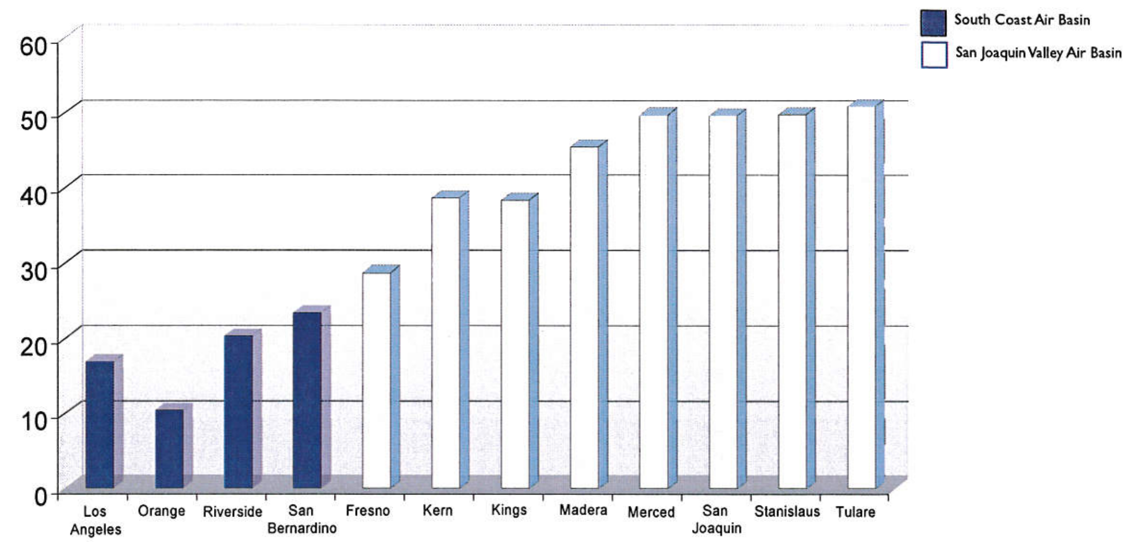

Figure E-4. Average days per year residents are exposed to $PM_{2.5}$ concentrations above the 24-hr maximum federal standard (>35 μg/m^3) in 2005-2007 by county.

Economic Findings:
The Cost of the Status Quo and the Benefits of Meeting Federal Standards

In addition to the documented health effects caused by high levels of pollution, residents in these regions pay a high economic price for adverse air quality. Recognizing that some known effects of exposure to these pollutants, such as loss of lung function, cannot yet be quantified in economic terms, the actual economic benefits are likely higher than the results reported here.

Specifically,

- In the San Joaquin Valley overall, the cost of air pollution is more than $1,600 per person per year, which translates into a total of nearly $6 billion in savings if federal ozone and $PM_{2.5}$ standards were met.
- In the South Coast Air Basin, the cost of air pollution is more than $1,250 per person per year, which translates into a total of almost $22 billion in savings if federal ozone and $PM_{2.5}$ standards were met.

These dollar values represent avoiding the following adverse health effects of ozone and $PM_{2.5}$ for the two air basins combined:

- 3,860 fewer premature deaths among those age 30 and older
- 13 fewer premature deaths in infants
- 1,950 fewer new cases of adult onset chronic bronchitis
- 3,517,720 fewer days of reduced activity in adults
- 2,760 fewer hospital admissions
- 141,370 fewer asthma attacks
- 1,259,840 fewer days of school absence
- 16,110 fewer cases of acute bronchitis in children
- 466,880 fewer lost days of work
- 2,078,300 fewer days of respiratory symptoms in children
- 2,800 fewer emergency room visits

To place the reduction in premature deaths in perspective, attaining the federal $PM_{2.5}$ standard would save more lives than reducing the number of motor vehicle fatalities to zero in most of the counties in this study. In Los Angeles County, $PM_{2.5}$–related deaths are more than double the number of motor vehicle-related deaths.

Ozone-Related Economic Benefits by County

	Respiratory Hospital Admissions (All ages)	Asthma Attacks Asthmatic population	Emergency Room Visits	Days of School Absences	Minor Restricted Activity Days	Mortality	Total
San Joaquin Valley Air Basin							
Fresno	$1,730,000	$301,000	$6,040	$3,350,000	$2,780,000	$19,880,000	$28,050,000
Kern	$1,550,000	$246,000	$4,620	$3,020,000	$2,240,000	$19,880,000	$26,940,000
Kings	$190,000	$47,000	$1,070	$480,000	$490,000	$0	$1,210,000
Madera	$230,000	$41,000	$710	$430,000	$410,000	$0	$1,110,000
Merced	$300,000	$58,000	$1,070	$680,000	$520,000	$0	$1,560,000
San Joaquin	$660,000	$121,000	$2,490	$1,210,000	$1,110,000	$0	$3,100,000
Stanislaus	$610,000	$111,000	$2,490	$1,200,000	$980,000	$6,630,000	$9,530,000
Tulare	$910,000	$156,000	$2,840	$1,650,000	$1,410,000	$13,250,000	$17,380,000
South Coast Air Basin							
Los Angeles	$15,400,000	$3,183,000	$54,120	$58,630,000	$31,790,000	$79,510,000	$188,600,000
Orange	$3,530,000	$916,000	$16,240	$22,300,000	$9,350,000	$19,880,000	$56,000,000
Riverside	$7,210,000	$1,210,000	$19,840	$12,170,000	$10,810,000	$ 99,390,000	$130,800,000
San Bernardino	$6,870,000	$1,205,000	$19,840	$12,880,000	$11,220,000	$72,890,000	$105,100,000

$PM_{2.5}$-Related Economic Benefits by County

	Premature & Post-Neo Natal Mortality	Respiratory Symptoms & Bronchitis	Non-Fatal Heart Attacks	Respiratory & Cardio Hospital Admissions	Children's Asthma ER Visits	Minor Restricted Activity Days	Work Loss Days	Total
San Joaquin Valley Air Basin								
Fresno	$1,405,000,000	$41,220,000	$10,940,000	$3,030,000	$42,280	$6,710,000	$2,890,000	$1,470,000,000
Kern	$1,213,000,000	$33,710,000	$8,340,000	$800,000	$33,040	$5,190,000	$2,230,000	$1,263,000,000
Kings	$192,200,000	$7,261,000	$1,890,000	$390,000	$6,040	$1,210,000	$510,000	$203,500,000
Madera	$218,700,000	$6,439,000	$1,680,000	$490,000	$5,680	$1,040,000	$410,000	$228,800,000
Merced	$251,800,000	$8,349,000	$2,310,000	$530,000	$9,950	$1,410,000	$580,000	$265,000,000
San Joaquin	$728,900,000	$20,640,000	$5,470,000	$1,620,000	$19,180	$3,190,000	$1,400,000	$761,200,000
Stanislaus	$656,000,000	$18,940,000	$4,910,000	$1,460,000	$17,760	$2,950,000	$1,280,000	$685,600,000
Tulare	$728,900,000	$20,900,000	$5,400,000	$1,400,000	$22,380	$3,280,000	$1,250,000	$761,200,000
South Coast Air Basin								
Los Angeles	$11,440,000,000	$421,200,000	$137,400,000	$35,790,000	$423,900	$80,460,000	$44,930,000	$12,160,000,000
Orange	$2,697,000,000	$104,700,000	$34,000,000	$6,950,000	$99,200	$19,710,000	$11,090,000	$2,874,000,000
Riverside	$3,055,000,000	$84,000,000	$25,940,000	$8,720,000	$92,000	$14,770,000	$7,160,000	$3,196,000,000
San Bernardino	$2,730,000,000	$89,460,000	$29,090,000	$7,450,000	$110,000	$17,530,000	$8,500,000	$2,882,000,000

IMPACT CHARTS

Ozone-Related Adverse Health Effects By County

	Respiratory Hospital Admissions (All ages)	Asthma Attacks Asthmatic population	Emergency Room Visits	Days of School Absences	Minor Restricted Activity Days	Mortality
San Joaquin Valley Air Basin						
Fresno	46	5,670	17	43,980	42,970	3
Kern	41	4,640	13	37,810	34,620	3
Kings	5	890	3	6,050	7,580	0
Madera	6	780	2	5,500	6,320	0
Merced	8	1,090	3	8,530	8,070	0
San Joaquin	17	2,290	7	13,100	17,170	0
Stanislaus	16	2,100	7	13,500	15,190	1
Tulare	24	2,940	8	23,040	21,830	2
South Coast Air Basin						
Los Angeles	380	59,100	150	653,300	483,840	12
Orange	87	17,010	45	184,500	142,380	3
Riverside	185	22,480	55	125,840	164,470	15
San Bernardino	173	22,380	55	144,690	170,720	11

$PM_{2.5}$-Related Adverse Health Effects By County

	Premature & Post-Neo Natal Mortality	Respiratory Symptoms & Bronchitis	Non-Fatal Heart Attacks	Respiratory & Cardio Hospital Admissions	Children's Asthma ER Visits	Minor Restricted Activity Days	Work Loss Days
San Joaquin Valley Air Basin							
Fresno	212	104,215	156	80	119	103,770	18,500
Kern	183	81,228	119	53	93	80,170	14,280
Kings	29	15,207	27	10	17	18,770	3,340
Madera	33	14,235	24	13	16	16,020	2,850
Merced	38	24,269	33	14	28	21,840	3,880
San Joaquin	110	46,908	78	43	54	49,360	8,740
Stanislaus	99	43,814	70	39	50	45,660	8,120
Tulare	110	54,678	77	37	63	50,750	9,030
South Coast Air Basin							
Los Angeles	1,727	1,000,440	1,960	903	1,175	1,224,600	241,690
Orange	411	233,310	485	175	275	300,010	59,100
Riverside	461	217,570	370	220	255	224,780	44,500
San Bernardino	412	260,480	415	187	305	266,830	52,850

Implications

More than 20,000,000 residents in these air basins face significant public health risks and high economic costs from the present unhealthful levels of ozone and fine particles. The findings in this study show how meeting federal clean air standards would bring substantial economic and health gains to the two regions. The benefits for the more populous or more polluted counties within each air basin would be even more pronounced.

As the state's population continues to increase, the gains from attaining the health-based air quality standards will grow, but also become more difficult to achieve. It is clear that identifying and acting on opportunities now to reduce emissions from the sources of ozone and fine particle pollution would produce substantial gains to more than 20 million Californians.

Research Approach

A well-established three-stage approach is used to determine the benefits of attaining the ozone and $PM_{2.5}$ air quality standards by identifying and quantifying the links between air quality and exposure, exposure and ill health, and avoiding ill health and the resulting economic gain.

Establishing the links between polluted air and exposure is accomplished using the Regional Human Exposure Model (REHEX), which was developed to estimate a population's exposure to concentrations above the air quality standards. This model accounts for the spatial and temporal pollution patterns across a region, which is important because pollution patterns vary significantly across a large area. Exposure for the populations in the SoCAB and SJVAB are estimated using 5x5 kilometer grids and 2005-2007 pollution levels. Averaging over three years reduces the influence of weather anomalies that do not accurately represent longer term trends in air quality. REHEX generates estimates of exposure by county, by age, and by ethnic group as defined by the U.S. Bureau of the Census.

These exposure estimates are then coupled with concentration-response functions from the health science literature to calculate how many fewer adverse health effects and premature deaths would be expected if the 2007 population instantaneously experienced attainment of the NAAQS.

Finally, economic values are applied to the avoided adverse health effects and extended lives to estimate in dollar terms the social value of more healthful air. These values are based on the cost of treating illness and the expressed value that people place on avoiding illness and premature death.

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The Benefits of Meeting Federal Clean Air Standards in the South Coast and San Joaquin Valley Air Basins

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Final Report

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All statements and conclusions in this study are solely those of the authors.

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ACRONYMS

ACS	American Cancer Society
ARB	California Air Resources Board
CAAQS	California Ambient Air Quality Standards
COI	Cost of illness
COPD	Chronic obstructive pulmonary disease
C-R	Concentration response
CV	Contingent Valuation
EPA	U.S. Environmental Protection Agency
FRM	Federal Reference Method
MRAD	Minor restricted activity day
NAAQS	National Ambient Air Quality Standards
ppb	Parts per billion
ppm	Parts per million
REHEX	Regional Human Exposure Model
RR	Relative risk
SAB-HEES	Science Advisory Board Health and Ecological Effects Subcommittee
SCAQMD	South Coast Air Quality Management District
SJVAB	San Joaquin Valley Air Basin
SJVAPCD	San Joaquin Valley Air Pollution Control District
SoCAB	South Coast Air Basin
SYMVAL	Symptom Valuation Model
VSL	Value of a statistical life
WLD	Work loss day
WTA	Willingness to accept
WTP	Willingness to pay

I. INTRODUCTION

1.1 BACKGROUND

California's Los Angeles region and San Joaquin Valley have air pollution levels of a severity rivaled only by Houston, Texas. Historical and current air quality levels for ozone and fine particles ($PM_{2.5}$) remain unhealthful. Both the South Coast Air Basin (SoCAB) and the San Joaquin Valley Air Basin (SJVAB) are classified by the U. S. Environmental Protection Agency (EPA) as extreme nonattainment areas for ozone and severe nonattainment areas for $PM_{2.5}$.

Both the federal government and California have set health-based air quality standards for ozone and fine particles ($PM_{2.5}$) because there is extensive and convincing evidence, and wide concurrence in the medical community, that these pollutants pose a serious risk to health. Adverse effects clearly associated with ozone range from premature death, hospitalizations, and school absences to symptoms that limit normal daily activity. $PM_{2.5}$ exposure is tied to a range of effects from premature death and the onset of chronic bronchitis to heart attacks, work loss days (WLDs), and respiratory symptoms.

Between 2005 and 2007, ambient ozone levels in the SoCAB exceeded the health-based 8-hr National Ambient Air Quality Standard (NAAQS) for ozone on 115 to 120 days per year. In the SJVAB, exceedances of this standard occurred on 112 to 139 days. Ozone levels are typically elevated in the warm season, which suggests that air is unhealthful on most summer days.

While both regions have achieved reductions in PM_{10}, which includes fine and coarse particles, concentrations of the more dangerous fine particles—$PM_{2.5}$—remain unhealthful. In the SJVAB, the population was exposed to levels that exceeded the 24-hr NAAQS on from 38 to 76 days, and in the SoCAB on from 45 to 48 days per year. To meet the maximum 24-hr standard, accounting for background concentrations, levels must fall by more than 50% in both air basins. These health-based standards will be very difficult to achieve in either region.

1.2 OBJECTIVES OF THIS STUDY

The primary objective of this study is to assess the health and related economic benefits that will result from attainment of the ozone and $PM_{2.5}$ standards, to the extent that they can be quantified with present knowledge.

1.3 OVERVIEW OF THE RESEARCH APPROACH

A well-established three-stage approach is used to determine the benefits of attaining the ozone and $PM_{2.5}$ air quality standards by identifying and quantifying the links between air quality and exposure, exposure and ill health, and avoiding ill health and the resulting economic gain.

Establishing the links between polluted air and exposure is accomplished using the Regional Human Exposure Model (REHEX), which was initially developed in 1989 to estimate a population's exposure to concentrations above the air quality standards. This model accounts for the spatial and temporal pollution patterns across a region, which is important because pollution patterns vary significantly across a large area. Here, exposure for the population is estimated by 5- x 5-km grids relative to pollution levels averaged from 2005 to 2007. Averaging reduces the influence of weather anomalies that do not accurately represent longer term trends in air quality. REHEX generates estimates of exposure by county, by age, and by ethnic group as defined by the U.S. Bureau of the Census.

These exposure estimates are then coupled with concentration-response functions from the health science literature to calculate the expected number of adverse health effects and premature deaths avoided if the population instantaneously experienced attainment of the NAAQS.

Finally, economic values are applied to the avoided health effects and extended lives to estimate in dollar terms the social value of more healthful air. Specific values are derived from the economics literature and have all undergone peer review, both as part of that literature and as part of scientific and technical assessments of which values are most appropriate for valuing health and life in relation to air pollution exposure.

II. POPULATION EXPOSURE TO OZONE AND PARTICULATE MATTER

II.1 THE EXPOSURE ASSESSMENT APPROACH

Accurate estimates of human exposure to inhaled air pollutants are necessary for appraisal of the health risks that these pollutants pose and for the design and implementation of strategies to control and limit those risks. Most exposure estimates are based on measured concentrations of outdoor (ambient) air concentrations obtained at fixed-site air monitoring stations. Ambient concentrations are used as surrogates for personal exposure. Personal exposure to air pollutants depends not only on ambient concentrations in locations or microenvironments (e.g., home, work, schools, vehicles) where individuals spend time, but also on the amount of time individuals spend in the microenvironments and on the concentrations in the microenvironments. Microenvironment concentrations are affected not only by infiltration of outdoor air, but also by indoor sources and indoor pollutant deposition. Outdoor concentrations vary spatially and temporally and are affected by proximity to local outdoor sources, which may result in concentrations that deviate significantly from ambient concentrations at the nearest air monitoring stations.

Despite the recognized discrepancies between personal exposure and exposures based on ambient concentrations obtained from fixed-site air monitoring stations, compliance with the NAAQS depends exclusively on outdoor measurements of pollutants. The NAAQS are intended to protect public health with an adequate margin of safety. Most epidemiologic studies of air pollution health effects use ambient concentrations as surrogates for actual population exposures. In fact, virtually all concentration-response relationships from large population studies use ambient concentrations as the exposure input parameter. The exposure assessment approach for this study is constrained to rely on ambient concentrations not only because the ambient air quality database is the only database with sufficient spatial and temporal coverage to address the population, but also because this study requires quantification of the benefits of attainment of the ambient-based NAAQS and must rely on the ambient-based concentration-response relationships from the health science literature to quantify those benefits. The approach is also guided by the concern for spatial resolution of both the population and ambient concentrations.

The population exposure assessment approach used for this study involves representing the population and ambient concentrations on spatial grids covering California's SoCAB and SJVAB. Each grid square is 5 km x 5 km in size. Five-kilometer resolution is sufficient to capture the urban- and regional-scale spatial gradients in between air quality monitoring stations, which are located from 10 km to 50 km apart in these areas. This resolution is insufficient to capture intra-urban spatial variations associated with close proximity to major roadways or stationary emission sources. Spatially and temporally resolved air quality and population data are used in the REHEX model (Lurmann et al. 1989; Lurmann et al. 1994; Fruin et al. 2001) to quantify the frequency of population exposure to various levels of ambient ozone and particulate matter concentrations over multi-year periods.

II.2 POPULATION

Detailed population data from the 2000 U.S. Census have been previously gridded for use in exposure assessments. For this analysis, gridded population data were developed for eight age groups: <1 year, 1 year, 2-4 years, 5-17 years, 18-21 years, 22-29 years, 30-64 years, and >64 years, and four racial groups: white non-Hispanic, black non-Hispanic, other non-Hispanic, and Hispanic. The age groups were defined by the concentration-response relationships chosen for use in the benefits evaluation. Racial groups were defined by the U.S. Census. The relative age distribution and racial distribution in each grid were assumed to be time-invariant between 2000 and 2007.

The baseline period selected for exposure assessment was 2005 through 2007 because NAAQS compliance assessment requires three years of data and these were the three most recent calendar years with complete data at the time of this analysis. Population data for 2000 were projected to 2007, the most recent year in this period, to be consistent with the baseline period for air quality data and the economic parameters (2007 dollars). The population growth between 2000 and 2007 for the SoCAB was determined from gridded population data for 2005 and 2010 that were used in the South Coast Air Quality Management District's (SCAQMD) Socioeconomic Report for the 2007 Air Quality Management Plan (SCAQMD 2007a; Sue Liu, personal communication). The population growth between 2000 and 2007 in the SJVAB was based on the county population data for 2005 and 2014 presented in the 2008 $PM_{2.5}$ Air Quality Plan (SJVAPCD 2008). Hence, the population data used in this study are consistent with those used in the most recent agency air quality planning efforts.

The spatial distribution of population is illustrated in Figures II-1 and II-2. They show the modeling grids with significant population in the SoCAB and SJVAB. The highest population density is 229,000 and 74,000 persons per grid in the SoCAB and SJVAB, respectively. The population in exposure grids that cover more than one county is tabulated separately. A total of 981 and 1708 county-specific exposure grids were used for assessing exposure in the SoCAB and SJVAB, respectively. Grid squares with extremely low population density (below 2 persons per km^2 or 50 persons per grid) were not included because they account for a very small portion of the total population and they are usually located far from air quality monitors.

The age and racial distribution of the population in each county and air basin are summarized in Tables II-1 through II-4. The estimated 2007 population in the portions of Los Angeles, Orange, Riverside, and San Bernardino Counties that lie within the SoCAB are 10.2, 3.1, 2.0, and 2.0 million, respectively, and totals 17.3 million. The overall age distribution in the SoCAB is 28.6% children (age 17 years or less) and 71.4% adults. The SoCAB population is 40.9% Hispanic, 37.4% white non-Hispanic, 7.5% black non-Hispanic, and 14.1% other non-Hispanic.

The SJVAB covers a substantially larger area than the SoCAB, but its population is only 3.51 million or about one-fifth the population of the SoCAB. The estimated 2007 population in portions of San Joaquin, Stanislaus, Merced, Madera, Fresno, Kings, Tulare, and Kern Counties that lie within the air basin are 639,000, 499,000, 231,000, 137,000, 873,000, 140,000, 395,000, and 598,000, respectively. The SJVAB population is 31.8% children, age 17 years or less, and 68.2% adults. The SJVAB population is 41.6% Hispanic, 46.2% white non-Hispanic, 4.8% black non-Hispanic, and 7.5% other non-Hispanic. The SJVAB population is slightly younger and has proportionately more whites than the SoCAB population.

Estimates of the population of children attending school were also needed to determine the benefits of reduced school absences associated with air quality improvements. Detailed school enrollment data and schedules have been reviewed in previous studies. On average, the data for Southern California indicate that 91% of children ages 5-17 years attend school in the non-summer period (mid-August through May) and 21% in the summer (June through mid-August) (Hall et al. 2003). In the San Joaquin Valley, more schools operate only on a traditional school schedule. On average, 97% and 21% of school-age children in the SJV attend school in the non-summer period and in the summer, respectively (Hall et al. 2007).

II.3 CURRENT AMBIENT AIR QUALITY

The SoCAB and SJVAB air basins are classified as "extreme" nonattainment areas for ozone and "severe" nonattainment areas for $PM_{2.5}$ by the EPA. The most relevant NAAQS for ozone is the 8-hr daily maximum standard of 75 parts per billion (ppb) (or 0.075 parts per million [ppm]). It has essentially replaced the 1-hr daily maximum ozone standard of 0.12 ppm, which is less stringent[1] in these air basins. To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hr average ozone concentrations measured at each monitor within an area over each year must not exceed 0.075 ppm. For PM NAAQS, both the 35 $\mu g/m^3$ 24-hr $PM_{2.5}$ standard and the 15 $\mu g/m^3$ annual $PM_{2.5}$ standard are more stringent than the 150 $\mu g/m^3$ 24-hr PM_{10} standard. The 24-hr $PM_{2.5}$ standard is the toughest PM standard; it is achieved when the 3-year average of the 98th percentile of 24-hr concentrations at each monitor within an area does not exceed 35 $\mu g/m^3$. Because attainment will be achieved when the more stringent standards are reached, this study focuses on the 8-hr ozone standard and the 24-hr and annual average $PM_{2.5}$ standards. The benefits of compliance with the more stringent California standards (a 70 ppb 8-hr daily maximum ozone and a 12 $\mu g/m^3$ annual average $PM_{2.5}$ standard) are not addressed in this study, but have been estimated in other recent studies (ARB, 2008).

In the 2005-2007 period, the 75 ppb 8-hr ozone level was exceeded on 112 to 139 days per year in the SJVAB and on 115 to 120 days per year in the SoCAB. The spatial patterns of the exceedances frequencies are illustrated in Figures II-3 and II-4. The spatial maps for the SoCAB show that about half of the populated regions exceeded the 8-hr ozone standard more than 30 days per year in 2006 and 2007. Similarly, the maps show that about half of the populated regions in the SJVAB exceeded the 8-hr ozone standard more than 25 days per year in 2005 and 2006. Two communities exceeded the standard more than 100 days per year: Crestline in the SoCAB in 2005 and Arvin in the SJVAB in 2006. The measurement data show that both the frequency and the severity of exceedances are high, especially in the SoCAB. The highest 1-hr and 8-hr daily maximum concentrations in the SoCAB during 2005 to 2007 were 182 and 142 ppb, respectively. The ozone design value (the 3-year average of the fourth-highest daily 8-hr maximum) is 122 ppb in this period. The highest 1-hr and 8-hr daily

[1] Here, stringent means more limiting in terms of the difficulty of attainment.

maximum concentrations in the SJVAB during 2005 to 2007 were 141 and 123 ppb, respectively, and the ozone design value is 107 ppb. Attainment of the 8-hr NAAQS is expected when the air quality improvements reduce the ozone design value to 75.49 ppb. Thus, attainment of the ozone standard requires a 38% and 29% decrease in the design value in the SoCAB and SVJAB, respectively. However, because there is a global background concentration of about 40 ppb, the required reduction of ozone in excess of the background level to reach attainment is 57% and 47% in the SoCAB and SVJAB, respectively. The SCAQMD and SJVAPCD have adopted air quality plans designed to reach attainment of the former NAAQS for ozone of 80 ppb by 2023 (SCAQMD 2007b; SJVAPCD 2007). The agencies have not yet formally released plans to address compliance with the newer 75 ppb standard.

The frequency of exceedances of the 35 $\mu g/m^3$ daily $PM_{2.5}$ standard is somewhat lower than that for ozone, ranging from 38 to 76 days per year in the SJVAB and 45 to 48 days per year in the SoCAB. The spatial patterns of daily concentrations exceeding 35 $\mu g/m^3$ are shown in Figures II-5 and II-6. For example, we estimate there were 47 days in the SoCAB and 76 days in the SJVAB in 2007 that had one or more locations with $PM_{2.5}$ above 35 $\mu g/m^3$. The frequencies are estimated rather than measured because $PM_{2.5}$ is often measured (by the Federal Reference Method) every third day rather than every day (which occurs at only a few stations). The highest measured daily concentrations were 132 $\mu g/m^3$ in the SoCAB (in Azusa) and 104 $\mu g/m^3$ in the SJVAB (in Fresno). Because $PM_{2.5}$ is derived from primary particle emissions as well as from gaseous emissions (secondary), the highest values can be quite erratic. For example, while the highest $PM_{2.5}$ was 132 $\mu g/m^3$ at Azusa, the second highest reading in 3 years at that station was 63 $\mu g/m^3$, and the second highest at any SoCAB station was 106 $\mu g/m^3$. Fortunately, the standard has a statistical form that relies on the 3-year average of the 98th percentile values for determination of attainment status. As shown in Table II-5, the design values for the 2005-2007 period are substantially lower than these peak levels: 73.4 $\mu g/m^3$ in the SoCAB (at Riverside-Rubidoux) and 69.8 $\mu g/m^3$ in the SVJAB (at Bakersfield – California St.). These design values have been estimated using EPA's procedures that account for frequency of measurements and substitution of quarterly maximum values for missing data when records are less than 75% complete. Attainment of the daily $PM_{2.5}$ standard will require 52% and 49% reductions in ambient concentrations from 2005-2007 levels in the SoCAB and SJVAB, respectively. If one considers the background concentration of 6 $\mu g/m^3$, the reductions in $PM_{2.5}$ in excess of the background are 56% in the SoCAB and 54% in the SJVAB. The SCAQMD and SJVAPCD have adopted air quality plans designed to reach attainment of the former NAAQS for $PM_{2.5}$ of 65 $\mu g/m^3$ by 2014. The agencies have not yet formally released plans to address compliance with the newer and much more stringent 35 $\mu g/m^3$ standard.

