

APPENDIX K

H-GAC Documentation of VMEPs

Houston/Galveston Attainment Demonstration and
Post-1999 Rate-of-Progress SIP

December 2000

MEASURE TITLE: Scrappage

Program Description

This measure assumes scrappage of 7,200 light-duty vehicles by 2007 from fleet turnover from the City of Houston. Vehicles older than 15 years would receive City of Houston vehicles as a result of new vehicle purchases by the City of Houston fleet turnover program.

Program Participants: H-GAC and City of Houston.

Predicted Emissions Reduction

This analysis assumed 7,200 15-year-old (or older) vehicles. The vehicles supplied by the City of Houston are assumed to be the average Houston-Galveston area light-duty vehicles. The analysis also used the MOBILE5 default VMT and emission rates for 15-year-old and older vehicles to estimate total tpd values. 15-year-old light-duty vehicle emission rates are about 3 g VOC/mile and 2 g NOx/mile, compared with the average emission rates shown in the table.

Table 1. Average emission rates by vehicle type.

ROADWAY TYPE	LDGV	LDGT1	LDGT2	HDGV	LDDV	LDDT	HDDV	MC	LDV	All Vehicles
VOC (g/mile)	0.40	0.47	0.45	1.36	0.06	0.10	1.12	4.65	0.42	0.48
NOx (g/mile)	0.62	0.66	0.77	3.87	0.50	0.54	5.58	0.97	0.63	1.00

At the 13,000 miles per year with the numbers of vehicles scrapped, 0.73 tpd VOC and 0.39 tpd NOx emissions reductions are expected under this program.

State Commitment

H-GAC, as the regional metropolitan transportation planning agency for the Houston-Galveston area, commits to make a best faith effort to implement this project. HGAC will be responsible for monitoring and reporting the emission reductions to the TNRCC. TNRCC will verify that the numbers of vehicles scrapped will and have been scrapped.

MEASURE TITLE: Smoking Vehicle Program

Program Description

Currently, there is a voluntary smoking vehicle program in place in Texas, whereby inspectors and citizens, upon observation of a smoking vehicle, may report the license plate and other information regarding an offending vehicle. The information is put into a database and a letter and pamphlet is sent to the owner of the vehicle, requesting correction of the problem. This measure would have smoking vehicle owners bring their vehicles to an emissions inspection station for an out-of-cycle test.

Program Participants: H-GAC's Clean Air Action Program and CMAQ Funding. Clean Air Action promotes community awareness of air quality issues and the resulting health effects facing the Houston-Galveston region.

Predicted Emissions Reduction

Assumptions:

Smoking vehicle NO_x emission factor is equivalent to the Tier 1 "High" basic emission rate (BER) determined during the FTP mode for LDV/LDT1 vehicles. This is 1.28 g/mi (EPA, 1999). The repaired vehicle NO_x emission factor is equivalent to Tier 1 "Repaired" BER determined during the FTP mode for LDV/LDT1 vehicles. This is 0.60 g/mi (EPA, 1999). Each smoking vehicle is driven 12,000 mi/yr.

21.8% of the vehicles in Texas are in the Houston-Galveston area (based on 1999 FY vehicle registrations from the Texas DOT).

The number of reported vehicles per year is twice that reported during the 6-month period between January 1 and June 30, 1999 (i.e., $2 \times 6,837 = 13,674$ for all of Texas per "Smoking Vehicle Program" TNRCC data).

Based on the assumptions outlined above:

The actual number of smoking vehicles in HGA = $13,674 \times 0.218 = 2,981$

NO_x emissions of smoking vehicles = $EF_{\text{High BER}} \times \text{no. vehicles} \times \text{VMT/yr} = (1.28 \text{ g/mi.} \times 2,981 \text{ vehicles} \times 12,000 \text{ mi./vehicle}) / (453.6 \text{ g/lb} \times 2000 \text{ lb/ton}) = 50 \text{ tpy}$

If 50% of these vehicles were repaired, their NO_x emissions would be = $EF_{\text{Repaired BER}} \times \text{no. vehicles} \times \text{VMT/yr} = (0.600 \text{ g/mi.} \times 0.5 \times 2,981 \text{ vehicles} \times 12,000 \text{ mi./vehicle}) / (453.6 \text{ g/lb} \times 2000 \text{ lb/ton}) = 12 \text{ tpy}$.

The remaining uncaptured vehicles (50%) would still be emitting $0.5 \times 50 \text{ tpy} = 25 \text{ tpy}$.

Therefore, after instituting the mandatory program, emissions would be $12 + 25 = 37 \text{ tpy}$.

Total NO_x emissions reduced = $50 - 37 = 13 \text{ tpy} = 0.04 \text{ tons per day}$

This is considered a conservative estimate of the emission reductions achievable through this program. Reductions will increase if more vehicles are repaired, or if more vehicles are reported. In developing the program, efforts would be made to increase the number of vehicles reported, cited, and then repaired.

EPA, 1999. "Development of Light-Duty Emission Inventory Estimates in the Notice of Proposed Rulemaking for Tier 2 and Sulfur Standards," EPA420-R-99-005, Office of Mobile Sources, March.

State Commitment

H-GAC, as the regional metropolitan transportation planning agency for the Houston-Galveston area, commits to

make a best faith effort to implement this project. H-GAC will be responsible for monitoring and reporting the emission reductions to the TNRCC. TNRCC will verify that the control technology is operating effectively and is properly maintained through periodic testing and reporting requirements.

MEASURE TITLE: Fleet emission controls

Program Description

Under this program, emission reductions from (to date publicly-owned) vehicle fleets will be realized through clean vehicle purchases and retrofits of EPA-approved voluntary retrofit packages. For the year 2001, a list of vehicle purchases funded under the current programs is shown in table below.

Year 2001 Clean Fleet Purchases

Applicant	Program Vehicles	Vehicle Type	Fuel
Texas Department of Transportation 20 - ½ FORD ½ ton; LPG 20 - ½ CHEVY ¾ ton; CNG	24	Standard Pick-up (light-duty)	Dual LPG-Gas
	16	Standard (light-duty)	Dual CNG-Gas
Houston METRO	16	Large Sedan (light-duty)	CNG
	10	Standard Pick-up (light-duty)	CNG
City of Houston	16	Light-duty trucks and vehicles	CNG
Alvin ISD	15	School Bus (heavy-duty)	Dual LPG-Gas
Texas Water Development Board	1	Mid-Size Sedan (light-duty)	Dual LPG-Gas
	1	Standard Pck-up (light-duty)	Dual LPG-Gas
Houston METRO	50	Transit Buses	Low Emitting Diesel

The likely fleets that would be targeted under this program would be public vehicle fleets of heavy-duty vehicles, such as transit buses, refuse haulers, and service vehicles. This could include public-private fleets such as the Postal Service or other fleets that might be funded under the CMAQ program.

Program Participants: H-GAC's Greater Houston Regional Clean Cities Coalition and CMAQ Funding.

Participants would be representatives of the municipal, county, or other public entity with authority to develop and implement the emission reduction plans. The Greater Houston Regional Clean Cities Coalition was formed to promote alternative fuels and vehicles in the 8-county severe ozone nonattainment area. In September 1997, Houston was officially designated as the 55th member of the U.S. Department of Energy's (DOE) Clean Cities Program. To commemorate this achievement, a Designation Ceremony was held in which 29 stakeholders signed a Memorandum of Understanding pledging to promote the use of alternative fuels in an effort to improve air quality, encourage economic growth and increase energy security. The DOE Clean Cities program is a voluntary, locally based government/industry partnership designed to encourage the use of alternative fuels such as ethanol, methanol, natural gas, propane and electricity. In addition, Clean Cities works with local governments and businesses to promote fleet conversions to alternative fuel vehicles and to build a local fueling infrastructure

Predicted Emissions Reduction

In the current year, light-duty vehicles represent 84 purchases and 65 heavy-duty vehicles purchases for \$350K. CMAQ funding of up to \$2 million will be available yearly for emission reduction proposals. For 2001, 15 heavy-

duty vehicle purchases will cost \$22,000 each in CMAQ funding, so by using the bulk in CMAQ funding for heavy-duty vehicles about 1,000 can be purchased per year.

Light-duty Vehicles

The emission benefit was estimated in part using information in the April 2000 Attainment Demonstration. Numerous simplifications were used to arrive at this estimate. All vehicles were assumed to be four years old or less, and evenly distributed in age from one to four years. Next, all vehicles were assumed to travel 15,000 miles per year, and to be driven 6 days per week. Per vehicle emission benefits are estimated using the differences between the certification emission levels for Tier 2 and SULEV LDVs/LDTs. The certification levels for the two relevant LDV/LDT emission standards being compared in this analysis (Tier 2 versus California SULEV) are listed below:

<u>Pollutant</u>	<u>Tier 2 Certification Level</u>	<u>CA-SULEV Certification Level</u>
NO _x	0.07	0.02
VOC	0.09	0.01

The 84 light-duty purchases meeting SULEV emission levels instead of Tier 2 vehicles will result in 0.00019 tpd NOx and 0.00030 VOC reduction. Over the course of 7 years of similar purchases, 588 vehicle purchases would result in 0.0013 tpd NOx and 0.0021 tpd VOC reduction.

Heavy-duty Vehicles

The heavy-duty vehicles purchased under this program currently result and for 3 years until the 2004 standards take effect in a much lower average emission rate of 2.5 g/hp-hr instead of the 3.68 g-NOx/hp-hr (with a 4 g/hp-hr standard) of a typical diesel engine. After 2004, CNG and LPG engines are expected to result in continued reductions over diesel engine at least equivalent to the heavy-duty spark-ignition engine standard of 0.8 g-NOx/hp-hr (1 g/hp-hr VOC+NOx) instead of the 1.84 g-NOx/hp-hr (2.5 g/hp-hr VOC+NOx).

