2004 SAN DIEGO REGIONAL TRANSPORTATION IMPROVEMENT PROGRAM REGIONAL EMISSIONS ANALYSIS AND MODELING PROCEDURES

INTRODUCTION

SANDAG and the U.S. Department of Transportation (DOT) must make a determination that the 2004 Regional Transportation Improvement Program (RTIP) conforms to the State Implementation Plan (SIP) for air quality. Conformity to the SIP means that transportation activities will not create new air quality violations, worsen existing violations, or delay the attainment of the national ambient air quality standards.

On October 4, 2002, the U.S. DOT made the conformity finding of the 2002 San Diego RTIP (FY 2003 to FY 2007).

To evaluate transportation conformity of the 2004 RTIP (FY 2005 to FY 2009), emissions forecasts were prepared for the years 2010, 2014, 2020, and 2030. The air quality analysis of the 2004 RTIP is consistent with the analysis prepared for the 2030 Regional Transportation Plan (RTP). The SANDAG Board of Directors made a conformity determination and adopted the 2030 RTP on March 28, 2003. On that date, the Board of Directors also reaffirmed the 2002 RTIP conformity finding. The U.S. DOT made the conformity finding for the 2030 RTP on April 9, 2003.

On July 23, 2004, the SANDAG Board of Directors will be asked to make a finding of conformity and to adopt the 2004 RTIP. The Board also will be asked to redetermine conformity of the 2030 RTP to the current 1-Hour ozone emissions budgets.

GROWTH FORECASTS

Every three to five years, SANDAG produces a long-range forecast of population, housing, and employment growth for the San Diego region. The most recent is the Final 2030 Cities/County Forecast, which was accepted by the SANDAG Board of Directors for use in planning studies on December 19, 2003.

The forecast process relies upon three integrated forecasting models. The first one, the Demographic and Economic Forecasting Model (DEFM), provides a detailed econometric and demographic forecast for the entire region. The second one, the Interregional Commuting Model, provides a forecast of interregional commuting expected during the forecast period. The third one, the Urban Development Model, allocates the results of the first two models to subregional areas based upon the current plans and policies of the jurisdictions.

The Final 2030 Cities/County Forecast is based solely upon the general and community plans of the 18 cities as adopted. For the unincorporated area, the forecast is based upon the most recent (December 2002) version of the County's GP2020 plan update, as the Board of Supervisors feels that it most accurately reflects the County's future direction.

SANDAG consulted with the San Diego Region Conformity Working Group (CWG) on the use of the Final 2030 Cities/County Forecast for the 2004 RTIP air quality conformity analysis. Both DOT and the EPA have concurred that approved plans should be used as input in the air quality conformity process. Table 1 shows the regional population and employment growth forecast for the San Diego region through 2030.

Table 1 — SAN DIEGO REGIONAL POPULATION AND EMPLOYMENT FORECAST

Final 2030 Cities/County Forecast		
Year	**Total Population**	**Total Employment**
2000	2,813,833	1,384,676
2010	3,211,721	1,528,522
2020	3,528,605	1,672,883
2030	3,855,085	1,824,030

Source: SANDAG, 2003

TRANSPORTATION MODELING

SANDAG follows a widely used four-step transportation modeling process to forecast travel activity in the San Diego region. Travel forecasting procedures are described in more detail in SANDAG's Regional Transportation Models (1995) and the Preliminary 2030 Forecast Process and Model Documentation (April 2003), which are available upon request.

The estimates of regional transportation-related emissions analysis meet the requirements established in the Transportation Conformity Rule, Sections 93.122(b) and 93.122(c). These requirements relate to the procedures to determine regional transportation-related emissions, including the use of network-based travel models, methods to estimate traffic speeds and delays, and the estimation of vehicle miles of travel.

Tranplan is the transportation planning computer package used to forecast travel activity utilizing datasets that are maintained in the geographic information system (GIS). The transportation modeling steps consist of:

1. Generating average weekday person trip ends in each zone.
2. Estimating trip movements between zones using a trip distribution model.
3. Allocating trips to different forms of transportation using a mode split model.
4. Assigning vehicle trips to road segments using a traffic assignment model.

Two iterations through the modeling process are made to reach equilibrium between transportation facilities and demand, where congested travel times from the first iteration are input to the second iteration.

The transportation models require two major inputs. One input is a zonal level households and land use forecast, which determines the number of trips generated. Highway and transit system networks are the other key input that affects the amount and location of vehicular travel.

Highway Networks

The regional highway networks in the San Diego 2004 RTIP include all roads classified by local jurisdictions in their circulation elements. These roads include freeways, expressways, and the Regional Arterial System (RAS). The RAS consists of all conventional state highways, prime arterials, and selected major streets. In addition, some residential streets are included in the networks for connectivity between zones.