Spatial maps of the estimated annual average $PM_{2.5}$ concentrations in the air basins are shown in Figures II-7 and II-8. Concentrations tend to increase from modest levels in the western areas of Los Angeles and Orange Counties to fairly high levels in the eastern area surrounding the cities of Riverside and San Bernardino. The Riverside-Rubidoux area has consistently recorded the highest annual averages in the SoCAB. Annual $PM_{2.5}$ levels in the SJV are lowest in the northwest, near Stockton, and highest in the southeast, in Bakersfield (Kern County). $PM_{2.5}$ concentrations gradually increase between the northern and southern ends of the San Joaquin Valley. As indicated in Table II-5, the highest 3-year average $PM_{2.5}$

concentration is 19.7 μg/m^3 in Riverside (at the Rubidoux station) and 20.4 μg/m^3 in Bakersfield (at the Planz Road station). Compliance with the annual standard requires 24% and 26% reduction in ambient concentrations in the SoCAB and SJVAB, respectively. Considering the 6 μg/m^3 background concentration, $PM_{2.5}$ concentrations in excess of the background need to be reduced by 34% and 37% in the SoCAB and SJVAB, respectively. The local air pollution management agencies have adopted plans to reach attainment of the annual standard by 2014 (SCAQMD 2007b; SJVAPCD 2008). Because the reductions in concentrations needed to meet the annual standard are significantly less than those needed to meet the new daily standard, additional control emission measures beyond those incorporated in existing air quality management plans will need to be adopted and implemented to achieve the clean air goals.

In summary, air quality conditions in these two air basins are surprisingly similar even though the SJV is much larger, less densely populated, and dominated by agricultural rather than urban land use. The highest annual average $PM_{2.5}$ levels are virtually the same. The frequency of ozone standard exceedances is similar (~100 days per year). The ozone and daily $PM_{2.5}$ exceedances are more severe in the SoCAB than SJVAB; however, the $PM_{2.5}$ exceedances are more frequent in the SJVAB. Significant reductions in emissions are needed in both areas to attain the NAAQS.

II.3.1 Spatial Mapping

Ambient air quality data from California's network of monitoring stations were used to spatially map concentrations to the exposure grids. Measured concentration data were spatially interpolated and extrapolated to provide estimates of concentrations at each population grid. For the 2005-2007 baseline period, hourly ozone data were available for 24 stations within the SoCAB and 19 stations within the SJVAB. Ozone data from additional monitors located just outside the air basin boundaries were used in the spatial mapping. The ozone data were used to create maps of hourly concentrations for each day of the baseline period (1,096 days and 26,304 maps). While $PM_{2.5}$ data are collected using a variety of methods in California, only data collected using the Federal Reference Method (FRM) are used for attainment assessment. Hence, only $PM_{2.5}$ data collected using a FRM were used in the study. Daily $PM_{2.5}$ data were available at 14 stations in the SoCAB and 12 stations in the SJVAB on a variety of frequencies, including every day, every third day, and every sixth day. The spatial mapping of daily $PM_{2.5}$ concentrations was performed using the FRM data on days when at least 8 of the 14 stations in the SoCAB and 6 of the 12 stations in the SJVAB had valid 24-hr data. Daily spatial maps were generated for 356 days (or 119 days per year) in the SoCAB and 318 days (or 106 days per year) in the SJVAB. The annualized frequency of occurrence of daily $PM_{2.5}$ conditions was computed assuming these days were representative of the entire 3-year period. Annual average $PM_{2.5}$ concentrations were calculated from the FRM data using EPA's methodology (i.e., annual average = average of quarterly averages) and mapped for each year.

The spatial mapping method assigns exposure grid concentrations from the nearest station if the station is located within 3 km of the center of the exposure grid. If no stations with valid data are located within 3 km of the center of the exposure grid, the concentration is calculated by inverse-distance squared weighting of the concentrations from the four stations closest to the center of the exposure grid, provided all stations are located within 100 km of the exposure grid center. In areas with sparse network coverage, the algorithm may be applied with one to three stations. This method is very similar to the method used by EPA on its AIRNow web site (www.epa.gov/airnow) for mapping air quality indices and by other recent California health benefit analyses (SCAQMD, 2007a; ARB, 2008). Examples of the maps created with this method are shown in Figures II-7 and II-8. They show the spatially mapped annual average $PM_{2.5}$ concentrations for 2005, 2006, and 2007. The annual $PM_{2.5}$ concentrations are estimated to vary smoothly across the regions. The maps of daily $PM_{2.5}$ and hourly ozone maps often have more spatial variability than these examples because they reflect the day-to-day variations in meteorological conditions that greatly influence the spatial patterns. The ozone maps also reflect the greater spatial coverage of monitoring station data for ozone than for $PM_{2.5}$.

II.4 FUTURE AMBIENT AIR QUALITY

For purposes of this exposure analysis, we are interested in the spatial and temporal distribution of ambient concentrations for a three-year period in which the air quality standard is attained. Attainment of the standard occurs after the design value is reduced to the level of the standard. Two methods are available to estimate future-year air quality conditions. One method involves the application of detailed meteorological, emissions, and air quality models to estimate the distributions of future concentrations under specific emission scenarios. Such models are used to develop emission control strategies to reach attainment in the air quality plans. Typically, the detailed models are applied for relatively short periods (usually less than a few weeks per year) rather than multi-year periods. The resources (time and budget) required to apply this method for a three-year period in these areas are far greater than those available for this study, so this method is not feasible as the primary method for the present study.

The second method involves the application of the simple linear rollback model shown below.

$$C_{xyt}^{Future} = C_{Bkgrd} + \left(C_{xyt}^{Base} - C_{Bkgrd}\right)\left(\frac{C_{Std} - C_{Bkgrd}}{C_{Max} - C_{Bkgrd}}\right) \qquad \text{if } C_{xyt}^{Base} \geq C_{Bkgrd} \qquad (1)$$

$$C_{xyt}^{Future} = C_{xyt}^{Base} \qquad \text{if } C_{xyt}^{Base} < C_{Bkgrd} \qquad (2)$$

where C_{xyt}^{Future} = the future concentration at location *x,y*, and time *t*,

C_{xyt}^{Base} = the baseline period concentration at location *x,y*, and time *t*,

C_{Bkgrd} = the background concentration,

C_{Max} = the baseline or current design value concentration, and

C_{Std} = the air quality standard threshold concentration.

This method assumes that future concentration changes in excess of the background concentration will linearly track changes in the current or baseline maximum concentration (minus the background concentration). It assumes that concentrations in excess of the background concentration with attainment will be linearly reduced in proportion to the ratio of the standard (adjusted for background) to the design value (also adjusted for background).

Concentrations at or below the background level are assumed to be unaffected by changes in emissions. The rollback model is a very simple air quality model that disregards much of the detailed knowledge of the atmospheric chemistry and physics that influence concentrations, yet it is likely the most suitable model when the specific emission control measures needed to reach attainment in a region are not yet identified. The reason is that attainment can be achieved with different sets of control measures that will produce different spatial and temporal patterns of concentrations; without knowledge of the specific path to attainment, it is best to keep the projection method as simple as possible. Nevertheless, the effects of NO_x emission reductions on ozone are nonlinear and the simple linear rollback approach is likely to overestimate ozone reductions in the more heavily populated (or high NO_x) portions of the air basins. The areas with less-than-linear effects of NO_x reductions on ozone are usually areas with high baseline NO_x levels and low or moderate baseline ozone levels.

The parameters used to project the distributions of concentrations with attainment are shown in Table II-5. They project that future ozone levels in excess of the background would be 57% and 47% of current levels in the SoCAB and SJVAB, respectively. Similarly, the future 24-hr and annual $PM_{2.5}$ concentrations in excess of the background are estimated as 56% and 34% of current levels in the SoCAB, and 54% and 37% of current levels in the SJVAB. These factors are applied to the spatially mapped baseline-period concentrations that exceed that background to generate the future-year spatial maps of concentrations for the same time period (three years).

II.5 CURRENT AND FUTURE POPULATION EXPOSURE ESTIMATES

The REHEX model was applied using the population and air quality data described above to estimate the population exposure to ozone and $PM_{2.5}$ in the baseline period and in the future with attainment. The population exposure to air pollution was quantified not only in terms of the exposure metrics relevant to the air quality standards, but also in terms of the exposure metrics used in the concentration-response relationships reported in the health science literature. The exposure metrics for ozone include the 1-hr daily maximum, the 2-week average 1-hr daily maximum, the 5-hr daily maximum, the 8-hr daily maximum, and the 24-hr average concentrations. Certain concentration-response relationships use 8-hr 10 a.m. to 6 p.m. ozone rather than 8-hr daily maximum ozone; the two metrics are almost indistinguishable in these air basins. The exposure metrics for $PM_{2.5}$ include the 24-hr average concentration and the annual average concentrations.

Most of the concentration-response relationships used in this study apply to all days of the year. The school-absence concentration-response relationship applies to exposures on the day preceding the school absence. For this analysis, exposures occurring on Fridays, Saturdays, and holidays were excluded as well as the day preceding each holiday.

II.5.1 Exposure Frequency Distributions

The overall frequency distributions of daily exposure for the population are shown in Figures II-9 through II-20. The total number of person-days of exposure is large for these regions and time period, 6.3 billion per year in the SoCAB (17.3 million x 365 days) and 1.3 billion per year in the SJVAB (3.51 million x 365 days). The figures show the number of person-days of exposures per year to concentrations above various concentration thresholds. The distributions are presented on a logarithmic scale because there is commonly a five order of magnitude difference between the number of person-days of exposure to the highest observed levels compared to the number of person-days of exposure to background concentrations. For example, Figure II-9 shows that the estimated number of person-days per year of exposure in the SoCAB to 8-hr daily maximum ozone above 40, 60, 80, 100, 120, and 140 ppb is 3.2 billion, 901 million, 202 million, 34 million, 3.1 million, and 38,000, respectively, in the baseline case. Figure II-9 also indicates that under the NAAQS attainment scenario, the estimated number of person-days per year of exposure to 8-hr daily maximum ozone above 40, 60, 80, and 100 ppb is 3 billion, 116 million, 200,000, and zero, respectively. Figure II-19 and Figure II-20 show the estimated number of persons exposed to annual average $PM_{2.5}$ concentrations above various concentration thresholds in the air basins. Figure II-20, for example, indicates the estimated number of SJVAB residents exposed to annual average $PM_{2.5}$ concentrations above 14, 16, 18, 20 ,and 22 $\mu g/m^3$ is 2.7 million, 2.1 million, 1.1 million, 0.26 million, and 21,000, respectively, in the 2005-2007 period, and 0.66 million, 21,000, 0, 0, and 0, respectively, with attainment. All the distributions show large differences in the frequency of exposure between the baseline and NAAQS attainment scenario.

II.5.2 Spatial Distributions of Exposure

The estimated spatial distributions of exposure to ozone concentrations above 75 ppb are shown in Figures II-21 and II-22. In 2005-2007, the western portions of Riverside and San Bernardino Counties, as well as the San Fernando Valley and Santa Clarita, are estimated to have a large number of ozone exposures (e.g., > 1 million person-days per year per grid) above 75 ppb. Fewer exposures to levels above the standard occurred in the coastal areas and central Los Angeles County. In the SJVAB in 2005-2007, the highest number of person-days of exposure occured in and around the populated urban areas of Bakersfield, Fresno, Visalia, Merced, and Modesto. Exposures above 75 ppb ozone are fewer in Stockton than in the other urban areas. The baseline spatial exposure maps clearly show that areas with high numbers of adverse ozone exposures extend broadly across the air basins. The spatial exposure maps with ozone NAAQS attainment show a dramatic shrinkage of the areas affected and the number of high exposures per year.

Figures II-23 and II-24 show the spatial distribution of estimated population exposure to 24-hr average $PM_{2.5}$ concentrations above 35 $\mu g/m^3$. In the San Joaquin Valley, the spatial distribution of exposures to high $PM_{2.5}$ concentrations is similar to those for ozone: the greatest number of exposures occurs in the urban areas. In the SoCAB, the largest number of person-days of exposure to $PM_{2.5}$ above 35 $\mu g/m^3$ occurs in central Los Angeles County in the baseline period. Areas in the western portions of Riverside and San Bernardino Counties also have a large number of exposures to high concentrations, even though they are not as densely populated as central Los Angeles County. With attainment, a small number of exposures above the level of the standard is estimated in Fresno, Bakersfield, and western portions of Riverside and San Bernardino Counties. The latter is expected because of the statistical form of the daily standard (i.e., it controls to the 98^{th} percentile of the concentration distribution).

The spatial distributions of population exposures to annual average $PM_{2.5}$ concentrations above 15 µg/m^3 are shown in Figures II-25 and II-26. The number of residents estimated to be exposed to annual average $PM_{2.5}$ concentrations above 15 µg/m^3 is greater in densely populated central Los Angeles County than elsewhere in the SoCAB. Likewise, in the SJVAB, more residents of the central and southern population centers, Fresno, Visalia, and Bakersfield, are exposed to high annual average $PM_{2.5}$ than residents living in the northern urban areas and the rural areas. With attainment of the NAAQS, the area with residents exposed to concentrations above 15 µg/m^3 shrinks substantially from that in the baseline period. Only residents living in Bakersfield and near Riverside are estimated to receive annual $PM_{2.5}$ exposures above 15 µg/m^3 during some years with attainment.

II.5.3 Exposure Frequency by County, Age Group, and Racial/Ethnic Group

8-hr Daily Maximum Ozone Exposures

The estimated number of exposures to 8-hr daily maximum ozone concentrations above 75, 80, and 100 ppb is listed in Table II-6 for the individual counties and for the whole air basins. The REHEX model estimates 306 million and 108 million person-days of exposures per year to 8-hr concentrations above 75 ppb in the SoCAB and SJVAB, respectively, in the baseline period. The estimated number of person-days above 100 ppb is 34 million in the SoCAB (9 times lower than those above 75 ppb) and 2.4 million in the SJVAB (45 times lower than those above 75 ppb). Table II-7. shows a population-weighted average number of days residents are exposed to ozone concentrations above the same thresholds. Residents of the SJVAB are estimated to have 31 days per year with exposures above 75 ppb compared to 18 days per year for residents of the SoCAB. At the 100 ppb threshold, residents of the SJVAB have 0.7 days per year compared to 2 days per year for residents of the SoCAB.

The results for the individual counties reflect the population and air quality differences across the air basins. For example, the total number of exposures above 75 ppb is about 100 million in Los Angeles, Riverside, and San Bernardino Counties and 9 million in Orange County. The average resident of Orange, Los Angeles, San Bernardino, and Riverside Counties experiences 3, 10, 47, and 48 days per year with 8-hr daily maximum ozone concentrations above 75 ppb in the baseline period. The inland counties have lower populations than Los Angeles County, but a much higher frequency of high ozone concentration days. Residents of Riverside and San Bernardino Counties are estimated to have 4.7 and 7.2 days, respectively, above 100 ppb ozone on average, which is substantially higher than in other counties. In the SJVAB, the largest numbers of person-days of exposure to ozone above 75 ppb are estimated for Fresno, Kern, and Tulare Counties. The average number of days above 75 ppb is 51, 46, and 40 days per year in Kern, Tulare, and Fresno Counties, respectively, compared to 8, 14, 18, 30, and 30 days per year in San Joaquin, Stanislaus, Merced, Madera, and Kings Counties. The combination of high population and more frequent adverse air quality conditions results in high numbers of person-days of exposure in Kern, Tulare, and Fresno Counties. The results for the 100 ppb ozone level indicate residents of Fresno and Kern Counties have, on average, 1 and 2 days per year with more severe 8-hr exposures. Residents of the other SJV counties have less than 1 day per year on average with 8-hr ozone exposures above 100 ppb. With NAAQS attainment, we estimate the residents of San Bernardino and Kern Counties will have 0.9 and

0.6 days per year, respectively, with 8-hr ozone above 75 ppb on average. These results are consistent with the statistical form of the NAAQS, which allows for one day on average per year above the level of the standard at the highest station.

Tables II-8 and II-9 show the age distribution of the 8-hr ozone exposures. The largest age group, adults ages 30 to 64 years, reflects the greatest number of person-days of exposure. Because the age distributions are fairly similar across the region, the estimated number of ozone exposure days above 75 ppb is similar for the different age groups. Even without consideration of human time activity, the model results indicate children and young adults in the SJVAB are exposed slightly more frequently than adults over age 30. For example, infants under age 1 are exposed to 8-hr ozone above 75 ppb on 31.6 days per year compared to 30 days per year for adults over age 64. In the SoCAB, children ages 1 to 4 years and elderly adults have a slightly higher frequency of exposures to high ozone than 18- to 64-year-old adults.

Tables II-10 and II-11 show the number of person-days and average days of exposure to the 8-hr ozone concentration thresholds by racial/ethnic group. The results show that Hispanics in the SJVAB and non-Hispanic whites in the SoCAB are exposed more frequently than other racial groups to 8-hr ozone levels above 75 ppb in the 2005-2007 period. For example, the estimated number of days with ozone above 75 ppb is 14, 16, 17, and 21 days per year for other races, blacks, Hispanics, and whites, respectively, in the SoCAB and 27, 29, 32, and 30 days per year for other races, blacks, Hispanics and whites, respectively, in the SJVAB. Spatial differences in the population racial/ethnic makeup in different counties and grids are responsible for the differences in exposure frequencies. The differences in ozone exposure vary more by race/ethnicity than by age group. However, as Table II-7 shows, the largest variations in ozone exposures are by region (or county) rather than by race/ethnicity or age.

<u>24-hr Average $PM_{2.5}$ Exposures</u>

The estimated number of exposures of the population to 24-hr average $PM_{2.5}$ concentrations above 35, 50, and 65 $\mu g/m^3$ are shown in Tables II-12 and II-13. The results for the baseline period indicate 289 million and 153 million person-days of exposure to concentrations above 35 $\mu g/m^3$ occur annually in the SoCAB and SJVAB, respectively. The estimated number of person-days per year of exposure to daily $PM_{2.5}$ above 65 $\mu g/m^3$ is 9 million in the SoCAB and 16 million in the SJVAB. The majority of exposures above 35 $\mu g/m^3$ in the SoCAB occur in Los Angeles County. In the SJVAB, the majority of exposures above 35 $\mu g/m^3$ occur in Fresno and Kern Counties. Residents of the overall SoCAB, Los Angeles, Orange, Riverside, and San Bernardino Counties are estimated to experience 17, 17, 10, 20, and 23 days per year of exposure to concentrations above 35 $\mu g/m^3$ on average. Residents of the SJVAB are estimated to experience 44 days per year of exposure to concentrations above 35 $\mu g/m^3$ on average. Residents of Fresno, Kings, Tulare, and Kern Counties are estimated to experience 50 days per year with $PM_{2.5}$ above this threshold. On average, SJVAB residents are estimated to experience 2½ times as many days above the daily $PM_{2.5}$ NAAQS as SoCAB residents in the 2005-2007 period. The estimated average number of days of exposure above the 65 $\mu g/m^3$ level is 0.6 days in the overall SoCAB, 2.5 days in San Bernardino County, 4.6 days in the overall SJVAB, and 10.7 days in Kern County. These population-weighted averages strongly suggest SJVAB residents have more frequent exposures to high daily $PM_{2.5}$ than SoCAB residents, which is similar to the results for ozone exposures.

With attainment of the 24-hr NAAQS, population exposure to 24-hr average $PM_{2.5}$ concentrations above 35 $\mu g/m^3$ is estimated to be 3.5 million and 11.4 million person-days per year in the SoCAB and SJVAB, respectively. Residents on average would experience 0.2 days per year in the SoCAB and 3.2 days per year in the SJVAB with $PM_{2.5}$ concentrations above 35 $\mu g/m^3$. Residents of Los Angeles and Orange Counties would experience zero days per year and residents of Riverside and San Bernardino Counties would experience less than one day per year with $PM_{2.5}$ concentrations above 35 $\mu g/m^3$. Similarly, residents of the four northern-most counties in the SJVAB would experience less than 2 days per year with attainment whereas residents of the four southern-most counties would experience 3.2 to 7.5 days per year with attainment. The $PM_{2.5}$ air monitoring site that controls the $PM_{2.5}$ design value for the SJVAB is located in Kern County (Bakersfield) and residents of Kern County, on average, would experience 7.5 days per year with $PM_{2.5}$ concentrations above 35 $\mu g/m^3$ with attainment. This frequency closely matches the 98th percentile requirement of the NAAQS, 7.3 days.

Tables II-14 through II-17 show the results for estimated daily $PM_{2.5}$ exposures by age group and racial/ethnic group. The average number of days per year above 35 $\mu g/m^3$ ranges from 15.9 for elderly adults to 17.1 for children ages 1 to 4 years in the SoCAB, and ranges from 43.1 days for elderly adults to about 44 days for ages 1 to 29 years in the SJVAB. Thus, on average within an air basin, the variation in frequency of exposures to adverse $PM_{2.5}$ levels by age group is small. The exposure estimates for racial and ethnic groups suggest that blacks and Hispanics have slightly more frequent exposure to elevated $PM_{2.5}$ concentrations than whites and other races in both air basins. "Other race" residents are estimated to experience 16% fewer days per year (or 2.9 days) than black residents of the SoCAB and 9% fewer days per year (or 3.7 days) than Hispanic residents of the SJVAB with exposure to $PM_{2.5}$ concentrations above 35 $\mu g/m^3$. The $PM_{2.5}$ exposure differences among racial/ethnic groups are generally smaller than regional (county) differences, and larger than age differences.

Annual Average $PM_{2.5}$ Exposures

The estimated annual average exposure of residents to $PM_{2.5}$ in 2005-2007 and with attainment is summarized in Tables II-18 through II-23. The exposure calculations indicate 91%, 64%, and 15% of the SoCAB population and 100%, 66%, and 30% of the SJVAB population are exposed to annual average $PM_{2.5}$ concentrations above 12, 15, and 18 $\mu g/m^3$, respectively, in the baseline period. Results indicate that 75%, 15%, 69%, and 78% of residents in Los Angeles, Orange, Riverside, and San Bernardino Counties are exposed to annual average $PM_{2.5}$ above the 15 $\mu g/m^3$ standard in 2005-2007. In the SJVAB, we estimate 0%, 17%, and 35% of the residents of San Joaquin, Stanislaus, and Merced Counties, respectively, and 100% of residents of the other counties are exposed to annual average $PM_{2.5}$ above 15 $\mu g/m^3$ in 2005-2007. Age breakdown shows that the percent of population exposed to annual average $PM_{2.5}$ concentrations above 15 $\mu g/m^3$ in the baseline period ranges from 61% for elderly adults to 66% for 18- to 21-year-old adults in the SoCAB, and from 63% for elderly adults to 68% for infants and adults ages 22 to 29 years in the SJVAB. The race/ethnicity breakdown indicates approximately 55%, 60%, 70%, and 78% of white, other race, Hispanic, and black residents, respectively, of the SoCAB are estimated to be exposed to annual $PM_{2.5}$ concentrations above the 15 μg/m^3 NAAQS threshold. In the SJVAB, approximately 61%, 56%, 72%, and 66% of white, other race, Hispanic, and black residents, respectively, are estimated to be exposed to annual $PM_{2.5}$ concentrations above the NAAQS threshold. The race/ethnicity exposure distributions for both daily and annual $PM_{2.5}$ indicate blacks in the SoCAB and Hispanics in the SJVAB receive disproportionately more exposures than other racial or ethnic groups.

With attainment of the annual NAAQS, the model estimates that only 1% of the SoCAB population and 6% of the SJVAB population would be exposed to annual average $PM_{2.5}$ concentrations above 15 μg/m^3. The reason a portion of the population may experience exposure to concentrations above the level of the NAAQS even with attainment is that quantification of individual yearly exposures and the NAAQS is based on three-year average exposure. No exposures to annual $PM_{2.5}$ concentrations above 15 μg/m^3 are estimated to occur in the western half of the SoCAB or in the central and northern portion of the SJVAB (i.e., north of Tulare County) with attainment. However, approximately 1%, 3%, 3%, and 30% of residents in San Bernardino, Riverside, Tulare, and Kern Counties, respectively, are estimated to be exposed to annual $PM_{2.5}$ concentrations above 15 μg/m^3 under the NAAQS attainment scenario. It is important to recognize that the 4-5 μg/m^3 reductions in annual $PM_{2.5}$ to achieve NAAQS attainment represent a dramatic improvement in air quality relative to background levels, and a dramatic reduction in population exposure to harmful levels. Furthermore, since the daily $PM_{2.5}$ standard is more stringent than the annual standard, it is quite possible that the emission control plans adopted to attain the daily $PM_{2.5}$ standard may result in greater reduction in annual $PM_{2.5}$ than estimated in this study.

Table II-1. 2007 SoCAB population by county and age group.

County	<1 Yr	1 Yr	2-4 Yrs	5-17 Yrs	18-21 Yrs	22-29 Yrs	30-64 Yrs	>64 Yrs	All Ages
Los Angeles	157,842	172,032	516,098	2,007,264	564,461	1,226,088	4,543,517	1,011,927	10,199,229
Orange	47,352	52,268	156,808	579,795	158,807	346,449	1,452,627	302,945	3,097,051
Riverside	32,296	44,157	132,478	394,548	104,689	164,762	877,488	263,373	2,013,791
San Bernardino	33,766	40,736	122,212	441,317	117,713	198,286	872,944	174,625	2,001,599
Air Basin (persons)	271,256	309,193	927,596	3,422,924	945,670	1,935,585	7,746,576	1,752,870	17,311,670
Air Basin (percent)	1.6%	1.8%	5.4%	19.8%	5.5%	11.2%	44.7%	10.1%	100.0%

Table II -2. 2007 SoCAB population by county and racial/ethnic group.

Region	White Non-Hispanic	Black Non-Hispanic	Hispanic	Other Non-Hispanic
Los Angeles County	3,134,742	941,660	4,579,977	1,542,861
Orange County	1,552,669	48,103	958,199	538,076
Riverside County	971,793	144,079	713,027	184,874
San Bernardino County	818,438	172,647	832,597	177,917
Air Basin (persons)	6,477,642	1,306,489	7,083,800	2,443,728
Air Basin (percent)	37.4%	7.5%	40.9%	14.1%

Table II-3. 2007 SJVAB population by county and age group.

County	<1 Yr	1 Yr	2-4 Yrs	5-17 Yrs	18-21 Yrs	22-29 Yrs	30-64 Yrs	>64 Yrs	All Ages
San Joaquin	9,498	9,706	30,965	145,247	39,147	66,011	269,929	68,788	639,291
Stanislaus	7,372	7,676	24,180	114,748	29,419	52,567	210,335	53,059	499,356
Merced	3,842	3,912	12,576	59,091	14,520	24,625	90,810	21,943	231,319
Madera	1,924	2,054	6,435	29,476	7,659	14,322	59,960	14,904	136,734
Fresno	14,249	14,406	44,735	205,401	58,319	101,530	346,688	87,199	872,527
Kings	2,175	2,194	6,643	28,868	9,089	19,893	60,517	10,405	139,784
Tulare	6,895	6,725	21,339	97,960	25,550	43,509	154,567	38,639	395,184
Kern	10,216	10,281	31,547	143,345	37,542	69,619	243,733	51,544	597,827
Air Basin (persons)	56,171	56,954	178,420	824,136	221,245	392,076	1,436,539	346,481	3,512,022
Air Basin (percent)	1.6%	1.6%	5.1%	23.5%	6.3%	11.2%	40.9%	9.9%	100.0%

Table II-4. 2007 SJVAB population by county and racial/ethnic group.

County	White Non-Hispanic	Black Non-Hispanic	Hispanic	Other Non-Hispanic
San Joaquin	311,729	43,091	203,052	81,515
Stanislaus	297,327	12,319	161,931	27,850
Merced	96,823	8,596	108,380	17,761
Madera	69,259	5,283	56,985	5,309
Fresno	348,392	46,061	398,085	80,375
Kings	60,007	11,212	62,629	6,128
Tulare	168,158	5,615	205,226	16,556
Kern	272,036	35,892	263,007	27,401
Air Basin (persons)	1,623,731	168,069	1,459,295	262,895
Air Basin (percent)	46.2%	4.8%	41.6%	7.5%

Table II-5. Parameters used to estimate ambient ozone and $PM_{2.5}$ concentrations with NAAQS attainment.

Pollutant and Averaging Time	SoCAB Design Value, 2005-2007	SJV Design Value, 2005-2007	Attainment Level	Background Concentration
Ozone 8-hr Daily Maximum	122 ppb	107 ppb	75.49 ppb	40 ppb
$PM_{2.5}$ 24-hr Daily Maximum	73.4 μg/m³	70.0 μg/m³	35.49 μg/m³	6 μg/m³
$PM_{2.5}$ Annual Average	19.7 μg/m³	20.4 μg/m³	15.05 μg/m³	6 μg/m³

Table II-6. The estimated population exposure to 8-hr daily maximum ozone concentrations above 75, 80, and 100 ppb in the 2005-2007 baseline period and with NAAQS attainment by county.