<u>Pollutant</u>	<u>Heavy-duty Diesel Certification Level</u>	<u>Heavy-duty CNG/Gasoline Certification Level</u>
NO _x (<2004)	3.68 g/hp-hr	2.5 g/hp-hr
NO _x (>2004)	1.84 g/hp-hr	0.8 g/hp-hr

For 2001-2003, if the 2000 vehicle purchases and for 2004-2007, 4000 vehicle purchases will produce a 1.18 and 1.04 g-NOx/hp-hr emission reductions. With the average conversion rate of 2.04 hp-hr/mile and 25,000 mile per year (MOBILE default for average 10 year life of HDDV), an average reduction of 0.00017 tpd NOx reduction per vehicle is expected. The NOx reduction from heavy-duty vehicles is then expected to be 1.02 tpd.

Fleet vehicles that are heavier and travel more miles per year (such as transit buses) would produce equivalent emission reductions with the purchase of fewer vehicles. For both light and heavy-duty vehicles, the expected NOx reduction is expected to be 1.02 tpd

State Commitment

H-GAC, as the regional metropolitan transportation planning agency for the Houston-Galveston area, commits to make a best faith effort to implement this project. H-GAC will be responsible for monitoring and reporting the emission reductions to the TNRCC. TNRCC will verify that the control technology is operating effectively and is properly maintained through periodic testing and reporting requirements. HGAC will provide annual reports on vehicle purchases.

MEASURE TITLE: Highway Demonstration Projects

Program Description

Ongoing demonstration projects are applying diesel/water emulsion or catalyst aftertreatment devices to highway diesel engines. Current demonstration projects at the Port of Houston and the City of Houston are expected to result in emission reductions, and are estimated under other voluntary measure descriptions. The most likely candidates to date are the Ceryx QuadCat system and diesel/water emulsion technology currently obtaining certification in California. Both these technologies likely reduce NOx emissions by 20% over current levels.

This voluntary program seeks to expand the current demonstration projects to other privately-owned vehicle fleets. Funding sources need to be identified through H-GAC, TNRCC, or Federal programs. These projects would not be eligible to offset any mandate State or Local emission or activity controls put forward in the State Implementation Plan.

Program Participants: HGAC-Private/Public Fleets and TNRCC’s and EPA’s Supplemental Environmental Project Funds

Predicted Emissions Reduction

HGAC will pursue opportunities where they exist to develop partnerships with private owner/operators for emission reduction projects. In order to calculate emission reductions, 10,000 heavy-duty diesel vehicles traveling an average of 25,000 miles per year are targeted for either of these retrofit strategies. By employing this technology with older higher-emitting vehicles and/or those that travel more miles per year, fewer vehicles will need to implement this program to achieve the calculated reduction.

The average emission rate for heavy-duty vehicles is 5.58 g/mile as shown in the table below. Using this figure with the average annual activity assumption above, a 0.84 tpd NOx reduction is realized.

Table 1. Average emission rates by vehicle type.

	LDGV	LDGT1	LDGT2	HDGV	LDDV	LDDT	HDDV	MC	All Vehicles
VOC (g/mile)	0.4	0.47	0.45	1.36	0.06	0.1	1.12	4.65	0.48
NOx (g/mile)	0.62	0.66	0.77	3.87	0.50	0.54	5.58	0.97	1.00

State Commitment

H-GAC, as the regional metropolitan transportation planning agency for the Houston-Galveston area, the Greater Houston Partnership, and the EPA Region VI’s Clean Air Action program commit to make a best faith effort to implement this project. H-GAC will be responsible for monitoring and reporting the emission reductions to the TNRCC. TNRCC will verify that the control technology is operating effectively and is properly maintained through periodic testing and reporting requirements. HGAC will provide annual reports on vehicle retrofits or other programs.

MEASURE TITLE: Private fleet emission controls

Program Description

Under this program, emission reductions from (to date publicly-owned) vehicle fleets will be realized through clean vehicle purchases and retrofits of EPA-approved voluntary retrofit packages. The new vehicle purchases may be standard or alternative-fueled vehicles that meet lower standards.

Program Participants: H-GAC's Greater Houston Regional Clean Cities Coalition, along with the Greater Houston Partnership and EPA Region VI Clean Air Action program, will implement the emission reduction plans.

The Greater Houston Regional Clean Cities Coalition was formed to promote alternative fuels and vehicles in the 8-county severe ozone nonattainment area. In September 1997, Houston was officially designated as the 55th member of the U.S. Department of Energy's (DOE) Clean Cities Program. To commemorate this achievement, a Designation Ceremony was held in which 29 stakeholders signed a Memorandum of Understanding pledging to promote the use of alternative fuels in an effort to improve air quality, encourage economic growth and increase energy security. The DOE Clean Cities program is a voluntary, locally based government/industry partnership designed to encourage the use of alternative fuels such as ethanol, methanol, natural gas, propane and electricity. In addition, Clean Cities works with local governments and businesses to promote fleet conversions to alternative fuel vehicles and to build a local fueling infrastructure.

The private heavy-duty vehicle fleets will be the audience for this effort because larger emission reductions per vehicle can be realized. These private vehicle fleets will include private refuse haulers, delivery trucks (such as grocery or retail chains or private mail service), and service vehicles.

Predicted Emissions Reduction

Light-duty Vehicles

The emission benefit was estimated in part using information in the April 2000 Attainment Demonstration. Numerous simplifications were used to arrive at this estimate. All vehicles were assumed to be four years old or less, and evenly distributed in age from one to four years. Next, all vehicles were assumed to travel 15,000 miles per year, and to be driven 6 days per week. Per vehicle emission benefits are estimated using the differences between the certification emission levels for Tier 2 and SULEV LDVs/LDTs. The certification levels for the two relevant LDV/LDT emission standards being compared in this analysis (Tier 2 versus California SULEV) are listed below:

<u>Pollutant</u>	<u>Tier 2 Certification Level</u>	<u>CA-SULEV Certification Level</u>
NO _x	0.07	0.02
VOC	0.09	0.01

Over the course of 7 years, 1,500 vehicle purchases would result in 0.003 tpd NO_x and 0.004 tpd VOC reduction for 2007.

Heavy-duty Vehicles

The heavy-duty vehicles purchased under this program currently result and for 3 years until the 2004 standards take effect in a much lower average emission rate of 2.5 g/hp-hr instead of the 3.68 g-NO_x/hp-hr (with a 4 g/hp-hr standard) of a typical diesel engine. After 2004, CNG and LPG engines are expected to result in continued reductions over a comparable diesel engine at least equivalent to the heavy-duty spark-ignition engine standard of

0.8 g-NOx/hp-hr (1 g/hp-hr VOC+NOx) instead of the 1.84 g-NOx/hp-hr (2.5 g/hp-hr VOC+NOx). The average conversion factor from g/hp-hr to g/mile is approximately 2.04 for heavy-duty vehicles in MOBILE5b, so the average difference in emission rates for cleaner vehicle purchases is 2.3 g/mile per vehicle.

<u>Pollutant</u>	<u>Heavy-duty Diesel Certification Level</u>	<u>Heavy-duty CNG/Gasoline Certification Level</u>
NO _x (<2004)	3.68 g/hp-hr	2.5 g/hp-hr
NO _x (>2004)	1.84 g/hp-hr	0.8 g/hp-hr

By 2007, 19,000 such heavy-duty vehicles traveling at an average of 25,000 miles per year will produce a 3.2 tpd NOx reduction. By targeting larger trucks traveling more miles per year, the reductions achieved may be greater than predicted for the same numbers of vehicles.

For both light and heavy-duty vehicles, the expected NOx reduction is expected to be 3.21 tpd

State Commitment

H-GAC, as the regional metropolitan transportation planning agency for the Houston-Galveston area, the Greater Houston Partnership, and the EPA Region VI's Clean Air Action program commit to make a best faith effort to implement this project. H-GAC will be responsible for monitoring and reporting the emission reductions to the TNRCC. TNRCC will verify that the control technology is operating effectively and is properly maintained through periodic testing and reporting requirements. HGAC will provide annual reports on vehicle purchases.

MEASURE TITLE: Nonroad Demonstration Projects

Program Description

Ongoing demonstration projects are applying diesel/water emulsion or catalyst aftertreatment devices to nonroad diesel engines. Current demonstration projects at the Port of Houston and the City of Houston are expected to result in emission reductions and are estimated under other voluntary measure descriptions. For spark-ignition nonroad engines built before 2004 or those used in agricultural or construction equipment, commercially available three-way catalyst or lean-burn retrofit packages could be used to retrofit such engines.

This voluntary program seeks to expand the current demonstration projects to other owner/operators of nonroad equipment. These projects would not be eligible to offset any mandated State or Local emission or activity controls put forward in the State Implementation Plan.

Program Participants: HGAC-Private/Public Fleets plus TNRCC's and EPA's Supplemental Environmental Project Funds

Predicted Emissions Reduction

HGAC will pursue opportunities where they exist to develop partnerships for emission reduction projects. The most likely emission reductions will come from programs targeting construction, agricultural, industrial, and commercial equipment. Commercial vessels and locomotives are covered under other voluntary reductions. Emission reduction from voluntary controls on aircraft is not feasible. Construction, airport service, and lawn and garden equipment are already covered under mandated state programs, so these segments for the most part are unavailable for voluntary emission reduction programs. Other segments, Agricultural, Commercial Fishing and Recreational Vessels and Aircraft, are unlikely to produce emission reductions from voluntary measures, because control measures are either technically unfeasible (Aircraft and to some extent Fishing and Recreational vessels), or very costly.

