
***For Emergency Preparedness: Using ArcGIS, Census Data,
and Local Data to Analyze Potential Human and
Economic Impacts of River Flooding in Reno, Nevada***

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MGIS Capstone Project Summary Report (Dec. 14, 2012)

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Presented at GIS in the Rockies 2012 Conference (Denver, Sept. 21, 2012)

Outline

Abstract

- 1. Overview of Flooding in Reno, Nevada**
- 2. Project Goals and Objectives**
- 3. Study Area**
- 4. Methodology and Data**
 - A. Overview of Methodology
 - B. Software
 - C. Data
 - 1) Spatial Data
 - 2) Demographic Data
 - 3) Resources About Census Data
 - D. Downloading and Preparing U.S. Census Bureau Data Tables
 - E. Using ArcMap
- 5. Results of Analyses / Visualization Products**
- 6. Summary and Tasks for the Future**

References

Appendix A – *“For Emergency Management Preparedness: Potential Human and Economic Impacts by Flooding of the Truckee River in the City Limits of Reno, Nevada”*
(short report for city staff)

Abstract

The Truckee River floods frequently in Reno, Nevada. A damaging flood event usually occurs every 10 years, and the last large event, which was a 50-year flood, was in 2005. Local flood mitigation efforts have been postponed due to the economic downturn.

Currently, city decision-makers and emergency management staff do not have detailed data about the people and facilities located in the recurring flood areas, which could help estimate the human and economic impacts of a flood occurring today. These data and estimates could help city emergency response staff and decision-makers prepare for and reduce the negative impacts of a flood.

This paper describes how a spatial analysis project was conducted to gather pertinent data about the people, facilities and buildings in Reno that could be impacted by a large flood event similar to ones that occurred in 1997 and 2005. Other communities that experience similar emergencies can use this project as a template for a similar study in their area of interest.

Datasets from the U.S. Census Bureau and from local GIS programs were obtained; demographic data was prepared in Microsoft Excel for joining to a shapefile of Census tracts; and spatial overlay analyses were conducted using ArcGIS 10 software. A short report was produced with maps and tables of the results to help city staff learn about the potential human and economic impacts of a flood and prepare for a flood emergency. This short report is included in Appendix A.

1. Overview of Flooding in Reno, Nevada

The Truckee River flows out of Lake Tahoe in Tahoe City, California, and continues 105 miles until it empties into Pyramid Lake, a terminal lake in northern Nevada (State of Nevada Division of Water Resources, n.d.). Along the way, the river runs through the city

of Reno and the

adjacent city of

Sparks, Nevada.

These cities are at the

base of the Sierra

Nevada mountain

range, which typically

receives a lot of snow

in the winter. Two or

more feet of snow can fall during one week; then the next week, it will be 60 degrees.

Warm weather and rainy systems from the Pacific can cause the snow on the ground to

melt rapidly. When it does, the meltwater makes its way into the Truckee River, and

floods occur in Reno and Sparks.

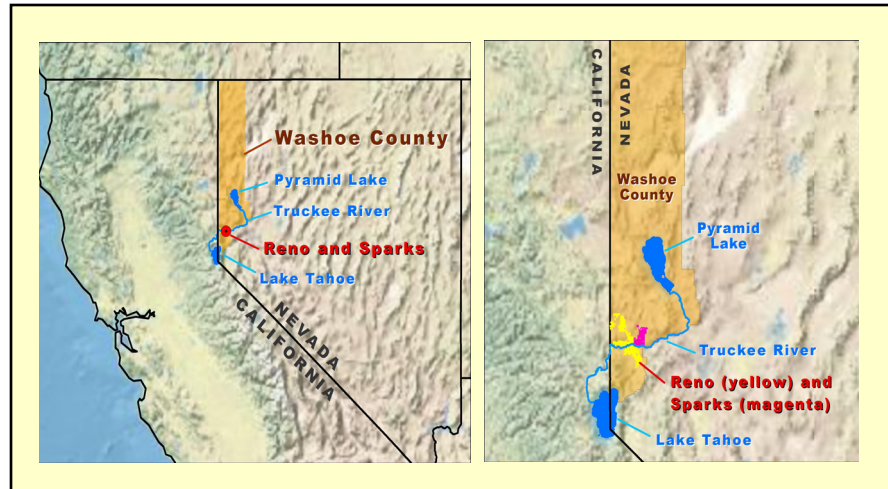


Figure 1. Locator Map of Washoe County, Nevada.

(Map created by Valerie Johnson, December 2012. "USA Topographic Map" basemap from ArcGIS Online Map Service, <http://www.esri.com/software/arcgis/arcgis-online-map-and-geoservices/map-services>, 12/13/12.)



Photo 1. An American Airlines plane is surrounded by floodwaters at the Reno-Tahoe International Airport in 1997. (Source: Truckee River Flood Management Project's "Flood Storage Mitigation in Critical Flood Zone 1" presentation (Slide 7) (n.d.).

Accessed 2/23/2012 from <http://truckeeflood.us/154/presentations.html>.)

Numerous floods have been documented in Reno and Sparks since the late 1800s. There have been two highly damaging floods in the past 15 years – in 1997 and 2005. The U.S. Army Corps of Engineers deemed the flood of 1997 a 117-year flood, which inundated over 7,000 acres (Truckee River Flood Management Project, n.d.; see Photo 1). Various reports place the damages of the 1997 flood between \$650 to \$700 million (Carner, 2011; TheStormKing.com, 2012). On New Year's Day in 2005, a 50-year flood, which inundated over 4,000 acres, left downtown Reno under several feet of water and caused a reported \$18 million in damages (TheStormKing.com, 2012).



Photo 2. Downtown Reno during the 2005 flood. The Truckee River, in the foreground, flows from west to east. Several old bridges with small arches constrict the flow of floodwaters. The black high-rise building on the right is now the location of Reno City Hall. (Source: Truckee River Flood Management Project's "Town Hall Meeting" 8/10/2009 presentation (Slide 9). Accessed 2/23/2012 from <http://truckeeflood.us/154/presentations.html>.)

The map below shows the extents of these two floods. (Note: These polygon shapefiles were based on accounts provided by observers just after the floods occurred. Observers drew boundaries of the floods on aerial photos, which were then digitized.) Most of the flooding occurred in downtown Reno; on the eastern side of Reno, in an area with a mix of industrial complexes and residential neighborhoods; and on the southern side of Sparks, in an industrial area. This project focused on those areas in the flood extents that are in the Reno city limits as of July 12, 2012.

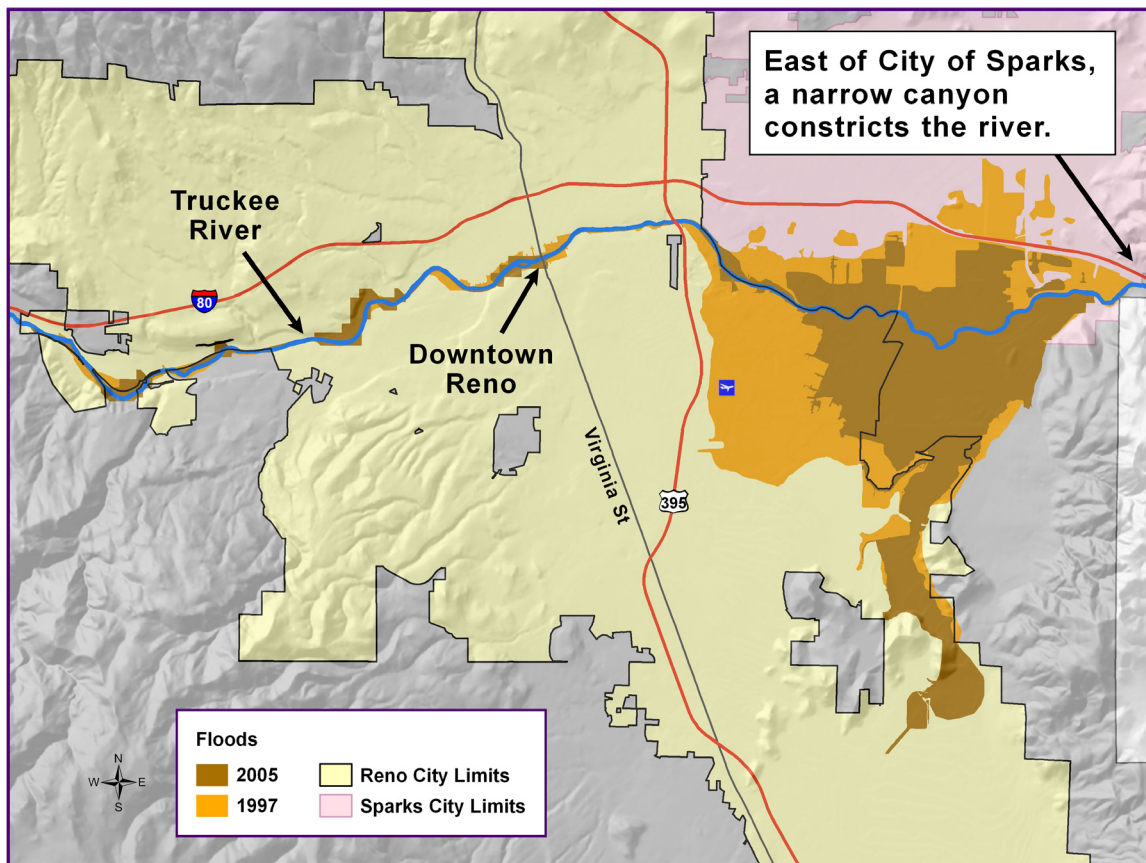


Figure 2. Map showing the observed extents of recent floods. The 1997 event, shown in orange, flooded over 7,200 acres and was deemed a 117-year flood. The 2005 event, shown in brown, flooded over 4,300 acres and was deemed a 50-year flood. (Map created by Valerie Johnson, September 2012).

After the 2005 flood, the City of Reno, the City of Sparks, Washoe County, and the U.S. Army Corps of Engineers agreed to develop the Truckee River Flood Project, the mission of which is to “... reduce the impact of flooding in the Truckee Meadows, restore the Truckee River ecosystem, and improve recreational opportunities by managing the development and implementation of the Truckee River Flood Project” (Truckee River Flood Management Authority, 2011). This consortium of local governments, along with area stakeholders, developed a plan that included building a levee and floodwall, purchasing property, elevating homes in the floodplain, replacing old constricting bridges in downtown Reno, and re-routing the North Truckee Drain, a tributary (ThisIsReno.com, 2011).

However, due to the economic downturn of the past four years, several of these plans—including replacing old bridges in downtown Reno—have been postponed. Mitigation measures had been estimated to cost \$1.6 billion, but the scaled-back projects are now estimated to cost \$450 million (DeLong, 2012). Even with this lower cost figure, the local governments are having difficulty funding mitigation projects.

Unfortunately, it’s not a question of *if* another flood will occur – it’s a question of *when*. Currently, city decision-makers and emergency management staff do not have detailed data about the people and facilities located in the recurring flood areas, which could help estimate the human and economic impacts of a flood occurring today. These data and estimates could help city emergency response staff and decision-makers prepare for and reduce the negative impacts of a flood.

2. Project Goals and Objectives

The focus of this project was to use local GIS data and U.S. Census Bureau data to A) conduct spatial analyses in ArcGIS 10 to determine the potential human and economic impacts that a flood similar to two historic flood events would cause today and B) create a short report with maps and tables of the results of the analyses. This project had two primary goals:

A. Goal 1 – Information for Emergency Response Staff

The first goal was to provide city emergency response staff with information about citizens who could be at-risk from another flood, with the objective that staff will be better prepared to help these citizens when a flood occurs. The information could help them answer questions such as: Where are the residents who are elderly, lack transportation, and have fewer financial resources? Where are the residents (elderly, very young, disabled) who may require special emergency response measures?

