RESEARCH & DEVELOPMENT

How to Account for Seasonal Population Shifts in Distributing the Powell Bill Allocation Funds

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16. Abstract

The Powell Bill Unit of the North Carolina Department of Transportation (NCDOT) annually distributes a fixed appropriation from the State Highway Fund to participating North Carolina (NC) municipalities to maintain municipal streets through resurfacing and other maintenance activities. Presently the funds are distributed by a formula allocating 75% of the funding based on municipality population and 25% based on municipality street mileage. This formula does not consider municipalities that are affected by seasonal population shifts. However, such shifts exist. The objectives of this research are to estimate seasonal population shifts of NC municipalities and to develop recommendations for Powell Bill funding allocation to reflect the impact. The research defined seasonal population as the number of visitors to a municipality who stay from one day up to six months in a given year. The research team assessed the funding distribution formulas of 50 State Departments of Transportation (DOTs) in the United States and found that 11 DOTs distribute funds based only on population, 6 DOTs based only on mileage, and 18 based on both population and mileage. According to an extensive study of 10 data sources, the research team found that the most reliable and feasible sources to account for seasonal population are 2010 U.S. Census data, 5-years American Community Survey, Seasonal Tourism Volumes, and July 1 Population Estimates by North Carolina Office of State Budget and Management. A seasonal population estimation formula utilizing all the above 4 sources was selected to provide the most reliable and current estimates. In addition, three funding allocation strategies based on cap, group, and need approaches were developed to better address the impact of seasonal population. An Excel based tool was provided to assist NCDOT engineers and administrators to modify the parameters of the proposed allocation strategies so that administration decisions can be made accordingly. This research also found that military vehicles do not exert an exacerbate damage to local streets based on literature review and interviews with multiple military personnel.

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EXECUTIVE SUMMARY

The work presented in this final report seeks to identify the municipalities that experience seasonal population increase, quantify the amount, and assess the effect (allocation shortfall) relative to the current Powell Bill funding allocation formula. The report outlines how to adjust the formula to more equitably distribute funding. With the completion of this work the North Carolina Department of Transportation (NCDOT) will better understand seasonal population impacts on municipalities, be in possession of alternative funding allocation formulas, and be able to make informed decisions on how to proceed.

Based on a literature review of 14 studies that define seasonal population it is clear that the definitions of seasonal population vary among researchers. Each definition is based on the use of different components which are linked to the scope of their goals. Therefore, based on those studies, this research defines seasonal population as the number of visitors to a municipality who stay between one day and up to six months in a given year.

In addition, this research investigated funding distribution formulas of 50 State Departments of Transportation (DOTs) to better understand the diversity and the focus of funding allocations. Out of the 50 DOTs, 11 distribute funds based only on population and six DOTs perform their distribution based only on mileage. Eighteen states distribute their funds based on both population and mileage. Fifteen based on other categories including needs, county area, local match, revenue programs, and vehicle registration.

Based on a study of 10 data sources, we found that the most affordable and reliable data sources are 2010 U.S. Census data, 5-years American Community Survey (ACS), Seasonal Tourism Volumes (STV), and July 1 Population Estimates by North Carolina Office of State Budget and Management. The research team evaluated data sources based on the following criteria:

1. Affordable and reliable: readily available, low-cost or no-cost data reliable for all North Carolina (NC) municipalities. This category includes 2010 U.S. Census data, 5-years ACS, STV, and July 1 Population Estimates by North Carolina Office of State Budget and Management.
2. Affordable but not reliable: readily available, low-cost or no-cost data that is neither reliable for all NC municipalities nor is sufficiently detailed to use for an estimation model. This category includes Hotel/Motel Lodging data, Motor Vehicle Count, Crash Data, Water Usage, and Survey Calls.
3. Reliable but not affordable: data that may be available for all NC municipalities but is costly to obtain, impractical to collect, or both. For example, Cellphone data.

As shown in Table 1, the research developed five methods to estimate seasonal population based on affordable and reliable data sources. Method 1 was developed as a test case with 2010 U.S. Census data only. Therefore, the results are neither accurate nor do they represent current seasonal population. Method 2 utilized 2010 U.S. Census data for share of seasonal housing and average person per household. It also used 5-Years ACS (2013-2017) for several housing units total, and STV data for percent of visitors with respect to the peak season visitors. Method 3 used the average person per household in 2017 to replace the average person per household based on 2010 U.S. Census data used in Method 2. Method 4 utilized only parameters for 2017, including 2017 permanent population, 2017 housing units, and 2017 persons per household. This method did not

use any decennial census data and accepted the latest ACS estimates for the seasonal population. Method 5 introduced the municipality's regional average travel party size which approximated the number of people per household. Unlike Methods 1-4 which rely on local household size to estimate seasonal population, the use of regional average travel party size ($ATPS_{2017}$) will lead to a more reliable estimate. Therefore, this research recommended Method 5 for seasonal population estimation.

Table 1. Methods Developed to Capture Seasonal Population

Method No.	Formula	Sources
1	$SPop_1 = Seas_{HU_{2010}} \times PPH_{2010}$	2010 U.S. Census
2	$SPop_2 = [(P_{Seas_{2010}} * HU_{2017}) * PPH_{2010}] * \frac{\Sigma_{i=1}^{4}(p\_seas_i)}{4}$	2010 U.S. Census, 5-Years ACS (2013-2017), and STV data (2013-2017).
3	$SPop_3 = [P_{Seas_{2010}} \times HU_{2017}] \times PPH_{2017} * \frac{\Sigma_{i=1}^{4}(p\_seas_i)}{4}$	2010 U.S. Census, 5-Years ACS (2013-2017), and STV data (2013-2017).
4	$SPop_4 = Seas_{HU_{2017}} \times PPH_{2017} * \frac{\Sigma_{i=1}^{4}(p\_seas_i)}{4}$	5-Years ACS (2013-2017) and STV data (2013-2017).
5	$SPop_5 = \left[\frac{Seas_{HU_{2010}}}{HU_{2010}} * HU_{2017}\right] * (ATPS_{2017}) * \frac{\Sigma_{i=1}^{4}(p\_seas_i)}{4}$	2010 U.S. Census, 5-Years ACS (2013-2017), STV data (2013-2017).

$Seas_{HU_{2010}}$ = House unit vacant for seasonal use (2010 U.S. Census)
PPH_{2010} = Average person per household (2010 U.S. Census)
$P_{Seas_{2010}}$ = Seasonal Share of housing (2010 U.S. Census)
HU_{2017} = Number of Housing Units total (2017 5-year ACS)
PPH_{2017} = Average Number of Persons per Household (2017 5-years ACS)
$Seas_{HU_{2017}}$ = Number of Housing Units for seasonal use (2017 5-years ACS)
HU_{2010} = Housing Unit estimate (2010 U.S. Census)
$ATPS_{2017}$ = Average travel party size per households (STV, 2013-2017)
p_seas_i = In each season, a percent of visitors to the peak season visitors (STV)

Three funding allocation strategies were developed to better address seasonal population's impact. The first is the Cap Based Allocation, which uses the same per capita and per mile values from the most recent year (i.e. \$19.56/person and \$1,600.17/mile). The new funding allocation for a municipality is the summation of per capita value multiplied by the total population (seasonal + permanent) and per mile value multiplied by the total mileage of the municipality. To avoid an excessive increase to municipalities which experience high seasonal population but has minimal mileage, a cap of maximum allocation is assigned. For example, a capping policy can be that no municipalities should receive a total allocation increase more than 50% of last year's allocation. Under the capping policy, no municipality will have a funding reduction. The legislature needs to allocate additional funding for Powell Bill and the amount depends on the level of capping.

The Group Based Allocation recommends dividing all qualified municipalities into five groups based on their seasonal population percentage. Then allocate a percentage factor for each group. For all municipalities fall in the same group, they will receive a funding increase of the same percentage from previous years' allocation. There are four scenarios provided for the Group Based Allocation under the assumptions that either keeps the total Powell Bill budget unchanged or require additional funding. This allows NCDOT administrators to estimate the impact on total budget and funding allocation for each municipality based on the assumption chosen. In addition, NCDOT can also adjust the range for each group and the respective percent factor to see the impact. An Excel based tool was provided to assist NCDOT engineers and administrators to

modify the parameters of the proposed allocation strategies so that administration decisions can be made accordingly.

Under the Need Based Allocation, the same Powell Bill funding allocation formula is used. The difference is that municipalities with a high seasonal population percentage (i.e. greater than 50%) can request additional funding based on need. Those qualified municipalities can submit requests for additional funding if they have a need for improving local streets. An NCDOT committee will be assigned to evaluate and assess the need and budget. Funding will be allocated based on a priority ranking system considering the amount of structural deficiency, mileage, budget, social and environmental impact, and the seasonal population percentage. This approach allows NCDOT to help municipalities with high seasonal population impact to improve local street conditions based on their needs.

The research also investigated the impact of heavy military equipment usage on local streets. Based on interviews with 2 military officers and literature reviews, the research found that military vehicles do not exert an exacerbate damage to local streets. Military bases follow local laws on vehicle weight limits. Heavy military equipment are designed with multiple axles which distribute loads to avoid potential street damage.

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1 INTRODUCTION

Annually, North Carolina (NC) State street-aid (Powell Bill) allocations are made to eligible and qualified municipalities in NC. The general statutes require that the North Carolina Department of Transportation (NCDOT) administers State aid to qualified NC municipalities. Seventy-five percent (75%) of the total funds are divided by the population of all eligible and qualified municipalities to produce a per capita allocation ($19.56 per capita in 2017). Twenty-five percent (25%) are divided by the local street mileage to produce a per mile allocation rate ($1,600.17 per mile in 2017). The per capita rate is multiplied by the population of a municipality and per mile rate is multiplied by the mileage of local streets to obtain the amount of the fund allocated to a city or town. In 2017, there were a total of 508 eligible municipalities that received a total Powell Bill funding of $147.4 million (State Street-Aid to Municipalities, 2018). The complete list of these municipalities is attached in Table 32 in Appendix A.

The Powell Bill Unit of NCDOT uses the permanent population of each municipality to determine how much of the funds should be allocated to the individual municipalities. However, some municipalities in NC face extreme shifts in population size depending on the season. The problem is that the population used in the current formula does not account for the seasonal population shifts. Thus, these municipalities are, in effect, underfunded. Therefore, there is a need to allocate the Powell Bill fund in a way that truly reflects population size by adjusting for seasonal population. In order to do so research must be done on how municipal populations in NC are affected by seasonal shifts.

This report contains the findings on how the NCDOT Powell Bill formula should be adjusted to address seasonal population shifts in support of the Powell Bill Program so that it is fairly and equitably administered.

1.1 Research Need Definition

Some municipalities eligible to receive Powell Bill funds face extreme shifts in population size depending on the season. However, this change is not currently accounted for in the current allocation. For example, according to the Carolina Population Center (CPC) of the University of North Carolina (UNC), it is estimated that the Greater Topsail Island Area in NC has a seasonal population increase from 5,988 permanent residents to 61,353 seasonal residents during the summer months (Carolina Demography, 2014b). There are also other factors or events affecting seasonal population fluctuation in various municipalities in NC.

Another important factor to consider is military impact. There is a concern that additional impact on local roadway maintenance is present due to some of the 9 military installations located in NC. Therefore, it is necessary to investigate the level of impact on local streets from military equipment usage.

1.2 Research Objectives

The objectives of this research are to identify the municipalities that experience seasonal population shifts and military impact, quantify them, develop an adjusted allocation formula, and provide recommendations for NCDOT to better address the impact.

The detailed objectives of the proposed research are to:

1. Review current literature to identify sources of data on seasonal population shifts and identify impacts of military equipment on highways and roads.
2. Collect specific data on seasonal population shifts in NC's municipalities that includes which municipalities face seasonal population shifts and how significant these population shifts are.
3. Analyze the data to determine the effects of seasonal population shifts on municipal streets and on the allocation of Powell Bill funds.
4. Create new formulas to reflect on these population shifts.
5. Develop implementation strategies and assess their impact on the funding allocation.

2 LITERATURE REVIEW

A thorough literature review was conducted with the purpose of improving the current formula for the NCDOT Powell Bill fund distribution. This literature review included methods for estimating seasonal population, current practices of the 50 Departments of Transportation (DOTs), and assessment of the military impact on local roads.

2.1 Seasonal Population Definitions

Previous research defined population in different ways. A summary of the definitions is listed in Table 2. For example, permanent residents are defined as all persons who live within a geographic area most of the time. This definition is preferred and utilized within all literature and agrees with the U.S. Census definition.

However, the definition of seasonal population varies among researchers because each is using their own definitions and choosing components depending on the scope and context of their research (Smith, 1989). For example, elderly "snowbirds" and "sunbirds" are a focus of Smith and House's (2006), while Campanelli et al. (2017) prioritize understanding commuters, seasonal workers, daytrippers, and summer residents in the context of their work on Nantucket Island. With respect to length of stay, there are no consistent patterns to consider for the seasonal population, though many localized studies differentiate between shorter-duration stays ("visitor", "tourist", or "travelers") and longer-duration stays ("seasonal residents" or "second homeowners"). All of the studies presented in Table 2 define the length of stay of seasonal population to be at least one day to a maximum of six months.

The U.S. Census defined seasonal housing units as housing units that are vacant and intended for use occasionally during certain seasons of the year (Note: if a housing unit is currently occupied by someone whose permanent residence is elsewhere, that housing unit is classified as vacant by the U.S. Census (U.S. Census Bureau Population Division, 2018a). The U.S. Census does not have a specific definition for seasonal residents, but the seasonal components can be calculated using the seasonal housing unit (SHU) data. This SHU is collected by the U.S. Census in the decennial census and the American Community Survey (ACS) and includes those houses or places of residence that are specified by the owner to be occupied only during certain seasons of the year. These houses are not part of their usual place of residence (U.S. Census Bureau, 2018b).

Table 2 includes an extensive list of components which were identified as part of the seasonal population. Fourteen studies have been conducted with the purpose of defining and assessing seasonal population. Within the 14 studies, researchers utilized multiple methods to assess the different components of seasonal population. The sources utilized include cellphone data, census data, surveys, and travel data. The most utilized source was census data which was applied to six studies. Two studies utilized cellphone data, three utilized survey, two studies used travel data (hotel/motel lodging record), and only one utilized VIIRS night-lights by Earth Observation Group, NOAA National Geophysical Data Center.

Table 2. Summary of Previous Seasonal Population Studies

Categories	Component	Definition	Methodology	Data Source
Smith (1989); Smith (1994); Smith and House (2007)				
Permanent residents	Permanent	Florida was the respondents' usual place of residence or the place they lived and slept most of the time.	The survey reached about 500 Florida households each month between September 2000 and December 2003. Respondents were asked a series of questions regarding his or her demographic characteristics, residency status, and migration behavior.	Telephone surveys conducted by the Bureau of Economic and Business Research at the University of Florida.
Seasonal Resident	Temporary residents	Florida was not the respondents' usual place of residence or the place they lived and slept most of the time. A stay of 1 month or more.		
	Travelers	Permanent residents who reported that they spent more than 30 days away from home.		
Cleland et al. (2003)				
Seasonal Resident	Snowbird and Tourist	Persons moving due to weather conditions and stay a minimum of 3 months but not greater than 6 months.	The survey asked participants for their arrival month, departure month, length of stay, housing type, County distribution, age, and reasons for visiting.	Surveyed Florida State Fair and received 300 responses.
Smith and House (2006)				
Seasonal Resident	Snowbirds	A temporary elderly population that stays at their place of residence but spends several months each year away from home.	Utilize survey data to determine the number, time, and duration of temporary moves.	Phone call survey

Continuation				
Categories	**Component**	**Definition**	**Methodology**	**Data Source**
Pinellas County Metropolitan Planning Organization (2009)				
Permanent Residents	Permanent	Persons are living in structures designed for permanent residency (including mobile homes and group quarters) that identify Pinellas County as their permanent residence and can be identified as such by the U.S.Census.	Divide the population of each census tract by the total number of dwelling units in each tract to obtain the average number of persons per dwelling unit. Multiply the average number of persons per dwelling unit by the number of potential additional units in that track likely to be occupied by permanent residents. Add the results to the 2006 permanent population to determine the maximum permanent population.	2000 Census and 2006 Pinellas County Geographic Information System.
Seasonal Resident	Seasonal Residents	Persons who reside in a structure designed for permanent residency (including mobile homes) in for less than 6 months and who declare their permanent residence as somewhere other than Pinellas County.	2000 Census identified a percentage of the seasonal dwelling units to the total dwelling units. Assume that the percentage identified in the 2000 Census would not substantially change over time.	2000 Census
	Tourists	Persons are in Pinellas County for less than 2 months for vacation.	Multiply the seasonal dwelling units to the number of persons per seasonal unit from the 1994 survey.	Distribution of hotel/motel/timeshare units for 2006.
Charles-Edwards et al. (2010); Silm and Ahas (2010)				
Seasonal Resident	Long - Term Repeat Visitors	People who stay in a single location for some months.	Survey data performed every 5 years by the Australian Census has a questioner that determine the movements of seasonal residents and their activities.	Australian Bureau of Statistics' Population and Housing Census (APHC)
	Short - Term Repeat Visitors	People who stay in a single location for up to a month each year.		
	Mobile	Once-off visitors are traveling from place to place along a pre-determinate route.		
Swanson and Tayman (2011)				
Permanent Residents	Present Population	People who might be identified as part of the permanent population.	Use of the 2010 census to determine permanent population.	2010 Census
Seasonal Resident	Visitor	People who are in a given area on census day for a short period that will not consider their usual place of residence, but who also are not part of the area's daytime population.	Counting occupied rooms in hotels and other facilities in combination with an average number per occupied room, and surveys conducted via transportation modes, entry and exit points area, and visitor sites. By performing a count of homeless people in sheltered homes and 2 days canvassing of streets and phone surveys. Utilizing the US decennial census vacant housing, which includes those reserved for seasonal, recreational, or occasional use. Using the 2005 Census and remote sensing imagery.	2010 Census and Las Vegas Convention and Visitors Authority. Applied Survey Research 2010 Census 2005 Census
	Homeless	People who for various reasons live in emergency shelters or traditional housing for some time.		
	Seasonal Population	People who are in an area for more than a couple of weeks, but not more than 6 months.		
	Daytime Population	Residents of another area than the one in question who are present (e.g., commuters or day trippers).		

Continuation				
Categories	**Component**	**Definition**	**Methodology**	**Data Source**
Davies (2011)				
Seasonal Resident	Seasonal Migration	Migration-related to Tourism, that tends to occur during vacation season.	Passive mobile position data comprise data stored in the memory or log file of the mobile operators.	Passive Mobile Position Data.
Graebert, Wyckof, and Bretz (2014)				
Permanent Residents	Permanent	A person is living in the home at the time of the survey or absent for no more than 2 months.	Values obtained by utilizing U.S. Census 2012 data.	U.S. Census 2012 and the American Community Survey (ACS).
Seasonal Resident	Seasonal Resident	A person who uses a second home.	Base on the number of seasonal housing units 2012 and seasonal occupancy multiplier.	U.S. Census 2012.
	Transient	A person who utilized overnight accommodations.	Purchased data for hotels and motels accommodations in ten county regions in Michigan.	Smith Travel Research, Inc. (STR).
Florida (2016)				
Permanent Residents	Permanent	It is the place where a person lives and sleeps most of the time.	Use of U.S. Census 2010 to correlate values and estimate population for 2014.	U.S. Census 2010 and the Bureau of Economic and Business Research (BEBR).
Seasonal Resident	Temporary Residents	Is the place one staying only for a few days, weeks or months.	The Bureau of Economic and Business Research provided estimates for every county and sub-county in Florida.	
Campanelli et al. (2017)				
Permanent Residents	Permanent	A person who is living in the home at the time of the survey or absent for no more than 2 months.	The study performed to estimate the population of Nantucket utilizes a variety of data sources to determine their effectiveness and reliability. The most relevant sources were the Nantucket Street Census, solid waste, StreetLight data (cellphone data), and transportation data.	Street Census population, StreetLight data (cellphone data), Solid Waste, and Transportation data.
Seasonal Resident	Tourist	Tourist that make short stays are also known as visitors.		
	Commuters	Day-trippers tend to travel due to business but return to their houses at night.		
	Seasonal workers	Attracted to seasonal jobs such as agriculture, construction, and tourism.		
	Summer Residents	A person who has a second home on Nantucket.		
Stathakis and Baltas (2018)				
Seasonal Resident	Tourists	Tourist that make short stays are also known as visitors.	Used a correlation of average night-light (Satelite signal of average radiance composite images using night time data) per month for each region in Greece to determine seasonal ambient population.	VIIRS night-lights by Earth Observation Group, NOAA National Geophysical Data Center.
	Seasonal workers	Attracted to seasonal jobs such as agriculture, construction, and tourism.		
	Second Homeowners	People who spend more days than tourism at their second-home location.		
	Migrants	Registered or unregistered people who move in space for several reasons including refugees.		

2.2 Seasonal Population Definition for this Research

Smith (1989) identified that there is no ideal definition or parameters to account for the seasonal population shift. What is included in the seasonal population depends on the scope of the research. Therefore, since the U.S Census data is the primary source of data for this research, the U.S. Census definition is adapted. In this research, permanent residents are defined as those who usually live and sleep in a place of residence. The seasonal population is defined as the number of visitors to a city who stay between 1 day and 6 months.

2.3 Seasonal Population Data Collection Methods

Table 3 represents the types of seasonal population identified for this research. Also, it describes how to assess them and its relevance. Seasonal residents can be directly estimated by utilizing the seasonal household information provided by the U.S. Census. In addition, in 2010, NC had a total of 1,620 housing units vacant for agricultural/seasonal workers (Migration Policy Institute, 2019) which is a small number for the entire state. Nevertheless, since there is data available for agricultural/seasonal workers, this factor could be captured and estimated for in seasonal population if it were determined to be relevant.

Cellphone data can provide good estimation of the commuter population. But purchasing cellphone data for all municipalities in NC is too costly. Alternative sources for commuting data from the U.S. Census are available and can be used to estimate the annual average flow of commuters to and from municipalities. However, commuters are not part of the seasonal population for this research based on the seasonal population definition.

Table 3. Seasonal Population Components

	Component	How to Account?	Where to add it to the proposed formula?	Will be feasible to account?	Is it relevant?
Permanent Residents	Regular Permanent Residents	NC-OSBM* U.S. Census Bureau	Population	Yes	Yes
	Military Population	NC-OSBM* U.S. Census Bureau	Population	Yes	Yes
	Students	NC-OSBM* U.S. Census Bureau	Population	Yes	Yes
	Convicts	NC-OSBM* U.S. Census Bureau	Population	Yes	Yes
	Homeless	U.S. Census Bureau Point-in-Time Counts	Population	Yes	Yes
	Unauthorized Residents	Department of Homeland Security (DHS) and ACS	Population	Yes	Yes
Seasonal Residents		U.S. Census Bureau	Population	Yes	Yes
Agricultural/ Seasonal workers		U.S. Census Bureau	Population	Yes	No
Commuters		Cellphone Data Employment Patterns (U.S. Census Bureau)	Mileage	Yes	No
Visitors/Tourist		Cellphone Data	Mileage	No	Yes

* North Carolina Office of State Budget and Management (NC-OSBM). The Military, Students, Prisoners, Homeless, and Unauthorized Residents are considered in the NCOSBM as part of the "Permanent Population."

The only components to be considered for the Powell Bill study are permanent population, military, student, convicts, agricultural/seasonal workers, visitors/tourists, unauthorized residents, and seasonal residents. The military, student, convict, and homeless population is captured as permanent population in the decennial census and included in the annual estimates of population produced by the North Carolina Office of State Budget and Management (NC-OSBM). Since the NC-OSBM provides the annual estimated population growth values to the NCDOT Powell Bill unit, there is no need to do further calculation to capture these components. In addition to these special populations, there is an estimate of 321,000 unauthorized residents in NC (Migration Policy Institute, 2019). All residents, regardless of legal status, are counted in the decennial census and are included in annual population estimates. Thus, this population is already accounted for in the annual estimates produced by NC-OSBM and there is no need to do further calculation to capture these components.

The seasonal population components included for this research consist of the factors presented in Table 4. All components that can be included in a seasonal population are listed. Nevertheless, not all the components have a reasonable form of measurement or are feasible to measure.

Table 4. Area to Focus for the Powell Bill Allocation

Type	Components	Source	Classification	Feasibility	Relevance
Permanent Population	Household Population	NC-OSBM	Population	Yes	Yes
	Military Population	NC-OSBM	Population	Yes	Yes
	College Students Living in Dorms	NC-OSBM	Population	Yes	Yes
	Convicts	NC-OSBM	Population	Yes	Yes
	Homeless	NC-OSBM	Population	Yes	Yes
	Unauthorized Residents	NC-OSBM	Population	Yes	Yes
Seasonal Population	Seasonal Residents	2010 U.S. Census 5-year ACS Seasonal Tourism Volume NC-OSBM	Population	Yes	Yes
	Agricultural and Seasonal Workers	United State Department of Agriculture	Population	Yes	No
Other	Commuters	Employment patterns (U.S. Census)	Mileage	Yes	No
	Daytripper	Cellphone data	Mileage	No	Yes

There are two approaches for estimating seasonal population: the direct and indirect approaches. The direct approaches consist of using census and survey data to estimate the seasonal population. The direct approaches are considered the most widely used approach (Graebert et al., 2014). The indirect approaches focus on symptomatic variables that reflect changes in the temporary population (Smith, 1989).

2.3.1 Direct Approaches

Direct approaches are the preferred data sources utilized by some researchers to estimate seasonal population because they provide highly reliable data collection results (Smith, 1989; Smith et al., 2013; Graebert et al., 2014). Literature for direct approach for the primary data sources utilized for this research, including census, surveys, and visitor survey data are presented and discussed in detail below.

2.3.1.1 *Census Data*

Multiple sources have stated and verified that the U.S. Census is the most reliable and valuable source of demographic data in the United States (Smith et al., 2013; University of Florida, 2016). The U.S. Census is a 100% count of all housing units at a single point in time, which is decennially (every ten years) on April 1. The decennial census consists of census forms sent to every household in America. The head of the household completes the forms, providing the requested data, and returns it to the U.S. Census. If the information is not sent by mail, census personnel go door to door to make sure the 100% count is completed (U.S. Census Bureau, 2019a). Special populations are counted through a variety of processes. Individuals living in group quarters facilities, such as correctional facilities, are counted through the group quarters enumeration; this process also includes individuals experiencing homelessness who are receiving services at service-based locations. In addition, on-the-ground canvassing efforts targeting known locations of transitory populations (e.g., campgrounds, tent cities, and motels), are conducted to count resident populations that may not have a usual home elsewhere (U.S. Census Bureau, 2019a).

The U.S. Census collects its data by applying a combination of data collection processes. These processes include but are not limited to the direct responses mentioned above from people and the door to door canvassing. In addition, the U.S. Census collects administrative data from Social Security, Medicare, and Internal Revenue Service offices. The decennial census is a combination of administrative data, surveys, and census data (U.S. Census Bureau, 2019b). Therefore, because of its reliability (Smith et al., 2013), 2010 U.S. Census data was selected as the basis of this work to provide an estimate of seasonal population.

The census questionnaire collects basic information such as age, sex, race, ethnicity, marital status, and housing unit characteristics. The housing characteristics reported in the census include the total number of houses, the number of vacant units, seasonal, recreational, or occasional use houses (seasonal share of housing), and the total number of renters and owners (U.S. Census Bureau 2011).

Unfortunately, census data is collected every ten years, and this leads to data that can become increasingly outdated in the following decade (Erbach-schoenberg et al., 2016). Recognizing this fact, the U.S. Census Bureau developed the ACS (detailed below), which provides more annually updated information on characteristics of population and household. Despite the implementation of the ACS, the decennial census remains the best source of data on occupancy status of housing units, particularly in resort areas, due largely to its comprehensive coverage and single point-in-time estimate. For this research, the 2010 U.S. Census is used to estimate the seasonal share of housing ($P_{Seas_{2010}}$).

2.3.1.2 American Community Survey (ACS)

The ACS is an ongoing survey conducted by the U.S. Census Bureau. The ACS collects population data every year and provides annual updates on key demographic, economic, and social indicators (U.S. Census Bureau, 2018b). Through the ACS, entities are able to estimate changes in population and have an estimate of population change for each year following the last decennial census. There are three main differences between the ACS and the decennial census. These are noted below.

1. The U.S. Census is a 100% count of population and housing. The ACS is a sample-based survey. Each year, the ACS collects data for about a 1% sample of the population.
2. The U.S. Census is conducted for a single point in time (April 1). The ACS data are collected throughout the year.
3. The U.S. Census collects a small number of demographic details (10 questions in 2010). The ACS questionnaire is a more extensive survey that captures information on a range of social, demographic, and economic characteristics, including education, employment, home value, and mortgage status.

There are two ways the U.S. Census Bureau collects the ACS data, one is by mail and the other is via internet. The ACS publishes the survey annual reports every Fall (U.S. Census Bureau, 2018b). Since the ACS is based on a sample and not a 100% count, there is a level of uncertainty associated with this data. The U.S. Census also provides a margin of error for each published ACS estimate. The larger the sample, the smaller the error. As a result, more populous areas generally have less uncertainty in their ACS estimates than less populous areas.

For this research, the total housing stock (HU_{2017}) was the value obtained from the 2017 5-Year ACS. This is a more current estimate of local housing than the total derived from the 2010 U.S. Census and will help to account for growth or demolitions in local housing stock since 2010.

2.3.1.3 *Survey Calls*

Survey calls are a widely used statistical method to collect random sample data. These consist of placing a random call to ask responders a series of questions based on the topic of interest. However, this methodology is costly and time consuming. The data collected by survey calls are representative of the population at-large but fail to provide data for small areas because random sampling may miss those areas and the data source will become partially biased (Smith and House, 2006).

2.3.1.4 *Seasonal Tourism Volumes (STV)*

The National Visitor Survey (NVS) is a continuous survey method utilized by the government in Australia and other countries. The main objective of the NVS is to provide detailed and accurate information regarding the timing and magnitude of population changes. The NVS consists of surveying visitors in tourist areas in Australia to determine the seasonal population.

NC performs a similar type of survey which is annually reported by Visit North Carolina (VNC) using data provided by Smith Travel Research (STR). Information collected includes the purpose of the trip, mode of travel, travel party characteristics, places visited, number of nights, accommodations, activities, spending, and demographics. This information is weighted to match U.S. Census variables (market size, age of household head, household income, and household

size). VNC creates the regional report to represent the tourist and traveler data that is specific to each geographic area in NC. The report is divided into three sections: Coast, Piedmont, Mountain (Visit North Carolina, 2016).

VNC releases tourist data each year with details including the purpose of the trip, places visited, mode of travel, demographics, spending, activities, number of nights, and travel party characteristics. In addition to statewide reports, VNC releases regional reports that provide detail on visitors to NC's three primary regions: Coast, Mountains, and Piedmont. Figure 1 is an example of the 2016 lodging report for each NC region. None of the VNC reports add to 100% because the responses are not mutually exclusive. In other words, a person can report staying in different types of accommodations within a given trip.

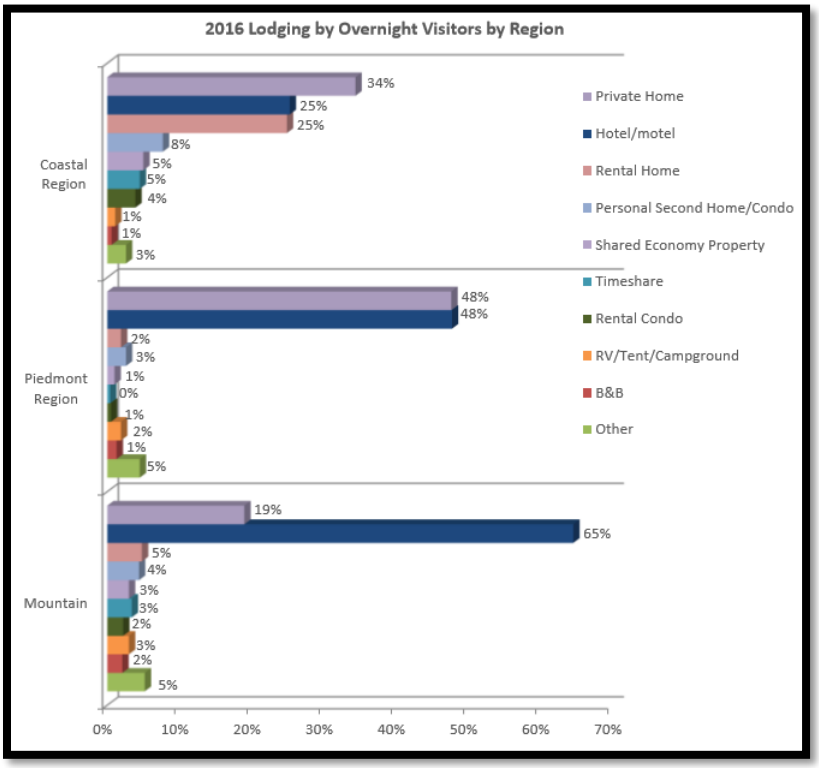


Figure 1. STV Regional Visitor Lodging Data *(*Visit North Carolina, 2016)

Another key statistic provided by VNC is overnight travel by season, or the share of travelers to each region in Winter, Spring, Summer, and Fall. Figure 2 presents a sample of this data. For this research, we calculated the average seasonal distribution of the past 5 years of overnight travel by season (2013-2017).

