An Analysis of Strategies to Identify, Repair and Retire Smoking and High-Emitting Vehicles in the Denver Metropolitan Region

Regional Air Quality Council
High-Emitting Vehicle Work Group
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We would like to thank the following Work Group participants for their efforts to reduce air pollution due to high-emitting and smoking vehicles.

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Colorado Department of Revenue
City and County of Denver
Denver Regional Council of Governments
Douglas County
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Envirotest Systems Corporation
City of Federal Heights
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EXECUTIVE SUMMARY

INTRODUCTION

The Regional Air Quality Council (RAQC) has a long-standing interest in reducing mobile source pollution due to both gasoline- and diesel-powered vehicles. This report examines the contribution of gasoline-powered vehicles to mobile source pollution in the Denver metro area and analyzes five potential strategies to address the problem. Diesel-powered vehicles are addressed separately in the joint RAQC/AQCC May 2002 report, *Reducing Diesel Emissions in the Denver Region*.

In December 2001, the RAQC formed the Smoking Vehicle Work Group. This Work Group is comprised of members of the general public, private companies, academia, and state and local governments. Originally the group was convened to discuss potential strategies to reduce particulate matter ($PM_{2.5}$) due to smoking vehicles. After the Work Group met a number of times, it became apparent that to adequately address the full scope of the problem, a focus on more than $PM_{2.5}$ due to smoking vehicles was needed. The Work Group determined that it would be more appropriate to address the problem of both gas phase and particle phase high-emitting vehicles. At this point, the Work Group was renamed the High-Emitting Vehicle Work Group.

WORK GROUP RECOMMENDATIONS

The consensus of the Work Group was that both a Smoking Vehicle Pullover Program and a mandatory Remote Sensing High-Emitter Identification and Enforcement Program should be implemented. There were a number of reasons for this recommendation that include:

- Cost-effectiveness of both programs;
- RSD4000 is ready to identify gas phase high-emitters but not particle phase high-emitters;
- Smoking vehicles can only be identified with the human eye at the current time;
- Increased program coverage with dual approach; and
- RSD4000 could identify vehicles in the Denver metro area avoiding the current I/M Program.

This costs to implement both programs will be approximately $325,000 (additional $50,000 in first year start-up costs) on an annual basis. Of this total, the cost to local governments for the Smoking Vehicle Pullover Program is estimated to be $133,000 annually (See Appendix E for cost by local government) and will be paid for by fine revenue (See page 35, Table V for discussion of fine revenue). The remaining $40,000 of this program are costs to the RAQC for the local government outreach effort. The RAQC will seek grant funding for this task.

The cost of the High-Emitter Identification and Enforcement Program is estimated at $150,000 with an additional first year start-up cost of $50,000 needed to make enhancements to the Department of Revenue's motor vehicle registration system to flag vehicles requiring confirmatory tests. A decision needs to be made on how to pay for this program. Options to pay for program costs include requiring motorists who are identified as high-emitters to pay the additional testing and administrative fees, or spreading the incremental costs among all motorists as part of the testing fee negotiated under the emissions testing contract. These funding decisions will need to be made by the General Assembly as part of authorizing legislation.

This combined program will repair or retire approximately 33,700 to 80,600 high-emitters annually depending on remote sensing coverage and the cut points used in the remote sensing program. The number of vehicles repaired or retired under this combined approach is based on an estimated 1,320 repaired or retired vehicles in the Smoking Vehicle Pullover Program. Under the RSD4000 High-Emitter Identification Program, an estimated 32,400 high-emitters will be repaired with 20% remote sensing coverage and 79,300 high-emitters will be repaired with 60% remote sensing coverage.

There are a number of implementation issues that need to be considered. The issues are:

Smoking Vehicle Pullover Program

- Funding for a local government education campaign will be needed.
- A model ordinance will need to be developed and adopted by communities.
- Fines and fees will need to be established to be used by local courts.

High-Emitter Identification and Enforcement Program

- The Clean Screen Program must be in place.
- The General Assembly will need to consider legislation that will authorize the program that includes appropriate enforcement and compliance mechanisms. There will also need to be a statutory change to require vehicles identified as high-emitters to pass a confirmatory test before renewing their registration.
- Enhancements will be needed in the motor vehicle registration system.
- A funding mechanism will need to be developed for the program.

COST/BENEFIT ANALYSIS OF POTENTIAL STRATEGIES

The Work Group investigated the strategies listed below to assess their effectiveness in addressing the problem posed by smoking and high-emitting vehicles. Included in the analysis are operational costs and benefits due to the Work Group's proposed enhancements. The strategies are:

A. Inspection and Maintenance Program Enhancements (Page 18)
B. CDPHE Smoking Vehicle Hotline Enhancements (Page 22)
C. Region-wide Trained Staff Smoking Vehicle Program (Page 26)
D. Region-wide Smoking Vehicle Pullover Program (Page 32)
E. RSD4000 High-Emitter Identification Program (Page 37)

HIGH-EMITTING VEHICLES

The Work Group found that there are two primary categories of high-emitting vehicles. These vehicles can be characterized as:

- Gas phase high-emitting vehicles: These gasoline-powered vehicles emit high amounts of carbon monoxide (CO), hydrocarbons (HC), nitrogen oxides (NOx), and other pollutants that are invisible.
- Particle phase high-emitting vehicles: These gasoline-powered vehicles emit a high amount of $PM_{2.5}$. There are two subgroups in this classification:

- Non-Visible Particle Phase High-Emitters: The majority of the particle phase classification do not emit visible smoke.
- Smoking Vehicles: A smaller portion of the particle phase classification emit visible smoke.

For the strategy analyses contained in this report, it is important to estimate the number of high-emitters by category that might be found in the Denver metro area. Overall, the gasoline-powered vehicle fleet in the Denver region is estimated to be approximately 2,000,000 vehicles. RAQC staff estimates that 240,000, or 12%, are high-emitters. Of this total, an estimated 140,000 are gas phase-only high-emitters, 40,000 are particle phase-only high-emitters, and 60,000 are vehicles that could be both particle and gas phase high-emitters.

RAQC staff used a number of data sources to determine the contribution of these high-emitters to mobile source pollution in the Denver metro area. The contribution of these vehicles to $PM_{2.5}$, HC, and CO is estimated to be 46%, 35%, and 39%, respectively.

REPORT TO THE REGIONAL AIR QUALITY COUNCIL

1. INTRODUCTION

The Regional Air Quality Council (RAQC) has a long-standing interest in reducing mobile source pollution due to both gasoline- and diesel-powered vehicles. This report examines the contribution of gasoline-powered vehicles to mobile source pollution in the Denver metro area and analyzes five potential strategies to address the problem. Diesel-powered vehicles are addressed separately in the joint RAQC/AQCC May 2002 report, *Reducing Diesel Emissions in the Denver Region*.

For many years, experts have felt that a small portion of the gasoline-powered vehicle fleet, the high-emitters, caused a significant amount of Denver's mobile source pollution. These high-emitting, gasoline-powered vehicles can be characterized as:

- Gas phase high-emitting vehicles: These gasoline-powered vehicles emit high amounts of carbon monoxide (CO), hydrocarbons (HC), nitrogen oxides (NOx), and other pollutants that are invisible. They are referred to as gas phase high-emitters.
- Particle phase high-emitting vehicles: These gasoline-powered vehicles emit a high amount of particulate matter ($PM_{2.5}$). The overall classification is referred to as particle phase high-emitters. There are two subgroups in this classification:
    - Non-Visible Particle Phase High-Emitters: The majority of the particle phase classification do not emit visible smoke.
    - Smoking Vehicles: A smaller portion of the particle phase classification emit visible smoke.

These are key distinctions referred to throughout this report although it is difficult to say with certainty a vehicle will be found in only one of these categories. Some research shows that non-visible particle phase high-emitters can "flip" to smoking vehicles under certain conditions and some smoking vehicles will not smoke all the time. Additionally, some particle phase high-emitters can also be gas phase high-emitters. For the purposes of quantifying the benefits, and the number of vehicles the strategies in this report will have to address, it is important to

distinguish these vehicles from one another. Another important note is that throughout this report, high-emitter or high-emitting vehicle is used generally to describe all of the above categories.

One of the first efforts to address the problem of high-emitting vehicles in the Denver metro area was the 1993 Total Clean Cars Program. This program was sponsored by Total Petroleum in conjunction with the RAQC and the Colorado Department of Public Health and Environment (CDPHE). The goal of the program was to reduce emissions from high-emitting vehicles through vehicle repair or retirement. The program was successful in repairing or retiring 489 high-emitting vehicles.

Another significant effort that included high-emitting vehicles was the 1998 *Northern Front Range Air Quality Study* (NFRAQS). NFRAQS showed that non-visible particle phase high-emitters/smoking vehicles were a relatively small portion of the fleet, but caused a disproportionate amount of mobile source pollution. The results of this study indicated that non-visible particle phase high-emitters/smoking vehicles cause approximately 50% of the gasoline exhaust particles ($PM_{2.5}$) in the Denver metro area.

Soon after NFRAQS was completed, the RAQC completed the metro area's first comprehensive, long range air quality plan. The *Blueprint for Clean Air* was completed in 1999 and included recommendations to develop strategies to address smoking vehicles.

The recommendations made in the *Blueprint for Clean Air* were developed in the RAQC's August 2000 report to the Governor, *Options to Reform the Current Inspection/Maintenance Program*. The RAQC recommended a number of strategies to reduce emissions from high-emitting vehicles. The findings from this effort concluded that the I/M Program will be needed in the Denver metro area into the foreseeable future. Some of the options that were recommended to address high-emitters included adding a high-emitter identification and enforcement component to the Clean Screen Program, improvement of the effectiveness of emission-related repairs, and increasing or eliminating the current $450 repair waiver limit.

In December 2001, the RAQC formed the Smoking Vehicle Work Group. This Work Group is comprised of members of the general public, private companies, academia, and state and local governments. Originally the group was convened to discuss potential strategies to reduce $PM_{2.5}$ due to smoking vehicles. After the Work Group met a number of times, it became

apparent that to adequately address the full scope of the problem, a focus on more than $PM_{2.5}$ due to smoking vehicles was needed. The Work Group determined that it would be more appropriate to address the problem of both gas phase and particle phase high-emitting vehicles. At this point, the Work Group was renamed the High-Emitting Vehicle Work Group.

The issue this Work Group is addressing, reducing emissions due to high-emitting gasoline-powered vehicles, is of national importance. In 2001, the National Research Council (NRC) Committee on Vehicle Emissions Inspection and Maintenance Programs issued its report on *The Road Ahead for Vehicle Emissions Inspection and Maintenance Programs*. Overall, the committee found that, "...vehicle emissions inspection and maintenance programs are missing opportunities to reduce air pollution by expending too many resources to inspect cleaner low-emitting vehicles and not effectively dealing with the dirtiest ones" and that "...there is a need for programs that repair or eliminate high-emitting vehicles from the fleet, given the major influence these vehicles have on total emissions."

2. HIGH-EMITTER IDENTIFICATION AND CONTRIBUTION

This section of the analysis describes the methodology and assumptions used to estimate the contribution of non-visible particle phase high-emitters and smoking vehicles to overall $PM_{2.5}$ pollution in the Denver metro region. It also details the contribution of gas phase high-emitters to overall HC and CO pollution. Additional analysis was performed to estimate the number of vehicles within each of these categories that would need to be targeted by any recommended strategy. The source documents for this section's data analysis include:

- Blueprint for Clean Air, RAQC, 1999.
- Northern Front Range Air Quality Study - Summary Report, Colorado State University, March 1998.
- Northern Front Range Air Quality Study, Measurement of Exhaust Particle Matter Emissions from In-Use Light-Duty Motor Vehicles in the Denver, Colorado Area, Colorado State University, March 1998.
- Travel Behavior Inventory - Household Survey Report, DRCOG, April 2000.
- *The Road Ahead for Vehicle Emissions Inspection and Maintenance Programs*, National Research Council, 2001.
- *On-Road Remote Sensing of Automobile Emissions in the Denver Area: Year 3*, University of Denver, January 2002.
- *Environmental Systems Products (ESP) Presentation - Update to RAQC Concerning UV Smoke Measurement Technology*, ESP, July 2002.

