Appendix D

Detailed Discussion of National Exploratory Analyses

D. Relationship between National Blood Lead Data and Explanatory Variables

D.1 Analyses of National Blood Lead Data by Demographic Variables

Demographic information from the 2000 U.S. Census is being utilized in both the high and low resolution models, with data being acquired at the county level for the entire nation and at the Census tract level for Massachusetts. Initially, 50 demographic variables within 10 general categories are being explored, most of which had been previously used by Battelle in a CDC-sponsored study to predict risk of elevated blood-lead concentrations at the census tract level (Strauss, 2001). In many cases, these variables are constructed from counts or summary statistics published in the detailed U.S. Census Tables. For example, within each geographic area, the census provided the number of houses that were built before 1950 and the median income of all households. In order for this study to draw comparisons from tract to tract and/or county to county, however, the census variables need to be manipulated in a fashion that depended upon the format of the variable.

D.1.1 Income Variables

Initial results from exploring and modeling the income-related variables are presented in Tables A1 to A9. Highlights from the analysis of each exploratory variable are listed below.

Median Family Income – The relationship between the proportion of children with blood lead level ≥ 10 µg/dL and Median Family Income becomes increasingly negative with each successive time period, as probability of an EBLL declines as family income increases. Probability of a blood lead level ≥ 10 µg/dL declines steadily across the four periods. Mean and Median Family Income show just a slight decrease from the initial time periods to the later three periods. Median Family Income is significant in all four models when considered alone, and also consistently significant when crossed with the time variables (time, time squared, and categorical time period).

Median Household Income – Similar relationships between the proportion of children with blood lead level ≥ 10 µg/dL and Median Household Income are seen across the four time periods, with probability of an EBLL declining a bit more as household income increases in more recent years. Blood lead levels decline steadily across the four periods. Mean and Median Household Income show just a slight decrease from the initial time periods to the later three periods. Median Household Income is significant in all four models. When crossed with the time variables, most interactions are significant, although some of the models failed to converge.

Median Per Capita Income – A bit more consistent relationship is seen between the proportion of children with blood lead level ≥ 10 µg/dL and Median Per Capita Income, with probability of an EBLL decreasing as median per capita income decreases. Mean and median Median Per Capita Income show a slight decreases from the initial time periods to the later three periods. Median Per Capita Income is significant in Model 2 for probability of blood lead level ≥ 10 µg/dL. In the models using only a linear time variable, Median Per Capita Income was significant in Models 1 to 3, but not 4. The quadratic time variable model yielded significicant terms in all models except 4, in which only the interaction term with the time squared variable was significant.

Percent Units with No Household Earnings – The relationship between the proportion of children with blood lead level ≥ 10 µg/dL and Percent of Units with No Household Earnings becomes more positive over time, with probability of an EBLL increasing more steeply over time as percent of units with no household earnings increases. This is driven mainly by large decreases in probability of an EBLL in counties with very low percentages of no household earnings. Mean and Percent of Units with No Household Earnings are stable across the four time periods. Percent of Units with No Household Earnings is significant in models 1 to 4 when considered without time and remains significant in the models with the time variables added.

Percent Units with No Household Wage – These findings are very similar to the previous variable. The relationship between the proportion of children with blood lead level ≥ 10 μg/dL and Percent of Units with No Household Wage becomes more positive over time, with probability of an EBLL increasing more steeply over time as percent of units with no household earnings increases. Mean and Percent of Units with No Household Wage remain stable across time. Percent of Units with No Household Wage is significant in models 1 to 4 when considered without time and remains significant in the models with the time variables added.

Percent Households on Public Assistance – Consistent relationships between the proportion of children with blood lead level ≥ 10 μg/dL and Percent of Households on Public Assistance are seen across the four time periods, with probability of an EBLL increasing slightly as Percent of Households on Public Assistance increases. Mean and median Percent of Households on Public Assistance are stable over tme. Percent of Households on Public Assistance is significant in all models when considered without time and remains significant in the models with the time variables added.

Percent Households Below Poverty Line – Consistent relationships between the proportion of children with blood lead level ≥ 10 μg/dL and Percent of Households Below the Poverty Line are seen across the four time periods, with probability of an EBLL increasing very slightly as Percent of Households Below the Poverty Line increases. Mean and median Percent of Households Below the Poverty Line increase from the initial time period to the later three periods. Percent of Households Below the Poverty Line is significant in all models, except Model 1 when considered alone in which it did not converge.

Percent Units with Family Income Below Poverty Line – Consistently nearly flat relationships are present between the proportion of children with blood lead level ≥ 10 μg/dL and Percent of Units with Family Income Below the Poverty Line across the four time periods. Mean and median Percent of Units with Family Income Below the Poverty Line increase from the initial time period to the later three periods. Percent of Units with Family Income Below the Poverty Line is significant in Models 1 to 4 when considered alone and when modeled with the three time variables.

Percent Units Spending Less than Five Years in Poverty – There is a more positive relationship between the proportion of children with blood lead level ≥ 10 μg/dL and Percent of Units Spending Less than Five Years in Poverty in the 1995-1999 time period, that becomes flatter in the later three periods. Mean and median Percent of Units Spending Less than Five Years in Poverty increase just slightly from the initial time period to the later three periods. Percent of Units Spending Less than Five Years in Poverty is significant in Models 2 to 4 when considered alone with Model 1 not converging. All four models are significant when the linear time variable is added. When the quadratic time variable is added, Percent of Units Spending Less than Five Years in Poverty is significant in Models 1 and 3 while Models 2 and 4 fail to converge. Similarly when the categorical time variable is used, Percent of Units Spending Less than Five Years in Poverty is significant in Models 2 and 3, but Models 1 and 4 do not converge.

A few trends stand out across these nine related variables. One, average levels of some poverty statistics increase slightly from the 1995-1999 time period to the later three periods. This may indicate a slightly different mix of counties included in the 1995-1999 time period. Also, each of the nine variables is significant in predicting probability of elevated blood lead levels in nearly all the models. As seen in

Tables 4-1 to 4-4, the variable Percent No Household Wage with a quadratic time variable provides the best fit for Models 1 to 3, with Percent of Households with No Earnings combined with the linear time variable providing the best fit for Model 4.

D.1.2 Race Variables

Results from the eight race variables explored are presented in Figures/Tables A10 to A17, with highlights listed below.

Percent American Indian and Alaskan Native Alone – Most counties have very low percentages of American Indian and Alaskan Natives, with the 90th percentile averaging 1.2 percent. For counties with above 30 percent American Indian and Alaskan Native, there are very similar trends and levels of proportion of children with blood lead level ≥ 10 μg/dL. The mean percent of American Indian and Alaskan Native decreases slightly from the 1995-1999 time period to the later three periods. All models with Percent of American Indian and Alaskan Native failed to converge.

Percent Asian Alone – The relationship between proportion of children with blood lead level ≥ 10 μg/dL and percent Asian is negative in all time periods but flattens in later periods as the probability of EBLLs decreases. Mean percent Asian declines slightly from the initial time period to the later three periods. Percent Asian considered alone is significant in Models 1 and 2, not significant in Model 4, and failed to converge in Model 3. When considering a linear, quadratic, and categorical time variables, Percent Asian is significant in Models 1 to 3.

Percent Black Alone – There is a strong positive relationship between proportion of children with blood lead level ≥ 10 μg/dL and percent Black as the probability of EBLL increases as percent Black increases; however, this relationship is flattening and becoming more linear over time. Mean and median percent Black increases slightly from the initial time period to the later three periods, perhaps indicating that counties with higher percentage of Black populations are included in the later time periods. Percent Black is significant in all four models when considered alone. It is also significant in all models that converge when the models with the time variables added are run.

Percent White Alone – The relationship between proportion of children with blood lead level ≥ 10 μg/dL and percent White changes from negative in the 1995-1999 period to flat by the most recent time period. Mean and median percent White decrease slightly from the initial time period to the later three periods. Percent White is significant in Models 2 to 4, but not Model 1 when considered without time. It remains significant in Models 2 to 4 when the linear time variable is added, while Model 1 does not converge. Percent White is significant in Models 1 and 3 when the quadratic time variable is added, while Percent White is not significant in any models with the categorical time variable, although the interaction terms are significant.

Percent Native Hawaiian and Other Pacific Islander Alone – Proportion of children with blood lead level ≥ 10 μg/dL appears to decline consistently as percent Native Hawaiian increases across all four time periods; however, probability of EBLLs is very low across time periods for any counties with 10 or more percent Native Hawaiian. Mean and median percent Native Hawaiian remain fairly stable across time periods, with mean of 0.04 and median of 0.0. Percent Native Hawaiian is significant in Models 1 and 3 when considered alone. With the linear time variable, Percent Native Hawaiian is significant in Models 2 to 4. With the quadratic time variable, Percent Native Hawaiian is significant in Models 2 and 4. With the categorical time variable, Percent Native Hawaiian is significant in Models 1 to 3.

