TN TDOT Department of Transportation

U.S. Department of Transportation
Federal Highway Administration

Comprehensive Planning Guidebook for Commodity and Freight Movement in Tennessee: Supplementary Documents

Supplementary Material for RES 2014-19 Final Report from The University of Memphis| Authors: Mihalis Golias, Sabyasachee Mishra, Karlis Pujats, Mitra Salehi Esfandarani, Neda Nazemi, Hana Takhtfiroozeh | December 1, 2021

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THE UNIVERSITY OF MEMPHIS

DISCLAIMER

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Appendix A. Freight Data Disaggregation Tool User Manual

A.1 Introduction

The following section will present a step-by-step example of how to use the developed ArcGIS application. In total, eight tools were developed: three data preprocessing, two disaggregation, and three postprocessing tools. The preprocessing tools were developed to prepare data inputs in disaggregation tools. The main purpose of the TRANSEARCH Preprocessing Tool is to preprocess TRANSEARCH data by aggregating it to the SCTG 2-digit code industry code and estimate county productions and attractions. The Spatial and Economic Data Preprocessing Tool was employed to estimate the disaggregate-zone economic indicator shares and values. The IO Accounts Supply and Use Table Conversion Tool was developed to convert the BEA Input-Output Accounts Supply and Use tables from the IO industry to NAICS 3-digit or 2-digit codes and estimate annual Gross Domestic Product (GDP) shares of commodity-producing and using industries. The IO Accounts and Regression Disaggregation Method Tool was developed to apply the regression disaggregation method. The IO Accounts and Proportional Weight Disaggregation Method Tool was developed to use the proportional weighting method. The postprocessing tools were created to provide the user with analytical and visualization capabilities. The PA Estimation OD Selection Tool provides the capabilities to output specific disaggregate OD flow and estimate productions and attractions. The specific OD flow can be selected by unique SCTG code, Mode or Mode Group, Equipment, and Trade Type code, county, or disaggregate zone. The visualization tools provided the user with the ability to automate map creation to visualize either disaggregate origin-destination flows or productions and attractions. The PA MAP Tool and OD MAP Tool provides the capability to visualize either origin-destination or production and attraction flows by creating ArcMap Map Exchange Document (MXD) export maps as PDF and JPG files.

The next subsection will describe the Freight Data Disaggregation Tool Installation steps (see section A.2). Followed by step-by-step instructions on how to execute the developed Freight Flow Disaggregation Tools in the following order: TRANSEARCH Preprocessing Tool (see section A.3), Spatial and Economic Data Preprocessing Tool (see section A.4), IO Accounts Supply and Use Table Conversion Tool (see section A.5), IO Accounts and Proportional Weight Disaggregation Method Tool (see section A.6), IO Accounts and Regression Disaggregation Method Tool (see section A.7), PA Estimation OD Selection Tool (see section Appendix Chapter 2044345444 8), PA MAP Tool (see section A.9), and finally the OD MAP Tool (see section A- 11).

Required Files

Freight Data Disaggregation Tools.pyt

A.2 Installation

Description

The following section describes the **Freight Data Disaggregation Tool** installation steps.

STEP 1

Copy the **Freight Data Disaggregation Tool** folder to the desktop (see Figure A-1). If the user wishes to copy the tool to a different location, the user must make sure there are **no spaces*** **in the folder path**.

> **The path that leads to the stored tool **should not have any spaces or unrecognized symbols** as the ESRI ArcMap software may give out an **error**, when executing the tools. The same principals should be maintained when considering paths for tool inputs and outputs.*

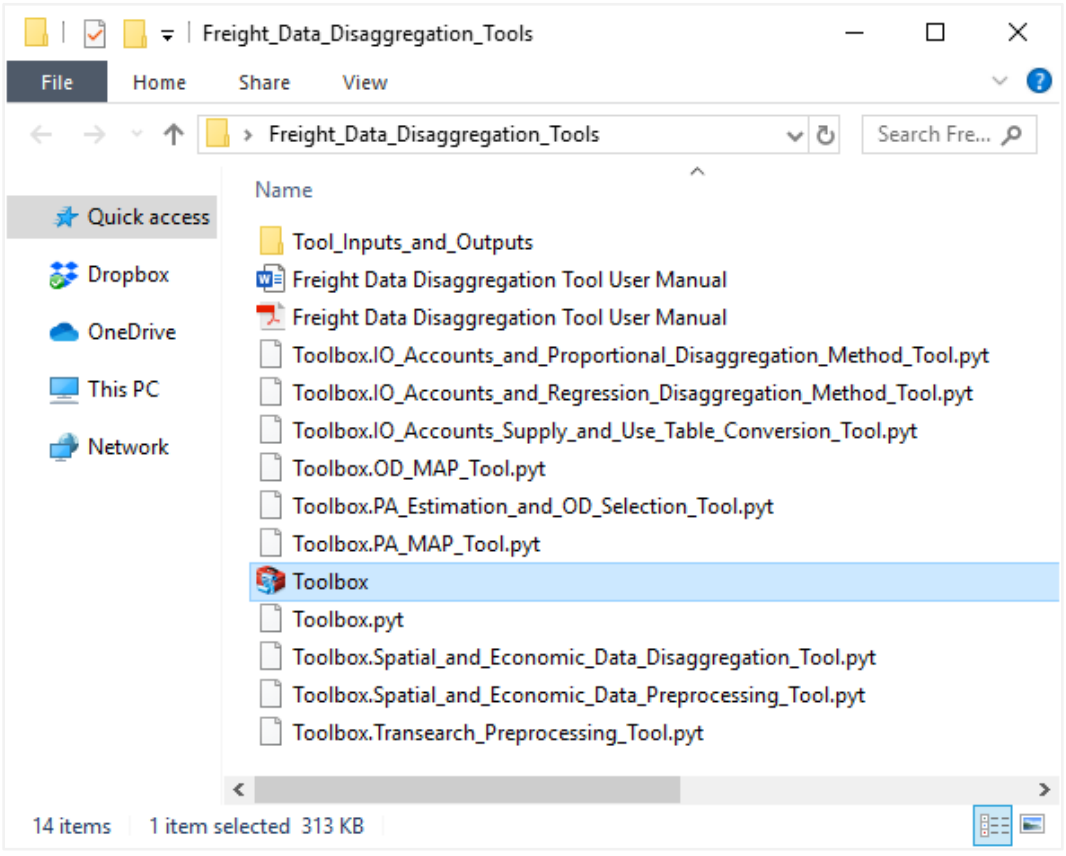


FIGURE A-1 FREIGHT DATA DISAGGREGATION TOOL FOLDER

STEP 2

Open ArcMap of ESRI ArcGIS. Open the ArcToolbox window. Right-click on the ArcToolbox window and select the **Add Toolbox** option. Select the file **Toolbox.pyt** located in folder **/ Freight Data Disaggregation Tool** and click Open (see Figure A-2). A new toolbox will appear in the ArcToolbox window.

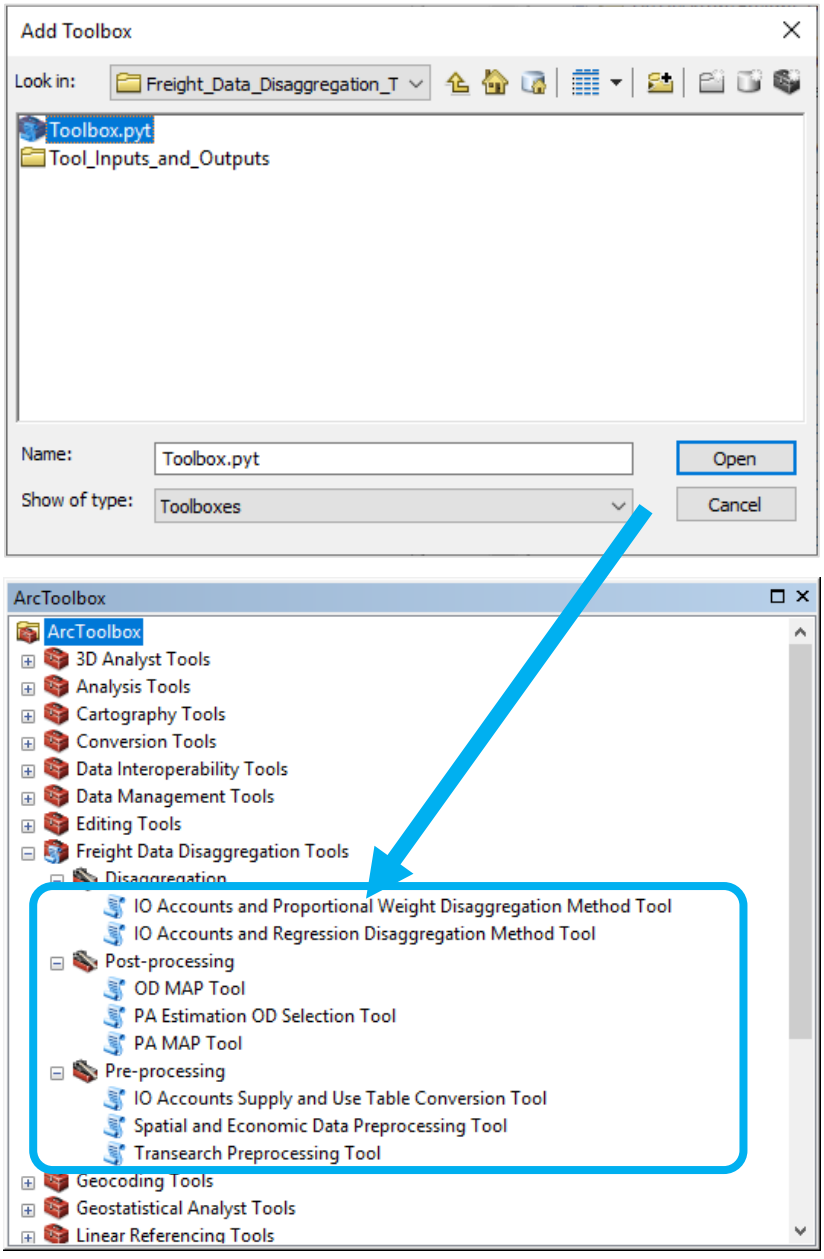


Figure A-2 Adding a New ArcGIS Toolbox

STEP 3

Now the applications are ready for use. However, the new toolbox **Freight Data Disaggregation Tools.pyt** will not be pinned to the panel with ArcGIS toolboxes - ArcToolbox (i.e., next time the user opens ArcGIS, toolbox **Freight Data Disaggregation Tools.pyt** will not be present and should be added again). To pin the new toolbox to the panel ArcToolbox the user has to exit ArcGIS and open the folder where ArcGIS is installed (e.g., C:\Program Files (x86)\ArcGIS). Next, the user has to open the folder with all ArcGIS toolboxes (e.g., C:\Program Files (x86)\ArcGIS\Desktop10.5.1\ArcToolbox\Toolboxes) and then place the toolbox **Freight Data Disaggregation Tools.pyt** to that folder (see Figure A-3). Now anytime the user opens ArcGIS, the toolbox **Freight Data Disaggregation Tools.pyt** will be pinned to ArcToolbox.

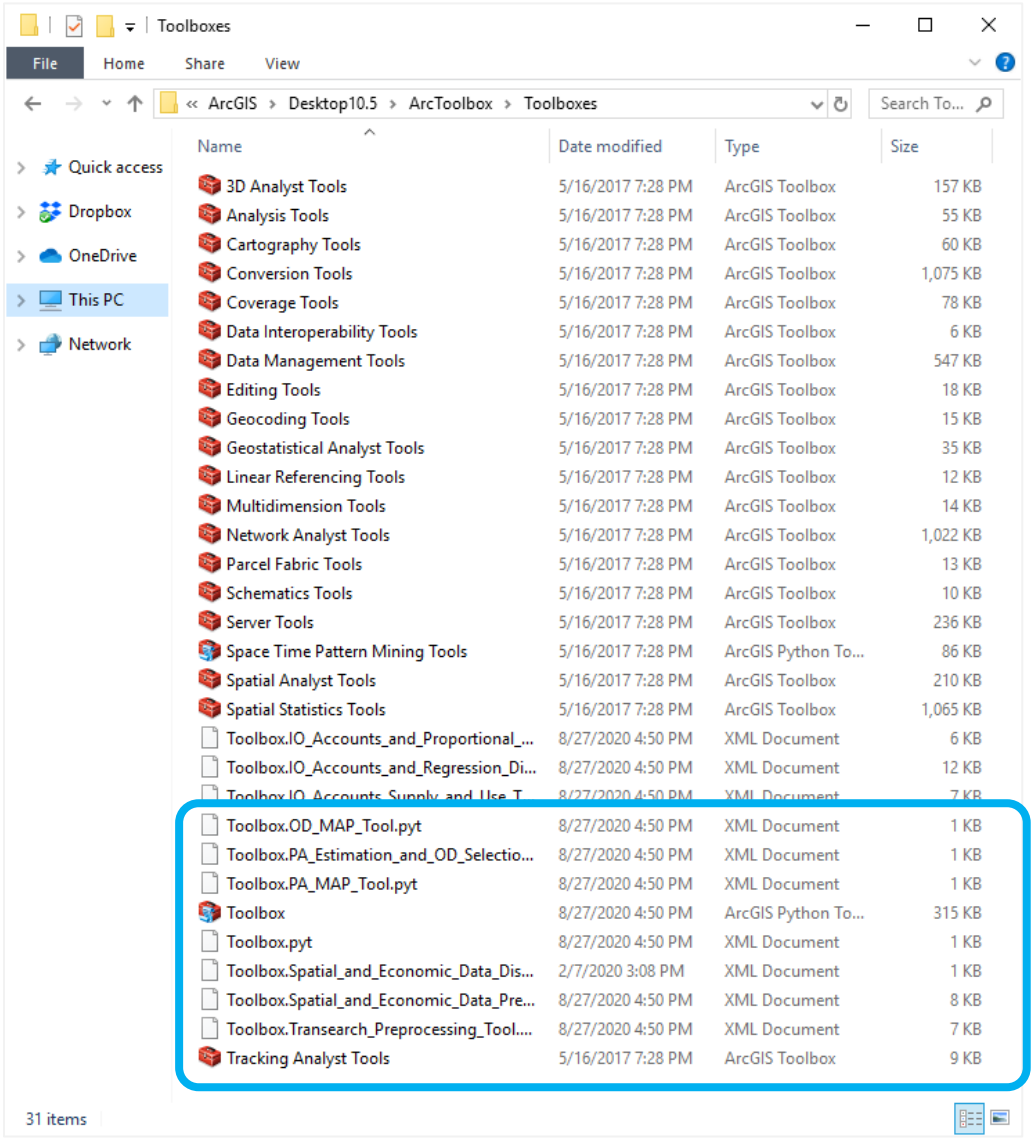


Figure A-3 Adding a New Toolbox to ArcToolbox

A.3 TRANSEARCH Preprocessing Tool

Description

The TRANSEARCH data available for this research was given by the 3-digit SCTG code industry. The developed disaggregation methodologies and tools require SCTG 2-digit code industry type since the crosswalk from SCTG to NAICS requires an SCTG 2-digit code. This tool pre-processes TRANSEARCH data and adds an SCTG 2-digit code industry code. Additionally, the tool provides options to estimate production and attractions in tons at the county level, average Internal-Internal (I-I), Internal-External (I-E), External-Internal (E-I) commodity flow lengths, split data into smaller portions by unique field attributes, and/or specific zones selected by the user. Zone productions and attractions are performed by the following fields: SCTG 2-digit code, equipment type, trade type, and mode. The option to select and pre-process data for a specific subarea in Tennessee (e.g., east Tennessee county origins and destinations) and field attributes (e.g., specific SCTG 2-digit code, Equipment, Trade Type, and Mode) is also available. The rationale for allowing the user to pre-process a subset of the whole data is to allow faster processing times and PC memory issues in cases where subareas are of interest. A schematic overview of TRANSEARCH Preprocessing Tool inputs and outputs is shown in Figure A-6. The output from this tool will be used as an input only in two of the developed tools: i) the IO Accounts and Proportional Weight Disaggregation Method Tool, and ii) the IO Accounts and Regression Disaggregation Method Tool. Next, we present example input file formats and data field names, types, lengths.

Example Input Files

TRANSEARCH_Database.gdb/TRANSEARCH_Data (see Figure A-4)

Spatial_Database.gdb/County_File (see Figure A-5)

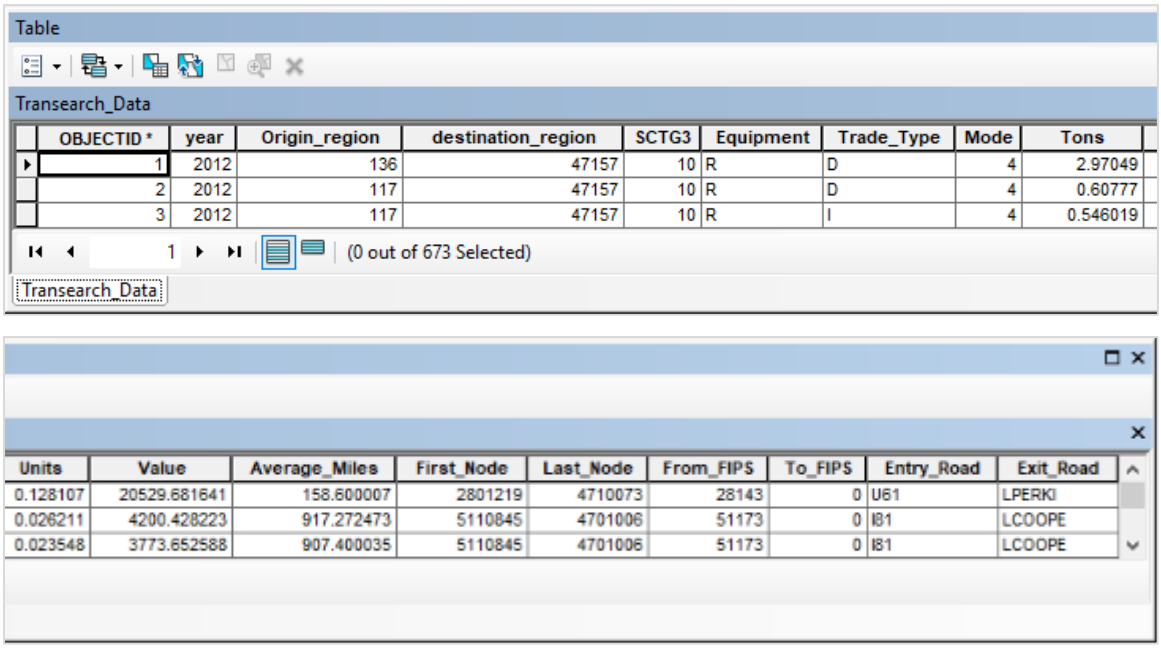


Figure A-4 TRANSEARCH Database

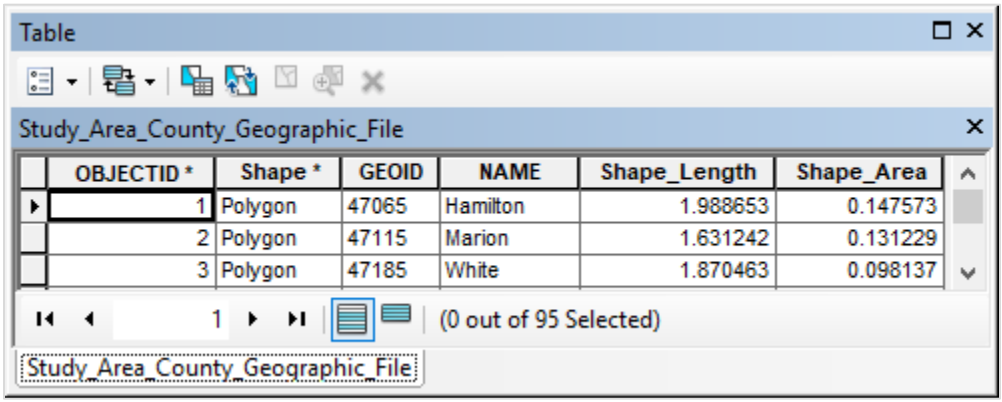


Figure A-5 Study Area County Geographic File

TABLE A-1 TRANSEARCH DATA FIELD NAMES, TYPES, LENGTHS, AND DESCRIPTIONS

Field Name	*Field Type*	*Field Length*	*Field Description*
year	Short		Base or scenario year
Origin_region	Long		Origin region number
destination_region	Long		Destination region number
SCTG3	Long		3-digit SCTG code
Equipment	Text	1	Equipment
Trade_Type	Text	1	Trade Type
Mode	Short		Mode number
Tons	Double		The number annual tons carried
Units	Double		The number of truckloads carried (equivalent of number of trucks)
Value	Double		Estimated value of goods at origin in U.S. dollars
Average_Miles	Double		Average Miles
First_Node	Long		First node of Tennessee roadway system that the freight flow is passing
Last_Node	Long		Last node of Tennessee roadway system that the freight flow is passing
From_FIPS	Long		The county of the state a truck movement entered Tennessee from
To_FIPS	Long		The county of the state to which a truck movement leaving Tennessee entered
Entry_Road	Text	6	The highway used to enter Tennessee in the route assignment process
Exit_Road	Text	6	The highway used to leave Tennessee in the route assignment process

TABLE A-2 STUDY AREA COUNTY DATA FIELD NAMES, TYPES, LENGTHS, AND DESCRIPTIONS

Field Name	*Field Type*	*Field Length*	*Field Description*
GEOID	Text	5	County Code
NAME	Text	15	County Name

TRANSEARCH Preprocessing Tool Inputs and Outputs

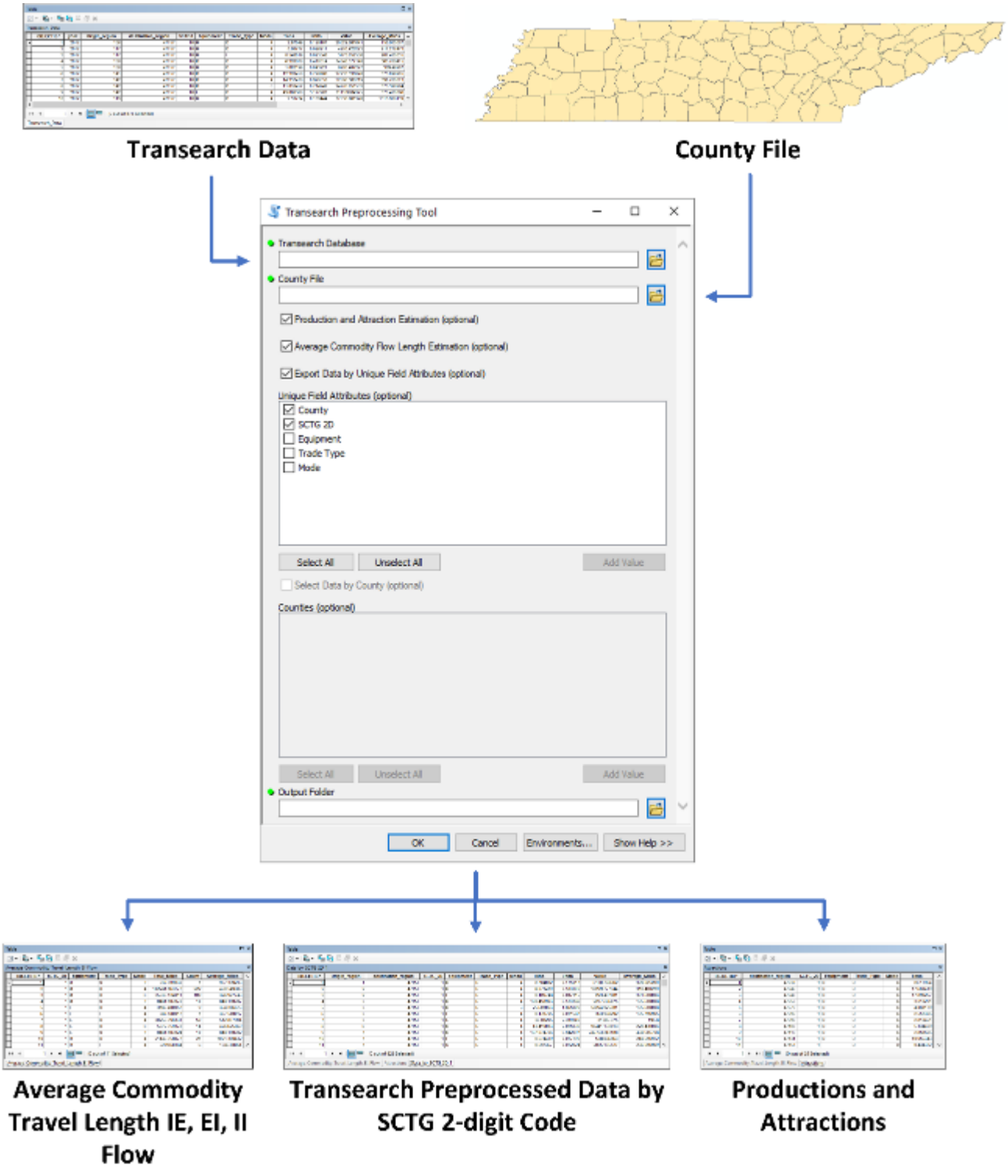


Figure A-6 TRANSEARCH Preprocessing Tool Inputs and Outputs

STEP 1

Open the newly added **Freight Data Disaggregation Tool** toolbox, select the **Pre-processing** tool group, and lunch **TRANSEARCH Preprocessing Tool** (see Figure A-7).

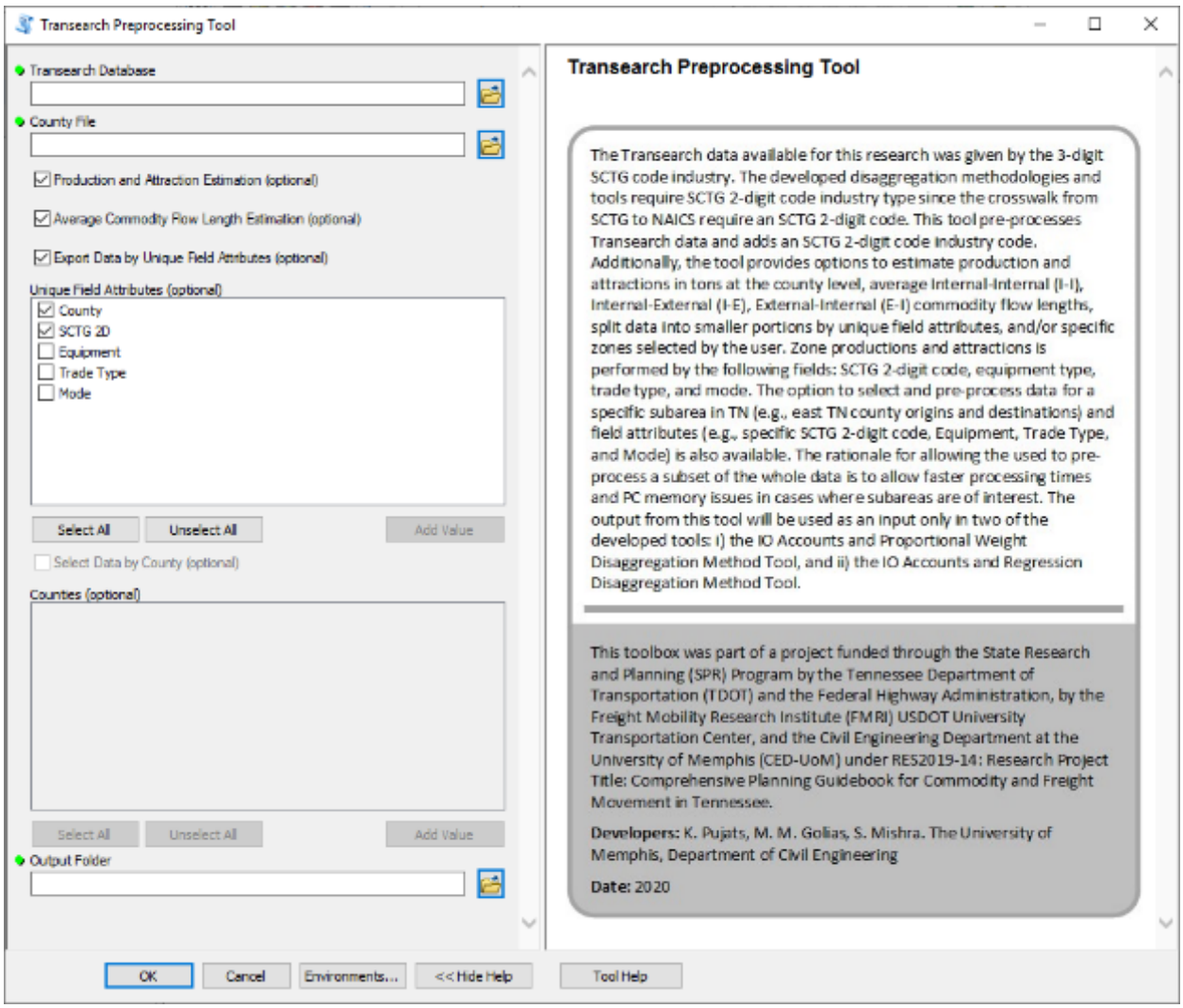


Figure A-7 TRANSEARCH Preprocessing Tool

STEP 2

Input path to TRANSEARCH freight flow database (.gdb/*) in tools input parameter **TRANSEARCH Database** (see Figure A-8)

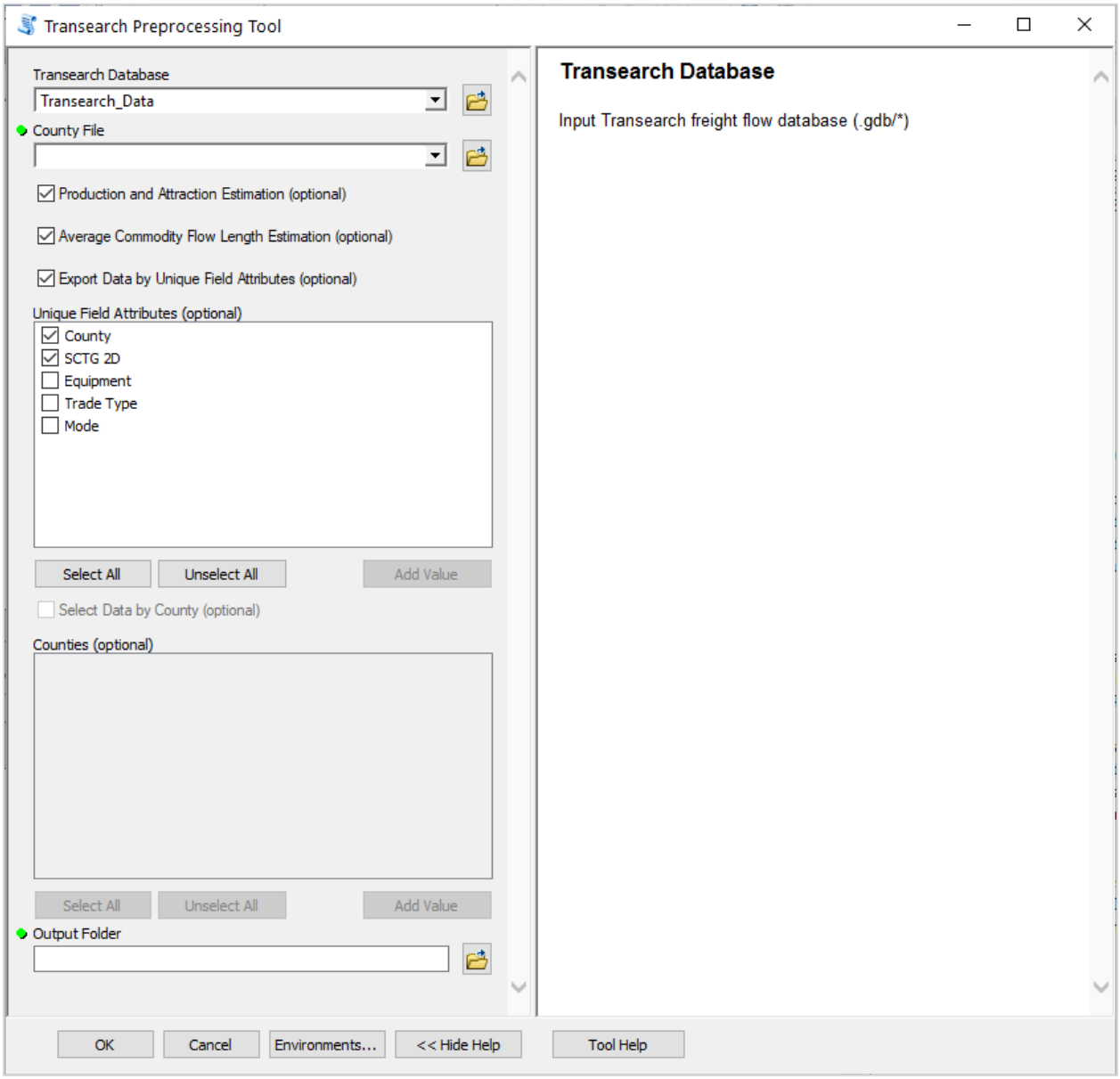


Figure A-8 Input TRANSEARCH Freight Flow Database (.gdb/*)

STEP 3

Input path to the geographic file containing study area counties with geographic entity codes (GEOIDs) in tools input parameter **County File** (see Figure A-9).

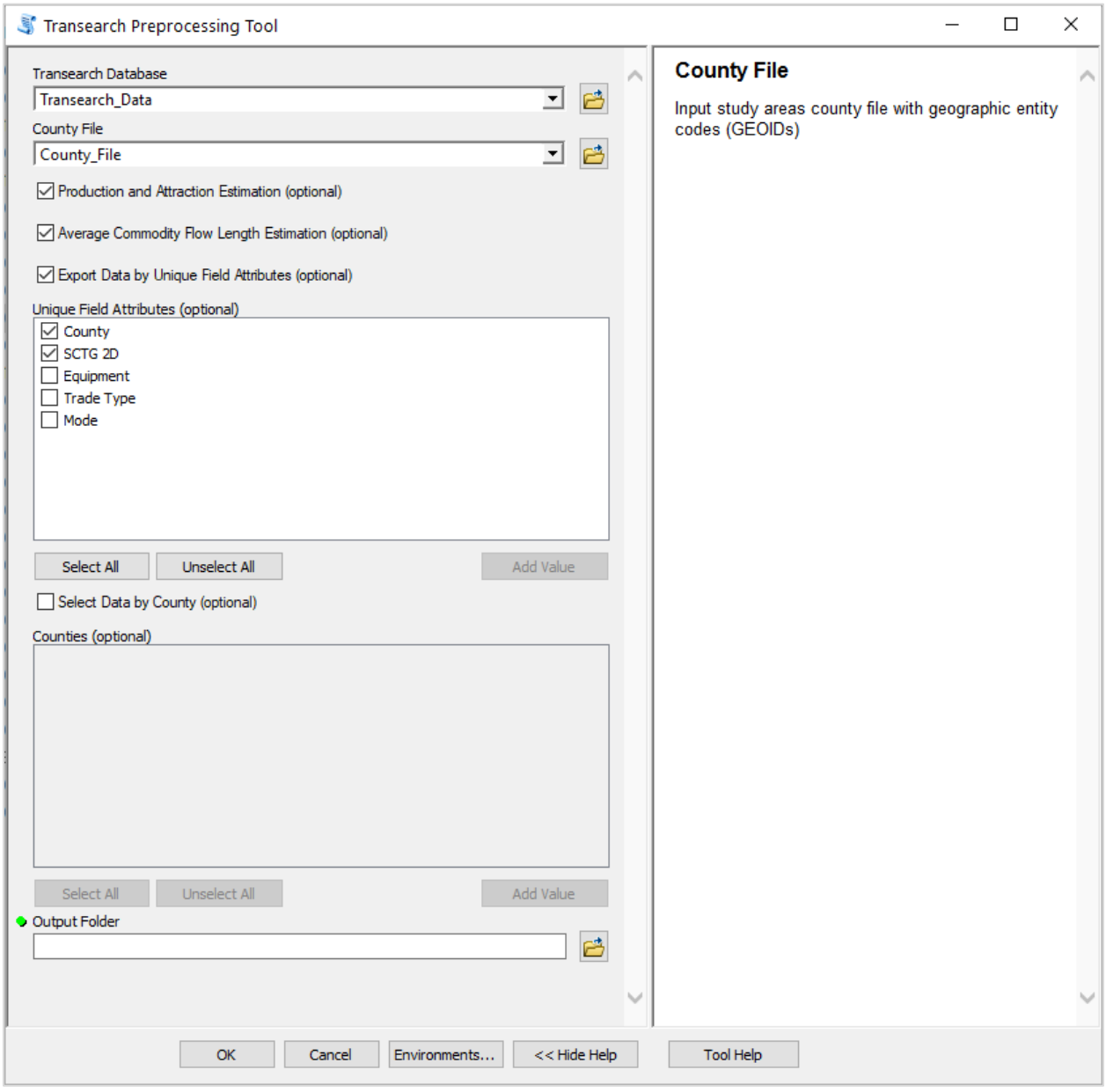


Figure A-9 Input Study Area County File

STEP 4

Select the option **Production and Attraction Estimation** if the user wishes to estimate TRANSEARCH zone productions and attractions for a given county network (see Figure A-10)

*The output from the following option will be used as input in **IO Accounts and Regression Disaggregation Method Tool**.*

(Default: True)

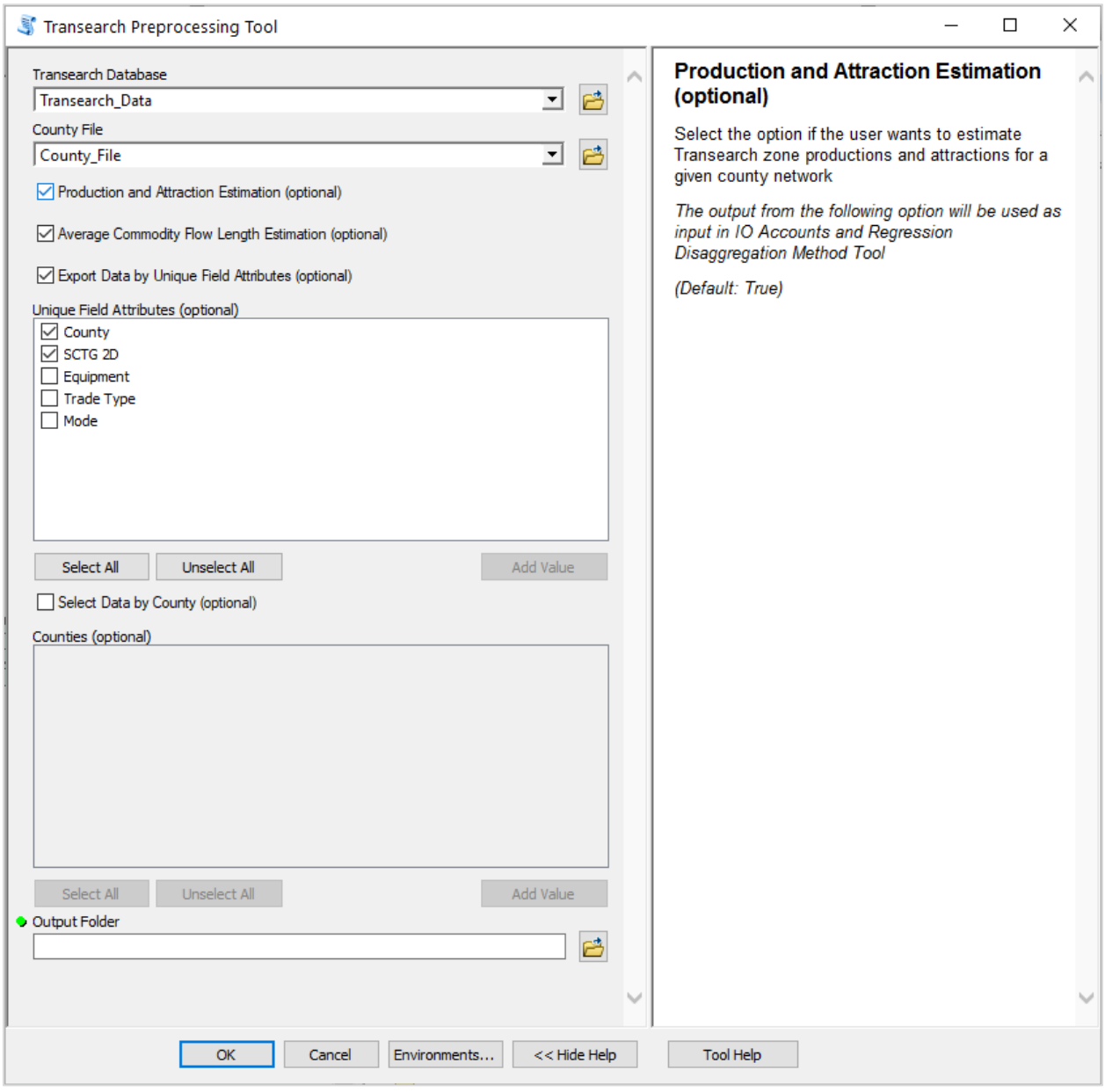


Figure A-10 Select the Option to Estimate Productions and Attractions

STEP 5

Select the option **Average Commodity Flow Length Estimation** if the user wishes to estimate TRANSEARCH average commodity flow travel length (see Figure A-11).

(Average commodity travel lengths will be processed for study areas Internal-Internal (II), External-Internal (EI), and Internal-External (IE) flows)

*The output from the following option will be used as input in **IO Accounts and Regression Disaggregation Method Tool** freight distribution option using the **Gravity model**.*

(Default: True)

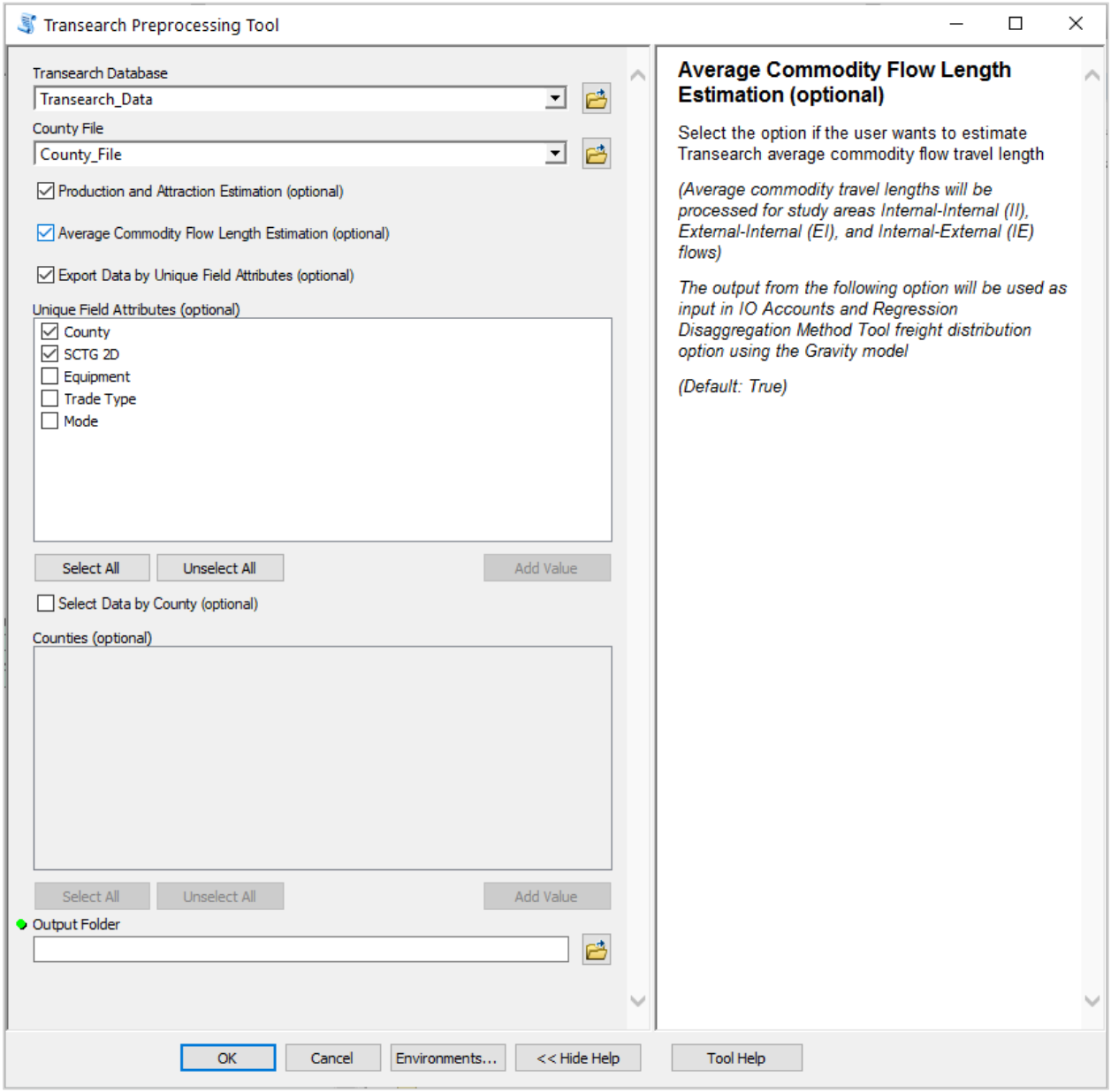


Figure A-11 Select the Option to Estimate Average Commodity Flow Length

STEP 6

Select the option **Export Data by Unique Field Attributes** if the user wishes to split the TRANSEARCH database by unique field attributes (see Figure A-12).

(Default: True)

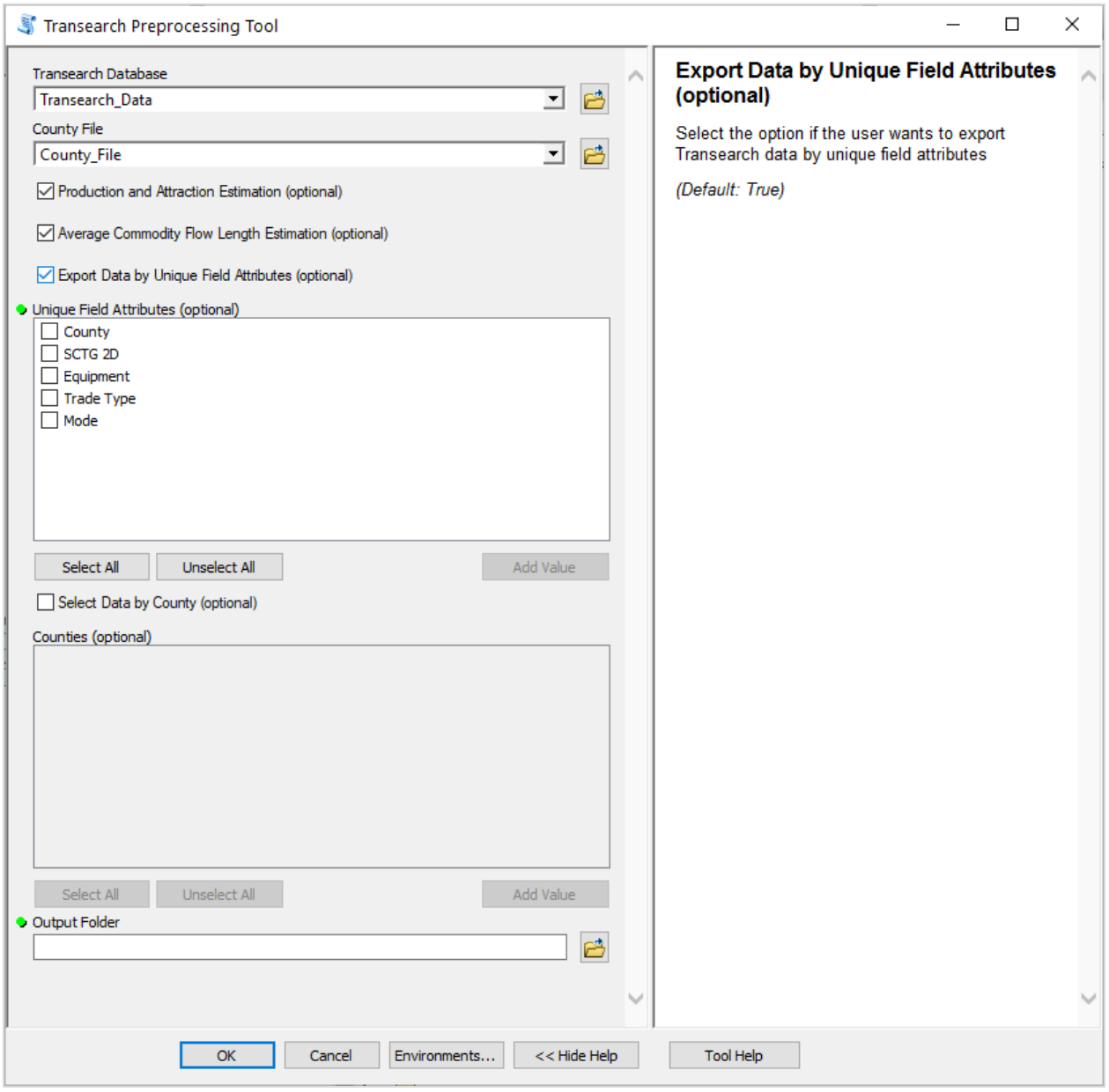


Figure A-12 Select the Option to Split the TRANSEARCH Database by Unique Field Attributes

STEP 6.1

Option **Unique Field Attributes** allows selecting the unique field attributes (County origins and destinations, SCTG 2-digit code, Equipment, Trade Type, and Mode) by which TRANSEARCH database will be exported (see Figure A-13).

(Default: County, SCTG 2D)

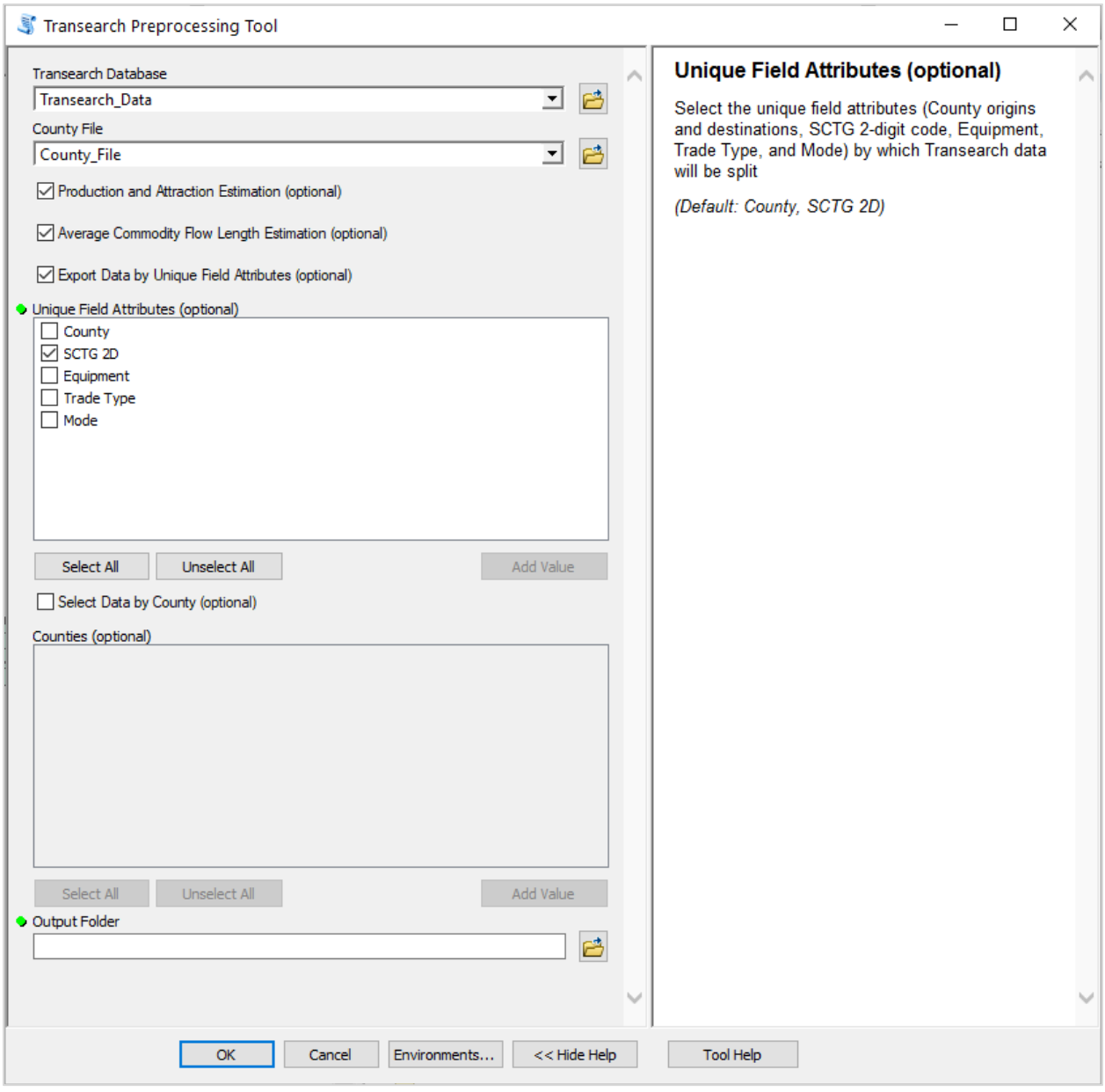


Figure A-13 Select Unique Field Attributes

STEP 7

Select the option **Select Data by County** if the user wishes to pre-process the TRANSEARCH database for selected counties (see Figure A-14).

(Default: True)

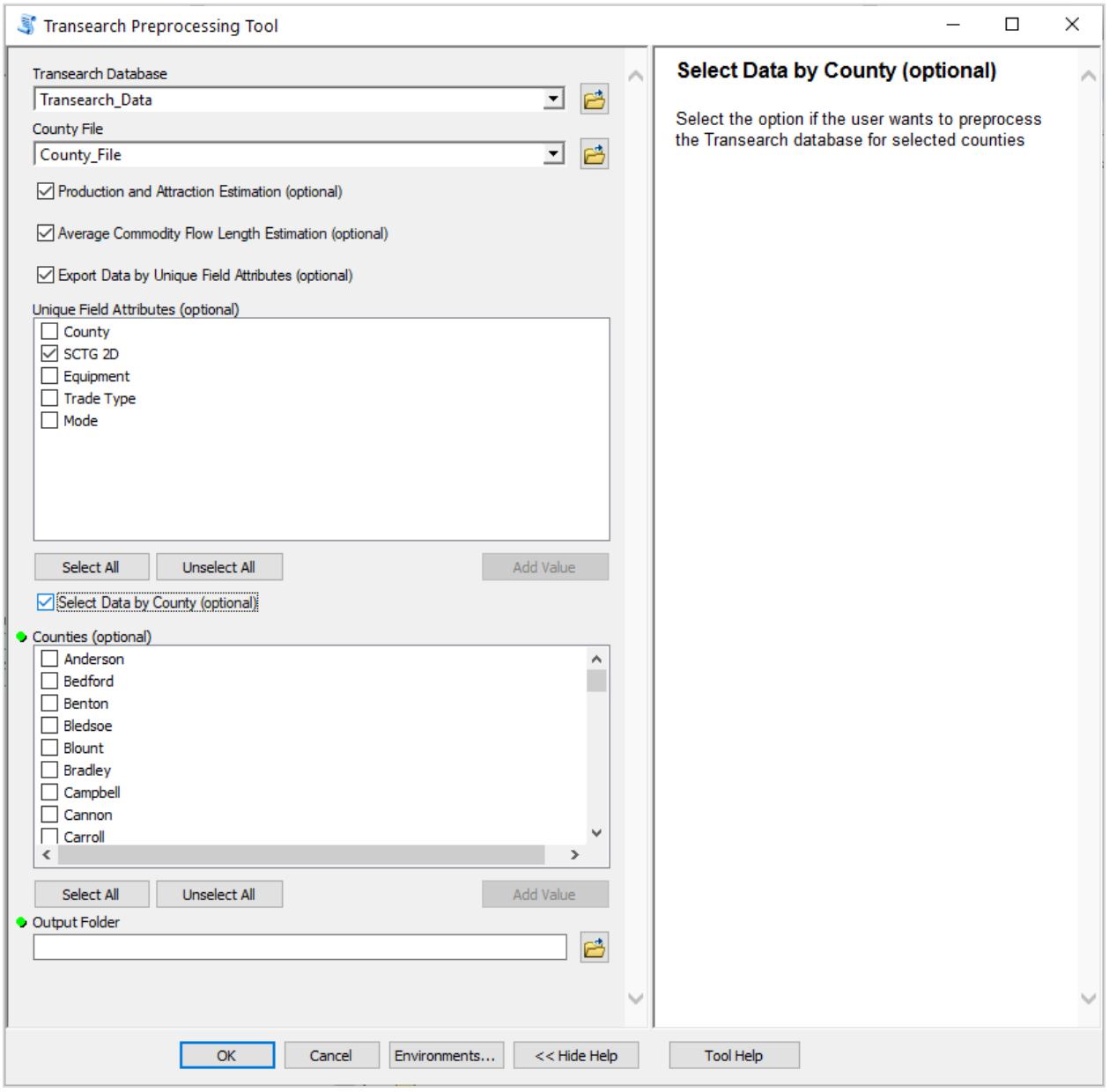


Figure A-14 Select the Option to Pre-process TRANSEARCH Database for Selected Counties

STEP 7.1

Option **Counties** allows user to select counties for which the TRANSEARCH database will pre-processed (see Figure A-15).

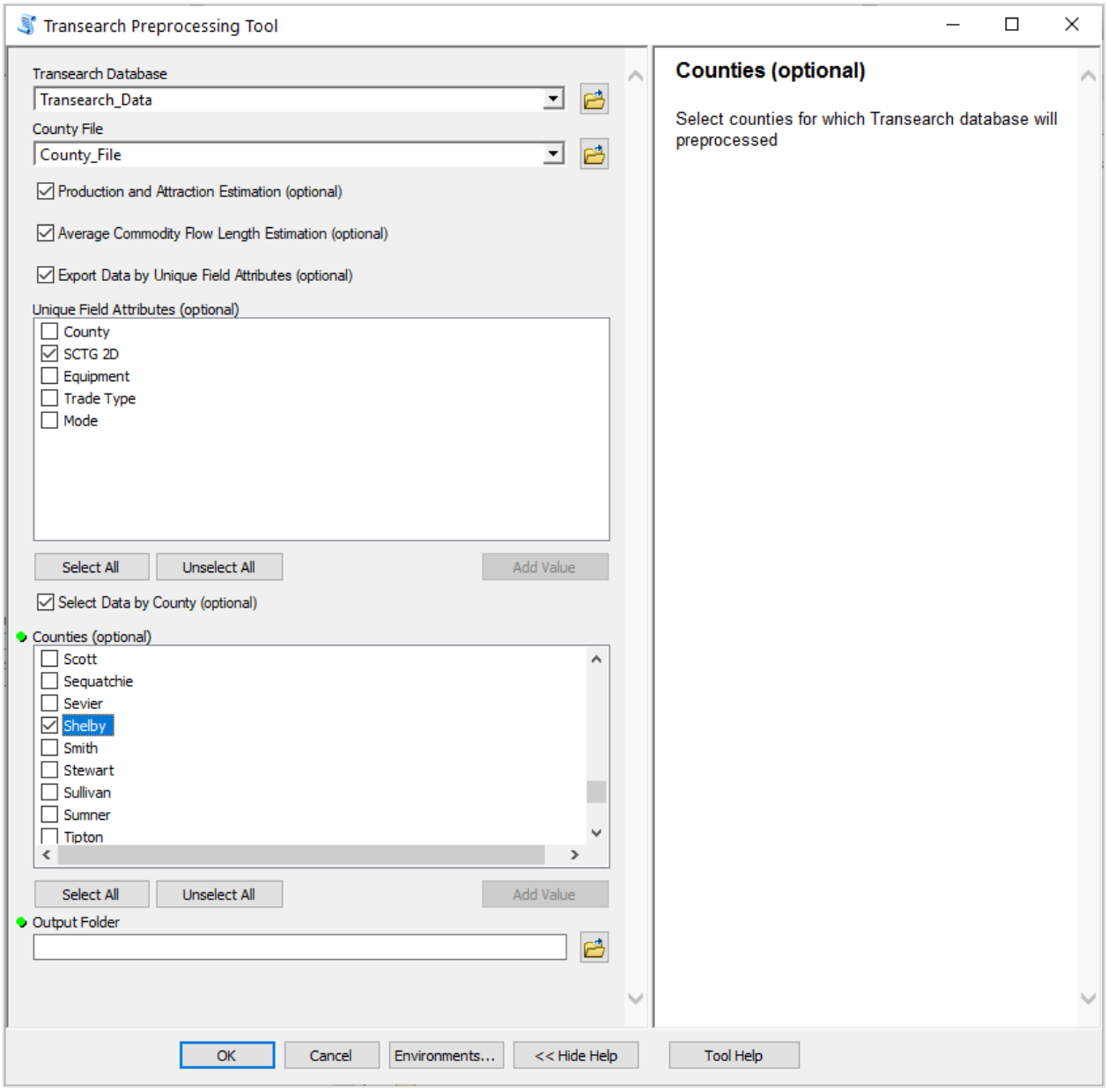


Figure A-15 Select the Counties

STEP 8

In the tools **Output Folder** parameter, select the output folder path where the processed files will be outputted (see Figure A-16).

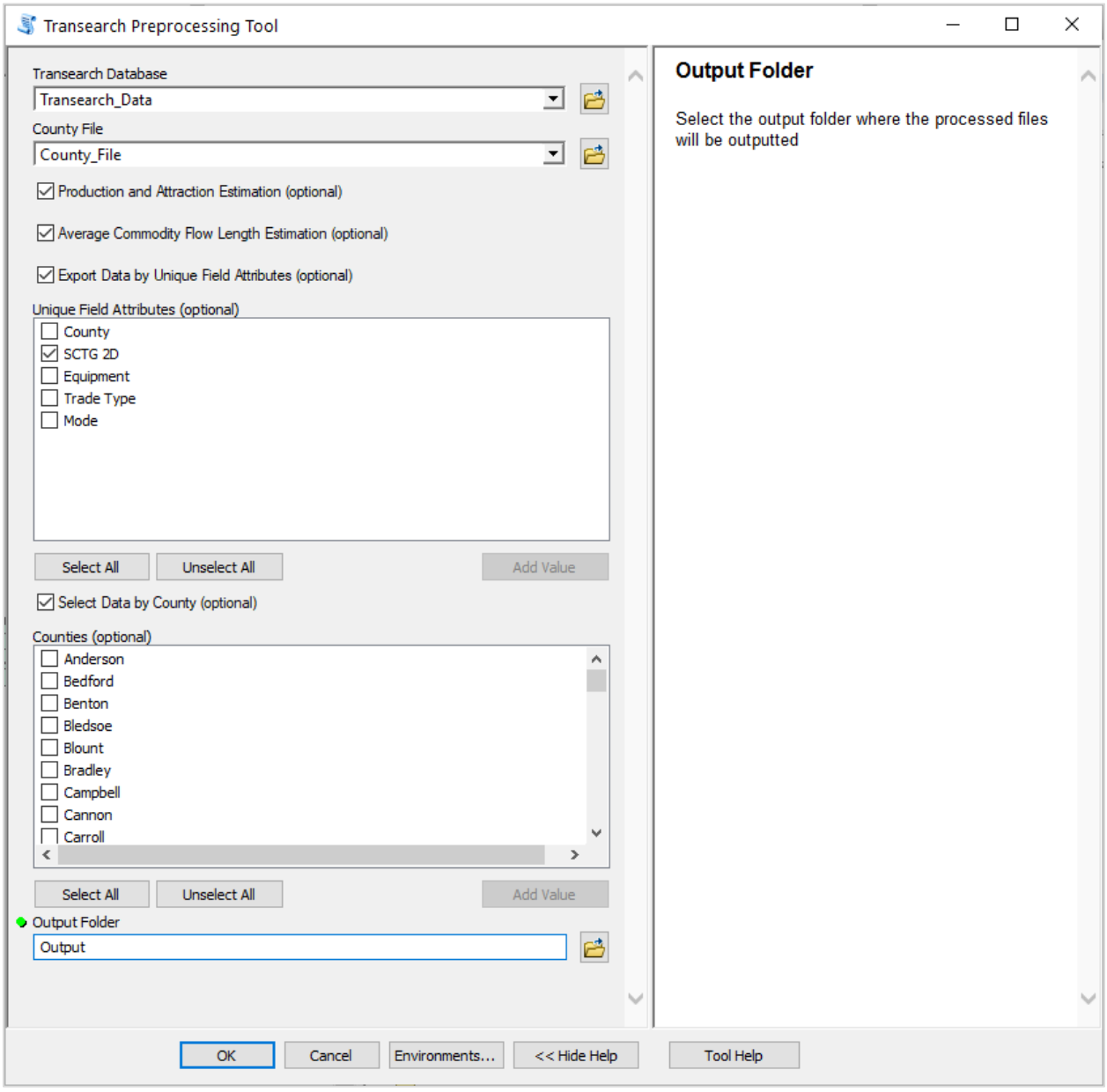


Figure A-16 Select the Output Folder

STEP 9

Once all required parameters are inputted, press OK to execute the application. The ArcGIS application invokes a task completion window, which reports the status of each task (see Figure A-17). Also, processed outputs (Pre-processed TRANSEARCH Data (see Figure A-18), Productions and Attractions (see Figure A-19), and Average Commodity Travel Length for II, IE, EI (see Figure A-20) for the selected options (**Average Commodity Flow Length Estimation, Production and Attraction Estimation**, and also when the option **Split Data by Unique Field Attributes** is disabled) will be imported to ArcMap display.

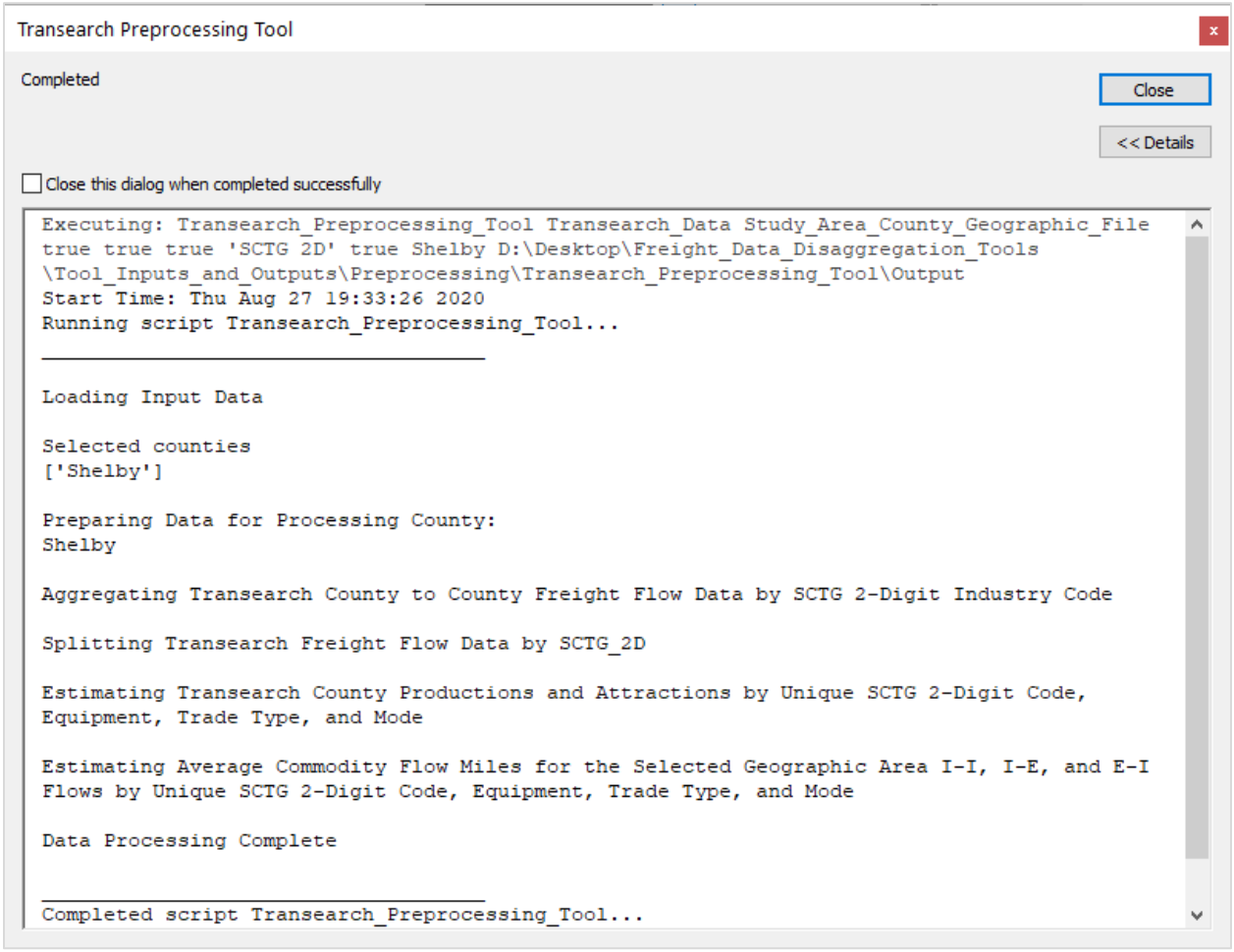


Figure A-17 TRANSEARCH Preprocessing Tool Performance Task Window

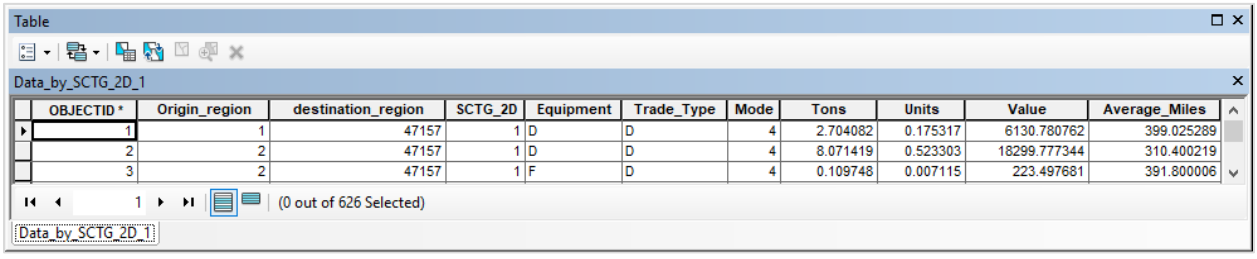


Figure A-18 Preprocessed TRANSEARCH Data

Table

Productions

OBJECTID *	Origin_region	SCTG_2D	Equipment	Trade_Type	Mode	Tons
1	47003	1	D	D	6	11.157824
2	47005	1	D	D	6	4.854592
3	47007	1	D	D	6	2.84348

(0 out of 65 Selected)

Productions

Table

Attractions

OBJECTID *	destination_region	SCTG_2D	Equipment	Trade_Type	Mode	Tons
1	47037	1	D	D	6	28.17964
2	47043	1	D	D	6	17.660419
3	47045	1	D	D	6	17.899267

(0 out of 22 Selected)

Attractions

Figure A-19 County Productions and Attractions

Table

Average_Commodity_Travel_Length_II_Flow

OBJECTID *	SCTG_2D	Equipment	Trade_Type	Mode	Total_Miles	Count	Average_Miles
1	1	D	D	6	17156.499907	81	211.808641
2	1	F	D	4	311.100004	1	311.100004
3	1	L	D	6	385.800005	3	128.600002

(0 out of 3 Selected)

Average_Commodity_Travel_Length_II_Flow

Table

Average_Commodity_Travel_Length_IE_Flow

OBJECTID *	SCTG_2D	Equipment	Trade_Type	Mode	Total_Miles	Count	Average_Miles
1	1		N	8	0	7	0
2	1	D	D	4	28024.860927	70	400.355156
3	1	D	N	7	894.199994	1	894.199994

(0 out of 4 Selected)

Average_Commodity_Travel_Length_IE_Flow

Table

Average_Commodity_Travel_Length_EI_Flow

OBJECTID *	SCTG_2D	Equipment	Trade_Type	Mode	Total_Miles	Count	Average_Miles
1	1		D	8	0	2	0
2	1	B	N	7	937.339233	1	937.339233
3	1	D	D	4	116212.237229	248	468.597731

(0 out of 12 Selected)

Average_Commodity_Travel_Length_EI_Flow

Figure A-20 Average Commodity II, IE, and EI Flow Lengths

A.4 Spatial and Economic Data Preprocessing Tool

Description

The following tool provides the following capabilities. First, if the option **Estimate the Disaggregate Zone Economic Indicator Shares** is enabled, the tool will estimate the economic indicator (employment, the value of sales, and sq. footage) shares of each disaggregate zone NAICS 3-digit industry code. Second, if the option **Estimate Disaggregate Zone Economic Indicator Values** is enabled, the tool will estimate economic indicator (employment, the value of sales, and sq. footage) values by NAICS 3-digit industry code for aggregate and disaggregate zones. Third, if the option Estimate using NAICS 2-digit industry code is enabled the tool will estimate the economic indicator shares of each disaggregate/aggregate zone the NAICS 2-digit industry code not the NAICS 3-digit. Fourth, if the option **Estimate Disaggregate and TRANSEARCH Zone Centroid Latitude and Longitude** is enabled, the tool will estimate centroid latitude and longitude for each TRANSEARCH and disaggregate zone. A schematic overview of Spatial and Economic Data Preprocessing Tool inputs and outputs is shown in Figure A-24. The output from this tool is used as input in: i) IO Accounts and Proportional Weight Disaggregation Method Tool, and ii) IO Accounts and Regression Disaggregation Method Tool. Next, we present example input file formats and data field names, types, lengths.

Example Input Files

- **InfoUSA_Database.gdb/InfoUSA_Data** (see Figure A-21)
- **Spatial_Database.gdb/County_File** (see Figure A-5)
- **Spatial_Database.gdb/Disaggregate_Zone_File** (see Figure A-22)
- **Spatial_Database.gdb/TRANSEARCH_Zone_File** (see Figure A-23)

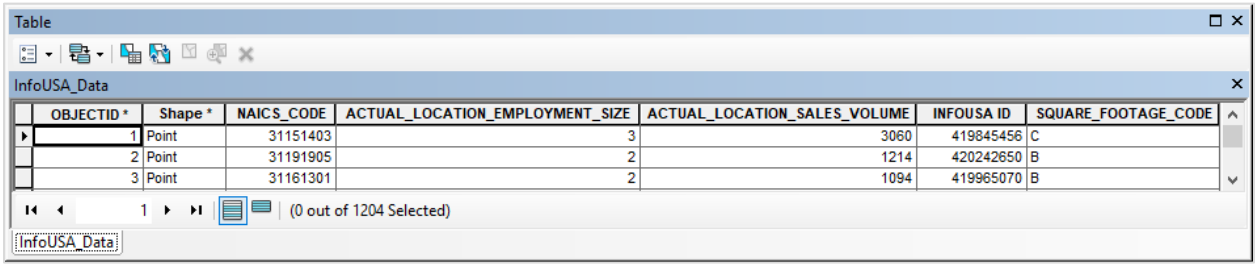


Figure A-21 InfoUSA Data

TABLE A-3 INFOUSA DATA FIELD NAMES, TYPES, LENGTHS, AND DESCRIPTIONS

Field Name	Field Type	Field Length	Field Description
NAICS_CODE	Long		8-digit NAICS Code
ACTUAL_LOCATION_EMPLOYMENT_SIZE	Long		Employment
ACTUAL_LOCATION_SALES_VOLUME	Long		Sales Volume
INFOUSA_ID	Long		InfoUSA ID of particular establishment
SQUARE_FOOTAGE_CODE	Text	1*	Square Footage

Make sure the field length for the **SQUARE_FOOTAGE_CODE is **one** as the **Spatial and Economic Data Preprocessing Tool** may give out the following error: **Memory Error: cannot allocate array memory***

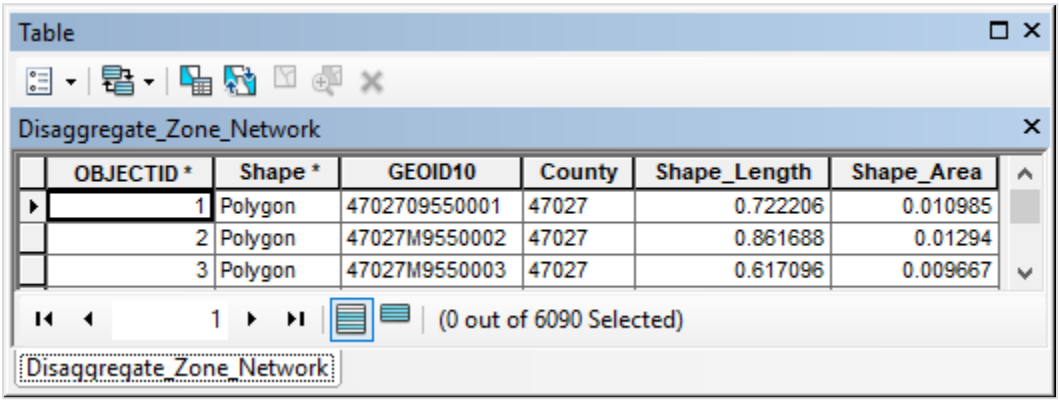


Figure A-22 Disaggregate Zone File

TABLE A-4 DISAGGREGATE ZONE DATA FIELD NAMES, TYPES, LENGTHS, AND DESCRIPTIONS

Field Name	*Field Type*	*Field Length*	*Field Description*
GEOID10	Text	13	Geographic Entity Code for the Disaggregate Zones
County	Text	5	Geographic Entity Code for the Counties

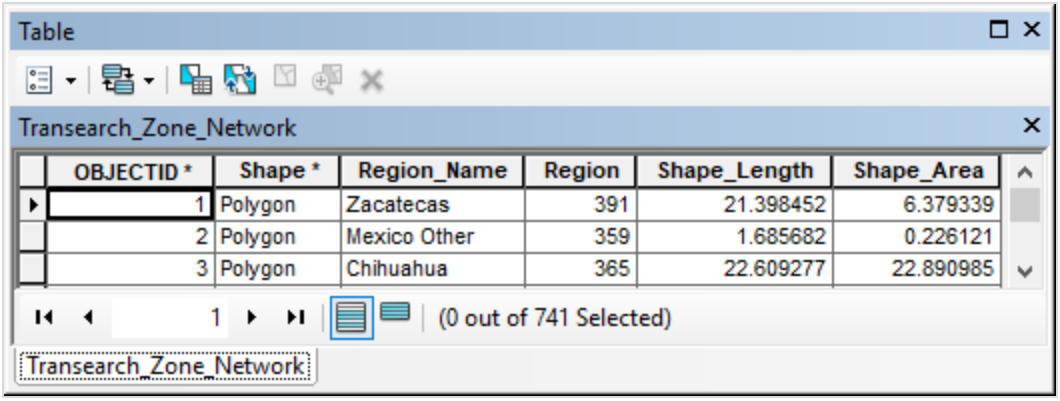


Figure A-23 TRANSEARCH Zone File

TABLE A-5 TRANSEARCH ZONE DATA FIELD NAMES, TYPES, LENGTHS, AND DESCRIPTIONS

Field Name	*Field Type*	*Field Length*	*Field Description*
Region_Name	Text	50	Region Name
Region	Long		Region Number

Spatial and Economic Data Preprocessing Tool Inputs and Outputs

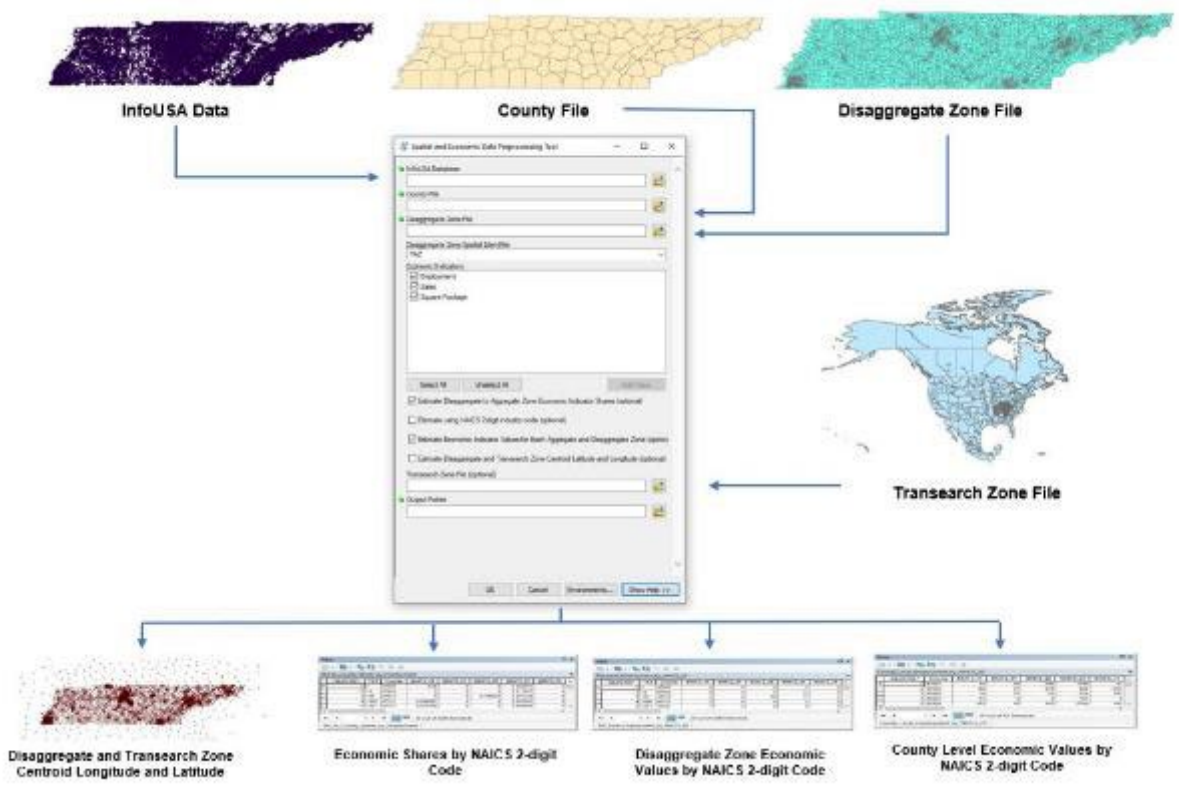


Figure A-24 Spatial and Economic Data Preprocessing Tool Inputs and Outputs

STEP 1

Open the newly added **Freight Data Disaggregation Tool** toolbox, select the **Pre-processing** tool group, and lunch the **Spatial and Economic Data Preprocessing Tool** (see Figure A-25).

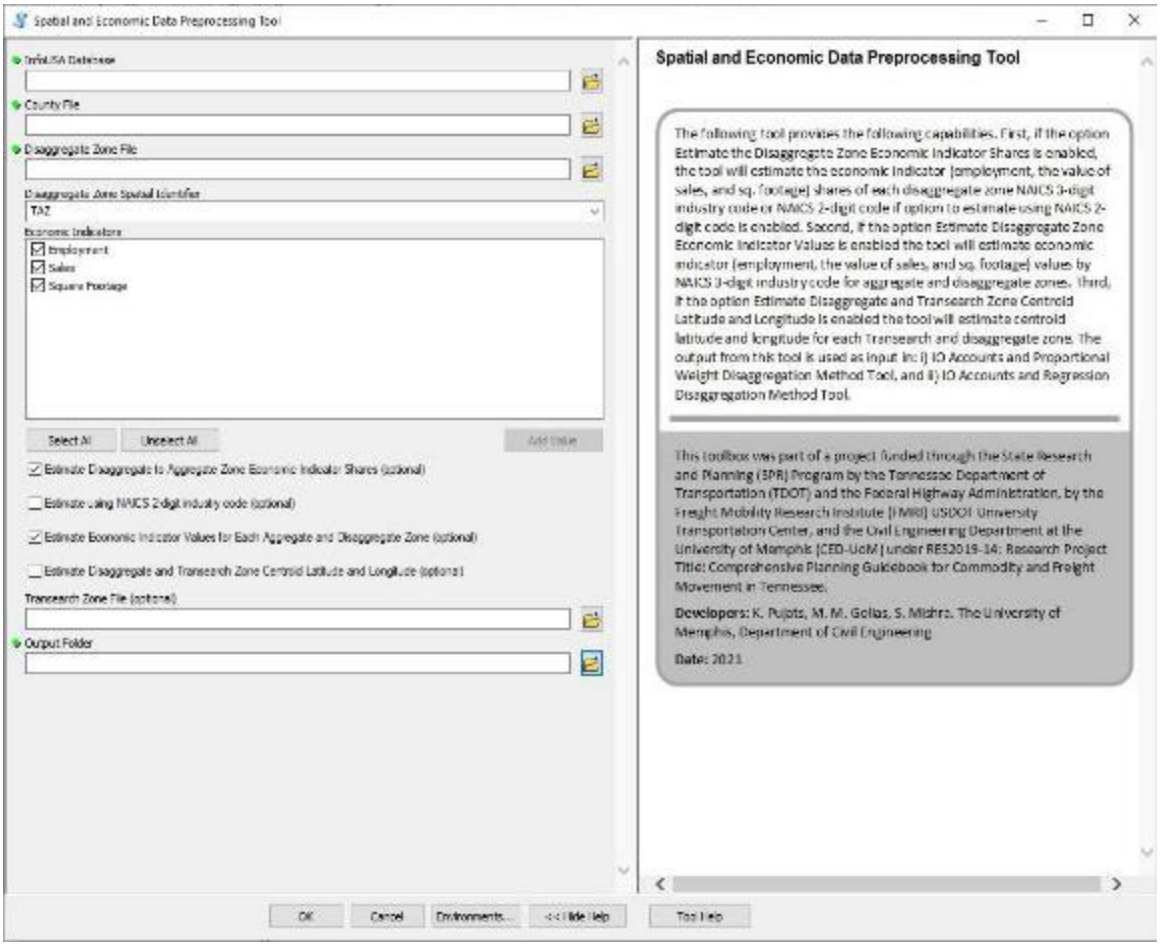


Figure A-25 Spatial and Economic Data Preprocessing Tool

STEP 2

Input path to InfoUSA* database (.gdb/*) in tools input parameter **InfoUSA Database** (see Figure A- 26).

> **User should input the Info USA database in the format as shown* Figure A-21. *Also, user should make sure that field attributes does not contain any empty cells, as tool may give out an error.*

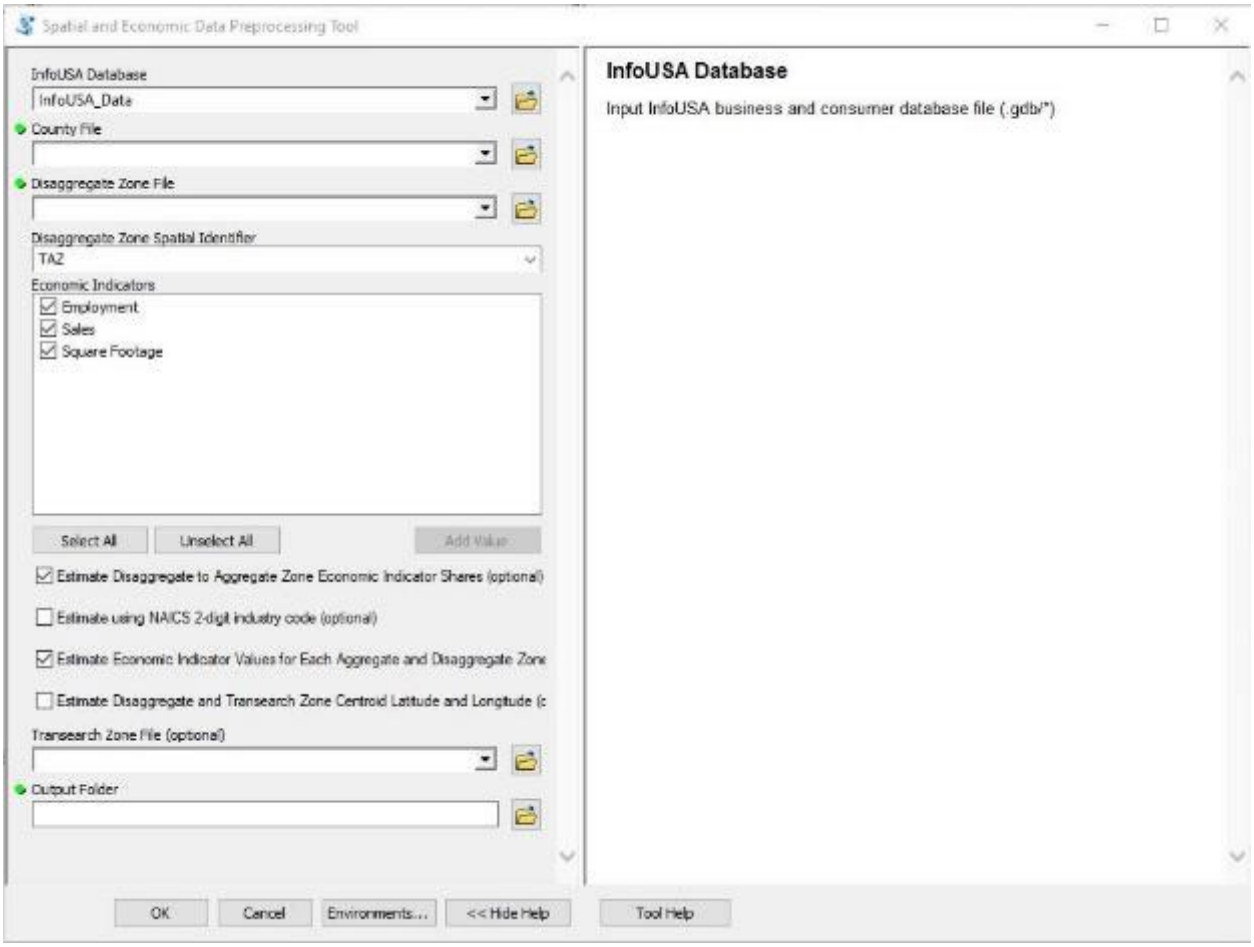


Figure A-26 Input InfoUSA database (.gdb/*)

STEP 3

Input path to the geographic file containing study area counties with geographic entity codes (GEOIDs) in tools input parameter **Study Area County File** (see Figure A-27).

