

2.0 Development Process of the Floodplain Management Plan

The documentation of the process used to develop the FMP is described in this section. This includes a complete assessment of flood hazards, whether for loss of life or property damage. The process of developing the plan also includes records of meetings and public involvement activities.

2.1 Floodplain Hazard Assessment

Numerous reports and studies exist that describe the problems associated with flooding along Wildcat Creek. The References section near the end of this report presents a bibliography of these resources. The following sub-sections describe the flood hazards for different reaches along Wildcat Creek.

Areas susceptible to flooding along Wildcat Creek are rural residential areas in the County, southern Keats and the western and southern sides of Manhattan, which are along the stream and in the adjacent floodplains.

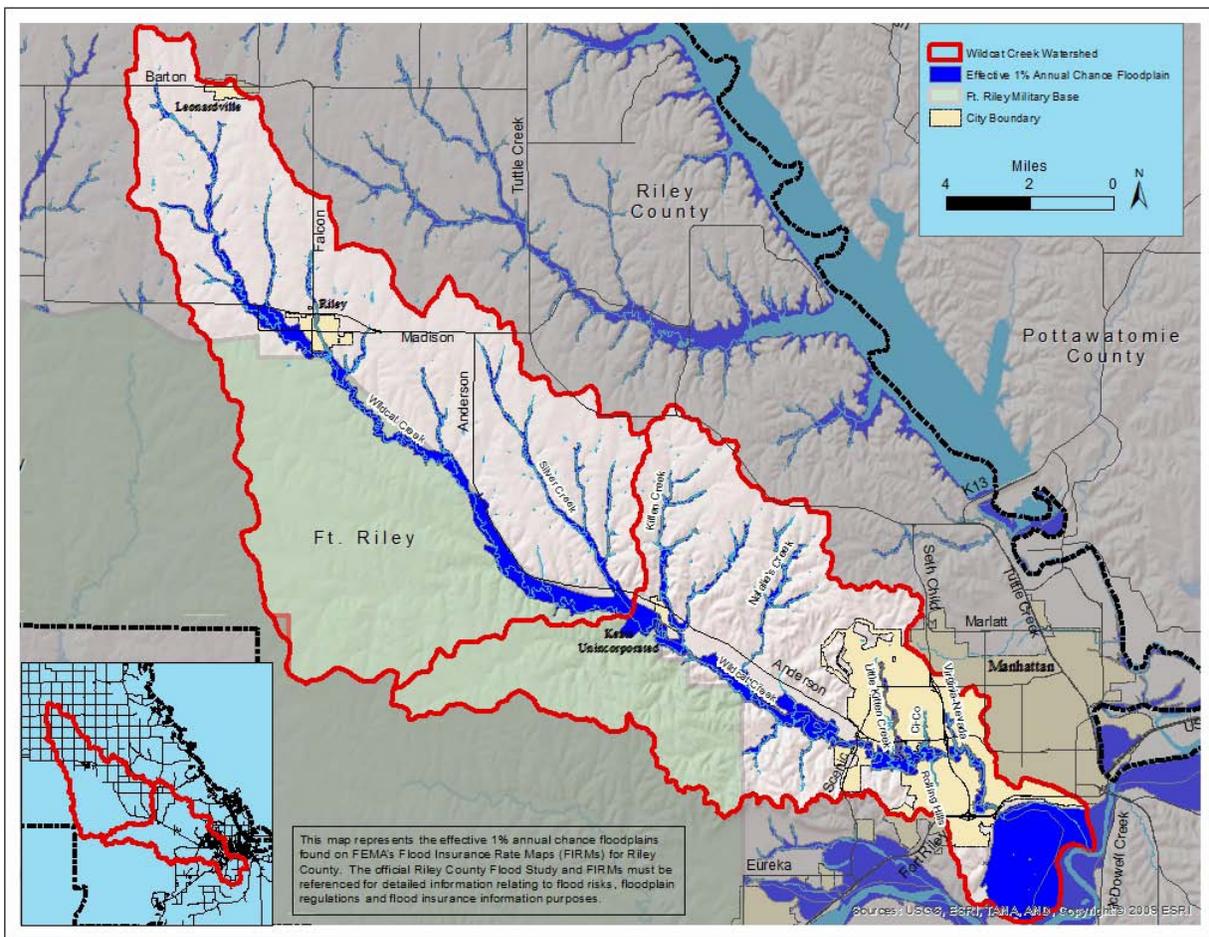


FIGURE 3. EFFECTIVE FLOODPLAINS IN WILDCAT CREEK (RILEY COUNTY FLOOD STUDY, 2005).

The primary references for flood hazards are related to FEMA work products. The Flood Insurance Study (FIS) for Riley County, Kansas (FEMA) provides a good assessment of flooding. A revision to that study is expected in 2014 using Digital Flood Insurance Rate Maps (DFIRMs). This section presents both the current information from the FIS and DFIRMs, as well as information from the preliminary results of the flood study revision for Riley County in maps and in the risk assessment process.

The preliminary results include a detailed flood model of the Wildcat Creek watershed based on its complete build-out using the Manhattan Urban Area Comprehensive Plan's Future Land Use Map.

The Riley County Hazard Mitigation Plan (HMP) (April 15, 2011) also identifies flood hazards, which are further described in the sections below. Section 4.4.2 of the HMP provides Jurisdiction Profiles for the community. The Flood Hazard Profile for Unincorporated Riley County rates the hazard posed by Wildcat Creek. According to the HMP, the impact of upstream development in unincorporated Riley County on downstream constituents is a serious consideration for unincorporated Riley County. The Flood Hazard Profile for this vicinity of Wildcat Creek indicated an evident risk to property identified at the western border of the City of Manhattan: Manhattan Flood Profile states:

"A review of the FEMA FIRM for Manhattan indicates the areas most susceptible to flooding occur along two designated flood zones identified as Zones A, AE, AH, and Zone X. The first flood zone is located along Wildcat Creek which enters Manhattan on the west city boundary along Anderson Avenue and moves east-southeast until joining the Kansas River. There were no major population centers or improvements identified within this flood zone up to the levee located along the southeast side of Manhattan that protects an area identified as Zone X. The levee protected area begins along Fair Lane at Denison Avenue, and trends north-northeast to Bertrand Street and Highway 24. Notable population areas were identified within this protected area (Riley County Hazard Mitigation Plan, p.99)."

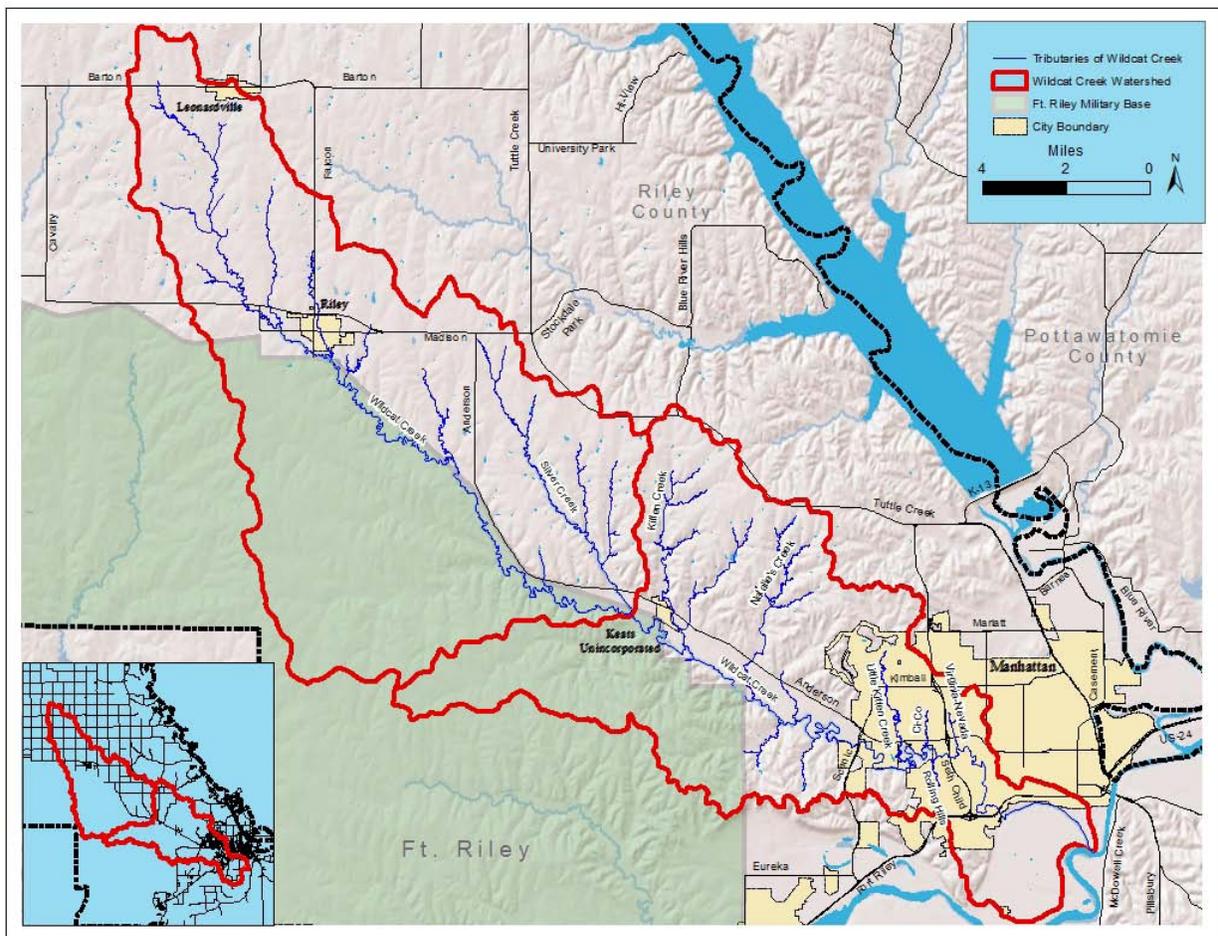


FIGURE 4. INDEX MAP SHOWING THE VARIOUS TRIBUTARIES OR SUB-WATERSHEDS OF WILDCAT CREEK NEAR THE WEST SIDE OF THE CITY OF MANHATTAN.

TABLE 1. FLOOD HISTORY.

Month	Year	Name of Water Body	Estimated Probability of Occurance in Each Year <i>(limited by uncertainty in period of record, also uncertainty values depending on year)</i>
June	1903	Kansas River & Big Blue River	Not Available
September	1914	Wildcat Creek	Not Available
May	1915	Wildcat Creek	Not Available
June	1935	Kansas River & Big Blue River	Not Available
October	1941	Wildcat Creek	Not Available
July	1951	Wildcat Creek	Not Available
July	1951	Kansas River & Big Blue River	0.2% (500-yr return frequency)
June	1954	Wildcat Creek	Not Available
September	1970	Wildcat Creek	Not Available
June	1977	Wildcat Creek	4% (25-yr return frequency)
(Summer)	1993	Wildcat Creek Kansas River & Big Blue River	Not Available
May	2007	Wildcat Creek	Not Available
June	2010	Wildcat Creek	Not Available

The following sections have been organized to provide a sub-watershed perspective, focusing on reaches of the creek between distinguishing man-made features (such as Seth Child Bridge) or tributaries leading to Wildcat Creek. The location of tributaries and other features along Wildcat Creek are described as being on the left or right bank of the stream. To orient oneself, this can be envisioned as if you are traveling upstream on Wildcat Creek from its confluence with the Kansas River, with features being located to the left or right of your boat on the waterway.

Hydrological information has been gathered from the effective Flood Insurance Study (FIS) and Flood Insurance Rate Maps (FIRMs) (FEMA, 2010) and preliminary hydrological information from a preliminary FIS and DFIRMs produced by AMEC Environment & Infrastructure (AMEC, 2012). The AMEC preliminary information also included a study of flooding along Wildcat Creek, with the watershed built out based on the Manhattan Urban Area Comprehensive Plan’s Future Land Use Map.

The following sections display maps of the results of the study, including the index map. Aerial maps with flood hazards are presented in the subsections below for each sub-watershed of Wildcat Creek. Separate maps present the effective 1% Annual Chance Floodplain or the preliminary 1% Annual Chance Floodplain and the Future 1% Annual Chance Floodplain calculated by AMEC Environment & Infrastructure (see map title and legends for specific map differences). Flood hazards related to future conditions on Fort Riley land are not shown.

2.1.1 Flood Hazards: Wildcat Creek from Kansas River to Seth Child Road. (K-113).

This is the lower reach of Wildcat Creek, including the confluence with the Kansas River. Just downstream of Seth Child Road (Highway K-113) on the right bank lies the confluence with the urbanized sub-watershed, the Virginia-Nevada tributary. Major roads in this reach are Manhattan Avenue and Fort Riley Boulevard (Highway K-18).

The following facts should be noted in this reach:

1. *Source of the Problem.* The source of flooding problems in this reach of Wildcat Creek is floodwater from the upper reaches of the watershed passing through this area. There is evidence that existing bridges at Fort Riley Boulevard (Highway K-18) restrict the flow of floodwaters passing through this area. Flooding is also impacted by the water levels of the Kansas River to the southeast. Localized flooding can also occur throughout this reach of the watershed.
2. *Flood Data.* The current Flood Insurance Study, dated July 6, 2010, shows that the peak discharge of the 1% Annual Chance Flood is 18,100 cubic feet per second (cfs) at the confluence with the Kansas River. The preliminary Flood Insurance Study for Riley County shows that existing peak discharge of the 1% Annual Chance Flood is 16,496 cfs at the confluence. In addition, the preliminary flood study calculated what future flood events would be, based on the complete build out of the Wildcat Creek watershed, based on the Manhattan Urban Area Comprehensive Plan's Future Land Use maps. The peak discharge for the 1% Annual Chance Flood would be 22,444 cfs at the confluence.

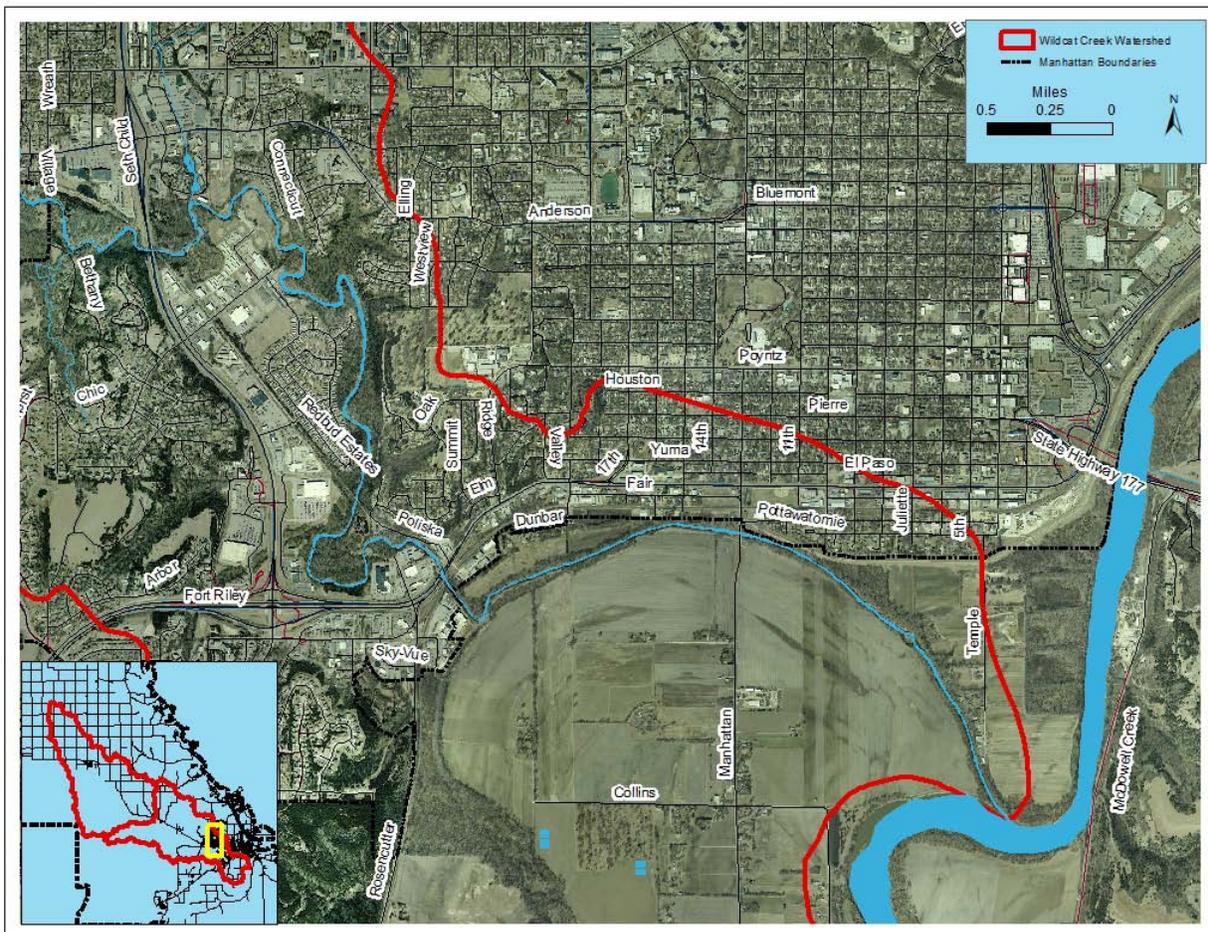


FIGURE 5. LOCATION OF THE LOWER REACH OF WILDCAT CREEK.

