SANDIA REPORT
SAND2024-12278
Printed September 2024

Sandia National Laboratories

SecPop Version 4.4.0: Sector Population, Land Fraction, and Economic Estimation Program

User's Guide, Model Manual, and Verification Report

Accident Consequence Modeling and Analysis Department

Prepared by
Sandia National Laboratories
Albuquerque, New Mexico
87185 and Livermore,
California 94550

Issued by Sandia National Laboratories, operated for the United States Department of Energy by National Technology & Engineering Solutions of Sandia, LLC.

Available to DOE and DOE contractors from
U.S. Department of Energy
Office of Scientific and Technical Information
P.O. Box 62
Oak Ridge, TN 37831

Telephone: (865) 576-8401
Facsimile: (865) 576-5728
E-Mail: reports@osti.gov
Online ordering: http://www.osti.gov/scitech

Available to the public from
U.S. Department of Commerce
National Technical Information Service
5301 Shawnee Rd
Alexandria, VA 22312

Telephone: (800) 553-6847
Facsimile: (703) 605-6900
E-Mail: orders@ntis.gov
Online order: https://classic.ntis.gov/help/order-methods/

ABSTRACT

In 1973 the U.S. Environmental Protection Agency (EPA) developed SecPop to calculate population estimates to support a study on air quality. The Nuclear Regulatory Commission (NRC) adopted this program to support siting reviews for nuclear power plant construction and license applications. Currently SecPop is used to prepare site data input files for offsite consequence calculations with the MACCS Code. SecPop enables the use of site-specific population, land use, and economic data for a polar grid defined by the user.

Updated versions of SecPop have been released to use U.S. decennial census population data. SECPOP90 was released in 1997 to use 1990 population and economic data. SECPOP2000 was released in 2003 to use 2000 population data and 1997 economic data. SecPop Version 4 was released in 2018 to use 2010 population and both 2007 and 2012 economic data. This report describes the current code version, SecPop version 4.4.0, which includes 2020 population data and 2017 economic data.

This report contains guidance for the installation and use of the code as well as a description of the theory, models, and algorithms involved. This report contains appendices which describe the development of the 2020 census file and 2017 county file. Finally, an appendix is included that describes the validation assessments performed.

ACKNOWLEDGEMENTS

The technical content for this User Guide highly leverages the content from previous SecPop User Guides, most recently, the SecPop Version 4: Sector Population, Land Fraction, and Economic Estimate Program, User Guider, Model Manual, and Verification Report, NUREG/CR-6525, Rev. 2. Additional contributions were received from NRC and Sandia National Laboratories (SNL) project managers, technical experts, and code authors dedicated to the production of a valuable resource for the MACCS user community.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

This page left blank

ACRONYMS AND TERMS

Acronym/Term	Definition
AHS	American Housing Survey
BEA	U.S. Bureau of Economic Analysis
BLS	U.S. Bureau of Labor Statistics
CPI	Consumer Price Index
EPA	U.S. Environmental Protection Agency
EPZ	Emergency Planning Zone
FIPS	Federal Information Processing Standard
GDP	Gross Domestic Product
IC	Independent City
NRC	U.S. Nuclear Regulatory Commission
NRCS	National Resources Conservation Service
NRI	National Resources Inventory
PCI	Per Capita Income
REAcct	Regional Economic Accounting Tool
SecPop	Sector Population and Economic Estimator
USDA	U.S. Department of Agriculture

This page left blank

1. INTRODUCTION

1.1. Background

In 1973 the U.S. Environmental Protection Agency (EPA) developed Sector Population and Economic Estimator (SecPop) to calculate population estimates. The code used 1970 population census data and was created to support a study on air quality. The NRC adopted this program to perform siting reviews for nuclear power plant construction and license applications.

With updates to census and economic data, a number of newer versions of SecPop were released. The previous major SecPop releases were SECPOP90 [1], SECPOP2000 [2], and SecPop Version 4 [3]. SECPOP90 supported both site and regional analyses. The site analysis provides population and economic data estimates for any location within the continental United States. Regional analysis assesses compliance of available sites against siting parameters (i.e., specific population density criteria); however, this feature was removed for SECPOP2000 because some of the software packages originally used for regional analysis were no longer available. Similarly, more recent versions of SecPop only support site analyses.

1.2. Current Version

The current version of SecPop (v4.4.0) described in this document contains the following updates:

1. To process updated population data from the 2020 U.S. Census.
2. To process updated economic and land use data from the 2017 database.
3. To include data for Alaska and Hawaii (previous versions of SecPop only incorporated data for the contiguous United States).
4. Updated to run on Java 17 platform.
5. Updated documentation to clarify how population and economic multipliers are applied to the non-farm wealth per capita.

To ensure successful implementation of the new databases, the values calculated by SecPop were compared with the raw data in the most recent census and county files and all tests passed. Additionally, the current version was regression tested against the previous version and these tests all passed as well. Regression testing compares newer versions with older ones to ensure consistency where consistency is expected and to verify that recent changes have not fixed one problem but introduced another. Details of the comparisons are provided in Appendix D.

The current version of SecPop at the time of this writing is 4.4.0 and this document is based on that version. However, this document is generally relevant to earlier versions (starting with 4.3.1) and is expected to be relevant for subsequent versions of SecPop. A summary of previous versions of SecPop is also displayed in Table 1-1 below.

Table 1-1 SecPop Version History

SecPop Version	Updates Made
Version 4.0	Internal (within Sandia) development version
Version 4.1.0	Internal development version, initial development version after SecPop2000
Version 4.2.0	Internal development version, interface changes for usability to correct issues noted in version 4.1.9, includes support for 2010 census data and 2007 county data
Version 4.2.1	Includes correction for regional farm fraction
Version 4.2.2	Minor improvements, improved algorithm for assigning economic regions
Version 4.3.0	Minor usability improvements, includes ability to read in 2012 county file
Version 4.3.1	Modified dialog box control, previous controls were not all visible when running Windows 10
Version 4.4.0	Includes support for 2020 census data and 2017 county data, added support for locations in Alaska and Hawaii, updated to run on Java 17, updated documentation to clarify how population and economic multipliers are applied to the non-farm wealth per capita

1.3. Objective

The objective of this document is to provide guidance to users on the application and use of the SecPop code and to describe the models, algorithms, and sources of data for the calculations. The document provides step by step instructions on the installation, setup, and execution of site analyses in SecPop. The document also describes the validation tests and results.

1.4. Hardware and Software Requirements

SecPop is a Java-based program that was developed to run on a personal computer. The SecPop software requires approximately 1.3 gigabytes of hard-disk storage, which is primarily used to store census and county databases. Currently, the executable file that is distributed to install SecPop is compatible with Windows only and has been tested on Windows 10™ and Windows 11™ operating systems. Because it has not been tested on other operating systems, the user should perform basic testing for functionality and reliability if SecPop is installed on another operating system.

2. USER'S GUIDE

SecPop allows the user to estimate population, land use, and economic values related to a specific site. It creates a site file that is needed by MACCS to perform a site-specific offsite consequence analysis of the health-effect, economic, and environmental impacts of a hypothetical, atmospheric release of radioactive material from a nuclear facility.

The census files included with SecPop contain population and area information at the census block level. The county file contains economic and land-use information at the county level. SecPop provides estimates based on the site location, radial distances, and compass sectors centered on the site. The user enters the radii and selects the number of compass sectors for the grid. SecPop supports 16, 32, 48, and 64 compass sectors.

2.1. Installation

SecPop is installed by clicking on the SecPop Installer 4.4.0.exe file and selecting the menu entry "Run as Administrator" if you are logged in as a standard user. If you are logged in as an administrator, double clicking on the SecPop Installer 4.4.0.exe file starts the installation of SecPop. The installation process requires that the license agreement is accepted. Administrative privileges are required to install SecPop. The default installation folder is C:\Program Files\SecPop 4.4.0. This folder contains a folder named Census containing the 2020 census data (Census2020.bin and Census2020.aux), 2010 census data (Census2010.bin and Census2010.aux), the 2000 census data (Census00.bin), the 2017 county data (County2017.dat), the 2012 county data (County2012.dat), the 2007 county data (County2007.dat), and the 2002 county data (County2002.dat).

The installation folder also contains a folder named Sites containing the latitude and longitude coordinates of nuclear sites in the United States. These data can be imported by SecPop and used to define a site location. Additionally, the folder named Uninstall_SecPop removes the SecPop software from your computer.

After SecPop is installed, the entry SecPop 4.4.0 can be found in the Windows Start menu under "S" when looking at all apps. This is a link to SecPop.exe and selecting this link starts SecPop.

2.2. Menus

SecPop opens with the main menu, which consists of the following items listed along the top of the main application window.

- File menu is used to import a previously created site file or define program preferences such as the default file locations.
- Problem menu is used to create a new project, open an existing project, save, or close a project.
- Calculate menu is used to perform site-specific population and economic calculations.
- View Results menu is used to view results associated with the last calculation.
- Help menu is used to identify the current version number.

2.2.1. File Menu

2.2.1.1. Import Site File

The Import MACCS Site File command under the File menu is active when a project is open. Selecting the command opens a dialog box pointing to the default program directory and allows the user to select a MACCS Site File (.inp extension). An .inp file is a SecPop output file and does not need to have been created with the current SecPop version. Importing one of these site files populates several fields in the project tabs using values from the imported site file. Not every site file contains every needed SecPop input field, such as latitude and longitude. Comment fields in the imported site file are not copied to the project; however, the Problem Remarks field shows the name of the imported site file and the version of SecPop used to create it. This function allows the user to quickly create a new project from an existing site file.

2.2.1.2. Preferences

Clicking Preferences under the File menu opens a form that allows the user to choose the data files for SecPop to use and identifies the default locations for files, as shown in Figure 2-1. The Census File option opens a dialog box to the location of the current census file. The 2020 census (Census2020.bin), the 2010 census (Census2010.bin) and the 2000 census (Census00.bin) files are included with SecPop. The 2020 file is selected by default on installation.

The Economic File button is used to change the county file. Data are available from 2017 (County2017.dat), 2012 (County2012.dat), 2007 (County2007.dat), and 2002 (County2002.dat), with 2017 the default selection. It is generally recommended to use the most current versions of the data files; however, it is sometimes useful to be able to reproduce results based on the older data files. The 2002 county file can only be used with the 2000 census file; similarly, the 2007 and 2012 county files can only be used with the 2010 census file and the 2017 county file can only be used with the 2020 census file. SecPop generates an error message when incompatible file combinations are selected.

The Problem Directory button is used to select the default directory where projects and output are saved. The user needs to select the location where he or she wants to save SecPop projects. This only needs to be done once unless the user subsequently wants to change the location.

The Site Directory button is used to change the default location of predefined site-location (coordinate) files. These coordinate files, installed with SecPop, include the latitude and longitude for all U.S. reactors and some fuel facilities (see Appendix A for complete list). The user does not need to change this directory unless he or she manually moves the files.

Clicking Save closes the window and maintains directory locations selected by the user.

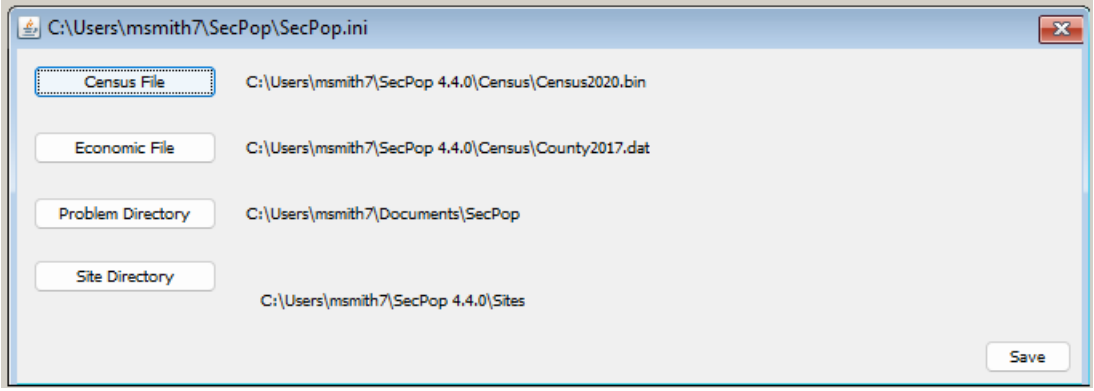


Figure 2-1 Preferences Window

2.2.1.3. Exit

Clicking Exit from the File menu closes the SecPop program. A message box opens, prompting the user to save the project settings of the current project (see Figure 2-2).

Clicking Yes saves the project settings and closes the application.

Clicking No does not save the project settings and closes the application.

Clicking the X in the upper right corner does not save the project settings and closes the application.

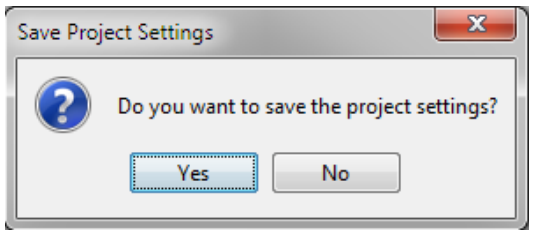


Figure 2-2 Save Project Settings Window

2.2.2. Problem Menu

The Problem menu contains functions that allow basic management of a SecPop project.

2.2.2.1. New

Under the Problem menu, clicking New opens a window (see Figure 2-3) displaying the default problem directory and a text box to enter a project name. The Problem Directory is initially the same as the directory defined in the Preference form but can be modified by clicking the Problem Directory button. A project name must be entered in the Project Name field before creating the new project.

The example used in this section is a 16-sector site file centered on Arkansas Nuclear One, a two-unit nuclear reactor site in Russellville, AR, based on a target year of 2022. It is recommended that the project name include the site, target year, and number of sectors. In this example, the project name is "Example - Arkansas - 2022 - 16 Sectors." A folder is created with this name in the problem directory. This is where the project file and any resulting output files are saved.

Clicking Save opens a project window that is described in Section 2.3 and illustrated in Figure 2-11.

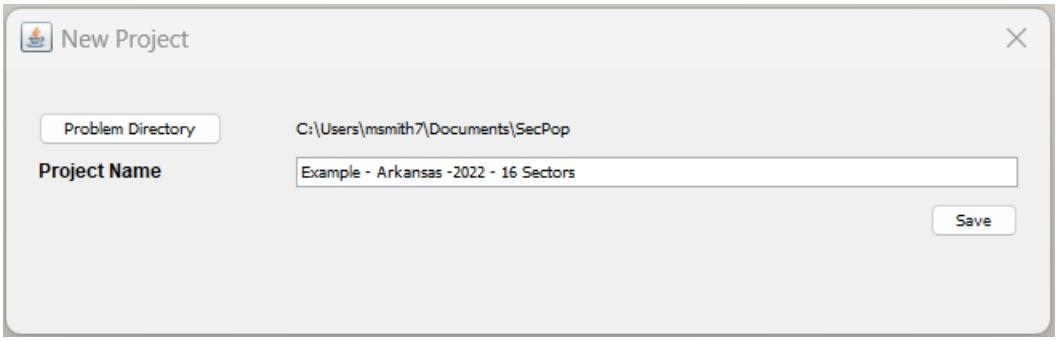


Figure 2-3 New Project Window

2.2.2.2. Open

Clicking Open in the Problem menu opens a dialog window as shown in Figure 2-4. The window is initialized to the default Problem Directory and filters for existing SecPop project files (.spproj extension). The user can navigate to any other folder where SecPop project files have been saved. Choosing a file and clicking Open opens a project window that is described in Section 2.3.

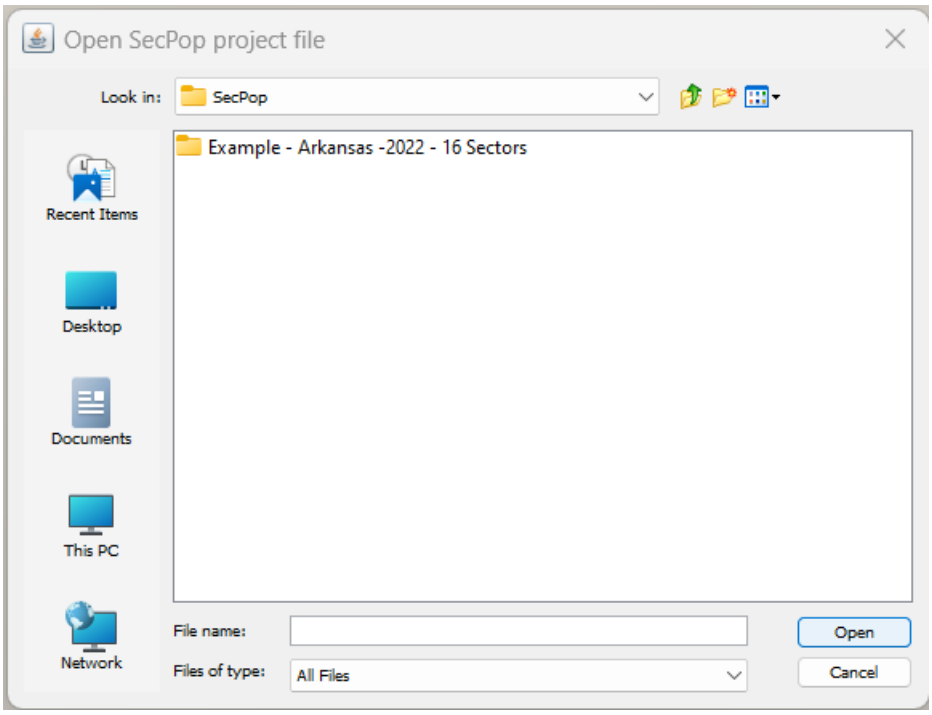


Figure 2-4 Open Existing Project Window

2.2.2.3. Save

Clicking Save in the Problem menu saves the current project settings to the project file.

