# Guide to Interpreting the Public School Sample Stratification Tables
## for Your State NAEP 2017

## Overview

NAEP State Coordinators and State Assessment Directors often ask Westat for details about the sampling design that is used for the NAEP sample of public schools in their state. Thus, to aid in the explanation, stratification tables used for selecting each state's sample, as well as TUDA samples, are being made available for the 2017 NAEP assessment and this document provides an overview on how to interpret the tables. Note, this is only background information regarding the sample and is not essential to coordinator activities. This information may be disregarded if it is felt that there is no need for it.

Included in this document is a table describing each of the twelve (12) types of location used for stratification (Table 1) and an Example State Table, which is referenced to illustrate the interpretation of information in the tables (Table 2).

The tables displaying the stratification used for your state or TUDA grade 4 and grade 8 public school samples for NAEP 2017 are posted on the NAEP Network under "Coordinator Responsibilities > School Sample > NAEP 2017 > Stratification Tables." This guide is intended to help interpret those tables.

## Frame and Sample

When sampling is undertaken, a frame is necessary to draw information from.  A frame can be thought of as a list of all known units in the population that are available to be sampled.  It is a well known fact that the quality of sampling is directly related to the quality of the frame.  In many fields, a great deal of time and energy are focused on the maintenance and quality of the frame.  For NAEP, the frame is the information obtained from the Common Core of Data (CCD) regarding public schools in the United States for the school year 2014-2015.  The CCD file provided the frame for all regular public, state-operated public, Bureau of Indian Education (BIE), and Department of Defense (DoD) schools in the United States and its territories, which were open as of the 2014-2015 school year.

As can be seen, the obtained CCD file is two years out of date and the common question arises, "*why use this resource instead of collecting the information from the state?*"  Since considerable resources are already spent in the collection of CCD information, duplicating this effort would not make fiduciary sense. Also, the CCD information provides a uniform and documented list of schools from which to draw the sample which is in contrast to a unique data collection effort that would have to be undertaken by the NAEP program for state by state collection. If NAEP were to attempt to assume its own frame development, it would most likely require a full time staff to handle that project alone.

## Definition of Stratification and Why Used

One of the common terms heard when NAEP sampling is discussed is stratification.  Stratification is the process of grouping sampling units based on some common characteristic.  In the case of NAEP sampling, schools are stratified first on the type of location of the school and second on minority enrollment (as a percentage) in the school.  The purpose of stratification in the sampling process is to increase the efficiency of the school sampling process by reducing (or eliminating) variability in the sample for important school subgroups within each jurisdiction.  Note, while stratification is used as part of the sampling process, the overall sampling methodology is not considered stratified sampling. (For suggested readings see References at the end of the document.)

## Strata for School Sampling in NAEP

Strata for school sampling in NAEP are based on two school factors: (1) type of location (as a category; also referred to as level of urbanization) and (2) minority enrollment (as a percentage). The way these school factors are delineated for stratification differs across states and, accordingly, the strata are specific to a given state and cannot be described the same way across all states.  A third school factor of school achievement is used to further sort the schools within each of the location/minority enrollment strata.  If school-level achievement data cannot be acquired for a state, which is extremely uncommon, the median income level for the zip code in which the school resides is used.  For the NAEP 2015 sampling process every state had available achievement data for the process and zip codes were not used.

## Type of Location

Table 1 below describes each of the twelve types of location used for stratification. Locale codes identify the geographic status of a school on an urban continuum ranging from "large city" to "rural." They are based on a school's physical address. The urban-centric locale codes are assigned through a methodology developed by the U.S. Census Bureau's Population Division in 2005 and are not determined by the NAEP program.

The twelve types of location are combined following a set methodology for all states, but different combination outcomes will occur for each state. Within any given state, these location types are grouped in such a way that each category contains at least nine percent[1] of the students in the state. Every school falls into one of these categories and the data are obtained for schools from the CCD.

One can examine the specific school location codes for schools in a state using the CCD's online table builder at http://nces.ed.gov/ccd/bat.  More in-depth information regarding school location codes can be found at http://nces.ed.gov/ccd/rural_locales.asp.

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[1] This figure is sometimes less than 9 percent if the state contains one of the districts in the Trial Urban District Assessment (TUDA) program.

In the public NAEP reporting of school location within states, for example in the NAEP Data Explorer, only four categories are reported and are the summation of the categories based on the first digit. These categories are City, Suburb, Town and Rural.