The maps in this section show the Floodway and 1% Annual Chance Flood boundaries of the current flood model, as well as the Floodway, 1% Annual Chance Flood and Future Conditions 1% Annual Chance Flood boundaries. Please note the title of each map for details.

3. *Land Use & Building Data.* A variety of land uses are present in this reach of Wildcat Creek. In the southern part of this reach, known as Hunter's Island, there is open space, agricultural and rural residential uses. Some of the open space and agricultural land was acquired with Federal Hazard Mitigation Grant Program funds and local matching funds following the 1993 flood. The existing homes were generally built in a wide time frame, ranging from the early 1920s to the 1990s.

Adjacent to Fort Riley Boulevard (Highway K-18) are industrial uses comprised of contractor businesses and self-storage units. A 197-room, full-service hotel is located along Wildcat Creek in this area. The industrial uses were built from the 1950s to the 1970s. The hotel was built in 1981. The Riley County Law Enforcement Center is also located in this area to the west of the hotel at the intersection of Fort Riley Boulevard (Highway K-18) and Seth Child Road (Highway K-113).

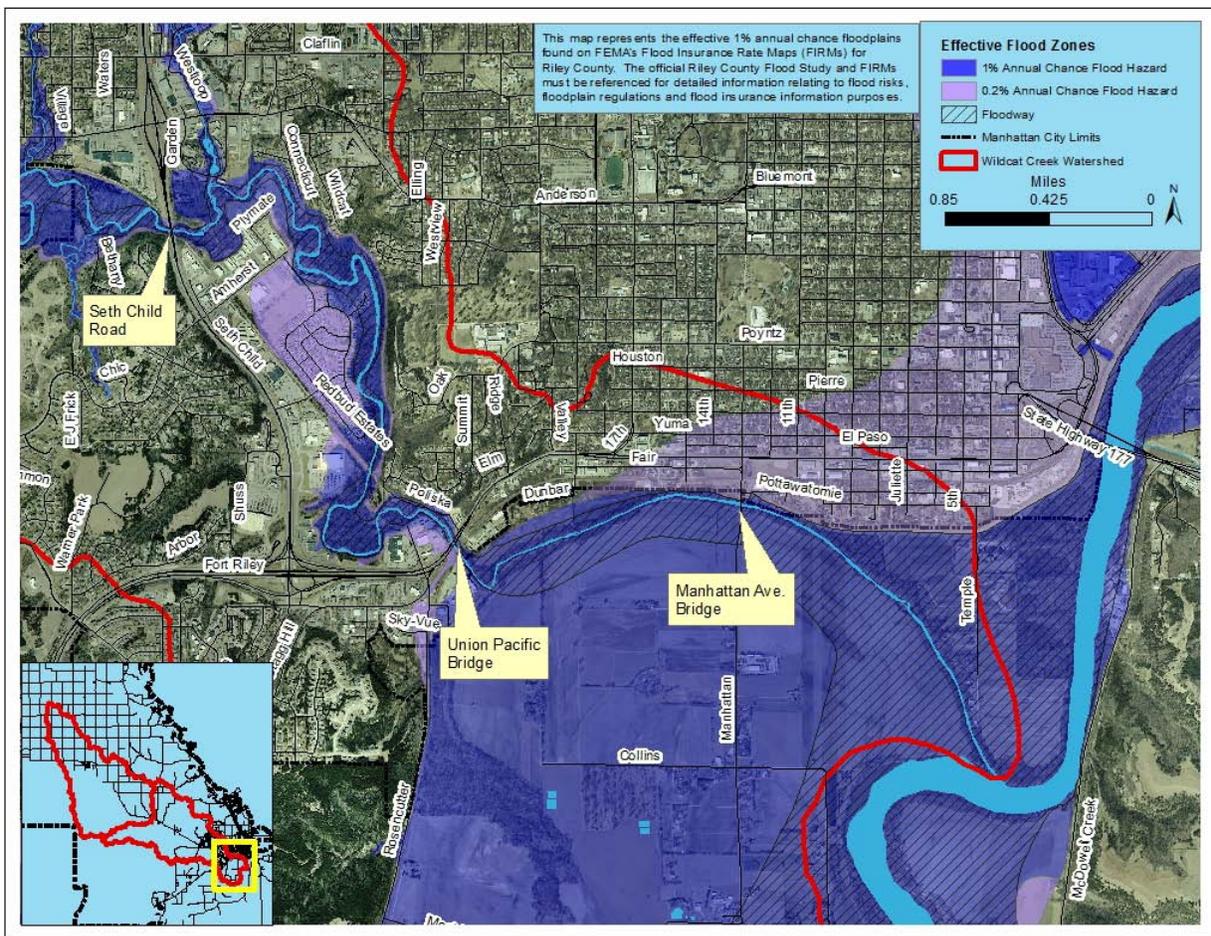


FIGURE 6. EFFECTIVE FLOODPLAIN OF THE LOWER REACH OF WILDCAT CREEK.

Newer commercial developments, including large box retailers, and industrial uses that are similar to that along Ft. Riley Boulevard (Highway K-18) are located between Wildcat Creek and Seth Child Road (Highway K-113). Residential uses are also present in this area.

6. *Critical Facilities.* A Riley County Rural Fire Station is located in the vicinity of Hunter’s Island (reference Executive Order 11988). A business that stores hazardous materials above the Tier II threshold is located in this reach. A public utility infrastructure element that is considered critical to the operation of the system is also located in this area of Wildcat Creek. Because of the need to keep these critical facilities confidential, the exact location has not been provided; however, officials of Riley County, the City of Manhattan and the State of Kansas have the location and information regarding the facilities.

2.1.2 Flood Hazards: Wildcat Creek from Seth Child Road to Scenic Drive.

This is the second reach on Wildcat Creek upstream of the Kansas River floodplain. Two notable right bank tributaries in this reach are CiCo Tributary and Little Kitten Creek, which are both well developed. The Rolling Hills Tributary is a left bank tributary between the CiCo Tributary and Little Kitten Tributary. An unnamed tributary also enters this reach of Wildcat Creek on the left bank to the west of Wildcat Creek. This unnamed tributary is not specifically listed in current FEMA flood insurance studies because the amount of developed land is less than one square mile. Because of this, FEMA, the City of Manhattan and Riley County have not conducted a detailed study of this tributary as of yet.

TABLE 2. FLOOD DATA, WILDCAT CREEK FROM KANSAS RIVER TO SETH CHILD RD.

Elevation Location	Current 1% Annual Chance Flood	Preliminary 1% Annual Chance Flood	Future Conditions 1% Annual Chance Flood
Manhattan Avenue Bridge	1019.1'	1019.5'	N/A
UP Bridge	1021.0'	1021.0'	1023.3'
Seth Child Road	1039.3'	1041.7'	1045.0'

Limited information regarding this tributary is provided below. No roads cross Wildcat Creek in this area. The majority of floodplain along this reach is open space attributed to Frank Anneberg Park and the Wildcat Creek Golf Course.

1. *Source of the Problem.* The source of the flooding problems in this reach of Wildcat Creek is floodwaters from the upper reaches of the watershed passing through this area and by the confluence with the four (4) tributaries in this reach. Localized flooding can also occur throughout this reach of the watershed.

A small watershed basin, commonly referred to as Barton Lake, exists on the unnamed tributary that was mentioned above. This basin was established in the 1930s and had been dry for many years, acting as a large detention basin for the tributary watershed and Wildcat Creek watershed as a whole. The current property owner has recently spent considerable resources to seal Barton Lake, which has changed the dynamics of the basin. As previously mentioned, this tributary has not had a detailed study because the area is largely vacant rangeland. When this area begins to develop, the City of Manhattan and/or Riley County will need to analyze the drainage impacts from the new developments.

2. *Flood Data.* The current Flood Insurance Study, dated July 6, 2010, shows that the peak discharge of the 1% Annual Chance Flood is 17,600 cfs at the Highway K-113/Seth Child Road Bridge. A Flood Insurance Study is in preliminary form for the Riley County flood re-study. This study shows that peak discharge of the 1% Annual Chance Flood is 16,496 cfs just upstream of K-113/Seth Child Road Bridge. In addition, the peak discharge for the Future Conditions 1% Annual Chance Flood storm would be 22,444 cfs at this point.

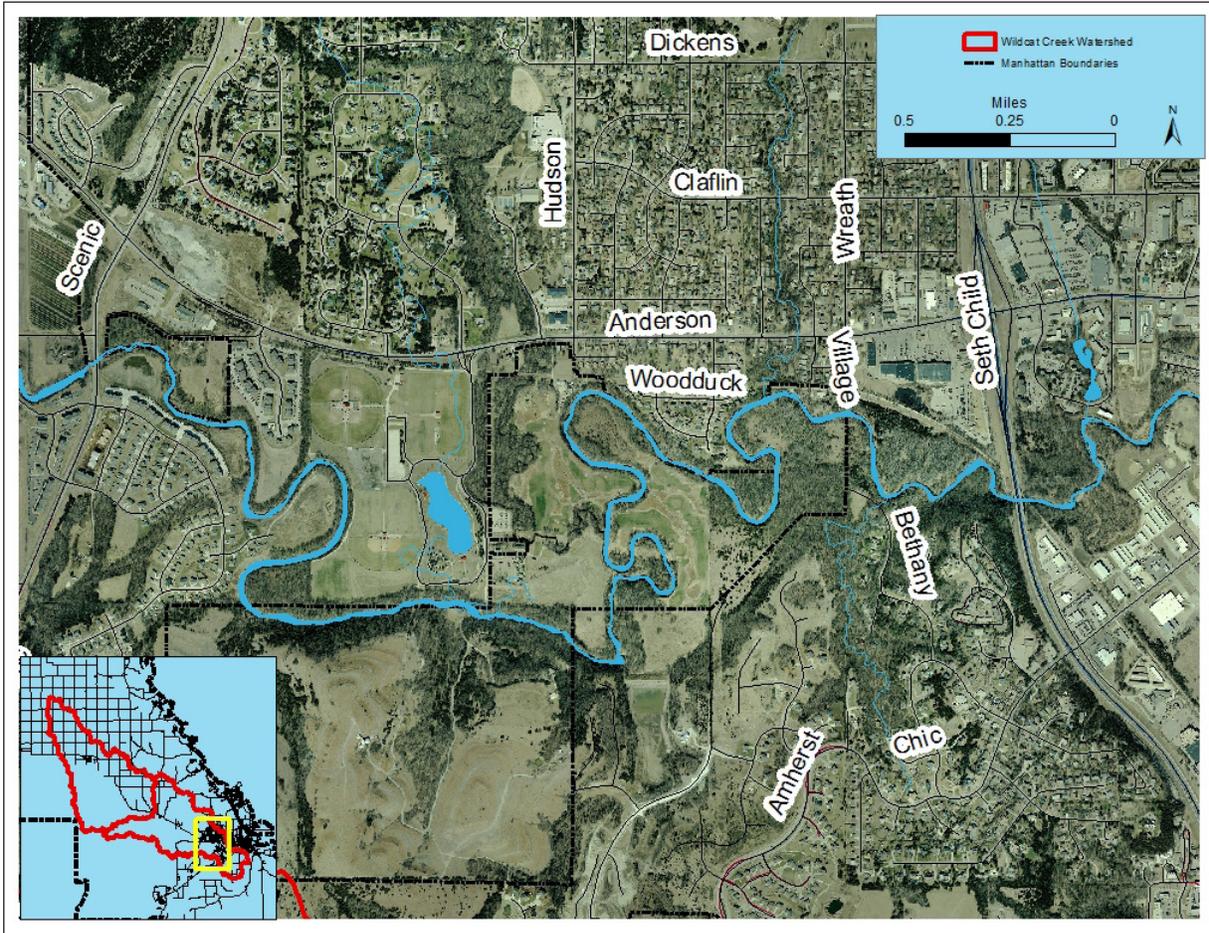


FIGURE 8. LOCATION OF THE MIDDLE REACH OF WILDCAT CREEK.

The preliminary flood study shows the peak discharge southeast of Anneberg Park as 16,680 cfs for the existing 1% Annual Chance Flood and 22,660 cfs for the Future Conditions 1% Annual Chance Flood.

The current flood model shows the flood elevation of the 1% Annual Chance Flood elevation at the confluence of Rolling Hills Tributary at 1046.5 feet, 1044.77 at the CiCo Tributary confluence, 1050.8 feet at the confluence of Little Kitten Tributary, and 1063.2 feet at Scenic Drive. The maps in this section show the Floodway and 1% Annual Chance Flood boundaries of the current flood model, as well as the Floodway, 1% Annual Chance Flood and Future Conditions 1% Annual Chance Flood boundaries. Please note the title of each map for details.

3. **Land Use & Building Data.** The majority of development in this reach of Wildcat Creek consists of single-family homes. The Plaza West/Village Plaza Shopping Center is located adjacent to Seth Child Road (State Highway K-113). Two-family and multiple-family dwellings are also present on the west side of this reach near Scenic Drive. In addition to these land uses, there is open space attributed to Frank Anneberg Park and the Wildcat Creek Golf Course. Other open space is present in privately held land that has not been developed. The residential uses east of Anneberg Park are generally twenty to thirty years old, with homes closer to the Plaza West/Village Plaza as old as eighty years. Homes and apartment buildings west of Anneberg Park were built in the late 1990s and mid-2000s. The Plaza West/Village Plaza Shopping Center was first developed in the 1960s.

