Memorandum

Date: March 15, 2006

To: File

From: Michael Freeman **(DRAFT)**

Subject: Evaluation of 2005 Vehicle Registration Data for District of Columbia

Background

The Mobile 6.2 model that is used to develop emissions rates for mobile source emissions inventory for the State Implementation Plan (SIP) and transportation conformity analysis requires a number of vehicle-specific inputs. In the Washington non-attainment region emissions rates are developed for each jurisdiction in the non-attainment area. Two of the inputs are: vehicle registration data used to develop age distribution by vehicle type, and the percentage of diesel vehicles for each vehicle type. As part of the interagency consultation procedures in place, the transportation department and the environmental department have agreed to update these data sets once every three years. The region has been using 2002 registration data sets for all emissions analysis and we are in the process of using the 2005 raw registration data information to develop 2005 input files to the Mobile 6.2 model.

Vehicle registration data have been used to develop the two input files used in the Mobile 6.2 model; namely “xxx.rdt” (age distribution by vehicle type) and “xxx.dsf” (percentage of diesel vehicles for each vehicle type and for each model year). DC staff has transmitted to TPB staff 2005 raw registration data files. TPB staff has used these raw data to produce a set of “xxx.rdt” and “xxx.dsf” files using a method that includes vehicle identification

number (VIN) decoding software. This memo will document TPB staff's findings and make recommendations for developing rdt and dsf files for future air quality planning studies.

Methodology

COG used the following outline to develop rdt and dsf files (depicted graphically as a flowchart in Attachment 1.0).:

1) Extract all unique VIN (deleting duplicates and purging expired registrations) by jurisdiction from the 2005 vehicle registration database (July 2005 snapshot) and decode with VINPOWER decoding software. The decoding software provided model year, Mobile 6.2 vehicle type, and other vehicle attributes. Attachment 1A summarizes the VIN control totals and decoded results. A summary of the number of decoded VIN by vehicle type and jurisdiction is provided in Attachment 1B.
2) Convert the decode results:
    a. Vehicle age distribution: This is the first of the two input files needed.
        i. *Vehicle type*: The VIN decoder software breaks down the registration data in to the Mobile 6.2 28 vehicle categories. However, the current version of Mobile 6.2 16 can only handle registration (xxx.rdt) files in 16 vehicle types and it uses the "xxx.dsf" files internally to break it into 28 categoires. Therefore, the decoded data are converted from the 28 (Mobile 6.2) types to 16 vehicle types by combining the diesel and gasoline vehicle types. Attachment 2 shows the method used for converting the 28 types to 16 types.
        ii. *Model Years*: Since the raw registration file reflects July 1, 2005 conditions, it includes model year 2005 and 2006 as the first year vehicles. The Mobile 6.2 guidance recommends combining the two model years into model year 'one'. In addition, Vinpower does not decode VINs for vehicles that were manufactured prior to 1980 since the VINs did not meet International Standards Organization (ISO)

standards prior to 1980. In order to solve this problem, we used the decoded results to directly assign vehicles to model years one through twenty-four, and used the year 24 profile to develop year 25 and older model years. The vehicle registration records were used to determine control totals by jurisdiction for: (A) Mobile 6 vehicle type years < than 25; (B) Mobile 6 vehicle types year = 25 or older. For Mobile 6 vehicle type year = 25, apply regional distribution for mobile year = 24 and normalize to match control total % from step (B). For Mobile years 1 through 24, use vin decode results to develop distributions by vehicle type and year. Then normalize years 1 through 24 of each row so that years 1 through 25 = 100%. Develop 16 (vehicle type) by 25 (Mobile 6 year) matrices by jurisdiction. This is the rdt file for input into Mobile 6.

b. Diesel percentages by vehicle type: This is the second input file needed in Mobile 6.2 model. For percentage of diesel vehicles by vehicle type and by year (xxx.dsf) file development, use the vehicle equivalency table and the VIN decode to calculate the number of diesel and gasoline vehicles for each of the 16 vehicle types. The ratio of diesel vehicles to the total number of vehicles is the dsf for each category. Since the VIN decoder will not decode for year 25, use the dsf calculated for year 24 for year 25, also.

Comparison with Mobile 6 Defaults

The next step in the processes was to compare the data developed using the methodology described above with mobile 6 defaults used in previous air quality planning efforts. The attached comparison charts were used to summarize the findings.

1) Vehicle Age Distribution

a. For LDV and LDT1, LDT2, LDT3, LDT4 (less so than the others) vehicle types, the VIN Decodes compare well with the Mobile defaults. The vehicle types with the

most observations (LDV, LDT2) match better than vehicle types with fewer observations.

b. Generally "Heavy Duty" vehicle categories do not track as well as "Light Duty" vehicle categories among all jurisdictions.

c. For the motorcycle category, the mobile defaults put all vehicles older than 12 years into the 12th year category and no values are provided for years 13 through 25.

2) Percentage of Diesel Vehicles: The diesel fractions calculated from vin decode results were plotted against mobile defaults as shown in Attachment 5. The following conclusions were made from reviewing the diesel fractions.

a *LDV: Both the vin decodes and Mobile defaults have dsf values near zero for* years 1 to 20. For years 20 to 25, the mobile defaults increase to about 0.08, but the dsf values based on VIN decodes increase to about 0.25 for the same years.

b *LDT1/LDT2/LDT3/LDT4:* The DSF values generated by the VIN decode method are near zero for a number of years as compared to the Mobile 6 default.

c *HDV2B:* VIN decoder and Mobile defaults are fairly close with VIN decodes slightly higher in years 1 through 10 and mobile defaults slightly higher in years 11 through 24. However, two large spikes occur in year 8 and year 19 with the vin decodes.

d. *HDV3/HDV4:* VIN decodes are lower than Mobile defaults for these categories, particularly in later years.

e. *HDV5/HDV6/HDV7:* VIN decodes are higher than Mobile defaults for these categories.

f. *HDV8A/HDV8B:* Both VIN decodes and Mobile defaults have dsf values at or near 1.0.

Recommendations

1) Age Distributions

- Use distributions developed by COG based on VIN decode results for each jurisdiction and 14 vehicle types. For school bus and transit bus use Mobile defaults for HDBT/HDBS because busses vehicle registration data reflects that busses are purchased infrequently in large numbers with big variations from year.

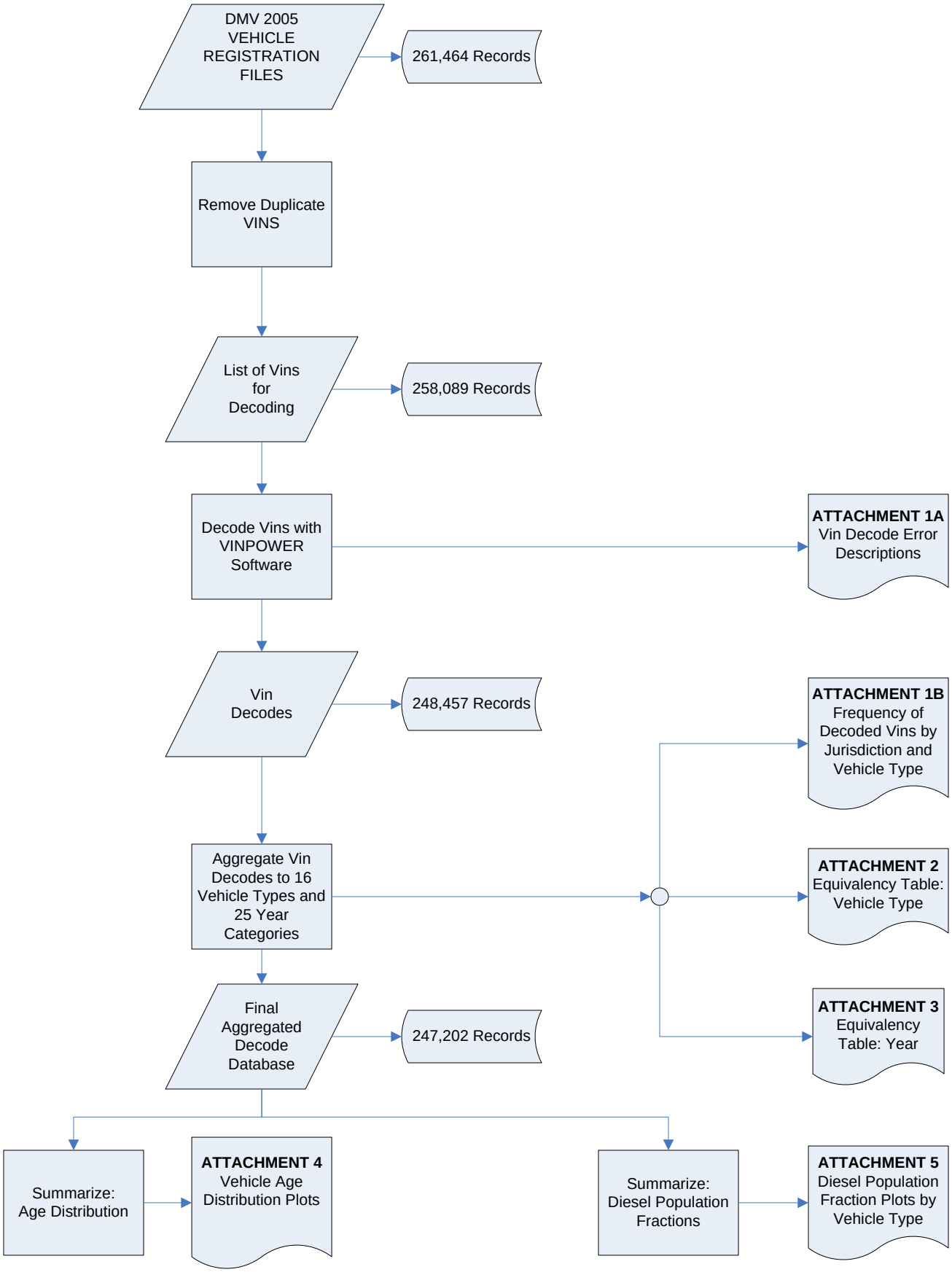
2) Diesel Fractions

- Due to the relatively small number of registered vehicles in the District of Columbia (considered regionally), we may want to consider aggregating other jurisdictions from Maryland and Virginia together with the District to estimate a regional diesel fraction for some or all vehicle types. MWCOG staff has aggregated registration records for Virginia and Maryland independently and each regional aggregation provides a more consistent diesel fraction from year to year and by vehicle type. However when each jurisdiction is evaluated separately, large spikes tended to occur through time due to small sample sizes of individual jurisdictions.

LIST OF ATTACHMENTS

- **ATTACHMENT 1.0**: VIN DECODE PROCESS FLOWCHART
- **ATTACHMENT 1A**: 2005 VEHICLE REGISTRATION DATA VINPOWER DECODE RESULTS
- **ATTACHMENT 1B**: FREQUENCY OF DECODED VINS BY VEHICLE TYPE
- **ATTACHMENT 2**: EQUIVALENCY TABLE: VEHICLE TYPE (28 Mobile 6.2 Vehicle Types Versus 16 Mobile 6.2 Vehicle Types)
- **ATTACHMENT 3**: EQUIVALENCY TABLE: YEAR (Manufacturer Model Year Versus Mobile 6.2 Model Year)
- **ATTACHMENT 4**: COMPARISON OF VEHICLE AGE DISTRIBUTIONS (VIN Decoder Results Versus 2002 Registration Data for 16 Vehicle Types)
- **ATTACHMENT 5**: PERCENTAGE OF DIESEL VEHICLES BY VEHICLE TYPE (Comparison of VIN Results with 2002 Defaults for 14 vehicle types)

ATTACHMENT 1.0
Vin Decode Process Flowchart
District of Columbia



ATTACHMENT 1A

2005 Vehicle Registration Data
VinPower Decode Results

State	VINS
DC	258,089

Error Code	Error Code Description	DC
	No Error - Decoded Sucessfully	96.3%
1	VIN Number contains illegal characters	0.4%
2	VIN too short to decode (i,e.: < 10 chars)	0.4%
3	VIN Exceeds 17 characters	0.0%
4	Check Digit is bad	1.2%
5	This vehicle is unavailable in the database	0.8%
6	The model year for this vehicle is unavailable	0.2%
7	VIN Decode Error	0.0%
	Error w/o Error Code	0.7%
	TOTAL	**100.0%**

ATTACHMENT 1B
FREQUENCY OF DECODED VINS BY JURISDICTION AND VEHICLE TYPE

Sum of count	source	
cog_veh	Vin Decodes	%
HDBS	664	0.3%
HDBT	923	0.4%
HDV2B	3,727	1.5%
HDV3	599	0.2%
HDV4	1,516	0.6%
HDV5	208	0.1%
HDV6	339	0.1%
HDV7	288	0.1%
HDV8A	379	0.2%
HDV8B	52	0.0%
LDT1	1,677	0.7%
LDT2	46,372	18.8%
LDT3	11,586	4.7%
LDT4	2,864	1.2%
LDV	173,864	70.3%
MC	2,144	0.9%
Grand Total	247,202	100.0%

ATTACHMENT 2
EQUIVALENCY TABLE - VEHICLE TYPE

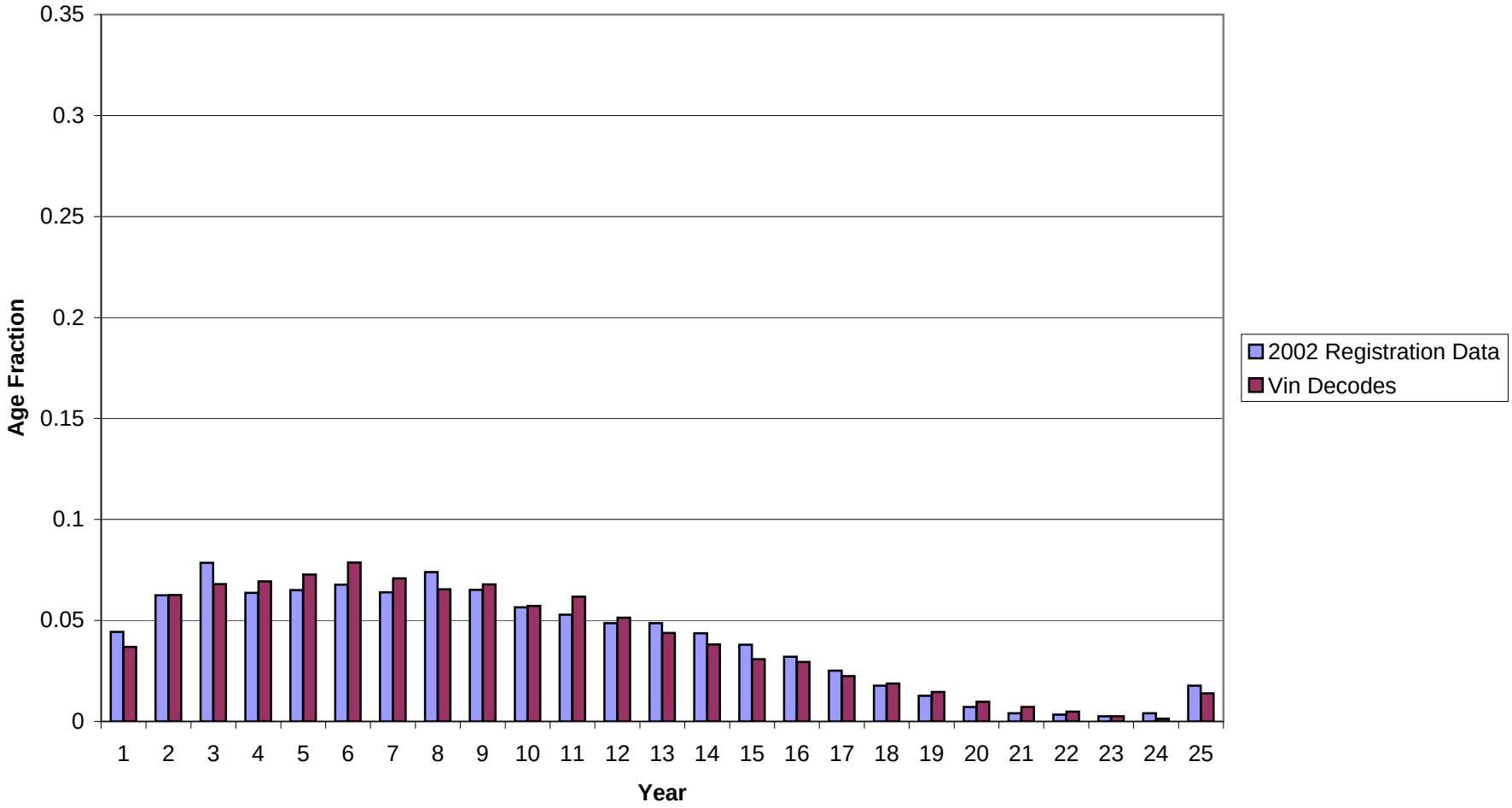
Mobile 6 Vehicle Type		COG Vehicle Type																TOTAL
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
		LDV	LDT1	LDT2	LDT3	LDT4	HDV2B	HDV3	HDV4	HDV5	HDV6	HDV7	HDV8A	HDV8B	HDBS	HDBT	MC	
1	LDGV	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.00
2	LDGT1	-	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.00
3	LDGT2	-	-	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	1.00
4	LDGT3	-	-	-	1.00	-	-	-	-	-	-	-	-	-	-	-	-	1.00
5	LDGT4	-	-	-	-	1.00	-	-	-	-	-	-	-	-	-	-	-	1.00
6	HDGV2B	-	-	-	-	-	1.00	-	-	-	-	-	-	-	-	-	-	1.00
7	HDGV3	-	-	-	-	-	-	1.00	-	-	-	-	-	-	-	-	-	1.00
8	HDGV4	-	-	-	-	-	-	-	1.00	-	-	-	-	-	-	-	-	1.00
9	HDGV5	-	-	-	-	-	-	-	-	1.00	-	-	-	-	-	-	-	1.00
10	HDGV6	-	-	-	-	-	-	-	-	-	1.00	-	-	-	-	-	-	1.00
11	HDGV7	-	-	-	-	-	-	-	-	-	-	1.00	-	-	-	-	-	1.00
12	HDGV8A	-	-	-	-	-	-	-	-	-	-	-	1.00	-	-	-	-	1.00
13	HDGV8B	-	-	-	-	-	-	-	-	-	-	-	-	1.00	-	-	-	1.00
14	LDDV	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.00
15	LDDT12	-	0.50	0.50	-	-	-	-	-	-	-	-	-	-	-	-	-	1.00
16	HDDV2B	-	-	-	-	-	1.00	-	-	-	-	-	-	-	-	-	-	1.00
17	HDDV3	-	-	-	-	-	-	1.00	-	-	-	-	-	-	-	-	-	1.00
18	HDDV4	-	-	-	-	-	-	-	1.00	-	-	-	-	-	-	-	-	1.00
19	HDDV5	-	-	-	-	-	-	-	-	1.00	-	-	-	-	-	-	-	1.00
20	HDDV6	-	-	-	-	-	-	-	-	-	1.00	-	-	-	-	-	-	1.00
21	HDDV7	-	-	-	-	-	-	-	-	-	-	1.00	-	-	-	-	-	1.00
22	HDDV8A	-	-	-	-	-	-	-	-	-	-	-	1.00	-	-	-	-	1.00
23	HDDV8B	-	-	-	-	-	-	-	-	-	-	-	-	1.00	-	-	-	1.00
24	MC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.00	1.00
25	HDGB	-	-	-	-	-	-	-	-	-	-	-	-	-	0.50	0.50	-	1.00
26	HDDBT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.00	-	1.00
27	HDDBS	-	-	-	-	-	-	-	-	-	-	-	-	-	1.00	-	-	1.00
28	LDDT34	-	-	-	0.50	0.50	-	-	-	-	-	-	-	-	-	-	-	1.00