This project identified the following facilities and populations that may at risk:

- Important facilities that may require special response measures (schools and colleges, day care facilities, medical care facilities, nursing homes, hotels, government buildings, fire stations, police stations).
- Population (total; under 5 yrs; over 65 yrs). (Information about population with a disability was also wanted; however, this data will not be available from the U.S. Census Bureau at the Census tract level until early 2013.)
- Number of households with annual income under \$15,000 per year.
- Number of households without a vehicle.

B. Goal 2 – Information for Decision-Makers

The second goal of this project was to provide city decision-makers with information about the current value of and taxes received annually from buildings on parcels in the areas that were flooded in 1997 and 2005, with the objective that managers will be more aware of the financial impact of damages caused by flooding. For example, the loss of buildings could result in reduced tax assessment of property, which would negatively affect the city's budget (which already has been drastically reduced the past several years). Also, managers can utilize the building values and tax revenues in cost/benefit analyses of proposed flood mitigation projects. The municipal government has had changes in its organizational structure and management team since the last flood occurred in 2005. People who now are decision-makers should be aware of the potential economic impact.

3. Study Area

The study area is the portion of the current city limits of Reno, Nevada, that was impacted by the 1997 and 2005 floods of the Truckee River (see map in Figure 2). In the current city limits, over 4,200 acres are in the 1997 flood extent and over 6,900 acres are in the 2005 flood extent.

4. Methodology and Data

The methodology and data used in this project are described in this section.

A. Overview of Methodology

1. Acquire spatial data from local government GIS program (datasets described later), and, as needed, use ArcCatalog to re-project to State Plane Coordinate System Nevada West (Feet).
2. Download from the U.S. Census Bureau's American FactFinder website CSV files at the Census tract level of Census 2010 and American Community Survey (ACS) data.
3. In Excel, review tables and prepare them for joining to shapefiles.
4. In ArcMap 10, create a new shapefile of only those Census tracts that intersect the 1997 flood extent (use Select by Location) and then clip it to the current city limits. (Note: The 1997 extent polygon selects 18 tracts, whereas the 2005 extent polygon selects 17 tracts.)
5. In ArcMap, join an Excel table of demographic data to the clipped tracts shapefile (created in Step A4) and export to a new shapefile. Repeat for each Excel table.
6. In ArcMap 10, use Select by Location to perform overlay analyses to select the following:
 - Important facilities that intersect a polygon of the combined flood extents. Create new shapefiles.
 - Ground-floor parcels that are not vacant land (i.e., parcels with buildings) that intersect each flood extent (use only ground-floor parcels in order to exclude condominiums that are on the second floor or higher because they won't be damaged by flood waters). Export to new shapefiles.
7. Use ArcMap to create thematic maps. Get feedback from staff about draft maps.
8. Produce short report with maps and tables. Get feedback from staff about draft.
9. In the future, regularly maintain the short report to keep it current as data changes.

B. Software

Two software applications were used for this project.

- Esri ArcGIS 10 (ArcCatalog for re-projecting spatial data; ArcMap for performing overlays and creating maps).
- Microsoft Excel 2003 (for preparing Census tables for use in ArcMap).

C. Data

For this project, several spatial datasets, including a polygon shapefile of the Census tracts for Washoe County, were obtained from the local government GIS program. The coordinate system of each dataset was identified and re-projected as needed to NAD83 State Plane Coordinate System Nevada West (Feet). Tables of demographic data were downloaded from the U.S. Census Bureau's American FactFinder website (specific steps are described later).

1) Spatial Data

Numerous spatial datasets were obtained from the local government GIS program, but only the following ones were used in the overlay analyses:

- Business data (2010 InfoUSA point dataset; used to identify hotels/motels that may need to be evacuated and that may not be available to serve as temporary post-disaster shelters for displaced citizens)
- Census tracts
- City limits of Reno and Sparks
- Day care facilities, schools, and colleges
- Flood extents from 1997 and 2005 events
- Government buildings (courthouses, fire stations, police stations, and other municipal buildings)
- Medical care facilities (hospitals, nursing homes)
- Parcels (with assessed building values from County Property Assessor)

The following spatial datasets were used on maps to aid in visualization:

- Hillshade created from 10-meter digital elevation model
- Hydrographic data (river and lakes)
- Street centerlines and major roads

2) Demographic Data

Demographic data from the U.S. Census Bureau's 2010 Census and the American Community Survey (ACS) 2005-2010 5-year estimates were used. The U.S. Census Bureau's Online American FactFinder was utilized for downloading the demographic data at Census tract level.

Why Use the Census Tract Geographic Unit?

For the urban part of Washoe County, Nevada, the Census geographic units (polygons) range in size from state (the largest unit), to county, to tract, to block group, to block (the smallest unit). Each Census tract reports data for an average of 4,000 people (from 1,200 up to 8,000 people), whereas each Census block reports data for about 100 people (Census.gov, n.d.). Though data at the Census block level would have been desirable for use in this project, the Census tracts had to be used because the American Community Survey (ACS) data for Washoe County, Nevada, are available only at the tract level (not at the smaller unit), and the ACS data covers topics such as household income, number of vehicles per household, and number of households with a disability.

Other communities that want to conduct this project and need to obtain the Census tract polygon dataset should check with their local or state GIS Clearinghouses to see if that organization has the tract dataset for distribution. If not, a shapefile of the 2010 tracts can be downloaded for free from <http://www.census.gov/geo/www/tiger/>. Also, the Census Bureau has a shapefile of the tracts that already includes some demographic data from the SF-1 form (population, age, race) in the attribute table.

About Differences Between the 2000 Census and the 2010 Census

Several changes were implemented with the 2010 Census (Census.gov, 2009; Spisszak, 2011):

- The 2000 Census included a short-form questionnaire (data tables SF-1 and SF-2) and a long-form questionnaire (data tables SF-3 and SF-4). The long-form questionnaire was used in 1 in 6 households.
- Starting in 2010, the decennial Census now includes only the short-form questionnaire, covering topics such as population, age, and race.
- Information previously obtained from the long-form questionnaire, such as marital status, income, number of vehicles, and disability, are now covered in the more frequently conducted ACS. The ACS has a sample size of 1 in 40 households, which means that the margin of error is greater than that of the now-defunct long-form questionnaire.

3) Resources About Census Data

The following resources were helpful in learning about using demographic data from the U.S. Census Bureau:

- Census Handbook titled, “A Compass for Understanding and Using American Community Survey Data – What State and Local Governments Need to Know”; http://www.census.gov/acs/www/guidance_for_data_users/handbooks/ (Click on the link to the PDF called “What State and Local Governments Need to Know.”)
- Short ESRI Slideshow titled, “Census 2010 and ACS: Top 10 Things You Need to Know,” by Catherine Spisszak (presented at the ESRI International User Conference, July 12, 2011, San Diego); discusses differences between decennial census and ACS, as well as margin of error; <http://www.slideshare.net/CCIMTECH/esri-2010-census-and-acs>
- Slideshow written by Barbara Parmenter of the Tufts University GIS Center about using Census’s American FactFinder website and downloading data, as well as changing headers and rows of the downloaded CSV tables in Excel; <https://wikis.uit.tufts.edu/confluence/display/GISatTufts/Tufts+GIS+Tip+Sheets+ArcGIS10> (Scroll down to “Learning GIS Basics.” Under “Census Data”, click the link to “Census Tutorial: Downloading and Mapping American FactFinder Data (for Census 2000 and 2010 and American Community Survey)”.)

D. Downloading and Preparing U.S. Census Bureau Data Tables

Each CSV table of demographic data downloaded from the American FactFinder website has to be manipulated in Microsoft Excel before use in ArcMap. This section lists instructions to obtain the data tables and prepare them for use.

1. Locate Demographic Data

- a. Use Census Bureau’s American FactFinder. Go to factfinder2.census.gov.
- b. Under “Geographies” (left side of screen), pick “Census Tract”.
- c. Then (on the right side of screen) choose your state, county, and “All Census Tracts within County”.
- d. Click “Add to Your Selections”.
- e. Close the pop-up window.
- f. On the next screen that appears, narrow the search by typing in a topic (e.g., Income) or typing in a specific table number. Below are the table numbers used in this project:

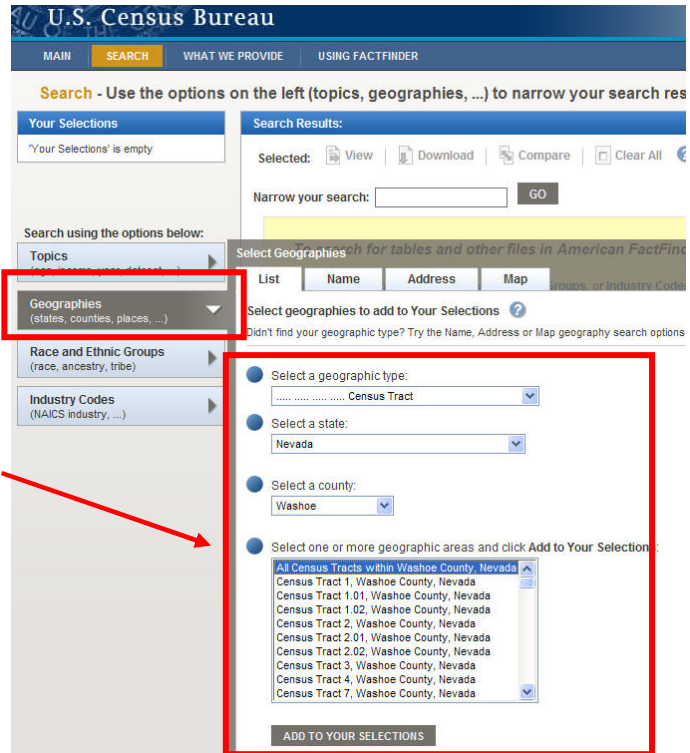


Figure 3. Screenshot of FactFinder Geographies page.

- **QT_P1** (“Age Groups and Sex: 2010”, 2010 SF1)
- **S1901** (“Income in Past 12 Months”, 2010 ACS 5-year estimates)
- **B08201** (“Household Size by Vehicles Available”, 2010 ACS 5-year estimates)

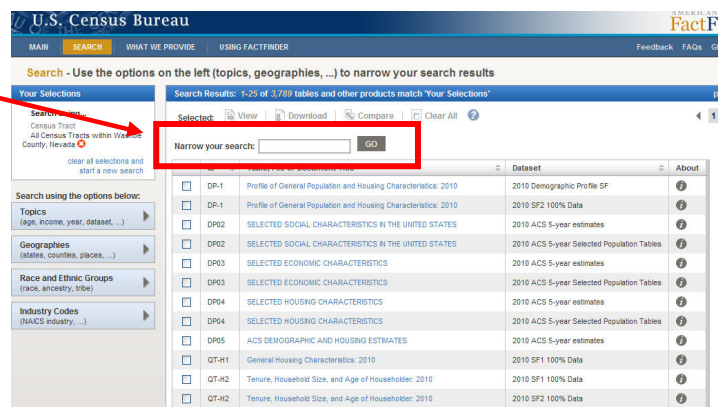


Figure 4. Screenshot of FactFinder Search page.

2. Download CSV File

- a. Preview the table before downloading the CSV file. If it's acceptable, click the "Download" button, otherwise click the "Back to Search" button.

	Census Tract 1.01, Washoe County, Nevada	Census Tract 1.02, Washoe County, Nevada	Census Tract 2.01, Washoe County, Nevada	Census Tract 2.02, Washoe County, Nevada	Census Tract 3, Washoe County, Nevada	Census Tract 4, Washoe County, Nevada	Census Tract 7, Washoe County, Nevada	Census Tract 9, Washoe County, Nevada	Census 10.05, 1 County									
	Margin of Estimate	Margin of Error	Margin of Estimate	Margin of Error	Margin of Estimate	Margin of Error	Margin of Estimate	Margin of Error	Margin of Estimate									
Total	1,719	+/-199	1,715	+/-184	1,243	+/-116	1,276	+/-121	2,249	+/-122	2,440	+/-133	2,685	+/-121	1,871	+/-152	1,453	
No vehicle available	958	+/-191	726	+/-170	75	+/-53	352	+/-113	148	+/-82	156	+/-89	572	+/-156	530	+/-172	182	
1 vehicle available	545	+/-143	702	+/-181	843	+/-164	573	+/-123	1,280	+/-166	828	+/-189	1,107	+/-233	658	+/-177	580	
2+ vehicle available																		

Figure 5. Screenshot of CSV Table Preview page.

