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Data Files: LRT/BRT/SCT/CRT Development Outcomes Final Phase

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LRT/BRT/SCT/CRT Development Outcomes FINAL PHASE:

Data Methodology Documentation and Codebooks

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I. Introduction

The current collection of databases building on Dr. Arthur C. Nelson's prior transit research funded by NITC, including "Do TODs make a difference?"[1] and "A National Study of BRT Development Outcomes,"[2] and finally "Updating and Expanding LRT/BRT/SCT/CRT Data and Analysis."[3] These databases provide a data infrastructure for several projects on development outcomes of transit systems across the United States.[4] These data offer a foundation for analyses that provide insights into the influence of transit systems on such topics as economic growth and resilience, real estate market trends and transportation choices being made both near transit stations and in transit-served counties as a whole. The projects listed above included Shift-Share analyses, which measured the dynamics of economic strength in transit-served counties in terms of shifts in share of jobs by sector at transit stations in comparison to the whole county. Shift-Share analyses also identified shifts in shares of demographic segments at transit station in comparison to the whole county. Analyses also included the change of demographics near transit stations, including commuting mode choice, household size, race and ethnicity, income, household type, housing tenure, and other key population characteristics. The research team at the University of Arizona most recently used the database as part of its project, "LRT/BRT/SCT/CRT Development Outcomes FINAL PHASE."[5] The FINAL PHASE allowed us to use a Jenk's breaks analysis to create typologies of station areas to assess the extent to which types of stations (as opposed to transit systems as a whole) make a difference in economic development (based on LEHD data), and people (census data) during the periods before, during and after the Great Recession as appropriate for each system and mode. It will also allow us to refine hedonic regression analysis. The FINAL PHASE added new material to the database that has been made available through technology transfer.

General Transit Feed Specification (GTFS)

Transit authorities prepare their data about stops and routes along the various modes of public transportation available in their communities, including local, express, and rapid bus routes, commuter rail transit, light rail, streetcar rail, and heavy rail subway-metro systems. The General Transit Feed Specification (GTFS) data standard provides a universal format for transit data. It prescribes which data are necessary for a transit authority to record and provide publicly. One stated goal in the GTFS project is to facilitate the creation of useful software applications by third parties, thus removing this requirement from transit authorities and allowing them to focus their expertise on the needs of the transit system itself.[6] The data are provided in the format of

[1] Reports at https://nitc.trec.pdx.edu/research/project/547/Do_TODs_Make_a_Difference?, Accessed 11-13-2019.
[2] See https://nitc.trec.pdx.edu/research/project/650/National_Study_of_BRT_Development_Outcomes Accessed 11-13-2019.
[3] See project details and results at https://nitc.trec.pdx.edu/research/project/1103. Accessed 2-9-2021.
[4] Project details at https://nitc.trec.pdx.edu/research/project/763/DO_TODs_MAKE_A_DIFFERENCE?_Phase_2, Accessed 11-13-2019.
[5] See https://nitc.trec.pdx.edu/research/project/1253. Accessed 11-13-2019.
[6] Google Transit APIs 2019: https://developers.google.com/transit. Accessed 11-13-2019.

text files exported from relational databases. The tables provided in the specification include stops, routes, stop times, and trips, each in separate tables, plus a number of tables that provide ancillary data. To use the data in GIS studies requires joining various tables of the specification together (see figure 1 for an example).

The chronology of the GTFS segment of the project began in 2017, and the included transit system data are of a 2017 vintage. TransitFeeds.com provides regular updates to the data, which can be downloaded by city or transit authority.

LEHD LODES Employment Data

The Longitudinal Employer-Household Dynamics (LEHD) Origin-Destination Employment Statistics (LODES) data set,[7] released by the US Census Bureau, provides a full census of employment figures, not relying upon probability-based sampling. It provides the number of employees per US census block, which can be aggregated to larger enumeration units as needed. The data are segmented into jobs by employee age, income, NAICS industry sectors, race, educational attainment, and sex. There are two LODES data sets included in our database, the Residence Area Characteristics (RAC) figures, which provide the number of employed individuals residing in a census block, and the Work Area Characteristics (WAC) figures, which provide the number of employed individuals working in a census block. LODES also provide Origin-Destination tables, not included in our databases, which provide a lookup table that relates each worker's resident census block to that same worker's work area census block (the location of their place of employment).

Census & ACS Demographic Data

Demographic data from the US Census provide information relevant to the projects' focus on outcomes of transit system development, particularly the degree to which transit stations attracted people, and by which demographic segments. These include total population, total workers, total labor force, commuting mode, housing tenure, number of vehicles per household, race and ethnicity, household type and income, and age of householder.

The US Census Decennial data sets for 2000 and 2010, and The American Community Survey (ACS) 5-year sample data sets for 2009 and 2016 are compiled at the census block group enumeration level, as a fine spatial scale of aggregation aids in at least partially overcoming the data issues inherent in areal aggregation. All data are provided on the basis of the 2010 census block groups. Multiple methods were required to compile the data for use, which are outlined below.

[7] US Census Bureau LEHD website: https://lehd.ces.census.gov/data/. Accessed 11-13-2019.

II. Methodology

GTFS

Transit systems for this study were derived from General Transit Feed Specification (GTFS) static files, which most transit authorities across the United States provide in accordance with the Google GTFS data standard. The stop times table is the lookup table that allows the user to join the other tables together. The GTFS standard tables were processed through ArcGIS Model Builder. GTFS tables were downloaded for whole transit authorities from the TransitFeeds website.[8] Most transit authorities in the United States are included in this site, and their data sets are updated regularly.

A lookup table (not included in figure 1) was created in Excel to list all transit routes per city and their modes and approximate year opened. The information stored in this table was established through manual research of the transit routes included. This table was joined to the transit GIS feature classes in order to provide this information for each station and route.

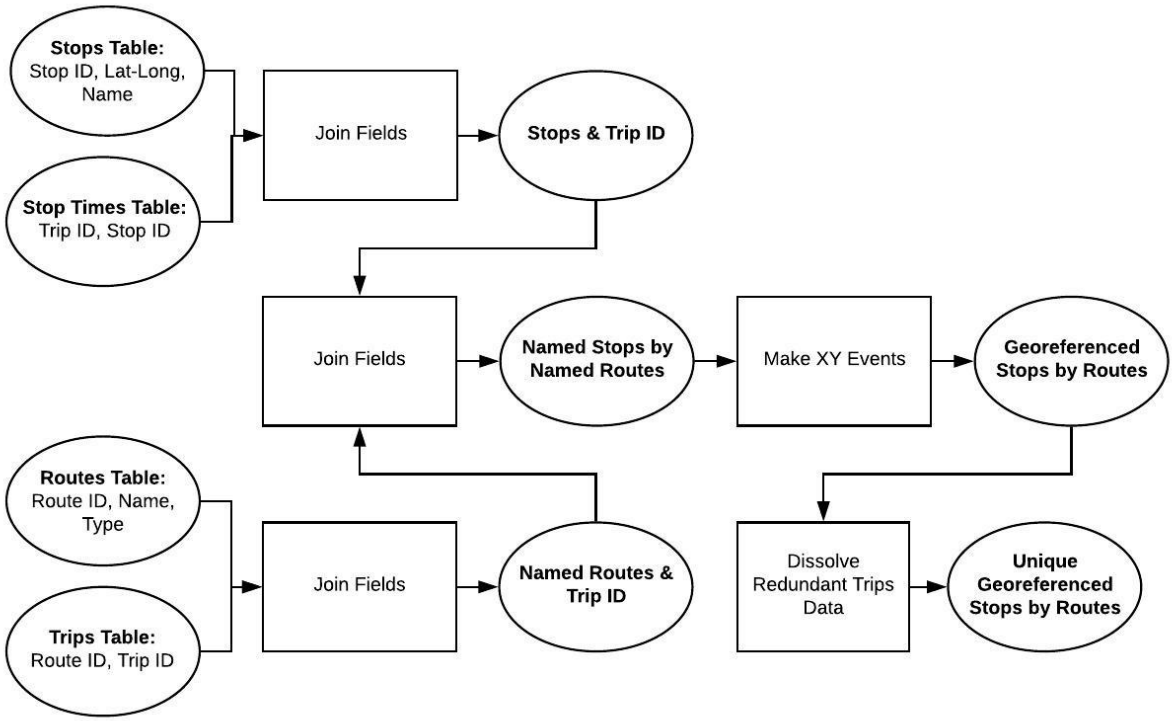

Figure 1. Simplified GIS process model for linking GTFS stops by routes which required four tables to join Stop ID and Route ID.

[8] See www.transitfeeds.com. Accessed 11-13-2019.

LEHD

Each data table was downloaded from the LEHD FTP site,[9], WAC and RAC for each year and state desired, and each table was joined to the GIS shapefile from NHGIS for census blocks.[10] In the census block shapefile the GEOID10 field provides the census block ID for matching to the LEHD table, using a unique ID in the table, which is the h_geocode field for RAC tables and w_geocode field for WAC tables. See the LODES 7.3 technical documentation for more information. An iterative model in ArcGIS Model Builder was used to run the process over all the tables. Next, 3 fields were inserted that allowed the data to be combined into one GIS shapefile per MSA: the LEHD_Year, City, and WAC_RAC fields. These fields identify the year, MSA, and whether the table is WAC or RAC, respectively. These fields were added iteratively to all files, which were then combined to create one shapefile per MSA that includes both WAC and RAC data. These are stored in a GIS geodatabase as feature classes.

GIS analysis was done to compute Euclidean (straight-line) distances between transit station points and census block edges. The Near tool in ArcGIS was used to establish distances from the geographic coordinate system and projection of USA Contiguous Albers Equal Area Conic, which has the unit of measurement as meters. This is a projection commonly used for accurate measurement of distances across the continental United States. The distances were then stored in appropriate fields by calculating them into feet distances using the conversion x*3.28084, where x is a vector of meter-based distances. Each transit mode was measured for each MSA. Distances were removed within each MSA for modes that did not exist in that MSA, leaving null values.