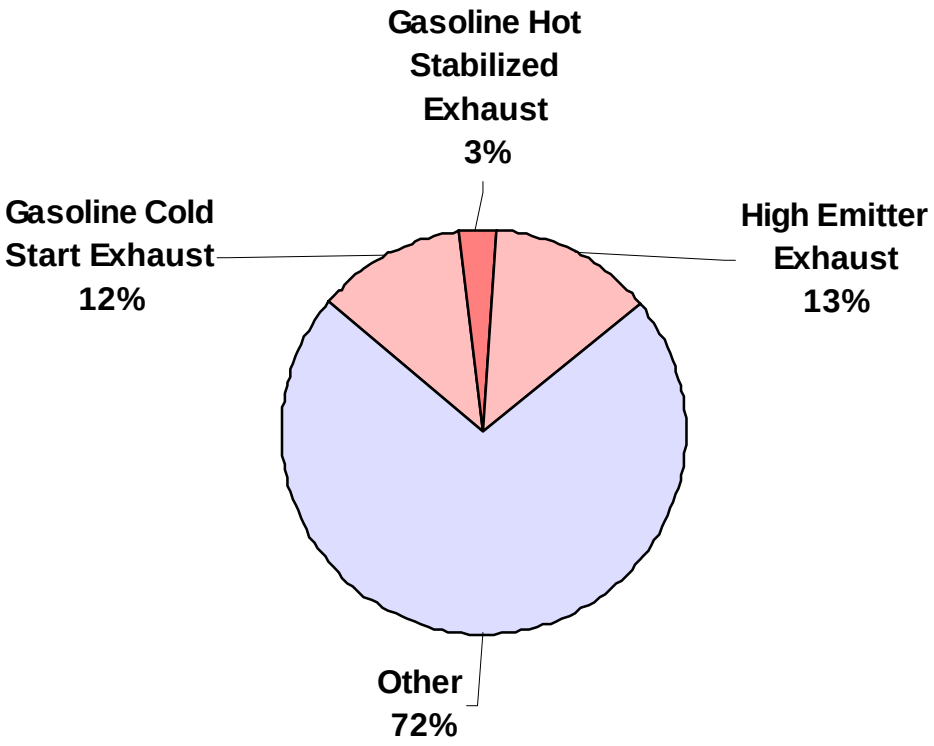
Particulate Matter ($PM_{2.5}$)

The key findings of the *NFRAQS Summary Report* indicate that, "High emitting or smoking gasoline powered vehicles, which comprise a small fraction of the in-use vehicle fleet, produced nearly one-half of the gasoline exhaust particles." NFRAQS does not specifically define non-visible particle phase high-emitters and smoking vehicles because it is difficult to categorize these vehicles specifically due to a variety of conditions. Sometimes vehicles will be "puffers" or "flippers"; vehicles that emit smoke under certain conditions and no smoke under other conditions. The report also indicates that some observations include vehicles with high PM that do not have a visible exhaust plume and some vehicles with a visible exhaust plume with low PM.

For the analysis detailed in this section, an assumption is made that non-visible particle phase high-emitters and smoking vehicles are in distinct categories. This is done to develop the $PM_{2.5}$ contribution from these vehicles and determine the number of vehicles in both categories. Classifying these vehicles in separate categories, and estimating the number of vehicles in each category, is necessary for assessing the effectiveness of the strategies developed in Section 3.

Figure I from the *NFRAQS Summary Report* is used to estimate the contribution of all particle phase emitters. This chart indicates 13% of total $PM_{2.5}$ is from direct PM exhaust emissions from all high-emitting particle phase vehicles. Additional contributions to the total $PM_{2.5}$ include 12% and 3% from direct PM exhaust emissions from cold start and hot stabilized gasoline-powered vehicles, respectively. The total direct gasoline-powered vehicle $PM_{2.5}$ contribution is 28% (13%+12%+3%). Therefore, all high-emitting particle phase vehicles' emissions are 46%

Figure I. Contributions to Total PM2.5 at Welby by Chemical Mass Balance Modeled Analysis

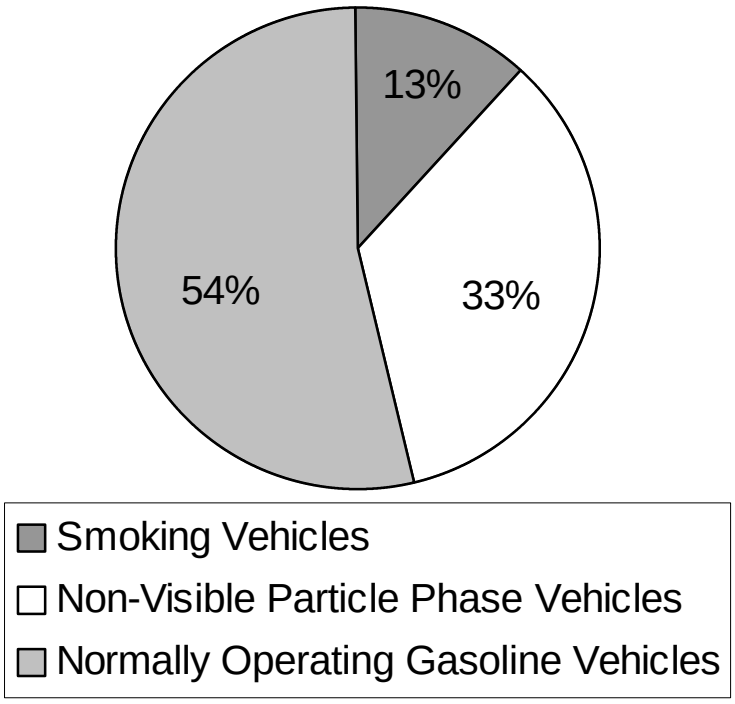


(13%/28%) of the total gasoline-powered vehicle contribution. This equates to nearly one-half of the gasoline exhaust particles stated in NFRAQS. The remaining 54% of the gasoline-powered vehicle $PM_{2.5}$ contribution is assumed to be due to normally operating gasoline-powered vehicles.

In the *Blueprint for Clean Air,* light-duty gasoline-powered vehicles' total contribution to $PM_{2.5}$ emissions was estimated to be 1.77 TPD for the Denver metro area. An estimate of the smoking vehicles' contribution to the total $PM_{2.5}$ emissions was developed using DRCOG VMT data, Colorado fuels sales data, Colorado vehicle registration data, and NFRAQS data. The NFRAQS data used for this estimate includes vehicle PM emissions factors and $PM_{2.5}$/PM fractions, and the estimate that approximately 1% of the Denver metro area fleet are smoking vehicles. Within the total 1.77 TPD, smoking vehicles' contribution to $PM_{2.5}$ was calculated at 0.23 TPD (Refer to Appendix A).

Below, Figure II shows the 46% due to high-emitting particle phase vehicles further broken down to detail the apportionment of $PM_{2.5}$ emissions due specifically to non-visible particle phase high-emitters and smoking vehicles. The smoking vehicle estimate represents approximately 13% (0.23 $PM_{2.5}$ TPD/1.77 $PM_{2.5}$ TPD) of the gasoline-powered vehicle primary $PM_{2.5}$ emissions. Therefore, the estimated non-visible particle phase high-emitters' contribution is 33% (46%-13%), or 0.58 TPD (1.77 $PM_{2.5}$ TPD*33%), of the total gasoline-powered vehicle $PM_{2.5}$ emissions in the Denver metro area.

Figure II. Contributions to Total PM2.5 From Smoking Vehicles, Non-Visible Particle Phase Vehicles, and Normally Operating Gasoline Vehicles



It is difficult to estimate the number of vehicles that cause high-emitter emissions because the relationship between non-visible particle phase high-emitters and smoking vehicle emissions is not clear. Figure II shows that the estimated 1% of the Denver metro area fleet that are smoking vehicles contribute 13% of the $PM_{2.5}$. If both classifications of particle phase high-emitters have equal emissions, approximately 3% of the fleet would have to be non-visible particle phase high-emitters to generate the remaining 33% in Figure II. If the emissions for non-visible particle phase high-emitters is half that of smoking vehicles, then approximately 5% of the fleet would have to be non-visible particle phase high-emitters to generate the remaining 33% in Figure II.

For this analysis, smoking vehicles comprise 1% of the Denver metro fleet and emit 13% of the total direct gasoline-powered vehicle $PM_{2.5}$ emissions. It is reasonable to assume that non-visible particle phase high-emitters comprise approximately 4% ((3% + 5%)/2 = 4%) of the Denver metro area fleet and emit 33% of the total direct gasoline-powered vehicle $PM_{2.5}$ emissions.

Hydrocarbons and Carbon Monoxide

The NRC Committee on Vehicle Emissions Inspection and Maintenance Programs generally characterized that 10% of a fleet contributes approximately 50% of on-road HC and CO emissions in urbanized areas. Another study, *On-Road Remote Sensing of Automobile Emissions in the Denver Area: Year 3*, conducted by the University of Denver, indicates that approximately 10% of the highest emitting vehicles of HC and CO in the Denver metro area fleet contribute approximately 35% and 39% of on-road HC and CO emissions, respectively. The Work Group based its definition on this research which defines any vehicle that falls in the highest emitting 10% of the fleet as a gas phase high-emitter.

Estimated Target Population and Characteristics of High-Emitting Vehicles

Overall, the gasoline-powered vehicle fleet in the Denver region is estimated to be approximately 2,000,000 vehicles in 2002. Of this total, an estimated 5% of the total vehicles in the metro area will be non-visible particle phase high-emitters (4%) and smoking vehicles (1%), which equates to 80,000 and 20,000 vehicles, respectively. Based on the University of Denver research, the dirtiest 10% of the fleet are defined as gas phase high-emitters. This equates to an estimated 200,000 vehicles.

During the course of its work, the Work Group found that there is a potential correlation between the gas phase emissions of particle phase high-emitters. Preliminary data from Environmental Systems Products' (ESP) Virginia Pilot Operation shows that approximately 60% of particle phase high-emitters might also be high-emitters of CO >3% and/or HC>2000. This ESP data is used to further apportion high-emitters into the categories of particle phase high-emitter, gas phase high-emitter, and those vehicles that are high-emitters of both particle and gas phase pollutants.

As previously stated, particle phase high-emitters are estimated to equal 100,000 vehicles. Based on ESP's preliminary data, an estimated 60,000 of these 100,000 particle phase high-emitters (100,000*60%) might also be high-emitters of HC and/or CO. Therefore, 60,000 vehicles could be high-emitters of both particle and gas phase pollutants. These 60,000 vehicles are subtracted from both the 100,000 particle phase high-emitters and the 200,000 gas phase high-emitters resulting in an estimated 40,000 particle phase-only high-emitters, 140,000 gas phase-only high-emitters, and 60,000 vehicles that could be both particle and gas phase high-emitters. This analysis concludes that there are an estimated 240,000 vehicles, or 12% of the fleet, that are high-emitters in the Denver region. Table I details the target population of high-emitters.