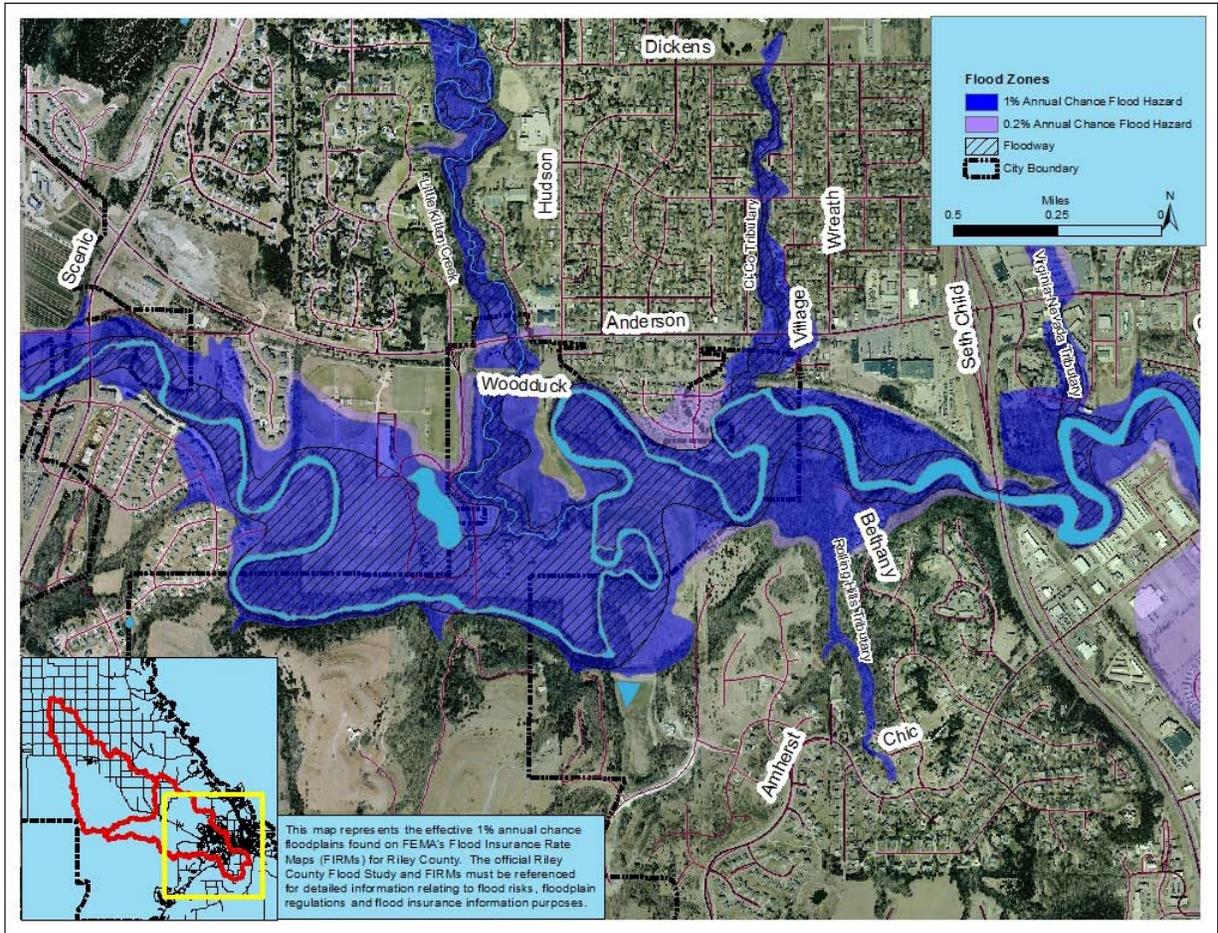


FIGURE 9. EFFECTIVE FLOODPLAIN OF THE MIDDLE REACH OF WILDCAT CREEK.

4. *Development Trends.* The eastern part of this reach is completely built out. Because of the terrain in this area, there are large lot developments and/or common areas for trails and drainage capacity. The middle portion of this reach is largely open space created by the park and golf course and undeveloped land on the left bank. Because of the existing terrain, which is similar to that to the east, a comparable residential pattern of large lots, with common areas and/or large yards can be anticipated.

TABLE 3. FLOOD DATA, WILDCAT CREEK FROM SETH CHILD RD. TO SCENIC DR.

Elevation Location	Current 1% Annual Chance Flood	Preliminary 1% Annual Chance Flood	Future Conditions 1% Annual Chance Flood
Rolling Hills Trib.	1046.5'	1045.6'	1050.2'
Ci-Co Trib.	1044.7'	1045.9'	1050.5'
Little Kitten Trib.	1050.8'	1050.6'	1052.6'
Scenic Drive	1063.2	1061.2'	1066.0'

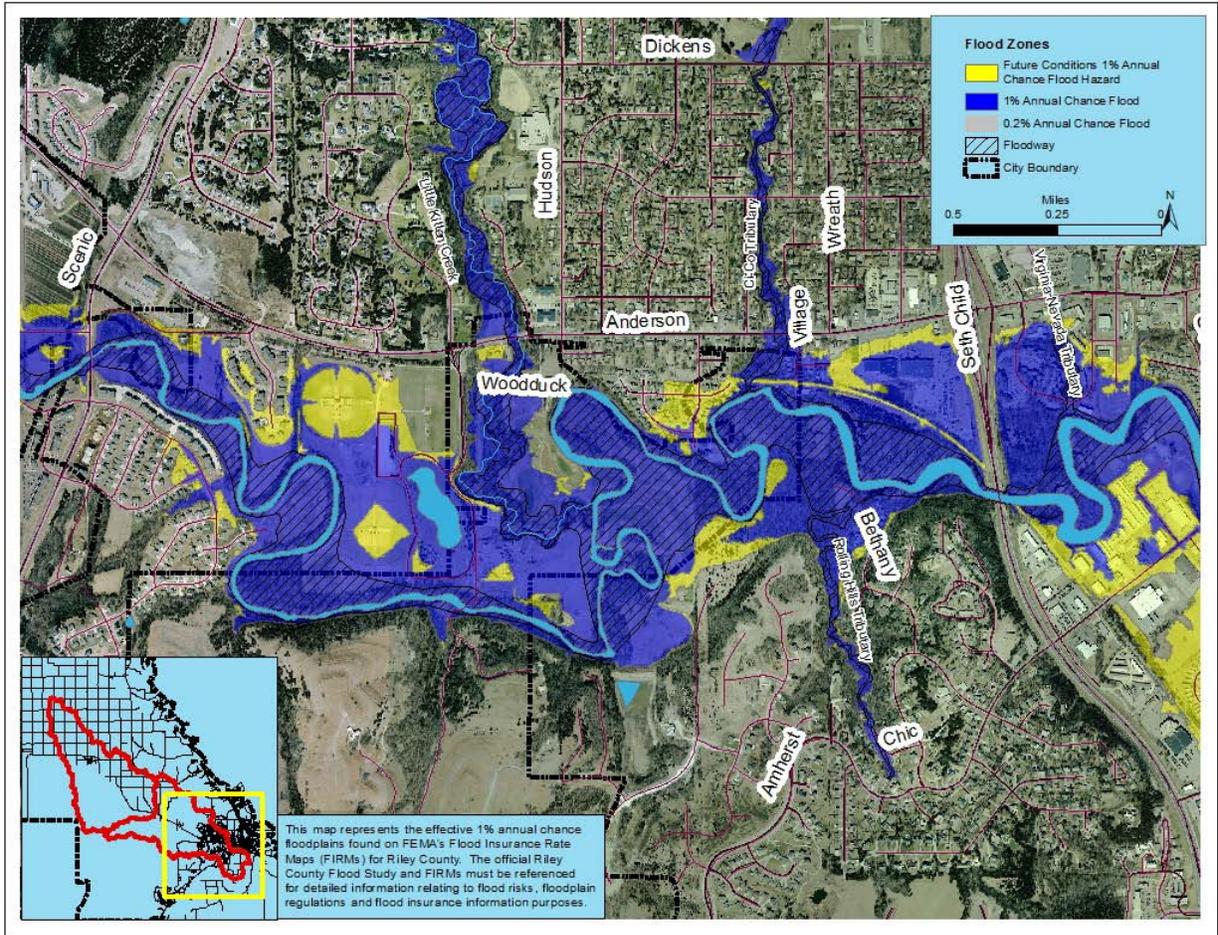


FIGURE 10. PRELIMINARY FLOODPLAIN OF THE MIDDLE REACH OF WILDCAT CREEK.

The western edge of this reach is mostly built out with single-family, two-family and multiple-family dwellings. Several multiple-family dwelling complexes in various stages of development are located in the upper extent of this reach of the watershed. On the left bank of the creek are a few commercial office developments along Anderson Avenue that are present.

5. *Development Constraints.* The largest development constraints to new or future redevelopment of this area are the floodway of Wildcat Creek and the steep terrain along the left bank of the creek.

6. *Critical Facilities.* A number of critical facilities are located in this reach of Wildcat Creek, including businesses storing hazardous materials above the Tier II threshold and critical public infrastructure elements. Due to the nature of these critical facilities and the need to keep the information confidential, the exact location has not been provided. However, officials of Riley County, the City of Manhattan and the State of Kansas have the location and information regarding the facilities.

2.1.3 Flood Hazards: Virginia-Nevada Tributary.

The Virginia-Nevada Tributary is the first major tributary that drains into Wildcat Creek. The tributary is on the right bank near Seth Child Road. Below is a map of this reach.

1. *Source of the Problem.* The source of flooding problems is primarily found in the lower parts of the tributary caused by water from Wildcat Creek leaving its banks and flooding the multiple-family dwellings and businesses on Garden Way.

Large stormwater detention basins have been constructed in recent years that have significantly reduced the flood impacts from new and existing developments in the upper reaches of this tributary. The overall impact can be seen when comparing the flood data found in the next section from the current flood model data (studied prior to the construction of these basins) and the preliminary flood model data in the upper reaches of the tributary watershed.

The tributary is channelized via a large underground culvert in the West Loop Shopping Center. The culvert collects the stormwater near the intersection of Beechwood Terrace and Claflin Road and directs it towards an existing wet basin in the middle of the Garden Way development. Localized flooding can occur in other areas of the tributary.

2. *Flood Data.* The current Flood Insurance Study, dated July 6, 2010, shows that the peak discharge of the 1% Annual Chance Flood is 1,590 cubic feet per second (cfs) at the mouth of the tributary. The peak discharge at Beechwood Terrace is 1,260 cfs. The preliminary Flood Insurance Study shows that peak discharge of the 1% Annual Chance Flood is 1,288 cfs near the mouth of the tributary and 534 cfs at Beechwood Terrace. The peak discharge for the Future 1% Annual Chance Flood storm is calculated to be 1,442 cfs near the tributary mouth and 726 cfs at Beechwood Terrace. The maps in this section show the Floodway and 1% Annual Chance Flood boundaries of the current flood model, as well as the Floodway, 1% Annual Chance Flood and Future Conditions 1% Annual Chance Flood boundaries. Please note the title of each map for details.

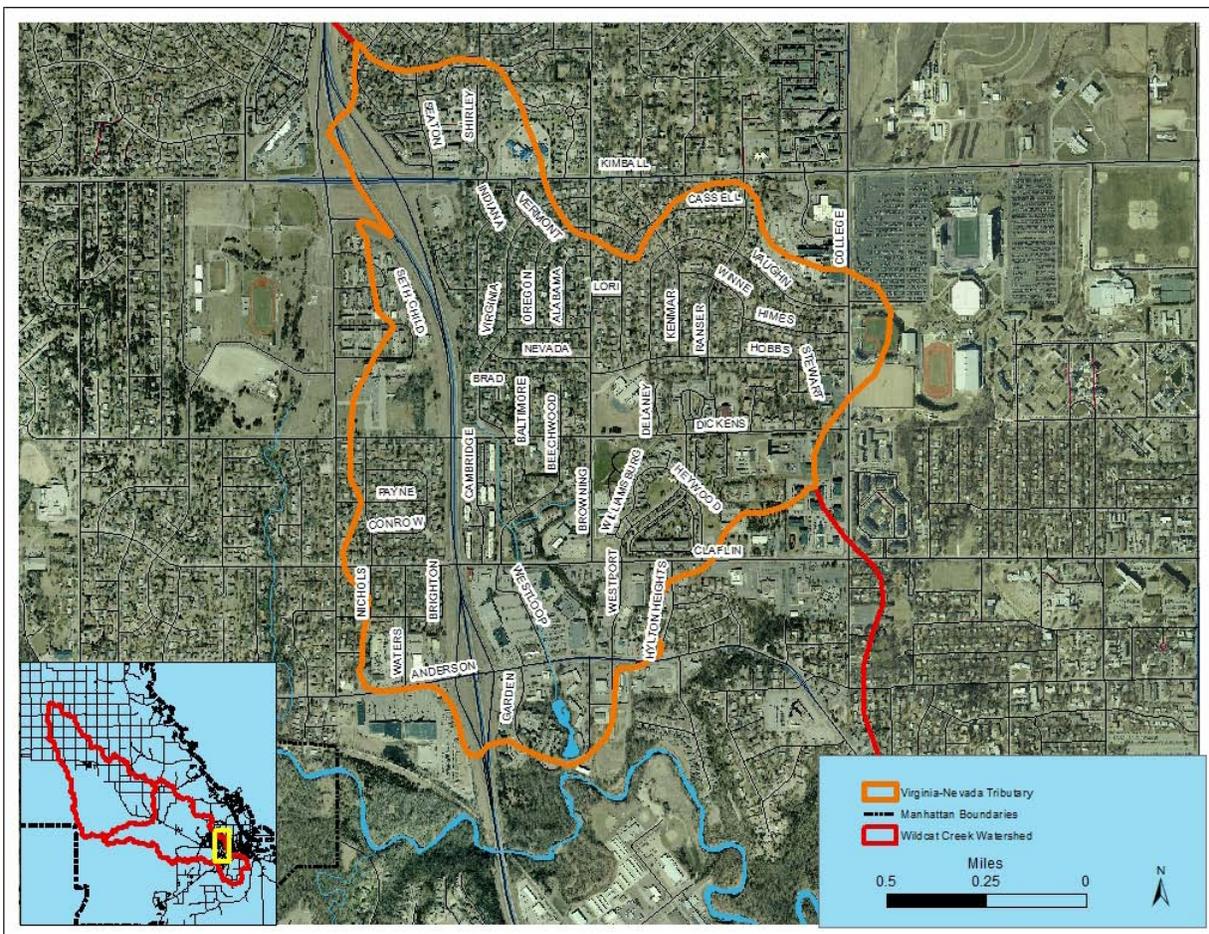


FIGURE 11. LOCATION OF THE VIRGINIA-NEVADA REACH.

