

County	Custer	Upstream River Mile	158.7
Classification	CM: Confined meandering	Downstream River Mile	149.2
General Location	To Powder River confluence	Length	9.50 mi (15.29 km)

Narrative Summary

Reach C21 is 9.5 miles long and extends from River Mile (RM) 158.7 downstream to the mouth of the Powder River at RM 149.2. It is a Confined Meandering (CM) reach type, as the river flows down a sinuous course that is highly confined by Fort Union Formation sandstones and younger erosion-resistant terraces.

Reach C21 has just over 4,000 feet of rock riprap and 71 feet of mapped flow deflectors, which collectively armor 4.1 percent of the total stream bank. About one half of the armor is protecting road embankments, and the other half is protecting the railroad.

Bear Rapids forms two distinct shoals as bedrock shelves in the river between RM 153 and RM 154 near the mouth of Camp Creek.

Between 1950 and 2001 there was about 53 net acres of riparian encroachment into the channel, and the bankfull channel area decreased by ~58 acres, indicating a diminishing river size over the last half-century. This trend is common below the mouth of the Bighorn River, where flow alterations have reduced peak flows and cause the active river channel to shrink. Consumptive water uses, primarily associated with irrigation, have contributed to the reduced flows.

Land use is dominated by agriculture with 164 acres of the ~7,000 acre mapping footprint occupied by transportation-related land uses. There is one ~0.6 acre series of corrals near the mouth of Mack Creek at RM 157.2R that are within 200 feet of the river. There are also several acres of corrals within 300 feet of the river on the left bank at RM 154.9L. At RM 153.3R there is another much larger series of corrals that are within 500 feet of Camp Creek.

There are 49 acres of Russian olive in the reach, which appears to dominate riparian areas.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The 100-year flood has dropped by 19 percent. The 2-year flood, which strongly influences overall channel form, has dropped by 24 percent. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 5,080 cfs to 3,140 cfs with human development, a reduction of 38 percent. More typical summer low flows, described as the summer 95% flow duration, have dropped from 6,730 cfs under unregulated conditions to 3,510 cfs under regulated conditions, a reduction of 48 percent.

CEA-Related observations in Reach C21 include:

- Natural channel stability provided by bedrock
- Minimal bank armoring

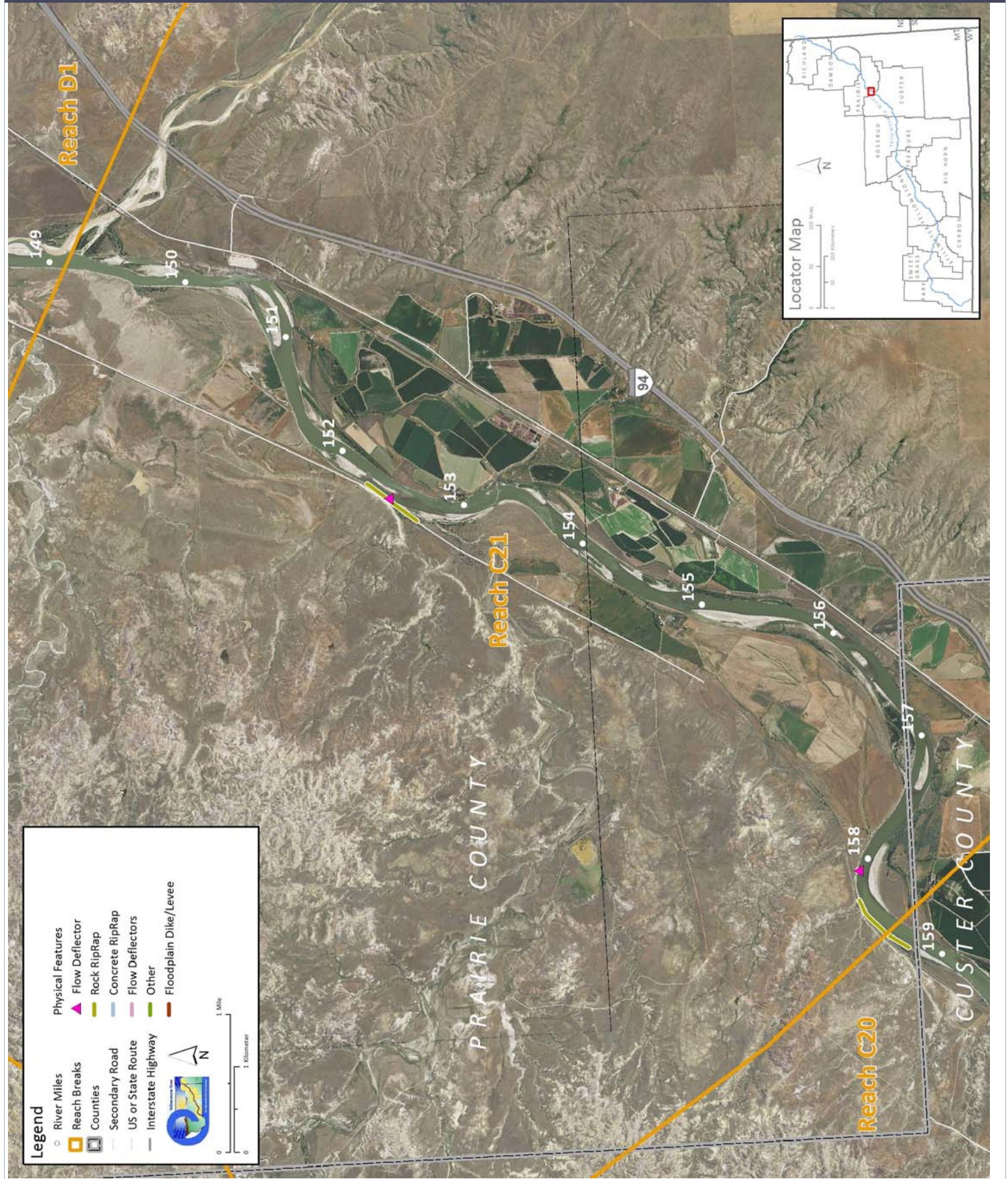
Recommended Practices (may include Yellowstone River Recommended Practices--YRRPs) for Reach C21 include:

- Russian olive removal
- Nutrient management at corrals at RM 157.2R and RM 153.2R, and 154.9L

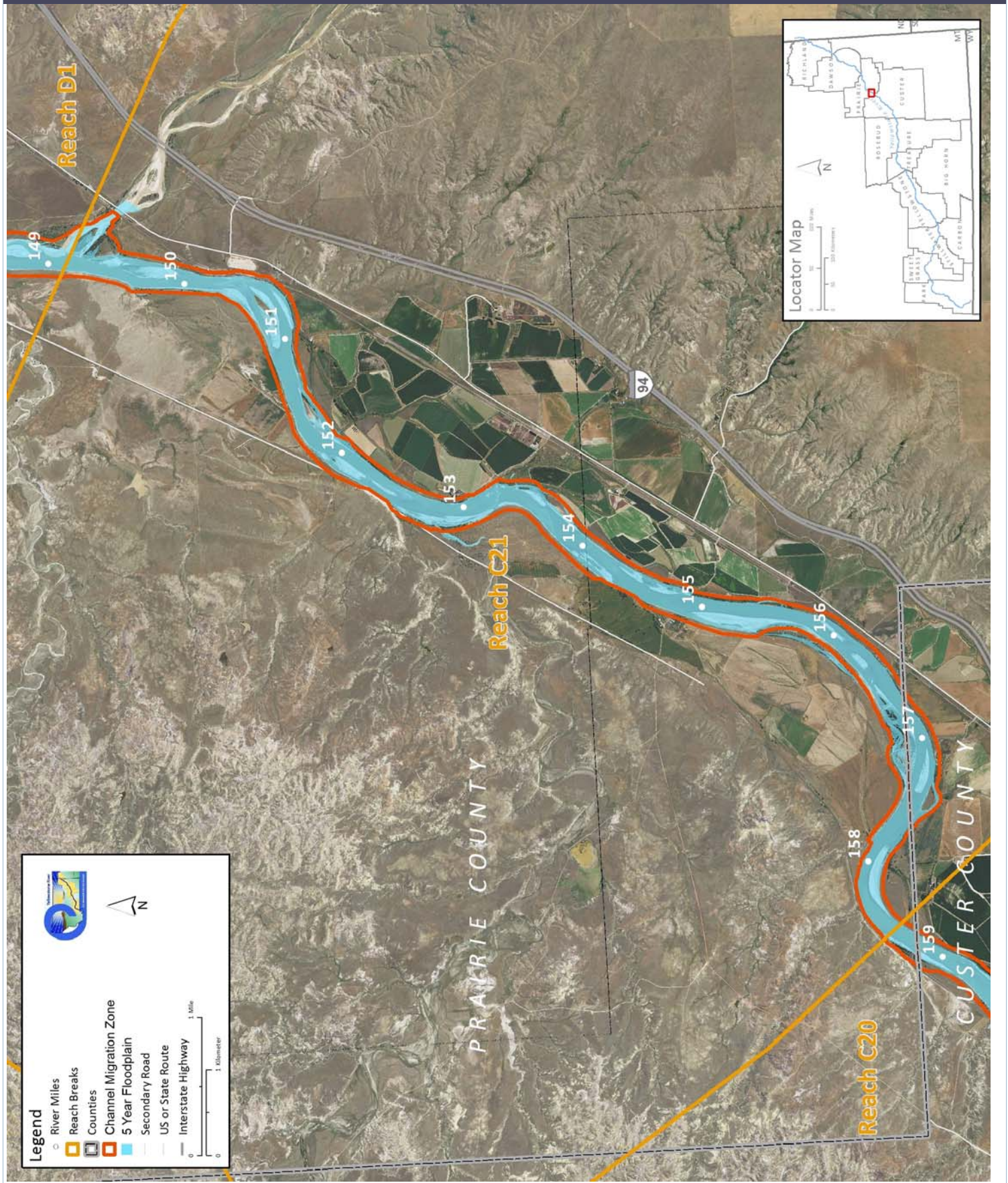
The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated 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)	63,900	48,600	-23.9%			
100 Year (cfs)	119,000	96,800	-18.7%			
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.
	973.2	929.6	936.0	914.8	-58.4	
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	4,024	4.0%	-41			
Concrete Riprap	0	0.0%	0			
Flow Deflectors	71	0.1%	71			
Total	4,096	4.1%	30			
Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s	Numerous side channels have been blocked by small dikes.			
	0	0				
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	64.9	62.0				
Acres/Year	2.5	2.5				
Acres/Year/Valley Mile	0.3	0.3	53.32 acres			
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)	29.2	76.2	-1.1	104.4		
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	95.2	35%				
100 Year	12.7	3%				
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.			
	2.4	0%				
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)	6,629.3	6,527.2	Flood (Ac)	1,799.1	1,915.9	
Ag. Infrastructure (Ac)	35.4	99.7	Sprinkler (Ac)	0.0	0.0	
Exurban (Ac)	0.0	11.1	Pivot (Ac)	0.0	0.0	
Urban (Ac)	0.0	0.0				
Transportation (Ac)	100.5	163.8				
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.	
	0.0	1.2	1.2	1.0%		
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	7.7	0.9	79.6			
Emergent	61.4	7.2				
Scrub/Shrub	10.5	1.2				
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.			
	48.6	0.8%				
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.	
	8.9	3.3	7.5	-1.4		

