ON-ROAD EMISSIONS TESTING PROGRAM STATUS

A REPORT TO VIRGINIA GENERAL ASSEMBLY

Prepared in response to 2006 House Joint Resolution 208 by the Virginia Department of Environmental Quality

December 2006

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REPORT TO VIRGINIA GENERAL ASSEMBLY

Executive Summary

2006 House Joint Resolution 208 provides "That the Department of Environmental Quality be requested to consult with the Environmental Protection Agency to identify and implement ways to increase the use of on-road remote sensing of vehicle emissions. The Department of Environmental Quality, in consultation with the Environmental Protection Agency, is further requested to identify gross polluters and increase the percentage of vehicles that may be prescreened using on-road remote sensing of vehicle emissions in the Northern Virginia nonattainment area and include information on associated costs and air quality benefits and impacts." It also directs the Department of Environmental Quality (DEQ) to report to the General Assembly their progress with meeting the requests identified in the resolution to the 2007 and 2008 General Assemblies.

In August 2006, DEQ implemented the high emitter identification program and has notified 43 owners of vehicles that their vehicle had been observed as having emissions higher than specified standards. The owners of these vehicles are asked to receive a verification emissions test and make necessary repairs. In October 2006 DEQ began issuing notices to vehicles that met clean screen criteria. As of October 2006, DEQ had issued 34 clean screen notices. Vehicles that receive clean screen notices are viewed as having a passing emission test and not required to receive an emission test in the near future.

DEQ currently does not receive credit for conducting the on-road emissions testing program in its State Implementation Plan and is working with EPA to identify ways to obtain credit for emission reductions achieved through the on-road emission testing program. DEQ will also contact other states conducting on-road emissions testing to identify partnerships that may be established to pursue receiving additional credits for on-road testing programs from EPA.

A follow-up report will be provided to the 2008 General Assembly that provides an update on the agency's progress with implementing the on-road emissions testing program and will identify opportunities for increasing the use of on-road emission testing to clean screen vehicles.

ON-ROAD EMISSIONS TESTING PROGRAM STATUS

REPORT TO VIRGINIA GENERAL ASSEMBLY

2006 HOUSE JOINT RESOLUTION NO. 208 provides:

"That the Department of Environmental Quality be requested to consult with the Environmental Protection Agency to identify and implement ways to increase the use of on-road remote sensing of vehicle emissions. The Department of Environmental Quality, in consultation with the Environmental Protection Agency, is further requested to identify gross polluters and increase the percentage of vehicles that may be prescreened using on-road remote sensing of vehicle emissions in the Northern Virginia nonattainment area and include information on associated costs and air quality benefits and impacts."

"The Department of Environmental Quality shall submit to the Division of Legislative Automated Systems an executive summary and report of its progress in meeting the requests of this resolution no later than the first day of the 2007 and 2008 Regular Sessions of the General Assembly. The executive summaries and reports shall be submitted for publication as report documents as provided in the procedures of the Division of Legislative Automated Systems for the processing of legislative documents and reports and shall be posted on the General Assembly's website."

Note: DEQ is using the term "On-Road Emissions (ORE) testing for the program in place in Virginia. The term "Remote Sensing Device (RSD) has been used in the literature and by some other states to describe similar programs. This report uses the term remote sensing or RSD in reference to the process or to the remote sensing equipment itself.

Background

Federal Requirements

The 1990 Federal Clean Air Act Amendments require that Inspection and Maintenance (I/M) Programs be implemented in urbanized areas exceeding the National Ambient Air Quality Standards for ozone and/or carbon monoxide (CO). The Federal Clean Air Act requires implementation of an enhanced I/M Program in the census-defined Washington DC Metropolitan Statistical Area. In Virginia, this area includes the cities of Alexandria, Fairfax, Falls Church, Manassas, and Manassas Park, and the counties of Arlington, Fairfax, Prince William, Loudoun, and Stafford. Federal regulations also require that a nominal 0.5% of the vehicles subject to I/M program also be subject to "on-road testing." Per EPA, "On-road testing is to be part of the emissions testing program, but is to be a compliment to testing otherwise required." (40 CFR 51.371).

Biennial Emissions Inspection Program

DEQ currently operates a decentralized enhanced I/M program in the Northern Virginia area consisting of approximately 455 independently owned inspection stations. All gasoline fueled vehicles less than 25 years old and up to 10,000 pounds gross vehicle weight rating (GVWR) are required to pass an emissions test or receive a waiver biennially before their motor vehicle license plates can be renewed. Currently, vehicles of model year 1996 and newer, and up to 8,500 lbs. GVWR are required to receive the on board diagnostic (OBD) test. Vehicles over 8500 lbs. GVWR may receive an OBD test if they are so equipped. Older vehicles, currently 1982 through 1995, receive a two-mode Acceleration Simulation Mode (ASM-2) test if they are able to be tested on a single axle dynamometer. Other vehicles receive a two-speed idle (TSI) test. In addition, all vehicles must pass a gas cap pressure test, a visual inspection of applicable emissions control equipment components, and a pre- and post-inspection check for visible emissions.

On-road Emissions Testing in Other Areas

Although several states are doing a nominal amount of on-road emissions testing to satisfy the EPA requirement of monitoring 0.5% of the fleet, only three other states have large scale programs. Texas has operated a high emitter identification and repair program similar to Virginia's since 1999. Missouri has operated a clean screen only program since 1999, as has Colorado since 2004. California's South Coast Air Quality Management District has recently started an 18-month pilot high emitter identification pilot project. In other countries, Cuidad Juarez in Mexico has been using on-road emission testing off and on since the late 1990s to issue high emitter fines. Korea, Taiwan, India, Japan, China, New Zealand, UK, Austria, and Sweden are countries that are working on or have recently completed pilot projects and studies utilizing remote sensing technology.

In addition, recent studies in Nogales AZ and Boston MA indicate that remote sensing devices can be used to identify high emitting heavy duty diesel vehicles.

VA On-Road Emissions Testing to Date

In 2004, DEQ contracted with Environmental Systems Products, Inc. (ESP) to collect emissions data using the RSD-4000 and later the RSD-4600 remote sensing devices (See Appendix A) in the Northern Virginia I/M program area and in certain non-I/M areas. On-road emissions testing is used to enhance the effectiveness of the existing I/M program as follows:

- Identify high emitting vehicles within the I/M area that may have received inadequate repairs or undergone catastrophic emission control system failures, thus requiring repairs in between normal inspection cycles. This process is know as high emitter identification.
- Identify high emitting vehicles that are registered in Virginia, but outside the Northern Virginia I/M area and that operate primarily within the

program area. These vehicles must be brought into compliance with I/M standards.

