APPENDIX C: Summary of Conformity Determination

Conformity Determinations

for the

2022 Metropolitan Transportation Plan

and the

2000 - 2002 Transportation Improvement Program

for the

Houston-Galveston
Transportation Management Area

March 23rd, 2000

HOUSTON-GALVESTON AREA COUNCIL
TRANSPORTATION DEPARTMENT

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Executive Summary

The Houston-Galveston Area Council (H-GAC) has conducted an analysis of the 2022 Metropolitan Transportation Plan and the 2000 – 2002 Transportation Improvement Program for conformance with the State Implementation Plan's ozone 9% Rate-of-Progress for the Houston-Galveston ozone nonattainment area. The analysis, undertaken in accordance with procedures established under federal and state regulation and guidance, comprised projected regional vehicular emissions for specific landmark years in the future. The purpose of the analysis is to demonstrate that future transportation plans are consistent with the state's air quality goals for the region.

The results of the conformity determination show that the 2022 Metropolitan Transportation Plan and the 2000 - 2002 Transportation Improvement Program for the Houston-Galveston Transportation Management Area meet the requirements of the State Implementation Plan, the Clean Air Act (42 U.S.C. 7504, 7506 (c) and (d)) as amended on November 15, 1990 and the final conformity rule (40 CFR Parts 51 and 93).

Table 1: Conformity Analysis Summary by Analysis Year

Analysis Year	VOC Emissions (tons/day)	NOx Emissions (tons/day)
1990 Baseline	251.7	337.1
2000	114.15	268.34
2007	93.26	227.56
2015	82.20	191.02
2022	86.72	196.48

The results of the conformity analysis, shown in Figures 1 and 2 and Table 1, indicate that the transportation projects outlined in the 2022 Metropolitan Transportation Plan and the 2000 – 2002 Transportation Improvement Program adhere to regional air quality targets and requirements. The graph and table summarize VOCs and NOx emissions for each analysis year as compared to the Motor Vehicle Emissions Budget for the region and 1990 emissions levels. The data show that the emissions from each analysis year fall below both the emission budget of 132.68 tons VOC per day and 283.01 tons Nitrogen Oxide (NOx) per day and 1990 emission levels. Table 1

shows that commitments to the timely implementation of Transportation Control Measures contained in the State Implementation Plan have been kept. Therefore, the analysis supports the finding of conformance with the SIP and its 9% Rate of Progress Budgets.