The table below demonstrates where the likely emission reductions will occur. Industrial equipment, such as forklifts or aerial lifts (also called manlifts), and to a lesser extent commercial equipment, such as pumps, generators, and compressors, is powered by both spark-ignition engines, where 80% control is feasible through the use of three-way catalysts, and by diesel engines, where about 20% control is feasible. One State measure covers spark-ignition engines beginning with the model year 2004, so much of this equipment will already meet lower emission standards reducing the opportunity for emission reductions from retrofits of spark-ignition. The NO_x emissions from the other likely categories are dominated by diesel equipment, so the likely emission reduction from retrofitted equipment is 20% control. By applying aggressive controls to much of the equipment as shown in the table below, a 0.5 – 2.5 tpd NO_x reduction is likely through voluntary measures.

Table 1. Eight-county Houston/Galveston offroad equipment NOx emissions summary for the 2007 base case. (Without Mandated Tier II/III, Diesel Emulsions and NOx Catalyst Retrofits) and likely available emission reductions with a trading program

Equipment Type	Base Emissions (TPD)	Emission Reduction (%/TPD)
Commercial Vessels	41.68	0%
Construction and Mining Equipment	32.08	0%
Industrial Equipment	15.00	~5-15% ; 0.5 - 2.0
Agricultural Equipment	12.85	0%
Locomotives	12.09	0%
Aircraft	7.37	0%
Airport Service Equipment	6.00	0%
Commercial Equipment	5.10	~0-10% ; 0 - 0.5
Marine Vessels, Recreational	2.33	0%
Commercial Fishing Vessels	2.19	0%
Lawn & Garden Equipment	1.16	0%
Logging	0.49	0%
Total		0.5 – 2.5

State Commitment

HGAC, as the regional metropolitan transportation planning agency for the Houston-Galveston area, commits to make a best faith effort to implement this project. HGAC will be responsible for monitoring and reporting the emission reductions to the TNRCC.

MEASURE TITLE: Voluntary Locomotive Emission Reductions

Program Description

Additional reductions in locomotive emissions can be realized through the application of one or more measures described here as fleet management (using primarily emission controlled engines), fuel/water emulsions, and NOx catalyst retrofit devices. The reductions associated with fleet management can be achieved by railways operating more controlled engines within the Houston-Galveston area than would occur with normal fleet turnover. The use of fuel/water emulsions and NOx catalyst retrofit devices can also provide similar or additional control, provided there is significant penetration of these measures.

The emission reductions in addition to those associated with the Federal emission standards is expected to be 17%, or 2.0 tons of NOx per day.

Program Participants: TNRCC, EPA, H-GAC and Railways (Union Pacific, Burlington Northern Santa Fe, Kansas City Southern, others). H-GAC’s Greater Houston Regional Clean Cities Coalition, CMAQ Funding, and Tx-DOT. Participants would be representatives of the municipal, county, or other public entity with authority to develop and implement the emission reduction plans. The Greater Houston Regional Clean Cities Coalition was formed to promote alternative fuels and vehicles in the 8-county severe ozone nonattainment area. In September 1997, Houston was officially designated as the 55th member of the U.S. Department of Energy’s (DOE) Clean Cities Program. To commemorate this achievement, a Designation Ceremony was held in which 29 stakeholders signed a Memorandum of Understanding pledging to promote the use of alternative fuels in an effort to improve air quality, encourage economic growth, and increase energy security. The DOE Clean Cities program is a voluntary, locally based government/industry partnership designed to encourage the use of alternative fuels such as ethanol, methanol, natural gas, propane and electricity. In addition, Clean Cities works with local governments and businesses to promote fleet conversions to alternative fuel vehicles and to build a local fueling infrastructure.

Predicted Emissions Reduction

Overall for this measure, a 17% reduction is calculated from a base 2007 inventory of 12.1 TPD NOx, and can be reached through the three measures described below. A 20% reduction calculation is shown below, so 85% penetration rate for emission control technologies may be assumed for these measures.

1) EPA [EPA (1997), “Locomotive Emissions Standards; Regulatory Support Document,” April, 1997] estimated the fleet mix that is expected by 2007 (shown below), and a 20% reduction can be reached by employing a fleet mix that matches the EPA estimated fleet mix expected in 2017 (also shown below). Other fleet mixes may reach similar emissions levels.

	2007	2007	2017	2017
	Line Haul	Switching	Line Haul	Switching
Base (uncontrolled)	3%	67%	0%	12%
Tier 0	63%	27%	35%	67%
Tier 1	12%	3%	9%	3%
Tier 2	22%	3%	56%	18%

2) Another measure to reach 20% NOx reduction is by employing fuel/water emulsions fleet wide.

3) Still another measure is selectively employing NOx catalyst retrofits (such as SCR systems) or using properly designed or retrofitted LNG engines. The retrofits would be most effective with the higher emitting Tier 0 or Base locomotive engines which are expected to comprise 58% of line haul and 96% of switching NOx emissions based on the EPA support document [EPA (1997), “Locomotive Emissions Standards; Regulatory Support Document,” April, 1997.]. By applying a NOx retrofit device which is estimated to control 50% of the NOx emissions, to 40% of the fleet (most effectively with Base or Tier 1 engines), a 20% overall reduction can be realized.

Of course, the proper mix of these methods could also provide similar reductions.

State Commitment

HGAC, as the regional metropolitan transportation planning agency for the Houston-Galveston area, commits to make a best faith effort to implement this project. HGAC will be responsible for monitoring and reporting the emission reductions to the TNRCC. EPA, TNRCC, H-GAC, and the affected Railways will sign a voluntary agreement such as a Statement of Principals. A reporting requirement from the Railways to the H-GAC and State will be required to demonstrate the reductions.

MEASURE TITLE: Commercial Marine

Program Description

Additional reductions in commercial emissions can be realized through the application of one or more measures described here as speed reductions, fleet management (using primarily emission controlled engines), or through incentives for cleaner burning engines, either for propulsion or hotelling generator power. The emissions reductions could be from either vessels and/or dock-based equipment, though they are described here as derived from vessels only.

Program Participants: TNRCC, Ship Operators, Ferries and regional ports.

Predicted Emissions Reduction

The emission reductions in addition to those associated with the Federal emission standards estimated in the SIP could be as much as 4 to 5 tons of NOx per day. H-GAC anticipates that these reductions can be obtained through a combination of the measures summarized below.

1) One option is the reduction of ocean-going vessel speeds during transit across Galveston Bay. While traveling across the Bay at 12 knots, roughly 70% of the engine power during transit is associated with propulsion of the vessel, with the remainder to power auxiliary as shown in the equation below.

$$\begin{aligned}\text{Engine Power} &\approx 0.3 + 0.7 * V^3 \text{ where } V \text{ is relative vessel speed to full speed} \\ \text{Engine Work} &\approx 0.3 / V + 0.7 * V^2\end{aligned}$$

If ocean-going vessel speed is reduced to 10 knots, then overall work is reduced by 15%. The ocean-going vessel transit emissions across the Bay are estimated to be 12.7 tpd NOx. The expected reduction is then 2.0 tpd of NOx.

2) For ocean-going vessels, a significant fraction of the overall emissions, 14.75 tpd NOx, occurs during dwelling. Onboard generator engines can achieve at least a 25% NOx emission reduction through the use of engine management while in ports that encourage such controls. Assuming a 40% compliance rate, the 10% overall reduction results in a 1.5 tpd NOx reduction.

3) For ocean-going vessels, the propulsion engines' management (such as timing changes or water injection) may be modified during port calls to Houston. Wärtsilä and other engine manufacturers have claimed that such modifications can be accomplished by ship personnel when visiting sensitive ports and emission reductions of 20-50% per ship could be realized. With incentives in place, a 3% overall reduction in total transit emissions of 15.3 tpd NOx would result in about 0.5 tpd NOx reduction.

4) Emissions from assist tugs, push boats, and barge pumps are estimated to be 10.9 tpd NOx. With fleet management or engine repower, newer, lower-emitting, engines can reduce overall emissions. Current estimates indicate that 36% of the engine in vessels in 2007 will be of 2000 or later vintage. By incorporating engines of this vintage up to 60% of the total, a 10% emission reduction can be realized, resulting in a 1.1 tpd NOx reduction.

5) Ferries in the region can be retrofitted with Selective Catalytic Reduction (SCR) packages to reduce NOx emissions by 70%, with likely vendors claiming 70-90% reductions. Ferries typically run at very constant engine loads, so urea-ammonia injection can be metered accurately to meet the reduction requirements. If feedback controls can be improved significantly, higher reduction estimates may be possible, but we have assumed the lowest end of the reduction potential.

CMAQ funding has been requested for implementation and verification of the emissions reduction package for two regional ferries. Additional CMAQ funding or other sources will be considered to implement this emission reduction plan for other ferries or any new ferries purchased by 2007.

A 70% overall reduction is calculated from a base 2007 inventory of 1.14 tpd NOx, resulting in 0.8 tpd reduction from such a program. Ferries operate more often (hours per day) during peak summertime conditions, so emission reductions will occur preferentially during the peak ozone season, likely resulting in greater than 0.8 tpd NOx emission reductions during the primary ozone season.

State Commitment

HGAC, as the regional metropolitan transportation planning agency for the Houston-Galveston area, commits to make a best faith effort to implement this project. HGAC will be responsible for monitoring and reporting the emission reductions to the TNRCC. TNRCC, HGAC, other state agencies and each of the regional ports would need to sign a voluntary agreement, such as a Statement of Principles, to demonstrate and report the reductions.

