APPENDIX C
BIG SPRING CREEK TMDL TECHNICAL ASSISTANCE AERIAL PHOTOGRAPHY ASSESSMENT (FINAL)
BEAVER CREEK

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TABLE OF CONTENTS

APPENDICES

FIGURES AND TABLES

FIGURES

Associated Figures are provided separately.

TABLES

1.0 INTRODUCTION

This report presents the results of a remote assessment of channel and riparian vegetation conditions that was conducted for Beaver Creek, tributary to Big Spring Creek in central Montana. This assessment of Beaver Creek is a portion of the assessment of Big Spring Creek and three of its tributary streams: Cottonwood Creek, Beaver Creek and East Fork of Big Spring Creek. Big Spring Creek is a tributary to the Judith River and is located in Central Montana near Lewistown. Under Section 303(d) of the Clean Water Act, three of the above streams, Big Spring Creek, Cottonwood Creek and Beaver Creek, are listed on the 2002 Montana 303(d) List. Existing data on the East Fork of Big Spring Creek were insufficient for making a beneficial use support determination in 2002, and the stream was scheduled for reassessment. Table 1-1 summarizes 303(d) status of the streams assessed in this report.

Table 1-1 ***303(d) Status of Beaver Creek and Selected Tributaries in 2002***

Stream	Beneficial Uses Impacted	Probable Causes	Probable Sources
Big Spring Creek	Aquatic Life Cold Water Fishery	Fish Habitat Degradation Nutrients PCBs Riparian Degradation Sedimentation	Municipal Point Sources Agriculture Grazing Land Disposal Septic Systems Hydromodification Channelization
Cottonwood Creek	Aquatic Life Cold Water Fishery Drinking Water Supply Industrial Recreation	Dewatering Fish Habitat Degradation Flow Alteration Nutrients Organic Enrichment Riparian Degradation Sedimentation	Agriculture Grazing Hydromodification Habitat Modification Removal of Riparian Vegetation
Beaver Creek	Aquatic Life Cold Water Fishery Drinking Water Supply Recreation	Bank erosion Dewatering Fish habitat degradation Flow alteration Nutrients Riparian Degradation Sedimentation	Agriculture Grazing Habitat Modification Removal of Riparian Vegetation
East Fork of Big Spring Creek	Scheduled for Reassessment	Scheduled for Reassessment	Scheduled for Reassessment

According to the Montana Water Quality Act, the State of Montana must monitor the extent to which the state's surface water bodies support legally designated beneficial uses. As part of this monitoring, the state must develop Total Maximum Daily Loads (TMDLs) and associated water quality restoration plans for Montana water bodies in which one or more pollutants impair designated beneficial uses. The Montana Department of Environmental Quality (MDEQ) will be developing a TMDL for Big Spring Creek Planning Area. The results of the remote assessment presented in this report were designed to provide technical assistance to the MDEQ Big Spring Creek TMDL Assessment (MDEQ Task Order No. 202104-03). A copy of MDEQ Task Order No. 202104-03 is provided as Appendix A.

2.0 METHODS

Black and white stereo aerial photography, 7.5-minute topographic maps and planimetric maps were used to delineate the target streams into relatively homogeneous reaches. Reach breaks were established using the following criteria: 1) at status boundaries as delineated by the applicable planimetric map, 2) at significant changes in channel slope, valley type, 3) at functional changes in riparian vegetation and 4) at the confluence of major tributary streams. Reach names and breaks were transcripted onto the topographic maps and aerial photos. Table 2-1 provides a summary of the topographic and planimetric maps used for each target stream.

