# Final Sampling Project Report

*Team Heeringa:*
Chia Wen Cheng
Makenna Harrison
Noah R Marcotte
Wenqing Qian
Zhuoyu Wang

SURVMETH 625: Applied Sampling

19 April 2023

University of Michigan, Ann Arbor

## 1. Population and Frame Characteristic

For this study, our goal is to monitor rates of drug use and cigarette smoking among teenagers in the State of Michigan. Our client is the Michigan Department of Education. To produce estimates of these behaviors, we will draw a sample of students to participate in our research. Here, our population is students currently enrolled in grades 7 through 12 in schools across the 83 counties in Michigan. We will implement a two-stage sampling procedure. First, we will sample schools, then we will sample students within each selected school. Therefore, our sampling frame has two components. For the first stage, we will use a list of public and private schools in the state. This list was obtained from Michigan's Department of Education in 2022. Then, for the second stage frame we will use a list of currently enrolled students for each school. Those schools selected will serve as our primary sampling units (PSU). In addition, we will use previous year's classroom enrollment as measures of size for each school.

Additionally, decimal numbers in this report are rounded to two digits for presentation purposes, but when performing calculations with those numbers, we use their full, unrounded fractions to ensure accuracy.

## 2. Overall Design

Our client is interested in the following three key variables related to teenage smoking and drug use, "ever smoked one cigarette", "ever smoked marijuana", and "age when first approached to smoke cigarettes or marijuana". The Department of Education would like to generate estimates of means and proportions for each variable, having a coefficient of variation ($cv$) of no more than 0.05. We calculate these estimates along with their respective element variance, desired sampling variance (level of precision), and estimated necessary minimum sample size to maintain a simple random sample (SRS). These estimated values are provided in *Table 2.1*. Additionally, the calculations to achieve these values are as follows:

(1) Estimates of the element variances ($s^2$) for each variable sample proportion ($p$);

- For variables "ever smoked one cigarette" and "ever smoked marijuana", we use the formula: $s^2 = p(1-p),\ (ignoring\ the\ finite\ population\ correction)$

(2) Estimates of the desired sampling variance for each variable mean($\bar{y}$)/proportion were derived from the following inequality by solving for the standard error ($se$) of the estimate and squaring it,

- $cv = \frac{se(\bar{y})}{\bar{y}} \leq 0.05 \rightarrow se(\bar{y}) \leq 0.05 * \bar{y}$ (the formula is the same for the proportion)

(3) Now that we have the sampling variance for all three variables, we are able to calculate the sample size($n$) needed for SRS by the following formulas.

- For variables "ever smoked one cigarette" and "ever smoked marijuana", we use the formula: $Var(p) = \frac{1}{n-1}p(1-p) \rightarrow n = \frac{p(1-p)}{Var(p)} + 1$
- For variable "age when first approach to smoke cigarettes or marijuana", we use the formula: $Var(\bar{y}) = \frac{1}{n}s^2 \rightarrow n = \frac{1}{Var(\bar{y})}s^2$

**Table 2.1: Sampling variance and sample size needed in an SRS design (cv = 0.05)**

| Variable | Sample Mean or Proportion | Element Variance | Desired Sampling Variance | Sample Size Needed for SRS | Design Effect | roh |
|---|---|---|---|---|---|---|
| *"ever smoked one cigarette"* | 0.25 | 0.19 | 0.0002 | 1201 | 2.5 | 0.03 |
| *"ever smoked marijuana"* | 0.15 | 0.13 | 0.00006 | 2268 | 2 | 0.02 |
| *"age when first approach to smoke cigarettes or marijuana"* | 12 | 1 | 0.36 | 3 | 1.7 | 0.01 |

Furthermore, a similar study was previously conducted using a sample size of n = 7,500 students between the ages of 13 and 19, selected from a total of a = 150 clusters. From this study we obtained the design effect for each variable mean/proportion, and using this information, computed synthetic estimates of roh (*Table 2.1*). The calculation of synthetic rate of homogeneity (roh) is as follows ($b$ is the number of elements selected within each cluster):

$$b = \frac{n}{a} = \frac{7500}{50} = 50 \qquad roh = \frac{deff - 1}{b - 1}$$

The total budget for data collection for this project is $500,000. The client and the data collection organization estimate that the data collection will cost $3,000 per primary stage cluster (school), and $50 per completed questionnaire within a cluster. Using this information, we calculate the optimum sub-sample size ($b_{opt}$), optimum cluster size ($a_{opt}$), optimum overall sample size ($n_{opt}$), and estimated cost for each of our key variables as summarized in *Table 2.2*. Since roh is portable and we had previously calculated it for each of the variables, we were able to use it in calculating our optimum sample size. The calculations are as follows, where $c_a$ indicates cost per primary stage cluster and $c_b$ equals cost per completed questionnaire within a cluster:

$$C = 500000 \qquad b_{opt} = \sqrt{\frac{c_a}{c_b}\frac{1 - roh}{roh}}$$

$$c_b = 50 \qquad a_{opt} = \frac{C}{c_a + b_{opt} * c_b}$$

$$c_a = 3000 \qquad deff = 1 + (b_{opt} - 1) * roh$$

**Table 2.2: Estimates of optimum sub-sample and expected cost and design effect**

| Variable | $b_{opt}$ | $a_{opt}$ | $n_{opt}$ | Estimated Cost | Expected Design Effect |
|---|---|---|---|---|---|
| *"ever smoked one cigarette"* | 44 | 96 | 4224 | $499,200 | 2.32 |
| *"ever smoked marijuana"* | 54 | 88 | 4752 | $501,600 | 2.08 |
| *"age when first approached to smoke cigarettes or marijuana"* | 64 | 81 | 5184 | $502,200 | 1.9 |

We decided to use $b_{opt}$ = 64 (b* = 64) for our overall optimum subsample size in our design under our fixed cost constraint of $500,000. While slightly over budget, we chose this design because it gives us the largest overall sample size. Assuming equal sized clusters, using this roh in our calculations yielded the largest overall sample size ($n_{opt}$ = 5184) and the smallest design effect ($deff$ = 1.9). For our estimates of $b_{opt}$ and $a_{opt}$, we rounded to the nearest integer. If we had truncated our values instead, we would have come under budget for all three designs. However, considering we are not too far over budget, we feel our choice to round to the nearest integer is justified.

This design has a smaller number of clusters and a larger number of subsamples than the other designs. While this design may have a larger optimum sample size, it has a higher sampling variance. However, we thought the increase in sampling variance was not large enough to constitute the use of another design. Using other roh values resulted in smaller sample sizes and larger design effects. With this design, we take a subsample of 64 students from 81 different schools. Using the estimated size of the target population provided by our client (N = 830138), our sampling fraction (f) for this design is 0.00624.