ATTACHMENT 3
EQUIVALENCY TABLE - YEAR

Vehicle Model Year	Mobile 6 Year
2006, 2005	1
2004	2
2003	3
2002	4
2001	5
2000	6
1999	7
1998	8
1997	9
1996	10
1995	11
1994	12
1993	13
1992	14
1991	15
1990	16
1989	17
1988	18
1987	19
1986	20
1985	21
1984	22
1983	23
1982	24
<= 1981	25

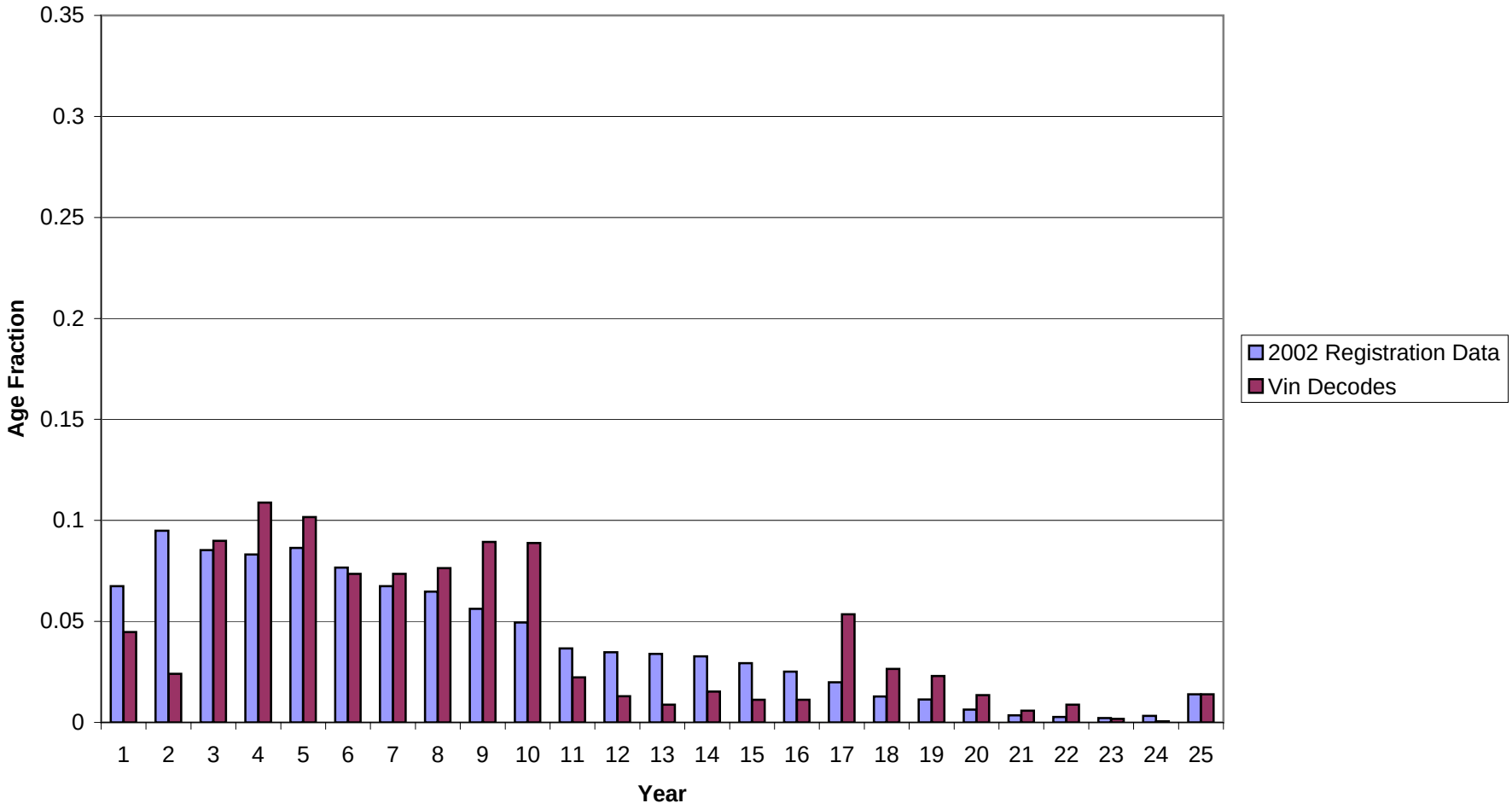
ATTACHMENT 4

2005 Age Fractions
District of Columbia
Vehicle Type = LDV
Number of Decoded Vins = 173,864



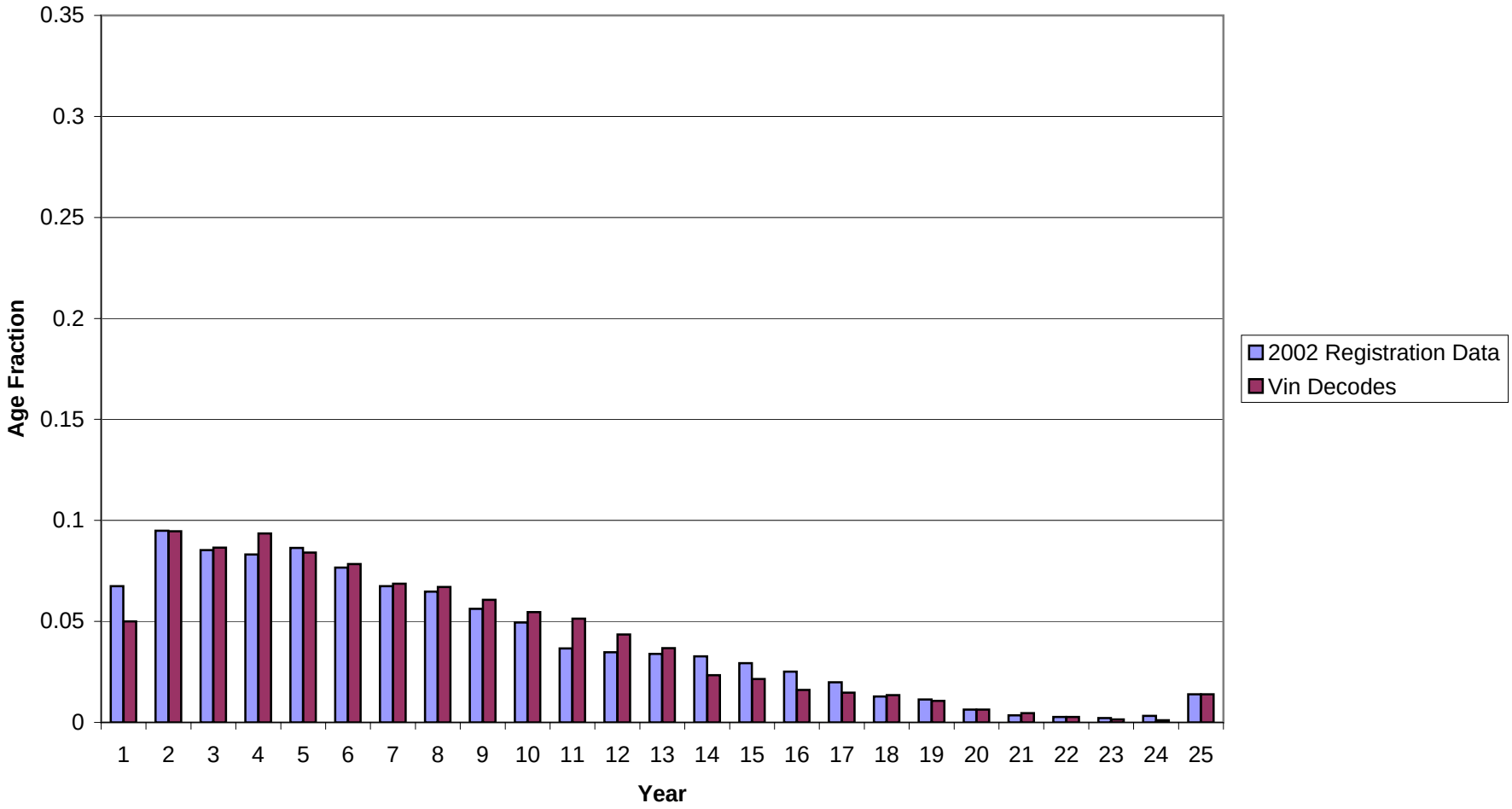
ATTACHMENT 4

2005 Age Fractions
District of Columbia
Vehicle Type = LDT1
Number of Decoded Vins = 1,677