Region	Person-days of Exposure Above Concentration (in millions per year)				
	In the 2005-2007 Baseline Period			With NAAQS attainment	
	>75 ppb	>80 ppb	>100 ppb	>75 ppb	>80 ppb
South Coast Air Basin	306.28	202.27	33.96	2.61	0.20
Los Angeles County	104.97	65.93	9.70	0.48	0.09
Orange County	8.86	4.18	0.34	0	0
Riverside County	97.48	65.42	9.552	0.32	0
San Bernardino County	94.98	66.74	14.37	1.82	0.11
SJV Air Basin	108.20	69.03	2.42	0.68	0.01
San Joaquin County	5.07	2.99	0.03	0	0
Stanislaus County	6.97	4.37	0	0	0
Merced County	4.28	2.17	0	0	0
Madera County	4.05	2.35	0.07	0.02	0
Fresno County	34.69	22.43	0.97	0.32	0
Kings County	4.22	2.40	0.06	0	0
Tulare County	18.24	11.19	0.07	0	0
Kern County	30.67	21.13	1.22	0.34	0.01

Table II-7. The estimated average number of days per year that the population is exposed to 8-hr daily maximum ozone concentrations above 75, 80, and 100 ppb in the 2005-2007 baseline period and with NAAQS attainment by county.

Region	Average Number of Days Per Year Above Concentration				
	In the 2005-2007 Baseline Period			With NAAQS attainment	
	>75 ppb	>80 ppb	>100 ppb	>75 ppb	>80 ppb
South Coast Air Basin	17.7	11.7	2	0.2	0
Los Angeles County	10.3	6.5	1	0	0
Orange County	2.9	1.4	0.1	0	0
Riverside County	48.4	32.5	4.7	0.2	0
San Bernardino County	47.5	33.3	7.2	0.9	0.1
SJV Air Basin	30.8	19.7	0.7	0.2	0
San Joaquin County	7.9	4.7	–	0	0
Stanislaus County	14.0	8.8	–	0	0
Merced County	18.5	9.4	–	0	0
Madera County	29.6	17.2	0.5	0.1	0
Fresno County	39.8	25.7	1.1	0.4	0
Kings County	30.2	17.2	0.4	0	0
Tulare County	46.2	28.3	0.2	0	0
Kern County	51.3	35.3	2.0	0.6	0

Table II-8. The estimated population exposure to 8-hr daily maximum ozone concentrations above 75, 80, and 100 ppb in the 2005-2007 baseline period and with NAAQS attainment by age group.

Air Basin	Age Group	Person-days of Exposure Above Concentration (in millions per year)				
		In the 2005-2007 Baseline Period			With NAAQS attainment	
		>75 ppb	>80 ppb	>100 ppb	>75 ppb	>80 ppb
South Coast	Children < 1 Year	4.88	3.24	0.55	0.04	0.003
	Children 1 Year	5.94	3.96	0.67	0.05	0.004
	Children 2-4 Years	17.833	11.87	2.03	0.16	0.012
	Children 5-17 Years	62.90	41.77	7.13	0.57	0.043
	Adults 18-21 Years	16.81	11.15	1.91	0.15	0.011
	Adults 22-29 Years	29.34	19.31	3.31	0.26	0.018
	Adults 30-64 Years	135.88	89.52	15.05	1.14	0.094
	Adults >64 Years	32.69	21.46	3.30	0.23	0.017
San Joaquin	Children < 1 Year	1.77	1.13	0.04	0.01	0
	Children 1 Year	1.79	1.14	0.04	0.01	0
	Children 2-4 Years	5.57	3.55	0.13	0.04	0.001
	Children 5-17 Years	25.54	16.28	0.59	0.16	0.002
	Adults 18-21 Years	6.89	4.39	0.16	0.04	0.001
	Adults 22-29 Years	12.31	7.86	0.28	0.08	0.001
	Adults 30-64 Years	43.91	28.05	0.96	0.26	0.003
	Adults >64 Years	10.41	6.63	0.22	0.06	0.001

Table II-9. The estimated average number of days per year that the population is exposed to 8-hr daily maximum ozone concentrations above 75, 80, and 100 ppb in the 2005-2007 baseline period and with NAAQS attainment by age group.

Air Basin	Age Group	Average Number of Days Per Year Above Concentration				
		In the 2005-2007 Baseline Period			With NAAQS attainment	
		>75 ppb	>80 ppb	>100 ppb	>75 ppb	>80 ppb
South Coast	Children < 1 Year	18	11.9	2	0.2	0
	Children 1 Year	19.2	12.8	2.2	0.2	0
	Children 2-4 Years	19.2	12.8	2.2	0.2	0
	Children 5-17 Years	18.4	12.2	2.1	0.2	0
	Adults 18-21 Years	17.8	11.8	2	0.2	0
	Adults 22-29 Years	15.2	10	1.7	0.1	0
	Adults 30-64 Years	17.5	11.6	1.9	0.1	0
	Adults >64 Years	18.6	12.2	1.9	0.1	0
San Joaquin	Children < 1 Year	31.6	20.2	0.7	0.2	0
	Children 1 Year	31.4	20.1	0.7	0.2	0
	Children 2-4 Years	31.2	19.9	0.7	0.2	0
	Children 5-17 Years	31.0	19.8	0.7	0.2	0
	Adults 18-21 Years	31.1	19.8	0.7	0.2	0
	Adults 22-29 Years	31.4	20.0	0.7	0.2	0
	Adults 30-64 Years	30.6	19.5	0.7	0.2	0
	Adults >64 Years	30.0	19.1	0.6	0.2	0

Table II-10. The estimated population exposure to 8-hr daily maximum ozone concentrations above 75, 80, and 100 ppb in the 2005-2007 baseline period and with NAAQS attainment by race/ethnicity group.

Air Basin	Age Group	Person-days of Exposure Above Concentration (in millions per year)				
		In the 2005-2007 Baseline Period			With NAAQS attainment	
		>75 ppb	>80 ppb	>100 ppb	>75 ppb	>80 ppb
South Coast	White*	133.56	88.31	14.37	1.13	0.114
	Black*	20.76	14.00	2.52	0.23	0.013
	Hispanic	117.67	77.76	13.43	1.02	0.057
	Other*	34.29	22.19	3.64	0.23	0.016
San Joaquin	White*	48.71	31.25	1.00	0.27	0.002
	Black*	4.96	3.20	0.14	0.04	0
	Hispanic	47.52	30.08	1.13	0.32	0.006
	Other*	7.07	4.55	0.16	0.05	0

* Non-Hispanic

Table II-11. The estimated average number of days per year that the population is exposed to 8-hr daily maximum ozone concentrations above 75, 80, and 100 ppb in the 2005-2007 baseline period and with NAAQS attainment by race/ethnicity group.

Air Basin	Age Group	Average Number of Days Per Year Above Concentration				
		In the 2005-2007 Baseline Period			With NAAQS attainment	
		>75 ppb	>80 ppb	>100 ppb	>75 ppb	>80 ppb
South Coast	White*	20.6	13.6	2.2	0.2	0
	Black*	15.9	10.7	1.9	0.2	0
	Hispanic	16.6	11	1.9	0.1	0
	Other*	14	9.1	1.5	0.1	0
San Joaquin	White*	30	19.2	0.6	0.2	0
	Black*	29.5	19	0.8	0.3	0
	Hispanic	32.6	20.6	0.8	0.2	0
	Other*	26.9	17.3	0.6	0.2	0

* Non-Hispanic

Table II-12. The estimated population exposure to daily $PM_{2.5}$ concentrations above 35, 50, and 65 μg/m^3 in the 2005-2007 baseline period and with NAAQS attainment by county.

Region	Person-days of Exposure Above Concentration (in millions per year)				
	In the 2005-2007 Baseline Period			With NAAQS attainment	
	>35 μg/m^3	>50 μg/m^3	>65 μg/m^3	>35 μg/m^3	>50 μg/m^3
South Coast Air Basin	289.04	67.45	9.00	3.55	0
Los Angeles County	171.44	37.37	1.48	0.31	0
Orange County	32.16	4.90	0.73	0.00	0
Riverside County	39.47	11.72	2.55	1.44	0
San Bernardino County	45.97	13.46	4.71	1.80	0
SJV Air Basin	153.08	57.70	16.15	11.37	0
San Joaquin County	18.34	2.91	0.26	0.07	0
Stanislaus County	19.25	6.90	1.13	0.93	0
Merced County	8.88	2.33	0.53	0.50	0
Madera County	6.23	2.54	0.56	0.28	0
Fresno County	43.33	18.87	4.45	2.76	0
Kings County	6.94	2.82	0.79	0.56	0
Tulare County	19.67	7.88	2.05	1.76	0
Kern County	30.44	13.44	6.38	4.50	0

Table II-13. The estimated average number of days per year that the population is exposed to daily $PM_{2.5}$ concentrations above 35, 50, and 65 $\mu g/m^3$ in the 2005-2007 baseline period and with NAAQS attainment by county.

Region	Average Number of Days Per Year Above Concentration				
	In the 2005-2007 Baseline Period			With NAAQS attainment	
	>35 μg/m³	>50 μg/m³	>65 μg/m³	>35 μg/m³	>50 μg/m³
South Coast Air Basin	17	4.1	0.6	0.2	0
Los Angeles County	16.9	3.8	0.1	0	0
Orange County	10.4	1.7	0.1	0	0
Riverside County	20.3	6.1	1.3	0.7	0
San Bernardino County	23.4	6.8	2.5	0.9	0
SJV Air Basin	43.6	16.4	4.6	3.2	0
San Joaquin County	28.7	4.6	0.4	0.1	0
Stanislaus County	38.6	13.8	2.3	1.9	0
Merced County	38.4	10.1	2.3	2.2	0
Madera County	45.5	18.6	4.1	2	0
Fresno County	49.7	21.6	5.1	3.2	0
Kings County	49.6	20.2	5.6	4	0
Tulare County	49.8	20	5.2	4.5	0
Kern County	50.9	22.5	10.7	7.5	0

Table II-14. The estimated population exposure to daily $PM_{2.5}$ concentrations above 35, 50, and 65 $\mu g/m^3$ in the 2005-2007 baseline period and with NAAQS attainment by age group.

Air Basin	Age Group	Person-days of Exposure Above Concentration (in millions per year)				
		In the 2005-2007 Baseline Period			With NAAQS attainment	
		>35 μg/m³	>50 μg/m³	>65 μg/m³	>35 μg/m³	>50 μg/m³
South Coast	Children < 1 Year	4.60	1.11	0.15	0.06	0
	Children 1 Year	5.30	1.29	0.19	0.08	0
	Children 2-4 Years	15.90	3.86	0.57	0.23	0
	Children 5-17 Years	58.23	13.95	1.95	0.77	0
	Adults 18-21 Years	16.15	3.88	0.52	0.20	0
	Adults 22-29 Years	32.65	7.67	0.91	0.34	0
	Adults 30-64 Years	128.38	29.44	3.91	1.55	0
	Adults >64 Years	27.83	6.26	0.81	0.33	0
San Joaquin	Children < 1 Year	2.48	0.94	0.27	0.19	0
	Children 1 Year	2.51	0.95	0.27	0.19	0
	Children 2-4 Years	7.83	2.97	0.84	0.59	0
	Children 5-17 Years	36.03	13.59	3.83	2.70	0
	Adults 18-21 Years	9.68	3.66	1.03	0.72	0
	Adults 22-29 Years	17.27	6.57	1.86	1.31	0
	Adults 30-64 Years	62.34	23.44	6.54	4.60	0
	Adults >64 Years	14.94	5.57	1.52	1.07	0

Table II-17. The estimated average number of days per year that the population is exposed to daily $PM_{2.5}$ concentrations above 35, 50, and 65 $\mu g/m^3$ in the 2005-2007 baseline period and with NAAQS attainment by race/ethnicity group.

Air Basin	Age Group	Average Number of Days Per Year Above Concentration				
		In the 2005-2007 Baseline Period			With NAAQS attainment	
		>35 $\mu g/m^3$	>50 $\mu g/m^3$	>65 $\mu g/m^3$	>35 $\mu g/m^3$	>50 $\mu g/m^3$
South Coast	White*	15.8	3.3	0.5	0.2	0
	Black*	18.5	4.3	0.6	0.2	0
	Hispanic	17.5	4.4	0.5	0.2	0
	Other*	15.6	3.6	0.4	0.1	0
San Joaquin	White*	42.8	16.1	4.4	3.1	0
	Black*	43.4	16.4	4.9	3.6	0
	Hispanic	44.9	17.2	4.9	3.4	0
	Other*	41.2	14.6	3.7	2.6	0

* Non-Hispanic

Table II-18. The estimated population exposed to annual average $PM_{2.5}$ concentrations above 12, 15, and 18 $\mu g/m^3$ in the 2005-2007 baseline period and with NAAQS attainment by county.

Region	Persons Exposed to Concentrations Above Threshold				
	In the 2005-2007 Baseline Period			With NAAQS attainment	
	>12 $\mu g/m^3$	>15 $\mu g/m^3$	>18 $\mu g/m^3$	>12 $\mu g/m^3$	>15 $\mu g/m^3$
South Coast Air Basin	15,711,063	10,999,438	2,548,726	10,837,698	91,124
Los Angeles County	9,880,253	7,606,792	455,088	7,496,553	–
Orange County	2,625,391	457,175	1,643	408,903	–
Riverside County	1,557,753	1,381,850	909,272	1,381,799	68,104
San Bernardino County	1,647,666	1,553,621	1,182,723	1,550,442	23,020
SJV Air Basin	3,511,874	2,310,467	1,064,496	2,146,628	192,733
San Joaquin County	639,291	0	0	0	0
Stanislaus County	499,356	86,854	0	0	0
Merced County	231,319	81,945	0	10,300	0
Madera County	136,586	136,365	0	131,870	0
Fresno County	872,527	872,508	61,625	871,751	0
Kings County	139,784	139,784	46,368	139,784	0
Tulare County	395,184	395,184	361,848	395,184	12,941
Kern County	597,827	597,827	594,655	597,740	179,792

Table II-19. The estimated percent of population that is exposed to annual average $PM_{2.5}$ concentrations above 12, 15, and 18 $\mu g/m^3$ in the 2005-2007 baseline period and with NAAQS attainment by county.

Region	Percent of Population Exposed to Concentrations Above Threshold				
	In the 2005-2007 Baseline Period			With NAAQS attainment	
	>12 $\mu g/m^3$	>15 $\mu g/m^3$	>18 $\mu g/m^3$	>12 $\mu g/m^3$	>15 $\mu g/m^3$
South Coast Air Basin	91%	64%	15%	63%	1%
Los Angeles County	97%	75%	4%	73%	0%
Orange County	85%	15%	0%	13%	0%
Riverside County	77%	69%	45%	69%	3%
San Bernardino County	82%	78%	59%	77%	1%
SJV Air Basin	100%	66%	30%	61%	6%
San Joaquin County	100%	0%	0%	0%	0%
Stanislaus County	100%	17%	0%	0%	0%
Merced County	100%	35%	0%	4%	0%
Madera County	100%	100%	0%	96%	0%
Fresno County	100%	100%	7%	100%	0%
Kings County	100%	100%	33%	100%	0%
Tulare County	100%	100%	92%	100%	3%
Kern County	100%	100%	99%	100%	30%

Table II-20. The estimated population exposed to annual average $PM_{2.5}$ concentrations above 12, 15, and 18 $\mu g/m^3$ in the 2005-2007 baseline period and with NAAQS attainment by age group.

Air Basin	Age Group	Persons Exposed to Concentrations Above Threshold				
		In the 2005-2007 Baseline Period			With NAAQS attainment	
		>12 $\mu g/m^3$	>15 $\mu g/m^3$	>18 $\mu g/m^3$	>12 $\mu g/m^3$	>15 $\mu g/m^3$
South Coast	Children < 1 Year	246,924	174,868	43,920	172,870	1,550
	Children 1 Year	280,137	200,073	54,680	197,845	2,052
	Children 2-4 Years	840,403	600,219	164,043	593,536	6,156
	Children 5-17 Years	3,113,354	2,216,524	562,616	2,190,628	20,411
	Adults 18-21 Years	867,061	619,824	153,427	613,326	5,319
	Adults 22-29 Years	1,801,743	1,267,463	261,276	1,251,500	7,667
	Adults 30-64 Years	7,019,920	4,856,905	1,107,740	4,776,388	41,710
	Adults >64 Years	1,541,522	1,063,562	201,023	1,041,605	6,258
San Joaquin	Children < 1 Year	56,171	38,139	18,169	35,572	3,279
	Children 1 Year	56,954	38,401	18,081	35,764	3,290
	Children 2-4 Years	178,418	119,438	56,125	111,047	10,127
	Children 5-17 Years	824,117	546,182	255,156	506,573	46,659
	Adults 18-21 Years	221,240	148,448	67,492	138,397	12,053
	Adults 22-29 Years	392,067	266,753	122,937	249,262	22,115
	Adults 30-64 Years	1,436,459	933,647	429,002	866,957	78,713
	Adults >64 Years	346,448	219,459	97,534	203,056	16,498

Table II-21. The estimated percent of population that is exposed to annual average $PM_{2.5}$ concentrations above 12, 15, and 18 $\mu g/m^3$ in the 2005-2007 baseline period and with NAAQS attainment by age group.

Air Basin	Age Group	Percent of Population Exposed to Concentrations Above Threshold				
		In the 2005-2007 Baseline Period			With NAAQS attainment	
		>12 $\mu g/m^3$	>15 $\mu g/m^3$	>18 $\mu g/m^3$	>12 $\mu g/m^3$	>15 $\mu g/m^3$
South Coast	Children < 1 Year	91%	64%	16%	64%	1%
	Children 1 Year	91%	65%	18%	64%	1%
	Children 2-4 Years	91%	65%	18%	64%	1%
	Children 5-17 Years	91%	65%	16%	64%	1%
	Adults 18-21 Years	92%	66%	16%	65%	1%
	Adults 22-29 Years	93%	65%	14%	65%	0%
	Adults 30-64 Years	91%	63%	14%	62%	1%
	Adults >64 Years	88%	61%	11%	59%	0%
San Joaquin	Children < 1 Year	100%	68%	32%	63%	6%
	Children 1 Year	100%	67%	32%	63%	6%
	Children 2-4 Years	100%	67%	31%	62%	6%
	Children 5-17 Years	100%	66%	31%	61%	6%
	Adults 18-21 Years	100%	67%	30%	63%	5%
	Adults 22-29 Years	100%	68%	31%	64%	6%
	Adults 30-64 Years	100%	65%	30%	60%	5%
	Adults >64 Years	100%	63%	28%	59%	5%

Table II-22. The estimated population exposed to annual average $PM_{2.5}$ concentrations above 12, 15, and 18 $\mu g/m^3$ in the 2005-2007 baseline period and with NAAQS attainment by race/ethnicity group.

Air Basin	Age Group	Persons Exposed to Concentrations Above Threshold				
		In the 2005-2007 Baseline Period			With NAAQS attainment	
		>12 $\mu g/m^3$	>15 $\mu g/m^3$	>18 $\mu g/m^3$	>12 $\mu g/m^3$	>15 $\mu g/m^3$
South Coast	White*	5,659,709	3,570,354	911,014	3,483,248	31,560
	Black*	1,218,513	1,022,610	214,995	1,018,202	6,266
	Hispanic	6,587,126	4,944,164	1,183,072	4,903,746	46,799
	Other*	2,245,717	1,462,310	239,651	1,432,502	6,499
San Joaquin	White*	1,623,593	998,309	472,513	918,878	89,917
	Black*	168,069	110,289	47,848	103,972	10,725
	Hispanic	1,459,285	1,055,670	495,287	989,507	83,827
	Other*	262,889	147,866	49,727	135,842	8,427

* Non-Hispanic

Table II-23. The estimated percent of population that is exposed to annual average $PM_{2.5}$ concentrations above 12, 15, and 18 $\mu g/m^3$ in the 2005-2007 baseline period and with NAAQS attainment by race/ethnicity group.

Air Basin	Age Group	Percent of Population Exposed to Concentrations Above Threshold				
		In the 2005-2007 Baseline Period			With NAAQS attainment	
		>12 $\mu g/m^3$	>15 $\mu g/m^3$	>18 $\mu g/m^3$	>12 $\mu g/m^3$	>15 $\mu g/m^3$
South Coast	White*	87%	55%	14%	54%	0%
	Black*	93%	78%	16%	78%	0%
	Hispanic	93%	70%	17%	69%	1%
	Other*	92%	60%	10%	59%	0%
San Joaquin	White*	100%	61%	29%	57%	6%
	Black*	100%	66%	28%	62%	6%
	Hispanic	100%	72%	34%	68%	6%
	Other*	100%	56%	19%	52%	3%

* Non-Hispanic

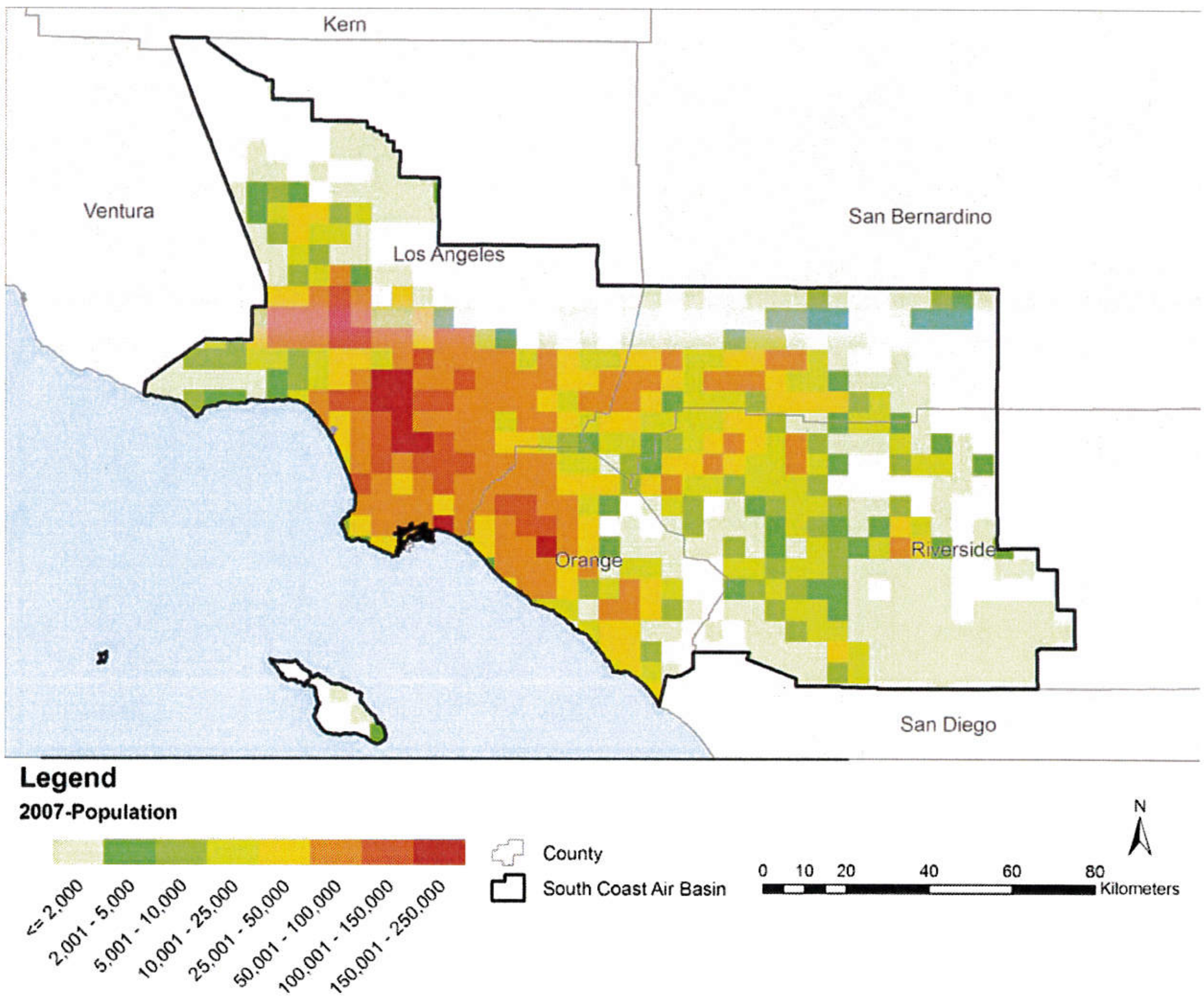

Figure II-1. The 2007 population density in the South Coast Air Basin resolved to the 5- x 5-km exposure grids.

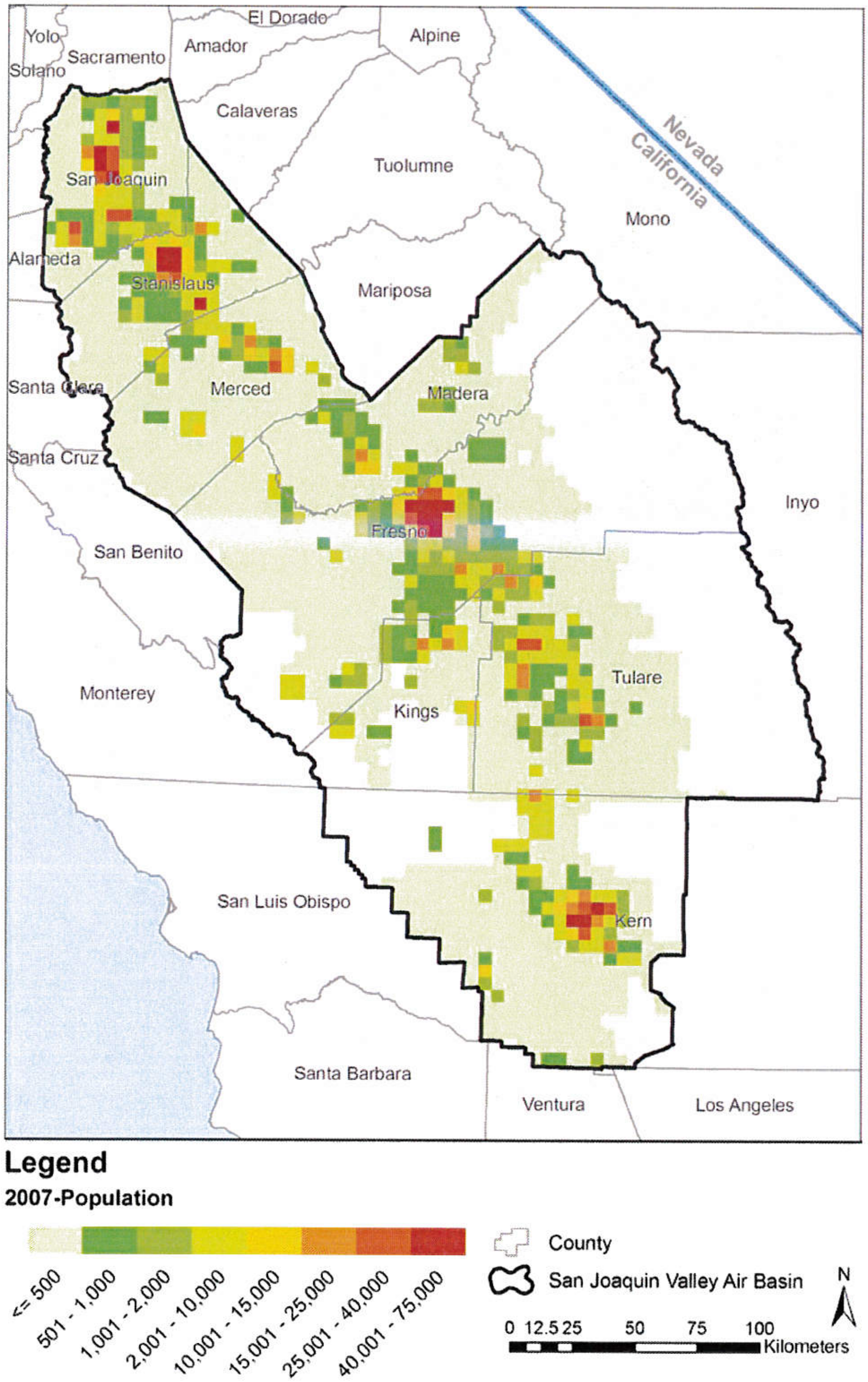

Figure II-2. The 2007 population density in the San Joaquin Valley Air Basin resolved to the 5- x 5-km exposure grids.

