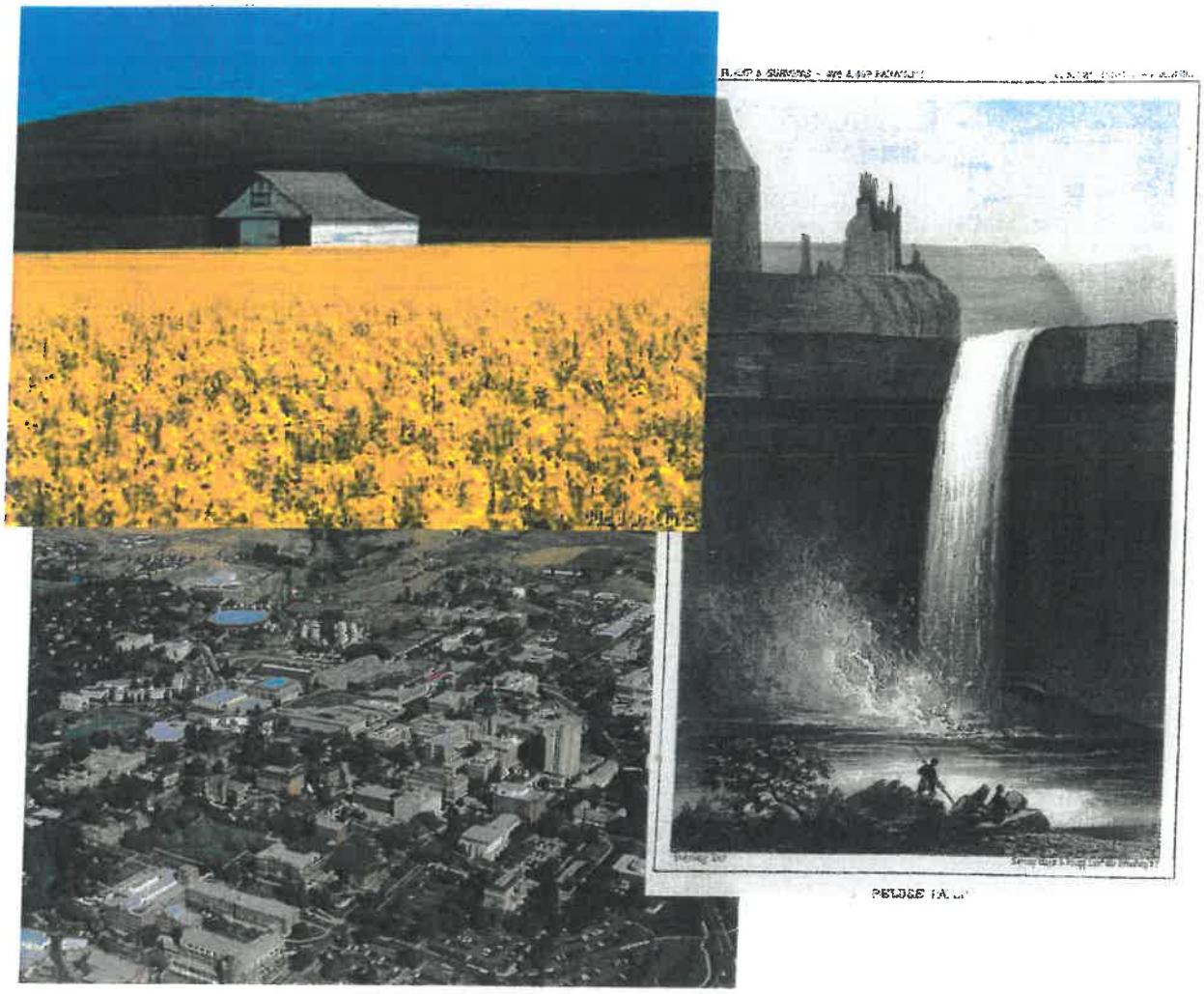
2004
Whitman County
Hazard Identification and Vulnerability Analysis



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National Flood Insurance Policies

Table 3.12 shows NFIP policies in Whitman County, by community. There are a total of 128 policies in Whitman County, the majority of which are found in Pullman, Palouse or scattered about the unincorporated county. These numbers reinforce the fact that Pullman and to a lesser extent Palouse and Colfax, are the communities most vulnerable to flooding. It also shows that flooding can occur to scattered property throughout the county. There are four repetitive loss properties in the County, all located in Pullman.

Table 3.12: NFIP Policies by Community

NFIP Policies in Whitman County	
Community	*Number of Flood Policies*
Albion, Town Of	9
Colfax, City Of	11
Endicott, Town Of	2
Garfield, Town Of	6
Oakesdale, Town Of	5
Palouse, City Of	19
Pullman, City Of	43
Rosalia, Town Of	7
Saint John, Town Of	1
Tekoa, City Of	1
Uniontown, Town Of	2
Whitman County, Unincorporated	22
Total	**128**

Hazard Profiles for Whitman County Communities and Unincorporated Areas

Most of this data came from the 1979 FEMA Flood Insurance Studies for Whitman County and its communities. Supplemental information for events and changing conditions after the adoption of these reports was supplied by County and town officials. Data for Pullman was also supplied by the 2003 City of Pullman Comprehensive Flood Hazard Management Plan. Data was also used from the Rosalia and Palouse Flood Mitigation Plans, prepared by Eastern Washington University (ESU). Each town with mapped floodplains has two flood maps accompanying the risk assessment. The first shows a 1996 aerial of the town with flood hazard zones overlaid. The second map is of the same area of the town (and same scale), but showing an USGS topographical hillshade map overlaid with flood hazard zones. This is intended to make it easier to distinguish features on the aerial maps. Towns with asterisks have no Flood Insurance Studies.

Town of Albion

Albion, a bedroom community of 620 people, is located about six miles northwest of Pullman on the South Fork of the Palouse River. Factors contributing to flooding are heavy rains, rapid snow melt, and ice jams at the Union Pacific Railroad Bridge.

Past Events

Albion has experienced flooding as a result of the overflow of the South Fork Palouse River. Major floods have occurred in 1910, 1933, 1948, and 1972. The town also experienced flooding in 1996.

Location

Hills rise on all sides of Albion, with the South Fork Palouse passing through the southwest part of town in a narrow floodplain. Flooding typically occurs in this area. There is also a small, un-named intermittent creek, contained in a drainage ditch, that passes through the town from the northeast and joins the Palouse near D Street. This stream does not normally flood at the same time as the South Fork Palouse.

Frequency

Past events have shown that major flooding can occur in Albion at a frequency of about twenty years.

Severity

The past events of 1910, 1933, 1948 and 1972 had recurrence intervals of 100, 10, 50 and 30 years respectively. During the 1972 event, one home at Front and C Streets was evacuated, although it was not damaged. Flooding caused furnace ductwork damage beneath a home at Front and G Streets, and two homes south of the river were slightly damaged. The unnamed stream usually overtops due to flash flooding, but flooding does not usually exceed more than a foot in depth. The 1996 flood caused about $38,000 to public facilities and five residents received IA grants.

Exposure

Some residential structures are located along the South Fork Palouse River, but the majority of the development in Albion is on a hill above the floodplain. Properties along Front Street are most exposed to flooding. Property on the south side of the river, along Stanford Street, is also exposed. Property located along the unnamed stream is potentially exposed to flash flooding. An analysis of aerial photographs indicates that there are approximately 50 structures located within the 100- or 500-year floodplain. Furthermore there are at least 2 structures located in the floodway.

Vulnerability

Homes and property located in the floodplain are most vulnerable to flooding. The homes that have basements are even more vulnerable. The homes near the unnamed stream do not have basements and are not as vulnerable to the damaging effects of flooding.

Figure 3.7: Albion Flood Hazard w/ Aerial

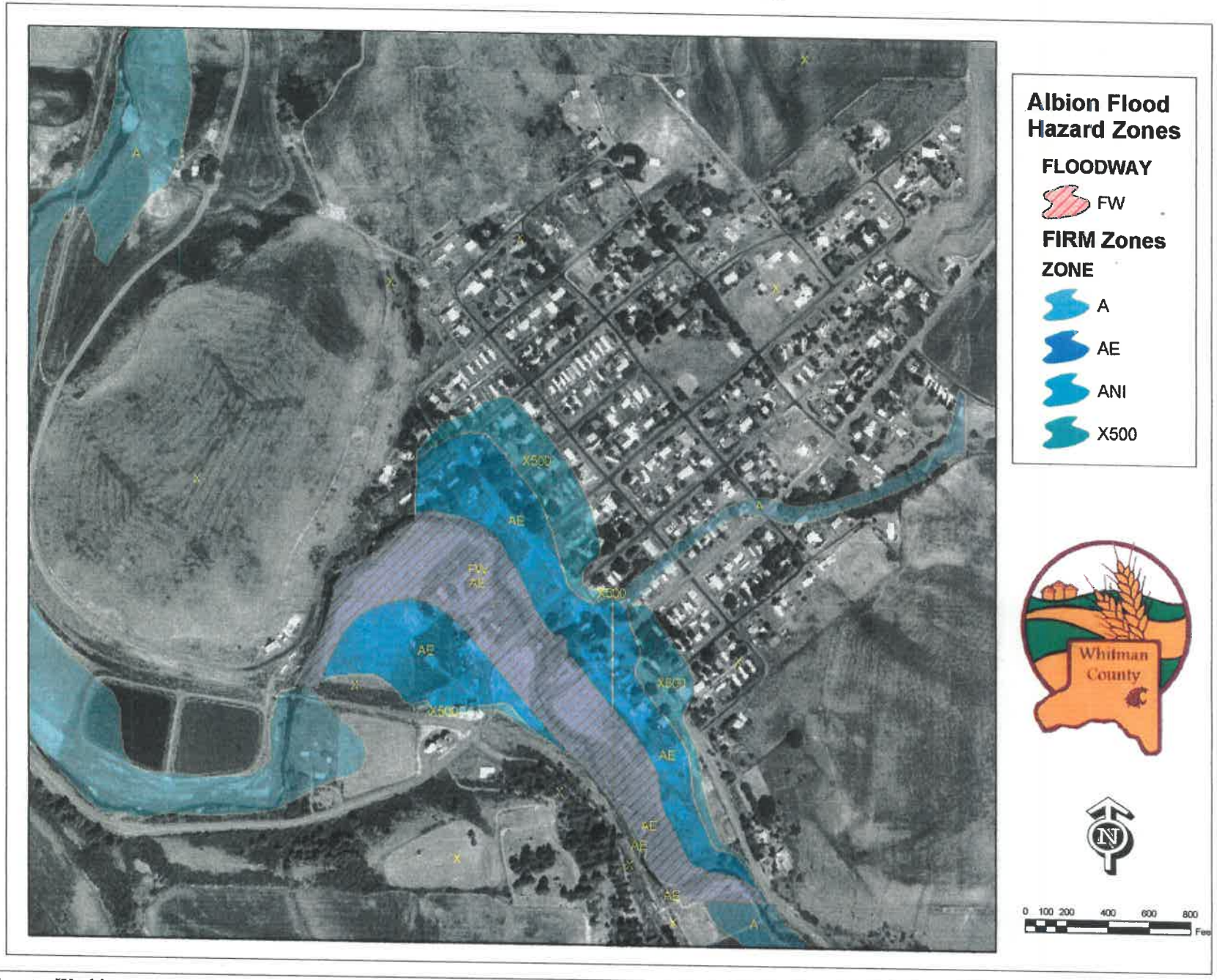

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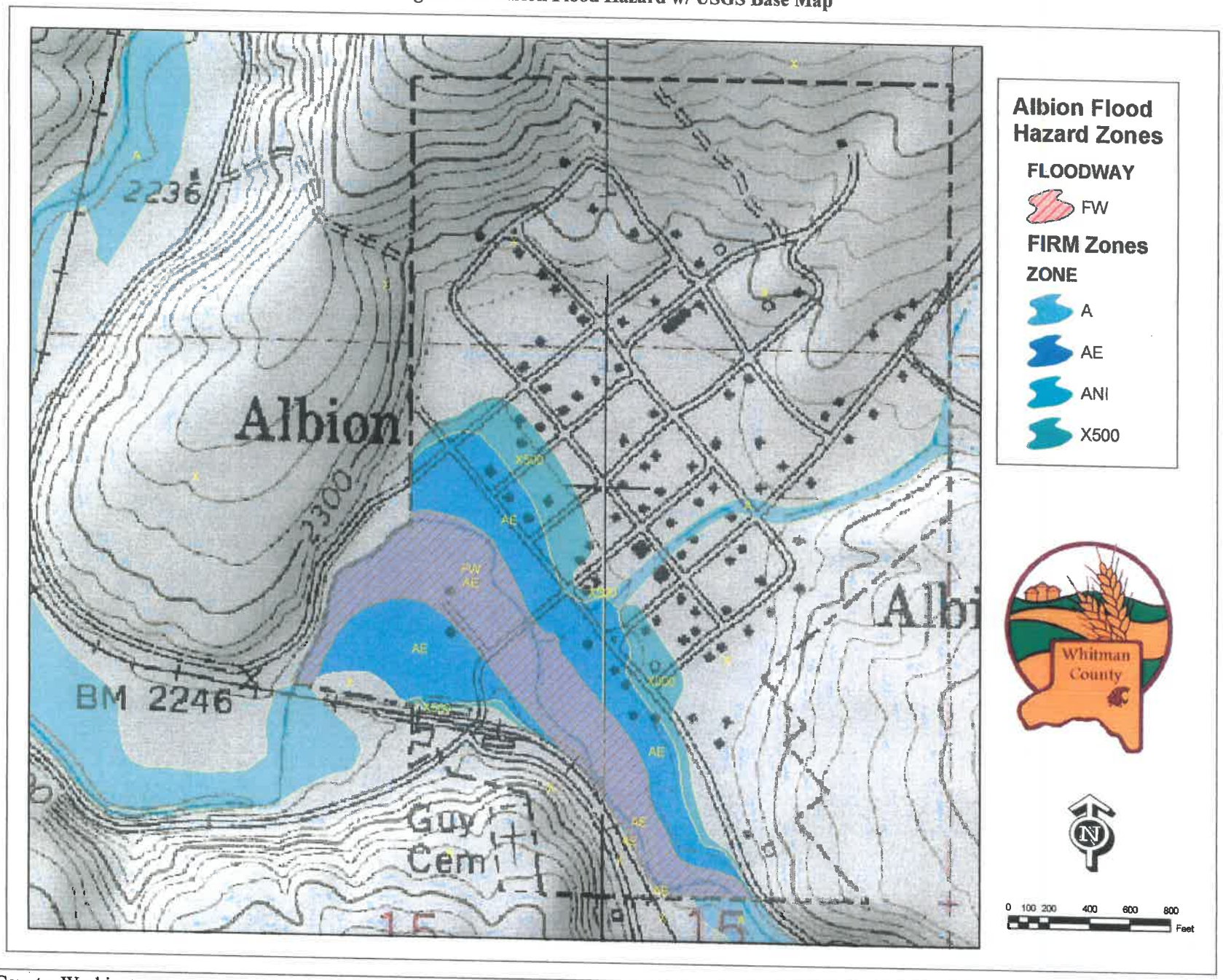
Figure 3.8: Albion Flood Hazard w/ USGS Base Map



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City of Colfax *

Colfax is the County seat of Whitman County. There is no Flood Insurance Study available for Colfax. Research has indicated that flooding on the South Fork Palouse, which meanders north through the city, caused problems in the past. During the 1960s, the Army Corp of Engineers channelized the river through the downtown, which has mitigated flooding to the present. Damage does occur just outside of town where the North and South Forks of the Palouse join. It is theorized that the cement lined river channel of the South Fork speeds up sediment transport through the town during a flood event, but then deposits it just outside of town, causing flooding. Colfax has 11 National Flood Insurance Policies. After the 1996 flood event, the town received approximately $241,000 in Public Assistance (PA) grants. There were also 22 Individual Assistance (IA) grants. It is difficult to determine though whether the damage occurred within city limits, or was assigned to Colfax due to proximity. An analysis of 1996 aerial photographs indicates that there are at least two structures located in the floodplain where it is not channelized. Furthermore, Colfax's sewerage treatment plant, which is located outside the city limits, is located in the floodplain.

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Figure 3.9: Colfax Flood Hazard w/ Aerial

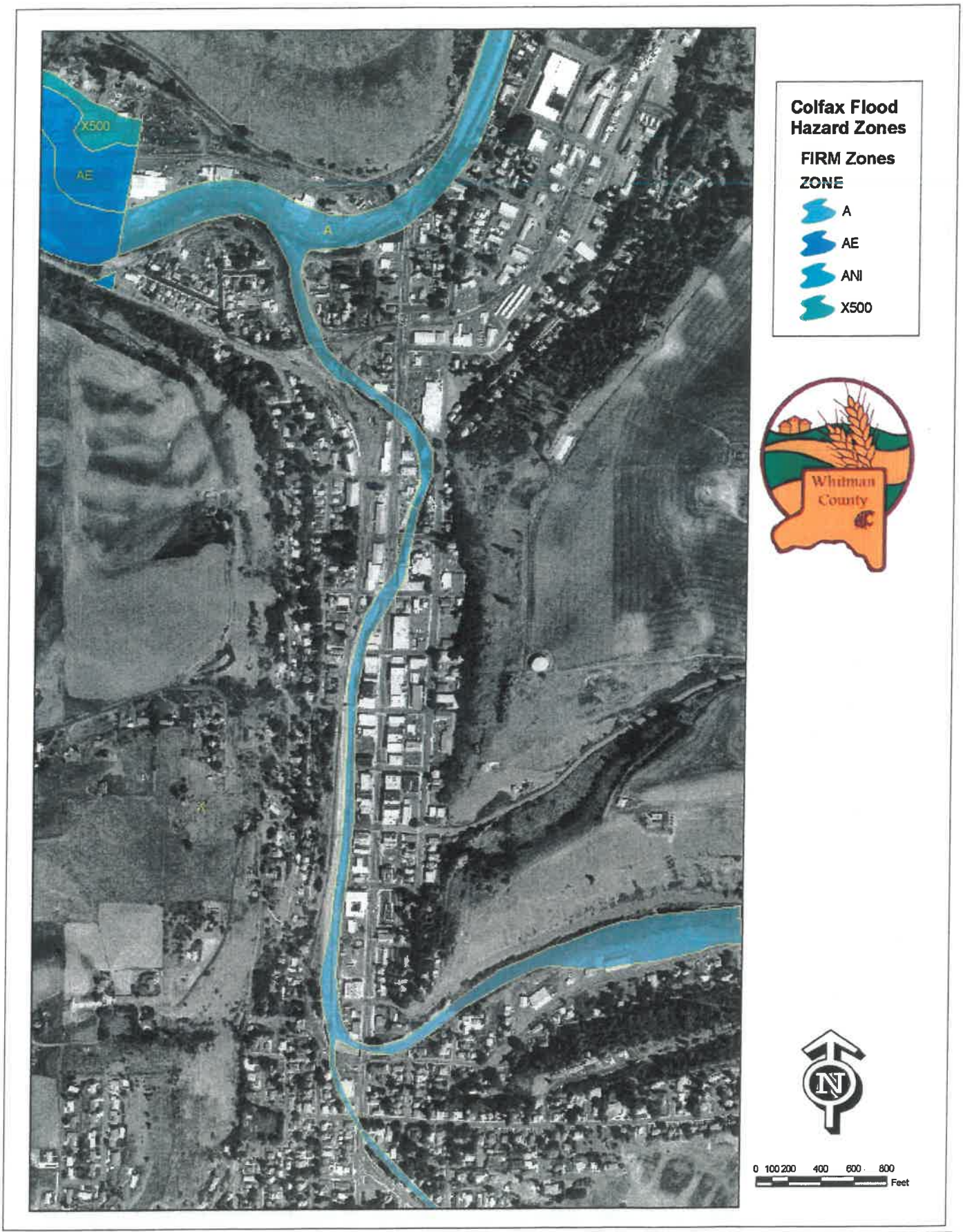

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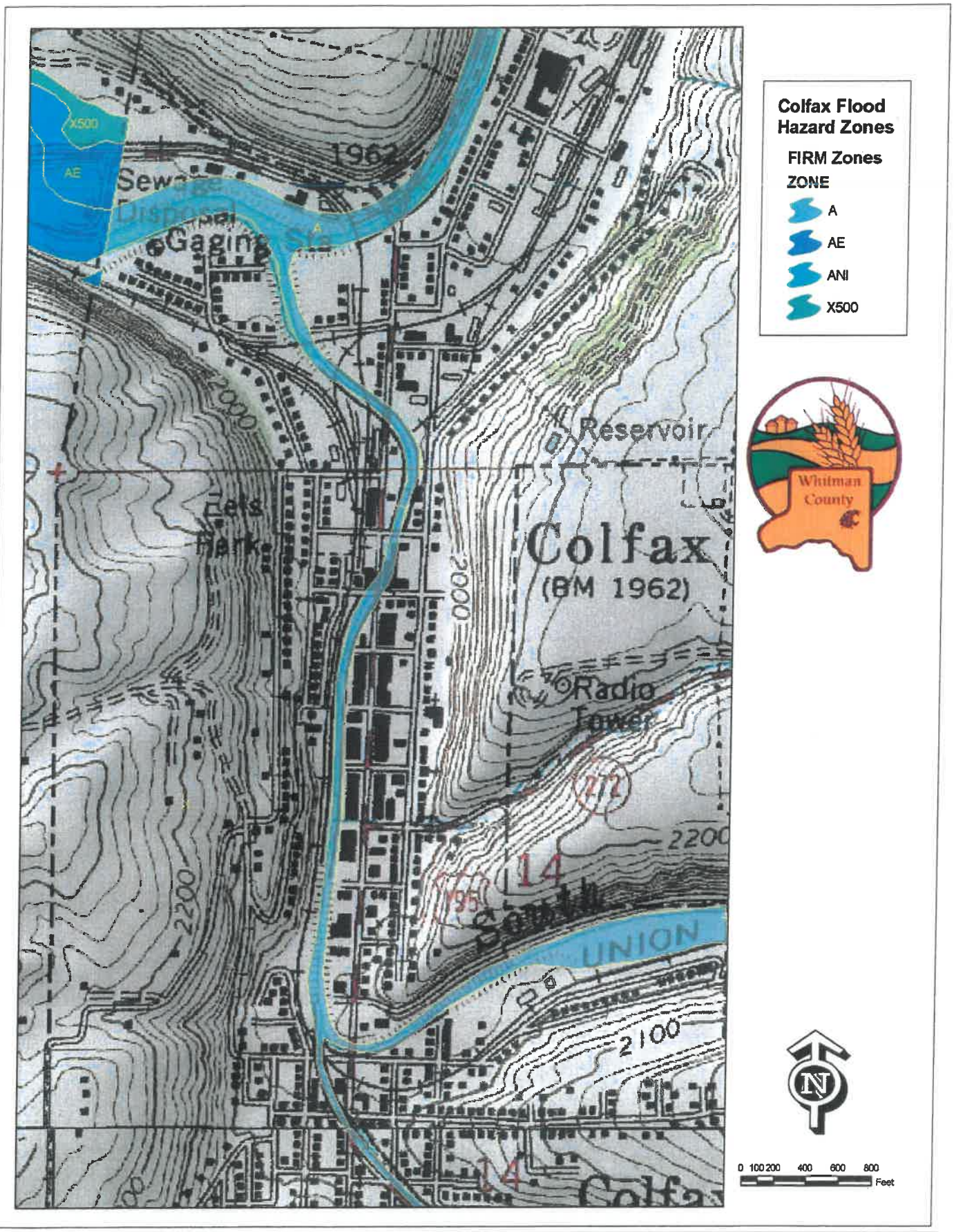
Figure 3.10: Colfax Flood Hazard w/ USGS Base Map



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Town of Colton

Colton is a farming community of 395 people located on Union Flat Creek and U.S. Highway 195. It is located in southwest Whitman County, about 16 miles south of Pullman and 4 miles west of the Idaho border. Flash flooding and a flat creek bed are responsible for severe flooding during winter and early spring months.