Table 2-1 ***Map Summary***

Stream	Topographic Map(s)	Planimetric Map(s)
Big Spring Creek	Danvers Spring Creek Junction Glengarry Lewistown Pike Creek	BLM Lewistown 1:100,000-scale planimetric map
Cottonwood Creek	Spring Creek Junction Glengarry West Fork Beaver Creek Castle Butte Jump Off Peak	BLM Lewistown 1:100,000-scale planimetric map
Beaver Creek	Glengarry West Fork Beaver Creek Castle Butte	Lewis and Clark National Forest Forest Visitors Map
E. Fork of Big Spring Creek	Heath Half Moon Canyon	BLM Big Snowy 1:100,000-scale planimetric map

Within each reach, aerial photography was used to characterize and assess several parameters (described below in Section 2.1) pertaining to channel and riparian vegetation condition for each target stream. The dates of the aerial photographs varied somewhat between the streams: aerial photo coverage from June 6, 1989 was used to assess Big Spring Creek; aerial photos taken on May 30, 1995 were used to assess the three target tributaries to Big Spring Creek. All aerial photographs were at a scale of 1:6,000. Data were entered into the *Watershed Condition Inventory Remote Data Collection Form* created by Land & Water Consulting and edited and approved by Pete Schade of the MDEQ. Completed data forms are included as Appendix B.

Each target stream was assessed from its mouth to its headwaters, with the exception of East Fork of Big Spring Creek where aerial photo coverage was not available for approximately the lower eight miles of the stream. Because of the lack of photo coverage these eight miles were not included in this assessment.

2.1 Assessment Parameters

The following parameters were included in the aerial photo assessment:

2.1.1 Reach Information

Reach Name: Consists of the first three letters of the target stream name followed by a number (e.g. COT14). Reaches are numbered consecutively from the stream's mouth to its headwaters.

Reach Length (ft): The linear length of the specified stream reach. Measured to the nearest foot using a digital planimeter and topographic map.

2.1.2 Riparian Vegetation Area

Buffer Width: Measured to the nearest 5 feet to a maximum of 50 feet. An average width of the riparian vegetation buffer adjacent to both sides of the stream in the delineated reach.

Vegetation Type (%): Occularly assessed from the aerial photos. Types included (within a 50' buffer): 1) Conifers and Deciduous Trees, 2) Woody Shrubs, 3) Grass/Sedge (groundcover), 4) Bare ground/Disturbed and 5) Impervious/Urban.

Vegetation Condition: This parameter was replaced by "Vegetation Impact Category", described below. The replacement was made to more accurately organize and compare the reaches. This parameter appears on the data collection forms, but no data were collected.

Degraded Riparian Vegetation: number of feet of stream bank (both sides) with human-impacts to riparian vegetation. Impacts included: 1) areas that had physically observable damaged riparian communities (e.g. trampled), 2) complete lack of riparian vegetation and 3) no woody vegetation observable on banks where such vegetation would be expected based on comparison with upstream/downstream reaches. Impacted riparian vegetation areas were transcribed onto topographic maps and impacted areas were measured to the nearest decimal foot with GIS. The percentage of the reach with degraded riparian vegetation was then calculated by the following formula:

(feet degraded riparian vegetation) / (feet of stream bank, both sides) = % of the reach impacted

Vegetation Impact Category: The reaches were ranked according to the level (% of reach) of impacts and assigned to an impact category according to the following criteria: 1) degraded riparian conditions along 50% or more of the reach indicates a **Highly Impacted** condition; 2) degraded riparian conditions along 25-49% of the reach indicates a **Moderately Impacted** condition; and 3) degraded riparian conditions along 1-24% of the reach indicates a **Lightly Impacted** to riparian vegetation condition. Only reaches with no observable impacts to riparian vegetation (% of reach impacted = 0) were ranked as **Not Impacted**.

2.1.3 Channel Condition

Sinuosity: Sinuosity = reach channel length / reach valley length (as measured from an aerial photo)

Valley Gradient or Slope (%): Gradient = change in elevation in feet / distance of elevation change in feet (measured between contour intervals from the topographic map)

Rosgen Type (Level 1): Stream channel classification based on channel slope, sinuosity, valley type, stream pattern and form (Rosgen, 1996).

