

September,22, 2014

Subject: Comments on the Tongue River Railroad DEIS, Docket #30186

Dear Mr. Blodgett,

My wife and I currently own the Fix Ranch that is located about 20 miles SW of Miles City in the Tongue River Watershed. I am also the chair of the Coal and Tongue River Railroad Task Force for the Northern Plains Resource Council. Northern Plains organizes Montana citizens to protect water quality, protect family farmers and ranchers and protect the unique quality of life we have in Montana. I have been a member of Northern Plains for many years, and am a past chair of the organization. These comments are in addition to the comments that I have submitted at the hearings in Miles City.

The draft Environmental Impact Statement (DEIS) for the Tongue River Railroad (TRR) is very difficult to read and does not give us any idea which direction the TRR is headed. I would suggest that the DEIS be redone and eliminate some of the alternatives. The scope is so large that the details of the route that may be chosen cannot be covered in this draft. The information supplied is inadequate and you cannot derive a final Environmental Impact Statement (EIS) from the DEIS.

There are two alternatives that cross my ranch. The Tongue River alternative and the Moon Creek alternative. There are two different routes for each of these alternatives near the proposed Otter Creek mine. I will address the Tongue River alternative first. The proposed Tongue River alternative would cross about 3 miles of our ranch.

If completed, the Tongue River Railroad (TRR) would traverse the ranch I have lived on for almost twenty four years. The TRR would devalue my property and injure my economic interests by interrupting my ranching operations. In particular, the Railroad would form a wall that would prevent my cattle from getting to the Tongue River for water. It would go through my calving pasture and could separate cows from their calves. Calves could get onto the track and be killed by the trains. The stock crossings proposed are only culverts and the cows may not learn to use them. I would need to drill wells and supply water to the cattle in the new pastures created by the fencing of the railroad easement. There is no power available so I would either

have to pay an excessive price to provide power to these wells or install solar panels to provide power to water the stock.

The TRR could start fires. A few years ago a 60 mph wind pushed a fire across the Tongue River and came very close to our house. A county or state road would need to be built along the TRR easement so that firefighters stationed in Miles City could respond to fires created by the TRR. This road will probably require more taxes to build the road and to maintain it. The road will bring more traffic and it will require more acres of my ranch that will be taken out of production. It will bring more dust to the area if it is a gravel road. It will serve as a closer path to Miles City for some of the people up the river and it may become their preferred road. Along with traffic, I will have the possibility of vehicles or the people in them starting fires. There will be easier access to my stock if they want to steal some of them. The increase in traffic could bring more noxious weeds to the area as well.

TRR personnel have made it clear that they have the right of eminent domain and intend to use it. It is a terrible strain knowing that the TRR can come and take our land for very little money. I have a private bridge across the Tongue River and am concerned that it may be condemned to use for construction and maintenance of the TRR. The weight of construction equipment going across the bridge could cause it to fail prematurely. It may require that I will have to redeck the bridge. I may have to accept liability for people injured on the bridge. It is a one lane bridge and two cars cannot meet on it. The route to the bridge is not direct from the highway and semi-trucks may have to go past my house to gain better access. I may have to build a different access road so that there is a more direct route to the bridge from the highway.

Noxious weeds will be another problem associated with the TRR. The TRR easement will serve as a corridor that will allow weeds to proliferate. Leafy Spurge or Spotted Knapweed will likely follow the TRR easement and then we will have to fight these weeds on our property as well. This will be an additional economic burden on us.

The TRR will bisect our pastures and negatively impact our cattle. The TRR would create a smaller pasture inside of my calving pasture on the riverside of the grade. This pasture has lots of Cottonwoods and Chokecherry bushes that protect the cattle from the wind and weather in the spring. The pasture created near the river will be smaller and may not be usable for calving out as many cows as in the past. In addition this pasture is subject to ice jam flooding. Animals could be trapped by the railroad grade and may not be able to get away from the rising

water. The train could frighten the baby calves and make them jump into the Tongue River and drown. The pasture created on the other side of the tracks will be very small and may not be usable like that. I would probably have to refence the area into another bigger pasture. I may have to remove an existing fence. I would have to study the area to figure out the best way to utilize the land. Another pasture the TRR goes through would be split as well. The river side of the track would be smaller and would not be usable without opening the fence into another area. I currently have my circle pivot fenced out but may have to move the fence there as well to utilize the ground better. There is a small access to water from this new pasture and a fence would probably have to be removed so that cattle could access the river. I also have a hay yard where I store hay that may have to be moved. It would be close to the TRR and if a fire started it could burn the hay very quickly. Farther up the river in this pasture the TRR would go through a dam. They have said that they would move the dam, but it is unknown which side of the grade they would put the replacement dam. If the road goes along the route, there may not be room for a dam. There would be a culvert in Circle creek that goes through this pasture and it drains a lot of country. My current access road has a culvert in the bottom, but it doesn't handle all the water. When the creek runs full the water runs over my road. I have also had water back up over this road on Circle Creek from ice jam flooding in the Tongue River. The railroad grade would dam up this creek and could be washed out in a large rain event. The grade and size of culvert(s) is a concern on Circle Creek. This may be an area where a trestle would be better. It would allow more water to pass and allow the cattle to pass underneath. The pasture that is created above the railroad grade may not have enough water. There is one dam in the pasture and it usually dries up by the end of the summer. I use this pasture in the early spring and then the fall and through the winter. I would probably have to drill a new well so that I have a reliable water source for this pasture. I may need access culverts so that cattle can get to the river or to my artesian well for water. The artesian well flow has decreased in flow over the last few years and I am currently working on a solar system to pump the well in the winter time. The pasture above the grade may not be accessible if it is a snowy winter. Currently the cattle go back into the hills for cover when a bad storm comes and they will not be able to do that easily if the TRR grade is there. Again, the cattle may not want to go through a culvert that goes under the railroad. It would only be usable if the culvert also goes under the road that needs to be built. That makes the culvert longer and less likely for the cattle to use. It will be a lot of trial and

error to see what will work if the TRR is ever built. I have a set of portable corrals at the exit to this pasture and I may need to make the corral better so that I can haul cattle more easily. I usually bring the cattle home to wean them, but the route through the railroad culverts and the chokecherries and across my bridge may make it difficult to do that any longer. I would probably have to wean the cattle at the corrals I just mentioned. The TRR would also go through a 100 acre pasture next to my calving pasture. This pasture would be cut off from water and I may have to fence it into a larger pasture to use it. I currently put 50 heifers in this pasture for about 20 days for the start of the breeding season. The next pasture the TRR goes through would be cut off from the river for water. I would probably have to drill a well in that pasture to provide water, so that the cattle wouldn't have to go to the river. I may want a culvert there to access the river if I cannot get any water. Once again, it will be a trial and error system. There will be a pasture of the neighbors that will be cut off and I may end up buying that property to add to my pasture if they cannot use it. I would have to negotiate with them to buy the property if it becomes available. That would require refencing as well.

The easement will need to be fenced to keep livestock from getting on the track. The TRR has not made a firm commitment to any timely and necessary repairs of the fence. In all likelihood, we will be responsible for repairs to keep our cattle off the grade. The TRR has not determined whether we will be paid for livestock that are killed on the railroad grade.

Culverts will need to be added to allow cattle to cross between our pastures that would be bisected by the TRR. Cattle may not readily go through the culverts to utilize the pasture and may have to be herded to the other side to utilize the grass. Some may never learn to go through the culvert. We may have to put the cattle in a corral and transport them across the track to utilize the pasture. This will require additional corrals to gather and load the animals. We may need to corral the cattle next to the culvert to try to train them to go through the culverts. Culverts may fill with ice or water and be unusable for livestock.

In addition to culverts we will need grade crossings as well to take wide machinery across the track. Grade crossings may not be easily accessible. We may have to drive up or down the TRR easement to find a crossing to move our machinery. Grade crossings will need cattleguards so that we will not need to open gates to get across the grade. Hopefully, TRR will provide the cattleguard and maintain it. Cattleguards tend to fill with dirt and have to be cleaned occasionally. We may need to clean the cattleguards if TRR or the County does not do it.

We may have to accept more liability if the TRR is built. Our insurance could go up. All phases of our operation will cost us more to operate if the TRR is built.

TRR land men came to my ranch several years ago to talk about obtaining an easement or right of way across my property. My neighbor at the time and I talked with them and discussed the location of the railroad easement and where the crossings would be located. I tried to convince TRR personnel to move the route farther away from the river off of the floodplain and out of my calving pasture. They refused to consider the route I asked for. They informed me at the time that they intended to move the route over ½ mile on my place. I was considering putting an irrigation circle pivot on the property across the river, but was holding off to see if the railroad was going to be built on its original route. They told me that the new route would be used. I felt that I could then put the circle pivot where the original route was planned. I noticed that when the TRR III EIS came out they actually showed both routes approved by the Surface Transportation Board. I am thankful that the new DEIS does not show the original route any longer. But this is just a draft and I do not know what route will be chosen for a preferred route. The Environmental Impact statement talked about double tracks in several places along the route and I don't know if I have double tracks or not.

My personal and Northern Plains' conservation interests in fish and wildlife species and their habitat will be harmed if the Tongue River Railroad is allowed to proceed without the environmental safeguards required by law. The Railroad would result in the degradation of habitat and further decline of populations of species such as the pallid sturgeon, bald eagle, sage grouse, other fish and wildlife, and sensitive plant species.

I take pleasure in knowing that pallid sturgeon, bald eagles, sage grouse, other fish and wildlife, and sensitive plants are nearby. The Surface Transportation Board failed to determine the baselines for these species and how they will be impacted from the Railroad. Many of the areas were not looked at for the DEIS. The fires of 2012 had ravished a large area and the wildlife was gone. Some of my neighbors wanted to have a three year study done to make sure the wildlife had moved back. The Surface Transportation Board and the TRR did not allow this to happen. No studies were done in those areas. I allowed ICF on my property to study the wildlife and they have found a Sage Grouse Lek on the Moon Creek alternative across our ranch.

We have lots of wildlife on our property. There are Mule deer and Whitetail deer, antelope, Sage hens, pheasants, prairie dogs, ground owls, beaver, numerous song birds,

including meadow larks, swallows, mourning doves, woodpeckers, hawks, eagles, ducks and Canada geese. Elk are starting to migrate into this area and one of my sons saw a nice bull elk across the river a few years ago. There are coyote, fox, badgers, raccoons, skunk, porcupine and wolves have been spotted nearby. Bobcats and mountain lions have been spotted on my ranch. There was a bear captured in Miles City a few years ago and relocated to the Custer Forest south of our ranch. The prairie dog numbers rise and fall as bubonic plague comes and goes through the area. If the Railroad is completed, I fear I will no longer be able to view and enjoy these fish, wildlife, and plants to the extent I do now.

We allow public hunting on our property via Block Management which provides additional income. We usually have a couple hundred hunter days a year on our ranch. The wildlife numbers will be affected by a railroad running through the property and it could make management of the block management area more difficult. We may be forced to curtail the Block Management hunting during construction of the TRR and will have to make a decision as to whether we will continue it if the TRR is built. This is true both for reasons of liability (we are concerned about being liable in the instance that a hunter or his property are damaged by the railroad), and due to over-hunting concerns detailed below.

The Tongue River Ranch that adjoins our ranch was recently purchased by the State of Montana and is being used by the public for hunting. The current access to that ranch is from Interstate 94 through the Moon Creek exit. If a road is built along the TRR, the distance to the Tongue River Ranch would be shorter from Miles City and traffic will increase to access hunting on the Tongue River Ranch. This will increase the traffic on the new road that will be built along the TRR grade. Hunters may try to sneak into my property and hunt on it. I will have to post signs more visibly than I do now (an additional personal cost and effort on top of the need to watch my property more closely). One sign on my bridge is sufficient now.

I fish in the Tongue River and have caught some nice catfish. I have also caught smallmouth Bass, Goldeye and Carp. There are more species of fish coming into my section of the river since the upstream bypass was installed on the Tongue and Yellowstone diversion dam. I am worried that the TRR would injure my recreational interests in fishing. The DEIS needs to do a better baseline study on how many fish are in the river or how railroad construction would impact the fish.

The fish in Tongue River are in grave danger. The survival of the Pallid Sturgeon is tied to the Tongue River. The Tongue River was used for the Pallid Sturgeon to spawn many years ago. The TRR will produce sediment and other environmental impacts on Pallid Sturgeon and other aquatic resources. These impacts were never quantified. How much sediment will be brought into the Tongue River from all of these different alternatives? The cumulative effects from the TRR and Coal Bed Methane development and development of the Otter Creek Mine and other mines upstream may permanently damage the Tongue River. The river water quality is already exceeding the non-degradation thresholds from CBM development.

The Tongue River Railroad would also be loud and noisy. It would not allow me to enjoy the solitude of the area as I do now. The ranch is beautiful and we can hear birds singing and coyotes howling. The noise from trains honking at crossings and the rumble will definitely disturb this tranquil environment.

If the Surface Transportation Board permits the Tongue River Railroad, my economic, aesthetic, conservation and recreation interests will be injured. Fish, plant, and wildlife species will continue to decline and their habitat will continue to be degraded and I, other Northern Plains members, and the general public will suffer substantive harm.

As I get older I would like to pass the ranch on to my sons. The TRR has been hanging over our heads for many years. I have lost many of my neighbors who were friends because they did not want to deal with the TRR. I do not want to pass on the problems that are associated with fighting an unneeded railroad.

The Moon Creek proposal will split my ranch in half, with an east half and a west half. I have not looked at this alternative as long as the Tongue River alternative. I have been thinking about the Tongue River alternative since 1991 when we bought the ranch. I only began looking at the Moon Creek alternative for the last year or two. It appears that the route through my big pasture would go over the top of the well and windmill that is in the State section. The DEIS says that the well will be sealed. I would probably need to have two wells drilled to replace it, one in each pasture that is created from the railroad easement being fenced. There is no power there so two solar wells would need to be installed to water the cattle. The west half of the big pasture does not have much water and the new well would be critical to watering that pasture.

The route appears to go over the top of a sage grouse lek that is in this pasture. Given the level of national concern about sage grouse, the proposed TRR's impact on sage grouse leks needs to be taken seriously.

I doubt that I can get the cattle to use culverts to go under the track. I would probably have to put the cattle in one pasture and then move them to the other after they have grazed the first pasture. I may have to corral the cattle and haul them across the tracks to the other side. This would require an-at grade crossing near the corral at the south end of the ranch. Currently the corral is on the East side of the proposed Moon Creek alternative. I would probably need to build a corral on the West side of the tracks as well to be able to gather and haul the cattle back across to the East side.

There would be the same concerns with fires and weeds that we have for the Tongue River route. The operation of the railroad would cause fires and this area is far enough away from the ranch that I may not see the fires until they are out of control. The Moon Creek alternative would also need a county road alongside of it to help fight fires and spray for weeds. The road would need to start near Interstate 94 and go south through my ranch and then up the Tongue River until the SH ranch. The road would have to be continued after the Harwood ranch to the Brandenburg Bridge to gain access to the area along the track. The DEIS is deficient because it neither identifies locations for roads like these nor discusses their particular impacts.

When the route goes out of my big pasture into the North pasture, the grade is quite steep. The DEIS did not say whether a helper unit would be required at this point or not. The DEIS did also not address if any sidings would be installed on the Moon Creek route and where they might be.

The cut near the top of the Moon Creek and Tongue River divide would be large and it appears that the drainage path for water could be altered and water that normally goes into the Moon Creek drainage may go into the Tongue River drainage. The drainage path to the first reservoir on the top of the grade would be crossed by the TRR. A culvert may not be enough to fill this reservoir, since some of the drainage would be diverted into the Tongue River drainage. It is difficult to fill and only fills under certain conditions.

The route is on top of my access road in the North Pasture. I would have to build a new road to have access into this pasture. It is owned by the BLM and I do not know whether they will allow a new road to be built or not.

If a county road is built parallel to the track I may be able to use that for access into the pasture. The road would give access to the public for hunting in this pasture. It would also give access to the State land. The State Land has an agreement with block management to allow the landowner to restrict use via the block management system. The hunters would first need to sign a permission slip to hunt in this state land. The BLM land does not have that sort of agreement and the public could hunt there without permission. The private land in the North pasture is not fenced separately from the private land, so hunters may not know when they are leaving the BLM land and entering the private land. I do not know if I would continue the block management program or not. If an unlimited number of hunters come into the BLM land, I may have to cut down the number of hunters I let in to hunt. The road would give the public access for stealing cattle, the same as a road for the Tongue River route.

The North pasture would also be cut in two by the TRR and the fences installed for it. I may need to take out the South fence in the North pasture and make it into an east and west pasture that would be combined with my big pasture. I doubt I could get the cattle to use culverts to cross from East to West in the North pasture and it is too difficult to haul cattle into the North Pasture. I may be able to leave the South fence in and herd the cattle to the North into the North Pasture from the big pasture, after I haul them over the tracks. It would make it very difficult to operate the ranch, and increase the time spent herding cattle.

I would need to have some at grade crossings in the North pasture to be able to access areas on each side of the tracks. The dams in the North Pasture to the west of the tracks may not have sufficient water for the cattle and an additional well may be required. It would also need to be solar powered, as there is no power available there. The east section could also use an additional well. It is very difficult to get vehicles into the north pasture and well drillers may not be able to access the area to drill a well.

Once the final EIS is complete, the TRR has a permit and can utilize their eminent domain authority. I have suffered financial loss from the fact that a permit was allowed across

my property. I have included the verified statement that I have submitted for the permit application to describe that financial loss. I do not want to have additional loss from another permit and that is why I am recommending the no action alternative.

I visited with the folks at the hearing in Miles City. I explained that I could not download the Google Earth program because our internet is so slow. The ICF and Surface Transportation Board said they would send me a map on disc that I could use. I have never received the map.

I have also included the testimony that I gave in Miles City. Due to the time restraints, I gave part of the testimony in the first session and the rest of it in the second session.

During scoping, maps were available that showed where a siding was supposed to be on the Tongue River Route. It was located on the Hirsh Ranch. The newest DEIS does not identify that as a possible siding location and no other siding locations are identified. There is only general discussion about where there may be sidings. We cannot comment about how a siding may impact our operation without knowing whether we have a siding or not.

I have looked over the maps provided on the internet site for the different routes. These maps are not available in the DEIS and are very useful to know where the routes are proposed. I looked over the Tongue River Road route and I am concerned about the section near the Tongue and Yellowstone Irrigation Dam (T&Y). The route goes through the Leonard and Dustin Muggli Farm and then across the Tongue just above the T&Y dam. The berms created and the supports in the river will be a concern. The existing T&Y dam holds back ice during ice jam flooding and often flood the Leonard and Dustin Muggli Farm. The water in the past has even gone around the T&Y diversion dam. The dam has been modified to allow fish to swim upstream past the dam and there is also a downstream bypass to allow fish to go back into the river instead of being trapped in the irrigation ditch. There was work that was done for the upstream bypass on the West side of the T&Y. It included a large berm to support the upstream bypass channel. This berm should protect the possible washout from ice jam floods that try to go around the diversion dam on the West side. The new construction for berms to support the bridge for the TRR will change the dynamics of the Tongue River in that location and could cause the ice jam flooding to be even more severe and may cause the flood waters to go onto the ranch belonging to the

Murnion family. The construction there may cause the water to go around the diversion dam and cut a new river channel. It will surely cause more flooding on the Muggli Farm as well.

The DEIS does not look at the possibility of flooding at Miles City and how the TRR berm will affect that flooding. The city of Miles City has done a study on the possibility of rebuilding the dike that protects Miles City and it has not looked at the TRR berm at all. I have included the study that was done for Miles City for a new dike. The interaction of the TRR berm and the Tongue River will affect ice jam flooding and normal flooding all along the Tongue River alternative. It must be studied in the EIS to determine how the two things will interact with each other.

The Burlington Northern (BN), which owns the track that goes through Miles City, has recently increased the speed limit to 60 mph through Miles City. They have stated that they merely have to build the track to a new specification and can increase speed because the roadbed is capable of it. This has caused quite a bit of concern in Miles City and I have included several newspaper clippings talking about the increase in speed. I have looked at the wye proposed at the BN tracks at Miles City and it does not appear that trains could go 60 mph on the wye going up Tongue River. Can the TRR move the tracks and make the turns gentler so that they can go 60 mph through those curves? If so, wouldn't that require an additional bridge across the Tongue River, go through Spotted Eagle Lake and take out more businesses and homes? Also if the curve going to the West was upgraded to accommodate a 60 mph speed limit, wouldn't that go through most of the Fish Hatchery? There is quite a bit of concern regarding upgrades to the crossing going to Spotted Eagle recreation area with the new 60 mph speed limit. The existing crossing only includes flashing lights and does not include a protection arm. There is also concern about how far train cars will go in a derailment at 60 mph versus 30mph.

I also included a newspaper clip talking about relocation of the railroad crews at Forsyth to Laurel. This seems to indicate that Burlington Northern has no intention of ever building and operating the Tongue River Railroad.

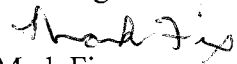
There is no need for the Tongue River Railroad anymore. The Otter Creek mine does not exist and will probably never be built. The cumulative impacts associated with the remnants of Coal Bed Methane (CBM) in Wyoming, plus the problems associated with the Decker Mine, the

Spring Creek Mine and the new proposed mine on Young's Creek in Wyoming all affect the Tongue River Watershed. The water quality this spring is worse than we have ever seen in the Tongue River. Development of the Otter Creek mine would only make the water quality worse. It would damage our irrigated lands, possibly destroying their productivity. The waters released from developing the Otter Creek mine are high in salts and would destroy our soils when they are discharged into Otter Creek and the Tongue River.

Not long ago, I went to Denver and testified to the EPA regarding climate change. I have included my testimony to the EPA. We are seeing dramatic changes due to climate change and the weather is changing dramatically. It is making it more difficult to raise crops and run cattle. Food supplies will be in danger as well as water supplies if we do not work to slow down coal production and the burning of coal. Building a new coal mine on Otter Creek would only make climate change worse. The application and the DEIS do not say where the coal will be used. The DEIS only suggests that it will replace existing coal. The DEIS also says that the coal consumption forecast is the same whether the TRR is built or not. If OEA's logic is correct, this would mean that there is no new market for Tongue River coal, and there is no need for the TRR, as all it would do is displace existing mines and mining jobs while decreasing the value of ranches like mine, and making them notably more expensive and difficult to operate.

I participated in the draft Programmatic Agreement in the DEIS. I do not feel that the culture can be protected if the railroad is built.

I can only see one alternative that will work and that is the 'no action' alternative. I encourage the Board to select it.


Mark Fix

Fix Ranch

Miles City, Montana



Flood Mitigation Feasibility Report

Prepared for Miles City, MT

2/5/15



Flood Mitigation Feasibility Report

Prepared for Miles City, MT

February 2015

KLJ Project #2409116



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Appendices

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Appendix 3: MDT Bore Samples

Appendix 4: SK Geotechnical Bore Samples

Appendix 5: 100-Year & 500-Year Preliminary Levee Cost Estimate

LIST OF ABBREVIATIONS

Abbreviation	Meaning
BFE	Base Flood Elevation
CFR	Code of Federal Regulations
CFS	Cubic Feet Per Second
CLOMR	Conditional Letter of Map Revision
CMSP	Chicago, Milwaukee, St. Paul and Pacific Railroad
DEQ	Montana Department of Environmental Quality
DNRC	Montana Department of Natural Resources and Conservation
EA	Environmental Assessment
EIS	Environmental Impact Study
FDPA	Flood Disaster Protection Act
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FT	Feet
GIS	Geographic Information System
HEC-RAS	Hydrologic Engineering Center River Analysis System
HFIAA	Homeowner Flood Insurance Affordability Act
LCR	Levee Certification Report
LiDAR	Light Detection and Ranging
LOMA	Letter of Map Amendment
LOMR	Letter of Map Revision
LP III	Log-Pearson Type-III
MDT	Montana Department of Transportation
MT	Montana
NAIP	National Agricultural Imagery Program
NEPA	National Environmental Policy Act
NFIP	National Flood Insurance Program
NPDES	National Pollution Discharge Elimination System
NRCS	Natural Resource Conservation Service
O&M	Operations and Maintenance
OPC	Opinion of Probable Cost
PMR	Physical Map Revision
PRP EE	Preferred Risk Policy Eligibility Extension
PRR	Pennsylvania Railroad
ROW	Right-of-Way
SCS	Soil Conservation Services
SFHA	Special Flood Hazard Area
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WPA	Work Progress Administration
WSEL	Water Surface Elevation

Summary

Miles City, MT has recognized a need to develop a Flood Mitigation Feasibility Report for the Yellowstone and Tongue Rivers to assess flood risks and floodplain regulation issues. They retained the consulting engineering firm of KLJ, Inc. (KLJ), to assist them in determining feasible alternatives to decrease flood risk and reduce the regulation burden on the community. Recently there has been increased pressure from the community to develop a solution to ease the financial burden for residents of Miles City and the surrounding areas of Custer County, who are mapped in the SFHA. Consideration was given to alternatives that would remove the affected properties from the SFHA. The major effort of this study was centered on the area, looking downstream along the rivers, contained by the right overbank of the Tongue River from the golf course north to the confluence of the Tongue River and the Yellowstone River, the left overbank of the Tongue River from the Old Milwaukee Railroad Bridge to the confluence of the Tongue River and the Yellowstone River, and the right bank of the Yellowstone River from the water plant to the eastern city limits, a distance of approximately 5.5 miles.

The results of this report indicate there is significant risk of flooding, principally induced by ice jams at the confluence of the two rivers and just downstream of the eastern city limits. However, multiple solutions to mitigate and minimize flood risk and reduce the regulation burden are identified as feasible possibilities. The alternatives producing the highest cost benefit (in relation to reduced flood insurance premiums) as well as having the largest decrease of flood risk, are structural flood control projects along the right bank of the Tongue and Yellowstone Rivers as well as the city water plant. The most current modeling of the two rivers was completed by the United States Army Core of Engineers (USACE), which was reported in the 2007 FIS. This model was obtained by KLJ, and multiple structural flood control elements were added for each proposed structural alternative to assess upstream, downstream, and floodway impacts. The Plan developed by this report contains recommendations for channel improvements, hydraulic structural improvements and flood control levee embankments.

This study is intended to be of a preliminary nature. A broad overview and preliminary structural analysis of levee and floodwalls, as well as hydraulic structures was performed to determine if the

alternatives were feasible. This report is intended to give high level cost, schedule, and scope of the feasible alternatives.

KLJ has laid out five alternatives, with each alternative having varying degrees of benefits and costs. The five alternatives reviewed by KLJ give the City a broad range of potential options to consider to alleviate regulation economic burdens as well as potentially decreasing the risk of severe flooding.

1 Introduction

A Flood Mitigation Feasibility Report for Miles City and surrounding developed areas of Custer County was conducted by KLJ. This flood mitigation study involved assessing the flood mitigation need, identifying a range of flood mitigation alternatives, conducting a screening of alternatives and soliciting public involvement and input.

1.1 Study Area

Miles City, MT is located at the confluence of the Yellowstone and Tongue Rivers in Custer County, eastern Montana as shown in Exhibit 1 in Appendix 1. The Yellowstone River has its headwaters at Yount Peak in the Absaroka Mountain Range outside the southeast boundary of Yellowstone National Park. It then flows northeasterly through Montana and into North Dakota to its confluence with the Missouri River in McKenzie County, as shown in Exhibit 2 in Appendix 1. The Tongue River is a tributary to the Yellowstone, whose headwaters start in the Big Horn Mountains in Wyoming. The Tongue River flows north through eastern Montana until meeting with the Yellowstone River at Miles City. The principal area of focus for the study is shown in Exhibit 3 in Appendix 1. While the Study is centered on Miles City, areas upstream and downstream were considered to assess impacts of the proposed alternatives.

1.2 Historic Notes

The USGS and USACE have documented a long history of flood events at Miles City. There have been 19 recorded flood events since 1882, with eight being major floods resulting in documented property and infrastructure damage. The two most damaging floods occurred in 1929 and 1944, and the high water marks are indicated in Exhibit 4 in Appendix 1. In 1936, an embankment was constructed by the WPA to protect against a flood equal to the 1929 peak (Department of the Army U.S. Army Engineer District, Omaha, 1978). Additional embankments were added by local interests in 1950 and 1974 as well. However, during the 1944 flood, the WPA embankment failed and was overtopped and undermined in multiple locations as indicated in Exhibit 7 Appendix 1. It is estimated that the damages from the 1944 flood event were equivalent to \$3.3 million in current dollars. In 1948, the *“Study of the Yellowstone*

River Basin and its Tributaries” was prepared by the USACE. Within the report, the USACE recommended a local flood protection project at Miles City due to the extreme risk of ice jam flooding at the confluence of the two rivers. Documents show that public support for the project could not be gained, and the USACE subsequently placed the project in an inactive status in 1961. In 1969, the USACE initiated a restudy due to renewed local interest. The restudy was completed in 1974 and reaffirmed the authorized levee plan from 1948. An update to the 1974 restudy was completed in 1979, and the USACE began design on a flood protection project. Additionally, in 1979 FEMA published its FIS and issued Miles City’s first effective FIRM which indicated a large portion of the community as being in the 100-year floodplain and approximately 80% of the community contained in the 500-year floodplain. Exhibit 5 in Appendix 1, shows the historical FIRM. The effective FIRM map was changed in 2010 due to updated river hydraulics and better topographic maps. A comparison shows that the historic FIRM has less inundation during a 100-year flood event, than the current FIRM, as found in Exhibit 6 in Appendix 1.

With the implementation of the new FIRM, Exhibit 6 in Appendix 1, all mortgage lending to property indicated in the SFHA was required to have a flood insurance policy through the NFIP. Even though the embankments along the river provide some level of flood protection, they fail to meet federal requirements for levee embankments and are not considered when mapping the 100-year floodplain. As the USACE progressed with its design in 1979 to construct certified federal levees, Miles City was unable to acquire the proper ROW for the project, and in 1983 the USACE placed the project in inactive status. Additional efforts to engage the USACE have occurred between 1983 and 2013, but for various reasons the project remains inactive. Appendix 2 shows the effective FIRM’s for Miles City and its surrounding areas.

In 1996, the USACE, at the request of the City, surveyed the WPA embankment and local extensions to determine if the existing embankment could be included in the Public Law 84-99 Rehabilitation Assistance Program. This program provides funding from the federal government to repair flood control structures after a flood event. However, due to numerous design deficiencies noted by the USACE, the existing embankments were determined to be ineligible.

The USACE completed revisions to the effective FIS in 2007. The revisions included new BFE and flood boundaries developed using composite probability including ice-affected flow conditions on the Yellowstone and Tongue Rivers. The embankments in Miles City cannot be certified in accordance with FEMA’s requirements, and they were not considered as providing protection from the base flood. Subsequently, FEMA utilized the 2007 Flood Insurance Study to update the effective FIRM map which

caused additional areas that had not been in the SFHA to now be included. This change, as well as the changing NFIP flood insurance rates, has created a current state of public discontent in regards to flood control and flood insurance. This discontent has led to the commission of this Flood Mitigation Feasibility study in order to provide accurate and up-to-date information to the local flood control committee. With this information, the committee will be able to make an informed recommendation to the Miles City Council for an alternative to increase public safety and decrease the negative effects of floodplain regulations and flood insurance upon the community.

1.3 Historic Flooding

Miles City, experiences flooding events regularly, as it lies at the confluence of two large, perennial rivers. Based on data from the USGS, during the past five years, the Yellowstone River has risen above flood stages on five separate occasions. Flooding events have been well-documented as cited in the 2007 Flood Insurance Study. **All costs are expressed in historic dollar figures.**

Past Floods

Major floods have occurred in Miles City in the following years: March 1882, March 1888, March 1892, February 1899, June 1918, March 1928, March 1929, and March 1944. Fairly complete information is available on the floods of 1929 and 1944, but no known records of earlier floods are available other than newspaper accounts, old photographs, and verbal accounts of longtime residents. Minor floods have occurred in Miles City in March 1904, May 1909, March 1912, and September 1923. The records on minor floods are incomplete and studies of flood damages are based on old photographs, newspaper accounts, and verbal accounts of residents. In the history of all past floods, available information indicated that loss of life due to floods has not been encountered at Miles City.

Flood of March 1882

The only record of the major flood of 1882 is a photograph hanging in the Olive Hotel in Miles City. This shows water flowing through Main Street at an estimated depth of two feet and considerable deposits of heavy ice at the intersection of Main and 5th Streets. This would indicate that the major portion of the then existing town was inundated with estimated damages of \$2,500. There is a little doubt that an ice jam at the mouth of the Tongue River was the cause of the flood.

