FUTURE FISHERIES IMPROVEMENT PROGRAM GRANT APPLICATION

All sections must be addressed, or the application will be considered invalid

I. APPLICANT INFORMATION

A. Applicant Name: Clark Fork Coalition (Brian Chaffin, Executive Director)

Mailing Address: P.O. Box 7593

City: Missoula State: MT Zip: 59807

Telephone: 406-542-0539 E-mail: brian@clarkfork.org

B. Contact Person (if different than applicant): Gretchen Watkins

Address: 140 South 4th Street West, Suite 1

City: Missoula State: MT Zip: 59801

Telephone: 406-550-5514 E-mail: Gretchen@clarkfork.org

C. Landowner and/or Lessee Name (if different than applicant): Allan D. Frey and A'Lisa M. Scott

Mailing Address: 1655 Frey Lane

City: Missoula State: MT Zip: 59808

Telephone: Available upon request E-mail: alyssa@blackfoot.net

II. PROJECT INFORMATION

A. Project Name: Lower Grant Creek Restoration

River, stream, or lake: Grant Creek, 12-digit Hydrologic Unit Codes 170102040103

Location: Township: 13N Range: 20W Section: 14

Latitude: 46.879677 Longitude: -114.095970 *Within project (decimal degrees)*

County: Missoula

B. Purpose of Project: *(high level, focus on why the project is important)*

The purpose of this project is to address one of the most impacted reaches on Grant Creek, spanning approximately 5000 feet of Dale Frey's and A'Lisa Scott's property and 800 feet on Cory's, just upstream of the Fish Wildlife and Parks fishing access points and the confluence with the Clark Fork River. This reach has vertically eroding banks up to 6 feet high, contributing large amounts of sediment to the stream. Additionally, there is a loss of connectivity between the channel and floodplain, reduced habitat, and diminished riparian vegetation and cover. The landowners, who raise cattle, are committed to limiting livestock access to the creek with a 35 feet buffer minimum. Cattle access is a significant source of sediment and nutrients and hinders riparian vegetation growth. Restoring this section will improve temperature, habitat and ensure adequate connectivity with the Clark Fork River and its tributary Grant Creek to enhance natural recruitment and refuge for fish. This will improve fishing at the adjacent Kelly Island (off Council Way) FWP Public Fishing Access.

C. Brief Project Description (attach additional information to end of application). Please include the anticipated construction schedule:

To address legacy grazing and development impacts, and enhance fish habitat, we will employ various restoration techniques. Treatments will include 5,800 feet of bank treatment, the installation of woody debris matrices, large wood structures, and over 8000 feet of fencing to protect riparian vegetation, including willow and other native plantings. We will also install two hardened crossings that will be gated, allowing for the possible installation of stock water tanks. The grazing management plan will help with vegetation establishment, and natural processes will provide adequate long-term maintenance once established. Additionally, cattle will be excluded from the riparian area to protect the restored vegetation and reduce sediment and nutrient input. Drawing on lessons from similar projects, CFC will implement effective treatments for each restoration issue on Grant Creek. For example, floodplain treatments will be set lower to activate during high flow, pools will be deepened to ensure longevity, and riparian vegetation will be watered as needed. Noxious weeds will be treated before and after restoration using herbicides and hand-pulling. The project benefits will be protected by a 20 year agreement with the landowner to fence out livestock to protect riparian areas and create wild fish habitat.

Project coordination and planning will start as soon as the notification of award. We will finalize the landowner agreement, grazing management plan, and final plan set in summer 2025. We will secure permits in the winter 2025-2026 and will solicit bids spring 2026. We plan to proceed to construction after July 1st, 2026, and complete the project by winter 2026. The final project elements include fencing, weed control, and plant maintenance which will conclude the 2-year project and be managed by the landowner agreement into the future. Educational activities and community outreach highlighting the project (i.e., field tours), will take place at the site throughout the project planning and construction window and into the future.

D. What was the cause of habitat degradation and how will the project correct the cause?

The degradation of habitat in Grant Creek stems from a combination of historical land use practices and hydrological alterations. Channel straightening during agricultural development disrupted the creek's natural meandering pattern, reducing habitat complexity and increasing erosion. The removal of riparian vegetation further exacerbated bank instability, leading to increased sedimentation and loss of shade, which has negatively impacted water temperature regulation. Additionally, the decline in beaver activity, once an important natural force for creating diverse aquatic habitat, has contributed to the creek's entrenched condition. Beyond these physical changes, significant upstream stormwater and irrigation flow manipulation have altered the timing, magnitude, and duration of instream flow, disrupting the natural hydrological balance. To correct these issues, the proposed restoration project will reintroduce native vegetation along the creek, providing shade to moderate water temperatures and improve overall habitat conditions. Bank stabilization efforts will reduce sedimentation, helping to maintain cleaner water and healthier spawning grounds for fish. The project will also incorporate large wood structures and floodplain reconnection, enhancing nutrient cycling and restoring more natural flow dynamics. These measures will collectively improve habitat complexity, supporting a more resilient and thriving aquatic ecosystem.

E. Length of stream or size of lake that will be treated (project extent): 5800

Length/size of impact, if larger than project extent (e.g., stream miles opened): _____

F. Project Budget Summary:

Grant Request (Dollars):	**$**	**80,000**
Matching Dollars:	**$**	**$130k DEQ secured / $50k DNRC pending**
Matching In-Kind Services:*	**$**	

**salaries of government employees are not considered matching contributions*

Other Contributions (not used as match)	**$**	**148,000**
Total Project Cost:	**$**	**408,000**

G. Attach itemized (line item) budget – *see budget template*

H. Attach project location map(s) that include:

- [x] Extent of the project, including context (relation to major landmark or town)
- [x] Indication of public and private property
- [x] Riparian buffer locations and widths (if applicable) and grazing locations

I. Attach project plans:

- [x] Detailed sketches or plan views with the location and proposed restoration
- [x] Pre-project photographs (GPS location strongly recommended)
- [ ] If water leasing or water salvage is involved, attach a supplemental questionnaire (https://myfwp.mt.gov/getRepositoryFile?objectID=36110)

J. Attach support letters or statements of (e.g., landowner consent, community or public support). For FWP statement, attach provided template. List any other project partners:

See attached letters from Dale Frey's and A'Lisa Scott's, Missoula Conservation District, Missoula City Stormwater, and Missoula County.

III. MAINTENANCE AND MONITORING (attach additional information to end of application):

A. A 20-year maintenance commitment is required*. Please confirm that you will ensure this protection and describe your approach. Attach any relevant maintenance plans. *If it is a water leasing project, describe the length of the agreement.*

Yes	No
x	

We will establish a landowner agreement that covers fencing to protect the 35-foot buffer of the restored riparian area.

B. Will grazing be part of or adjacent to the project? If so, describe or attach land management plans, including short term and long term grazing regimes. If the landowner is not the applicant, please describe their involvement in the project. *If you want assistance with grazing plan development, note your need.*

Yes, grazing will be adjacent to the restored area. Part of the grazing management plan and landowner agreement will be to fence out livestock. Landowners have independently sought financial assistance to pay for fencing in the past, and it is a critical component of this project that will be covered in the landowner agreement, grazing management plan and associated final plan set. The landowners have agreed to a 35-foot buffer from the creeks edge for at least 20 years.

C. Will the project be monitored to determine if goals were met? If so, what are the short-term and long-term plans to assess benefits and lessons learned? Were pre-project data collected? Will monitoring information be shared with FWP?

Yes, the project will be monitored to assess whether its goals are met, with both short-term and long-term plans in place to evaluate effectiveness and refine future restoration strategies. Pre-project data have already been collected, including Bank Erosion Hazard Index (BEHI) assessments, which will be compared to post-project data to estimate sedimentation reduction. To measure habitat improvements, photo point monitoring will be conducted before construction in fall 2025 and again two years later, following methodologies outlined in the *Oregon Watershed Enhancement Board Guide to Photo Monitoring.* Using the Solocator app, 10-12 photo points will be established with precise coordinates and bearings to document key restoration features. Additionally, the Clark Fork Coalition (CFC) will track plant mortality by conducting survival counts of installed woody riparian container stock in late summer 2026. CFC will oversee two seasons of site maintenance, ensuring proper vegetation establishment. If plant survival rates fall below 75%, at least 50% of the dead plants will be replaced after the 2027 mortality count to maintain restoration success. Furthermore, CFC has been collecting summer temperature and flow data since 2023 and 2024 and will continue monitoring these metrics until 2027, providing valuable insights into hydrological changes and their impact on aquatic habitat.
Monitoring information will be shared with Montana Fish, Wildlife & Parks (FWP), supporting broader conservation efforts and aligning with state fisheries management goals. These evaluations will help ensure that habitat connectivity and quality improvements contribute to the long-term health of fish populations and riparian ecosystems.

IV. PROJECT BENEFITS (attach additional information to end of application):

A. What species of fish will benefit from this project?

The restoration of Grant Creek will provide significant benefits to several key fish species that rely on healthy tributary systems for spawning, rearing, and migration. Bull trout (N) and westslope cutthroat trout (N), designated for conservation management, will see improvements in habitat quality and connectivity, which will help sustain both migratory and resident populations. Additionally, rainbow trout and brown trout, classified under quality management, will benefit from improved habitat conditions that enhance natural recruitment. By protecting adult spawners and maintaining connectivity between the Clark Fork River and its tributaries, this project will support the long-term health of both native and non-native trout populations. The enhanced ecological stability provided by restoration efforts will ultimately create a more sustainable fishery and reinforce Montana Fish, Wildlife & Parks' broader conservation goals.

B. How will the project protect or enhance wild fish habitat?

The restoration of Grant Creek near its confluence with the Clark Fork River aligns with key priorities outlined in the Statewide Fisheries Management Plan (2023-2026), particularly in improving habitat quality and connectivity. The restoration project will protect and enhance wild fish habitat by improving habitat quality and connectivity, which are essential for sustaining healthy fish populations. By stabilizing streambanks, reducing sedimentation, and restoring riparian vegetation, the project will create better spawning and rearing conditions and lower temperature from shading and spring connection benefiting native fish like bull trout, westslope cutthroat trout, rainbow trout, and brown trout. Grant Creek serves as an important tributary to the Clark Fork River, and restoration efforts will ensure that fish can migrate freely between Grant Creek cold-water refuges and productive mainstem river environments. Additionally, enhanced water quality and temperature regulation will support juvenile fish survival, while improved stream flow conditions will maintain critical upwelling areas used for potential trout spawning.

C. What is the expected improvement to fish populations, both short term and long term? How might the project translate to angler success?

The expected improvements to fish populations from restoring ranch land near Grant Creek could be quite promising. In the short term, habitat restoration—such as stabilizing streambanks, reintroducing native vegetation, and improving water flow—would enhance spawning habitat and reduce sedimentation and temperature, benefiting species like cutthroat and rainbow trout. Improved water quality and temperature regulation would also increase juvenile fish survival rates, leading to healthier populations.
In the long term, these efforts could create a more resilient aquatic ecosystem, boosting biodiversity and supporting larger, more robust fish stocks. Over time, better habitat conditions may lead to more consistent recruitment, ensuring sustainable fish populations in the region.
As for angler success at Kelly Island Fishing Access Site, restoration benefits could translate downstream. With a healthier upstream ecosystem, more fish will migrate between the Clark Fork and Grant Creek, increasing catch rates and possibly even the average size of wild fish available to anglers.

D. Will the project increase public fishing opportunity for wild fish and, if so, how? Is public fishing allowed onsite? Is it allowed by permission? If not, describe how the public would benefit.

Yes, the project will increase public fishing opportunities for wild fish by enhancing the aquatic habitat in Grant Creek and its connection to the Clark Fork River. Restoration efforts will improve water quality, stabilize streambanks, and restore natural flow conditions, creating better spawning and rearing habitat for trout. Over time, these improvements will lead to healthier fish populations, which will migrate between Grant Creek and the Clark Fork River, benefiting anglers at Kelly Island Fishing Access Site. Although fishing will not be allowed directly at the restoration site and is not permitted by permission, the public will still gain access to improved fishing conditions through the adjacent access site. Anglers at Kelly Island can expect increased catch rates, larger fish, and more consistent seasonal fishing as a result of the ecological benefits stemming from the immediately upstream restoration project.

E. Aside from angling, what local or large-scale public benefits will be realized from this project?

Beyond angling, the restoration of Grant Creek near the Clark Fork River will bring several ecological and recreational benefits to the local community. Improved riparian habitat and enhanced water quality will attract a greater diversity of birds, making the area more appealing for birdwatchers and nature enthusiasts. The reduction of excess nutrients in the water will lead to less algae growth, improving overall aquatic health and creating clearer water conditions. This, in turn, will benefit recreational activities such as swimming, making the creek and surrounding waters more enjoyable and safer for visitors. Additionally, the restoration will support a healthier watershed by stabilizing streambanks, reducing erosion, and enhancing flood resilience, contributing to long-term environmental sustainability. As the ecosystem improves, the project will strengthen the connection between people and nature, offering a more vibrant and accessible outdoor experience for the public.

F. Will the project interfere with water or property rights of adjacent landowners? (explain):

The restoration project will not interfere with the water or property rights of adjacent landowners. The downstream property is owned by the State of Montana Fish, Wildlife & Parks (FWP), and it is maintained as a public park. Since FWP prioritizes conservation and public access, the restoration efforts align with their long-term management goals for the area. Additionally, the project will enhance ecological conditions without altering water allocations or restricting property use, ensuring that adjacent landowners experience only positive environmental benefits. By improving habitat quality and stabilizing streambanks, the project will support fish and wildlife populations while maintaining the integrity of public lands for recreation and conservation.

G. Will the project result in the development of commercial recreational use on the site (including paid access)? Explain:

No

H. Is this project associated with the reclamation of past mining activity?

No

Each approved project applicant must enter into a written agreement with Montana Fish, Wildlife & Parks specifying terms and duration of the project. The applicant must obtain all applicable permits prior to project construction. A competitive bid process must be followed when using State funds.

V. AUTHORIZING STATEMENT

I (we) hereby declare that the information and all statements to this application are true, complete, and accurate to the best of my (our) knowledge and that the project or activity complies with rules of the Future Fisheries Improvement Program.

Applicant Signature:  Date: 5/15/2025

Submittal: **Applications must be signed and received on or before November 15 and May 15 to be considered for the subsequent funding period**. Late or incomplete applications will be rejected.

Mail to:	FWP Future Fisheries Fish Habitat Bureau PO Box 200701 Helena, MT 59620-0701	Email:	Future Fisheries Coordinator FWPFFIP@mt.gov (electronic submissions must be signed) For files over 10MB, use https://transfer.mt.gov and send to mmcgree@mt.gov

BUDGET TEMPLATE SHEET FOR FUTURE FISHERIES PROGRAM APPLICATIONS

Both tables MUST be completed appropriately or the application will be invalid. Please see the example budget sheet for clarification.

PROJECT COSTS					GRANT REQUEST AND FUNDING			
Work Items (Itemize by Category)	**Number of Units**	**Unit Description***	**Cost/Unit**	**Total Cost**	**FUTURE FISHERIES REQUEST**	**Matching Contributions (Cash or In-Kind)*** **	**Other Contributions (Funds not used as match)**	**Total Funding**
**Units = feet, hours, cubic yards, etc. Do not use lump sum unless necessary.*								
Personnel								
Survey				$ -				$ -
Design				$ -			11,000.00	$ 11,000.00
Engineering				$ -			11,000.00	$ 11,000.00
Permitting				$ -		5,000.00		$ 5,000.00
Oversight				$ -		14,224.00	31,000.00	$ 45,224.00
Maintenance**				$ -		9,000.00		$ 9,000.00
			Sub-Total	$ -	$ -	$ 28,224.00	$ 53,000.00	$ 81,224.00
Travel								
Mileage				$ -				$ -
Per diem				$ -				$ -
			Sub-Total	$ -		$ -	$ -	$ -
Construction Materials								
Cat. 1 Rock	110	CY	$10.00	$ 1,100.00		1,100.00		$ 1,100.00
Alluvium	2246	CY	$6.00	$ 13,476.00		13,476.00		$ 13,476.00
				$ -				$ -
				$ -				$ -
				$ -				$ -
				$ -				$ -
				$ -				$ -
				$ -				$ -
			Sub-Total	$ 14,576.00	$ -	$ 14,576.00	$ -	$ 14,576.00
Equipment, Labor, and Mobilization								
Diversions	1	LS	$5,000.00	$ 5,000.00	5,000.00			$ 5,000.00
Vegetation	1	LS	$5,000.00	$ 5,000.00	5,000.00			$ 5,000.00
Staging	1	LS	$1,500.00	$ 1,500.00	1,400.00	100.00		$ 1,500.00
Earthwork	3020	CY	$5.00	$ 15,100.00	15,100.00			$ 15,100.00
Channel	5800	LF	$25.00	$ 145,000.00		50,000.00	95,000.00	$ 145,000.00
Large wood	34	EA	$1,250.00	$ 42,500.00	42,500.00			$ 42,500.00
Matrix type 1	2650	LF	$15.00	$ 39,750.00		39,750.00		$ 39,750.00
Matrix type 2	1810	LF	$25.00	$ 45,250.00		45,250.00		$ 45,250.00
Wetland	2	AC	$5,500.00	$ 11,000.00	11,000.00			$ 11,000.00
Floodplain	1.4	Ac	$1,500.00	$ 2,100.00		2,100.00		$ 2,100.00
				$ -				$ -
			Sub-Total	$ 312,200.00	$ 80,000.00	$ 137,200.00	$ 95,000.00	$ 312,200.00
			OVERALL TOTALS	$ 326,776.00	$ 80,000.00	$ 180,000.00	$ 148,000.00	$ 408,000.00

(Revised 5/16/2025)

BUDGET TEMPLATE SHEET FOR FUTURE FISHERIES PROGRAM APPLICATIONS

OTHER REQUIREMENTS:

**For projects that include a maintenance request, it cannot exceed 10% of the total project cost.

***Match can include in-kind materials or labor. Justification for in-kind labor (e.g. hourly rates used) can be noted below. Do not use government salaries as match.

Additional budget detail:

APPLICATION MATCHING CONTRIBUTIONS

Total should equal match listed above; do not include requested funds

CONTRIBUTOR	IN-KIND	CASH	TOTAL	Secured? (Y/N)
	$ -	$ -	$ -	
	$ -	$ -	$ -	
	$ -	$ -	$ -	
	$ -	$ -	$ -	
	$ -	$ -	$ -	
	$ -	$ -	$ -	
	$ -	$ -	$ -	
	$ -	$ -	$ -	
TOTALS	$ -	$ -	$ -	

OTHER CONTRIBUTIONS

Total should equal other contributions listed above; these are funds not specically matched to the Future Fisheries application

CONTRIBUTOR	IN-KIND	CASH	TOTAL	Secured? (Y/N)
	$ -	$ -	$ -	
	$ -	$ -	$ -	
	$ -	$ -	$ -	
	$ -	$ -	$ -	
	$ -	$ -	$ -	
	$ -	$ -	$ -	
	$ -	$ -	$ -	
	$ -	$ -	$ -	
TOTALS	$ -	$ -	$ -	


SE
S
SW
120
150
180
210
176°S (T) 46.875996, -114.096521 ▲ 931m
Cows
Fry Grant Creek
28 Jun 2024, 11:54:54 AM


W
NW
240
270
300
330
290°W (T) 46.880581, -114.09252 ▲ 944m
Exposed bank
Fry Grant Creek
28 Jun 2024, 8:27:38 AM

Allan D. Frey and A'Lisa M. Scott

1655 Frey Lane

Missoula, MT 59808

May 9, 2025

Future Fisheries Improvement Program
FWP Fisheries Division
P.O. Box 200701
Helena, MT 59620

Dear Michelle McGree,

We own approximately 70 acres of land that includes a section of lower Grant Creek. The Frey family has been ranching on this land for nearly 90 years. We are writing to share our support for the Clark Fork Coalition's (CFC) funding request for the stream restoration project which includes our property.

For several years we have inquired to many agencies how restore our section of Grant Creek. This full restoration will help us accomplish this goal. It will also help with a faster restoration of the fish and wildlife. We will work with CFC to create grazing management plan and final design and landowner agreements using the best practices and technology available.

We look forward to implementing this restoration and seeing the creek restored. We feel this would be a lasting positive impact for the Montana Fish Wild Life and Parks and a benefit for the greater good of the Clark Fork watershed.

Thank you for your consideration.

Sincerely,

Allan D. Frey (Dale) and A'Lisa M. Scott

May 7, 2025

Michelle McGree, Future Fisheries Coordinator
Future Fisheries Improvement Program
FWP Fisheries Division
P.O. Box 200701
Helena, MT 59620

Dear Ms. McGree:

I am writing to express our strong support for the funding request submitted by the Clark Fork Coalition (CFC) for the stream restoration project on Dale Frey's and adjoining properties in the Lower Grant Creek Watershed. The Missoula Conservation District (MCD) staff were some of the first to meet with Mr. Frey and discuss his vision of restoration. We brought all sorts of partners to the property, including our local FWP Biologist; however, we have never had the capacity to facilitate and implement this project. Without the partnership, in fact leadership, of the CFC, and funding we already received from DNRC, and now DEQ, this project would not be at the phase it is today, but there is still not enough to complete the project without FWP being involved. The MCD supports CFC's request for Future Fisheries Improvement Program support.

CFC assembled and built the Grant Creek Working Group, a community-driven group which developed a Vision and Strategy for Restoring Grant Creek. Because of our relationship with landowners, and our citizen board-driven structure, the MCD was one of the few agencies allowed a voting role in the Group. CFC used the Working Group's concerns to draft the recently approved Grant Creek Watershed Restoration Plan (WRP), which aims to enhance water quality, restore natural habitats, and improve the overall health of the watershed. This project is a critical component of the WRP. The City of Missoula, Missoula County, the CFC, and the MCD have all entered into an MOU to support work along the creek however each group can.