Rosgen Type Potential (Level 1): Potential (future) Rosgen stream classification based on occular evidence of natural stream geomorphologic transition *or* evidence of a degraded stream condition that with improvement would have a different stream classification

Channel Degradation: Evidence of the following channel degradation characteristics on an aerial photo: 1) Rip rap, 2) Channelization, 3) Unstable Banks, 4) Severely Eroding Banks. Unstable banks were characterized as those with ocular evidence of light to moderate erosion, while severely eroding banks were characterized as those with evidence of wider scale bank slumping, mass wasting or bank failure.

Impacted channel areas were transcribed onto topographic maps and impacted areas were measured to the nearest decimal foot with GIS. The percentage of the reach with each of the above channel characteristics was then calculated by the following formula:

(feet of channel characteristic) / (feet of stream bank, both sides) = % of the reach impacted

Overall Channel Condition: This parameter was replaced by "Channel Impact Category", described below. The replacement was made to more accurately organize and compare the reaches. This parameter appears on the data collection forms, but no data were collected.

Channel Impact Category: The reaches were ranked according to the cumulative score of *anthropogenic* impacts created by the summation of % of each reach in the four channel degradation parameters (rip rap, channelization, unstable banks, severely eroding banks): reaches with a cumulative score greater than 50 were labeled as **Highly Impacted;** reaches with a score of 25 to 49 were labeled as **Moderately Impacted**; reaches with a score of 1 to 24 were labeled as **Lightly Impacted**; reaches with a score of 0 were labeled as **Not Impacted**. In calculating the channel impact score, the eroding stream banks that appeared to result from naturally erodible bank terraces were removed so that only anthropogenic impacts were included.

Meander Cutoff Potential: Subjective rating of Low, Medium or High potential that a stream meander will be cut off in the future due to erosion/deposition.

2.1.4 General Characteristics

Reference Potential: Whether or not the reach could be considered *reference*, or a reach representing "ideal" or least impacted channel and vegetation characteristics

Land Use: Adjacent anthropogenic or natural land use characteristics that may be contributing to water quality impairment and/or bank instability. Land use comments were transcripted onto aerial photos.

3.0 IMPACT SUMMARY

3.1 Beaver Creek

This section presents a summary and analysis of selected riparian and channel condition variables. **Appendix B** presents a tabular summary of all of the data collected on Beaver Creek.

3.1.1 Riparian Vegetation Impacts

Table 3-1 provides a summary of selected characteristics of riparian vegetation on Beaver Creek. The majority of the reaches were classified as Highly and Moderately Impacted, indicating riparian degradation between 25 and 50 percent of the reach. Beaver Creek reaches that were ranked as Lightly or Not Impacted will be considered "Vegetation Reference Reaches" for the purposes of this assessment (Section 4.0).

Table 3-1 ***Riparian Vegetation Characteristics – Beaver Creek***

Reach	Total Bank Length (ft)	Buffer Width (ft)	Vegetation Type (% of reach)					Degraded Riparian Vegetation (%)	Vegetation Impact Category
			Con/Dec (%)	Woody Shrub (%)	Bare ground/ disturbed (%)	Grass/ Sedge (%)	Impervious/ Urban (%)		
BEA9	12638	15	20	20	0	60	0	83	Highly Impacted
BEA12	16704	10	5	20	0	75	0	80	Highly Impacted
BEA8	15788	15	5	35	0	60	0	79	Highly Impacted
BEA7	8282	10	5	30	5	60	0	78	Highly Impacted
BEA5	17234	15	5	60	0	35	0	69	Highly Impacted
BEA16	8490	15	25	25	0	50	0	65	Highly Impacted
BEA17	12170	15	30	20	0	50	0	65	Highly Impacted
BEA3	9804	20	30	40	0	25	5	57	Highly Impacted
BEA4	11218	30	55	20	0	20	5	51	Highly Impacted
BEA2	16234	10	5	20	5	70	0	45	Moderately Impacted
BEA18	5732	50	0	60	0	40	0	37	Moderately Impacted
BEA6	14234	35	5	75	0	20	0	35	Moderately Impacted
BEA11	14364	50	5	75	0	20	0	28	Moderately Impacted
BEA15	12794	25	30	30	0	40	0	28	Moderately Impacted
BEA10	15586	50	5	70	0	25	0	23	Lightly Impacted
BEA14	11184	>50	40	40	0	20	0	8	Lightly Impacted
BEA1	8844	>50	5	80	0	15	0	0	Not Impacted
BEA13	8418	50	10	75	0	15	0	0	Not Impacted
BEA19	39324	>50	75	15	0	10	0	0	Not Impacted