Percent Other Race Alone – Proportion of children with blood lead level ≥ 10 µg/dL declines as Percent Other Race increases across all four time periods; however, the decline is steeper in the 1995-2000 and 2000-2002 time periods. Mean and median percent Other Race remain fairly stable across time periods, although the average percentages are very low. Percent Other Race is significant in Models 1 to 3 when considered alone. With the linear, quadratic, and categorical time variables, Percent Other Race is significant only in Model 1, although many of the interaction terms are significant.

Percent Multiple Races – Proportion of children with blood lead level ≥ 10 µg/dL declines as Percent Multiple Race increases across all four time periods; however, the decline is steeper in the 1995-2000 time periods. Mean percent Multiple Races declines slightly from the initial time period to the later three periods. Percent Multiple Races is significant in Model 2 when considered alone. With the linear and quadratic time variables, Percent Other Race is significant in Models 1 to 3. With the categorical time variable, Percent Other Race is only significant in Model 1, although some interaction terms in Models 3 and 4 are significant.

Percent Hispanic – The relationship between proportion of children with blood lead level ≥ 10 µg/dL and percent Hispanic is consistent and slightly negative across the four time periods. Mean percent Hispanic increases significantly from the initial time period (3.99%) to the later three periods (5.53 to 5.94%). Percent Hispanic is significant only in Models 1 and 2 when considered without time. No models converged with the linear time variable added and only the interaction terms in Models 3 and 4 were significant when the quadratic time variable was included. Only in Model 1 with the categorical time variable is Percent Hispanic significant.

The eight race variables are not as consistently predictive of blood lead levels as the income variables. Additionally, some display differing relationships across the time periods, which may be related to changes in the distributions of the variables over the time periods. Three different variables provided best-fitting models as seen in Tables 4-1 to 4-4. Percent Hispanic with the categorical time variable yielded the lowest log-likelihood ratios for Models 1 to 3 and Percent Asian with the categorical time variable for Model 4. Different variables were selected for the models after accounting for differences in degrees of freedom across the different time models. Percent Black with the quadratic time variable was selected for Model 1. Percent Multiple Race with the quadratic time variable was selected for Model 2. Percent Asian with the linear time variable was selected for Models 3 and 4.

D.1.3 Housing Cost Variables

Figure/Table A19 and A20 contain the exploratory results of the two variables related to housing cost.

Median Rent – Proportion of children with blood lead level ≥ 10 µg/dL consistently decline as Median Rent increases across all four time periods. Mean and median Median Rent decline slightly from the initial time period to the later three periods. Median Rent is significant in Models 1 to 4 both with and without the time variables. The only exception was Model 4 with the linear time variable, which failed to converge.

Housing Value – Proportion of children with blood lead level ≥ 10 µg/dL consistently decline as Housing Value increases across all four time periods, although the slope of the decline appears to be decreasing with each successive time period as the intercepts decrease. Mean and median Housing Value decline from the initial time period to the later three periods. Median Rent is significant in Models 1 to 4 both with and without the time variables. The only exception was Model 2 with the categorical time variable, which failed to converge.

As reported in Tables 4-1 to 4-4, Median Rent with the categorical time variables provided the lowest log-likelihood statistics for Models 1 and 2. For both models, Median Rent with the quadratic time variable was selected for the multivariate analysis after adjusting for degrees of freedom differences. For Models 3 and 4, Median Rent with the quadratic time variable yielded the lowest log-likelihood statistics and was selected for the multivariate analysis.

D.1.4 Occupancy Variables

Figure/Table A18 contains results of exploring Percent of Rental Units and Figure/Table A21 contains results of exploring Percent of Vacant Units.

Percent Rented Units – There is a negative relationship between proportion of children with blood lead level ≥ 10 µg/dL and Percent Rented Units in the 1995-1999 time periods; however, the relationship becomes very nearly flat in the later three periods. Mean and median percent Rented Units declines very slightly from the initial time period to the later three periods. Percent Rented Units is significant in Models 2 and 3 when considered alone; is significant in Models 1, 2, and 4 with the linear time variable; is significant in Models 3 and 4 with the quadratic time variable; and is significant in Models 2 and 4 with the categorical time variable.

Percent Vacant Units – The relationship between proportion of children with blood lead level ≥ 10 µg/dL and percent Vacant Units is slightly negative in the first two time periods, but becomes slightly positive in the two more recent periods. Mean and median percent Vacant Units increase slightly from the initial time period to the later three periods. Percent Vacant Units is significant in Models 2 to 4 with Model 1 not significant, when considered alone and with the linear time variable added. When the quadratic time variable was added, Percent Vacant Units was significant in Models 3 and 4 while the interaction with time squared is significant in Models 1, 2, and 4. When the categorical time variable was added, Percent Vacant Units was only significant in Model 1, but the interaction terms were significant in all models.

The log-likelihood statistics in Tables 4-1 to 4-4 report the lowest values for Percent Vacant Units with the categorical time variable for Models 1 and 3, Percent Rented units with the categorical time variable for Model 2, and Percent Rented units with the linear time variable for Model 4. For Models 1 to 3, however, different variables were selected for the consideration in the final models. Percent Vacant Units with the quadratic time variable was selected for Model 1. Percent Rented Units with the linear time variable was selected for Model 2. Percent Rented Units with the quadratic time variable was selected for Model 3.

D.1.5 Single Parent Status Variable

Exploratory analysis results are contained in Figure/Table A22.

Percent Single Parent Households – The relationship between proportion of children with blood lead level ≥ 10 µg/dL and Percent Single Parent Households is consistently positive across the four time periods. Mean and median percent Single Parent Households decrease very slightly across the four time periods. Percent Single Parent Households is significant across nearly all models, although Model 3 failed to converge with the quadratic and categorical time variable models.

D.1.6 Housing Age Variables

A number of variables related to housing age by county were investigated to identify those that best predict children's blood lead levels. The results of the 12 variables explored are contained in Figure/Tables A23 to A34.

Median Year Built – Consistent relationships between proportion of children with blood lead level ≥ 10 µg/dL and Median Year Built are seen across the four time periods with blood lead levels declining as age of housing increases. Mean and median Median Year Built increase by about a year from the 1995-2000 time period to the later three periods. Median Year Built is significant in all models except Model 1 with no time variables, which failed to converge. Nearly all interaction terms in Models 1 and 2 are also significant, whereas in Models 3 and 4 many of the interaction terms were not significant.

Median Year Occupied Units were Built – The results for Median Year Occupied Units were Built are very similar to those observed for Median Year Built. Consistent relationships between proportion of children with blood lead level ≥ 10 µg/dL and Median Year Occupied Units were Built are seen across the four time periods with blood lead levels declining as age of housing increases. Mean and median Median Year Occupied Units were Built increase by about a year from the 1995-2000 time period to the later three periods. Median Year Occupied Units were Built is significant in all models. Only the Median Year Occupied Units were Built by time interaction term was not significant in Models 3 and 4.

Percent Units Built Before 1940 – Mainly consistent relationships between proportion of children with blood lead level ≥ 10 µg/dL and Percent Units Built Before 1940 are seen across the four time periods with blood lead levels increasing as the percentage increases. Mean and median Percent Units Built Before 1940 decrease from the 1995-2000 time period to the later three periods with the median dropping by over three percent (17.7 to 14.4). Percent Units Built Before 1940 is significant in all models, although Model 2 did not converge when the quadratic time variable was included.

Percent Units Built Before 1950 – The relationship between proportion of children with blood lead level ≥ 10 µg/dL and Percent Units Built Before 1950 is positive across the four time periods with blood lead levels increasing as the percentage increases, although it appears that the slope is decreasing in the two most recent periods. Mean and median Percent Units Built Before 1950 decrease from the 1995-2000 time period to the later three periods with the median dropping by over three percent. Percent Units Built Before 1950 is significant in all models, but failed to converge in Model 1 with no time variables and Model 3 with the quadratic time variable. In Model 4, the interaction with the linear time variable is not significant in the two runs with the linear and quadratic time variables.

Percent Units Built Before 1960 – Similar results are seen with this variable as with the Percent Units Built Before 1950. Percent Units Built Before 1960 is significant in all Models except Model 3 that failed to converge with the no time variable option and Model 4 that failed to converge for the quadratic time variable option.

