

County	Sweet Grass	Upstream River Mile	463
Classification	UB: Unconfined braided	Downstream River Mile	459.7
General Location	Big Timber	Length	3.30 mi (5.31 km)

Narrative Summary

Reach A4 is approximately 3.3 miles long, extending from near the Sweet Grass County Fairgrounds downstream to the Boulder River confluence. Reach A4 is very dynamic with active channel migration, threats to infrastructure, bank armor, flanked barbs, and active riparian recruitment on raw gravel bars. The most dynamic portion of the reach is upstream of the Highway 191 Bridge; in spring of 2013 a large meander formed a 1,500 foot long chute cutoff near the fairgrounds which abandoned about 3,500 feet of channel to the south.

About 19 percent of the banks in Reach A4 are armored, with the majority of that armor being rock riprap. Between 2001 and 2011, there was a loss of about 1,000 feet of armor in the reach. Over 800 feet of that lost bank protection was flow deflectors; flanked barbs are visible in the middle of the channel downstream of the fairgrounds. With the avulsion of 2013, those flanked barbs are now sitting in the abandoned channel. Similar to reaches upstream, the river channel in Reach A4 has increased in size since 1950 by about 19 acres, and the channel expansion has been at the expense of riparian cover. Almost a quarter of the Channel Migration Zone (CMZ) has been restricted by physical features, and the restrictions are primarily due to bank armor that is protecting agricultural land.

Since 1950, over 7,500 feet of side channels in Reach A4 have been blocked by berms, which have caused a 25 percent drop in braiding parameter for the reach. Russian olive has colonized these historic channels. Like many other reaches the loss of active side channels in this reach has been accompanied by a lengthening of the main thread. Between 1950 and 2001, the main channel lengthened by about 1,000 feet through the 3.3 mile reach.

Land use in Reach A4 is predominantly agricultural, although there are several hundred acres of urban/exurban development associated with the town of Big Timber. Most of the agricultural land is non-irrigated; however there are hundreds of acres of flood, sprinkler, and pivot irrigation in the reach. Almost 150 acres of irrigated ground are within the 5-year floodplain in Reach A4, and most of that commonly flooded ground is south of the fairgrounds. This area also has most of the 160 acres of mapped wetlands in the reach.

There is one mapped dump site in Reach A4, which is on the high terrace edge at Big Timber. There is also one major petroleum product pipeline in the reach that runs parallel to the river on its north side. The pipeline is owned by ConocoPhillips, and passes under both Big Timber Creek and Otter Creek within 1,500 feet of the Yellowstone River.

Almost 200 acres of land in Reach A4 are within the mapped Channel Migration Zone. This includes 83 acres of flood, 42 acres of sprinkler, and 37 acres of pivot. A total of 21 acres of land in the CMZ has been developed to urban/exurban use.

This area of the upper Yellowstone River has seen three severe floods in the last 20 years. The 1996 and 1997 floods were very damaging, early-June events that peaked at 37,100 and 38,000 cfs, respectively. At the time, these were considered to be sequential 100-year floods. Then in late June of 2011, the river peaked at 40,600 cfs, which is currently the flood of record at Livingston. This flood exceeded a 100-year event, with both the 1996/1997 events considered to have exceeded a 75-year flood.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been moderate in this reach. The mean annual flood is estimated to have dropped from 11,900 cfs to 11,500 cfs, a drop of about 3.4 percent. The biggest influence has been on low flows: severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 1,880 cfs to 1,620 cfs with human development, a reduction of 14 percent. More typical summer low flows, described as the summer 95% flow duration, have dropped from 1,760 cfs under unregulated conditions to 1,680 cfs under regulated conditions at the Livingston gage, a reduction of 4.6 percent.

CEA-Related observations in Reach A4 include:

- Restriction of the Historic Migration Zone (HMZ) isolating side channels and reducing riparian turnover.
- Primary channel lengthening in association with loss of side channels.
- Rapid migration and channel realignment resulting in barb flanking and abandonment of rock in channel.
- Isolation of historic channels (over 7,500 feet) by berms.
- Russian olive colonization within isolated side channels.
- Riparian recruitment (cottonwood establishment) on islands created by channel migration.

