

# Flagstaff Watershed Protection Project Cost Avoidance Study

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By the  
Arizona Rural Policy Institute

Alliance Bank Business Outreach Center  
The W.A. Franke College of Business

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# Flagstaff Watershed Protection Project Cost Avoidance Study

## Overview

This study estimates the potential financial damages mitigated by the implementation of the Flagstaff Watershed Protection Project (FWPP). The goal of FWPP is to reduce the threat of catastrophic wildfire and post-fire flood impacts by conducting fuel-reduction forest treatments in two watersheds critical to the City of Flagstaff – the Dry Lake Hills (Rio de Flag) and Mormon Mountain (Lake Mary). By thinning unnaturally dense vegetation and using prescribed fire in these areas, the risk of intense wildfire and post-fire impacts will be significantly reduced.

The primary risks of wildfire are two-fold: damage from fire and damage from resulting floods. Severe, uncharacteristic fire destroys trees, wildlife, and recreation value and threatens homes and infrastructure in its path. Floods occur in the areas downstream of burns and can cause severe damage miles from the fire itself. According to the University of Wyoming College of Agriculture and Natural Resources, increased runoff and erosion after intense wildfires on steep hillsides can increase peak runoff by up to 100 times the average flow<sup>1</sup>. This happens after moderate to severe fires that burn the soil to the point that it is hydrophobic, and can no longer absorb water. After the 2010 Schultz Fire, which burned adjacent to the City of Flagstaff, flooding caused millions of dollars in damages to property in downstream neighborhoods. This study assumes that post-fire flooding would be similar to a 500-year flood event in the drainages below the Dry Lake Hills (depicted in Figure 1 in the Appendix).



*Decades of aggressive fire suppression have left forests more at risk of catastrophic crown fires. Photo courtesy of the Flagstaff Fire Department.*



*The steep slopes of the Dry Lake Hills funnel rain and snowmelt through urban Flagstaff. Photo courtesy of Patrick McDonald.*

*Dry Lake Hills* - The Dry Lake Hills area is located north and uphill from Flagstaff's cultural, political, tourist, university, and retail core. Heavily used for recreation and unnaturally dense with ponderosa pine and mixed-conifer forests, this area is vulnerable to intense fire that would devastate its scenic and recreational value. Based on the example

of the Schultz Fire, hydrophobic soils are likely to impair a slope's ability to retain moisture, funneling previously unseen amounts of storm runoff through downtown Flagstaff, Northern Arizona University,

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<sup>1</sup> "The Science behind Wildfire Effects on Water Quality, Erosion." *Living with Wildfire in Wyoming*. University of Wyoming Extension. 2013.

and many of the city's neighborhoods. The initial flows would be laden with ash and mud and would threaten hundreds of homes, businesses, and government buildings. Subsequent floods would continue to interrupt traffic and retail activity, stifling both citizens' daily routines and the area's essential flow of visitors. Figure 1 in the appendix shows the estimated floodplain used in the analysis of flooding below the Dry Lake Hills. This map was based on the FEMA 500-year floodplain. Note that these boundaries are only estimates and the actual reaches of a flood would be unpredictable.

*Mormon Mountain* - Mormon Mountain, located approximately 30 miles south of Flagstaff, is also unnaturally overstocked with trees, leaving it vulnerable to catastrophic fire. The mountain lies at the head of the basin above Upper Lake Mary, a reservoir providing roughly 50% of the city's drinking water. As with the Dry Lake Hills area, the initial damage to scenery and recreation would likely be overshadowed by the resulting floods and debris flows following a severe fire.



*A dense variety of trees encroach on Forest Road 648 leading to the top of Mormon Mountain. Photo courtesy of Jeff Peterson.*

Burned hillsides would no longer absorb monsoon rains, polluting the reservoir's waters with silt, ash, and mud, and reducing storage capacity. The result would be a water supply no longer useable until the reservoir is dredged to remove sediment, and the treatment plant is re-engineered/upgraded to handle the known chemical changes to the water itself. Both of these processes would be expensive. The immediate solution would be the costly process of drilling 11 new wells.

Nearly three quarters of Flagstaff voters (74%), aware of the risks to these areas, voted to fund the \$10 million FWPP in a 2012 election, through sale of municipal bonds. These funds will be used to treat (through thinning and prescribed burning) 10,544 acres of National Forest – 7,569 acres in the Dry Lake Hills and 2,975 acres on Mormon Mountain – and another 3,000 acres of state, city, and private lands throughout the Rio de Flag watershed.

This study uses data from the Army Corps of Engineers' *Rio De Flag, Flagstaff, Arizona, Economic Reevaluation Report*<sup>2</sup>, and the Ecological Restoration Institute's *A Full Cost Accounting of the 2010 Schultz Fire*<sup>3</sup>. The former study includes in-depth estimates of assets at risk downstream of the Dry Lake Hills. The latter estimates the costs associated with the Schultz Fire, including response and mitigation, loss of property values, and specific flood damage to property.

The Arizona Rural Policy Institute (RPI) prepared this cost avoidance study at the request of the FWPP Monitoring Team. It will demonstrate to the voters of Flagstaff the scale of the potential benefit of the investment they supported. Conversely, it will show the potential cost if the work was not completed.

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<sup>2</sup> *Rio De Flag, Flagstaff, Arizona, Economic Reevaluation Report*. The U.S. Army Corps of Engineers. 2011.

<sup>3</sup> *A Full Cost Accounting of the 2010 Schultz Fire*. The Ecological Restoration Institute. Northern Arizona University. 2012.