*Table 2.3* shows the design effect ($deff_{(2)}$), effective sample size ($n_{eff}$), and expected coefficient of variation ($cv(\bar{y})$) under our design, assuming the portability of estimates of roh and the element variance. All key variable estimates meet the client's request to have an expected coefficient of variation 0.05. Calculations are as follows, where $b_{(2),\,opt}$ = 64, $n_{opt} = 5184$, $p$ equals the proportion for "ever smoked one cigarette" or "ever smoked marijuana" and $\bar{y}$ is the mean for "age when first approached to smoke cigarettes or marijuana".

$deff_{(2)} = 1 + (b_{(2),\,opt} - 1) * roh$; $var_{(2),SRS}(p) = \frac{p(1-p)}{n_2}$ or $var_{(2),SRS}(\bar{y}) = \frac{se(\bar{y})}{n_2}$

$var(p) = deff_2 * var_{(2),SRS}(p)$ or $var(\bar{y}) = deff_2 * var_{(2),SRS}(\bar{y})$

$n_{eff} = \frac{n_{opt}}{deff_{(2)}}$ ; $cv(\bar{y}) = \frac{se(\bar{y})}{\bar{y}}$ , where $\bar{y}$ is the proportion or mean of the variable and $se(\bar{y})$ is the square root of the design sampling variance.

**Table 2.3: Expected design effects given $b_{opt}$ = 64**

| Variable | Design Effect | | SRS Variance | | Design Sampling Variance | | Effective Sample Size | Expected Coefficient of Variation |
|---|---|---|---|---|---|---|---|---|
| | Total | 20% | Total | 20% | Total | 20% | Total Sample | Total Sample |
| *"ever smoked one cigarette"* | 2.93 | 1.37 | 4e-5 | 2e-4 | 1e-4 | 2e-4 | 1770 | 0.04 |
| *"ever smoked marijuana"* | 2.29 | 1.24 | 2e-5 | 1e-4 | 5e-5 | 2e-4 | 2268 | 0.05 |
| *"age when first approach to smoke cigarettes or marijuana"* | 1.9 | 1.17 | 2e-4 | 1e-3 | 4e-4 | 7e-4 | 2728 | 0.002 |

Additionally, if we were to calculate a hypothetical subclass of 20% that is evenly distributed across strata/schools, we would take 20% from our $b$ and $n$, $b_{opt} = 64 *. 20 = 13$; and $n_{opt} = 5184 *. 20 = 1037$. Here, we calculate the design effect, SRS variance, design sampling variance, and expected coefficient of variation for this 20% subclass using the same formulas and sample proportions and means given to us for the total sample. Now that we have the estimated design sampling variance for the total sample and the 20% subclass, we can calculate confidence intervals for our variable proportion/mean estimates. The standard error is calculated as $se = \sqrt{var_2(p)} = \sqrt{deff_2 * var_{(2),SRS}(p)}$ and the confidence interval is calculated as $p \pm se * t_{0.975,80}$. Where p is the sample mean/proportion, se is the standard error, and $t_{0.975,80} = 1.99$ (the t score at the 95% confidence level with a-1 = 80 degrees of freedom). *Table 2.4* contains these estimates and their confidence intervals:

**Table 2.4: Sample Mean/Proportion with Confidence Intervals**

| | Proportion/Mean (SE) | | 95% Confidence Interval | |
|---|---|---|---|---|
| | Total Sample | 20% Subclass | Total Sample | 20% Subclass |
| *"ever smoked one cigarette"* | 0.25 (0.01) | 0.25 (0.02) | [0.23,0.27] | [0.22, 0.28] |
| *"ever smoked marijuana"* | 0.15 (0.01) | 0.15 (0.01) | [0.14,0.16] | [0.13, 0.17] |
| *"age when first approached to smoke cigarettes or marijuana"* | 11 (0.02) | 11 (0.03) | [11.96, 12.04] | [11.93, 12.07] |

## 3. Allocations

In this section, we will allocate how many schools to sample from each stratum and how many students to subsample from each selected school. In order to maintain *EPSEM* (equal probability of selection) across all strata, we will use the stratified *Probability Proportion to estimate Size* (PPeS) design to sample clusters and subsample students.

Our sampling fraction (not inflated) is calculated as: $f = \frac{a_{opt} \times b_{opt}}{N} = \frac{5148}{830{,}183} = 0.00624$

As previously stated, our optimum number of clusters ($a_{opt}$) is 81. We allocate the number of clusters to each stratum proportionate to the number of students in each stratum ($W_h$). We do this by multiplying $a_{opt}$ by the proportion of students in each stratum ($W_h$). Thus, we have the number of expected schools, $a_h$, for each stratum. The overall student count from the previous year was treated as the measure of size ($MOS$) for the PPeS sampling.

According to PPeS: $f_h = f_1 \times f_2 = \left( \frac{a_h MOS_{h\alpha}}{\sum_{\alpha=1}^{A_h} MOS_{h\alpha}} \right) \times \left( \frac{b^*_h}{MOS_{h\alpha}} \right) \Rightarrow \quad b^*_h = f_h \times \frac{\sum_{\alpha=1}^{A_h} MOS_{h\alpha}}{a_h}$

$f_1$ is the first stage sampling rate and $f_2$ is the second stage sampling rate. $A_h$ is the number of schools for each stratum. $a_h$ is the indicator for the school in stratum $h$. $MOS_{h\alpha}$ is the measures of size of school $\alpha$ in stratum $h$. We calculate the target subsample size for each stratum ($b^*_h$) using the above formula. These calculated values are presented below (*Table 3.1*):

**Table 3.1: Uninflated PPeS Allocation**

| $h$ | $n_h$ | $a_h$ | $b^*_h$ |
|---|---|---|---|
| 1 | 74 | 1 | 74.13 |
| 2 | 57 | 1 | 56.97 |
| 3 | 60 | 1 | 59.89 |
| 4 | 51 | 1 | 50.53 |
| 5 | 132 | 2 | 65.59 |
| 6 | 189 | 3 | 62.70 |
| 7 | 1152 | 18 | 64.46 |
| 8 | 1152 | 18 | 64.44 |
| 9 | 2304 | 36 | 63.94 |
| **Total** | **5171** | **81** | |

However, since we expect a 30% response rates among schools, and a 70% response rate among students, we will need to generate inflated estimates for $a_{opt}$ and $b_{opt}$ (see *Table 3.2*):

**Table 3.2: Inflated Cluster and Subsample Sizes**

| $b_{infl}$ | $a_{infl}$ | $n_{infl}$ | **Sampling fraction** |
|---|---|---|---|
| 92 | 270 | 24686 | 0.0297 |

Furthermore, we will need to apply this same inflation technique to the first and second stage sampling across the 9 strata. We derive the inflated number of clusters ($a_{h,\,infl}$) by dividing each $a_h$ by 0.3 and rounding to the nearest integer. This same procedure will need to be applied to subsample sizes in each stratum ($b^*_h$), where we will divide by 0.7 to get $b^*_{h,\,infl}$ (see *Table 3.3*).

