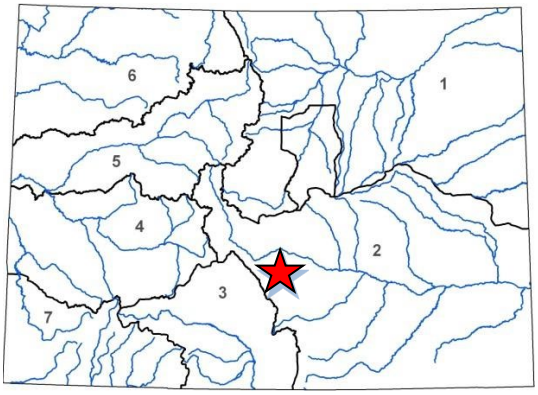
COLORADO
Colorado Water Conservation Board
Department of Natural Resources

Big Cottonwood Long-term Recovery & Restoration
River Science
January 2022 Board Meeting

Colorado Watershed Restoration Program Application



LOCATION	
County/Counties:	Fremont
Drainage Basin:	Arkansas

DETAILS	
Total Project Cost:	$224,788
Colorado Watershed Restoration Program Request:	$99,344
Recommended amount:	$99,344
Other CWCB Funding:	$0
Other Funding Amount:	$125,444
Applicant Match:	$0
Project Type(s): Project	
Project Category(Categories): Watershed Restoration	
Measurable Result: Final Implementation Plan, constructed process-based restoration	

For the past three years, River Science, in partnership with the Arkansas River Watershed Collaborative (ARWC) and other local partners, worked to address issues caused by the Hayden Pass Fire and subsequent flooding. Recovery response focused initially on the protection of life and property and building community trust and engagement. Now, five years post-fire and three years post-flood, the focus is shifting towards rehabilitation, restoration, and improvement of this area's riparian systems and habitat. This project is shovel-ready and poised to move directly into implementation.

As of the fall of 2021, there remain several concerns for Big Cottonwood Creek, specifically around disconnected floodplains that exacerbate future flood (and fire), poor water quality, riparian health, and habitat conditions. A full recovery of these systems could take hundreds of years. This project will work with the natural environment to help speed up recovery through techniques that mimic natural processes. PBR has a proven track record of success in other states and there is a unique opportunity to implement these cost-effective, low-tech technologies within a fire-impacted steam with a well-documented, pre-disturbance inundations footprint that has been significantly reduced by post-fire activities. The objective is to return the creek to pre-existing conditions and restore a degraded system that is vital to the community and the entire Upper Arkansas River Basin.

This project will work to achieve the following objectives:

1. Reconnect the floodplain to spread and slow flood waters.
2. Reduce frequent bank failures which introduce large amounts of fine sediment into the system.
3. Expand low-flow inundation extent.
4. Increase structure and geomorphic diversity.
5. Reduce velocity to increase aquatic habitat.
6. Restore deep incisions by trapping sediment to increase the elevation of the creek bed.
7. Mitigate steeper grades and faster flows which will improve water residence time and infiltration.
8. Increase and restore habitat for aquatic and terrestrial wildlife.
9. Reduce risk of dangerous bank conditions for private and public access.
10. Provide viable habitat for the introduction of the Greenback Cutthroat Trout.
11. Serve as a model that can be transferable across the State to address long-term, post-fire recovery needs.

Project Title: Big Cottonwood Long-Term Recovery & Restoration
Grant Type: Colorado Watershed Restoration Program
Location: Coaldale, Colorado- Fremont County
Total Project Cost: $224,788.00
CWCB Request: $99,344.00
Cash Match: $113,444.00
In-Kind Match: $12,000.00
Project Contact: Chelsey Nutter- 719-221-8213- chelsey@river.science

Summary

For the past three years, River Science, in partnership with the Arkansas River Watershed Collaborative (ARWC) and other local partners, worked to address issues caused by the Hayden Pass Fire and subsequent flooding. Recovery response focused initially on the protection of life and property while simultaneously building community trust and engagement. Now, five years post-fire and three years' post-flood, we believe that our focus can shift towards rehabilitation, restoration, and improvement of this area's riparian systems and habitat. To date, we have completed extensive community outreach, hydraulic and hydrologic modeling, risk assessments, and long-term recovery planning. Our project is shovel-ready and poised to move directly into implementation, providing the needed focus on water quality improvement, reducing high-risk sediment loading into the Arkansas River, and improving riparian and aquatic habitat.

Specifically, this project will focus on restoring fluvial processes of Big Cottonwood Creek utilizing Process-Based Restoration (PBR) techniques. Pre-fire, Big Cottonwood Creek was a healthy riparian system with a narrow, winding, and slow-moving creek. Functionally, this creek's natural beaver ponds created several natural grade controls that slowed flows, trapped sediment, and tied it to the floodplain and groundwater system. Today the stream shows little evidence of ever being a small, winding creek with a connected floodplain. The post-fire flood events have carved deep incisions throughout the Big Cottonwood Creek channel. Such conditions have, and will continue to, cause several hydrologic, hydraulic, and habitat concerns.

PBR uses simple, cost-effective, hand-built structures that mimic beaver dams (beaver dam analogs, BDAs) and large wood accumulations (i.e., post-assisted log structures, PALS). When strategically introduced to a stream, these structural elements can amplify natural hydrologic, geomorphic, and biological processes that accelerate the recovery of incised creeks. Specifically, these treatments can widen the incised channel and use that generated material to lift, or aggrade, the channel bed. With many of the creeks' hydraulic, hydrologic, and habitat issues stemming from the deep incision, PBR offers a way to accelerate this channel bed aggradation and a chance to improve the conditions in a few years as opposed to hundreds of years.

Qualifications

Sponsor/Stakeholders

River Science will serve as the lead project sponsor and will complete treatments with in-house staff and through a contract with a Colorado Correctional Industries (CCI) (SWIFT Crew). River Science will partner with Canon City High School (CCHS) and River Watch to assist with the 10-year monitoring of the project. Private landowners and the community will serve as our immediate stakeholders who will provide access to their lands. Dr. Wheaton of Utah State University will serve as our expert consultant for the design of treatments, and we will work with the Upper Arkansas Water Conservancy District & Division of Water Resources to assure protection of water rights. We will continue to explore opportunities with our partners Trout Unlimited & Colorado Parks and Wildlife to explore the potential (future) introduction of the endangered Greenback Cutthroat Trout.

Match

We have submitted a proposal for Natural Resource Damages California Gulch funding through the Colorado Department of Public Health & Environment (CDPHE). To date, we have held a tour and follow up meeting with the Trustees and feel confident that our proposal will be selected for funding. This funding is currently not secure but final decisions will be made December 2021. In-kind match will be provided by the Canon City High School River Science class. River Science has a year-long course at CCHS, and an integral part of the class is field work. Students will assist River Science in collecting & analyzing data, conducting research, monitoring & maintenance. Breakdown of matching funds is as follows: Cash Match (50%), In-Kind (5%), Total Match (55%).

Organizational Capacity

History of Accomplishments

River Science although relatively new, has a rich history of accomplishments. Most of our primary past projects have focused on providing data, surveys, elevation models, and modeling for post-fire projects. We have served as sub-contractors on several CWCB funded projects including Hayden Pass Recovery Phases 1&2 (precursors to this application) and Spring Creek Fire Recovery Projects. We are currently working on a CWCB & Local Sponsor funded project in Canon City Colorado – Van Norman Project. In addition to post-fire and process-based restoration, we have a robust education program that is currently taking shape with Fremont County High Schools where we teach a year-long River Science course. Lastly, in 2019, River Science was awarded the contract to administer the statewide River Watch of Colorado which hosts over 111 volunteer groups who collect water quality data and has been in existence for 30 years.

Project Team

Luke Javernick founded River Science in 2016. Luke is an award-winning (Marie Sklodowska-Curie Action) river scientist who spent the early part of his career studying and improving rivers in New Zealand, Colorado, Oregon, and Italy. Using physical model experiments, Luke's post-doc research focused on utilizing low-cost, low-tech PBR techniques to improve river processes, health, and management. Luke is passionate about leveraging open-source software, low-cost hardware, and advanced computing to collect affordable data at a meaningful scale to provide valuable information to our clients and projects. Luke's vision, ambition, and creative approaches have helped launch River Science into a successful nonprofit with strong partnerships across Colorado. Luke will serve as the project implementation lead. He will lead the SWIFT Crew through implementation and will provide all monitoring and maintenance.

Chelsey Nutter has a rich history of working on water-related projects in the Arkansas River Basin, receiving the Arkansas River Basin Hero Award from the IBCC in 2019. With over ten years of experience managing water projects and programs, Chelsey brings a comprehensive knowledge of water rights, water administration, restoration, and stakeholder engagement. Chelsey has a BS in Land Use & Geographic Information Systems from the Metropolitan State College of Denver and a Public & Nonprofit Administration MBA from Adams State College. Chelsey will be responsible for project administration, reporting, grant management, stakeholder engagement, landowner agreements, permitting, and contracts.

Sub-Contractors & Volunteers- Dr. Wheaton is a geomorphologist and expert in process-based restoration. Dr. Wheaton has served as a consultant on several of our projects and provides a keen eye for the planning and execution of process-based restoration treatments. Dr. Wheaton will serve as a consultant on the design and implementation of our project. We will partner with CCI for the implementation of our treatments. We have years of experience working with inmate SWIFT Crews through numerous post-fire recovery projects. These teams are "swift" and can complete work in a fraction of time it would take other restoration-based groups. For long-term monitoring & maintenance we will partner with CCHS & River Watch giving us a robust set of volunteers to conduct long-term research and data collection.