## Cost Summary

Table 1 lists the high and low estimated damages that the Flagstaff Watershed Protection Project hopes to mitigate. The estimates have been adjusted to 2014 dollars and they are divided between the two watersheds. In the Dry Lake Hills they are estimated between \$489 and \$986 million. In the Mormon Mountain area they are estimated between \$84 and \$215 million. Between the two treatment areas, potential financial damages range from \$573 million to \$1.2 billion. Details of each cost estimate will be discussed below.

**Table 1 – Summary of Potential Impacts**

Source	Low	High
	(\$ millions)	(\$ millions)
<b>Dry Lake Hills</b>		
Response and Remediation	43	43
Structures and Contents	132	286
Property Value	256	524
Habitat	0.4	15
Communication Towers	30	80
BNSF Railroad Interruption	12	23
Retail Sales	15	15
<b>Dry Lake Hills Total</b>	<b>\$489 million</b>	<b>\$986 million</b>
<b>Mormon Mountain</b>		
Response and Remediation	12	12
City Water Supply	17	37
Habitat	1	22
Communication Towers	54	144
<b>Mormon Mountain Total</b>	<b>\$84 million</b>	<b>\$215 million</b>
<b>Total, Both Areas</b>	<b>\$573 million</b>	<b>\$1,201 million</b>

*Several of these costs show no difference between high and low estimates. For those categories, only one figure was identified.*

## Response and Remediation Costs

The response to a fire would incur immediate expenses, including suppression, post-fire rehabilitation, evacuation, and repair costs. A simple estimate of this comes from records of costs incurred during and after the Schultz Fire in 2010. Table 2 shows expenditures by state, county, city, and federal government agencies, and a variety of utilities after the Schultz Fire and flood. These figures include actual expenditures for fire suppression and flood mitigation in 2010 – 2012, and planned flood mitigation efforts in 2013 and 2014. Table 2 also adjusts the costs to 2014 dollars.



*The 2010 Schultz Fire provides an example of response and remediation costs for fires near Flagstaff.*

**Table 2 – Response and Remediation Costs, Schultz Fire and Flood**

Funding Agency	Expense
City of Flagstaff	\$5,451,721
Coconino County	\$14,821,116
Arizona Division of Emergency Management (ADEM)	\$1,135,149
Arizona Department of Transportation (ADOT)	\$3,038,074
Fire Department	\$147,100
Natural Gas Utilities	\$182,600
Electrical Utilities	\$115,000
Water Utilities	\$89,434
Federal Emergency Management Agency (FEMA)	\$5,722,000
US Forest Service (USFS)	\$14,395,200
Natural Resources Conservation Service (NRCS)	\$7,650,000
Federal Highway Administration (FHWA)	\$6,200,000
<b>Total</b>	<b>\$58,947,394</b>
<b>Adjusted to 2014 dollars</b>	<b>\$61,169,000</b>

*(Dustin Woodman, Coconino County)*

The Schultz burn area is adjacent to the Dry Lake Hills area, and the two share similar weather, geography, flora, and fire regime. Therefore, these costs are used to estimate response and remediation costs for the FWPP. As Table 3 shows, dividing the Schultz costs by the fire’s 15,000 acre footprint yields expenditures of just over \$4,000 per acre. Applying this rate to the estimated footprints of the FWPP indicates response and remediation estimates of \$43 million for the Dry Lake Hills area and \$12 million for the Mormon Mountain treatment area<sup>4</sup>. Total costs for both areas are estimated to be \$55 million.

These estimates assume that the areas would burn with an intensity similar to that of the Schultz Fire, and the response would be comparable.

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<sup>4</sup> The Dry Lake Hills treatment area estimated here includes 7,569 acres of national forest as well as 3,000 acres of state, city, and private land.



**Table 3 – Estimate of Response and Remediation Costs**

<b>Schultz Response and Remediation Costs (2014)</b>	\$61,169,000
Approximate Acreage	15,000
<b>Cost Per Acre</b>	<b>\$4,078</b>
<b>Dry Lake Hills</b>	
Treatment Acreage (National Forest, State, City, Private)	10,569
<b>Estimated Cost</b>	<b>\$43,100,000</b>
<b>Mormon Mountain</b>	
Treatment Acreage	2,975
<b>Estimated Cost</b>	<b>\$12,100,000</b>
<b>Total Estimated Response and Remediation Costs</b>	<b>\$55,200,000</b>

*Estimates are rounded. Dry Lake Hills Area includes 7,569 acres of National Forest and 3,000 acres of state, city, and private land.*

## Army Corps of Engineers and Assets at Risk

Many of the assets at risk of flooding were valued by the Army Corps of Engineers (ACE), in 2011, as part of the Rio De Flag Flood Control Project. The ACE planned to mitigate the damage potential of severe flooding through downtown Flagstaff. Because of its enormous cost, much of the project has stalled in the planning stages, but the plans provide valuable data for this report. The ACE’s *2011 Economic Reevaluation Report* shows estimates of damages that would occur during 100- and 500-year floods. The same footprint of these potential flood events informed the floodplain used for FWPP cost avoidance projections.

Using the ACE footprint for this analysis is considered appropriate, assuming that in the aftermath of a catastrophic fire the steep, hydrophobic slopes would cause very common storms to produce intense flooding similar to extremely rare (such as 100-or 500 year) storm events.

Only portions of the 500-year floodplain footprint used for the Rio de Flag Flood Control Project were used in this study, because that project also includes a significant portion of Clay Avenue Wash which would not be affected by fire in the Dry Lake Hills. The estimates in this report correct for areas not included in the FWPP flood footprint.

Table 4 below lists the numbers of structures located in the floodplain, as determined by the ACE in 2011. It is important to note that between the writing of the *Economic Reevaluation Report*, in 2011, and today (2014), Northern Arizona University has invested tens of millions of dollars in new construction within the flood footprint. Portions of downtown Flagstaff have also experienced significant commercial growth in those years.