To select clusters from strata, we stratify based on two auxiliary variables we believe to be related to students' smoking behavior. First, we achieve implicit stratification within the regions by geographic location. Here, we ordered the 83 counties into a list moving across the map (see *Appendix II*) in an s-shaped to ensure geographically contiguous units were adjacent to each other. Then, within each county, we ordered all the schools by type (public ahead of private).

Next, we calculate zone sizes for each stratum. We first define the sampling interval for each stratum ($k_h$) as $MOS_{h\alpha}/a_{h,\,infl}$ (see *Table 3.3*). For each stratum, if the value of $k_h$ is a non-integer, we will multiply it by either 10 or 100 (depending on the number of decimals) to create a new interval ($k_{h,\,new}$). Next, we selected a random start between 1 and $k_{h,\,new}$ using sample() function in R. Then, we add $k_{h,\,new}$ repeatedly until we obtained a total of $a_{h,\,infl}$ numbers. We then divide each selected case by the same number it was multiplied by earlier (1, 10, or 100), and truncate the decimals to get integers. We then used this sequence of integers to make our selection from the cumulative counts by taking schools where the cumulative number of students first exceeded $k_{h,\,new}$. *Table 3.3* enumerates the inflated values alongside the number of schools for each stratum ($n_h$), the estimated number of students in each strata ($MOS_{h\alpha}$), the random start for PSU selection, and minimum measure of size.

**Table 3.3: Inflated PPeS Allocation**

| $h$ | $n_h$ | $a_{h,infl}$ | $MOS_{h\alpha}$ | $b^*_{h,infl}$ | $k_h$ | **Random Start** (*seed: 625*) | **Minimum MOS**[1] |
|---|---|---|---|---|---|---|---|
| 1 | 74 | 1 | 3561 | 105.89 | 3561 | 2226 | 105 |
| 2 | 57 | 2 | 5474 | 81.39 | 2737 | 543 | 82 |
| 3 | 60 | 3 | 8631 | 85.55 | 2877 | 415 | 85 |
| 4 | 51 | 2 | 4855 | 72.19 | 2427.5 | 13268 | 73 |
| 5 | 132 | 6 | 18907 | 93.71 | 3151.17 | 71675 | 94 |
| 6 | 189 | 11 | 33133 | 89.57 | 3012.09 | 127418 | 89 |
| 7 | 1152 | 62 | 191992 | 92.08 | 3096.65 | 249087 | 93 |
| 8 | 1152 | 61 | 188830 | 92.05 | 3095.57 | 34754 | 93 |
| 9 | 2304 | 122 | 374755 | 91.34 | 3071.76 | 214121 | 91 |

[1] We set seed at 1000 and generated the following 9 random numbers: 0.34993746, 0.75546158, 0.31708425, 0.86581282, 0.76416075, 0.07288487, 0.49261774, 0.63516203, 0.08485787.

## 4. An Illustration of Cluster Selections in Strata 8 & 9 and Unit Selections in Stratum 7

*First-stage Selection (Strata 8 & 9)*

We implemented first-stage selection for all nine strata using our inflated estimates ($a_{h,\,infl}$). For the sake of illustration, we will only discuss in detail the sampling procedure and results for the last two strata. This same selection methodology should be applied to strata 1-7 (see *Table 3.3*).

The total number of schools in these last strata are 61 and 122 (for Regions 8 and 9, respectively). Within each strata we adopted a systematic sampling to select schools. Here, we calculated the sampling interval for both strata ($k_h$) based on the sum of all high schools in the region ($MOS_{h\alpha}$) and the inflated number of schools selected from the region ($a_{h,\,infl}$). There are 188830 students in Region 8 and 374755 students in Region 9. Thus, for Region 8, the sampling interval ($k_8$) is calculated to be 3095.57, and Region 9's sampling interval ($k_9$) is 3071.76. For Stratum 8, we selected a random start between 1 and 309,557 ($k_{8,\,new}$): 34,754. We added $k_{8,\,new}$ 60 times to our random start to obtain 61 schools for selection. Each time, we truncated the last two digits form whole integers which corresponded to the selected schools. We applied this same sampling procedure to Stratum 9. Here, our random start was selected from between 1 and 307176 ($k_{9,\,new}$): 214121. We then repeatedly added $k_{9,\,new}$ to the random start 121 times, removed the last two digits, to get an index for each of the 122 schools we select.

There were no oversized units in either of the strata. There were also no selected units in Region 8 that failed to meet the minimum sufficient size. However, 7 units adjacent to the selected school were of insufficient size. Therefore, we implemented a "linking after selection" procedure to combine these undersized units with neighboring schools to yield large enough units for selection.

For instance, *Skyline High School* is one of the selected units, whose size is 420. However, its next unit *Early College Alliance - Milan* only has 26 students. The two schools following *Early College Alliance - Milan — Saline Alternative High School* (53) and *Washtenaw County Drop Back In Academy* (38) — are also not large enough until we reached the third one after it. Then we moved backwards, linking *Saline Alternative High School*, *Washtenaw County Drop Back In Academy*, and *Early College Alliance - Milan* to create a linked unit of size 117, and our selected unit *Skyline High School* ended up not being linked to any other units.

There are 4 schools not meeting the minimum sufficient size in Stratum 9: Cloverdale Dvlpmntl Training Ctr. (49), ST PAUL LUTHERAN SCHOOL (39), Commonwealth Community Development Academy (66), Hope of Detroit Academy (45). Taking Cloverdale Dvlpmntl Training Ctr. as an example, the next school on the list (Birmingham Covington School) has already reached the minimum size, so we linked Cloverdale Dvlpmntl Training Ctr. with the school in front of it (Clifford H. Smart Middle School) and obtained a linked unit sized 734. This size is large enough, so we simply substituted the undersized school with the linked one. In addition, another 14 schools also need to be linked because those next to them on the list are too small in size. A similar procedure is followed when linking these undersized units. The complete information about unit linking in both strata is displayed in *Appendix III*. The full list of

first-stage units we sampled from Region 8 and 9 is included in the same appendix, with linked units highlighted in light green shades.

*Second-stage selection (Stratum 7)*

The example school given is located in Region 7. In this stratum, the average cluster size is 64.46 before being inflated for nonresponse and 92.08 after inflation. Since its measure of size is 242, the within-PSU sampling rate ought to be $\frac{b^*_h}{MOS_{h\alpha}} = \frac{92.08}{242} = 0.38$. However, in reality there are only 219 students in the school. Thus, the actual subsample size should be $x_{h\alpha} = \frac{b^*_h}{MOS_{h\alpha}} B_{h\alpha} = \frac{92.08}{242} \times 219 = 83.3327$ (where $B_{h\alpha}$ is the actual size of the school ($\alpha$) in stratum ($h$). Here, the probability of selecting 83 students from this school is 66.73% and the probability of selecting 84 students is 33.27%. According to the random number we drew between 0 and 1, we finally sampled 83 students from Applesamp Middle School to maintain the within-PSU sampling rate and *epsem* across all students.