Floods of March 1888, March 1892, and February 1899

There are no factual records of these major floods. An estimate of the flood damages based on pictures of these floods, topography of the city, and development of the city gives the following flood damage estimates. March 1888-\$5,000, March 1892-\$10,000, and February 1899-\$30,000. Newspaper accounts mention water flowing down Main Street which indicates a flood of somewhat smaller magnitude than the area flooded in March 1882. All three floods were caused by ice jams at the mouth of the Tongue River.

Flood of March 1904

On March 10, 1904 an ice jam at the mouth of the Tongue River backed water up Main Street to as far as 8th Street intersection, damaging a few frame business buildings and flooding a number of homes. The reported damages resulting from this minor flood are \$5,000.

Flood of May-June 1909

The minor flood of 1909 resulted from snowmelt in the mountains and rains in late May and early June. The Tongue and Yellowstone Rivers were at flood stages, but no damages were reported in newspaper accounts so it was assumed the extent of damages was approximately \$2,000 caused by flooding of a few homes on "The Island." Newspaper files indicated that previous to the flood stage of the Yellowstone, Miles City had anticipated a serious flood with extensive damages.

Flood of March 1912

A minor flood caused by an ice jam and high water in the Tongue River Valley was reported in March 1912. Very little damage was reported at this time. The estimated amount of damage for this flood was \$1,000 resulting from the inundation of several basements.

Flood of June 1918

The major flood that occurred during June 1918 was caused by a rapid melting of snow in the mountains resulting in extremely high water in the Yellowstone River. The water overflowed its banks into the old channel of the Tongue River and inundated approximately 85 buildings on "The Island" and the area adjacent to the old Tongue River Channel. Damages to personal property, buildings, and extra living costs to families forced to leave their homes was estimated to have been \$20,000.

Flood of September 1923

Heavy rainfall in the upper Tongue River Basin caused high water in the Tongue River which resulted in a minor flood. Very little damage was reported. The area flooded was on "The Island" and was of shorter duration than the flood of 1918. Estimated damages of \$5,000 caused by flooding of basements and some low buildings on "The Island" were reported.

Flood of March 1928

An ice jam formed in the Yellowstone River in March 1928 and caused a major flood over the area of "The Island" and the area adjacent to the old Tongue River Channel. The water in most places did not reach the first floors but did flood all basements and damaged foundations. The area inundated in this flood is the same as in the flood of June 1918. With 144 residences damaged in the 1928 flood and 85 residences damaged in the flood of June 1918 at an estimated \$20,000, it is therefore estimated that the damages of this flood were approximately \$38,000.

Flood of March 1929

During January and February of 1929, severe cold weather was experienced at Miles City, and ice formed to a depth of about 51 inches on the Yellowstone River. The weather moderated around March 1, and rains up to 0.5 inch fell throughout the Tongue River Valley between March 1 and March 5. An ice jam formed at the mouth of the Tongue River against the thick ice still in place on the Yellowstone River. The resulting flood was of major proportions with water backed up a mile southeast of the Northern Pacific Railway. About 50% of the better residential area south and east of Northern Pacific Railway was inundated. The water rose to a depth which covered the first floor of buildings on "The Island" and low ground were reported flooded to the depth of the eaves. The area between the Northern Pacific and CMSP & PRR was flooded as far as 4th Street. There were approximately 300 residences, a church, and a large school building flooded. The estimated damage from this flood is \$51,600 including damages to residences, buildings, pavements, sewers, and all public property. The city water pumphouse was reported sheared off by ice cakes in this flood.

Flood of March 1944

Rapidly melting snow in the lower reaches of the Tongue River in March 1944 caused the ice to break up and gorge against firm ice on the Yellowstone. Ice gorged on 19 March 1944 along the Yellowstone from a point below State Highway #22 Bridge to the mouth of the Tongue River. The levee built in 1936 was to protect against a flood equal to the 1929 flood intensity. Backwater from the ice jam flowed around the north end of the levee inundating "The Island" area. The water continued to rise, reaching a crest on March 20th causing four breaks in the existing levee. Water also flowed through a 222 foot gap in the levee which was never finished because of right-of-way difficulties. The following areas were inundated before flood waters receded: city park, ball park area including large cabin camp, area from 4th Street to Tongue River, area from River Street to old Tongue River Channel, small areas on the east side of old channel on Tongue River, and "The Island." The flooded area of the city is about the same as for the flood of 1929 except the residential district east of the Northern Pacific Railway was not flooded in 1944, as the ice jam was concentrated further down the Yellowstone River. Sandbags placed on the CMSP and PRR spur on 3rd Street prevented inundation of the business district as crest elevations brought the water just to the rails of the spur. During the ice jam, the water rose as much as 38 inches an hour. The breakup of ice in the Yellowstone River was facilitated by the dropping of approximately fourteen 250 pound demolition bombs on the downstream end of the ice jam. Damages consisted of flooded basements and first floors of houses, flooded business property, settling of pavement cracked floor at water plant, inundated county and state highway shops and yard, damage to levee, cost of evacuation and relief of families. A survey of Miles City by Fort Peck District showed that 206 residences, seven businesses, and one small farm were damaged at an estimated cost of \$103,900. (Engineers U. A., 2007)

Additional Floods have occurred in 1949, 1971, 1972, 1974, 1978, 1979, 1994, 1995, 2003, 2004, 2007, 2008, 2011 and 2012.

Figure 1: 1881 Flood in Miles City, Montana (Montana's Flooded Past, 2011)



Figure 2: 1944 Flood in Miles City (Montana's Flooded Past, 2011)



Figure 3: Garfield School 1944 (Montana's Flooded Past, 2011)



Figure 4: Ice Jam 1944 (Montana's Flooded Past, 2011)



Figure 5: Pleasant Street Flooding 1944 (Montana's Flooded Past, 2011)



Figure 6: Milwaukee Railroad Bridge



Figure 7: Eroded BNSF railroad embankment during the flood of 2011 (Fitzgerald, 2011)



Figure 8: Road overtopped with water near Miles City during the flood of 2011 (Hartman, 2011)



Figure 9: Yellowstone River flooded during the flood of 2011 (Hartman, 2011)



2 Flood Vulnerability

Miles City, MT is located within the natural floodplain at the confluence of the Yellowstone and Tongue Rivers. Drainage basin characteristics for each river vary significantly. For example, the Yellowstone drains an area of approximately 48,000 mi² while the Tongue collects drainage from approximately 5,000 mi². The Tongue River is controlled by reservoirs while the Yellowstone flows uncontrolled. The State of Montana updated its Multi-Hazard Mitigation Plan and Statewide Hazard Assessment in November (Division, 2014) 2010. This plan accumulated historic data on flooding within Miles City as well as projected the economic and social effects of a 100-year flood event. Statistics from the State Hazard Mitigation Plan are contained in the discussion below.

2.1 Physical Flood Risks

Flooding becomes a risk when communities develop within natural floodplains. If floodplains remained undeveloped, only the most significant and rare events would cause major damage. Flood risk also depends on numerous physical features and local conditions specific to Miles City. Some of the major local conditions that increase the risk of flooding include:

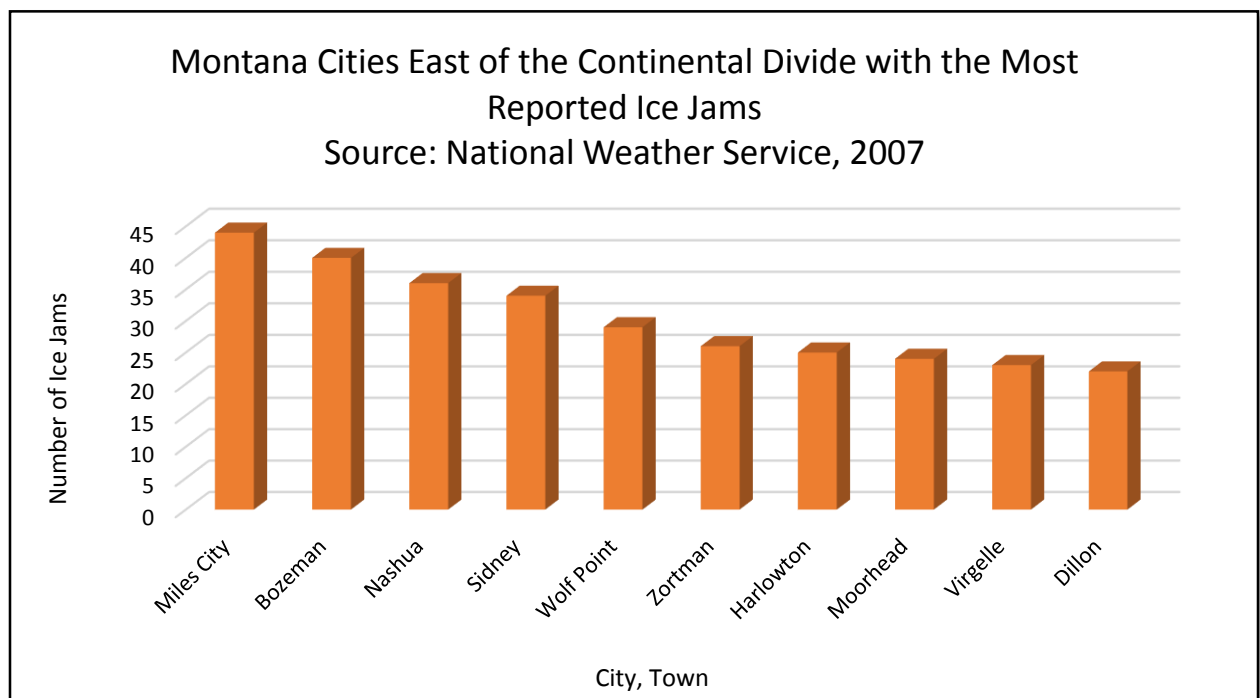
- High incidence ice jam locations
- Bank erosion/water velocity
- Geomorphology
- Snow melt and precipitation
- Floodplain encroachment

2.1.1 Ice Jamming

Ice jamming occurs when there are prolonged cold periods followed by warm periods that cause the ice to break up on a flowing body of water and restrict the flow of water within a channel. The restriction causes water to back up behind the ice jam at possibly rapid rates. According to the State Multi Hazard Mitigation Plan, Montana has 1,473 recorded ice jams, the most of any lower 48 state. The plan also states that Miles City has the most recorded ice jams (45 in recorded history) of any city in Montana. This means Miles City has the highest recorded number of ice jams in the contiguous United States.

Figure 10 a graph depicting Montana's top ten cities for ice jams.

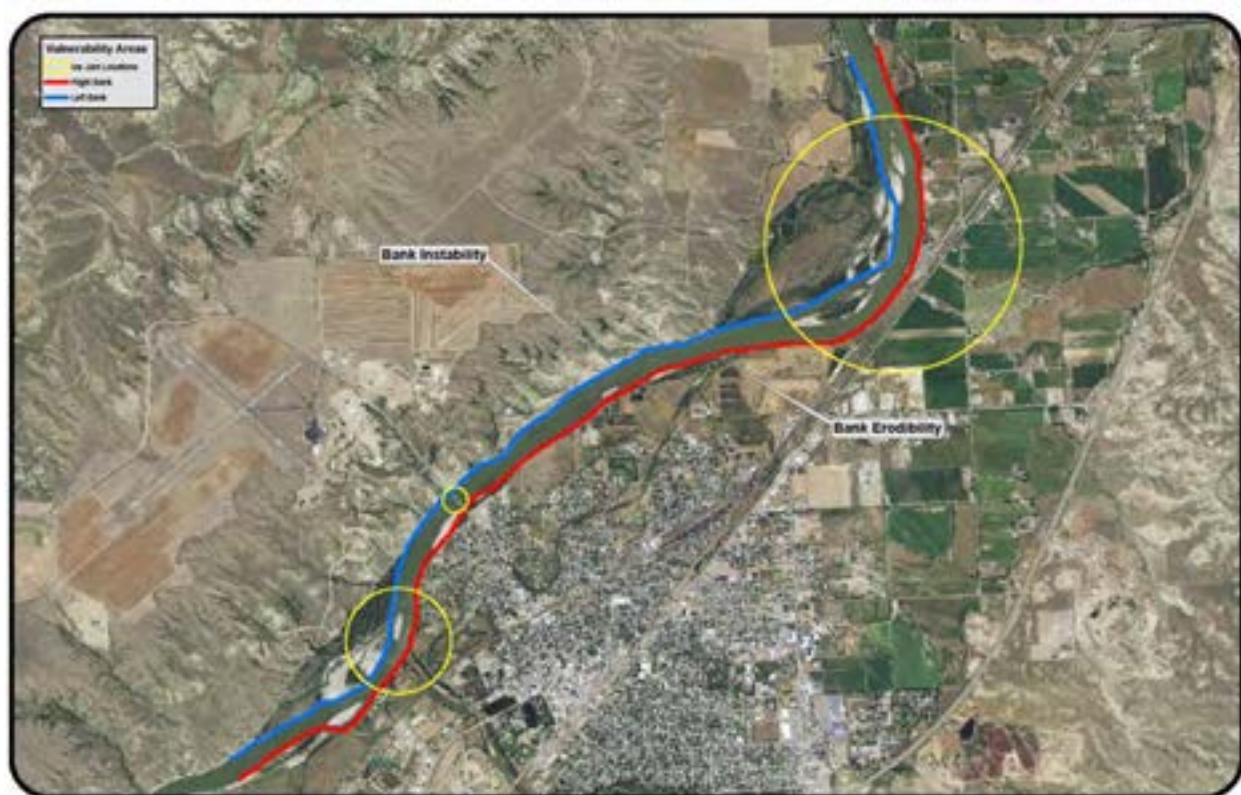
Figure 10: Top Ten Cities in Montana for Ice Jams



Frequent ice jams have been observed on both the Tongue River and the Yellowstone River. The locations indicated on Figure 11 are the most common areas for ice jamming to occur. The confluence of the Tongue and the Yellowstone Rivers presents the highest threat. Many instances of the Tongue River

ice breaking up before the Yellowstone have been observed. This causes the Tongue River ice to block up against the Yellowstone River ice and cause the water surface to rise quickly upstream of the confluence. An additional location is the area just downstream of Miles City where the bedrock shelf causes the river channel to widen and shallow. Within this area, the water velocity and depth of the Yellowstone reduces and allows ice to slow down and restrict flow. The flow restriction causes a backup of water along the Yellowstone and upstream on the Tongue. The Highway 59 bridge over the Yellowstone also has had reported ice jamming issues. All these locations pose significant concern when analyzing the potential flood risk for Miles City.

Figure 11: Vulnerability Map



2.1.2 Bank Erosion and Floodplain Encroachment

In 1913, the Tongue River Channel through Miles City was shortened approximately 3 miles by the elimination of some bends and the construction of a cut-off to a new point of the existing confluence with the Yellowstone River. These channel improvements, which were accomplished by the Milwaukee Railroad in conjunction with the City, tend to lower open water stages on the Tongue River but have little effect on ice jam floods. The old Tongue River channel can be seen in Figure 12.

Figure 12: Old Tongue River



After the elimination of the original channel, the city developed in the floodplain up to the extent of the right bank of the Yellowstone. When the WPA embankment was constructed, Exhibit 7 in Appendix 1, the river channel was constricted by it. This effectively narrowed the river channel and focused the river into a smaller space, which causes the floods to rise faster, reach greater heights, have a greater velocity, and reach downstream areas faster than if the river were left to its natural floodplain. The resultant increase in velocity raises the potential that bank erosion and embankment damage can occur. These effects were observed and documented during the 1944 flood event. Several areas of the WPA embankment suffered breaches and damage which resulted in the inundation of the old Tongue River Channel and surrounding neighborhood. The USACE also has documented damages through the history of the existing embankments. “There are several instances where the levee has been undercut and eroded throughout its lifetime” (Department of the Army U.S. Army Engineer District, Omaha, 1978). Exhibit 7 in Appendix 1, shows the locations and the resulting flood damage to the embankment.

Future flood mitigation alternatives should consider proper bank stability, erosion protection or expansion of the floodway adjacent to Miles City. Additionally, north of the Highway 59 Bridge, a significant portion of the western bank of the Yellowstone River (approximately seven acres of land) sloughed off into the river in the summer of 2011. A narrow portion of the river's channel became even narrower. Due to the bank slough constricting the river channel, increasing velocities, caused the levee damage that can be seen in Exhibit 7 in Appendix 1. The damaged area in Exhibit 7 is shown as red, where the slough had occurred, this can be better seen in Figure 13 and Figure 14 below. These deposits not only restrict the flow capacity of the river and increase velocity, but are also areas that cause ice jams. The first image is an aerial photograph from the Yellowstone River Corridor Study, taken in 2011. The second is a photograph taken in 2013 from the USDA, as part of the NAIP. As evidenced by the 2013 image, the landmass is slowly eroding away, but continues to block a significant portion of the river channel. A sandbar is forming as well. Water velocities will remain high during periods of flooding for as long as the river is constricted between the landmass and the existing embankment. It is likely that the existing embankment will need to be repaired in this location more often than other locations.

Figure 13: 2011 Aerial Image of Riverbank Failure (Yellowstone River Corridor Study, 2011)

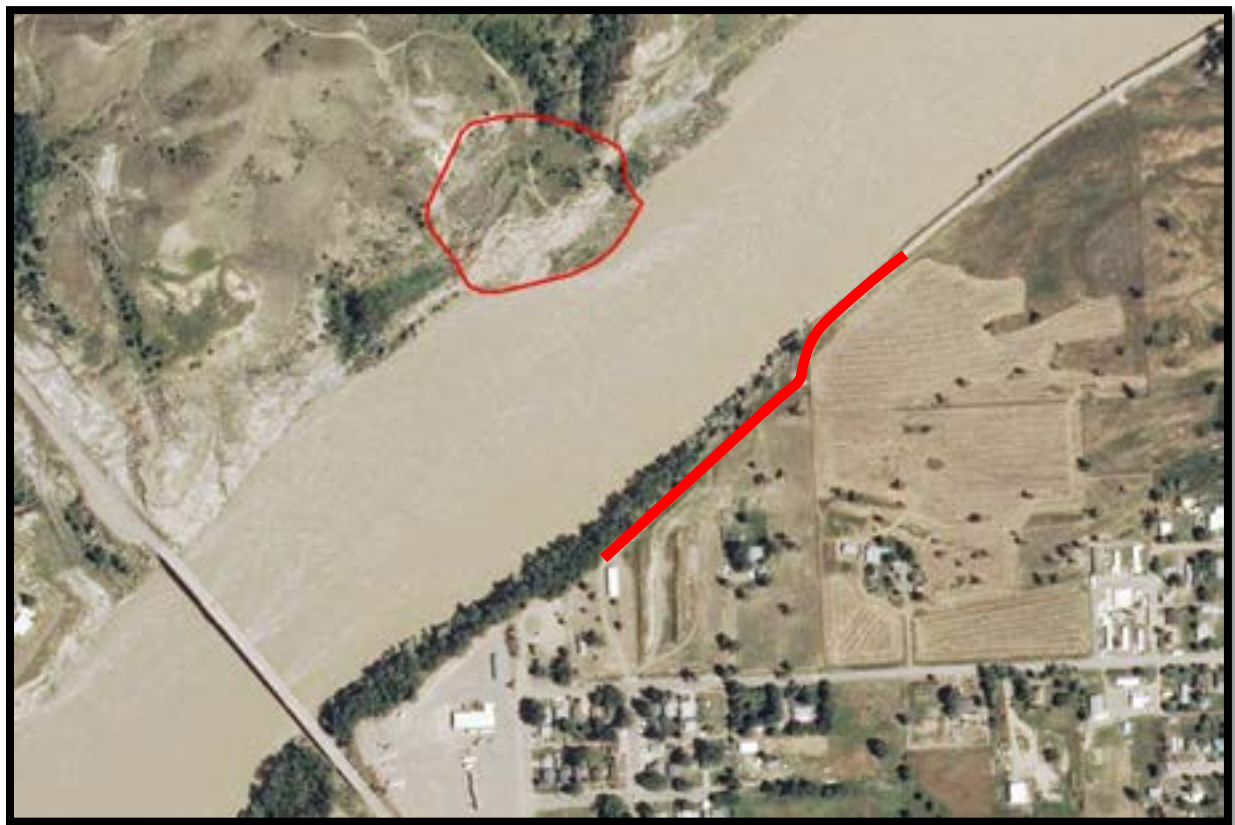


Figure 14: 2013 Aerial Image of Riverbank Failure (NAIP 2013)



2.1.3 Geomorphology

Miles City is located in the glaciated Missouri Plateau region of the Great Plains Physiographic Province.

This region is characterized by broad, terraced river valley and relatively high inter stream uplands which have been progressively dissected and eroded by drainage courses. Overburden materials in the river valleys are primarily recently deposited alluvial clay, silt, sand and gravel deposits. Bedrock is the Fort Union formation of Paleocene age, consisting of sand stone, siltstone and clay shale. (Department of the Army U.S. Army Engineer District, Omaha, 1978)

A review of the USGS Soil Survey also indicates that the soil under Miles City consists of varying formations of silt, sand and gravel deposits (Service, 2014).

These soils have high hydraulic conductivity which allows for groundwater to move and equalize very quickly. This has been observed by the large amount of homeowners with basements experiencing seepage during high rainfall events and flooding.

Generally, given the soil types, there is a high probability of under seepage that occurs under the existing embankments. This results in a higher risk of embankment failure from erosion of soil, also known as “soil piping” of the underlying soils.

Existing soil bore data was also collected by the USACE but cannot be found due to a building fire where the data was located. This data is referenced in a USACE report discussing proposed levee design:

Forty-six exploratory borings, ranging in depth from 10 to 40 feet, were drilled along the proposed site. Most borings were drilled through the existing levee fill through a relatively impervious natural surface soil blanket. Overburden materials from the borings were primarily alluvial clay, silt, and sandy gravel. Lean clay, gravelly clay, or clayey silt deposits were encountered at the surface in the majority of the borings. The gravel in the underlying aquifer ranged in size from fine to coarse. Although no cobbles or boulders were seen in the borings, they may be present in this stratum. Free water was encountered in most borings. The depth to water varies from 2 feet to 15 feet. Eight borings were drilled to bed rock. The depth to rock varied from about 15 feet to 35 feet. (Department of the Army U.S. Army Engineer District, Omaha, 1978)

KLJ received 13 boring samples from the MDT that were taken along the Tongue River during the Main Street bridge reconstruction. See Appendix 3 for logs of the 13 borings. The bore samples were taken from a relatively small area along the Tongue River, as they were used for a bridge project. The borings show the soil mainly consists of clayey silt, silty sand, coarse sand and gravel, above the bedrock of silt stone and sandstone.

KLJ also performed six additional soil bores at locations indicated in Exhibit 8 in Appendix 1, to independently verify the solid substrate. The logs of these borings can be seen in Appendix 4. The soil classification matches the information reviewed by the USACE and the MDT and substantiates comments received during the first public meeting and from discussions with contractors and residents in Miles City regarding the large amount of seepage during river flood events.

Generalized soil conditions were developed for representative sections along the river banks. The upper 40 feet of borings were reviewed to determine the soil type; this was anticipated to be the primary zone of influence for levees and structures (non-bridge structures). The generalized soil profiles were divided among the seven types as listed: sand, sandy gravel, gravelly sand, silt, sandy silt, siltstone and sandstone. A typical soil bore consisted of either fill or topsoil followed by some type of silty soil, such as sandy silt, silty clay, silty sand, silt and clayey silt. The silt layer was then followed by a layer of sand and then gravel. Finally the bed rock was reached and was either siltstone or sandstone. The depth of the bores ranged from 5.9 feet to 131.9 feet deep, with an average of 51.3 feet. The water table depth ranged from 9.8 feet to 24 feet. Based on high hydraulic conductivity of sandy material, under seepage is a primary concern within the river bank area. Without control, under seepage in pervious foundations beneath levees may result in excessive hydrostatic pressures beneath an impervious top stratum on the landside; sand boils (caused when water pressure wells up through sand) and piping of material beneath the levee itself can occur. Under seepage problems are most acute where a pervious substratum underlies a levee, and extends both landward and riverward with a relatively thin top stratum on the landside of the levee. Principal seepage control measures that can be used to mitigate under seepage are cutoff trenches, riverside impervious blankets, landside seepage berms, pervious toe trenches, and pressure relief wells.

2.1.4 Snow Melt and Precipitation

Precipitation and flow monitoring have been studied in detail in both the FIS, Yellowstone River and Tongue River at Miles City, Custer County, Montana (USACE 2007) and the Stream Flow Statistics for Unregulated and Regulated Conditions for Selected Locations on the Yellowstone, Tongue, and Powder Rivers, Montana 1928-2002. Most of the flooding issues within the city occur during the spring snowmelt runoff combined with ice jamming. Historically, the flooding problems associated with the June snowmelt from the higher elevations in the basin have been minimal; however, the combination of June snowmelt paralleled with a high rainfall has the potential for serious flooding and should be recognized.

2.1.5 Vulnerable Infrastructure

Based on the current FIRM, schools, nursing homes hospitals, businesses and residential homes would potentially be inundated during a 100-year flood. Infrastructure locations are displayed in Exhibit 9 in Appendix 1.

In the event of a flood, emergency measures may need to be taken to protect these buildings in order to provide continuous service. Flood hazard data was obtained from FEMA-generated Hazus analysis of

flooding in Custer County. The flood scenario was for a simulated 100-year flood, and FEMA estimates approximately \$16,000,000 worth of damage to the existing building stock with a majority of the damage occurring within Miles City (Division, 2014). There are also numerous state facilities (i.e. Fish, Wildlife & Parks, Labor & Industry) within the Miles City flood hazard zones that are vulnerable to flood damages and losses, with an approximate cumulative economic value of \$5,500,000 (Division, Mt.gov, 2014).

3 National Flood Insurance Program

“100-Year Flood” is a shorthand expression for a flood that has a 1 in 100 chance of being exceeded in any given year. This may also be expressed as the 1% annual chance exceedance flood, or “1% annual chance flood” for short. Similarly, a 200-year flood has a 1 in 200 (or 0.05%) chance of being exceeded in any given year.

In 1968, the NFIP was designed to reduce future flood losses through local floodplain management and to provide protection against potential losses through flood insurance for property owners.

As part of the NFIP, FIRMs are developed to show properties located within a SFHA. SFHAs are defined as the area that will be inundated by the flood event having a 1-% chance of being equaled or exceeded in any given year. The

1-% annual chance flood is also referred to as the base flood or 100-year flood. The mapped area for the 1-% annual chance flood is commonly referred to as the 100-year floodplain. Miles City, MT has effective FIRMs, and currently there are approximately 3,650 parcels contained within the SFHA.

3.1 Local Flood Insurance Impacts

Flood insurance premiums can be a significant impediment to the continued growth of a city. Excessive premium costs will discourage new businesses and residents from purchasing land in the floodplain. The cost of premiums has been increasing, and will continue to rise. On July 6, 2012, the Biggert-Waters Flood Insurance Reform Act of 2012 was signed into law. The main driving point of the Biggert-Waters Act was the extension of the NFIP until September 30, 2017. This law also amended the National Flood Insurance Act of 1968 and the FDPA of 1973. The Biggert-Waters Act slowly phases out flood insurance subsidies by incrementally increasing premiums until they reach the full actuarial cost. This will affect the Pre-FIRM (a building for which construction or substantial improvement occurred on or before December 31, 1974, or before the effective date of an initial FIRM) Zone A, “grandfathered”, and PRP EE policies and the Post-FIRM (a building for which construction or substantial improvement occurred after

December 31, 1974, or on or after the effective date of an initial FIRM, whichever is later) PRP EE policies. However, in spring 2014, Congress passed the HFIAA which reversed some of the changes to the NFIP introduced by the Biggert-Waters Act. The HFIAA provides refunds for people who have had large flood insurance rate increases due to the sale or purchase of a home; it also caps the average annual premium increase at 18% and allows subsidies for insurance rates that are based on current flood maps.

Miles City, MT currently stands as the largest flood insurance policy holder in the state. The community represents approximately 23% of all flood insurance policies within Montana. Approximately ninety-one percent of the policies in Miles City are single family policies. This is consistent with the Montana statistics, where the state average is 87%. The total number of insurance policies in place for Miles City as of December 2013 is 1,312. These are policies that are within city limits; there are also numerous policy holders in surrounding developed areas of Custer County. Based on preliminary analysis, a new levee system may have the potential to remove almost all parcels in the floodplain that it would protect.

The current annual premiums, the policies holders within Miles City pay, is approximately \$625,000 per year for flood insurance premiums. The numbers are calculated by data obtained from FEMA, and averages are shown in Table 1.

Table 1: Average Miles City Flood Insurance Rates

Miles City, MT Flood Insurance Policies as of December 2013				
Policy Type : Single Family	Policies Pre-FIRM	Annual Premium	Polices Post-FIRM	Annual Premium
ZONE A	316	\$ 723.00	11	\$ 670.00
Grandfather	126	\$ 176.00	23	\$ 342.00
PRP EE	581	\$ 346.00	48	\$ 383.00
PRP	79	\$ 311.00	6	\$ 365.00
Total	1102	\$ 476,239.00	88	\$ 35,810.00
Policy Type : 2-4 Family	Policies Pre-FIRM	Annual Premium	Polices Post-FIRM	Annual Premium
ZONE A	9	\$ 868.00	0	N/A
Grandfather	9	\$ 71.00	2	N/A
PRP EE	14	\$ 344.00	4	N/A
PRP	1	\$ 414.00	1	N/A
Total	33	\$ 13,681.00	7	N/A
Policy Type : Other Residential	Policies Pre-FIRM	Annual Premium	Polices Post-FIRM	Annual Premium
ZONE A	4	\$ 577.00	1	N/A
Grandfather	1	N/A	1	N/A
PRP EE	2	N/A	1	N/A
PRP	1	N/A	1	N/A
Total	8	\$ 2,308.00	4	N/A
Policy Type : NON-Residential	Policies Pre-FIRM	Annual Premium	Polices Post-FIRM	Annual Premium
ZONE A	25	\$ 1,348.00	4	\$ 544.00
Grandfather	25	\$ 1,963.00	6	\$ 407.00
PRP EE	5	\$ 1,113.00	4	\$ 884.00
PRP	0	N/A	0	N/A
Total	55	\$ 88,340.00	14	\$ 8,154.00
Total Policies			1,312	
Total Annual premiums for Miles City			\$ 624,532.00	

Table 1 above shows the number of policies broken down by policy type (e.g. Single Family, Non-residential, etc.). These are split into two categories: the Pre-FIRMs and the Post-FIRMs. Pre-FIRM is a building for which construction or substantial improvement occurred on or before December 31, 1974 or before the effective date of an initial Flood Insurance Rate Map (FIRM). Post-FIRM is a building for which construction or substantial improvement occurred after December 31, 1974 or on or after the effective date of an initial Flood Insurance Rate Map (FIRM), whichever is later. They are then further categorized by policy classifications: Zone A, Grandfathered, PRP EE and PRP. In Miles City, the overwhelming majority of policies are single family homes, Pre-FIRM. The rates for these could increase in the future depending upon changing federal regulations. This could be a substantial increase in total yearly premiums. If a proposed flood control project were to move forward and provide protection from the 100-year or 500-year event, the premiums that Miles City residents pay would be significantly decreased and the requirement for mandatory flood insurance policies would be waived.

4 FEMA Levee Accreditation Requirements

For the levee to be recognized as providing the 1%-annual-chance level of flood protection on NFIP maps, protection systems must meet, and continue to meet, the minimum standards set forth in Title 44 of the CFR Section 65.10 for the following three categories:

- Design
- Operation
- Maintenance

4.1 Design Criteria

For levees to be recognized by FEMA, evidence must be provided that adequate design and sound engineering practices have been followed. Minimum requirements for the following categories must be met

- a. Freeboard
- b. Closures
- c. Embankment protection
- d. Embankment and foundation stability
- e. Settlement
- f. Interior drainage

4.2 Operation Criteria

A formal plan of operation, including specific actions and assignments of responsibility by individual name or title, must also be developed for each system. Minimum requirements for the following categories must be met in the operation plan:

- a. Documentation of flood warning system
- b. Formal plan of operation
- c. Periodic operation of closures
- d. Internal drainage plan, including manual backups
- e. Periodic inspections

4.3 Maintenance Criteria

A formal plan of maintenance must be officially adopted, and a copy of the plan provided to FEMA by the owner of the levee system. Minimum requirements for the following categories must be met:

- a. Activities to be performed
- b. Frequency of their performance
- c. Person, by name or title, responsible for their performance

4.4 Levee Certification

If appropriate documentation is certified by a Registered Professional Engineer to show that a levee system meets these three categories, FEMA will "accredit" the levee system and will revise the effected FIRM panel to show the impacted area landward of the levee system as having a moderate flood risk. FEMA will label the levee-impacted area as Zone X (shaded). Flood insurance is not mandatory in Zone X areas.