Table 4 also lists the depreciable value of the structures and the value of their contents, in the floodplain below the Dry Lake Hills<sup>5</sup>.

<sup>5</sup> The Army Corps of Engineers calculated the depreciable value of structures using square footage multipliers obtained from the Marshall & Swift Valuation services. The value of contents was developed through surveys sent

**Table 4 – Structure and Content Value of Floodplain**

Residential	947
Commercial	71
Public	32
Industrial	84
Total Structures	1134
<b>Structure and Content Value</b>	<b>\$766 million</b>
<b>Adjusted to 2014 dollars</b>	<b>\$811 million</b>

*(Economic Reevaluation Report, Corrected to Exclude Clay Avenue Wash)*

The total value of the structures in the floodplain and their contents in 2011 was estimated to be approximately \$766 million. Adjusted to 2014 dollars, this would grow to \$811 million. As mentioned above, this number is conservative; it omits new construction – largely on the NAU campus – over the past three years. Note that this number is not a damage estimate; it is shown here to demonstrate value of at-risk structures and their contents.

Maps showing many of the structures within the floodplain are located in the Appendix. These include the downtown and university area (Figure 2); the Fourth Street and Sunnyside area (Figure 3); and the Continental area (Figure 4).

### Structure and Content Damages

The projected flood damages in these areas were derived using the Army Corps of Engineers' Hydrological Engineering Center's Flood Damage Reduction Analysis Model (HEC-FDA), which computes expected damages according to given parameters. The ACE used the expected flows, and the values of the structures and their contents to estimate these damages. Table 5 below lists the damage estimates the ACE has predicted for a 100- and a 500- year flood event.

**Table 5 – Expected Damages to Structures**

Expected Damages	Total Damages	Adjusted to 2014 dollars
100-Year Event	\$ 124,800,000	\$ 132,000,000
500-Year Event	\$ 270,900,000	\$ 286,000,000

The total projected damages equal \$125 million, and \$271 million for 100-year and 500-year events, respectively. As stated above, these damage estimates exclude any new construction between 2011 and 2014. Inflating these numbers to 2014 dollars suggests possible damages of \$132 million and \$286 million.

### Railroad Damages

The ACE Economic Reevaluation Study also projected costs incurred by the Burlington Northern Santa Fe Railway if its tracks were damaged by the volume and flow of floodwater. Between physical damages and the costs of delayed rail traffic, a total financial impact to the BNSF Railway was estimated between \$11 million during a 100-year flood, and \$22 million during a 500-year flood. These numbers were

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to the actual property owners. For a more detailed explanation of the Army Corps of Engineers' methodology, see the *Economic Reevaluation Report*.

estimated by a consultant hired by the City of Flagstaff (for publication in the Economic Reevaluation Study). Table 6 shows these values adjusted to 2014 dollars, suggests a damage range between \$12 million and \$23 million.

**Table 6 – Estimated Cost to Railroad**

Estimate	2011 dollars	2014 dollars
High (500-Year Event)	11,000,000	11,600,000
Low (100-Year Event)	22,000,000	23,300,000

As with many of the figures borrowed from the ACE, this range indicates expectations during one flood event. Experience suggests that following catastrophic fires, such events would potentially occur sporadically and with high-intensity during the monsoon season.

### Loss of Property Value

Perhaps the largest financial consequence of a wildfire in the Dry Lake Hills area would be the subsequent loss of property values. Residents, businesses, institutions, and governments would feel these impacts and losses throughout the city. Multiple factors, ranging from water damage to the loss of a forested backdrop, would depress what is one of the more expensive real estate markets in the state. The resulting loss in property owners’ personal wealth would be staggering. For many residents, home equity is a major portion of net worth and the same is true of many businesses. The value of government and university assets is also important, impacting cost of borrowing and the ability to acquire new assets.



*Floodwaters in residential areas can cause extensive damages to property. Photo courtesy of the Flagstaff Fire Department.*



*Flooding after the Schultz Fire overwhelmed established drainage infrastructure. Photo courtesy of Joanne Keene.*

Because Flagstaff property values include a premium based on intangibles such as natural beauty and access to adjacent forest land, all parcels in the city would likely see some loss of value. The overall percentage of loss conservatively assumed in this analysis is 6.7%. This rate was calculated using the drop experienced by homeowners in the neighborhoods north of Flagstaff affected by the 2010 Schultz Fire and floods. It is an average built both on properties inundated and damaged, and those in the region that lost value due to intangible commodities such as degraded views and buyer uncertainty<sup>6</sup>.

<sup>6</sup> Brown, T.C., Daniel, T.C., 1984. Modeling Forest Scenic Beauty: Concepts and Application to Ponderosa Pine. USDA Forest Service.

### Methodology: Determine FCV of Region

According to records provided by the Coconino County Assessor's Office (2014), the aggregate full cash value (FCV) of properties in the city is \$5.6 billion. As stated above, decreases within all city properties are very likely. However, to provide a more conservative comparison, impacts on a smaller footprint – within a quarter mile of the floodplain – are also projected here. Within that reach sit approximately 10,300 parcels, with an aggregate FCV of \$2.7 billion.

### Adjust for Market Value

The county reports the FCV of properties for tax purposes. However, these figures are usually lower than actual market value. To translate FCV to market value, we first identified sales that occurred during the time period used to value property for tax year 2014 (January, 2011 – October 2012). Within the floodplain, 72 properties were sold during that time. The aggregate FCV of those properties was \$15.6 million, and the sum of their sales prices was \$21 million. This indicates that the market value of these properties is approximately 135% of their full cash value (\$21 million = 135% X \$15.6 million).

Under these assumptions, the aggregate market value of properties in the city (tax year 2014) is an estimated \$7.5 billion (\$5.6 billion X 135%). Within the smaller footprint, that value is \$3.6 billion (\$2.7 billion X 135%). These numbers represent all properties on the county tax roll, both public and private.