The Frey family donated a portion of their property to Montana Fish, Wildlife, and Parks for the fishing access complex off Council Way. The complex includes the confluence of the Clark Fork River, making Grant Creek a spawning tributary to a much larger system that immediately benefits public fishing. The proposed restoration will address key issues such as erosion control, sedimentation, habitat restoration, water quality, and temperature improvements. The project will directly serve the community by enhancing the sport fisheries, which are vitally important to our local economy and ecosystem services.

This partnership with the Clark Fork Coalition, local agricultural producers, and government agencies has amazing potential to improve fish habitat, particularly by restoring a series of cold-water springs in the channel where fish are already known to spawn. We wholeheartedly support the Clark Fork Coalition's funding request and urge you to consider this proposal. The MCD is committed to doing what we can to support this project. We need your help. Your investment in this project will have a lasting positive impact on the Grant Creek Watershed and the Clark Fork River fishery. Thank you for your consideration.

Sincerely,

Radley Watkins
Executive Director

1075 South Avenue West, Suite 3, Missoula, Montana 59801, Office Phone (406) 258-3430, www.missoulacd.org

LANDS AND COMMUNITIES

Mailing Address: 200 W. Broadway
Physical Address: 127 E. Main St. Suite 2
Missoula, MT 59802-4292

P: 406.258.4657 | F: 406.258.3920
E: lac@missoulacounty.us

Missoula COUNTY

May 7, 2025

Michelle McGree
Future Fisheries Improvement Program, FWP Fisheries Division
P.O. Box 200701
Helena, MT 59620

Dear Michelle McGree,

I am writing to express our strong support for the funding request submitted by the Clark Fork Coalition for the stream restoration project on Dale Frey's and adjoining properties in the Lower Grant Creek Watershed. This project is a critical component of the recently approved Grant Creek Watershed Restoration Plan (WRP), which aims to enhance water quality, restore natural habitats, and improve the overall health of the watershed.

The Grant Creek Working Group, along with the Vision and Strategy for Restoring Grant Creek, has laid a solid foundation for this initiative. The collaborative efforts and comprehensive planning involved in developing the project demonstrate a clear commitment to sustainable watershed management and environmental stewardship.

The proposed stream restoration project will address key issues such as erosion control, habitat restoration, temperature, and water quality improvement. By implementing these measures, we anticipate significant ecological benefits, including increased floodplain connectivity, improved fish and wildlife habitats, and enhanced resilience to erosion.

We believe that the successful implementation of this project will serve as a model for other watershed restoration efforts in the region. It will also foster stronger community engagement and partnerships, furthering our collective goal of preserving and protecting our natural resources for future generations.

We wholeheartedly support the Clark Fork Coalition's funding request and urge you to consider this proposal favorably. Your investment in this project will have a lasting positive impact on the Grant Creek Watershed and the broader community.

Thank you for your consideration.

Sincerely,

Chet Crowser
Chief Lands and Communities Officer
Missoula County
ccrowser@missoulacounty.us

MISSOULA
PUBLIC WORKS & MOBILITY DEPARTMENT – STORMWATER
1345 W. Broadway • Missoula, Montana 59802 • (406) 552-6379

May 7, 2025

Michelle McGree
Future Fisheries Improvement Program
FWP Fisheries Division
P.O. Box 200701
Helena, MT 59620

RE: Letter of Support for Future Fisheries Program
Clark Fork Coalition - Lower Grant Creek Restoration

Dear Michelle:

I am writing to express my enthusiastic support for the Clark Fork Coalition and their critical efforts in restoring and protecting Lower Grant Creek. Their work in stream restoration plays a fundamental role in improving water quality, enhancing habitat, and mitigating the impacts of stormwater runoff and nonpoint source pollution. I strongly urge you to support their project.

Stormwater runoff is one of the leading causes of water pollution in urban and suburban areas. As rainwater flows over impervious surfaces such as roads, parking lots, and rooftops, it collects contaminants such as oil, heavy metals, pesticides, fertilizers, and sediment. These pollutants are then carried into nearby streams, rivers, and lakes, degrading water quality and threatening aquatic life. Unlike point source pollution, which originates from a single, identifiable source, nonpoint source pollution is diffuse and difficult to control, making it a persistent environmental challenge.

Stream restoration initiatives, such as those led by the Clark Fork Coalition, provide an effective solution to these issues by improving the natural function of waterways. Restored streams help to filter pollutants, reduce erosion, and enhance groundwater recharge. Additionally, naturalized streambanks and riparian buffers absorb excess nutrients, stabilize soil, and create habitats for diverse wildlife.

By investing in stream restoration, we are not only protecting our water resources but also fostering a sustainable approach to stormwater management. I commend the Clark Fork Coalition for their dedication and expertise in addressing these environmental concerns and urge you to provide them with the necessary support to continue their invaluable work.

Thank you for your time and consideration. I appreciate your commitment to evaluating projects that have a meaningful impact on water quality and environmental conservation.

Sincerely,

Tracy Campbell
Superintendent

LOWER GRANT CREEK RESTORATION PROJECT
CONCEPTUAL DESIGN

PROJECT PARTNERS

CLARK FORK COALITION
P.O. BOX 7593
MISSOULA, MONTANA 59807

MONTANA DEPARTMENT OF ENVIRONMENTAL QUALITY
1520 E 6TH AVE
HELENA, MONTANA 59601

MISSOULA CONSERVATION DISTRICT
1075 SOUTH AVENUE W, SUITE 3
MISSOULA, MONTANA 59801

MONTANA FISH, WILDLIFE, AND PARKS
3201 SPURGIN ROAD
MISSOULA, MONTANA 59804

MONTANA DEPARTMENT OF NATURAL RESOUCES & CONSERVATION
CONSERVATION DISTRICT BUREAU
1539 ELEVENTH AVE.
HELENA, MONTANA 59601

PROJECT DESCRIPTION

RIVER DESIGN GROUP, INC. (RDG) WAS RETAINED BY CLARK FORK COALITION (CFC) IN COOPERATION WITH MISSOULA CONSERVATION DISTRICT, MONTANA FISH, WILDLIFE & PARKS, AND MONTANA DEPARTMENT OF ENVIRONMENTAL QUALITY TO PREPARE A CONCEPTUAL RESTORATION PLAN (CRP) FOR LOWER GRANT CREEK FROM MISSOULA MONTANA AIRPORT DOWNSTREAM TO THE CONFLUENCE WITH THE CLARK FORK RIVER. FROM THE RATTLESNAKE WILDERNESS BOUNDARY TO THE CLARK FORK RIVER (14.5 MILES), GRANT CREEK IS CLASSIFIED AS A B-1 WATERBODY AND LISTED AS WATER-QUALITY IMPAIRED FOR ALGAE, FLOW REGIME MODIFICATION AND ALTERATION IN STREAMSIDE COVER, NITRATE/ NITRITE, TOTAL NITROGEN, SEDIMENT AND TEMPERATURE. PROBABLE SOURCES OF IMPAIRMENT INCLUDE IRRIGATED CROP PRODUCTION, LOSS OF RIPARIAN HABITAT, LAND DEVELOPMENT, STREAMBANK MODIFICATIONS, AND WATER DIVERSIONS. CFC, PROJECT PARTNERS, AND PRIVATE LANDOWNERS ARE INTERESTED IN ADDRESSING WATER QUALITY IMPAIRMENTS THROUGH IMPROVED LAND USE MANAGEMENT AND BOTH PASSIVE AND ACTIVE RESTORATION STRATEGIES TO ADDRESS GEOMORPHIC, AQUATIC, AND FLOODPLAIN LIMITING FACTORS IN THE LOWER WATERSHED. THIS CRP IS ACCOMPANIED BY A BASIS OF CONCEPTUAL DESIGN REPORT THAT PROVIDES MORE DETAILED INFORMATION ON THE INVESTIGATIONS THAT WERE CONDUCTED TO SUPPORT THE CONCEPTS AND RESTORATION STRATEGIES ILLUSTRATED IN THESE DRAWINGS.

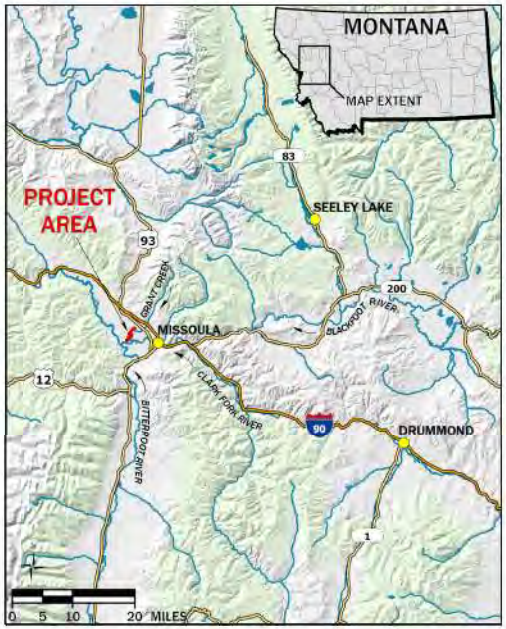
THE CRP AIMS TO RESTORE, TO THE GREATEST EXTENT PRACTICAL GIVEN EXISTING SITE CONSTRAINTS, CHANNEL AND FLOODPLAIN AND VEGETATION CONDITIONS THAT WILL SUPPORT HIGH QUALITY WATER AND IMPROVED AQUATIC HABITAT FOR FOCAL FISH SPECIES INCLUDING THREATENED BULL TROUT (SALVELINUS CONFLUENTUS) USING LOWER GRANT CREEK AS A MIGRATORY CORRIDOR TO ACCESS HIGH QUALITY SPAWNING HABITAT IN THE UPPER WATERSHED. FURTHER, THE CRP PRESENTS CONCEPTS AND STRATEGIES TO REDUCE LAND LOSS ASSOCIATED WITH HIGH RATES OF BANK EROSION DUE TO LAND CLEARING AND CONVERSION OF SCRUB-SHRUB AND FORESTED RIPARIAN COMMUNITIES TO POST-AGRICULTURAL ASSEMBLAGES. RESTORATION STRATEGIES ARE EXPECTED TO INCREASE THE OVERALL VALUES AND FUNCTION OF THE AQUATIC ENVIRONMENT BY REDUCING NON-POINT SOURCE POLLUTANTS IDENTIFIED ON THE MONTANA 303(D) LIST OF IMPAIRED WATERBODIES (MDEQ 2014).

DRAWING INDEX

GENERAL NOTES

1. SLOPES DESIGNATED AS 2:1, 1.5:1 ET CETERA, ARE THE RATIOS OF HORIZONTAL DISTANCE TO VERTICAL DISTANCE.
2. DIMENSIONS ARE GIVEN IN FEET AND TENTHS OF A FOOT.
3. ALL EXISTING CONDITIONS ARE TO BE VERIFIED IN THE FIELD PRIOR TO CONSTRUCTION AND ANY ADJUSTMENTS TO THE DRAWINGS SHALL BE COORDINATED BY RDG.
4. PROTECT ALL VEGETATION AND LAND AREAS NOT LOCATED WITHIN THE PROJECT CONSTRUCTION, STAGING, OR EARTHWORK LIMITS. EXERCISE CARE IN AREAS NOT SO MARKED TO AVOID UNNECESSARY DAMAGE TO NATURAL VEGETATION.
5. THE PROJECT SPONSOR IS RESPONSIBLE FOR COMPLYING WITH ALL PERMITS INCLUDING ALL FEDERAL, STATE, COUNTY, AND LOCAL PERMIT CONDITIONS.
6. EXCAVATION, TRENCHING, SHORING, AND SHIELDING SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR PERFORMING THE WORK. THESE DRAWINGS ARE NOT INTENDED TO PROVIDE MEANS OR METHODS OF CONSTRUCTION.
7. EXCAVATION SHALL MEET THE REQUIREMENTS OF OSHA 29 CFR PART 1926, SUBPART P, EXCAVATIONS. ACTUAL SLOPES SHALL NOT EXCEED THE SLOPES AS INDICATED ON DRAWINGS.
8. ALL EXCAVATORS SHALL BE EQUIPPED WITH MACHINE GRADE GPS. CONSTRUCTION AREAS WILL BE STAKED OUT BY RDG PRIOR TO CONSTRUCTION.
9. RDG WILL PROVIDE SURVEY CONTROL FOR EQUIPMENT WITH GPS MACHINE CONTROL CAPABILITY. RDG SHALL PROVIDE SURVEY STAKING AND LAYOUT FOR CONSTRUCTION, INCLUDING HORIZONTAL CONSTRUCTION EXTENTS, SUBGRADE EXCAVATION EXTENTS, AND FINISHED GRADE ELEVATIONS.
10. VERTICAL TOLERANCE FOR CONSTRUCTION COMPLIANCE WILL BE 0.3 FEET. HORIZONTAL TOLERANCE WILL BE 1.0 FEET.
11. CONTRACTOR SHALL CONFIRM QUANTITIES. REPORTED VOLUMES ARE NEATLINE AND DO NOT INCLUDE ADJUSTMENTS FOR COMPACTION OR OTHER FACTORS.

LOWER GRANT CREEK VICINITY MAP



REUSE OF DRAWINGS

STANDARD OF PRACTICE

RIVER DESIGN GROUP, INC. WORKS EXCLUSIVELY IN THE RIVER ENVIRONMENT AND UTILIZES THE MOST CURRENT AND ACCEPTED PRACTICES AVAILABLE FOR PLANNING AND DESIGN OF RIVER, FLOODPLAIN, AND AQUATIC HABITAT RESTORATION PROJECTS. CURRENT STANDARDS FOR THE DESIGN OF RESTORATION PROJECTS VARY DEPENDING ON PROJECT GOALS. STABILITY CRITERIA INCLUDE DESIGNING STREAMBED AND STREAMBANK STRUCTURES FOR THE AVERAGE ANNUAL PEAK FLOW DISCHARGE (90 CFS).

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COVER PAGE AND NOTES

LOWER GRANT CREEK RESTORATION PROJECT

NO.	DATE	BY	DESCRIPTION	CHK
1	08-05-24	DW	CONCEPTUAL DESIGN	JM
2	09-06-24	DB	CONCEPTUAL DESIGN	JM

PROJECT NUMBER
RDG-24-041

DRAWING NUMBER
1.0

SHEET 1 OF 25

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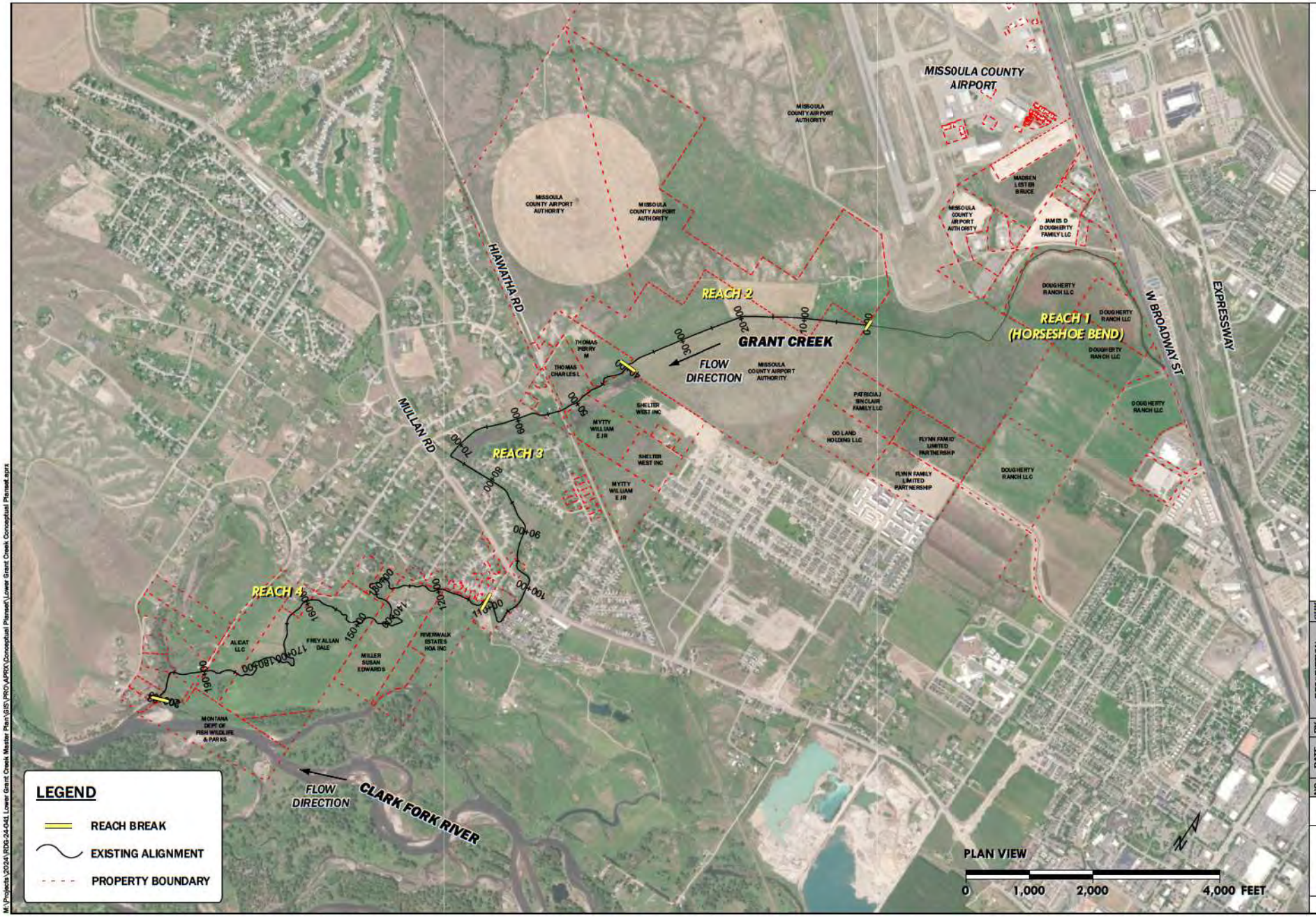

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EXISTING CONDITIONS

LOWER GRANT CREEK RESTORATION PROJECT

NO.	DATE	BY	DESCRIPTION	CHK
1	08-05-24	DW	CONCEPTUAL DESIGN	JM
2	09-06-24	DB	CONCEPTUAL DESIGN	JM

PROJECT NUMBER
RDG-24-041

DRAWING NUMBER
2.0

TYPICAL CHANNEL CONDITIONS IN REACH 2, SHOWING STRAIGHTENED, SIMPLIFIED CHANNEL LACKING COMPLEXITY.

TYPICAL CHANNEL CONDITIONS IN UPPER REACH 4, SHOWING ENTRENCHED CHANNEL WITH STEEP ERODING BANKS.

OVER-WIDENED RIFFLE HABITAT UNIT WITH COBBLE-GRAVEL SUBSTRATE IN UPPER REACH 4.

EXAMPLE HIGH BANK EROSION HAZARD INDEX, REACH 4.

BANK REVETMENT ON OUTSIDE OF MEANDER BEND, REACH 4.

INSET FLOODPLAIN DEVELOPMENT ON INSIDE OF MEANDER BEND, REACH 4. EXAMPLE LOW/VERY LOW BANK EROSION HAZARD INDEX.

SHALLOW, OVER-WIDENED CHANNEL AS A RESULT OF GRAZING IMPACTS, REACH 4.

SPRING-FED BACKWATER ALCOVE, REACH 4.

VIEW DOWNSTREAM OF BEAVER DAM AND ASSOCIATED BACKWATER IN LOWER REACH 4.

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EXISTING CONDITIONS PHOTO POINTS

LOWER GRANT CREEK RESTORATION PROJECT

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PROJECT NUMBER
RDG-24-041

DRAWING NUMBER

2.1

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PLAN VIEW INDEX

LOWER GRANT CREEK RESTORATION PROJECT

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2	09-06-24	DB	CONCEPTUAL DESIGN	JM

PROJECT NUMBER
RDG-24-041

DRAWING NUMBER
3.0

SHEET 4 OF 25

TOTAL WOOD QUANTITIES

ITEM	QUANTITY (EA)	DIAMETER (IN)	LENGTH (FT)	ROOTWAD
CATEGORY 1 WOOD	70	10-12	12-15	YES
CATEGORY 2 WOOD	15886	2-10	10-15	OPTIONAL
CATEGORY 3 WOOD	69920	<3	10-12	OPTIONAL
WILLOW CUTTINGS	247933	0.25-1	8	NO

NOTE:
CONTRACTOR IS REQUIRED TO CUT TO LENGTH CATEGORY 1-3 WOOD TO MEET STRUCTURE DIMENSIONS AS REPORTED ON THE DETAIL DRAWINGS.

TOTAL ROCK QUANTITIES

ITEM	QUANTITY (EA)	DIAMETER (IN)	
CATEGORY 1 ROCK	1740	6-8	
ITEM	QUANTITY (CY)	GRADATION	
		SIZE (IN)	PERCENT PASSING
STREAMBED/STREAMBANK FILL	8608	4	80-100
		3	30-80
		1	10-30
		0.08	10

TOTAL EARTHWORK QUANTITIES

ITEM	QUANTITY (CY)
CUT	27982

NOTE:
BACKFILL QUANTITIES TO BE DETERMINED IN SUBSEQUENT DESIGN PHASE.