2.2.2.4. Save As

Clicking Save As in the Problem menu opens a window similar to the one in Figure 2-3 that displays the default problem directory and a text box to enter a project name.

The Problem Directory is initially the same as the directory defined in the Preference form but can be modified by clicking the Problem Directory button.

A project name must be entered in the Project Name field.

After the new project directory is created, SecPop saves the project file with the values consistent with the previous project opened in the new project folder. None of the previous result files are copied to the new project directory.

2.2.2.5. Close

Selecting the Close option closes the current project but does not close the application. A dialog box is displayed as shown in Figure 2-2 .

Clicking Yes saves the project settings and closes the project.

Clicking No does not save the project settings and closes the project.

Clicking the X in the upper right corner does not save the project settings and closes the project.

2.2.3. Calculate Menu

Once all the input fields for the three tabs in the project window have been entered (discussed further in Section 2.3), a site-specific calculation may be performed by clicking on Population from the Calculate menu. At this point, the calculation window shown in Figure 2-5 opens.

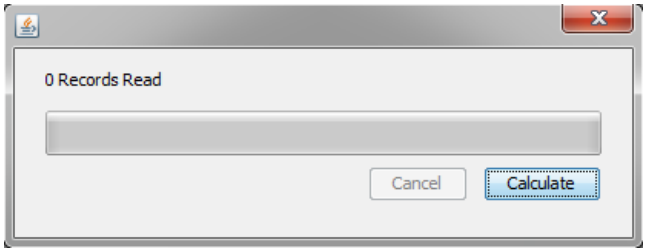


Figure 2-5 Calculate Window

When Calculate is clicked, SecPop checks to see if output files already exists in the project folder. If so, the message in Figure 2-6 appears, asking if output files should be overwritten. SecPop only checks for files with the default names, so renaming the output files or moving them into a different folder allows for multiple output sets to be saved in the project or other folder.

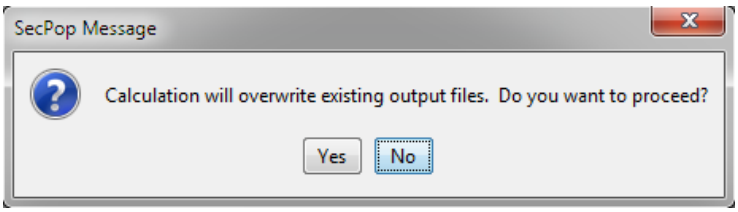


Figure 2-6 Message Window Warning the User

Once SecPop has checked for output files, it checks whether all required fields have been assigned correctly. If the information is incomplete, an error message is displayed. The missing information must be provided before the calculation can proceed.

The project settings are saved before the calculation starts. The status of the calculation is shown by updating the census block record counter and the status bar as shown in Figure 2-7. Cancel can be clicked to terminate the calculation. No intermediate results are available.

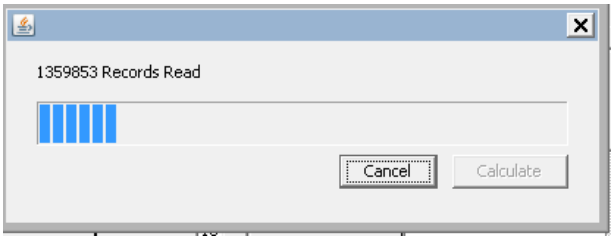


Figure 2-7 Calculation Status Window

Once the calculation is complete, the text "Calculation Completed" is displayed in the Calculate window, as shown in Figure 2-8, as well as the number of census blocks read. The results are available in the project folder.

Clicking the X in the upper right corner closes this window.

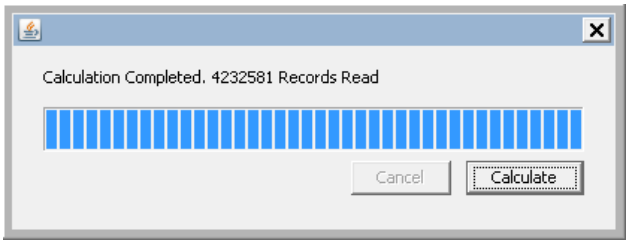


Figure 2-8 Calculate Window Showing Calculation Completed

2.2.4. View Results Menu

Once the calculation has completed, the commands to view result files are available in the View Results menu. These files are created automatically during a calculation. They are available to open in Notepad from the View Results menu. They can also be opened using other applications such as Excel or Word from the project folder. There are four types of results files, as described in Table 2-1. The name of each file begins with the project name followed by an extension. The sample file names are based on the project name MyProject.

Table 2-1 SecPop Results File Types

Menu Item	Sample File name	Description
MACCS Site File	MyProject.inp	MACCS formatted input file for use with MACCS and WinMACCS containing population, land use, and economic data
Extended Site File	MyProject_site_extended.tsv	Extended, tab-separated data file corresponding to the "MyProject.inp" file. Land use and economic data are reported by grid element rather than by economic region.
REAcct Input File	MyProject_REAcct.econ	MACCS formatted input file for use with the alternative, REAcct, GDP-based economic model. Contains county land-area fraction and county population fraction for each grid element in XML format.
REAcct Tab Separated File	MyProject _REAcct_Extended.tsv	Extended, tab-separated data file corresponding to the "MyProject_REAcct.econ" file. Contains county land-area fraction and county population fraction for each grid element in tab-separated format. Economic data from the county file are included for the counties referenced in this file.

The MACCS site file can be used for a MACCS calculation. The tab separated files are provided to facilitate post-processing of results in a spreadsheet program such as Excel. The REAcct input file and the REAcct tab-separated files described in Table 2-1 are not compatible with MACCS 3.11 and earlier versions but may be compatible with a future version.

All four of these files are saved automatically in the project folder as text files when the calculation is completed. Any text editor, such as Notepad, can be used to view these files. In addition to these files, the two tab separated files are formatted to be viewed in Excel. Displaying populations using a graphic rosette is not supported in SecPop 4.4.0.

2.2.4.1. MACCS Site File

The MACCS site file contains input to the MACCS offsite consequence analysis code. The file begins with two comment lines that contain quality assurance information and parameter settings. The first portion of a site file is shown in Figure 2-9. The data fields in the MACCS site file are described in Table 2-2.

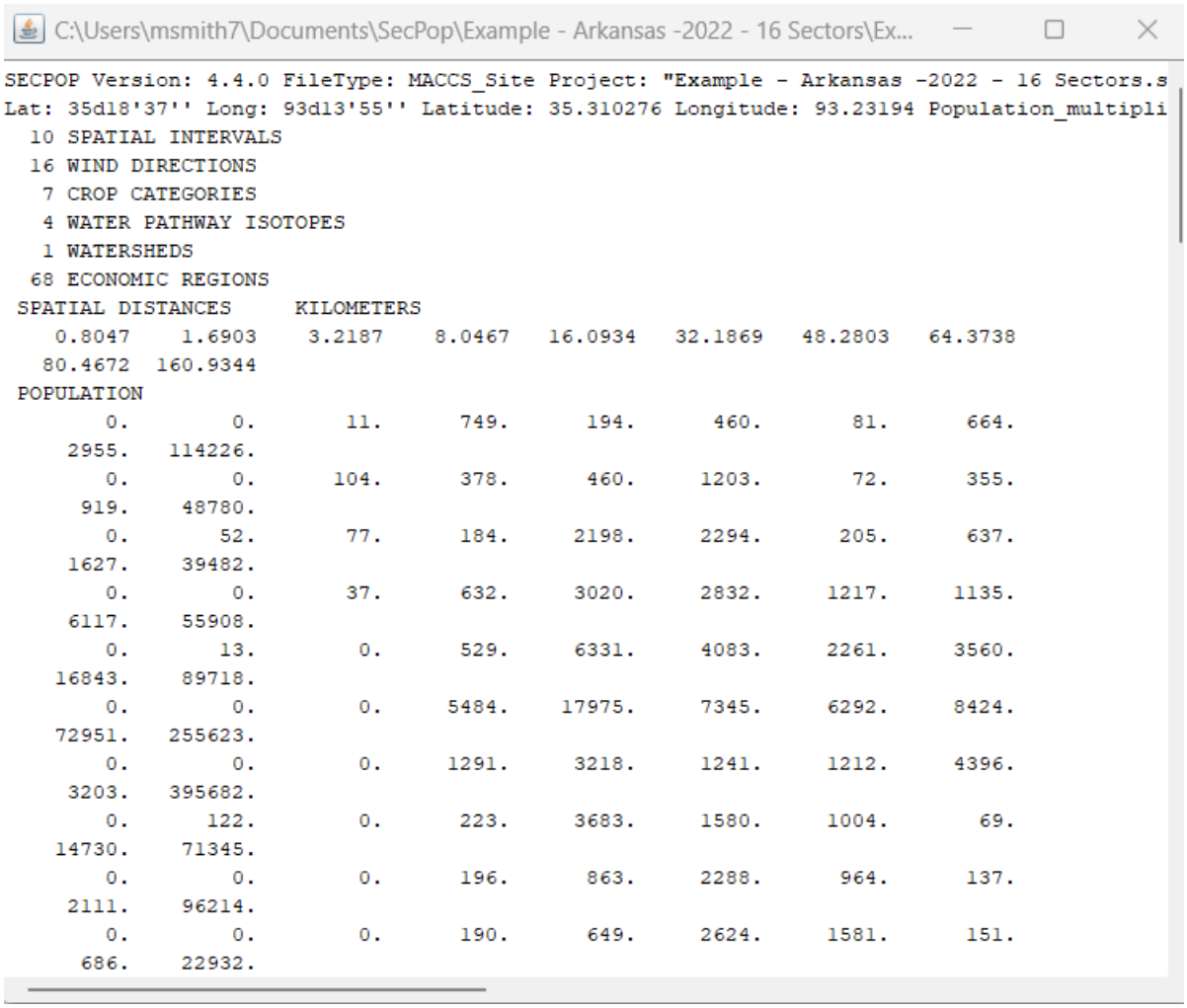


Figure 2-9 MACCS Input File (Site File)

Table 2-2 MACCS Input File Data Fields

Keyword	Description	Units
SPATIAL INTERVALS	Number of radial spatial intervals	None
WIND DIRECTIONS	Number of sectors in the spatial grid	None
WIND DIRECTIONS	Number of crop categories that are used by the food pathway model	None
WATER PATHWAY ISOTOPES	Number of radionuclides in drinking water pathway	None
WATERSHEDS	Number of water pathways	None
ECONOMIC REGIONS	Number of economic regions	None

Keyword	Description	Units
SPATIAL DISTANCES[1]	Distance to the outer radii of each ring	km
POPULATION	Number of people for each grid element	None
LAND FRACTION	Fraction of area that is land for each grid element	None
REGION INDEX	Economic region number for each grid element	None
WATERSHED INDEX	Defines watershed to use for each grid element	None
CROP SEASON AND SHARE	Name of Crop	None
	Start of the growing season	Julian Day
	End of the growing season	Julian Day
	Fraction of farmland used for the crop	None
WATERSHED DEFINITION	Radionuclide	None
	Ingestion Factor for watershed class 1	None
	Ingestion Factor for watershed class 2	None
	Ingestion Factor for watershed class 3	None
	Ingestion Factor for watershed class 4	None
REGIONAL ECONOMIC DATA	Economic region number	None
	Name of region	None
	Fraction of land used for farming	None
	Fraction of farm sales resulting from dairy	None
	Total annual farm sales	$/hectare
	Farmland property value	$/hectare
	Non-farmland property value	$/person

SecPop does not perform any calculations for estimating crop season and share or for estimating watershed data. The values in the site file for those categories (watershed index, crop season, crop share, watershed radionuclides, wash off rates, and ingestion factors) are default values. The default values are mostly the same as the ones used in NUREG-1150, with the exception that two watersheds were defined in NUREG-1150 to distinguish between freshwater and saltwater bodies in

[1] Note that the output files always show radial boundaries in kilometers, even if miles were used as the units for SecPop inputs.

terms of water ingestion. Only a single watershed is defined in the current version of SecPop because watershed definitions are highly site dependent and SecPop does not allow a user to enter this information through the interface.

If the user desires to modify any of these parameters, the site file must be edited manually after it is created. The MACCS site file is sensitive to the column numbers for the data, i.e., it is a fixed-format file. Additional information on the format and data fields for the MACCS site file can be found in the MACCS users' guide [4].

2.2.4.2. Extended Site File

The extended site file begins with two comment lines that contain quality assurance information and parameter settings used. The data fields in the extended site file are described in Table 2-3.

The differences between the extended site file and the MACCS site file are as follows:

- The watershed data are not included in the extended site file.
- The crop data are not present in the extended site file.
- The economic region data are not present in the extended site file.
- The extended site file format is tab separated rather than fixed.
- Grid data in the extended site file are listed so all values corresponding to a compass sector are on a single line. The MACCS site file breaks up the data associated with a compass sector into multiple lines.
- Economic data are listed for each grid element.

The extended site file is for the convenience of the user, is intended to be used with a spreadsheet program such as Excel and is not currently used as a MACCS input. Note that the extended file provides economic values for every grid element, independent of the economic regions defined in SecPop.

Table 2-3 Extended Site File Data Fields

Keyword	Description	Units
SPATIAL_INTERVALS	Number of radial spatial intervals	None
WIND_DIRECTIONS	Number of compass sectors in the spatial grid	None
SPATIAL_DISTANCES	Distance to the outer radius of each ring	km
POPULATION	Number of people who reside within each grid element	None
LAND_FRACTION	Fraction of area that is land for each grid element	None
FARM_FRACTION	Fraction of land used for farming	None
DAIRY_SALES_FRACTION	Fraction of farm sales resulting from dairy	None
AGRICULTURAL_SALES_PER_HECTARE	Total annual farm sales	$/hectare
FARM_VALUE_PER_HECTARE	Farmland property value	$/hectare
NON_FARM_WEALTH_PER_CAPITA	Non-farmland property value	$/person

2.2.4.3. REAcct Input File

The REAcct input file is in extensible markup language (XML) format, making it both machine and human readable. An XML formatted file is based on keywords and attributes associated with a keyword. An excerpt from a REAcct input file is shown in Figure 2-10 .

A REAcct input file lists each grid element starting with the keyword *Grid*. To identify a grid element, attributes of *radius*, *direction*, and *distance* are used.

For grid elements that contain one or more census blocks, each county that is at least partially contained in the grid element is included in the section named *County*. Each county is described by its name using the attribute *name* and its Federal Information Processing Standard (FIPS) code using the attribute *fips*. Population fraction and land area fraction within the county are described using the keywords *pop_frac* and *area_frac*. If a county is completely contained within the spatial grid, the sum of all population and area fractions in the REAcct input file are 1.0 for that county.

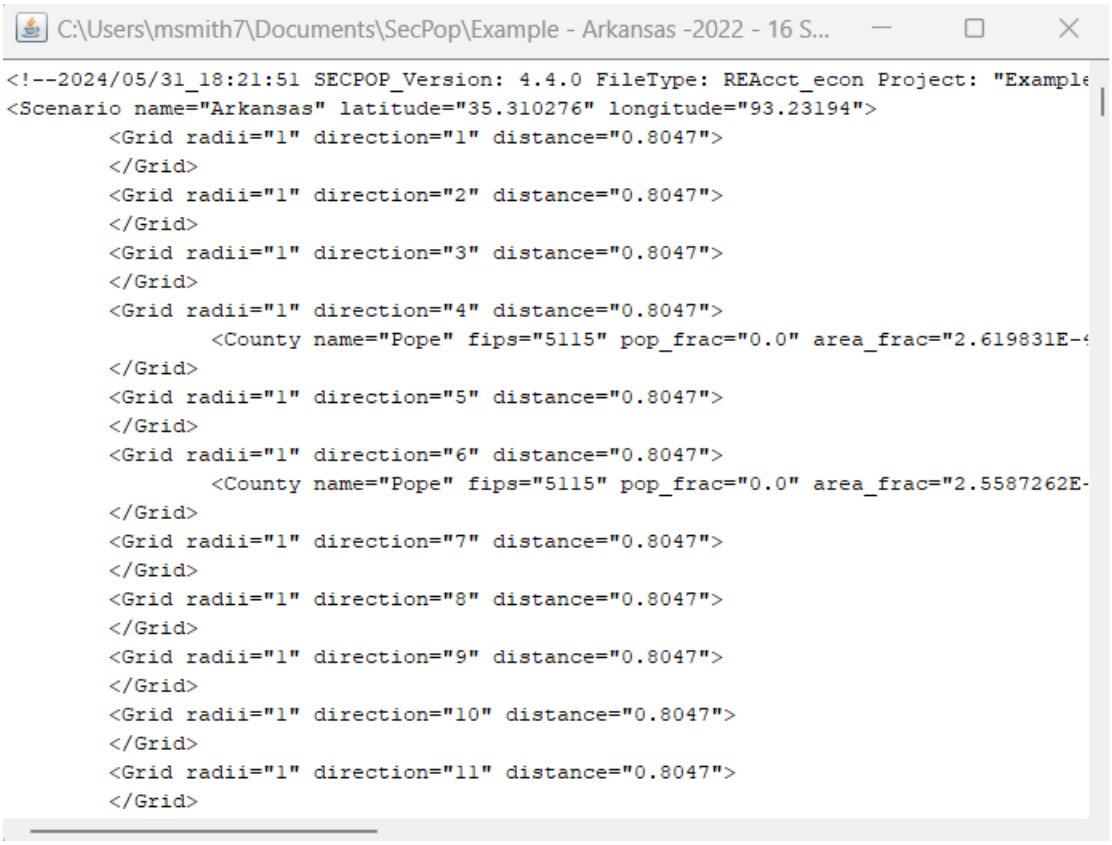


Figure 2-10 REAcct Input File

2.2.4.4. REAcct Tab Separated File

The REAcct tab-separated file contains the same information as the REAcct input file plus economic values for each county from the county file. The specific data fields are described in Table 2-4. This additional information is available for the benefit of the user for post-processing with a spreadsheet program such as Excel.