- Identify very clean vehicles within the I/M area that have much lower than average emissions, potentially postponing their next regularly scheduled biennial emissions inspection test. This process is referred to as "clean screening."
- Identify vehicles that are registered outside Virginia, but operate primarily within the program area and are high emitters. These vehicles will be referred to authorities in the states in which they are registered concerning compliance with I/M standards.
- Evaluate fleet emissions trends and I/M program effectiveness. This entails collecting "no-I/M" baseline emissions data in the non-I/M areas of Richmond and Tidewater Virginia. Emissions trends can be analyzed by comparing test results collected with results recorded in "Virginia Remote Sensing Device Study – Final Report" (February 2003).

2005 On-Road Emissions Testing Results

To support the accomplishment of these program goals, ESP collected emissions data in the Northern Virginia I/M Program area starting in November of 2004. ESP also sampled in the Richmond and Tidewater areas for the purpose of establishing a no-I/M baseline emissions profile. Results for the first full calendar year of operation, 2005, were compiled and analyzed.

Following are the key conclusions drawn from this analysis:

- The program met its data collection goals. Over 1.5 million measurements were attempted and over one-half million unique vehicles were measured during the year (See Appendix B). Valid RSD measurements were made on 19% of the Northern Virginia I/M fleet.
- Vehicles registered in Virginia's I/M areas had significantly lower HC, CO, NO and particulate emissions than vehicles registered in Virginia's non-I/M areas.
- The introduction of OBD vehicle design requirements (generally model years 1996 and newer) has resulted in significantly lower emissions, especially in HC, CO and particulates.
- The vehicle fleet in the I/M area is newer than the fleet in the non-I/M area.
- On-road emissions data could be used together with tailpipe emissions testing results to determine appropriate on-road testing standards.

Appendix C shows the observation sites used during 2005 and Appendix D gives overall observation statistics.

High Emitter Identification

Identifying High Emitters

DEQ began implementation of the high emitter identification program on August 1, 2006. According to DEQ regulations vehicles can be identified as high emitters in two ways: 1) two hit scenario, where a vehicle is observed as a high emitter twice within 120 days, and 2) one hit scenario, where a vehicle is identified as a high emitter once and has also been identified as having a high probability of being a high emitter based on emissions test history of its particular make and model, or high emitter index (HEI). The high emitter index is calculated quarterly by DEQ based on the previous year of emissions test data.

High Emitter Standards

An important factor in a high emitter identification program is minimizing the number of vehicles that are identified as high emitters by on-road emissions testing, but which pass the confirmation test. On-road emissions standards that are too stringent could cause vehicles that do not need repairs to be identified as high emitters. At the same time, on-road emissions standards that are too lenient will not identify many truly high emitting vehicles. To minimize the number of "false positives" while not unduly reducing the high emitter identification rate, DEQ has taken two approaches, 1) selection of on-road emissions standards that are comparable to the I/M test tailpipe standards, and 2) review of individual vehicle biennial emissions test history.

With respect to on-road emissions standards, DEQ's contractor analyzed past on-road emissions data and compared them to biennial I/M test results. This information was used to determine the on-road emissions standards for each of the emissions gases (HC, CO, and NOx) which would minimize the number of confirmation test initial passes, while maximizing the high emitter identification rate. Setting the on-road emissions standards as a linear function of the tailpipe test standards was determined to be better than using a single standard for all vehicle sizes, as had been done in some other state programs. (Tailpipe test standards are a function of vehicle type, model year and either vehicle weight or engine size.) Using these new on-road emissions standards, DEQ expects to attain a lower percentage of initial confirmation test passes relative to results in other studies. Nonetheless, a certain number of initial confirmation test passes or "errors of commission" will always occur due to tailpipe test variability, on-road emission measurement variability (background interference and emissions/speed- acceleration synchronization), vehicle drive mode variability, and vehicle emission control variability.

With respect to individual vehicle biennial emissions test history, DEQ is carefully comparing past emissions test results with the on-road emissions measurements for potential high emitters in order to weed out likely "false positives." For example, one vehicle with a clean I/M program emissions test history was determined to be garaged within one half mile of the remote sensing

device at which it was observed as a high emitter. The high on-road emissions measurements were determined to be consistent with cold startup conditions, and the high emitter notification was nullified. DEQ hopes to be able to automate some of these kinds of determinations as more data become available.

Notifying High Emitters

Vehicles identified as potential high emitters are sent a notice of violation advising them to obtain a confirmation test at a regular emissions inspection station and get repairs if needed within 30 days. If the vehicle passes the initial confirmation test, no test fee is charged. If the vehicle fails the confirmation test the owner is required to get the necessary repairs and have the vehicle re-inspected. If the vehicle does not ultimately receive a pass or a waiver (based on repair costs) the owner is subject to a fine, depending on the severity of the violation, of up to the minimum waiver expenditure (currently $680).

Initial High Emitter Identification Results

Since August 1 the on-road emissions testing has identified 43 vehicles as high emitters and sent notices to the owners as of October 20. Of these, 22 vehicles had received a confirmation test (including one regular emissions test). Of these 22, 10 vehicles passed the initial test and 12 failed. It is not known how many of the passing vehicles received repairs prior to the confirmation test, but at least two received extensive repairs. In 3 cases the NOVs were returned as "address unknown, no forwarding address" and in 3 cases (including one confirmation test fail) DEQ was notified by the owner that the vehicle was no longer registered or operated in Virginia. Seven vehicles were "past due" (over 30 days since the NOV was sent) and final notices have been sent to the owners. The remaining vehicles had not yet responded but were not yet overdue.

Clean Screening

Identifying Clean Screen Vehicles

The clean screen component of on-road emissions testing provides for issuing an emissions test Pass to a limited number of vehicles observed by remote sensing as being very clean. Per DEQ regulations, DEQ determines the maximum number of clean screen passes based on 5% of the number of on-road observations the previous month. Also, to limit the loss of emissions reduction "credit" received by the emissions inspection program as a whole, DEQ limits the clean screen passes to the number of high emitter NOVs issued the previous month. A vehicle must be observed as very clean multiple times with no readings over the high emitter standards during a given time period to be considered under the clean screen provisions of the program.