Past Events

In past years, Colton has experienced flooding as a result of the overflow of Union Flat Creek. Extensive flooding occurred in 1910 and 1948, and minor flooding occurred in 1956, 1958, 1963 and 1965.

Location

Union Flat Creek flows through the northern section of the city limits of Colton. Two small intermittent streams flow north through the town before emptying into Union Flat Creek. The first of these streams flow through the town in a well-defined channel before joining Union Flat Creek east of Steptoe Street and north of Depot Street. The second stream has its confluence with Union Flat Creek near the western city limit near Depot Street. The two forks of the second stream (one from the south and the other from the west) come together south of Broadway Street and flow north through low undeveloped land between Broadway and Depot streets. There is also a third unnamed stream that flows from the north in a well-defined channel west of the Burlington Northern Railroad tracks that joins Union Flat Creek west of Steptoe Street.

Frequency

Past events have shown that severe flooding can occur every 40 years, while minor flooding can occur every decade.

Severity

Recurrence intervals for past flood events are not available, but the lack of detailed past event data indicates that flooding may not have been too severe in Colton.

Exposure

Commercial structures are located along Union Flat Creek on the floodplain in the central portion of the town. The areas on the east and west sides of Colton along Union Flat Creek are mostly undeveloped, being chiefly used as farm and grazing land. Colton has 4 NFIP policies. Aerial photograph analysis revealed that there are approximately 5 structures located in the floodway, 100-year, and 500-year floodplains, including a school.

Vulnerability

Property, especially those with basements, most vulnerable to flooding are those located in the floodplain near Union Flat Creek.

Figure 3.11: Colton Flood Hazard w/ Aerial

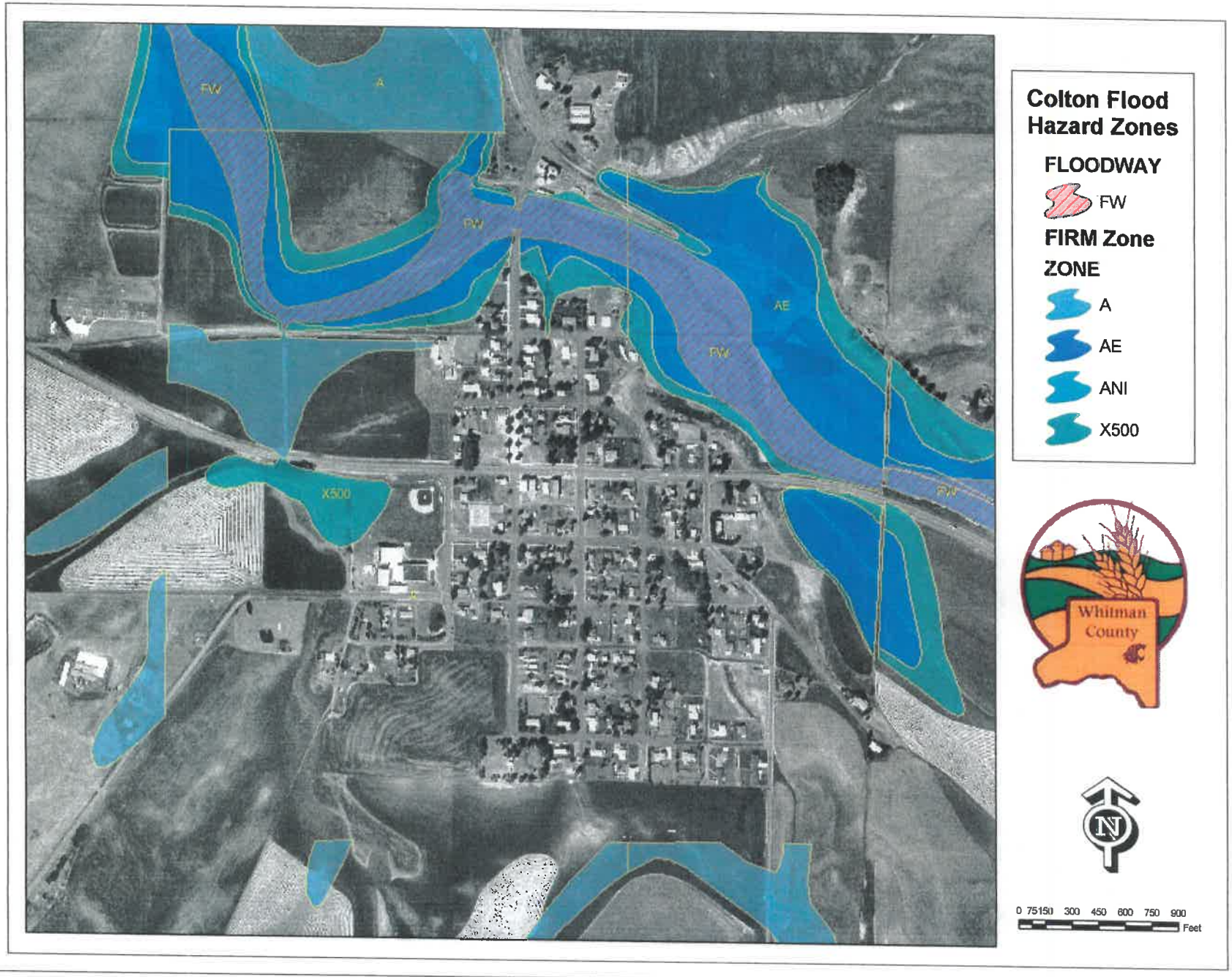

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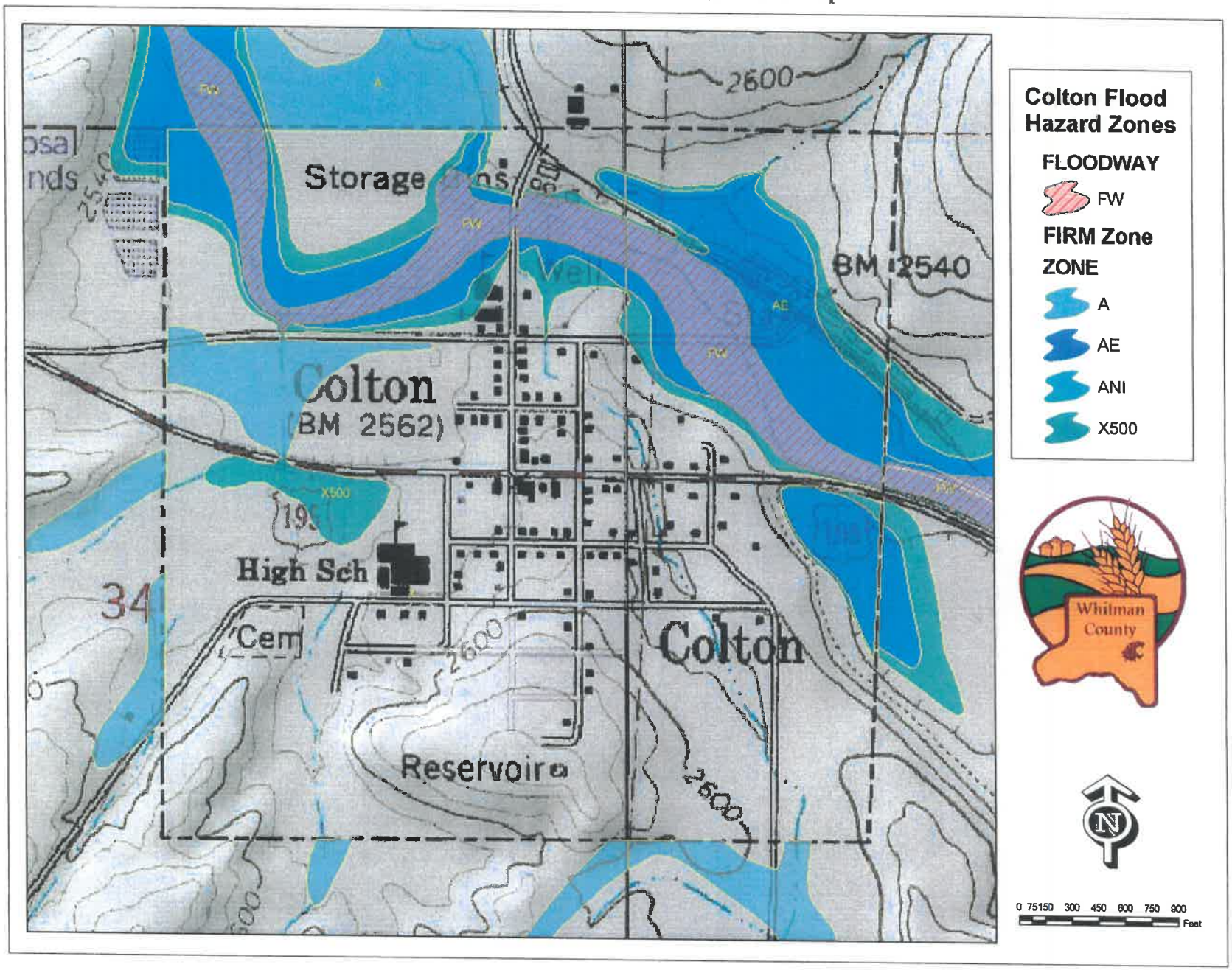
Figure 3.12: Colton Flood Hazard w/ USGS Base Map



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Town of Endicott

Endicott is an agricultural community of 355 people located about 14 miles west of Colfax. Rebel Flat Creek passes through the town. Flooding in the past was generally caused by the creek being blocked by ice and debris at the bridges crossing the creek.

Past Events

Two floods in Endicott have been recorded. Both floods occurred prior to the construction of a new bridge over Rebel Flat Creek on Country Road 6140. In 1948, ice jammed against the old bridge and the creek overflowed, flooding G Street, Dean Street and Alkali Street. The water was about 18 inches deep and entered one house and a shop owned by the County. Basements were also flooded. A large tree also impeded creek flow downstream of the Third Street Bridge. The second flood, which occurred in 1963, was considered a minor flood by local observers. The town experienced some flooding in 1996, as one resident received an IA grant.

Location

Rebel Flat Creek is the sole source of flooding in Endicott, and flows east through the southwest part of town.

Frequency

Flooding is extremely infrequent in Endicott, occurring only twice in the last century, and generally due to low bridge structures.

Severity

The 1948 flood flooded basements and damaged two structures. The 1963 flood caused no damage, but had a 20-year recurrence interval.

Exposure

Development along Rebel Flat creek is primarily residential. The residential development is concentrated on the northeast side of the creek and is quite scattered on the southwest side. Endicott has 4 NFIP policies. Analysis of aerial photographs indicates that there are approximately 8 structures located in the floodway, about 20 in the 100-year floodplain, and about 20 structures located in the 500-year floodplain.

Vulnerability

Properties most vulnerable are those located in the floodplain in the area of Third Street, between G and Alkali Streets. Properties in this area that have basements are more vulnerable.

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Figure 3.13: Endicott Flood Hazard w/ Aerial

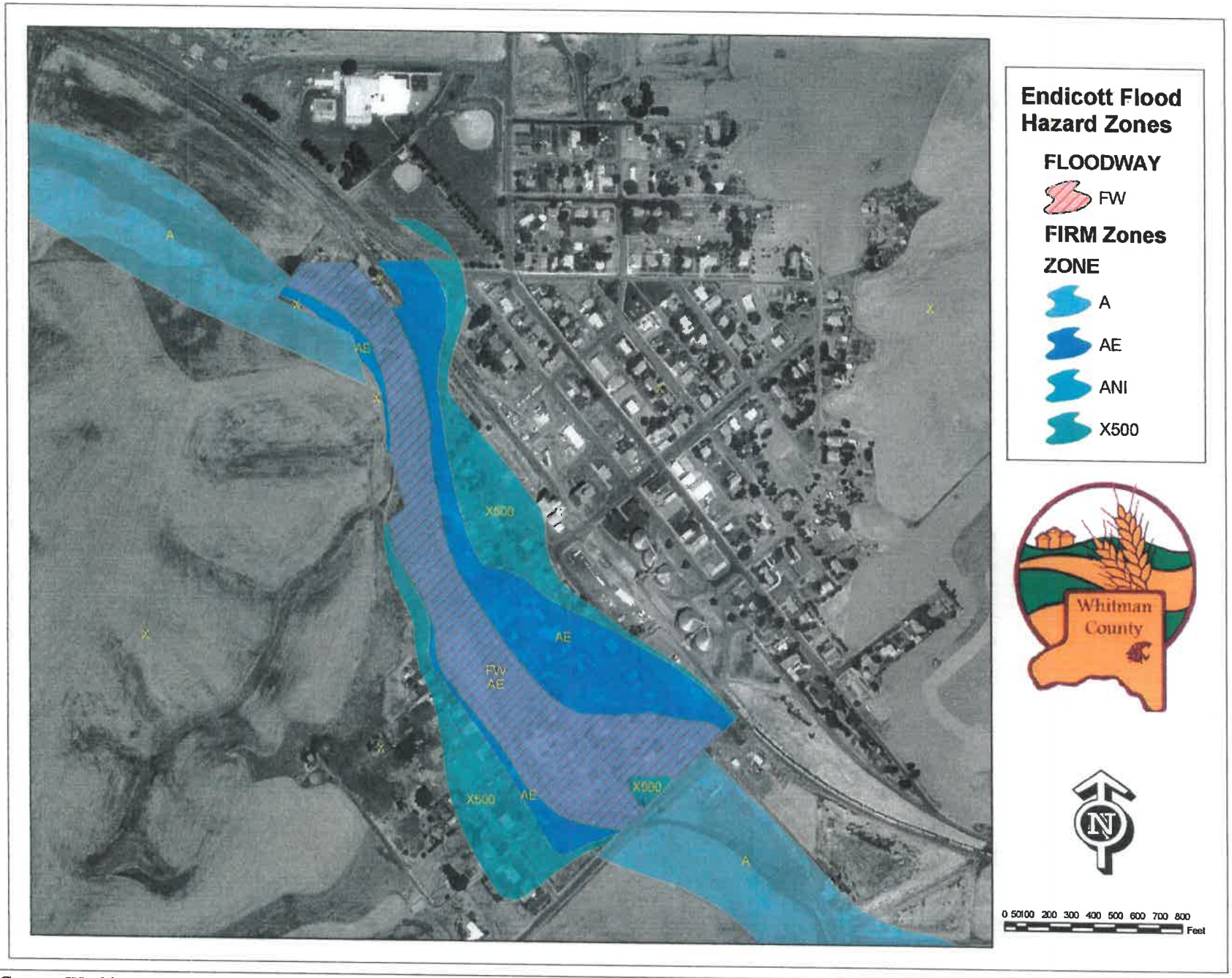

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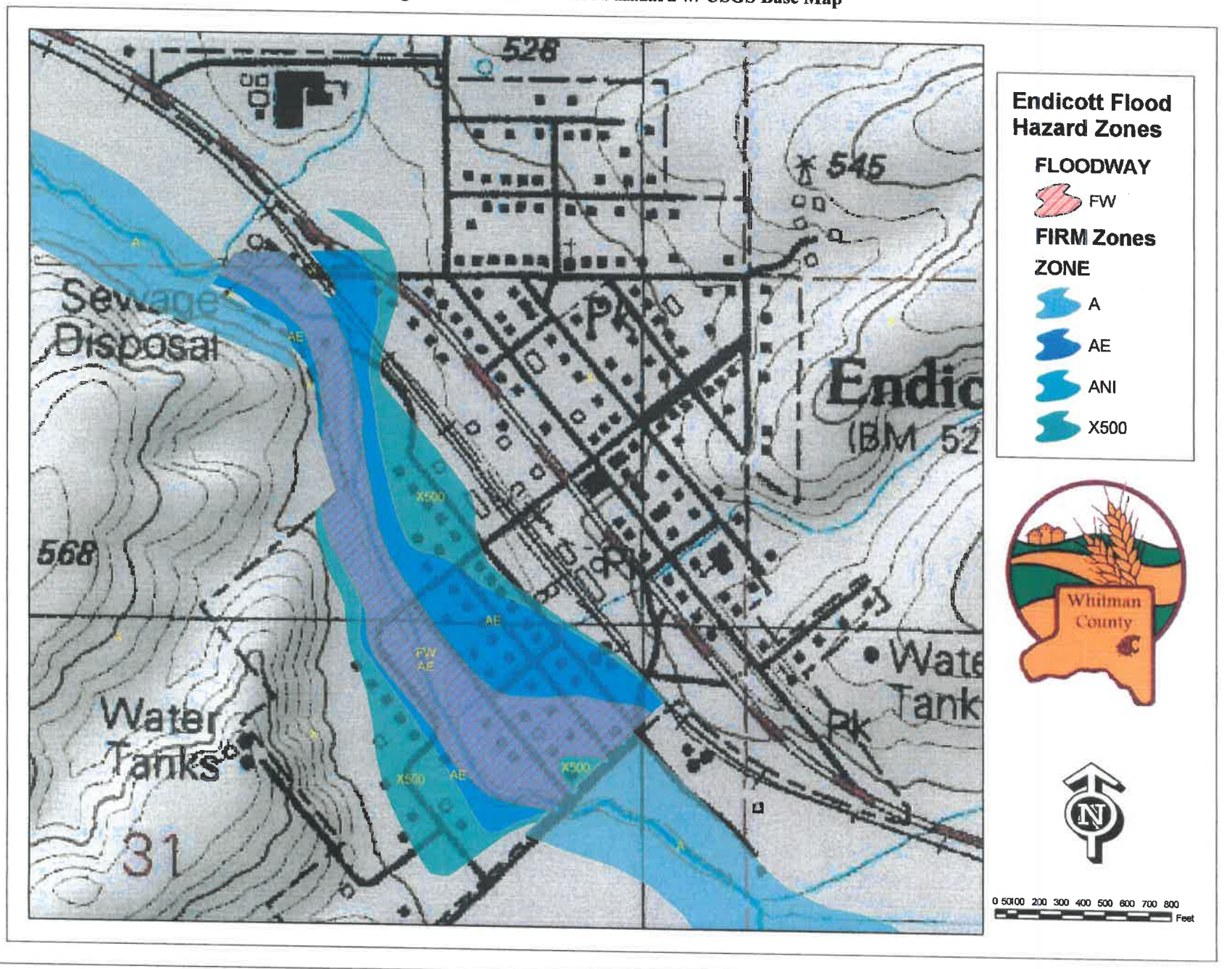
Figure 3.14: Endicott Flood Hazard w/ USGS Base Map



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*Town of Farmington**

There is currently no data available for flooding in Farmington. This suggests that the town, located between the North and South Forks of Pine Creek near the Idaho border, does not have any major flood concerns.

Town of Garfield

Garfield is a farming community of 610 located in the northeast part of Whitman County near the Idaho border. It is located about 15 miles northeast of Colfax. The town is located on Silver Creek. Flooding is caused by the overflowing of Silver Creek. A major contributor of flooding is ice jams at the railroad trestle.

Past Events

Serious flooding occurred in Garfield in 1948, 1972, and 1974. During the 1974 event, which had duration of only one day, water got into numerous buildings in the downtown area. The major factor contributing to this flooding was an ice jam at the railroad trestle near B and Idaho Streets. Flooding occurred in 1996, as there were 4 IA grants in Garfield.

Location

Silver Creek, which flows intermittently east through the southern part of Garfield, is the source of flooding for the community. The topography rises both to the north and south of the creek, but the downtown is relatively low in relation to the creek. In this area, the floodplain widens to the north to encompass most of the downtown.

Frequency

Flooding is also infrequent in Garfield, with only four events recorded in the 20th century.

Severity

None of the buildings in downtown Garfield have basements, so flooding generally occurs on the ground floor of structures located in the floodplain within the business district. This flooding can damage personal property within these buildings, but does no major harm to the structures themselves.

Exposure

Development adjacent to Silver Creek generally consists of scattered farm related and residential structures. As mentioned above though, the floodplain widens at the downtown area to encompass most of the downtown. Garfield has 6 NFIP policies. Analysis of 1996 aerial photography indicates at least 3 structures in the floodway, approximately 50 in the 100-year floodplain and about 50 in the 500-year floodplain.

Vulnerability

Properties most vulnerable to flooding are those located closest to Silver Creek, where flood depths may be highest. Any properties located in the floodplain that have basements are vulnerable, as are businesses that have equipment and personal property that can be damaged by flooding that is not elevated from the floor.