The features of the REAcct tab separated file that differ from the REAcct input file are as follows:

- The first two lines of the REAcct tab separated file contain quality control information. The next three lines contain headings.
- Only the grid elements that have census blocks assigned to them are listed.
- There is no hierarchical structure in the REAcct tab separated file. There is a single line for each county portion assigned to a grid element with repeated information as applicable.
- Each line is associated with a county. Additional information taken from the county data and census files is listed on the same line.

Table 2-4 REAcct_Extended.tsv File Data Fields

Data Group	Column	Description	Units
Data by Grid Element	1	Radius index	None
	2	Sector number (1 means north)	None
	3	Distance (outer radial boundary)	km
	4	Fraction of the county population residing within grid element	None
	5	Land area fraction of county area within grid element	None
County Description	6	County name	None
	7	State name	None
	8	County FIPS code	None
Data by County	9	Land area	m^2
	10	Population	None
	11	Land fraction	None
	12	Dairy fraction of agricultural sales	None
	13	Value of farm land	$/hectare
	14	Value of nonfarm wealth	$/person
	15	Agricultural sales	$/hectare
	16	County FIPS code (same as column 8)	None

2.2.5. Help Menu

The Help menu provides the full title of SecPop with the version number.

2.3. Project Tabs

When a project is opened, a window specifies the site-specific parameters. This window contains three tabs organizing the project parameters into three categories.

2.3.1. Basic Parameters Tab

The Basic Parameters tab is shown in Figure 2-11. The values on this tab are described in the following subsections.

2.3.1.1. Problem Remarks

Problem Remarks is a text field where project notes, such as a justification for a population and economic multiplier, can be entered. These notes are saved to the project file but are not echoed in any output file. This field is optional.

If a MACCS site file is imported into SecPop using the menu item File/Import MACCS Site File command, the name and path of the site file and the SecPop version used to create the MACCS site file is written to the *Problem Remarks* field.

2.3.1.2. Population Multiplier

A decimal number to be used as a population multiplier is entered in this field. This multiplier is uniformly applied throughout the grid. The default value is 1.0. This field is required and currently must be a positive number less than or equal to 10.

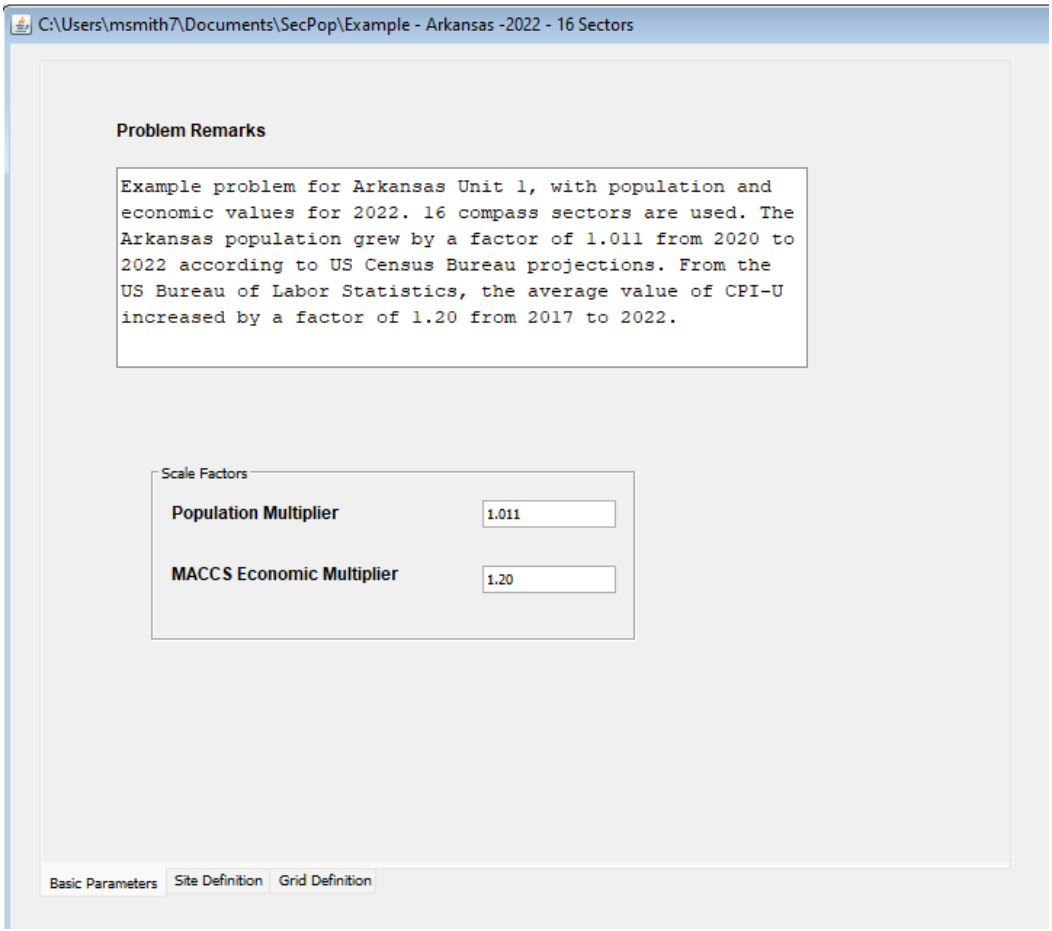


Figure 2-11 Basic Parameters Window

This multiplier is intended to facilitate calculations for years other than those represented by the census files. The U.S. census website has national and state level population forecasts that can be used to estimate an appropriate value for this multiplier. Since the multiplier is a real number, fractional population values can be generated.

For the Arkansas example, the population multiplier could be the target year (2022) population estimate for the state of Arkansas, 3,045,637[2], divided by the 2020-census Arkansas population, 3,011,524, yielding a population multiplier of 1.011. Note that this approach assumes the population in the calculational grid has the same growth rate as the whole state. If the calculational grid includes multiple states, the user could consider the population growth of each state and use a weighted average or simply consider the growth for the entire US.

2.3.1.3. MACCS Economic Multiplier

A decimal number multiplier for economic values is entered in this field. The default value is 1.0. This field is required and must be a positive number less than or equal to 10.

The multiplier is applied uniformly to all economic values contained in the county file, namely agricultural sales, farmland property values, and non-farm property values. This multiplier is intended to facilitate calculations for years other than those represented by the county files. Typically, an inflation factor based on the consumer price index (CPI) is used as the multiplier.

Additionally, for the non-farm property values only, the population multiplier is also applied to help ensure the wealth of the county remains the same if the population increases given it is derived using per capita estimations. Essentially, for this value only, the multipliers are applied as a ratio of economic increase over population increase.

For the Arkansas example, the economic multiplier could be estimated to be the amount of buying power $1 in 2017 has in the target year (2022). Using a CPI inflation calculator[3], this yields an economic multiplier of 1.20. This multiplier is applied to all values in the site file with units of dollars.

2.3.2. Site Definition Tab

The second tab in the project window is Site Definition, as shown in Figure 2-12. The components on the Site Definition tab are defined in the following paragraphs.

The required inputs on this tab are the latitude and longitude representing the location of the reactor or other facility. A set of these is provided for various nuclear power plant and nuclear fuel cycle facilities in the U.S. Coordinates represent the reactor center for a single unit site or the center point between reactors at a multi-unit site. Single unit analyses at a multi-unit site could also use coordinates centered on the reactor of interest. The coordinates should be reviewed to ensure they represent the specific release location of interest.

[2] See Population Estimates available at https://data.census.gov/table?q=2022%20arkansas%20total%20populationhttps://data.census.gov/table?q=2022%20arkansas%20total%20population

[3] See CPI Inflation Calculator at http://www.bls.gov/cpi/cpiurs.htm

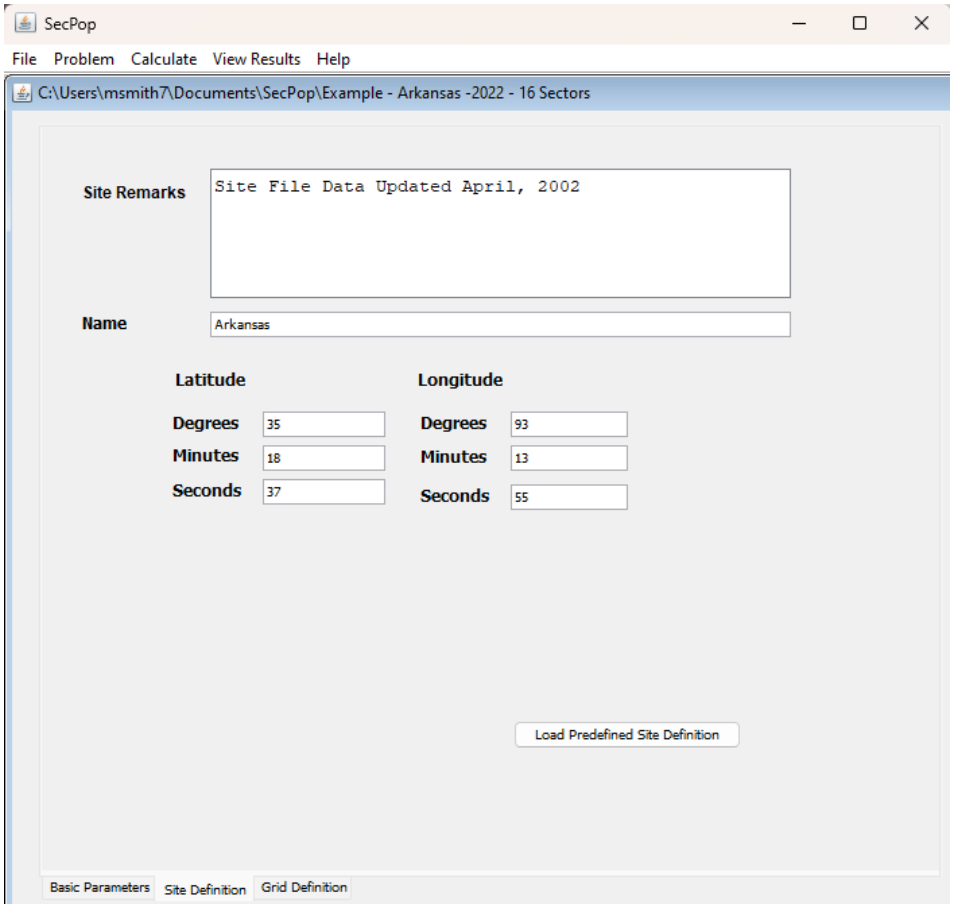


Figure 2-12 Site Definition Window

2.3.2.1. Site Remarks

Site Remarks is a text field where any notes about the site, for example plant specific information like containment type, may be entered. These notes are saved to the project file but do not appear in any output files. This field is optional. If a predefined site file is imported by clicking *Load Predefined Site Definition*, the *Site Remarks* field in the predefined site file is copied to this text field.

2.3.2.2. Name

The name field is a descriptive name of the reactor or facility. This field is printed in the REAcct input files but not the MACCS site files and has no impact on the SecPop calculations. This field is optional. If a predefined site file is imported by clicking *Load Predefined Site Definition*, the *Site Name* field in the predefined site file is copied to this text field.

2.3.2.3. Latitude and Longitude

The latitude of the site is entered in degrees, minutes, and seconds. Latitude is considered north and must be between 0 and 90. Negative values are not allowed. All three fields are required. Zeroes (0's) must be entered when the minutes or seconds are equal to zero.

The longitude of the site is entered as integer values of degrees, minutes, and seconds. Longitude is considered west and must be between 0 and 180. Negative values are not allowed. All three fields are required. A zero (0) must be entered when either the minutes or seconds are equal to zero.

Often, latitude and longitude are given in decimal format instead of degrees. The following example converts 72.5375 degrees to degrees, minutes, and seconds.

- The *Degrees* field is the integer portion of the decimal. In this example, it is 72.
- The *Minutes* field is the integer portion of (*Decimal – Degrees)**60. In our example, (72.5375 – 72)*60 = 32.25. The integer portion is 32 minutes.
- The *Seconds* field is ((72.5375 – *Degrees*)*60 – *Minutes)**60. In our example, this is (32.25 – 32) * 60, or 15 seconds. This number should be rounded to the nearest integer.

To convert from degrees, minutes, and seconds to a decimal value, use the following formula:

Decimal = *Degrees* + *Minutes*/60 + *Seconds*/3600.

SecPop checks to see if the coordinates of the site lie outside of the continental U.S. plus Hawaii and Alaska by comparing the coordinates to the minimum and maximum coordinates of the continental U.S., Hawaii, and Alaska SecPop considers the continental U.S. to be from latitude 24° to 49° north and longitude 65° to 126° west, Hawaii to be from latitude 18° to 29° north and longitude 153° to 179° west, and Alaska to be from latitude 51° to 72° north and longitude 129° to 180° west. If the coordinates are determined to be outside of these specified ranges, SecPop displays a warning message. This message does not stop the calculation from proceeding.

2.3.2.4. Load Predefined Site Definition

Instead of inputting the latitude and longitude manually, the more common option is to use one of the predefined coordinate (.sit) files that are distributed with SecPop by clicking *Load Predefined Site Definition*. A dialog window opens, initialized to the default directory for coordinate files as specified in the SecPop *Preferences* window. This default directory contains a coordinate file (.sit extension) for every operating reactor in the U.S. as well as some decommissioned reactors and fuel facilities (See Appendix A for a complete list). Selecting any of these files automatically populates the latitude and longitude fields, as well as the *Site Remarks* and *Name* text field. Figure 2-12 shows the results of selecting the coordinate file Arkansas.sit.

2.3.3. Grid Definition Tab

The third tab is the Grid Definition tab, as shown in Figure 2-13. The number of compass sectors, the radial boundaries, and the economic regions are chosen on this tab.

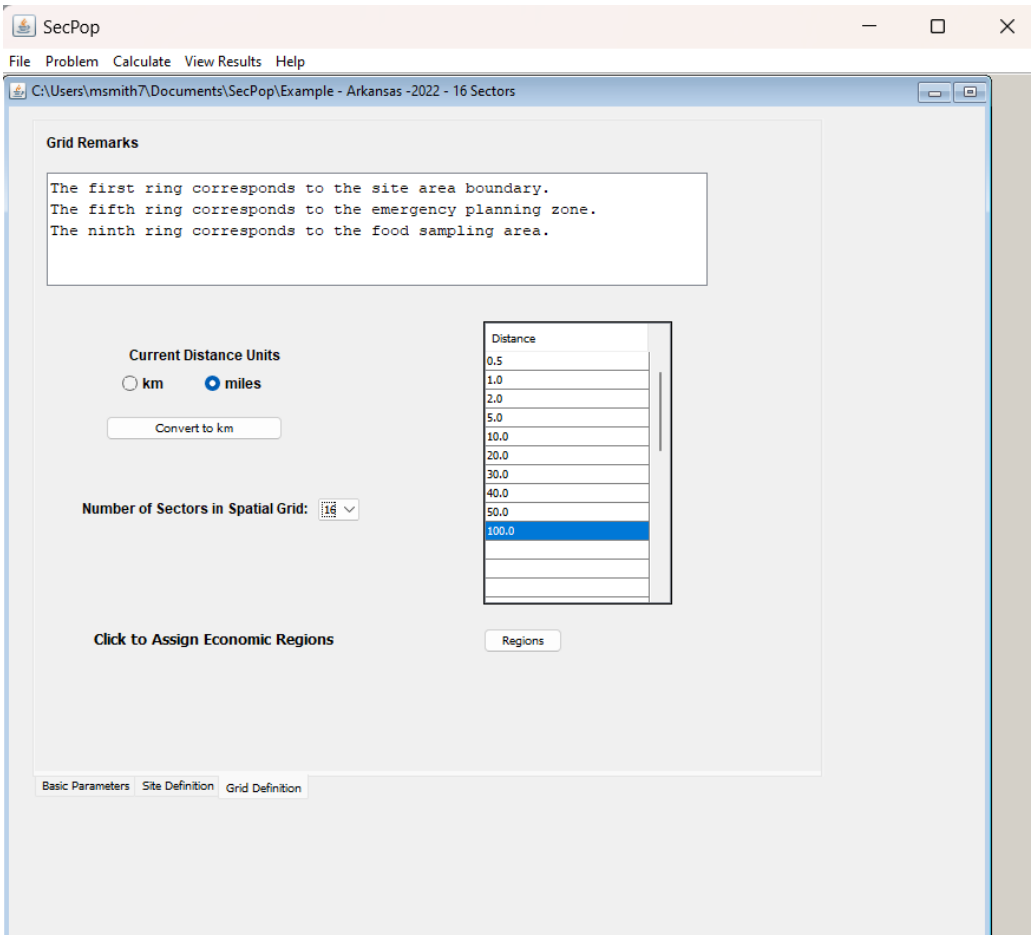


Figure 2-13 Grid Definition Window

The inputs of the grid definition tab are defined as follows.