Budget/ Timeline/ Monitoring & Evaluation

We propose to start this project in March of 2022 with matching funds. We will begin with tasks 1 & 2, community engagement & project preparedness. We expect to need funding from this grant request in April or May of 2022 or when we receive an NTP. Task 3- Implementation will move fast if we work with a SWIFT crew; we anticipate approximately six weeks for implementation. We blocked off two months for implementation to provide adequate time for any surveying, equipment rental, and land use modifications that may arise. The bulk of our time will be spent on monitoring and maintenance. We propose a five-year monitoring & maintenance plan as described in the scope of work. Additional monitoring will be completed for five additional years funded by River Science.

The funding requested in this proposal is essential for project completion & success. Funding will be utilized during the planning, implementation, and monitoring phases and will be focused on purchasing needed materials, equipment rentals, and labor costs (see Exhibit B- Detailed Budget).

Proposal

Existing Plans and Completed Assessments

For the past three years, River Science, in partnership with the Arkansas River Watershed Collaborative (ARWC) and other local partners, worked to address issues caused by the Hayden Pass Fire and subsequent flooding. Recovery response focused initially on the protection of life and property and building community trust and engagement. Now, five years post-fire and three years' post-flood, we believe that our focus can now shift towards rehabilitation, restoration, and improvement of this area's riparian systems and habitat. To date, we have completed extensive community outreach, hydraulic and hydrologic modeling, risk assessments, and long-term recovery planning. Our project is shovel-ready and poised to move directly into implementation, providing the needed focus on water quality improvement, reducing high-risk sediment loading into the Arkansas River, and improving riparian and aquatic habitat. We have competed several detailed reports for this project. Links below:
1) Big Cottonwood Hydraulic & Hydrology Report, 2) Big Cottonwood Hazards Report, 3) Big Cottonwood Recovery Plan

In addition to technical reporting, we have worked with our partners ARWC to develop educational materials to tell the story of the fire, flood, and community. These can be found here:
1) Big Cottonwood Case Study, 2) Post-Fire Flooding Video

We recently completed surveys and conducted hydraulic modeling to depict current conditions, treatment options, and expected inundation extents. These maps can be found in Exhibit C of this application. Lastly, we are in the process of creating a post-fire long-term recovery brochure the draft is included in Exhibit D.

Multiple Objectives

Hydraulic & Hydrologic Concerns

Numerous areas have deep incisions (8-12 feet shown in Figures 2A, 2C, 2D), undermined banks and trees, and significant head cuts that continue to propagate upstream (Figure 2B). These massive head cuts and deep incision causes steep and unstable banks. Hydraulic concerns are focused on the incised channels and increased sediment transport due to concentrated flows. These concentrated flows continue to cut the channel down, cause bank failures, and deliver enormous amounts of sediment downstream (including to the Arkansas River).

Figure 2. Post-fire flood events on the Big Cottonwood Creek have caused: A) large head cuts that continue to cause incision, and B) numerous areas of incision that range from 8-12 feet, C) large numbers of undermined trees, and D) significant bank erosion and sediment sources.

Hydraulic model simulations were used to explore the stream's changes. Simulations were performed in the same low-flow conditions with the pre-fire elevation data of 2016 and current 2021 elevation data (Figure 3). Model results show a drastic reduction in the existing topography's ability to spread flow and significantly higher shear stress values. Calculating the total inundation area pre-fire, Big Cottonwood Creek had 11.1 acres inundated with 1.95 acres ponded. Post-fire and flood show 6.3 acres inundated and 0.3 acres ponded. This equates to a ~40% reduction in low flow inundation and ~85% reduction in ponded areas.

As shown in Figures 3A and 3C, the 2016 channel geometry had several areas of floodplain connectivity and lower shear stress values compared to the 2021 conditions shown in Figures 3b and 3D. These hydraulic conditions will continue to cause deeper incisions and bank failures, which will increase sediment generated and transported (diminishing water quality). As much of the upstream watersheds remain unburned, this area can experience another wildfire. The post-fire flood events could be more devastating in the future, given these creeks confined and concentrated flows. Further, the riparian system is not prepared to withstand future post-fire flooding.

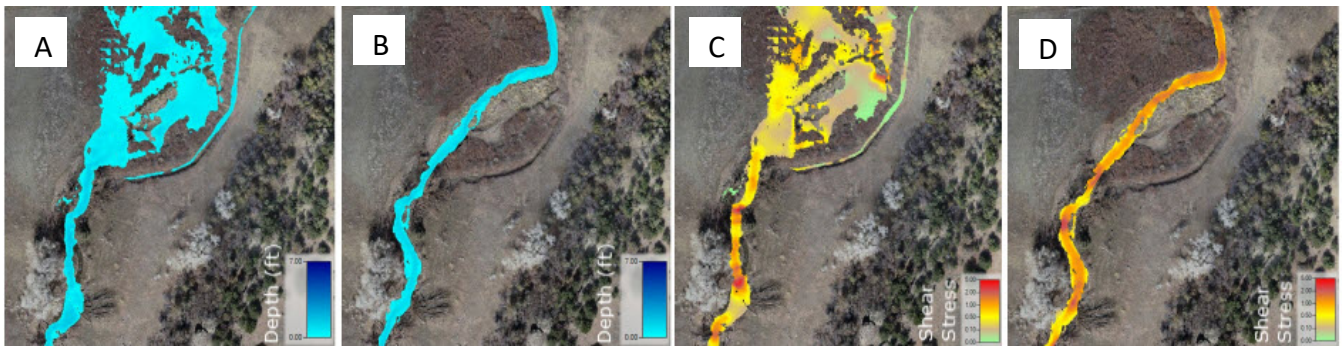


Figure 3. Figures A and C show (2016) pre-fire conditions of depth and shear stress, respectively; Figures B and D (2021) show post-fire depth and shear stress, respectively. Larger figures are provided in Exhibit C.

Riparian Health Concerns

As discussed in the section above, the hydraulic simulations of pre-and post-fire topographic conditions showed that the area of inundation was reduced from 11.1 acres to 6.3 acres, respectively. This reduction in available habit quantity is a striking difference and a metric to highlight the significant incision. However, habitat quality is another concern. The hydraulic conditions that exist create large amounts of fine sediment loads into the system (i.e., bank failures) and large amounts of sediment transport due to the concentrated flows. Recent field observations showed a total lack of pools upstream of the Harry Walker Dam to the USFS property (a 4-mile stretch) created by large amounts of sediment in the system that fills in any temporary pool. The creek is consistently alternating between riffle and run sections with very fast-moving waters along these miles.

Water quality has been documented on Big Cottonwood Creek over the last three years as part of River Watch of Colorado. Typical parameter readings (pH, dissolved oxygen, alkalinity, and hardness) show the creeks' water quality is within acceptable parameters, but with room for improvement. However, sediment loads are related to post-fire as fine sediments fill in the channel substrate voids, which degrades habitat for macroinvertebrates (the backbone to larger aquatic life and health). Within Big Cottonwood Creek and tributaries, 2019 sampling found no macroinvertebrates. This was attributed to the lack of suitable substrate due to high loads of fine sediment and high-velocity conditions due to a complete lack of typical structure (i.e., downed trees, large boulders, pools, etc.). Today, macroinvertebrates (Mayfly and Caddisfly) have been identified in Big Cottonwood Creek, but these poor stream conditions still exist and will likely continue as the frequent bank failures generate large amounts of fine sediment that blanket the bottom substrate and fill in any temporary pools.

Recovery Response Techniques & Process-Based Restoration

Following the Stream Evolution Model shown in Figure 9, Big Cottonwood Creek may likely widen and aggrade overtime to one day become a well-connected floodplain. However, this evolution from the current stage (2 or 3) to pre-fire conditions (ranging from stage 7, 8, 0, and 1) may take hundreds, possibly thousands of years. During this time, Big Cottonwood Creek would continue to suffer from the impairments listed above. However, targeted restoration aimed at accelerating this stream evolution could be done with cost-effective process-based restoration (PBR) methods as outlined by Wheaton et al. (2019).

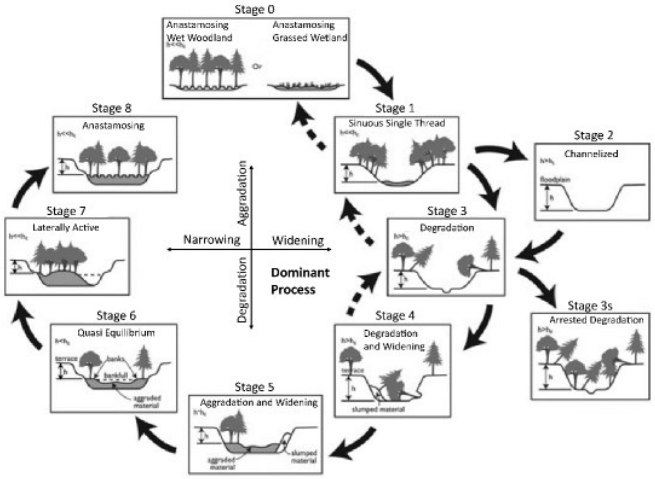


Figure 9. Stream evolution model (SEM) proposed by Cluer and Thorne (2014) illustrating approximate stages and pathways associated with recovery to Stage 0. Restoration in Big Cottonwood Creek could accelerate recovery trajectories.

PBR focuses on using the creek's flow and stream power to help perform the restoration labor. Through carefully planned treatments, hand-built structures in series can be used to restore the lacking geomorphic processes. For example, using local and natural materials, a channel spanning treatment (Figure 5C & D) can be used as a grade control structure. The structure would trap sediment, raise the channel bed elevation, slow the flow's velocity, and reduce fine sediment. Other treatments attached to one bank's side, can force flow into the opposing bank (Figure 5A & B) that accelerate bank erosion and migration that can supply downstream the channel spanning grade control structures with new sediment sources, which helps widen and aggrade the channel. Such treatments

provide much-needed structure to the creek by providing pools, shelter, slower water for the struggling macroinvertebrate life, and potentially future habitat and quality conditions necessary for the Greenback Cutthroat Trout. These treatments that aim to widen and aggrade the channel will also help to reduce the issues listed above in section 2.1.2 (Riparian Health & Habitat Concerns).