We still performed systematic sampling to select students, following a similar protocol as in first stage selection. Since the sampling interval is $k = B_{h\alpha}/x_{h\alpha} = 2.63855$, we specified a random starting point between 1 and 263 ($k_{new}$) as 178. After repeatedly adding $k_{new}$ and truncating to form integers, we generated 83 student IDs. The list of students selected is attached in *Appendix III*.

## 5. Estimation Procedures

We now have the numbers of the expected schools for each region, $a_h$, as stratum, to plan for the nonresponse error. We then collapsed strata 1 & 2 and strata 3 & 4 because they only contained 1 PSU, and recoded the stratum in the ascending order of the regions. We generated seven pseudo-stratum for the next steps for sampling error computing unit (SECU) and variance estimation.

Within each of the seven pseudo-stratum, we form 2 SECUs. Thus, the first stratum has 1 expected school in each SECU; the second has 1; the third has 1; the fourth has 1 or 2; the fifth stratum has 9; the sixth has 9; the last stratum has 18. We will choose clusters randomly when forming SECUs.

Since we have two SECUs within each collapsed stratum, we are able to apply a paired difference method by treating SECUs within each collapsed stratum as pairs.

**Table 5.1: Sampling error codes**

| *h* | *a_h* | collapsed stratum codes | number of SECUs | expected size per SECU |
|---|---|---|---|---|
| 1 | 1 | 1 | 2 | 1 |
| 2 | 1 | | | |
| 3 | 1 | 2 | 2 | 1 |
| 4 | 1 | | | |
| 5 | 2 | 3 | 2 | 1 |
| 6 | 3 | 4 | 2 | 1 or 2 |
| 7 | 18 | 5 | 2 | 9 |
| 8 | 18 | 6 | 2 | 9 |
| 9 | 36 | 7 | 2 | 18 |

The estimations of the standard errors and the 95% confidence intervals of the mean/proportion for both the total sample and the 20% subclass sample are mentioned in the “overall design” section. You may refer to tables 2.4 to 2.5 for the calculations. To clarify our calculation process, again, we hold the assumption that the 20% subclass is evenly distributed across strata/school.

Taylor Series Linearization (TSL) can be used to approximate the variance of mean and the standard error. TSL is a method that obtains a first-order linear approximation for the ratio estimator, and then uses the variance estimate for this approximation to estimate the variance of the estimate itself. We select TSL because the three expected coefficients of variation for each variable of interest are less than 0.1, in which the second term in the TSL remains small enough for ignorance and the approximation works well under this circumstance. In addition, the nonresponse rate is fixed for the two sampling stages in our case, which does not raise concerns in adequacy of our final sample sizes. Last but not least, we use the stratified PPeS design, and thus do not need to weight sample totals.

To calculate the variance estimate of the total sample, we will use the following formula.

**Formula for Variance Estimation (Method: Taylor Series)**

$$Var(r) \approx (1/x^2)[var(y) + r^2 var(x) - 2rcov(y,x)]$$

$$var(x) = \sum_{h=1}^{H=7}(x_{h1} - x_{h2})^2$$
$$var(y) = \sum_{h=1}^{H=7}(y_{h1} - y_{h2})^2$$
$$cov(y,x) = \sum_{h=1}^{H=7}(x_{h1} - x_{h2})(y_{h1} - y_{h2})$$

$x$ : the total sample size

$y$ : the sum of the variable interested(sample totals) of total sample

$$y = \sum_{h=1}^{H=7}\sum_{\alpha=1}^{A}\sum_{\beta=1}^{B} y_{h\alpha\beta}$$

$r$: the mean of the variable interested of total sample

$$r = y/x$$

$h$: the indicator of the collapsed stratum

$H$: the number of the collapsed strata

$y_{h1}$: the sample totals in the first pseudo PSU in the $h_{th}$ collapsed stratum

$x_{h1}$: the sample size in the first pseudo PSU of the $h_{th}$ collapsed stratum

For the variance estimate of the 20% subclass, we calculate the estimation of the standard error of a mean/proportion still using the above formula. However, the some meanings of the symbols change:

(1) the $x$ refers to the sample size of the 20% subclass;
(2) $y$ refers to the sum of the variable interested(sample totals) for the 20% subclass;
(3) $r$ refers to the mean of the variable interested for the 20% subclass;
(4) $y_{h1}$ refers to sample totals in the first pseudo PSU in the $h_{th}$ SECU for the 20% subclass;
(5) $x_{h1}$ refers to the sample size in the first pseudo PSU of the $h_{th}$ SECU for the 20% subclass.