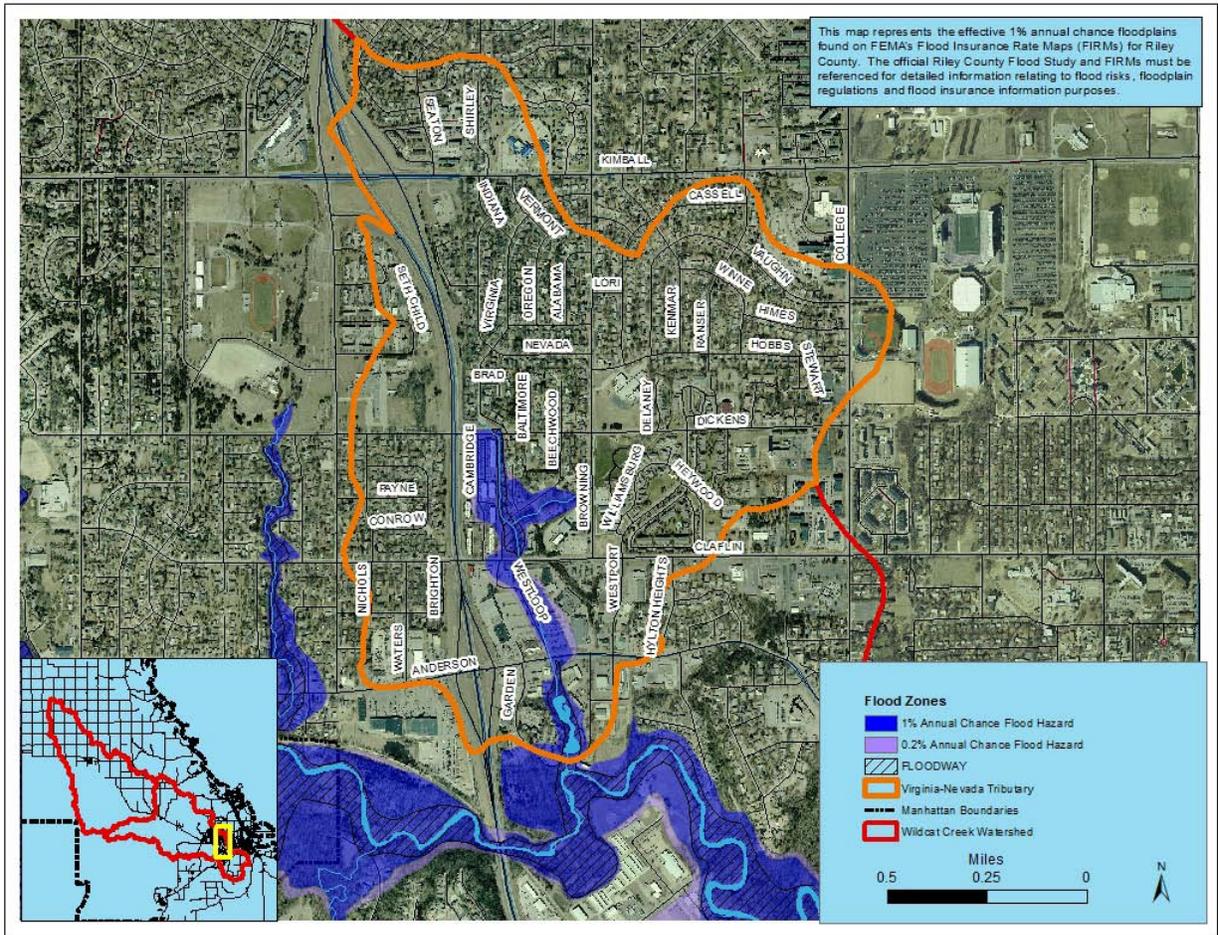


FIGURE 12. EFFECTIVE FLOODPLAIN OF THE VIRGINIA-NEVADA REACH.

- 3. Land Use & Building Data.** A variety of land uses are present in this tributary. Upper reaches of the tributary are largely single-family residential developments, with a few multiple-family apartment complexes. In the middle and lower portions of the watershed are mostly large apartment complexes and commercial developments. The single-family homes were built in the 1970s. The apartment complexes were built in the early 1960s. The commercial developments were also constructed in the 1970s. The West Loop Shopping Center has seen major redevelopment in 2011-2012, with the construction of a new grocery store.
- 4. Development Trends.** Anderson Avenue and Seth Child Road is a commercial node, with several retail and service commercial businesses. Multiple-family residential buildings are located to the south of Anderson Avenue. Between Clafin Road and Dickens Avenue are several apartment complexes, a large religious center and some single-family homes. To the north of Dickens Avenue are mostly single-family homes. There are a few multiple-family apartment complexes along Kimball Avenue in the upper portions of the tributary.
- 5. Development Constraints.** The tributary watershed is completely built out. No vacant land is available to develop upon. Some areas of the watershed have experienced redevelopment, such as the West Loop Shopping Center and areas along Clafin Road.
- 6. Critical Facilities.** A number of facilities that house children (schools, preschools, etc.) or elderly citizens (nursing homes or assisted living facilities) are located in the Virginia-Nevada Tributary.

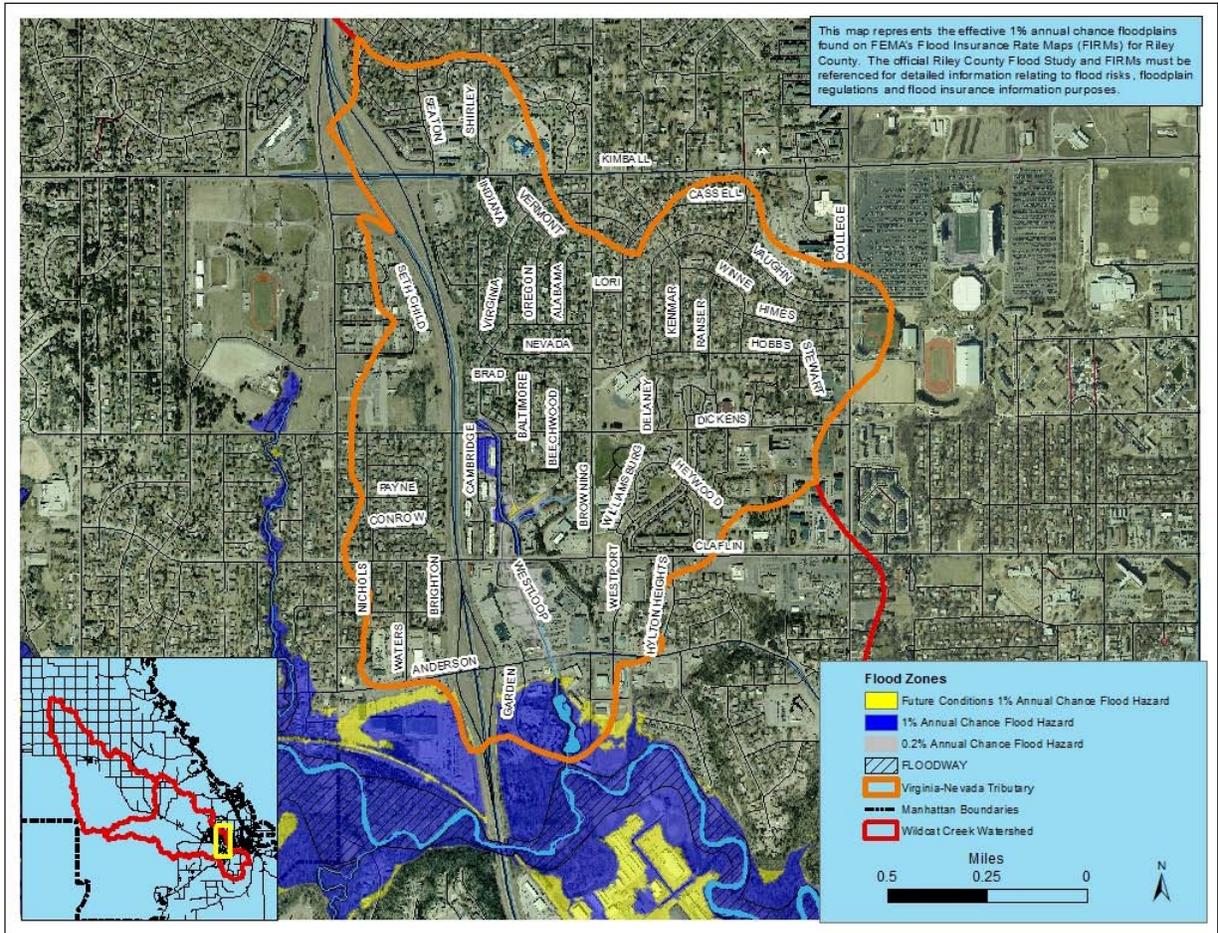


FIGURE 13. PRELIMINARY FLOODPLAIN OF THE VIRGINIA-NEVADA REACH.

These are critical facilities due to the significant amount of resources necessary to evacuate these facilities in flood events. No other major critical facilities or infrastructure is located in this tributary. Due to the nature of these critical facilities and the need to keep the information confidential, the exact location has not been provided. However, officials of Riley County, the City of Manhattan and the State of Kansas have the location and information regarding the facilities.

TABLE 4. FLOOD DATA, VIRGINIA-NEVADA TRIBUTARY.

Elevation Location	Current 1% Annual Chance Flood	Preliminary 1% Annual Chance Flood	Future Conditions 1% Annual Chance Flood
Mouth	1036.3'	1040.6'	1044.1'
Beechwood Terrace	1066.3'	1061.8'	1062.2'

2.1.4 Flood Hazards: CiCo Tributary.

CiCo Tributary is the next right bank tributary along Wildcat Creek in the limits of Manhattan. The tributary extends from Wildcat Creek, just south of Anderson Avenue to the north to Churchill Street.

1. *Source of the Problem.* The lower reaches of the tributary, south of Anderson Avenue are impacted by backwater effects from high water conditions on Wildcat Creek. To the area south of CiCo Park, the main concern is severe erosion along the channel and its impact on homes adjacent to the channel. The City of Manhattan has undertaken a detailed study of this tributary. A professional consultant, Olsson Associates, completed the study and has recommended a number of mitigation measures, including detention basins in CiCo Park to reduce the rate of stormwater runoff and improvements to the stream channel downstream of Dickens Road to mitigate erosion problems (Olsson Associates, 2012). Localized flooding can occur in other areas of the tributary.
2. *Flood Data.* The drainage area studied by the current Flood Insurance Study, dated July 6, 2010, is 0.86 square miles. The current study shows that the peak discharge of the 1% Annual Chance Flood is 1,680 cfs at the mouth of the tributary. The drainage area of the CiCo Tributary associated with the preliminary flood study is shown as 0.83 square miles. The peak discharge of the 1% Annual Chance Flood calculated by the preliminary study is 1,588 cfs at the same location. The peak discharge for the Future Conditions 1% Annual Chance Flood storm would be 1,880 cfs at this location. The maps in this section show the flood boundary for the current flood model of the 1% Annual Chance Flood for the preliminary flood model and the flood inundation depths for the Future Conditions 1% Annual Chance Flood.
3. *Land Use & Building Data.* Most all of the tributary watershed is developed with single-family residential uses.

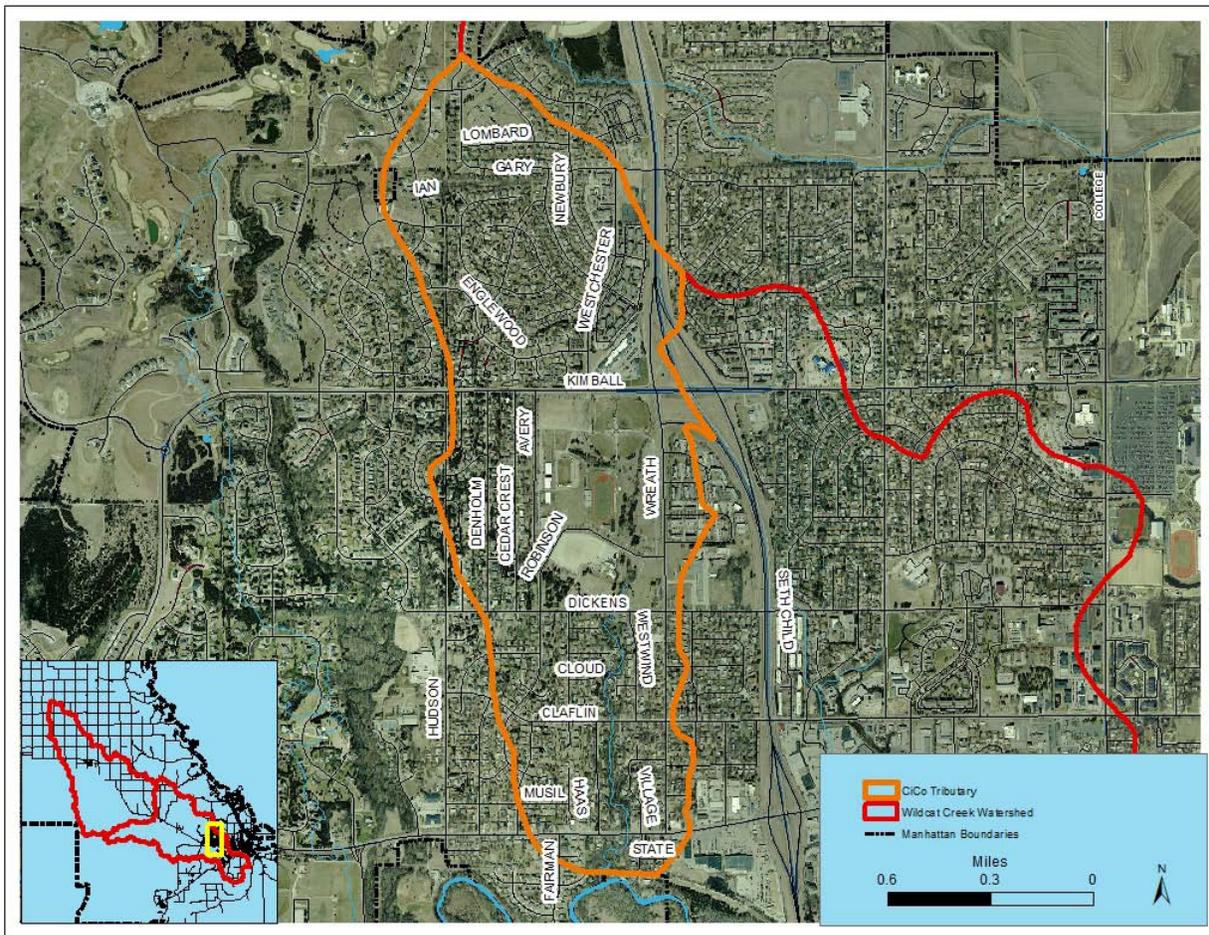


FIGURE 14. LOCATION OF THE CICO REACH.

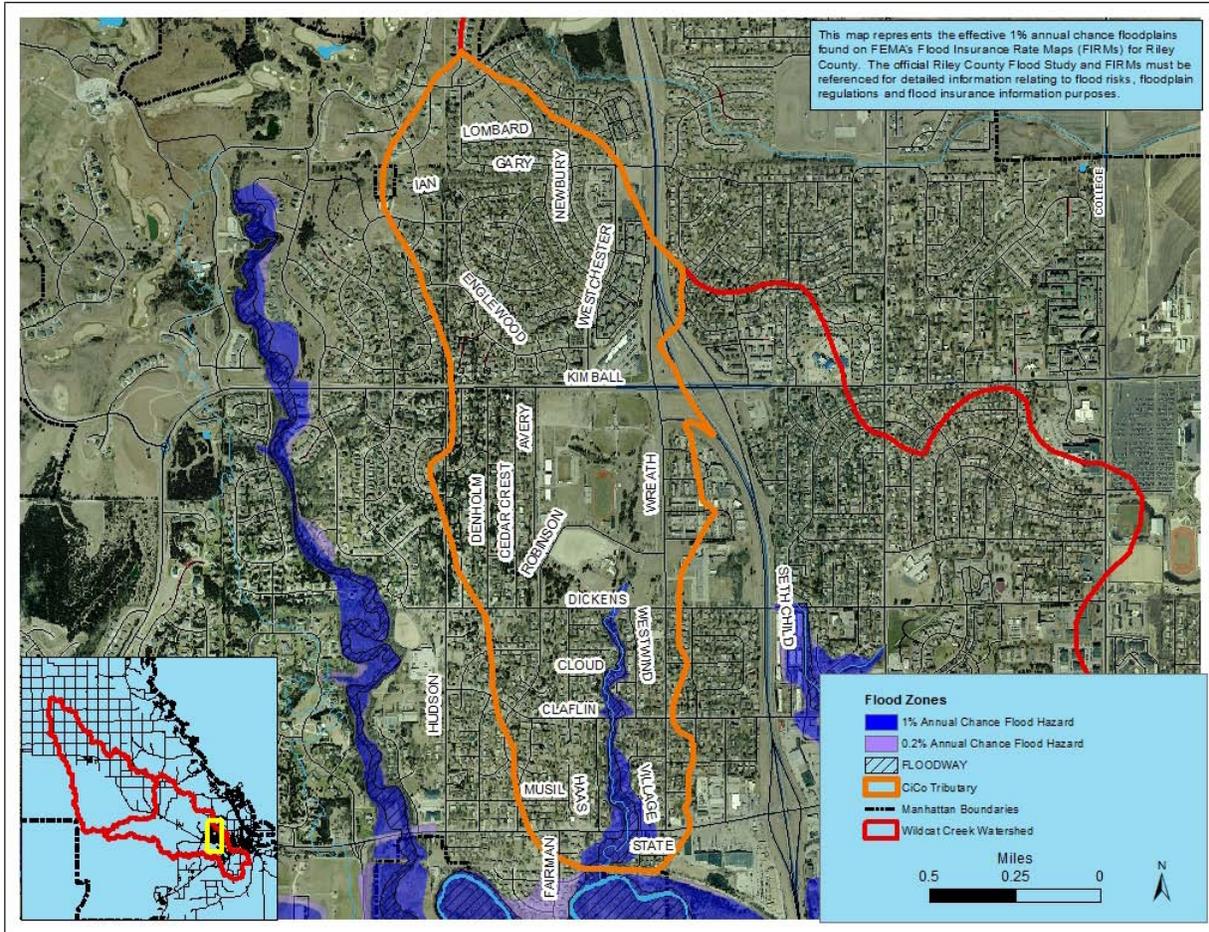


FIGURE 15. EFFECTIVE FLOODPLAIN OF THE CICO REACH.