LARGE WOOD STRUCTURE QUANTITIES

ITEM	QUANTITY (EA)	
	REACH 2	REACH 4
LARGE WOOD STRUCTURES	0	35
CATEGORY 1 WOOD	0	70
CATEGORY 2 WOOD	0	140
CATEGORY 3 WOOD	0	350

CONSTRUCTED CHANNEL STREAMBED QUANTITIES

ITEM	QUANTITY	
	REACH 2	REACH 4
CONSTRUCTED RIFFLE	4969 LF	3730 LF
CATEGORY 1 ROCK	994 EA	746 EA
STREAMBED FILL	1739 CY	1306 CY

VEGETATED WOOD MATRIX QUANTITIES

ITEM	QUANTITY	
	REACH 2	REACH 4
VEGETATED WOOD MATRIX TYPE 1	8245 LF	6271 LF
VEGETATED WOOD MATRIX TYPE 2	5218 LF	7928 LF
CATEGORY 2 WOOD	3365.75 EA	12380 EA
CATEGORY 3 WOOD	26926 EA	42644 EA
WILLOW CUTTINGS	118140 EA	129793 EA
STREAMBANK FILL	2389.9 CY	3173.1 CY

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MATERIALS AND QUANTITIES

LOWER GRANT CREEK RESTORATION PROJECT

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1	08-05-24	DW	CONCEPTUAL DESIGN	JM
2	09-06-24	DB	CONCEPTUAL DESIGN	JM

PROJECT NUMBER
RDG-24-041

DRAWING NUMBER
4.0

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EXISTING CHANNEL CHARACTERISTICS	
Length	4380 ft
Valley Slope	0.015 ft/ft
Channel Slope	0.0006 ft/ft
Sinuosity	1.1
Bankfull Discharge	90 cfs
2-Year Flow	170 cfs
10-Year Flow	358 cfs
50-Year Flow	538 cfs
100-Year Flow	629 cfs

EXISTING CONDITIONS, LIMITING FACTORS, & CONSTRAINTS

THE PROJECT REACH OF LOWER GRANT CREEK BEGINS ON THE PROPERTY OF THE MISSOULA COUNTY AIRPORT AUTHORITY (REACH 2). THROUGH REACH 2, GRANT CREEK IS DITCHED AND STRAIGHTENED, PROVIDING NO GEOMORPHIC OR HYDRAULIC COMPLEXITY. THE CHANNEL IS INCISED, LACKS FLOODPLAIN CONNECTIVITY, AND HAS LITTLE POTENTIAL FOR FLOOD ATTENUATION. WOODY RIPARIAN VEGETATION IS SPARSE, PROVIDING LITTLE COVER, SHADE, OR RECRUITABLE WOOD. CONSTRAINTS IN REACH 2 INCLUDE THE EXISTING FLYWAY FOR MISSOULA AIRPORT ABOVE THE PROJECT AREA. THIS RESTRICTS THE USE OF CONSTRUCTED WETLANDS AS A RESTORATION STRATEGY DUE TO THE LIKELY ATTRACTION OF WATERFOWL.

RESTORATION STRATEGIES

RESTORATION STRATEGIES IN REACH 2 INCLUDE:

- CONSTRUCTING AN APPROPRIATELY SIZED BANKFULL CHANNEL THAT INCORPORATES PLANFORM AND LONGITUDINAL PROFILE COMPLEXITY AND PROMOTES HYPORHEIC EXCHANGE THROUGH THE USE OF RIFFLE, RUN, POOL, AND GLIDE HABITAT FEATURES;
- RAISING THE CHANNEL BED PROFILE TO RECONNECT HISTORIC FLOODPLAIN SURFACES, PROMOTE GROUNDWATER RECHARGE, AND PROVIDE FLOOD ATTENUATION;
- INSTALLING STREAMBANK STRUCTURES THAT REDUCE SEDIMENT LOADING AND PROMOTE THE ESTABLISHMENT OF WOODY RIPARIAN VEGETATION, COVER, AND AQUATIC HABITAT COMPLEXITY; AND
- PLACING LARGE WOOD AND INSTALLING WILLOW TRENCHES ON THE FLOODPLAIN TO PROVIDE ROUGHNESS AND PROMOTE THE NATURAL RECRUITMENT OF WOODY RIPARIAN VEGETATION.

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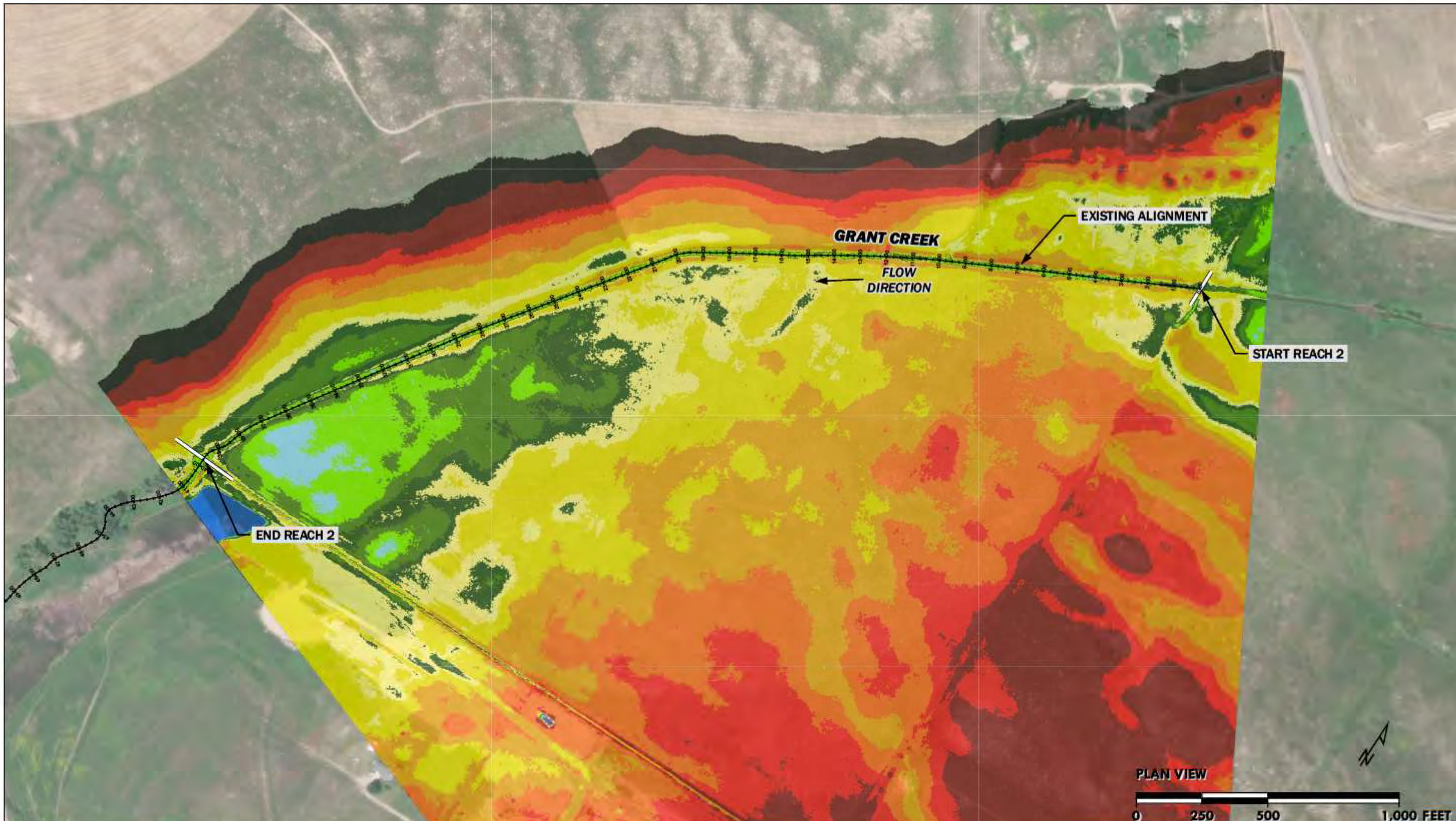
EXISTING CONDITIONS REACH 2

LOWER GRANT CREEK RESTORATION PROJECT

NO.	DATE	BY	DESCRIPTION	CHK
1	08-05-24	DW	CONCEPTUAL DESIGN	JM
2	09-06-24	DB	CONCEPTUAL DESIGN	JM

PROJECT NUMBER
RDG-24-041

DRAWING NUMBER
5.0



ELEVATION RELATIVE TO LiDAR WATER SURFACE (FT)

-5.0 - -2.0
-2.0 - -1.5
-1.5 - -1.0
-1.0 - -0.3
-0.3 - 0.3
0.3 - 1.0
1.0 - 1.5
1.5 - 2.0
2.0 - 3.0
3.0 - 4.0
4.0 - 5.0
5.0 - 6.0
6.0 - 9.0
>9.0

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REACH 2 EXISTING CONDITIONS RELATIVE ELEVATION MODEL

LOWER GRANT CREEK RESTORATION PROJECT

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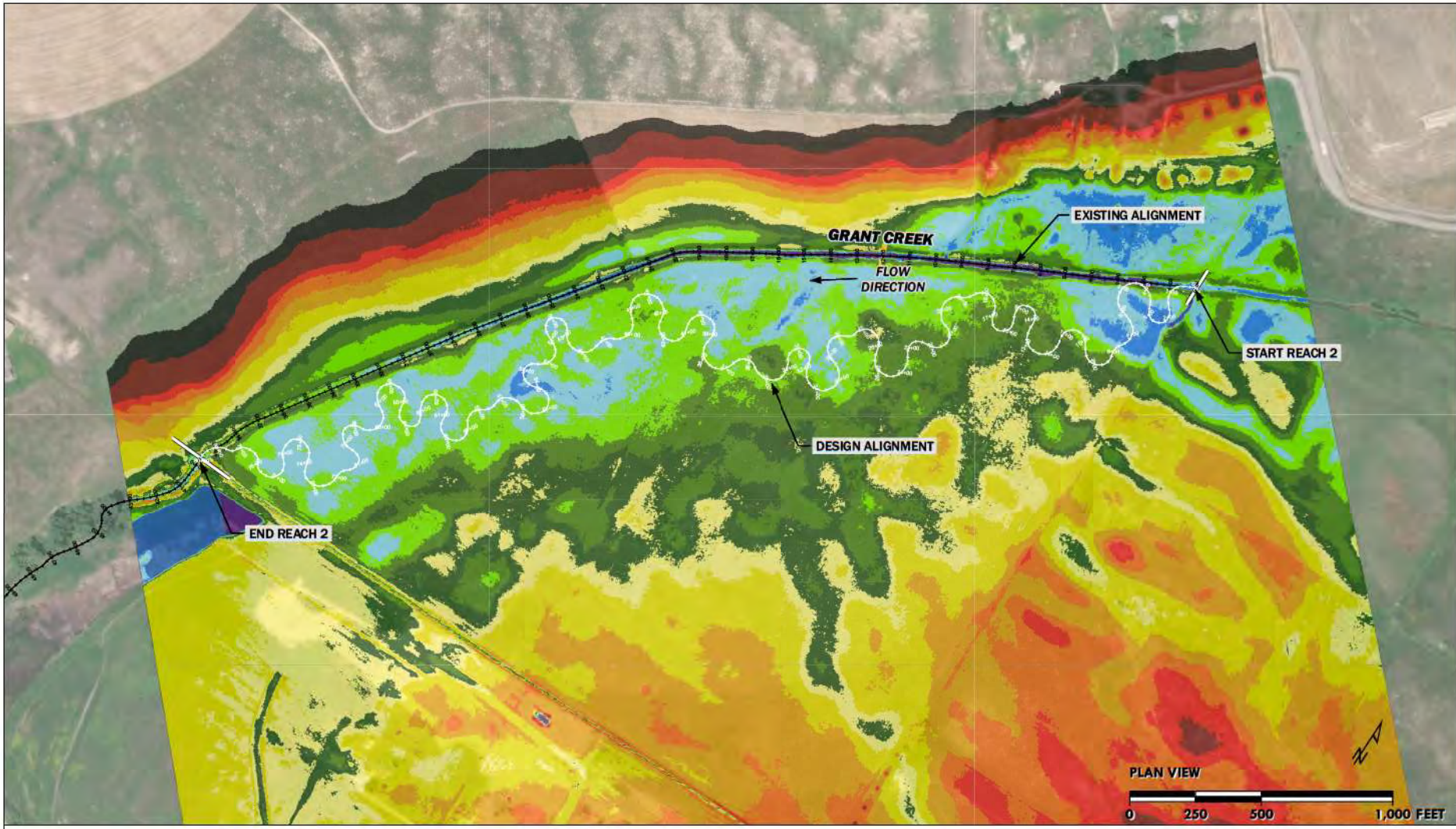
2	09-06-24	DB	CONCEPTUAL DESIGN	JM

PROJECT NUMBER
RDG-24-041

DRAWING NUMBER

5.1



ELEVATION RELATIVE TO DESIGN BANKFULL (FT)

-5.9 - -2.0	-2.0 - -1.5	-1.5 - -1.0	-1.0 - -0.3	-0.3 - 0.3	0.3 - 1.0	1.0 - 1.5	1.5 - 2.0	2.0 - 3.0	3.0 - 4.0	4.0 - 5.0	5.0 - 6.0	6.0 - 9.0	>9.0

REACH 2 DESIGN CONDITIONS RELATIVE ELEVATION MODEL

LOWER GRANT CREEK RESTORATION PROJECT

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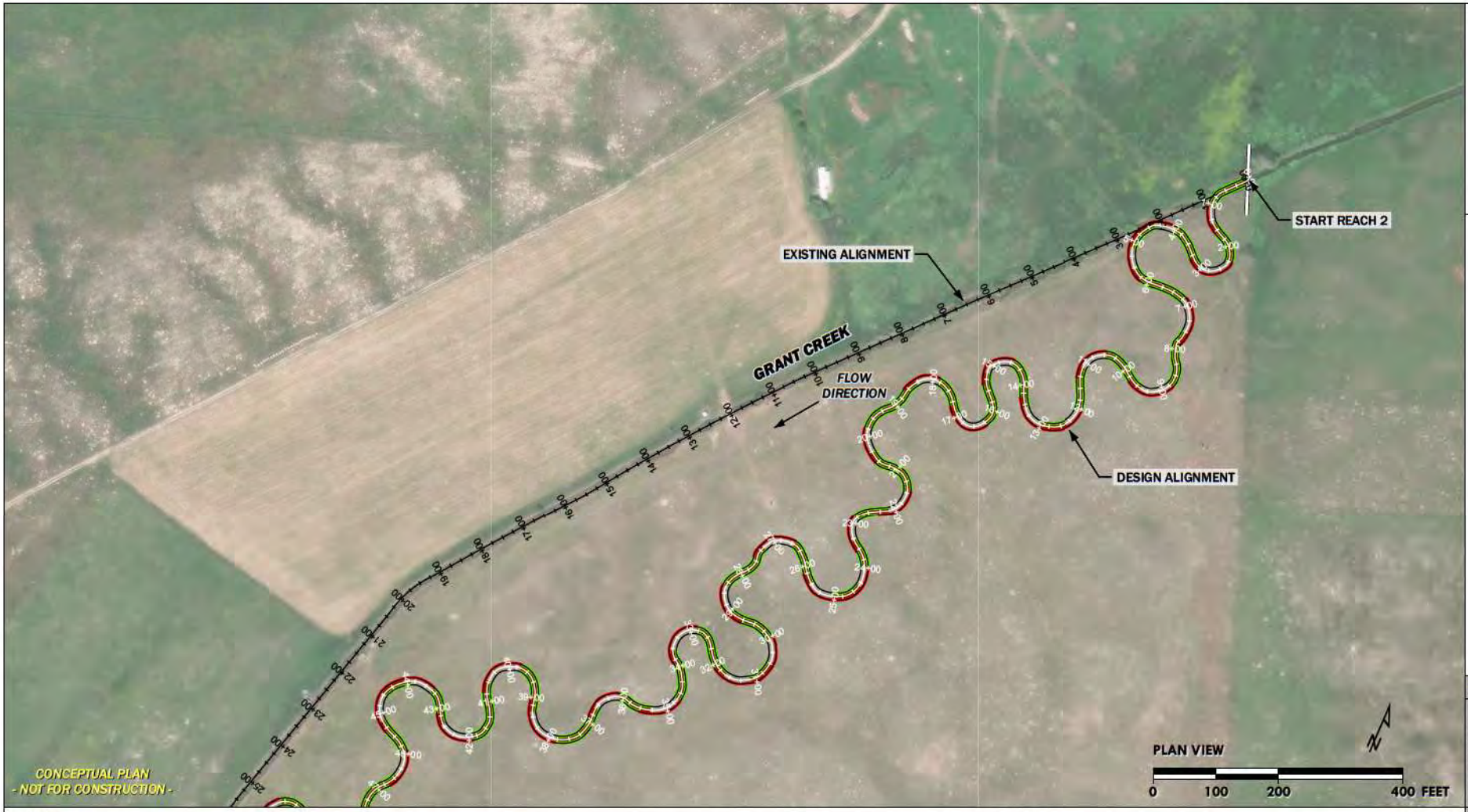
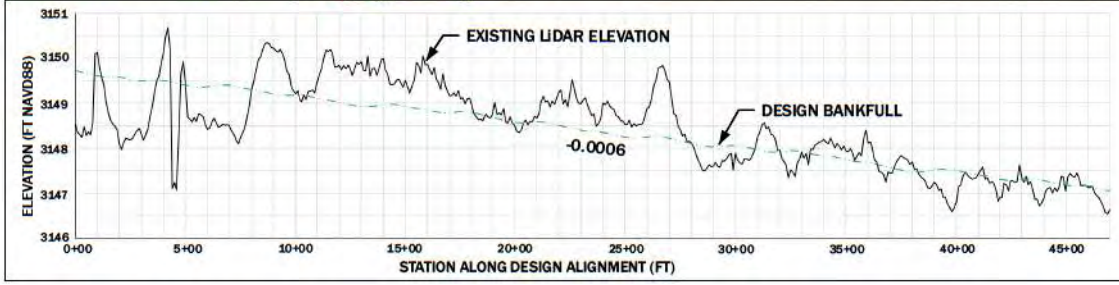
PROJECT NUMBER
RDG-24-041

DRAWING NUMBER

5.2





LEGEND

- VEGETATED WOOD MATRIX - TYPE 1
- VEGETATED WOOD MATRIX - TYPE 2
- CONSTRUCTED CHANNEL STREAMBED

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PLAN AND PROFILE
REACH 2

LOWER GRANT CREEK RESTORATION PROJECT

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1	08-05-24	DW	CONCEPTUAL DESIGN	JM
2	09-06-24	DB	CONCEPTUAL DESIGN	JM

PROJECT NUMBER
RDG-24-041

DRAWING NUMBER
5.3

LEGEND

- VEGETATED WOOD MATRIX - TYPE 1
- VEGETATED WOOD MATRIX - TYPE 2
- CONSTRUCTED CHANNEL STREAMBED

NO.	DATE	BY	DESCRIPTION	CHK
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PLAN AND PROFILE
REACH 2
LOWER GRANT CREEK RESTORATION PROJECT

PROJECT NUMBER
RDG-24-041

DRAWING NUMBER
5.4

BANKFULL CROSS SECTION DESIGN CRITERIA						
	Riffle		Run		Pool	
Variable	Value (ft)	Dimensionless Coefficient	Value (ft)	Dimensionless Coefficient	Value (ft)	Dimensionless Coefficient
Area	29		30.5	1.05	33.4	1.15
Width/Depth	5					
Range (Low)	4					
Range (High)	6					
Width						
Average	12		10.5		14.4	1.20
Range (Low)	11		9.7		13.2	1.10
Range (High)	13		11.5		15.7	1.30
Avg. Depth						
Average	2.4		2.9	1.20	2.0	
Range (Low)	2.2	0.91	2.6	1.10	1.9	
Range (High)	2.7	1.12	3.1	1.30	2.2	
Max. Depth						
Average	3.1	1.30	3.6	1.50	6.6	2.75
Range (Low)	2.6	1.20	3.9	1.60	4.2	1.75
Range (High)	3.8	1.40	4.1	1.70	7.2	3.00
Max. Scour	3.6	1.50	3.6	1.50	4.8	2.00

PLANFORM GEOMETRY DESIGN CRITERIA		
Variable	Value (ft)	Dimensionless Ratio
Bankfull Width	12	
Radius of Curvature		
Average	36	3.0
Range (Low)	24	2.0
Range (High)	48	4.0
Meander Length		
Average	144	12.0
Range (Low)	96	8.0
Range (High)	192	16.0
Belt Width		
Average	360	
Range (Low)	240	20.0
Range (High)	480	40.0
Sinuosity	2.1	

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CHANNEL DESIGN CRITERIA
REACH 2
LOWER GRANT CREEK RESTORATION PROJECT

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PROJECT NUMBER
RDG-24-041

DRAWING NUMBER
5.5

EXISTING CONDITIONS, LIMITING FACTORS, & CONSTRAINTS

REACH 3 EXTENDS 1.36 MILES FROM THE SOUTHERN BOUNDARY OF THE MISSOULA COUNTY AIRPORT AUTHORITY PROPERTY DOWNSTREAM TO THE START OF REACH 3 (RIVERWALK ESTATES HOA, INC.). REACH 2 WAS STRAIGHTENED AND CHANNELIZED TO ACCOMMODATE RESIDENTIAL DEVELOPMENTS IN THE HISTORICAL GRANT CREEK FLOODPLAIN. IN 2008, MISSOULA COUNTY RETAINED HDR ENGINEERING, INC. TO ENGINEER AND CONSTRUCT THE GRANT CREEK RESTORATION AND FLOOD CONTROL PROJECT. THE PROJECT CONSISTED OF CONSTRUCTING TWO FLOOD ATTENUATION / DETENTION BASINS UPSTREAM AND DOWNSTREAM OF HIAWATHA ROAD TO REDUCE FLOOD HAZARD RISK TO ADJACENT RESIDENTIAL DEVELOPMENTS. A SECOND COMPONENT OF THE PROJECT WAS THE CONSTRUCTION OF A CONCRETE INLET PEAK FLOW BYPASS STRUCTURE AND PIPELINE UPSTREAM OF MULLAN ROAD. THE EFFECTIVENESS OF THESE PROJECTS IN AMELIORATING FLOOD RISK IS UNCERTAIN AND WAS BEYOND THE SCOPE OF THIS CONCEPTUAL RESTORATION PLAN FOR LOWER GRANT CREEK.