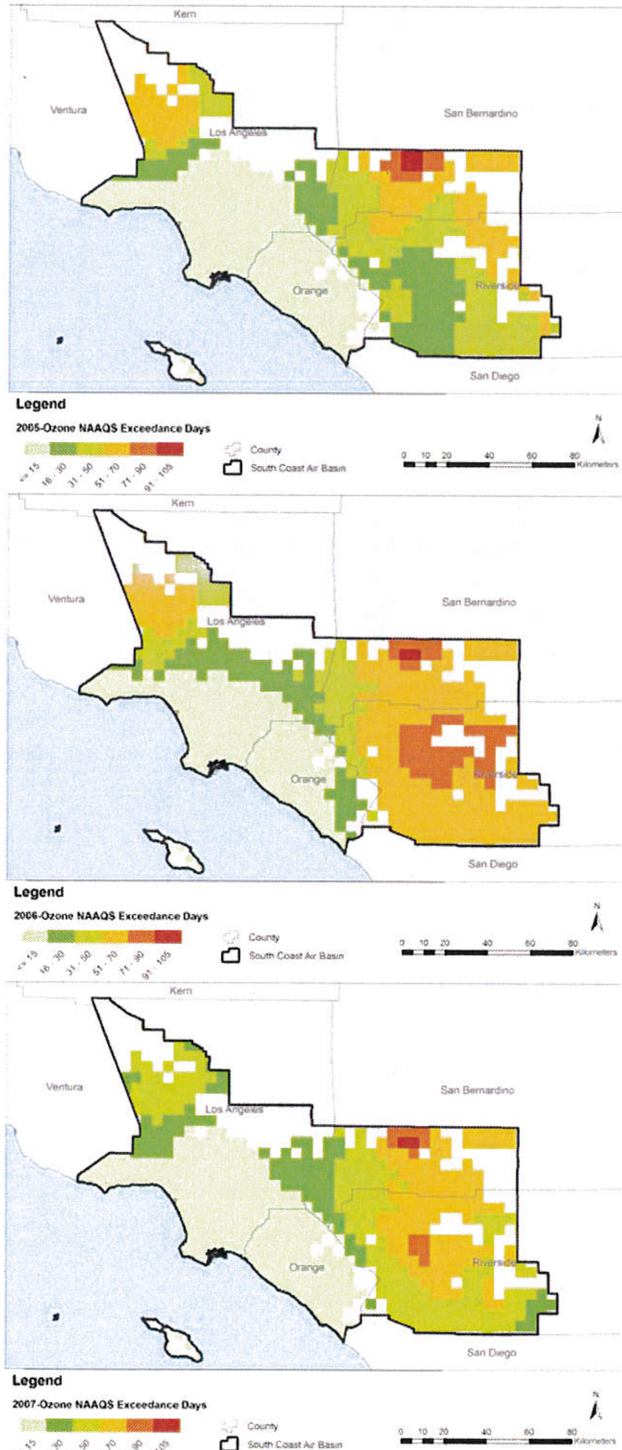

Figure II-3. Spatial maps of the number of days per year that the 8-hr daily maximum ozone concentration exceeded 75 ppb in the South Coast Air Basin in 2005 (top), 2006 (middle), and 2007 (bottom).

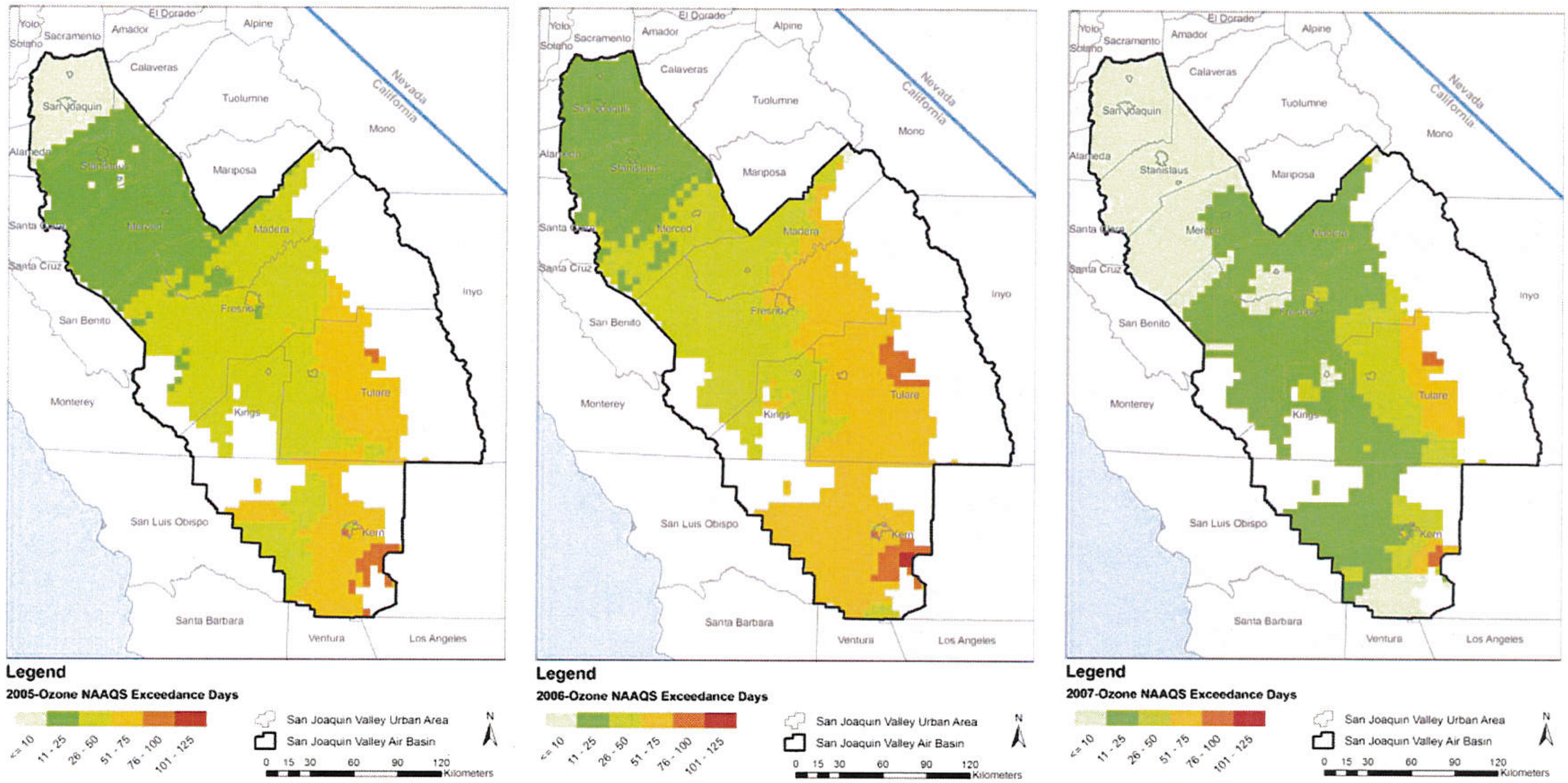

Figure II-4. Spatial maps of the number of days per year that the 8-hr daily maximum ozone exceeded 75 ppb in the San Joaquin Valley Air Basin in 2005 (left), 2006 (middle), and 2007 (right).

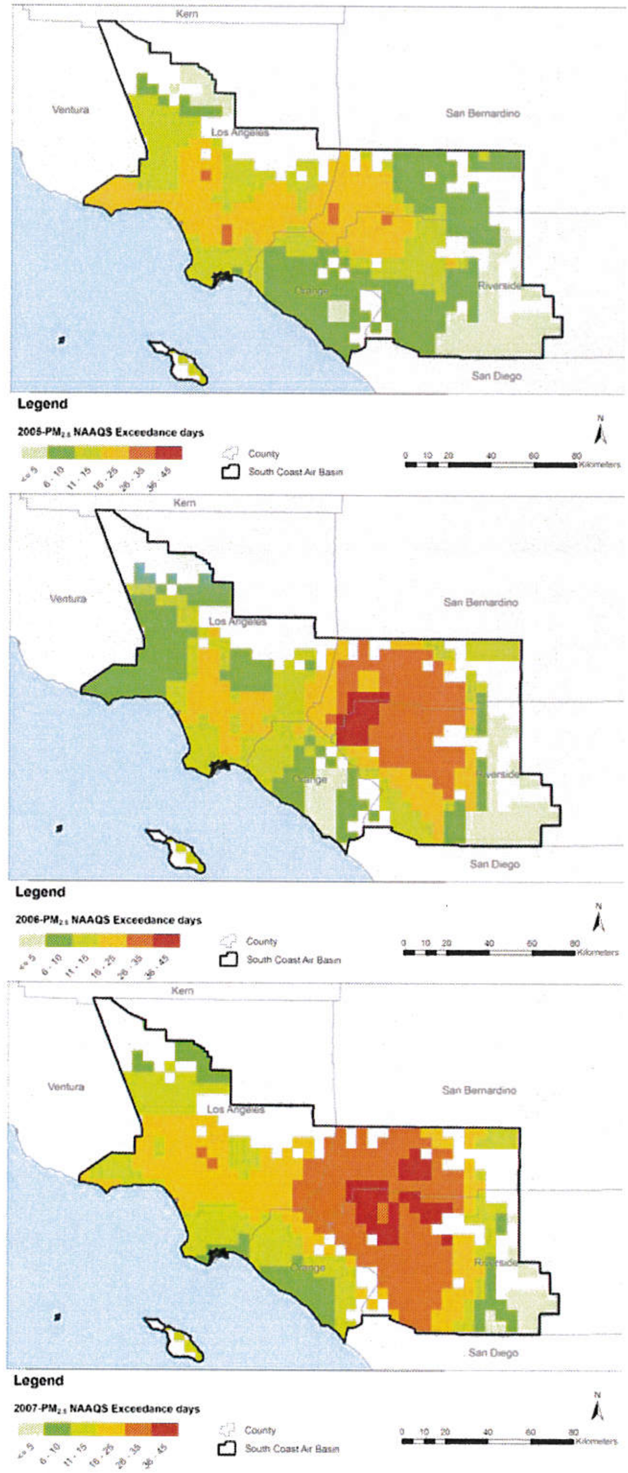

Figure II-5. Spatial maps of the number of days per year that the 24-hr $PM_{2.5}$ concentration exceeded 35 $\mu g/m^3$ in the South Coast Air Basin in 2005 (top), 2006 (middle), and 2007 (bottom).

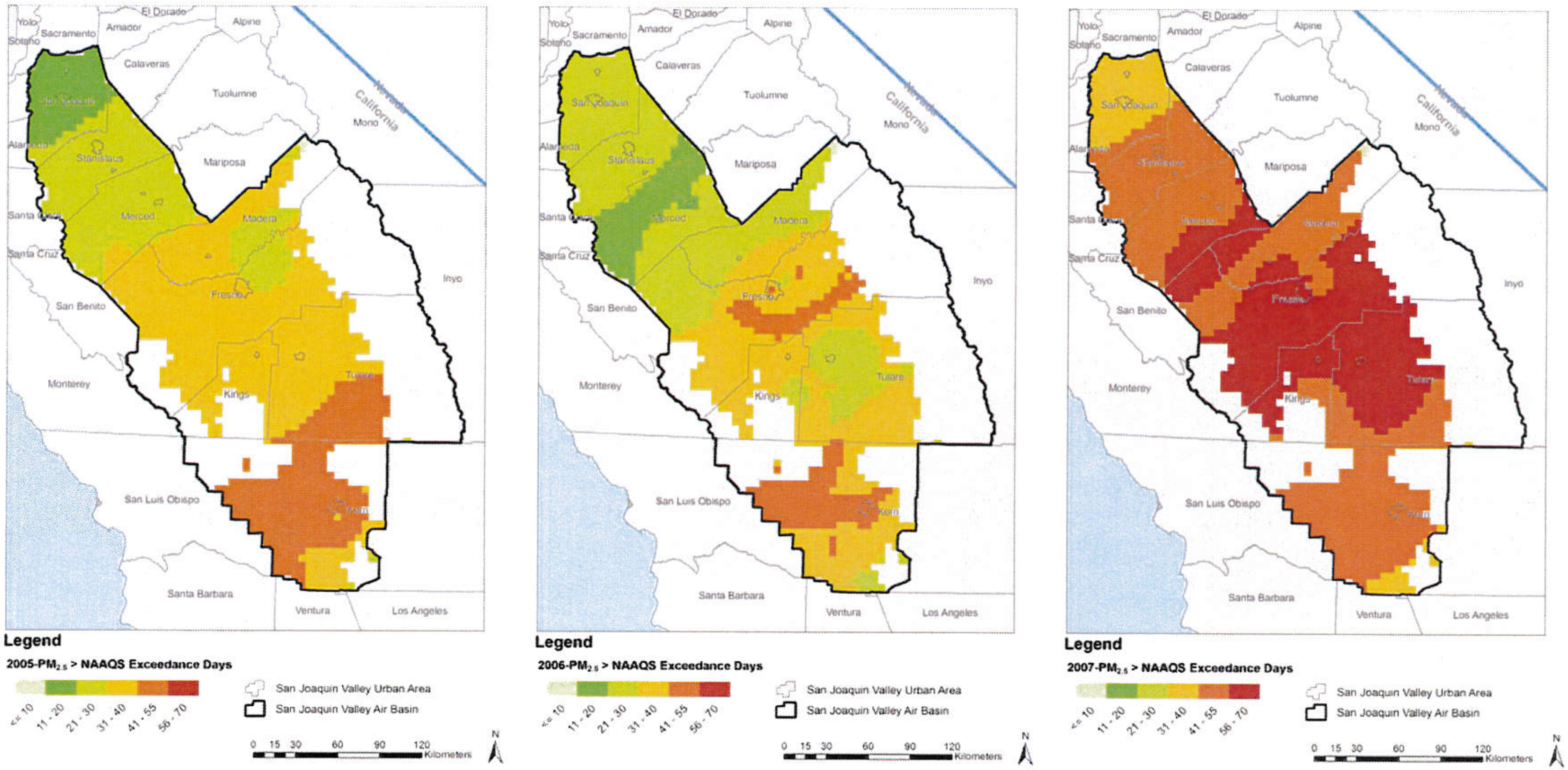

Figure II-6. Spatial maps of the number of days per year that the 24-hr $PM_{2.5}$ concentration exceeded 35 $\mu g/m^3$ in the San Joaquin Valley Air Basin in 2005 (left), 2006 (middle), and 2007 (right).

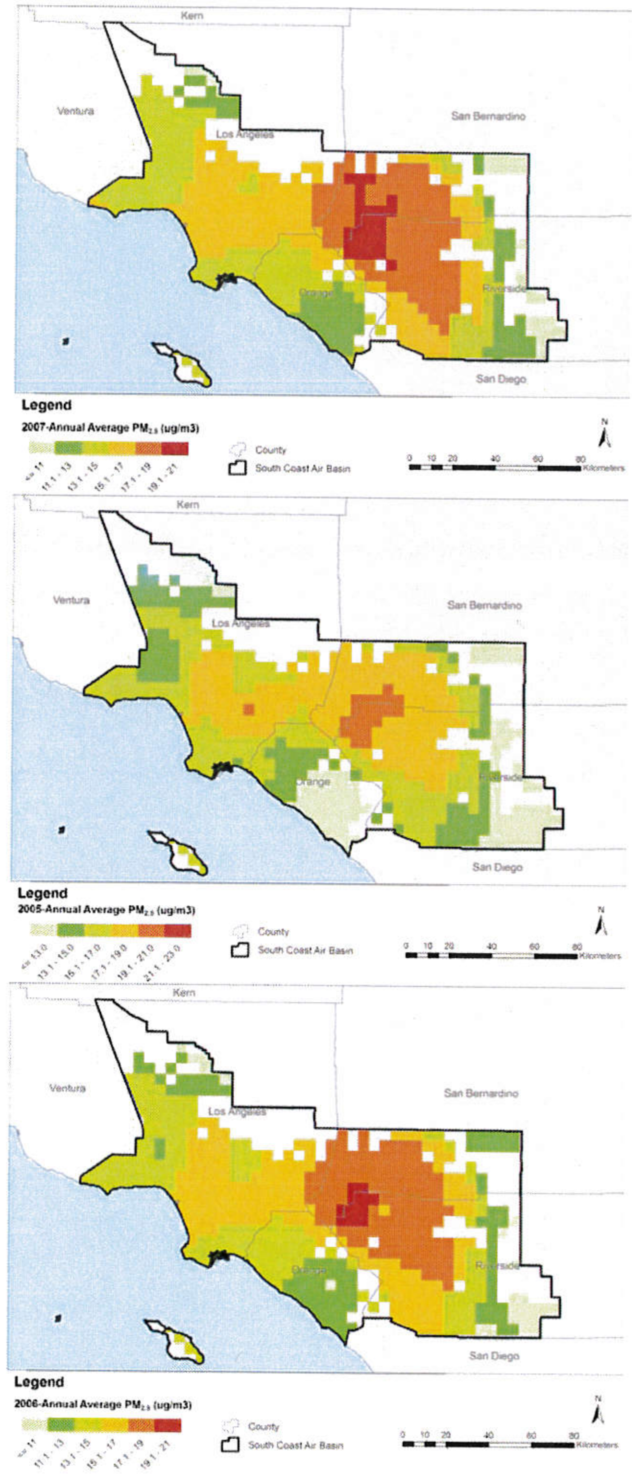

Figure II-7. Spatial maps of the estimated annual average $PM_{2.5}$ concentration in the South Coast Air Basin in 2005 (top), 2006 (middle), and 2007 (bottom).

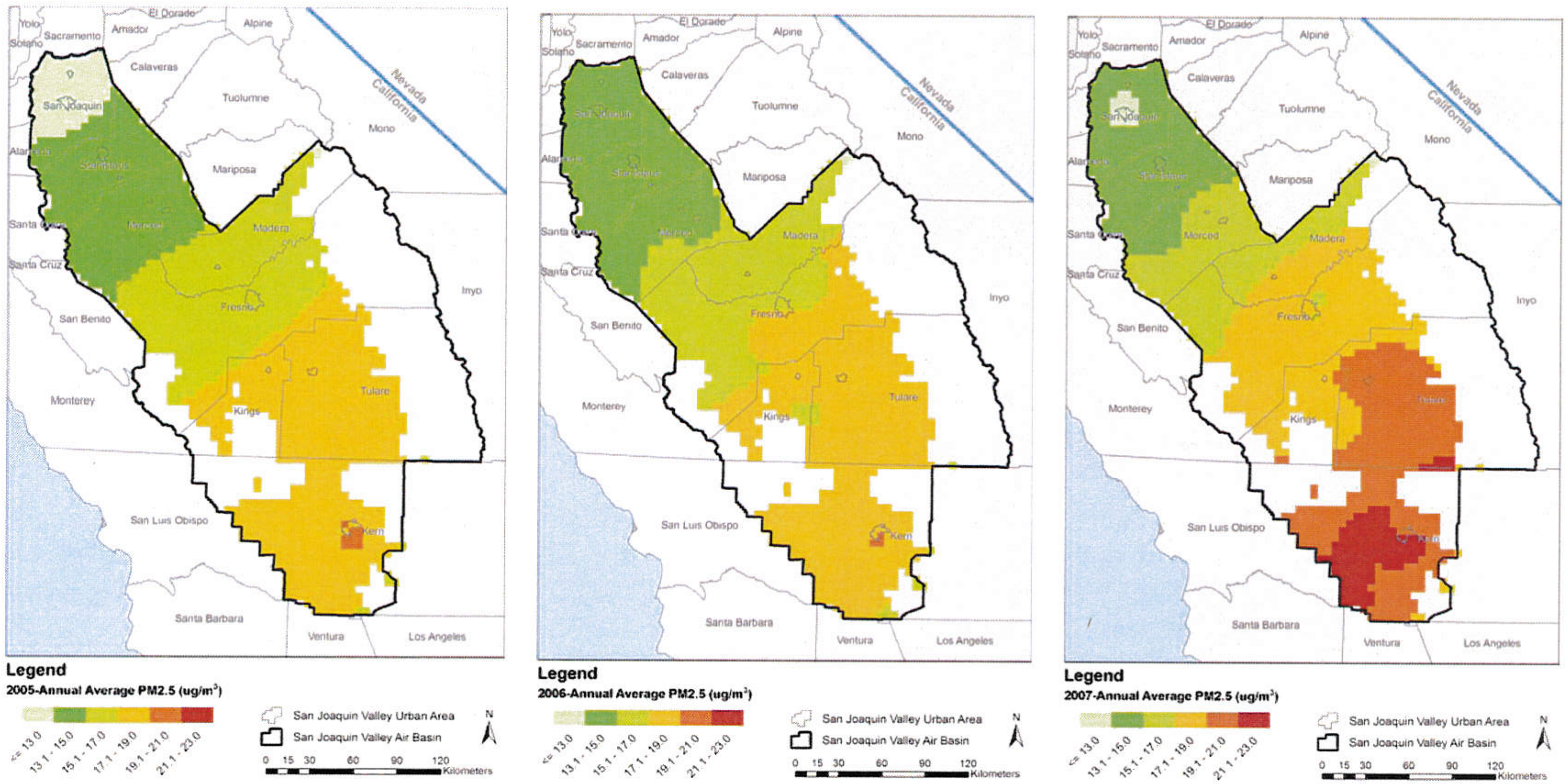

Figure II-8. Spatial maps of the estimated annual average $PM_{2.5}$ concentration in the San Joaquin Valley Air Basin in 2005 (left), 2006 (middle), and 2007 (right).

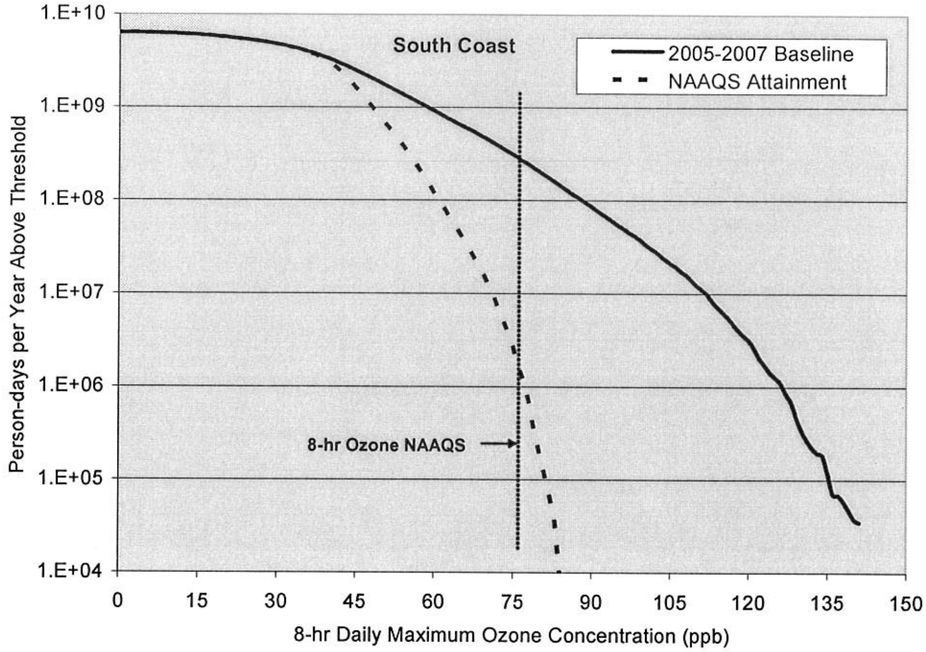

Figure II-9. The distribution of estimated exposures to 8-hr average daily maximum ozone concentrations above various thresholds in 2005-2007 and with NAAQS attainment in the South Coast Air Basin.

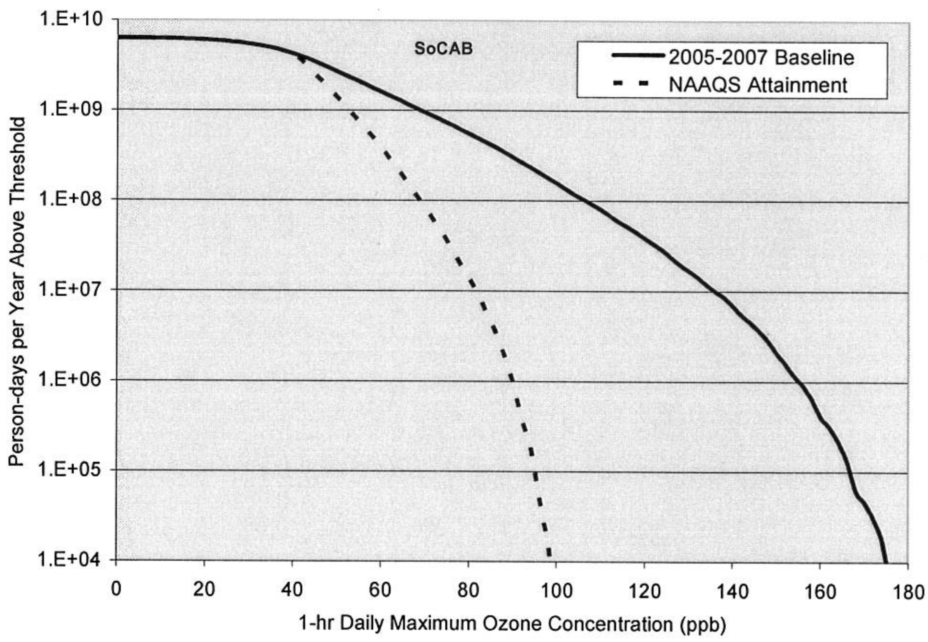

Figure II-10. The distribution of estimated exposures to 1-hr average daily maximum ozone concentrations above various thresholds in 2005-2007 and with NAAQS attainment in the South Coast Air Basin.

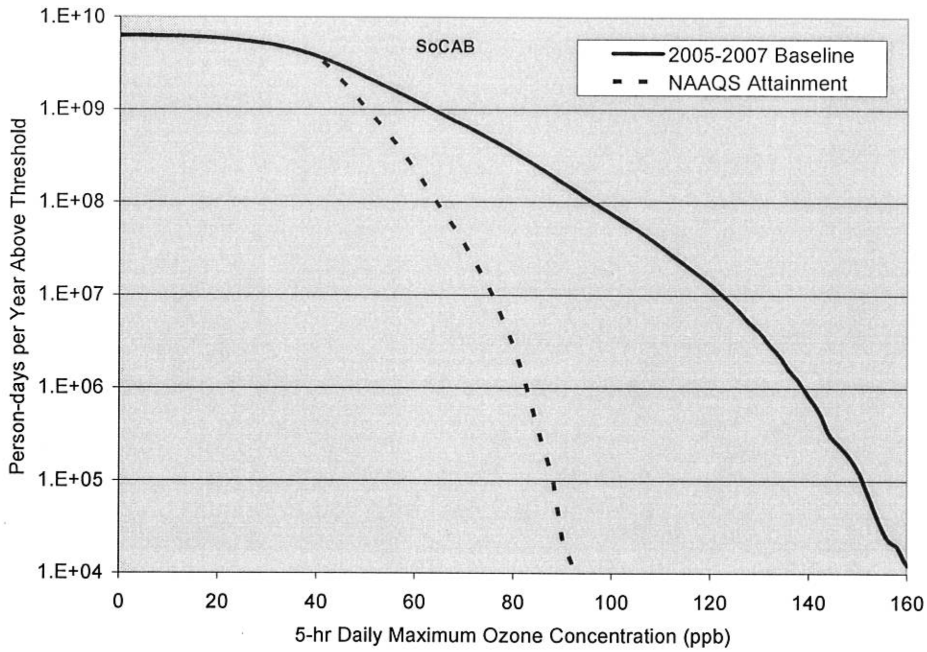

Figure II-11. The distribution of estimated exposures to 5-hr average daily maximum ozone concentrations above various thresholds in 2005-2007 and with NAAQS attainment in the South Coast Air Basin.