- b. On the Download screen, under "Comma delimited (csv) format (data rows only)" (zipped file), choose "Data and annotations in a Single File" and click OK. (In Excel, you will have to rename column headings, so if you think you will want to refer to original column headings, then choose "... in separate files".)

Select a download format and click OK. ?

Comma delimited (.csv) format (data rows only)
(.csv is compatible with spreadsheet programs such as Microsoft Excel)

Data and annotations in a single file

Data and annotations in separate files

Presentation-ready formats

PDF

Microsoft Excel (.xls)

Rich Text Format (.rtf)

Orientation

Portrait Landscape

Paper size

8 1/2" x 11"

8 1/2" x 14"

[PDF] or indicate a document in Adobe's Portable Document Format. To view the file you will need the Adobe® Acrobat® Reader available free from Adobe.

OK CANCEL

Figure 6. Screenshot of CSV Download page.

- c. Another screen appears with the message that the file is complete. Then click the "Download" button.
- d. After the file has been downloaded to your computer, before searching for another table, click the small "x" in the upper left corner of the main page to remove the topic from your selection.

3. Prepare CSV Tables in Excel

- a. First, save CSV file as an Excel file. Use a meaningful file name; keep table name in it.

Figure 7. Screenshot of table about households and vehicles, with blank cells in Excel.

- b. The table has several blank cells. In order to join the Excel table to the tracts shapefile, you must remove these blank cells and put all the field names in the first row. Here's what has to be changed in the table: Rename headings in first row, delete blank and unneeded rows, delete unneeded columns (optional), and change field types (see Step 4 below). You can copy and paste ID and ID2 to the top. The second field (ID2) will be what the join in ArcMap is based on, so remember what you name it; you may want to name it GEOID because GEOID10 is what's used in the tracts shapefile. For the third field, I used TRACT2010 to indicate the data was from the 2010 Census and I used TRACTACS to indicate the data was from the ACS. Other fields need to be renamed to something descriptive; if saving to a geodatabase, the length of the new field name isn't a problem, but if saving to a shapefile, the field name is limited to 10 characters. Repeat this process for each table.

Figure 8. Screenshot of same table as above, with blank cells removed and field headings renamed.

4. Change ID Field Types in Excel

- a. In order to join tables in ArcMap, the field containing the unique tract number (“ID2” or “GEOID”, if so named) must be changed from a *number* field to a *text* field.
- b. Using the regular Excel method of “Format Cells” to change to “Text” type will not work. It looks fine in Excel, but in ArcMap the Join function will not recognize the field this method is used.

- c. Instead, select the second column (contains the unique tract number).

	A	B	C	D	E	F
1	ID	ID2	TRACTACS	THH	THH_ERR	VEH_0
2	1400000US32031000101	32031000101	1.01	1719	199	9
3	1400000US32031000102	32031000102	1.02	1715	184	7
4	1400000US32031000201	32031000201	2.01	1243	116	
5	1400000US32031000202	32031000202	2.02	1276	121	3
6	1400000US32031000300	32031000300	3	2249	122	1

- d. Go to “Data > Text to Columns”. A wizard opens up. On the screen for Step 1, choose “Delimited”, then click “Next”. On the screen for Step 2, choose “Tab”, then click “Next”. On the screen for Step 3 – which is shown below – choose “Text”, then click “Finish”.

Figure 9. Screenshot of text field to change to number.

- e. Save your file. Repeat process for each Excel file, then exit Excel.

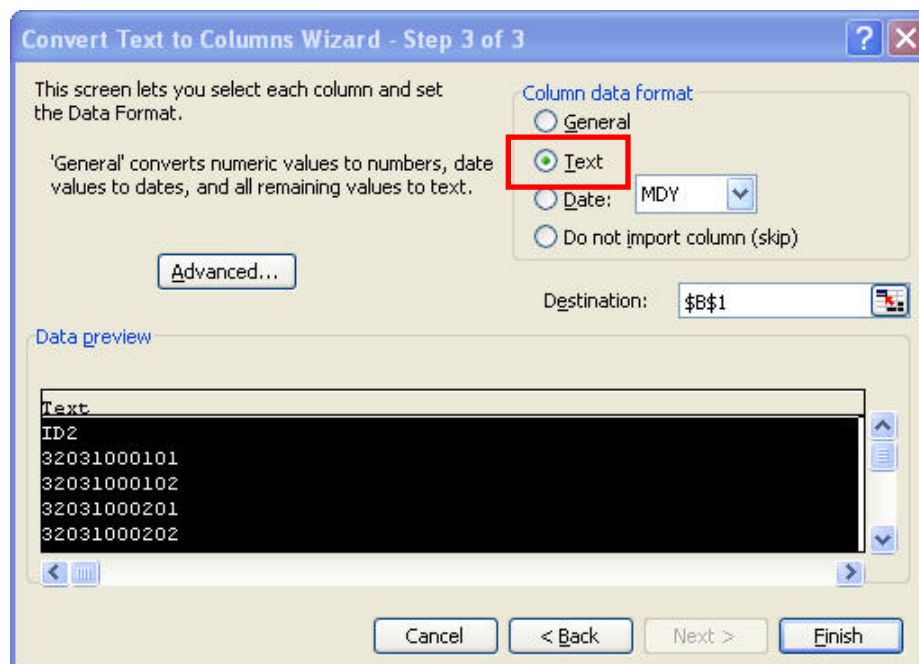


Figure 10. Screenshot of Step 3 of wizard to change number field to text.

E. Using ArcMap

This section describes the specific steps used to join the Excel tables to the clipped Census tract shapefile, perform the spatial overlay analyses, and symbolize datasets for use in printed maps.

1. Join Tracts Shapefile With Excel Table

- a. Add the shapefile of the clipped Census tracts (that intersect the 1997 flood extent and clipped to the city limits; 18 polygons) and an Excel table to ArcMap.
- b. Right-click on the tracts layer and choose Join.
- c. For the tracts layer, pick the unique field with the tract numbers (field called GEOID10).
- d. The field in the Excel table to join is the second field (name depends on what you named it; e.g., ID2 or GEOID).
- e. Choose to keep matching records.
- f. Export to a new shapefile and save with meaningful name (e.g., Tracts2010_Population; TractsACS20052010_HouseholdIncome).
- g. Remove the join. Repeat as needed for each Excel table.

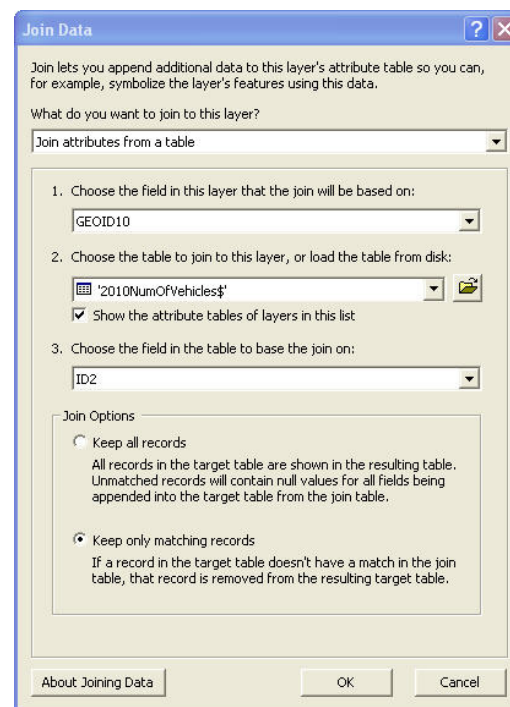


Figure 11. Screenshot of window to join table data to Census tracts layer.

2. Select by Location

- a. Use Select by Location to select the parcels with buildings (excluding condos) that intersect the clipped Census tracts layer and save to a new shapefile.
- b. For each of the shapefiles of “important facilities”, use Select by Location to select the facilities that intersect the clipped Census tracts layer and save to a new shapefile. Repeat as needed.

3. Calculate Area Weighted Estimates

- a. In the map in Figure 12, the Census tracts (magenta outline) cover an area much larger than where the 1997 and 2005 floods occurred (orange and brown areas). The original Census data about the total number of people/households in each tract

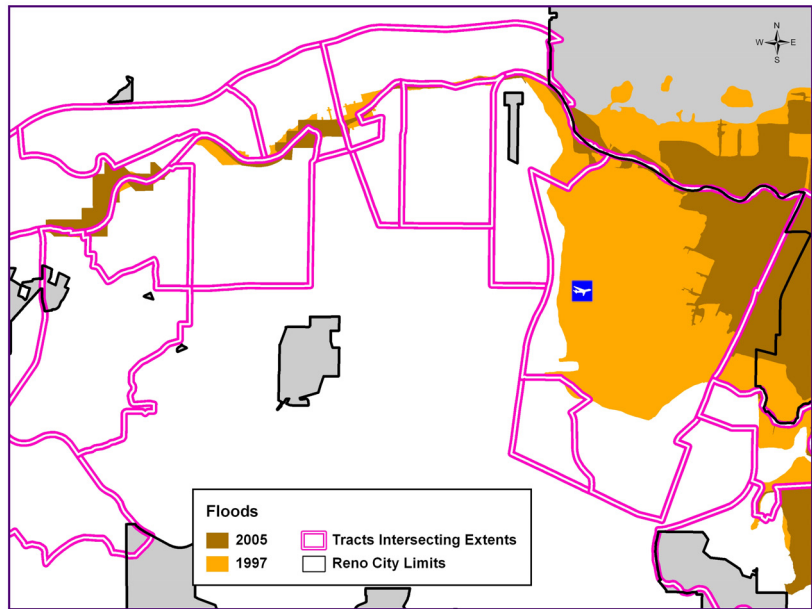


Figure 12. Zoomed in map of Census tracts in Reno that intersect 1997 flood extents. (Map created by Valerie Johnson, September 2012.)

misrepresent how many people/households are actually located in the flood extents. So, “area weighted” estimates of people/households were determined. This was accomplished by 1) taking the area of a tract and dividing it by the area of the portion of the tract that intersects the 1997 flood extent (the larger flood event), which results in a percentage, and 2) multiplying that percentage by the total number of people/households within that entire tract. This method assumes that people are evenly distributed within a Census tract, which is not realistic. However, the estimates determined by the area weighted method are the best estimates available without conducting door-to-door surveys of all residences in the flood extent. New fields (type Double) have to be added to the attribute tables and calculated (for area of tract in the flood extent; for the percentage; and for the area weighted estimates of the people/households (example field names: aw_totalpop, aw_65up, aw_5less, aw_hh15K, aw_hhnoveh)). The formulas for calculating area weighted estimates are: Step 1) $[\text{PERCENTAGE}] = [\text{AREA}]/[\text{FLOODAREA}]$. Step 2) $[\text{AREAWIGHTED_FIELD}] = [\text{PERCENTAGE}] * [\text{ORIGINALFIELD_WITH_DATA}]$.

4. Visualize Data

- a. Make maps that staff will find useful and easy to read.
- b. For map symbology, start by choosing Quantities > Graduated Colors. For Fields >

Value, choose the area weighted field you want to show.

- c. For classification, start with the default classification scheme -- Natural Breaks (Jenks). Then click the “Classify” button to get to the “Classification” window, where (on the right side) you can adjust the “Break

Values” to ones easily recognized (e.g., type in 150, 300, 450, so on).

- d. Alter the colors of the symbols as desired.
- e. Get staff feedback on draft symbology and break values. Staff are the ones who will be using the maps, so make the data useful for them.