Percent Units Built Before 1970 – Again, these results are very similar to the other Percent Units Built Before variables. Each time period has a consistently positive relationship between proportion of children with blood lead level ≥ 10 µg/dL and percent built before 1970 and mean and median percentages decline from the 1995-2000 time period to the others. Percent Units Built Before 1970 is significant in all models. The interaction between Percent Units Built Before 1970 and the linear time variable is not significant in Models 2 to 4 for the run with the linear time variable and in Models 2 and 3 for the run with the quadratic time variable.

Percent Units Built Before 1980 – Results are very similar to those for Percent Units Built Before 1970. Percent Units Built Before 1980 is significant in all models. Again, the interaction between Percent Units Built Before 1980 and the linear time variable is not significant in a number of models for the options with the linear and quadratic time variables.

Percent Occupied Units Built Before 1940 – The results of the exploratory analyses on this variable are very similar to those seen from the Percent Units Built Before 1940 variable, and most of the other Percent Units Built Before variables. Percent Occupied Units Built Before 1940 is significant in all models, however Model 4 failed to converge in the model without a time variable and Model 2 failed to converge in the model with the categorical time variable.

Percent Occupied Units Built Before 1950 – Similar results. Percent Occupied Units Built Before 1950 is significant in all models except Model 3 in model with no time variable. The interaction between Percent Units Built Before 1970 and the linear time variable is not significant in Models 2 to 4 for the run with the linear time variable and in Models 2 and 3 for the run with the quadratic time variable.

Percent Occupied Units Built Before 1960 – Similar results. Percent Occupied Units Built Before 1960 is significant in all Models that converged. Models 1 and 2 did not converge for no time variable; Models 3 and 4 did not converge for the linear time variable model; and Model 4 did not converge for the quadratic time variable option.

Percent Occupied Units Built Before 1970 – Similar results. As with the other variables in this family, Percent Occupied Units Built Before 1970 is significant in all models, except those that failed to converge, which we Model 3 with no time variable and Model 2 with the quadratic time variable. Again, the interactions between the Percent Occupied variable and the linear time variable are not consistently significant in the models with the linear and quadratic time variables.

Percent Occupied Units Built Before 1980 – Similar distributional and significance results.

The exploratory results of all 10 of the percentage variables appeared to be quite similar. Whether percent of all housing units or percent of occupied units was used did not seem to make a difference in the results. Similarly, the cutoff year used also did not seem to impact results. Three different percentage variables were among the best-fitting models. As seen in Tables 4-1 to 4-4, Percent Built Before 1960 provided the best fit for Models 1 and 2 in terms of both log-likelihood statistics and after adjustment for degrees of freedom. Percent Occupied Units built Before 1950 provided the best fit for Model 3, while Percent Occupied Units built Before 1940 provided the best fit for Model 4. Thus, it appears that the cutoff years 1940 through 1960 for housing age generally provide better model fits, depending on the model.

D.1.7 Children's Age Variables

Figure/Table A35 and A36 contain the exploratory results for percentage and number of residents less than six years old, respectively.

Percent Less Than 6 Years of Age – A clear difference in the relationship between proportion of children with blood lead level ≥ 10 μg/dL and Percent Less Than 6 Years of Age is seen between the 1995-1999 time period and the later three periods. The 1995-1999 period has a strong positive relationship between the two variables with areas with higher percentages of young children associated with higher probabilities of EBLLs, while the relationship if flat to slightly negative in the later three periods. The mean and median percents are fairly stable across the time periods. Without accounting for time, Percent Less Than 6 Years of Age is significant only in Models 1 and 2. With the addition of any of the three time variables, Percent Less Than 6 Years of Age is significant only in Model 1 although the interaction with the linear time variable term is not significant in the models with the linear and quadratic time variables.

Number Less Than 6 Years of Age – The relationship between proportion of children with blood lead level ≥ 10 µg/dL and Number Less Than 6 Years of Age is highly positive for the first two periods, but the slopes appear to decline in the latter two periods, with the 2002-2003 period have the least positive slope. Mean and median Number Less Than 6 Years of Age decrease steadily across the four time periods, perhaps indicating that additional smaller counties are included in the later years. Not accounting for time, Number Less Than 6 Years of Age is significant in all models. With the linear time variable added, Number Less Than 6 Years of Age is significant in Models 1 to 3 and the interaction with the time variable is as well. With the quadratic time variable, only Model 3 and all terms were significant. With the categorical time variable, only Models 1 and 3 converged and all terms are significant in both.

As reported in Tables 4-1 to 4-4, the Percent Less Than 6 Years of Age variable with the quadratic time variable provided the best fit for all four models after adjusting for degrees of freedom differences.

D.1.8 Education Level Variables

Exploratory analyses were conducted upon the four percentage variables. Results are detailed in Figure/Table A37 to A40.

Percent Residents with Less Than 9th Grade Education – Consistent relationships between proportion of children with blood lead level ≥ 10 µg/dL and Percent Residents with Less Than 9th Grade Education are seen across the four time periods with blood lead levels decreasing as the percentage increases, although it appears that the slope of the relationship is flattening over time. Mean and median Percent Residents with Less Than 9th Grade Education increase from the 1995-2000 time period to the later three periods with the mean increasing about one percentage point. Not accounting for time, Percent Residents with Less Than 9th Grade Education is significant in Models 1 and 2 and not significant in Models 3 and 4. With the linear time variable included, Percent Residents with Less Than 9th Grade Education is significant in Models 1 and 2, although the interaction with the time variable is not significant in those models. With the quadratic time variable included, Percent Residents with Less Than 9th Grade Education is again significant in Models 1 and 2, although the interaction with the time squared variable is significant in all four models. All models are significant with the categorical time variable included.

Percent Residents without a High School Degree – The relationship between proportion of children with blood lead level ≥ 10 µg/dL and Percent Residents without a High School Degree is somewhat positive in the 1995-1999 period but nearly flat in the later three time periods. Mean and median Percent Residents without a High School Degree increases from the 1995-2000 time period to the later three periods. Not accounting for time, Percent Residents without a High School Degree is significant in Models 2 to 4, with Model 1 failing to converge. With the linear time variable included, Percent Residents without a High School Degree is significant in Models 1 to 3, although the interaction with the time variable is only significant in Model 1. With the quadratic time variable included, Percent Residents without a High School Degree and the interaction with the time squared term is significant in all four models. All models are significant with the categorical time variable included.

Percent Residents without College Education – The relationship between proportion of children with blood lead level ≥ 10 μg/dL and Percent Residents without College Education is slightly positive across all four time periods with blood lead levels increasing slightly as the percentage increases, although the 2000-2001 relationship is nearly flat. Mean and median Percent Residents without College Education increase from the 1995-2000 time period to the later three periods. Percent Residents without College Education is significant in Models 2 to 4, but failed to converge in Model 1, when not accounting for time. With the linear time variable included, Percent Residents without College Education and the interaction terms are significant in all models. With the quadratic time variable included, Percent Residents College Education and the interaction with the time squared term are significant in all four models. With the categorical time variable included, Percent Residents without College Education and all interactions are significant in Models 2 to 4, while Model 1 did not converge.

Percent Residents without College Degree – Similar results were obtained for this variable. The relationship between predicted proportion of children with blood lead level ≥ 10 μg/dL and Percent without College Degree is positive across time, with higher lead levels associated with slightly higher percentages. Mean and median Percent Residents without College Degree increase slightly from the 1995-2000 time period to the later three periods. Not accounting for time, Percent Residents without College Degree is significant in Models 1, 2, and 4, but failed to converge in Model 3. With the linear time variable included, Percent Residents without College Degree and the interaction terms are significant in Models 1 to 3, but only the interaction term is significant in Model 4. With the quadratic time variable included, Percent Residents without College Degree and the interaction with the time squared term are significant in Models 1 to 3, but only the interaction terms are significant in Model 4. With the categorical time variable included, Percent Residents without College Degree and all interactions are significant in Models 1 to 3, while Model 4 did not converge.

Similar exploratory results were seen across these four variables focusing on parents' education level. In general, higher lead levels are associated with less education. Also, the percentage of residents included in the analyses without various education levels increases slightly across the four time periods. After adjusting for difference in degrees of freedom, Tables 4-1 to 4-4 report that Percent Residents without College Degree with the quadratic time variable provides the best fit for Model 1, Percent Residents without Any College with the quadratic time variable provides the best fit for Models 2 and 3, and Percent Residents without Any College with the linear time variable provides the best fit for Models 4.

D.1.9 Population Variables

The detailed results of the exploratory analyses on the three variables in this category are included in Figure/Table A41 to A43.