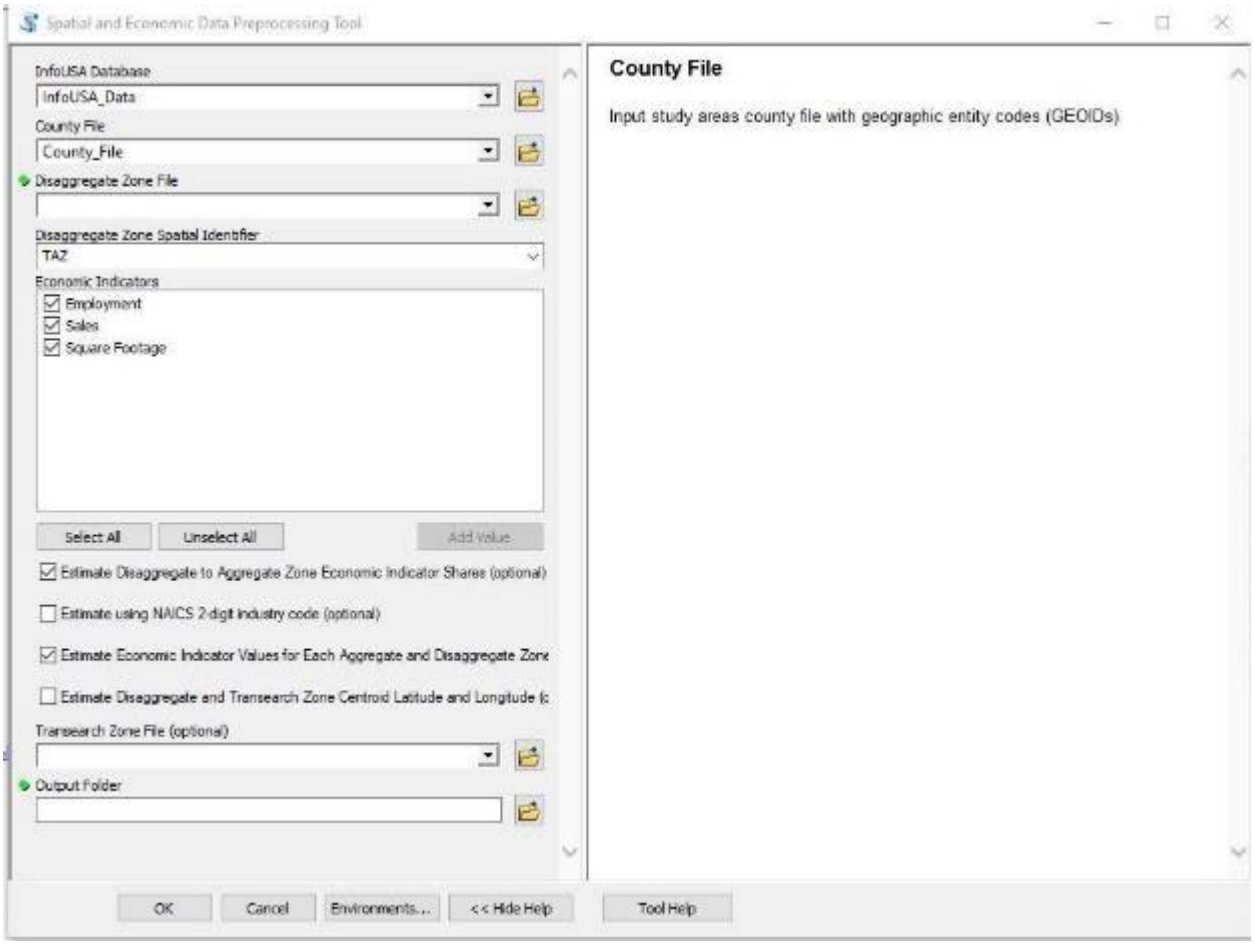


Figure A-27 Input Study Area County File

STEP 4

Input path to the geographic file containing study area disaggregate zones with geographic entity codes (GEOIDs) in tools input parameter **Disaggregate Zone File** (see Figure A-28).

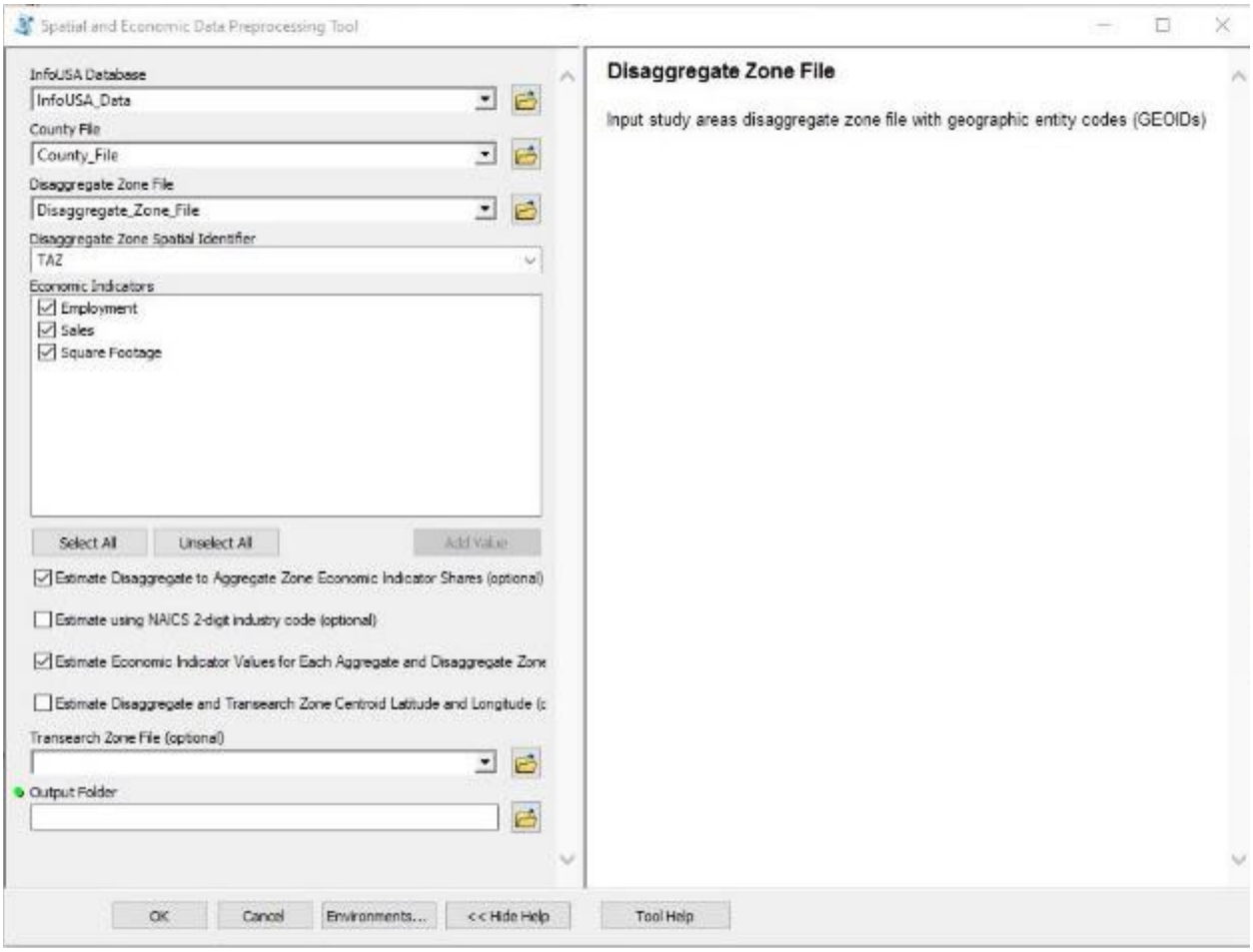


Figure A-28 Input Disaggregate Zone File

STEP 5

Select the type of disaggregate-level geographic zone in the tools input parameter **Disaggregate Zone Spatial Identifier** (see Figure A-29).

(Default: TAZ)

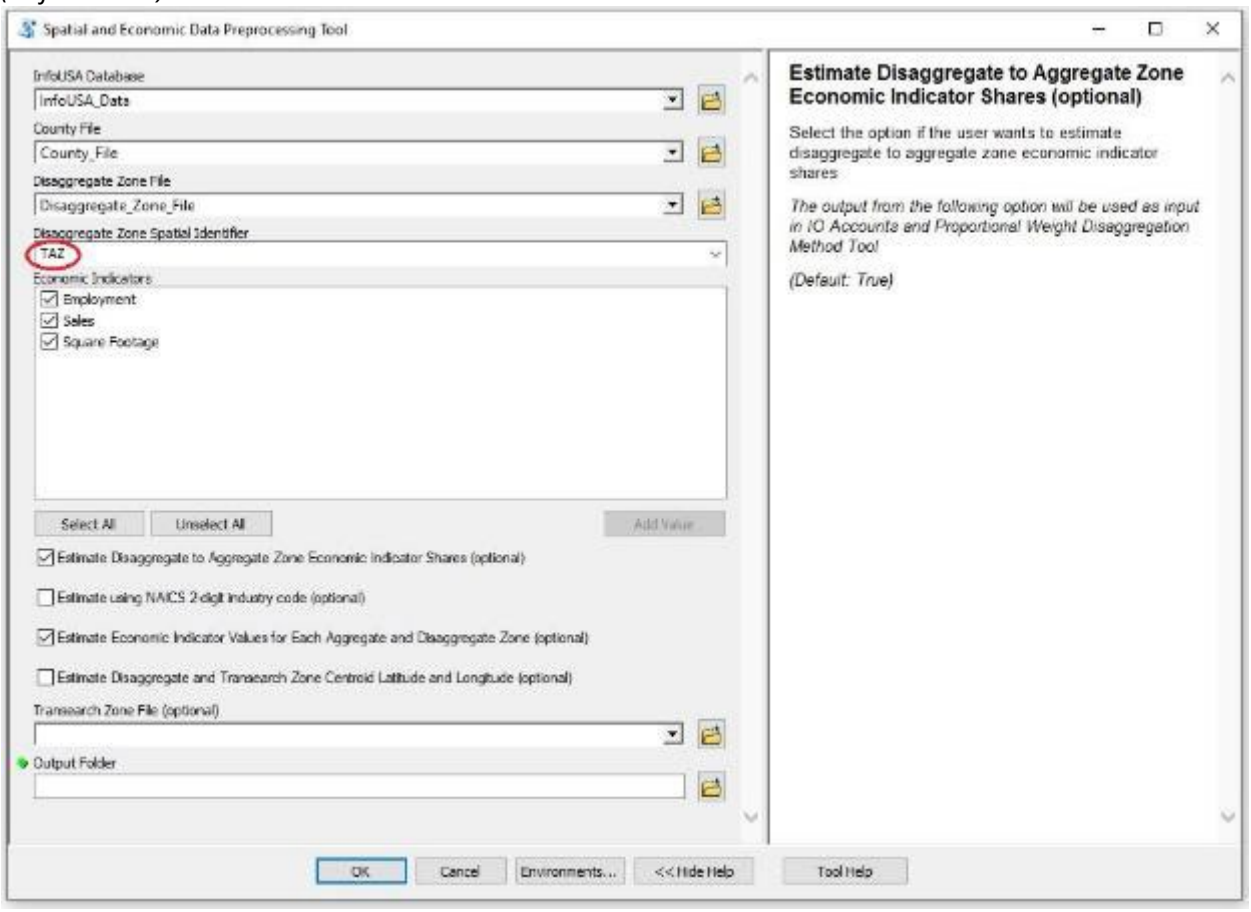


Figure A-29 Select Disaggregate Zone Spatial Identifier

STEP 6

Select the economic indicator(s) by which the spatial shares will be estimated in tools input parameter **Economic Indicators** (see Figure A-30).

(Default: All)

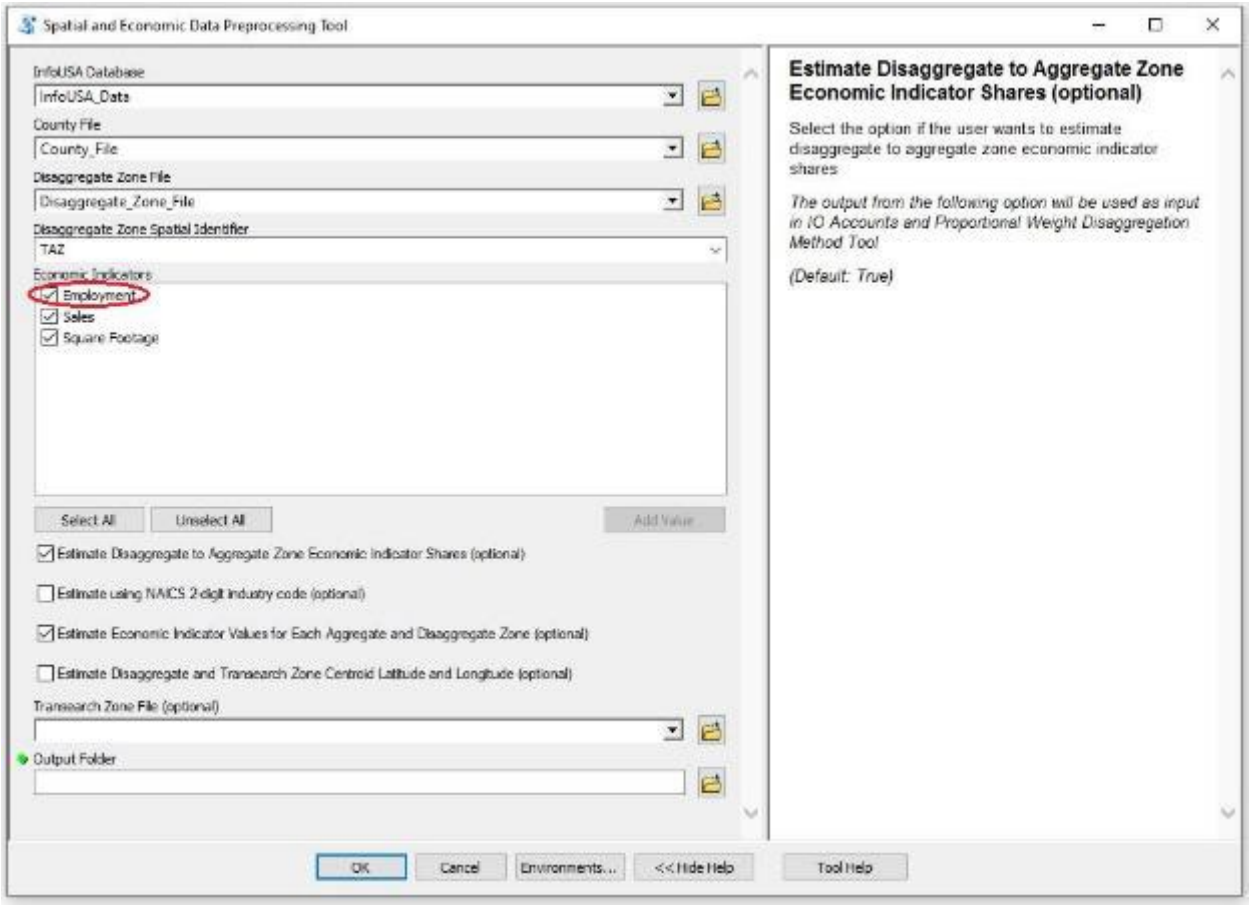


Figure A-30 Select the Economic Indicators

STEP 7

Select the option **Estimate the Disaggregate to Aggregate Zone Economic Indicator Shares** if the user wants to estimate disaggregate to aggregate zone economic indicator shares (see Figure A-31).

*The output from the following option will be used as input in **IO Accounts and Proportional Weight Disaggregation Method Tool.***

(Default: True)

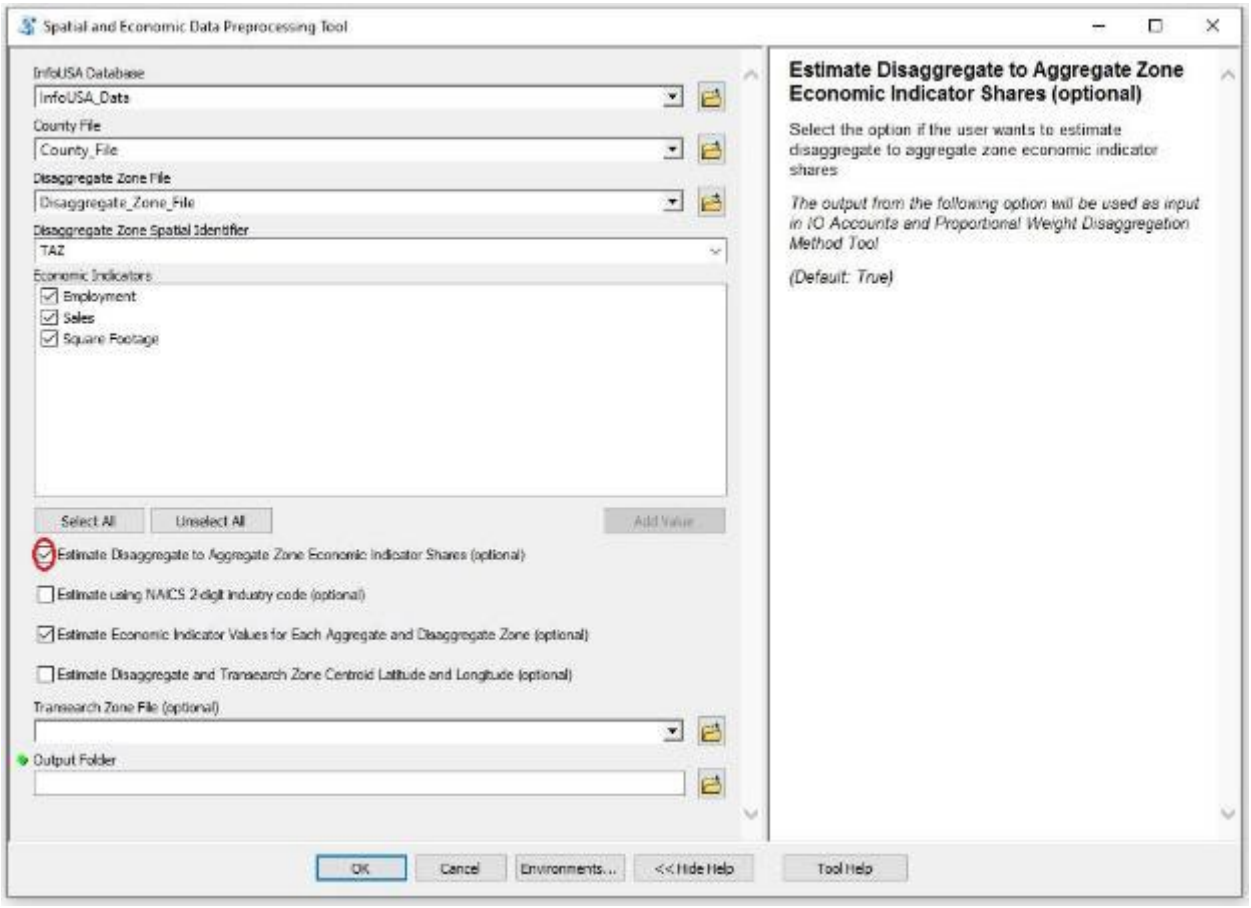


Figure A-31 Select the Option to Estimate the Disaggregate to Aggregate Zone Economic Indicator Shares

STEP 8

Select the option **Estimate using NAICS 2-digit industry code** if the user wants to estimate based on NAICS 2-digit industry code (see Figure A-32).

*The output from the following option will be used as input in **IO Accounts and Regression Disaggregation Method Tool***

(Default: True)

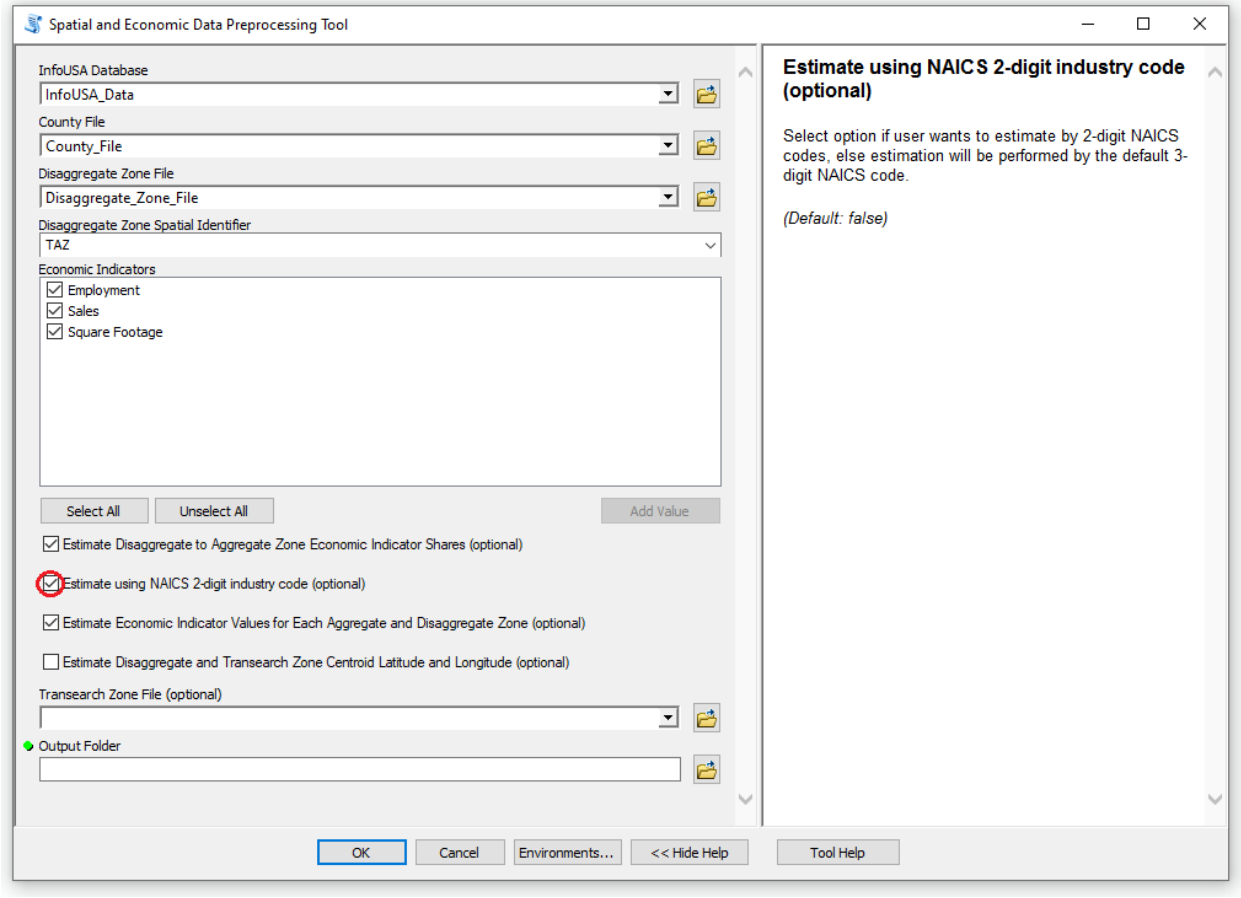


Figure A-32 Select the Option to Estimate using NAICS 2-digit industry code

STEP 9

Select the option **Estimate Disaggregate and TRANSEARCH Zone Centroid Latitude and Longitude** if the user wants to estimate disaggregate and TRANSEARCH zone centroid latitude and longitude (see Figure A-33).

*The output from the following option will be used as input in **IO Accounts and Regression Disaggregation Method Tool** freight distribution option using the **Gravity model.***

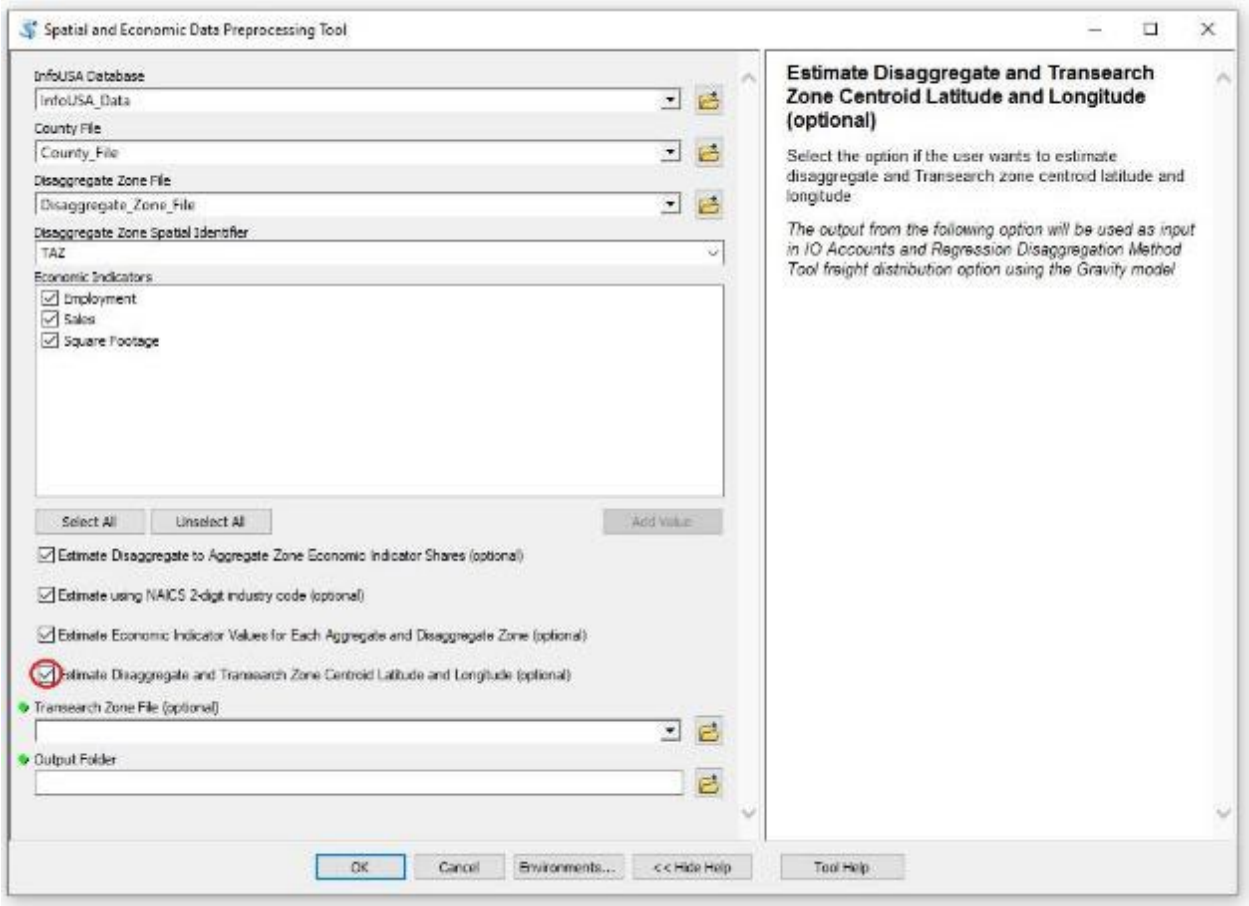


Figure A-33 Select the Option to Estimate Disaggregate and TRANSEARCH Zone Centroid Latitude and Longitude

STEP 9.1

Input geographic file with TRANSEARCH database zones in tools input parameter **TRANSEARCH Zone Geographic File** (see Figure A-34).

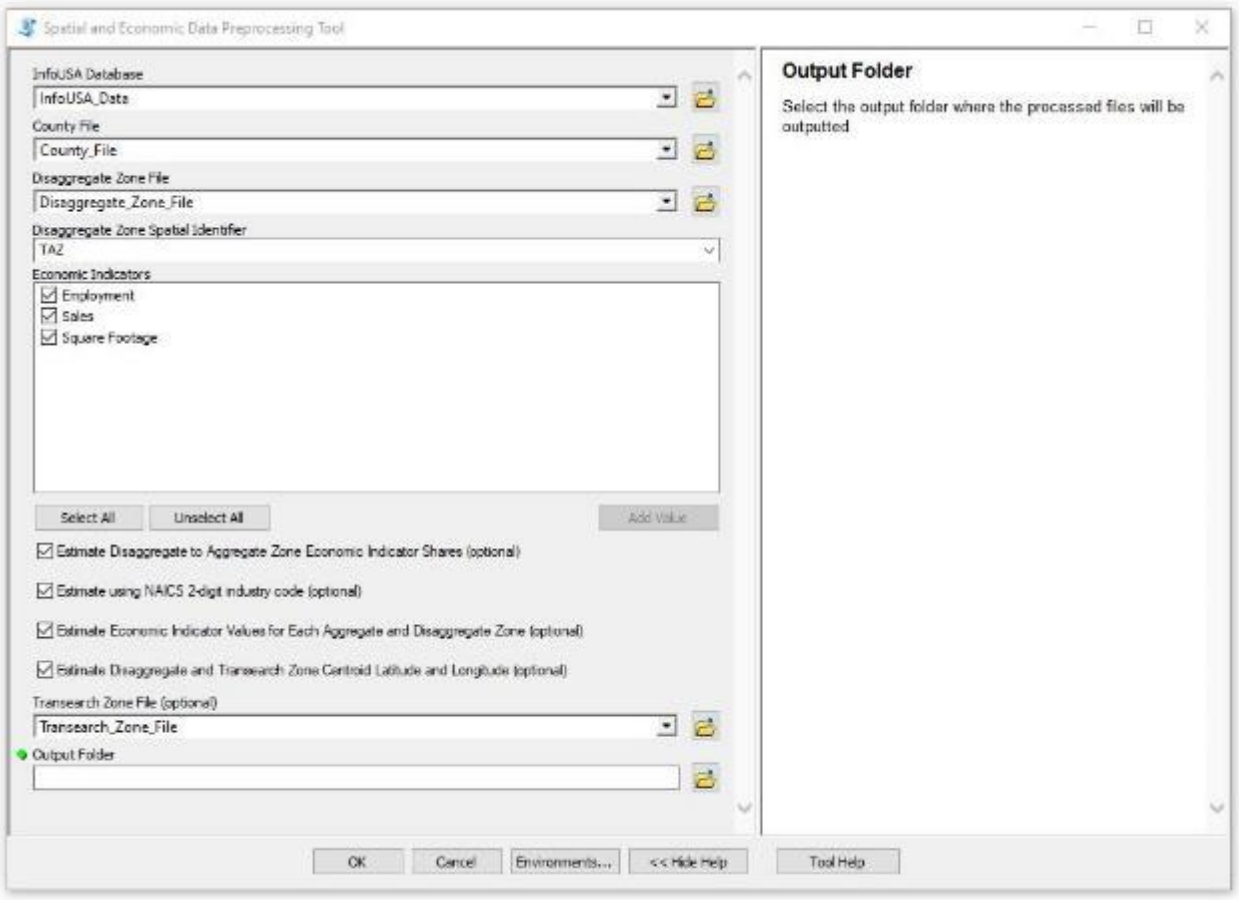


Figure A-34 Input TRANSEARCH Zone Geographic File

STEP 10

Select the output folder where the processed files will be outputted in the tools input parameter **Output Folder** (see Figure A-35).

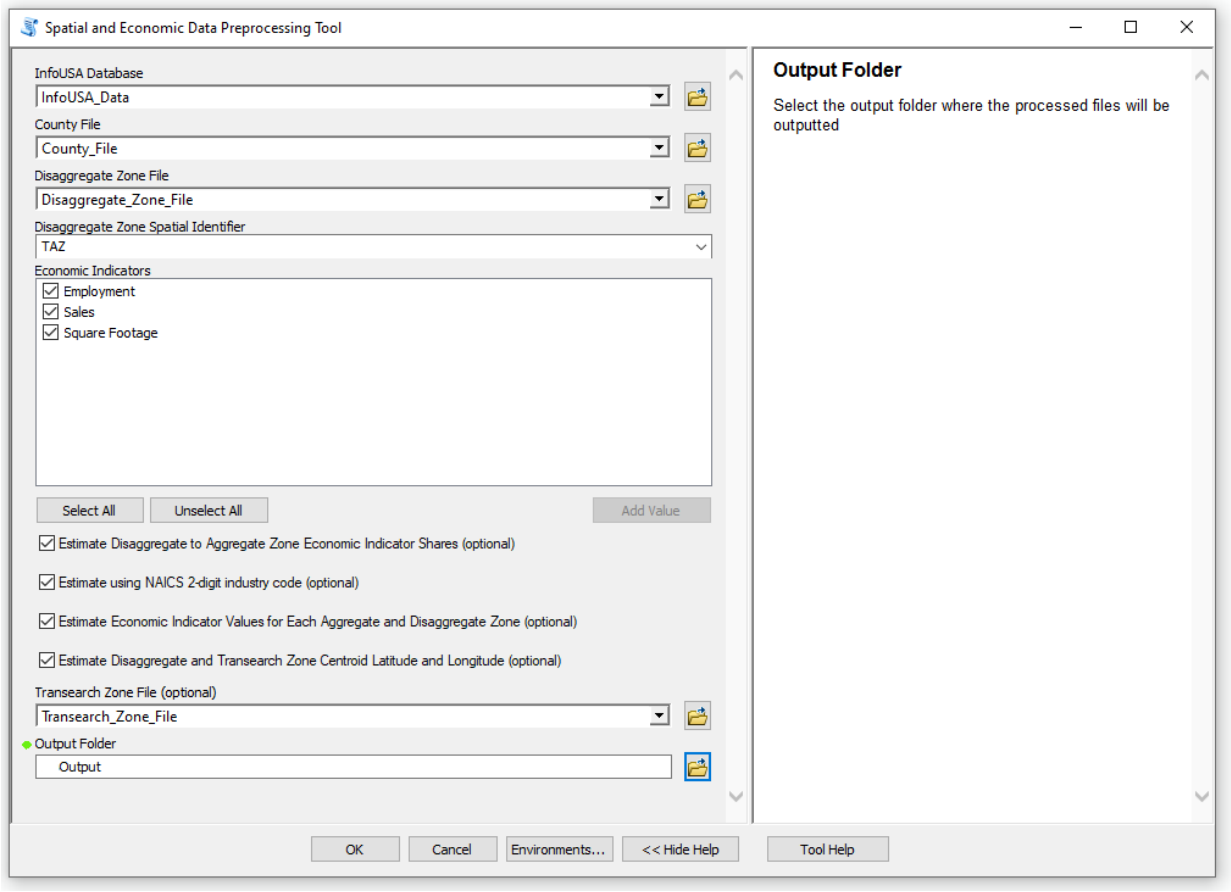


Figure A-35 Select the Output Folder

STEP 11

Once all required parameters are inputted, press OK to execute the application. The ArcGIS application invokes a task completion window, which reports the status of each task (see Figure A-36). Also, processed outputs (disaggregate to aggregate zone economic indicator shares (see Figure A-37), aggregate zone economic indicator values (see Figure A-38), disaggregate zone economic indicator values (see Figure A-39), and Disaggregate and TRANSEARCH zone centroid latitude and longitude Tables (see Figure A-40) will be imported to ArcMap display.

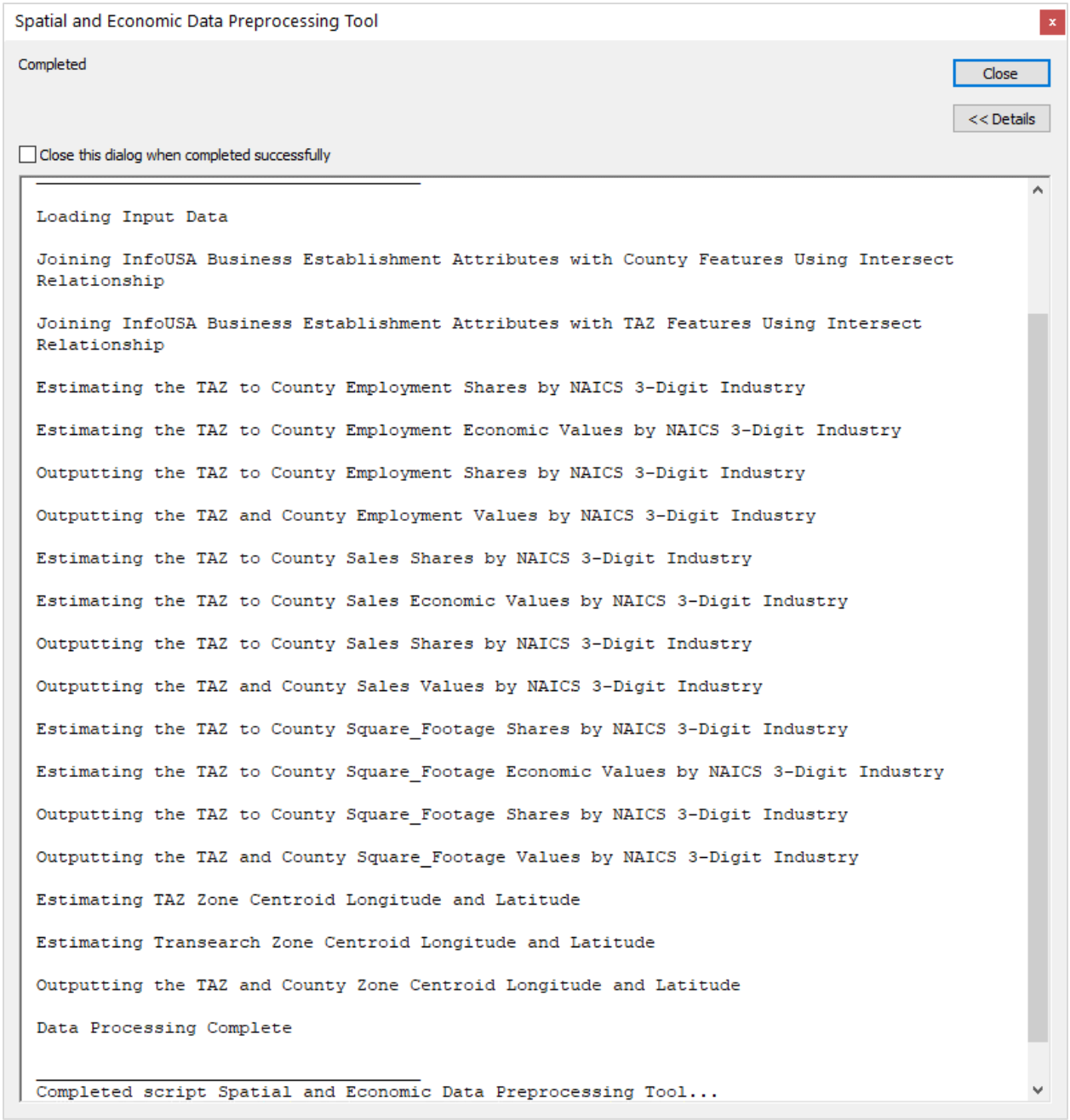
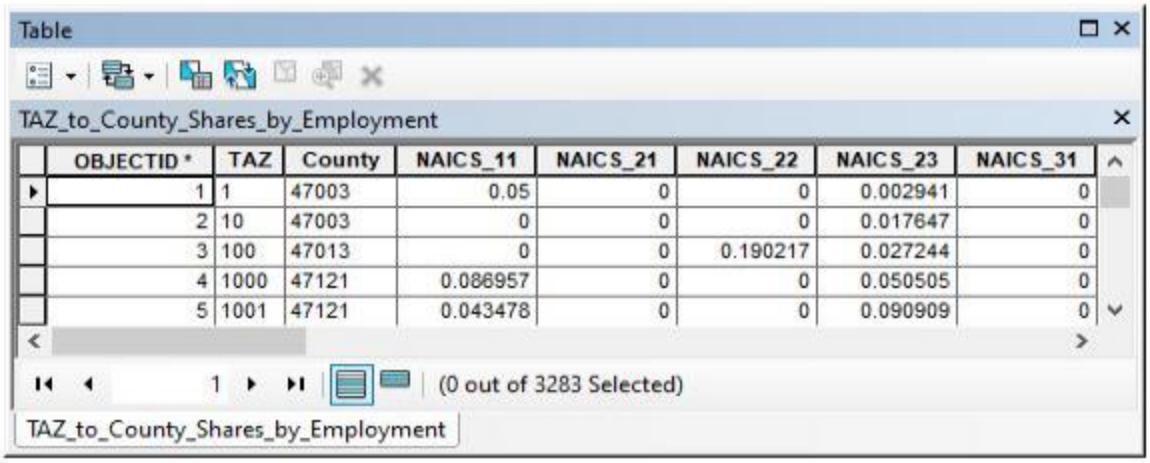


Figure A-36 Spatial and Economic Data Preprocessing Tool Performance Task Window



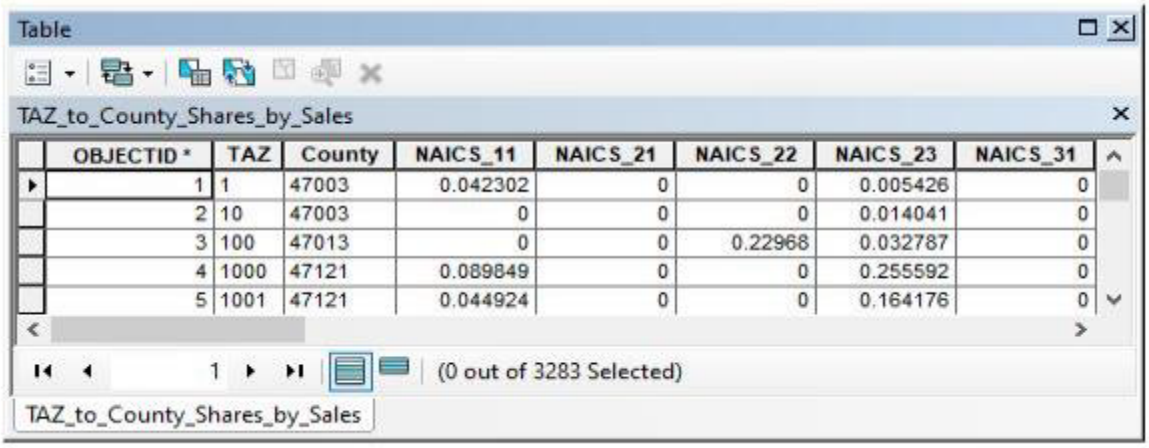
Table

TAZ_to_County_Shares_by_Employment

OBJECTID *	TAZ	County	NAICS_11	NAICS_21	NAICS_22	NAICS_23	NAICS_31
1	1	47003	0.05	0	0	0.002941	0
2	10	47003	0	0	0	0.017647	0
3	100	47013	0	0	0.190217	0.027244	0
4	1000	47121	0.086957	0	0	0.050505	0
5	1001	47121	0.043478	0	0	0.090909	0

1 (0 out of 3283 Selected)

TAZ_to_County_Shares_by_Employment



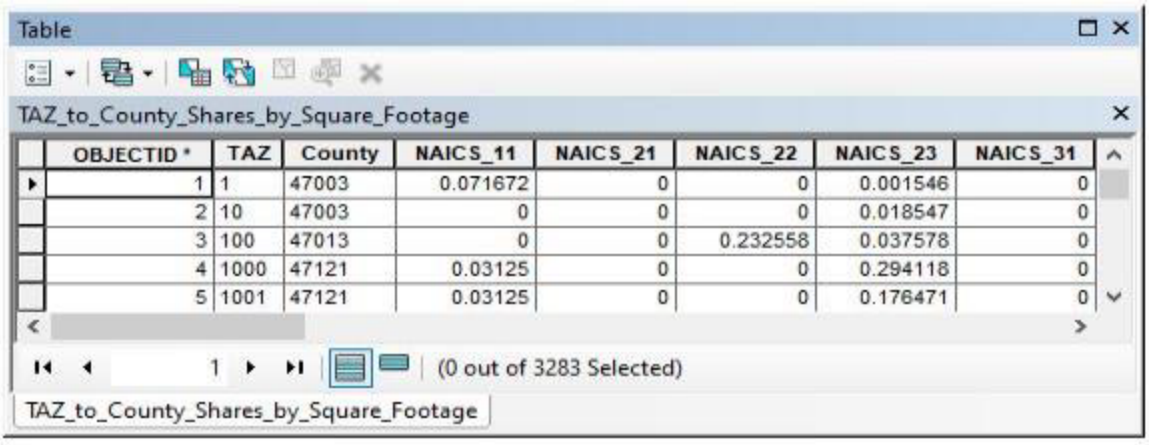
Table

TAZ_to_County_Shares_by_Sales

OBJECTID *	TAZ	County	NAICS_11	NAICS_21	NAICS_22	NAICS_23	NAICS_31
1	1	47003	0.042302	0	0	0.005426	0
2	10	47003	0	0	0	0.014041	0
3	100	47013	0	0	0.22968	0.032787	0
4	1000	47121	0.089849	0	0	0.255592	0
5	1001	47121	0.044924	0	0	0.164176	0

1 (0 out of 3283 Selected)

TAZ_to_County_Shares_by_Sales



Table

TAZ_to_County_Shares_by_Square_Footage

OBJECTID *	TAZ	County	NAICS_11	NAICS_21	NAICS_22	NAICS_23	NAICS_31
1	1	47003	0.071672	0	0	0.001546	0
2	10	47003	0	0	0	0.018547	0
3	100	47013	0	0	0.232558	0.037578	0
4	1000	47121	0.03125	0	0	0.294118	0
5	1001	47121	0.03125	0	0	0.176471	0

1 (0 out of 3283 Selected)

TAZ_to_County_Shares_by_Square_Footage

Figure A-37 Disaggregate zone to county shares by economic indicator and NAICS 3-digit industry code

Table

County_Level_Employment_by_NAICS_2D

OBJECTID *	County	NAICS_11	NAICS_21	NAICS_22	NAICS_23	NAICS_31
1	47001	54	94	295	1709	43
2	47003	160	27	279	680	1263
3	47005	16	27	51	234	203
4	47007	83	8	0	107	0
5	47009	455	42	163	2780	493

1 (0 out of 95 Selected)

County_Level_Employment_by_NAICS_2D

Table

County_Level_Sales_by_NAICS_2D

OBJECTID *	County	NAICS_11	NAICS_21	NAICS_22	NAICS_23	NAICS_31
1	47001	5610	20422	320574	400455	8675
2	47003	30613	7051	108915	170291	315522
3	47005	3883	11314	46677	80488	12504
4	47007	16574	1331	0	32144	0
5	47009	92019	12581	126319	718657	147868

1 (0 out of 95 Selected)

County_Level_Sales_by_NAICS_2D

Table

County_Level_Square_Footage_by_NAICS_2D

OBJECTID *	County	NAICS_11	NAICS_21	NAICS_22	NAICS_23	NAICS_31
1	47001	151250	133750	208750	1942500	87500
2	47003	366250	75000	192500	808750	135000
3	47005	48750	100000	50000	232500	41250
4	47007	195000	25000	0	122500	0
5	47009	332500	156250	237500	2768750	265000

1 (0 out of 95 Selected)

County_Level_Square_Footage_by_NAICS_2D

Figure A-38 Aggregate Zone Economic Indicator Values by NAICS 3-digit Industry

Table

TAZ_Level_Employment_by_NAICS_2D

OBJECTID *	TAZ	County	NAICS_11	NAICS_21	NAICS_22	NAICS_23	NAICS_31
1	1	47003	8	0	0	2	0
2	10	47003	0	0	0	12	0
3	100	47013	0	0	35	17	0
4	1000	47121	2	0	0	5	0
5	1001	47121	1	0	0	9	0

(0 out of 3283 Selected)

TAZ_Level_Employment_by_NAICS_2D

Table

TAZ_Level_Sales_by_NAICS_2D

OBJECTID *	TAZ	County	NAICS_11	NAICS_21	NAICS_22	NAICS_23	NAICS_31
1	1	47003	1295	0	0	924	0
2	10	47003	0	0	0	2391	0
3	100	47013	0	0	39590	4904	0
4	1000	47121	416	0	0	5645	0
5	1001	47121	208	0	0	3626	0

(0 out of 3283 Selected)

TAZ_Level_Sales_by_NAICS_2D

Table

TAZ_Level_Square_Footage_by_NAICS_2D

OBJECTID *	TAZ	County	NAICS_11	NAICS_21	NAICS_22	NAICS_23	NAICS_31
1	1	47003	26250	0	0	1250	0
2	10	47003	0	0	0	15000	0
3	100	47013	0	0	50000	22500	0
4	1000	47121	1250	0	0	25000	0
5	1001	47121	1250	0	0	15000	0

(0 out of 3283 Selected)

TAZ_Level_Square_Footage_by_NAICS_2D

Figure A-39 Disaggregate Zone Economic Indicator Values by NAICS 3-digit Industry

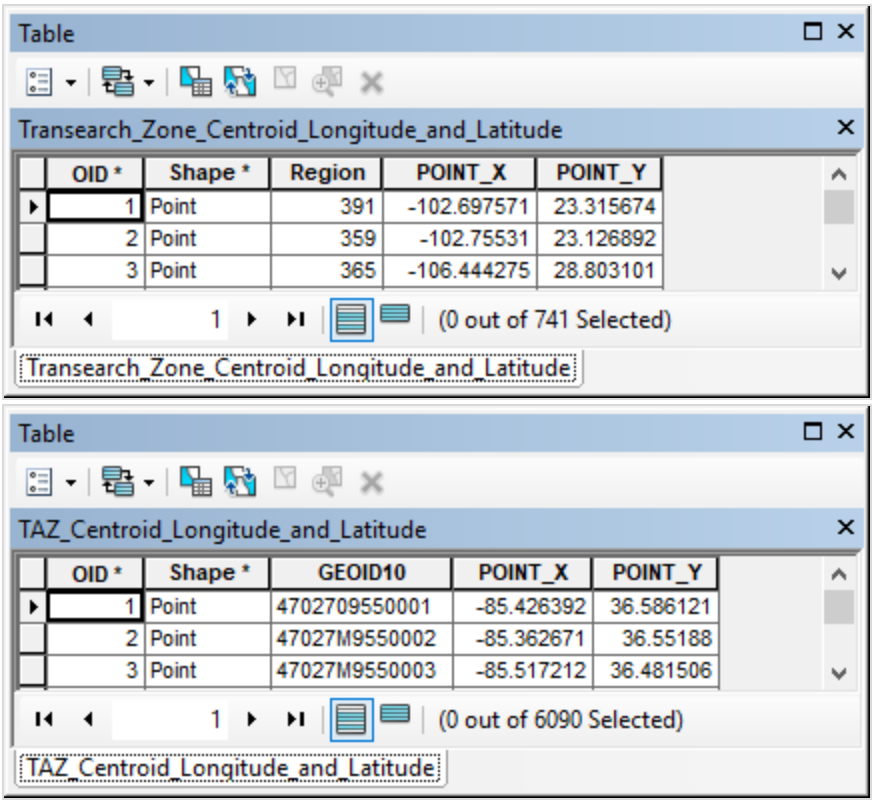


Figure A-40 Disaggregate and TRANSEARCH Zone Longitude and Latitude

A.5 IO Accounts Supply and Use Table Conversion Tool

Description

The following tool converts the Bureau of Economic Analysis (BEA) Input-Output Accounts (IO) Supply and Use Tables from the IO industry to NAICS 3-digit or 2-digit codes using a crosswalk Table provided BEA. In addition, the tool provides the option to convert the annual Gross Domestic Product (GDP) to the shares of commodity-producing and using industries by proportionally weighting. The tool also gives an option to adjust the commodity-producing and using industry shares by setting a minimum percentage value of how much each commodity-producing and using industry should contain. A schematic overview of IO Accounts and Use Table Conversion Tool inputs and outputs is shown Figure A-44. The output from this tool is used as input in: i) IO Accounts and Proportional Weight Disaggregation Method Tool, and ii) IO Accounts and Regression Disaggregation Method Tool. Next, we present example input file formats and data field names, types, lengths.

Example Input Files

- **IO_Accounts_Database.gdb/Supply_Table** (see Figure A-41)
- **IO_Accounts_Database.gdb/Use_Table** (see Figure A-42)
- **Crosswalk_Table_Database.gdb/IO_Code_to_NAICS_Code_Crosswalk_Table** (see Figure A-43)

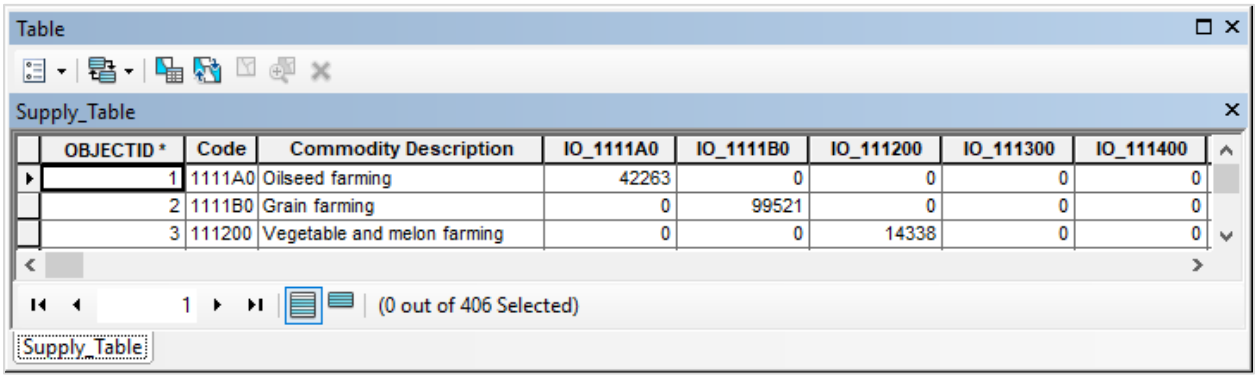


Figure A-41 IO Accounts Supply Table

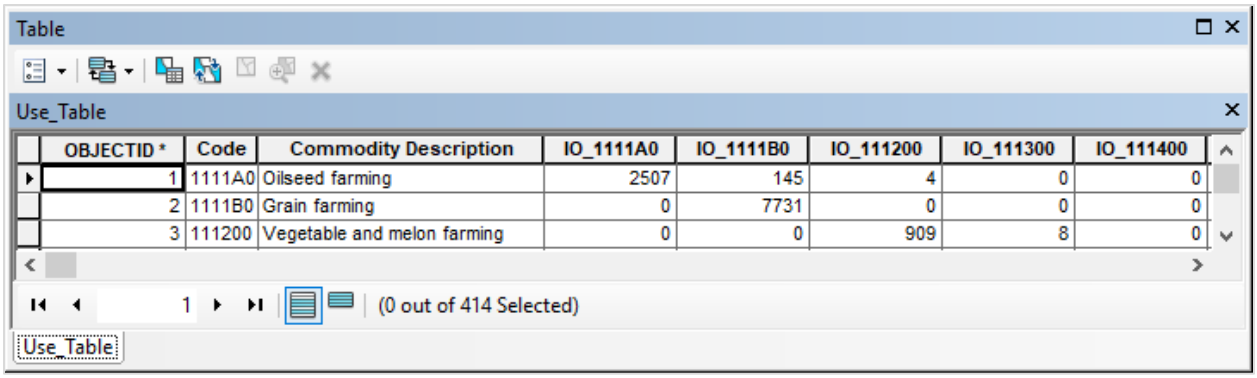


Figure A-42 IO Accounts Use Table

TABLE A-6 SUPPLY AND USE TABLE DATA FIELD NAMES, TYPES, LENGTHS, AND DESCRIPTIONS

Field Name	*Field Type*	*Field Length*	*Field Description*
Code	Text	6	IO commodity code
Commodity_Description	Text	100	IO commodity code description
IO_Code	Long		IO commodity code of supplying or using industry

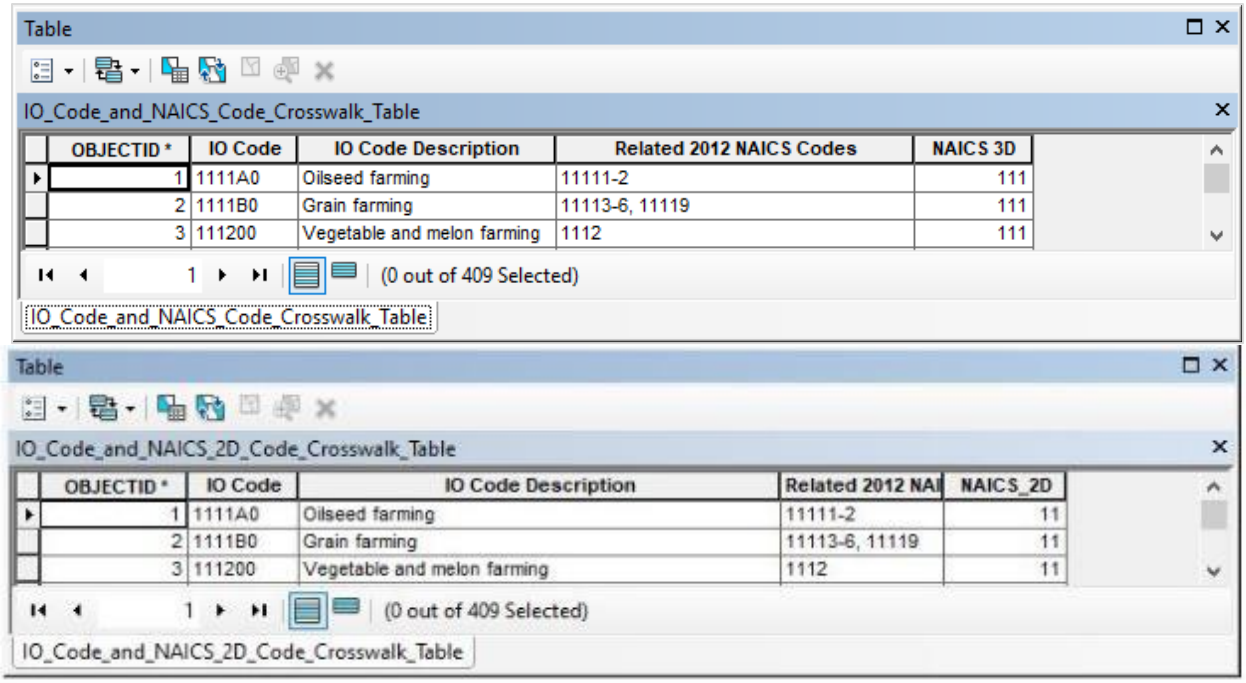


Figure A-43 IO Account Code to NAICS 2- and 3-Digit Code Crosswalk Table

TABLE A-7 IO ACCOUNT CODE TO NAICS CODE CROSSWALK TABLE DATA FIELD NAMES, TYPES, LENGTHS, AND DESCRIPTIONS

Field Name	*Field Type*	*Field Length*	*Field Description*
IO_Code	Text	6	IO commodity code
IO_Code_Description	Text	100	IO commodity code description
Related_2012_NAICS_Codes	Text	35	Related NAICS codes
NAICS_3D or 2D	Long		3-digit or 2-digit NAICS code

IO Accounts Supply and Use Table Conversion Tool Inputs and Outputs

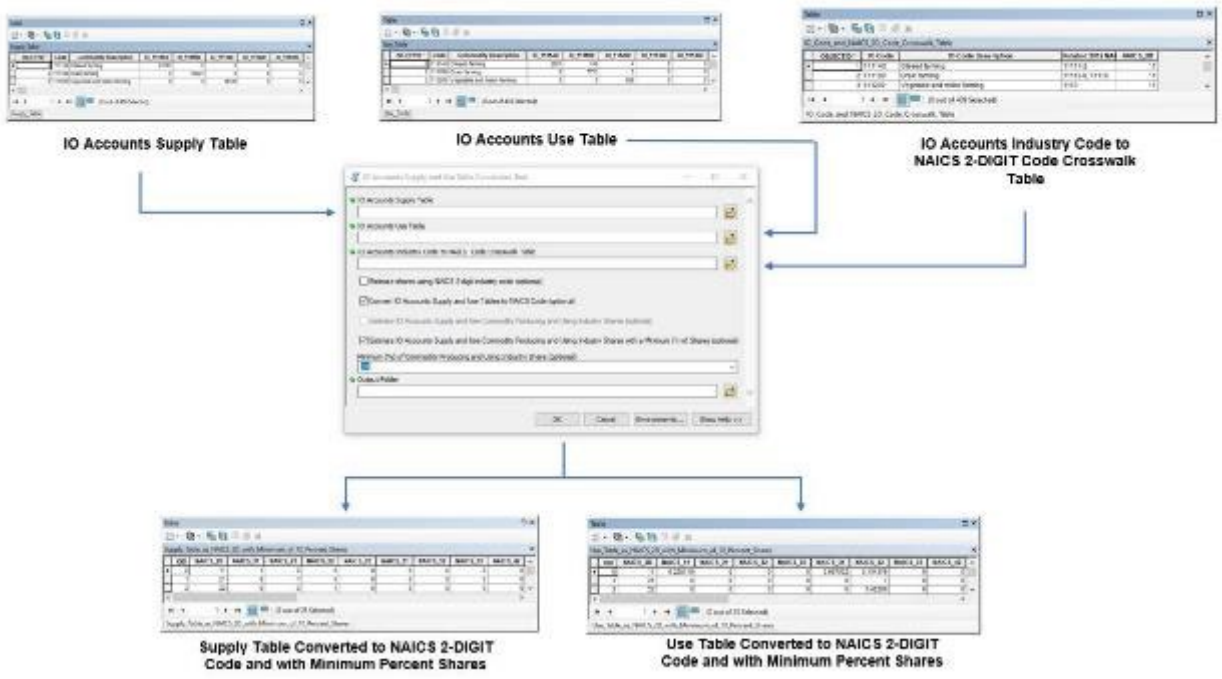


Figure A-44 IO Accounts Supply and Use Table Conversion Tool Inputs and Outputs

STEP 1

Open the newly added **Freight Data Disaggregation Tool** toolbox, select the **Pre-processing** tool group, and lunch **IO Accounts Supply and Use Table Conversion Tool** (see Figure A-45).

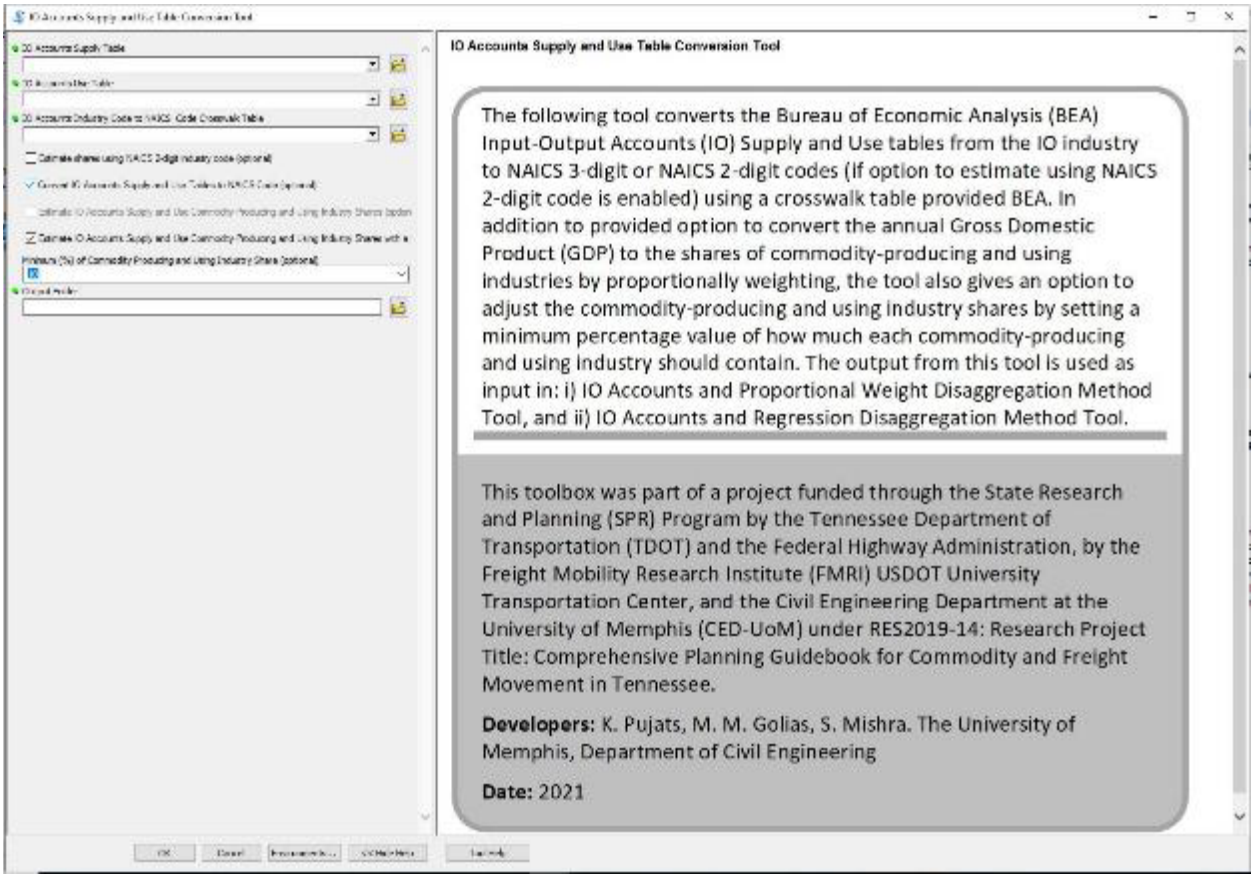


Figure A-45 IO Accounts Supply and Use Table Conversion Tool

STEP 2

Input BEA Input-Output Accounts Supply Table in tools input parameter **IO Accounts Supply Table** (see Figure A-46).

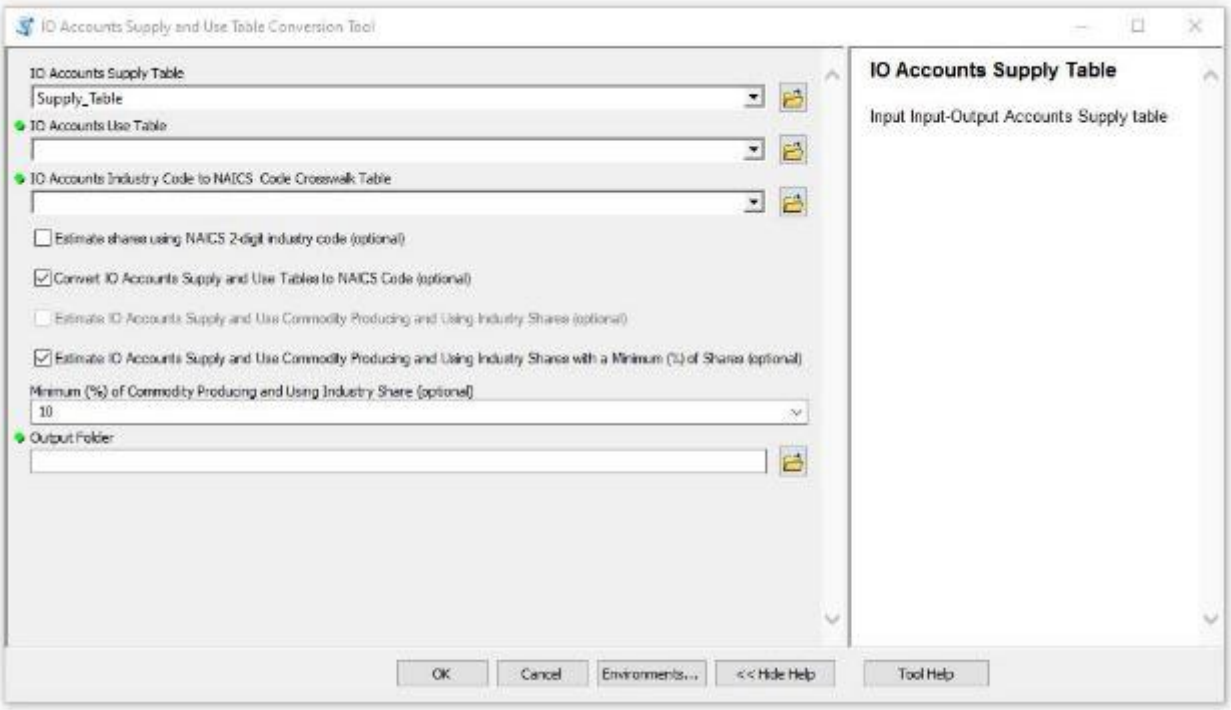


Figure A-46 Input IO Accounts Supply Table

STEP 3

Input BEA Input-Output Accounts Use Table in tools input parameter **IO Accounts Use Table** (see Figure A-47).

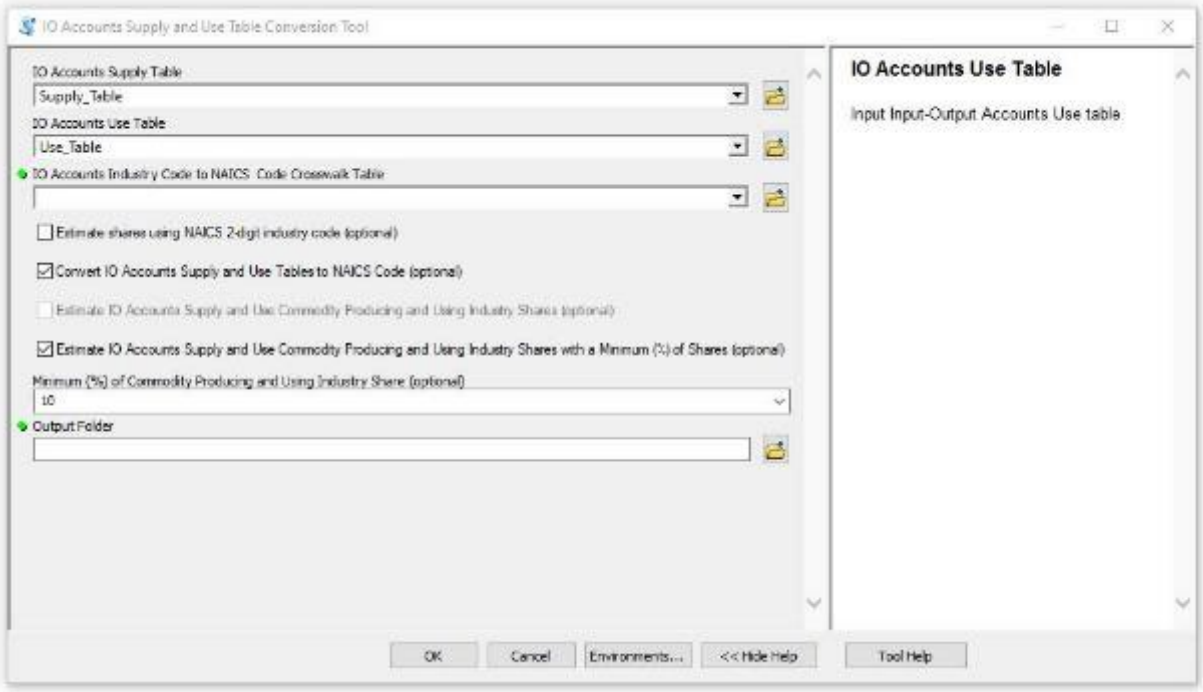


Figure A-47 Input IO Accounts Use Table

STEP 4

Input BEA Input-Output Accounts industry code to NAICS 2-digit and 3-digit code crosswalk Table in tools input parameter **IO Accounts Industry Code to NAICS Code Crosswalk Table** (see Figure A-48).

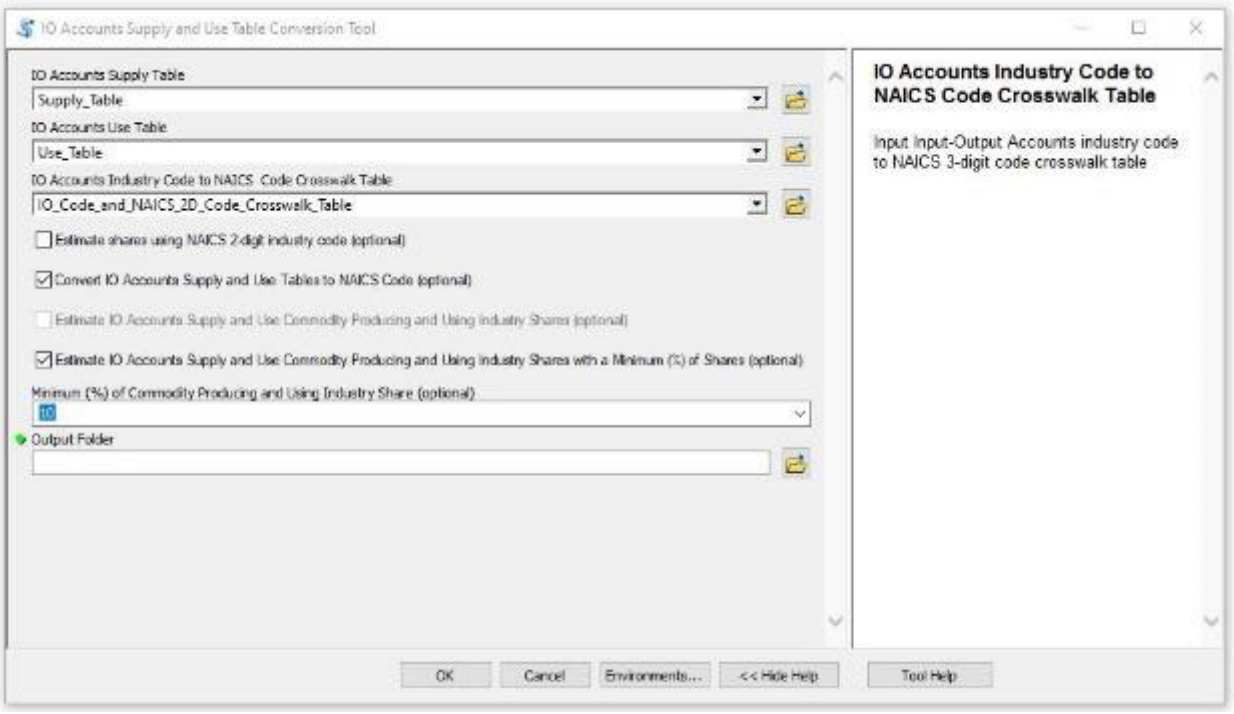


Figure A-48 Input IO Accounts Industry Code to NAICS Code (2D or 3D) Crosswalk Table

STEP 5

Select the option **Estimate shares using NAICS 2-digit industry code** if the user wants to estimate the shares using NAICS 2-digit industry code (see Figure A-49).

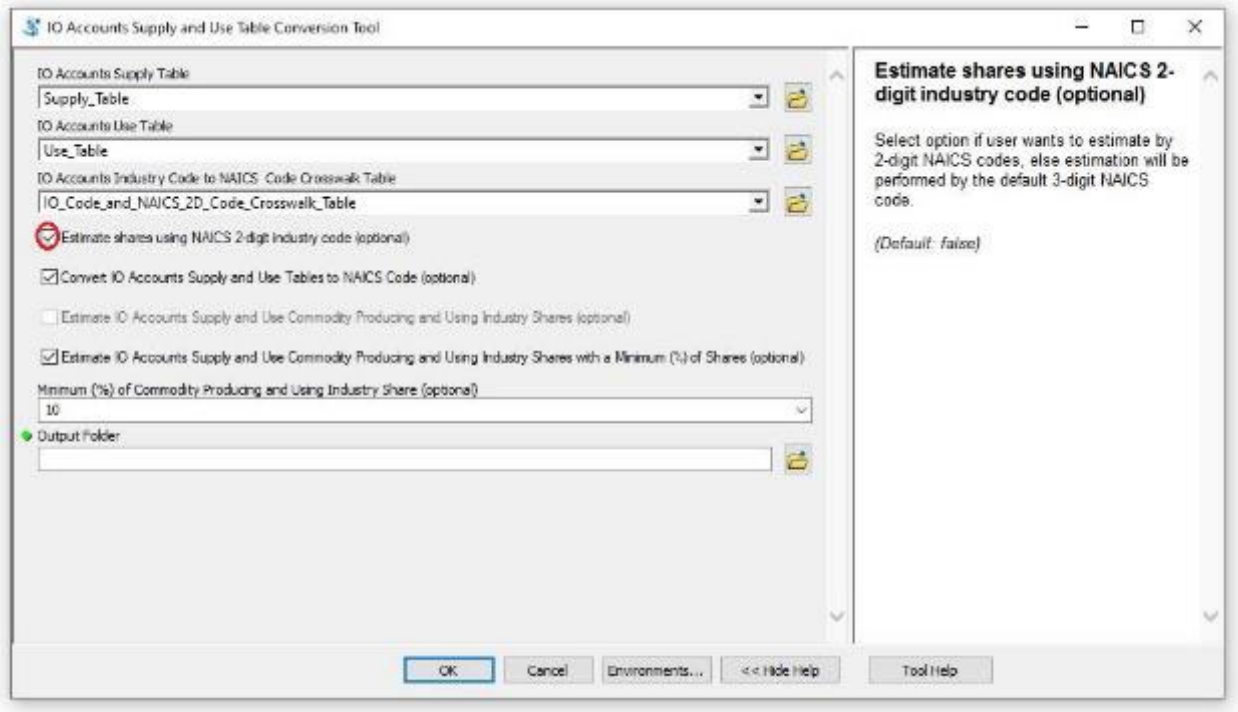


Figure A-49 Select the Option Estimate shares using NAICS 2-digit industry code

STEP 6

Select the option **Convert IO Accounts Supply and Use Tables to NAICS 3-digit Code** if the user wants to convert IO Accounts Supply and Use Tables to NAICS 3-digit code (see Figure A-50).

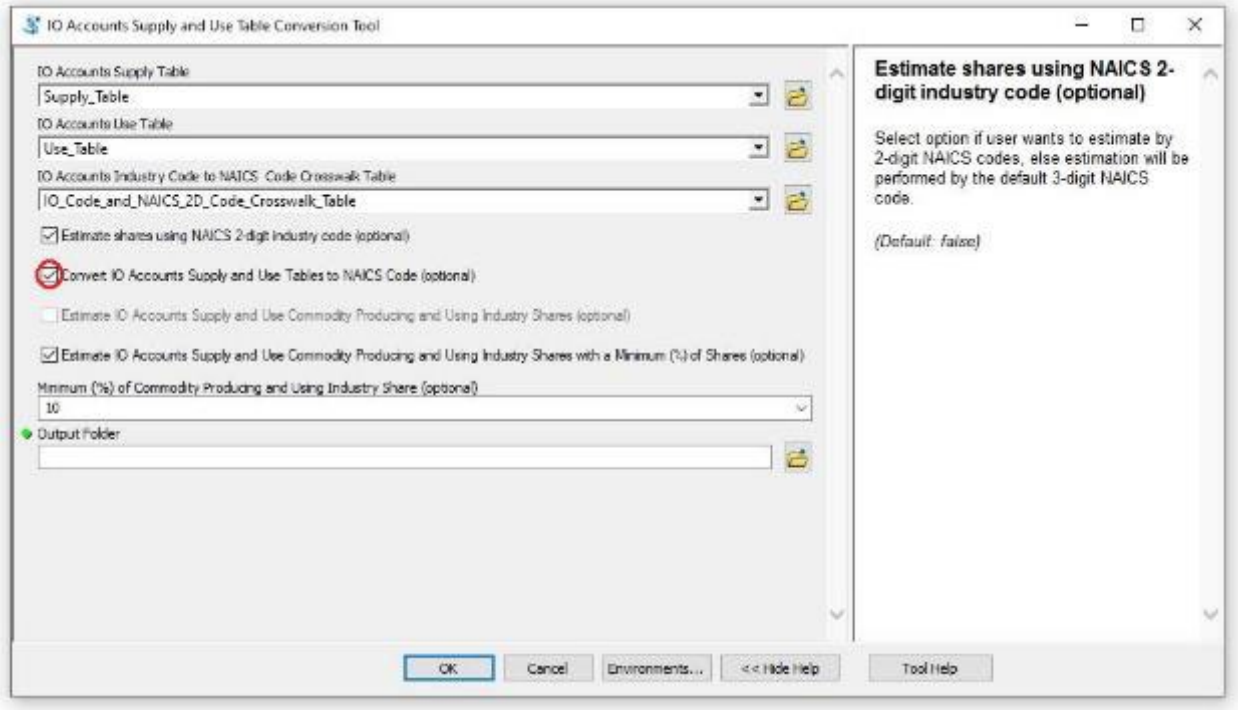


Figure A-50 Select the Option Convert IO Accounts Supply and Use Tables to NAICS 2-digit Code

STEP 7

Select the option **Estimate IO Accounts Supply and Use Commodity Producing and Using Industry Shares** if the user wants to estimate IO Accounts Supply and Use commodity-producing and using shares by NAICS 3-digit code (see Figure A-51).

(Default: True)

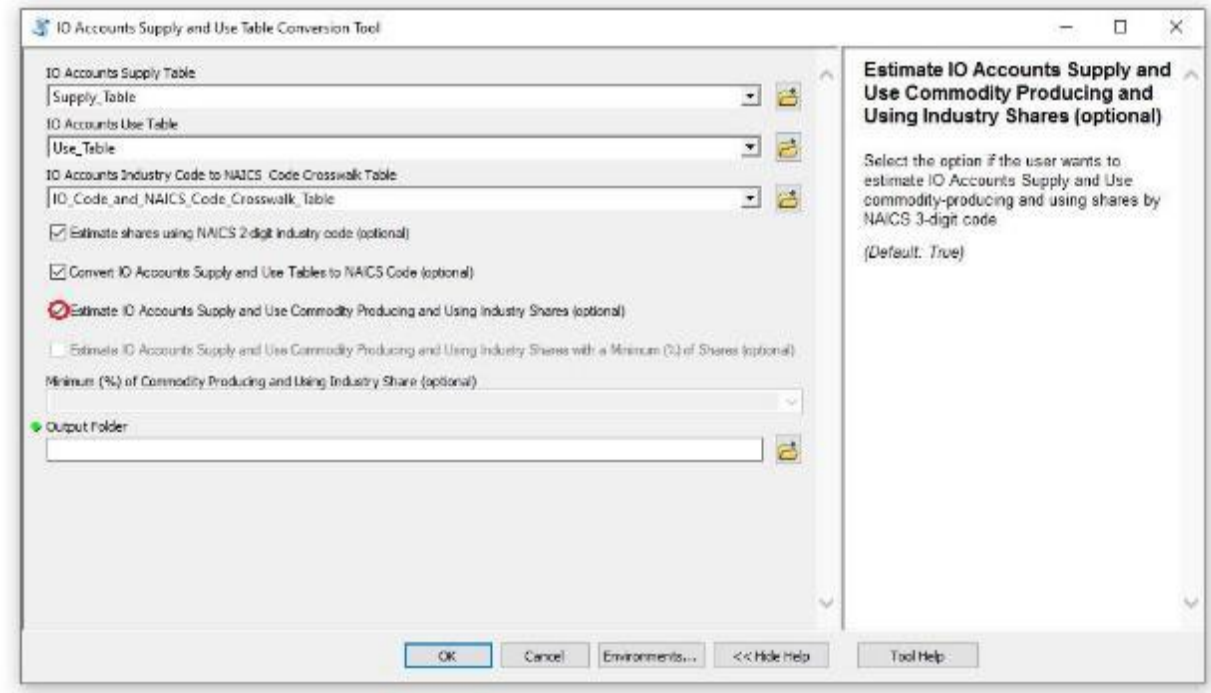


Figure A-51 Select the Option Estimate IO Accounts Supply and Use Commodity Producing and Using Industry Shares

STEP 8

Select the option **Estimate IO Accounts Supply and Use Commodity Producing and Using Industry Shares with a Minimum (%) of Shares** if the user wants the converted IO Account Tables to NAICS 3-digit shares to be proportionally adjusted to contain a minimum of a selected percentage of commodity-producing and using industry shares (see Figure A-52).

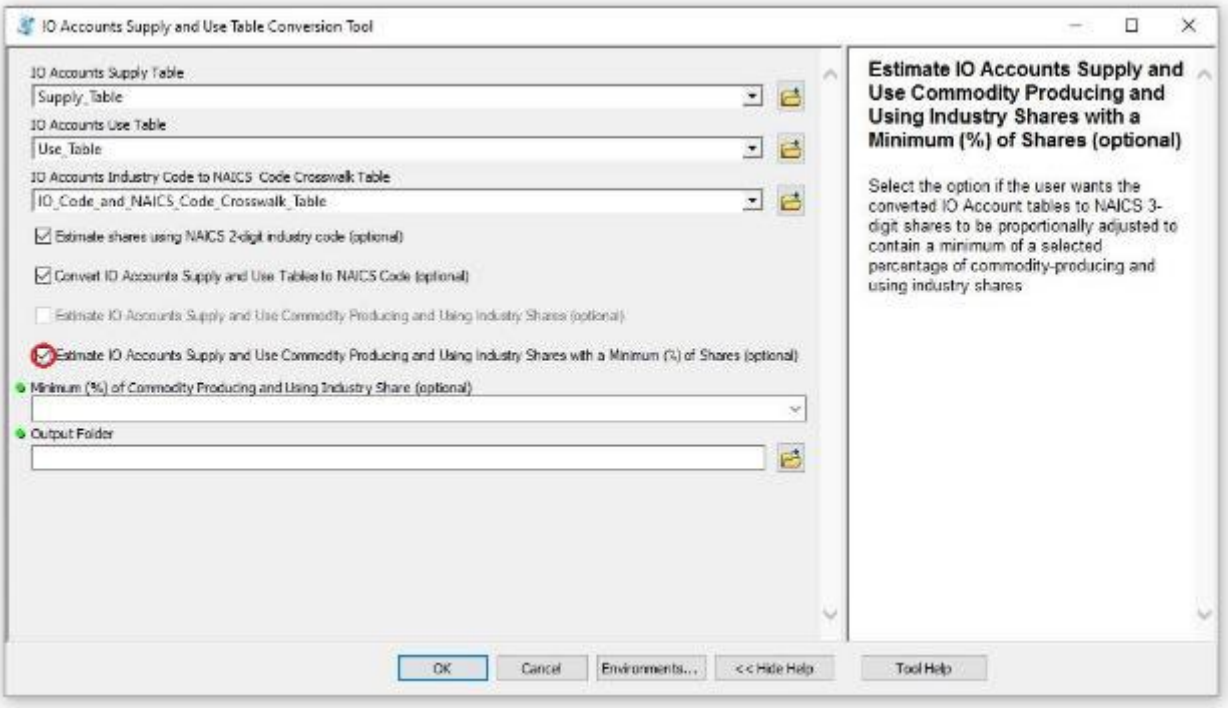


Figure A-52 Select the Option Estimate IO Accounts Supply and Use Commodity Producing and Using Industry Shares with a Minimum (%) of Shares

STEP 8.1

Select the minimum (%) of commodity-producing and using industry share in tools input parameter **Minimum (%) of Commodity Producing and Using Industry Share** (see Figure A-53).

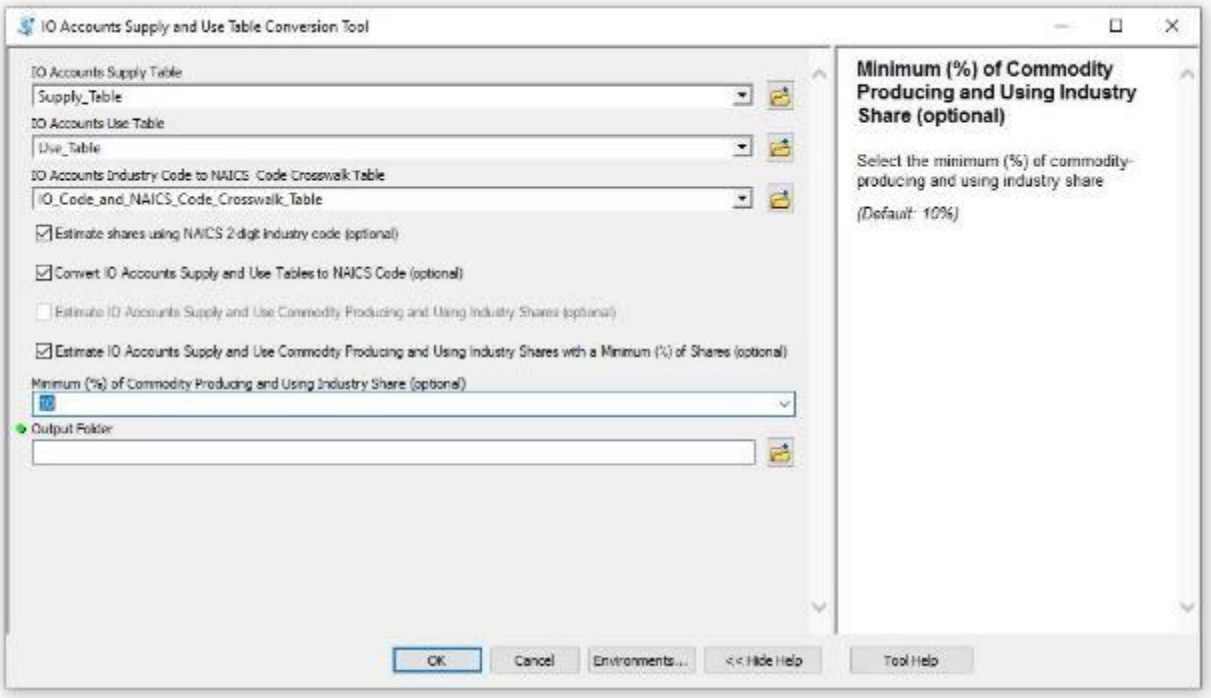


Figure A-53 Select the Minimum (%) of Commodity Producing and Using Industry Share

STEP 9

Select the output folder in the tools input parameter **Output Folder,** where the processed Input-Output Account Supply and Use Tables will be outputted (see Figure A-54).

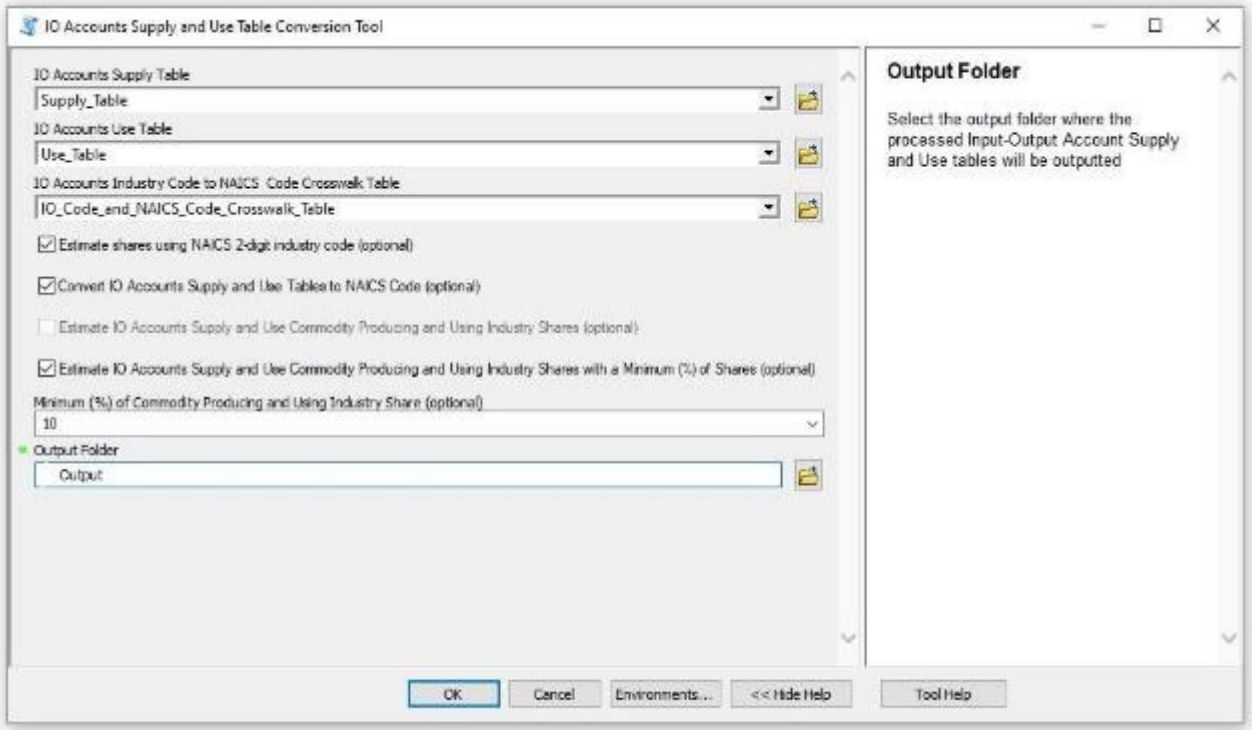


Figure A-54 Select the Output Folder

STEP 10

Once all required parameters are inputted, press OK to execute the application. The ArcGIS application invokes a task completion window, which reports the status of each task (see Figure A-55). Also, processed outputs (Converted IO Accounts Supply and Use Tables to NAICS 3- digit code (see Figure A-56) and IO Accounts Supply (see Figure A-57) and Use (see Figure A-58) shares will be imported to ArcMap display.