2.3.3.1. Grid Remarks

Grid Remarks is a text field where any notes about the grid, for example justification for the radial distances, may be entered. These notes are saved to the project file but do not appear in any of the output files. This field is optional.

2.3.3.2. Current Distance Units

Radial distances can be entered in miles or kilometers. Clicking either *km* or *miles* defines the units used in the *Distance* grid.

2.3.3.3. Convert to km or Convert to miles

When the *Current Distance Units* is set to km, the button is labeled *Convert to miles*. Clicking this button converts all values in the *Distance* grid to miles. When the *Current Distance Units* is set to miles, the button is labeled *Convert to km*. Clicking this button converts all values in the *Distance* grid to km.

2.3.3.4. Radial Distances

The Grid Definition tab contains a table input field where the radii of interest for the problem are entered. Input is limited to 35 radii to maintain compatibility with MACCS. At least two radii must

be defined. The radii should be consistent with the number of radii (NUMRAD) and distances (SPAEND) to be used in MACCS. The radii and number of sectors are used to define a rosette around the facility for which each grid element has an assigned economic region number. Users should consider the magnitude of radionuclide release along with the purpose of the MACCS offsite consequence analysis to determine a calculational grid appropriate to capture offsite consequences.

2.3.3.5. Number of Sectors

A drop-down menu allows the user to choose the number of compass sectors in the spatial grid. The options are 16, 32, 48, and 64 sectors, with a default of 16 sectors. The number of sectors in SecPop must be the same as NUMCOR in MACCS. It must also be the same as the number of wind directions in the meteorological data file to be used by MACCS. Sector one is always centered on due north and the site is always at the center of the grid.

Figure 2-14 shows an example of a polar grid that has 16 compass sectors and nine radial rings. A sector is the same as a compass direction (16 total), while a grid element is a single cell in a compass direction. There are 16 × 9 = 144 grid elements shown in Figure 2-14.

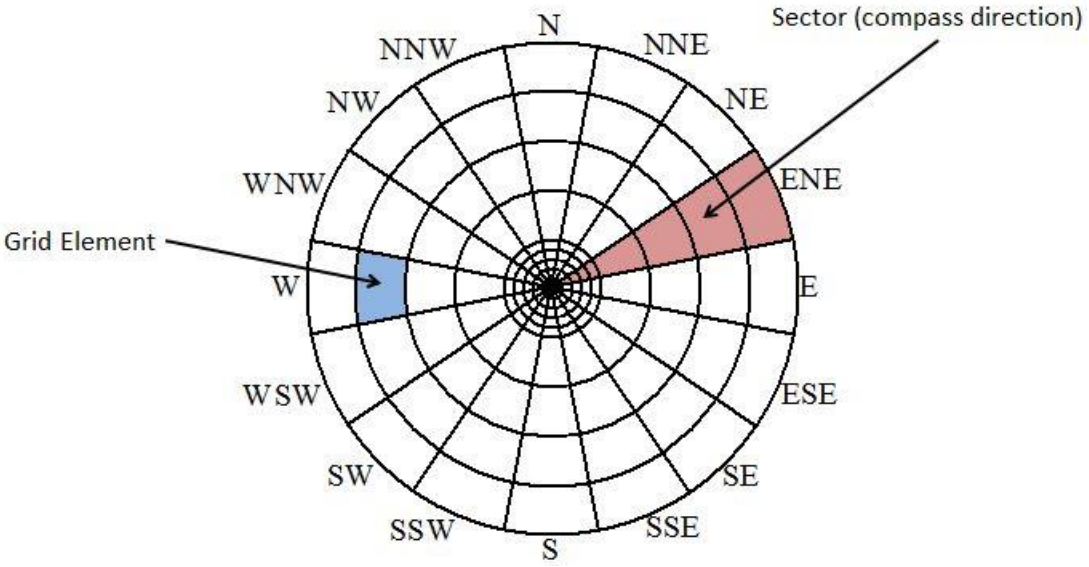


Figure 2-14 Example Polar Calculation Grid (Rosette)

2.3.3.6. Regions

Selecting "Regions" opens a window where economic regions are defined. This window is described further in the following section. At least two radii must be entered in the Grid Definition screen before the Regions window can open.

When economic regions are not defined by the user, SecPop automatically defines the regions when a calculation is requested. SecPop uses a simple algorithm that assigns the exclusion area to all grid elements within the first radius, a unique economic region to all grid elements between the first and second radii, and the same economic region to all other grid elements. This has the effect of defining a minimal exclusion area and applies the average land use and economic values over all grid elements beyond the second radius. This default definition of economic regions is useful only when economic

results are not important, so it is recommended in most cases to use the Assign Economic Regions function.

2.4. Assign Economic Regions Window

The final step before calculations are performed is to assign economic regions. Economic regions are defined by either importing an existing site file with economic regions already defined or by using the *Assign Economic Regions* form as described in this section.

Clicking *Regions* on the *Grid Definition* tab opens a window used to assign the economic regions, as shown in Figure 2-15.

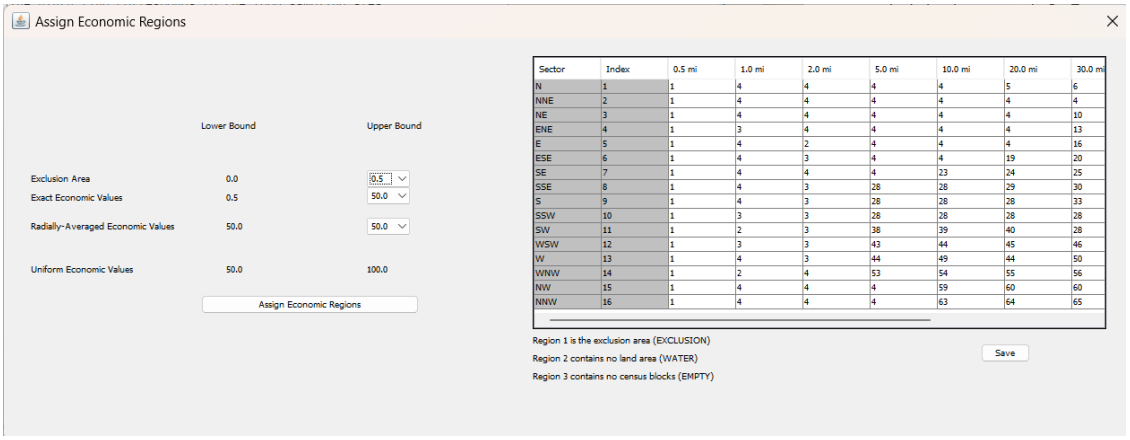


Figure 2-15 Economic Regions Window

There are three main options for assigning economic regions.

1. SecPop can assign region numbers to the grid based on the user-defined areas corresponding to the four region assignment types: exclusion area, exact economic values, radially-averaged economic values, and uniform economic values. The user enters the upper (outer) bound for each region assignment type using the drop-down menus and then clicks *Assign Economic Regions*.
2. Region numbers can be manually entered or modified in the grid.
3. Regions can be imported from an existing MACCS site file by using the *File/Import MACCS Site File* option in the main menu.

A detailed description of each region assignment type is provided below. The *Exclusion Area* is required to contain at least one ring. The *Lower Bound* and the *Upper Bound* may be equal for *Exact Economic Values and Radially-Averaged Economic Values.* In general, the use of different region types allows flexibility to specify the greatest resolution computational grid. Though region numbers may exceed the upper bound of 99 in this window, SecPop does not allow saving the economic region assignment when the upper bound of 99 economic regions is exceeded. The limit of 99 is the result of a current MACCS limitation that only allows the region index to be two-digit integers. This limit may be relaxed in the future and the need to average economic values over multiple grid elements may be eliminated. The current options for averaging economic values are described in this section.

2.4.1. Exclusion Area

The NRC defines the exclusion area as the area surrounding a reactor where the licensee has the authority to determine all activities, including exclusion or removal of personnel and property. It is expected that no population reside within it. The exclusion area boundary for a given reactor site is defined by the licensee. Each grid element within the exclusion area is assigned an economic region number of 1, as illustrated in Figure 2-15. This region is assigned zero population and zero economic values. This region type must contain at least the first ring.

If any people are found to be in the exclusion area, this population is not included in the SecPop calculation, and the user is alerted via a message window like the one in Figure 2-16. In this example, the exclusion area is assigned to the two inner rings corresponding to the area within 1.0 mile. SecPop calculates about 233 people in this area that would be excluded from the population array in the MACCS site file corresponding to the following compass directions in the ring from 0.5 to 1.0 mile: 3, 5, 8, 15, and 16 (corresponding to directions of NE, E, SSE, NW, and NNW). The actual population calculated by SecPop is not an integer because the population from the census data is multiplied by a real value to account for population growth. If this is not intentional, the radius of the exclusion area should be decreased so this population is not excluded from the calculation. In this Arkansas example, adjusting the exclusion area to be within 0.5 miles does not exclude anyone since no population is located within the 0.5-mile radius.

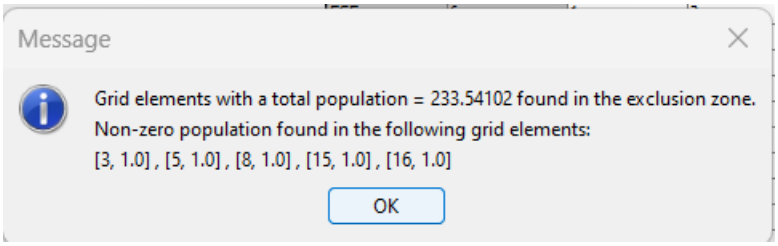


Figure 2-16 Non-Zero Exclusion Area Population Message

2.4.2. Exact Economic Values

When the user selects an area for the *Exact Economic Values* region assignment type, each grid element in that area usually has a unique economic region number assigned. However, there are a few exceptions to this rule. The first exception is when a grid element is comprised exclusively of one county. If one or more other grid elements are also exclusively comprised of the same county, these grid elements share the same region number. In this case, the MACCS site file uses the county name as part of the economic region description field. Another exception is when a grid element contains no land area, perhaps corresponding to a large river, lake or ocean. These grid elements are assigned to region number 2, which has zero population and zero economic values. The third exception is when a grid element contains no census blocks; these grid elements are assigned to region number 3. Region 3 has zero population but has economic data related to farmland. The user is reminded of the definitions for regions 1, 2, and 3 at the bottom of the Economic Regions window, as shown in Figure 2-15. The capitalized words shown in this legend (i.e., EXCLUSION, WATER, and EMPTY) are used as part of the region description in the MACCS site file.

Any grid element in this area that contains two or more counties is assigned a unique region number and the economic values of the counties in that grid element are weighted averages. Averaging is done by population weighting for nonfarm values and by land-area weighting for farm values.

The *Exact Economic Values* region assignment type provides the greatest resolution and therefore should be used for as much of the grid as possible. In the example shown in Figure 2-15, using exact economic values from 0.5 to 50 miles and uniform economic values from 50 to 100 miles creates 70 economic regions, which is below the upper bound of 99. When the computational grid uses more radii or more compass sectors, the user might need to take an iterative approach to adjust the upper bound radius for *Exact Economic Values* to keep the total number of regions below 100. As a rule, *Exact Economic Values* and *Radially Averaged Economic Values* should be used within the area for which economic results are to be reported. *Uniform Economic Values* should be reserved for the area beyond which economic results are to be reported.

2.4.3. Radially-Averaged Economic Values

When the user selects an area for the *Radially Averaged Economic Values* region assignment type, every grid element in this area that is in the same angular compass sector is assigned the same region number. The exception is when a grid element is composed of a single county that has previously been assigned a region number. In the example shown in Figure 2-15, this region assignment type is not used. However, in a more finely meshed computational grid, the maximum region number may exceed 99. In this case, it would be appropriate to use this region assignment type.

2.4.4. Uniform Economic Values

When the user selects an area for the *Uniform Economic Values* region assignment type, every grid element in this area is assigned the same economic region number regardless of angular compass sector or radius. The only exception is when a grid element is composed of a single county that has already been assigned a region number. In the example shown in Figure 2-15, this region assignment type is applied to the ring between 50 and 100 miles and all 16 grid elements in this area are assigned to region number 70. The grid elements with the same region number have economic values averaged over all represented counties, weighted by land area or population, depending on the economic value calculated. This region uses the coarsest approximation and in general should be used sparingly and outside the region for which offsite consequence analysis results are to be reported.

2.4.5. Assign Economic Regions

Once the areas are defined for each region assignment type, the user clicks *Assign Economic Regions*. The census file is read, and region numbers are assigned using the defined criteria. When the number of unique economic regions exceeds 99, the user should take an iterative approach to adjust the areas corresponding to the region assignment types of *Exact Economic Values* and *Radially Averaged Economic Values*. It is recommended that the user seek the greatest resolution possible while maintaining the total number of regions below 100. Each time these limits are adjusted, click *Assign Economic Regions* to redefine the assignment of economic regions. The census file only needs to be read the first time this button is clicked so subsequent revisions of the areas are relatively fast.

A large census block may span two or more grid elements but is only assigned to the one grid element that contains the centroid of the census block, potentially leaving surrounding grid elements defined as having no population. The user should also be aware of the possibility with concave-shaped census blocks for the centroid of population to lie outside the actual census block.

Grid elements with the same assigned region number have the same economic values assigned in the MACCS site file. Once the economic regions are defined, *Save* closes the window and saves the assigned regions. The window can also be closed at any time without saving by clicking the X in the upper right corner.

This page left blank

3. COMPUTATIONAL METHODOLOGY

The SecPop code uses block-level census data and county-level land use and economic data to estimate the population, land fraction, and other economic information for each of the user-defined grid elements. The methodology involved can be broken down into (1) the algorithms used within the code to accomplish this purpose and (2) the database structures used for the block and county level databases. This section discusses the algorithms for population estimation and determining distances based on latitude and longitude. Appendices B and C discuss the structure of the census and county files, respectively and the sources of data used to generate them.

3.1. Population Estimation and Density Algorithms

For a user-defined site location and radial grid, SecPop establishes latitude and longitude boundaries that encompass the grid for computational optimization. When a point (corresponding to a census block) is found to lie within the boundaries of the grid, the distance of that point from the site is calculated using the equations provided in the following subsection to determine if in fact the point lies within the outer limit of the grid. If the point meets the distance criteria, it is then processed to determine the exact grid element in which it lies based on its radial distance and direction from the site. The population associated with that data point is then added to the population of the appropriate grid element.

The algorithm used to determine the latitude and longitude boundaries of the grid is discussed in Subsection 3.1.1. The iterative algorithm used to determine the westernmost point in the census data file lying on or to the west of the western longitude boundary of the grid is discussed in Subsection 3.1.2. Finally, the algorithms used to determine if a data point lies within the grid and to determine the specific grid element within which any point lies are discussed in Subsection 3.1.3.

3.1.1. Boundaries Algorithm

The heart of the boundaries algorithm is the calculation of distance (in km) per degree latitude and per degree longitude for a specific geodetic latitude. The geodetic latitude is first converted to radians. The corresponding latitude in the master coordinate system, which is geocentric, is then calculated using Equation 3-1:

$$\theta_{GC} = \tan^{-1}\left[\left(\frac{R_{ep}}{R_{eq}}\right)^2 \tan\theta_{GD}\right] \qquad \text{Equation 3-1}$$

Where

θ_{GC} = the geocentric latitude (radians)
R_{ep} = the polar radius of the earth, 6356.752 km
R_{eq} = the equatorial radius of the earth, 6378.137 km
θ_{GD} = the geodetic latitude (radians)

The distinction between geodetic and geocentric latitudes is in the way angle is calculated in an ellipsoidal coordinate system. Geodetic latitude is based on the angle between the normal to the surface and the equatorial plane. Geocentric latitude is based on the angle between the equatorial plane and a line segment connecting a point on the surface with the center of the ellipsoidal

coordinate system. For an oblate ellipsoid, like the earth, the geodetic latitude is always greater in magnitude or equal to the corresponding geocentric latitude. They are equal at three loci, any point on the equator (both latitudes are zero) and at both of the poles (both latitudes are 90°).

The geocentric radius, R_{GC}, is then calculated using Equation 3-2:

$$R_{GC} = \frac{R_{eq} R_{ep}}{\sqrt{R_{eq}^2 \sin^2\theta_{GC} + R_{ep}^2 \cos^2\theta_{GC}}} \qquad \text{Equation 3-2}$$

The geocentric radius is the radius from the center to a point on the surface of an ellipsoid that approximates the actual shape of the earth, and this radius is a function only of latitude, as shown in Equation 3-2. The distance (km) per degree latitude, DPDLAT, and the distance (km) per degree longitude, DPDLON, are specified by Equations 3-3 and 3-4:

$$DPDLAT = R_{GC} \frac{\sin\theta_{GC}}{\sin\theta_{GD}} \cdot \left(\frac{\pi}{180}\right) \qquad \text{Equation 3-3}$$

$$DPDLON = R_{GC} \cos\theta_{GC} \cdot \left(\frac{\pi}{180}\right) \qquad \text{Equation 3-4}$$

It can be shown that if the west-east longitudinal boundaries are established at the longitudes corresponding to the boundary of the outer radius of the grid on the latitude of the site, the entire grid lies between those same two longitudinal boundaries. The values of those longitudinal boundaries can be found by dividing the outer radius of the grid by DPDLON, the distance per degree longitude at the geodetic latitude of the site.

Finding the north and south latitudinal boundaries is more complex. The distance per degree latitude decreases with increasing latitude. To ensure that the boundaries encompass the entire grid, distance per degree latitude determined at the Tropic of Cancer is used for the half of the grid lying below the latitude of the site, and the distance per degree latitude determined at the site is used for the half of the grid north of the site. As a result, the north and south boundaries are always outside the grid, but this is acceptable since the boundaries are used only to eliminate the census data points that do not need to undergo further processing.