Eighth-mile and quarter-mile dummies were added to each LEHD feature class by coding a 1 value if an observation's edge fell within a given distance band from the transit station. For example, an observation at a distance of up to 660 feet from the station would be coded as a 1 in the 1/8th-mile distance band; outside that distance range, the observation would receive a 0 in that distance band. These distance bands go as far as 2 miles for both eighth and quarter-mile bands. Beyond that point, the distances are not reported, reserving them as a referent category.

MSA mode dummies were added to the data representing which modes are found in the MSA. These were derived from a census layer of MSA polygons coded with 1 or 0 values for the presence or absence of each mode in a given MSA. Field names are as follows: e.g., CRT, LRT.

County mode dummies were also added to the data representing which modes are found in the county. These were derived from a census layer of county polygons coded with 1 or 0 values for the presence or absence of each mode in a given county. Field names are as follows: e.g., CRT_Cty, LRT_Cty.

[9] See https://lehd.ces.census.gov/data/lodes/LODES7/. An alternative approach is to use the US Census Bureau's useful website "On the Map" to make custom downloads of shapefiles and other data. See https://onthemap.ces.census.gov/. Accessed 11-13-2019.
[10] See the NHGIS website, https://www.nhgis.org/. Accessed 11-13-2019.

Census & ACS

The Census and ACS data for the project were downloaded from the ACS, American FactFinder and the Census ftp websites and postprocessed for use in GIS and statistical software.

The census block group shapefiles for 2010 were downloaded from the NHGIS website. The data were joined to Census Block Groups via a unique ID matching between the feature class of block groups and the tables. The GEOID10 field was used to make the join. The census assigns each of its variables a single code that is used for each year of the ACS, and separate codes for census years.

Because the enumeration unit boundaries changed between decennial censuses for years 2000 and 2010, our data for year 2000 and 2009, both of which were based upon the Census 2000 enumeration unit zonal configurations, were processed through a "crosswalk" areal interpolation to match the earlier data to the 2010 census block groups. The process involves a weighted linear combination of the data in the original year with the later-year unit. The weights are assigned with the assumption that the variable (e.g., population) is evenly distributed across the area of the enumeration unit. An intersection is made between the original enumeration units (the source zones) and the later-year units (the target zones), with the result that a proportion of the old unit is assigned to a smaller subset of the old unit (the intersection zone). That proportion is calculated in each of the intersection zones as "new area/old area." In GIS, the SHAPE_AREA field for the original year 2000 census block group shapefile was stored in a new field, AREA_2000 and the year 2000 shapefiles were intersected with the year 2010 shapefiles to create a new set of areal units, the intersection zones. Each new unit's AREA_2000 field was divided by its new SHAPE_AREA field, producing the intersection zone's proportion of the source zone's area, AREA_PROP (Garb et al. 2007).

This proportion was used as a weight for interpolating the year 2000 and 2009 variables to the 2010 enumeration units. This was done through a linear combination to create a variable proportion for each variable in each intersection zone. This consisted of multiplying the AREA_PROP field with each variable vector. The intersection zones were then aggregated to the 2010 units (by dissolving the intersection zones using the GEOID10 field, which is the 2010 enumeration unit ID), and each variable proportion was summed to produce the new variable values. This process provides the most accurate results when using the smallest available scale of enumeration unit. There are drawbacks to the method, including some degree of error due to the nature of the method. Other projects (e.g., NHGIS) have released more robust approaches to areal interpolation and dasymmetric mapping (a related methodology), but their results were not applicable to this data set.[11]

[11] See the NHGIS website, https://www.nhgis.org/. Accessed 11-13-2019.

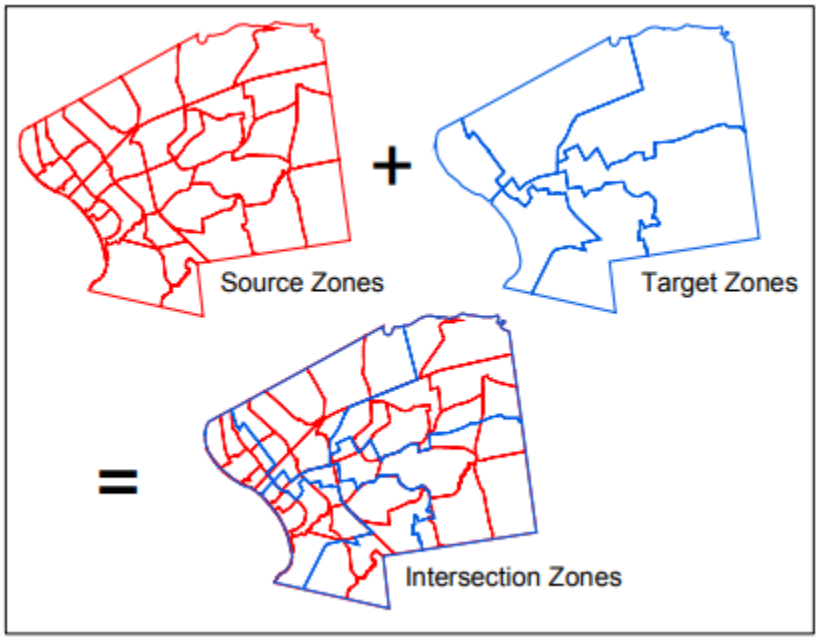

Figure 2. Areal interpolation allows translation of areally aggregated data between units with different zonal configurations. *Source*: Garb et al. (2007).

The 2016 data set was downloaded as a geodatabase from the Census website and the variables, stored in separate tables, were field joined to the feature classes prior to GIS analysis.

American FactFinder tables were processed in the R statistical package subsequent to download to compile rows from many separate files into one file.

Compiling ACS 2010 Data Listed by Sequence Number

A subset of the Census 2010 variables used for the project were provided through the ACS 5-Year Summary Files. These were not available through American FactFinder and were downloaded from the ACS ftp site[12] for 5-year summary files and compiled prior to joining to the GIS shapefiles. These variables are noted in Table 3.3 below as coming from the "sequence template."

These variables are stored online in a series of separate files that must be combined to produce the desired file for each variable. Each variable is stored as a flat data table that must be looked up under its sequence number to get the header (i.e., field names) and matched to a geography file, which holds corresponding enumeration unit IDs.

Within the Summary File folder, the "Sequence Number and Table Number Lookup" file provides a lookup between the table numbers for ACS variables (e.g., B07401 for "GEOGRAPHICAL MOBILITY IN THE PAST YEAR BY AGE FOR RESIDENCE 1 YEAR AGO IN THE UNITED STATES") and the sequence number in which the variable is stored, and the start position of the variable in the table.

[12] See ftp://ftp2.census.gov/acs2010_5yr/summaryfile/. Accessed 11-11-2019.

In addition to the Sequence Number and Table Number Lookup file, which lists all variables and their start position in the table, the files needed for each variable are as follows:

1. One sequence (header) file per variable
    a. Each sequence file references a group of variables
2. One geography file per state
3. Data tables for the desired aggregation level (e.g., census block groups)

To compile the data for use in GIS or statistical packages requires the following steps:

1. Identify the sequence number and start position for each variable
2. Compile data tables for all desired variables and geographic areas into one file.
    a. Use R function list.files() to list files in a directory and grep() to select a subset if needed.
    b. Use R script that includes functions rbind() to bind rows together, and cbind() to bind columns together. Use do.call() to iterate in these functions.
3. Copy the field names from the sequence file and paste to the compiled data table.
4. Compile geography files using the process in step 2 above.
5. Calculate unique LOGRECNO values per state by concatenating state abbreviation and LOGRECNO fields. Do this in both the geography file and the data table.
6. Use VLOOKUP() in Excel to match the LOGRECNO field between geography file and main data table. Using this match, copy the GEOID values from the geography file to the data table.
    a. All geography files list the GEOIDs for each aggregation level of census enumeration units. The LOGRECNOs are matched to the correct aggregation level. They are unique across all aggregation levels.
    b. The LOGRECNO and the state name abbreviation should be concatenated to produce a unique ID for use in multi-state data sets.
7. Remove the fields for unneeded variables.

GIS Analysis

GIS analysis was done to compute Euclidean (straight-line) distances between transit station points and census block edges. The Near tool in ArcGIS was used to establish distances from the geographic coordinate system and projection of USA Contiguous Albers Equal Area Conic, which has the unit of measurement as meters. This is a projection commonly used for accurate measurement of distances across the continental United States. The distances were then stored in appropriate fields by calculating them into feet distances using the conversion x*3.28084, where x is a vector of meter-based distances. Each transit mode was measured for each MSA. Distances were removed within each MSA for modes that did not exist in that MSA, leaving null values.

Eighth-mile and quarter-mile dummies were added to each LEHD feature class by coding a 1 value if an observation's edge fell within a given distance band from the transit station. For example, an observation at a distance of up to 660 feet from the station would be coded as a 1 in the $1/8^{th}$-mile distance band; outside that distance range, the observation would receive a 0 in that distance band. These distance bands go as far as 2 miles for both eighth and quarter-mile bands. Beyond that point, the distances are not reported, reserving them as a referent category.

MSA mode dummies were added to the data representing which modes are found in the MSA. These were derived from a census layer of MSA polygons coded with 1 or 0 values for the presence or absence of each mode in a given MSA. Field names are as follows: e.g., CRT, LRT.

County mode dummies were also added to the data representing which modes are found in the county. These were derived from a census layer of county polygons coded with 1 or 0 values for the presence or absence of each mode in a given county. Field names are as follows: e.g., CRT_Cty, LRT_Cty.

LEHD jobs data were aggregated to the census block group level in GIS and joined to the census and ACS data sets, providing the total jobs, as well as the wage categories summed following Nelson & Ganning (2015).