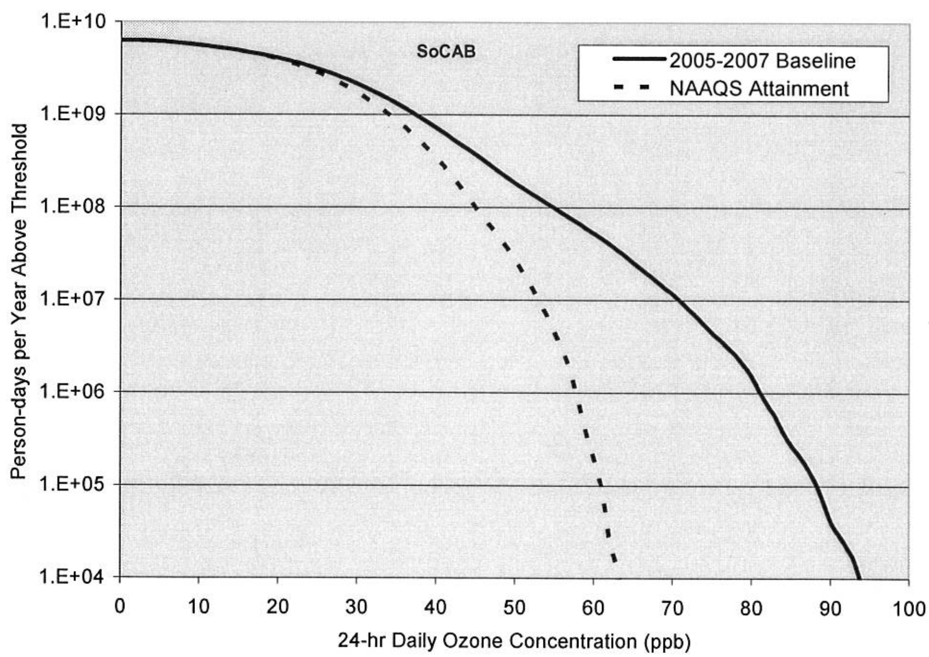

Figure II-12. The distribution of estimated exposures to 24-hr ozone concentrations above various thresholds in 2005-2007 and with NAAQS attainment in the South Coast Air Basin.

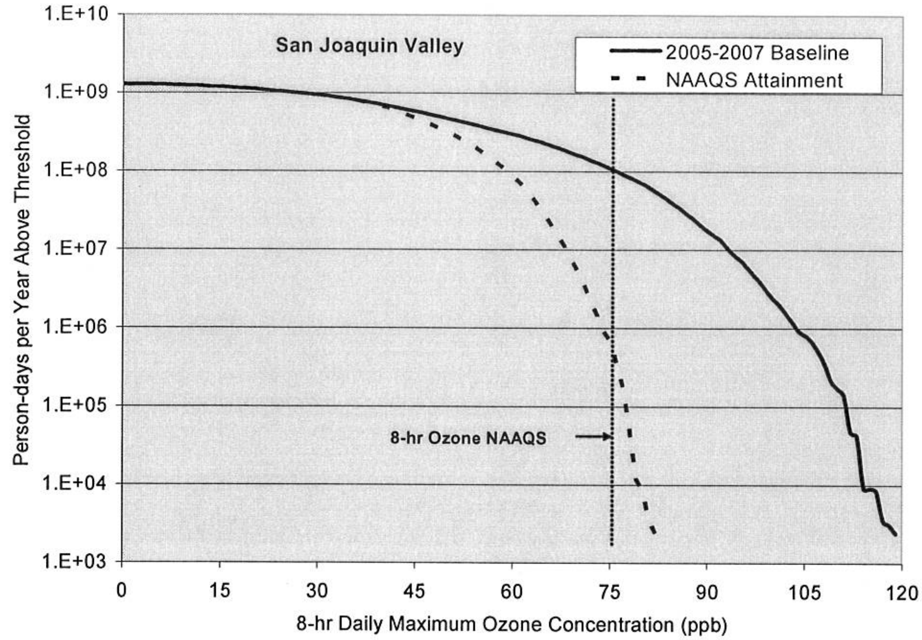

Figure II-13. The distribution of estimated exposures to 8-hr average daily maximum ozone concentrations above various thresholds in 2005-2007 and with NAAQS attainment in the San Joaquin Valley Air Basin.

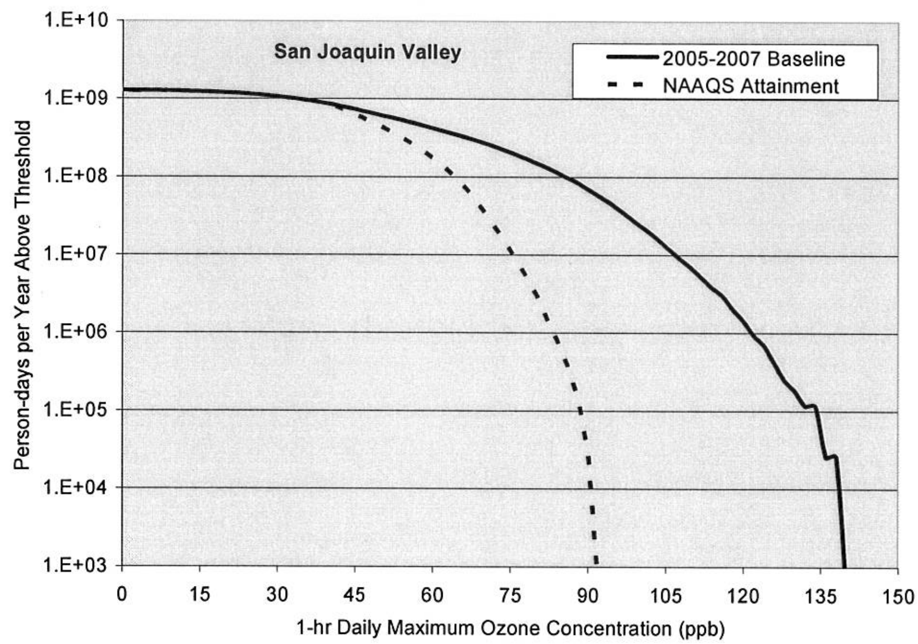

Figure II-14. The distribution of estimated exposures to 1-hr average daily maximum ozone concentrations above various thresholds in 2005-2007 and with NAAQS attainment in the San Joaquin Valley Air Basin.

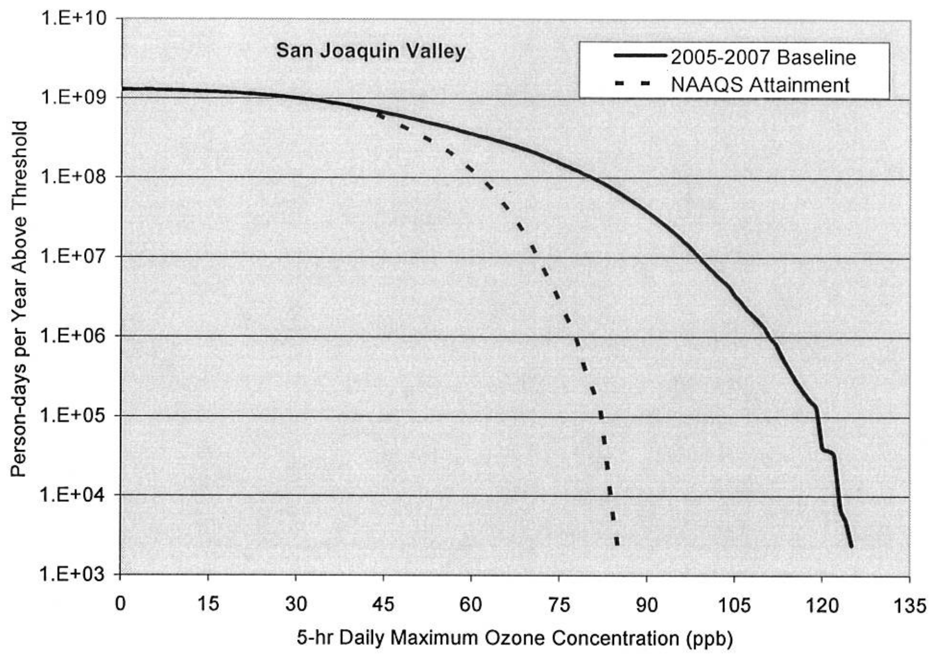

Figure II-15. The distribution of estimated exposures to 5-hr average daily maximum ozone concentrations above various thresholds in 2005-2007 and with NAAQS attainment in the San Joaquin Valley Air Basin.

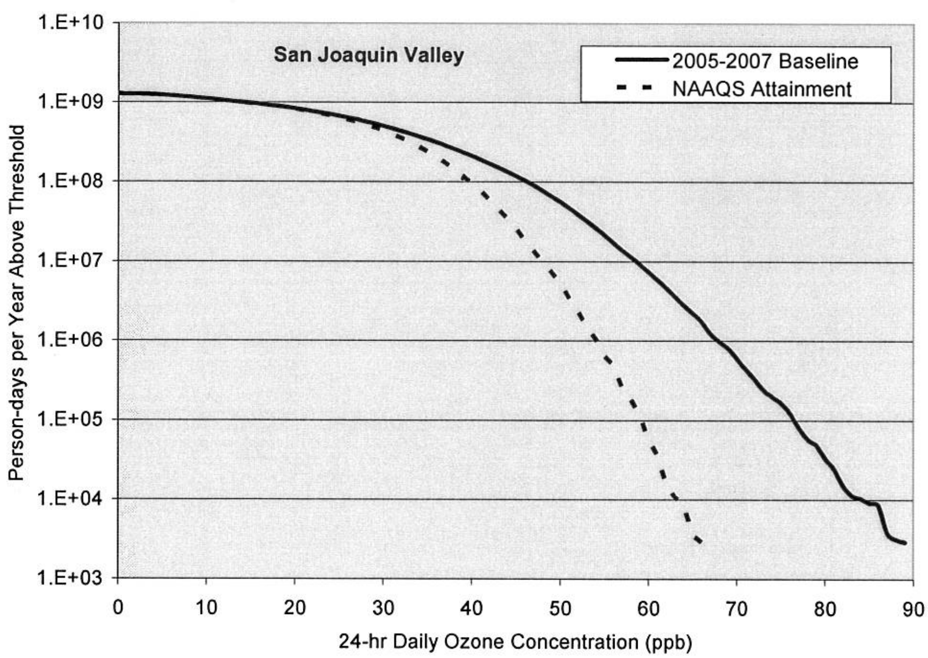

Figure II-16. The distribution of estimated exposures to 24-hr average ozone concentrations above various thresholds in 2005-2007 and with NAAQS attainment in the San Joaquin Valley Air Basin.

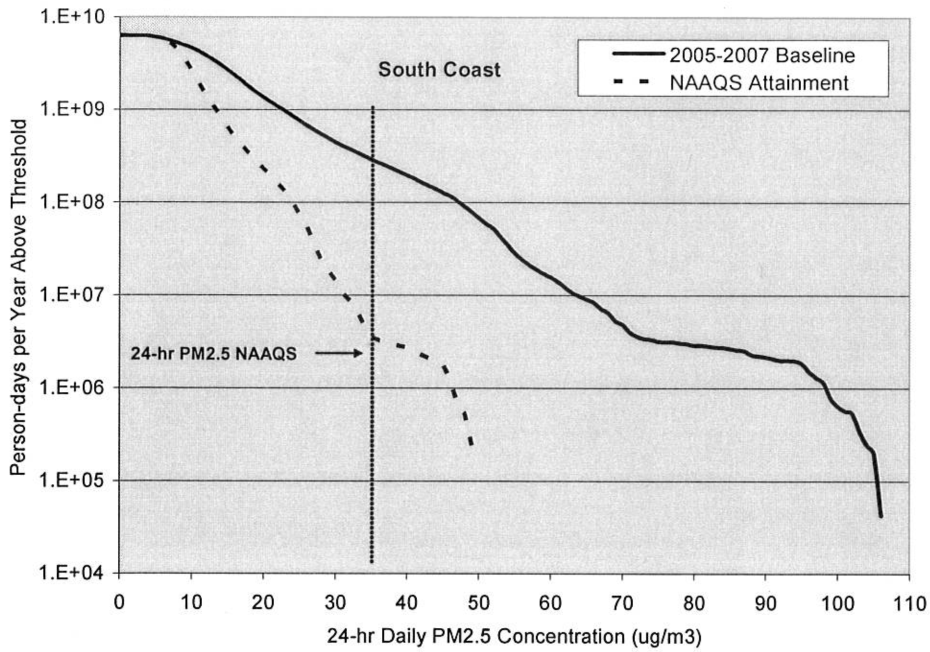

Figure II-17. The distribution of estimated exposures to daily $PM_{2.5}$ concentrations above various thresholds in 2005-2007 and with 24-hr NAAQS attainment in the South Coast Air Basin.

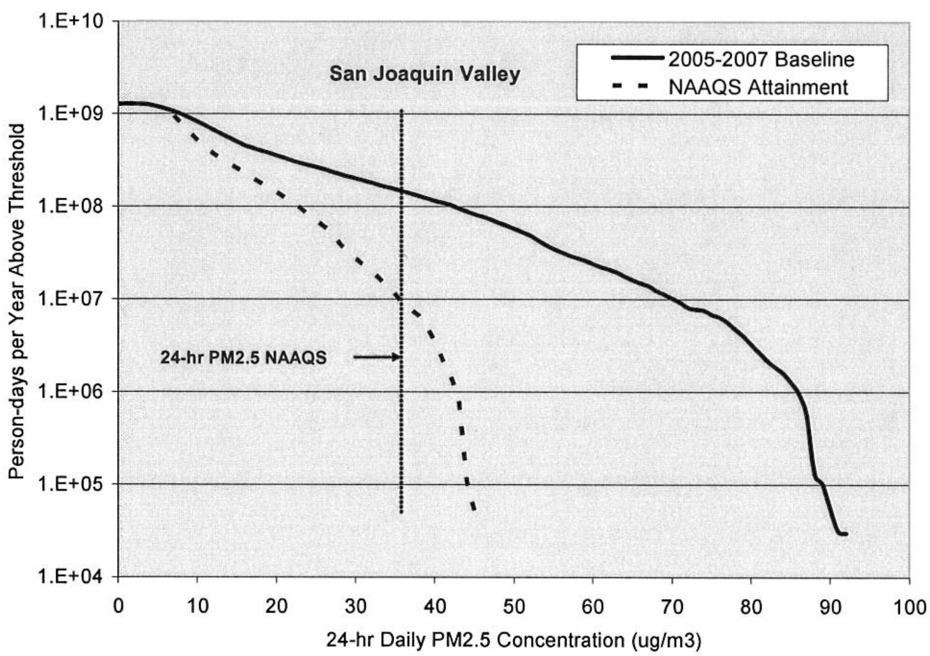

Figure II-18. The distribution of estimated exposures to daily $PM_{2.5}$ concentrations above various thresholds in 2005-2007 and with 24-hr NAAQS attainment in the San Joaquin Valley Air Basin.

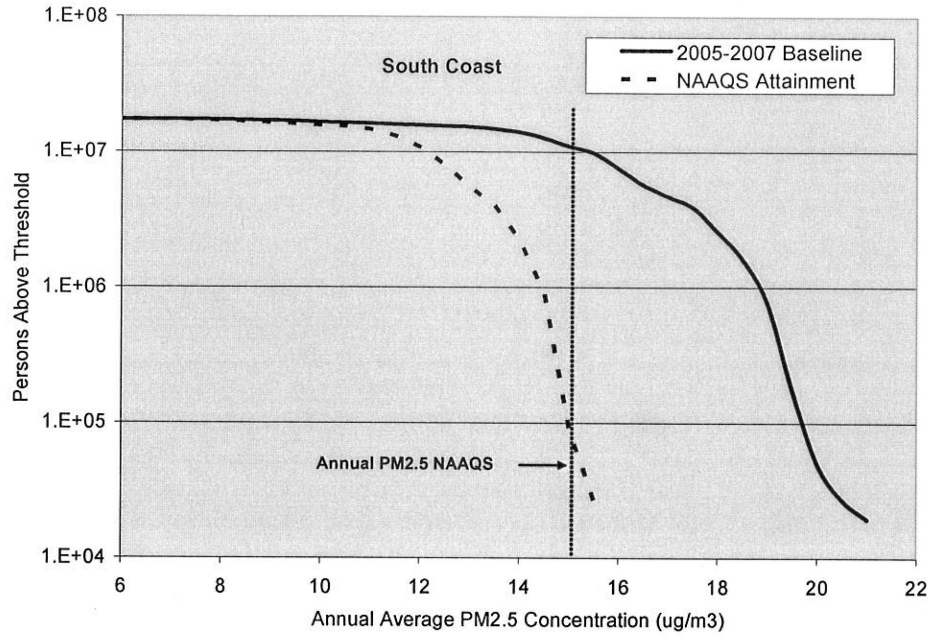

Figure II-19. The distribution of estimated exposures to annual average $PM_{2.5}$ concentrations above various thresholds in 2005-2007 and with annual NAAQS attainment in the South Coast Air Basin.

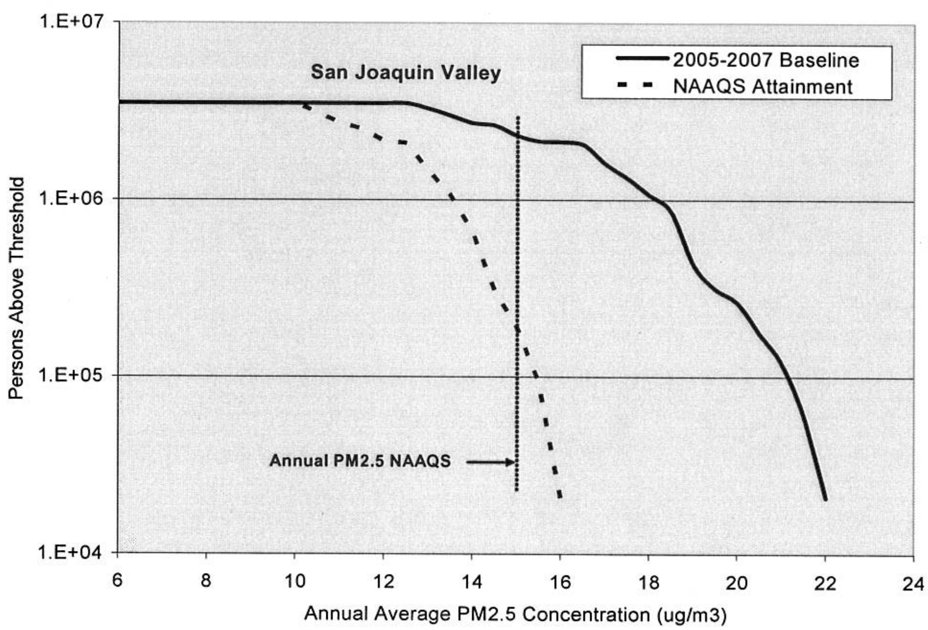

Figure II-20. The distribution of estimated exposures to annual average $PM_{2.5}$ concentrations above various thresholds in 2005-2007 and with annual NAAQS attainment in the San Joaquin Valley Air Basin.

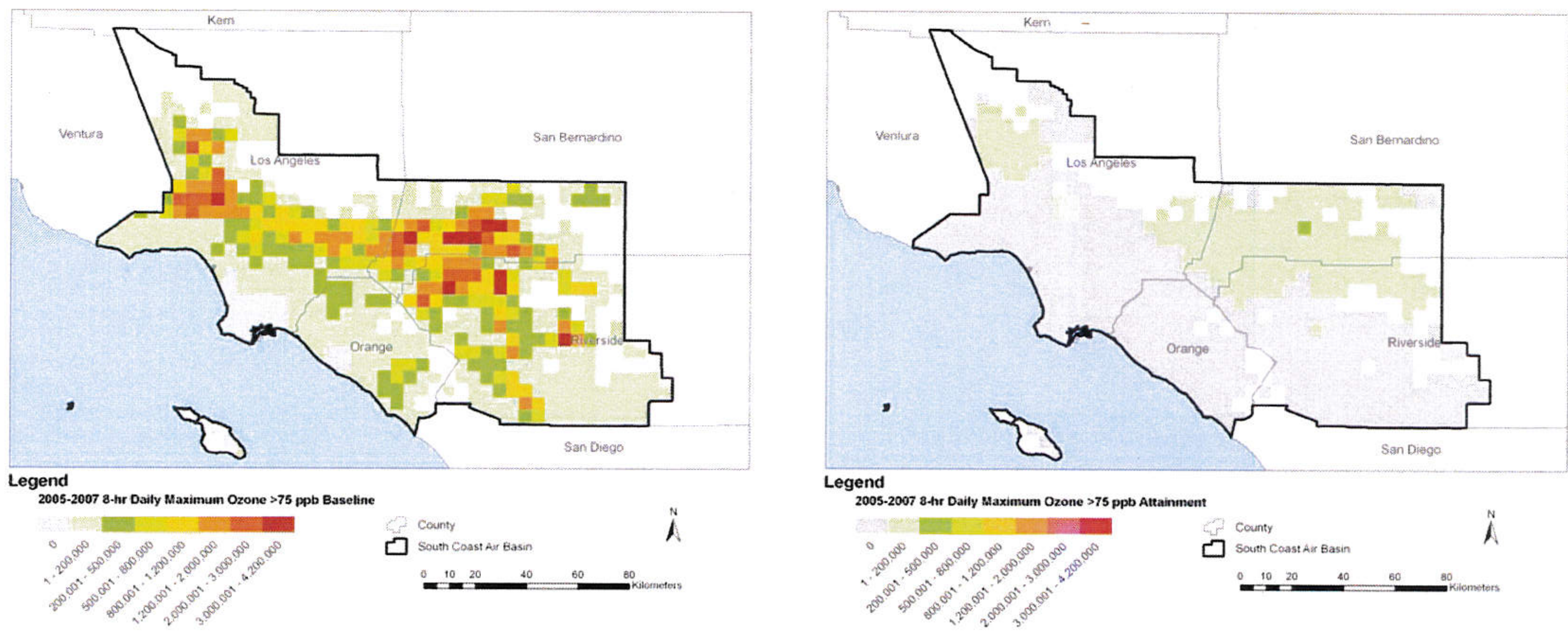

Figure II-21. Spatial map of the estimated number of persons-days per year of exposure to ozone concentrations above 75 ppb in 2005-2007 (left) and with attainment (right) in the South Coast Air Basin.

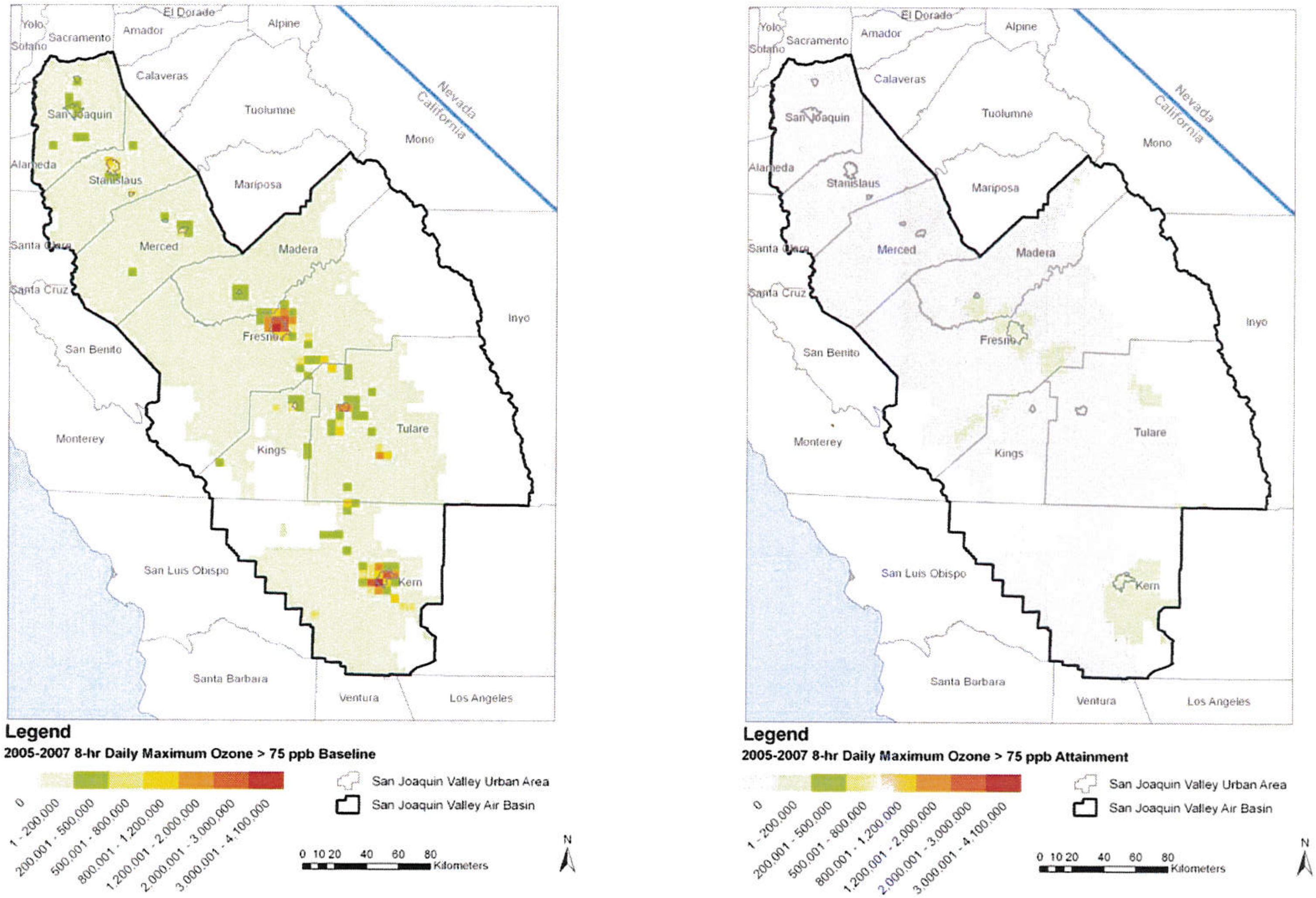

Figure II-22. Spatial map of the estimated number of persons-days per year of exposure to ozone concentrations above 75 ppb in 2005-2007 (left) and with attainment (right) in the San Joaquin Valley Air Basin.

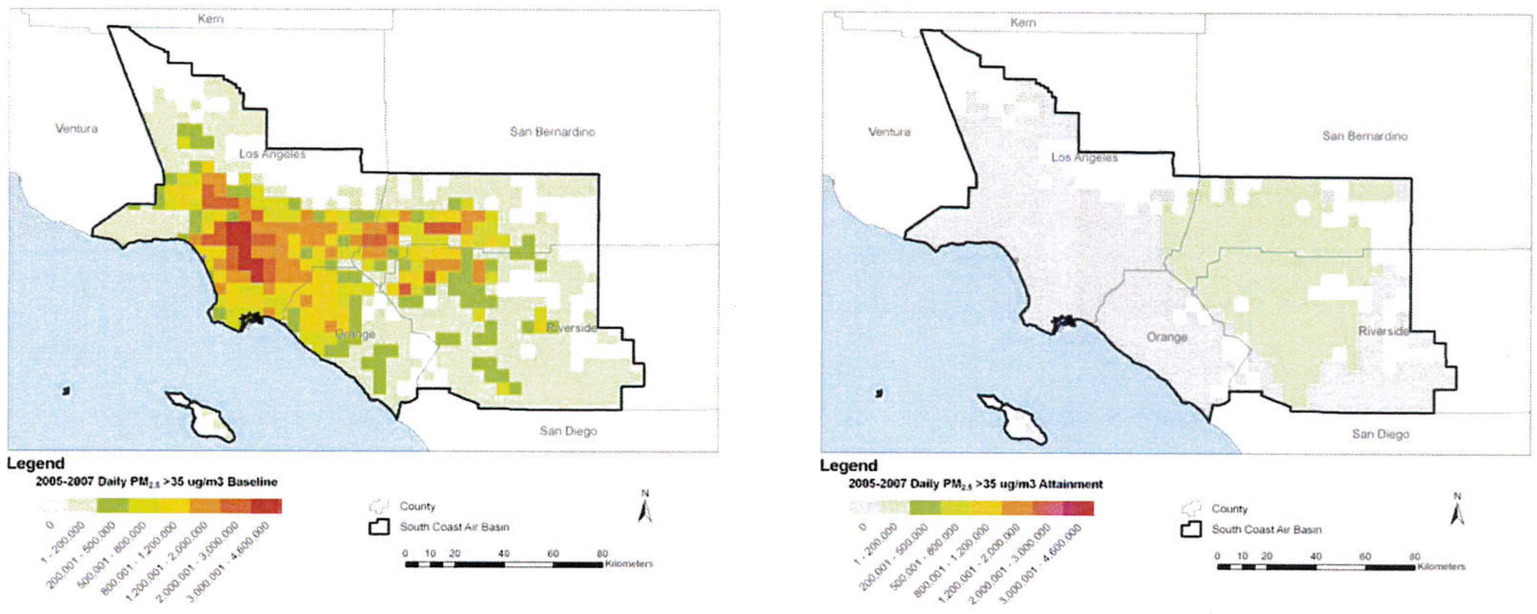

Figure II-23. Spatial map of the estimated number of persons-days per year of exposure to $PM_{2.5}$ concentrations above 35 $\mu g/m^3$ in 2005-2007 (left) and with attainment (right) in the South Coast Air Basin .