Currently, vehicles that would receive the on board diagnostic (OBD) biennial emissions test are not eligible for clean screen. This is because the OBD system (required for light duty gasoline powered vehicles 1996 and newer, and light duty diesel vehicles 1997 and newer) is designed to detect vehicle emission control

component problems before they necessarily become tailpipe emissions problems. Also, the OBD system checks emissions that are not necessarily measured by the DEQ biennial tailpipe test, such as cold start and certain evaporative emission problems. Thus, a vehicle could have an OBD system fault and still have clean tailpipe emissions. DEQ is concerned that issuing a clean screen pass to a vehicle which had an OBD fault indicated by an illuminated malfunction indicator (MIL) light could not only result in increased emissions, but could jeopardize the credibility of the clean screen program. DEQ intends to work with EPA and other states to determine how OBD vehicles could be reliably clean screened without adversely affecting the program integrity or program emission reductions.

Initial Clean Screen Identification Results

DEQ began implementation of the clean screen component of on-road emissions testing based on observations in September of 2006. Based on the above criteria, 34 clean screen notices were issued in October of 2006. (Note: Because a full month's of observations must be compiled before the clean screen passes are determined for a given month, a determination for each month cannot be made until the following month.) For these 34 vehicles, DMV has logged a Pass in their emissions status record as of the date of last qualifying clean observation.

Clean Screening in Other States

The Missouri "Gateway Clean Air Program" has utilized a "rapid screen" component of its centralized emissions inspection program since 1999 as a way to reduce the wait time at its centralized emission inspection stations. Owners that receive a rapid screen notice can avoid going to their next inspection test if they pay the normal test fee of $24 to the centralized contractor. The centralized contractor runs both the emissions testing stations and the rapid screen remote sensing equipment. Missouri rapid screens approximately 15% of the fleet subject to I/M. Missouri has determined that approximately 5% of the tailpipe test emissions reduction benefits for HC and CO, and 3% for NOx, are lost due to the rapid screen program. They have not yet calculated the effective loss for OBD testing. Missouri is converting to a decentralized program in Fall of 2007 and does not plan to continue with the rapid screen component due to the incompatibility of rapid screen and OBD results as well as the effect of reducing the testing volume at the new decentralized stations.

Colorado Department of Public Health and Environment (DPHE) added a clean screen component to it's I/M program in late 2004. As with Missouri, Colorado has centralized, contractor-run I/M inspection stations and, similarly, clean screen candidates must pay the full test fee of $25 to receive a clean screen pass. DPHE has found that only 6% to 8% of the subject I/M fleet are eligible for clean screen. They estimate that they loose approximately one ton per day out of 89 tons per day in HC emissions reductions as a result of the clean screen component. Colorado does not need NOx reductions to achieve its air quality goals.

Repair Assistance

DEQ has allocated $300,000 per year to fund a repair assistance component of the ORE program. Owners of vehicles that are identified as high emitters by ORE testing can receive financial assistance to help cover the cost of emissions related repairs if the owners meet certain low income criteria. So far DEQ has received no written requests for financial assistance.

Owners have 60 days from the date of the confirmation test pass or waiver to submit a financial assistance request form. An owner must have a valid driver's license, a current registration for the vehicle and a current safety inspection. Vehicles that are deemed to be commercial are not eligible for financial assistance.

With the submission of the assistance form, the owner must also supply all relevant documents supporting emissions related repairs for the vehicle. The owner may submit any confirmable amount of repairs for consideration, but the maximum benefit received will only be half the minimum waiver expenditure. An applicant must have an annual family household income of 133% or less of the current years Federal Poverty Guidelines amounts.

Determining "Disappeared Vehicle" Status

The EPA Office of Inspector General recently finalized an audit of several state I/M programs including Virginia. (http://www.epa.gov/oig/reports/2007/20061005-2007-P-00001.pdf) As part of this report, EPA analyzed DEQ I/M program data for calendar year 2004. A primary concern of this report was the number of "disappeared vehicles" or vehicles which had received an emissions inspection fail, but with no subsequent pass or waiver. EPA was concerned that these vehicles may be circumventing the program, which could affect the "compliance rate" used in determining emission reduction credits. DEQ was able to use remote sensing observation data, along with data from DMV and Carfax, to demonstrate that few of these vehicles were actually being driven in the I/M area. Of the 7014 vehicles identified by EPA as "disappeared vehicles" remote sensing data was able to determine that only about 2% were operating in the I/M area for more than one year.

Discussions with EPA

DEQ has evaluated the emissions reduction credits attributable to on-road emissions testing high emitter identification using the available EPA emissions models. The results have been disappointing. Consequently, DEQ is not taking credit for the on-road emissions testing program in its State Implementation Plan; rather, ORE is listed as a voluntary measure. DEQ believes that the current EPA models greatly underestimate the actual benefits of the high emitter identification program as implemented in VA. There are several reasons for this.

The current EPA model is based on assigning annual test emissions inspection program benefits to the portion of the fleet observed by remote sensing, and assigning biennial program benefits to the portion not observed by remote sensing. However, there is evidence that the additional emission reductions attributed to an annual emission inspection program as compared to a biennial program is understated because vehicles appear to deteriorate more in the first year after repairs rather than linearly over two years. DEQ believes this difference could be substantial. Also, the EPA model is based on assigning fixed on-road emissions standards to all vehicles based solely on model year and vehicle type. DEQ has developed a system of on-road emissions standards that better takes into account actual on-road emissions. DEQ met with an EPA staff person on September 27, 2006 to discuss these issues. DEQ plans to continue to work with EPA to develop methods to demonstrate the increased emission reductions resulting from these standards.

The state of Texas likewise is not taking credit for its on-road emissions testing program. Because Texas has an annual I/M program, the current EPA model will not even give an evaluation result of their program. Texas is having an independent assessment done of their program, which should be available in January of 2007. Based on the results of this assessment, and the Texas Legislature's comments following the report, the Texas Commission on Environmental Quality (TCEQ) may be interested in pursuing additional credits from EPA along with DEQ.

In addition to the above differences in modeling methodology, there are definite on-road emissions testing benefits that are outside of the EPA modeling domain. For example, DEQ has already used on-road emissions (ORE) results to identify fraudulent emissions inspections. ORE evidence was presented to one inspector who admitted "clean piping" or using the emission results of a different vehicle to obtain a pass. It is expected that once other inspectors learn of this, the frequency of such occurrences will diminish. Associated with this benefit is the benefit of the deterrent effect on faulty or incomplete repairs. Repair technicians would be more likely to attempt better and longer lasting repairs, rather than just enough to pass the emissions inspection, knowing that they would have an unhappy customer if their vehicle were to be identified as a high emitter. Overall, DEQ believes these deterrent effect benefits could be considerable. DEQ plans to work with EPA to develop methods to quantify benefits such as these.