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Prairie	Upstream River Mile	149.2
Classification	CM: Confined meandering	Downstream River Mile	137
General Location	To Terry Bridge	Length	12.20 mi (19.63 km)

Narrative Summary

Reach D1 is located in Prairie County, and extends from just below the mouth of the Powder River to Terry. The reach is a 12.2 mile long Confined Meandering (CM) reach type, indicating that the river flows along a meandering course that is confined by older geologic units. Sandstones of the Fort Union Formation and younger erosion-resistant terraces confine the channel through the reach. Because of the geologic confinement, channel migration rates are low and the riparian corridor is notably thin or absent. There is one Fishing Access Site at the upper end of the reach at the Powder River confluence (Powder River Depot).

There are less than 1000 feet of bank armor in the reach; including about 550 feet of rock riprap and 140 feet of flow deflectors. The flow deflectors were all built between 2001 and 2011. During that timeframe there was a loss of 650 feet of rock riprap where it was protecting an old railroad bridge at RM 144.5. The bridge was built in 1907 for the railroad and now serves County Road 42.

Wolf Rapids is located on the apex of a large meander at RM 146. These rapids are formed from an exposed bedrock shelf that extends across the entire river.

Reach D1 has lost almost a mile of side channel length since 1950, but none of this loss has been associated with intentional blockages. There has been 126 acres of riparian recruitment into abandoned 1950s channels.

Land use is predominantly agricultural, and there has been 310 acres of land developed under pivot irrigation. There are two animal handling facilities just north of Terry that are adjacent to old swales. One dump site was mapped on the right bank of the river at RM 137.5R, about ¾ miles upstream from the Terry Bridge.

About 51 percent of the historic 5-year floodplain has become isolated, primarily due to flow alterations. The abandoned Milwaukee rail line embankment has been breached by river erosion in several locations on the south side of the river.

A total of four ice jams have been reported in the reach. One of these events was in February (1996), and three occurred in March (1993, 2009, and 2011). No damages were reported.

There are about 20 acres of mapped Russian olive in the reach.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The 2-year flood, which strongly influences overall channel form, has dropped by 22 percent. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 4,850 cfs to 2,810 cfs with human development, a reduction of 42 percent. More typical summer low flows, described as the summer 95% flow duration, have dropped from 6,940 cfs under unregulated conditions to 3,270 cfs under regulated conditions, a reduction of 53 percent.

CEA-Related observations in Reach D1 include:

- Breaching of abandoned Milwaukee Railroad line

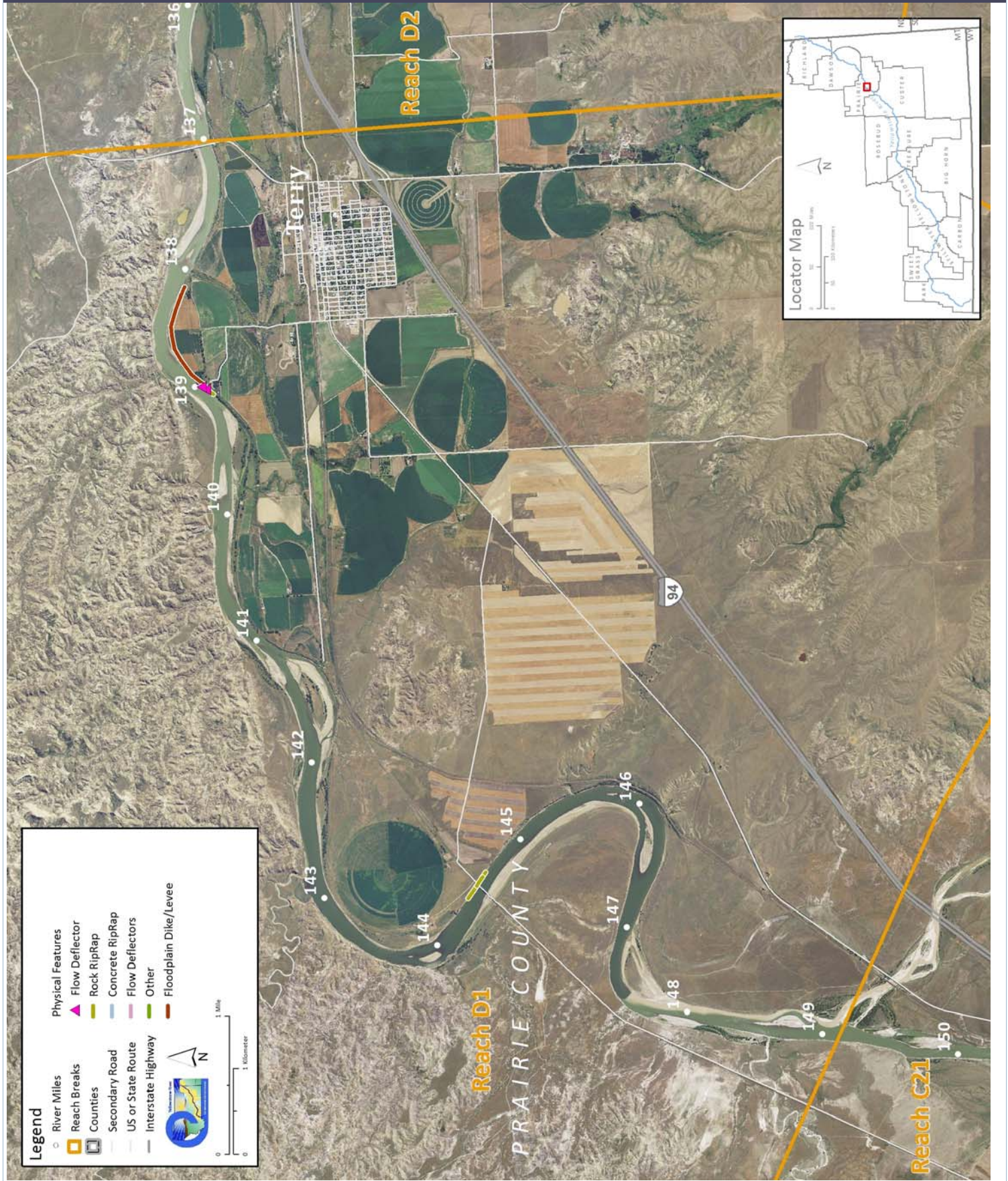
Recommended Practices (may include Yellowstone River Recommended Practices--YRRPs) for Reach D1 include:

- Dump site Practice at RM 137.5R
- Russian olive removal

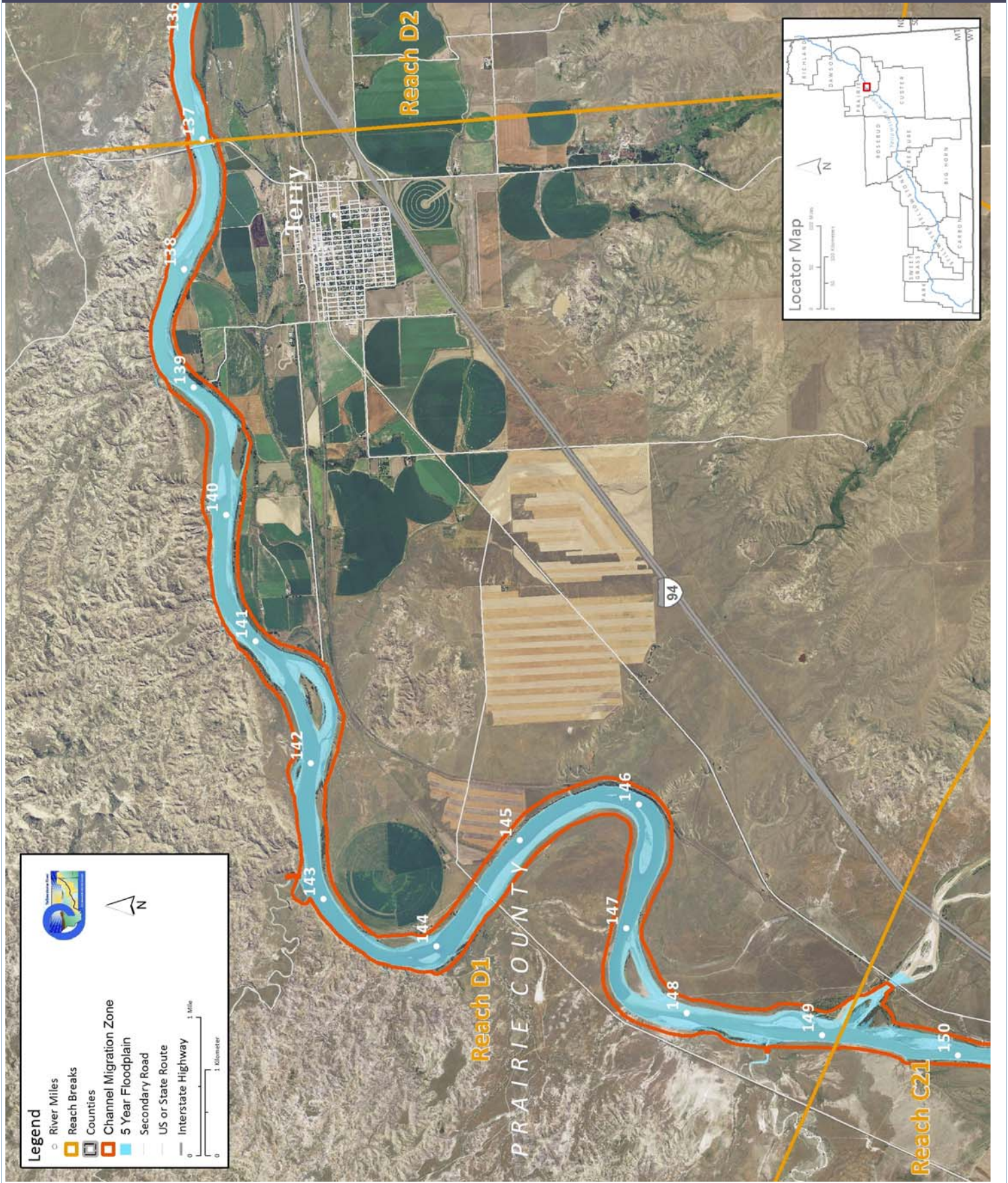
The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated 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)	68,200	53,000	-22.3%			
100 Year (cfs)	140,000	119,000	-15.0%			
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.
	1,265.9	1,213.5	1,213.1	1,230.9	-34.9	
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	545	0.4%	-651			
Concrete Riprap	0	0.0%	0			
Flow Deflectors	243	0.2%	243			
Total	787	0.6%	-409			
Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s	Numerous side channels have been blocked by small dikes.			
	0	0				
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	88.0	68.1	7.17 acres			
Acres/Year	3.4	2.7				
Acres/Year/Valley Mile	0.4	0.3				
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)	-50.3	92.6	12.9	55.2		
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	95.5	51%				
100 Year	14.9	3%				
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.			
	11.8	1%				
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)	6,528.5	6,539.6	Flood (Ac)	682.4	846.1	
Ag. Infrastructure (Ac)	7.0	56.6	Sprinkler (Ac)	0.0	0.0	
Exurban (Ac)	0.0	16.2	Pivot (Ac)	0.0	310.5	
Urban (Ac)	0.0	0.0				
Transportation (Ac)	103.5	58.7				
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.	
	1.2	0.2	1.4	1.0%		
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	27.0	3.0	45.0			
Emergent	18.0	2.0				
Scrub/Shrub	0.0	0.0				
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.			
	19.9	1.4%				
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.	
	5.8	2.9	3.4	-2.4		