Total Housing Units – The relationship between proportion of children with blood lead level ≥ 10 μg/dL and Total Housing Units is positive as predicted probability of EBLL increases as number of housing units increases. Mean and median Total Housing Units in each county decrease steadily across the four time periods. Total Housing Units and all interaction terms are significant in all models that converged.

Total Population – The results for Total Population are very similar to Total Housing Units. The relationship between proportion of children with blood lead level ≥ 10 μg/dL and Total Population is positive across the four time periods. Mean and median Total Population in each county decrease steadily across the four time periods. Total Population and all interaction terms are significant in all models that converged.

Housing Density – In general, the predicted proportion of children with blood lead level ≥ 10 µg/dL declines slightly as housing density increases, although the relationship is flattening over time. Mean and median Housing Density decline from the initial time period to the later three time periods. Without accounting for time, Housing Density is not significant in any models. With the linear time variable, Housing Density is not significant but the interaction term is significant in Models 1, 2, and 4, with Model 3 failing to converge. With the quadratic time variable, Housing Density is not significant but both interaction terms are significant in Models 2 to 4, with Model 1 not converging. Similarly, with the categorical time variable, Housing Density is not significant but most of the interaction terms are significant.

Generally, the Total Population and Total Housing Units variables yielded similar results. After adjusting for differences in degrees of freedom, Tables 4-1 to 4-4 report that Total Housing Units with no time adjustment provided the best fit for Model 1, Total Population with the quadratic time variable provided the best fit for Model 2, Housing Density with the quadratic time variable provided the best fit for Model 3, and Housing Density with the no time adjustment provided the best fit for Model 4.

D.2 Analyses of National Blood Lead Data by Environmental Variables

Environmental data analyzed for the national models included the ASPEN air modeling data, TRI data, and drinking water data. Presented below are exploratory analysis results from investigating these three variable types.

D.2.1 Air Lead Variables

The model estimates toxic air pollutant concentrations for every census tract in the continental United States, however – these data are only available for 1999. Three variables representing modeled estimates of toxic air pollutant concentrations were obtained from the ASPEN model for each county and investigated – average air lead level, median air lead level, and 95th percentile of air lead level. Figures/Tables A44 to A46 contain the detailed exploratory analysis results.

Average Air Lead – The Average air lead levels are impacted by a small number of very large values. For example, in the 1995-2000 data, the 90th percentile is .004 and the maximum is nearly 50 times higher at.213. Consistently positive relationships between the predicted proportion of children with blood lead level ≥ 10 µg/dL and average air lead levels are seen across the four time periods, generally with higher average air levels associated with higher blood lead levels. That relationship, however, appears to be flattening in the more current data. Mean and median Average Air Lead decrease very slightly across the time periods. Average Air Lead was significant in Models 2 through 4, but was not significant in Model 1. With the linear time variable added, Average Air Lead and the interaction term are both significant in Models 2 and 3 while only Average Air Lead is significant in Model 4 and neither term is significant in Model 1. With the quadratic time variable added, Average Air Lead is significant in Models 2 to 4 while the interaction with the time squared variable is not significant. Model 1 did not converge. With the categorical time variable added, Average Air Lead is significant in Modes 1, 2, and 4, with some of the interaction terms being significant and Model 3 not converging.

Median Air Lead – The relationship between proportion of children with blood lead level ≥ 10 µg/dL and Median Air Lead is similar to that seen with Average Air Lead, positive but flattening over time. Mean and median Median Air Lead decrease very slightly from the initial time period to the later time periods. Not accounting for time, Median Air Lead was significant in all models. With the linear time variable added, Median Air Lead and the interaction term are both significant in Models 2 and 3 while only Median Air Lead is significant in Model 1 and Model 4 did not converge. With the quadratic time variable added, Median Air Lead is significant in Models 2 to 4 while the interaction with the time squared variable is only significant in Model 2. Model 1 did not converge. With the categorical time variable added, Median Air Lead is significant in Modes 1 to 3, with only a few of the interaction terms being significant and Model 4 not converging.

Air Lead 95th Percentile – As with the other air lead variables, probability of EBLL increases as Air Lead 95th Percentile increases with a flattening of the relationship over time. Mean and median Air Lead 95th Percentile also decrease slightly from the initial time period to the later time periods. Not accounting for time, Air Lead 95th Percentile was significant in Models 2 and 3. With the linear time variable added, Air Lead 95th Percentile and the interaction term are both significant in Models 2 and 3 while only Air Lead 95th Percentile is significant in Model 4 and neither in Model 1. With the quadratic time variable added, Air Lead 95th Percentile and both interaction terms are significant in Models 2 and 3 while only the interaction with time squared is significant in Model 1 and neither in Model 4. With the categorical time variable included, Air Lead 95th Percentile and most interactions are significant in all models.

Tables 4-1 to 4-4 report that Air Lead 95th Percentile with the quadratic time variable included provided the best fit for Models 1 to 3, while Air Lead 95th Percentile with the linear time variable included provided the best fit for Model 4.

D.2.2 Toxics Release Inventory Variables

Three types of TRI variables were utilized – total compounds, lead only, and total lead. Within each types, five pollution variables were explored – total lead in the air, lead in fugitive air, lead from smokestacks, lead in surface water, and lead in water by injection. The results for the 15 TRI variables are discussed below and presented in Figures/Tables A88 to A102.

TRI Compounds (Total Air) – Higher proportion of children with blood lead level ≥ 10 µg/dL are associated with higher levels of lead compounds in total air in each of the four time periods with strong positive relationships across time. The distributions of lead compounds in total air decline consistently across the four time periods as the mean declines from 577.1 in the 1996-1999 period to 427.6 in the 2004-2005 period. Not accounting for time, TRI Compounds (Total Air) is significant in Models 1, 2, and 4, with Model 3 not converging. With the linear time variable added TRI Compounds (Total Air) is significant in all four models, although the interaction term is not significant in any models. With the quadratic time variable added, only Models 2 and 3 converged and TRI Compounds (Total Air) and the interaction with the time squared variable were significant. With the categorical time variable added, TRI Compounds (Total Air) and most interaction terms were significant in Models 1, 2, and 4 while Model 3 did not converge.

TRI Compounds (Fugitive Air) – The results from the analysis of TRI Compounds in fugitive air are similar to those for TRI Compounds (Total Air) with higher predicted proportion of children with blood lead level ≥ 10 µg/dL associated with higher levels of lead compounds in total air in each of the four time periods, although there is a decline in the slopes over time. The distributions of TRI Compounds (Fugitive Air) decline consistently across the four time periods as the mean declines from 184.7 in the 1996-1999 period to 134.3 in the 2004-2006 period. Not accounting for time, TRI Compounds (Fugitive Air) is significant in Models 2 to 4, while Model 3 did not converge. With the linear time variable added TRI Compounds (Fugitive Air) is significant in Models 2 to 4, although the interaction term is not significant in those models. With the quadratic time variable added, TRI Compounds (Fugitive Air) and the interaction with the time squared variable were both significant in Models 2 and 3, while only the interaction term was significant in Model 1. With the categorical time variable added, TRI Compounds (Fugitive Air) and all interaction terms were significant in Models 1, 2, and 4 while Model 3 did not converge.

TRI Compounds (Air Lead from Stacks) – Again, there is a strong positive relationship between proportion of children with blood lead level ≥ 10 μg/dL and TRI Compounds (Air Lead from Stacks) levels. Mean levels of TRI Compounds (Air Lead from Stacks) consistently decline with each successive time period. The TRI Compounds (Air Lead from Stacks) variable is significant in all models, regardless of how time was accounted for. With the linear time variable, the interaction terms were not significant. With the quadratic time variable added, the time squared was significant in all four models. Most interaction terms were significant with the categorical time variable added.

TRI Compounds (Water Surface) – The relationship between proportion of children with blood lead level ≥ 10 μg/dL and TRI Compounds (Water Surface) is positive across all four time periods, although it flattens in the two most recent periods. Mean and 90th percentile levels of TRI Compounds (Water Surface) decline with each successive time period. TRI Compounds (Water Surface) is significant in Models 2 and 3 when not accounting for time. With the linear time variable, TRI Compounds (Water Surface) is significant only in Model 2. Only Models 1 and 4 converge with the quadratic time variable added and TRI Compounds (Water Surface) is not significant in either although the interaction with time squared is significant. With the categorical time variable added, Compounds (Water Surface) is significant in all models.

TRI Compounds (Water by Injection) – Slightly lower probability of EBLLs are associated with higher levels of TRI Compounds (Water by Injection) across each time period with the relationship flattening out in the more recent periods. Although over 90 percent of quarterly county records have values of 0 in each time period, mean levels of TRI Compounds (Water by Injection) increase over time, with the 2002-2003 and 2004-2006 periods being nearly equal. TRI Compounds (Water by Injection) is not significant in any of the models, regardless of accounting for time. When the quadratic time variable was added, the interaction terms were significant in Model 1.