Based on discussions with EPA staff and Texas TCEQ it is expected that EPA will require after the fact program data to verify any increased emissions reductions credit. Thus, final increased credit approval from EPA will be dependent on accumulating at least a year of program data, after quantifying actual vehicles identified and reduced emissions realized from repaired vehicles. DEQ has contacted EPA about meeting to determine the protocol for such an analysis to ensure that all the required parameters are collected.

DEQ staff is participating in an EPA Federal Advisory Committee Act (FACA) committee charged with developing a strategy for states and EPA to use in transitioning I/M programs from tailpipe-testing systems to OBD-testing systems. A final report is due from the committee in July of 2007, with ongoing work as needed until August 2008. DEQ will urge this committee to consider the role of remote sensing in future I/M program design.

ORE Issues Identified

Increasing High Emitter Identification

In over two months of operation the ORE high emitter identification program has identified only 43 vehicles out of a total of 53,379 unique vehicle observations in August and September (including non-I/M areas). This low identification rate (0.08%) is much less than the 2 percent fail rate that was originally anticipated. However, it is actually somewhat greater than the identification rate of 0.05% experienced thus far for 2006 in Texas. DEQ believes that it is necessary to increase the number of high emitting vehicles identified.

Increasing the number of high emitters identified can be accomplished two ways: increasing the remote sensing van days and better use of the current van coverage. Increasing the number of van days would require an increase in contract dollar expenditure. Although Colorado and Missouri fund their remote sensing programs at least partially by means of fees that are paid for clean screen passes in lieu of receiving an emissions test, this option is not possible under current Virginia Code.

However, the high emitter identification rate could be increased by altering the choice of RSD van sites. For example, currently most sites utilize freeway on- and off-ramps. Recent studies indicate that vehicles using these highways tend to be cleaner than vehicles using predominately "surface roads." There are two issues with accomplishing this, however. The northern Virginia area does not have many single lane roadways, which are best for remote sensing equipment placement. Also, DEQ's contract with ESP is based on paying by unique vehicle observed. Thus ESP has a financial incentive to use high volume sites, as opposed to high emitter sites. DEQ may have to revise its contract terms with ESP in order to more effectively identify high emitting vehicles.

Increasing Clean Screening

The number of clean screen passes issued is currently limited to the number of high emitters identified so as not to loose any emissions reduction credit. Thus, increasing the number of high emitters identified would allow a commensurate increase in the number of clean screen passes issued. Also, increasing the emissions reduction credit attributable to the high emitters identified and repaired could allow an associated increase in clean screen passes, if consistent with the overall emissions reduction needs of northern Virginia air quality plan.

RSD Technical Advances to Increase the Number and Quality of Observations:
Requiring a manned remote sensing van unit to obtain ORE data has proven to be a large expense. Unmanned remote sensing units have been under development for several years, and DEQ had originally hoped to be able to incorporate them into the ORE program. To date no such unmanned device is in production. However, ESP is expecting to complete development in 2008 on a new remote sensing unit, the RSD-5000 platform, which promises to allow for wireless, remote monitoring of vehicles. It will also allow for greater use of remote sensing technology in limited roadway spaces. Both these improvements would greatly enhance the ORE program in northern Virginia.

DEQ believes that improvements in remote sensing equipment accuracy will enable fine tuning of the ORE program standards, thus increasing the both number of total observations as well as the percentage of high emitters identified. Two existing sources of error in remote sensing measurements are background interference and time alignment between the speed/acceleration and emissions measurements. The RSD-4600 remote sensing unit which ESP provided to DEQ in spring of 2006 has allowed better calibration procedures, which has improved data quality with respect to background interference. However, the speed/acceleration to emissions measurement issue is more complicated. It involves determining the load on the engine (i.e., the speed/acceleration readings) at the exact moment the emissions that are to be sampled were generated. One way to do this is to use two speed/acceleration bars. The RSD-4600 unit has this capability but the software to perform the calculations has not been finalized.

Study to Determine ORE Cost Effectiveness

DEQ intends to solicit proposals to evaluate the ORE program after discussions with EPA provide a better definition of the scope of the evaluation required. The evaluation will take into account the emissions reductions outlined in the previous section as well as the emissions disadvantages from the clean screen program. It is expected that a full year of ORE testing data will be needed to adequately determine the potential emissions reduction benefits.

Unlike the benefits, the costs of running the program are better defined. The costs thus far can be broken down into one time startup costs, including making changes to the Vehicle Inspection Database (VID), and ongoing operation costs. The ongoing operation costs could increase slightly due to changes in van siting requirements, as discussed above. They could also decrease substantially if unmanned remote sensing units become a reality. Costs associated with the ORE program are summarized below:

Startup
VID system development $ 287,772.50 one time

ORE data to July 2006	$ 706,000.00	one time
Evaluation contract	TBD	one time
Ongoing		
Dedicated Staff	$ 70,000.00	annual
ORE data	$ 300,000.00	annual
Repair assistance	$ 300,000.00	annual