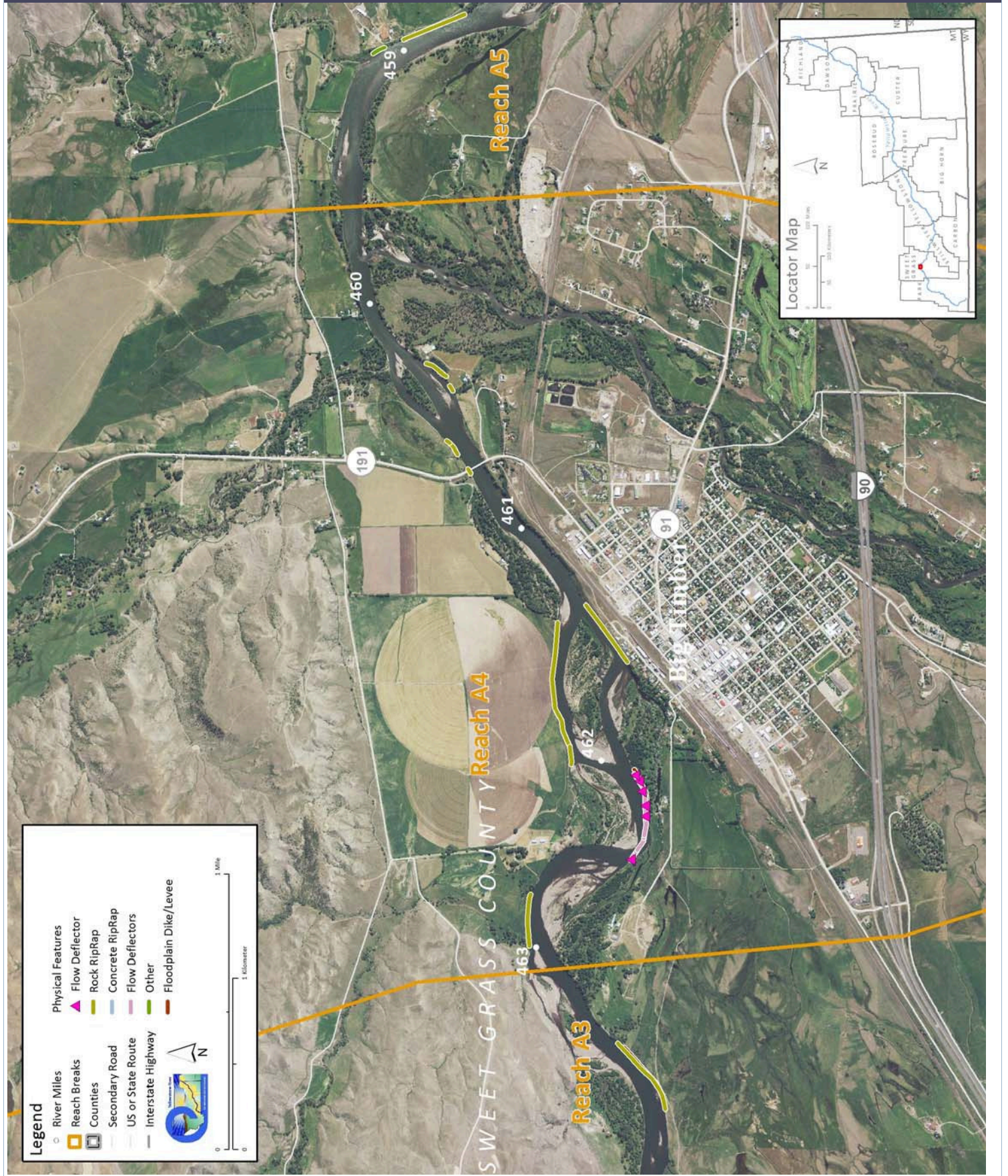
Recommended Practices (may include Yellowstone River Recommended Practices--YRRPs) for Reach A4 include:

- Removal of flanked armor at RM 462.3
- Side channel restoration/management (RM 461.2, RM 462)
- CMZ management due to encroachment (200 acres restricted)
- Russian olive removal (2.7 acres)
- Solid waste removal from dump on right bank at RM 461
- Pipeline management at Big Timber Creek and Otter Creek tributary crossings just north of Yellowstone River.