Transit Station Place Types Analysis

A cluster analysis based on Jenks breaks facilitates refining analysis of transit system outcomes with respect to types of transit stations by mode. Jenks breaks analysis will comprise the following dimensions, which provide insight into station design and planning:

- Land use mix (an entropy measure);
- Jobs-population balance (a measure of jobs versus population concentration);
- Distance to downtown and other major activity centers (a centrality measure);
- Employment sector composition (a measure of economic concentration); and
- Socioeconomic composition (a measure of demographic concentration)

III. How to use the data

A. Linking the transit station information with the LEHD and ACS data

GTFS transit data are in point feature class format. To link them to the LEHD and ACS polygon feature classes, use GIS overlay and, where applicable, aggregation functions. The Spatial Join function in ArcGIS allows for linking station data fields to enumeration units or vice versa. An example would attach transit stations' variable fields to census blocks where stations intersect with blocks. Other functions for aggregation and various summary statistics are listed below.

Table 1 Variables for levels of spatial aggregation

	Station Level	Transit-served County Level	Single-County Level	Metro Level
Distance Band Dummies by Mode	X		X	X
Station Names*	X			
County Names			X	
County Level Transit Dummies by Mode	X	X	X	
Metro Level Dummies by Mode				X
Metro Name		X		X

*Station names not yet added to the data sets.

B. Aggregating the data at a band-level

Distance bands are nested within stations, which are nested within counties, within metro areas. Distance band dummy fields isolate each observation that is located within each distance band. To separate observations located in distance bands into metros, counties, or stations requires further isolation by those scales.

To separate observations by distance bands for separate transit stations, use both distance band dummy and transit station name.

To separate observations by distance bands within all transit-served counties within an MSA, select/isolate observations by MSA, then use distance band fields and the transit county dummy field, which is separated for each transit mode (e.g., CRT or LRT).

To separate observations by distance bands within a single transit-served county within a metro, use distance bands, transit mode dummy, and county name.

To separate observations by distance bands for separate metros, use distance band dummies, transit mode dummy, and MSA name. Alternatively, isolate the data set to a single MSA and then run aggregation.

C. Aggregating the data at a county-level

Aggregating to county level requires use of both transit mode county dummy and county names to create a unique ID for each mode in each county.

D. Aggregating the data at a metro-level

Aggregating to metro level requires use of both transit mode metro dummy and metro names to create a unique ID for each mode in each metro area.

E. Aggregating the data at a station-level

Aggregating to the station level may be more complicated as aggregations across band-levels might be different depending on the variable. Another issue lies in the method used to assign the census enumeration units to each station. The Near analysis only provides one distance per enumeration unit, the nearest station. This results in most stations not being assigned to all of the surrounding enumeration units. An analysis that seeks to assign all surrounding units to each station must take a different analysis approach, such as a series of buffers that allow each enumeration unit to be assigned to multiple stations. This could be accomplished by the use of a many-to-many lookup table between the stations and enumeration units. Another approach would produce multiple copies (rows) of each enumeration unit, each one with a separate transit station assignment.

Important note: Citation for use of NHGIS shapefiles, upon which the LEHD and some Census/ACS data sets are built, is required:
https://www.nhgis.org/research/citation

IV. GIS-Derived Variables in All Data Sets

Table 2 GIS Data Codebook

Data variable names	Source (data, years)	Variable & Description of variable
BRT_Cty	Census county shapefile 2017	BRT-served counties dummy
CRT_Cty	Census county shapefile 2017	CRT-served counties dummy
HRT_Cty	Census county shapefile 2017	HRT-served counties dummy
LRT_Cty	Census county shapefile 2017	LRT-served counties dummy
SCT_Cty	Census county shapefile 2017	SCT-served counties dummy
PMT_Cty	Census county shapefile 2017	PMT-served counties dummy
TourSCT_Cty	Census county shapefile 2017	TourSCT-served counties dummy
XBT_Cty	Census county shapefile 2017	XBT-served counties dummy
DBRT_E	GIS Analysis	Distance from BRT station point to census block edge
DCRT_E	GIS Analysis	Distance from CRT station point to census block edge
DLRT_E	GIS Analysis	Distance from LRT station point to census block edge
DSCT_E	GIS Analysis	Distance from SCT station point to census block edge
DHRT_E	GIS Analysis	Distance from HRT station point to census block edge
DExB_E	GIS Analysis	Distance from XBT station point to census block edge
City	GIS Analysis	City of observation
BRT	Census MSA shapefile 2017	BRT-served MSA dummy
CRT	Census MSA shapefile 2017	CRT-served MSA dummy
LRT	Census MSA shapefile 2017	LRT-served MSA dummy
SCT	Census MSA shapefile 2017	SCT-served MSA dummy
HRT	Census MSA shapefile 2017	HRT-served MSA dummy
ExB	Census MSA shapefile 2017	XBT-served MSA dummy
City	GIS Analysis	City of observation
BRT	Census MSA shapefile 2017	BRT-served MSA dummy
CRT	Census MSA shapefile 2017	CRT-served MSA dummy
LRT	Census MSA shapefile 2017	LRT-served MSA dummy
SCT	Census MSA shapefile 2017	SCT-served MSA dummy
HRT	Census MSA shapefile 2017	HRT-served MSA dummy
ExB	Census MSA shapefile 2017	XBT-served MSA dummy
Next section: Distance band dummies by 1/8th-mile increments. Format for each one: D<mode>E_B0125 (example: DHRTE_B0125 for distance to HRT mode station from edge of census block). Only band is reported below as E_B0125, etc.		
Data variable names	**Source (data, table, and year)**	**Description of variable**
E_B0125	GIS Spatial Analysis from continuous distance field	Distance band dummy 1/8th-mile from station to block edge
E_B0250	GIS Spatial Analysis from continuous distance field	Distance band dummy 1/4th-mile from station to block edge
E_B0375	GIS Spatial Analysis from continuous distance field	Distance band dummy 0.0375-mile from station to block edge

E_B0500	GIS Spatial Analysis from continuous distance field	Distance band dummy half-mile from station to block edge
E_B0625	GIS Spatial Analysis from continuous distance field	Distance band dummy 0.0625-mile from station to block edge
E_B0750	GIS Spatial Analysis from continuous distance field	Distance band dummy 0.0750-mile from station to block edge
E_B0875	GIS Spatial Analysis from continuous distance field	Distance band dummy 0.0875-mile from station to block edge
E_B1000	GIS Spatial Analysis from continuous distance field	Distance band dummy 1.000-mile from station to block edge
E_B1125	GIS Spatial Analysis from continuous distance field	Distance band dummy 1.125-mile from station to block edge
E_B1250	GIS Spatial Analysis from continuous distance field	Distance band dummy 1.250-mile from station to block edge
E_B1375	GIS Spatial Analysis from continuous distance field	Distance band dummy 1.375-mile from station to block edge
E_B1500	GIS Spatial Analysis from continuous distance field	Distance band dummy 1.500-mile from station to block edge
E_B1625	GIS Spatial Analysis from continuous distance field	Distance band dummy 1.625-mile from station to block edge
E_B1750	GIS Spatial Analysis from continuous distance field	Distance band dummy 1.750-mile from station to block edge
E_B1875	GIS Spatial Analysis from continuous distance field	Distance band dummy 1.875-mile from station to block edge
E_B2000	GIS Spatial Analysis from continuous distance field	Distance band dummy 2-mile from station to block edge
Next section: quarter-mile distance band dummies, same format as eighth-mile dummies above.		
E_B0250_1	GIS Spatial Analysis from continuous distance field	Distance band dummy 1/4th-mile from station to block edge
E_B0500_1	GIS Spatial Analysis from continuous distance field	Distance band dummy half-mile from station to block edge
E_B0750_1	GIS Spatial Analysis from continuous distance field	Distance band dummy 0.0750-mile from station to block edge
E_B1000_1	GIS Spatial Analysis from continuous distance field	Distance band dummy 1.000-mile from station to block edge
E_B1250_1	GIS Spatial Analysis from continuous distance field	Distance band dummy 1.250-mile from station to block edge
E_B1500_1	GIS Spatial Analysis from continuous distance field	Distance band dummy 1.500-mile from station to block edge
E_B1750_1	GIS Spatial Analysis from continuous distance field	Distance band dummy 1.750-mile from station to block edge
E_B2000_1	GIS Spatial Analysis from continuous distance field	Distance band dummy 2-mile from station to block edge

V. Transit station codebook

Table 3 Transit Station Data Codebook

Data variable names	Source (data, table, and year)	Source variable names	Description of variable
Stop_lat	GTFS Stops table, 2017	Stop_lat	Stop latitude
Stop_lon	GTFS Stops table, 2017	Stop_lon	Stop longitude
Stop_desc	GTFS Stops table, 2017	Stop_desc	Stop description
Stop_name	GTFS Stops table, 2017	Stop_name	Stop name
Stop_id	GTFS Stops table, 2017	Stop_id	Stop unique id
Route_id	GTFS Routes table, 2017	Route_id	Route unique id
CSAFP	Census county shapefile 2017	CSAFP	CSA fips code
CBSAFP	Census county shapefile 2017	CBSAFP	CBSA fips code
CBSA_NAME	Census county shapefile 2017	CBSA_NAME	CBSA name
STATEFP	Census county shapefile 2017	STATEFP	State fips code
COUNTYFP	Census county shapefile 2017	COUNTYFP	County fips code
COUNTY_NAME	Census county shapefile 2017	COUNTY_NAME	County name
Transit_type	GTFS Routes table, 2017	Transit_type	Mode type
City	analyst	City	City
Comments	analyst	Comments	Comments
Year_opened_approx	analyst	Year_opened_approx	Approximate year station opened
Wheelchair_boarding	GTFS Stops table, 2017	Wheelchair_boarding	Whether wheelchair boarding available at stop
Trnst_Mode	GTFS Stops table, 2017	Trnst_Mode	Mode type code

Wheelchair	GTFS Stops table, 2017	wheelchair	Wheelchair stop
Route_short_name	GTFS Routes table, 2017	Route_short_name	Route short name
Route_long_name	GTFS Routes table, 2017	Route_long_name	Route long name

VI. LEHD codebook

Table 4 LEHD Data Codebook

Data variable names	**Source (data, years)**	**Variable & Description of variable**
NAICS_UPPER	Sum of select LEHD variables 2002 – 2015	See figure 6 below
NAICS_MIDDLE	Sum of select LEHD variables 2002 – 2015	See figure 6 below
NAICS_LOWER	Sum of select LEHD variables 2002 – 2015	See figure 6 below
Manufacturing	Sum of select LEHD variables 2002 – 2015	See figure 5 below
LightIndus	Sum of select LEHD variables 2002 – 2015	See figure 5 below
Rtl_Ldg_Food	Sum of select LEHD variables 2002 – 2015	See figure 5 below
Knowledge	Sum of select LEHD variables 2002 – 2015	See figure 5 below
Office	Sum of select LEHD variables 2002 – 2015	See figure 5 below
Education	Sum of select LEHD variables 2002 – 2015	See figure 5 below
Health	Sum of select LEHD variables 2002 – 2015	See figure 5 below
Arts_Ent_Rec	Sum of select LEHD variables 2002 – 2015	See figure 5 below
LEHD_Year	GIS Analysis, 2002-2015	Year of LEHD data for observation
WAC_RAC	GIS Analysis	IDs whether observation is from WAC or RAC table
City	GIS Analysis	City of observation

Residence Area Characteristics (RAC) File Structure			
Pos	**Variable**	**Type**	**Explanation**
1	h_geocode	Char15	Residence Census Block Code
2	C000	Num	Total number of jobs
3	CA01	Num	Number of jobs for workers age 29 or younger[14]
4	CA02	Num	Number of jobs for workers age 30 to 54[14]
5	CA03	Num	Number of jobs for workers age 55 or older[14]
6	CE01	Num	Number of jobs with earnings $1250/month or less
7	CE02	Num	Number of jobs with earnings $1251/month to $3333/month
8	CE03	Num	Number of jobs with earnings greater than $3333/month
9	CNS01	Num	Number of jobs in NAICS sector 11 (Agriculture, Forestry, Fishing and Hunting)
10	CNS02	Num	Number of jobs in NAICS sector 21 (Mining, Quarrying, and Oil and Gas Extraction)
11	CNS03	Num	Number of jobs in NAICS sector 22 (Utilities)
12	CNS04	Num	Number of jobs in NAICS sector 23 (Construction)
13	CNS05	Num	Number of jobs in NAICS sector 31-33 (Manufacturing)
14	CNS06	Num	Number of jobs in NAICS sector 42 (Wholesale Trade)
15	CNS07	Num	Number of jobs in NAICS sector 44-45 (Retail Trade)
16	CNS08	Num	Number of jobs in NAICS sector 48-49 (Transportation and Warehousing)
17	CNS09	Num	Number of jobs in NAICS sector 51 (Information)
18	CNS10	Num	Number of jobs in NAICS sector 52 (Finance and Insurance)
19	CNS11	Num	Number of jobs in NAICS sector 53 (Real Estate and Rental and Leasing)
20	CNS12	Num	Number of jobs in NAICS sector 54 (Professional, Scientific, and Technical Services)
21	CNS13	Num	Number of jobs in NAICS sector 55 (Management of Companies and Enterprises)
22	CNS14	Num	Number of jobs in NAICS sector 56 (Administrative and Support and Waste Management and Remediation Services)
23	CNS15	Num	Number of jobs in NAICS sector 61 (Educational Services)
24	CNS16	Num	Number of jobs in NAICS sector 62 (Health Care and Social Assistance)
25	CNS17	Num	Number of jobs in NAICS sector 71 (Arts, Entertainment, and Recreation)
26	CNS18	Num	Number of jobs in NAICS sector 72 (Accommodation and Food Services)
27	CNS19	Num	Number of jobs in NAICS sector 81 (Other Services [except Public Administration])
28	CNS20	Num	Number of jobs in NAICS sector 92 (Public Administration)
29	CR01	Num	Number of jobs for workers with Race: White, Alone[15]

[15] Race, Ethnicity, Educational Attainment, and Sex variables are only available for data years 2009 and later and are made available through a Beta release.

Figure 3. LEHD Variables of Residence Area Characteristics (RAC) File Structure

30	CR02	Num	Number of jobs for workers with Race: Black or African American Alone[15]
31	CR03	Num	Number of jobs for workers with Race: American Indian or Alaska Native Alone[15]
32	CR04	Num	Number of jobs for workers with Race: Asian Alone[15]
33	CR05	Num	Number of jobs for workers with Race: Native Hawaiian or Other Pacific Islander Alone[15]
34	CR07	Num	Number of jobs for workers with Race: Two or More Race Groups[15]
35	CT01	Num	Number of jobs for workers with Ethnicity: Not Hispanic or Latino[15]
36	CT02	Num	Number of jobs for workers with Ethnicity: Hispanic or Latino[15]
37	CD01	Num	Number of jobs for workers with Educational Attainment: Less than high school[15,16]
38	CD02	Num	Number of jobs for workers with Educational Attainment: High school or equivalent, no college[15,16]
39	CD03	Num	Number of jobs for workers with Educational Attainment: Some college or Associate degree[15,16]
40	CD04	Num	Number of jobs for workers with Educational Attainment: Bachelor's degree or advanced degree[15,16]
41	CS01	Num	Number of jobs for workers with Sex: Male[15]
42	CS02	Num	Number of jobs for workers with Sex: Female[15]
43	createdate	Char8	Date on which data was created, formatted as YYYYMMDD

Figure 3. RAC file table (continued)

Workplace Area Characteristics (WAC) File Structure			
Pos	**Variable**	**Type**	**Explanation**
1	w_geocode	Char15	Workplace Census Block Code
2	C000	Num	Total number of jobs
3	CA01	Num	Number of jobs for workers age 29 or younger[14]
4	CA02	Num	Number of jobs for workers age 30 to 54[14]
5	CA03	Num	Number of jobs for workers age 55 or older[14]
6	CE01	Num	Number of jobs with earnings $1250/month or less
7	CE02	Num	Number of jobs with earnings $1251/month to $3333/month
8	CE03	Num	Number of jobs with earnings greater than $3333/month
9	CNS01	Num	Number of jobs in NAICS sector 11 (Agriculture, Forestry, Fishing and Hunting)
10	CNS02	Num	Number of jobs in NAICS sector 21 (Mining, Quarrying, and Oil and Gas Extraction)
11	CNS03	Num	Number of jobs in NAICS sector 22 (Utilities)
12	CNS04	Num	Number of jobs in NAICS sector 23 (Construction)
13	CNS05	Num	Number of jobs in NAICS sector 31-33 (Manufacturing)
14	CNS06	Num	Number of jobs in NAICS sector 42 (Wholesale Trade)
15	CNS07	Num	Number of jobs in NAICS sector 44-45 (Retail Trade)
16	CNS08	Num	Number of jobs in NAICS sector 48-49 (Transportation and Warehousing)
17	CNS09	Num	Number of jobs in NAICS sector 51 (Information)
18	CNS10	Num	Number of jobs in NAICS sector 52 (Finance and Insurance)
19	CNS11	Num	Number of jobs in NAICS sector 53 (Real Estate and Rental and Leasing)
20	CNS12	Num	Number of jobs in NAICS sector 54 (Professional, Scientific, and Technical Services)
21	CNS13	Num	Number of jobs in NAICS sector 55 (Management of Companies and Enterprises)
22	CNS14	Num	Number of jobs in NAICS sector 56 (Administrative and Support and Waste Management and Remediation Services)
23	CNS15	Num	Number of jobs in NAICS sector 61 (Educational Services)
24	CNS16	Num	Number of jobs in NAICS sector 62 (Health Care and Social Assistance)
25	CNS17	Num	Number of jobs in NAICS sector 71 (Arts, Entertainment, and Recreation)
26	CNS18	Num	Number of jobs in NAICS sector 72 (Accommodation and Food Services)
27	CNS19	Num	Number of jobs in NAICS sector 81 (Other Services [except Public Administration])
28	CNS20	Num	Number of jobs in NAICS sector 92 (Public Administration)
29	CR01	Num	Number of jobs for workers with Race: White, Alone[15]
30	CR02	Num	Number of jobs for workers with Race: Black or African American Alone[15]
31	CR03	Num	Number of jobs for workers with Race: American Indian or Alaska Native Alone[15]
32	CR04	Num	Number of jobs for workers with Race: Asian Alone[15]

Figure 4. LEHD Variables of Worker Area Characteristics (WAC) File Structure

33	CR05	Num	Number of jobs for workers with Race: Native Hawaiian or Other Pacific Islander Alone[15]
34	CR07	Num	Number of jobs for workers with Race: Two or More Race Groups[15]
35	CT01	Num	Number of jobs for workers with Ethnicity: Not Hispanic or Latino[15]
36	CT02	Num	Number of jobs for workers with Ethnicity: Hispanic or Latino[15]
37	CD01	Num	Number of jobs for workers with Educational Attainment: Less than high school[15,16]
38	CD02	Num	Number of jobs for workers with Educational Attainment: High school or equivalent, no college[15,16]
39	CD03	Num	Number of jobs for workers with Educational Attainment: Some college or Associate degree[15,16]
40	CD04	Num	Number of jobs for workers with Educational Attainment: Bachelor's degree or advanced degree[15,16]
41	CS01	Num	Number of jobs for workers with Sex: Male[15]
42	CS02	Num	Number of jobs for workers with Sex: Female[15]
43	CFA01	Num	Number of jobs for workers at firms with Firm Age: 0-1 Years[17]
44	CFA02	Num	Number of jobs for workers at firms with Firm Age: 2-3 Years[17]
45	CFA03	Num	Number of jobs for workers at firms with Firm Age: 4-5 Years[17]
46	CFA04	Num	Number of jobs for workers at firms with Firm Age: 6-10 Years[17]
47	CFA05	Num	Number of jobs for workers at firms with Firm Age: 11+ Years[17]
48	CFS01	Num	Number of jobs for workers at firms with Firm Size: 0-19 Employees[17,18]
49	CFS02	Num	Number of jobs for workers at firms with Firm Size: 20-49 Employees[17,18]
50	CFS03	Num	Number of jobs for workers at firms with Firm Size: 50-249 Employees[17,18]
51	CFS04	Num	Number of jobs for workers at firms with Firm Size: 250-499 Employees[17,18]
52	CFS05	Num	Number of jobs for workers at firms with Firm Size: 500+ Employees[17,18]
53	createdate	Char8	Date on which data was created, formatted as YYYYMMDD

Figure 4. WAC file table (continued).