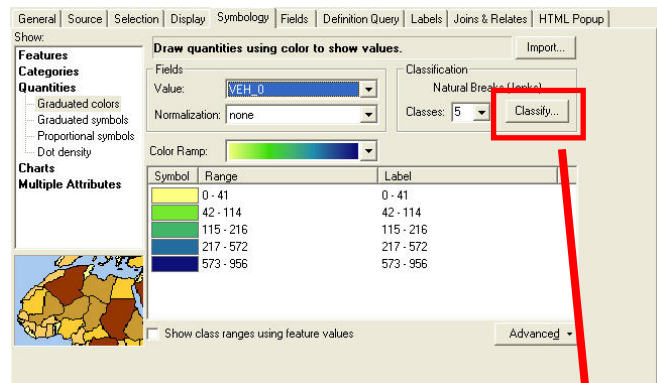


Figure 13. Screenshot of ArcMap Symbology tab.

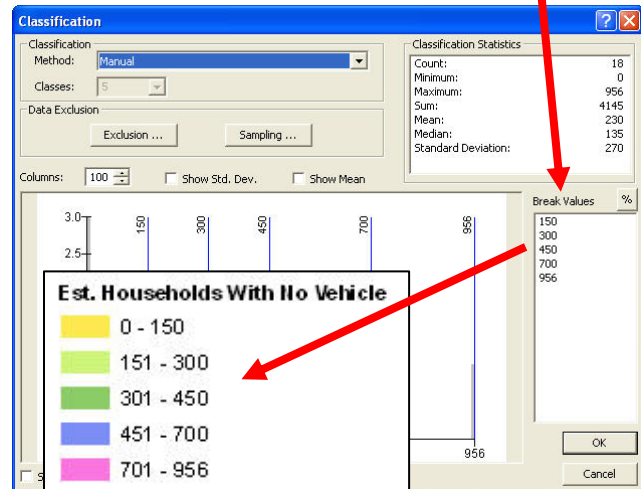


Figure 14. Screenshot of ArcMap Classification tab.

5. Results of Analyses / Visualization Products

Several maps and tables summarizing the results of the overlay analyses were created for the short report for city staff, which is in Appendix A. An estimated 5,639 people live in the 1997 flood extent, and of these, 339 are age 5 and younger, and 819 are age 65 and older. An estimated 352 households do not have a vehicle. Table 1 summarizes the results.

Reno Citizens/Households in 1997 Flood Extent	Area Weighted Estimates (see pg. 5 for information about area weighted estimates)	
Total Population*	5,639	
Population Age 5 and Younger*	339	
Population Age 65 and Older*	819	
Population Age 85 and Older*	88	
Households With Annual Income of \$15,000 or Less**	374	
Households With No Vehicle**	352	
Households of 2 or More Persons With No Vehicle	91	
<p><i>* Based on data from 2010 Census.</i></p> <p><i>** Based on data from American Community Survey (2005-210 5-year estimate).</i></p>		
Values of Buildings on Ground-Floor Parcels in 1997 and 2005 Flood Extents in Reno City Limits	Current Values* in 1997 Extent (the larger flood)	Current Values* in 2005 Flood Extent (the smaller flood)
Assessed Building Values	\$284,504,502	\$182,845,258
Annual Tax Revenue (Buildings) to Reno**	\$9,735,535	\$5,081,778
<p><i>* Washoe County Assessor's Office assessed building values as of July 2012.</i></p> <p><i>** Reno's millage tax rate was 2.779% as of July 2012. Annual tax revenue (buildings) is millage rate times assessed building values.</i></p>		

Table 1. Summary of the results of the overlay analyses.

Maps in the short report for staff include:

- Area of interest map showing the river, city limits, flood extents, and a few major roadways (see Figure 2 in this document for this map)
- Map of the selected Census tracts that intersect the 1997 flood extents (see Figure 12 in this document for zoomed in view of this map)
- Map of the important facilities intersecting a polygon of the combined flood extents (see Figure 15 on next page for this map)

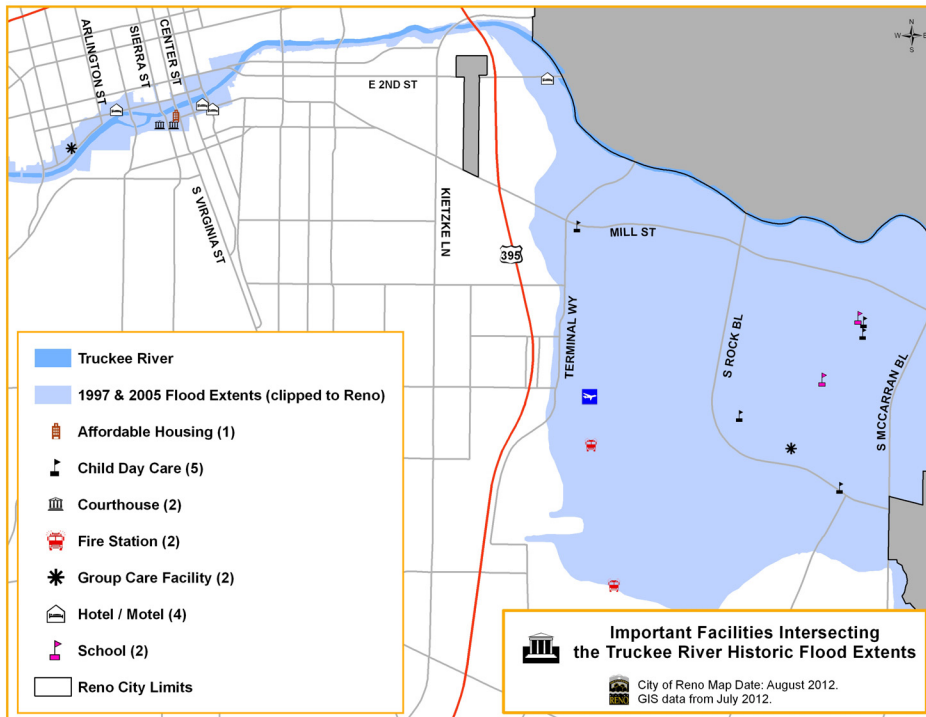


Figure 15. Important facilities in Reno in the 1997 and 2005 flood extents. In the map legend, the number of each type of facility is shown in parentheses. (Map created by Valerie Johnson, July 2012.)

The short report for staff also includes small-scale and large-scale maps focusing on the river corridor of the clipped Census tracts with values symbolized into classes for the following topics:

- Area weighted population (see Figure 16 for this map)
- Area weighted population age 5 and under
- Area weighted population age 65 and older (see Figure 17 for this map)
- Area weighted number of households with annual income of \$15,000 or less (see Figure 18 for this map)
- Area weighted number of households with no vehicle (see Figure 19 for this map)

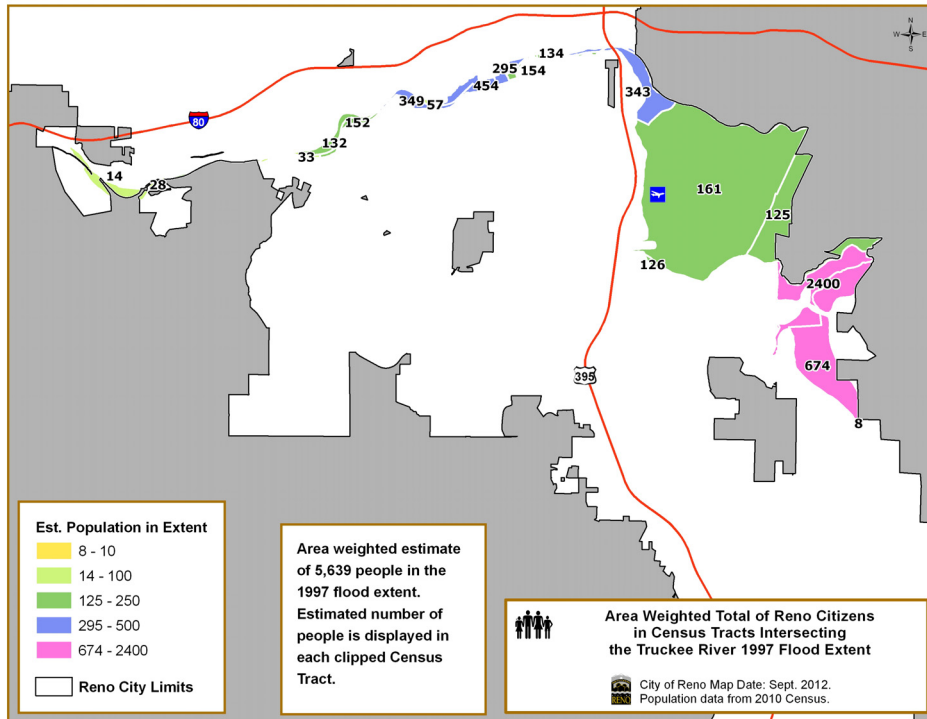


Figure 16. Estimated total population in Reno in the 1997 flood extent.
(Map created by Valerie Johnson, July 2012.)

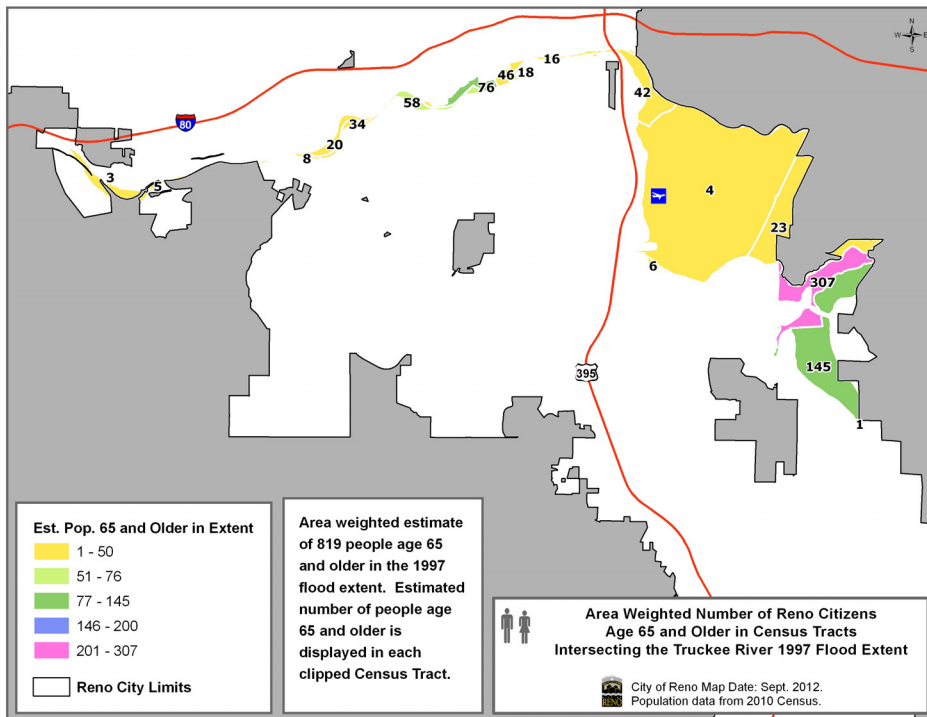


Figure 17. Estimated population age 65 and older in Reno in the 1997 flood extent.
(Map created by Valerie Johnson, July 2012.)

