HAYDEN PASS FIRE & FLOOD RECOVERY PHASE 2
FINAL REPORT

Prepared for:

Colorado Water
Conservation Board

Colorado Watershed
Restoration Grants

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BACKGROUND

A rainless lightning strike on July 8, 2016, ignited the Hayden Pass Fire in the Sangre de Cristo Wilderness above Coaldale, Colorado. By the time the fire was contained, it had burned 16,700 acres of forest dominated by beetle-killed trees. In the months following the fire, monsoonal storms brought the first flash floods and debris flows to the burn scar area. Ash flushed into the Arkansas River from Hayden and Big Cottonwood Creek watersheds and generated large debris dams in the rugged, steep upper reaches of those drainages located on USFS land. Storms continued this process on the burn in 2017 and 2018, with the most significant damage to date occurring on July 24, 2018. During a heavy storm burst over the top of the Big Cottonwood drainage, an estimated flow rate of ~4000 CFS generated flows that destroyed and damaged homes, outbuildings, vehicles, bridges, and prompted a helicopter rescue.

These late summer storms caused Big Cottonwood Creek to reclaim its floodplain and some of the homes within it. High velocity, high volume post-fire flows incised the channel to depths of more than 8 feet in some places, created large debris dams of natural and man-made materials, scoured vegetation from the floodplain, and carried large amounts of rock, sediment and debris through the drainage into the Arkansas River. The behavior of these flows is described in a hydrological and hydraulic study by River Science and Lotic Hydrological, which is available in the *Additional Deliverables* section of this report.

In the first two years following the fire, recovery coordination and resources were sparse. The number and scope of completed erosion control or flood mitigation projects completed were unclear. A central clearinghouse of this information and coordination between potential sources of funding was missing. With very little resource availability or recovery guidance accessible by the community up to the date of the July 2018 flood, the need for comprehensive planning to guide restoration efforts that protect life and safety, critical infrastructure while enhancing the ecological health and resilience of riparian corridors and their larger watersheds became clear and urgent.

INTRODUCTION

When NRCS Emergency Watershed Protection funds became available in late summer 2018 through Fremont County for use in the flood-impacted Big Cottonwood/Little Cottonwood/Bitter Creeks watershed, three needs became apparent. First, a local point of contact to help engage eligible landowners in the immediate EWP process was needed. Second, engagement with all impacted landowners to determine needs and appropriate projects not covered by EWP was necessary. Third, coordination between project partners and existing and potential partners would be essential to ensure that all available resources are brought to the drainage and that each project functions supportively to other existing and proposed work.

Through Phase 1 of this project funded by CWCB, we were able to meet these needs in the community. The first phase included community outreach and coordination for a Natural Resources Conservation Service Emergency Watershed Protection (NRCS EWP) grant, which is completed, post-fire needs and risk assessment, and beginning development of a recovery plan, starting with the Big Cottonwood watershed. We completed urgent post-fire mitigation work in the heavy-hit Big Cottonwood drainage to help protect life and safety and develop trust within the community. With funding, we also completed an early hydrological and hydraulic study by River Science and Lotic Hydrological, which is available in the *Deliverables* section of this report. This analysis supported EWP planning, enabled prioritization of recovery projects, continues to inform the larger Drainage Recovery Plan, and can be shared with planners and other communities facing post-fire conditions.

Through Phase 1 and into Phase 2 work, the process departed from our original plan due to changes in funding, timelines, partners, unexpected roadblocks, and lessons learned from working with landowners in a rural community. These shifts stemmed from frustrating but enlightening obstacles and generated surprising and heartening opportunities for cooperation and healing in the community.

The community did not respond to participation in a formalized coalition but instead formed an informal network that built trust for communication, information sharing, and project implementation. As the current and further hydrological study showed that other fire-impacted drainages were not likely to be significantly

impacted by post-fire flooding, we shifted resources to focus on the hard-hit and at-risk Big Cottonwood drainage and its landowners. To provide relevant support to the community and protect the most vulnerable drainage, we reallocated resources and adapted goals for Phase 2. We thank CWCB for this flexibility which is critically needed to meet needs in ever-changing post-fire conditions.