LEHD NAICS Sector Groups & Wage Groups

The data set includes aggregations of LEHD variables into sector groups and wage groups, following Nelson & Ganning (2015). Below are figures outlining the NAICS sectors included in each of the sector groups and wage groups.

Table 6.1 Combinations of NAICS Sectors for Analysis

Manufacturing
Manufacturing
Industrial
Utilities
Wholesale Trade
Transportation and Warehousing
Retail-Accommodation-Food Service
Retail Trade
Accommodation and Food Services
Knowledge
Information
Professional, Scientific, and Technical Services
Office
Finance and Insurance
Real Estate and Rental and Leasing
Management of Companies and Enterprises
Administrative and Support and Waste Management and Remediation Services
Other Services (except Public Administration)
Public Administration
Education
Educational Services
Health Care
Health Care and Social Assistance
Art-Entertain-Recreation
Arts, Entertainment, and Recreation

Figure 5. NAICS Sector Groups. Source: Nelson & Ganning (2015).

NAICS	LEHD Code	Description
44	CNS07	Retail Trade
56	CNS14	Administrative, Support, Waste Mgmt., Remediation
61	CNS15	Educational Services
71	CNS17	Arts, Entertainment and Recreation
72	CNS18	Accommodation and Food Services
81	CNS19	Other Services (except Public Administration)
		Weighted Mean Wages and National Share of Jobs
48	CNS08	Transportation and Warehousing
53	CNS11	Real Estate and Rental and Leasing
62	CNS16	Health Care and Social Assistance
92	CNS20	Public Administration
		Weighted Mean Wages and National Share of Jobs
22	CNS03	Utilities
31	CNS05	Manufacturing
42	CNS06	Wholesale Trade
51	CNS09	Information
52	CNS10	Finance and Insurance
54	CNS12	Professional, Scientific and Technical Services
55	CNS13	Management of Companies and Enterprises
		Weighted Mean Wages and National Share of Jobs

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Figure 6. NAICS Wage Groups. Adapted with modifications from: Nelson & Ganning (2015). "National Study of BRT Outcomes." https://nitc.trec.pdx.edu/research/project/650. Accessed 5/1/2019.

VII. ACS & Decennial Census codebook

GIS-derived variables matching those in pages 14-15 above are included for each ACS/Decennial Census year. Each is derived on the basis of census block groups for the ACS/Decennial Census data.

Table 5 ACS & Decennial Census Data Codebook

Table 5.1 Census 2000 Codes

Variable	Census Code	Census Table	Description
GEOIDcbg			Geographic data
GEO.display-label			Geographic data
TotalPop	NP001A	SF1b	Total population
TotalHH	NH001A	SF1b	Total households
Auto	NP030A	SF3b	MEANS OF TRANSPORTATION TO WORK for Workers 16 years and over% Car, truck, or van:
Trnst	NP030A	SF3b	MEANS OF TRANSPORTATION TO WORK for Workers 16 years and over% Public transportation (excluding taxicab):
Motorcycle	NP030A	SF3b	MEANS OF TRANSPORTATION TO WORK for Workers 16 years and over% Motorcycle
Bike	NP030A	SF3b	MEANS OF TRANSPORTATION TO WORK for Workers 16 years and over% Bicycle
Walked	NP030A	SF3b	MEANS OF TRANSPORTATION TO WORK for Workers 16 years and over% Walked
OtherTrans	NP030A	SF3b	MEANS OF TRANSPORTATION TO WORK for Workers 16 years and over% Other means
WrkHome	NP030A	SF3b	MEANS OF TRANSPORTATION TO WORK for Workers 16 years and over% Worked at home
HHunder25	NP055A	SF3b	sum from NP055A variables
HH25_44	NP055A	SF3b	sum from NP055A variables
HH45_64	NP055A	SF3b	sum from NP055A variables
HH65Plus	NP055A	SF3b	sum from NP055A variables
Hispanic	NP010B	SF1b	Hispanic or Latino:
TotalOcc	NH007A	SF3b	Total occupied housing units
OwnOcc	NH007A	SF3b	Owner occupied
RntrOcc	NH007A	SF3b	Renter occupied
OwnOccNoVeh	NH044A	SF3b	TENURE BY VEHICLES AVAILABLE for Occupied housing units% Owner occupied:% No vehicle available

OwnOcc1Veh	NH044A	SF3b	TENURE BY VEHICLES AVAILABLE for Occupied housing units% Owner occupied:% 1 vehicle available
OwnOcc2Veh	NH044A	SF3b	TENURE BY VEHICLES AVAILABLE for Occupied housing units% Owner occupied:% 2 vehicles available
OwnOcc3Veh	NH044A	SF3b	TENURE BY VEHICLES AVAILABLE for Occupied housing units% Owner occupied:% 3 vehicles available
OwnOcc4Veh	NH044A	SF3b	TENURE BY VEHICLES AVAILABLE for Occupied housing units% Owner occupied:% 4 vehicles available
OwnOcc5Veh	NH044A	SF3b	TENURE BY VEHICLES AVAILABLE for Occupied housing units% Owner occupied:% 5 or more vehicles available
RntrOccNoVeh	NH044A	SF3b	TENURE BY VEHICLES AVAILABLE for Occupied housing units% Renter occupied:% No vehicle available
RntrOcc1Veh	NH044A	SF3b	TENURE BY VEHICLES AVAILABLE for Occupied housing units% Renter occupied:% 1 vehicle available
RntrOcc2Veh	NH044A	SF3b	TENURE BY VEHICLES AVAILABLE for Occupied housing units% Renter occupied:% 2 vehicles available
RntrOcc3Veh	NH044A	SF3b	TENURE BY VEHICLES AVAILABLE for Occupied housing units% Renter occupied:% 3 vehicles available
RntrOcc4Veh	NH044A	SF3b	TENURE BY VEHICLES AVAILABLE for Occupied housing units% Renter occupied:% 4 vehicles available
RntrOcc5Veh	NH044A	SF3b	TENURE BY VEHICLES AVAILABLE for Occupied housing units% Renter occupied:% 5 or more vehicles available
WhiteNonHisp	NP010B	SF1b	Not Hispanic or Latino: - White alone
BlackNonHisp	NP010B	SF1b	Not Hispanic or Latino: - Black or African American alone
NatNonHisp	NP010B	SF1b	Not Hispanic or Latino: - American Indian and Alaska Native alone
AsianNonHisp	NP010B	SF1b	Not Hispanic or Latino: - Asian alone
PacifNonHisp	NP010B	SF1b	Not Hispanic or Latino: - Native Hawaiian and Other Pacific Islander alone
OtherNonHisp	NP010B	SF1b	Not Hispanic or Latino: - Some Other Race alone
HH_Kids	NP019A	SF1b	Households with one or more people under 18 years:
HHnoKids	NP019A	SF1b	Households with no people under 18 years:
OnePersHH	NP020F	SF1b	Nonfamily households: - 1-person household
MaleHH_kids	NP020F	SF1b	male householder with kids, no wife present
FemaleHH_kids	NP020F	SF1b	female householder with kids, no husband present

SinParHH	Sum	na	MaleHH_kids + FemaleHH_kids
TotalWrkrs	NP043C	SF3b	MEANS OF TRANSPORTATION TO WORK for Workers 16 years and over% Total:
WhiteAln	NP003B	SF1b	White alone
BlackAln	NP003B	SF1b	Black or African American alone
NatAln	NP003B	SF1b	American Indian and Alaska Native alone
AsianAln	NP003B	SF1b	Asian alone
PacifAln	NP003B	SF1b	Native Hawaiian and Other Pacific Islander alone
OtherAln	NP003B	SF1b	Other races alone
TwoPlusRaces	NP003B	SF1b	People of two or more races
Total_LbrFrc	NP125A	SF3b	SEX BY WORK STATUS IN THE PAST 12 MONTHS BY USUAL HOURS WORKED PER WEEK IN THE PAST 12 MONTHS BY WEEKS WORKED IN THE PAST 12 MONTHS FOR THE POPULATION 16 TO 64 YEARS for Population 16 to 64 years% Total:
Auto_Aln	NP030A	SF3b	MEANS OF TRANSPORTATION TO WORK for Workers 16 years and over% Car, truck, or van:% Drove alone
Auto_pool	NP030A	SF3b	MEANS OF TRANSPORTATION TO WORK for Workers 16 years and over% Car, truck, or van:% Carpooled:
BG_ID	Na		Census block group ID
NAICS_UPPER			sum of LEHD variables – see figure 4 for details
NAICS_MIDDLE			sum of LEHD variables – see figure 4 for details
NAICS_LOWER			sum of LEHD variables – see figure 4 for details
C000			LEHD variable C000 (total workers)
Manufacturing			sum of LEHD variables – see figure 4 for details
LightIndus			sum of LEHD variables – see figure 4 for details
Rtl_Ldg_Food			sum of LEHD variables – see figure 4 for details
Knowledge			sum of LEHD variables – see figure 5 for details
Office			sum of LEHD variables – see figure 5 for details
Education			sum of LEHD variables – see figure 5 for details
Health			sum of LEHD variables – see figure 5 for details
Arts_Ent_Rec			sum of LEHD variables – see figure 5 for details