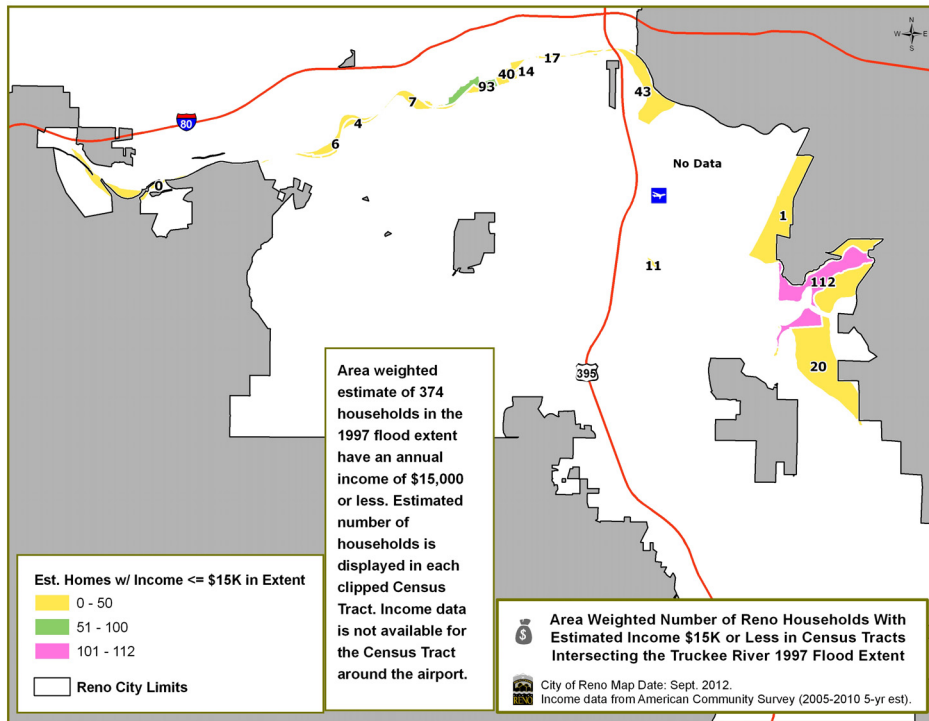


Figure 18. Estimated number of households with annual income of \$15,000 or less in Reno in the 1997 flood extent.
 (Map created by Valerie Johnson, July 2012.)

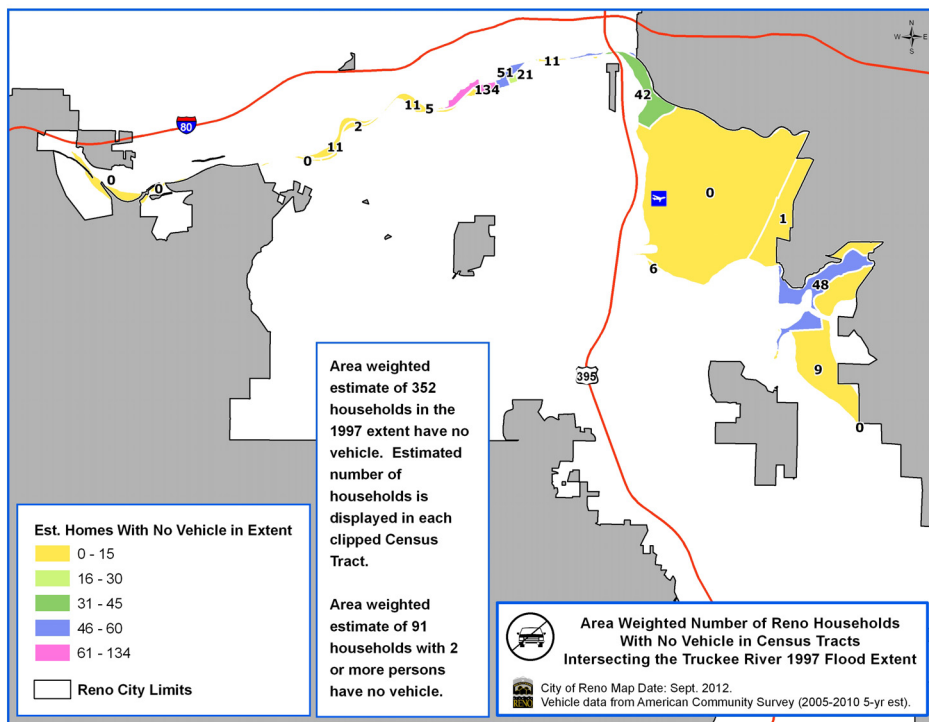


Figure 19. Estimated number of households with no vehicle in Reno in the 1997 flood extent.
 (Map created by Valerie Johnson, July 2012.)

6. Summary and Tasks for the Future

The most time-consuming aspect of this project was to locate the appropriate demographic data tables on the U.S. Census Bureau's American FactFinder website and then to prepare the data tables in Excel so they could be utilized in ArcMap. Symbolization for the thematic maps was the next most time-consuming part.

However, the resulting maps and tables in the short report should help city emergency response staff and decision-makers prepare for the next flood. Other communities can conduct a similar project and create the analyses, tables, maps and reports useful for their situation.

For the future, the short report needs to be maintained with up-to-date information in order for it to remain useful to staff. Future tasks include:

- In early 2013, check the American FactFinder website for ACS 5-year estimates about population with a disability.
- Thereafter, keep datasets, overlay analysis results, tables, maps, and the short report updated on a regular basis as new ACS data become available.

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Appendix A

The short report for city staff, *“For Emergency Management Preparedness: Potential Human and Economic Impacts by Flooding of the Truckee River in the City Limits of Reno, Nevada,”* appears in Appendix A.

***For Emergency Management Preparedness:
Potential Human and Economic Impacts
by Flooding of the Truckee River
in the City Limits of Reno, Nevada***

October 2012



Downtown Reno, Normal Early Summer River Flow



Downtown Reno, New Year's Day 2005 Flood

Analysis, Maps, and Report created by Valerie Johnson, City of Reno GIS Division

Source of Photos: Truckee River Flood Management Project (2012)

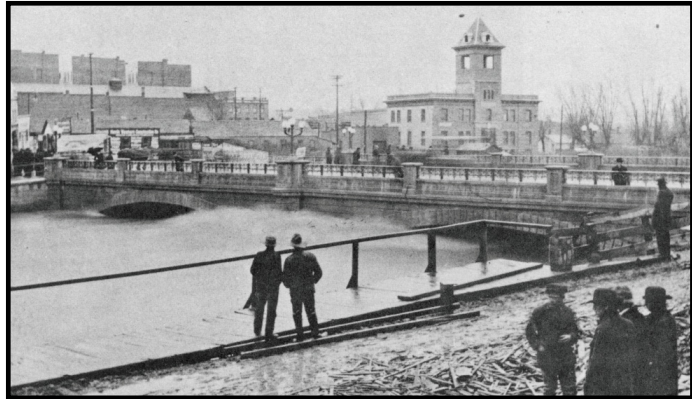
Table of Contents

Introduction	2
Map 1: Area of Interest	3
Table 1: Summary Data at a Glance	4
About the Data and Analysis Methods Used	5
About Census Tracts and Area Weighted Estimates	5
Map 2: Assessed Values of Buildings on Ground-Floor Parcels in Reno in 1997 Flood Extent	6
Map 3: Important Facilities in Reno in 1997 and 2005 Flood Extents	7
Table 2: List of Important Facilities in Reno in 1997 and 2005 Flood Extents	7
Map 4: Number of Reno Citizens in 1997 Flood Extent (includes zoomed in map)	8
Map 5: Number of Reno Citizens Age 5 and Under in 1997 Flood Extent (includes zoomed in map)	9
Map 6: Number of Reno Citizens Age 65 and Older in 1997 Flood Extent (includes zoomed in map)	10
Map 7: Number of Reno Households With Annual Income of \$15,000 and Less in 1997 Flood Extent (includes zoomed in map)	11
Map 8: Number of Reno Households With No Vehicle in 1997 Flood Extent (includes zoomed in map)	12

Introduction

The Truckee River, which flows through the heart of the city of Reno, Nevada, has a significant damaging flood event about every 10 years. It's not a matter of **if** a flood will occur again, but rather of **when**.

- The 117-year flood in 1997 inundated over 7,200 acres and caused damages of \$650 - \$700 million (in 1997 dollars).**
- The 50-year flood in 2005 inundated over 4,300 acres and caused damages of \$18 million (in 2005 dollars).***



Downtown Reno, 1907 Flood*

What kind of damages would a flood similar to the 1997 and 2005 flood events cause today?

This short report and the maps in it describe a few of the potential impacts to people, buildings, and tax revenues for people and buildings located within the Reno city limits in areas that were inundated by the 1997 and 2005 flood events.

City managers can benefit from learning about the impact a similar flood today could have on property taxes. Emergency response staff can better plan for a flood event by knowing more about the people and facilities that may require special responses during a flood event (for example, elderly people needing help in evacuating).



Reno-Tahoe International Airport, 1997 Flood*

Included are in this report are:

- Assessed values of buildings on ground-level parcels in Reno.
- Annual tax revenue based on buildings on the ground-level.
- Area weighted estimates of the population that could be affected (total population; age 5 and under; age 65 and older).
- Area weighted estimates of the number of households with an annual income of \$15,000 or less.
- Area weighted estimates of the number of households that do not have a vehicle.

* Source of Photos: Truckee River Flood Management Project (2012).

** J. Carner, "Water, Water Everywhere", Daily Sparks Tribune (April 1, 2011); "Floods in Driest State", TheStormKing.com (2012).

*** "Floods in Driest State", TheStormKing.com (2012).

Map 1: Area of Interest

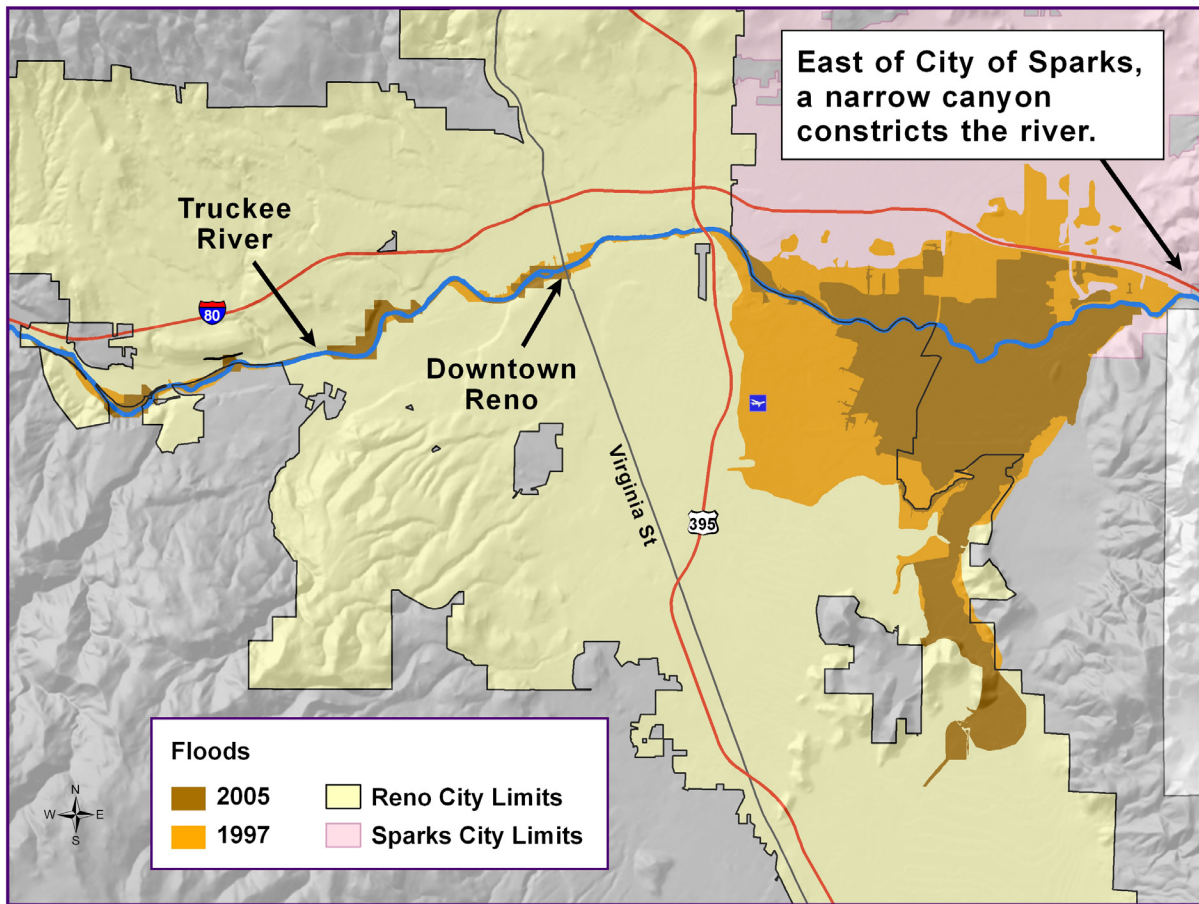


Figure 1. Reno City Limits and the Extents of the 1997 and 2005 Floods.