**Table 1**. Description of the Type of Location Strata

| Location # | Description |
|---|---|
| 11 | **City, Large**: Territory inside an urbanized area and inside a principal city with population of 250,000 or more. |
| 12 | **City, Midsize**: Territory inside an urbanized area and inside a principal city with population less than 250,000 and greater than or equal to 100,000. |
| 13 | **City, Small**: Territory inside an urbanized area and inside a principal city with population less than 100,000. |
| 21 | **Suburb, Large**: Territory outside a principal city and inside an urbanized area with population of 250,000 or more |
| 22 | **Suburb, Midsize**: Territory outside a principal city and inside an urbanized area with population less than 250,000 and greater than or equal to 100,000. |
| 23 | **Suburb, Small**: Territory outside a principal city and inside an urbanized area with population less than 100,000. |
| 31 | **Town, Fringe**: Territory inside an urban cluster that is less than or equal to 10 miles from an urbanized area. |
| 32 | **Town, Distant**: Territory inside an urban cluster that is more than 10 miles and less than or equal to 35 miles from an urbanized area. |
| 33 | **Town, Remote**: Territory inside an urban cluster that is more than 35 miles from an urbanized area. |
| 41 | **Rural, Fringe**: Census-defined rural territory that is less than or equal to 5 miles from an urbanized area, as well as rural territory that is less than or equal to 2.5 miles from an urban cluster. |
| 42 | **Rural, Distant**: Census-defined rural territory that is more than 5 miles but less than or equal to 25 miles from an urbanized area, as well as rural territory that is more than 2.5 miles but less than or equal to 10 miles from an urban cluster. |
| 43 | **Rural, Remote**: Census-defined rural territory that is more than 25 miles from an urbanized area and is also more than 10 miles from an urban cluster. |

In the Example State Table included at the end of this document, the location codes are grouped into five strata. Notice that location codes of 11, 32, 33 and 43 are not found in the table. This is because no schools are found in these types of location in this state or maybe the type of location does not even exist (*i.e.* no large cities in the state):

- Locale 12 - **City, Midsize** (15.2% of students)
- Locale 13 - **City, Small** (12.4%)
- Locale 21, 22 - **Suburb, Large and Midsize** (44.6%)
- Locale 23 - **Suburb, Small** (11.0%)
- Locale 31, 41, 42 - **Town, Fringe, Rural, Fringe and Distant** (16.8%)

Therefore, the schools in this example state are sorted (or stratified) into the above five school location categories. The sample counts in the stratification summary tables reflect the number of schools involved in the 2017 operational assessment (Alpha) for reading and mathematics.

## Minority Enrollment

Within each of the school location strata, the schools are further stratified by minority enrollment within the schools (as a percentage). Once again, the categories differ across states, and they also may differ across location categories within a state. For a given state, the categories are based on the two largest "minority groups" within each type of location category. This can also be thought of as the second and third largest race/ethnicity groups within the location category. For example, if Hispanic is the largest group in a school, Black and White students would be considered the "minority" groups being the 2$^{nd}$ and 3$^{rd}$ largest in size. Note in 2013 the race category of "two or more races" was added. While this categorization is only used in a few states, it is likely to become more prevalent in the future.

The race/ethnicity category most prevalent in the schools within a given location category is designated the "majority" category and the next two most prevalent groups are designated as the two largest "minority groups." In the Example State Table, within the first location category (Locale = 12), the two largest "minority groups" are identified as "Black" and "White" whereas within the next location category (Locale = 13), the two groups are identified as "Hispanic" and "Black." Note that the percentage next to the group name indicates the average school percentage of students within that location code that have been identified as belonging to that minority group category.

The percentages for these two minority groups within each location category determine the further stratification of schools within the location category. Based on the minority percentages, there are three ways that schools are further stratified within the location category.

> *Scenario 1* - If no minority group contains 7 percent or more of the students (e.g. 6% Black, 5% White), no stratification beyond the location category is used. On the Example State Table, the location category labeled "Locale = 31, 41, 42" does not have a minority group category with 7 percent or more of the students (5% Hispanic, 2% Asian). Therefore, this location category has no further stratification by minority groups.

> *Scenario 2* – If at least one minority group is 7 percent or greater and at most one minority group is greater than 15 percent (e.g. 8% Black, 2% White; 40% Black, 11% White; 14% Black, 11% White), schools are classified into three minority cells based on the sum of the percentages of the two minority groups. On the Example State Table, the location category labeled "Locale = 12" provides an example. In this location category, there are not two groups each containing greater than 15 percent of the population of students (40% Black, 15% Hispanic). The category labeled "Locale 21, 22" also provides an example (10% Hispanic, 8% Black). Schools are categorized as high, medium, and low, based on the sum of the percents of the two minority groups. Schools are sorted based on the sum of the percentages and divided so three groups are created that have approximately equal numbers of students per minority classification. The actual percentages used as cut points to define the three groups are shown in the columns headed "School Minority Characteristics." These percentages are unique by state and grade, as

well as by location category and are dependent on the properties of the schools in the location category.