3.1.2 Stream Channel Characteristics

Table 3-2 provides a summary of selected stream channel characteristics of Beaver Creek. There were no Highly Impacted reaches with respect to channel condition; all reaches fell into the Moderately Impacted, Lightly Impacted or Not Impacted categories. Beaver Creek reaches that were ranked as Lightly or Not Impacted will be considered "Channel Reference Reaches" for the purposes of this assessment (Section 4.0). Note that the Cumulative Channel Impact Score is the sum of the four Channel Degradation Characteristics minus the portion of the eroding banks that were classified as natural erosion from unvegetated terraces.

Table 3-2 ***Stream Channel Characteristics – Beaver Creek***

Reach	Total Bank Length (ft)	Channel Degradation Characteristics (% of reach)				Minus (-) "Natural" Erosion	Cumulative Channel Impact Score	Channel Impact Category
		Rip rap	Channelized	Unstable Banks	Severely Eroding Banks			
BEA12	16704	1	0	37	8	0	46	Moderately Impacted
BEA9	12638	0	11	19	15	0	45	Moderately Impacted
BEA17	12170	0	0	35	2	0	37	Moderately Impacted
BEA16	8490	0	16	19	0	0	35	Moderately Impacted
BEA4	11218	3	11	11	4	0	29	Moderately Impacted
BEA3	9804	6	0	18	3	0	26	Moderately Impacted
BEA7	8282	0	0	11	9	0	20	Lightly Impacted
BEA8	15788	0	0	11	9	0	20	Lightly Impacted
BEA5	17234	0	2	12	4	0	17	Lightly Impacted
BEA2	16234	3	0	7	2	0	12	Lightly Impacted
BEA10	15586	0	0	7	5	0	12	Lightly Impacted
BEA6	14234	0	0	4	7	0	11	Lightly Impacted
BEA15	12794	0	0	10	0	0	10	Lightly Impacted
BEA18	5732	0	0	6	0	0	6	Lightly Impacted
BEA14	11184	0	0	5	0	0	5	Lightly Impacted
BEA11	14364	0	0	0	2	0	2	Lightly Impacted
BEA1	8844	0	0	0	0	0	0	Not Impacted
BEA13	8418	0	0	0	0	0	0	Not Impacted
BEA19	39324	0	0	0	0	0	0	Not Impacted

Table 3-3 provides a comparison of Vegetation and Channel Impact ratings, listed from the most highly impacted to the least impacted. In general, vegetation and channel conditions in each reach were within one impact category of one another, with the exceptions of BEA5, BEA7 and BEA8, where the vegetation was highly impacted but the channel only lightly impacted.