In the middle of the watershed is CiCo Park, which consists of large open spaces, a swimming pool, the Riley County Fair Grounds and the Manhattan High School football and track stadium. To the north of Kimball Avenue, just west of Seth Child, are the Candlewood Shopping Center and multiple-family apartment complexes. The residential uses are generally forty years old. There are newer residential developments in the upper reaches of the tributary watershed built in the 1990s. The commercial retail properties were built in the mid-1980s.

4. *Development Trends.* The tributary is completely built out. Single-family homes are built on moderately sized lots (10,000 to 15,000 square feet in area). The layout of the existing development is dependent on the terrain, which dictates the use of linear or curvilinear streets and cul-de-sacs and associated lot layouts. Areas of CiCo Park may be re-purposed or redeveloped depending on the City, County and School District's needs.
5. *Development Constraints.* The tributary watershed is completely built out. No vacant land is available to develop.
6. *Critical Facilities.* Two facilities that house children (schools, preschools, etc.) or elderly citizens (nursing homes or assisted living facilities) of Manhattan are located in the CiCo Tributary. These are critical facilities due to the significant resources necessary to evacuate these facilities in a flood event. No other major critical facilities or infrastructure is located in this tributary. Due to the nature of these critical facilities and the need to keep the information confidential, the exact location has not been provided. However, officials of Riley County, the City of Manhattan and the State of Kansas have the location and information regarding the facilities.

TABLE 5. FLOOD DATA, CICO TRIBUTARY.

Elevation Location	Current 1% Annual Chance Flood	Preliminary 1% Annual Chance Flood	Future Conditions 1% Annual Chance Flood
Dickens Avenue	1076.1'	1073.7'	1074.7'
Claflin Road	1061.7'	1061.8'	1062.3'
Anderson Avenue	1050.9'	1049.5'	1050.4'

2.1.5 Flood Hazards: Little Kitten Creek.

Little Kitten Creek is the next right bank creek that flows into Wildcat Creek. It is a large tributary that extends from Wildcat Creek to the flint hills north of Kimball Avenue.

1. *Source of the Problem.* Flooding along the confluence of Little Kitten Creek and Wildcat Creek has occurred when Wildcat Creek has been in its flood stages. In other areas of the creek, localized flooding can occur. The impacts of stormwater runoff through the creek have been improved with the development of Colbert Hills Golf Course and the Grand Mere Development in the upper reaches of the tributary.

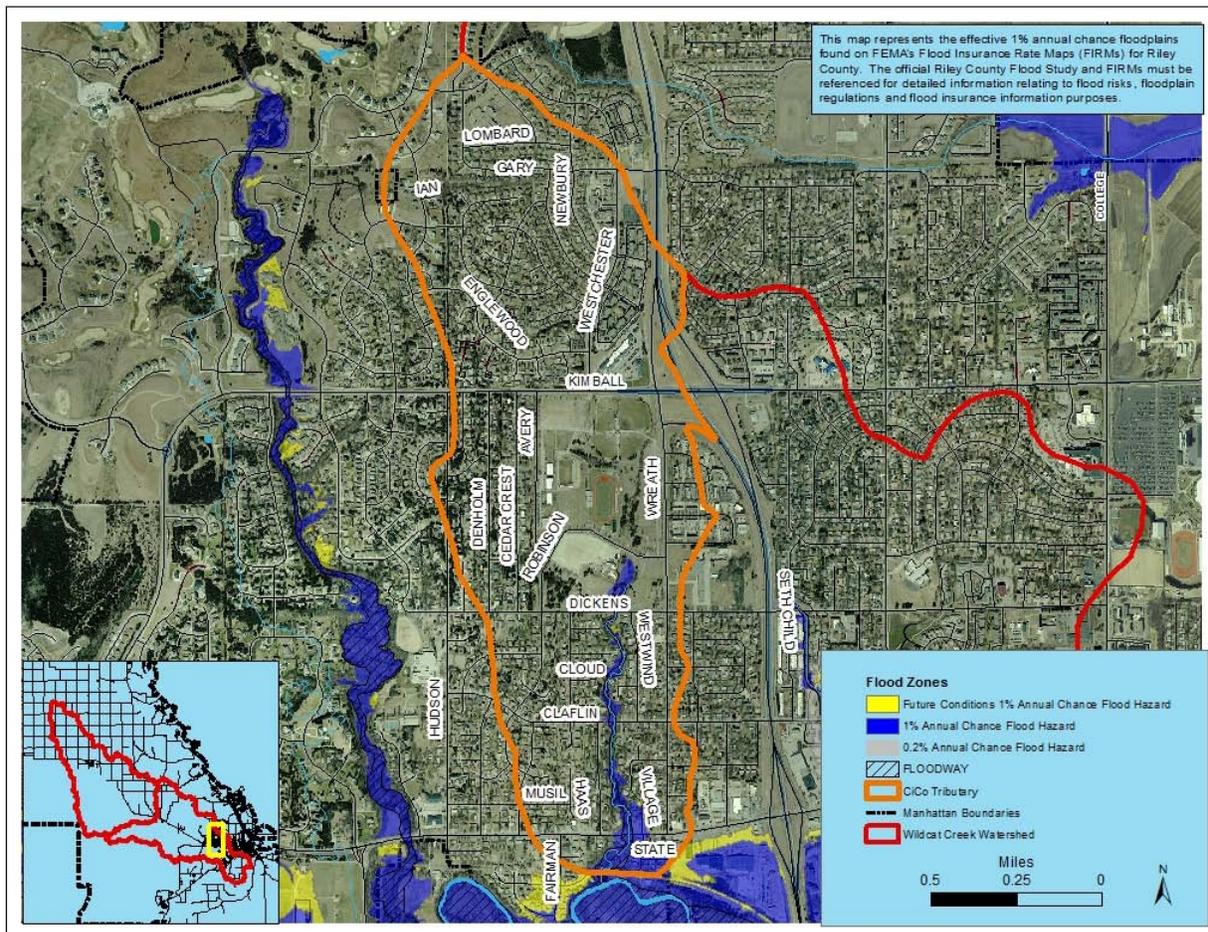


FIGURE 16. PRELIMINARY FLOODPLAIN OF THE CICO REACH.

Several large detention basins have been constructed, which have improved the rate of runoff in the area. This is reflected when comparing the flood data and reviewing the flood information maps provided in this section.

- 2. Flood Data.** The current FIS shows the drainage area to be 2.85 square miles. This study lists the peak discharge of the 1% Annual Chance Flood as 3,160 cfs at the mouth of Little Kitten Creek. The preliminary FIS expanded the drainage area and study boundary for this tributary further to the north than previously studied. The new drainage area of the preliminary flood model is 3.05 square miles. This study shows that peak discharge of the 1% Annual Chance Flood is 3,331 cfs near the confluence with Wildcat Creek. In addition, the peak discharge for the Future Conditions 1% Annual Chance of Flood storm would be 3,097 cfs at this point. The Base Flood Elevations are impacted by overflow waters of Wildcat Creek and also backwater effects by the creek during flood stages. The maps in this section show the flood boundary for the current flood model of the 1% Annual Chance Flood for the preliminary flood model and the flood inundation depths for the Future Conditions 1% Annual Chance Flood.
- 3. Land Use & Building Data.** The tributary watershed is primarily single-family residential homes built on moderate sized to estate sized lots (8,000 square feet to 1.0+ acres). The area to the south of Kimball is completely built out. The area to the north of Kimball Avenue is in various stages of development. The new development is primarily situated in the Grand Mere Development, a master planned golf course community. Some commercial uses, multiple-family residential uses and retirement communities exist along Kimball Avenue in the northern reaches.

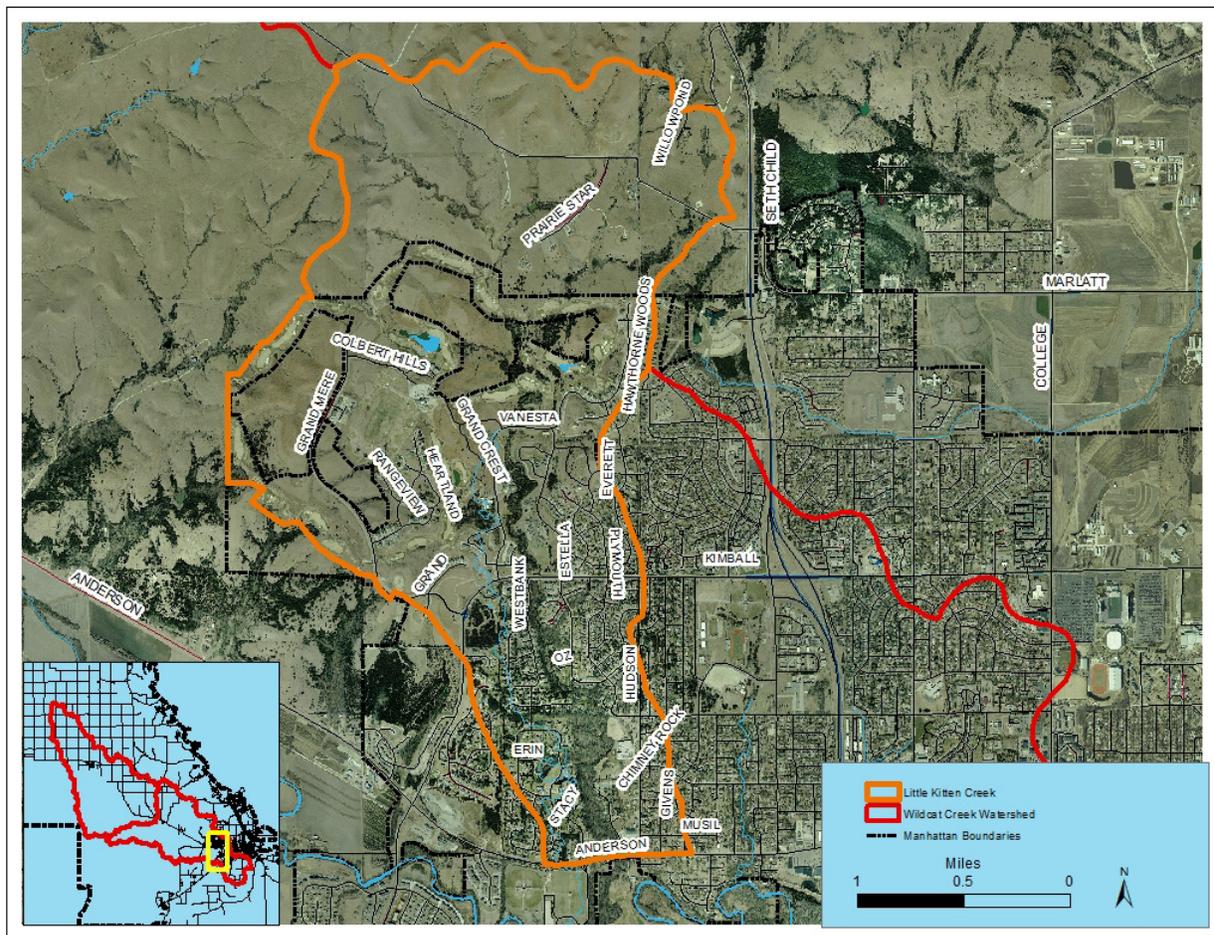


FIGURE 17. LOCATION OF THE LITTLE KITTEN REACH.

The other prominent land use in the Little Kitten Creek Tributary is the Colbert Hills Golf Course, which Grand Mere is situated in and around. Finally, there is open flint hills range land, mostly associated with Kansas State University.

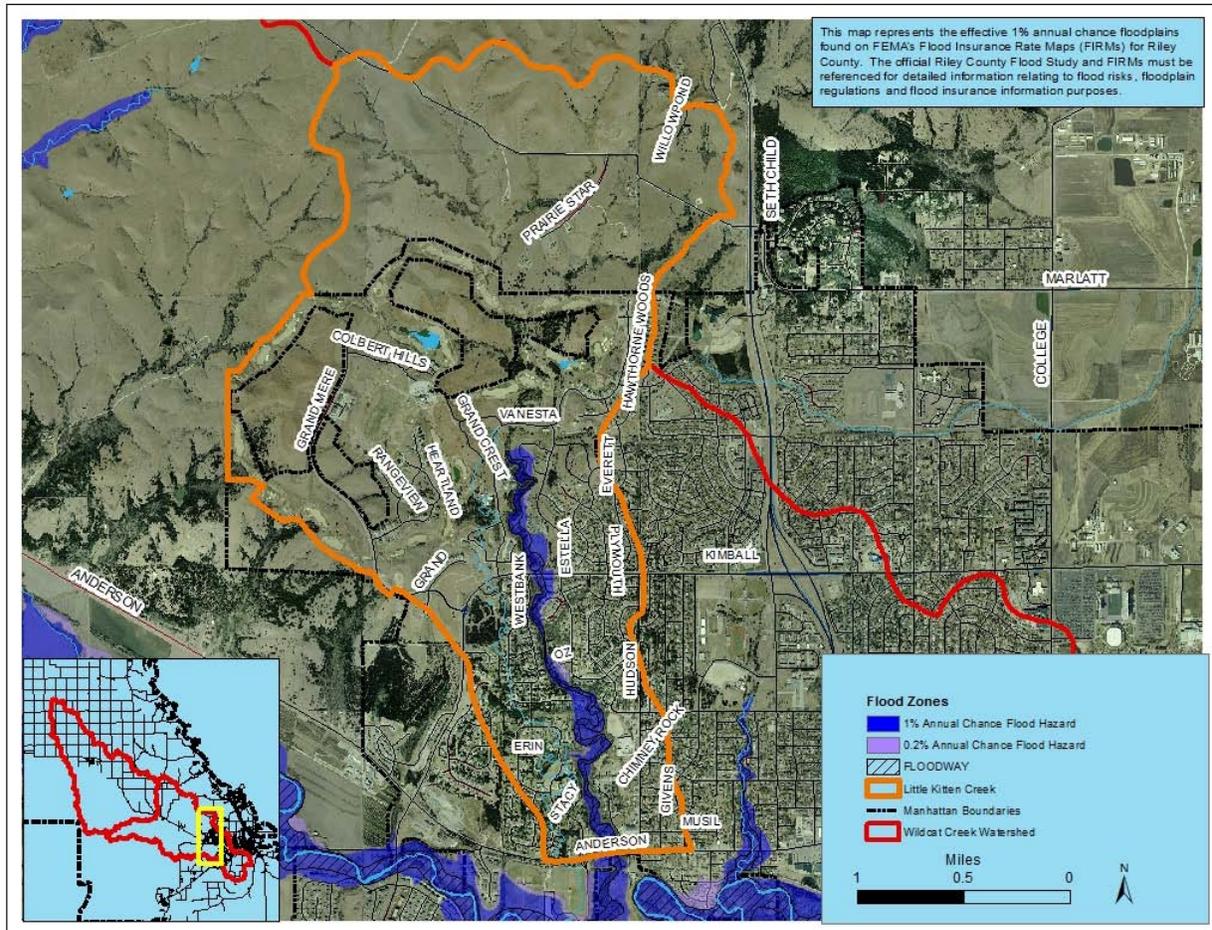


FIGURE 18. EFFECTIVE FLOODPLAIN OF THE LITTLE KITTEN REACH.