3.1.2. First Element Location Algorithm

A binary search algorithm is used to determine the first point in the census data file that lies on or to the west of the western longitudinal boundary of the grid. The set of records in the census data file is divided into two halves and it is determined in which half the western boundary lies. The procedure is then repeated concentrating on that half of the set. This is continued until one of two situations occurs. If two adjacent points are found which straddle the boundary, the easternmost record is marked. If a point is found that lies on the western boundary, the records are searched backward sequentially until the first of the data elements is found that lies to the west of the boundary and that point is marked.

3.1.3. Specific Grid Element Determination

When a census data point is found to lie within the longitudinal and latitudinal boundaries of the grid, a SecPop algorithm calculates the surface distance (the distance measured along the surface of

the earth) between the census data block center point and the site center point. If the distance is less than the outer radius of the grid, then the census block lies within the region of interest. Surface distance is calculated using the Pythagorean theorem based on longitudinal and latitudinal distances. Longitudinal distance is calculated by multiplying the difference in longitudes between the site and the element by the value of DPDLON calculated for the site. Similarly, latitudinal distance is calculated by multiplying the difference in latitudes by an average DPDLAT. Since values for DPDLAT vary significantly with latitude, the value used is the average of the value calculated at the site and the value at the census block. The census data element is then located within a radial ring based on this surface distance. This method essentially introduces a local flat plane approximation to earth's surface.

Once it is determined that a census block lies within the grid, it is then necessary to determine in which of the grid elements the census data point lies. The angle (measured clockwise from true north) of a line from the site center to the census block is found from Equation 3-5:

$$\theta_{de} = \tan^{-1}\left(\frac{x}{y}\right) \qquad \text{Equation 3-5}$$

Where

θ_{de} = the angle made between a line from the site to the data element and true north
x = the distance from the longitude of the data element to the longitude of the site
y = the distance from the latitude of the data element to the latitude of the site

This value, θ_{de}, is then used to determine the specific grid element in which the census block is located.

3.2. Land Fraction Algorithms

In addition to location and population, every record in the block-level database also includes the land area of the block and a code to indicate which county in the U.S. the block resides. In addition, the 2010 and 2020 census files contain water area for each census block. Total area of the block is the sum of land and water areas. This additional information allows for a finer granularity of land-fraction data than was available with previous census data. This information is used by both the land-fraction algorithm and the economic-factors algorithms to estimate land fractions and economic factors, respectively.

County-level databases contain the land-fraction data for every county in the continental U.S. The sources for the economic factors and the sources of the data are described in Table 3-1.

With the 2000 and earlier census files, the area of the census blocks cannot be used to determine section land fractions directly for two reasons. First, the area given is only the land area; no water area is included with the block-level data. Second, there is no simple way to aggregate the block areas to determine how much of a of a grid element they "fill up" since the geometry of the blocks is unknown. Instead, the area of the blocks is used to weight the county-level land fraction data.

With the 2010 and 2020 census data, this deficiency is resolved. Data at the census-block level contains both land and water areas, so land fraction data at the county level are not needed. This allows a higher level of granularity with the 2010 and 2020 data.

Table 3-1 County Level Data File Variables and Data Sources

Variable	Description	Source for COUNTY2002.DAT (compatible with 2000 census file)	Source for COUNTY2007.DAT (compatible with 2010 census file)	Source for COUNTY2012.DAT (compatible with 2010 census file)	Source for COUNTY2017.DAT (compatible with 2020 census file)
FRMFRC	Fraction of land devoted to farming in the region	2002 Census of Agriculture Data Files Supplied by the U.S. Department of Commerce Economics and Statistics Administration Bureau of the Census	2007 Census of Agriculture Data Files Supplied by the U.S. Department of Commerce Economics and Statistics Administration Bureau of the Census	2012 Census of Agriculture Data Files Supplied by the U.S. Department of Commerce Economics and Statistics Administration Bureau of the Census	2017 Census of Agriculture Data Files Supplied by the U.S. Department of Commerce Economics and Statistics Administration Bureau of the Census
DPF	Fraction of farm sales resulting from dairy production in the region				
ASFP	Annual average farm sales for the region ($/hectare)				
VFRM	Average farmland value for the region ($/hectare)				
VNFRM	Average non-farm value for the region ($/person)	2003 and 2004 Statistical Abstract of the United States, U.S. Dept. of Commerce, Economics and Statistics Admin., Bureau of the Census 2004 County and City Data Book, U.S. Dept. of Commerce, Bureau of the Census, Data User Services Div.	2008 and 2009 Statistical Abstract of the United States, U.S. Dept. of Commerce, Economics and Statistics Admin., Bureau of the Census 2009 County and City Data Book, U.S. Dept. of Commerce, Bureau of the Census, Data User Services Div.	2013 and 2014 Statistical Abstract of the United States, U.S. Dept. of Commerce, Economics and Statistics Admin., Bureau of the Census 2014 County and City Data Book, U.S. Dept. of Commerce, Bureau of the Census, Data User Services Div.	2018 and 2019 Statistical Abstract of the United States, U.S. Dept. of Commerce, Economics and Statistics Admin., Bureau of the Census 2019 County and City Data Book, U.S. Dept. of Commerce, Bureau of the Census, Data User Services Div.

During a site-specific calculation, a running sum for each grid element is made of the total area of the blocks that lie within each section and a running sum is made of all the weighted land fraction

data. At the end of the calculation, the sum of the weighted land fractions is divided by the sum of the block areas. For the 2000 (and older) census data, this is equivalent to the following formula for the land fraction for grid element i, j:

$$FRCLND\_2000(i,j) = \frac{\sum_n LA_{Block} \times FRCLND(County_{Block})}{\sum_n (LA_{Block})} \qquad \text{Equation 3-6}$$

Where

$FRCLND(i, j)$ = the estimated land fraction for the grid element defined by sector i and the area between radii j and $j-1$ (where $j = 0$ refers to the center of the grid, i.e., a radius of zero),

$FRCLND(County_{Block})$ = the land fraction of the county in which the present census block resides,

LA_{Block} = the land area of a census block whose centroid is within grid element (i,j), and

N = the number of census blocks that resides in grid element (i, j).

For the 2010 (and 2020) census data, the algorithm takes account of the additional information provided in the database by using the following equation to estimate land fraction for a grid element:

$$FRCLND\_2010(i,j) = \frac{\sum_n LA_{Block}}{\sum_n (LA_{Block} + WA_{Block})} \qquad \text{Equation 3-7}$$

Where

WA_{Block} = the water area of a census block whose centroid is within grid element (i,j).

Note that in areas where census blocks tend to be large, e.g., lakes, deserts, national and state parks, it is possible that no census block centroid lies within a grid element and the resulting land fraction is estimated to be 0. While this is appropriate for a lake, it may not represent desert regions accurately. The user may need to edit the output data manually in such cases to obtain a better estimate for areas that do not contain census block centroids. Whenever the denominator of Equation 3-6 or 3-7 is zero, the estimated value is assigned to be zero. The current version of SecPop clearly identifies grid elements with land but no population by assigning them an economic region index of 3. When the entire area of the grid element is water, the economic region index is set to 2.

3.3. Economic Factors Algorithms

SecPop estimates the economic factors that are defined in the Site Data File. The economic factors are calculated for the user-defined economic regions. The user can define the number of rings that comprise the exclusion area, and this region is assigned an economic region index of 1. The economic values assigned to this region are zeros because MACCS is not intended to calculate onsite consequences.

The algorithm used to calculate the economic factors is very similar to that used in Section 3.2. The only difference is that the values are accumulated for each economic region instead of each grid element. The county-level database has values for each economic factor by county. The Economic Factor (*EF*) for each economic region, *i*, is calculated using the following equation:

$$EF(i) = \frac{\sum_{n} LA_{Block} \times EF(County_{Block})}{\sum_{n} LA_{Block}} \qquad \text{Equation 3-8}$$

Where

$EF(i)$ = the estimated economic factor for economic region i,
$EF(County_{Block})$ = the economic factor of the county in which the census block resides,
LA_{Block} = the land area of a census block that lies within an economic region i,
n = the number of census blocks that belong to economic region i.

The exception to using Equation 3-8 to estimate economic factors is for the average nonfarm value for a region, VNFRM, when calculated in conjunction with 2010 or 2020 census data. In this case, the weighting is based on population rather than land area. The weighting is based on land area (Equation 3-8) when using 2000 census data for compatibility with older versions of SecPop. For this one specific case, Equation 3-8 is replaced with Equation 3-9 below.

$$VNFRM(i) = \frac{\sum_{n} POP_{Block} \times VNFRM(County_{Block})}{\sum_{n} POP_{Block}} \qquad \text{Equation 3-9}$$

Where

$VNFRM(i)$ = the estimated average per capita nonfarm value for economic region i,
$VNFRM\ (County_{Block})$ = the per capita nonfarm value of the county in which the census block resides, and
POP_{Block} = the population of a census block that belongs to economic region i.

3.4. Database Structure

The database files that are distributed with SecPop are the block-level census files, Census00.bin, Census2010.bin and Census2020.bin, and the county-level files, County2002.dat, County2007.dat, County2012.dat, and County2017.dat. The 2000 and 2020 block-level census databases contain nearly eight million records, while the 2010 block-level census database contains eleven million records, corresponding to the number of census blocks at the time of each census. The county-level census database contains over three thousand records, one for every county in the U.S. Only subsets of the possible combinations of census and county files are allowed because of changes in the sets of counties included circa 2000, circa 2010, and circa 2020. Specifically, Census00.bin is compatible with County2002.dat, Census2010.bin is compatible with County2007.dat and County2012.dat, and Census2020.bin is compatible with County2017.dat. The sections below describe the databases in more detail.

3.4.1. Block-Level Database

The 2000, 2010, and 2020 block-level census data are stored in binary files, Census00.bin, Census2010.bin, and Census2020.bin. The 2000 data contain 7,938,746 records (census blocks), the 2010 data contain 11,007,989 records, and the 2020 data contain 8,132,968 records. The 2000 and 2010 data used by SecPop are subsets of the original census data because they exclude Alaska, Hawaii, and the US territories but the 2020 data included Alaska and Hawaii. Each record is 12 bytes long and contains the following five pieces of information:

(1) a 2-byte integer code for the longitude of the geometric centroid of the census block,
(2) a 2-byte integer code for the latitude of the geometric centroid of the census block,
(3) a 2-byte integer for the residential population that resides within the census block,
(4) a 4-byte integer for the land area (0.001 km^2) of the census block, and
(5) a 2-byte integer code for the county in which the census block resides.

The integer codes for the longitude and latitude were derived to reduce the storage required for the block-level database. The longitude can be calculated using the following formula:

longitude = (integer_code + 91993) / 1000.0

The latitude can be calculated using the following formula:

latitude = (integer_code + 16610) / 1000.0

The integer code for the county is the index to the county-level database and is the first field in each record of that database. More information on the county-level database can be found in the next sub-section. Details on how the block-level databases were constructed and verified can be found in the appendices.

3.4.2. County-Level Database

The county-level data are stored in a fixed-width format ASCII text file. The file County2002.dat is used with the year 2000 census data files. The County2007.dat and County2012.dat files are used with the year 2010 census data files. The file County2017.dat is used with the year 2020 census data files. The county-level database files contain a line of data for each of the 3109 counties in the contiguous United States. The County2017.dat file contains a line of data for 3,143 counties because it includes Alaska and Hawaii. The data in these files are preceded by one header line.

The 2007, 2012, and 2017 county data files contain only non-census information. These county data files contain the following fields for each county:

FIPS Code	standard US federal code that identifies the state and county
State	two-letter abbreviation of the state in which the county lies
County Name	name of the county
FRCLND	fraction of area that is land in the county
FRMFRC	fraction of land devoted to farming in the county
DPF	fraction of farm sales resulting from dairy production in the county
ASFP	annual-average farm sales for the county ($/hectare)
VFRM	average farmland value for the county ($/hectare)
VNFRM	average non-farm value for the county ($/person)

Notes comma separated fields describing data exceptions. Exceptions are listed in the order of FRMFRC, DPF, ASFP, FVFRM and VNFRM.

- "-" signifies that the data are listed in the agricultural census table with a value of zero for the respective field
- "d" signifies that the data are listed in the agricultural census table but data was withheld by the census bureau for confidentiality purposes
- "ex" signifies that the data are not listed in the agricultural census table and for this reason was assigned value of zero
- "b" signifies that farm area reported slightly exceeds county land area, and for this reason was assigned the value of one
- "pci" signifies that BEA combined an independent city and its neighboring county with a single PCI so the same value is applied to each
- "IC" signifies that the county is actually an independent city that has its own FIPS code

A sample of the 2017 database is shown in Table 3-2 . The 2007 and 2012 database follow the same format.

Table 3-2 Excerpt From the 2017 County-Level Database

Fips	State	County	FRCLND	FRMFRC	DPF	ASFP	VFRM	VNFRM	Notes
53001	WA	Adams	0.997506	0.789043	0	925	12263	355329	, d, , , ,
53003	WA	Asotin	0.993193	0.616243	0	127	29701	425559	, -, , , ,
53005	WA	Benton	0.966146	0.563894	0	4049	19520	434196	, d, , , ,
53007	WA	Chelan	0.975546	0.031969	0	10685	43811	480019	, -, , , ,
53009	WA	Clallam	0.651454	0.015454	0	1728	41223	421599	, d, , , ,

The census specific fields, namely the population and the area, are written to an auxiliary file used by SecPop when the 2007, 2012, or 2017 county data are used. This information is created from the census database. This files, Census2010.aux and Census2020.aux, contains the following fields for each county:

FIPS Code	standard US federal code that identifies the state and county
State	two-letter abbreviation of the state in which the county lies
County Name	name of the county
LandArea	county land area in m**2
WaterArea	county water area in m**2
Population	county population

A sample of the Census2020.aux data file is shown in Table 3-3.

Table 3-3 Excerpt From the 2020 Census Auxilliary Database

Fips	State	County	Land Area	Water Area	Population
53001	WA	Adams	4.99E+09	1.25E+07	20613
53003	WA	Asotin	1.65E+09	1.13E+07	22285
53005	WA	Benton	4.40E+09	1.54E+08	206873
53007	WA	Chelan	7.57E+09	1.90E+08	79074
53009	WA	Clallam	4.50E+09	2.41E+09	77155

The 2002 county data file contains similar data. However, an additional county index needed for the previous software, SecPop2000, is included in the file. Because the census population and area information is included in the 2002 county data file, it is not necessary to have an auxiliary file containing the census specific information.

This page left blank

REFERENCES

[1] NUREG/CR-6525, SAND93-4032, "SECPOP90: Sector Population, Land Fraction and Economic Estimation Program," U.S. Nuclear Regulatory Commission, Washington, DC, 1993 (ADAMS ML18053A699).

[2] NUREG/CR-6525, Rev. 1, "SECPOP2000: Sector Population, Land Fraction, and Economic Estimation Program," U.S. Nuclear Regulatory Commission, Washington, DC, 2003 (ADAMS ML032310279).

[3] NUREG/CR-6525, Rev. 2, "SecPop Version 4: Sector Population, Land Fraction, and Economic Estimation Program, User Guide, Model Manual, and Verification Report," U.S. Nuclear Regulatory Commission, Washington, DC, 2019.

[4] SAND2023-01315, "MACCS User Guide – Version 4.2," Sandia National Laboratories, Albuquerque, NM, 2023.

This page left blank

APPENDIX A. COORDINATE (.SIT) FILES

Table A-1 lists all the coordinate files provided with SecPop in the SecPop\Sites directory. The coordinates provided with each site were obtained from aerial views using publicly available software. For precise estimates, users should confirm site specific coordinates.

Table A-1 SecPop Coordinate (.Sit) Files

Operating Power Reactor Sites		
Arkansas.sit	Ginna.sit	Prairie Island.sit
Beaver Valley.sit	Grand Gulf.sit	Quad Cities.sit
Braidwood.sit	Hatch.sit	River Bend.sit
Browns Ferry.sit	Hope Creek.sit	Robinson.sit
Brunswick.sit	Indian Point.sit	Salem.sit
Byron.sit	Joseph M Farley.sit	Seabrook.sit
Callaway.sit	Lasalle.sit	Sequoyah.sit
Calvert Cliffs.sit	Limerick.sit	Shearon Harris.sit
Catawba.sit	Mcguire.sit	South Texas.sit
Clinton.sit	Millstone.sit	St Lucie.sit
Columbia Gen Sta.sit	Monticello.sit	Surry.sit
Comanche Peak.sit	Nine Mile Point.sit	Susquehanna.sit
Cooper.sit	North Anna.sit	Three Mile Island.sit
Davis-Besse.sit	Oconee.sit	Turkey Point.sit
Diablo Canyon.sit	Palisades.sit	Virgil Summer.sit
Donald C Cook.sit	Palo Verde.sit	Vogtle.sit
Dresden.sit	Peach Bottom.sit	Waterford.sit
Duane Arnold.sit	Perry.sit	Watts Bar.sit
Fermi.sit	Point Beach.sit	Wolf Creek.sit
Fitzpatrick.sit		
Shutdown Power Reactor Sites		
Big Rock Point.sit	Lacrosse.sit	San Onofre.sit
Crystal River.sit	Maine Yankee.sit	Trojan.sit
Ft Calhoun.sit	Oyster Creek.sit	Vermont Yankee.sit
Haddam Neck.sit	Pilgrim.sit	Yankee Rowe.sit
Kewaunee.sit	Rancho Seco.sit	Zion.sit
Fuel Cycle Facility Sites		
Advanced Medical Systems.sit	Idaho NatL Engineering And Environ.sit	Portsmouth.sit
Bwx Technologies.sit	Mallinckrodt.sit	Richland Framatome.sit
General Atomics.sit	Morris General Electric.sit	Safety Light Corp.sit
Hanford Meteorological Tower.sit	Nuclear Fuel Services.sit	Squibb.sit
Hematite - Combustion Engr.sit	Oak Ridge.sit	Westinghouse Elec Corp.sit
Honeywell.sit	Paducah.sit	Wilmington Ge.sit

This page left blank

APPENDIX B. 2020 CENSUS FILE

This section describes the development of the 2020 census file for the SecPop code. All information needed to create the 2020 census file was obtained from the U.S. Census Bureau, specifically the 2020 Census: Redistricting File (Public Law 94-171) Dataset[4]. Each state has four *.pl files that make up the Legacy Format Summary Files[5]. The geographic content file, an example shown in Figure B-1 below, contains the needed block information for the census file as well as county information needed for the county file. This data extraction process is much different than what was done previously for the 2010 census file as the census data extraction software that was used is no longer available.