THE FOLLOWING RESTORATION CONSTRAINTS PRECLUDE ACTIVE RESTORATION STRATEGIES IN REACH 3:

- EXISTING FLOOD ATTENUATION BASINS LIMIT OPPORTUNITIES TO RESTORE APPROPRIATE CHANNEL PLANFORM DIMENSIONS IN UPPER REACH 3.
- RESIDENTIAL DEVELOPMENTS IN THE MIDDLE AND LOWER PORTION OF REACH 3 ENCROACH ON THE HISTORICAL GRANT CREEK FLOODPLAIN AND LIMIT OPPORTUNITIES TO CORRECT THE DIMENSIONS, PATTERN, AND PROFILE OF GRANT CREEK.
- HIAWATHA ROAD, MULLAN ROAD, AND THE PEAK FLOW BYPASS STRUCTURE ARE FIXED INFRASTRUCTURE CONSTRAINTS.

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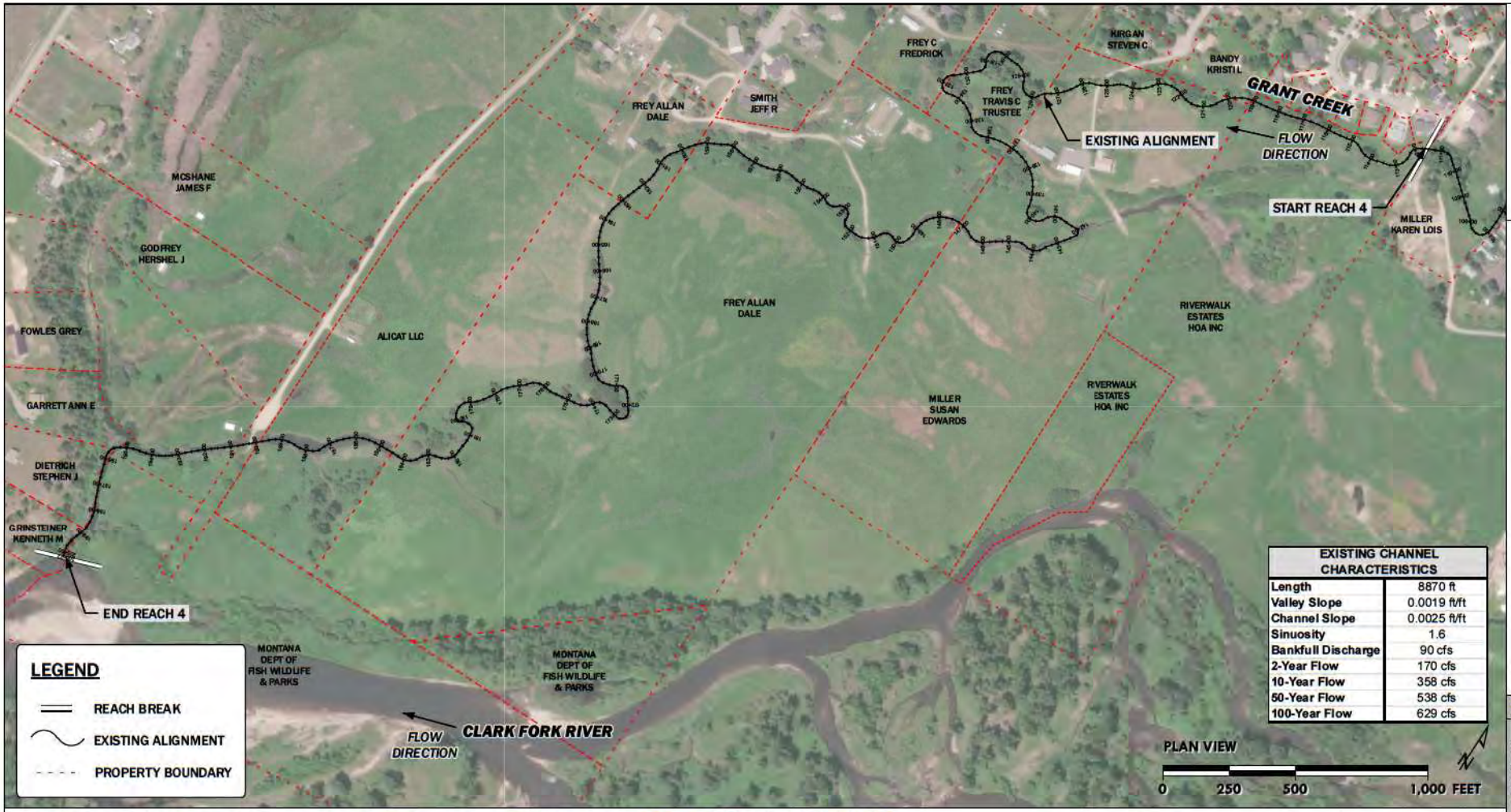
EXISTING CONDITIONS REACH 3

LOWER GRANT CREEK RESTORATION PROJECT

NO.	DATE	BY	DESCRIPTION	CHK
1	08-05-24	DW	CONCEPTUAL DESIGN	JM
2	09-06-24	DB	CONCEPTUAL DESIGN	JM

PROJECT NUMBER
RDG-24-041

DRAWING NUMBER
6.0



EXISTING CONDITIONS, LIMITING FACTORS, & CONSTRAINTS

REACH 4 BEGINS WHERE THE CHANNEL EXITS THE RESIDENTAL DEVELOPMENT AND EXTENDS DOWNSTREAM TO THE CONFLUENCE WITH THE CLARK FORK RIVER. UPPER REACH 4 IS FORESTED AND SEVERELY ENTRENCHED WITH STEEP AND ERODING BANKS. RESTORATION IN UPPER REACH 4 IS CONSTRAINED BY THE PROXIMITY TO HOMES IN THE HISTORIC FLOODPLAIN. DOWNSTREAM OF THE FORESTED AREA WOODY RIPARIAN VEGETATION IS LIMITED AND THE REACH IS CHARACTERIZED AS INCISED AND OVER-WIDENED WITH LIMITED FLOODPLAIN CONNECTIVITY. EXCESS BANK EROSION AND SILTATION ARE PERVASIVE IN REACH 4. AS A WHOLE, THE REACH LACKS HYDRAULIC AND GEOMORPHIC COMPLEXITY AND HIGH QUALITY AQUATIC HABITAT.

RESTORATION STRATEGIES

RESTORATION STRATEGIES IN REACH 4 INCLUDE:

- CONSTRUCTING AN APPROPRIATELY SIZED BANKFULL CHANNEL THAT INCORPORATES PLANFORM AND LONGITUDINAL PROFILE COMPLEXITY AND PROMOTES HYPORHEIC EXCHANGE THROUGH THE USE OF RIFFLE, RUN, POOL, AND GLIDE HABITAT FEATURES;
- RAISING THE CHANNEL BED PROFILE TO RECONNECT HISTORIC FLOODPLAIN SURFACES, PROMOTE GROUNDWATER RECHARGE, AND PROVIDE FLOOD ATTENUATION;
- INSTALLING STREAMBANK STRUCTURES THAT REDUCE SEDIMENT LOADING AND PROMOTE THE ESTABLISHMENT OF WOODY RIPARIAN VEGETATION, COVER, AND AQUATIC HABITAT COMPLEXITY;
- PLACING LARGE WOOD AND INSTALLING WILLOW TRENCHES ON THE FLOODPLAIN TO PROVIDE ROUGHNESS AND PROMOTE THE NATURAL RECRUITMENT OF WOODY RIPARIAN VEGETATION;
- CONSTRUCTING OFF-CHANNEL WETLANDS TO PROVIDE HIGH QUALITY WILDLIFE HABITAT, FLOOD ATTENUATION, AND WATER QUALITY BENEFITS; AND
- IMPLEMENTING A GRAZING MANAGEMENT PLAN TO PROTECT SENSITIVE FLOODPLAIN AND RIPARIAN AREAS.

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EXISTING CONDITIONS REACH 4

LOWER GRANT CREEK RESTORATION PROJECT

NO.	DATE	BY	DESCRIPTION	CHK
1	08-05-24	DW	CONCEPTUAL DESIGN	JM
2	09-06-24	DB	CONCEPTUAL DESIGN	JM

PROJECT NUMBER
RDG-24-041

DRAWING NUMBER
7.0

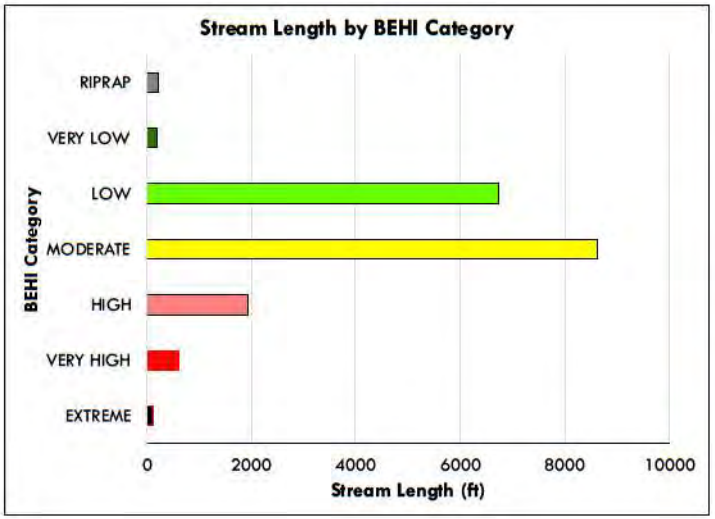
Lower Grant Creek Phase 4
Bank Erosion Hazard Index (BEHI) Assessment

CATEGORY

- EXTREME
- VERY HIGH
- HIGH
- MODERATE
- LOW
- VERY LOW
- RIPRAP

LOWER GRANT CREEK PHASE 4 BANK EROSION SEDIMENT YIELD.

BEHI RATING	LENGTH (FT)	MIGRATION RATE (FT/YR)	BANK HEIGHT (FT)	DENSITY (LBS/FT^3)	SEDIMENT YIELD (TONS/YR)
EXTREME	129	0.47	7.0	100	21
VERY HIGH	598	0.39	6.1	100	71
HIGH	1923	0.31	5.0	100	149
MODERATE	8621	0.23	3.6	100	357
LOW	6735	0.17	3.0	100	172
VERY LOW	201	0.1	1.5	100	2
RIPRAP	222	0	3.0	100	0
TOTAL	18,430				772



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REACH 4 EXISTING CONDITIONS BEHI ASSESSMENT

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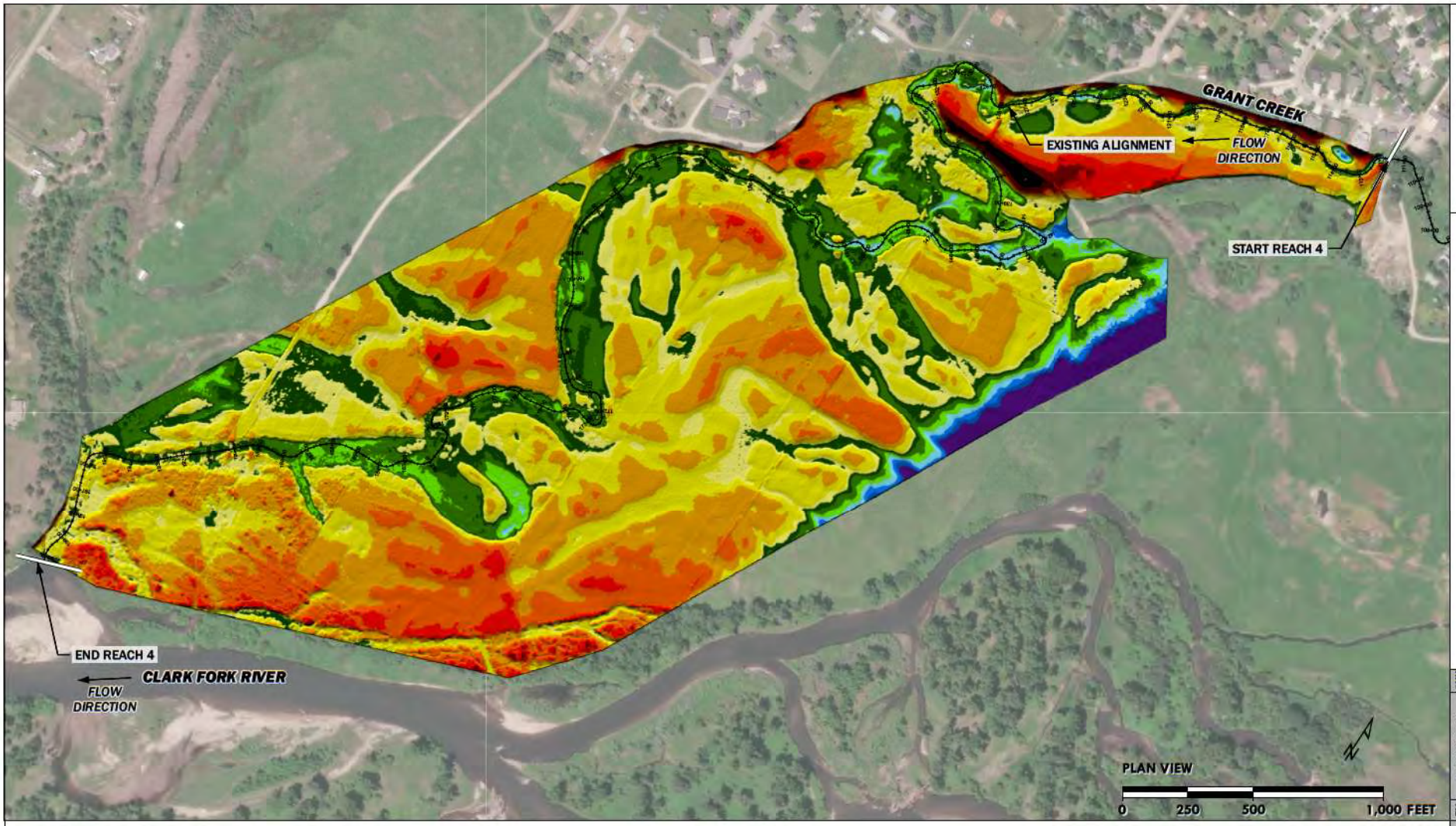

ELEVATION RELATIVE TO EXISTING BANKFULL (FT)

<-6.7 - -2.0	-2.0 - -1.5	-1.5 - -1.0	-1.0 - -0.3	-0.3 - 0.3	0.3 - 1.0	1.0 - 1.5	1.5 - 2.0	2.0 - 3.0	3.0 - 4.0	4.0 - 5.0	5.0 - 6.0	6.0 - 9.0	>9.0

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REACH 4 EXISTING CONDITIONS RELATIVE ELEVATION MODEL

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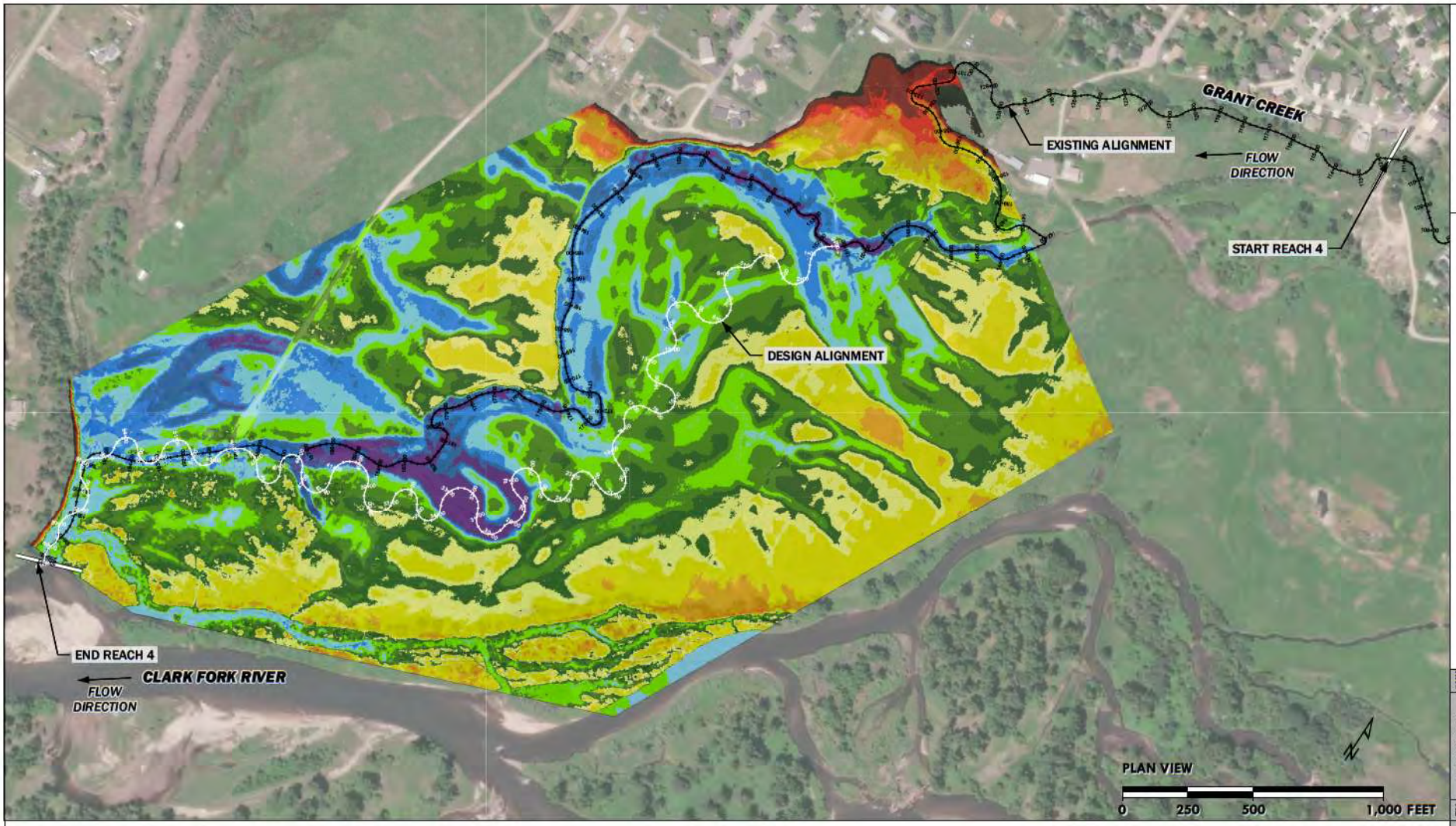
PROJECT NUMBER
RDG-24-041

DRAWING NUMBER

7.2



ELEVATION RELATIVE TO DESIGN BANKFULL (FT)

-5.9 - -2.0	-2.0 - -1.5	-1.5 - -1.0	-1.0 - -0.3	-0.3 - 0.3	0.3 - 1.0	1.0 - 1.5	1.5 - 2.0	2.0 - 3.0	3.0 - 4.0	4.0 - 5.0	5.0 - 6.0	6.0 - 9.0	>9.0

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REACH 4 DESIGN CONDITIONS RELATIVE ELEVATION MODEL

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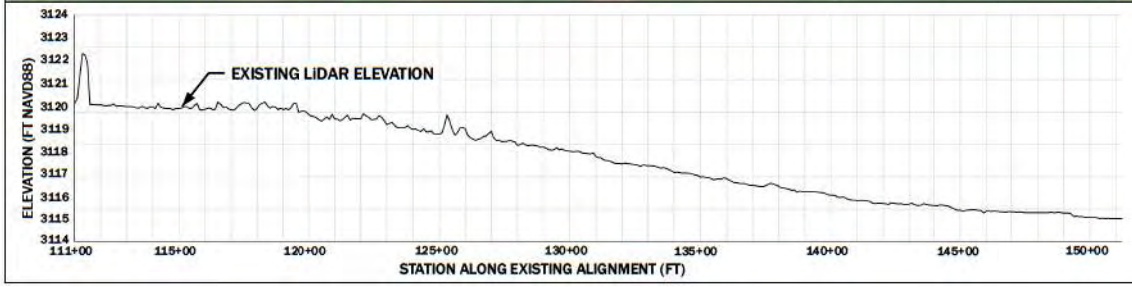
PROJECT NUMBER
RDG-24-041

DRAWING NUMBER

7.3

SHEET 16 OF 25



LEGEND

- VEGETATED WOOD MATRIX - TYPE 1
- VEGETATED WOOD MATRIX - TYPE 2
- CONSTRUCTED CHANNEL STREAMBED
- LARGE WOOD STRUCTURE
- CONSTRUCTED WETLAND