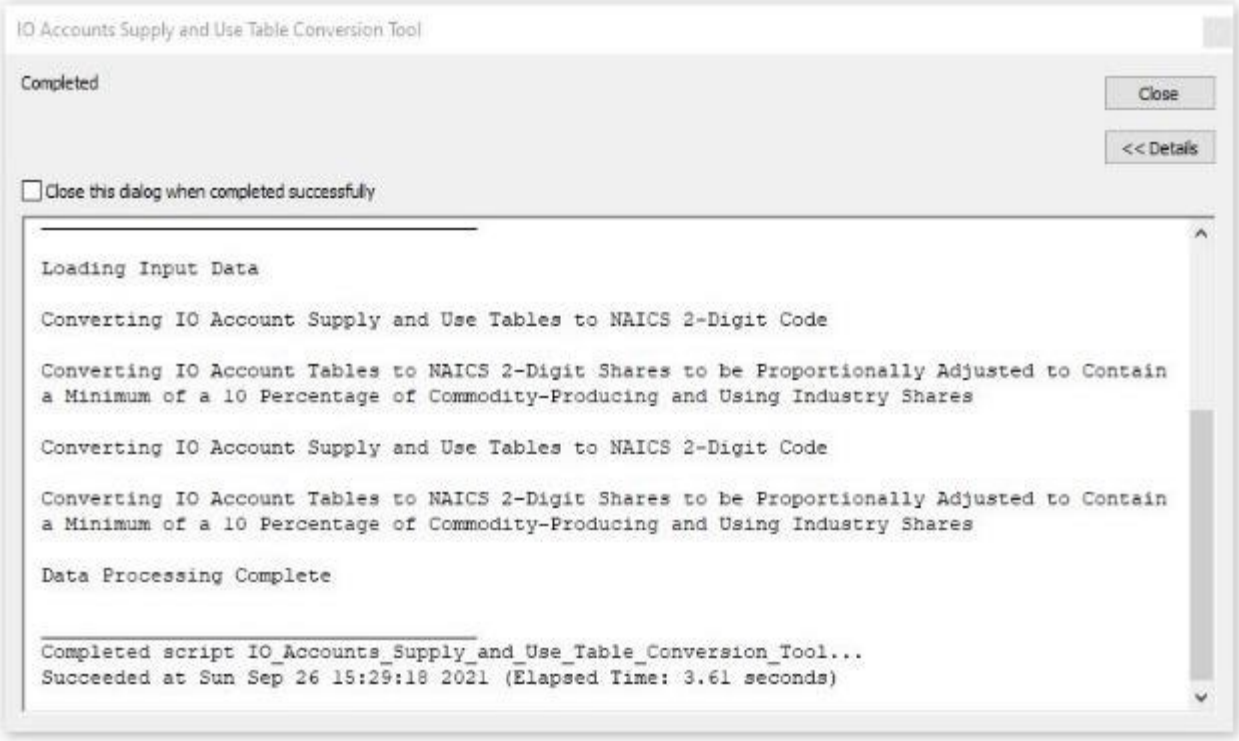


Figure A-55 IO Accounts Supply and Use Table Conversion Tool Performance Task Window

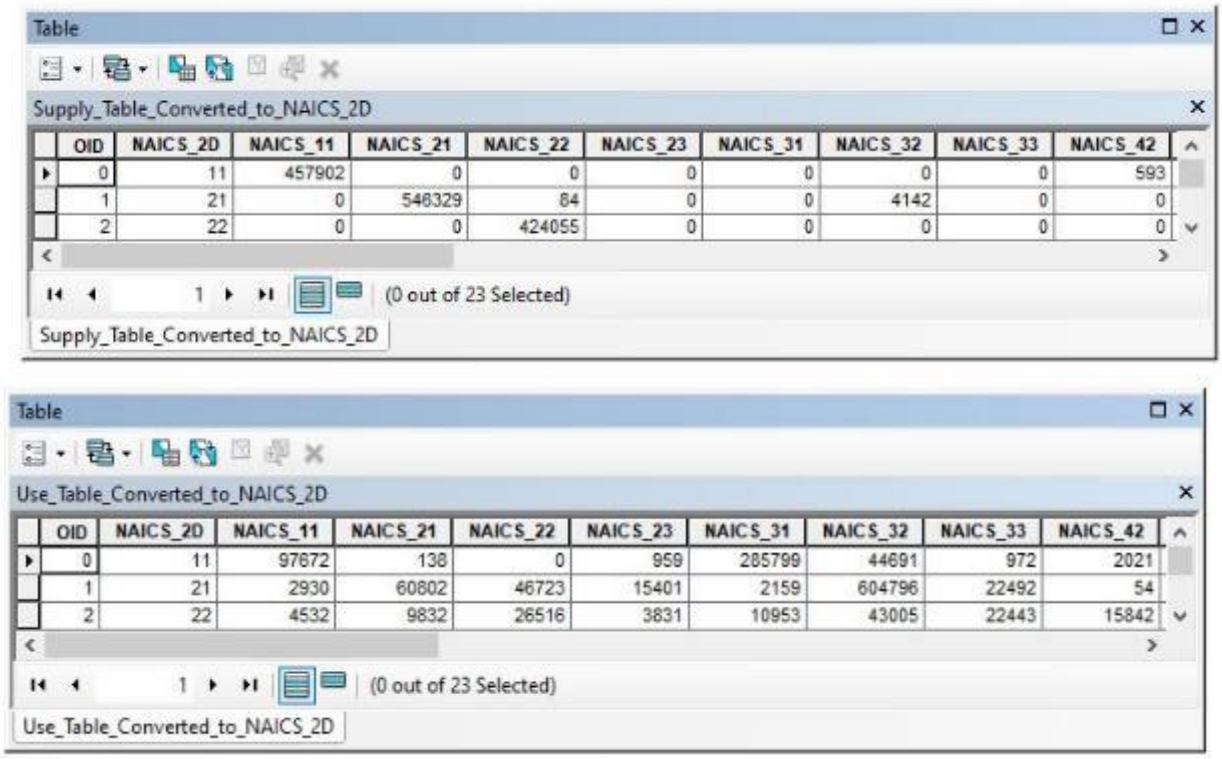


Figure A-56 Converted IO Accounts Supply and Use Tables to NAICS 2-digit Code

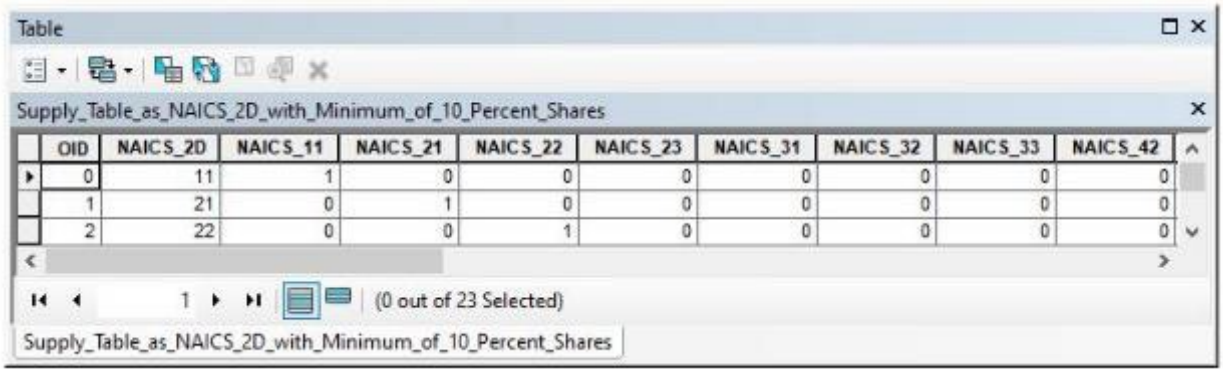


Figure A-57 IO Accounts Commodity-Producing Industry Share Table

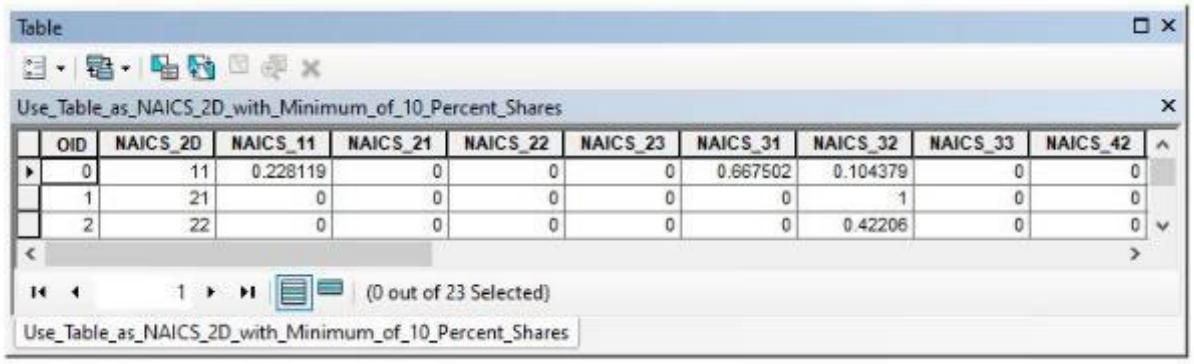


Figure A-58 IO Accounts Commodity-Using Industry Share Table

A.6 IO Accounts and Proportional Weight Disaggregation Method Tool

Description

The following tool disaggregates freight flow data (TRANSEARCH) by commodity type (SCTG 2-digit), from the aggregate zone (County) to disaggregate zones by allocating commodity freight flow of each aggregate-level origin-destination pair by the share of commodity-producing and using industries (NAICS 3-digit or 2-digit), estimated using Bureau of Economic Analysis (BEA) Input-Output (IO) Accounts Supply and Use Tables and the ratio of the disaggregate-level origin and destination economic indicator values (employment, value of sales, sq. footage) to the aggregate-level origin and destination economic indicator values obtained from InfoUSA. A schematic overview of IO Accounts and Proportional Weight Disaggregation Method Tool inputs and outputs is shown in Figure A-61. Next, we present example input file formats.

Example Input Files

- **TRANSEARCH_Preprocessed_Data_SCTG_2D.gdb/Data_by_SCTG_2D_1** (see Figure A-18) (Obtained from the outputs of the **TRANSEARCH Preprocessing Tool**)

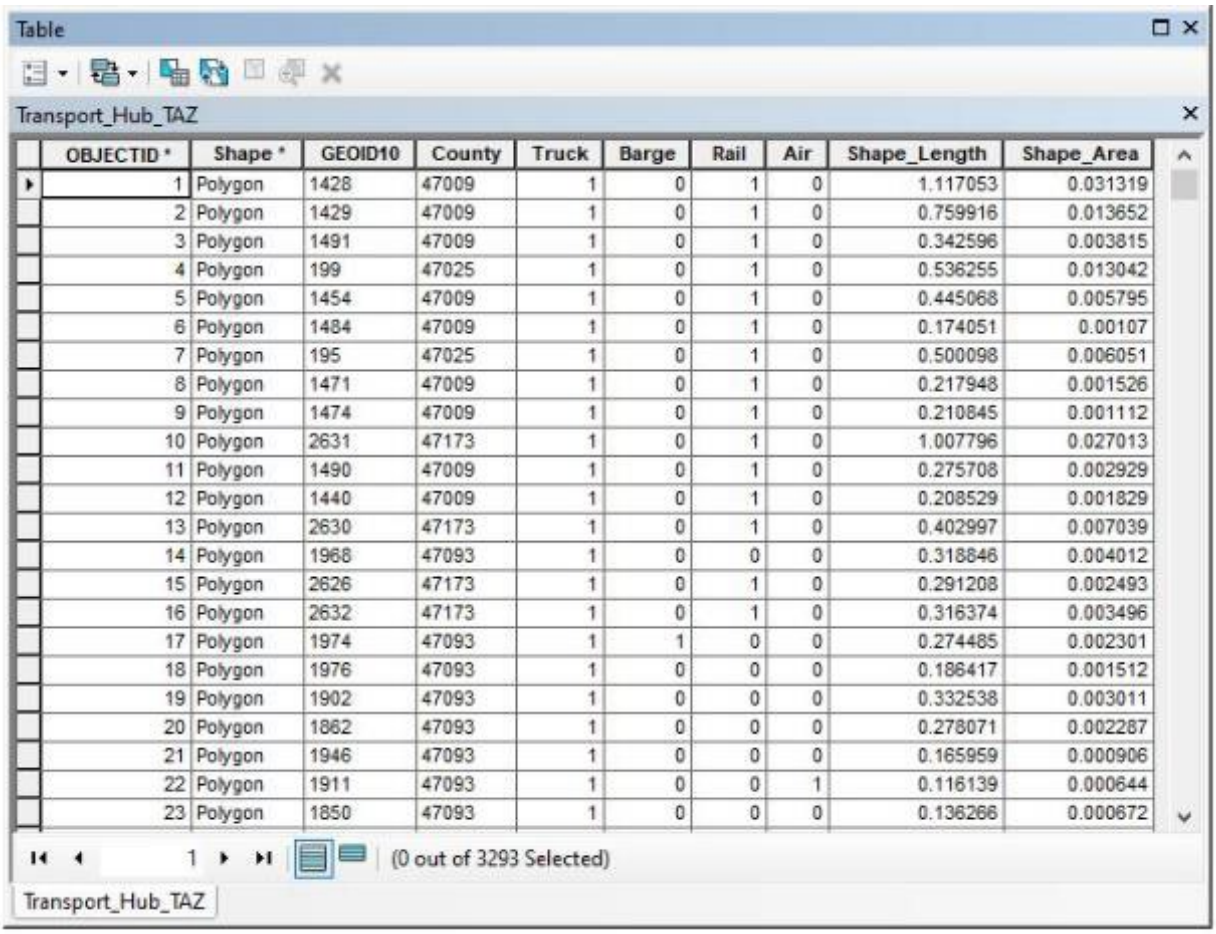
- **Economic_Shares_by_NAICS_3D.gdb/TAZ_to_County_Shares_by_Employment_and_NAICS_3D** (see Figure A-37) (Obtained from the outputs of the **Spatial and Economic Data Preprocessing Tool**)

- **Disaggregate Zone Transport Hubs.gdb/ Transport_Hub_TAZ** (see Figure A-59)

- **Crosswalk_Table_Database.gdb/SCTG_2_Digit_to_NAICS_2_Digit_Code_Crosswalk_Table** (see Figure A-60)

- **Supply_Table_as_NAICS_3D_with_Minimum_of_10_Percent_Shares.dbf** (see Figure A-57) (Obtained from the outputs of the **IO Accounts Supply and Use Table Conversion Tool**)

- **Use_Table_as_NAICS_3D_with_Minimum_of_10_Percent_Shares.dbf** (see Figure A-58) (Obtained from the outputs of the **IO Accounts Supply and Use Table Conversion Tool**)



OBJECTID *	Shape *	GEOID10	County	Truck	Barge	Rail	Air	Shape_Length	Shape_Area
1	Polygon	1428	47009	1	0	1	0	1.117053	0.031319
2	Polygon	1429	47009	1	0	1	0	0.759916	0.013652
3	Polygon	1491	47009	1	0	1	0	0.342596	0.003815
4	Polygon	199	47025	1	0	1	0	0.536255	0.013042
5	Polygon	1454	47009	1	0	1	0	0.445068	0.005795
6	Polygon	1484	47009	1	0	1	0	0.174051	0.00107
7	Polygon	195	47025	1	0	1	0	0.500098	0.006051
8	Polygon	1471	47009	1	0	1	0	0.217948	0.001526
9	Polygon	1474	47009	1	0	1	0	0.210845	0.001112
10	Polygon	2631	47173	1	0	1	0	1.007796	0.027013
11	Polygon	1490	47009	1	0	1	0	0.275708	0.002929
12	Polygon	1440	47009	1	0	1	0	0.208529	0.001829
13	Polygon	2630	47173	1	0	1	0	0.402997	0.007039
14	Polygon	1968	47093	1	0	0	0	0.318846	0.004012
15	Polygon	2626	47173	1	0	1	0	0.291208	0.002493
16	Polygon	2632	47173	1	0	1	0	0.316374	0.003496
17	Polygon	1974	47093	1	1	0	0	0.274485	0.002301
18	Polygon	1976	47093	1	0	0	0	0.186417	0.001512
19	Polygon	1902	47093	1	0	0	0	0.332538	0.003011
20	Polygon	1862	47093	1	0	0	0	0.278071	0.002287
21	Polygon	1946	47093	1	0	0	0	0.165959	0.000906
22	Polygon	1911	47093	1	0	0	1	0.116139	0.000644
23	Polygon	1850	47093	1	0	0	0	0.136266	0.000672

Figure A-59 Transport hubs

TABLE A-8 TRANSPORT HUBS, FIELD NAMES, TYPES, LENGTHS, AND DESCRIPTIONS

Field Name	*Field Type*	*Field Length*	*Field Description*
GEOID	Text	4	County code
County	Text	5	County number
Truck	Short		Mode type
Barge	Short		Mode type
Rail	Short		Mode type
Air	Short		Mode type

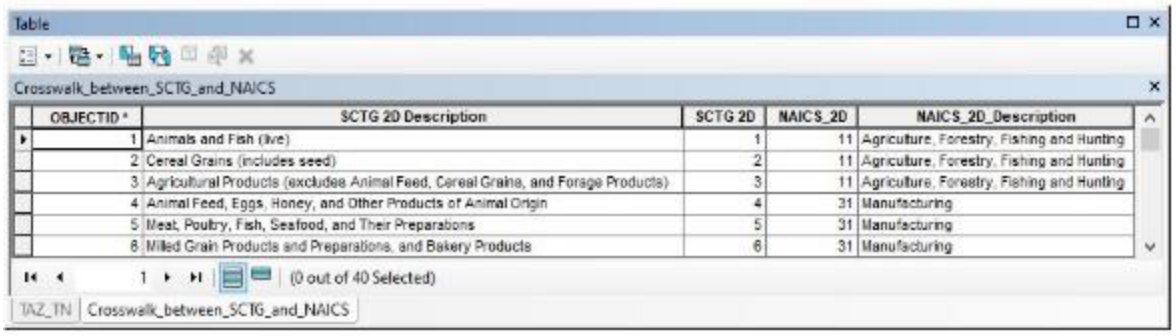


Figure A-60 SCTG 2-Digit to NAICS 2-digit Code Crosswalk Table

TABLE A-9 SCTG 2-DIGIT TO NAICS 2-DIGIT CODE CROSSWALK TABLE, FIELD NAMES, TYPES, LENGTHS, AND DESCRIPTIONS

Field Name	*Field Type*	*Field Length*	*Field Description*
SCTG 2D Description	Text	8000	Description of SCTG 2D
SCTG 2D	Long		SCTG 2D code
NAICS 2D	Long		NAICS 2D code
NAICS 2D Description	Text	80	Description of NAICS 2D

IO Accounts and Proportional Weight Disaggregation Method Tool Inputs and Outputs

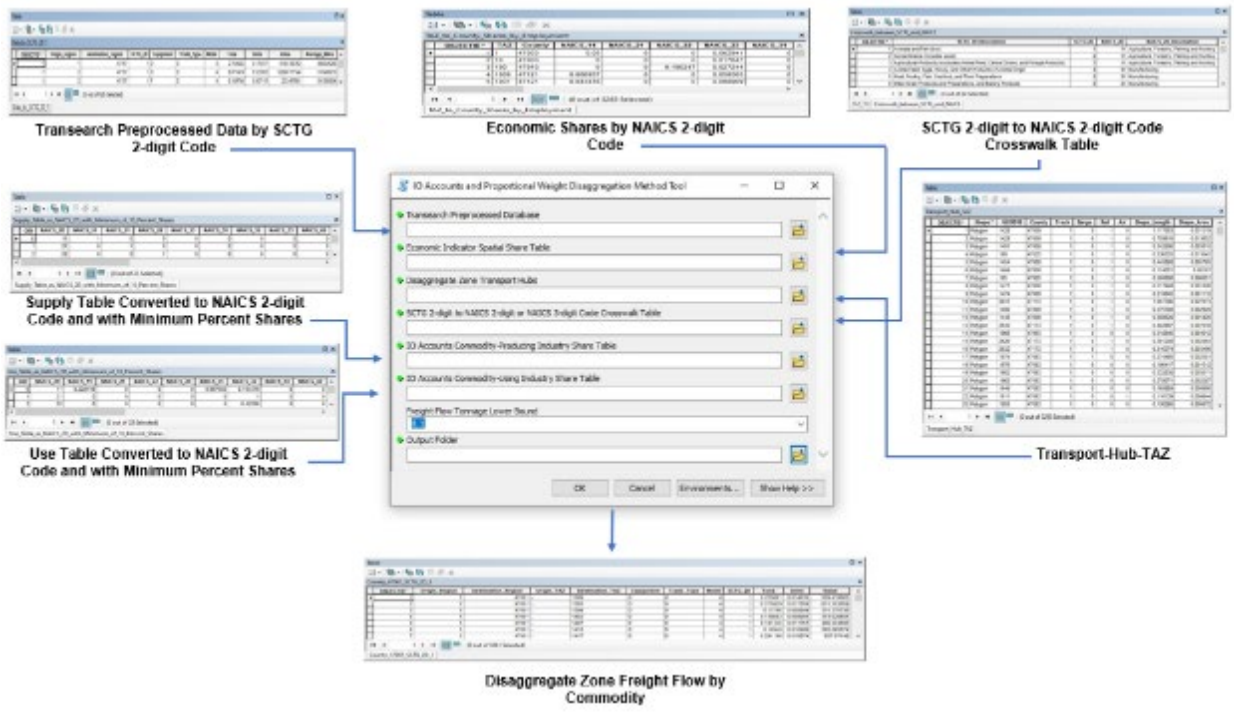


Figure A-61 IO Accounts and Proportional Weight Disaggregation Method Tool Inputs and Outputs

STEP 1

Open the newly added **Freight Data Disaggregation Tool** toolbox, select **Disaggregation** tool group and lunch **IO Accounts and Proportional Weight Disaggregation Method Tool** (see Figure A-62).

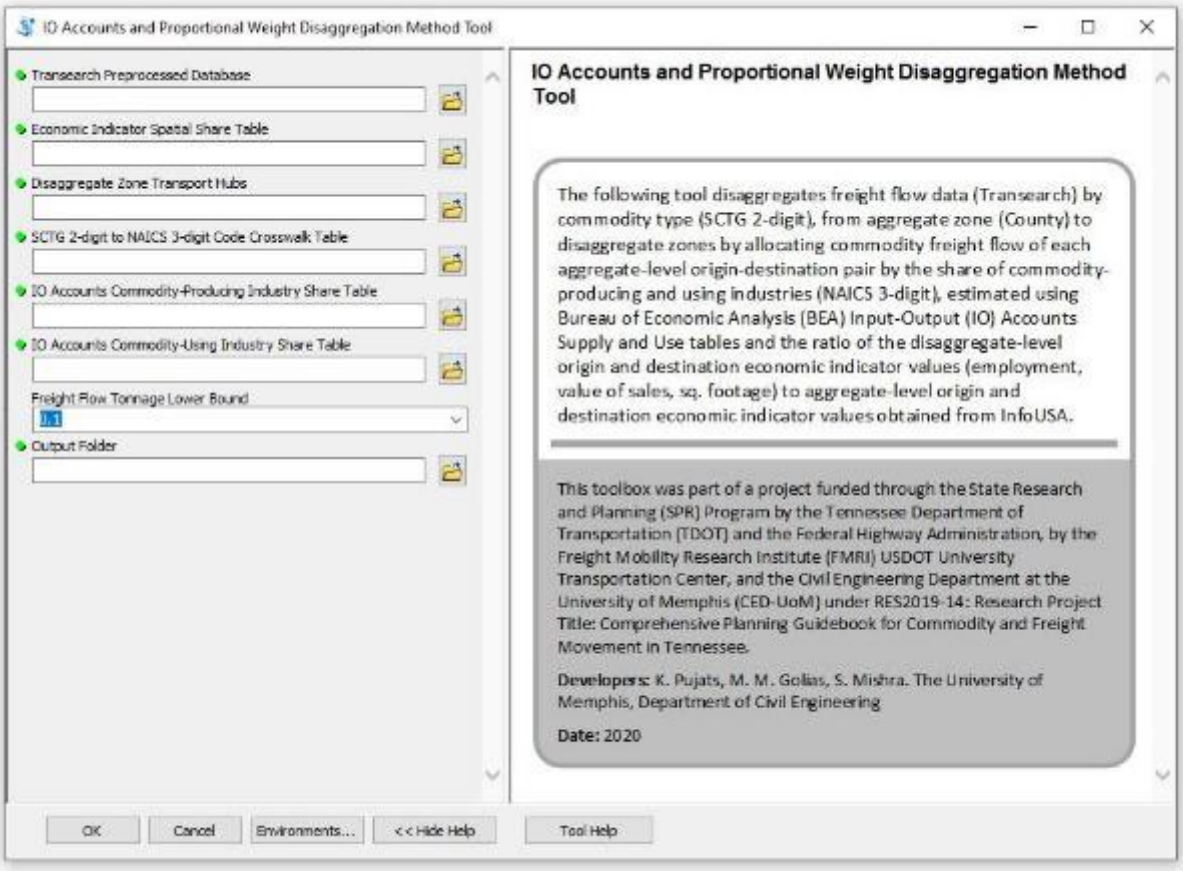


Figure A-62 IO Accounts and Proportional Weight Disaggregation Method Tool

STEP 2

Input TRANSEARCH pre-processed freight flow database workspace (*.gdb) in tools input parameter **TRANSEARCH Pre-processed Database** (see Figure A-63).

*Input obtained from the outputs of the **TRANSEARCH Preprocessing Tool***

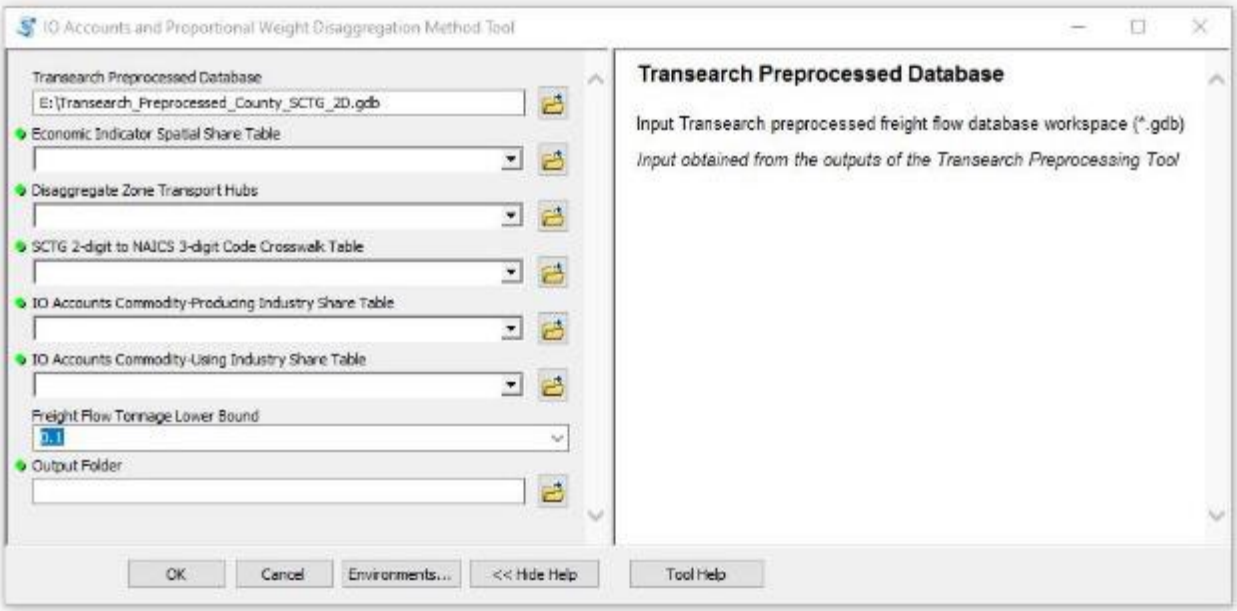


Figure A-63 Input TRANSEARCH Pre-processed Database

STEP 3 (Option 1: Employment Spatial Shares)

Input employment spatial share Table in tools input parameter **Economic Indicator Spatial Share Table** (see Figure A-64).

*Input obtained from the outputs of the **Spatial and Economic Data Preprocessing Tool***

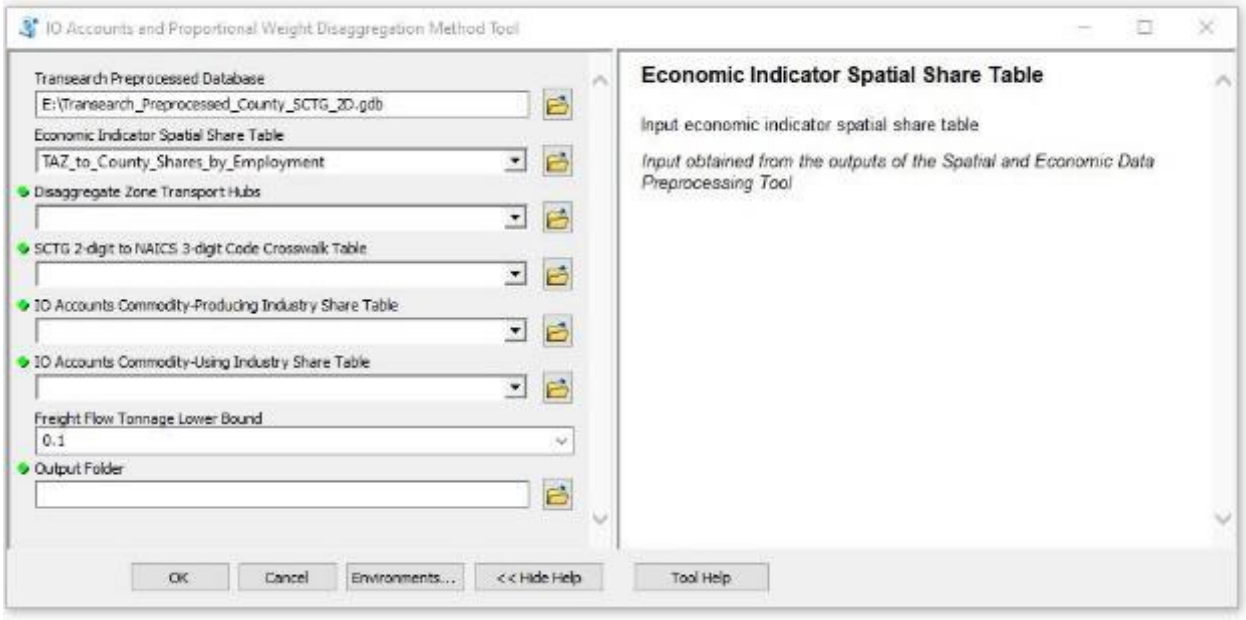


Figure A-64 Input Employment Spatial Share Table

STEP 3 (Option 2: Value of Sales Spatial Shares)

Input value of sales spatial share Table in tools input parameter **Economic Indicator Spatial Share Table** (see Figure A-65).

*Input obtained from the outputs of the **Spatial and Economic Data Preprocessing Tool***

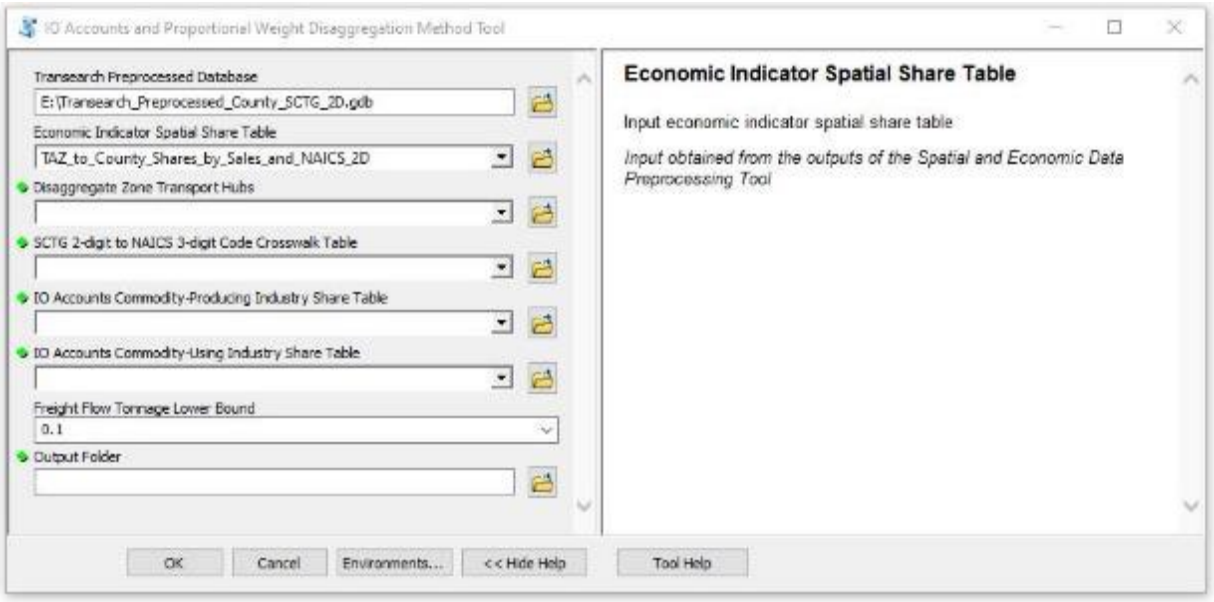


Figure A-65 Input Value of Sales Spatial Share Table

STEP 3 (Option 3: Square Footage Spatial Shares)

Input square footage spatial share Table in tools input parameter **Economic Indicator Spatial Share Table** (see Figure A-66).

*Input obtained from the outputs of the **Spatial and Economic Data Preprocessing Tool***

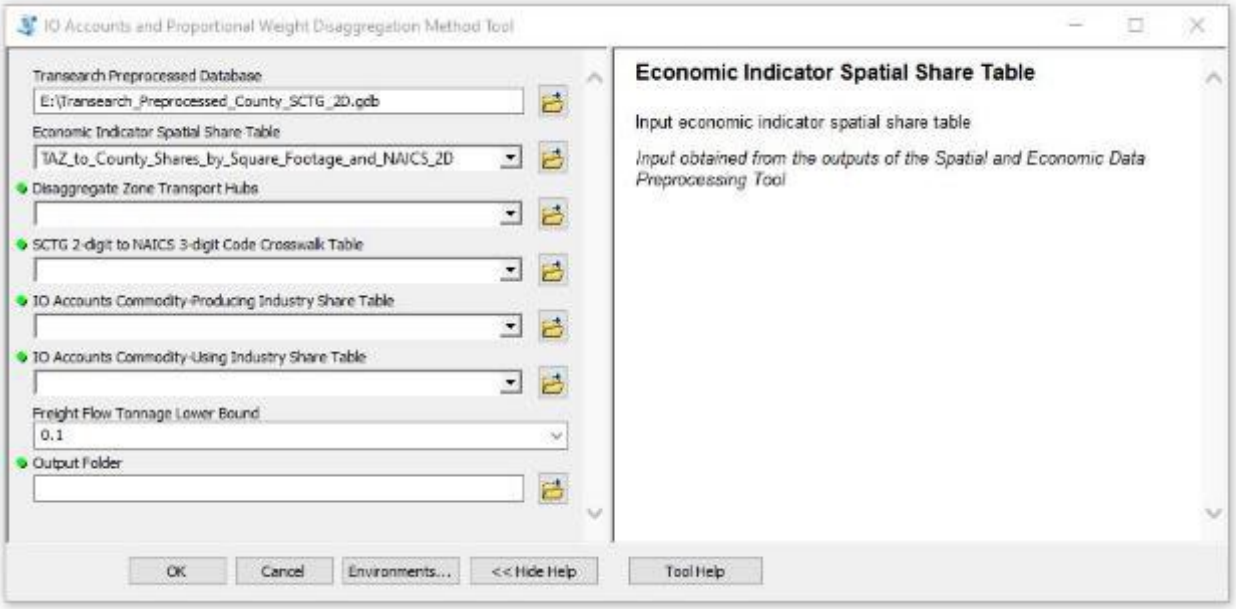


Figure A-66 Input Square Footage Spatial Share Table

STEP 4

Input Transport_Hub_TAZ Table in tools input parameter **Disaggregate Zone Transport Hubs** (see Figure A-67).

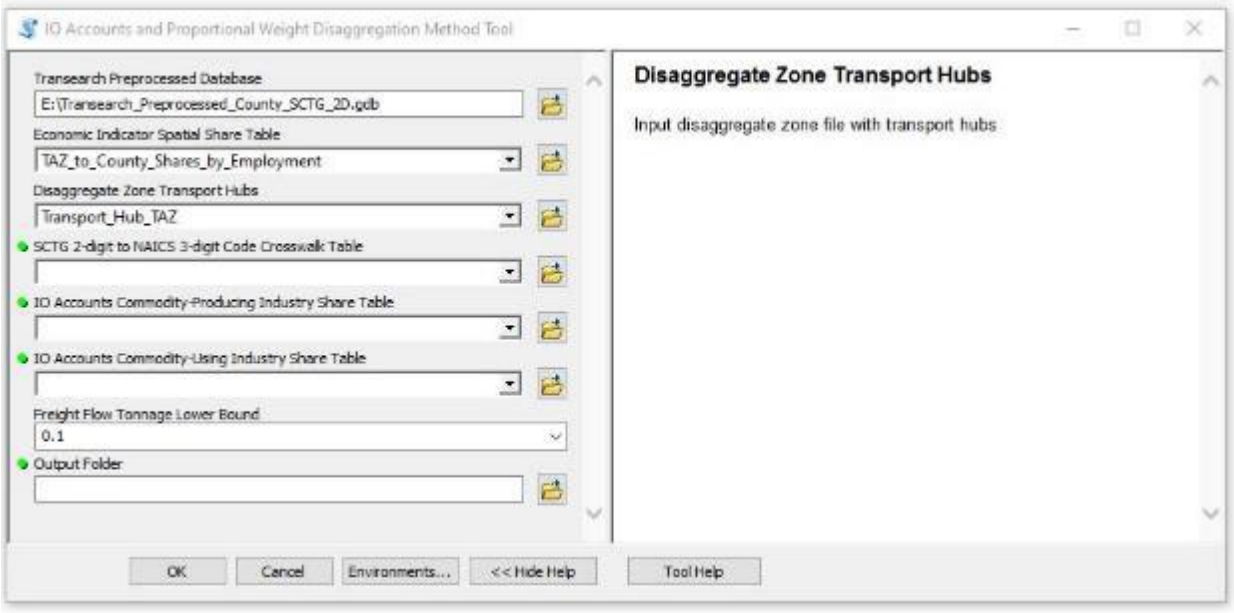


Figure A-67 Input Transport_Hub_TAZ Table

STEP 5

Input SCTG 2-digit to NAICS 3-digit crosswalk Table in tools input parameter **SCTG 2-digit to NAICS 3-digit Code Crosswalk Table** (see Figure A-68).

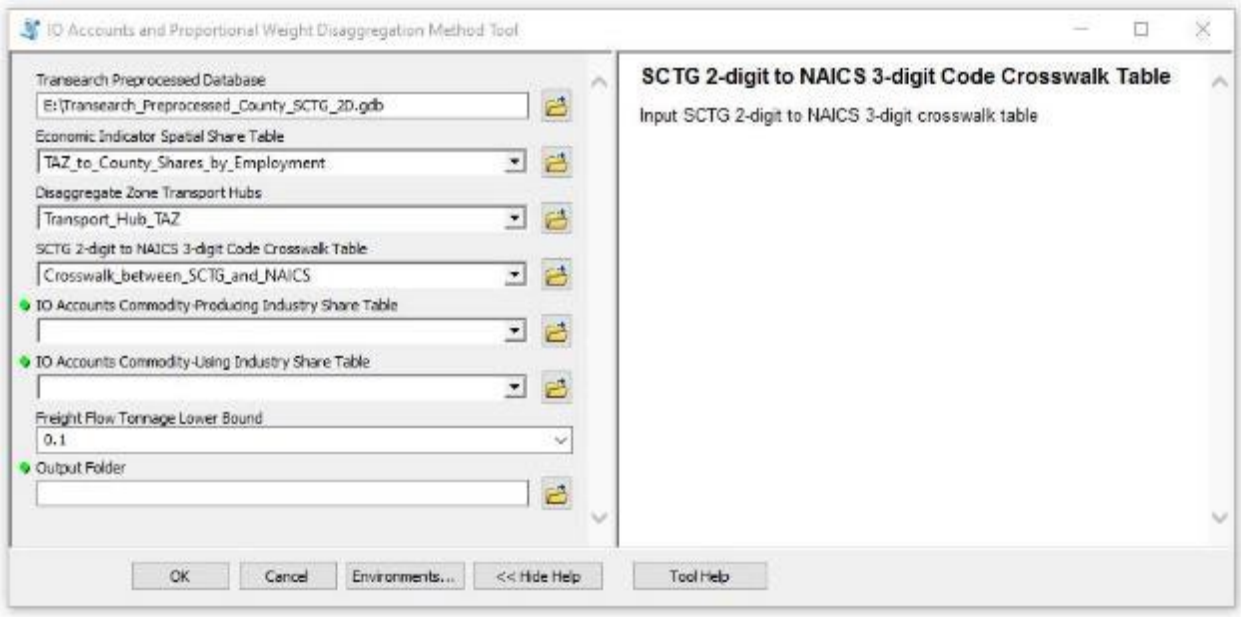


Figure A-68 Input SCTG 2-digit to NAICS 3-digit Code Crosswalk Table

STEP 6

Input BEA Input-Output Accounts commodity-producing industry share Table converted to NAICS 3-digit code in tools input parameter **IO Accounts Commodity-Producing Industry Share Table** (see Figure A-69).

*Input obtained from the outputs of the **IO Accounts Supply and Use Table Conversion Tool***

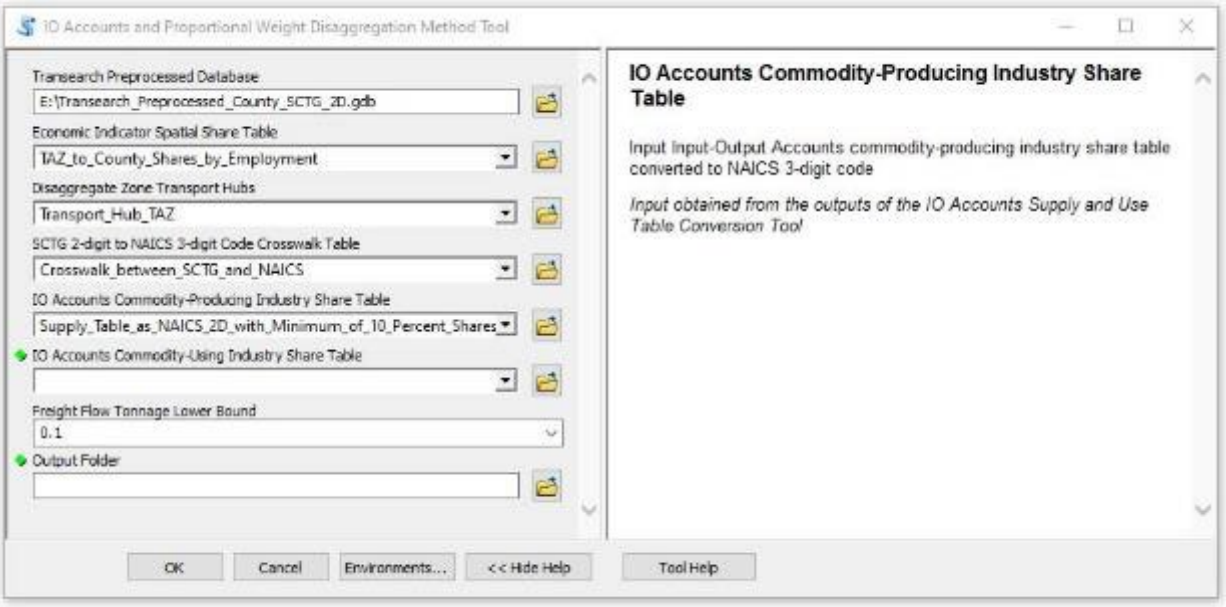


Figure A-69 Input IO Accounts Commodity-Producing Industry Share Table

STEP 7

Input Input-Output Accounts commodity-using industry share Table converted to NAICS 3-digit code in tools input parameter **IO Accounts Commodity-Using Industry Share Table** (see Figure A-70).

*Input obtained from the outputs of the **IO Accounts Supply and Use Table Conversion Tool***

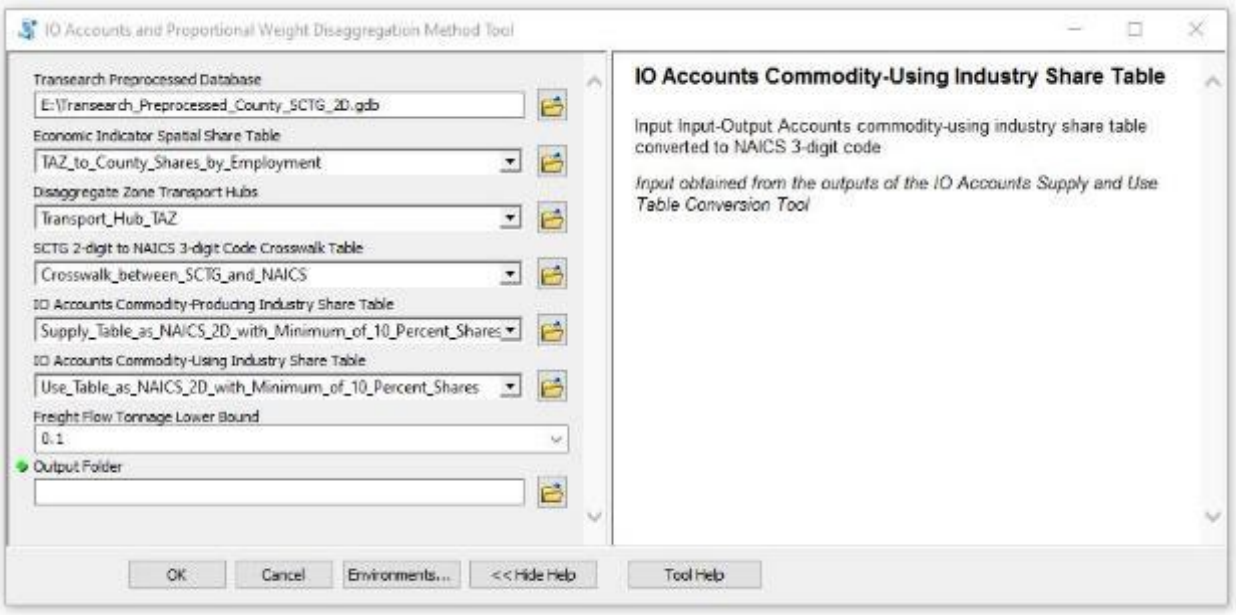


Figure A-70 Input IO Accounts Commodity-Using Industry Share Table

STEP 8

Select the lower bound for the output freight flow tonnage in tools input parameter **Freight Flow Tonnage Lower Bound** (see Figure A-71).

Purpose: Reduction of number instances with low values

(Default: 0.1)

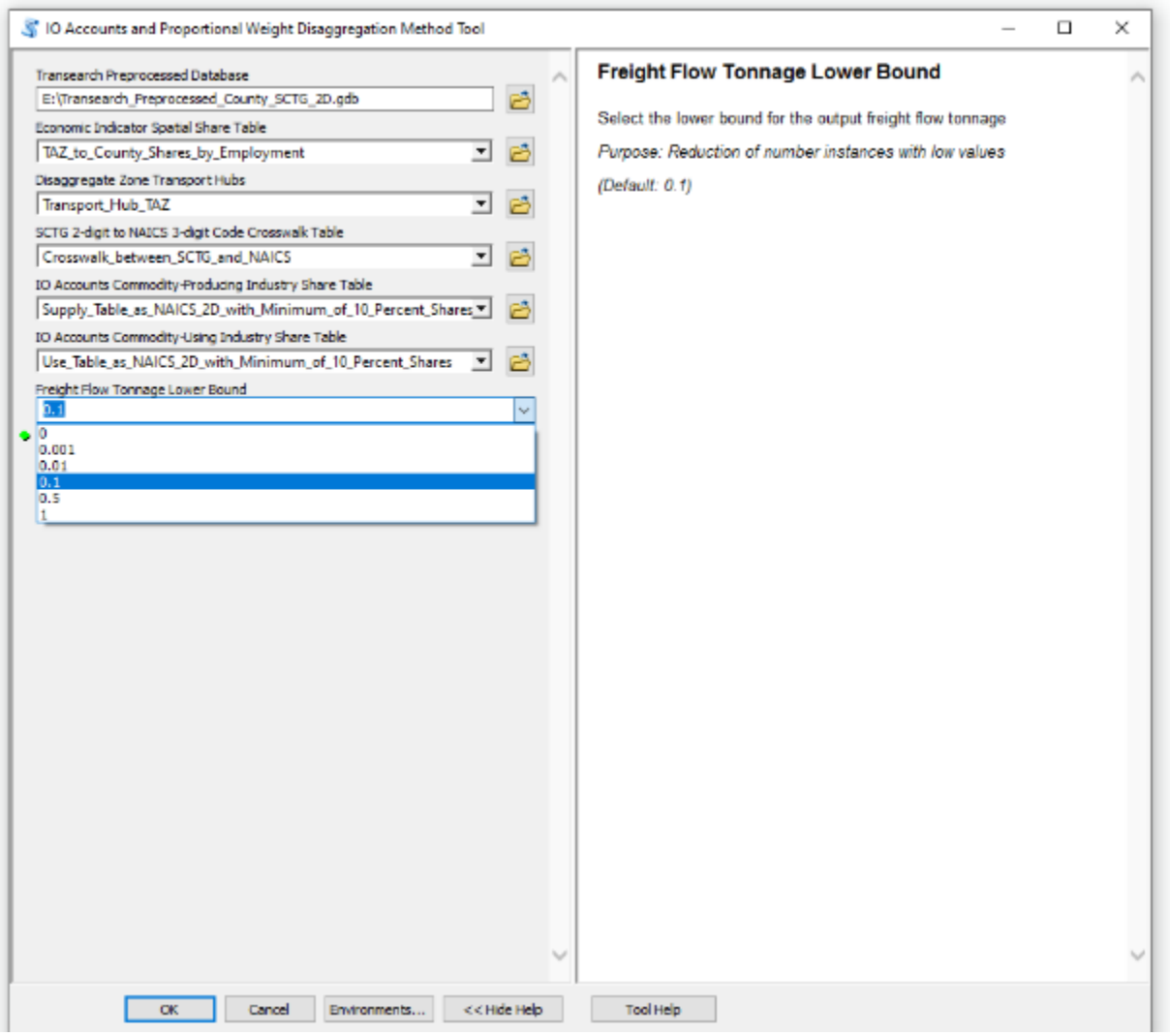


Figure A-71 Select the Freight Flow Tonnage Lower Bound

STEP 9

Select the output folder in the tools input parameter **Output Folder**, where the disaggregated freight flow data will be outputted (see Figure A-72).

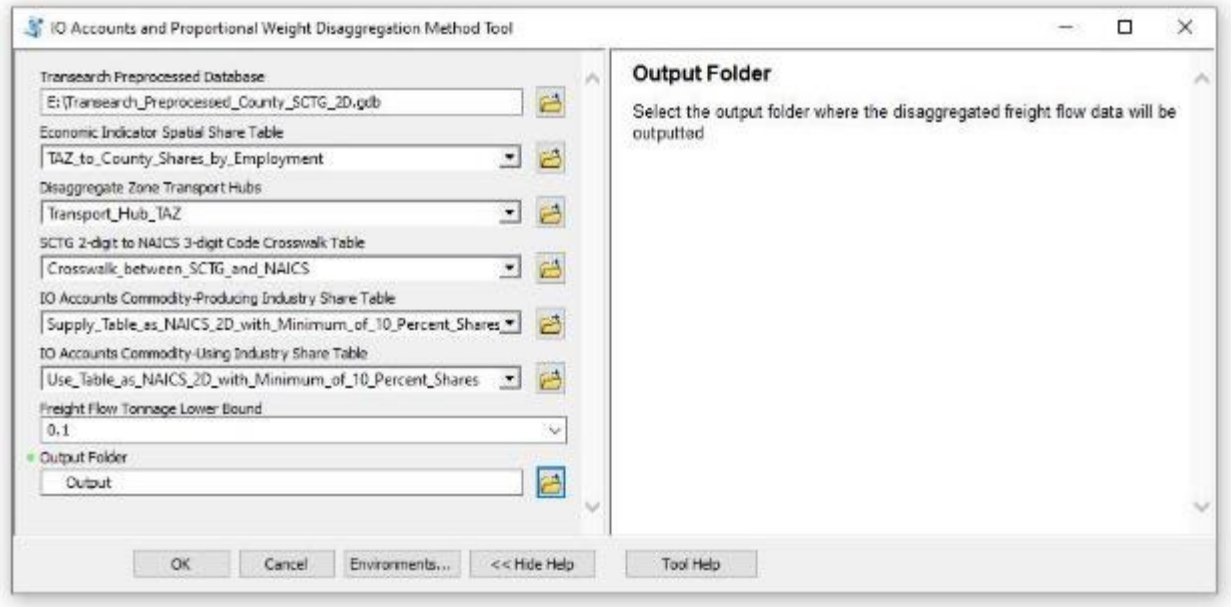


Figure A-72 Select the Output Folder

STEP 10

Once all required parameters are inputted, press OK to execute the application. The ArcGIS application invokes a task completion window, which reports the status of each task (see Figure A-73). The disaggregated freight flow data attribute Table using employment (see Figure A-74), the value of sales (see Figure A-75), and square footage (see Figure A-76) will be outputted in the selected output folder.

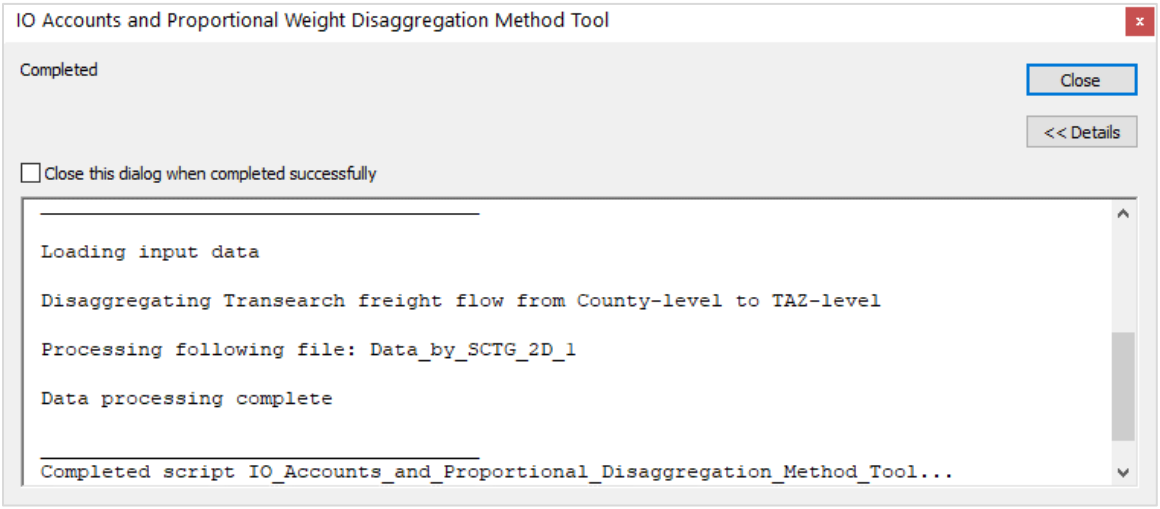
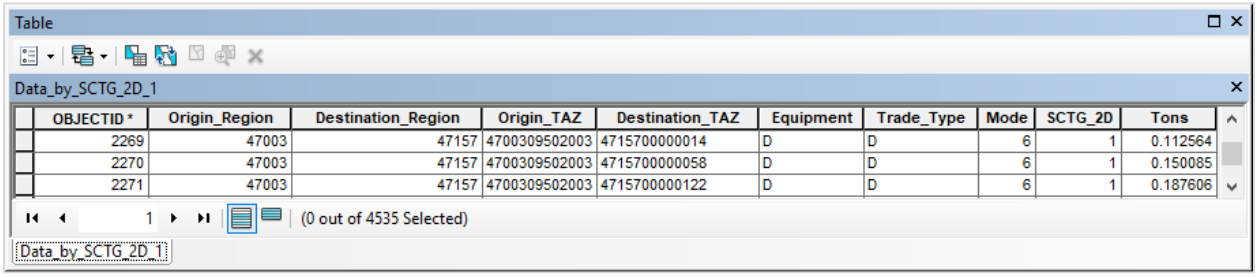
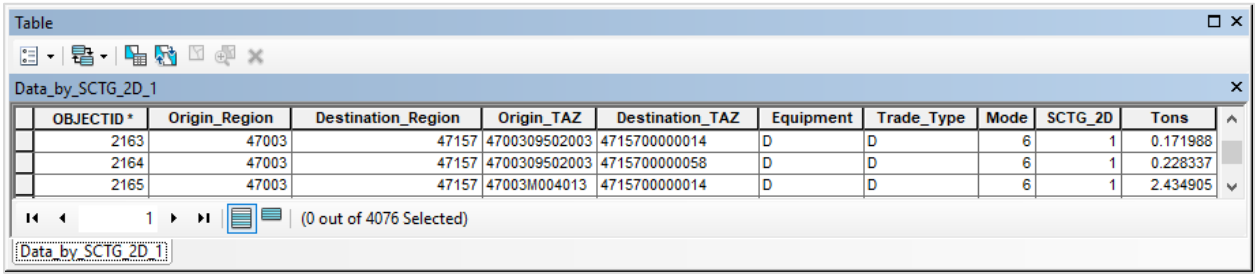


Figure A-73 IO Accounts and Proportional Weight Disaggregation Method Tool Performance Task Window



OBJECTID *	Origin_Region	Destination_Region	Origin_TAZ	Destination_TAZ	Equipment	Trade_Type	Mode	SCTG_2D	Tons
2269	47003	47157	4700309502003	4715700000014	D	D	6	1	0.112564
2270	47003	47157	4700309502003	4715700000058	D	D	6	1	0.150085
2271	47003	47157	4700309502003	4715700000122	D	D	6	1	0.187606

Figure A-74 Disaggregated Freight Flow Data Using IO Accounts, Proportional Weighting, and Employment



OBJECTID *	Origin_Region	Destination_Region	Origin_TAZ	Destination_TAZ	Equipment	Trade_Type	Mode	SCTG_2D	Tons
2163	47003	47157	4700309502003	4715700000014	D	D	6	1	0.171988
2164	47003	47157	4700309502003	4715700000058	D	D	6	1	0.228337
2165	47003	47157	47003M004013	4715700000014	D	D	6	1	2.434905

Figure A-75 Disaggregated Freight Flow Data Using IO Accounts, Proportional Weighting, and Value of Sales

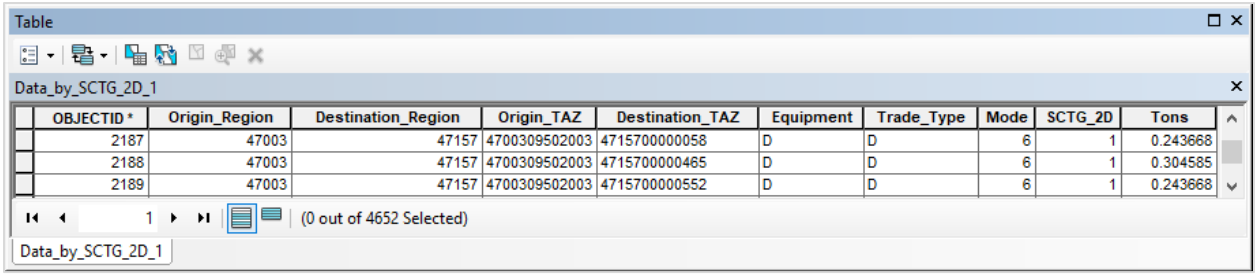


Figure A-76 Disaggregated Freight Flow Data Using IO Accounts, Proportional Weighting, and Square Footage

A.7 IO Accounts and Regression Disaggregation Method Tool

Description

The following tool disaggregates freight flow (TRANSEARCH) by commodity (SCTG 2-digit), from the aggregate zone (County) to disaggregate zones using the relationship between economic indicators (employment, value of sales, and sq. footage) by NAICS 3-digit or 2-digit industry code obtained from InfoUSA and by allocating commodity freight flow of each aggregate-level origin-destination pair by the share of commodity-producing and using industries (NAICS 3-digit or 2-digit), estimated using Bureau of Economic Analysis (BEA) Input-Output (IO) Accounts Supply and Use Tables. A schematic overview of IO Accounts and Regression Disaggregation Method Tool inputs and outputs is shown in Figure A-77. Next, we present example input file formats.

Example Input Files

- **TRANSEARCH_Preprocessed_Data_SCTG_2D.gdb/Data_by_SCTG_2D_1** (see Figure A-18) (Obtained from the outputs of the **TRANSEARCH Preprocessing Tool**)

- **Productions_and_Attractions.gdb** (see Figure A-19) *(Obtained from the outputs of the **TRANSEARCH Preprocessing Tool**)*

- **Spatial_Database.gdb/County_File** (see Figure A-5)
- **Disaggregate Zone Transport Hubs.gdb/ Transport_Hub_TAZ** (see Figure A-59)

- **Crosswalk_Table_Database.gdb/SCTG_2_Digit_to_NAICS_2_Digit_Code_Crosswalk_Table** (see Figure A-60)

- **Supply_Table_as_NAICS_3D_with_Minimum_of_10_Percent_Shares.dbf** (see Figure A-57) (Obtained from the outputs of the **IO Accounts Supply and Use Table Conversion Tool**)

- **Use_Table_as_NAICS_2D_with_Minimum_of_10_Percent_Shares.dbf** (see Figure A-58) (Obtained from the outputs of the **IO Accounts Supply and Use Table Conversion Tool**)

- **Aggregate_Zone_Economic_Values_by_NAICS_3D.gdb** (see Figure A-38) *(Obtained from the outputs of the **Spatial and Economic Data Preprocessing Tool**)*

- **Disaggregate_Zone_Economic_Values_by_NAICS_3D.gdb** (see Figure A-39) *(Obtained from the outputs of the **Spatial and Economic Data Preprocessing Tool**)*

- **Estimated_Zone_Centroid_Longitude_and_Latitude.gdb** (see Figure A-40) *(Obtained from the outputs of the **Spatial and Economic Data Preprocessing Tool**)*

- **Avg_Commodity_Travel_Length.gdb** (see Figure A-20) *(Obtained from the outputs of the **TRANSEARCH Preprocessing Tool**)*

IO Accounts and Regression Disaggregation Method Tool Inputs and Outputs

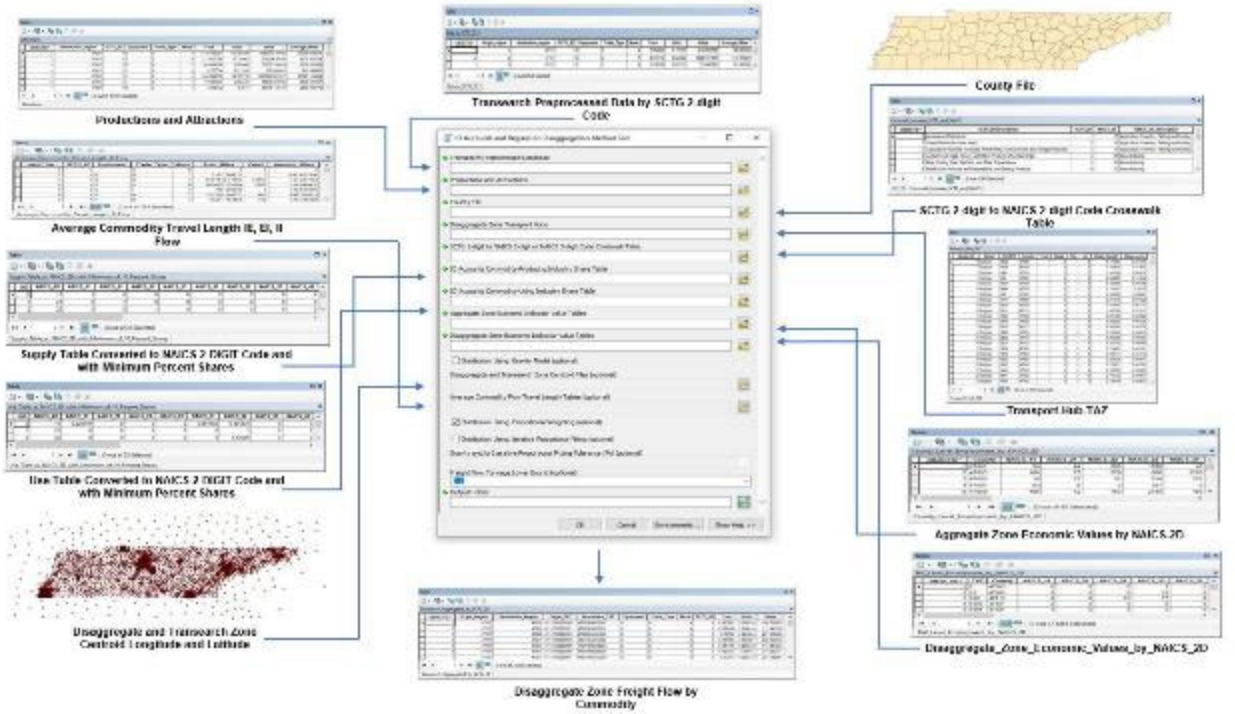


Figure A-77 IO Accounts and Regression Disaggregation Method Tool Inputs and Outputs

STEP 1

Open the newly added **Freight Data Disaggregation Tool** toolbox, select the **Disaggregation** tool group and lunch **IO Accounts and Regression Disaggregation Method Tool** (see Figure A-78).

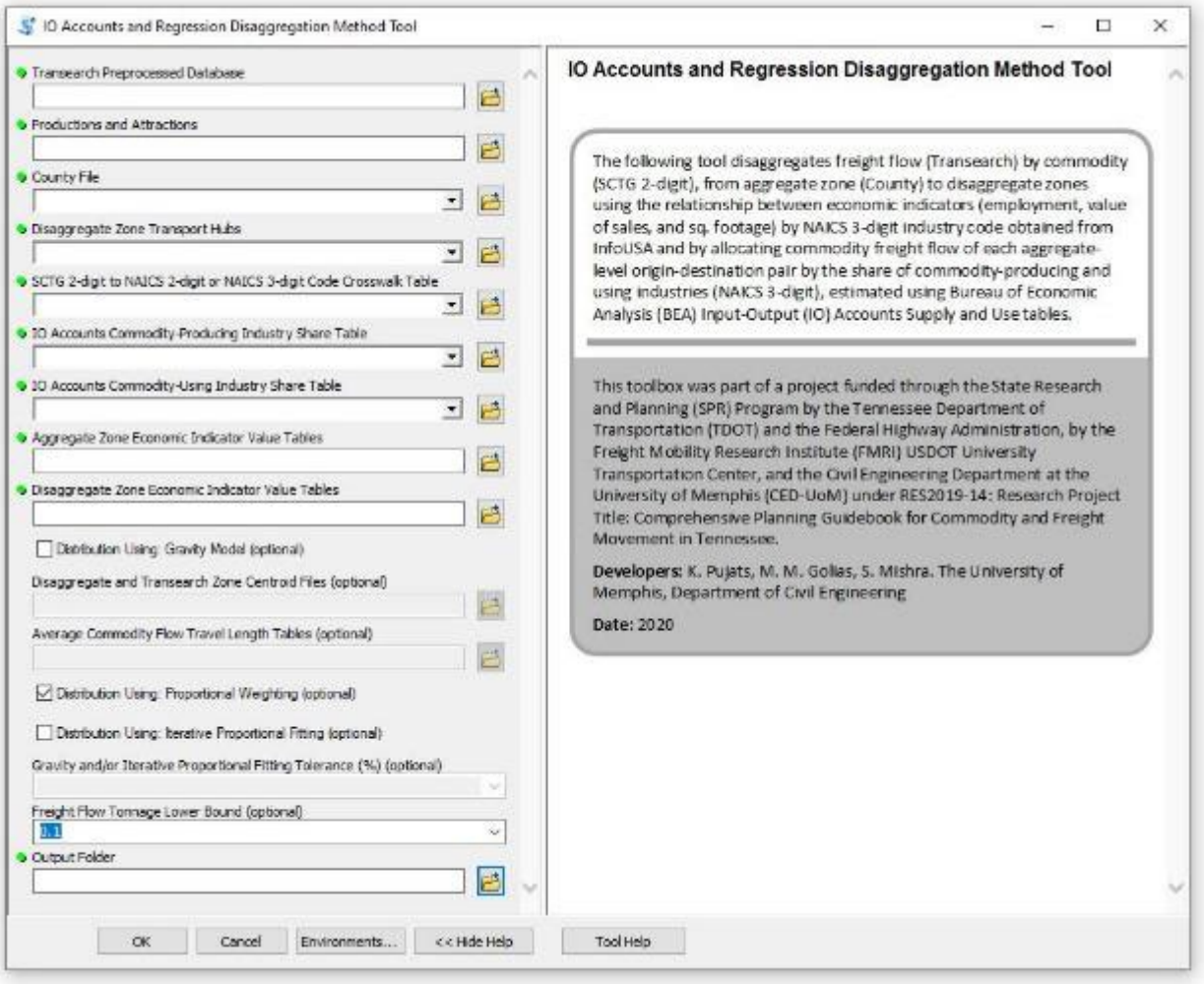


Figure A-78 IO Accounts and Regression Disaggregation Method Tool

STEP 2

Input TRANSEARCH pre-processed freight flow database workspace (*.gdb) in tools input parameter **TRANSEARCH Pre-processed Database** (see Figure A-79).

*Input obtained from the outputs of the **TRANSEARCH Preprocessing Tool***

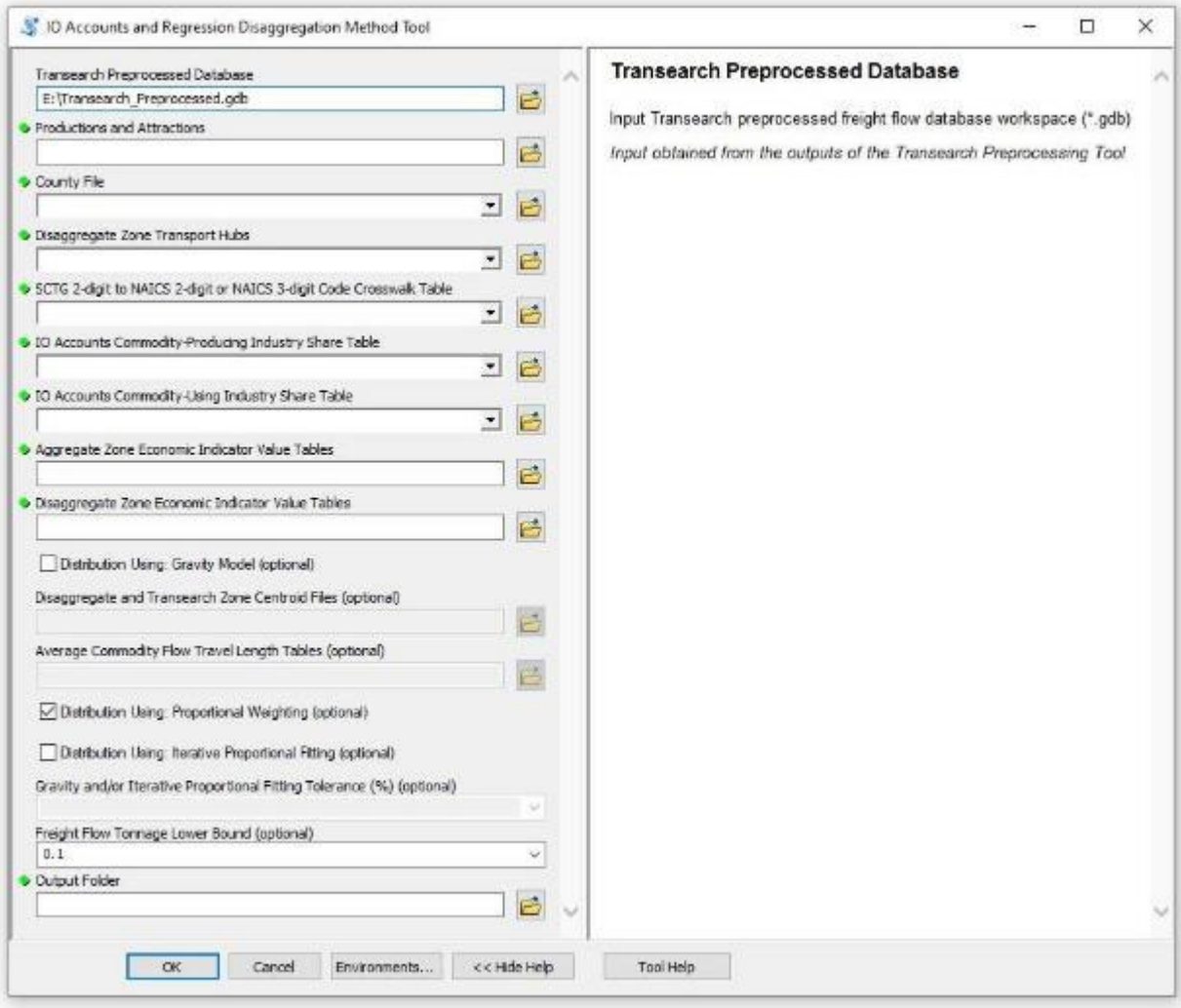


Figure A-79 Input TRANSEARCH Preprocessed Database Workspace (*.gdb)

STEP 3

Input study areas TRANSEARCH zone productions and attractions Table workspace (*.gdb) in tools input parameter **Productions and Attractions** (see Figure A-80).

*Input obtained from the output of the **TRANSEARCH Preprocessing Tool***

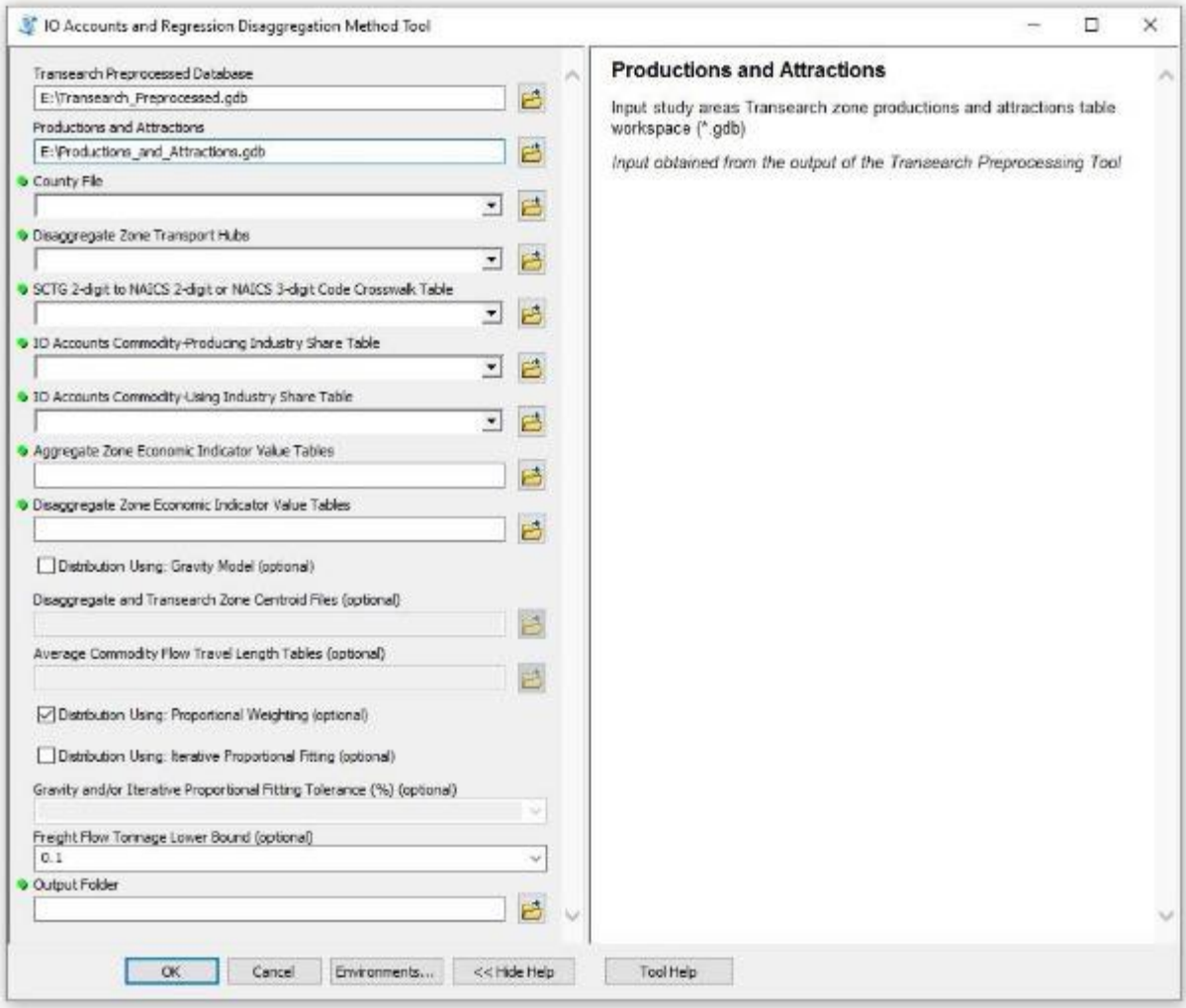


Figure A-80 Study Area County Productions and Attractions Workspace (*.gdb)

STEP 4

Input geographic file containing study area counties with geographic entity codes (GEOIDs) in tools input parameter **Study Area County Geographic File** (see Figure A-81).

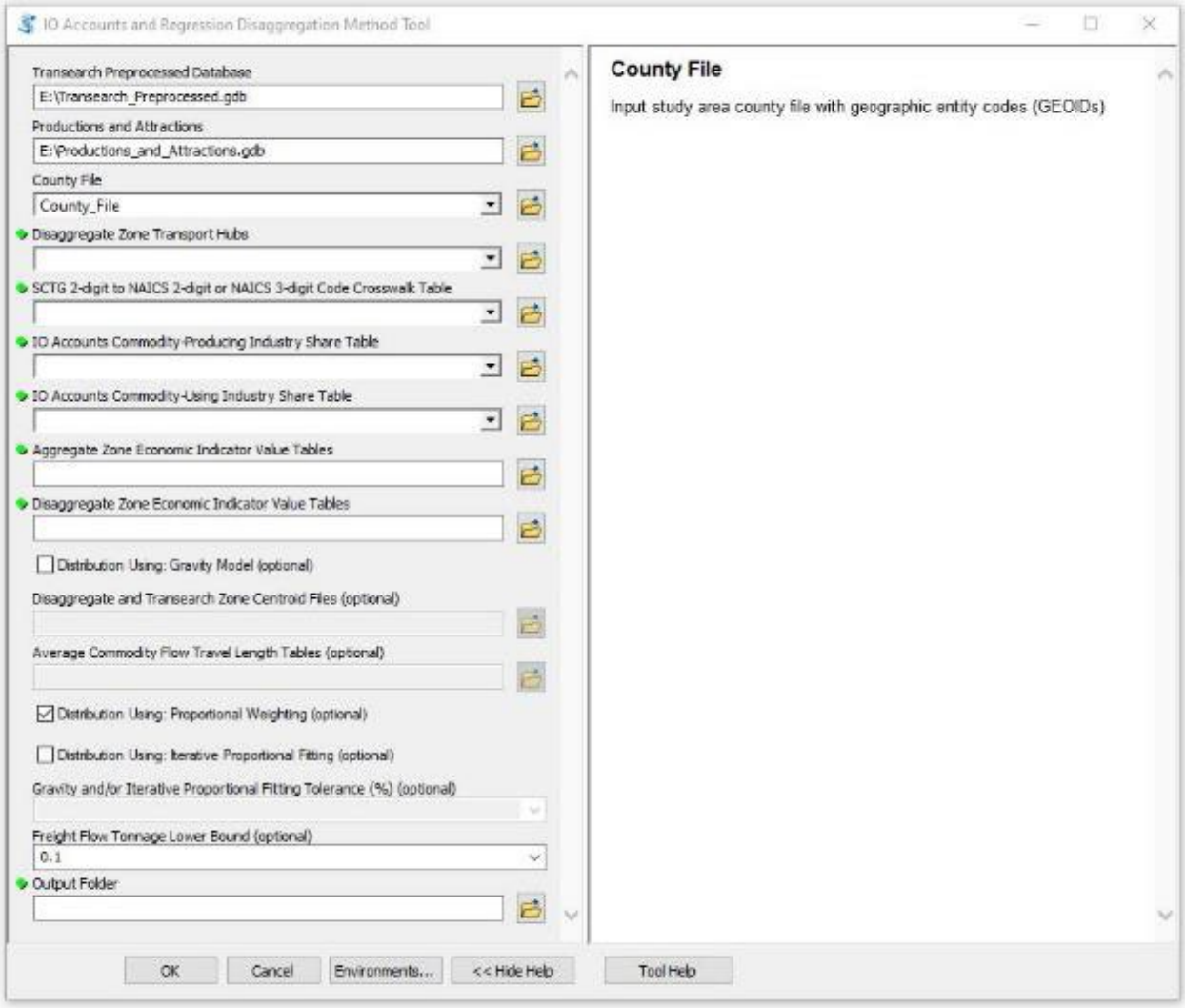


Figure A-81 Input Study Area County Geographic File

STEP 5

Input Transport_Hubs_TAZ in tools input parameter **Disaggregate Zone Transport Hubs** (see Figure A-82).

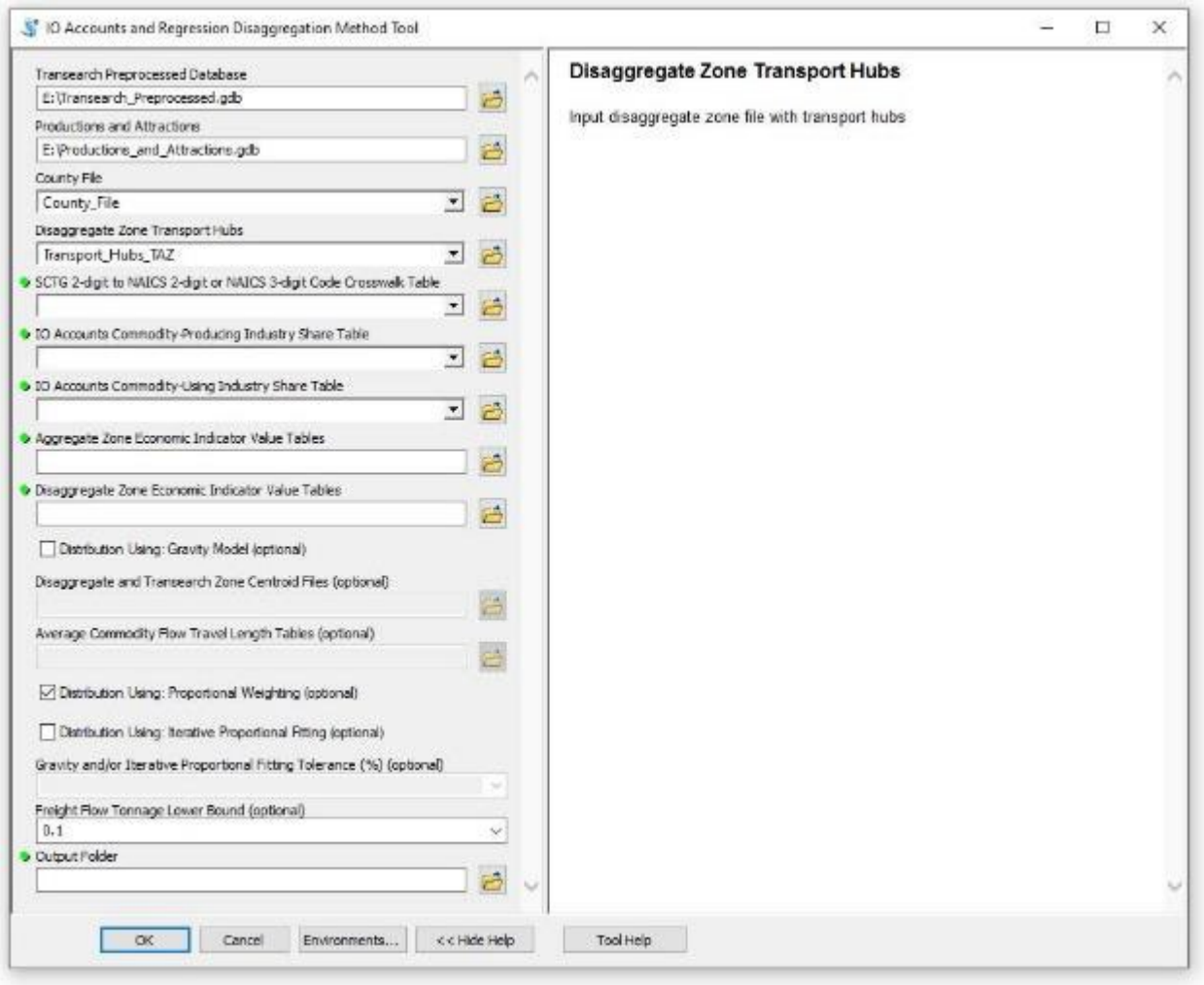


Figure A-82 Input Study Area County Geographic File

STEP 6

Input SCTG 2-digit to NAICS 3-digit crosswalk Table in tools input parameter **SCTG 2-digit to NAICS 3-digit Code Crosswalk Table** (see Figure A-83).

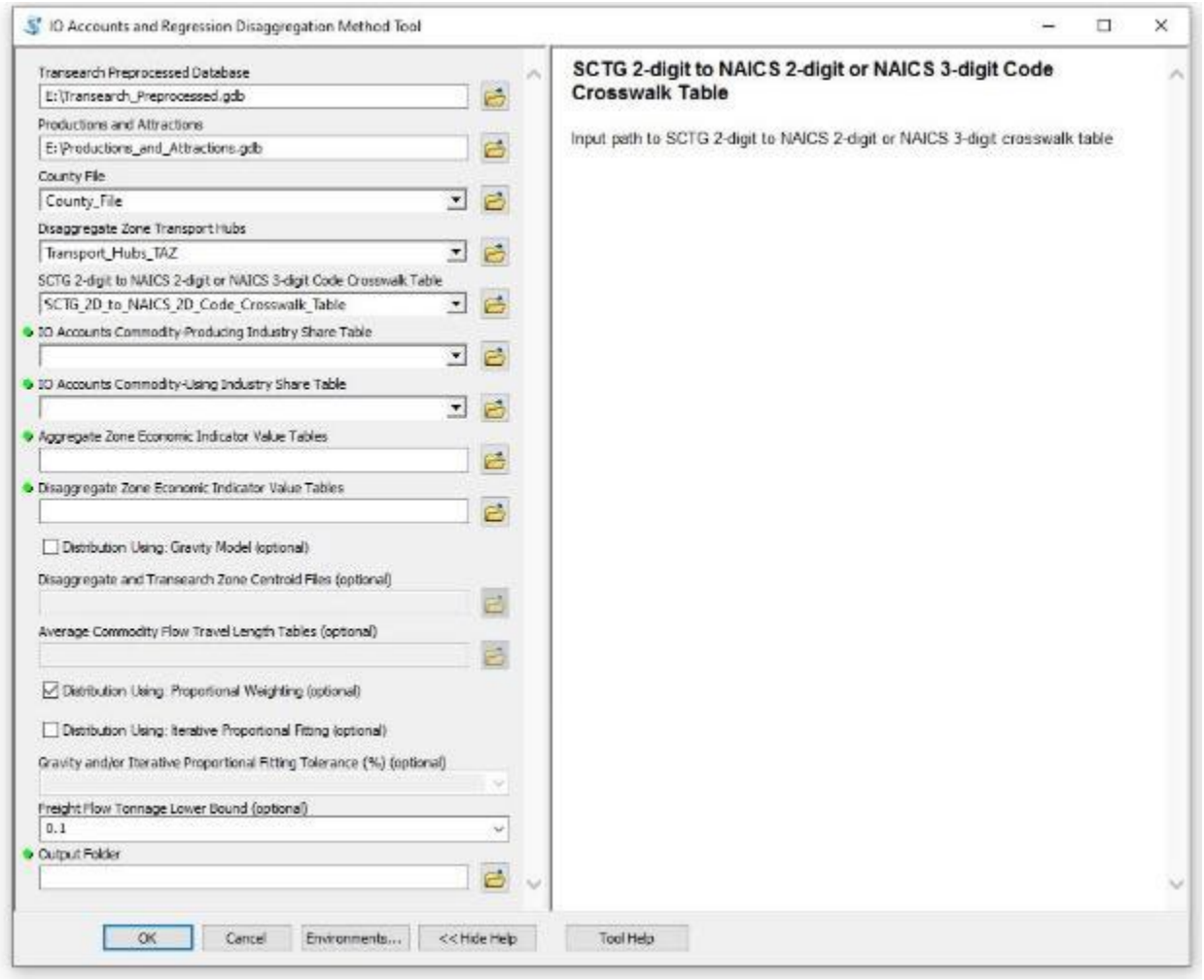


Figure A-83 Input SCTG 2-digit to NAICS 3-digit Code Crosswalk Table

STEP 7

Input BEA Input-Output Accounts Supply Table converted to NAICS 2-digit or 3-digit code in tools input parameter **IO Accounts Supply Table** (see Figure A-84).