# Appendices:

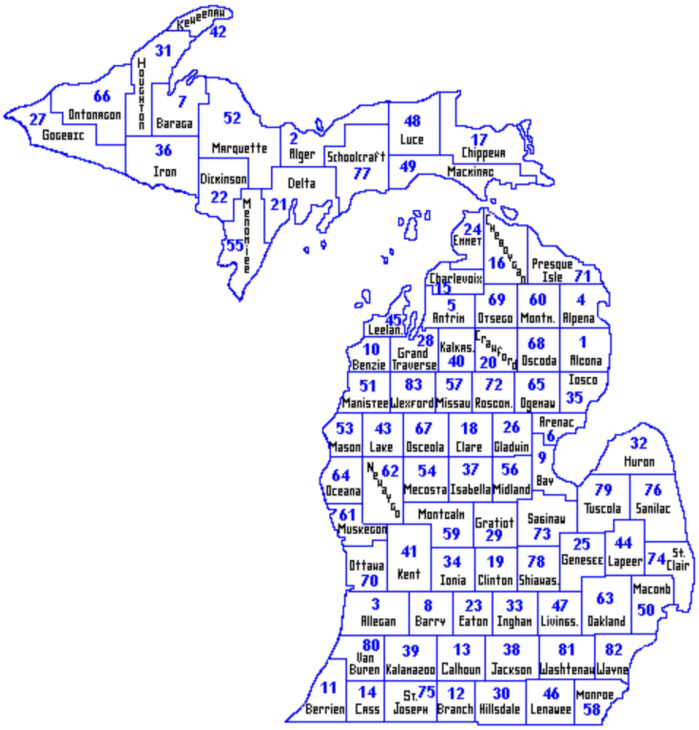
## Appendix I: Notation Table

| Notation | Meaning | Notation | Meaning |
|---|---|---|---|
| $a$ | number of clusters | $h$ | number of stratum |
| $b$ | the number of elements selected within each cluster | $a_h$ | number of expected schools for each stratum |
| $C$ | budget for data collection for this project | $a_{h,\,infl}$ | inflated number of expected schools for each stratum |
| $c_a$ | cost per primary stage cluster | $b^*_h$ | target subsample size for each stratum |
| $c_b$ | cost per completed questionnaire within a cluster | $b^*_{h,\,infl}$ | the inflated subsample size of each element of each stratum |
| $cv$ | coefficient of variation | $n_h$ | sample size for each stratum |
| $var$ | variance | $f_h$ | sampling fraction of each stratum |
| $n$ | sample size | $A_h$ | number of schools for each stratum |
| $\bar{y}$ | mean of population totals | $B_{h\alpha}$ | actual size of the α_th school in h_th stratum |
| $s^2$ | estimates of the element variance | $MOS_{h\alpha}$ | the measures of size of α _th school in h_th stratum |
| $p$ | sample proportion | $W_h$ | the proportion of the number of students in stratum h_th in total sample size |
| $deff$ | design effect | $k$ | sampling interval for second-stage sampling |
| $roh$ | ratio of homogeneity | $r$ | the mean of the variable interested from total sample |

| | | | |
|---|---|---|---|
| $f$ | overall sampling fraction (without inflation) | $k_h$ | sampling interval for each stratum |
| $t$ | t-score | $k_{h,new}$ | the new sampling interval of each stratum |
| SECU | sampling error computing unit | $x_{h\alpha}$ | the actual subsample size |
| PSU | primary sampling units | $a_{opt}$ | optimum cluster size |
| $f_1$ | the first stage sampling rate | $b_{opt}$ | optimum sub-sample size |
| $f_2$ | the second stage sampling rate | $n_{opt}$ | optimum overall sample size |
| | | $n_{eff}$ | effective sample size |

## Appendix II: Michigan Counties Map used when sorting the school list

https://www.michigan.gov/mdhhs/doing-business/licensing/child-welfare/institutions/online-lookups/michigan-counties-map



## Appendix III: Linked schools in Strata 8 & 9

### Undersized and linked units in Stratum 8

| School selected | Undersized units (Self/next/both)* | Size before linking | Schools linked | Total size after linking |
|---|---|---|---|---|
| Skyline High School | Next | 420 | None | 420 |
| Holt Junior High School | Next | 933 | Stockbridge Alternative High School | 953 |
| Lake Fenton Middle School | Next | 294 | Special Services - North | 307 |
| LUTHERAN HIGH SCHOOL-NW | Next | 309 | OAKLAND STEINER SCHOOL<br>ANN ARBOR CHRISTIAN SCHOOL | 368 |
| ST MICHAEL SCHOOL | Next | 182 | STS PETER & PAUL SCHOOL | 199 |
| LUTHERAN HIGH SCH-WESTLAND | Next | 208 | GO LIKE THE WIND SCHOOL<br>BIBLE BAPTIST CHURCH SCHOOL<br>SAINT MARTHA SCHOOL<br>GTB LIFE LONG LEARNING CTR<br>LOUISIANA HOMES SCHOOL | 282 |
| ST PATRICK SCHOOL | Next | 96 | ST PAUL SCHOOL | 133 |

* “Self” means the exact unit selected is undersized; “next” means the unit selected is not undersized but the next one on the list is; and “both” means both the selected unit and the one following are undersized.

### Undersized and linked units in Stratum 9

| School selected | Undersized units (Self/next/both) | Size before linking | Schools linked | Total size after linking |
|---|---|---|---|---|
| Ubly Community High School | Next | 264 | Huron Learning Center | 298 |
| Croswell-Lexington Middle School | Next | 395 | Sanilac ISD Special Education Services; Marlette Learning Center | 439 |
| Yale Junior High School | Next | 333 | Phoenix Alternative School<br>Capac Adult and Community Education<br>St. Clair County Learning Academy | 418 |
| Cloverdale Dvlpmntl Training Ctr. | Self | 49 | Clifford H. Smart Middle School | 734 |
| Bloomfield Hills Andover H.S. | Next | 951 | Crossroads for Youth | 1027 |

| | | | | |
|---|---|---|---|---|
| Hart Middle School | Next | 774 | Huron Valley Adult Education | 800 |
| MANISTEE CATHOLIC CENT SCHS | Next | 98 | MENOMINEE CATHOLIC CENTRAL | 121 |
| ST ELIZABETH ANN SETON M S | Next | 161 | ST JOSEPH'S SCHOOL | 166 |
| Armada Middle School | Next | 310 | Career Preparation Center | 382 |
| ST PAUL LUTHERAN SCHOOL | Self | 39 | ST MARY'S SCHOOL<br>ST MARY/MC CORMICK CATHOLIC ACADEMY<br>CONCORDIA LUTHERAN NORTH | 101 |
| Annapolis High School | Next | 824 | Dickinson Center | 849 |
| Ferguson Academy for Young Women | Next | 286 | Barnard Center | 300 |
| Communication and Media Arts HS | Next | 516 | Downriver High School | 563 |
| Colin Powell Academy | Next | 237 | Summit Academy | 288 |
| Commonwealth Community Development Academy | Both | 66 | Edison Public School Academy | 307 |
| Hope of Detroit Academy | Both | 45 | George Crockett Consortium High School | 94 |
| ST PATRICK SCHOOL | Next | 102 | ST PAUL LUTHERAN SCHOOL | 130 |
| LUTHERAN HIGH SCHOOL-NORTH | Next | 628 | None | 628 |

**Appendix V: List of schools sampled in Strata 8 & 9 (after linking)**

## Stratum 8 (after linking):

| Selection number | Stratum | School | Cumulative MOS | Within School Interval |
|---|---|---|---|---|
| 1 | 8 | Davis Middle School | 387 | 3.5539 |
| 2 | 8 | Addison High School | 3721 | 5.4162 |
| 3 | 8 | Madison High School | 6690 | 5.8041 |
| 4 | 8 | Deerfield Public Schools | 9660 | 2.6538 |
| 5 | 8 | Chelsea High School | 13571 | 14.7431 |
| 6 | 8 | Forsythe Middle School | 15844 | 6.8749 |