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Prairie	Upstream River Mile	137
Classification	CM: Confined meandering	Downstream River Mile	126.5
General Location	To Fallon, I-90 Bridge	Length	10.50 mi (16.90 km)

Narrative Summary

Reach D2 is located in Prairie County, and extends from Terry to Fallon and the I-90 Bridge. The reach is a 10.5 mile long Confined Meandering (CM) reach type, indicating that the river flows along a meandering course that is confined by older geologic units. Sandstones of the Fort Union Formation and younger erosion-resistant terraces confine the channel through the reach. Because of the geologic confinement, channel migration rates are low and the riparian corridor is notably thin or absent. The Channel Migration Zone (CMZ) is extremely narrow because there has been essentially no bank migration in this reach since 1950.

There are just over 1,000 feet of bank armor in the reach; all of which is rock riprap that is protecting the Fallon Bridge.

Land use is predominantly agricultural with more acreage irrigated under pivot than under flood; as of 2011 there were 712 acres in flood and 1,070 acres in pivot in the reach. All of the pivots are on the north side of the river, and several of them extend to the river bank.

One dump site was mapped on the right bank at RM 135.1. There is also an animal handling facility on lower O'Fallon Creek near RM 130.

About 57 percent of the historic 5-year floodplain has become isolated, primarily due to flow alterations. There has been almost 50 acres of riparian encroachment in the reach, likely due to reduced 2-year flows.

Two ice jams have been reported in the reach. In early April of 1943, the breakup of ice jams at Fallon resulted in a 13 foot rise in the river stage at Intake. According to records, many of the farmers "remained in their homes, taking refuge in the attics and second floors of their homes, and some in the haylofts of their barns". More recently in February 1996, lowland flooding resulted from another ice jam breakup.

There are about 20 acres of mapped Russian olive in the reach.

Bluff pools and terrace pools make up 57 percent of the low flow fish habitat mapped in the reach, indicating that this reach may provide important areas for fish species that prefer this habitat type.

O'Fallon Creek enters the Yellowstone River at RM 129. The lowermost 3,100 feet of this creek has been diked off, and the channel now bypasses that remnant and flows directly into the Yellowstone. This abandoned channel supports some emergent wetland and could potentially provide excellent restoration opportunities for wetlands and slackwater areas connected to the Yellowstone River in this highly confined reach.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The 2-year flood, which strongly influences overall channel form, has dropped by 22 percent. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 4,850 cfs to 2,810 cfs with human development, a reduction of 43 percent. More typical summer low flows, described as the summer 95% flow duration, have dropped from 6,940 cfs under unregulated conditions to 3,270 cfs under regulated conditions, a reduction of 53 percent.

CEA-Related observations in Reach D2 include:

- Breaching of abandoned Milwaukee Railroad line
- Diking of lower O'Fallon Creek and isolation of ~3,000 feet of historic tributary channel

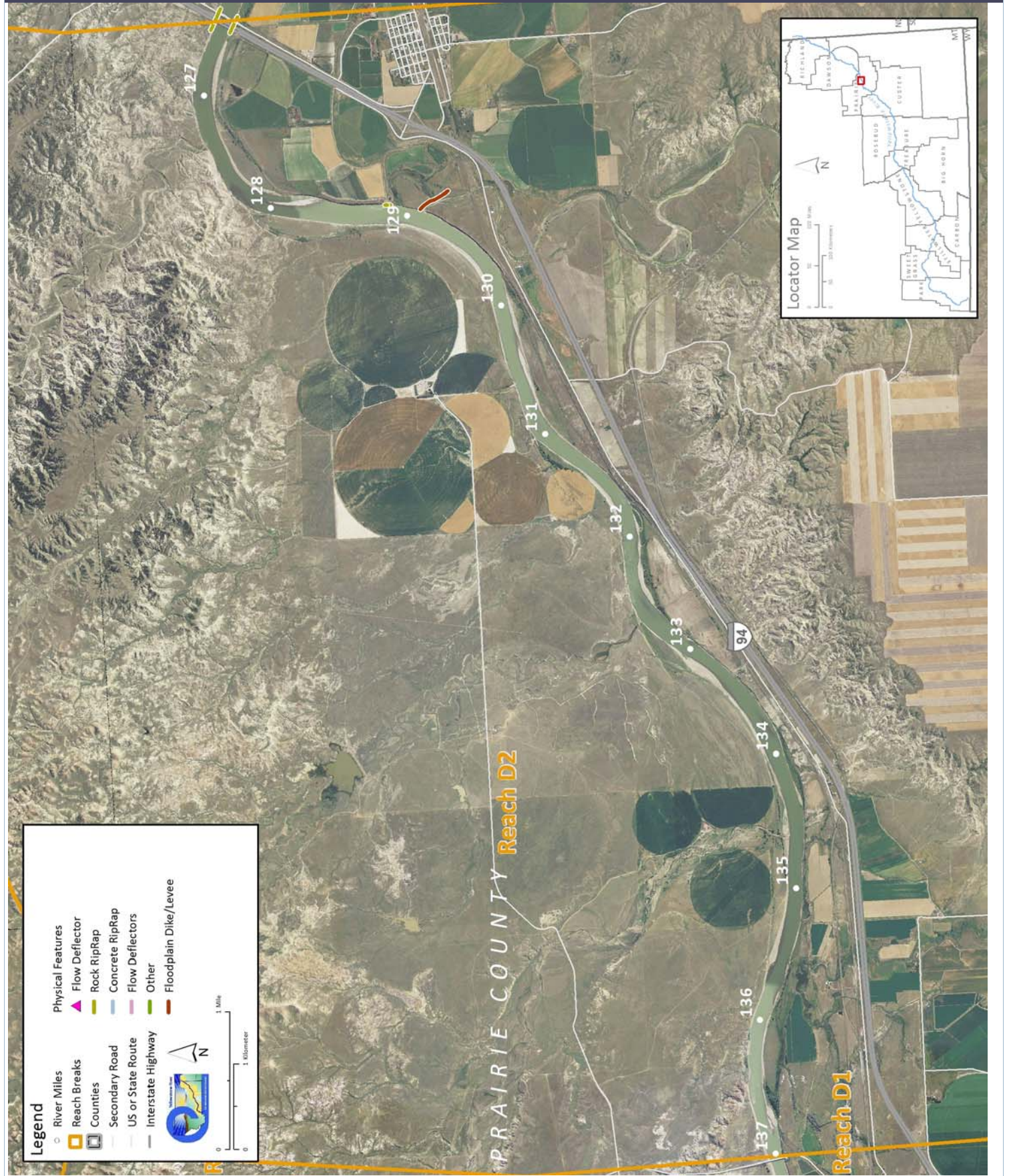
Recommended Practices (may include Yellowstone River Recommended Practices--YRRPs) for Reach D2 include:

- Dump site YRRP at RM 137.5R
- Nutrient management at animal handling facility on lower O'Fallon Creek RM 130
- Russian olive removal

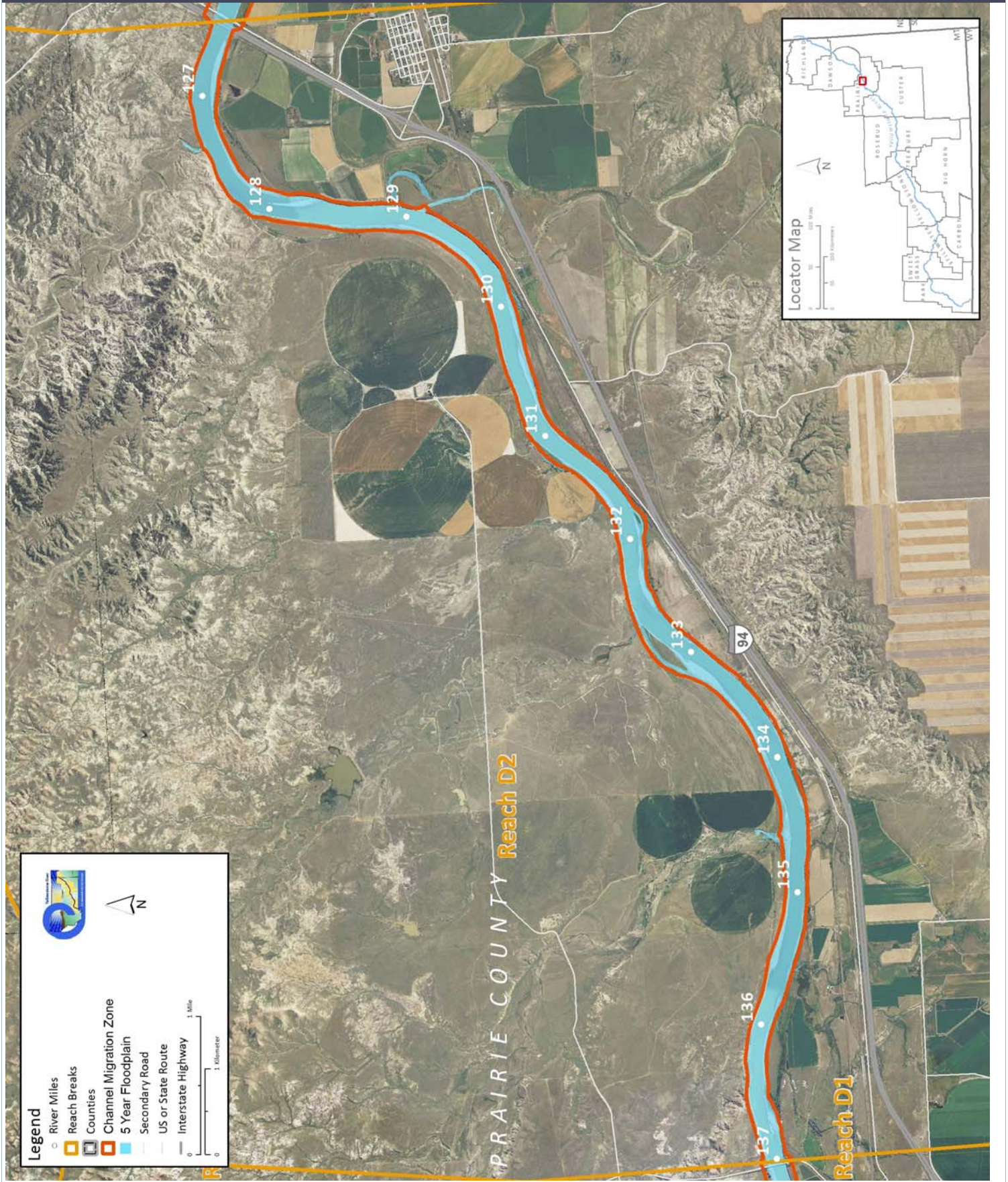
The following table summarizes some key CEA results that have been used to describe overall condition and types of human influences affecting the river. The values are specific to this single reach. Blanks indicate that a particular value was not available for this area. This information is consolidated 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)	68,300	53,100	-22.3%			
100 Year (cfs)	141,000	120,000	-14.9%			
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.
	1,007.7	979.9	984.9	993.8	-13.9	
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	1,055	0.9%	166			
Concrete Riprap	0	0.0%	0			
Flow Deflectors	0	0.0%	0			
Total	1,055	0.9%	166			
Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s	Numerous side channels have been blocked by small dikes.			
	0	0				
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	48.8	32.3	48.3 acres			
Acres/Year	1.9	1.3				
Acres/Year/Valley Mile	0.2	0.1				
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)	-117	51.9	3.4	-61.7		
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	100.7	57%				
100 Year	39.7	7%				
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.			
	5.6	0%				
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)	7,045.8	6,783.1	Flood (Ac)	630.5	711.7	
Ag. Infrastructure (Ac)	9.7	60.7	Sprinkler (Ac)	0.0	0.0	
Exurban (Ac)	0.0	3.2	Pivot (Ac)	0.0	1,070.2	
Urban (Ac)	0.0	0.0				
Transportation (Ac)	142.2	348.3				
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	2.8	5.2	2.0%		
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	11.0	1.1	38.4			
Emergent	22.9	2.3				
Scrub/Shrub	4.5	0.5				
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.			
	10.8	1.0%				
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.	
	7.2	1.6	7.4	0.2		