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Figure 3.15: Garfield Flood Hazard w/ Aerial

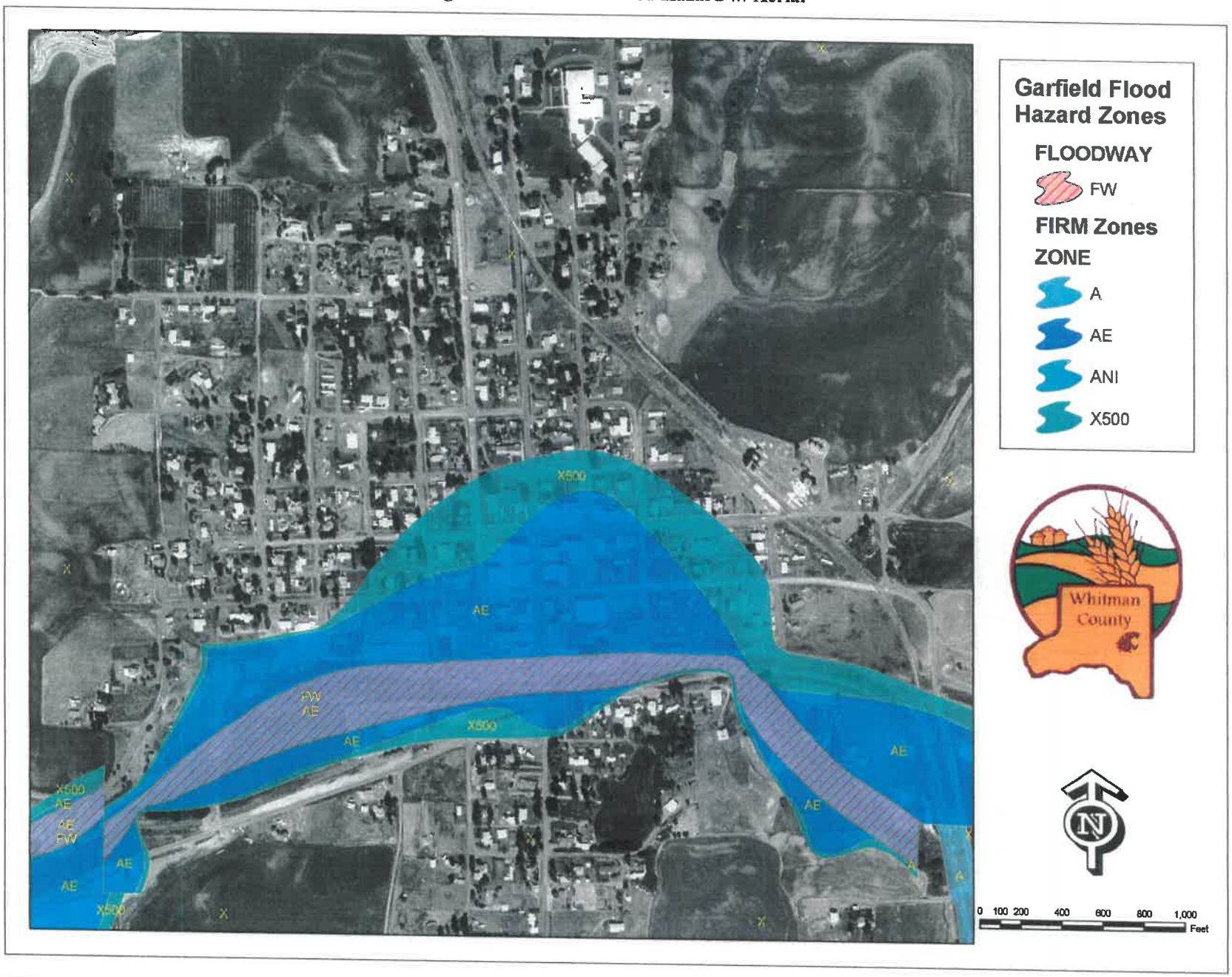

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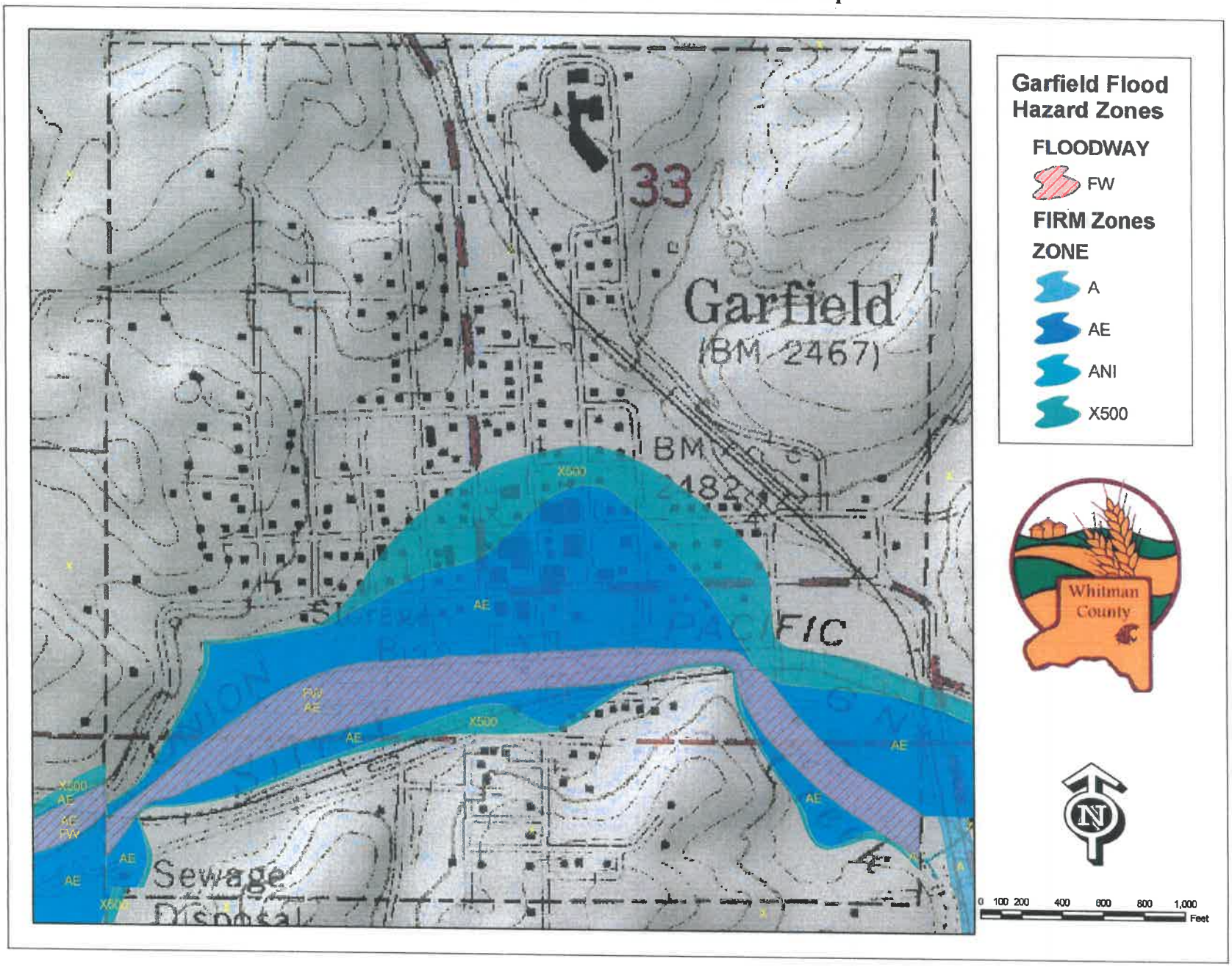
Figure 3.16: Garfield Flood Hazard w/ USGS Base Map



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*Town of La Crosse**

La Crosse (population 370) is located about one mile north of State Highway 26 in western Pullman County. It is not located on any rivers or creeks and does not have any flood risks.

*Town of Lamont**

Lamont (population 105) is a tiny town located in the scablands of northwest Whitman County, about a mile southwest of State Route 23. It does not lie near any creek or river and does not have any flood risks.

*Town of Malden**

Malden (population 210) is a small former railroad town located on the north side of a hill on the south side of Pine Creek. Malden does not experience any flooding.

Town of Oakesdale

Oakesdale is a farming community of 415 located in northwest Whitman County. It is located approximately 17 miles north of Colfax. It is located on the confluence of McCoy and Spring Creeks. Spring Creek then drains to Pine Creek. Flooding is generally caused by the overflow of McCoy Creek and its tributaries due to flash flooding and low creek flow capacity.

Past Events

Extensive flooding occurred in 1948 and 1963 in Oakesdale, although damage from these events was minimal. The 1996 floods also affected Oakesdale. There was 1 IA grant for the town.

Location

The principal flooding problems in Oakesdale are caused by McCoy Creek. McCoy Creek is an intermittent stream that flows southeast into Oakesdale roughly parallel to SR 271 and flows through the eastern part of the town where it joins Spring Creek just north of Jackson and 1st (SR 271) Streets. Spring Creek is also an intermittent stream and flows northeast through Oakesdale.

Three smaller unnamed tributaries and drainage swale to McCoy and Spring Creeks are also located in Oakesdale. Tributary No. 1 is located on the west side of town and joins Spring Creek near the intersection of McCoy and Brown Streets. Tributary No. 2 flows from the north, near the eastern town limit, and joins McCoy Creek near Bartlet and Idaho Streets. Tributary No. 3 also flows from the north, from the northern town limits and joins McCoy Creek about 1.36 miles upstream of its confluence with Spring Creek. The drainage swale flows north along Bush Street and drains into Spring Creek.

Frequency

Flooding is infrequent in Oakesdale and only two minor (in terms of damage) events occurred during the 20th century.

Severity

No detailed information is available about the severity of flooding in Oakesdale. Past events were described as "extensive" but only causing "minimal" damage. Photographs in the Oakesdale FIS show shallow flooding from the 1963 event in the streets around the confluence of Spring and McCoy Creeks.

Exposure

McCoy Creek passes through generally undeveloped farm land in the north part of the city, where scattered farm structures are exposed. Near the center of town, the floodplain is narrower, but enters a more developed area. Spring Creek flows through well-developed residential areas that also have a potential for growth. The intermittent streams and swale are in deep drainages and are not located near any development. The town has 5 NFIP policies. Aerial photography indicates about 2 structures located in the floodway, approximately 50 located in the 100-year floodplain, and about 20 in the 500-year floodplain.

Vulnerability

A large portion of the developed area in Oakesdale is located in the floodplain. Properties with basements and businesses with personal property not elevated are most vulnerable.

Figure 3.17: Oakesdale Flood Hazard w/ Aerial

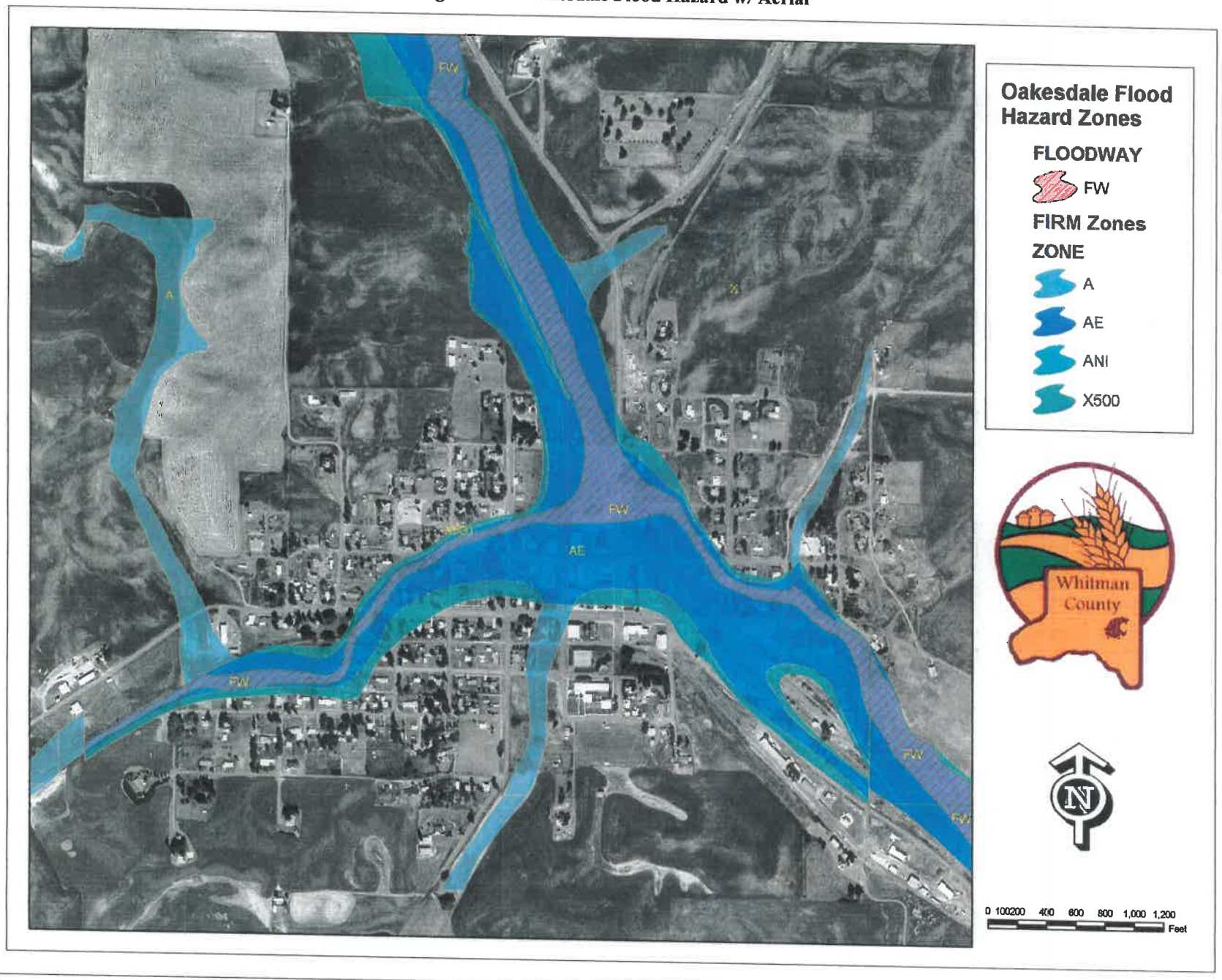

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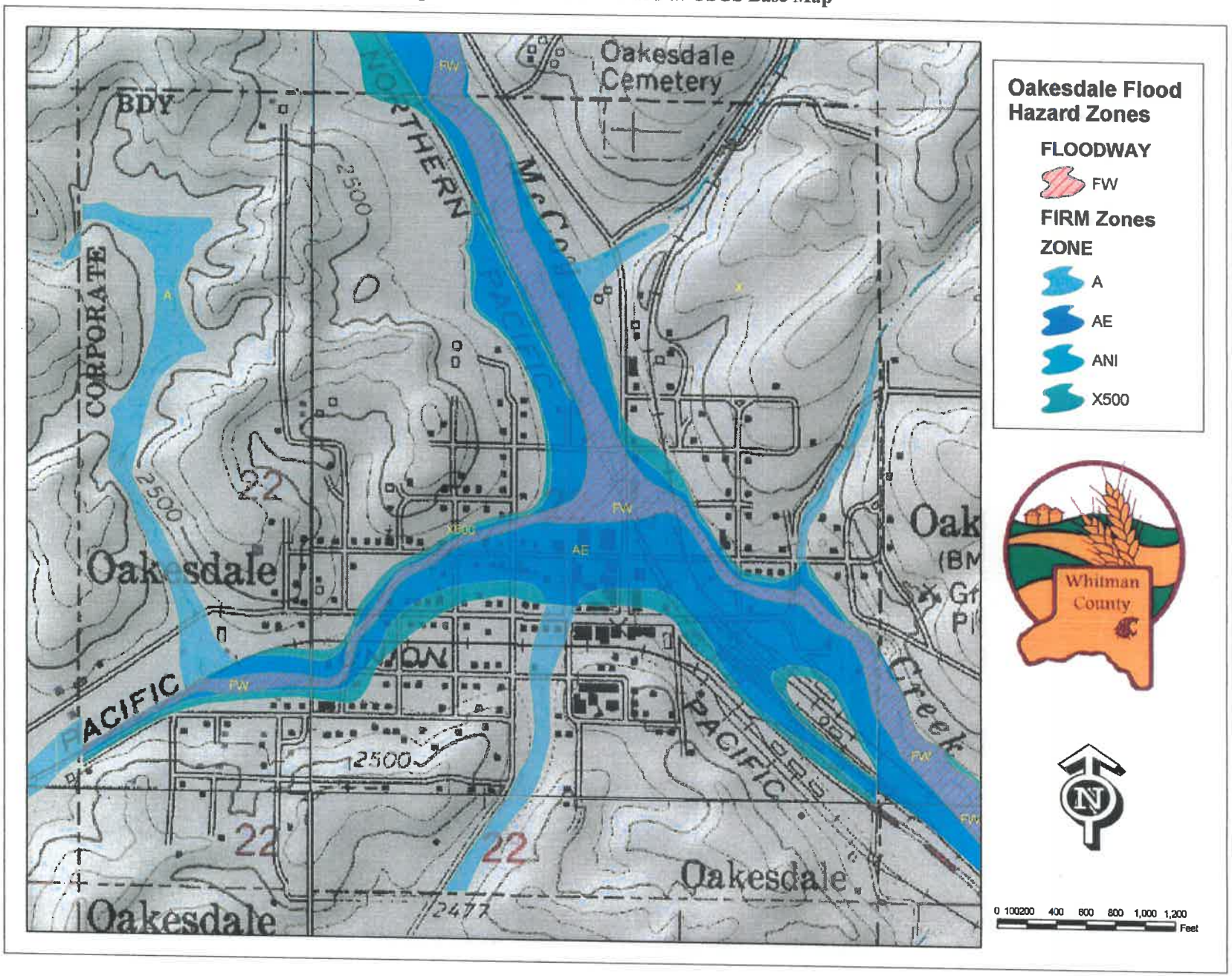
Figure 3.18: Oakesdale Hazard w/ USGS Base Map



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City of Palouse

Palouse is an agricultural and farming community of 1,010 people located in eastern Whitman County, about two miles from the Idaho border. It is located on the (North Fork) Palouse River, and is accessible to Pullman, 16 miles to the south, via SR 27. Flood damage is usually caused by Palouse River overflowing into the adjacent downtown located on the north side of the river. After Pullman, Palouse is the most vulnerable community to flooding in the County. The City of Palouse Flood Mitigation Plan, prepared in 1997 by the Department of Urban and Regional Planning at Eastern Washington University, was used to prepare the Palouse Risk Assessment below.

Past Events

The FEMA FIS for Palouse indicates that Palouse had two flooding events in 1972 and 1974. The Palouse Flood Mitigation Plan also indicated that the town had a flood in 1933 that inundated most of the area along Main Street, and may be attributed to heavy logging in the Moscow Mountains, which can increase erosion and run-off, and by the removal of dams on the Palouse River. The January 16, 1974 flood was even more severe than the 1933 flood. During this event Main Street flooded, damaging shops and businesses located along it. Palouse experienced its most severe flooding in 1996. The river expanded to a 400 foot wide silt laden surge, flooding nearly everything along and near Main Street. There was also damage to homes and businesses on the south side of the river as well. The sewerage treatment plant, built above the 100-year floodplain, was inundated. The flood damaged at least twenty businesses and forced many residents to evacuate.

Location

The Palouse River, a small perennial stream that rises in Idaho to the east, flows west through the southern part of Palouse. Flooding occurs in the floodplains adjacent to it when it overflows due to due heavy rain and/or rainfall over snow cover in winter or early spring. The downtown of Palouse is built on a formerly low, marshy area that was subject to flooding, but was developed due to demand for expansion of the town from its original location on the south side of the river on steep hills. The City of Palouse also contains two unnamed intermittent steams that flow from the south. The first of these streams joins the Palouse River west of the intersection of Almota Road and the Burlington Northern Railroad tracks. The second unnamed stream joins the Palouse River north of the intersection of Almota and Moscow Streets after flowing from the south along the BNRR tracks.

Frequency

Flooding can occur more frequently in Palouse than in many other communities in the county due to its receiving higher rainfall, and being located on a permanent river. Three major floods occurred during the twentieth century, giving the town a probability of a major flood at least every 33 years.

Severity

The two past events (1972 and 1974) had recurrence intervals of 10 and 30 years. The latter flood caused extensive damage along Main St. in downtown Palouse. Thus any event equal or greater than a 30-year recurrence interval can be expected to cause flooding. The 1996

flood was greater than a 100-year event. The flood level of 18.3 feet was 2 feet higher than the 1974 flood. The peak stream discharge of the 1996 flood was 14,200 cfs. The estimated 100-year flood discharge is 13,340 cfs. The 1996 event was quite severe in terms of damage. In the public sector, the town sustained $163,742 in damages and received $122,000 in public assistance and a survey of private property owners found that 67 properties sustained damage totaling $1.6 million, an average of $24,000 per property. Twenty-four residents received IA grants.

Exposure

There is a full build-out of commercial and residential structures located in the floodplain in the central portion of the City. Properties located in the floodplain outside the downtown are chiefly used for grazing and agriculture. The Palouse Flood Mitigation Plan conducted an inventory of flood prone structures using direct observation and analyzing photographs of the 1996 flood. This inventory found 95 flood-prone structures. The uses of these structures include 29 residential structures (13 of which were manufactured homes), 50 commercial buildings, and 8 public facilities. Palouse has 19 NFIP policies.

Vulnerability

Property located along Main Street on the north side of the Palouse River is most vulnerable to flooding. Main Street is located in the floodplain and is the main thoroughfare of city, where its main commercial structures are located. The 1996 flood was greater than the predicted 100-year, and thus many structures, such as the sewerage treatment plant, which were built to this flood standard, was nonetheless inundated.

