Abandoned Channels (Avulsions)

Applicability

The following Best Management Practices (BMPs) summarize several recommended approaches to managing abandoned channels within the Musselshell River stream corridor. The information is based upon the on-site evaluation of floodplain features and discussions with producers and is intended for producers and residents who are living or farming in areas where abandoned channel segments exist.

Figure 1. 2011 avulsion, Musselshell River.

Description

Perhaps the most dramatic 2011 flood impact on the Musselshell River was the number of avulsions that occurred over the period of a few weeks. An "avulsion" is the rapid formation of a new river channel across the floodplain that captures the flow of the main channel thread. River avulsions typically occur when rivers find a relatively steep, short flow path across their floodplain. When floodwaters re-enter the river over a steep bank, they form headcuts that migrate upvalley, creating a new channel, causing intense erosion, and sending a sediment slug down stream. If the new channel completely develops, it can capture the main thread, resulting in a successful avulsion. If floodwaters recede before the new channel is completely formed, or if the floodplain is resistant to erosion, the avulsion may fail. From near Harlowton to Fort Peck Reservoir, 59 avulsions occurred on the Musselshell in the spring of 2011, abandoning a total of 39 miles of channel. The abandoned channel segments range in length from 280 feet to almost three miles. One of the reasons there were so many avulsions on the Musselshell River in 2011 is because the floodwaters stayed high for weeks, allowing channels to fully develop on the floodplain

Figure 2. Upstream-migrating headcuts showing creation of avulsion path, 2011.

before the waters receded. The extent of avulsions may have been made worse by the isolation of the natural river floodplain, especially due to the Milwaukee Road berm above Melstone, which resulted in deeper water and higher energy in the available floodplain area.

This BMP is intended to help optimize the balance of land use and ecological function in these unique areas.

The Abandoned Channel BMP summarizes the following:

I. ***Re-activating Abandoned Channels:*** Considerations for reactivating the original stream channel through excavation, grading, or plugging.

II. ***Maintaining Abandoned Channels:*** Potential benefits of maintaining abandoned channel features.

I. Re-activating Abandoned Channels

The most common form of an avulsion that occurred in 2011 is a bendway cutoff. This happens when a meander bend forms a new, shorter channel through it's core. This is a common, natural river process that leaves floodplain swales known as oxbows. As they evolve, oxbows generally form first as open water wetlands, then continally fill in with fine sediment to become a low, arc-shaped floodplain swale/wetland. Meander cutoffs have posed problems for producers in the corridor, as the avulsions have commonly isolated land, eroded fields, and abandoned infrastructure (pump sites, diversions, bridges, etc.). As such, these sites have been comonly considered for re-activation; that is, putting the river back into its original pre-avulsion channel.

Figure 3. Meander cutoff formed by 2011 flood.

Unfortunately, however, when producers consider this approach, the following challenges tend to develop that may prove costly to address and difficult to maintain:

a. Because the new channels are steeper, they tend to downcut and perch the oxbow above the new channel. Re-routing the channel back into the old channel may require ***grade controls*** to raise the downcut channel bed to its original elevation.
b. Sediment and debris deposited in the oxbow during the latter stages of the flood may require ***extensive excavation***.
c. Because a new avulsion path has been created, it will persist as the preferred route during future flooding, ***making re-routing a tenuous prospect*** in the long-term.

In most cases, these issues have proven insurmountable, and avulsions have been left in place. As described in Section II of this BMP, there may be significant long-term benefits to this approach. In some cases, those issues are less severe, and producers have pursued re-activating the old channel. This has generally been achieved by placing plugs across the avulsion and using the plug as an access route/crossing. If this approach is undertaken, the following considerations are recommended:

a. Rather than completely isolating the avulsion with high plugs or comletely filling it, it can be designed to serve as a high flow channel that will contibute to groundwater recharge, water quality improvement, riparian renewal, floodwater storage, and floodplain protection. These benefits are all described in Section II of this BMP. Converting an avulsion to a higher flow feature requires the construction of a stable grade control on the upstream end that is well-tied- in to the active streambanks, and has an elevation crest that is designed to overtop at a set flow. This necessarily requires significant hydrologic design efforts, including an evaluation of the stage/discharge relationship at the head of the avulsion. The downstream face of the grade control will require an armor treatment to prevent its failure due to overtopping scour and headcutting.