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PLAN AND PROFILE
REACH 4

LOWER GRANT CREEK RESTORATION PROJECT

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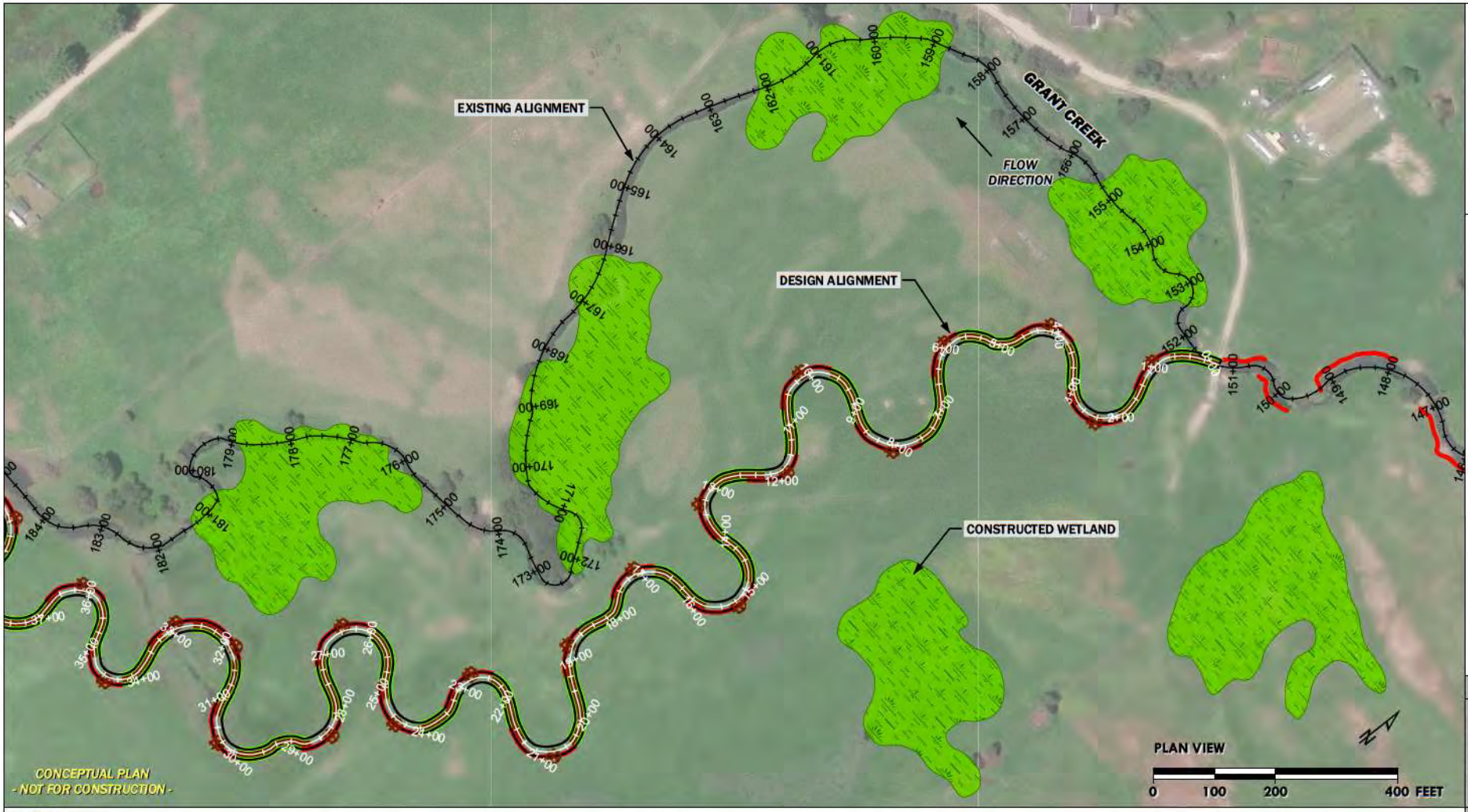
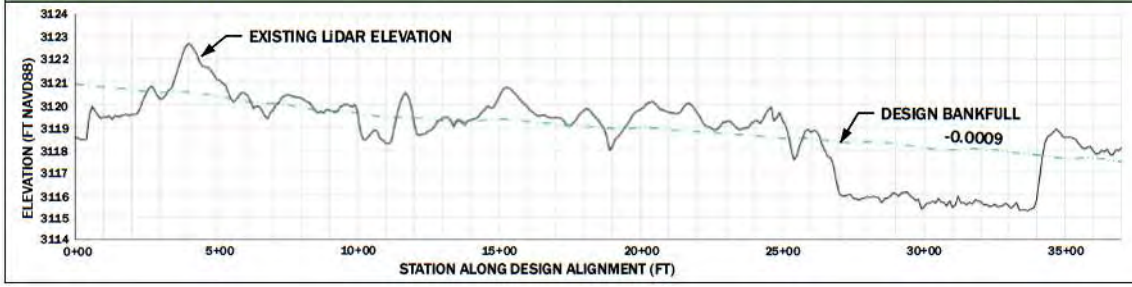
PROJECT NUMBER
RDG-24-041

DRAWING NUMBER

7.4





LEGEND

- VEGETATED WOOD MATRIX - TYPE 1
- VEGETATED WOOD MATRIX - TYPE 2
- CONSTRUCTED CHANNEL STREAMBED
- LARGE WOOD STRUCTURE
- CONSTRUCTED WETLAND

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PLAN AND PROFILE
REACH 4
LOWER GRANT CREEK RESTORATION PROJECT

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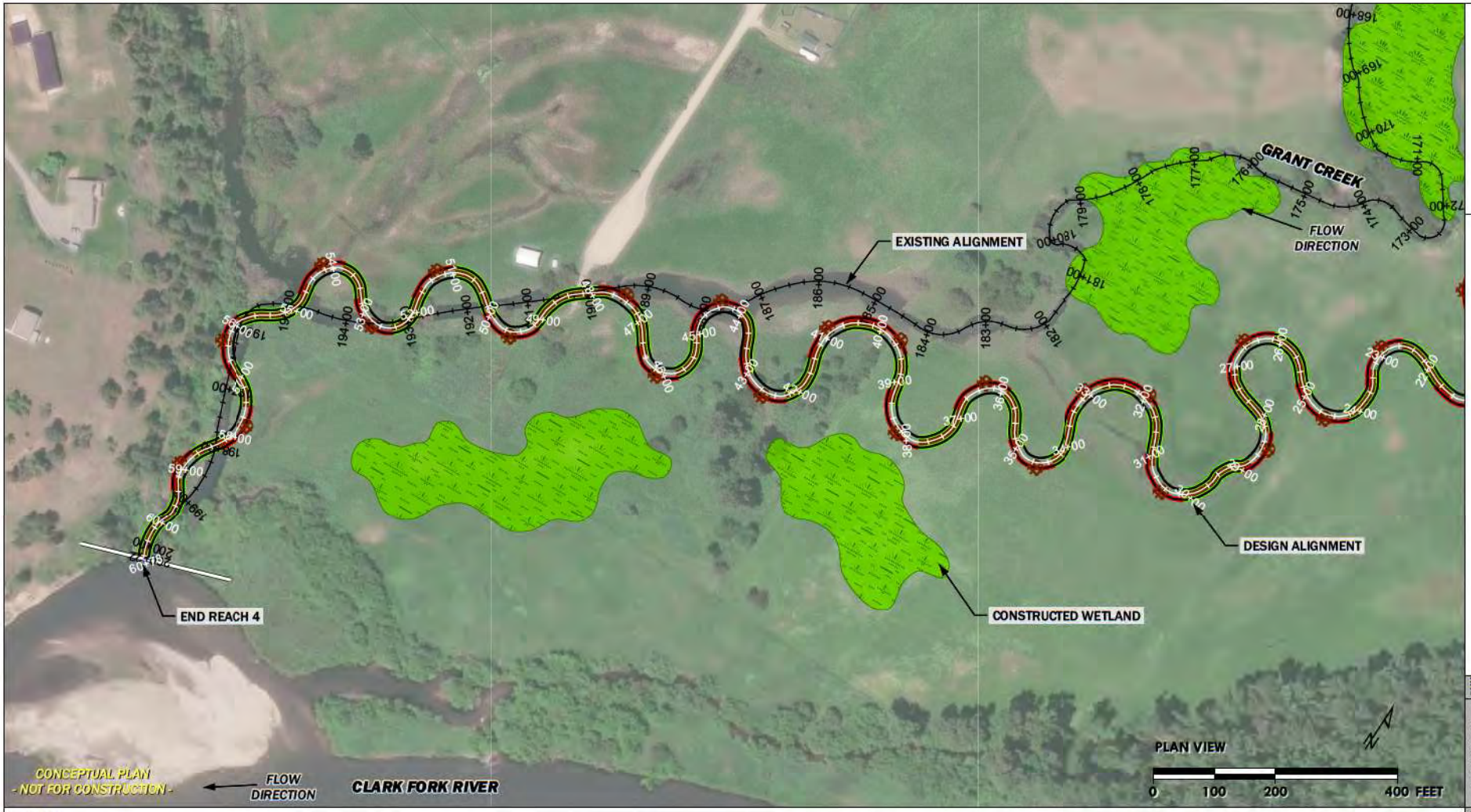
DRAWING NUMBER
7.5



LEGEND

- VEGETATED WOOD MATRIX - TYPE 1
- VEGETATED WOOD MATRIX - TYPE 2
- CONSTRUCTED CHANNEL STREAMBED
- LARGE WOOD STRUCTURE
- CONSTRUCTED WETLAND

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PLAN AND PROFILE
REACH 4

LOWER GRANT CREEK RESTORATION PROJECT

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BANKFULL CROSS SECTION DESIGN CRITERIA						
Variable	Riffle		Run		Pool	
	Value (ft)	Dimensionless Coefficient	Value (ft)	Dimensionless Coefficient	Value (ft)	Dimensionless Coefficient
Area	29		30.5	1.05	36.3	1.25
Width/Depth	10	1.0	8	1.0	13	1.0
Range (Low)	9	0.9	5	0.6	10	0.8
Range (High)	13	1.3	12	2.5	16	1.6
Width						
Average	17	1.0	18	1.05	21	1.25
Range (Low)	15	0.9	14	0.80	19	1.10
Range (High)	19	1.1	22	1.30	24	1.40
Avg. Depth						
Average	1.7	1.0	2.2	1.30	3.1	1.80
Range (Low)	1.5	0.90	1.8	1.20	2.7	1.60
Range (High)	2.0	1.20	2.9	1.40	3.4	2.00
Max. Depth						
Average	3.0	1.00	3.4	2.00	5.4	
Range (Low)	2.7	0.90	2.7	1.60	4.8	2.80
Range (High)	3.3	1.10	3.9	2.30	6.0	3.50
Max. Scour	3.4	2.00	4.3	2.50	6.8	4.00

PLANFORM GEOMETRY DESIGN CRITERIA		
Variable	Value (ft)	Dimensionless Ratio
Bankfull Width	17	
Radius of Curvature		
Average	55	3.3
Range (Low)	43	2.5
Range (High)	68	4.0
Meander Length		
Average	204	12.0
Range (Low)	136	8.0
Range (High)	272	16.0
Belt Width		
Average	136	8.0
Range (Low)	34	2.0
Range (High)	238	14.0
Sinuosity	1.8	

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CHANNEL DESIGN CRITERIA
REACH 4
LOWER GRANT CREEK RESTORATION PROJECT

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PROJECT NUMBER
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DRAWING NUMBER
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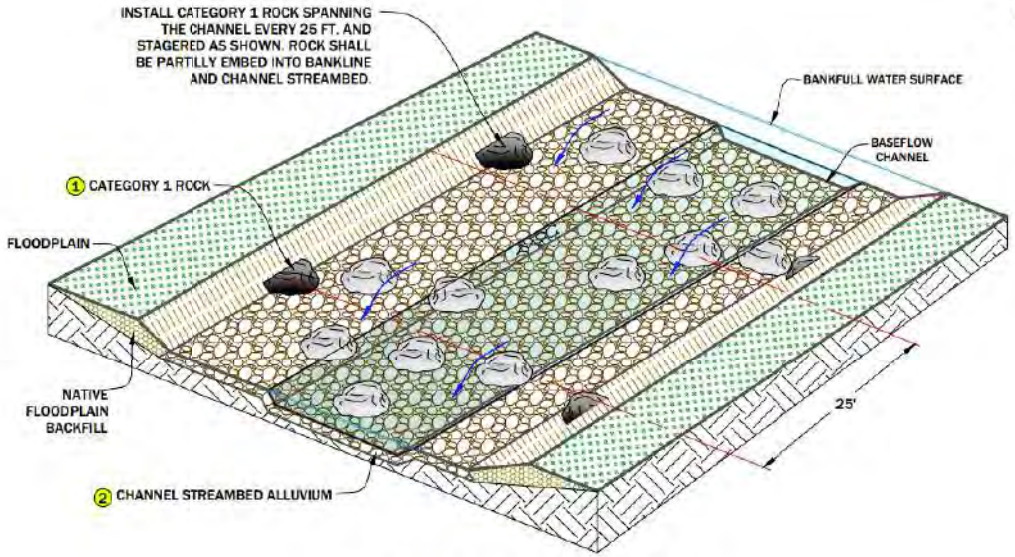
GENERAL NOTES

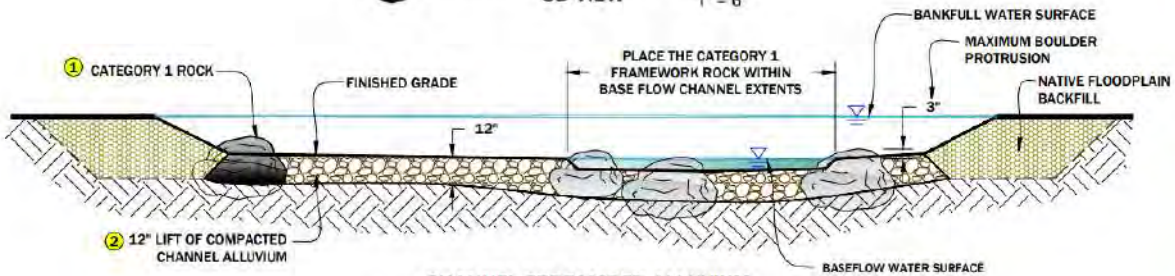
1. CONSTRUCTION OF THE CHANNEL STREAMBED WILL OCCUR AFTER THE CHANNEL SUBGRADE IS PREPARED.
2. ANY CHANGES TO THE CONSTRUCTION SEQUENCE MUST BE APPROVED THE CONSTRUCTION MANAGER.
3. IT IS THE CONTRACTORS RESPONSIBILITY TO CUT WOOD INTO APPROPRIATE SIZE LENGTHS TO FIT STRUCTURE DIMENSIONS.
4. CONTRACTOR SHALL MARK THE UPSTREAM AND DOWNSTREAM EXTENTS OF THE LOCATIONS OF THE CONSTRUCTED CHANNEL STREAMBED STRUCTURES.

NOTES ON CONSTRUCTED CHANNEL STREAMBED INSTALLATION

1. PRIOR TO CONSTRUCTION OF THE CHANNEL STREAMBED, CONSTRUCTION MANAGER SHALL VERIFY CHANNEL SUBGRADE ELEVATIONS. CHANNEL SUBGRADE SERVES AS THE FOUNDATION FOR THE CONSTRUCTED CHANNEL STREAMBED.
2. CONTRACTOR SHALL STOCKPILE CHANNEL ALLUVIUM PER SPECIFICATIONS NOTED ON THE DRAWING.
3. PREPARE THE FRAMEWORK. CONTRACTOR SHALL PLACE 10-INCH TO 12-INCH BOULDER SILLS (CATEGORY 1 ROCK) ON THE SURFACE OF THE CHANNEL SUBGRADE PRIMARILY WITHIN THE LOW FLOW CHANNEL AS INDICATED ON THE DRAWING. DUE TO THE INHERENT VARIABILITY IN MATERIALS, BOULDER ELEVATIONS SHALL BE ADJUSTED TO ASSURE BOULDER PROTRUSION ABOVE FINISH GRADE WILL BE NO GREATER THAN 0.5-FT.
4. PREPARE THE MATRIX. AFTER THE FRAMEWORK BOULDER RIBS ARE INSTALLED AND INSPECTED BY CONSTRUCTION MANAGER, PLACE APPROPRIATE CHANNEL STREAMBED ALLUVIUM GRADATION AND WASH FINES INTO STREAMBED. CHANNEL STREAMED ALLUVIUM SHALL BE PLACED TO THE FULL COURSE THICKNESS OF 12-INCHES TO FINISHED GRADE.



CHANNEL STREAMBED ALLUVIUM AND FRAMEWORK INSTALLATION
1 3D VIEW 1" = 6'



CHANNEL STREAMBED ALLUVIUM AND FRAMEWORK INSTALLATION
2 SECTION VIEW 1" = 5'

STREAMBED FILL GRADATION	
SIZE (IN)	PERCENT PASSING
4	80-100
3	30-80
1	10-30
0.08	10
NOTE: MIX SALVAGED MATERIAL AND IMPORTED MATERIAL TO ACHIEVE SPECIFIED GRADATION	

MATERIAL SCHEDULE (PER FOOT)			
	ITEM	DIA. (IN)	QUANTITY (EA)
1	CATEGORY 1 ROCK	6" - 8"	0.2 EA
2	ALLUVIUM	4" MINUS	0.35 CY

TYPICAL CONSTRUCTED STREAMBED THROUGH A RIFFLE FEATURE

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CONSTRUCTED CHANNEL STREAMBED DETAIL

LOWER GRANT CREEK RESTORATION PROJECT

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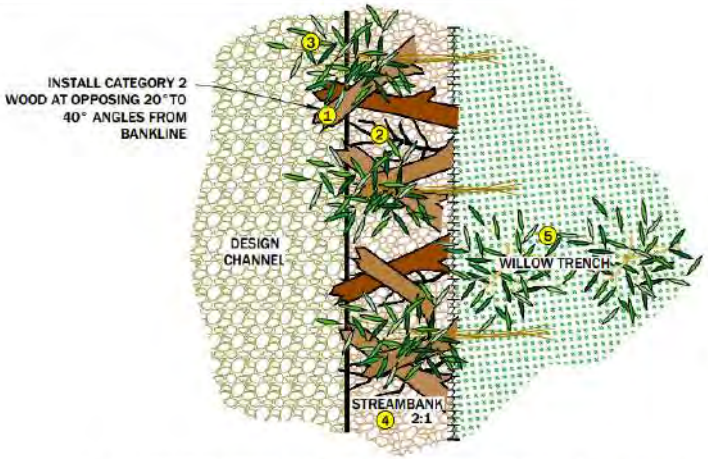
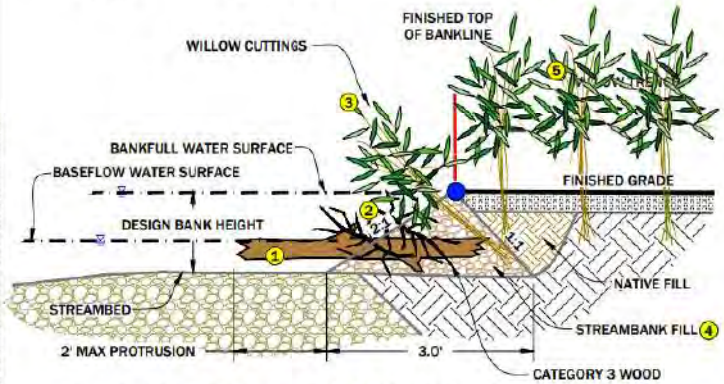
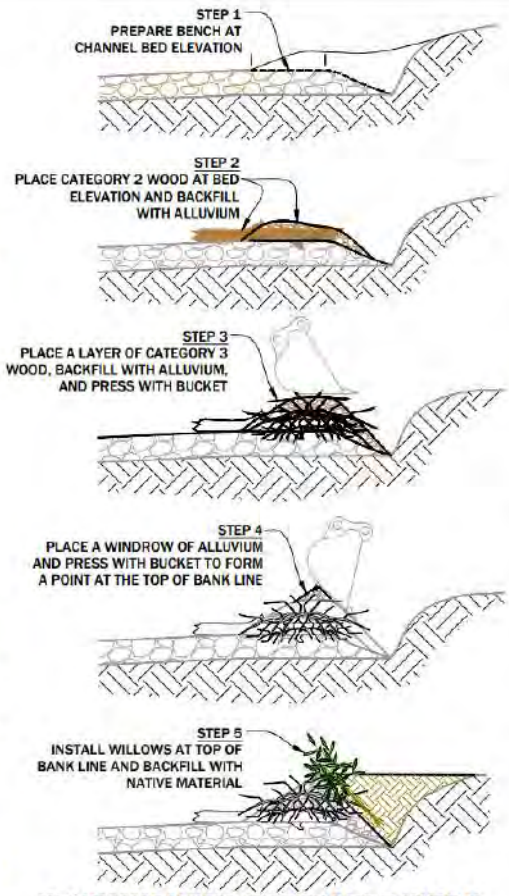


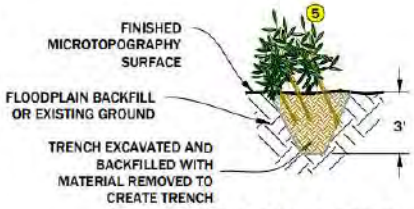
1 VEGETATED WOOD MATRIX - TYPE 1
PLAN VIEW 1" = 3'



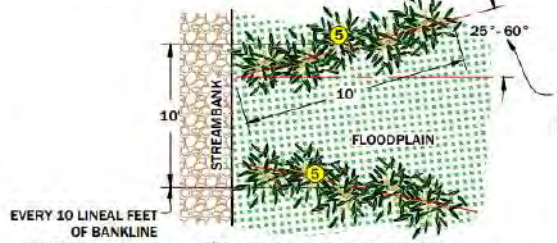
2 VEGETATED WOOD MATRIX - TYPE 1
SECTION VIEW 1" = 3'



3 RECOMMENDED VEGETATED WOOD MATRIX INSTALLATION SEQUENCE
SECTION VIEW 1" = 5'



4 WILLOW TRENCH
SECTION VIEW NTS



5 WILLOW TRENCH
PLAN VIEW NTS

GENERAL NOTES

1. CONSTRUCTION OF THE VEGETATED WOOD MATRIX WILL OCCUR AFTER THE CHANNEL AND FLOODPLAIN BACKFILL IS PLACED AND THE CHANNEL STREAMBED IS CONSTRUCTED. INSTALLATION OF FLOODPLAIN TREATMENT SHALL BE COMPLETED AFTER VEGETATED WOOD MATRIXES ARE INSTALLED.
2. IF VEGETATED WOOD MATRIX STRUCTURES ARE INSTALLED PRIOR TO OCTOBER 1, LEAVE BACK TRENCH UNFILLED AND COMPLETE STRUCTURE WHEN DORMANT WILLOWS ARE AVAILABLE.
3. IT IS CONTRACTOR'S RESPONSIBILITY TO CUT WOOD INTO APPROPRIATE SIZE LENGTHS TO FIT STRUCTURE DIMENSIONS.
4. ANY CHANGES TO THE CONSTRUCTION SEQUENCE MUST BE APPROVED BY CONSTRUCTION MANAGER.
5. CONTRACTOR SHALL MARK AND CONSTRUCTION ENGINEER SHALL APPROVE THE GENERAL LOCATION FOR EACH VEGETATED WOOD MATRIX STRUCTURE PRIOR TO CONSTRUCTION.

