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Center For Regional Studies
College of Business
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2018 Economic Impact of a 1997 Truckee River Flood Event

Executive Summary

The economic impact of flooding similar to the one caused by the cresting of the Truckee River in January 1997 is estimated at $2.5 billion in 2018 dollars. The total economic impact includes existing replacement cost of damaged structures ($222 million), value of damaged contents within the structures ($1.8 billion), and loss of business output ($520 million).

2018 Economic Impact

Replacement Cost of Existing Structures	$222,396,109
Structure Content Values	$1,791,321,164
Business Disruption	$520,404,147
Total Economic Impact	**$2,534,121,420**

Assumes one-foot flood level above first floor and 15 days of business disruption

The economic impact only includes properties located in Reno-Sparks and impacted by the cresting of the Truckee River in January 1997 (as identified by the Truckee River Flood Management Authority) and does not include additional properties in the region that were affected by flooding of other rivers, tributaries, ditches, and canals during the 1997 storm. The economic impact also does not include damages to roads, losses to automobiles, and emergency and cleanup costs.

Introduction

Historic cresting of the Truckee River has caused widespread economic damage across Reno-Sparks. The most recent large-scale flooding occurred in January 1997, with over $700 million (1997 dollars) in property and content losses (Army Corps of Engineers; Truckee Meadows Final General Re-evaluation Report (GRR), December 2013), and an estimated $1.47 billion (1997 dollars) in total damages (National Weather Service; NevadaFloods.org). The January 1997 flood was the fourth highest level reached by the Truckee River in downtown Reno (Table 1).

Table 1. Top Ten Flood Events in Downtown Reno

Historic Crests - Truckee River
(1) 15.72 ft on 12/23/1955
(2) 15.22 ft on 11/21/1950
(3) 14.40 ft on 02/01/1963
(4) 14.30 ft on 01/02/1997
(5) 13.50 ft on 12/31/2005
(6) 12.74 ft on 03/18/1907
(7) 12.65 ft on 02/17/1986
(8) 12.12 ft on 01/09/2017
(9) 11.65 ft on 02/10/2017
(10) 11.50 ft on 12/23/1964
Flood Stage = 11 feet (downtown Reno)

Source: National Weather Service

The January 1997 event was measured as a 0.87% "annual chance exceedance" (ACE) event, which is defined as a 0.87% chance of a flood of that magnitude occurring in any given year. Flood levels for 0.87% ACE events are approximately one-foot higher than 1% ACE (1/100; commonly referred to as a 100-year events), but not as destructive as 0.2% ACE (1/500; commonly referred to as a 500-year events).

The following analysis estimates the current economic impact on structures, contents, and businesses from damages to properties affected by the 1997 event.

REPLACEMENT COST OF STRUCTURES

Over 2,500 properties were impacted by the 1997 flooding of the Truckee River, according to the Truckee River Flood Management Authority, including almost 1,000 single-family homes (Table 2). In terms of size of improvements (structures) as of fiscal-year 2018, industrial land uses contain the most square feet vulnerable to another 1997 flood event, followed by commercial land uses. Altogether, over 40 million square feet of improvements stand to be threatened by a similar cresting of the Truckee River.

Table 2. Current Property Status of Parcels Impacted by 1997 Flooding Event

Land Use	Parcels	Square Feet of Improvements
Parks & Other	466	563,226
Single-Family	958	1,644,690
Mobile Homes[1]	5	5,496
Multifamily	112	2,374,054
Commercial	370	10,756,139
Industrial	574	25,594,383
Public Utilities	18	85,942
Grand Total	**2,505**	**41,023,930**

1. Square feet total does not include mobile homes taxed as personal property (no foundations) or those located in mobile home parks.
Source: Washoe County Assessor's Office (FY 2018)

The cost to replace existing structures are sourced from fiscal-year 2018 Washoe County property tax rolls, for both current values of structures (depreciated) and replacement cost at new (not depreciated).[1] The cost to replace existing improvements to depreciated levels is almost $1.5 billion, whereas the cost to replace these structures as new reaches almost $2.8 billion if every square foot of structures was damaged (Table 3).