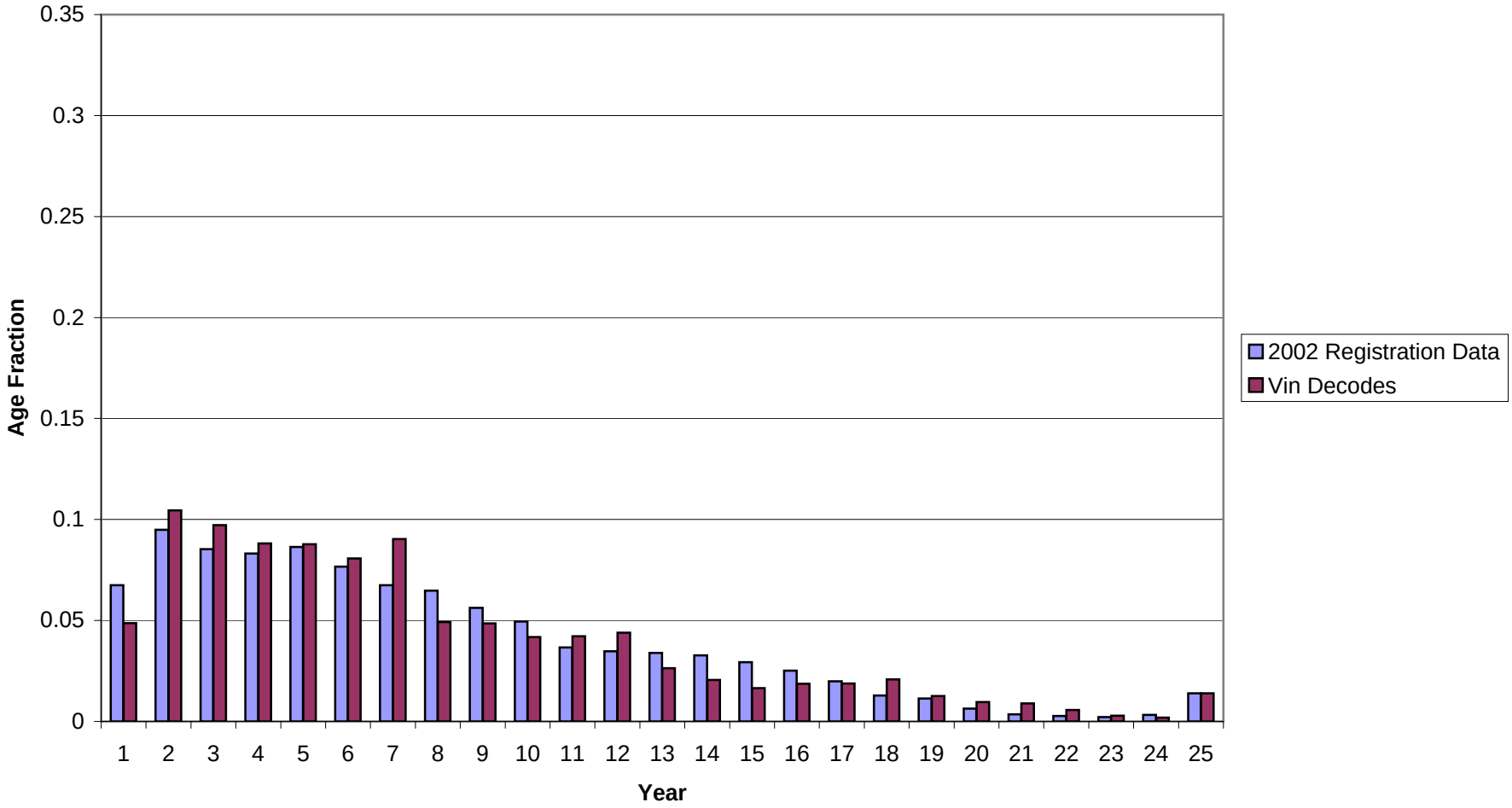
ATTACHMENT 4

2005 Age Fractions
District of Columbia
Vehicle Type = LDT2
Number of Decoded Vins = 46,372



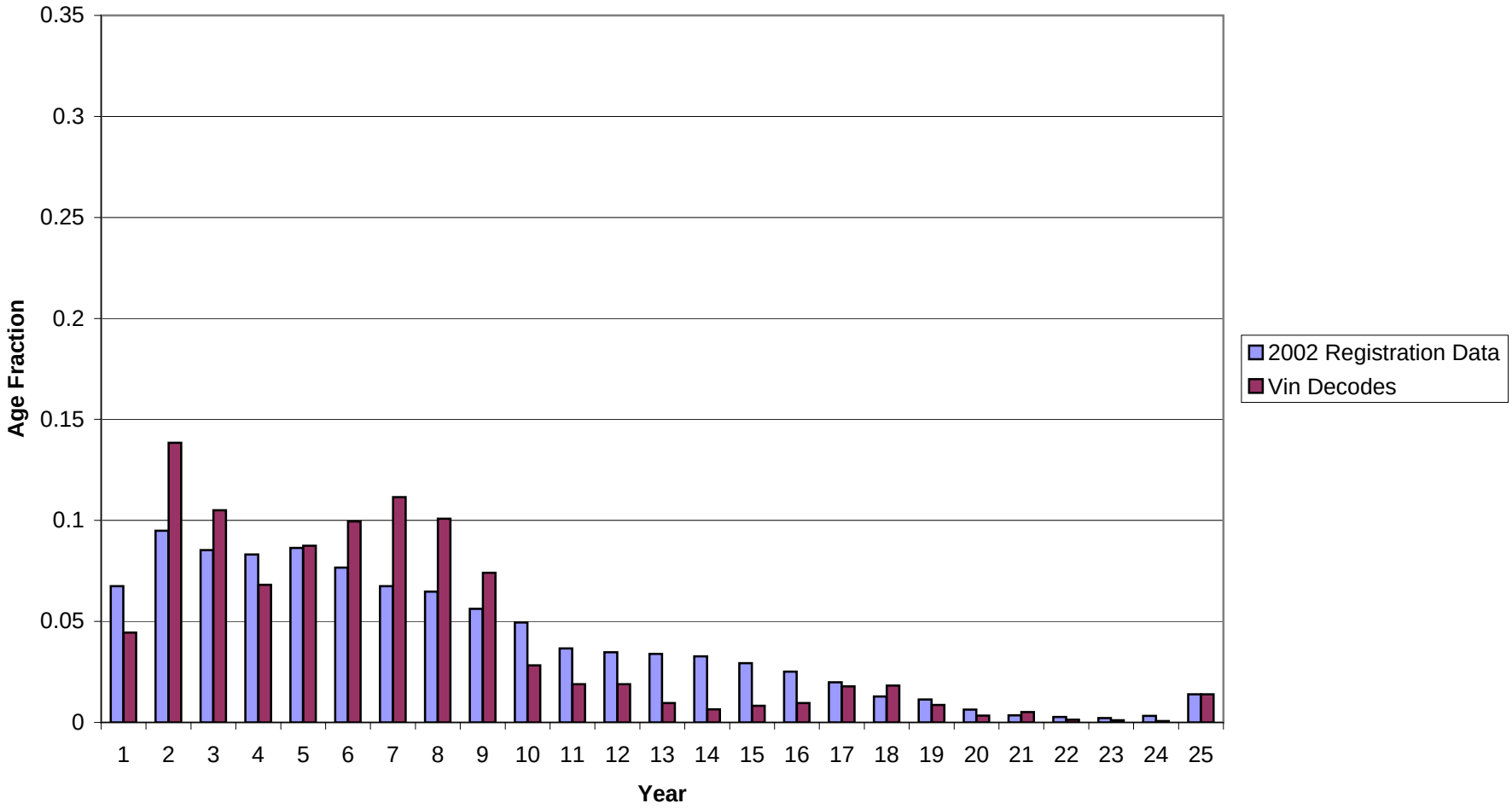
ATTACHMENT 4

2005 Age Fractions
District of Columbia
Vehicle Type = LDT3
Number of Decoded Vins = 11,586



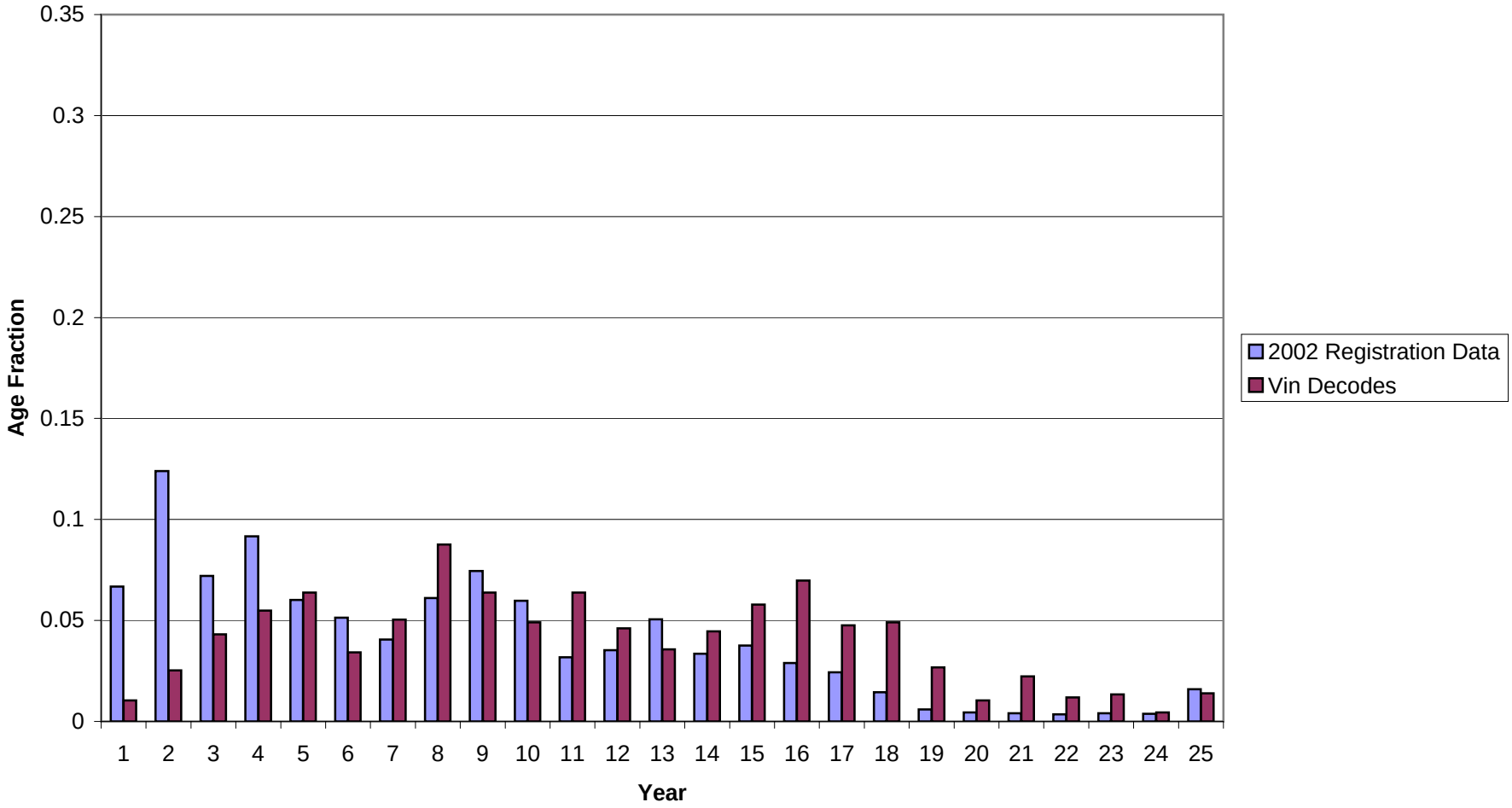
ATTACHMENT 4

2005 Age Fractions
District of Columbia
Vehicle Type = LDT4
Number of Decoded Vins = 2,864



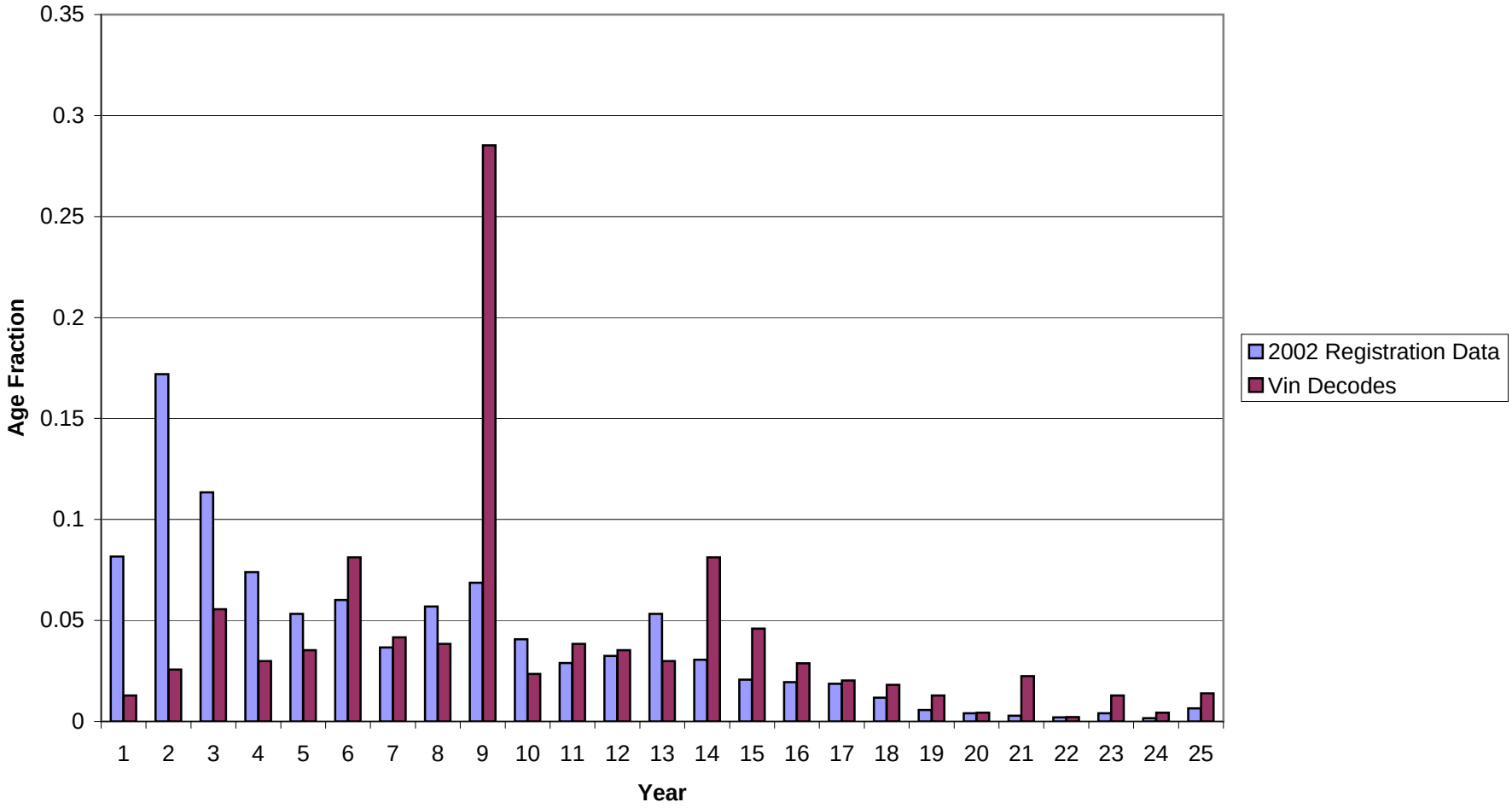
ATTACHMENT 4

2005 Age Fractions
District of Columbia
Vehicle Type = HDBS
Number of Decoded Vins = 664