NOTES ON VEGETATED WOOD MATRIX INSTALLATION

1. EXCAVATE TO THE EXCAVATION LIMITS AS SHOWN. EXCAVATED MATERIAL SHALL BE STOCKPILED ON THE FLOODPLAIN OUTSIDE OF THE IMMEDIATE WORK AREA.
2. PREPARE THE BENCH OF THE STRUCTURE BY PLACING CHANNEL STREAMBED ALLUVIUM FROM THE BASE OF THE EXCAVATION DEPTH/BOTTOM OF EXCAVATION TO WITHIN 1.0-FT. OF FINISHED GRADE.
3. CATEGORY 2 AND CATEGORY 3 WOOD, AND CHANNEL STREAMBED ALLUVIUM SHALL BE PLACED IN ALTERNATING LAYERS AND BUCKET COMPACTED UP TO THE TOP OF BANK ELEVATION AS SHOWN BELOW IN THE INSTALLATION SEQUENCE. PLACE SIX (6) FT TO EIGHT (8) FT. DORMANT WILLOW CUTTINGS AT A DENSITY OF 5 PER LINEAR FT ALONG THE TOP OF BANK LINE ELEVATION. WILLOW CUTTINGS SHALL SLOPE AT AN APPROXIMATE 1:1 SLOPE AS SHOWN IN SECTION VIEW. STEMS MAY OVERLAP. THE CUT ENDS SHALL BE PLACED AT THE BASE OF THE SLOPES WITH THE UN-CUT ENDS EXTENDING BEYOND THE EDGE OF THE TRENCH SO NO GREATER THAN ONE-THIRD OF THE TOTAL CUTTING LENGTH IS EXPOSED BEYOND THE TOP OF BANK EDGE. WILLOW CUTTINGS SHOULD INTERCEPT THE DESIGN TOP OF BANK LINE AS SHOWN IN STEP 5 OF THE INSTALLATION SEQUENCE.
4. THE UPSTREAM AND DOWNSTREAM ENDS OF THE STRUCTURE SHALL TRANSITION SMOOTHLY INTO ADJACENT STREAMBANK STRUCTURES TO MINIMIZE EROSION, FLANKING, AND BANK FAILURE. STRUCTURE ENDS MAY BE STABILIZED WITH ADDITIONAL CATEGORY 1 ROCK AS APPROVED BY ENGINEER.
5. AFTER INSTALLATION OF THE VEGETATED WOOD MATRIX, BACKFILL THE STRUCTURE WITH STOCKPILED MATERIAL TO FINISHED GRADE, AND BUCKET COMPACT. INSTALL WILLOW TRENCHES AT A RATE OF 2 PER LINEAR FOOT (OR 20 PER TRENCH) AS SHOWN. NO AREAS BEHIND THE FINISHED BANKLINE ARE TO BE LEFT BELOW FINISHED GRADE.

STREAMBED FILL GRADATION

SIZE (IN)	PERCENT PASSING
4	80-100
3	30-80
1	10-30
0.08	10

NOTE: MIX SALVAGED MATERIAL AND IMPORTED MATERIAL TO ACHIEVE SPECIFIED GRADATION.

TYPE 1 - VEGETATED WOOD MATRIX MATERIAL SCHEDULE (PER LINEAR FOOT)

	ITEM	DIA. (IN)	QTY.
1	CATEGORY 2 WOOD	2"-4"	0.2500
2	CATEGORY 3 WOOD	< 2"	2
3	WILLOW CUTTINGS	0.25"-1.0"	3
4	STREAMBANK ALLUVIUM	4" MINUS	0.1 CY

WILLOW TRENCH MATERIAL SCHEDULE (PER LINEAL FOOT)

	ITEM	DIA.	QUANTITY (EA)
5	WILLOW CUTTINGS	0.25" - 1"	5

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VEGETATED WOOD MATRIX (TYPE 1)

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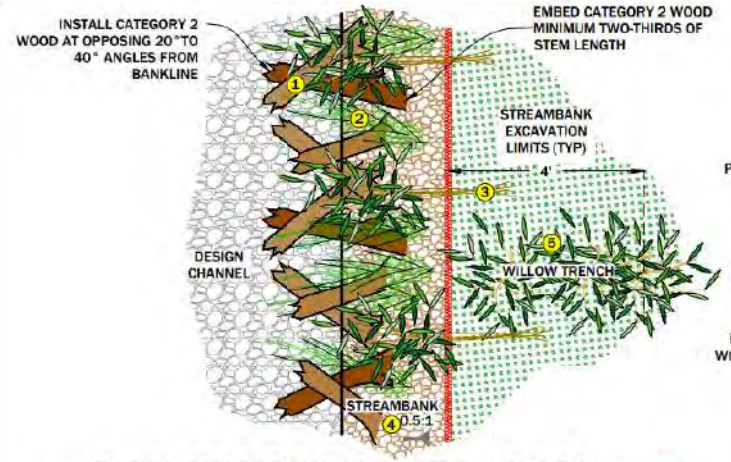
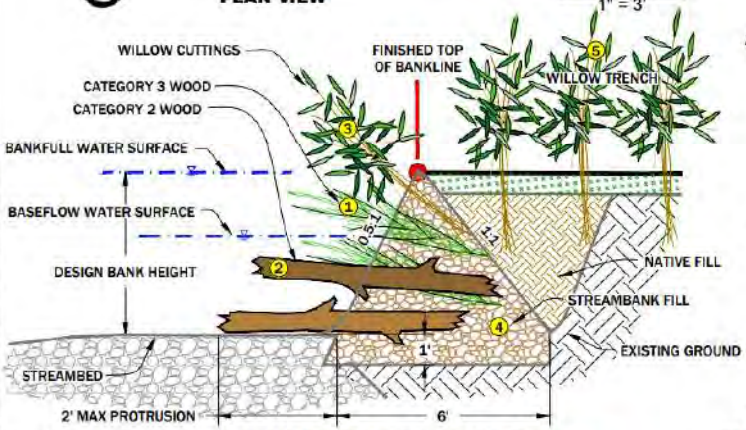
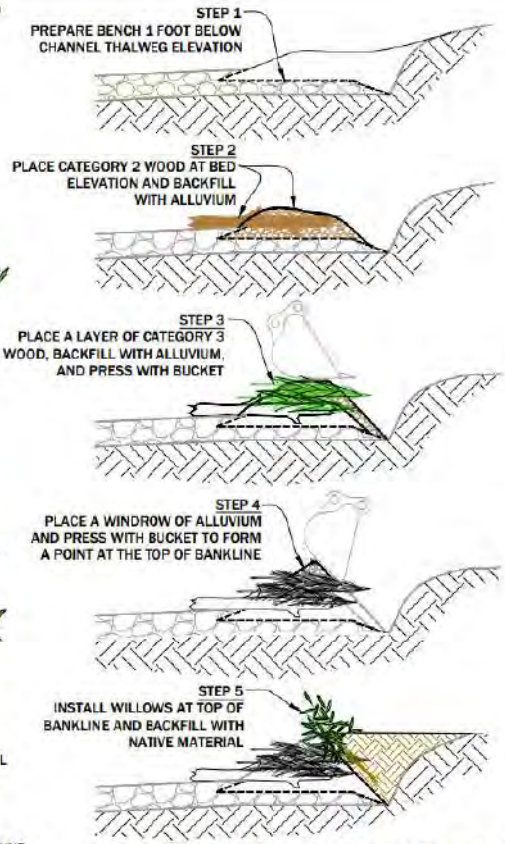
SHEET 22 OF 25



1 VEGETATED WOOD MATRIX - TYPE 2
PLAN VIEW
1" = 3'



2 VEGETATED WOOD MATRIX - TYPE 2
SECTION VIEW
1" = 3'



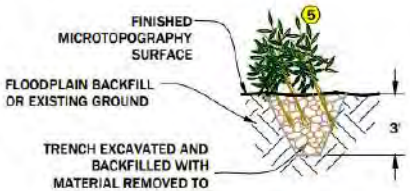
3 RECOMMENDED VEGETATED WOOD MATRIX INSTALLATION SEQUENCE
SECTION VIEW
1" = 5'

GENERAL NOTES

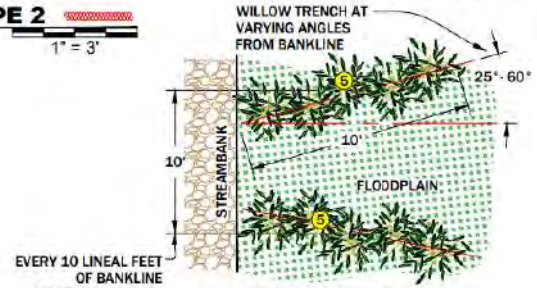
1. IF VEGETATED WOOD MATRIX STRUCTURES ARE INSTALLED PRIOR TO OCTOBER 1, LEAVE BACK TRENCH UNFILLED AND COMPLETE STRUCTURE WHEN DORMANT WILLOWS ARE AVAILABLE.
2. IT IS CONTRACTOR'S RESPONSIBILITY TO CUT WOOD INTO APPROPRIATE SIZE LENGTHS TO FIT STRUCTURE DIMENSIONS.
3. ANY CHANGES TO THE CONSTRUCTION SEQUENCE MUST BE APPROVED BY CONSTRUCTION MANAGER.
4. CONTRACTOR SHALL MARK AND CONSTRUCTION ENGINEER SHALL APPROVE THE GENERAL LOCATION FOR EACH VEGETATED WOOD MATRIX STRUCTURE PRIOR TO CONSTRUCTION.

INSTALLATION NOTES

1. EXCAVATE TO THE EXCAVATION LIMITS AS SHOWN. EXCAVATED MATERIAL SHALL BE STOCKPILED ON THE FLOODPLAIN OUTSIDE OF THE IMMEDIATE WORK AREA.
2. PREPARE THE BENCH OF THE STRUCTURE BY PLACING STREAMBED ALLUVIUM MINIMUM 1 FOOT BELOW CHANNEL THALWEG ELEVATION.
3. CATEGORY 2 AND CATEGORY 3 WOOD, AND STREAMBED ALLUVIUM SHALL BE PLACED IN ALTERNATING LIFTS AND BUCKET COMPACTED UP TO THE TOP OF BANK ELEVATION AS SHOWN IN THE INSTALLATION SEQUENCE. PLACE 6 FT TO 8 FT. DORMANT WILLOW CUTTINGS AT A DENSITY OF 5 PER LINEAR FT ALONG THE TOP OF BANK LINE ELEVATION. WILLOW CUTTINGS SHALL SLOPE AT AN APPROXIMATE 1:1 SLOPE AS SHOWN IN SECTION VIEW. STEMS MAY OVERLAP. THE CUT ENDS SHALL BE PLACED AT THE BASE OF THE SLOPES WITH THE UN-CUT ENDS EXTENDING BEYOND THE EDGE OF THE TRENCH SO NO GREATER THAN ONE-THIRD OF THE TOTAL CUTTING LENGTH IS EXPOSED BEYOND THE TOP OF BANKLINE. WILLOW CUTTINGS SHOULD INTERCEPT THE DESIGN TOP OF BANKLINE AS SHOWN IN STEP 5 OF THE INSTALLATION SEQUENCE.
4. THE UPSTREAM AND DOWNSTREAM ENDS OF THE STRUCTURE SHALL TRANSITION SMOOTHLY INTO ADJACENT STREAMBANK STRUCTURES TO MINIMIZE EROSION, FLANKING, AND BANK FAILURE.
5. AFTER INSTALLATION OF THE VEGETATED WOOD MATRIX, BACKFILL THE STRUCTURE WITH STOCKPILED MATERIAL TO FINISHED GRADE, AND BUCKET COMPACT. INSTALL WILLOW TRENCHES AT A RATE OF 5 PER LINEAR FOOT (OR 50 PER TRENCH) AS SHOWN. NO AREAS BEHIND THE FINISHED BANKLINE ARE TO BE LEFT BELOW FINISHED GRADE.



4 WILLOW TRENCH
SECTION VIEW NTS



5 WILLOW TRENCH
PLAN VIEW NTS

TYPE 2 - VEGETATED WOOD MATRIX MATERIAL SCHEDULE (PER LINEAR FOOT)			
	ITEM	DIA. (IN)	QTY.
1	CATEGORY 2 WOOD	2"-4"	0.25
2	CATEGORY 3 WOOD	< 2"	2
3	BANK WILLOW CUTTINGS	0.25"-1.0"	5
4	STREAMBANK ALLUVIUM	4" MINUS	0.3 CY

WILLOW TRENCH MATERIAL SCHEDULE (PER LINEAL FOOT)			
	ITEM	DIA.	QUANTITY (EA)
5	TRENCH WILLOW CUTTINGS	0.25" - 1"	5

STREAMBED FILL GRADATION	
SIZE (IN)	PERCENT PASSING
4	80-100
3	30-80
1	10-30
0.08	10

NOTE: MIX SALVAGED MATERIAL AND IMPORTED MATERIAL TO ACHIEVE SPECIFIED GRADATION

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236 Wisconsin Avenue
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tel.406.862-6927
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VEGETATED WOOD MATRIX (TYPE 2)

LOWER GRANT CREEK RESTORATION PROJECT

NO.	DATE	BY	DESCRIPTION	CHK
1	08-05-24	DW	CONCEPTUAL DESIGN	JM
2	09-06-24	DB	CONCEPTUAL DESIGN	JM

PROJECT NUMBER
RDG-24-041

DRAWING NUMBER
8.2

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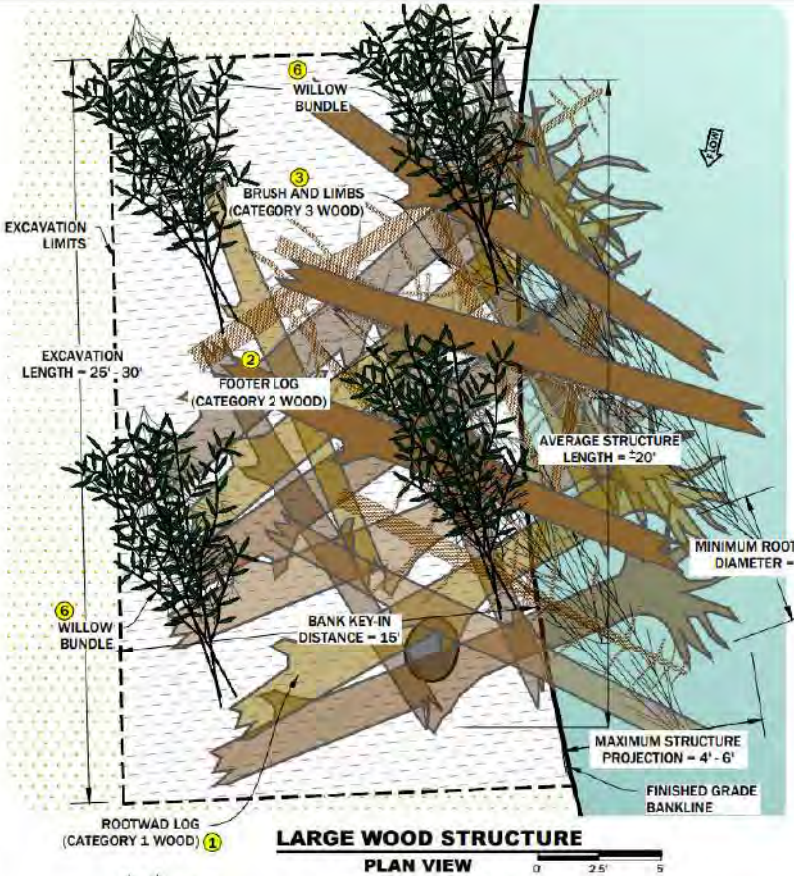
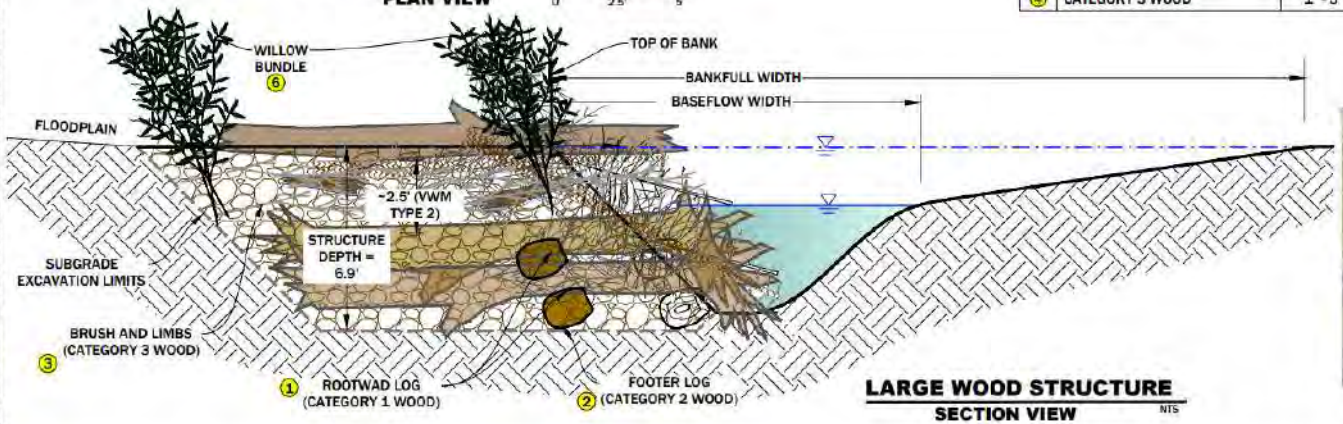


LARGE WOOD STRUCTURE
PLAN VIEW
0 2.5' 5



LARGE WOOD STRUCTURE
SECTION VIEW NTS

GENERAL NOTES

1. CONSTRUCTION OF THE LARGE WOOD STRUCTURE WILL OCCUR BEFORE THE CONSTRUCTED CHANNEL STREAMBED AND VEGETATED WOOD MATRIX BANK TREATMENTS ARE INSTALLED.
2. ANY CHANGES TO THE CONSTRUCTION SEQUENCE MUST BE APPROVED THE ENGINEER.
3. FIELD ENGINEER SHALL MARK THE GENERAL CONSTRUCTION LOCATION FOR EACH LARGE WOOD STRUCTURE PRIOR TO CONSTRUCTION.

CONSTRUCTION NOTES

1. EXCAVATE TO THE EXCAVATION LIMITS. EXCAVATED MATERIAL SHALL BE STOCKPILED ON THE FLOODPLAIN OUTSIDE OF THE IMMEDIATE WORK AREA.
2. INSTALL TWO FOOTER LOGS (CATEGORY 2 WOOD) AT THE BASE OF THE EXCAVATED TRENCH AT THE ORIENTATIONS NOTED IN PLAN VIEW. FOOTER LOGS SHALL PROJECT NO GREATER THAN 1 FT. BEYOND THE FINISH GRADE BANK LINE. EXPOSED ENDS OF FOOTER LOGS SHALL BE BROKEN/ROUGHENED SO AS TO APPEAR NATURAL. SAWED ENDS OF FOOTER LOGS SHALL NOT BE EXPOSED.
3. INSTALL TWO ROOTWAD LOGS (CATEGORY 1 WOOD) INTERSECTING BOTH FOOTER LOGS AT THE ORIENTATION NOTED IN PLAN VIEW. THE UPSTREAM ROOTWAD SHALL NOT PROJECT INTO THE CHANNEL AND SHALL BE FLUSH WITH THE FINISHED BANK LINE. THE DOWNSTREAM ROOTWAD SHALL PROJECT NO GREATER THAN 3 FT. BEYOND THE FINISHED BANK LINE
4. BACKFILL TRENCH WITH STOCKPILED MATERIAL UP TO THE TOP OF THE FOOTER LOGS (CATEGORY 2 WOOD). BACKFILL SHALL BE BUCKET COMPACTED.
5. INSTALL A SECOND TIER OF TWO FOOTER LOG (CATEGORY 2 WOOD) FOOTER LOGS SHALL PROJECT NO GREATER THAN 1 FT. BEYOND THE FINISH GRADE BANK LINE. EXPOSED ENDS OF FOOTER LOGS SHALL BE BROKEN/ROUGHENED SO AS TO APPEAR NATURAL. SAWED ENDS OF FOOTER LOGS SHALL NOT BE EXPOSED.
6. INSTALL SMALL WOOD AND BRUSH (CATEGORY 3 WOOD) AT APPROXIMATE 45° ANGLE TO ROOTWAD STEMS. BRUSH AND LIMBS SHALL PROJECT NO GREATER THAN 3 FT. BEYOND THE FINISHED BANK LINE.
7. INSTALL ONE TO TWO ROOTWAD LOGS (CATEGORY 1 WOOD) INTERSECTING THE LOWER TIER OF ROOTWADS AT THE ORIENTATION NOTED IN PLAN VIEW. THE ROOTWADS SHALL PROJECT NO GREATER THAN 2 FT. BEYOND THE FINISHED BANK LINE.
8. INSTALL SMALL WOOD AND BRUSH (CATEGORY 3 WOOD) AND WILLOW CUTTINGS INTERWOMEN INTO WOOD MATRIX UP TO FINISHED GRADE. BRUSH, LIMBS, AND WILLOW CUTTINGS SHALL PROJECT NO GREATER THAN 4 FT. BEYOND THE FINISHED BANK LINE.
9. BACKFILL WOOD MATRIX WITH STREAMBED FILL UP TO FINISHED GRADE WITH STOCKPILED NATIVE MATERIAL. NO AREAS BEHIND THE FINISHED BANKLINE ARE TO BE LEFT BELOW FINISHED GRADE.
10. INSTALL DEFLECTOR LOGS (CATEGORY 2 WOOD)) AT APPROXIMATE 45° ANGLE TO ROOTWAD STEMS. DEFLECTOR LOGS SHALL BE HALF EMBEDDED IN THE FLOODPLAIN AND PROJECT NO GREATER THAN 4 FT. BEYOND THE FINISHED BANK LINE. EXPOSED ENDS OF FOOTER LOGS SHALL BE BROKEN/ROUGHENED SO AS TO APPEAR NATURAL. SAWED ENDS OF FOOTER LOGS SHALL NOT BE EXPOSED.