### Calculate Drop in Value

The expected drop in property value used here is borrowed from *A Full Cost Accounting of the 2010 Schultz Fire*. That study estimated that property in select neighborhoods north of town had lost an average of 6.7% of their value after the fire and subsequent flooding. This number included corrections for an overall market decline at the time.

The 6.7% estimate is considered conservative. It should be noted that the area damaged by the Schultz flooding was exclusively residential. Significant damages to business and government property would likely have even greater repercussions.

Table 7 shows the calculations for estimated value loss both for the entire City of Flagstaff and for the quarter mile footprint.

**Table 7 – Estimate of Lost Market Value**

Area	FCV	Market Value	Loss (6.7%)	Adjusted to 2014 dollars
Within 1/4 mile of floodplain (lower estimate)	\$2,727,786,162	\$3,682,511,319	\$ 246,728,258	\$ 255,602,000
City of Flagstaff (upper estimate)	\$5,580,660,655	\$7,533,891,884	\$ 504,770,756	\$ 522,925,000

According to these calculations, the total loss in equity attributable to catastrophic fire and flooding in the Dry Lake Hills is between \$247 million and \$505 million. These values reflect tax year 2014, which

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Kim, Y.-S., Wells, A. 2005. The impact of forest density on property values. *Journal of Forestry* 103, 156-151.  
Do repeated wildfires change homebuyers' demand for homes in high-risk areas? A hedonic analysis of the short and long-term effects of repeated wildfires on house prices in Southern California. *Journal of Real Estate Finance and Economics*, 2009: 38 (2):155-17

considers the value of property between January, 2011, and October, 2012. These values were adjusted to 2014 dollars, raising the impacts to between \$256 million and \$523 million.

As mentioned above, despite the large numbers, these estimates are most likely conservative for several reasons. Even high-end estimates omit county properties that border the city. The market values of these parcels are affected by the same factors as those in the city. Also, the 6.7% figure was taken from the Schultz flood area, which was a purely residential zone. As was shown above, the core of the city is at risk below the Dry Lake Hills. The effects of flooding in this area on the factors that determine property values would almost certainly be more extreme. Since this area contains the university, historic downtown, railroad, schools, and access to the hospital and other health care facilities, the primary components of the community infrastructure would be disrupted. In addition, many of the events that make Flagstaff attractive, such as festivals, parades, and nightlife, would be disrupted during the summers for several years after a flood.

### City of Flagstaff Water Supply

The primary motivation for the southern portion of the FWPP – the western slope of Mormon Mountain – is the protection of Upper Lake Mary. Historically, this reservoir has provided about half of the city’s potable water. A burdensome side effect of many fires in recent years has been the pollution of water sources by post-fire runoff and loss of reservoir storage capacity.



*Upper Lake Mary, half of Flagstaff’s water supply, is at risk. Photo courtesy of the Flagstaff Fire Department.*

For example, the aftermath of two Colorado wildfires – 1996’s Buffalo Creek Fire and 2002’s Hayman Fire – sent over one million cubic yards of sediment into the Strontia Springs Reservoir, a major municipal water source for the cities of Denver and Aurora. Dredging the reservoir in order to restore it to a useable state cost the city of Denver \$26 million<sup>7</sup>.

According to Brad Hill, City of Flagstaff Utilities Director, a similar disaster in the Upper Lake Mary Watershed would require either drilling 11 new wells, dredging Lake Mary and expanding the capacity of the water treatment facility, or both. As shown in Table 8, the cost of these processes would be between \$17 million and \$37 million<sup>8</sup>.

**Table 8 – Cost to Flagstaff’s Water Supply**

High Estimate	\$17,000,000
Low Estimate	\$37,000,000

<sup>7</sup> LaRubio, Neil. “Communities help pay for ecosystem services provided by forests.” *High Country News*. Feb 22, 2012.

<sup>8</sup> Brad Hill’s Lake Mary cleanup estimates were based on conversations with officials in Denver and Fort Collins, Colorado, regarding their past experiences. The cost estimates for re-designing the water treatment facility were based on adjustments made by Salt River Project after the Rodeo-Chediski fire in 2002. Then, many cities in Maricopa County were forced to make design changes in their filtration processes.

These estimates are conservative; they do not reflect the time required to make the changes, borrowing costs, or increased production costs (such as pumping water from one quarter mile below the surface).

## Mexican Spotted Owl Habitat

A value is also placed on the habitat of the threatened Mexican spotted owl. The treatment area of the FWPP includes all or portions of 10 protected activity centers (PACs), for a total of approximately 3,955 acres of protected habitat within the project area.



*The FWPP treatment areas cover an estimated 10 protected activity centers for the Mexican Spotted Owl. Photo courtesy of Rachel Greer.*

Economists use various methods to attach a dollar amount to habitat. The two referenced here include:

- **Funds spent in conservation efforts.** If the United States Fish and Wildlife Service (USFWS) will spend \$100 million on spotted owl recovery projects, and 1,000 units of owl habitat exist, then the value per unit of owl habitat, according to USFWS policy, is \$100,000.
- **Willingness to pay.** A random survey of American households solicited respondents' willingness to pay on an annual basis for conservation efforts specific to the Mexican spotted owl. In a 1997 paper, economists John Loomis and Earl Ekstrand<sup>9</sup> reported this amount to be \$2.6 million (\$3.66 million in 2014 dollars).

Elaboration of both of these methods can be found on page 19 of *A Full Cost Accounting of the 2010 Schultz Fire*, in an analysis by Dr. Gary Snider. The findings of this analysis provide a range of value per PAC. The low, based on the USFWS recovery efforts, is \$100,000 per PAC. The high, based on the 1997 survey results, is \$3.66 million per PAC.

