

<b>County</b>	Park	<b>Upstream River Mile</b>	511
<b>Classification</b>	PCA: Partially confined anabranching	<b>Downstream River Mile</b>	508.7
<b>General Location</b>	To near Suce Cr, Wineglass Mtn to west	<b>Length</b>	2.30 mi (3.70 km)

## Narrative Summary

Reach PC11 is located in the Paradise Valley downstream of Deep Creek, and consists of a Partially Confined Anabranching (PCA) reach type, reflected by multiple channels separated by wooded islands, and local abutment of the channel against low glacial terraces. Long floodplain dikes and bank armor installations have isolated natural migration and avulsion areas from the active channel corridor. These dikes and levees narrow the corridor significantly in the downstream direction; whereas in the upper portions of Reach PC11 the active corridor is approximately 2,000 feet wide, it is narrowed approximately 400 feet by floodplain dikes and bank armor at the downstream boundary of Reach PC11.

Some of the most significant impacts to Reach PC11 occurred prior to 1950. This includes the isolation of a major anabranching channel on the east side of the river that has been improved as a spring creek. The dike blocking this channel is located at its upper end in Reach PC10; within Reach PC11 this channel is over a mile long.

Although many of the impacts to Reach PC11 occurred prior to 1950, one dike isolated a channel more recently. This 1/4 mile long channel to the west of the main river was blocked off between 1988 and 1991. Within Reach PC11, several channels that have historically been relatively connected to the active river are now largely isolated, forming spring creeks on each side of the river that run parallel to the river for miles. Continual improvements on these spring creeks are evident on the air photos, including original development efforts that included deepening and widening the relic Yellowstone River channels, and re-routing these channels to lengthen them as they parallel the main thread. On the west side of the river, a lengthened spring creek is separated from the river by over a mile of floodplain dike in Reach PC11 alone.

Approximately 35 percent of the bankline in Reach PC11 is armored by Rock Riprap (8,645 feet), and another 8 percent of the bank is protected by flow deflectors (2,047 feet). Approximately 6,900 feet of floodplain dikes protect the spring creek on the west side of the corridor from Yellowstone River overflows. Armor, dikes, and levees have isolated 26 percent of the natural Channel Migration Zone.

Since 1950 the main channel has increased length by approximately 10 percent or 1,200 feet. This trend is common in reaches where side channels have been lost and the main thread has more consolidated flow. The bankfull footprint has grown by 40 acres since 1950, which may reflect main channel expansion due to side channel loss.

Similar to other reaches in Park County, the extent of flood irrigation has dropped in the reach since 1950, and the amount of sprinkler and pivot irrigation has increased. The dominant land use remains agriculture, however, with 139 acres in flood irrigation, 102 acres in sprinkler, and 80 acres in pivot. Another 600 acres are in non-irrigated agriculture. There are almost 80 acres of emergent wetlands in Reach PC10, reflecting a large wet meadow complex across the river from the mouth of Deep Creek.

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 now considered to have exceeded a 75-year flood.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been relatively small in this reach. 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 1,550 cfs to 1,500 cfs with human development, a reduction of 3.2 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 PC11 include:

- Channel Migration Zone restrictions by floodplain dikes and bank armor causing simplification.
- Loss of side channel connectivity due to floodplain dikes and bank armor causing simplification.
- Increase in primary channel length with reduction in side channel length.