*Input obtained from the outputs of the **IO Accounts Supply and Use Table Conversion Tool***

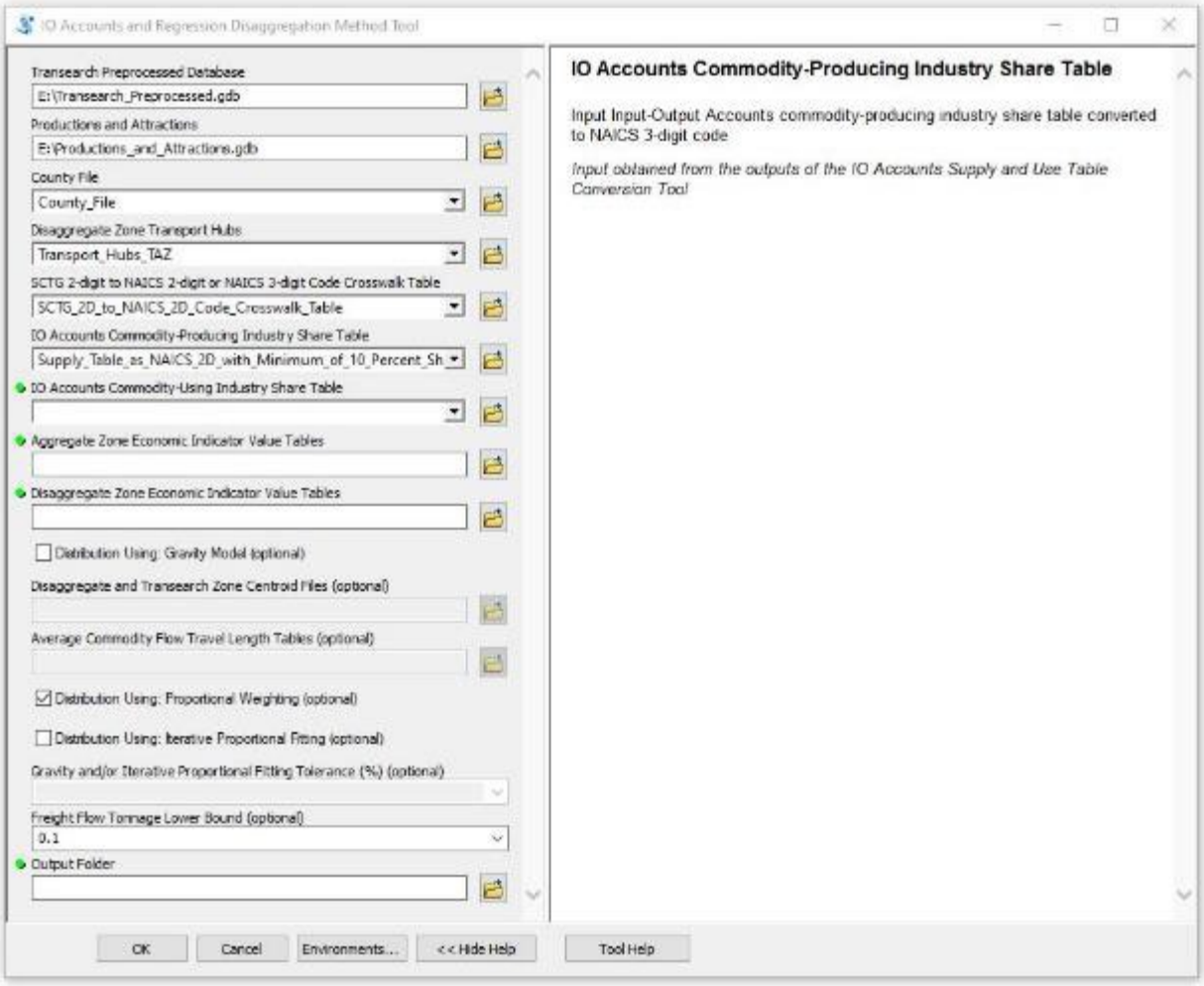


Figure A-84 Input IO Accounts Commodity-Producing Industry Share Table

STEP 8

Input BEA Input-Output Accounts Use Table converted to NAICS 3-digit code in tools input parameter **IO Accounts Use Table** (see Figure A-85).

*Input obtained from the outputs of the **IO Accounts Supply and Use Table Conversion Tool***

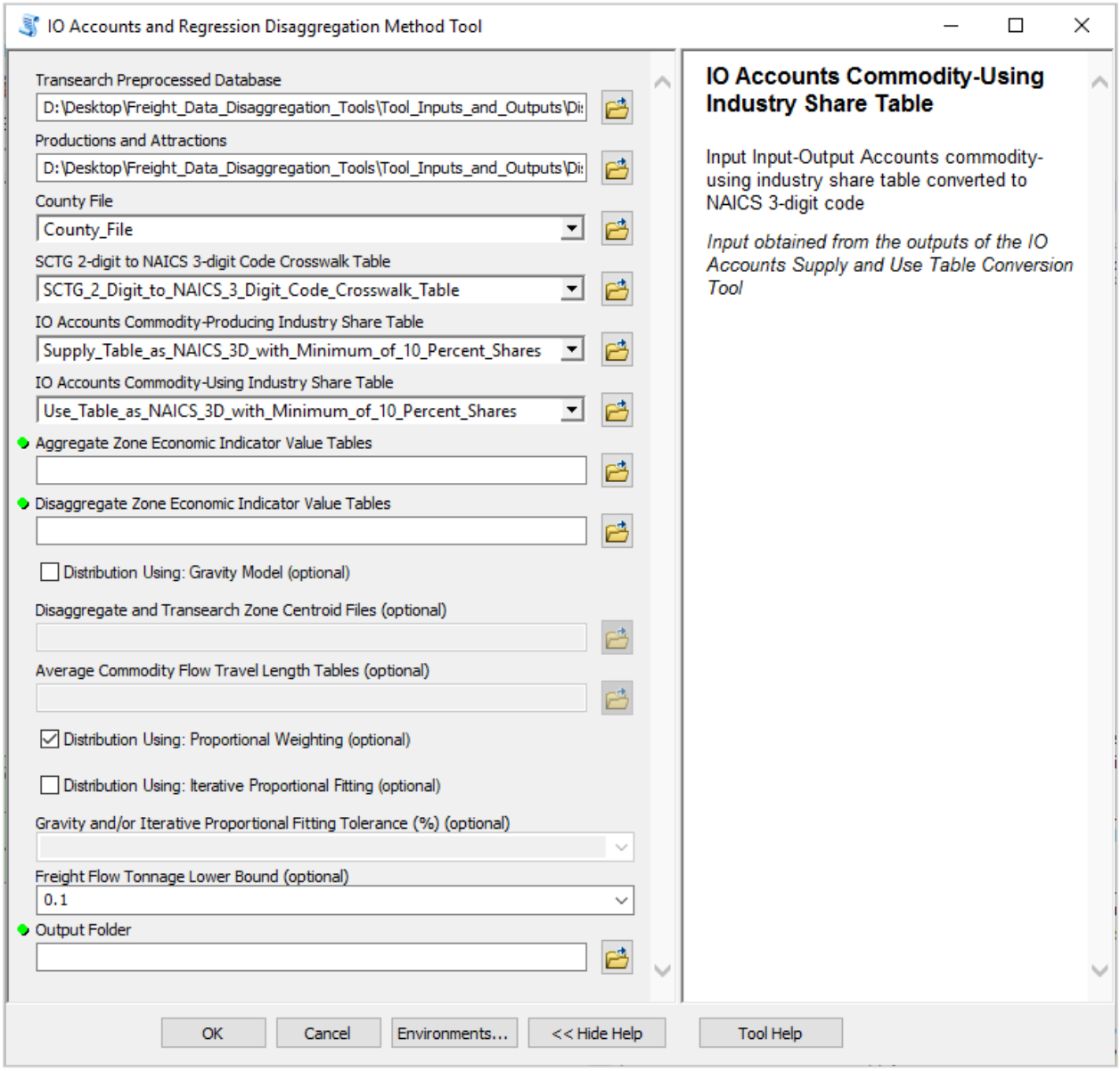


Figure A-85 Input IO Accounts Commodity-Using Industry Share Table

STEP 9

Input aggregate zone economic indicator value Table workspace (*.gdb) in tools input parameter **Aggregate Zone Economic Indicator Value Tables** (see Figure A-86).

*Input obtained from the outputs of the **Spatial and Economic Data Preprocessing Tool***

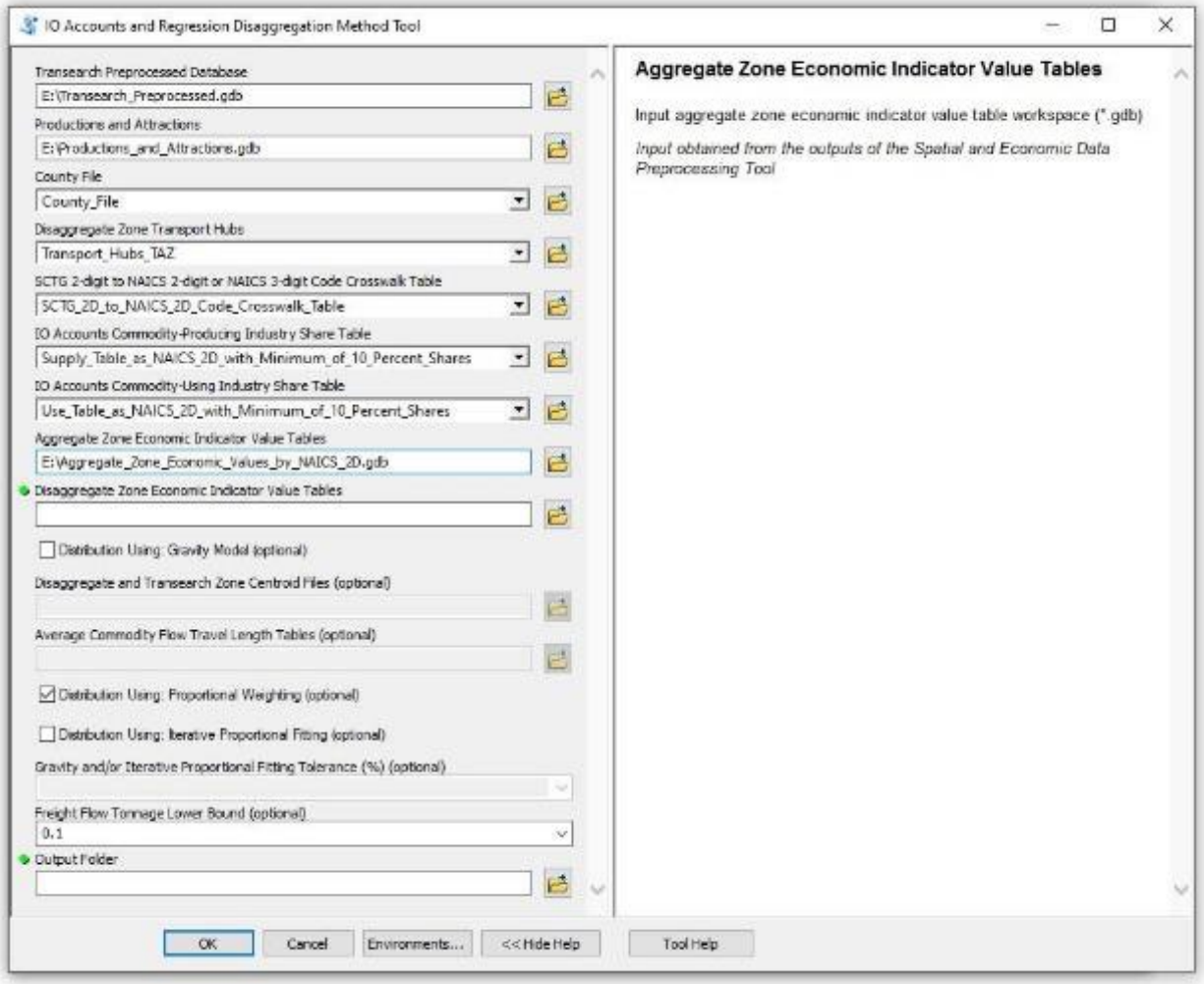


Figure A-86 Input Aggregate Zone Economic Indicator Value Table Workspace (*.gdb)

STEP 10

Input disaggregate zone economic indicator value Table workspace (*.gdb) in tools input parameter **Disaggregate Zone Economic Indicator Value Tables** (see Figure A-87).

*Input obtained from the outputs of the **Spatial and Economic Data Preprocessing Tool***

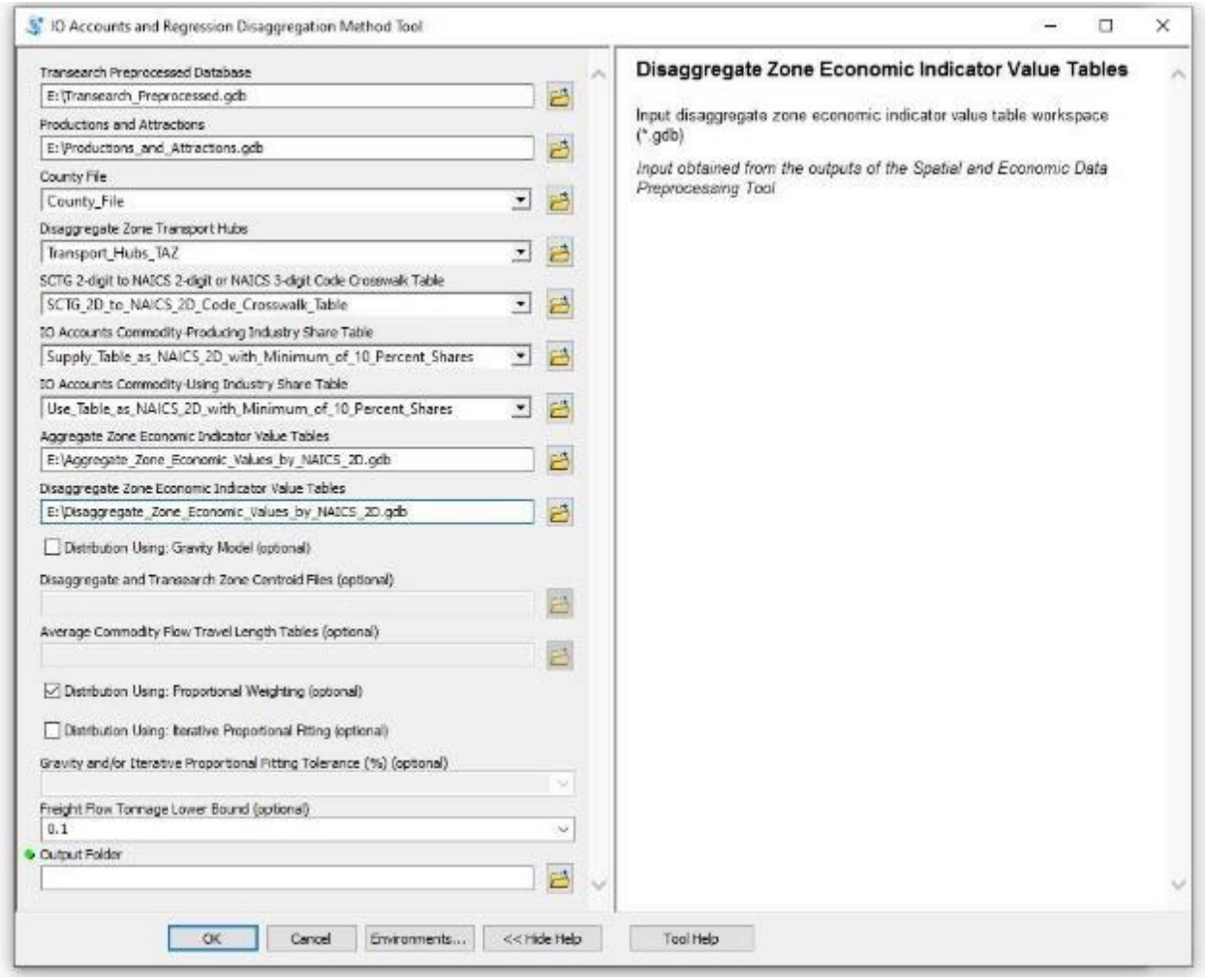


Figure A-87 Input Disaggregate Zone Economic Indicator Value Table Workspace (*.gdb)

STEP 11

Select the option **Distribution Using: Gravity Model** to disaggregate freight flow distribution using the Gravity Model (see Figure A-88).

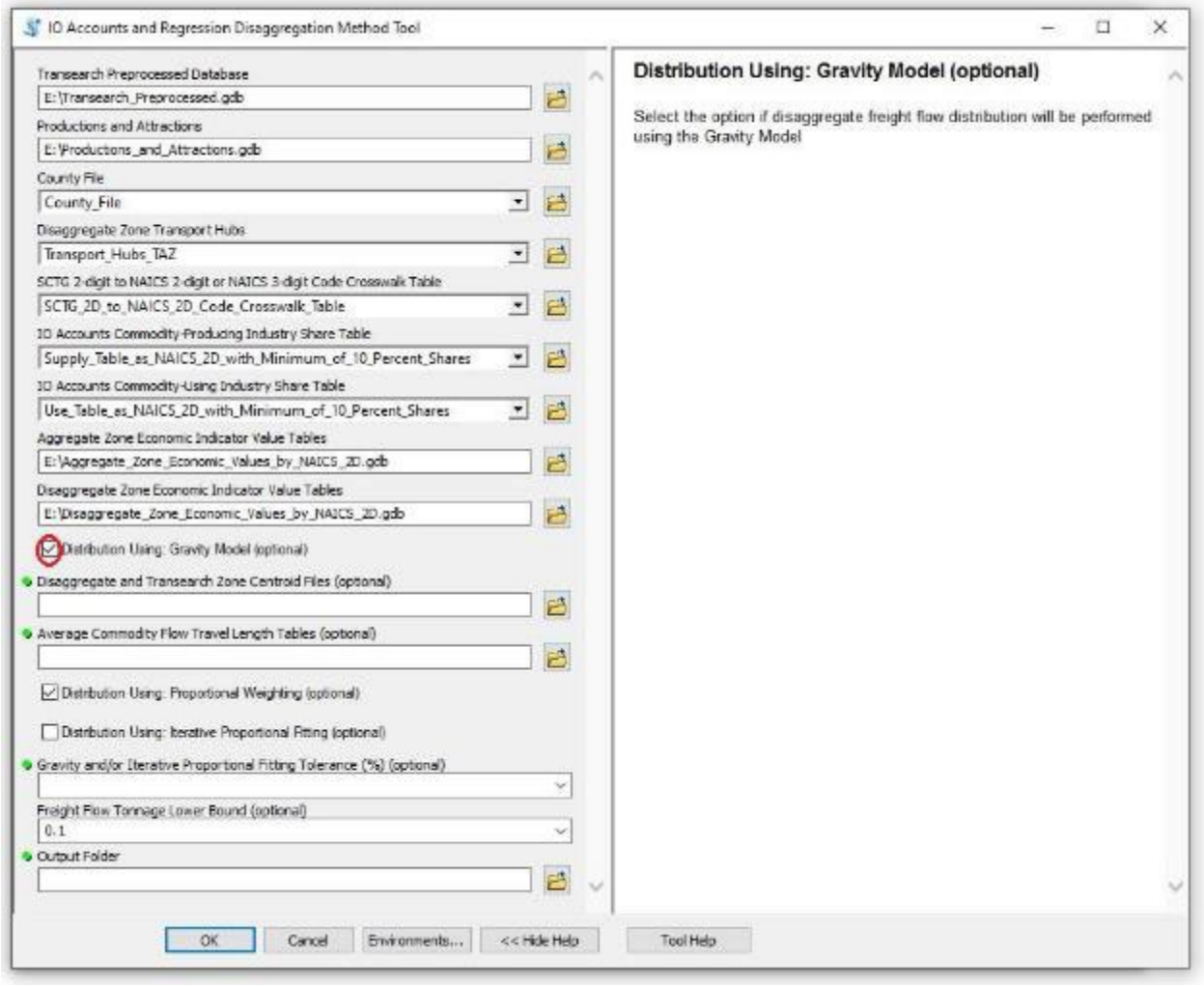


Figure A-88 Select the Option to Distribute Freight Flow Using the Gravity Model

STEP 11.1

Input disaggregate and TRANSEARCH zone centroid file workspace (*.gdb) in tools input parameter **Disaggregate and TRANSEARCH Zone Centroid Files** (see Figure A-89).

*Input obtained from the outputs of the **Spatial and Economic Data Preprocessing Tool***

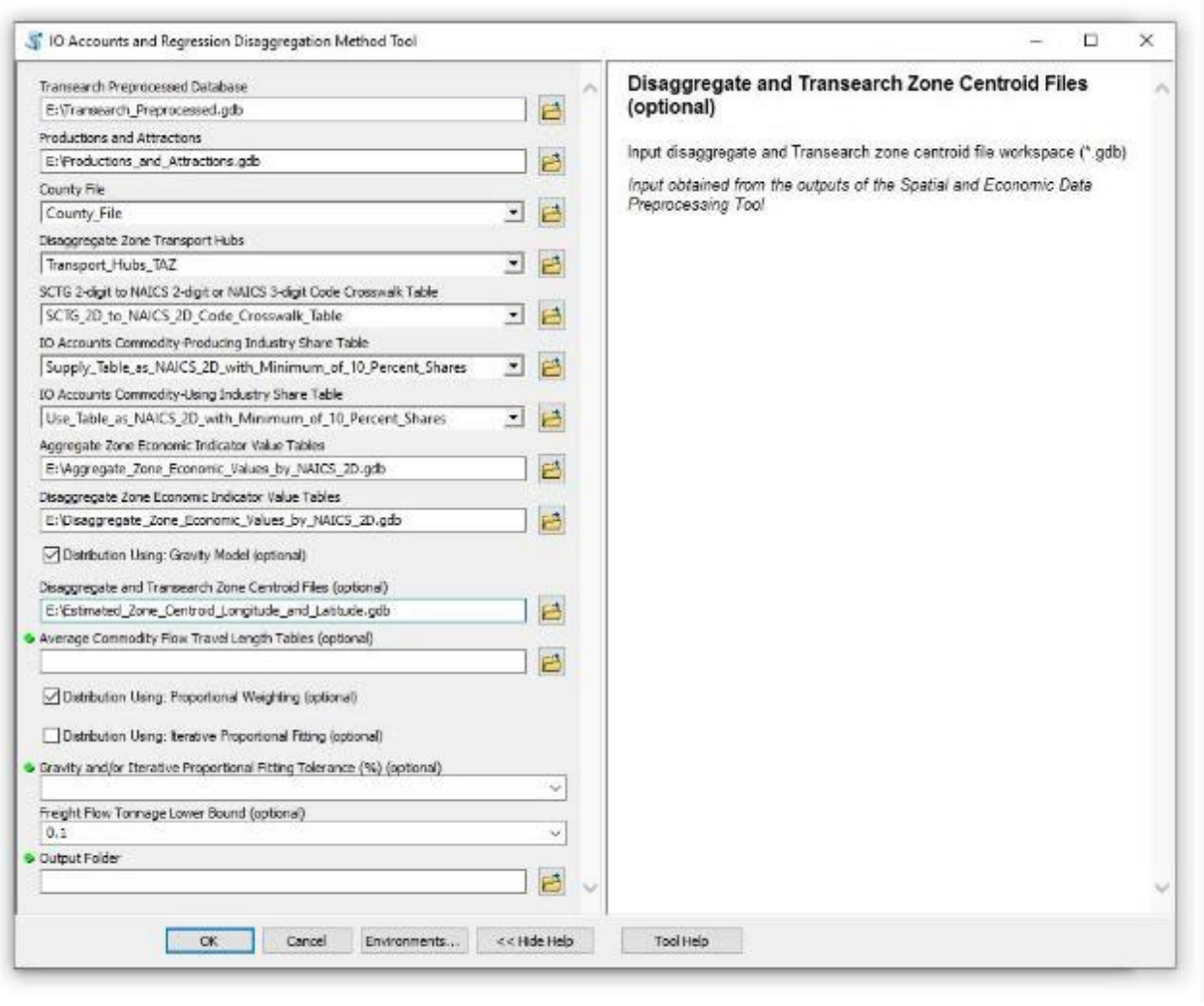


Figure A-89 Input Disaggregate and TRANSEARCH Zone Centroid File Workspace (*.gdb)

STEP 11.2

Input TRANSEARCH average commodity flow travel length Table workspace (*.gdb) in tools input parameter **Average Commodity Flow Travel Length Tables** (see Figure A-90).

*Input obtained from the output of the **TRANSEARCH Preprocessing Tool***

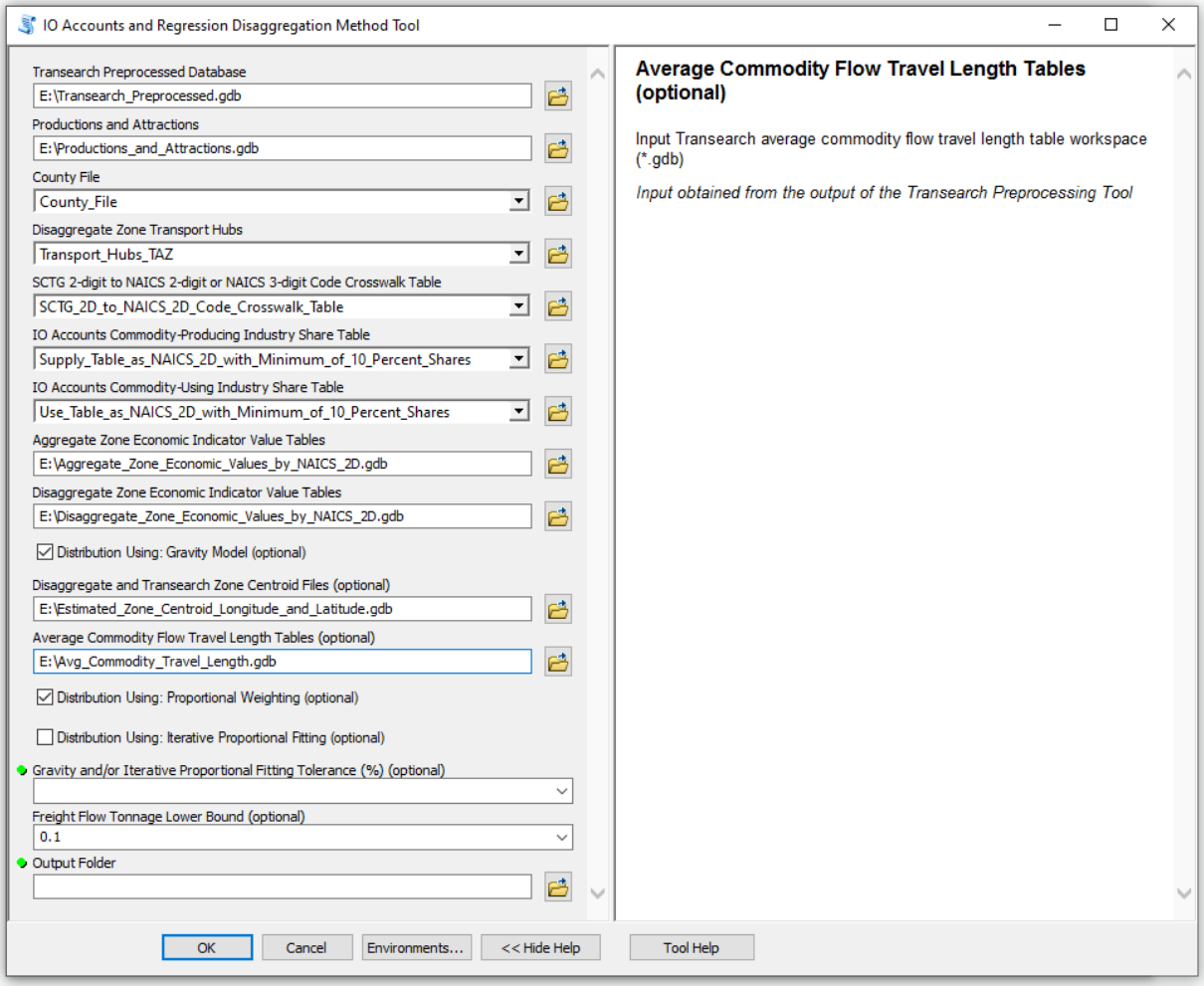


Figure A-90 Input Average Commodity Flow Travel Length Table Workspace (*.gdb)

STEP 12

Select the option **Distribution Using: Proportional Weighting** to disaggregate freight flow distribution using Proportional Weighting (see Figure A-91).

(Default: True)

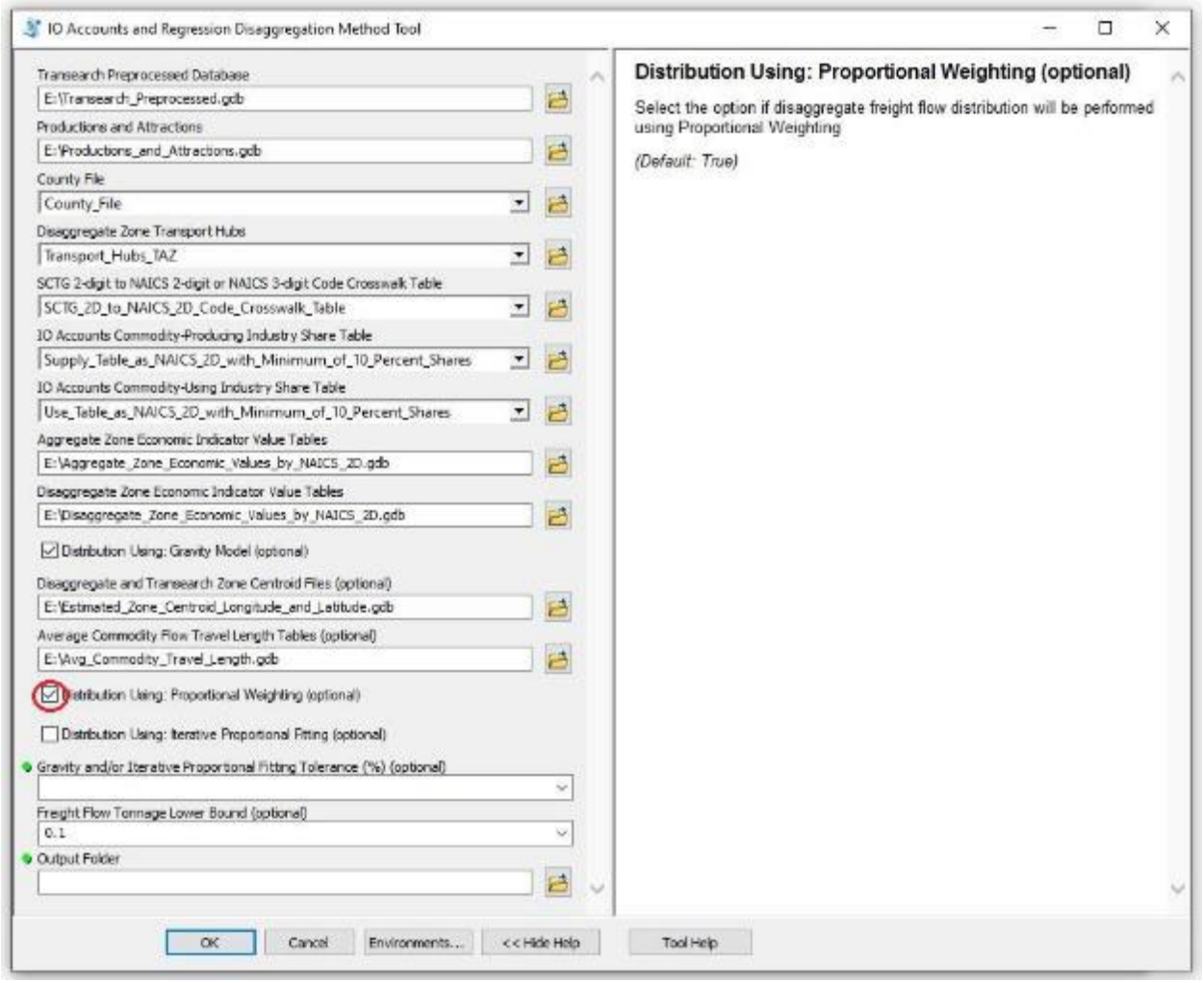


Figure A-91 Select the Option to Distribute Freight Flow Using Proportion Weighting

STEP 13

Select the option **Distribution Using: Iterative Proportional Fitting (IPF)** to disaggregate freight flow distribution using Iterative Proportional Fitting (see Figure A-92).

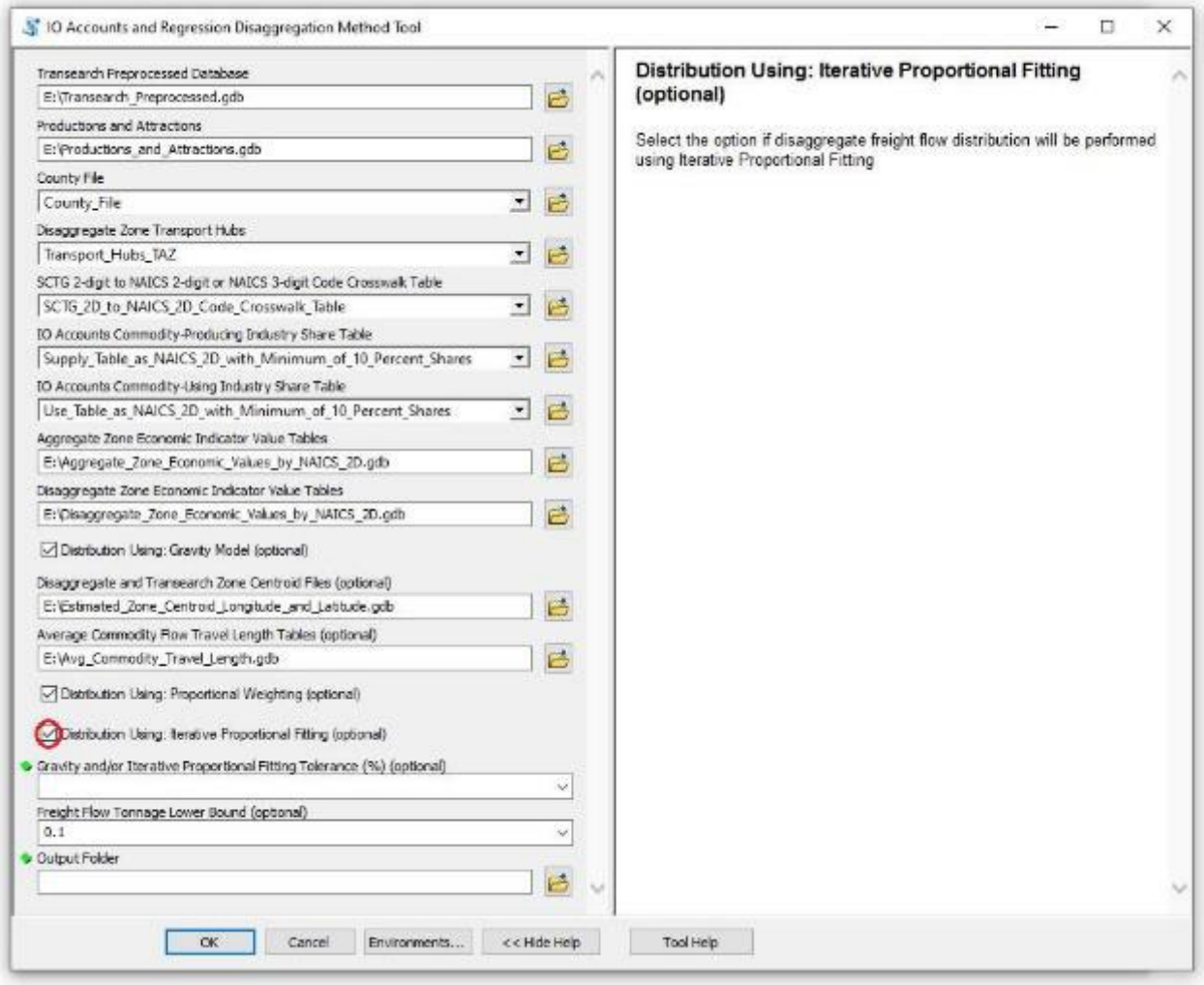


Figure A-92 Select the Option to Distribute Freight Flow Using Iterative Proportional Fitting

STEP 14

Select the tolerance (%) for Gravity Model and/or Iterative Proportional Fitting Method in tools input parameter **Gravity and/or Iterative Proportional Fitting Tolerance (%)** (see Figure A-93).

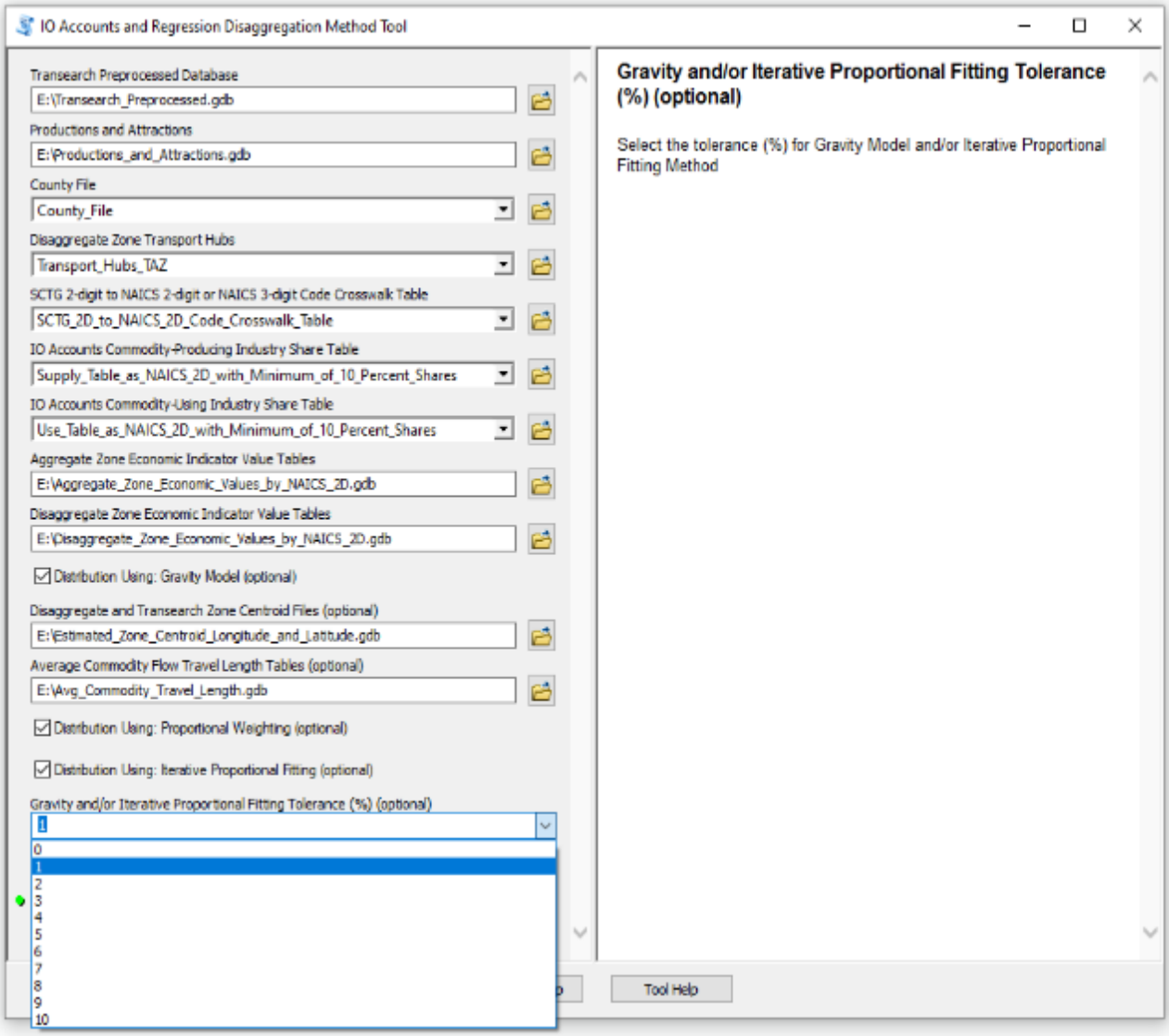


Figure A-93 Select the Tolerance (%) if the Gravity Model and/or Iterative Proportional Fitting Method was Selected

STEP 15

Select the lower bound for the output freight flow tonnage in tools input parameter **Freight Flow Tonnage Lower Bound** (see Figure A-94).

Purpose: Reduction of number instances with low values

(Default: 0.1)

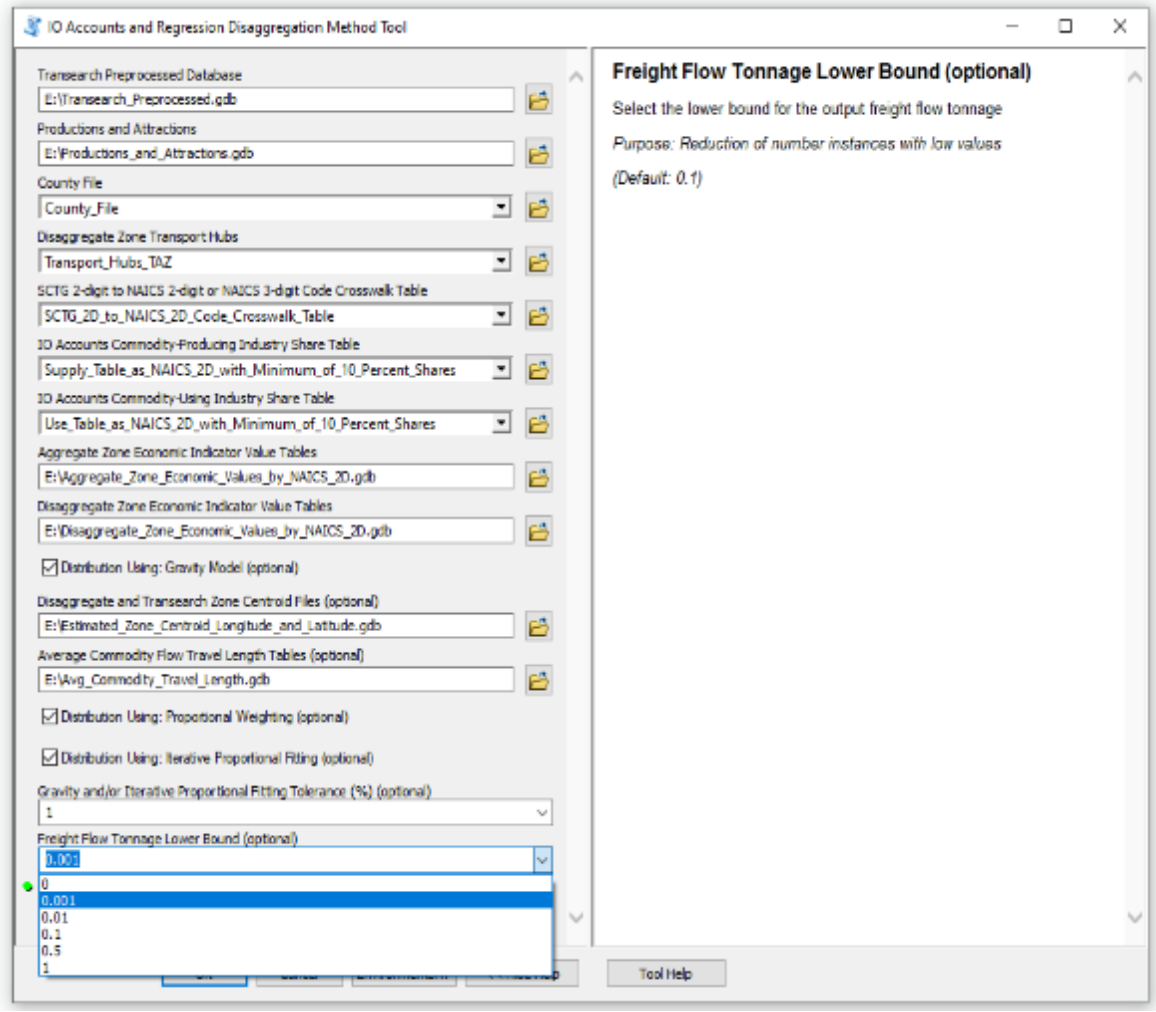


Figure A-94 Select the Freight Flow Tonnage Lower Bound

STEP 16

Select the output folder in the tools input parameter **Output Folder**, where the disaggregated freight flow data will be outputted (see Figure A-95).

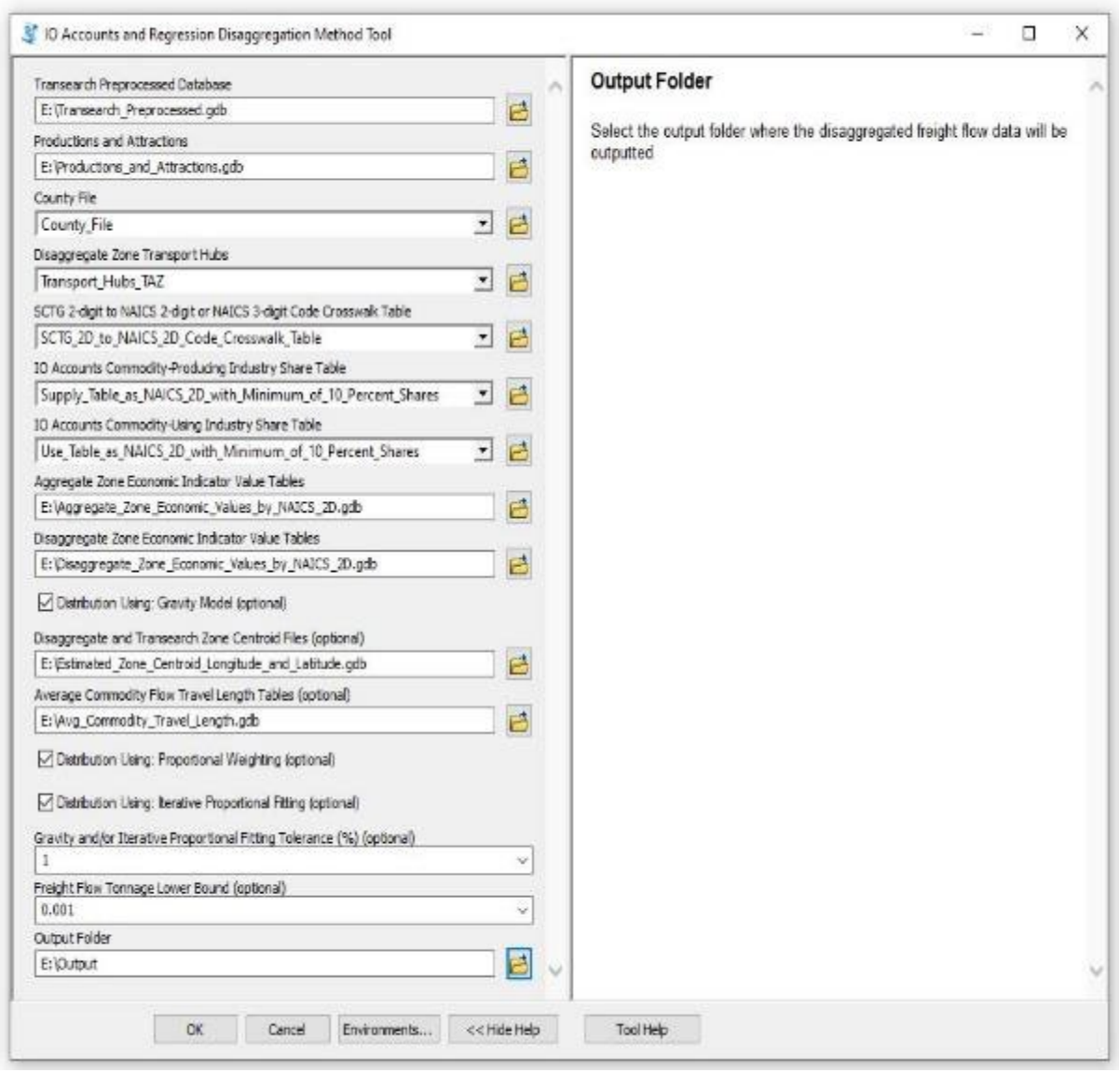


Figure A-95 Select the Output Folder

STEP 17

Once all required parameters are inputted, press OK to execute the application. The ArcGIS application invokes a task completion window, which reports the status of each task (see Figure A-96). Disaggregated freight flow data attribute Table using Gravity Model (see Figure A-97), Iterative Proportional Fitting (IPF) (see Figure A-98), and Proportional Weighting (see Figure A-99) will be outputted in the selected output folder.

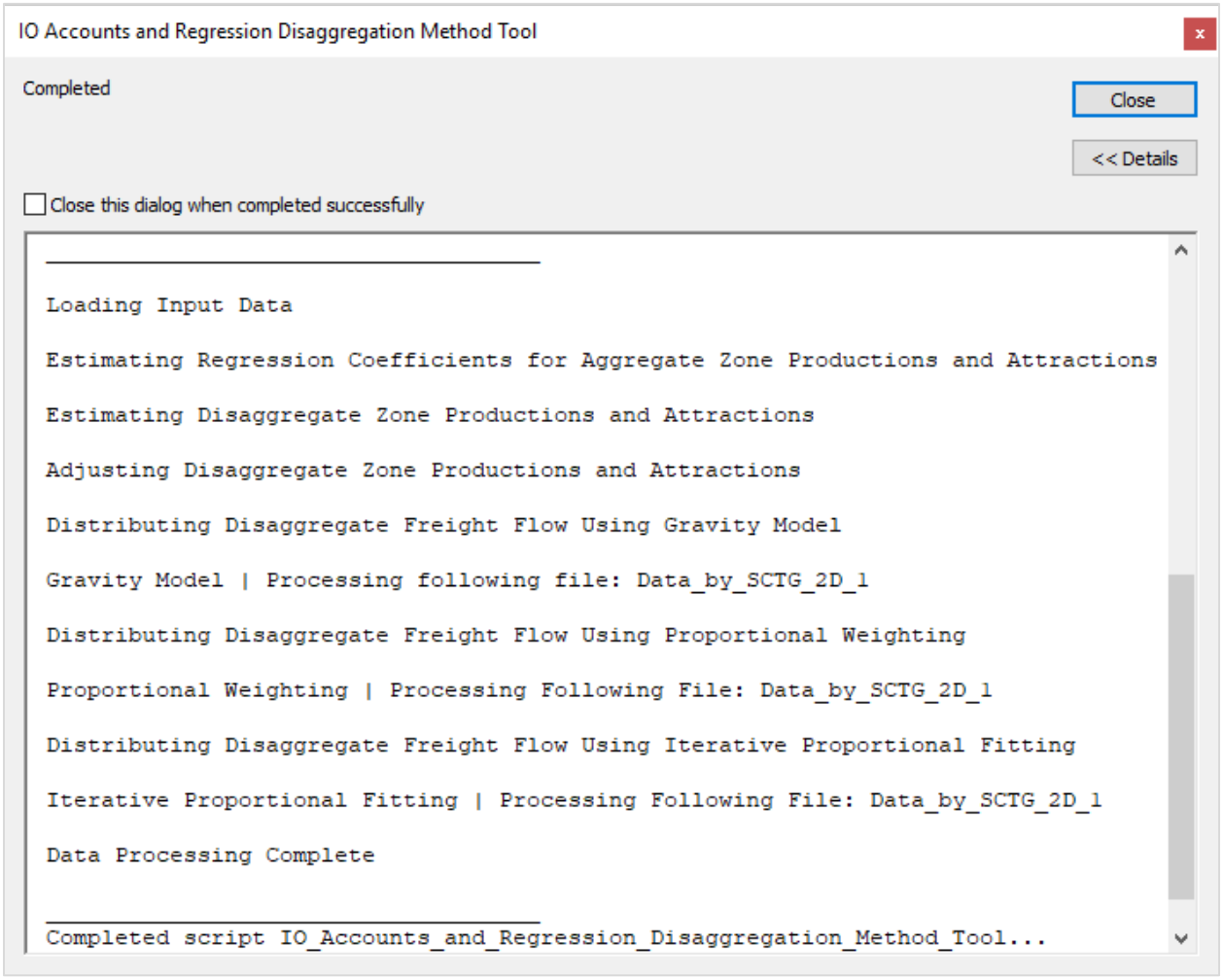
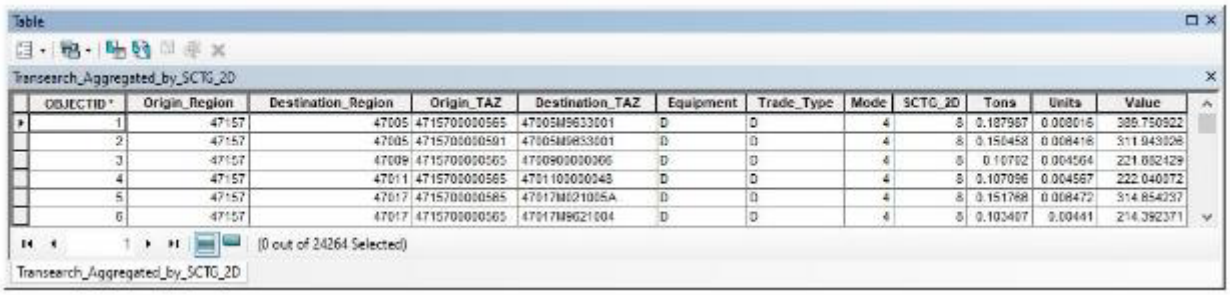


Figure A-96 IO Accounts and Regression Disaggregation Method Tool Performance Task Window



Table

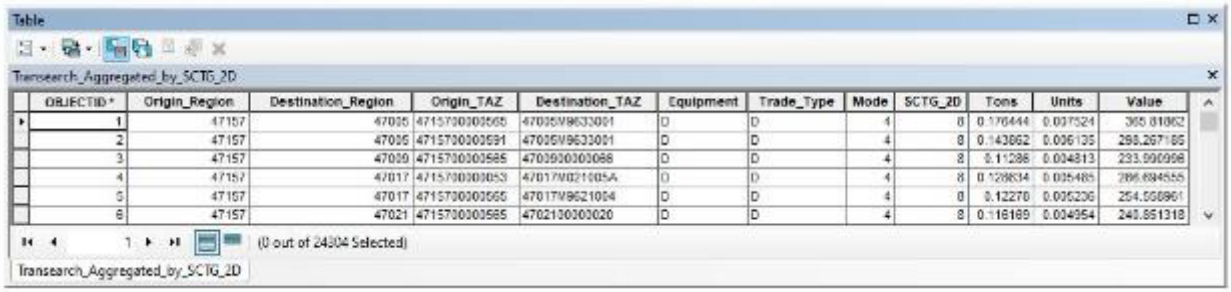
Transearch_Aggregated_by_SCTG_2D

OBJECTID *	Origin_Region	Destination_Region	Origin_TAZ	Destination_TAZ	Equipment	Trade_Type	Mode	SCTG_2D	Tons	Units	Value
1	47157	47005	4715700000565	47005M9633001	D	D	4	8	0.187987	0.008016	389.750922
2	47157	47005	4715700000591	47005M9633001	D	D	4	8	0.150458	0.006416	311.943028
3	47157	47009	4715700000565	4700900000066	D	D	4	8	0.10702	0.004564	221.882429
4	47157	47011	4715700000565	4701100000048	D	D	4	8	0.107096	0.004567	222.040072
5	47157	47017	4715700000565	47017M021005A	D	D	4	8	0.151768	0.006472	314.654297
6	47157	47017	4715700000565	47017M921004	D	D	4	8	0.103407	0.00441	214.392371

(0 out of 24264 Selected)

Transearch_Aggregated_by_SCTG_2D

Figure A-97 Disaggregated Freight Flow Data Using IO Accounts, Regression, and Gravity Model



Table

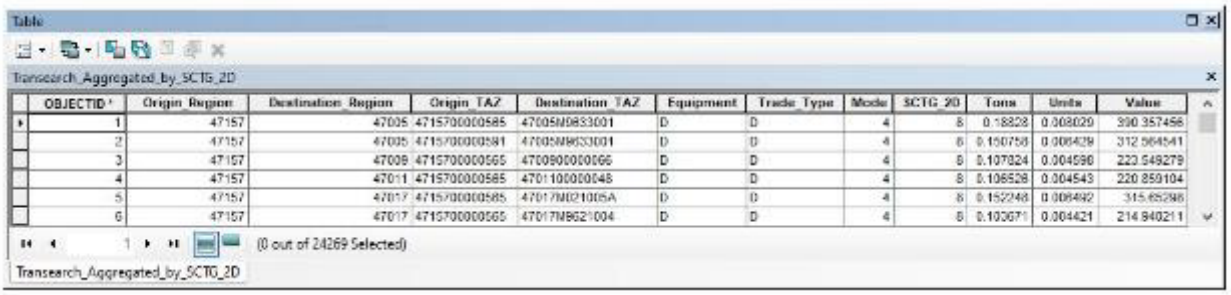
Transearch_Aggregated_by_SCTG_2D

OBJECTID *	Origin_Region	Destination_Region	Origin_TAZ	Destination_TAZ	Equipment	Trade_Type	Mode	SCTG_2D	Tons	Units	Value
1	47157	47005	4715700000565	47005M9633001	D	D	4	8	0.176444	0.007524	365.81862
2	47157	47005	4715700000591	47005M9633001	D	D	4	8	0.143662	0.006125	298.267186
3	47157	47009	4715700000565	4700900000066	D	D	4	8	0.11286	0.004813	233.990998
4	47157	47017	4715700000565	47017M021005A	D	D	4	8	0.128614	0.005485	266.694555
5	47157	47017	4715700000565	47017M9621004	D	D	4	8	0.12276	0.005236	254.566961
6	47157	47021	4715700000565	4702100000020	D	D	4	8	0.116189	0.004954	240.861318

(0 out of 24304 Selected)

Transearch_Aggregated_by_SCTG_2D

Figure A-98 Disaggregated Freight Flow Data Using IO Accounts, Regression, and Iterative Proportional Fitting (IPF)



Table

Transearch_Aggregated_by_SCTG_2D

OBJECTID *	Origin_Region	Destination_Region	Origin_TAZ	Destination_TAZ	Equipment	Trade_Type	Mode	SCTG_2D	Tons	Units	Value
1	47157	47005	4715700000565	47005M9633001	D	D	4	8	0.18828	0.008029	390.357466
2	47157	47005	4715700000581	47005M9633001	D	D	4	8	0.150756	0.006429	312.564541
3	47157	47009	4715700000565	4700900000066	D	D	4	8	0.107024	0.004566	221.849279
4	47157	47011	4715700000565	4701100000048	D	D	4	8	0.106528	0.004543	220.859104
5	47157	47017	4715700000565	47017M021005A	D	D	4	8	0.152248	0.006492	315.65298
6	47157	47017	4715700000565	47017M921004	D	D	4	8	0.103671	0.004421	214.940211

(0 out of 24269 Selected)

Transearch_Aggregated_by_SCTG_2D

Figure A-99 Disaggregated Freight Flow Data Using IO Accounts, Regression, and Proportional Weighting

A.8 PA Estimation OD Selection Tool

Description

The following tool provides the capabilities to output specific disaggregate OD flow and estimate productions and attractions. The specific OD flow can be selected by unique SCTG code, Mode or Mode Group, Equipment, and Trade Type code. In addition, the tool provides the ability to select the freight flow by unique county or disaggregate zone. A schematic overview of PA Estimation OD Selection Tool inputs and outputs is shown in Figure A-100. The output from this tool is used as input in: i) OD MAP Tool, and ii) PA MAP Tool.

Example Input Files

- **Processed_Disaggreagte_Data**

(Obtained from the outputs of the **IO Accounts and Regression Disaggregation Method Tool** and/or **IO Accounts and Proportional Weight Disaggregation Method Tool**)

- **Spatial_Database.gdb/County_File** (see Figure A-5)

- **Spatial_Database.gdb/Disaggregate_Zone_File** (see Figure A-22)

PA Estimation OD Selection Tool Inputs and Outputs

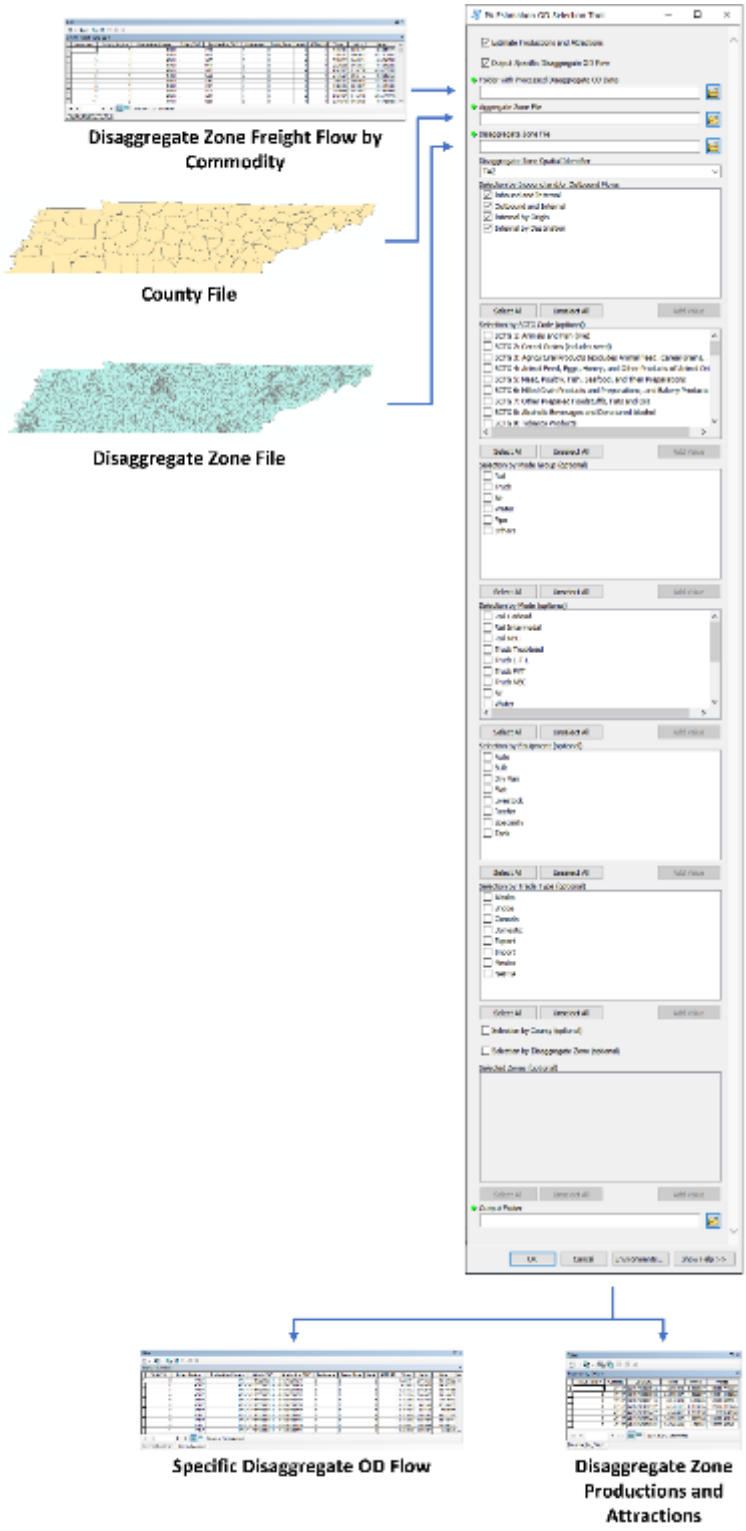


Figure A-100 PA Estimation OD Selection Tool Inputs and Outputs

STEP 1

Open the newly added Freight Data Disaggregation Tool **toolbox, select the** Post-processing **tool group, and lunch** PA Estimation OD Selection Tool (see Figure A-101).

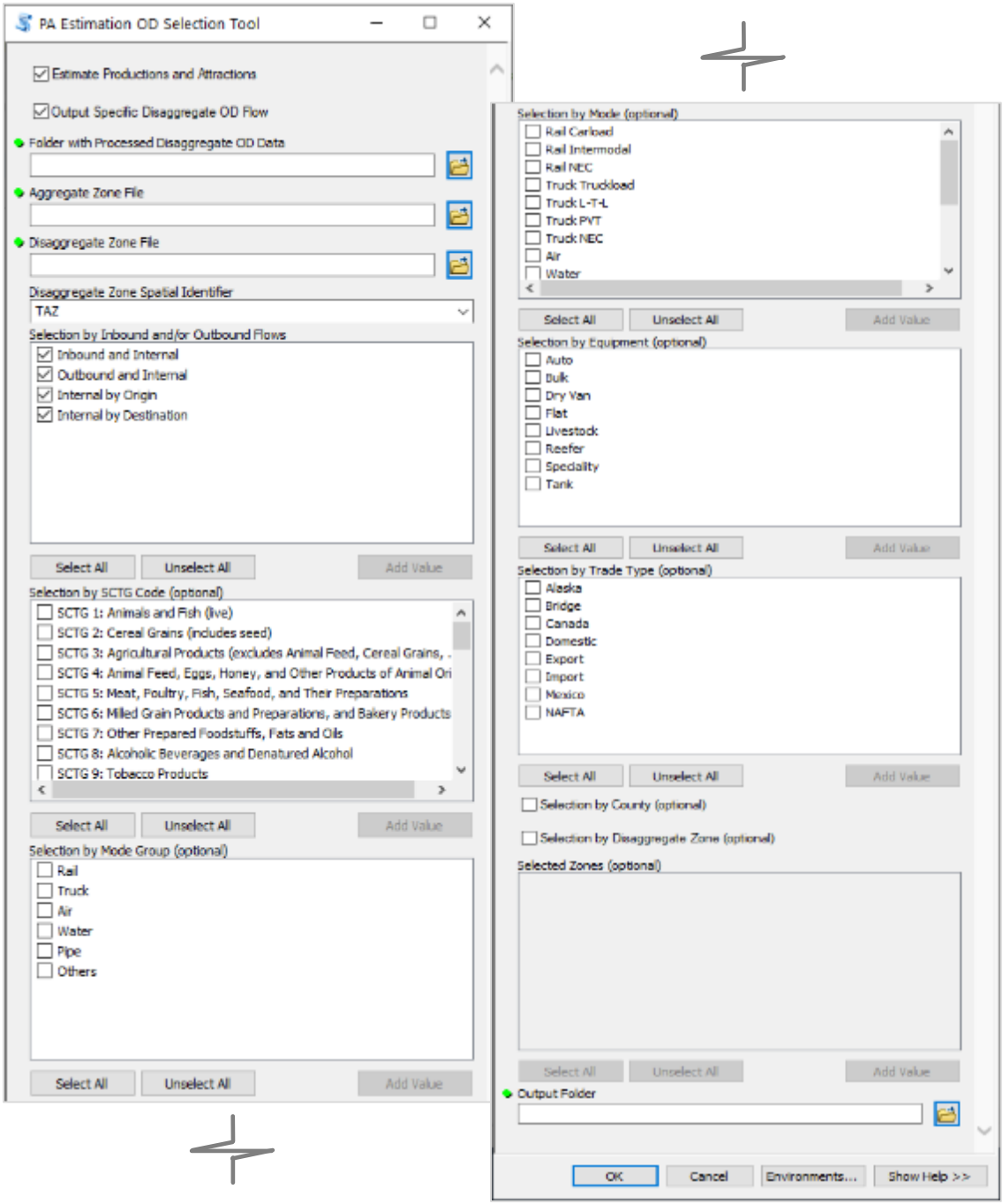


Figure A-101 PA Estimation OD Selection Tool

STEP 2

Select the **Estimate Productions and Attractions** if the user wishes to estimate productions and attractions for the specific disaggregate OD flow (see Figure A-102).

(Default: True)

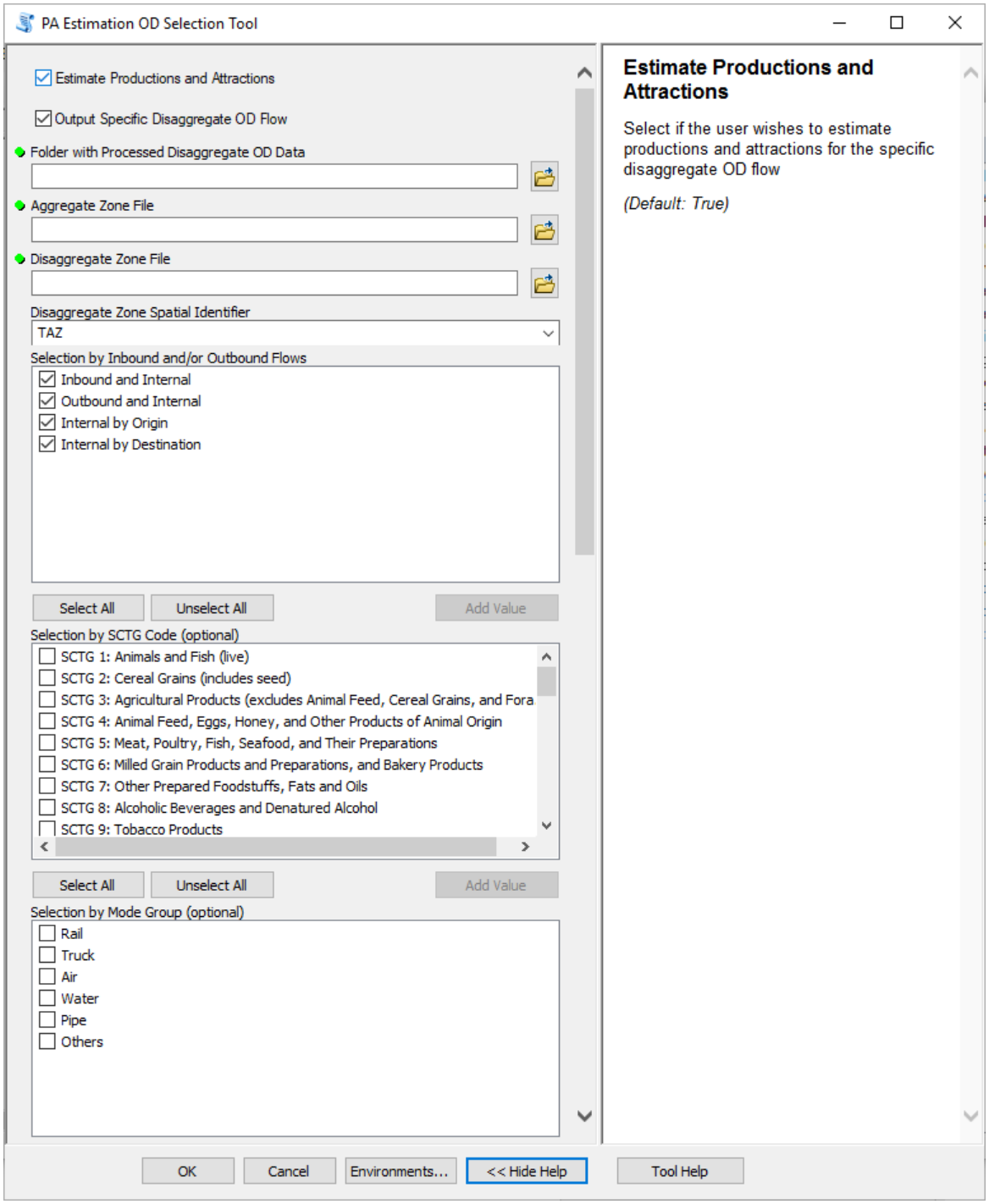


Figure A-102 Select the Estimate Productions and Attractions

STEP 3

Select the **Output Specific Disaggregate OD Flow** if the user wishes to output the specific disaggregate OD flow (see Figure A-103).

(Default: True)

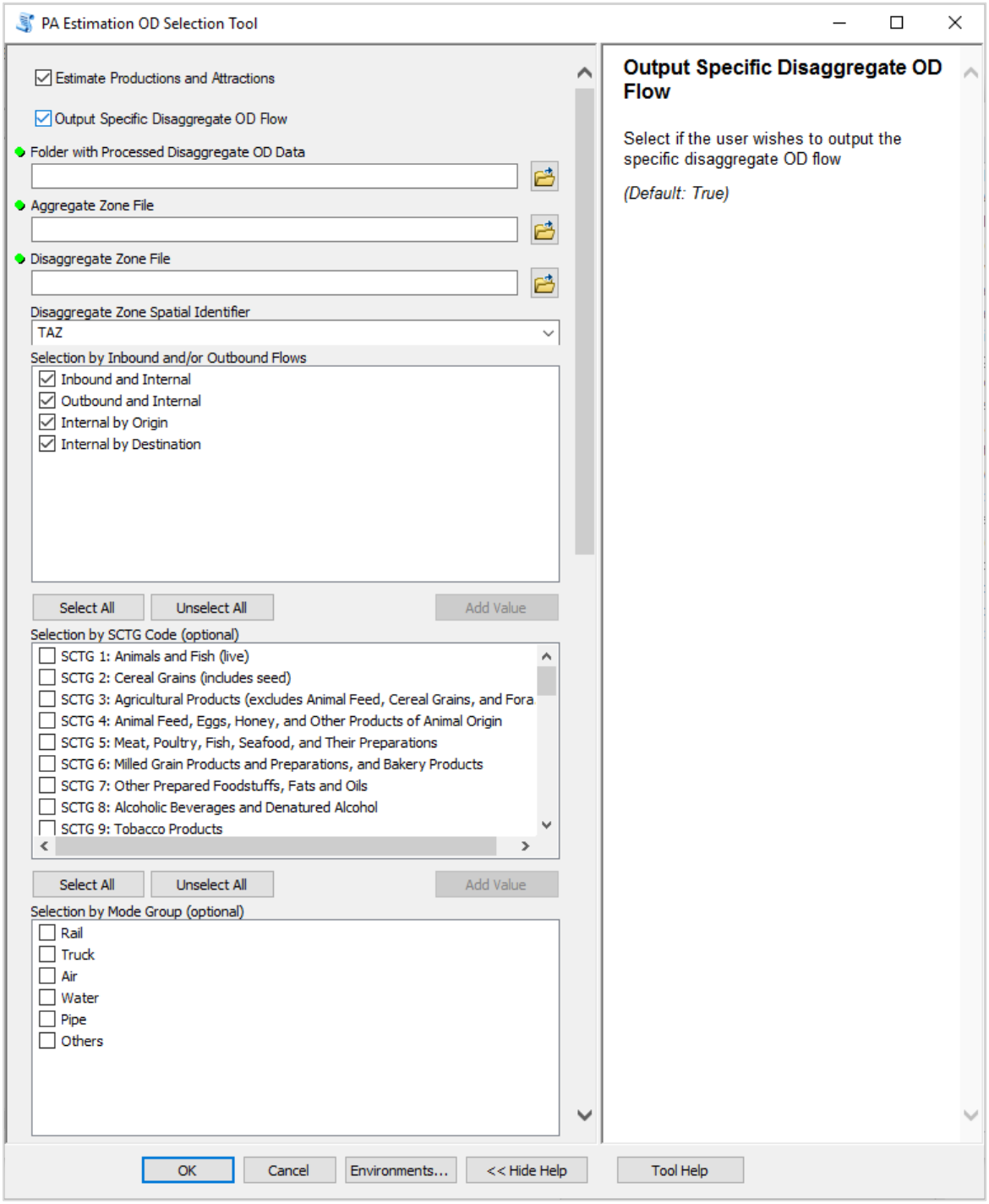


Figure A-103 Select the Output Specific Disaggregate OD Flow

STEP 4

Input path to the folder containing processed disaggregate OD data in the input parameter **Folder with Processed Disaggregate OD Data** (see Figure A-104).

*Input obtained from the outputs of the **IO Accounts and Regression Disaggregation Method Tool** and/or **IO Accounts and Proportional Weight Disaggregation Method Tool***

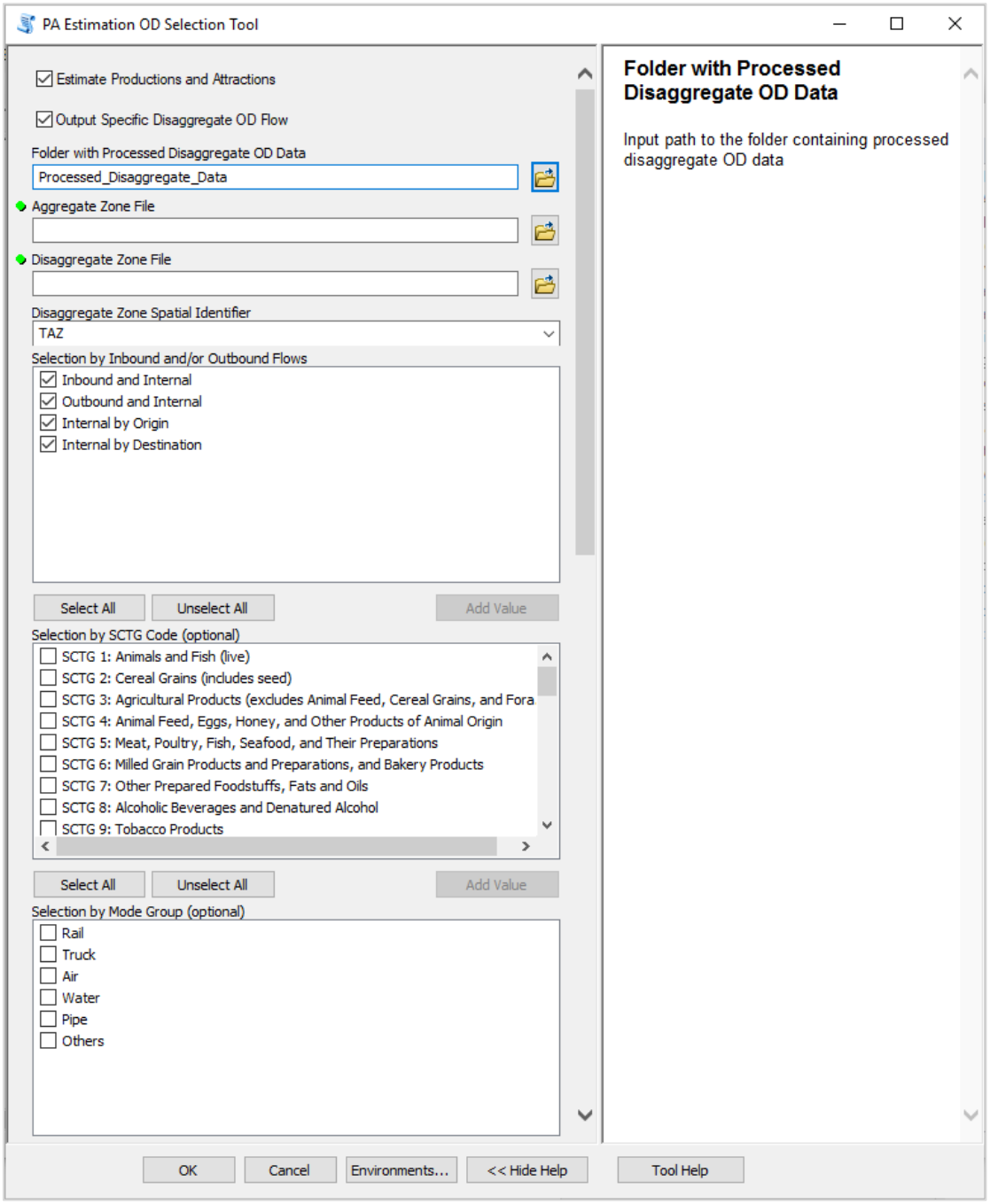


Figure A-104 Select Folder Containing Processed Disaggregate Data

STEP 5

Input path to the geographic file containing study area counties with geographic entity codes (GEOIDs) in tools input parameter **Aggregate Zone File** (see Figure A-105).

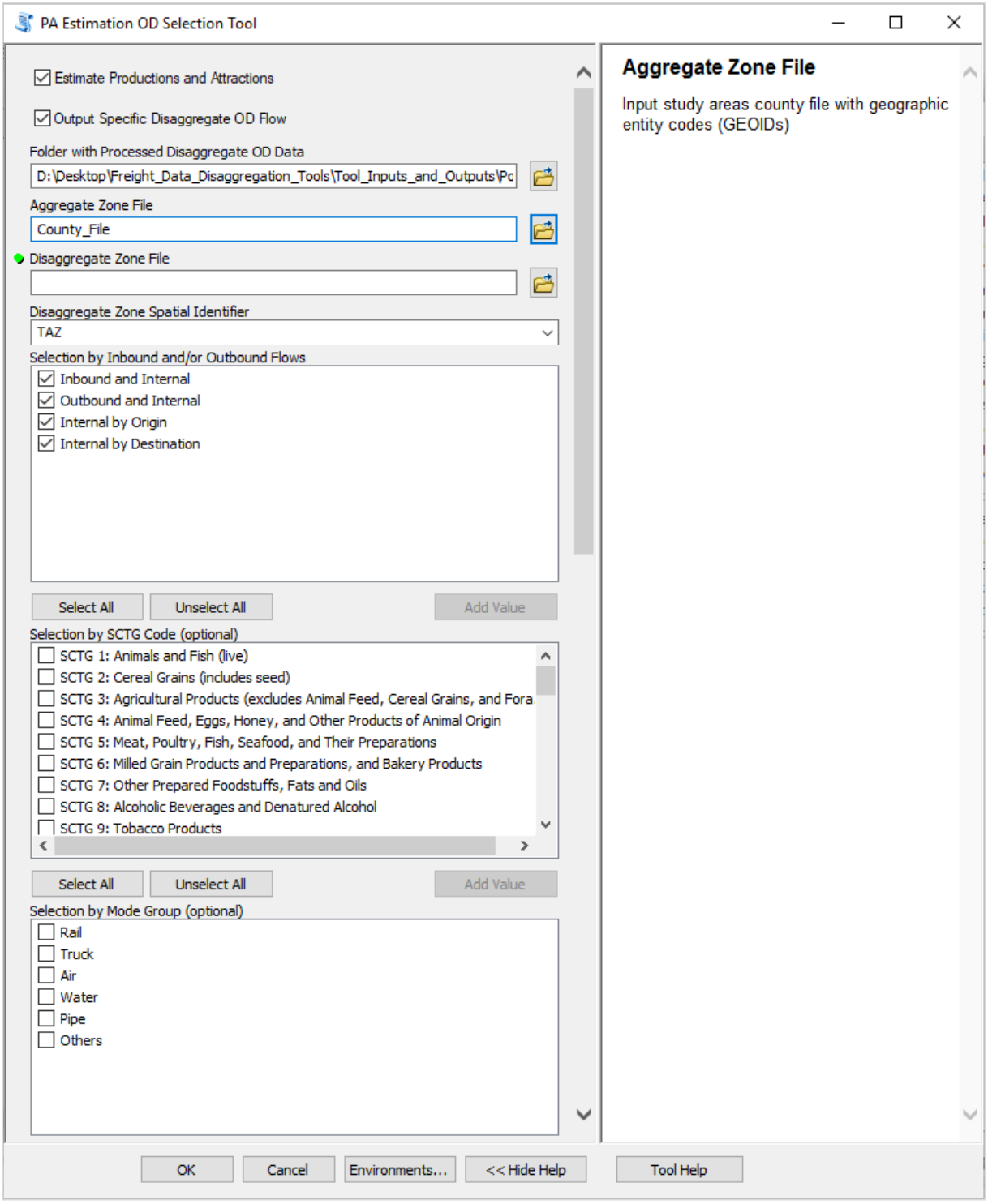


Figure A-105 Input Study Area County File

Input path to the geographic file containing study area disaggregate zones with geographic entity codes (GEOIDs) in tools input parameter **Disaggregate Zone File** (see Figure A-106).

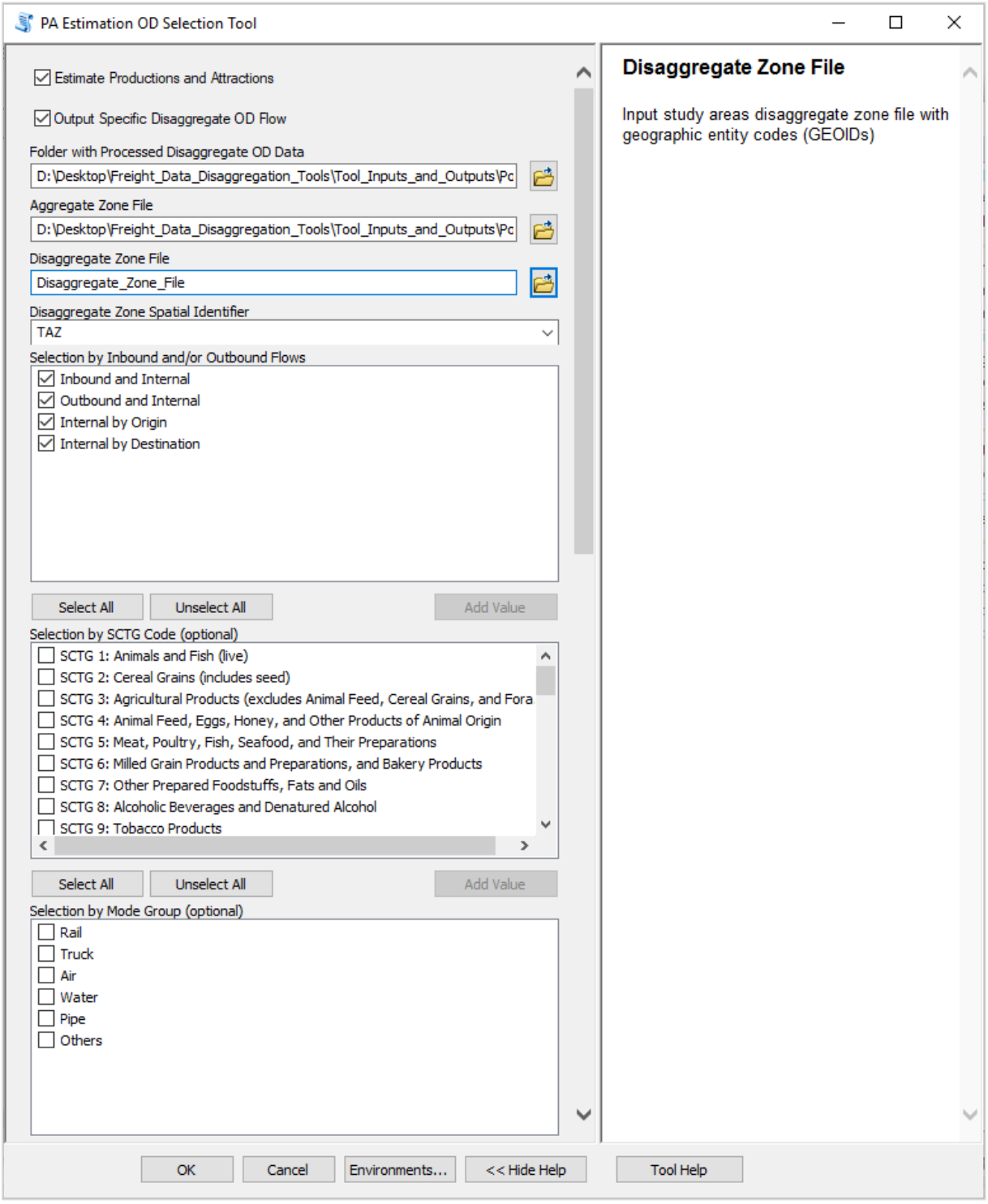


Figure A-106 Input Disaggregate Zone File

STEP 6

Select the type of disaggregate-level geographic zone in the tools input parameter **Disaggregate Zone Spatial Identifier** (see Figure A-107).

(Default: TAZ)

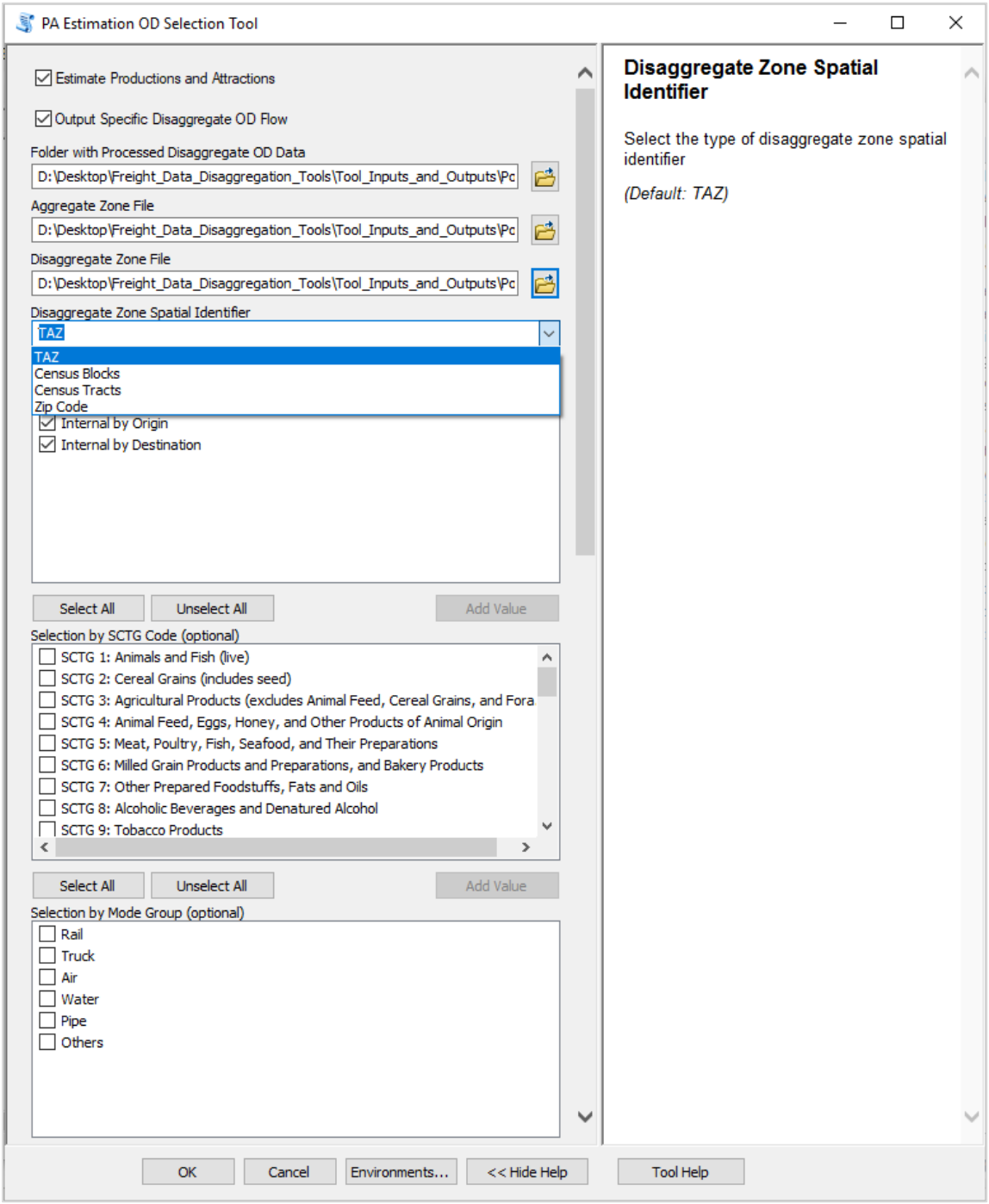


Figure A-107 Select Disaggregate Zone Spatial Identifier

STEP 7

Select by which inbound and outbound flow the disaggregated data will be outputted in the **Selection by Inbound and /or Outbound Flows** input parameter (see Figure A-108).