OBJECTIVES & METHODS

Every community and every post-fire situation is different and ever-changing, making planning for recovery a challenge. Early efforts revealed needs, gaps, and challenges in the Hayden Pass Fire area. With the support and flexibility of CWCB, we did our best to adapt to these changes during our work in Phase 2. We responded to new needs and shifted objectives to complete the most critical mitigation projects, include as many voices as possible, and provide the most needed information while respecting the community's character and requests. Project objectives were organized into four primary categories:

- facilitation of community organization, outreach and education, and continued support of the Hayden Pass Fire & Flood Recovery (HFFR) Coordinator
- analysis of floodplain hazards, risk assessment, and prioritization within the at-risk Big Cottonwood drainage
- development of a **Recovery Case Study** and **Drainage Recovery Plan** for Big Cottonwood
- community support and monitoring for EWP projects

Specifically, our work encompassed the following objectives:

1. *Increase community support, transparency, and communication by developing a watershed recovery network led by the HFFR Coordinator.*

In addition to landowner outreach and education for the purposes of implementing the EWP project in Phase 1, we began to form a recovery coalition. We hoped this organization would create local ownership and meaningful engagement throughout the recovery process, making it relevant to local needs - and more sustainable. We envisioned that it would include landowners in each drainage impacted by the Hayden Pass Fire, starting with the Big Cottonwood drainage in Phase 1 and extending to all impacted drainages in Phase 2. We conducted outreach to potential partners such as USFS, BLM, State Land Board, Division of Water Resources, Colorado Parks & Wildlife, local watershed-based nonprofits, agricultural interests, and recreational fishing and rafting interests. We invited them to become a part of this group. We wanted to cast a wide net to create a group that could develop a robust, holistic recovery plan and leverage technical and fiscal resources for the widest impact on the whole watershed.

In reality, this process went differently. As the additional hydrological study showed little significant risk to other drainages affected by the fire, we focused on the vulnerable Big Cottonwood drainage. The community was not responsive to participating in a formal coalition and was honest with us about this. Instead, we followed the community's lead in fostering an informal network to facilitate communication, foster trust, and get work done. Throughout Phase 2, the Recovery Coordinator continued to use this network to monitor post-fire conditions and assess the performance of EWP and other recovery projects, hear and respond to concerns about potential flooding and changes in water use and movement in the drainage, disseminate information on flood preparation and awareness, share long-term recovery process updates, and develop and share educational materials. Please see the *Conclusion & Discussion* section of this report for more information on this process.

2. *Complete hazard analysis and risk assessment to inform project prioritization for the Big Cottonwood Drainage.*

Field assessments to document current floodplain issues were completed from January to July 2019.

Issue identification included any risks to life and property that existed in the Big Cottonwood Creek drainages (including Bitter and Little Cottonwood Creeks), Hayden Creek, and Sullivan Creek drainages (including Mosher and Oak creeks). Such issues were identified by: i) hydraulic simulations and ii) field visits. All issues and risks were divided into one of the following categories:

- Flooding (e.g., what return interval do houses become inundated and at what depth and velocity).
- Hazards (e.g., risk of falling trees near homes or that may divert flow toward homes or infrastructure).
- Debris (e.g., potential to mobilize and cause downstream issues, existing debris jams, and channel spanning trees capable of causing future debris jams).
- Channel issues (e.g., bank erosion near homes, significant channel incision that is dangerous or degrading to the land function).

Hydraulic simulations were conducted using the previously calibrated HEC-RAS 2d model and post-fire hydrologic data presented in the H&H report. Flood scenarios of 10-, 25-, 50-, and 100-year return intervals were conducted. While many outbuildings were observed to become inundated, only houses are marked and discussed. Flood conditions' depths and velocities were used to determine the level of risk the house likely faces during the different scenarios. High-risk properties are those that are likely to flood under all scenarios and experience significant dangerous depths and velocities. Moderate risk properties are those that are likely to become inundated under less frequent events and /or experience moderate depths and velocities.

Hazards, debris, and channel issues are mapped and ranked according to perceived risk to life and property using a high, moderate, and low system. Most of these issues have GPS-tagged images (i.e., photo points) that were taken during field visits. All photo points were integrated into GIS software to provide reference to the specific issues identified.