MEASURE TITLE: Commute Solutions

Program Description

Both the current and anticipated future Commute Solutions Program include several individual TCMs evaluated here as a package. Evaluating the program in this manner is consistent with the real-world implementation approach in the Houston area. In addition, it reduces the amount of analysis for TCMs that, individually, would typically result in very small emission reductions. The approach also helps capture the variations in individual, day-to-day choices in travel options. Individual TCMs that make up the Commute Solutions program include:

- ✓ Regional mass transit
- ✓ Carpooling
- ✓ Vanpooling
- ✓ Mass transit with Commuter Services (includes park and ride lots and fixed route circulators that connect with existing METRO services and shuttles)
- ✓ Guaranteed ride home program
- ✓ Teleworking
- ✓ Parking Management
- ✓ Biking and walking to work
- ✓ Flextime and
- ✓ Compressed Work Weeks

Additional TCMs suggested at various working group and committee meetings that fall into one or more of the above categories include:

- ✓ Ride Share
- ✓ Expanded carpools
- ✓ New/expanded park and ride
- ✓ Employer/onroad
- ✓ Station cars
- ✓ Parking cash-out
- ✓ Unbundling of SOV park and
- ✓ Private transit services

METHODOLOGY FOR ANALYSIS

Travel Reduction: Based on experience with program growth in the past several years, together with the results of surveys indicating individuals' willingness to participate in covered programs, this measure was modeled as resulting in ten percent of employees participating at least once per week by 2007. It was assumed that the participation resulted in removing one round-trip work trip per week. Some individuals drive to transit centers, carpoolers have a driver who is accumulating VMT, and vanpools replace SOV travel but have emissions of their own. In this analysis these factors are assumed to be offset by individuals who participate in Commute Solutions more than once per week. Total 2007 employment is projected at 3,085,050. Ten percent of that is 308,505. Pending receipt of average trip distances, it is assumed that the average work trip distance is 30 miles (based on recent vanpool trip averages of 33 miles). Therefore, each individual participation day results in a round-trip savings of 60 miles. Therefore, total VMT savings are

308,505 participants * 60 miles per day * 0.14 (days per week of reduced work travel) = 2,644,328 miles per average day

Predicted Emissions Reduction

It was assumed that only light-duty vehicles (LDV) were affected by this measure, so the average emission rate for light-duty vehicles was multiplied by the estimated VMT reduction resulting from the estimated number of participants and their daily travel. Overall reductions for VOC and NOx from the trip reductions are expected to be 1.2 and 1.8 tons per day, respectively.

The average speed for the light-duty vehicles is shown in the table below for individual roadways, and the overall average was calculated from the speeds on the individual roadways. From the total VMT, the VMT mix was calculated as well.

Program Participants: HGAC Transportation Planning

Predicted Emissions Reduction

Table 1. Average speed and VMT mix for the 24 hour 8-County Area

ROADWAY TYPE	Avg. Speed	LDGV	LDGT1	LDGT2	HDGV	LDDV	LDDT	HDDV	MC	TOTALS
LOCAL (INTRAZONAL)	29.07	351154	143855	42921	18935	1020	1786	34895	595	595160
URBAN INTERSTATE	61.92	18870501	3315238	1003857	494068	54768	41169	1561231	25366	25366199
URBAN OTHER FREEWAY	62.58	16525568	2903272	879113	432673	47962	36053	1367226	22214	22214082
URBAN PRIN. ART.	37.76	10232534	2489807	736442	309159	29700	30919	804628	14648	14647836
URBAN OTHER ART.	31.88	20071290	4883799	1444543	606420	58257	60647	1578291	28732	28731979
URBAN COLLECTOR	32.43	1326775	543533	162169	71542	3852	6750	131843	2249	2248713
LOCAL (CENT. CONN.)	24.21	7502945	3073691	917070	404572	21783	38169	745576	12717	12716523
RURAL INTERSTATE	69.89	3747898	658444	199378	98127	10878	8177	310078	5038	5038018
RURAL OTHER FWY.	69.58	3352126	588914	178324	87765	9729	7313	277335	4506	4506011
RURAL PRIN. ART.	58.18	1360857	331127	97942	41116	3950	4112	107010	1948	1948062
RURAL OTHER ART.	56.73	2972138	723188	213907	89798	8627	8981	233712	4255	4254605
RURAL MAJOR COL.	54.4	3486264	1428199	426119	187986	10122	17735	346434	5909	5908767
RURAL COLLECTOR	49.31	700008	286769	85561	37746	2032	3561	69561	1186	1186424
TOTALS	42.5	90500059	21369835	6387345	2879907	262680	265372	7567818	129362	129362378
VMT Mix	-	0.700	0.165	0.049	0.022	0.002	0.002	0.059	0.001	

The average emission rate for light-duty vehicles was determined using MOBILE5b model runs for Harris County with the 42.5 mph average speed (including the SIP I/M adjustments), and adjusted for low sulfur gasoline and Tier 2 light-duty emission standards as described by ENVIRON (2000). {ENVIRON (2000), "Comparison of Current and Revised SIP Highway Emissions Modeling," Memorandum to Lily Wells of HGAC from Environ, October 20, 2000.} These are shown in Table 3 below.

After these adjustments, the emission rates for LDDV and LDDT were lower than corresponding, so they were ignored for the calculation of the average emission rate for LDV. The light-duty (now LDGV, LDGT1, and LDGT2) and all vehicle average emission rates were determined from the VMT mix shown in Table 2.

Table 3. Average emission rates by vehicle type.

ROADWAY TYPE	LDGV	LDGT1	LDGT2	HDGV	LDDV	LDDT	HDDV	MC	LDV	All Vehicles
VOC (g/mile)	0.40	0.47	0.45	1.36	0.06	0.10	1.12	4.65	0.42 0.46	0.48
NOx (g/mile)	0.62	0.66	0.77	3.87	0.50	0.54	5.58	0.97	0.63 0.66	1.00

LDV italicized with speed limit.

The emission factors for light duty vehicles were multiplied by the number of participating employees, the fraction of work days (0.14), and the round-trip work trip miles (60), resulting in a savings of 1.2 tons of VOC and 1.8 tons of NOx daily.

State Commitment

TNRCC will verify that the control programs are operating effectively.

MEASURE TITLE: Regional Computerized Traffic Signal System (RCTSS)

Program Description

This program is modeled as a compilation of individual initiatives to reduce vehicle congestion on surface streets through signal timing and other traffic management programs.

The Houston METRO Regional Computerized Traffic Signal System (**RCTSS**) and METRO Public Transit System (MPTS) are being integrated into a common systems architecture with real-time interoperability. **RCTSS** is also integrated with the TxDOT, Houston District, and Metropolitan Regional Freeway Management System. This totally integrated, county-wide system provides over 1,800 square miles of real-time coordination between transit and traffic functions.

One objective of the 2022 Metropolitan Transportation Plan (MTP) is to define strategies that reduce existing and future traffic congestion. Transportation Control Measures (TCM) such as changeable message signs and ramp metering are two of many cost-effective strategies that are being employed in the region to help reduce congestion. The Regional Computerized Traffic Signal System (RCTSS) designed by Harris County, City of Houston, TxDOT, and METRO includes signal synchronization at over 3,000 intersections.

Program Participants: H-GAC’s Transportation Planning, Harris County, City of Houston, TxDOT, and METRO includes signal synchronization at over 3,000 intersections.

Predicted Emissions Reduction

It was assumed that only roadways designated as local streets, either intrazonal or central connectors, were affected by this measure. The average emission rate for all vehicles with and without the initiative was multiplied by the estimated VMT for ‘Local’ roadways shown in the table below. Overall reductions for VOC and NOx from the trip reductions are expected to be 1.42 and 0.03 tons per day, respectively.

The average speed for the light-duty vehicles is shown in the table below for individual roadways, and the overall average was calculated from the speeds on the individual roadways. From the total VMT, the VMT mix was calculated as well. The ‘Local’ VMT affected by this measure is also shown in the table below.

Table 1. Average speed and VMT mix for the 24 hour 8-County Area

ROADWAY TYPE	Avg. Speed	LDGV	LDGT1	LDGT2	HDGV	LDDV	LDDT	HDDV	MC	TOTALS
LOCAL (INTRAZONAL)	29.07	351154	143855	42921	18935	1020	1786	34895	595	595160
URBAN INTERSTATE	61.92	18870501	3315238	1003857	494068	54768	41169	1561231	25366	25366199
URBAN OTHER FREEWAY	62.58	16525568	2903272	879113	432673	47962	36053	1367226	22214	22214082
URBAN PRIN. ART.	37.76	10232534	2489807	736442	309159	29700	30919	804628	14648	14647836
URBAN OTHER ART.	31.88	20071290	4883799	1444543	606420	58257	60647	1578291	28732	28731979
URBAN COLLECTOR	32.43	1326775	543533	162169	71542	3852	6750	131843	2249	2248713
LOCAL (CENT. CONN.)	24.21	7502945	3073691	917070	404572	21783	38169	745576	12717	12716523
RURAL INTERSTATE	69.89	3747898	658444	199378	98127	10878	8177	310078	5038	5038018
RURAL OTHER FWY.	69.58	3352126	588914	178324	87765	9729	7313	277335	4506	4506011
RURAL PRIN. ART.	58.18	1360857	331127	97942	41116	3950	4112	107010	1948	1948062
RURAL OTHER ART.	56.73	2972138	723188	213907	89798	8627	8981	233712	4255	4254605

RURAL MAJOR COL.	54.4	3486264	1428199	426119	187986	10122	17735	346434	5909	5908767
RURAL COLLECTOR	49.31	700008	286769	85561	37746	2032	3561	69561	1186	1186424
TOTALS	42.5	90500059	21369835	6387345	2879907	262680	265372	7567818	129362	129362378
Overall VMT Mix	-	0.700	0.165	0.049	0.022	0.002	0.002	0.059	0.001	
'Local' VMT Mix	24.4	0.590	0.242	0.072	0.032	0.002	0.003	0.059	0.001	

The baseline average emission rate for all vehicles was determined using MOBILE5b model runs for Harris County with the 24.4 mph average speed (including the SIP I/M adjustments) and adjusted for low sulfur gasoline and Tier 2 light-duty emission standards as described by ENVIRON (2000). {ENVIRON (2000), "Comparison of Current and Revised SIP Highway Emissions Modeling," Memorandum to Lily Wells of HGAC from Environ, October 20, 2000.} These are shown in Table 2 below. With implementation of this measure an average speed increase of 21% is expected, resulting in higher average speeds for the VMT on local surface streets.