Assuming the range of loss per PAC is between \$100,000 and \$3,660,000, and assuming that damage to any portion of a PAC incurs these losses, the total cost of 10 lost Mexican spotted owl PACs would be between \$1 million and \$36 million. Table 9 shows these calculations.

**Table 9 – Estimated Value of Mexican Spotted Owl Habitat**

Estimate	Low	High
Range	\$100,000	\$3,660,000
<b>Dry Lake Hills</b>		
Number of PACs	4	4
<b>Cost</b>	<b>\$400,000</b>	<b>\$14,640,000</b>
<b>Mormon Mountain</b>		
Number of PACs	6	6
<b>Cost</b>	<b>\$600,000</b>	<b>\$21,960,000</b>

<sup>9</sup> Loomis, J and E. Ekstrand 1997. Economic Benefits of critical habitat for the Mexican Spotted Owl: A scope test using a multiple-bounded contingent valuation survey. *Journal of Agriculture and Resource Economics*.

## Communication Towers

The communication towers located atop both Mormon Mountain and Mount Elden are vulnerable to uncharacteristic, stand-replacing wildfires. A precedent for the destruction of these facilities was set in June, 1977, when the Radio Fire burned on Mount Elden’s peak, destroying millions of dollars’ worth of equipment and interrupting regional communications.



*The communications towers on the top of Mormon Mountain are essential to the region. Photo courtesy of Jeff Peterson.*

Although the towers on the western high point of Mount Elden are likely no longer in danger, after the Radio Fire left that area mostly devoid of trees, the southeastern portion of the mountain, known as Devil’s Head, holds 10 communications structures – towers and buildings – surrounded by ponderosa pines.

Similarly, the top of Mormon Mountain holds eight towers and ten buildings. Among the users of these facilities are television stations, FM radio broadcasters, cellular phone service providers, 2-way radio users (including county law enforcement), telephone providers, and internet providers.

Jonathan Koger, President of the Mormon Mountain Users’ Group, estimates that the replacement costs of these structures and their contents would be in the range of \$3 million to \$8 million per structure (tower or building). This suggests that replacement alone would incur costs of between \$54 million and \$144 million on Mormon Mountain (eighteen structures) and \$30 million to \$80 million on the Devil’s Head area of Mount Elden (10 structures). Table 10 shows these estimates. The estimated total cost of these areas burning is between \$84 million and \$224 million.

**Table 10 – Estimated Replacement Cost of Communications Facilities**

Location	Buildings/Towers	Replacement Cost Estimates (\$millions)	
		Low (\$3 million/structure)	High (\$8 million/structure)
Devil’s Head (Dry Lake Hills area)	10	30	80
Mormon Mountain	18	54	144
<b>Total</b>	<b>28</b>	<b>84</b>	<b>224</b>

However, this range does not reflect the impacts of communications losses in the area. Were these facilities to burn, many services including cell phone service, Internet, radio, and public safety (law enforcement, fire, emergency medical service) communications would cease. The results would be disastrous across the community, from business operations to fire suppression efforts.

## Business Revenue/Tax Collections

The area at risk of flooding includes the city’s downtown commercial center and roadways to much of the region’s tourist destinations, including Historic Route 66 and the Grand Canyon. Table 11 below lists the annual gross revenue in 2013 for the areas that include downtown Flagstaff and the 4<sup>th</sup> Street corridor, both of which lie within the floodplain and include major commercial districts.

**Table 11 – Retail business Revenue at Risk**

	June	July	August	September	Average
Gross Revenue	\$15,862,000	\$17,481,000	\$15,202,000	\$17,412,000	\$16,489,000
Tax Revenue	\$275,000	\$288,000	\$275,000	\$314,000	\$288,000
Daily Gross Revenue	\$529,000	\$564,000	\$490,000	\$580,000	\$541,000
Daily Tax Revenue	\$9,174	\$9,289	\$8,866	\$10,457	\$9,447

*(City of Flagstaff)*

During June, when many major fires begin, these two districts generate over \$500,000 in sales each day. The evacuations and reduced tourism traffic that would result from a wildfire in the Dry Lake Hills would severely disrupt business. During the next three months, the region tends to experience monsoonal weather patterns with regular strong rainstorm events. Post-fire flooding would disrupt transportation arteries and would dramatically affect daily sales of a similar amount during those months.

In 2013, the average daily gross revenue between June and September was \$541,000. The city’s share of the daily income tax generated through these sales is approximately \$9,447.

For purposes of estimating total impact of business losses after fire, the following assumptions are used:

- Year 1, ten days of flooding
- Years 2 – 5, five days of flooding
- Each day of flooding equals a loss of one average day’s revenue in the area.

Under those assumptions, the loss of retail sales is estimated to be \$15 million over five years. Included in this figure is a loss of tax revenue equaling nearly \$100,000 the first year and \$50,000 annually for the next five years. Table 12 shows these calculations.

**Table 12 – Estimate of Lost Retail Sales and Sales Tax Collections**

	Year 1	Year 2	Year 3	Year 4	Year 5
Lost Retail Days	10	5	5	5	5
Lost Retail Sales (\$541,000/day)	\$ 5,410,000	\$2,705,000	\$2,705,000	2,705,000	\$2,705,000
Lost Retail Present Value (2014 dollars, 3% inflation)	\$ 15,014,322				
Sales Tax (\$9,447/day)	\$ 94,470	\$ 47,235	\$ 47,235	\$ 47,235	\$ 47,235
Sales Tax Present Value (2014 dollars, 3% inflation)	\$ 262,182				

The \$15 million figure reflects lost revenue at the retail level. It does not include jobs that would be lost as a result of the ripple effects of taking those dollars out of the community.