Table I -Estimated Number of High-Emitters in the Denver Metro Fleet

Gasoline Powered Vehicles	Percent of Fleet	Number of High-Emitting Vehicles	Number of Clean Vehicles
Clean (Cold start/Hot Stabilized)	88%		1,760,000
Gas Phase High-Emitters	7%	140,000	
Non-Visible Particle Phase High-Emitters	1.6%	32,000*	
Smoking Vehicles	0.4%	8,000*	
Combined Particle Phase and Gas Phase High Emitters	3%	60,000	
Total	100%	240,000	1,760,000

*40% of the total 80,000 non-visible particle phase high-emitters and 40% of the 20,000 smoking vehicles.

In addition to a possible correlation between particle phase and gas phase high-emitters, there seems to be a correlation between high-emitters of HC and CO. Figure III below details the degree of overlap of the 10% of vehicles categorized as gas phase high-emitters of CO, HC, and NOx. This figure shows that high-emitters of CO have a high probability of being a high-emitter of HC and vice-versa. The potential correlation is that approximately 61% of the 10% categorized as high-emitters (10%*61%=6.1% in Figure III) of HC will be high-emitters of CO and vice-versa. University of Denver data for the Denver metro area fleet indicates that this correlation is smaller at approximately 3.6%. Figure III indicates those vehicles that are high-emitters of NOx do not have a high probability of being a high-emitter of CO or HC.

Figure III. Overlap Among the Highest 10% Emitters of CO, HC and NOx

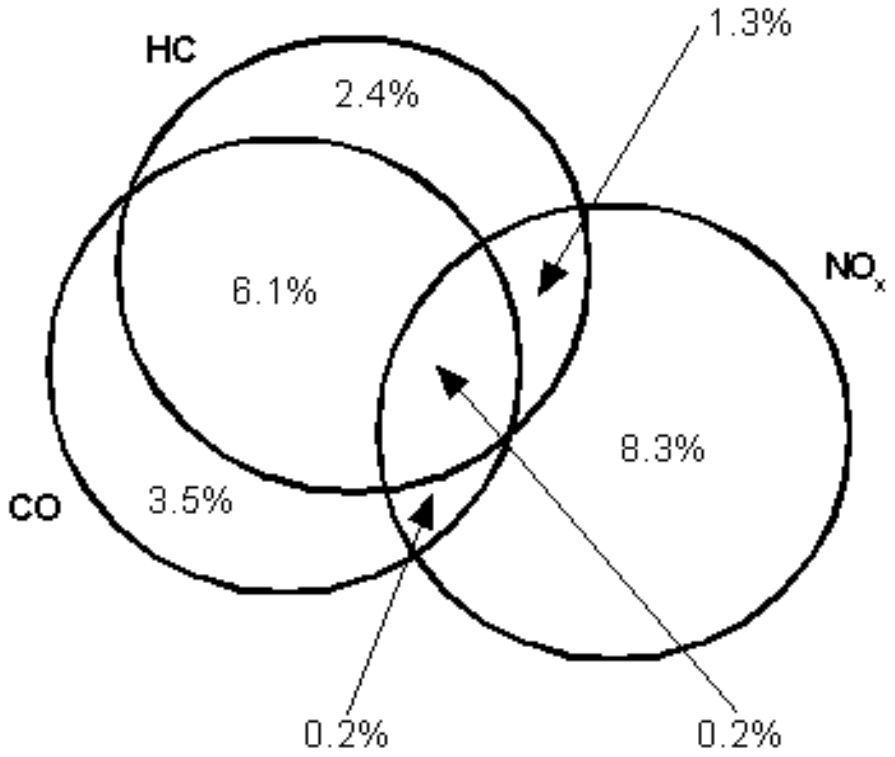


Figure III. Degree of overlap among the highest 10% of emitters of CO, HC, and NOx in the light-duty vehicle fleet. Based on results of emissions tests administered on 12,977 vehicles in California random roadside inspections tested from June 9, 1998 to October 29, 1999. Note that the sizes of the overlapping areas are not drawn to scale. (National Research Council, 2001).

Based on the data presented in this section there are an estimated 240,000 high-emitters of $PM_{2.5}$, HC, and CO in the Denver metro area. There is a potential correlation that many particle phase high-emitters might also be gas phase high-emitters. As shown on Figure III, there is also a potential correlation that high-emitters of HC will be high-emitters of CO and vice-versa.

3. EVALUATION OF IMPACTS OF CURRENT SMOKING AND HIGH-EMITTING VEHICLE EFFORTS

Below, existing efforts to address both smoking vehicles and gas phase high-emitters are discussed. Smoking vehicles are addressed by the I/M Program, Denver's Trained Staff Smoking Vehicle Program, Boulder's Smoking Vehicle Pullover Program, and CDPHE's Smoking Vehicle Hotline. The only program currently addressing gas phase high-emitters is the I/M Program. At this time, there are no programs in place that address non-visible particle phase high-emitters that only emit invisible $PM_{2.5}$.

The I/M Program in the enhanced area, including the independent testing stations, currently captures about 13% of the estimated population of smoking vehicles on an annual basis. Envirotest stations failed 2,802 smoking vehicles (0.28%) out of the 989,830 cars tested. The independent testing stations failed 594 smoking vehicles (0.88%) out of the 67,146 cars tested. Some of these vehicles that are failed will not return for follow-up testing and will avoid I/M Program emissions testing.

CDPHE reports that an estimated 23% of vehicles that fail their first test do not return to complete the inspection process, thus the numbers in Table II have been adjusted downward by 23% to account for these unresolved failures. CDPHE indicates that it is likely that some of these vehicles continue to operate within the program area. Past evaluations indicate that 4% of these vehicles manage to be re-registered in the Denver metro area, 30-40% are registered in counties outside the metro area, and the remaining 55-60% are not accounted for in the system. The adjustment for unresolved failures results in an estimated 2,158 and 458 smoking vehicles passing a retest at Envirotest and independent stations, respectively. CDPHE indicates that these vehicles which initially fail and subsequently pass a retest are assumed to have been repaired. Table II, column three, below quantifies current efforts to address smoking vehicles as a percentage of the total pool of the 20,000 smoking vehicles (this includes smoking vehicles that could also be gas phase high-emitters) calculated in Section 2.

Table II - Annual Estimate of Current Smoking Vehicle and Gas Phase High-Emitter ID and Repair Efforts

Program	Estimated Smoking Vehicles Repaired or Retired	Percentage of Total Smoking Vehicles (20,000)	Estimated Gas Phase High-Emitters Repaired or Retired	Percent of Total Gas Phase High-Emitters Repaired or Retired (140,000)
Denver Trained Staff Program	124	0.6%	75**	0.05%
Enhanced I/M240	2,158*	10.8%	40,897	29.2%
I/M Idle Test - Enhanced Area	458*	2.3%	17,714	12.7%
CDPHE Smoking Vehicle Hotline	123	0.6%	75**	0.05%
Total	2,863	14%	79,665	42%

*Smoking vehicles failed in the I/M Program are2,802 and 594 but have been adjusted downward here by 23% to account for unresolved failures.

**These vehicles are smoking vehicles that are also potential gas phase high-emitters of CO and HC.

Additional enforcement of smoking vehicles laws is performed by both the City and County of Denver and the City of Boulder. Denver's Trained Staff Smoking Vehicle Program results in the repair or retirement of approximately 124 vehicles annually. Boulder's Smoking Vehicle Pullover Program results in the repair of some vehicles.

The final program implemented to address smoking vehicles is the Smoking Vehicle Hotline operated by CDPHE that receives approximately 6,000 citizen complaints annually. Based on a sample of 484 hotline complaints for the month of April 2002, 41% of the complaints were for vehicles in the AIR Program area and gasoline-powered. Using a conservative 5% compliance

rate with this voluntary program, and an annual number of complaints of 6,000, the number of vehicles repaired as a result of this program is estimated to be 123.

In addition to smoking vehicles, the I/M Program addresses gas phase high-emitters that are high-emitters of CO, HC, and NOx. According to the 2002 *Annual Report on the Automobile Inspection and Readjustment (AIR) Program*, 55,915 vehicles failed their initial biennial I/M240 test in the enhanced area. An additional 23,600 vehicles failed their initial annual two speed idle test in the enhanced area. Again, of all the failed vehicles, 23% do not return to complete the testing process, thus these numbers have also been adjusted downward by 23% in Table II. Additionally, the smoking vehicles failed in the I/M Program have been subtracted from these totals in Table II.

These adjustments result in approximately 41,000 gas phase high-emitters subject to I/M240 and 18,000 gas phase high-emitters subject to the two speed idle test passing their retest. Again, CDPHE indicates that these vehicles which initially fail and subsequently pass a retest are assumed to have been repaired. Table II, column five, quantifies current efforts to address gas phase high-emitters as a percentage of the total pool of 140,000 gas phase high-emitters calculated in Section 2.

Net results indicate that, not accounting for the occasional law enforcement citation of a smoking vehicle, Denver metro area smoking vehicle programs currently address about 14% of the smoking vehicles on an annual basis. These vehicles are particle phase high-emitters but preliminary data from ESP indicates that approximately 60% of these vehicles might also be high-emitters of HC and CO. Therefore, 60% of the smoking vehicles addressed are also included in the total of gas phase high-emitters currently being repaired or retired. Overall, the I/M Program is addressing approximately 42% of the gas phase high-emitters in the Denver metro area.

The High-Emitting Vehicle Work Group found that the strategies currently addressing smoking vehicles and gas phase high-emitters in the Denver metro area address only a portion of the population of target vehicles. Any smoking vehicle identification strategy that focuses on visually observing vehicles will miss a significant number of high-emitters of invisible $PM_{2.5}$, HC, and CO. Any strategy that focuses only on gas phase high-emitters could miss a significant number of smoking vehicles.

4. COST/BENEFIT ANALYSIS OF POTENTIAL STRATEGIES

The sections below contain the strategies the Work Group investigated to address the problem posed by high-emitting vehicles. As described in the Executive Summary, the Work Group recommended strategies D and E.

A. Inspection and Maintenance Program Enhancements - Not Recommended
B. CDPHE Smoking Vehicle Hotline Enhancements - Not Recommended
C. Region-wide Trained Staff Smoking Vehicle Program - Not Recommended
D. Region-wide Smoking Vehicle Pullover Program - Recommended
E. RSD4000 High-Emitter Identification Program - Recommended

Each strategy includes a cost and benefit analysis. Included in the analysis are operational costs and benefits due to the Work Group's proposed enhancements. In many cases assumptions have been made to quantify both costs and benefits. The costs contained in this analysis are estimates generated from both departmental/agency data and data from other sources if departmental data were missing or difficult to obtain. All personnel costs include fringe benefits but do not include overhead for facilities.

Overall, consumer costs for repairing vehicles were not developed because the range of costs could vary significantly. Additionally, emissions benefits from the individual strategies were not quantified due to lack of data on the effectiveness or longevity of repairs.

A. Inspection and Maintenance Program Enhancements - Not Recommended

Current Program Description

The enhanced I/M Program was initiated as a strategy for reducing CO pollution from automobiles. There are two test procedures used in the I/M Program. The I/M240 dynamometer test, which is used as a part of the enhanced I/M Program, monitors 1982 and newer gasoline-powered vehicles throughout a variety of operating modes. The two-speed idle test uses a tachometer and probe to monitor idle emissions of 1981 and older gasoline-powered vehicles. Both currently test for CO and HC and only I/M240 tests for NOx. Neither test regimen can identify either PM or opacity. As part of each

test regimen a technician does a visual test for visible smoke. Smoking vehicles fail the visual inspection and owners are required to repair their vehicle before they are allowed to pass.

The statistics developed in Section 3 indicate that the current I/M Program in the enhanced area, both Envirotest and the decentralized stations, annually addresses about 42% of the total population of gas phase high-emitters. Additionally, the I/M Program addresses approximately 13% of the total population of smoking vehicles (Please refer to Table II, page 16).