Table 2. Average emission rates by vehicle type.

ROADWAY TYPE	LDGV	LDGT1	LDGT2	HDGV	LDDV	LDD T	HDDV	MC	Speed	All Vehicles
VOC (g/mile)	0.61	0.67	0.67	2.01	0.09	0.16	1.77	5.19	24.4	0.742
NOx (g/mile)	0.59	0.65	0.76	3.35	0.51	0.55	5.64	0.79	24.4	1.000
VOC (g/mile)	0.53	0.59	0.58	1.73	0.08	0.13	1.51	4.97	29.5	0.645
NOx (g/mile)	0.60	0.65	0.77	3.50	0.48	0.52	5.36	0.86	29.5	0.998

By applying the expected emission rate reduction with the total VMT (13,311,683) on these roadways, emission reductions of 1.42 tpd VOC and 0.03 tpd NOx are expected.

State Commitment

H-GAC, as the regional metropolitan transportation planning agency for the Houston-Galveston area, commits to make a best faith effort to implement this project. H-GAC will be responsible for monitoring and reporting the emission reductions to the TNRCC.

TNRCC will verify that the control programs are operating effectively.

MEASURE TITLE: Cool Cities

Program Description

The existing tree canopy coverage of our region will be used to calculate the economic and environmental benefits that trees provide in terms of pollution mitigation and cooling costs.

Two benefits of trees that will be examined are ozone mitigation and avoided carbon. The Texas Forest Service claims that trees lost since 1972 would have removed more than 6 million pounds of ozone, and significant amounts of other pollutants, as well. Energy savings from the urban canopy will be examined, and a report will assess if and how much savings the average single family dwelling in the Houston metro area with trees will receive, anticipated to be approximately \$72 per home. The corresponding reduction in energy demand amounts to about 10 million tons of avoided carbon emissions per year.

In order to meet federal compliance standards for ground level ozone by 2007, trees are one tool to lower ozone concentrations in an inexpensive and simple way.

Program Participants:

American Forests, in partnership with the Houston Green Coalition, a group composed of municipal, state and local non-governmental organizations, and the USDA Forest Service, Gulf Coast Institute and H-GAC's Clean Air Action Program.

Predicted Emissions Reduction

0.0 – 1.0 tpd NOx

State Commitment

H-GAC, as the regional metropolitan transportation planning agency for the Houston-Galveston area, commits to make a best faith effort to implement this project. HGAC will be responsible for monitoring and reporting the emission reductions to the TNRCC.

TNRCC and TxDOT will verify that the control technology is operating effectively and is properly maintained through periodic testing and reporting requirements.

MEASURE TITLE: Smart Growth

Program Description

Under this program, HGAC will encourage green development through population densification and mixed land use initiatives to reduce number, frequency, and length of trips.

The primary mechanism to encourage this is the City of Houston’s planned Tax Increment Reinvestment Zones (TIRZ) to reinvigorate the urban area. As of March 2000 and shown below, 26,603 residential dwellings are planned and many completed with accompanying retail, commercial, and other (high school) development to service the additional residential space. An additional 22,400 residential developments are planned for the Woodland Town Center from 1999 through 2007.

Current Reinvestment Zones and Planned Residential Development

Lamar Terrace/St George Place	430 residential units and commercial development
Midtown	3884 residential units and commercial development
Market Square	977 residential units and commercial development
Village Enclaves	400 residential units and commercial development
Memorial Heights	1000 residential units and commercial development
Eastside	Commercial development
OST/Almeda	1519 residential units and commercial development
Gulfgate	Commercial development
South Post Oak	452 residential units and commercial development
Lake Houston	2703 residential units and commercial development
Greater Greenspoint	5338 residential units and commercial development
City Park	288 residential units and commercial development
Old Sixth Ward	408 residential units
Fourth Ward	2200 residential units and commercial development
East Downtown	Commercial development
Uptown	1399 residential units and commercial development
Memorial City	3000 residential units and commercial development
Fifth Ward	600 residential units and commercial development
Upper Kirby	1575 residential units and commercial development
Southwest Houston	430 residential units and commercial development

In addition, the Woodland Town Center is expecting to add residential units, while providing a mixed use, transit oriented, approach. In addition, the City of Houston is expecting to expand the TIRZ program. In order to account for these developments, 10% additional urban residential units are expected to be added to the list above, resulting in 53,903 total urban residential units by 2007.

Program Participants: H-GAC, the Woodland Town Center and the City of Houston Initiatives

Predicted Emissions Reduction

From H-GAC travel demand modeling, the average travel per household is expected to be 58 miles per day. According to the study: *TTI (1997), “Urban Design, Telecommunication and Travel Forecasting Conference: Summary, Recommendations and Compendium of Papers,” Final Report, August 1997, Prepared by Lisa G. Day of the Texas Transportation Institute, Prepared for U.S. Department of Transportation, Federal Transit Administration, Federal Highway Administration, and the U.S. Environmental Protection Agency*, with urban redevelopment, the number of trips is expected to be reduced by 25-30% and each trip is expected to be reduced by 30-50% because, for instance, commute distance is much less. Overall, each redevelopment residential unit was expected to have 56.5%, or 33 miles per day, less daily travel. However, many studies of transit and pedestrian oriented developments have found little ability on the part of residents to choose to change their work locations as a

result of living in the new development, and as a result travel may not be reduced as much as is desired. Therefore, this analysis more conservatively assumes that only 15 percent of residents can change their travel behavior by the 30 - 50% cited in the study (40% is assumed here).

By 2007, total VMT that would have resulted from the 53,903 units if no change in driving behavior was occurring would be calculated as follows:

$(53,903 \text{ units} \times 58 \text{ miles per day per household}) / 1.75 \text{ driving age people per household} = 1,786,499 \text{ miles per day}$
 (an average of 33 miles per person per day).

The VMT reduction is 15% of residents (14,149 people) x 33 miles per day x .6 (60% of original travel) = travel = 280,150 miles of travel.

It is expected that such green development would result in VMT reduction for heavy and light-duty vehicles. In order to estimate emission reductions, the average emission rate for all vehicles under average conditions was multiplied by the VMT reductions and is described below.

The average speed for the light-duty vehicles is shown in the table below for individual roadways, and the overall average was calculated from the speeds on the individual roadways. From the total VMT, the VMT mix was calculated as well.

Table 1. Average speed and VMT mix for the 24 hour 8-County Area

ROADWAY TYPE	Avg. Speed	LDGV	LDGT1	LDGT2	HDGV	LDDV	LDDT	HDDV	MC	TOTALS
LOCAL (INTRAZONAL)	29.07	351154	143855	42921	18935	1020	1786	34895	595	595160
URBAN INTERSTATE	61.92	18870501	3315238	1003857	494068	54768	41169	1561231	25366	25366199
URBAN OTHER FREEWAY	62.58	16525568	2903272	879113	432673	47962	36053	1367226	22214	22214082
URBAN PRIN. ART.	37.76	10232534	2489807	736442	309159	29700	30919	804628	14648	14647836
URBAN OTHER ART.	31.88	20071290	4883799	1444543	606420	58257	60647	1578291	28732	28731979
URBAN COLLECTOR	32.43	1326775	543533	162169	71542	3852	6750	131843	2249	2248713
LOCAL (CENT. CONN.)	24.21	7502945	3073691	917070	404572	21783	38169	745576	12717	12716523
RURAL INTERSTATE	69.89	3747898	658444	199378	98127	10878	8177	310078	5038	5038018
RURAL OTHER FWY.	69.58	3352126	588914	178324	87765	9729	7313	277335	4506	4506011
RURAL PRIN. ART.	58.18	1360857	331127	97942	41116	3950	4112	107010	1948	1948062
RURAL OTHER ART.	56.73	2972138	723188	213907	89798	8627	8981	233712	4255	4254605
RURAL MAJOR COL.	54.4	3486264	1428199	426119	187986	10122	17735	346434	5909	5908767
RURAL COLLECTOR	49.31	700008	286769	85561	37746	2032	3561	69561	1186	1186424
TOTALS	42.5	90500059	21369835	6387345	2879907	262680	265372	7567818	129362	129362378
VMT Mix	-	0.700	0.165	0.049	0.022	0.002	0.002	0.059	0.001	

The average emission rate for light-duty vehicles was determined using MOBILE5b model runs for Harris County with the 42.5 mph average speed (including the SIP I/M adjustments) and adjusted for low sulfur gasoline and Tier 2 light-duty emission standards as described by ENVIRON (2000). *{ENVIRON (2000), "Comparison of Current and Revised SIP Highway Emissions Modeling," Memorandum to Lily Wells of HGAC from Environ, October 20, 2000.}* These are shown in Table 2 below.

Table 2. Average emission rates by vehicle type.