The route improvements and additions in the 2004 RTIP are developed as an integral part of San Diego's regional growth management and forecasting process. They are intended to provide adequate travel service that is compatible with adopted regional policies for land use and population growth. All regionally significant projects from the 2004 RTIP are included in the quantitative emissions analysis. These include all state highways, all proposed National Highway System routes, all regionally significant arterials, and all FHWA functionally classified "Other Principal Arterials." Projects included in the 2004 RTIP are listed in Table 1.

The networks also account for programs intended to improve the operation of the highway system, including high occupancy vehicle (HOV) lanes and ramp metering. Existing and proposed toll facilities also are modeled to reflect time, cost, and capacity effects of these facilities. The SR 125 South project and SR 241 are the only modeled toll facilities in the San Diego region.

In addition, several managed/HOV lanes are included in the 2004 RTIP. Facilities with proposed managed lanes include I-5, I-15, I-805, and SR 52. It is assumed that the excess capacity not utilized by carpools and transit on HOV routes with two or more lanes in the peak direction as well as reversible HOV routes would be managed so that single occupant vehicles could use these lanes under a pricing mechanism. Traffic flows would be managed so that the facility would operate at level of service C or better.

Based upon the networks and programs described above, the 2004 RTIP transportation forecasts differentiate between single occupant and multi-occupancy or high occupancy vehicle travel times. SANDAG normally maintains networks for 2000 (the 2030 Cities/County Forecast base year) and the years 2010, 2020, and 2030. A 2014 network also was created to conduct the air quality conformity analysis of the 2004 RTIP for the 2014 1-Hour ozone emissions budgets.

Locally funded regionally significant projects also have been included in the air quality conformity analysis. These projects are funded with *TransNet* funds, a 20-year one-half percent local sales tax for transportation that expires in 2008, and other local revenue sources.

Transit Networks

SANDAG also maintains transit network datasets for existing and proposed transit systems. Bus speeds assumed in the transit networks are derived from modeled highway speeds and reflect the effects of congestion. Regional and express transit routes on surface streets are assumed to operate out of congestion due to priority transit treatments. Higher bus speeds may result for transit vehicles operating on highways with HOV lanes and HOV bypass lanes at ramp meters, compared to those routes that operate on highways where these facilities do not exist.

Locally funded regionally significant transit projects have been included in the air quality conformity analysis of the 2004 RTIP. These transit projects also are funded with *TransNet* funds or other local revenue sources. Once network coding is completed, the transportation models are run for the applicable scenarios. Four highway and transit networks (2010, 2014, 2020, and 2030) were coded for the conformity analysis.

Transit projects included in the 2004 RTIP are listed in Table 1.

Trip Generation

Trip generation is the first step in the transportation modeling process. Average weekday trip ends by all forms of transportation starting and ending in each zone are estimated for ten trip types: home-work, home-college, home-school, home-shop, home-other, work-other, and other-other, serve passenger, visitor, and airport.

The trip generation model works by applying trip rates to zone level growth forecasts. Trip production rates are expressed as trips per household. Trip production rates vary by trip type and structure type. Trip attractions are expressed as trips per acre of non-residential land use or trips per household. Trip attraction rates vary by trip type and land use category. The Final 2030 Cities/County Forecast was used to produce trip generation forecasts for the years 2010, 2014, 2020, and 2030.

In recent years, urban planners have engaged in a debate about whether increasing highway capacity generates induced travel. Most opinions revolve around the following ideas:

- Households will make new trips because adding highway capacity reduces the cost or time spent traveling to a location. However, travel costs or travel times will ultimately increase over time as more vehicles use a facility and the new road begins to experience congestion.
- New facilities may cause a diversion of existing trips from more congested roads to less congested ones. New land uses along a corridor also may result in redistribution of trips to a new destination using an alternative route, but do not necessarily cause more trips overall.

SANDAG's regional transportation model uses a relatively high trip generation rate for households (8.1 vehicle trips per day), which may account for possible increases in trip making as new facilities are built. Also, the model accounts for travel diversion among facilities.

Trip Distribution

After trip generation, trip movements between zones are determined using a trip distribution gravity model. Inputs to the trip distribution model include zone level trip generation forecasts by trip type, zone-to-zone travel times, and friction factors by trip type.

Travel times are based upon the 2004 RTIP network scenarios. Highway improvements may induce longer trip lengths by allowing motorists to travel farther in the same amount of time. This effect is represented with the trip distribution model. Travel times differ between initial and final model iterations. Initial travel times reflect free-flow conditions, and final times reflect the effects of congestion.