Because the I/M equipment can not test for PM or opacity some non-visible particle phase high-emitters and smoking vehicles can circumvent the I/M Program. Because some of these vehicles do not smoke all the time, their emissions problems may be missed during the visual smoke inspection. Additionally, there are short-term fixes to smoking vehicles to reduce or mask smoking sufficiently enough to pass the visual test. Vehicles that have these short-term, non-durable repairs performed may pass their emissions test and continue to be high-emitters.

Another issue that reduces I/M effectiveness is that 23% of the vehicles that failed their initial I/M test disappeared from the program. It is not clear how many of these were failed for smoke, nor is it clear if the vehicles are still in the program area. CDPHE indicates that it is likely that some of these vehicles continue to operate within the program area. Past evaluations indicate that 4% of these vehicles manage to be re-registered in the Denver metro area, 30-40% are registered in counties outside the metro area, and the remaining 55-60% are not accounted for in the system.

At the request of the RAQC, CDPHE staff followed up on one month's worth of vehicles reported as smoking through the Smoking Vehicle Hotline (See Appendix B for the CDPHE Analysis). CDPHE found that over 60% of those vehicles that were reported as smoking did not show any evidence of having been through the I/M Program. These statistics make the case for greater on-road enforcement of vehicle emissions laws.

Enhancements

Both ESP and CDPHE indicate that there is no developed technology that could be used for enhancing in-lane technology to allow it to test for either PM or opacity. Thus, changes in the I/M Program equipment are not technologically feasible as a means of identifying non-visible particle phase high-emitters and smoking vehicles.

In a recent report to the legislature on the AIR Program, the Air Quality Control Commission (AQCC) expressed concern about the durability of vehicle repairs mandated by the program. The Work Group considered a program in which those vehicles that have failed the emissions test, either for high CO, HC, or visible smoke are required to be re-inspected again in six months. If the vehicle failed its emissions test a second time, it would be inspected annually thereafter. This enhancement would have required Department of Revenue and county clerk automated system changes.

Another enhancement that the Work Group considered to address repair durability was to require vehicle owners that fail their I/M test to provide documentation of the repairs made to the vehicle before their next emissions test. This would have allowed technicians to ensure that repairs made to high-emitting vehicles were durable. This enhancement would have been piloted for a period of two years in order to determine the effectiveness of high-emitting vehicle repairs.

Strategy Analysis - I/M Program Enhancements

Benefits

- Infrastructure for I/M Program is already established; changes would not be overly complicated.
- More frequent inspections would focus on vehicles that have already proven to be high-emitters.
- Reduction in emissions would occur from repairing vehicles that are high-emitters. Statistics developed in Section 3 indicate that 2,616 smoking vehicles and 58,611 gas phase high-emitters fail their initial emissions test (reduced by 23% to account for unresolved failures). If 10% of the

highest emitters were subjected to re-testing, 6,120 vehicles would be repaired.

Costs

- Costs to implement Department of Revenue and County Clerk automated system changes. Based on fiscal notes attached to previous legislation requiring automation changes approximate costs would be one time cost of $50,000.
- More frequent inspections. Assuming consumers would pay for the re-test, the costs to the consumer would be $153,000 in the first year for re-tests.
- Enhanced training for technicians to assess what repairs can be defined as durable. There is no data available to determine this cost.
- Program costs are $153,000. Estimated program cost per vehicle repaired is $25. Number of vehicles repaired is estimated at 6,120.

Program Disadvantages

- Visual inspections may still not catch smoking vehicles that do not smoke all the time and will not catch non-visible particle phase high-emitters.
- More frequent inspections could increase program avoidance.
- Research shows that over 60% of vehicles identified through the Smoking Vehicle Hotline may be avoiding the I/M Program altogether making the case for greater on-road enforcement.

B. CDPHE Smoking Vehicle Hotline - Not Recommended

Current Program Description

The CDPHE Mobile Sources Program operates a Smoking Vehicle Hotline that receives 6,000 citizen complaints annually. The purpose of this hotline is to identify and inform smoking vehicles owners of options to repair their vehicles.

Smoking vehicle complaints are received via the Smoking Vehicle Hotline or the web site. When a complaint is received, CDPHE staff transcribes the vehicle information from voicemail into an electronic format. At the end of each month, CDPHE staff begins the following process:

- CDPHE staff compiles the data and emails a file to the Department of Revenue, Division of Motor Vehicles (DMV).
- The DMV staff emails the file to the General Government Computer Center (GGCC) in the Department of Personnel and Administration. GGCC runs a matching process to ensure the CDPHE vehicle description data matches DMV's records. Matched vehicle records, which are not in their first four model years of life, are kept in the file.
- The matched data is then emailed back to DMV.
- DMV emails the file back to CDPHE.
- CDPHE then emails the file to the Integrated Document Factory (IDF) in the Department of Personnel and Administration. IDF sends the informational brochures via bulk mail.

Of the 6,000 annual complaints, there is an 86% match rate. These 5,160 matches result in an informational brochure being sent to the owner of the smoking vehicles. If the letter is returned due to an incorrect address (1-2%) the notification process ends.

If the vehicle is not a fleet vehicle, the program is voluntary and it is up to the owner to get the vehicle repaired. Because of this, and the fact there is no follow-up with vehicle owners, the effectiveness of the program is unknown.

Enhancements

The enhancements examined would have increased the effectiveness of the Smoking Vehicle Hotline Program. The enhancements considered were:

- Development of a public relations campaign to increase the program's visibility (See Appendix C for detailed information on PR Campaigns and their cost).
- Using Smoking Vehicle Hotline data to flag vehicles for increased attention for smoke during the vehicle's next inspection.

The Work Group examined an enhancement which would have required vehicles that were the subject of a complaint on the Smoking Vehicle Hotline to be inspected prior to being able to re-register. This is similar to a registration program in the state of Nevada. However, this option was not pursued because the Work Group felt it could be prone to abuse or generate a high number false calls from an untrained public.

The first enhancement listed above would have increased the visibility of the Hotline Program and increased the number of calls to the Smoking Vehicle Hotline and web site. This would have included an easy to remember number that would be included in the PR campaign. Anecdotal evidence showed that enhanced public relations in the past resulted in increasing average monthly complaints from 440 to approximately 1,800 per month. The campaign was sponsored by a cellular phone service that offered free minutes for each smoking vehicle called in.

The public relations campaign was assumed to double the number of complaints to 6,000 additional complaints annually. According to the April 2002 sample of smoking vehicle complaints provided by CDPHE, 41% of these complaints would be for vehicles in the AIR Program area and gasoline-powered. Based on this data, 2,460 vehicle owners would have been sent information. Statistics from the Fort Collins pilot of a voluntary program show a low compliance rate. Therefore, a 5% voluntary compliance rate was assumed resulting in 123 additional repaired or retired vehicles.

The second enhancement would have CDPHE provide the Smoking Vehicle Hotline data to Envirotest and to local de-centralized stations. The inspecting stations would

have the vehicles flagged in their system. When the vehicle was next inspected, the technician would know to perform a smoking vehicle check.

Strategy Analysis - Enhanced Hotline Program

Benefits

Implementation of the hotline enhancement detailed above would have had the following potential benefits:

- Enhancing the public relations effort would have increased the number of complaints to the hotline and website, resulting in additional vehicles repaired.
- The public awareness campaign might have also contributed to the voluntary repair of additional vehicles, not reported as smoking through the hotline.
- Additional vehicles potentially repaired as a result of an enhanced public relations program, assuming a 5% voluntary compliance rate, was 123. Preliminary data shows that approximately 75 (60%) of the smoking vehicles might also be gas phase high-emitters.

Costs

The CDPHE Smoking Vehicle Hotline Program currently has a relatively low annual cost of $14,000. Personnel costs for five part-time staff equal 74% of the program's total costs. Operational costs, such as phones and mailings, account for the remaining 26%. Overall, program costs in the areas of staffing and public relations would have increased due to the enhancements discussed above.

- According to CDPHE, more staff time would have been needed to transcribe the additional calls or the timeliness of data submitted to the Department of Motor Vehicles (DMV) will be affected. Additionally, the costs associated with mailing the informational brochure would rise. These costs potentially increase 21% from $14,000 to $17,000 annually for an increase of $3,000.

- The public relations campaign cost was estimated at $40,000 and could have been more or less depending on how extensive the campaign.
- Total program costs were estimated at $43,000. Program costs for repairing 123 vehicles would be $350 per vehicle.

Program Disadvantages

- Lack of data on program effectiveness.
- CDPHE staff indicated that vindictive complaints are made against people whose vehicles do not smoke. The potential for this type of abuse was unknown.
- False calls during the winter months could have increased drastically due to mis-identification of vehicles emitting steam on cold mornings.

C. Trained Staff Smoking Vehicle Program - Not Recommended

Current Program Description

The City and County of Denver has had a smoking vehicle ordinance banning visible automobile emissions since 1979. The ordinance requires that gasoline-powered vehicles smoke no more than five seconds during any period of operation. Since 1990, Denver's Environmental Protection Division (EPD) in the Department of Environmental Health has enforced this ordinance through its Smoking Vehicle Program. Detailed below is a high level description of the program and its policies and procedures.

This program utilizes approximately 150 volunteer field staff from the EPD and other City and County departments to identify and ticket smoking vehicles. These inspectors receive training on how to identify smoking vehicles and are allowed to issue a courtesy letter or a summons for violators to appear in environmental court. The vehicle owners who are mailed a summons to appear in court are required to take further action.

Additionally, complaints are received from the general public. Those vehicle owners who are the subject of these public complaints are always sent a courtesy letter rather than a summons. Those that are mailed a courtesy letter are not required to take further action. Both the summons and courtesy mailings contain brochures in English and Spanish that explain the City's ordinance, the summons or courtesy letter, the compliance process, and the court process.

When inspectors identify a smoking vehicle, they enter the vehicle identification information onto a special "report card". The inspector also indicates if the violator will be issued a courtesy letter or a summons. There are a number of factors why an inspector might issue a courtesy letter instead of a summons, but they are primarily due to the violator having out-of-state license plates. The inspector then submits the "report card" to administrative staff at the EPD who enters the information into an Access database.

After entering the vehicle information into the database, the EPD administrative staff person transcribes each smoking vehicle report onto a separate Division of Motor Vehicle (DMV) form and faxes them to DMV weekly. After DMV has run the matching

process and EPD administrative staff has picked up the address information, the program manager makes the final decision to mail a courtesy letter or summons. The administrative staff then sends the vehicle owner the appropriate packet of information. All summonses to appear are sent via certified mail. In some cases, if the summons is undeliverable via mail, the EPD will work with the appropriate sheriff's office or private investigators to locate and serve difficult-to-find smoking vehicle owners.

In order to avoid a court appearance, the owner of the smoking vehicle must provide proof of compliance prior to the compliance date listed on the summons. These include:

- Prove the vehicle is in compliance with the City ordinance through a free visual inspection; or
- Surrender both license plates to the EPD program staff, or their state or county office, and provide proof to program staff; or
- Provide notarized proof that the vehicle has been sold and that the new owners know that the vehicle smokes.

In 2001, the EPD made 520 inquiries to the DMV to match smoking vehicle registrations to inspector reports. Of the 520 inquiries, 12% (62) had no DMV match, 26% (137) were sent a courtesy letter, and 62% (321) were sent a summons to appear in court. Of those sent a summons to appear in court, approximately 18% (59) were undeliverable, 44% (142) complied prior to their court date and 38% (125) took their case to court.