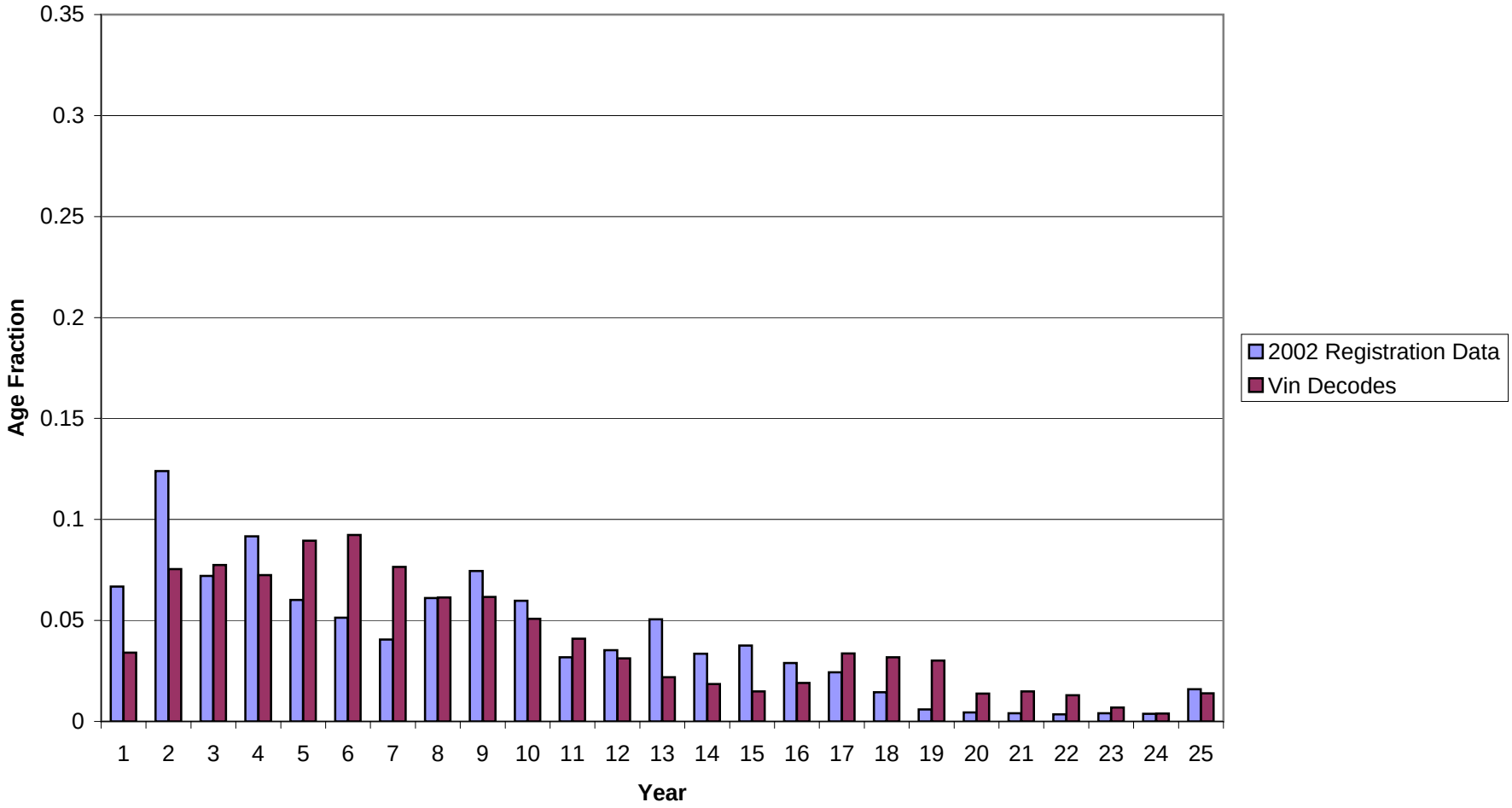
ATTACHMENT 4

2005 Age Fractions
District of Columbia
Vehicle Type = HDBT
Number of Decoded Vins = 923



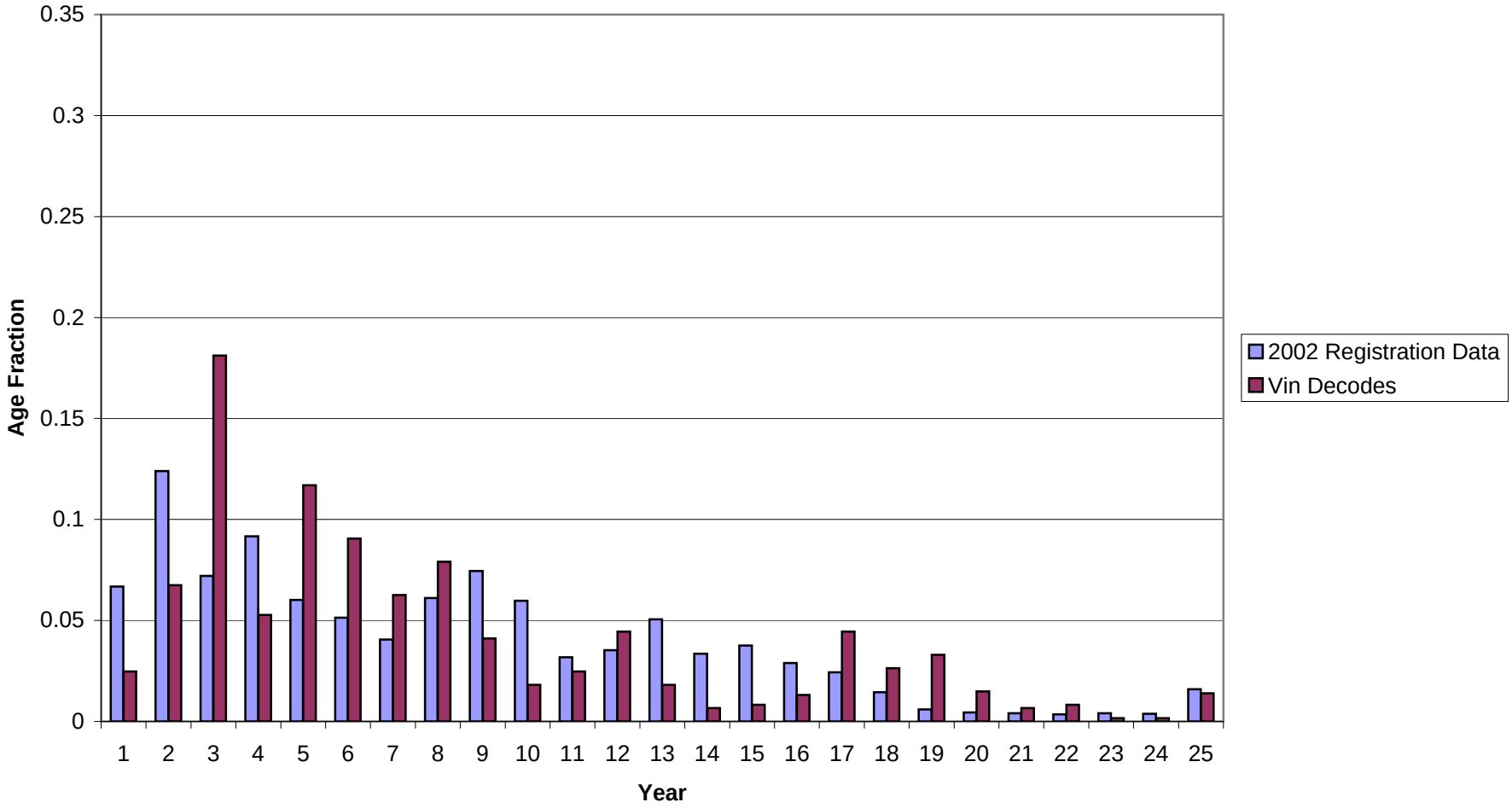
ATTACHMENT 4

2005 Age Fractions
District of Columbia
Vehicle Type = HDV2B
Number of Decoded Vins = 3,727



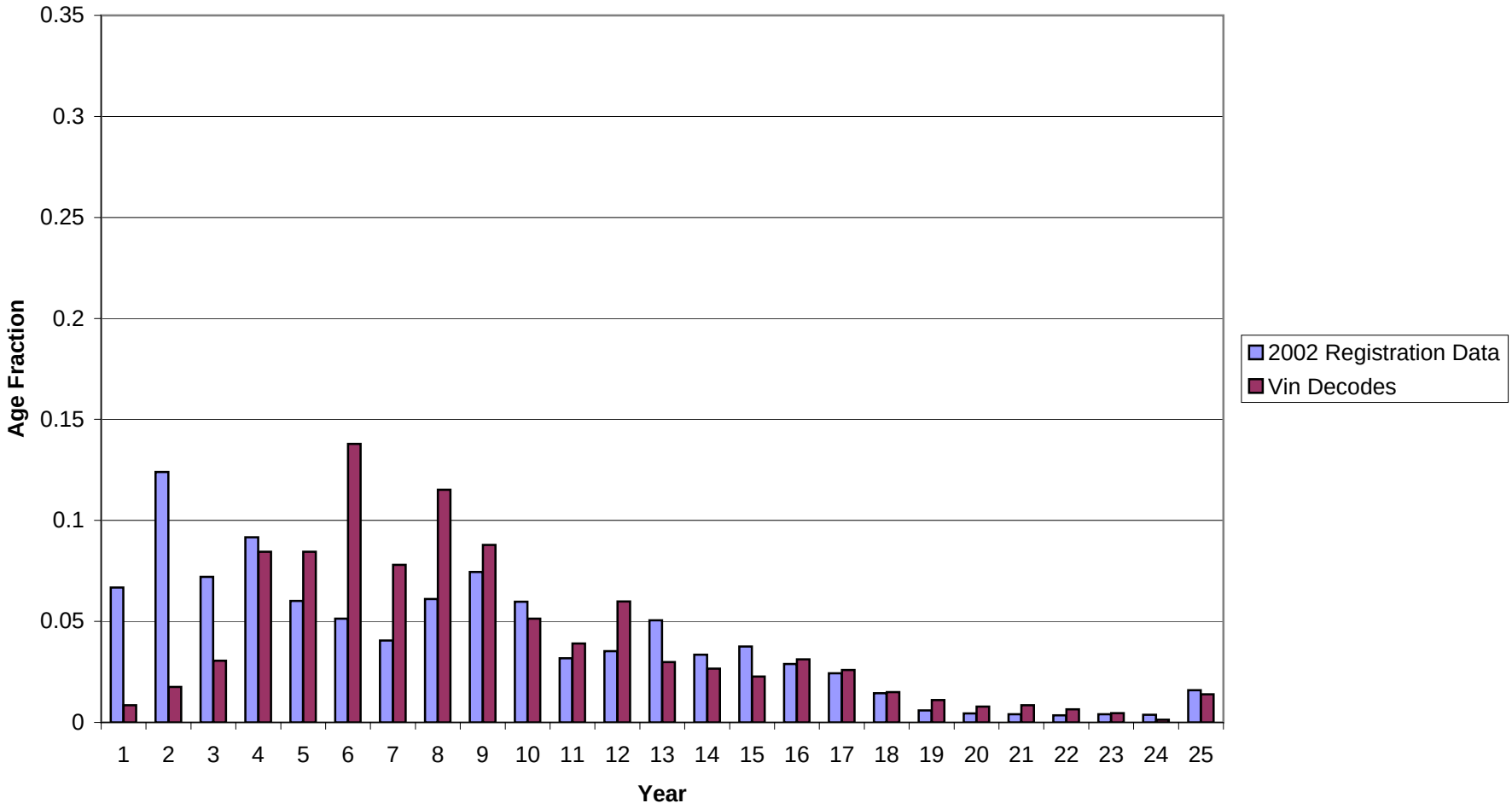
ATTACHMENT 4

2005 Age Fractions
District of Columbia
Vehicle Type = HDV3
Number of Decoded Vins = 599



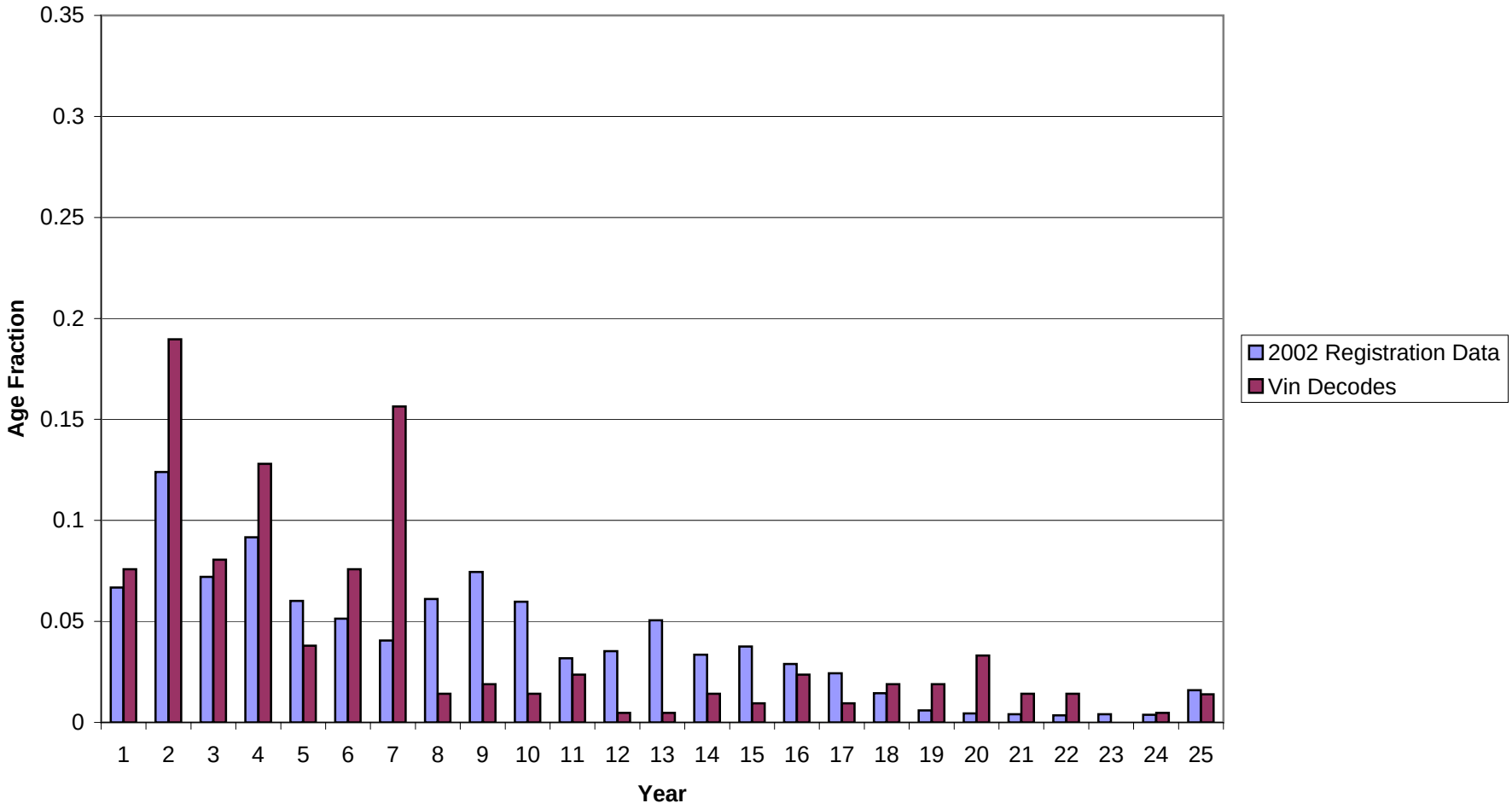
ATTACHMENT 4

2005 Age Fractions
District of Columbia
Vehicle Type = HDV4
Number of Decoded Vins = 1,516