We used the 5-year average for both average travel party size and seasonal distribution for two reasons. First, this 5-year period aligns with the data collected from the 2017 5-Year ACS (2013-2017). Second, there can be year-to-year fluctuations in these numbers. Taking an average of 5-years helps provide a more stable estimate.

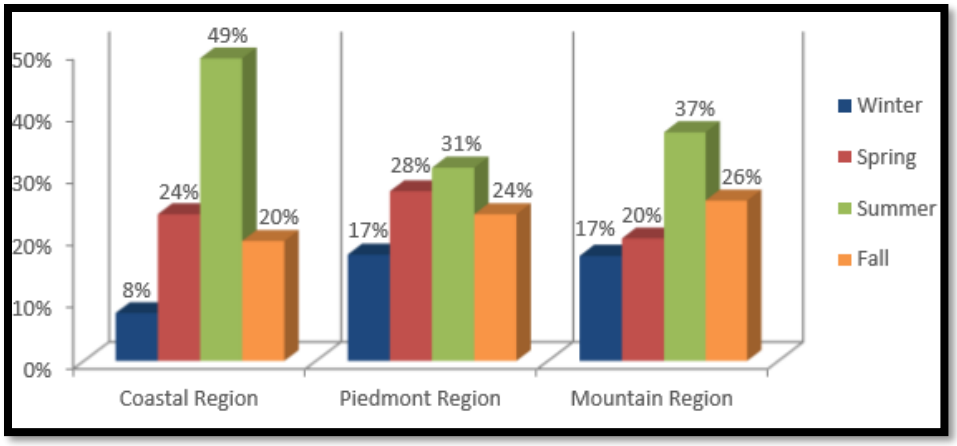


Figure 2. STV Seasonal Visitor Lodging Data *(*Visit North Carolina, 2016)

2.3.2 Indirect Approaches

An indirect approach is a population approximation obtained by using a closely related variable that reflects changes in population (Smith, 1989). Indirect approaches are rarely utilized by researchers to estimate seasonal population because the information collected is hard to obtain and most of the time the data is outdated or incomplete (Campanelli et al., 2017). Literature discussing indirect approach methods are presented and discussed in detail below.

2.3.2.1 *Cellphone Data*

A reliable but expensive method utilized to determine seasonal population patterns is cellphone data. Cellphone data provides a precise location of the current population and is capable of collecting point locations on a given day (Erbach-schoenberg et al., 2016). With this data, it is possible to track and determine seasonal patterns. Since approximately 96% of the population has cellphone reliability of this data is high (Davies, 2011). However, cellphone data is costly. Consequently, it is not possible to purchase data for more than a few locations - far fewer than what is needed for a statewide statistical sample.

Cellphone data available to purchase in NC is obtained from more than 1,000 apps that collect phone location. The cellphone data provides a repetitive pattern of movement (travel path), and with this data, it is possible to determine "home location" for each individual in a determinate city as well as the places they visit or travel to in any given time period.

When analyzing cellphone data, Goldstein (2018) developed a set of guidelines for transportation planners and travel modelers on how to evaluate, identify the usage of data, and support strengths and weaknesses for the use of cellphone data. Goldstein's primary purpose is to determine and evaluate how a cellphone could better represent travel behavior using the exhaustive volume of real-time data that were not previously available to identify the location of the cellphones and obtain an accurate result.

2.3.2.2 *Hotel/Motel Lodging*

Hotel and motel lodging data are difficult to obtain because town government data is often incomplete or outdated and the taxing and data collection processes tend to vary across municipalities (Campanelli et al., 2017). According to the study performed by Smith and House (2007), hotels and motels are a less reliable source of data to estimate seasonal patterns because they are more likely to be affected by respondent error. Additionally, the process of obtaining lodging data is time-consuming and costly.

2.3.2.3 *Motor Vehicle Count*

Motor vehicle counts (MVCs) is the preferred indirect method utilized by most of the DOTs to examine and detect travel behaviors. Using MVCs, it is possible to detect seasonal variations by identifying traffic behaviors and inferring and detecting seasonal patterns. These patterns are useful for determining the total seasonal population (Campanelli et al., 2017).

For NC, the MVCs are performed by using Permanent Average Data Traffic (PADT) which had a continuous count on a given intersection. NC only has 80 point stations covering 75-76 counties. PADT data is useful to establish a seasonal pattern for those counties. But it lacks the detailed information to determine the values of seasonal population.

2.3.2.4 *Crash Data*

Crash data is a statistical database maintained by the state DOTs that is based on live crash reports (2001-2017). In NC this data identifies crash rates for each municipality. As a result, crash data can also be utilized as an indirect approach to determine seasonal patterns. The correlation between crash data and seasonal population can be implemented by analyzing temporal patterns in automotive crashes (which tend to increase in areas where the population is higher). Therefore, it is possible to detect seasonal patterns with this source and, indirectly, to determine seasonal population (University of North Carolina, 2017).

2.3.2.5 *Commuter Data*

The U.S. Census Bureau has developed Quarterly Workforce Indicators (QWI) data since 1990. The QWI is a dataset that provides approximately 32 economic indicators including employment, geographic location of residence, location of workplace, age, and gender (U.S. Census Bureau, 2018b). Using this data, it is possible to determine the number of commuters per municipality in NC and to perform a correlation to determine the damage to local roads induced by commuters.

2.3.2.6 *Others Indirect Approaches*

In much earlier times, there were two different methods utilized to estimate population. The first method was based on the density of habitation coefficients and the second was based on natural resources available (Zorn, 2007; Silm and Ahas, 2010). Therefore, by applying a similar concept to the present, water consumption could be an indicator of seasonal patterns.

The CPC has conducted a series of in-depth research studies on seasonal population change in the Greater Topsail Area (Carolina Demography 2014a, 2014b) and the impact of seasonal populations in the state more broadly (Tippett 2017). The research for the Greater Topsail Area collected data on monthly water usage, the realistic peak occupancy rate for vacation rentals and hotels, month

data on Room Occupancy Tax (ROT), and the occupancy rate for campgrounds, RV parks, and houseguest visitors (Carolina Demography 2014a, 2014b).

Based on the findings, CPC developed a tool to estimate the seasonal population change for the Topsail region. The Town of Sunset Beach in NC also estimated and analyzed peak seasonal population by collecting data on housing units and their water consumption (Cape Fear Council of Governments, 2010).

More recent work was conducted by Tippett (2017) using U.S. Census data, VNC travel impact statistics, annual municipal expenditures, locally-provided monthly data on water usage, rooms occupancy, emergency services, and key informant interviews to evaluate the benefits and challenges of seasonal populations for NC communities more broadly (Tippett, 2017). All findings indicate that the data based on the U.S. Census is the most accurate and reliable.

2.3.3 Summary and Plan for Powell Bill Seasonal Population Estimation

After evaluating and considering the available strategies to assess seasonal population shift in NC, the research team agrees with previous researchers who had performed different methodologies to account for the seasonal population. It is concluded that there is no ideal source of data to define seasonal population and its components (Smith, 1989); rather, the best source will depend on the scope and context of the research. Lastly, the research team has determined the importance of utilizing a direct and indirect approach to validate U.S. Census data and correctly account for seasonal population shifts.

For this research, the team will perform the data analysis based on a combination of 2010 U.S. Census, 2017 5-Years ACS, and VNC Statistics because it was proven that the decennial census is the most reliable and widely used methodology (Smith et al., 2013). Crash data can be used for validation purposes. This data provides a crash history per city or municipality in a given month. The values can be correlated with the seasonal population to determine peaks which will be indicators of the seasonal shift. It is assumed that if the population increases, the probability of crashes will increase as well. Therefore, the research team considered this source an indirect approach for the Powell Bill research.

In addition, if discrepancies occur, cellphone data can be considered as an alternative source of validation for a small set of municipalities. Due to budget limits, cellphone data analysis will not be utilized for seasonal population estimation.

2.4 Current Practices of 50 DOTs in the United States

A literature review was conducted to collect and assess common practices performed by all DOTs in the United States. Existing reports and regulations for all states were analyzed and compiled below.

2.4.1 Overview of Formulas and Practices

Based on the review of current practices of the 50 DOTs in the United States, it was found that DOTs do not have consistent formulas for street and roadway maintenance funding allocation. Eight categories of factors considered for funding allocation were identified within the 50 states. Table 5 represents the results of these findings. The form of distribution includes:

- **Population:** Twenty-nine states distribute funds base on population. Out of those states, 11 states reported the utilization of the decennial census to determine population values.
- **Mileage:** Twenty-four states distribute funds base on lane mileage ration within the city or municipality.
- **County area mileage:** Ten states distribute funds based on the ratio of the total mileage square area of their county over the mileage area of the state.
- **Need:** Five states perform their funding distribution based on local needs. Local need includes but is not limited to the damage of the road, most hazardous areas, and priority roads.
- **Local match:** Five states distribute 80% of their funding to the cities or municipalities and require a local 20% match. In some cases, 80% is reinforced after the completion of the project.
- **Revenue program:** Texas is the only state which distributes funding based on local revenues. Local agencies tend to obtain a portion of the revenue contribution. For further details of Texas, the formula is shown in Table 33 in Appendix B.
- **Vehicle registration:** Five states distribute funds based on the ratio between the total vehicles registered in the municipality and the total vehicle registered within the state.

A complete version of the 50 DOTs data with its respective sources and formulas is presented in Table 33 in Appendix B.

Table 5. Forms of Distribution

#	State	Distribution Based on							
		Population	Mileage	Vehicle Registration	County Area (mile sq.)	Need	Local Match (80/20)	Revenue Programs	Others
1	Alabama								$500,000 distributed to each county commission of the state. 10% should be distributed to the municipalities of each county. $125,000 to each county commission beginning January 1st. $533,000 distributed annually to Alabama DOT.
2	Alaska						X		
3	Arizona								Two forms of distribution: RARF = (10.5%) (Arterial Streets) + (56.2%) (Freeways) PTF = (66.7%) (Regional Area Road Fund) + (33.3%) (Public Transportation)
4	Arkansas	X			X				
5	California	X	X						
6	Colorado		X	X					
7	Connecticut	X	X						
8	Delaware	X	X						
9	Florida					X			
10	Georgia	X			X				
11	Hawaii	X			X				
12	Idaho	X	X	X					

Continuation									
#	State	Distribution Based on							
		Population	Mileage	Vehicle Registration	County Area (mile sq.)	Need	Local Match (80/20)	Revenue Programs	Others
13	Illinois	X	X		X				
14	Indiana	X	X	X					
15	Iowa								$471.5 million County Funds equally distributed annually. $295.8 million City Funds equally distributed annually.
16	Kansas		X	X					
17	Kentucky	X					X		
18	Louisiana	X	X						
19	Maine		X						
20	Maryland								90.4 % to DOT, 7.7 % Baltimore City, and 1.2 % of Counties and Cities
21	Massachusetts								The program's authorities directly administrate funds
22	Michigan	X	X						
23	Minnesota	X	X	X		X			
24	Mississippi	X	X						
25	Missouri								($408 M) (Cities) + ($250M) (Other State Agencies) + ($280M) (Debt Payment) + ($1,434M) (State Road and Bridges) + ($96M) (Multimodal)
26	Montana	X	X		X				
27	Nebraska						X		
28	Nevada	X							
29	New Hampshire	X							
30	New Jersey								Funds are distributed to: • Local Scoping Program • Local Lead Program • Local Safety Program • High Priority Projects • Safety Routes to School • Transit Village • Available for projects that improve quality of life by fostering more livable communities, enhance the travel experience.
31	New Mexico					X	X		
32	New York		X						
33	North Carolina	X	X						
34	North Dakota	X							
35	Ohio	X							
36	Oklahoma	X	X		X				
37	Oregon	X							
38	Pennsylvania	X	X						

Continuation									
#	State	Distribution Based on							
		Population	Mileage	Vehicle Registration	County Area (mile sq.)	Need	Local Match (80/20)	Revenue Programs	Others
39	Rhode Island								RIDOT manages all design, construction, maintenance activities directly
40	South Carolina	X	X		X				
41	South Dakota		X						
42	Tennessee	X	X		X				
43	Texas	X	X		X			X	
44	Utah		X						
45	Vermont					X			
46	Virginia					X			
47	Washington	X							
48	West Virginia						X		
49	Wisconsin	X	X						
50	Wyoming	X			X				

2.4.2 DOTs Distributing Funds Based on Population and Mileage

When performing an analysis of the DOTs data, it was found that out of the 50 states, 18 DOTs distribute funds based on population and mileage which is similar to NC. Table 5 summarized the approaches to distribute funds utilized by the 50 DOTs. From the table, it is observed that six DOTs utilize mileage as the only factor for distribution. Eleven DOTs perform their distribution only by considering population and 15 DOTs practice another form of distributions which are explained in Table 6.

There are six DOTs distributing funds based on mileage only. Eleven DOTs distributing funds based on population only. Eighteen DOTs consider both population and mileage. The other 15 states developed their own approach considering factors other than population or mileage. Each of these states performed their distribution based on what seems to be more suitable for them, such as need, local match, revenues, categorical distributions, county area, and vehicle registration. Figure 3 is a pie chart illustrating the distribution of different states base on the factors considered for funding allocation. Figure 3 represents how many DOTs distribute their funds based on Population, Mileage, Mileage and Population, and another form of distributions such as need, local match, and those previously presented in Table 5.

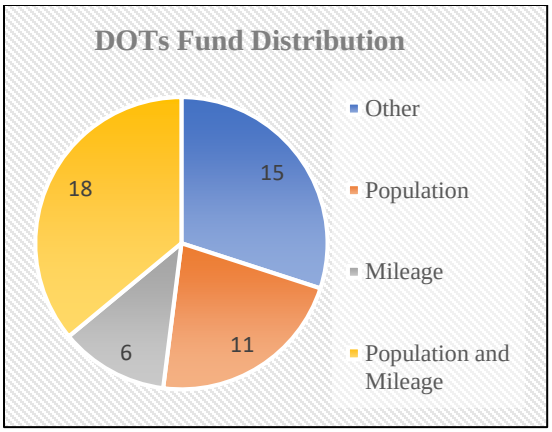


Figure 3. DOTs Fund Distribution

Table 6. Factors Considered for funding Distribution by 50 DOTs

#	State	Distribution Based on		
		Population	Mileage	Others
1	Alabama			$500,000 distributed to each county commission of the state. 10% should be distributed to the municipalities of each county. $125,000 to each county commission beginning January 1st. $533,000 distributed annually to DOT.
2	Alaska			Local Match
3	Arizona			RARF= (10.5%) (Arterial Streets) + (56.2%) (Freeways) PTF= (66.7%) (Regional Area Road Fund) + (33.3%) (Public Transportation)
4	Arkansas	X		
5	California	X	X	
6	Colorado		X	
7	Connecticut	X	X	
8	Delaware	X	X	
9	Florida			Based on needs
10	Georgia	X		
11	Hawaii	X		
12	Idaho	X	X	
13	Illinois	X	X	
14	Indiana	X	X	
15	Iowa			RUTF= (471.5 million) (County Funds equally distributed) + (295.8 million) (City Funds equally distributed)
16	Kansas		X	
17	Kentucky	X		
18	Louisiana	X	X	
19	Maine		X	
20	Maryland			90.4% to DOT + 7.7% Baltimore City + 1.2% Counties and Cities
21	Massachusetts			The program's authorities directly administrate funds
22	Michigan	X	X	
23	Minnesota	X	X	
24	Mississippi	X	X	
25	Missouri			Transportation Fund Total Revenue ($2,468M) = ($408 M) (Cities) + ($250M) (Other State Agencies) + ($280M) (Debt Payment) + ($1,434M) (State Road and Bridges) + ($96M) (Multimodal)
26	Montana	X	X	
27	Nebraska			Local Match 80% DOT, 20% Cities or Municipalities

Continuation				
#	State	Distribution Based on		
		Population	Mileage	Others
28	Nevada	X		
29	New Hampshire	X		
30	New Jersey			• Local Scoping Program: funded to member sub-regions for the advance of projects and preliminary engineering projects. • Local Lead Program: funds available to provide an opportunity for sub-regions for project's final designs, right-of-way, and construction projects. • Local Safety Program: funds available for improvement of known safety hazards on local and county roads. • High Priority Projects: funds available for a number of specific projects which are specified in the Safety, Accountable, Flexible, and Efficient Transportation Equity Act: Legacy for Users (SAFETEA-LU). • Safety Routes to School: funds available for projects which enable primary and secondary school children to walk or bike to class. • Transit Village: funds available for municipalities who have been formally designated as Transit Village by the Commissioner of Transportation. • Transportation Enhancement Program: funds available for projects that improve quality of life by fostering more livable communities, enhance the travel experience.
31	New Mexico			Based on need and local match 80% DOT, 20% Cities or Municipalities
32	New York		X	
33	North Carolina	X	X	
34	North Dakota	X		
35	Ohio	X		
36	Oklahoma	X	X	
37	Oregon	X		
38	Pennsylvania	X	X	
39	Rhode Island			RIDOT manages all design, construction, maintenance activities directly
40	South Carolina	X	X	
41	South Dakota		X	
42	Tennessee	X	X	
43	Texas	X	X	
44	Utah		X	
45	Vermont			Based on need
46	Virginia			Based on need
47	Washington	X		
48	West Virginia			Local Match 80% DOT, 20% Cities or Municipalities
49	Wisconsin	X	X	
50	Wyoming	X		

2.4.3 Formulas Used for Population and Mileage Distribution

Based on the analysis of distribution performed by the 50 state DOTs, the research team decided to focus only on the 17 states which considered mileage and population similar to the Powell Bill funds. Table 7 presents the program names utilized by each state, the purpose of the program, and the formulas utilized. States as Illinois, Indiana, Michigan, Minnesota, Oklahoma, and Pennsylvania have more than one program available for municipal funds. Each of these programs is described in Table 7.

Table 7. Formulas for DOTs with Population and Mileage Distribution

#	State	Program Name	Program Purpose	Formula
5	California	Transportation Improvement Program (STIP)	To maintain, improve, rehabilitate, and construct roads	County population (75%). State Highway Mileage (25%)
7	Connecticut	Town Aid Program (TAP)	For transportation maintenance	TAR= ($1,500) (for the first 32 mile) + pro rata allocation ratio ((town population)/ (state population))
8	Delaware	Municipal Street Aids (MSA)	For maintenance of municipal street	MSA= (40%) (Population of the municipalities based on the U.S. Census) + (60%) (Municipalities mileage)
12	Idaho	Net Highway Distribution Account (NHDA).	Road maintenance	Funding= (0.30) (cities population) + (0.70) [(0.45) (MVR) + (0.10) (equally divided) + (0.45) (Improved road mileage)]
13	Illinois	Surface Transportation Program (STP)	For highway projects, bridge projects on any public road including local functional classes, transit capital projects, and public facilities	STP= (33.33%) (Non-urban areas) + (33.33%) (Non-urban population) + (33.33%) (Non-urban mileage of the total system)
		Motor Fuel Tax	Road maintenance	Motor Fuel Tax= (45.6%) (IDOT) + (54.4%) (Local Proportion) **The local distribution is allocated as follow:** Municipalities: 49.10% Counties over 1 million people: 16.74% Counties under 1 million people: 18.27% Road Districts/Townships: 15.89%
14	Indiana	Motor Vehicle Highway Account (MVH)	For traffic safety, construction, reconstruction, improvement, and maintenance of highways of the state.	Local Agencies= (15%) ((population in cities)/ (population in all cities)) + (32%) [(5%) (evenly distributed in counties) + (30%) ((vehicles registration in counties)/ (vehicle registration in all counties)) + (65%) ((mileage in county)/ (mileage in all counties))]
		Highway Road and Street Account (LRS)	For engineering, land acquisition, construction, resurfacing, restoration, and rehabilitation of highway facilities.	Local Agencies= Counties > 50,000 [(60%) ((population in county)/ (population in all counties)) + (40%) ((road mileage in the county)/ (all counties road mileage))]
18	Louisiana	Louisiana Parish Transportation Fund Act (PTF)	For the maintenance, construction, and repair of parish roads.	**Class** — **Parish Population** — **Per Capita Distribution** 1 — 1 to 16,000 — $13.32 2 — 16,001 to 45,000 — $10.82 3 — 45,001 to 100,000 — $8.32 4 — 100,001 to 200,000 — $7.32 5 — 200,001 to 400,000 — $5.57 6 — 400,001 and over — $4.65 Parishes with a population of 475,000 or greater shall participate in any distribution made based on the number of miles of roads and streets under their jurisdiction divided by the total of parish road in the state

Continuation				
#	**State**	**Program Name**	**Program Purpose**	**Formula**
22	Michigan	Michigan Transportation Fund (MTF)	For road maintenance.	**MTF**= (20%) (County Funds equally distributed) + (80%) [(39.1%) (Highways) + (39.1%) (County Roads) + (21.8%) (Municipal Streets)]
				Cities and Villages= (99% Local and Major Streets) ((total mileage in the county)/ (total mileage in all counties) + (total population in the county)/ (total population in all counties)) + (1% Others) ((total mileage in the city)/ (total mileage in all cities))
23	Minnesota	County State Aid Highway (CSAH)	For the construction, maintenance, and administration of state highways.	**CSAH**= (60% based on money need) + (40%) (Relative shares of motor vehicles registration in each county)
		Municipal State Aid Streets (MSAS)		**MSAS**= (50%) (Based on money need) + (50%) ((population in municipality)/ (total state municipalities population))
				Revenue not derived in previous formulas= (50%) (money needed) + (30%) ((county road miles)/ (total state counties road miles)) + (10%) ((county motor vehicle registrations)/ (total state)) + (10%) (equal shares to all 87 counties)
24	Mississippi	State Aid Roads	To supports infrastructure, routine maintenance, pass through, new capacity, safety, tort claims, and others.	SAR= (1/3) (All counties in equal share) + (1/3) ((# of rural road miles in a county)/ (# of rural road miles in all counties of the state)) + (1/3) ((Rural population of the county)/ (Rural population of all counties of the state))
26	Montana	Highway Restricted Account	To assist in transportation construction, repairs, and maintenance.	**Highway Restricted Account**= $150,000 (for the Montana Local Technical Assistance Transportation Program) + $6,306,000 [(40%) ((population in each city and town)/ (total rural population in cities and towns)) + (40%) ((rural road mileage)/ (total state rural road mileage)) + (20%) ((land area in each county)/(total land area of the state))] + $10,360,000 [50% ((population in corporate limits of city or town bears)/ (total population within corporate limits of all cities and towns in Montana)) + (50%) ((cities or towns street alley mileage)/(total street and alley mileage within the corporate limits of cities and towns in Montana))]
33	North Carolina	Powell Bill	For municipal maintained streets.	75% base on population +25% base on mileage
36	Oklahoma	County Road Funding	For county roads, bridges maintenance, and construction.	65.3% of the 27.00% is apportioned based on county road miles, population, and land area, specifically: 40% based on county road mileage relative to the statewide sum of county road mileage+30% based on county population relative to statewide population (U.S. Census Bureau) + 30% based on county land area relative to statewide land area.
				23.1% of the 27.00% is apportioned based on rural population, road miles, and land area, specifically: 1/3 based on the county rural population relative to statewide rural population+1/3 based on county road mileage relative to the statewide sum of county road mileage+1/3 based on county land area relative to statewide land area.
				11.6% of the 27% is apportioned to counties based on a formula similar to that for County Bridge Program funds but also considering terrain and traffic volume: 20% of a county's percent of statewide collector miles plus+60% of a county's bridge factor plus+20% of a county's percent of statewide average daily vehicle miles of travel.

Continuation				
#	**State**	**Program Name**	**Program Purpose**	**Formula**
38	Pennsylvania	Liquid Fuel Tax Fund (LFTF)	To maintain, construct, and rehabilitate local roads.	**LFTF for Counties=** (50%) ((population on counties)/ (population of the state)) + (50%) ((Counties local road mileage)/ (local road mileage to the state))
				LFTF for Municipalities= (50%) ((population on municipalities)/ (population of the state)) + (50%) ((Municipalities local road mileage)/ (local road mileage to the state))
40	South Carolina	C program	To helps counties to maintain roads in good conditions by funding for repairs, improvements, and paving projects.	Formula=1/3 ((land area of the county bears)/ (the total land area of the State)) + 1/3 ((population of the county bears)/ (the total population of the State as shown by the latest official decennial census)) + 1/3((mileage of all rural roads in the county bears)/ (total rural road mileage in the State))
42	Tennessee	The State Highway Aid (SHA) Program	Fund maintenance, construction, and repair of county roads.	**State Highway Aid=** (1/3 total share) (county's lane miles) ($59688,154) + (1/3 total share) (population) (59,688,154) + (1/3 total share) (land area) (59,688,154)
43	Texas	Texas Transit Funding	For the construction, maintenance, rehabilitation, and acquisition of right of way for non-tolled public roadways.	**State Transit Fund=**65% Rural districts [65% Need (75% population+ 25% land area) + (35% Performance (33% Local Expense+33% revenue mileage riders + 33% Revenue mileage expenses)] + 35% Urban districts [50% Need(population) + (50% Performance (30% Local Expense + 30% revenue mileage riders + 20% Revenue mileage expenses + 20% riders' capital)]
49	Wisconsin	Local Road Improvement Program (LRIP)	For severely deteriorated county highways, a municipal street in cities and villages, and town roads.	**LRIP=** (43%) (CHI)+ (28.5%) (TRI)+ (28.5%) (MSI) **The County Highway Improvement Program (CHI) =** 60% population + 40% on road mileage. Each county is guaranty a minimum of 0.5% ($77,290.82). **The Town Road Improvement Program (TRI) =**100% based on mileage. **The Municipal Street Improvement Program (MSI) =**50% population + 50% on road mileage.

Geographic Pattern in DOTs Distributions

To have a better understanding of the mileage and population, distributions were plotted in Figure 4, Figure 5, and Figure 6 to represent the geographic distributions. However, no strong pattern was detected.

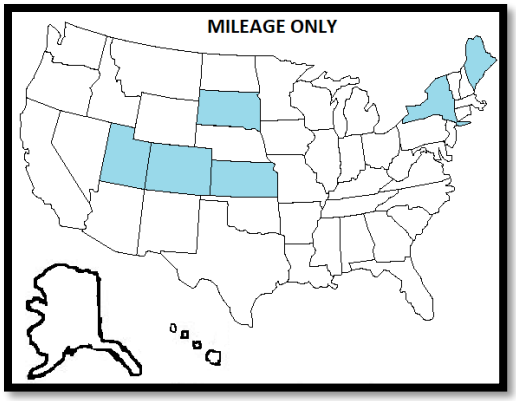


Figure 4. States Distribution Base on Mileage Only

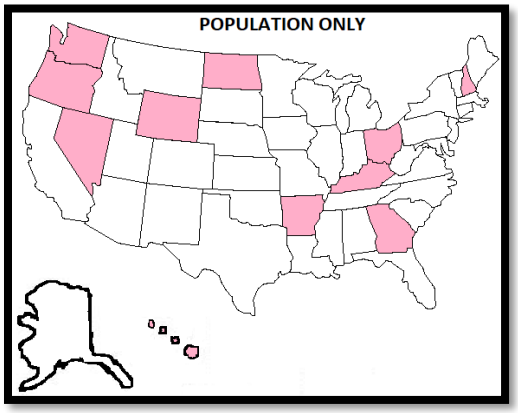


Figure 5. States Distribution Base on Population Only

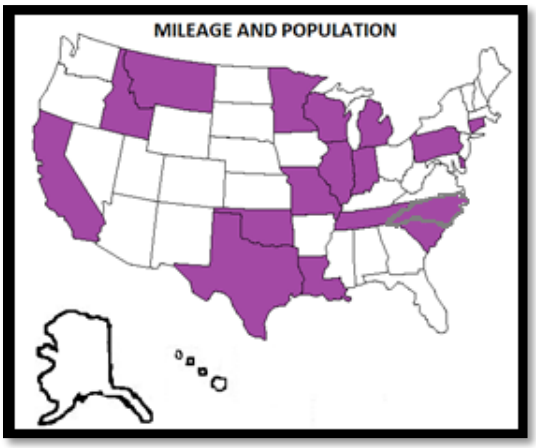


Figure 6. States Distribution Base on Mileage and Population

2.4.4 Summary of Current Practices of DOTs in the United States

The data presented in Table 8 is based on the 18 states that distribute funds to cities and municipalities based on population and mileage. All distributions are presented by percentage. California is the only state with an exact distribution as NC, 75% on population and 25% on mileage. Delaware and Wisconsin have a distribution of 40% on population and 60% on mileage. Illinois, Mississippi, Oklahoma, and South Carolina allocate 33.3% based on population, 33.3% based on mileage, and 33.3% based on other categories.

Texas and Minnesota have a distribution of 50% based on population and 50% based on other categories. Indiana and Michigan perform their distribution 20% on population 80% on mileage. Indiana, Idaho, Minnesota, Oklahoma, Montana, Tennessee, Louisiana, and Connecticut have a range of distribution including population, mileage, and others (local match, need, vehicle registration, revenue programs, and county areas). Out of the 17 states, Pennsylvania is the only state who has a distribution of 50% on population and 50% on mileage. Connecticut and Louisiana have a categorical distribution, for example, Louisiana distributes funds based on categories created based on population size and distribute mileage funds only to those places with a population greater than 475,000.

Table 8. State DOTs Distribution Base on Percentage

State	Distribution Based on		
	Population	Mileage	Others
California	75%	25%	
Connecticut	Pro rata	$1,500/mile for first 32 mile	
Delaware	40%	60%	
Idaho	30%	31.5%	38.5%
Illinois	33.3%	33.3%	33.3%
	35%	16%	49%
Indiana	62.5%	24%	13.5%
	60%	40%	
	20%	80%	
Louisiana	Various rate for 6 classifications	Allocation base on mileage for municipalities with a population greater than 475,000	
	20%	80%	
Michigan	10%	30%	60%
Minnesota	33.3%	33.3%	33.3%
	45.8%	45.8%	8.4%
	75%	25%	
Mississippi	21%	31%	48%
Montana	50%	50%	
North Carolina	33.3%	33.3%	33.3%
Oklahoma	33.3%	33.3%	33.3%
	49.2%	23.9%	26.9%
	40%	60%	
Pennsylvania	75%	25%	
South Carolina	Pro rata	$1,500/mile for first 32 mile	
Tennessee	40%	60%	
Texas	30%	31.5%	38.5%
Wisconsin	33.3%	33.3%	33.3%

2.5 Review of Military Impact

Another factor to be considered for the implementation of the new formula for the Powell Bill is the military impact. The U.S. Military has had a prominent presence in NC and the traffic of its heavy equipment can have an impact on the deterioration of roads in nearby municipalities. According to Levy et al. (2015), NC currently has the four largest military population in the United States.

There are 10 military bases, a military ocean terminal, and two U.S. Coast Guard bases located within the state. They are Fort Bragg, Camp Lejeune Marine Corps Base, Cherry Point Marine Corps Air Station and Naval Air Depot, New River Marine Corps Air Station, Marine Corps Camp Grieger, Seymour Johnson Air Force Base, Pope Air Force Base, Camp Butner, Camp Mackall, Simons Army Airfield, Sunny Point Military Ocean Terminal, the U.S. Coast Guard Base in Elizabeth City, and Aviation Station Morehead City. Figure 7 shows the military installations discussed above. NC's bases and other military installations are geographically concentrated in the Eastern and Southern regions of the state.

Figure 7. Military Installations in NC (Levy et al., 2015)

According to the Defense Manpower Data Center, more than 102,000 active duty military personnel were assigned to units in NC as of June 2015. The Marine Corps and the Army are by far the two largest branches of the military in the state, followed by a smaller presence of Air Force, Navy, and Coast Guard personnel. Table 9 shows the number and distribution of military personnel in NC. The impact on local road deterioration from heavy military equipment traffic is speculated to be at these military installations.

Table 9. Distribution US Forces in NC (Levy et al., 2015)

	Camp Lejeune	Cherry Point	Fort Bragg	New River	Seymour Johnson	Unknown	Total
Air Force	--	3	1,993	21	4,154	141	6,312
Army	24	--	45,365	--	3	470	45,862
Coast Guard	165	--	--	--	--	1,441	1,606
Marine Corps	29,718	7,162	3	5,508	--	1,307	43,698
Navy	3,576	406	235	41	--	270	4,528
Total	33,483	7,571	47,596	5,570	4,157	3,629	102,006

The 25% mileage portion of the Powell Bill formula addresses the impact on roads. Therefore, since NC has 13 military bases and is the state with the largest military population, it is important to evaluate the impact of military equipment on municipal roads. To investigate the impact, the following literature review was performed to analyze and quantify the impact of the military vehicle on municipal roads. In addition, the research team met multiple military experts to assess this problem better and to understand military impact on NC local roads (the details can be found in section 5.1 and in Appendix D).

2.5.1 Military Vehicles Weight and Damage Analysis

The research performed by Layman and Ashbaugh (2000) included an evaluation of 78 different types of vehicles. The 78 vehicles were tested in a particular area to determine the fatigue damage potential on bridges. One military truck was tested (ML-80 truck), and the vehicle damage fatigue potential was 4.4 which does not induce damage compared to other heavy vehicles. The fatigue damage potential is unitless and instead of utilizing the gross vehicle weight, it comprises functions such as axle weight, spacing, and vehicle length (layman and Ashbaugh, 2000). An 18-wheeler truck with a weight greater than 578 kN is reported to have a 20.36 damage potential. The key findings in this article are the importance of being able to assess fatigue damage depending on the 78 existing common and FHWA-proposed truck configurations for relative fatigue damage potential. They concluded that fatigue damage is a function of axle weight, spacing, and vehicle length instead of gross vehicle weight. From this article, the research team evaluated the different types of military vehicles size and weights to determine if there is any damage exert due to military vehicles. A list of military vehicles and weight is presented in Table 10. Figure 8 was retrieved from (Laman and Ashbaugh, 2000) to represent the graphical of damage fatigue potential by vehicle's weight.

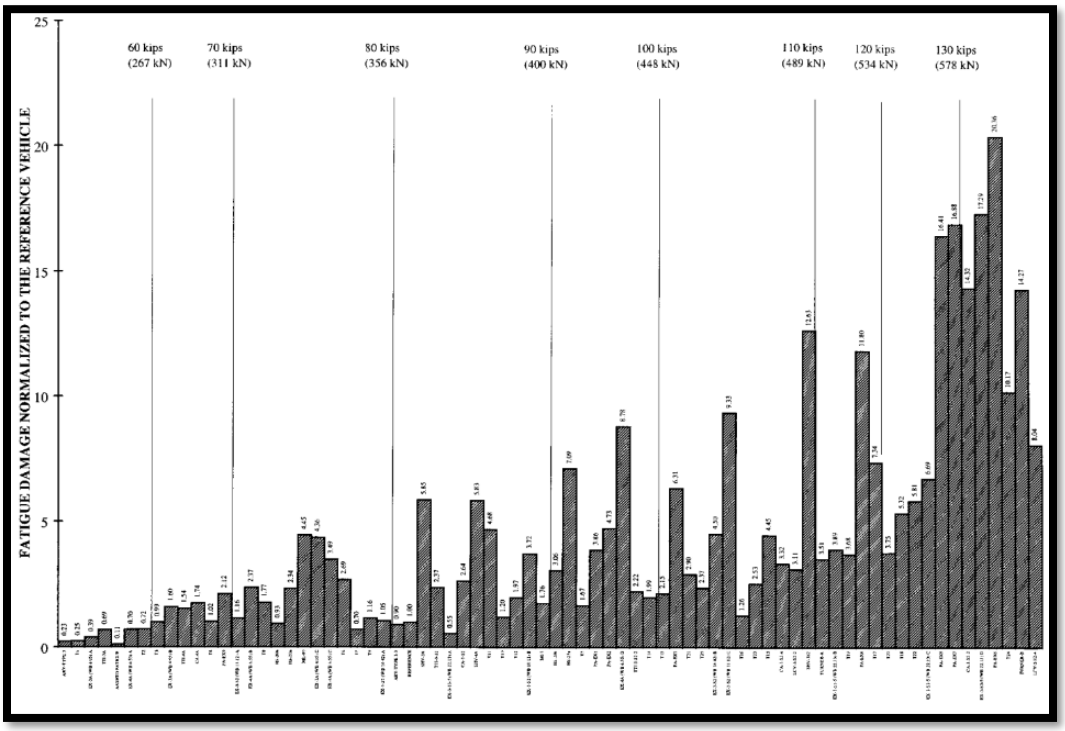


Figure 8. Fatigue Damage vs. Vehicle Type (Laman and Ashbaugh, 2000)

Table 10. Military Vehicles by Weight (Military Advantages, 2018)

Vehicle Name	Military Division	Weight (kN)
High Mobility Multipurpose Wheeled Vehicle (HMMWV)	Transport/Air Force/Army/ Marine/Navy	76.72
M1117 Armored Security Vehicle (ASV)	Transport	147.47
Lightweight Tactical All-Terrain Vehicle (LTATV)	Transport/Air Force/Army /Marine/Navy	7.97
Medium Tactical Vehicle Replacement (MTVR)	Transport/Marine/Navy	89.68
Heavily Compacted Mobility Tactical Truck (HEMTT)	Transport	90.67
Family of Medium Tactical Vehicle (FMTV)	Transport /Army/Marine	99.64
Cougar 6x6 MRAP	Transport/Air Force/Army/ Marine/Navy	171.38
AAV& Amphibious Assault Vehicle	Transport/Army	259.06
All-Terrain Vehicle	Air Force/Army/Marine	137
Joint Light Tactical Vehicle (JLTV)	Air Force/Army/ Marine/Navy	104.62
M1126 Stryker Combat Vehicle	Army	189.32
M1 A2 Abrams Main Battle Tank	Army/Marine	684.53
M2/M3 Bradley Fighting Vehicle	Army	275
M88A2 Hercules Recovery Vehicle	Army/Marine	506.17
M9 Armored Combat Earthmover	Army/Marine	243.12
M160 Remote Controlled Mine Clearance System	Army	59.78
Husky Vehicle Mounted Mine Detection System	Army	91.67
Buffalo Mine Protected Route Clearance Vehicle	Army/Marine/Navy	225.78
Cougar 4x4 MRAP	Army/Marine/Navy	171.38
M-ATV	Army/Marine	124.55
Heavy Expanded Mobility Tactical Truck	Army/Marine	99.64
Lav-25 Light Armored Vehicle	Marine	140.49

The military presence in NC is considered to have a low impact on local roads. This claim is performed by comparing the results in Table 10 and Figure 8. It is concluded that damage exerted by military vehicles is not as significant compared to the damage generated by an 18-wheeler. Out of the 22 vehicles, only the M1 A2 Abrams Main Battle Tank weights 684.53 KN which is higher than 18-wheelers truck weight.

Even though the Battle Tank weighs more than the permitted weight, this vehicle is rarely driven on local roads. In the study performed by Lyon (1991), it was mentioned that military loads pass roadside scales that are designed for commercial trucks. Even though the military has a heavyweight vehicle, they have multiple axles which help to distribute loads and reduces the concentrated loads that will damage the roads.

Svendsen et al. (2017) attempted to quantify the impact of soil and vegetation disturbance produced by utilizing military vehicles and equipment on land areas. The article indicates that changes in the Universal Soil Loss Equation C factor that can be used to determine the areas of

disturbed land to help in the quantification of land erosion or vegetation removal due to military activities. The finding indicates military vehicles spent 15.9% of the time and 5.9% of the distance traveled off roads. Despite the findings, there is no indication of damage to concrete or asphalt.

2.5.2 Regulations for Military Vehicles on Local Roads

Lyon (1991) indicated in his study that Oak Ridge National Laboratory has more than 330,000 miles of public roads in its database. Out of those, 60,000 are part of the strategic highway network of the Department of Defense. Also, the research identified and explained the mobilization and deployment process. It was indicated that the United States Army Force Command (FORSCOM) is responsible for controlling the movements of deploying units. Within the FORSCOM, the Major United States Army Reserve Commands (MUSARC) is in charge of the procedures for approving and monitoring unit movement plans at least every 2 years. To mobilize and deploy convoy movements from the home stations to ports or aerial stations, the military must receive approval of mobilization from the State Movement Control Center.

In addition to the movement control strategy, the army works with each state DOT. DOTs establish their criteria for convoys and other movement permits (Lyon, 1991). The military works with the DOTs for construction and other highway limitation criteria as well. Routes request must be submitted 60 days in advance, and after all, permits are approved a movement order is generated, and permission to utilize the roads is granted.

The regulations performed by Force, Corps and Agency (1996) requires that the movement of military vehicles on public highways, bridges, and tunnels do not exceed legal limits without permission of the state, local, or toll authorities. National defense highways are usually accomplished under the public highway programs and the military use of highways are subject to laws and regulations of the state and political subdivisions. The Force, Corps and Agency (1996) stated that highways are designed to serve the national defense for many years because they are designed considering heavy loads.

Based on the extensive research on military usage it is concluded that the military does not exert an exacerbate damage to the road. Therefore, the military portion of the proposed formula will be ruled out. Even if some of the heavy military vehicles utilize local roads, the vehicles have multiple axles which help to distribute loads and generate less damage. At the same time, military bases follow local laws and their vehicles tend to follow weight limit laws.

2.5.3 Summary of Military Impact

Based on the literature review, the research team concluded that military vehicles do not exert an exacerbate damage to the road. Even if some of the heavy military vehicles utilize local roads, the vehicles are designed with multiple axles which help to distribute loads and generate less damage. At the same time, military bases follow local laws and their vehicles tend to follow weight limit laws. In addition, the research team found that no other DOTs consider military use in their formulas.

3 DATA SOURCES

Estimating the seasonal population is a difficult task due to the complexity. There are multiple definitions of seasonal residents and accommodations types. Properly identifying them is important. Additionally, direct data to quantify seasonal populations is not generally available. Consequently, seasonal populations can be hard to quantify.

For this project, the seasonal population refers to overnight visitors in a municipality, specifically, overnight visitors who stay between one day and less than six months. Any overnight visitor who stays for six months or longer would be classified as a "permanent resident" of a community in U.S. Census data products and would no longer fit the definition of a seasonal resident.

The definition of seasonal population for this project focuses on the overnight seasonal population and excludes day trippers and commuters. Overnight visitors include individuals traveling for both business and leisure purposes and their travel patterns often exhibit cyclical trends corresponding to certain times of the year.

Due to the complexity of assessing seasonal populations, the strategies previously described were evaluated to identify the best strategy to capture seasonal population for the NC municipalities. These categories are the following:

1. Affordable and reliable: readily available, low-cost or no-cost data reliable for all NC municipalities.
2. Affordable but not reliable: readily available, low-cost or no-cost data that is neither reliable for all NC municipalities nor is sufficiently detailed to use for an estimation model.
3. Reliable but not affordable: data that may be available for all NC municipalities but is costly to obtain, impractical to collect, or both.

3.1 Affordable and Reliable

Data sources in the affordable and reliable category are readily available at no cost and are produced with details for all NC municipalities. The decennial census and the ACS data produced by the U.S. Census Bureau are the only high-quality and comprehensive data sources to provide estimates of one component of the seasonal population, which is the residential housing designated for seasonal use. These data only cover residential properties and do not include commercial properties, such as hotels, motels, bed and breakfasts, and RV camping sites.

3.1.1 Decennial Census Data

Strengths: 100% count of all people and housing units in the United States, which is considered the most reliable source of demographic and housing unit data.

Limitations: Only collected every 10 years, which may pose challenges for communities experiencing rapid population growth. It only captures residential properties and does not provide information on commercial properties.

3.1.2 American Community Survey (ACS)

Strengths: Annually updated source of demographic and housing unit data that is available for all communities in the state.

Limitations: As a sample-based survey, the ACS margins of error can be large for sparsely populated communities, raising concerns about their use. It only captures residential properties and does not provide information on commercial properties.

3.1.3 Seasonal Tourism Volume (STV)

Strengths: Annually updated source of visitor's survey data available for all regions (Mountain, Coastal, and Piedmont) in the state.

Limitations: As a sample-based survey, the STV margins of error can be large, especially during recession years, the data is not accurate. It only captures responses provided by tourists who volunteer to fill the forms and to account for the margin of errors, a five year average is performed.

3.1.4 July 1 Population Estimates by NC-OSBM

Strengths: Annually updated source of demographic data that is available for all communities in the state.

Limitations: July 1 Population estimates only captures permanent population.

3.2 Affordable but not Reliable

Data sources included in this category are those that can be obtained at relatively low-cost but are either not available for all NC municipalities, or are not sufficiently detailed to use in an estimation model. One example of this is hotel/motel lodging. Hotel/ motel lodging data reports are typically produced at the state or national level and do not have sufficient detail on small towns or municipalities. Consequently, utilizing lodging data is not good enough for generating an accurate representation for all the eligible municipalities in NC.

3.2.1 Hotel/Motel Lodging

Strengths: Provides data on a large subset of commercial properties that serve as accommodation for the seasonal population.

Limitations: Existing data is not comprehensive (available for only a small subset of NC municipalities) and lacks key indicators (average daily room rates, average persons per room) necessary to estimate the seasonal population. Furthermore, other researchers have indicated that hotel/motel data quality may be relatively poor Smith and House (2007).

3.2.2 Motor Vehicle Count

Strengths: Provides continuous data collection.

Limitations: NC only has 80 point stations covering 75-76 counties. PADT data is useful to establish a seasonal pattern for those counties. But it lacks the detailed information to determine the values of seasonal population.

3.2.3 Crash Data

Strengths: Provides data on live crash reports for the entire state (2001-2017).

Limitations: Crash data can only be used to determine seasonal traffic volume patterns, not the total seasonal population.

3.2.4 Water Usage

Strengths: Provides an indication of the size and utilization of commercial and private property.

Limitations: Existing data is not readily available (available for only a small subset of NC municipalities). There is a lack of direct and reliable links between water usage and seasonal population.

3.2.5 Survey Calls

Strengths: Can provide a direct estimation of the seasonal population.

Limitations: Expensive and time consuming. It can be inaccurate depending on the sample size selected.

3.3 Reliable but Not Affordable

Data sources categorized as reliable but not affordable are those that could potentially give accurate results but subscribing to this type of service is too costly. If purchasing cellphone data for the Powell Bill project became a possibility, NCDOT can only afford to obtain data for a few municipalities. It will not be adequate to generate a reliable representation for the 508 eligible municipalities in NC.

3.3.1 Cellphone Data

Strengths: Pinpoints actual movement of people and is highly reliable.

Limitations: Expensive to obtain.

4 STRATEGIES FOR ESTIMATING SEASONAL POPULATION

To document all strategies and methods used for capturing seasonal population, the research team evaluated how to capture seasonal population based on where people stay. The research team pursued strategies to estimate both housing and hotel accommodations.

The data sources utilized to capture housing population were 2010 U.S. Census data, 2017 5-year ACS, Seasonal Tourism Volumes (STV), and July 1 Population Estimates. The strategies utilized to capture hotel population include accommodation data provided by Smith Travel Research (STR), occupancy tax data, and STV percentage ratios.

4.1 Housing

After analyzing the different methods available to determine the seasonal population, a combination of direct and indirect approaches were used to estimate NC seasonal population. The direct method utilized the following 4 data sources 1) U.S. Census 2010, 2) 5-Year ACS, 3) STV, and 4) July 1 Population Estimates data.

The methods utilized to assess strategies to determine seasonal population shifts include a literature search of best approaches. One of the best approaches is to use 2010 U.S. Census data. However, since census information is collected every ten years, modifications need to be made in order to update the census. We used the 5-Year ACS (2013-2017) to provide an updated estimate of housing stock while using the 2010 U.S. Census estimate of the share of housing dedicated to seasonal use. In addition, the NC-OSBM is considered the most reliable source of data for annual updates to the permanent population. Therefore, the July 1 Population Estimates of 2017 from the NC-OSBM were used to update the permanent population values.

To effectively calculate seasonal population, five methods were tested to determine the seasonal population. Each of the methods were developed with the purpose to identify the most accurate approach. The proposed methods only determined seasonal population staying in seasonal housing accommodations and do not represent seasonal population staying in hotels, bed and breakfasts, campgrounds, and private homes.

4.1.1 Data Sources

The four data sources used to develop each method are shown in Table 11 and described below:

Table 11. Summary of Sources Utilized by the Five Methods

Methods	2010 U.S. Census	5-Years ACS	STV	July 1 Population Estimates
1	X			
2	X	X	X	
3	X	X	X	
4		X	X	
5	X	X	X	X

4.1.1.1 *2010 U.S. Census, U.S. Census Bureau*

The 2010 U.S. Census data used included the total number of housing units, number of vacant units, and reasons for the vacancy, including units for seasonal, recreational, or occasional use houses (seasonal share of housing) (U.S. Census Bureau, 2011).

For this research, the seasonal share of housing in 2010 ($P_{Seas_{2010}}$) was used to determine the seasonal share of housing in NC. The seasonal share of housing is the share of all housing units that were identified as seasonal, recreational, or occasional use houses in the 2010 U.S. Census. These houses include units occupied on occasional basis as corporate apartments, vacation homes, and other temporary places where the occupants reported their place of residence elsewhere (U.S. Census Bureau 2011).

For each municipality in the state, $P_{Seas_{2010}}$ was calculated by dividing the total number of housing units for seasonal use in the municipality ($Seas_{HU_{2010}}$) by all housing units in the municipality (HU_{2010}) as detailed in the following equation.

$$\mathrm{P_{Seas_{2010}}} = \frac{\mathrm{Seas_{HU_{2010}}}}{\mathrm{HU_{2010}}} \qquad \text{(Equation 1)}$$

$P_{Seas_{2010}}$ = Seasonal share of seasonal housing in each municipality.
$Seas_{HU_{2010}}$ = Number of housing units for seasonal use (2010 U.S. Census)
HU_{2010} = Number of housing units total in 2010 (2010 U.S. Census)

4.1.1.2 *5-Year ACS, U.S. Census Bureau*

There are two types of data products released from the ACS. The first is the single-year estimates; these are released each year for all areas with populations of 65,000 or more. The second is what is called the 5-year estimates. These combine data collected over the previous five years to provide estimates for all geographic levels across the United States, including all municipalities. The 2009 5-year ACS (2013-2017) was the first 5-year file released by the U.S. Census; this data was based on samples collected between 2005 and 2009. The most recent data set for all geographies is the 2017 5-year ACS; this contains data collected between 2013 and 2017. The number of housing units vacant for seasonal use is obtained by surveys collected from the U.S. decennial census and the ACS.

This research used the total housing stock (HU_{2017}) from the 2017 5-Year ACS (2013-2017) to account for the growth in local housing stock since the 2010 U.S. Census.

4.1.1.3 *Seasonal Tourism Volumes, Visit North Carolina (VNC)*

As previously explained in section 2.3.1.4, VNC is the institution in charge of collecting data for touristic volume in NC. Based on the information collected by VNC, this research will utilize the average travel party size ($ATPS_{2017}$) data over the past 5 years (2013-2017) for each of the NC regions (Mountain, Coastal, and Piedmont). Average travel party size is used instead of other indicators (such as average persons per household) because tourist parties may have different characteristics than the permanent residents of a location, and this data better reflect those differences.

Before calculating the STV, municipalities were assigned to the Coastal, Piedmont, and Mountain regions based on their parent county. Municipalities with land in multiple counties were assigned to the county that contained the largest share of their population. Municipality population share by county was determined using the NC-OSBM 2017 Municipal Population Estimates by County.

STV was used to adjust for seasonality in tourism and provide an annual estimate of the tourist impact. Places with large seasonal populations are not expected to have the same number of visitors year-round. To account for these fluctuations, the average of the past 5 years of regional visitation by season was used.

In order to do so, the peak visitor season was identified for all 3 regions (coast, mountains, and Piedmont). For example, in the 2017 STV reports, Figure 9 was provided to represent the travel volume by season and region.. Notice that Summer was the most common season for overnight visitors, and it was assigned a 100% seasonal population during peak season as noted in column Figure 9.

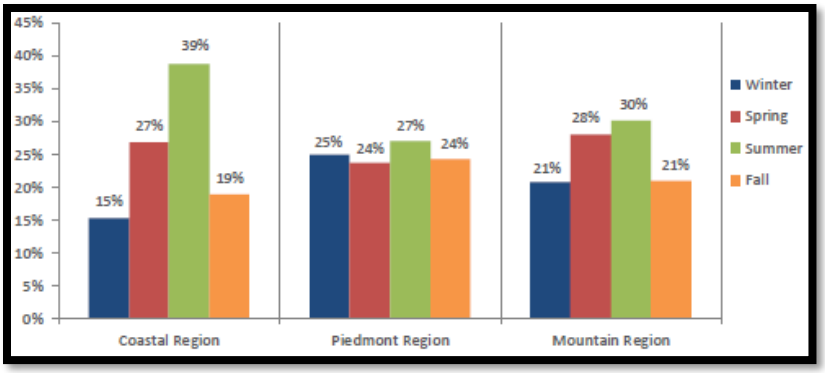


Figure 9. STV Travel Volume by Season for 2017 (Visit North Carolina, 2017)

Subsequently, the other seasons were proportionally adjusted based on how many visitors came to the region relative to peak season (Summer). In 2016, for example, 49% of Coastal overnight visitors came in the Summer compared to 8% during Winter, which was the lowest season. These values are reported in Figure 10 (Visit North Carolina, 2016).

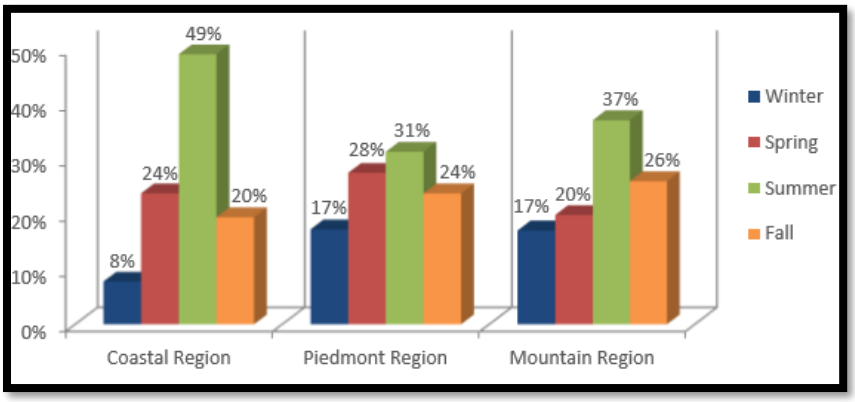


Figure 10. STV Travel Volume by Season for 2016 (Visit North Carolina, 2016)

To estimate the potential visitor volume during Winter, the proportion of Winter visitors to Summer visitors: [8%/49%] = 16% was calculated for 2016. In 2017, the Summer share of visitors on the Coast was very different at 100% compared to 25% in Winter. The difference between 2016 and 2017 is typical and indicates the variability of the data. As a result, the 5-year average was used to reduce the volatility of the data from year to year. Table 12 displays the 5-year average share of visitor volume for each region and each season.

Table 12. Estimated Visitor Volume Compared to Peak Season, by NC Region and Season, 2013-2017

	Winter	Spring	Summer	Fall
Coast	25%	52%	100%	45%
Mountains	61%	67%	100%	81%
Piedmont	82%	92%	100%	90%

After accounting for the four seasons and distributions shown in Table 12, the adjusted seasonal population was calculated using the following equation:

$$SPop_{adj} = \frac{\sum_{i=1}^{n}(p_{seas_n})}{4} \quad \text{(Equation 2)}$$

$SPop_{adj}$ = Seasonal population adjustment

p_{seas_n} = In each season, % of visitors with respect to the peak season visitors (STV) (Table 12)

The main purpose of this formula is to evenly distribute summer population within all seasons and adjust seasonal fluctuations to obtain a yearly average. For example, Sugar Mountain Village is considered to be in the Mountain region. Therefore, for this municipality, the factors utilized in equation 2 are 61%, 67%, 100%, 81%.

4.1.1.4 *July 1 Population Estimates by NC-OSBM*

The NC-OSBM provides population estimates and projections and publishes the results on July 1 annually. The data is used as the basis for Powell Bill permanent population estimation.

The population estimates are produced based on a model using 2010 U.S. Census data and a collection of state, federal, and local government sources to estimate annual change (NC-OSBM, 2019). Sources include data such as births and deaths, annexations, building activities, and institutional populations. All these data sources help to have an accurate population estimate of NC annual growth in population.

The previous data sources are used because those data are reliable and provide a direct measurement of the population. Therefore, the following methods were developed with these data sources.

4.1.2 Methods

Five methods were evaluated to determine to try to capture seasonal population. Each method is presented below.

4.1.2.1 *Method 1*

Method 1 was developed with the 2010 U.S. Census data alone using 2010 permanent populations, 2010 housing units, and 2010 persons per household. Thus, it is a snapshot of 2010 housing and population. The data utilized were the number of housing units available for seasonal use ($Seas_{HU_{2010}}$) and the average number of persons per households (PPH_{2010}). Defined by the U.S. Census, the number of housing units vacant for seasonal use are those houses, trailers, or all housing units which are designated for "seasonal, recreational, or occasional use." The Equation and parameters are explained below.

$$SPop_1 = Seas_{HU_{2010}} \times PPH_{2010} \quad \text{(Equation 3)}$$

$Seas_{HU_{2010}}$ = House unit vacant for seasonal use (2010 U.S. Census)

PPH_{2010} = Average person per household (2010 U.S. Census)

4.1.2.2 *Method 2*

Using the same principle as Method 1, Method 2 was developed considering the recent growth in local house stock. Method 2 consisted of 2010 permanent populations, 2010 persons per household, and 2017 housing units. This considers the increase in the number of homes available for seasonal use from 2010 to 2017 to obtain a more up-to-date seasonal population. Method 2 utilized the most recent ACS housing unit estimates (2017 5-Year data) in conjunction with the seasonal housing share and persons per household variables derived from the 2010 U.S. Census. The formula utilizes a partial estimate of 2017 values because the only parameter that is updated is the housing unit. Equation and parameters are explained below.

$$SPop_2 = [(P_{Seas_{2010}} * HU_{2017}) * PPH_{2010}] * \frac{\Sigma_{i=1}^{4}(p\_seas_i)}{4} \quad \text{(Equation 4)}$$

$P_{Seas_{2010}}$ = Seasonal Share of housing (2010 U.S. Census)
HU_{2017} = Number of Housing Units total (2017 5-year ACS)
PPH_{2010} = Average Number of Persons per Household (2010 U.S. Census)
p_seas_i = In each season, percent of visitors with respect to the peak season visitors (STV)

4.1.2.3 *Method 3*

Method 3 accounts for growth in local housing stock as well by using 2017 housing units. However, it also utilizes 2017 persons per household while still using 2010 permanent population. The formula is solved using both 2017 5-Year ACS (2013-2017) total housing units and persons per household estimates. Equation and parameters are explained below:

$$SPop_3 = [P_{Seas_{2010}} \times HU_{2017}] \times PPH_{2017} * \frac{\Sigma_{i=1}^{4}(p\_seas_i)}{4} \quad \text{(Equation 5)}$$

$P_{Seas_{2010}}$ = Seasonal Share of housing (2010 U.S. Census)
HU_{2017} = Housing Units total (2017 5-years ACS)
PPH_{2017} = Average Number of Persons per Household in 2017 (2017 5-years ACS)
p_seas_i = In each season, percent of visitors with respect to the peak season visitors (STV)

4.1.2.4 *Method 4*

Method 4 utilized only parameters for 2017 including 2017 permanent population, 2017 housing units, and 2017 persons per household. This method does not use any decennial census data and accepts the latest ACS estimates for the seasonal population. Equation and parameters are explained below.

$$SPop_4 = Seas_{HU_{2017}} \times PPH_{2017} * \frac{\Sigma_{i=1}^{4}(p\_seas_i)}{4} \quad \text{(Equation 6)}$$

$Seas_{HU_{2017}}$ = Number of Housing Units for seasonal use (2017 5-years ACS)

PPH_{2017} = Average Number of Persons per Household (2017 5-years ACS)
p_seas_i = In each season, percent of visitors with respect to the peak season visitors (STV)

4.1.2.5 *Method 5*

Method 5 introduces the municipality's regional average travel party size which approximates the number of people per household. Unlike Methods 1-4 which rely on local household size to estimate seasonal population, the use of regional average travel party size ($ATPS_{2017}$) may be a more appropriate value. The $ATPS_{2017}$ values are from VNC and this provides a more direct estimate of actual tourist behavior (Smith, 1989). Local household sizes may vary substantially more than tourist party sizes across the region. Therefore, the seasonal population in each of NC's municipalities was estimated by evaluating the potential percentage increase in the local population due to tourism.

The potential increase represented by the seasonal population was calculated by dividing the 2017 seasonal population estimate by the 2017 municipal population estimates from NC-OSBM. After accounting for all variables, the adjusted seasonal population for Method 5 was estimated with the following equation.

$$SPop_5 = \left[\frac{Seas_{HU_{2010}}}{HU_{2010}} * HU_{2017}\right] * (ATPS_{2017}) * \frac{\Sigma_{i=1}^{4}(p\_seas_i)}{4} \quad \text{(Equation 7)}$$

$Seas_{HU_{2010}}$ = Housing unit vacant for seasonal use (2010 U.S. Census)
HU_{2010} = Housing Unit estimate (2010 U.S. Census)
HU_{2017} = Housing Unit estimate (2017 5-Year data ACS)
$ATPS_{2017}$ = Average travel party size per households (STV, 2013-2017)
p_seas_i = In each season, a percent of visitors to the peak season visitors (STV)

With this formula, it is determined that the total seasonal population is equal to the average yearly seasonal visitors received.

4.1.2.5.1 Impact of Seasonal Population

The seasonal population in each of the NC municipalities is estimated by evaluating the percentage increase in the local population. The potential increase is deemed to be the seasonal population. The increase was determined by dividing the seasonal population estimate by municipal permanent population estimates from NC-OSBM. For example, 2017 permanent population was used in equation 8.

$$Ppop_{2017} = \frac{SPop_5}{Pop_{2017}} \quad \text{(Equation 8)}$$

$Ppop_{2017}$ = A percent of seasonal population in each municipality
$SPop_5$ = Seasonal population total (from Method 5)
Pop_{2017} = Permanent population total (2017 NC-OSBM)
Pop_{2017} = Permanent population estimate (2017 NC-OSBM)

4.1.3 Results

After evaluating the seasonal population results obtained (from the 508 eligible municipalities in NC) using each of the five methods, the data was assessed. The first analysis includes Table 13 data which is the comparison of the results of the 10 municipalities that experience the greatest seasonal population increase in raw numbers. As seen in Table 13, the top two municipalities - Oak Island and Emerald Isle - are consistent across all five methods. There is some variation in the top 10 across the methods, but the consistent trend is that most of the top municipalities experiencing large inflows of seasonal population are in the Mountain and Coastal areas of the state. Compared to Methods 2-5, Method 1 is a clear outlier, with much larger numerical size estimates of the seasonal population. Method 1 is the only method evaluated that does not make an adjustment for the seasonality of the seasonal population.

Similarly, consistent patterns across the five methods are observed when evaluating Table 14, which shows the top 10 municipalities by an estimated percent increase in permanent population due to seasonal population. While there are some minor fluctuations in ranking across methods, the top five impacted municipalities - Sugar Mountain, Beech Mountain, Lake Santeetlah, Bald Head Island, and Oak Island - are consistent across the methods, and again show the impact of seasonal populations in the Mountain and Coastal areas of the state.

We selected Method 5 as the preferred method for estimating seasonal population in North Carolina's municipalities for multiple reasons. First, Method 5 utilizes data from all the 4 different data sources: 2010 U.S. Census, 2017 5-Year ACS, VNC STV, and July 1 Population Estimates. It alone uses the latest data from a range of reliable sources. In addition, the regional average travel party size ($ATPS_{2017}$) values produced by VNC provides an estimate of actual tourist behavior (Smith, 1989). Person per household varies considerably more than tourist party sizes across the region and ATPS gives a better representation of the three areas in NC (Piedmont, Mountain, and Coastal).

Results from Method 5 described above yielded an estimated total of 105,492 seasonal residents per year or a 1.87% population increase. The eligible 508 Powell Bill municipalities in NC had a combined population of 5,757,674 in 2017. The complete seasonal population table with the percentages of each municipality is listed in Table 34 in Appendix C.

Table 13. Top 10 Municipalities by the Estimated Size of Seasonal Population

Region	Municipality	Equivalent Seasonal Population				
		Method 1	Method 2	Method 3	Method 4	Method 5
Coastal	Oak Island	9,889	5,716	5,580	5,278	6,206
Coastal	Emerald Isle	8,294	4,674	4,474	4,933	5,050
Coastal	Kill Devil Hills	8,262	4,480	4,499	3,379	4,310
Coastal	Atlantic Beach	7,070	3,896	4,246	3,926	4,990
Coastal	Nags Head	5,418	3,021	2,979	3,493	3,415
Coastal	Ocean Isle Beach	4,742	2,812	2,770	2,987	3,255
Coastal	Sunset Beach	4,622	2,602	2,779	3,409	3,106
Coastal	Carolina Beach	4,507	2,567	2,833	3,422	2,760
Coastal	Surf City	4,410	2,807	3,220	2,859	2,936
Mountain	Beech Mountain	4,262	3,425	3,294	2,878	3,458

Table 14. Top 10 Municipalities by the Percentage Increase of the Permanent Population

Region	Municipality	Percent Increase in Population				
		Method 1	Method 2	Method 3	Method 4	Method 5
Mountain	Sugar Mountain	1,447%	1,265%	1,349%	1,107%	1,259%
Mountain	Beech Mountain	1,332%	1,016%	977%	854%	1,026%
Coastal	Bald Head Island	1,198%	644%	586%	549%	773%
Coastal	Ocean Isle Beach	862%	435%	429%	462%	504%
Mountain	Lake Santeetlah	642%	548%	612%	586%	666%
Coastal	Holden Beach	584%	318%	358%	320%	374%
Coastal	North Topsail Beach	499%	271%	274%	196%	332%
Coastal	Topsail Beach	478%	239%	247%	283%	277%
Coastal	Atlantic Beach	473%	260%	284%	262%	333%
Mountain	Seven Devils	471%	333%	309%	295%	339%

Data from Method 5 indicate that 478 of the 508 eligible municipalities experience seasonal population in a given year. In total, NC seasonal population is 105,492 equivalent residents per year, which is a 1.87% increment over the total permanent population. However, when this ratio is evaluated by geographic zones (Coastal, Piedmont, and Mountain), the results were as follows:

- The Coastal area has a total permanent population of 720,497 and a seasonal population of 63,340 which yields a ratio of 8.8%.
- The Piedmont area has a total permanent population of 4,569,379 and a seasonal population of 19,298 which yields a ratio of 0.4%.
- The Mountain area has a total permanent population of 362,329 and a seasonal population of 22,854 which yields a ratio of 6.3%.

Even though the Piedmont area is also affected by seasonal population, the ratios indicate a major concentration occurs in the Coastal and Mountain areas which is to be expected.

The seasonal population ratio for the 508 municipalities for Method 5 is presented in Table 15. There are 20 municipalities who experience a seasonal population increase greater than 100%. In total, 7% of the total number of municipalities experience more than a 50% increase of seasonal population.

Table 15. Seasonal Population vs. Permanent Population Ratio Distribution

Seasonal Population Ratio	# of Municipalities
100% - 1259%	20
50-100%	8
25-50%	8
10-25%	18
6-10%	8
3-6%	26
1-2.99%	89
0%-1%	331
Total	**508**

4.2 Hotel

The strategies utilized to capture hotel population include contacting STR, collecting municipal occupancy tax data, and utilizing seasonal STV percentage ratios to calculate hotel population.

4.2.1 Strategies

A detailed explanation of each of the three strategies investigated to capture visitors staying in hotel is presented below.

4.2.1.1 *STR*

STR is an American company in charge of collecting and tracking supply and demand data for global hotel industry. They provide data reports to researchers, chambers of commerce, economic development agencies, and others for a fee.

The research team contacted STR personnel and requested information regarding the type of data they could provide. STR collects hotel information for approximately 250 municipalities in NC. Besides collecting the hotel information of less than half of the municipalities of the state, the STR data only captures hotel capacity; the occupancy rate and average persons per room are not provided in their reports.

STR provides two sample data which represent the type of information collected from them. Table 17 allows us to know the location of the hotel and the price range in which their rooms are sold. Also, STR allows us to know the number of rooms in a hotel. Information on how many rooms, on average, are occupied or how many persons per room are in the hotel is not captured by STR.

Table 16 provides the total number of hotels and hotel rooms in a given city or area. If calculations need to be made to determine the total number of hotels in Charlotte, for example, the sum of all values in Census Props (total number of hotels in that area specified by the U.S. Census) should be made and that will give us the total number of hotels in Charlotte. Sample Props indicate the actual number of hotels reporting data to STR. STR does not collect data from hotels that have less than 10 rooms and from independent hotels who choose not to report. As a result, the STR data sample is about 84.1% of all hotels for areas in which it collects data.

Table 16. Property Rooms Data Base for NC Market (Smith Travel Research Inc., 2019)

State Name	Market	Tract	City	Census Props	Census Rooms	Sample Props	Sample Rooms
NC	Charlotte, NC-SC	Charlotte CBD/Airport, SC	Charlotte	54	8669	45	8026
NC	Charlotte, NC-SC	Charlotte I-77/Southpark, SC	Charlotte	59	7622	55	7292
NC	Charlotte, NC-SC	Charlotte University Place, SC	Charlotte	45	4903	37	4183
NC	Charlotte, NC-SC	Gastonia/Northwest, NC	Belmont	2	112	1	85
NC	Charlotte, NC-SC	Gastonia/Northwest, NC	Cornelius	6	529	6	529
NC	Charlotte, NC-SC	Gastonia/Northwest, NC	Dallas	1	26	0	0
NC	Charlotte, NC-SC	Gastonia/Northwest, NC	Davidson	2	146	1	128

Table 17. Hotel Data Base for Raleigh Market (Smith Travel Research Inc., 2019)

Hotel Name	City	State	Rooms	County	Class	Location	Price	Single Low Rate	Single High Rate	Double Low Rate	Double High Rate	Suite Low Rate	Suite High Rate	Operation
Holiday Inn Express Apex Raleigh	Apex	NC	64	Wake County	Upper Midscale	Suburban	Midprice	$81	$95	$81	$95	$99	$140	Franchise
Candlewood Suites Apex Raleigh Area	Apex	NC	81	Wake County	Midscale	Suburban	Economy	$0	$0	$0	$0	$97	$109	Franchise
The Mayton Inn	Cary	NC	45	Wake County	Luxury	Suburban	Luxury	$194	$219	$194	$219	$219	$429	Independent
Best Western Plus Cary Inn NC State	Cary	NC	138	Wake County	Upper Midscale	Suburban	Economy	$73	$95	$76	$95	$82	$150	Franchise
Independent Cary Inn at Crossroads	Cary	NC	0	Wake County	Economy	Suburban	Budget	$55	$60	$55	$60	$0	$0	Independent
Springhill Suites Raleigh Cary	Cary	NC	130	Wake County	Upscale	Suburban	Upscale	$0	$0	$0	$0	$179	$189	Franchise
Fairfield Inn & Suites	Cary	NC	108	Wake County	Upper Midscale	Suburban	Midprice	$149	$149	$149	$149	$159	$159	Franchise

4.2.1.2 *Occupancy Tax*

Occupancy tax collections represent another potential way to evaluate the impact of hotels and similar lodging units. The research team contacted municipalities from across the state to share their data. Two municipalities provided details on occupancy revenues: Wilmington and Charlotte.

Occupancy revenues do not provide a full picture of the potential number of overnight visitors. To convert revenues into population, information on two key factors is needed:

- Average daily room rates (ADR) or the average cost per room in a given time period;
- Average guests per room.

However, these data elements are not collected or reported by municipalities. Consequently, assumptions need to be made based on reports previously published about the hotel industry in North Carolina. The following analysis for the city of Charlotte and Wilmington presents examples of the assumptions and calculations performed based on the data received.

4.2.1.2.1 Charlotte

A contact at the City of Charlotte provided details on monthly room occupancy tax collections for FY2000 through FY2018. In the most recent complete year reported (FY2018), Charlotte received $22,221,598 in tax revenues based on a 3% occupancy tax.

Based on this, we estimated that gross room revenues were equivalent to the reported taxes divided by the tax rate, or:

$$\frac{\$22{,}221{,}598 \text{ tax revenue}}{0.03} = \$740{,}719{,}933 \text{ Gross room revenue}$$

According to a report from the Charlotte Regional Visitor's Authority cited in the Charlotte Observer (Portillo, 2016), the most recent estimate of average daily room rate (ADR) in 2016 was $111.89. Based on this, the number of available rooms per night was calculated as follows.

$$\frac{\$740{,}719{,}933 \text{ gross room revenue}}{\$111.89 \text{ average cost/nights}} = 6{,}620{,}073 \text{ Available rooms/nights}$$

According to VNC, the average overnight travel party to the Piedmont region in 2018 had 2.1 visitors per room (Visit North Carolina, 2018). To convert rooms into population, we multiple total room nights by travel party size, or:

$$(6{,}620{,}073 \text{ available rooms/nights}) * (2.1 \text{ visitors/room}) = 13{,}902{,}153 \text{ Visitors/nights}$$

Finally, to convert overnight visitor into an annual seasonal population we divide total overnight visitor nights by 365 days in the year:

$$\frac{13{,}902{,}153 \text{ visitors/nights}}{365 \text{ nights/year}} = 38{,}088 \text{ Visitors/year}$$

On the other hand, the total seasonal population obtained with the STV Percentage Ratio (detailed below in 4.2.1.3), indicated an average of 24,409 people in hotels in Charlotte per day.

To estimate the potential population increase due to overnight hotel visitors in Charlotte, we evaluate the annual seasonal population in comparison to the most recent (2017) population estimate from the NC-OSBM (NC Budget and Management, 2017):

$$\frac{38{,}088\ visitors/year}{845{,}235\ permanent\ population} = 0.0451 \text{ or } \mathbf{4.51\%\ increase}$$

4.2.1.2.2 Wilmington

A contact at the City of Wilmington provided details on monthly room occupancy tax collections for FY2015-16 through FY2017-18. In the most recent complete year reported (FY2018), Wilmington hotels, motels, and inns reported gross accommodation sales of $95,530,228. Other properties reported sales of $5,711,137 for total gross sales from accommodations of $101,241,366.

Statewide, the average room rate in NC was $105.24 in 2018, according to publications from VNC. Based on this, the number of available rooms per night was calculated as follow:

$$\frac{\$101{,}241{,}366\ gross\ room\ revenues}{\$105.24 \text{ average cost/nights}} = 962{,}005 \text{ Available rooms/nights}$$

According to VNC, the average visitors per room to the Coastal region in 2018 had 2.4 guests (Visit North Carolina, 2018). To convert rooms into people the calculations were as follow:

$$(962{,}005 \text{ available rooms/nights})(2.4 \text{ visitors/rooms}) = 2{,}308{,}811 \text{ Visitors/nights}$$

Finally, to convert visitor per night into an annual seasonal population we divide total visitors per nights by 365 days in the year:

$$\frac{2{,}308{,}811 \text{ visitors/nights}}{365 \text{ nights/year}} = 6{,}326 \text{ Visitors/year}$$

On the other hand, the total seasonal population obtained with the STV Percentage Ratio (detailed below in 4.2.1.3), indicate an average of 1,485 people in hotels in Wilmington per day.

To estimate the potential population increase due to overnight hotel visitors in Wilmington, we evaluate the annual seasonal population in comparison to the most recent (2017) population estimate from the NC-OSBM:

$$\frac{6{,}326\ visitors/year}{121{,}150\ permanent\ population} = 0.0522 \text{ or } \mathbf{5.22\%\ increase}$$

4.2.1.2.3 Observations

There are two issues resulting from the utilization of occupancy tax. The first issue is that not all of the 508 eligible municipalities report an occupancy tax (Magellan Strategy Group, 2017). Some large cities do not report or collect occupancy tax because they are not required to do so. As a result, only 84 municipalities collect occupancy tax at a municipality level and 81 counties collect tax at a county level.

For municipalities that do collect occupancy tax data, there is no data on average room rates or average persons per room. As a result, assumptions have to be made in order to account for the missing information. As seen in the sample calculations for the cities of Charlotte and Wilmington, the results are different from the estimations on the STV Percentage Ratios. Therefore, the results cannot be validated. There is simply no consistent measured data across all municipalities that can be used to determine a reliable seasonal population due to hotel occupancy.

4.2.1.3 *STV Percentage Ratios*

VNC is the institution in charge of performing annual reports related to tourism trends in the state. This includes the impact of both business and leisure travel. Every year, VNC publishes a Regional Visitor Profile Report (Visit North Carolina, 2017). In these reports, lodging information is reported for Coastal, Mountain, and Piedmont areas of NC that represent the types of accommodations where visitors stay overnight. The accommodations utilized by the largest percentage of overnight visitors include Seasonal Housing, Hotel/Motel, Private Home (Visitors staying at a family or friend's house), and Others (e.g., RV/Tent). The research team analyzed five years of this lodging report data (2013-2017) and created a 5-year average of accommodation type. The results are presented in Table 18.

Table 18. STV Cumulative Average

Area	Seasonal Housing (%)	Hotel/Motel (%)	Private Home (%)	Others (%)
Coastal	34.41	31.89	28.83	4.87
Mountain	13.90	56.50	21.66	7.94
Piedmont	4.79	46.78	43.28	5.15

After calculating the 5- year average of the lodging accommodations for Coastal, Mountain, and Piedmont, the ratio of each accommodation type to Seasonal Housing were evaluated. The results are presented in Table 19. Seasonal Housing was considered to be the base factor because the formula developed by the research team to capture seasonal population represents potential overnight visitors in Seasonal Housing. The research team then used the STV Percentage Ratios to evaluate the potential size of the seasonal population in other accommodation types. We multiplied the ratios in Table 19 by the estimated seasonal population in seasonal housing.

Table 19. STV Percentage Ratios with Respect to Seasonal Housing

Area	Seasonal Housing	Hotel/Motel	Private Home	Others
Coastal	1	0.926	0.837	0.141
Mountain	1	4.064	1.558	0.571
Piedmont	1	9.766	9.035	1.075

As previously stated in the occupancy tax examples, STV Percentage Ratios are also not the most accurate method to use for calculating seasonal population in hotels. The data gave imperfect results because some assumptions are still made (all municipalities categorized in Coastal, Mountain, or Piedmont areas must behave the same). While estimates for Wilmington and Charlotte with the STV Percentage Ratios may better approximate the impact of hotels, the STV Percentage Ratios yield highly implausible estimates for other communities. This is especially true in small communities with a large number of housing units vacant for seasonal use.

For example, Beech Mountain town had an estimated population of 337 in 2017. Most of their housing units are seasonal units, yielding an estimated 3,458 additional residents in Beech Mountain town based on overnight visitors in seasonal housing (Table 20). Multiplying 3,458 by the Hotel/Motel factor of 4.064 for the Mountain region (Table 19) yields an estimated 14,057 annual impact of overnight visitors in hotels/motels.

Table 20. STV Sample Seasonal Population Estimations

#	Area	Municipality	Permanent Population 2017	Seasonal Housing (per year)	Hotel/ Motel (per year)	Private Homes (per year)	Others (per year)	Total Equivalent Seasonal Population
2	Coastal	Ahoskie (town)	4,806	36	33	30	5	104
5	Coastal	Alliance (town)	790	3	2	2	0	7
13	Coastal	Askewville (town)	230	1	1	1	0	4
14	Coastal	Atkinson (town)	345	5	5	4	1	15
15	Coastal	Atlantic Beach (town)	1,497	4,990	4,624	4,181	706	14,501
16	Coastal	Aulander (town)	828	8	7	6	1	22
493	Coastal	Wilmington (city)	121,150	1,602	1,485	1,342	227	4,655
6	Mountains	Andrews (town)	1,831	49	198	76	28	350
12	Mountains	Asheville (city)	91,910	1,702	6,920	2,653	972	12,247
22	Mountains	Bakersville (town)	474	32	130	50	18	229
24	Mountains	Banner Elk (town)	1,126	355	1,441	553	203	2,551
29	Mountains	Beech Mountain (town)	337	3,458	14,057	5,389	1,975	24,880
39	Mountains	Biltmore Forest (town)	1,391	116	473	181	66	837
1	Piedmont	Aberdeen (town)	7,680	47	457	423	50	977
3	Piedmont	Alamance village	1,097	4	38	35	4	81
4	Piedmont	Albemarle (city)	16,109	94	918	849	101	1,962
7	Piedmont	Angier (town)	5,161	8	74	69	8	158
8	Piedmont	Ansonville (town)	604	23	225	208	25	481
9	Piedmont	Apex (town)	48,471	145	1,414	1,309	156	3,023
10	Piedmont	Archdale (city)	12,105	25	241	223	27	516
84	Piedmont	Charlotte (city)	845,235	2,499	24,409	22,583	2,687	52,179

To achieve this many overnight visitors in hotels/motels annually require an implausible number of hotel rooms in this community. Assuming an average of two guests per room, Beech Mountain town would need 7,000 hotel rooms, occupied at 100% occupancy every day of the year. To put this in perspective, this is roughly the same number of hotel rooms in the entire city of Asheville (6,858), according to data obtained from STR.

STV Percentage Ratios are the sole approach for estimating hotels/motels that can be applied to all municipalities. While they may improve estimates of the impact of seasonal population for some places, they create implausibly large estimates for other places. As a result, we cannot recommend the use of STV Percentage Ratios for evaluating the impact of Hotels/Motels on seasonal population.

4.2.2 Results

After evaluating each strategy, the research team concluded that hotel population should be omitted from the equation and that the research is continued with the formula presented above (equation 7). Proceeding with this alternative is known to be imperfect it is based entirely and only on housing units. However, this assumption is still considered to be a better alternative (and reliable) because of its basis on U.S. Census data. It maximizes proportional fairness.

4.3 Recommendations

The previous strategies to try to capture hotel population lead to inconsistent results. This can result in wide ranging disparities between municipalities in funding allocations. Therefore, the

seasonal population formula (equation 7) will be the one used as a surrogate for seasonal population in NC.

5 MILEAGE

In this section, the research team assessed the mileage portion of the Powell Bill allocation formula by evaluating the military impact and identifying future work such as considering lane mileage.

5.1 Military

The research team investigated multiple sources related to military highway use including the following:

5.1.1 Interview 1: Lieutenant Colonel Brad C. McCoy

On December 6, 2018, the research team met with Lieutenant Colonel-U.S. Army Brad C. McCoy who was a Ph.D. candidate of NCSU and faculty member of the United States Military Academy (USMA) at the West Point. Brad C. McCoy has completed the Army's Ranger, airborn, and Pathfinder schools, and earned his combat infantry badge. He has served as a platoon leader, a general's aide, company commander, and multiple staff jobs at the battalion and brigade levels, and has been deployed twice, spending 14 months in Iraq in 2004 and 2005 and 15 months in Afghanistan from 2007 to 2008.

The research team discussed military impacts on municipal roads to learn about the data available and to identify possible contacts inside Bragg or Lejeune military bases. The most significant points of the meeting were:

- Military vehicles usually do not utilize local roads.
- If military vehicles utilize roads, they are in accordance with federal laws regarding equipment weight. For the procedure used by the Army see the attached paper titled "Conus Base Transportation Movement Control During Mobilization - Will the Current System Do the Job?"
- Heavy equipment are transported by rail.

The meeting minutes are attached in Appendix D.

5.1.2 Interview 2: William R. Vavrik

On October 30, 2018, the research team had a skype call with William R. Vavrik from Applied Research Associates (ARA) to determine whether or not military vehicles exert damage to the NC local roads. Mr. Vavrik informed us that from all the past research he had to perform related to military, there is little to no damage to local roads. The support of his claim is based on the fact that military bases utilize their roads to perform training activities. At the same time, Mr. Vavrik explained that high stresses over a small area typically cause damage to roads. Even though military vehicles look and are heavy, they are designed to have a low pound per square foot (psf) value because military vehicle typically uses more axles, wider tread, and longer tires than other vehicles.

Mr. Vavrik also suggested that garbage trucks and fire trucks are "pavement killers" and perform more damage to local roads that would nearly any military vehicle. Garbage trucks have double

axles and continuously compress trash generating high pressure in small areas. Firetrucks often only have 2 axles yet may carry 500 gallons of water. This heavy and concentrated load can be highly damaging the roads.

Mr. Vavrik recommended contacting Mr. Jeb Tingle of the US Army Engineering Research Development Center at the Waterways Experiment Station to learn more about their research in the performance of military vehicles in atypical places (e.g., unstable soils). The most significant points of the meeting where:

- Military vehicles do not exert much damage to local roads.
- Garbage and fire trucks can exert greater damage to local roads.

5.1.3 Conclusion

Base on the literature review and meetings with military experts, the research team concluded that military bases do not utilize local roads for the transport of heavy equipment, and they do not exert an exacerbate damage to the road. Therefore, the mileage portion of the proposed formula will be modified nor will it be adjusted to account for military impact. Even if some of the heavy military vehicles utilize local roads, the vehicles are designed with multiple axles which help to distribute loads and generate less damage. At the same time, military bases follow local laws and their vehicles tend to follow weight limit laws. In addition, the research team found that no other DOTs consider military use in their formula.

5.2 Lane Mileage

The current Powell Bill formula distributes funds based on permanent population and certified mileage for distributing funds. The municipal street mileage portion of the formula is linked to 25% of the total funding. However, this part of the formula only takes into account the total road (certified) mileage of municipalities. Certified mileage only captures road and street length from beginning to end and ignores the number and size of the lanes on the roads. According to the Federal Highway Administration, lane mileages increase at an average rate of 2.1 lanes per centerline every year to accommodate travel needs (Office of Highway Policy Information, 2011).

As the population grows, the need to improve capacity to existing roads increases as well. Therefore, since certified mileage does not capture the lane mileage each municipality has to maintain and use their own funds to cover maintenance of the lane mileage that do not receive funding. Appropriate modifications need to be assessed with regard to the current Powell Bill Funding allocation. However, the committee decided not to move forward on expanding the project for the consideration of lane mileage at this point of time based on the assumption that most streets have 2 lanes and the data is not readily available. The meeting minutes of the committee meeting is attached in Appendix E.

6 FUNDING ALLOCATION

Multiple approaches and scenarios were tested during this quarter to determine the best allocation method to recommend modifying the Powell Bill funding distribution. These approaches are explained as follows.

6.1 Cap Based Allocation

The cap-based allocation distributes funding by using the same per capita and per mile value from the most recent year ($19.56/person and $1,600.17/mile). The Cap Based Allocation uses capping policy to avoid large allocations to small municipalities who experience high seasonal population. To obtain the new allocation, the following calculations were performed:

Population Allocation = (Seasonal Population + Permanent Population)*(per capita)

Mileage Allocation = (Total miles in a municipality)*(per mile)

Total Allocation = Population Allocation + Mileage Allocation

For example, Sugar Mountain and Topsail Beach are two municipalities that presented a high percentage increase in population. However, in these municipalities, the total mileage is low. Capping policy sets a maximum percentage of funding increase based on an estimated seasonal population to avoid allocating a very large amount of funding to municipalities with low mileage and needs. Cap can be set at various levels. For example, a capping policy can be that no municipalities should receive a total allocation increase more than 50% of last year's allocation. The legislature can decide the capping level. Table 21 shows additional funds needed for different capping levels without any municipality having funding reduction.

Table 21. Additional Funds Need for Cap Approach

Cap	Funding Needed (Millions)
50%	1.7
30%	1.4
10%	0.9

Table 22 represents a sample of the results obtained from the cap approach at 50%. The results from the cap approach are consistent for all municipalities and avoid large allocations increase for small municipalities. The advantage of this approach is that there will be a consistent capping level for all municipalities and the level can be determined by policymakers based on funding availability.

Table 22. Sample Calculations

								New Allocation			Cap Allocation		
#	Municipality	Permanent Population 2017	Seasonal Population	% Increase in Population	Mile	Per Capita	Per Mile	Population Allocation	Mileage Allocation	Total Allocation	Difference in Temporary Allocations	% Actual Funding Increase	Actual New Allocation
2	Ahoskie	4806	36	1%	33.07	$19.56	$1,600.17	$94,697	$52,917	$147,614	$702	0%	$147,614
441	**Sugar Mountain**	**197**	**2480**	**1259%**	**14.08**	**$19.56**	**$1,600.17**	**$52,360**	**$22,530**	**$74,891**	**$48,507**	**50%**	**$39,575**
454	**Topsail Beach**	**409**	**1133**	**277%**	**5.24**	**$19.56**	**$1,600.17**	**$30,159**	**$8,385**	**$38,544**	**$22,160**	**50%**	**$24,576**
502	Woodfin	6640	72	1%	35.02	$19.56	$1,600.17	$131,278	$56,038	$187,316	$1,415	1%	$187,316
1	Aberdeen	7680	47	1%	47.05	$19.56	$1,600.17	$151,118	$75,288	$226,406	$915	0%	$226,406
508	Zebulon	4901	21	0%	21.14	$19.56	$1,600.17	$96,255	$33,828	$130,082	$402	0%	$130,082
…	…	…	…	…	…	…	…	…	…	…	…	…	…
Total		5,652,205	105,491		23,028				$36,848,115	$149,449,016	$2,063,183		$149,093,010

6.2 Group Based Allocation

This approach allocates the funding by grouping municipalities based on a percentage ration of seasonal population increase (i.e. Table 23) and assigns a unique factor to each group (i.e. Table 24). The Grouping Allocation uses the same per capita and per mile value from the most recent year ($19.56/person and $1,600.17/mile) and these values are multiplied by the proposed factors. Four scenarios were developed for the grouping approach and they are explained as follows.

6.2.1 Scenario 1: Total Powell Bill Funding Remains Unchanged. Adjust Municipalities' Funding Based on Total Funding Received from Previous Year

The first scenario is that the total Powell Bill budget remains unchanged ($147 M). The municipalities with a higher seasonal population percentage will have a funding increased and the municipalities with lower seasonal population percentage will have funding deduction. To perform this scenario, the following steps were performed:

Step 1: Set up grouping criteria

The grouping criteria are set based on the percent increase of seasonal population. Table 23 shows an example of grouping. Municipalities are divided into five groups based on their seasonal population increase. NCDOT administration can determine the number of groups and ranges of groups based on the need and funding availability.

Table 23. Grouping with Seasonal Population Increase Range

Group	Lower Bound	Upper Bound	Number of Municipalities
A	100%	1300%	20
B	50%	100%	8
C	25%	50%	8
D	1%	25%	141
E	0%	1%	331

Step 2: Determine the multiplier for each group

Table 24 lists the multiplier for each grouping category. In order to keep the total Powell Bill funding at the same amount from last year, Group E with the lowest seasonal population percentage will receive a 1.03% cut. Group A - D will receive from 3% to 50% increase of the current allocation. The 1.03% deduction was determined based on a trial and error process. This can also be an administrative decision from NCDOT.

Table 24. Grouping Factor in Scenario 1

Group	Percent Factor
A	50%
B	30%
C	15%
D	3%
E	-1.03%

For example, Asheboro city has a 105 seasonal population per year, which is a 0.4% increase of its permanent population, therefore, Asheboro city belongs to group E and will receive a 1.03% in budget deduction. Another municipality, Blowing Rock town with an annual seasonal population of 1,917, experience a 144% increase of its permanent population, will be categorized in group A, therefore, Blowing Rock town will receive a 50% budget increase.

Step 3: Calculate the new allocation

A sample calculation of the cities previously grouped in step 3 is as follows. Asheboro city has a current allocation of $662,189.94. After a -1.03% cut, the new allocation would be $655,389.79 and the difference between the new allocation and the current budget is a reduction of $6,800.15. Blowing Rock town, however, receives a total of $76,054.30 based on its current allocation. By utilizing the grouping approach, the proposed allocation would be $114,081.45 which is a $38,027.15 budget increase. The detailed allocation for both of the examples are shown below in Table 25 and Table 26.

Table 25. Allocation of Asheboro City in Scenario 1

Asheboro City						
Permanent Population 2017	**Seasonal Population**	**Percent Increase in Population**	**Current Powell Bill Allocation**	**Group and Factor**	**Proposed Allocation**	**Difference**
25,791	105	0.4%	$662,189.94	E / -1.03%	$655,389.79	-$6,800.15

Table 26. Allocation of Blowing Rock Town in Scenario 1

Blowing Rock Town						
Permanent Population 2017	**Seasonal Population**	**Percent Increase in Population**	**Current Powell Bill Allocation**	**Group and Factor**	**Proposed Allocation**	**Difference**
1,327	1,917	144%	$76,054.30	A / 50%	$114,081.45	$38,027.15

6.2.2 Scenario 2: Requires Powell Bill Funding Increase. Adjust Municipalities' Funding Based on Total Funding Received from Previous Year

Scenario 2 assumes that no municipality will receive a funding deduction and additional funding will be needed. Municipalities in group E will receive the same allocation as using the formula from last year. The new multiplier for other groups is listed in Table 27. In total, an additional $1.34 million will be needed, which is about 1% of the current Powell Bill allocation.

Table 27. Group Factor with Budget Increase in Scenario 2

Group	Percent Factor
A	50%
B	30%
C	15%
D	3%
E	0%

The grouping approach has multiple advantages. The total budget can be controlled by adjusting the percent factors. The grouping criteria are flexible and can be modified by decision makers for

various situations. However, some shortages still need to be addressed. Since most of the municipalities have a small percentage of seasonal population increase, hundreds of them receive the same increase ratio while the base funding varies. In addition, grouping and factor allocation are based on arbitrary decisions.

6.2.3 Scenario 3: Total Powell Bill Funding Remains Unchanged. Adjust Municipalities' Funding Based on Permanent Population Portion Received from Previous Year

For Scenario 3, the total Powell Bill budget remains unchanged. The municipalities with a higher seasonal population percentage will have a funding increased and the municipalities with lower seasonal population percentage will have funding deduction. Just like Scenario 1, Group E in Scenario 3 also receives a funding deduction (i.e. Table 28). However, the multiplier in group E is changed to -0.74% because, in Scenario 3, the adjustment is based only on the permanent population portion received from the previous year.

Table 28. Grouping Factor in Scenario 3

Group	Percent Factor
A	50%
B	30%
C	15%
D	3%
E	-0.74%

For example, Asheboro city will receive a cut of $3,729.26 ($ 504,413.62 × 0.74%). The results of this sample calculations are shown in Table 29.

Table 29. Allocation of Asheboro City in Scenario 3

Asheboro City						
Percent Increase in Population	**Population Allocation**	**Mileage Allocation**	**Current Powell Bill Allocation**	**Group and Factor**	**Proposed Allocation**	**Difference**
0.4%	$504,413.62	$157,776.32	$662,189.94	E / -0.74%	$658,460.68	-$3,729.26

6.2.4 Scenario 4: Requires Powell Bill Funding Increase. Adjust Municipalities' Funding Based on Population Portion Received from Previous Year

In Scenario 4, the assumption is that no municipality will receive a funding deduction and additional funds will be needed. The new allocation for Scenario 4 will be determined by multiplying the grouping factor to the funding received based on the population portion. A $0.73M increase in total Powell Bill funding is needed according to the adjustment multiplier.

For example, the town of Blowing Rock, with a current population allocation of $25,953 is in group A. In Scenario 4, the proposed allocation for Blowing Rock will be $25,953 × (1+50%) = $38,929. This amount will be added to the current mileage allocation which gives a total proposed allocation of $89,030 for the next fiscal year. The results of this sample calculations are shown in Table 30.

Table 30. Allocation of Blowing Rock Town in Scenario 4

Blowing Rock Town						
Percent Increase in Population	**Population Allocation**	**Mileage Allocation**	**Current Powell Bill Allocation**	**Group and Factor**	**Proposed Allocation**	**Difference**
144%	$25,953.12	$50,101.18	$76,054.30	A / 50%	$89,030.86	$12,976.56

6.3 Need Based Allocation

Need Based Allocation utilized the same Powell Bill funding allocation formula. The difference is that municipalities with a high seasonal population percentage (i.e. greater than 50%) can request additional funding based on need. Those qualified municipalities can submit requests for additional funding if they have a need for improving local streets. A NCDOT committee will be assigned to evaluate and assess the need and budget. Funding will be allocated based on a priority ranking system considering the amount of structural deficiency, mileage, budget, social and environmental impact, and the seasonal population percentage. It is recommended to use the following criteria to prioritize the funding allocation:

1. The most critical criterion is the physical condition of the road.
2. NCDOT can also consider whether a road is used for evacuation, whether it:
   a. Has a high level of agricultural travel,
   b. Is built as an arterial route, and/or
   c. It is located in a fiscally constrained municipality etc.

This approach allows NCDOT to help municipalities with high seasonal population impact to improve local street conditions based on their needs. Table 15 (in section 4.1.3) which provides information about the numbers of municipalities experiencing seasonal population increase by different ratios.

6.4 Results

Three approaches to modify the Powell Bill allocation are introduced in this research. The results for the proposed allocation are summarized in Table 31.

Table 31. Summary of Approaches

Allocation Approach	Scenario	Additional Funding Required?*	Funding Deduction for Some Municipalities?
Cap	50%	Yes, $ 1.7M	No
	30%	Yes, $ 1.4M	No
	10%	Yes, $ 0.9M	No
Group	1	No	Yes
	2	Yes, $ 1.3M	No
	3	No	Yes
	4	Yes, $ 0.7M	No
Need	N/A	Yes, Depending on Needs	No

*All the funding differences are adjustable by changing parameters in the corresponding approach. The amount listed are based on the examples previously shown.

Cap Approach

Design

- Use previous year per capita and per mile values.
- Cap on max allocation. For example, no more than 50% or a suggested percentage increase over last year's total allocation.

Results

- An additional $1.7M (at 50%), $1.4M (at 30%) or $0.9M (at 10%) is needed.

Advantages

- Consistent allocation for all eligible municipalities.
- Additional funding depending on cap level.
- Avoid an unnecessary large increase in allocation.

Disadvantages

- Capping levels have to be determined at administration decisions.

Group Approach

Design

- Scenario 1: Total Powell Bill funding remains unchanged.
- Scenario 2: Additional funding is needed to account for seasonal population.
- Scenario 3: Total Powell Bill funding remains unchanged.
- Scenario 4: Additional funding is needed to account for seasonal population.

Results

- Scenario 1: Approximately 1% of funding cut for a large number of municipalities.
- Scenario 2: Additional Powell Bill funding request is $1,336,181.
- Scenario 3: Approximately 0.50% funding cut for a large number of municipalities.
- Scenario 4: Additional Power Bill funding request is $731,231.75.

Advantages

- Scenario 1: Maintain same budget; better represent the needs of high seasonal population municipalities.
- Scenario 2: Additional Powell Bill budget required to cover the seasonal population impact (approximate 1%).
- Scenario 3: No need to require additional Powell Bill funding; better represent the needs of high seasonal population municipalities.
- Scenario 4: No municipalities receive funding cuts. Additional Power Bill funding request is minimal.

Disadvantages

- Arbitrary determination on grouping and factor values.
- The same factor used for all municipalities in the same group while municipalities' funding base varies.

Need Based Allocation

Design

- Allocate additional funding based on need for municipalities with a higher seasonal population percentage.

Results

- Qualified municipalities will receive additional funding based on their needs.

Advantages

- NCDOT can determine which municipalities are eligible for funding and determine how much additional funding should be given to the municipalities based on their needs.

Disadvantages

- A committee needs to be formed to evaluate and assess the needs.

An Excel spreadsheet is provided as an allocation calculator for Cap and Group Based Allocation. The detailed instruction is shown in Appendix F.

7 CONCLUSIONS

This research found that out of the 50 DOTs in the United States, 11 DOTs distribute funds based only on population, six DOTs based only on mileage, 18 states based on both population and mileage. Fifteen distributed funding based on needs, county area, local match, revenue programs, and vehicle registration. Caltrans used the same funding distribution formula as NC (75% on population and 25% on mileage). None of the DOTs include seasonal population or military equipment impact in funding distribution consideration. Therefore, the factors considered in the Powell Bill funding distribution are consistent with the ones used by peer DOTs.

However, due to the unique geographic characteristics of NC, there is a seasonal population shift pattern could be considered in the Powell Bill funding distribution. This research investigated 10 direct and indirect data sources and found that the most affordable and reliable data sources are 2010 U.S. Census data, 5-years ACS, STV, and July 1 Population Estimates by NC-OSBM.

Based on those four data sources, the research developed five methods to estimate seasonal population and recommended Method 5. Method 5 utilized 2010 U.S. Census data for share of seasonal housing. It also used 5-Years ACS (2013-2017) for number of total housing units and introduced the municipality's regional average travel party size ($ATPS_{2017}$). Unlike Methods 1-4 which rely on local household size to estimate seasonal population, the use of regional average travel party size ($ATPS_{2017}$) will lead to a more reliable estimate. Therefore, this research recommended Method 5 for seasonal population estimation.

The estimation based on Method 5 indicated that 478 of the 508 eligible municipalities experience seasonal population impact. It also yielded an estimated seasonal population of 105,492 per year in NC, which equivalents to a 1.87% seasonal population increase from permanent population. The seasonal population in NC is significant in some municipalities, especially for those located

in the Coastal and Mountain areas. The results by geographic zones (Coastal, Piedmont, and Mountain) are as follows:

- The Coastal area has a total permanent population of 720,497 and a seasonal population of 63,340 which yields a ratio of 8.8%.
- The Piedmont area has a total permanent population of 4,569,379 and a seasonal population of 19,298 which yields a ratio of 0.4%.
- The Mountain area has a total permanent population of 362,329 and a seasonal population of 22,854 which yields a ratio of 6.3%.

The ratios indicate a major concentration occurs in the Coastal and Mountain areas, while the impact to Piedmont is relatively low especially with respect to its large volume of permanent population. A small number of municipalities receive a larger impact from seasonal population shift. For example, 28 municipalities have 50% or higher seasonal to permanent population ratio. A large number of municipalities receive a smaller impact. Three hundred thirty-one municipalities have a less than 1% seasonal population increase.

After analyzing seasonal population, three approaches were developed to address seasonal population impact. The first is the Cap Based Allocation, which uses the same per capita and per mile values from the most recent year (i.e. $19.56/person and $1,600.17/mile). The new funding allocation for a municipality is the summation of per capita value multiplied by the total population (seasonal + permanent) and per mile value multiplied by the total mileage of the municipality. To avoid an excessive increase to municipalities which experience high seasonal population but has minimal mileage, a cap of maximum allocation is assigned. The Group Based Allocation recommends to divide all qualified municipalities into five groups based on their seasonal population percentage. Then allocate a percentage factor for each group. For all municipalities fall in the same group, they will receive a funding increase of the same percentage from previous years' allocation. An Excel based tool was provided to assist NCDOT engineers and administrators to modify the parameters of the proposed allocation strategies so that administration decisions can be made accordingly.

Under the Need Based Allocation, the same Powell Bill funding allocation formula is used. The difference is that municipalities with a high seasonal population percentage (i.e. greater than 50%) can request additional funding based on need. Those qualified municipalities can submit requests for additional funding if they have a need for improving local streets. An NCDOT committee will be assigned to evaluate and assess the need and budget. Funding will be allocated based on a priority ranking system considering the amount of structural deficiency, mileage, budget, social and environmental impact, and the seasonal population percentage. This approach allows NCDOT to help municipalities with high seasonal population impact to improve local street conditions based on their needs.

The research also investigated the impact of heavy military equipment usage on local streets and found that military vehicles do not exert an exacerbate damage to local streets. Therefore, it is not recommended to include military equipment's impact in Powell Bill funding allocation consideration.

8 FUTURE STUDIES

There are several recommendations for future studies. First, seasonal population estimation is based on 2010 Census counts and ACS 2017 5-year housing unit estimates 2017 housing unit data. While the new 2020 U.S. Census data will be available in 2021, it is highly recommended to use the new 2020 U.S. Census data for seasonal population estimation, evaluate the impact and compare the results with the results from this study. According to NC-OSBM, there will also be a need to evaluate the availability of data such as household size from the 2020 decennial census given new procedures of disclosure avoidance (differential privacy). NC-OSBM is currently evaluating this issue and will be reaching out to agencies to give them an opportunity to provide feedback to the Census Bureau.

Second, the municipal street mileage portion of the formula is linked to the remaining 25% of the total funding. As previously identified, this part of the formula only takes into account the total road (certified) mileage of municipalities. It is recommended to identify the actual lane mileage for each eligible municipality which would better represent the actual road surface maintenance need. This will provide a more accurate estimate of road surface area and overall maintenance needs and result in a more equitable funding allocation that better represents the actual need of the municipalities.

APPENDIX

APPENDIX A

Table 32. Municipalities Received Powell Bill Funding in 2018

#	Area	Municipality	#	Area	Municipality
1	Piedmont	Aberdeen town	47	Coastal	Boiling Spring Lakes city
2	Coastal	Ahoskie town	48	Mountains	Boiling Springs town
3	Piedmont	Alamance village	49	Coastal	Bolivia town
4	Piedmont	Albemarle city	50	Coastal	Bolton town
5	Coastal	Alliance town	51	Mountains	Boone town
6	Mountains	Andrews town	52	Piedmont	Boonville town
7	Piedmont	Angier town	53	Mountains	Bostic town
8	Piedmont	Ansonville town	54	Mountains	Brevard city
9	Piedmont	Apex town	55	Coastal	Bridgeton town
10	Piedmont	Archdale city	56	Piedmont	Broadway town
11	Piedmont	Asheboro city	57	Piedmont	Brookford town
12	Mountains	Asheville city	58	Coastal	Brunswick town
13	Coastal	Askewville town	59	Mountains	Bryson City town
14	Coastal	Atkinson town	60	Piedmont	Bunn town
15	Coastal	Atlantic Beach town	61	Coastal	Burgaw town
16	Coastal	Aulander town	62	Piedmont	Burlington city
17	Coastal	Aurora town	63	Mountains	Burnsville town
18	Coastal	Autryville town	64	Piedmont	Butner town
19	Coastal	Ayden town	65	Coastal	Calabash town
20	Piedmont	Badin town	66	Coastal	Calypso town
21	Piedmont	Bailey town	67	Piedmont	Cameron town
22	Mountains	Bakersville town	68	Piedmont	Candor town
23	Coastal	Bald Head Island village	69	Mountains	Canton town
24	Mountains	Banner Elk town	70	Coastal	Cape Carteret town
25	Coastal	Bath town	71	Coastal	Carolina Beach town
26	Coastal	Bayboro town	72	Coastal	Carolina Shores town
27	Coastal	Bear Grass town	73	Piedmont	Carrboro town
28	Coastal	Beaufort town	74	Piedmont	Carthage town
29	Mountains	Beech Mountain town	75	Piedmont	Cary town
30	Coastal	Belhaven town	76	Piedmont	Castalia town
31	Piedmont	Belmont city	77	Coastal	Caswell Beach town
32	Coastal	Belville town	78	Piedmont	Catawba town
33	Piedmont	Benson town	79	Coastal	Cedar Point town
34	Piedmont	Bermuda Run town	80	Mountains	Cedar Rock village
35	Piedmont	Bessemer City city	81	Coastal	Cerro Gordo town
36	Piedmont	Bethania town	82	Coastal	Chadbourn town
37	Coastal	Bethel town	83	Piedmont	Chapel Hill town
38	Coastal	Beulaville town	84	Piedmont	Charlotte city
39	Mountains	Biltmore Forest town	85	Piedmont	Cherryville city
40	Piedmont	Biscoe town	86	Piedmont	China Grove town
41	Piedmont	Black Creek town	87	Coastal	Chocowinity town
42	Mountains	Black Mountain town	88	Piedmont	Claremont city
43	Coastal	Bladenboro town	89	Coastal	Clarkton town
44	Mountains	Blowing Rock town	90	Piedmont	Clayton town
45	Coastal	Boardman town	91	Piedmont	Clemmons village
46	Coastal	Bogue town	92	Piedmont	Cleveland town

Continuation					
#	Area	Municipality	#	Area	Municipality
93	Coastal	Clinton city	141	Coastal	Enfield town
94	Mountains	Clyde town	142	Piedmont	Erwin town
95	Piedmont	Coats town	143	Coastal	Eureka town
96	Coastal	Cofield village	144	Coastal	Everetts town
97	Coastal	Colerain town	145	Coastal	Fair Bluff town
98	Coastal	Columbia town	146	Piedmont	Fairmont town
99	Mountains	Columbus town	147	Coastal	Faison town
100	Piedmont	Concord city	148	Piedmont	Faith town
101	Piedmont	Conetoe town	149	Piedmont	Falcon town
102	Mountains	Connelly Springs town	150	Coastal	Falkland town
103	Piedmont	Conover city	151	Mountains	Fallston town
104	Coastal	Conway town	152	Coastal	Farmville town
105	Piedmont	Cooleemee town	153	Piedmont	Fayetteville city
106	Piedmont	Cornelius town	154	Mountains	Fletcher town
107	Coastal	Cove City town	155	Mountains	Fontana Dam town
108	Piedmont	Cramerton town	156	Mountains	Forest City town
109	Piedmont	Creedmoor city	157	Mountains	Forest Hills village
110	Coastal	Creswell town	158	Coastal	Fountain town
111	Mountains	Crossnore town	159	Piedmont	Four Oaks town
112	Piedmont	Dallas town	160	Piedmont	Foxfire village
113	Piedmont	Danbury town	161	Mountains	Franklin town
114	Piedmont	Davidson town	162	Piedmont	Franklinton town
115	Piedmont	Denton town	163	Piedmont	Franklinville town
116	Mountains	Dillsboro town	164	Coastal	Fremont town
117	Mountains	Dobbins Heights town	165	Piedmont	Fuquay-Varina town
118	Piedmont	Dobson town	166	Coastal	Garland town
119	Coastal	Dover town	167	Piedmont	Garner town
120	Mountains	Drexel town	168	Coastal	Garysburg town
121	Coastal	Dublin town	169	Coastal	Gaston town
122	Piedmont	Dunn city	170	Piedmont	Gastonia city
123	Piedmont	Durham city	171	Coastal	Gatesville town
124	Mountains	Earl town	172	Piedmont	Gibson town
125	Coastal	East Arcadia town	173	Piedmont	Gibsonville town
126	Piedmont	East Bend town	174	Mountains	Glen Alpine town
127	Piedmont	East Laurinburg town	175	Piedmont	Godwin town
128	Piedmont	East Spencer town	176	Coastal	Goldsboro city
129	Piedmont	Eastover town	177	Piedmont	Goldston town
130	Piedmont	Eden city	178	Piedmont	Graham city
131	Coastal	Edenton town	179	Mountains	Granite Falls town
132	Coastal	Elizabeth City city	180	Piedmont	Granite Quarry town
133	Coastal	Elizabethtown town	181	Piedmont	Green Level town
134	Mountains	Elk Park town	182	Coastal	Greenevers town
135	Piedmont	Elkin town	183	Piedmont	Greensboro city
136	Mountains	Ellenboro town	184	Coastal	Greenville city
137	Piedmont	Ellerbe town	185	Coastal	Grifton town
138	Piedmont	Elm City town	186	Coastal	Grimesland town
139	Piedmont	Elon town	187	Mountains	Grover town
140	Coastal	Emerald Isle town	188	Coastal	Halifax town

Continuation					
#	Area	Municipality	#	Area	Municipality
189	Coastal	Hamilton town	236	Coastal	Kitty Hawk town
190	Piedmont	Hamlet city	237	Piedmont	Knightdale town
191	Piedmont	Harmony town	238	Coastal	Kure Beach town
192	Coastal	Harrells town	239	Coastal	La Grange town
193	Coastal	Harrellsville town	240	Mountains	Lake Lure town
194	Piedmont	Harrisburg town	241	Piedmont	Lake Park village
195	Coastal	Hassell town	242	Mountains	Lake Santeetlah town
196	Coastal	Havelock city	243	Coastal	Lake Waccamaw town
197	Piedmont	Haw River town	244	Piedmont	Landis town
198	Mountains	Hayesville town	245	Mountains	Lansing town
199	Piedmont	Henderson city	246	Coastal	Lasker town
200	Mountains	Hendersonville city	247	Mountains	Lattimore town
201	Coastal	Hertford town	248	Mountains	Laurel Park town
202	Piedmont	Hickory city	249	Piedmont	Laurinburg city
203	Piedmont	High Point city	250	Mountains	Lawndale town
204	Piedmont	High Shoals city	251	Coastal	Leland town
205	Mountains	Highlands town	252	Mountains	Lenoir city
206	Mountains	Hildebran town	253	Coastal	Lewiston Woodville town
207	Piedmont	Hillsborough town	254	Piedmont	Lewisville town
208	Coastal	Hobgood town	255	Piedmont	Lexington city
209	Piedmont	Hoffman town	256	Piedmont	Liberty town
210	Coastal	Holden Beach town	257	Piedmont	Lilesville town
211	Coastal	Holly Ridge town	258	Piedmont	Lillington town
212	Piedmont	Holly Springs town	259	Piedmont	Lincolnton city
213	Coastal	Hookerton town	260	Piedmont	Linden town
214	Piedmont	Hope Mills town	261	Coastal	Littleton town
215	Mountains	Hot Springs town	262	Piedmont	Locust city
216	Mountains	Hudson town	263	Piedmont	Long View town
217	Piedmont	Huntersville town	264	Piedmont	Louisburg town
218	Piedmont	Indian Trail town	265	Piedmont	Love Valley town
219	Coastal	Jackson town	266	Piedmont	Lowell city
220	Coastal	Jacksonville city	267	Piedmont	Lucama town
221	Piedmont	Jamestown town	268	Piedmont	Lumber Bridge town
222	Coastal	Jamesville town	269	Piedmont	Lumberton city
223	Mountains	Jefferson town	270	Piedmont	Macclesfield town
224	Piedmont	Jonesville town	271	Piedmont	Macon town
225	Piedmont	Kannapolis city	272	Piedmont	Madison town
226	Coastal	Kelford town	273	Mountains	Maggie Valley town
227	Coastal	Kenansville town	274	Coastal	Magnolia town
228	Piedmont	Kenly town	275	Piedmont	Maiden town
229	Piedmont	Kernersville town	276	Coastal	Manteo town
230	Coastal	Kill Devil Hills town	277	Mountains	Marion city
231	Piedmont	King city	278	Mountains	Mars Hill town
232	Mountains	Kings Mountain city	279	Mountains	Marshall town
233	Mountains	Kingstown town	280	Piedmont	Marshville town
234	Coastal	Kinston city	281	Piedmont	Marvin village
235	Piedmont	Kittrell town	282	Piedmont	Matthews town

Continuation					
#	Area	Municipality	#	Area	Municipality
283	Piedmont	Maxton town	330	Coastal	Ocean Isle Beach town
284	Piedmont	Mayodan town	331	Mountains	Old Fort town
285	Coastal	Maysville town	332	Coastal	Oriental town
286	Piedmont	McAdenville town	333	Piedmont	Oxford city
287	Piedmont	McDonald town	334	Coastal	Pantego town
288	Piedmont	McFarlan town	335	Piedmont	Parkton town
289	Piedmont	Mebane city	336	Coastal	Parmele town
290	Coastal	Mesic town	337	Piedmont	Peachland town
291	Piedmont	Micro town	338	Coastal	Peletier town
292	Piedmont	Middleburg town	339	Piedmont	Pembroke town
293	Piedmont	Middlesex town	340	Coastal	Pikeville town
294	Piedmont	Midland town	341	Piedmont	Pilot Mountain town
295	Coastal	Minnesott Beach town	342	Coastal	Pine Knoll Shores town
296	Piedmont	Mint Hill town	343	Piedmont	Pine Level town
297	Piedmont	Misenheimer village	344	Piedmont	Pinebluff town
298	Piedmont	Mocksville town	345	Piedmont	Pinehurst village
299	Piedmont	Monroe city	346	Piedmont	Pinetops town
300	Mountains	Montreat town	347	Piedmont	Pineville town
301	Piedmont	Mooresville town	348	Coastal	Pink Hill town
302	Coastal	Morehead City town	349	Piedmont	Pittsboro town
303	Mountains	Morganton city	350	Coastal	Plymouth town
304	Piedmont	Morrisville town	351	Piedmont	Polkton town
305	Piedmont	Morven town	352	Mountains	Polkville city
306	Piedmont	Mount Airy city	353	Coastal	Pollocksville town
307	Piedmont	Mount Gilead town	354	Coastal	Powellsville town
308	Piedmont	Mount Holly city	355	Piedmont	Princeton town
309	Coastal	Mount Olive town	356	Piedmont	Princeville town
310	Piedmont	Mount Pleasant town	357	Piedmont	Proctorville town
311	Coastal	Murfreesboro town	358	Piedmont	Raeford city
312	Mountains	Murphy town	359	Piedmont	Raleigh city
313	Coastal	Nags Head town	360	Piedmont	Ramseur town
314	Piedmont	Nashville town	361	Piedmont	Randleman city
315	Coastal	Navassa town	362	Piedmont	Ranlo town
316	Coastal	New Bern city	363	Piedmont	Raynham town
317	Piedmont	New London town	364	Piedmont	Red Cross town
318	Mountains	Newland town	365	Piedmont	Red Springs town
319	Coastal	Newport town	366	Piedmont	Reidsville city
320	Piedmont	Newton city	367	Piedmont	Rennert town
321	Coastal	Newton Grove town	368	Mountains	Rhodhiss town
322	Piedmont	Norlina town	369	Coastal	Rich Square town
323	Coastal	North Topsail Beach town	370	Piedmont	Richfield town
324	Mountains	North Wilkesboro town	371	Coastal	Richlands town
325	Coastal	Northwest city	372	Coastal	River Bend town
326	Piedmont	Norwood town	373	Coastal	Roanoke Rapids city
327	Coastal	Oak City town	374	Piedmont	Robbins town
328	Coastal	Oak Island town	375	Mountains	Robbinsville town
329	Piedmont	Oakboro town	376	Coastal	Robersonville town

Continuation					
#	Area	Municipality	#	Area	Municipality
377	Piedmont	Rockingham city	425	Piedmont	Spring Hope town
378	Piedmont	Rockwell town	426	Piedmont	Spring Lake town
379	Piedmont	Rocky Mount city	427	Mountains	Spruce Pine town
380	Piedmont	Rolesville town	428	Piedmont	St. Pauls town
381	Mountains	Ronda town	429	Piedmont	Staley town
382	Coastal	Roper town	430	Piedmont	Stallings town
383	Coastal	Rose Hill town	431	Piedmont	Stanfield town
384	Coastal	Roseboro town	432	Piedmont	Stanley town
385	Mountains	Rosman town	433	Piedmont	Stantonsburg town
386	Piedmont	Rowland town	434	Piedmont	Star town
387	Piedmont	Roxboro city	435	Piedmont	Statesville city
388	Coastal	Roxobel town	436	Piedmont	Stedman town
389	Piedmont	Rural Hall town	437	Piedmont	Stem town
390	Mountains	Ruth town	438	Piedmont	Stoneville town
391	Mountains	Rutherford College town	439	Coastal	Stonewall town
392	Mountains	Rutherfordton town	440	Piedmont	Stovall town
393	Coastal	Saint Helena village	441	Mountains	Sugar Mountain village
394	Coastal	Salemburg town	442	Coastal	Sunset Beach town
395	Piedmont	Salisbury city	443	Coastal	Surf City town
396	Mountains	Saluda city	444	Coastal	Swansboro town
397	Coastal	Sandy Creek town	445	Mountains	Sylva town
398	Coastal	Sandyfield town	446	Coastal	Tabor City town
399	Piedmont	Sanford city	447	Coastal	Tar Heel town
400	Piedmont	Saratoga town	448	Piedmont	Tarboro town
401	Mountains	Sawmills town	449	Mountains	Taylorsville town
402	Coastal	Scotland Neck town	450	Piedmont	Taylortown town
403	Coastal	Seaboard town	451	Coastal	Teachey town
404	Piedmont	Seagrove town	452	Piedmont	Thomasville city
405	Piedmont	Sedalia town	453	Piedmont	Tobaccoville village
406	Piedmont	Selma town	454	Coastal	Topsail Beach town
407	Mountains	Seven Devils town	455	Coastal	Trent Woods town
408	Coastal	Seven Springs town	456	Coastal	Trenton town
409	Coastal	Severn town	457	Piedmont	Trinity city
410	Coastal	Shallotte town	458	Piedmont	Troutman town
411	Piedmont	Sharpsburg town	459	Piedmont	Troy town
412	Mountains	Shelby city	460	Mountains	Tryon town
413	Piedmont	Siler City town	461	Coastal	Turkey town
414	Coastal	Simpson village	462	Mountains	Valdese town
415	Piedmont	Sims town	463	Coastal	Vanceboro town
416	Piedmont	Smithfield town	464	Coastal	Vandemere town
417	Coastal	Snow Hill town	465	Piedmont	Vass town
418	Piedmont	Southern Pines town	466	Mountains	Waco town
419	Coastal	Southern Shores town	467	Piedmont	Wade town
420	Coastal	Southport city	468	Piedmont	Wadesboro town
421	Mountains	Sparta town	469	Piedmont	Wagram town
422	Piedmont	Speed town	470	Piedmont	Wake Forest town
423	Piedmont	Spencer town	471	Piedmont	Walkertown town
424	Mountains	Spindale town	472	Coastal	Wallace town

Continuation					
#	Area	Municipality	#	Area	Municipality
473	Piedmont	Walnut Cove town	491	Mountains	Wilkesboro town
474	Coastal	Walnut Creek village	492	Coastal	Williamston town
475	Coastal	Walstonburg town	493	Coastal	Wilmington city
476	Piedmont	Warrenton town	494	Piedmont	Wilson city
477	Coastal	Warsaw town	495	Piedmont	Wilson's Mills town
478	Coastal	Washington city	496	Coastal	Windsor town
479	Coastal	Washington Park town	497	Coastal	Winfall town
480	Coastal	Watha town	498	Piedmont	Wingate town
481	Piedmont	Waxhaw town	499	Piedmont	Winston-Salem city
482	Mountains	Waynesville town	500	Coastal	Winterville town
483	Mountains	Weaverville town	501	Coastal	Winton town
484	Mountains	Weldon town	502	Mountains	Woodfin town
485	Piedmont	Wendell town	503	Coastal	Woodland town
486	Mountains	West Jefferson town	504	Coastal	Wrightsville Beach town
487	Piedmont	Whispering Pines village	505	Piedmont	Yadkinville town
488	Piedmont	Whitakers town	506	Piedmont	Yanceyville town
489	Coastal	White Lake town	507	Piedmont	Youngsville town
490	Coastal	Whiteville city	508	Piedmont	Zebulon town

APPENDIX B

Table 33. Funding Distribution Formulas for 50 State DOTs

#	State	Program Name	Program Purpose	Source			Funding			Allocation Based on Population		Formula	Citation
				Federal	State	Revenue	County	City	Municipal	Ratio	Census		
1	Alabama	Alabama Transportation Safety Fund	To maintain, repair, and construct local roads for municipalities and cities	X			X	X	X			$500,000 distributed to each county commission of the state. 10% should be distributed to the municipalities of each county. $125,000 to each county commission beginning January 1st. $533,000 distributed annually to DOT.	Alabama Legislature (2016)
2	Alaska	Rural Transit Assistance Program (RTAP)	To implement training and technical assistance programs in the state	X		X						Project cost of capital assistantship: 90.7% cover by RTAP + 9.03% by local match. Project cost of project administration: 90.7% cover by RTAP + 9.03% by local match. Project cost of ADA paratransit: 90.7% cover by RTAP +n9.03% by local match. Project cost of preventive maintenance: 90.7% cover by RTAP + 9.03% by local match. Project cost for project planning: 90.7% cover by RTAP + 9.03% by local match.	Alaska Community Transit (2016)
3	Arizona	Regional Area Road Fund (RARF) and Public Transportation Fund (PTF)	Road maintenance			X						**RARF=** (10.5%) (Arterial Streets) + (56.2%) (Freeways) PTF= (66.7%) (Regional Area Road Fund) + (33.3%) (Public Transportation)	Arizona Department of Transportation (2018)
4	Arkansas	County Road State Aid Program (CRSAP)	Road maintenance, construct and repair of roads			X	X				X	50% divided equally. 25% divided in the proportion that the area of the County bears to the area of the State. 25% divided in the proportion that the rural population of the County bears to the rural population of the State (based on most recent decennial federal census).	Arkansas State Highway and Transportation Department (2012)
5	California	Transportation Improvement Program (STIP)	To maintain, improve, rehabilitate and construct roads			X	X			X		County population (75%). State Highway Mileage (25%)	Economic Analysis Branch Division of Transportation Planning California Department of Transportation. (2014)

#	State	Program Name	Program Purpose	Source			Funding			Allocation Based on Population		Formula	Citation
				Federal	State	Revenue	County	City	Municipal	Ratio	Census		
6	Colorado	Highway Users Tax Fund (HUTF)	For highway related functions, and to the department of public safety		X	X	X		X			HUTF First Stream= (65%) (CDOT)+(26%) (Counties)+(9%) (cities) HUTF First Stream= (60%) (CDOT)+ (22%) (Counties)+ (18%) (cities) **The distribution for the cities and counties is as follow:** **Cities**= (80%) ((Motor vehicles registered in each city or town)/ (Total of vehicles registered in all cities and towns in the state)) + (20%) ((Road miles in each city or town)/ (Total of miles of all cities and town in the state)) **Counties**= (60%) (Road mileage in each county) + (15%) (Motor vehicles registered in unincorporated areas) + (15%) (Motor vehicles registered in the entire county) + (15%) (square footage of deck on bridge longer than twenty feet long)	Bhatt (2017)
7	Connecticut	Town Aid Program (TAP)	Transportation for maintenance		X			X		X		TAR= ($1,500) (for the first 32 mile) + pro rata allocation ratio ((town population)/ (state population))	Connecticut Department of Transportation (2010)
8	Delaware	Municipal Street Aids (MSA)	For maintenance of municipal street		X				X		X	MSA= (40%) (population of the municipalities bases on the US Census) + (60%) (Municipalities mileage)	Delaware Department of Transportation (2018)
9	Florida	Small County Road Assistance Program (SCRAP)	To assist small counties in resurfacing, reconstructing, maintain roads	X	X		X					Primary criteria: - The physical condition of the road as measured by the department. Secondary criteria: - Whether a road is used as an evacuation route. - Whether a road has high levels of agricultural travel. - Whether a road is considered a major arterial route. - Whether a road is considered a feeder road. - Whether a road is located in a fiscally constrained county.	The Florida Senate (2016)
10	Georgia	Surface Transportation Program (STP)	For new constructions, resurfacing, or maintenance	X				X	X	X		STP= (62.5%) (population on urban and rural areas) + (27.5%) (used in any area of the state)	Georgia Department of Transportation (2008)
11	Hawaii	Transportation Alternatives Program (TAP)	For transportation alternatives, including construction planning and design of on and off-road pedestrian and bicycling facilities, infrastructure projects, roadways, right of way, etc.	X	X			X	X	X		TAP= (50%) (based on population) + (50%) (for use in any area of state) **The population distribution is performed in 3 different categories:** Urbanized areas with a population over 200,000. Urban areas with population of 5,001 to 200,000. Areas with population of 5,000 or less.	Hawaii Department of Transportation (2018)

#	State	Program Name	Program Purpose	Source			Funding			Allocation Based on Population		Formula	Citation
				Federal	State	Revenue	County	City	Municipal	Ratio	Census		
12	Idaho	Net Highway Distribution Account (NHDA)	Road maintenance			X	X	X		X		Funding= (0.30) (cities population) + (0.70) [(0.45) (MVR) + (0.10) (equally divided) + (0.45) (Improved road mileage)]	Idaho Department of Transportation (2018)
13	Illinois	Surface Transportation Program (STP) and Motor Fuel Tax	For highway projects, bridge projects on any public road, including local functional classes, transit capital projects and public facilities	X		X	X	X	X	X		STP= (33.33%) (Non-urban areas) + (33.33%) (Non-urban population) + (33.33%) (Non-urban mileage of the total system) Motor Fuel Tax= (45.6%) (IDOT) + (54.4%) (Local Proportion) **The local distribution is allocated as follow:** Municipalities: 49.10% Counties over 1 million people: 16.74% Counties under 1 million people: 18.27% Road Districts/Townships: 15.89%	Bureau of Local Roads and Street (2018)
14	Indiana	Motor Vehicle Highway Account (MVH) and Highway Road and Street Account (LRS)	For traffic safety, construction, reconstruction, improvement, and maintenance of highways of the state. For engineering, land acquisition, construction, resurfacing, restoration, and rehabilitation of highway facilities.			X	X	X		X		Local Agencies= (15%) ((population in cities)/ (population in all cities)) + (32%) [(5%) (evenly distributed in counties) + (30%) ((vehicles registration in counties)/ (vehicle registration in all counties)) + (65%) ((mileage in county)/ (mileage in all counties))] Local Agencies= Counties >50,000 [(60%) ((population in county)/ (population in all counties)) + (40%) ((road mileage in the county)/ (all counties road mileage))] Counties<50,000 [(20%) ((population in county)/ (population in all counties)) + (80%) ((road mileage in the county)/ (all counties road mileage))]	Indiana Department of Transportation (2018)
15	Iowa	Road Use Tax Fund (RUTF)	To promote economic development by funding construction improvements of roads and street			X	X	X				RUTF= (471.5 million) (County Funds equally distributed) + (295.8 million) (City Funds equally distributed)	Iowa Department of Transportation (2018)
16	Kansas	Special City and County Highway Fund (SCCHF)	To provide safe, efficient, and reliable transportation network on and off the State Highway System	X	X		X	X				SCCHF= (43%) (Cities) + [(57%) (Counties) + $5,000 + ((county road mileage)/ (total road mileage)) + (daily vehicle mileage travel) + (motor vehicle registration fee per county)]	Kansas Department of Transportation (2018)

Continuation												
#	State	Program Name	Program Purpose	Source			Funding			Allocation Based on Population		Formula	Citation
				Federal	State	Revenue	County	City	Municipal	Ratio	Census		
17	Kentucky	Rural Secondary Roads (RSR)	Road maintenance			X	X		X		X	The County and Municipal Road Aid funding is distributed based on population as determined by the census. The Emergency Funding Program consists of withholding the 3% of road aid funding from participant counties and participants can request funding for their local projects with a 20% match. The Rural Secondary Program consists of 80/20 bridge funding programs where the rural secondary program provides 80% of total cost and counties 20%, and it also consists of the flex funds which is money distribute based on state road conditions in each county.	Kentucky Department of Transportation (2018)
18	Louisiana	Louisiana Parish Transportation Fund Act (PTF)	For the maintenance, construction, and repair of parish roads		X		X				X	Class — Parish Population — Per Capita Distribution 1 — 1 to 16,000 — $13.32 2 — 16,001 to 45,000 — $10.82 3 — 45,001 to 100,000 — $8.32 4 — 100,001 to 200,000 — $7.32 5 — 200,001 to 400,000 — $5.57 6 — 400,001 and over — $4.65	Lousiana Department of Transportation (2017)
19	Maine	Local Road Assistant Program (LRAP)	For maintenance of highway and winter maintenance		X			X				Rates per lane-mile. **Rural Town rates.** -$600 per lane-mile for town ways. -$600 per lane-mile for state aid/minor collectors. -$300 per lane-mile for seasonal town ways. **Urban Compact Municipality rates** Within urban compact areas: -$2,500 per first 2 lanes mile for summer maintenance of state highway and state aid highways. -$1,250 additional per more than 2 lanes mile for summer maintenance of state highway and state aid highways. -$1,700 per lane-mile for winter maintenance of state highways. - $0 per lane -mile for town ways. **Outside urban compact areas:** -Same rates as "rural towns".	Maine Department of Transportation (2018)
20	Maryland	Transportation Trust Fund (TTF)	For debt services, maintenance, operations administration, and capital projects	X		X	X	X	X			TTF= (90.4%) (Maryland Department of Transportation) + (7.7%) (Baltimore City) + (1.9%) (Counties and Municipalities)	Maryland Department of Transportation (2018)

Continuation													
#	State	Program Name	Program Purpose	Source			Funding			Allocation Based on Population		Formula	Citation
				Federal	State	Revenue	County	City	Municipal	Ratio	Census		
21	Massachusetts	Massachusetts Transportation Trust Fund (MTTF) and Commonwealth Transportation Fund (CTF)	To build and maintain infrastructure in the state of Massachusetts.	X		X							Massachusetts Department of Transportation (2014)
22	Michigan	Michigan Transportation Fund (MTF)	For road maintenance	X		X	X	X	X		X	**MTF**= (20%) (County Funds equally distributed) + (80%) [(39.1%) (Highways) + (39.1%) (County Roads) + (21.8%) (Municipal Streets)] **Cities and Villages**= (99% Local and Major Streets) ((total mileage in the county)/ (total mileage in all counties) + (total population in the county)/ (total population in all counties)) + (1% Others) ((total mileage in the city)/ (total mileage in all cities)) **County Road Commission**= (23% Local Roads) ((total mileage in the county)/ (total mileage in all counties) + (total population in the county)/ (total population in all counties)) + (64% Primary Roads) ((proration mileage in the county)/ (total proration mileage in all counties) + 1/83 (each county)@ + 12 months tax collection in motor vehicle per each county)) + (10% Urban) ((total mileage in the county)/ (total mileage in all counties)) + (3% Others) ((total mileage in the county)/ (total mileage in all counties))	Michigan Municipal League (2018)
23	Minnesota	County State Aid Highway (CSAH) and Municipal State Aid Streets (MSAS)	For construction, maintenance and administration of state highways.	X		X	X		X	X		**CSAH**= (60% based on money need) + (40%) (Relative shares of motor vehicles registration in each county) **MSAS**= (50%) (Based on money need) + (50%) ((population in municipality)/ (total state municipalities population)) **Revenue not derived in previous formulas**= (50%) (money needed) + (30%) ((county road miles)/ (total state counties road miles)) + (10%) ((county motor vehicle registrations)/ (total state)) + (10%) (equal shares to all 87 counties)	Minnesota Department of Transportation (2018)
24	Mississippi	State Aid Roads	To supports infrastructure, routine maintenance, pass through, new capacity, safety, tort claims, and others	X	X		X				X	SAR= (1/3) (All counties in equal share) + (1/3) ((# of rural road miles in a county)/ (# of rural road miles in all counties of the state)) + (1/3) ((Rural population of the county)/ (Rural population of all counties of the state))	Mississippi Department of Transportation (2018)

Continuation													
#	State	Program Name	Program Purpose	Source			Funding			Allocation Based on Population		Formula	Citation
				Federal	State	Revenue	County	City	Municipal	Ratio	Census		
25	Missouri	Vermont Better Roads Program	To improve and maintain state highways, reinforce bridges, acquisition of land, construction, and maintenance purposes.		X	X		X	X			Transportation Fund Total Revenue ($2,468M) = ($408M) (Cities) + ($250M) (Other State Agencies) + ($280M) (Debt Payment) + ($1,434M) (State Road and Bridges) + ($96M) (Multimodal)	Missouri Department of Transportation (2018)
26	Montana	Highway Restricted Account	For assistance to the transportation construction, repairs, and maintenance		X			X		X		**Highway Restricted Account**=$150,000 (for the Montana Local Technical Assistance Transportation Program) + $6,306,000 [(40%) ((population in each city and town)/ (total rural population in cities and towns)) + (40%) ((rural road mileage)/(total state rural road mileage)) + (20%) ((land area in each county)/(total land area of the state))] + $10,360,000 [50% ((population in corporate limits of city or town bears) / (total population within corporate limits of all cities and towns in Montana)) + (50%) ((cities or towns street alley mileage)/ (total street and alley mileage within the corporate limits of cities and towns in Montana))]	Montana Legislative Services Division (2017)
27	Nebraska	Motor Vehicle Registration, and Build Nebraska Act	To maintain, construct, and repair local roads	X		X		X	X			**Motor Vehicle Registration=**53.33% (Cities)+46.67%(Counties) **Build Nebraska Act=** 25% local raise of all Highway Allocation Revenue (HAR) received. 50% must be raised (of all HAR) by Cities with population greater than 100,000. 25% must be raised (of all HAR) by Cities with population below 100,000	Nebraska Department of Transportation (2018)
28	Nevada	The Surface Transportation Program (STP) and the Transportation Alternative Program (TAP)	For projects preserve or improve conditions/ performance of the state highway, bridges, or public road	X	X	X	X	X	X	X		STP=50% [(Urban) (84.24%) + (Nonurban) (6.76%) + (Small Urban Areas) (9%)] + 50% [(NDOT) (95%) + (Off System Bridge Program) (5%)] TAP=50% (NDOT) + 50% [(Urban) (83.3%) + (Nonurban) (7.8%) + (Small Urban Areas) (8.9%)]	Nevada Department of Transportation (2017)
29	New Hampshire	Betterment Program	To ensure adequate maintenance and improvement to the state highway system not supported with Federal Aid			X		X	X	X		Betterments Distribution= ((88%))/ ((6 state districts)) + (12%)/ ((all cities))	Sheehan and Cass (2016)

Continuation													
#	State	Program Name	Program Purpose	Source			Funding			Allocation Based on Population		Formula	Citation
				Federal	State	Revenue	County	City	Municipal	Ratio	Census		
30	New Jersey	Local Aids	For the advance of projects and preliminary engineering projects, for sub-regions for projects final designs, right-of-way, and/or construction projects, for improvement of known safety hazards, and priority of projects.	X	X				X				New Jersey Transportation Trust Fund Authority (2018)
31	New Mexico	Local Government Road Fund (LGRF) and Cooperative Agreement Program	For project development, construction, reconstruction, improvement, maintenance, or repair of public highways, streets, and public school parking lots, or for the acquisition of right of way, or for in-place material or improvement.		X		X		X			LGRF= (42%) (Cooperative Agreement Program) + (16%) (Municipal Arterial Program) + (16%) (Bus Routes) + (26%) (County Arterial Program) Cooperative Agreement program= 33% for agreements entered into with counties + 49% for agreements entered into with municipalities + 14% for agreements entered into with school districts + 4% for agreements entered into with other entities.	New Mexico Department of Transportation (2014)
32	New York	The Consolidated Local Street and Highway Improvement Program (CHIPS)	For road maintenance		X	X	X		X			CHIPS= LAF+ TIF **TIF=**total of $145 million= $60 million [(MVR) (20.7%) + (CHM) (20.7%)] + $85 million [(VMT42.7%) (LM) (Cities) + (VMT) (LM) (18.5%) (Counties) + (VMT) (10.7%) (LM) (Village) + (VMT) (LM) (28.1%) (Towns)] **LAF=** [(towns) (38%) + (counties) (30%) + (NYC) (14%) + (other cities) (9%) + (villages) (9%)]	New York Department of Transportation (2018)
33	North Carolina	Powell Bill Fund	For construction, planning, and maintenance on streets, sidewalks, bikeways, and greenways such as resurfacing, patching, widening, storm drainage, curb and gutter, patching, and maintain municipal streets within their corporate limits.	X					X		X	Formula= (75%) (Population) + (25%) (Certified Mileage)	Al-Ghandour and Benson (2014)

Continuation												
#	State	Program Name	Program Purpose	Source			Funding			Allocation Based on Population		Formula	Citation
				Federal	State	Revenue	County	City	Municipal	Ratio	Census		
34	North Dakota	Highway Tax Distribution Fund	For the construction, reconstruction, repair, and maintenance of public highways	X		X	X	X		X		Highway Tax Distribution Fund= 61.3% (State Highway Fund) + 22% (Counties) (Vehicles Registration) + 1.5% (Transit) + 12.5% (Cities) ((city population)/ (states city population)) + 2.7% (Townships)	North Dakota State Treasure (2018)
35	Ohio	The Gasoline Excise Tax Fund (GETF)	For construction, maintenance or reconstruction of roads.	X	X	X	X	X	X	X		Program % Amount (Million) Small Cities 2.5 10.1 Urban Paving 8.8 35 County Local Bridge 8.6 34.4 County Surface Transportation 7.1 28.6 Block Grant Program Municipal Bridge 2.5 10 Local Major Bridge 5.0 20 MPO/Large Cities 53.8 214.8 **GETF**= 42.86% (Municipalities) + 37.14% (Counties) + 20% (Townships)	Ohio Department of Transportation Office of Research (2017)
36	Oklahoma	County Road Funding	For county roads and bridges maintenance and construction	X		X	X				X	**Formula 1** 65.3% of the 27.00% is apportioned based on county road miles, population, and land area, specifically: 40% based on county road mileage relative to the statewide sum of county road mileage + 30% based on county population relative to statewide population (Bureau of the Census) + 30% based on county land area relative to statewide land area. **Formula 2** 23.1% of the 27.00% is apportioned based on rural population, road miles, and land area, specifically: 1/3 based on the county rural population relative to statewide rural population + 1/3 based on county road mileage relative to the statewide sum of county road mileage + 1/3 based on county land area relative to statewide land area. **Formula 3** 11.6% of the 27.00% is apportioned to counties based on a formula similar to that for County Bridge Program funds but also considering terrain and traffic volume:20% of a county's percent of statewide collector miles plus + 60% of a county's bridge factor plus + 20% of a county's percent of statewide average daily vehicle miles of travel.	Lansford (2011)
37	Oregon	State Highway fund	The construction, improvement, maintenance, operation and use if public highways, road, streets, and roadside rest areas.		X	X	X	X		X		State Highway Fund= (59%) (Equal distribution state wide) + (50%) ((population in each city)/ (population of the state)) + (25%) ((Vehicle registered in each county)/ (Vehicle registered in the state))	Oregon Department of Transportation (2018)

Continuation													
#	State	Program Name	Program Purpose	Source			Funding			Allocation Based on Population		Formula	Citation
				Federal	State	Revenue	County	City	Municipal	Ratio	Census		
38	Pennsylvania	Liquid Fuel Tax Fund (LFTF)	To maintain, construct, and rehabilitate local roads.			X	X		X	X		**LFTF for Counties=** (50%) ((population on counties)/ (population of the state)) + (50%) ((Counties local road mileage)/ (local road mileage to the state)) **LFTF for Municipalities= (**50%) ((population on municipalities)/ (population of the state)) + (50%) ((Municipalities local road mileage)/ (local road mileage to the state))	Office of Planning (2016)
39	Rhode Island	The New Revenue Bond and the New Starts Funding	For maintenance, prevention, and rehabilitation of roads and bridges, pavement, transit, and transportation alternatives for the entire state.	X	X								Rhode Island Department of Transportation (2018)
40	South Carolina	C program	To helps counties to maintain roads in good conditions by funding for repairs, improvements, and paving projects.			X	X				X	Formula= 1/3 ((land area of the county bears)/ (the total land area of the State)) + 1/3 ((population of the county bears)/ (the total population of the State as shown by the latest official decennial census)) + 1/3((mileage of all rural roads in the county bears)/ (total rural road mileage in the State))	South Carolina Department of Transportation (2018)
41	South Dakota	Transportation Asset Management Plan (TAMP)	To efficiently provide a safe and effective public transportation system.	X	X		X	X				Distribution system based on road mileage which is subdivided into 6 categories. 1) Interstate: Interstate or a federal functional classification of rural principal arterial. 2) Major Arterial: These roads are federal functional classification as National Highway System non-interstate route and/or has a federal classification of rural principal arterial. 3) Minor Arterial: These roads are federal functional classification of rural minor arterial or the route has a federal designation of National Highway System. 4) State Urban: Roads that are classified as principal arterials or considered interstates located in cities with population greater than 5,000. 5) State Municipal: Roads that are not classified as principal arterials or considered interstate and pass through a community with a population between 450 to 5,000. 6) State Secondary: This category includes all remaining routes on the state system that the federal functional classification considers as a collector.	South Dakota Department of Transportation (2018)

Continuation												
#	State	Program Name	Program Purpose	Source			Funding			Allocation Based on Population		Formula	Citation
				Federal	State	Revenue	County	City	Municipal	Ratio	Census		
42	Tennessee	The State Highway Aid (SHA) Program	Fund maintenance, construction and repair of county roads			X	X			X		**State Highway Aid=** (1/3 total share) (county's lane miles) ($59688,154) + (1/3 total share) (population) (59,688,154) + (1/3 total share) (land area) (59,688,154)	Mattson, and Potts, (2015)
43	Texas	Texas Transit Funding	For the construction, maintenance, rehabilitation and acquisition of ROW for non-titled public roadways.	X	X			X			X	**State Transit Fund**=65% Rural districts [65% Need (75% population+ 25% land area) +(35% Performance (33% Local Expense+33% revenue mileage riders +33% Revenue mileage expenses)] +35% Urban districts [50% Need(population)+(50% Performance (30% Local Expense+30% revenue mileage riders +20% Revenue mileage expenses + 20% riders' capital)]	Cherrington, Tan, and Hansen (2017)
44	Utah	B&C Road Fund	For highway purposed, maintenance, construction, reconstruction, or renovation.			X	X	X				B&C Road Fund= (70%) (UDOT)+ (30%) (Cities and Counties)	Utah Department of Transportation (2018)
45	Vermont	Vermont Better Roads Program	To promote the use of erosion control and maintenance techniques for saving money on maintenance and protect the quality of water.	X	X				X			**Total eligible project cost:** Category A B C D Amount $10,000 $25,000 $50,000 $ 75,000 **Maximum grant award:** Category A B C D Amount $8,000 $20,000 $40,000 $60,000 **Match**=Total Project Cost∗0.2	Vermont Transportation (2017)
46	Virginia	Bill 1887 and Transportation Trust Fund	Funds must be used for the cost of structurally deficient bridges and the mileage and cost to replace deteriorated pavements, for projects recommended by the district's local governments, and high priority projects.	X								**Bill 1887**=45% (Bridges and Pavements) + 27.5% (District Grant Program) + 27.5% (Statewide Needs) **TTF=** (78.7%) (VDOT)+ (14.7%) (Mass Trans Fund) + (2.4%) (Airport Fund) + (4.2%) (Port Fund)	Virginia Department of Transportation (2017)

Continuation													
#	State	Program Name	Program Purpose	Source			Funding			Allocation Based on Population		Formula	Citation
				Federal	State	Revenue	County	City	Municipal	Ratio	Census		
47	Washington	Surface Transportation Block Grant (STBG) and State Transportation Asset Management Plan (STAMP)	Funding support to the local agencies for highway and bridge construction and repairs/ State Transportation Asset Management Plan (STAMP) was created with the goal of improving how federal funds are allocated in Washington State.	X	X		X				X	Population ≥ 200,000 – Distributed based on 2010 Census data as required. 5,000 ≤ Population ≤ 200,000 – Distributed based on 2010 Census data for these population areas. Population ≤ 5,000 – Distributed based on rural lane miles. Flexible –Distributed based on 75% population and 25% of total county lane miles. Local Programs administration costs will be decreased from the initial allocations based on a proportional share of the total allocation for each entity.	Washington State Department of Transportation (2018)
48	West Virginia	State Road Fund	Improvement, renovation, and construction of West Virginia highways.	X					X				Tomblin, Mattox (2016)
49	Wisconsin	Local Road Improvement Program (LRIP)	Seriously deteriorated county highways, municipal street in cities and villages, and town roads.				X		X	X		**LRIP=** (43%) (CHI) + (28.5%) (TRI) + (28.5%) (MSI) **The County Highway Improvement Program (CHI)=** 60% population + 40% on road mileage. Each county is guaranty a minimum of 0.5% ($77,290.82). **The Town Road Improvement Program (TRI) =** 100% based on mileage. **The Municipal Street Improvement Program (MSI) =** 50% population + 50% on road mileage.	Wisconsin Department of Transportation (2018)
50	Wyoming	The Motor Fuel Allocation (MFA)	82.78% of this fund to programs such as construction, maintenance, equipment, facilities, traffic, and financial services. 17.22% is distributed toward the legislative section of transportation such as patrol, driver's license, human resources, and motor vehicles.	X		X	X	X	X	X		**MFA=** (66.68%) (WYDOT) + (23.51%) (Counties) + (9.81%) (Municipalities) **Gasoline Distribution=** (13.5%) (Counties) + (14%) (County Road Construction Account) + (15%) (Cities) + (57.5%) (Highway Fund) **Diesel Distribution=** (20%) (Counties) + (5%) (Cities) + (75%) (Highway Fund) The counties distribution is performed by 1/3 based on area of county ratio, 1/3 based on rural population ration and 1/3 based on assessed valuation ratio. The cities perform the distribution by 3/4 based on gasoline taxed paid and 1/4 based on population ratio. County Road Construction Account distributes its funding by 1/2 based on area of county ratio and 1/2 based on rural population ratio.	Wyoming Department of Transportation (2018)

APPENDIX C

Table 34. Seasonal Population and Percentage of All Municipalities

#	Area	Municipality	Seasonal Population	% Increase in Population
1	Piedmont	Aberdeen town	47	0.61%
2	Coastal	Ahoskie town	36	0.75%
3	Piedmont	Alamance village	4	0.35%
4	Piedmont	Albemarle city	94	0.58%
5	Coastal	Alliance town	3	0.33%
6	Mountains	Andrews town	49	2.66%
7	Piedmont	Angier town	8	0.15%
8	Piedmont	Ansonville town	23	3.82%
9	Piedmont	Apex town	145	0.30%
10	Piedmont	Archdale city	25	0.20%
11	Piedmont	Asheboro city	105	0.41%
12	Mountains	Asheville city	1,702	1.85%
13	Coastal	Askewville town	1	0.60%
14	Coastal	Atkinson town	5	1.48%
15	Coastal	Atlantic Beach town	4,990	333.33%
16	Coastal	Aulander town	8	0.93%
17	Coastal	Aurora town	13	2.60%
18	Coastal	Autryville town	2	1.18%
19	Coastal	Ayden town	26	0.52%
20	Piedmont	Badin town	35	1.75%
21	Piedmont	Bailey town	3	0.55%
22	Mountains	Bakersville town	32	6.73%
23	Coastal	Bald Head Island village	1,368	772.95%
24	Mountains	Banner Elk town	355	31.49%
25	Coastal	Bath town	51	21.34%
26	Coastal	Bayboro town	21	1.69%
27	Coastal	Bear Grass town	0	0.00%
28	Coastal	Beaufort town	626	14.90%
29	Mountains	Beech Mountain town	3,458	1026.21%
30	Coastal	Belhaven town	44	2.78%
31	Piedmont	Belmont city	53	0.47%
32	Coastal	Belville town	9	0.40%
33	Piedmont	Benson town	22	0.62%
34	Piedmont	Bermuda Run town	63	2.32%
35	Piedmont	Bessemer City	8	0.15%
36	Piedmont	Bethania town	7	2.17%
37	Coastal	Bethel town	11	0.73%
38	Coastal	Beulaville town	5	0.35%
39	Mountains	Biltmore Forest town	116	8.36%
40	Piedmont	Biscoe town	5	0.29%
41	Piedmont	Black Creek town	2	0.20%
42	Mountains	Black Mountain town	371	4.38%
43	Coastal	Bladenboro town	12	0.72%
44	Mountains	Blowing Rock town	1,917	144.48%
45	Coastal	Boardman town	0	0.00%
46	Coastal	Bogue town	22	3.08%

Continuation				
#	Area	Municipality	Seasonal Population	% Increase in Population
47	Coastal	Boiling Spring Lakes city	155	2.31%
48	Mountains	Boiling Springs town	9	0.20%
49	Coastal	Bolivia town	3	1.71%
50	Coastal	Bolton town	8	1.18%
51	Mountains	Boone town	233	1.20%
52	Piedmont	Boonville town	7	0.59%
53	Mountains	Bostic town	0	0.00%
54	Mountains	Brevard city	248	3.08%
55	Coastal	Bridgeton town	6	1.28%
56	Piedmont	Broadway town	6	0.46%
57	Piedmont	Brookford town	0	0.00%
58	Coastal	Brunswick town	7	0.65%
59	Mountains	Bryson City town	108	7.12%
60	Piedmont	Bunn town	3	0.93%
61	Coastal	Burgaw town	17	0.43%
62	Piedmont	Burlington city	125	0.23%
63	Mountains	Burnsville town	63	3.63%
64	Piedmont	Butner town	15	0.19%
65	Coastal	Calabash town	642	32.18%
66	Coastal	Calypso town	1	0.22%
67	Piedmont	Cameron town	4	1.14%
68	Piedmont	Candor town	0	0.00%
69	Mountains	Canton town	37	0.84%
70	Coastal	Cape Carteret town	227	10.41%
71	Coastal	Carolina Beach town	2,760	45.49%
72	Coastal	Carolina Shores town	462	12.54%
73	Piedmont	Carrboro town	46	0.22%
74	Piedmont	Carthage town	18	0.77%
75	Piedmont	Cary town	770	0.48%
76	Piedmont	Castalia town	2	0.97%
77	Coastal	Caswell Beach town	551	121.80%
78	Piedmont	Catawba town	3	0.47%
79	Coastal	Cedar Point town	493	33.82%
80	Mountains	Cedar Rock village	1	0.46%
81	Coastal	Cerro Gordo town	1	0.64%
82	Coastal	Chadbourn town	10	0.56%
83	Piedmont	Chapel Hill town	365	0.61%
84	Piedmont	Charlotte city	2,499	0.30%
85	Piedmont	Cherryville city	14	0.23%
86	Piedmont	China Grove town	15	0.34%
87	Coastal	Chocowinity town	3	0.38%
88	Piedmont	Claremont city	6	0.39%
89	Coastal	Clarkton town	2	0.27%
90	Piedmont	Clayton town	56	0.28%
91	Piedmont	Clemmons village	69	0.35%
92	Piedmont	Cleveland town	6	0.71%
93	Coastal	Clinton city	43	0.50%
94	Mountains	Clyde town	18	1.43%

Continuation				
#	Area	Municipality	Seasonal Population	% Increase in Population
95	Piedmont	Coats town	5	0.24%
96	Coastal	Cofield village	8	1.88%
97	Coastal	Colerain town	19	10.28%
98	Coastal	Columbia town	12	1.39%
99	Mountains	Columbus town	19	1.91%
100	Piedmont	Concord city	298	0.33%
101	Piedmont	Conetoe town	2	0.71%
102	Mountains	Connelly Springs town	5	0.29%
103	Piedmont	Conover city	30	0.36%
104	Coastal	Conway town	5	0.61%
105	Piedmont	Cooleemee town	5	0.52%
106	Piedmont	Cornelius town	840	2.69%
107	Coastal	Cove City town	2	0.65%
108	Piedmont	Cramerton town	8	0.15%
109	Piedmont	Creedmoor city	19	0.41%
110	Coastal	Creswell town	3	1.09%
111	Mountains	Crossnore town	47	23.89%
112	Piedmont	Dallas town	11	0.23%
113	Piedmont	Danbury town	2	1.10%
114	Piedmont	Davidson town	424	3.20%
115	Piedmont	Denton town	10	0.63%
116	Mountains	Dillsboro town	24	10.09%
117	Mountains	Dobbins Heights town	8	0.93%
118	Piedmont	Dobson town	9	0.56%
119	Coastal	Dover town	3	0.68%
120	Mountains	Drexel town	5	0.28%
121	Coastal	Dublin town	1	0.35%
122	Piedmont	Dunn city	47	0.48%
123	Piedmont	Durham city	704	0.27%
124	Mountains	Earl town	2	0.65%
125	Coastal	East Arcadia town	6	1.33%
126	Piedmont	East Bend town	2	0.27%
127	Piedmont	East Laurinburg town	2	0.72%
128	Piedmont	East Spencer town	3	0.22%
129	Piedmont	Eastover town	9	0.23%
130	Piedmont	Eden city	69	0.46%
131	Coastal	Edenton town	105	2.22%
132	Coastal	Elizabeth City	72	0.41%
133	Coastal	Elizabethtown town	30	0.85%
134	Mountains	Elk Park town	15	3.38%
135	Piedmont	Elkin town	25	0.64%
136	Mountains	Ellenboro town	6	0.68%
137	Piedmont	Ellerbe town	5	0.47%
138	Piedmont	Elm City town	9	0.75%
139	Piedmont	Elon town	22	0.18%
140	Coastal	Emerald Isle town	5,050	133.47%
141	Coastal	Enfield town	10	0.39%
142	Piedmont	Erwin town	18	0.40%

Continuation				
#	Area	Municipality	Seasonal Population	% Increase in Population
143	Coastal	Eureka town	0	0.00%
144	Coastal	Everetts town	3	1.76%
145	Coastal	Fair Bluff town	16	1.72%
146	Piedmont	Fairmont town	50	1.91%
147	Coastal	Faison town	4	0.37%
148	Piedmont	Faith town	7	0.89%
149	Piedmont	Falcon town	4	1.11%
150	Coastal	Falkland town	0	0.00%
151	Mountains	Fallston town	5	0.78%
152	Coastal	Farmville town	21	0.46%
153	Piedmont	Fayetteville city	520	0.25%
154	Mountains	Fletcher town	55	0.67%
155	Mountains	Fontana Dam town*	0	0
156	Mountains	Forest City town	70	0.94%
157	Mountains	Forest Hills village	14	3.75%
158	Coastal	Fountain town	5	1.15%
159	Piedmont	Four Oaks town	5	0.24%
160	Piedmont	Foxfire village	94	8.86%
161	Mountains	Franklin town	221	5.42%
162	Piedmont	Franklinton town	4	0.18%
163	Piedmont	Franklinville town	2	0.17%
164	Coastal	Fremont town	6	0.46%
165	Piedmont	Fuquay-Varina town	48	0.19%
166	Coastal	Garland town	5	0.80%
167	Piedmont	Garner town	49	0.16%
168	Coastal	Garysburg town	13	1.25%
169	Coastal	Gaston town	5	0.46%
170	Piedmont	Gastonia city	122	0.16%
171	Coastal	Gatesville town	3	1.07%
172	Piedmont	Gibson town	4	0.70%
173	Piedmont	Gibsonville town	10	0.14%
174	Mountains	Glen Alpine town	8	0.52%
175	Piedmont	Godwin town	-	0.00%
176	Coastal	Goldsboro city	49	0.14%
177	Piedmont	Goldston town	2	0.66%
178	Piedmont	Graham city	41	0.28%
179	Mountains	Granite Falls town	15	0.33%
180	Piedmont	Granite Quarry town	6	0.18%
181	Piedmont	Green Level town	15	0.67%
182	Coastal	Greenevers town	5	0.83%
183	Piedmont	Greensboro city	694	0.24%
184	Coastal	Greenville city	179	0.20%
185	Coastal	Grifton town	6	0.21%
186	Coastal	Grimesland town	2	0.35%
187	Mountains	Grover town	2	0.25%
188	Coastal	Halifax town	10	4.34%
189	Coastal	Hamilton town	2	0.63%

*Fontana Dam was not incorporated until 2011, therefore have data on its % seasonal in 2010 and a 0% seasonal population increase is considered.

Continuation				
#	Area	Municipality	Seasonal Population	% Increase in Population
190	Piedmont	Hamlet city	41	0.65%
191	Piedmont	Harmony town	6	1.10%
192	Coastal	Harrells town	1	0.46%
193	Coastal	Harrellsville town	-	0.00%
194	Piedmont	Harrisburg town	52	0.31%
195	Coastal	Hassell town	0	0.00%
196	Coastal	Havelock city	11	0.06%
197	Piedmont	Haw River town	8	0.32%
198	Mountains	Hayesville town	20	5.37%
199	Piedmont	Henderson city	56	0.37%
200	Mountains	Hendersonville city	486	3.43%
201	Coastal	Hertford town	35	1.65%
202	Piedmont	Hickory city	237	0.58%
203	Piedmont	High Point city	462	0.41%
204	Piedmont	High Shoals city	2	0.28%
205	Mountains	Highlands town	2,375	252.43%
206	Mountains	Hildebran town	5	0.24%
207	Piedmont	Hillsborough town	29	0.40%
208	Coastal	Hobgood town	3	0.83%
209	Piedmont	Hoffman town	6	1.07%
210	Coastal	Holden Beach town	2,382	373.92%
211	Coastal	Holly Ridge town	204	12.40%
212	Piedmont	Holly Springs town	73	0.22%
213	Coastal	Hookerton town	1	0.36%
214	Piedmont	Hope Mills town	32	0.19%
215	Mountains	Hot Springs town	98	16.70%
216	Mountains	Hudson town	17	0.43%
217	Piedmont	Huntersville town	285	0.48%
218	Piedmont	Indian Trail town	70	0.18%
219	Coastal	Jackson town	10	2.11%
220	Coastal	Jacksonville city	60	0.08%
221	Piedmont	Jamestown town	13	0.31%
222	Coastal	Jamesville town	4	0.83%
223	Mountains	Jefferson town	69	4.38%
224	Piedmont	Jonesville town	13	0.59%
225	Piedmont	Kannapolis city	87	0.18%
226	Coastal	Kelford town	12	5.06%
227	Coastal	Kenansville town	2	0.29%
228	Piedmont	Kenly town	9	0.66%
229	Piedmont	Kernersville town	35	0.14%
230	Coastal	Kill Devil Hills town	4,310	59.76%
231	Piedmont	King city	14	0.20%
232	Mountains	Kings Mountain city	19	0.18%
233	Mountains	Kingstown town	0	0.00%
234	Coastal	Kinston city	87	0.43%
235	Piedmont	Kittrell town	0	0.00%
236	Coastal	Kitty Hawk town	1,903	53.64%
237	Piedmont	Knightdale town	23	0.16%

Continuation				
#	**Area**	**Municipality**	**Seasonal Population**	**% Increase in Population**
238	Coastal	Kure Beach town	1,325	59.56%
239	Coastal	La Grange town	12	0.42%
240	Mountains	Lake Lure town	2,351	193.03%
241	Piedmont	Lake Park village	4	0.11%
242	Mountains	Lake Santeetlah town	280	665.57%
243	Coastal	Lake Waccamaw town	411	27.88%
244	Piedmont	Landis town	4	0.12%
245	Mountains	Lansing town	29	18.44%
246	Coastal	Lasker town	1	1.24%
247	Mountains	Lattimore town	2	0.40%
248	Mountains	Laurel Park town	353	15.64%
249	Piedmont	Laurinburg city	58	0.37%
250	Mountains	Lawndale town	4	0.65%
251	Coastal	Leland town	472	2.50%
252	Mountains	Lenoir city	86	0.48%
253	Coastal	Lewiston Woodville town	3	0.63%
254	Piedmont	Lewisville town	52	0.39%
255	Piedmont	Lexington city	48	0.26%
256	Piedmont	Liberty town	7	0.27%
257	Piedmont	Lilesville town	3	0.58%
258	Piedmont	Lillington town	4	0.11%
259	Piedmont	Lincolnton city	47	0.44%
260	Piedmont	Linden town	0	0.00%
261	Coastal	Littleton town	9	1.34%
262	Piedmont	Locust city	14	0.41%
263	Piedmont	Long View town	13	0.27%
264	Piedmont	Louisburg town	20	0.59%
265	Piedmont	Love Valley town	143	117.03%
266	Piedmont	Lowell city	9	0.23%
267	Piedmont	Lucama town	6	0.53%
268	Piedmont	Lumber Bridge town	0	0.00%
269	Piedmont	Lumberton city	65	0.31%
270	Piedmont	Macclesfield town	8	1.71%
271	Piedmont	Macon town	2	1.32%
272	Piedmont	Madison town	15	0.69%
273	Mountains	Maggie Valley town	1,379	97.15%
274	Coastal	Magnolia town	6	0.58%
275	Piedmont	Maiden town	6	0.19%
276	Coastal	Manteo town	784	49.55%
277	Mountains	Marion city	59	0.69%
278	Mountains	Mars Hill town	31	1.44%
279	Mountains	Marshall town	29	3.04%
280	Piedmont	Marshville town	11	0.45%
281	Piedmont	Marvin village	16	0.22%
282	Piedmont	Matthews town	65	0.21%
283	Piedmont	Maxton town	16	0.71%
284	Piedmont	Mayodan town	4	0.15%
285	Coastal	Maysville town	9	0.88%

Continuation				
#	Area	Municipality	Seasonal Population	% Increase in Population
286	Piedmont	McAdenville town	4	0.51%
287	Piedmont	McDonald town	3	2.76%
288	Piedmont	McFarlan town	2	1.72%
289	Piedmont	Mebane city	46	0.34%
290	Coastal	Mesic town	10	4.90%
291	Piedmont	Micro town	0	0.00%
292	Piedmont	Middleburg town	0	0.00%
293	Piedmont	Middlesex town	4	0.49%
294	Piedmont	Midland town	10	0.25%
295	Coastal	Minnesott Beach town	116	23.77%
296	Piedmont	Mint Hill town	60	0.22%
297	Piedmont	Misenheimer village	2	0.28%
298	Piedmont	Mocksville town	25	0.46%
299	Piedmont	Monroe city	56	0.16%
300	Mountains	Montreat town	626	72.09%
301	Piedmont	Mooresville town	148	0.37%
302	Coastal	Morehead City town	1,048	11.17%
303	Mountains	Morganton city	107	0.63%
304	Piedmont	Morrisville town	82	0.32%
305	Piedmont	Morven town	5	1.08%
306	Piedmont	Mount Airy city	82	0.79%
307	Piedmont	Mount Gilead town	25	2.24%
308	Piedmont	Mount Holly city	32	0.21%
309	Coastal	Mount Olive town	13	0.29%
310	Piedmont	Mount Pleasant town	10	0.52%
311	Coastal	Murfreesboro town	27	0.81%
312	Mountains	Murphy town	63	3.77%
313	Coastal	Nags Head town	3,145	105.04%
314	Piedmont	Nashville town	16	0.31%
315	Coastal	Navassa town	9	0.46%
316	Coastal	New Bern city	196	0.65%
317	Piedmont	New London town	0	0.00%
318	Mountains	Newland town	33	4.69%
319	Coastal	Newport town	18	0.38%
320	Piedmont	Newton city	37	0.28%
321	Coastal	Newton Grove town	1	0.24%
322	Piedmont	Norlina town	10	0.90%
323	Coastal	North Topsail Beach town	2,560	332.00%
324	Mountains	North Wilkesboro town	42	0.96%
325	Coastal	Northwest city	6	0.73%
326	Piedmont	Norwood town	420	17.49%
327	Coastal	Oak City town	10	3.18%
328	Coastal	Oak Island town	6,206	81.34%
329	Piedmont	Oakboro town	15	0.74%
330	Coastal	Ocean Isle Beach town	3,255	503.85%
331	Mountains	Old Fort town	26	2.81%
332	Coastal	Oriental town	183	20.12%
333	Piedmont	Oxford city	33	0.39%

Continuation				
#	Area	Municipality	Seasonal Population	% Increase in Population
334	Coastal	Pantego town	8	4.66%
335	Piedmont	Parkton town	2	0.45%
336	Coastal	Parmele town	4	1.53%
337	Piedmont	Peachland town	8	1.97%
338	Coastal	Peletier town	113	15.35%
339	Piedmont	Pembroke town	10	0.30%
340	Coastal	Pikeville town	0	0.00%
341	Piedmont	Pilot Mountain town	9	0.58%
342	Coastal	Pine Knoll Shores town	1,741	129.70%
343	Piedmont	Pine Level town	8	0.44%
344	Piedmont	Pinebluff town	5	0.36%
345	Piedmont	Pinehurst village	1,753	10.46%
346	Piedmont	Pinetops town	8	0.65%
347	Piedmont	Pineville town	19	0.20%
348	Coastal	Pink Hill town	1	0.23%
349	Piedmont	Pittsboro town	26	0.55%
350	Coastal	Plymouth town	37	1.03%
351	Piedmont	Polkton town	0	0.00%
352	Mountains	Polkville city	6	1.16%
353	Coastal	Pollocksville town	7	2.07%
354	Coastal	Powellsville town	3	1.12%
355	Piedmont	Princeton town	7	0.56%
356	Piedmont	Princeville town	17	0.76%
357	Piedmont	Proctorville town	2	1.62%
358	Piedmont	Raeford city	21	0.42%
359	Piedmont	Raleigh city	1,918	0.42%
360	Piedmont	Ramseur town	21	1.28%
361	Piedmont	Randleman city	4	0.10%
362	Piedmont	Ranlo town	4	0.11%
363	Piedmont	Raynham town	0	0.00%
364	Piedmont	Red Cross town	4	0.49%
365	Piedmont	Red Springs town	12	0.35%
366	Piedmont	Reidsville city	56	0.40%
367	Piedmont	Rennert town	4	0.95%
368	Mountains	Rhodhiss town	10	0.95%
369	Coastal	Rich Square town	12	1.33%
370	Piedmont	Richfield town	11	1.63%
371	Coastal	Richlands town	9	0.52%
372	Coastal	River Bend town	48	1.60%
373	Coastal	Roanoke Rapids city	52	0.35%
374	Piedmont	Robbins town	2	0.22%
375	Mountains	Robbinsville town	19	3.17%
376	Coastal	Robersonville town	10	0.69%
377	Piedmont	Rockingham city	27	0.30%
378	Piedmont	Rockwell town	5	0.23%
379	Piedmont	Rocky Mount city	268	0.49%
380	Piedmont	Rolesville town	25	0.40%
381	Mountains	Ronda town	2	0.46%

Continuation				
#	Area	Municipality	Seasonal Population	% Increase in Population
382	Coastal	Roper town	9	1.61%
383	Coastal	Rose Hill town	6	0.35%
384	Coastal	Roseboro town	10	0.84%
385	Mountains	Rosman town	11	1.84%
386	Piedmont	Rowland town	21	2.10%
387	Piedmont	Roxboro city	29	0.36%
388	Coastal	Roxobel town	3	1.46%
389	Piedmont	Rural Hall town	14	0.45%
390	Mountains	Ruth town	0	0.00%
391	Mountains	Rutherford College town	5	0.33%
392	Mountains	Rutherfordton town	46	1.10%
393	Coastal	Saint Helena village	11	2.49%
394	Coastal	Salemburg town	3	0.66%
395	Piedmont	Salisbury city	171	0.50%
396	Mountains	Saluda city	244	33.28%
397	Coastal	Sandy Creek town	0	0.00%
398	Coastal	Sandyfield town	4	0.78%
399	Piedmont	Sanford city	32	0.11%
400	Piedmont	Saratoga town	2	0.41%
401	Mountains	Sawmills town	8	0.16%
402	Coastal	Scotland Neck town	30	1.54%
403	Coastal	Seaboard town	14	2.33%
404	Piedmont	Seagrove town	4	1.80%
405	Piedmont	Sedalia town	0	0.00%
406	Piedmont	Selma town	12	0.18%
407	Mountains	Seven Devils town	740	339.44%
408	Coastal	Seven Springs town	0	0.00%
409	Coastal	Severn town	3	1.30%
410	Coastal	Shallotte town	170	3.62%
411	Piedmont	Sharpsburg town	12	0.61%
412	Mountains	Shelby city	77	0.39%
413	Piedmont	Siler City town	25	0.30%
414	Coastal	Simpson village	0	0.00%
415	Piedmont	Sims town	0	0.00%
416	Piedmont	Smithfield town	49	0.43%
417	Coastal	Snow Hill town	9	0.57%
418	Piedmont	Southern Pines town	660	4.72%
419	Coastal	Southern Shores town	1,463	49.24%
420	Coastal	Southport city	284	8.15%
421	Mountains	Sparta town	72	3.96%
422	Piedmont	Speed town	0	0.00%
423	Piedmont	Spencer town	15	0.46%
424	Mountains	Spindale town	27	0.63%
425	Piedmont	Spring Hope town	14	1.10%
426	Piedmont	Spring Lake town	28	0.25%
427	Mountains	Spruce Pine town	57	2.61%
428	Piedmont	St. Pauls town	2	0.09%
429	Piedmont	Staley town	1	0.32%

Continuation				
#	Area	Municipality	Seasonal Population	% Increase in Population
430	Piedmont	Stallings town	37	0.23%
431	Piedmont	Stanfield town	7	0.46%
432	Piedmont	Stanley town	2	0.05%
433	Piedmont	Stantonsburg town	5	0.70%
434	Piedmont	Star town	7	0.78%
435	Piedmont	Statesville city	78	0.30%
436	Piedmont	Stedman town	7	0.60%
437	Piedmont	Stem town	0	0.00%
438	Piedmont	Stoneville town	12	1.03%
439	Coastal	Stonewall town	4	1.56%
440	Piedmont	Stovall town	2	0.43%
441	Mountains	Sugar Mountain village	2,480	1258.99%
442	Coastal	Sunset Beach town	3,106	73.84%
443	Coastal	Surf City town	2,936	137.40%
444	Coastal	Swansboro town	177	5.93%
445	Mountains	Sylva town	59	2.16%
446	Coastal	Tabor City town	13	0.32%
447	Coastal	Tar Heel town	3	2.05%
448	Piedmont	Tarboro town	56	0.52%
449	Mountains	Taylorsville town	11	0.51%
450	Piedmont	Taylortown town	2	0.30%
451	Coastal	Teachey town	5	1.37%
452	Piedmont	Thomasville city	45	0.17%
453	Piedmont	Tobaccoville village	8	0.32%
454	Coastal	Topsail Beach town	1,133	277.03%
455	Coastal	Trent Woods town	25	0.63%
456	Coastal	Trenton town	1	0.44%
457	Piedmont	Trinity city	23	0.34%
458	Piedmont	Troutman town	6	0.22%
459	Piedmont	Troy town	25	0.76%
460	Mountains	Tryon town	118	6.67%
461	Coastal	Turkey town	0	0.00%
462	Mountains	Valdese town	24	0.54%
463	Coastal	Vanceboro town	11	1.16%
464	Coastal	Vandemere town	33	13.05%
465	Piedmont	Vass town	5	0.63%
466	Mountains	Waco town	5	1.72%
467	Piedmont	Wade town	0	0.00%
468	Piedmont	Wadesboro town	40	0.73%
469	Piedmont	Wagram town	9	1.09%
470	Piedmont	Wake Forest town	152	0.42%
471	Piedmont	Walkertown town	18	0.34%
472	Coastal	Wallace town	7	0.17%
473	Piedmont	Walnut Cove town	0	0.00%
474	Coastal	Walnut Creek village	3	0.39%
475	Coastal	Walstonburg town	2	1.17%
476	Piedmont	Warrenton town	21	2.53%
477	Coastal	Warsaw town	7	0.24%

Continuation				
#	Area	Municipality	Seasonal Population	% Increase in Population
478	Coastal	Washington city	65	0.68%
479	Coastal	Washington Park town	19	4.48%
480	Coastal	Watha town	5	2.06%
481	Piedmont	Waxhaw town	78	0.57%
482	Mountains	Waynesville town	676	6.67%
483	Mountains	Weaverville town	113	2.93%
484	Mountains	Weldon town	43	2.80%
485	Piedmont	Wendell town	16	0.23%
486	Mountains	West Jefferson town	80	6.15%
487	Piedmont	Whispering Pines village	64	1.87%
488	Piedmont	Whitakers town	8	1.20%
489	Coastal	White Lake town	1,200	139.26%
490	Coastal	Whiteville city	45	0.85%
491	Mountains	Wilkesboro town	19	0.52%
492	Coastal	Williamston town	25	0.47%
493	Coastal	Wilmington city	1,602	1.32%
494	Piedmont	Wilson city	126	0.26%
495	Piedmont	Wilson's Mills town	7	0.25%
496	Coastal	Windsor town	25	0.73%
497	Coastal	Winfall town	3	0.46%
498	Piedmont	Wingate town	8	0.19%
499	Piedmont	Winston-Salem city	781	0.32%
500	Coastal	Winterville town	13	0.14%
501	Coastal	Winton town	15	2.07%
502	Mountains	Woodfin town	72	1.09%
503	Coastal	Woodland town	8	1.03%
504	Coastal	Wrightsville Beach town	1,620	64.72%
505	Piedmont	Yadkinville town	15	0.49%
506	Piedmont	Yanceyville town	11	0.53%
507	Piedmont	Youngsville town	2	0.15%
508	Piedmont	Zebulon town	21	0.42%

APPENDIX D

Meeting Minutes

Project N.: **RP 2019-09**
Title: **"How to Account for Seasonal Population Shifts in Distributing the Powell Bill Allocation Funds"**
Meeting: **Information Gathering Meeting**
Location: **Phone Call**
Date: **December 6, 2018**
Time: **4:15 PM - 4:45 PM**

Meeting Attendees

- Minerva Bonilla, NCSU
- Brad C. McCoy, Lieutenant Colonel-U.S. Army

Purpose & Activities

- The goal of this meeting was to discuss about military impact in municipal roads and learn about the data available or reference to possible contacts inside Bragg or Lejeune military bases.

Starting time: 1:30 PM

- Military vehicles do not use local roads on a regular base.
- Military vehicles leave the bases only to move equipment if they have to go between bases but heavy equipment are transported in the Heavy Expanded Mobility Tactical Truck that has 10 axles and evenly distributes heavy loads.
- Typically, heavy equipment is sent to other locations by rail (sometimes plane) but not road.
- Military bases follow federal laws on heavy equipment weights allowed on roads.
- Will be hard to obtain military statistics of how many vehicles leave military bases and utilize roads because this type of information is typically classified.

The most significant points of the meeting where:

1) Military vehicles do not utilize local roads
2) If military vehicles utilize local roads, they are in accordance of federal laws regarding equipment weight.
3) Heavy equipment are transported by rail.

Action Item

Contact Force Bragg Camp public affair to request general statistics of how much they use public roads versus other type of transportation.

APPENDIX E

Meeting Minutes

Project N.: RP 2019-09

Title: "How to Account for Seasonal Population Shifts in Distributing the Powell Bill Allocation Funds"

Meeting: Steering Committee Meeting
Location: 1 S Wilmington St. Raleigh, NC 27601
DOT TPB Transportation Building, Room # (GM-C)
Date: September 23, 2019
Time: 2:00 PM - 4:00 PM

Meeting Attendees

Majed Al-Ghandour	Molly Stevens
Jennie Bunton	Tyrone Williams
Curtis Bradley	Rebecca Tippett
Vicki Eastland (Phone call)	Min Liu
Karyl Fuller (Phone call)	William Rasdorf
Calvin Leggett	Minerva Bonilla
Chris Nida	Chuanni He
Kent Taylor	

Purpose

The main purpose of this meeting is to report current findings regarding calculations for the seasonal population to the committee chair of the Powell Bill project and other experts on this subject.

Starting time: 2:00 pm

- Introduction of attendees.
- Dr. Rasdorf introduced previous meeting (July 15, 2019) key points, highlights of the results, and what is expected from this meeting.
- Dr. Tippett introduced hotel findings and stated that there is no reliable and comprehensive way to account for hotel population. Three strategies were utilized to capture hotel population. Their advantages and disadvantages were discussed with attendees.
- Due to the results obtained from the 3 methods utilized to capture seasonal population, it was concluded that hotel population data is not reliable and it is not recommended for this research.
- The research team recommends that the funding allocation formula be based entirely on Census data because Census data is 100% count, there is available data for all municipalities, and census data maximize proportional fairness.

- The research team recommended to use the seasonal formula previously introduced at April 3rd committee meeting.
- Dr. Liu restated the April 3rd meeting results for the Powell Bill funding allocation.
- Dr. Liu presented 2 approaches for the funding allocation. The first approach is a maximum cap based on percentage total funding per municipality. The second approach utilizes grouping categories as criteria for new distribution. In this second approach, 2 scenarios are presented. The first scenario considers total funding that is fixed at $147 M. The second scenario considers additional funding so that there are no budget reductions for any municipality.
- Mrs. Eastland asked if the multipliers in the grouping approach are for the population only or if it is multiplied by the entire funding allocation.

. Dr. Liu explained the multiplier is for the entire formula

- Dr. Bradley stated that if the committee considers it to be necessary to focus on the mileage part of the formula, an extension can be granted to perform such a study.
- Suggestions for the researchers to try the percent multiplier adjusted based on population allocation only was introduced. This new idea could be a 3 and 4 scenario.

Adjourn at 4:00 pm.

The most significant points of the meeting where:

1) Three strategies were considered to capture seasonal population staying in hotels. However, none of these strategies is recommended because they generate large uncertainty in the calculations.
2) In addition to the capping and grouping categories, the committee recommended creating 2 new scenarios for the grouping category. Scenario 3 new funding allocation adjustment will be calculated by multiplying the factor to the previous year's funding allocation based on population. The total Powell Bill funding remains unchanged. Scenario 4 new funding allocation adjustment will be calculated by multiplying the factor to the previous year's funding allocation based on population. Additional budget required to cover seasonal population.
3) The committee recommended selecting a subgroup of municipalities with high seasonal population percentages. These municipalities will be separated and money will be allocated based on need.
4) The committee recommended to add more granularity in grouping method.
5) The committee decided not to move forward on expanding the project for the consideration of lane mileage because most streets have 2 lanes and the data is not readily available.

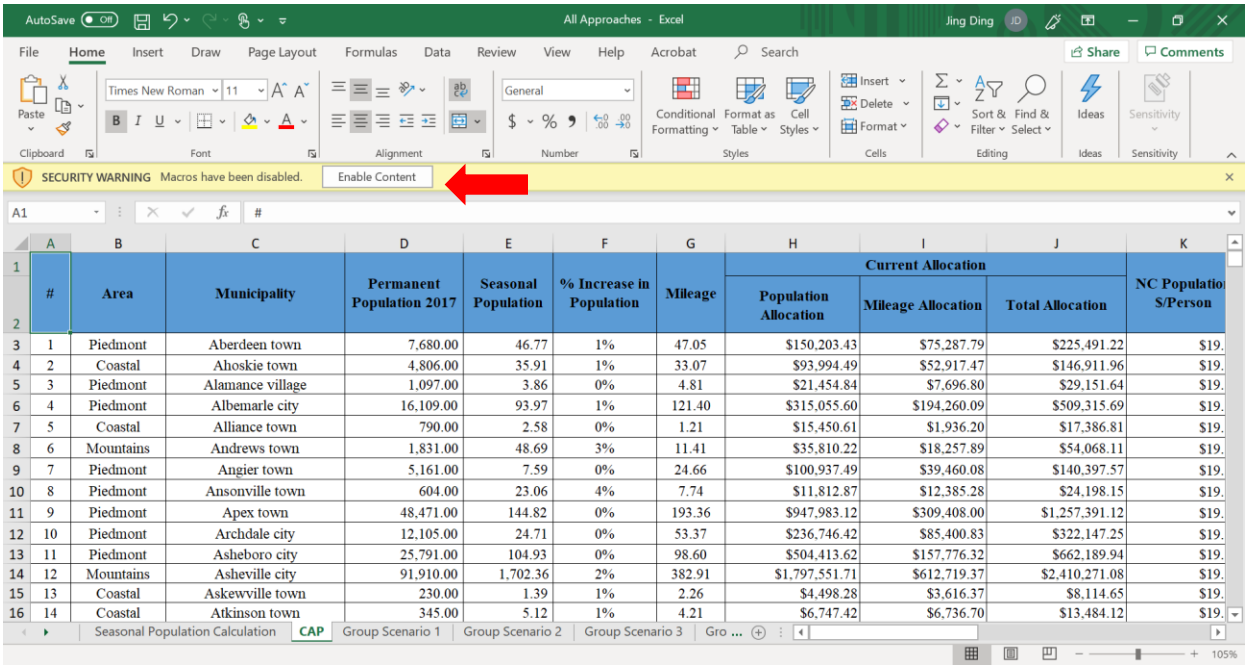
APPENDIX F

Instruction for Allocation Calculator

This is an instruction for decision makers to custom their own allocation plan using the calculator based on Excel. The calculator offers Cap and Group Based Allocation (including 4 types of scenarios) which are introduced in the final report in section 6. The calculator file is provided as an excel file named "Powell Bill Calculations," and will be submitted with the final report.

Interface

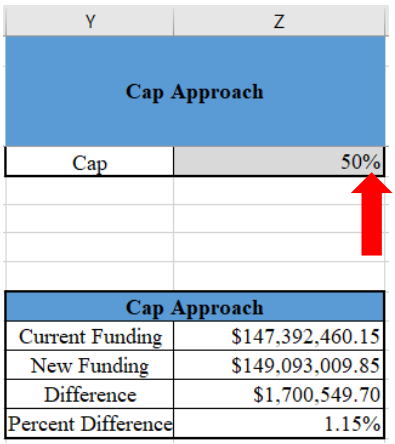
The interface of the file is shown in Figure 11. In order to use the calculator, Macro in Excel must be enabled. In some computers, there can be a security warning. In this case, click "Enable Content" to enable Macro.



#	Area	Municipality	Permanent Population 2017	Seasonal Population	% Increase in Population	Mileage	Current Allocation			NC Population $/Person
							Population Allocation	Mileage Allocation	Total Allocation	
1	Piedmont	Aberdeen town	7,680.00	46.77	1%	47.05	$150,203.43	$75,287.79	$225,491.22	$19.
2	Coastal	Ahoskie town	4,806.00	35.91	1%	33.07	$93,994.49	$52,917.47	$146,911.96	$19.
3	Piedmont	Alamance village	1,097.00	3.86	0%	4.81	$21,454.84	$7,696.80	$29,151.64	$19.
4	Piedmont	Albemarle city	16,109.00	93.97	1%	121.40	$315,055.60	$194,260.09	$509,315.69	$19.
5	Coastal	Alliance town	790.00	2.58	0%	1.21	$15,450.61	$1,936.20	$17,386.81	$19.
6	Mountains	Andrews town	1,831.00	48.69	3%	11.41	$35,810.22	$18,257.89	$54,068.11	$19.
7	Piedmont	Angier town	5,161.00	7.59	0%	24.66	$100,937.49	$39,460.08	$140,397.57	$19.
8	Piedmont	Ansonville town	604.00	23.06	4%	7.74	$11,812.87	$12,385.28	$24,198.15	$19.
9	Piedmont	Apex town	48,471.00	144.82	0%	193.36	$947,983.12	$309,408.00	$1,257,391.12	$19.
10	Piedmont	Archdale city	12,105.00	24.71	0%	53.37	$236,746.42	$85,400.83	$322,147.25	$19.
11	Piedmont	Asheboro city	25,791.00	104.93	0%	98.60	$504,413.62	$157,776.32	$662,189.94	$19.
12	Mountains	Asheville city	91,910.00	1,702.36	2%	382.91	$1,797,551.71	$612,719.37	$2,410,271.08	$19.
13	Coastal	Askewville town	230.00	1.39	1%	2.26	$4,498.28	$3,616.37	$8,114.65	$19.
14	Coastal	Atkinson town	345.00	5.12	1%	4.21	$6,747.42	$6,736.70	$13,484.12	$19.

Figure 11. Interface of the Calculator

Six tabs are included in the calculator. The first one "Seasonal Population Calculation" is a summary of the seasonal population for all municipalities for reference. The 5 rest of them are the Cap Based Allocation and 4 scenarios of Group Based Allocation calculator. The main table is the detailed allocation plan for each municipality. On the right top corner of each Tab, as shown in Figure 12, is the operating area with changeable parameters in light gray for users to design their own funding allocation plan. Below the operating area is the summary of total funding including current Powell Bill funding, proposed total funding, and the difference between proposed funding and the current one. The percent difference is the difference divided by current funding. For example, based on current funding of $147,392,460, a 50% limit was set for Cap Based Allocation, then the new funding should be $149,093,010, and the total difference will be $1,700,550, which is 1.15% of current funding.



Y	Z
Cap Approach	
Cap	50%

Cap Approach	
Current Funding	$147,392,460.15
New Funding	$149,093,009.85
Difference	$1,700,549.70
Percent Difference	1.15%

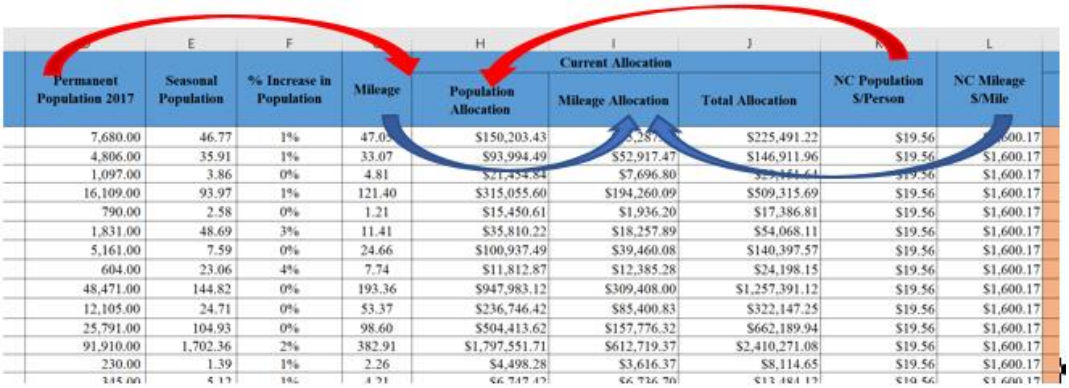
Figure 12. Operating Areas of Cap Allocation Approach

Cap Based Allocation

This approach allocates the funding by using the same per capita and per mile value from the most recent year ($19.56/person and $1,600.17/mile). Then multiply population by per capita value and mileage by per mile value to calculate the proposed funding. The cap is used to avoid excessively large allocations.

In this tab, the second column is the area of the corresponding municipality, which has been divided into 3 regions: Mountains, Piedmont and Coastal. The column named "Permanent Population 2017" is the permanent population based on 2017 census data. Column E is the seasonal population of the municipality according to the calculation in the first tab "Seasonal Population Calculation". Column F gives the percentage of seasonal population among 2017 permanent population. Column G is "Mileage" which is the certified lane mileage for each municipality.

The current total allocation including population allocation and mileage allocation is listed in Figure 13. Population allocation equals to population funding per capita multiply permanent population. Mileage allocation is mileage allocation per mile multiplied by lane mileage. Temporary funding allocation gives the temporary population and mileage allocation before capping is adapted.



	E	F		H	I	J	K	L
				Current Allocation				
Permanent Population 2017	Seasonal Population	% Increase in Population	Mileage	Population Allocation	Mileage Allocation	Total Allocation	NC Population $/Person	NC Mileage $/Mile
7,680.00	46.77	1%	47.05	$150,203.43	[illegible]	$225,491.22	$19.56	[illegible]600.17
4,806.00	35.91	1%	33.07	$93,994.49	$52,917.47	$146,911.96	$19.56	$1,600.17
1,097.00	3.86	0%	4.81	$21,454.84	$7,696.80	$29,151.64	$19.56	$1,600.17
16,109.00	93.97	1%	121.40	$315,055.60	$194,260.09	$509,315.69	$19.56	$1,600.17
790.00	2.58	0%	1.21	$15,450.61	$1,936.20	$17,386.81	$19.56	$1,600.17
1,831.00	48.69	3%	11.41	$35,810.22	$18,257.89	$54,068.11	$19.56	$1,600.17
5,161.00	7.59	0%	24.66	$100,937.49	$39,460.08	$140,397.57	$19.56	$1,600.17
604.00	23.06	4%	7.74	$11,812.87	$12,385.28	$24,198.15	$19.56	$1,600.17
48,471.00	144.82	0%	193.36	$947,983.12	$309,408.00	$1,257,391.12	$19.56	$1,600.17
12,105.00	24.71	0%	53.37	$236,746.42	$85,400.83	$322,147.25	$19.56	$1,600.17
25,791.00	104.93	0%	98.60	$504,413.62	$157,776.32	$662,189.94	$19.56	$1,600.17
91,910.00	1,702.36	2%	382.91	$1,797,551.71	$612,719.37	$2,410,271.08	$19.56	$1,600.17
230.00	1.39	1%	2.26	$4,498.28	$3,616.37	$8,114.65	$19.56	$1,600.17
345.00	5.12	1%	4.21	$6,747.42	$6,736.70	$13,484.12	$19.56	$1,600.17

Figure 13. Current Allocation Calculation

Column P is the difference between new allocation and current one. Column Q is the percentage of funding increase. The Cap Based Allocation is then used to adjust then temporary allocation. In column R, a judgment is made to determine whether the municipality receives more than the cap maximum. As shown in Figure 14, the city in the red square has a temporary allocation of $97,591, which is 170% of current one. Hence, this city triggered the limitation rule of 50% cap maximum. Column S provides the actual new allocation, which is 50% increase for this municipality. For those with an increase less than cap limitation, actual allocation is the same as temporary allocation.

	P	Q	R	S	T
	Difference in Temporary Allocations	% Funding Increase	Method 2: Cap on Maximum		Difference in Actual Allocation
			Excede the cap limitation?	Actual New Allocation	
.02	$914.80	0%	FALSE	$226,406.02	$914.80
.20	$702.24	0%	FALSE	$147,614.20	$702.24
.09	$75.45	0%	FALSE	$29,227.09	$75.45
.62	$1,837.93	0%	FALSE	$511,153.62	$1,837.93
.18	$50.37	0%	FALSE	$17,437.18	$50.37
.45	$952.34	2%	FALSE	$55,020.45	$952.34
.01	$148.44	0%	FALSE	$140,546.01	$148.44
.19	$451.04	2%	FALSE	$24,649.19	$451.04
.57	$2,832.45	0%	FALSE	$1,260,223.57	$2,832.45
.54	$483.29	0%	FALSE	$322,630.54	$483.29
.19	$2,052.25	0%	FALSE	$664,242.19	$2,052.25
.30	$33,294.22	1%	FALSE	$2,443,565.30	$33,294.22
.83	$27.18	0%	FALSE	$8,141.83	$27.18
.31	$100.19	1%	FALSE	$13,584.31	$100.19
.20	$97,591.37	170%	TRUE	$86,041.25	$28,680.42
.20	$150.22	1%	FALSE	$27,625.20	$150.22
.11	$251.57	1%	FALSE	$24,062.11	$251.57
.67	$45.95	0%	FALSE	$10,962.67	$45.95
.77	$509.34	0%	FALSE	$147,465.77	$509.34

Figure 14. Cap Limitations and Effects

The Cap Based Allocation limits the maximum amount of funding a municipality can receive. For example, if users want to change the limitation to 30%, the steps are to click Z3 cell, input "30" and press "Enter". The cap will be changed from 50% to 30%. Allocation for each municipality will automatically be updated. The total proposed allocation will be changed to $148,797,542.44, which is approximately 0.95% of the total funding as shown below in Figure 15.

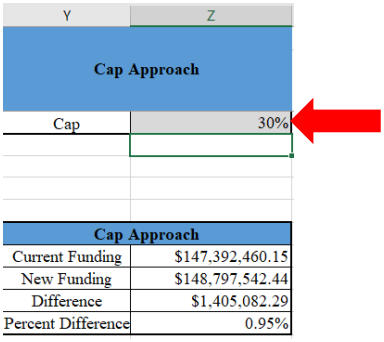


Figure 15. Examples of Cap Approach

Group Based Allocation

The Group Based Allocation distributes the funding by dividing municipalities into several groups and assign a unique multiplier to each group. Four scenarios were designed in this approach. For Scenarios 1 and 2, the allocation for each municipality equals to current Powell Bill allocation times multipliers. For Scenarios 3 and 4, allocation equals to population allocation times multiplier plus current mileage allocation. Meanwhile, Scenarios 1 and 3 require to remain the total Powell Bill funding budget unchanged. Hence, in this calculator, the percent multiplier in group E will be assigned to a negative number based on a trial and error process to keep the total Powell Bill Budget unchanged. As for Scenario 2 and 4, total Powell Bill budget does not have to remain the same level and it can be increased as needed. In all of the scenarios NCDOT administrators and legislatures can used this tool to adjust the group ranges and multipliers to see the impact on the municipalities and the total Powell Bill budget. It is an administration decision by legislatures to determine those parameters.

Scenarios 1 and 2

The main table in Scenarios 1 and 2 are shown in Figure 16. Columns E and H identify which group a municipality belongs to and its corresponding multiplier. Column I is the proposed funding and Column J is the difference between the proposed funding and the current one.

	A	B	C	D	E	F	G	H	I	J
1	#	Municipality	Permanent Population 2017	Seasonal Population	% Increase in Population	Current Powell Bill Allocation	Group	Multiplier	Proposed Allocation	Difference
2	1	Aberdeen town	7,680	47	1%	$225,491.22	E	-1%	$223,173.77	-$2,317.45
3	2	Ahoskie town	4,806	36	1%	$146,911.96	E	-1%	$145,402.09	-$1,509.87
4	3	Alamance village	1,097	4	0%	$29,151.64	E	-1%	$28,852.04	-$299.60
5	4	Albemarle city	16,109	94	1%	$509,315.69	E	-1%	$504,081.27	-$5,234.42
6	5	Alliance town	790	3	0%	$17,386.81	E	-1%	$17,208.12	-$178.69
7	6	Andrews town	1,831	49	3%	$54,068.11	D	3%	$55,690.15	$1,622.04
8	7	Angier town	5,161	8	0%	$140,397.57	E	-1%	$138,954.65	-$1,442.92
9	8	Ansonville town	604	23	4%	$24,198.15	D	3%	$24,924.09	$725.94
10	9	Apex town	48,471	145	0%	$1,257,391.12	E	-1%	$1,244,468.47	-$12,922.65
11	10	Archdale city	12,105	25	0%	$322,147.25	E	-1%	$318,836.43	-$3,310.82
12	11	Asheboro city	25,791	105	0%	$662,189.94	E	-1%	$655,384.38	-$6,805.56
13	12	Asheville city	91,910	1,702	2%	$2,410,271.08	D	3%	$2,482,579.21	$72,308.13
14	13	Askewville town	230	1	1%	$8,114.65	E	-1%	$8,031.25	-$83.40
15	14	Atkinson town	345	5	1%	$13,484.12	D	3%	$13,888.64	$404.52
16	15	Atlantic Beach town	1,497	4,990	333%	$57,360.83	A	50%	$86,041.25	$28,680.42
17	16	Aulander town	828	8	1%	$27,474.98	E	-1%	$27,192.61	-$282.37

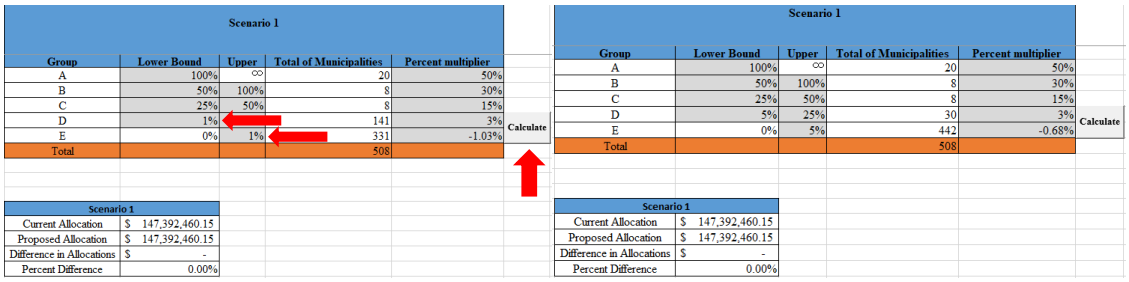
Figure 16. Main Table for Scenarios 1 and 2

As can be seen in Figure 17, upper bound and lower bound give the range of seasonal population percentage for each group. Allocation for a municipality equals to current funding times multiplier. For this approach, the upper and lower bound are modifiable, as well as the percent multiplier (Note that the bound must be consecutive, otherwise some of the municipalities will display "False"). In a similar way, funding for each municipality and summary for total funding will be updated. The operating area is shown in Figure 17. For example, users can change the upper bound for Group E to 5% and the lower bound for group D to 5% (there is no municipality falls on the exact bound limits). In Scenario 1, the detailed steps are:

1. Click cell Q7, input "5" and press "Enter".
2. Click cell P6, input "5" and press "Enter".
3. The total proposed allocation will be updated to $146,897,322, as shown in Figure 17(a).

In order to make the total allocation remain the same, click "Calculate" bottom.

4. The Allocation for municipalities and total proposed allocation will be recalculated to match the principle. The difference in allocation will become 0 as shown in figure 17(b).



Scenario 1

Group	Lower Bound	Upper	Total of Municipalities	Percent multiplier
A	100%	∞	20	50%
B	50%	100%	8	30%
C	25%	50%	8	15%
D	1%	25%	141	3%
E	0%	1%	331	-1.03%
Total			508	

Calculate

Scenario 1	
Current Allocation	$ 147,392,460.15
Proposed Allocation	$ 147,392,460.15
Difference in Allocations	$ -
Percent Difference	0.00%

(a)

Scenario 1

Group	Lower Bound	Upper	Total of Municipalities	Percent multiplier
A	100%	∞	20	50%
B	50%	100%	8	30%
C	25%	50%	8	15%
D	5%	25%	30	3%
E	0%	5%	442	-0.68%
Total			508	

Calculate

Scenario 1	
Current Allocation	$ 147,392,460.15
Proposed Allocation	$ 147,392,460.15
Difference in Allocations	$ -
Percent Difference	0.00%

(b)

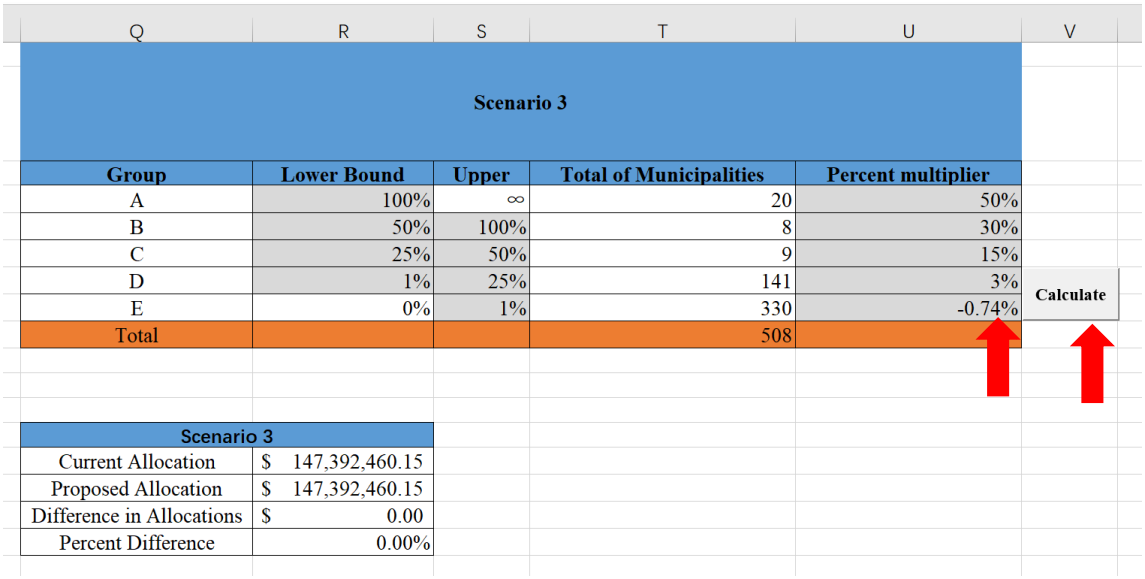
Figure 17. Percent Multipliers for Scenarios 1

Scenarios 3 and 4

In Scenarios 3 and 4, new allocation will be adjusted based on the portion of current population allocation only. Hence, the current population allocation is provided in these 2 scenarios. As shown in Figure 18, proposed allocation is the current portion of population allocation times assigned multiplier and then add to the portion of mileage allocation. Steps for customizing allocation plan is similar to Scenarios 1 and 2. For example, to change percent multiplier of group D to 5% in Scenario 3, click the U7 cell, input 7 and press "Enter", then click "Calculate" as shown in Figure 19. Detailed allocation for each municipality will be updated automatically.

A	B	C	D	E	F	G	H	I	J	K	L
#	Municipality	Permanent Population 2017	Seasonal Population	% Increase in Population	Current Allocation			Group	Multiplier	Proposed Allocation	Difference
					Population Allocation	Mileage Allocation	Total Allocation				
1	Aberdeen town	7,680	47	1%	$150,203.43	$75,287.7	$225,491.22	E	-0.74%	$224,380.72	-$1,110.50
2	Ahoskie town	4,806	36	1%	$93,994.49	$52,917.47	$146,911.96	E	-0.74%	$146,217.04	-$694.92
3	Alamance village	1,097	4	0%	$21,454.84	$7,696.80	$29,151.64	E	-0.74%	$28,993.01	-$158.63
4	Albemarle city	16,109	94	1%	$315,055.60	$194,260.09	$509,315.69	E	-0.74%	$506,986.41	-$2,329.28
5	Alliance town	790	3	0%	$15,450.61	$1,936.20	$17,386.81	E	-0.74%	$17,272.58	-$114.23
6	Andrews town	1,831	49	3%	$35,810.22	$18,257.89	$54,068.11	D	3.00%	$55,142.41	$1,074.30
7	Angier town	5,161	8	0%	$100,937.49	$39,460.08	$140,397.57	E	-0.74%	$139,651.31	-$746.26
8	Ansonville town	604	23	4%	$11,812.87	$12,385.28	$24,198.15	D	3.00%	$24,552.54	$354.39
9	Apex town	48,471	145	0%	$947,983.12	$309,408.00	$1,257,391.12	E	-0.74%	$1,250,382.43	-$7,008.69
10	Archdale city	12,105	25	0%	$236,746.42	$85,400.83	$322,147.25	E	-0.74%	$320,396.92	-$1,750.33
11	Asheboro city	25,791	105	0%	$504,413.62	$157,776.32	$662,189.94	E	-0.74%	$658,460.68	-$3,729.26
12	Asheville city	91,910	1,702	2%	$1,797,551.71	$612,719.37	$2,410,271.08	D	3.00%	$2,464,197.63	$53,926.55
13	Askewville town	230	1	1%	$4,498.28	$3,616.37	$8,114.65	E	-0.74%	$8,081.40	-$33.25
14	Atkinson town	345	5	1%	$6,747.42	$6,736.70	$13,484.12	D	3.00%	$13,686.54	$202.42
15	Atlantic Beach town	1,497	4,990	333%	$29,277.93	$28,082.90	$57,360.83	A	50.00%	$71,999.81	$14,638.98
16	Aulander town	828	8	1%	$16,193.81	$11,281.17	$27,474.98	E	-0.74%	$27,355.25	-$119.73
17	Aurora town	495	13	3%	$9,681.08	$14,129.46	$23,810.54	D	3.00%	$24,100.97	$290.43
18	Autryville town	199	2	1%	$3,891.99	$7,024.73	$10,916.72	D	3.00%	$11,033.48	$116.76
19	Ayden town	4,976	26	1%	$97,319.30	$49,637.13	$146,956.43	E	-0.74%	$146,236.93	-$719.50
20	Badin town	1,984	35	2%	$38,802.55	$15,569.61	$54,372.16	D	3.00%	$55,536.24	$1,164.08
21	Bailey town	539	3	1%	$10,541.62	$6,464.67	$17,006.29	E	-0.74%	$16,928.35	-$77.94
22	Bakersville town	474	32	7%	$9,270.37	$5,392.56	$14,662.93	D	3.00%	$14,941.04	$278.11
23	Bald Head Island village	177	1,368	773%	$3,461.72	$40,996.24	$44,457.96	A	50.00%	$46,188.82	$1,730.86
24	Banner Elk town	1,126	355	31%	$22,022.01	$18,737.94	$40,759.95	C	15.00%	$44,063.25	$3,303.30
25	Bath town	238	51	21%	$4,654.74	$3,136.32	$7,791.06	D	3.00%	$7,930.71	$139.65
26	Bayboro town	1,255	21	2%	$24,544.96	$7,536.78	$32,081.74	D	3.00%	$32,818.09	$736.35
27	Bear Grass town	73	-	0%	$1,427.71	$1,104.11	$2,531.82	E	-0.74%	$2,521.27	-$10.55
28	Beaufort town	4,200	626	15%	$82,142.50	$37,059.83	$119,202.33	D	3.00%	$121,666.61	$2,464.28
29	Beech Mountain town	337	3,458	1026%	$6,590.96	$105,466.91	$112,057.87	A	50.00%	$115,353.34	$3,295.47
30	Belhaven town	1,600	44	3%	$31,292.38	$26,162.71	$57,455.09	D	3.00%	$58,393.86	$938.77
31	Belmont city	11,403	53	0%	$223,016.89	$87,513.05	$310,529.94	E	-0.74%	$308,881.12	-$1,648.82

Figure 18. Main Table for Scenarios 3 and 4



Q	R	S	T	U	V

Scenario 3

Group	Lower Bound	Upper	Total of Municipalities	Percent multiplier
A	100%	∞	20	50%
B	50%	100%	8	30%
C	25%	50%	9	15%
D	1%	25%	141	3%
E	0%	1%	330	-0.74%
Total			508	

Calculate

Scenario 3	
Current Allocation	$ 147,392,460.15
Proposed Allocation	$ 147,392,460.15
Difference in Allocations	$ 0.00
Percent Difference	0.00%

Figure 19. Percent Multipliers for Scenario 3

REFERENCES

Alabama Legislature (2016). "SB 180 Act - RFD: Transportation and Energy S180," Alabama State, Bill, retrieved from the web <https://legiscan.com/AL/text/SB108/2018> (Oct. 24, 2018).

Alaska Community Transit (2016). "Alaska State Management Plan," Technical Report.

Al-Ghandour, M., Benson, S. (2015). "Overview of the Powell Bill Program (State Street-Aid)," PowerPoint Presentation, General Statutes 136-41.1-136-41.4.

Arkansas State Highway and Transportation Department (2012). "Arkansas State Highway and Transportation Department - Lead AR," PowerPoint Presentation, retrieved from the web < https://www.arkansashighways.com/PowerPoints/2012/120612_SEB_leadAR.pdf > (Oct. 16, 2018).

Arizona Department of Transportation (2018). "Maricopa County Transportation Excise Tax FY 2018 Actual Revenue Distribution Flow," Phoenix, AZ, Diagram, retrieved from the web <https://apps.azdot.gov/files/FMS/RARF/Flow/rarftankchart_17.pdf> (Oct. 24, 2018).

Bhatt, S. (2017). "Final Budget Allocation Plan for Fiscal Year 2017-18," Technical Report.

Bureau of Local Roads and Street (2018). "Chapter 4 Local Roads and Street," Illinois Department of Transportation. Manual, retrieved from the web <https://www.idot.illinois.gov/Assets/uploads/files/Doing-Business/Manuals-Split/Local-Roads-and-Streets/Chapter%2004.pdf> (Oct. 22, 2018).

Campanelli, F., Donovan, T., Wehse, A., and Winter, S. (2017). "Estimating the Effective Population of Nantucket," Technical Report, Workcester Polytechnic Institute.

Carolina Demography (2014a). "Tools to Estimate the Seasonal Population of the Greater Topsail Area," Technical Report, Carolina Population Center, University of North Carolina 1-8. Chapel Hill, NC.

Carolina Demography (2014b). "Greater Topsail Summer Population Estimates," Technical Report, Carolina Population Center, University of North Carolina, Chapel Hill, NC.

Charles-Edwards, E., Bell, M., Brown, D. (2010). "Where People Move and When: Temporary Population Mobility in Australia," *Journal of People and Place*, 16(1), 21-30.

Cherrington, L., Tan, S., and Hansen, T. (2017). "Sources of Funding Transit in Texas Final Report Sources of Funding Transit in Texas," Project PCR 15-11.2, Texas A&M; Transportation Institute, Austin, TX, Technical Report.

Cleland, F., Perone, J.S., and Tucker, L. (2003). "Study of Potential TDM and Transit Service Adjustment to Serve Seasonal Residents," Technical Report, Florida Department of Transportation 1-36.

Connecticut Department of Transportation (2010). "Town Aid Grants for Roads and Public Transportation Services," Connecticut Legislature, retrieved from the web <https://www.ct.gov/dot/cwp/view.asp?a=1410&q=424512> (Oct. 6, 2018).

Davies, A. (2011). "On Constructing Ageing Rural Populations: Capturing the Grey Nomad," *Journal of Rural Studies*, 27(2), 191–199.

Delaware Department of Transportation (2018). "Municipal Street Aid,", Technical Report.

Economic Analysis Branch Division of Transportation Planning California Department of Transportation (2014). "Transportation Funding in California," Technical Report.

Erbach-Schoenberg, E., Alegana, V. A., Sorichetta, A., Linard, C., Lourenço, C., Ruktanonchai, N. W., Tatem, A. J. (2016). "Dynamic Denominators: the Impact of Seasonally Varying Population Numbers on Disease Incidence Estimates." *Population Health Metrics*, 14(35) 1–10.

Force, A., Corps, M., & Agency, D. L. (1996). "Transportation and Travel, Highways for National Defense," Washington, DC.

Georgia Department of Transportation (2008). "Georgia Department of Transportation STIP Financial Plan, Technical Report.

Goldstein, L. D. (2018). "Cellphone Location Data for Travel Behavior Analysis," National Cooperative Highway Research Program, Washington D.C.: Transportation Research Board. Technical Report #868.

Graebert, M. B., Wyckof, M., and Bretz, L. (2014). "Northwest Michigan Seasonal Population Analysis," <https://www.networksnorthwest.org/userfiles/filemanager/3292/> (Sept. 4, 2018).

Hawaii Department of Transportation (2018). "Hawaii Department of Transportation, Transportation Alternative Program," Technical Report.

Idaho Department of Transportation (2018). "Idaho Distribution Account Sources and Distribution," Technical Report.

Indiana Department of Transportation (2018). "Indiana Highway and Street Funding," Purdue University, Local Technical Assistance Program, PowerPoint presentation retrieved from the web < https://www.in.gov/ocra/files/Session_9_INDOT_IMS_Conference_10.20.11.pdf> (Sept. 8, 2018).

Iowa Department of Transportation (2018). "Fiscal Year 2018 Transportation Funding," Diagram, retrieved from the web, <https://iowadot.gov/about/pdf/pipeline.pdf> (Nov. 8, 2018).

Kansas Department of Transportation (2018). "Kansas Department of Transportation Budget Analysis FY 2018," Technical Report.

Kentucky Department of Transportation (2018). "KYTC's Budgeted Funding for FY 2017-18," Technical Report.

Lansford, N. (2011). "Primary Sources of County Road Funding," Oklahoma Cooperative Extension Service, Oklahoma State University, pp. AGEC889:1-8. Technical Report.

Louisiana Department of Transportation (2017). "Parish Transportation Fund Act," Legislature report retrieved from the web<https://app.lla.state.la.us/llala.nsf/AFF9F8BA38C9576F86257AB8006EFF39/$FILE/Parish%20Transportation%20Fund%20Act%20FAQ.pdf> (Oct. 24, 2018).

Magellan Strategy Group (2017) "Profile of North Carolina Occupancy Taxes and Their Allocation," Version 5.0, retrieved from the web, <http://www.magellanstrategy.com/wp-content/uploads/2018/07/NC-Occupancy-Tax-Profile.-July-31-2018.-Version-5.0-Final.pdf?x96831> (May 10, 2018).

Maine Department of Transportation (2018). "Local Road Assistance Program (LRAP)," Main Legislature, retrieved from the web < https://www1.maine.gov/mdot/csd/lrap/> (Oct. 24, 2018).

Maryland Department of Transportation (2018). "Transportation Trust Fund," Technical Report.

Massachusetts Department of Transportation (2014). "Massachusetts Transportation Funding Flow Chart," Budget Report.

Mattson, S., and Potts, K. (2015). "Tennessee Transportation Funding: Challenges and Options," Tennessee Comptroller of the Treasure, Office of Research and Education Accountability. Nashville, TN. Technical Report.

Michigan Municipal League (2018). "Act 51-Michigan Transportation Fund, (February), 2018," Fact Sheet, retrieved from the web <https://www.canton-mi.org/DocumentCenter/View/7031/Act-51-Fact-Sheet > (Nov. 5, 2018).

Migration Policy Institute (2019). "Profile of the Unauthorized Population: North Carolina," <https://www.migrationpolicy.org/data/unauthorized-immigrant-population/state/NC> (Aug. 9, 2019).
Military Advantage (2018). "Military Equipment Guide," Website, retrieved from the web <https://www.military.com/equipment> (Oct. 16, 2018).
Minnesota Department of Transportation (2018). "Minnesota's Highway Finances," Technical Report.
Mississippi Department of Transportation (2018). "State Aid Road in Counties," Website, retrieved from the web <https://law.justia.com/codes/mississippi/2013/title-65/chapter-9/section-65-9-3/> (Oct. 16, 2018).
Missouri Department of Transportation (2018). "Appropriation Request," Missouri Department of Transportation. Technical Report.
Montana Legislative Services Division (2017). "Act HB - 475," Montana Legislative Services Division. Technical Report.
Nebraska Department of Transportation (2018). "Projected Highway User Revenue Distribution," Technical Report.
Nevada Department of Transportation (2017). "Nevada Statewide Transportation Improvement Program," Technical Report.
New Jersey Transportation Trust Fund Authority (2018). "Plan for Financing Anticipated NJDOT/NJ TRANSIT Capital Program Outlays for Fiscal Year 2019," Federal Aid Quality Improvement Team, Technical Report, retrieved from the web <https://www.njleg.state.nj.us/OPI/Reports_to_the_Legislature/transportation_trust_fund_financial_plan_FY2019.pdf> (Nov. 5, 2018).
New Mexico Department of Transportation (2014). "Local Government Road Fund Project Handbook," Technical Report.
New York Department of Transportation (2018). "Consolidated Local Street and Highway Improvement Program (CHIPS)," NYDOT, New York, NY, Website, retrieved from the web <https://www.dot.ny.gov/programs/chips> (Sept. 18, 2018).
North Carolina Office of State Budget and Management (2017). "2017 Municipal Population Estimate," NC Office of State Budget and Management, retrieved from the web <https://www.osbm.nc.gov/facts-figures/demographics> (May 3, 2019).
North Carolina Office of State Budget and Management (2019). "State Demographer," NC Office of State Budget and Management, <https://files.nc.gov/ncosbm/demog/muniestbymuni_2017.html> (Mar. 3, 2019).
North Dakota State Treasure (2018). "Chapter 54-27 Fiscal Administration," Technical Report.
Office of Planning (2016). "Policies and Procedures for the Administration of the County Liquid Fuel Tax Act of 1931 and Act 44 of 2007 and the liquid Fuel Tax Act 655, 9." Pennsylvania Department of Transportation. Publication. PUB 9 (3-16). Harrisburg, PA. Technical Report.
Office of Highway Policy Information (2011). "Highway Finance Data Collection," Policy and Governmental Affairs. Website, retrieved from the web < https://www.fhwa.dot.gov/policyinformation/pubs/hf/pl11028/chapter1.cfm> (Jun. 9, 2019).
Ohio Department of Transportation Office of Research (2017). "2017 Annual Statement," Technical Report.
Oregon Department of Transportation (2018). "Financial Services," Oregon Department of Transportation, Salem, OR. Website, retrieved from the web <https://www.oregon.gov/ODOT/About/Pages/Financial-Information.aspx> (Sept. 29, 2018)

Pinellas County Metropolitan Planning Organization (2009). "Permanent, Seasonal Tourist Population Forecast Report," Technical Report (1-14) Clearwater, FL 33755.
Portillo, E. (2016). "Hotel Construction Booming for Now – But Trouble Down the Line?," The Charlotte Observer, retrieved from the web <https://www.charlotteobserver.com/news/business/biz-columns-blogs/development/article93799532.html > (May 6, 2018).
Rhode Island Department of Transportation (2018). "Rhode Island Transportation Improvement Program," Technical Report.
Sheehan, V.F., and Cass, W. (2016). "NHDOT Annual Betterment Report FY 2016," Technical Report NH RSA 235:23-a.
South Carolina Department of Transportation. (2018). "The C Program." Bennettsville SC, Website, retrieved from the web <https://www.scdot.org/projects/c-program.aspx> (Sept. 21, 2018).
South Dakota Department of Transportation (2018). "Fact Book 2018-2019," Technical Report.
Silm, S., and Ahas, R. (2010). "The Seasonal Variability of Population in Estonian Municipalities," *Journal of Environment and Planning*, 42(10), 2527–2546.
Smith, S. K. (1989). "Toward a Methodology for Estimating Temporary Residents," *Journal of the American Statistical Association*, 84(406), 430–436.
Smith, S. K. (1994). "Estimating Temporary Populations," *Journal of Applied Demography*, Journal 9(1), 4-7.
Smith, S. K., and House, M. (2006). "Snowbirds, Sunbirds, and Stayers: Seasonal Migration of Elderly Adults in Florida," *Journal of Gerontology* 61(5), 232–239.
Smith, S. K. and House, M. (2007). "Temporary Migration: a Case Study of Florida," Population Research and Policy Review, 26(1) 437-454.
Smith, S. K., Tayman, J., and Swanson, D. A. (2013). "A Practitioner's Guide to State and Local Population Projections," *Journal of Demographic Methods and Population Analysis*, Springer, Netherlands.
Smith Travel Research Inc. (2019). "Hotel Data," STR Share Center, Sample Data.
Stathakis, D., and Baltas, P. (2018). "Seasonal Population Estimates Based on Night-time Lights, Computers, Environment, and Urban Systems," Technical Report (68) 133–141.
Swanson, D. A., and Tayman, J. (2011). "On Estimating a De Facto Population and Its Components," Technical Report (17-31) 1-27.
Tippett, R. M. (2017). "Benefits and Challenges of Tourism for NC Community," Carolina Population Center, University of North Carolina, Chapel Hill, NC.
The Florida Senate (2016). "Small County Road Assistance Program," Senate State of Florida, Florida, FL. Law, retrieved from the web <http://www.flsenate.gov/Laws/Statutes/2016/339.2816> (Oct. 6, 2018).
Tomblin, E. R., Mattox, P.A. (2016). "West Virginia Statewide Transportation Improvement Program," retrieved from the web <https://transportation.wv.gov/highways/programplanning/STIP/Documents/STIP_16_21/16_21_Apr_Ltr.pdf> (Oct. 6, 2018)
University of Florida (2016). "Florida Estimates of Population 2016," Bureau of Economic and Business Research. Technical Report (1-52)
University of North Carolina (2017). "North Carolina Crash Data," retrieved from the web <https://www.nc.gov/crash-data> (Feb.18, 2018).

U.S. Census Bureau (2011). "Housing Characteristics: 2010," U.S. Department of Commerce. Economic and Statistics Administration, retrieved from the web <https://www.census.gov/prod/cen2010/briefs/c2010br-07.pdf> (Feb. 18, 2019).
U.S. Census Bureau, (2018a). "Definition and Explanation," < https://www.census.gov/housing/hvs/definitions.pdf> (Nov. 20, 2019).
U.S. Census Bureau, Population Division (2018b). "U. S. Census Bureau Glossary," <https://www.census.gov/glossary/#term_Seasonalunits> (Feb.18, 2019).
U.S. Census Bureau, Population Division (2018c). "Understanding and Using American Community Survey Data," <https://www.census.gov/content/dam/Census/library/publications/2018/acs/acs_general_handbook_2018.pdf > (Mar. 3, 2019).
U.S. Census Bureau (2019a). "About Business Surveys," retrieved from the web <https://www.census.gov/programs-surveys/surveyhelp/about-business-surveys.html> (Jul. 18, 2019).
U.S. Census Bureau (2019b). "About Household Surveys," retrieved from the web <https://www.census.gov/programs-surveys/surveyhelp/about-household-surveys.html> (Jul. 18, 2019).
Utah Department of Transportation (2018). "Transportation Funding in Utah," PowerPoint presentation, retrieved from the web <https://le.utah.gov/lrgc/briefings/BB.TransportationFundingJan2014.pdf> (Oct. 6, 2018).
Visit North Carolina (2016). "2016 North Carolina Regional Travel Summary," Visit North Carolina. Unit of the Economic Development Partnership of North Carolina, <https://www.ncrla.org/wp-content/uploads/2017/10/2016-North-Carolina-Regional-Travel-Summary.pdf> (Jul. 18, 2019).
Visit North Carolina (2017). "2017 North Carolina Visitor Profile," Visit North Carolina. Unit of the Economic Development Partnership of North Carolina, <https://partners.visitnc.com/contents/sdownload/69277/file/2017-North-Carolina-Visitor-Profile.pdf> (May 10, 2019).
Visit North Carolina (2018). "2017 North Carolina Regional Visitor Profile," Visit North Carolina. Unit of the Economic Development Partnership of North Carolina, <https://partners.visitnc.com/contents/sdownload/71007/file/2018-North-Carolina-Regional-Visitor-Profile.pdf> (May 10, 2019).
Vermont Transportation (2017). "Vermont Better Roads Program," Technical Report, retrieved from the web <http://www.virginiadot.org/projects/resources/SYIP/2015/HB3DistrictInfo/HB1887_Hampton_Roads_SYIP_Hearing_04-21-15.pdf> (Sept. 16, 2018).
Virginia Department of Transportation (2017). "Fiscal Year 2018, Commonwealth Transportation Fund Budget," Technical Report.
Washington State Department of Transportation (2018). "State Transportation Asset Management Plan (STAMP)," Technical Report.
Wisconsin Department of Transportation (2018). "Transportation Budget Trend 2018-2019," Technical Report.
Wyoming Department of Transportation (2018). "FY 2019 Operating Budget," Technical Report.
Zorn, J. R. (2007). "Estimating the Population Size of Ancient Settlements: Methods, Problems, Solutions, and a Case Study," Technical Report (295), 31–48.