Table III illustrates the outcomes of the 267 total summonses. Also shown are the statistics if the program were implemented region-wide as discussed in the program enhancements section below. These region-wide calculations are based on applying Denver's ratio of 1 inspector for every 4,000 people and multiplying Denver's ratio of 3.67 contacts per inspector annually. This methodology will increase the number of inspectors throughout the metro-area by 516 and lead to 1,892 additional contacts. From this total, approximately 960 summonses to appear in court will result. This is based on current program statistics which show 62% of the total contacts will result in a summons to court and 18% of those will be undeliverable.

Table III - Smoking Vehicle Ticketed Cases

Outcome	Denver Statistics	Denver Percentage	Estimated Regional Total (Excluding Denver)*
Passed No Repairs	42	16%	154
Sold	15	6%	58
Turned in Plates	15	6%	58
Failed Inspection	2	1%	10
Passed with Repairs	94	35%	337
Cases Open	19	7%	67
Not Guilty	34	13%	125
Guilty	17	6%	58
Failure to Appear	29	10%	96
Total Ticketed Cases	267	100%	963

*Numbers may be off slightly due to rounding

Enhancements

The following options to enhance the Trained Staff Smoking Vehicle Program were investigated:

- Development and implementation of a local government education campaign to work with the region's counties and municipalities (Denver has been removed because they already have the Trained Staff Smoking Vehicle Program) to pursue implementation of a Trained Staff Smoking Vehicle Program (Please refer to Appendix D for list of local governments).
- Creation of a model smoking vehicle ordinance to assist counties and municipalities in their implementation efforts.

The first enhancement investigated would have involved working with local governments in the Denver metro area to educate them regarding the benefits of implementing a

Trained Staff Smoking Vehicle Program. Please refer to Appendix D for a list of local governments that were to be included in this effort.

In order to implement a local government education program, the RAQC would have needed to develop a model ordinance to assist local governments in implementing a Trained Staff Smoking Vehicle Program. The Work Group found it is important for the targeted communities to create and enforce their own ordinances to maximize revenue for the local government. Several communities in the region, including both Denver and the City of Boulder, have developed smoking vehicle ordinances which could have been used as a model.

Strategy Analysis - Region-Wide Trained Staff Smoking Vehicle Program

Benefits

Implementing a targeted campaign to educate local governments about this program would have aided in program effectiveness. If local governments created their own Trained Staff Smoking Vehicle Program based on the staffing ratios of the Denver program, one inspector would be required for every 4,000 people in population. Implementation of such a program region-wide would have led to the following benefits:

- Fine revenue could have increased by significant amounts. Currently Denver does not use its ability to fine for smoking vehicles as a revenue generator, but instead as a means to require automobile repairs. Fines are often suspended. If a local community wanted the revenue to assist in paying for the program, possible fines of between $60,000 to $95,000 could be generated to offset program costs. Table IV below illustrates the possible fine revenue based on either a $150 or $300 fine. For this analysis, vehicle owners who pass the inspection with repairs are subjected to a $50 fine to cover court costs. Those that fail to appear are subjected to both the smoking vehicle fine and a $150 fine for their failure to appear.
- Trained staff would have limited the number of false calls that can occur during winter months through mis-identification of steam.

- Focus on compliance would have ensured vehicles were repaired or retired.
- Estimated retirement of 116 additional vehicles and the repair of 337 additional vehicles. Please refer to Table III above.
- Preliminary data shows that approximately 270 (60%) of the smoking vehicles might also be gas phase high-emitters.

Table IV - Smoking Vehicle Projected Fine Revenue (Excluding Denver Program)

Outcome	Summons Results	$150 Fine	$300 Fine
Passed No Repairs	154	0	0
Sold	58	$8,700	$17,400
Turned in Plates	58	$8,700	$17,400
Failed Inspection	10	$1,500	$3,000
Passed with Repairs*	337	$16,850	$16,850
Cases Open	67	$5,100	$10,200
Not Guilty	125	0	0
Guilty	58	$4,350	$8,700
Failure to Appear**	96	$14,400	$21,600
Total	963	$59,600	$95,150

*Only charged a $50 fine to cover court costs.

**Charged maximum fine and $150 for FTA. Only 50% of the FTA fines will be collected.

Costs

In 2001, the Denver Trained Staff Smoking Vehicle Program cost an estimated $45,000. Personnel costs for management staff, inspectors, judges, attorneys and support staff equal 93% of the program's total costs with the remainder being operational costs.

Applying the program and the local government education costs on a region-wide basis would have resulted in an additional cost of $242,000, which does not include Denver. These calculations were developed using an economy of scale factor. Communities smaller than Denver would not have the economies of scale in implementing a program

that a city the size of Denver has. Therefore, our calculations use an economy of scale factor of 1.4 for communities under 35,000 in population and an economy of scale factor of 1.2 for communities over 35,000.

- Management staff, trained inspection staff, and administrative staff would have been needed in the targeted local governments. Additionally, more court time would have been needed to adjudicate all the cases. This would have increased the staffing and operational costs region-wide by $202,000.
- A local government education campaign was anticipated to cost approximately $40,000 annually for staff time and materials.
- There could have been increased costs for the state if vehicle registration inquiries were received from many additional local governments.
- Total costs for a region-wide program were estimated to be $242,000 per year. Approximately 453 vehicles would have been repaired or retired at a program cost average of $535 per vehicle.

Program Disadvantages

- Mailing summonses to bad addresses would result in reduced program effectiveness.

D. Smoking Vehicle Pullover Program - Recommended

Current Program Description

Roadside pullover of smoking vehicles is conducted by both local law enforcement and the Colorado State Patrol. The Colorado Springs Police Department issued 29 smoking vehicle citations last year, and the Colorado State Patrol issued 37. Historically, smoking vehicles have not been a high priority for law enforcement, which has resulted in few smoking vehicle tickets. The City of Boulder is an exception. Boulder's "Visible Emissions" ordinance is similar to Denver's but prohibits gasoline-powered vehicles from emitting *any* visible pollutants.

In the 1970's, Boulder's Environmental and Zoning Enforcement Work Group was created to enforce the ordinance. The personnel in Environmental Enforcement are armed peace officers with the responsibility of enforcing nuisance laws; which includes smoking vehicles. In addition to the officers of Environmental Enforcement, officers with the Boulder Police Department will write tickets for smoking vehicle violations.

Usually, officers encounter smoking vehicles while on normal patrol. The officer will pullover a smoking vehicle and issue the owner a summons to court. The officer will then inform the owner that if they fix the problem, they can avoid going to court. Once the repair is complete, the owner can call Environmental Enforcement to schedule a free inspection. If the person complies and passes the free inspection, Environmental Enforcement will provide a dismissal the owner can take to the clerk of court.

Although the focus of the program is on compliance, approximately 5% of owners do not want to pay to fix their vehicle. If the vehicle owner does not comply prior to court they can plead guilty, avoid a court appearance, and pay a fine. If the vehicle owner wants to contest their ticket, they can plead not guilty and take their case before a jury. If they plead guilty, or are found guilty, a $300 fine will be imposed.

According to Environmental Enforcement's managing officer, smoking vehicles have become less of a problem due to the area's fleet demographics. The older, higher polluting vehicles are not as common in Boulder as they once were. Another reason for the decline could be that patrols have shifted to nighttime hours from Thursday to

Saturday during the summertime as part of enforcement of noise and cigarette smoking ordinances. Program statistics indicate that enforcement activities peaked in 1981 with 446 tickets. Up until 1985, statistics remained constant and then dropped significantly to an average of 19 tickets per year. From January 2001 to April 2002, 36 smoking vehicle tickets were written. Seventy-eight percent (28) were dismissed due to compliance, 5% (2) cases were resolved by payment of a $300 fine, and 17% (6) cases are pending.

Enhancements

In order to enhance the effectiveness of a Smoking Vehicle Pullover strategy, two enhancements are recommended:

- Development and implementation of a local government education campaign to work with the region's counties and municipalities to pursue implementation of a Smoking Vehicle Pullover Program (See Appendix E for list of local governments).
- Creation of a model smoking vehicle ordinance to assist communities in their implementation efforts.

The development of an education campaign to persuade local governments in the Denver metro area to implement a Smoking Vehicle Pullover Program will be key to the program's success. The local government education campaign should target the cities and counties, including Denver, in the region (See Appendix E for the list of local governments). Denver is included in the analysis of the Smoking Vehicle Pullover Program although it already has its own dedicated Trained Staff Smoking Vehicle Program.

Creation of a model smoking vehicle ordinance to assist local governments in their implementation efforts will also be necessary. Again, if communities are going to implement a Smoking Vehicle Pullover Program they need to have local ordinances in place to maximize revenue.

Strategy Analysis - Region-Wide Smoking Vehicle Pullover Program

Benefits

Below are the estimated benefits and costs based on implementing a Region-Wide Smoking Vehicle Pullover Program in the targeted counties and municipalities, including Denver. This program will result in an estimated 2,200 pullovers annually. This estimate is based on approximately 620 traffic officers writing between 1.5 and 4 smoking vehicle summonses annually. This range is dependant upon the size of the community and its police department. The estimates used to determine these statistics were provided by a sample of different sized police departments. RAQC staff called these departments to determine the size of both their patrol and traffic units and the number of moving violation citations for the city. The percentage of patrol and traffic officers from the sample was then applied to the rest of the targeted police departments to estimate the relative size of their patrol and traffic units. The distinction between a local government's patrol and traffic units is important. The Work Group emphasized that enforcement of this strategy be carried out only by traffic units, not patrol units.

To determine the number of citations written by each officer, the total number of moving violation citations for the local government was divided by the total number of patrol officers. The resulting average ranged between 150 - 400 citations per officer, with larger police departments writing more tickets than smaller departments. From this average, 1% of tickets were assumed to be for smoking vehicles arriving at between 1.5 and 4 tickets written per patrol officer. The range of tickets written (1.5 to 4) is then multiplied by the number of traffic officers in each jurisdiction for a total of 2,200 smoking vehicle tickets written annually. Please refer to Appendix E for a breakdown of this number by county and municipality.

Additional assumptions are made about the breakdown of the percentage of violators who will comply, pay a fine, or take their case to court. These numbers are based on data from both the Denver and City of Boulder programs because the Boulder program does not generally take people to court. For this analysis, an estimated 60% will comply, 5% will pay the fine and not repair their vehicle, 25% will make a court appearance with 75% being found guilty and paying the maximum fine and 10% will fail to appear. Based on these assumptions, the following benefits will result:

- The number of smoking vehicle summonses to appear in court region-wide will increase by 2,200. According to Table V, 1,320 vehicle owners will comply. The remainder will be adjudicated and will result in estimated fine revenue of $177,000 to $272,000 depending on the fines charged.
- Use of trained law enforcement officers should limit the number of false calls that can occur during winter months due to mis-identification of steam.
- Focus on compliance ensures many vehicles are repaired.
- Issuing tickets to motorists at the time of the infraction increases cost-effectiveness because it reduces the number of summonses lost because of bad mailing addresses.

Table V - Smoking Vehicle Roadside Pullover Summons Revenue

Outcome	Summons	Fines $150	Fines $300
Comply*	1,320	$66,000	$66,000
Pay Fine	110	$16,500	$33,000
Court Appearance	550	$61,950	$123,900
FTA**	220	$33,000	$49,500
Total	2,200	$177,450	$272,400

*Only charged a $50 fine to cover court costs

**Charged maximum fine and $150 for FTA. Only 50% of the FTA fines will be collected.

Costs

Currently, the annual cost to operate the City of Boulder's Environmental Enforcement Program is very low at approximately $1,000. The two Environmental Enforcement officers spend little time enforcing the smoking vehicle ordinance due to other priorities. The current costs for Boulder are an add-on to another program that involves certified peace officers. Thus, our calculations add an economy of scale factor of 1.4 for communities under 35,000 in population and 1.2 for communities over 35,000.