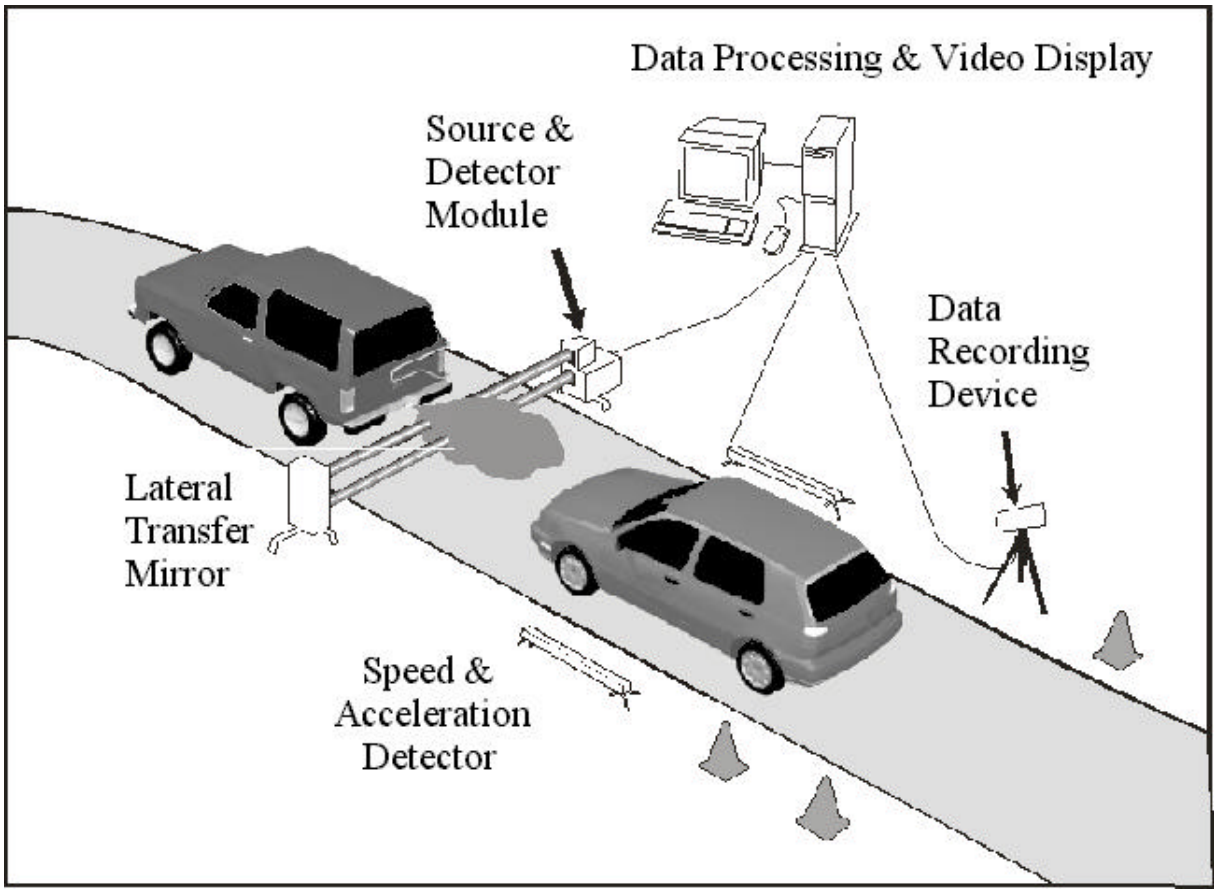
Conclusion

DEQ will continue to implement the on-road emission testing program and will present further information on the vehicles sampled, the high emitting vehicles sampled, and vehicles that receive clean screen notices to the 2008 General Assembly. DEQ will also include information on the progress towards receiving credit for emission reductions achieved through the on-road testing program.

APPENDIX A: REMOTE SENSING DEVICES

The RSD device detects vehicle emissions when a car drives through an invisible light beam the system projects across a roadway. Figure B-1 illustrates the remote sensing equipment set-up. The process of measuring emissions remotely begins when the RSD device Source & Detector Module (SDM) sends an infrared (IR) and ultraviolet (UV) light beam across a single lane of road to a lateral transfer mirror. The mirror reflects the beam back across the street (creating a dual beam path) into a series of detectors in the SDM.

Figure A-1 Remote Sensing Device Set-Up



Fuel specific concentrations of HC, CO, CO2, NOx and smoke are measured in vehicle exhaust plumes based on their absorption of IR/UV light in the dual beam path. During this process, the data-recording device captures an image of the rear of the vehicle, while the Speed & Acceleration Detector measures the speed and rate of acceleration of each vehicle.

The RSD units are housed in fully outfitted Chevrolet vans. These vans are equipped with heating/cooling, a generator, and adequate storage for all components. The vans carry a full compliment of road safety equipment and tools for making small repairs. The vans are equipped with additional lighting for testing during pre-dawn and post dusk hours.

The majority of the data for the Virginia ORE program was gathered using the EPS RSD-4000 remote sensing unit. The RSD-4000 includes the many features over the earlier model used in a 2002 Virginia pilot project including:

- A longer beam range for safer, more versatile deployment
- A fuel specific smoke measurement using a UV wavelength that senses the fine particles invisible to traditional visible light opacity meters

The RSD-4600 unit was voluntarily provided to the Virginia ORE by ESP in spring of 2006. In addition to the features of the RSD-4000, the RSD-4600 provides:

- an improved calibration regime which can be completely automated
- compatibility with dual speed/acceleration bars.

Appendix B

VA 2005 ORE OBSERVATION DATA SUMMARY

Month	Collection Days	Van Days	Testing Hours	Raw Records	Unique Records	I/M Area Registered (quarterly)
January	19	19	82:02:52	36,380	12,873	
February	15	15	115:27:34	66,710	23,421	
March	20	23	183:52:06	93,875	30,475	48,295
April	18	30	272:25:23	145,664	52,407	
May	19	35	382:09:41	202,520	60,991	
June	20	40	484:33:55	285,364	77,082	155,744
July	20	25	280:12:51	161,259	48,537	
August	21	31	324:24:44	195,279	71,593	
September	17	17	206:28:08	136,740	48,936	67,783
October	13	13	110:21:52	55,561	20,293	
November	13	15	112:36:25	52,605	19,754	
December	19	22	231:39:54	135,001	43,977	30,297
Totals	**214**	**285**	**2786:15:25**	**1,566,958**	**510,339**	**302,119**
Averages	18 per month	24 per month	232:11:17 per month	130,580 per month	42,528 per month	25,177 per month
			13:01:12 per day	7,322 per day	2,385 per day	1,412 per day

Based on the number of Collection Days (some days with more than one van)

Total **Unique** I/M Area Registered Vehicles

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APPENDIX C: REMOTE SENSING SITES IN 2005

FIGURE C-1 SITES BY REGION

Region / Jurisdiction	Sites	Sessions
Northern Virginia:		
ALEXANDRIA	3	10
ARLINGTON	2	8
FAIRFAX	26	206
FAIRFAX CITY	2	9
FALLS CHURCH	1	9
LOUDOUN	5	18
MANASSAS	1	6
PRINCE WILLIAM	6	43
STAFFORD	6	32
Subtotal	52	341
Fredericksburg:		
FREDERICKSBURG Subtotal	6	34
Richmond Area:		
HANOVER	1	5
HENRICO	5	21
RICHMOND	6	22
Subtotal	12	48
Tidewater Area:		
CHESAPEAKE	2	19
HAMPTON	1	9
NEWPORT NEWS	3	11
NORFOLK	2	3
Subtotal	8	42
Total	78	465