(Default: All)

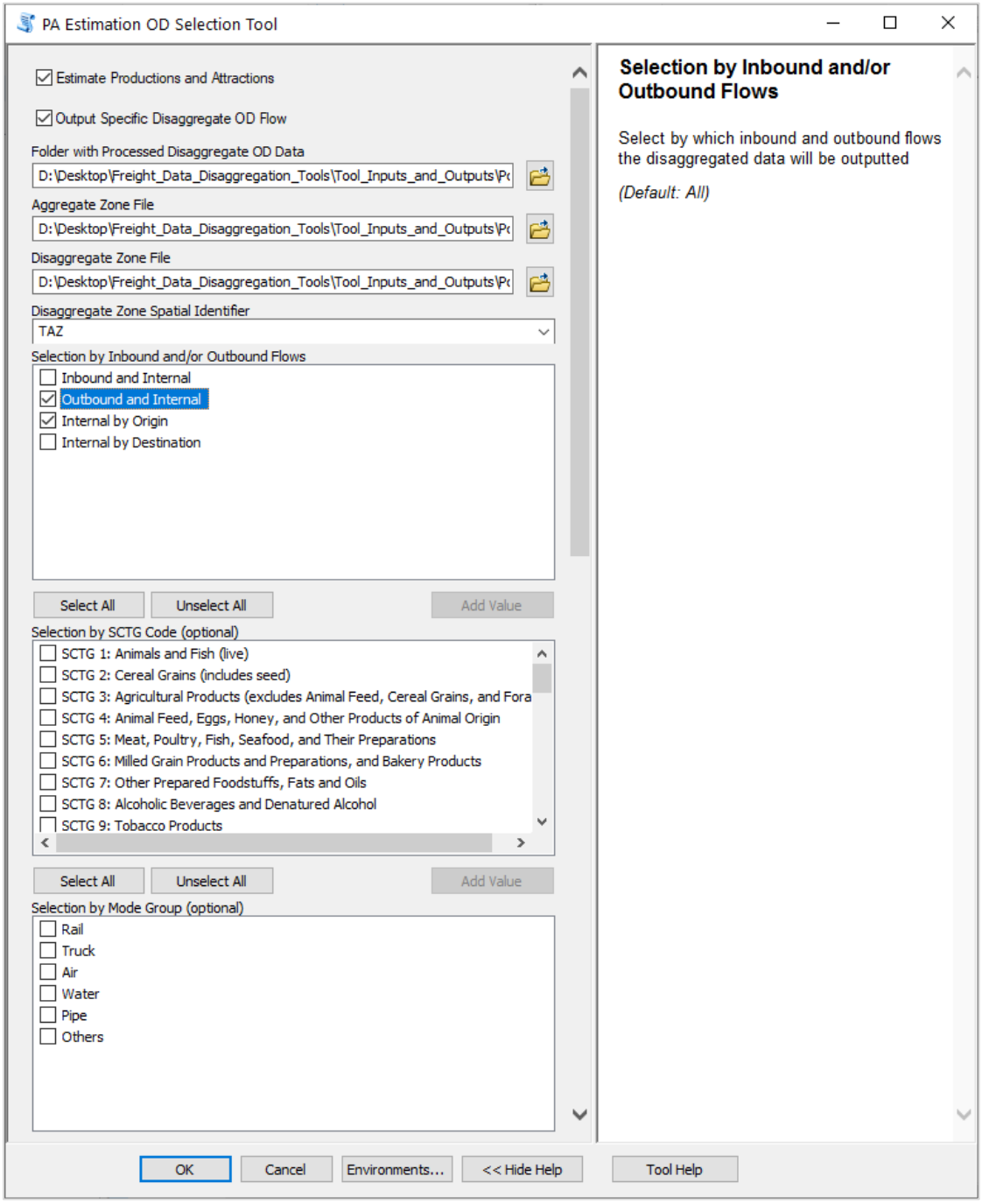


Figure A-108 Select Inbound and/or Outbound Flows

STEP 8

Select the option **Selection by SCTG Code** if the user wishes to output data by specific SCTG 2-digit code (see Figure A-109).

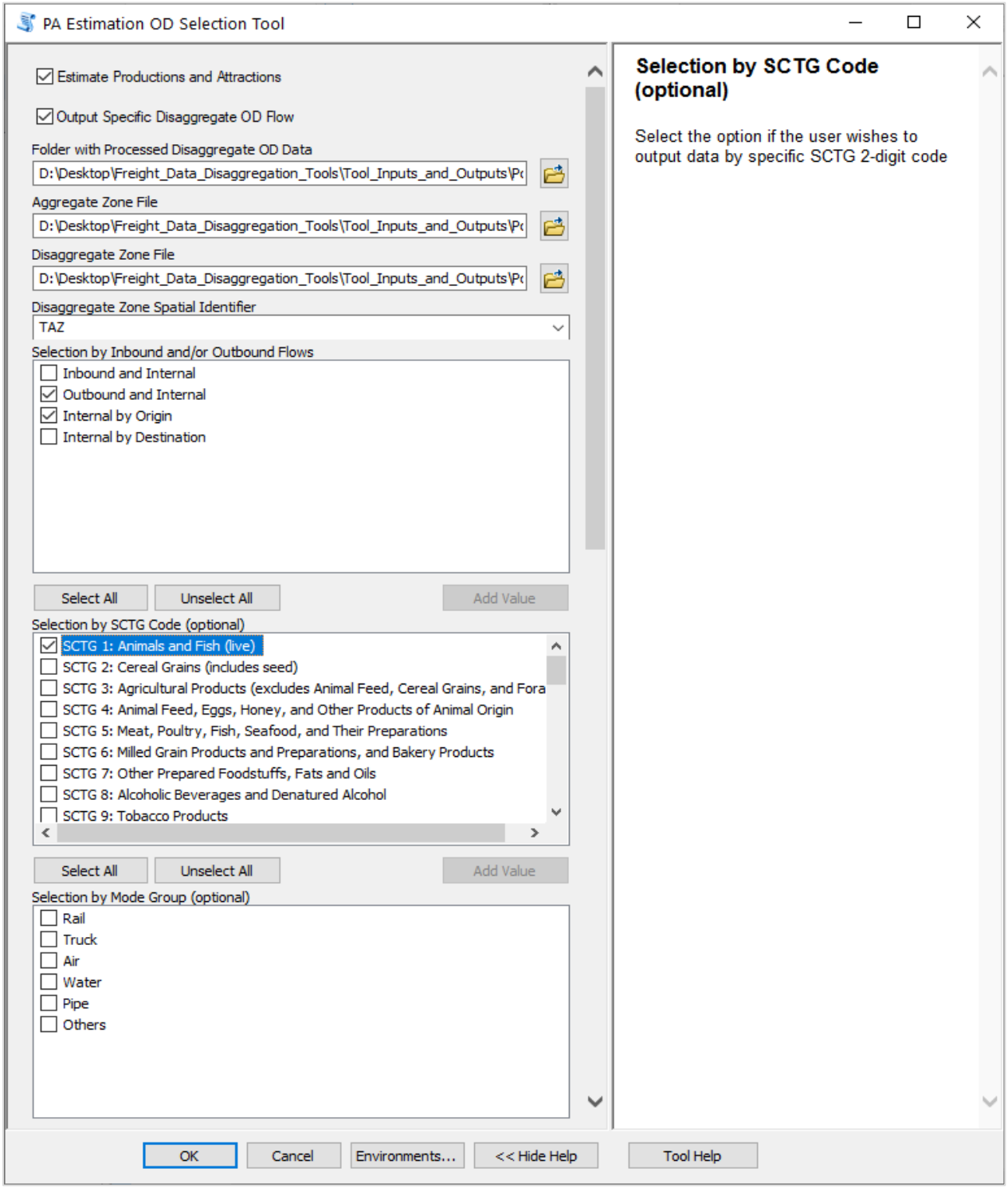


Figure A-109 Select Data by SCTG Code

STEP 9 (Option 1: Selection by Mode Group)

Select the option **Selection by Mode Group** if the user wishes to output data by a specific mode group (see Figure A-110).

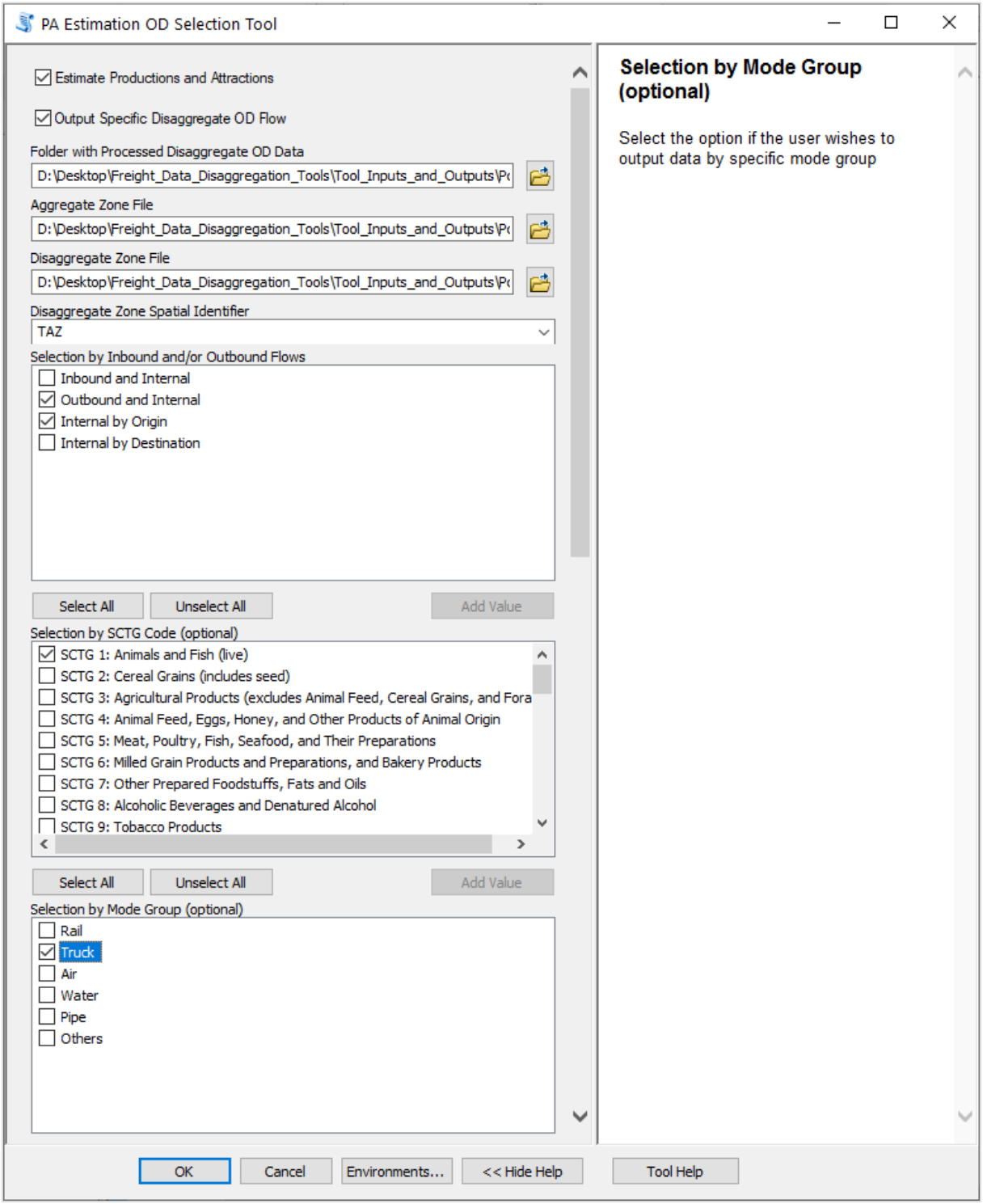


Figure A-110 Select Data by Mode Group

STEP 10 (Option 2: Selection by Mode)

Select the option **Selection by Mode** if the user wishes to output data by a specific mode (see Figure A-111).

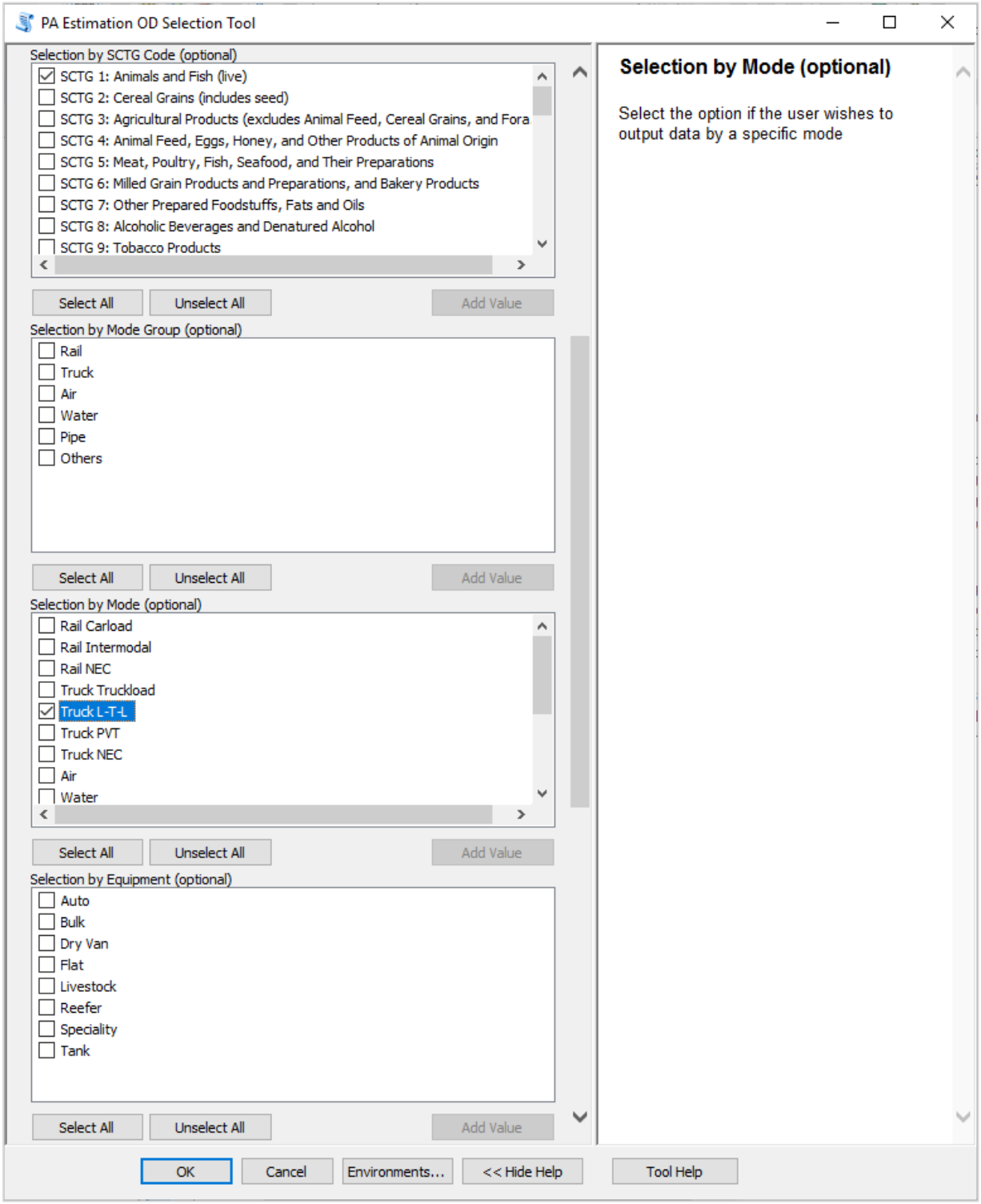


Figure A-111 Select Data by Mode

Select the option **Selection by Equipment** if the user wishes to output data by specific equipment (see Figure A-112).

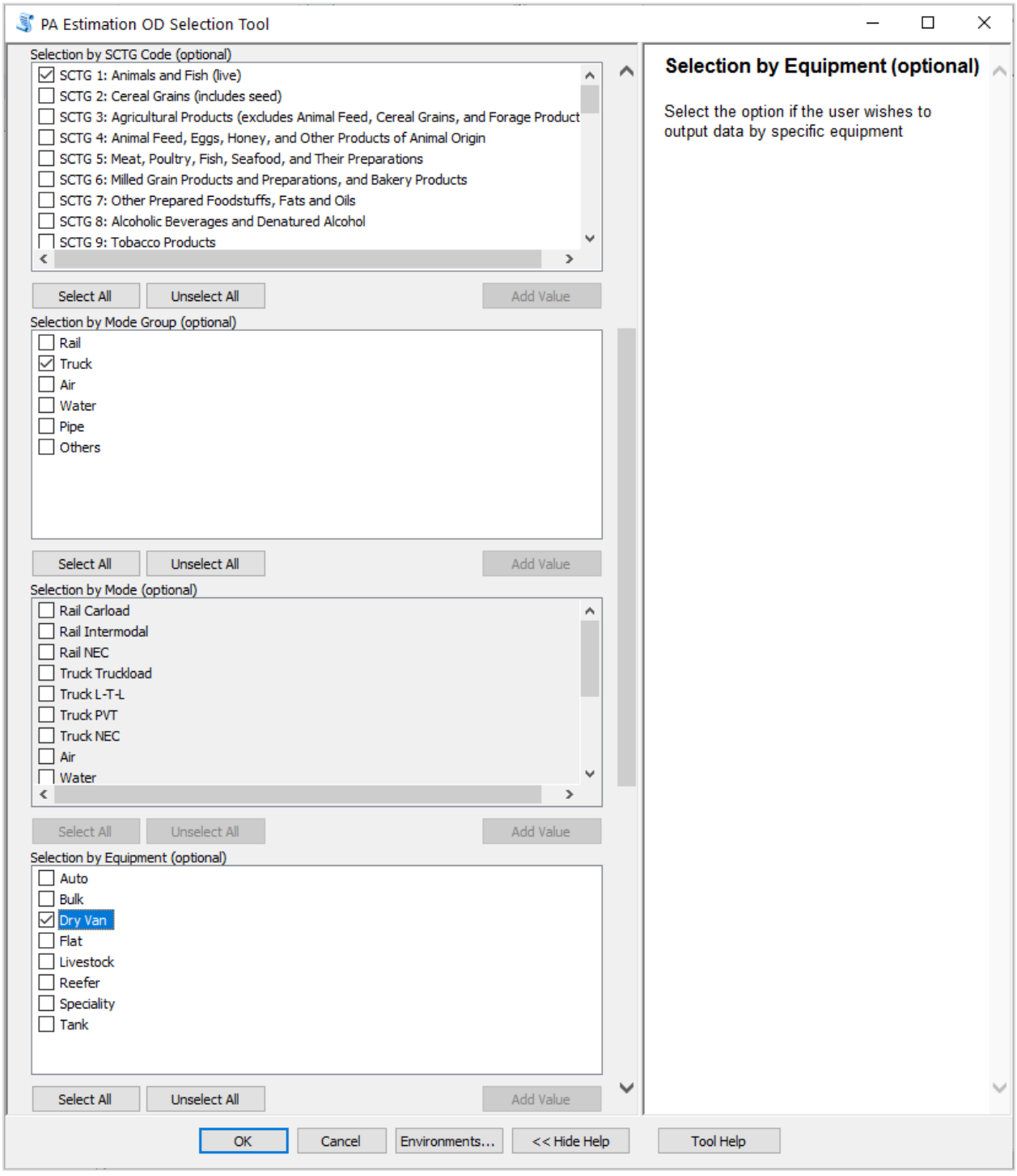


Figure A-112 Select Data by Equipment

STEP 11

Select the option **Selection by Trade Type** if the user wishes to output data by trade type (see Figure A-113).

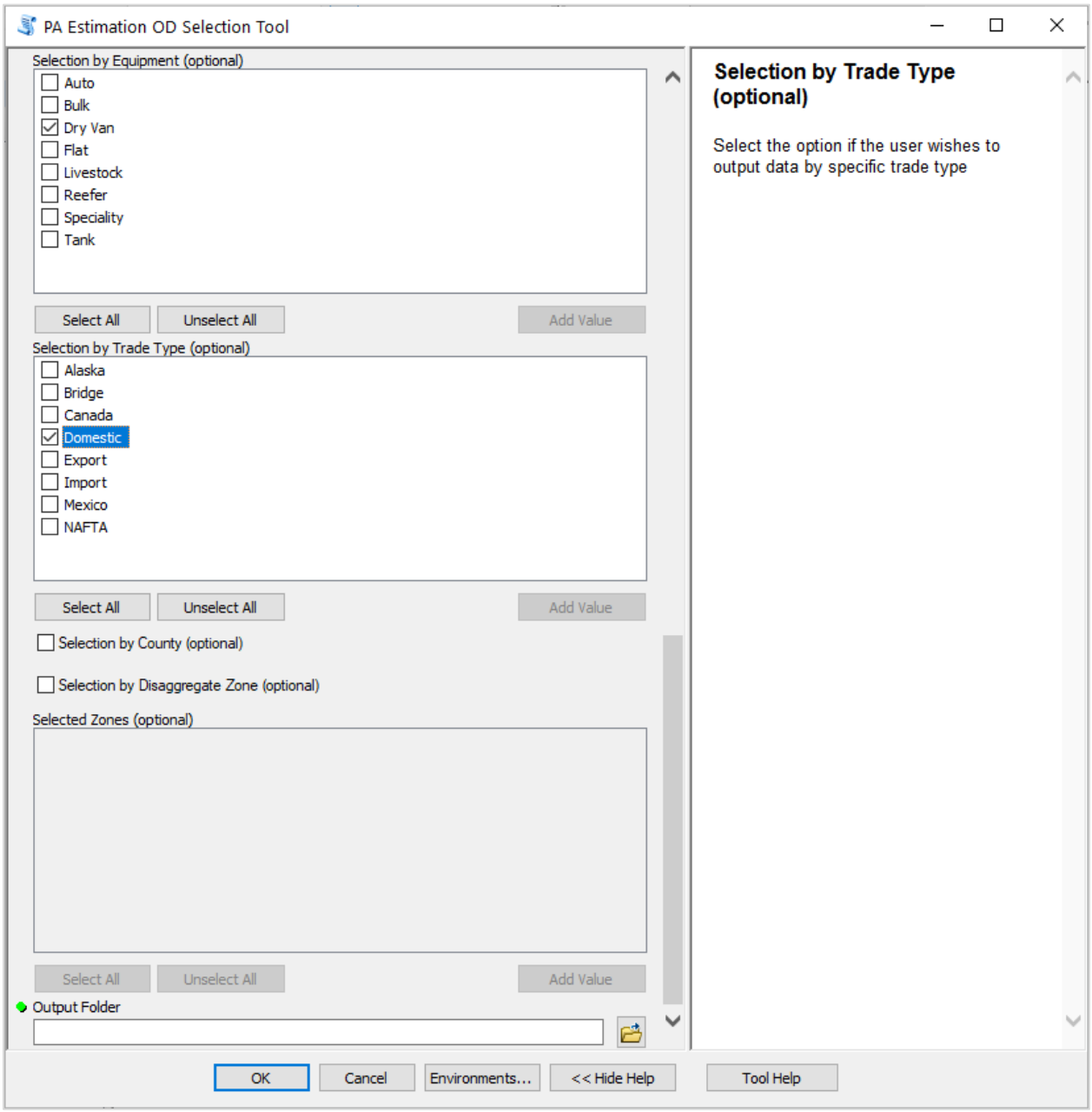


Figure A-113 Select Data by Trade Type

STEP 12 (Option 1: Selection by County)

Select the option **Selection by County** if the user wishes to output data by specific county (see Figure A-114).

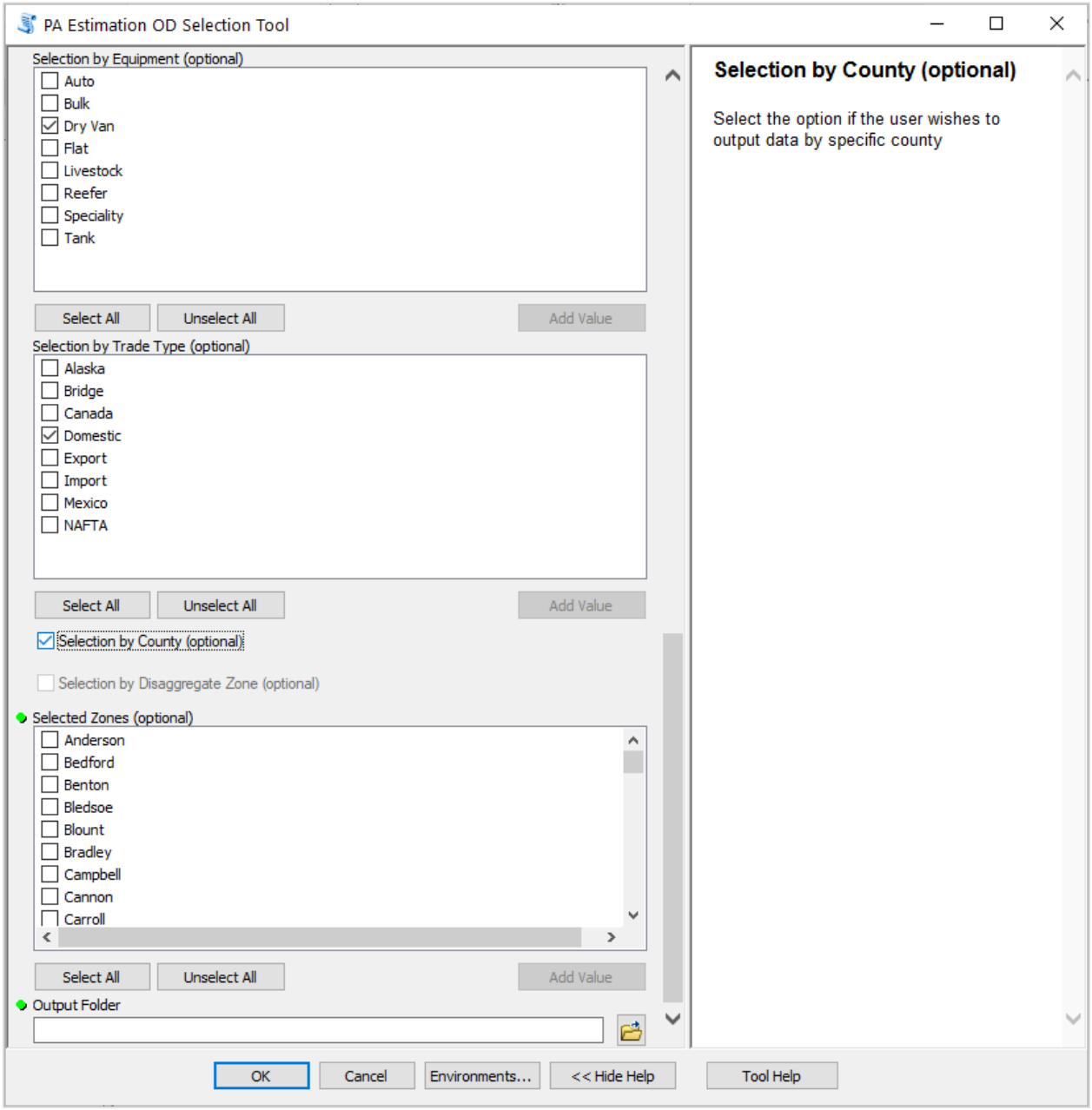


Figure A-114 Select Data by County

STEP 13 (Option 2: Selection by Disaggregate Zone)

Select the option **Selection by Disaggregate Zone** if the user wishes to output data by specific disaggregate zone (see Figure A-115).

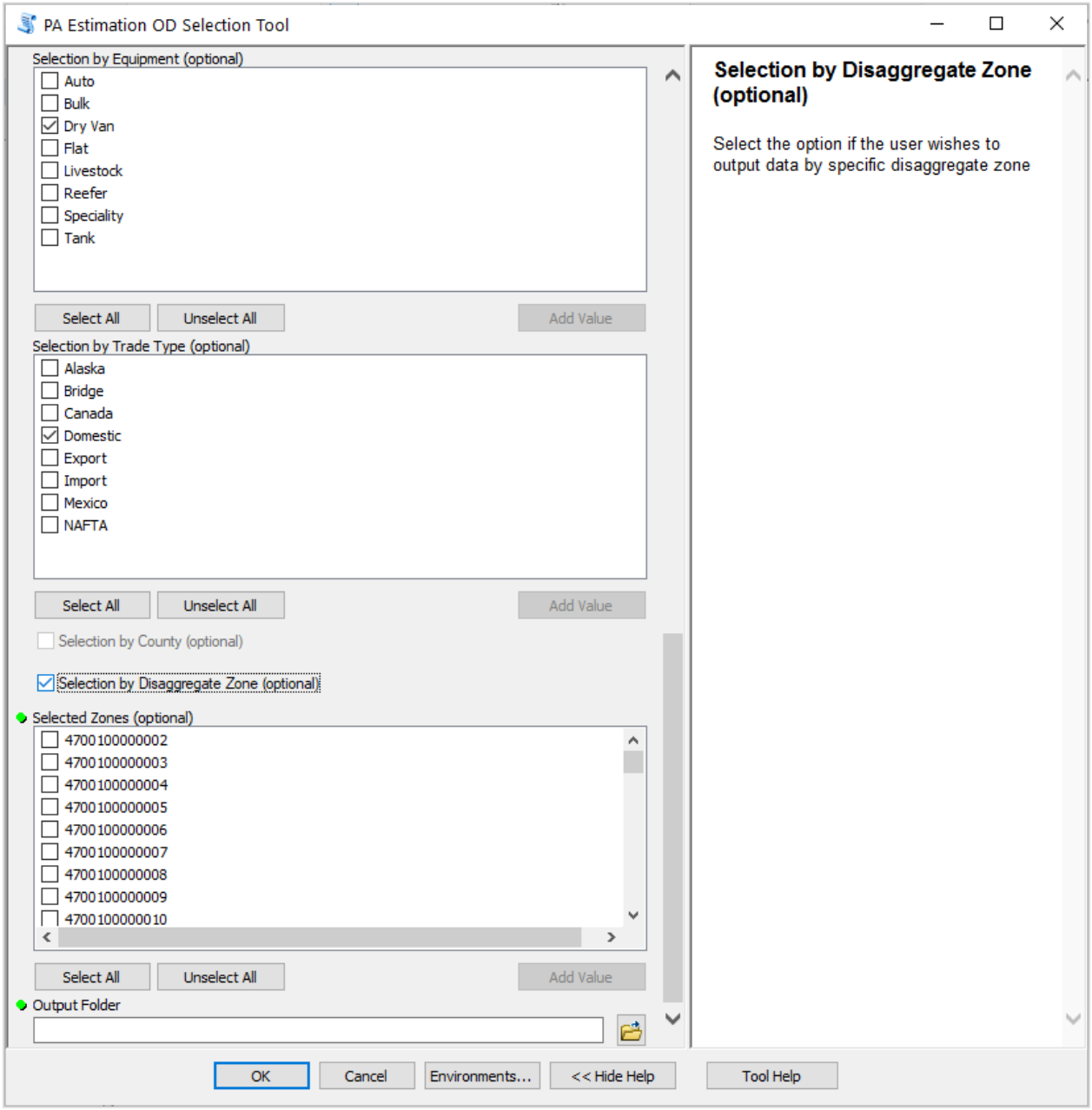


Figure A-115 Select Data by Disaggregate Zone

STEP 14

Select the zones by which the data will be outputted (per individual zone) in the input parameter **Selected Zones** (see Figure A-116).

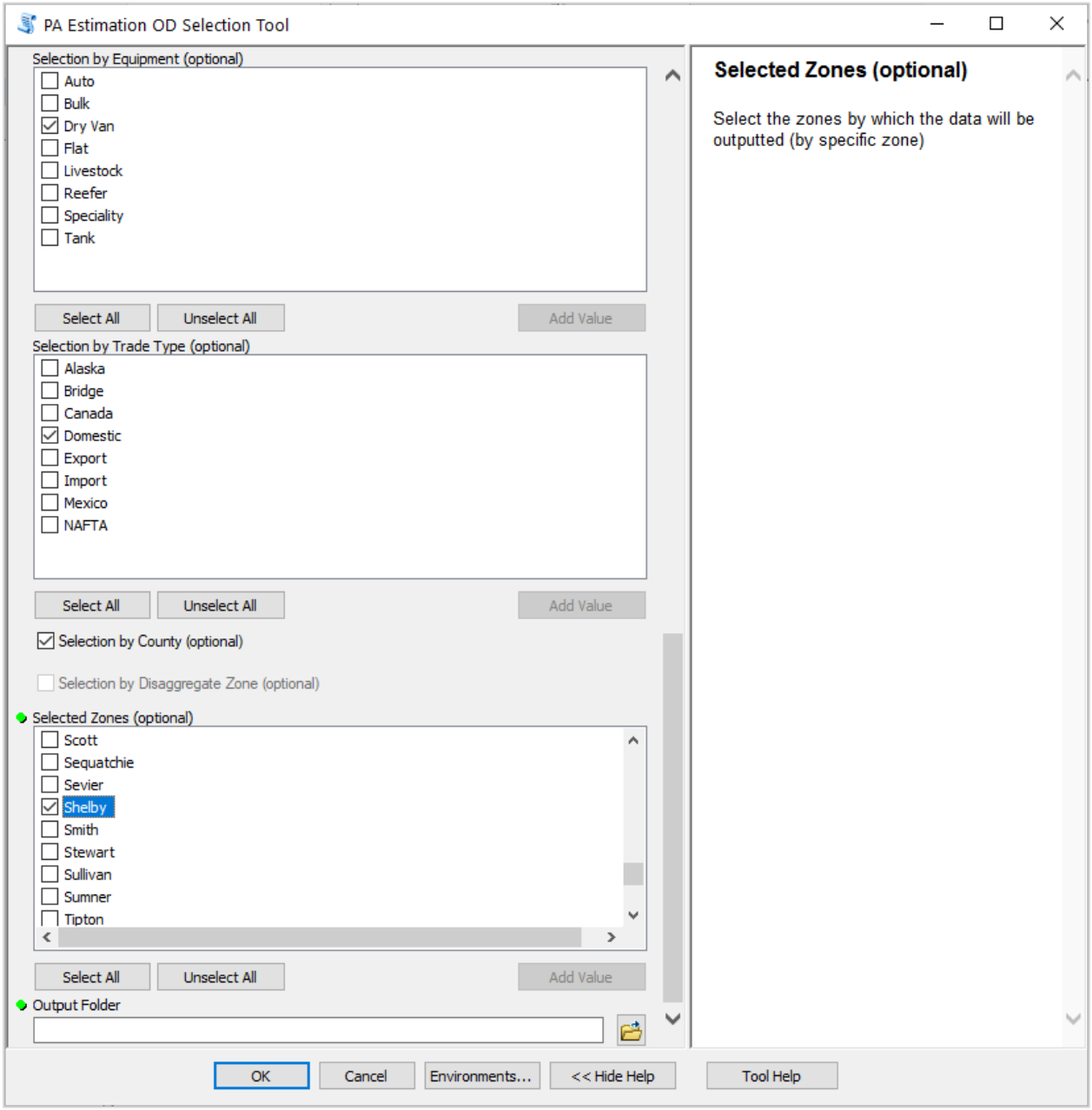


Figure A-116 Select the Zones

STEP 15

Select the output folder in the tools input parameter **Output Folder**, where the disaggregated freight flow data will be outputted (see Figure A-117).

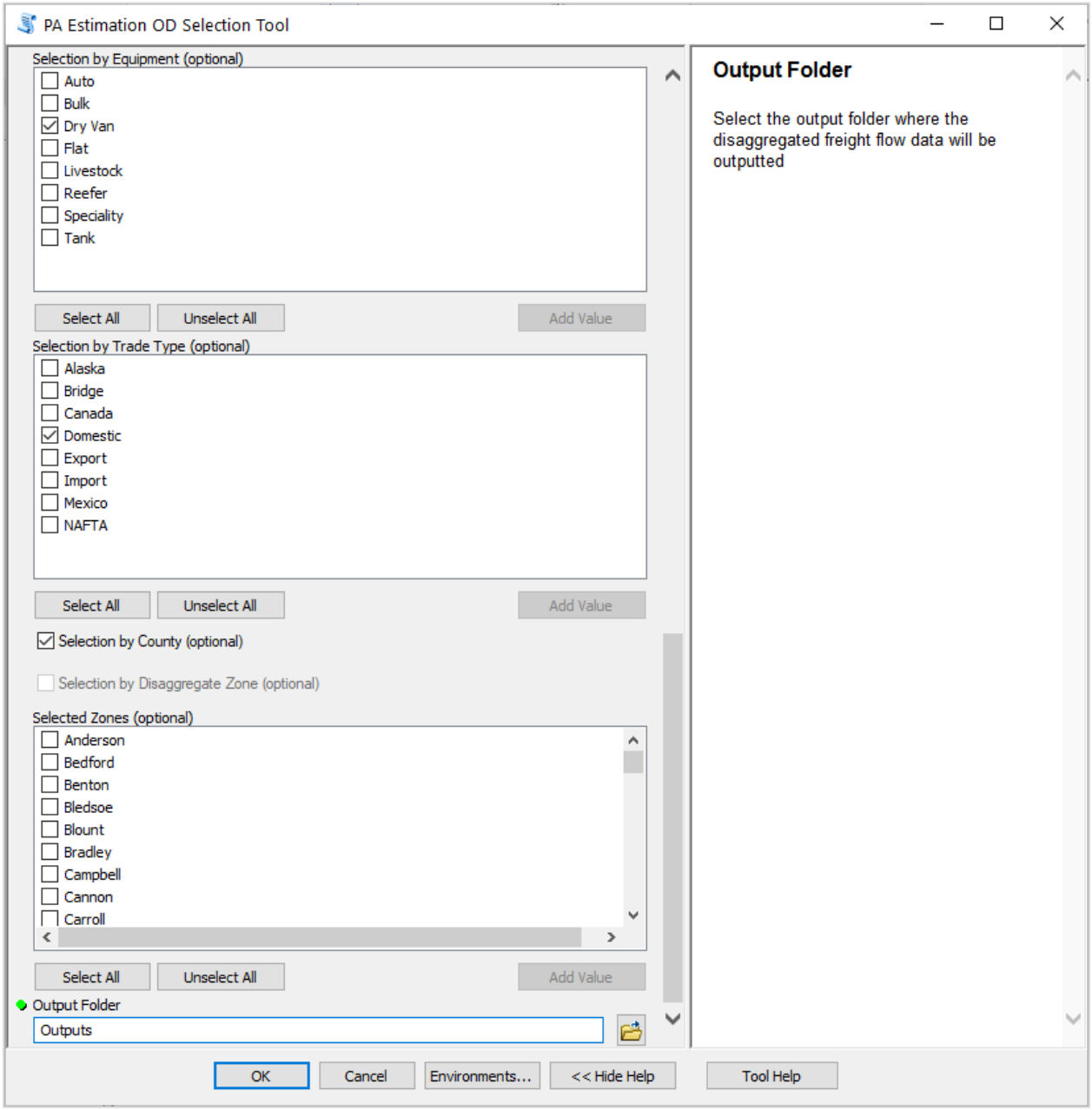


Figure A-117 Select the Output Folder

STEP 16

Once all required parameters are inputted, press OK to execute the application. The ArcGIS application invokes a task completion window, which reports the status of each task (see Figure A-118). For each disaggregation method, the specified disaggregate OD flow and estimated productions and attractions will be outputted. An example output of specified disaggregate OD flow and estimated attractions are presented in Figure A-119 and Figure A-120, respectively.

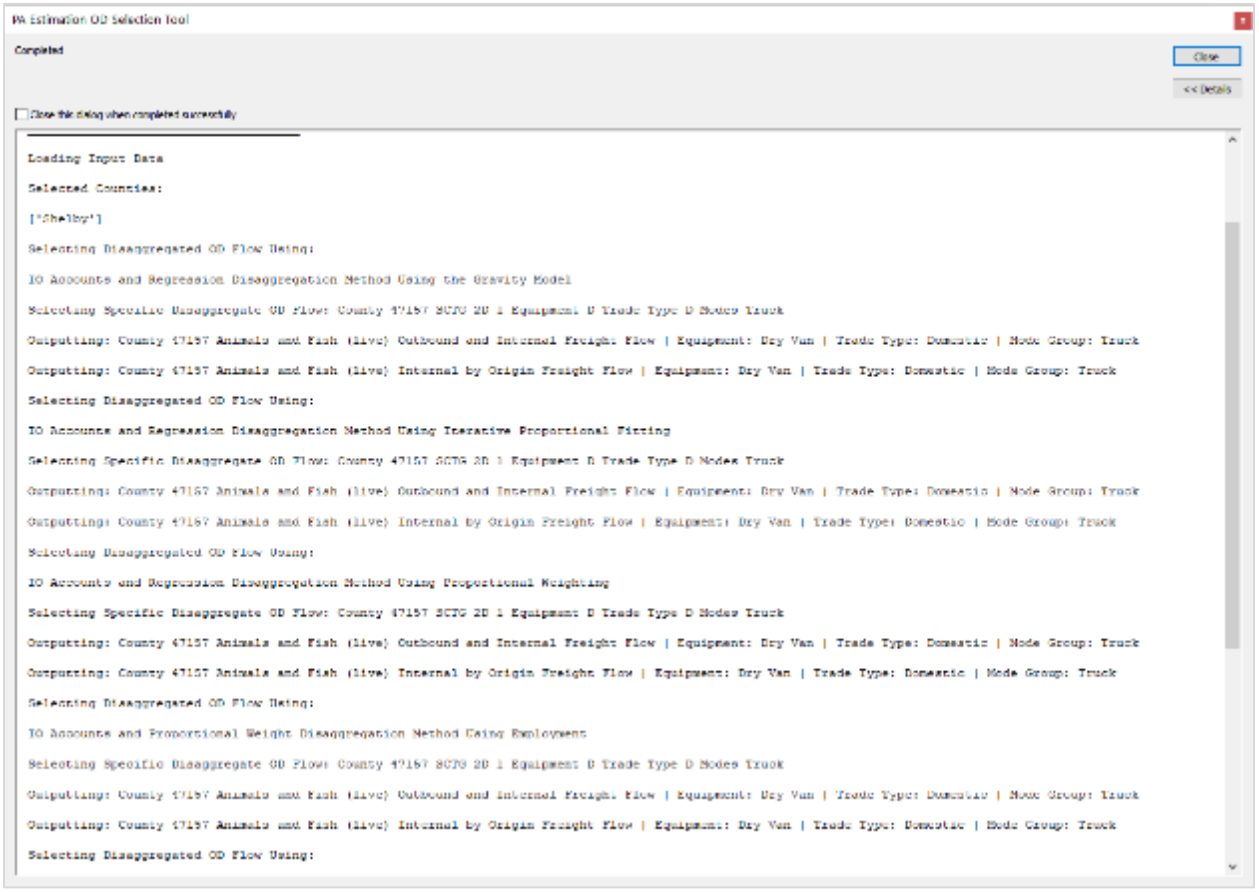
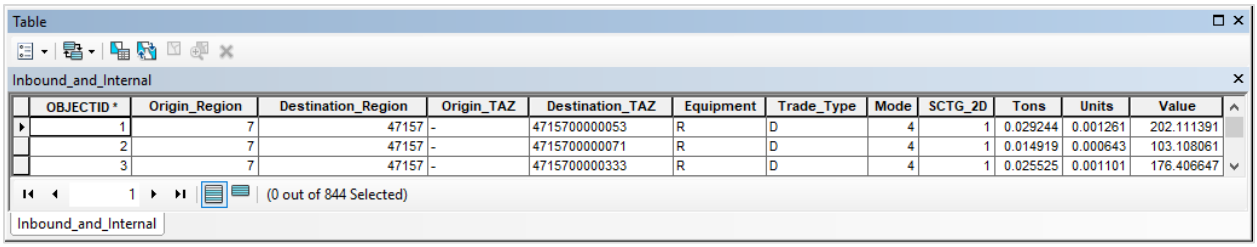


Figure A-118 PA Estimation and Selection Tool Performance Task Window



Table

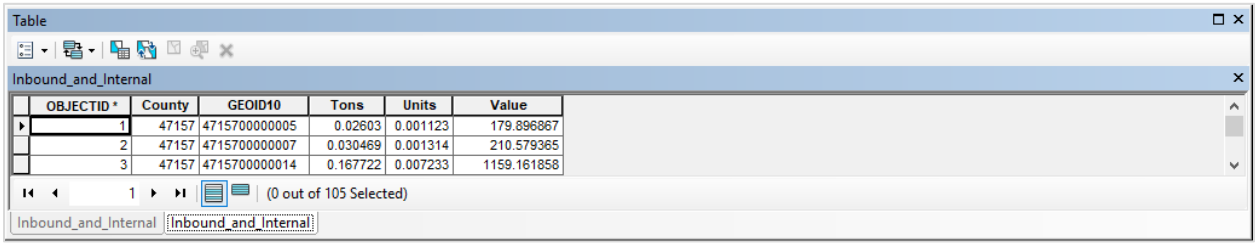
Inbound_and_Internal

OBJECTID *	Origin_Region	Destination_Region	Origin_TAZ	Destination_TAZ	Equipment	Trade_Type	Mode	SCTG_2D	Tons	Units	Value
1	7	47157	-	4715700000053	R	D	4	1	0.029244	0.001261	202.111391
2	7	47157	-	4715700000071	R	D	4	1	0.014919	0.000643	103.108061
3	7	47157	-	4715700000333	R	D	4	1	0.025525	0.001101	176.406647

1 (0 out of 844 Selected)

Inbound_and_Internal

Figure A-119 Example Table of Specified Disaggregate OD Flow



Table

Inbound_and_Internal

OBJECTID *	County	GEOID10	Tons	Units	Value
1	47157	4715700000005	0.02603	0.001123	179.896867
2	47157	4715700000007	0.030469	0.001314	210.579365
3	47157	4715700000014	0.167722	0.007233	1159.161858

1 (0 out of 105 Selected)

Inbound_and_Internal Inbound_and_Internal

Figure A-120 Example Table of Estimated Attractions of Specified Disaggregate OD Flow

A.9 PA MAP Tool

Description

The following tool provides the capability to visualize the disaggregate production and attraction flow by creating ArcMap Map Exchange Document (MXD) using the input template measured in Tons, Units, and Value. In addition, the tool provides the ability to export maps as PDF and JPG files. A schematic overview of PA MAP Tool inputs and outputs is shown in Figure A-122.

Example Input Files

- **Folder with Estimated Productions and Attractions**
(Obtained from the outputs of the **PA Estimation OD Selection Tool**)

- **Folder with Production and Attraction MXD Map Template** (see Figure A-121)

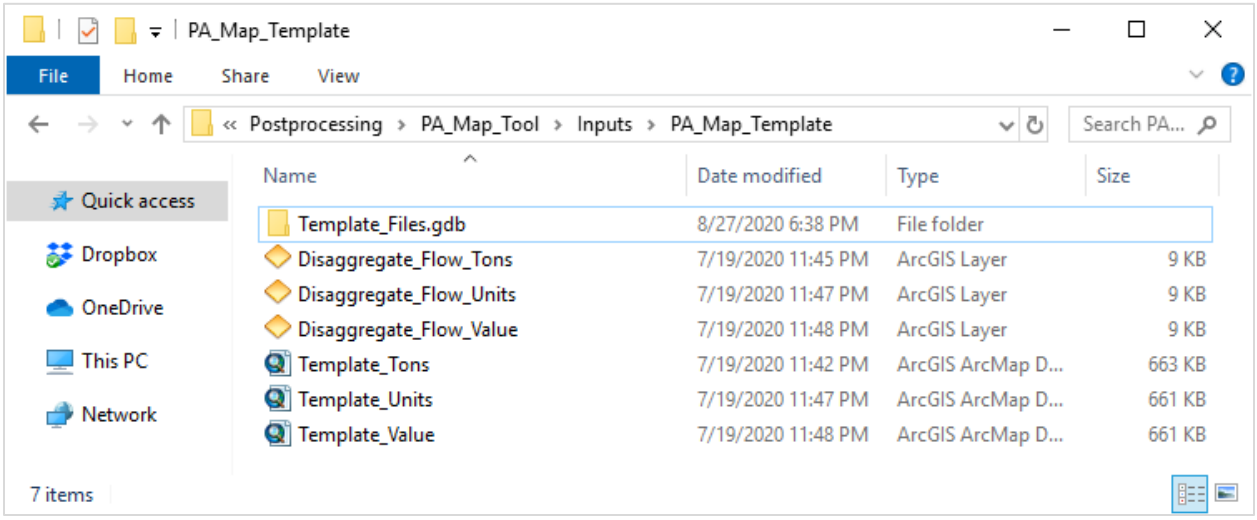


Figure A-121 Folder with Production and Attraction MXD Map Template

PA MAP Tool Inputs and Outputs

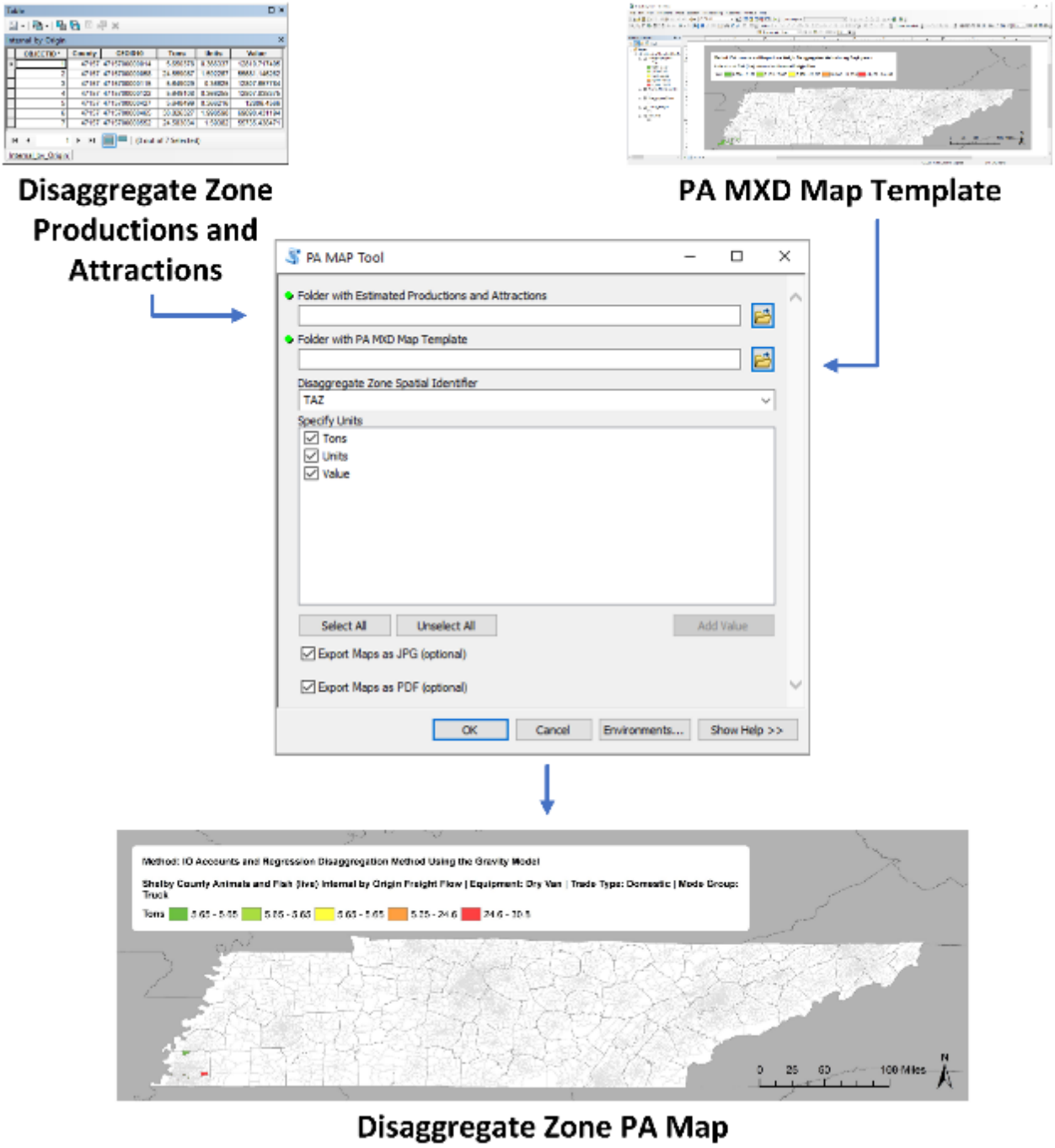


Figure A-122 PA MAP Tool Inputs and Outputs

STEP 1

Open the newly added **Freight Data Disaggregation Tool** toolbox, select the **Post-processing** tool group, and lunch **PA MAP Tool** (see Figure A-123).

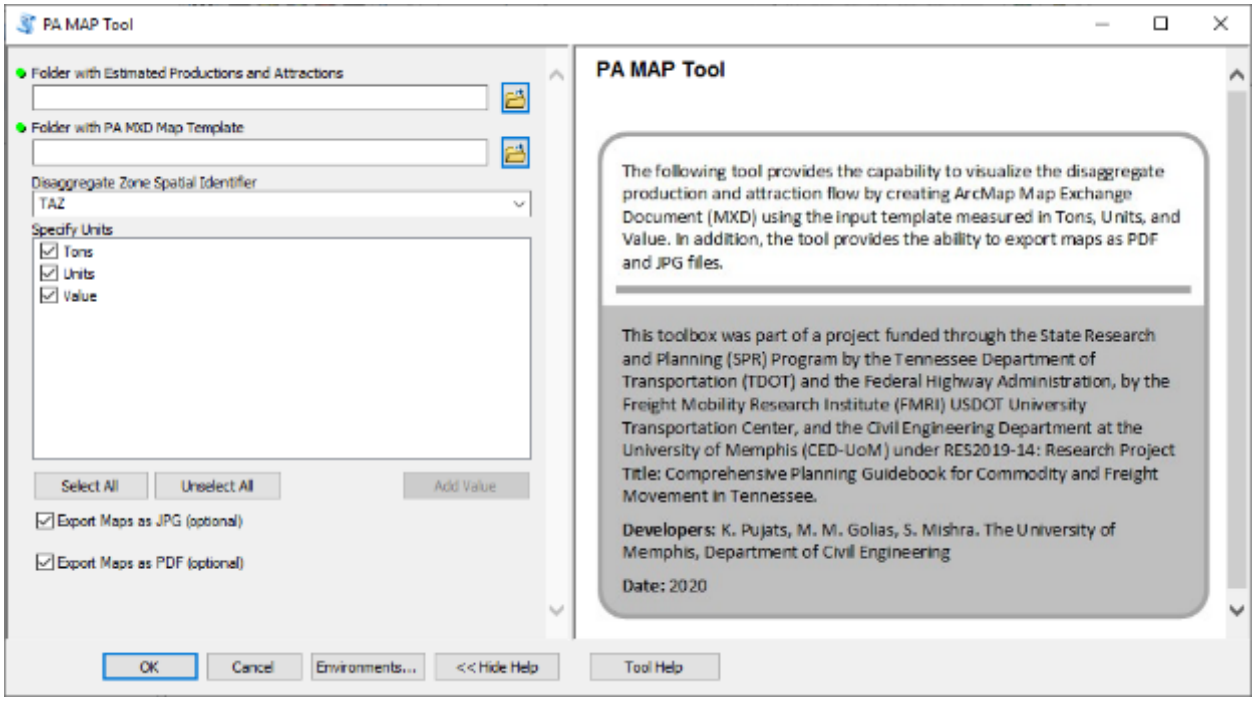


Figure A-123 PA MAP Tool

STEP 2

Input path to the folder* containing estimated disaggregate flow productions and attractions in the input parameter **Folder with Estimated Productions and Attractions** (see Figure A-124).

*Input obtained from the outputs of the **PA Estimation OD Selection Tool.***

*Due to the long length of folder names, it is suggested to copy the ***Disaggregate_Data*** folder on the desktop. Otherwise, the tool output paths may exceed the systems maximum length of the*

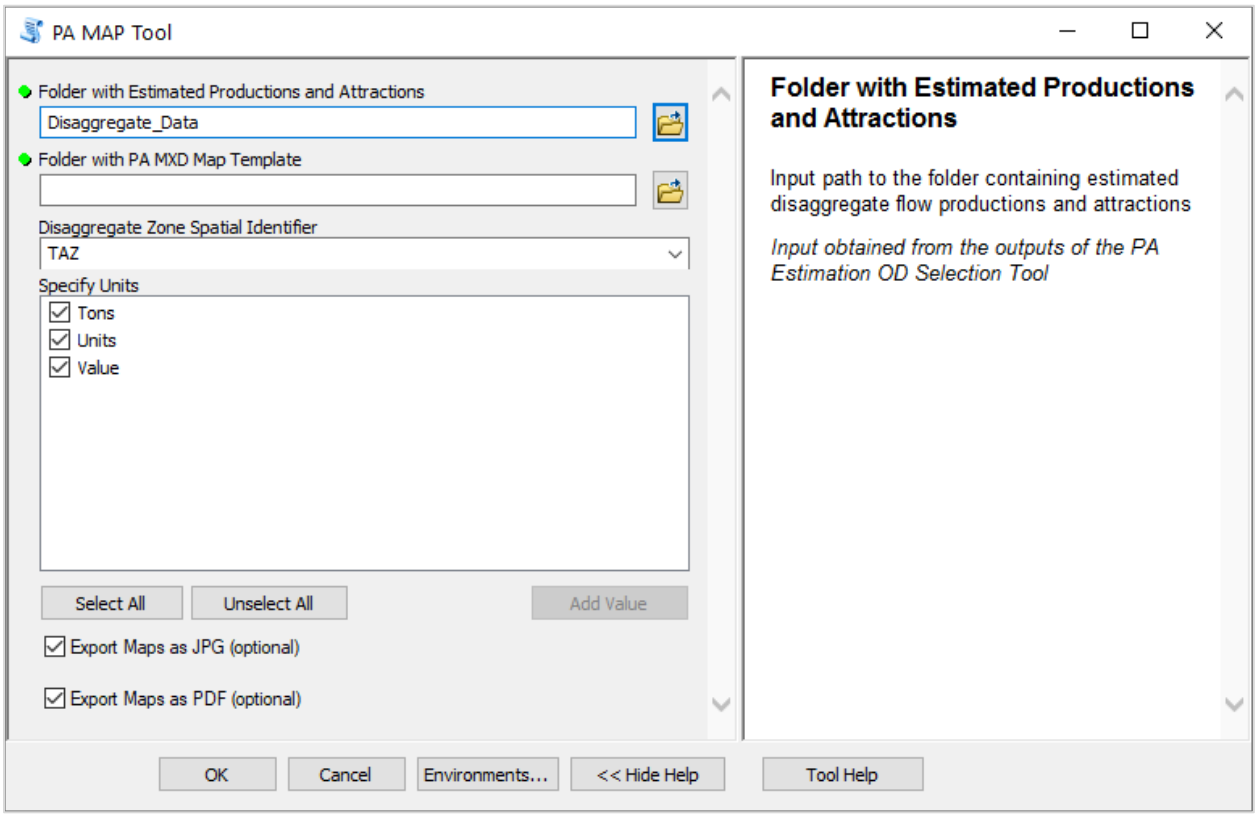


Figure A-124 Input Path to Folder with Estimated Productions and Attractions

STEP 3

Input path to the folder containing production and attraction MXD template* in the input parameter **Folder with PA MXD Map Template** (see Figure A-125).

*If other disaggregate zone boundary files are used to process data, then the **PA MAP Template** has to be updated. Instructions on how to update the **PA MAP Template** are described at the end of this (**PA MAP Tool)** section.*

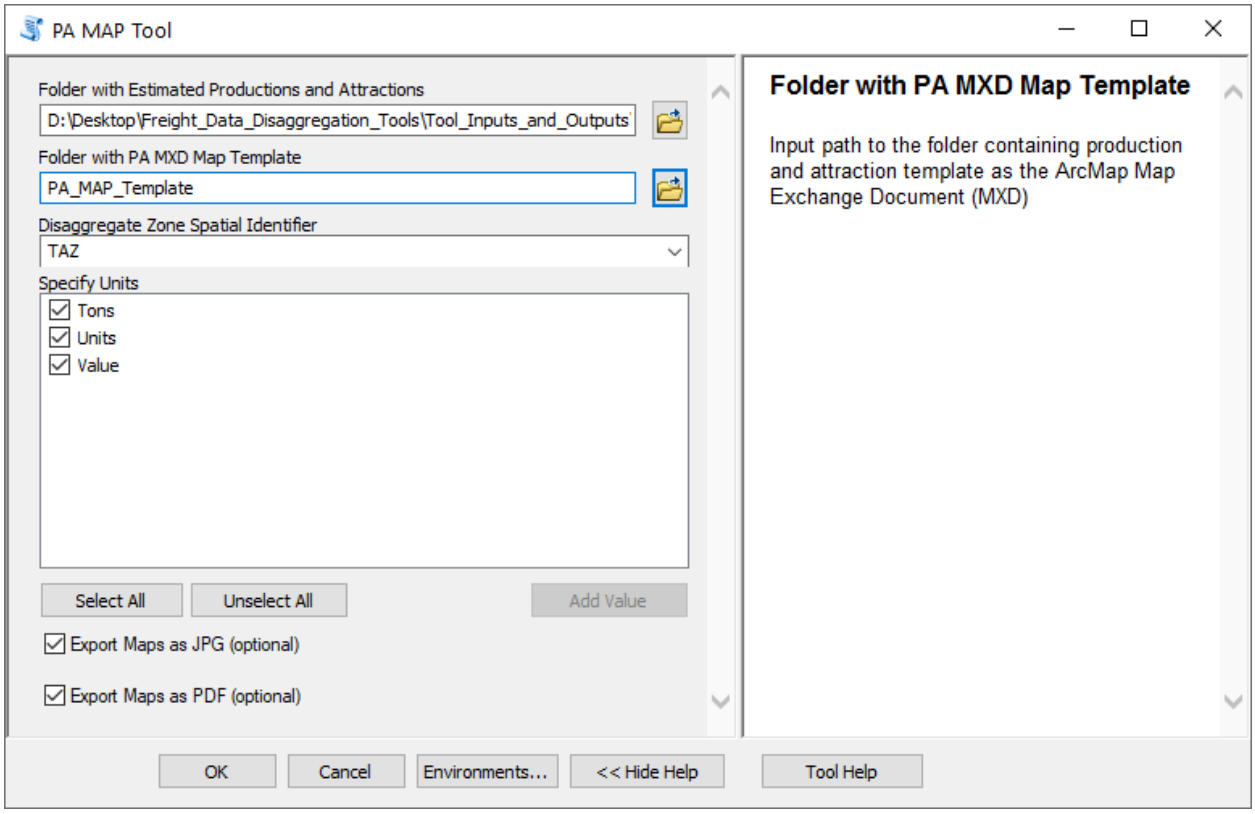


Figure A-125 Input Path to Folder with Production and Attraction MXD Template

STEP 4

Select the type of disaggregate-level geographic zone in the tools input parameter **Disaggregate Zone Spatial Identifier** (see Figure A-126).

(Default: TAZ)

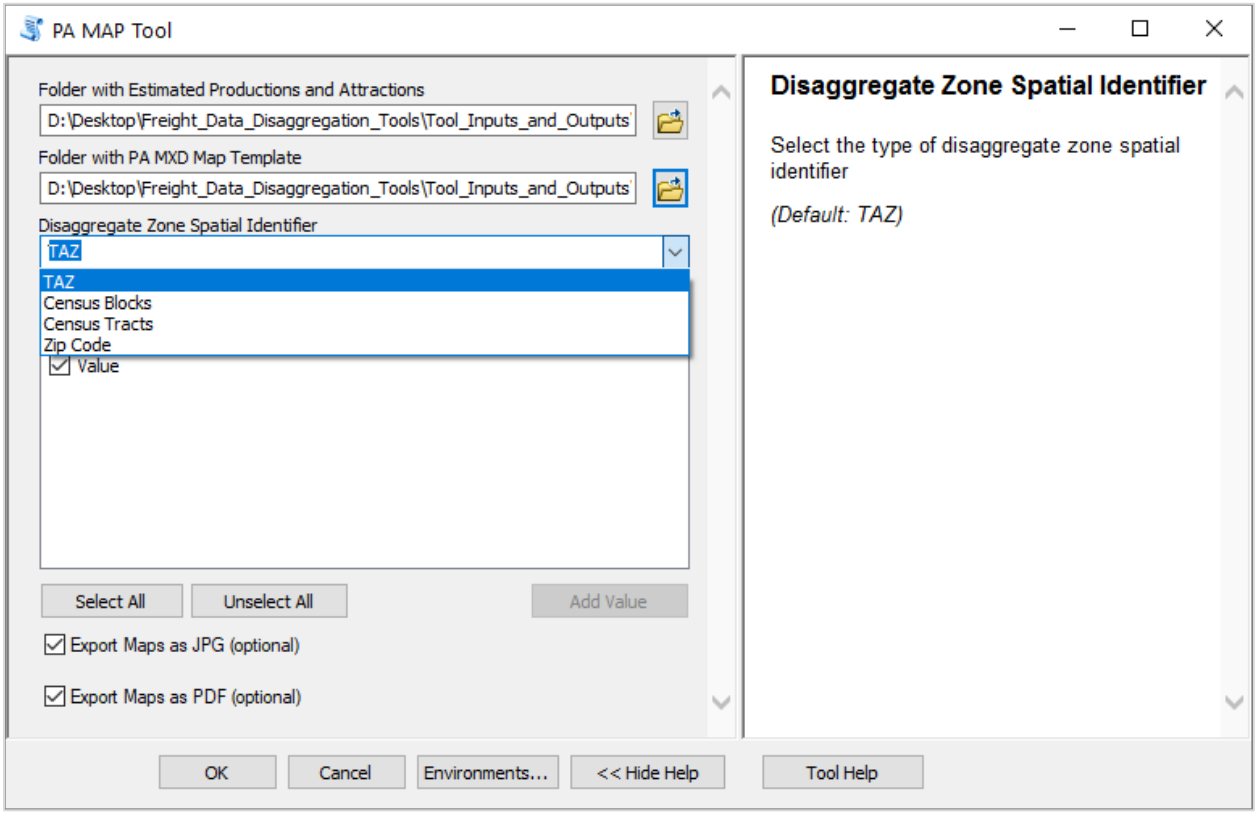


Figure A-126 Select Disaggregate Zone Spatial Identifier

STEP 5

Select the units (Tons, Units, Value) by which the maps will be outputted in the input parameter **Specify Units** (see Figure A-127).

(Default: All)

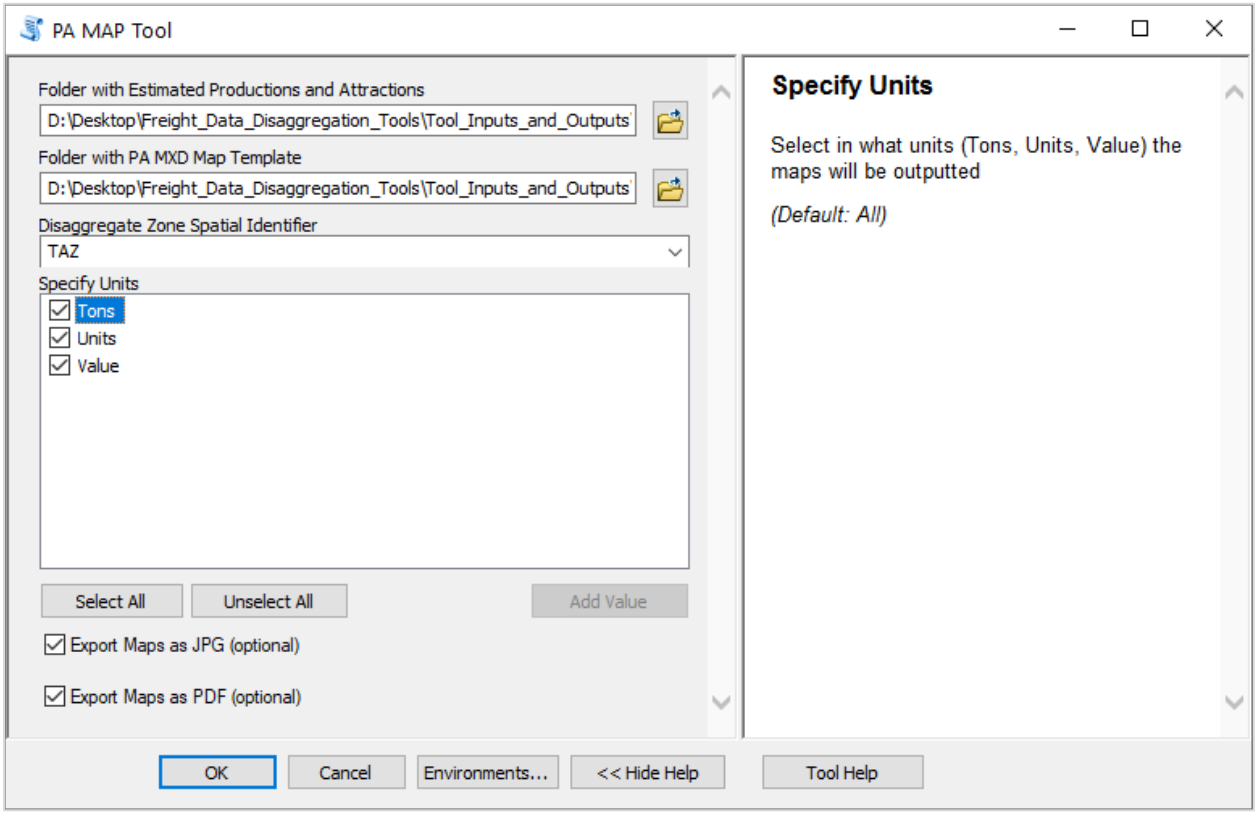


Figure A-127 Select the Output Units

STEP 6

Select the option **Export Maps as JPG** if the user wishes to output maps in JPG format (see Figure A-128).

(Default: True)

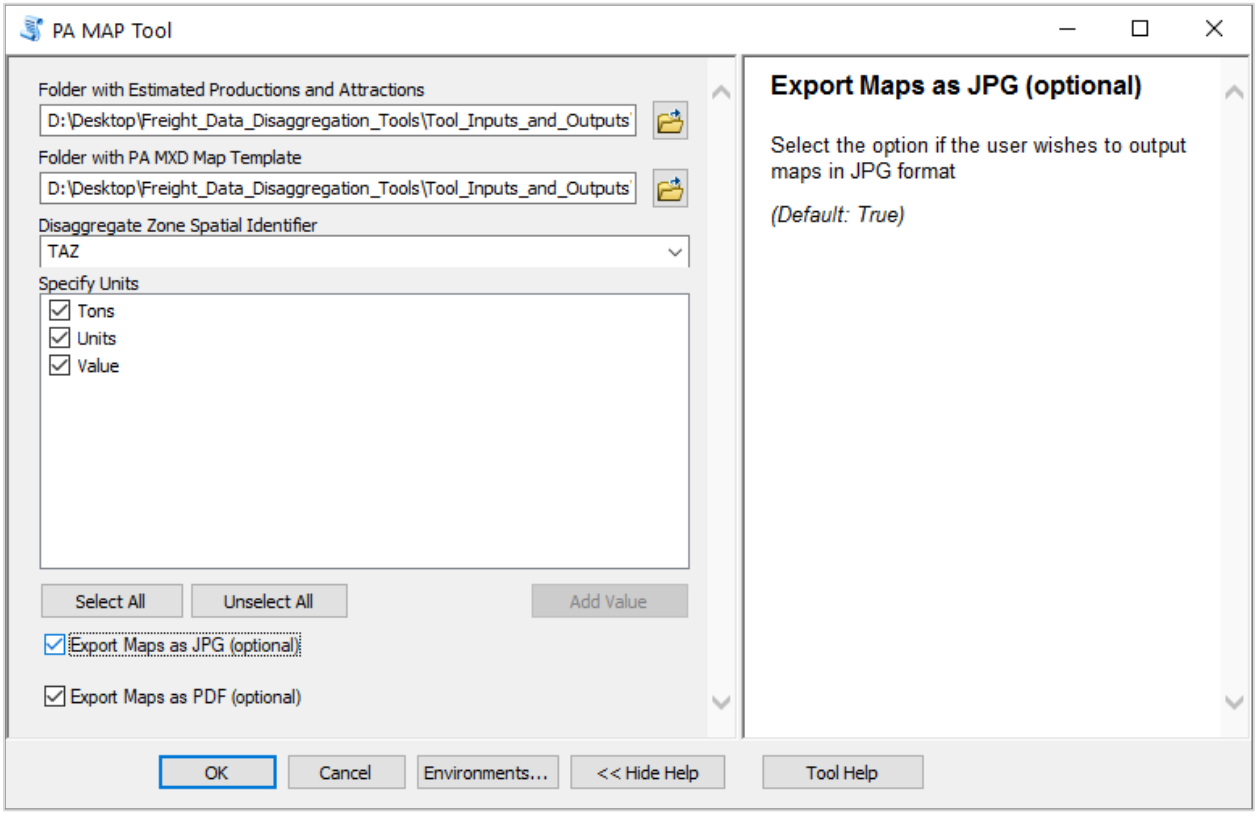


Figure A-128 Select the Option to Export Maps as JPG

STEP 7

Select the option **Export Maps as PDF** if the user wishes to output maps in PDF format (see Figure A-129).

(Default: True)

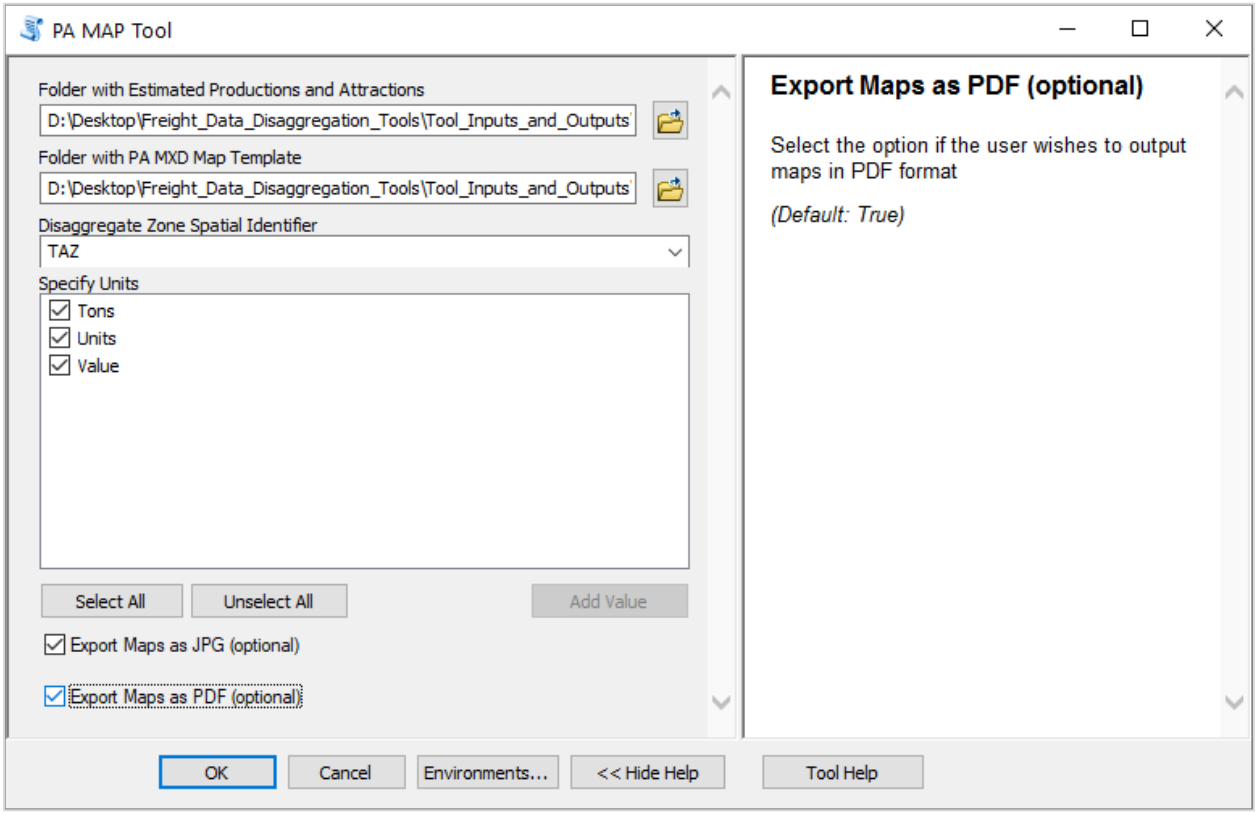


Figure A-129 Select the Option to Export Maps as PDF

STEP 8

Once all required parameters are inputted, press OK to execute the application. The ArcGIS application invokes a task completion window, which reports the status of each task (see Figure A-130). For each disaggregation method and estimated productions and attractions, a folder with the MXD map will be created and exported as a JPG file (see Figure A-131, Figure A-132, Figure A-133, Figure A-134, Figure A-135, Figure A-136).

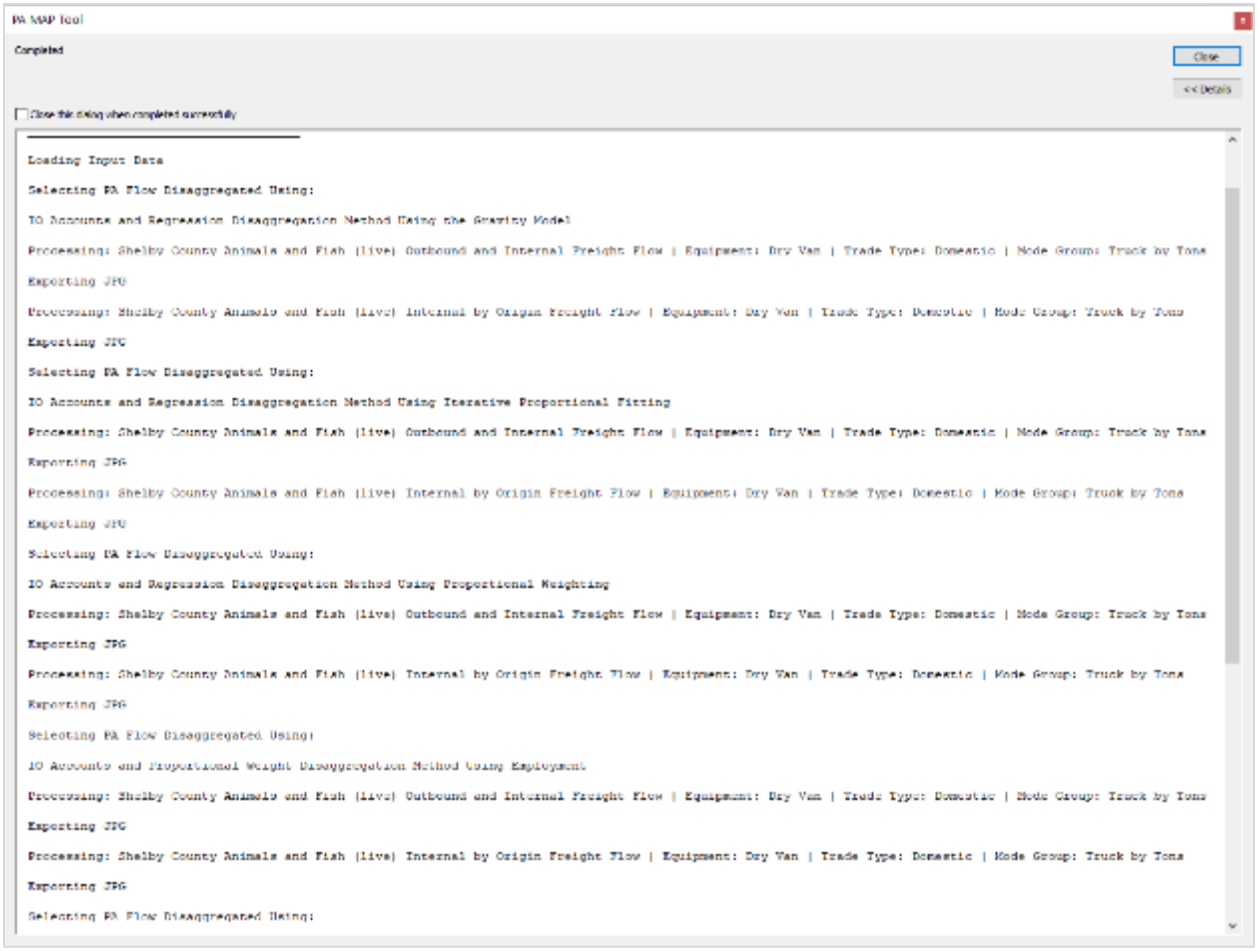


Figure A-130 PA MAP Tool Task Window

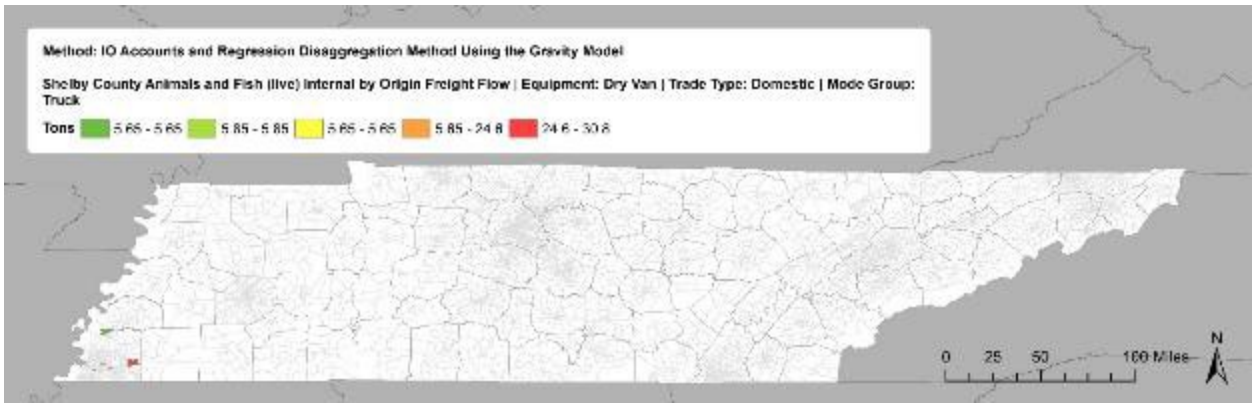


Figure A-131 Example PA Flow Visualization Using the Outputs from the Regression Disaggregation Method and the Gravity Model Distribution

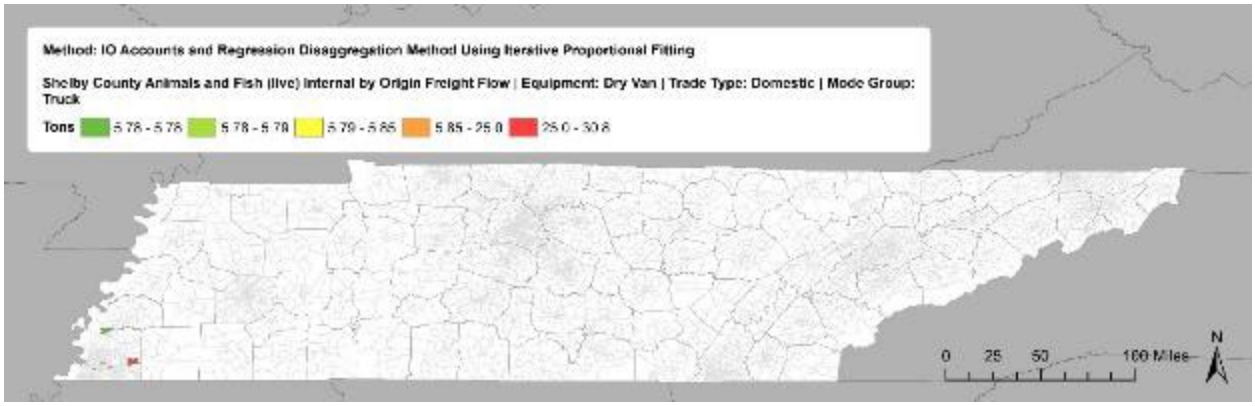


Figure A-132 Example PA Flow Visualization Using the Outputs from the Regression Disaggregation Method and the Iterative Proportional Fitting distribution

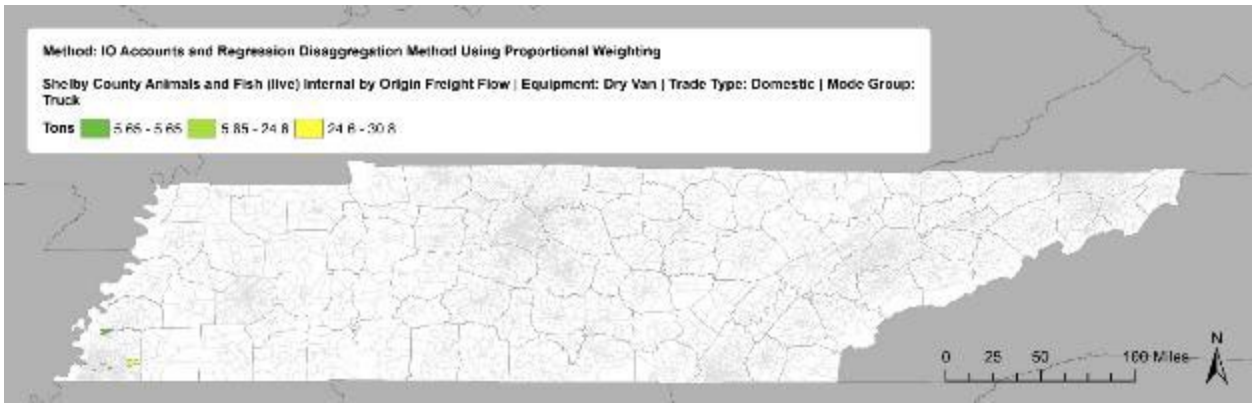


Figure A-133 Example PA Flow Visualization Using the Outputs from the Regression Disaggregation Method and the Iterative Proportional Weighting distribution

Figure A-134 Example PA Flow Visualization Using the Outputs from the Proportional Weighting Disaggregation Method Using Employment

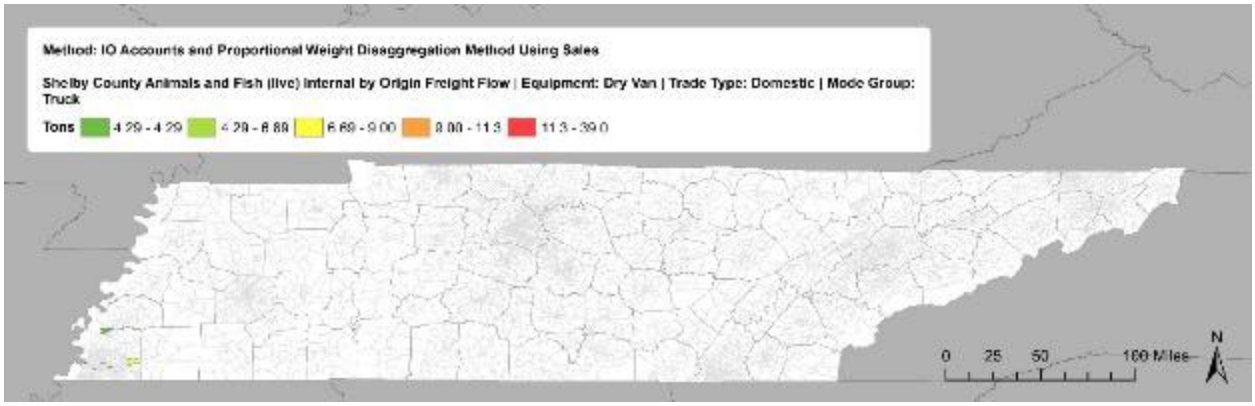


Figure A-135 Example PA Flow Visualization Using the Outputs from the Proportional Weighting Disaggregation Method Using Value of Sales

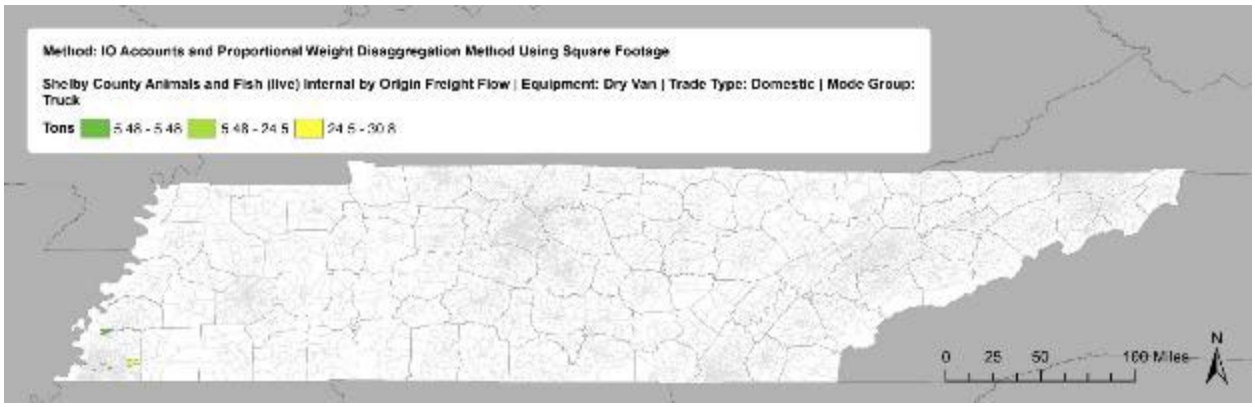


Figure A-136 Example PA Flow Visualization Using the Outputs from the Proportional Weighting Disaggregation Method Using Square Footage

A.10 Updating PA Map Template

Description

In the case when a new disaggregate zone file is used, the production and attraction map template has to be updated. The following steps will guide the user to replace the **Disaggregete_Zones** file with a new disaggregate zone file and how to update the **Disaggregate_Flow** file**.**

STEP 1

First, the **Disaggregate_Zones** file in the **Template_Files.gdb** (see Figure A-137) is replaced with the new zonal file and renamed back to **Disaggregate_Zones.**

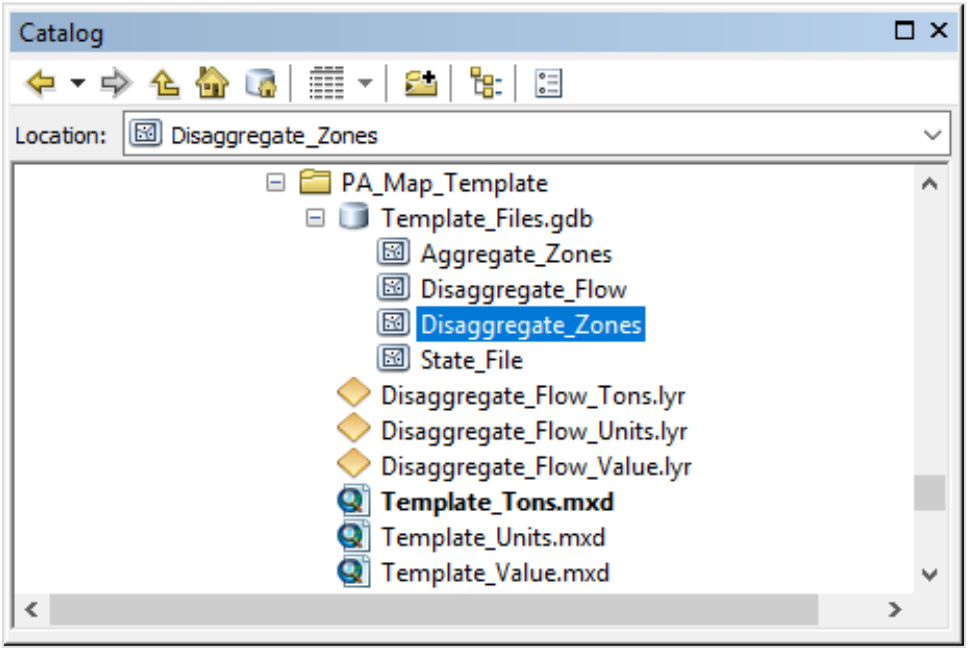


Figure A-137 Template_Files.gdb

STEP 2

Then the **Disaggregate_Flow** in the **Template_Files.gdb** (see Figure A-137) is replaced with the new disaggregate flow file. The new **Disaggregate_Flow** file is created first by adding both the new disaggregate zone file and any Table with estimated disaggregate level productions and attractions (obtained from the **PA Estimation and OD Selection Tool**) to the ArcMap display (see Figure A-138).