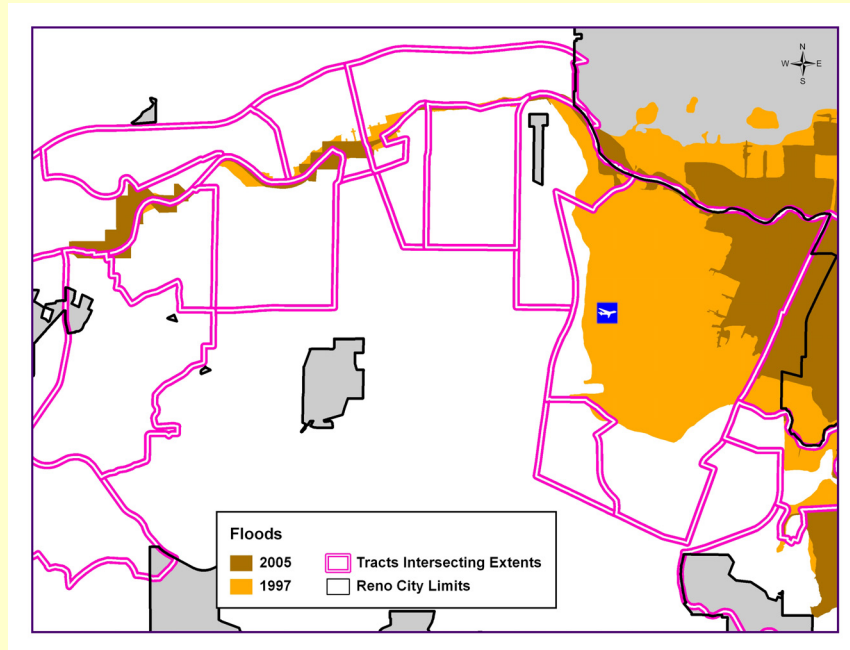
Table 1: Summary Data at a Glance

Reno Citizens/Households in 1997 Flood Extent	Area Weighted Estimates (see pg. 5 for information about area weighted estimates)	
Total Population*	5,639	
Population Age 5 and Younger*	339	
Population Age 65 and Older*	819	
Population Age 85 and Older*	88	
Households With Annual Income of \$15,000 or Less**	374	
Households With No Vehicle**	352	
Households of 2 or More Persons With No Vehicle	91	
<p>* Based on data from 2010 Census. ** Based on data from American Community Survey (2005-210 5-year estimate).</p>		
Values of Buildings on Ground-Floor Parcels in 1997 and 2005 Flood Extents in Reno City Limits	Current Values* in 1997 Extent (the larger flood)	Current Values* in 2005 Flood Extent (the smaller flood)
Assessed Building Values	\$284,504,502	\$182,845,258
Annual Tax Revenue (Buildings) to Reno**	\$9,735,535	\$5,081,778
<p>* Washoe County Assessor's Office assessed building values as of July 2012. ** Reno's millage tax rate was 2.779% as of July 2012. Annual tax revenue (buildings) is millage rate times assessed building values.</p>		

About the Data and Analysis Methods Used

Spatial data (map data) used in this report (including Census tract polygons) are from the local city and county GIS programs. Demographic data about population/age groups are from the U.S. Census Bureau's 2010 Census; data about household income and households without a vehicle are from the U.S. Census Bureau's American

Community Survey 2005-2010 5-year estimate. Eighteen Census tract polygons intersect both the polygon of the current Reno city limits **and** the 1997 flood extent polygon (orange area in map below). These tracts are outlined in magenta in the map below.

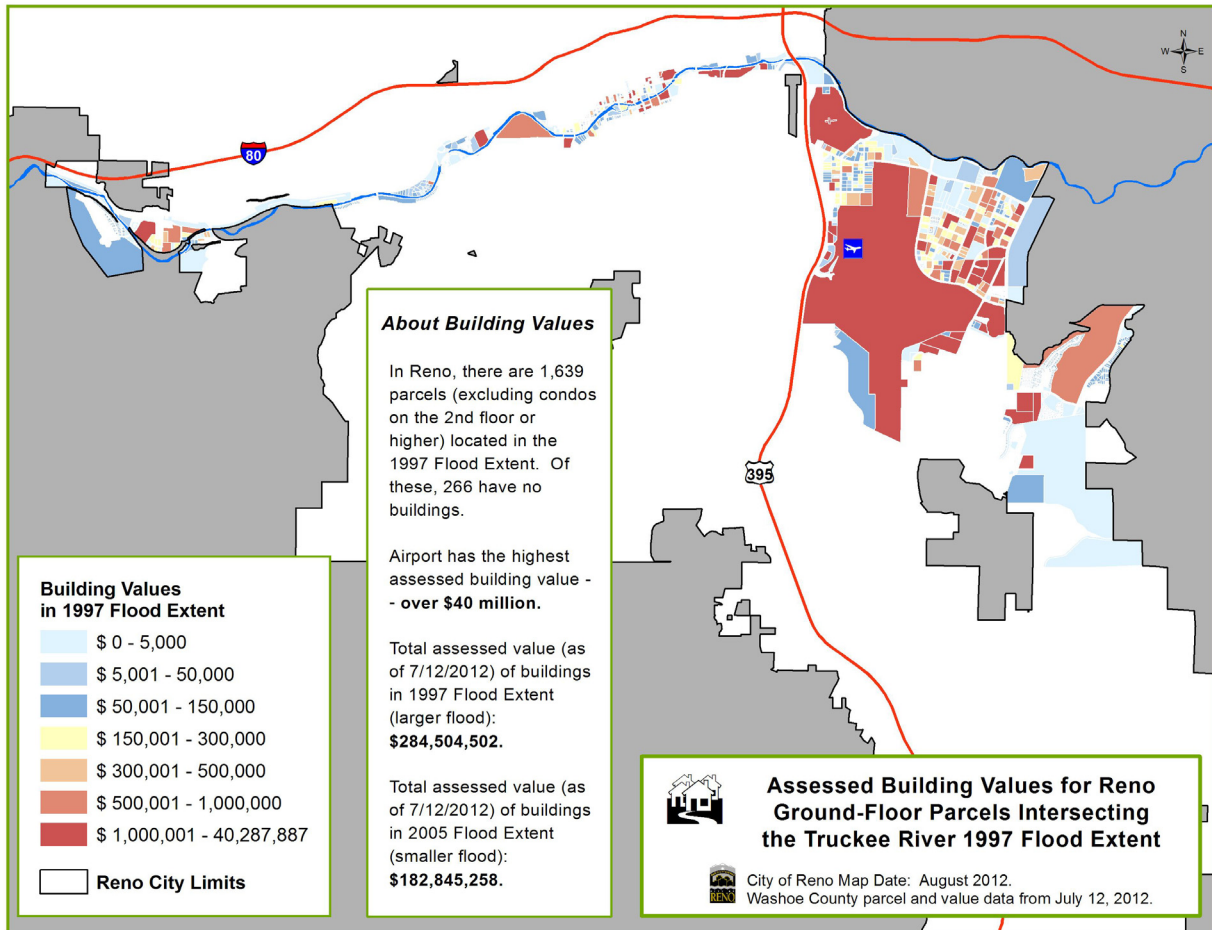


About Census Tracts and Area Weighted Estimates

In the map above, notice that the boundaries of the Census tracts (magenta outline) cover an area much larger than where the 1997 and 2005 floods occurred (orange and brown areas). The data about the total number of people/households in each Census tract (in the entire tract) misrepresents how many people/households are actually located in the flood extents. So, "area weighted" estimates of people/households were determined. This was accomplished by 1) taking the area of a Census tract and dividing it by the area of the portion of the tract that intersects the 1997 flood extent (the larger flood event), which results in a percentage, and 2) multiplying that percentage by the total number of people/households within that entire tract.

Example: Suppose that a Census tract has an area of 10 square miles, a total population of 5,000 people, and 800 households without a vehicle. However, only a 1-square mile portion of that tract is within the 1997 flood extent. Thus, 1 divided by 10 equals 10%, which is the percentage that will be used to multiply the total numbers. So, this example Census tract would have an area weighted population estimate of 500 people (10% times 5,000 = 500) and an area weighted estimate of 80 households without a vehicle (10% times 800 = 80). Note: This method assumes that people are evenly distributed within a Census tract, which is not realistic. However, the estimates determined by the area weighted method are the best estimates available without conducting door-to-door surveys of all residences in the flood extent.