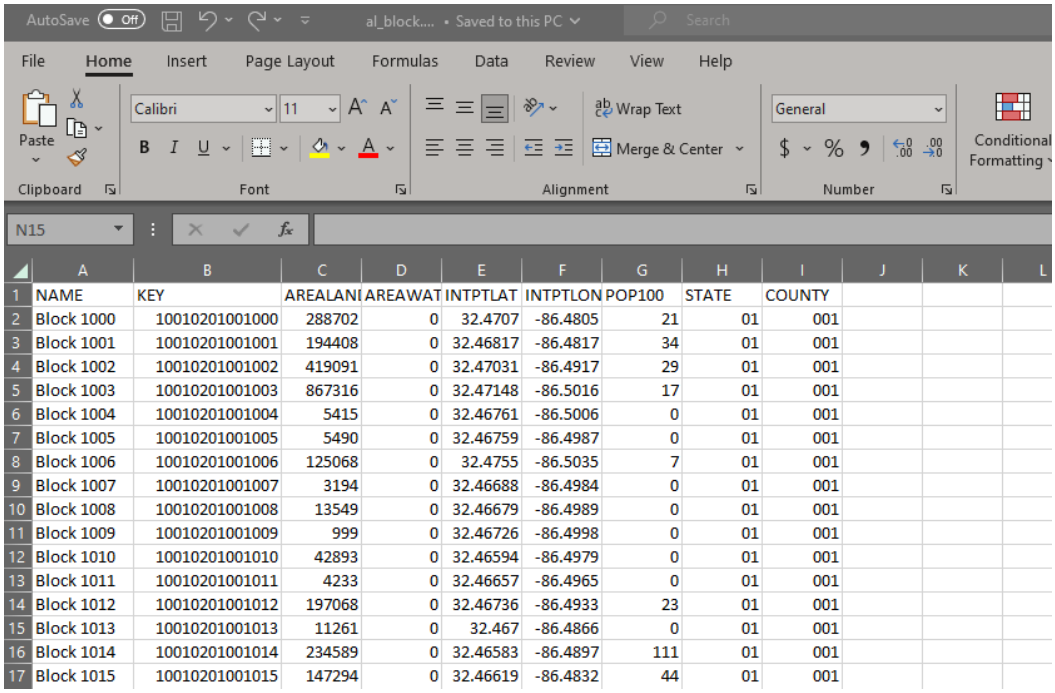
Figure B-1 Example Geographic Content File

From this file, the following variables are extracted for each state for use in SecPop and placed in individual Excel files as shown in Figure B-2 below.

- Block name
- Geographic code identifier
- Area (Land) (in units of 1 m^2)
- Area (Water) (in units of 1 m^2)
- Internal Point (Latitude)
- Internal Point (Longitude)
- Population Count (100%)
- County code

[4] US Census Bureau, 2020 Census State Redistricting Data (Public Law 94-171) Summary File, U.S. Department of Commerce, 2021. https://www2.census.gov/programs-surveys/decennial/2020/technical-documentation/complete-tech-docs/summary-file/2020Census_PL94_171Redistricting_StatesTechDoc_English.pdf

[5] https://www2.census.gov/programs-surveys/decennial/2020/data/01-Redistricting_File--PL_94-171/



	A	B	C	D	E	F	G	H	I
1	NAME	KEY	AREALANI	AREAWAT	INTPTLAT	INTPTLON	POP100	STATE	COUNTY
2	Block 1000	10010201001000	288702	0	32.4707	-86.4805	21	01	001
3	Block 1001	10010201001001	194408	0	32.46817	-86.4817	34	01	001
4	Block 1002	10010201001002	419091	0	32.47031	-86.4917	29	01	001
5	Block 1003	10010201001003	867316	0	32.47148	-86.5016	17	01	001
6	Block 1004	10010201001004	5415	0	32.46761	-86.5006	0	01	001
7	Block 1005	10010201001005	5490	0	32.46759	-86.4987	0	01	001
8	Block 1006	10010201001006	125068	0	32.4755	-86.5035	7	01	001
9	Block 1007	10010201001007	3194	0	32.46688	-86.4984	0	01	001
10	Block 1008	10010201001008	13549	0	32.46679	-86.4989	0	01	001
11	Block 1009	10010201001009	999	0	32.46726	-86.4998	0	01	001
12	Block 1010	10010201001010	42893	0	32.46594	-86.4979	0	01	001
13	Block 1011	10010201001011	4233	0	32.46657	-86.4965	0	01	001
14	Block 1012	10010201001012	197068	0	32.46736	-86.4933	23	01	001
15	Block 1013	10010201001013	11261	0	32.467	-86.4866	0	01	001
16	Block 1014	10010201001014	234589	0	32.46583	-86.4897	111	01	001
17	Block 1015	10010201001015	147294	0	32.46619	-86.4832	44	01	001

Figure B-2 Extracted census data in Excel

In 2020, there are 8,132,968 census blocks covering the entire United States, including Alaska and Hawaii. The previously used, 2010 Census data had 11,078,297 which is considerably more than the 2020 dataset. However, the reduction in census blocks between 2010 and 2020 was confirmed by the U.S. Census Bureau[6]. Nonetheless, given the large number of census blocks, the data for each state was then combined into an Access database to form one census file.
Final formatting was then done in Access and included the following:

- Extraction of the FIPS code from the long key
- Addition of a sequentially increasing ID (key field) for each census block, for search purposes
- Storage of latitudes and longitudes as 4-byte floating point numbers
- Sorting of data in descending order of longitude
- Writing a program to convert the data to a binary file, which is more efficient than a text file in terms of both file size and speed.

[6] https://www.census.gov/geographies/reference-files/time-series/geo/tallies.2020.html#list-tab-1626061381
https://www.census.gov/geographies/reference-files/time-series/geo/tallies.2020.html#list-tab-1626061381

APPENDIX C. 2017 COUNTY FILE

This section describes the development of the 2017 county file for the SecPop code. This file contains pertinent county level economic data used to determine the economic factors for each user-defined economic region in the Site Date file. Table C-1 lists every field input into the 2017 county file (County2017.dat). Every value in the county file except FRCLND (land fraction) and VNFRM (non-farmland property value), as well as most of the notes fields, came directly from the 2017 Agricultural Census. The raw data was downloaded from the data query website of the U.S. Department of Agricultural (USDA) 2017 Census[7] [1]. A screenshot of the data query tool from USDA is shown in Figure C-1.

Table C-1 Fields Inputs in the 2017 County File

Field Name	Explanation of field
FIPS	Unique identifier for each county
STATE	Name of state
COUNTY	Name of county
FRCLND	Fraction of county's total area that is land as opposed to water (-)
FRMFRC	Fraction of county's total land area that is used for farming (-)
DPF	Fraction of farm sales resulting from dairy production in county (-)
ASFP	Total annual sales from all farms in a county ($/hectare of farmland)
VFRM	Farmland property value for the county ($/hectare of farmland)
VNFRM	Non-farmland property value for the county ($/person)
NOTES: -	Represents a value of 0
NOTES: b	Indicates that farm area from the 2017 Agricultural Census is slightly larger than land area from the 2020 Census. In these cases, the farm area is set equal to the land area.
NOTES: d	Indicates that data were withheld from 2017 Agricultural Census to avoid disclosing information for individual farms.
NOTES: ex	Refers to a county not listed in the 2017 Agricultural Census. It was therefore assumed that no agriculture exists in the county.
NOTES: IC	Means this county is an independent city that has its own FIPS code
NOTES: pci	Means per capita income was combined for an independent city and its neighboring county. The same value for per capita income was used for both.

[7] https://www.nass.usda.gov/Quick_Stats/CDQT/chapter/1/table/1/

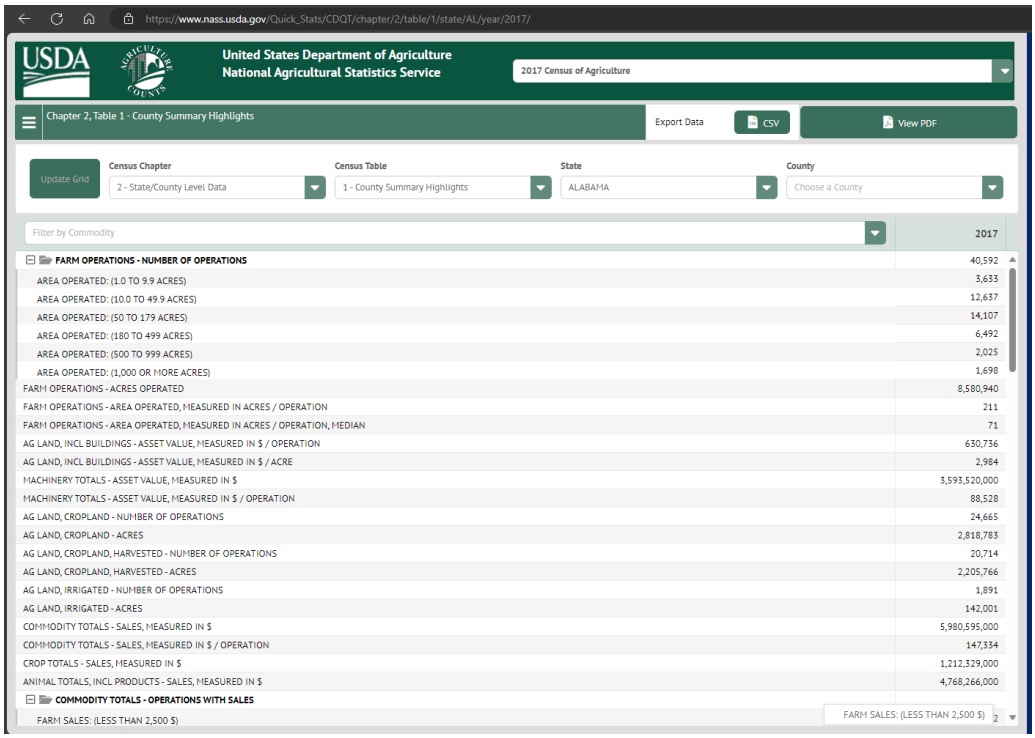


Figure C-1 Data Query Tool for 2017 Agricultural Census

The data sets that are needed from the Agricultural Census are shown in Table C-2. The name of the data type, table, and data time is an exact copy of what was displayed in the data query tool to obtain the needed data. The full dataset was downloaded in a text file and the needed fields below were extracted from the full dataset and further manipulated in Excel.

Table C-2 Data Extracted from 2017 Agricultural Census

Field	Data Type	Table Name	Data Item
1	2- State/County Data	Table 1. County Summary Highlights: 2017	FARM OPERATIONS – ACRES OPERATED
2	2- State/County Data	Table 2. Market Value of Agricultural Products Sold Including Food Marketing Practices and Value-Added Products: 2017 and 2012	COMMODITY TOTALS – SALES, MEASURED in $ (includes non-food products such as cotton and wool)
3	2- State/County Data	Table 2. Market Value of Agricultural Products Sold Including Food Marketing Practices and Value-Added Products: 2017 and 2012	MILK – SALES, MEASURED in $ (milk and other dairy products from cows)
4	2- State/County Data	Table 8. Farms, Land in Farms, Value of Land and Buildings, and Land Use: 2017 and 2012	AG LAND, INCL BUILDINGS – ASSET VALUE, MEASURED IN $
5	1 – U.S./State Level Data	Table 1. Historical Highlights: 2017 and Earlier Census Years	MACHINERY TOTALS – ASSET VALUE, MEASURED IN $

After all the necessary data sets were extracted, some conversions were performed so that the data would be in the proper format for the SecPop county file. The first step was to convert farmland from acres to hectares, using a factor of 0.404686 hectares per acre. The value for farm sales per hectare (ASFP) was calculated by dividing Field 2 (total sales) by Field 1 (land in farms after converting from acres to hectares). Dairy sales fraction (DPF) was calculated by dividing Field 3 (total sales – milk and other dairy products from cows) by Field 2 (total sales).

The final step was the calculation of farm property value (VFRM), which combines data from Field 4 and Field 5. To calculate this, Field 5 (state level total for machinery and equipment) was converted to a county-level amount by using the percentage of farmland in each county in the state. This value was then added to Field 4, the value of land and buildings available at the county level. Finally, the summed value was divided by Field 1 (county farmland converted to hectares).

Land fraction (FRCLND) came directly from the 2020 U.S. Census. Between 2010 and 2020, the only changes to the county areas were Shannon County, South Dakota was renamed to Oglala Lakota County (as of May 2015) and Bedford City, Virginia was removed. The process for extracting information from the U.S. Census is described in Appendix B. Land fraction was calculated by dividing land area by the sum of land area and water area.

Farm fraction (FRMFRC) was calculated by dividing the farm area (Field 1) from the 2017 Agricultural Census by the land area from the 2020 U.S. Census. There were a few cases where the amount of farmland from the agriculture census slightly exceeded the county size from the census file, meaning essentially that the entire county is farmland. For these cases, FRMFRC was set to a value of 1 and a note of "b" was entered in the corresponding notes field.

There needs to be one-to-one correspondence between the FIPS codes in the county file and those in the census file. A comparison was done between the 2020 census file and 2017 county file, which revealed that there were several independent cities that have census data but were not present in the agricultural census: Baltimore, MD; St. Louis, MO; Bronx, NY; Washington, DC; and 36 cities in Virginia. A review of these cities demonstrated that they were omitted from the agricultural census because there was no agricultural to report, not that data was neglected. This conclusion was because the three largest independent cities were included in the agricultural census. Therefore, the other independent cities were added to the county file with values of zero for agricultural parameters (FRMFRC, ASFP, DPF, and VFRM) and a note of "ex" was entered in the corresponding notes fields. Additionally, a note of "IC" was included in the City notes field.

Two other notes relating to agriculture were included in the county file. A note of "-"was entered to signify that no value was available for that field in the specific county; therefore, there was probably no agriculture in that county. The "d" code was entered to signify that the corresponding value was known but was withheld to prevent confidential sales information from being revealed for a single farm. All counties with either "-" or "d" codes used a value of 0 for the agricultural parameters (FRMFRC, ASFP, DPF, and VFRM).

The above methodology produced every field needed for the county file except for non-farmland property value and its corresponding notes field.

C.1. Non-farmland Property Value

Calculation of VNFRM (county non-farmland property value per person) was the most complex step of the process. Exact county-level values are not readily available, so a calculation methodology was utilized. The overall approach was to use a set of known or readily accessible inputs defined in Table C-3 to first estimate the national-level non-farmland property value per person, $VNFRM_{US}$, and then to convert that to a county-level value, VNFRM, using a ratio of county per capita income, PCI_{CO}, to national per capita income, PCI_{US}. Equations C-1 and C-2 were used to estimate $VNFRM_{US}$. $VNFRM_{US}$ was then converted to a county-level VNFRM using Equation C-3. The definition and source of each input variable used in the calculations are provided in the following sections.

Table C-3 Inputs to Calculations for Non-Farmland Property Value

Input	Definition of Input Acronym	2017 Value
FLV_{US}	Average fraction of home value due to land in the U.S.	0.45
LPA_{US}	Average housing units per acre in the U.S.	5 units per acre
MHV_{US}	Median housing value in the U.S.	$200k per unit
PCI_{CO}	Per capita income for each county	various
PCI_{US}	Per capita income for the U.S.	$51,156.95 per person
POP_{US}	Population of the U.S.	325,719,178 people
RTW_{US}	Reproducible tangible wealth in the U.S.	$112,329.4 billion
UBL_{US}	Amount of urban and built-up land in the U.S.	116.3 million acres
VFA_{US}	Value of farm assets in the U.S.	$3,005.9 billion
$VFHP_{US}$	Value of farm household possessions in the U.S.	$40.8 billion
$VNFRM_{US}$	Value of non-farmland possessions in the U.S.	$496,438 per person
VSL_{US}	Value of suburban land in the U.S.	$52,335 billion

$$VSL_{US} = UBL_{US} \times LPA_{US} \times FLV_{US} \times MHV_{US} \quad \text{Equation C-1}$$

$$VNFRM_{US} = \frac{RTW_{US} - VFA_{US} + VFHP_{US} + VSL_{US}}{POP_{US}} \quad \text{Equation C-2}$$

Having calculated a national average for non-farmland property value, $VNFRM_{US}$, a conversion was then made to a county-level value by using a ratio of each county's per capita income to the national per capita income (Equation C-3). This assumes that on the county level, property value is directly proportional to per capita income.

$$VNFRM_{CO} = VNFRM_{US} \times \left(\frac{PCI_{CO}}{PCI_{US}}\right) \quad \text{Equation C-3}$$

This method of calculating a county-level value for non-farmland property dates to the NUREG-1150 study [2]. A new methodology for non-farmland property value was researched; however, no alternative was found for which the required information was readily available. The current method was reviewed by two Sandia National Laboratories economists and was determined to be applicable and justifiable.