4. *Development Trends.* As previously mentioned, the lower reaches of the tributary are primarily built out. The upper reaches are under development in Grand Mere. The extreme upper reach of the tributary is not anticipated to be developed because the land is under control by Kansas State University for their various research and educational uses.
5. *Development Constraints.* The Flint Hills terrain is the primary constraint to development in the tributary. Large tracts of land in the extreme upper reaches of the tributary, owned by Kansas State University, are valued in their current state for research and educational purposes. The primary area under development is in Grand Mere. This development is a master planned community that has planned for a mix of generally low density residential uses and a small commercial center. Grand Mere has also developed a master drainage plan consisting of open space, and detention and retention basins to control the amount and rate of runoff from the development.
6. *Critical Facilities.* There are a number of critical facilities in the Little Kitten Creek watershed. The list includes a school, nursing homes and assisted living facilities, preschools, a Manhattan Fire Station, and public infrastructure elements.

Due to the nature of these critical facilities and the need to keep the information confidential, the exact location has not been provided. However, officials of Riley County, the City of Manhattan and the State of Kansas have the location and information regarding the facilities.

TABLE 6. FLOOD DATA, LITTLE KITTEN CREEK.

Elevation Location	Current 1% Annual Chance Flood	Preliminary 1% Annual Chance Flood	Future Conditions 1% Annual Chance Flood
Kimball Avenue	1120.1'	1121.9'	1122.8'
Anderson Avenue	1065.0'	1066.0'	1068.0'
Confluence w/ Wildcat Creek	1051.0'	1053.0'	1054.1'

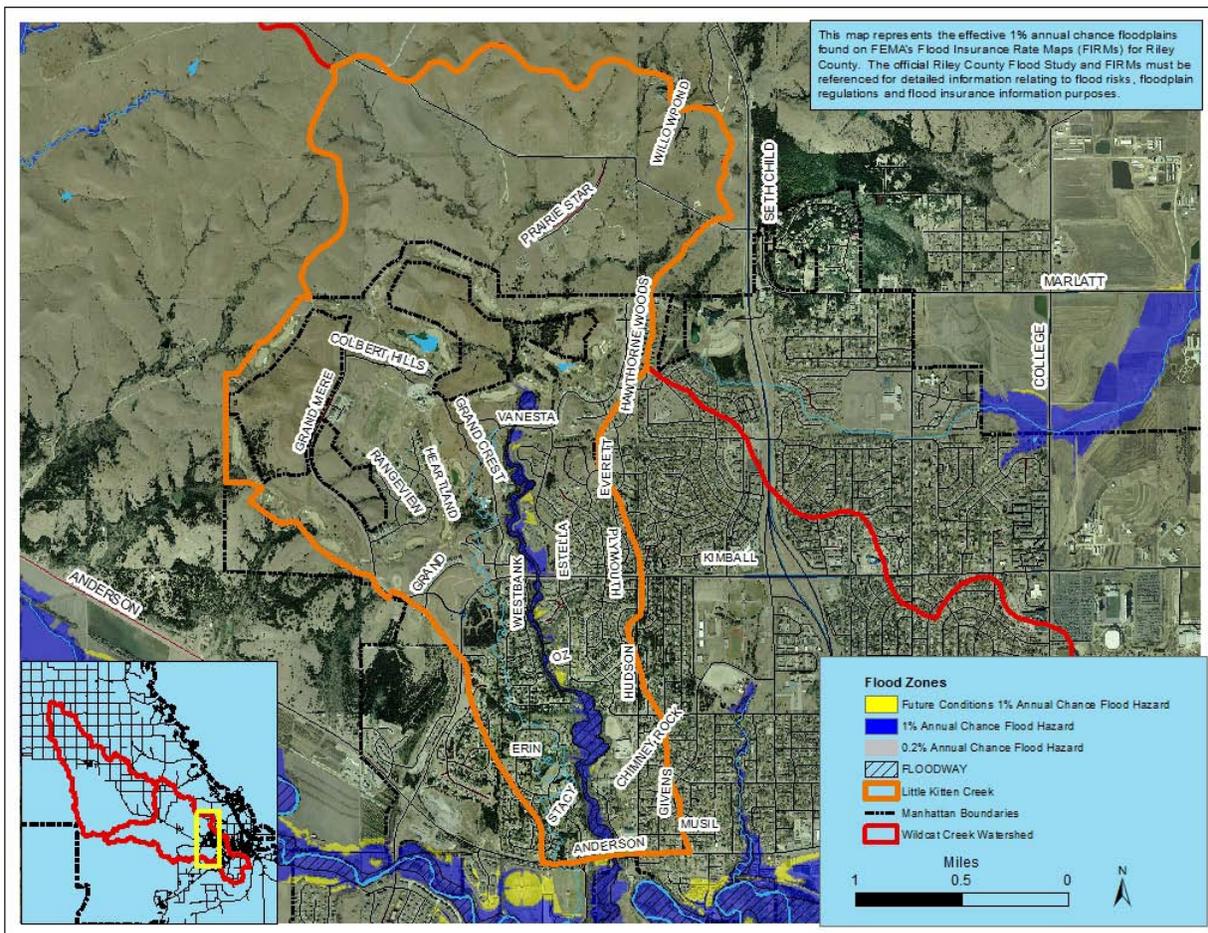


FIGURE 19. PRELIMINARY FLOODPLAIN OF THE LITTLE KITTEN REACH.

2.1.6 Flood Hazards: Rolling Hills Tributary.

Rolling Hills Tributary is a small left bank tributary of Wildcat Creek extending south from Anderson Avenue.

1. *Source of the Problem.* Flooding along the confluence of the Rolling Hills Tributary and Wildcat Creek when Wildcat Creek is in its flood stages is the primary flood hazard. However, in other areas of the tributary, localized flooding can occur.
2. *Flood Data.* The current FIS shows the drainage area to be 0.35 square miles. This study shows that the peak discharge of the 1% Annual Chance Flood as 1,050 cfs at the mouth of the tributary. The preliminary FIS expanded the drainage area slightly, with the preliminary flood model having 0.42 square miles of study area. This study shows that peak discharge of the 1% Annual Chance Flood is reduced compared to current FIS with 780 cfs near the confluence with Wildcat Creek. In addition, the peak discharge for the Future Conditions 1% Annual Chance Flood storm would be 1,053 cfs at this point. The reduction of the peak flow is primarily due to new detention basins being constructed in the tributary watershed since this area was last modeled in 2003. The Base Flood Elevations are impacted by backwater effects when Wildcat Creek is in flood stage. The maps in this section show the flood boundary for the current flood model of the 1% Annual Chance Flood for the preliminary flood model and the flood inundation depths for the Future Conditions 1% Annual Chance Flood.
3. *Land Use & Building Data.* The small tributary watershed is composed completely of single-family residential homes built on large lots (25,000 to 50,000 + square feet). These homes were built from the 1970s through the 2000s.

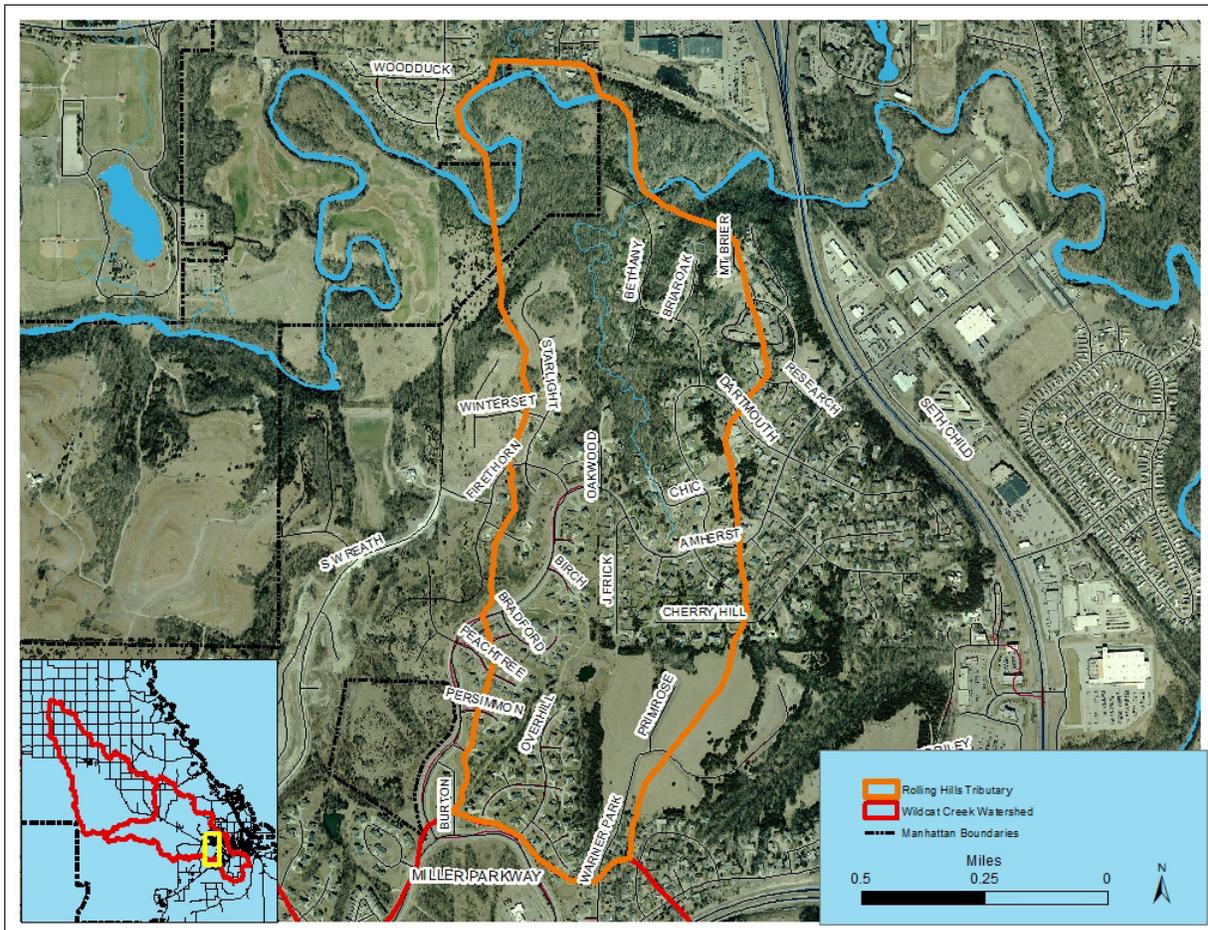


FIGURE 20. LOCATION OF THE ROLLING HILLS REACH.

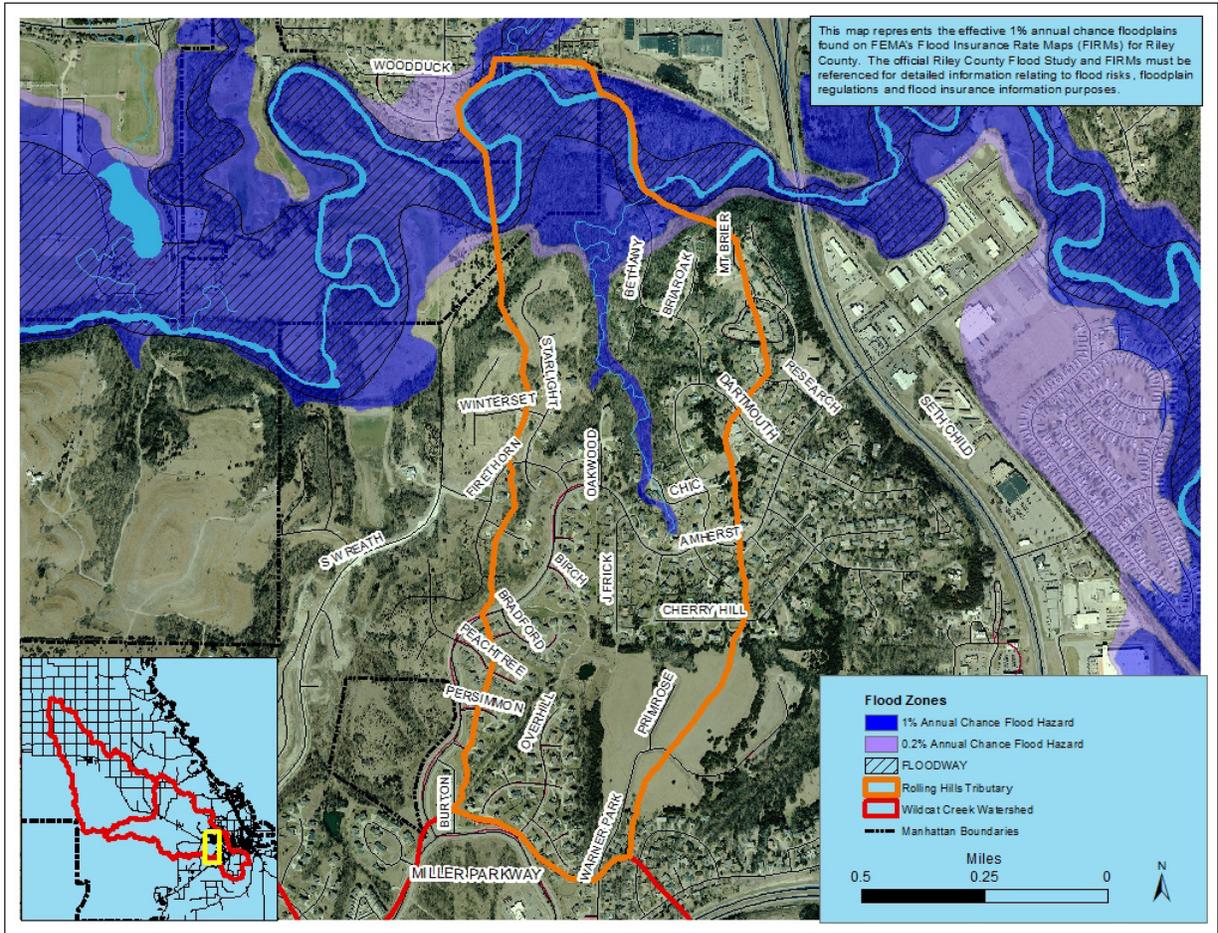


FIGURE 21. EFFECTIVE FLOODPLAIN OF THE ROLLING HILLS REACH.