5 Coordination and Input

Stakeholders had opportunities to provide input several times throughout the Feasibility Study. Meetings, emails, phone conversations, a project website, email newsletters, press releases and written communication were all utilized as a conduit between stakeholders and KLJ throughout the process of the study. Much of the daily contact was on an informal basis, including obtaining data and sharing information. Press releases, media briefings, public meetings and major agency briefings were handled via a more formal process.

5.1 Miles City

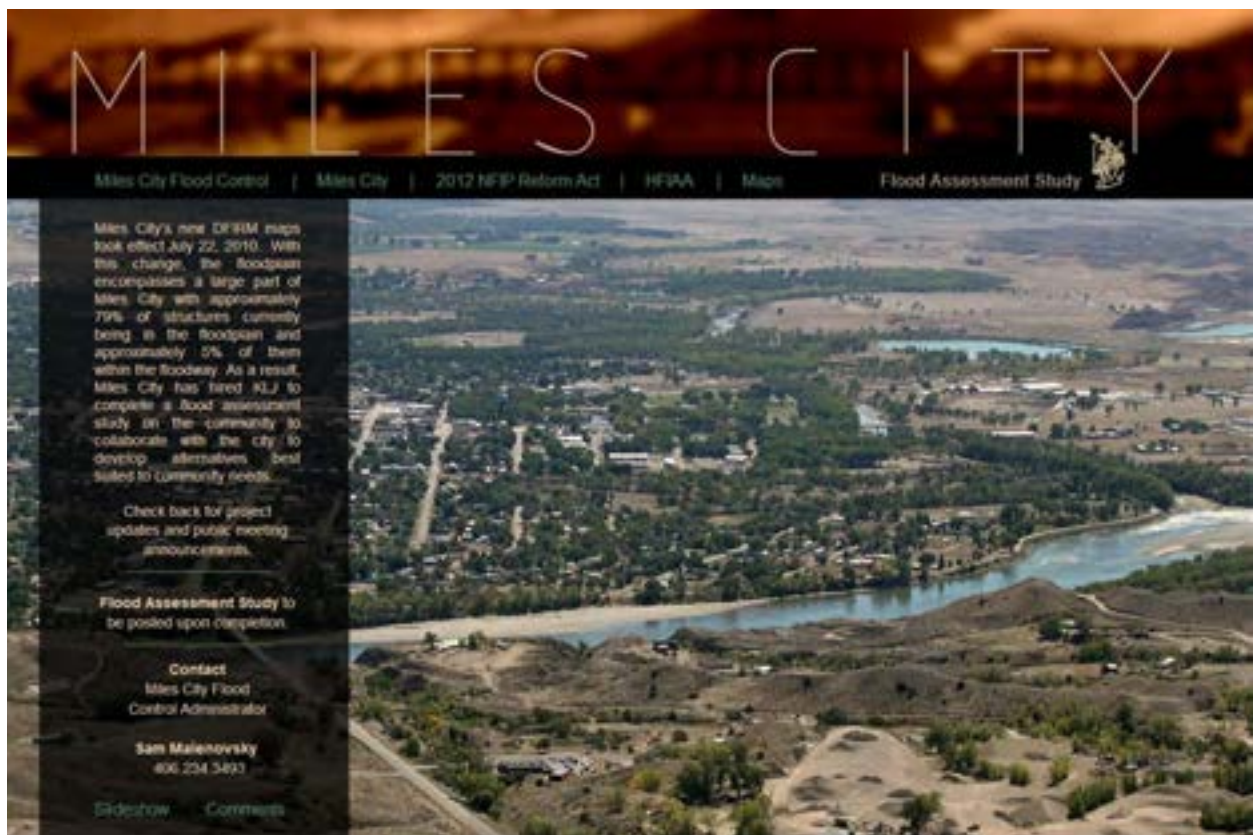
The primary stakeholders for this Study are the residents of Miles City and the surrounding community. Throughout the Study, KLJ coordinated with Miles City public works staff, the Flood Control Committee,

The Mayor and General Council. The public input process, as part of the Miles City Flood Control project, is a critical component in reaching a realistic, feasible and palatable long-term solution for the community. Public input has been actively sought, through multiple mediums, on an ongoing basis throughout the duration of this study.

5.2 Project Website

A project website was established as a primary communication tool and platform to allow the public access to maps, reports and other important project-related content. The website also features a comments section where site visitors can express their opinions on the flood assessment study. A slideshow of Miles City photos was also compiled and shared on this site. This site has been updated as additional project information has become available and will continue to be updated as the project progresses (see Figure 15 for website example). For further information on the project website, visit www.milescityfloodassessmentstudy.com.

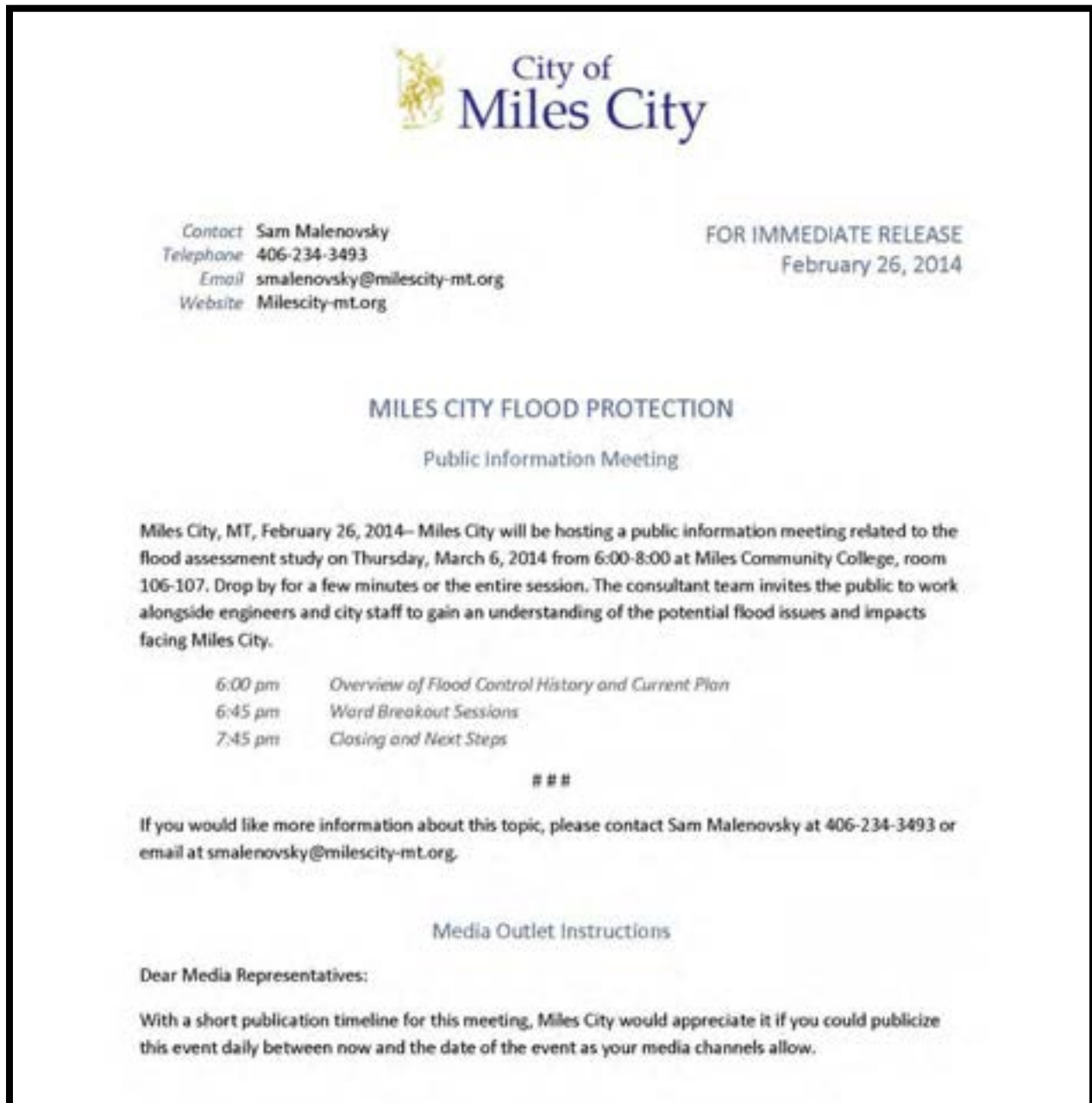
Figure 15: Miles City Study Website



5.3 Press Release

In preparation for the initial Miles City Flood Assessment Study public input meeting, the following press release was drafted and published in the Miles City Star. This method of public communication was used to access and educate the largest Miles City audience in regard to the March 6, 2014 public meeting.

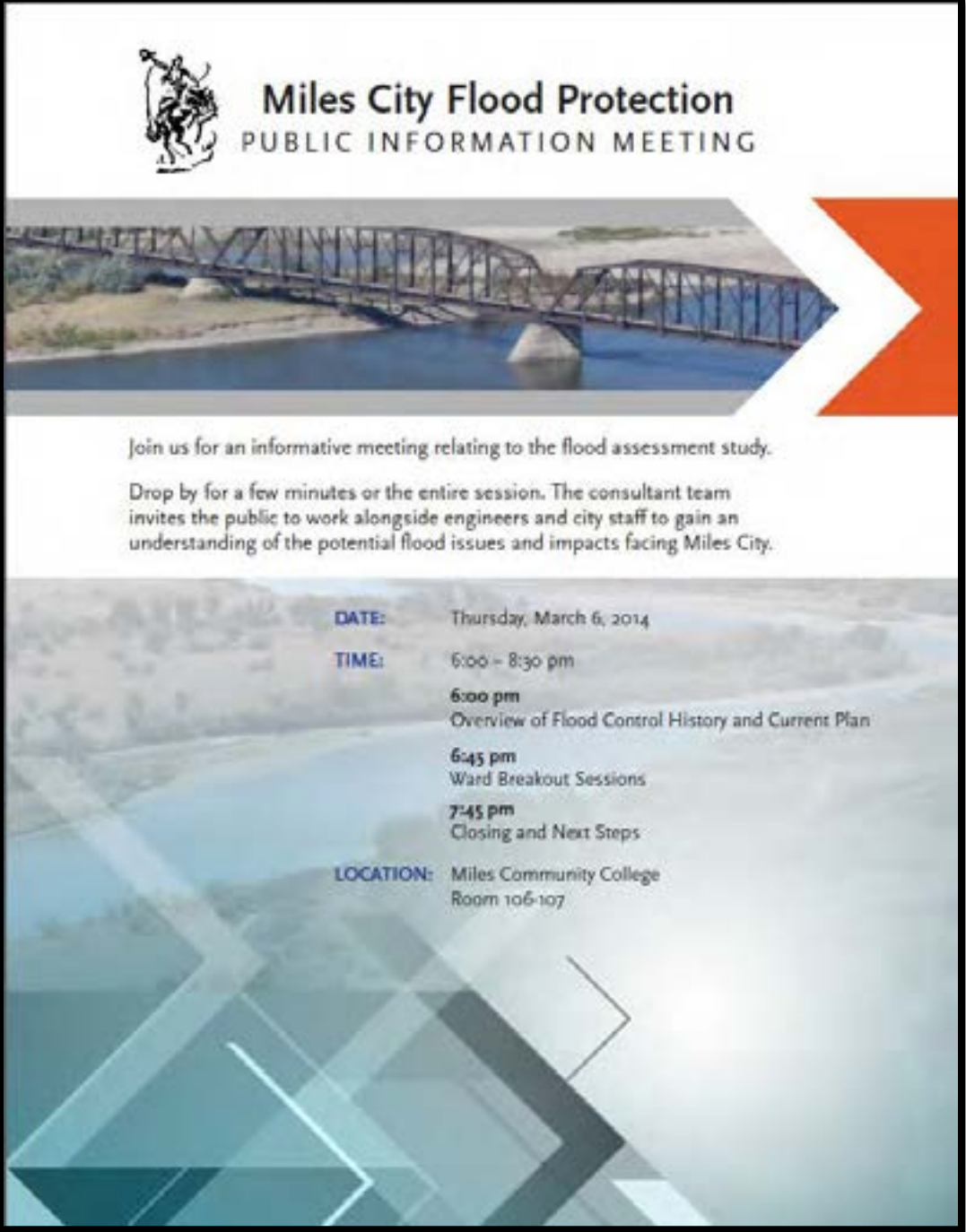
Figure 16: Press Release



5.4 Informational Flyer

In addition to the press release discussed above, an informational flyer was also produced and distributed to raise awareness of the March 6, 2014 public input meeting. This promotional piece, Figure 17, was shared around the community and resulted in helping to generate an outstanding turnout at the public input meeting.

Figure 17: Informational Flyer



The flyer features a header with the Miles City logo (a Native American on horseback) and the title "Miles City Flood Protection PUBLIC INFORMATION MEETING". Below the title is a photograph of a large steel truss bridge over a river. To the right of the photo is a large orange arrow pointing right. The main text invites the public to a meeting on Thursday, March 6, 2014, from 6:00 to 8:30 pm. It describes the agenda: an overview of flood control history and current plans at 6:00 pm, followed by ward breakout sessions at 6:45 pm, and a closing with next steps at 7:45 pm. The location is Miles Community College, Room 106-107. The bottom of the flyer has a decorative geometric pattern in shades of blue and grey.

Miles City Flood Protection
PUBLIC INFORMATION MEETING

Join us for an informative meeting relating to the flood assessment study.

Drop by for a few minutes or the entire session. The consultant team invites the public to work alongside engineers and city staff to gain an understanding of the potential flood issues and impacts facing Miles City.

DATE: Thursday, March 6, 2014

TIME: 6:00 – 8:30 pm

6:00 pm
Overview of Flood Control History and Current Plan

6:45 pm
Ward Breakout Sessions

7:45 pm
Closing and Next Steps

LOCATION: Miles Community College
Room 106-107

5.5 Public Input Meeting

The initial Miles City Flood Assessment Study public input meeting was designed to serve as a discussion platform, through which engaged residents had the opportunity to voice their questions, concerns and suggestions for the project moving forward. The meeting began with a welcome from Council president and Flood Control Committee Chairperson, John Hollowell, followed by a brief project introduction from Floodplain Administrator Sam Malenovsky. Carl Jackson, Joel Paulsen and Molly Sullivan of KLJ then proceeded to lead the meeting participants through a facilitated discussion on the project purpose, technical details of the study and possible pending federal policy implications.

Given the diverse areas impacted in Miles City, ward breakout sessions were held following the general session outlined above. This meeting format allowed for a free-flow discussion amongst residents, community officials and the KLJ consulting team.

Following the ward breakout sessions, all participants regrouped as a whole for a final question and answer session. KLJ had several city and ward maps available at the public input meeting to facilitate conversations throughout the evening.

City staff and KLJ consultants were pleased by the overwhelming turnout and general success of this initial Miles City Flood Assessment Study public input meeting. A follow-up meeting was held in September 2014 to present the findings of the Miles City Flood Mitigation Feasibility Report and hone in on details relating to potential next steps in the flood risk mitigation process. The result of the public input meetings indicated that there was overwhelming support from the community to address the flood insurance and flood risk issues in Miles City.

6 Data Collection

This section summarizes the data collected and used in the development of Miles City Flood Mitigation Feasibility Report.

6.1 Past Reports

The USACE produced several reports regarding improving the existing levee protecting Miles City. The most detailed report was published in 1978. The *Phase I General Design Memorandum No. MY-1* was the equivalent of a pre-engineering report. A levee alignment was selected from several alternatives, and cost estimates were included. The report published in 1978 essentially reaffirmed previous reports that analyzed the flooding concerns in Miles City. The levee was initially constructed as part of the WPA in 1936 (Department of the Army U.S. Army Engineer District, Omaha, 1978). In 1949, Congress approved a levee project to protect Miles City via USACE Section 204 procedures (Department of the

Army U.S. Army Engineer District, Omaha, 1978). This project was placed in inactive status due to a lack of local interest. A restudy report was ordered in 1969 and completed in 1974. The reports produced by the USACE show that the construction of a new levee system along the Tongue and Yellowstone Rivers have a benefit to cost ratio that is greater than one. That is, the monetary value of the benefits of the levee are greater than the monetary costs of the levee system. The data and concepts contained in the reports produced by the USACE were used as a starting point for this Study.

6.2 Hydraulic Models

The USACE's HEC-RAS (river modeling software) model of the Yellowstone and Tongue Rivers at Miles City was used to estimate water surface elevations throughout the corridor. The consultant team obtained a copy of the model and subsequently rebuilt and calibrated it in order to analyze the effects of the alternatives considered in Section 8.

6.3 As-Built Drawings

Utility drawings, showing water and sewer locations, were obtained from Miles City and used to evaluate infrastructure impacts from the alternatives. Other critical infrastructure drawings obtained include Miles City street plans, and plat maps within the community.

6.4 Geographic Information System (GIS)

The majority of the digital information for the Project is in GIS format. ERSI's ArcMap 10.1 mapping software was used to display and analyze the data. Property information including boundaries, property identification numbers, and ownership information was obtained from Miles City. The dataset included parcel information which was used to approximate properties impacted by project alternatives. A table of affected properties was intersected with the City Assessor's property valuation table to compute property acquisition costs through the city. LiDAR surveys of the City and County were used as preliminary elevations during project development. This was used in place of field surveying due to cost restriction for the feasibility study. For complete design of any flood control alternative, a higher level of accuracy for elevations will need to be obtained.

6.5 Geotechnical Analysis

The purpose of the geotechnical analysis was to provide reasonable geotechnical parameters for the preliminary design of project features. The geotechnical analyses included a review of the existing geotechnical conditions found along the project alignment; evaluation of typical soils and properties; evaluation of seepage at levees and structures; evaluation of slope stability and settlement of levees; and settlement of the floodwalls, closure structures and pump stations. This analysis provided useful information for the preliminary analysis of under seepage controls at levees and floodwalls and for cost

estimating of foundations. The geotechnical design and recommendations are based on available information provided during initial review of the project alternatives and not considered detailed enough for final design. Further investigation and detailed review is required for final design of all of the levees and structures discussed. Additional geotechnical information will allow for design of the project features based on conditions at each of the particular locations.

7 Model Hydrology and Hydraulics

7.1 Hydrology

For this study, all hydrology and associated peak flows were taken from the 2007 FIS Study, produced by the USACE and published by FEMA.

Flows used in the USACE model were determined by using USGS flow gages. Within Miles City, there is a flow gaging station located on the Yellowstone River approximately 0.8 miles downstream of the confluence of the Tongue River and several hundred feet upstream of the State Highway 59 Bridge. The Tongue River gaging station is immediately downstream of the Interstate 94 Bridge.

7.1.1 Yellowstone River

Seventy-three years of record were used to determine discharge-frequency estimates for the Yellowstone River. The LP-III method was followed to determine peak discharges. Peak flows from a USGS gaging station located in Sidney, MT were used to supplement Miles City data and extend the period of record following the procedures established in, Guidelines For Determining Flood Flow Frequency published by the US Department of the Interior (Survey, 1981).

Seasonal discharge-frequency curves were also developed for the Yellowstone River. This was necessary since peak flood stage caused by ice may exceed peak stages caused by higher summer flows without ice. Peak flows were separated into ice-affected (winter) and non-ice-affected (summer) groupings. Mean daily flows with an instantaneous peaking factor of 1.05 were used to determine both seasonal curves. Peaking factors are determined by comparing highest recorded flows with the daily mean flows. Finally, a summer and winter composite discharge-frequency curve was generated that takes into account peak flows from both the ice-affected and non-ice-affected conditions. The composite looks at a probability of the summer vs. winter flooding. The all season record flows without regard to which season they occur in. The extension then also uses data from the downstream gage to extend the period of record.

USACE determined the peak flows as shown below in Table 2. From their analysis, the USACE determined that the 17B Extension of Record discharge-frequency curve should be used for analysis of the Yellowstone River, as it most accurately reflects historical flow data.

Table 2: Yellowstone River Hydrology from FIS

Flood Event	Summer (cfs)	Winter (cfs)	Summer and Winter Composite (cfs)	All-Season (cfs)	17B Extension of Record (cfs)
2-Year	52,300	14,900	55,000	51,000	54,200
5-Year	67,409	24,200	70,000	66,300	70,300
10-Year	76,000	31,900	82,000	75,400	81,800
20-Year	83,300	40,700	91,000	83,600	91,000
50-Year	91,700	54,400	100,000	93,400	101,000
100-Year	97,500	66,700	105,000	100,000	111,000
500-Year	109,000	104,000	125,000	116,000	128,000

7.1.2 Tongue River

The method of analysis to determine peak flows in the Tongue River was similar to the procedures used to determine discharge-frequency curves for the Yellowstone River. The Tongue River has 66 years of record for analysis. The LP-III method was again used to generate the discharge-frequency curves.

Ice-affected and non-ice-affected conditions were analyzed using average daily peak flows with an instantaneous peaking factor of 1.31 as recommended by the USACE. The LP-III method was followed for the seasonal discharge-frequency curves, and a composite discharge-frequency curve was developed.

USACE determined the peak flows as shown below in

Table 3. From their analysis, the USACE used the All-Season discharge-frequency curve for further analysis, as it matched historical flows most accurately.

Table 3: Tongue River Hydrology from FIS

Flood Event	Summer (cfs)	Winter (cfs)	Summer and Winter Composite (cfs)	All-Season (cfs)
2-Year	2,750	1,590	3,610	3,350
5-Year	4,970	3,970	6,180	6,080
10-Year	6,600	6,240	8,610	8,270
20-Year	8,250	9,220	10,900	10,700
50-Year	10,500	14,500	16,000	14,200
100-Year	12,200	19,500	20,000	17,200
500-Year	16,400	65,900	33,000	25,400

7.1.3 Coincident Analysis

The USACE also evaluated the effect of simultaneous peak flows occurring on the Yellowstone and Tongue Rivers. Based on USACE analysis, the peak events are correlated. The coincidental flows experienced in the Yellowstone are shown below in

Table 4. This occurs when the Tongue River is experiencing its peak flow, as determined above. The analysis showed that the coincidental flows are less than the calculated Bulletin 17B extended flows; the USACE did not use them for the FIS and we did not consider them further for any future analysis.

Table 4: Coincident Yellowstone River Flow from FIS

Flood Event	Summer (cfs)	Winter (cfs)	17B Extension of Record (cfs)	Coincidental with Tongue Peak (cfs)
2-Year	52,300	14,900	54,200	26,900
5-Year	67,409	24,200	70,300	43,700
10-Year	76,000	31,900	81,800	54,900
20-Year	83,300	40,700	91,000	65,500
50-Year	91,700	54,400	101,000	78,800
100-Year	97,500	66,700	111,000	88,500
500-Year	109,000	104,000	128,000	110,000

7.1.4 Stage-Frequency Analysis

Though peak flows tend to occur during the non-ice-affected summer conditions, peak stages will typically occur during the ice-affected winter conditions. This is due to ice blocking a significant portion of the river channel that otherwise would be used for conveyance. Table 5 below displays the stage-frequency curves for ice-affected and open-water conditions. For comparison, the flood stage for the Yellowstone River occurs at 10 feet (USGS, 2014).

Table 5: Winter versus Summer Peak Stage on Yellowstone River from FIS

Flood Event	Ice-Affected Yellowstone River Stage	Open-Water Yellowstone River Stage
5-Year	12.4	12.5
10-Year	15.6	13.6
25-Year	18.7	14.5
50-Year	20.9	15.1
100-Year	23.3	16.0

7.1.5 Model Flows

The flows selected for final modeling are a combination of river gage hydrology and statistical analysis. As shown on previous page, the peak summer flow is greater than peak winter flows; however, it does not accurately represent the 100-year peak stage. In order to remedy this, a composite flow profile was generated. This was accomplished by analyzing the probability of exceedance of a given stage, based on winter and summer stage-frequency curves. Once the composite stage-frequency curve was developed, flows were matched to the 100-year stage. This increased the 100-year flow used for stage analysis in the Yellowstone River from 111,000 cubic feet per second to as much as 160,000 cubic feet per second. The peak flow passing through the Tongue River likewise increased from 17,200 to as much as 37,000 cubic feet per second. To be clear, the 100-year flows are not 160,000 or 37,000 on the Yellowstone and Tongue Rivers. Rather, those are the flows that result in the equivalent 100-year flood stages that should be produced with concurrent 100-year flows and ice jams. The corresponding gage heights for the 100-year flows are 2356.6 (Yellowstone) and 2369 (Tongue).

7.2 Hydraulics

The Hydrologic Engineering Center's River Analysis System (HEC-RAS) model was used to analyze inundation along the Yellowstone River, the Tongue River and through Miles City.

7.2.1 Model Geometry

The HEC-RAS model is divided into five reaches: one for the Yellowstone, one for the Tongue, and three to model the three different hypothetical breaches in the Tongue River embankment. The locations of the breaches in the embankment were chosen by the USACE to represent theoretical worst case scenarios. Three breaches were selected because the embankment from the two railroads that pass through town (Transco Railway Products and Burlington Northern Santa Fe) act as quasi-levees, dividing the city into three areas. Surveyed cross-sections were used to determine channel geometry and flow paths.

7.2.2 Model Scenarios

Seven different analyses were done to determine the floodplain and floodways in Miles City. Five analyses determined the floodplain, and two determined the floodways. Two of the floodplain scenarios modeled the Tongue and Yellowstone Rivers with their embankment intact, and three scenarios modeled the Tongue River with its embankment breached.

7.2.3 Model Flows

For the purpose of the FIS, the 100-year flow is the most significant event. Floodplains and floodways are delineated based on the 100-year event. As discussed before, flows through the Yellowstone and Tongue Rivers were artificially increased in order to match the composite stage-frequency curve. These higher flows were used in the FIS to determine the floodplain and floodway. Flow through the Yellowstone varies from 130,000 to 160,000 cubic feet per second, and flow through the Tongue varies from 30,000 to 37,000 cubic feet per second.

7.3 Feasibility Study Modeling

The FIS hydrology was retained in this study. However, the FIS flows do not provide the stage discharge curve used by the USACE due to the heavy influence of ice. As the alignment of a potential levee changes, it is necessary to revisit this step in the hydrology & hydraulic analysis. In a procedure similar to the methodology the USACE used, the given river gage hydrology was modified to simulate higher stages due to ice blockages. However, artificially increasing flows in order to match given river stages would only reflect the existing conditions. To more accurately model proposed modifications, the depth of ice cover was altered to match the profile generated from the USACE HEC-RAS model that produced the FIS and FIRMs. Since the 100-year flow rate and depth of ice coverage is independent of channel geometry, any modifications can be made without recalibrating flow to match river stages.

The ice thickness varied from cross-section to cross-section, ranging from zero feet to as many as five feet. On average, 0.22 feet of ice was added to the Yellowstone, and 2.69 feet of ice was added to the Tongue. The new profile generated from the ice-affected hydrology matched the final FIS profile at each cross-section to within 0.5 feet. On average, the new hydrology increased the river profile by 0.04 feet. Two miles were added to the upstream end of the Yellowstone River in order to determine the effects of levee improvements. Additional cross-sections were determined from terrain data obtained from the USACE Yellowstone River Corridor Study. Flow was assumed to be constant; there are no significant tributaries between the most upstream end of the USACE model, and the additional two miles. USACE determined roughness coefficients were used for both in channel flow and overbank flow. No additional culverts or bridge crossings were modeled. Differences between the existing conditions and proposed conditions were considered negligible or non-existent two miles upstream of Miles City. This suggests that reconstructing a new levee may have little to no effect on the land upstream of Miles City, but further model refinement will be needed to confirm this.

8 Flood Mitigation Alternatives

KLJ put together five alternatives that will allow the City to choose the one they feel best meets their needs. Each alternative, with the exception of Alternative #1, will provide varying degrees of relief from flood insurance premium costs, and the last two alternatives will significantly decrease the risk of flood damage in Miles City. KLJ has also provided recommendations on what we feel provides the greatest cost to benefit ratio.

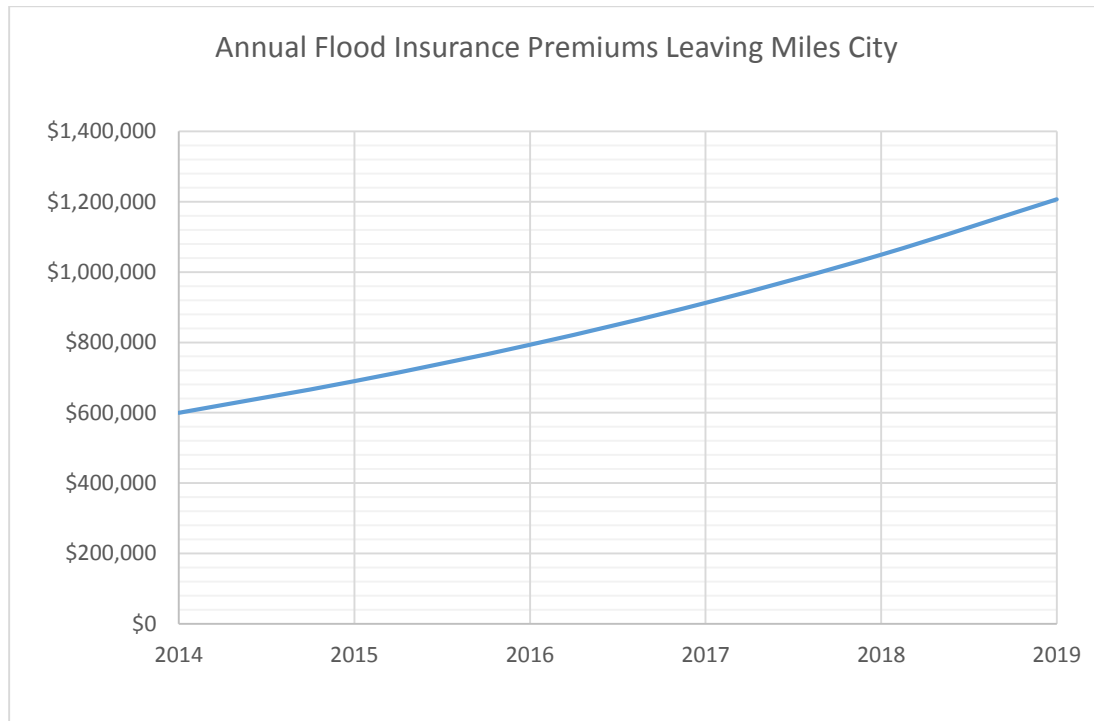
8.1 Alternative #1 Do Nothing

If it is determined that all other proposed alternatives either do not address the City's concerns, or are too costly, the City may choose to not pursue additional flood mitigation measures. Flood insurance premiums would need to be paid, and emergency flood fighting and repair measures to the existing embankment should be expected. Miles City, collectively, is currently paying more than \$600,000 annually for flood insurance (see Section 3.0 for additional information regarding flood insurance). The majority of these policies were first established prior to the most recent FIRM being approved. As the majority of the pre-FIRM policies are based upon a lower water surface elevation contained in the previous FIRM, it should be expected that insurance rates will increase dramatically when replacement policies take effect. Ultimately, FEMA is moving toward having all flood insurance rates set to the full risk rate over time. Based on the Biggert-Waters Reform Act of 2012, which has since been amended by the HFIAA of 2014, flood insurance policies that are paying below full-risk premiums may increase annually by more than 15%. Figure 18 displays a 15% annual increase for Miles City's \$600,000 worth of flood insurance premiums. After five years the insurance premiums will have reached their approximate full actuarial rates; by this time the insurance costs have more than doubled, with the total amount leaving the city annually exceeding \$1.2 million.

KLJ recommends that taking a no action approach should be a non-alternative due to the continued financial hardship for the residents of Miles City. Additionally, the magnitude of the flood risk as described in the effective FIRM is extremely significant. With more than 75 % of the City contained within the floodplain, the risks seem too high to consider taking no action.