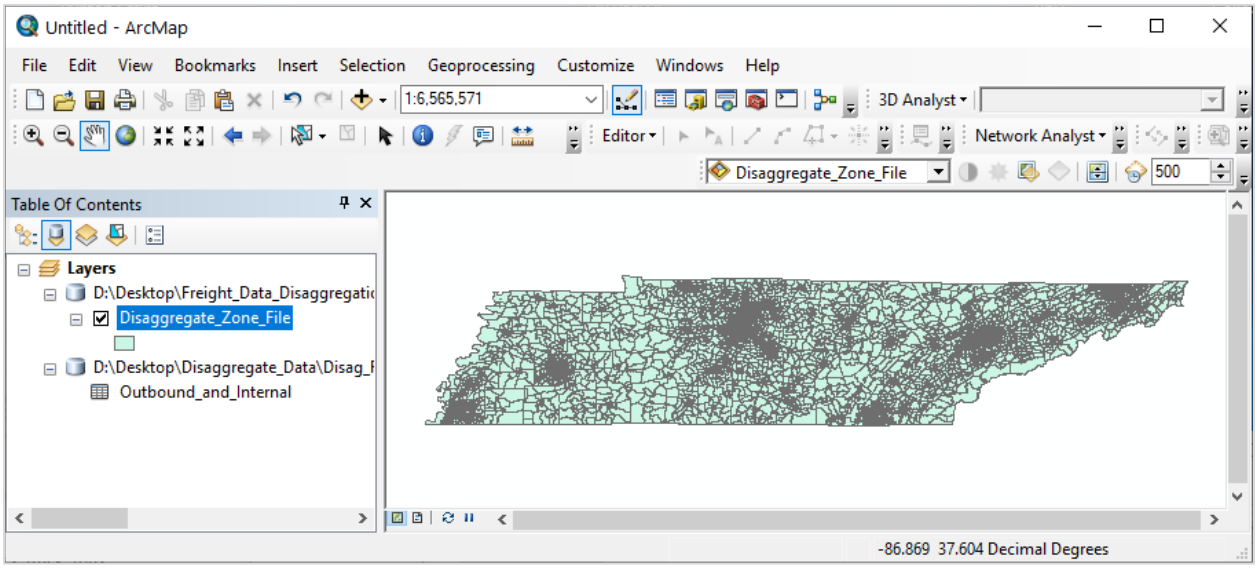


Figure A-138 Disaggregate_Flow File Update

STEP 3

Next, the estimated production and attraction Table is joined with the new disaggregate zone file (see Figure A-139).

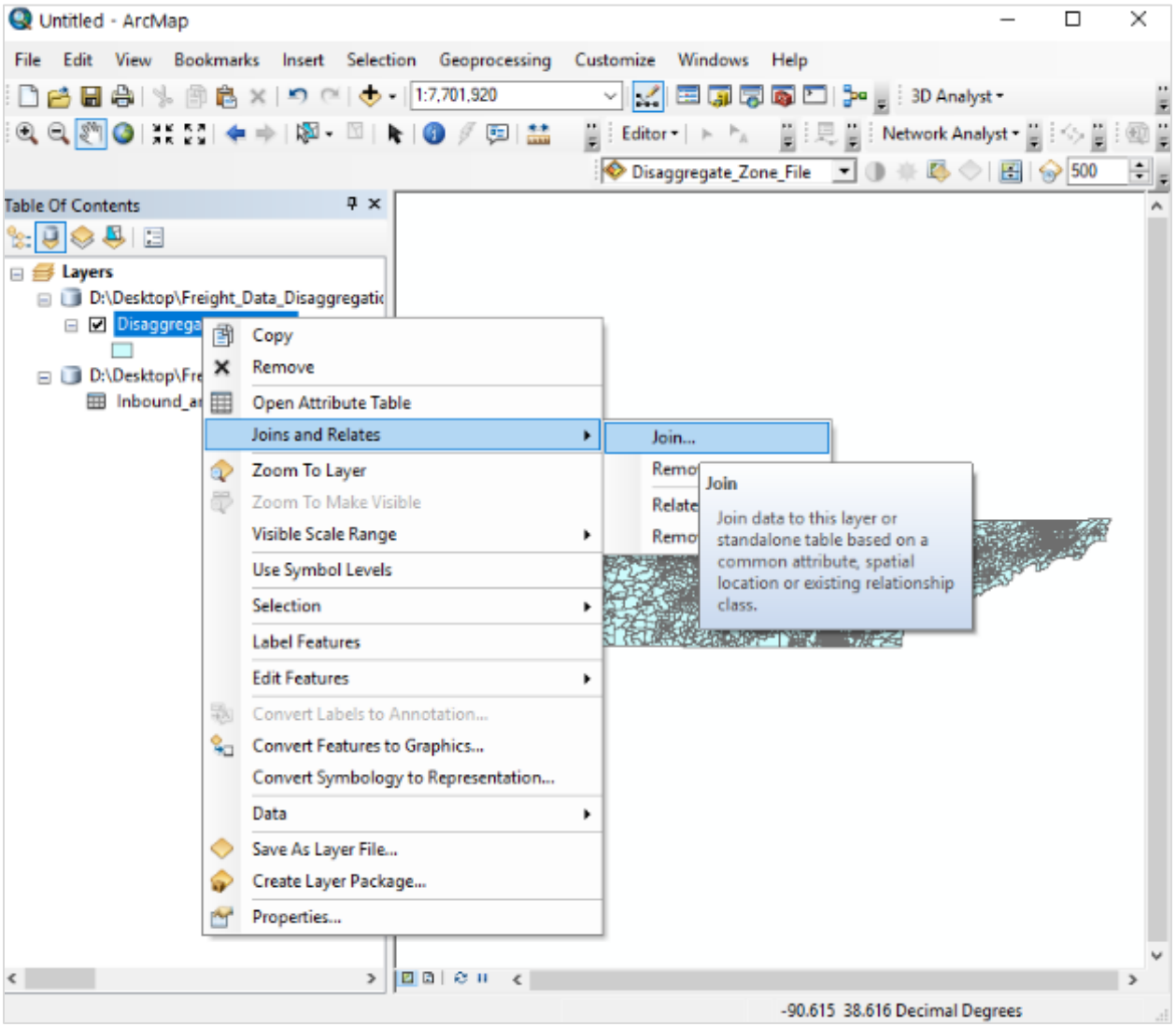


Figure A-139 Creating New Disaggregate_Flow File

STEP 4

Select the corresponding field identifier containing disaggregate zones (see Figure A-140).

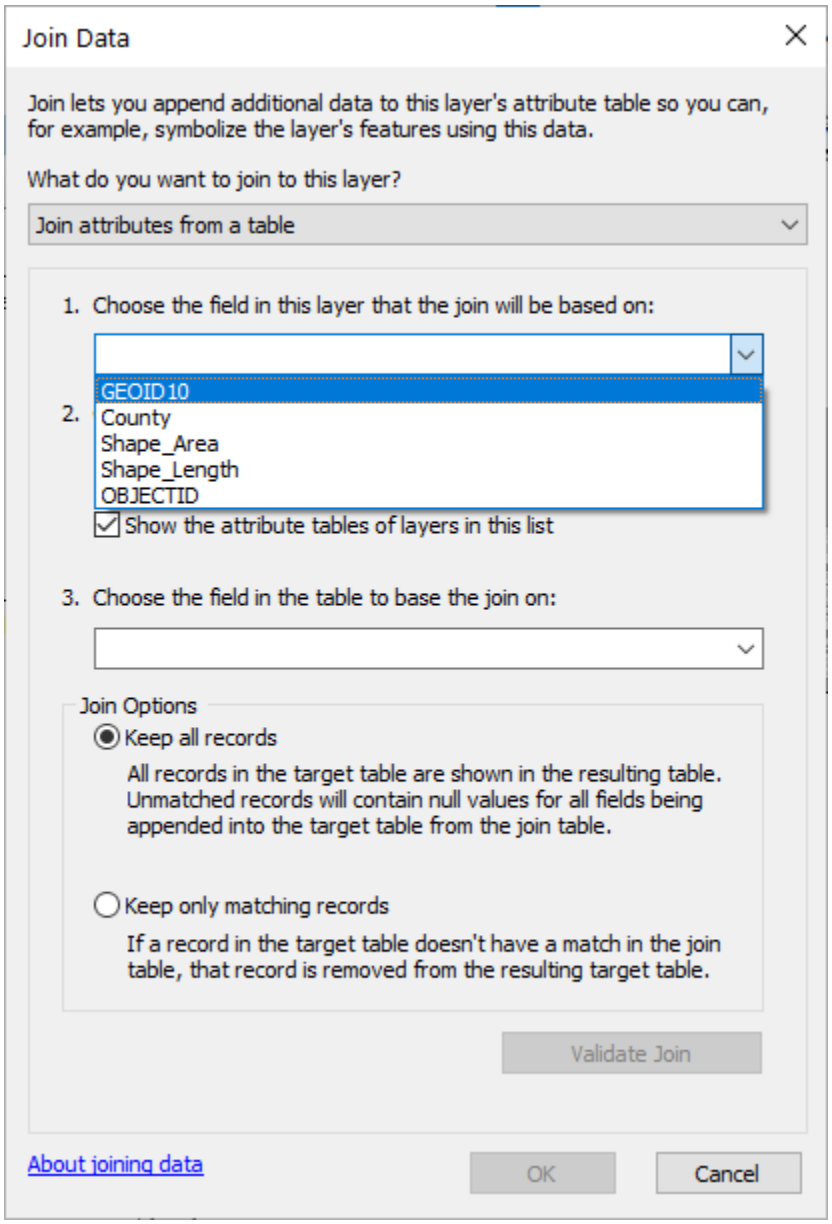


Figure A-140 Disaggregate Zone File Field Identifier

STEP 5

Choose the join Table (see Figure A-141).

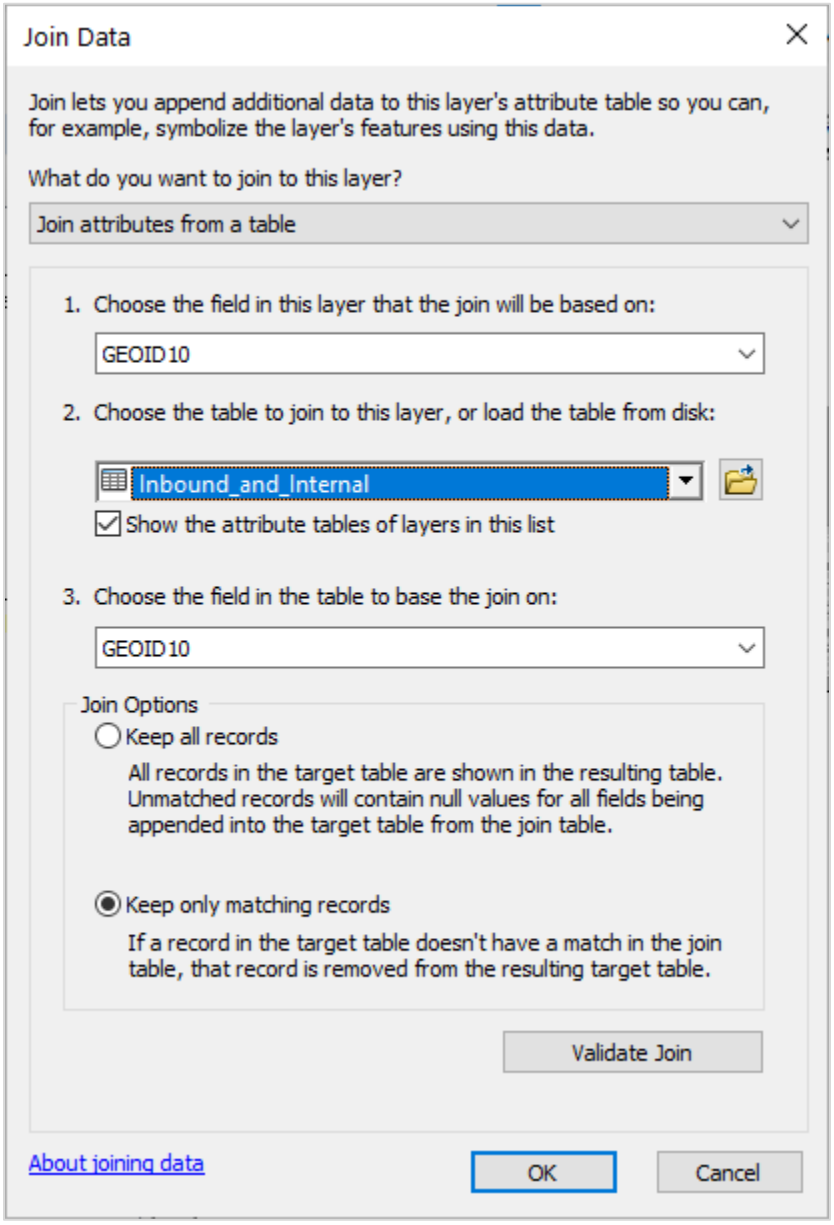


Figure A-141 Join Table

STEP 6

Choose the corresponding field to join with the disaggregate zone file (see Figure A-142).

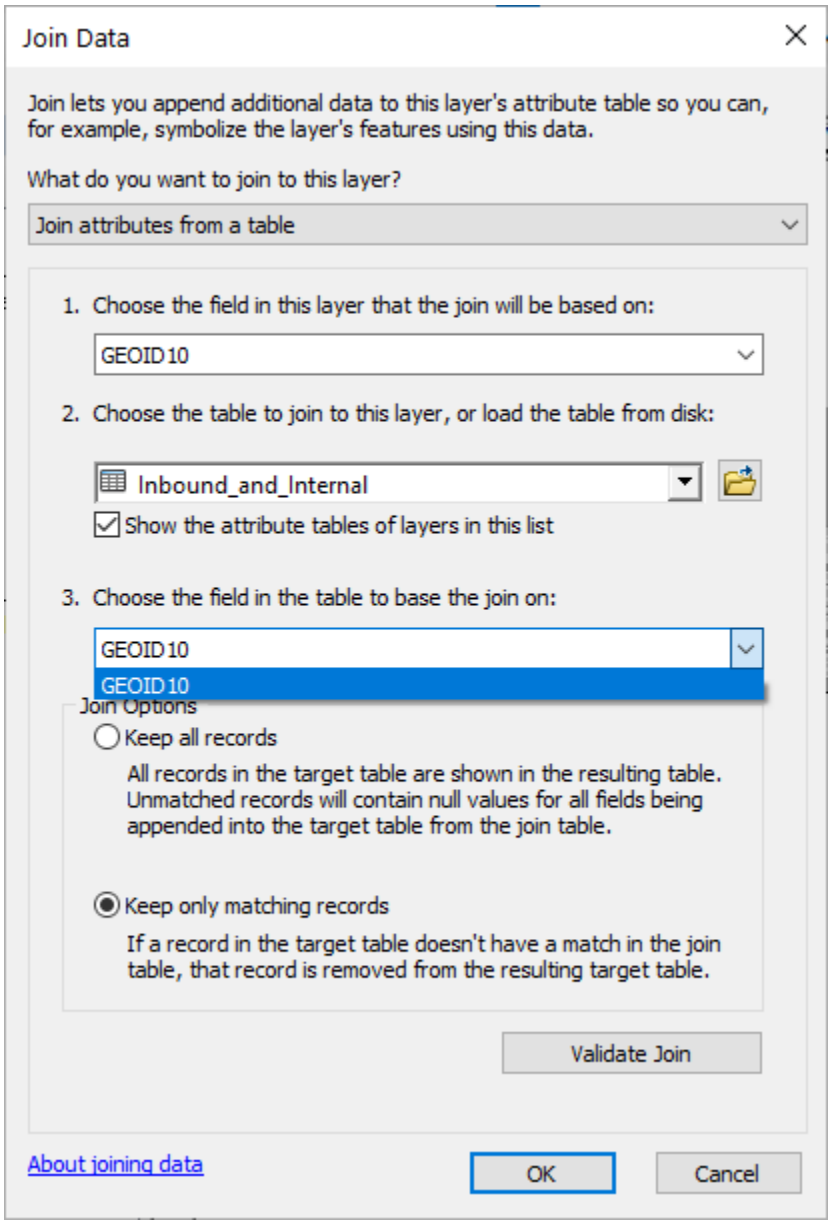


Figure A-142 Choose the Table Join Field

STEP 7

Choose the **Keep only matching records** option (see Figure A-143).

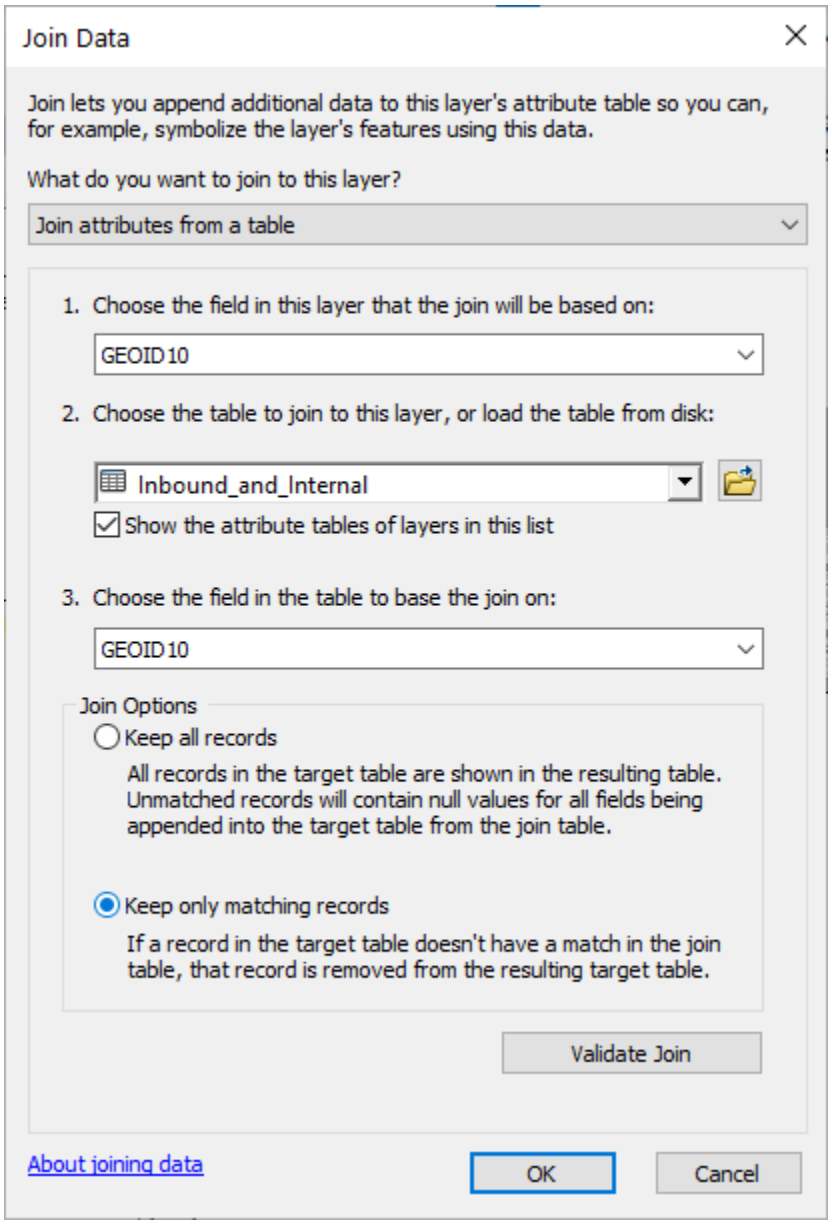


Figure A-143 Keep Only Matching Records

STEP 8

Replace the **Disaggregate_Flow** file in the **Template_Files.gdb** (see Figure A-137) by exporting the newly joined disaggregate zone productions and attraction flow (see Figure A-144) and save it as **Disaggregate_Flow** (see Figure A-145).

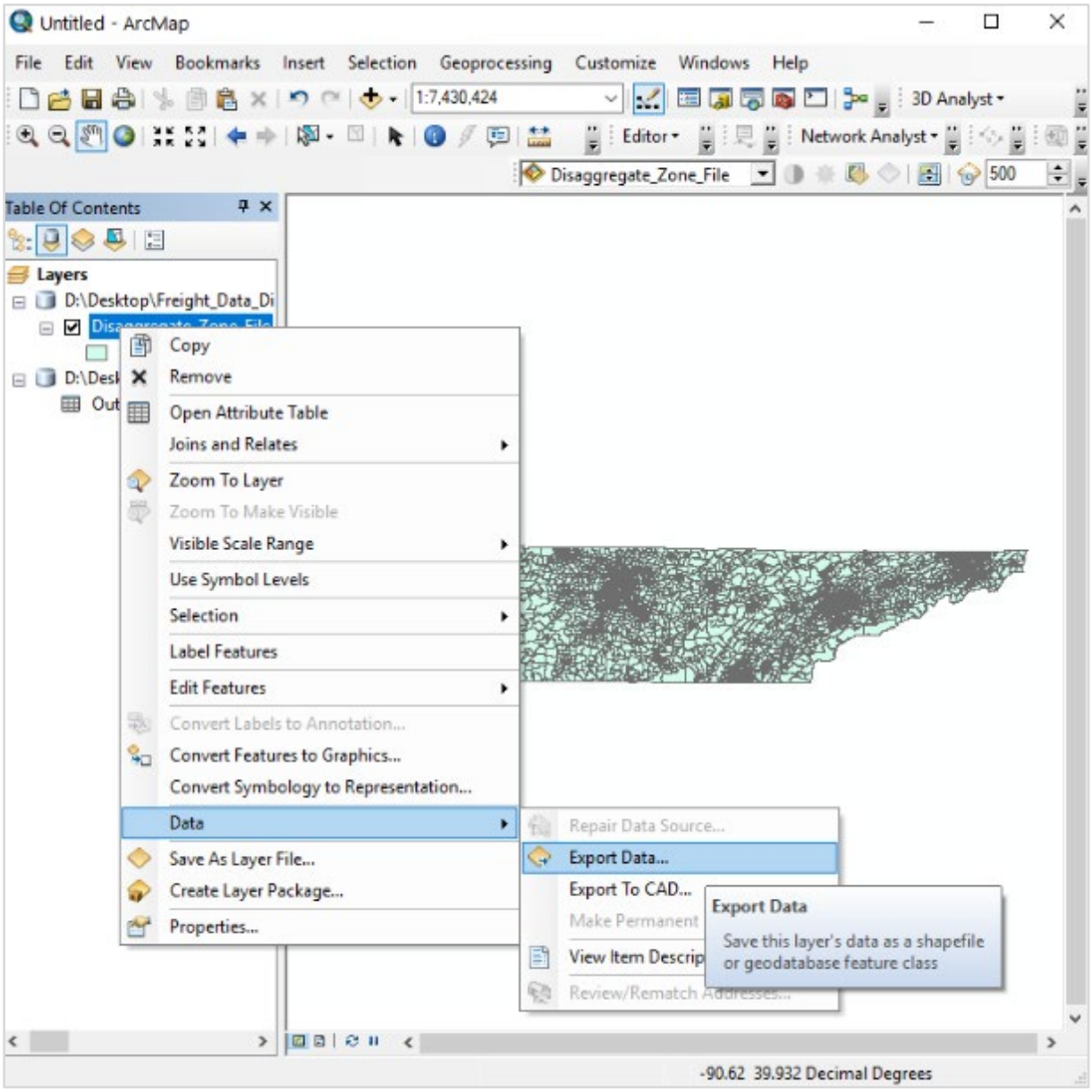


Figure A-144 Export the Joined Disaggregate Zone Flow File

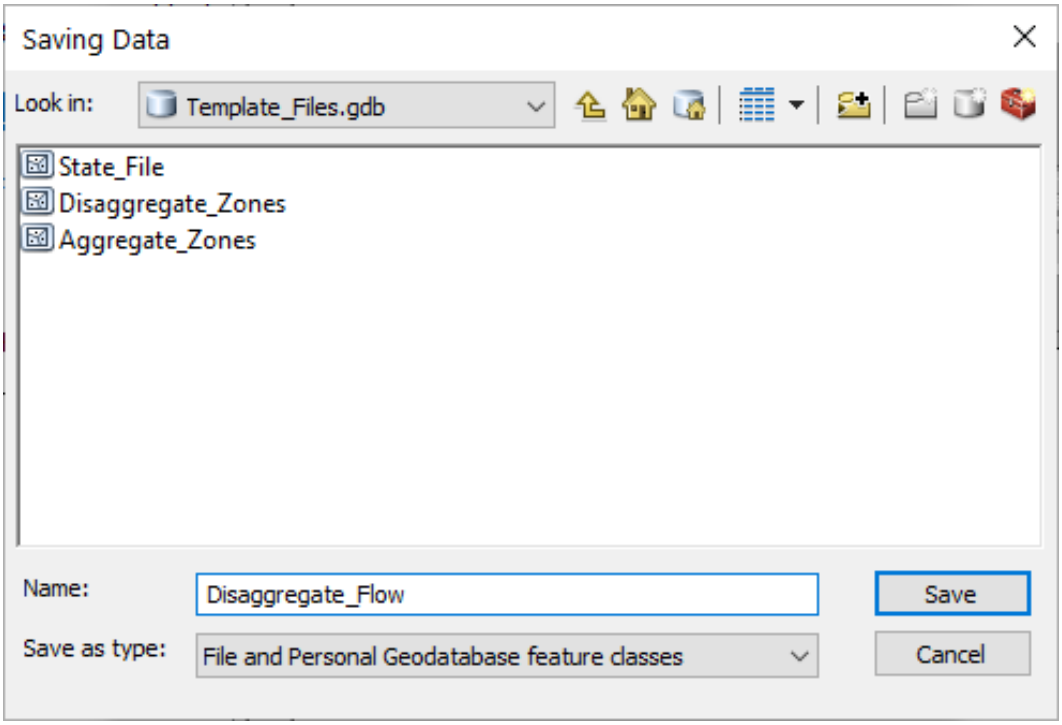


Figure A-145 Save as Disaggregate_Flow

A.11 OD MAP Tool

Description

The following tool provides the capability to visualize the disaggregate origin-destination flow by creating ArcMap Map Exchange Document (MXD) using the input template measured in Tons, Units, and Value. In addition, the tool provides the ability to export maps as PDF and JPG files. A schematic overview of OD MAP Tool inputs and outputs is shown in Figure A-147.

Example Input Files

- **Folder with Specified Disaggregate Origin-Destination Flows**
(Obtained from the outputs of the **PA Estimation OD Selection Tool**)

- **Folder with Origin-Destination MXD Map Template** (see Figure A-146)

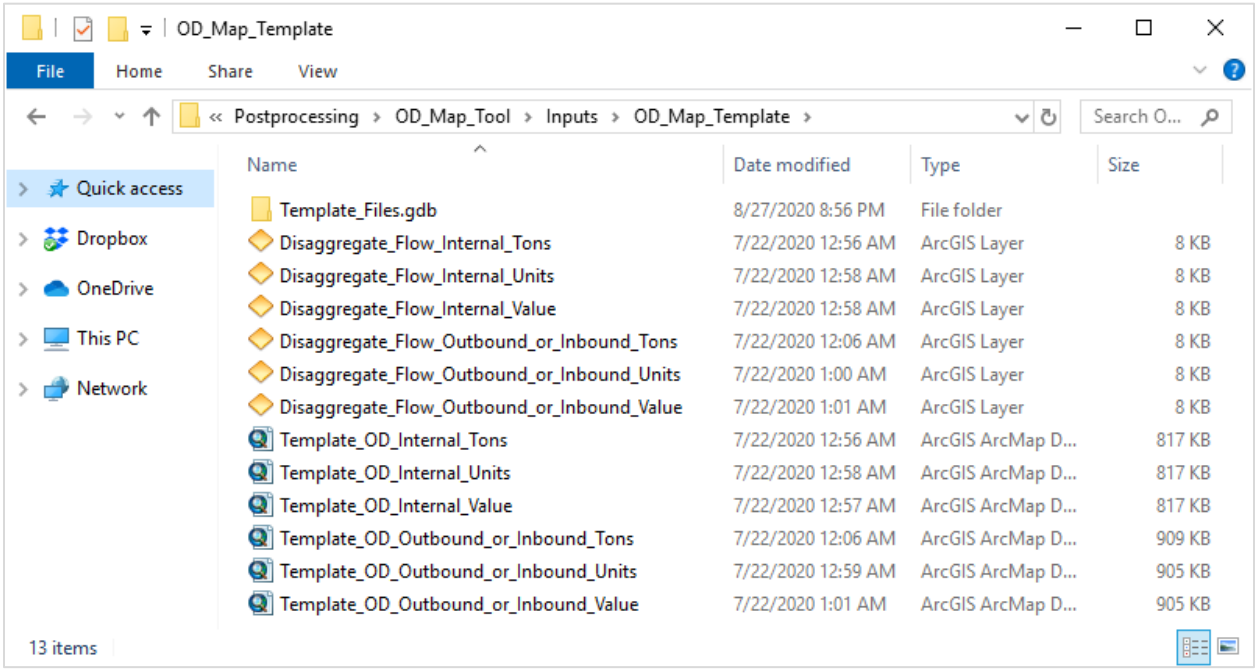


Figure A-146 Folder with Origin-Destination MXD Map Template

OD MAP Tool Inputs and Outputs

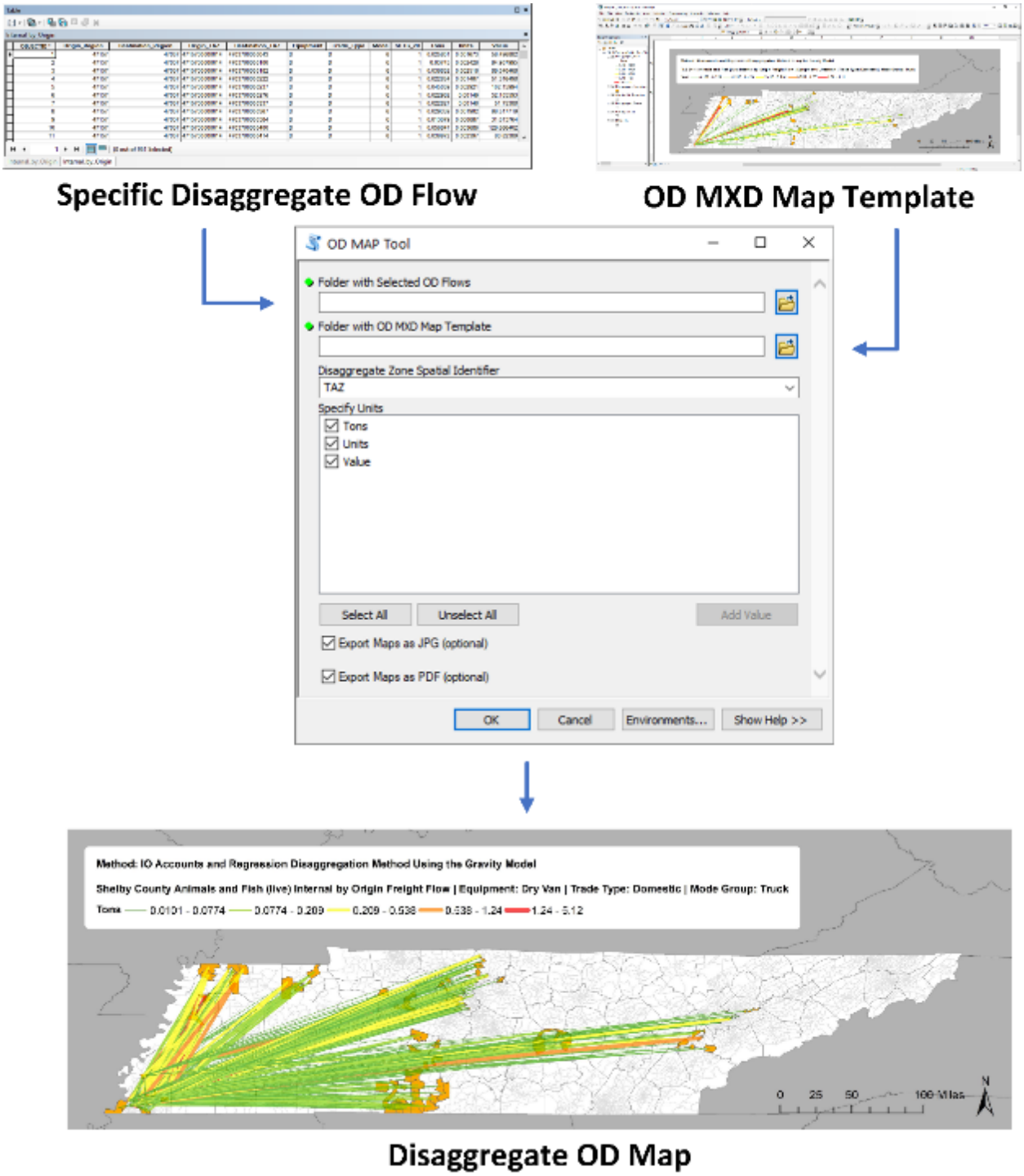


Figure A-147 OD MAP Tool Inputs and Outputs

Open the newly added **Freight Data Disaggregation Tool** toolbox, select the **Post-processing** tool group, and lunch **OD MAP Tool** (see Figure A-148).

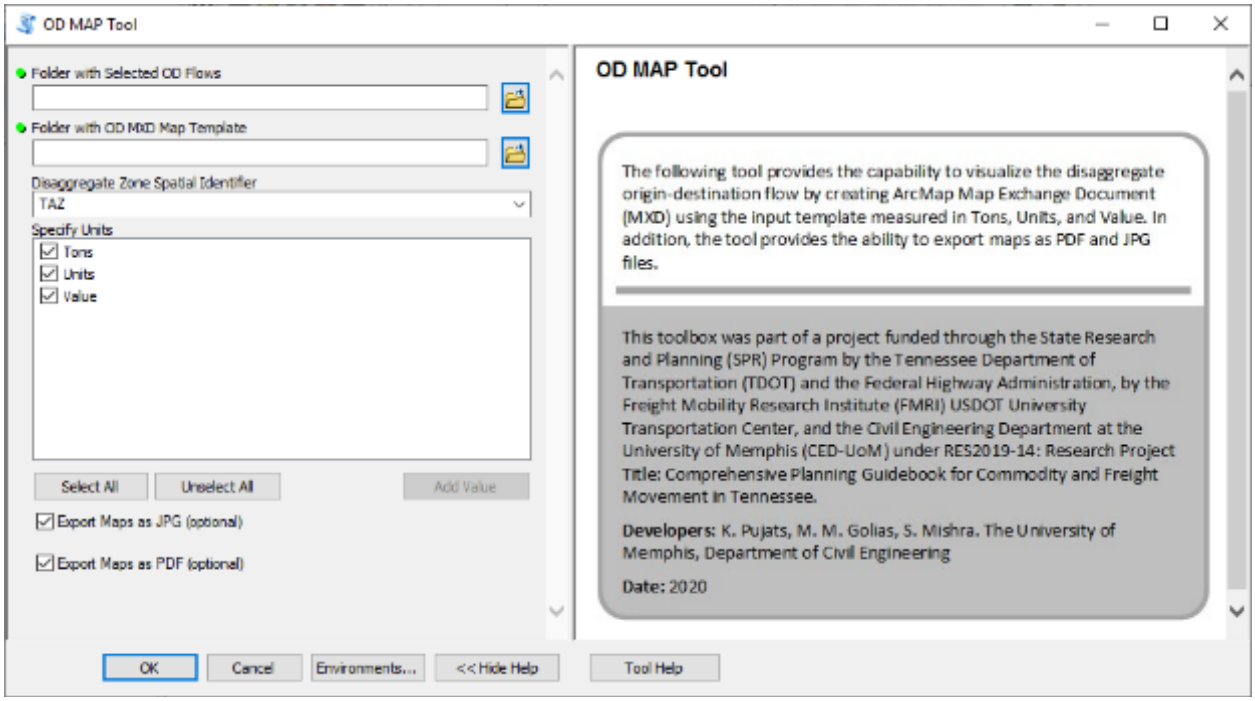


Figure A-148 OD MAP Tool

STEP 1

Input path to the folder* containing specified disaggregate origin-destination flows in the input parameter **Folder with Selected OD Flows** (see Figure A-149).

*Input obtained from the outputs of the **PA Estimation OD Selection Tool.***

*Due to the long length of folder names, it is suggested to copy the ***Disaggregate_Data*** folder on the desktop. Otherwise, the tool output paths may exceed the systems maximum length of the*

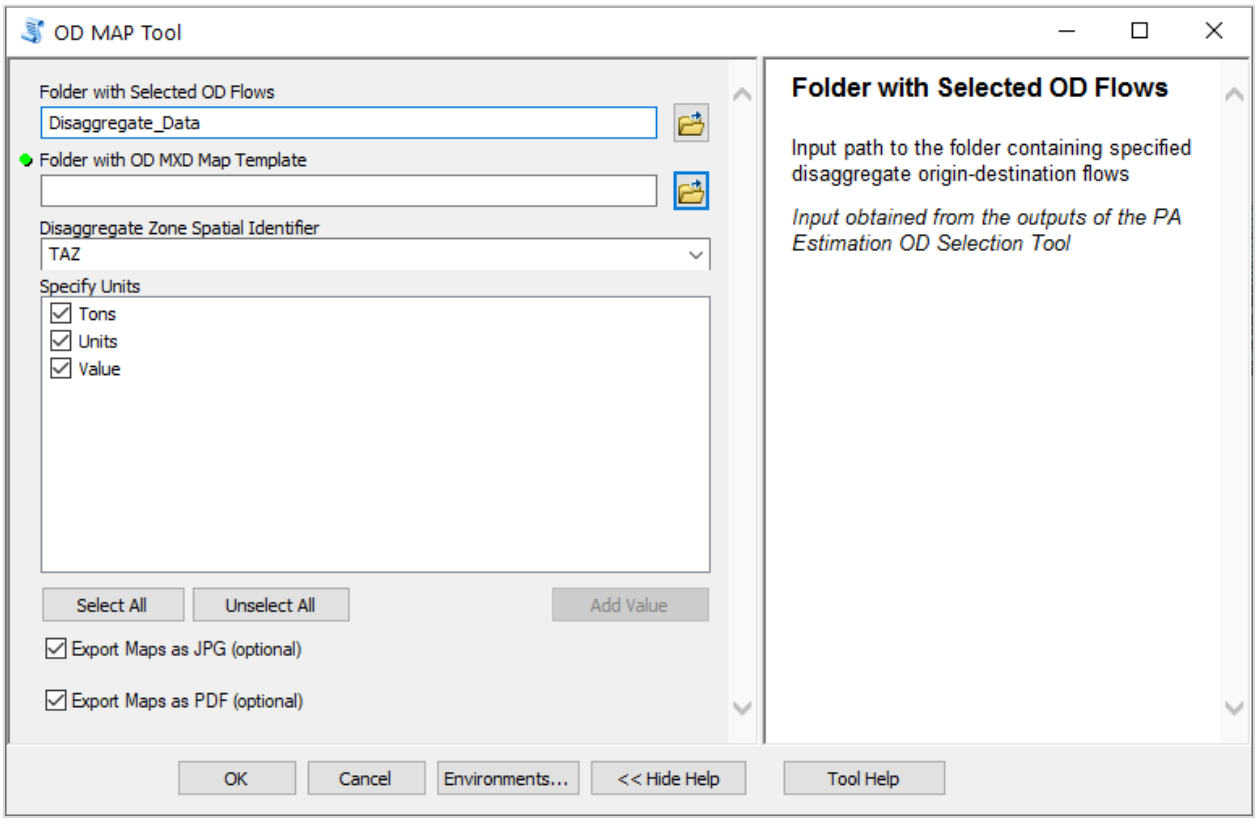


Figure A-149 Input Path to Folder with Disaggregate Origin-Destination Flows

STEP 2

Input path to the folder containing the origin-destination MXD template* in the input parameter **Folder with OD MXD Map Template** (see Figure A-150).

> **If other disaggregate zone boundary files are used to process data, then the **OD MAP Template** has to be updated. Instructions on how to update the **OD MAP Template** are described at the end of this (**OD MAP Tool**) section.*

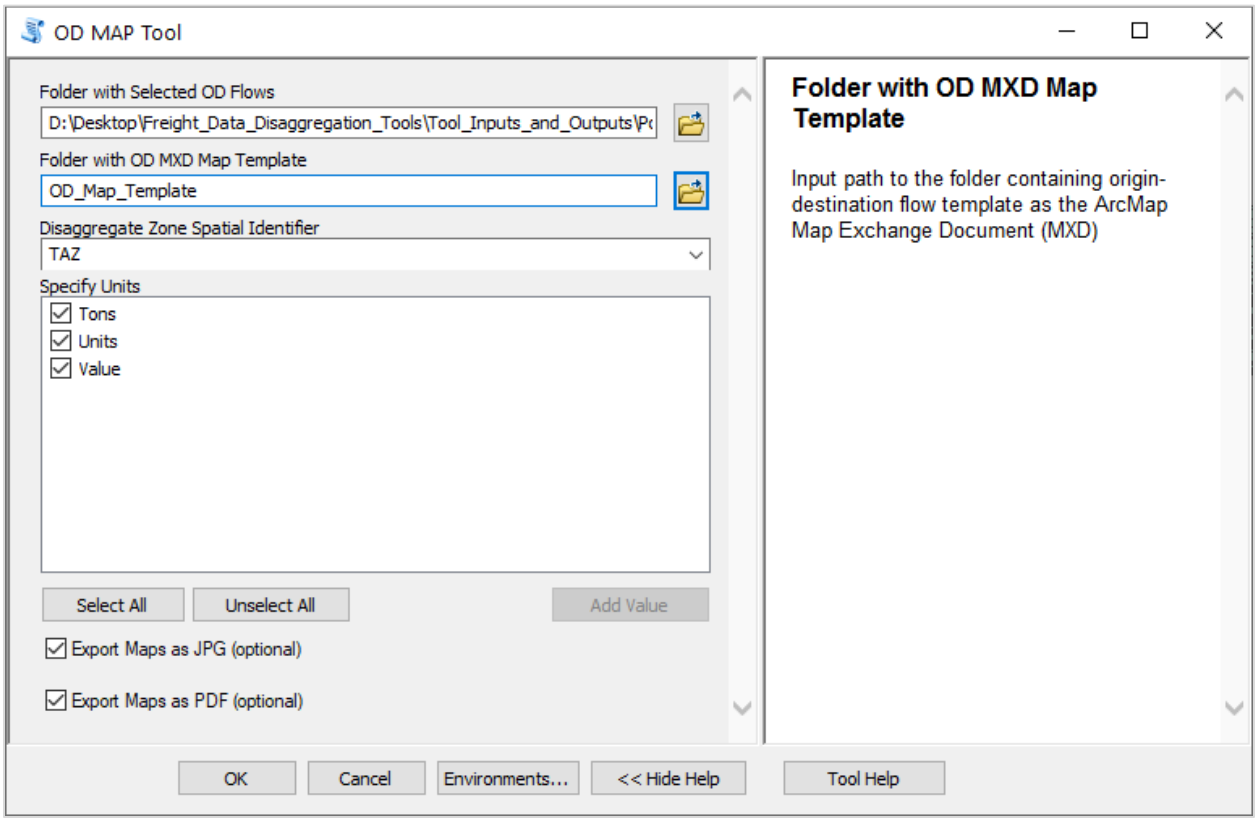


Figure A-150 Input Path to Folder with Origin-Destination Map Template

STEP 3

Select the type of disaggregate-level geographic zone in the tools input parameter **Disaggregate Zone Spatial Identifier** (see Figure A-151).

(Default: TAZ)

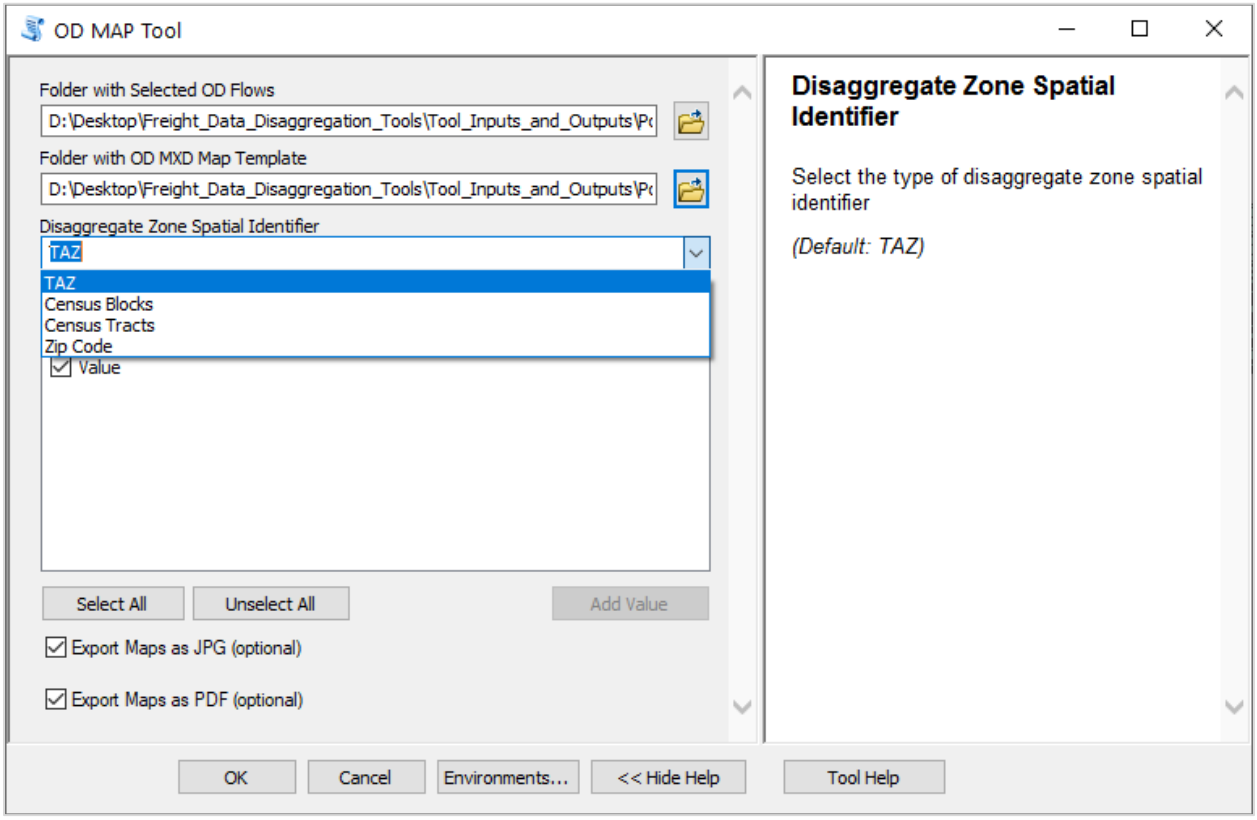


Figure A-151 Select the Disaggregate Zone Spatial Identifier

STEP 4

Select the units (Tons, Units, Value) by which the maps will be outputted in the input parameter **Specify Units** (see Figure A-152).

(Default: All)

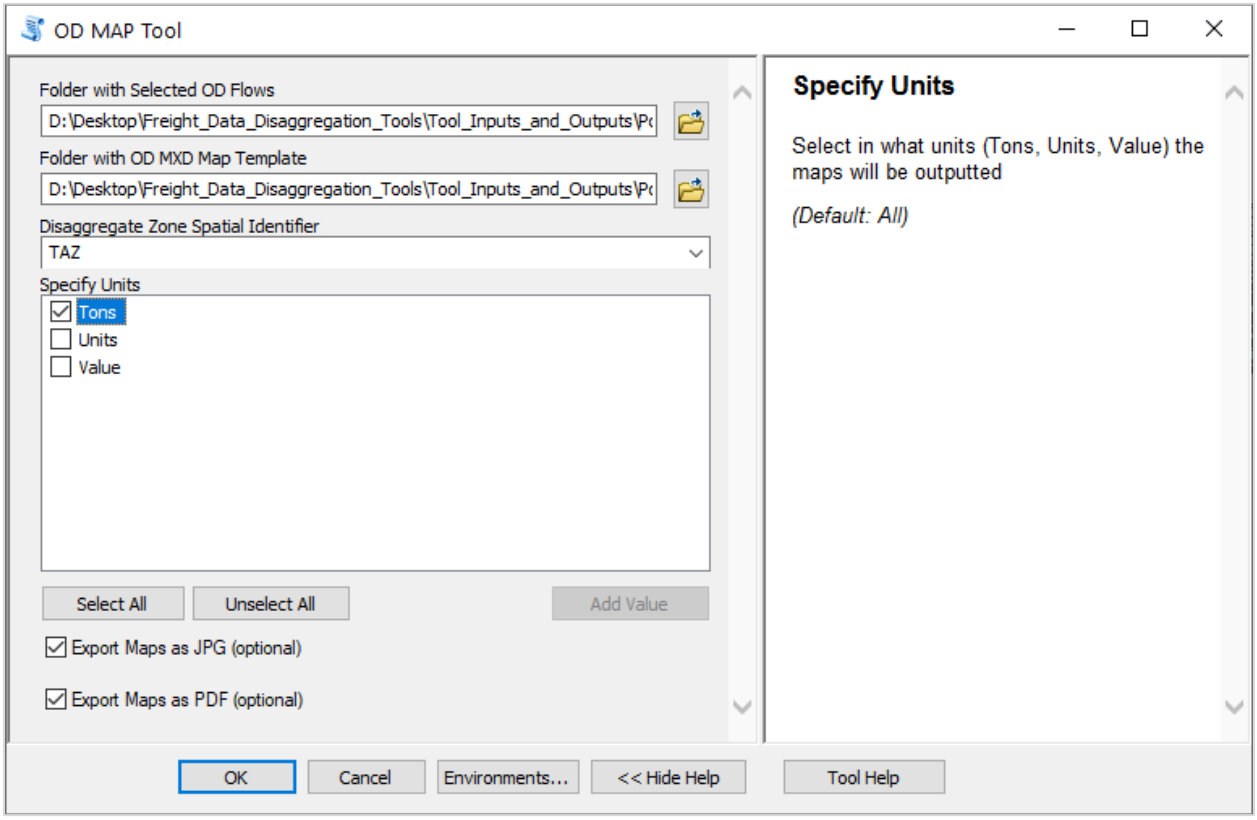


Figure A-152 Select the Output Units

STEP 5

Select the option **Export Maps as JPG** if the user wishes to output maps in JPG format (see Figure A-153).

(Default: True)

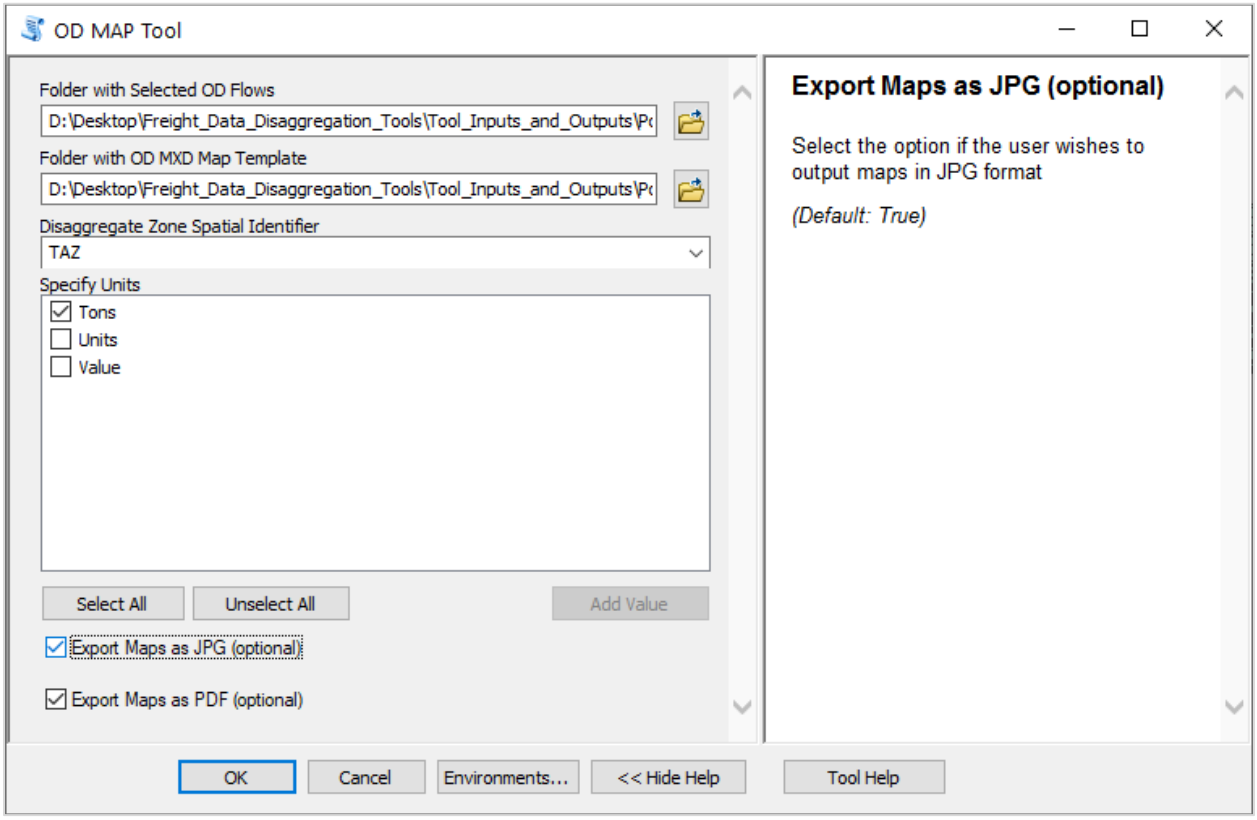


Figure A-153 Select the Option to Export Maps as JPG

STEP 6

Select the option **Export Maps as PDF** if the user wishes to output maps in PDF format (see Figure A-154).

(Default: True)

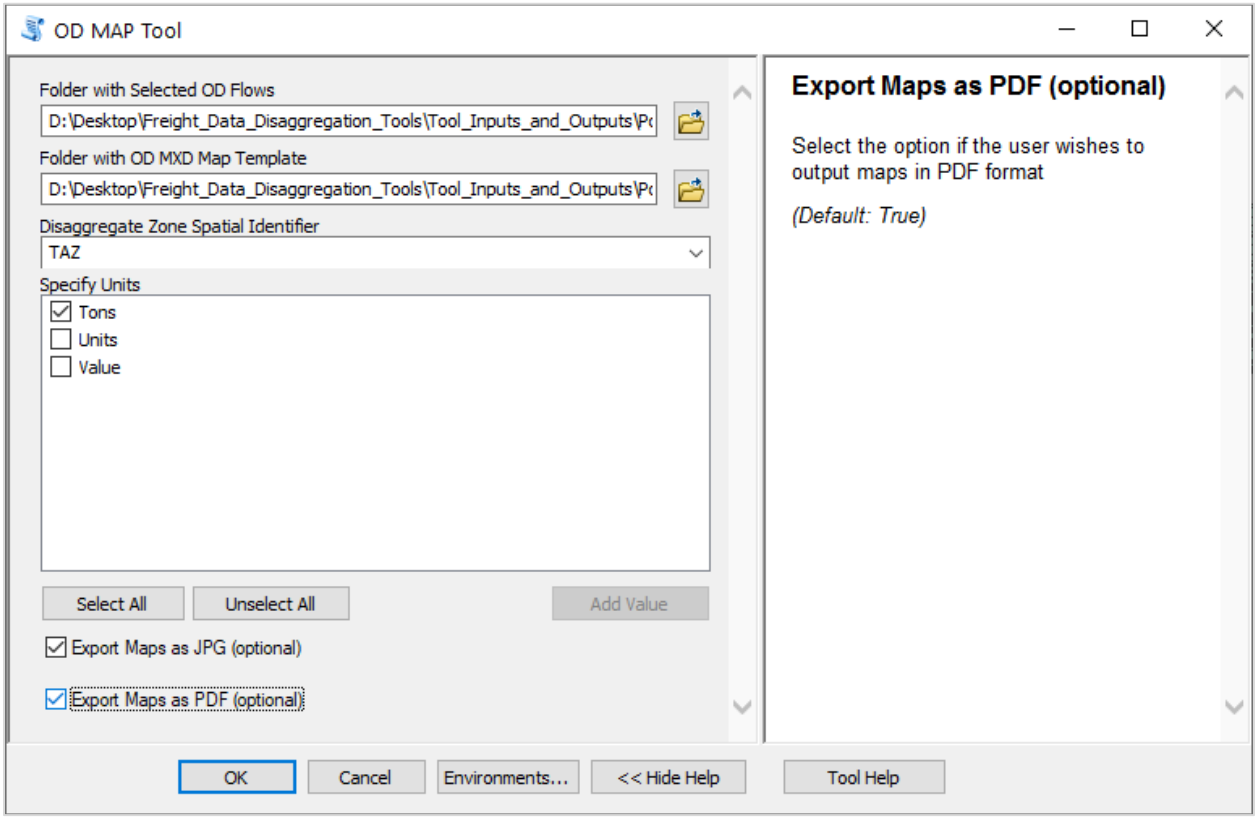


Figure A-154 Select the Option to Export Maps as PDF

STEP 7

Once all required parameters are inputted, press OK to execute the application. The ArcGIS application invokes a task completion window, which reports the status of each task (see Figure A-155). For each disaggregation method and estimated productions and attractions, a folder in the MXD map will be created and exported as a JPG file. Maps for each disaggregation method and internal by origin flow are shown in the following figures: Figure A-156, Figure A-157, Figure A-158, Figure A-159, Figure A-160, Figure A-161. Maps for each disaggregation method and outbound and internal freight flow are shown in the following figures: Figure A-162, Figure A-163, Figure A-164, Figure A-165, Figure A-166, Figure A-167.

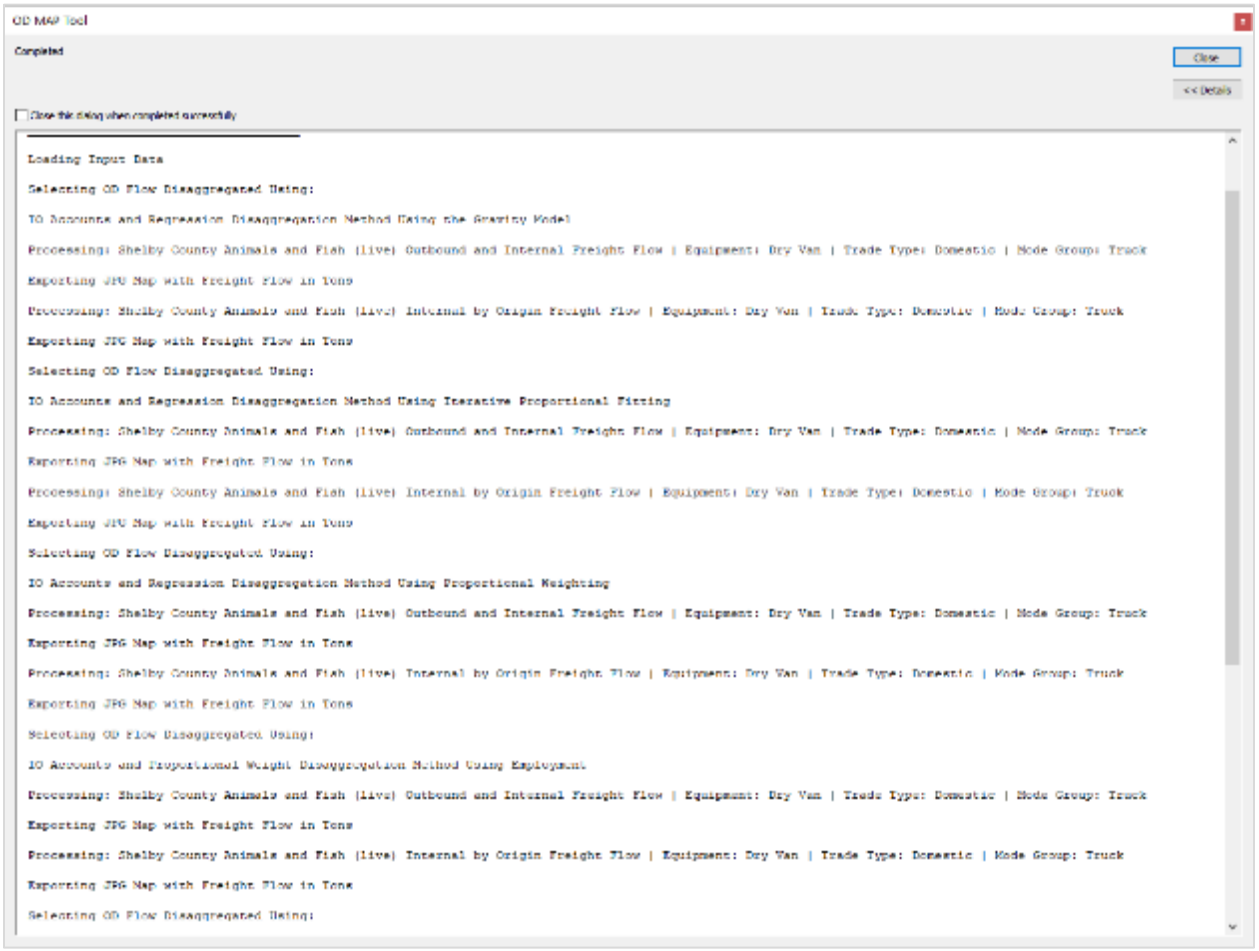


Figure A-155 OD Map Tool Task Window

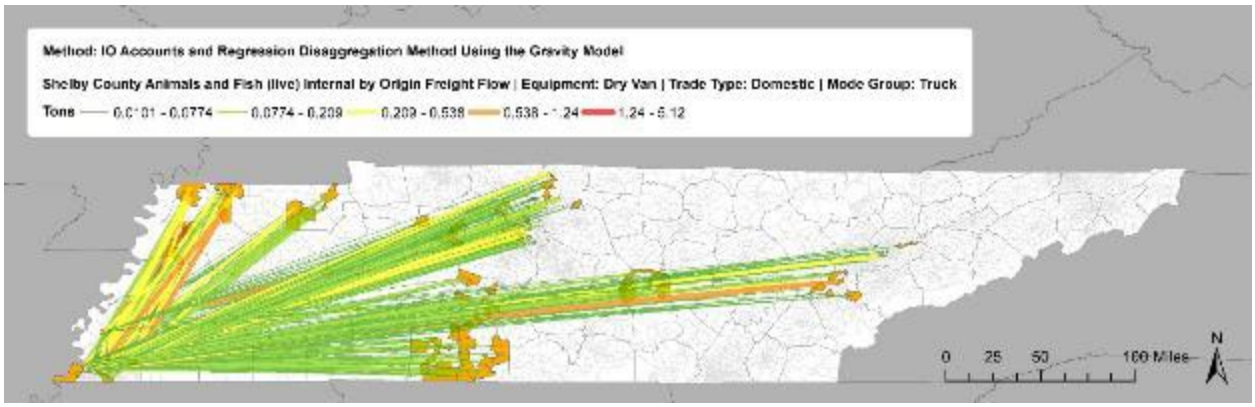


Figure A-156 Example Internal by Origin OD Flow Visualization Using the Outputs from the Regression Disaggregation Method and the Gravity Model Distribution

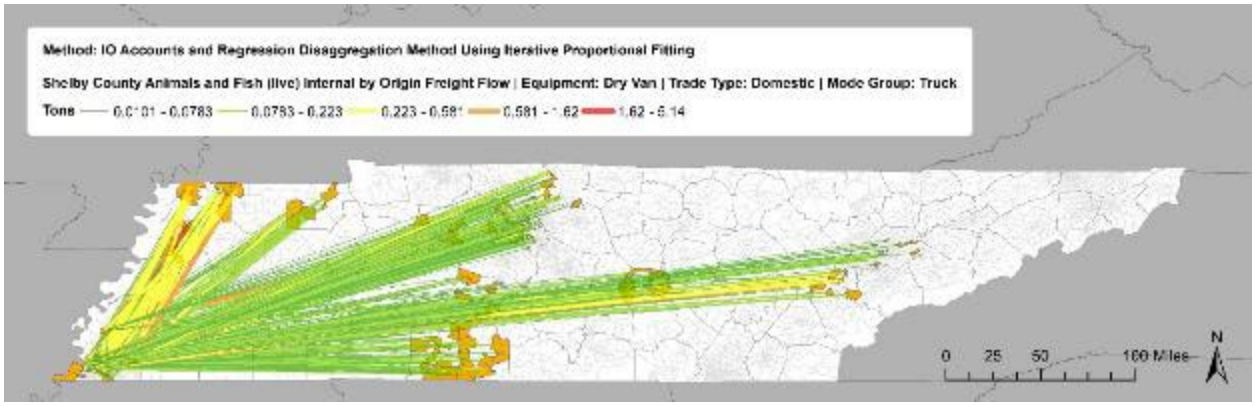


Figure A-157 Example Internal by Origin OD Flow Visualization Using the Outputs from the Regression Disaggregation Method and the Iterative Proportional Fitting

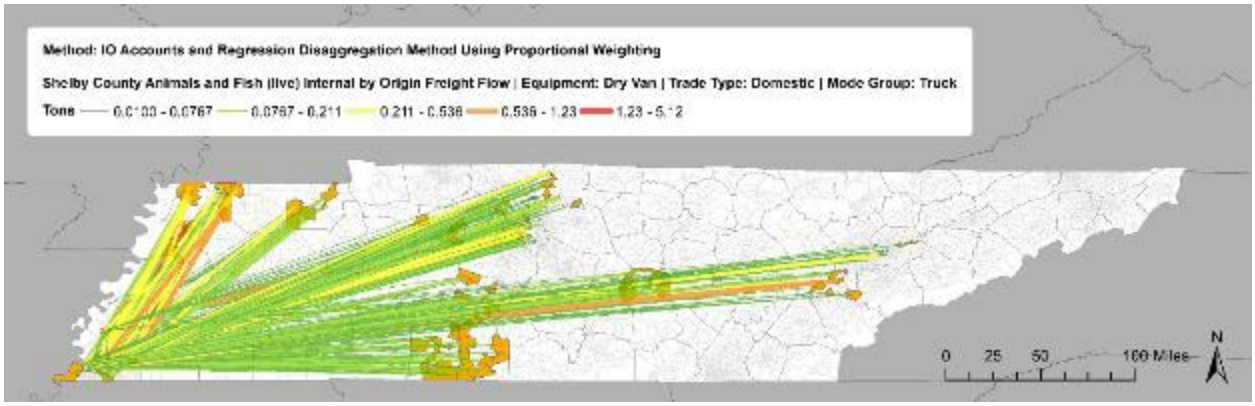


Figure A-158 Example Internal by Origin OD Flow Visualization Using the Outputs from the Regression Disaggregation Method and the Proportional Weighting

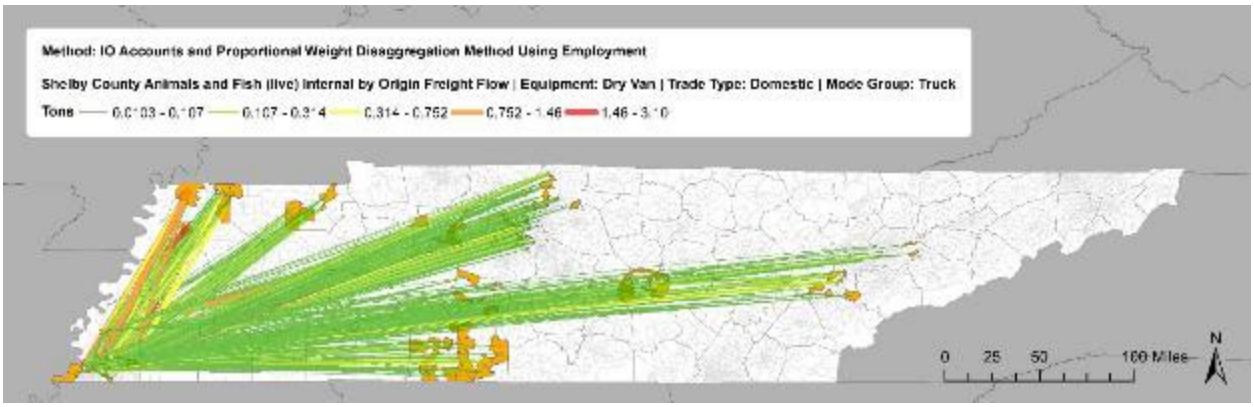


Figure A-159 Example Internal by Origin OD Flow Visualization Using the Outputs from the Proportional Weighting Disaggregation Method Using Employment

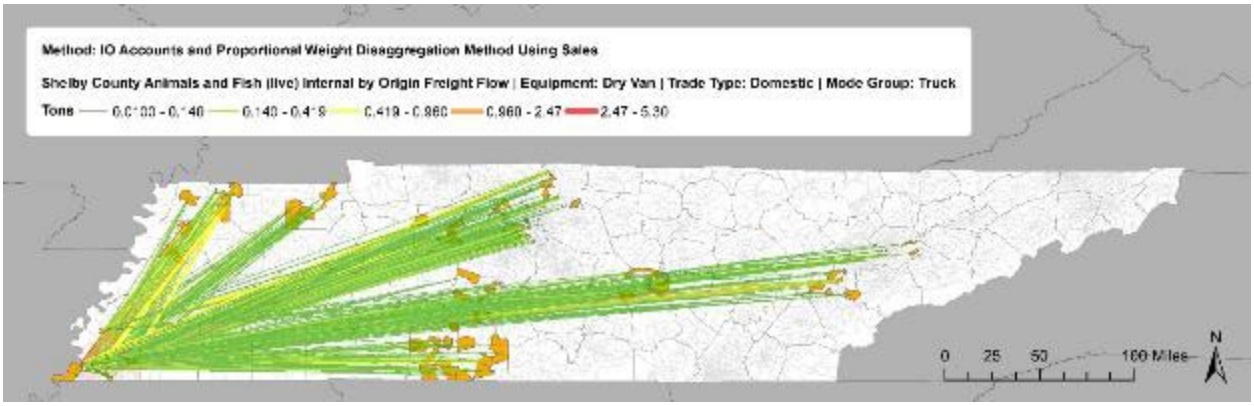


Figure A-160 Example Internal by Origin OD Flow Visualization Using the Outputs from the Proportional Weighting Disaggregation Method Using Value of Sales

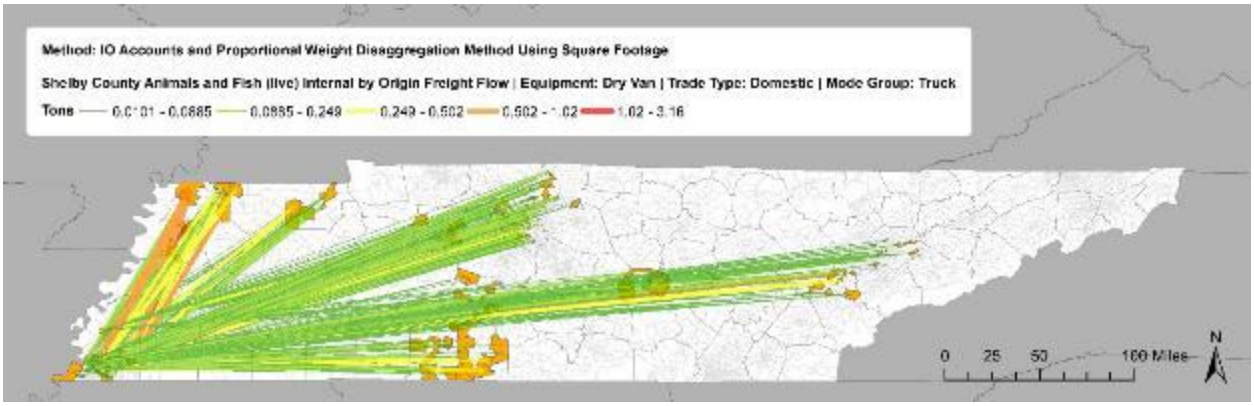


Figure A-161 Example Internal by Origin OD Flow Visualization Using the Outputs from the Proportional Weighting Disaggregation Method Using Square Footage

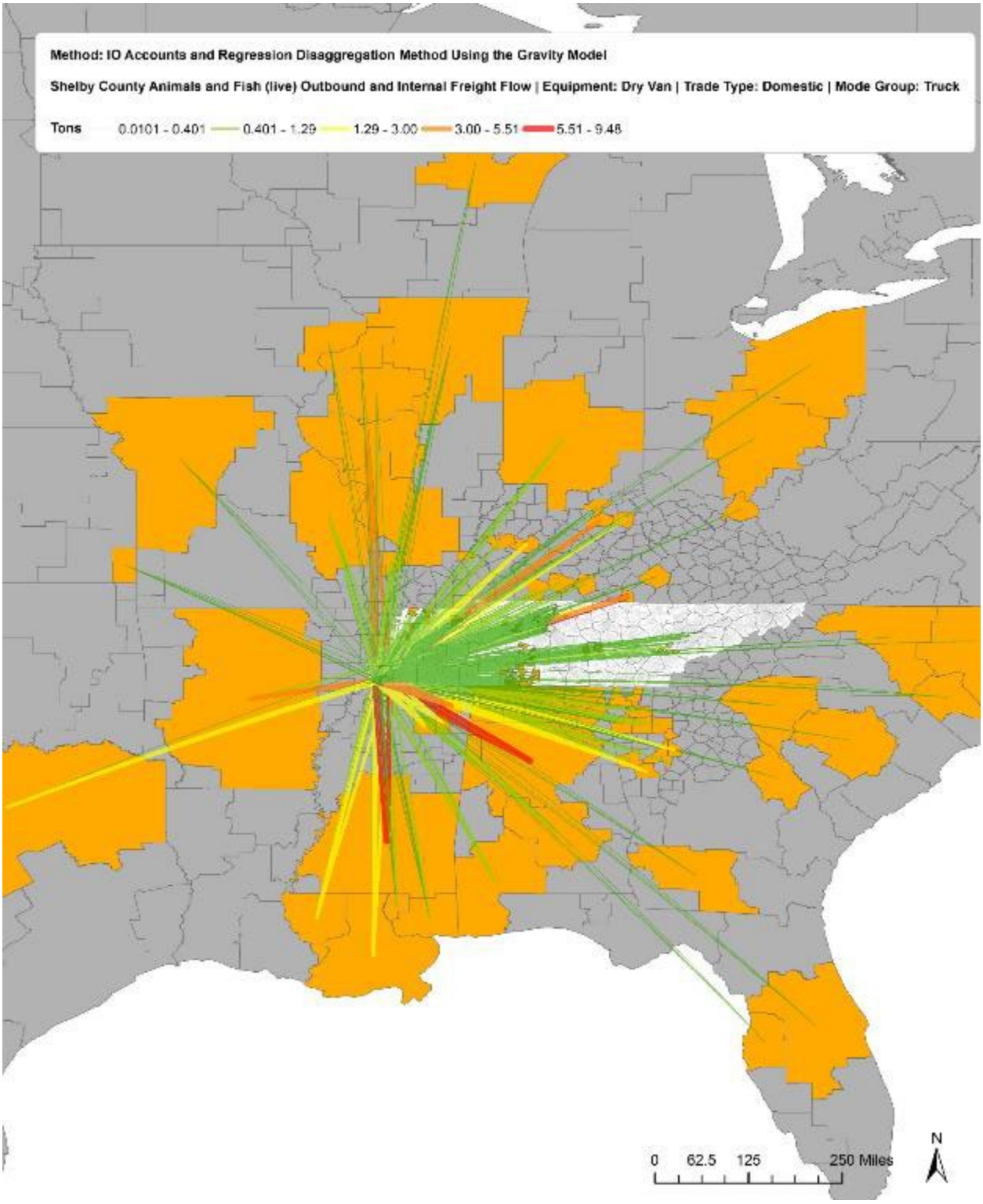


Figure A-162 Example Outbound and Internal OD Flow Visualization Using the Outputs from the Regression Disaggregation Method and the Gravity Model Distribution

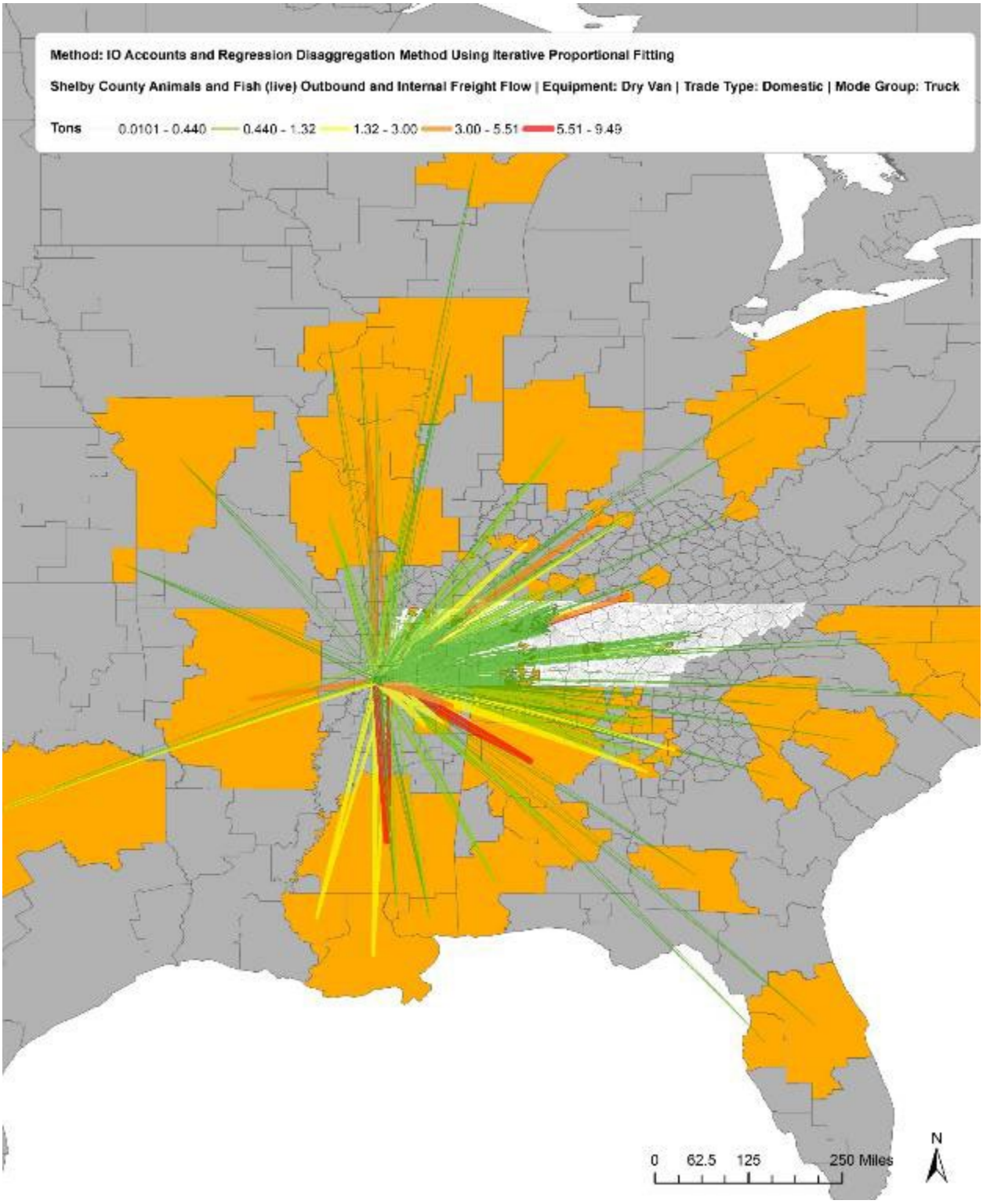


Figure A-163 Example Outbound and Internal OD Flow Visualization Using the Outputs from the Regression Disaggregation Method and the Iterative Proportional Weighting

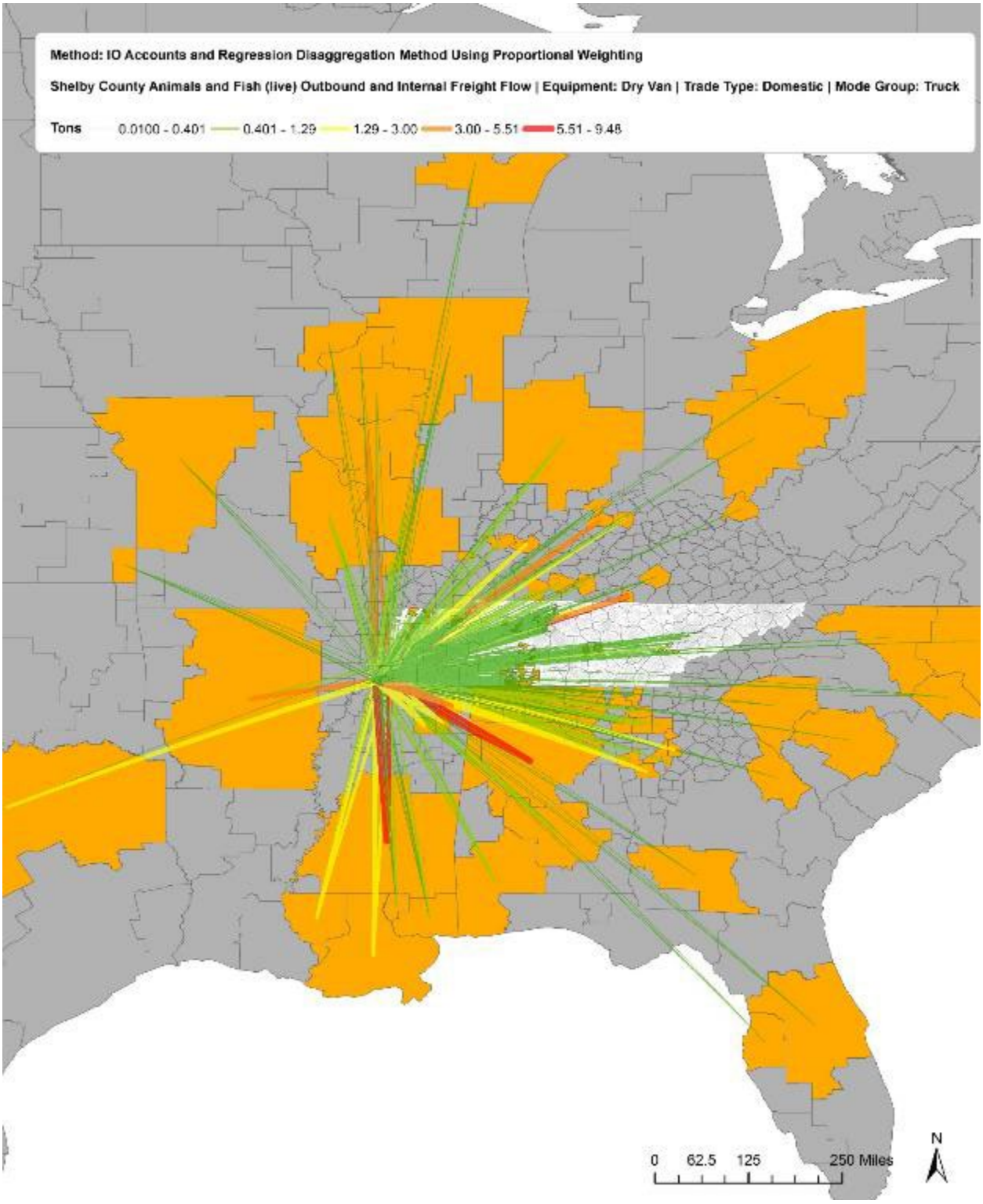


Figure A-164 Example Outbound and Internal OD Flow Visualization Using the Outputs from the Regression Disaggregation Method and the Proportional Weighting

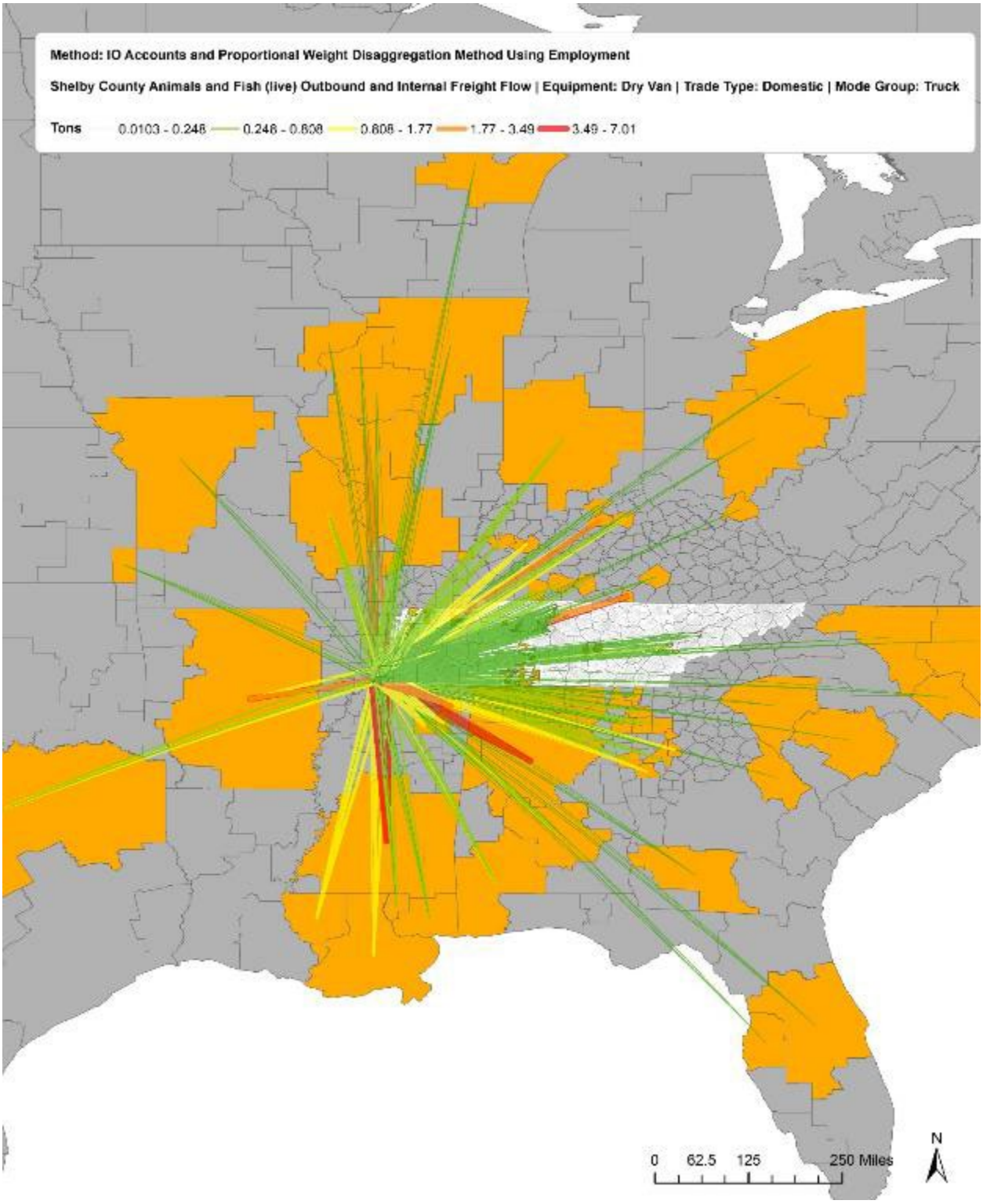


Figure A-165 Example Outbound and Internal OD Flow Visualization Using the Outputs from the Proportional Weighting Disaggregation Method and Employment