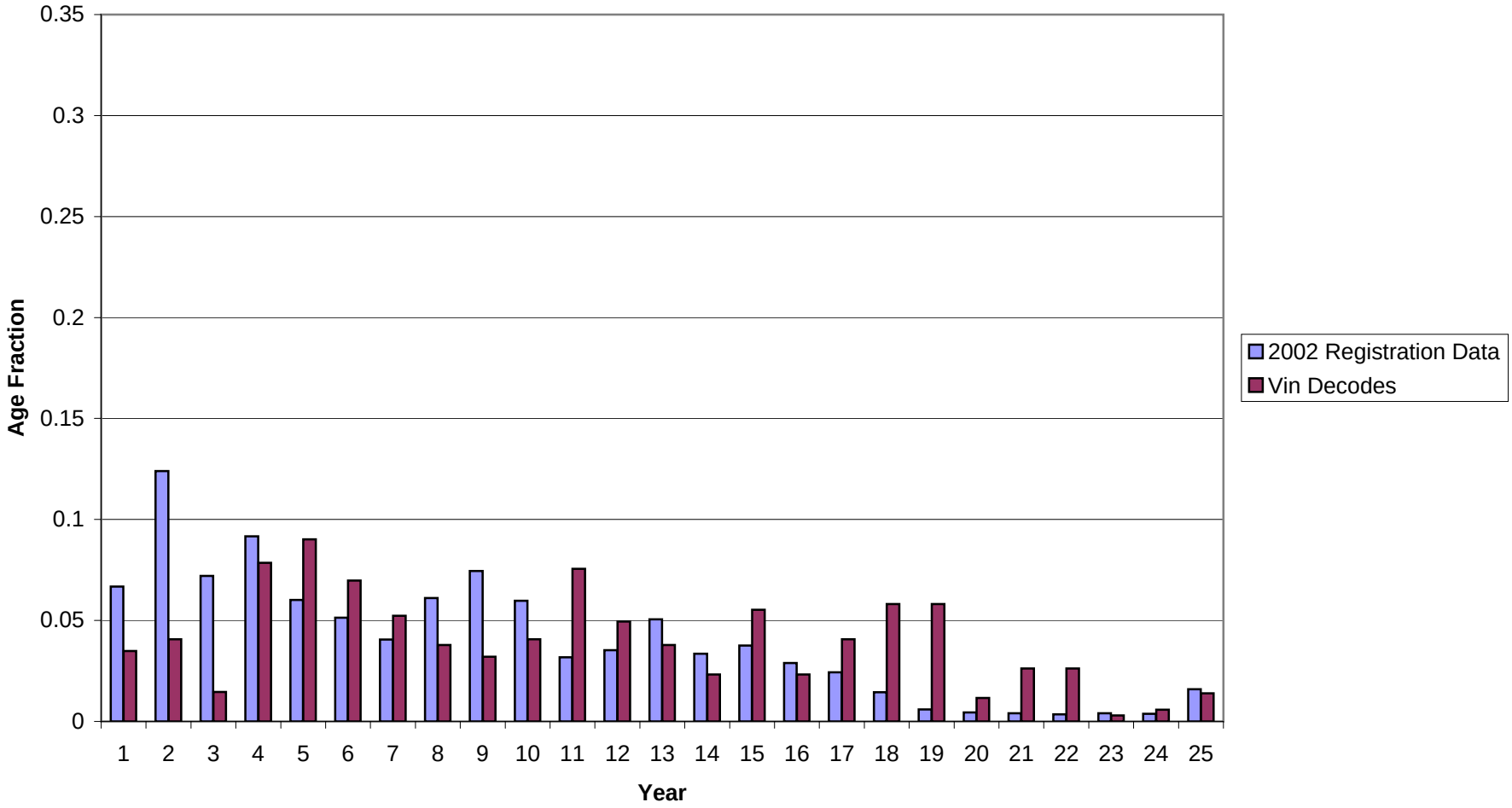
ATTACHMENT 4

2005 Age Fractions
District of Columbia
Vehicle Type = HDV5
Number of Decoded Vins = 208



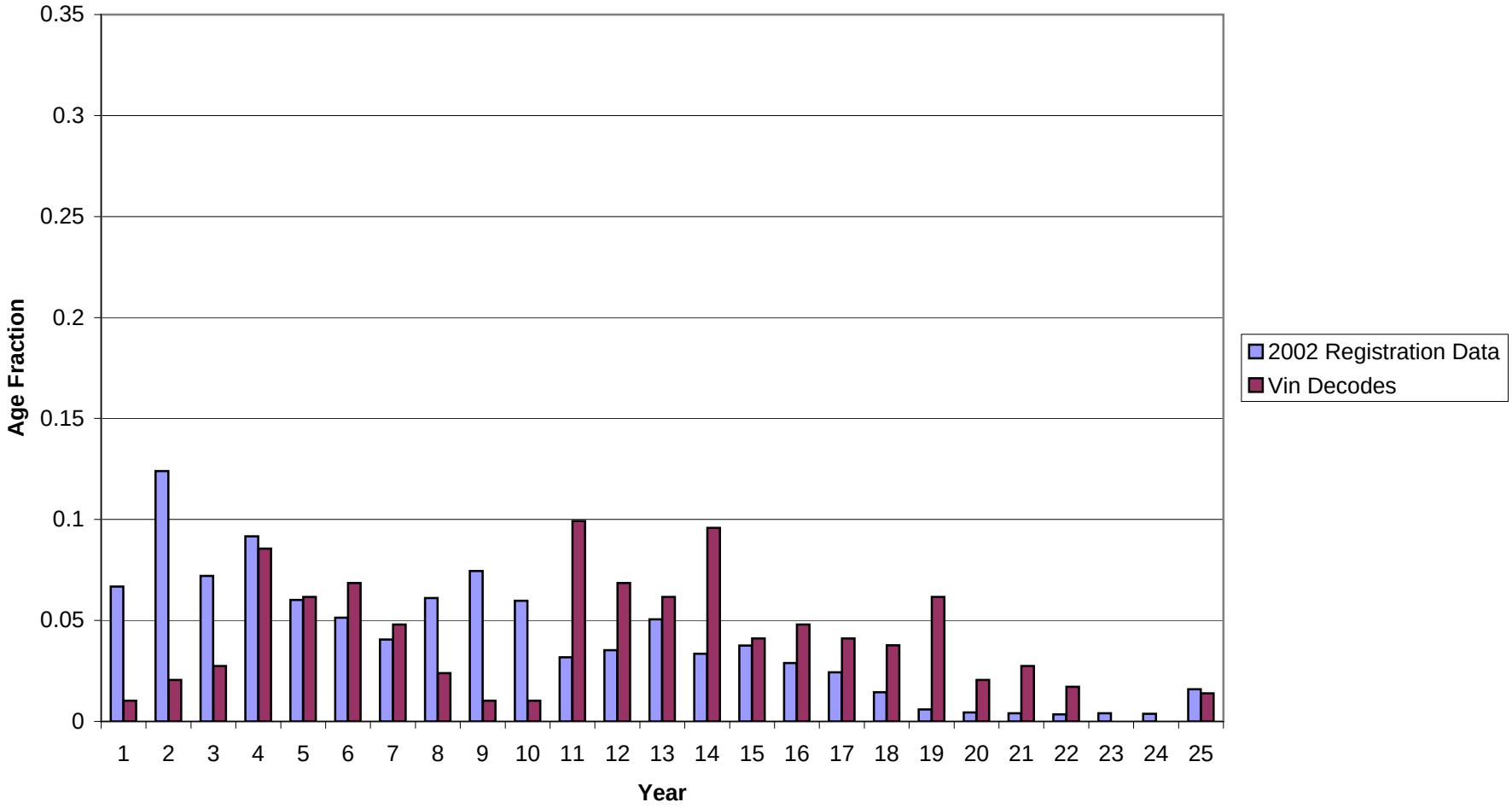
ATTACHMENT 4

2005 Age Fractions
District of Columbia
Vehicle Type = HDV6
Number of Decoded Vins = 339



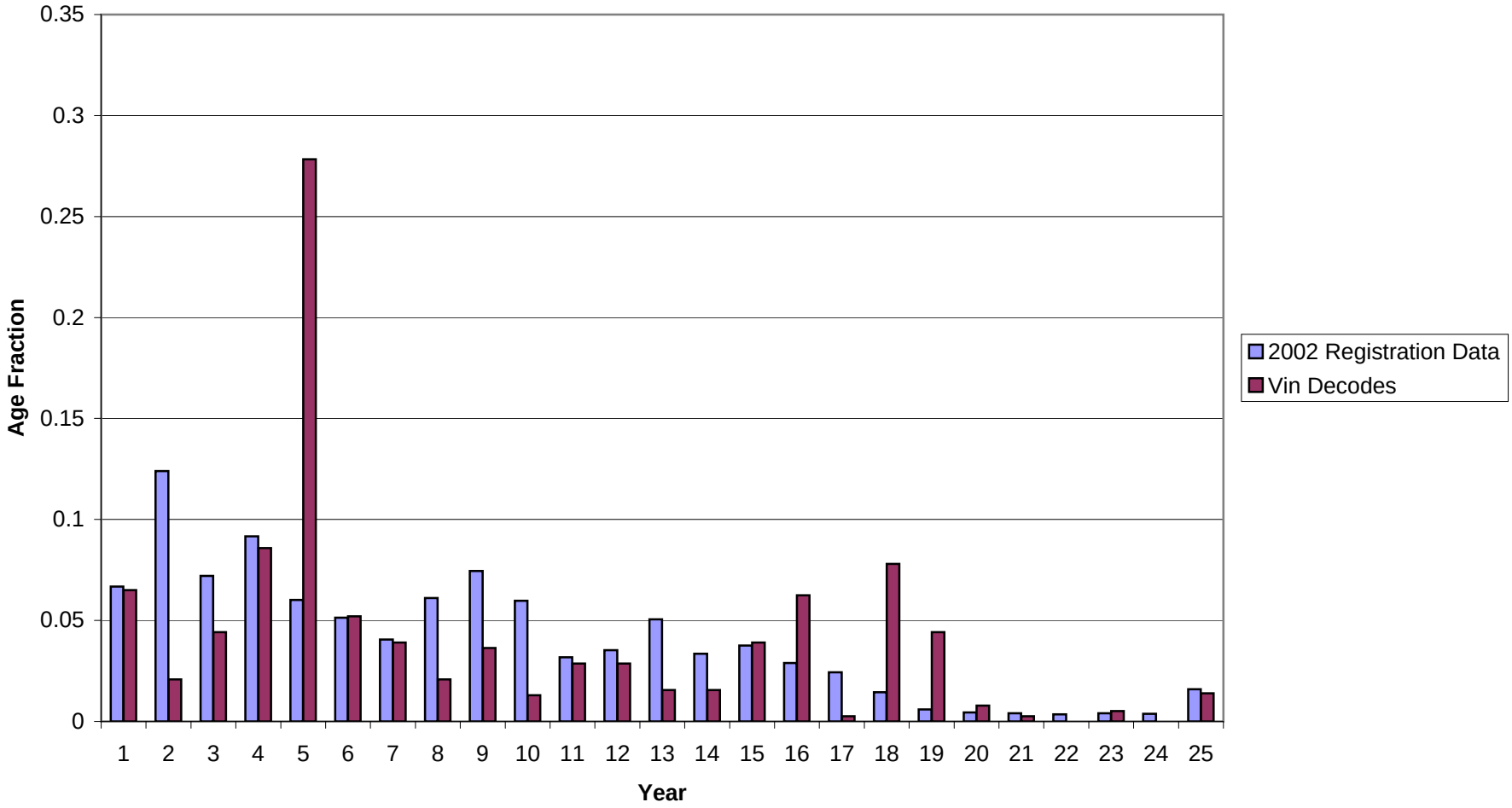
ATTACHMENT 4

2005 Age Fractions
District of Columbia
Vehicle Type = HDV7
Number of Decoded Vins = 288



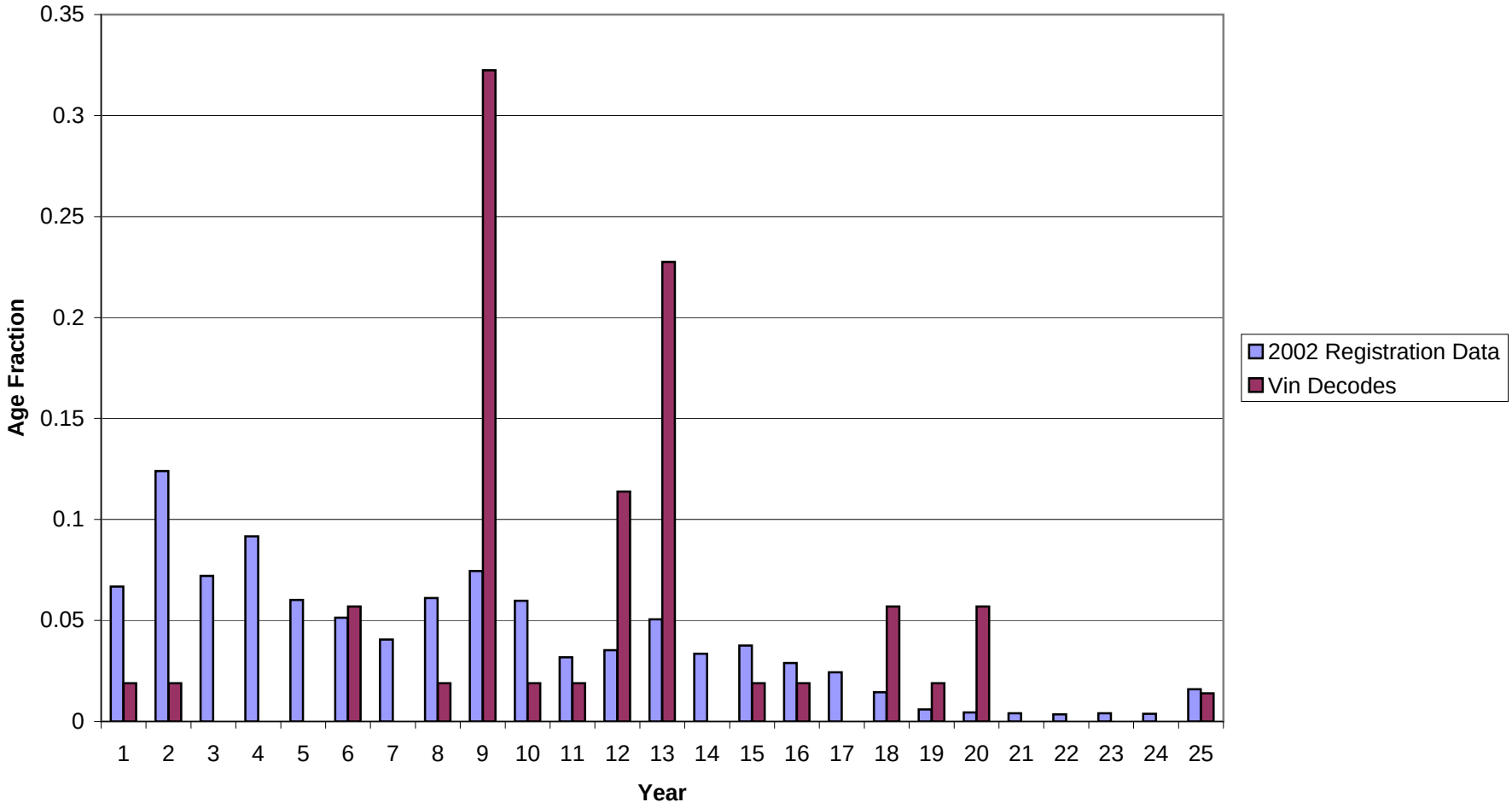
ATTACHMENT 4

2005 Age Fractions
District of Columbia
Vehicle Type = HDV8A
Number of Decoded Vins = 379