8.1.1 Opinion of Probable cost

Figure 18: Potential Annual Flood Insurance Premiums Leaving Miles City, Based on 10 Percent Increase in Annual Premiums



8.2 Alternative #2 LOMAs

A LOMA is an official amendment, by letter, to an effective NFIP map, LOMAs establish a building's location in relation to the SFHA. LOMAs are issued because a property has been inadvertently mapped as being in the floodplain, but is actually on natural high ground above the BFE. LOMAs may be used if the City decides to forgo an accredited levee project. Certain parcel owners would be able to apply for LOMAs in areas they feel have been misrepresented by the effective FIRMs. As seen in Exhibit 10 in Appendix 1 (Map of LOMAs), the current number of effective LOMAs is 165. There is potential for more LOMAs relieving some homeowners of the need for flood insurance. In order for a LOMA to be granted, an elevation certificate must be prepared for the property, and the structure in question. The certificate must be certified by either a Professional Engineer, or a Licensed Land Surveyor (Federal Emergency Management Agency, 2013). Once the elevation certificate is obtained, the LOMA procedure is relatively straightforward. If FEMA determines elevation of the lowest ground adjacent to the structure is higher than the floodplain elevation, a letter will be issued that will waive the flood insurance requirements for the owner of the buildings. If the full parcel is surveyed and shown to be higher than the BFE, then the

full parcel can be removed. LOMAs could be applied as a temporary measure to alleviate the burden of flood insurance while a larger project is pursued, or LOMAs could be applied in conjunction with a larger project. However, while LOMAs may be effective for a small number of people, they will not solve the larger problem of having an uncertified levee.

8.2.1 Letter of Map Amendment Issues

A LOMA is a letter from FEMA stating that an existing structure or parcel of land - that is on naturally high ground and has not been elevated by fill - would not be inundated by the base flood. The number of parcel owners this will help is relatively small and the burden of flood will still be a possibility even with a LOMA.

Certain areas of the FIRM map have a significant number of LOMAs issued by FEMA. It appears that additional LOMAs may be granted for the same areas. Exhibit 10, in Appendix 1, shows the locations of the current effective LOMAs and the areas within the City with the possibility of future LOMAs. These locations were estimated using the best publically available LiDAR data. It should also be noted that a LOMA is no guarantee of not paying flood insurance; the lender still has discretion to require flood insurance.

8.2.2 Opinion of Probable cost

The cost of pursuing LOMAs would be minimal to the City; it would be the responsibility of the owner of the property to pay for the required elevation certificate necessary for a LOMA. An official elevation certificate costs anywhere from a few hundred to one thousand dollars for the certificate alone, and another several hundred for the surveying firm to process the LOMA paperwork.

8.3 Alternative #3 Letter of Map Change by using 2D model

8.3.1 The Current FEMA Model

The current FEMA floodplain map for Miles City was developed by the USACE using the HEC-RAS. This model takes great care to consider the interaction of the Yellowstone and Tongue Rivers including ice jams. The model also considers levee failures of the existing uncertified Tongue River levees. Flows from these levee failures consist of high peak flows that generally flow to the northeast across the city where the flow must accrue enough to overtop the Yellowstone River levee prior to returning to the river system. Separate failure locations along the Tongue River are run in roughly parallel directions toward the Yellowstone River resulting in most of the city being placed in the 100-year floodplain. The BFE

resulting from these separate failure locations within the model causes steps from one failure channel to the next, resulting in large variability in BFEs.

8.3.2 The Evolution of Modeling Techniques and Why It Matters

With the evolution of computer power has also come an ability to more accurately model complex water systems. A typical river has a single flow path, however, when that water leaves the river and crosses overland to another river, its path is subject to engineering judgment. The engineer often had to decide the path and model the impacts. If multiple parallel paths exist, this can lead to inconsistent results between the paths. Recent developments in modeling, in the form of two dimensional models, allow for the software to choose the path and to even change over time. This provides a more accurate and consistent answer. In floodplain mapping, this may make a significant difference in the map.

8.3.3 One vs. Two Dimensional Modeling

The early HEC-RAS model software could only model a steady state flow, which is a flow that does not change over time. The Miles City model, as well as most FEMA models, are constructed in this manner. The current software can model a full hydrograph, or the dimension of time. However, it can still only model one dimension of space. Put simply, the engineer decides the centerline of the river or overland flow path. Water will not flow left or right but only along the designated path. Water is generally not allowed to freely flow between parallel paths. In addition, if the path chosen is incorrect, the actual flow of the water will also be incorrect. The two dimensional model solves this problem. Similar to HEC-RAS, it can model the full hydrograph or dimension of time. But unlike HEC-RAS, it models the full floodplain as a network of grid cells. This allows water to take any direction from one cell to an adjacent cell. In a real sense, the water chooses its path based on topography and obstructions placed in the floodplain. If allowance is made for time, the path taken can change over the course of the flood.

8.3.4 Modeling Complex Flow Paths

To achieve the full power of the two dimensional (2D) model, river and overland models are merged. This is done within the XPSWMM software produced by XP Solutions. The river model is created within HEC-RAS. Cross-sections are trimmed at the edge of the floodplain or other natural high ground. The model is imported into XPSWMM. The floodplain surface is then added as well as the active grid network to create overland portion of the model. The two are then connected by an interface line which allows water to flow freely between the two models. Once water enters the overland model, it is allowed to take any path necessary to return to the river systems. XPSWMM is approved by FEMA for 2D modeling of floodplains.

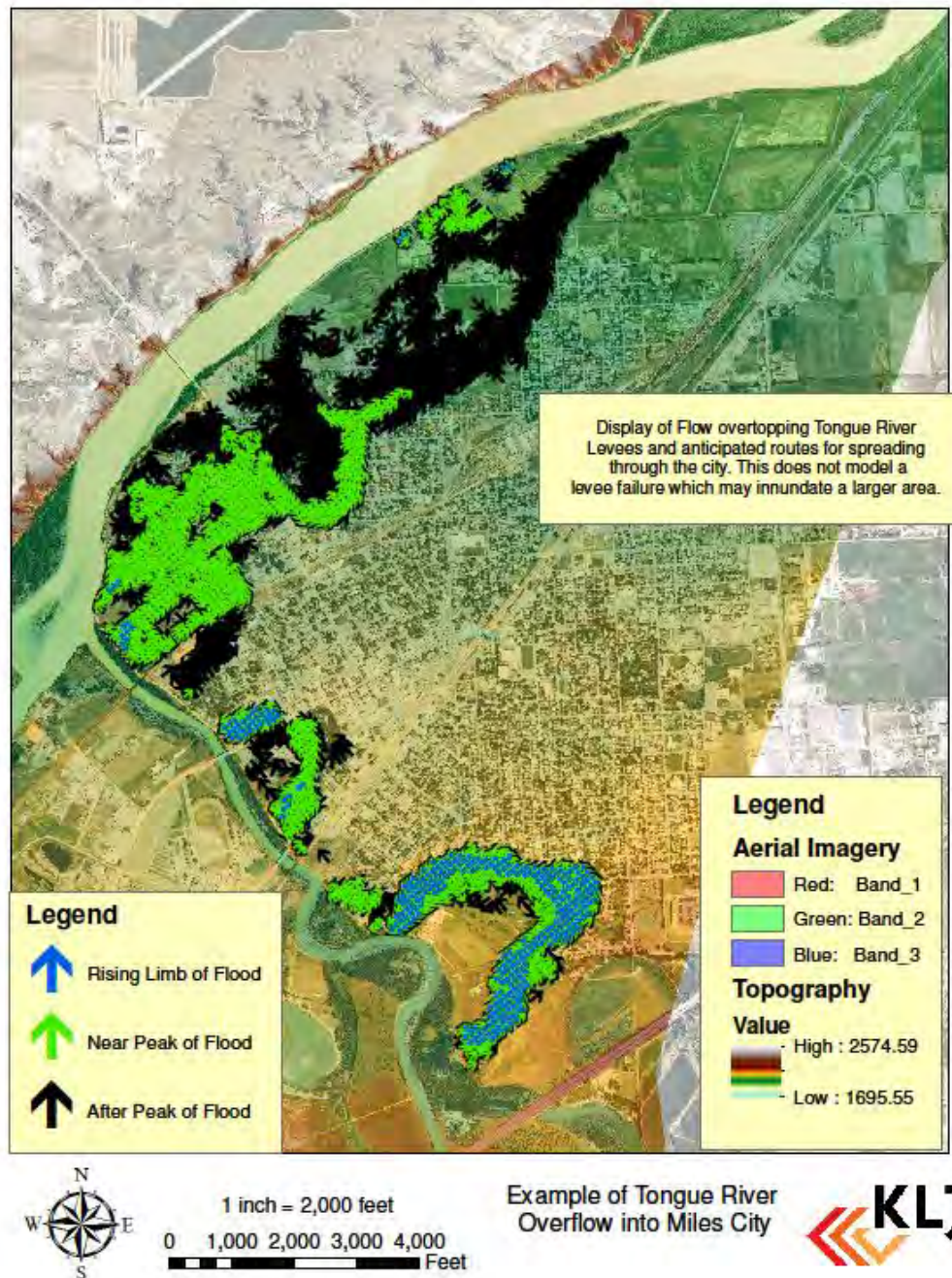
8.3.5 Sample Two Dimensional Model of Miles City

A sample model was created for Miles City. This model was created solely to demonstrate the complexity of flow paths in Miles City. This model was similar but not exactly like the FEMA model. Additional flow was added to the Tongue River to ensure it would overflow the embankment and spill east into the city. Inundation west of the Tongue River was largely ignored. Figure 19 is a map showing the area of flow over time. The flow is shown as color-coded arrows. Blue arrows represent the initial overflow as the flood begins. Green arrows represent the areas of flow near the peak of the flood. Black arrows represent the flood after the peak, but while water is still spilling over the embankment. This example is based on overflow of the Tongue River embankment and not an embankment breach. As such, the flows and inundation areas are smaller than predicted by the USACE in the current FEMA map. However, the flows do help to illustrate the power of the 2D model to show anticipated flood routes. Areas of flooding include old oxbows and the old river channel near the Yellowstone River. These are areas that residents would expect flooding to occur and validates the power of the 2D model.

8.3.6 Modeling Embankment Breaches

As stated above, Figure 19 does not represent an embankment breach. As part of a remapping process, it would be necessary to map levee breaches.

Figure 19: Model of Tongue River Overtopping Levee



Note: this is a sample model intended only to show that flow paths in Miles City are complex. Do not assume this shows a proposed floodplain.

A breach would be modeled by causing a portion of the existing embankment to rapidly erode to ground level. These breaches would cause high peak flows and areas of greater inundation. However, it is

expected that flow paths would still naturally turn north towards the low areas of town rather than northeast as predicted by the current HEC-RAS model.

8.3.7 Assumptions and Limitations

Inherent in the modeling are several assumptions and limitations. It is not practical to completely redo the flow frequency distribution which governs the amount of flow in the river for a current event. Nor is it practical to redo the stage flow downstream boundary condition created by the USACE to simulate ice jam conditions. Finally, the three breaches assumed by the USACE would still be modeled. All of these assumptions provide an initial flow in the river, a downstream tail water condition and a flow through the city. However, the 2D model would still remap the areas of inundation that occur due to these embankment breaches. The 2D model, although more detailed than the 1D model, still has limitations. Water will flow from grid cell to grid cell; thus, the size of the grid cell will dictate the precision of the mapping. It is anticipated that grid cells will be approximately 100 feet by 100 feet in size which is sufficient to map the inundation while maintaining a stable model. It will also be necessary to extend the model upstream to capture any areas of impact due to any changes made by the city.

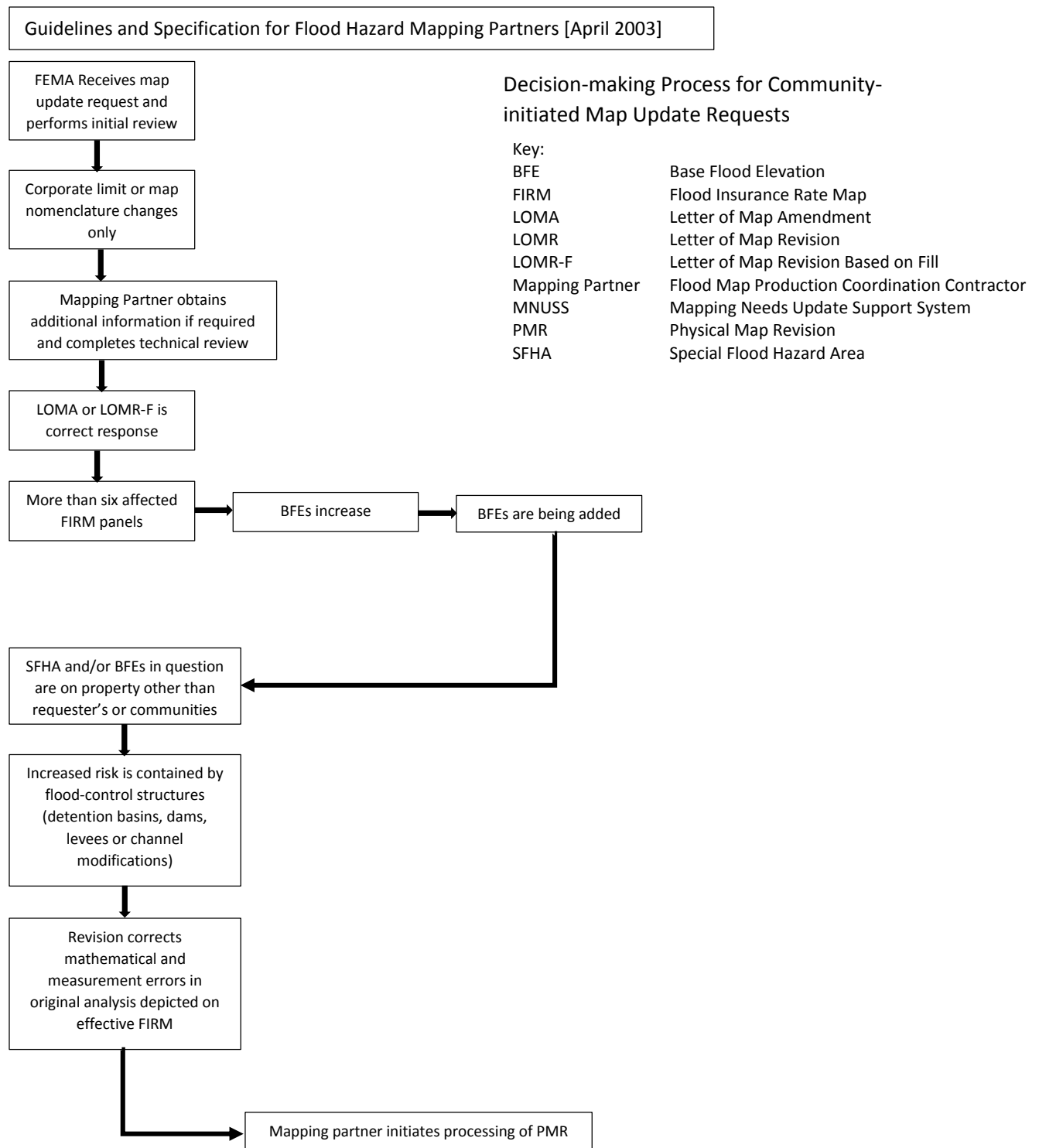
8.3.8 Which FEMA Process

With the new 2D mapping, either a LOMR or a PMR would be required. The difference lies in the extent of the map changes. The first changes a portion of the map, and the second replaces the current map altogether. Guidelines and Specifications for Flood Hazard Mapping Partnersⁱ states that a PMR is required if more than one FIRM panel is covered, significantly more area will be mapped into the floodplain, or if increases to the BFEs are expected. It is anticipated that the scope of the 2D modeling would cover multiple FIRM panels, thus requiring a PMR. Apart from the question of 2D modeling, a new certified levee system near the existing alignment would raise BFEs on the rivers meeting the third condition. In that case, a PMR would be required.

8.3.9 Physical Map Revision Process (Diagram)

The attached figure provides a flow chart for determining if a PMR will take place

Figure 20: Flood Hazard Mapping Work Flow



8.3.10 Physical Map Revision Process

Regardless of the ultimate format, LOMR or PMR, the process begins with a decision by the City on the alternative. When sufficient detail is ready, a CLOMR will be sent by the city to DNR and FEMA. This will start the process and the decision of the ultimate process. It is expected the PMR process will be used, but FEMA may decide on the LOMR process. The CLOMR action will cause a decision on the process to take place. After completion of the work, a LOMR or PMR will be submitted. After technical review (typically 90 days on a LOMR, longer on a PMR), the map returns to the community. A 90-day appeal process is initiated. Upon completion of those 90 days and answering of all technical questions, the map can be adopted. It is expected the overall process will be one year or more.

8.3.11 Currency of Data

Data for the project submitted to FEMA must be within the past seven years. LiDAR from the Yellowstone Study is 2007. Worst case scenario would require update of this data.

8.3.12 Opinion of Probable cost

2D modeling is more labor intensive than 1D modeling. There are also additional data requirements for 2D modeling. In order to pursue 2D modeling, new bathymetry (river soundings), and potentially new LiDAR will be required in order to meet federal requirements for floodplain mapping. Construction and calibration of the model will take more effort than a 1D model would have, and it should be expected that if 2D modeling is pursued, the process for new maps to be accepted by FEMA may be a drawn out process.

Table 6: LOMA OPC

Survey (1D/2D) River Modeling	Est. Days	Est. Cost
Survey to extend river cross-sections upstream two miles	5	\$15K
Reacquisition of LiDAR of project area, LiDAR collection*	1	\$35K
Reacquisition of LiDAR of project area, survey control*	6	\$12K
Reacquisition of river topography*	8	\$25K
Subtotal	18	\$87K
Survey Internal Drainage	Est. Days	Est. Cost
Survey of storm sewer system	20	\$48K
Construction of internal drainage map	6	\$7K
Subtotal	26	\$55K
Integrated 1D/2D Mapping	Est. Days	Est. Cost
Model Creation and Calibration	50	\$60K
Embankment Failures	10	\$12K
Alternatives	10	\$12K
Inundation Mapping	10	\$12K
Subtotal	80	\$96K

Internal Drainage Modeling	Est. Days	Est. Cost
Creation of Internal Drainage Network	20	\$24K
Coincidental Hydrology	2	\$2.4K
Troubleshooting and Final Model	8	\$9.6K
Inundation Mapping	5	\$6K
Subtotal	35	\$42K
FEMA Submittals	Est. Days	Est. Cost
Initial CLOMR Submittal	5	\$6K
PMR Submittal	15	\$18K
Resubmittals, response to FEMA	15	\$18K
Delivery of final maps and documents	5	\$6K
Subtotal	40	\$48K
Total	199	\$328K

8.3.13 Anticipated Timeline

Upon completion of survey, base model completion and calibration should take three months.

Alternatives, if any, will be an additional two weeks per alternative. Internal drainage will be concurrent with river modeling. Inundation mapping will be one month. Initial submittal to FEMA will be one month. FEMA review and resubmittals will be approximately four months. This will allow for preliminary mapping to be available in approximately nine months. Assuming a 90-day appeal process, the expected time frame until final map adoption would be approximately one year.

It is uncertain what percent of properties would be affected by this map change. Additional preliminary modeling would be required to achieve any valid estimation.

8.4 Alternative #4 Reconstruct Levee System 100-Year flood

This alternative is the reconstruction of the City levee system following a similar alignment to the existing levee system. Final design will determine the ultimate alignment; however, the levee would be offset from its current position due to geotechnical parameters. This offset will also aid in lowering the river velocity within the channel to mitigate damage to the west side of the levee. Tentative alignment is shown in Figure 21.

Figure 21: Preliminary Levee Alignment



Approximately 60 parcels will be impacted by the new levee. However, it is not likely that all 60 houses will need to be purchased and demolished; it is more likely a significant number of easements will need to be acquired to provide space for the levee while reducing the number of homes that would be relocated. The potential flood risk in Miles City is very high due to unique physical and seasonal features, KLJ recommends a levee be designed for at least the 100-year flood. However, changing governmental regulations, potential changes to levee certification standards, i.e., BFE changing, can all lead to a future 100 year BFE that is higher than the effective FIRM map of today. With this in mind, KLJ strongly recommends the 500-year flood as the basis for the freeboard of any proposed levee. Both the 100 year and the 500 year levee options represent a significant cost to the community, both for the construction and the annual maintenance cost after construction has been completed. However, it addresses all the pending issues. Of the five alternatives represented, only options #4 and #5 provide certified flood protection and removal of structures from the SFHA. Both 100-year and 500-year alternatives were analyzed, and designing for the 500-year flood results in an additional one to two feet, in terms of levee height, when compared to constructing a levee designed to 100-year flood event.

8.4.1 Proposed Future Flood Mitigation Alignments and Typical Cross-Section

In order for a levee to meet FEMA requirements in terms of flood protection, it must meet certain design criteria established in CFR Section 65.10. The most important criteria, in terms of affecting design and quantity of materials required, are

- Freeboard
- Closure Structures
- Embankment Protection
- Interior Drainage

A levee designed to minimum certification standards must have three feet of freeboard at the base flood. That is, the crown of the levee must be at least three feet higher than the BFE. Closure structures occupy a relatively small area of the levee, and thus will not have a significant effect on the quantities of fill material used to construct the levee. Embankment protection will consist of either riprap, or concrete armor to prevent undercutting and erosion during periods of high flow. Finally, interior drainage is concerned with managing the seepage of water below the levee during high river stages, and dealing with runoff from rain events during outfall closure. Under seepage is a concern that must be addressed, because saturated soils have a fraction of their dry, compacted strength. Without designing to control under seepage, the risk of levee failure increases substantially.

For our preliminary design a typical cross-section of the levee was determined by calculating the BFE, adding three feet of freeboard, and offsetting the current levee by approximately 75 feet landward. A 10-foot wide crown width was assumed, with a 4:1 side slope. An additional 15 feet of access right-of-way was also included on the landward side; this must be provided to ensure access for emergency flood fighting measures.

The typical levee cross-section, showing the average riverward and landward heights, may be seen in Figure 22. Based on meeting the existing BFE, the tallest portion of the levee will be approximately halfway between the Tongue and Yellowstone confluence and the wastewater treatment facility. Measured from the river side it will be approximately 17 feet tall. On average the entire levee system, measuring from the riverside height of the levee, will be slightly more than 11 feet tall.

On average, the proposed levee will be approximately 1.5 feet higher than the existing embankment. Based on the existing BFE, it appears the only locations that the existing levee meet or exceed the three-foot freeboard requirements are the areas immediately adjacent to the highway and railroad bridges,

where they tie into the higher ground of the embankment. The levees surrounding the water treatment plant just barely meet the BFE and are deficient in meeting freeboard requirements. The levees surrounding the wastewater treatment facility do meet and exceed freeboard requirements; additionally, preliminary review of the bore samples show that the levees most likely will not meet the seepage criteria for levee certification. Therefore, for our analysis purposes we did not account for alteration/modification. Replacement of the existing embankment at that location was considered.

The typical section of the levee includes a toe-drain on the landward side of the levee to collect water that seeps under the levee. Without controlling under seepage, sand boils will develop, which could result in localized flooding, erosion or even levee failure. The toe-drain could be either tied into the existing storm sewer system, or will be collected and conveyed to a lift station. Further investigation will be needed when examining the possibility of connecting toe-drain to existing storm sewer, this can be done during project design. Landward berms were not considered as an under seepage control mechanism, as the minimum suggested width of an under seepage berm is 150 feet, based on USACE standards (US Army Corps of Engineers, 2000).

8.4.2 Cumulative Hydraulic Impacts

Offsetting the new levee from the current embankments alignment will allow for a wider area of conveyance. This will result in lower water velocity in the vicinity of the levee. This will cause less erosion and undercutting, leading to a lower likelihood of levee failure, and lower repair and maintenance costs. Based on a preliminary model of the theoretical levee, upstream and downstream hydraulic effects of the new levee (in terms of water surface elevation) are negligible within a mile of Miles City. Channel velocities are reasonable, and should not increase erosion either upstream or downstream.

8.4.2.1 Bridge Analysis

The bridges along the Tongue and Yellowstone Rivers will require a hydraulic analysis of the state-owned and adjacent railroad bridges to verify that the hydraulic characteristics (freeboard, water surface elevation, water velocity, scour, etc...) are not impacted by the proposed levee system. Exhibit 11, in Appendix 1, shows the locations of bridges that will need to be analyzed. Due to the level of detail obtained within this study, the hydraulic analysis has not been determined for the bridges; the bridges will require further analysis. We assumed a low level of detail to account for the bridge modification/replacement if required. The addition to the cost is under line No. 27, Item Bridge Modifications/ Replacement in Appendix 5 Levee cost estimates.

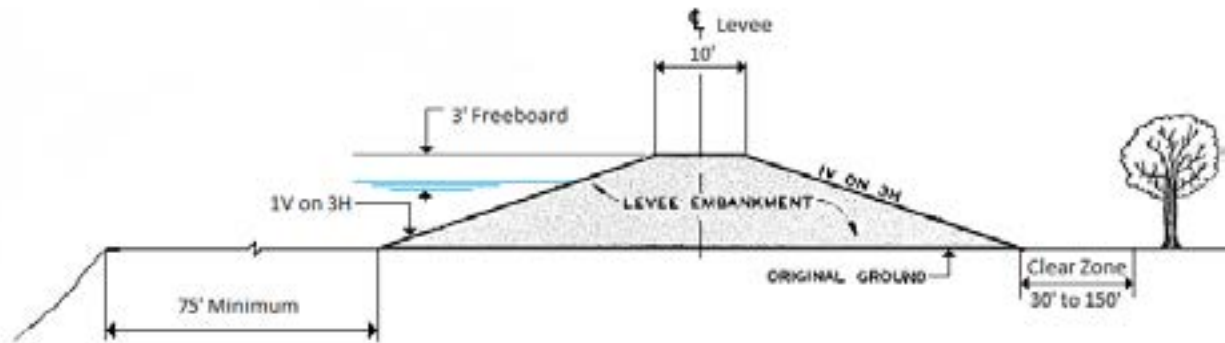
8.4.3 Existing Embankment

Miles City's existing earthen embankment systems have been maintained and added to since construction in 1936 by the WPA. During a flood in 1944, the embankment failed in several locations. USACE "Analyses of the levee height and structural condition have shown that it is inadequate in both respects" (Department of the Army U.S. Army Engineer District, Omaha, 1978). The public has access to the river on areas through certain portions of the embankment's length; however, a majority of the embankment was constructed on privately owned land, and public access to the river is prohibited.

8.4.4 Preliminary Design of Levee

The typical levee cross-section developed for the project is shown in Figure 22. The levee cross-sections must have a minimum side slope of at least 3 horizontal to 1 vertical (3H: 1V). A 3:1 slope is the steepest slope that can be conveniently traversed with conventional mowing equipment and walked during inspections. For our preliminary design purposes we assumed a 4:1 side slope. The width of the levee crown depends primarily on roadway requirements and future emergency need that would provide access to normal maintenance operations and flood fighting operations. Minimum widths of 10 to 12 feet are commonly used with wider turnaround areas provided at specified intervals; these widths are about the minimum feasible for construction using modern heavy earthmoving equipment and should always be used for safety concerns. The project levee height through Miles City and surrounding areas averages approximately 11 feet, including a minimum of 3 feet of freeboard for the design flood event. The average levee foot print will be approximately 98 feet, this will change depending on the topography. The typical levee layout also includes a clear zone (30 to 150 feet) beyond the landside toe of the levee for seepage control measures, inspection and maintenance access. The preliminary engineering also took into consideration the levee and channel bank stability. The proposed levee alignment was designed using a 75-foot offset between the riverside toe and the river channel. The levee offset will vary based on changes incorporated during project design.

Figure 22: Typical Levee Cross-Section



8.4.5 Levee Seepage Analysis

The levee seepage analysis is a very

Figure 23: Sand Boil Example Due To High Seepage Rate

important part of the levee design process, because groundwater levels have significant effect on the levee's stability. The high rates of seepage can result in levee boils (sand boils), or internal erosion of soils in the foundation or toe on the landside of the levee. This can jeopardize the integrity of the levee or lead to levee failure. Preliminary levee seepage analysis shows that the pervious soils conditions along the river channel may cause significant seepage issues, and preventative measures for levee seepage



will be necessary. The preventative measure recommend by the USACE was the use of "landside berms", along with "relief wells" and a "pump station." Upon preliminary analysis by KLJ, we assumed the use of landside berm incorporated with perforated pipe surrounded by sand drain to allow flow to pipe, with relief wells and a pump station used to calculate preliminary design cost. Seepage analysis will need to be more thoroughly conducted during the project design, to determine the most practical and cost effective design.

8.4.6 Structural Design

The preliminary structural engineering for this study consisted of stability analyses and size estimating for major structures and components for features identified for the project. Structural features include floodwalls, closure structures (roadway) and interior drainage structures.

The objective of structural engineering was to determine the feasibility of design in order to establish enough preliminary design analysis to develop quantities for a baseline cost estimate. The detailed design of these features was not developed for this report. For features such as floodwalls, pump stations and closure structures, the overall sizes, lengths and cost were determined from previous project experience of similar arrangement.

8.4.6.1 Floodwalls

The floodwalls would be used as a barrier for flood flows where space constraints prevent the use of levees. For the purpose of determining floodwall costs, a standard reinforced-concrete cantilever T-wall was assumed for this project. This is the most common type of flood wall, and was the consideration for our design.

The cross bar of the T serves as a base and the stem serves as the water barrier. When founded on earth, a vertical base key is sometimes used to increase resistance to horizontal movement. If the wall is founded on rock, a key is usually not provided. Where required, the wall can be supported on piles. A sheet pile cutoff can be included to control under seepage or provide scour protection for the foundation. T-type walls may be provided with a horizontal or sloped base. (Engineers D. o., 1989)

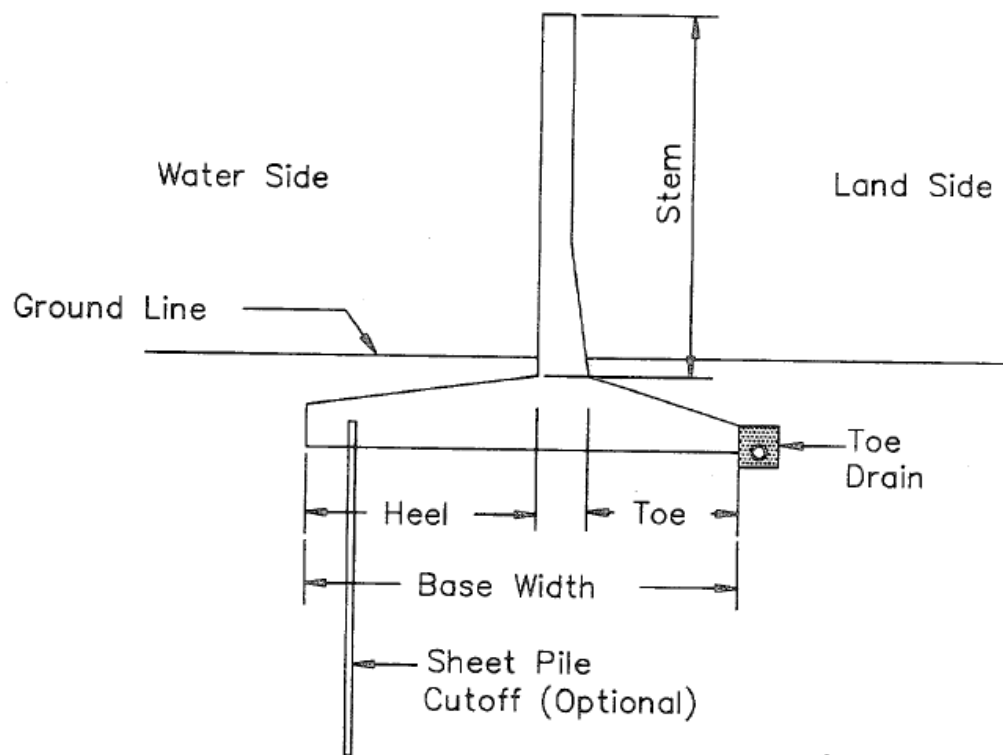
Cantilever T-type flood walls have a shallow-footing base slab and a vertical stem extending above ground to the design water elevation (including three feet of freeboard). Due to material along the river bank being pervious, a steel sheet pile cutoff is assumed along the upstream edge of the heel of the base slab, extending into the foundation to control seepage along with a toe-drain along the toe side of the levee as seen in Figure 24.

8.4.6.1.1 Floodwall Seepage

Uncontrolled seepage below rigid structures, such as floodwalls, can lead to instability and failure of structure. Under seepage beneath floodwall structures will need to be analyzed in detail during the design phase to define the steps needed to determine the critical seepage, developed from the head conditions representing the minimum base length of the foundation.