*Scenario 3* – If both minority groups contain greater than 15 percent of the population of students (e.g. 33% Black, 29% White), schools are classified into four classes based on the enrollment percentage in each group. These four classes separate the groups into a grouping of low-low, low-high, high-low, and high-high. For example, in the location category of "Locale = 13" the classification has been separated into low Hispanic—low Black; low Hispanic—high Black; high Hispanic—low Black; and high Hispanic—high Black. These four classes are created by sorting the largest minority group by the percent, splitting into two groups that have about equal numbers of students, and then repeating the process using the percentage of second largest minority. The actual percentages used as cut points to define high and low are shown in the columns headed "School Minority Characteristics." These percentages are unique by state and grade, as well as by location category and are dependent on the properties of the schools in the location category.

*Check Your Understanding* – A section at the end of this document provides some examples for checking your understanding of the three scenarios of strata formation using minority enrollment. An answer key follows the examples.

With these methods of splitting the location category using the minority group percentages, strata are created that are approximately the same size in terms of student counts. Thus, for each of the minority strata within a location stratum, the population numbers of schools may not be similar, but the sizes or counts of the student populations within each are. This can be seen under the heading of "Frame" and the columns of "Schools" and "Enrollment."

## Description of Frame and Sample for Your State

In the Example State Table, the columns with the heading "Frame" describe by stratum the number of schools, the student enrollment in those schools, and the percent of the population that these students represent in the state. For example, in stratum 4 there are 22 schools enrolling a total of 1,366 students that represent 3.14% of the student population in the state.

The columns with the heading "Sample" describe by stratum the number of sampled schools, the expected number of students to be sampled within these sampled schools, and an estimate of the population that these students represent. Examining stratum 4 again, there are 5 schools to be sampled and 329 students are expected to be sampled from these schools. These sampled students will represent 3.44% of the student population in the state. This estimate is constructed by the appropriate weighting which takes into account the probability that the school was selected and an estimated probability that a student will be selected from a selected school (as the student sample has not yet been drawn.)

One cannot, from the information found in this table alone, determine a given school's probability of selection since the probability is proportional to "size," with size being defined as the number of students enrolled in the school in the focus grade. The enrollment figure is derived from the data file of the Common Core of Data, from which the sample of schools was drawn. In addition, the probability of

selection cannot be estimated by using the number of schools within a specific stratum since the overall sampling process is not stratified sampling.

## Final Stratification Step

The final step in the stratification process, though not part of these tables, is the sorting of schools within each of the unique stratum by a measure of school achievement.  Typically this measure is the percent of students at or above proficient on the state mathematics assessment within the school. Performance on the reading assessment could be used in place of mathematics since the two are highly correlated.  The same achievement indicator is used for all schools in the state and is based on availability and coverage. If no achievement data are available, the median income level for the zip code in which the school resides is used.  As stated before, since the advent of NCLB, typically every state has publicly available achievement data for schools and zip codes are not used.

The question then arises of, "*why would you do this?*" The answer: to try to make sure the most representative sample of the population is drawn.  As stated by Jaeger (1984), "*When a variable can be used to sort within the strata that is highly correlated with the outcome variable, in this case a state achievement measure and a NAEP achievement measure, the sampling procedure gains greater efficiency.*"  A statement collected from the sampling staff at Westat regarding this final sort communicated, "*Sorting by achievement data is a way of implicitly stratifying the minority strata, so that we get a good spread of schools of different levels of achievement in our sample. Because the achievement level is correlated with what we are measuring, it means we are reducing the chance of getting an overrepresentation of schools in the sample that have low or high achievement results. Therefore we are reducing the variance of our estimates.*"

A final note, and maybe only for trivia purposes, this final sort on achievement uses what is known as a serpentine sort.  A serpentine sort has the sort reverse order as it changes strata. So a strata is sorted from highest to lowest and the strata following it is then sorted from lowest to highest.  This has the additional impact of ensuring a representative sample is drawn.