ROADWAY TYPE	LDGV	LDGT1	LDGT2	HDGV	LDDV	LDDT	HDDV	MC	All Vehicles
VOC (g/mile)	0.40	0.47	0.45	1.36	0.06	0.10	1.12	4.65	0.48
NOx (g/mile)	0.62	0.66	0.77	3.87	0.50	0.54	5.58	0.97	1.00

By applying the expected VMT reductions with the average emission rate for all vehicles shown in Table 2, emission reductions of 0.15 tpd VOC and 0.31 tpd NOx are expected.

State Commitment

H-GAC, as the regional metropolitan transportation planning agency for the Houston-Galveston area, commits to make a best faith effort to implement this project. H-GAC will be responsible for monitoring and reporting the emission reductions to the TNRCC. TNRCC will verify that the urban redevelopment corresponds with the estimates described above through reporting requirements.

MEASURE TITLE: Local Government Emission Reduction Programs

Program Description

Under this program, cities, counties, and/or other public organizations (e.g., school districts, transit authorities) would develop multi-component emission reduction strategies. Such strategies would target on-road and off-road mobile sources as well as stationary sources. As an example, the City of Houston has targeted NOx emission reductions through a combination of initiatives including commute options for city employees, stationary source emission controls, diesel equipment retrofits, and contract incentives to encourage retrofits by contractors working on city projects. Several other public entities have expressed interest in investigating similar programs.

The emission reduction plan targets NOx emission sources that have the potential to be controlled or eliminated. Potential control measures include promoting carpool/vanpool or public transit use by employees, modifying employee on-the-job driving requirements, installing retrofit emission control devices on mobile and stationary emission sources owned by the participating entity, and providing incentives and/or contract requirements for contractors to similarly retrofit their equipment. The measures will be partially self-funded by the participating entities (general revenues, capital improvement funds, etc.) with the potential for CMAQ funding for certain aspects of the program (e.g., demonstration projects for retrofit control devices, incentives for contractor retrofit of on-road vehicles, etc.).

Program Participants: H-GAC's Greater Houston Regional Clean Cities Coalition, CMAQ Funding, and local elected officials. Participants would be representatives of the municipal, county, or other public entity with authority to develop and implement the emission reduction plans. The Greater Houston Regional Clean Cities Coalition was formed to promote alternative fuels and vehicles in the 8-county severe ozone nonattainment area. In September 1997, Houston was officially designated as the 55th member of the U.S. Department of Energy's (DOE) Clean Cities Program. To commemorate this achievement, a Designation Ceremony was held in which 29 stakeholders signed a Memorandum of Understanding pledging to promote the use of alternative fuels in an effort to improve air quality, encourage economic growth, and increase energy security. The DOE Clean Cities program is a voluntary, locally based government/industry partnership designed to encourage the use of alternative fuels such as ethanol, methanol, natural gas, propane and electricity. In addition, Clean Cities works with local governments and businesses to promote fleet conversions to alternative fuel vehicles and to build a local fueling infrastructure.

How the Program Works

The emission reduction plan targets NOx emission sources that have the potential to be controlled or eliminated. Potential control measures include promoting carpool/vanpool or public transit use by employees, modifying employee on-the-job driving requirements, installing retrofit emission control devices on mobile and stationary emission sources owned by the participating entity, and providing incentives and/or contract requirements for contractors to similarly retrofit their equipment. The measures will be partially self-funded by the participating entities (general revenues, capital improvement funds, etc.) with the potential for CMAQ funding for certain aspects of the program (e.g., demonstration projects for retrofit control devices, incentives for contractor retrofit of on-road vehicles, etc.).

Predicted Emissions Reduction

Emission reductions will be the sum of the reductions achieved by the specific program components that are implemented. The emission reduction plan developed by the City of Houston will result in NOx emission decreases totaling 2.51 tons per day from measures which fall into one of the following three categories: VMT reductions, mobile source emission reductions, and stationary source emission reductions.

It should be noted that a significant fraction of the total potential reduction will be due to emission reductions achieved by contractors working on City projects, in response to the City's planned incentive/penalty program to encourage the use of low-emission equipment. The contractors may use some or all of these reductions in "emission reduction plans" filed with the TNRCC in order to avoid the "work day shift" and/or the accelerated Tier

2/Tier 3 purchase requirements. To the extent that the reductions are used in emission reduction plans, they may not be available for VMEP credit. Therefore, the City of Houston commitment is likely to result in 0.96 tpd NOx reduction from other SIP programs. Other municipal, county, and public entities will be encouraged and are expected to also contribute similar voluntary reductions to total 1.5 tpd of NOx reduction.

VMT reductions

Free bus passes to City employees. This will be an expansion of an existing City of Houston program that currently provides Metro bus passes to City employees working at specified downtown locations. The program will be expanded to all City employees. In a recent survey of City employees (in which over 95% of employees responded), 4,173 employees indicated an interest in participating in this program when it is made available to all. Assuming 90% actual participation (of those expressing a willingness to participate) would result in 3,756 bus riders not driving a personal vehicle to work. (This does not include the 1,019 employees who have participated in the program since 1993. VMT reductions associated with these individuals have been taken into account by region-wide traffic data.)

The survey cited above revealed that the average round-trip commute distance for City employees is 40 miles. This results in a daily VMT reduction of 150,240 miles (3,756 trip reductions x 40 miles/trip.) Assuming 48 5-day work weeks per year (240 days/year) and 90% consistency of use (that is, on average a rider will take the bus 9 days out of 10,) the VMT reduction will be 32,451,840 VMT (150,240 VMT/day x 240 days/year x 0.90).

Reduction calculations used the 8-county average speed and VMT data for light duty vehicles traveling on local or urban roads shown in Table 1 below, and average emission rates determined using Mobile5b model runs for Harris County with the 42.5 mph average speed and including the SIP I/M adjustments, low sulfur gasoline, and Tier 2 light duty emission standards. These emission rates are shown in Table 2 below.

Table 1. Average speed and VMT mix for the 8-County area.

	mph	LDGV	LDGT1	LDGT2	HDGV	LDDV	LDDT	HDDV	MC	All VMT
Local (Intrazonal)	29.07	351,154	143,855	42,921	18,935	1,020	1,786	34,895	595	595,161
Urban Interstate	61.92	18,870,501	3,315,238	1,003,857	494,068	54,768	41,169	1,561,231	25,366	25,366,198
Urban Other Freeway	62.58	16,525,568	2,903,272	879,113	432,673	47,962	36,053	1,367,226	22,214	22,214,081
Urban Princ. Art.	37.76	10,232,534	2,489,807	736,442	309,159	29,700	30,919	804,628	14,648	14,647,837
Urban Other Art	31.88	20,071,290	4,883,799	1,444,543	606,420	58,257	60,647	1,578,291	28,732	28,731,979
Urban Collector	32.43	1,326,775	543,533	162,169	71,542	3,852	6,750	131,843	2,249	2,248,713
Local (Cent. Collector)	24.21	7,502,945	3,073,691	917,070	404,572	21,783	38,169	745,576	12,717	12,716,523
Rural Interstate	69.89	3,747,898	658,444	199,378	98,127	10,878	8,177	310,078	5,038	5,038,018
Rural Other Freeway	69.58	3,352,126	588,914	178,324	87,765	9,729	7,313	277,335	4,506	4,506,012
Rural Princ. Art.	58.18	1,360,857	331,127	97,942	41,116	3,950	4,112	107,010	1,948	1,948,062
Rural Other Art.	56.73	2,972,138	723,188	213,907	89,798	8,627	8,981	233,712	4,255	4,254,606
Rural Major Collector	54.40	3,486,264	1,428,199	426,119	187,986	10,122	17,735	346,434	5,909	5,908,768
Rural Collector	49.31	700,008	286,769	85,561	37,746	2,032	3,561	69,561	1,186	1,186,424
VMT Total (mph avg.)	42.46	90,500,058	21,369,836	6,387,346	2,879,907	262,680	265,372	7,567,820	129,363	129,362,382
VMT Mix		70.0%	16.5%	4.9%	2.2%	0.2%	0.2%	5.9%	0.1%	
Local/Urban LD VMT mix		76.5%	17.7%	5.3%		0.2%	0.2%			

Table 2. Average emission rates by vehicle type.

	LDGV	LDGT1	LDGT2	HDGV	LDDV	LDDT	HDDV	MC	All Vehicles
VOC (g/mile)	0.4	0.47	0.45	1.36	0.06	0.1	1.12	4.65	0.48
NOx (g/mile)	0.62	0.66	0.77	3.87	0.50	0.54	5.58	0.97	1.00

Using the described VMT reductions and emission rates, emission reductions from the free bus pass program are estimated to be 0.06 tpd VOC and 0.09 tpd NOx.

Subsidize carpools/vanpools

This program will encourage the use of carpools and vanpools as commute options by subsidizing the cost (for example, of fuel and/or insurance). The survey of City employees cited above indicated that 44% of the City's 22,874 employees are interested in participating in such a program. Assuming 90% actual participation (of those expressing willingness to take part) would result in 9,058 participants. Assuming that three participating employees ride in one vehicle as opposed to three vehicles, there is the potential reduction of 3,019 daily trips. Using the same vehicle and mileage assumptions as for the bus pass program yields a daily VMT reduction of 120,760 VMTs (3,019 trips x 40 miles/trip) and an annual VMT reduction of 26,084,160 VMTs (120,760 VMT/day x 240 days/year x 0.90).

Using these VMT reductions and the emission rates shown in Table 2 above, emission reductions from the carpool/vanpool program are estimated to be 0.05 tpd VOC and 0.07 tpd NOx.