Table 3-3 ***Vegetation/ Channel Impact Comparison - Beaver Creek***

Reach	Vegetation Impact Category	Channel Impact Category	Reach	Vegetation Impact Category	Channel Impact Category	Reach	Vegetation Impact Category	Channel Impact Category
BEA3	Highly Impacted	Moderately Impacted	BEA7	Highly Impacted	Lightly Impacted	BEA10	Lightly Impacted	Lightly Impacted
BEA4	Highly Impacted	Moderately Impacted	BEA8	Highly Impacted	Lightly Impacted	BEA14	Lightly Impacted	Lightly Impacted
BEA9	Highly Impacted	Moderately Impacted	BEA2	Moderately Impacted	Lightly Impacted	BEA1	Not Impacted	Not Impacted
BEA12	Highly Impacted	Moderately Impacted	BEA6	Moderately Impacted	Lightly Impacted	BEA13	Not Impacted	Not Impacted
BEA16	Highly Impacted	Moderately Impacted	BEA11	Moderately Impacted	Lightly Impacted	BEA19	Not Impacted	Not Impacted
BEA17	Highly Impacted	Moderately Impacted	BEA15	Moderately Impacted	Lightly Impacted			
BEA5	Highly Impacted	Lightly Impacted	BEA18	Moderately Impacted	Lightly Impacted			

3.1.3 Previous Assessments

The National Resource Conservation Service (NRCS) performed a helicopter survey of several of the Big Spring Creek tributaries in 1995. Observations that could be compared with Land & Water's assessment of Beaver Creek are summarized below in Table 3-4.

Table 3-4 ***1995 Helicopter Survey (NRCS) - Beaver Creek***

Source	Channelization	"Entrenched/Eroding Banks/Active Erosion Site"	"Impacted/Absent Veg. Community"
1995 NRCS Survey	3,427	3,557	15,363
Land & Water Assessment	4,230	36,625 (Unstable Banks + Severely Eroding Banks)	105,960 (Degraded Riparian Vegetation)

All data are in feet
All data includes both natural and anthropogenic sources

In all three data categories presented in Table 3-4, Land & Water found higher levels of impact than were found in the NRCS helicopter survey. The reasons for the different findings are not clear, but probably result from the different methodologies employed in the two assessments. No information regarding the method used by the NRCS or how the agency defined vegetation impacts or eroding banks was located for this report.

4.0 DISCUSSION/RECOMMENDATIONS

4.1 Relationship of Riparian Vegetation Characteristics with Channel Erosion

Select riparian characteristics were compared to the total percentage of unstable and eroding banks in each reach in order to provide a quantitative estimate of the correlation between riparian vegetation and bank stability (Table 4-1). The combined % of unstable and eroding banks was sorted and divided in quartiles, and the data presented in Table 4-1 are presented separately for each of these quartiles. In general, erosion decreased as buffer width, tree cover and shrub cover increased, conforming to the expectation that woody vegetation stabilizes stream banks. Conversely, increased grass and sedge coverage was associated with increasing erosion.

Table 4-1 ***Comparison Between Riparian Vegetation Characteristics and Channel Erosion - Beaver Creek***

	Riparian Vegetation Characteristics						
Reach	**Buffer Width (ft)**	**Con/Dec (% of reach)**	**Woody Shrub (% of reach)**	**Bare ground/ disturbed (% of reach)**	**Grass/ Sedge (% of reach)**	**Impervious/ Urban (% of reach)**	**Combined Unstable/Eroding Banks (% of reach)**
BEA12	10	5	20	0	75	0	46
BEA17	15	30	20	0	50	0	37
BEA9	15	20	20	0	60	0	34
BEA3	20	30	40	0	25	5	21
BEA7	10	5	30	5	60	0	20
Averages Quartile 4	*14*	*18*	*26*	*1*	*54*	*1*	*32*
BEA8	15	5	35	0	60	0	20
BEA16	15	25	25	0	50	0	19
BEA5	15	5	60	0	35	0	16
BEA4	30	55	20	0	20	5	15
BEA10	50	5	70	0	25	0	12
Averages Quartile 3	*25*	*19*	*42*	*0*	*38*	*1*	*16*
BEA6	35	5	75	0	20	0	11
BEA15	25	30	30	0	40	0	10
BEA2	10	5	20	5	70	0	9
BEA18	50	0	60	0	40	0	6
BEA14	>50	40	40	0	20	0	5
Averages Quartile 2	*30*	*16*	*45*	*1*	*38*	*0*	*8*
BEA11	50	5	75	0	20	0	2
BEA1	>50	5	80	0	15	0	0
BEA13	50	10	75	0	15	0	0
BEA19	>50	75	15	0	10	0	0
Averages Quartile 1	*50*	*24*	*61*	*0*	*15*	*0*	*1*