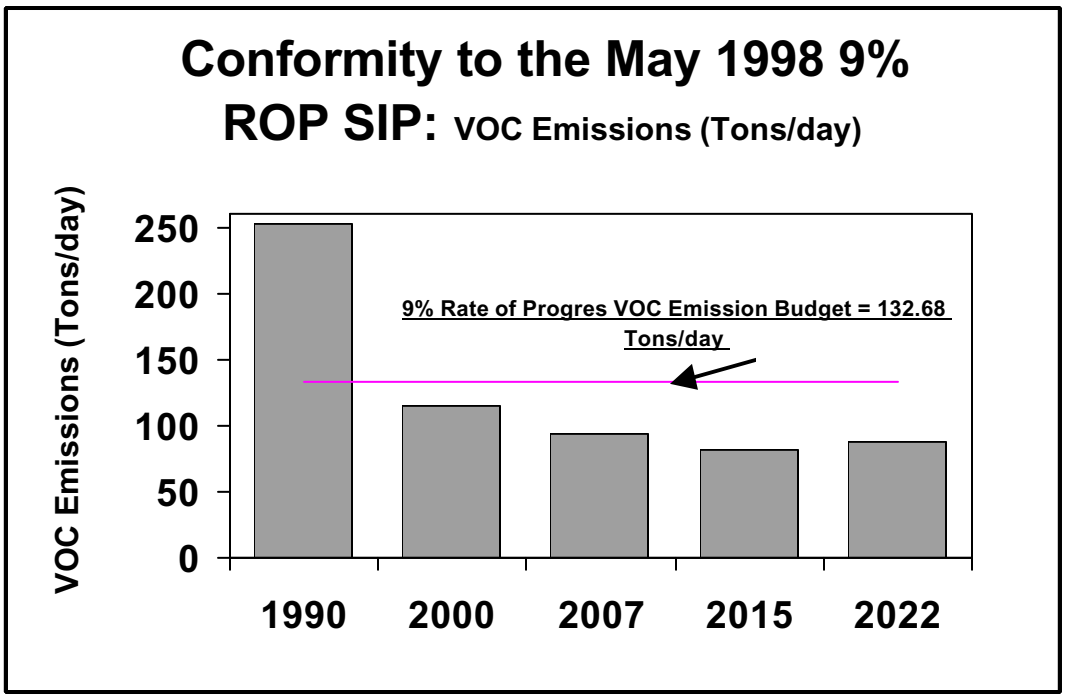

Figure 1: Conformity of the MTP & TIP: VOC Emissions

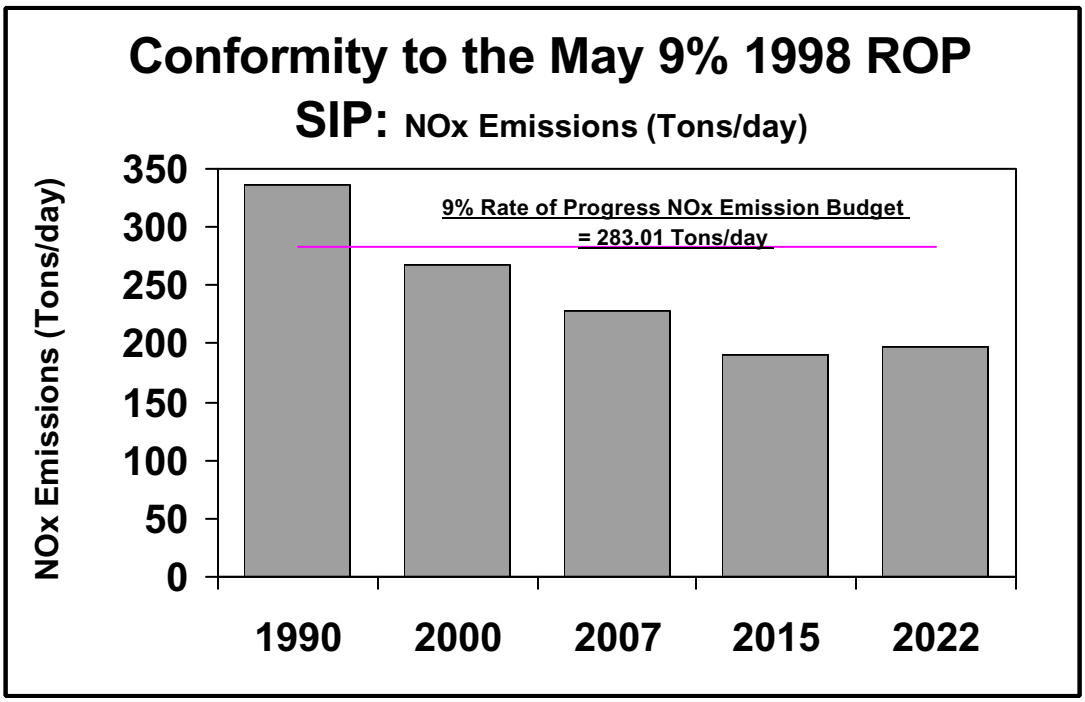

Figure 2: Conformity of the MTP & TIP: NOx Emission

Preparation of this conformity analysis has been undertaken with extensive interagency consultation and frequent opportunity for public comment. Two formal opportunities for public review and comment have been conducted. A thirty day review and comment of the proposed conformity process was initiated at a public meeting held on September 9th, 1999 and remains available for comment on H-GAC's agency web site. A second 30-day public comment period for review of the final conformity analysis was open from January 24, 2000 through February 23, 2000.

I. Introduction and Background

With the signing of the Clean Air Act Amendments of 1990 (CAAA) into law, the Houston-Galveston region was designated non-attainment for exceeding the National Ambient Air Quality Standard (NAAQS) for the pollutant ozone. On a scale ranging from marginal to extreme, the Houston-Galveston region was labeled as "Severe-II" and given until the year 2007 to attain the ozone standard. The CAAA requires each state to submit a state implementation plan (SIP) to the U.S. Environmental Protection Agency (EPA). The SIP is a legally binding document that defines the structure through which emissions will be reduced and the ozone standard will be attained. As the central focus of the air quality planning process, the SIP ties in transportation planning through the conformity provisions in the CAAA. These provisions verify that federal actions on transportation projects are consistent with the air quality objectives contained in the SIP. In many cases, transportation-related control measures identified in the SIP are contained and funded in the metropolitan transportation plan (MTP) and the transportation improvement program (TIP).

Section 176(c)(4) of the CAAA required EPA to promulgate rule-making on conformity determinations for transportation plans and programs. In response to this requirement, the EPA published its Criteria and Procedures for Determining Conformity to State or Federal Implementation Plans of Transportation Plans, Programs, and Projects Funded Under Title 23 U.S.C. or the Federal Transit Act in the Federal Register on November 24, 1993. This conformity rule requires metropolitan planning organizations (MPOs) and the U.S. Department of Transportation to make conformity determinations on metropolitan transportation plans and transportation improvement programs before they are adopted, approved, or accepted in air quality non-attainment areas. EPA has promulgated three separate amendments to the conformity rule, most recently in August of 1997. Most aspects of the August 1997 amendments did not become effective until the State of Texas recently proposed revisions of its Conformity State Implementation Plan to the EPA in November 1998.

Special provisions are described in the final conformity rule for MPOs to conduct conformity determinations on their plans and TIPs. These criteria and procedures vary according to the pollutant for which the area is designated nonattainment and also according to the time period in which the determination is conducted. The conformity rule requires that conformity analysis adhere to a number of requirements:

- The analysis process must use the most recent planning assumptions in force at the time of the conformity determination and employ the latest available emissions model.
- The transportation plan and TIP must provide for the timely implementation of transportation control measures (TCMs) from the applicable implementation plan.
- A regional emissions analysis must be conducted for significant air quality milestone years and the MTP horizon year.
- Volatile organic compounds (VOCs) and nitrogen oxide (NOx) emissions from each analysis year must be less than the motor vehicle emissions budget (MVEB) established in the May 1998 9% Rate of Progress SIP.
- Emissions from each analysis year must be shown to be less than 1990 baseline emissions levels.

H-GAC, as MPO for the Houston-Galveston Transportation Management Area (TMA), is required to review the transportation plan and determine its conformity with the 1998 Texas 9% Rate of Progress SIP for Ozone Attainment for the Houston-Galveston Ozone Nonattainment Area, in accordance with the EPA's final conformity rule published in the Federal Register on August 15th, 1997.

A. Early and continuing consultation

Local, state and federal transportation and air quality agencies affected by conformity were consulted on the scope, schedule, methodologies and products of the conformity finding. A steering committee composed of representatives of each of the following agencies consulted regularly during the conformity process:

- The Houston-Galveston Area Council (H-GAC)
- The Metropolitan Transit Authority of Harris County (METRO)
- The City of Houston
- Harris County
- The Texas Department of Transportation (TxDOT)
- The Texas Natural Resources Conservation Commission (TNRCC)
- The Federal Highway Administration (FHWA)
- The Federal Transit Administration (FTA)
- The US Environmental Protection Agency (EPA)

B. Public involvement

Public Involvement is also a key feature of the conformity process. Subsequent to interagency review and comment, H-GAC published its proposed conformity methodology and schedule for public review and comment for a 30 day period. In addition, this information was made available at a public meetings. Additional public comments were collected at these meetings.

Another public comment period on the completed draft conformity finding was held from January 24th to February 24th, 2000. During this period, a public meeting was held to receive additional comments and questions. Written comments and questions received written response within two weeks of the close of the comment period for the draft finding. Public comment was also received by the Transportation Policy Council at such time as scheduled for consideration and action. Appendix E1 contains more detailed information on the public process.

C. Interagency Review and Comment

Interagency review and comment on the conformity finding was conducted in accordance with consultative process identified in the Conformity SIP. Because of the limited time to complete the conformity process, H-GAC requests that, to the extent practicable, reviewing agencies consider concurrently reviewing the draft final conformity document. H-GAC will be responsible for insuring that all comments and responses are available to the interagency steering committee.

D. Emissions Analysis Methodologies

Emissions Analysis Methodologies are consistent with procedures used to estimate the rate of progress emissions budgets. The interagency consultative process was used to define any necessary changes to emissions calculations due to federal control measures that have been promulgated since adoption of the 9% Rate of Progress SIP, such as National Low Emission Vehicle (NLEV) and Heavy Duty Diesel Vehicle (HDDV) standards. Network based modeling was used to estimate travel inputs to the emissions analysis.