The cost estimate for a metro-wide program is estimated to be $173,000 region-wide. The table in Appendix E illustrates these costs by community. Costs for this option include:

- The local government education campaign is estimated to cost $40,000.
- Operational costs are estimated at $133,000.
- The total program costs for this strategy are estimated at $173,000 for an estimated 1,320 vehicles repaired or retired. Program costs are approximately $130 per vehicle.
- Preliminary data shows that approximately 800 (60%) of the smoking vehicles might also be gas phase high-emitters.

Program Disadvantages

- Potential political and public resistance to implementing an intrusive measure now that the Denver metro area is in attainment with the federal air quality standards.
- Historic resistance from law enforcement to pullover smoking vehicles.
- Law enforcement resources potentially focusing on homeland security issues.

E. RSD4000 High-Emitter Identification Program - Recommended

Program Description

ESP indicates that it has a new remote sensing device, the RSD4000. ESP is currently testing the RSD4000 at three sites in the nation and indicates it is ready and available to undertake an on-road program for gas phase emissions of CO, HC, and NOx. ESP is evaluating data and attempting to correlate a smoke factor that measures opacity to identify particle phase high-emitters. Preliminary testing indicates the RSD4000 should be able to identify PM and/or an opacity smoke factor. However, ESP indicates the RSD4000 smoke factor identification needs more evaluation and is not yet ready to identify PM or opacity from particle phase high-emitters.

Detailed below are both a voluntary and mandatory approach that could be implemented using the RSD4000. Both of these approaches include estimates of the potential number of gas phase high-emitters identified. Estimates of the number of particle phase high-emitters identified are also included but are dependant upon the RSD4000's ability to identify PM or opacity.

A Clean Screen Program in the Denver metro area is scheduled for implementation in 2003. This program allows cars that pass a remote sensing device, and are deemed to be clean, to skip their next regular emissions test cycle. A High-Emitter Identification Program using RSD4000 to identify high-emitters, and possibly smoking vehicles, could be added to the planned Clean Screen Program. Current law mandates a voluntary approach to high-emitter identification. Within the current legal framework, the AQCC can require off-cycle repairs of high-emitting vehicles identified through remote sensing, but there is no enforcement mechanism to ensure compliance. In a voluntary program, owners of vehicles found to be high-emitters through remote sensing could be sent a letter indicating their car was identified as a high-emitter and asking them to take their vehicle to an Envirotest site for a confirmatory test. If this test reveals the vehicle is in fact a high-emitter, the owner would be informed that the vehicle is in violation of state law. CDPHE could, as it currently does with the Hotline, provide information on repairs and encourage the owner to make repairs promptly. The compliance rate under a voluntary approach is estimated at 5%.

Another alternative is adding a mandatory High-Emitter Identification and Enforcement Program to the Clean Screen Program. Statutory changes and Department of Revenue computer system updates would be required to implement this program. Additionally, enforcement options would need to be developed. The Work Group considered a range of enforcement options for being identified as a high-emitting vehicle that include:

A. Requiring the owner to repair the vehicle within 30 days and show proof of passing a confirmatory test before being allowed to register the vehicle in the next registration cycle.
B. Requiring the owner to repair the vehicle and show proof of passing a confirmatory test within 30 days, or receive a fine at the time of registration renewal.
C. Immediate pull over and confirmatory test with roadside dynamometer, along with citation and fine.

Either a voluntary or mandatory approach is dependent upon implementation of the Clean Screen Program. The Carbon Monoxide State Implementation Plan (SIP) calls for a phasing in of remote sensing coverage for the Clean Screen Program. In the first year, 20% of the fleet is to be evaluated with remote sensing. The SIP recommends that this number increase by 20% per year up to 80% fleet coverage. If a High-Emitter Identification and Enforcement Program were added to the Clean Screen Program, remote sensing measurements could also be used to identify high-emitting vehicles. The SIP notes that remote sensing studies recommend obtaining two valid remote sensing measurements within a certain time period to determine if a vehicle is clean or high-emitting.

High-Emitter Identification

A draft report, *RSD Clean Screening Implementation Plan (Draft) - April 2002*, from Envirotest Systems Corporation (Envirotest) estimates the number of vehicles that could be identified in an RSD3000 remote sensing program for the Denver metro area. The RSD3000 is not as effective as the RSD4000 so a program using the RSD4000 could potentially identify more vehicles. Also, this report states that it is difficult to estimate the number of vehicles identified in a remote sensing program because of a number of complex factors. The primary factor is that remote sensing productivity declines over

time. As program coverage increases, a larger percentage of RSD measurements are recorded on vehicles that already have the required two RSD measurements. To reduce this effect, additional sites are required as program coverage increases.

Based on these factors, Envirotest estimates that in the first year 421,000 vehicles (20% remote sensing coverage) will receive two RSD measurements in an 11 month period. At program maturity, 1,030,000 vehicles (60% remote sensing coverage) will receive two RSD measurements in an 11 month period. Clean Screen coverage of 80% of the fleet is not estimated in the report. Currently, Envirotest indicates that there is a cost-effectiveness threshold which limits coverage to 60% of the fleet. As operating costs decrease, the report indicates it may become feasible to evaluate a higher percentage of the fleet.

The remote sensing coverages of 20% and 60% cited in the paragraph above are based on a 2,000,000 vehicle fleet. However, Envirotest indicates that the number of active vehicles registered in the program area is smaller by 5% - 10% because vehicles retire or move out of the area. Therefore, Envirotest used 1,800,000 registered, on-road vehicles to estimate remote sensing coverages in the Denver metro area.

In Section II, page 12 of this report, RAQC staff estimated the number of gas and particle phase high-emitters that could be found in the Denver metro fleet at 240,000 vehicles. Table VI below shows the distribution of high-emitters that could be gas phase high-emitters, particle phase high-emitters, and both.

Table VI - Estimate of High-Emitters in the Denver Metro Fleet

Gasoline Powered Vehicles	**Percent of Fleet**	**Number of High-Emitting Vehicles**
Gas Phase High-Emitters	7%	140,000
Non-Visible Particle Phase High-Emitters	1.6%	32,000
Smoking Vehicles (Particle Phase)	0.4%	8,000
Combined Particle Phase and Gas Phase High-Emitters	3%	60,000
Total	12%	240,000

For the purposes of the remote sensing strategy analysis, we have totaled the 140,000 gas phase high-emitters to include the 60,000 particle phase high-emitters that could also be gas phase high-emitters for a total of 200,000 vehicles. This equates to 10% of the Denver fleet. The reason for this is that these vehicles will be identified through remote sensing's ability to detect gas phase pollutants and will be identified because of these emissions.

Additionally, the non-visible particle phase high-emitters and smoking vehicles have been totaled because, if RSD4000 can identify PM or opacity, these vehicles will be identified regardless of visible or non-visible emissions. This totals 40,000 particle phase-only high-emitters or 2% of the Denver fleet.

If remote sensing can only identify gas phase high-emitters, and they comprise 10% of the approximately 421,000 vehicles identified by remote sensing in the program's first year (20% remote sensing coverage), 42,000 vehicles will be gas phase high-emitters. Approximately 103,000 of the 1,030,000 vehicles identified by remote sensing at program maturity (60% remote sensing coverage) will be gas phase high-emitters.

If remote sensing can identify *both* the gas phase and particle phase high-emitters, which equate to 12% of the fleet, then approximately 50,500 of the 421,000 vehicles identified by remote sensing in the program's first year (20% remote sensing coverage) will be both gas and particle phase high-emitters. Approximately 124,000 of the 1,030,000 vehicles identified by remote sensing at program maturity (60% remote sensing coverage) will be both gas and particle phase high-emitters.

Table VII below details the estimated number of high-emitters identified by remote sensing. Please note that the High-Emitter Identification Program described in this report is an add-on to the Clean Screen Program so the number of vehicles identified as high-emitters is dependant upon the number of vehicles identified in the Clean Screen Program. If we want to identify more high-emitters, the number of remote sensing units on the road will need to be increased which will increase the cost of the program.

Table VII - Number of High-Emitters Identified in Denver Fleet

Gasoline Powered Vehicles	Estimated Number of High-Emitting Vehicles in Denver Fleet	20% Remote Sensing Coverage	60% Remote Sensing Coverage
Gas Phase High-Emitters*	200,000	42,100	103,000
Particle Phase Only High-Emitters**	40,000	8,400	20,600
Total w/ Particle Phase Only High-Emitters***	240,000	50,500	123,600

*60% of these gas phase high-emitters are estimated to be particle phase high-emitters.

**Combined non-visible particle phase high-emitters and smoking vehicles. This total equates to 40% of total particle phase high-emitters because 60% of particle phase high-emitters are included in the gas phase vehicle totals.

***If RSD4000 can identify PM or opacity.

High-Emitter Repair - 20% Remote Sensing Coverage

The results of a high-emitter identification component added to the Clean Screen Program at 20% remote sensing coverage that identifies gas phase high-emitters with two RSD measurements are estimated to be:

- Voluntary Program: 42,100 high-emitters identified. If 5% of the vehicle owners notified repair their vehicle an estimated 2,100 vehicles will be repaired.
- Mandatory Program: 42,100 high-emitters identified. Because of the potential for unresolved failures/program avoidance this total is adjusted downward by 23% for 32,400 high-emitters repaired.

The results of a high-emitter identification component added to the Clean Screen Program at 20% remote sensing coverage that identifies *both* gas and particle phase high-emitters with two RSD measurements are estimated to be:

- Voluntary Program: 50,500 high-emitters identified. If 5% of the vehicle owners notified repair their vehicle an estimated 2,500 vehicles will be repaired.
- Mandatory Program: 50,500 high-emitters identified. Because of the potential for unresolved failures/program avoidance this total is adjusted downward by 23% for 39,000 high-emitters repaired.

High-Emitter Repair - 60% Remote Sensing Coverage

The results of a high-emitter identification component added to the Clean Screen Program at 60% remote sensing coverage that identifies gas phase high-emitters with two RSD measurements are estimated to be:

- Voluntary Program: 103,000 high-emitters identified. If 5% of the vehicle owners notified repair their vehicle an estimated 5,150 vehicles will be repaired.
- Mandatory Program: 103,000 high-emitters identified. Because of the potential for unresolved failures/program avoidance this total is adjusted downward by 23% for 79,300 high-emitters repaired.

The results of a high-emitter identification component added to the Clean Screen Program at 60% remote sensing coverage that can identify *both* gas and particle phase high-emitters with two RSD measurements are estimated to be:

- Voluntary Program: 123,600 high-emitters identified. If 5% of the vehicle owners notified repair their vehicle an estimated 6,200 vehicles will be repaired.
- Mandatory Program: 123,600 high-emitters identified. Because of the potential for unresolved failures/program avoidance this total is adjusted downward by 23% for 95,200 high-emitters repaired.

Table VIII below shows the total number of gas and particle phase vehicles repaired under both the voluntary and mandatory programs at 20% and 60% remote sensing coverage. The first row shows the number of gas phase vehicles repaired. The second row shows the total number of gas phase high-emitters in addition to particle phase

high-emitters repaired if the RSD4000 can identify PM or opacity from the particle phase high-emitters.