3. *Create a **Case Study and Drainage Recovery Plan** to identify needs, guide future projects, identify potential funding, and provide recommendations for the long-term recovery of the Big Cottonwood Drainage.*

The **Case Study** tells the story of recovery in the rural community impacted by the Hayden Pass Fire, focuses on lessons learned during the implementation of rapid recovery like NRCW EWP, explains the challenges faced in the community, and offers possible avenues for avoiding these problems in similar communities. The Recovery coordinator worked with landowners, partners, staff, and a professional designer to write the language, compile photographs and inform the development of infographics to create a highly readable Case Study that is now available to communities, fire recovery organizations, and policymakers to assist in more effective fire recovery decision-making in rural communities where similar conditions and challenges persist. The Case Study is a companion to the Drainage Recovery Plan discussed below. The Case Study is accessible through the *Deliverables* section of this report.

Luke Javernick of River Science created the technical component of the ***Drainage Recovery Plan,*** which builds on his existing hydrology and hydraulics report by offering technical recommendations for the most beneficial restoration projects and approaches for the long-term recovery of the drainage, with a particular focus on soil and revegetation regeneration and recovery of fisheries and wildlife habitat. The Drainage Recovery Plan utilizes aerial imagery, ground assessment of changes in drainage conditions over the post-fire period, and hydraulic simulation of the inundation area to explore long-term recovery issues. These issues include private property and infrastructure, irrigation structures, disconnected floodplains that exacerbate future floods (or fire and floods), and poor water quality and habitat conditions. These

concerns are discussed in the plan within the contexts of infrastructure concerns and fluvial processes. The Drainage Recovery Plan is accessible in the *Deliverables* section of this report.

4. *Develop educational materials to be shared with landowners, partners, planners, and other communities to communicate project phases, findings, and recommendations.*

In addition to the **Case Study** and **Drainage Recovery Plan** discussed above, the Recovery Coordinator developed and maintained educational materials for landowners, partners, planners, and communities facing or preparing for post-fire conditions. Please see the *Additional Deliverables* section to view these materials and resources.

The Hayden Pass Fire & Flood Recovery StoryMap is an interactive platform shared with the community and partners. It tells the story of the post-fire recovery in the Hayden Pass area in an interactive format that includes language, photographs, interactive maps, and live links to complimentary reports, resources, and other helpful information.

The Hayden Pass Fire Recovery page is hosted within the Post-Fire Recovery section of ARWC's website ***arkcollaborative.org.*** This page is a central location for information about the fire, post-fire flooding, and recovery. It contains all reports and studies available for the fire and recovery. It includes updates and resources for the communities of the Hayden Pass Fire as well as resources that are relevant to any community facing or preparing for post-fire conditions. The Recovery Coordinator developed and maintained this page for the duration of the post-fire flood recovery period and updated the page with reports and resources as they became available. We installed a survey tool on the page to allow community members to share their concerns with us, which helped to drive the risk assessment process. We used the *Updates* function of the page and direct email and phone calls to provide flood season preparation information and warnings to residents in the area during the critical post-fire flooding period.

5. *Provide project monitoring and community support for a period of two years.*

Because only a fraction of eligible landowners in the Big Cottonwood drainage participated in the NRCS EWP project, the need for monitoring of these projects to support landowners burdened with ongoing maintenance lessened considerably. Please see the **Case Study** in the *Deliverables* section for more information on challenges with EWP. We reallocated resources from monitoring to put toward development of the **Drainage Recovery Plan**, a resource that became much more critical for the community.

The Coordinator provided ongoing landowner support for all landowners in the drainage whether or not they participated in EWP. When possible, we reviewed landowner plans for private recovery work, met onsite to provide recommendations for private recovery work, connected landowners to additional resources needed to complete this work. We communicated changes in funding availability and coordinated site visits from River Science.

In partnership with Canon City High School, River Science conducted water quality monitoring on Big Cottonwood Creek over the last three years. Typical parameter readings (pH, dissolved oxygen, alkalinity, and hardness) show the creeks' water quality is within normal health 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). Field data in Big Cottonwood Creek and the Arkansas River just downstream of the Big Cottonwood confluence showed significant impacts on aquatic life following the 2018 flood events.