LARGE WOOD STRUCTURE
MATERIAL SCHEDULE (PER LINEAR STRUCTURE)

	ITEM	DIA. (IN)	LENGTH (FT)	ROOTWAD (Y/N)	QTY.
1	SUBGRADE EXCAVATION				5 CY
2	CATEGORY 1 WOOD	10"-12"	12-15	YES - 18IN DIA. MIN	2 EA
3	CATEGORY 2 WOOD	3"-10"	10-15	NO	4 EA
4	CATEGORY 3 WOOD	1" - 3"	10-12	OPTIONAL 1-2 FT	10 EA

EXAMPLE OF A LARGE WOOD STRUCTURE

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236 Wisconsin Avenue
Whitefish, MT 59937
tel.406.862.4927
fax.406.862.4963

LARGE WOOD STRUCTURE DETAIL

LOWER GRANT CREEK RESTORATION PROJECT

NO.	DATE	BY	DESCRIPTION	CHK
1	08-05-24	DW	CONCEPTUAL DESIGN	JM
2	09-06-24	DB	CONCEPTUAL DESIGN	JM

PROJECT NUMBER
RDG-24-041

DRAWING NUMBER
8.3

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1 Project Background

1.1 Introduction

River Design Group, Inc. (RDG) was retained by Clark Fork Coalition (CFC) in cooperation with Missoula Conservation District, Montana Fish, Wildlife & Parks, and Montana Department of Environmental Quality to prepare a Conceptual Restoration Plan for lower Grant Creek near Missoula, Montana (Figure 1-1). The project area encompasses three reaches (Reaches 2 – 4) that extend from the Missoula Montana Airport downstream to the confluence with the Clark Fork River (Figure 1-2). A restoration plan was completed for Reach 1 (Horseshoe Bend) by HDR Engineering, Inc. in 2023.

Lower Grant Creek has been subject to significant alteration from development including railroads and roads, agriculture and grazing, and residential developments. These disturbances have severely compromised river and floodplain functionality and habitat quality. From the Rattlesnake Wilderness boundary to the Clark Fork River (14.5 miles), Grant Creek is classified as a B-1 waterbody and listed as water-quality impaired for algae, flow regime modification and alteration in streamside cover, nitrate/nitrite, total nitrogen, sediment and temperature. Probable sources of impairment include irrigated crop production, loss of riparian habitat, land development, streambank modifications, and water diversions. CFC, project partners, and private landowners are interested in addressing water quality impairments through improved land use management and both passive and active restoration strategies to address geomorphic, aquatic, and floodplain limiting factors in the lower watershed. The intent of this Basis of Conceptual Design Report is to provide detailed information on the assessment of existing conditions and evaluation of limiting factors and constraints that informed the development of the restoration strategies and concepts presented in the accompanying Conceptual Restoration Plan.

1.2 Restoration Goals

The Conceptual Restoration Plan aims to restore, to the greatest extent practical given existing site constraints, channel, floodplain, and vegetation conditions that will support high quality water and improved aquatic habitat for focal fish species including threatened bull trout (*Salvelinus confluentus*) using lower Grant Creek as a migratory corridor to access high quality spawning habitat in the upper watershed. Further, strategies to reduce land loss associated with high rates of bank erosion due to land clearing and conversion of scrub-shrub and forested riparian communities to post-agricultural assemblages are incorporated. Restoration strategies are expected to increase the overall values and function of the aquatic environment by reducing non-point source pollutants identified on the Montana 303(d) List of impaired waterbodies (MDEQ 2014).

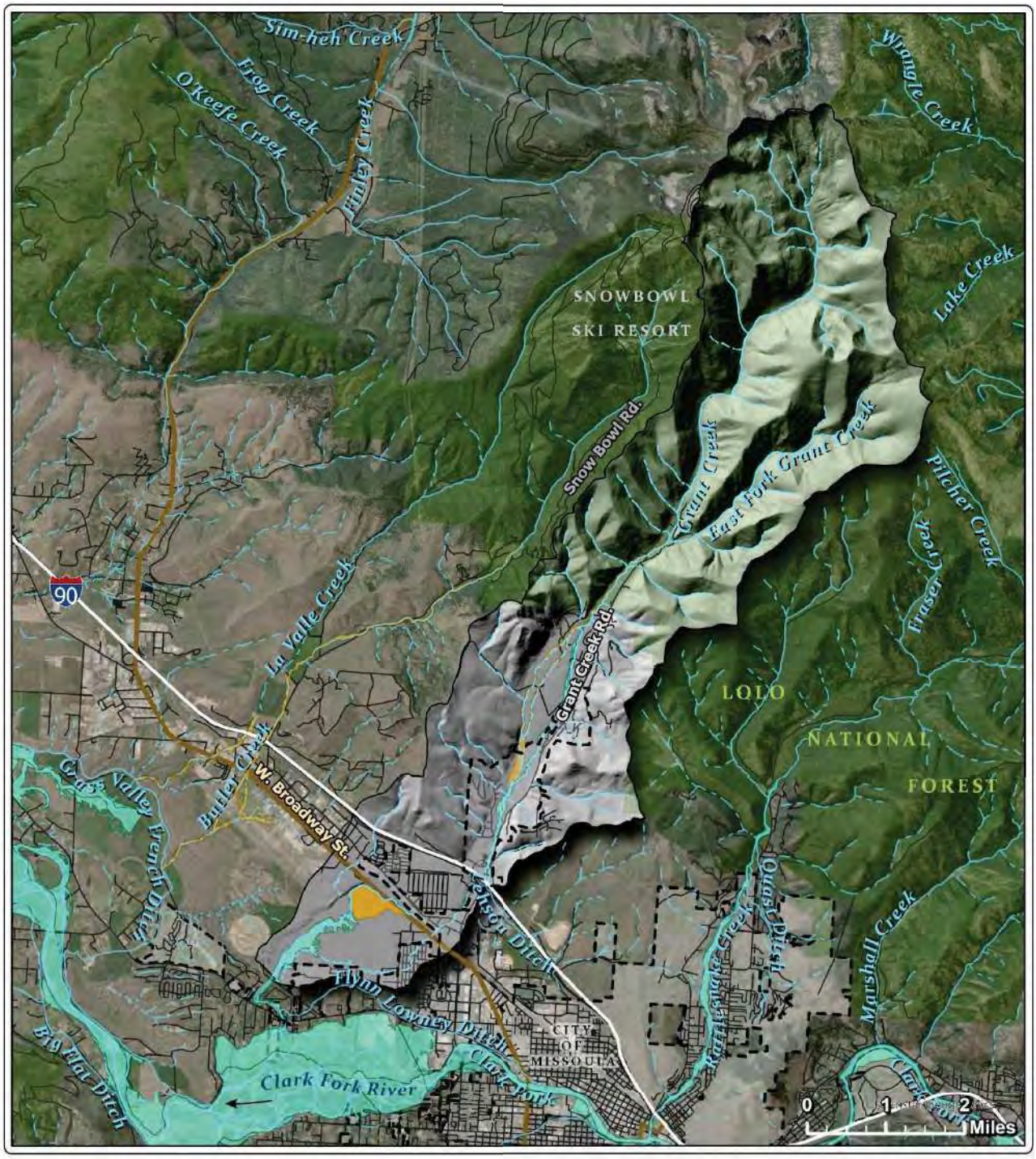

Figure 1-1. Location of the Grant Creek Watershed near Missoula, Montana.

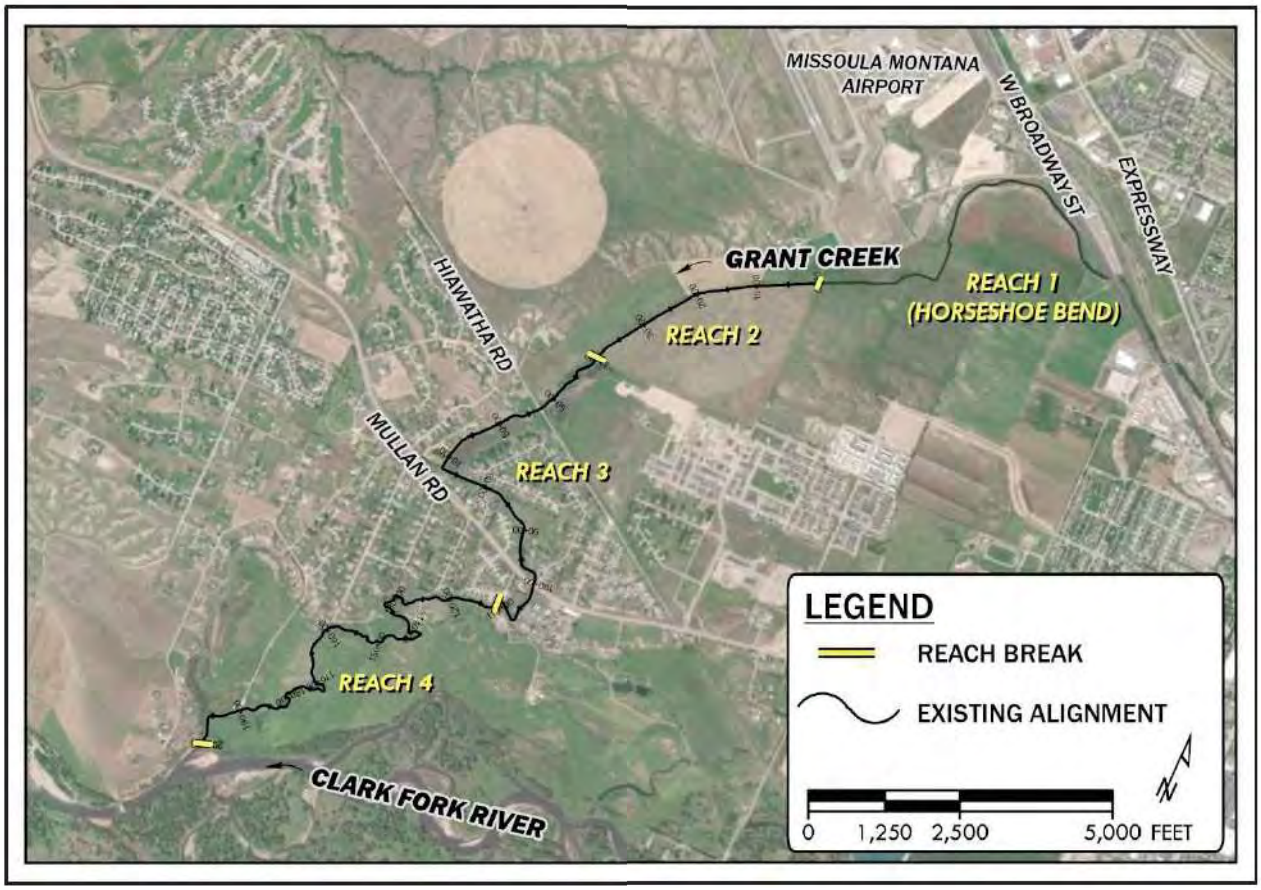

Figure 1-2. Project Reaches 2 through 4 on lower Grant Creek.

1.3 Previous Investigations

The *Grant Creek Riparian Assessment* (Land et al. 2022) provided important background information on the history of disturbance and restoration efforts in the Grant Creek watershed, as well as existing conditions, specifically as pertaining to riparian vegetation and fish habitat.

The *Grant Creek Hydrology and Hydraulics* report (HDR 2020) established recommended peak flow recurrence interval discharges for lower Grant Creek for use in design of projects associated with the Mullan BUILD Project.

2 Existing Conditions Assessment

The following sections describe existing conditions within the Grant Creek watershed, including watershed-scale geology and geomorphology, hydrology, vegetation, and aquatic habitat. Project reach-specific geomorphic, vegetation, and aquatic habitat conditions are also described.

2.1 Hydrology

Grant Creek originates in the Rattlesnake Wilderness 12 miles north of Missoula, Montana (Figure 1-1). The creek flows approximately 18 miles in a south-westerly direction to its confluence with the Clark Fork River. The drainage area at the upstream end of the project area is 38 square miles. Watershed elevations range from 8142 feet at the headwaters to 3112 at the confluence with the Clark Fork, with an average watershed elevation of 4582 feet. Mean annual precipitation is approximately 27 inches (USGS 2024). The hydrology of Grant Creek is snowmelt-driven with peak flows typically occurring in the late spring and low flows in late summer and fall. The project area of Grant Creek suffers from chronic dewatering and low flows in the summer months due to irrigation withdrawals. However, a series of springs in Reach 4 provide perennial flow (Land et al. 2022).

There are no streamflow gaging stations on Grant Creek. Flood frequency statistics were obtained from the *Grant Creek Hydrology and Hydraulics* report (HDR 2020). An at-a-station hydraulic analysis was completed to estimate the bankfull discharge using field-surveyed bankfull channel dimensions, slopes, and pebble count data. Flood frequency statistics are summarized in Table 2-1.

Table 2-1. Flood frequency statistics for the Grant Creek project reach.

Return Interval (yrs)	Probability (%)	Peak Flow (cfs)
Bankfull ($Q_{1.5}$)	---	90
2	50	170
10	10	358
50	2	538
100	1	629

2.2 Geology and Geomorphology

Grant Creek headwaters in the Rattlesnake Mountains in the quartzite-rich Garnet formation, then continues downstream through the limestone and argillite-dominant Helena and Wallace formations (Figure 2-1). The morphology of Grant Creek along this section is more controlled by bedrock lithology than adjacent floodplain processes. The soil profile becomes thicker and more prominent where the stream gradient declines and reaches a gentler slope. This is where floodplain depositional processes become dominant and build fluvial terraces (Figure 2-1). The soil composition in Reach 1 (Horseshoe Bend) is principally glacial outwash deposits of sand and

gravel, with lacustrine deposits of silt and clay present at deeper depths. These are relics of glacial processes that existed during the Pleistocene, with Glacial Lake Missoula depositing fine clay material and glacial outwash plains creating a heterogenous mixture of sand, gravel, and clay. Reaches 2 through 4 are characterized by contemporary riverine processes from the nearby Clark Fork River. The soil profile composition at these sites is characterized by silty alluvium with moderate amounts of gravel. The composition of the soil profile spatially correlates to the relict flow paths of the ancestral Clark Fork River.

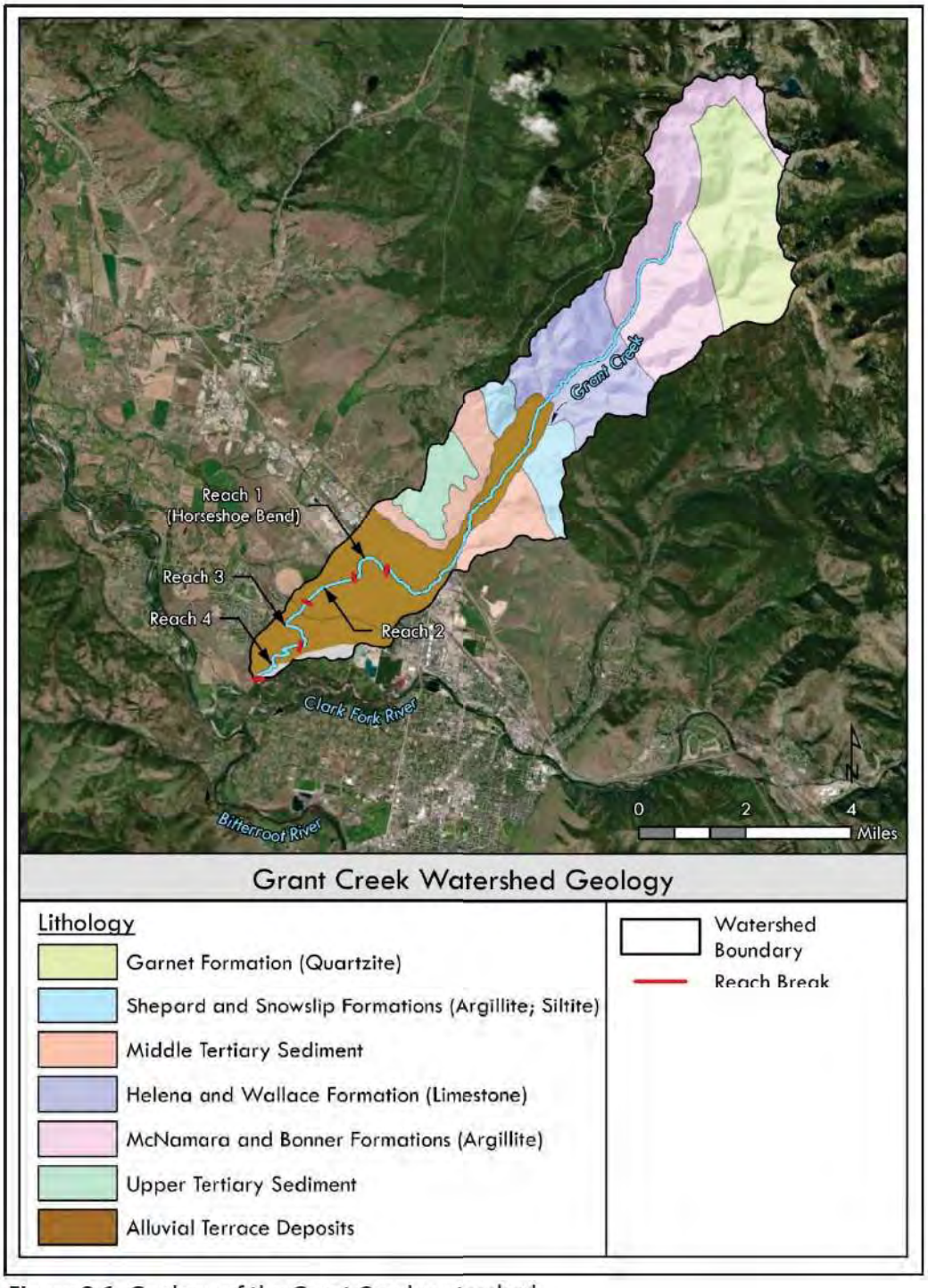

Figure 2-1. Geology of the Grant Creek watershed.

2.3 Riparian Vegetation and Aquatic Habitat

Existing riparian vegetation and aquatic habitat conditions in the Grant Creek watershed are described in detail in the *Grant Creek Riparian Assessment* (Land et al. 2022). This includes an evaluation of riparian and fish habitat conditions for the length of Grant Creek downstream from Snowbowl Road according to the USDA Natural Resources Conservation Service (NRCS) Riparian Assessment Method (RAM) (NRCS 2004). The RAM consists of a quantitative evaluation of metrics including stream incision, bank erosion, pool frequency, and streambank vegetation condition. Based on values of the associated metrics, riparian and aquatic habitat quality is ranked as either *sustainable*, *at risk*, or *not sustainable*.

The upper Grant Creek watershed within the Rattlesnake Wilderness is heavily forested, providing robust riparian vegetation and high-quality water and aquatic habitat. Habitat quality is classified as *sustainable* in this section. From Snowbowl Road to Interstate 90 (3.7 miles) Grant Creek is characteristic of a B3 stream type, exhibiting cobble substrate and some large woody debris. Despite some agricultural use and residential development that encroaches on the floodplain, the riparian area consists of mostly healthy cottonwood forest that is hydrologically connected to the channel. Habitat quality is mostly classified as *sustainable* through this segment (Land et al. 2022).

From Interstate 90 to Broadway (1.5 miles), the adverse impacts of development on the Grant Creek channel and riparian area become more pronounced. Although cottonwoods and some willows are present along the channel margins, the riparian area is severely restricted by industrial and commercial development, and invasive forbs and noxious weeds are locally extensive. Grant Creek is mostly channelized through this reach and is characteristic of a B3 stream type. Aquatic habitat is limited by a lack of pools and large woody debris and several culverts, leading to habitat ratings of *at risk* and *not sustainable* in this segment (Land et al. 2022).

Broadway marks the upstream extent of Reach 1 (Horseshoe Bend) (Figure 1-2). The channel and riparian area from Reach 1 through 4 (5.1 miles) has been heavily manipulated and disturbed from agriculture and residential development. The channel can be broadly characterized as a G-type "gully" channel and exhibits high entrenchment, minimal floodplain connectivity, high rates of bank erosion, and limited riparian vegetation. Substrate is dominated by fines and flow is intermittent in this section due to irrigation withdrawals. Numerous culverts in this section may provide challenges for fish passage. Habitat quality is predominantly classified as *not sustainable* in this segment (Land et al. 2022). Existing conditions in Reaches 2 through 4 are described in detail in Sections 2.4 to 2.6.

2.4 Reach 2 Existing Conditions

Reach 2 extends 0.8 miles on the property of the Missoula County Airport Authority (Figure 2-2). The stream was historically channelized and provides poor geomorphic, hydraulic, and habitat complexity. The reach is devoid of woody riparian vegetation to provide cover, shade, and a source of large wood; vegetation consists of pasture grasses. The lack of riparian vegetation to

Figure 2-2. Existing conditions and land ownership in lower Grant Creek Reach 2.

stabilize banks and morphologic complexity and large wood to dissipate flow energy has led to lateral and vertical channel erosion and a loss of floodplain connectivity (Figure A-5). Fine sediment loading from erosion has overwhelmed the transport capacity of the channel, contributing to siltation of the bed. Historic vegetation removal and floodplain disconnection have resulted in a floodplain that provides little habitat complexity or diversity. The contemporary morphology of Reach 2 does not allow for natural riverine processes to create complex in-channel and floodplain features, and has led to the degradation of aquatic, riparian, and terrestrial habitat. Typical channel conditions in Reach 2 are shown in Figure 2-3.

Figure 2-3. Typical channel conditions in Reach 2 of lower Grant Creek.

2.5 Reach 3 Existing Conditions

Reach 3 extends 1.4 miles downstream from the southern property boundary of the Missoula County Airport Authority to the start of Reach 4 (Riverwalk Estates HOA, Inc.) (Figure 2-4). Crossings at Hiawatha Road and Mullan Road, as well as a concrete diversion dam in upper Reach 3 present potential barriers to fish passage and large wood transport. Reach 3 was straightened and channelized to accommodate residential developments in the historical Grant Creek floodplain. As such, the channel is entrenched and lacks floodplain connectivity and planform complexity. Substrate consists mostly of fines. Much of the reach has a narrow woody riparian corridor inclusive of mature cottonwood (*Populus* sp.) and birch (*Betula* sp.). The channel exhibits some hydraulic complexity as a result of wood recruitment, but overall habitat quality is poor (Figure 2-5). Reach 3 exhibits some signs of recent beaver activity.

Figure 2-4. Existing conditions and land ownership in lower Grant Creek Reach 3.

Figure 2-5. Typical channel conditions in Reach 3.

Flood risk is a continuing concern in Reach 3. In 2008, Missoula County retained HDR Engineering, Inc. to engineer and construct the Grant Creek Restoration and Flood Control Project. The project consisted of constructing two flood attenuation/detention basins upstream and downstream of Hiawatha Road to reduce flood hazard risk to adjacent residential developments (Figure 2-4; Figure 2-6). Erosion near the inlet structure may be contributing to greater streamflow capture to the ponds than was designed (Land et al. 2022). A second component of the project was the construction of a concrete inlet peak flow bypass structure and pipeline upstream of Mullan Road (Figure 2-4). The effectiveness of these projects in ameliorating flood risk is uncertain and was beyond the scope of the Conceptual Restoration Plan.

Figure 2-6. Flood attenuation basin in Reach 3.

2.6 Reach 4 Existing Conditions

Reach 4 begins where the creek exits a large culvert and enters the property of Riverwalk Estates HOA, Inc. The reach extends 1.7 miles downstream to the confluence with the Clark Fork River (Figure 2-7). It is likely that the creek was historically channelized for large sections of Reach 4 to enable agricultural practices and residential development in the floodplain. There are several crossings of varying size in the reach that may potentially impede the downstream transport of woody debris.

The upper 2600 feet of Reach 4 is mostly forested, including mature cottonwoods (*Populus* sp.) and willows (*Salix* sp.), and natural wood recruitment and storage provides some hydraulic and geomorphic complexity (Figure 2-8). The gradient is steeper through this section (Figure A-1), and coarse (cobble-gravel) sediment transport and deposition are active processes, contributing to the development of some riffles, pools, and bars (Figure 2-9). Most of upper Reach 4, where the channel runs adjacent to a suburban residential development, is severely entrenched and provides little floodplain connectivity (Figure A-6). The lack of connected floodplain to dissipate energy during high flows contributes to local erosion of streambanks and further incision of the channel (Figure 2-10). The eroding right bank at Station 133+00 has been stabilized with large concrete slabs and riprap (Figure 2-11). Besides a narrow riparian corridor through upper Reach 4, floodplain vegetation consists mostly of grasses.

Figure 2-7. Existing conditions and land ownership in lower Grant Creek Reach 4.

Figure 2-8. Examples of wood-forced hydraulic and geomorphic complexity in upper Reach 4.

Figure 2-9. Examples of riffle-pool development (left) and bar formation (right) in upper Reach 4.

Figure 2-10. Channel conditions in upper Reach 4 showing high entrenchment and eroding banks.

Figure 2-11. Bank stabilization at Station 133+00.

Below Station 138+00, cattle grazing has a clear and adverse impact on fluvial processes and aquatic habitat. In some instances, cattle fencing in the channel inhibits the downstream transport of wood and forms debris jams that may present challenges to fish passage (Figure 2-12). As a result of historic floodplain vegetation removal and ongoing browse pressure, woody riparian vegetation exists only in isolated stands. Floodplain vegetation consists mostly of pasture grasses, leaving the channel exposed to solar gain and providing poor terrestrial habitat and bank reinforcement. A mostly simple channel planform and lack of large wood provide little means of energy dissipation during high flows, contributing to channel incision and lateral bank erosion (Figure 2-13). Bank erosion is exacerbated by cattle tramping, leading to severe over widening in some areas (Figure 2-14).

Figure 2-12. Fencing impeding the downstream transport of wood.

Figure 2-13. Channel conditions in lower Reach 4 showing bank erosion and entrenchment.

Figure 2-14. Example over-widened channel in lower Reach 4.

Lower Reach 4 is low-gradient, and the degraded channel lacks the capacity to transport the abundant fine sediment load, leading to siltation. Warm temperatures and excess nutrient loading contribute to the growth of algae (Figure 2-15). Floodplain connectivity is generally poor in this section (Figure A-6), although in some areas the channel has begun to develop an inset floodplain (Figure 2-16). Springs contribute perennial flow to lower Reach 4 at Stations 142+00 and 195+00. These areas provide low-energy, hydrologically connected off-channel habitat. Beaver activity is evident in lower Reach 4, including a dam at Station 197+00 that creates a large backwater area (Figure 2-17). Despite some areas of Reach 4 exhibiting characteristics of good aquatic habitat, in general the reach is severely degraded and the natural recovery of riverine processes and high-quality habitat is limited by residential encroachment in the historic floodplain and ongoing agriculture and grazing practices.

Figure 2-15. Algae growth in lower Reach 4.

Figure 2-16. Inset floodplain development in lower Reach 4.

3 Limiting Factors and Constraints

This section describes existing limiting factors to aquatic habitat and river and floodplain functionality and constraints to restoration in the Grant Creek project area.

3.1 Limiting Factors

Table 3-1 summarizes limiting factors to habitat and stream function and their associated causes, as determined from the existing conditions assessment. Note the interrelations and complexities among limiting factors and their causes; one limiting factor can be a cause of another limiting factor. All of the limiting factors identified pertain to all three project reaches.

Table 3-1. Summary of limiting factors to aquatic habitat and river and floodplain functionality and associated causes in lower Grant Creek. Specific outcomes or component processes associated with causes of impairment are indicated in parentheses.

Limiting Factor	Cause of Impairment
Poor aquatic habitat cover and complexity	• Channel straightening (lateral migration; geomorphic and hydraulic complexity) • Minimal large wood recruitment, storage, and transport (cover; sediment deposition and sorting; pool formation) • Reduced beaver activity (channel complexity and habitat creation)
Minimal large wood recruitment, storage, and transport	• Lack of riparian vegetation (wood recruitment) • Loss of beaver activity (wood recruitment and storage) • Culverts, diversion dam, fencing (wood transport)
Reduced beaver activity	• Beaver removal • Lack of riparian vegetation
Lack of riparian vegetation	• Floodplain development (vegetation removal) • Agriculture and grazing practices (vegetation conversion; browse pressure) • Channel incision/floodplain disconnection (lowered water table; seedling recruitment, transport and establishment) • Poor floodplain habitat diversity (seedling recruitment, transport, and establishment)
Channel incision/floodplain disconnection	• Channel straightening (energy dissipation) • Minimal large wood recruitment, storage, and transport (energy dissipation) • Flow reductions and dewatering
Movement of aquatic biota	• Flow reductions and dewatering • Culverts and diversion dam
Flow reductions and dewatering	• Surface water and groundwater withdrawals • Climatic shifts (reduced snowpack; drought)
Siltation	• Excess bank erosion (sediment supply; transport capacity) • Channel incision/floodplain disconnection (floodplain sediment storage) • Flow reductions and dewatering (sediment transport capacity)

Table 3-1. Summary of limiting factors to aquatic habitat and river and floodplain functionality and associated causes in lower Grant Creek. Specific outcomes or component processes associated with causes of impairment are indicated in parentheses.

Limiting Factor	Cause of Impairment
Excess bank erosion	• Lack of riparian vegetation (root reinforcement) • Agriculture and grazing practices (cattle tramping) • Channel incision/floodplain disconnection (flood attenuation; energy dissipation) • Minimal large wood recruitment, storage, and transport (energy dissipation) • Channel straightening (energy dissipation)
Poor floodplain habitat diversity	• Floodplain development (vegetation removal; wetland loss) • Agriculture and grazing practices (vegetation conversion; browse pressure) • Channel incision/floodplain disconnection (loss of side channels and alcoves)
Excess nutrients and algae	• Agriculture and grazing practices (runoff of fertilizers and livestock waste) • Lack of riparian vegetation (nutrient retention and uptake) • Poor floodplain habitat diversity (nutrient retention and uptake) • Elevated water temperature (algae growth)
Elevated water temperature	• Lack of riparian vegetation (stream shading) • Channel straightening (pool frequency; hyporheic exchange) • Minimal large wood recruitment, storage, and transport (pool formation; hyporheic exchange) • Siltation (hyporheic exchange) • Flow reductions and dewatering • Excess bank erosion (high width/depth)

3.2 Restoration Constraints

This section describes existing constraints to restoration in the Grant Creek project area by reach.

Reach 2

Due to the existing runway flight path for Missoula Airport above the project area, the Missoula Country Airport Authority is concerned with restoration actions that may attract large birds, particularly waterfowl. This precludes the use of constructed wetlands as a restoration strategy in Reach 2.

Reach 3

The density and encroachment of suburban development represents a significant constraint to restoration in Reach 3. This precludes restoration actions to raise the bed elevation of Grant Creek, add planform variability and morphologic complexity, and reactivate the historic

floodplain. The history of flooding in this reach and the two flood attenuation/detention basins also pose as obstacles to restoration. The Hiawatha Road and Mullan Road crossings, a concrete diversion dam, and the peak flow bypass structure are fixed infrastructure constraints in Reach 3.

Reach 4

In the upper 3000 feet of Reach 4, restoration is constrained by the proximity of the channel to residential development. This limits opportunities to restore floodplain connectivity and add planform and morphologic complexity. Multiple stream crossings in Reach 4 also represent fixed infrastructure constraints. Active grazing and a history of beaver removal present continuing challenges in Reach 4; a comprehensive grazing management plan and coexistence between landowners and beaver will be essential to ensure successful restoration outcomes.

4 Restoration Strategies

The Conceptual Restoration Plan aims to promote natural fluvial and floodplain processes that create and sustain complex aquatic, riparian, and terrestrial ecosystems and build resilience to climatic and anthropogenic disturbances. Key processes include lateral, longitudinal, and vertical hydrologic connectivity, wood accumulation, and beaver activity. Specifically, restoration treatments were developed to address the limiting factors and causes of impairment identified in Section 3.1 with consideration of the constraints identified in Section 3.2. Table 4-1 summarizes proposed restoration treatments, the specific limiting factors addressed, and reaches where the treatment is recommended. Due to the constraints imposed on restoration in Reach 3, no restoration treatments are recommended. Sections 4.1 to 4.7 provide detailed descriptions of the restoration treatments identified in Table 4-1 and in the Conceptual Restoration Plan. Feasibility considerations are discussed in Section 4.9.

Table 4-1. Summary of proposed lower Grant Creek restoration treatments, limiting factors addressed, and reaches where the treatment is recommended.

Restoration Treatment	Limiting Factors Addressed	Reaches Recommended
Channel reconstruction	Poor aquatic habitat complexity Channel incision/floodplain disconnection Siltation Elevated water temperature	Reaches 2 & 4
Vegetated streambank structures	Excess bank erosion Siltation Lack of riparian vegetation Poor aquatic habitat cover and complexity Elevated water temperature Minimal large wood recruitment and storage	Reaches 2 & 4
Large wood habitat structures	Poor aquatic habitat cover and complexity Minimal large wood recruitment and storage Elevated water temperature	Reach 4
Floodplain willow trenches	Lack of riparian vegetation Poor floodplain habitat diversity Excess nutrients and algae	Reaches 2 & 4
Floodplain roughness and revegetation	Lack of riparian vegetation Poor floodplain habitat diversity Excess nutrients and algae	Reaches 2 & 4
Wetland creation	Poor floodplain habitat diversity Excess nutrients and algae Siltation	Reach 4
Grazing management plan	Lack of riparian vegetation Excess bank erosion Poor floodplain habitat diversity Excess nutrients and algae	Reach 4

4.1 Channel Reconstruction

New channel construction will address the general lack of geomorphic and aquatic habitat complexity in the project area. Design channels will incorporate planform variability and morphologic complexity in the form of riffle, run, pool, and glide features that provide diverse habitat and promote hyporheic exchange. Channels will be sized to accommodate the estimated bankfull discharge of 90 cfs. The channel bed profile will be elevated to reconnect historic floodplain surfaces, promote groundwater recharge, and provide flood attenuation. In addition to driving increased hyporheic exchange, channel construction will address water temperature impairments by creating cold water refugia in pools and lowering channel width-to-depth ratios. A reduction in width-to-depth ratios will also increase stream power and sediment transport capacity, thereby reducing siltation. An example constructed channel is shown in Figure 4-1. Specific channel design criteria for Reaches 2 and 4 is described in Appendix B.

Figure 4-1. Example constructed channel through a riffle feature.

4.2 Vegetated Wood Matrix Structures

Vegetated wood matrix (VWM) structures address excess bank erosion and fine sediment loading by providing temporary stability on eroding banks and on newly constructed channel margins until floodplain vegetation becomes established. VWM structures are composed of intermeshed layers of small logs and brush built on an alluvium foundation. Willow cuttings are placed within the brush layers at elevations that are in contact with the water table during the growing season. The structure is backfilled with gravel and soil to fill the voids and provide growth media for the cuttings. By projecting slightly from the edge of the bank, the brush offers cover for aquatic habitat and roughness for dissipating flow velocity and bank stress. The brush can also function as a browse deterrent by making access to cuttings difficult. Over time, the brush will decompose, and woody vegetation will become established along the streambank, providing shade and a source of instream wood (Figure 4-2).

Figure 4-2. VWM structures on Ninemile Creek near Missoula, Montana following construction (left) and after one year of growth (right).

4.3 Large Wood Habitat Structures

Large wood habitat structures will be installed along newly constructed channel margins to maintain pools, create hydraulic complexity, provide cover, and promote woody debris accumulation. Large wood structures consist of multiple tiers of stacked large logs (key members) with attached rootfans (Figure 4-3). Smaller wood and brush are racked between the key members. The structure is backfilled with alluvium to counteract buoyancy and sliding forces. Preferred wood species include the native conifers Douglas fir (*Pseudotsuga menzisii*), western larch (*Larix occidentalis*), ponderosa pine (*Pinus ponderosa*), lodgepole pine (*Pinus contorta*), western redcedar (*Thuja plicata*), Engelmann spruce (*Picea engelmannii*), grand fir (*Abies grandis*), subalpine fir (*Abies lasiocarpa*), western hemlock (*Tsuga heterophylla*), and rocky mountain juniper (*Juniperus scopulorum*).

Figure 4-3. Example large wood habitat structure on a side channel of the Kootenai River, Idaho.

4.4 Willow Trenches

Willow trenches address the lack of robust woody riparian vegetation in the project area. The structures are incorporated on newly constructed channel margins and consist of buried willow (*Salix* spp.) cuttings placed perpendicular to the bankline intermixed with bank structures. Willow trenches extend approximately 10 feet laterally from the top of bank and are spaced every 10 feet longitudinally along the bankline. In addition to increasing overall floodplain habitat diversity, the willow trenches promote nutrient retention and uptake and provide roughness to dissipate flow energy and promote floodplain sediment deposition and natural vegetation recruitment during overbank flows. Species in cutting specifications can be varied to include other riparian shrubs such as red-osier dogwood (*Cornus sericea*) and alder (*Alnus* spp.).

4.5 Floodplain Roughness and Revegetation

Floodplain roughness is a technique to establish short-term floodplain stability for disturbed areas on the floodplain resulting from construction activities. Floodplain roughness consists of buried wood and microtopography to replicate the roughness function of floodplain vegetation. Buried wood consists of small logs and brush projecting one to two feet above the surface and buried two feet into the floodplain to prevent buoyancy. Microtopography consists of small furrows and ridges excavated into the floodplain surface to provide surface variation within six inches of the floodplain elevation.

Buried wood and microtopography reduce the velocity of overbank flows such that topsoil is retained and fine sediment entrained in the flow is deposited. Floodplain roughness creates conditions that support establishment of plant communities by introducing organic material, retaining moisture and nutrients, trapping seeds and promoting natural recruitment. Floodplain roughness can discourage browsing by making access to planted material or naturally colonizing trees and shrubs more difficult. In addition to roughness features, all disturbed floodplain areas will be seeded to promote natural recruitment and regeneration of native riparian vegetation and to discourage weed invasion. Examples of floodplain roughness treatments are provided in Figure 4-4.

Figure 4-4. Example floodplain roughness treatments after construction (left) and one-year post-construction (right).

4.6 Wetland Creation

Wetland creation involves the establishment of new wetlands in the floodplain. Wetlands increase floodplain habitat diversity, provide floodplain water storage and flood attenuation, and filter nutrients, sediments, and pollutants. Wetland depths will range from 0 to 6 feet below the floodplain elevation. Wetland side slopes will transition gently to adjacent floodplain elevations, providing a mix of open water, deep water emergent, and shallow water emergent wetland habitat. Wetlands will be positioned in locations that reduce excavation volumes and the risk of channel capture and avulsion.

4.7 Grazing Management Plan

Lack of riparian vegetation has been identified as a primary limiting factor affecting streambank stability and establishment of floodplain woody vegetation communities in Reach 4. Implementation of a grazing management plan to reduce browse pressure and allow planted vegetation integrated in streambank and floodplain treatments to develop to maturity for a period of time is recommended. In the short term (e.g. 3 to 5 years), a riparian exclosure is strongly encouraged to reduce ungulate and livestock browse pressure on newly planted live cuttings, seedlings and vegetation. In the long-term, a rotational grazing management plan that allows for short-duration, flash grazing in the spring and late fall can be implemented if carefully monitored for resource damage. Hardened water gaps and off-channel watering sources can be integrated in the plan to ensure restoration actions complement existing and future land management needs of the landowners.

4.8 Additional Recommended Actions

Flow reductions, dewatering, and passage barriers are key limiting factors to aquatic biota and river and floodplain function identified in the Grant Creek project area. In addition to the restoration strategies proposed above and in the Conceptual Restoration Plan, we recommend further actions to address these impairments and ensure successful restoration outcomes. To address perennial low flows and dewatering, we suggest a comprehensive evaluation of existing diversion infrastructure to ensure that water withdrawals comply with legal water rights and to identify opportunities to improve irrigation efficiency. Similarly, to address fish passage barriers, we recommend assessing the size and placement of culverts, as well as diversion structures, to identify and mitigate challenges to fish movement.

5 Conclusion

Grant Creek is an important ecological resource to the Clark Fork River; its headwaters in the Rattlesnake Wilderness provide clean, cold water and high-quality aquatic, riparian, and terrestrial habitat. The lower Grant Creek project area has been adversely impacted by clearing of floodplain vegetation, channelization, and residential development and agriculture and grazing practices in the historic floodplain. Overall, the channel provides poor aquatic habitat quality and river and floodplain functionality. Limiting factors in the project area include limited large wood recruitment, storage, and transport; lack of riparian vegetation; channel incision and floodplain disconnection; challenges to movement of aquatic biota; flow reductions and dewatering; excess bank erosion and siltation; and limited beaver activity. The Conceptual Restoration Plan aims to restore, to the greatest extent possible given constraints imposed by existing infrastructure and residential encroachment in the floodplain, processes that create and sustain river and floodplain ecosystems and provide high-quality habitat. Proposed restoration strategies include channel and wetland construction, bank stabilization with vegetated bank structures, riparian plantings, and a grazing management plan. Continuing challenges in the project area include flow reductions and dewatering and passage for aquatic biota. These limiting factors will need to be addressed to ensure successful restoration outcomes.

A.6 Bank Erosion Hazard Index Assessment

Figure A-7. Grant Creek Reach 4 BEHI assessment results.