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP



County	Prairie	Upstream River Mile	126.5
Classification	PCS: Partially confined straight	Downstream River Mile	118.1
General Location	Downstream of Fallon Bridge	Length	8.40 mi (13.52 km)

Narrative Summary

Reach D3 straddles the Prairie/Dawson County line, extending from the Fallon Bridge to about two miles into Dawson County. The reach is 8.4 miles long and has been classified as a Partially Confined Straight (PCS) reach type, indicating minimal meandering and some influence of the valley wall on river form and process. Sandstones of the Fort Union Formation typically form the south bank, and younger erosion-resistant terraces confine the channel to the north. Because of the geologic confinement, channel migration rates are low and the riparian corridor is notably thin or absent. The Channel Migration Zone (CMZ) is extremely narrow because there has been only minor bank migration in this reach since 1950. All of the migration measured in the reach was at RM 123, where the river abruptly hits the south valley wall and apparently backwaters as it has developed a series of islands that drive local bank movement. From 1950 to 2011, the right bank migrated almost 900 feet at this single location. These islands provide areas for riparian colonization and habitat for bird species such as least terns.

Approximately 1,500 feet of bank armor have been mapped in the reach; about 2/3 of that armor protects the Interstate Bridge, with the remainder (600 feet) protecting irrigated land. Two pipelines cross the river about 1,000 feet downstream from the Interstate Bridge. One is an 8-inch petroleum product line that has been abandoned and purged, and the other is a product line that was directionally drilled in 1999. About 4,000 feet downstream from the Fallon Bridge, three large bridge piers from an old trestle remain in the middle of the river.

The Glendive Pump Station #1 is located about two miles downstream of the Fallon Bridge at RM 124.5L and is part of the Glendive Unit of the Buffalo Rapids Project. Construction of the unit began November 12, 1937, with ground breaking for excavation of the main canal. The following April 1938, excavation began on the lateral system. The first operation of the pumping station occurred on September 26, 1939, before the Unit was completed; diverted water was allowed to flow about ten miles down the main canal. Ice damage in 2012 required in extensive repairs to the pumping station. The unit serves 16,500 acres of irrigated land.

Land use in Reach D3 is predominantly agricultural, with about 600 acres of pivot irrigation development since 1950. All of the pivots are on the north side of the river, and several of them extend to the river bank and into the CMZ. In total, 57 acres of land under pivot irrigation are within the CMZ, making them especially prone to the threat of bank erosion. Although there has been extensive pivot development, most irrigated land had remained in flood irrigation in 2011 (1,500 acres).

Dump sites were mapped on the banks or in adjacent riparian areas at RM 125.6R, RM 124.2L, and RM 122L.

The most recently available map of the proposed Keystone Pipeline route shows that the line would cross the Yellowstone River at the lower end of Reach D3, at approximately RM 118.2 (www.keystone.steamingmules.com). The river is at Milepost 198 on the proposed pipeline route.

About 108 acres or 49 percent of the historic 5-year floodplain has become isolated in Reach D3, primarily due to flow alterations.

There are 11 acres of mapped Russian olive in the reach.

Bluff pools and terrace pools make up 22 percent of the low flow fish habitat mapped in the reach, indicating that this reach may provide important areas for fish species that prefer this habitat type.

A hydrologic evaluation of flow depletions indicates that flow alterations over the last century have been major in this reach. The magnitude of the 100-year flood is now 20,000 cfs or 14 percent lower than it was pre-development. The 2-year flood, which strongly influences overall channel form, has dropped by 22 percent. Low flows have also been impacted; severe low flows described as 7Q10 (the lowest average 7-day flow anticipated every ten years) for summer months has dropped from an estimated 4,820 cfs to 2,750 cfs with human development, a reduction of 43 percent. More typical summer low flows, described as the summer 95% flow duration, have dropped from 6,970 cfs under unregulated conditions to 3,240 cfs under regulated conditions, a reduction of 55 percent.

Seasonal low flows have increased by 62 percent in the winter and 75 percent in the fall.