Table 3. Current Structure Values for Parcels Impacted by 1997 Flooding Event

Land Use	Square Feet of Improvements	Cost to Replace Improvements at Existing Value (Depreciated)	Cost to Replace Improvements at New (Not Depreciated)
Parks & Other	563,226	$10,958,861	$17,664,308
Single-Family	1,644,690	$122,524,926	$213,134,419
Mobile Homes[1]	5,496	$861,886	$2,626,950
Multifamily	2,374,054	$84,125,232	$172,554,141
Commercial	8,601,462	$475,849,897	$925,890,924
Casinos	2,154,677	$32,209,843	$51,855,052
Industrial	25,594,383	$744,899,944	$1,364,482,046
Public Utilities	85,942	$16,636,792	$46,483,781
Grand Total	**41,023,930**	**$1,488,067,381**	**$2,794,691,622**

1. Square feet and cost to replace totals do not include mobile homes taxed as personal property (no foundations) or those located in mobile home parks.
Source: Washoe County Assessor's Office (FY 2018)

[1] Improvements (structures) in the State of Nevada are depreciated at a rate of 1.5% per year for up to 50 years (75%) of value. As a result, Washoe County Assessor's Office reports depreciated value of improvements for tax purposes. Depreciation is removed from these values by adding back the 1.5% annual depreciation based on the age of the structures.

More detailed estimates of economic damages to improvements from historical flooding on the Truckee River are not available due to the difficulty of determining and collecting values on a structure by structure basis. Damage to properties in the region from the 1997 flood was estimated at approximately $700 million by the National Weather Service. In 2018 dollars, the $700 million in damages equates to over $1.1 billion in damages, if adjusted for inflation only. However, the property damages reported by the National Weather Service include other types of damages in addition to structures.

To estimate the damage to current structures from a 1997 flood magnitude, depth percent damage functions by type of structure, as calculated and provided by Army Corps of Engineers, are used (Appendix 1). In January 1997 the Truckee River crested 4.3 feet above the flood stage, with multiple photographs documenting flood waters submerging structures by at least a foot from ground level. Conservatively assuming one-foot flood depth above first floor, Depth % Damage functions developed by the Army Corps of Engineers are applied to structure types to estimate existing structural depreciated replacement costs ($222 million) and new replacement costs ($416 million), as a result of the Truckee River cresting similar to the 1997 event (Table 4).

Table 4. Current Structure Damage Estimates for a 1997 Flood Magnitude

Land Use	Square Feet of Improvements[1]	Cost to Replace Improvements at Existing Value (Depreciated)[1]	Cost to Replace Improvements at New (Not Depreciated)[1]	Depth % Damage Functions @ 1-Foot Above 1st Floor[2]	Damage Cost to Improvements at Existing Value (Depreciated)	Damage Cost to Improvements at New (Not Depreciated)
Parks & Other	563,226	$10,958,861	$17,664,308	13%	$1,424,652	$2,296,360
Single-Family	1,644,690	$122,524,926	$213,134,419	16%	$19,603,988	$34,101,507
Mobile Homes[3]	5,496	$861,886	$2,626,950	45%	$387,849	$1,182,128
Multifamily	2,374,054	$84,125,232	$172,554,141	15%	$12,618,785	$25,883,121
Commercial	8,601,462	$475,849,897	$925,890,924	13%	$61,860,487	$120,365,820
Casinos	2,154,677	$32,209,843	$51,855,052	16%	$5,153,575	$8,296,808
Industrial	25,594,383	$744,899,944	$1,364,482,046	16%	$119,183,991	$218,317,127
Public Utilities	85,942	$16,636,792	$46,483,781	13%	$2,162,783	$6,042,892
Grand Total	**41,023,930**	**$1,488,067,381**	**$2,794,691,622**		**$222,396,109**	**$416,485,763**

1. Washoe County Assessor's Office, FY 2018
2. As reported in Truckee Meadows Final General Re-evaluation Report (GRR), Appendix C: Economics, Washoe County, Nevada, (Army Corps of Engineers).
3. Square feet and cost to replace totals do not include mobile homes taxed as personal property (no foundations) or those located in mobile home parks.

Structure Content Values

In addition to damages to structures as a result of flooding, there can also be considerable damage to contents within structures. Much like estimating structural damages, accurately

calculating content values is determined on a property by property basis. Following the 1997 flood event, the Army Corps of Engineers surveyed a sample of properties damaged by the cresting of the Truckee River to calculate content values based on a structure's cost to replace after depreciation. The Army Corps of Engineers determined that residential units and public facilities have a content value to replacement cost ratio of 50%, commercial property has a ratio of 100%, and non-distribution storage/warehousing has a ratio of 160%. Due to the central proximity of Reno-Sparks to the west coast, the number of large warehouses, and no inventory taxes in Nevada, the Army Corps of Engineers found that a significant number of "regional distribution warehouses" exist in the area with a content value to replacement cost ratio of 558%.

After applying content value ratios to replacement values of properties impacted by the Truckee River cresting in 1997, the total content value in 2018 dollars is estimated at over $4.1 billion (Table 5).

Table 5. Estimated Content Values by for Parcels Impacted by 1997 Flooding Event

Land Use	Square Feet of Improvements[1]	Cost to Replace Improvements at Existing Value (Depreciated)[1]	Content Value Rate[2]	Estimated Content Value
Parks & Other	563,226	$10,958,861	50%	$5,479,431
Single-Family	1,644,690	$122,524,926	50%	$61,262,463
Mobile Homes[3]	5,496	$861,886	50%	$430,943
Multifamily	2,374,054	$84,125,232	50%	$42,062,616
Commercial	8,601,462	$475,849,897	100%	$475,849,897
Casinos	2,154,677	$32,209,843	155%	$49,925,257
Industrial	3,723,878	$163,805,554	160%	$262,088,886
Regional Distribution Warehouses[4]	21,870,505	$581,094,390	558%	$3,242,506,696
Public Utilities	85,942	$16,636,792	50%	$8,318,396
Grand Total	**41,023,930**	**$1,488,067,381**		**$4,147,924,585**

1. Washoe County Assessor's Office, FY 2018

2. Content values are estimated as a precent of depreciated structure values by type of structure as reported in Truckee Meadows Final General Re-evaluation Report (GRR) – Appendix C: Economics – Washoe County, Nevada, (Army Corps of Engineers).

3. Square feet and improvement replacement cost totals do not include mobile homes taxed as personal property (no foundations) or those located in mobile home parks.

4. Regional distribution warehouses are identified using Washoe County Assessor occupancy codes 406 (storage warehouses), 407 (distribution warehouses), 453 (industrial flex buildings), 494 (industrials, light manufacturing), and 584 (mega warehouses).

Similar to damages to structures from flooding, entire inventories of contents may not be fully immersed from a few feet of water above flood stage, thus not all contents may be completely damaged from a flooding event similar to 1997. On the other hand, some types of contents such as grains for pet food do become completely damaged when bottom layers are flooded.

As with replacement costs for structures, depth percent damage functions for one-foot of flooding from Army Corps of Engineers are used to estimate content values damaged by a 1997 flood event. Using a one-foot flood depth above first floor, the percent of damage functions are applied to structure types to estimate the value of contents damaged ($1.8 billion) as a result of the Truckee River cresting similar to the 1997 event (Table 6).

Table 6. Current Content Damage Estimates for a 1997 Flood Magnitude

Land Use	Square Feet of Improvements[1]	Estimated Content Value[2]	Depth % Damage Functions @ 1-Foot Above 1st Floor[3]	Estimated Damage Value of Contents
Parks & Other	563,226	$5,479,431	14%	$767,120
Single-Family	1,644,690	$61,262,463	9%	$5,513,622
Mobile Homes[4]	5,496	$430,943	85%	$366,302
Multifamily	2,374,054	$42,062,616	9%	$3,785,635
Commercial	8,601,462	$475,849,897	19%	$88,032,231
Casinos	2,154,677	$49,925,257	19%	$9,485,799
Industrial	25,594,383	$3,504,595,583	48%	$1,682,205,880
Public Utilities	85,942	$8,318,396	14%	$1,164,575
Grand Total	**41,023,930**	**$4,147,924,585**		**$1,791,321,164**

1. Washoe County Assessor's Office, FY 2018

2. Content values are estimated as a precent of depreciated structure values by type of structure as reported in Truckee Meadows Final General Re-evaluation Report (GRR) – Appendix C: Economics – Washoe County, Nevada, (Army Corps of Engineers).