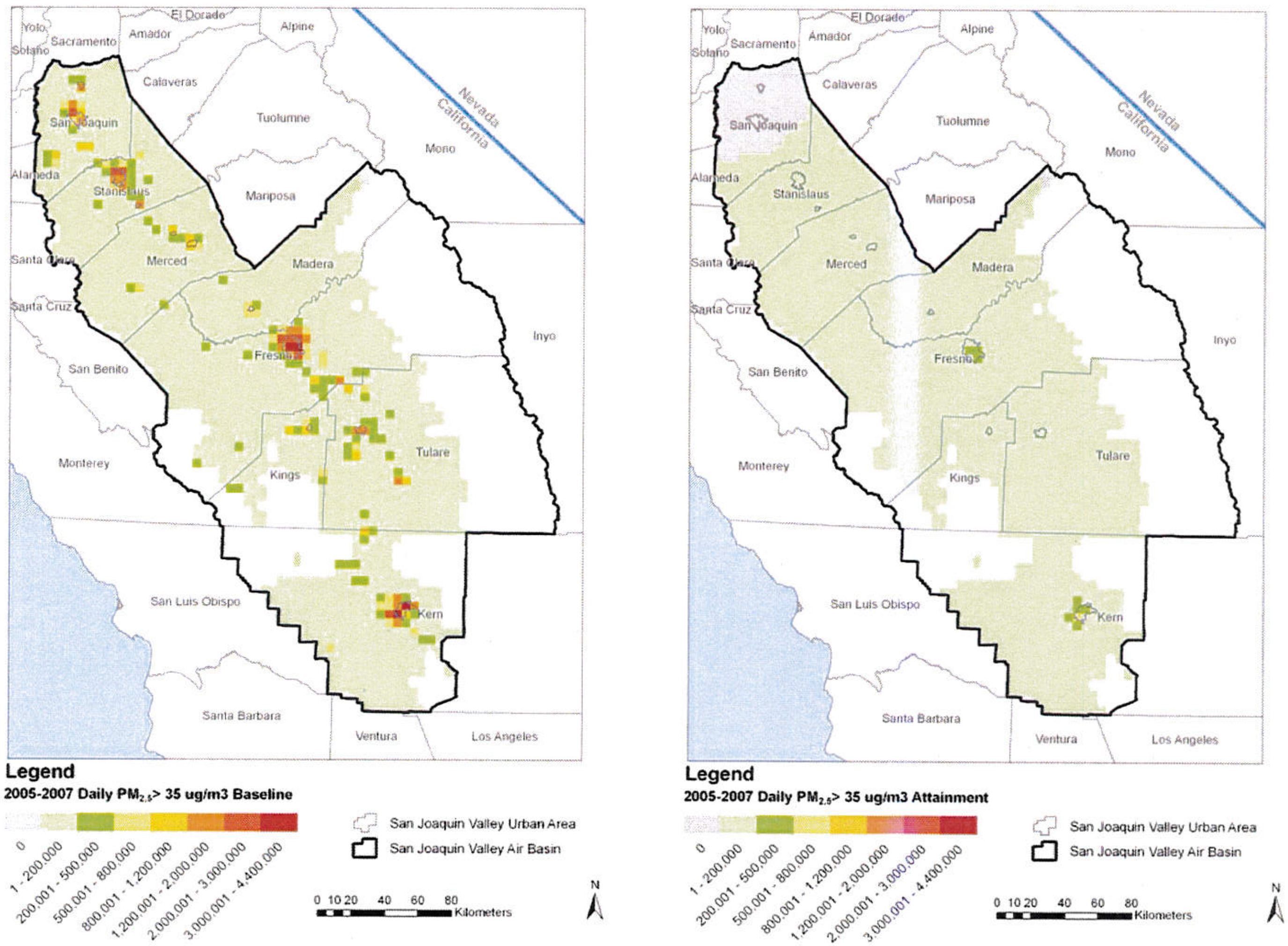

Figure II-24. Spatial map of the estimated number of persons-days per year of exposure to $PM_{2.5}$ concentrations above 35 $\mu g/m^3$ in 2005-2007 (left) and with attainment (right) in the San Joaquin Valley Air Basin .

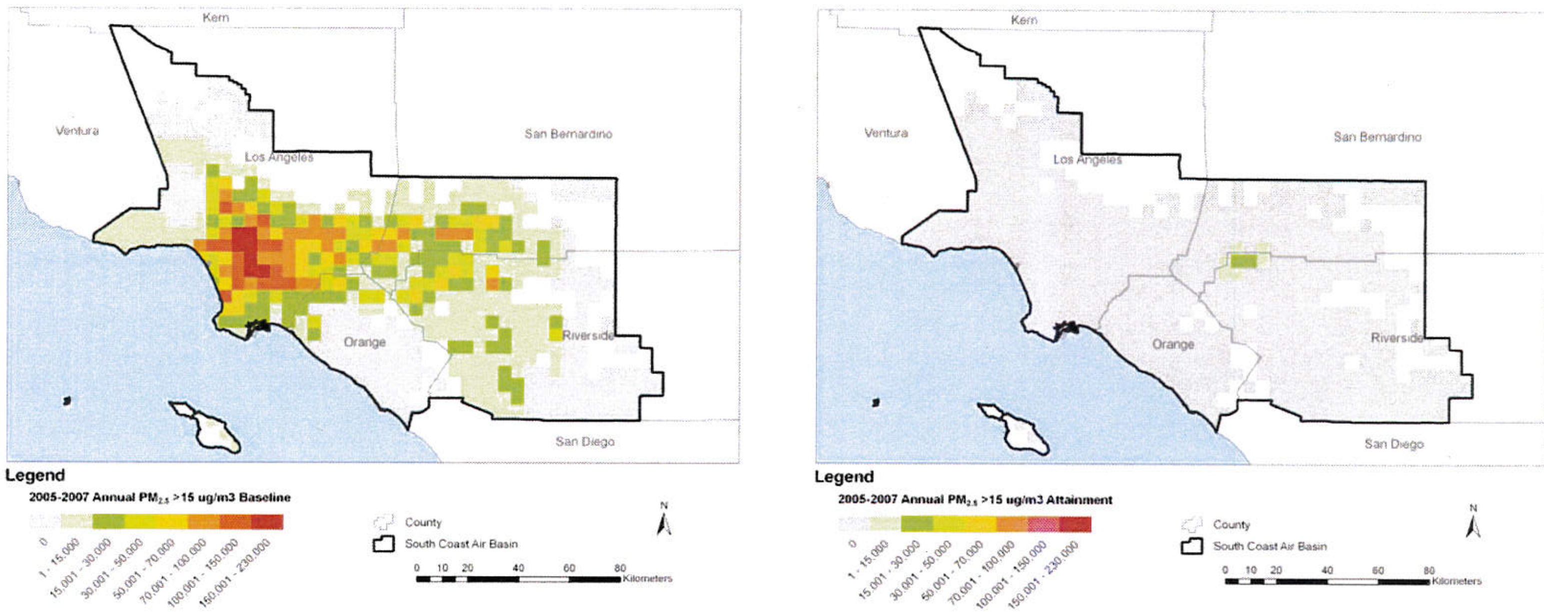

Figure II-25. Spatial map of the estimated number of people exposed to annual average $PM_{2.5}$ concentrations above 15 $\mu g/m^3$ in 2005-2007 (left) and with attainment (right) in the South Coast Air Basin .

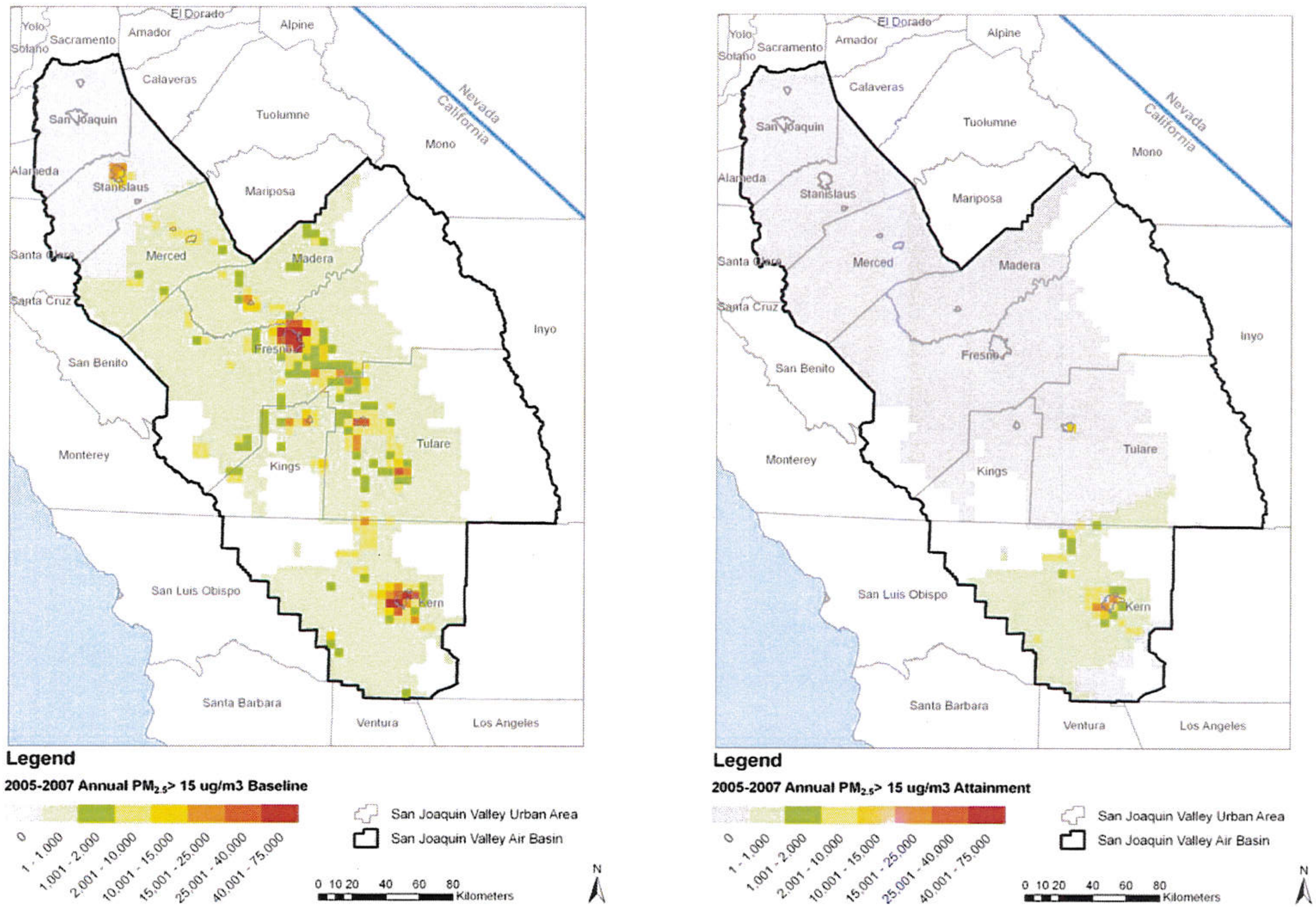

Figure II-26. Spatial map of the estimated number of people exposed to annual average $PM_{2.5}$ concentrations above 15 μg/m^3 in 2005-2007 (left) and with attainment (right) in the San Joaquin Valley Air Basin .

III. ADVERSE OZONE AND PM-RELATED HEALTH EFFECTS

Ozone and fine particles ($PM_{2.5}$) have long been associated with adverse health effects, and a growing body of health science literature enables us to quantify how changes in air quality translate into changes in the number of adverse health effects in a population. In order to select specific studies to estimate such changes for the purposes of this study, we consider a number of factors. In particular, to be used a study:

- Must be peer-reviewed
- Must account for potential confounders such as other pollutants and weather
- Must use reasonable measures of pollutants
- Must be based on a population not significantly different from the population being assessed
- Must provide a basis to estimate changes in an effect that can be valued in economic terms
- Is preferred if it is more recent, using more advanced analytical methods and reflecting more recent demographics
- Is preferred if it covers longer periods and larger populations
- Is preferred if it meets other criteria and is also region-specific
- Is preferred if it meets other criteria and has been used in previous peer-reviewed benefits assessments

Given this, we identified six ozone-related and twelve $PM_{2.5}$-related effects that would be appropriate for inclusion in this study.[2] These effects are summarized in Table III-1.

III.1 DEVELOPING HEALTH (CONCENTRATION-RESPONSE) FUNCTIONS

To quantify the expected changes in health effects associated with reduced exposure to ozone and $PM_{2.5}$, we have used the basic exponential concentration-response (C-R) function developed in the EPA's first comprehensive analysis of the costs and benefits of the Clean Air Act (EPA 1999), and widely used in benefit assessments since.[3]
Specifically, the functional form used is as follows:

$$\Delta C = -C_0(e^{-\beta\Delta P} - 1)$$

where:

ΔC = the change in the number of cases (of a particular health outcome)
C_0 = the number of baseline cases (of the health outcome)
ΔP = the change in ambient pollution concentrations
β = an exponential "slope" factor derived from the health literature pertaining to that specific health outcome.

[2] Some effects, such as individual respiratory symptoms, or eye irritation, are not included here because they are at least in part captured by effects such as MRADs, work loss days, school absence days and upper and lower respiratory symptom days.

[3] The one exception is the case of ozone-related emergency room visits, for which we use a linear C-R function.

In most of the recent health literature, "relative risk" factors are reported which relate change in pollution levels to the increased odds of developing various health effects. These risk factors are related to the β in the EPA concentration-response functions in the following manner:

$$\beta = (1 + \text{Increased Odds})/(\text{Change in Pollution})$$

The specific health studies used to develop these β values are described in the following sections.

III.1.1 Ozone Morbidity

Minor Restricted Activity Days (MRADs)

Minor restricted activity days (MRADs) are days when various (often, respiratory) symptoms reduce normal activities, but do not prevent going to work or attending school. The combination of symptoms that induces an MRAD is more restrictive than any individual symptom. A study by Ostro and Rothschild (1989), which used a national sample of the adult (18-65) working population over six years (1976-1981) to determine some of the health consequences of ozone and fine particles, is used here. They found an association between ozone and minor restrictions in activity, after controlling for fine particles, that can be used to derive an exponential ozone C-R function. Using a weighted average of the coefficients reported in the analysis, the EPA (2003b) developed a best estimate β coefficient of 0.0022; an annual (baseline) number of 7.8 MRADs per person was also derived from the study. Further following Ostro and Rothschild, we apply this function to the nonelderly, or "working" adult portion of the population. The EPA (2003b) notes that this application is likely to produce a somewhat conservative health outcome estimate, since elderly adults are likely at least as susceptible to ozone pollution as are individuals under the age of 65.

Asthma Emergency Room Visits

Several studies have established a relationship between increases of ozone and a variety of asthmatic symptoms. In one of the more comprehensive works undertaken, Weisel et al. (1995) conducted a five-year retrospective study of the relationship between summer ozone concentrations and asthma-induced emergency room (ER) visits. Specifically, they examined the relationship between ambient ozone levels and ER visits by asthmatics in central and northern New Jersey for five consecutive years (1986-1990). A similar study was undertaken by Cody et al. (1992) for the same geographic area and the summer months of 1988 and 1989. While Weisel et al.'s results derive from a single pollutant equation, the Cody et al. study includes SO_2 as a co-pollutant. In each case, though, multiple linear regression analyses were conducted for each year, generating positive and significant coefficients of daily ER visits with ozone concentrations. From these studies' coefficients, the EPA (2003b) derived slope coefficients for a linear C-R function. For our analysis, we average these two linear coefficients, resulting in a β value of 0.0323. It is this value that forms the basis for our calculation of reductions in asthma-related emergency room visits from improved ozone levels. The specific function thus developed is as follows:

Δ asthma-related ER visits = (β/ Base Pop) ΔO3 pop,

where: β = ozone coefficient = 0.0323

Base Pop = original studies' baseline population in NJ = 4,436,976

ΔO3 = change in daily 5-hr average ozone concentration (ppb)

pop = the affected population (all ages).

School Absences

Ozone-related school absences is a health outcome that has been examined in two recently published health studies. The first, by Chen et al. (2000), considered the association between air pollution and daily elementary school absenteeism in Washoe County, Nevada, from 1996 to 1998. Student absenteeism was regressed on three air pollutants (ozone, PM_{10}, and carbon monoxide), weather variables, and other confounding factors, using autoregression analysis. The second study, by Gilliland et al. (2001), examined 1996 school absences for 12 southern California communities with differing concentrations of multiple pollutants (ozone, NO_2, and carbon monoxide). These researchers used a two-stage time series regression model, controlling for day of the week and temperature, to assess whether there were any associations between pollution levels and absences. Both studies found ozone to be statistically associated with daily absenteeism. More specifically, Chen et al. predicted that for every 50 ppb increase in ozone the overall absence rate increased by 13.01 percent. In contrast, Gilliland et al. found that a 20 ppb increase in 8-hr average ozone concentrations was associated with a 16.3 percent increase in the all-absence rate. From these results, we can derive exponential β values of 0.002446 and 0.00755, which we then average, resulting in an ozone-related school absence concentration-response β value of 0.004998. Finally, EPA (2003b) reports a daily school absence rate of 0.055, obtained from the U.S. Department of Education.

Asthma Attacks

In an early, yet still widely cited, study, Whittemore and Korn (1980) examined daily asthma attack diaries from 16 panels of asthmatics living in six communities of southern California during the mid-1970s. They used multiple logistic regression analysis to test for relationships between daily attack occurrences and daily levels of two types of pollutants (photochemical oxidants and total suspended particulates), plus a variety of weather variables. Results for the two pollutant models showed significant relationships between daily levels of both pollutants and reported asthma attacks. The EPA (2003b) adjusted the model's oxidant results so that they could be used with ozone data. The resulting β value of 0.001843 can then be applied to the asthmatic portion of the population, which we assume to be 3.86 percent of the all-age population (as reported in American Lung Association, 2002). Finally, a daily incidence rate of wheezing attacks for adult asthmatics of 0.055 is assumed as our baseline rate, based on an analysis of the 1999 National Health Interview Survey (EPA 2003b).

Respiratory Hospital Admissions

For non-elderly (ages 0-64), ozone-related respiratory hospital admissions, we turn to a report by Thurston and Ito (1999), which summarized an extensive literature on hospital admissions that included ozone as one of the explanatory variables In this report, a statistical synthesis of three Canadian studies (Burnett et al. 1994; Thurston et al. 1994; and Burnett et al.

1997) yielded a quantitative estimate of the respiratory hospital admission effect associated with ozone exposures for the non-elderly general population. Specifically, they calculated a relative risk factor of 1.18 per 100 ppb increase in daily 1-hr maximum ozone levels. From this, we derive a concentration-response β estimate of 0.001655. For respiratory hospital baseline admission rates, we turn to the Office of Statewide Health Planning and Development's Inpatient Hospital Discharge Frequencies for California (2003) and the U.S. National Hospital Discharge Survey(USDHHS 2005) to construct age-specific hospital discharge numbers for each county.

To estimate ozone-related avoided incidences of respiratory hospital admissions for patients 65 and older, we generate a pooled β value using several health studies referenced by the EPA (2003b). All of these studies found significant associations between ozone and various categories of respiratory hospital admissions. The studies include: Schwartz (1995), which analyzed the relationship between ozone and all respiratory admissions for the cities of New Haven, Connecticut and Tacoma, Washington; and Moolgavkar et al. (1997), Schwartz (1994a), and Schwartz (1994b), which considered pneumonia and chronic obstructive pulmonary disease (COPD) admissions in Minneapolis and Detroit. Our pooled β estimate is equal to 0.004536. Finally, as described for the under-65 case, our county-specific baseline figures come from the California and U.S. Hospital Discharge reports.

III.1.2 Ozone Mortality

Recent reviews of new health scientific literature on the relationship between ozone and premature mortality (see Deck and Chestnut 2008; NRC 2008) recommend that ozone mortality now be included in health benefit analyses. We therefore make use of five recent ozone mortality studies: three EPA-funded meta-analyses (Bell et al. 2005; Ito et al. 2005; Levy et al. 2005); a time-series analysis for 98 U.S. urban communities by Bell et al. (2006); and a case-crossover analysis of 48 U.S. cities by Zanobetti and Schwartz (2008). We pool the results of these five studies to derive a β coefficient of 0.0004556, using the inverse of reported variances as weights. Baseline death rates for each county are obtained from the California Department of Health Services Death Statistical Data (CDHS 2004).

III.1.3 $PM_{2.5}$ Morbidity

Chronic Bronchitis

A case of chronic bronchitis is typically considered to be a recurring condition of mucus in the lungs and wet cough during at least 3 months per year for several years in a row. Abbey et al. (1995) studied the association between fine particles (including $PM_{2.5}$) and new occurrences of these chronic respiratory symptoms in a survey group of nearly 1,900 Californian Seventh Day Adventists. The survey period extended from 1977 to 1987, and the study found a statistically significant relationship between $PM_{2.5}$ and the development of chronic bronchitis in adults aged 27 and over. From this work, the EPA calculated a concentration-response β value of 0.0137 and from an earlier work by Abbey (1993), they obtained an annual bronchitis incidence rate per person of 0.00378. We apply these factors to the proportion of our adult population (27 years of age and older) without chronic bronchitis (which, according to the American Lung Association, is 95.57 percent of the population).

Cardiovascular Hospital Admissions

For non-elderly (ages 18-64), particulate-related, cardiovascular hospital admissions, we rely on a technical paper by Moolgavkar (2000) which used generalized additive models to study the associations between daily admissions and several pollutants in three major metropolitan areas, including Los Angeles County. Utilizing their estimated change of 0.9 percent in daily cardiovascular admissions associated with a 10 μg/m^3 increase in $PM_{2.5}$, we derive a concentration-response β value of 0.000896. For cardio hospital baseline admissions rates, we use the Office of Statewide Health Planning and Development's Inpatient Hospital Discharge Frequencies for California (2003) and the U.S. National Hospital Discharge Survey (March 2005) to construct age-specific hospital discharge numbers for each county in the two study areas.

To estimate $PM_{2.5}$-related occurrences of cardio hospital admissions for patients 65 and older, we combine the results of two health studies (Moolgavkar 2003; Ito 2003), which presented re-analyses of the associations between particulate pollution and elderly hospital admission data in Los Angeles and Cook Counties and for Detroit, Michigan. Both works found statistically significant relationships between $PM_{2.5}$ and cardiovascular admissions, and from these studies, we calculate an average β value of 0.0014375. Lastly, our county-specific baseline numbers again come from the California and U.S. Hospital Discharge reports (USDHHS 2005).

Non-Fatal Heart Attacks

To calculate reductions in non-fatal heart attacks, we utilize a study by Peters et al. (2001) which used a case-crossover approach to investigate whether high levels of particulates can trigger the onset of nonfatal acute myocardial infarctions (MI). With multivariate analyses of data gathered in the greater Boston area, they found that the risk of MI onset increased as particulate levels rose. Specifically, they calculated an estimated odds ratio of 1.69 for a 24-hr $PM_{2.5}$ increase of 20 μg/m^3. From this, we estimate the concentration-response β to be equal to 0.02412. Finally, to estimate a baseline per-person incidence rate, we rely on the 1999 NHDS public use data files, adjusted by 0.93 for the probability of surviving a heart attack after 28 days. The daily incidence rate per person for the western United States is reported to be 0.00001 (see Rosamond et al. 1999).

Minor Restricted Activity Days

As noted above in the ozone morbidity section, minor restricted activity days (MRADs) are days when various (often, respiratory) symptoms reduce normal activities, but do not prevent going to work or attending school. Ostro and Rothschild (1989), noted above, used six years (1976-1981) of data from the Health Interview Survey (HIS)—a large cross-sectional database collected by the National Center for Health Statistics—to determine some of the health consequences of particulate matter and ozone. They also found a statistical association between fine particles and minor restrictions in activity, after controlling for ozone, that can be used to derive an exponential $PM_{2.5}$ C-R function. From the data included in the analysis, the

EPA (2003b) developed a $PM_{2.5}$ β coefficient of 0.00741, which is again a weighted average of the coefficients reported in Ostro and Rothschild (1989). As in the ozone case, an annual (baseline) number of 7.8 MRADs per person was derived. Finally, we again apply this function to the non-elderly, or "working" adult portion of the population. As we noted earlier, this application is likely to produce a somewhat conservative health outcome estimate, since elderly adults are probably at least as susceptible to fine particles as are individuals under the age of 65.

Work Loss Days

Ostro (1987) examined the effect of fine particulate matter on work loss days using a national survey of working adults (aged 18-64) in 49 metropolitan areas in the United States. He found a significant link between $PM_{2.5}$ levels and work loss days for each of the six years of the study (1976-1981), estimating separate coefficients for each year of the analysis. The β coefficient developed by the EPA (2003b) from this work (0.0046) is a weighted average of the coefficients estimated by Ostro, using the inverse of the variance as the weight. In addition, the EPA used a more recent data set (Adams et al. 1999) to determine a daily work loss days incidence (baseline) rate of 0.00595, which we use in our analysis.

Acute Bronchitis

Dockery et al. (1996) examined the respiratory health effects of exposure to a number of pollutants, including fine particles, on a sample of over 13,000 children (8-12 years old) from 24 communities in the United States and Canada. Using a two-stage logistic regression model, and adjusting for the potential confounding effects of gender, parental asthma and education, history of allergies, and current smoking in the home, they found $PM_{2.1}$ to be significantly related to cases of bronchitis. From this work, the EPA developed a $PM_{2.5}$ concentration-response function for acute bronchitis in children. The estimated β value of 0.0272 results from combining Dockery et al.'s odds ratio of 1.50 with the study's observed difference in particles of 14.9 $\mu g/m^3$ between the most and least polluted cities. In addition, the EPA recommends using a baseline incidence rate of 0.043 cases per child per year, as reported by the American Lung Association (2002). Finally, while the Dockery et al. sample focused on children within a 5-year age range, we extend their results to include all school-aged children, based on the assumption that the response of all school-aged children will be similar to those in the study's more specific age group.

Lower Respiratory Symptoms

In an earlier health study, Schwartz et al. (1994) used logistic regression and found a statistical association between lower respiratory symptoms (defined as cough, chest pain, phlegm and wheeze) in children and a number of pollutants, including PM_{10}, acid aerosols, gaseous pollutants, and fine particles. The study was conducted in six cities over a five-year period (1984-1988) and considered a sample of over 1,800 students enrolled in grades two through five. More recently, Schwartz and Neas (2000) replicated the earlier analysis, focusing their efforts on $PM_{2.5}$. In a model that also included coarser particulate matter ($PM_{10-2.5}$), an odds ratio of 1.29 was associated with a 15 $\mu g/m^3$ change in $PM_{2.5}$. From this work, we generate an exposure-response function, with an estimated β value of 0.01698 and a daily baseline rate of 0.0012. Finally, while the Schwartz and Neas work is suggestive of an age range from 7 to 14, we again extend these results to include all school-aged children because the response of older teenagers and younger children is likely to be similar to the children in the studied cohort.