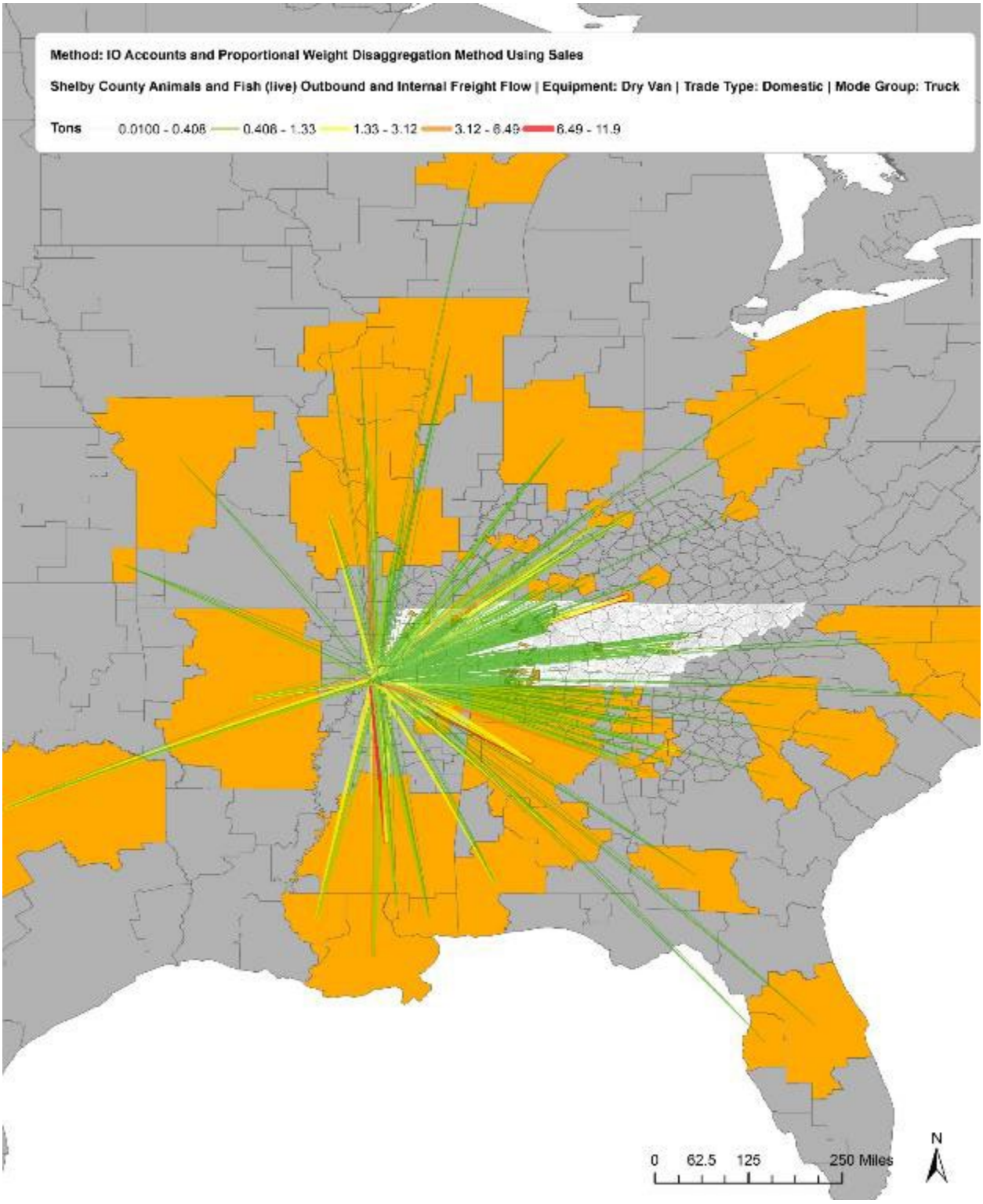


Figure A-166 Example Outbound and Internal OD Flow Visualization Using the Outputs from the Proportional Weighting Disaggregation Method and Value of Sales

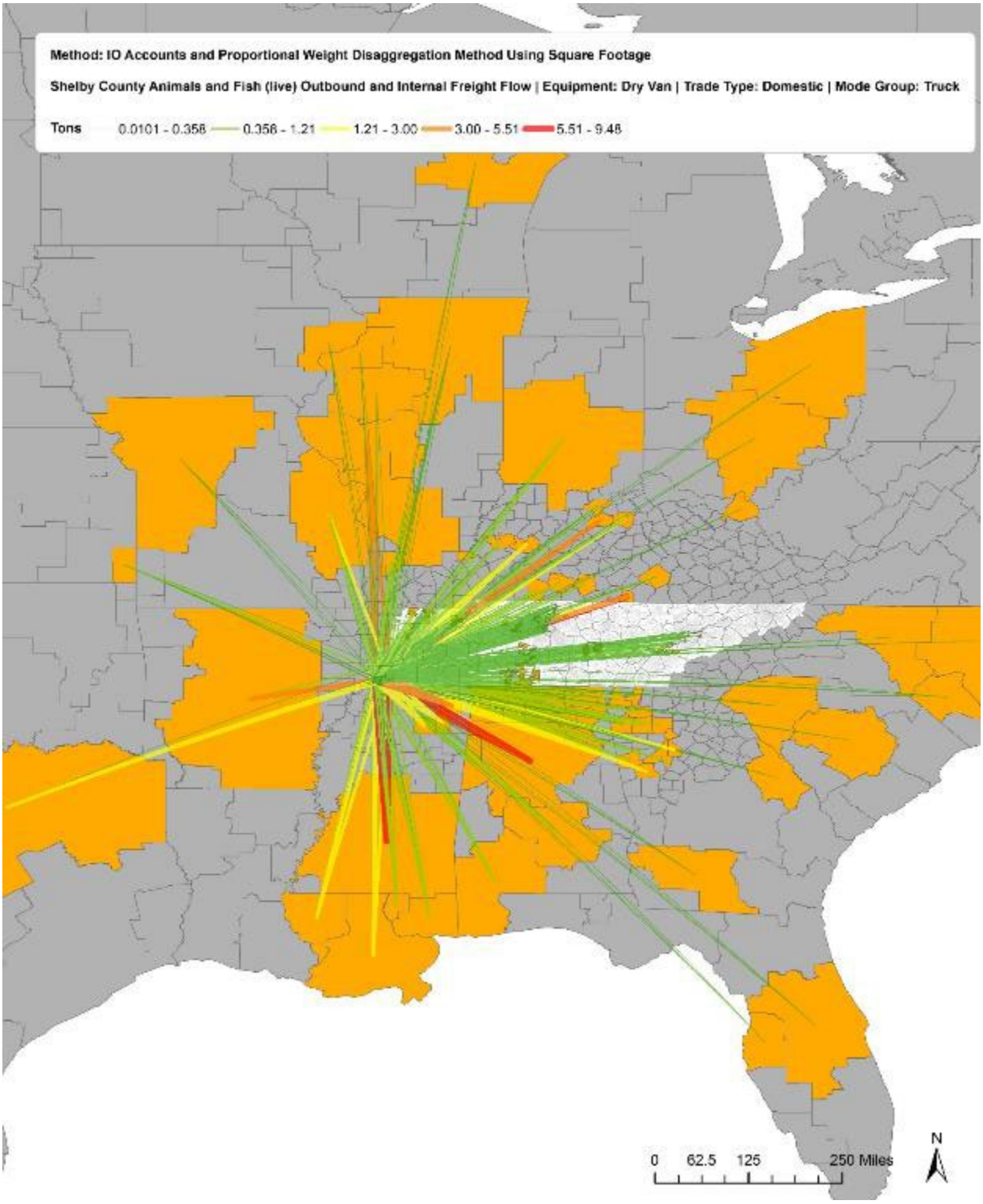


Figure A-167 Example Outbound and Internal OD Flow Visualization Using the Outputs from the Proportional Weighting Disaggregation Method and Square Footage

A.12 Updating OD Map Template

Description

In the case when a new disaggregate zone file is used, the origin-destination map template has to be updated by replacing the **Disaggregate_Zones** file in the **Template_Files.gdb** (see Figure A-168) with a new disaggregate zone file and renamed back to **Disaggregate_Zones.**

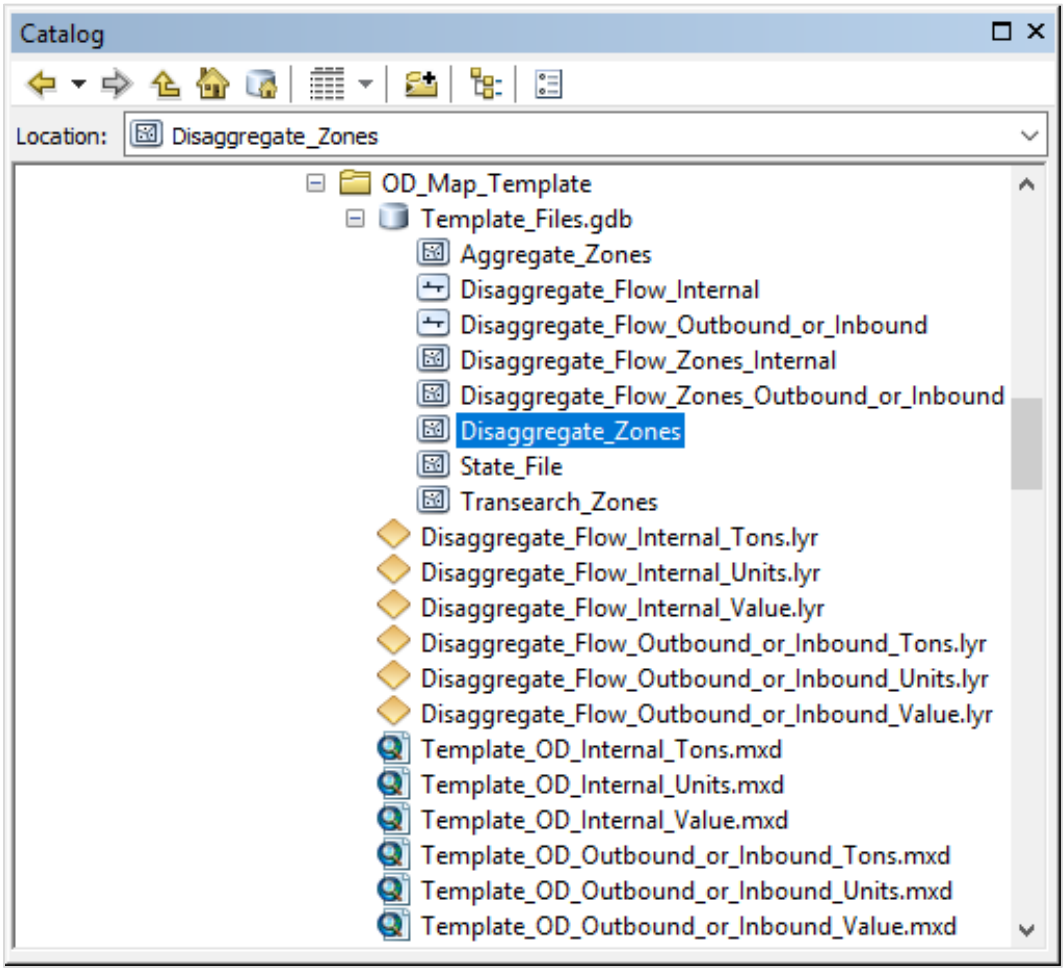


Figure A-168 OD Map Template_Files.gd

Appendix B. Summary of Different Disaggregation Methods

TABLE B-1 SUMMARY OF PROPORTIONAL WEIGHTING DISAGGREGATION METHODS

Study	*Method*	*Objective*	*Spatial Level*	*Commodity Level*	*Modes*	*Freight Data*	*Disaggregation Variables*
Battelle Institute, 2002 (1)	Proportional Weighting	Develop a methodology that allocates FAF2 data to smaller geographies	County	STCC 2-digit and 4-digit	Truck	FAF2	VMT
Zang et al., 2003 (2)	Proportional Weighting	Develop a methodology for statewide intermodal transportation planning by using a public domain database	TAZ	SCTG 2-digit	Truck	CFS	Employment, population
Opie et al., 2009 (3)	Proportional Weighting	Develop methods to disaggregate the FAF2 into small geographic areas that will be used to estimate freight flow trend and directional analysis	County	NAICS 3-digit and 6-digit	Truck, Rail, Water, Air	FAF2, Statewide model	Employment, population, VMT, payroll

Study	*Method*	*Objective*	*Spatial Level*	*Commodity Level*	*Modes*	*Freight Data*	*Disaggregation Variables*
J. R. Wilburn and Associates, Inc., 2017 (4)	Proportional Weighting	Develop a commodity flow assignment methodology that would effectively reflect all freight movement within a community	County and Census tract	SCTG 2-digit	Truck	FAF4	Employment
Shin and Aultman-Hall, 2007 (5)	Proportional Weighting	Develop a nationwide freight analysis zone (FAZ) system	Zip Code, FAZ	NAICS 3-digit level	Truck, rail, water, air, pipeline	CFS	Employment
Cambridge Systematics, Inc., 2013 (13)	Proportional Weighting	Develop truck trip generation data	TAZ	SIC 4-digit level	Truck	ITMS (TRANSEARCH)	Employment, acreage
Southern California Association of Governments, 2012 (7)	Proportional Weighting	Develop a Heavy-Duty Truck model to evaluate important policy choices and investment decisions at Traffic Analysis Zone level	TAZ	NAICS 2-digit	Truck	TRANSEARCH	Employment, acreage, population
Jansuwan et al., 2016 (8)	Proportional Weighting	Develops a two-stage approach to estimate a statewide truck O-D trip Table	County	SCTG 2-digit	Truck	FAF2	Employment, population

Study	*Method*	*Objective*	*Spatial Level*	*Commodity Level*	*Modes*	*Freight Data*	*Disaggregation Variables*
Fischer et al., 2000 (9)	Proportional Weighting with outputs from IO models	Develop urban truck travel demand model	TAZ	STCC 2-digit	Truck	ITMS (TRANSEARCH), IMPLAN	Employment, acreage, population, livestock
Sorratini and Smith, 2000 (10)	Proportional Weighting with outputs from IO models	Develop a statewide truck trip forecasting model based on commodity flows and input-output coefficients	TAZ	STCC 2-digit	Truck	CFS, TRANSEARCH, IMPLAN	Employment, acreage, population
Mitra and Toliver, 2009 (11)	Proportional Weighting with outputs from IO models	Develop a framework for modeling statewide freight movement using publicly available data	TAZ	NAICS 2-digit	Truck	FAF2, Waybill, Air Carrier Statistics, Transborder Freight Database	Employment, population
Giuliano et al., 2010 (12)	Proportional Weighting with outputs from IO models	Develop an automated integration system for freight flow analysis and planning	TAZ	Aggregated commodity categories	Truck, rail, water, air	CFS, IMPLAN	Employment, population

TABLE B-2 SUMMARY OF REGRESSION DISAGGREGATION METHODS

Study	*Method*	*Objective*	*Spatial Level*	*Commodity Level*	*Modes*	*Freight Data*	*Disaggregation Variables*
Viswanathan et al., 2008 (14)	Regression and Proportional weighting	Develop a methodology to disaggregate FAF2 Data for Florida	County	Aggregated commodity categories	Truck	FAF2	Employment, population
Ruan and Lin, 2010 (15)	Regression, Proportional Weighting	Explore different synthesis methodologies to generate high geographic resolution freight outbound shipment data	County	SCTG 2-digit	Truck, rail, water, air, pipeline	FAF2	Employment, the number of inter-modal facilities
Cambridge Systematics, Inc., 2009 (16)	Regression and Proportional Weighting	Develop a method to divide FAF2 regional commodity O-D data for all modes and all commodities to county-level O-D data	County	SCTG 2-digit	Truck, rail, marine, air, pipeline	FAF2, BTS border crossing data	Employment, acreage, population, livestock, electricity generated
Ross et al., 2016 (17)	Regression and Proportional weighting	Disaggregate FAF level commodity flow data to create nationwide truck movement estimates at the county level and the level of GDOT TAZs	County and GDOT TAZ	SCTG 2-digit	Truck	FAF3	Employment, population
Chin and Hwang, 2007 (18)	Cross-classification, Regression, and Proportional Weighting	Develop national freight demand estimation methodology for quantifying freight production/consumption by industries based on business patterns and population	County or Zipcode	NAICS 3-digit	Truck, rail, water, air, pipeline	CFS	Employment, shipment value, payroll, total make value

Study	*Method*	*Objective*	*Spatial Level*	*Commodity Level*	*Modes*	*Freight Data*	*Disaggregation Variables*
Cambridge Systematics, Inc., 2012 (19)	Regression with outputs from IO models and Proportional Weighting	Develop county-level disaggregated FAF2 data for traffic generation, attraction, distribution, and mode split	County	SCTG 2-digit	Truck, rail, water, air, pipeline	FAF2, IMPLAN, Waybill	Employment, acreage, population
Parsons Brinckerhoff, 2009 (20)	Regression with outputs from IO models and Proportional Weighting	Develop a methodology to create a commodity flow forecast	County	STCC 2-digit	Truck, rail, water, air, pipeline	FAF2, IMPLAN, Waybill, Air Carrier Statistics	Employment
Oliveiro-Neto et al., 2013 (21)	Regression with outputs from IO models and Proportional Weighting	Develop a methodology for estimating ton-miles of goods movements for the U.S, freight multimodal network system	County	NAICS 3-digit	Truck, Rail, Water	FAF3, CFS	Population, payroll

TABLE B-3 SUMMARY OF OTHER DISAGGREGATION METHODS

Study	*Method*	*Objective*	*Spatial Level*	*Commodity Level*	*Modes*	*Freight Data*	*Disaggregation Variables*
Prozzi et al., 2006 (22)	Multinomial Logit Model	Develop intercounty and interstate truck travel data in a format to be used as input for Statewide Analysis Model (SAM)	County	Aggregated commodity categories	Truck	CFS, IMPLAN	Fractional attraction and production level of a commodity by county
Harris et al., 2009 (23)	Iterative Proportional Fitting	Develop a methodology to disaggregate national freight origin/destination database using various socioeconomic factors to the local level	County	SCTG 2-digit	Truck, rail, water, air, pipeline	FAF2, TRANSEARCH	Value of sales, personal income, population, employment
Ranaiefar et al., 2013 (24)	Structural equations	Develop structural equation modeling (SEM) framework that makes the most use out of available public data	FAZ	SCTG 2-digit	Truck	FAF3	Employment, number of establishments, population, acreages, GDP, and other
Livshits et al., 2018 (25)	Behavior-based model with outputs from IO models	Develop a methodology for behavior-based freight model	TAZ	STCC 2-digit level	Truck, rail, air, pipeline	FAF4, IMPLAN, Waybill, TRANSEARCH	Employment, population, the value of sales
Momtaz et al., 2020 (26)	Econometric and Proportional Weighting	Develop a fused database from FAF and TRANSEARCH to determine transportation network flows at a fine spatial resolution	County	Aggregated commodity categories	Truck	FAF4, TRANSEARCH	Employment, population

Appendix C. Data Collection

C.1 Business Patterns Databases

TABLE C-1 BUSINESS DYNAMICS STATISTICS (BDS) METADATA

Data Source	Business Dynamics Statistics (BDS)
Agency/Source	U.S. Census
Description	BDS provides measures of the net and gross job flows associated with entering, exiting, expanding, and contracting establishments, including job creation and destruction measures. Aggregate statistics are available at the national and state level, by firm characteristics and industry classification.
Data Type	Business Patterns
Data Info	Employment - job creation and destruction, job expansions and contractions, number of establishments and firms, establishment opening and closing, number of startups and firm shutdowns
Spatial (Smallest Geography)	MSA
Temporal	Annual
Modes of Freight	-
Classification System	SIC
Public/Commercial	Public
URL	URL

TABLE C-2 BUSINESS EMPLOYMENT DYNAMICS (BED) METADATA

Data Source	Business Employment Dynamics (BED)
Agency/Source	Bureau of Labor Statistics (BLS)
Description	BED provides quarterly data on establishment openings, closings, expansions, and contractions by industry and size of the firm and establishment births, deaths, and survival by age for the nation and states.
Data Type	Business Patterns
Data Info	Employment and number establishments by industry, establishment births and deaths
Spatial (Smallest Geography)	County
Temporal	Quarterly
Modes of Freight	-
Classification System	NAICS
Public/Commercial	Public
URL	URL

TABLE C-3 LONGITUDINAL BUSINESS DYNAMICS (LBD) METADATA

Data Source	Longitudinal Business Dynamics (LBD)
Agency/Source	U.S. Census
Description	LBD provides longitudinally linked data for all employer establishments in the Census Bureaus' business register, the Standard Statistical Establishment List (SSEL). Data has information about the annual age of establishment, entry and exit information by the size of establishment, and entry/exit information.
Data Type	Business Patterns
Data Info	Establishment age by initial size and size by sector and state, firm annual age and size by sector, size, and state
Spatial (Smallest Geography)	Census Block
Temporal	Annual
Modes of Freight	-
Classification System	NAICS
Public/Commercial	Public
URL	URL

TABLE C-4 LEHD ORIGIN-DESTINATION EMPLOYMENT STATISTICS (LODES) METADATA

Data Source	LEHD Origin-Destination Employment Statistics (LODES)
Agency/Source	U.S. Census
Description	LODES provides longitudinally linked data of employment statistics, including workplace and residential area characteristics.
Data Type	Business Patterns
Data Info	Workplace and residence census block code, the total number of jobs, number of employments by age group, income group, industry sectors
Spatial (Smallest Geography)	Census Block
Temporal	Annual
Modes of Freight	-
Classification System	NAICS
Public/Commercial	Public
URL	URL

TABLE C-5 NATIONAL ESTABLISHMENT TIME-SERIES (NETS) METADATA

Data Source	National Establishment Time-Series (NETS)
Agency/Source	Walls & Associates
Description	NETS provides time-series data of business establishments, aggregated data from Dun & Bradstreet with refined analysis of employment and business patterns, including sole proprietors, part-time jobs, and farm operations, which are not included in government data sources.
Data Type	Business Patterns
Data Info	Type of establishment, employment at a location, job growth relative to peers, estimated annual sales at the establishment, etc.
Spatial (Smallest Geography)	Facility
Temporal	Annual
Modes of Freight	-
Classification System	NAICS and SIC
Public/Commercial	Commercial
URL	Walls & Associates

C.2 Business Records Databases

TABLE C-6 D&B HOOVERS METADATA

Data Source	D&B Hoovers
Agency/Source	Dun & Bradstreet
Description	D&B Hoovers leverages the world's largest commercial database of 120 million business records.
Data Type	Business Records
Data Info	Business information, categorization by industry, annual sales, employment, identification if business imports or exports, or it is an agent for goods
Spatial (Smallest Geography)	Lat/Long
Temporal	Up-to-date
Modes of Freight	-
Classification System	NAICS and SIC
Public/Commercial	Commercial
URL	URL

TABLE C-7 INFOUSA METADATA

Data Source	InfoUSA
Agency/Source	InfoGroup
Description	InfoUSA provides business and consumer contact databases.
Data Type	Business Records
Data Info	Business information and categorization by industry, annual sales, employment, square footage
Spatial (Smallest Geography)	Lat/Long
Temporal	Up-to-date
Modes of Freight	-
Classification System	NAICS and SIC
Public/Commercial	Commercial
URL	URL

C.3 Freight Flow Databases

TABLE C-8 CARLOAD WAYBILL SAMPLE (WAYBILL) METADATA

Data Source	Carload Waybill Sample (Waybill)
Agency/Source	Surface Transportation Board (STB)
Description	Waybill sample is a sample of carload waybills for all U.S. rail traffic submitted by those rail carriers terminating 4,500 or more revenue carloads annually.
Data Type	Freight Flow Data
Data Info	Sample of railroad shipping and revenue information
Spatial (Smallest Geography)	BEA
Temporal	Annual
Modes of Freight	Rail
Classification System	STCC
Public/Commercial	Public
URL	URL

TABLE C-9 BTS AIR CARRIER STATISTICS METADATA

Data Source	Air Carrier Statistics
Agency/Source	The Bureau of Transportation Statistics (BTS)
Description	The Air Carrier Statistics database contains domestic and international air carrier traffic information on US and foreign air carriers having at least one service point in the United States.
Data Type	Freight Flow Data
Data Info	Airline traffic, airfare, airline on-time data, air carrier financial reports
Spatial (Smallest Geography)	Airport
Temporal	Monthly
Modes of Freight	Air
Classification System	-
Public/Commercial	Public
URL	URL

TABLE C-10 BTS BORDER CROSSING ENTRY DATA METADATA

Data Source	Border Crossing Entry Data
Agency/Source	The Bureau of Transportation Statistics (BTS)
Description	The Border Crossing Entry Data provides summary statistics for inbound crossings at the U.S.-Canadian and the U.S.-Mexican border at the port level.
Data Type	Freight Flow Data
Data Info	The number of vehicles, containers
Spatial (Smallest Geography)	Port
Temporal	Monthly
Modes of Freight	Truck, Rail
Classification System	-
Public/Commercial	Public
URL	URL

TABLE C-11 COMMODITY FLOW SURVEY (CFS) METADATA

Data Source	Commodity Flow Survey (CFS)
Agency/Source	U.S. Census
Description	CFS is a shipper survey of approximately 100,000 establishments from mining, manufacturing, wholesale trade, auxiliaries (i.e., warehouses and distribution centers), and select retail and service trade industries that ship commodities. Data requested by the CFS includes the type of commodities shipped, their origins and destinations, their value and weight, and mode(s) of transport.
Data Type	Freight Flow Data
Data Info	Type, origin and destination, value, weight, modes of transportation, distance shipped, and ton-miles of commodities shipped
Spatial (Smallest Geography)	CSA or MSA
Temporal	Every five years
Modes of Freight	Truck, Rail, Air, Water, Pipeline, Other
Classification System	NAICS and SCTG
Public/Commercial	Public
URL	URL

TABLE C-12 ENERGY INFORMATION ADMINISTRATION (EIA) ENERGY-RELATED DATA METADATA

Data Source	Energy-Related Statistics
Agency/Source	Energy Information Administration (EIA)
Description	EIA collects, analyzes, and disseminates independent and impartial energy information to promote policymaking, efficient markets, and public understanding of energy and its interaction with the economy and the environment.
Data Type	Freight Flow Data
Data Info	Location of coal mines, all types of power plants, oil/gas refining, and processing, uranium productions, market hubs, pipelines and transmissions, other transport and storage locations. Quarterly domestic coal distribution, by origin state and by mode. Fossil fuels, nuclear electric power, renewable energy.
Spatial (Smallest Geography)	County
Temporal	Annual
Modes of Freight	Truck, Rail, Water
Classification System	Electric power sector
Public/Commercial	Public
URL	URL

TABLE C-13 FREIGHT ANALYSIS FRAMEWORK (FAF) METADATA

Data Source	Freight Analysis Framework (FAF)
Agency/Source	Federal Highway Administration (FHWA)
Description	FAF is data from various sources to create a comprehensive picture of freight movement among states and major metropolitan areas by all modes of transportation.
Data Type	Freight Flow Data
Data Info	Tonnage, value, units, ton-miles by regions of origin and destination, commodity type and mode
Spatial (Smallest Geography)	CSA or MSA
Temporal	Every five years
Modes of Freight	Truck, Rail, Air, Water, Pipeline, Other
Classification System	SCTG
Public/Commercial	Public
URL	URL

TABLE C-14 IMPLAN METADATA

Data Source	IMPLAN
Agency/Source	IMPLAN
Description	MPLAN provides economic indicators regarding production, employment, final demand. IMPLAN's data includes trade flow information, giving users special insight into how goods and services move between economies. Data is constructed from publicly available data sources.
Data Type	Freight Flow Data
Data Info	Commodity production and consumption by industry and institutions
Spatial (Smallest Geography)	Zip Code
Temporal	Annual
Modes of Freight	-
Classification System	IMPLAN commodities
Public/Commercial	Commercial
URL	URL

TABLE C-15 BTS NORTH AMERICAN TRANSBORDER FREIGHT DATABASE METADATA

Data Source	North American Transborder Freight Database
Agency/Source	The Bureau of Transportation Statistics (BTS)
Description	The Transborder Freight Database contains freight flow information by commodity type and mode for U.S. exports and imports from Canada and Mexico.
Data Type	Freight Flow Data
Data Info	Value, weight shipments by commodity, a port of entry or exit
Spatial (Smallest Geography)	Port
Temporal	Monthly
Modes of Freight	Truck, Rail, Air, Water, Pipeline, Other
Classification System	HS
Public/Commercial	Public
URL	URL

TABLE C-16 PORT IMPORT/EXPORT REPORTING SERVICE (PIERS) METADATA

Data Source	Port Import/Export Reporting Service (PIERS)
Agency/Source	IHS PIERS
Description	PIERS database provides information on U.S. foreign waterborne imports and exports. The database also reports trade shipment statistics for cargo movements between ports in Mexico and South America to major trade partners worldwide.
Data Type	Freight Flow Data
Data Info	Date, vessel, location, a port of discharge, description of goods, weight, number of containers
Spatial (Smallest Geography)	Port
Temporal	Monthly
Modes of Freight	Water
Classification System	HS
Public/Commercial	Commercial
URL	URL

TABLE C-17 ITA TRADESTATS EXPRESS - NATIONAL TRADE DATA METADATA

Data Source	TradeStats Express - National Trade Data
Agency/Source	International Trade Administration (ITA)
Description	TradeStats Express displays the latest annual U.S. merchandise trade statistics at national and state levels. Data is represented as maps, graphs, and Tables as exports, imports, and trade balances and custom-tailored to your year and dollar ranges and display preferences.
Data Type	Freight Flow Data
Data Info	State-by-state exports ($) and imports to a selected market
Spatial (Smallest Geography)	State
Temporal	Annual
Modes of Freight	-
Classification System	NAICS
Public/Commercial	Public
URL	URL

TABLE C-18 TRANSEARCH METADATA

Data Source	TRANSEARCH
Agency/Source	IHS Global Insight
Description	TRANSEARCH is an annual database of U.S. county-level freight movement data used for freight modeling and forecasting.
Data Type	Freight Flow Data
Data Info	Tonnage, value, ton-miles by regions of origin and destination, commodity type and mode
Spatial (Smallest Geography)	County/TAZ
Temporal	Annual
Modes of Freight	Truck, Rail, Air, Water, Pipeline, Other
Classification System	STCC
Public/Commercial	Commercial
URL	URL

TABLE C-19 TREDIS TREDPLAN-REGIONS METADATA

Data Source	**Tredis**
Agency/Source	TREDPLAN-Regions
Description	TREDPLAN-Regions gives an analyst a flexible way of examining how regional and state growth and transportation needs will be affected by future changes in the economy, technology, climate, and trade.
Data Type	Freight Flow Data
Data Info	Value, tonnage, TEUs, truckloads, autonomous and connected truck fleets, growth/decline in GDP, employment, wages by industry, occupation by area
Spatial (Smallest Geography)	County
Temporal	-
Modes of Freight	Freight
Classification System	-
Public/Commercial	Commercial
URL	URL

C.4 Geospatial Databases

TABLE C-20 FEDERAL RAILROAD ADMINISTRATION (FRA) GEOGRAPHIC INFORMATION SYSTEM METADATA

Data Source	Geographic Information System
Agency/Source	Federal Railroad Administration (FRA)
Description	FRA provides railroad infrastructure for passenger rail, rail 1s, mainline rail, STRACNET, grade crossings.
Data Type	Geospatial data
Data Info	Rail network
Spatial (Smallest Geography)	Link
Temporal	-
Modes of Freight	Rail
Classification System	-
Public/Commercial	Public
URL	URL

TABLE C-21 HIGHWAY PERFORMANCE MONITORING SYSTEM (HPMS) METADATA

Data Source	Highway Performance Monitoring System (HPMS)
Agency/Source	Federal Highway Administration (FHWA)
Description	The HPMS is a national-level highway information system that includes data on the extent, condition, performance, use, and operating characteristics of the nation's highways. The HPMS contains administrative and extent of system information on all public roads, while information on other characteristics is represented in HPMS as a mix of universe and sample data for arterial and collector functional systems. Limited information on travel and paved miles is included in summary form for the lowest functional systems.
Data Type	Geospatial data
Data Info	Highway network and AADT, AADT_Single_Unit Truck and Bus AADT, AADT_Combination (Combination Truck AADT)
Spatial (Smallest Geography)	Link
Temporal	Annual
Modes of Freight	Truck
Classification System	-
Public/Commercial	Public
URL	URL

TABLE C-22 THE BUREAU OF TRANSPORTATION STATISTICS (BTS) INTERMODAL FREIGHT FACILITIES METADATA

Data Source	Intermodal Freight Facilities
Agency/Source	The Bureau of Transportation Statistics (BTS)
Description	Intermodal Freight Facilities is a spatial Table of intermodal facilities, type, mode type, association.
Data Type	Geospatial Data
Data Info	Intermodal facilities
Spatial (Smallest Geography)	Facility
Temporal	-
Modes of Freight	Truck, Rail, Air, Port
Classification System	-
Public/Commercial	Public
URL	URL

TABLE C-23 MULTIMODAL FREIGHT NETWORK (MFN)

Data Source	Multimodal Freight Network (MFN)
Agency/Source	The Bureau of Transportation Statistics (BTS)
Description	Multimodal Freight Network (MFN) encompasses highways and the local roads, railways, navigable waterways, pipelines, key seaports, airports, and intermodal facilities.
Data Type	Geospatial data
Data Info	Network Data
Spatial (Smallest Geography)	Link or node
Temporal	-
Modes of Freight	Truck, Rail, Air, Water, Pipeline, Other
Classification System	-
Public/Commercial	Public
URL	URL

TABLE C-24 NATIONAL HIGHWAY PLANNING NETWORK (NHPN) METADATA

Data Source	National Highway Planning Network (NHPN)
Agency/Source	Federal Highway Administration (FHWA)
Description	NHPN is a geospatial network database that contains line features representing just over 450,000 miles of highways in the United States. The NHPN contains geospatially referenced information on the National Highway System (NHS), the Eisenhower Interstate System, the Strategic Highway Network (STRAHNET), and NHS Intermodal Connectors.
Data Type	Geospatial Data
Data Info	Highway network
Spatial (Smallest Geography)	Link
Temporal	-
Modes of Freight	Truck
Classification System	-
Public/Commercial	Public
URL	URL

TABLE C-25 BTS NATIONAL TRANSPORTATION ATLAS DATABASE METADATA

Data Source	National Transportation Atlas Database
Agency/Source	The Bureau of Transportation Statistics (BTS)
Description	The National Transportation Atlas Database is a geospatial database by mode.
Data Type	Geospatial data
Data Info	Network Data
Spatial (Smallest Geography)	Link or node
Temporal	-
Modes of Freight	Truck, Rail, Air, Water, Pipeline, Other
Classification System	-
Public/Commercial	Public
URL	URL

TABLE C-26 NATIONAL TRANSPORTATION RESEARCH CENTER METADATA

Data Source	National Transportation Research Center
Agency/Source	Oak Ridge National Laboratory (ORLN)
Description	ORLN prepares modal networks and skim Tables for use in transportation analysis, including CFS preparation. These modal networks and county-to-county Tables show the level of service by each mode.
Data Type	Geospatial data
Data Info	Network Data
Spatial (Smallest Geography)	Link
Temporal	
Modes of Freight	Truck, Rail, Air, Water, and Pipeline
Classification System	-
Public/Commercial	Public
URL	URL

TABLE C-27 OFFICE OF PIPELINE SAFETY (OPS) METADATA

Data Source	Office of Pipeline Safety (OPS)
Agency/Source	Pipeline and Hazardous Materials Safety Administration (PHMSA)
Description	OPS provides various data about federally-regulated and state-regulated natural gas pipelines, hazardous liquid pipelines, and liquefied natural gas (LNG) plants.
Data Type	Geospatial data
Data Info	Gas and liquid pipelines network, commercially navigable waterways inland, ocean, and Great lakes
Spatial (Smallest Geography)	Link
Temporal	-
Modes of Freight	-
Classification System	-
Public/Commercial	Public
URL	URL

C.5 Probe Databases

TABLE C-28 ATRI METADATA

Data Source	ATRI
Agency/Source	The American Transportation Research Institute (ATRI)
Description	ATRI collects truck position data throughout the U.S. and North America from a large sample of trucks that use onboard, wireless communications systems.
Data Type	Probe Data
Data Info	Truck ID, geographic information at lat/long level, and temporal information regarding the location of a truck
Spatial (Smallest Geography)	Lat/long
Temporal	Second
Modes of Freight	Truck
Classification System	-
Public/Commercial	Commercial
URL	URL

TABLE C-29 STREETLIGHT GPS DATA METADATA

Data Source	StreetLight GPS Data
Agency/Source	StreetLight
Description	StreetLight provides GPS data by type of vehicle, weight rating, and trip purpose by type of land use.
Data Type	Probe Data
Data Info	Truck ID, geographic information at lat/long level, and temporal information regarding the location of a truck, trip starting and endpoints
Spatial (Smallest Geography)	Lat/long
Temporal	Second
Modes of Freight	Truck
Classification System	-
Public/Commercial	Commercial
URL	URL

TABLE C-30 INRIX ROADWAY ANALYTICS METADATA

Data Source	INRIX
Agency/Source	NRIX Roadway Analytics
Description	INRIX Roadway Analytics is an on-demand, cloud-based analytics suite that leverages INRIX global traffic data to help public agencies and consultants more effectively monitor, measure, and manage road networks' performance.
Data Type	Probe Data
Data Info	Travel time, speed, and cost data, geographic information of corridor segment, and temporal information
Spatial (Smallest Geography)	Road segment
Temporal	1 min
Modes of Freight	Trucks, cars
Classification System	-
Public/Commercial	Commercial
URL	URL

TABLE C-31 MARITIME INTELLIGENCE METADATA

Data Source	Maritime Intelligence
Agency/Source	Lloyds List Intelligence
Description	Lloyds List Intelligence provides business information services to the local maritime community. Detailed vessel movements, real-time Automatic Identification System (AIS) positioning, comprehensive information on ships, companies, ports, casualties, credit reports, industry data, and analysis, including short-term market outlook reports.
Data Type	Transportation Statistics and Probe Data
Data Info	Freight rates, trade volumes, fleet size, and charter rates, handled commodities at terminals
Spatial (Smallest Geography)	Facility
Temporal	Up-to-date
Modes of Freight	Water
Classification System	Lloyds commodities
Public/Commercial	Commercial
URL	URL

C.6 Socioeconomic Databases

TABLE C-32 LOCAL AREA UNEMPLOYMENT STATISTICS (LAUS) METADATA

Data Source	Local Area Unemployment Statistics (LAUS)
Agency/Source	Bureau of Labor Statistics (BLS)
Description	LAUS program produces monthly and annual employment, unemployment, and labor force data for Census regions and divisions, States, counties, metropolitan areas, and many cities, by place of residence.
Data Type	Socioeconomic Data
Data Info	Labor force, employment, unemployment, the unemployment rate
Spatial (Smallest Geography)	County, City
Temporal	Monthly
Modes of Freight	-
Classification System	-
Public/Commercial	Public
URL	URL

TABLE C-33 BEA REGIONAL ECONOMIC ACCOUNTS METADATA

Data Source	Regional Economic Accounts
Agency/Source	Bureau of Economic Analysis (BEA)
Description	The Regional Economic Accounts tell us about the geographic distribution of U.S. economic activity and growth. The estimates of gross domestic product by state and state and local area personal income, and the accompanying detail, provide a consistent framework for analyzing and comparing individual state and local area economies.
Data Type	Socioeconomic Data
Data Info	Consumer spending by state, employment, GDP, personal income, real personal income by county, regional parities by metro area
Spatial (Smallest Geography)	County
Temporal	Annual
Modes of Freight	-
Classification System	NAICS and SIC
Public/Commercial	Public
URL	URL

TABLE C-34 AMERICAN COMMUNITY SURVEY (ACS) METADATA

Data Source	American Community Survey (ACS)
Agency/Source	U.S. Census Bureau
Description	The American Community Survey (ACS) is part of the U.S. Census Bureau's Decennial Census Program and is designed to provide current social, economic, housing, and demographic estimates throughout the decade.
Data Type	Socioeconomic Data
Data Info	Income and population
Spatial (Smallest Geography)	Census Tract
Temporal	Annual
Modes of Freight	-
Classification System	-
Public/Commercial	Public
URL	URL

C.7 Socioeconomic Databases by Commodity

TABLE C-35 CONSUMER EXPENDITURE SURVEYS (CE) METADATA

Data Source	Consumer Expenditure Surveys (CE)
Agency/Source	Bureau of Labor Statistics (BLS)
Description	The Consumer Expenditure Survey (CE) collects information from the Nation's households and families on their buying habits (expenditures), income, and characteristics.
Data Type	Socioeconomic Data by Commodity
Data Info	Income, expenditures by the household
Spatial (Smallest Geography)	Metro Area
Temporal	Annual
Modes of Freight	-
Classification System	Commodity
Public/Commercial	Public
URL	URL

TABLE C-36 MINERAL COMMODITY SUMMARIES METADATA

Data Source	Mineral Commodity Summaries
Agency/Source	US Geological Survey (USGS)
Description	USGS provides Mineral Commodity Summaries data sheets contain information on the domestic industry structure, Government programs, tariffs, and 5-year salient statistics for over 90 individual minerals and materials.
Data Type	Socioeconomic Data by Commodity
Data Info	Value of mineral productions by the state in dollars, employment by commodity produced
Spatial (Smallest Geography)	State
Temporal	Annual
Modes of Freight	-
Classification System	Commodity
Public/Commercial	Public
URL	URL

TABLE C-37 NATIONAL AGRICULTURAL STATISTICS SERVICE (NASS) METADATA

Data Source	National Agricultural Statistics Service (NASS)
Agency/Source	United States Department of Agriculture (USDA)
Description	NASS publishes U.S., State, County, and other geographic level agricultural statistics for many commodities and data series. Quick Stats is a web-based application that gives you the ability to query the agricultural census and survey statistics.
Data Type	Socioeconomic Data by Commodity
Data Info	Employment by commodity, acreage by commodity, animals, and products
Spatial (Smallest Geography)	County
Temporal	Annual
Modes of Freight	-
Classification System	Commodity
Public/Commercial	Public
URL	URL

C.8 Socioeconomic Databases by Industry

TABLE C-38 ANNUAL RETAIL TRADE SURVEY (ARTS) METADATA

Data Source	Annual Retail Trade Survey (ARTS)
Agency/Source	U.S. Census Bureau
Description	ARTS produces industry-level estimates of sales, expenses, and other items for the retail sector in the U.S. each year.
Data Type	Socioeconomic Data by Industry
Data Info	Total annual sales, e-commerce sales, sales taxes, end-of-year inventories, purchases, total operating expenses, gross margins, and end-of-year accounts receivable for retail businesses
Spatial (Smallest Geography)	National
Temporal	Annual
Modes of Freight	-
Classification System	NAICS
Public/Commercial	Public
URL	URL

TABLE C-39 ANNUAL SURVEY OF MANUFACTURES (ASM) METADATA

Data Source	Annual Survey of Manufactures (ASM)
Agency/Source	U.S. Census Bureau
Description	ASM provides sample estimates of statistics for all manufacturing establishments with one or more paid employees.
Data Type	Socioeconomic Data by Industry
Data Info	Employment, payroll, worker hours, payroll supplements, cost of materials, selected operating expenses, value added by manufacturing, capital expenditures, inventories, and energy consumption
Spatial (Smallest Geography)	State
Temporal	Annual
Modes of Freight	-
Classification System	NAICS
Public/Commercial	Public
URL	URL

TABLE C-40 BUREAU OF ECONOMIC ANALYSIS (BEA) INPUT/OUTPUT TABLES METADATA

Data Source	Bureau of Economic Analysis (BEA) Input/Output Tables
Agency/Source	Bureau of Economic Analysis (BEA)
Description	I/O analysis is an economic tool that measures the relationships between various industries in the economy. I/O Tables show the commodity inputs used by each industry to produce its output, the commodities produced by each industry, and the use of commodities by final consumers.
Data Type	Socioeconomic Data by Industry
Data Info	GDP, personal income, prices and inflation, employment by industry
Spatial (Smallest Geography)	National
Temporal	Annual
Modes of Freight	-
Classification System	SCTG
Public/Commercial	Public
URL	URL

TABLE C-41 COUNTY AND ZIP CODE BUSINESS PATTERNS (CBP) (ZBP) METADATA

Data Source	County and Zip Code Business Patterns (CBP) (ZBP)
Agency/Source	U.S. Census Bureau
Description	CBP and ZBP is an annual series that provides subnational economic data by industry. This series includes the number of establishments, employment during the week of March 12, first quarter payroll, and annual payroll.
Data Type	Socioeconomic Data by Industry
Data Info	Employment, number of establishments, payroll by industry
Spatial (Smallest Geography)	County and Zipcode
Temporal	Annual
Modes of Freight	-
Classification System	6-digit NAICS
Public/Commercial	Public
URL	URL

TABLE C-42 CURRENT EMPLOYMENT STATISTICS (CES) METADATA

Data Source	Current Employment Statistics (CES)
Agency/Source	Bureau of Labor Statistics (BLS)
Description	CES program produces detailed industry estimates of nonfarm employment, hours, and earnings of workers on payrolls. CES National Estimates produces data for the nation, and CES State and Metro Area produces estimates for all 50 States, the District of Columbia, Puerto Rico, the Virgin Islands, and about 450 metropolitan areas and divisions.
Data Type	Socioeconomic Data by Industry
Data Info	Nonfarm employment, hours, earnings by industry
Spatial (Smallest Geography)	Metro Area
Temporal	Monthly
Modes of Freight	-
Classification System	NAICS
Public/Commercial	Public
URL	URL

TABLE C-43 ECONOMIC CENSUS METADATA

Data Source	Economic Census
Agency/Source	U.S. Census Bureau
Description	The Economic Census provides detailed information on employer businesses, including detailed data by industry, geography, and more. The first data release will be in September 2019.
Data Type	Socioeconomic Data by Industry
Data Info	Total number of establishments, the value of sales, shipments, receipts, revenue, primary business activity, the total number of employees, total annual payroll, total first-quarter payroll, and industry-specific statistics
Spatial (Smallest Geography)	Zip Code
Temporal	Every five years
Modes of Freight	-
Classification System	NAICS and NAPCS
Public/Commercial	Public
URL	URL

TABLE C-44 BEA INDUSTRY ECONOMIC ACCOUNTS METADATA

Data Source	Industry Economic Accounts
Agency/Source	Bureau of Economic Analysis (BEA)
Description	The Industry Economic Accounts, presented both in an input-output framework and as annual output by each industry, provide a detailed view of the interrelationships between U.S. producers and users and the contribution to production across industries. These accounts are used extensively by policymakers and businesses to understand industry interactions, productivity trends, and the U.S. economy's changing structure.
Data Type	Socioeconomic Data by Industry
Data Info	GDP by industry, gross output by industry, input-output accounts, employment by sector, integrated industry-level production account (KLEMS)
Spatial (Smallest Geography)	National
Temporal	Annual
Modes of Freight	-
Classification System	NAICS and SIC
Public/Commercial	Public
URL	URL

TABLE C-45 NATIONAL INCOME AND PRODUCT ACCOUNTS (NIPA) METADATA

Data Source	National Income and Product Accounts (NIPA)
Agency/Source	Bureau of Economic Analysis (BEA)
Description	NIPA Tables present the value and composition of national output and the types of incomes generated in its production.
Data Type	Socioeconomic Data by Industry
Data Info	Income and employment by industry, GDP, GDI, national income, corporate profits, government receipts and expenditures, personal income and disposable income, personal consumption expenditures, personal savings
Spatial (Smallest Geography)	National
Temporal	Annual
Modes of Freight	-
Classification System	NAICS and SIC
Public/Commercial	Public
URL	URL

TABLE C-46 NONEMPLOYER STATISTICS (NES) METADATA

Data Source	Nonemployer Statistics (NES)
Agency/Source	US Census Bureau
Description	NES is an annual series that provides subnational economic data for businesses with no paid employees and are subject to federal income tax. This series includes the number of businesses and total receipts by industry.
Data Type	Socioeconomic Data by Industry
Data Info	The number of establishments and receipts are published by geographic area, NAICS industry, and a receipts-size class of establishments
Spatial (Smallest Geography)	County and MSA
Temporal	Annual
Modes of Freight	-
Classification System	NAICS
Public/Commercial	Public
URL	URL

TABLE C-47 OCCUPATIONAL EMPLOYMENT STATISTICS (OES) METADATA

Data Source	Occupational Employment Statistics (OES)
Agency/Source	Bureau of Labor Statistics (BLS)
Description	OES program produces employment and wage estimates annually for over 800 occupations. These estimates are available for the nation, individual states, and/or metropolitan and nonmetropolitan areas; national occupational estimates for specific industries are also available.
Data Type	Socioeconomic Data by Industry
Data Info	Employment, hourly wage by occupational title
Spatial (Smallest Geography)	Metro Area
Temporal	Semiannual
Modes of Freight	-
Classification System	SIC and NAICS
Public/Commercial	Public
URL	URL

TABLE C-48 QUARTERLY CENSUS OF EMPLOYMENT AND WAGES (QCEW) METADATA

Data Source	Quarterly Census of Employment and Wages (QCEW)
Agency/Source	Bureau of Labor Statistics (BLS)
Description	QCEW program publishes a quarterly count of employment and wages reported by employers covering more than 95 percent of U.S. jobs, available at the county, MSA, state, and national levels by industry.
Data Type	Socioeconomic Data by Industry
Data Info	Employment, wages, by industry and population
Spatial (Smallest Geography)	County
Temporal	Quarterly
Modes of Freight	-
Classification System	NAICS
Public/Commercial	Public
URL	URL

TABLE C-49 STATISTICS OF US BUSINESSES (SUSB) METADATA

Data Source	Statistics of US Businesses (SUSB)
Agency/Source	US Census Bureau
Description	SUSB is an annual series that provides national and subnational data on the distribution of economic data by enterprise size and industry. The series excludes data on nonemployer businesses, private households, railroads, agricultural production, and most government entities.
Data Type	Socioeconomic Data by Industry
Data Info	Number of firms, number of establishments, annual payroll, and employment
Spatial (Smallest Geography)	County
Temporal	Annual
Modes of Freight	-
Classification System	NAICS
Public/Commercial	Public
URL	URL

TABLE C-50 WORKFORCE INFORMATION DATABASE (WID) METADATA

Data Source	Workforce Information Database (WID)
Agency/Source	Analyst Resource Center (ARC)
Description	WID is a standardized database structure developed to store and disseminate local, state, regional, and national workforce information on the economy, industry, labor supply and demand, and other aspects of and areas affected by the U.S. workforce.
Data Type	Socioeconomic Data by Industry
Data Info	Employment, wages, income, layoffs, industries, occupations, employers, education and training completers, educational programs, population demographics, selected economic indicators, and other data
Spatial (Smallest Geography)	Varies
Temporal	Annual
Modes of Freight	-
Classification System	NAICS
Public/Commercial	Public
URL	URL

C.9 Socioeconomic Forecast Databases

TABLE C-51 IHS MARKIT METADATA

Data Source	IHS Markit
Agency/Source	IHS Markit
Description	IHS Markit county-level macroeconomic forecasts cover 30 years and contain annual data.
Data Type	Socioeconomic Data Forecast
Data Info	Gross domestic product, employment, imports, exports, and interest rates
Spatial (Smallest Geography)	County
Temporal	Semiannual
Modes of Freight	-
Classification System	NAICS
Public/Commercial	Commercial
URL	URL

TABLE C-52 WOODS & POOLE ECONOMICS METADATA

Data Source	Woods & Poole Economics
Agency/Source	Woods & Poole Economics
Description	Woods & Poole Economics specializes in long-term county economic data and demographic data projections.
Data Type	Socioeconomic Data Forecast
Data Info	Data and projection to 2050 for employment and earnings by industry, household data, personal income, the private non-farm establishment by size, economic output, retail sales, population
Spatial (Smallest Geography)	County
Temporal	Annual
Modes of Freight	-
Classification System	SIC and NAICS
Public/Commercial	Commercial
URL	URL

C.10 Transportation Statistics Databases

TABLE C-53 ATA METADATA

Data Source	ATA Monthly Truck Tonnage Report (MTTR) and Trucking Activity Report (TRAC)
Agency/Source	American Trucking Associations (ATA)
Description	ATA Monthly Truck Tonnage Report (MTTR) and Trucking Activity Report (TRAC) Comprehensive analysis of tonnage trends, the report explores the underlying factors affecting trucking services' demand.
Data Type	Transportation Statistics
Data Info	Truck tonnage, mileage, revenue, equipment utilization, and traffic
Spatial (Smallest Geography)	National
Temporal	Monthly
Modes of Freight	Truck
Classification System	-
Public/Commercial	Commercial
URL	URL

TABLE C-54 FLEETSEEK METADATA

Data Source	FleetSeek
Agency/Source	FleetSeek
Description	FleetSeek is a proprietary database of half a million North American trucking operations and contacts used by thousands of trucking product and service providers. An online subscription allows users to access our accurate and up-to-date database of contacts and demographics within the trucking industry, including owners, managers, and operators of trucking fleets and in-depth information about the fleets they manage.
Data Type	Transportation Statistics
Data Info	Trucking fleet sizes, mileage, locations, and industries served
Spatial (Smallest Geography)	Fleet office and transport lane
Temporal	Up to date
Modes of Freight	Truck
Classification System	SIC
Public/Commercial	Commercial
URL	URL

TABLE C-55 INTERMODAL DATA AND STATISTICS METADATA

Data Source	Intermodal Data and Statistics
Agency/Source	Intermodal Association of North America (IANA)
Description	IANA collects and maintains a range of data on the performance of the North American intermodal freight network. These subscriptions provide critical tools for the effective management of business assets across the intermodal supply chain.
Data Type	Transportation Statistics
Data Info	Regional volume flows, various sizes and types of equipment, equipment owners, cumulative data by month
Spatial (Smallest Geography)	Corridor
Temporal	Monthly
Modes of Freight	Truck, Rail, Water
Classification System	-
Public/Commercial	Commercial
URL	URL

TABLE C-56 MARITIME STATISTICS REPORTS AND SURVEY SERIES AND FLEET STATISTICS METADATA

Data Source	Maritime Statistics Reports and Survey Series and Fleet Statistics
Agency/Source	Maritime Administration (MARAD)
Description	MARAD provides data products, statistics, and reports on a variety of maritime transportation-related topics. Including reports of historical importance, trade statistics, U.S. Flag fleet lists, and information on U.S. coastal containership capacities. MARAD also tracks vessel calls in U.S. ports and provides data and statistics about U.S. waterborne foreign container trade by U.S. Customs ports and districts.
Data Type	Transportation Statistics
Data Info	Imports in metric tons and TEU
Spatial (Smallest Geography)	Port
Temporal	Annual
Modes of Freight	Water
Classification System	-
Public/Commercial	Public
URL	URL

TABLE C-57 NATIONAL PERFORMANCE MANAGEMENT RESEARCH DATA SET (NPMRDS) METADATA

Data Source	National Performance Management Research Data Set (NPMRDS)
Agency/Source	Federal Highway Administration (FHWA)
Description	NPMRDS provides a national data set of average travel times on the FHWA for use in its performance measures and management activities. This data set is also available to State Departments of Transportation and Metropolitan Planning Organizations to use for their performance management activities.
Data Type	Transportation Statistics
Data Info	Average travel times reported every 5 minutes
Spatial (Smallest Geography)	Link
Temporal	Monthly
Modes of Freight	Truck
Classification System	-
Public/Commercial	State DOT or MPO
URL	URL

TABLE C-58 AAR RAIL TRAFFIC DATA METADATA

Data Source	Rail Traffic Data
Agency/Source	Association of American Railroads (AAR)
Description	AAR compiles and distributes information on North American freight railroads, including finances, operations, performance, input cost indexes, traffic.
Data Type	Transportation Statistics
Data Info	A sample of weekly, monthly, and annual rail traffic by commodity
Spatial (Smallest Geography)	National
Temporal	Weekly
Modes of Freight	Rail
Classification System	STCC groups
Public/Commercial	Public/Commercial
URL	URL

TABLE C-59 RAILINC RAIL INDUSTRY INDEXES METADATA

Data Source	Railinc Rail Industry Indexes
Agency/Source	Railinc
Description	Railinc's line of nearly 40 products and services support railroads, equipment owners, shippers, and suppliers, along with every link of their supply chains. Class I, short line, regional railroads, and transportation professionals alike use Railinc's tools and information to manage and analyze their rail traffic.
Data Type	Transportation Statistics
Data Info	Free report of year-to-year analysis of commodities shipped by carloads
Spatial (Smallest Geography)	National
Temporal	Annual
Modes of Freight	Rail
Classification System	STCC
Public/Commercial	Public/Commercial
URL	URL

TABLE C-60 CSCMP STATE OF LOGISTICS REPORT METADATA

Data Source	State of Logistics Report
Agency/Source	Council of Supply Chain Management Professionals (CSCMP)
Description	The report has tracked and measured all costs associated with moving freight through the U.S. supply chain since 1988.
Data Type	Transportation Statistics
Data Info	Logistics cost by mode
Spatial (Smallest Geography)	National
Temporal	Annual
Modes of Freight	Truck, Rail, Air, Water, Pipeline, Other
Classification System	-
Public/Commercial	Commercial
URL	URL

TABLE C-61 BTS TRANSPORTATION SERVICES INDEX (TSI) METADATA

Data Source	Transportation Services Index (TSI)
Agency/Source	The Bureau of Transportation Statistics (BTS)
Description	TSI is the index, which is seasonally adjusted, combines available data on freight traffic and passenger travel, weighted to yield a monthly measure of transportation services output.
Data Type	Transportation Statistics
Data Info	Transportation Services Index
Spatial (Smallest Geography)	National
Temporal	Monthly
Modes of Freight	Truck
Classification System	-
Public/Commercial	Public
URL	URL

TABLE C-62 WATERBORNE COMMERCE STATISTICS CENTER (WCSC) METADATA

Data Source	Waterborne Commerce Statistics Center (WCSC)
Agency/Source	U.S. Army Corps of Engineers (USACE)
Description	WCSC collects, processes, distributes, and archives vessel trip and cargo data.
Data Type	Transportation Statistics
Data Info	Short-tons by commodity at the national level, inbound-outbound container traffic by port, annual commodity group flow movements by waterway, ports their function, and what type of commodities are shipped or received
Spatial (Smallest Geography)	Waterway
Temporal	Annual
Modes of Freight	Water
Classification System	Commodity group
Public/Commercial	Public
URL	URL

C.11 Vehicle Inventory and Classification Metadata

TABLE C-63 TRAVEL MONITORING ANALYSIS SYSTEM (TMAS) METADATA

Data Source	Travel Monitoring Analysis System (TMAS)
Agency/Source	The Bureau of Transportation Statistics (BTS)
Description	The FHWA has collected TMAS data included in the GIS Traffic Stations Version database from the State DOTs.
Data Type	Weight Data
Data Info	Traffic volumes, vehicle classification, truck weights obtained at weight stations, station location, travel direction
Spatial (Smallest Geography)	Weight Station
Temporal	Annual
Modes of Freight	Truck
Classification System	-
Public/Commercial	Public
URL	URL

TABLE C-64 VEHICLE INVENTORY AND USE SURVEY (VIUS) METADATA

Data Source	Vehicle Inventory and Use Survey (VIUS)
Agency/Source	US Census Bureau
Description	VIUS is an internal FHWA data program that assists in collecting and analyzing data on traffic volumes, vehicle classification, truck weights for traffic statistics, and analysis. It is used for the development of policies and regulations.
Data Type	Weight Data
Data Info	Weight, number of axles, overall length, body type, commodities handled, distance traveled, mileage
Spatial (Smallest Geography)	Individual
Temporal	Discontinued
Modes of Freight	Truck
Classification System	-
Public/Commercial	Public
URL	URL

Appendix D. Advantages/Disadvantages of Identified Freight Flow Estimation and Disaggregation Methodologies

TABLE D-1 SUMMARY OF ADVANTAGES AND DISADVANTAGES OF IDENTIFIED FREIGHT FLOW ESTIMATION AND DISAGGREGATION METHODOLOGIES

Methods	*Description*	*Advantages*	*Disadvantages*
Regression Methods	Regression models are used to establish a statistical relationship between two or more variables. Regression analysis includes a dependent variable that is the function of different levels of independent variables. *Sources: Cambridge Systematics et al.* (*13*) *and Holguín-Veras et al.* (*27*)	• Ability to identify relations of demand generation • Can be used not only to forecast future demand but also to establish the dynamics between variables • It has statistical measures to evaluate the goodness-of-fit	• May overestimate the future number of trips if the number of observations by category is not the same • Violations of the OLS assumptions could lead to inaccurate parameters (*27*)
Spatial Regression	A spatial regression modeling methodology is employed to correct spatial autocorrelation—a linear correlation or dependence among variables based on spatial proximity. *Sources: Novak et al.* (*28*) *and Holguín-Veras et al.* (*27*)	• Improve model fit compared to OLS • Eliminates problems associated with the spatial autocorrelation	• The spatial structure is fixed and cannot be applied to other geographic zones

Methods	*Description*	*Advantages*	*Disadvantages*
Cross-Classification	Cross-Classification methods measure the changes in one variable according to the features of two or more variables. For example, productions can be calculated by separating the population in an urban area into relatively homogenous groups based on specific socioeconomic characteristics. *Source: Stopher and McDonald* (*29*)	• Can improve model fitness compared to OLS • No need for linearity assumptions between variables • Independent of the zone system of the study area • No prior assumption about the shape of the relationship is required • Relationships can differ in form from class to class of any one variable	• There is no statistical goodness-of-fit measure • Large data sample required • There is no effective way to choose among variables for classification, and the resultant relationships may be invalid.
Multiple Classification Analysis (MCA)	The Multiple Classification Analysis (MCA) is an alternative procedure for selecting the variables and their categories for cross-classification models. MCA overcomes the disadvantages met in the cross-classification method by permitting a statistically based selection of variables and comparing alternative groupings of any given variable. *Sources: Stopher and McDonald* (*29*) *and Holguín-Veras et al.* (*27*)	• Can overcome the disadvantages associated with cross-classification analyses • MCA performs better than OLS models • It has statistical measures to evaluate the goodness-of-fit	• Higher data requirements compared to regression analysis • May overestimate the future number of trips if the number of observations by category is not the same
Artificial Neural Network (ANN)	Artificial neural network (ANN) models are based on highly simplified brain dynamics and have been used as powerful computational tools to solve complex pattern recognition, function estimation, and classification problems. Neural networks are nonlinear algorithms with the ability to learn and classify. *Sources: Ghosh-Dastidar and Adeli* (*30*) *and Holguín-Veras et al.* (*27*)	• Performs better than multiple regression • Can produce accurate results • Do not need to preselect independent variables • The learning capability of the model can discover more complex and suiTable interactions among the independent variables	• Large data sample required • Increased computational effort and interpretation compared to multiple regression • Order is not considered • Correlation between error terms has not been considered

Methods	*Description*	*Advantages*	*Disadvantages*
Decision Tree	Decision trees are mainly used to analyze data that has meaningful and systematic correlations among the variables. The method utilizes various rules and criteria to identify the significant interdependencies between the dependent and independent variables and classify the data into several homogeneous clusters in which members are assumed to share similar attributes. *Source: Zahra Pourabdollahi* (*31*)	• Performs better ANN • Multiple variable analysis capabilities • Can handle high dimension datasets • Easy to interpret • Handles both numerical and categorical data	• It is restricted to one output attribute • Overfitting • If the type of dataset is numeric, then it generates a complex decision tree
Bayesian Belief Network (BBN)	A Bayesian belief network (BBN) is a modeling and knowledge representation structure used in artificial intelligence that consists of a graphical model depicting probabilistic relationships among variables of interest. This graphical model is a valuable tool for representing the causal relationships in a given set of variables. *Source: Torres and Huber* (*32*)	• Can handle incomplete data because the dependencies among variables are known • Can help to gain an understanding about a problem domain • Ability to combine prior knowledge and data • Overfitting prevention	• High computational complexity • Performs poorly on high dimension data • Hard to interpret

Methods	*Description*	*Advantages*	*Disadvantages*
Input-Output Methods (IO)	The Input-Output analysis relates the quantity and type of products produced at a given location to the quantity and type of products supplied to the location. The location can be a single facility, a collection of unrelated facilities within a region, or a specific industry within a region. The theory of input-output analysis is that the relationship between inputs and outputs is relatively constant across different geographies and time periods, and therefore inferences can be made about both the inputs and outputs if just one of the factors is known at a single location. *Source: Cambridge Systematics et al.* (*13*) *and Holguín-Veras et al.* (*27*)	• Linked to the economy • Can give land-use interactions • Policy effects could be considered if coefficients are elastic	• Require specific input-output Table • Need to identify import and export trade flows • Restrictive assumptions if fixed coefficients • Need conversion from values to tons
Geographic Allocation (Proportional Weighting)	This technique involves disaggregating commodity flows to smaller geographies based on each of the smaller geographic units' features. Commodity flow allocation to subnational levels can be based on the physical size of the disaggregated geographies, socioeconomic data variables, industry-specific, and commodity-specific activity data within each of the sub-regions. *Source: Cambridge Systematics et al.* (*13*)	• Simple to calculate • Limited data requirements	• The model has difficulties often fails to grasp significant economic, technological and social changes in the system • No statistical tests on parameter values
Multinomial Logit Model (MNL)	Multinomial logit models are an expansion of the basic, binary Logit models. They are used to evaluate the relationship between a set of independent variables and a set of dependent variables that represent mutually exclusive, discrete alternatives. *Source:* Cambridge Systematics et al. (*16*)	• Ability to analyze a choice set consisting of multiple alternatives • Can handle high dimension datasets • Relatively easy to calibrate the model • Easy to interpret	• Do not work effectively with small datasets • Order, where relevant, is not taken into account • No correlation between error terms

Methods	*Description*	*Advantages*	*Disadvantages*
Nested Logit Model (NL)	The Nested Logit (NL) model is a significant extension to the traditional MNL model. The primary motivation to switch from the MNL model to the NL model is the restrictive MNL assumption of independent and identically distributed (IID) error terms (and the related behavioral assumption – the independence of irrelevant alternatives (IIA) assumption). *Source:* Bliemer et al. (*33*)	• Can work with alternatives that are not independent • Relaxed Independence of irrelevant alternatives (IIA) assumption	• Order, where relevant, is not taken into account
Gravity Model	Gravity models distribute trips by purpose between origins and destinations, based on the total tons produced at an origin, attracted to a destination, and the relative impedance, in the form of friction factors of traveling between these zones. *Source:* National Academies of Sciences (*34*)	• Limited data requirements • Some policy effects through a transport cost function	• Limited scope for including explanatory factors and policy effects • Limited number of calibration parameters
Time Series	Time series analysis involves examining the historic flows on a transportation facility, with only time as an indicator variable. Time series analysis is particularly appropriate when the forecast is short term, and insufficient time and resources exist to build and calibrate a behavioral model. *Sources:* National Academies of Sciences (*34*) and *Holguín-Veras et al.* (*27*)	• Require multiple data points over time for the same facility • Limited data requirements for independent variables	• Little insight into causality • Limited possibility to study policy effects
Trip Rates	Trip rates are estimated as the number of trips entering or exiting a site at a given time. Rates are functions of the type of socioeconomic factor. Rates are often estimated with few observations. *Source: Holguín-Veras et al* (*27*)	• Simple to calculate • Limited data requirements (zonal data) Can be aggregated to any level of geography	• Not able to connect the effect of business size on which may lead to significant errors • Little insight into causality and limited scope for policy effects

Methods	*Description*	*Advantages*	*Disadvantages*
Establishment-level (disaggregate) Models	Establishment level models can lead to more accurate models because there is a more direct connection between freight activity and employment. Estimates can then be aggregated to larger geography levels (e.g., city block, ZIP code, and transportation analysis zones (TAZs)) using suiTable aggregation procedures. *Source:* Holguin-Veras et al. (*35*)	• Limited data size requirements • Establish a direct connection between the attributes of the establishment and the measure of FSA that is being estimated • Could be aggregated to any level of geography	• Lack of geographic diversity in estimation data • Not all models are necessarily the best for every application
Iterative Proportional Fitting (IPF)	This technique is ideal for two-dimensional Tables where the marginal (column and row) totals are known (or estimated through an activity variable), but the distribution throughout the matrix is unknown. For a commodity flow database, the columns and rows correspond with origins and destinations. The totals of commodity flow for an origin at a large aggregation level are known, while the commodity flows for sub-regions would not be known. Iterative proportioning can be used to develop estimates of flows at the sub-regional level. *Source*: Cambridge Systematics et al. (*13*)	• The ability to investigate intra-zone variation • Cross-tabulations can be created for any combination of variables • The data is in a form that is ready to be passed into an individual-level mode	• Constraints are highly dependent on the sampling
System Dynamics (SD)	System Dynamics (SD) is an approach to understand the nonlinear behavior of complex systems over time using stocks, flows, internal feedback loops, Table functions, and time delays. System dynamics should be used to understand and explore the nature of the problem and allows the modeler to investigate general dynamic tendencies. Source: Noto (*36*), Gumzej and Grm (*37*), and Haghani et al. (*38*)	• Limited data requirements • Can give land-use interactions • External and policy effects variables can be included	• Increased computation time with large data sets • No statistical tests on parameter values

Appendix E. A Simple Numerical Example of the Proposed Method

The numerical example shows how the developed methods disaggregate the aggregate-level freight flow of 100 tons of Animals and Fish (live) (SCTG 2D = 1) that originates from zone 1 and destines in zone 2. In the following example, we are given a single aggregate-level zone pair, where each aggregate zone has two subzones, with one producing industry (NAICS 3-digit = 112) and two using industries (NAICS 3-digit = {112, 311}). For additional given inputs, see below.

Given:

A set of aggregate zones:

$$\mathrm{I} = \{1, 2\}$$

Freight flow from aggregate zone 1 to 2 for commodity $\mathrm{c} = 1$*:*

$$\mathrm{T}_{1,2}^{1} = 100$$
$$\mathrm{U}_{1,2}^{1} = 10$$
$$\mathrm{V}_{1,2}^{1} = 20{,}000$$

A set of disaggregate zones in aggregate zone $\mathrm{i} = 1$*:*

$$\mathrm{J}_1 = \{3, 4\}$$

A set of disaggregate zones in aggregate zone $\mathrm{i} = 2$*:*

$$\mathrm{J}_2 = \{5, 6\}$$

Commodity $\mathrm{c} = 1$ *producing industries (NAICS 3-digit):*

$$\mathrm{K}^{\mathrm{P1}} = \{112\}$$

Commodity $\mathrm{c} = 1$ *using industries (NAICS 3-digit):*

$$\mathrm{K}^{\mathrm{U1}} = \{112, 311\}$$

Gross Domestic Product in Millions of dollars of commodity $\mathrm{c} = 1$ *producing industry:*

$$\mathrm{p}_{112,1} = 190{,}000$$

Gross Domestic Product in Millions of dollars of commodity $\mathrm{c} = 1$ *using industries:*

$$\mathrm{u}_{112,1} = 38{,}000$$
$$\mathrm{u}_{311,1} = 152{,}000$$

Aggregate zone productions:

$$\mathrm{T}_{\mathrm{i},1}^{\mathrm{P}} = \{5900, 11800\}, \text{ where } \mathrm{i} \in \mathrm{I}$$

Aggregate zone attractions:

$$\mathrm{T}_{\mathrm{i},1}^{\mathrm{U}} = \{14620, 77350\}, \text{ where } \mathrm{i} \in \mathrm{I}$$

Aggregate zone industry economic indicator values:

$$x_{i,112,Emp} = \{40, 20\}\ ,\ x_{i,311,Emp} = \{500, 3{,}000\},\ \text{where } i \in I$$
$$x_{i,112,Sales} = \{20{,}000, 2{,}500\}\ ,\ x_{i,311,Sales} = \{70{,}000, 1{,}500{,}000\},\ \text{where } i \in I$$
$$x_{i,112,Sqrt} = \{50{,}000, 100{,}000\}\ ,\ x_{i,311,Sqrt} = \{180{,}000, 1{,}500{,}000\},\ \text{where } i \in I$$

Disaggregate zone industry economic indicator values:

$$x_{j,112,Emp} = \{10, 30\}, x_{j,311,Emp} = \{100, 400\} \text{ where } j \in J_1$$
$$x_{j,112,Emp} = \{5, 15\},\ x_{j,311,Emp} = \{750, 2250\} \text{ where } j \in J_2$$

$$x_{j,112,Sales} = \{6500, 13500\}, x_{j,311,Sales} = \{20{,}000, 50{,}000\} \text{ where } j \in J_1$$
$$x_{j,112,Sales} = \{750, 1{,}750\},\ x_{j,311,Sales} = \{500{,}000, 1{,}000{,}000\} \text{ where } j \in J_2$$

$$x_{j,112,Sqrt} = \{12{,}500, 37{,}500\}, x_{j,311,Sqrt} = \{75{,}000, 105{,}000\} \text{ where } j \in J_1$$
$$x_{j,112,Sqrt} = \{20{,}000, 80{,}000\},\ x_{j,311,Sqrt} = \{550{,}000, 950{,}000\} \text{ where } j \in J_2$$

Distance between the disaggregate zones:

$$d_{3,5} = 180$$
$$d_{3,6} = 200$$
$$d_{4,5} = 215$$
$$d_{4,6} = 230$$

Average travel length of commodity $c = 1$*:* $d_1 = 150$

Disaggregation method: Regression

Commodity producing and using industry share estimation

Industries share of producing commodity:

$$s_{kc}^{P} = \frac{p_{kc}}{\sum_{k \in K^{Pc}} p_{kc}}, \forall\ k \in K^{Pc}, c \in C$$

$$s_{112,1}^{P} = \frac{p_{112,1}}{p_{112,1}} = \frac{190{,}000}{190{,}000} = 1$$

Industries share of using commodity:

$$s_{kc}^{U} = \frac{u_{kc}}{\sum_{k \in K^{Uc}} u_{kc}}, \forall\ k \in K^{Uc}, c \in C$$

$$s_{112,1}^{U} = \frac{u_{112,1}}{u_{112,1} + u_{311,1}} = \frac{38{,}000}{38{,}000 + 152{,}000} = 0.2$$

$$s^{U}_{311,1} = 0.8$$

Regression coefficient estimation

We assume that we have already performed non-negative least square regression for both the aggregate zone productions and attractions and found the following regression coefficients for NAICS 112 and 311 industries.

Regression equation to estimate total tons of productions by commodity for the aggregate zones:

$$T^{P}_{ic} = \sum_{e \in E, k \in K^{Pc}} \gamma^{c}_{ke} * x_{ike} * s^{Pc}_{k} \ , \forall\, i \in I, c \in C$$

Aggregate zone production regression coefficients:

$$\gamma^{1}_{112,\text{Emp}} = 0$$
$$\gamma^{1}_{112,\text{Sales}} = 0$$
$$\gamma^{1}_{112,\text{Sqrt}} = 0.12$$

Regression equation to estimate total tons of attraction by commodity for the aggregate zones:

$$T^{U}_{ic} = \sum_{e \in E, k \in K^{Uc}} \delta^{c}_{ke} * x_{ike} * s^{Uc}_{k} \ , \forall\, i \in I, c \in C$$

Aggregate zone attraction regression coefficients:

$$\delta^{1}_{112,\text{Emp}} = 0$$
$$\delta^{1}_{112,\text{Sales}} = 0$$
$$\delta^{1}_{112,\text{Sqrt}} = 0.16$$
$$\delta^{1}_{311,\text{Emp}} = 30.40$$
$$\delta^{1}_{311,\text{Sales}} = 0$$
$$\delta^{1}_{311,\text{Sqrt}} = 0$$

Disaggregate productions/attractions estimation

Regression equation to estimate total tons of productions by commodity for the disaggregate zones:

$$T^{P}_{jc} = \sum_{e \in E, k \in K^{Pc}} \gamma^{c}_{ke} * x_{jke} * s^{P}_{kc} \,, \forall\, j \in J_i, i \in I, c \in C$$

$$T^{P}_{3,1} = \gamma^{1}_{112,Sqrt} * x_{3,112,Sqrt} * s^{P}_{112,1} = 0.12 * 12{,}500 * 1 = 1{,}500$$

$$T^{P}_{4,1} = 4{,}500$$
$$T^{P}_{5,1} = 2{,}400$$
$$T^{P}_{6,1} = 9{,}600$$

Regression equation to estimate total tons of attractions by commodity for the disaggregate zones:

$$T^{U}_{jc} = \sum_{e \in E, k \in K^{Uc}} \delta^{c}_{ke} * x_{jke} * s^{U}_{kc}, \forall\, j \in J_i, i \in I, c \in C$$

$$T^{U}_{3,1} = \delta^{1}_{112,Sqrt} * x_{3,112,Sqrt} * s^{U}_{112,1} + \delta^{1}_{311,Emp} * x_{3,311,Emp} * s^{U}_{311,1} =$$
$$= 0.16 * 12{,}500 * 0.2 + 30.4 * 100 * 0.8 = 2{,}832$$
$$T^{U}_{4,1} = 10{,}928$$
$$T^{U}_{5,1} = 18{,}880$$
$$T^{U}_{6,1} = 57{,}280$$

Disaggregate zone production and attraction adjustment to match aggregate zone attractions and productions

Adjusted disaggregate zone productions:

$$T^{P}_{jc} = \frac{T^{P}_{jc}}{\sum_{j \in J_i} T^{P}_{jc}} * T^{P}_{ic}, \forall\, j \in J_i, c \in C, i \in I$$

$$T^{P}_{3,1} = \frac{T^{P}_{3,1}}{T^{P}_{3,1} + T^{P}_{4,1}} * T^{P}_{1,1} = \frac{1{,}500}{1{,}500 + 4{,}500} * 5{,}900 = 1{,}475$$

$$T^{P}_{4,1} = 4{,}425$$
$$T^{P}_{5,1} = 2{,}360$$
$$T^{P}_{6,1} = 9{,}440$$

Adjusted disaggregate zone attractions:

$$T^{U}_{jc} = \frac{T^{U}_{jc}}{\sum_{j \in J_i} T^{U}_{jc}} * T^{U}_{ic}, \forall\, j \in J_i, c \in C, i \in I$$

$$T^{U}_{3,1} = \frac{T^{U}_{3,1}}{T^{U}_{3,1} + T^{U}_{4,1}} * T^{U}_{1,1} = \frac{2{,}832}{2{,}832 + 10{,}928} * 14{,}620 = 3{,}009$$

$$T_{4,1}^{U} = 11{,}611$$
$$T_{5,1}^{U} = 19{,}175$$
$$T_{6,1}^{U} = 58{,}175$$

Disaggregate zone production and attraction adjustment to match the specific origin-destination flow

In our example, we are interested in disaggregating freight flow that originates from zone 1 and destines to zone 2. Thus we will need to adjust the disaggregate zone products for zone 1 to match the specific origin-destination flow $T_{1,2}^{1} = 100$ and attractions for zone 2.

Adjusted disaggregate zone productions to match specific origin-destination flow:

$$T_{jc}^{P} = \frac{T_{jc}^{P}}{\sum_{j \in J_A} T_{jc}^{P}} * T_{AB}^{c}, \forall\, j \in J_A, c \in C, A \in I, B \in I$$

$$T_{3,1}^{P} = \frac{T_{3,1}^{P}}{T_{3,1}^{P} + T_{4,1}^{P}} * T_{1,2}^{1} = \frac{1{,}475}{1{,}475 + 4{,}425} * 100 = 25$$
$$T_{4,1}^{P} = 75$$

Adjusted disaggregate zone attractions to match specific origin-destination flow:

$$T_{jc}^{U} = \frac{T_{jc}^{U}}{\sum_{j \in J_B} T_{jc}^{U}} * T_{AB}^{c}, \forall\, j \in J_B, c \in C, A \in I, B \in I$$

$$T_{5,1}^{U} = \frac{T_{5,1}^{U}}{T_{5,1}^{U} + T_{6,1}^{U}} * T_{1,2}^{1} = \frac{3{,}009}{3{,}009 + 11{,}611} * 100 = 24.79$$

$$T_{6,1}^{U} = 75.21$$

Production and attraction distribution methods

Distribution method: ***Iterative Proportional Fitting***

Initial disaggregate zone freight flow distribution values:

Step 1: $T_{ab}^{c} = 1, \forall\, a \in J_A, b \in J_B, c \in C, n = 0$

Zone	3	4	5	6	Productions	Productions Calculated
3	1	1	1	1	25	4
4	1	1	1	1	75	4
5	1	1	1	1	0	4
6	1	1	1	1	0	4
Attractions	0	0	24.79	75.21		
Attractions Calculated	4	4	4	4		

Adjusted disaggregate zone freight flow distribution by commodity by origin row values:

Step 2: $T^c_{ab(n+1)} = \frac{T^c_{ab}}{\sum_{b \in J_B} T^c_{ab}} * T^P_{ac}, \forall\ a \in J_A, c \in C$

Zone	3	4	5	6	Productions	Productions Calculated
3	6.25	6.25	6.25	6.25	25	25
4	18.75	18.75	18.75	18.75	75	75
5	0	0	0	0	0	0
6	0	0	0	0	0	0
Attractions	0	0	24.79	75.21		
Attractions Calculated	25	25	25	25		

Adjusted disaggregate zone freight flow distribution by commodity by destination column values:

Step 3: $T^c_{ab(n+2)} = \frac{T^c_{ab(n+1)}}{\sum_{a \in J_A} T^c_{ab(n+1)}} * T^U_{bc}, \forall\ b \in J_B, c \in C$

Zone	3	4	5	6	Productions	Productions Calculated
3	0	0	6.20	18.80	25	25
4	0	0	18.59	56.41	75	75
5	0	0	0	0	0	0
6	0	0	0	0	0	0
Attractions	0	0	24.79	75.21		
Attractions Calculated	0	0	24.79	75.21		

By disaggregating freight flow using the regression method and distributing using the iterative

proportional fitting, we have found the following disaggregate freight flow:

$$T_{3,5}^{1} = 6.20$$
$$T_{3,6}^{1} = 18.80$$
$$T_{4,5}^{1} = 18.59$$
$$T_{4,6}^{1} = 56.41$$

Total tons of the disaggregate zone freight flow conversion to units and value

Disaggregate zone freight flow conversion to units:

$$U_{ab}^{c} = \frac{U_{AB}^{c}}{T_{AB}^{c}} * T_{ab}^{c}, \forall\, a \in J_A, b \in J_B, c \in C$$

$$U_{3,5}^{1} = \frac{U_{1,2}^{1}}{T_{1,2}^{1}} * T_{3,5}^{1} = \frac{10}{100} * 6.20 = 0.62$$

$$U_{3,6}^{1} = 1.88$$
$$U_{4,5}^{1} = 1.86$$
$$U_{4,6}^{1} = 5.64$$

Disaggregate zone freight flow conversion to values:

$$V_{ab}^{c} = \frac{V_{AB}^{c}}{T_{AB}^{c}} * T_{ab}^{c}, \forall\, a \in J_A, b \in J_B, c \in C$$

$$V_{3,5}^{1} = \frac{V_{1,2}^{1}}{T_{1,2}^{1}} * T_{3,5}^{1} = \frac{20{,}000}{100} * 6.20 = 1{,}240$$

$$V_{3,6}^{1} = 3{,}760$$
$$V_{4,5}^{1} = 3{,}718$$
$$V_{4,6}^{1} = 11{,}282$$

Distribution method: *Gravity Model*

Friction factor function by commodity type (QRFM Third Edition, 2019):

$$f_{ab}^{c} = e^{-\frac{d_{ab}}{d_c}}, \forall\, a \in J_A, b \in J_B, c \in C$$

$$f_{3,5}^{1} = e^{-\frac{d_{3,5}}{d_1}} = e^{-\frac{200}{150}} = 0.3012$$

$$f_{3,6}^{1} = 0.2636$$

$$f_{4,5}^{1} = 0.2385$$
$$f_{4,6}^{1} = 0.2158$$

Disaggregate zone freight flow distribution by commodity using the Gravity model method:

$$T_{ab}^{c} = T_{ac}^{P} * \frac{T_{bc}^{U} * f_{ab}^{c}}{\sum_{b \in J_B} T_{bc}^{U} * f_{ab}^{c}} , \forall\, a \in J_A, b \in J_B, c \in C$$

$$T_{3,5}^{1} = T_{3,1}^{P} * \frac{T_{5,1}^{U} * f_{3,5}^{1}}{T_{5,1}^{U} * f_{3,5}^{1} + T_{6,1}^{U} * f_{3,6}^{1}} = 25 * \frac{24.79 * 0.3012}{24.79 * 0.3012 + 75.21 * 0.2636} = 6.84$$

$$T_{3,6}^{1} = 18.16$$
$$T_{4,5}^{1} = 20.03$$
$$T_{4,6}^{1} = 54.97$$

Zone	3	4	5	6	Productions	Productions Calculated
3	0	0	6.84	18.16	25	25
4	0	0	20.03	54.97	75	75
5	0	0	0	0	0	0
6	0	0	0	0	0	0
Attractions	0	0	24.79	75.21		
Attractions Calculated	0	0	26.865	73.135		

Adjusted disaggregate zone freight flow distribution by commodity by destination column values:

Step 3: $$T_{ab(n+2)}^{c} = \frac{T_{ab(n+1)}^{c}}{\sum_{a \in J_A} T_{ab(n+1)}^{c}} * T_{bc}^{U}, \forall\, b \in J_B, c \in C$$

Zone	3	4	5	6	Productions	Productions Calculated
3	0	0	6.31	18.68	25	24.99
4	0	0	18.48	56.53	75	75.01
5	0	0	0	0	0	0
6	0	0	0	0	0	0
Attractions	0	0	24.79	75.21		
Attractions Calculated	0	0	24.79	75.21		

Adjusted disaggregate zone freight flow distribution by commodity by origin row values:

Step 2: $T^c_{ab(n+1)} = \frac{T^c_{ab}}{\sum_{b \in J_B} T^c_{ab}} * T^P_{ac}, \forall\ a \in J_A, c \in C$

Zone	3	4	5	6	Productions	Productions Calculated
3	0	0	6.31	18.69	25	25
4	0	0	18.48	56.52	75	75
5	0	0	0	0	0	0
6	0	0	0	0	0	0
Attractions	0	0	32.77	67.23		
Attractions Calculated	0	0	24.79	75.21		

By disaggregating freight flow using the regression method and distributing using the Gravity Model, we have found the following disaggregate freight flow:

$$\mathrm{T}^1_{3,5} = 6.31$$
$$\mathrm{T}^1_{3,6} = 18.69$$
$$\mathrm{T}^1_{4,5} = 18.48$$
$$\mathrm{T}^1_{4,6} = 56.52$$

Total tons of the disaggregate zone freight flow conversion to units and value

Disaggregate zone freight flow conversion to units:

$$U^c_{ab} = \frac{U^c_{AB}}{T^c_{AB}} * T^c_{ab}, \forall\ a \in J_A, b \in J_B, c \in C$$

$$\mathrm{U}^1_{3,5} = \frac{\mathrm{U}^1_{1,2}}{\mathrm{T}^1_{1,2}} * \mathrm{T}^1_{3,5} = \frac{10}{100} * 6.31 = 0.63$$

$$\mathrm{U}^1_{3,6} = 1.87$$
$$\mathrm{U}^1_{4,5} = 1.85$$
$$\mathrm{U}^1_{4,6} = 5.65$$

Disaggregate zone freight flow conversion to values:

$$V_{ab}^{c} = \frac{V_{AB}^{c}}{T_{AB}^{c}} * T_{ab}^{c}, \forall\, a \in J_A, b \in J_B, c \in C$$

$$\mathrm{V}_{3,5}^{1} = \frac{\mathrm{V}_{1,2}^{1}}{\mathrm{T}_{1,2}^{1}} * \mathrm{T}_{3,5}^{1} = \frac{20{,}000}{100} * 6.31 = 1{,}262$$

$$\mathrm{V}_{3,6}^{1} = 3{,}738$$
$$\mathrm{V}_{4,5}^{1} = 3{,}696$$
$$\mathrm{V}_{4,6}^{1} = 11{,}304$$

Distribution method: *Proportional Weighting*

Disaggregate zone freight flow distribution by commodity using Proportional Weighting method:

$$T_{ab}^{c} = T_{AB}^{c} * \frac{T_{ac}^{P}}{\sum_{a \in J_A} T_{ac}^{P}} * \frac{T_{bc}^{U}}{\sum_{b \in J_B} T_{bc}^{U}}, \forall\, a \in J_A, b \in J_B, c \in C$$

$$\mathrm{T}_{3,5}^{1} = \mathrm{T}_{1,2}^{1} * \frac{\mathrm{T}_{3,1}^{\mathrm{P}}}{\mathrm{T}_{3,1}^{\mathrm{P}} + \mathrm{T}_{4,1}^{\mathrm{P}}} * \frac{\mathrm{T}_{5,1}^{\mathrm{U}}}{\mathrm{T}_{5,1}^{\mathrm{U}} + \mathrm{T}_{6,1}^{\mathrm{U}}} = 100 * \frac{25}{25 + 75} * \frac{24.79}{24.79 + 75.21} = 6.20$$

$$\mathrm{T}_{3,6}^{1} = 18.80$$
$$\mathrm{T}_{4,5}^{1} = 18.59$$
$$\mathrm{T}_{4,6}^{1} = 56.41$$

Total tons of the disaggregate zone freight flow conversion to units and value

Disaggregate zone freight flow conversion to units:

$$U_{ab}^{c} = \frac{U_{AB}^{c}}{T_{AB}^{c}} * T_{ab}^{c}, \forall\, a \in J_A, b \in J_B, c \in C$$

$$\mathrm{U}_{3,5}^{1} = \frac{\mathrm{U}_{1,2}^{1}}{\mathrm{T}_{1,2}^{1}} * \mathrm{T}_{3,5}^{1} = \frac{10}{100} * 6.20 = 0.62$$

$$\mathrm{U}_{3,6}^{1} = 1.88$$
$$\mathrm{U}_{4,5}^{1} = 1.86$$
$$\mathrm{U}_{4,6}^{1} = 5.64$$

Disaggregate zone freight flow conversion to values:

$$V_{ab}^{c} = \frac{V_{AB}^{c}}{T_{AB}^{c}} * T_{ab}^{c}, \forall\, a \in J_A, b \in J_B, c \in C$$

$$\mathrm{V}_{3,5}^{1} = \frac{\mathrm{V}_{1,2}^{1}}{\mathrm{T}_{1,2}^{1}} * \mathrm{T}_{3,5}^{1} = \frac{20{,}000}{100} * 6.20 = 1{,}240$$

$$\mathrm{V}_{3,6}^{1} = 3{,}760$$
$$\mathrm{V}_{4,5}^{1} = 3{,}718$$
$$\mathrm{V}_{4,6}^{1} = 11{,}282$$

Disaggregation method: Proportional Weighting

Commodity producing and using industry share estimation

Industries share of producing commodity:

$$s_{kc}^{P} = \frac{p_{kc}}{\sum_{k \in K^{Pc}} p_{kc}}, \forall\, k \in K^{Pc}, c \in C$$

$$\mathrm{s}_{112,1}^{\mathrm{P}} = \frac{\mathrm{p}_{112,1}}{\mathrm{p}_{112,1}} = \frac{190{,}000}{190{,}000} = 1$$

Industries share of using commodity:

$$s_{kc}^{U} = \frac{u_{kc}}{\sum_{k \in K^{Uc}} u_{kc}}, \forall\, k \in K^{Uc}, c \in C$$

$$\mathrm{s}_{112,1}^{\mathrm{U}} = \frac{\mathrm{u}_{112,1}}{\mathrm{u}_{112,1} + \mathrm{u}_{311,1}} = \frac{38{,}000}{38{,}000 + 152{,}000} = 0.2$$

$$\mathrm{s}_{311,1}^{\mathrm{U}} = 0.8$$

Disaggregate zone industry economic indicator share estimation

Disaggregate zones industries share of the economic indicator:

$$r_{jke} = \frac{x_{jke}}{\sum_{j \in J_i} x_{jke}}, \forall\, k \in K, j \in J_i, i \in I$$

Disaggregate zone industry shares of employment:

$$r_{3,112,\text{Emp}} = \frac{x_{3,112,\text{Emp}}}{x_{3,112,\text{Emp}} + x_{4,112,\text{Emp}}} = \frac{10}{10 + 30} = 0.25$$

$$r_{4,112,\text{Emp}} = 0.75$$
$$r_{5,112,\text{Emp}} = 0.25$$
$$r_{6,112,\text{Emp}} = 0.75$$

$$r_{3,311,\text{Emp}} = 0.20$$
$$r_{4,311,\text{Emp}} = 0.80$$
$$r_{5,311,\text{Emp}} = 0.25$$
$$r_{6,311,\text{Emp}} = 0.25$$

Disaggregate zone freight flow distribution by commodity using economic indicator Proportional Weighting method:

$$T_{ab}^{ce} = T_{AB}^{c} * \left(\sum_{k^P \in K^{Pc}} s_{kc}^{P} * r_{ak^P e}\right) * \left(\sum_{k^U \in K^{Uc}} s_{kc}^{U} * r_{bk^U e}\right), \forall\, a \in J_A, b \in J_B, c \in C$$

By disaggregating freight flow using the Proportional Weighting method and disaggregate zone industry shares by employment, we have found the following disaggregate freight flow:

$$T_{3,5}^{1,\text{Emp}} = T_{1,2}^{1} * \left(s_{112,1}^{\text{P}} * r_{3,112^{\text{P}},\text{Emp}}\right) * \left(s_{112,1}^{\text{U}} * r_{5,112^{\text{U}},\text{Emp}} + s_{311,1}^{\text{U}} * r_{5,311^{\text{U}},\text{Emp}}\right) =$$
$$= 100 * 1 * 0.25 * (0.2 * 0.25 + 0.8 * 0.25) = 6.25$$

$$T_{3,6}^{1,\text{Emp}} = 18.75$$
$$T_{4,5}^{1,\text{Emp}} = 18.75$$
$$T_{4,6}^{1,\text{Emp}} = 56.25$$

Total tons of the disaggregate zone freight flow conversion to units and value

Disaggregate zone freight flow conversion to units:

$$U_{ab}^{c} = \frac{U_{AB}^{c}}{T_{AB}^{c}} * T_{ab}^{c}, \forall\, a \in J_A, b \in J_B, c \in C$$

$$U_{3,5}^{1} = \frac{U_{1,2}^{1}}{T_{1,2}^{1}} * T_{3,5}^{1} = \frac{10}{100} * 6.25 = 0.625$$

$$U_{3,6}^{1} = 1.875$$
$$U_{4,5}^{1} = 1.875$$
$$U_{4,6}^{1} = 5.625$$

Disaggregate zone freight flow conversion to values:

$$V_{ab}^{c} = \frac{V_{AB}^{c}}{T_{AB}^{c}} * T_{ab}^{c}, \forall\, a \in J_A, b \in J_B, c \in C$$

$$\mathrm{V}_{3,5}^{1} = \frac{\mathrm{V}_{1,2}^{1}}{\mathrm{T}_{1,2}^{1}} * \mathrm{T}_{3,5}^{1} = \frac{20{,}000}{100} * 6.25 = 1{,}250$$

$$\mathrm{V}_{3,6}^{1} = 3{,}750$$
$$\mathrm{V}_{4,5}^{1} = 3{,}750$$
$$\mathrm{V}_{4,6}^{1} = 11{,}250$$

Similarly, freight flow disaggregation can be performed using the Proportional Weighting method, and the disaggregate zone industry shares by the value of sales and square footage.