## Summary

While total costs identified in this document range from \$573 million to \$1.2 billion (\$84 - \$215 million in the Mormon Mountain area and \$489 - \$986 million in the Dry Lake Hills area), many costs have not been accounted for in this study. Several of the omissions that would surely carry costs include:

- Increased travel time for residents and visitors
- Increased potable water pumping and treatment costs
- Damage to utilities (electrical, sewer, water, etc.)
- Health problems, both physical and mental
- Evacuation costs during both fires and flooding
- Negative impact on tourism
- Negative impact on outdoor recreation
- Negative impact on air quality
- Damages to residential streets
- Vehicles damaged and destroyed

These costs and many others could be calculated and added to the total, but the impact as shown now makes the case that the \$10 million pledged by city voters, versus upwards of \$1 billion in after-fire costs, is a wise investment.



*The Woody Fire, in 2006, threatened the west side of Flagstaff. Previous treatments allowed firefighters to contain the blaze before it burned any structures. Photo courtesy of Calvin Johnson.*

## Appendix

Maps of the estimated floodplain and the buildings at risk.

Note that these delineations are estimates and floodwaters can be very unpredictable.

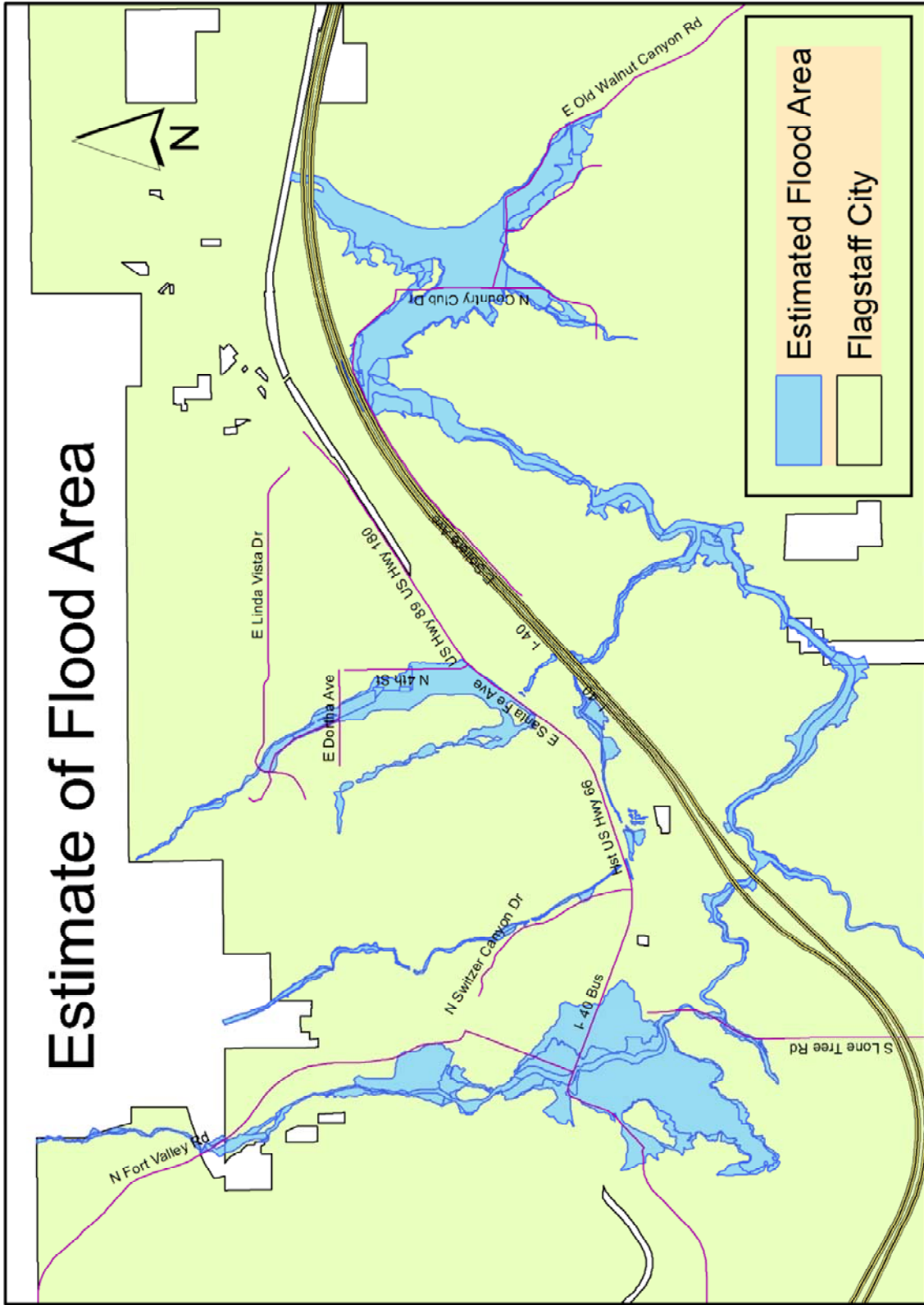


Figure 1 – Map of Estimated Floodplain within Flagstaff

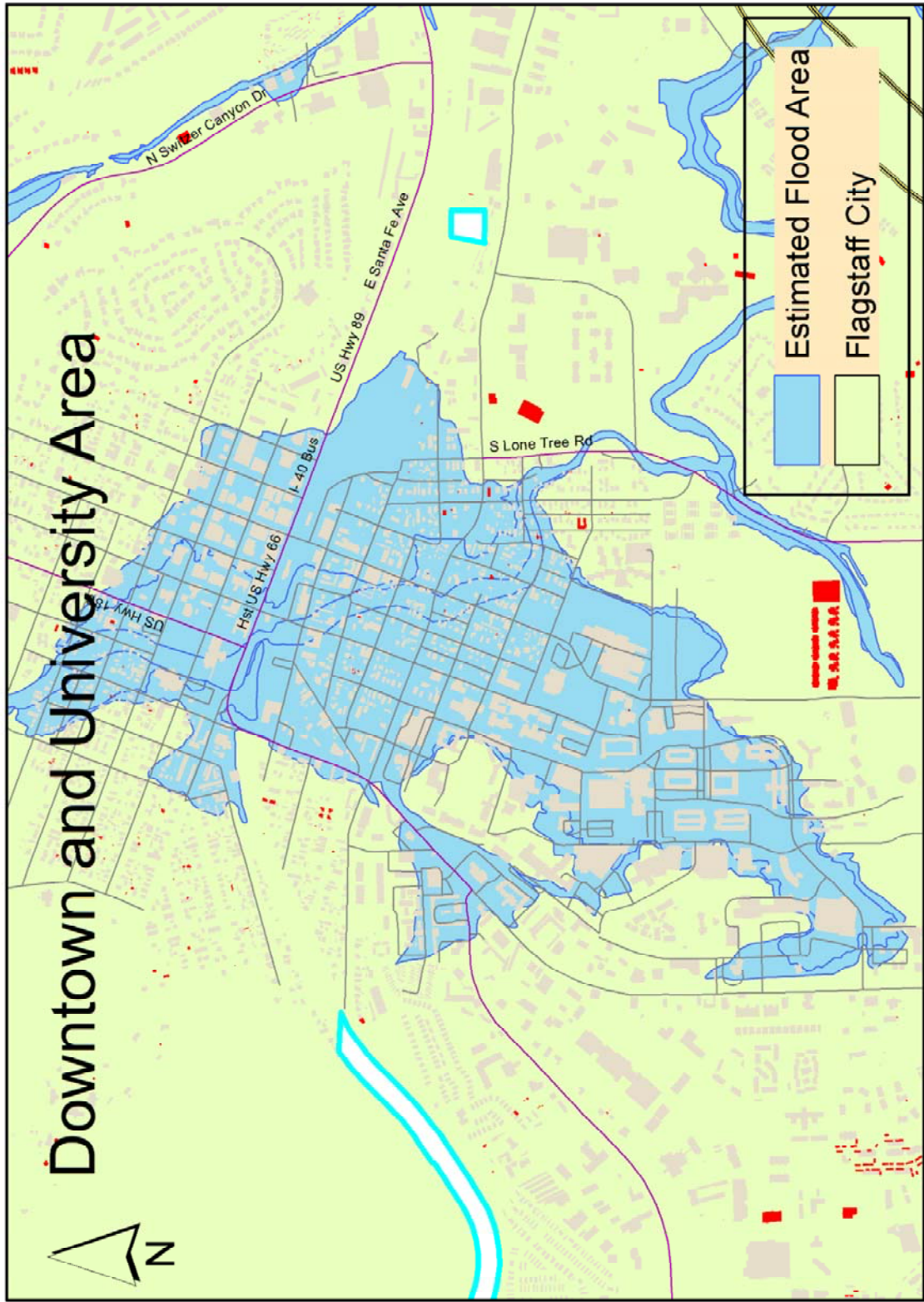


Figure 2 – Map of Estimated Floodplains and Structures at Risk, Downtown Flagstaff and Northern Arizona University