**Map 2: Assessed Values of Buildings on Ground-Floor Parcels
in Reno in 1997 Flood Extent**



Map 3: Important Facilities in Reno in 1997 and 2005 Flood Extents

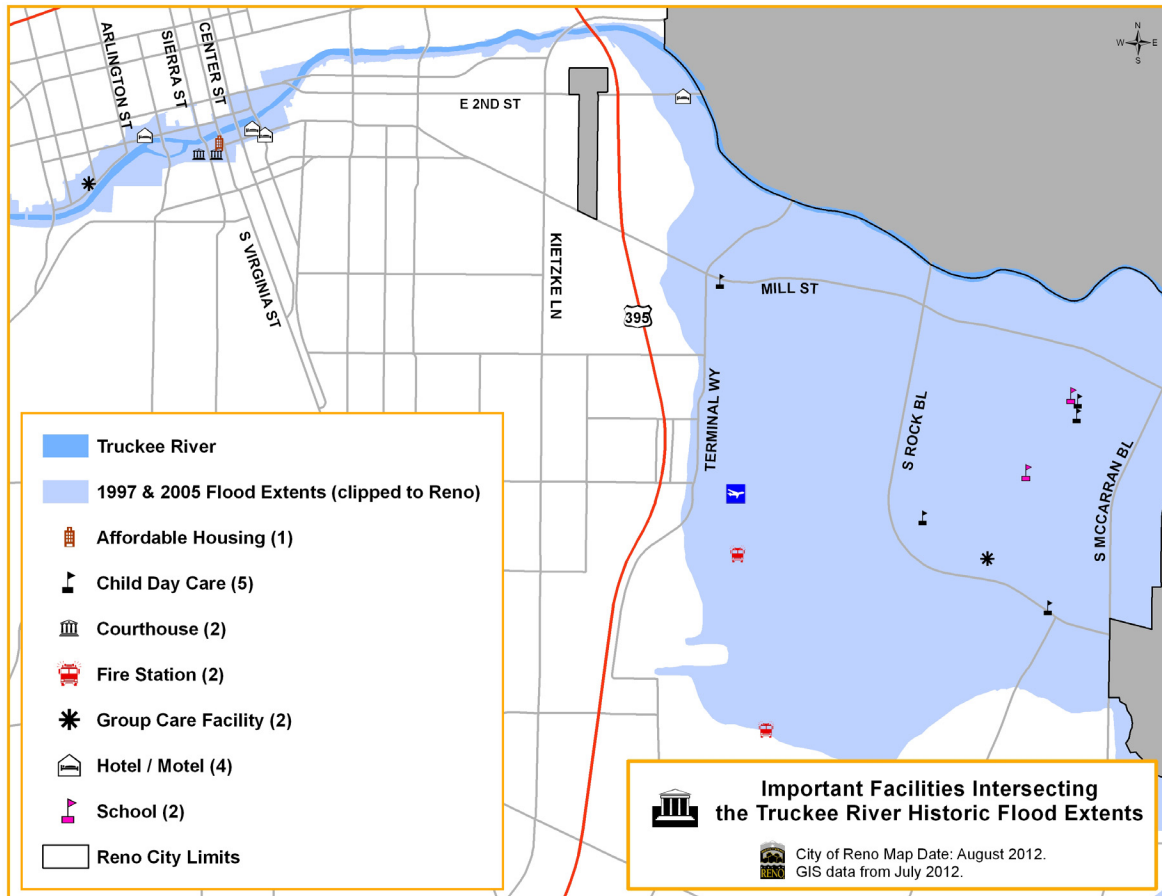
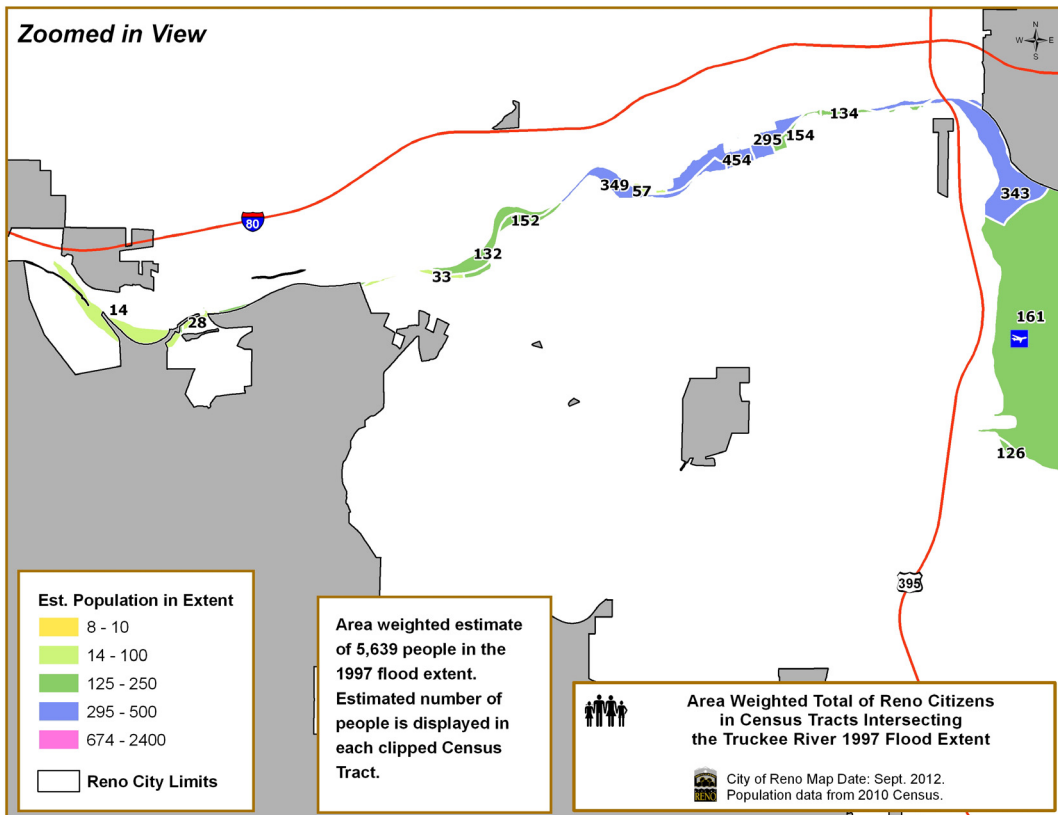
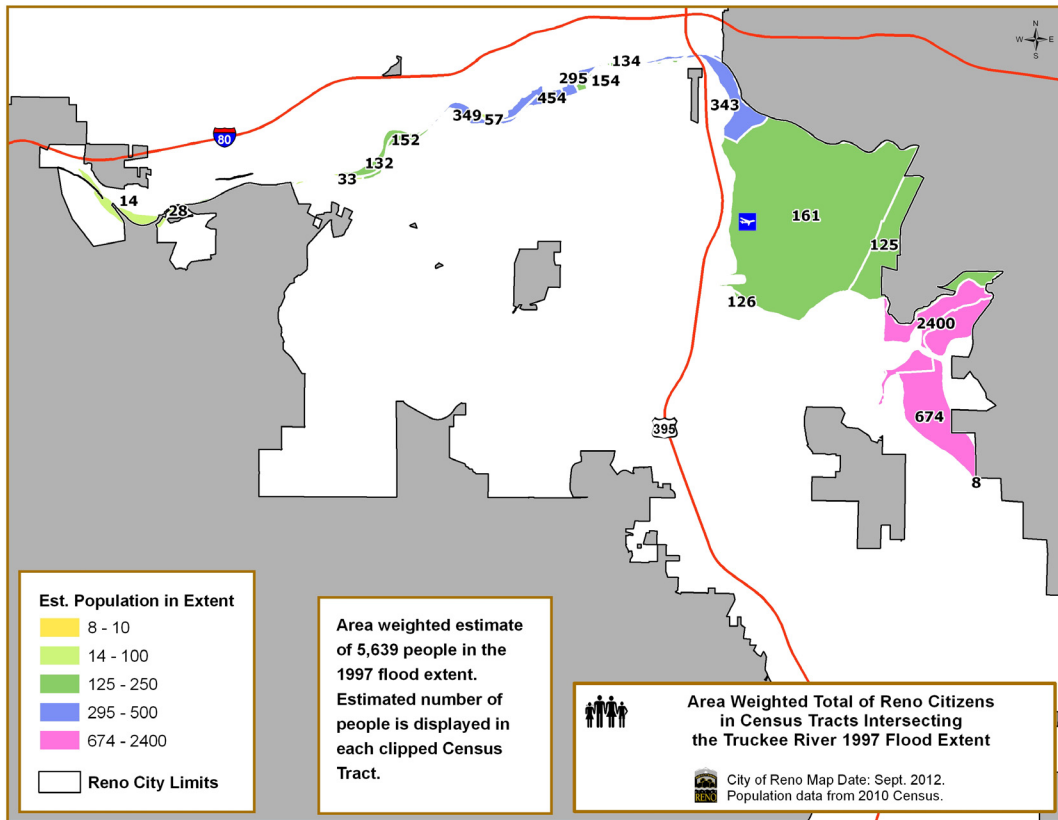


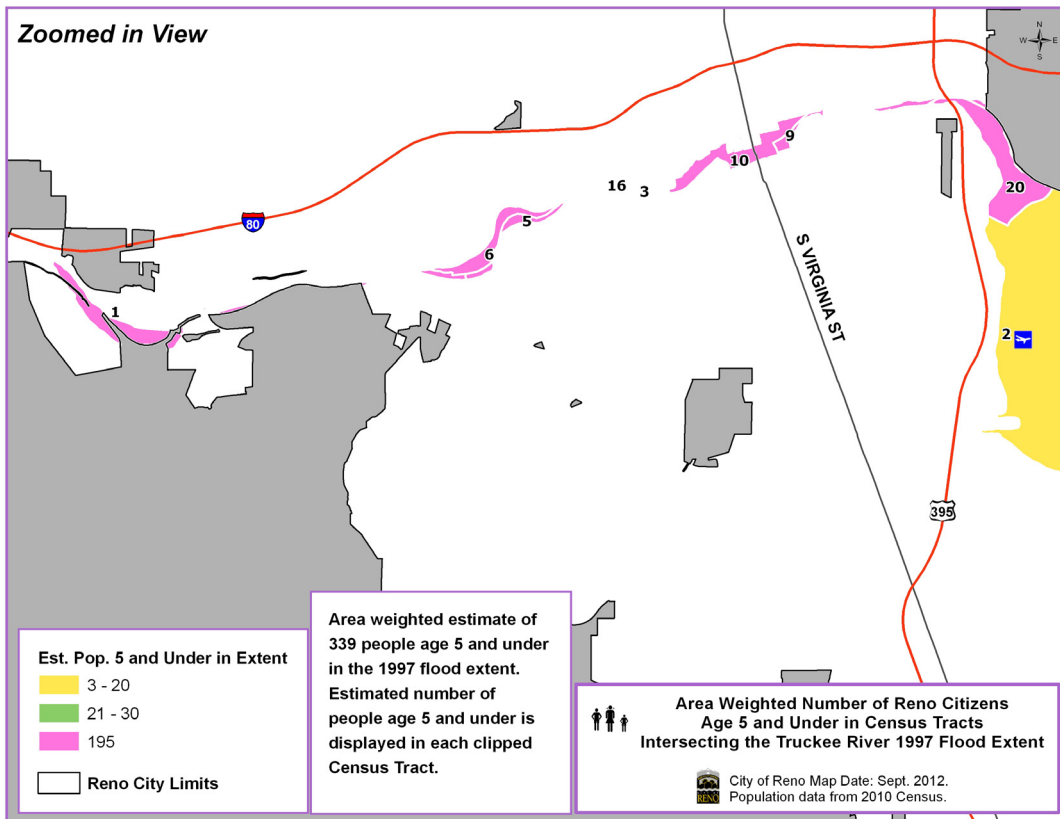
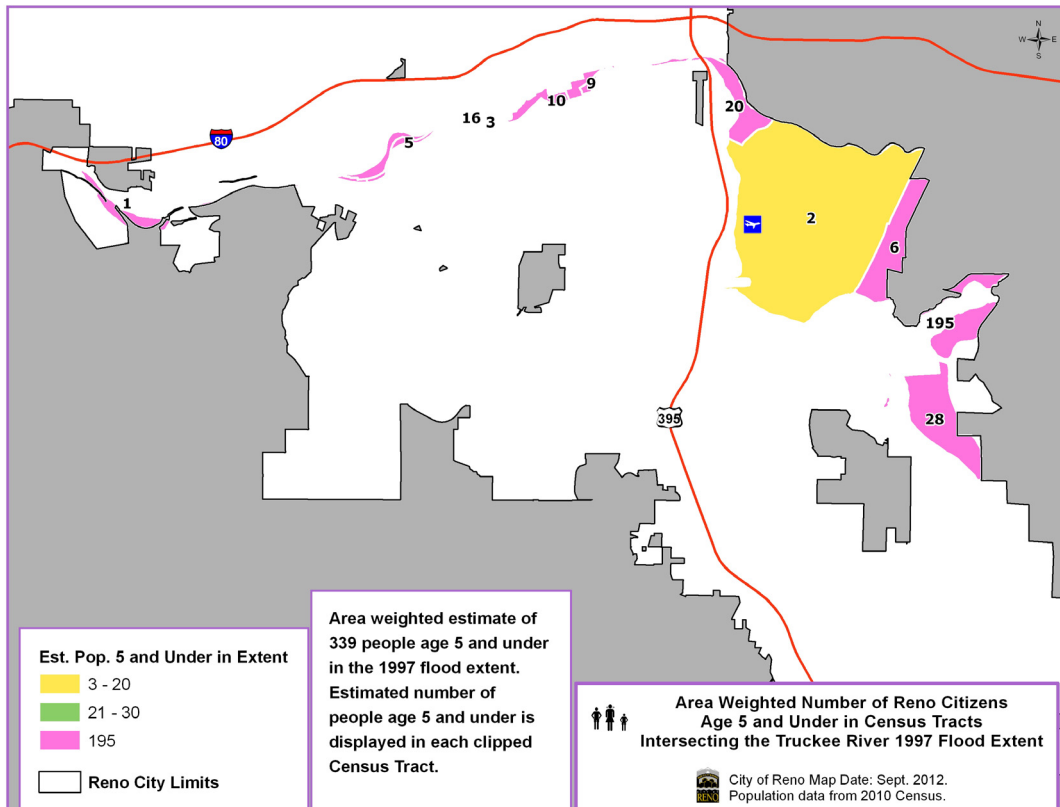
Table 2: List of Important Facilities in Reno in 1997 and 2005 Flood Extents

CATEGORY	FACILITY NAME	ADDRESS
Affordable Housing	Riverside Artist Lofts	17 S Virginia St
Child Day Care Facilities	Aces	1195 Corporate Blvd Unit B
	Child Garden Children's Ctr	565 Reactor Way
	Early Education & Care Dept.	1090 S Rock Blvd
	Nevada Performing Arts Inc	2920 Mill St
	Stepping Stones Children's Ctr	1230 Corporate Blvd
Fire Stations	Reno-Tahoe Airport Fire Dept	1802 Riley Ave
	Nevada Air National Guard Fire & Emergency Services	1776 National Guard Way
Government Facilities	District Courthouse	75 Court St
	Municipal Courthouse	1 S Sierra St
Group Care Facilities	Riverhaven Residential Care	727 Riverside Dr
	Willow Springs Center	690 Edison Way
Hotels/Motels	Lakemill Lodge	200 Mill St
	Reno Riviera Motel	395 W 1st St
	Siena Hotel Spa Casino	1 S Lake St
	Grand Sierra Resort	2500 E 2nd St
Schools	I Can Do Anything Charter School	1195 Corporate Blvd Unit C
	Regional Technical Institute	380 Edison Way