Table VIII - Vehicles Repaired at 20% and 60% Clean Screen Coverage by Voluntary and Mandatory Program

RSD Identification Capability	20% Remote Sensing Coverage - Voluntary Program	60% Remote Sensing Coverage - Voluntary Program	20% Remote Sensing Coverage - Mandatory Program	60% Remote Sensing Coverage - Mandatory Program
Gas Phase Only	2,100	5,150	32,400	79,300
Both Gas and Particle Phase	2,500	6,200	39,000	95,200

Program Implementation Phase-In

Although approximately 10% of the Denver metro area vehicles have been identified as gas phase high-emitters in this report, the High-Emitter Identification Program should be phased in by targeting the highest emitting vehicles first. Repair facilities could be overwhelmed by up to 80,000 high-emitting vehicles coming in for repairs on an annual basis. In a high-emitter program of this size, cut points should be established that address the highest emitting vehicles first. According to Dr. Donald Stedman at the University of Denver, these vehicles should be above cut points >4% CO and/or >1000ppm HC. As the program matures, cut points could be lowered to address additional high-emitting vehicles.

Strategy Analysis - RSD4000 with High-Emitter Identification Program

Benefits

- Remote sensing is unintrusive.
- Remote sensing measures on-road operation while I/M240 is a simulation of road conditions.

- ESP indicates that RSD4000 enhances efficiency of remote sensing's measurements for multiple pollutants.
- Remote sensing can assist in detecting vehicles that may be avoiding the I/M Program.
- Infrastructure for either a voluntary or mandatory High-Emitter Identification Program using RSD4000 can be added to the Clean Screen Program.
- Voluntary program could result in 2,100 high-emitters repaired with 20% remote sensing coverage and 5,150 high-emitters repaired with 60% remote sensing coverage on an annual basis. Particle phase-only high-emitters are not included in this total.
- Mandatory program could result in 32,400 high-emitters repaired with 20% remote sensing coverage and 79,300 high-emitters repaired with 60% remote sensing coverage on an annual basis. Particle phase-only high-emitters are not included in this total.

Costs

- Costs to implement Department of Revenue and County Clerk automated system changes. Based on fiscal notes attached to previous legislation requiring automation changes the approximate first year start-up cost would be $50,000.
- Program cost of $150,000 per year. ESP estimates that adding RSD4000 will cost about $450,000 over three years, or an average of $150,000 annually. ESP indicates that this increased cost might be able to be covered within the current $25 per vehicle inspection fee because of cost savings resulting from remote sensing legislation passed by the Colorado General Assembly in the 2002 legislative session.
- Cost per repaired vehicle in a voluntary program is between $30 and $70 (based on annual cost of $150,000). Particle phase-only high-emitters are not included in this cost.
- Cost per repaired vehicle in a mandatory program is between $2 and $5 (based on annual cost of $150,000). Particle phase-only high-emitters are not included in this cost.

Program Disadvantages

- Uncertainty regarding RSD4000 effectiveness for identifying PM or opacity.
- Need for statutory changes for a mandatory program.
- Influx of vehicles needing repairs could overwhelm repair facilities in the Denver metro area.

5. STRATEGY COMPARISON

Table IX - Strategy Analysis Overview

Strategy	Recommendation	Program Advantages and Disadvantages	Estimated Program Cost	Estimated Number of Vehicles Repaired/Retired	Estimated Cost Per Vehicle
I/M Program with High-Emitter Enhancements	Not Recommended	• Established program • Focus on high-emitters • Particle phase vehicles difficult to ID • Program avoidance issues • Consumer pays	$153,000 + $50,000 first year start up cost	6,120	$25
Smoking Vehicle Hotline with Public Education and Reporting Enhancements	Not Recommended	• Ease of implementation • Educational benefit • Low voluntary compliance rate • Lack of data on program effectiveness	$43,000	120	$350
Region-Wide Trained Staff Smoking Vehicle Program	Not Recommended	• Possible fine revenue • Emphasis on vehicle repair • Limits false calls • Need to establish ordinances • Cost-effectiveness • Possible public resistance - intrusive	$242,000	450	$535

Region-Wide Smoking Vehicle Pullover Program	Recommended	• Possible fine revenue • Cost-effectiveness • Emphasis on vehicle repair • Limits false calls • Need to establish ordinances • Possible political/public resistance - intrusive.	$173,000	1,320	$130
RSD4000 High-Emitter Identification Program	Recommended	• Add-on to Clean Screen Program • Focuses on high-emitters • Number of vehicles identified • Catches multiple pollutants • On-road test vs. simulation • Identify program avoidance • RSD4000 technology not proven to identify PM/opacity • Possible statutory changes	$150,000 + $50,000 first year start up cost	Voluntary: 2,100 - 5,150* Mandatory: 32,400 - 79,300*	Voluntary: $30 to $70** Mandatory: $2 to $5**

*Not inclusive of particle phase high-emitters. If RSD4000 can identify particle phase high-emitters the number of vehicles repaired will increase and the cost per vehicle repaired will decrease.

**Based on a $150,000 annual cost.

6. WORK GROUP RECOMMENDATIONS

The consensus of the Work Group is that both a Smoking Vehicle Pullover Program and a mandatory Remote Sensing High-Emitter Identification and Enforcement Program should be implemented. The primary reason for this dual approach is that the RSD4000 is ready to identify gas phase high-emitters but not particle phase high-emitters. Smoking vehicles can only be identified with the human eye at the current time and the RAQC should work with local governments to utilize law enforcement resources to address this problem. By combining the Smoking Vehicle Pullover Program and the RSD4000 High-Emitter Identification and Enforcement Program, both smoking vehicles and gas phase high-emitters will be identified and repaired. This dual approach will allow greater benefits than either program by itself.

Another reason supporting this dual approach was that both programs independent of each other have limited program coverage. The RSD4000 has limited coverage due to the requirements to operate the technology (i.e., single lane of traffic). Also, the cost of the RSD4000 will limit the number of units deployed around the metro area. Therefore, RSD4000 should cover the main travel corridors to identify the maximum number of high-emitters. Region-wide coverage by law enforcement will capture smoking vehicles. Utilizing RSD4000 in conjunction with a Smoking Vehicle Pullover Program will increase the number of high-emitters identified and repaired.

A final reason supporting this dual approach is that many vehicles avoid the current I/M Program. Over 60% of vehicles reported to the Smoking Vehicle Hotline over one month should have shown an inspection history and did not (See Appendix B). A Smoking Vehicle Pullover Program may catch these vehicles. Another 23% of vehicles that failed their emissions test never returned to complete the inspection process. Although some of these vehicles are sold outside the program area or salvaged, some continue to operate in the program area. An RSD4000 High-Emitter Identification Program could identify these vehicles. These statistics make the case for greater on-road enforcement.

This costs to implement both programs will be approximately $325,000 (additional $50,000 in first year start-up costs) on an annual basis. Of this total, the cost to local governments for the Smoking Vehicle Pullover Program is estimated to be $133,000 annually and, as discussed in the program analysis, will be paid for by fine revenue. The remaining $40,000 of this program

are costs to the RAQC for the local government outreach effort. The RAQC will seek grant funding for this task.

The cost of the High-Emitter Identification and Enforcement Program is estimated at $150,000. An additional first year start-up cost of $50,000 is needed to make enhancements to the Department of Revenue's motor vehicle registration system to flag vehicles requiring confirmatory tests. Funding options are discussed under the program's implementation issues section below.

This combined program will repair or retire approximately 33,700 to 80,600 high-emitters annually depending on remote sensing coverage and the cut points used in the remote sensing program. The number of vehicles repaired or retired under this combined approach is based on an estimated 1,320 repaired or retired vehicles in the Smoking Vehicle Pullover Program. Under the RSD4000 High-Emitter Identification Program, an estimated 32,400 high-emitters will be repaired with 20% remote sensing coverage and 79,300 high-emitters will be repaired with 60% remote sensing coverage.

A. Region-Wide Smoking Vehicle Pullover

As developed by the Work Group participants, the Smoking Vehicle Pullover Program is a local government education campaign designed to educate law enforcement leadership about the problem and convince them to include smoking vehicle citations in traffic officers' moving violation citation statistics. The second component, after securing law enforcement buy-in, is to work with elected officials and city management staff to establish the necessary ordinances and systems to process offenders. The final component of the program is to train traffic officers so that they are able to identify and ticket visibly smoking vehicles. The local government education campaign and training component will concentrate first on local law enforcement and then on elected officials and city management (See Appendix E for list of local governments).

The local governments represented on the Work Group agree with this recommendation. However, they did indicate that law enforcement resources may be allocated towards homeland security issues. They asked that this recommendation include the flexibility to implement the Trained Staff Smoking Vehicle Program if law enforcement resources are unavailable. The Trained Staff Smoking Vehicle Program is

not as cost-effective as the Smoking Vehicle Pullover Program, but is a viable substitute with a solid track record in the City and County of Denver.

Implementation Issues

- Funding for a local government education campaign will be needed.
- A model ordinance will need to be developed, and local communities will need to adopt one if they do not have one.
- A local government staff person must be designated in each local community to inspect vehicles and determine if they are smoking.
- Fines and fees will need to be established to be used by local courts.
- Local communities will need to prepare their citizens for this through a public education campaign.
- Law enforcement resources potentially focusing on homeland security issues.

B. RSD4000 - High-Emitter Identification and Enforcement Program

In the January 2000 Carbon Monoxide State Implementation Plan, the RAQC and CDPHE recommended the implementation of a Clean Screen Program. This program allows cars that pass a remote sensing device, and are deemed to be clean, to skip their regular emissions test. Overall, a Clean Screen Program would make the inspection and maintenance of vehicles more effective, efficient, and consumer friendly. The General Assembly has enacted legislation authorizing a Clean Screen Program and CDPHE is currently in negotiations with Envirotest regarding Clean Screen implementation.

The Work Group considered the addition of a High-Emitter Identification and Enforcement Program as outlined in the August 2000 report to the Governor, *Options to Reform the Current Inspection/Maintenance Program*. The consensus was that the mandatory program defined in the report to the Governor was the most cost-effective option because a high-emitter component could be added to the Clean Screen Program with little additional cost and the number of vehicles repaired would be high.

The High-Emitter Identification and Enforcement Program raised a host of enforcement issues regarding what should be done with those vehicles that are found to be high-emitters through remote sensing. RAQC staff presented a range of enforcement measures that could be implemented. The Work Group indicated that immediate roadside pullover with a roadside dynamometer test was too intrusive. The Work Group believed a registration based enforcement mechanism, possibly augmented by a fine, would be the appropriate approach. The option reviewed by the Work Group was developed in the August 2000 report which recommends:

> *Once a vehicle has been identified as a high-emitter and the owner is notified, the owner should be required to present the vehicle for a confirmatory test within 30 days. If the vehicle fails the confirmatory test, the owner should be required to obtain necessary repairs to the vehicle and pass a retest of the vehicle within 30 days. In addition, the vehicle subsequently could be placed on a more frequent inspection cycle to ensure the repairs remain effective.*
>
> *If the vehicle fails to pass the confirmatory test or retest within the required time frames, enforcement options could include a fine, a suspension of the vehicle registration, revocation of license plates and/or a required emission test and fine at the time of registration renewal.*
>
> *High-emitting vehicles should be tested and repaired as soon as possible after remote sensing identification to achieve the emissions reduction available. For those motorists who ignore the requirement to get a confirmatory test and necessary repairs, an enforcement mechanism is necessary to encourage compliance. Ultimately, the non-complying vehicle owner should be required to pass an emissions test and pay a fine before the vehicle can be registered at its next scheduled renewal. In the meantime, the vehicle owner could also be fined and/or the vehicle registration could be suspended and license plates could be revoked and confiscated until the owner complies.*

In addition, the Work Group reviewed other recommendations made in the August 2000 report regarding a High-Emitter Program that included:

- *The high-emitter requirements should apply to all vehicles identified routinely operating in the metro area regardless of model year exemption, collector status, Colorado county of registration, or any other prior exemption.*
- *Data from the RSD and I/M 240 program should be collected and analyzed to provide documentation on the effectiveness of the high - emitter program.*

Implementation Issues

In order to implement the High-Emitter Identification and Enforcement Program outlined above, the Clean Screen Program must be in place. Additionally, the General Assembly will need to consider legislation that will authorize a High-Emitter Identification and Enforcement Program that includes appropriate enforcement and compliance mechanisms. There will need to be a statutory change to require vehicles identified as high-emitters to pass a confirmatory test before renewing their registration. Enhancements will also be needed in the motor vehicle registration system to flag vehicles requiring confirmatory tests and annual registrations. This enhancement will have a fiscal impact on the Colorado Department of Revenue.