Mode Choice

At this point in the modeling process, total person trip movements between zones are split into different forms of transportation: drive alone, 2-person carpools, 3+ person carpools, transit, and other (bicycling and walk). Trips between zone pairs are allocated to modes based upon the cost and time of traveling by a particular mode compared to the cost and time of traveling by other modes. For example, vehicle trips on a congested route would be more likely to be diverted to light rail than vehicle trips on an uncongested freeway.

Income level also is considered since surveys show that high-income travelers are more concerned about the level of service offered by a mode than those with lower incomes. The mode choice model is calibrated using 1995 Travel Behavior Survey trip tables by mode and income and 1995 Regional Transit Survey transit trip characteristics. Preliminary Census 2000 journey-to-work data and 2000 onboard transit passenger counts also are used in the calibration process.

A number of data files are input to the mode choice model. These include:

- Zonal incomes,
- Trip tables from the distribution model,
- Peak and off-peak period highway times,
- Peak period HOV times,
- Peak and off-peak period transit times,
- Transit fares,
- Auto driving and parking costs, and
- Transit accessibility measures.

Highway and transit travel time datasets differ between initial and final passes through the modeling process. Final iteration times reflect congestion effects identified in the first iteration.

The model produces a.m. peak, p.m. peak, and off-peak period trip tables for vehicles and transit riders. The a.m. peak period is from 6:00 to 9:00 in the morning and the p.m. peak period is from 3:00 to 6:00 in the afternoon. The off-peak period covers the remaining 18 hours of the day. A series of mode choice model runs were performed in the course of analyzing the 2004 RTIP scenarios through two model iterations.

Highway Assignment

Highway assignment produces traffic volume estimates for all roadway segments in the system. These traffic volumes are an important input to emissions modeling.

The highway assignment model works by finding roads that provide the shortest travel time between each zone pair. Trips between zone pairs are then accumulated on road segments making up minimum paths. Highway travel times consider posted speed limits, signal delays, and congestion delays. The model computes congestion delays for each segment based upon the ratio of the traffic volume to roadway capacity. Four iterations of equilibrium assignment and capacity restraint are performed within each assignment model run.

Motorists may choose different paths during peak hours when congestion can be heavy and off-peak hours when roadways are typically free flowing. For this reason, traffic is assigned separately for a.m. peak, p.m. peak, and off-peak periods.

Vehicle trip tables for each scenario reflect increased trip-making due to population growth and variations in travel patterns due to the alternative transportation facilities/networks proposed.

Model accuracy is assessed by comparing model estimated 2000 traffic volumes with actual traffic counts obtained through SANDAG's traffic monitoring program and Highway Performance Monitoring System (HPMS) estimates of vehicle miles of travel (VMT).

POST-TRANPLAN PROCESSING

Standard Tranplan output needs to be reformatted and adjusted to be useful for emissions modeling. Several routines and computer programs have been written to accomplish the following major functions:

- Correcting link specific traffic volume forecasts for calibration error;
- Adding in estimated travel on roads not in the transportation modeling process;
- Computing link speeds based upon corrected link volumes, Highway Capacity Manual relationships between congestion and speed (or signal delay);
- Splitting link volumes into heavy-duty truck and other traffic to obtain speed distributions by vehicle class; and
- Preparing a data set that contains total VMT, number of trip starts, and VMT by speed category by time of day for each vehicle class.

Post-Tranplan processing routines are performed twice. First, they are run after the initial model iteration to provide travel times for the final model iterations. Second, they are performed on the final model assignments to provide inputs for emissions modeling.

MOTOR VEHICLE EMISSIONS MODELING

Emissions Model

In October 2002, ARB released EMFAC 2002, a new emissions inventory model that calculates emissions for motor vehicles operating in California. It is an integrated model that combines emission rate data with vehicle activity to calculate regional emissions. EPA approved EMFAC 2002 for use in conformity determinations on April 1, 2003.

The EMFAC 2002 model supports calculation of emissions for the Burden mode. The Burden mode is used for calculating regional emission inventories. In this mode, the model reports total emissions as tons per day for each pollutant, by vehicle class and the total vehicle fleet. The Burden mode uses emission factors that have been corrected for ambient conditions and speeds combined with vehicle activity to calculate emissions in tons per day. Vehicle activity includes the number of vehicles, daily vehicle miles traveled, and the number of daily trips.

The air quality analysis for the 2004 RTIP was conducted using EMFAC 2002's Burden mode. Projections of daily regional emissions were prepared for reactive organic gases (ROG), nitrogen oxides (NOx), and carbon monoxide (CO).

On-road motor vehicle emissions are attributed to several different processes:

- Starting exhaust,
- Running exhaust,
- Idle exhaust (calculated for heavy-duty trucks only),
- Resting and diurnal evaporation,
- Running losses, and
- Hot soak evaporation.