4.2 Characteristics of Reference Reaches

Vegetation and Channel Reference Reaches were identified for Beaver Creek to provide a gauge for forming restoration targets. As was discussed in Section 3.1.1 and 3.1.2, reference reaches are those that were classified as Lightly or Not Impacted in the vegetation and channel condition assessments. Reaches in reference condition occurred throughout the three regions of Beaver Creek (upper, middle, and lower). A summary of the average characteristics of the reference reaches is presented for vegetation and channel conditions in Table 4-2 and 4-3, respectively.

Table 4-2 ***Vegetation Reference Reaches - Beaver Creek***

Location on Beaver Cr.	Reach	Coniferous/Deciduous (%)	Woody Shrub (%)	Degraded Riparian Vegetation (%)
Middle	BEA10	5	70	23
Upper	BEA14	40	40	8
Lower	BEA1	5	80	0
Upper	BEA13	10	75	0
Upper	BEA19	75	15	0
	averages	*27*	*56*	*6*
	TARGET	27% tree + 56% shrub = **≥ 83% tree/shrub types**		**Degraded Riparian Vegetation ≤ 6%**

Table 4-3 ***Channel Reference Reaches - Beaver Creek***

Location on Beaver Cr.	Reach	Channelization (%)	Unstable Banks (%)	Severely Eroding Banks (%)
Middle	BEA7	0	11	9
Middle	BEA8	0	11	9
Lower	BEA5	2	12	4
Lower	BEA2	0	7	2
Middle	BEA10	0	7	5
Lower	BEA6	0	4	7
Upper	BEA15	0	10	0
Upper	BEA18	0	6	0
Middle	BEA14	0	5	0
Middle	BEA11	0	0	2
Lower	BEA1	0	0	0
Upper	BEA13	0	0	0
Upper	BEA19	0	0	0
	averages	0	6	3
	TARGET	**Channelized 0%**	6% unstable + 3% severely eroding = **Eroding Banks ≤ 9%**	

4.3 Comparison of Reference Reaches with Highly Degraded Reaches

The target conditions derived in Tables 4-2 and 4-3 above were compared to the conditions in the most degraded reaches on Beaver Creek. For Beaver Creek, the "most degraded" reaches were defined to be those in which the vegetation condition and/or the channel condition were rated as Highly Impacted (Table 3-3). These represent reaches of Beaver Creek that appear to be in the greatest need of restoration and where the largest potential reductions in sediment loading could be achieved. Table 4-4 summarizes the most degraded reaches and describes their land use characteristics. Table 4-5 compares the most degraded reaches to reference conditions.

Table 4-4 ***"Most Degraded" Reaches – Beaver Creek***

Reach	Location on Beaver Cr.	Vegetation Impact Category	Channel Impact Category	Land Use Characteristics
BEA3	Lower	Highly Impacted	Moderately Impacted	ranch on LB; extensive grazing; 2 bridges both with riprap; dirt roads; 1 agriculture field to within 20' of bank LB/RB
BEA4	Lower	Highly Impacted	Moderately Impacted	fields to edge, LB/RB; 2 bridges; riprap
BEA9	Middle	Highly Impacted	Moderately Impacted	ranch; fields to edge; RB/LB; 1 fiord; 1 bridge; road and stock access near ranch facility
BEA12	Middle	Highly Impacted	Moderately Impacted	grazing; ranch on LB
BEA16	Upper	Highly Impacted	Moderately Impacted	grazing; stock access
BEA17	Upper	Highly Impacted	Moderately Impacted	2 bridges; grazing
BEA5	Lower	Highly Impacted	Lightly Impacted	channelized ~ 300' road; 1 bridge; grazing
BEA7	Middle	Highly Impacted	Lightly Impacted	field to edge RB/LB; 2 bridges; ranch
BEA8	Middle	Highly Impacted	Lightly Impacted	creek runs through agriculture fields with little to no buffer; 1 bridge