A funding mechanism will also need to be developed for the program. Options include requiring motorists who are identified as high-emitters to pay the additional testing and administrative fees, or spreading the incremental costs among all motorists as part of the testing fee negotiated under the emissions testing contract. These funding decisions will need to be made by the General Assembly as part of authorizing legislation.

APPENDICES

Appendix A - Smoking Vehicle Contribution to $PM_{2.5}$

1995 ESTIMATED PM2.5 EMISSIONS - GASOLINE POWERED ON-ROAD VEHICLES
Using BCA Methodology, DRCOG Travel Data, State Fuel Sales & NFRAQS Emissions Factor Data

MODEL YEAR GAS VH	DRCOG 1995 VMT/D	GAS VH % VMT	DRCOG % Miles/MY	MODEL YR VMT/Day	NFRAQS mg PM/Mile	PM grams/day	NFRAQS %PM2.5/PM	PM2.5 grams/day	PM2.5 tpd
pre 80	50,734,000	94.6%	4.8%	2,303,729	82.60	190,288	91%	173,162	0.19
81-85	50,734,000	94.6%	17.4%	8,346,491	48.20	402,301	91%	366,094	0.40
Smoker	50,734,000	94.6%	1.0%	489,000	434.00	212,226	98%	207,981	**0.23**
86-90	50,734,000	94.6%	17.4%	8,346,491	28.50	237,875	91%	216,466	0.24
91+	50,734,000	94.6%	59.4%	28,508,652	24.90	709,865	91%	645,978	0.71
TOTAL			100%	**47,994,364**				**1,609,681**	**1.77**

NOTES:

NFRAQS indicates that approximately 1% of the Denver metro fleet are smoking gasoline-powered vehicles.

DRCOG Report -Travel Behavior Inventory, Tables 63 & 64, indicates % VMT and VMT/vehicle for MY decades 1950's through 1990's

DRCOG Report -Travel In the Denver Region, Figure 12, indicates approximately 50.7 million VMT and 1.5 million vehicles in 1995

Smoker Miles per day were estimated as follows:

- ((1,500,000 vehicles in 1995)*(1%))*((32.6 miles per day per vehicle for 1981-90 vehicles)) = 489,000 miles/day
- Smoker miles per day were subtracted from the 1980's MY category, because the NFRAQS recruited smokers were all of that MY category
- 1980's MY VMT ((50,734,000)*(94.6%))*(35.8%)= 17,181,982
- Smoker = 489,000
- Remaining 1980's VMT = 17,181,982 - 489,000 = 16,692,982
- The remaining 1980's VMT is split between the 1981-85 and 1986-90 MY categories.

Appendix B - CDPHE Analysis of Smoking Vehicles and Inspection Histories

- Hotline complaint listing for April 2002 containing gasoline and diesel fueled vehicles, the county of registration unknown...484 vehicle complaints. Vehicle license plate information was applied to the Colorado Registration Information System.

- Total number of vehicles matched to registration records, which indicated gasoline as the fuel type and eligibility for period emissions inspection....224 individual vehicle registrations.

- Total number of inspection records associated with the 224 vehicle registrations.....200 inspection records.

  Note:
  - The inspection record data base represented inspection histories since 1995.
  - A registration record for an eligible vehicle should result in one or more inspection records.

- Of the 200 inspection records identified, 26 indicated an overall failing status; therefore, 174 indicated an overall pass status.
- Of the 200 inspection records identified, two failed for smoke; therefore, 198 did not fail for smoke.
- The total number of inspection records for the 224 matched vehicle registration records is 200 inspections. These 200 inspections represent 83 vehicles.
- Of these 83 vehicles, one vehicle failed for smoke. This same vehicle failed for smoke twice, hence the two inspection records for smoke previously noted.
- Of the original 224 individual vehicle registrations matched to the complaint listing indicating I/M program eligibility, 141 vehicles had no inspection history.

Note: All data searches were based on individual vehicle license plate information as reported. License plate information has historically proven to be somewhat unreliable in that license plates do not always represent a unique vehicle. Additionally, license plate information is hand entered by inspectors at the time of inspection and is therefore subject to some level of error.

Appendix C - Cost Information On Public Information Campaigns

Implementation of a successful public relations campaign is critical to the success of the smoking vehicle enforcement programs detailed above. In this section, four successful public relations campaigns are used to illustrate different approaches and their associated costs. The four programs are the RAQC's Voluntary Ozone Reduction Program, DRCOG's VanPool Program, DRCOG's Telework Program, and the CDPHE's High Pollution Advisory Program.

The first of these is the RAQC's 2001 Voluntary Ozone Reduction Program. Overall costs for this program were $80,000 for the RAQC, DRCOG, and CDPHE. This program is considered the most extensive effort among our examples. Included in this effort was:

- Staff time to do outreach efforts, staff booths at special events, presentations to several organizations, placing articles in newsletters, RAQC web site updates, contacting media outlets, businesses, and citizens;
- Public relations materials that included press releases, flyers, brochures, and magnets; and
- A four week advertising campaign with KOA radio and advertisements on RTD buses.

The second example is DRCOG's VanPool Program. This campaign is an example of another extensive campaign that cost $60,000. DRCOG used many different approaches to advertise such as:

- Public relations materials that included press releases to all local newspapers;
- A mailer sent to all companies in the southeast corridor;
- VanPool advertising included on the back of a mailer distributed to the entire metro area. The next month an insert was mailed to select areas in the southeast;
- Several articles in the quarterly RideArrangers Newsletter;
- Advertising in the Denver Business Journal, Office Park news, and a six-week campaign with KHOW-AM, KJCD-FM, KOA-AM, KTLK-AM, and KXKL-FM radio stations; and
- Several permanent highway signs with VanPool information were placed near exits along I-25 and US 36.

The DRCOG Telework Colorado Program is an example of a successful, lower-cost campaign. The effort cost $22,000 and consisted of:

- Public relations materials that included press releases to all local newspapers;
- A six-week advertising campaign in the Front Range Tech Biz and the Denver Business Journal;
- An article in the quarterly RideArrangers Newsletter; and
- A four week advertising campaign on KOA radio.

The last public relations campaign is the CDPHE High Pollution Advisory Program. This campaign was established in the mid-1980s and has been incredibly successful. Public relations costs have dropped since the inception of the program because it has become so ingrained in people's lives. The cost for this program is approximately $5,000 and includes:

- Staff time;
- A media kick-off event at the beginning of high pollution season; and
- A media kit provided to all media outlets.

Appendix D - Trained Staff Contacts and Costs by Community

Counties & Municipalities	Population 4/1/2002	Trained Staff per Community	Contacts per Community	Total Cost per Community
ADAMS COUNTY	387,667			
Brighton	22,585	6	22	$2,629
Commerce City	22,036	6	21	$2,566
Federal Heights	12,698	3	12	$1,478
Northglenn	32,529	9	31	$3,787
Thornton	89,312	23	86	$8,913
Unincorp. Area	81,924	21	79	$8,176
ARAPAHOE COUNTY	509,973			
Centennial				
Cherry Hills Village	6,112	2	6	$712
Englewood	32,217	8	31	$3,751
Glendale	5,145	1	5	$599
Greenwood Village	11,892	3	11	$1,385
Littleton	41,814	11	40	$4,173
Sheridan	5,734	1	6	$668
Unincorp. Area	158,884	42	152	$15,856
BOULDER COUNTY	306,632			
Boulder	96,710	25	93	$9,651
Erie	8,680	2	8	$1,011
Lafayette	25,409	7	24	$2,958
Longmont	75,686	20	73	$7,553
Louisville	20,624	5	20	$2,401
Lyons	1,668	0	2	$194
Nederland	1,462	0	1	$170
Superior	18,383	5	18	$2,140
Unincorp. Area	46,032	12	44	$4,594
BROOMFIELD COUNTY				
Broomfield	41,794	11	40	$4,171
DOUGLAS COUNTY	217,616			
Castle Rock	23,936	6	23	$2,787
Lone Tree	4,873	1	5	$567
Parker	31,569	8	30	$3,675
Unincorp. Area	155,404	41	149	$15,508
JEFFERSON COUNTY	546,845			
Arvada	104,950	27	101	$10,473
Edgewater	5,629	1	5	$655
Golden	18,102	5	17	$2,107
Lakewood	147,956	39	142	$14,765
Morrison	423	0	0	$49
Wheat Ridge	33,661	9	32	$3,919
Unincorp. Area	190,826	50	183	$19,043
MULTI-COUNTY				
Aurora	288,745	75	277	$28,815
Westminster	107,233	28	103	$10,701
TOTALS		**516**	**1,892**	**$202,601**

Appendix E - Smoking Vehicle Roadside Pullover Tickets and Costs by Community

Counties & Municipalities	Population 4/1/2002	Officers per Community	Traffic Officers	Summonses per Community	Total Cost per Community
ADAMS COUNTY	387,667	281	21	85	$4,815
Brighton	22,585	40	26	78	$5,167
Commerce City	22,036	45	29	88	$5,813
Federal Heights	12,698	22	14	43	$2,842
Northglenn	32,529	57	6	20	$1,321
Thornton	89,312	112	8	34	$1,919
Unincorp. Area	81,924				
ARAPAHOE COUNTY	509,973	374	28	113	$6,408
Centennial					
Cherry Hills Village	6,112	20	13	52	$3,444
Englewood	32,217	84	8	29	$1,947
Glendale	5,145	28	18	55	$3,617
Greenwood Village	11,892	60	6	21	$1,391
Littleton	41,814	66	7	23	$1,312
Sheridan	5,734	21	14	41	$2,713
Unincorp. Area	158,884				
BOULDER COUNTY	306,632	160	12	48	$2,741
Boulder	96,710	161	12	49	$2,759
Erie	8,680	14	9	27	$1,808
Lafayette	25,409	35	23	68	$4,521
Longmont	75,686	106	8	32	$1,816
Louisville	20,624	33	21	64	$4,263
Lyons	1,668				
Nederland	1,462	5	4	6	$373
Superior	18,383				
Unincorp. Area	46,032				
BROOMFIELD COUNTY					
Broomfield	41,794	86	9	30	$1,709
DENVER COUNTY	573,880				
Denver	573,880	1,468	111	443	$25,153
DOUGLAS COUNTY	217,616	200	15	60	$3,427
Castle Rock	23,936	31	20	60	$4,004
Lone Tree	4,873				
Parker	31,569	36	23	70	$4,650
Unincorp. Area	155,404				
JEFFERSON COUNTY	546,845	403	30	122	$6,905
Arvada	104,950	135	10	41	$2,313
Edgewater	5,629	17	11	33	$2,196
Golden	18,102	35	23	68	$4,521
Lakewood	147,956	228	17	69	$3,907
Morrison	423	1	1	1	$75
Wheat Ridge	33,661	58	6	20	$1,345
Unincorp. Area	190,826				
MULTI-COUNTY					
Aurora	288,745	538	41	162	$9,218
Westminster	107,233	146	11	44	$2,502
TOTALS		**5,106**	**616**	**2,200**	**$132,911**