Table 5.2 – 2009 Codes

Variable	ACS Code	Description
TotalPop	B03002	Total population
WhiteNonHisp	B03002	Not Hispanic or Latino: - White alone
BlackNonHisp	B03002	Not Hispanic or Latino: - Black or African American alone
NatNonHisp	B03002	Not Hispanic or Latino: - American Indian and Alaska Native alone
AsianNonHisp	B03002	Not Hispanic or Latino: - Asian alone
PacifNonHisp	B03002	Not Hispanic or Latino: - Native Hawaiian and Other Pacific Islander alone
OtherNonHisp	B03002	Not Hispanic or Latino: - Some Other Race alone
TotalWrkrs	B08301	MEANS OF TRANSPORTATION TO WORK for Workers 16 years and over% Total:
Auto	B08301	MEANS OF TRANSPORTATION TO WORK for Workers 16 years and over% Car, truck, or van:
Auto_Aln	B08301	MEANS OF TRANSPORTATION TO WORK for Workers 16 years and over% Car, truck, or van:% Drove alone
Auto_pool	B08301	MEANS OF TRANSPORTATION TO WORK for Workers 16 years and over% Car, truck, or van:% Carpooled:
Trnst	B08301	MEANS OF TRANSPORTATION TO WORK for Workers 16 years and over% Public transportation (excluding taxicab):
Bike	B08301	MEANS OF TRANSPORTATION TO WORK for Workers 16 years and over% Bicycle
Walked	B08301	MEANS OF TRANSPORTATION TO WORK for Workers 16 years and over% Other means of transportation
OtherTrans	B08301	MEANS OF TRANSPORTATION TO WORK for Workers 16 years and over% Walked
WrkHome	B08301	MEANS OF TRANSPORTATION TO WORK for Workers 16 years and over% Worked at home
TotalHH	B11005	Total households
HH_kids	B11005	Households with one or more people under 18 years:
MaleHH_kids	B11005	male householder with kids, no wife present
FemaleHH_kids	B11005	female householder with kids, no husband present
HHnoKids	B11005	Households with no people under 18 years:
OnePersHH	B11016	Nonfamily households: - 1-person household
HHunder25	B19037	householder under 25 years old
HH25_44	B19037	householder age 25 to 44
HH45_64	B19037	householder age 45 to 64
HH65Plus	B19037	householder age 65 and older
OwnOcc	B25003	Owner occupied
RntrOcc	B25003	Renter occupied
OwnOccNoVeh	B25044	TENURE BY VEHICLES AVAILABLE for Occupied housing units% Owner occupied:% No vehicle available
OwnOcc1Veh	B25044	TENURE BY VEHICLES AVAILABLE for Occupied housing units% Owner occupied:% 1 vehicle available

OwnOcc2Veh	B25044	TENURE BY VEHICLES AVAILABLE for Occupied housing units% Owner occupied:% 2 vehicles available
OwnOcc3Veh	B25044	TENURE BY VEHICLES AVAILABLE for Occupied housing units% Owner occupied:% 3 vehicles available
OwnOcc4Veh	B25044	TENURE BY VEHICLES AVAILABLE for Occupied housing units% Owner occupied:% 4 vehicles available
OwnOcc5Veh	B25044	TENURE BY VEHICLES AVAILABLE for Occupied housing units% Owner occupied:% 5 or more vehicles available
RntrOccNoVeh	B25044	TENURE BY VEHICLES AVAILABLE for Occupied housing units% Renter occupied:% No vehicle available
RntrOcc1Veh	B25044	TENURE BY VEHICLES AVAILABLE for Occupied housing units% Renter occupied:% 1 vehicle available
RntrOcc2Veh	B25044	TENURE BY VEHICLES AVAILABLE for Occupied housing units% Renter occupied:% 2 vehicles available
RntrOcc3Veh	B25044	TENURE BY VEHICLES AVAILABLE for Occupied housing units% Renter occupied:% 3 vehicles available
RntrOcc4Veh	B25044	TENURE BY VEHICLES AVAILABLE for Occupied housing units% Renter occupied:% 4 vehicles available
RntrOcc5Veh	B25044	TENURE BY VEHICLES AVAILABLE for Occupied housing units% Renter occupied:% 5 or more vehicles available
WhiteAln	B02001	White alone
BlackAln	B02001	Black or African American alone
NatAln	B02001	American Indian and Alaska Native alone
AsianAln	B02001	Asian alone
PacifAln	B02001	Native Hawaiian and Other Pacific Islander alone
OtherAln	B02001	Other races alone
Total_LbrFrc	B23022	SEX BY WORK STATUS IN THE PAST 12 MONTHS BY USUAL HOURS WORKED PER WEEK IN THE PAST 12 MONTHS BY WEEKS WORKED IN THE PAST 12 MONTHS FOR THE POPULATION 16 TO 64 YEARS for Population 16 to 64 years% Total:
Hispanic	B03002	Hispanic or Latino:
SinParHH	Sum	MaleHH_kids + FemaleHH_kids
BG_ID	Na	Census block group ID
NAICS_UPPER	sum of LEHD variables	sum of LEHD variables – see figure 6 for details
NAICS_MIDDLE	sum of LEHD variables	sum of LEHD variables – see figure 6 for details
NAICS_LOWER	sum of LEHD variables	sum of LEHD variables – see figure 6 for details
C000	LEHD variable C000	LEHD variable C000 (total workers)
Manufacturing	sum of LEHD variables	sum of LEHD variables – see figure 5 for details
LightIndus	sum of LEHD variables	sum of LEHD variables – see figure 5 for details

Rtl_Ldg_Food	sum of LEHD variables	sum of LEHD variables – see figure 5 for details
Knowledge	sum of LEHD variables	sum of LEHD variables – see figure 5 for details
Office	sum of LEHD variables	sum of LEHD variables – see figure 5 for details
Education	sum of LEHD variables	sum of LEHD variables – see figure 5 for details
Health	sum of LEHD variables	sum of LEHD variables – see figure 5 for details
Arts_Ent_Rec	sum of LEHD variables	sum of LEHD variables – see figure 5 for details

Table 5.3 - 2010 Codes

Variable	Code	Source	Sequence	start position of Seq	Description
ID	ID		na	na	
state	State	AFF Cen2010	na	na	geographic
state_code	state_code	AFF Cen2010	na	na	geographic
state_name	state_name	AFF Cen2010	na	na	geographic
county_code	county_code	AFF Cen2010	na	na	geographic
COUNTY	COUNTY	AFF Cen2010	na	na	geographic
GEOID_txt	GEOID_txt	AFF Cen2010	na	na	geographic
WhiteNonHisp	sf1_P005003	AFF Cen2010	na	na	Not Hispanic or Latino: - White alone
BlackNonHisp	sf1_P005004	AFF Cen2010	na	na	Not Hispanic or Latino: - Black or African American alone
NatNonHisp	sf1_P005005	AFF Cen2010	na	na	Not Hispanic or Latino: - American Indian and Alaska Native alone
AsianNonHisp	sf1_P005006	AFF Cen2010	na	na	Not Hispanic or Latino: - Asian alone
PacifNonHisp	sf1_P005007	AFF Cen2010	na	na	Not Hispanic or Latino: - Native Hawaiian and Other Pacific Islander alone
OtherNonHisp	sf1_P005008	AFF Cen2010	na	na	Not Hispanic or Latino: - Some Other Race alone
HH_kids	sf1_P020002	AFF Cen2010	na	na	Households with one or more people under 18 years:
MaleHH_kids	Sum	AFF Cen2010	na	na	*sum of P020018, P020009
FemaleHH_kids	Sum	AFF Cen2010	na	na	*sum of P020022, P020013

SinParHH	Sum	AFF Cen2010	na	na	MaleHH_kids + FemaleHH_kids
HHnoKids	sf1_P020026	AFF Cen2010	na	na	Households with no people under 18 years:
OnePersHH	sf1_P028010	AFF Cen2010	na	na	Nonfamily households: - 1-person household
HHunder25	Sum	AFF Cen2010	na	na	*sum of H017003, H017013
HH25_44	Sum	AFF Cen2010	na	na	*sum of H017004, H017005, H017014, H017015
HH45_64	Sum	AFF Cen2010	na	na	*sum of H017006, H017007, H017008, H017016, H017017, H017018
HH65Plus	Sum	AFF Cen2010	na	na	*sum of H017009, H017010, H017011, H017019, H017020, H017021
OwnOcc	sf1_H017002	AFF Cen2010	na	na	Owner occupied
RntrOcc	sf1_H017012	AFF Cen2010	na	na	Renter occupied
OwnOccTotal	sf1_H017001	AFF Cen2010	na	na	Total occupied housing units
TotalPop	sf1_P003001	AFF Cen2010	na	na	Total (population)
WhiteAln	sf1_P003002	AFF Cen2010	na	na	White alone
BlackAln	sf1_P003003	AFF Cen2010	na	na	Black or African American alone
NatAln	sf1_P003004	AFF Cen2010	na	na	American Indian and Alaska Native alone
AsianAln	sf1_P003005	AFF Cen2010	na	na	Asian alone
PacifAln	sf1_P003006	AFF Cen2010	na	na	Native Hawaiian and Other Pacific Islander alone
OtherAln	sf1_P003007	AFF Cen2010	na	na	Some Other Race alone
TwoPlusAlone	sf1_P003008	AFF Cen2010	na	na	Two or More Races
Hispanic	sf1_P005010	AFF Cen2010	na	na	Hispanic or Latino:
TotalHH	sf1_P030001	AFF Cen2010	na	na	Total households
TotalWrkrs	B08301_001	ACS 5 YR SF Seq Templates	30	89	MEANS OF TRANSPORTATION TO WORK for Workers 16 years and over% Total:
Auto	B08301_002	ACS 5 YR SF Seq Templates	30	89	MEANS OF TRANSPORTATION TO WORK for Workers 16 years and over% Car, truck, or van:
Auto_Aln	B08301_003	ACS 5 YR SF Seq Templates	30	89	MEANS OF TRANSPORTATION TO WORK for Workers 16 years and over% Car, truck, or van:% Drove alone
Auto_pool	B08301_004	ACS 5 YR SF Seq Templates	30	89	MEANS OF TRANSPORTATION TO WORK for Workers 16 years