E. Documentation

The format and content of the conformity documentation was determined by the conformity steering committee. It includes the following for each analysis year which network-based travel modeling is conducted:

- Summary of economic/demographic inputs to the travel modeling process by analysis year;
- Listing of emissions model inputs by analysis year;
- Listing of off-model reductions and methodologies used;
- Discussion of HPMS adjustments
- Summaries of travel demand forecasts (person, vehicle and transit trips by mode and purpose) and summaries of vehicle miles of travel (by major functional classifications and vehicle speed) for each analysis year;
- Listings of regionally significant and non-federal added capacity highway and transit projects by analysis year, including funding source;
- Listing of CMAQ projects and
- Network link listings by analysis year.

II. Demonstration of Conformity

To demonstrate conformity as defined by EPA's final rule, analysis of transportation plans and TIPs must address the following criteria:

- Are the MTP and TIP consistent with the most recent estimates of on-road mobile source emissions?
- Does the MTP and TIP provide for expeditious implementation of transportation control measures (TCMs) in the applicable SIP?
- Does the MTP and TIP contribute to annual emissions reductions consistent with Section 182(b) and Section 187(a)(7) of the CAAA? This criteria is met and conformity is demonstrated if both VOC and NOx emissions in each of the analysis years modeled are:
    - Less than the 1990 base year emissions inventory, and
    - Less than the specified emissions "budget" in the May 1998 9% Rate of Progress SIP.

Each of these criteria is discussed briefly below.

A. Consistency with Emissions Estimates

Estimates of on-road mobile source emissions are based on recent model runs of H-GAC's travel demand forecasting models and the EPA's Mobile Emissions Factor Model, MOBILE5a_h. The travel demand modeling procedures rely on up-to-date projections of population, employment, travel and congestion. Emission estimation procedures use input data developed from a TNRCC data-builder program[1] specific to the Houston-Galveston area, reflecting controls in place or expected to be in place for each analysis year.

1) Travel Demand Modeling Procedures

Population and Employment Forecasts:

The 1990 Census Summary Tape File 1 (STF1) is the source of the 1990 Base Year population data for each of the eight counties and their respective census tracts. The 1990 MPO Abstract Tape (MPOAT) acquired from Dun's Marketing Services, a subsidiary of Dun & Bradstreet, is the source of 1990 base year place of work employment data at the county and census tract levels.

In 1997, the Houston-Galveston Area Council (H-GAC) began a two phased process to update a set of forecasts originally produced in 1995. The first step involved the development of new household and employment estimates for the year 2000. Estimates for employment were developed with employer-level data and were controlled to an estimate of total wage and salary employment for the eight-county region from the Bureau of Economic Analysis (BEA). As the employment estimates were derived from data that was described at a level of geography more detailed than the traffic analysis zone (TAZ) geography used in travel demand analysis, the estimates (after controlled to regional total) were aggregated to the TAZ-level.

Estimates of year 2000 households were derived from two data sources at different levels of detail. For the most populous part of the eight-county region, parcel level estimates of the number of households were acquired from a third party data source. For the remainder of the region, estimates of households at the TAZ-level were

[1] This program was developed by Wayne Young, TNRCC, in a joint effort with H-GAC in gathering the most up to date data for the region.

provided by the Planning Office of the Texas Department of Transportation – Houston District. After the TAZ level data were controlled to the regional totals, some re-allocations were made among TAZs in corridors where very detailed inventories of existing population and employment had been developed during the course of corridor studies.

The second major effort undertaken to develop updated forecasts was to develop new regional forecasts for households, population and employment for the 8-county transportation planning region. H-GAC made use of the REMI model to develop the new regional demographic forecasts. H-GAC made use of an 8-county regional version of the REMI model to explore two alternative demographic scenarios. Based upon the recommendations of an expert panel assembled by H-GAC and staff from REMI, H-GAC decided to vary two major inputs to the REMI model. The first variable was level of transportation investment and the second was energy prices. The two scenarios constructed were labeled as "conservative" and "aggressive". REMI-based forecasts were developed for each year between the current year (year 2000) and the horizon year (2025). The horizon year chosen for this update of the air quality conformity analysis of the 2022 MTP is the year 2022.

Following a review of the alternative regional forecasts from the two alternative scenarios, H-GAC determined that the most likely scenario and the one to be used as the basis for developing new forecasts was the "aggressive" scenario. Using an allocation process developed specifically for this effort the new regional forecasts were then allocated 199 sub-areas referred to as Regional Analysis Zones (RAZs). In this allocation process, all 199 sub-areas compete with each other for based on historic growth trends and land availability. This process was repeated for each of the three forecast years (i.e., 2007, 2015 and 2022). Land availability was re-estimated after every application of the process to account for land consumed or returned to the available land "inventory". The resulting RAZ allocations were then allocated to traffic analysis zones (TAZs) based upon the TAZs share of RAZ from the original forecast.

Table 2 below presents the 1990 estimates (which were the basis for the forecast) as well as forecasted 2000, 2007, 2015 and 2022 population, households and employment for the eight-county non-attainment area.

Table 2: Regional Household Population and Employment Estimates and Forecasts1990, 2000, 2007, 2015 and 2022

	YEAR				
	1990	2000	2007	2015	2022
Households	3,680,600	4,489,900	4,910,700	5,509,900	6,089,300
Employment	1,810,000	2,371,100	2,632,900	2,877,700	3,047,100

Source: H-GAC, September, 1999.

Scenario Development and Modeling:

To address the conformity tests, analysis year networks were developed for 2000, 2007, 2015, and 2022. Results from the 1990 base year network, developed for previous emissions inventory and conformity analyses, were also used for comparison. The modeling practices employed in this conformity analysis are the same practices used by H-GAC in modeling for the SIP, MTP, TIP and other projects.

Base (1990) Scenario

Using the 1990 household and employment forecasts for the eight county TMA, trip generation (i.e., production and attraction) estimates were developed for each of six trip purposes: Homebased Work (HBW), Homebased School (HBSCH), Homebased Shop (HBSHP), Homebased Other (HBO), Non-Homebased (NHB), and Truck-Taxi Trips (TRTX). The trip production models used to produce these estimates are cross-classification models based on household size and income, while the attraction models are based on employment. The 1990 external-local and external-through trip tables were based on 1990 external station (cordon) volumes.

Table 3 details the resulting person and vehicle trip estimates by purpose for the year 1990. The HBSCH, HBSHP, and HBO trips have been summed to a Homebased Non-Work (HBNW) total.