Figure 3.19: Palouse Flood Hazard w/ Aerial

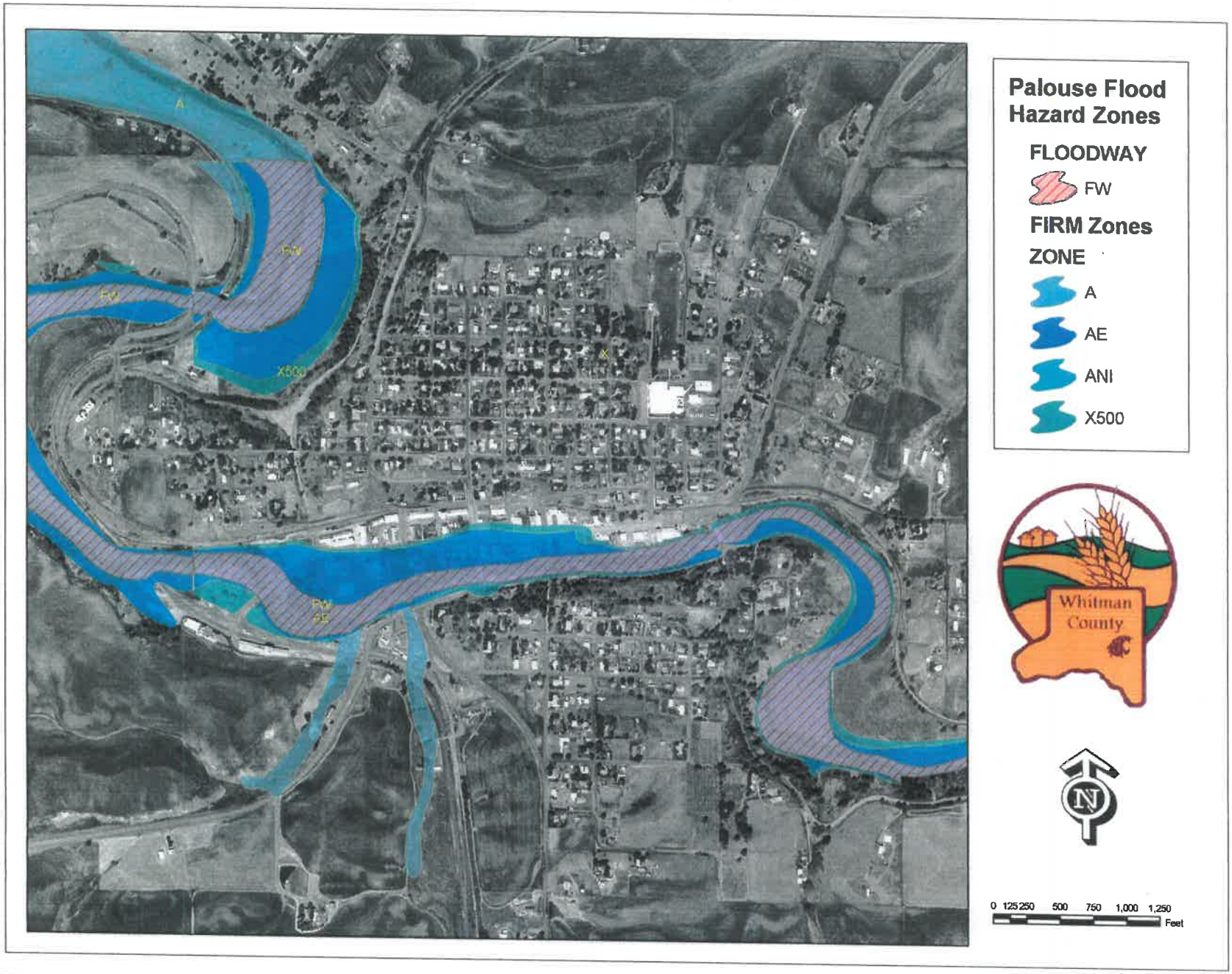

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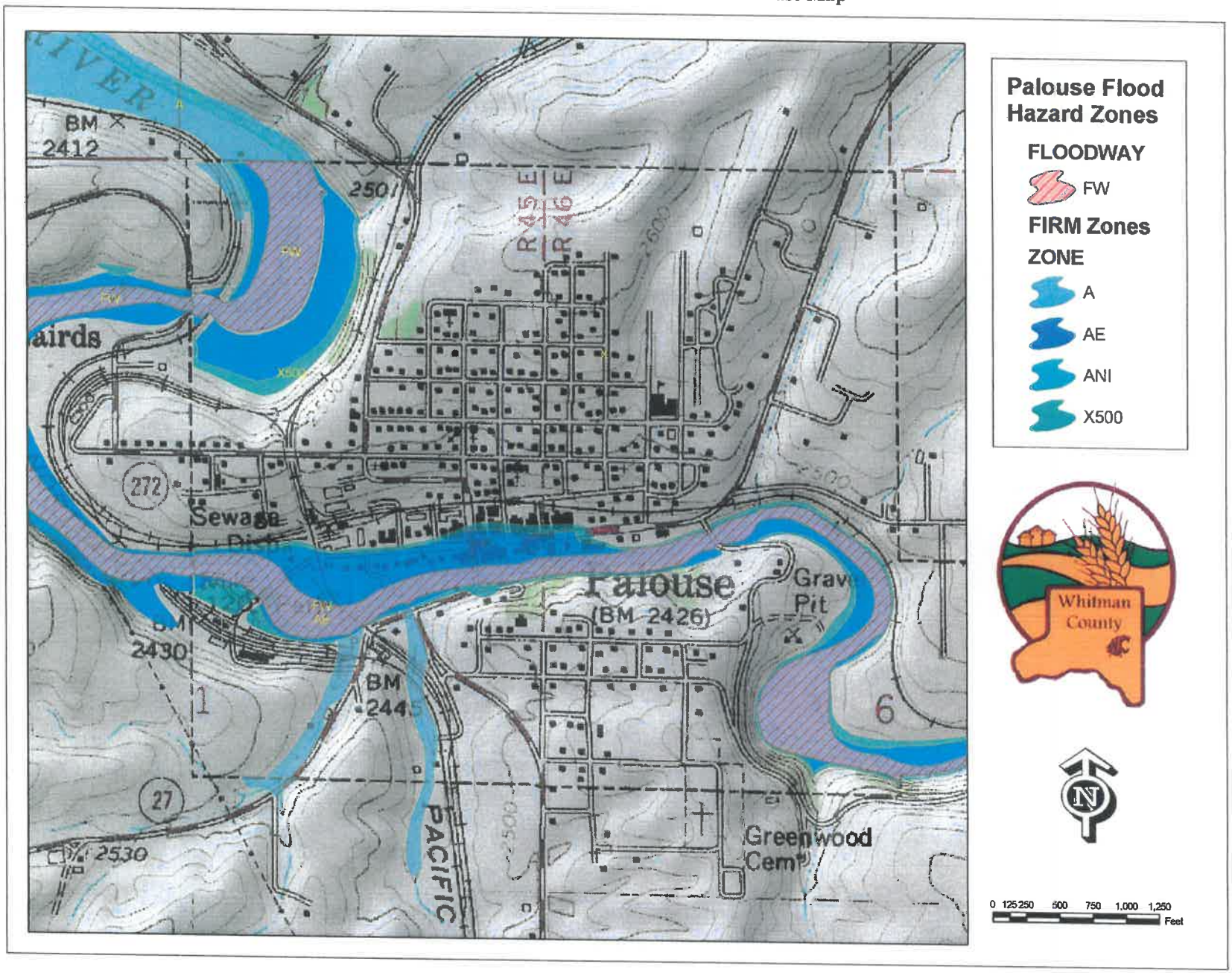
Figure 3.20: Palouse Flood Hazard w/ USGS Base Map



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City of Pullman

Pullman, located about 15 miles southeast of Colfax, is the largest and principal city of Whitman County. It is home to 25,300 people, over 60% of the County's total population. Of this, about 18,000 attend Washington State University (WSU), which is located in the town. The town also has numerous professional and retail businesses that serve the university and its population.

Pullman, originally named Three Forks, lies on rolling hills above the floodplains of the South Fork Palouse River, Paradise Creek and Missouri Flat Creek. Much of the commercial and industrial development lies in the flat bottomlands where these creeks converge. Pullman has the worst flood problem of all the communities in Whitman County. Flooding is usually caused by heavy rainfall in winter or early spring, typically on snow over frozen ground. Rapid snowmelt and heavy rainfall can combine to create flash flooding events where the generally low capacity creeks overtop their banks spilling into the adjacent floodplains. Overflows can also be caused by debris and ice flows blocking drainage at bridges and abutments. The rapid, high flow events typically cause massive erosion and carry high levels of sediment, much of which is deposited in the highly developed floodplains after the floods have receded.

Past Events

Pullman has had extensive flooding since its founding around 1876. The first major event occurred in 1884, and is still considered the second biggest flood on record. The March 1910 flood was the largest flood of record, with a peak flow of 7500 cfs. The peak flow of 1910 was equivalent to a 125-year flood. These flows inundated nearly all the bottomland area, destroyed several buildings and bridges, and badly damaged a number of downtown buildings, roads and railroads. The floodwaters also eroded streets and yards and deposited massive amounts of sediment and debris in Pullman. The flood caused isolation and the water supply was contaminated. Damaged was estimated at $250,000, or about $47,000,000 in 2004 dollars.[34] Other floods occurred in 1933, 1948, 1964 and 1972. The most recent event occurred in 1996, which caused over $250,000 in damage.

Location

Flooding occurs in the developed bottomlands of the creeks that flow through Pullman. The South Fork Palouse River is the main river in Pullman. It originates in the Moscow Mountains in Idaho, and flows northwest through the center of Pullman to Colfax, where it joins the North Fork to form the Palouse River. Paradise Creek and Missouri Flat are two of the largest tributaries of the South Fork Palouse River. They originate east of Pullman in Idaho and flow westerly to join the South Fork at Pullman, hence the town's original name of Three Forks. Other minor creeks in Pullman include Airport Road Creek, Dry Fork Creek and Wawawai Creek, all of which can experience some flooding.

The South Fork Palouse drains areas of 85 square miles above Paradise Creek, 132 square miles above Missouri Flat Creek, and 159 square miles, including Missouri Flat Creek drainage. Missouri Flat Creek drains an area of 27.1 square miles. The drainage areas are

[34] Inflation Conversion Factors for Dollars 1665 to Estimated 2014, http://oregonstate.edu/dept/pol_sci/fac/sahr/sahr.htm

mostly rolling plateau lands, extensively developed for dry farming. Headwater reaches of the areas extend into forested slopes of the Moscow Mountains.

Frequency

Minor flooding can occur every 5-10 years, while major flooding has typically occurred at least once every twenty years.

Severity

Past events of 1910, 1948, 1972 and 1996 recorded peak flows of 7500, 5200, 4570 and 4500 cfs in the South Fork Palouse River,[35] respectively. Floodwaters exceeded depths of three feet in the downtown corridor during each of these events. These events can cause extensive and expensive damage to downtown, including sediment deposition. Minor flooding can also block roads, disrupting commerce and transportation and isolating WSU. Due to sedimentation and debris in the creeks, lesser events can cause as much or worse flooding than higher peak flow events in the past. The 1996 flood required about $250,000 in public assistance, and 37 IA grants were given out to residents.

Exposure

Much of Pullman's commercial and industrial development is located in the floodplains along the South Fork Palouse River and Missouri Flat Creek. Pullman's downtown business district is located at the confluence of the South Fork Palouse River, Missouri Flat and Dry Fork Creeks. The 2003 Flood Hazard Management Plan for Pullman conducted an inventory of structures located in the 100-year floodplain. The study found 210 structures located in the floodplain, the majority of which were residential homes and mobile homes. See Table 3.13.

Table 3.13: Pullman Structures in Floodplain

Buildings Located within 100 Year Floodplain	
Structure Type	*Number within 100 Year Floodplain*
Commercial	56
Industrial	9
Public Facilities	9
Single Family Homes	34
Mobile Homes	89
Multi-family Homes	13

Besides buildings located in the floodplain, the Flood Plan also identified 40 hydraulic structures in the floodplain that can be damaged or exacerbate flooding. These generally include road, pedestrian, and railroad bridges, and culverts.

Vulnerability

The Pullman Comprehensive Flood Hazard Management Plan identified and compiled a detail list of existing flood problem areas.[36] They identified 8 areas on the South Fork

[35] The river gauge is located about 600 feet upstream from the confluence of Missouri Flat Creek
[36] Pullman Comprehensive Flood Hazard Management Plan pp. 26-28

Palouse River, 5 on Dry Fork Creek, 8 on Missouri Flat Creek and 2 on Paradise Creek. Problems in these areas include stretches of creeks that experience stream bank erosion, areas with large amounts of sediment that reduce conveyance and increase the base flood elevation, and areas where bridge abutments and small culverts block or reduce conveyance. It is at these choke points (small culverts and bridge abutments) where debris can get caught and the river and creeks typically overflow into the adjacent floodplain. Pullman also contains four repetitive loss properties. These are properties that have experienced damage from floods at least twice in a rolling ten-year period.

In addition Pullman has 49 property owners who own National Flood Insurance Program (NFIP) policies, about 37% of all policies owned in the County. Six of these properties were built after the FIS was adopted. It is also interesting to note that three flood policy owners own properties not located in the floodplain (FEMA Zone X). For confidentiality purposes the exact addresses of NFIP properties cannot be listed here, nonetheless the amount and location of policies is a good indicator of flood vulnerable locations and properties.

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Figure 3.21: Pullman Flood Hazard w/ Aerial

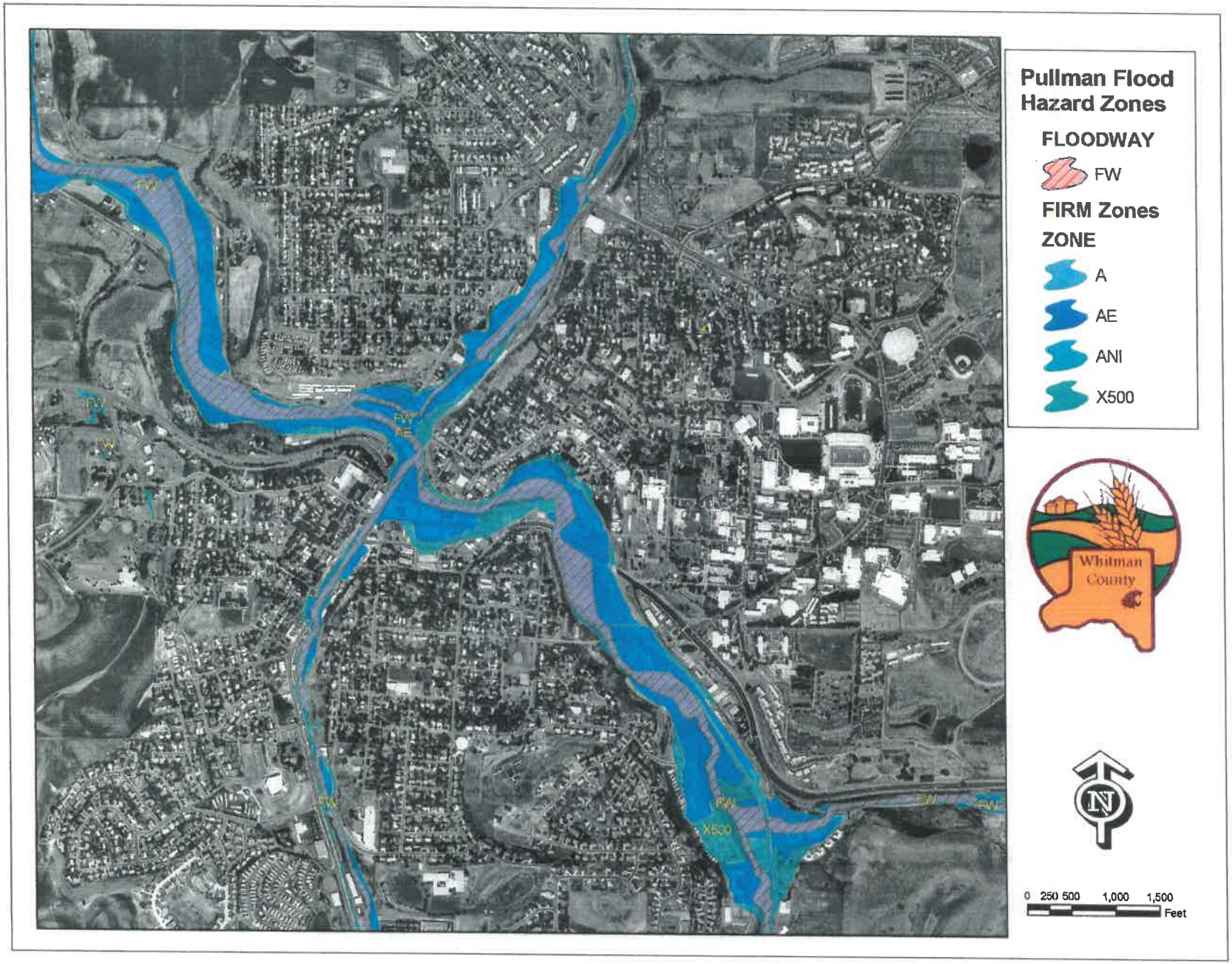

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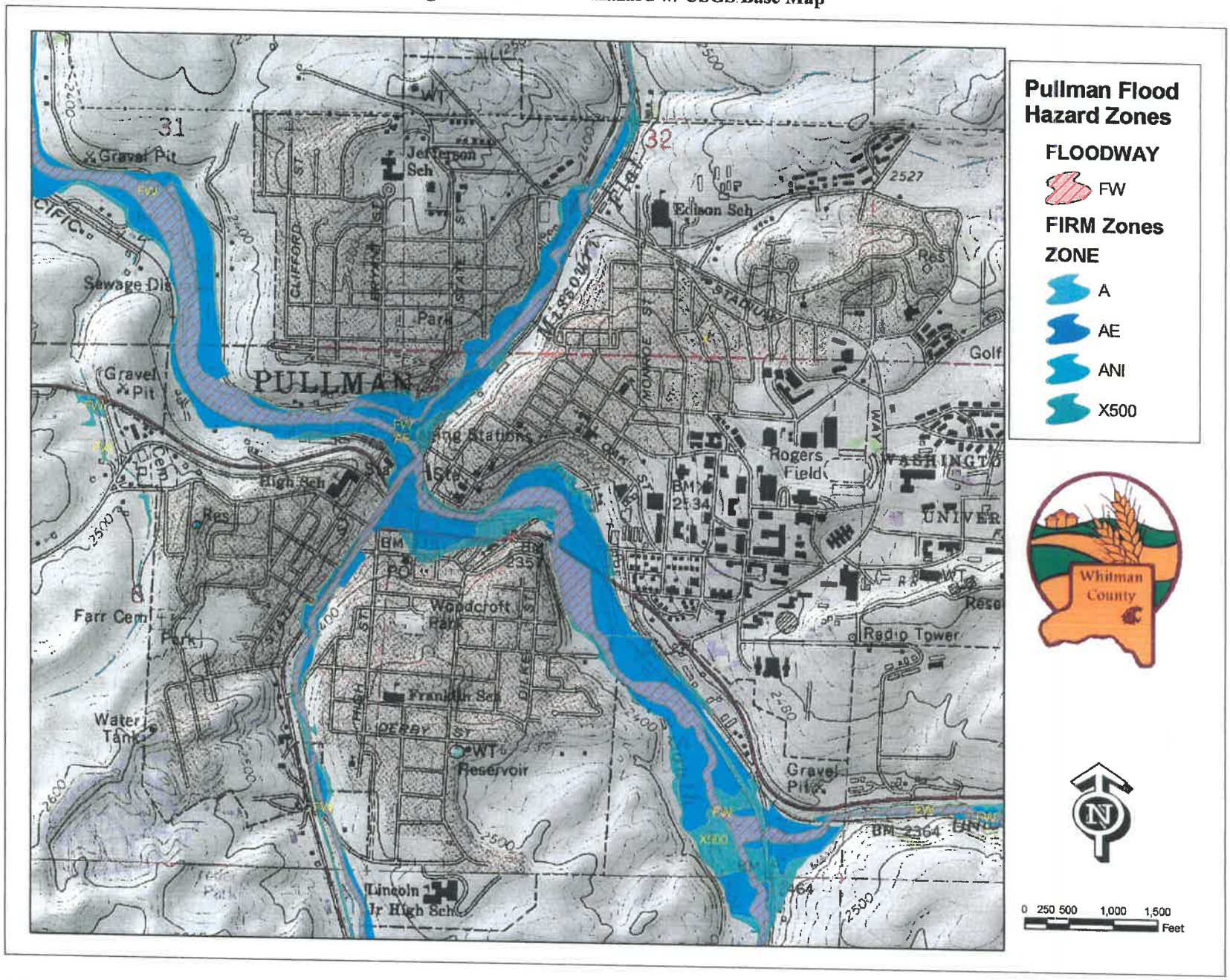
Figure 3.22: Pullman Hazard w/ USGS Base Map



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Town of Rosalia

Rosalia is a farming community and commuter suburb to Spokane of 650 people located in north central Whitman County near the Spokane County border. Pine Creek flows north through the town and State Highway 195 passes just east of the town. Spokane is about 35 miles north of Rosalia, and Colfax is about 25 miles south. Flooding is caused by the overflow of Pine Creek into the adjacent floodplain.

Rosalia has a Flood Mitigation Plan that was prepared in 1997 by Eastern Washington University. Information from this plan was used for the Rosalia Flood Risk Assessment below.

Past Events

Rosalia has had a well documented history of flooding dating back to the town's earliest history. Past flood events have occurred in 1881, 1910, 1948, 1963, 1974, 1979, 1996 and 1997. The flood of 1963 was the highest recorded ever in the town, with a stream flow of 10,600 cfs. The New Year's Flood of 1997, which caused extensive damage elsewhere in the County, also caused extensive damage to Rosalia during its short duration. After the flood receded, 21 buildings, as well as the Town's park, swimming pool, and roads were damaged. Total damage from the flood was about $272,000. Of this, about $46,000 of the damage was to public facilities and infrastructure. The town received about $6,000 in PA grants.

Location

Pine Creek is the sole cause of flooding in Rosalia. It flows north through the western portion of town after originating in the Mission Mountain area of Idaho. Flood damage occurs to the property located within the 100-year floodplain of the river.

Frequency

Flooding in Rosalia can be expected at least once every five to ten years. Past events have shown that except for the 1980s, Rosalia has experienced at least two floods every decade since the 1960s.

Severity

The 1997 event can be used as a best estimate of the severity of flooding in Rosalia. This event damaged 21 buildings and infrastructure and caused about $272,000 in damage. Flooding usually occurs during ten year events which have a peak discharge of 4,980 cfs. Discharges at and above this amount will typically cause the river to overflow and flood the surrounding floodplain and property located within it.

Exposure

An inventory of structures located within the floodplain was conducted for the preparation of the Rosalia Mitigation Plan. Excluding garages and outbuildings, this inventory found 43 flood-prone structures located in the floodplain, 12 of which were residential. Within this inventory, 21 buildings were found that store agricultural products or chemicals. The flooding of these structures can cause the chemicals to leak if not properly contained, causing environmental damage to the area. There are 7 NFIP policies in Rosalia.

Critical Facilities & Infrastructure

The Rosalia plan also identified critical facilities located in the floodplain. These include a wastewater treatment lagoon and associated pump house, the town park which contains the town pool, a sports fields, and a lift station.

Rosalia also has infrastructure that is exposed to flooding. This includes dikes that help protect the town from flooding, two bridges, and a sewer system.

Vulnerability

Structures and infrastructure most vulnerable to the effects of flooding are those located lowest and closest to the river. Any structures with basements or unprotected chemical storage are particularly vulnerable. The town's sewer system is vulnerable as flood water nearly inundated the pump station during the 1997 flood, which was an estimated ten-year event. Floods of greater severity may inundate the pump station, eventually causing raw sewage to spill into Pine Creek and the town.