3. As reported in Truckee Meadows Final General Re-evaluation Report (GRR) – Appendix C: Economics – Washoe County, Nevada, (Army Corps of Engineers).

4. Square feet and improvement replacement cost totals do not include mobile homes taxed as personal property (no foundations) or those located in mobile home parks.

IMPACTS ON INDUSTRIES

Current business establishments located on properties impacted by the 1997 cresting of the Truckee River were identified by address-mapping the "employer directory" downloaded from the Department of Employment, Training, & Rehabilitation website in June 2018. The

directory includes company names, addresses, North American Industrial Classification System (NAICS) codes, industry descriptions, and ranges of employment sizes. Table 7 summarizes establishments and employment by major industry for those entities currently located on flood-vulnerable properties.

Table 7. Current Establishments & Employment Located on Parcels Impacted by 1997 Flooding Event

Summary	*Existing Establishments Located on Parcels Impacted by 1997 Flood*		*Greater Reno-Sparks*		*Establishments on 1997 Flood Parcels as a % of Reno-Sparks*
Total Firms	**1,861**		**12,434**		15.0%
Total Employment	**37,415**		**214,389**		17.5%
Average Wage	**$25.20**		**$23.23**		
Total Annual Payroll			**$2,616,532,206**		
Firms by Industry					
Agriculture & Forestry	4	**0.2%**	40	**0.3%**	10.0%
Construction	191	**10.3%**	1,109	**8.9%**	17.2%
Educational, Health, & Social Services	114	**6.1%**	1,480	**11.9%**	7.7%
Entertainment, Accommodation, & Food Services	135	**7.3%**	1,264	**10.2%**	10.7%
Finance, Insur., & Real Estate	116	**6.2%**	1,450	**11.7%**	8.0%
Government	25	**1.3%**	121	**1.0%**	20.7%
Information	22	**1.2%**	165	**1.3%**	13.3%
Management & Admin. Services	154	**8.3%**	1,080	**8.7%**	14.3%
Manufacturing	196	**10.5%**	511	**4.1%**	38.4%
Mining	6	**0.3%**	24	**0.2%**	25.0%
Other Services	163	**8.8%**	903	**7.3%**	18.1%
Professional Services	174	**9.3%**	1,628	**13.1%**	10.7%
Retail Trade	142	**7.6%**	1,409	**11.3%**	10.1%
Transportation,Warehousing, & Utilities	190	**10.2%**	509	**4.1%**	37.3%
Wholesale Trade	212	**11.4%**	616	**5.0%**	34.4%
Undefined	17	**0.9%**	125	**1.0%**	13.6%
Employment by Industry					
Agriculture & Forestry	10	**0.0%**	446	**0.2%**	2.2%
Construction	4,251	**11.4%**	15,074	**7.0%**	28.2%
Educational, Health, & Social Services	3,203	**8.6%**	43,425	**20.3%**	7.4%
Entertainment, Accommodation, & Food Services	2,559	**6.8%**	35,859	**16.7%**	7.1%
Finance, Insur., & Real Estate	2,121	**5.7%**	9,699	**4.5%**	21.9%
Government	896	**2.4%**	8,691	**4.1%**	10.3%
Information	625	**1.7%**	1,921	**0.9%**	32.5%
Management & Admin. Services	5,000	**13.4%**	19,844	**9.3%**	25.2%
Manufacturing	4,299	**11.5%**	13,702	**6.4%**	31.4%
Mining	18	**0.0%**	96	**0.0%**	18.8%
Other Services	1,452	**3.9%**	5,690	**2.7%**	25.5%
Professional Services	1,757	**4.7%**	10,175	**4.7%**	17.3%
Retail Trade	2,771	**7.4%**	24,587	**11.5%**	11.3%
Transportation,Warehousing, & Utilities	5,176	**13.8%**	15,575	**7.3%**	33.2%
Wholesale Trade	3,243	**8.7%**	9,409	**4.4%**	34.5%
Undefined	37	**0.1%**	196	**0.1%**	18.6%

Source: Department of Employment, Training, & Rehabilitation (DETR); geocoded by Center for Regional Studies

The resulting analysis of industries located in close proximity to the Truckee River shows that although only 18% of total Reno-Sparks jobs are located on properties impacted by the river's cresting in 1997, approximately a third of jobs in Information; Manufacturing; Transportation, Warehousing, and Utilities; and Wholesale Trade would be affected by a similar flooding event.