LB = left bank
RB = right bank

Table 4-5 ***"Most Degraded" Reach Target Characteristic Values – Beaver Creek***

	Target Characteristic	*Target Value (%)*	BEA3	BEA4	BEA9	BEA12	BEA16	BEA17	BEA5	BEA7	BEA8
Vegetation	Tree/shrub Types	≥ *83*	70	75	40	25	50	50	65	35	40
	Degraded Riparian Vegetation	≤ *6*	57	51	83	80	65	65	69	78	79
Channel	Channelized	*0*	0	11	11	0	16	0	2	0	0
	Eroding Banks	≤ *9*	21	15	34	45	19	37	16	20	20

4.4 Restoration Focus Areas

4.4.1 Previous Restoration Activities

In 1995, the NRCS conducted several restoration projects on privately owned and state land on Beaver Creek. Table 4-6 describes the restoration projects that were detailed in the NRCS study. There was no information available regarding the success of these projects or describing whether the riparian management was continued past the 1995 study.

Table 4-6 ***1995 NRCS Restoration Projects***

Reach	Owner	Riparian Fencing (ft)	Channel Improved* (ft)	Stream/Riparian Improved* (ft)	Off-site Watering Locations Provided	Comments
BEA16/ BEA17	Walt and Gail Regli	None	1,930	3,200	One	Complete

*No information was provided as to the improvement technique.

4.4.2 Restoration Priorities

For each of the "most degraded" reaches of Beaver Creek described in Section 4.3, this section summarizes the major impacts observed during the air photo assessment. Because of their heavily impacted condition, these reaches represent the areas most likely in need of restoration.

BEA3 - The primary impact was to riparian vegetation; 57% of the riparian vegetation community was degraded. The tree/shrub cover was within 13% of the target value. 21% of the channel was unstable or eroding, also within 13% of the target value for eroding banks. A ranch with evidence of grazing and fields/roads to within 20 feet of the bank edge was observed. Proper riparian function may be improved by providing off-site watering locations coupled with riparian fencing.

BEA4 – This reach was similar in characteristics to the adjacent downstream reach, BEA3 (above). The primary impact was to riparian vegetation; 51% of the riparian vegetation community was degraded. The tree/shrub cover was within 8% of the target value. 11% of the channel was unstable or eroding, within 6% of the target value for eroding banks. 11% of the channel had been channelized. Agricultural fields with limited streamside buffers were observed and 3% of the banks are stabilized with riprap.

BEA9 - The primary impact was to riparian vegetation; 83% of the riparian vegetation community was degraded. The tree/shrub cover was half of the target value. 34% of the channel was unstable or eroding, over three times the target value for eroding banks. 11% of the channel had been channelized. A ranch with fields to the bank edge and concentrated stock access was observed.

BEA12 - The primary impact was to riparian vegetation; 80% of the riparian vegetation community was degraded. The tree/shrub cover was approximately 25% of the target value. 45% of the channel was unstable or eroding, over four times the target value for eroding banks. A ranch with evidence of livestock grazing was observed.

BEA16 - The channel condition was relatively good; the percentage of unstable or eroding banks was within 10% of the target value and a small amount of the reach was channelized (16%). The primary impacts to the reach were to the riparian vegetation: 65% of the riparian vegetation was degraded. The tree/shrub cover was less than approximately 35% of the target value. Evidence of grazing and concentrated stock access was observed.

According to the 1995 NRCS data, between BEA16 and BEA17, 1,930 feet of the channel and 3,200 feet of the stream/riparian area was improved in 1995, although not information was provided to describe how these improvements were made. One off-site watering location was installed.