Figure 3.23: Rosalia Flood Hazard w/ Aerial

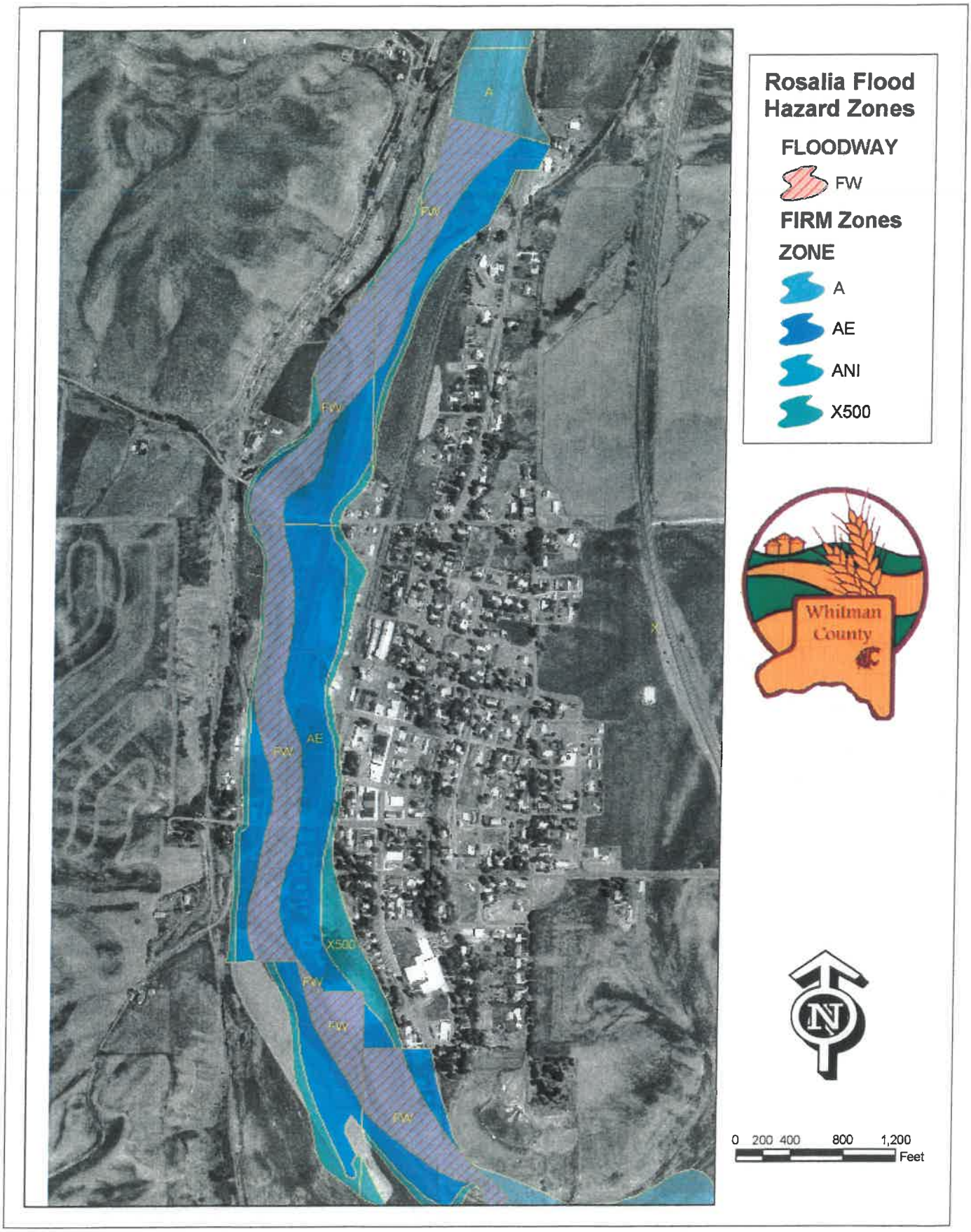

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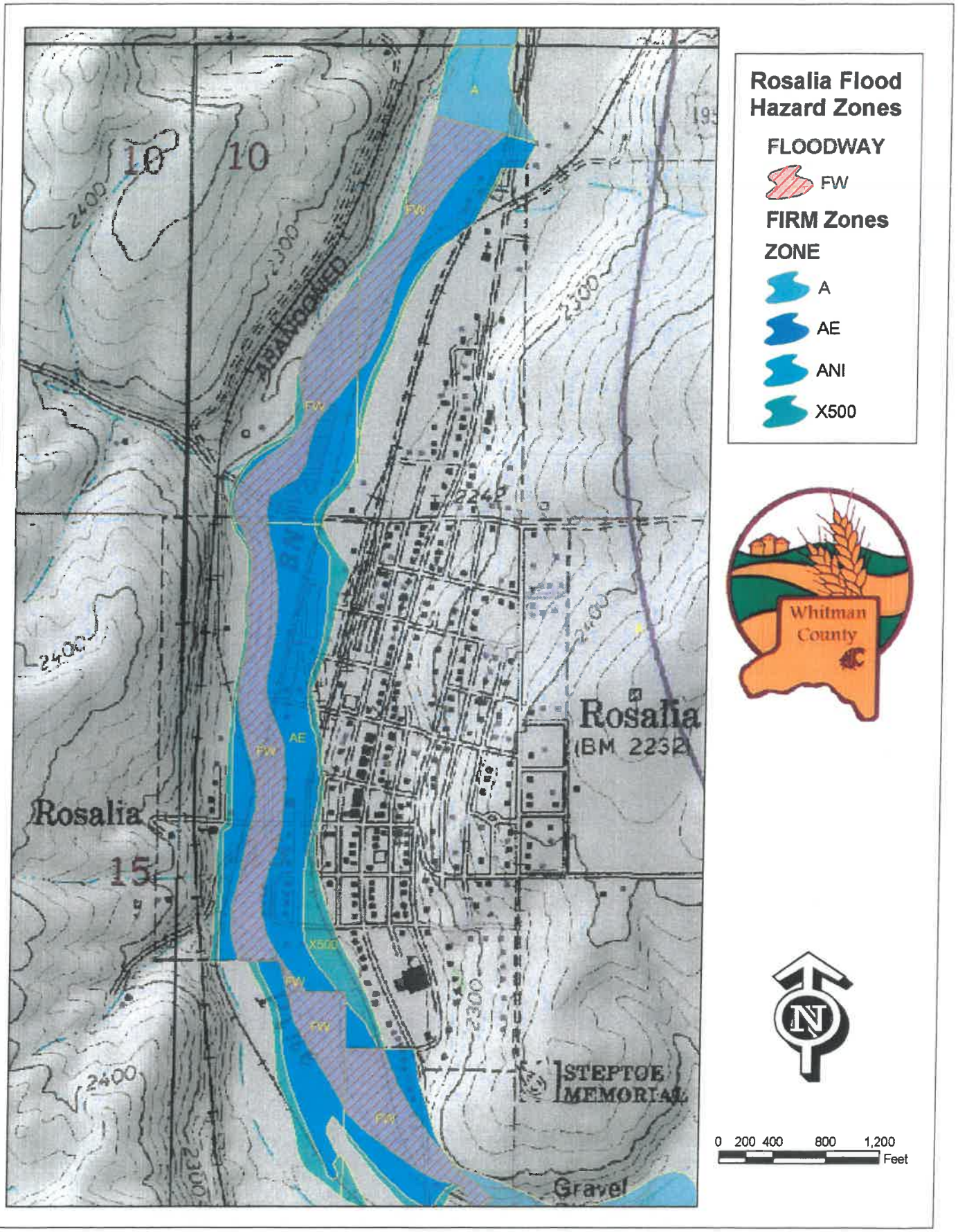
Figure 3.24: Rosalia Hazard w/ USGS Base Map



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*Town of St. John**

St. John is a town of 518 people located in the Pleasant Valley along Pleasant Valley Creek. SR 23 passes through the town and connects it with US 195 and I-90. There is no flood insurance study available for St John, but flood maps indicate that Paradise Creek has a floodplain that roughly parallels SR 23 and exposes some commercial and residential structures behind downtown to flooding. The town has 1 NFIP policy. After the 1996 floods, there was one IA grant in St. John. Analysis of aerial photography indicates that there are approximately 30 structures located in the floodplain.

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Figure 3.25: St. John Flood Hazard w/ Aerial

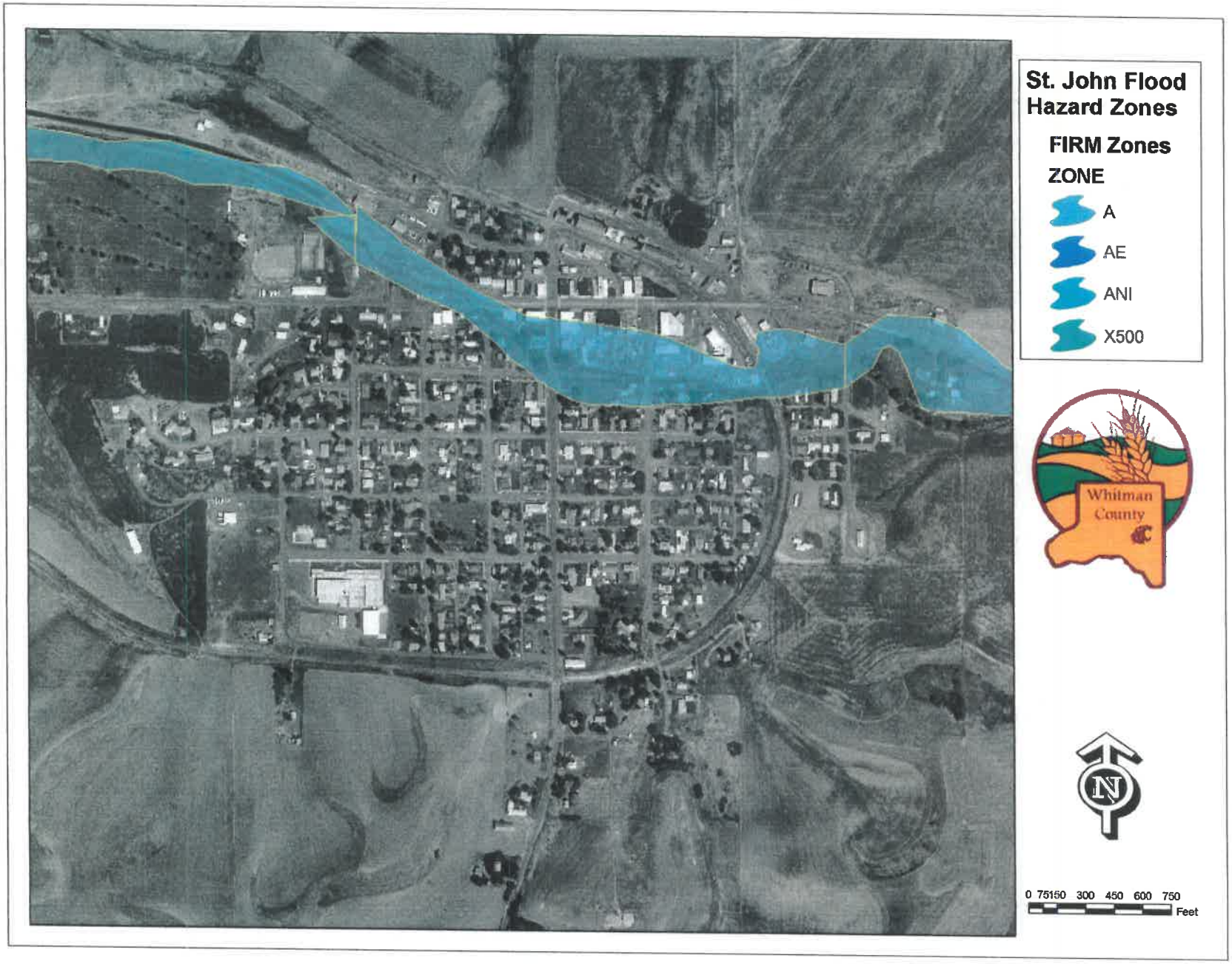

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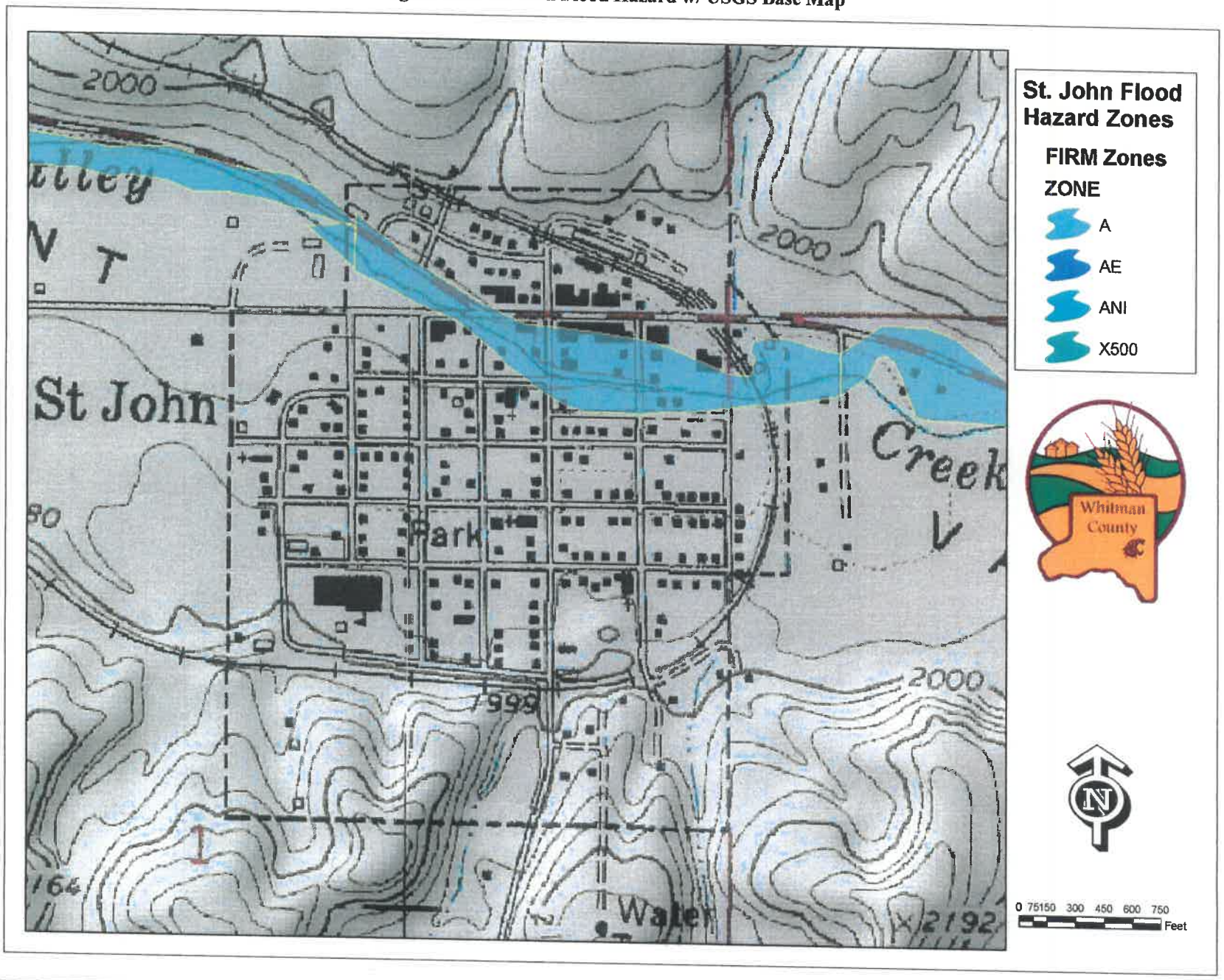
Figure 3.26: St. John Flood Hazard w/ USGS Base Map



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City of Tekoa

Tekoa is an agricultural community of 820 people located in northeast Whitman County near the border with Spokane County and the State of Idaho. Hangman Creek flows through the town, draining into the Spokane River. It is located about 35 miles north of Pullman. Flooding usually results from overflows on Hangman and Little Hangman Creeks caused by high precipitation, ice jams at bridges and inadequate channel capacity.

Past Events

Flooding has occurred in Tekoa in 1948, 1969, 1970, 1974 and 1996. The flood of 1969 is considered by some local residents to be the severest. During this flood, water rose above the Union Pacific Railroad tracks and flowed into the area in the vicinity of Main and Ramsey Streets.

Location

Hangman Creek originates near Tensed, Idaho and flows northwest through Tekoa before joining the Spokane River just below the falls in Spokane. A small tributary, Little Hangman Creek, flows from the northeast through Tekoa before joining Hangman Creek in the western part of town. There are also two unnamed intermittent streams that flow through Tekoa before joining Hangman Creek. One flows through the east portion of town before joining Hangman Creek near Park and Leslie Streets. The other stream flows from the southwest and joins Hangman Creek near Elizabeth Street.

Frequency

Past events indicate that flooding can occur every ten to 20 years, with severe flooding occurring once every century.

Severity

Most of the town, including the downtown business district, is located on high hills above the river, so does not experience the effects of flooding. Most development exposed to flooding are sparse agriculture and commercial structures. Reccurance rates are not available, but on average flooding is not very severe in Tekoa. The town received $7,500 in PA grants from the 1996 flood and there were also 4 IA grants for Tekoa.

Exposure

Flood prone development in Tekoa is limited to sparse commercial and agricultural structures. Flooding can occur in the north and west parts of town which are below the high hills where most of the town's development is located. Analysis of aerial photographs and USGS maps has identified at least 12 structures located in the 100- or 500-year floodplains. Tekoa has one NFIP policy.

Vulnerability

Vulnerable are those structures located within the floodplains of Hangman and Little Hangman Creeks.

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Figure 3.27: Tekoa Flood Hazard w/ Aerial

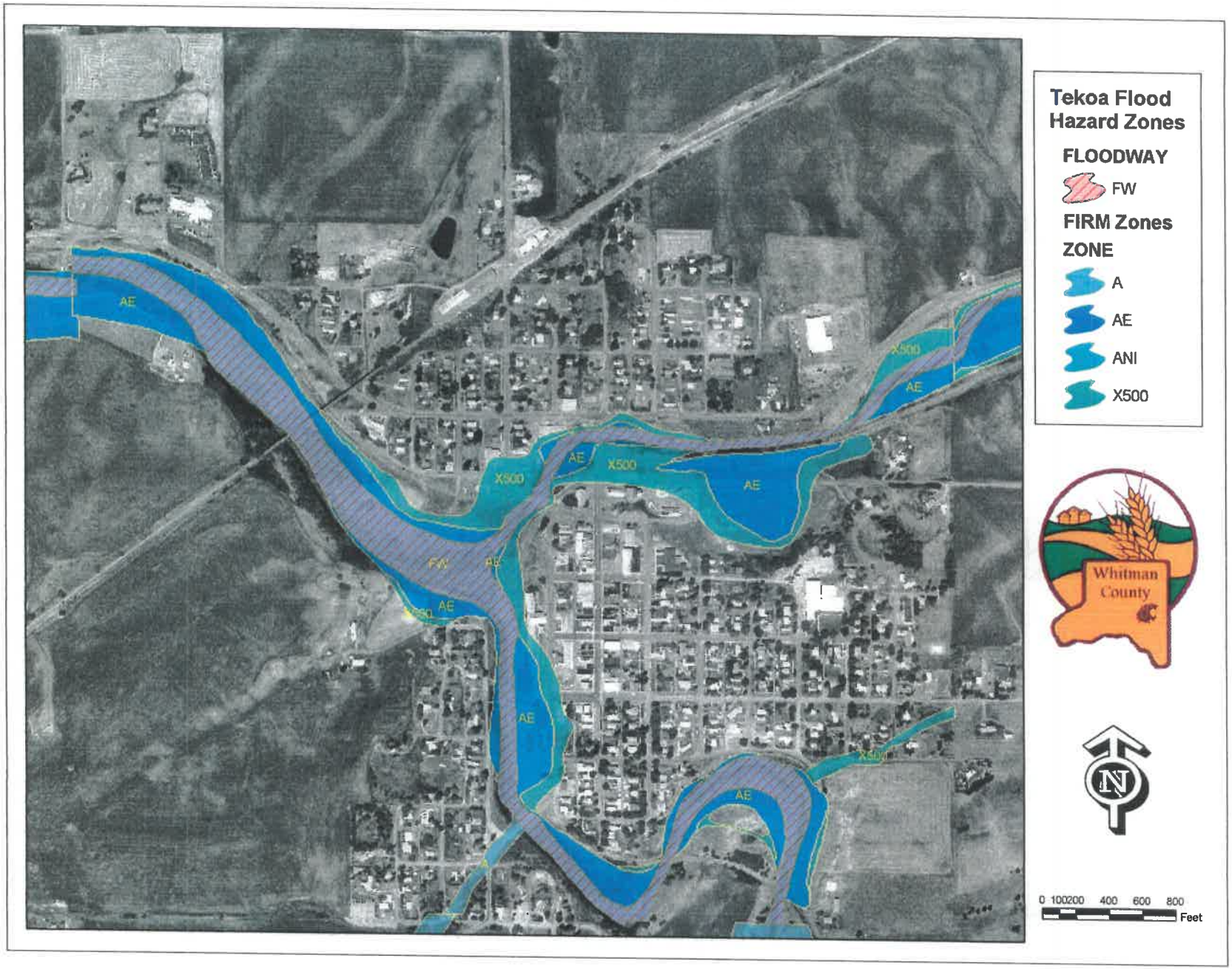

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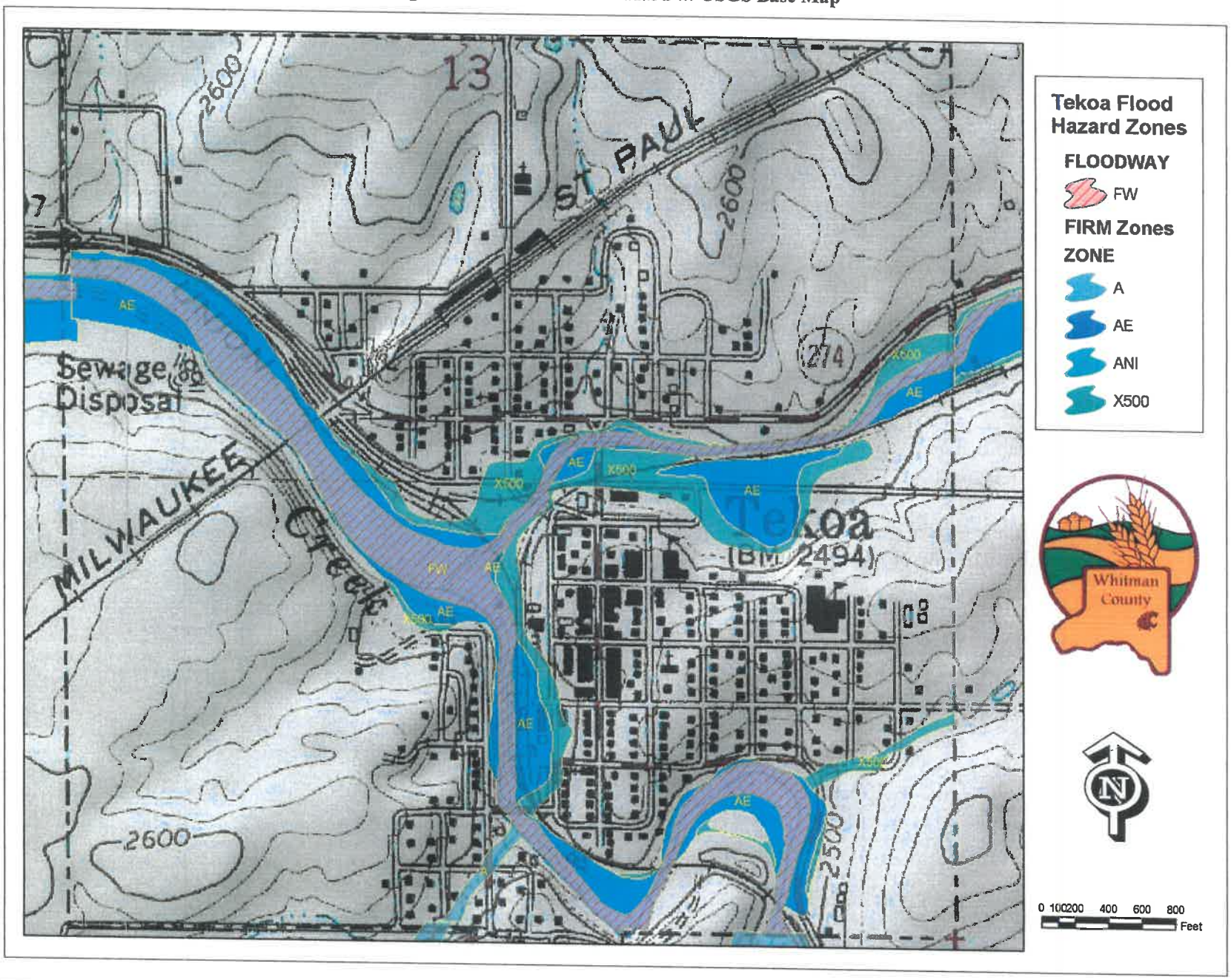
Figure 3.28: Tekoa Flood Hazard w/ USGS Base Map



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Town of Uniontown

Uniontown has a population of 325. It is located in southeast Whitman County on Union Flat Creek and the South Fork Union Flat Creek. U.S. Highway 195 passes north through the town towards Pullman, which is about 15 miles northwest of Uniontown. The Idaho border is located about 1.5 miles to the east. Flooding in Uniontown is caused by the overflow of Union Flat Creek and its South Fork. The overflows generally occur at the convergence of the two creeks as a result of heavy precipitation, rapid snow melt and inadequate channel capacity.