**Table 2**. Example State Table

**Example State Table for NAEP**
Grade 4 Sample of Schools

| Frame Source | Location category and minority characteristics of strata | Stratum: Location by minority | Primary + secondary minority percent min | Primary + secondary minority percent max | Primary minority percent min | Primary minority percent max | Secondary minority percent min | Secondary minority percent max | Frame Schools | Frame Students Enrollment | Frame Students Population Percent | Sample Schools | Sample Students Expected student sample size | Sample Students Sample-based estimate of population percent |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Frame Source | locale = 12 | 1 | 8% | 46% | | | | | 31 | 2,192 | 5.04% | 7 | 507 | 4.99% |
| | 40% Black | 2 | 49% | 64% | | | | | 30 | 2,196 | 5.05% | 7 | 530 | 5.55% |
| | 15% White | 3 | 64% | 97% | | | | | 39 | 2,231 | 5.13% | 9 | 490 | 5.21% |
| | locale = 13 | 4 | | | 0% | 17% | 2% | 16% | 22 | 1,366 | 3.14% | 5 | 329 | 3.44% |
| | 20% Hispanic | 5 | | | 0% | 17% | 17% | 49% | 23 | 1,306 | 3.00% | 5 | 338 | 3.39% |
| | 19% Black | 6 | | | 18% | 62% | 7% | 21% | 20 | 1,356 | 3.12% | 4 | 257 | 2.69% |
| | | 7 | | | 18% | 62% | 22% | 45% | 25 | 1,359 | 3.12% | 5 | 283 | 2.96% |
| Schools listed as eligible in CCD | locale = 21, 22 | 8 | 1% | 5% | | | | | 72 | 6,433 | 14.78% | 17 | 1,307 | 13.54% |
| | 10% Hispanic | 9 | 5% | 13% | | | | | 82 | 6,476 | 14.88% | 20 | 1,506 | 15.52% |
| | 8% Black | 10 | 14% | 96% | | | | | 95 | 6,488 | 14.91% | 21 | 1,311 | 13.58% |
| | locale = 23 | 11 | 2% | 5% | | | | | 15 | 1,576 | 3.62% | 5 | 384 | 4.02% |
| | 16% Hispanic | 12 | 6% | 31% | | | | | 19 | 1,630 | 3.75% | 5 | 358 | 3.75% |
| | 11% Black | 13 | 35% | 89% | | | | | 23 | 1,599 | 3.67% | 5 | 377 | 3.95% |
| | locale = 31, 41, 42 5% Hispanic 2% Asian | 14 | | | | | | | 102 | 7,313 | 16.80% | 24 | 1,678 | 17.40% |
| | Eligible CCD Total | | | | | | | | 598 | 43,521 | 100.00% | 139 | 9,655 | 100.00% |
| New schools | | | | | | | | | 0 | | | 0 | 0 | |
| Total | | | | | | | | | 598 | 43,521 | | 139 | 9,655 | |

# References

Cochran, W. G. (1977). *Sampling Techniques*. Third Edition. John Wiley and Sons, Inc: New York.

Jaeger, R. M. (1984). *Sampling in Education and the Social Sciences*. Longman, Inc: New York.

Kalton, G. (1983). *Introduction to Survey Sampling*. Sage University Paper series on Quantitative Application in the Social Sciences #35. Sage Publications Ltd: Beverly Hills.

Lehtonen, R. and Pahkinen, E. (2004) . Practical Methods for Design and Analysis of Complex Surveys. Second edition. Wiley: Chichester.

Lohr, S.L. (1999). Sampling: Design and Analysis. Duxbury: Pacific Grove.

Thompson, S. K. (1992). *Sampling*. John Wiley and Sons, Inc: New York.

Williams, W. H. (1978). *A Sampler on Sampling*. John Wiley and Sons, Inc: New York.

Check Your Understanding - For each location category, how many strata are created 0, 3, or 4? *(Answers at bottom)*

1.

| |
|---|
| Locale = 11, 12 |
| 22% Black |
| 13% Asian |

2.

| |
|---|
| Locale = 22, 23 |
| 21% Black |
| 2% Hispanic |

3.

| |
|---|
| Locale = 12, 13 |
| 30% White |
| 16% American Indian |

4.

| |
|---|
| Locale = 22, 23 |
| 34% Hispanic |
| 14% Black |

5.

| |
|---|
| Locale = 41, 42, 43 |
| 6% Hispanic |
| 5% American Indian |

6.

| |
|---|
| Locale = 41, 42 |
| 28% Black |
| 19% Hispanic |

7.

| |
|---|
| Locale = 12 |
| 9% White |
| 8% Hispanic |

1. 3
2. 3
3. 4
4. 3
5. 0
6. 4
7. 3