| | | | | |
|---|---|---|---|---|
| 7 | 8 | Milan High School | 18983 | 15.0380 |
| 8 | 8 | Willow Run High School | 22108 | 8.5976 |
| 9 | 8 | Lincoln Middle School | 25338 | 11.5151 |
| 10 | 8 | Community High School | 28503 | 7.1698 |
| 11 | 8 | Ypsilanti High School | 31485 | 18.7781 |
| 12 | 8 | Skyline High School | 34787 | 6.5180 |
| 13 | 8 | East Jackson High School | 37801 | 6.7508 |
| 14 | 8 | Michigan Center Jr/Sr High School | 41068 | 11.0185 |
| 15 | 8 | TA Wilson School | 43724 | 4.2212 |
| 16 | 8 | Columbia Central High School | 47249 | 8.6441 |
| 17 | 8 | Charlotte Senior High School | 50426 | 14.7741 |
| 18 | 8 | Grand Ledge High School | 53938 | 26.7704 |
| 19 | 8 | Waverly Senior High School | 56403 | 16.4657 |
| 20 | 8 | C.W. Otto Middle School | 59273 | 6.7353 |
| 21 | 8 | Everett High School | 63742 | 25.1874 |
| 22 | 8 | Holt Senior High School | 66495 | 21.5870 |
| 23 | 8 | Mason High School | 69138 | 16.7916 |
| 24 | 8 | Webberville High School | 71679 | 3.3366 |
| 25 | 8 | Haslett High School | 75483 | 13.9982 |
| 26 | 8 | Holt Junior High School Stockbridge Alternative High School | 78190 | 14.7897 |
| 27 | 8 | Brighton High School | 82329 | 34.8093 |
| 28 | 8 | Hartland High School | 85585 | 27.9964 |
| 29 | 8 | Howell High School | 88838 | 40.0392 |
| 30 | 8 | Pinckney High School | 90361 | 23.6355 |
| 31 | 8 | Fowlerville Junior High School | 93649 | 7.4647 |
| 32 | 8 | Beecher High School | 96681 | 7.4336 |
| 33 | 8 | Clio Area High School | 99522 | 16.2329 |
| 34 | 8 | Andrew G. Schmidt Middle School | 102552 | 8.4579 |

| | | | | |
|---|---|---|---|---|
| 35 | 8 | George R. Carter Middle School | 105710 | 8.1630 |
| 36 | 8 | Grand Blanc Community High School | 109022 | 39.7598 |
| 37 | 8 | LakeVille High School | 112158 | 9.2028 |
| 38 | 8 | LakeVille Middle School | 115138 | 4.0815 |
| 39 | 8 | Bendle Middle School | 118100 | 2.9486 |
| 40 | 8 | Fenton Senior High School | 121429 | 18.6384 |
| 41 | 8 | Northern High School | 124344 | 14.1999 |
| 42 | 8 | Bendle/Carman-Ainsworth Alternative Education | 127451 | 7.5423 |
| 43 | 8 | Lake Fenton Middle School Special Services - North | 130618 | 4.7644 |
| 44 | 8 | LUTHERAN HIGH SCHOOL-NW OAKLAND STEINER SCHOOL ANN ARBOR CHRISTIAN SCHOOL | 133628 | 5.7110 |
| 45 | 8 | Owosso Middle School | 136911 | 8.2561 |
| 46 | 8 | Corunna High School | 140055 | 12.6791 |
| 47 | 8 | St. Johns Middle School | 143193 | 8.5200 |
| 48 | 8 | ST MICHAEL SCHOOL STS PETER & PAUL SCHOOL | 146025 | 3.0883 |
| 49 | 8 | Alma Middle School | 149182 | 4.9506 |
| 50 | 8 | Birch Run High School | 152263 | 8.9545 |
| 51 | 8 | White Pine Middle School | 155283 | 12.4928 |
| 52 | 8 | Saginaw High School | 158593 | 14.7586 |
| 53 | 8 | Heritage High School | 161739 | 27.6084 |
| 54 | 8 | Academy for Technology and Enterprise | 164709 | 4.9351 |
| 55 | 8 | LUTHERAN HIGH SCH-WESTLAND GO LIKE THE WIND SCHOOL BIBLE BAPTIST CHURCH SCHOOL SAINT MARTHA SCHOOL GTB LIFE LONG LEARNING CTR | 167738 | 4.3764 |

| | | | | |
|---|---|---|---|---|
| | | LOUISIANA HOMES SCHOOL | | |
| 56 | 8 | John Glenn High School | 171328 | 14.3396 |
| 57 | 8 | Cramer Junior High School | 173717 | 5.2299 |
| 58 | 8 | ST PATRICK SCHOOL<br>ST PAUL SCHOOL | 176898 | 2.0640 |
| 59 | 8 | Jefferson Middle School | 180168 | 8.8614 |
| 60 | 8 | H.H. Dow High School | 184157 | 22.2078 |
| 61 | 8 | West Intermediate School | 186292 | 8.1941 |

**Stratum 9 (after linking):**

| Selection number | Stratum | School | Cumulative MOS | Within School Interval |
|---|---|---|---|---|
| 1 | 9 | Ubly Community High School<br>Huron Learning Center | 2290 | 4.6605 |
| 2 | 9 | Unionville-Sebewaing High School | 5281 | 4.8951 |
| 3 | 9 | Carsonville-Port Sanilac H.S. | 8517 | 4.4885 |
| 4 | 9 | Croswell-Lexington Middle School<br>Sanilac ISD Special Education Services<br>Marlette Learning Center | 11417 | 6.1775 |
| 5 | 9 | Marine City Middle School | 14569 | 5.1766 |
| 6 | 9 | Port Huron Northern High School | 18560 | 23.9908 |
| 7 | 9 | Port Huron High School | 20671 | 26.1646 |
| 8 | 9 | Yale Junior High School<br>Phoenix Alternative School<br>Capac Adult and Community Education<br>St. Clair County Learning Academy | 23898 | 6.5373 |
| 9 | 9 | Imlay City High School | 26809 | 10.4627 |
| 10 | 9 | Lapeer East Senior High School | 30956 | 22.5207 |
| 11 | 9 | Anderson Middle School | 32981 | 5.7553 |
| 12 | 9 | Brandon High School | 36631 | 19.2833 |

| | | | | |
|---|---|---|---|---|
| 13 | 9 | Clarkston High School | 40611 | 29.1674 |
| 14 | 9 | Clifford H. Smart Middle School Cloverdale Dvlpmntl Training Ctr. | 42103 | 11.4793 |
| 15 | 9 | Farmington High School | 46150 | 20.9567 |
| 16 | 9 | Hazel Park High School | 48864 | 16.9218 |
| 17 | 9 | Milford High School | 51887 | 26.4462 |
| 18 | 9 | Page Middle School | 54457 | 6.4747 |
| 19 | 9 | Lake Orion Community High School | 59143 | 37.9411 |
| 20 | 9 | MacArthur K-8 University Academy | 60529 | 1.5796 |
| 21 | 9 | North Farmington High School | 64530 | 21.8325 |
| 22 | 9 | Oak Park High School | 67459 | 20.9098 |
| 23 | 9 | Rochester High School | 70511 | 27.6504 |
| 24 | 9 | Southfield High School | 73216 | 20.5814 |
| 25 | 9 | Troy High School | 75983 | 32.9678 |
| 26 | 9 | Waterford Kettering High School | 79790 | 24.6320 |
| 27 | 9 | Wylie E. Groves High School | 82477 | 21.0506 |
| 28 | 9 | Bloomfield Hills Andover H.S.; Crossroads for Youth | 85209 | 16.0616 |
| 29 | 9 | Southfield-Lathrup High School | 89499 | 23.8969 |
| 30 | 9 | Waterford Mott High School | 91244 | 27.2907 |
| 31 | 9 | Walled Lake Western High School | 94735 | 25.1794 |
| 32 | 9 | Oxford Area Middle School | 97467 | 10.8068 |
| 33 | 9 | Alice M. Birney Middle School | 100509 | 7.2879 |
| 34 | 9 | Novi Middle School | 103475 | 15.8427 |
| 35 | 9 | Athens High School | 107213 | 29.0736 |
| 36 | 9 | Lakeland High School | 110916 | 27.1030 |
| 37 | 9 | Hart Middle School Huron Valley Adult Education | 113320 | 12.5115 |
| 38 | 9 | Walled Lake Community Education Center | 116010 | 3.5189 |