					and over% Car, truck, or van:% Carpooled:
Trnst	B08301_010	ACS 5 YR SF Seq Templates	30	89	MEANS OF TRANSPORTATION TO WORK for Workers 16 years and over% Public transportation (excluding taxicab):
Motorcycle	B08301_017	ACS 5 YR SF Seq Templates	30	89	MEANS OF TRANSPORTATION TO WORK for Workers 16 years and over% Motorcycle
Bike	B08301_018	ACS 5 YR SF Seq Templates	30	89	MEANS OF TRANSPORTATION TO WORK for Workers 16 years and over% Bicycle
Walked	B08301_019	ACS 5 YR SF Seq Templates	30	89	MEANS OF TRANSPORTATION TO WORK for Workers 16 years and over% Walked
OtherTrans	B08301_020	ACS 5 YR SF Seq Templates	30	89	MEANS OF TRANSPORTATION TO WORK for Workers 16 years and over% Other means
WrkHome	B08301_021	ACS 5 YR SF Seq Templates	30	89	MEANS OF TRANSPORTATION TO WORK for Workers 16 years and over% Worked at home
Total_LbrFrc	B23022_001	ACS 5 YR SF Seq Templates	71	201	SEX BY WORK STATUS IN THE PAST 12 MONTHS BY USUAL HOURS WORKED PER WEEK IN THE PAST 12 MONTHS BY WEEKS WORKED IN THE PAST 12 MONTHS FOR THE POPULATION 16 TO 64 YEARS for Population 16 to 64 years% Total:
OwnOccTotal	B25003_001	ACS 5 YR SF Seq Templates	95	11	TENURE for Occupied housing units% Total:
OwnOcc	B25003_002	ACS 5 YR SF Seq Templates	95	11	TENURE for Occupied housing units% Owner occupied
RntrOcc	B25003_003	ACS 5 YR SF Seq Templates	95	11	TENURE for Occupied housing units% Renter occupied
OwnOccNoVeh	B25044_003	ACS 5 YR SF Seq Templates	97	111	TENURE BY VEHICLES AVAILABLE for Occupied housing units% Owner

					occupied:% No vehicle available
OwnOcc1Veh	B25044_004	ACS 5 YR SF Seq Templates	97	111	TENURE BY VEHICLES AVAILABLE for Occupied housing units% Owner occupied:% 1 vehicle available
OwnOcc2Veh	B25044_005	ACS 5 YR SF Seq Templates	97	111	TENURE BY VEHICLES AVAILABLE for Occupied housing units% Owner occupied:% 2 vehicles available
OwnOcc3Veh	B25044_006	ACS 5 YR SF Seq Templates	97	111	TENURE BY VEHICLES AVAILABLE for Occupied housing units% Owner occupied:% 3 vehicles available
OwnOcc4Veh	B25044_007	ACS 5 YR SF Seq Templates	97	111	TENURE BY VEHICLES AVAILABLE for Occupied housing units% Owner occupied:% 4 vehicles available
OwnOcc5Veh	B25044_008	ACS 5 YR SF Seq Templates	97	111	TENURE BY VEHICLES AVAILABLE for Occupied housing units% Owner occupied:% 5 or more vehicles available
RntrOccNoVeh	B25044_010	ACS 5 YR SF Seq Templates	97	111	TENURE BY VEHICLES AVAILABLE for Occupied housing units% Renter occupied:% No vehicle available
RntrOcc1Veh	B25044_011	ACS 5 YR SF Seq Templates	97	111	TENURE BY VEHICLES AVAILABLE for Occupied housing units% Renter occupied:% 1 vehicle available
RntrOcc2Veh	B25044_012	ACS 5 YR SF Seq Templates	97	111	TENURE BY VEHICLES AVAILABLE for Occupied housing units% Renter occupied:% 2 vehicles available
RntrOcc3Veh	B25044_013	ACS 5 YR SF Seq Templates	97	111	TENURE BY VEHICLES AVAILABLE for Occupied housing units% Renter occupied:% 3 vehicles available
RntrOcc4Veh	B25044_014	ACS 5 YR SF Seq Templates	97	111	TENURE BY VEHICLES AVAILABLE for Occupied housing units% Renter occupied:% 4 vehicles available

RntrOcc5Veh	B25044_015	ACS 5 YR SF Seq Templates	97	111	TENURE BY VEHICLES AVAILABLE for Occupied housing units% Renter occupied:% 5 or more vehicles available
BG_ID	na	na	na	na	Census block group ID
NAICS_UPPER	sum of LEHD variables	na	na	na	LEHD wage groups: NAICS code-based job sectors of upper income
NAICS_MIDDLE	sum of LEHD variables	na	na	na	LEHD wage groups: NAICS code-based job sectors of middle income
NAICS_LOWER	sum of LEHD variables	na	na	na	LEHD wage groups: NAICS code-based job sectors of lower income
C000	LEHD variable C000	na	na	na	LEHD total workers
Manufacturing	sum of LEHD variables	na	na	na	LEHD sector groups: NAICS code-based manufacturing job sectors
LightIndus	sum of LEHD variables	na	na	na	LEHD sector groups: NAICS code-based light industrial job sectors
Rtl_Ldg_Food	sum of LEHD variables	na	na	na	LEHD sector groups: NAICS code-based retail-lodging-food job sectors
Knowledge	sum of LEHD variables	na	na	na	LEHD sector groups: NAICS code-based knowledge job sectors
Office	sum of LEHD variables	na	na	na	LEHD sector groups: NAICS code-based office job sectors
Education	sum of LEHD variables	na	na	na	LEHD sector groups: NAICS code-based education job sectors
Health	sum of LEHD variables	na	na	na	LEHD sector groups: NAICS code-based health job sectors
Arts_Ent_Rec	sum of LEHD variables	na	na	na	LEHD sector groups: NAICS code-based arts-entertainment-recreation job sectors
***See descriptions below:**					
Variable descriptions	Variable codes	Summary File			
MaleHH_nonfam_kids	P020018	sf1			
MaleHH_fam_kids	P020009	sf1			
FemaleHH_nonfam_kids	P020022	sf1			

FemaleHH_fam_kids	P020013	sf1			
Total Owner occupied Householder 15 to 24 years	H017003	sf1			
Total Owner occupied Householder 25 to 34 years	H017004	sf1			
Total Owner occupied Householder 35 to 44 years	H017005	sf1			
Total Owner occupied Householder 45 to 54 years	H017006	sf1			
Total Owner occupied Householder 55 to 59 years	H017007	sf1			
Total Owner occupied Householder 60 to 64 years	H017008	sf1			
Total Owner occupied Householder 65 to 74 years	H017009	sf1			
Total Owner occupied Householder 75 to 84 years	H017010	sf1			
Total Owner occupied Householder 85 years and over	H017011	sf1			
Total Renter occupied Householder 15 to 24 years	H017013	sf1			
Total Renter occupied Householder 25 to 34 years	H017014	sf1			
Total Renter occupied	H017015	sf1			

Householder 35 to 44 years					
Total Renter occupied Householder 45 to 54 years	H017016	sf1			
Total Renter occupied Householder 55 to 59 years	H017017	sf1			
Total Renter occupied Householder 60 to 64 years	H017018	sf1			
Total Renter occupied Householder 65 to 74 years	H017019	sf1			
Total Renter occupied Householder 75 to 84 years	H017020	sf1			
Total Renter occupied Householder 85 years and over	H017021	sf1			

Table 5.4 - 2016 Codes

ACS 2016	Code	Description
BG_ID	na	Census block group ID
NAICS_UPPER	sum of LEHD variables	LEHD wage groups: NAICS code-based job sectors of upper income
NAICS_MIDDLE	sum of LEHD variables	LEHD wage groups: NAICS code-based job sectors of middle income
NAICS_LOWER	sum of LEHD variables	LEHD wage groups: NAICS code-based job sectors of lower income
C000	LEHD variable C000	LEHD total workers
Manufacturing	sum of LEHD variables	LEHD sector groups: NAICS code-based manufacturing job sectors
LightIndus	sum of LEHD variables	LEHD sector groups: NAICS code-based light industrial job sectors
Rtl_Ldg_Food	sum of LEHD variables	LEHD sector groups: NAICS code-based retail-lodging-food job sectors
Knowledge	sum of LEHD variables	LEHD sector groups: NAICS code-based knowledge job sectors

Office	sum of LEHD variables	LEHD sector groups: NAICS code-based office job sectors
Education	sum of LEHD variables	LEHD sector groups: NAICS code-based education job sectors
Health	sum of LEHD variables	LEHD sector groups: NAICS code-based health job sectors
Arts_Ent_Rec	sum of LEHD variables	LEHD sector groups: NAICS code-based arts-entertainment-recreation job sectors
TotalPop	B03002_1 or B01001	total population
WhiteNonHisp	B03002_3	Not Hispanic or Latino: - White alone
BlackNonHisp	B03002_4	Not Hispanic or Latino: - Black or African American alone
NatNonHisp	B03002_5	Not Hispanic or Latino: - American Indian and Alaska Native alone
AsianNonHisp	B03002_6	Not Hispanic or Latino: - Asian alone
PacifNonHisp	B03002_7	Not Hispanic or Latino: - Native Hawaiian and Other Pacific Islander alone
OtherNonHisp	B03002_8	Not Hispanic or Latino: - Some Other Race alone
Hispanic	B03002_12	Hispanic or Latino:
TotalWrkrs	B08301_1	MEANS OF TRANSPORTATION TO WORK for Workers 16 years and over% Total:
Auto	B08301_2	MEANS OF TRANSPORTATION TO WORK for Workers 16 years and over% Car, truck, or van:
Auto_Aln	B08301_3	MEANS OF TRANSPORTATION TO WORK for Workers 16 years and over% Car, truck, or van:% Drove alone
Auto_pool	B08301_4	MEANS OF TRANSPORTATION TO WORK for Workers 16 years and over% Car, truck, or van:% Carpooled:
Trnst	B08301_10	MEANS OF TRANSPORTATION TO WORK for Workers 16 years and over% Public transportation (excluding taxicab):
Motorcycle	B08301_17	MEANS OF TRANSPORTATION TO WORK for Workers 16 years and over% Motorcycle:
Bike	B08301_18	MEANS OF TRANSPORTATION TO WORK for Workers 16 years and over% Bicycle
Walked	B08301_19	MEANS OF TRANSPORTATION TO WORK for Workers 16 years and over% Other means of transportation
OtherTrans	B08301_20	MEANS OF TRANSPORTATION TO WORK for Workers 16 years and over% Walked
WrkHome	B08301_21	MEANS OF TRANSPORTATION TO WORK for Workers 16 years and over% Worked at home
TotalHH	B11005_1	total households
HH_kids	B11005_2	Households with one or more people under 18 years:
MaleHH_kids	B11005_6 & _9 summed	male householder with kids, no wife present