Appendix F. TRANSEARCH Preprocessing Tool

The TRANSEARCH data available for this research was given by the 3-digit SCTG code industry. The developed disaggregation methodologies and tools require SCTG 2-digit code industry type since the crosswalk from SCTG to NAICS require an SCTG 2-digit code. This tool (see Figure F-1) preprocesses TRANSEARCH data and adds an SCTG 2-digit code industry code. Additionally, the tool provides options to estimate production and attractions in tons at the county level, average Internal-Internal (I-I), Internal-External (I-E), External-Internal (E-I) commodity flow lengths, split data into smaller portions by unique field attributes, and/or specific zones selected by the user. Zone productions and attractions are performed by the following fields: SCTG 2-digit code, equipment type, trade type, and mode. The option to select and preprocess data for a specific subarea in Tennessee (e.g., east Tennessee county origins and destinations) and field attributes (e.g., specific SCTG 2-digit code, Equipment, Trade Type, and Mode) is also available. The rationale for allowing the user to preprocess a subset of the whole data is to allow faster processing times and PC memory issues in cases where subareas are of interest. The output from this tool will be used as an input only in two of the developed tools: i) the IO Accounts and Proportional Weight Disaggregation Method Tool, and ii) the IO Accounts and Regression Disaggregation Method Tool

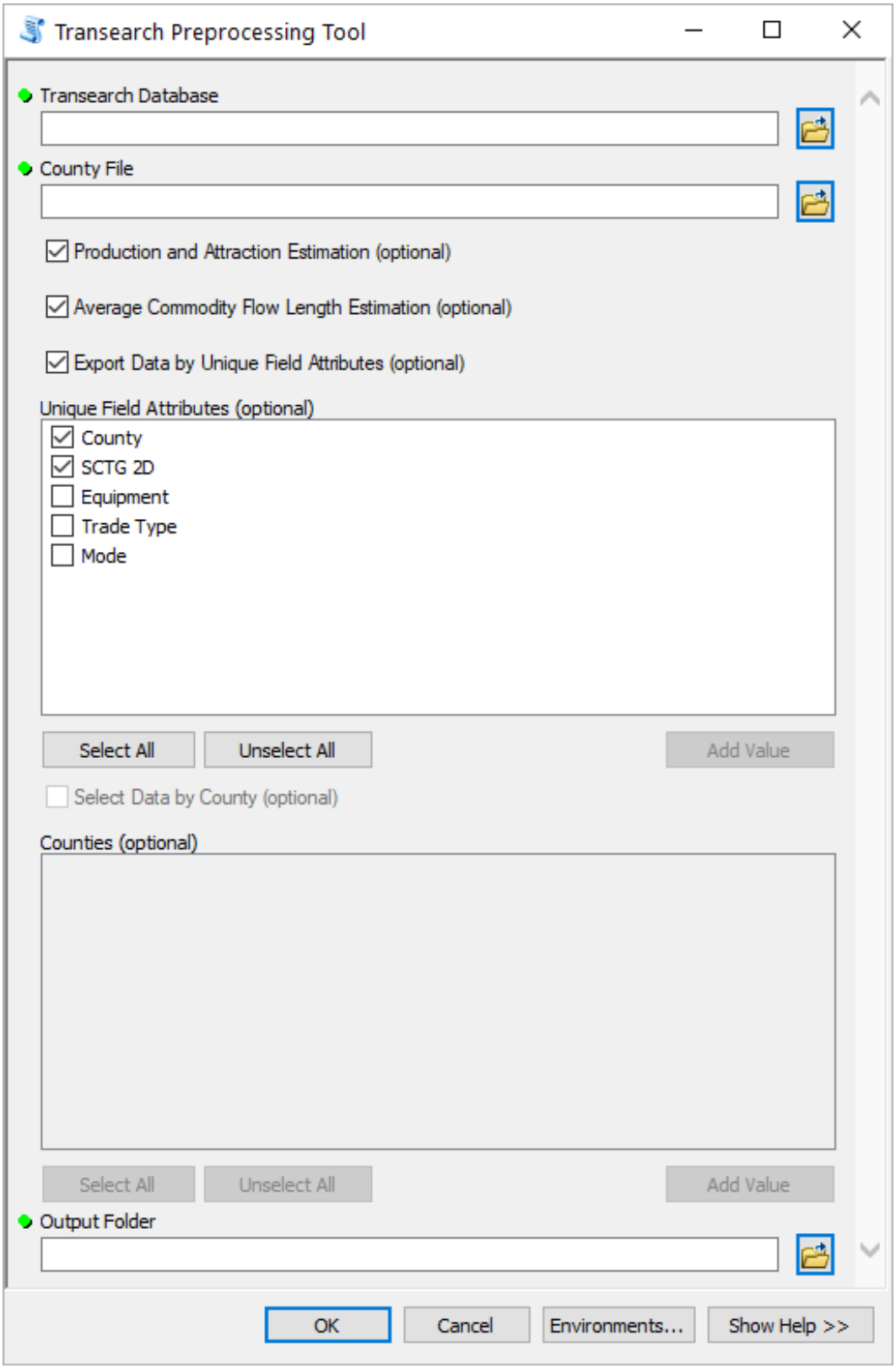


Figure F-1 TRANSEARCH Preprocessing Tool

F.1 Preprocessing tool: Spatial and Economic Data Preprocessing Tool

The Spatial and Economic Data Preprocessing Tool (see Figure F-2) provides the following capabilities. First, if the option Estimate the Disaggregate Zone Economic Indicator Shares is enabled, the tool will estimate the economic indicator (employment, the value of sales, and sq. footage) shares of each disaggregate zone NAICS 3-digit industry code. Second, if the option Estimate Disaggregate Zone Economic Indicator Values is enabled, the tool will estimate economic indicator (employment, the value of sales, and sq. footage) values by NAICS 3-digit industry code for aggregate and disaggregate zones. Third, if the option Estimate using NAICS 2-digit industry code is enabled the tool will estimate the economic indicator shares of each disaggregate/aggregate zone the NAICS 2-digit industry code not the NAICS 3-digit. Fourth, if the option Estimate Disaggregate and TRANSEARCH Zone Centroid Latitude and Longitude is enabled, the tool will estimate centroid latitude and longitude for each TRANSEARCH and disaggregate zone. This tool's output is used as input in i) IO Accounts and Proportional Weight Disaggregation Method Tool, and ii) IO Accounts and Regression Disaggregation Method Tool.

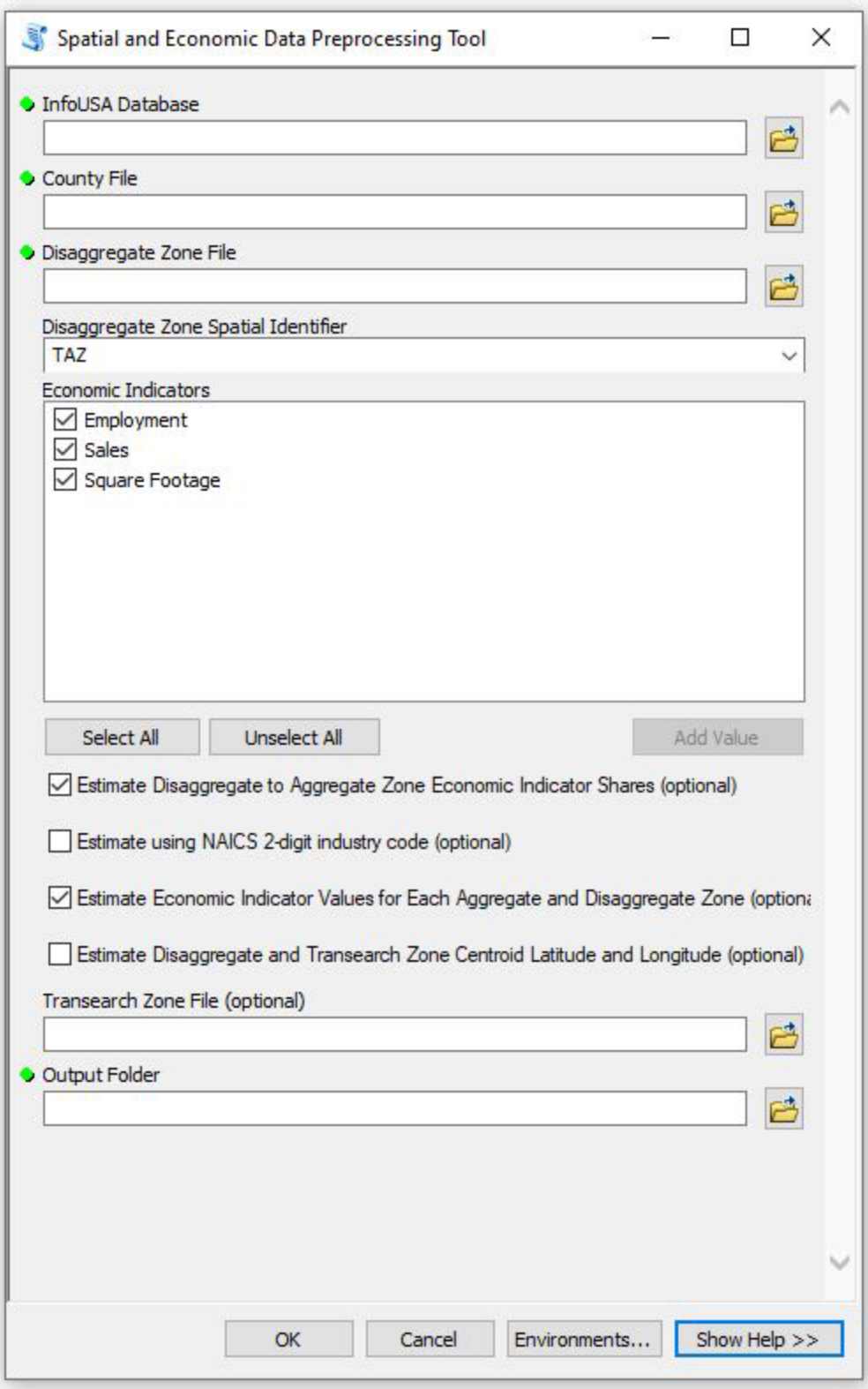


Figure F-2 Spatial and Economic Data Preprocessing Tool

F.2 Preprocessing tool: IO Accounts Supply and Use Table Conversion Tool

The IO Accounts Supply and Use Table Conversion Tool (see Figure F-3) converts the Bureau of Economic Analysis (BEA) Input-Output Accounts (IO) Supply and Use Tables from the IO industry to NAICS 3-digit or 2-digit codes using a crosswalk Table provided by BEA. In addition, to the option to convert the annual Gross Domestic Product (GDP) to the shares of commodity-producing and using industries by proportionally weighting, the tool also gives an option to adjust the commodity-producing and using industry shares by setting a minimum percentage value of how much each commodity-producing and using industry should contain. This tool's output is used as input in i) IO Accounts and Proportional Weight Disaggregation Method Tool, and ii) IO Accounts and Regression Disaggregation Method Tool.

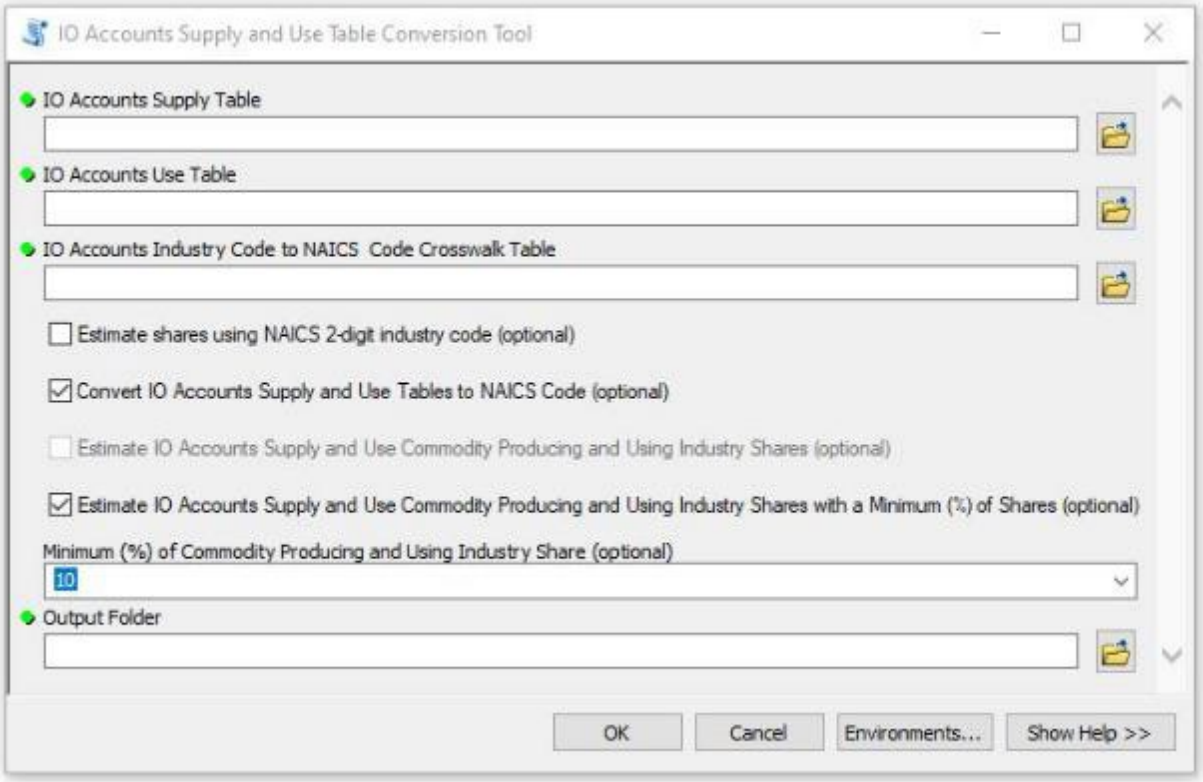


Figure F-3 IO Accounts Supply and Use Table Conversion Tool

F.3 Disaggregation tool: IO Accounts and Regression Disaggregation Method Tool

The IO Accounts and Regression Disaggregation Method Tool (see Figure F-4) disaggregates freight flow (TRANSEARCH) by commodity (SCTG 2-digit), from the aggregate zone (County) to disaggregate zones using the relationship between economic indicators (employment, value of sales, and sq. footage) by NAICS 3-digit or NAICS 2-digit industry code obtained from InfoUSA and by allocating commodity freight flow of each aggregate-level origin-destination pair by the share of commodity-producing and using industries (NAICS 3-digit or 2-digit), estimated using Bureau of Economic Analysis (BEA) Input-Output (IO) Accounts Supply and Use Tables.

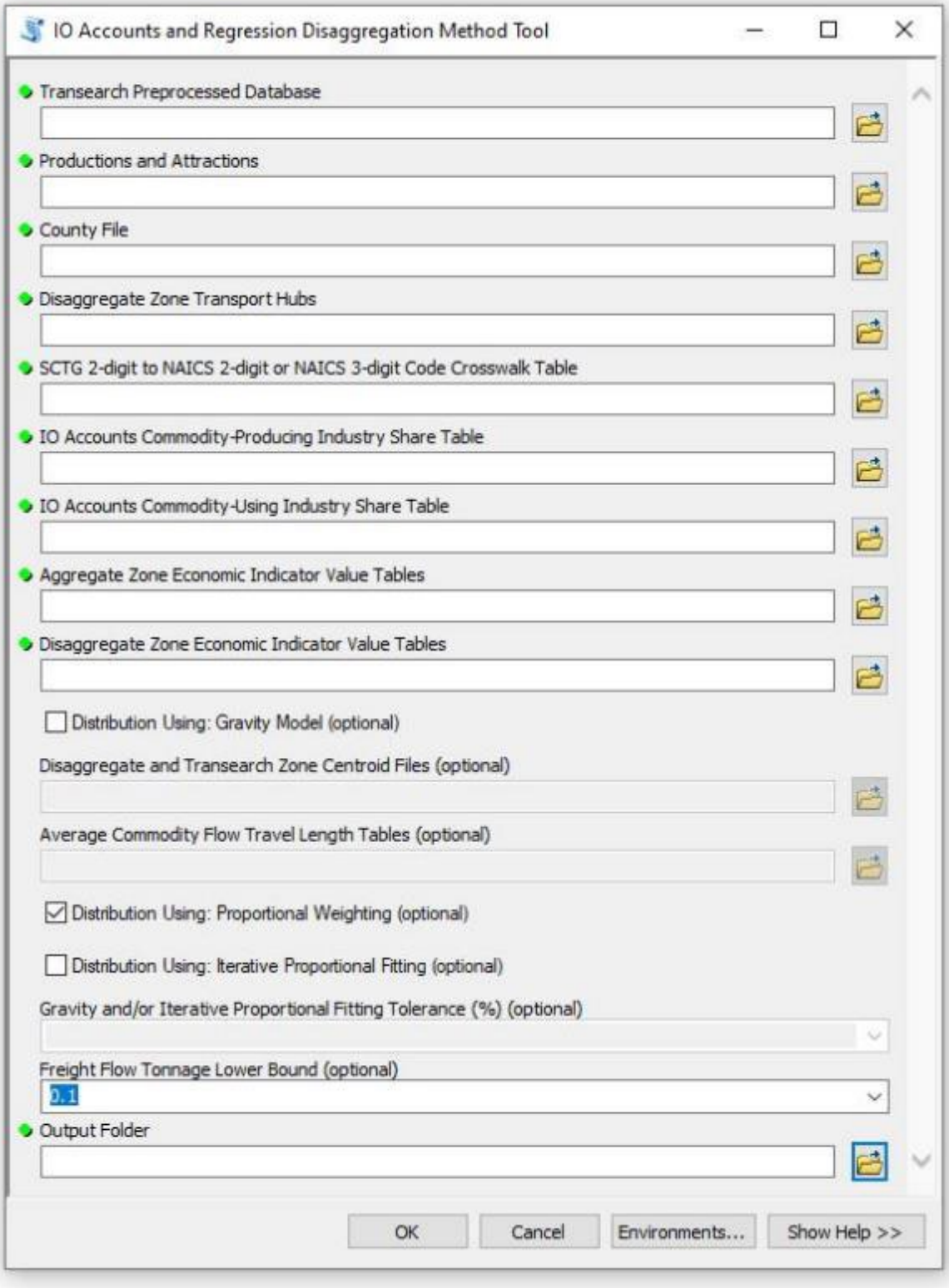


Figure F-4 IO Accounts and Regression Disaggregation Method Tool

F.4 Disaggregation tool: IO Accounts and Proportional Weight Disaggregation Method Tool

The IO Accounts and Proportional Weight Disaggregation Method Tool (see Figure F-5) disaggregates freight flow data (TRANSEARCH) by commodity type (SCTG 2-digit), from the aggregate zone (County) to disaggregate zones by allocating commodity freight flow of each aggregate-level origin-destination pair by the share of commodity-producing and using industries (NAICS 3-digit or 2-digit), estimated using Bureau of Economic Analysis (BEA) Input-Output (IO) Accounts Supply and Use Tables and the ratio of the disaggregate-level origin and destination economic indicator values (employment, value of sales, sq. footage) to the aggregate-level origin and destination economic indicator values obtained from InfoUSA.

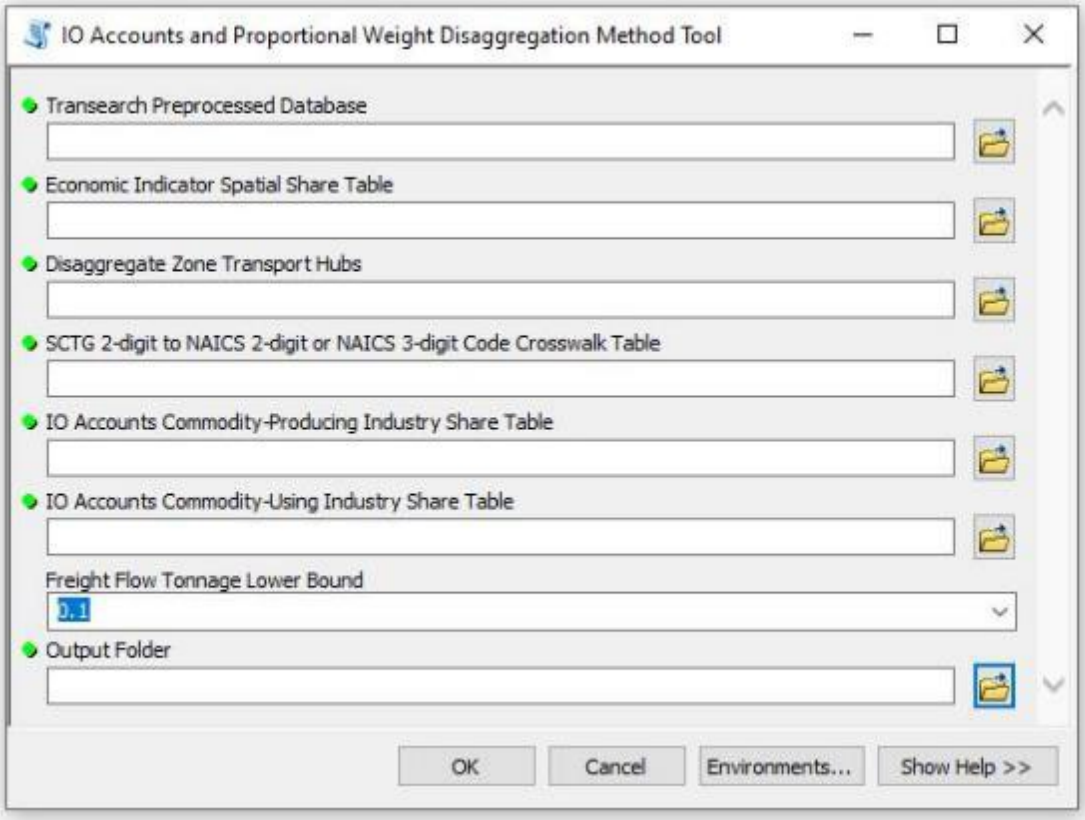


Figure F-5 Accounts and Proportional Weight Disaggregation Method Tool

F.5 Postprocessing tool: PA Estimation OD Selection Tool

The PA Estimation OD Selection Tool (see Figure F-6) provides the capabilities to output specific disaggregate OD flow and estimate productions and attractions. The specific OD flow can be selected by unique SCTG code, Mode or Mode Group, Equipment, and Trade Type code. In addition, the tool provides the ability to select the freight flow by unique county or disaggregate zone. This tool's output is used as input in i) OD MAP Tool, and ii) PA MAP Tool.

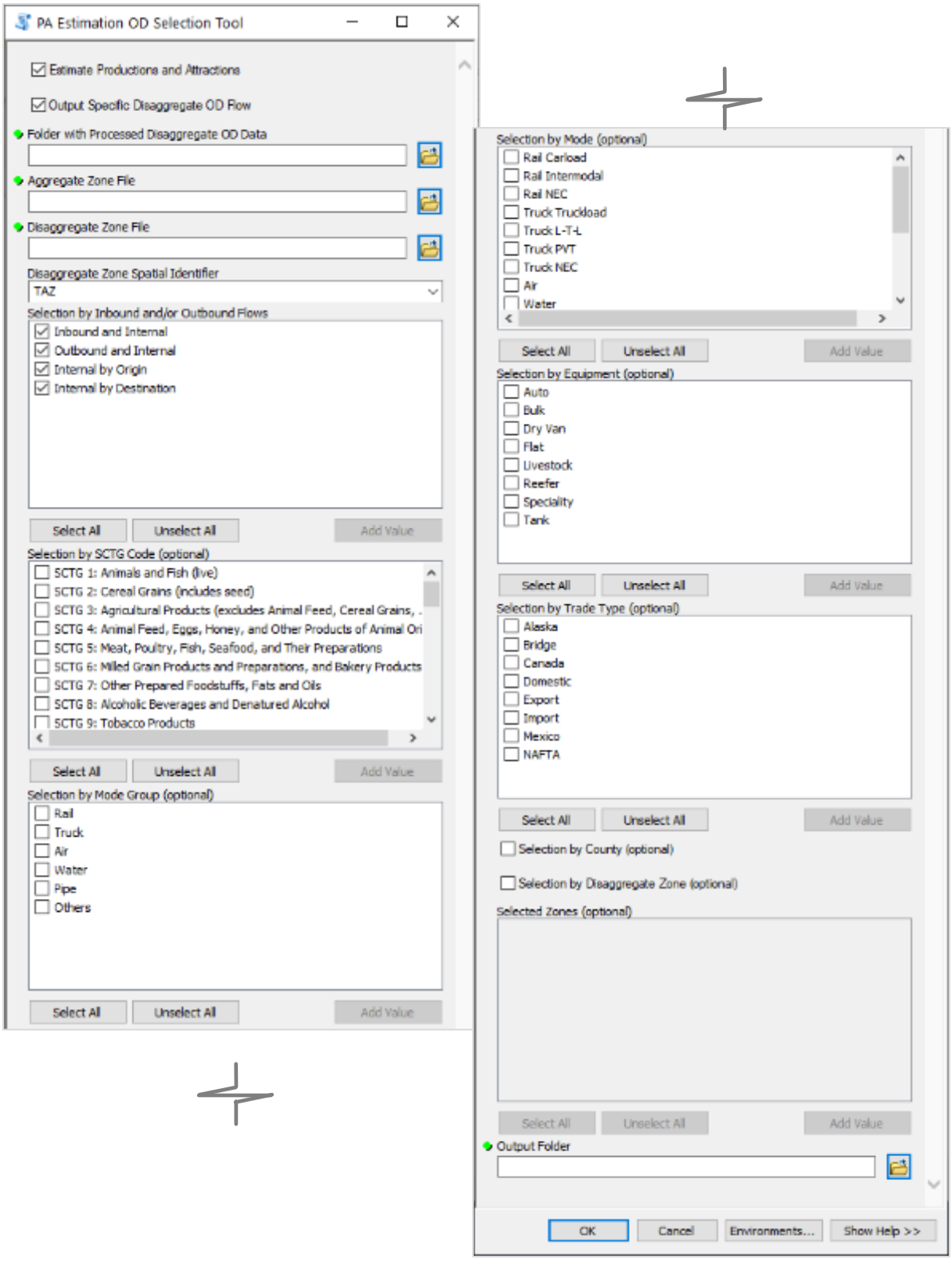


Figure F-6 PA Estimation OD Selection Tool

F.6 Postprocessing tool: PA MAP Tool

The PA MAP Tool (see Figure F-7) provides the capability to visualize the disaggregate PA flow by creating MXD map documents using the input template measured in Tons, Units, and Value. In addition, the tool provides the ability to export maps as PDF and JPG files.

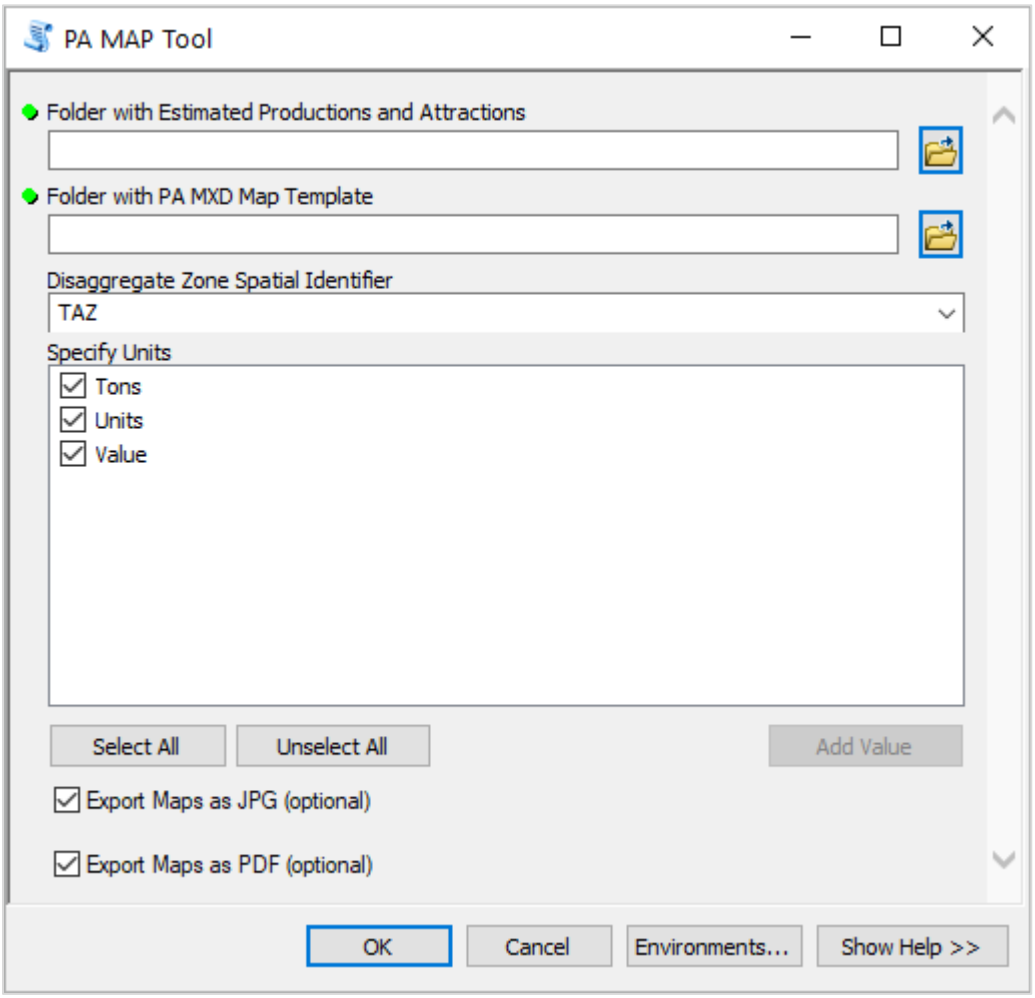


Figure F-7 PA MAP Tool

F.7 Postprocessing tool: OD MAP Tool

The OD MAP Tool (see Figure F-8) provides the capability to visualize the disaggregate OD flow by creating MXD map documents using the input template measured in Tons, Units, and Value. In addition, the tool provides the ability to export maps as PDF and JPG files. Next, for each disaggregation method, we present an example disaggregate zone flow maps created using OD MAP Tool and Tennessee Statewide Model TAZ network. Example maps will showcase a selected TAZ (TAZ: 1657) motorized and other vehicle production flow that originates and destines in the State of Tennessee for the truck mode group.

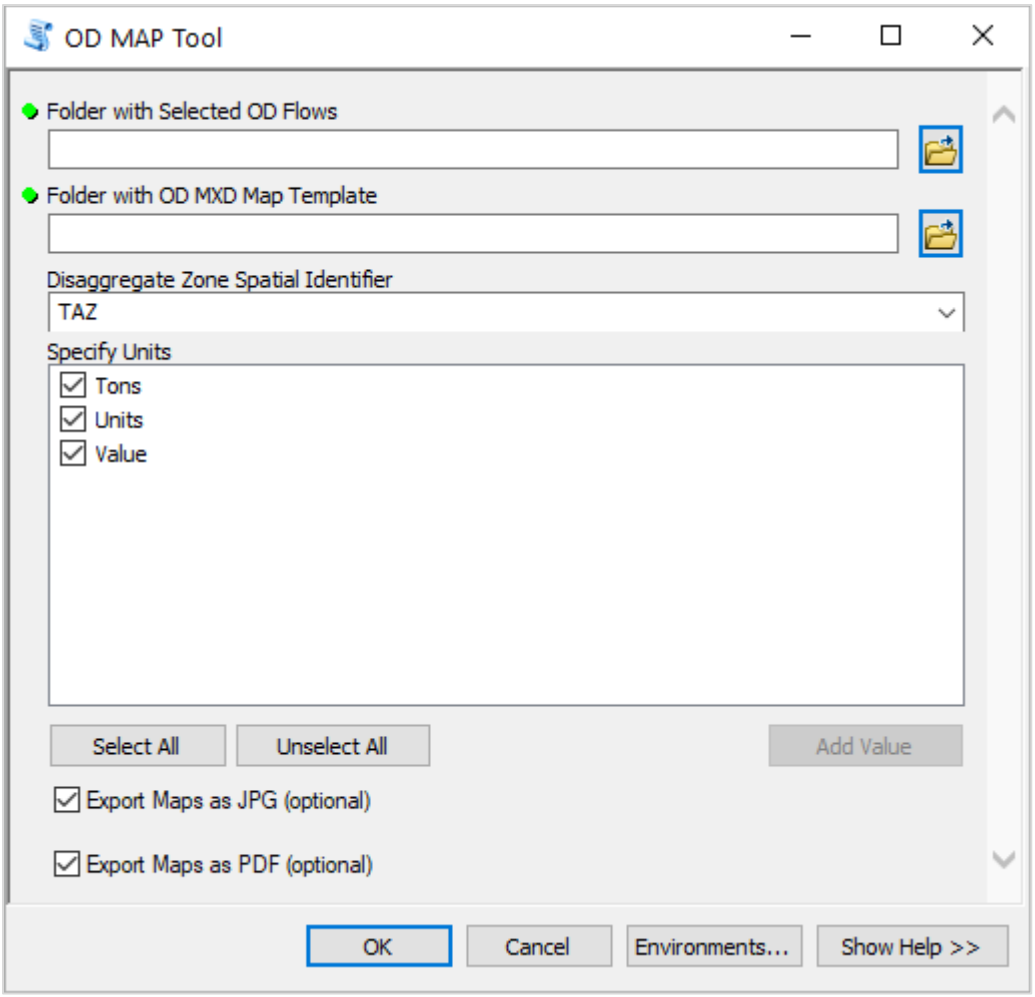


Figure F-8 OD MAP Tool

Appendix G. Piedmont Atlantic Megaregion Summit

G.1 Introduction

The Piedmont-Atlantic megaregion located in the Southeastern United States (see Figure G-1) covers parts of Georgia, Alabama, South Carolina, North Carolina, and Tennessee. The megaregion's major metropolitan areas are Atlanta, Birmingham, Charlotte, Greenville, Huntsville, Memphis, Nashville, Piedmont Triad (Greensboro–Winston-Salem), Research Triangle (Raleigh–Durham). Fan and Yu (*41*) reported that megaregions are playing an increasingly critical role in regional and global economic competition. In addition, businesses, policymakers, and community leaders are confronted by challenges that can be addressed at a mega-regional level. Ross (*42*) noted while megaregions are geographically large areas and differ in actual size, demographics, and competitive advantages, they are similar in that they are defined by agglomerations of related economic activity, transportation links, and cultural relationships. The following sections described the state freight planning practices located in the Piedmont-Atlantic megaregion described provides following by the identified collaboration opportunities across the state lines.

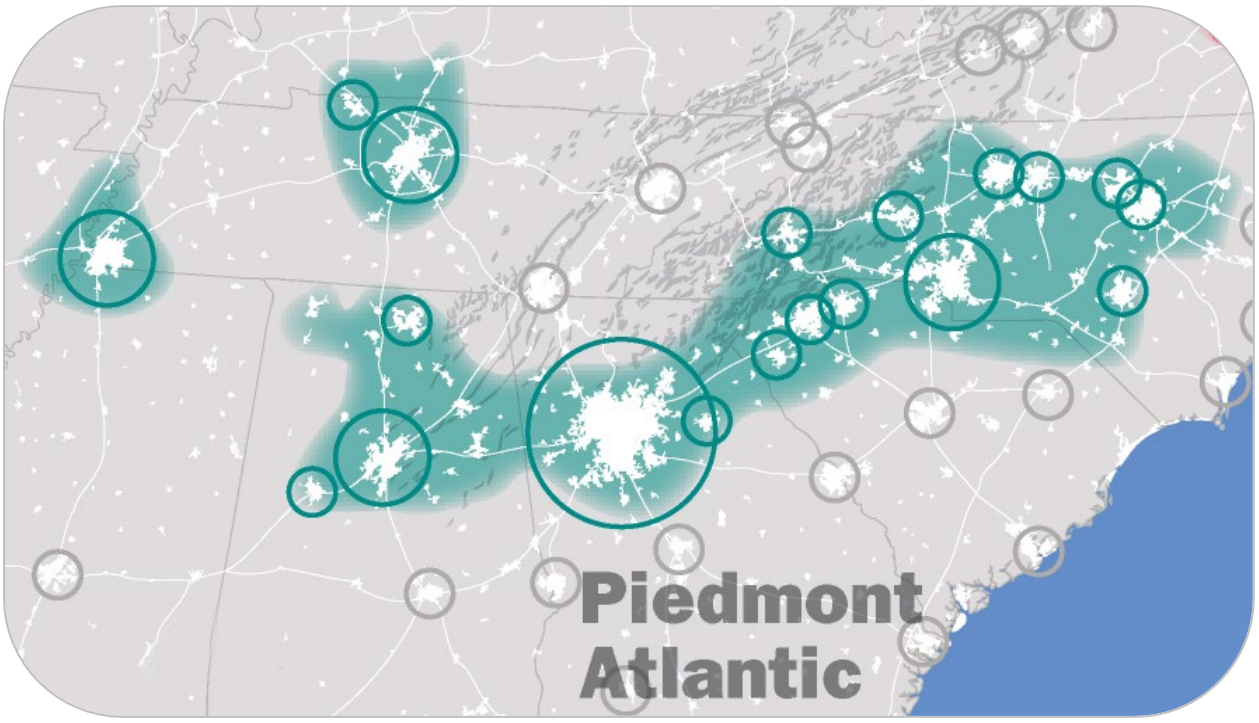


Figure G-1 The Piedmont-Atlantic Megaregion 2050 (Source: America2050.org)

G.2 PAM State Freight Plans

Alabama

The Alabama Statewide Freight Plan (*4*) is an update to the 2016 Alabama Statewide Freight Plan, which was completed under guidelines outlined in the Moving Ahead for Progress in the 21st Century Act (MAP-21). The 2017 Freight Plan considers recent policy changes at the federal level. The plan complies with the current federal transportation bill, known as the FAST Act (Fixing America's Surface Transportation Act). It aligns Alabama's freight policy with current guidance from the Federal Highway Administration (FHWA) Office of Freight Management and Operations. The plan also utilizes the most recent transportation and commodity flow data available, including FHWA's Freight Analysis Framework Version 4.3 (FAF 4.3) commodity flow data and the Statewide Travel Demand Model developed during the recently completed Alabama 2040 Statewide Transportation Plan effort.

Key plan elements include:

- An overview of relevant policy that influences freight planning at the statewide level
- A discussion of existing and projected commodity flows and freight network characteristics, which provide the baseline for identifying needs statewide
- A profile of the Interim National Multimodal Freight Network (NMFN) within the State of Alabama
- A summary of freight improvements of statewide significance, which forms the basis for the overall Freight Investment Plan
- A description of the measures and procedures that will be used by ALDOT to monitor transportation system performance with respect to freight mobility

An important element of the statewide freight planning process is the engagement of key stakeholders through the Freight Advisory Committee (FAC). The FAC membership has direct knowledge of and connections with all freight modal networks (roadway, rail, air, and water). It represents users/shippers and policymakers from both the public and private sectors.

Georgia

Georgia Statewide Freight and Logistics Plan (*43*) was organized into the following five tasks: Plan Development Advisory Committee and Stakeholder Engagement Plan, Strategic Need for Investing, Strategic Freight & Logistics Framework, Economic Evaluation, and Scenario Projection, Recommendations & Project Evaluation. At the start of the project, the State Freight and Logistics Plan's Development Advisory Committee was formed, which met monthly through the life of the study. The Advisory Committee was comprised of senior representatives of the GDOT Office of Intermodal Programs, the Transportation Policy Advisor to the Governor, the Center of Innovation for Logistics/Georgia Department of Economic Development, FHWA, and other agency representatives to ensure the plan was coordinated among the various agencies. The purpose of the Strategic Need for Investing task was to describe Georgia's freight and logistics sector's competitive position relative to other regions in the country and to build a case for increased investment in Georgia's freight-related assets. Strategic Freight & Logistics

Framework was designed to provide information on each of the freight modes in Georgia. Each mode was discussed separately. The modal profiles assemble the key sources of available data for each freight mode in the State. The topics are covered in detail based on available data and information collected directly from modal stakeholders. The modal profiles are also designed to provide a set of issues and needs for each mode that can be utilized as a source for identifying potential freight improvement solutions to be analyzed. The Economic Evaluation and Scenario Projection task offers further details about growth trajectories Georgia may take through the year 2050, underlining the importance of freight infrastructure as a key foundation for the State's future development. The pace of Georgia's growth, in turn, will influence long-term freight transportation demand. The Freight Improvement Project Recommendations task describes the freight improvement project recommendations developed as part of the Freight & Logistics Plan. Freight improvement projects discussed in this chapter were identified through stakeholder outreach, reviewing recent transportation plans, and needs analysis conducted as part of earlier tasks in this study. Key projects were then analyzed individually and grouped into packages. The packages were further analyzed using an economic impact tool, and the results were used to develop a list of priority freight packages for the State of Georgia.

North-Carolina

The North Carolina Statewide Multimodal Freight Plan (*44*) is the State's first statewide multimodal freight plan. States plan describes the underlying industry drivers of goods movement in the State and assessing how different supply chains impact the system's condition and performance. The Statewide Freight Plan also identifies transportation and logistics investments that can lead to statewide economic growth.

The North Carolina Department of Transportation recognizes the need to have a plan that:

- Sets specific multimodal transportation goals, strategies, and actions that will contribute to North Carolina job growth, improved economic competitiveness, and enhanced quality of life
- Provides clear, compelling freight-specific recommendations that support the 25-year vision and addresses the criteria in the Strategic Transportation Investments (STI) prioritization process
- Offers strategies for helping elected officials and the general public better understand the value of freight transportation investments and their economic benefits
- Positions North Carolina to capitalize on the creation of the National Highway Freight Program developed as part of the Fixing America's Surface Transportation (FAST) Act, which requires states to establish State Freight Plans

South-Carolina

The South Carolina Multimodal Transportation Plan (MTP), "Charting a Course to 2040" (*45*), is updated every five years to reflect the latest information on travel and growth trends, goals and objectives, infrastructure conditions, future deficiencies, and estimated funding.

The 2040 Multimodal Transportation Plan is comprised of several component plans that

include the following:

- The Executive Summary consists of the vision, goals, objectives, and measures for the overall MTP, as well as an analysis of transportation system needs and funding
- Interstate Plan provides an analysis of current congestion and forecast of future congestion
- Freight Plan (Amendment 1) includes an inventory of infrastructure, condition, commodity flows, performance measures, identification of the Strategic Freight Network and the Freight Investment Summary
- The Strategic Corridor Network Plan includes the network evaluation and identification methodology, analysis of current congestion, and forecast of future congestion
- Rail Plan provides freight and passenger service, performance, trends, and needs. Statewide Transit Plan includes a review of existing service, trends, human service coordination, and needs
- Regional Public Transit and Human Health Service Coordination Plans for each of the State's ten regions and includes a review of existing services, trends, human service coordination, and needs
- The Statewide Strategic Safety Plan to identify emphasis areas and strategies aimed at eliminating highway fatalities and severe injuries

Tennessee

The Tennessee Statewide Multimodal Freight Plan (*46*) was developed to define the Tennessee freight system's strategic goals and establish a strategy to achieve freight-related goals that align with TDOT's guiding principles and fulfill the requirements of the FAST Act. The Statewide plan was built on input from the public and private freight stakeholders. The plan also inventories the existing assets of the freight transportation system, evaluates the economic benefits of the system, anticipates future trends and economic growth, and determines implemenTable strategies for Tennessee to improve freight movement across all modes of transportation, as well as the equally important connections between modes. To better understand the relationship between freight and the economy, the statewide plan evaluated the types of goods Tennessee produces, Tennessee's requirements from outside markets to support the industry in the State, and Tennessee's role in connecting national and international markets. To support strategic investments in freight-related infrastructure, Tennessee has already advanced in several developments: preparation of a Long-Range Transportation Plan, an update of Statewide Travel Demand Model, development of a Statewide Rail Plan, organization of a Statewide Freight Advisory Committee (FAC), development of Environmental Policy guidelines, and development of the Corridor Management Agreements (CMAs) that provide a framework for multi-jurisdictional coordination of transportation and land use planning efforts. To better understand common barriers to the system's efficiency, the statewide plan discussed the freight-related issues regarding bottlenecks and safety. Stakeholder perceptions of the system's performance will also be addressed to provide a more comprehensive and inclusive analysis. Performance measures were outlined that help the public and TDOT evaluate the effects of constructed projects on freight movement in the State. The plan also included forecasted Tennessee freight movements and changes in freight trends, needs, and issues and communicated these attributes' effects to stakeholders. As part of the stakeholder and public outreach, TDOT established a Freight Advisory Committee (FAC) for the

State of Tennessee that is made up of public representatives from TDOT, MPOs, counties, cities, chambers of commerce, port authorities, airports, and universities. Through the stakeholder involvement and analysis of Tennessee's freight data conducted for this plan, TDOT has identified policies and strategies to improve the State's freight landscape. This information will contribute to the decisions that TDOT will make today and, in the future, on prioritizing the projects chosen to advance Tennessee's multimodal freight transportation system. As a final section, the statewide plan lists freight funding sources to support plan implantation.

G.3 PAM Cooperation Opportunities

A case study of the Piedmont Atlantic Megaregion Fan and Yu (*41*) reported that the emerging recognition of megaregions enables cooperation across jurisdictional borders to address specific challenges and presents an opportunity to reshape a large federal system of infrastructure and funding. The following section will discuss projects and collaboration opportunities across the state lines.

Ports

East coast ports have experienced significant growth since the completion of the Panama Canal Expansion in 2016. Article by Point to Point (*47*) reported that the Port of Savannah, currently the nation's fastest-growing port, moved 4.35 million TEUs in the calendar year 2018, its highest annual volume ever, and a 7.5 percent increase over 2017. The article also identified a future shift in freight from the West Coast to the East, decreasing the demand for West Coast intermodal, rail, and long-haul capacity. The Midwest has now become a potential capture market. For example, the port of Savannah is 1,000 miles closer to Chicago than Los Angeles.

Atlanta Regional Freight Mobility Plan (*48*) reported to accommodate the strong growth of the Port of Savannah initiative is to create a network of rail connections that will make the Port of Savannah more accessible to the entire State. The Network Georgia plan divides Georgia and portions of surrounding states into six zones (see Figure G-2): (1) Southwest Georgia, (2) Northwest Georgia, (3) Port Atlanta, (4) I-95 Corridor North, (5) I-95 Corridor South, and (6) Middle Georgia. Of the six proposed inland ports as part of the Network Georgia initiative, the Southwest Georgia port (based in Cordele) is open and operating while the Northwest Georgia port (based in Chatsworth).

Figure G-2 Network Georgia Zones (source: Atlanta Regional Freight Mobility Plan (*48*))

High-Speed Passenger Rail

High-speed rail can strengthen connectivity between megaregions, but the great expense and infrastructure investment necessary to achieve this connectivity will require careful coordination (*49*). There are some intercity passenger initiatives Atlanta-Birmingham HSR (see Figure G-3), Atlanta-Chattanooga-Nashville-Louisville HSR (see Figure G-6), Atlanta- Charlotte- Raleigh HSR (see Figure G-4), Southeast HSR (see Figure G-7).

The High-Speed Rail Planning Services Final Report (*50*) evaluated the feasibility of high-speed rail for three corridors in the southeastern United States. The corridors are as follows Atlanta, GA to Birmingham, AL; Atlanta, GA to Macon, GA to Jacksonville (see Figure G-5), FL; Atlanta, GA to Chattanooga, Tennessee to Nashville, Tennessee to Louisville, KY. The Southeast Corridor is one of the first five federally designated higher-speed rail corridors in the country. The corridor is a network of passenger and freight rail that runs from Washington, DC to Jacksonville, Fla., encompassing D.C., Virginia, North Carolina, South Carolina, Tennessee, Georgia, and Florida.

I-95 Corridor Coalition Report (*51*) noted that South Carolina, for example, reported a collaborative effort with North Carolina to coordinate freight arterials to accommodate Charlotte, NC. Georgia, North Carolina, and South Carolina departments of transportation have held public hearings on a Tier 1 draft environmental impact statement (DEIS) for a proposed Atlanta-to-Charlotte, North Carolina, passenger-rail corridor investment plan.

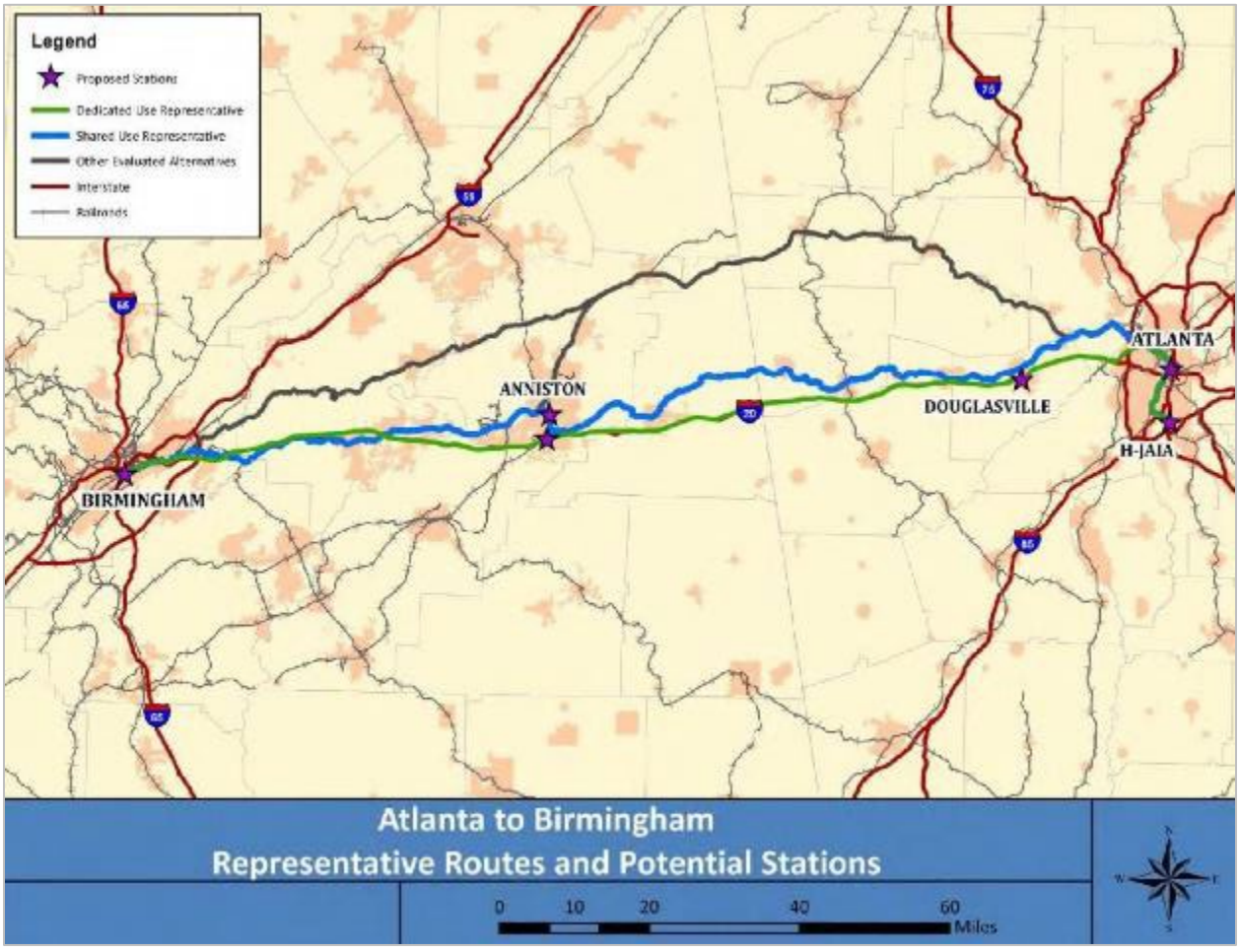


Figure G-3 Atlanta to Birmingham Representative Routes and Potential Stations Source: The High-Speed Rail Planning Services Final Report (8))

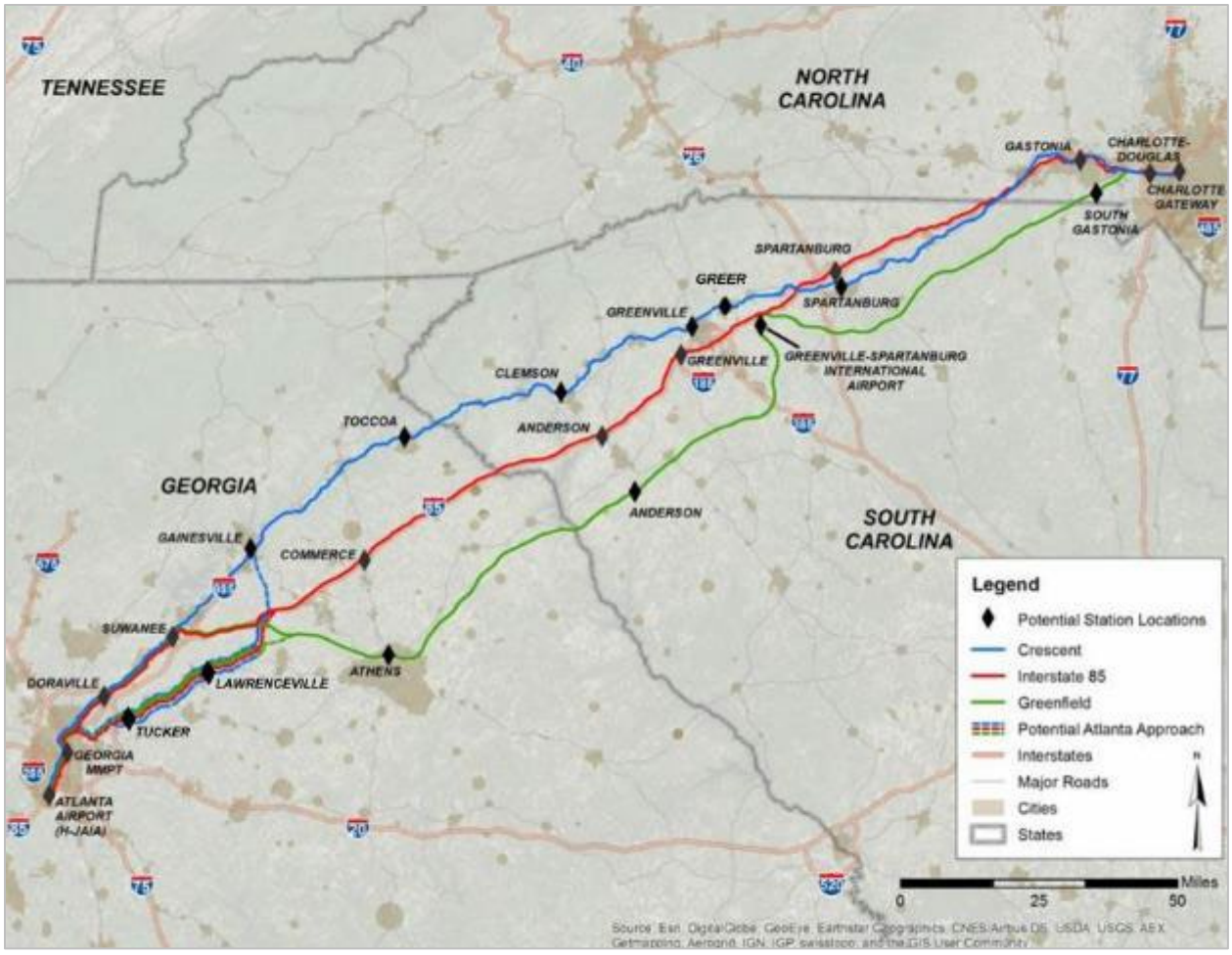


Figure G-4 Three potential route alternatives Atlanta to Charlotte Source: The High-Speed Rail Planning Services Final Report (8))

Figure G-5 Atlanta to Jacksonville Representative Routes and Proposed Stations (Source: The High-Speed Rail Planning Services Final Report (*50*))

Figure G-6 Atlanta-Chattanooga-Nashville-Louisville Representative Routes and Potential Stations (Source: The High-Speed Rail Planning Services Final Report (*50*))

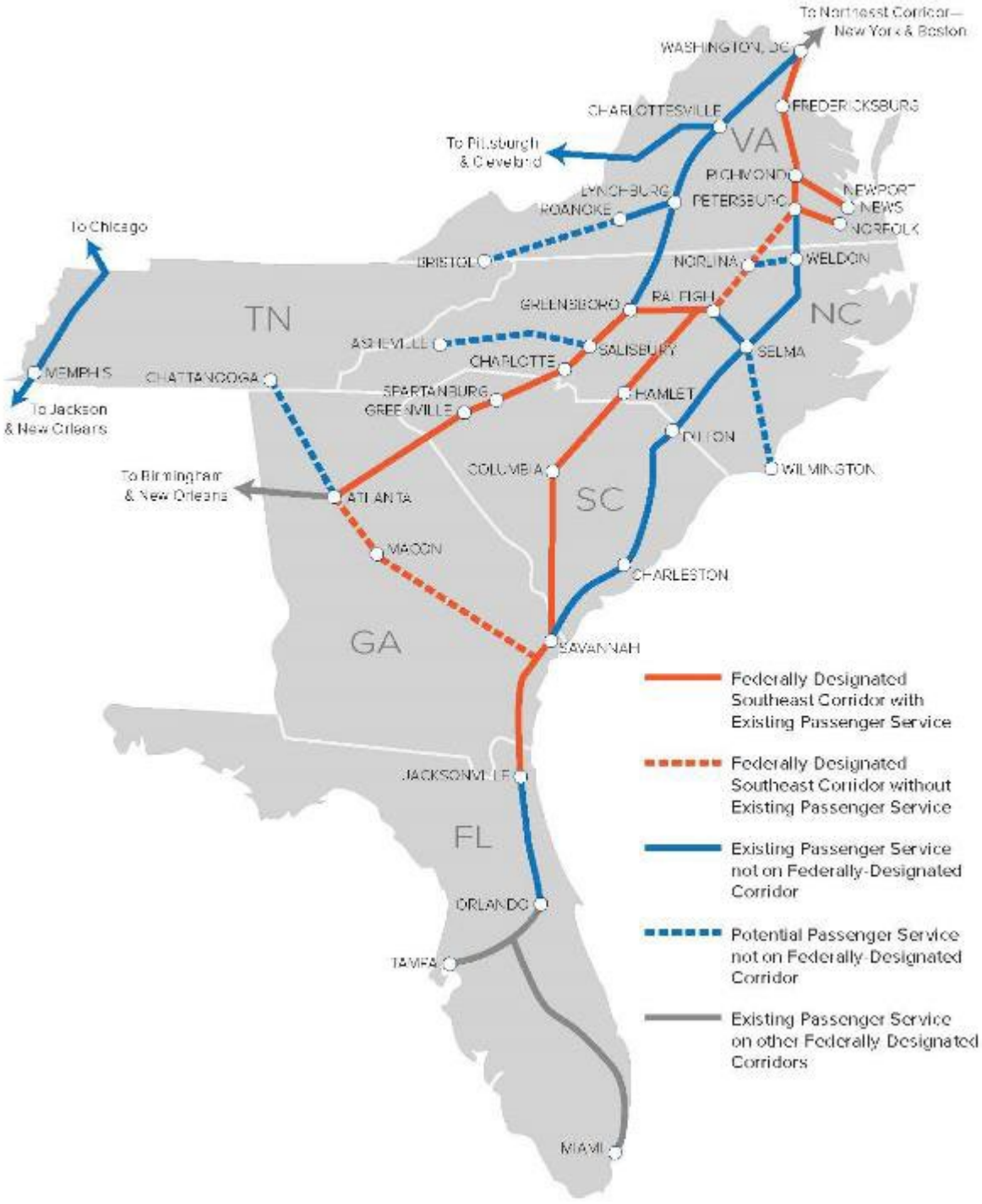


Figure G-7 Southeast Corridor (Source: https://www.ncdot.gov)

Freight Rail

Fan and Yu (41) listed the implementation of a high-speed freight rail corridor as one of the potential opportunities. High-speed freight rail corridors in the PAM could relieve/mitigate the congestion on the highways, achieve sustainable development, and reduce foreign oil dependency, besides optimizing and updating existing rail lines. Cost-effective investment in high-speed rail systems, a mixed rail system (including both passenger and freight) should be considered and implemented. Tennessee Statewide Multimodal Freight Plan (*46*) reported by paralleling interstate alignment, the Crescent Corridor (see Figure G-8) improves the capacity and resiliency of the freight transportation system in the US with the added potential to support additional mode shifts from the truck to rail for long-haul traffic. Completion of the Crescent Corridor is planned by 2030. Norfolk Southern study shows that the Crescent Corridor will create 122,820 jobs across the rail network and new terminal facilities in Birmingham, Alabama, Memphis, Tennessee, Charlotte, North Carolina., and Greencastle, Pennsylvania.

Figure G-8 Crescent Corridor (Source: http://www.nscorp.com)

The Greensboro Urban Area 2035 Long Range Plan (*52*) reported that North Carolina state might want to develop more east-west high-performance lines. The east-west line's goal would be to reach the Midwest and the Mississippi River at Memphis and St. Louis. One option is the CSX east-west mainline from Wilmington, through Monroe, Charlotte, and Marion to Johnson City (Tennessee). It is perfectly straight in the east, and it has the longest stretch of tangent (straight) track in the US – steep grades and crooked trackage in western North Carolina limited speed through the Blue Ridge Mountains. It is used primarily to bring coal out of the Appalachians. Another option involves combining the CSX east-west mainline from Wilmington through Monroe, and not Charlotte, to Chester (SC), and then back into North Carolina via NS from Spartanburg (SC), through Asheville into Tennessee. The last option would be using the CSX mainline from Wilmington through Monroe to Chester (SC) and not attempt to create an in-state route through the North Carolina Mountains. Two other options make sense, both on NS. One route is from Morehead City west through Raleigh to Greensboro, and then north to Lynchburg, VA. The second is similar: from Morehead City west through Raleigh and Greensboro to Winston-Salem, and then north to Roanoke, Virginia.

The Southeast Rail Operations Study (*53*) reported that NS is developing a new intermodal terminal at the Charlotte Douglas International Airport. CSXT is doubling its terminal capacity at Hovis Road. The two intermodal facilities would support both the Crescent Corridor and National Gateway initiatives. They would add needed capacity to the Charlotte intermodal market, which serves parts of Tennessee, Georgia, North Carolina, and South Carolina.

Highway

Tennessee Statewide Multimodal Freight Plan (*46*) reported that the Corridor K (see Figure G-9) study is an economic development and transportation study which follows US 64 / 74, linking Chattanooga and Asheville, North Carolina. The corridor includes Hamilton, Polk, and Bradley counties in Tennessee and six counties in North Carolina, and two Georgia counties. The study emphasizes the need for east-west access to move goods to and from market areas and Atlantic coastal ports. The benefits of corridor development could lead to better access to Atlantic coastal ports is important to businesses in the region as more companies utilize international suppliers and sell to international and national customers. Improved the east-west connection of the transportation system can reduce the time and costs of the regional business.

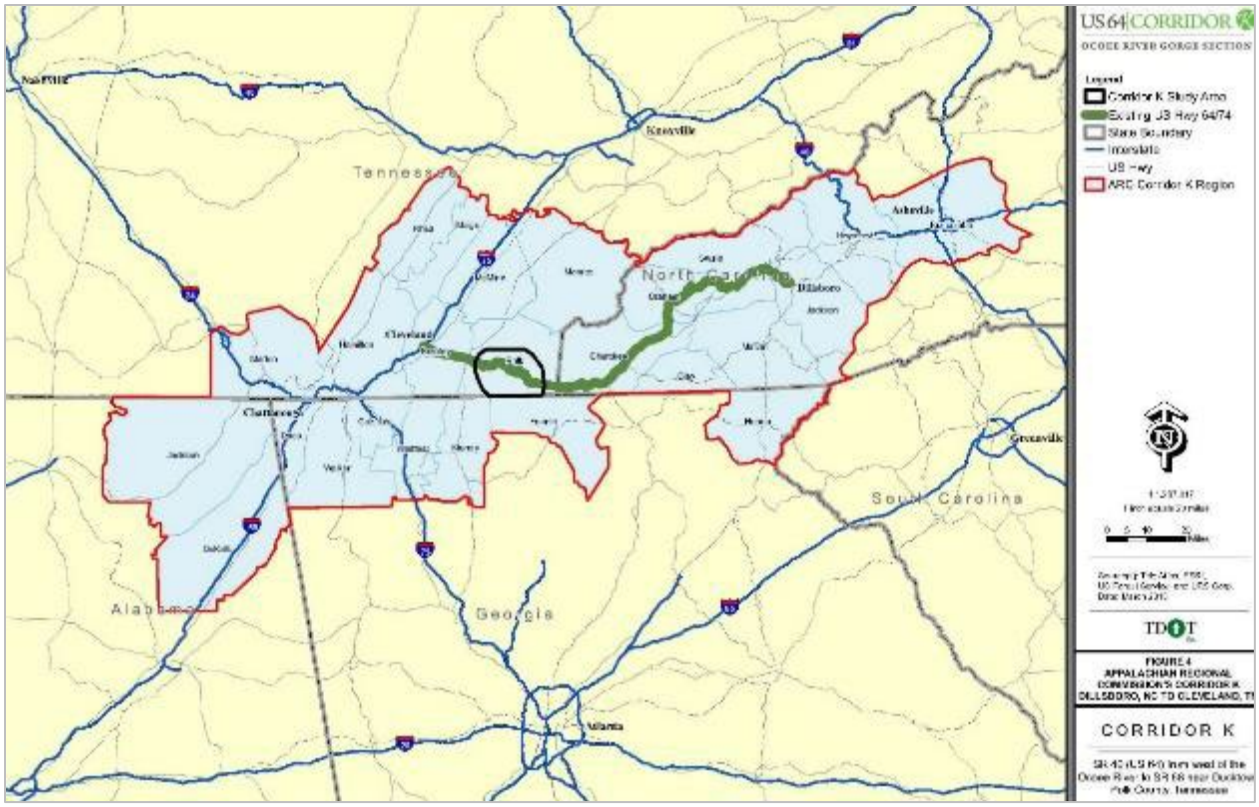


Figure G-9 Corridor K (Source: Corridor K Study (*54*))

I-95 Corridor Coalition Report (*51*) noted that several agencies reported, for example, that considering pass-through effects on neighboring states proved to be a major eye-opener: improvements made in one State can have definite effects in neighboring states.

Georgia Statewide Freight and Logistics Plan (*43*) reported that the Chattanooga bypass alternative, along with the Macon-Lagrange-U.S. 27 improvements, were found to have the highest potential return on investment to the State. The Macon-Lagrange portion of this improvement was also found to have significant benefits for east-west traffic moving through the State. This would include traffic moving between Savannah, Macon, and Augusta to Alabama or points further to the west. I-75 Corridor Feasibility Study (*55*) reported projects that terminate in an adjoining state, such as the Chattanooga Bypass, need to be coordinated with Georgia.

Creating Improved Megaregion Governance Framework

Fan and Yu (*41*) megaregion freight planning is complex and requires the engagement of multiple jurisdictions, organizations, and interests. Enhancing partnership across geographic scales help overcome these issues. Partnerships can also help overcome financial obstacles and move ideas from planning to implementation. PAM's policymakers need to help the State to treat competition and cooperation correctly.

Hylton (*56*) reported that the megaregion governance structure should include selected a hybrid structure, cross-sectoral alliances of public and private-sector partnerships with federal leadership to facilitate cooperation among different interests.

Ross (*42*) reported that a megaregion framework's power is that it can be adapted to different strategies depending on unique locational challenges to address current and future competitiveness.

Megaregional Dataset

Fan and Yu (*41*), another issue presented by the researchers is the lack of a complete dataset at a megaregional level. Complete and high-quality data is essential to perform freight planning for megaregions effectively. Thus, the dataset (such as private sector economic data) must be available in the PAM at the megaregion scale to solve multi-jurisdictional issues.

I-95 Corridor Coalition's extensive interviews with 15 state Departments of Transportation (DOTs) (*51*) highlighted the need for a greater understanding of existing data analysis tools. Staff expertise with data analytics, including understanding commodity flow, was reported as challenging and often inadequate. The report also noted that several states cited opportunities they had identified and used in seeking data sources. These datasets were primarily internal and were sometimes used to provide nontraditional data, such as oversize/overweight data.

Environment

Fan and Yu (*41*) reported that the most congested freeway in the PAM is Interstate I-85 and I-20. Regions in the PAM need to work together to determine how to address environmental issues. To resolve environmental problems, a megaregional approach calls for new ideas, methods, and tools for planning beyond the current toolbox of MPOs because of the megaregion's geographical scale. MPOs will need to develop common standards and policies to ensure uniformity among the planning organizations.

Funding

Fan and Yu (*41*) coordination among multiple jurisdictions in resolving transportation and freight movement issues in the PAM can be organized to obtain federal funding. Decisionmakers should ensure that funding and financing are managed to encourage partners to address megaregion-scale freight transportation problems. The policymakers in the PAM should also help the state designate freight corridors. These designated freight corridors in the PAM are able to access funding when available.

Atlanta Regional Commission report (*48*) noted that partnership opportunities with the private sector are available in freight and have had noTable applications in railroad projects and commercial development. The timeline for project implementation has a crucial effect on the prospects for success. If a project drags out five years or more before it begins to earn returns, the compounded cost of capital makes it uncompetitive with alternative investments that earn

returns faster. Provisions in the FAST Act for federal permitting improvement and acceleration of project delivery address this problem at the national level.

Coalition Support

The I-95 Corridor Coalition report (*51*) suggested holding information exchanges on states' freight planning tools, innovative data applications, and state-level freight planning best practices. Support multistate, regional, and corridor-wide freight planning discussions. Hold a truck parking workshop and symposium.

Appendix H. Freight Workshop Material

COLLABORATION OPPORTUNITIES FOR REGIONAL FREIGHT PLANNING IN THE PIEDMONT ATLANTIC MEGAREGION WORKSHOP

Friday, August 20, 2021, 9:00 AM – 1:00 PM Eastern Time (US and Canada)

Zoom Meeting (please see below call information)

https://memphis.zoom.us/j/83869932620?pwd=TnVQMnE1d3hSQURqTFVwL3hESWdCZz09

AGENDA

Item	Lead	Time
Welcome and Workshop Goals	Martin Lipinski Daniel Pallme	9:00 AM – 9:15 AM
Projects Overview: Freight disaggregation and truck parking GIS tools	Mike Golias Sabyasachee Mishra	9:15 AM- 10:15 AM
Survey Results/Roundtable discussion	Mike Golias Sabyasachee Mishra	10:15 – 11:00 AM
15 MINUTE BREAK **11:00 AM – 11:15 AM**		
Survey Results/Roundtable discussion	Martin Lipinski Daniel Pallme	11:15 AM – 12:45 PM
Closing Remarks/Future Steps	Martin Lipinski Daniel Pallme	12: 45 PM – 1: 00 PM

Figure H-1 Woskshop Agenda

H.1 Freight Workshop Minutes

H.1.1 Introductions

1. Introduction by Martin Lipinski (University of Memphis-UoM) and Daniel Pallme (TDOT) and Attendees' introduction

   Attendees:

   1) Sonya R. Baker (Assistant Chief of Studies in Alabama DOT)
   2) Marygrace Parker (Director, Freight Program, The Eastern Transportation Coalition)
   3) Lisa Bollinger (Transportation Planning Manager at Spartanburg Area)
   4) David F. Hooper (Administrator of Rock Hill-Fort Mill Area Transportation Study (RFATS))
   5) Erik Johnson (Freight Planning Specialist in Virginia DOT)
   6) Andrew Ludasi (Freight Planning in New Jersey DOT)
   7) Thomas McQueen (AICP Assistant Administrator in Georgia DOT)
   8) Tony Arrington (Alabama DOT)
   9) Rickey Fitzgerald (Freight and Multimodal Operations Manager in Florida DOT)
   10) Nicole Katsikides (Research Scientist in Texas A&M Transportation Institute)
   11) David Elder (AICP, Assistant Planning Director in Connecticut DOT)
   12) Trung Trinh (Transportation Planner / Freight Coordinator at MDOT)
   13) Amy Kosanovic (Tennessee DOT)
   14) Daniel Pallme (Tennessee DOT)
   15) Melanie Murphy (Tennessee DOT)
   16) Mike Golias (UoM)
   17) Sabyasachee Mishra (UoM)
   18) Karlis Pujats (IHS Markit)
   19) Dimitrios Giampouranis (UoM)
   20) Mitra Salehi Esfandarani (UoM)
   21) Vasileios Liatsos (UoM)

H.1.2. Agenda

1. Agenda presentation by Mike Golias.
2. Daniel Pallme underlined the main goal of the presentation as the interstate collaboration on freight modeling and planning and summarized the scope of the two presented projects.
3. Melanie Murphy provided an overview about TN research projects

H.1.3. Project Presentations

1. Karlis Pujats and Mike Golias summarized two projects funded by TDOT
   Project 1: Freight Data Disaggregation
   Project 2: Truck Parking Needs in TN
2. Mike Golias pointed out ways to improve both projects.
3. Sonya Baker asked for some clarification about the data sources.

4. Mike Golias and Daniel Pallme responded.
5. Conversation about presented project's data source availability.
6. Nicole Katsikides referred to the availability of relative truck parking data in Maryland.
7. Mike Golias presented results from the survey.
8. Truck Parking, Last Mile access and dedicated freight infrastructures are pointed as high priority freight issues.
9. Time Frame and Possibilities of collaboration were discussed.
10. Mike Golias finished his presentation by underlying some other main freight issues and the importance of state collaboration.

10 Minutes Break

H.1.4. Open floor discussion

a. Truck Parking

1. Erik Johnson mentioned that there are several multi state organizations that are engaged in the truck parking topic and TRB just put together a domestic scan on truck parking, mostly focused on the technological side of things like parking information systems and dissemination.
2. Daniel Pallme asked the participants for their recommendations for identifying coalitions that are the most promising. The Eastern Transportation Coalition and the Appalachian Regional Commission were identified.
3. Thomas McQueen mentioned that FHW provides free datasets that should be taken under consideration.
4. MaryGrace Parker asked Mike Golias if the tools that were presented: i) can be used by other States, ii) could work with publicly available data to provide the same results, and iii) if data from multiple States are fed into the tools, would they provide with a larger regional picture of the issue
5. Mike Golias proposed to utilize the tools with publicly available data as a comparison to TRANSEARCH data to identify any benefits as a future research project.
6. Nicole Katsikides added that data purchased for other topics can possibly utilized for truck parking studies.
7. Erik Johnson highlighted that the safety component must be involved too. More specifically, by using crash data, crashes can be attributed to unauthorized parking.

b. Short Line Railroads

1. Daniel Pallme mentioned that the State of Tennessee distributed $20 million out of the total $85 million to help short line railroads in Tennessee and concluded that there is not much room for collaboration in this topic, but it is worth letting other States and the public know of programs like that.

c. Data Disaggregation

1. Andrew Ludasi proposed to use multiple years of IHS (TRANSEARCH) data to check for differences over the years.

d. Urban Freight Access Delivery

1. Sabya Mishra made a great point about the stakeholders' concerns about using the developed tool when the database is not free. Also, there could be incremental benefits of having access to more data and answering some difficult questions for planning purposes so the developed tools can be expanded further or strengthened.
2. In response to Daniel Pallme concerns about the urban freight access delivery in downtown Nashville and Memphis, Andrew pointed out that New Jersey does not have this issue since it is a primarily suburban state, but a lot of work has been done on the downtown deliveries in places like Philadelphia and Mississippi (Jacksonville mostly).
3. Sonya R. Baker mentioned that there was the same problem in Birmingham which was mitigated through bridge replacement projects for 59 and 20.

e. Railroad Crossing Accidents

1. Daniel Pallme recommended a new technology known as Waze, which informs drivers about anything ahead.
2. Trung Trinh mentioned that construction was missing in the freight issues priority list. He also pointed out that there is no good way for some locations in their state to have detours for the trucks to route around, so considering the construction would be a priority.

f. Dedicated Freight Infrastructure

1. Thomas McQueen mentioned that a dedicated truck lane is one of the significant mega projects that are under the design phase in Georgia. It is going to be northbound only because it has more heavy trucks than southbound. In other words, more incidents happen at more locations at more times during the day over the northbound than the southbound. The design phase of this project cost them 1.8 billion.
2. Thomas McQueen also highlighted the importance of this project since it improves freight movement, decreases travel times, enhances safety, and provides transportation improvements and efficiencies. It also helps with travel time reliability; if trucks can make it within their service windows, truck parking and unauthorized parking can be improved.
3. Thomas McQueen pointed out that in case of using a dedicated truck lane, less interaction between passenger vehicles and trucks will occur, which provides an excellent opportunity for using the autonomous trucks and less traffic flow. Since the dedicated truck parking is under the design phase, the second one using autonomous trucks might come next.

H.2. Closing Remarks

1. Daniel Pallme and Mike Golias mentioned the closing remarks and future steps and thanked all 11 states for attending and sharing their perspectives.
2. Major issues to consider:
    a. Freight demand modeling using freely available data: what are the limitations and to what extend can such data provide accurate models; at what level of accuracy needed do stated and/or MPOs should purchase proprietary data
    b. What are the benefits of dedicated freight infrastructure (such as the innovative dedicated truck lanes in GA) and what are the benefit multipliers when such projects cross state boundaries?
    c. A lot of data and new studies are available for truck parking. How can states utilize such data and the products of the studies to better utilize existing truck parking capacity and plan for the future? The issue of safety also needs to have a prominent place in any decision making and modeling/planning
    d. Prioritization and construction planning needs to be a major component and priority in freight planning

H.3 Freight Summit Survey

Start of Block: Default Question Block

Q1 **COLLABORATION OPPORTUNITIES FOR REGIONAL FREIGHT PLANNING IN THE PIEDMONT ATLANTIC MEGAREGION WORKSHOP**

TN DOT is in the progress of completing a study on data disaggregation for freight movements in the State of TN. As part of the study a half-day virtual workshop is being planned to promote collaboration between the Piedmont Atlantic, Northeast, and Florida Megaregions states on freight planning, operations and management and project selection. The date for the workshop will be decided upon in consultation with all the participating States. The purpose of this short survey is to identify freight issues that are of concern to your state and to rank their importance. An additional purpose is to identify areas where it would be possible to collaborate with researchers and DOT personnel from other states to study the problems. The results of this survey will form the basis for discussion during a half-day virtual workshop planned for Summer 2021.

If you have any questions about this survey please feel free to contact the project principal investigator, Dr. Mihalis (Mike) Golias at: mgkolias@memphis.edu Thank you in advance for your time.

Please provide your name, contact information, and affiliation.

Q2 First & Last Name

_____

Q3 Job Title

_____

_____

_____

_____

_____

Q4 Email

_____

Q6 Which state DOT do you represent?

_____

Q7 Which division do you represent?

_____

Q8 **.** Does your state have a freight plan and if so when was the last update? Please provide the year of the recent update.

- ○ Yes (1) _____
- ○ No (2)

Page Break

Q9 Please rate the freight issues for your state from 1-worst to 10-best.

Q10 Please rate the following freight related issues for your state between 1-worst to 10-best.

	1 2 3 4 5 6 7 8 9 10
Truck parking ()	
Dedicated freight infrastructure (i.e., dedicated truck lanes) ()	
Urban freight access and delivery ()	
Short line railroads ()	
Truck related accidents ()	
"Last Mile" access ()	
Railroad crossing accidents ()	
Freight planning ()	

Q11 Please rate the listed freight issues for your state in terms of infrastructure preservation from 1-worst to 10-best.

	1 2 3 4 5 6 7 8 9 10
Road ()	
Rail ()	
Ports ()	

Q12 Please rate the listed freight issues for your state in terms of environmental issues from 1-worst to 10-best.

	1 2 3 4 5 6 7 8 9 10
Air quality ()	
Alternative fuels ()	

Q13. Please list any other issues not mentioned above and also rate them from 1-worst to 10-best.

	1 2 3 4 5 6 7 8 9 10
1 ()	
2 ()	
3 ()	
4 ()	

Page Break

Collaboration opportunities among States.

Q14 To what degree do you believe collaboration among States is possible for the following freight issues?

	High (1)	Medium (2)	Low (3)
Truck parking (1)	○	○	○
Dedicated freight infrastructure (i.e., dedicated truck lanes) (2)	○	○	○
Urban freight access and delivery (3)	○	○	○
Short line railroads (4)	○	○	○
Truck related accidents (5)	○	○	○
"Last Mile" access (6)	○	○	○
Railroad crossing accidents (7)	○	○	○
Freight planning (8)	○	○	○

Q15. To what degree do you believe collaboration among States is possible for the following freight issues terms of infrastructure preservation?

	High (1)	Medium (2)	Low (3)
Road (1)	○	○	○
Rail (2)	○	○	○
Ports (4)	○	○	○

Q16 To what degree do you believe collaboration among the States is possible for the following freight issues in terms of environmental issues?

	High (1)	Medium (2)	Low (3)
Air quality (1)	○	○	○
Alternative fuels (2)	○	○	○

Q17**.** Please list any other issues not mentioned above and also rate them based on the extent of collaboration you believe is possible between the States for the issues.

	High (1)	Medium (2)	Low (3)
1 (1)	○	○	○
2 (2)	○	○	○
3 (3)	○	○	○
4 (4)	○	○	○

Page Break

Q18 Rate the issues you selected as possible items for collaborations among the States based on the time frame of collaboration.

Q19. Please mention the time frame of collaboration for the freight issues you selected as possible items of collaboration between the States.

	Short (1)	Medium (2)	Long (3)
Truck parking (1)	○	○	○
Dedicated freight infrastructure (i.e., dedicated truck lanes) (2)	○	○	○
Urban freight access and delivery (3)	○	○	○
Short line railroads (4)	○	○	○
Truck related accidents (5)	○	○	○
"Last Mile" access (6)	○	○	○
Railroad crossing accidents (7)	○	○	○
Freight planning (8)	○	○	○

Q20. Please mention the time frame of collaboration for the freight issues you selected as possible items of collaboration between the States considering infrastructure preservation.

	Short (1)	Medium (2)	Long (3)
Road (1)	○	○	○
Rail (2)	○	○	○
Pipelines (5)	○	○	○

Q21 Please mention the time frame of collaboration for the freight issues you selected as possible items of collaboration between the States considering environmental issues.

	Short (1)	Medium (2)	Long (3)
Air quality (1)	○	○	○
Alternative fuels (2)	○	○	○

Q22. Please list any other issues not mentioned above and also rate the time frame of collaboration.

	Short (1)	Medium (2)	Long (3)
1 (1)	○	○	○
2 (2)	○	○	○
3 (3)	○	○	○
4 (4)	○	○	○

Page Break

Q23. Please provide your availability for the following weeks for the workshop.

	Available (1)	Maybe (2)	Not available (3)
June 21st (1)	○	○	○
June 28th (2)	○	○	○
July 5th (3)	○	○	○
July 12th (5)	○	○	○
July 19th (6)	○	○	○
July 26th (7)	○	○	○
August 2nd (8)	○	○	○
August 9th (9)	○	○	○
August 16th (10)	○	○	○

Q24 Please provide additional comments or other issues not listed that you would like to see discussed as opportunities for collaborations among the States.

_____

_____

Appendix I. Dictionaries and Crosswalk Tables

TABLE I-1 TRANSEARCH MODE CODE AND GROUP DICTIONARY

Number	*Code*	*Description*	*Mode Group*
0	NONE	None	None
1	CL	Rail Carload	Rail
2	IMX	Rail Intermodal	Rail
3	RAIL	Rail NEC	Rail
4	TL	Truck Truckload	Truck
5	LTL	Truck L-T-L	Truck
6	PVT	Truck PVT	Truck
7	TRUCK	Truck NEC	Truck
8	AIR	Air	Air
9	WTR	Water	Water
10	OTH	Other	Oth
11	PIPE	Pipeline	Pipe
12	MAIL	Mail	Oth
13	FTZ	Foreign Trade Zones	Oth
14	CONT	Water Containerized	Water
15	BULK	Water Non-Containerized	Water

TABLE I-2 TRANSEARCH EQUIPMENT CODE DICTIONARY

Equipment Code	*Description*
A	Auto
B	Bulk
D	Dry Van
F	Flat
L	Livestock
R	Reefer
S	Specialty
T	Tank

TABLE I-3 TRANSEARCH TRADE TYPE DICTIONARY

Trade Type	*Description*
A	Alaska
B	Bridge
C	Canada
D	Domestic
E	Export
I	Import

M	Mexico
N	NAFTA

TABLE I-4 SCTG 2-DIGIT CODE TO NAICS 3-DIGIT CODE CROSSWALK TABLE (SEE ANDERSON ET AL. (*39*))

SCTG 2-digit Code	*SCTG 2-digit Description*	*NAICS 3-digit Code*	*NAICS 3-digit Code Description*
1	Animals and Fish (live)	112	Animal Production and Aquaculture
2	Cereal Grains (includes seed)	111	Crop Production
3	Agricultural Products (excludes Animal Feed, Cereal Grains, and Forage Products)	111	Crop Production
4	Animal Feed, Eggs, Honey, and Other Products of Animal Origin	311	Food Manufacturing
5	Meat, Poultry, Fish, Seafood, and Their Preparations	311	Food Manufacturing
6	Milled Grain Products and Preparations, and Bakery Products	311	Food Manufacturing
7	Other Prepared Foodstuffs, Fats and Oils	311	Food Manufacturing
8	Alcoholic Beverages and Denatured Alcohol	312	Beverage and Tobacco Product Manufacturing
9	Tobacco Products	312	Beverage and Tobacco Product Manufacturing
10	Monumental or Building Stone	212	Mining (except Oil and Gas)
11	Natural Sands	212	Mining (except Oil and Gas)
12	Gravel and Crushed Stone (excludes Dolomite and Slate)	212	Mining (except Oil and Gas)
13	Other Non-Metallic Minerals not elsewhere classified	212	Mining (except Oil and Gas)
14	Metallic Ores and Concentrates	212	Mining (except Oil and Gas)
15	Coal	212	Mining (except Oil and Gas)
16	Crude Petroleum	211	Oil and Gas Extraction
17	Gasoline, Aviation Turbine Fuel, and Ethanol (includes Kerosene, and Fuel Alcohols)	324	Petroleum and Coal Products Manufacturing
18	Fuel Oils (includes Diesel, Bunker C, and Biodiesel)	324	Petroleum and Coal Products Manufacturing

19	Other Coal and Petroleum Products, not elsewhere classified	324	Petroleum and Coal Products Manufacturing
20	Basic Chemicals	325	Chemical Manufacturing
21	Pharmaceutical Products	325	Chemical Manufacturing
22	Fertilizers	325	Chemical Manufacturing
23	Other Chemical Products and Preparations	325	Chemical Manufacturing
24	Plastics and Rubber	326	Plastics and Rubber Products Manufacturing
25	Logs and Other Wood in the Rough	113	Forestry and Logging
26	Wood Products	321	Wood Product Manufacturing
27	Pulp, Newsprint, Paper, and Paperboard	322	Paper Manufacturing
28	Paper or Paperboard Articles	322	Paper Manufacturing
29	Printed Products	323	Printing and Related Support Activities
30	Textiles, Leather, and Articles of Textiles or Leather	313	Textile Mills
31	Non-Metallic Mineral Products	327	Nonmetallic Mineral Product Manufacturing
32	Base Metal in Primary or Semi-Finished Forms and in Finished Basic Shapes	331	Primary Metal Manufacturing
33	Articles of Base Metal	332	Fabricated Metal Product Manufacturing
34	Machinery	333	Machinery Manufacturing
35	Electronic and Other Electrical Equipment and Components, and Office Equipment	334	Computer and Electronic Product Manufacturing
36	Motorized and Other Vehicles (includes parts)	336	Transportation Equipment Manufacturing
37	Transportation Equipment, not elsewhere classified	336	Transportation Equipment Manufacturing
38	Precision Instruments and Apparatus	339	Miscellaneous Manufacturing

39	Furniture, Mattresses and Mattress Supports, Lamps, Lighting Fittings, and Illuminated Signs	337	Furniture and Related Product Manufacturing
40	Miscellaneous Manufactured Products	339	Miscellaneous Manufacturing