TRI Lead Only (Total Air) – Higher proportion of children with blood lead level ≥ 10 μg/dL are associated with higher levels of TRI Lead Only (Total Air) in each of the four time periods with strong positive relationships across time. Mean and 90th percentile levels of TRI Lead Only (Total Air) decline over the first three time periods, with a slight increase in the mean in the 2004-2005 data. Not accounting for time, TRI Lead Only (Total Air) is only significant in Model 2. With the linear time variable added, it is significant in Model 2 although the interaction term is significant in both Models 1 and 2. With the quadratic time variable added, TRI Lead Only (Total Air) is not significant in any models but the interaction terms are significant in all four models. With the categorical time variable added, TRI Lead Only (Total Air) and all interaction terms are significant in all models.

TRI Lead Only (Fugitive Air) – The results for this variable are very similar to the previous one with strong positive relationships between proportion of children with blood lead level ≥ 10 μg/dL and TRI Lead Only (Fugitive Air) across time. Mean and 90th percentile levels of TRI Lead Only (Fugitive Air) are higher in the 1995-1999 period than in the subsequent three periods. Not accounting for time, TRI Lead Only (Fugitive Air) was only significant in Model 2. Similarly, with the linear time variable added, TRI Lead Only (Fugitive Air) and the interaction term were only significant in Model 2. With the quadratic time variable, TRI Lead Only (Fugitive Air) is significant in Model 1, although the interactions with time and time squared were significant in Models 1 to 3. With the categorical time variable added, TRI Lead Only (Fugitive Air) and all interaction terms were significant in all models.

TRI Lead Only (Air Lead from Stacks) – Similar to the first two TRI Lead Only variables, a positive relationship is evident between probability of EBLLs and TRI Lead Only (Air Lead from Stacks). Mean and 75th and 90th percentile levels of TRI Lead Only (Air Lead from Stacks) are higher in the 1995-1999 period than in the subsequent three periods, although there is a slight increase in the mean in the most current period. Not accounting for time, TRI Lead Only (Air Lead from Stacks) is not significant in any models. With the linear time variable, TRI Lead Only (Air Lead from Stacks) is significant in Model 3 while the interaction terms were significant in Models 1 to 3. TRI Lead Only (Air Lead from Stacks) was not significant with the quadratic time variable added, but most interaction terms were. With the categorical time variable, TRI Lead Only (Air Lead from Stacks) was significant in Models 1 to 3 and the interaction terms are significant in all models.

TRI Lead Only (Water Surface) – The relationship between proportion of children with blood lead level ≥ 10 µg/dL and TRI Lead Only (Water Surface) is strongly positive during the 1995 to 1999 time period, but is less positive in the later periods. Over 75 percent of county-level values are 0 across all four time periods. Mean and 90th percentile levels of TRI Lead Only (Water Surface) decline over time. TRI Lead Only (Water Surface) is not significant for any models when not accounting for time and with the linear time variable added. No models converged with the quadratic time variable. With the categorical time variable, TRI Lead Only (Water Surface) was only significant in Model 2, although some of the interaction terms were significant in Models 1 to 3.

TRI Lead Only (Water by Injection) – In the 1995-1999 period, higher proportion of children with blood lead level ≥ 10 µg/dL was associated with higher levels of TRI Compounds (Water by Injection). In later periods, the relationship flattens and becomes slightly negative. Over 90 percent of quarterly county records have values of 0 in each time period. Mean levels of TRI Compounds (Water by Injection) are significantly lower in the 1995-1999 period than in the later three periods. TRI Compounds (Water by Injection) is not significant in any of the models, regardless of how time was handled, although some of the interaction terms were significant.

TRI Total Lead (Total Air) – Higher predicted proportion of children with blood lead level ≥ 10 µg/dL was associated with higher levels of Total Lead in total air. Mean and median levels of TRI Total Lead (Total Air) decline with each successive time period. TRI Total Lead (Total Air) is significant in Models 2 and 3 when time is not accounted for. With the linear time variable added, TRI Total Lead (Total Air) was significant in models 2 and 3 although the interaction terms were significant in all models. With the quadratic time variable added, TRI Total Lead (Total Air) was significant in Models 2 and 3 while both interaction terms were significant in Models 2 to 4 (Model 1 did not converge). All terms were significant when the categorical time variable was added.

TRI Total Lead (Fugitive Air) – Strong positive relationships existed between proportion of children with blood lead level ≥ 10 µg/dL and TRI Total Lead (Fugitive Air) in each time period. Mean, 75th percentile, and 90th percentile values of TRI Total Lead (Fugitive Air) decline with each successive time period. TRI Total Lead (Fugitive Air) is only significant in Model 1 when not accounting for time. With the linear time variable, TRI Total Lead (Fugitive Air) was significant in Models 2 and 3 while the interaction terms were significant in Models 1 and 2. With the quadratic time variable added, TRI Total

Lead (Fugitive Air) was significant in Model 2 while both interaction terms were significant in Models 1 to 3. All terms in each model (except Model 3 that did not converge) were significant when the categorical time variable was added.

TRI Total Lead (Air Lead from Stacks) – Positive relationships existed between proportion of children with blood lead level ≥ 10 µg/dL and TRI Total Lead (Air Lead from Stacks) over time, but the slope decreases with each successive time period. The distribution of TRI Total Lead (Air Lead from Stacks) is much higher in the 1995-1999 period than in the later periods and continues to decline slightly over time after that. TRI Total Lead (Air Lead from Stacks) is significant in Models 2 and 3 when not accounting for time. With the linear time variable, TRI Total Lead (Air Lead from Stacks) was significant in Models 2 and 3 while the interaction terms were significant in Models 1 to 3. With the quadratic time variable added, TRI Total Lead (Air Lead from Stacks) was only significant in Model 3 while both interaction terms were significant in Models 1 to 3 and the time squared term alone significant in Model 4. All terms in each model were significant when the categorical time variable was added.

TRI Total Lead (Water Surface) – The relationship between proportion of children with blood lead level ≥ 10 µg/dL and TRI Total Lead (Water Surface) is positive across the four time periods. The distribution of TRI Total Lead (Water Surface) is declining across time, as mean levels fall from 122 in the 1995-1999 period to 82 in the 2004-2005 period. TRI Compounds (Water Surface) is not significant in any of the four models when not accounting for time and with the linear time variable included. With the quadratic time variable included, the only significant term is the interaction with time squared in Models 3 and 4. When the categorical time variable was added, TRI Compounds (Water Surface) and the interaction terms were significant in Models 1 to 3, but not in Model 4.

TRI Total Lead (Water by Injection) – The relationship between proportion of children with blood lead level ≥ 10 µg/dL and TRI Total Lead (Water by Injection) is slightly negative across the four time periods. Over 90 percent of quarterly county records have values of 0 in each time period. Mean levels of TRI Compounds (Water by Injection) are significantly lower in the 1995-1999 period than in the later three periods. TRI Compounds (Water by Injection) is not significant in any of the four models when not accounting for time. With the linear time variable included, both interaction terms were significant in Models 1 and 2 while only the interaction with time squared was significant in Models 3 and 4. With the quadratic time variable included, the interaction with time squared in Models 3 and 4. When the categorical time variable was added, TRI Compounds (Water by Injection) and most interaction terms were not significant in any models.

The TRI variables were mixed in their ability to predict proportion of children with blood lead level ≥ 10 µg/dL. The three Water by Injection variables did not yield many significant terms, while the Water Surface models mainly only yielded significant terms with the categorical time variable. Although the log-likelihood ratios from each model are similar across the 15 variables as seen in Tables 4-1 to 4-4, four different variables provided the best fit across the four models. TRI Total Lead (Fugitive Air) with the quadratic time variable provided the best fit for Model 1. The best fit for Model 2 was provided by TRI Lead Only (Total Air) with the quadratic time variable. TRI Lead Only (Water by Injection) with time not accounted for provided the best fit for Model 3. TRI Total Lead (Fugitive Air) with time not accounted for provided the best fit for Model 4.

D.2.3 Lead in Drinking Water

Figure/Table A87 contain the exploratory results from analyzing the Mean Water Lead Concentration variable from the Drinking Water Information System.