Figure 5: Images of PBR treatments that show Channel-Spanning BDAs and PALS, bank-attached & midchannel PALS.

Monitoring Plan & Connection to Projects/ Programs

Our monitoring & maintenanceplan is outlined in the SOW. Monitoring will take place monthly for the first three years and seasonally for the next seven years. Funding requested through this proposal and partner match will be utilized for the first five years of monitoring, as this is a critical element of this project. The additional five years of proposed monitoring will be funded through River Science. Information gathered from this project can be transferable to other projects and provide a demonstration for long-term recovery of post-fire impacted streams. The work we are proposing is beneficial to multiple projects and programs that depend on the health and vitality of the Arkansas River, including the Voluntary Flow Program, Gold Medal Fishery, municipal, agricultural, environmental, and recreational water supply, and much more.

Mapping

Detailed reference maps are provided in **Exhibit C** for all reaches and provide project objective maps that shows the treatment goals for a particular section of river (i.e., incision recovery, lateral connectivity,). Within each of the five reaches, River Science has prepared potential restoration treatments that would target a specific reach's degradation. These treatments were placed/designed using available elevation datasets to strategically increase the current post-fire inundation from the 6.3 acres back to the pre-fire conditions of approximately 11 acres. The figures show the estimated valley bottom (i.e., the active and inactive floodplain), the envisioned treatments, and the treatment's hydraulic and geomorphic Zone of Influence (ZOI). The ZOI is not a representation of post-treatment low-flow inundation. Rather, the ZOI is a generic representation of possible channel migration and how treatments will deflect water during small frequent floods. As shown in the Figures in Exhibit C, bank attached and channel spanning PALS and/or BDAs are alternated in relative proximity. This approach is designed to quickly cause channel migration to generate materials that will be quickly trapped downstream by channel spanning PALS and/or BDAs to cause frequent channel widening and trapped sediment for channel aggradation. These treatments would require several iterations and several years to reach their full potential. However, the tradeoff in time is the benefit of low-cost restoration.

Exhibit A- Scope of Work

Grantee	Uviation World Water dba. River Science
Primary Contact	Chelsey Nutter, Project Manager
Address	430 Main Street, Canon City, CO 81212
Phone	719-221-8213
Project Name	Big Cottonwood Long-Term Recovery & Restoration
Grant Amount	$99,344.00

Introduction & Background

For the past three years, River Science, in partnership with the Arkansas River Watershed Collaborative (ARWC) and other local partners, worked to address issues caused by the Hayden Pass Fire and subsequent flooding. Recovery response focused initially on the protection of life and property and building community trust and engagement. Now, five years post-fire and three years' post-flood, we believe that our focus can now shift towards rehabilitation, restoration, and improvement of this area's riparian systems and habitat. To date, we have completed extensive community outreach, hydraulic and hydrologic modeling, risk assessments, and long-term recovery planning. Our project is shovel-ready and poised to move directly into implementation.

As of the fall of 2021, there remain several concerns for Big Cottonwood Creek, specifically around disconnected floodplains that exacerbate future flood (and fire), poor water quality, riparian health, and habitat conditions. A full recovery of these systems could take hundreds if not thousands of years. We propose working with the natural environment to help speed up recovery through techniques that mimic natural processes. PBR has a proven track record of success in other states but has been stifled in Colorado due to potential water rights impacts. We have a unique opportunity to implement these cost-effective, low-tech technologies since we propose work within a fire impacted stream with a well-documented, pre-disturbance inundation footprint that has been significantly reduced by post-fire activities. The objective is to return the creek to pre-existing conditions and restore a degraded system that is vital to this community and the entire Upper Arkansas River Basin.

Fire and the State of Colorado's water are inseparable. As wildfire becomes more prevalent and drought persists, our State must examine how many post-fire impacted rivers and streams negatively influence our State's hydraulics, hydrology, water quantity, and water quality. As outlined above, several issues of degradation caused by post-fire flooding have left the creek's processes and habitat lacking. In an age where we must better manage our water and watersheds, we must consider restoring post-fire flood conditions and help return creeks to their proper health and hydrological function.

Objectives

- Reconnect the floodplain to spread and slow flood waters (creating healthy systems for future post-fire landscape)
- Reduce frequent bank failures which introduce large amounts of fine sediment into the system
- Expand low-flow inundation extent (initially 11.1 acres and now 6.3 acres)
- Increase structure and geomorphic diversity (i.e., pools, slow moving water, ponded areas)
- Reduce velocity to increase aquatic habitat
- Restore deep incisions by trapping sediment to increase the elevation of the creek bed
- Mitigate steeper grades and faster flows which will improve water residence time and infiltration
- Increase and restore habitat for aquatic and terrestrial wildlife
- Reduce risk of dangerous bank conditions for private and public access
- Provide viable habitat for the introduction of the Greenback Cutthroat Trout
- Serve as a model that can be transferable across the State to address long-term, post-fire recovery needs.

Tasks

Task 1: Community Outreach & Partner Engagement (Matching Funds Only- No Request for CWCB Funds)

Description

Although we have been building partnerships within this community over the past few years, it is important to start all projects with community outreach. We will hold meetings within the community to assure that all are aware of the project, benefits, and anticipated outcomes. We continuously meet with landowners who are already aware of and support our proposed recovery work. We will expand this engagement to include partners and others within the community.

Methods/Procedure:

- One on one meetings & agreements with Landowners where work will commence
- Information provided through our extensive community email list and on our website
- Outreach with past and potential partners including Fremont County, Trout Unlimited, Colorado Parks & Wildlife, Upper Arkansas Water Conservancy District, Bureau of Land Management, US Forest Service, Canon City Water District, etc.

Deliverable

Successful delivery of information and engagement to community members and partners.

Task 2: Expert Consulting & Project Preparedness

Description

Luckily, we have spent the last three years preparing for this project with extensive modeling, engagement, and implementation planning. With that said, we want to move into implementation with the highest level of knowledge and preparedness. Therefore, we would like to bring out the experts in Process-Based Restoration to review our proposal on the ground before implementation. Dr. Wheaton (Utah State Professor) is an expert on PBR. We have worked with Dr. Wheaton for many years and highly respect his keen eye on the ground. Dr. Wheaton has provided this level of consulting for other projects, which assures a high level of success for these types of projects. Additionally, we will need to work with landowners and other partners to finalize permitting and land access agreements. Lastly, we will purchase all materials required for implementation.

Methods/Procedure:

- Field visit with Dr. Wheaton
- Follow up implementation planning meeting with Dr. Wheaton
- Individual Landowner Agreements
- Army Corps of Engineers 401 Permit (already initiated conversations)
- Contract with Colorado Correction Industries (have a good working relationship with CCI)
- Purchase all needed materials and equipment

Deliverable:

Final Implementation Plan (includes maps, photos, modeling, contracts, permits).

Task 3: Process-Based Restoration Implementation

Description

Lead SWIFT Crew in the implementation of all treatments along 1.8 miles of Big Cottonwood Creek. Construct BDAs and PALs according to final implementation plan.

Methods/Procedure:

- Construct treatments in each reach according to implementation plan

- Utilize SWIFT Crew for a three-week period to complete implementation

Deliverable
Successful completion of treatment implementation documented through progress reports as described in Task 5

Task 4: Monitoring & Maintenance

Description
Due to the nature of these hand-built structures, monitoring and maintenance are mandatory. Although the cost is low, River Science must maintain structures for the first few years until they are established. A primary component of this project is to document these treatments to serve as a model for other communities and projects. We anticipate a 10-year monitoring schedule to provide the crucial data needed for this project. We have partnered with Canon City High School (CCHS) through our year-long course, River Science. Students who take this course will help monitor this project for the next 10-years. Our partnership with CCHS provides hands-on experience for students while also providing low-cost labor for monitoring needs.

Methods/Procedure:
- Monitoring may include surveys (drone & land), cross-section flow, depth, & width, water quality parameters (pH, temp, turbidity, etc.), riparian & habitat health indicator assessments.
- Maintenance may include reconstruction of damaged structures, development of new structures, removal of structures.
    - Years 1-2: Monthly monitoring and maintenance
    - Years 3-5: Seasonal monitoring and maintenance (limited maintenance, reduces every year)
    - Years 5-10: Seasonal monitoring (not included in the budget)

Deliverable
Annual monitoring reports and annual plans. Each year River Science will update the monitoring plan based on annual results.

Task 5: Project Management (Matching Funds Only- No Request for CWCB Funds)

Description
The project manager will serve as the point of contact and will be responsible for grant administration, working with funders & partners, managing personnel and sub-contractors, managing permits & agreements, scheduling, task management, progress, and monitoring reports, and overall project compliance.

Methods/Procedure:
- Serve as point of contact for funders, partners, landowners, and contractors
- Assure compliance with permitting and performance
- Prepare and submit progress reports and communicate regularly with partners
- Responsible for grant tracking and budget management
- Accountable for project management, scheduling, task management

Deliverable
6-month progress reports & final reporting and inspections provided to CWCB through the project's duration. Project reports will include photos, maps, modeling, and narrative on project progress, success & limitations. A final report will be provided, which may also serve as a template for other restoration projects in the Upper Arkansas Basin or throughout the State.