Emission factors vary by vehicle class, fuel usage, and technology. Thirteen vehicle classes are modeled: passenger car, two types of light-duty trucks, medium-duty truck, two types of light-heavy-duty trucks, medium-heavy-duty truck, heavy-heavy-duty truck, line-haul vehicle, urban bus, school bus, motorcycle, and motor home. The fuels modeled are gasoline, diesel, and electrically powered vehicles. Technology categories can be grouped into catalyst, non-catalyst, and diesel.

Emission factors for processes that vary by temperature (i.e., starting exhaust, hot soak, and running exhaust) are broken down further by specified temperature ranges. Exhaust emission factors also are broken down by speed range.

Regional Emissions Forecasts

Countywide forecasts of average weekday ROG, NOx, and CO emissions were produced for 2010, 2014 2020, and 2030 using the EMFAC 2002 model. ROG and NOx emissions are based on the summer season, while CO emissions are based on the winter season.

Emissions Modeling Results

An emissions budget is the part of the SIP that identifies emissions levels necessary for meeting emissions reduction milestones, attainment, or maintenance demonstrations.

The 2004 RTIP must meet the ozone motor vehicle emissions budgets contained in the 2002 1-Hour Ozone Maintenance Plan. This Maintenance Plan established ROG and NOx budgets for 2010 and 2014. EPA made a budget adequacy finding on May 14, 2003. On June 26, 2004, EPA approved the Maintenance Plan and motor vehicle emissions budgets as SIP revisions. These SIP revisions became effective on July 28, 2003.

SANDAG and the U.S. DOT are required to redetermine conformity of the 2030 Revenue Constrained RTP within 18 months of EPA's adequacy findings of any new motor vehicle emissions budgets to comply with Section 93.104(e)(2) of the Transportation Conformity Rule for initial SIP submissions. As stated above, EPA's adequacy finding of the 1-Hour Ozone Maintenance Plan budgets was issued after the 2030 RTP's air quality conformity determination. Therefore, the regional emissions analyses for the 2030 Revenue Constrained RTP and the 2004 RTIP were developed simultaneously. That is, the 2030 RTP conformity redetermination is being conducted concurrently with the 2004 RTIP conformity finding.

The 2004 RTIP also must meet the CO emissions budget established in the 1993 CO Maintenance Plan that was approved by EPA in June 1998.

As shown in Table 2, the projected emissions of ROG, NOx, and CO from both the 2004 RTIP and the 2030 Revenue Constrained RTP are lower than the 1-Hour Ozone Maintenance Plan and CO Maintenance Plan emissions budgets.

ARB currently is preparing a CO Maintenance Plan for the San Diego region. This plan would update the 1993 plan and would cover the second ten years of the maintenance period. ARB is expected to adopt the CO Maintenance Plan in July 2004 for transmittal to EPA. The Draft 2003 CO budget was established at 728.35 tons per day. This CO budget would become the applicable budget for conformity determinations after EPA makes a budget adequacy finding. The projected CO emissions from the 2004 RTIP also are below the new draft CO budget.

Table 2 summarizes the 2004 RTIP and 2030 Revenue Constrained Plan air quality conformity analysis and the budget test for the current motor vehicle emissions budgets. This analysis shows that both the 2004 RTIP and the 2030 Revenue Constrained Plan (including interim years) meet the applicable budgets.

TABLE 2— 2004 RTIP AND 2030 REVENUE CONSTRAINED RTP
AIR QUALITY CONFORMITY ANALYSIS

Year	Average Weekday Vehicle Starts (1,000s)	Average Weekday Vehicle Miles (1,000s)	CO		ROG		NOx	
			SIP Emissions Budget Tons/Day	CO Emissions Tons/Day	SIP Emissions Budget Tons/Day	ROG Emissions Tons/Day	SIP Emissions Budget Tons/Day	NOx Emissions Tons/Day
2010	15,351	87,511	1,194.87	443.12	46	44	88	84
2014	15,934	91,763	1,194.87	330.32	36	34	66	61
2020	16,887	99,207	1,194.87	231.65	36	27	66	42
2030	18,468	110,920	1,194.87	148.83	36	18	66	25

EXEMPT PROJECTS

Section 93.126 of the Transportation Conformity Rule exempts certain highway and transit projects from the requirement to determine conformity. The categories of exempt projects include safety, mass transit, air quality (ridesharing and bicycle and pedestrian facilities), and other (such as planning studies).

The 2004 RTIP programs funding for exempt projects that, according to the conformity rule, may be implemented even in the absence of a conforming transportation plan and transportation improvement program. However, these projects must be included in an interim plan or program. SANDAG followed interagency consultation procedures to determine whether projects are exempt. Exempt projects are listed in Table 1.