Past Events

Extensive flooding occurred in 1910 and 1948 with minor flooding occurring in 1956, 1958, 1963 and 1965. Actual damage from these events is not known.

Location

Flooding in Uniontown usually occurs in the northern part of town where the South Fork of Union Flat Creek joins Union Flat Creek. Union Flat Creek, which flows through the northern section of town, originates about 4 miles to the east of Union in Idaho. The South Fork of Union Flat Creek flows north through the town from its source about two miles south of Uniontown. The South Fork parallels State Highway 195 and Washington Street before swinging northeast to join Union Flat Creek. Spring Creek, which also may cause minor flooding, flows from the west before joining the South Fork near Spring Street.

Frequency

Past events have shown that extensive flooding can occur every fifty years, while minor flooding can occur at least once every 5-10 years.

Severity

Flood discharge rates of the creeks and damage from the past floods are not known. Two events during the first half of the 20th century were described as "extensive" while more recent events have been described as "minor".

Exposure

Development in the floodplain along Union Flat Creek is scattered and consists of agricultural related, and some commercial structures. Along the South Fork Union Flat Creek floodplain, development is primarily residential. Uniontown has 2 NFIP policies. Aerial photography analysis indicates there are at least 30 structures located in the100- floodplain. There is also at least one structure located in the 500-year floodplain.

Vulnerability

Structures and property most vulnerable to flooding are those located in the area of convergence of the Union Flat Creek and its South Fork. Vulnerable structures include Burlington Northern railroad tracks and agricultural industries that use them.

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Figure 3.29: Uniontown Flood Hazard w/ Aerial

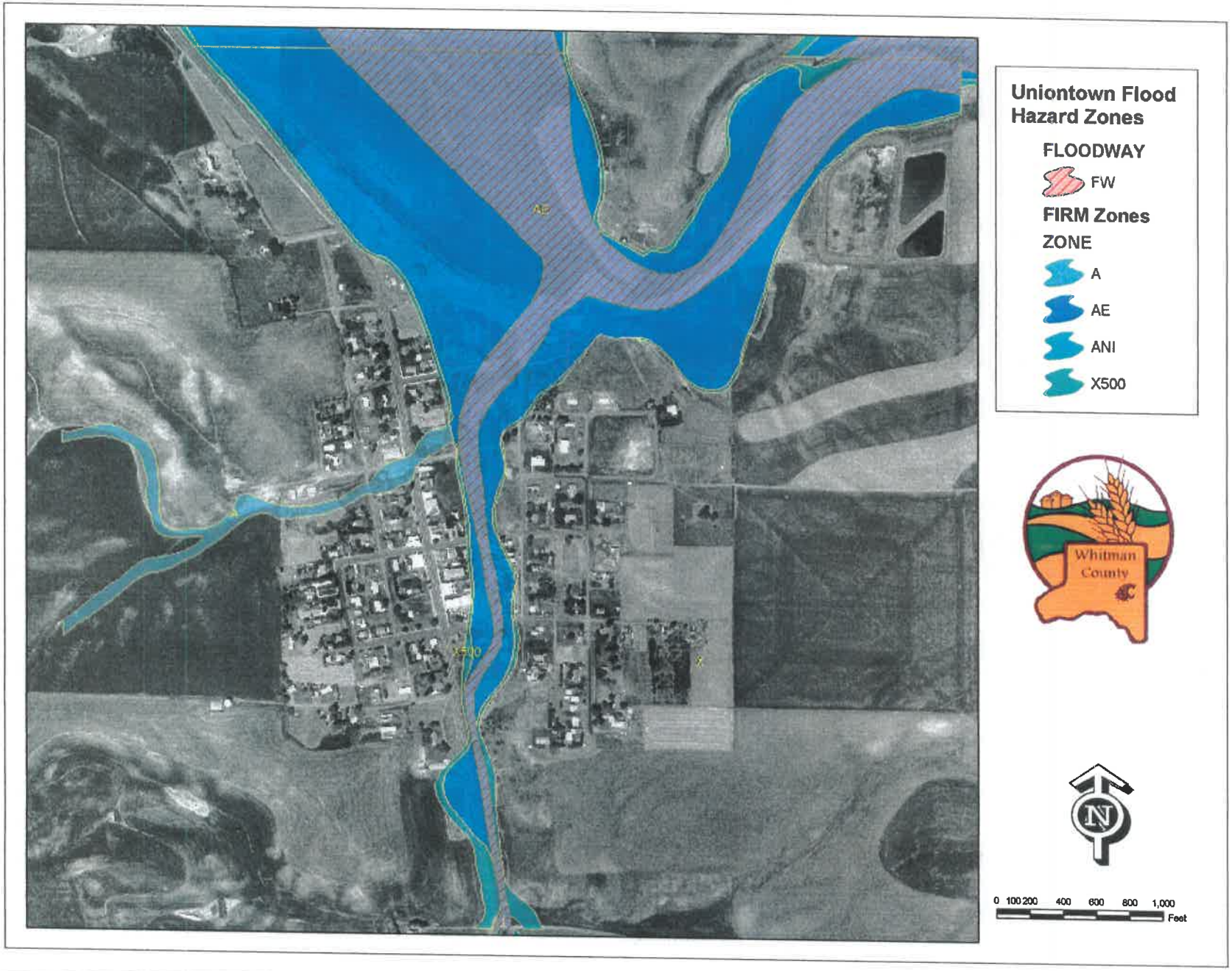

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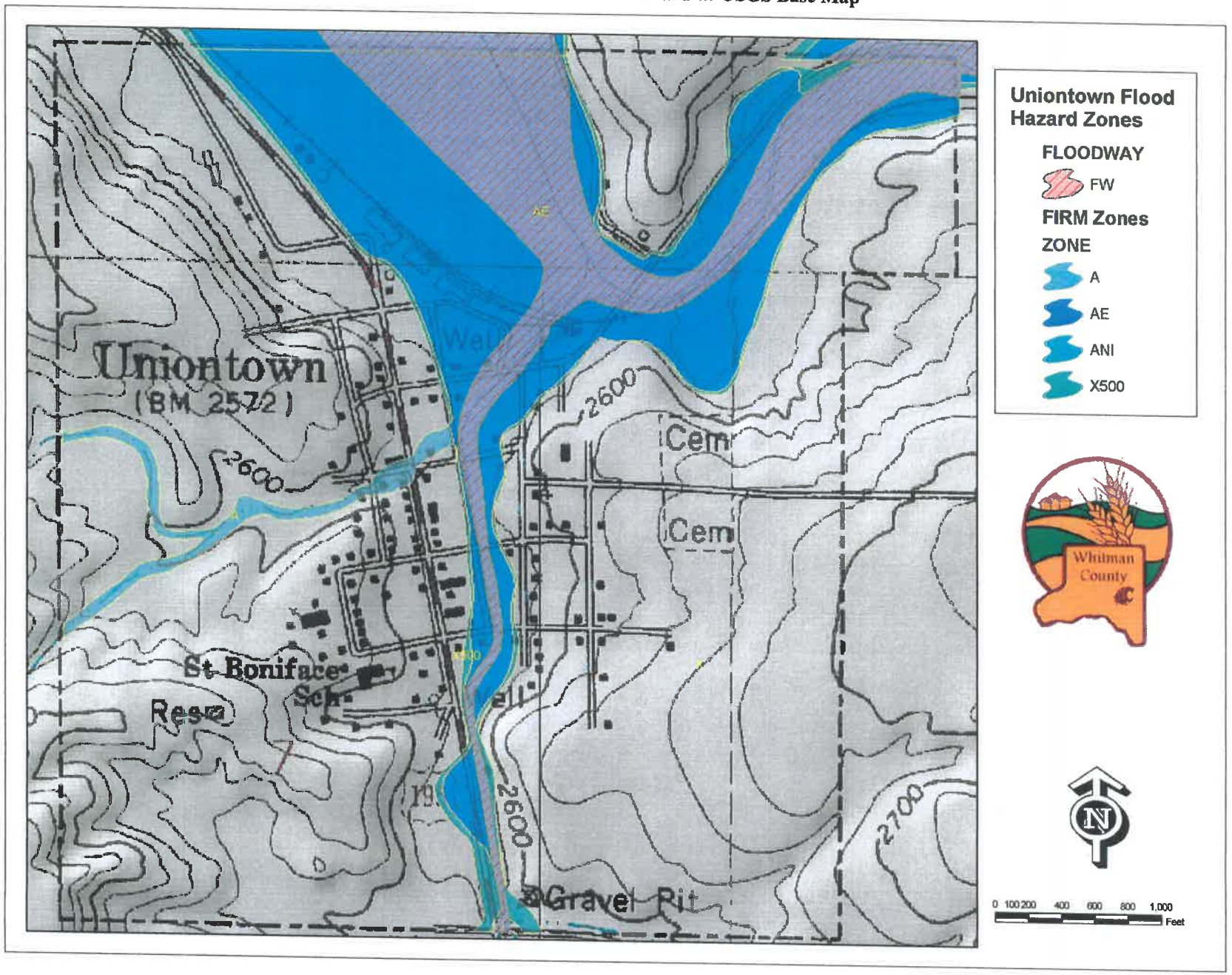
Figure 3.30: Uniontown Flood Hazard w/ USGS Base Map



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Unincorporated Whitman County

The vast majority of Whitman County is unincorporated land used mostly for farming and grazing. About 6,317 people or about 15% of the total County population, live in the unincorporated areas. There are also some small, agriculturally related communities within the unincorporated areas, such as Pine City, Hooper, Winona, Hay, and Elberton. Most flood events result from the overtopping of the rivers and creeks in the county, but due to the sparse development, damage is usually limited to scattered sites around the County and problem streams.

Damage is more often the result of the effects of sediment. The abrasiveness and increased mass of sediment-laden water increases erosion and scouring as well clean up costs. These impacts are more costly that the direct impact of structures becoming wet. In past flooding events damage has included blocked culverts, stream bank erosion, flooded roads, and sediment deposition on roads and property. Flooding on the rural stretches of streams can also cause minor landslides near roads and on some properties.

Past Events

Flooding in the unincorporated parts of the County is not as well documented as in the towns and cities, but the dates tend to coincide. Different creeks flood during different events, but the 1948 floods are cited as one of the most county-wide. The 1996 floods were also county wide, with the unincorporated areas experiencing as much flooding as some of the towns. Nonetheless damage was much less. In total the County received $892,000 in Public Assistance from the 1996 Federal Declaration.

Location

All of the rivers and creeks in the County have the potential to flood, but three major areas were identified by County officials: The stretch of the North Fork Palouse River between Colfax and Elberton, all of Union Flat Creek, and Rebel Flat Creek from near Colfax downstream to Endicott. Other creeks and rivers in unincorporated areas subject to flooding include Paradise Creek east of Pullman and the South Fork Palouse River upstream of Pullman.

Frequency

Minor flooding can be expected in the unincorporated parts of the County at least every five years, if not more. Major, damaging flooding does not occur in the unincorporated parts of the County.

Severity

Recurrence rates for many of the floods have ranges from a 30-year flood to a 100-year flood. Less severe floods may also cause minor flooding in the unincorporated areas, but detailed information is not available. Due to the high levels of erosion associated with flood events, sedimentation of stream channels is reducing capacity, thus making lesser flood events more severe in terms of areas inundated and/or damaged.

Exposure

The vast majority of Whitman County is used for agricultural purposes. About 76% is used for cropland, 19% for pasture/open range, and only 5% for urban/other development. Thus there are only a few, widely scattered structures in the unincorporated parts of the County. The unincorporated communities located on some of the creeks may have larger concentrations of structures in the floodplains, but the FIS for these areas indicate most of these unincorporated communities are locate above the floodplain. The unincorporated County has 22 NFIP policies.

Vulnerability

Due to the low amount of development in the unincorporated parts of the County, most property that is vulnerable to flooding is infrastructure, such as roads, railroads and bridges. The County does expect future development in the Pullman-Moscow Corridor along Paradise Creek, so potential development located here is vulnerable to flooding.

Scenario

Flooding in Whitman County would occur during the cold winter or early spring months when heavy rainfall brought in with warm Chinook winds, causes a rapid increase in temperature. This heavy rainfall in conjunction with the warm air causes snowmelt and rapid run-off on the otherwise frozen ground., the top layers of the loess soil have the potential to erode away during this rapid run-off. The extent of erosion will depend on the extent of ground cover and agricultural management regimes in practice at the time of the event. The more ground cover and accompanying measures reducing velocity, the less erosion and less transported sediment.

The sudden increase in water run-off overwhelms rivers and creeks, which typically overtop, flooding areas where the rivers are blocked or channel capacity is otherwise reduced, such as in towns that have numerous bridges. The run-off also carries debris, ice, and sediment, which can be deposited where the rivers overflow and contribute to scour. Minor flooding can occur along numerous roadways, leaving sediment and minor landslides that are costly and time-consuming to clean up. Not all rivers flood at the same time as others, or during the same events, so it is difficult to predict where flooding may actually occur during any given predicted storm event.

Issues/Recommendations

The many streams and rivers of Whitman County are generally low discharge rivers that typically overflow after severe weather events in conjunction with snow cover on the ground. Rivers that have average discharges of 40 cfs can swell to 10,000 or even 15,000 cfs. Except in the most severe events, or exacerbated by man-made forces, such as bridge abutments, the rivers can typically handle the added capacity without overtopping. Nonetheless stream capacities are diminishing due to sedimentation of the streams. Rivers that may only overtop during 50-year events may now overtop during 10 or 30-year events. Much of this erosion

can be attributed to the cultivation of the rich, dry, and highly erodable loess soil for wheat and other grain farming. It should be noted though that erosion of the loess soil is a natural occurrence. Intense cultivation over the last 130 years has only sped up the process. Besides maintenance and dredging of problem rivers, designation of target watersheds whose rivers and creeks drain into flood prone communities such as Pullman and Palouse is recommended. These watersheds would implement farming practices that would reduce erosion and thus lessen the flood vulnerability of the most at-risk communities due to sedimentation during flood events.

Mitigation measures to consider:

Identify strategic watersheds that transport sediment into developed or developing areas.

Within these strategic watersheds encourage agricultural and grazing practices that maintain ground cover and slow water velocity within strategic intermittent streams.

Within the floodplains of these strategic intermittent streams make a special effort to maintain ground cover and slow water velocity.

Discourage development in floodplains.

Encourage the retrofitting or relocation of floodprone structures.

Practice a multi objective planning approach to reducing flood risks. Floodprone structures might be located in ideal areas for riverside recreation. Also, these floodplains are the areas of greatest seismic instability being composed of soft alluvial soils that magnify ground shaking and are susceptible to liquefaction.

Encourage wet flood proofing practices where retrofitting and relocation are not possible.

Encourage the purchase of flood insurance.

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3.8. Severe Weather

Definitions

Blizzard: A storm with considerable falling and/or blowing snow combined with sustained winds or frequent gusts of 35 mph or greater that frequently reduces visibility to less than one-quarter mile. Blizzards typically are confined to the Columbia River Gorge and Northwest Washington near the Fraser River Valley of British Columbia.

Freezing Rain: This is the result of rain occurring when the temperature is below the freezing point. When this occurs the rain will freeze on impact and will result in a layer of glaze ice over everything it touches. Although the layer of glaze is generally quite thin it can measure up to one inch in depth. In a severe ice storm an evergreen tree measuring 20 meters high and 10 meters wide can be burdened with up to six tons of ice, creating a serious threat to power and telephone lines and transportation routes.

Severe Local Storms: These include what are termed "microscale" atmospheric systems: tornadoes, thunderstorms, windstorms, ice storms and snowstorms. Typically, major impacts from a severe storm are to transportation and loss of utilities. The major characteristic all of these events have in common is that their effects are usually limited in scope. Although one of these storms may cause a great deal of destruction and even death, its impact is generally confined to a small area.

Snowstorms: These are caused by a war between air of different temperatures and densities. This resultant low pressure system can cover thousands of square miles with snow. Snowstorms affecting Whitman County form along the mid-Pacific polar front and head south. Heavy snow in western Washington is generally confined to the mountains with heavy accumulation in the lowlands uncommon. Eastern Washington can expect snow during much of the winter.

Thunderstorms: This is the most common of severe weather systems. These are typically 25 kilometers in diameter and last 30 minutes from birth to growth through maturity to decay. Thunderstorms are underrated hazards. Lightning, which occurs with all thunderstorms, is a serious threat to human life nationwide. Heavy rains dumped in a small area over a very short time can lead to flash flooding. Strong winds, hail and tornadoes are also dangers associated with thunderstorms.

Tornados: Tornadoes are characterized by funnel clouds of varying sizes that generate winds as fast as 500 miles per hour. They can affect an area of ¼ to ¾ of a mile, with the path varying in width and length. Tornadoes can come from lines of cumulonimbus clouds or from a single storm cloud. They are measured using the Fujita Scale ranging from F0 to F6.

Windstorms: These are storms consisting of violent winds. There are several sources of windstorms. Southwesterly winds are associated with strong storms moving onto the coast from the Pacific Ocean. Southern winds parallel to the Cascade Mountains are the strongest and most destructive winds. Windstorms tend to damage ridgelines that face into the winds.

General Background

The location of the State of Washington on the windward coast in mid-latitudes is such that climatic elements combine to produce a predominantly marine-type climate west of the

Cascade Mountains, while east of the Cascades, the climate possesses both continental and marine characteristics.

The state's climate is impacted by two significant factors:

- Mountain ranges: The Olympic Mountains and the Cascade Mountains affect rainfall. The first major release of rain occurs along the west slopes of the Olympics, and the second is along the west slopes of the Cascade Range. Additionally, the Cascades are a topographic and climatic barrier. Air warms and dries as it descends along the eastern slopes of the Cascades, resulting in near desert conditions in the lowest section of the Columbia Basin in eastern Washington. Another lifting of the air occurs as it flows eastward from the lowest elevations of the Columbia Basin toward the Rocky Mountains. This results in a gradual increase in precipitation in the higher elevations along the northern and eastern borders of the state.
- Location and intensity of semi-permanent high and low-pressure areas over the North Pacific Ocean: During the summer and fall, circulation of air around a high-pressure area over the North Pacific brings a prevailing westerly and northwesterly flow of comparatively dry, cool and stable air into the Pacific Northwest. As the air moves inland, it becomes warmer and drier, resulting in a dry season. In the winter and spring, the high pressure resides further south while low pressure prevails in the Northeast Pacific. Circulation of air around both pressure centers brings a prevailing southwesterly and westerly flow of mild, moist air into the Pacific Northwest. Condensation occurs as the air moves inland over the cooler land and rises along the windward slopes of the mountains. This results in a wet season beginning in late October or November, reaching a peak in winter, and gradually decreasing by late spring.

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In interior valleys, measurable rainfall occurs on 150 days each year and on 190 days in the mountains and along the coast. Thunderstorms over the lower elevations occur up to 10 days each year and over the mountains up to 15 days.

During the wet season, rainfall is usually of light to moderate intensity and continuous over a period of time, rather than heavy downpours for brief periods; heavier intensities occur along the windward slopes of the mountains.

The strongest winds are generally from the south or southwest and occur during the fall and winter. In interior valleys, wind velocities reach 40 to 50 mph each winter, and 75 to 90 mph a few times every 50 years. The highest summer and lowest winter temperatures generally occur during periods of easterly winds.