Figure C-2 Site Locations in Northern Virginia

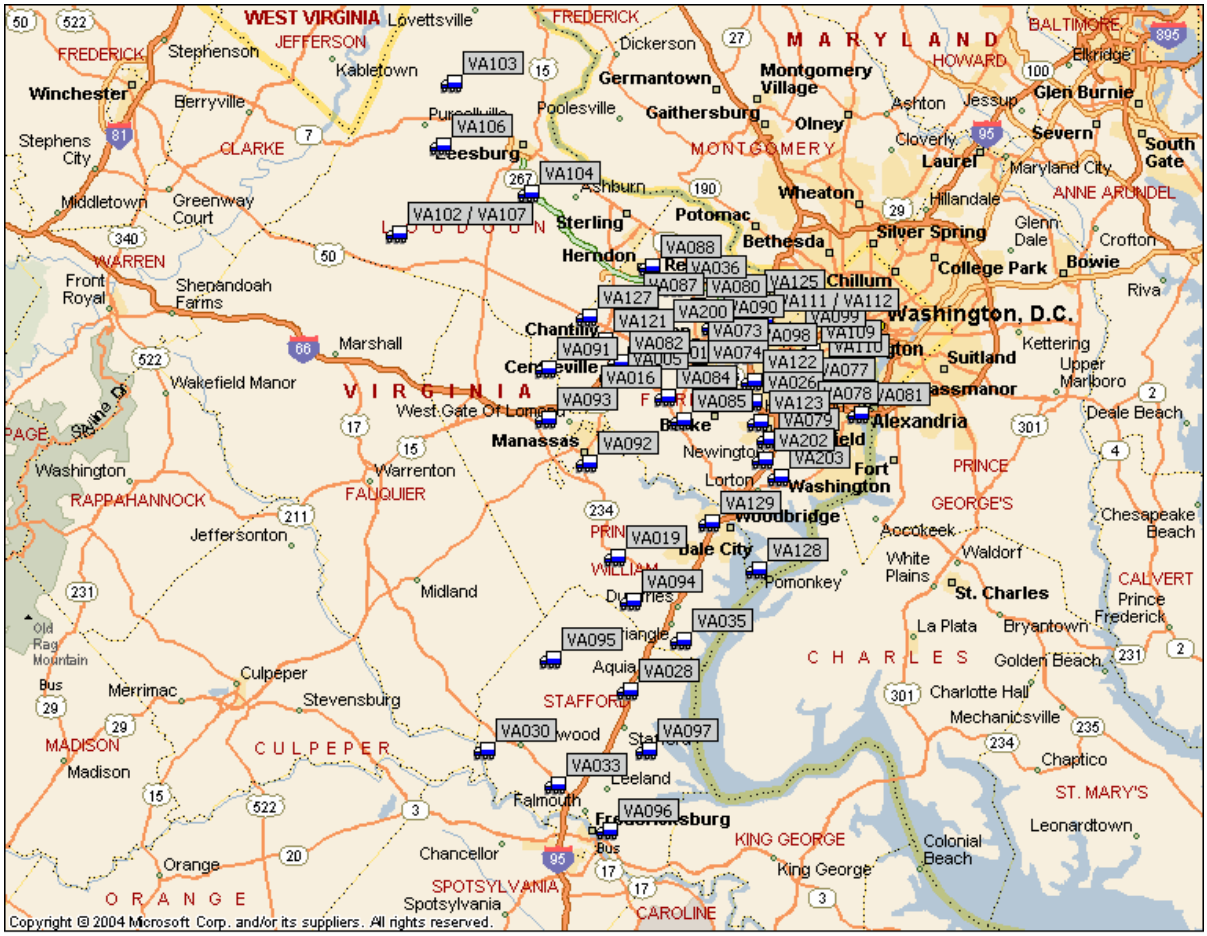


Figure C-3 Site Locations in Fredericksburg