4. *Development Trends.* As mentioned, the tributary is completely built out with single-family homes. Because of the terrain of the flint hills, these residential lots are located on curvilinear streets and cul-de-sacs and have large rear yards that primarily follow the tributary channel and other ravines in the minor watershed.
5. *Development Constraints.* The flint hills terrain is the primary constraint to development in the tributary. The backwater effects from Wildcat Creek near the confluence with the Rolling Hills Tributary generally prohibits development due to mapped floodways.
6. *Critical Facilities.* Because of the small size of the Rolling Hills Tributary, there are no critical facilities.

TABLE 7. FLOOD DATA, ROLLING HILLS TRIBUTARY.

Elevation Location	Current 1% Annual Chance Flood	Preliminary 1% Annual Chance Flood	Future Conditions 1% Annual Chance Flood
Confluence with Wildcat Creek	1042.2' (backwater effect)	1045.3' (backwater effect)	1050.2'

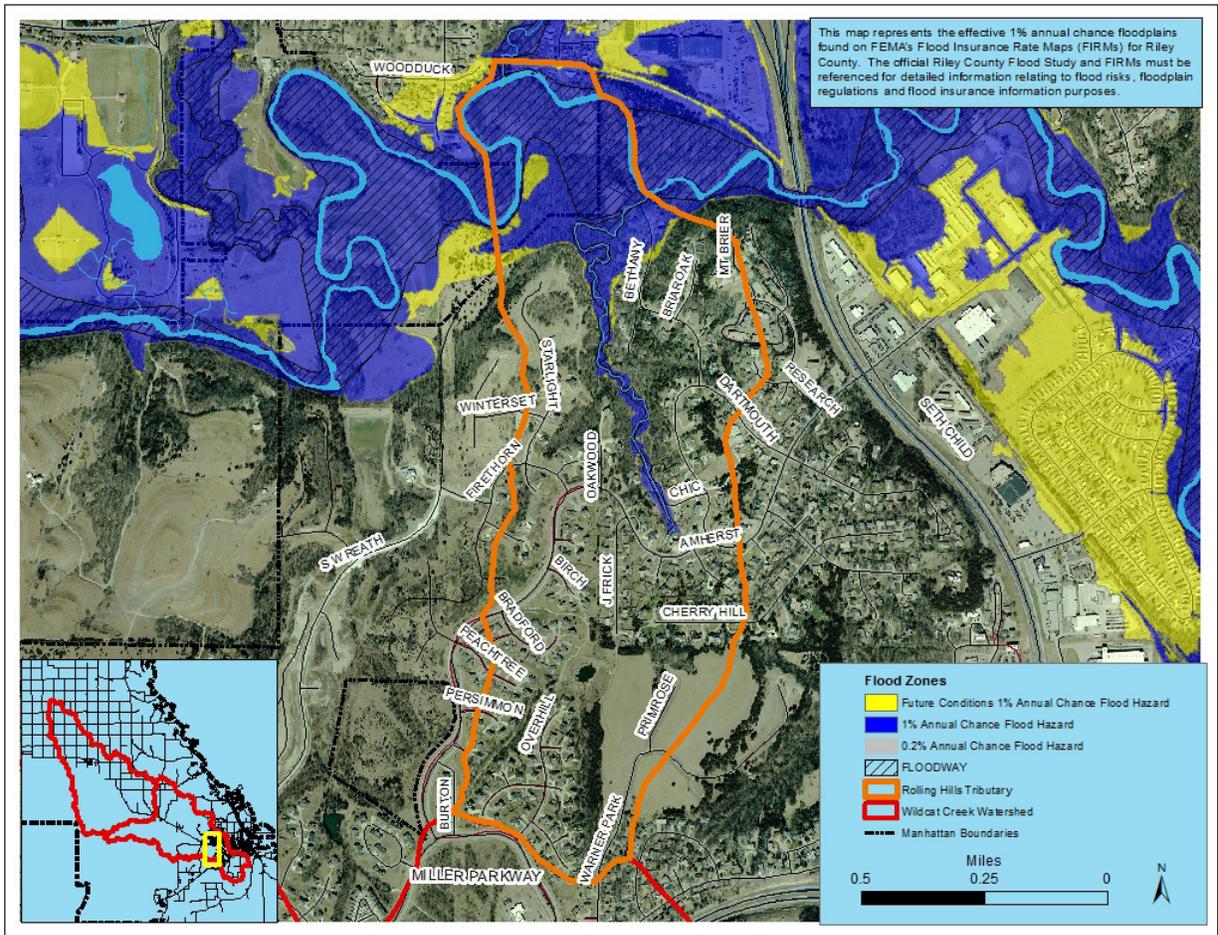


FIGURE 22. PRELIMINARY FLOODPLAIN OF THE ROLLING HILLS REACH.

2.1.7 Flood Hazards: Manhattan to Keats.

This reach encompasses Wildcat Creek upstream from the Manhattan city limits to the western edge of Keats and includes the left bank tributaries of Kitten Creek, two unnamed tributaries and three small right bank tributaries including one on Fort Riley. The Fort Riley tributary is not discussed in this section.

1. *Source of the Problem.* Flooding along the confluence of the Kitten Creek Tributary and Wildcat Creek when Wildcat Creek is in its flood stages is the primary flood hazard. However, in other areas of the tributary, localized flooding can occur.
2. *Flood Data.* The current FIS does not contain information regarding the drainage area or the peak discharge of this reach or any of its tributaries.
3. *Land Use & Building Data.* The majority of this area is in agricultural use, with associated residences and outbuildings. However, there is a concentration of single family residential homes within the unincorporated town site of Keats. There are also single family residential homes scattered throughout the reach. Blueville Nursery, a commercial garden store and landscaping operation, is located at the downstream end of the reach.
4. *Development Trends.* There have been some single-family residences constructed in scattered locations.

However, Riley County discourages a large number of non-agricultural residences from locating in highly productive agricultural areas. Blueville Nursery has added several structures in recent years. The area near the intersection of Anderson Avenue and Scenic Drive/Kimball Avenue may be developed with commercial and/or residential uses in the future.

5. *Development Constraints.* In addition to the flint hills terrain, the primary development constraint in this area is the Riley County Vision 2025 Comprehensive Plan and implemented Zoning and Subdivision Regulations, which discourage the widespread placement of non-agricultural residences in productive agricultural areas. The boundaries of Fort Riley to the south restrict development in that direction.

6. *Critical Facilities.* The Keats fire station is the only critical facility in this reach.

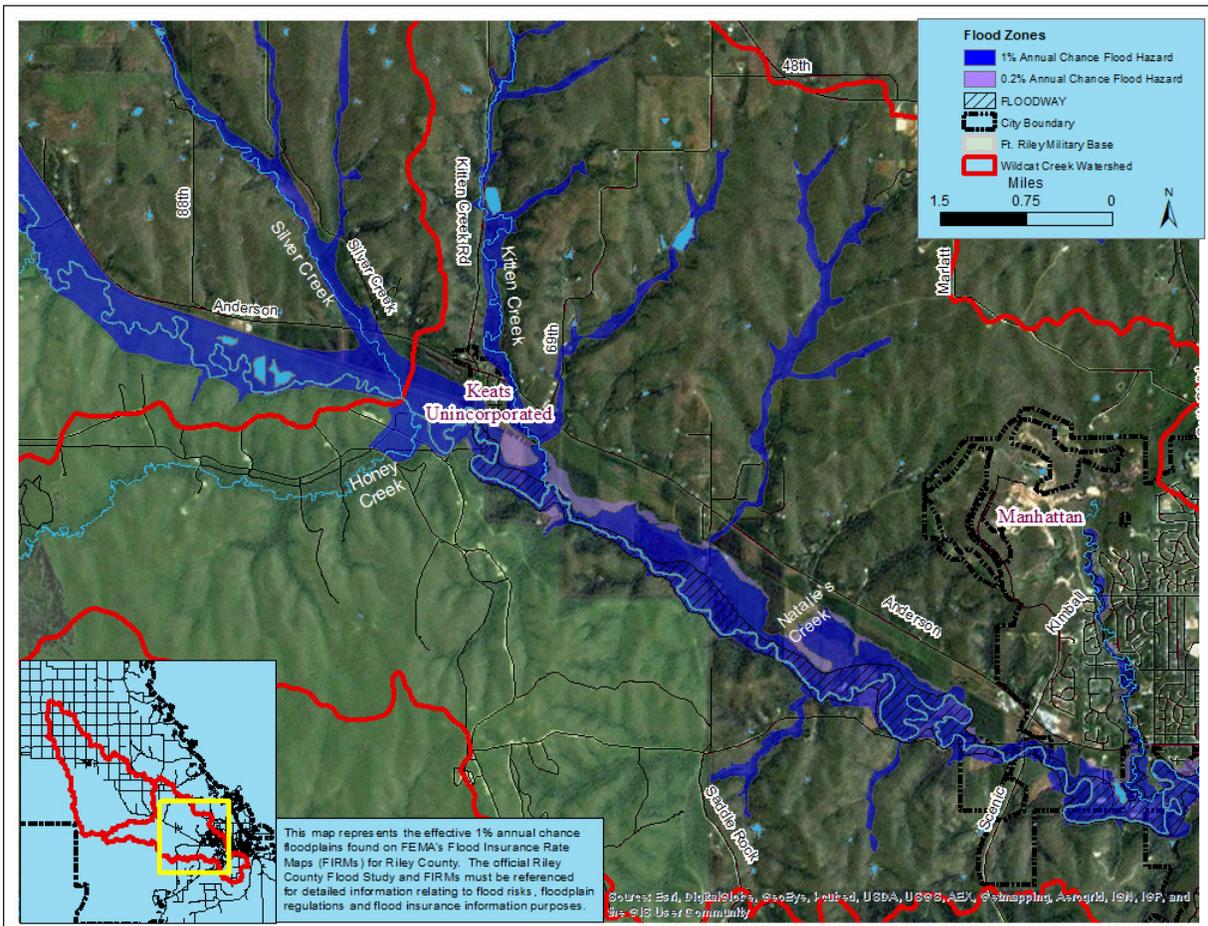


FIGURE 23. EFFECTIVE FLOODPLAIN OF WILDCAT CREEK: MANHATTAN TO KEATS.

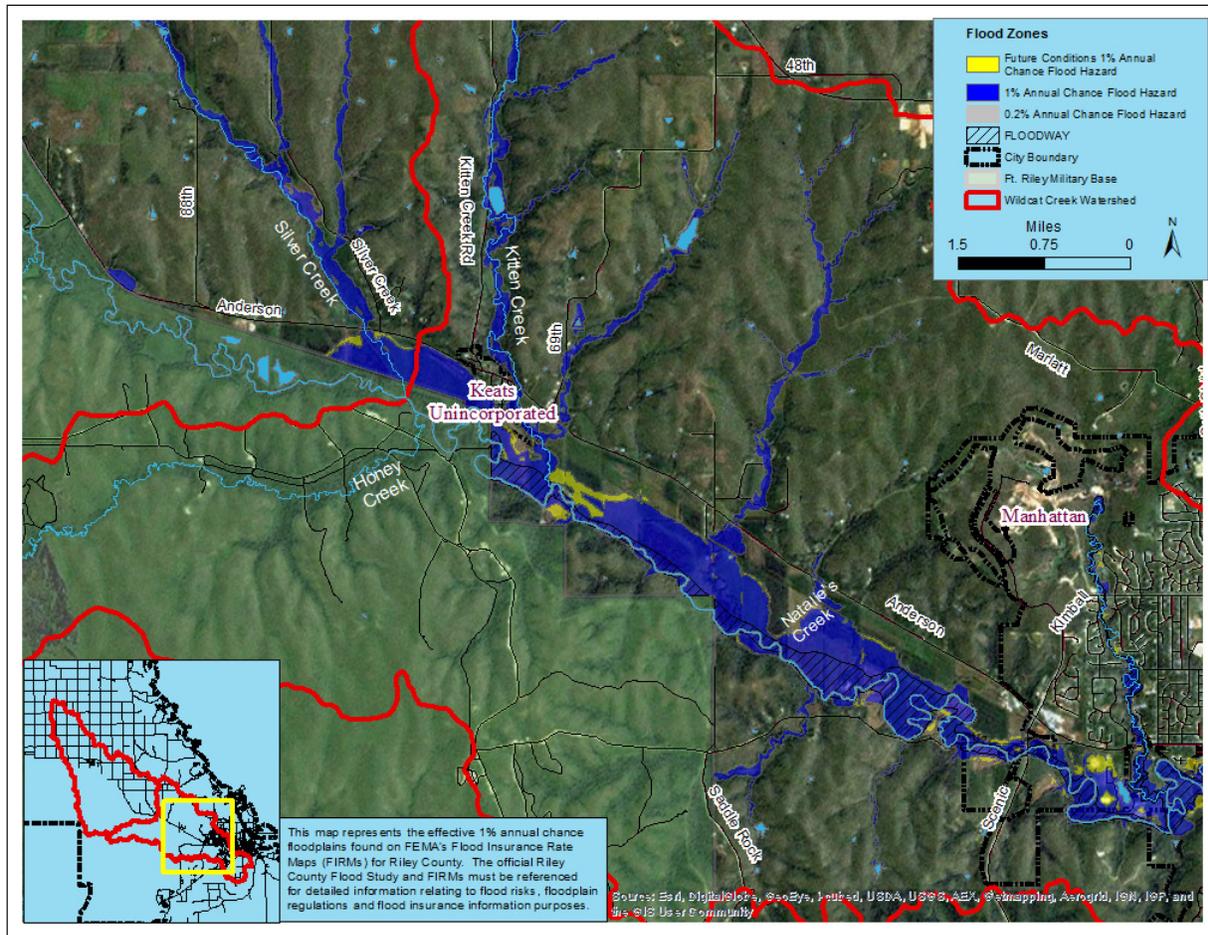


FIGURE 24. PRELIMINARY FLOODPLAIN OF WILDCAT CREEK: MANHATTAN TO KEATS.

2.1.8 Flood Hazards: Keats to Riley.

This reach extends from the western boundary of the unincorporated town site of Keats to the eastern boundary of the incorporated City of Riley and includes the right bank tributary of Silver Creek and a smaller unnamed tributary.

The reach also includes the left bank tributaries of Honey Creek, Wind Creek and the Little Arkansas Creek, all of which are on the Fort Riley military reservation, which are not discussed in this section.

1. *Source of the Problem.* The primary concern in this reach is flash flooding in localized areas.
2. *Flood Data.* The current FIS does not include information regarding the drainage area, however, the study does show the peak discharge of the 1% Annual Chance Flood as 14,100 cfs at Keats. The preliminary FIS is not available for this reach.
3. *Land Use & Building Data.* The majority of this area is in agricultural use, with associated residences and outbuildings. This area also includes some scattered residential home sites and residential subdivisions surrounded by rolling hills and farm land/pastures. The boundary of the Fort Riley military reservation to the south restricts development in that direction. During the Wildcat Creek Watershed Working Group meetings, much discussion centered on whether or not military use of the land was adversely affecting the land's ability to absorb water. Compaction of the soil under heavy military equipment was at the center of the discussion.