The climate east of the Cascade Mountains has characteristics of both continental and marine climates. Summers are warmer, winters are colder, and precipitation is less than in western Washington. Extremes in both summer and winter temperatures generally occur when air from the continent influences the inland basin.

In the driest areas, rainfall occurs about 70 days each year in the lowland and about 120 days in the higher elevations near the eastern border and along the eastern slopes of the Cascades. Annual precipitation ranges from seven to nine inches near the confluence of the Snake and

Columbia Rivers in the Tri-Cities area, 15 to 30 inches along the eastern border and 75 to 90 inches near the summit of the Cascade Mountains. During July and August, four to eight weeks can pass with only a few scattered showers. Thunderstorms, most as isolated cells, occur on one to three days each month from April through September. A few damaging hailstorms are reported each summer.

During the coldest months, freezing drizzle occasionally occurs, as does a Chinook wind that produces a rapid rise in temperature. Chinook (a Native American word meaning "snow-eater") winds are warm, moist wind patterns originating in the Pacific Ocean during the winter that cool, and then rapidly warm as they pass over the western and eastern slopes of the Cascades and Rockies. On the Columbia Plateau they can cause drastic and rapid increases in temperature, which can also cause rapid snow melt and contribute to flooding. Whitman County averages about 28 inches of snow every year.

During most of the year, the prevailing wind is from the southwest or west. The frequency of northeasterly winds is greatest in the fall and winter. Wind velocities ranging from four to 12 mph can be expected 60 to 70 percent of the time; 13 to 24 mph, 15 to 24 percent of the time; and 25 mph or higher, one to two percent of the time. The highest wind velocities are from the southwest or west and are frequently associated with rapidly moving weather systems. Extreme wind velocities can be expected to reach 50 mph at least once in two years; 60 to 70 mph once in 50 years; and 80 mph once in 100 years.

Hazard Profile

Whitman County can periodically experience the effects of thunderstorms, dust storms, tornadoes, and in the winter, blizzards. Past events have shown that severe weather is typically not a major problem in Whitman County; rather the secondary hazards, such as flooding from heavy rain, cause most damage during and after a sever weather event.

Past Events

Due to relative infrequency and minimal severity, past severe storm events in Whitman County are not well documented. Whitman County, as well as all of Eastern Washington, Northern Idaho and parts of Oregon, was paralyzed by the January 13, 1950 Blizzard. Some of the worst severe weather occurred in March 1989, which consisted of heavy rains and sheet flooding and caused Whitman County to be declared a Presidential Disaster Area. In October 1991, there was a firestorm and high winds that also caused the County to be declared a Presidential Declared Disaster. A storm in February 1996 caused major flooding in the County. This event was also declared a Presidential Disaster, and allowed the County to receive about $1.2 million in federal assistance.

Location

Due to its location on the high Columbia Plateau between the Cascades and Rockies, Whitman County can experience the see-saw effects of Chinook Winds during the winter. Precipitation typically falls as snow, but the winds can cause temperature changes of 50° Fahrenheit in a matter of hours. Because of the elevation though, Whitman County does not see much of the extreme summer weather, such as tornadoes and hail that is found just north in Spokane County.

Frequency

Severe weather tends to be rather infrequent. Secondary effects, such as flooding, cause most damage. Whitman County will experience about one hail event each year, but damage is usually non-significant. Tornadoes are infrequent, as the county may experience one about every 20 years. The Washington State Hazard Mitigation Plan lists recurrence rates for severe weather events in Whitman County. These are shown below in Table 3.14.

Table 3.14: Recurrence Rates for Severe Weather Events in Whitman County

Severe Weather Frequencies	
severe weather type	*recurrence rate**
High Winds	93%
Thunderstorms	43%
Winter Storm	30%
Dust Storm	5%
Tornado	5%
Blizzard	0%

*100%= Once per Year, 5%= Once Every 20 Years

Severity

The most severe of storms in Whitman County can drop large amounts of rain or snow in short amounts of time. The Blizzard of 1950 dropped at least 50" of snow in the Whitman County area. Tornados and hail are infrequent and usually cause minor, isolated damage, most often to crops.

Warning Time

Meteorologists can often predict the likelihood of the onset of a severe storm. This can give several days of warning time. However they cannot predict the actual severity or where the most severity will occur. Hail storms and tornados can be predicted hours to minutes before they occur; as meteorologists watch particular events unfold.

Secondary Hazards

The most detrimental effects of severe weather are the secondary hazards that can be triggered by them. Most storm related damage in the county usually occurs after the storm in the form of heavy and rapid flooding. The heavy rains can cause rapid run-off and contribute to erosion. Thunderstorms and lightening strikes can trigger brush fires that can spread rapidly. Other effects of severe weather is downed power lines. These secondary hazards are dealt with in more detail in their respective sections in the Risk Assessment. For floods see page 3-23 and for wildfires see page **Error! Bookmark not defined.**.

Exposure and Vulnerability

All of the people, property and infrastructure, and the natural environment of Whitman County are potentially exposed to the effects of severe weather. Nonetheless, severe weather events are relatively infrequent and less severe than in other parts of the State. Spokane

County, the next County north of Whitman typically experiences damaging severe weather such as hailstorms and tornados, while Whitman County may experience nothing. This is due to its location high on the Columbia Plateau between the Snake and Spokane River Valleys, which seem to channel the extreme weather. The County does have some vulnerabilities to severe weather which are discussed below.

Population

The whole population (41,000) of Whitman County is exposed to severe weather. The populations most vulnerable to severe weather are those with inadequate shelter and those located in isolated areas, which an infrequent tornado or hailstorm may cause significant damage. About 15% of Whitman County's population, about 6,300 people, live in unincorporated areas. This population tends to be widely dispersed throughout the County. Heavy snow with cold weather can also be a problem for vulnerable populations. Emergency responders may not be able to identify quickly where these problems may occur, and thus not be able to assist isolated people.

Property and Infrastructure

All property and infrastructure in the County is exposed to the effects of severe weather. Severe weather tends to mostly affect transportation infrastructure and utilities. Power lines can be knocked down by heavy winds or frozen ice, and landslides and minor flooding can block roads. Crops can also be destroyed by hail and tornadoes. Blizzards and heavy snow, as well as dust storms, can limit visibility and potentially isolate scattered farms, rural homes and small communities. The County does have a dense road network though, which decreases the vulnerability due to isolation somewhat.

Environment

The whole natural environment of the county is potentially exposed to severe weather. The County is primarily crop and grazing land with scares tree cover and does not support any significant or endangered animal or fish populations, so the vulnerability of the environment is minimal. The secondary effects of severe weather, such as flash flooding, can erode stream banks which may disrupt animal populations that inhabit the riparian areas.

Scenario

Severe weather could occur during the winter when Chinook winds accompanied by heavy rains drops precipitation over frozen snow and cause heavy runoff and eventually flooding. The heavy rain may also knock down ice covered power lines. Also during the winter, Whitman County may experience a blizzard that causes white-out conditions, blocking roads and isolating scattered rural homes and communities. During the summer, an isolated thunderstorm can produce a tornado that occurs near a population center and cause significant damage to property. Lightening strikes during the dry, hot summer can also cause wildfires that may spread out of control. The wind events can knock down power and phone lines, cutting off communication and electricity.

Issues/Recommendations

Severe weather cannot be prevented, but nonetheless measures can be taken to mitigate the effects. Critical infrastructure and utilities can be hardened to prevent damage during an event. The secondary effects of flooding can be addressed through decreasing run off and water velocity and "Firewise" measures can reduce the impact of flashy brush fires on developments.

3.9. Volcano

Definitions

Ash Fall: Volcanoes tend to erupt lavas so thick and charged with gases that they explode into ash rather than flow.

Debris Avalanches: Volcanoes are prone to debris and mountain rock avalanches that can approach speeds of 100 mph.

Debris Flows: These are dense mixtures of water-saturated debris that move down-valley; looking and behaving much like flowing concrete. They form when loose masses of unconsolidated material are saturated, become unstable, and move down slope. The source of water varies but includes rainfall, melting snow or ice, and glacial outburst floods.

Lahars: Lahars are rapidly flowing mixtures of water and rock debris that originate from volcanoes. While lahars are most commonly associated with eruptions, heavy rains, and debris accumulation, earthquakes may also trigger them. They may also be termed debris or mud flows.

Lateral Blasts: These are explosive events in which energy is directed horizontally instead of vertically from a volcano. They are gas charged, hot mixtures of rock, gas and ash that are expelled at speeds up to 650 mph.

Lava Flows: Lava flows are normally the least hazardous threat posed by volcanoes. Cascades volcanoes are normally associated with slow moving andesite or dacite lava.

Pyroclastic Flows and Surges: Pyroclastic flows are avalanches of hot (570-1470° F) ash, rock fragments and gas that move at high speeds down the sides of a volcano during explosive eruptions or when the edge of a thick, viscous, lava flow or dome breaks apart or collapses. Speeds range from 20 to more than 200 miles per hour.

Stratovolcano: The volcanoes in the Cascade Range in Snohomish County are all stratovolcanoes. They are typically steep-sided, symmetrical cones of large dimension built of alternating layers of lava flows, volcanic ash, cinders, blocks, and bombs and may rise as much as 8000 feet above their bases.[37]

Tephra: The ash and the large volcanic projectiles that erupt from a volcano into the atmosphere are called tephra. The largest fragments (2½ inches) fall back to the ground fairly near the vents, as close as a few feet and as far as 6 mi. The smallest rock fragments (ash) are composed of rock, minerals, and glass that are less than 1/8 inch in diameter. Tephra plume characteristics are affected by wind speed, particle size, and precipitation.

Volcanic Gases: All active volcanoes emit gases. These gases may include steam, carbon dioxide, sulfur dioxide, hydrogen sulfide, hydrogen, and fluorine.

[37] USGS Cascade Volcano Observatory

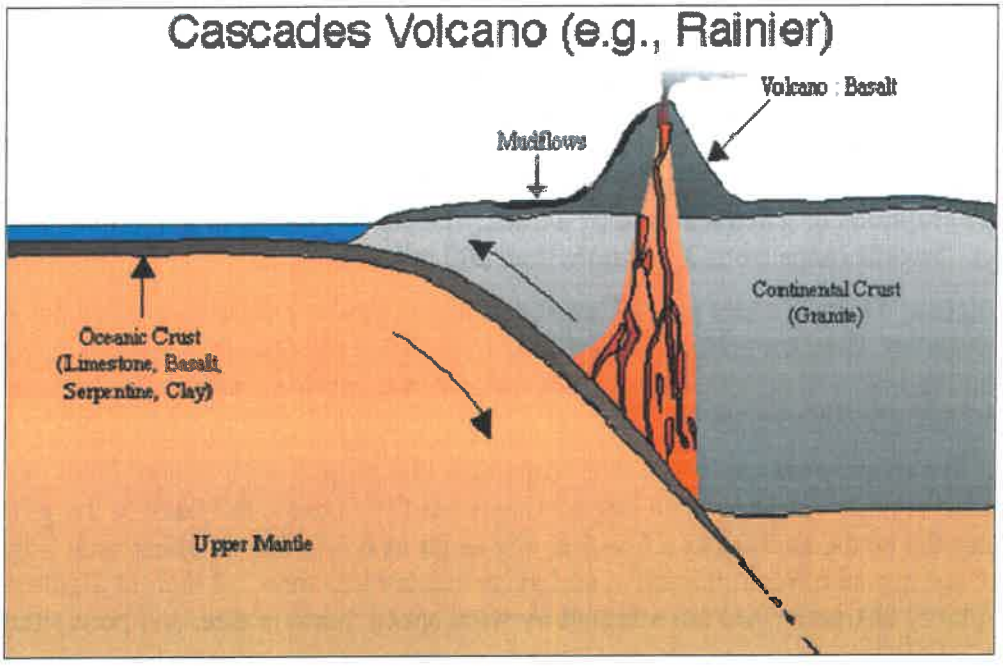
General Background[38]

A volcano is a vent in the earth's crust through which magma, rock fragments, gases, and ash are ejected from the earth's interior. Over time, accumulation of these erupted products on the earth's surface creates a volcanic mountain.

Washington State has five major volcanoes in the Cascade Range – Mount Baker, Glacier Peak, Mount Rainier, Mount St. Helens and Mount Adams. Mt Hood, located in northern Oregon, can also affect the State.

Volcanoes can lie dormant for centuries between eruptions, and the risk posed by volcanic activity is not always apparent. When Cascade Mountain Range volcanoes do erupt, high-speed avalanches of hot ash and rock called pyroclastic flows, lava flows, and landslides can devastate areas 10 or more miles away, while huge mudflows of volcanic ash and debris called **lahars** can inundate valleys more than 50 miles downstream. Falling ash from explosive eruptions, called **tephra,** can disrupt human activities hundreds of miles downwind, and drifting clouds of fine ash can cause severe damage to the engines of jet aircraft hundreds or thousands of miles away.

Figure 3.31: How Cascade Volcanoes are Formed[39]



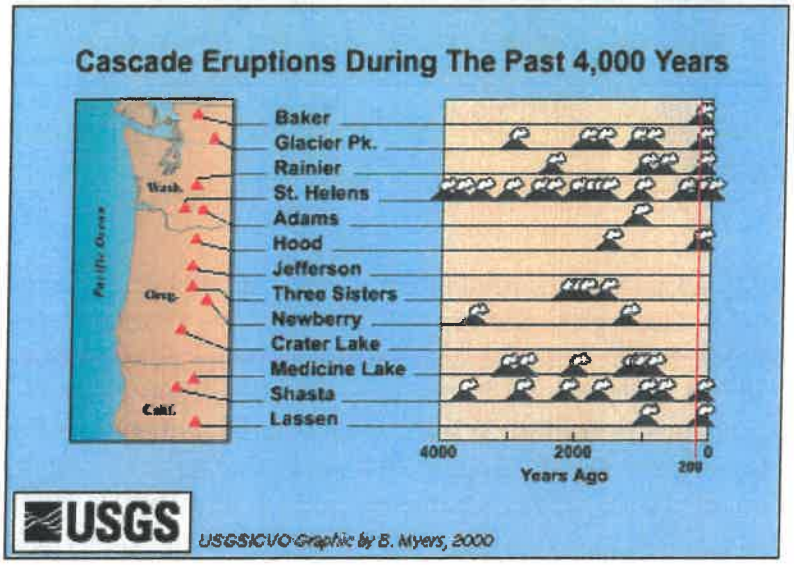
[38] Washington State Draft HIVA, 2003, Volcano Profile
[39] http://www.ruf.rice.edu/~leeman/Cascades.gif

Hazard Profile

Past Events

Geologically speaking, volcanic eruptions are quite frequent. Figure 3.32 shows a list of past eruptions from volcanoes in the Cascades over the last 4,000 years. From a human standpoint though, they are quite infrequent and may only occur every few generations or more. The last major volcanic eruption was quite recent though, with the explosion of Mt. St. Helens on May 18, 1980. Due to its great distance, and location across the continental divide of the Cascades, the lava and lahar flow from this eruption did not (and could not) affect Whitman County. The County though is almost directly downwind from the volcano, and thus saw about ¾ inch of tephra (ash) fall. This tephra fall was more of a curiosity than a hazard. Schools and businesses were closed for day or so, but no major disruptions or harm were done to the County, especially after it was cleaned up within a few days.

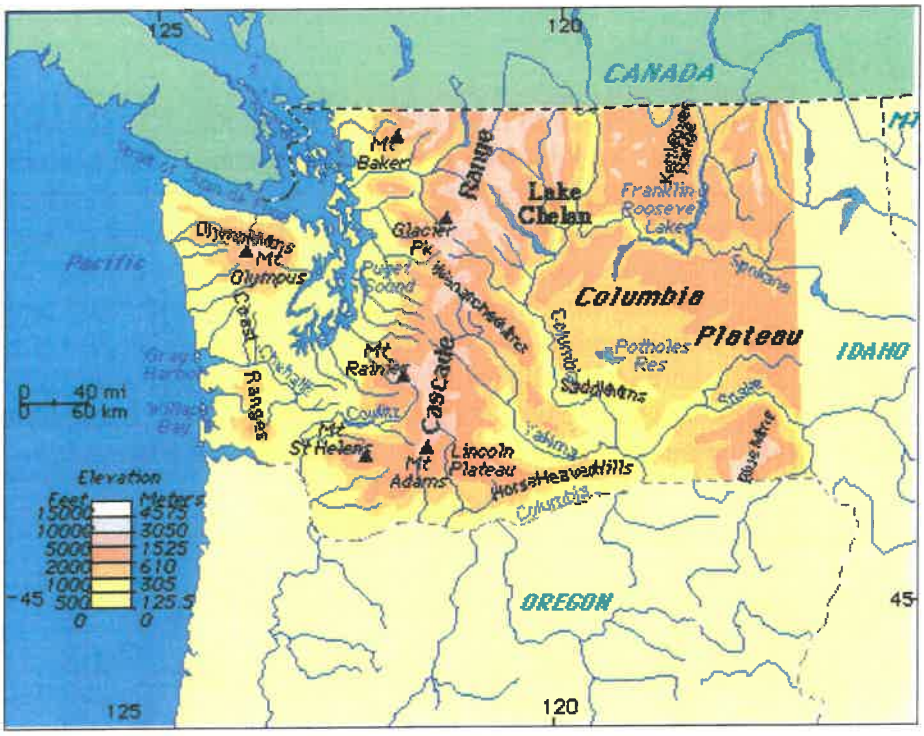
Figure 3.32: Past Volcanic Events



Location

The Cascade Range extends more than 1000 miles from southern British Columbia into northern California and includes thirteen potentially active volcanic peaks in the U.S. The mountains begin approximately 150 miles west of Whitman County, and are 70- 80 miles wide in this part of the range. Many of these volcanoes are far from the County and/or not directly downwind from them. The most hazardous volcanoes are those directly west and southwest of the County. The closest volcanoes southwest are Mt. Adams, (175 miles), Mt St. Helens (215 miles) and Mt. Hood (230 miles). Mt Rainier is about 190 miles west of the county. Figure 3.33 shows the location of the Cascade Mountains in Washington State. Whitman County is located on the map just north of the Snake River.

Figure 3.33: Location of Cascade Mountains and Volcanoes[40]

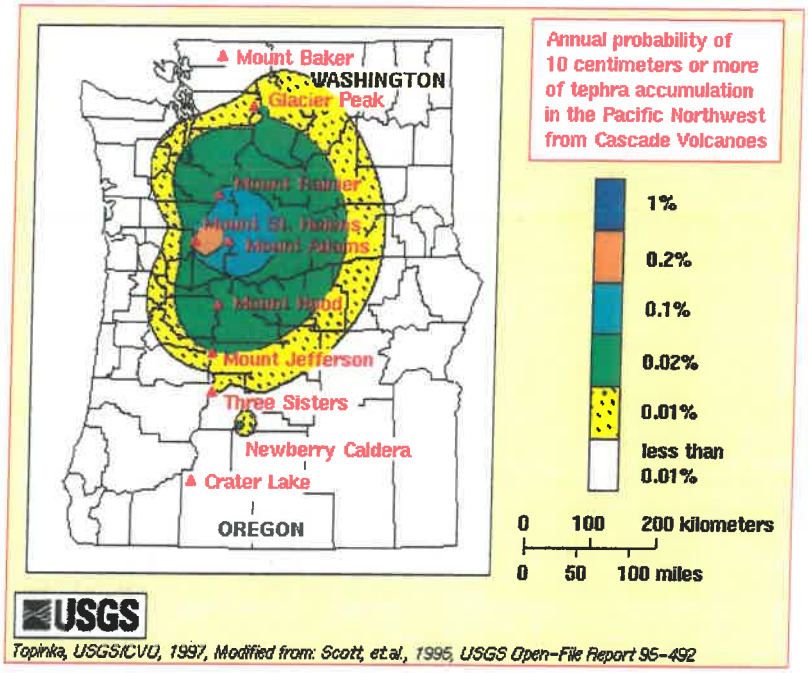


Frequency

Eruptions in the Cascades have occurred at an average rate of 1-2 per century during the last 4,000 years. The U.S. Geological Service (USGS) classifies Glacier Peak, Mt. Adams, Mt. Baker, Mt. Hood, Mt. St. Helens, and Mt. Rainier as being potentially active Washington state volcanoes. Mt. St. Helens is by far the most active volcano in the Cascades, with four major explosive eruptions in the last 515 years. The actual probability of an eruption in any given year is extremely low though. Figure 3.34 shows the annual probability of a tephra (or ash) accumulation of 10 or more centimeters (about 4 inches). The probability of 10 centimeters or more of tephra accumulation affecting Whitman County is less than 0.01% in any given year.

[40] http://www.eigenvector.com/maps/Washington.gif

Figure 3.34: Annual Probability of Tephra Fall in the Northwest



Severity

A one-inch deep layer of ash weighs an average of ten pounds per square foot causing danger of structural collapse. Ash is harsh, acidic, gritty, and it has a sulfuric odor. Ash may also carry a high static charge for up to two days after being ejected from a volcano. An ash cloud combines with rain, sulfur dioxide in the cloud combines with water to form diluted sulfuric acid that may cause minor, but painful burns to the skin, eyes, nose, and throat.

Warning Time

Constant monitoring of all active volcanoes means that there will be more than adequate time for evacuation before an event, and adequate time to find shelter or protect property after an event. Since 1980, Mt. Saint Helens, (which serves as a proxy for all the other Cascade Volcanoes) has settled into a pattern of intermittent, moderate and generally non-explosive activity, and the severity of tephra, explosions, and lava flows have diminished. All episodes, except for one very small event in 1984, have been successfully predicted several days to 3 weeks in advance. However, scientists remain uncertain as to whether the current cycle of explosivity has ended with the 1980 explosion. The possibility of further large-scale events continues for the foreseeable future.[41]

Exposure and Vulnerability

Whitman County is only moderately exposed to an eruption of a volcano. The County is located generally downwind of four volcanoes, and could potentially experience the impacts of a tephra fall from any of these. Using the latest eruption of Mt. St. Helens as an indicator, a tephra fall in Whitman County would be anywhere from ½ inch to one inch. Nonetheless,

[41] Tilling, Robert I., Lyn Topinka, and Donald Swanson. "Eruptions of Mt. Saint Helens: Past, Present and Future," USGS Special Interest Publication, 1990.

some people, property, and the environment are vulnerable to the effects of a tephra fall. These are discussed below.