Exhibit B- Schedule, Budget, Detailed Budget

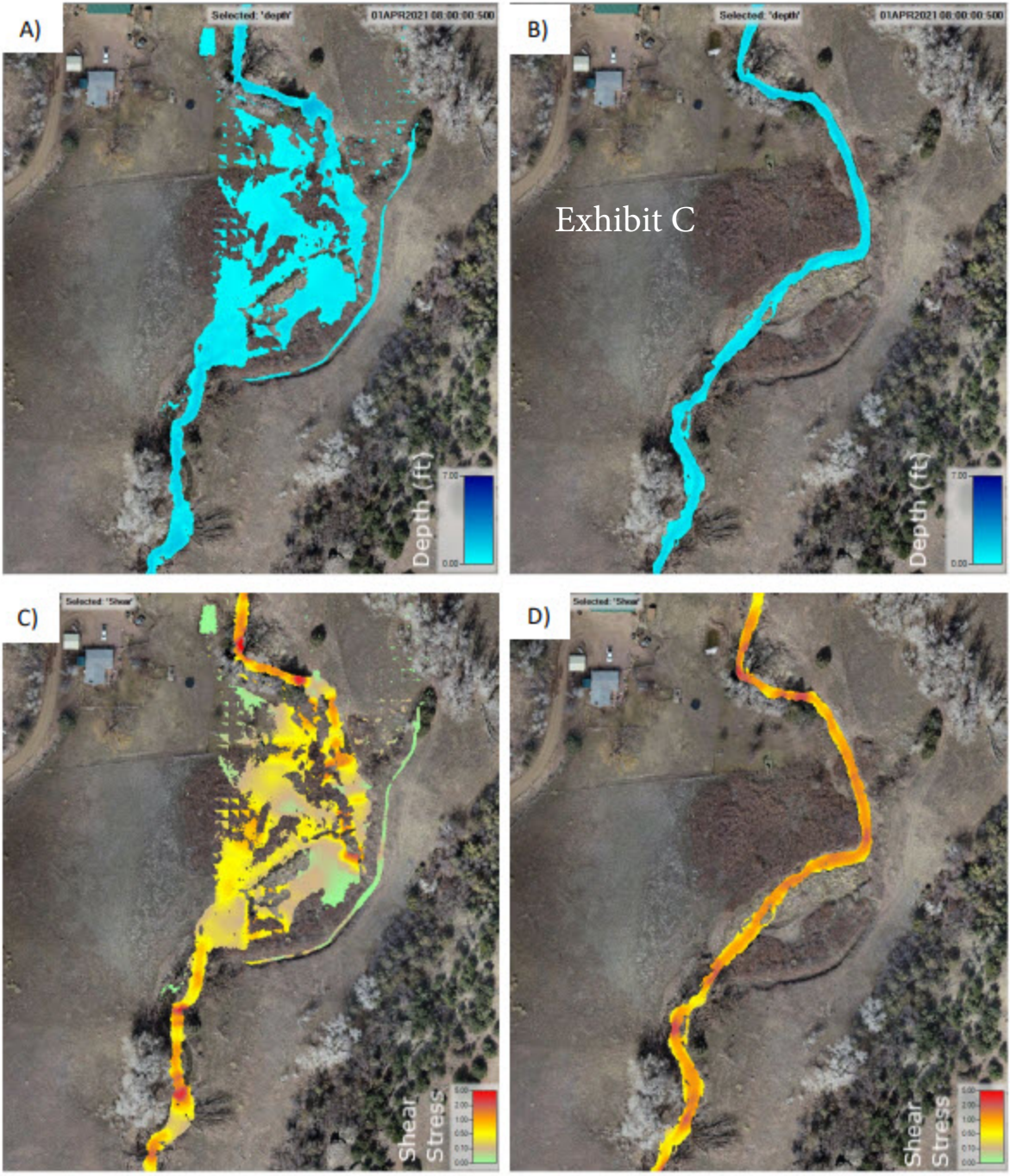
Big Cottonwood Long-Term Recovery Schedule																
	2022												2023	2024	2025	2026
Task	Jan	Feb	Mar	April	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec				
1																
2																
3																
4																
5																

Budget & Timeline Table						
Task	Description	Target Start Date	Target Completion Date	CWCB Funds	Matching Funds	Total
1	Community Engagment	3/1/2022	5/1/2022	$0.00	$9,232.00	$9,232
2	Project Prepardness & Consulting	4/1/2022	6/1/2022	$47,520.00	$11,061.00	$58,581
3	PBR Implementation	6/1/2022	8/1/2022	$28,064.00	$19,200.00	$47,264
4	Monitoring & Maintenance	8/1/2022	8/1/2026	$23,760.00	$60,451.00	$84,211
5	Project Management	3/1/2022	8/1/2026	$0.00	$25,500.00	$25,500
	TOTALS			**$99,344.00**	**$125,444.00**	**$224,788.00**

Big Cottonwood Post-Fire Long-Term Recovery & Restoration Proposal

Task		Expense					River Science Personnel				Match	CWCB Request
							Exec. Director		Project Manager			
							Rate= $125/hr		Rate= $85/hr			
		Description	Rate	Unit Type	Unit Multiplier	Total	Hours	Subtotal	Hours	Subtotal		
Task 1- Community Outreach & Engagement												
1-A	Landowner Engagment Meetings					$ -	20	$ 2,500	10	$ 850	$ 3,350	$ -
1-B	Community Outreach (Email, Website, Meetings)					$ -	10	$ 1,250	10	$ 850	$ 2,100	$ -
1-C	Partner Outreach					$ -	20	$ 2,500	10	$ 850	$ 3,350	$ -
1-D	Travel	Milage	$ 0.54	Mile	800	$ 432.00	0			$ -	$ 432	$ -
	Subtotal Task 1					$ 432		$ 6,250		$ 2,550	$ 9,232	$ -
Task 2- Expert Consulting & Project Prepardness												
2-A	Expert Field Visit & Meeting	Dr. Wheaton Consuling Visit	$ 7,000	Each	1	$ 7,000	25	$ 3,125	10	$ 850	$ 10,975	$ -
2-B	Materials & Equipment	Rock, Post Pounder, etc.	$ 10	Foot	4752	$ 47,520		$ -		$ -	$ -	$ 47,520
2-C	Travel	Milage	$ 0.54	Mile	160	$ 86.40		$ -		$ -	$ 86	$ -
	Subtotal Task 2					$ 54,606		$ 3,125		$ 850	$ 11,061	$ 47,520
Task 3- PBR Implementation												
1-A	PBR Implementation	CCI Labor	$ 3,400	Day	8	$ 27,200.00	140	$ 17,500	20	$ 1,700	$ 19,200	$ 27,200
1-D	Travel	Milage	$ 0.54	Mile	1600	$ 864.00					$ -	$ 864
	Subtotal Task 1					$ 28,064		$ 17,500		$ 1,700	$ 19,200	$ 28,064
Task 4- Monitoring & Maintanence												
1-A	Maintanence (3 years)	Materials & Equipment	$ 5	foot	4752	$ 23,760.00		$ -	20	$ 1,700	$ 1,700	$ 23,760
1-B	Monitoring					$ -	352	$ 44,000	10	$ 850	$ 44,850	$ -
1-C	Labor	CCHS	$ 25	Hour	480	$ 12,000.00					$ 12,000	$ -
1-D	Travel	Milage	$ 0.54	Mile	3520	$ 1,900.80					$ 1,901	
	Subtotal Task 1					$ 37,661		$ 44,000		$ 2,550	$ 60,451	$ 23,760
Task 3- Project Management												
3-A	Reporting, Consulting, Permitting, Agreements							$ -	300	$ 25,500	$ 25,500	$ -
	Subtotal Task 5					$ -		$ -		$ 25,500	$ 25,500	$ -
	Grand Total					$ 120,763		$ 70,875		$ 33,150	$ 125,444	**$ 99,344**