Table 3: Internal Trips by Purpose for The 8 County Transportation Planning Region

Purpose	1990	% of Total
HBW Person Trips	2,200,543	17.1
HBNW Person Trips	6,155,066	48.0
NHB Person Trips	3,806,188	29.6
TRTX Vehicle Trips	675,625	5.3
Total Internal Trips	12,837,422	100.0

Using a 1990 highway network and a set of F-factors calibrated to the year 1985 and validated to the year 1990, person trips by purpose as well as the Truck-Taxi and External-local vehicle trips were distributed using the Disaggregate Trip Distribution Model (the Atomistic Model) of the TxDOT Trip Distribution Package (TTDP). Table 4 details by a general facility type structure the 1990 network which was used in the trip distribution as well as the assignment phases of this scenario analysis.

Table 4: 1990 Network for The 8 County Transportation Planning Region

Miles	Freeway/Tollway	Principal Arterial	Other Arterial	Collector	HOV Lanes[A]
Centerline	510	818	2,112	2,245	44
Lane	2,848	3,294	6,382	4,624	44

Source: H-GAC, 2000 **[A] Excluding ramp structures**

Transit mode shares were estimated based upon METRO's 1990 Transit On-Board Survey. Following the estimation of transit mode share, the Mezzo-level High Occupancy Vehicle (HOV) carpool model of the TTDP was utilized to account for and estimate the level of usage of the HOV lane system by carpools and to convert the person trip tables to vehicle trip tables. Based upon the transit mode share estimates produced by the METRO and the auto occupancy estimates from the H-GAC 1984 Regional Travel Survey (subsequently revised based upon the 1990 Nationwide

Personal Transportation Survey (NPTS)), the HOV carpool demand on the 1990 HOV lane system was estimated.

Following the conversion of the person trip tables to vehicle trip tables, the vehicle trip tables were factored by trip purpose to represent the time periods desired for the estimation of time-of-day travel demand. The procedure used by H-GAC to factor trip tables relies on time-of-day trip table factors by trip purpose and the trip table factoring procedures of the TTDP. The trip table factors were developed based on an analysis of the 1984 H-GAC Regional Travel Survey data. Because the Regional Travel Survey contained no data on truck/taxi and external travel, survey data from other urban areas was used to develop trip table factors for those trip purposes.

In addition to factoring the 24-hour trips to represent the desired time period, the trip tables are converted from production-to-attraction orientation to origin-destination orientation. The factors used to perform this step are also based on the H-GAC Regional Travel survey.

Time-of-Day Trip Table Factors

Based on analyses of the trip table factors developed in 30-minute intervals, the daily vehicle trip tables were separated into the following time periods:

AM Peak	-	6:30 AM to 8:30 AM
Mid-day	-	8:30 AM to 3:30 PM
PM Peak	-	3:30 PM to 6:30 PM
Overnight	-	6:30 PM to 6:30 AM

Following the separation of the 24-hour trip tables by purpose for each of the four time periods, the trip tables for each trip purpose were summed to develop a single time-of-day trip table (e.g., AM Peak trip table). Each time-of-day trip table was then assigned to the appropriate 1990 time-of-day network. The time-of-day networks are the 1990 network with capacities reflective of the appropriate time-of-day. For example, the facilities represented in the 1990 AM peak network have 2-hour peak period capacities which vary by facility type, number of lanes, and area type.

The resulting time-of-day link volume estimates were then input to H-GAC's post-assignment speed model to develop link-level time-of-day speed estimates. The

post-assignment speed model is based on procedures recommended in the report entitled Highway Vehicle Speed Estimation Procedures For Use in Emissions Inventories prepared by Cambridge Systematics for the U.S. Environmental Protection Agency in September 1991.

The speed estimation model relies primarily on the speed estimation techniques described in the Highway Capacity Manual (HCM). The HCM relationships are used to estimate the speeds for estimated volume-to-capacity ratios from zero to one. The extensions of the models for volume-to-capacity ratios exceeding one are based on the traditional Bureau of Public Roads (BPR) impedance adjustment function. The methods rely on the estimated volume-to-capacity ratio as a key measure of congestion for estimating the congested speed based on the constrained equilibrium volume of a link. Separate procedures are used for freeways and non-freeway streets.

The speed model was developed and calibrated by applying them to the 1985 AM and PM peak-period assignments for the Houston-Galveston region and comparing the modeled directional speeds to more than 8,000 observed directional link speeds encoded in the link data. The models were also validated to year 1990 observed directional speeds.

The centroid connectors in the Houston-Galveston TMA networks represent local street facilities that provide access to higher-level roadway facilities. Local streets are generally relatively low volume uncongested streets. Since there is not a one-to-one correspondence between centroid connectors and the local streets (i.e., a single centroid connector usually represents more than one local street) and since local streets generally operate without significant congestion, the speed models were not used to estimate the centroid connector speeds. The estimated speeds for the vehicle miles traveled (VMT) represented on centroid connectors was estimated based on the area type of the zone which is connected to the roadway network by the centroid connector and the length of the centroid connector. The estimated speed for intrazonal VMT (travel within a zone) is developed from the average of the centroid connector speeds for the zone.

The estimated level of travel (VMT) and congestion (speed) by link serve as inputs to the emissions model.

Analysis Years

Using the household and employment forecasts for 2000, 2007, 2015, and 2022, trip generation (i.e., production and attraction) estimates were developed for each of six trip purposes; Homebased Work (HBW), Homebased School (HBSCH), Homebased Shop (HBSHP), Homebased Other (HBO), Non-Homebased (NHB), and Truck-Taxi Trips (TRTX). The trip production models used to produce these estimates are cross-classification models based on household size and income, while the attraction models are based on employment. Trip generation estimates for external-local and external-through vehicle trips for all scenarios were developed by extrapolating historic growth in traffic between 1985 and 1996.

Table 5 summarizes the resulting person and vehicle trip estimates by purpose for the years 2000, 2007, 2015, and 2022. The HBSCH, HBSHP, and HBO trips have been summed to a Homebased Non-Work (HBNW) total.

Table 5: Internal Trips by Purpose for the 8 County Transportation Planning Region

Purpose	2000	% of Total	2007	% of Total	2015	% of Total	2022	% of Total
HBW Person Trips	2,720,063	17.7	3,024,435	17.3	3,436,578	17.8	3,840,497	17.9
HBNW Person Trips	7,032,442	45.7	8,176,738	46.7	8,725,077	45.3	9,659,526	45.2
NHB Person Trips	4,806,794	31.2	5,338,286	30.5	6,051,377	31.4	6,755,309	31.6
TRTX Veh. Trips	830,475	5.4	957,017	5.5	1,048,064	5.4	1,129,689	5.3
Total Trips	15,389,774	100.0	17,496,476	100.0	19,261096	100.0	21,385,021	100.0

Source: H-GAC, 2000

The regional roadway networks used in the conformity analysis represent the system of roadways assumed to be operational in each of the four analysis years. Therefore, the 2000 roadway network represents current roadways, plus roadways under construction, plus roadways expected to be operational by the end of FY 2000.