Reduce city-owned vehicle mileage

This program will reduce the miles traveled by City-owned vehicles during employees' performance of their jobs. Three components of this program are a reduction in the number of City-owned "take-home" cars, the re-institution of "pool cars" for use by City workers in downtown locations, and the installation of global positioning systems (GPS) in City vehicles to reduce unauthorized trips. The VMT reduction resulting from the reduction in take-home cars has not been quantified, because this reduction will be offset by an increase in the use of personal vehicles (or the use of bus, carpool, or vanpool) and does not represent an overall area decrease. However, City department experience has shown a 22% reduction in City vehicle mileage resulting from the use of pool cars (as opposed to employee-dedicated vehicles), and a 37% reduction in mileage resulting from the installation of GPS tracking devices in City vehicles.

Utilizing both of these reductions with the annual mileage of 86,262,500 VMT will yield a total reduction of 43,873,108 VMT. [86,262,500 x 0.22 = 18,977,750 VMT; (86,262,500 - 18,977,750) x 0.37 = 24,895,358 VMT; 18,977,750 + 24,895,358 = 43,873,108 VMT]

Using these VMT reductions and the emission rates shown in Table 2 above, emission reductions from the reduced City vehicle mileage program are estimated to be 0.08 tpd VOC and 0.12 tpd NOx.

Compressed work week/telecommute options

This program would expand City pilot programs to allow 4-day work weeks and work-from-home (telecommuting) for appropriate City employees. The 4-day work week would result in a reduction of one trip per week for each participating employee. Telecommuting would result in a trip reduction for each day the participating employee worked at home. For calculation purposes, it has been assumed that an equivalent of 25% of City employees will take off or work at home one day per week. With 22,874 City employees, this would be a reduction of 5,718 trips per week (22,874 x 0.25) and 228,720 VMT (5,718 trips x 40 mi/trip). On an annual (52 week/year) basis this would be a reduction of 11,893,440 VMT.

Using these VMT reductions and the emission rates shown in Table 2 above, emission reductions from the reduced City vehicle mileage program are estimated to be 0.02 tpd VOC and 0.03 tpd NOx.

The total reductions from the VMT reduction measures described above will be 0.20 tpd VOCs and 0.31 tpd NOx.

Mobile source emission reductions

Clean vehicle purchase - gasoline

The City has instituted a policy of specifying and purchasing the lowest-emitting vehicles and equipment available at time of purchase. This will result in the introduction into the City vehicle fleet of a higher percentage of low emission vehicles (LEVs) than would occur without such a policy. Based on past practice, the City expects to purchase approximately 900 gasoline vehicles per year between 2000 and 2004 when the Tier 2 light duty standards begin to take effect. That will result in the purchase of approximately 3,600 vehicles (out of the City's

fleet of approximately 7,820 gasoline vehicles), or 46% of the fleet. Between 2004 and 2007, at the same purchase rate, approximately 2,700 additional vehicles will be purchased, an additional 35% of the fleet.

The difference between current Tier 1 and LEV NOx standards for light duty vehicles is 0.3 g/mile (0.6 – 0.3). Therefore, the purchase of LEVs in favor of Tier 1 vehicles will result in a NOx reduction of 0.3 g/mile. Similarly, the difference between 2004’s Tier 2 standard and the interim (alternative) standard is 0.23 g/mile (0.3 – 0.07). The purchase, between 2004 and 2007, of Tier 2 certified vehicles rather than vehicles certified to the interim standard will result in a reduction of 0.23 g/mile. The annual effects of these reductions are summarized in Table 3 below, based on an annual purchase of 900 vehicles and an annual average vehicle mileage of 13,000 miles per year. The reductions start at 0.01 tpd in 2000 and increase to 0.10 tpd in 2007, averaging 0.06 tpd.

Table 3. Effect of preferential purchase of lowest-emitting gasoline vehicles.

Year	New vehicles	miles/year	g/mile red.	tons/year	tons/day
LEVs					
2000	900	13,000	0.3	3.9	0.01
2001	1,800	13,000	0.3	7.7	0.03
2002	2,700	13,000	0.3	11.6	0.04
2003	3,600	13,000	0.3	15.5	0.06
2004	3,600	13,000	0.23	11.9	0.05
2005	3,600	13,000	0.23	11.9	0.05
2006	3,600	13,000	0.23	11.9	0.05
2007	3,600	13,000	0.23	11.9	0.05
Tier 2s					
2004	900	13,000	0.23	3.0	0.01
2005	1,800	13,000	0.23	5.9	0.02
2006	2,700	13,000	0.23	8.9	0.03
2007	3,600	13,000	0.23	11.9	0.05

Clean vehicle purchase - diesel

Based on past practice, the City expects to purchase approximately 130 diesel vehicles per year between 2000 and 2004 when the Tier 2 heavy duty diesel standards take effect. That will result in the purchase of approximately 520 vehicles (out of the City’s fleet of approximately 1,456 diesel vehicles), or 36% of the fleet. The difference between current Tier 1 diesel and ULEV NOx standards for heavy duty vehicles is 1.84 g/mile (3.68 g/mile typical – 1.84 g/mile). Therefore, the purchase of LEVs in favor of Tier 1 vehicles will result in a NOx reduction of 1.84 g/mile. The annual effects of these reductions are summarized in Table 4 below, based on an annual purchase of 130 vehicles and an annual average vehicle mileage of 8,000 miles per year. The reductions start at 0.01 tpd in 2000 and increase to 0.03 tpd in 2003, averaging 0.02 tpd.

Table 4. Effect of preferential purchase of lowest-emitting diesel vehicles.

Year	New vehicles	miles/year	g/mile red.	tons/year	tons/day
2000	130	8,000	1.84	2.1	0.01
2001	260	8,000	1.84	4.2	0.02
2002	390	8,000	1.84	6.3	0.02
2003	520	8,000	1.84	8.4	0.03

Retrofit on-road vehicles – Demonstration projects

The City is currently initiating a series of demonstration projects to evaluate the effectiveness of various add-on emission control devices and fuel alternatives for diesel-powered vehicles. If these emission control measures prove effective and technically viable, they will be extended to the whole range of City-owned diesel-powered vehicles and equipment, as allowed by safety and technical considerations. For calculation of VMEP credit, the

demonstration projects are divided into two types: add-on control devices and diesel-water fuel emulsion. For this calculation, the add-on control devices are assumed to provide an average 60% NOx emission reduction, and the diesel-water fuel emulsion is assumed to provide a 25% NOx emission reduction. These reductions are consistent with the low end of vendors' estimates for their products. Actual reductions will be measured during the course of the demonstration projects.

There are 13 on-road diesel vehicles scheduled for testing with add-on control devices, and 5 vehicles scheduled for testing using the diesel-water emulsion fuel. In some cases an add-on control device will be used along with the emulsion fuel. In these cases, no attempt has been made to account for the combined use of the two devices. The City operates approximately 1,456 diesel on-road vehicles, which have been estimated to emit a total of 86.4 tpy NOx. The vehicles scheduled to be tested with add-on devices and emulsion fuel represent 0.89% and 0.34% of the on-road fleet, respectively. Assuming that the vehicles chosen for testing represent the fleet as a whole, the NOx emissions subject to reduction under the demonstration projects are 0.769 and 0.294 tpy for add-on devices and emulsion fuel, respectively. The reductions, using the assumed reduction percentages listed in the previous paragraph, will be 0.461 and 0.074 tpy for the two types of test, for a total of 0.535 tpy. Based on a conservative 365-day year the reductions will total 0.0015 tpd.

Retrofit on-road vehicles – Remaining fleet

After the demonstration projects have been completed, the vehicles not slated for replacement (with ULEVs) over the next four years will be retrofitted with add-on emission control devices and/or fueled with diesel-water emulsion fuel. As stated above, approximately 36% of the City's on-road diesel fleet is expected to be replaced by 2004. That will leave approximately 932 vehicles $[1,456 \times (1-0.36)]$ as candidates for retrofits. An assumed 80% of City on-road vehicles will be eligible for fueling with the emulsion fuel due to safety concerns; e.g., fire engines and other emergency equipment may not be suitable for the emulsion fuel because of its associated power loss.

Assuming that the remaining vehicles emit a proportional amount of the current total NOx, the amount of reduction from the retrofit of the remaining vehicles will be 33.2 tpy $[86.4 \times (1-0.36) \times 0.60]$. Since many, if not most, of these vehicles are not restricted to operation on weekdays (e.g., fire department and public works vehicles), the daily reduction of 0.091 tpd is based on 365 days per year. The reduction from fueling with emulsion fuel will be 17.28 tpy, or 0.047 tpd $[86.4 \times 0.80 \times 0.25]$, for a total of 0.138 tpd. This assumes that the control efficiencies of the add-on control devices and the emulsion fuel are additive. This assumption is being investigated by the demonstration projects.

Retrofit on-road vehicles – Contractors

In addition to the City-owned vehicles discussed above, an estimated 131.4 tpy NOx has been attributed to construction and operations/maintenance contractors working on City projects. A program of contract-based incentives and disincentives is being developed to encourage the retrofit or replacement of high-emitting vehicles and equipment. Using a conservative assumption that 75% of the vehicles used on City contracts are retrofitted with control devices that achieve a reduction of 60%, an overall NOx reduction of 59.1 tpy will result. Again based on 365 days per year the daily NOx reduction will be 0.162 tpd. The emulsion fuel reduction, using the same 75% participation assumption, will be 24.6 tpy or 0.067 tpd $[131.4 \times 0.75 \times 0.25]$, for a total of 0.229 tpd. *It should be noted that many, if not most, of the contractors will use these retrofits as part of their alternative emission reduction plans to enable them to avoid the "work day shift" rule or the accelerated Tier2/Tier 3 purchase rule. To the extent that this is done, these emission reductions may not be available for VMEP credit.*

Retrofit off-road vehicles – Demonstration projects

The demonstration projects described above also encompass off-road equipment such as tractors and earth-moving equipment. There are 10 off-road diesel vehicles/equipment scheduled for testing with add-on control devices and 5 pieces of equipment scheduled for testing using the emulsion fuel. The City operates approximately 1,244 diesel off-road vehicles, which have been estimated to emit a total of 138.6 tpy NOx. The vehicles scheduled to be tested with add-on devices and emulsion fuel represent 0.80% and 0.40% of the on-road fleet, respectively. Assuming that the vehicles chosen for testing represent the off-road fleet as a whole, the NOx emissions subject to reduction under the demonstration projects are 1.109 and 0.554 tpy for add-on devices and emulsion fuel, respectively. The

NOx reductions, based on the same reduction assumptions as for on-road vehicles, will be 0.665 and 0.139 tpy for the two types of test, for a total of 0.804 tpy, or 0.002 tpd on a 365 day-per-year basis.