CEA-Related observations in Reach D3 include:

- Isolation of historic 5-year floodplain area due to flow alterations

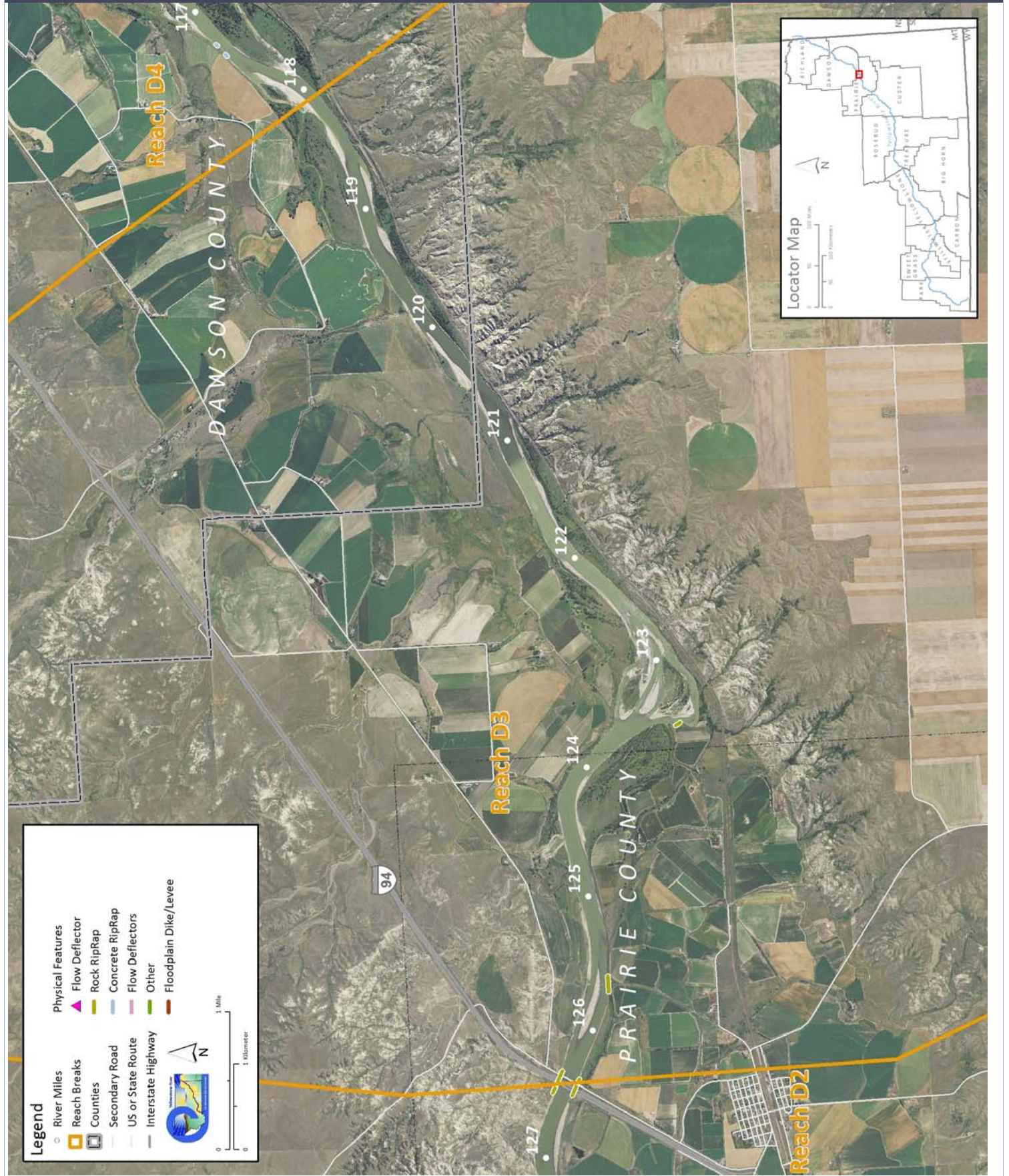
Recommended Practices (may include Yellowstone River Recommended Practices--YRRPs) for Reach D3 include:

- Solid waste (dump site) removal at RM 125.6R, RM 124.2L, and RM 122L
- Pipeline crossing practices at RM 126.2
- Russian olive removal

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)	68,900	53,700	-22.1%			
100 Year (cfs)	143,000	123,000	-14.0%			
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.
	859.0	873.8	874.4	875.1	16.1	
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	1,492	1.7%	210			
Concrete Riprap	0	0.0%	0			
Flow Deflectors	0	0.0%	0			
Total	1,492	1.7%	210			
Length of Side Channels Blocked (ft)	Pre-1950s	Post-1950s	Numerous side channels have been blocked by small dikes.			
	0	0				
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	85.7	56.1	13.81 acres			
Acres/Year	3.3	2.2				
Acres/Year/Valley Mile	0.4	0.3				
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)	-86.9	37	13.8	-36.1		
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	107.6	49%				
100 Year	100.7	13%				
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.			
	17.7	1%				
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)	5,808.1	5,698.2	Flood (Ac)	1,421.0	1,504.2	
Ag. Infrastructure (Ac)	21.5	69.3	Sprinkler (Ac)	0.0	0.0	
Exurban (Ac)	0.0	0.0	Pivot (Ac)	0.0	597.7	
Urban (Ac)	0.0	0.0				
Transportation (Ac)	65.1	78.0				
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.	
	5.3	0.0	5.3	1.0%		
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	12.1	1.5	99.3			
Emergent	80.1	10.2				
Scrub/Shrub	7.1	0.9				
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.			
	10.7	0.9%				
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.	
	30.6	7.8	5.5	-25.1		

PHYSICAL FEATURES MAP (2011)



CHANNEL MIGRATION ZONE MAP