Mean Water Lead Concentration –The relationship between proportion of children with blood lead level ≥ 10 µg/dL and Mean Water Lead Concentration is inconsistent across the four time periods. Over the 1995-1999 time period, there is a highly negative relationship between probability of an EBLL and water lead levels, with higher water lead levels associated with lower blood lead levels. There is also a negative relationship in the 2000-2001 period, although not as steep, while there is a positive relationship between the variables in the two more recent periods. , although the 2002-2003 period has a more positive slope. Over 90 percent of mean values are reported as -2.3. The distribution of Mean Water Lead Concentration is nearly identical across the four time periods, except for the very upper ends, with the maxima ranging from 1.1 to 10.3. Not accounting for time. Mean Water Lead Concentration is significant in Models 2 to 4 with Model 1 not converging. With the linear time variable, only the interaction term is significant in Models 1 and 2. With the quadratic time variable added, all terms are again significant in Model 1 with Mean Water Lead Concentration not significant in the other models. With the categorical time variable added, all the Model 1 terms are again significant, while most terms are not in the other models.

D.3 Analyses of National Blood Lead Data by Programmatic Variables

The programmatic data explored for the national model include (1) HUD grant funding related to lead hazard control and lead poisoning and (2) EPA Region.

D.3.1 Programmatic Funding

The funding data analyzed at the national level include grant funding histories for both HUD and CDC. Multiple variables were generated from each of these histories and analyzed – (1) current and cumulative per-capita dollars allocated to each county to combat childhood lead poisoning, (2) current funding levels on a 6-, 12-, 18-, 24-, 30-, and 36-month lag, (3) cumulative funding levels on a 6-, 12-, 18-, 24-, 30-, and 36-month lag, and (4) total current and cumulative combined funding levels on a 6-, 12-, 18-, 24-, 30-, and 36-month lag. The detailed exploratory analysis results for the 14 HUD funding variables are presented in Figures/Tables A47 and A60. The detailed exploratory analysis results for the 14 CDC funding variables are presented in Figures/Tables A61 and A74. The detailed exploratory analysis results for the 12 combined funding variables are presented in Figures/Tables A75 and A86. Note that these analyses may be impacted by the relatively low percentage of counties that have received HUD and CDC funding.

Current HUD Funding – The relationship between proportion of children with blood lead level ≥ 10 µg/dL and Current HUD Funding is consistently positive across the four time periods. Mean and 90th percentile Current HUD Funding changes across the time periods, declining in the 2000-2001 period but increasing in the 2004-2005 period. Not accounting for time, Current HUD Funding is found to be a significant predictor of probability of an EBLL in Models 2 to 4, with Model 1 not converging. With the linear time variable added, Current HUD Funding is significant in Models 2 to 4 while the interaction term is only significant in Model 1. With the quadratic time variable added, Current HUD Funding and both interaction terms are significant in Models 1 and 2, only the interaction terms are significant in Model 4, and Model 3 failed to converge. Current HUD Funding and all interaction terms are significant in Models 1 and 2 with the categorical time variable included (Models 3 and 4 did not converge).

Cumulative HUD Funding – There is a strong positive relationship between proportion of children with blood lead level ≥ 10 µg/dL and Cumulative HUD Funding levels. Mean and 90th percentile Cumulative HUD Funding levels increase over the four time periods, which makes sense because of the nature of this variable. Not accounting for time, Cumulative HUD Funding is significant in Model 1, but not Model 2 while Models 3 and 4 did not converge. With the linear time variable added, Cumulative HUD Funding and the interaction term are significant in Models 2 to 4 while Model 1 did not converge. With the quadratic time variable added, Cumulative HUD Funding and both interaction terms are significant in Model 1, Cumulative HUD Funding and the interaction with time is significant in Model 2, and only the interaction with time squared is significant in Model 4. With the categorical time variable included, Cumulative HUD Funding and all interaction terms are significant in Model 1, while only the interaction terms are significant in Models 2 to 4.

Current HUD Funding 6-month Time Lag – The relationship between proportion of children with blood lead level ≥ 10 µg/dL and Current HUD Funding 6-month Time Lag is strongly positive across the four time periods. As with the non-lagged Current HUD Funding variable, Mean Current HUD Funding 6-month Time Lag changes across the time periods, declining in the 2000-2001 period but increasing in the 2004-2005 period. Not accounting for time, Current HUD Funding 6-month Time Lag is found to be a significant predictor of probability of an EBLL in Model 1, but not Models 2 and 4, with Model 3 not converging. With the linear time variable added, Current HUD Funding 6-month Time Lag and the interaction are significant in Model 1, but not the others. With the quadratic time variable added, Current HUD Funding 6-month Time Lag and both interaction terms are significant in Models 1 to 3, but only the interaction terms are significant in Model 4. With the categorical time variable included, Current HUD Funding 6-month Time Lag is significant in all models, while significance of the interaction terms is not entirely consistent.

Current HUD Funding 12-month Time Lag – The relationship between proportion of children with blood lead level ≥ 10 µg/dL and Current HUD Funding 12-month Time Lag appears quite similar to the first two Current HUD Funding variables - strongly positive across the four time periods. The distribution of Current HUD Funding 12-month Time Lag is also similar. Not accounting for time, Current HUD Funding 12-month Time Lag is found to be a significant predictor of probability of an EBLL in Models 1 to 3, but not Model 4 that failed to converge. With the linear time variable added, Current HUD Funding 12-month Time Lag and the interaction are significant in Models 1 and 3, but only the funding variable is significant in Model 2. With the quadratic time variable added, Current HUD Funding 12-month Time Lag and both interaction terms are significant in all models. With the categorical time variable included, Current HUD Funding 12-month Time Lag is only significant Model 4, while at least two interaction terms are significant each of the four models.

Current HUD Funding 18-month Time Lag – The relationship between proportion of children with blood lead level ≥ 10 µg/dL and Current HUD Funding 18-month Time Lag, the distribution of Current HUD Funding 18-month Time Lag, and the modeling results are similar to the other Current HUD Funding variables.

Current HUD Funding 24-month Time Lag – The relationship between proportion of children with blood lead level ≥ 10 µg/dL and Current HUD Funding 24-month Time Lag, the distribution of Current HUD Funding 24-month Time Lag, and the modeling results are similar to the other Current HUD Funding variables.

Current HUD Funding 30-month Time Lag – The relationship between proportion of children with blood lead level ≥ 10 µg/dL and Current HUD Funding 30-month Time Lag, the distributional changes over time of Current HUD Funding 30-month Time Lag, and the modeling results (variable and interactions significant for all models with quadratic time variable) are similar to the other Current HUD Funding variables.

Current HUD Funding 36-month Time Lag – The relationship between proportion of children with blood lead level ≥ 10 µg/dL and Current HUD Funding 36-month Time Lag is positive across time as with the other Current HUD Funding variables. With the 36-month time lag, the distribution does not increase over time as with the other variables. In the models not accounting for time and with the linear time variable added, Current HUD Funding 36-month Time Lag and the interaction term are significant in all models. With the quadratic time variable added, Current HUD Funding 36-month Time Lag is significant in Models 2 to 4, but only the quadratic term is significant in Models 2 and 3. With the categorical time variable added, Current HUD Funding 36-month Time Lag is only significant in Model 1.

Cumulative HUD Funding 6-month Time Lag – As with the non-lagged Cumulative HUD Funding variable, there is a strong positive relationship between proportion of children with blood lead level ≥ 10 µg/dL and Cumulative HUD Funding 6-month Time Lag. Mean and 90th percentile Cumulative HUD Funding 6-month Time Lag levels increase over the four time periods. Not accounting for time, Cumulative HUD Funding 6-month Time Lag is significant in Models 1 to 3, but not in Model 4. With the linear time variable added, Cumulative HUD Funding 6-month Time Lag and the interaction term are significant in Models 1 to 4 while Models 2 and 3 did not converge. With the quadratic time variable added, Cumulative HUD Funding 6-month Time Lag is significant in all models, but the interaction terms are not consistently significant across models. With the categorical time variable included, Cumulative HUD Funding 6-month Time Lag and all interaction terms are significant in Models 1 and 2, while only the interaction terms are significant in Model 4 and Model 3 failed to converge.

Cumulative HUD Funding 12-month Time Lag – The relationship between proportion of children with blood lead level ≥ 10 µg/dL and Cumulative HUD Funding 12-month Time Lag, the distribution of Cumulative HUD Funding 12-month Time Lag, and the modeling results (with most terms being significant) are similar to the other Cumulative HUD Funding variables.

Cumulative HUD Funding 18-month Time Lag – The relationship between proportion of children with blood lead level ≥ 10 µg/dL and Cumulative HUD Funding 18-month Time Lag, the distribution of Cumulative HUD Funding 18-month Time Lag, and the modeling results (with most terms being significant) are similar to the other Cumulative HUD Funding variables.