Additional preventative measures such as steel sheet pile cutoffs along with toe drain and trenches on the landside edge of the levee may also need to be incorporated into the design in order to collect the water and route into a seepage collection system as illustrated in Figure 24.

Figure 24: Typical T-type Floodwall Cross-Section



8.4.7 Interior Flood Risk Reduction System Assessment

The interior drainage of the Miles City storm water system does not appear to be sufficient, and would need to be redesigned to provide sufficient drainage as stated by USACE:

The Interior drainage structures on the existing levee are not of proper design or adequate size. The interior drainage structures on the new levee would be considerably larger and more efficient. Improved interior drainage would mean less ponding, and a reduction in the threat of vector-borne diseases. The non-Federal interest would also be required to retain existing ponding areas behind the levee for temporary storage of interior storm runoff during flood stages on the Tongue and Yellowstone Rivers.

(Department of the Army U.S. Army Engineer District, Omaha, 1978)

Preliminary assessment of the project's need for internal drainage infrastructure focused on the sizing of pump stations for the interior 1-percent-annual-chance rain event and assumed simultaneous design flows in the Yellowstone and Tongue Rivers (i.e., blocked gravity outfalls). Internal drainage must be

addressed with the construction of a new levee in order to prevent flooding from large precipitation events coinciding with periods of high flow on the river. Internal drainage will consist of the levee's groundwater seepage system, urban storm sewer system, natural channels, stormwater ponds and lift stations. These components should be optimized to work together to provide adequate storage volume and discharge capacity to prevent internal flooding and prevent SFHA from being mapped internal to the levee system.

It is likely that existing lift stations will either need to be renovated or replaced. It is estimated that four lift stations along the levee will be necessary to handle the coincidental precipitation event. The size and cost of the lift stations will be governed by required discharge rates. Lift station cost could be minimized by providing additional stormwater storage area. This would allow for smaller pumps to be used. For the purposes of this report, it was assumed that the existing Old Tongue River Channel would be re-graded in a way to minimize localized flooding along the old river bed as well as the use of the old wastewater lagoons. In order to compensate for the storage that was removed, a large stormwater pond would need to be constructed somewhere near the wastewater treatment facility, and the old lagoons would provide an inexpensive option for retention. This would likely result in one large lift station to handle the majority of the runoff from Miles City and three smaller lift stations that would handle smaller, localized areas as well as the potential to collect water from the levee's groundwater seepage system. Pending soil boring results, the excavated material from the proposed stormwater pond within the Old Tongue River Channel may be used as borrow material to construct the levee system.

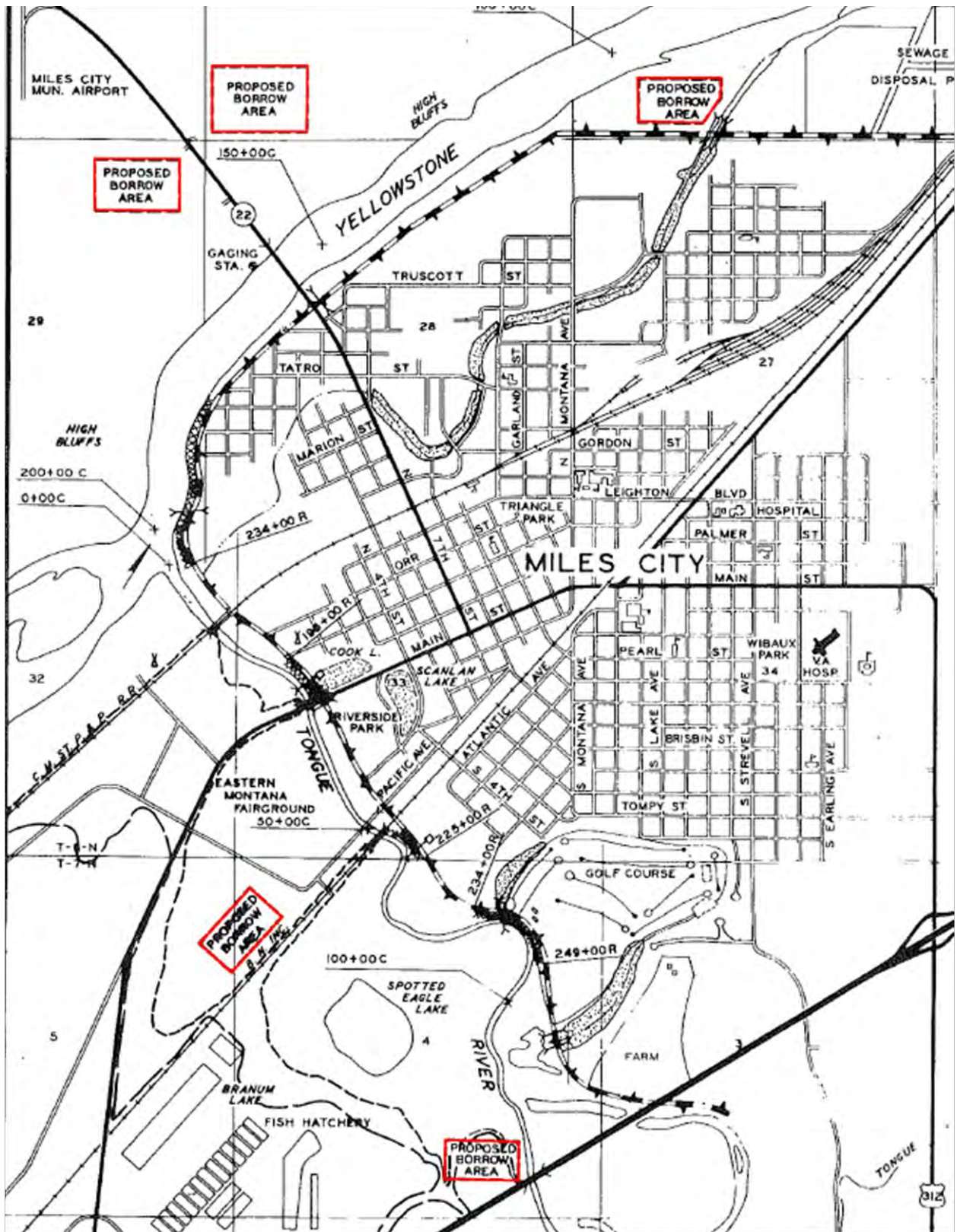
8.4.8 Borrow Sources

An office review of available topographic, soil and geological maps, aerial photographs, historical boring logs and well data, and information on existing engineering projects was made as part of the project. This data was used to establish a starting point for future detailed borrow source investigations and to provide a basis for estimating costs associated with obtaining borrow for levee construction. An extensive investigation into potential borrow sources is beyond the scope of this report. Borrow source investigation will be a key component of future final design tasks. A summary of potential borrow sources is discussed in the paragraphs below.

Preliminary geotechnical bore data shows portions of the existing levee may be able to be used as on-site borrow due to the content of this material. The existing levee use is dependent on further inspection of geotechnical properties of the levee material. Potential borrow sources generally consist of

existing pits within the area, but new sources are also proposed. It should be noted that the potential borrow sources identified are preliminary in nature and a detailed subsurface investigation consisting of test pits, soil borings and lab testing will be required to characterize and quantify available materials. In addition, environmental and cultural resource clearance may be needed to be obtained, along with any easements or ownership required to secure use of the site. Areas best suited as borrow sites are current farmland, upland pastures and areas with little vegetation (i.e. wooded, brushy or heavy vegetation). Figure 25 shows proposed borrow sites that were listed in USACE 1978 Phase I general design study (Department of the Army U.S. Army Engineer District, Omaha, 1978). The borrow site located near the wastewater treatment plant has potential to not only be used as a borrow pit, but also as a detention pond for stormwater runoff during times of high river levels. Pending further geotechnical analysis, this source would save money due to location of borrow and serve as second use of depleted borrow area, once the project is completed. The extra saving for the dual usage was not included in the OPC due to the unknown nature of the available material at this proposed borrow location; therefore, if this option is viable the cost will adjust accordingly.

Figure 25: Proposed Borrow Sites



Other potential borrow sites can be seen in Exhibit 8 in Appendix 1, showing the various soil types around Miles City. These soil types are from the SCS/NRCS soil hydro group classifications. The map areas of potential interest will be the purple areas, consisting of Marvan silty clay, Maris silty clay and Marvan-Vanda silty clay. These soils have a hydro group classification of D, meaning they have a very low infiltration rate. Exhibit 8, in Appendix 1, shows there is a potential for secondary improvement to the community for the construction of a new levee. This comes by expanding the size and habitat diversity of Spotted Eagle Pond, this is done by excavating borrow material adjacent to the pond. The location of this pond is within the rectangle proposed borrow area, showing areas that may have acceptable material. This is one of the potential public benefits of Alternatives 4 & 5.

8.4.9 Setback Recommendation

The setback recommendation for the levee system is a minimum of 75 feet due to the instability and erosion of the right channel bank (looking downstream). This setback will alleviate constriction within the channel, which in turn will lower velocities. Lowering the channel velocity will reduce the channel embankment erosion and reduce the need for channel embankment protection (i.e. riprap). The reduction of embankment protection reduced project costs substantially. Further geotechnical evaluation will need to be performed to determine if the elimination or reduction in the embankment erosion control is viable.

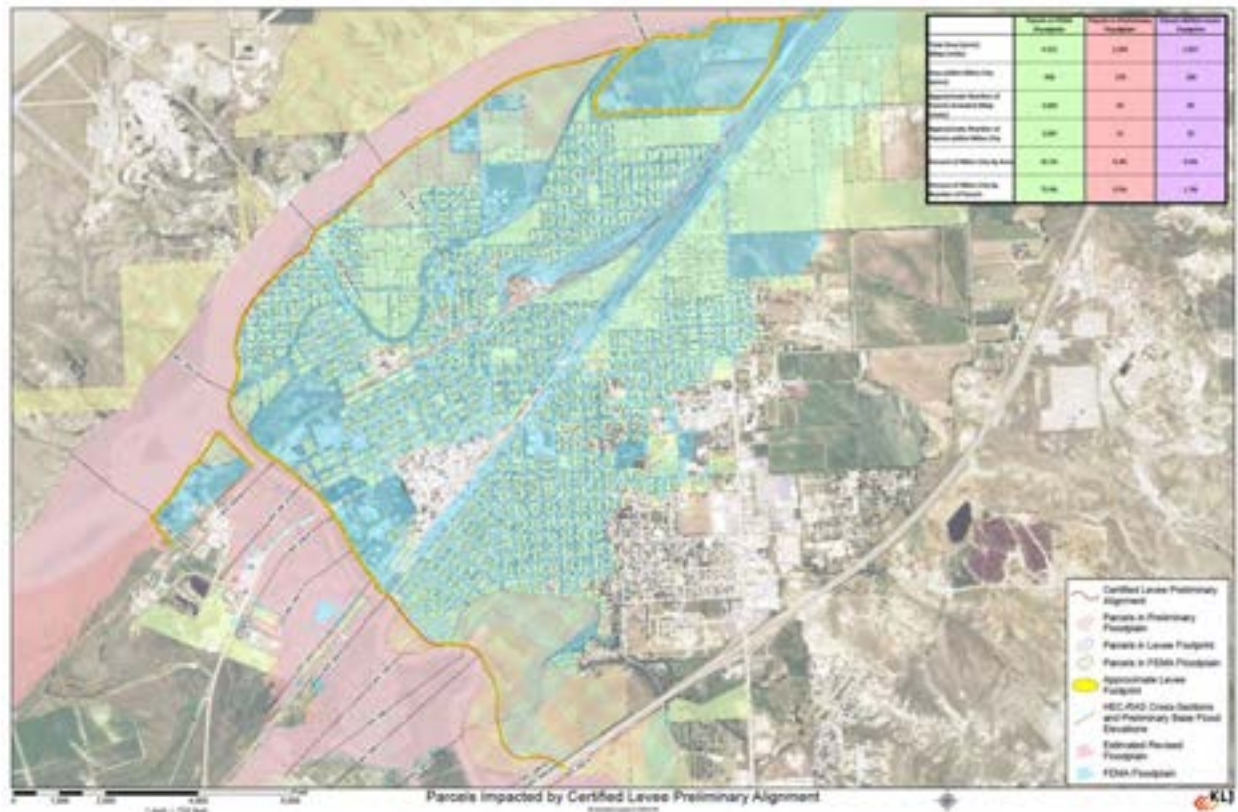
8.4.10 Preliminary Flood Mitigation Review-Property Set Back

The initial review using the existing levee alignment to construct a certified levee will substantially impact the residents in Miles City. There are approximately 3,600 parcels within and about Miles City that are affected by the FEMA floodplain.

With a certified levee, the majority of residents in Miles City will not be required to carry flood insurance. A preliminary look shows that the number of homes that can be removed from the FEMA floodplain is enough to quantify the benefits the certified levee system would have for Miles City and its surrounding area.

The most significant impact of this alternative would be the reduced risk of flood damages to the existing development throughout the floodplain. The alternative would improve the safety and well-being of thousands of families and hundreds of business within the 500-year floodplain. Similarly, future development of Miles City would have a reduced risk of flood loss.

The adverse impacts of this alternative include preliminary calculations that show approximately 65 properties that will be affected by the levee construction, and approximately 60 properties that would still be in the preliminary floodplain. The amount of land affected by the alternative is approximately 200 acres. This is due to the levee footprint and set back distance for structures, along with 175 acres that would remain in the preliminary floodplain. Figure 26 shows the affected parcels.



8.4.11 Opinion of Probable Cost of Levee

8.4.11.1 Basis of Cost

The cost estimates and associated information in this section are intended to provide background information to understand the basis for the development of the OPC, based on the proposed alignment at this time. Costs are based on analysis and assumptions consisting primarily of the following:

- Material cost quotes obtained from local suppliers.
- Preliminary quantity estimation related to earthwork associated with levee construction.
- Assembly of reference unit cost data from recent regional bid tabulations, similar flood risk reduction projects, published cost data and other typically observed costs.
- Quantity calculations based on analysis, preliminary design and drawings included in this report.
- Referenced categorical cost breakdowns of similar feasibility-level and EIS-level cost estimates, as performed by USACE and others, including more than 20 recent regional and national projects with relevant project scopes emphasizing flood control, levee, pump station and transportation work elements.
- Acquisition costs are based on estimated pre-flood assessed values of affected properties.
- For more defined project features, deterministic methods are used to estimate costs based on quantity takeoffs and estimated unit costs for assemblies and individual components.
- For less defined project features, qualitative methods are used where project unknowns limit the degree to which feature quantities can be itemized, counted or measured. In some of these cases, allowances are included to estimate the cost typically required for such work.

8.4.11.2 OPC Breakdown

Preliminary cost estimates were developed for the following elements directly associated with the project:

- Infrastructure modifications
- Ecological mitigation
- Roads, road raises, railroads and bridges
- Channel improvements and hydraulic structures
- Levees, floodwalls and closure structures
- Interior flood damage reduction systems (pumping stations)
- Recreation facilities (access points, boat ramps, access roads, foot trails, etc.)
- Cultural resource investigations and mitigation

Preliminary cost estimates were also developed for the following items required for the overall project, but not associated with specific elements:

- Lands and easements
- Planning, engineering and design
- Permitting and regulatory approvals
- Construction management

8.4.11.3 Project Features

Project costs have been estimated for the following three zones: Water Treatment Plant (WTP), Waste Water Treatment Plant (WWTP) and Miles City. The following in Table 7 is a summary of key project features in these zones. This list is not inclusive. For a full breakdown of project features included in the OPC, see Appendix 5.

Table 7: Project Features for Levee Zones

Category	Item	Units	WTP Reach ¹	WWTP Reach ¹	Miles City Reach ¹	Total Project ¹
Flood Risk Reduction Features	Length of Levee	Feet	4,200	7,700	20,000	32,000
	Length of Floodwall	Feet	0	0	2,000	2,000
	Number of Pump Stations	Each	0	1	3	4
	Channel Reconstruction	Feet	0	0	14,000	14,000
Municipal Infrastructure	Sanitary Sewer	Feet	0	450	0	450
	Water main	Feet	0	2,100	0	2,100
	Road	Feet	0	0	1,600	1,600

¹ Lengths are rounded to the nearest 100 feet.

8.4.11.4 Estimated Cost

An OPC was developed for the project in accordance with the methodology, basis of cost, cost breakdown and project features summarized above. There appears to be sufficient space to utilize full cross section levee embankments at the WTP and the WWTP. No Floodwalls are anticipated at these locations.

Table 8: Opinion of Probable Cost

Cost Breakdown/Element	Opinion of Probable Cost
Mobilization/Demobilization	\$1,940,000
Infrastructure Modifications	\$201,000
Roads, Road Raises, Bridges, and Railroads	\$4,165,000
Channel Improvements and Hydraulic Structures	\$1,630,000
Levees, Floodwalls and Closures	\$12,100,000
Interior Flood Damage Reduction Systems (Pumping Stations)	\$1,400,000
Estimated Construction Costs ^{1 2 3 4}	\$6,000,000
Lands and Easements ⁵	\$6,030,000
Planning, Engineering and Design	\$3,940,000
Construction Management	\$2,400,000
Recreational Facilities	\$1,000,000
Estimated Total Project Cost ^{1 2 3 4}	\$37,000,000

¹ Includes contingency (for additional information see Appendix 4).

² Includes cost of all levee sections.

³ This is a feasibility-level cost estimate based on feasibility-level design alternatives, alignments, quantities and unit prices. Costs will change with further design.

⁴ Does not include temporal escalation costs, operation and maintenance costs.

⁵ Regardless of funding mechanism selected, land acquisition and easement costs will always be part of the local share of the project.

8.4.11.5 OPC Considerations

The OPC was developed based on feasibility-level designs, unit prices that are benchmarked against 2013 and 2014 regional prices for similar construction scopes and engineering judgment. This feasibility-level OPC is intended to correspond to a Class 4 estimate, characterized by 10-15% design completion (per ASTM E 2516-06 and USACE EI 01D010 9/1/97). The OPC is based on feasibility level design alternatives, alignments, quantities and unit prices. Costs will change with further design. A contingency of 20% for construction costs and 10% for lands and easements has been established for the OPC based on referenced projects and published references. Time-value of money escalation costs are not included. Operation and maintenance costs are not included.

The OPC is a point estimate within an estimated accuracy range. The accuracy range is based on professional judgment considering the level of design completed, the complexity of the project, and the uncertainties in the project as scoped. This accuracy range is not intended to include costs for future

scope changes that are not part of the project as currently scoped, or risk contingency. Future cost estimates should incorporate construction schedule and time-value of money escalation and consider uncertainties associated with these elements. A construction schedule is not available at this time. The OPC is considered a feasibility-level construction estimate, and has been developed on the basis of similar projects and the consulting team's experience and qualifications. The OPC will change as more information becomes available and further design is completed. Given the level of project definition, uncertainty exists related to the limited design work completed to-date including, but not limited to, uncertainties associated with quantities, unit prices and design detail. In general, it can be anticipated that as the future level of project definition increases, the uncertainty associated with these items will decrease.

As the consulting team has no control over the eventual cost of labor, materials, equipment, services furnished by others, the contractor's methods of determining prices, competitive bidding or market conditions, the consulting team cannot and does not guarantee that proposals, bids or actual construction costs will not vary from the OPC.

8.5 Alternative #5 Reconstruct Levee System 500-Year

Analysis of level of protection for the 500-year flood will have greater beneficial impact than the 100-year flood protection. Flood protection from the 500-year flood would potentially remove Miles City from the SFHA Zone X on the FIRMs. Zone X areas are identified in community flood insurance studies as areas with moderate or minimal hazard from the principal source of flood. However, buildings in these zones could be flooded by severe, concentrated rainfall coupled by inadequate internal drainage systems. Flood insurance is available in participating communities but is not required by regulation in this zone. The top of levee elevation difference between the 100 and 500-year flood events is approximately 1 to 2 feet. While the average levee foot print (width) will be approximately 115 feet, this width will vary due to topography. The benefits provided by a 500-year flood protection is considered the plan most preferred due to the cost versus benefit. The cost can be seen in the OPC below, and the benefit is the higher level of protection that will be provided for Miles City and its surrounding community. The majority of the levee design will not significantly change due to the relatively small increase in levee height from the 100-year to the 500-year flood protection. The basic construction of the levee for protection from a 500-year flood event will not change. However the material volumes will increase, due to the increased height of the constructed levee, and the levee footprint (width) will widen due to the increase in levee height. This larger footprint will have a greater impact on the area

adjacent to the levee, thus requiring an increase in the amount of right-of-way that will need to be acquired.

8.5.1 Opinion of Probable Cost

The major change between the 100-year and 500-year levee protection is the quantity of fill required for construction.

This OPC is intended to provide information for consideration during decision-making and planning at this feasibility-level stage of the Miles City Study. After preliminary alternative evaluations and alignment revisions were presented during the City meetings, further design was completed and quantity takeoffs and real estate acquisitions have been estimated for the project. The cost estimate is of a level of detail intended to evaluate the feasibility of the project as defined at this time. The estimated costs will change based on final design and alternative selected by Miles City.

8.5.1.1 Estimated Cost

An OPC was developed for the project with the same methodology, basis of cost, cost breakdown and the project features summarized in section 8.4.

Table 9 Opinion of Probable Cost

Cost Breakdown/Element	Opinion of Probable Cost
Mobilization/Demobilization	\$2,040,000
Infrastructure Modifications	\$201,000
Roads, Road Raises, Bridges, and Railroads	\$4,200,000
Channel Improvements and Hydraulic Structures	\$1,630,000
Levees, Floodwalls and Closures	\$13,000,000
Interior Flood Damage Reduction Systems (Pumping Stations)	\$1,400,000
Estimated Construction Costs ^{1 2 3 4}	\$6,900,00
Lands and Easements ⁵	\$6,030,000
Planning, Engineering and Design	\$4,100,000
Construction Management	\$2,500,000
Recreational Facilities	\$1,000,000
Estimated Total Project Cost ^{1 2 3 4}	\$39,280,000

¹ Includes contingency (for additional information see Appendix 4).

² Includes cost of all levee sections.

³ This is a feasibility-level cost estimate based on feasibility-level design alternatives, alignments, quantities and unit prices. Costs will change with further design.

⁴ Does not include temporal escalation costs, operation and maintenance costs.

⁵ Regardless of funding mechanism selected, land acquisition and easement costs will always be part of the local share of the project.

9 Environmental Consideration

This section provides an overview of the environmental factors considered during preliminary levee alternative analysis. With preliminary review, the currently known environmental considerations in the study reach do not appear to present significant impediments to the project or project features. Due to the potential for the pursuit of federal funding, environmental analysis under NEPA would need to be completed. Due to the large size of the preliminary project alignment, interconnectivity of project areas, requirement of federal and state permits, potential affects on wetlands, river channel and economic impacts to communities, the project will require at least an EA; though it is very likely an EIS would be required due to the level of potential impact. The studies will need to take place because of the location of the project being within the 100-year floodplain. Large, complex projects such as the Miles City Levee Protection Project have many levels of environmental, community, historic/cultural and economic impacts that may be both beneficial and damaging.

There will be a need for continued dialogue with the agencies and jurisdictional representatives, as well as the stakeholders. This will allow for additional insight on approaches to minimize the environmental impacts as well as in cooperating features that may lessen the impact caused by the project. This project has the potential to increase the social and economic values through recreational benefits like improved recreational access along the study reach, public boat launches, and non-motorized public access to stream banks. This public access to the stream bank will benefit walkers, swimmers, anglers, and other forms of non-vehicle recreation. The potential to increase recreational values from the existing conditions will need to be further evaluated during the project's design phase.

9.1 National Environmental Policy Act (NEPA)

NEPA was enacted in 1970 with the purpose of requiring federal agencies to consider significant environmental impacts arising from projects under agency jurisdiction. Another main purpose of NEPA is to provide public participation in the project decision making process.

NEPA requires that potential environmental, social and economic impacts of proposed project be analyzed for all major federal projects that affect "the quality of the human environment." Most projects having federal participation, permitting or approval may be enough to make a project a "major federal action," which can result in private projects also being required to perform a widespread environmental review.

An EA is conducted to define the project requirements, potential environmental effects and alternative actions. The EA provides the project information needed for evaluating the environmental impacts and

determining whether an EIS must be prepared. If a federal permitting agency decides that an EIS is likely to be required due to project scope, scale or potential impacts, an EA can be used as a scoping document to define the information that should be included in an EIS.

9.2 Wetlands

A preliminary office review of wetlands concluded that additional investigation of wetlands via a field delineation is needed. This assumption is reinforced by the USACE's environmental statement:

A wetland area exists near the downstream end of the proposed project along the Yellowstone River. This wetland is an old channel of the Tongue River, and usually has about 5 acres of surface area. Its primary source of water is ground water supplemented by runoff from a northern sector of Miles City. (Department of the Army U.S. Army Engineer District, Omaha, 1978)

9.3 Cultural Resources

Cultural resources are defined as evidence of past human activity that includes pioneer homes, buildings or old roads; structures with unique architecture; prehistoric village sites; historic or prehistoric artifacts or objects; rock inscription; human burial sites; and earthworks, such as battlefield entrenchments, prehistoric canals or mounds. These cultural resources will need to be reviewed during the environmental review of the project area before construction could commence.

10 Permitting and Regulatory Considerations

The following sections provide a brief description of the potential permitting responsibilities for the Miles City Flood Protection project. Table 10 provides a brief, non-comprehensive listing of major permitting and regulatory considerations; there are other minor permits that will need to be acquired.

Table 10: Major Required Permits and Approvals

Agency	Permit Approval	Reason
Federal		
US Army Corps of Engineers (USACE)	Section 404 Individual Permit	Impacts to waters of the United States including wetlands
	Section 10 Individual Permit	Impacts to navigable water
	Section 106 Consultation	Condition of federal permit (USACE permit)
US Fish and Wildlife Service (USFWS)	Section 7 Consultation	Condition of federal permit (USACE permit)
Federal Emergency Management Agency (FEMA)	Conditional Letter of Map Revision Letter of Map Revision	Modifications within the 100-year floodplain
	Levee Certification	To demonstrate that the levees meet 44CFR65.10
State		
Department of Natural Resources and conservation (DNRC)	EA	Condition of Funding
	Floodway Permitting	DNRC approval requirement for changes to a Floodway
Montana Department of Environmental Quality (DEQ)	NPDES Construction Stormwater Permit	For construction activity disturbing one or more acres
	Section 401 Certification	Water quality certification ensures that federally permitted activities are in compliance with water quality standards
Montana—Office of the Engineer	Construction Permit	Construction of levees
	Sovereign Lands Permit	Project involves potential dredging and filling
Montana Department of Transportation (MDT)		Working within DOT ROW
Montana Fish, Wildlife & Park	124 Stream Protection Act Permit	Any streambed or stream bank alteration below the ordinary high water mark that is conducted by a government entity.

10.1 Federal Agencies

10.1.1 FEMA

FEMA is responsible for reviewing impacts to the 100-year flood elevation. For alternatives that include work within the 100-year floodplain, FEMA may require completion of a no-rise certificate or a CLOMR, followed by a LOMR. A CLOMR and LOMR would be necessary to demonstrate that the project does not

increase the BFE. The placement of a levee could potentially impact BFEs and floodway boundaries. In this case, submittal of the CLOMR will likely trigger a request for a PMR, for which a new floodplain and flood way map will be required. FEMA has criteria for certifying that flood risk reduction projects provide a specific level of protection against the base flood event. FEMA reviews documentation provided by the levee owner, demonstrating that the levee has been certified by a professional engineer and meets current design criteria. Following a review of submitted documentation, FEMA will map areas protected by a levee as moderately at risk (Zone X) on FIRMs.

10.1.2 USACE

The USACE issues permits for work within navigable waters (i.e., below the ordinary high-water line for the Yellowstone and Tongue Rivers) or within jurisdictional wetlands. The USACE reviews and approves modifications to the existing levee system. The project described in this report will likely be considered a major action with the potential for significant impact on the quality of the human environment. As a result, the project will require USACE approval under Section 10 of the Rivers and Harbors Act of 1899 and under Section 404 of the Clean Water Act. An environmental review will need to be conducted to meet the requirements of the NEPA of 1969, National Historic Preservation Act of 1966, and Council of Environmental Quality Regulations Endangered Species Act of 1973, Section 404 of the Clean Water Act, and other applicable laws and regulations. Under NEPA, applicable projects are assessed in relation to the environmental conditions of the area and the impact that alternatives would have upon those environmental conditions. It has always been the intent of the NEPA process to ensure that informed decision making, with respect to the environment, occurs when considering the need for a project and its alignment and design. The NEPA document will assess the impacts of the proposed action and reasonable alternatives, identify and evaluate mitigation alternatives, and discuss potential environmental monitoring. Coordination with responsible federal, state and local agencies; the general public; interested private organizations and parties; and any other affected party will assist in the determination of significant environmental issues and resources. The NEPA document will be a valuable tool to help guide and refine the design process. The information compiled will be valuable when completing the required Section 404. Early coordination with other agencies and the public is an essential part of the project development process. This coordination can help in determining the appropriate level of documentation required and in shaping discussion related to project purpose and need. It will also help in identifying the NEPA and permit requirements of other agencies, the range of alternatives, impacts to resources, possible mitigation measures and opportunities for environmental enhancement.

10.1.2.1 Section 404 Permitting

Because the project involves work in navigable waters, it will also require federal permitting under Sections 401 and 404 of the Clean Water Act. This permitting is achieved by completing a Joint Application for Proposed Work in Streams, Lakes and Wetlands in Montana. This joint application goes to several state and federal agencies and facilitates a more timely review process than applying for permits from each agency separately. It is recommended that the public interest and technical evaluation data required for a Section 404 permit and/or a Section 10 permit be compiled concurrently with the technical evaluation and environmental protection compliance data required for a Section 408 permit. This will facilitate a timely, concurrent USACE review.

10.2 State and Local Regulatory Considerations

A construction permit from the Montana Office of the State Engineer will need to be obtained before implementing the project. Local permitting considerations include municipal and county permits. Miles City will be responsible for acquiring all local, state, and federal licenses/permits required to comply with state and municipal laws, codes and regulations (road, borrow, construction, etc.), before starting construction activities. The contractor will need to acquire the national NPDES permit from the DEQ.

11 Levee Certification Requirements

The levee certification process is the technical finding for floodplain mapping purposes. To be part of the NFIP, there must be reasonable certainty that the levee protecting the area will contain the base flood (as flood being the 1 % annual chance exceedance, sometimes referred to as the 100-year flood event). The certification findings can be completed by a federal agency with levee design and construction qualifications (USACE) or by a Registered Professional Engineer.

11.1 Roles and Responsibilities

Miles City has jurisdiction over the floodplain and is responsible for seeking levee certification. Miles City may perform the certification analysis, or may request to have the technical determination done by others. However, the certification must be done by a Registered Professional Engineer. Levee certification is not done by FEMA; they are the recipients of the levee certification determination document as outlined in 44 CFR 65.10. If they agree with the findings, FEMA will then accredit the levee and the associated FIRMs will show that most of the flood hazard area is protected from a 100-year flood event.

11.2 Levee Certification Technical Guidance

The overall approach used to define the flood hazard and the elements used when assessing the 1% annual chance exceedance flood. The evaluation elements will include the definition of the exceedance criteria, design and construction details, O&M status and plans, residual risk and emergency response plans. Each section in the LCR will detail references and guidance documents used, other sources of information and professional state-of-the-practice documents. These sections will define the elements to establish whether or not the levee system is in accordance with the NFIP levee system requirements. Below is a list of the major factors that will need to be completed in order to be considered during the levee evaluation process.

- O&M Plan
- NFIP levee system evaluation field inspection
- Flood hazard characterization
- Capacity exceedance/failure criteria
- Levee height assurance determination
- Closure structures and devices
- Embankment protection from current or wave action
- Seepage/under seepage analysis
- Embankment and foundation stability
- Settlement
- Seismic analysis (where appropriate)
- Construction records and quality control testing
- Performance records
- Major maintenance and rehabilitation
- Interior drainage
- Residual risk and public safety
- Encroachments
- Ice issues
- Other applicable unique design criteria

12 Summary of Flood Mitigation Study

Five alternatives were analyzed both quantitatively and qualitatively. Doing nothing lacks any form of benefit and will not address the inherent risk the flooding situation presents to life and property damage. LOMAs may be implemented on their own or in conjunction with a larger project. However, LOMAs would only benefit a small portion of the property owners within the floodplain, and the owners would be liable to pursue this alternative on their own. 2D modeling has the potential to remove a portion of properties from the floodplain by more accurately depicting the flow of a 100-year flood event. However, remapping using a 2D model through FEMA's procedures has the potential to be a long, laborious process. Finally, constructing a new 100-year or 500-year levee will remove the majority of parcels out of the floodplain. However, these are by far the most expensive alternatives, and will take several years' worth of design, construction, and administrative work before the levee is certified, and the City is removed from the floodplain.