Total Project Cost: $ 224,788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Selected: 'depth'
01APR2021 08:00:00:500
Depth (ft)
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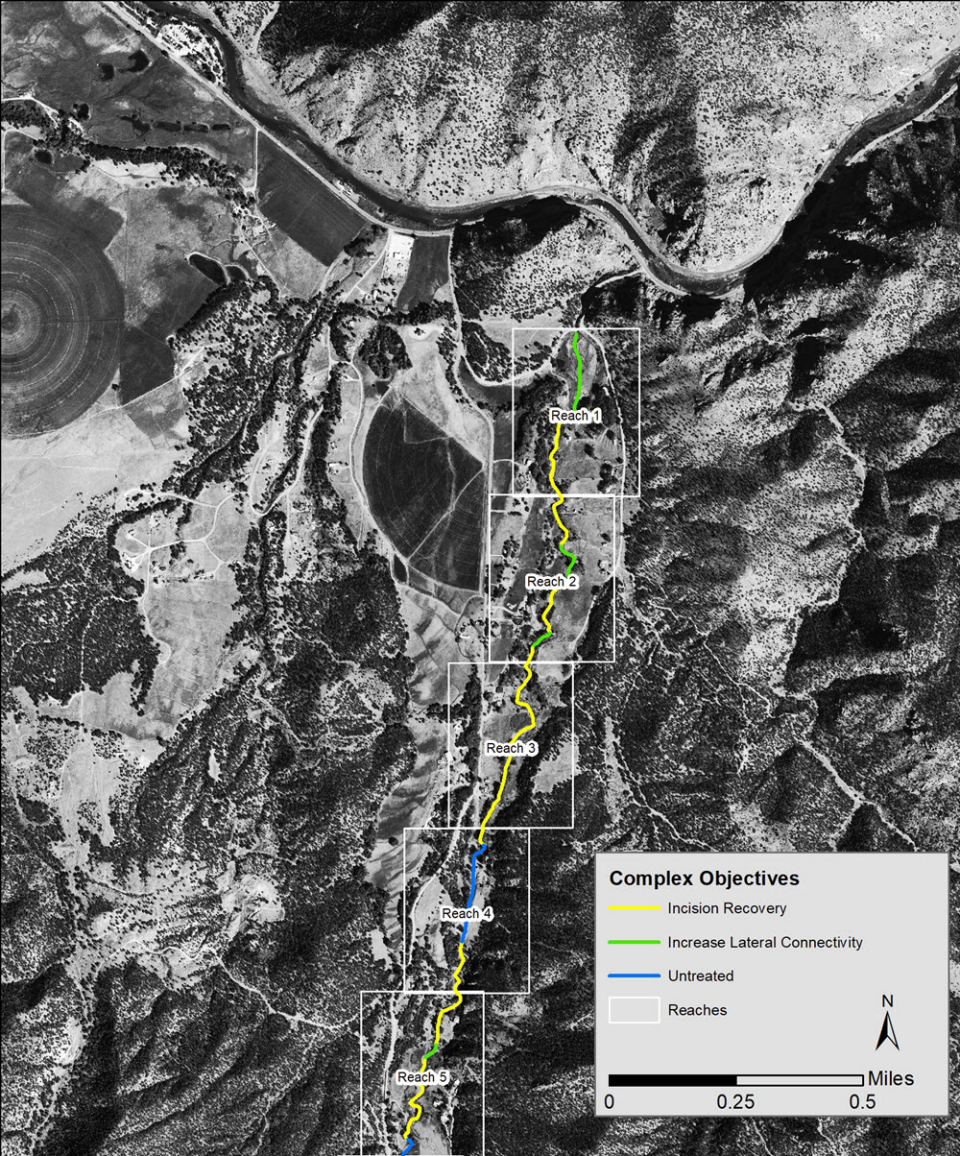
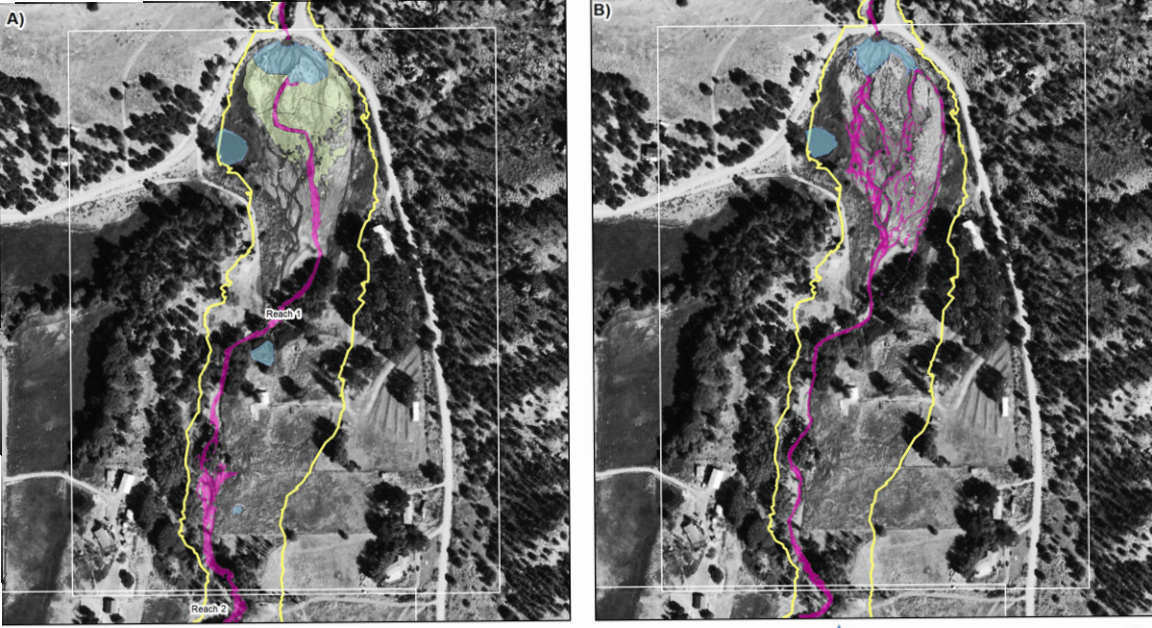
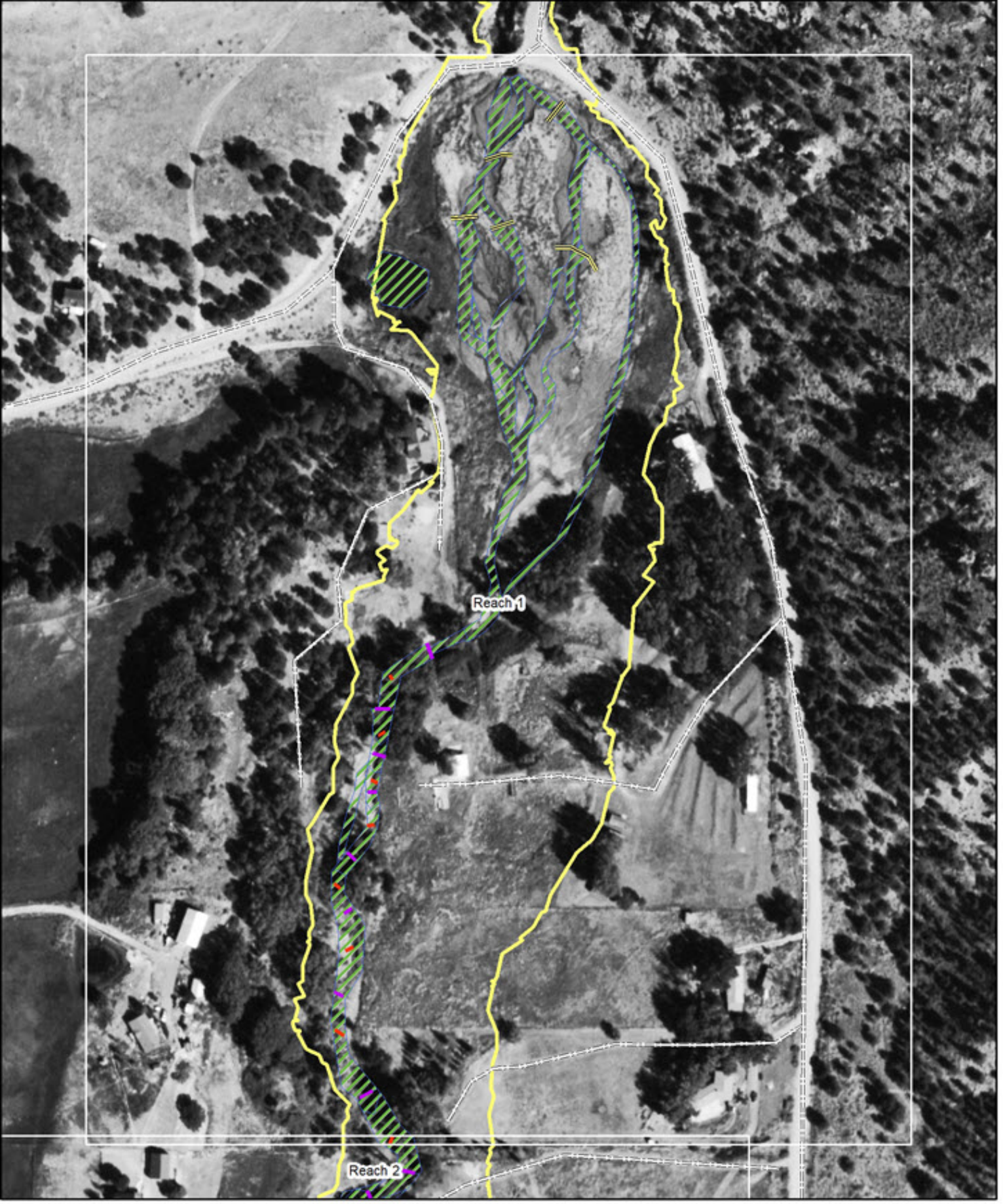
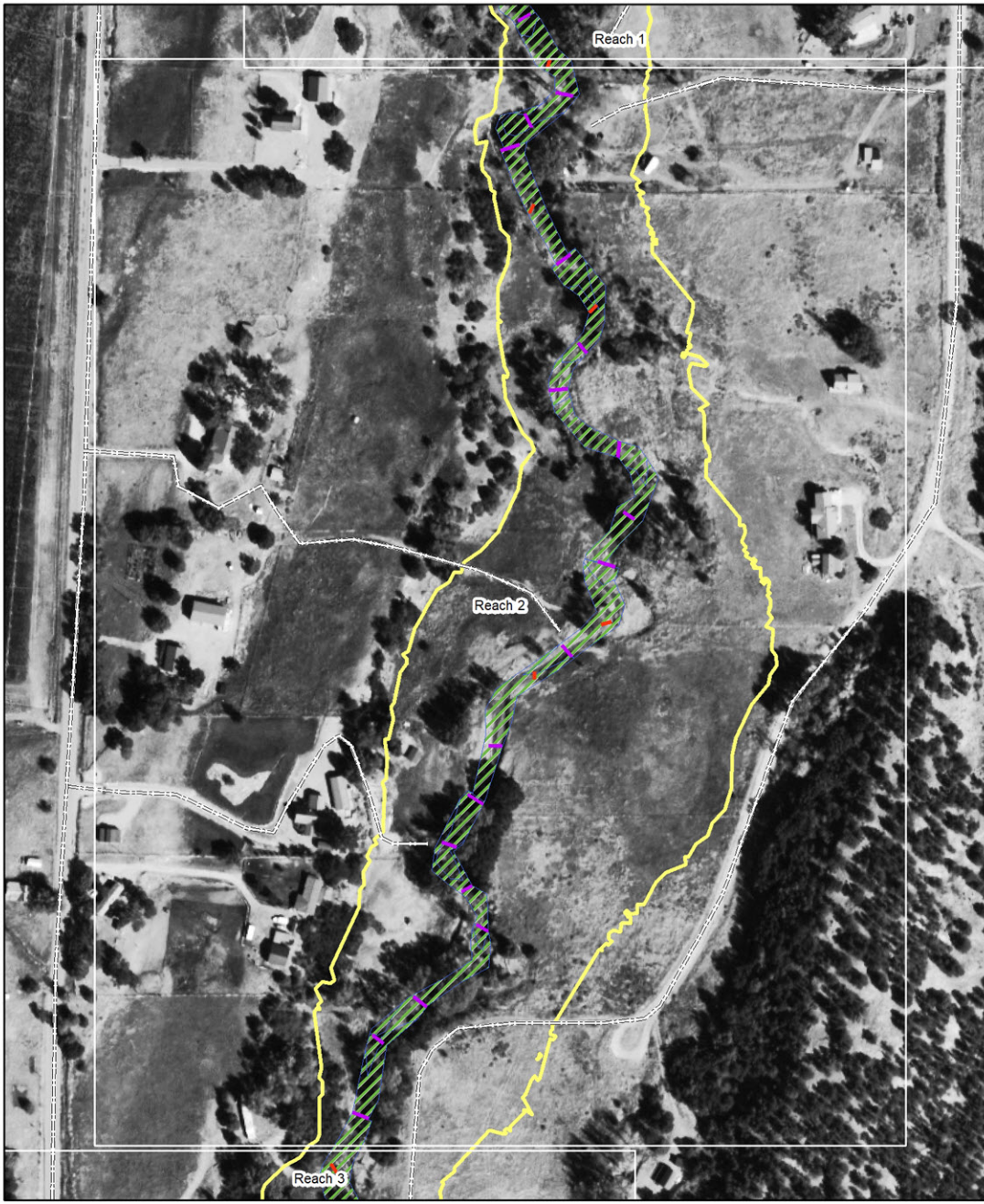
0.00
B)
Selected: 'depth'
01APR2021 08:00:00:500
Exhibit C
Depth (ft)
7.00
0.00
C)
Selected: 'Shear'
Shear Stress
D)
Selected: 'Shear'
Shear Stress