FemaleHH_kids	B11005_7 & _10 summed	female householder with kids, no husband present
HH_noKids	B11005_11	Households with no people under 18 years:
OnePersHH	B11016_10	Nonfamily households: - 1-person household
HHunder25	B19037_2	householder under 25 years old
HH25_44	B19037_19	householder age 25 to 44
HH45_64	B19037_36	householder age 45 to 64
HH65Plus	B19037_53	householder age 65 and older
TotalOcc	B25003_1	total occupied housing units
OwnOcc	B25003_2	Owner occupied
RntrOcc	B25003_3	Renter occupied
OwnOccNoVeh	B25044_3	TENURE BY VEHICLES AVAILABLE for Occupied housing units% Owner occupied:% No vehicle available
OwnOcc1Veh	B25044_4	TENURE BY VEHICLES AVAILABLE for Occupied housing units% Owner occupied:% 1 vehicle available
OwnOcc2Veh	B25044_5	TENURE BY VEHICLES AVAILABLE for Occupied housing units% Owner occupied:% 2 vehicles available
OwnOcc3Veh	B25044_6	TENURE BY VEHICLES AVAILABLE for Occupied housing units% Owner occupied:% 3 vehicles available
OwnOcc4Veh	B25044_7	TENURE BY VEHICLES AVAILABLE for Occupied housing units% Owner occupied:% 4 vehicles available
OwnOcc5Veh	B25044_8	TENURE BY VEHICLES AVAILABLE for Occupied housing units% Owner occupied:% 5 or more vehicles available
RntrOccNoVeh	B25044_10	TENURE BY VEHICLES AVAILABLE for Occupied housing units% Renter occupied:% No vehicle available
RntrOcc1Veh	B25044_11	TENURE BY VEHICLES AVAILABLE for Occupied housing units% Renter occupied:% 1 vehicle available
RntrOcc2Veh	B25044_12	TENURE BY VEHICLES AVAILABLE for Occupied housing units% Renter occupied:% 2 vehicles available
RntrOcc3Veh	B25044_13	TENURE BY VEHICLES AVAILABLE for Occupied housing units% Renter occupied:% 3 vehicles available
RntrOcc4Veh	B25044_14	TENURE BY VEHICLES AVAILABLE for Occupied housing units% Renter occupied:% 4 vehicles available
RntrOcc5Veh	B25044_15	TENURE BY VEHICLES AVAILABLE for Occupied housing units% Renter occupied:% 5 or more vehicles available
WhiteAln	B02001_2	White alone

BlackAln	B02001_3	Black or African American alone
NatAln	B02001_4	American Indian and Alaska Native alone
AsianAln	B02001_5	Asian alone
PacifAln	B02001_6	Native Hawaiian and Other Pacific Islander alone
OtherAln	B02001_7	Other races alone
Total_LbrFrc	B23022_1	SEX BY WORK STATUS IN THE PAST 12 MONTHS BY USUAL HOURS WORKED PER WEEK IN THE PAST 12 MONTHS BY WEEKS WORKED IN THE PAST 12 MONTHS FOR THE POPULATION 16 TO 64 YEARS for Population 16 to 64 years% Total:
SinParHH	sum: male&female	MaleHH_kids + FemaleHH_kids

Table 5.5 - Transit Station Place Typology Codes for All Years

Variable Name	Meaning
cluster4	Place Typology - a scale from 1 to 4, descending from highest to lowest intensity land use surrounding a transit station.

VIII. Version Control Documentation

Table 6 Documentation Version Control

Date of Change	Version Changed	Editor Name	What Was Changed? (Including Section, Content, Reason, etc.)
			•
			•

A. Transit station data changes

Table 7 Transit Station Data Version Control

Date of Change	Version Changed	Editor Name	What Was Changed? (Including Section, Content, Reason, etc.)
7/2018	1.0	R Hibberd	• Some transit type codes were corrected. E.g., Tacoma rail changed from LRT to SCT. Pittsburgh bus systems changed from XBT to BRT.
			•

B. LEHD data changes

Table 8 LEHD Data Version Control

Date of Change	Version Changed	Editor Name	What Was Changed? (Including Section, Content, Reason, etc.)
7/2018	1.0	R Hibberd	• Based on transit type code updates, distances and type codes were updated in the affected transit systems.
07/2020	3.0	R Hibberd	• LEHD data aggregated to census block groups and appended to ACS data
07/2020	3.0	R Hibberd	• Place Types codes appended to ACS

C. ACS data changes

Table 9 ACS Data Version Control

Date of Change	Version of Change	Editor Name	What Was Changed?
07/2020	3.0	R Hibberd	• LEHD data aggregated and appended to ACS census block groups
07/2020	3.0	R Hibberd	• Place Types codes appended to ACS

IX. Database Contents

The Transit Routes GDB contains feature classes with transit systems separated by transit mode type (e.g., streetcar or light rail). The data are presented in the following format: each transit mode type is contained in a separate feature class that contains all the systems for the cities included in our data project. The tables below describe the contents of the database.

TransitType.xlsx file is a lookup table used to append transit routes by mode for each city in the database.

Table 10 Transit Types Lookup Table

Fields	**Meaning**
route_id	ID used by TransitFeeds.com. This ID frequently changes and must be updated in the table.
transit_type	Transit mode type
City	City in which transit system operates
comments	Names of transit routes
year_opened_approx	Approximate year of route opening, gleaned from online research

Table 11 Feature Classes in TransitRoutes.gdb Geodatabase

Transit Mode Type	**File Name**
Bus Rapid Transit	_Transit_Merge_BRT_Project
Heavy Rail Transit	_Transit_Merge_HRT_Project
Light Rail Transit	_Transit_Merge_LRT_Project
Commuter Rail Transit	_Transit_Merge_CRT_Project
Streetcar Transit	_Transit_Merge_SCT_Project
Tourist Streetcar Transit	_Transit_Merge_TourSCT_Project
People Mover Transit	_Transit_Merge_PMT_Project
Express Bus Transit	_Transit_Merge_ExB_Project

*Note: data also include some cities not used in our projects: NYC, Chicago, LA, Baltimore, Denton, San Francisco

Table 12 TransitRoutes.gdb Geodatabase - Metropolitan Areas and Transit Mode Types

Region	Metropolitan Area(s)	LRT	BRT	SCT	CRT	ExB	HRT	PMT	Tourist SCT
US West Coast	Seattle-Tacoma, WA	X	X	X	X	X			
	Portland, OR	X		X	X	X			
	Eugene-Springfield, OR		X			X			
	Sacramento, CA	X				X			
	San Jose-San Francisco-Stockton, CA	X	X		X	X			
	San Diego-Oceanside-Escondido, CA	X	X		X				X
US West	Salt Lake City, UT	X	X	X	X	X			
	Las Vegas, NV		X						
	Reno, NV		X			X			
	Phoenix, AZ	X	X			X			
	Tucson, AZ			X		X			
	Albuquerque-Santa Fe, NM		X		X	X			
	Denver, CO	X			X	X			
US South	Austin, TX				X	X			
	Dallas-Fort Worth, TX	X		X	X	X			
	San Antonio, TX		X			X			
	Houston, TX	X				X			
	Little Rock, AR					X			X
	Charlotte, NC	X		X		X			
	Atlanta, GA			X		X	X		
	Nashville, TN		X		X	X			
	New Orleans, LA			X		X			
	Norfolk, VA	X				X			
	Miami, FL				X	X	X	X	
	Orlando, FL				X	X			
	Tampa, FL					X			X
US Midwest	Minneapolis-St. Paul, MN	X	X		X	X			
	Kansas City, MO		X	X		X			
	St. Louis, MO	X				X			

	Cleveland, OH	X	X				X		
	Cincinnati, OH			X		X			
	Buffalo, NY	X				X			
US East Coast	Pittsburgh, PA	X	X			X			
	Washington, D.C.		X	X	X	X	X		

*Note: data also include some cities not used in our projects: NYC, Chicago, Baltimore, Denton, San Francisco

Table 13 Decennial Census & American Community Survey Geodatabases with Longitudinal Employment-Housing Dynamics (LEHD) data

Years Covered by Data	**Geodatabase**	**Feature Classes**
2000	ACS_5YR_BG_PlaceTypes.gdb	Census_BG_2000_crosswalk_2010_FGT_PlaceTypes
2009	ACS_5YR_BG_PlaceTypes.gdb	ACS_5YR_BG_2009_crosswalk_2010_FGT_PlaceTypes; ACS_2009_Counties
2010	ACS_5YR_BG_PlaceTypes.gdb	Census_ACS_2010_BG_FGT_PlaceTypes; Census_ACS_2010_County_GIS
2016	ACS_5YR_BG_PlaceTypes.gdb	ACS_2016_5YR_BG_FGT_PlaceTypes; ACS_2016_5YR_COUNTY_ALLtransit

X. References

Garb, Jane L., Robert G. Cromley, and Richard B. Wait. "Estimating populations at risk for disaster preparedness and response." *Journal of Homeland Security and Emergency Management* 4, no. 1 (2007).

Nelson, Arthur C. and Joanna P. Ganning (2015). *National Study of BRT Development Outcomes.* Portland, OR: National Institute of Transportation and Communities.