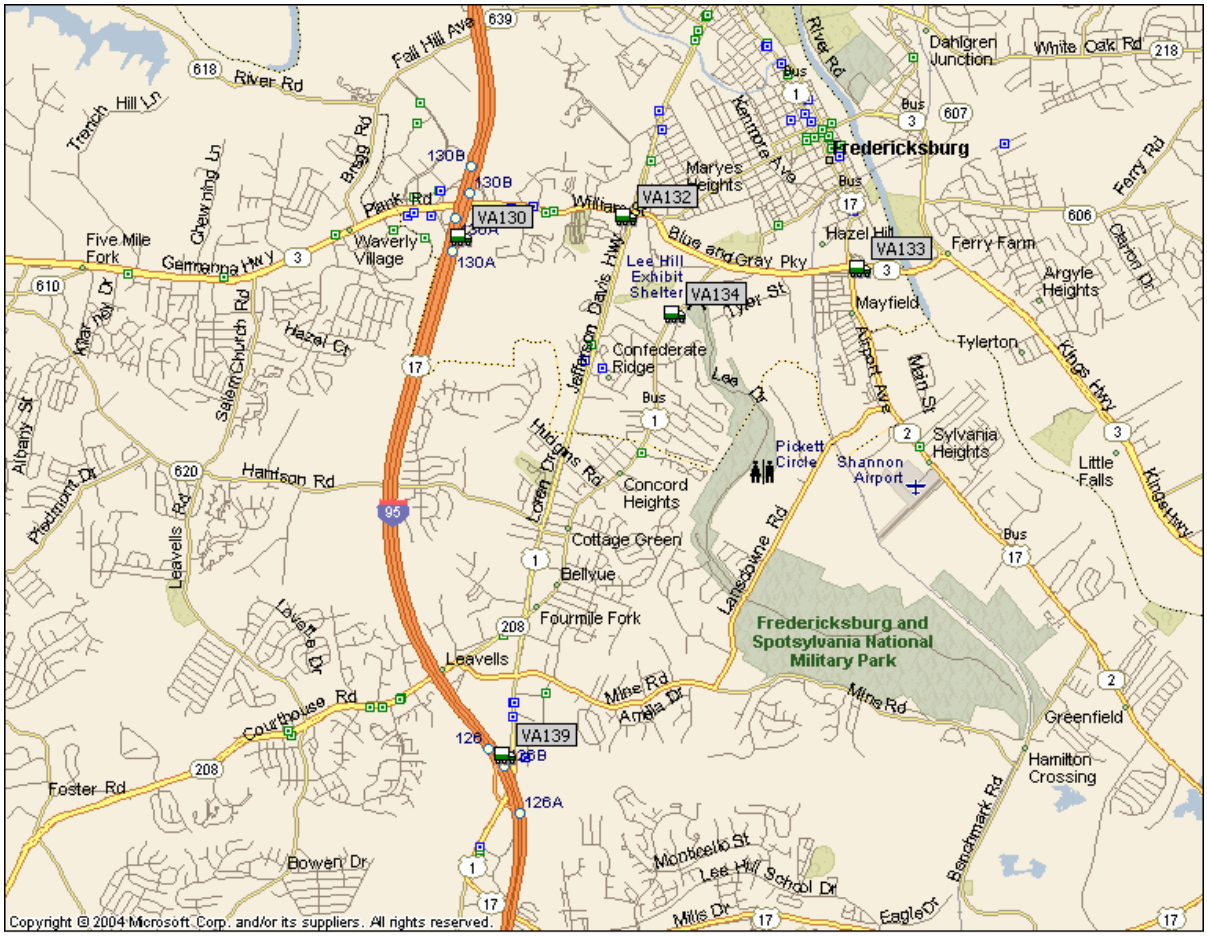


Figure C-4 Site Locations in the Richmond Area

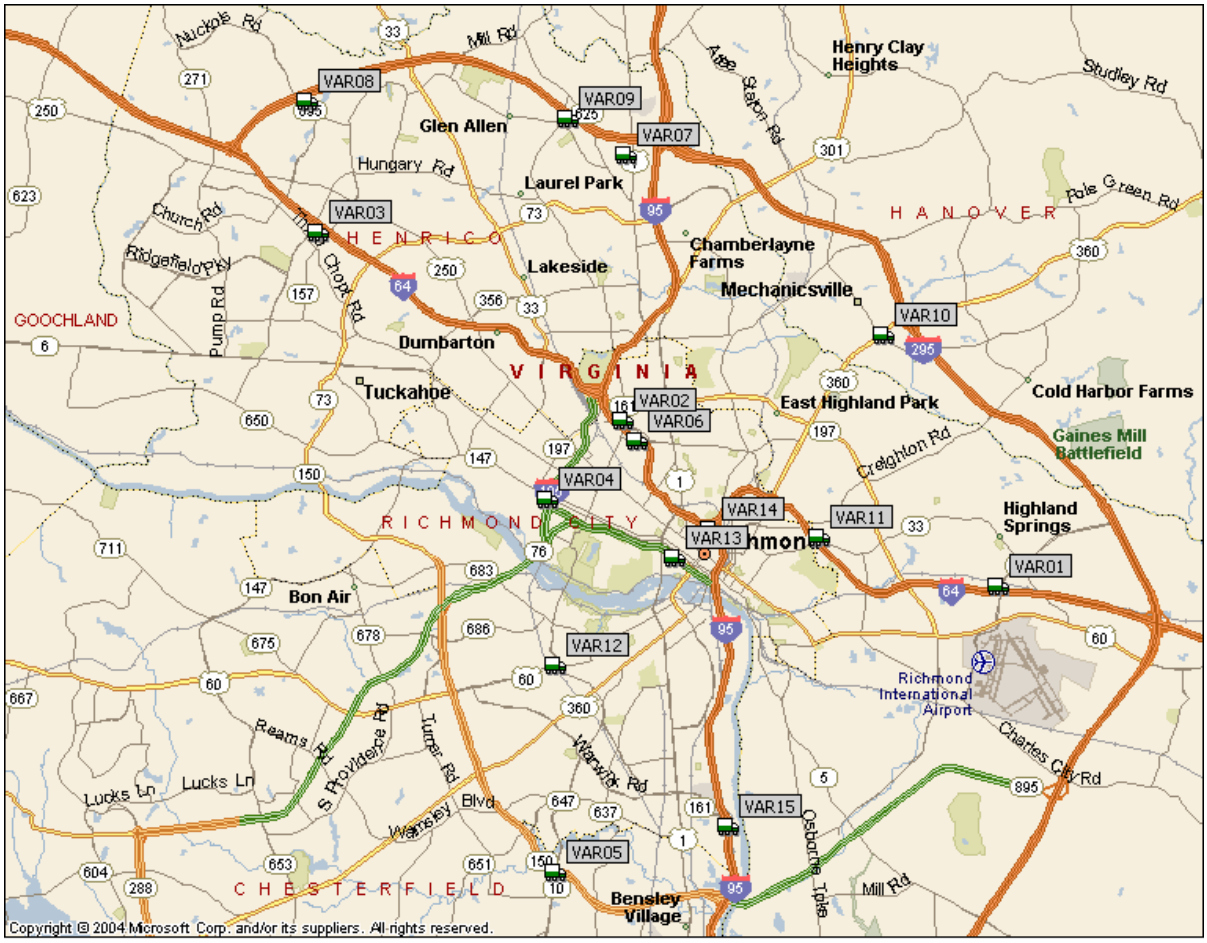
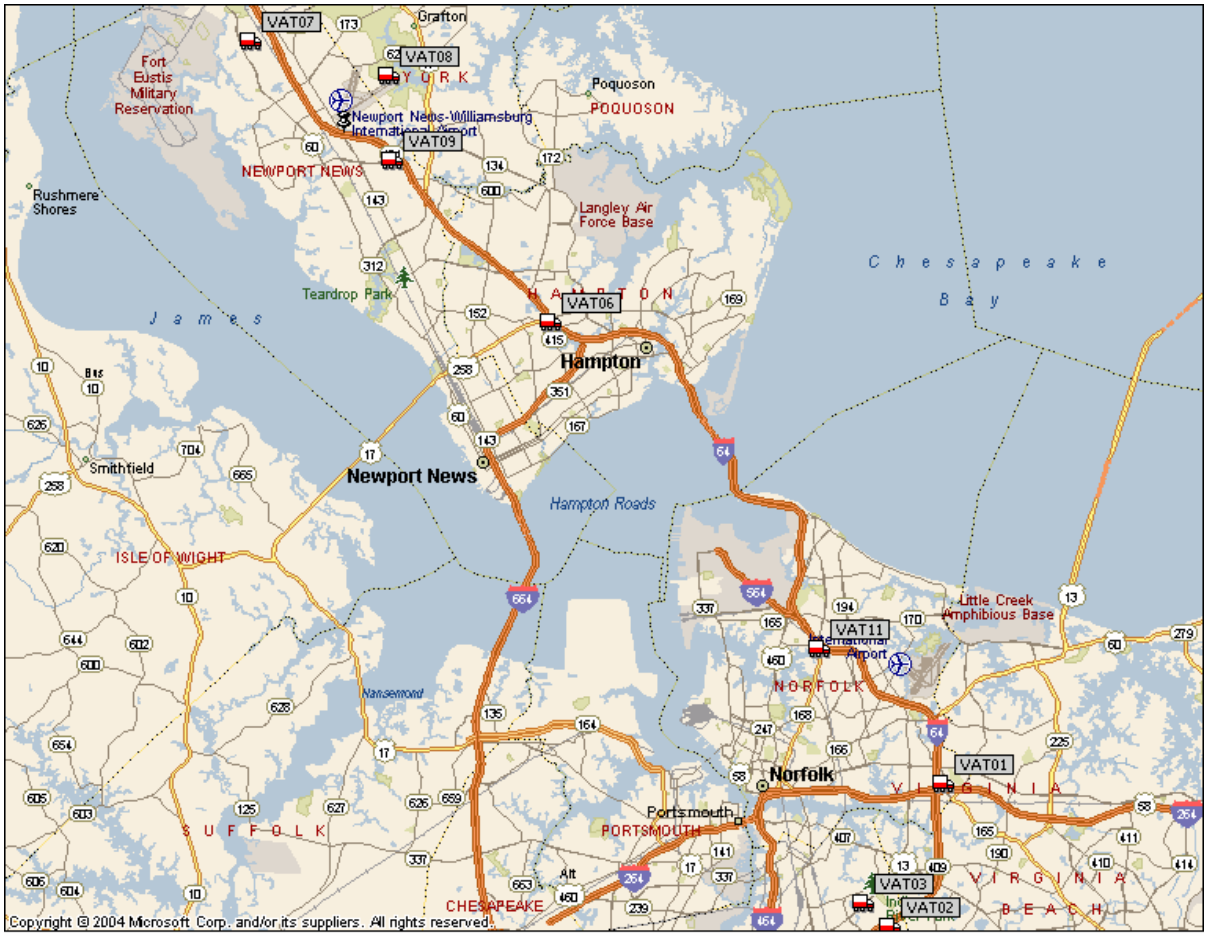