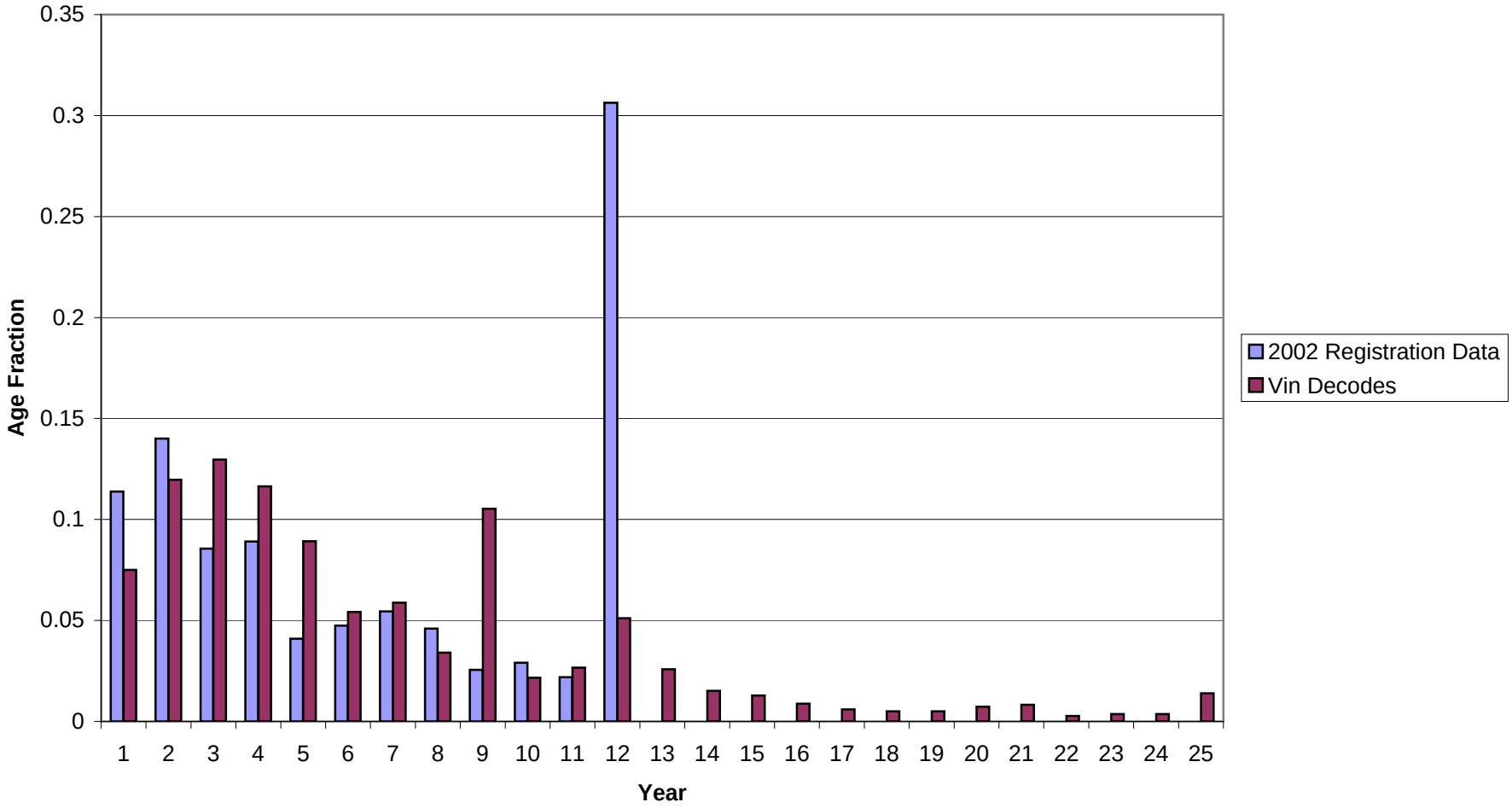
ATTACHMENT 4

2005 Age Fractions
District of Columbia
Vehicle Type = HDV8B
Number of Decoded Vins = 52



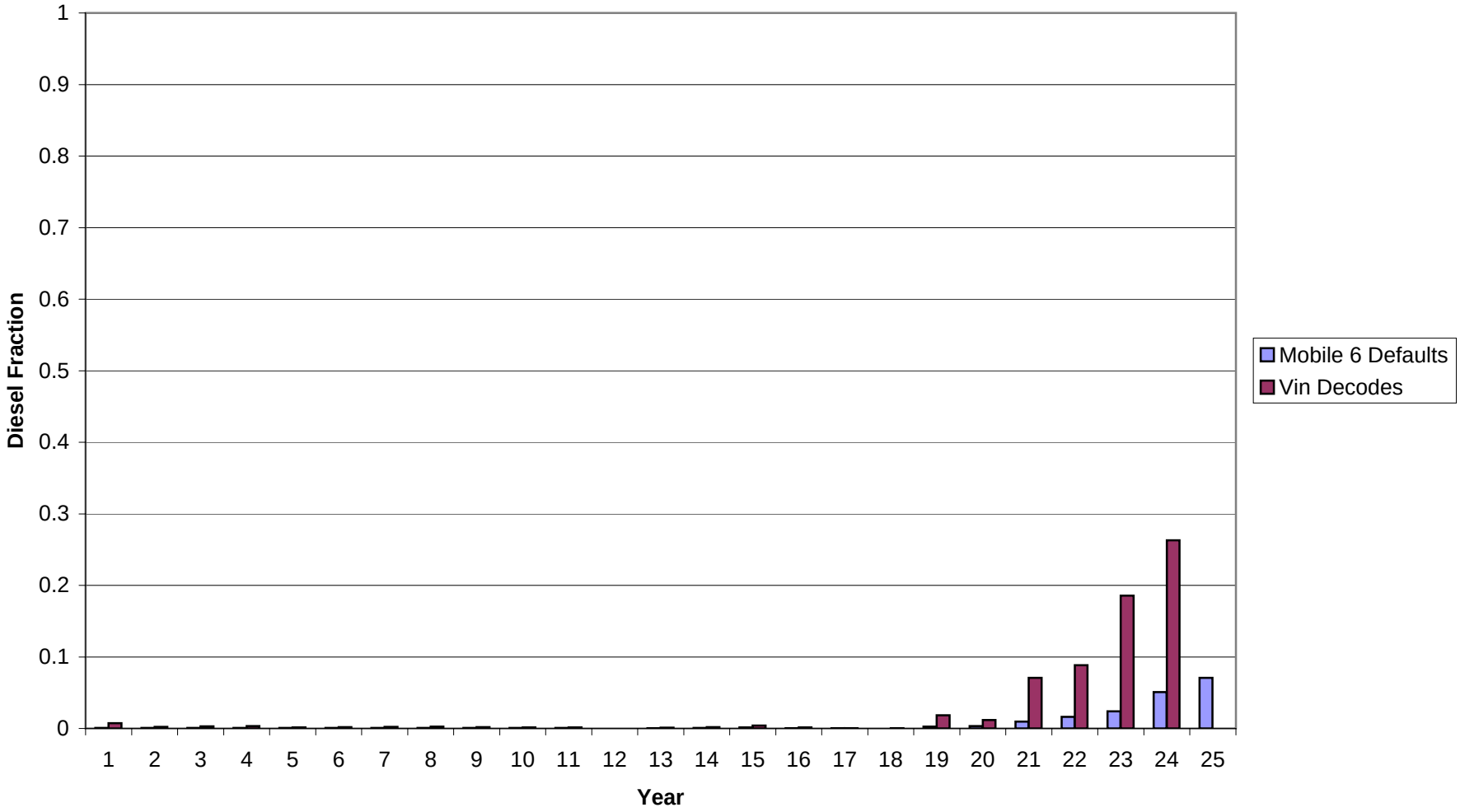
ATTACHMENT 4

2005 Age Fractions
District of Columbia
Vehicle Type = MC
Number of Decoded Vins = 2,144



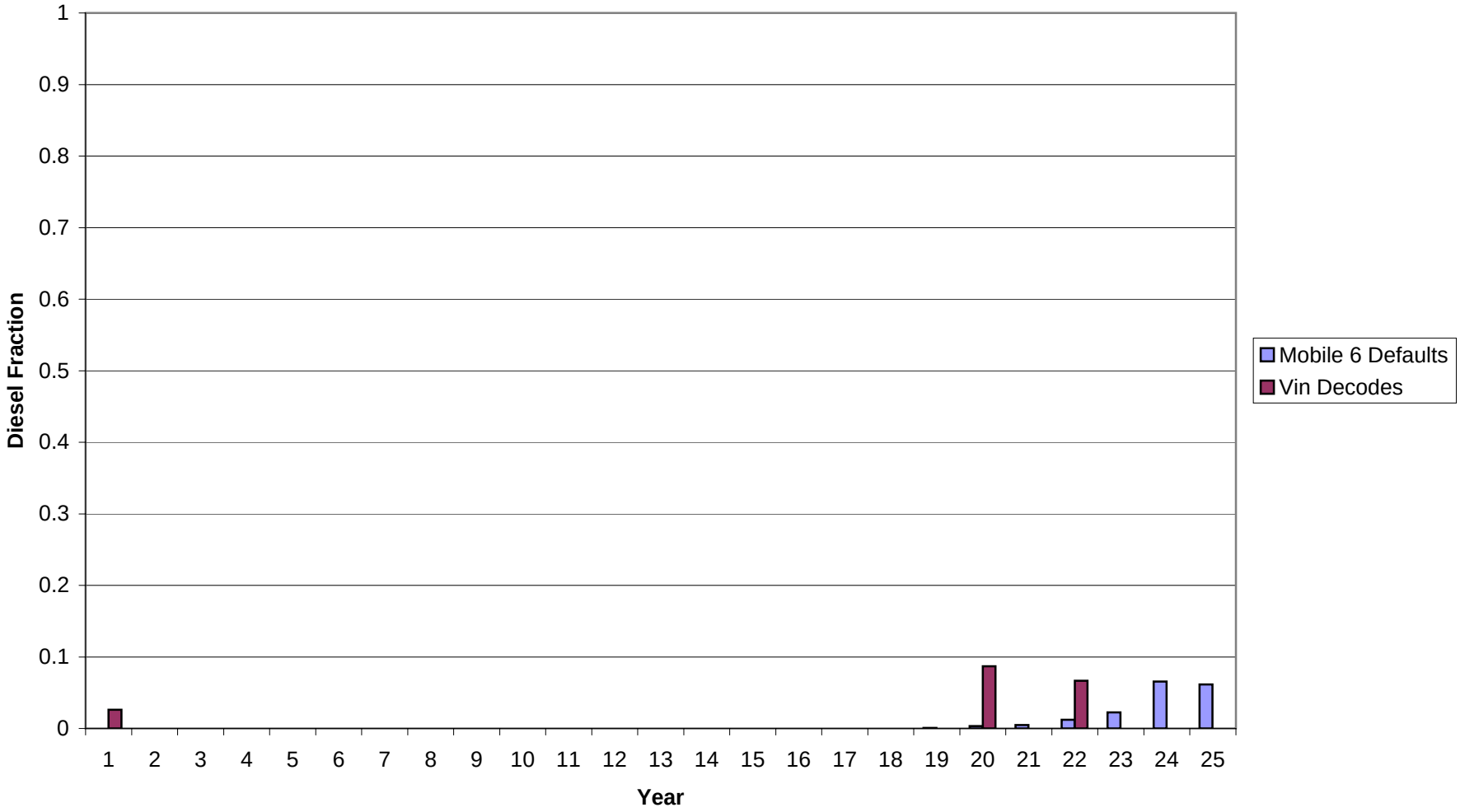
ATTACHMENT 5

2005 Diesel Fractions
District of Columbia
Vehicle Type = LDV



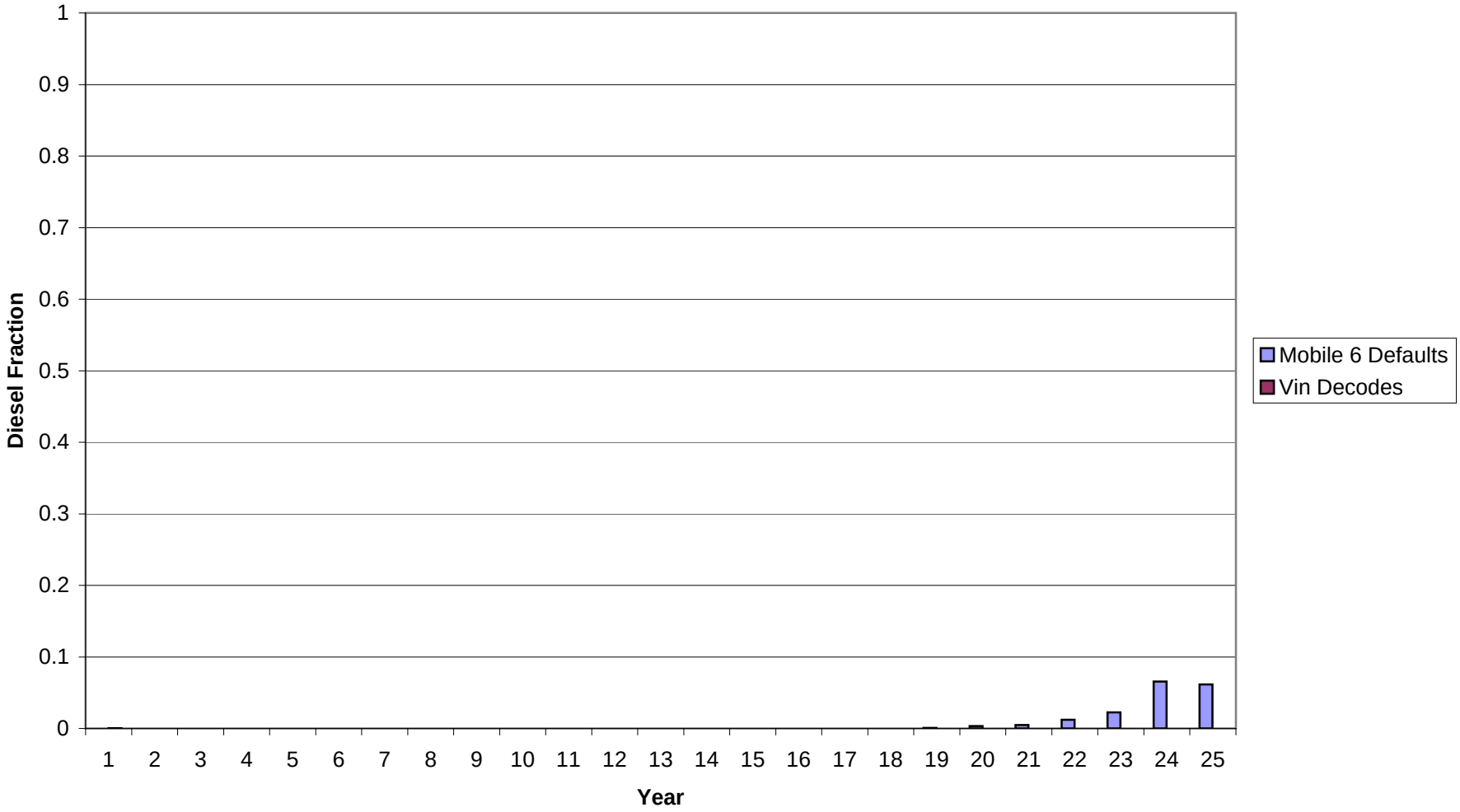
ATTACHMENT 5

2005 Diesel Fractions
District of Columbia
Vehicle Type = LDT1



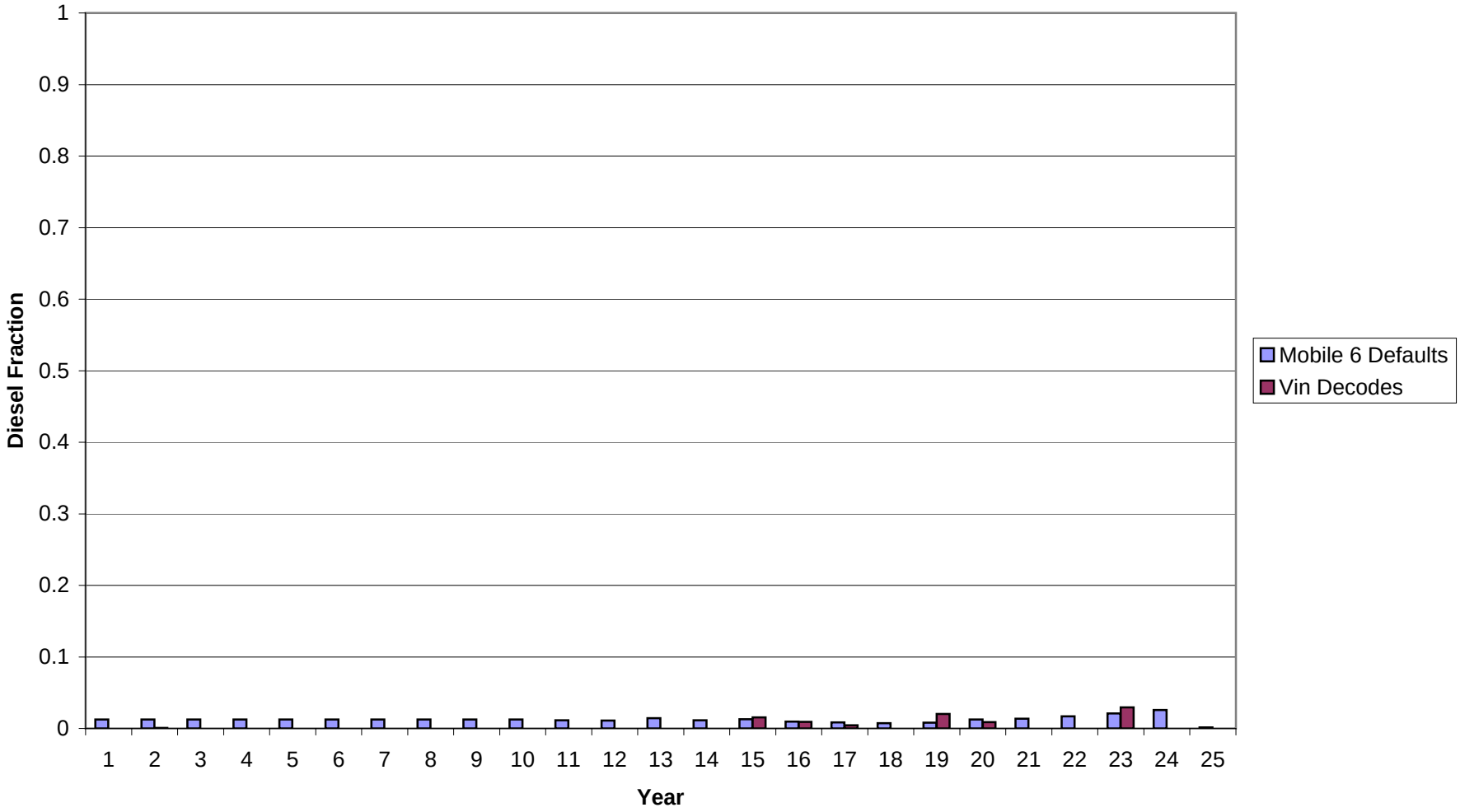
ATTACHMENT 5