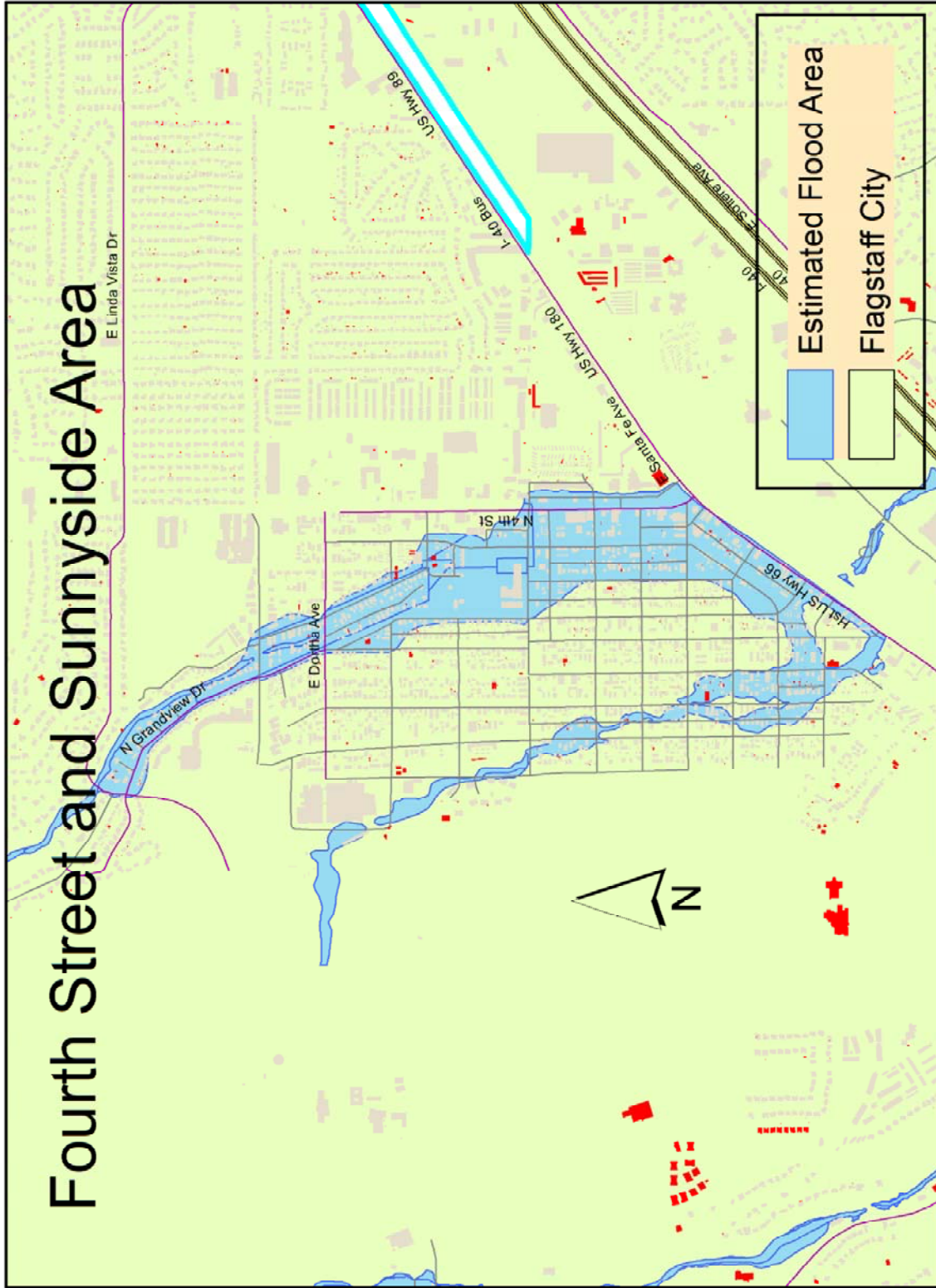


Figure 3 – Map of Estimated Floodplain and Structures at Risk, Fourth Street and Sunnyside Area

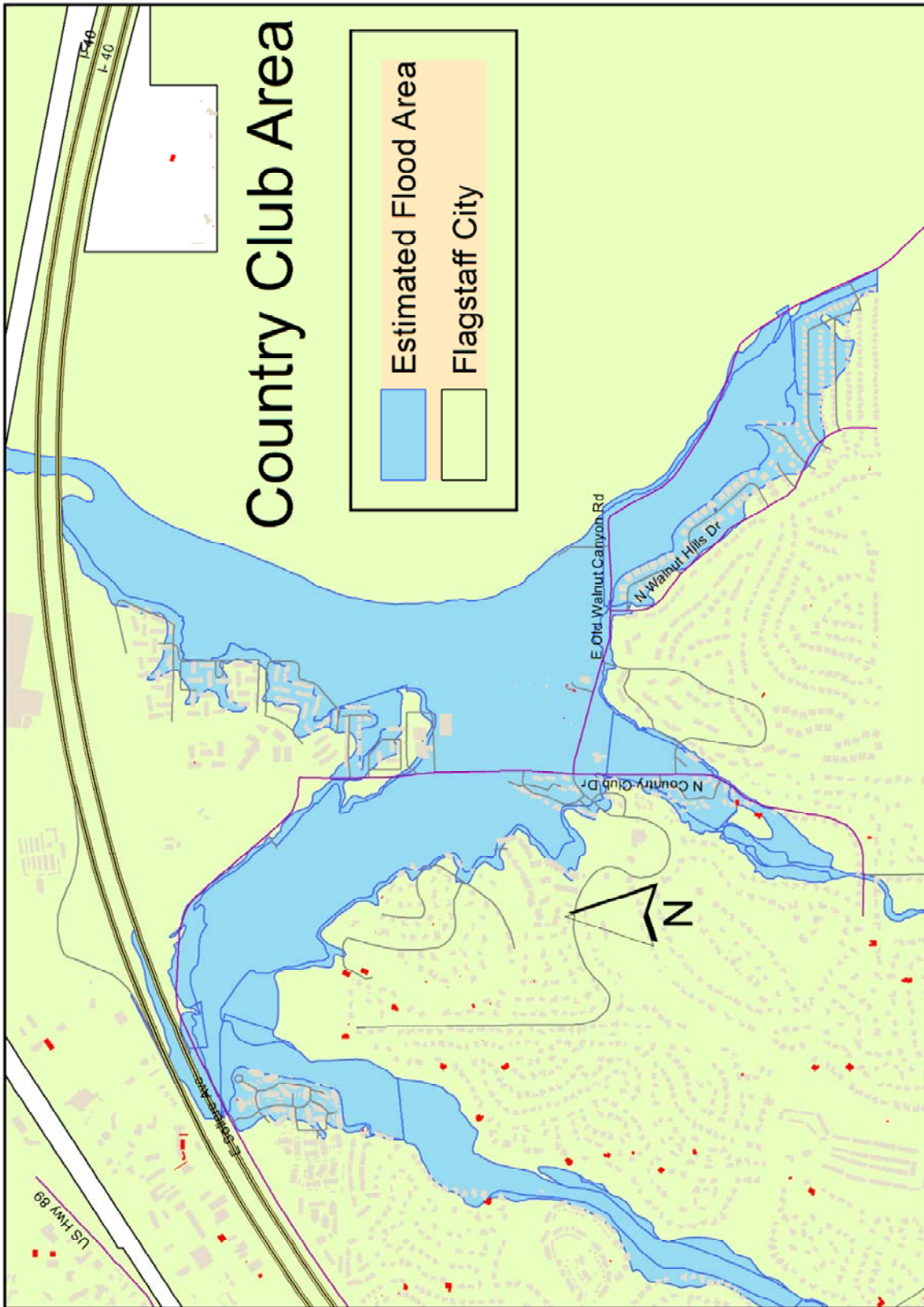


Figure 4 – Map of Estimated Floodplain and Structures at Risk, Country Club Area



**NORTHERN ARIZONA  
UNIVERSITY**  
*The W. A. Franke College of Business*



**Alliance Bank**  
*Business Outreach Center*

*The Arizona Rural Policy Institute*  
*Franke.nau.edu/abboc*  
*(928) 523-7373*