Population

The whole population of Whitman County is exposed to the effects of a tephra fall. The populations most vulnerable to the effects of a tephra fall are the elderly, the very young and those already experiencing ear, nose and throat problems. Homeless people, who may lack adequate shelter, are also vulnerable to the effects of a tephra fall, although Whitman County has few, if any, homeless people who would not be able to find adequate shelter or assistance during an event.

Property

All of the property and infrastructure exposed to nature in the County are exposed to the effects of a tephra fall. Vulnerable property includes equipment and machinery left out in the open, such as combines, whose parts the fine dust can clog. Since Whitman County receives snow every year, and roofs are built to withstand snowloads, most roofs are not vulnerable and would be able to withstand the potential load of ash. Infrastructure, such as drainage systems, are also potentially vulnerable to the effects of a tephra fall, since the fine ash can clog up pipes and culverts. This may be more of a problem if an eruption occurs during the winter or early spring when precipitation is highest and floods are most likely to occur.

Environment

The treeless, rolling landscape leaves the environment, particularly animals, exposed to a tephra fall from a volcanic eruption. Whitman County though does not serve as a major habitat for any protected species, so thus it is unlikely for any animal populations to be adversely affected. Tephra run-off can also potentially damage stream habitats, although this was not observed in Whitman County after the Mt. St. Helens eruption in 1980.

Scenario

The worst case scenario for Whitman County (and the region) would be a massive eruption from Mt. Hood that sent a tephra cloud downwind to Whitman County (although Mt. Hood is southwest of Whitman County, the prevailing southwest winds would blow ash directly over the county). No one would be injured or killed from the subsequent ash fall, but businesses and non-essential government would be closed for the period of time until the cloud passes. This could be a few days. People and animals without shelter will also be affected. Structures would be safe, but private property left out in the open, such as farm equipment, might be damaged by the fine ash dust.

Issues/Recommendations

Presently volcanic eruptions are not a major hazard issue in Whitman County. There are proper warning time and awareness mechanisms currently in place. The major issues that would come about, as with other disaster events, are clean-up costs.

3.10. Wildland Fire

Definitions

Brush fires: These are fast-moving fires that ignite grass, shrubs, bushes, scrub oak, chaparral, marsh grass (cattails), and grain fields. This is the type of wildfire most likely to affect Whitman County.

Conflagration: A conflagration is a fire, which grows beyond its original source area to engulf adjoining regions. Wind, extremely dry or hazardous weather conditions, excessive fuel buildup and explosions are usually the elements behind a wildfire conflagration.

Forest Fire: Forest fires are the uncontrolled destruction of forested lands caused by natural or human-initiated events. Wildfires occur primarily in undeveloped areas; these natural lands contain dense vegetation such as forest, grasslands or agricultural croplands. Because of their distance from firefighting resources and manpower, these fires can be difficult to contain and can cause a great deal of destruction.

Firestorm: This term describes a fire that expands to cover a large area, often more than a square mile. A firestorm usually occurs when many individual fires grow together to make one huge conflagration. The involved area becomes so hot that all combustible materials ignite, even if they are not exposed to direct flame. Temperatures may exceed 1000° Celsius as the fire creates its own local weather: superheated air and hot gases of combustion rise upward over the fire zone, drawing surface winds in from all sides, often at velocities approaching fifty miles per hour. Although firestorms seldom spread because of the inward direction of the winds, once started there is no known way of stopping them. Within the area of the fire, lethal concentrations of carbon monoxide are present; combined with the intense heat this hazard poses a serious life threat to responding fire forces. In exceptionally large events, the rising column of heated air and combustion gases carries enough soot and particulate matter into the upper atmosphere to cause cloud nucleation, creating a locally intense thunderstorm and the hazard of lightning strikes.

Interface Area: An area susceptible to wildland or forest fires because Wildland vegetation and urban or suburban development occur together.

General Background

Wildland fires are fires caused by nature or humans that result in the uncontrolled destruction of forests, brush, field crops, grasslands, and real and personal property. The wildland fire season in Washington usually begins in early July and typically culminates in late September with a moisture event; however, wildland fires have occurred in every month of the year. Drought, snow pack, and local weather conditions can expand the length of the fire season. The early and late shoulders of the fire season usually are associated with human-caused fires. Lightning generally is the cause of most fires in the peak fire period of July, August and early September.

Short-term loss caused by a wildland fire can include the destruction of timber, wildlife habitat, scenic vistas, and watersheds; vulnerability to flooding increases due to the destruction of watersheds. Long-term effects include smaller timber harvests, reduced access

to affected recreational areas, and destruction of cultural and economic resources and community infrastructure.

The Washington Department of Natural Resources protects 2.5 million acres of state-owned land and 10 million acres of land in private ownership through legislative directive [RCW 76.04]. The department fights about 1,000 wildland fires per year across the state; about 70 percent are in Eastern Washington. Most are small, usually extinguished while they are less than one acre in size. People start most wildland fires on state lands; major causes include arson, recreational fires that get out of control, smoker's carelessness, debris burning, fireworks and children playing with fire. The major cause of fires on federally protected lands is lightning.

Wildland fires can spread to more than 100,000 acres, depending on a number of factors, and may require thousands of firefighters and several months to extinguish. Federal, state, county, city, and private agencies and private timber companies provide fire protection and firefighting services on forestlands in Washington.

Based on figures from 1992 to 2001 (the latest available in spring 2003), the probability of future wildland fires on state-owned or protected lands are as follows:

- Annual human-caused fires – More than 500, burning about 4,404 acres total.
- Annual lightning-caused fires – More than 135 fires, burning about 10,866 acres total.

Factors that Influence Wildland Fire

A fire needs three elements in the right combination to start and grow – a heat source, fuel, and oxygen. How a fire behaves primarily depends on the characteristics of available fuel, weather conditions, and terrain.

- Fuel:
    - Lighter fuels such as grasses, leaves and needles quickly expel moisture and burn rapidly, while heavier fuels such as tree branches, logs and trunks take longer to warm and ignite.
    - Snags and hazard trees – those that are diseased, dying, or dead – are larger west of the Cascades, but more prolific east of the Cascades. In 2002, about 1.8 million acres of the state's 21 million acres of forestland contains trees killed or defoliated by forest insects and diseases.
- Weather:
    - East of the Cascades, summer drying typically starts in mid June and runs through early September, with drought conditions extending this season. Passage of a dry, cold front through this region can result in sudden increase in wind speeds and a change in wind direction affecting fire spread.
    - Thunderstorm activity, which typically begins in June with wet storms, turns dry with little or no precipitation reaching the ground as the season progresses into July and August. Thunderstorms with dry lightning are more prevalent in Eastern Washington.

- Terrain:
  - Topography of a region or a local area influences the amount and moisture of fuel.
  - Barriers such as highways and lakes can affect spread of fire.
  - Elevation and slope of landforms – fire spreads more easily as it moves uphill than downhill.

The peak burning period of a fire generally is between 1 p.m. and 6 p.m., with local factors (generally described above) greatly influencing this. Wildland fires can take on a life of their own when there is plenty of heat and fuel. They can create their own winds and weather, generating hurricane force winds of up to 120 miles per hour. Fires can heat fuels in their path, drying them out, and making them easier to ignite and burn.

Hazard Profile

Whitman County has a low risk to wildfires. It is not as exposed as other counties in the region nor is it as vulnerable. This is due to the fact that 76% of the land is cultivated for crops while another 5% is urbanized. The County has few trees, and where they do exist, are located along the eastern border near Idaho where the County receives more precipitation. The County though is exposed, and somewhat vulnerable, to brush fires. Whitman County's exposure and vulnerability to wildland fires is detailed below.

Past Events

Whitman County does not have a history of wildfires. Every few years minor brush fires break out in some of the canyons along the Snake River or in areas adjacent to railroad tracks or roads. These are most often caused by humans. The County was affected by the Firestorm of 1991, which caused significant damage and injuries in the Spokane area. Six counties, including Whitman County, were declared federal disaster areas (Federal Disaster #922) and received $12.3 million in Stafford Act assistance. It is not known how much damage the County received, if at all, as the 35,000 acres burned were confined primarily to the Spokane area. This fire was caused by high winds that downed power lines, igniting small fires, which in turn were spread and expanded by the high winds.

Location

If a wildfire or major brush fire were to occur in Whitman County, it would most likely occur in the western part of the County where there is less precipitation and large areas of cultivated land are fallow because of participation in Conservation Reserve Program[42] (CRP). The purpose of this program is to pay farmers to not cultivate lands which are highly erodable, and thus maintain the usable life of the soil. Wildfires can also occur on lands that are used as pasture or open range. Other areas include steep canyons near the Snake River and the scablands in the northwest part of the county. The Washington State Hazard

[42]Conservation Reserve Program http://www.fsa.usda.gov/dafp/cepd/crp.htm

Mitigation Plan also designates the northern part of the county adjacent to the border to Spokane County as a wildfire risk area.

Frequency

Small, minor brush fires, particularly in the remote canyons along the Snake River, can be expected at least every year, especially during the dry hot summer months. Many of these are caused by human carelessness, such as from fireworks or even cigarettes tossed from vehicles. Passing trains are also known to cause sparks which can trigger wildfires. There is no record of any major fires and thus a frequency for an occurrence is not known.

Severity

As mentioned above, wildfires in Whitman County tend to be small and usually confined to remote areas. There is no record of property or infrastructure being damaged by wildfires in the County.

Warning Time

Wildfires are typically caused by humans, whether intentionally or accidentally. There is no way to predict when one might break out then. Since it is reported that fireworks often cause brush fires, extra diligence might need to be taken during time around the Forth of July when the use of fireworks is highest. Dry lightening may also trigger wildfires. Severe weather can be predicted so special attention can be made during weather events that may trigger wildfires. If a fire does break out, and spreads rapidly, residents may only have days to even hours to evacuate.

Exposure and Vulnerability

Whitman County has few, if any, of its population, property and infrastructure exposed to potential wildfires. Scattered homes, ranches and communities in the western part of the County may be at higher risk, especially during the summer. Fallow lands under the CRP may be more vulnerable to wildfire. Most CRP land is also located in the western part of the state. Due to the Firestorm of 1991, the Washington State Hazard Mitigation Plan also maps the northern part of the County as a vulnerable area. Figure 3.35 at the end of this section shows a composite map of CRP lands and the area identified in the Washington HMP.

These areas are most vulnerable to the wildfires, especially brush fires.

Scenario

A wildfire in Whitman County would most likely occur during an extremely hot, dry summer, perhaps during a period of prolonged drought. There could be numerous causes: people playing with fireworks, sparks from machinery, such as farm equipment or automobiles, or even a lightening strike during a summer thunderstorm. Whatever the cause, a small local brush fire, fanned by heavy winds, could disperse embers, triggering more fires that could eventually merge into one or many large fires that don't burn out on their own. These brush fires could eventually reach scattered homes and farms, or even spread to some of the small communities in the area, such as Hay, La Crosse or Lamont. These fires could overwhelm emergency responders and resources and could lead to the evacuation of towns and possibly even some structures being destroyed.

Issues/Recommendations

Communities located in the dryer western portions of the County should participate in Firewise Programs.

http://firewise.org/

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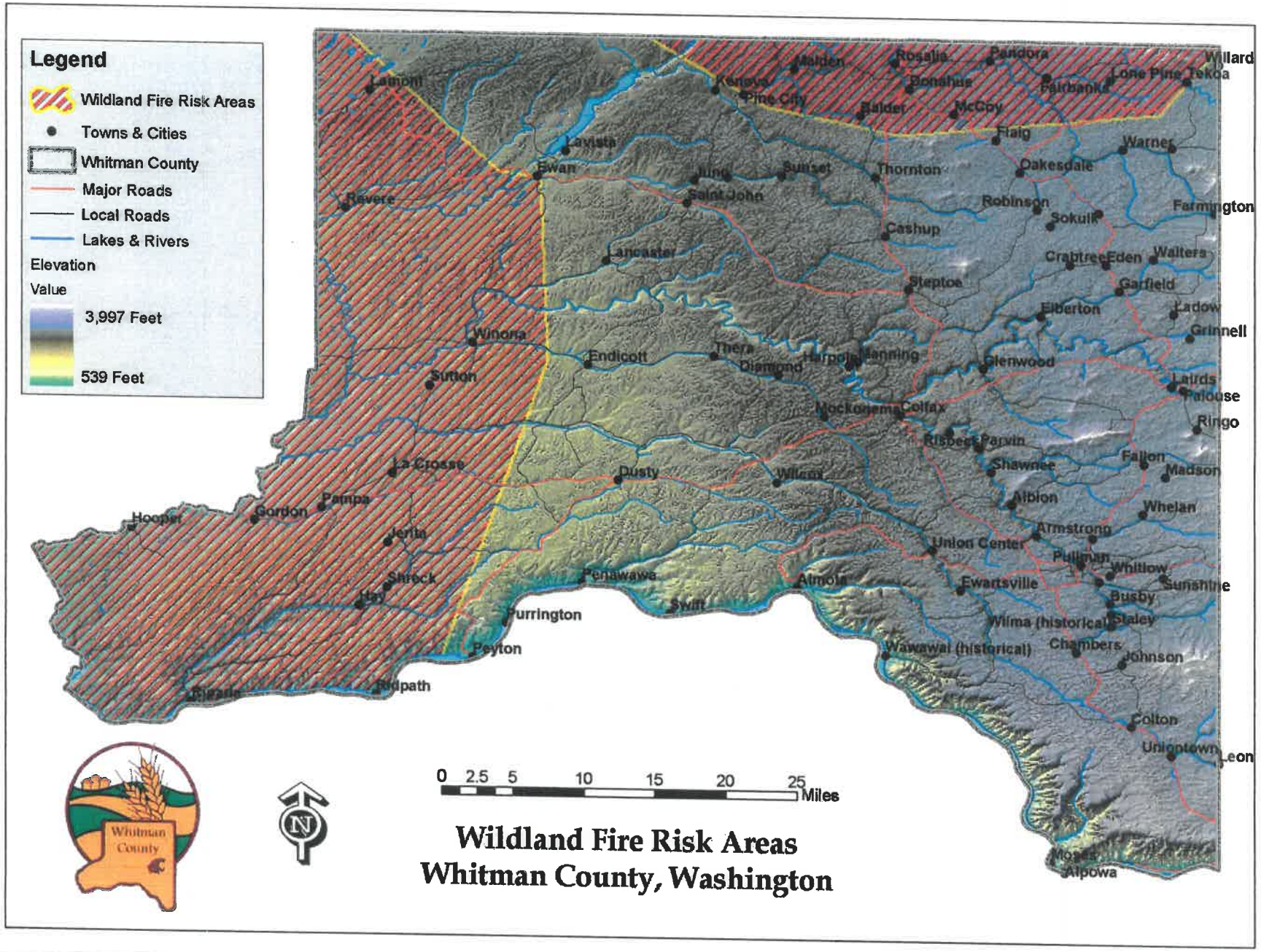
Figure 3.35: Wildland Fire Risk Areas



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3.11. Loss Estimation

The purpose of this section is to determine to potential effect, in terms of people and property, that a natural hazard may have on the County. Although it is impossible to predict what damage or injuries any one event may cause, it is possible to estimate potential losses based on past events, frequency of events, and predicted severity of an event. Used in conjunction with a detailed building inventory and population count, a general idea of loss can be estimated.

For this Whitman County HIVA, a very preliminary loss estimation has been put together. The purpose is paint a general picture of what potential losses Whitman County faces. This loss estimation is not totally accurate, and will need to be revised in the future, but nonetheless serves as a good starting point to determine where efforts should be focused to mitigate the detrimental effects of natural hazards.

Population and building counts were gathered from HAZUS-MH, a GIS-based hazard modeling program developed by FEMA, and 2000 U.S. Census Data for Whitman County. Loss estimation assumptions by hazard were gathered from the FEMA State and Local Mitigation Planning How-to Guides.

General assumptions include:

In 2000, Whitman County had a population of 40, 740.

Whitman County has approximately 10,700 structures, 99% of which are residential.

Total exposure value of all structures, including contents, is $3,753,026,000.

This averages out to an overall value for each property, including the building and its contents value (TV, DVD players, cars, etc.) of $350,325. Keep in mind this includes all properties, from large businesses like Washington State University to rural mobile homes.

The average household size in Whitman County is 2.31 people per home.

The next sections will give loss estimation by hazard, where applicable.

Drought

Drought typically is more of an economic hazard than a destructive hazard. Drought does not damage buildings or injure people per se, but can cause widespread unemployment and displacement.

Population affected: 40,740

Property affected (# of structures): 10,700

Property affected ($ value): $3.753 Billion

Potential losses: N/A

Earthquake

To estimate losses for earthquakes, the highest predicted PGA that Whitman County may experience (.075) was used in conjunction with the assumption that most buildings in the County are wood frame, pre-code construction (Hazus-MH indicated that 83% of structures are wood frame, with manufactured homes being the second largest percentage). The building damage ratio for these assumptions is 0.4%. Content loss is usually about half this ratio, so the total ratio is .06%

Population affected: 40,740

Property affected (# of structures): 10,700

Property affected ($ value): $3.753 Billion

Potential losses: $225,181,560

Flood

The flood loss estimation was based on an inventory of exposed structures located in the floodway, 100-year, or 500-year floodplains. Population was calculated by multiplying the number of structures estimated by the average household size in Whitman County. Potential losses were calculated by using a one story, no basement building experiencing a 2 foot flood as a model. This was assumed to be the dominant building height in the floodplain, and the likely depth of floods. Structure loss was assumed to be 22%, while content loss was assumed to be 33% of value.

Population affected: 1,500

Property affected (# of structures): 650

Property affected ($ value): $227,711,250

Potential losses: $125,241,187

Severe Weather

Severe Weather does not have a history of causing widespread damage to property throughout the County. For this study, it was decided to use 0.01% as the loss ratio for severe weather.

Population affected: 40,740

Property affected (# of structures): 10,700

Property affected ($ value): $3.753 Billion

Potential losses: $37,530,260

Volcano

Volcanic eruptions and the subsequent tephra falls do not cause much damage in the County, but may cause economic disruptions for a few days. The ratio used for this estimate is 0.001%.

Population affected: 40,740

Property affected (# of structures): 10,700

Property affected ($ value): $3.753 Billion

Potential losses: $3,753,026

Wildfire

Wildfire can potentially affect the western and northern parts of the County. Analysis of Census blocks using Hazus-MH indicates the population and structures exposed. FEMA suggests using a 40% loss ratio for areas of moderate fire risk.

Population affected: 3000

Property affected (# of structures): 1,200

Property affected ($ value): $420,389,358

Potential losses: $168,155,743

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4. Risk Rating

A risk rating has been completed for each of the major hazards described in this plan. For the purposes of this plan, the risk rating is a function of two factors. The first factor describes the probability that a hazard event will occur. The second factor describes the impact of the event. This is typically considered both in number of people affected and amount of dollar loss caused by the hazard event. Estimates of risk for Whitman County were based on the methodology that IHMP used in other Hazard Inventory and Vulnerability Analyses (HIVA) and Hazard Mitigation Plans (HMP). This fulfills the Washington Administrative Code (WAC 118-30-060(1)) requirement. Please note that the Risk Ranking differs somewhat in methodology than that used in the Loss Estimation in Section 3.11, although the results are similar. The Risk Ranking is based more on past events and thus is more subjective.

1.1. Probability of Occurrence

The probability of occurrence of a hazard event provides an estimation of how often the event occurs. This is generally based on the past hazard events that have occurred in the area and the forecast of the event occurring in the future. This is done by assigning a probability factor, which is based on yearly values of occurrence. The numerical value assigned to each category will be used to determine risk rating of each hazard. These are allotted as follows:

High - Hazard event is likely to occur within 5 years (Numerical value **3**)

Medium – Hazard event is likely to occur within 50 years (Numerical value **2**)

Low – Hazard event in not likely to occur within 50 years (Numerical value **1**)

Table 4.1: Probability of Hazard Occurrence

Hazard Event	Probability	Numerical Value
Drought	High	3
Flooding	High	3
Severe Weather	High	3
Wildland Fire	Medium	2
Volcano	Low	1
Earthquake	Low	1

1.2. Impact

The impact of each hazard was divided into two categories, impact to people and impact in dollar loss. These two categories were also assigned weighted values. Impact to people was given a weighted factor of 3 and impact of dollar losses was given a weighted factor of 2. For impact to people the categories were broken down as follows:

High - Hazard event seriously affects **greater than 1000 people** (Numerical value **3**)

Medium – Hazard event seriously affects **251-1000 people** (Numerical value **2**)

Low – Hazard event seriously affects **0-250 people** (Numerical value **1**)

Table 4.2: Impact to People from Hazards

Hazard Event	Impact	Numerical Value	Multiplied by Weighted Value of 3
Flooding	High	3	9
Earthquake	Medium	2	6
Severe Weather	Medium	2	6
Drought	Low	1	3
Volcano	Low	1	3
Wildland Fire	Low	1	3

For the impact in dollar loss, it was estimated what the dollar loss would be from a major event of each hazard. For impact in dollar loss, the categories were broken down as follows:

High - Hazard event causing damages **over $10 million** (Numerical value **3**)

Medium – Hazard event causing damages **between $1 and $10 million** (Numerical value **2**)

Low – Hazard event causing damages **less than $1 million** (Numerical value **1**)

Table 4.3: Impact in Dollar Losses for Hazards

Hazard Event	Impact	Numerical Value	Multiplied by Weighted Value of 2
Flood	High	3	6
Drought	Medium	2	4
Severe Weather	Medium	2	4
Earthquake	Medium	2	4
Wildland Fire	Medium	2	4
Volcano	Low	1	2

1.3. Risk Rating

The risk rating for each hazard was determined by multiplying the assigned numerical value for probability to the weighted numerical value of impact to people added to the weighted numerical value of dollar losses. The following equation expresses the risk rating calculation:

Risk Rating = Probability * Impact (people +dollar losses)

Table 4.4: Risk Rating

Hazard Event	Probability	Impact	Total (Probability *Impact)
Flood	3	9+6	45
Severe Weather	3	6+4	30
Drought	3	3+4	21
Wildland Fire	2	3+4	21
Earthquake	1	6+4	10
Volcano	1	3+2	5

The risk ratings were developed to help focus the mitigation strategies to areas that warrant greatest attention. The hazards were given an overall risk rating which ranked them in relation to one another.

The highest risk ratings such as floods and severe weather warrant major mitigation programs with attention to preparedness, response and recovery until the mitigation program has be implemented.

The medium risk ratings such as drought and wildland fire warrant modest program effort.

The low risk ratings such as earthquake and volcano warrant no special mitigation effort although inexpensive or all hazards preparedness, response and recovery measures may be warranted.