| | | | | |
|---|---|---|---|---|
| 39 | 9 | Academy of Lathrup Village | 118927 | 1.8142 |
| 40 | 9 | Walled Lake Northern High School | 123292 | 25.7580 |
| 41 | 9 | Stoney Creek High School | 125493 | 25.3358 |
| 42 | 9 | Life Skills Center of Pontiac | 128131 | 2.7212 |
| 43 | 9 | MANISTEE CATHOLIC CENT SCHS<br>MENOMINEE CATHOLIC CENTRAL | 131201 | 1.5327 |
| 44 | 9 | ST ELIZABETH ANN SETON M S<br>ST JOSEPH'S SCHOOL | 134303 | 2.5961 |
| 45 | 9 | Armada Area High School | 137777 | 9.8684 |
| 46 | 9 | Warren Mott High School | 140505 | 28.2916 |
| 47 | 9 | Wyandot Middle School | 143843 | 10.0874 |
| 48 | 9 | E.F. Siefert Elementary School | 146682 | 2.8307 |
| 49 | 9 | Fitzgerald Senior High School | 150617 | 16.3431 |
| 50 | 9 | Kelly Middle School | 153010 | 5.9117 |
| 51 | 9 | Lakeview High School | 155761 | 18.0478 |
| 52 | 9 | Lincoln High School | 159261 | 14.0441 |
| 53 | 9 | Frank Jeannette Jr. High School | 162199 | 14.2475 |
| 54 | 9 | Romeo High School | 165606 | 29.2143 |
| 55 | 9 | Shelby Junior High School | 168205 | 20.5032 |
| 56 | 9 | Utica High School | 171406 | 21.0349 |
| 57 | 9 | Adlai Stevenson High School | 174495 | 32.5142 |
| 58 | 9 | Carter Middle School | 177343 | 8.3358 |
| 59 | 9 | Richards Middle School | 180729 | 12.5584 |
| 60 | 9 | Sterling Heights Senior H.S. | 184619 | 22.1923 |
| 61 | 9 | Henry Ford II High School | 188178 | 31.1067 |
| 62 | 9 | Flynn Middle School | 189815 | 6.9282 |
| 63 | 9 | Armada Middle School Career Preparation Center | 192666 | 5.9742 |

| | | | | |
|---|---|---|---|---|
| 64 | 9 | North Lake High School | 195701 | 2.2208 |
| 65 | 9 | Dakota High School | 199707 | 38.5823 |
| 66 | 9 | L'Anse Creuse Middle School - East | 201820 | 8.5078 |
| 67 | 9 | ST MARY'S SCHOOL<br>ST MARY/MC CORMICK CATHOLIC ACADEMY<br>CONCORDIA LUTHERAN NORTH<br>ST PAUL LUTHERAN SCHOOL | 204882 | 1.5796 |
| 68 | 9 | Stevenson High School | 208456 | 32.9052 |
| 69 | 9 | South Middle School | 211289 | 5.9430 |
| 70 | 9 | Bryant Middle School | 214461 | 7.4600 |
| 71 | 9 | Central High School | 217506 | 14.2944 |
| 72 | 9 | Cody High School | 220611 | 16.8749 |
| 73 | 9 | Davidson Middle School | 224093 | 12.9337 |
| 74 | 9 | Denby High School | 226940 | 17.3440 |
| 75 | 9 | Ecorse Community High School | 229502 | 7.0221 |
| 76 | 9 | Finney High School | 233266 | 12.6522 |
| 77 | 9 | Fordson High School | 236466 | 37.2217 |
| 78 | 9 | Garden City High School | 239720 | 23.0681 |
| 79 | 9 | Grosse Pointe South High School | 242437 | 25.6642 |
| 80 | 9 | Ford High School | 245885 | 23.2557 |
| 81 | 9 | Huron High School | 248605 | 13.8721 |
| 82 | 9 | John D. Pierce Middle School | 251212 | 8.1012 |
| 83 | 9 | John Glenn High School | 254642 | 33.1398 |
| 84 | 9 | Kosciuszko School | 257122 | 6.6311 |
| 85 | 9 | Discovery Middle School | 260733 | 10.7130 |
| 86 | 9 | Mumford High School | 264154 | 32.3735 |
| 87 | 9 | Northville High School | 267072 | 34.3284 |
| 88 | 9 | Osborn High School | 270473 | 20.4250 |
| 89 | 9 | Pershing High School | 273280 | 19.2364 |

| | | | | |
|---|---|---|---|---|
| 90 | 9 | Redford Union High School | 276691 | 18.2511 |
| 91 | 9 | Riverview Community High School | 278612 | 13.9659 |
| 92 | 9 | Romulus Senior High School | 282282 | 19.4554 |
| 93 | 9 | Allen Park Middle School | 285067 | 9.7120 |
| 94 | 9 | Southgate Anderson High School | 288619 | 19.6274 |
| 95 | 9 | Hoover Middle School | 291135 | 9.9623 |
| 96 | 9 | Wayne Memorial High School | 295376 | 29.6679 |
| 97 | 9 | Western International High School | 297906 | 26.2272 |
| 98 | 9 | Churchill High School | 301364 | 32.7019 |
| 99 | 9 | Annapolis High School<br>Dickinson Center | 303500 | 13.2778 |
| 100 | 9 | Hally Magnet Middle School | 306608 | 5.9899 |
| 101 | 9 | Lowrey Middle School | 309626 | 5.0984 |
| 102 | 9 | Canton High School | 313170 | 31.4977 |
| 103 | 9 | Truman High School | 316666 | 26.2741 |
| 104 | 9 | Shumate Middle School | 318574 | 9.1177 |
| 105 | 9 | Ferguson Academy for Young Women<br>Barnard Center | 321890 | 4.6918 |
| 106 | 9 | Communication and Media Arts HS<br>Downriver High School | 324744 | 8.8050 |
| 107 | 9 | Colin Powell Academy<br>Summit Academy | 327865 | 4.5041 |
| 108 | 9 | Henry Ford Academy | 331152 | 7.5851 |
| 109 | 9 | Edison Public School Academy<br>Commonwealth Community Development Academy | 333901 | 4.8013 |
| 110 | 9 | Hillside Middle School | 337456 | 8.0230 |
| 111 | 9 | Plymouth High School | 341345 | 31.7010 |