C.2. Values Used in the Calculation of Non-Farmland Property Value, VNFRM

The values for the variables RTW_{US}, PCI_{US}, and PCI_{CO} were obtained from the U.S. Bureau of Economic Analysis (BEA) through the Interactive Data Application on its website[8], a screenshot of which is shown in Figure C-2.

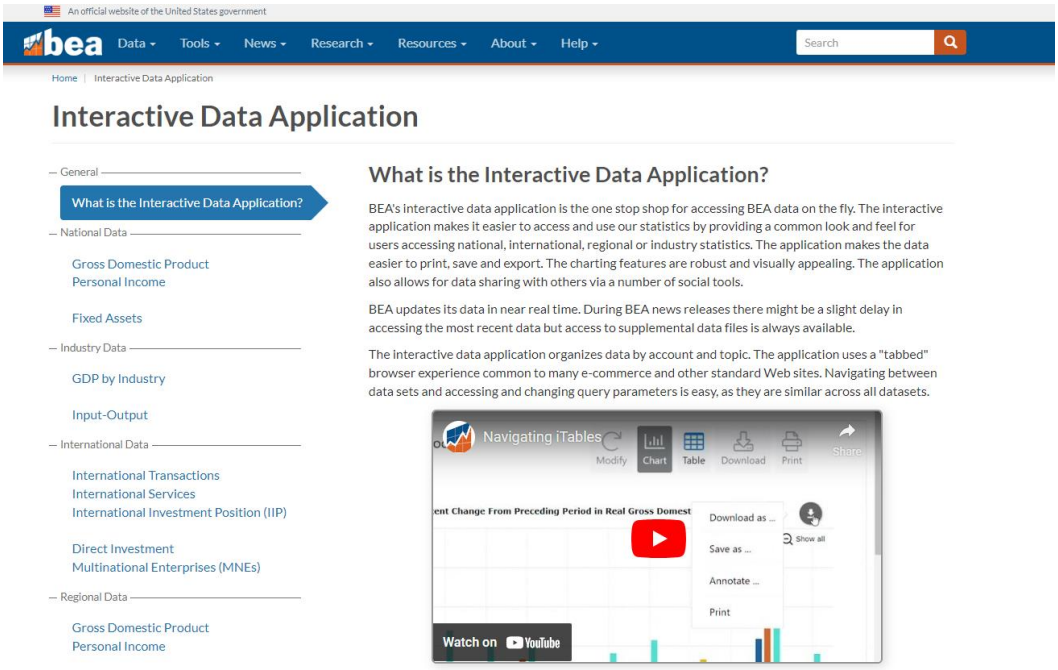


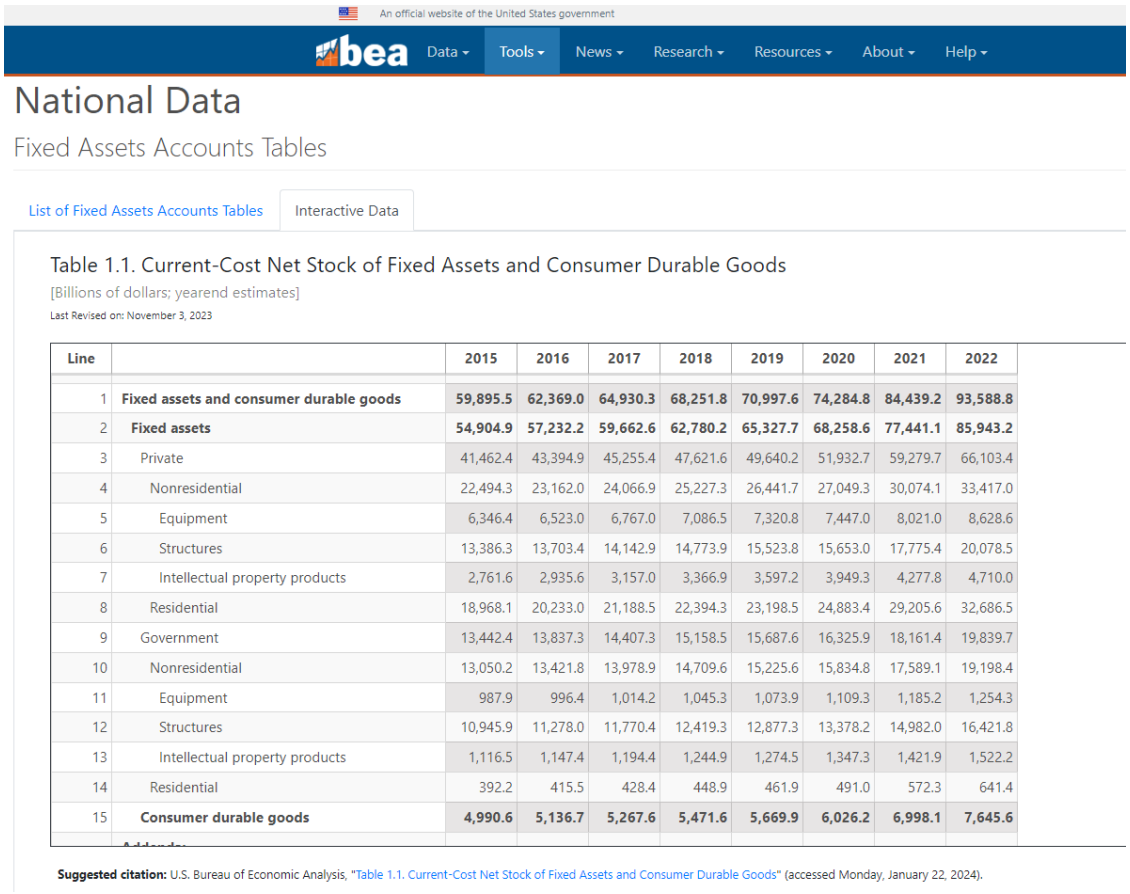
Figure C-2 BEA Interactive Data Application

C.3. Reproducible Tangible Wealth US (RTW_{US})

Reproducible tangible wealth, as used in this document, means the stock of private and government-owned durable equipment and structures, and of durable goods owned by consumers, in the United States. The value assigned captures the cost of recreating an area that becomes unusable. The word reproducible is an important part of the definition and thus it excludes the value of land. The term also excludes consumable goods.

The value of reproducible tangible wealth for 2017 was obtained by selecting Fixed Assets on the Interactive Data Application, then "Interactive Data Tables", then Section 1 – Fixed Assets and Consumer Durable Goods, and finally Table 1.1. Current-Cost Net Stock of Fixed Assets and Consumer Durable Goods (A). The required value appears in Line 1, "Fixed assets and consumer durable goods", which is displayed in Figure C-3.

[8] https://www.bea.gov/itable/



An official website of the United States government

bea Data Tools News Research Resources About Help

National Data

Fixed Assets Accounts Tables

List of Fixed Assets Accounts Tables | Interactive Data

Table 1.1. Current-Cost Net Stock of Fixed Assets and Consumer Durable Goods

[Billions of dollars; yearend estimates]

Last Revised on: November 3, 2023

Line		2015	2016	2017	2018	2019	2020	2021	2022
1	**Fixed assets and consumer durable goods**	**59,895.5**	**62,369.0**	**64,930.3**	**68,251.8**	**70,997.6**	**74,284.8**	**84,439.2**	**93,588.8**
2	**Fixed assets**	**54,904.9**	**57,232.2**	**59,662.6**	**62,780.2**	**65,327.7**	**68,258.6**	**77,441.1**	**85,943.2**
3	Private	41,462.4	43,394.9	45,255.4	47,621.6	49,640.2	51,932.7	59,279.7	66,103.4
4	Nonresidential	22,494.3	23,162.0	24,066.9	25,227.3	26,441.7	27,049.3	30,074.1	33,417.0
5	Equipment	6,346.4	6,523.0	6,767.0	7,086.5	7,320.8	7,447.0	8,021.0	8,628.6
6	Structures	13,386.3	13,703.4	14,142.9	14,773.9	15,523.8	15,653.0	17,775.4	20,078.5
7	Intellectual property products	2,761.6	2,935.6	3,157.0	3,366.9	3,597.2	3,949.3	4,277.8	4,710.0
8	Residential	18,968.1	20,233.0	21,188.5	22,394.3	23,198.5	24,883.4	29,205.6	32,686.5
9	Government	13,442.4	13,837.3	14,407.3	15,158.5	15,687.6	16,325.9	18,161.4	19,839.7
10	Nonresidential	13,050.2	13,421.8	13,978.9	14,709.6	15,225.6	15,834.8	17,589.1	19,198.4
11	Equipment	987.9	996.4	1,014.2	1,045.3	1,073.9	1,109.3	1,185.2	1,254.3
12	Structures	10,945.9	11,278.0	11,770.4	12,419.3	12,877.3	13,378.2	14,982.0	16,421.8
13	Intellectual property products	1,116.5	1,147.4	1,194.4	1,244.9	1,274.5	1,347.3	1,421.9	1,522.2
14	Residential	392.2	415.5	428.4	448.9	461.9	491.0	572.3	641.4
15	**Consumer durable goods**	**4,990.6**	**5,136.7**	**5,267.6**	**5,471.6**	**5,669.9**	**6,026.2**	**6,998.1**	**7,645.6**

Suggested citation: U.S. Bureau of Economic Analysis, "Table 1.1. Current-Cost Net Stock of Fixed Assets and Consumer Durable Goods" (accessed Monday, January 22, 2024).

Figure C-3 BEA Fixed Assets Accounts Table 1.1

This value is a net stock value as opposed to a gross stock value, which is what is needed in SecPop. Gross stock value refers to the original, total value, while net stock value accounts for the effects of depreciation. SecPop calculates a replacement cost, which is closer to the original value; therefore, SecPop uses the gross, not net value. The BEA no longer reports gross stock value. To convert between net and gross, a conversion factor of 1.73 is used, yielding a value of $64,930.3 billion * 1.73 = $112,329.4 billion. The conversion factor comes from the 1997 BEA report by Katz and Herman, "Improved Estimates of Fixed Reproducible Tangible Wealth" [3]. A more current reference could not be found. Although this report does not contain the factor of 1.73, it can be derived by taking the ratio of gross and net stock values.

C.4. Per Capita Income National Average (PCI_{US})

The process for extracting this value was like the process for obtaining RTW_{US}. The value was obtained by selecting Gross Domestic Product Personal Income from the same start screen, then "Interactive Data Tables", then Section 2 – Personal Income and Outlays, and finally Table 2.1. Personal Income and Its Deposition (A) (Q). The needed value was on line 1, Personal Income, which is total income for the entire U.S. population. Quarterly values are given, but annual values and various time periods are available using the Modify icon. The value obtained for 2017 was $16,662.8 billion, corresponding to the annual value. To convert this value into per capita income, it was divided by the total U.S. population for 2017, 325,719,178, yielding a national average per capita income of $51,156.95.

C.5. Per Capita Income on the County Level (PCI_{CO})

The process to extract this value was like the previous processes so no additional figures are displayed. The values were obtained by selecting Gross Domestic Product Personal Income under Regional Data, then "Interactive Data Tables", then CAINC1 County and MSA personal income summary: personal income, population, per capita personal income under Personal Income and Employment by County and Metropolitan Area. Next, "county" was selected as the major area followed by "All counties in the U.S." Next, the Statistic was set to "Per capita personal income (dollars)" and the Unit of Measure was selected as Levels. Finally, the year 2017 was selected and then the county data was downloaded as an Excel file. Because the values are already given per capita, no division by population was necessary.

C.6. U.S. Population (POP_{US})

U.S. population, both current and historical, can be found on the U.S. Census Bureau Website. Using Explore Census Data, the "2017: ACS 1-Year Estimates Selected Population Profiles" table was used. The page is shown in Figure C-4. The total population for the year 2017 was found to be 325,719,178.

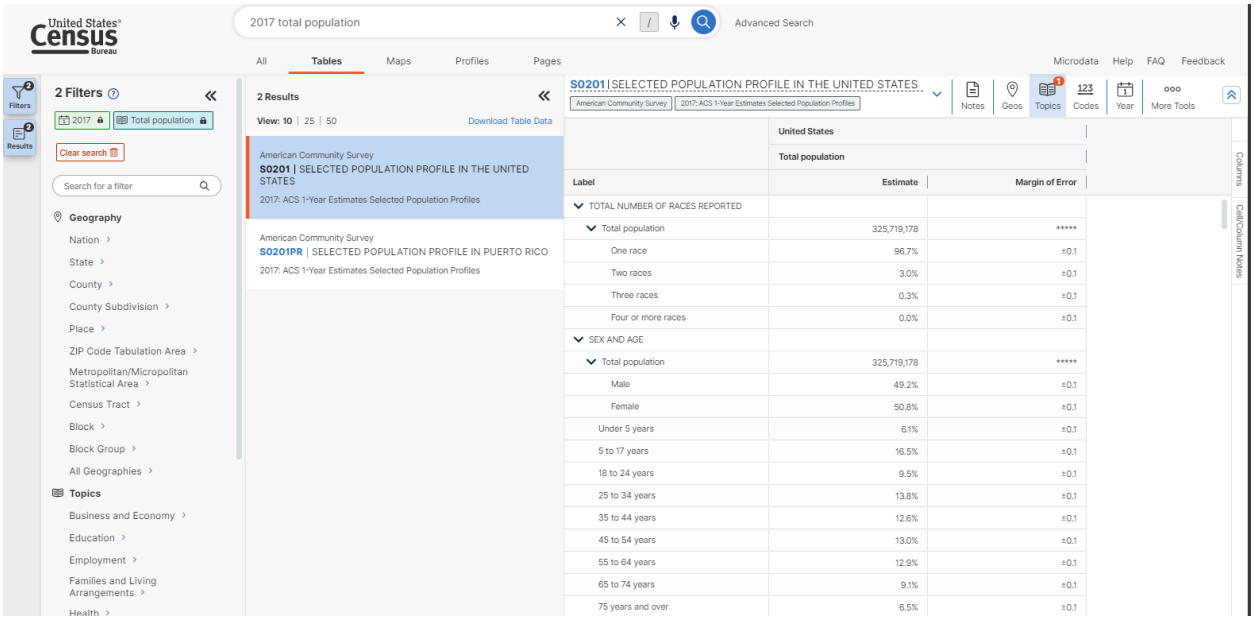


Figure C-4 U.S. Census Explore Census Data Website

C.7. Value of Farm Assets in the U.S. (VFA_{US})

The value of farm assets is available from the Economic Research Service[9], a branch of the USDA. To obtain the value for 2017, the "U.S. farm sector financial indicators, 2016-2023F" was opened as an Excel spreadsheet. The line "Farm assets", shows a nominal value of $3,005.9 billion for 2017. This is the value needed for the county file; it includes real estate, livestock and poultry, machinery and motor vehicles, crops, purchased goods, and financial assets.

[9] https://www.ers.usda.gov/data-products/farm-income-and-wealth-statistics/

C.8. Value of Farm Household Possessions in the U.S. ($VFHP_{US}$)

No source that could be referenced was found for the value of farm household possessions. As an alternative, an assumed value of $20,000 in possessions per farm was used and was multiplied by the number of farms in the U.S. in 2017, 2,042,220. The number of farms in the U.S. was obtained from the 2017 Census of Agriculture [1]. Because the value of farm household possessions, $40.8 billion, is very small compared to farm assets and reproducible tangible wealth, the assumption has only a minor effect on the calculation.

C.9. Value of Suburban Land in the U.S. (VSL_{US})

This value is calculated using equation C-1 with the variables described above.

C.10. Amount of Urban and Built-up Land in the U.S. (UBL_{US})

The amount of urban and built-up land in the U.S. was found in the 2017 National Resources Inventory (NRI) Summary Report [4] which is produced by the Natural Resources Conservation Service (NRCS), a branch of the USDA. The report was downloaded from the NRI website[10]. The amount of developed land, 116.3 million acres, was found in the NRI reports Table 7. This value includes large urban and built-up areas, rural transportation, and small built-up areas.

C.11. Average Housing Units per Acre in the U.S. (LPA_{US})

The value for housing units per acre was informed by data found in the American Housing Survey (AHS), sponsored by the U.S. Department of Housing and Urban Development, and conducted by the U.S. Census Bureau. The report is available from the U.S. Census Bureau website[11]. First, the Data tab was selected, then the year 2017, and then AHS 2017 Summary Tables. In Table "Housing Unit Characteristics – All Housing Units", the lot size for 1-unit structures is given. From this information, it is determined that the median lot size is between ¼ to ½ of an acre (i.e., 0.375 acres per lot). The inverse of this is 2.67 housing units per acre. However, this does not include multi-unit properties, which would certainly have the effect of increasing the number of units per acre.

In 2017, single unit properties, manufactured/mobile home or trailers and boats, RVs, and vans, etc. were 76% of the total units (71% being single unit properties). The remaining 24% contains multi-unit properties ranging from 2 to 50 or more units. Assuming an average of 5 units per multiunit property and the same median lot size as for the 1-unit structures, would give a total of 5.1 units per acre [((0.71 acres * 2.67 properties per acre * 1 unit per property) + (0.24 acres * 2.67 properties per acre * 5 units per property) = 5.1 units per acre].