BEA17 – The riparian conditions were the same as in the adjacent downstream reach, BEA16 (above). 65% of the riparian vegetation was degraded. The tree/shrub cover was less than approximately 35% of the target value. 37% of the channel was unstable or eroding. Evidence of grazing was observed.

According to the 1995 NRCS data, between BEA16 and BEA17, 1,930 feet of the channel and 3,200 feet of the stream/riparian area was improved in 1995, although no information was provided to describe how these improvements were made. One off-site watering location was installed.

BEA5 - The primary impact was to riparian vegetation; 69% of the riparian vegetation community was degraded. The tree/shrub cover was approximately 20% below the target value. The channel condition was relatively good; the percentage of unstable or eroding banks was within 7% of the target value and a small amount of the reach was channelized (2%). Evidence of grazing was observed.

BEA7 - The primary impact was to riparian vegetation; 78% of the riparian vegetation community was degraded. The tree/shrub cover was nearly 50% below the target value. 20% of the channel was unstable or eroding, within 9% the target value for eroding banks. A ranch with evidence of grazing and agricultural fields to the bank edge was observed.

BEA8 – This reach was similar in characteristics to the adjacent downstream reach, BEA7 (above). The primary impact was to riparian vegetation; 79% of the riparian vegetation community was degraded. The tree/shrub cover was 50% of the target value. 20% of the channel was unstable or eroding, within 9% the target value for eroding banks. The stream ran through agricultural fields that were to the bank edge.

5.0 CONCLUSIONS

Degraded riparian vegetation appeared to be the most common impact to Beaver Creek and the greatest potential cause of increased sediment input. The primary sources of vegetation impacts were related to land use: agriculture and grazing appeared to have had significant impacts to riparian communities.

On the majority of the reaches, the vegetation condition was classified as Highly or Moderately Impacted, indicating that on the majority of the reaches, greater than 25% of the riparian vegetation was degraded. There were no Highly Impacted reaches with respect to channel condition; all reaches fell into the Moderately Impacted, Lightly Impacted or Not Impacted categories

Select riparian characteristics were compared to the total percentage of unstable and eroding banks in each reach in order to provide a quantitative estimate of the correlation between riparian vegetation and bank stability. Few if any connections between vegetation condition and bank stability were obvious from the comparison, suggesting a more complicated set of circumstances controls bank stability on Beaver Creek.

In general, the proportion of stream banks in unstable condition decreased as buffer width, tree cover and shrub cover increased, suggesting that woody vegetation is key to maintaining bank stability on Beaver Creek. As is presented below (Table 5-1), degraded riparian vegetation was observed along 44% of the total bank length of Beaver Creek, and 15% of the streambanks were rated as either unstable (11%) or severely eroding (4%). Only 1% of the banks have been stabilized with riprap and only 2% of the stream has been channelized, indicating that few permanent “hard” alterations have been made to Beaver Creek and suggesting that restoration potential is very good.

Table 5-1 ***Summary of Degradation Statistics***

Degraded Riparian Vegetation	Riprap	Channelization	Unstable Banks	Severely Eroding Banks
44%	1%	2%	11%	4%

The air photo assessment that was conducted for this report was not at a scale that allows for detailed site-specific restoration recommendations. However, the following general recommendations could guide restoration efforts, particularly in those reaches identified in Section 4.3 as “most degraded” and thus most in need of restoration:

- Providing at least a 50 foot vegetation buffer between Beaver Creek and fields/roads;
- Improving proper riparian function by providing off-site watering locations coupled with riparian fencing;
- Enhancing the tree and woody shrub community where there is potential to aid in erosion reduction or maintenance of bank stability;
- Restructuring of the channelized portions of the reach to a more sinuous condition to aid in reducing stream flow velocities; and
- Mechanical bank stabilization where possible.