12.1 Expected Timeline

Table 11 below lists the five alternatives in order of how long it is anticipated for the selected alternative to go into effect. Naturally, doing nothing can be implemented immediately. LOMAs are typically processed by FEMA within 60 days. Once a LOMA is issued, flood insurance may be immediately canceled. 2D modeling, as previously discussed, is significantly more labor intensive than 1D modeling. This statement holds true for data gathering, model construction, model calibration and model review. As 2D models are the exception rather than the norm, it should be expected that a 2D model for Miles City will take several years to construct and be approved by FEMA. Finally, constructing a certified levee will take several years of design, and construction, in addition to the procedures that must be followed for FEMA to certify a levee.

Table 11: Expected Time to Implement Alternative

Alternative	Expected Time to Implement (years)
#1 Do Nothing	0
#2 LOMAs	1
#3 2D Modeling	4 to 7
#4 100-Year Certified Levee	5 to 7
#5 500-Year Certified Levee	5 to 7

12.2 Benefit-Cost Analysis

The effectiveness of the five alternatives were studied using a benefit-cost analysis. This analysis compares the present value of the benefits associated with the implementation of a project to the present value of its costs, in terms of today's dollars. For example, when approximating future flood insurance premiums, both increase in policy cost and inflation rates are taken into account. The Benefit to Cost Ratio is a convenient tool to determine whether or not a project's benefits are greater than its costs. For a project to be beneficial, its benefit to cost ratio must be greater than one. If it is less than one, the project is more costly than beneficial. Table 12 below shows the present values of benefits, costs, and the benefit to cost ratio for the five alternatives. Based on the input values selected, the new levee has the highest benefit to cost ratio, and thus is the project, in this instance, that has the highest benefit to Miles City. 2D Modeling also has a benefit to cost ratio greater than one, signifying that it too would have a positive effect on Miles City. However, the benefit to cost ratio for both the Do Nothing and LOMAs alternatives is almost non-existent. There are no benefits to the Do Nothing alternative, and the benefits for the LOMA alternative are insignificant when looking at the entire city.

Table 12: Benefit-Cost Analysis for Five Alternatives

Benefit-Cost Analysis Parameters	
Current Collective Annual Premiums	\$625,000.00
Number of Flood Insurance Policies in Miles City	1312
Average Policy Premium	\$476.37
Expected Annual Rate of Increase in Flood Insurance	10%
Annual Inflation Rate	3%
Period of Analysis (years)	30
Do Nothing	
Present Value of Benefits of Doing Nothing	\$0.00
Present Value of Costs of Doing Nothing	\$55,258,238.36
Benefits - Costs	-\$55,258,238.36
Benefits: Costs	0.00
LOMAs	
Possible Number of Policies Removed	100
Cost per LOMA	\$ 1,500
Total Cost of LOMAs	\$ 150,000
Present Value of Benefits of LOMAs	\$4,211,756
Present Value of Costs of LOMAs	\$51,196,482.39
Benefits - Costs	-\$46,984,726.41
Benefits: Costs	0.08

2D Modeling	
Number of Policies Removed	750
2D Modeling Cost	\$328,000
Years until FEMA Approval	2
Present Value of Benefits of 2D Modeling	\$21,567,205
Present Value of Costs of 2D Modeling	\$19,347,042
Benefits - Costs	\$2,220,162.42
Benefits: Costs	1.11
100-year Certified Levee	
Number of Policies Removed	1275
Local Share of New Levee Cost	\$32,360,000
Years until FEMA Approval	6
Present Value of Benefits of New Levee	\$49,503,328
Present Value of Costs of New Levee	\$38,114,910
Benefits - Costs	\$11,388,417.48
Benefits: Costs	1.30
500-year Certified Levee¹	
Number of Policies Removed	1275
Local Share of New Levee Cost	\$33,360,000
Years until FEMA Approval	6
Present Value of Benefits of New Levee	\$49,503,328
Present Value of Costs of New Levee	\$39,354,910
Benefits - Costs	\$10,148,417.48
Benefits: Costs	1.26

¹This benefit: cost ratio only takes into consideration insurance premiums vs. levee cost, therefore the 500-year protection appears to have a lower B:C ratio than the 100-year levee, which, when other factors are considered, would not be the case.

The recommended plan was considered by formulating three primary plan objectives: to reduce or eliminate flood damages to existing developments, to minimize the impact of any remaining flood hazards, and to prevent the creation of new flood hazards following implementation of the selected plan. When considering the alternatives, many factors were taken into account. Alternative #5 is the recommended choice for Miles City, MT; the benefits of this alternative are more significant than the other two alternatives. The majority of homes will be removed from the floodplain, and the number of homes with mandatory flood insurance policies will significantly decrease. The long-term effects of Alternative #5 will outweigh the short-term cost of the project. During design and construction of Alternative #5, residents may independently pursue LOMAs to reduce personal cost while the project is under construction. This may be a viable alternative for some citizens to decrease their immediate costs, as the proposed construction timeline will likely be several years.

12.3 Future Considerations

When looking at Miles City as a whole, the massive number of flood insurance policies mandated is a symptom of the overall problem: the decertified levee. Of the five alternatives, only reconstruction of the levee will solve the problems; LOMAs and 2D Modeling treat the symptoms, while doing nothing ignores the problem entirely. If any of the three alternatives besides levee reconstruction is selected, flood fighting measures will continue as they have for the past 80 years. The decertified levee will continually need to be repaired, and Miles City is at greater risk for a catastrophic flooding event. As the majority of properties within Miles City are in the floodplain, new construction and renovations to existing structures will not be allowed without a permit, based on Montana state law. No construction whatsoever is allowed for properties within the floodway.

Constructing a new levee will help mitigate risk. It is important to note that no flood control structure will eliminate risk entirely. The chances of failure of a new levee, however, would be significantly less than the current structure in place. That is not to say the new levee will be maintenance-free. In order to continue to benefit from the certified status, the levee must meet the minimum standards of USACE inspectors on an annual basis. This includes items such as, but not limited to, proper vegetation, functional closure devices and levee integrity, to name a few. In short, the levee must be properly maintained to continue, according to FEMA, to provide flood protection.

13 Conclusion

The USACE has evaluated alternatives for protection besides building a levee, coming to this conclusion:

I have evaluated alternatives solutions to the flood problems at Miles City. Upstream reservoirs would not eliminate ice-jam flooding. Channelization of the Tongue and Yellowstone Rivers would cause significant adverse environmental impacts and would cause only a partial reduction in the threat of ice-jam flooding. Flood proofing or relocation of the flood plain structures would involve most of the structures in Miles City, would cause major social impacts, and would not be economically or socially feasible.

(Department of the Army U.S. Army Engineer District, Omaha, 1978)

The goal of this flood mitigation study was to review the FIRM mapping and determine if the appropriate protection steps can be taken to remove the at-risk properties from the 100-year floodplain. Information from this study will assist local decision makers, city and public in prioritization of the future protection needs, financial planning and public outreach.

To determine the flood management features necessary for acceptable flood risk reduction and to define the land needs and costs associated with developing a Miles City Feasibility Flood Protection project, the following activities were performed:

1. Reconnaissance of the project area and research of existing geotechnical, hydrologic and hydraulic information, and available transportation and infrastructure engineering data
2. Development of a preliminary project configuration including levee and floodwall alignments, heights and ground contact zones (footprints), incorporating measures identified as priorities by the stakeholders for meeting flood protection goals
3. Identification of relevant regulatory requirements and consideration of these aspects in plan development
4. Preparation of drawings, maps and preliminary design descriptions
5. Preparation of a Preliminary Engineering Report, including cost estimate, with sufficient detail to be used as the basis for a final design
6. Solicitation of stakeholder input throughout the process

Due to the scope of the study it is intended only as a conceptual level design. As a result, additional detailed design (survey, soil borings, etc.) will be required prior to implementing any of the proposed projects details. Any numbers used in this document are an approximate estimation for representative purposes, and should not be taken as finalized.

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ⁱ Guidelines and Specifications for Flood Hazard Mapping Partners, FEMA, April 2003, Volume 2.

Appendix 1: Exhibits

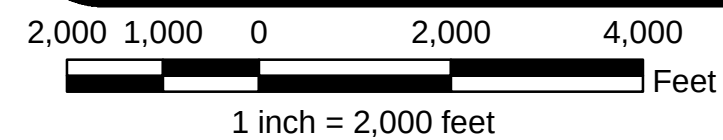
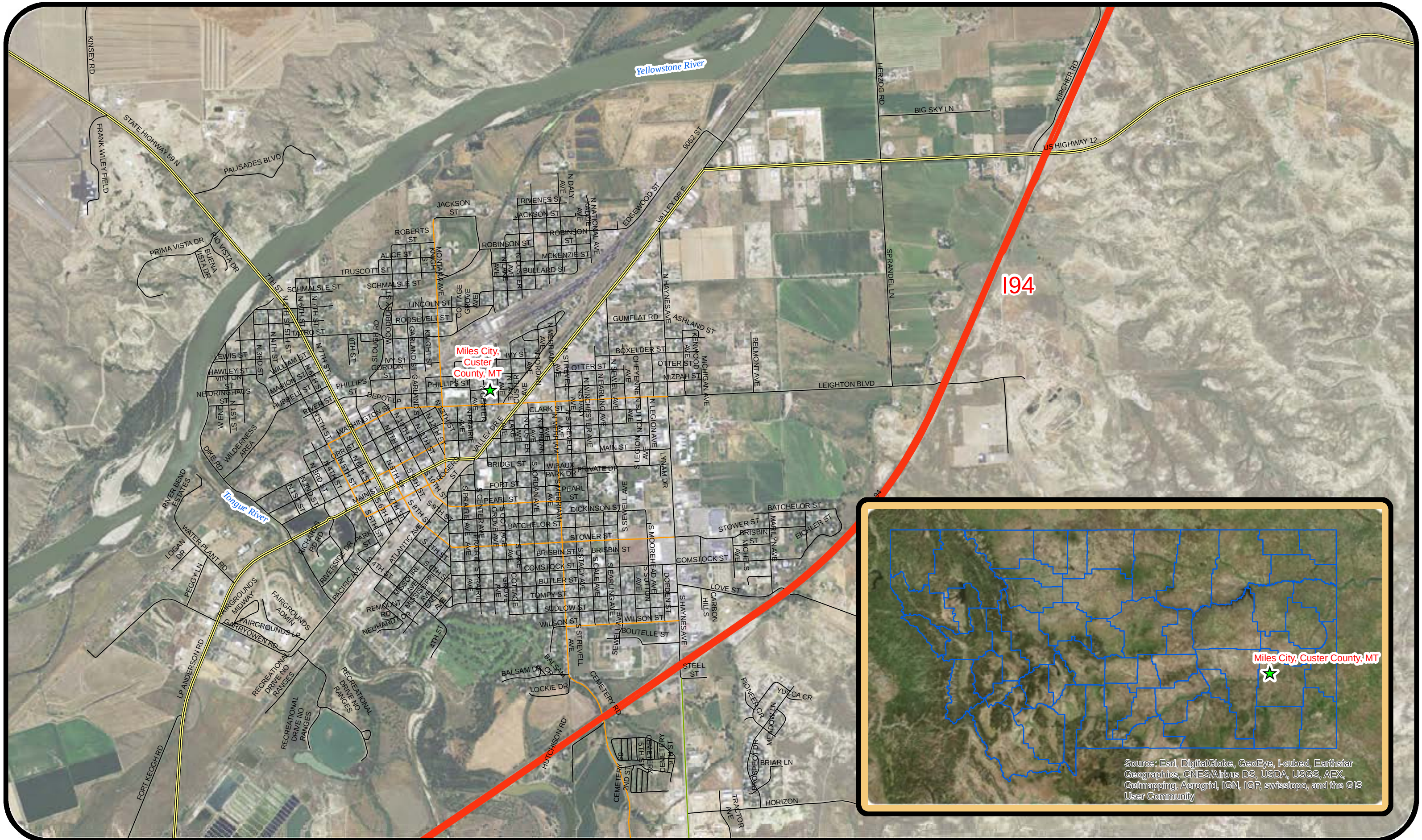


Exhibit 1

Miles City, Montana



Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar
Geographics, CNES/Airbus DS, USDA, USGS, AEX,
Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS
User Community



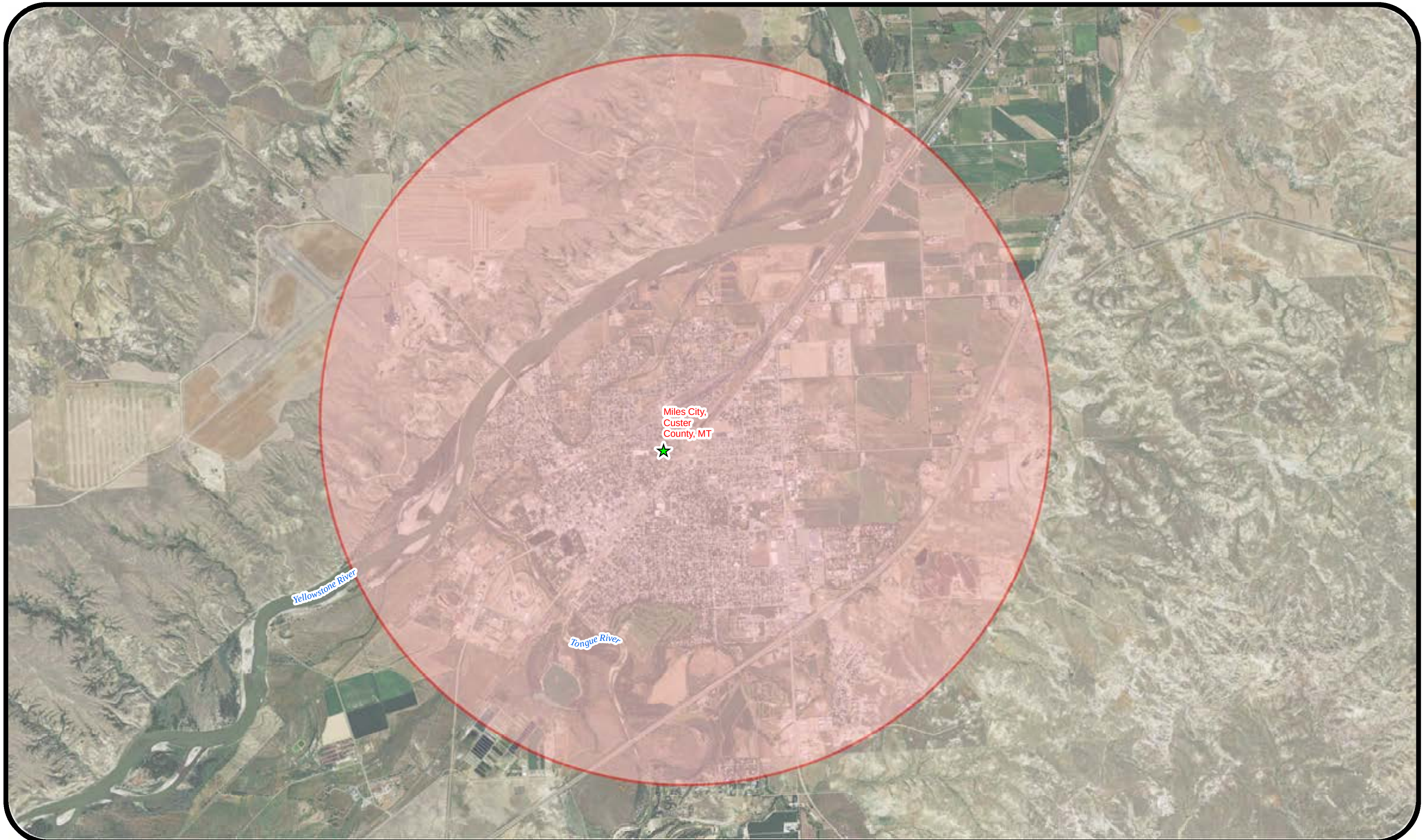
0 20 40 80 120 160 Miles
1 in = 40 miles

River Headwaters & Confluences

Exhibit 2



Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community



3,000 1,500 0 3,000 6,000
1 inch = 3,000 feet Feet

Exhibit 3

Feasibility Study Area



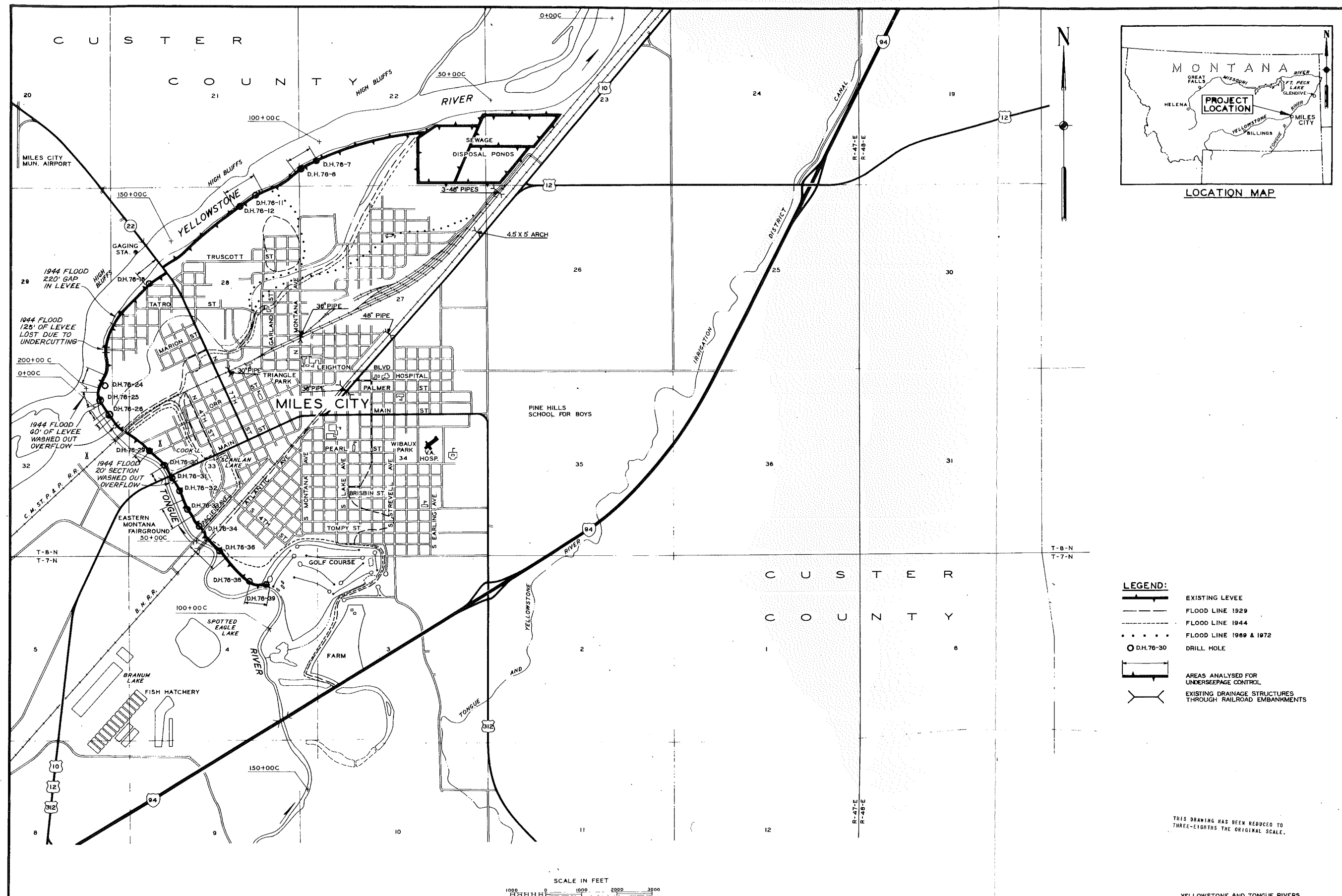
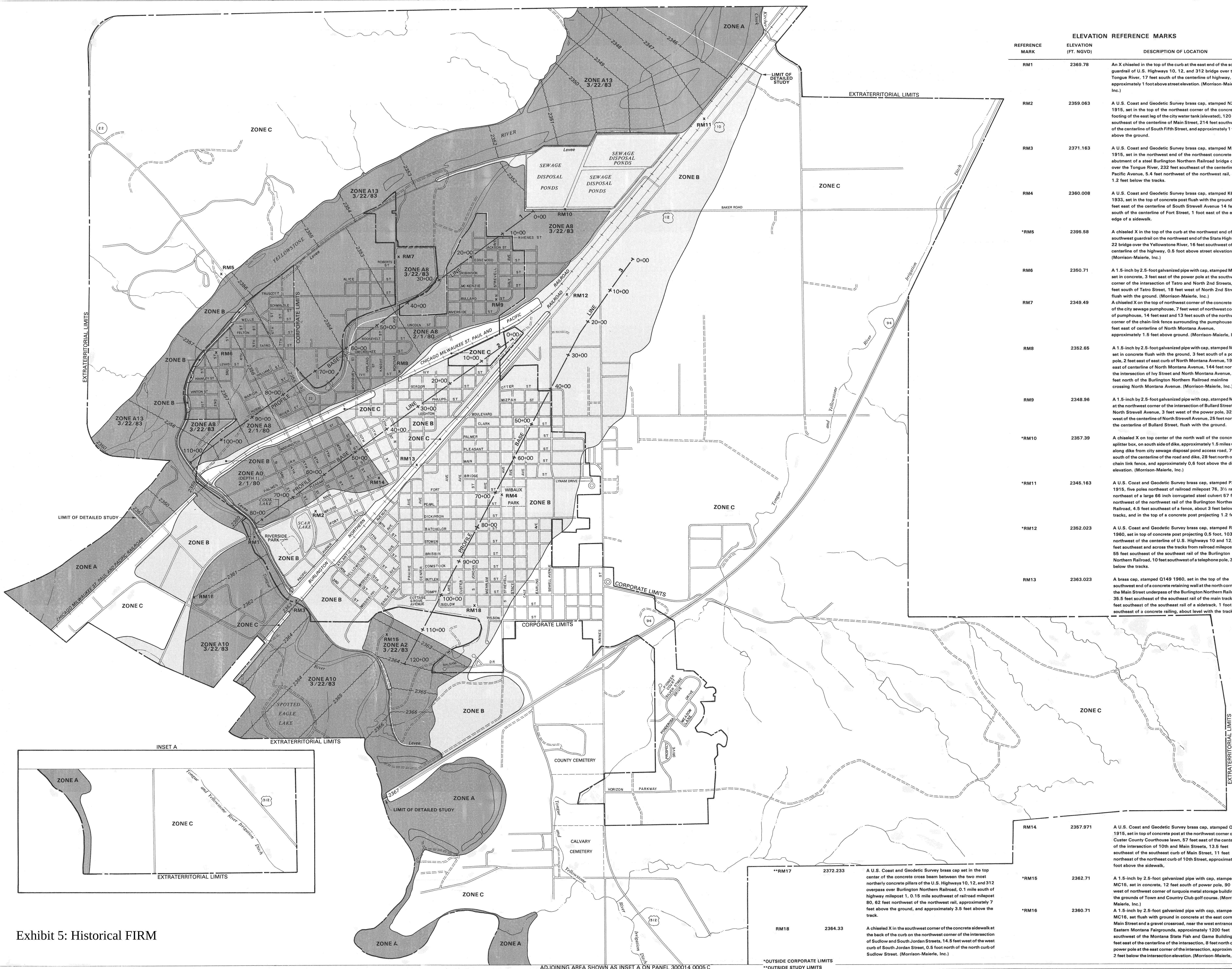


Exhibit 4: High Flood Water Marks

YELLOWSTONE AND TONGUE RIVERS
MILES CITY, MONTANA
LOCAL FLOOD PROTECTION PROJECT
VICINITY MAP

U.S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA
JULY 1978



REFERENCE MARK	ELEVATION REFERENCE MARKS	
	ELEVATION (FT. NGVD)	DESCRIPTION OF LOCATION
RM1	2369.78	An X chiseled in the top of the curb at the east end of the south guardrail of U.S. Highways 10, 12, and 312 bridge over the Tongue River, 17 feet south of the centerline of highway, and approximately 1 foot above street elevation. (Morrison-Maierle, Inc.)
RM2	2359.063	A U.S. Coast and Geodetic Survey brass cap, stamped N28 1915, set in the top of the northeast corner of the concrete footing of the east leg of the city water tank (elevated), 120 feet southeast of the centerline of Main Street, 214 feet southwest of the centerline of South Fifth Street, and approximately 1 foot above the ground.
RM3	2371.163	A U.S. Coast and Geodetic Survey brass cap, stamped M28 1915, set in the northwest end of the northeast concrete abutment of a steel Burlington Northern Railroad bridge over the Tongue River, 232 feet southeast of the centerline of Pacific Avenue, 5.4 feet northwest of the northwest rail, and 1.2 feet below the tracks.
RM4	2360.008	A U.S. Coast and Geodetic Survey brass cap, stamped K62 1935, set in the top of concrete post flush with the ground, 34 feet east of the centerline of South Strevell Avenue 14 feet south of the centerline of Fort Street, 1 foot east of the east edge of a sidewalk.
*RM5	2395.58	A chiseled X in the top of the curb at the northwest end of the southwest guardrail on the northwest end of the State Highway 22 bridge over the Yellowstone River, 16 feet southwest of the centerline of the highway, 0.5 foot above street elevation. (Morrison-Maierle, Inc.)
RM6	2350.71	A 1.5-inch by 2.5-foot galvanized pipe with cap, stamped MC6, set in concrete, 3 feet east of the power pole at the southwest corner of the intersection of Tatro and North 2nd Streets, 48 feet south of Tatro Street, 18 feet west of North 2nd Street, flush with the ground. (Morrison-Maierle, Inc.)
RM7	2349.49	A chiseled X on the top of northwest corner of the concrete pad of the city sewage pump house, 7 feet west of northwest corner of pump house, 14 feet east and 13 feet south of the northwest corner of the chain-link fence surrounding the pump house, 51 feet east of centerline of North Montana Avenue, approximately 1.5 feet above ground. (Morrison-Maierle, Inc.)
RM8	2362.65	A 1.5-inch by 2.5-foot galvanized pipe with cap, stamped MC8, set in concrete, 3 feet south of a power pole, 2 feet east of east curb of North Montana Avenue, 19 feet east of centerline of North Montana Avenue, 144 feet north of the intersection of Ivy Street and North Montana Avenue, 222 feet north of the Burlington Northern Railroad mainline crossing North Montana Avenue. (Morrison-Maierle, Inc.)
RM9	2348.96	A 1.5-inch by 2.5-foot galvanized pipe with cap, stamped MC9, at the northwest corner of the intersection of Bullard Street and North Strevell Avenue, 3 feet west of the power pole, 32 feet west of the centerline of North Strevell Avenue, 25 feet north of the centerline of Bullard Street, flush with the ground.
*RM10	2357.39	A chiseled X on top center of the north wall of the concrete splitter box, on south side of dike, approximately 1.5 miles west along dike from city sewage disposal pond access road, 7 feet south of the centerline of the road and dike, 28 feet north of the chain link fence, and approximately 0.6 foot above the dike elevation. (Morrison-Maierle, Inc.)
*RM11	2345.163	A U.S. Coast and Geodetic Survey brass cap, stamped P28 1915, five poles northeast of railroad milepost 76, 3 1/2 miles northeast of a large 66 inch corrugated steel culvert 57 feet northwest of the northwest rail of the Burlington Northern Railroad, 4.5 feet southeast of a fence, about 3 feet below the tracks, and in the top of a concrete post projecting 1.2 feet.
*RM12	2352.023	A U.S. Coast and Geodetic Survey brass cap, stamped R149 1960, set in top of concrete post projecting 0.5 foot, 103 feet northwest of the centerline of U.S. Highways 10 and 12, 72 feet southeast and across the tracks from railroad milepost 77, 55 feet southeast of the southeast rail of the Burlington Northern Railroad, 10 feet southwest of a telephone pole, 3 feet below the tracks.
RM13	2363.023	A brass cap, stamped Q149 1960, set in the top of the southwest end of a concrete retaining wall at the north corner of the Main Street underpass of the Burlington Northern Railroad, 35.5 feet southeast of the southeast rail of the main track, 5.5 feet southeast of the southeast curb of a sidetrack, 1 foot southeast of a concrete railing, about level with the tracks.
*RM14	2357.971	A U.S. Coast and Geodetic Survey brass cap, stamped O28 1915, set in top of concrete post at the northwest corner of the Custer County Courthouse lawn, 57 feet east of the centerline of the intersection of 10th and Main Streets, 13.5 feet southeast of the southeast curb of Main Street, 11 feet northeast of the northeast curb of 10th Street, approximately 1 foot above the sidewalk.
*RM15	2362.71	A 1.5-inch by 2.5-foot galvanized pipe with cap, stamped MC15, set in concrete, 12 feet south of power pole, 90 feet west of northwest corner of turquoise metal storage building on the grounds of Town and Country Club golf course. (Morrison-Maierle, Inc.)
*RM16	2360.71	A 1.5-inch by 2.5-foot galvanized pipe with cap, stamped MC16, set flush with ground in concrete at the east corner of Main Street and a gravel crossroad, near the west entrance into Eastern Montana Fairgrounds, approximately 1200 feet southwest of the Montana State Fish and Game Building, 56 feet east of the centerline of the intersection, 8 feet north of the power pole at the east corner of the intersection, approximately 2 feet below the intersection elevation. (Morrison-Maierle, Inc.)
RM17	2372.233	A U.S. Coast and Geodetic Survey brass cap set in the top center of the concrete cross beam between the two most northerly concrete pillars of the U.S. Highways 10, 12, and 312 overpass over Burlington Northern Railroad, 0.1 mile south of highway milepost 1, 0.15 mile southwest of railroad milepost 80, 62 feet northwest of the northwest rail, approximately 7 feet above the ground, and approximately 3.5 feet above the track.
RM18	2364.33	A chiseled X in the southwest corner of the concrete sidewalk at the back of the curb on the northwest corner of the intersection of Sudlow and South Jordan Streets, 14.5 feet west of the west curb of South Jordan Street, 0.5 foot north of the north curb of Sudlow Street. (Morrison-Maierle, Inc.)

KEY TO MAP

500-Year Flood Boundary

100-Year Flood Boundary

Zone Designations* With Date of Identification e.g., 12/27/14

100-Year Flood Boundary

500-Year Flood Boundary

Base Flood Elevation Line With Elevation in Feet**

Base Flood Elevation in Feet Where Uniform Within Zone**

Elevation Reference Mark

Zone D Boundary

River Mile

ZONE B

ZONE A1 DATE

ZONE A5 DATE

ZONE B

513

1E1 9971

RM7 X

M1 5

** Referenced to the National Geodetic Vertical Datum of 1929

*EXPLANATION OF ZONE DESIGNATIONS

ZONE	EXPLANATION
A	Areas of 100-year flood; base flood elevations and flood hazard factors not determined.
A0	Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet; average depths of inundation are shown, but no flood hazard factors are determined.
AH	Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet; base flood elevations are shown, but no flood hazard factors are determined.
A1-A30	Areas of 100-year flood; base flood elevations and flood hazard factors not determined.
A99	Areas of 100-year flood to be protected by flood protection system under construction; base flood elevations and flood hazard factors not determined.
B	Areas between limits of the 100-year flood and 500-year flood; or certain areas subject to 100-year flooding with average depths less than one (1) foot or where the contributing drainage area is less than one square mile; or areas protected by levees from the base flood. (Medium shading)
C	Areas of minimal flooding. (No shading)
D	Areas of undetermined, but possible, flood hazards.
V	Areas of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors not determined.
V1-V30	Areas of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors determined.

NOTES TO USER

Certain areas not in the special flood hazard areas (zones A and V) may be protected by flood control structures.

This map is for flood insurance purposes only; it does not necessarily show all areas subject to flooding in the community or all planimetric features outside special flood hazard areas.

INITIAL IDENTIFICATION:
JANUARY 23, 1974

FLOOD HAZARD BOUNDARY MAP REVISIONS:
OCTOBER 17, 1975

FLOOD INSURANCE RATE MAP EFFECTIVE:
FEBRUARY 1, 1980

FLOOD INSURANCE RATE MAP REVISIONS:
MARCH 22, 1983 to change Corporate Limits, to add new Special Flood Hazard Areas, to add Zone Designations, to add Base Flood Elevations, to add Zone Boundary Line Designations, to add Street Names, to add Streets, and to add Extraterritorial Limits.