Cumulative HUD Funding 24-month Time Lag – The relationship between proportion of children with blood lead level ≥ 10 µg/dL and Cumulative HUD Funding 24-month Time Lag (strongly positive), the distribution of Cumulative HUD Funding 24-month Time Lag (outside of the maxima decreasing), and the modeling results (with most terms being significant) are similar to the other Cumulative HUD Funding variables.

Cumulative HUD Funding 30-month Time Lag – The relationship between proportion of children with blood lead level ≥ 10 µg/dL and Cumulative HUD Funding 30-month Time Lag (strongly positive), the distribution of Cumulative HUD Funding 30-month Time Lag (outside of the maxima decreasing), and the modeling results (with most terms being significant) are similar to the other Cumulative HUD Funding variables.

Cumulative HUD Funding 36-month Time Lag – The relationship between proportion of children with blood lead level ≥ 10 µg/dL and Cumulative HUD Funding 36-month Time Lag (strongly positive) and the distribution of Cumulative HUD Funding 36-month Time Lag (outside of the maxima decreasing) are similar to the other Cumulative HUD Funding variables. With no time variable added to the model, Cumulative HUD Funding 36-month Time Lag is only significant in Model 1. With the linear and quadratic time variables added, Cumulative HUD Funding 36-month Time Lag and all interaction terms are significant in all models. With the categorical time variable included, Cumulative HUD Funding 36-month Time Lag is not significant in any models (Model 1 does not converge) but most of the interaction terms are significant.

Current CDC Funding – The relationship between proportion of children with blood lead level ≥ 10 µg/dL and Current CDC Funding is not consistent across the four time periods, as there is a slightly negative relationship in the 1995-1999 period followed by slightly positive relationships in the other three periods. Mean and 90th percentile Current CDC Funding changes across the time periods, declining overall but increasing in the more recent periods. Not accounting for time, Current CDC Funding is found to be a significant predictor of probability of an EBLL in all models. With the linear time variable added, Current CDC Funding and the interaction term are significant in Models 1, 2, and 4 while Model 3 does not converge. With the quadratic time variable added, Current CDC Funding and both interaction terms are significant in Models 1 and 3, only the interaction terms are significant in Model 2, and in Model 4 Current CDC Funding and the interaction with time squared were significant. With the categorical time variable included, Current CDC Funding and all interaction terms are significant in all models.

Cumulative CDC Funding – As with the Current CDC Funding results, the relationship between proportion of children with blood lead level ≥ 10 µg/dL and Cumulative CDC Funding levels is slightly negative relationship in the 1995-1999 period followed by slightly positive relationships in the other three periods. Mean and 90th percentile Cumulative CDC Funding levels increase over the four time periods, which makes sense because of the nature of this variable. Not accounting for time, Cumulative CDC Funding is significant in all models. Likewise, with the linear time variable added, Cumulative CDC Funding and the interaction term are significant in all models. With the quadratic time variable added, Cumulative CDC Funding and both interaction terms are significant in Model 1, Cumulative CDC Funding is significant in all models and nearly all interactions with time are significant. With the categorical time variable included, Cumulative CDC Funding and all interaction terms are significant in all models.

Current CDC Funding 6-month Time Lag – The relationship between proportion of children with blood lead level ≥ 10 µg/dL and Cumulative CDC Funding 6-month Time Lag (mixed) and the distribution of Cumulative CDC Funding 6-month Time Lag (decreasing over time) are similar to the other non-lagged Current HUD Funding variable. Not accounting for time, Current CDC Funding 6-month Time Lag is found to be a significant predictor of probability of an EBLL in Models 2 to 4, with Model 1 not converging. With the linear time variable added, Current CDC Funding 6-month Time Lag and the interaction are significant in all models. With the quadratic time variable added, Current CDC Funding 6-month Time Lag and both interaction terms are significant in Models 3 and 4, but only the interaction terms are significant in Models 1 and 2. With the categorical time variable included, Current CDC Funding 6-month Time Lag and all interaction terms are significant in all Models 1, 3, and 4, while Model 2 failed to converge.

Current CDC Funding 12-month Time Lag – The relationship between proportion of children with blood lead level ≥ 10 µg/dL and Current CDC Funding 12-month Time Lag (mixed), the distribution of

Current CDC Funding 12-month Time Lag (decreasing over time), and the modeling results (with nearly all terms being significant) are similar to the Current CDC Funding 6-month Time Lag variable.

Current CDC Funding 18-month Time Lag – The relationship between proportion of children with blood lead level ≥ 10 µg/dL and Current CDC Funding 18-month Time Lag (1995-1999 negative, other periods positive), the distribution of Current CDC Funding 18-month Time Lag (decreasing over time), and the modeling results are similar to the other Current CDC Funding variables. In the models with the linear time variable added, however, Current CDC Funding 18-month Time Lag is not significant although the interaction term is.

Current CDC Funding 24-month Time Lag – The relationship between proportion of children with blood lead level ≥ 10 µg/dL and Current CDC Funding 24-month Time Lag (1995-1999 negative, other periods positive), the distribution of Current CDC Funding 24-month Time Lag (decreasing over time), and the modeling results (with most terms being significant) are similar to the other Current CDC Funding variables.

Current CDC Funding 30-month Time Lag – The relationship between proportion of children with blood lead level ≥ 10 µg/dL and Current CDC Funding 30-month Time Lag (1995-1999 negative, other periods positive), the distribution of Current CDC Funding 30-month Time Lag (decreasing over time), and the modeling results (with most terms being significant) are similar to the other Current CDC Funding variables. In the models with the quadratic time variable added, however, Current CDC Funding 30-month Time Lag is not significant although most interaction terms are.

Current CDC Funding 36-month Time Lag – The relationship between proportion of children with blood lead level ≥ 10 µg/dL and Current CDC Funding 36-month Time Lag (1995-1999 negative, other periods positive) and the distribution of Current CDC Funding 36-month Time Lag (decreasing over time) are similar to the other Current CDC Funding variables. Not accounting for time, Current CDC Funding 36-month Time Lag is significant in Models 1 to 3, but not in Model 4. With the linear time variable added, Current CDC Funding 36-month Time Lag is significant in Model 1 but the interaction with time is significant in Models 1 to 3. With the quadratic time variable added, Current CDC Funding 36-month Time Lag is significant only in Model 1, while the interaction with time squared is significant in Models 1, 2, and 4.

Cumulative CDC Funding 6-month Time Lag – As with all the Current CDC Funding variables, the relationship between proportion of children with blood lead level ≥ 10 µg/dL and Cumulative CDC Funding 6-month Time Lag levels is slightly negative relationship in the 1995-1999 period followed by slightly positive relationships in the other three periods. Mean and 90th percentile Cumulative CDC Funding 6-month Time Lag levels increase over the four time periods, which makes sense because of the nature of this variable. Not accounting for time, Cumulative CDC Funding 6-month Time Lag is significant in all models. With the linear and quadratic time variables included, Cumulative CDC Funding 6-month Time Lag and nearly all interaction terms are significant. Similarly, with the categorical time variable included, Cumulative CDC Funding 6-month Time Lag and all interaction terms are significant.

Cumulative CDC Funding 12-month Time Lag – The relationship between proportion of children with blood lead level ≥ 10 µg/dL and Cumulative CDC Funding 12-month Time Lag (mixed), the distribution of Cumulative CDC Funding 12-month Time Lag (increasing over time), and the modeling results (with nearly all terms being significant when models converge) are similar to the Cumulative CDC Funding 6-month Time Lag variable and other CDC Funding variables.

Cumulative CDC Funding 18-month Time Lag – The relationship between proportion of children with blood lead level ≥ 10 µg/dL and Cumulative CDC Funding 18-month Time Lag (mixed), the distribution of Cumulative CDC Funding 18-month Time Lag (increasing over time), and the modeling results (with nearly all terms being significant when models converge) are similar to the other Cumulative CDC Funding variables.

Cumulative CDC Funding 24-month Time Lag – The relationship between proportion of children with blood lead level ≥ 10 µg/dL and Cumulative CDC Funding 24-month Time Lag (mixed), the distribution of Cumulative CDC Funding 24-month Time Lag (increasing over time), and the modeling results (with nearly all terms being significant when models converge) are similar to the other Cumulative CDC Funding variables. For Model 4, Cumulative CDC Funding 24-month Time Lag was not significant with the linear and quadratic time variables included.

Cumulative CDC Funding 30-month Time Lag – The relationship between proportion of children with blood lead level ≥ 10 µg/dL and Cumulative CDC Funding 30-month Time Lag (mixed), the distribution of Cumulative CDC Funding 30-month Time Lag (increasing over time), and the modeling results (with nearly all terms being significant when models converge) are similar to the other Cumulative CDC Funding variables. For Model 4, Cumulative CDC Funding 30-month Time Lag was not significant with the linear and quadratic time variables included. The interaction with time squared in the quadratic time variable models was only significant in Model 1.