| | | | | |
|---|---|---|---|---|
| 112 | 9 | Hope of Detroit Academy George Crockett Consortium High School | 343184 | 1.4701 |
| 113 | 9 | Detroit Academy of Arts and Sciences High School | 346499 | 11.6513 |
| 114 | 9 | Detroit Premier Academy | 349347 | 2.3303 |
| 115 | 9 | Cody 9th Grade Academy | 352667 | 6.0681 |
| 116 | 9 | DIVINE CHILD HIGH SCHOOL | 356250 | 13.8721 |
| 117 | 9 | ST PATRICK SCHOOL ST PAUL LUTHERAN SCHOOL | 358565 | 2.0331 |
| 118 | 9 | LUTHERAN HIGH SCHOOL-NORTH | 361549 | 9.8215 |
| 119 | 9 | Bedford Senior High School | 364444 | 26.7902 |
| 120 | 9 | Jefferson Middle School | 367871 | 5.1923 |
| 121 | 9 | Bedford Junior High School | 371256 | 13.0432 |
| 122 | 9 | Dundee Middle School | 373984 | 4.0662 |

## Appendix VI: List of Sampled Students from Applesamp Middle School

| Grade | Surname | Given name(s) | ID |
|---|---|---|---|
| 7 | MAGEE | MONICA L | 1 |
| 7 | BELL | KENNETH MARK | 4 |
| 7 | SHY | RANDALL ERON | 7 |
| 7 | VINSON | STEVEN A | 9 |
| 7 | BURGARD | PETER JOSEPH | 12 |
| 7 | ABELES | JODI | 14 |
| 7 | WALL | SAMUEL THOMAS | 17 |
| 7 | BRENING | TERESA M | 20 |
| 7 | SEGEBARTH | DAVID | 22 |
| 7 | COHEN | SCOTT A | 25 |
| 7 | LUTZ | ADAM MARK | 28 |
| 7 | RAYNOR | GREGORY K | 30 |
| 7 | WILDSTEIN | EVAN | 33 |
| 7 | BARRY | MICHAEL J | 35 |
| 7 | DYKHOUSE | JAY D | 38 |
| 7 | HATCHER | MERRICK D | 41 |
| 7 | SERGENT | STACY | 43 |
| 7 | MARIN | ERIK T | 46 |
| 7 | FOSTER | LORI A | 49 |
| 7 | HEADAPOHL | MARC DAVID | 51 |
| 7 | RENKER | COREY H | 54 |
| 7 | CURRY | TRACY YVETTE | 57 |
| 7 | BLACK | STEPHEN P | 59 |
| 7 | FRANCIS | DALE A | 62 |
| 7 | FEIGENBAUM | FRANK | 64 |
| 7 | CLARK | CHARLES M | 67 |
| 7 | LANGDON | JOHN DOUGLAS | 70 |
| 7 | TEMPLE | LOUISE ELIZABETH | 72 |
| 7 | WILLIAMS | LINDA K | 75 |
| 7 | ASHBROOK | ANDREW S | 78 |
| 7 | BRENNAN | T CASSEY | 80 |
| 7 | BEAUCAIRE | JERI | 83 |
| 7 | TANNER | DEBORAH SHIELDS | 85 |
| 7 | HINSLEY | PATRICIA NOEL | 88 |
| 7 | LAUNICZAK | MARA K | 91 |
| 7 | SCAMRNELLA | SANDRA ANNA MARIA | 93 |
| 8 | CONSTINE | RUSSELL P | 96 |
| 8 | ROGERS | ANTOINETTE DENISE | 99 |

| | | | |
|---|---|---|---|
| 8 | MOSS | ROBERT EARL | 101 |
| 8 | DYER | JENNIFER REBECCA | 104 |
| 8 | CUTHRELL | JASON ELLIS | 106 |
| 8 | NAUSS | MATTHEW P | 109 |
| 8 | COITEN | RICHARD S | 112 |
| 8 | KOLKMAN | ANN MARIE | 114 |
| 8 | KROSKY | DANIEL J | 117 |
| 8 | MILLS | RANDY SCOTT | 120 |
| 8 | CARSON | ERIK JOHN | 122 |
| 8 | KRAPFL | HEIDI R | 125 |
| 8 | BAVITZ | CHRISTOPHER THEODORE | 128 |
| 8 | GORNY | KAREN E | 130 |
| 8 | OCKER | MARK GRIFFITH | 133 |
| 8 | ROZENBLIT | IGOR A | 135 |
| 8 | MULLAN | BRIAN P | 138 |
| 8 | KANDIK | JULIE MARIE | 141 |
| 8 | FENSON | REBECCA R | 143 |
| 8 | JEZIC | NINA L | 146 |
| 8 | LEIBOVITZ | JAY BYRON | 149 |
| 8 | ALMLI | MARTA B | 151 |
| 8 | WEAVER | TRACEY DENISE | 154 |
| 8 | SPINDELMAN | MARC | 156 |
| 8 | SIMKIN | MARGARET RENEE | 159 |
| 8 | LOEVY | DEBRA L | 162 |
| 8 | HASKIN | JENNIFER L | 164 |
| 8 | DAHL | PHILLIP Y | 167 |
| 8 | EHRENBERG | JASON HERBERT | 170 |
| 8 | FROST | THORNTON HARRISON | 172 |
| 8 | ROMERO | ROSS I | 175 |
| 8 | BAILEY | THURSTON C | 177 |
| 8 | MENDEL | DAVID STUART | 180 |
| 8 | WILHELM | ANDREW J | 183 |
| 8 | CASCADE | JOSHUA CHARLES | 185 |
| 8 | BLANK | SALLY BAKER | 188 |
| 8 | GATTO | JULIA LYNN | 191 |
| 8 | MANSDORF | NICOLE LISA | 193 |
| 8 | EDIDIN | ERIC J | 196 |
| 8 | MARGOLIN | JONATHAN B | 199 |
| 8 | MORTON | MARCY DAWN | 201 |
| 8 | FELDSTEIN | RACHEL ELIZABETH | 204 |
| 8 | LEE | KAREN ELYSE | 206 |

| | | | |
|---|---|---|---|
| 8 | SILVER | ALLYSON | 209 |
| 8 | KUHN | LAURIE JOANNE | 212 |
| 8 | RISTIC | SYLIA C | 214 |
| 8 | CHILEWICH | MATTHEW ERIC | 217 |