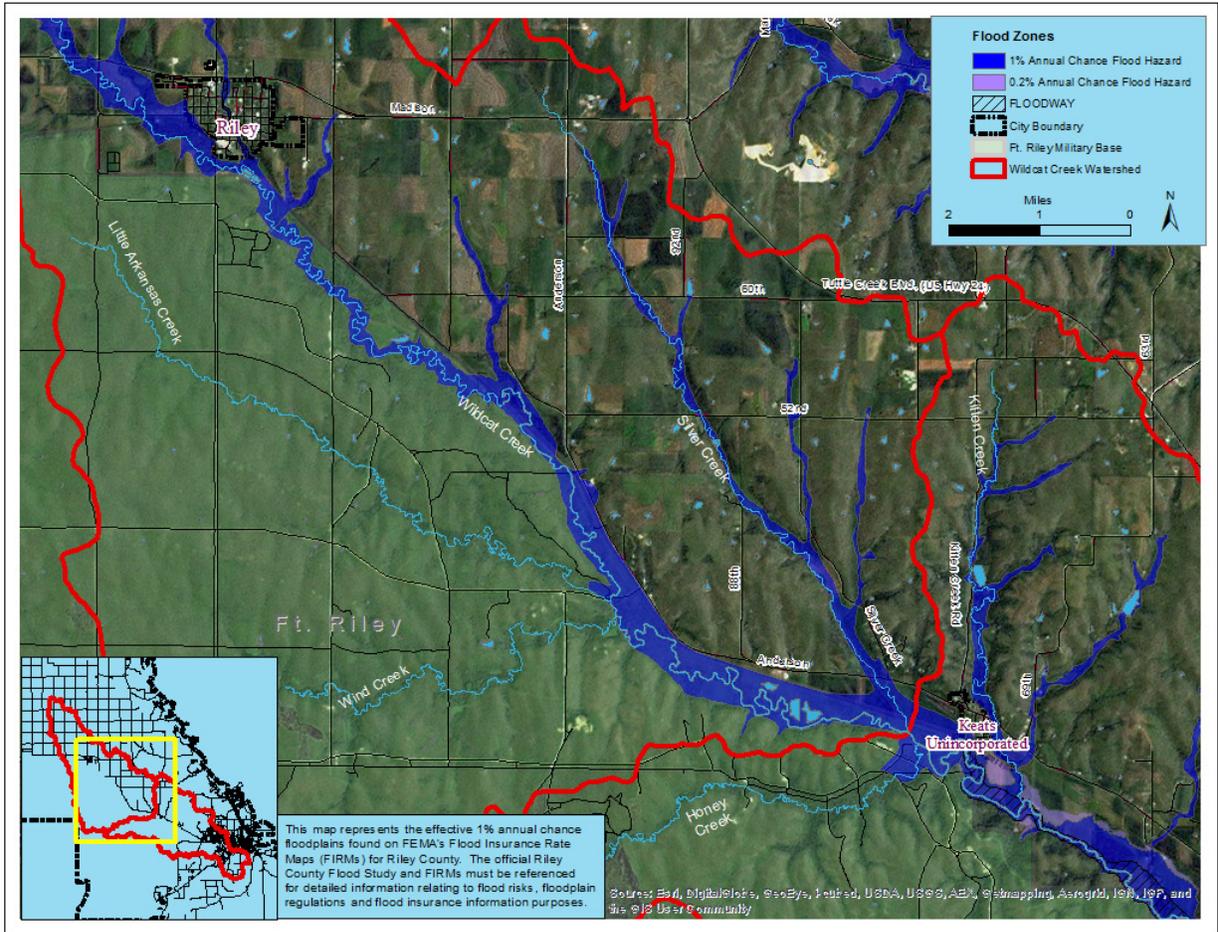


FIGURE 25. PRELIMINARY FLOODPLAIN OF WILDCAT CREEK: KEATS TO RILEY.

Fort Riley has contributed funding to implement a gauge at Keats, which allows enhanced forecasting for stakeholders that may use the new flood inundation maps of the Wildcat Creek at Scenic Drive National Weather Service forecast point and stream gauge. A scientific comparison of the nature of flows passing to the gauges at Keats, Scenic Drive and Seth Child Road, can help determine sources of flooding as more rain events occur. Land use is an important consideration to flooding and is part of determining rainfall runoff through hydrological modeling equations. Therefore, the Garrison Command submitted a letter explaining the development patterns on the Army base in the Wildcat Creek watershed (see appendix 2.1.8). Generally, the land at Fort Riley is well maintained. Progressive Low Impact Development techniques are part of all designs. Part of the land management includes the naturally occurring native species of plants which, because of their deep roots, encourage more infiltration into the soil than agricultural crops.

4. *Development Trends.* There have been some single-family residences constructed in scattered locations, however Riley County discourages a large number of non-agricultural residences from locating in highly productive agricultural areas.
5. *Development Constraints.* In addition to the flint hills terrain, the primary development constraint in this area is the Riley County Vision 2025 Comprehensive Plan and implemented Zoning and Subdivision Regulations, which discourage widespread placement of non-agricultural residences in productive agricultural areas. The boundary of Fort Riley to the south restricts development in that direction.
6. *Critical Facilities.* There are no critical facilities in this reach of the watershed.

2.1.9 Flood Hazards: Wildcat Creek Headwaters.

This reach encompasses an area from the eastern boundary of the City of Riley to the headwaters of Wildcat Creek. The headwaters extend from the north and northwest of Riley to an area just south and west of Leonardville. An unnamed left bank tributary extends north through the center of Riley, with several additional right and left bank tributaries extending north to the headwaters.

1. *Source of the Problem.* The primary concern in this reach is flash flooding in localized areas, especially in the City of Riley where the northern tributary joins the main stem of Wildcat Creek.
2. *Flood Data.* The current FIS does not include any information regarding this drainage area. The preliminary FIS is not available for this reach.
3. *Land Use & Building Data.* The majority of this area is in agricultural use, with associated residences and outbuildings and some non-agricultural residences in scattered locations. However, the area also includes numerous single-family residences and businesses in the cities of Riley and Leonardville.
4. *Development Trends.* The City of Riley has experienced the addition of a number of single-family residences in several subdivisions.

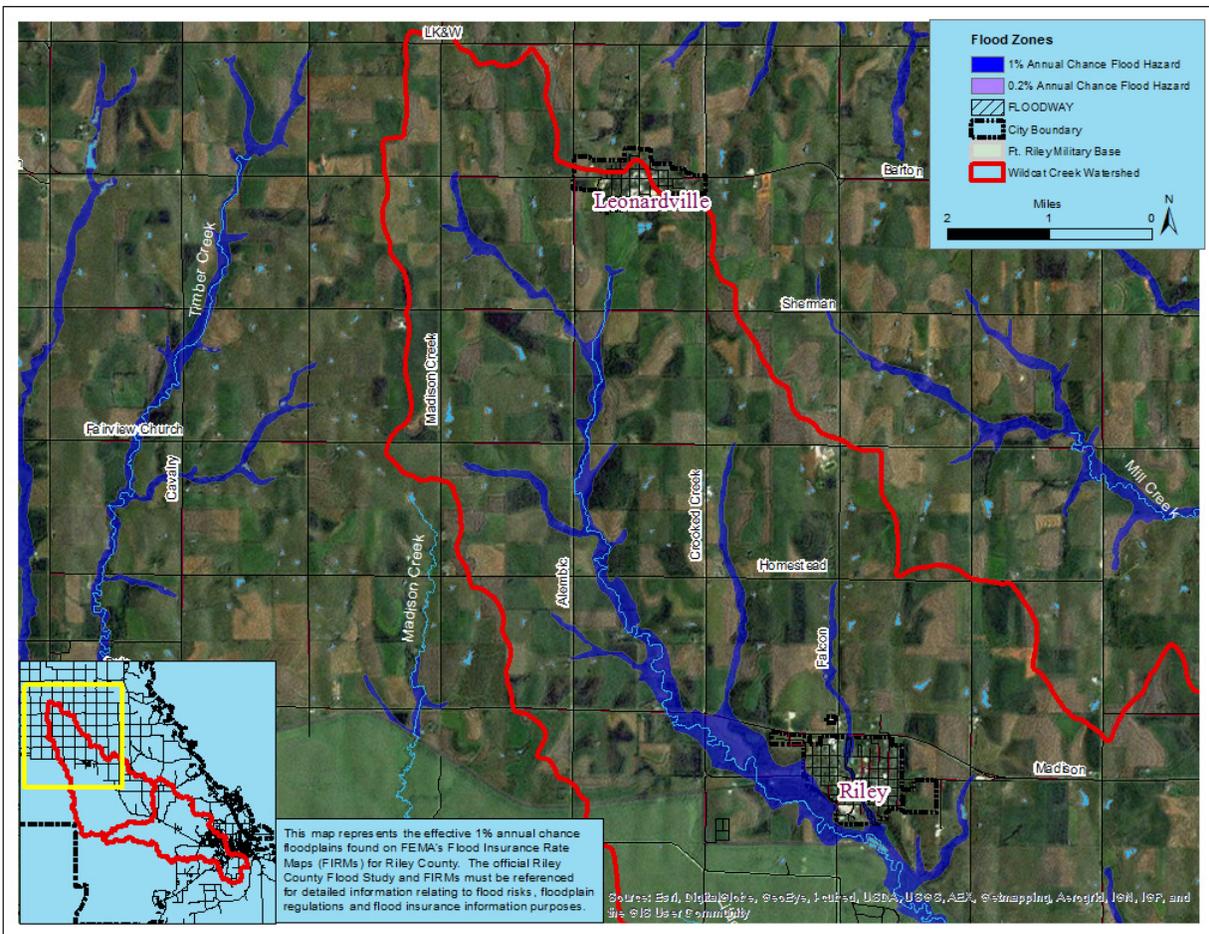


FIGURE 26. PRELIMINARY FLOODPLAIN OF WILDCAT CREEK: RILEY TO WILDCAT CREEK HEADWATERS.

Riley County discourages a large number of non-agricultural residences from locating in highly productive agricultural areas.

5. *Development Constraints.* The City of Riley is somewhat constrained by the limits of their municipal utility systems and the noise zones surrounding the Fort Riley military reservation. The primary development constraint in the outlying areas is the Riley County Vision 2025 Comprehensive Plan and implemented Zoning and Subdivision Regulations, which discourage the widespread placement of non-agricultural residences in productive agricultural areas. The boundary of the Fort Riley military reservation to the south restricts development in that direction.

6. *Critical Facilities.* The critical facilities in this area include public utilities, fire stations and government offices in the cities of Leonardville and Riley, the Riley County High School and schools in the City of Riley.

2.2 Public Involvement Process

This section briefly outlines the committee that created the Wildcat Creek Floodplain Management Plan and the public informational process in the plans formal adoption.

2.2.1 Wildcat Creek Watershed Working Group.

On July 16, 2011, following the June 6, 2011 flood event, the Manhattan City Commissioners and Riley County Board of County Commissioners established an ad-hoc committee, the Wildcat Creek Watershed Working Group (WCWWG), to research and provide recommended solutions for flooding along Wildcat Creek to the governing bodies.

At the June 21, 2011 City Commission meeting, the City Commission formally appointed Commissioner Richard Jankovich to co-chair the working group. On June 23, 2011, the Board of County Commissioners appointed Alvan Johnson to Co-Chair the working group. Following the Riley County Board of County Commissioner elections in November, 2012, Ron Wells took over as the County Co-Chair following an appointment on January 24, 2013.

The WCWWG first met on July 28, 2011 to establish the group's framework and to begin researching the flooding issues and determine mitigation measures to reduce the flood risks along the creek. Community members of the working group included:

Richard Jankovich, City Commission – Co-Chair	Mike Hill, Manhattan Urban Area Planning Board
Alvan Johnson, Riley County Commission – Co-Chair	Pat Keating
Mike Johnson, City of Leonardville	Mel Nudson
Tim Sharp, City of Riley	Charly Pottorff
Alan Hynek, Fort Riley	Kelly Briggs
Tom Taul, Riley County Planning Board	Tim Trubey
Mark Scott, Riley County Farm Bureau Association	Nyle Larson
Tim DeNoble, Kansas State University	Keith Westervelt
	Rod Harms

The working group was divided into six (6) sub-committees to further research various topics. The sub-committees were:

- Grants and Funding Sources
- Detention and Watershed
- Development and Freeboard
- Research & Data Collection
- Debris Mitigation and Enforcement
- Training and Education

To support and provide professional direction to the working group, a number of City, County, State and Federal staff members were involved. These staff members include:

Karen Davis, AICP, Community Development Director – City of Manhattan

Monty Wedel, AICP, Planning and Development Director – Riley County

Eric Cattell, AICP, Assistant Community Development Director – City of Manhattan

Steve Higgins, CFM, Zoning Enforcement Officer – Riley County

Chad Bunger, AICP, CFM, Planner II – City of Manhattan

Rich Vargo, County Clerk – Riley County

Rob Ott, P.E., City Engineer – City of Manhattan

Pat Collins, Emergency Management Director, – Riley County

Shane Swope, P.E., Stormwater Engineer – City of Manhattan

Tom Morrey, CFM, State NFIP Coordinator – State of Kansas

Jerry Snyder, Director of Fire Services – City of Manhattan

Brian Rast PE, CFM, PMP, Silver Jackets Coordinator for Kansas and Missouri – U.S. Army Corps of Engineers Kansas City District

Ryan Almes, Deputy Fire Chief – City of Manhattan

Since the creation of the ad-hoc committee, the group has discussed a number of issues, including:

1. Causes and extent of flooding.
2. What is being done about flooding.
3. What to do during a flood.
4. How people can protect their homes.
5. Flood insurance.
6. Taking care of drainage ways.
7. Updates on City and County projects .

During the initial stages of the Working Group meetings, the Kansas State Hazard Mitigation Team proposed a USACE Silver Jacket Pilot Project to implement some of the work that the WCWWG had discussed. Among other planning and research tools, the Silver Jacket Pilot Project proposed the creation of a Floodplain Management Plan. The WCWWG, along with supporting professional staff from the City, County, State and Federal levels, has been the de facto committee to draft the Wildcat Creek Floodplain Management Plan.

2.2.2 Other Public Involvement.

The general public was invited to attend the Wildcat Creek Watershed Working Group meetings and regularly participated throughout the process. Consistently property owners who were directly impacted by the flooding on Wildcat Creek attended meetings and provided valuable input and feedback. The document creation process and the final draft version of the Floodplain Management Plan were displayed on the City of Manhattan website and the Riley County website for public review and comment. Both the Manhattan Urban Area Planning Board and Riley County Planning Board have reviewed the document.

TABLE 8. RECORD OF PUBLIC MEETINGS.

Meeting Name	Location	Date
City Commission Meeting	City Hall	June 7, 2011
Wildcat Creek Public Meeting	City Hall	July 28, 2011
Wildcat Creek Watershed Working Group (WCWWG)	City Hall	August 11, 2011
WCWWG	City Hall	September 22, 2011
WCWWG	City Hall	October 27, 2011
WCWWG	City Hall	November 17, 2011
WCWWG	City Hall	January 12, 2012
WCWWG	City Hall	April 5, 2012
WCWWG	City Hall	June 28, 2012
WCWWG	City Hall	July 26, 2012
WCWWG	City Hall	October 18, 2012
WCWWG	City Hall	January 13, 2013

The Manhattan City Commission and Riley County Board of County Commissioners have formally adopted the plan as a policy document; likewise, the Manhattan Urban Area Comprehensive Plan and the Riley County Multi-Jurisdictional Hazard Mitigation Plan have been amended to recognize and reference this document.

Several flood related projects are underway in the City of Manhattan, including:

- The FEMA NFIP flood insurance rate maps will be updated on a county-wide basis, and will be presented to the public beginning in 2013.
- The Manhattan levee protects a significant portion of the southeastern part of the City from flooding on both the Big Blue and Kansas Rivers. The levee will go through a certification process for the NFIP involving a minor levee raise.
- In addition, the levee's reliability is being addressed with a USACE feasibility study.
- Also, the USACE will release a Levee Safety Action Classification for the levee in 2013.
- Finally, FEMA is conducting RISK MAP in the Lower Big Blue River and Upper Kansas River watersheds, where final discovery has been completed for both of these watersheds.

All of these activities may either directly or indirectly impact those interested in flood risk management along Wildcat Creek. The activities will also likely have public meetings, which will pose opportunities to present the Wildcat Creek Floodplain Management Plan for public review, comments and informational purposes.