To determine if flood insurance is available in this community, contact your insurance agent, or call the National Flood Insurance Program, at (800) 638-6629.

APPROXIMATE SCALE

1000 0 1000 FEET

Exhibit 5: Historical FIRM

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

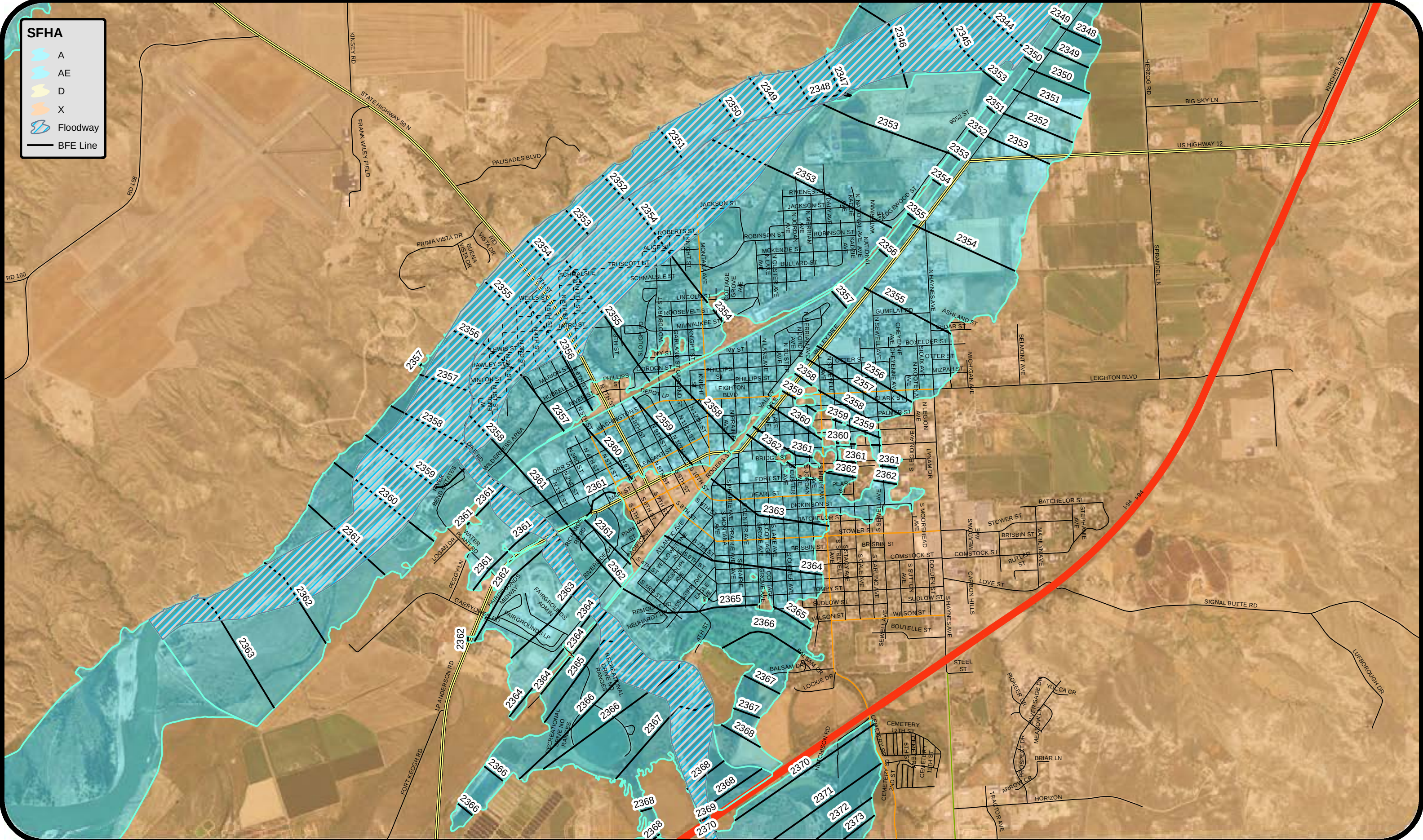
CITY OF
MILES CITY,
MONTANA
CUSTER COUNTY

ONLY PANEL PRINTED

COMMUNITY-PANEL NUMBER
300014 0005 C

MAP REVISED:
MARCH 22, 1983

Federal Emergency Management Agency



2,000 1,000 0 2,000 4,000
Feet
1 inch = 2,000 feet

Exhibit 6

Current FIRM



- Historic Embankment Failures
- Contemporary Embankment Repairs
- Embankment Problem Areas
- Existing Embankment
- Slumped Riverbank



High velocities and erosion resulting from restricted river due to 2011 landslide

High velocities and erosion resulting from restricted river due to levee system

Undercutting

1944 Flood: 220 foot gap in levee

Undercutting

1944 Flood: 125 feet of levee lost due to undercutting

Undercutting

Undercutting

Undercutting

1944 Flood: 60 foot section of levee washed out

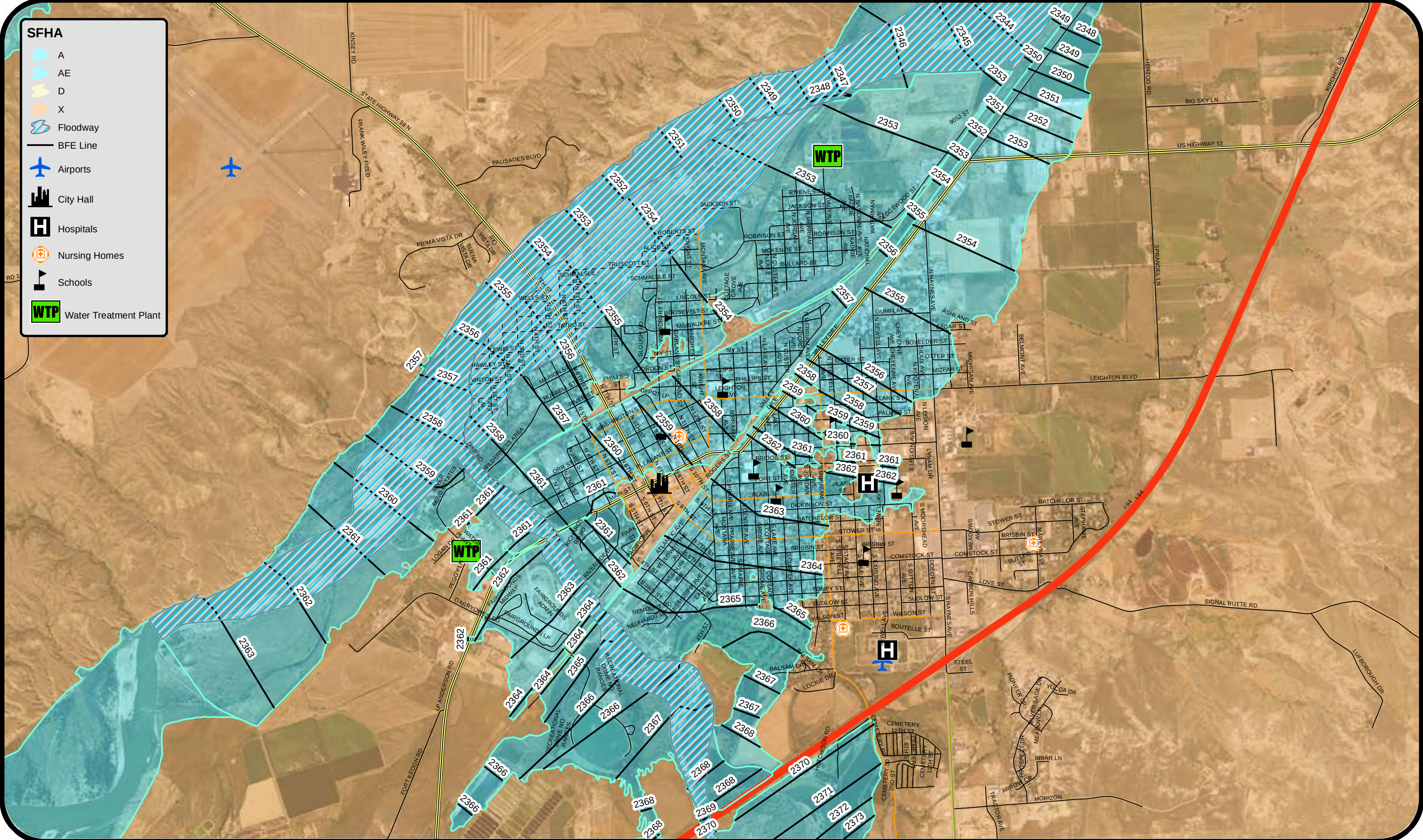
1944 Flood: 20 foot section of levee washed out

2,000 1,000 0 2,000 4,000 Feet
1 inch = 2,000 feet

Exhibit 7

Levee Problem Areas





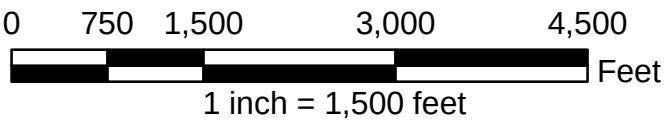
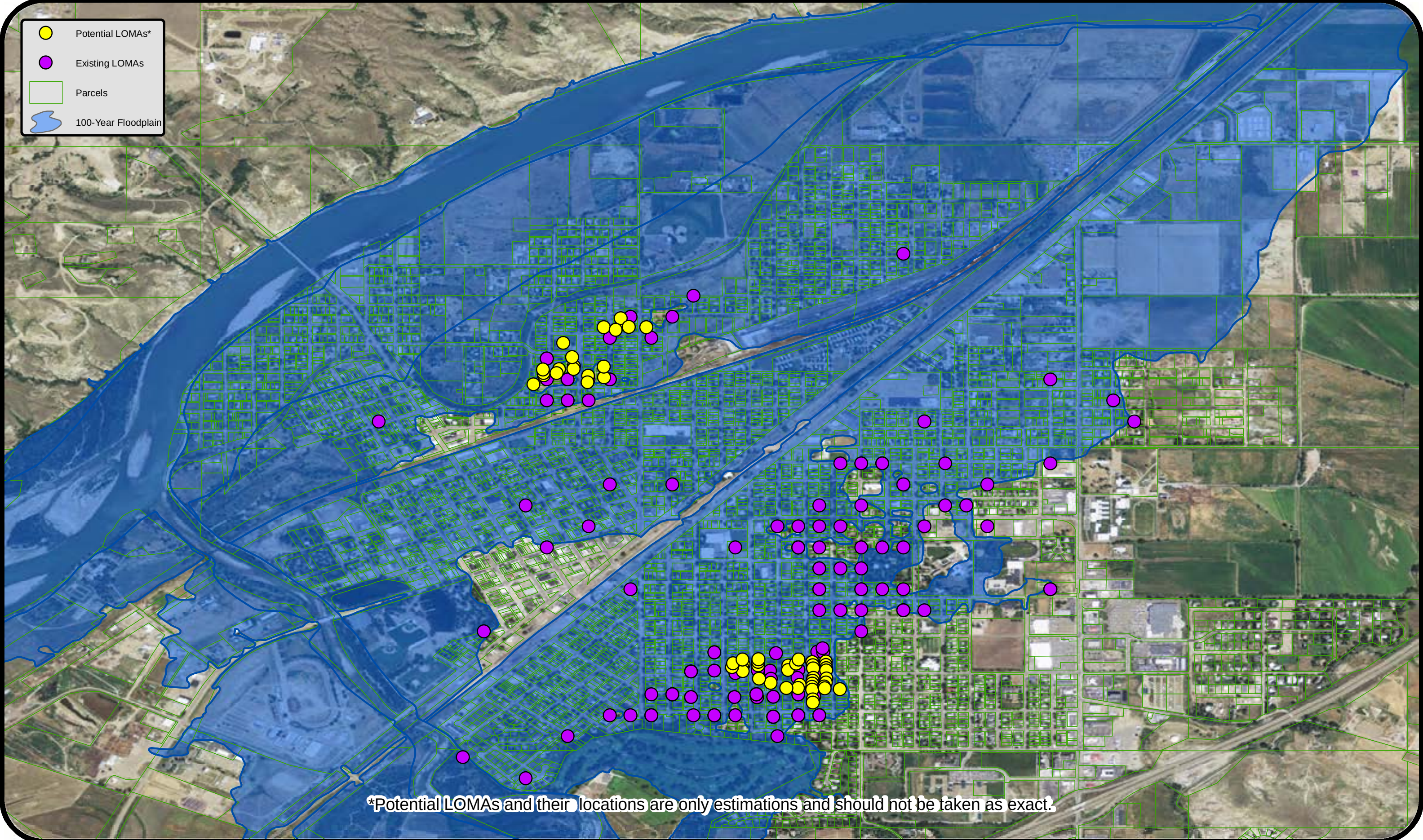
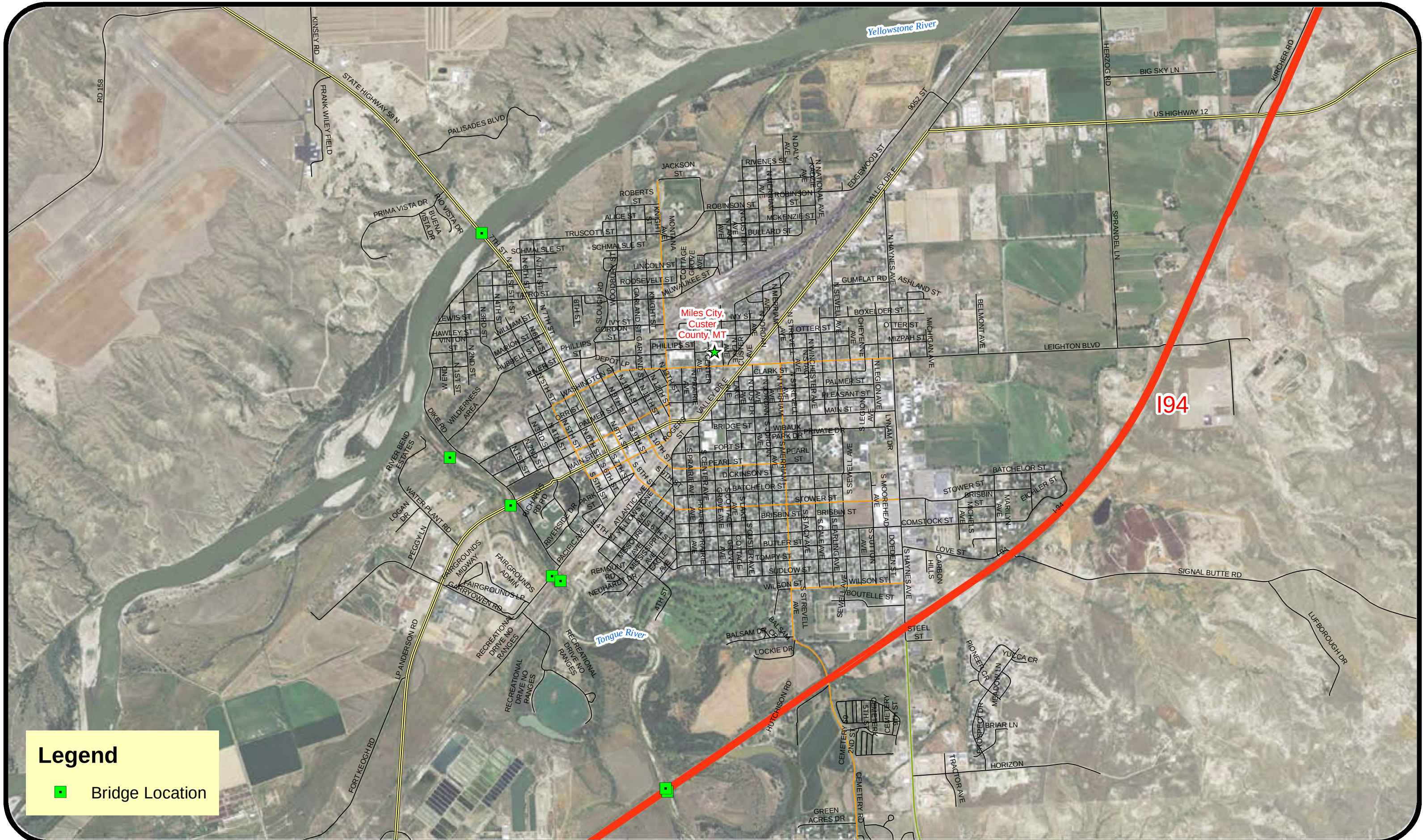


Exhibit 10

Existing & Potential LOMAs





Legend

■ Bridge Location

2,000 1,000 0 2,000 4,000
Feet
1 inch = 2,000 feet

Exhibit 11

Miles City, Montana
MDOT Bridge Locations



Appendix 2: Effective FIRMS

FIRM Panel Dates For Printed Panels of Custer County, MT And Incorporated Areas					
Panel	Effective Date	Panel	Effective Date	Panel	Effective Date
0325 D	July 22, 2010	0654 D	July 22, 2010	0875 D	July 22, 2010
0350 D	July 22, 2010	0658 D	July 22, 2010	0700 D	July 22, 2010
0375 D	July 22, 2010	0661 D	July 22, 2010	0725 D	July 22, 2010
0400 D	July 22, 2010	0662 D	July 22, 2010	0750 D	July 22, 2010
0425 D	July 22, 2010	0663 D	July 22, 2010	0975 D	July 22, 2010
0545 D	July 22, 2010	0664 D	July 22, 2010	1000 D	July 22, 2010
0650 D	July 22, 2010	0666 D	July 22, 2010	1025 D	July 22, 2010

MAP DATES

This FIRM Index displays the map dates for each FIRM panel at the time that this Index was printed. Because this Index may not be distributed to unaffected communities in subsequent revisions, users may determine the most current map date for each FIRM panel by visiting the FEMA Map Service Center website at <http://msc.fema.gov> or by calling the Map Service Center at 1-800-358-9616.

Communities annexing land on adjacent FIRM panels must obtain a current copy of the adjacent panel as well as the current FIRM Index. These may be ordered directly from the Map Service Center at the number listed above.

MAP REPOSITORIES

(Maps available for reference only, not for distribution.)

CUSTER COUNTY
(UNINCORPORATED AREAS):
County Planning Department
1010 Main Street
Miles City, Montana 59301
MILES CITY, CITY OF:
City Planning Department
17 South 8th Street
Miles City, Montana 59301

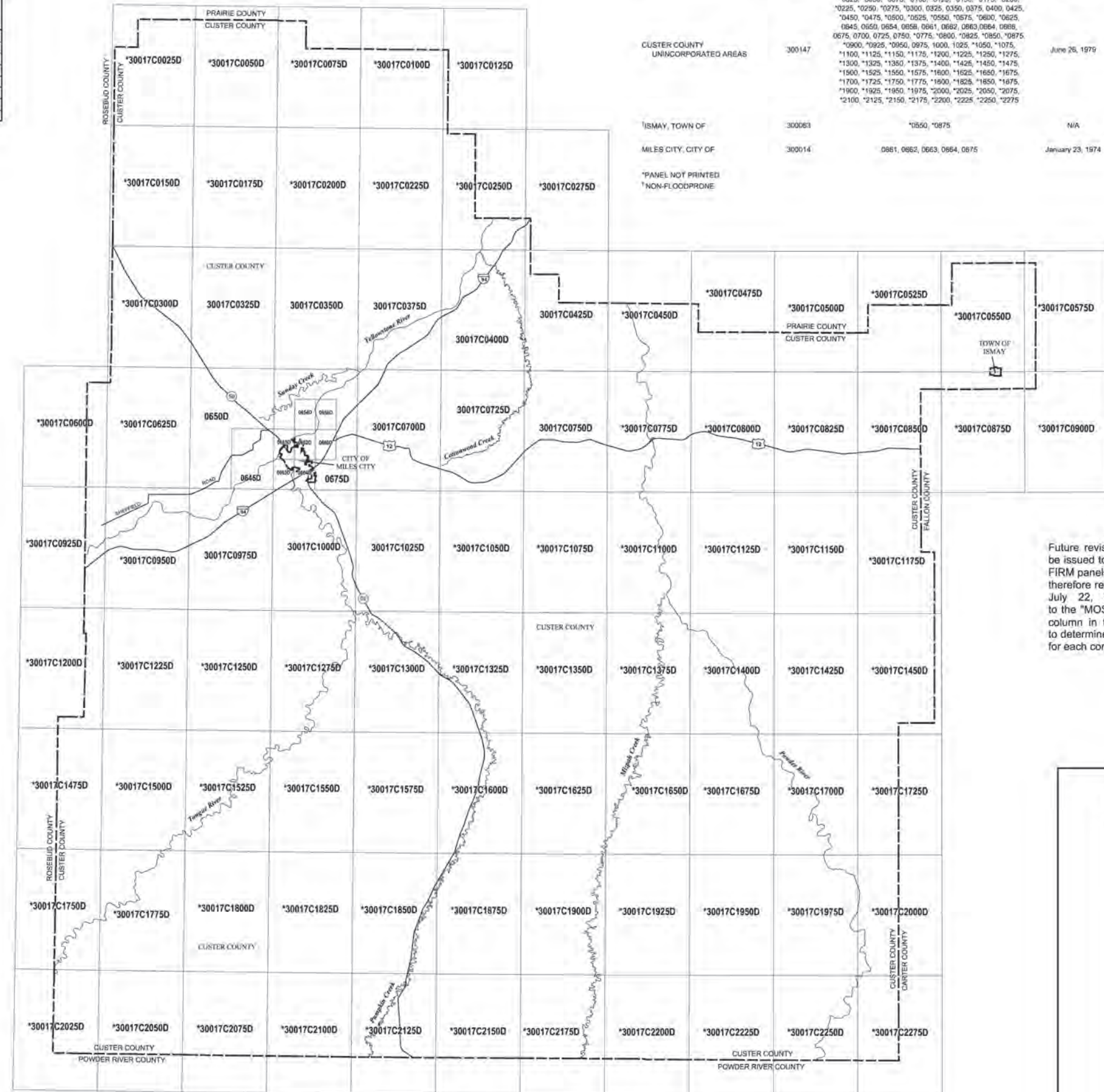
BASE MAP SOURCE

Base map Base map information shown on this FIRM was provided in digital format by the United States Department of Agriculture. This information was photogrammetrically compiled from Digital Orthophoto Quarter Quadrangles at a scale of 1:40,000, dated 2005 or later as a part of the National Agriculture Imagery Program.

ELEVATION DATUM

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same datum. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282
(301) 713-3242



* PANEL NOT PRINTED - AREA IN ZONE D

LISTING OF COMMUNITIES

COMMUNITY NAME	COMMUNITY NUMBER	LOCATED ON PANEL(S)	INITIAL NFIP MAP DATE	INITIAL FIRM DATE	MOST RECENT FIRM PANEL DATE
CUSTER COUNTY UNINCORPORATED AREAS	300147	*0025, *0050, *0075, *0100, *0125, *0150, *0175, *0200, *0225, *0250, *0275, *0300, *0325, *0350, *0375, *0400, *0425, *0450, *0475, *0500, *0525, *0550, *0575, *0600, *0625, *0645, *0650, *0654, *0658, *0661, *0662, *0663, *0664, *0666, *0675, *0700, *0725, *0750, *0775, *0800, *0825, *0850, *0875, *0900, *0925, *0950, *0975, *1000, *1025, *1050, *1075, *1100, *1125, *1150, *1175, *1200, *1225, *1250, *1275, *1300, *1325, *1350, *1375, *1400, *1425, *1450, *1475, *1500, *1525, *1550, *1575, *1600, *1625, *1650, *1675, *1700, *1725, *1750, *1775, *1800, *1825, *1850, *1875, *1900, *1925, *1950, *1975, *2000, *2025, *2050, *2075, *2100, *2125, *2150, *2175, *2200, *2225, *2250, *2275	June 26, 1979	September 1, 1987	July 22, 2010
ISMAY, TOWN OF	300063	*0550, *0875	N/A	N/A	N/A
MILES CITY, CITY OF	300014	0661, 0662, 0663, 0664, 0675	January 23, 1974	February 1, 1980	July 22, 2010
*PANEL NOT PRINTED *NON-FLOODPRONE					

NOTE TO USER

Future revisions to this FIRM Index will only be issued to communities that are located on FIRM panels being revised. This FIRM Index therefore remains valid for FIRM panels dated July 22, 2010 or earlier. Please refer to the "MOST RECENT FIRM PANEL DATE" column in the Listing of Communities table to determine the most recent FIRM index date for each community.



FEDERAL EMERGENCY MANAGEMENT AGENCY

MAP INDEX

FIRM

FLOOD INSURANCE RATE MAP

CUSTER COUNTY, MONTANA

AND INCORPORATED AREAS

(SEE LISTING OF COMMUNITIES TABLE)

MAP INDEX

PANELS PRINTED: 325, 350, 375, 400, 425, 445, 450, 454, 458, 461, 462, 463, 464, 465, 475, 700, 725, 750, 775, 1000, 1025

MAP NUMBER
30017CIND0A

EFFECTIVE DATE
JULY 22, 2010

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources or small creeks. The community map preparer should be consulted for possible updates or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations (BFEs)** and/or **floodway** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Floodway Elevations contained within the Flood Insurance Study (FIS) report that accompanied the FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole basis of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Control Base Flood Elevations shown on this map apply only to landward of 1/2 North American Vertical Datum of 1988 (NAVD83). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Floodway Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Floodway Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on the FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The projection used in the preparation of this map was Universal Transverse Mercator (UTM) zone 13. The horizontal datum was NAD83. Orthometric elevations, referenced to datum, reported on the FIS report and used in the production of FIRM for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same vertical datum. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at <http://www.ngs.noaa.gov> or contact the National Geodetic Survey at the following address:

National Geodetic Survey
NGA, NGS212
National Geodetic Survey
Spartanburg, SC 29583
1110 East-West Highway
Silver Spring, MD 20910-0287

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (800) 753-5242, or visit its website at <http://www.ngs.noaa.gov>.

Base map information shown on this FIRM was provided in digital format by the United States Department of Agriculture. This information was obtained by photographing aerially compiled from Digital Orthophoto Quarter Quadrangles at a scale of 1:40,000, issued 2001 or later as a part of the National Agriculture Imagery Program.

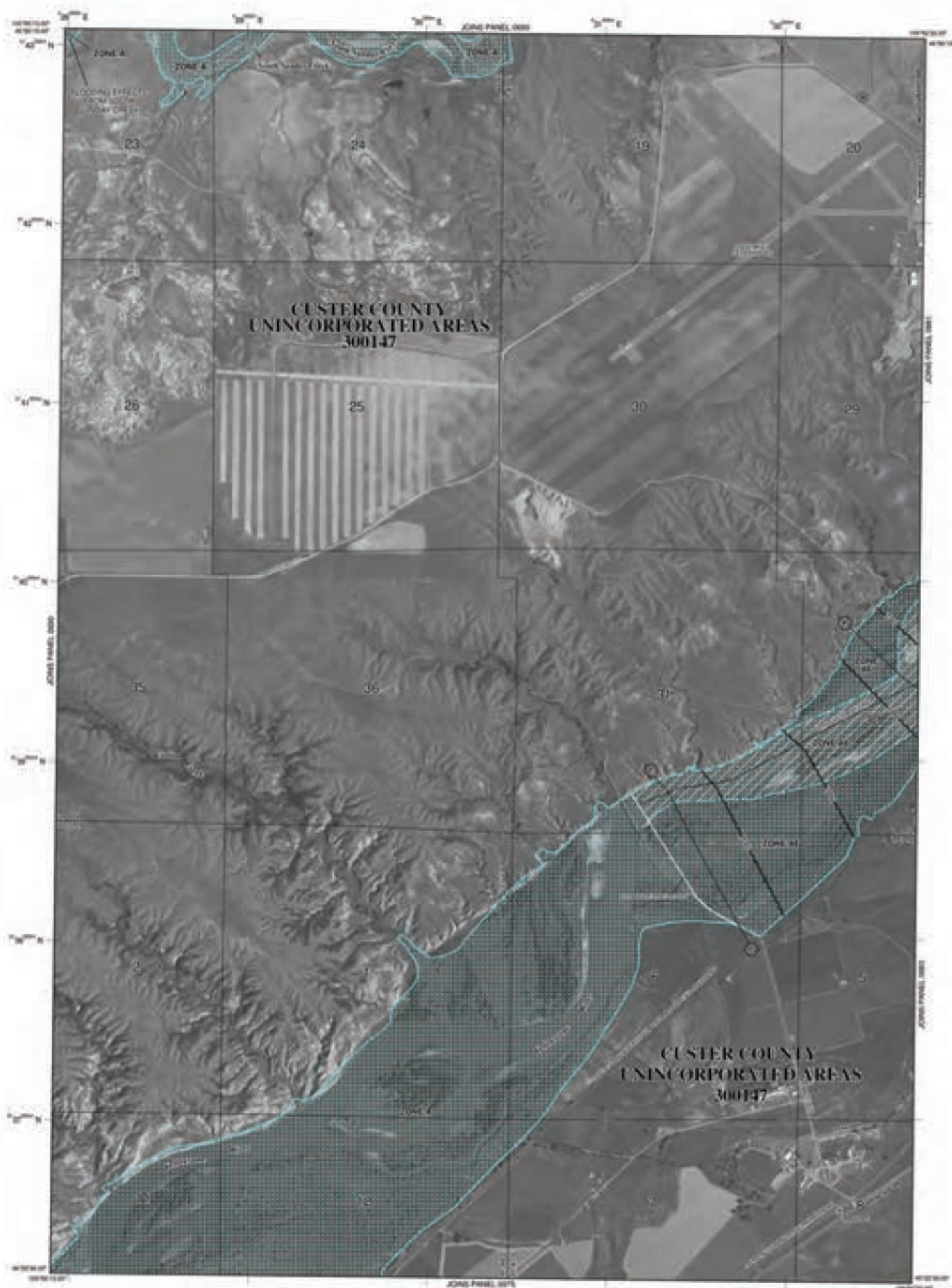
This map reflects more detailed and up-to-date stream channel configurations than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study report (which contain authoritative hydraulic data) may reflect stream channel dimensions that differ from what is shown on this map.

Corporate limits shown on this map are based on the latest data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels, community map repository addresses, and a listing of communities within numbering National Flood Insurance Program data for each community as well as a listing of the panels on which each community is located.

Contact the **FEMA Map Service Center** at 1-800-358-6115 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study report, and/or digital versions of this map. The FEMA Map Service Center may also be reached by fax at 1-800-358-6100 and by website at <http://www.fema.gov>.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call 1-877-FEMA-5847 or visit the FEMA website at <http://www.fema.gov>.



LEGEND

SPECIAL FLOOD HAZARD AREAS (SPFH) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zone A, AE, X, and V. The base flood elevation is the water surface elevation of the 1% annual chance flood.

- ZONE A** Areas of shallow water (1 to 3 feet deep) subject to flooding. Base Flood Elevation is indicated.
- ZONE AE** Areas of 1 to 3 feet deep water (1 to 3 feet deep) subject to flooding. Base Flood Elevation is indicated.
- ZONE X** Areas of 1 to 3 feet deep water (1 to 3 feet deep) subject to flooding. Base Flood Elevation is indicated.
- ZONE V** Areas of 1 to 3 feet deep water (1 to 3 feet deep) subject to flooding. Base Flood Elevation is indicated.
- ZONE V** Areas of 1 to 3 feet deep water (1 to 3 feet deep) subject to flooding. Base Flood Elevation is indicated.
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FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream and any adjacent floodplain areas that must be kept free of obstructions so that the 1% annual chance flood can be stored without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X Areas of 1 to 3 feet deep water (1 to 3 feet deep) subject to flooding. Base Flood Elevation is indicated.

OTHER AREAS

ZONE X Areas of 1 to 3 feet deep water (1 to 3 feet deep) subject to flooding. Base Flood Elevation is indicated.

CONCRETE BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPA)

OPA Areas of 1 to 3 feet deep water (1 to 3 feet deep) subject to flooding. Base Flood Elevation is indicated.

OPA Areas of 1 to 3 feet deep water (1 to 3 feet deep) subject to flooding. Base Flood Elevation is indicated.