Retrofit off-road vehicles – Remaining fleet

After the demonstration projects have been completed, the equipment not slated for replacement (with low emission equipment) over the next four years will be retrofitted with add-on emission control devices and/or fueled with diesel-water emulsion fuel. Approximately 13% of the City’s off-road diesel fleet is expected to be replaced by 2004. That will leave approximately 1,082 vehicles [1,244 x (1-0.13)] as candidates for retrofits. An assumed 100% of City off-road vehicles will be eligible for fueling with the emulsion fuel.

Assuming that the remaining vehicles (those that are not replaced) emit a proportional amount of the current total NOx, the amount of reduction from the retrofit of the remaining off-road equipment will be 72.3 tpy [138.6 x (1-0.13) x 0.60]. Since many, if not most, of these vehicles are not restricted to operation on weekdays (e.g., parks & recreation department and public works equipment), the daily reduction of 0.198 tpd is based on 365 days per year. The reduction from fueling with emulsion fuel will be 34.65 tpy [138.6 x 0.25], or 0.095 tpd, for a total of 0.293 tpd. This assumes that the control efficiencies of the add-on control devices and the emulsion fuel are additive, which is being investigated by the demonstration projects.

Retrofit off-road vehicles – Contractors

In addition to the City-owned equipment discussed above, an estimated 755.9 tpy NOx has been attributed to construction and operations/maintenance contractors working on City contracts. The program of contract-based incentives and disincentives under development to encourage the retrofit or replacement of high-emitting vehicles and equipment will apply to off-road as well as on-road equipment. Using a conservative assumption that 75% of the vehicles used on City contracts are retrofitted with control devices that achieve a reduction of 60%, an overall NOx reduction of 340.16 tpy will result. Again based on 365 days per year the daily NOx reduction will be 0.932 tpd. The emulsion fuel reduction, using the same 75% participation assumption, will be 141.73 tpy [131.4 x 0.75 x 0.25], or 0.388 tpd, for a total of 1.32 tpd. *It should be noted that many, if not most, of the contractors will use these retrofits as part of their alternative emission reduction plans to enable them to avoid the “work day shift” rule or the accelerated Tier2/Tier 3 purchase rule. To the extent that this is done, these emission reductions may not be available for VMEP credit.*

Stationary source emission reductions

The City operates numerous stationary sources, including boilers, heaters, generators, and sludge dryers. The estimated NOx emissions from these sources are summarized in Table 5 below. Emissions from these sources will be controlled by the application of add-on control devices as feasible. Using a conservative assumption that 50% of the NOx emissions will prove feasible for control, and that an average control effectiveness of 75% can be achieved, the NOx reduction will be 46.9 tpy (125.0 x 0.5 x 0.75), or 0.13 tpd (365 day-per-year basis).

Table 5. City of Houston stationary source emissions

Source Type	NOx Emissions, tpy
Boilers/Heaters	47.2
Generators	26.8
Sludge Dryers	51.0
Total	125.0
Assumed 50% subject to control	62.5
Anticipated 75% control	46.9

Total of Emission Reductions

The measures outlined above will result in NOx emission reductions of 2.51 tpd, as summarized in Table 6.

Table 6. Summary of voluntary measures

Category	Measure	NOx reduction, tpd	
VMT reductions	Bus pass program	0.09	
	Carpool/vanpool program	0.07	
	City vehicle VMT reductions	0.12	
	City employee commute options	0.03	
Total for category			0.31
City vehicle emission reductions (On-road)	Clean vehicles purchase – gasoline	0.06	
	Clean vehicles purchase – diesel	0.02	
	City diesel vehicle demo projects	0.0015	
	City diesel vehicle retrofits	0.138	
Total for category			0.22
City equipment emission reductions (Off-road)	City diesel equipment demo projects	0.002	
	City diesel equipment retrofits	0.293	
Total for category			0.30
City contractor vehicle/equipment retrofit	Contractor diesel vehicle retrofits	0.229	
	Contractor diesel equipment retrofits	1.32	
Total for category			1.55
Stationary source controls	Retrofit stationary sources	0.13	
Total for category			0.13
Total for all measures		2.51	
Total without contractor reductions*		0.96	

* Total without the contractors' contribution is included in the event that these reductions are used by the contractors for emission reduction plans in lieu of work day shift or Tier 2/Tier 3 purchase requirements.

State Commitment

HGAC, as the regional metropolitan transportation planning agency for the Houston-Galveston area, commits to make a best faith effort to implement this project. HGAC will be responsible for monitoring and reporting the emission reductions to the TNRCC.

TNRCC will verify that the control technology is operating effectively and is properly maintained through periodic testing and reporting requirements.

MEASURE TITLE: AERCO Pilot Project

Program Description

This program is modeled as a compilation of expected “sanctioned” trades. The emission reduction credits would be generated from retrofitted mobile sources. The retrofits would be an adaptation of engine emission controls including, but not limited to, catalysts or exhaust gas recirculation and/or diesel/water emulsions.

These controls are most likely to be applied to heavy-duty highway vehicles and nonroad equipment. Below in the tables are the estimated emission inventories for these mobile source segments and the likely emission reduction potential if a trading program provides a significant incentive for implementing these programs.

Program Participants: HGAC, AERCO, Lubrizol Corporation, Ceryx, potential other private vendors and private industry. Under the authority of the CAA, Area Emission Reduction Credit Organizations (AERCOs) were created by the Texas Legislature to encourage the improvement of air quality while helping to mitigate the adverse economic impacts of control strategies. AERCOs in the non-attainment areas may buy and sell "credits." Sources may purchase credits from another source directly, or from a regional credit bank, such as AERCO. The Houston-Galveston AERCO was instrumental in the first public purchase of air emission reduction credits (ERCs) within the state of Texas, and establishing a market price for ERCs. AERCO has limited and temporary funding for the promotion of the trading market in the Houston-Galveston nonattainment area. The organization is designated by the U.S. Internal Revenue Service, and as a 501 (c) 3 Corporation, the Houston-Galveston AERCO is able to receive tax deductible donations of emission reduction credits or contributions.

Predicted Emissions Reduction

This program will promote the use of “sanctioned” or propriety products in order to reduce emissions in the mobile sector. This program will market the products regionally and encourage their use as a pilot project. As part of the pilot project, companies wanting to use the emission reduction towards an allowance will be able to do so. Payment for AERCO’s staffing, expertise and emission packaging will be a percent such as 0.3 for each 1.0 tpy of emission reductions. In order for emission reductions to total 6 tpd of NOx towards the voluntary emission program, using 0.3 payment of each trade, a total of 26 tpd of mobile source reduction must be achieved. An exclusive contract will be considered with the Lubrizol Corporation for their diesel/water emulsion - PuriNOx, and their intellectual property using dual emulsion and catalyst for additional reductions.

For diesel equipment, the most likely initial control measure is either a lean NOx catalyst (such as Ceryx currently markets) or diesel/water emulsions (such as Lubrizol currently markets), both estimated to result in per engine emission reductions of 20%. For diesel equipment, cleaner engine purchases or other inventive strategies may also be employed to generate the required emission reductions.

Currently there is no incentive for voluntary mobile source emission reductions, so we expect that a packaged program would provide the needed motive for finding and implementing emission reductions that might not be available otherwise. Below in the tables are the likely segments where additional reductions might be generated, totaling 26 tpd NOx to produce 20 tpd of NOx emission reduction credits.

Table 1. Weekday 2007 NO_x emissions (TPD) by vehicle type for the August 2000 and Revised SIP inventories for the 8-county Houston nonattainment area.

Vehicle Type	Base Emissions (TPD)	Emission Reduction (%/TPD)
HDGV	13.1	-10% ; 1.3
HDDV	65.5	-10% ; 6.7
Total		8.0

Table 2. Eight-county Houston/Galveston offroad equipment NOx emissions summary for the 2007 base case. (Without Mandated Tier II/III, Diesel Emulsions and NOx Catalyst Retrofits) and likely available emission reductions with a trading program

Equipment Type	Base Emissions (TPD)	Emission Reduction (%/TPD)
Commercial Vessels	41.68	~10% ; 4.0
Construction and Mining Equipment	32.08	~10% ; 3.0
Industrial Equipment	15.00	~50% ; 7.0
Agricultural Equipment	12.85	~10% ; 1.0
Locomotives	12.09	~20% ; 2.0
Aircraft	7.37	0%
Airport Service Equipment	6.00	0%
Commercial Equipment	5.10	~20% ; 1.0
Marine Vessels, Recreational	2.33	0%
Fishing Vessels	2.19	0%
Lawn & Garden Equipment	1.16	0%
Logging	0.49	0%
Total		15.8

State Commitment

HGAC, as the regional metropolitan transportation planning agency for the Houston-Galveston area, commits to make a best faith effort to implement this project. HGAC will be responsible for monitoring and reporting the emission reductions to the TNRCC.