Figure C-5 Site Locations in Tidewater



APPENDIX D: Overall Program Statistics

Table D-1: Number of Remote Sensing Records by License Plate- 2005

Parameter	I/M Program Area	Virginia Non-I/M Area	Out of State	Total
Total Number of RSD Units Utilized	4	4	N/A	4
Total Number of Sites Utilized	52	26	N/A	78
Total Number of Van Collection Days Readings Taken	212	74	N/A	286
Total Number of Readings Taken	1,173,694	393,264	N/A	1,566,958
Total Number of Valid Readings Taken (Emissions, VSP, Audit, & License Plate Picture)	664,307	250,579	N/A	914,886
Total Number of Vehicles With "Unreadable" License Plates	57,170	22,509	N/A	79,679
Total Number of Readings With Readable License Plates	521,414	209,260	104,533	835,207
Total Number of Readings With Matched License Plates by Site Jurisdiction	504,520	202,088	N/A	706,608
Total Number of Readings With Matched License Plates Registered in Enhanced Area	461,755	24,886	N/A	486,641
Total Number of Readings With Matched License Plates Registered in Non-I/M Area	42,765	177,202	N/A	219,967

Table D-2: Multiple Measurements - 2005

Parameter	I/M Program Area	Virginia Non-I/M Area	Out of State	Total
Total Valid Measurements with VA matched VIN or OOS Plate	486,641	219,967	104,533	811,141
Total Number of Unique Vehicles Identified	302,119	160,895	80,323	543,337
Total Number of Vehicles Identified Once	203,541	122,882	65,966	392,389
Total Number of Vehicles Identified Twice	58,165	25,427	9,390	92,982
Total Number of Vehicles Identified Three Times	21,491	7,765	2,828	32,084
Total Number of Vehicles Identified Four or More Times	18,922	4,821	2,139	25,882

Table D-3: Unique VINs Successfully Measured - 2005

	Unique Vehicles Successfully Measured by Registered Jurisdiction		Light Vehicles Registered in Jurisdiction		% Measured	
	Diesel	Gas & Other	Diesel	Gas & Other	Diesel	Gas & Other
Northern Virginia:						
ALEXANDRIA	115	22,148	800	132,956	14%	17%
ARLINGTON	90	13,786	992	129,907	9%	11%
FAIRFAX COUNTY	1,255	146,415	6,541	735,905	19%	20%
FAIRFAX CITY	35	3,573	159	21,133	22%	17%
FALLS CHURCH	21	3,019	115	16,142	18%	19%
LOUDOUN	499	25,933	2,893	193,849	17%	13%
MANASSAS PARK	61	1,890	143	9,378	43%	20%
MANASSAS	98	4,746	370	31,118	26%	15%
PRINCE WILLIAM	697	54,278	3,536	255,464	20%	21%
STAFFORD	516	24,968	1,466	86,786	35%	29%
Subtotal	3,387	300,756	17,015	1,612,638	20%	19%
Fauquier & Fredericksburg:						
CAROLINE	41	2,594	352	23,610	12%	11%
FAUQUIER	164	3,207	1,643	57,859	10%	6%
FREDERICKSBURG	48	4,885	243	17,291	20%	28%
KING GEORGE	48	2,170	312	18,621	15%	12%
SPOTSYLVANIA	399	24,656	1,335	96,282	30%	26%
Subtotal	700	37,512	3,885	213,663	18%	18%
Richmond Area:						
CHESTERFIELD	78	6,506	2,320	246,788	3%	3%
HANOVER	152	7,604	1,464	87,095	10%	9%
HENRICO	204	20,451	1,948	231,218	10%	9%
RICHMOND CITY	288	9,585	2,545	131,375	11%	7%
Subtotal	722	44,146	8,277	696,476	9%	6%
Tidewater Area:						
CHESAPEAKE	137	12,178	2,182	165,024	6%	7%
HAMPTON	38	5,206	1,190	104,475	3%	5%
NEWPORT NEWS	31	6,701	1,030	140,026	3%	5%
NORFOLK	57	8,493	1,038	157,041	5%	5%
PORTSMOUTH	15	1,255	626	66,763	2%	2%
VIRGINIA BEACH	149	14,569	3,210	332,197	5%	4%
Subtotal	427	48,402	9,276	965,526	5%	5%
Total	4,584	398,189	34,811	3,291,931	13%	12%