Current economic output of private establishments located on properties impacted by the 1997 cresting of the Truckee River was estimated by applying employment totals to the IMPLAN economic input-output model for Washoe County. Economic impact models use federal surveys of industry-to-industry activity to estimate direct expenditures (direct impacts) at local levels, which then estimate secondary spending (indirect impacts), spending of new wages (induced impacts), labor income, and employment impacts. Table 8 summarizes the ***annual*** economic impact of the 1,819 non-government establishments currently located on properties impacted by the 1997 flood.

Table 8. Annual Economic Impact of Establishments Located on Properties Impacted by 1997 Flood

Economic Impact of Direct Spending	$5,039,493,919
Economic Impact of Secondary Spending	$1,698,504,758
Economic Impact of New Wage Spending	$1,935,403,777
Total Economic Impact	**$8,673,402,454**
Economic Impact Multiplier	**1.721**
Total Labor Income of All Impacts[1]	$3,040,194,550
Annual Full-Time Jobs Supported	**55,140**

2018 Dollars

1. Labor income is included in total economic impact

Source: Washoe County IMPLAN input-output model based on employment totals by industry as reported by Department of Employment, Training, & Rehabilitation

The importance of the 1,819 non-government establishments on the flood-impacted properties is explained by the economic impact multiplier of 1.721. The multiplier reports that for every dollar directly spent on the establishments, another $0.72 is circulated in the Reno-Sparks economy through secondary and new wage spending ("ripple effect"). And although 36,483 jobs are directly employed by the 1,819 non-government establishments, a total of 55,140 jobs are supported by the direct and secondary impacts.

It should be noted that government entities are not included in the analysis of economic impacts since their revenues and spending are sourced from industry output reported in Table 8. However, the impact on 896 government jobs located on flood-impacted properties has its own ripple effect in terms of government service delays. Properties, households, and industries not located in areas affected by the 1997 flood are indirectly impacted when local government offices are closed and personnel and resources are shifted to managing natural disasters.

The 1997 cresting of the Truckee River did not impact all establishments for a year, however, and literature searches for length of business disruption due to the 1997 flood were unsuccessful. In order to calculate the economic impact of disruption to business output as a result of a Truckee River crest similar to the 1997 event, a total of 15 business days (three calendar weeks) are assumed as the average disruption. The 15 business days are based on one week for flood waters to rise then recede, one week for damage surveys/claims and demolition, and one week for repair. The 15 business disruption days represent 6% of the 250 total business days in 2018, which excludes 52 Saturdays, 52 Sundays, and 10 public holidays. The resulting total economic impact loss from a three-week disruption to those private establishments located on properties impacted by the 1997 flood is $520 million (Table 9).

Table 9. Economic Impact Loss of a Three-Week Business Disruption to Establishments Located on Properties Impacted by 1997 Flood

Economic Impact of Direct Spending	$302,369,635
Economic Impact of Secondary Spending	$101,910,285
Economic Impact of New Wage Spending	$116,124,227
Total Economic Impact	**$520,404,147**

2018 Dollars

Source: Washoe County IMPLAN input-output model based on employment totals by industry as reported by Department of Employment, Training, & Rehabilitation

ASSUMPTIONS

The following assumptions were used in this analysis:

- The economic impact only includes properties located in Reno-Sparks and impacted by the cresting of the Truckee River in January 1997 and does not include additional properties in the region that were affected by flooding of other rivers, tributaries, ditches, and canals during the 1997 storm.
- Properties impacted by the cresting of the Truckee River in 1997 were identified by Truckee River Flood Management Authority.
- Amount of damage to structures uses the one-foot above first floor category in Depth % Damages tables calculated and provided by Army Corps of Engineers (Appendix 1).

- Content values within structures are estimated using content values as a percent of existing replacement cost by type of structure as calculated and provided by Army Corps of Engineers.
- Amount of damage to contents uses the one-foot above first floor category in Depth % Damages tables calculated and provided by Army Corps of Engineers (Appendix 1).
- The length of business operations disrupted by the cresting of Truckee River experienced in January 1997 is estimated to be three weeks, or 15 business days.