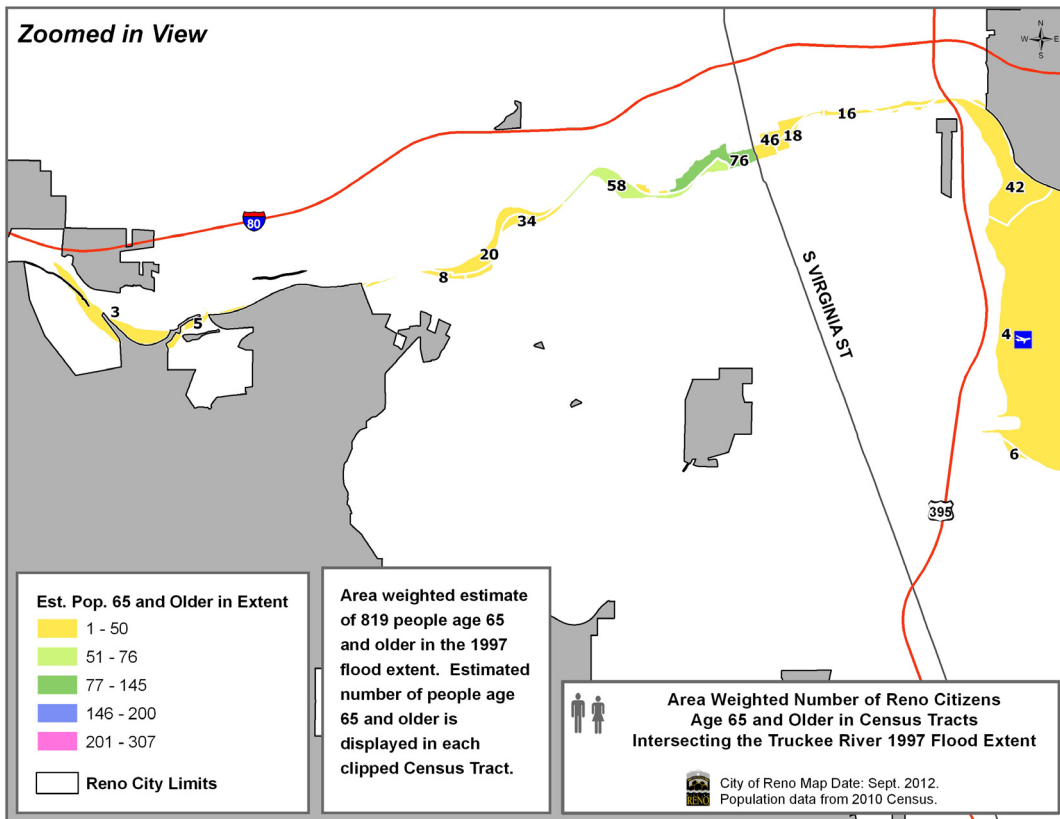
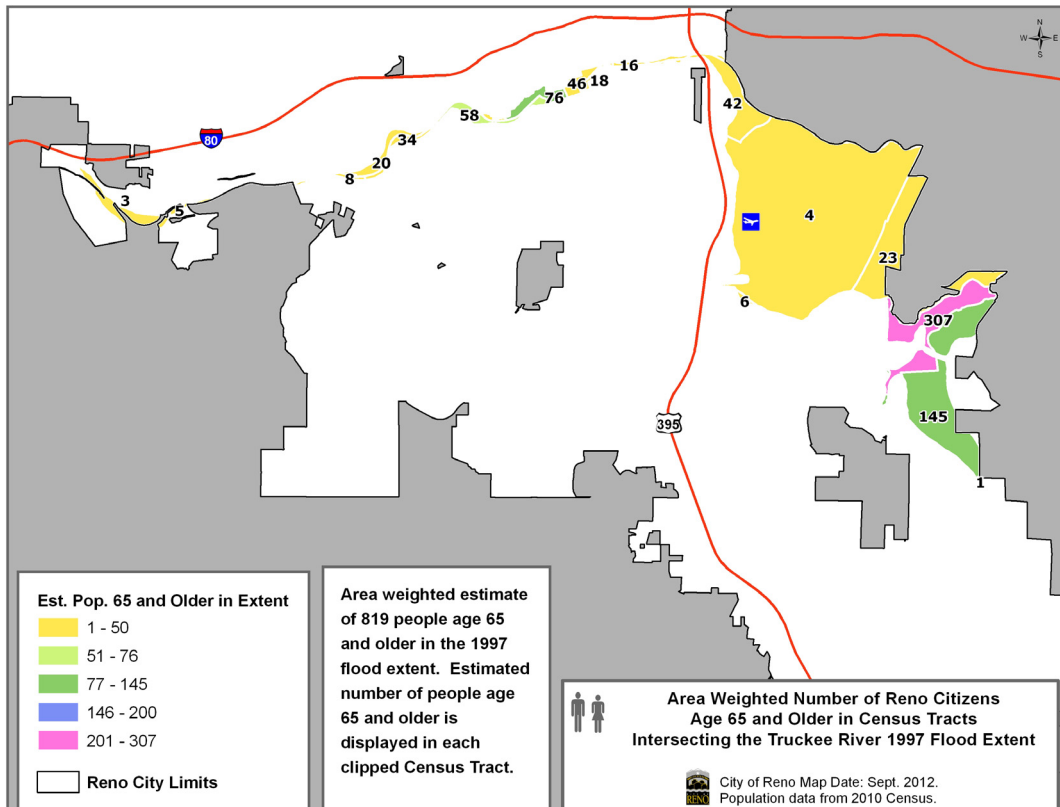
Map 4: Number of Reno Citizens in 1997 Flood Extent



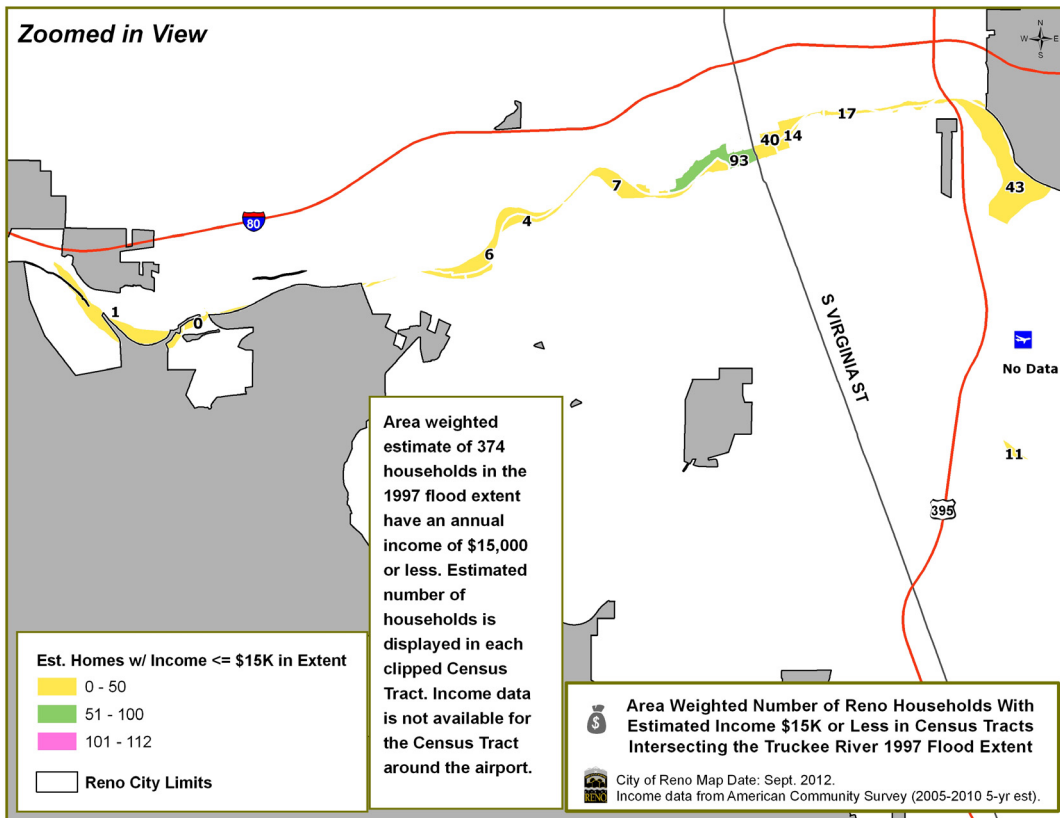
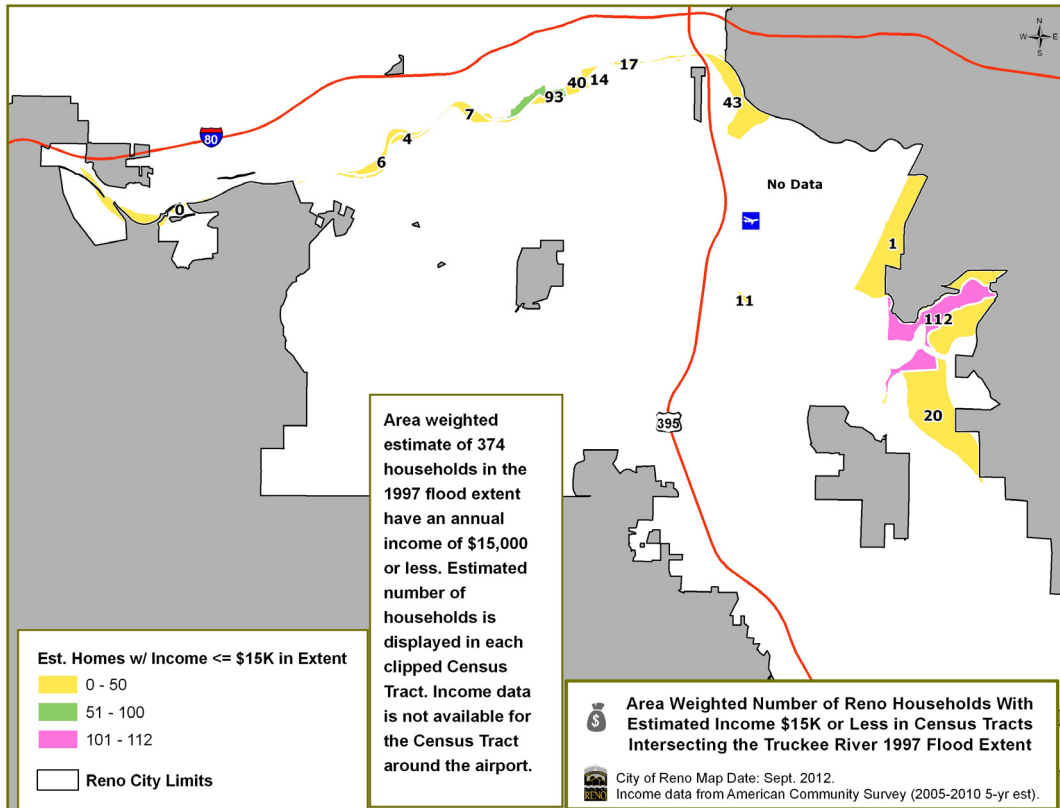
Map 5: Number of Reno Citizens Age 5 and Under in 1997 Flood Extent



Map 6: Number of Reno Citizens Age 65 and Older in 1997 Flood Extent



Map 7: Number of Reno Households With Annual Income of \$15,000 and Less in 1997 Flood Extent



Map 8: Number of Reno Households With No Vehicle in 1997 Flood Extent