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NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0645D

FIRM
FLOOD INSURANCE RATE MAP
CUSTER COUNTY,
MONTANA
AND INCORPORATED AREAS

PANEL 645 OF 2275
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS	NUMBER	PANEL	SHEET
CUSTER COUNTY	300147	0645D	1

MAP NUMBER
3001C0645D
EFFECTIVE DATE
JULY 22, 2010
Federal Emergency Management Agency

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources or from ice. The community map preparer should be consulted for precise updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **roadway** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Subwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRMA. Users should be aware that BFEs shown on the FIRMA represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRMA for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only to locations of U.S. North American Vertical Datum of 1988 (NAVD83). Users of this map should be aware that coastal flood elevations are also provided in the Summary of Subwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Subwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRMA.

Boundaries of the **Roadways** were computed at cross sections and interpolated between cross sections. The boundaries were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Roadway widths and other pertinent roadway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by flood control structures. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The projection used in the preparation of this map was Universal Transverse Mercator (UTM) zone 12. The horizontal datum was NAVD83. GPS data gathered in the field, collected, processed in UTM zones used in the production of FIRMA for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRMA.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same vertical datum. For information regarding conversion between the National Geodetic Vertical Datum of 1973 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at <http://www.ngs.noaa.gov> or contact the National Geodetic Survey at the following address:

National Geodetic Survey
NCEA, 760012
National Geodetic Survey
NCEA-3, 80503
1315 East-River Highway
Silver Spring, MD 20910-3080

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (202) 743-5040, or visit its website at <http://www.ngs.noaa.gov>.

Base map information shown on this FIRMA was provided in digital form by the United States Department of Agriculture. This information was photogrammetrically compiled from Digital Orthophoto Quarter Quadrangles of a scale of 1:40,000, dated 2001 or later as a part of the National Agriculture Imagery Program.

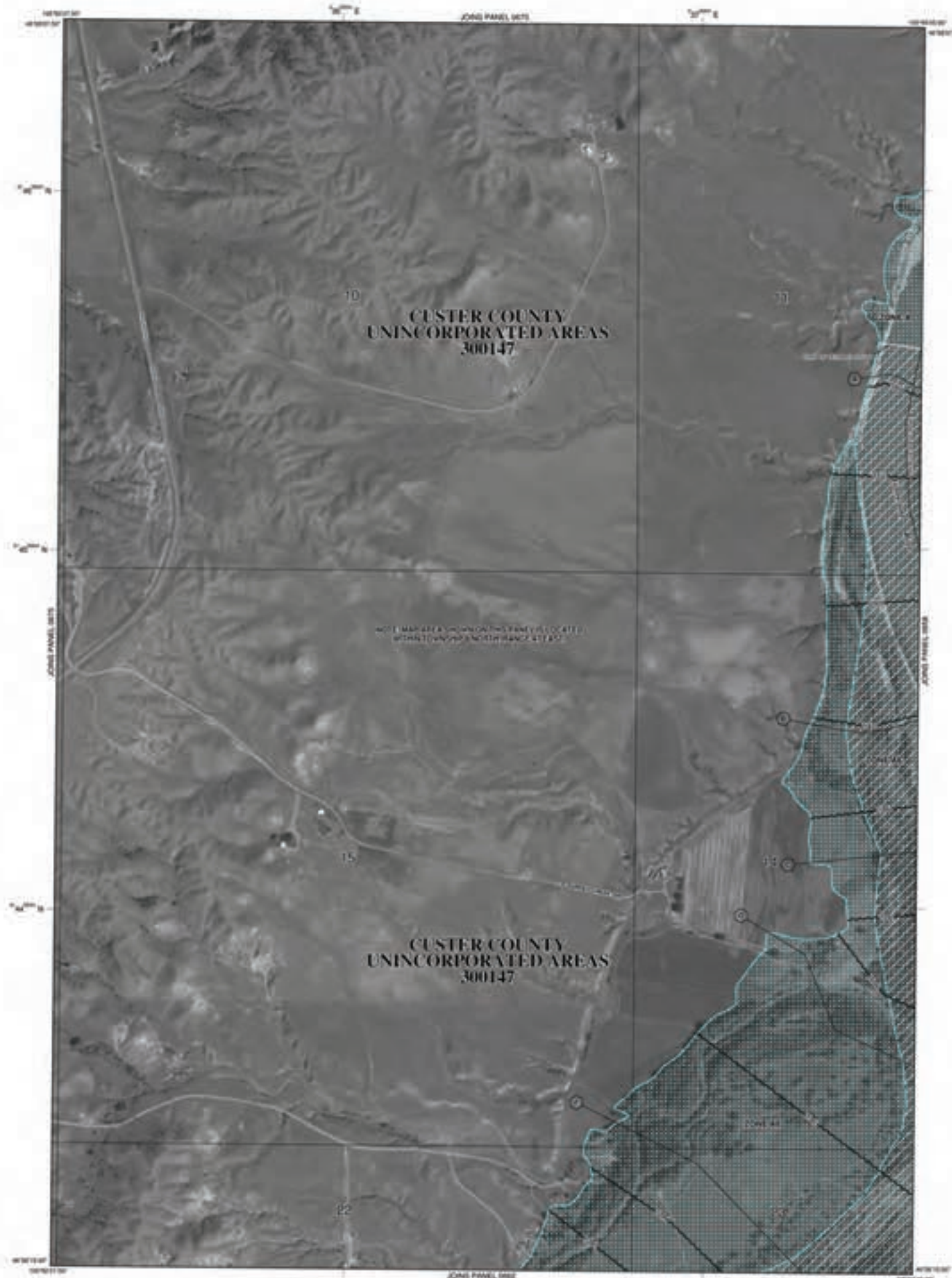
This map reflects more detailed and up-to-date stream channel configurations than those shown on the previous FIRMA for this jurisdiction. The boundaries and roadways that were transferred from the previous FIRMA may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study report which contain authoritative hydraulic data may reflect stream channel dimensions that differ from what is shown on this map.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or disannexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels, community map reporting addresses, and a listing of communities with participating National Flood Insurance Program data for each community as well as a listing of the panels on which each community is located.

Contact the **FIRMA Map Service Center** at 1-800-358-3616 for information on available products associated with this FIRMA. Available products may include previously issued Letters of Map Change, a Flood Insurance Study report, and/or digital versions of this map. The FIRMA Map Service Center may also be reached by Fax at 1-800-358-3615 and its website at <http://www.fema.gov>.

If you have **questions about this map** or **questions concerning the National Flood Insurance Program** in general, please call 1-877-FEMA-MAP (1-877-366-6275) or visit the FEMA website at <http://www.fema.gov>.



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHA) SUBJECT TO FLOODING BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood) also known as the base flood is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, X, B, V, and VE. The Base Flood Elevation is the water surface elevation of the 1% annual chance flood.

- 2000 A** No Base Flood Elevation determined.
- 2000 AE** Base Flood Elevation determined.
- 2000 AH** Flood depths of 1 to 2 feet (usually areas of ponding). Base Flood Elevation determined.
- 2000 AO** Flood depths of 1 to 2 feet (usually areas of ponding). Base Flood Elevation determined.
- 2000 B** Special Flood Hazard Area formerly designated from the 1% annual chance flood by a flood control system that was substantially destroyed. Zone AE indicates that the Special Flood Hazard Area is being reduced to directly proportionate from the 1% annual chance flood.
- 2000 VE** Area to be protected from 1% annual chance flood by a Federal flood protection system under construction. No Base Flood Elevation determined.
- 2000 V** Coastal flood zone with velocity hazard (wave action). No Base Flood Elevation determined.
- 2000 VE** Coastal flood zone with velocity hazard (wave action). Base Flood Elevation determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without excessive increases in flood heights.

OTHER FLOOD AREAS

- 2000 B** Areas of 0.2% annual chance flood, areas of 1% annual chance flood with average depths of less than 1 foot or with depths greater than 1 foot, and areas protected by levees from 1% annual chance flood.

OTHER AREAS

- 2000 X** Areas determined to be outside the 0.2% annual chance floodway. Areas in which flood hazards are unassessable, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPA)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% annual chance floodway boundary

0.2% annual chance floodway boundary

Floodway boundary

Base Flood Elevation

Base Flood Elevation

Base Flood Elevation

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PANEL 0654D

FIRM
FLOOD INSURANCE RATE MAP
CUSTER COUNTY,
MONTANA
AND INCORPORATED AREAS

PANEL 654 OF 2275
SEE MAP INDEX FOR FIRM PANEL LAYOUT

CONTAINS:
COMMUNITY NAME PANEL DATA
COMMUNITY NAME PANEL DATA

Visit us online! The Map Number shown below should be used when ordering maps. The Community Number shown above should be used as a reference for the subject community.

MAP NUMBER
30017C0654D

EFFECTIVE DATE
JULY 23, 2010

Federal Emergency Management Agency

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources or small creeks. The community map preparer should be consulted for precise updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **roadway** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Elevation Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and floodplain management.

Coastal Base Flood Elevations shown on this map apply only to locations of U.S. North American Vertical Datum of 1988 (NAVD83). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Elevation Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Elevation Elevations table should be used for construction and floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **Roadways** were computed at cross sections and interpolated between cross sections. The boundaries were based on hydrologic considerations with regard to requirements of the National Flood Insurance Program. Roadway widths and other pertinent roadway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 12. The horizontal datum was NAD83, GRS1980 spheroid. Differences in datum, spheroid, projection or UTM zone used in the production of FIRM(s) for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same vertical datum. For information regarding conversion between the National Geodetic Vertical Datum of 1955 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at <http://www.ngs.noaa.gov> or contact the National Geodetic Survey at the following address:

National Geodetic Survey
NCEA, 760012
National Geodetic Survey
NCEA-3, 6030
1315 East-West Highway
Silver Spring, MD 20910-2600

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (202) 743-5040, or visit its website at <http://www.ngs.noaa.gov>.

Base map information shown on this FIRM was provided in digital form by the United States Department of Agriculture. This information was photogrammetrically compiled from Digital Orthophoto Quarter Quadrangles of a scale of 1:40,000, dated 2001 or later as a part of the National Agriculture Imagery Program.

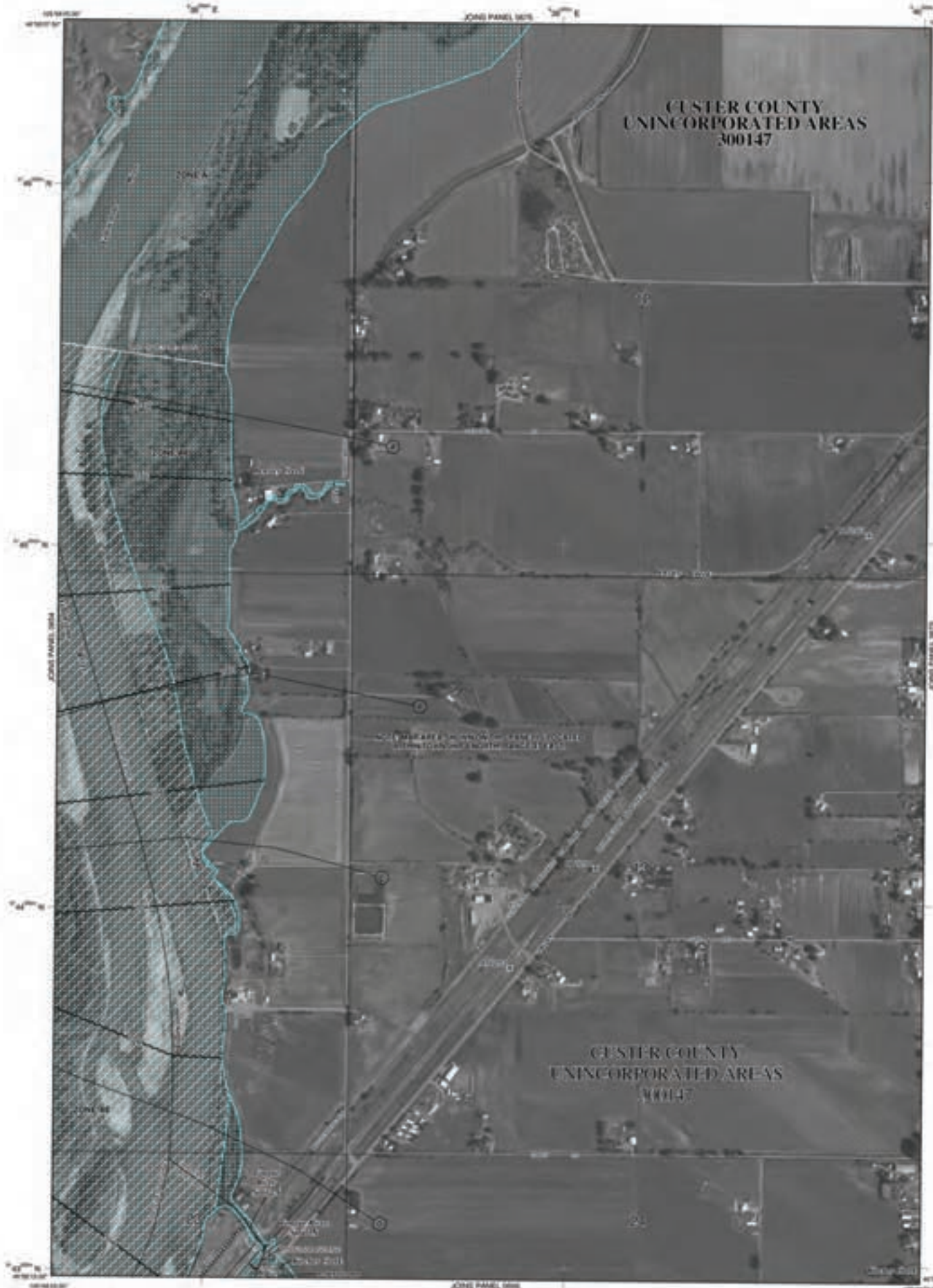
This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The boundaries and roadways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study report which contain authoritative hydraulic data may reflect stream channel dimensions that differ from what is shown on this map.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or disannexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the extent of map panels, community map reporting addresses, and a listing of communities with participating National Flood Insurance Program data for each community as well as a listing of the panels on which each community is located.

Contact the **FEMA Map Service Center** at 1-800-358-3615 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study report, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1-800-358-9600 and its website at <http://www.fema.gov>.

If you have **questions about this map** or **questions concerning** the National Flood Insurance Program in general, please call 1-877-FEMA-MAP (1-877-366-6267) or visit the FEMA website at <http://www.fema.gov>.



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHA) SUBJECT TO FLOODING BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood) also shown on the base flood is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zone A, AE, AH, AO, AR, AR1, AR2, and AR3. The Base Flood Elevation is the water surface elevation of the 1% annual chance flood.

- 2000 A** No Base Flood Elevation determined.
- 2000 AE** Base Flood Elevation determined.
- 2000 AH** Flood depths of 1 to 1 foot (usually areas of parking). Base Flood Elevation determined.
- 2000 AO** Flood depths of 1 to 1 foot (usually areas of parking). Base Flood Elevation determined. For areas of shallow flood depths, water is not considered.
- 2000 AR** Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was substantially destroyed. Users are advised that the Special Flood Hazard Area is being reduced to directly proportional from the 1% annual chance flood.
- 2000 AR1** Area to be protected from the 1% annual chance flood by a flood control system that was substantially destroyed. No Base Flood Elevation determined.
- 2000 AR2** Coastal flood zone with velocity hazard (wave action). No Base Flood Elevation determined.
- 2000 AR3** Coastal flood zone with velocity hazard (wave action). Base Flood Elevation determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodable areas that must be kept free of obstruction so that the 1% annual chance flood can be carried without excessive velocities or flood heights.

OTHER FLOOD AREAS

- 2000 B** Areas of 0.2% annual chance flood, water of 1% annual chance flood with average depths of less than 1 foot or with depths less than 1 foot, may, and areas protected by levees from 1% annual chance flood.

OTHER AREAS

- 2000 X** Areas determined to be outside the 0.2% annual chance floodway. Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCE SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPA)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

- 1% annual chance floodway boundary
- 0.2% annual chance floodway boundary
- Roadway boundary
- Base Flood Elevation
- 2000 and 2001 boundaries
- Boundary showing Special Flood Hazard Areas of adjacent Base Flood Elevation, flood depths or flood velocities
- Base Flood Elevation and water, elevation in feet
- Base Flood Elevation value where adjacent water, elevation in feet

* Referenced to the North American Vertical Datum of 1988 (NAVD83).

Circle section line

Topographic line

Geographic coordinates referenced to the North American Datum of 1983 (NAD83)

100-meter Universal Transverse Mercator grid (UTM) zone 12

100-foot grid (feet) reference

Base Flood Elevation (BFE) values

Base Flood Elevation (BFE) values

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PANEL 0658D

FIRM
FLOOD INSURANCE RATE MAP
CUSTER COUNTY,
MONTANA
AND INCORPORATED AREAS

PANEL 658 OF 2275
SEE MAP INDEX FOR FIRM PANEL LAYOUT

CONTAINS: **COMMUNITY** **SUMMARY PANEL SHEET**

EFFECTIVE DATE: **JULY 23, 2010**

Federal Emergency Management Agency

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources or small creeks. The community map preparer should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations (BFEs)** and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Elevation Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIS. Users should be aware that BFEs shown on the FIS report represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIS report for purposes of construction and/or floodplain management.

Control Base Flood Elevations shown on this map apply only to landward of 1:2 North American Vertical Datum of 1988 (NAVD83). Users of this report should be aware that control flood elevations are also provided in the Summary of Elevation Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Elevation Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on the FIS report.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic calculations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by flood control structures. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The projection used in the preparation of this map was Universal Transverse Mercator (UTM) zone 12. The horizontal datum was NAD83. Orthometric elevations, referenced to mean sea level, reported on FEMA maps used in the production of FISs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIS.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structures and ground elevations referenced to the same vertical datum. For information regarding conversion between the National Geodetic Survey Datum of 1983 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at <http://www.ngs.noaa.gov> or contact the National Geodetic Survey at the following address:

NGS Information Services
NCHA, 955012
National Geodetic Survey
3330 K St., NW
1310 East-West Highway
Silver Spring, MD 20910-2897

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (301) 713-3042, or visit its website at <http://www.ngs.noaa.gov>.

Base map information shown on this FIS was provided in digital form by the United States Department of Agriculture. This information was digitized from photography compiled from Digital Orthophoto Quarter Quadrangles at a scale of 1:40,000, dated 2005 or later as a part of the National Agriculture Imagery Program.

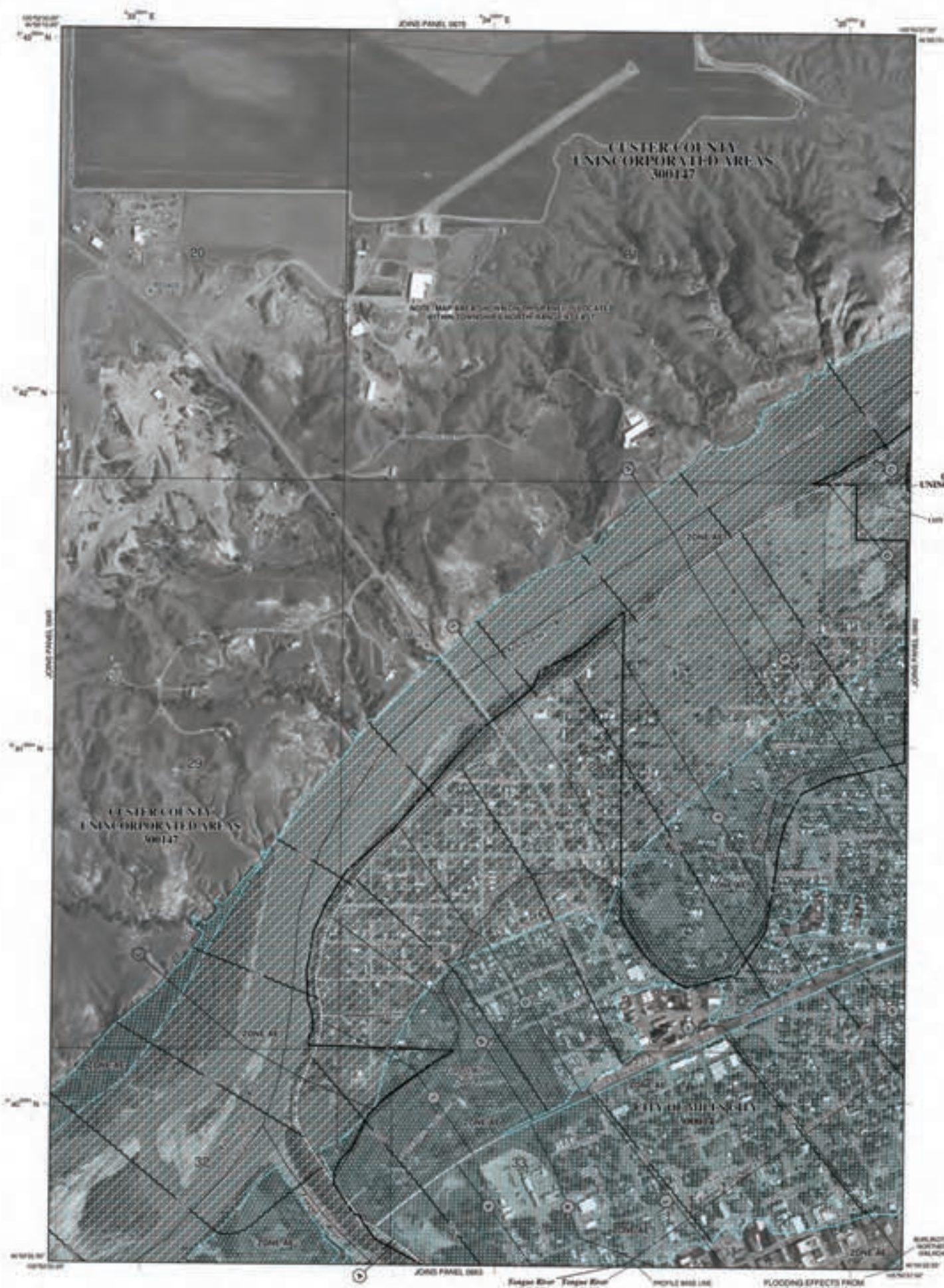
This map reflects more detailed and up-to-date stream channel configurations than those shown on the previous FIS for this jurisdiction. The boundaries and floodways that were transferred from the previous FIS may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study report (which contain authoritative hydraulic data) may reflect stream channel dimensions that differ from what is shown on this map.

Corporate limits shown on this map are based on the latest data available at the time of publication. Because changes due to annexations or dis-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels, community map repository addresses, and a listing of communities with numbering National Flood Insurance Program data for each community as well as a listing of the panels on which each community is located.

Contact the **FEMA Map Service Center** at 1-800-358-6115 for information on available products associated with this FIS. Available products may include previously issued Letters of Map Change, a Flood Insurance Study report, and/or digital versions of this map. The FEMA Map Service Center may also be reached by fax at 1-800-358-6115 and by website at <http://www.fema.gov>.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call 1-877-FEMA-MAP (1-877-366-6247) or visit the FEMA website at <http://www.fema.gov>.



LEGEND

SPECIAL FLOOD HAZARD AREAS (SPECIAL SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD)

The 1% annual chance flood (100-year flood) also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Areas in this map are subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zone A, AE, AH, AO, AR, A1, A2, A3, A4, A5, A6, A7, A8, A9, A10, A11, A12, A13, A14, A15, A16, A17, A18, A19, A20, A21, A22, A23, A24, A25, A26, A27, A28, A29, A30, A31, A32, A33, A34, A35, A36, A37, A38, A39, A40, A41, A42, A43, A44, A45, A46, A47, A48, A49, A50, A51, A52, A53, A54, A55, A56, A57, A58, A59, A60, A61, A62, A63, A64, A65, A66, A67, A68, A69, A70, A71, A72, A73, A74, A75, A76, A77, A78, A79, A80, A81, A82, A83, A84, A85, A86, A87, A88, A89, A90, A91, A92, A93, A94, A95, A96, A97, A98, A99, A100.

- Zone A:** Areas of shallow flooding (1 to 3 feet (local) areas of ponding). Base Flood Elevation determined.
- Zone AE:** Flood depths of 1 to 3 feet (local) areas of ponding. Average depths determined. The areas of about 100 feet (local) areas of ponding.
- Zone AH:** Special Flood Hazard Areas formerly protected from the 1% annual chance flood for a flood control system that was substantially destroyed. Zone AH indicates that the former flood control system is being replaced to provide protection from the 1% annual chance of greater flood.
- Zone AO:** Areas in the protected from 1% annual chance flood by a flood control system that was substantially destroyed. Zone AO indicates that the former flood control system is being replaced to provide protection from the 1% annual chance of greater flood.
- Zone AR:** Coastal flood areas with relatively frequent (more active) sea level rise. Base Flood Elevation determined.
- Zone A1:** Coastal flood areas with relatively frequent (more active) sea level rise. Base Flood Elevation determined.

FLOODWAY AREAS IN ZONE A1

The floodway is the channel of a river and any adjacent floodplain areas that must be kept free of obstructions so that the 1% annual chance flood can be passed without substantial increases in flood heights.

OTHER FLOOD AREAS

Zone X: Areas of 0.2% annual chance flood, areas of 0.2% annual chance flood with average depths of less than 1 foot or with depths less than 1 foot in any one area, and areas protected by levees from the 1% annual chance flood.

OTHER AREAS

Zone B: Areas determined to be outside the 0.2% annual chance floodplain. Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

Zone B1: Areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas. 1% annual chance floodplain boundary. 0.2% annual chance floodplain boundary. Floodway boundary. Zone B1 boundary.

Zone B2: Areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas. 1% annual chance floodplain boundary. 0.2% annual chance floodplain boundary. Floodway boundary. Zone B2 boundary.

Zone B3: Areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas. 1% annual chance floodplain boundary. 0.2% annual chance floodplain boundary. Floodway boundary. Zone B3 boundary.

Zone B4: Areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas. 1% annual chance floodplain boundary. 0.2% annual chance floodplain boundary. Floodway boundary. Zone B4 boundary.

Zone B5: Areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas. 1% annual chance floodplain boundary. 0.2% annual chance floodplain boundary. Floodway boundary. Zone B5 boundary.

Zone B6: Areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas. 1% annual chance floodplain boundary. 0.2% annual chance floodplain boundary. Floodway boundary. Zone B6 boundary.

Zone B7: Areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas. 1% annual chance floodplain boundary. 0.2% annual chance floodplain boundary. Floodway boundary. Zone B7 boundary.

Zone B8: Areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas. 1% annual chance floodplain boundary. 0.2% annual chance floodplain boundary. Floodway boundary. Zone B8 boundary.

Zone B9: Areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas. 1% annual chance floodplain boundary. 0.2% annual chance floodplain boundary. Floodway boundary. Zone B9 boundary.

Zone B10: Areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas. 1% annual chance floodplain boundary. 0.2% annual chance floodplain boundary. Floodway boundary. Zone B10 boundary.

Zone B11: Areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas. 1% annual chance floodplain boundary. 0.2% annual chance floodplain boundary. Floodway boundary. Zone B11 boundary.

Zone B12: Areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas. 1% annual chance floodplain boundary. 0.2% annual chance floodplain boundary. Floodway boundary. Zone B12 boundary.

Zone B13: Areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas. 1% annual chance floodplain boundary. 0.2% annual chance floodplain boundary. Floodway boundary. Zone B13 boundary.

Zone B14: Areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas. 1% annual chance floodplain boundary. 0.2% annual chance floodplain boundary. Floodway boundary. Zone B14 boundary.

Zone B15: Areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas. 1% annual chance floodplain boundary. 0.2% annual chance floodplain boundary. Floodway boundary. Zone B15 boundary.

Zone B16: Areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas. 1% annual chance floodplain boundary. 0.2% annual chance floodplain boundary. Floodway boundary. Zone B16 boundary.

Zone B17: Areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas. 1% annual chance floodplain boundary. 0.2% annual chance floodplain boundary. Floodway boundary. Zone B17 boundary.

Zone B18: Areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas. 1% annual chance floodplain boundary. 0.2% annual chance floodplain boundary. Floodway boundary. Zone B18 boundary.

Zone B19: Areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas. 1% annual chance floodplain boundary. 0.2% annual chance floodplain boundary. Floodway boundary. Zone B19 boundary.

Zone B20: Areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas. 1% annual chance floodplain boundary. 0.2% annual chance floodplain boundary. Floodway boundary. Zone B20 boundary.

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0661D

FIRM FLOOD INSURANCE RATE MAP

CUSTER COUNTY, MONTANA AND INCORPORATED AREAS

PANEL 061 OF 2275

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTRACT	NUMBER	PANEL	SUFFIX
0600000000	060000	0600	0
0600000000	060000	0600	0

Created in 1997, this map reflects current information on flood insurance rates and flood insurance rates. The information is subject to change and is not a guarantee of insurance coverage. For more information, contact your insurance agent or call the National Flood Insurance Program at 1-800-358-6115.

MAP NUMBER 30017C0661D

EFFECTIVE DATE JULY 22, 2010

Federal Emergency Management Agency

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources or small creeks. The community map repository should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information on areas where **Base Flood Elevations (BFEs)** and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Floodway Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIS. Users should be aware that BFEs shown on the FIS report represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be viewed in conjunction with the FIS report for purposes of construction and floodplain management.

Coastal Base Flood Elevations shown on this map apply only to landward of U.S. North American Vertical Datum of 1988 (NAVD83) BGL. Users of this report should be aware that coastal flood elevations are also provided in the Summary of Floodway Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Floodway Elevations table should be used for construction and floodplain management purposes when they are higher than the elevations shown on this FIS.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 12. The horizontal datum was NAD83. Orthometric elevations, referenced to mean sea level, were used in the preparation of this FIS. For adjacent jurisdictions, the use of different datum or projection systems may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIS.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structures and ground elevations referenced to the same vertical datum. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at <http://www.ngs.noaa.gov> to contact the National Geodetic Survey at the following address:

NGS Information Services
NGA, NGS212
National Geodetic Survey
5500 S. 26th St.
Silver Spring, MD 20910-2292

To obtain current elevation, description, and location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (202) 719-3242, or visit its website at <http://www.ngs.noaa.gov>.

Base map information shown on this FIS was provided in digital form by the United States Department of Agriculture. This information was georeferenced and geotagged from Digital Orthophoto Quarter Quadrangles at a scale of 1:100,000, dated 2005 or later as a part of the National Agriculture Imagery Program.

This map reflects new detailed and up-to-date stream channel configurations than those shown on the previous FIS for this jurisdiction. The floodplains and floodways that were transferred from the previous FIS may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study report (which contain authoritative hydraulic data) may reflect stream channel dimensions that differ from what is shown on this map.

Corporate limits shown on this map are based on the latest data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels, community map repository addresses, and a listing of Communities with participating National Flood Insurance Program data for each community as well as a listing of the panels on which each community is located.

Contact the **FEMA Map Service Center** at 1-800-368-6019 for information on available products associated with this FIS. Available products may include previously issued letters of Map Change, a Flood Insurance Study report, and/or digital versions of this map. The FEMA Map Service Center may also be reached by fax at 1-800-368-6020 and by website at <http://www.fema.gov>.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call 1-877-FEMA-MAP (1-877-368-6262) or visit the FEMA website at <http://www.fema.gov>.



LEGEND

SPECIAL FLOOD HAZARD AREAS (SPFH) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood) also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Areas in this map are subject to inundation by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, X, and V. The base flood elevation is the water surface elevation of the 1% annual chance flood.

- ZONE A:** No Base Flood Elevation determined.
- ZONE AE:** Base Flood Elevation determined.
- ZONE AH:** Flood depths of 1 to 3 feet (average depth of ponding). Base Flood Elevation determined.
- ZONE AO:** Flood depths of 1 to 3 feet (average depth of ponding). Base Flood Elevation determined.
- ZONE X:** Special Flood Hazard Areas formerly protected from the 1% annual chance flood for a flood control system that was subsequently destroyed. Zone X includes that the former flood control system is being replaced to provide protection from the 1% annual chance of greater flood.
- ZONE V:** Areas in the protected from 1% annual chance flood by a Federal flood protection system under construction, no Base Flood Elevation determined.
- ZONE V:** Coastal flood zone with velocity hazard (wave action) on Base Flood Elevation determined.
- ZONE V:** Coastal flood zone with velocity hazard (wave action) on Base Flood Elevation determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a water plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be passed without substantial increases in flood heights.

OTHER FLOOD AREAS

- ZONE X:** Areas of 0.2% annual chance flood, areas of 0.2% annual chance flood with average depths of less than 1 foot or with depths less than 1 foot, and areas protected by levees from 1% annual chance flood.

OTHER AREAS

- ZONE B:** Areas determined to be outside the 0.2% annual chance floodplains.
- ZONE B:** Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPA)

- OPA areas and OPA** are normally located within or adjacent to Special Flood Hazard Areas.
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