2005 Diesel Fractions
District of Columbia
Vehicle Type = LDT2



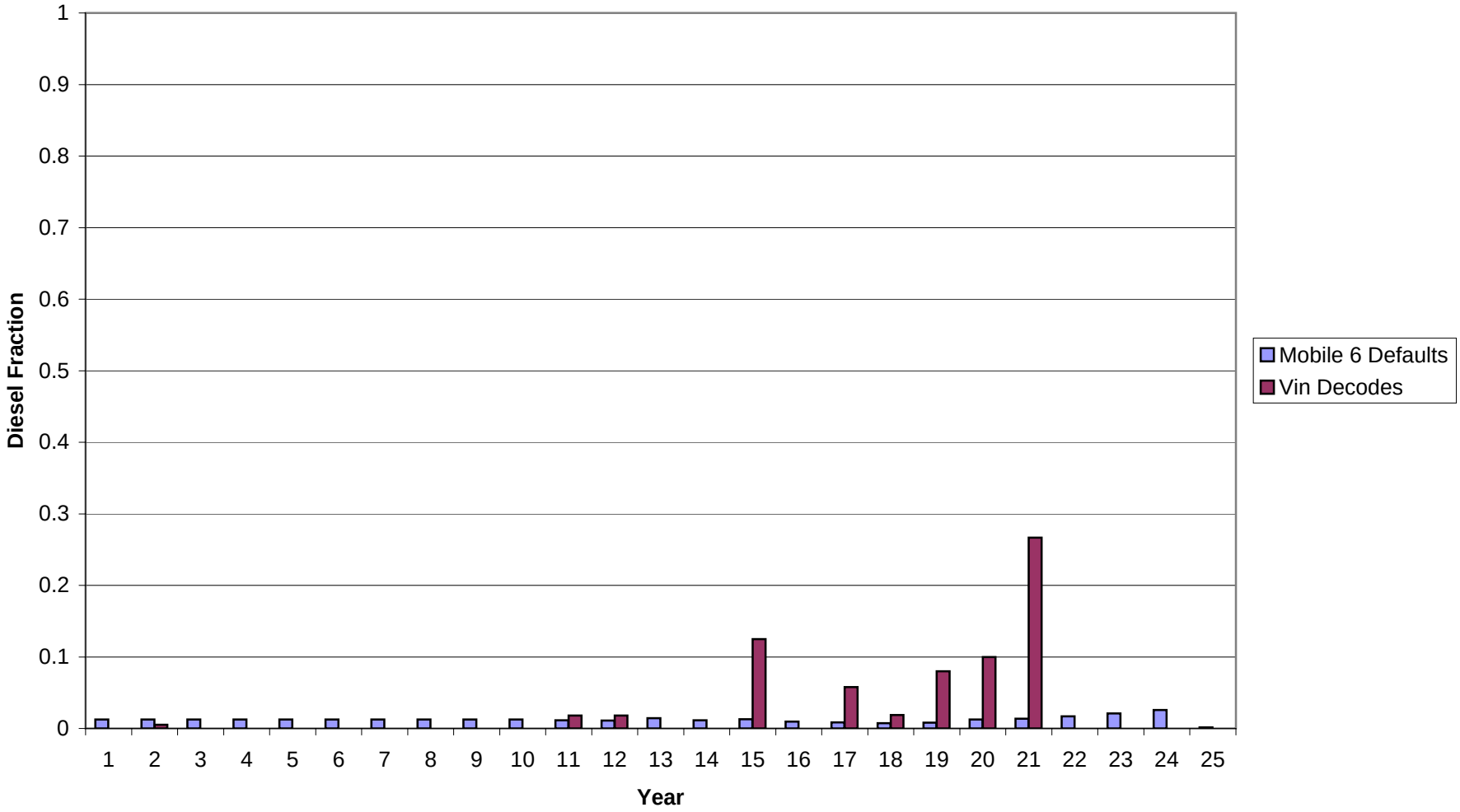
ATTACHMENT 5

2005 Diesel Fractions
District of Columbia
Vehicle Type = LDT3

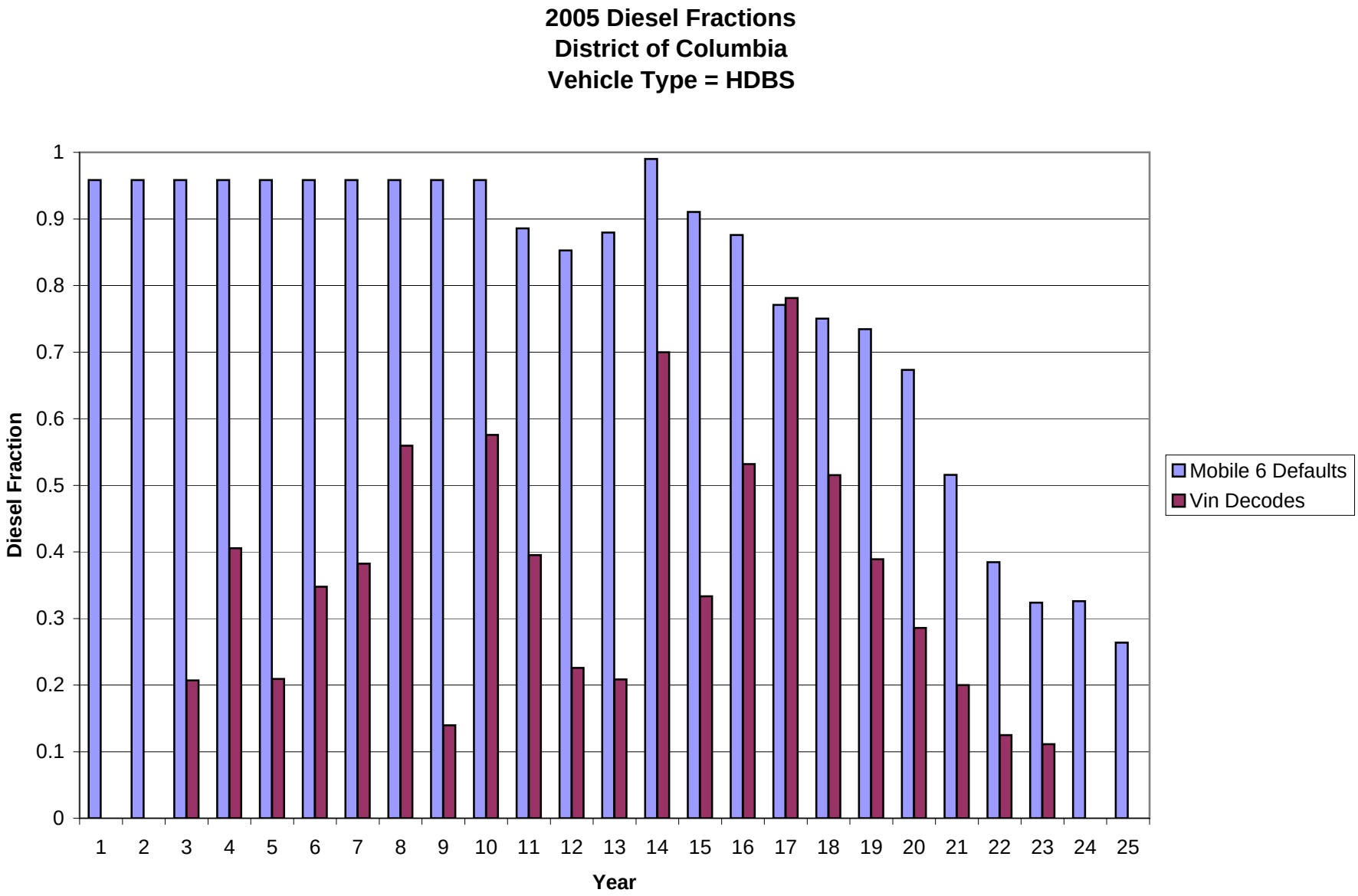


ATTACHMENT 5

2005 Diesel Fractions
District of Columbia
Vehicle Type = LDT4

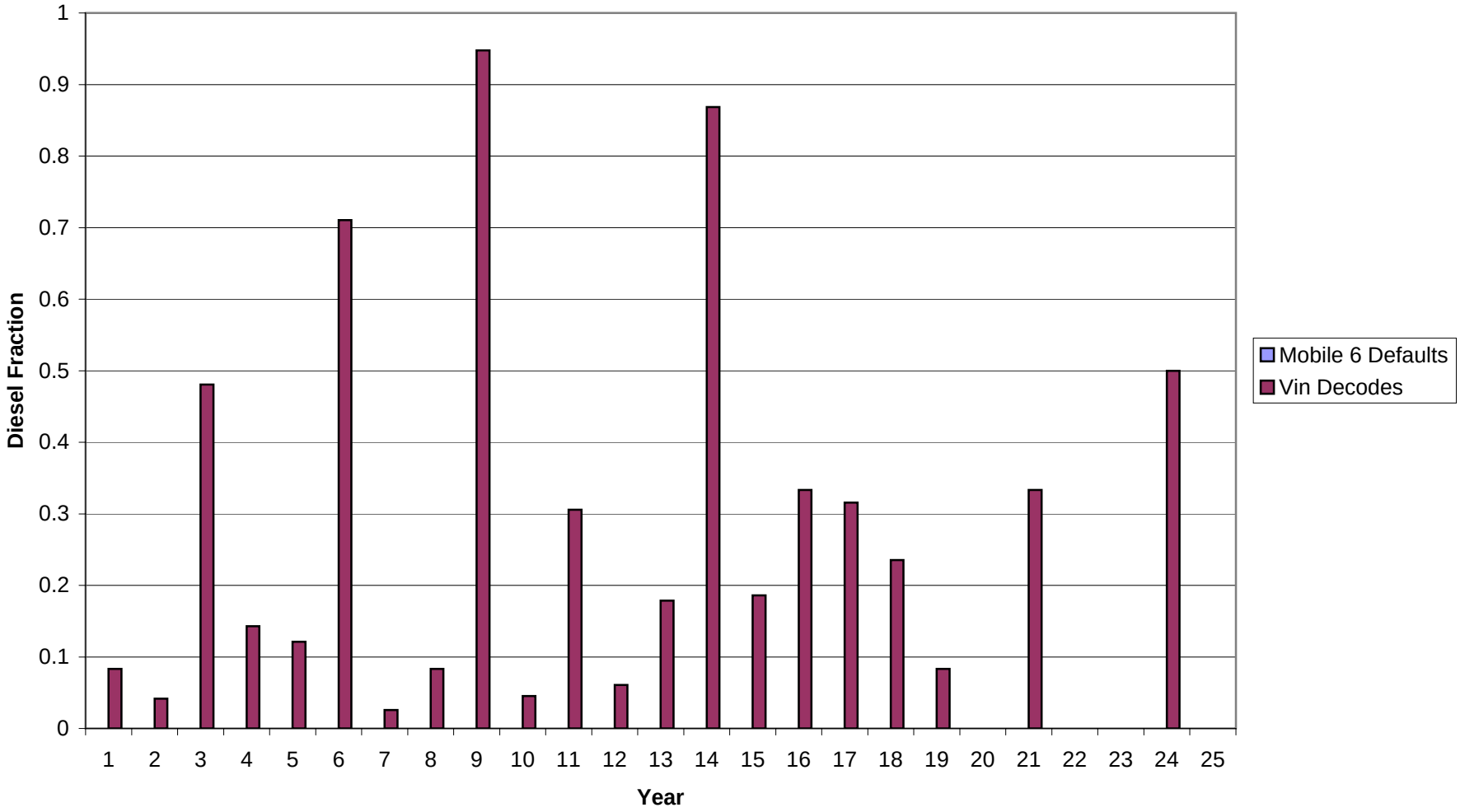


ATTACHMENT 5



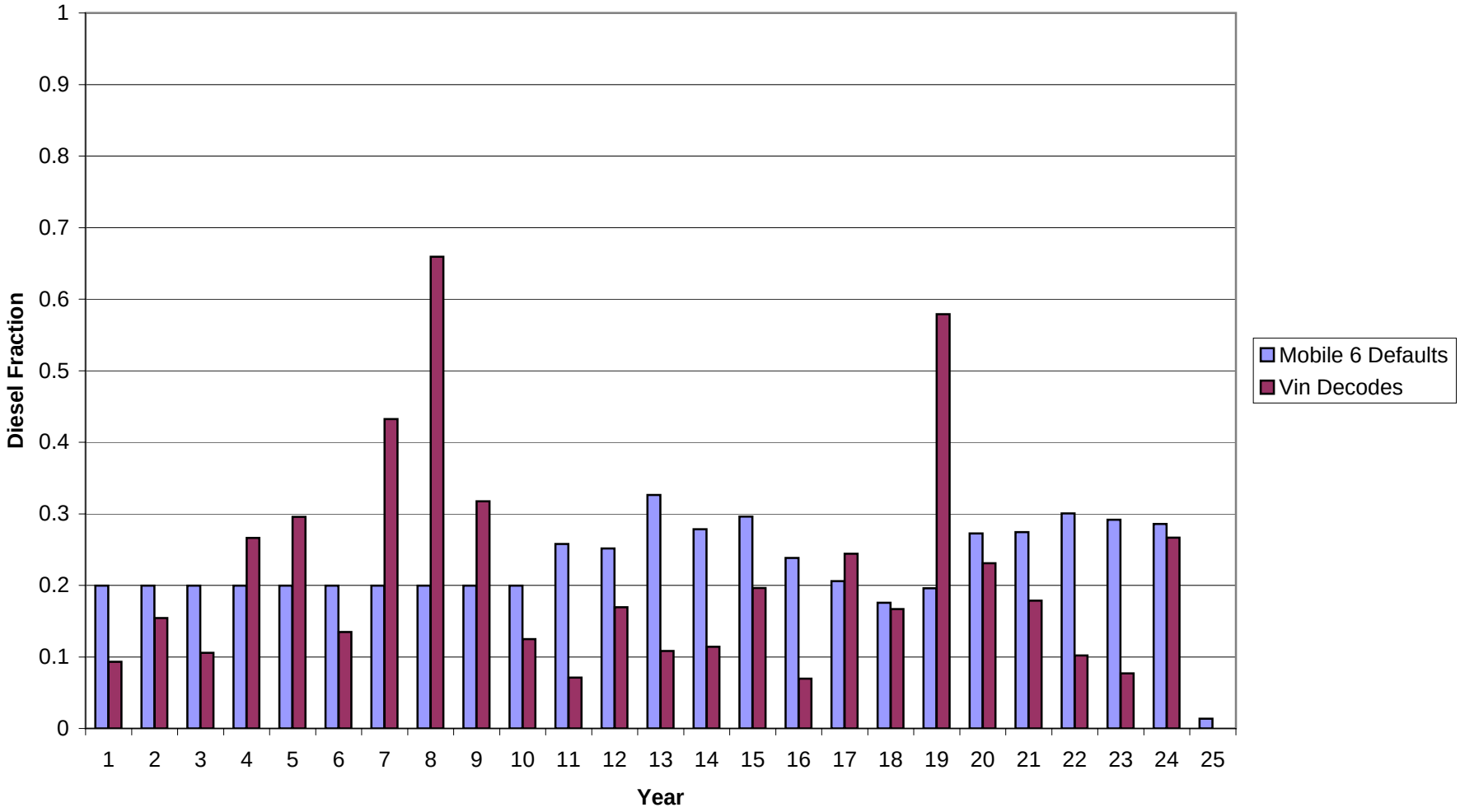
ATTACHMENT 5

2005 Diesel Fractions
District of Columbia
Vehicle Type = HDBT



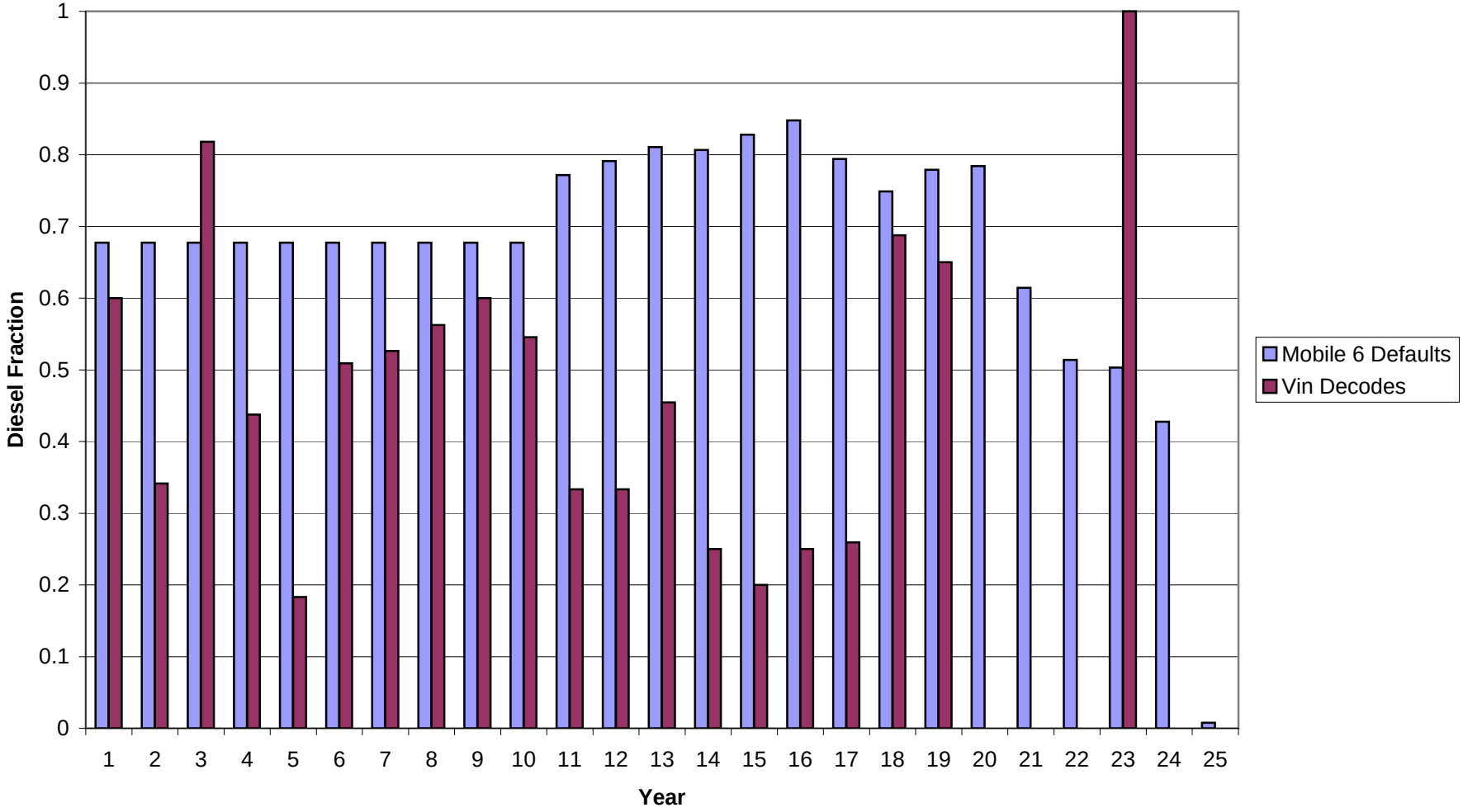
ATTACHMENT 5

2005 Diesel Fractions
District of Columbia