Upper Respiratory Symptoms

In a study of Utah school children (ranging in age from 9 to 11), Pope et al. (1991) examined the association between daily occurrences of upper respiratory symptoms and daily PM_{10} concentrations. A day of upper respiratory symptoms was defined as consisting of one or more of the following symptoms: runny or stuffy nose; wet cough; and burning, aching, or red eyes. Using logistic regression, the study found that PM_{10} was significantly associated with upper respiratory symptoms. The EPA (2003b) used this work to develop a concentration-response function with a β estimate of 0.0036. We convert this PM_{10}-derived β value to its $PM_{2.5}$ counterpart (0.0072) and also rely on Pope et al.'s daily upper respiratory symptom incidence rate per child of 0.3419. Finally, we note that the sample size in the Pope et al. study was quite small, and is most representative of the asthmatic children's population, not the total school-aged population. We therefore apply this exposure-response function only to asthmatic children, who are assumed to represent 11 percent of the total children's population.

Respiratory hospital admissions

To estimate $PM_{2.5}$-related occurrences of respiratory hospital admissions for patients 65 and older, we again combine the results of two health studies (Moolgavkar 2003; Ito 2003) which present reanalyses of the associations between particulate pollution and elderly hospital admission data in Los Angeles and Cook Counties and for Detroit, Michigan. Both works find statistically significant relationships between $PM_{2.5}$ and respiratory admissions, and from these studies, we calculate an average β value of 0.001977. Then, for the respiratory hospital baseline admissions rates, we again use the Office of Statewide Health Planning and Development's Inpatient Hospital Discharge Frequencies for California (2003) and the U.S. National Hospital Discharge Survey (March 2005) to construct age-specific hospital discharge numbers for each county in the two study areas.

Asthma emergency room visits

Children's Asthma ER Visits

For particulate-related children's asthma emergency room (ER) visits, we rely on a study by Norris et al. (1999), who examined the relation between air pollution and childhood hospital ER visits for asthma in Seattle from 1995 to 1996. By regressing daily ER counts against fine particulate matter (PM) levels, along with other pollutants, they determined that a change of 11 μg/m3 in fine PM was associated with a relative rate of 1.15 in daily ER visits. This generates a mid-range β value of 0.0127. Finally, a daily incidence baseline rate is derived from the National Center for Health Statistics.

III.1.4 $PM_{2.5}$ Mortality

Adult Mortality

The scientific literature that assesses associations between $PM_{2.5}$ and premature mortality in adults has expanded rapidly over the past decade, with several large-scale multi-city studies that extend or reanalyze earlier studies (for example, Pope et al. 1995; Krewski et al. 2000; Pope et al. 2002; Laden et al. 2006) as well as a California-specific study that focuses on the Los Angeles basin (Jerrett et al. 2005). To estimate $PM_{2.5}$-related mortality for regions in California requires determining which of these studies is most appropriate for conditions in this region. In general, as noted above, studies are preferred that are peer reviewed, cover longer periods, are more recent (better reflecting current demographics and lifestyles), include larger samples, account for confounding factors, and were conducted in locations that have the greatest similarity to the study population. There is also an increasing literature that measures (Woodruff et al. 1997) or indicates the probability- of (Loomis et al. 1999; Pereira et al. 1998; Wang et al. 1997; Chay and Greenstone 2003) an association between $PM_{2.5}$ and mortality in children less than one year of age.

Both EPA and CARB have conducted recent benefit assessments for $PM_{2.5}$ reduction (EPA 2003a; EPA 2004; EPA 2005; CARB 2005; CARB 2006, CARB 2008), as has the SCAQMD (SCAQMD 2007) and these assessments have also undergone review of the analytical approaches used, including the choice of C-R functions. The consensus has been that for national studies, Pope et al. (2002) is the preferred basis to estimate adult mortality. The EPA Science Advisory Board Health Effects Committee (SAB-HEES 2004) and a recent National Research Council panel (NRC 2008) further recommend that neonatal mortality now be included in the base analysis using the C-R function from Woodruff et al. (1997). For California, there is agreement that Pope et al. provides the best C-R function from the *national* literature, but there is also agreement that Jerrett et al. (2005) could better represent California (ARB 2005 and peer-review comments thereon). However, Deck and Chestnut (2008), after assessing a number of explanations for the significantly higher risk found by Jerrett et al. relative to the national American Cancer Society (ACS) results, conclude that until the reason(s) are better understood, this study should not be the primary basis for a central estimate of $PM_{2.5}$-related mortality.

Following the professional consensus, and based on the reasons further discussed below, we rely on a combination of the following studies to estimate adult mortality effects.

Pope et al. (2002)

This study meets all of the essential criteria noted above for the choice of a C-R function. It is a large-scale, longitudinal cohort study that follows a large nationally representative population (ages 30 and older) across 61 cities over a 16-year follow-up period from a base of 1979-1983. Extending the follow-up period to 16 years increases the mortality data set by a factor of three compared to earlier studies. This study also included $PM_{2.5}$ measurements from 1999 and the first three quarters of 2000, and controled more closely for a series of personal risk factors, including lifestyle and occupation. The increase for the all-cause mortality associated with annual average $PM_{2.5}$ is 6% per 10 $\mu g/m^3$.

Jerrett et al. (2005)

This study is based on the Los Angeles area population subset from the national cohort included in Pope et al. (2002), accounted for the same confounders, and also assessed the association between average annual $PM_{2.5}$ and differences in mortality in the age 30 and older population. The authors found a substantially higher association between $PM_{2.5}$ and mortality, with a 17% increase in all-cause mortality for every 10 μg/m^3 increase in $PM_{2.5}$. While this is quite a large difference, contrasted with the 6% increase found by Pope et al. for the 61 cities overall , there are sound reasons to conclude that the results better represent the Los Angeles Basin population. A primary reason is that Jerrett et al. used a detailed intra-urban exposure measure supported by 23 $PM_{2.5}$ monitors across the region. This contrasts with the national cohort studies that compare inter-urban exposure and have much less spatial resolution. Another is that traffic-generated primary particles have a greater association with observed effects, and traffic in the Los Angeles basin accounts for nearly five times the proportion of total primary particles emitted than is typical in most of the United States, at 3.7% compared to 0.75%.

For purposes of assessing benefits in California, the Jerrett et al. work could be more appropriate than Pope et al. in that the exposure measure more closely fits the approach that we use in REHEX. However, because there is no clear explanation for the much higher relative risk value, relative to the national data (ACS) on which Jerrett et al. is based, we are reluctant to rely entirely on this result until the work has been replicated.

Laden et al. (2006)

This study includes no California cities, but relies on a more rigorous random selection process than was used to form the ACS panel, and includes information on more personal characteristics. It also followed subjects for a long period, more than 20 years. The authors report a relative risk of 1.16, which is close to the Jerrett et al. result, and higher than Pope et al. (2002), both of which are based on the ACS data.

Relative Risk Factor Used in the Study

Research in this area has expanded considerably over the past two decades, both strengthening scientific confidence that the effect of fine particulate exposure on mortality is "real", and offering the conundrum of risk factors that vary significantly from study to study. In 2006, EPA sponsored an expert elicitation as part of the process of determining what risk factor(s) should be used in risk assessments conducted to inform policy decisions at the agency. Twelve experts provided responses, with a significant majority choosing a relative risk (RR) at or above 1.10. None recommended a value lower than 1.06. (Deck and Chestnut 2008; Roman et al. 2008)

Given the differing strengths of the primary underlying health studies, and the conclusions from the expert elicitation, we use a weighted average of Jerrett et al. (RR=1.17) and Laden et al. (RR=1.16), and Pope et al. (RR=1.06). This results in a relative risk factor of 1.10 and a C-R β of 0.009531. We assign greater weight (two-thirds) to Pope et al. because of the national scope of the study, and the inclusion of California residents. Both of the other studies include smaller samples, in one case including only cities outside of California, and in the other including only Southern California. Finally, we again use county-specific baseline death rates obtained from the California Department of Health Services Death Statistical Data (CDHS, 2004).

Post-neonatal Mortality

Woodruff et al. (1997)

This is the first comprehensive national study to assess the impact of particles (PM_{10}) on infant mortality in the United States. It includes a sample size of four million infants less than one year of age across 86 metropolitan areas for the interval 1989-1991. Overall, the study estimates an increase of 4% for all-cause infant mortality for every 10 $\mu g/m^3$ increase in PM_{10}. The EPA SAB-HEES (2004) now recommends that neonatal mortality be included in primary benefit analyses conducted by EPA, and that the Woodruff et al. C-R be used. We note that the Woodruff study, however, did not include infants in a number of states, including California (because maternal education levels were not reported for California). While the study is likely representative of national conditions, it is impossible to determine whether the omission of California infants makes it less representative of the California population. Nevertheless, we include post neonatal deaths in this primary benefit analysis, using a C-R β value of 0.007844 derived from the Woodruff study.

Table III-1. Health endpoints.

Ozone	$PM_{2.5}$
School absences Ages 5-17	Acute bronchitis Ages 5-17
Emergency room visits All ages	Lower respiratory symptoms in children Ages 5-17
Respiratory hospital admissions	Upper respiratory symptoms in children Ages 5-17 asthmatic population Respiratory hospital admissions Ages 65 and older
Asthma attacks All ages of the asthmatic population	Premature death (mortality Ages 18-64
Premature death (mortality) All ages	Asthma emergency room visits Under age 18
Minor restricted activity days Ages 18-64	Minor restricted activity days All ages Onset of chronic bronchitis Ages 27 and older Non-fatal heart attacks Ages 18 and older Cardiovascular hospital admissions Ages 18 and older Neo-natal mortality Under age 1 Work loss days Ages 18-64

IV. ECONOMIC VALUATION

IV.1 THE BASIS FOR VALUE

If we know how much illness and premature death might be avoided as a result of meeting the health-based air quality standards, why assign monetary values at all, and what is the basis for those values? First, neither society nor individuals can afford to do everything that would be worthwhile. As a result, we must choose among the things that we do. The social choice to control emissions in order to improve air quality and health is one of these things, and one that is a high priority for Californians. It is therefore useful to have a sense in economic terms of the scale of gains from successfully implementing pollution control policies and programs. This study is designed to provide a transparent measure of these gains, that uses the best available information, reflects social preferences, and can readily be compared against the value of other social choices.

The basis for each value begins with the premise that, within limits[4], society accepts individual choices as valid, and as reflecting the actual value that individuals place on their choices, whether it is which news channel to watch or which college is best for their child. That is, what an individual chooses to do accurately represents what is best for him or her, and by inference for society, which is simply the sum of the individuals that make up that society. Social value—what we want to capture here—is then simply the sum of value to individuals. To determine the value to individuals of reducing pollution-related health risks we use prices or implied prices (hedonic measures) when available, along with survey (contingent valuation) results.

One objective of this study is to provide a monetary, or dollar, measure of the benefits that would accrue from avoiding some of the known adverse health effects that result from exposure to unhealthful air. A critical aspect of such a measure is determining the value that society places on avoiding specific adverse effects. These range from symptoms that are less severe, such as days when activities are limited, through hospitalization, emergency room visits, asthma attacks and the onset of chronic bronchitis, to premature death. Individuals value reducing these effects to avoid:

- Loss of productive time (work and school) and the direct medical costs that result from avoiding or responding to adverse health effects
- The pain, inconvenience and anxiety that result from adverse effects, or efforts to avoid or treat them
- Loss of enjoyment and leisure time
- Adverse effects on others resulting from their own adverse health effects

[4] Most people readily accept limits on individual choices that are necessary to protect others. This includes things such as criminal statutes, speed laws, and a variety of environmental protections ranging from vehicular exhaust standards to protection of endangered species.

IV.2 CONCEPTS AND MEASURES OF VALUE

Ideal measures of value would represent all of the losses that result from adverse health effects. They would also accurately reflect real preferences and decision-making processes similar to those we use to make basic choices every day. Our decisions about which goods or services to buy are based on which items give the most satisfaction, or utility, relative to prices and income. Market prices are therefore accepted as reasonable measures of the value of those items that can be purchased. However, there is no market in which cleaner air (like many other environmental goods) can be bought. Consequently, values for such goods cannot be directly observed from prices. Economists have developed alternatives to market prices to measure the value of environmental improvements, including health benefits resulting from cleaner air.

Generally accepted measures of the value of changes in well-being due to reducing the adverse health effects of air pollution include the cost of illness (COI) measure and the willingness to pay (WTP) or willingness to accept (WTA) measures. All three measures have limitations but, when taken together, they yield a generally accepted range of values for the health benefits of improvements in air quality. In this study, we use the most appropriate available value for each health endpoint.

IV.2.1 Cost of Illness

The cost of illness (COI) method was the first to be developed and described in the health and safety literature as a basis to value reductions in risk. It requires calculating the actual direct expenditures on medical costs, plus indirect costs (usually lost wages), incurred due to illness. This method is still the primary measure used to value the benefit of avoiding hospital admissions and other medical treatments. The COI method has the advantage of being based on real dollars spent to treat specific health effects and the actual market value of work time. Since it includes only monetary losses, however, and does not include losses associated with the value of leisure time, of school or unpaid work time, or of general misery, it does not capture all of the benefits of better health. The method is therefore generally viewed as limited and representing a lower bound on value. The basic limitation is that it is a measure of the *financial* impact of illness, not the *change in well being* due to illness, since financial loss is only part of the value forfeited by illness and discomfort. Other factors associated with illness, most notably pain, inconvenience, and anxiety, can result in a significant disparity between COI estimates and WTP (or WTA) estimates. As discussed below, the COI approach has been shown to produce a lower-bound value estimate. Overall, COI measures are used when more complete measures are unavailable for a specific effect. While they generally represent a lower bound of value, using them allows the valuation of some adverse effects, such as emergency room visits, which might otherwise not be quantified.

IV.2.2 Market-based Values

Because we know that COI measures undervalue adverse health effects, many studies have been conducted to determine more complete values. For improvements in health, for example, we use WTP measures, which are both more complete than COI and consistent with accepted economic concepts about markets and individual economic choices. Market choices that reduce risks to health or life indirectly indicate the WTP for lower risks, or the WTA for higher risks. Values derived from these market-based methods are based on relating differences in wages or consumer costs to differing degrees of risk. Those differences indicate the demand for and the WTP for lower risk, or the WTA for greater risk. Because air quality is not a market commodity and has no observable market price, many of the values used in benefit assessments for environmental improvements depend on studies of market-determined wage differentials and consumer expenditures in relation to lower risk of harm from other causes. These differentials and expenditures are then surrogates for the market price for reduced risk of harm from air pollution.

There is an extensive economics literature assessing the value of reduced workplace risk of death. It is, however, important to control for factors other than risk that can influence wage differentials, such as unpleasant working conditions. Studies conducted in the past 20 years do control carefully for job attributes that are not related to differences in risk (Viscusi 1992, 1993, 2004; Viscusi and Aldy 2003). There is a smaller literature that investigates differences in consumer expenditures relative to risk of injury or death associated with product use. The results for the most carefully conducted work, which controls for product characteristics other than relative risk, are generally consistent with the wage-risk studies (Atkinson and Halvorsen 1990; Viscusi 1992). Finally, there are several "meta-analyses" that assess the value of reduced risk based on statistical amalgamation of multiple underlying studies.

IV.2.3 Contingent Valuation

When values inferred from markets are not available, another means to estimate value involves the use of surveys. This method is referred to as contingent valuation (CV) because people are asked to determine what something would be worth to them *as if* they were able to purchase or sell it. CV has become a significant source of values over the past two decades, as the methodology has matured and become more accepted, and as policy-makers (and the courts) have become more engaged with the application of economic values to decision-making. CV-based values, as with wage-risk based WTA values, are conceptually better than COI because they are more inclusive. Respondents can value loss of enjoyment and discomfort, as well as the direct costs of an adverse health effect. The survey approach is, however, expensive to administer and the validity of values derived from this method depends on careful design and application of the survey instrument. Nonetheless, CV measures are in many cases well-supported and add useful information to benefits assessment (Carson et al. 2001).

IV.2.4 Strengths and Limitations of Methods

The most appropriate basis for valuing reductions in adverse health effects is presently WTP values based on CV studies and WTA based on wage-risk studies (Viscusi 1993). COI measures are used when preferred measures are unavailable because a lower bound value is preferable to zero value, which is implied when an effect is not included in the benefits assessment. We use four criteria to choose specific values from the literature.

1. The value used should be appropriate for the type of risk. For example, involuntary risk might carry a higher value than voluntary risk. The degree of risk (1 in 10,000 or 1 in 1,000,000) is a factor, as is whether the risk of harm is increasing or decreasing. Whether harm is prospective or has already occurred is also a factor.[5]
2. A measure should be as complete as possible. That is, it should represent gains or losses in well-being as fully as possible.
3. If similar values are derived from studies using different methods, for example from market-based studies and CV studies, those values are given a greater weight on the premise that convergence implies a closer representation of true value.
4. If more than one valid study produces values that are similar for comparable adverse effects, those values are given greater weight.

Given these criteria, CV results for WTP are most highly ranked for appropriateness and validity, followed by WTA from wage-risk studies (supported by WTP from a valid consumer behavior study), and then COI measures.

IV.3 SPECIFIC VALUES FOR PREMATURE DEATH

Premature mortality is the most significant effect of exposure to unhealthful levels of air pollution that can presently be quantified. Consequently, determining a socially appropriate value to attach to reducing the risk of premature mortality is a crucial part of any benefit assessment. It is very important to keep in mind that we are not valuing the life of any identifiable individual, but rather the value of reducing a very small risk over a large population enough so that some people would live longer than would otherwise have been the case.

IV.3.1 The Concept of the Value of a Statistical Life

Wage-risk studies tell us how much more compensation workers must be paid to accept jobs with very slightly elevated risks of job-related death. Consider this example:

There are 10,000 workers and the annual risk of job-related death is 1/10,000 greater than in a lower wage job. This means that we would expect one job-related death in this group annually (10,000 x 1/10,000). Let's say that each worker is paid $700 per year more as a result of this risk, and workers not facing this risk are paid $700 per year less than those at risk. The implied value of reducing risk just enough to prevent one death is $700 x 10,000 = $7,000,000. This is what economists call the value of a statistical life (VSL). Studies of consumer choices and product risk are based on the same approach—the small difference that each consumer pays to reduce a slight risk aggregated to the level of reducing risk enough to prevent a single death.

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[5] The human capital method used in damage award legal cases is not used here, for example, because harm has already occurred. In assessing the benefits of environmental improvements we are considering the avoidance of harm, not compensation for harm.

IV.3.2 The Range of Values

There is a very wide range across all studies that assess VSL. However, this range can be narrowed significantly by considering the policy objectives with which we are concerned (attainment of the NAAQS), and by reviewing the methods used in each study. In a meta-analysis of VSL from U.S. wage-risk studies (Viscusi and Aldy 2003), most estimates fell into the range of $3.8-$9.0 million (in 2000 dollars) with a median for "prime-aged workers" of $7.6 million in 2007 dollars. This range is also consistent with the most robust consumer choice study (Atkinson and Halvorsen 1990), which found a VSL of $6.1 in 2007 dollars. Mrozek and Taylor (2002), however, using a method that controls for inter-industry wage differentials, report a value of $2.5 million. Finally, Kochi et al. (2006) used an empirical Bayes pooling method to combine VSL estimates from 40 selected studies and reported a value of $10.6 million for their U.S. sample.

IV.3.3 Issues in Selecting Specific Values

To assess the value to society of reducing the risk of premature death associated with elevated levels of air pollution, we want a value that is based on risk of a similar scale (in this case a very small annual risk) and is based on the preferences of people similar to the population at risk from pollution exposure. The need to match the degree of risk and population characteristics as closely as possible raises several issues, largely relating to factors such as age and income.

Groups Most at Risk

For mortality, we have evidence for the very young—newborns—and those aged 30 and over associating elevated pollution with premature death. We also know that the very young, those whose health is already compromised, and those aged 65 and older are at greater risk than the general population.

Age and the Value of Life

Because wage-risk studies are based largely on blue collar workers, they reflect the preferences of younger workers, and not those outside the workforce who are very young or older, but who are likely at greater risk of early death related to air pollution. Since younger people have longer life expectancies, using a VSL based on their preferences might overstate the appropriate VSL for the older population. Similarly, it is likely to understate society's value for young children, as several studies indicate that parents, and society more broadly, place greater value on preventing harm to children than to adults. Further, to the extent that blue collar workers have incomes below the average, their job choices might reflect a lower VSL than would be the case for white collar workers. Complicating this further, older adults are more likely to experience impaired health and could therefore have a lower VSL than is the case for a healthy younger or middle-aged adult or a child, although evidence suggests that this effect, if any, is small (Alberini et al. 2004). In determining which VSL to use to value air quality improvements, these factors are all considered.

The most recent research regarding health status and older age (Alberini et al. 2004) finds no strong evidence that VSL declines significantly with age, and then only at age 70 and above. Further, those with underlying health conditions report little difference in VSL than those who are healthier. At the other end of life, there is evidence (Dickie and Messman 2004; EPA 2003a and the references therein) that families and society place a higher value on children's well-being, but there is no well-established basis to adjust adult values to account for this. Although there are some studies that assess how much more we are willing to pay for children's health, relatively little has been done work regarding how we value their lives.

Consistent with these findings and the recommendations of peer-review advisory groups, benefit assessments carried out for proposed federal and state rules and programs (EPA 2003b, 2004, 2005; CARB 2005; CARB 2008) do not make any adjustment for age or health status. A recent National Research Council panel (NRC 2008), while recommending that further study is necessary, concluded that there is presently no adequate basis to adjust VSL for age.

IV.3.4 The Value of a Statistical Life Used in this Study

Given the range noted above, it is necessary to determine how to narrow this range and select a single value. There is no clear theoretical or mathematical logic for accomplishing this. For example, there is no basis to give any single study greater weight than another, which argues for averaging over a group of studies. Also, it is preferable (EPA-SAB 2007; NRC 2008) to include both wage-risk and stated preference (CV) values. This is in part because the VSL used needs to reflect in some way the age distribution of the population at greatest risk (i.e., the older population). CV studies include this population, whereas wage-risk studies largely do not.

For the purposes of this study, we construct a value based on the meta-analyses of Mrozek and Taylor, Viscusi and Aldy, and Kochi et al. Further, we rely on the U.S.-only values reported by Viscusi and Aldy, and Kochi et al., and include the expanded revealed preference estimate (based on Kochi et al., developed by Deck and Chestnut 2008). The mean of the Viscusi and Aldy U.S. values is $7.6 million, which we average with $2.5 million from Mrozek and Taylor and $10.6 million from Kochi et al. This yields $6.9 million based on hedonic wage-risk studies. Then we give equal weight to the average wage-risk VSL and the CV value of $6.3 million calculated by Deck and Chestnut, which they based on CV studies underlying the Kochi et al. meta-analysis, to determine a final VSL of $6.63 million. (All values are in 2007 dollars.)

IV.4 SPECIFIC VALUES FOR HEALTH ENDPOINTS

Generally accepted values for many endpoints have been developed over the past decade and are widely used in benefit assessments and regulatory analyses by the EPA and the states. These values have been peer-reviewed by advisory bodies, including committees of EPA's Scientific Advisory Board, and many have also been published in the peer-reviewed literature. We generally follow this established protocol, adjusting specific values for inflation and California-specific incomes. Where California-specific COI data are available, as for hospitalizations, we use those values.

IV.4.1 Onset of Chronic Bronchitis

Apart from premature death, the onset of chronic bronchitis is one of the most serious adverse effects that is associated with PM exposure and is quantifiable. The value of avoiding this effect has been estimated in two CV studies (Krupnick and Cropper 1989; Viscusi et al. 1991) and is $402,800 and $396,600 in 2007 dollars (for the SoCAB and SJVAB, respectively), beginning with the value used by EPA (2003b; 2004; 2005) to account for the severity of the disease relative to the underlying studies and updating to reflect current price levels in the two air basins.

IV.4.2 Hospitalizations

Respiratory-related and cardiovascular-related hospitalizations are costly both in terms of treatment and loss of work, household, and leisure time. We use a series of California-based values derived from Chestnut et al. (2006), again adjusting to 2007 dollars using region-specific consumer price indexes, and also separating hospital values for patients over 65 (who mostly are no longer active in the labor force, thus lowering their opportunity cost). In addition, while Chestnut et al. assessed the COI and WTP for adults, we apply this value to the entire population because when children are hospitalized, one or more adults faces the opportunity cost of time diverted from work, caring for other children and other normal activities. The values we apply are as follows:

- Respiratory Hospital Admissions, under 65—$39,550 (SoCAB) and $41,300 (SJVAB)
- Respiratory Hospital Admissions, 65 and over—$34,970 (SoCAB) and $33,490 (SJVAB)
- Cardio Hospital Admissions, under 65—$46,610 (SoCAB) and $44,630 (SJVAB)
- Cardio Hospital Admissions, 65 and over—$40,090 (SoCAB) and $38,390 (SJVAB)

IV.4.3 Minor Restricted Activity Days

Willingness to pay to avoid a day when normal activities are limited by a combination of pollution-related symptoms derives from Tolley et al.'s 1986 study, reported by EPA (2005) as $51 in 1999 dollars and 1990 income. We convert this to current dollars and adjust for income, yielding values of $65.70 and $64.70 in the SoCAB and SJVAB, respectively, per MRAD.

<u>Work Loss Days</u>

Apart from MRADs, when productivity might be lower, some work days are lost outright as a result of $PM_{2.5}$ exposure. These days are valued at the daily wage rate for each county, ranging from $138 in Tulare County to $188 in Orange County (EDD 2008).

Valuing Nonfatal Heart Attacks

Following EPA (2005) and Deck and Chestnut (2008), we note the absence of any WTP values for reduction in nonfatal heart attacks and turn to a COI-based approach. Our monetary value for this health endpoint considers the direct medical costs and the opportunity cost (foregone wages) associated with the heart attack. To calculate the direct medical costs, we combine the results of two studies: Eisenstein et al. (2001), who use a statistical regression model to estimate the first-year (or acute phase) direct medical costs of treating patients to be $24,921 in 1997 dollars; and Russell et al. (1998), who calculate the first year direct costs as $15,540 in 1995 dollars. Averaging these, and updating to 2007 dollars, gives us a direct cost figure of $30,168. For the opportunity costs, we use an age-specific annual lost earnings approach first developed by Cropper and Krupnick (1990). Updating their estimated average annual change in lost earnings to 2007 dollars gives us a foregone earnings estimate of $39,935. Combining this with the direct medical costs, our total annual cost of a nonfatal heart attack becomes $70,103.

School Absence Days

To value days of school absence, Smith et al. (1997) estimated lost productivity to the adult care-giver, under the assumption that one adult stayed home to take care of the sick child. In situations where two caregivers were involved, the lower income was used to estimate lost productivity. In cases where only one adult had an income (about 39 percent of the cohort studied), an imputed value for household work was used.

Using this methodology, Smith et al. estimated the total indirect cost of 3.6 million school loss days to be $194.5 million (in 1994 dollars) This translates into a per-day value of $54.03 (again, in 1994 dollars).

To apply these national figures to our analysis, two adjustments were then made. First, the value was updated to 2007 dollars. Second, it was modified to reflect wage levels in the two air basins. This is the approach adopted by EPA (2005) and used by Hall et al. (2003). This method produces a range of values from $98 in Tulare County to $165 in Orange County.

Upper and Lower Respiratory Symptom Days

For these effects, we adjusted the value that EPA (2005) has adopted, again adjusting for income and inflation to 2007 values. A lower respiratory symptom day is valued at $21.50 and $21.20, and an upper respiratory day at $34.50 and $33.90, for the SoCAB and SJVAB, respectively.

Acute Bronchitis

Bronchitis typically involves multiple symptoms and each occurrence has a duration of about six days (EPA 2005). To construct a value for this effect, we combine Loehman et al.'s (1979) values for chest discomfort and cough and update this number to 2007 dollars, producing values for one day of $19.70 and $19.40 for the SoCAB and SJVAB, respectively. Over a six-day period, these reach a total of $118 and $116.

Asthma Attack

This effect is valued based on a 1986 CV study conducted in Los Angeles (Rowe and Chestnut 1986) that estimated WTP to avoid a "bad asthma day." Adjusting EPA's most recent peer-reviewed figure to current dollars and adjusting for income, this value becomes $53.85 for the SoCAB and $53 for the SJVAB per event.

Emergency Room Visits

Emergency room visits are valued at $361 and $355 for the SoCAB and SJVAB in 2007 dollars, based on two combined COI studies (EPA 2005). This dollar measure does not include time lost at work or school, or the value of avoiding the pain and anxiety caused by the underlying condition and ER visit.