In the 2007 and 2012 county file, a value of 5 units per acre was used. Because the updated data provide a very similar value, the original value of 5 units per acre was continued in the 2017 county file and is considered reasonable.

C.12. U.S. Median Housing Value (MHVUS)

The median housing value also used data from the AHS, which was discussed previously. Table "Value, Purchase Price, and Source of Down Payment – Owner-occupied Units", gives a median housing value of $200,000 for owner occupied homes.

[10] https://www.nrcs.usda.gov/nri
[11] https://www.census.gov/programs-surveys/ahs/

C.11.C.13. Average Fraction of Home value due to Land in the U.S. (FLVUS)

In the 2007 SecPop county file a value of 0.45 was used based on the findings in [5]. It is assumed that this value is still valid for 2017 as the 2021 Land Market Survey states that according to the National Association of Realtors, the land value account for 40% of household real estate assets.

C.12.C.14. Conclusions

This section lays out a method for calculating a national average per capita value for non-farmland property. This is converted to a county-level value using a ratio of national per capita income to each county's per capita income as described in the equations above. This assumes that personal wealth and property values are directly proportional to income. It was found that for the independent cities in Virginia, BEA reported a single PCI for both the city and its neighboring or surrounding county. Since these are separate in the county file, the same PCI value was used to calculate non-farm property values for both the city and county, a code of "pci" was input in the nonfarm_value_notes field for each.

All the data sets described above were compiled in an Excel spreadsheet and then imported into a text file needed for the SecPop code.

Note that the values for VNFRM calculated on a grid-element bases by SecPop are input to MACCS through the site file, however there is no direct MACCS input for VNFRM. Rather, MACCS requires an input for an analogous value, VALWNF. While these two variables have equivalent units and definitions, they are used separately within the MACCS code. VALWNF has a single value for the entire grid and is used to determine whether decontamination is cost-effective (decontamination cost is less than VALWNF) or not cost-effective and the land is modeled as being condemned (decontamination cost is greater than VALWNF). If no site file is used, VALWNF is also used to calculate losses when the property in grid element is interdicted or condemned. If a site file is used, VNFRM is used to calculate losses when a grid element is interdicted or condemned. The same explanation is true for the MACCS variable VALWF and the SecPop variable VFRM. SecPop site files can be used to calculate a person-weighted average for VALWNF and a farm area-weighted average for VALWF. MACCS can run without the use of site file when generic or site-independent analyses are required.

C.13.C.15. References

[1] U.S. Department of Agriculture, 2017 Census of Agriculture, United States Summary and State Data, Volume 1, Geographic Area Series, Part 51, AC-17-A-51, 2019. https://www.nass.usda.gov/Publications/AgCensus/2017/Full_Report/Volume_1,_Chapter_1_US/usv1.pdf

[2] US NRC, Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants, NUREG-1150, Vol. 1, U.S. Nuclear Regulatory Commission, Washington, DC, 1990.

[3] Katz, Arnold J. and Herman, Shelby W., Improved Estimates of Fixed Reproducible Tangible Wealth, 1929-95, *Survey of Current Business*, (69-92), 1997. http://bea.gov/scb/pdf/national/niparel/1997/0597niw.pdf

[4] U.S. Department of Agriculture, Summary Report: 2017 National Resources Inventory, Natural Resources Conservation Service, 2020. https://www.nrcs.usda.gov/sites/default/files/2022-10/2017NRISummary_Final.pdf

[5] Davis, M.A., and J. Heathcote, The Price and Quantity of Residential Land in the United States, *Journal of Monetary Economics*, 54 (2595-2620), 2007. http://www.jonathanheathcote.com/land-final.pdf

APPENDIX D. SECPOP VERIFICATION ASSESSMENTS

This appendix describes the verification assessments that were conducted to ensure that SecPop is functioning as intended. A summary of the tests is provided in Table D-1. SecPop passed all tests.

Table D-1 SecPop Verification Test Matrix

Test	Objective	Test Site	Test Area
1a	Verify consistency between v4.3.1 and v4.4.0 of each SecPop calculated variable for each grid element	Columbia	0-50 mi
1b		Oyster Creek	0-50 mi
1c		Columbia	0-1000 mi
1d		Oyster Creek	0-1000 mi
2	Verify consistency of SecPop calculations with radii distance units set in miles to kilometers	Dresden	0-64 km
3a	Verify consistency of SecPop calculated total population when using difference number of compass sectors (16, 32, 48, and 64)	Columbia	0-50 mi
3b		Oyster Creek	0-50 mi
4a	Verify correct implementation of population multiplier and economic multiplier	Columbia	0-50 mi
4b		Oyster Creek	0-50 mi
5	Verify that v4.4.0 correctly imports all data from existing SecPop project files (.sppproj)	N/A	N/A
6a	Verify that changes in population and economic values are reasonable when comparing calculations using the 2010 census file and 2012 economic file to the 2020 census file and 2017 economic file	Columbia	0-50 mi
6b		Oyster Creek	0-50 mi
7	Verify that changes in county file parameters from 2012 to 2017 are reasonable	N/A	N/A

D.1. Test 1: Verify Consistency of Site Files Created Between SecPop 4.3.1 and 4.4.0

For these tests, the number of sectors for comparison was set at 16 and the 2010 census and 2012 county files were used. The test used two sites in the contiguous U.S., Columbia Generating Station in Washington (46.47139, -119.33305) and Oyster Creek in New Jersey (39.814167, -74.20638) at 50 miles, then at a 1000-mile radius. The regions were set to be consistent between the 4.3.1 and 4.4.0 project files, and results were compared.

For each site, regions were created in SecPop 4.3.1 and for SecPop 4.4.0. The number of radii was set to 18 for the 50-mile test and 28 for the 1000-mile test. Economic regions were defined as the 0- to 1-mile area being the exclusion area with the remainder having exact economic values.

For both Columbia and Oyster Creek, population and economic results in all output files were identical for both distances. Except in the REAcct_Extended.tsv file, the number of decimal places outputted for Land Area changed from 8 to 7 in version 4.4.0. However, this change appears to be just a minor cosmetic output change as no other outputs were affected in this file.

D.2. Test 2: Verify Correct Implementation of Distance Unit Conversion

The Dresden site was used for this test, as was done in testing previous SecPop versions. The following distances were first entered in km, then converted to miles, and then converted back from miles to km. This gave the expected results as follows:

Table D-2 Distance Unit Conversion

km	Convert column one to miles	Convert column two back to km
1	0.6213712	1
2	1.2427424	2
4	2.4854848	4
8	4.9709697	8
16	9.941939	16
32	19.883879	32
64	39.767757	64

A population calculation was run for the Dresden site for the units set in miles and then in km. The SecPop output files were compared and found to be identical.

D.3. Test 3: Verify Consistency of SecPop Calculated Total Population When Using Different Number of Compass Sectors

The two sites and areas from Test 1a and Test 1b were run with 16, 32, 48, and 64 compass sectors. These tests used the 2020 census file and 2017 county file. Both the Columbia and Oyster Creek site tests showed the exact same total population, no matter what number of sectors was used. This shows that SecPop is correctly dividing rings into sectors.

D.4. Test 4: Verify Correct Implementation of Population Multiplier and Economic Multiplier

The test sites and areas from Tests 1a and 1b were used with the 2020 census file and 2017 county file. SecPop 4.4.0 was run three separate times using the example population and economic multipliers shown in Section 2.3 (1.011 and 1.20, respectively). First the population multiplier was applied with no change in economics (economic multipier = 1.0). The results from this case showed that the population increased accordingly and the non-farm wealth per capita also decreased accordingly. Second, population remained the same (population multiplier = 1.0) and the economic multiplier of 1.20 was applied. The results from this case show the population remained the same and all economic values increased by a factor of 1.20. Lastly, the population and economic multiplier were applied together in one calculation. The results from this case show the population, agricultural sales and farmland property values increasing according to the specific multiplier applied. As for the non-farm wealth per capita, these values were adjusted by a factor of approximately 1.187 to account for both the population and economic adjustment (1.20/1.011). These results show that SecPop 4.4.0 correctly uses the population and economic multipliers in the calculations.

D.5. Test 5: Verify That v4.4.0 Correctly Imports All Data from Existing SecPop Project Files

The objective of this test is to verify that the radial distance, latitude, longitude, economic multiplier, population multiplier and economic region data (if available) are correctly imported when importing an existing SecPop site file. For this test, the site file used in the SOARCA Surry uncertainty analyses was used. This site file was created using SecPop 4.3.1 and utilized the 2010 census file and 2012 county file. The results show that SecPop 4.4.0 correctly imports the needed data.

D.6. Test 6: Verify That Changes in Population and Economic Values are Reasonable When Comparing Calculations Using the 2010 Census File and 2012 Economic File to the 2020 Census File and 2017 Economic File

Using SecPop 4.4.0 and the same location and sectors as Test 1a, populations and economic values were compared for calculations using the 2010 census and 2012 county files to calculations using the 2020 census and 2017 county file. The output files from calculations using the 2010 census file and 2012 county file were taken directly from Test 1a for Columbia and Test 1b for Oyster Creek. With the 2020 census file and 2017 county file, Oyster creek had 1097 people in the exclusion zone, as opposed to 1075 with the 2010 census file, while Columbia had 0 for both calculations.

After doing a complete check of all values in the extended site files it was found that there were numerous fields where there was a nonzero value using 2010/2012 data but not 2020/2017 or vice versa. All nonzero values were excluded from the comparisons for population and economic values. Table D-3 and Table D-4 show the minimum, maximum, and average percent difference when moving from the 2010 census and 2012 county files to the 2020 census and 2017 county files. Therefore, a positive change shows that the value increased in the newer files.

For the most part, the percentage changes seem very reasonable. There are a few things that stand out, however. There are some substantial changes in population. A closer look showed that these were all in sectors that had a very small 2010 population, so any change would be a large percentage of the total. Land fraction also had some substantial changes which is likely due to the change in census block organization between 2010 and 2020 since majority of the grid elements had little to no change in land fraction. Additionally, the land fraction per county between the 2012 and 2017 county data was comparable (see Test 7).

Table D-3 Percent Differences for Census and County Values Over Set of Grid Elements for Columbia Site

Variable	Minimum Percent Difference	Maximum Percent Difference	Average Percent Difference
Population	-91	450	23
Land fraction	-84	1280	9
Farmland fraction	-37	63	-3
Dairy sales fraction	-66	344	-12
Agricultural sales	-41	80	5
Farmland value	46	298	173

Variable	Minimum Percent Difference	Maximum Percent Difference	Average Percent Difference
Non-farmland value	-8	49	12

Table D-4 Percent Differences for Census and County Values Over Set of Grid Elements for Oyster Creek Site

Variable	Minimum Percent Difference	Maximum Percent Difference	Average Percent Difference
Population	-89	48900	305
Land fraction	-70	9088	49
Farmland fraction	-10	25	6
Dairy sales fraction	19	238	62
Agricultural sales	-38	100	70
Farmland value	5	156	26
Non-farmland value	5	23	14

D.7. Test 7: Verify That Changes in County File Parameters from 2012 to 2017 are Reasonable

The first step of this test was calculating the ratio of each parameter for each county by dividing either the 2012 value by the 2017 value or the 2017 by the 2012 value. The following equations were used:

$$Ratio = \frac{2012\ Value}{2017\ Value}$$

$$Ratio = \frac{2017\ Value}{2012\ Value}$$

Two tables of ratios were made to see how much the values changed over time. The tables were then searched to identify if there were any large values that may be of concern. Although there were some large ratios, these were found to be with small changes to even smaller economic values. With more typical economic values, there were no ratios that were of concern.
Next, the percent difference for each county file variable was calculated for each county using the following formula:

$$\%\ Difference = 200 * \frac{2017\ Value - 2012\ Value}{2017\ Value + 2012\ Value}$$

This equation shows that if one of the values is zero and the other is nonzero, the percent difference is either 200 or -200. This test was used to find the percent difference between the 2012 data and the 2017 data, indicating by how much each variable for every county changed. If there were generally more positive numbers for a certain variable, then the average of all the percent differences for that variable should be positive as well, resulting in a general increase of the variable over the period. This was found to be the case.

Lastly, the minimum, maximum, and average percent differences were calculated for each county file variable among all counties. Table D-5 shows the results. Alaska and Hawaii were not included since the data for these two states was not included in the 2012 county file and Bedford City, VA was removed as well since it was removed in the 2017 county file.

Table D-5 Percent Differences for 2012 and 2017 County File Parameters Over Entire Set of Counties

Variable	Minimum Percent Difference	Maximum Percent Difference	Average Percent Difference
Land fraction	-35	9	0
Farmland fraction	-200	200	0
Dairy sales fraction	-200	200	-18
Agricultural sales	-200	200	2
Farmland value	-200	200	133
Non-farmland value	-97	94	10

For the most part, the percentage changes seem very reasonable. A closer look reveals a few things that stand out. The minimum and maximum percent differences are both around -200% and 200% respectively. This occurs because there are some 2012 values that are zero and their corresponding 2017 value is non-zero, or vice versa. However, the average differences are reasonable.

The 2012 and 2017 county files were also compared to each other using the average, minimum, maximum and percentiles of each value. Table D-6 shows a comparison of land fraction, farm fraction, and dairy sales fraction. Table D-7 shows a comparison of annual farm sales, farmland value, and non-farmland value. Finally, Table D-8 shows how many of the 3,108 counties considered increased, decreased, or had no change when comparing a 2012 value to a 2017 value. Table D-8 also shows the largest individual increase and decrease among all 3,108 counties.

Table D-6 Comparison of 2012 and 2017 County File Parameters FRCLND, FRMFRC, and DPF

	Land Fraction FRCLND (-)		Farm Fraction FRMFRC (-)		Dairy Sales Fraction DPF (-)	
	2012	2017	2012	2017	2012	2017
Average	0.95	0.95	0.50	0.50	0.06	0.06
Minimum	0.09	0	0	0	0	0
5th Percentile	0.73	1.00	0.03	0.04	0	0
Median	0.99	1.00	0.47	0.46	0	0
95th Percentile	1.00	1.00	0.98	1.00	0.38	0.39
Maximum	1.00	1.00	1.00	1.00	0.87	1.00

Table D-7 Comparison of 2012 and 2017 County File Parameters ASFP, VFRN, and VNFRM

	Annual Farm Sales ASFP ($/ha)		Farmland Value VFRM ($/ha)		Non-farmland Value VNFRM ($/person)	
	2012	2017	2012	2017	2012	2017
Average	1,467	1,743	10,860	67,202	368,331	404,752
Minimum	-	-	-	-	170,165	176,704
5th Percentile	42	67	1,721	6,398	255,318	290,192
Median	918	944	8,123	54,904	347,283	383,467
95th Percentile	4,246	4,797	21,606	156,223	545,825	579,133
Maximum	60,721	731,539	508,539	1,348,570	1,164,792	2,138,954

Table D-8 Comparison of 2012 and 2017 County File Parameters

	Land Fraction FRCLND (-)	Farm Fraction FRMFRC (-)	Dairy Sales Fraction DPF (-)	Annual Farm Sales ASFP ($/ha)	Farmland Value VFRM ($/ha)	Non-Farmland Value VNFRM ($/person)
# Counties increase	1,670	1,424	646	1,469	3,021	2,590
# Counties no change	357	44	1,708	64	44	0
# Counties decreased	1,081	1,640	754	1,575	43	518
Maximum increase	0.09	0.78	0.57	$731,539	$1,348,570	$1,118,367
Maximum decrease	-0.22	-0.59	-0.62	$ (60,721)	$ (420,564)	$ (557,367)

As expected, the average land fraction for each county did not change. However, a considerable portion of counties either increased in land fraction (54%) or decreased (35%) which could be due to factors such as climate change and rising sea levels. Similarly, the average farm fraction did not change but more counties decreased (53%) from 2012 to 2017 than increased (46%). Similar behavior was observed for the dairy sales fraction with 24% of the counties decreasing from 2012 to

2017 and 21% increasing. Nonetheless, all parameters assessed in Table D-6 compare reasonably well.

For annual farm sales, farmland value, and non-farmland value, about 47-97% of counties increased from 2012 to 2017 while about 1-50% decreased. For these three parameters, the average, 5th percentile, median, 95th percentile and maximum values all increased from 2012 to 2017 which is to be expected given inflation and general increase in costs.

This page left blank

DISTRIBUTION

Email—Internal

Name	Org.	Sandia Email Address
Ted Anaya	08132	tranaya@sandia.gov
Daniel Clayton	08855	djclayt@sandia.gov
Kyle Clavier	08855	kaclavi@sandia.gov
Jay Dharsandia	08855	jadhars@sandia.gov
Lloyd Eubanks	08855	lleuban@sandia.gov
John Fulton	08855	jdfulto@sandia.gov
Mariah Garcia	08855	msmith7@sandia.gov
Audrey Nguyen	08855	anguye@sandia.gov
Fotini Walton	08855	fwalton@sandia.gov
Technical Library	1911	sanddocs@sandia.gov

Email—External

Name	Company Email Address	Company Name
Luis Betancourt	luis.betancourt@nrc.gov	US NRC
Keith Compton	keith.compton@nrc.gov	US NRC
Salman Haq	salman.haq@nrc.gov	US NRC
Andrew Nosek	andrew.nosek@nrc.gov	US NRC
Nazila Tehrani	nazila.tehrani@nrc.gov	US NRC
Elena Yegorova	elena.yegorova@nrc.gov	US NRC

This page left blank

This page left blank

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia LLC, a wholly owned subsidiary of Honeywell International Inc. for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.