The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated from a large dataset that is presented in more detail in the full reach narrative report.

Discharge	Undev.	Developed	% Change	"Undeveloped" flows represent conditions prior to significant human development, whereas "developed" flows reflect the current condition of both consumptive and non-consumptive water use.		
2 Year (cfs)	23,300	22,900	-1.7%			
100 Year (cfs)	43,400	43,200	-0.5%			
Bankfull Channel Area (Ac)	1950	1976	1995	2001	1950-2001	Bankfull channel area is the total footprint of the river inundated at approx. the 2-year flood.
	203.9	238.6	235.7	257.2	53.3	
Physical Features	2011 Length (ft)	% of Bankline	2001-2011 Change	There are additional types of bank armor such as car bodies and steel retaining walls, but they are relatively minor.		
Rock Riprap	6,143	16.8%	-168			
Concrete Riprap	0	0.0%	0			
Flow Deflectors	932	2.5%	-854			
Total	7,075	19.3%	-1,022			
Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s	Numerous side channels have been blocked by small dikes.			
	0	7,575				
Floodplain Turnover	1950 - 1976	1976 - 2001	1950-2001 In-channel riparian encroachment (negative number indicates retreat)	The rate of floodplain turnover reflects how many acres of land are eroded by the river. Turnover is associated with the creation of riparian habitat.		
Total Acres	64.1	58.2	-35.78 acres			
Acres/Year	2.5	2.3				
Acres/Year/Valley Mile	0.8	0.8				
Open Bar Area	Point Bars	Bank Attached	Mid-Channel	Total	The type and extent of open sand and gravel bars reflect in-stream habitat conditions that can be important to fish, amphibians, and ground-nesting birds such as least terns.	
Change in Area '50 - '01 (Ac)						
Floodplain Isolation	Acres	% of FP	Floodplain isolation refers to area that historically was flooded, but has become isolated do to flow alterations or physical features such as levees.			
5 Year	8.5	3%				
100 Year	0.0	0%				
Restricted Migration Area	Acres	% of CMZ	Channel Migration Zone restrictions refer to the area and percent of the CMZ that has been isolated by features such as bank armor, dikes, levees, and transportation embankments.			
	183.0	23%				
Land Use	1950	2011	1950	2011	Changes in land use reflect the development of the river corridor through time. The irrigated agricultural are is a sub-set of the mapped agricultural land.	
Agricultural Land (Ac)	2,380.8	2,154.9	Flood (Ac)	1,161.8	385.3	
Ag. Infrastructure (Ac)	112.7	138.6	Sprinkler (Ac)	0.0	194.7	
Exurban (Ac)	22.3	105.2	Pivot (Ac)	0.0	301.5	
Urban (Ac)	176.6	268.6				
Transportation (Ac)	60.8	64.4				
1950s Riparian Vegetation Converted to a Developed Land Use (ac)	To Irrigated	To Other Use	Total Rip. Converted	% of 1950s Rip.	Changes in the extents of riparian vegetation are influenced by land use changes within the corridor.	
	2.4	8.2	10.6	3.0%		
National Wetlands Inventory	Acres	Acres per Valley Mi	Total Wetland Acres	Wetlands units summarized from National Wetlands Inventory Mapping include Riverine (typically open water sloughs), Emergent (marshes and wet meadows) and Shrub-Scrub (open bar areas with colonizing woody vegetation).		
Riverine	3.7	1.3	164.1			
Emergent	140.0	47.6				
Scrub/Shrub	20.5	7.0				
Russian Olive (2001) (Appx. 100-yr Floodplain)	Acres	%	Russian olive is considered an invasive species and its presence in the corridor is fairly recent. Its spread can be used as a general indicator of invasive plants within the corridor.			
	2.7	0.3%				
Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)	1950	1976	2001	Change 1950-2011	Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.	
	0.0	0.0	0.0	0.0		

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP