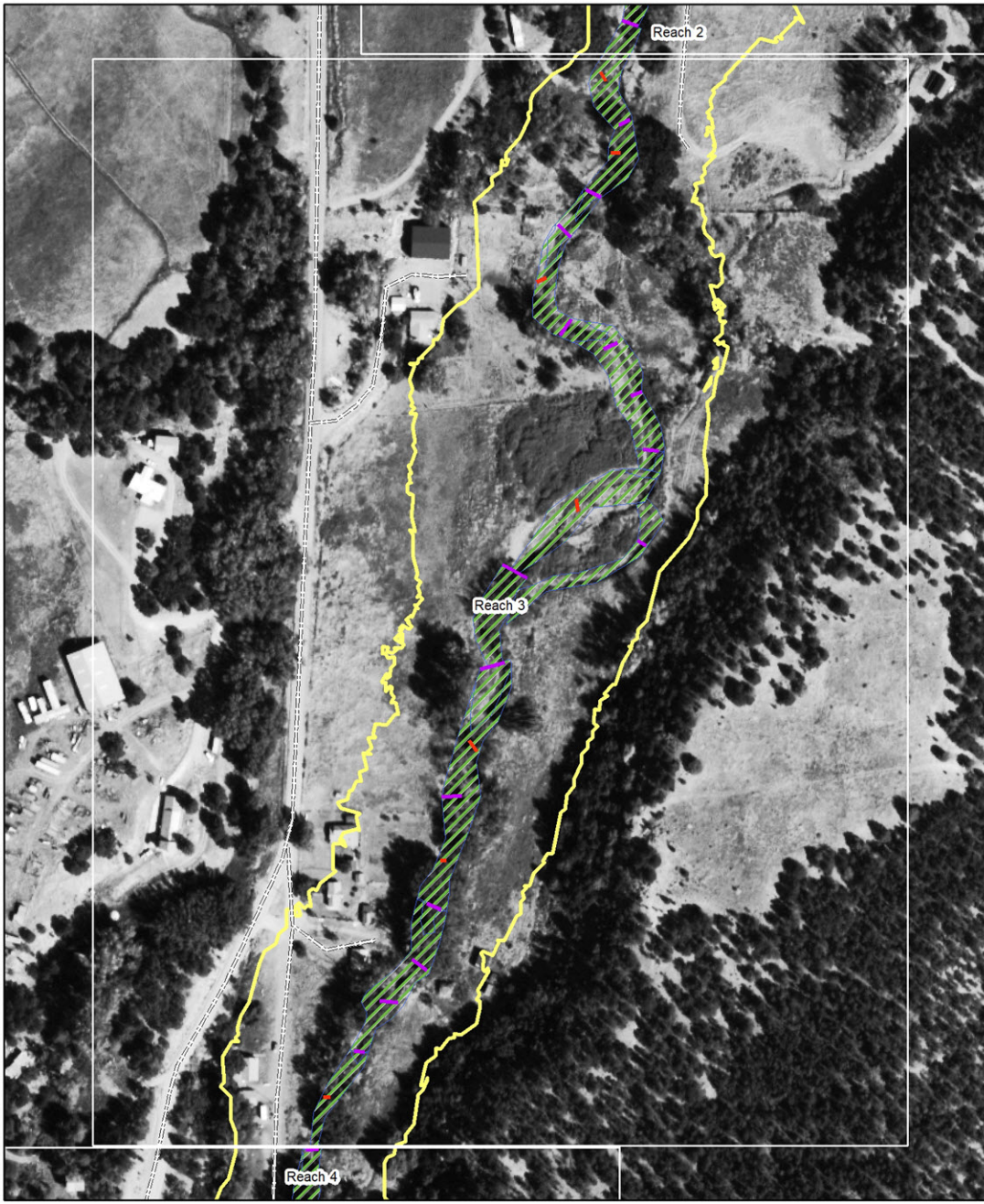

Reach 1
Reach 2
Reach 3
Reach 4
Reach 5
Complex Objectives
Incision Recovery
Increase Lateral Connectivity
Untreated
Reaches
N
Miles
0
0.25
0.5

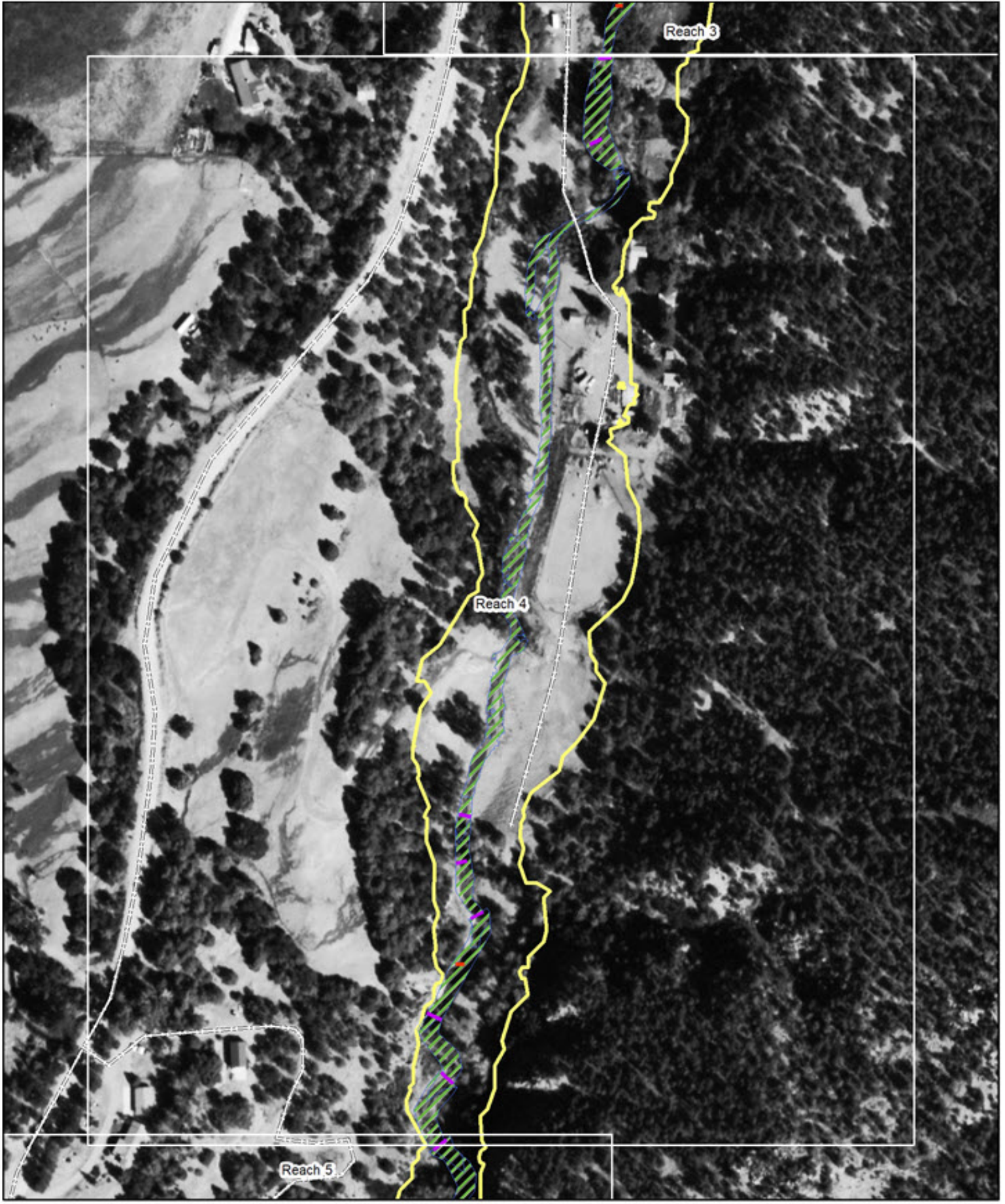

A)
B)
Reach 1
Reach 2
Free Flowing
Overflow
Ponded
Valley Bottom
Flow Direction
0
0.05
0.1
Miles
N



BDA Treatment
Bank Attached PALS Treatment
Channel Spanning PALS Treatment
Access Road
Complex ZOI
Valley Bottom
Flow Direction
Feet
0
260
520


Reach 1
Reach 2
Reach 3
BDA Treatment
Bank Attached PALS Treatment
Channel Spanning PALS Treatment
Access Road
Complex ZOI
Valley Bottom
Flow Direction
Feet
0
260
520


Reach 2
Reach 3
Reach 4
BDA Treatment
Bank Attached PALS Treatment
Channel Spanning PALS Treatment
Access Road
Complex ZOI
Valley Bottom
Flow Direction
Feet
0
255
510


Reach 3
Reach 4
Reach 5
BDA Treatment
Bank Attached PALS Treatment
Channel Spanning PALS Treatment
Access Road
Complex ZOI
Valley Bottom
Flow Direction
0
255
510
Feet

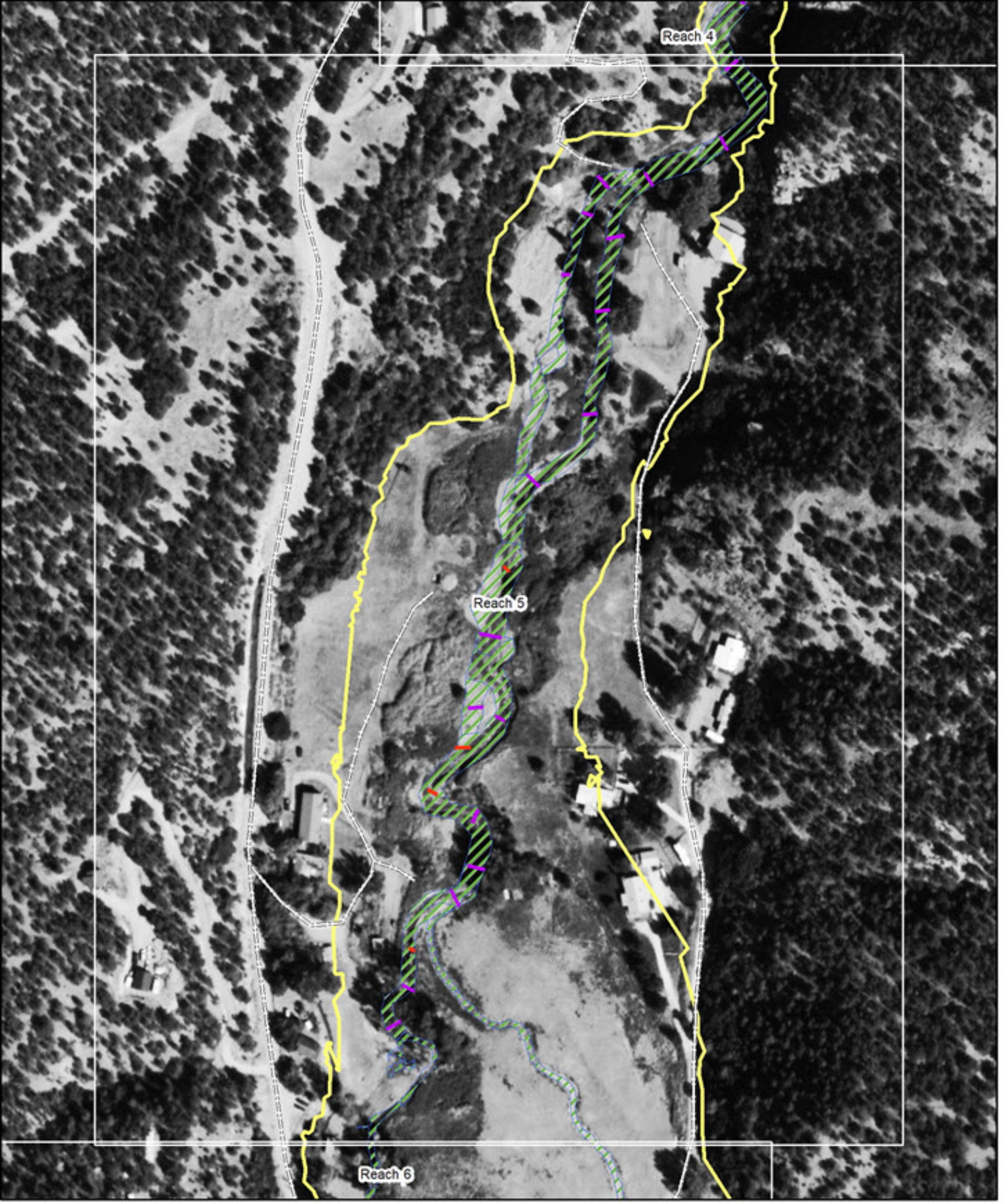

Reach 4
Reach 5
Reach 6
BDA Treatment
Bank Attached PALS Treatment
Channel Spanning PALS Treatment
Access Road
Complex ZOI
Valley Bottom
Flow Direction
0
255
510
Feet

Exhibit D

Post-Fire Hydrologic Impacts & Recovery Opportunities

river science

Fire Water Nexus

Fire and the State of Colorado's water are inseparable. As wildfire becomes more prevalent and drought persists, our State must examine how post-fire impacted rivers and streams negatively influence our state's hydraulics, hydrology, water quantity, and water quality. Each year Colorado wildfires add several hundred (or more) miles of creeks that will experience post-fire flooding. Post-fire flooding creates long-term issues for our waterways including incised channels, disconnection from floodplains, loss of riparian habitat, and extreme sediment loading.

Fires strip trees & vegetation from hillsides.

↓

Fire-scorched soils become hydrophobic soil (a temporarily impermeable soil layer), which cannot absorb rainwater.

↓

Without vegetation or stable soil, debris such as burned trees, soil and ash flow downhill during rain events.

↓

Communities downstream from these flows are at serious risk for flooding.

In 2020, 1% of our state's land burned in wildfires, which translates to over 1,000 miles of creeks located in burned watersheds. As fire & flooding are tied together, we must consider the long-term impacts on our waterways & how to help restore these systems to pre-fire conditions.

Initial Response

Each fire is unique, but as a general observation, large-scale destructive flooding persists for approximately five years following a wildfire. During this time, people living in and downstream of the burn face significant risks to their safety, homes, and water supplies. Hillsides stripped by fire can no longer absorb or catch rainfall. Burned trees fall and can be swept downstream with soil, ash, and other materials (known as debris). During this time, a focus on life & property is imperative.

For example, the 2016 Hayden Pass Fire in Fremont County produced its most significant post-fire flood two years after the fire. Initial estimates (based on precipitation) calculated the event as a 3,500 CFS flood.

After analysis, River Science discovered that the flood was a 10,200 CFS flood due to increased sediment & debris loading (known as the bulking factor).

From Protection to Recovery

Most watersheds (depending on severity of burn & associated landscape) begin the healing process during the 5–10-year post-fire period. Once the landscape has begun the process of regeneration and flood risks have subsided there are opportunities to focus on the long-term recovery of the watershed. Although immediate post-fire response (0-5 year) has gained traction, long-term recovery of waterways, water quality & riparian habitat are lacking. Without assistance, these systems could take decades if not hundreds of years to repair. Degraded water systems pose threats to our drinking water supplies, aquatic species, wildlife, recreation, and agriculture.

We feel that a focus on long-term post-fire recovery is essential to our economy, health, well-being, and environment.

PROTECTION & RECOVERY TIMELINE

PRE-FIRE	SHORT-TERM RECOVERY	LONG-TERM RECOVERY	
Ongoing Preparations	0-5 Years Post-Fire	5-10 Years Post-Fire	10+ Years Post-Fire
Proactive approach			
• Fuels Mitigation (Prescribed Burning, Clearing, Disease Mitigation) • Land Use Planning & Zoning (County Land Use Codes) • FireWise Education, Training, & Outreach	• Emergency Watershed Protection Program • Focus on Life & Property • Protection of Homes, Escape Routes, Infrastructure, and Recreation Safety	• Long-Term Recovery Planning • Focus on Recovery & Restoration • Focus on Water Quality & Quantity Concerns • Focus on Riparian Habitat & Connection with Floodplain • Implementation of Process-Based Restoration (PBR)	• PBR Mitigation & Monitoring • Continued Restoration Utilizing PBR Techniques & Methods
Risks if neglected			
• Increased Risk of Wildfires • Homes Built in Wildfire Prone Areas • Unintended Ignition of Human Caused Wildfires	• Increased Risk to Downstream Homes • Increased Damage to Property & Infrastructure • Increased Safety Concerns	• Increased Sediment Loading & Water Quality Issues • Disconnection from Floodplain & Increased Risk of Flooding • Further Degradation of Riparian Habitat and Wetlands • Decreased Retention for Groundwater Recharge • Flashy, Altered Streamflow	• Slow Recovery of Damaged Systems • Critical Loss of Habitat • Further Disconnect from Floodplain • Unhealthy Landscape for Future Wildfires & Post-Fire Flooding • Could take Decades if not Hundreds of Years to reach Full-Recovery Potential

Long-Term Recovery Objectives

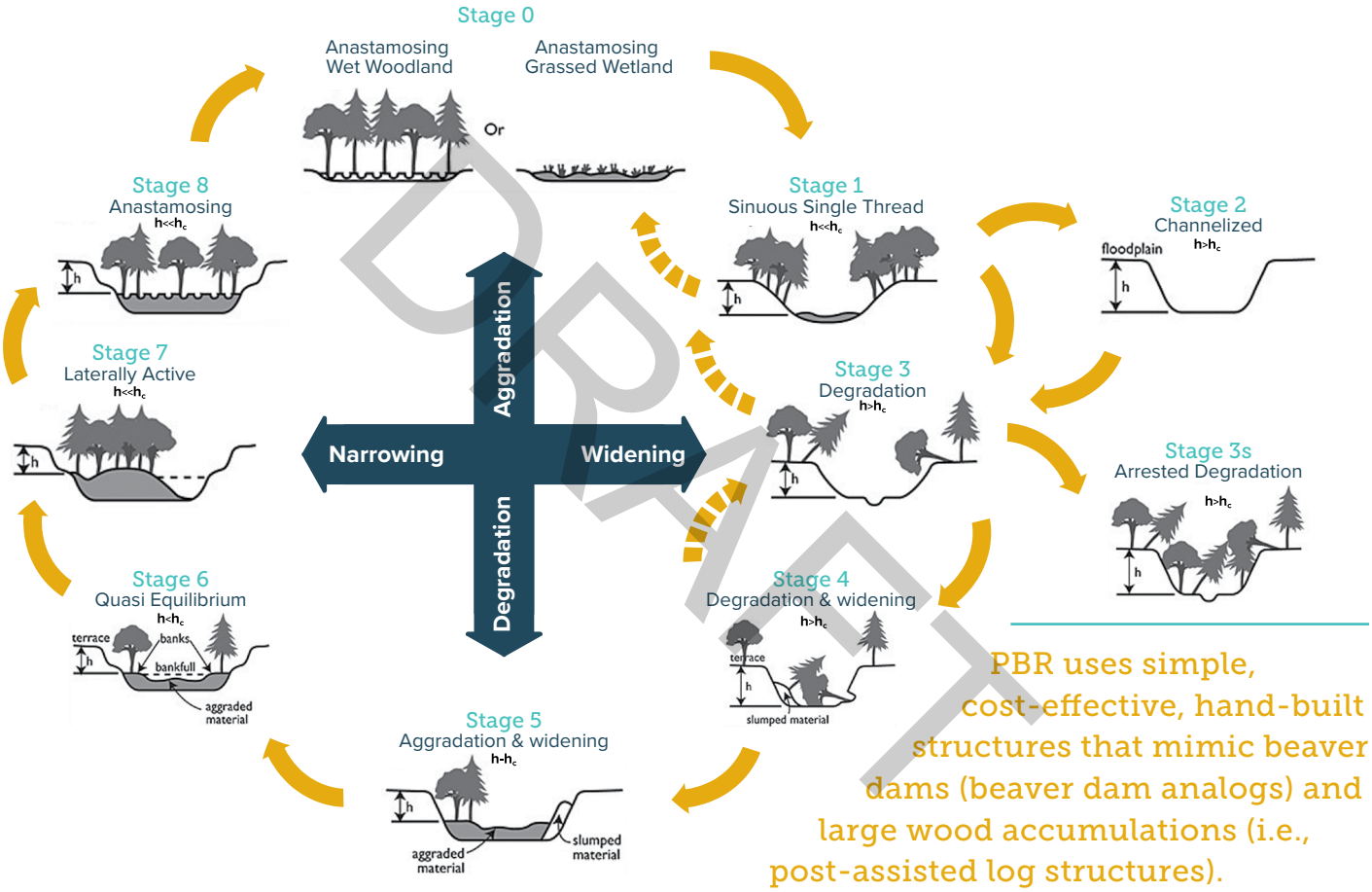
Although each fire & resulting flood are unique, we often find that long-term recovery objectives are similar across diverse landscapes.

Recovery objectives for impaired systems might include:

- Reconnecting the floodplain to spread and slow flood waters *(creating healthy systems for future post-fire landscape)*
- Expanding low-flow inundation extent
- Reducing frequent bank failures which introduce large amounts of fine sediment into the system
- Increasing structure and geomorphic diversity *(i.e., pools, slow moving water, ponded areas)*
- Reducing velocity to increase aquatic habitat
- Restoring deep incisions by trapping sediment to increase the elevation of the creek bed
- Mitigating steeper grades and faster flows which reduce water residence time and infiltration
- Increasing and restoring habitat for aquatic and terrestrial wildlife

Recovery Techniques Process Based Restoration (PBR)

Following the Stream Evolution Model below, post-fire creeks may likely widen and aggrade overtime to one day become a well-connected floodplain. However, this evolution from the current stage (2 or 3) to pre-fire conditions (ranging from stage 7, 8, 0, and 1) may take hundreds, possibly thousands of years. During this time, post-fire degraded systems would continue to suffer from the impairments identified in the objectives above. However, targeted restoration aimed at accelerating this stream evolution could be done with cost-effective process-based restoration (PBR) methods as outlined by Wheaton et al. (2019).



PBR uses simple, cost-effective, hand-built structures that mimic beaver dams (beaver dam analogs) and large wood accumulations (i.e., post-assisted log structures).

Cluer, B. and Thorne, C., 2014. A stream evolution model integrating habitat and ecosystem benefits. River Research and Applications, 30(2): 135-154. DOI: 10.1002/rra.2631

When strategically introduced to a stream, these structural elements can amplify natural hydrologic, geomorphic, and biological processes that accelerate the recovery of incised creeks and address limiting factors. Specifically, these treatments can widen the incised channel and use that generated material to lift, or aggrade, the channel bed. With many of the creeks' hydraulic, hydrologic, and habitat issues stemming from the deep incision, PBR offers a way to accelerate this channel bed aggradation and a chance to improve the conditions in a few years as opposed to hundreds of years.

The Opportunity

Every year we experience devastating fires. The impacts to post-fire hydrology are significant, long-lasting, and destructive given the scale and intensity of the Colorado wildfire.

PBR offers a cost-effective and practical solution to addressing the long-term recovery assistance needs of post-fire landscapes. Although PBR has had great success in neighboring states, its implementation has moved slowly in Colorado due to water rights & water administration concerns. Due to the unique nature of working in post-fire impaired landscapes where objectives are based on returning systems to their pre-fire conditions, water rights concerns should be limited. We believe that incredible work is being accomplished in the 0-5-year post-fire phase which focuses on the protection of life & property. We hope to build on these efforts and include the next phase (5-20 year) post-fire period which focuses on the health, rehabilitation and restoration of the watersheds that sustains us all.

Big Cottonwood Drainage in Fremont County is moving into its 6th-year post-fire, yet many issues remain. The pre-fire stream footprint for this creek was approximately 11 acres. Today, the stream footprint has been reduced to about 6 acres primarily due to incisions from post-fire flooding. Evidence of all risk factors (listed in the Protection to Recovery Timeline) is present in this stream for the 5–10-year post-fire recovery period. Opportunities exist to use PBR techniques to accelerate the recovery process and assist this system in reaching pre-fire conditions.

Learn more about Post-Fire Hydrologic Impacts & Recovery Opportunities

luke@river.science
719.428.9609
Canon City, CO 81212

river science

website: river.science

Exhibit E

COLORADO
Parks and Wildlife
Department of Natural Resources

South East Aquatics – Area 13
7405 US Hwy 50
Salida, CO 81201
P 719.530.5525 | C 719.530.5805

29 October 2021

Chris Sturm, Watershed Program Director
Colorado Water Conservation Board
1313 Sherman Street, Rm. 721
Denver, CO 80203
Chris.sturm@state.co.us

RE: Letter of Support – Big Cottonwood Long-Term Recovery Project

Dear Mr. Sturm,

I would like to express my support for the River Science grant application for the Big Cottonwood Long-Term Recovery Project. After touring this site, I have seen the degraded hydrological state of Big Cottonwood Creek as well as the potential future of this creek to provide critical habitat to a unique subspecies of Colorado River Cutthroat Trout known as the Hayden Creek Cutthroat Trout. These fish were rescued from the Hayden Pass fire in 2016. Specifically, this creek is in close proximity to the Hayden Creek Cutthroat's native area, lacks a fish population, and has the Harry Walker Dam to prevent cross-breading of this species. If restored, this site is highly favorable as a future location to protect this species.

Restoration is necessary as the current conditions of the creek are incised, high sediment loads, and the flow is shallow and swift making it unsuitable to support a health macroinvertebrate population and a fish population. Slowing the flow, adding pools, reducing sediment transport and bank erosion are all necessary to build a suitable habitat. Please consider this project's local benefits to landowners, habitat, and wider Arkansas River's sediment loading. We strongly support the objectives and anticipated outcomes of this project.

Sincerely,

Alex Townsend
Colorado Parks and Wildlife - Aquatic Biologist – Upper Arkansas River Basin
alexander.townsend@state.co.us

10/26/21

Chris Sturm, Watershed Program Director
Colorado Water Conservation Board
1313 Sherman Street, Rm. 721
Denver, CO 80203
Chris.Sturm@state.co.us

RE: Letter of Support – Big Cottonwood Long-Term Recovery Project

Dear Mr. Sturm,

I would like to express our support for the River Science grant application for the Big Cottonwood Long-Term Recovery Project. The grant request provides the critical support needed to help move this creek towards pre-fire hydrological state by using process-based restoration techniques. We believe that reducing bank erosion is important for this creek, various water users, and the wider Arkansas River. Further, we would like to see this creek once again support fish and the greater habitat. We strongly support the objectives and anticipated outcomes of this project and will provide access to our private land to implement the project.

Sincerely,

Michael Moulton

297 POLEMOUNTAIN RD.

10/26/21

Chris Sturm, Watershed Program Director
Colorado Water Conservation Board
1313 Sherman Street, Rm. 721
Denver, CO 80203
Chris.Sturm@state.co.us

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Sincerely,

331 Polk Mtn Lane
Coaldale CO 81222
303-910-5092
topper44_55@yahoo

10/26/21

Chris Sturm, Watershed Program Director
Colorado Water Conservation Board
1313 Sherman Street, Rm. 721
Denver, CO 80203
Chris.Sturm@state.co.us

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Sincerely,

Rick Quintana
0588 CR 40
Coaldale, Co. 81222