V. RESULTS: THE ESTIMATED ECONOMIC VALUE FROM REDUCED ADVERSE HEALTH EFFECTS WITH ATTAINMENT OF THE FEDERAL AIR QUALITY STANDARDS

Failure to attain health-based air quality standards poses a pervasive and ongoing threat to public health in much of California, as represented by this assessment of the scale of illness and premature death in the South Coast and San Joaquin Valley Air Basins.

V.1 THE SOUTH COAST AIR BASIN

Unsurprisingly, given the large value that individuals and society more broadly place on life, the overall economic benefits of attaining the NAAQS are dominated by premature mortality. It is estimated that across the SoCAB, 3,000 people would avoid premature death each year, accounting only for the effect of $PM_{2.5}$ and only for the population aged 30 and older. With a value for each life of $6.63 million, this effect by itself offers a benefit of attainment of nearly $20 billion each year. While this consequence of elevated fine particle levels is by far the most striking, other effects are also important.

For example, 1,590 new cases of adult-onset chronic bronchitis could be avoided every year with attainment of the $PM_{2.5}$ NAAQS. At a value of over $400,000 for each new case—reflecting the significant costs of treatment and loss of enjoyment and activity—avoiding this effect would generate benefits of over $640 million each year. In addition, attaining the federal fine particulate standard would prevent over 3,200 nonfatal heart attacks annually, generating an economic benefit of more than $226 million, and would reduce days of lost work by nearly 400,000, worth an estimated $72 million. Days of reduced upper respiratory symptoms to the region's asthmatic children would be lessened by more than 1.6 million cases, valued at over $55 million each year.

Ozone attainment offers the benefit of more than a million fewer school absence days, conservatively valued at more than $105 million per year. It should be noted that this only reflects the value of time lost to an adult caregiver and not any medical costs or loss of educational opportunity. MRADs would cost adults nearly 3 million days per year when their daily routine is limited to some degree by exposure to elevated ozone or $PM_{2.5}$. Avoiding MRADs offers an economic benefit of more than $195 million annually.

Tables V-1 through V-4 show the overall benefits in numbers of adverse health effects and annual deaths avoided and in dollars for ozone and for $PM_{2.5}$. Looking at the overall benefits, residents of the SoCAB could expect annual benefits of $21.23 billion if both the ozone and $PM_{2.5}$ NAAQS were attained.

The per capita benefits are also noteworthy and provide a sense of perspective. On a basin-wide average, annual benefits are over $1,225 per person. This varies across counties with the levels of pollution and the size of the more vulnerable populations, and very slightly with income (which determines or influences the value of some effects). The county-level average benefits per resident range from $955 in Orange County to over $1,650 in Riverside County.[6]

V.2 THE SAN JOAQUIN VALLEY AIR BASIN

In the SJVAB, the overall benefits of attaining the NAAQS are dominated by premature mortality. Again, this reflects the large value that individuals and society place on the value of a statistical life. Across the SJVAB, over 800 people are estimated to avoid premature death annually, accounting only for the effect of $PM_{2.5}$ and only for the population aged 30 and older. With a value for each life of $6.63 million, this effect alone offers a benefit of attainment of over $5 billion each year. While this consequence of elevated $PM_{2.5}$ levels is by far the most dominant, there are other important health outcomes to be realized as well.

For example, more than 580 nonfatal heart attacks could be avoided each year with attainment of the fine particulate standards, generating an economic benefit of more than $40 million for the SJVAB. Work loss days would also be reduced by nearly 70,000, with an estimated monetary value of $10.5 million, and over 360,000 cases of upper respiratory symptoms to the region's asthmatic children would be avoided, valued at more than $12 million annually. Finally, more than 360 new cases of chronic bronchitis could be avoided each year with attainment of the $PM_{2.5}$ NAAQS. At a value of almost $400,000 per case—reflecting the significant costs of treatment and loss of enjoyment and activity—avoiding this adverse outcome would generate benefits of over $140 million each year.

The attainment of $PM_{2.5}$ and ozone standards would generate a benefit of more than 540,000 fewer MRADs, valued at $35 million annually. Ozone attainment also offers the benefit of over 150,000 fewer school absence days, conservatively valued at more than $12 million per year. It should be noted that this only reflects the value of time lost to an adult caregiver and not any medical costs or loss of educational opportunity.

Tables VI-5 through VI-8 show the overall benefits in numbers of adverse health effects avoided and in dollars for ozone and for $PM_{2.5}$. Looking at the overall benefits, SJVAB residents could expect annual benefits of $5.73 billion with the attainment of both the ozone and $PM_{2.5}$ standards.

Finally, to provide a sense of perspective, we also examine the per capita benefits of these pollution reductions. For the SJVAB overall, annual benefits average over $1,600 per person, with county-level average benefits per resident ranging from $1,150 in Merced County to over $2,150 in Kern County.[7] These estimates vary across counties with the levels of pollution and the size of the more vulnerable populations, and very slightly with income (which determines or influences the value of some effects).

We note that these results report larger benefits from attaining the NAAQS than our previous analysis of the SJVAB (Hall et al. 2006, 2008). The differences are explained primarily

[6] Los Angeles $1,211; Orange $955; Riverside $1,652; San Bernardino $1,492; entire SOCAB $1,226.

[7] Fresno $1,716; Kerns $2,159; Kings $1,459; Madera $1,682; Merced $1,150; San Joaquin $1,195; Stanislaus $1,392; Tulare $1,969; entire SJVAB $1,631.

by increased exposures to $PM_{2.5}$, a higher relative risk factor for premature mortality (based on newer health studies), and the inclusion of non-fatal heart attacks and ozone-related premature mortality.

Table V-1. $PM_{2.5}$-related health effects in the South Coast Air Basin.

	Los Angeles	Orange	Riverside	San Bernardino	All Counties
Minor Restricted Activity Days Ages 18-64	1,224,600	300,010	224,780	266,830	2,016,220
Premature Mortality Ages 30 and older	1,720	410	460	410	3,000
Post Neo-Natal Mortality	7	1	1	2	11
Work Loss Days Ages 18-64	241,690	59,100	44,500	52,850	398,140
Lower Respiratory Symptoms Ages 5-17	47,160	10,930	9,540	11,970	79,600
Upper Respiratory Symptoms Asthmatic Children	944,900	220,400	206,300	246,500	1,618,100
Acute Bronchitis Ages 5-17	7,420	1,740	1,540	1,810	12,510
Chronic Bronchitis Ages 27 and older	960	240	190	200	1,590
Children's Asthma ER Visits	1,175	275	255	305	2,010
Non-Fatal Heart Attacks	1,960	485	370	415	3,230
Respiratory Hospital Admissions 0-64	95	14	19	27	155
Respiratory Hospital Admissions 65+	257	48	57	50	412
Respiratory Hospital Admissions Total	352	62	76	77	567
Cardio Hospital Admissions 0-64	121	25	26	27	199
Cardio Hospital Admissions 65+	430	88	118	83	719
Cardio Hospital Admissions Total	551	113	144	110	918

Table V-2. $PM_{2.5}$-related economic values in the South Coast Air Basin.

	Los Angeles	Orange	Riverside	San Bernardino	All Counties
Minor Restricted Activity Days (millions)	$80.46	$19.71	$14.77	$17.53	$132.5
Premature Mortality (millions)	$11,397	$2,717	$3,048	$2,717	$19,878
Post Neo-Natal Mortality (millions)	$46.38	$6.63	$6.63	$13.25	$72.89
Work Loss Days (millions)	$44.93	$11.09	$7.16	$8.50	$71.67
Lower Respiratory Symptoms (millions)	$1.02	$0.24	$0.21	$0.26	$1.71
Upper Respiratory Symptoms (millions)	$32.56	$7.59	$7.11	$8.49	$55.76
Acute Bronchitis (thousands)	$877.4	$205.8	$182.1	$214.0	$1,479.0
Chronic Bronchitis (millions)	$386.7	$96.7	$76.5	$80.5	$640.4
Children's Asthma ER Visits (thousands)	$423.9	$99.2	$92.0	$110.0	$725.1
Non-Fatal Heart Attacks (millions)	$137.4	$34.0	$25.94	$29.09	$226.4
Respiratory Hospital Admissions (millions)	$12.91	$2.26	$2.78	$2.86	$20.81
Cardio Hospital Admissions (millions)	$22.88	$4.69	$5.94	$4.59	$38.10
Total Value in Millions	$12,164	$2,900	$3,195	$2,882	$21,141

Table V-3. Ozone-related health effects in the South Coast Air Basin.

	Los Angeles	Orange	Riverside	San Bernardino	All Counties
Respiratory Hospital Admissions Ages 0-64	333	77	117	129	656
Respiratory Hospital Admissions Ages 65+	47	10	68	44	169
Respiratory Hospital Admissions All ages	380	87	185	173	825
Asthma Attacks Asthmatic population all ages	59,100	17,010	22,480	22,380	120,970
Emergency Room Visits All ages	150	45	55	55	305
School Absences Ages 5-17	408,310	115,320	78,650	90,430	692,710
Days of School Absences Ages 5-17	653,300	184,500	125,840	144,690	1,108,330
Minor Restricted Activity Days Ages 18-64	483,840	142,380	164,470	170,720	961,410
Mortality	12	3	15	11	41

Table V-4. Ozone-related economic values in the South Coast Air Basin.

	Los Angeles	Orange	Riverside	San Bernardino	All Counties
Respiratory Hospital Admissions (millions)	$15.40	$3.53	$7.21	$6.87	$33.0
Asthma Attacks (millions)	$3.183	$0.916	$1.21	$1.205	$6.514
Emergency Room Visits (thousands)	$54.12	$16.24	$19.84	$19.84	$110.04
Days of School Absences (millions)	$58.63	$22.30	$12.17	$12.88	$105.97
Minor Restricted Activity Days (millions)	$31.79	$9.35	$10.81	$11.22	$63.16
Mortality (millions)	$79.51	$19.88	$ 99.39	$72.89	$271.67
Total Value in Millions	$188.6	$56.0	$130.8	$105.1	$480.5

Table V-5. $PM_{2.5}$-related health effects in the San Joaquin Valley Air Basin.

	Fresno	Kern	Kings	Madera	Merced	San Joaquin	Stanislaus	Tulare	All Counties
Minor Restricted Activity Days Ages 18-64	103,770	80,170	18,770	16,020	21,840	49,360	45,660	50,750	386,340
Premature Mortality Ages 30 and older	211	182	29	33	38	110	99	110	812
Post Neo-Natal Mortality	1	1	0	0	0	0	0	0	2
Work Loss Days Ages 18-64	18,500	14,280	3,340	2,850	3,880	8,740	8,120	9,030	68,740
Lower Respiratory Symptoms Ages 5-17	4,900	3,830	710	670	1,170	2,280	2,100	2,600	18,260
Upper Respiratory Symptoms Asthmatic Children	98,270	76,530	14,340	13,420	22,870	44,130	41,260	51,520	362,340
Acute Bronchitis Ages 5-17	950	790	140	130	210	450	410	510	3,600
Chronic Bronchitis Ages 27 and older	95	78	17	15	19	48	44	48	364
Children's Asthma ER Visits	119	93	17	16	28	54	50	63	440
Non-Fatal Heart Attacks	156	119	27	24	33	78	70	77	584
Respiratory Hospital Admissions 0-64	8	5	2	1	1	4	3	3	27
Respiratory Hospital Admissions 65+	24	18	2	4	5	14	13	12	92
Respiratory Hospital Admissions Total	32	23	4	5	6	18	16	15	119
Cardio Hospital Admissions 0-64	11	7	2	2	2	5	5	5	39
Cardio Hospital Admissions 65+	37	23	4	6	6	20	18	17	131
Cardio Hospital Admissions Total	48	30	6	8	8	25	23	22	170

Table V-6. $PM_{2.5}$-related economic values in the San Joaquin Valley Air Basin.

	Fresno	Kern	Kings	Madera	Merced	San Joaquin	Stanislaus	Tulare	All Counties
Minor Restricted Activity Days (millions)	$6.71	$5.19	$1.21	$1.04	$1.41	$3.19	$2.95	$3.28	$24.98
Premature Mortality (millions)	$1,398.0	$1,206.0	$192.2	$218.7	$251.8	$728.9	$656.0	$728.9	$5,380.0
Post Neo-Natal Mortality (millions)	$6.63	$6.63	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$13.25
Work Loss Days (millions)	$2.89	$2.23	$0.51	$0.41	$0.58	$1.40	$1.28	$1.25	$10.55
Lower Respiratory Symptoms (thousands)	$103.9	$81.2	$15.1	$14.2	$24.8	$48.4	$44.5	$55.2	$387.3
Upper Respiratory Symptoms (millions)	$3.33	$2.60	$0.49	$0.46	$0.76	$1.50	$1.40	$1.75	$12.29
Acute Bronchitis Value (thousands)	$110.6	$92.0	$16.3	$15.1	$24.5	$52.4	$47.7	$59.4	$418.0
Chronic Bronchitis Value (millions)	$37.68	$30.94	$6.74	$5.95	$7.54	$19.04	$17.45	$19.04	$144.4
Children's Asthma ER Visits (thousands)	$42.28	$33.04	$6.04	$5.68	$9.95	$19.18	$17.76	$22.38	$156.3
Non-Fatal Heart Attacks (millions)	$10.94	$8.34	$1.89	$1.68	$2.31	$5.47	$4.91	$5.40	$40.94
Respiratory Hospital Admissions (millions)	$1.12	$0.80	$0.15	$0.17	$0.21	$0.63	$0.55	$0.52	$4.15
Cardio Hospital Admissions (millions)	$1.91	$1.20	$0.24	$0.32	$0.32	$0.99	$0.91	$0.88	$6.77
Total Value in Millions	$1,469	$1,264	$203	$229	$265	$761	$686	$761	$5,638

Table V-7. Ozone-related health effects in the San Joaquin Air Basin.

	Fresno	Kern	Kings	Madera	Merced	San Joaquin	Stanislaus	Tulare	All Counties
Respiratory Hospital Admissions Ages 0-64	32	30	4	4	6	15	13	17	121
Respiratory Hospital Admissions Ages 65+	14	11	1	2	2	2	3	7	42
Respiratory Hospital Admissions All ages	46	41	5	6	8	17	16	24	163
Asthma Attacks Asthmatic population all ages	5,670	4,640	890	780	1,090	2,290	2,100	2,940	20,400
Emergency Room Visits All ages	17	13	3	2	3	7	7	8	60
School Absences Ages 5-17	27,490	23,630	3,780	3,440	5,330	8,190	8,440	14,400	94,700
Days of School Absences Ages 5-17	43,980	37,810	6,050	5,500	8,530	13,100	13,500	23,040	151,510
Minor Restricted Activity Days Ages 18-64	42,970	34,620	7,580	6,320	8,070	17,170	15,190	21,830	153,750
Mortality	3	3	0	0	0	0	1	2	9

Table V-8. Ozone-related economic values in the San Joaquin Valley Air Basin.

	Fresno	Kern	Kings	Madera	Merced	San Joaquin	Stanislaus	Tulare	All Counties
Respiratory Hospital Admissions--All ages (millions)	$1.73	$1.55	$0.19	$0.23	$0.30	$0.66	$0.61	$0.91	$6.19
Asthma Attacks Asthmatic population (thousands)	$301	$246	$47	$41	$58	$121	$111	$156	$1,081
Emergency Room Visits (thousands)	$6.04	$4.62	$1.07	$0.71	$1.07	$2.49	$2.49	$2.84	$21.32
Days of School Absences (millions)	$3.35	$3.02	$0.48	$0.43	$0.68	$1.21	$1.20	$1.65	$12.02
Minor Restricted Activity Days (millions)	$2.78	$2.24	$0.49	$0.41	$0.52	$1.11	$0.98	$1.41	$9.95
Mortality (millions)	$19.88	$19.88	$ 0	$ 0	$ 0	$ 0	$6.63	$13.25	$59.63
Total Value in Millions	$28.05	$26.94	$1.21	$1.11	$1.56	$3.10	$9.53	$17.38	$88.88

VI. CONCLUSIONS AND IMPLICATIONS

VI.1 CONCLUSIONS

Almost every resident of the South Coast Air Basin, and *every* resident of the San Joaquin Valley Air Basin, regularly experiences air pollution levels known to harm health and to increase the risk of early death. For example, from 2005 through 2007, each person was on average exposed to unhealthful levels of ozone on nearly 20 and more than 30 days per year in the SoCAB and SJVAB, respectively. In Riverside and San Bernardino Counties this rises to nearly 50 days each year, and in Kern County, over 50 days. This is unsurprising, given how frequently and pervasively the health-based air quality standards are violated. These exposures translate directly into poorer health and an elevated risk of premature death. Further, some groups are more at risk than the average, with somewhat greater exposure for children. In the SJVAB, 66% of the population is exposed to health-endangering annual average levels of $PM_{2.5}$. In the SoCAB, this averages over 64%, and in the most populated county—Los Angeles—it averages 75%.

Other noteworthy results of the analysis include

1. For the San Joaquin Valley Air Basin overall, the economic benefits of meeting the federal $PM_{2.5}$ and ozone standards average more than $1,600 *per person per year*, or a total of nearly $6 billion.
2. Residents of the South Coast Air Basin, on average, would gain an annual economic benefit of more than $1,250 in improved health if the federal ozone and $PM_{2.5}$ standards were met, totaling nearly $22 billion.

These dollar values represent the following for the two air basins and two pollutants combined:

- 3,860 fewer premature deaths among those age 30 and older
- 13 fewer premature deaths in infants
- 1,950 fewer new cases of adult onset chronic bronchitis
- 3,517,720 fewer days of reduced activity in adults
- 2,760 fewer hospital admissions
- 141,370 fewer asthma attacks
- 1,259,840 fewer days of school absence
- 16,110 fewer cases of acute bronchitis in children
- 466,880 fewer lost days of work
- 2,078,300 fewer days of respiratory symptoms in children
- 2,800 fewer emergency room visits

To place the reduction in premature deaths in perspective, attaining the federal $PM_{2.5}$ standard would save more lives than reducing the number of motor vehicle fatalities to zero in most of the counties in this study. In Los Angeles County, $PM_{2.5}$-related deaths (CHP 2007) are *more than double* the number of motor vehicle-related deaths. Table VI-1 shows vehicular and $PM_{2.5}$-related deaths for all counties.

Table VI-1. $PM_{2.5}$-related vehicular deaths[8] relative to $PM_{2.5}$-related deaths annually.

County	Vehicular	$PM_{2.5}$-related
Los Angeles	801	1,720
Orange	210	410
Riverside	349	460
San Bernardino	387	410
SoCAB	1,747	3,000
Fresno	154	211
Kern	198	182
Kings	45	29
Madera	48	33
Merced	57	38
San Joaquin	93	110
Stanislaus	81	99
Tulare	98	110
SJV	774	812
Total	2,521	3,812

VI.2 IMPLICATIONS

The majority of California residents face significant public health risks from the present unhealthful levels of ozone and fine particles. This is in addition to other health challenges, including a high rate of poverty (which exceeds 30% in Fresno County, compared to a statewide rate below 20%) and lack of access to health care. Substantial economic and health gains would result from effective policies to reduce pollution levels.

The adverse impacts of air pollution are not distributed equally. Residents of Fresno, Kern, Kings, and Tulare Counties experience significantly more days when the $PM_{2.5}$ standards are violated than the basin-wide averages, as do San Bernardino and Riverside Counties. Tulare, Riverside and San Bernardino Counties join Fresno and Kern in being well above the basin average for the number of days of exposure above the ozone standards. Children under the age of 5 are exposed to unhealthful ozone concentrations on more days than adults. Blacks and Hispanics experience somewhat more frequent exposures to elevated levels of $PM_{2.5}$ than non-Hispanic whites do. These groups all stand to gain relatively more from successful pollution reduction efforts.

Because ozone is typically more often elevated during the summer months, and the $PM_{2.5}$ 24-hr standard is typically violated more frequently in the winter months, there is essentially no "clean" season in either air basin.

[8] http://www.chp.ca.gov/switrs/pdf/2006-sec8.pdf

As the population continues to increase, with associated increases in vehicle traffic and economic activity, the gains from attaining the health-based air quality standards will grow, but will also become more difficult to achieve. Identifying and acting on opportunities now would produce substantial gains for more than 20 million Californians.

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Appendix A. SENSITIVITY ANALYSIS BY ENDPOINT

The results presented in Section VI report a mid-value for each health effect, based on professional consensus regarding the concentration-response relationships that "best" represent the association between exposure and resulting adverse health effects. It is generally accepted, however, that the real association lies within a range. Here we present the results of sensitivity tests that estimate benefits based on such a range, generally based on 95% confidence intervals obtained from the original health studies. This analysis produces an expected wide range in the results, which are shown in Tables A-1 through A-4.

One noteworthy result is the high estimate for premature mortality, indicating nearly 4,900 deaths per year associated with violations of the NAAQS for $PM_{2.5}$ in the SoCAB and over 1,300 deaths per year in the SJVAB. This contrasts with our base case results of 3,000 and 800 avoided deaths in the SoCAB and SJVAB, respectively. The differences result from the use of the expert elicitation's (Roman et al. 2008) central value for the "base" case and Jerrett et al.'s (2005) result for the high case. As noted in Section IV.1, Jerrett et al. may be a better representation of risk, especially for the SoCAB population, than is the Roman et al. result, a conclusion reached by several peer reviewers who addressed this question recently for ARB (CARB 2005). However, as discussed in section IV.1 and in Deck and Chestnut (2008), the reasons why the Jerrett et al. results indicate a larger association between premature mortality and elevated levels of $PM_{2.5}$ is not yet fully understood.

Table A-1. Ozone-Related Effects Low and High Case Ranges – South Coast Air Basin.

Adverse Effect	All Counties – Range of Effects	All Counties – Range of Value
Respiratory Hospital Admissions All ages	490 – 1,140	$19,510,000 – 45,420,000
Asthma Attacks Asthmatic population all ages	27,730 – 210,960	$1,493,000 – 11,360,000
Emergency Room Visits All ages	210 – 400	$75,770 – 144,300
Days of School Absences Ages 5-17	521,500 – 1,666,000	$49,860,000 – 159,300,000
Minor Restricted Activity Days Ages 18-64	391,200 – 1,517,000	$25,310,000 – 98,150,000
Mortality All ages	30 – 50	$198,800,000 – 351,200,000

Table A-2. $PM_{2.5}$-Related Effects Low and High Case Ranges – South Coast Air Basin.

Adverse Effect	All Counties – Range of Effects	All Counties – Range of Value
Minor Restricted Activity Days Ages 18-64	1,650,00 – 2,376,000	$106,800,000 – 153,700,000
Premature Mortality Ages 30 and older	1,840 – 4,880	$12,190,000,000 – 32,330,000,000
Post Neo-Natal Mortality	6 – 20	$39,760,000 – 132,500,000
Work Loss Days Ages 18-64	337,340 – 458,400	$60,720,000 – 82,520,000
Lower Respiratory Symptoms Ages 5-17	18,410 – 131,700	$396,600 – 2,837,000
Upper Respiratory Symptoms Asthmatic Children	280,200 – 2,858,500	$9,656,000 – 98,500,000
Acute Bronchitis Ages 5-17	4,790 – 19,780	$566,400 – 2,339,000
Chronic Bronchitis Ages 27 and older	810 – 2,350	$326,300 – 946,600
Children's Asthma ER Visits	1,145 – 2,865	$413,100 – 1,034,000
Non-Fatal Myocardial Infarctions (Heart Attacks)	830 – 5,165	$58,180,000 – 362,100,000
Respiratory Hospital Admissions All ages	345 – 850	$12,400,000 – 31,520,000
Cardio Hospital Admissions All ages	740 – 1,150	$30,500,000 – 48,110,000

Table A-3. Ozone-Related Effects Low and High Case Ranges – San Joaquin Valley Air Basin.

Adverse Effect	All Counties – Range of Effects	All Counties – Range of Value
Respiratory Hospital Admissions All ages	100 – 225	$3,672,000 – 8,586,000
Asthma Attacks Asthmatic population all ages	4,660 – 35,650	$247,100 – 1,890,000
Emergency Room Visits All ages	40 – 80	$14,210 – 28,420
Days of School Absences Ages 5-17	71,260 – 227,800	$5,650,000 – 18,070,000
Minor Restricted Activity Days Ages 18-64	62,480 – 243,000	$4,042,000 – 15,720,000
Mortality All ages	6 – 14	$39,360,000 – 92,760,000

Table A-4. $PM_{2.5}$-Related Effects Low and High Case Ranges – San Joaquin Valley Air Basin.

Adverse Effect	All Counties – Range of Effects	All Counties – Range of Value
Minor Restricted Activity Days Ages 18-64	317,900 – 452,800	$20,570,000 – 29,300,000
Premature Mortality Ages 30 and older	500 – 1,320	$3,313,000,000 – 8,746,000,000
Post Neo-Natal Mortality	0 – 5	$ 0 – 33,130,000
Work Loss Days Ages 18-64	58,400 – 78,890	$8,970,000 – 12,120,000
Lower Respiratory Symptoms Ages 5-17	4,440 – 28,820	$94,170 – 611,300
Upper Respiratory Symptoms Asthmatic Children	64,280 – 625,000	$2,181,000 – $21,200,000
Acute Bronchitis Ages 5-17	1,390 – 5,660	$161,800 – 659,000
Chronic Bronchitis Ages 27 and older	185 – 540	$73,370,000 – 214,200,000
Children's Asthma ER Visits	260 – 615	$92,360 – 218,500
Non-Fatal Myocardial Infarctions (Heart Attacks)	160 – 880	$11,220,000 – 61,690,000
Respiratory Hospital Admissions All ages	60 – 175	$2,060,000 – 6,181,000
Cardio Hospital Admissions All ages	140 – 215	$5,540,000 – 8,636,000

Table II-15. The estimated average number of days per year that the population is exposed to daily $PM_{2.5}$ concentrations above 35, 50, and 65 $\mu g/m^3$ in the 2005-2007 baseline period and with NAAQS attainment by age group.

Air Basin	Age Group	Average Number of Days Per Year Above Concentration				
		In the 2005-2007 Baseline Period			With NAAQS attainment	
		>35 $\mu g/m^3$	>50 $\mu g/m^3$	>65 $\mu g/m^3$	>35 $\mu g/m^3$	>50 $\mu g/m^3$
South Coast	Children < 1 Year	17.0	4.1	0.6	0.2	0
	Children 1 Year	17.1	4.2	0.6	0.2	0
	Children 2-4 Years	17.1	4.2	0.6	0.2	0
	Children 5-17 Years	17.0	4.1	0.6	0.2	0
	Adults 18-21 Years	17.1	4.1	0.5	0.2	0
	Adults 22-29 Years	16.9	4.0	0.5	0.2	0
	Adults 30-64 Years	16.6	3.8	0.5	0.2	0
	Adults >64 Years	15.9	3.6	0.5	0.2	0
San Joaquin	Children < 1 Year	44.1	16.8	4.8	3.4	0
	Children 1 Year	44.0	16.7	4.8	3.4	0
	Children 2-4 Years	43.9	16.6	4.7	3.3	0
	Children 5-17 Years	43.7	16.5	4.6	3.3	0
	Adults 18-21 Years	43.8	16.5	4.6	3.3	0
	Adults 22-29 Years	44.0	16.8	4.7	3.3	0
	Adults 30-64 Years	43.4	16.3	4.6	3.2	0
	Adults >64 Years	43.1	16.1	4.4	3.1	0

Table II-16. The estimated population exposure to daily $PM_{2.5}$ concentrations above 35, 50, and 65 $\mu g/m^3$ in the 2005-2007 baseline period and with NAAQS attainment by race/ethnicity group.

Air Basin	Age Group	Person-days of Exposure Above Concentration (in millions per year)				
		In the 2005-2007 Baseline Period			With NAAQS attainment	
		>35 $\mu g/m^3$	>50 $\mu g/m^3$	>65 $\mu g/m^3$	>35 $\mu g/m^3$	>50 $\mu g/m^3$
South Coast	White*	102.66	21.68	3.56	1.51	0
	Black*	24.12	5.68	0.76	0.29	0
	Hispanic	124.07	31.20	3.79	1.44	0
	Other*	38.19	8.89	0.89	0.32	0
San Joaquin	White*	69.57	26.06	7.18	5.07	0
	Black*	7.29	2.76	0.83	0.60	0
	Hispanic	65.48	25.07	7.18	5.03	0
	Other*	10.83	3.84	0.98	0.68	0

* Non-Hispanic