Vehicle Type = HDV2B



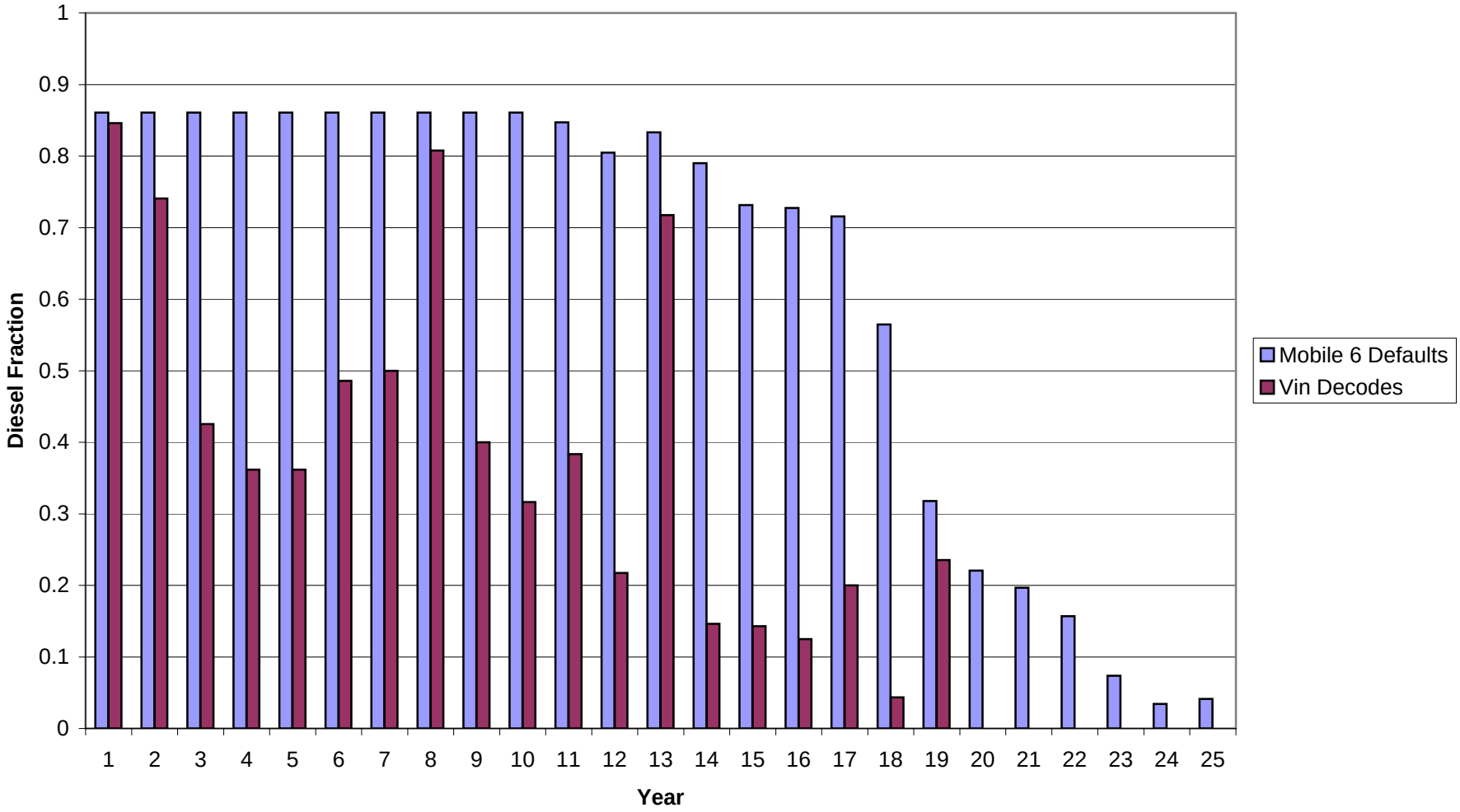
ATTACHMENT 5

2005 Diesel Fractions
District of Columbia
Vehicle Type = HDV3

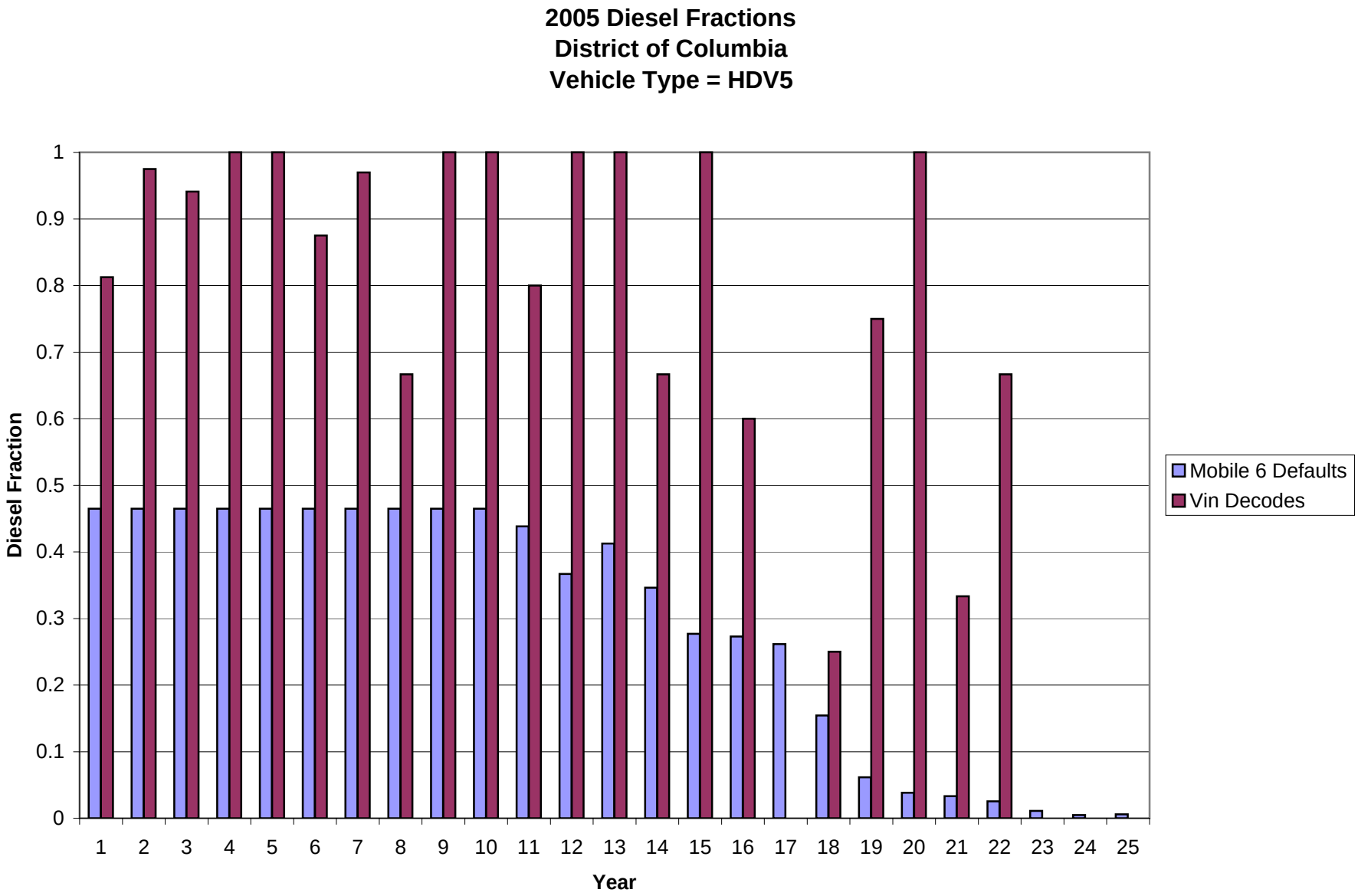


ATTACHMENT 5

2005 Diesel Fractions
District of Columbia
Vehicle Type = HDV4

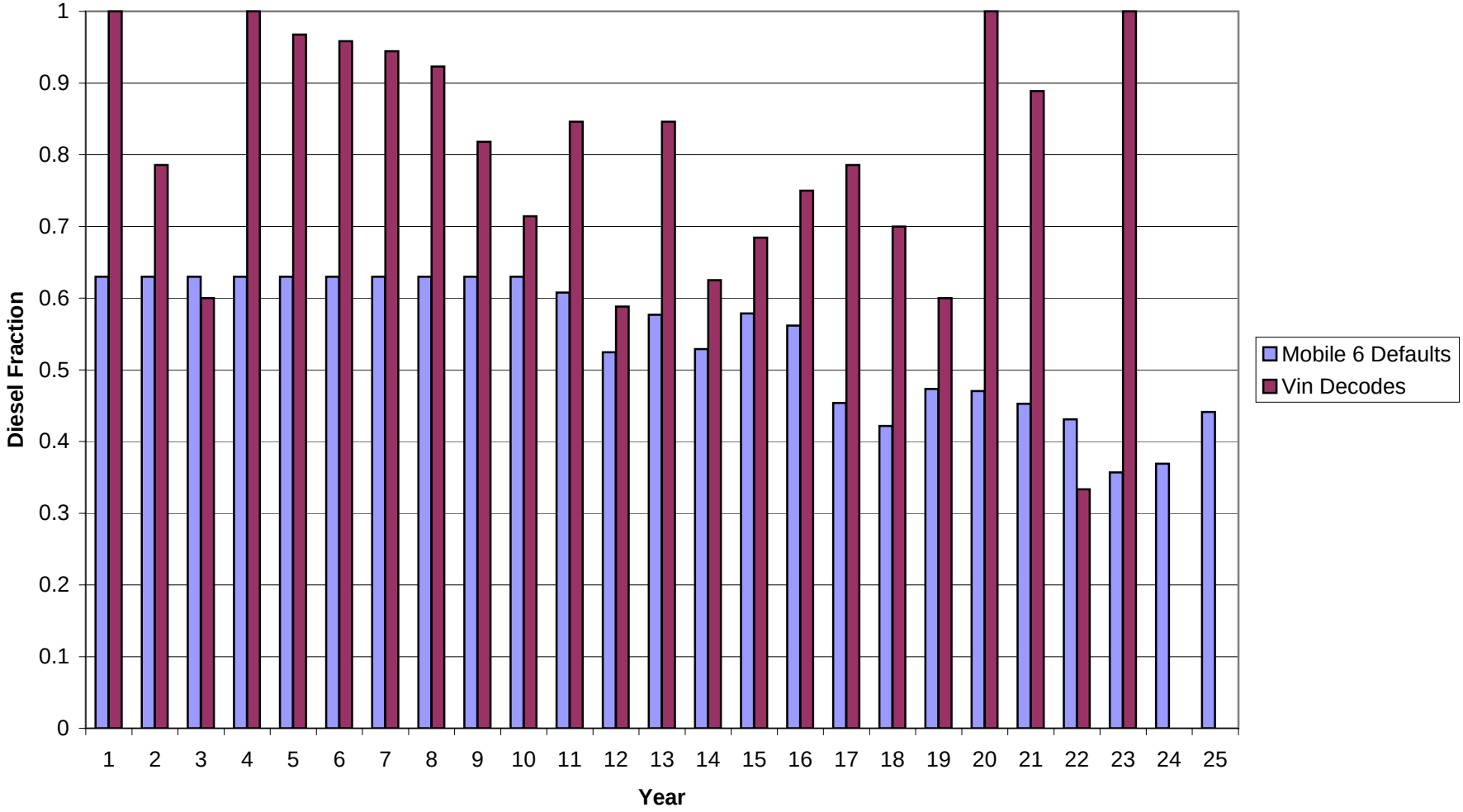


ATTACHMENT 5

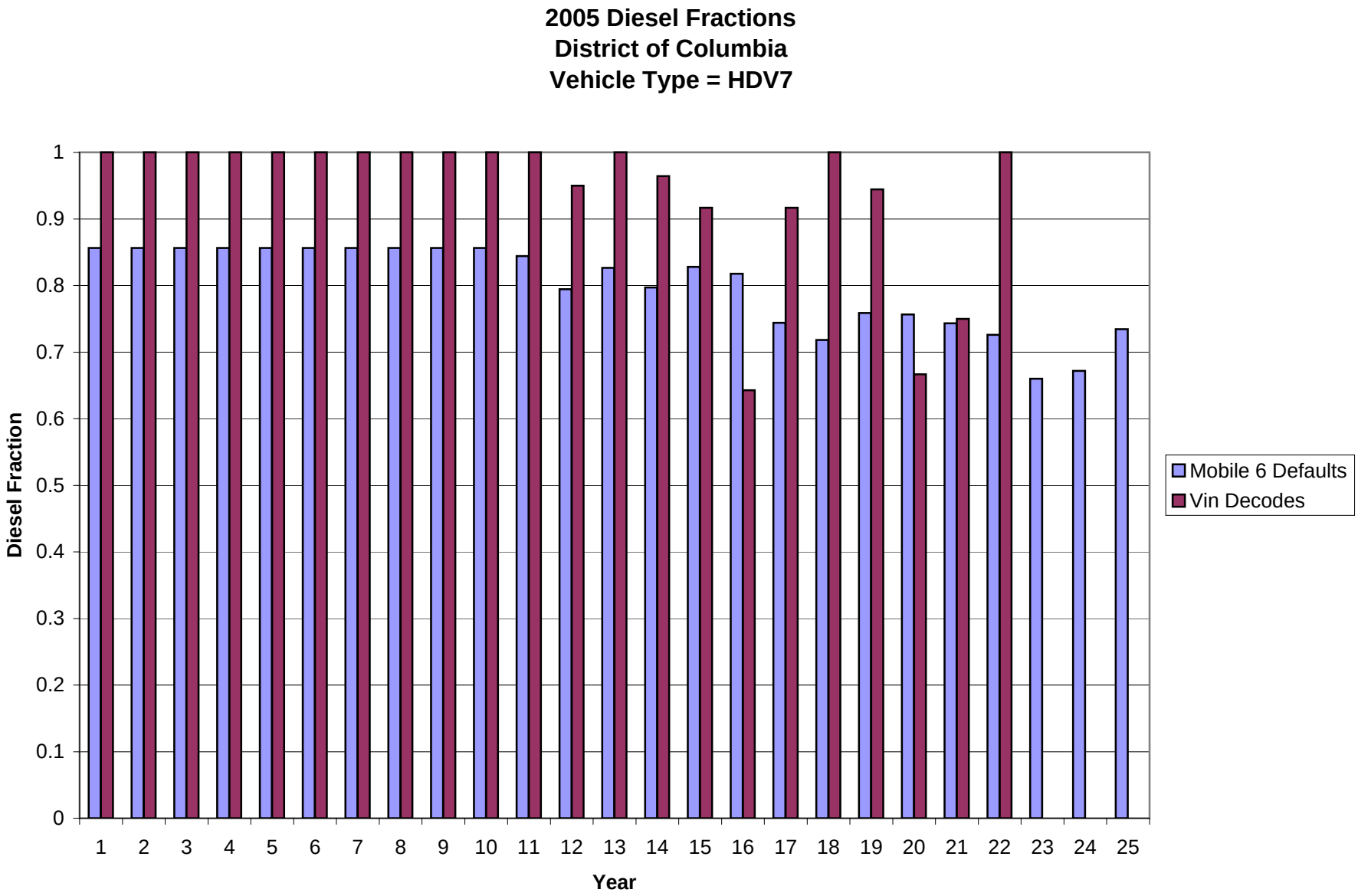


ATTACHMENT 5

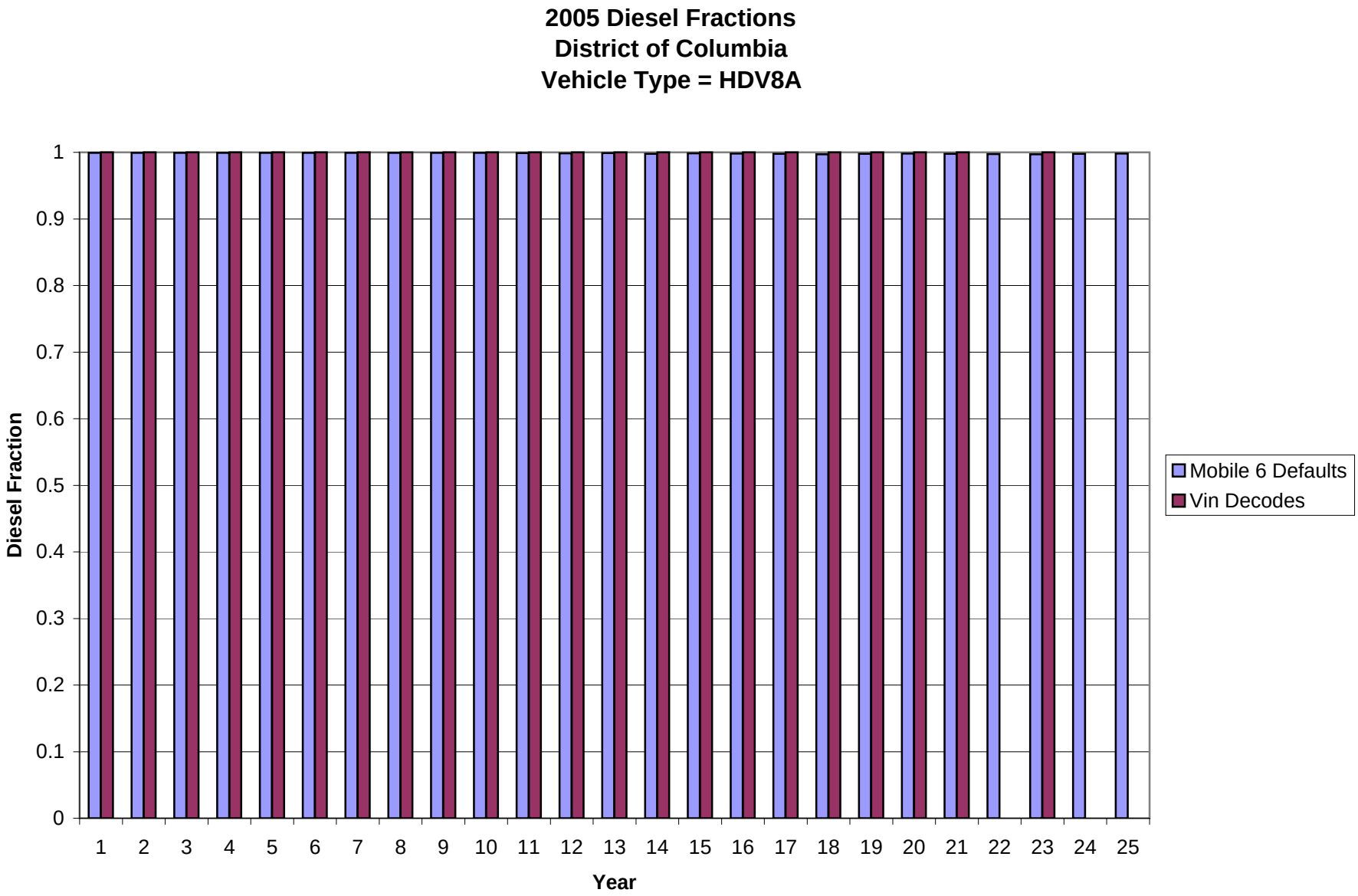
2005 Diesel Fractions
District of Columbia
Vehicle Type = HDV6



ATTACHMENT 5



ATTACHMENT 5



ATTACHMENT 5

2005 Diesel Fractions
District of Columbia
Vehicle Type = HDV8B