Appendix 1. Depth Percent Damage Functions (Army Corps of Engineers)

DAMAGE CATEGORY	STRUCTURE / CONENTS	DEPTH OF FLOODING ABOVE 1ST FLOOR						
		-1	0	1	2	5	10	15
Single Family (1 story)	**Structure**	3	13	23	32	53	73	80
	Std. Dev	3	2	2	2	2	3	5
	Contents	2	8	13	18	29	38	40
	Std. Dev	2	2	1	1	2	2	4
Single Family (2 story)	**Structure**	3	9	15	21	36	56	68
	Std. Dev	4	3	3	3	3	4	5
	Contents	1	5	9	12	21	32	37
	Std. Dev	4	3	3	3	3	4	4
Single Family split level	**Structure**	6	7	9	13	29	63	84
	Std. Dev	3	2	2	2	2	5	8
	Contents	2	3	5	8	20	46	61
	Std. Dev	2	2	1	1	2	4	6
Multi Family (1 story)	**Structure**	3	13	23	32	53	73	80
	Std. Dev	3	2	2	2	2	3	5
	Contents	2	8	13	18	29	38	40
	Std. Dev	2	2	1	1	2	2	4
Multi Family (2 story)	**Structure**	3	9	15	21	36	56	68
	Std. Dev	4	3	3	3	3	4	5
	Contents	1	5	9	12	21	32	37
	Std. Dev	4	3	3	3	3	4	4
Apartments	**Structure**	3	9	15	21	36	56	68
	Std. Dev	4	3	3	3	3	4	5
	Contents	1	5	9	12	21	32	37
	Std. Dev	4	3	3	3	3	4	4
Mobile Home	Structure Low	6	9	43	43	92	92	92
	Structure-Mean	6	10	45	46	97	97	97
	Structure High	8	13	58	59	100	100	100
	Contents-Low	0	0	80	95	95	95	95
	Contents-Mean	0	0	85	95	99	99	99
	Contents-High	0	0	95	100	100	100	100

DAMAGE CATEGORY	STRUCTURE / CONENTS	DEPTH OF FLOODING ABOVE 1ST FLOOR						
		-1	0	1	2	5	10	15
Commercial-S (1 story)	Structure	0	7	15	25	31	46	50
	Std. Dev	0	5	5	5	5	5	5
	Contents	0	0	11	30	75	80	100
	Std. Dev	0	0	4	4	4	4	4
Commercial-S (2 story)	Structure	0	5	10	13	22	38	38
	Std. Dev	0	5	5	5	5	5	5
	Contents	0	0	7	20	56	67	92
	Std. Dev	0	0	4	4	4	4	4
Commercial-U (1 story)	Structure	0	7	16	25	31	46	50
	Std. Dev	0	5	5	5	5	5	5
	Contents	0	0	36	54	78	85	100
	Std. Dev	0	0	4	4	4	4	4
Commercial-U (2 story)	Structure	0	5	10	13	22	38	38
	Std. Dev	0	5	5	5	5	5	5
	Contents	0	0	20	38	71	84	92
	Std. Dev	0	0	4	4	4	4	4
Casino	Structure	0	7	16	25	31	46	50
	Std. Dev	0	5	5	5	5	5	5
	Contents	0	0	19	39	73	86	93
	Std. Dev	0	0	4	4	4	4	4
Industrial	Structure	0	7	16	25	31	46	50
	Std. Dev	0	5	5	5	5	5	5
	Contents	0	0	48	50	54	64	72
	Std. Dev	0	0	4	4	4	4	4
Industrial Distribution	Structure	0	7	16	25	31	46	50
	Std. Dev	0	5	5	5	5	5	5
	Contents	0	0	48	50	54	64	72
	Std. Dev	0	0	4	4	4	4	4
Public (1 story)	Structure	0	7	16	25	31	46	50
	Std. Dev	0	5	5	5	5	5	5
	Contents	0	11	18	24	40	60	60
	Std. Dev	0	10	4	4	4	4	4
Public (2 story)	Structure	0	5	10	13	22	38	38
	Std. Dev	0	5	5	5	5	5	5
	Contents	0	7	10	18	33	58	58
	Std. Dev	0	10	4	4	4	4	4

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