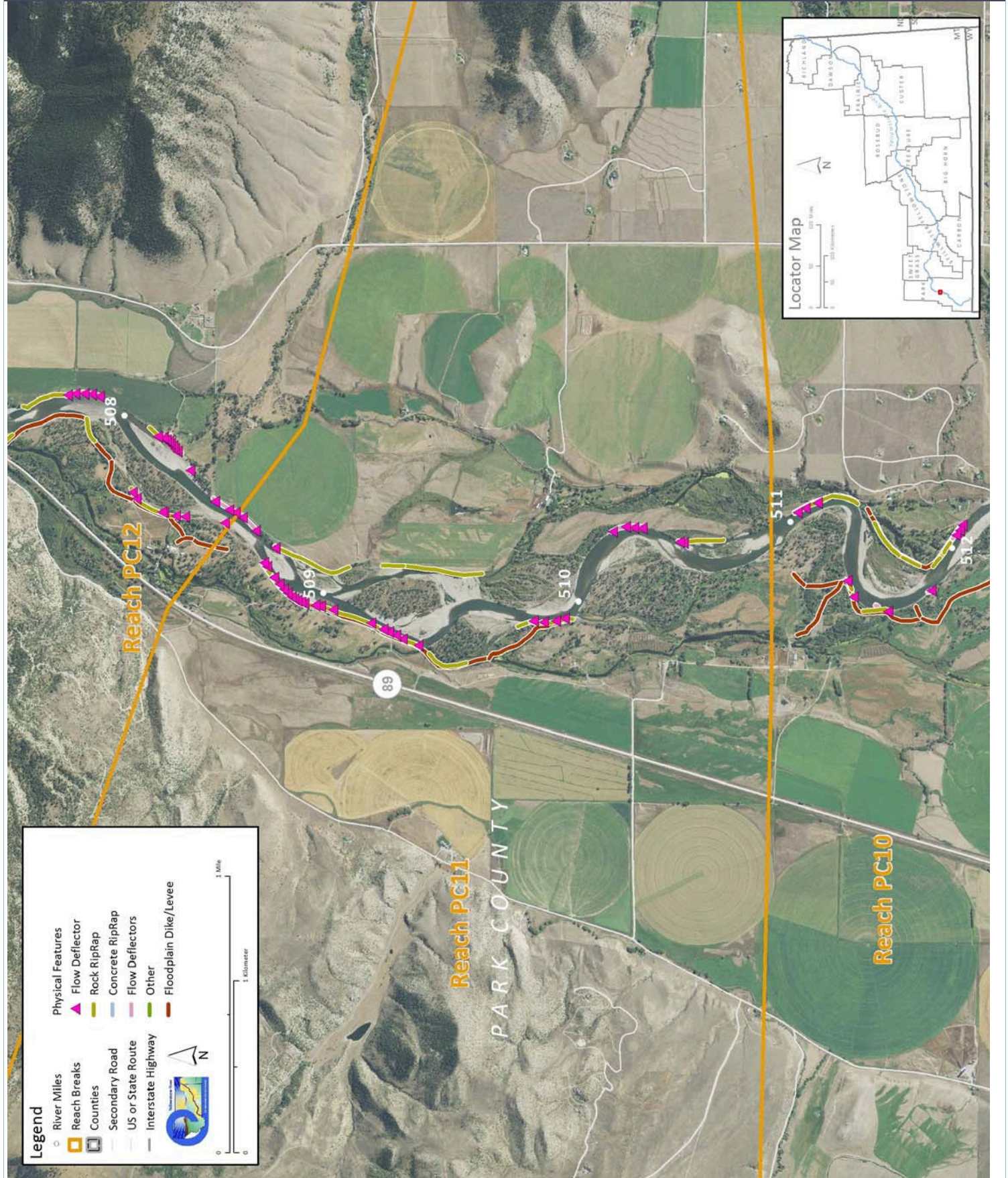
Recommended Practices (may include Yellowstone River Recommended Practices--YRRPs) for Reach PC11 include:

- Selective side channel restoration at RM 510L (may be difficult to reactivate side channels without affecting developed spring creek fishery)
- CMZ Management due to current restriction of 26 percent of the Channel Migration Zone

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.

<b>Discharge</b>	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)	19,500	19,400	-0.5%			
100 Year (cfs)	36,800	36,800	0.0%			
<b>Bankfull Channel Area (Ac)</b>	1950	1976	1995	2001	1950-2001	Bankful channel area is the total footprint of the river inundated at approx. the 2-year flood.
	147.8			187.6	39.9	
<b>Physical Features</b>	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	8,645	34.8%	45			
Concrete Riprap	0	0.0%	0			
Flow Deflectors	2,047	8.2%	-238			
<b>Total</b>	<b>10,692</b>	<b>43.0%</b>	<b>-193</b>			
<b>Length of Side Channels Blocked (ft)</b>	Pre-1950s	Post-1950s	Numerous side channels have been blocked by small dikes.			
	0	1,990				
<b>Floodplain Turnover</b>	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 Acres/Year Acres/Year/Valley Mile			acres			
<b>Open Bar Area</b>	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)						
<b>Floodplain Isolation</b>	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 100 Year						
<b>Restricted Migration Area</b>	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.			
	154.7	26%				
<b>Land Use</b>	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)	1,057.0	933.5	Flood (Ac)	501.0	138.5	
Ag. Infrastructure (Ac)	18.7	64.2	Sprinkler (Ac)	0.0	102.2	
Exurban (Ac)	0.0	2.2	Pivot (Ac)	0.0	79.5	
Urban (Ac)	0.0	0.0				
Transportation (Ac)	6.1	14.0				
<b>1950s Riparian Vegetation Converted to a Developed Land Use (ac)</b>	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.	
<b>National Wetlands Inventory</b>	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	27.5	13.5	158.0			
Emergent	75.5	37.1				
Scrub/Shrub	55.0	27.0				
<b>Russian Olive (2001) (Appx. 100-yr Floodplain)</b>	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.			
	0.3	0.1%				
<b>Riparian Forest at low risk of Cowbird Parasitism (Ac/Valley Mile)</b>	1950	1976	2001	Change 1950-2011	Cowbirds are associated with agricultural and residential development, displacing native bird species by parasitizing their nests.	

## PHYSICAL FEATURES MAP (2011)



## CHANNEL MIGRATION ZONE MAP