The 2007 network includes all roadways in the 2000 roadway network plus all roadways expected to be operational by the end of FY 2007. The 2015 roadway network includes all roadways in the 2007 network plus all roadways expected to be operational by the end of FY 2015. The 2022 roadway network includes all roadways in the 2015 roadway network plus all remaining projects in the Houston-Galveston 2022 Metropolitan Transportation Plan. Table 6 summarizes the regional roadway networks for 2000, 2007, 2015 and 2022. Appendix E2 of this document contains a listing of roadway projects by scenario. Appendix E3 contains a link-level listing of the roadway modeling networks used in the analysis.

Table 6: Roadway Networks for The 8 County Transportation Planning Region

	Miles	Freeway/ Tollway	Principal Arterial	Other Arterial	Collector	HOV Lanes[A]
2000	Centerline	603	1,149	3,018	1,502	89
	Lane	3,616	4,485	8,903	3,227	90
2007	Centerline	659	1,213	3,082	1,499	160
	Lane	4,209	4,968	9,473	3,248	250
2015	Centerline	702	1,325	3,190	1,516	175
	Lane	4,755	5,551	10,441	3,371	292
2022	Centerline	725	1,371	3,219	1,577	187
	Lane	4,885	5,873	10,824	3,791	316

Source: H-GAC, 2000 [A] **Excluding ramp structures**

Using the highway networks and a set of F-factors calibrated to the year 1985 and validated to the year 1990, the estimates of person trips by purpose as well as the Truck-Taxi and External-local vehicle trips were distributed using the Disaggregate Trip Distribution Model (the Atomistic Model) of the TTDP.

The estimates of person trips by trip purpose along with network descriptions of the roadway and transit facilities and services[2] were then input to the regional mode choice model. This model developed forecasts of person trips by 8 auto sub-modes (single-occupant non-toll, single-occupant toll, 2 person non-toll, 2-person toll, 3

[2] Provided by the Metropolitan Transit Authority (METRO)

person non-toll, 3-person toll, 4+ person non-toll and 4+ person toll) and six transit sub-modes (walk-to-local bus, walk-to-express bus, walk-to-commuter bus, walk-to-urban rail, drive-to-park-and-ride and drive-to-kiss-and-ride) for each of the analysis years.

Following the conversion of the auto person trip tables by mode to auto vehicle trip tables by mode, the vehicle trip tables were factored by trip purpose to represent the four time periods (AM Peak, Mid-day, PM Peak, and Overnight). Following the separation of the 24-hour trip tables by purpose to time-of-day trip tables by purpose, the trip tables by purpose were summed to develop a single time-of-day trip table (e.g., AM Peak trip table) for each mode. Each modal time-of-day trip table was then assigned simultaneously to the appropriate analysis year time-of-day network. Four time-of-day networks for each analysis year were created to correspond to the four time-of-day trip tables. These networks were created using the same time-of-day capacities that were used in the base year analysis.

The assigned time-of-day link volumes were then input to H-GAC's post-assignment speed model to develop link-level time-of-day speed estimates. The estimated speeds for the VMT represented on centroid connectors was estimated based on the area type of the zone which is connected to the roadway network by the centroid connector and the length of the centroid connector. The estimated speed for intrazonal VMT was developed from the average of the centroid connector speeds for the zone.

Transit and Toll Pricing Policies and Assumptions

In September of 1994 a fare increase was approved by the Metropolitan Transit Authority (METRO) Board of Directors. Prior to September of 1994, there had been no transit fare increase since the previous conformity determination of the MTP. Prior to and following the period since the last conformity analysis in November 1995, transit ridership levels were stable overall, with very slight declines in certain markets. However, since the summer of 1997, ridership levels have risen. Although, a complete understanding of the reasons for the increase are pending the analysis of marketing/survey data, it appears that revised fare structures and increased marketing efforts have played a role.

Assumptions regarding the level of transit service for the conformity determination of the MTP are consistent with METRO's 2020 Regional Transit Plan

(HORIZON 2020) and subsequently completed Major Investment Studies. Transit fares were assumed to remain at existing levels throughout the analysis period.

Both existing and future toll facilities were evaluated assuming currently reflected toll pricing would remain at a fixed amount.

Travel Model Results

The results from the travel models reflect the expected demographic trends in the region over the next couple of decades, as shown in Table 7. Vehicle miles of travel (VMT) is forecasted to climb almost 47 percent from 2000 to 2022 to a total of nearly 169 million per day in the region. The growth is forecasted to occur at a rate of about 1.7 percent per year until 2007, and then at two percent per year through the rest of the forecast period. The vehicle miles of travel and average speed results for each county and facility type for each of the analysis years are presented in Appendix E5.

Table 7: Summary Statistics – Travel Model Results for the 8 County Transportation Planning Region

Analysis Year	Vehicle Miles of Travel (Million VMT)	Average Speeds (mph)
1990	92.42	37.69
2000	115.56	39.10
2007	129.36	39.59
2015	149.28	39.67
2022	168.68	39.37

Source: H-GAC, 2000

2) Transit Bus VMT

Estimates of bus VMT were developed based upon the transit service levels for each year as provided to H-GAC by METRO.

3) Highway Performance Monitoring System Adjustments

As part of the process of developing emissions inventories for the EPA, H-GAC is required to adjust the estimates of vehicle miles of travel from the H-GAC travel demand models to be consistent with the VMT estimates collected for the Highway Performance Monitoring System (HPMS), a national standard. With the development of the revised emissions estimates for the revised 9% Rate-of-Progress State Implementation Plans, H-GAC began a practice of developing and applying an HPMS adjustment factor for both regionally significant (non-local) roads and local streets. Table 8 below presents updated HPMS non-local and local adjustment factors.

Table 8: HPMS Adjustment Factors Developed from 1995 VMT Estimates

Road Type Group	HPMS Adjustment Factor
Non-Local	1.0062
Local	1.0777

4) Emissions Modeling Procedures

Time-of-day mobile volatile organic compound (VOC) and nitrogen oxide (NOx) emissions estimates for the **2022** Metropolitan Transportation Plan and the 2000 - 2002 Transportation Improvement Program conformity analysis were developed from the link-based travel demand VMT and speeds estimates, and from vehicular emission factors. Rates for each link speed were obtained and multiplied by the link VMT to give VOC and NOx emissions for each link. Total emissions for each scenario were then obtained by aggregating the link-level results over a 24-hour period.

Emission Rates

Emission rates, or factors, were developed using the Environmental Protection Agency MOBILE5a_h mobile emissions model and procedures developed during the revisions to the 9% Rate-of-Progress State Implementation Plans (SIP) in 1996[3]. "Registration" emission factors, representing the emissions rates of vehicles based on their county of registration, were calculated using MOBILE5a_h, a modified version of the original MOBILE5a to account for updated inspections/maintenance program credits. POLFAC5B, a program developed by the Texas Transportation Institute (TTI), was then

[3] See Appendix E4 for MOBILE5a_h inputs and outputs

used to run MOBILE5 at multiple speeds. The inputs to the MOBILE5a_h model were the same as those used in the development of recent emissions inventory reports[4], with adjustments made to address the different analysis years and the changing fleet of vehicles subject to the Harris County inspections/maintenance program.

The emission rates obtained by POLFAC5B also reflect new federal measures, such as the National Low Emission Vehicle (NLEV) and Heavy Duty Diesel standards coming into effect in 2001 and 2004 respectively. "Commute" emission factors, or emission rates effectively representing the traffic in the counties at any one time of day, were then obtained using another TTI program, RATEADJ.[5] This program corrects emission factors for each county to reflect the vehicles traveling in each county that are registered elsewhere. This is particularly important considering that Harris County is presently the only county in the 8-county nonattainment area that has an Inspection and Maintenance Program. This process is undertaken to ultimately yield emissions that are representative of the traffic at any one place at any one time. Appendix E4 contains a more detailed listing and explanation of inputs used.

Highway Network Emissions

Emissions were then obtained using a third TTI program, IMPSUMA, which assigns emission factors to network links based on link speeds. The program then multiplies the emission factors by the link VMT and then aggregates the link emissions to county-level totals. IMPSUMA is run separately for each time period and for one 24 hour time period for local roads. Total emissions of NO_x and VOCs including diurnal emissions are produced for each roadway type in each county.

Bus Emissions

Emissions attributable to transit buses are estimated by time-of-day and for freeway and non-freeway road types for Harris County only. Buses are assumed to operate at the average operational speeds specific to the time and facility. Bus emissions are estimated by multiplying VMT by the appropriate Heavy Duty Diesel

[4] See the H-GAC reports *Revised Rate-of-Progress State Implementation Plan On-Road Mobile Source Emissions Inventories,* August 1996, and the *Revised On-Road Mobile Source Emissions Inventory Estimates in Support of the Vehicle Miles of Travel Offset State Implementation Plan*, June 1997.

[5] See Appendix E4 for excerpt from the August, 1996 H-GAC report regarding the development of "commute" factors.

Vehicle (HDDV) emission factor from the Mobile model. The resulting emissions are added to the Harris County HDDV emissions totals and, hence, the regional highway emission totals.

Emissions from Non-recurring Congestion

Non-recurring congestion consists of any non-routine congestion resulting from accidents or other random incidents. Although the travel demand modeling and speed estimation processes used by H-GAC account for delay associated with recurring congestion, they do not allow for the estimation of delay caused by non-recurring congestion. To address non-recurring congestion, H-GAC uses a delay-based procedure to estimate the emissions that would result from the delay caused by non-recurring congestion on Harris county freeways[6].

The procedure to estimate the effects of non-recurring congestion is based on research presented in "Urban Freeway Congestion: Quantification of the Problem and Effectiveness of Potential Solutions" by Jeffrey A. Lindley, ITE Journal, January 1987. Lindley suggested that freeway delay could be characterized as follows:

Total Freeway Delay = 1/3 Recurring Congestion + 2/3 Non-recurring Congestion

Non-recurring Congestion = 2(Recurring Congestion)

Where recurring delay represents the difference in vehicle hours of travel at hypothetical free-flow speeds and at estimated scenario freeway speeds. The delay associated with non-recurring congestion is estimated at twice the recurring delay and is then added to the recurring delay and free-flow travel time to establish a new estimate of total freeway vehicle hours of travel. By dividing the new estimate of freeway VHT to the estimate of travel on freeways (VMT), a new estimate of average travel speed on freeways is obtained. The effect of non-recurring congestion on emissions is then estimated by calculating the percentage change in freeway emissions due to the change in average travel speeds.

[6] By convention, it has been assumed that Harris County freeways bear the vast majority of the incidents that result in non-recurring congestion.

H-GAC performed this calculation by time of day for freeway travel in Harris County and summed the differences to establish a percent daily change in emissions. An example calculation using data from the AM Peak Period is provided below.

$$VHT_F = VHT_U + VHT_C + VHT_N$$

where,

VHT_F = vehicle hours of travel on freeways
VHT_U = vehicle hours of travel occurring under uncongested conditions.
VHT_C = vehicle hours of travel occurring under recurring congestion.
VHT_N = vehicle hours of travel occurring under non-recurring congestion.

Sample Calculation:

$$VHT_F = 95{,}700 + 28{,}900 \ (+ VHT_N)$$

$$VHT_F = 124{,}600 \ (+ VHT_N)$$

With an estimated VMT of 5,979,000, the 124,600 VHT equates to approximately 48 mph. Incorporating non-recurring delay is as follows:

$$VHT_F = 95{,}700 + 28{,}900 + 57{,}800$$
$$VHT_F = 182{,}400$$

Using the same estimate of travel and the new estimate of delay of 182,400 the estimated speed including non-recurring delay is 33 mph. The increase in emissions is simply estimated by applying the appropriate emission factors for each speed to the estimated freeway VMT. The above calculation was repeated for each of the four time periods for which Harris County freeway VMT was estimated, with the estimated emissions summed for each scenario (not including and including non-recurring delay). The difference was calculated for a day and applied to the emissions total as a percent change.

Using this procedure, the daily VOC emission total was adjusted upward by the amounts shown in Table 9 to account for non-recurring congestion. These adjustments were made to the travel model highway results.

Table 9: Non-Recurring Congestion Emission Adjustment

Analysis Year:	2000	2007	2015	2022
Adjustment:	0.0	0.0	0.0	0.022

Source: H-GAC, 2000

This methodology does not apply to NO_x emissions. The methodology to determine the emissions effects of nonrecurring congestion is based on the change in average speeds. Because NO_x emissions increase with speeds above 20 miles per hour (whereas VOC emissions decrease), this methodology would yield results indicating that freeway NO_x emissions would decrease as a result of the decrease in average speeds associated with nonrecurring congestion. Since such an outcome seems counterintuitive, NO_x levels on Harris County freeways are not ultimately adjusted for the effects of nonrecurring congestion.

Adjustment for NOx Reductions from Phase II Reformulated Gasoline

This region started using phase II reformulated gasoline (RFG) in 2000. The reductions in NOx emissions from the use of phase II RFG are not included in the MOBILE5a program. EPA directs that areas using MOBILE5a to model their emissions, use MOBILE5b to compute reductions in NOx emissions from RFG. The methodology laid out by the EPA in MOBILE5 Information Sheet #7, September 1998, was used to create the reduction factors in Table 10. The reduction factors were calculated separately for each of the for gasoline vehicle types for all three county types for each analysis year.

Table 10: Reduction Factors for NOx from Phase II RFG

Analysis Year	County	LDGV	LDGT1	LDGT2	HDGV
2000	Harris	0.948	0.960	0.962	0.956
	Urban	0.950	0.951	0.960	0.958
	Rural	0.948	0.959	0.964	0.963
2007	Harris	0.946	0.950	0.958	0.951
	Urban	0.951	0.956	0.956	0.952
	Rural	0.949	0.945	0.960	0.954
2015	Harris	0.953	0.945	0.956	0.950
	Urban	0.949	0.947	0.955	0.950
	Rural	0.946	0.949	0.953	0.949
2022	Harris	0.938	0.932	0.956	0.950
	Urban	0.948	0.946	0.960	0.950
	Rural	0.946	0.949	0.959	0.951

Source: ERG, 11/99

B. Expeditious Implementation of Transportation Control Measures

The Clean Air Act Amendments of 1990 required regions in nonattainment for one of the criteria pollutants to make enforceable commitments to implement, maintain and monitor Transportation Control Measures (TCMs). Pursuant to regulation, the Texas Natural Resource Conservation Commission requires an annual report on the status of regional TCMs included in the State Implementation Plan (SIP). The report contains an evaluation of categories of transportation control measure projects for which implementation agencies have committed in post-1990 SIP amendments to implementation magnitude and schedules and for which the Metropolitan Planning Organization (MPO) has committed to the funding and projected emission reductions. Accordingly, the evaluation focuses on the collective magnitude, timing, funding and air quality benefits of the projects by category.

A summary of the current status of TCMs are shown in Tables 11-13. The summary provides the SIP magnitude and emissions commitments, as well as the TCM schedule status. For each milestone year, “commitments” refers to new/additional projects expected to be open for service prior to the milestone. Therefore, for example, the amounts listed in Table 12 represent quantitative indicators associated with the total

of all projects in each SIP category anticipated to be open for service between October 1996 and October 1999. The TCM project listing is contained in Appendix 6.

Table 11: TCM Status for Milestone Year 1996 Commitments in the 9% Rate of Progress SIP

TCM	Commitments in SIP		Current Status of Categories (as % of Magnitude)		
	Magnitude	VOC Rdctns (lb/d)	Mileage/Other, % Let	Mileage/Other, % Operational	% Operational by 1996
1. Signalization	2.9 mi	2.14	100 %	100%	100 %
2. High-Occupancy Vehicle (HOV) Lanes	14.7 mi	317.73	100 %	100 %	100 %
3. Park & Ride Lots	3,745 spcs	52.00	100 %	100 %	100 %
4. Arterial Traffic Management System (ATMS)	41.0 mi	57.58	100 %	100 %	100 %
5. Computerized Traffic	22.2 mi	126.83	100 %	100 %	100 %

Source: H-GAC, 1999

Table 12: TCM Status for Milestone Year 1999 Commitments in the 9% ROP SIP

TCM	Commitments in SIP		Commitments Achieved		Current Status of Categories (as % of Magnitude)		
	Magnitude	VOC Rdctns (lb/d)	Magnitude	VOC Rdctns (lb/d)	Mileage /Other, % Let	Mileage/ Other, % Operational	% Operational by 1999
1. Signalization	49.3 mi	23.05	65.74 mi	30.74	100 %	100 %	100 %
2. Bicycles[7]	262.3 mi	198.95	13.12 mi	9.95	87 %	5 %	5 %
3. HOV Lanes / Vanpool	3.5 mi 225	69.48 145.1	4.73 mi 233 vans	93.90 150.26	100 % 100 %	100 % 100 %	100 % 100 %
4. Park & Ride Lots	1,643 spcs	91.49	1,867 spcs	103.96	100%	100 %	100 %
5. Arterial Traffic Management System	65.8 mi	91.38	94.31 mi	130.97	100 %	100 %	100 %
6. Computerized Traffic Management System (CTMS)	70.3 mi	320.11	93.72 mi	426.75	100%	100 %	100 %
7. Accident Investigation Sites	3.20 mi	50.94	3.20 mi	50.94	100 %	100 %	100 %
Total		**990.5**		**997.5**			

Source: H-GAC, 1999

Table 13: TCM Status for Milestone Year 1996 Commitments in the 9% ROP SIP

TCM	Commitments in SIP		Current Status of Categories (as % of Magnitude)		
	Magnitude	VOC Rdctns (lb/d)	Mileage/Other, % Let	Mileage/Other, %	% Operational by 2007
1. Arterial Traffic Management System (ATMS)	2.09 mi	1.71	100 %	0 %	100 %
2. Computerized Traffic Management System (CTMS)	59.5 mi	339.33	34 %	0 %	100 %
3. Accident Investigation Sites	30.00 mi	221.59	0 %	0 %	100 %

Source: H-GAC, 1999

[7] The following bike projects were not originally part of the region's SIP commitments, however they have been accounted for in Table 12.

-Texas City Trails: 4.0 miles of trail let to contract in 3/98
-Bayland Park Marina: 0.95 miles of trail let to contract in 11/98

C. Annual Emissions Reductions Estimates

The third main conformity criterion regards the consistency of the Metropolitan Transportation Plan and the Transportation Improvement Program with the ozone standard attainment demonstration and reasonable further progress requirements under the State Implementation Plan. Consistency with the SIP, as stated earlier, is demonstrated by meeting the two conformity tests: "budget" and "below the base year maximum."

To address this criterion, H-GAC has developed the following evaluation components:

- Base year inventory – A base estimate of emissions – namely the base year 1990.
- Analysis years. 2000, 2007, 2015, and 2022 were selected as analysis years representing the outcome of the projects beyond the Baseline scenario contained in the 2022 MTP. As with the Baseline scenarios proposed facilities are placed into the appropriate analysis year based upon the assumed operational date of the facility.

Analysis years were developed to evaluate mobile source VOC and NOx emissions, as stated in the background section. The results of the emissions analysis are shown in Tables 14 and 15.

Table 14: Conformity Finding of The 2022 MTP Volatile Organic Compounds (VOC) Emissions Analysis (tons per day)

CATEGORY	Volatile Organic Compounds				
	1990 Base	2000	2007	2015	2022
Highway Emissions	251.7	115.07	95.55	84.60	89.57
Emissions reductions from Non-Added-Capacity (N-A-C) projects:[8]					
CMAQ & Other projects	N/A	0.92	2.29	2.40	2.85
Total emissions after N-A-C adjustments	**251.7**	**114.15**	**93.26**	**82.20**	**86.72**
9% ROP SIP Budget:		132.68	132.68	132.68	132.68

[8] Calculations and Methodology for these emissions reductions are contained in Appendix 7.

Table 15: Conformity Finding of The 2022 MTP Nitrogen Oxides (NOx) Emissions Analysis (tons per day)

CATEGORY	Nitrogen Oxides				
	1990 Base	2000	2007	2015	2022
Highway Emissions	337.1	269.81	229.10	192.15	197.58
Emissions reductions from Non-Added-Capacity (N-A-C) projects:[9]					
CMAQ & Other projects	N/A	1.47	1.54	1.13	1.10
Total emissions after N-A-C adjustments	337.1	**268.34**	**227.56**	**191.02**	**196.48**
9% ROP SIP Budget:		283.01	283.01	283.01	283.01

1. Highway Emissions Estimates

As described earlier, emissions estimates are calculated using travel demand model data and EPA mobile source emission rates. The results are shown in the first lines of Tables 14 and 15, indicating transportation emissions continue to decline through the designated ozone attainment year for the region.

2. Emissions Reductions Measures

Congestion Mitigation and Air Quality Projects and Transportation Control Measures:

Under the Congestion Mitigation and Air Quality (CMAQ) Program, the non-added-capacity transportation projects are eligible for CMAQ funds in nonattainment areas. The projects funded with CMAQ money are aimed at reducing mobile source emissions. In addition, the conformity analyis attempts to take into account any other transportation control measures (TCMs). Examples of CMAQ and/or TCM projects in this analysis include:

- Regional Computerized Traffic Signal System (RCTSS)
- Arterial Traffic Management Systems (ATMS)
- Intersection Improvements
- Park-and-ride lots
- High Occupancy Vehicle Lanes (HOV)

[9] Calculations and Methodology for these emissions reductions are contained in Appendix 7.

- Transit Service Projects

Methodologies for estimating the emissions reductions relating to CMAQ/TCM projects as well as the actual CMAQ/TCM projects used in the plan's emissions reduction analysis are discussed in detail in Appendix 7.

The 2000 analysis year contains all existing and committed non-added-capacity roadway projects from the 2000 TIP that will be operational by the end of FY 2000 and meet the baseline criteria. For the CMAQ evaluation, a project meeting the baseline criteria must either be under construction or it was listed in the first 3 years of the previously conforming plan and/or TIP. The projects were analyzed with 2000, 2007, 2015 and 2022 emission factors to determine the level of emission reductions that would occur in the respective calendar year.

The 2007 analysis year includes projects from the 2000 analysis year plus projects with a letting date between FY 2000-2006 that will be operational by the end of FY 2007. The 2015 and 2022 analysis years follow the same pattern.

Pertinent calendar year emissions factors were applied for each analysis year. To determine total net emissions, the emission estimates were then subtracted from the emissions resulting from the “Highway” emissions for each analysis year. A listing of all CMAQ projects is contained in Appendix 7 of this document.

Clean Fuel Programs:

The Clean Fuel Programs incorporate both the Texas Clean Fleets Program (TCF) and the Houston-Galveston Alternative Fueled Vehicle (AFV) Program, as well as the Federal Energy Policy Act (EPACT) Program. The TCF requires fleet owners operating in serious, severe or extreme nonattainment areas to purchase a percentage of low emission vehicles (LEVs) when replacing or adding fleet vehicles. A LEV is defined as a vehicle certified to meet the federal LEV standards. Although there are exceptions, the program affects private fleets with greater than 25 fleet vehicles, local government fleets of 15 or more fleet vehicles, and mass transit fleets.

The EPACT program requires that an increasing percentage of new light duty vehicle purchases be alternative fuel vehicles for state and federal fleets and alternative fuel provider fleets greater than 50 vehicles. The Houston-Galveston AFV Program supports the efforts of public and private fleets in complying with the TCF program and EPACT regulations by providing funding for alternative fuel vehicle purchases and conversions.

The emission benefits for all alternative fuel programs were based on comparing the total emissions from the affected fleet vehicles to the emissions which the same number of conventional vehicles would have produced in the absence of the fleet program. The emission reductions from the TCF program were based on a comparison of LEV emissions to regular fleet emissions. Reductions from propane vehicles were also based on LEV emissions standards, since these vehicles are assumed to be as clean as a LEV, however, specific emission factors for Propane were not available. Emission reductions from electric vehicles were taken as the total emissions from regular vehicles that fleet replaced. Finally, compressed natural gas (CNG) vehicle emission reductions are based on a comparison of emission factors specifically for CNG to those from regular vehicles.

3. The Conformity Tests

As indicated by Tables 14 and 15, the conformity analysis of the 2022 Metropolitan Transportation Plan and the 2000-2002 Transportation Improvement Program demonstrates that the required conformity tests are passed. That is,

- In no analysis year are emissions expected to exceed the Motor Vehicle Emissions Budget of 132.68 tons VOC per day and 283.01 tons Nitrogen Oxide (NOx) per day.
- In no analysis year are emissions expected to exceed those of the base year, 1990.

Hence, the tests for the plan and the TIP have been met.

III. Conclusion

Mobile source emissions estimated for the **2022 MTP** and the 2000 - 2002 TIP are consistent with the most recent projections of population, employment, travel and congestion available. The **2022 MTP** demonstrates attainment of TCM targets established in the SIP and provides for expeditious implementation of additional measures designed to reduce congestion and vehicular travel demand.

H-GAC believes that it is both necessary and appropriate to take credit for emissions reductions due to the implementation of CMAQ/TCM projects, and the Texas Clean Fleets (TCF) Program, given current analysis methodologies and knowledge of the programs.

VOC and NOx emissions estimates from all the analysis years, shown in Tables 14 and 15, are lower than those estimated for the 1990 Base Year. Additionally, VOC and NOx emissions are lower than the VOC and NOx budget established by the 1998 Texas 9% Rate of Progress SIP. The **2022** Metropolitan Transportation Plan (MTP) and the 2000 - 2002 Transportation Improvement Program, therefore, pass both conformity tests required under EPA's Final Conformity Rule. The transportation improvements in the **2022** MTP and the 2000 - 2002 TIP are in conformity with both the SIP and the Clean Air Act, as amended.