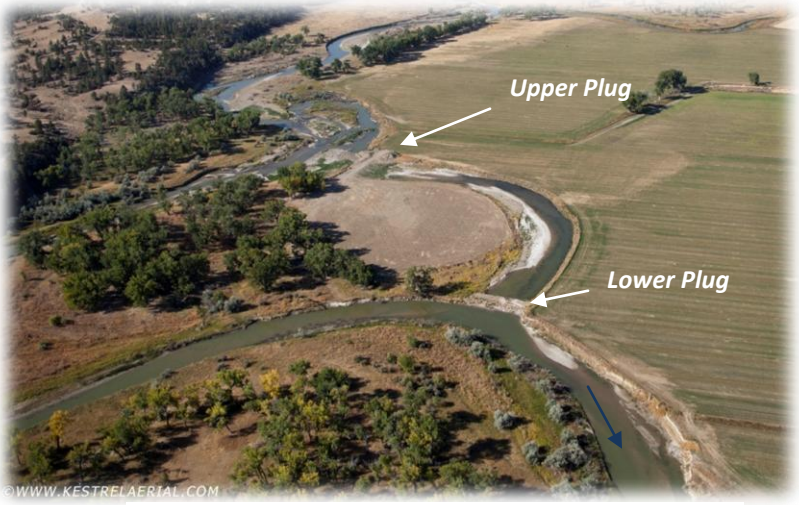

Figure 4. View upstream of plugged avulsion.

b. Steep banks in the avulsion path can create problems for irrigation, cropping, and equipment access. Grading or shaping the banks of the avulsion to a slope of no steeper than 3H:1V will help stabilize those banks prone to collapse, and will help vegetation to establish.

c. Planting the banks of the avulsion to native species will accelerate its conversion to a high flow, vegetated swale. Disturbed areas in avulsion paths should be carefully managed for noxious weeds.

II. Preservation of Abandoned Channels

The vast majority of avulsions that have occurred on the Musselshell River have been left untreated, either due to the challenges associated with re-routing the channel back to its original course, or due to lanowners' acceptance of the new channel condition. This has caused varying degrees of hardship for producers however, especially with respect to accessing irrigation infrastructure or hayfields. Where pump sites have been abandoned by avulsions, numerous producers have pursued a change in the Point of Diversion (POD) for that site from the Montana Department of Natural Resources and Conservation. This has alleviated the need for channel relocation to re-access irrigation water.

When abandoned channels are left to naturally evolve, they contribute postively to numerous ecological processes in the river corridor. Benefits derived from perserving floodplain oxbow features include improved water quality, water quantity, flood protections, and habitat.

a. ***Water Quality:*** Oxbows have been identified as providing important functions including sediment storage, pollutant absorption and nutrient cycling.
b. ***Water Quantity:*** One concern expressed by water users in the basin is that because the Musselsell River is currently steeper and shorter than before the flood, there is a tendency for water to pass through the basin faster than before. If oxbows remain connected to the stream channel, they can help mitigate this process, and also increase rates and volumes of surface and groundwater recharge later into the summer and fall.

Figure 5. View of flood debris trapped in wetland swale from edge of irrigated field. Photo credit: Karin Boyd.

c. ***Flood Protections:*** Several producers in the basin have noted that flooded fields were less impacted if they were protected by vegetated floodplain swales that captured sediment and debris. These features can act as a "strainer" during floods that trap potentially damaging sediment and woody debris. Oxbows also provide flood retention, storing water to reduce flood discharges downstream and prolong streamflow.
d. ***Habitat:*** Oxbows environments are currently being actively restored across the US to improve habitat for waterfowl, fisheries, and other wildlife. These habitats are considered unique in river systems, providing spawning and nursery habitat for fish, and high water tables that promote riparian growth and sustain wildlife habitat.

Air photos courtesy of Chris Boyer, Kestrel Aerial Services Inc. http://www.kestrelaerial.com/