Cumulative CDC Funding 36-month Time Lag – The relationship between proportion of children with blood lead level ≥ 10 µg/dL and Cumulative CDC Funding 36-month Time Lag (mixed), the distribution of Cumulative CDC Funding 36-month Time Lag (increasing over time), and the modeling results (with nearly all terms being significant when models converge) are similar to the other Cumulative CDC Funding variables. The modeling results are similar to the results for the Cumulative CDC Funding 30-month Time Lag models with Model 4 and the time squared variable not being significant.

Current Total Funding 6-month Time Lag – The relationship between proportion of children with blood lead level ≥ 10 µg/dL and Current Total Funding 6-month Time Lag is strongly positive across the four time periods. Mean and 90th percentile Current Total Funding 6-month Time Lag changes across the time periods, declining in the 2000-2001 and 2002-2003 periods but increasing in the 2004-2005 period. Not accounting for time, Current Total Funding 6-month Time Lag is found to be a significant predictor of probability of an EBLL in Models 2 and 4, but not Models 1 and 3. With the linear time variable added, Current Total Funding 6-month Time Lag is significant in Models 1 and 2, but the interaction term is only significant in Model 1. With the quadratic time variable added, Current Total Funding 6-month Time Lag and both interaction terms are significant in Models 1 to 3, but only the interaction terms are significant in Model 4. With the categorical time variable included, Current Total Funding 6-month Time Lag is significant in all models, while significance of the interaction terms is significant in most.

Current Total Funding 12-month Time Lag – The relationship between proportion of children with blood lead level ≥ 10 µg/dL and Current Total Funding 12-month Time Lag (strongly positive), the distribution of Current Total Funding 12-month Time Lag (decreasing but higher in 2004-2005), and the modeling results (with nearly all terms being significant) are similar to the Current Total Funding 6-month Time Lag variable.

Current Total Funding 18-month Time Lag – The relationship between proportion of children with blood lead level ≥ 10 µg/dL and Current Total Funding 18-month Time Lag (strongly positive) and the distribution of Current Total Funding 18-month Time Lag (decreasing but higher in 2004-2005) are similar to the Current Total Funding 6-month Time Lag variable. With the categorical time variable included, Current Total Funding 18-month Time Lag was only significant in Model 1, although all models had at least two significant interaction terms.

Current Total Funding 24-month Time Lag – The relationship between proportion of children with blood lead level ≥ 10 µg/dL and Current Total Funding 24-month Time Lag (strongly positive), the distribution of Current Total Funding 24-month Time Lag (decreasing but higher in 2004-2005), and the modeling results (with most terms being significant) are similar to the other Current Total Funding variables.

Current Total Funding 30-month Time Lag – The relationship between proportion of children with blood lead level ≥ 10 µg/dL and Current Total Funding 30-month Time Lag (strongly positive), the distribution of Current Total Funding 30-month Time Lag (decreasing but higher in 2004-2005), and the modeling results (with most terms being significant) are similar to the other Current Total Funding variables.

Current Total Funding 36-month Time Lag – The relationship between proportion of children with blood lead level ≥ 10 µg/dL and Current Total Funding 36-month Time Lag (strongly positive), the distribution of Current Total Funding 36-month Time Lag (decreasing but higher in 2004-2005), and the modeling results (with most terms being significant) are similar to the other Current Total Funding variables. With the categorical time variable included, Current Total Funding 36-month Time Lag was only significant in Model 1, although all models had at least two significant interaction terms.

Cumulative Total Funding 6-month Time Lag – The relationship between proportion of children with blood lead level ≥ 10 µg/dL and Cumulative Total Funding 6-month Time Lag is strongly positive across the four time periods. Mean and 90th percentile Cumulative Total Funding 6-month Time Lag increase steadily across the time periods, as expected. Not accounting for time, Cumulative Total Funding 6-month Time Lag is found to be a significant predictor of probability of an EBLL in Models 1 and 2, but not Models 3 and 4. With the linear time variable added, Cumulative Total Funding 6-month Time Lag and the interaction term are significant in Models 2 to 4, and Model 1 did not converge. With the quadratic time variable added, Cumulative Total Funding 6-month Time Lag is significant in all models, however, both interaction terms are significant only in Model 1. With the categorical time variable included, Cumulative Total Funding 6-month Time Lag is significant in Model 2 and the interaction terms in Models 2 and 4, while Models 1 and 3 did not converge.

Cumulative Total Funding 12-month Time Lag – The relationship between proportion of children with blood lead level ≥ 10 µg/dL and Cumulative Total Funding 12-month Time Lag (strongly positive), the distribution of Cumulative Total Funding 12-month Time Lag (increasing over time), and the modeling results (with most terms being significant when models converge) are similar to the Cumulative Total Funding 6-month Time Lag variable and other Total Funding variables.

Cumulative Total Funding 18-month Time Lag – The relationship between proportion of children with blood lead level ≥ 10 µg/dL and Cumulative Total Funding 18-month Time Lag (strongly positive), the distribution of Cumulative Total Funding 18-month Time Lag (increasing over time), and the modeling results (with most terms being significant when models converge) are similar to other Total Funding variables.

Cumulative Total Funding 24-month Time Lag – The relationship between proportion of children with blood lead level ≥ 10 µg/dL and Cumulative Total Funding 24-month Time Lag (strongly positive), the distribution of Cumulative Total Funding 24-month Time Lag (increasing over time), and the modeling results (with most terms being significant when models converge) are similar to other Total Funding variables.

Cumulative Total Funding 30-month Time Lag – The relationship between proportion of children with blood lead level ≥ 10 µg/dL and Cumulative Total Funding 30-month Time Lag is strongly positive except in the 1995-1999 period, in which it appears to be flat. The distribution of Cumulative Total

Funding 30-month Time Lag increases steadily over time as expected. The modeling results (with most terms being significant when models converge) are similar to other Total Funding variables.

Cumulative Total Funding 36-month Time Lag – The relationship between proportion of children with blood lead level ≥ 10 µg/dL and Cumulative Total Funding 36-month Time Lag is positive except in the 1995-1999 period, in which it appears to be slightly negative. The distribution of Cumulative Total Funding 36-month Time Lag increases steadily over time as expected. The modeling results (with most terms being significant when models converge) are similar to other Total Funding variables.

For Model 1, Tables 4-1 to 4-4 report that Cumulative Total Funding 36-month Time Lag with a quadratic time variable provided the best fit when considering log-likelihood statistics and associated degrees of freedom. Current CDC Funding 12-month Time Lag with a quadratic time variable provided the best fit for Models 2 and 3. Current HUD Funding 18-month Time Lag provided the best fit for Model 4.

D.3.2 EPA Region

EPA Region was investigated as a potential predictor of the probability of blood lead level ≥ 10 µg/dL to determine if that high-level geographic indicator should be included in multivariate models. Figure/Table A103 contains the exploratory results for this variable. The line plot in Figure A103 indicates that in all regions predicted probability of EBLL declines over time, although some regions display much more negative slopes than the others including Regions 3, 5, and 9. The model output in Table A103 indicates that probability of blood lead level ≥ 5 µg/dL in each individual EPA Region ia significantly higher than Region 10, which serves as the baseline. This was also true for probability of blood lead level ≥ 10 µg/dL, except that Region 8 is not significantly higher than Region 10. For probability of blood lead level ≥ 15 µg/dL, only Regions 4 and 8 were not higher than Region 10. For probability of blood lead level ≥ 25 µg/dL, Regions 2, 4, 5, 6, 7, and 8 were not significantly higher than Region 10.

D.3.3 Screening Penetration

Screening penetration rate was investigated as a potential predictor of the probability of blood lead level ≥ 10 µg/dL to determine if it should be included in the multivariate models. Figure/Table A104 contains the exploratory results for this variable. The line plot in Figure A104 indicates in general there is a negative relationship between proportion of children with blood lead level ≥ 10 µg/dL and Screening Penetration although this relationship is flatter in the later time periods than in the 1995-1999 period. Mean and median screening penetration rates increase steadily across the four time periods. Not accounting for time, the model output in Table A104b indicates that Screening Penetration was only significant in Model 4 with Models 1 to 3 not converging. With the linear and quadratic time variables added, Screening Penetration and the interaction terms were significant in all models, although Model 1 with the quadratic time variable did not converge. With the categorical time variable included, Screening Penetration was significant in Models 1, 2, and 4 with Model 3 not converging. A few of the interaction terms were significant in Models 1 and 2 as well.