RESULTS

1. *Increase community support, transparency, and communication by developing a watershed recovery network led by the HFFR Coordinator.*

As landowner and partner connections continued to take root during Phase 2 work, landowners, partners, and ARWC staff are forming a trusted network that is supremely local, positioning the community to respond quickly and effectively to watershed-related issues in the future. A system of informal supports involving neighbors helping each other and the recovery team, matching personal resources with those offered by the recovery team and agencies, and freely but informally sharing ideas and help on the ground rather than at meetings held in halls allowed the recovery efforts to gain momentum. These relationships have also paved the way for future restoration efforts that will be needed on private land in the next stage of recovery supported by the Drainage Recovery Plan.

With the formation of ARWC as a basin-wide organization with the resources to address watershed concerns like fire and flood through the larger watershed, the pressure is taken off small, micro-local groups like the Hayden Pass areas that do not have such resources. Instead, ARWC can take the lead in the recovery work and continue to support the communities around the Hayden Pass Fire in long-term recovery as needed. With that support, the network of landowners, staff, and partners be a conduit for community watershed education, creating a well-informed group that understands the complexity of holistic watershed health and how different projects impact the overall health and condition of the watershed, especially after a fire. A strong educational foundation will help guide the community to prioritize recovery projects that have the most comprehensive benefit to the whole watershed while considering local needs and concerns. This way of organizing is becoming critical as fires continue to burn throughout the basin.

2. *Complete hazard analysis and risk assessment to inform project prioritization for the Big Cottonwood Drainage.*

The **Hazard Report** is accessible in the ***Deliverables*** section of this final report. All mapped GIS layers are available as shapefiles. The mapped area is broken into 15 reaches for viewing convenience (Figure 1). These reaches are designated as C (i.e., Cottonwood), H (i.e., Hayden), and S (i.e., Sullivan). Maps (Figures 2-15) are provided in the report and organized by reaches C1-9, H1-2, and S1-2. Reach LC (i.e., Little Cottonwood) is also included despite landowners refusing current assistance. In total, 171 issues were identified, and 215 photo points were captured. Each figure is followed by a table that lists the issue identified, a description, and a risk ranking. Figures 16-23 provide a greater detail view of the 19 homes that are threatened by future flood events, and Tables 13-20 provide the address and associated risk.

3. *Create a Case Study and Drainage Recovery Plan to identify needs, guide future projects, identify potential funding, and provide recommendations for the long-term recovery of the Big Cottonwood Drainage.*

The Case Study and **Drainage Recovery Plan** are completed. They are available to the Hayden Pass area community and planners and other communities preparing for or facing post-fire conditions. These documents will be used to inform changes in post-fire response and long-term recovery projects within the Big Cottonwood area and other fire-impacted areas. Please see the two documents in the *Deliverables* section of this report for detailed results within each document.

4. *Develop educational materials to be shared with landowners, partners, planners, and other communities to communicate project phases, findings, and recommendations.*

The educational materials are completed and available for continued use by the Hayden Pass area community and other communities preparing for or facing post-fire conditions. The StoryMap, Resources, and Updates will be hosted on arkcollaborative.org for ongoing availability.

5. *Provide project monitoring and community support for a period of two years.*

The community support and water quality monitoring period are completed. Water quality data is discussed in the Drainage Recovery Plan, and information is available at www.river.science. The information is being used to guide long-term recovery project planning to support the riparian restoration, fisheries regeneration.

CONCLUSION & DISCUSSION

Wildfire changes the land and communities - and the forces of flood continue this change for many years after the fire is out. Work is needed immediately to protect people, structures, and water supplies. Long-term recovery focuses on restoring and protecting the land and water that we cherish and rely on – by stabilizing soil, reducing erosion and sedimentation, increasing native vegetation, and rehabilitating wildlife habitat. Fire and flood are challenging to manage. We are not in control. But natural and human communities are resilient, and the painful changes that follow fire create opportunities for regrowth.

Each fire and every community is unique, and recovery is complex. The social and emotional impacts to landowners and communities must be taken into account early on – trust must be carefully built – if recovery projects will be successful. It is essential to have local input and buy-in to help inform the process from the beginning. Communities and watersheds will heal over time, but a compassionate, experienced response that includes early community input will be most successful. Communities with watershed health organizations in place before the fire can respond quickly and equitably to fire and flood. These organizations should include many voices - from landowners, the recreation community, agricultural producers, water managers, wildlife, and others unique to each community.

Community Organization

We found that although we planned to form a coalition with landowner drainage workgroups before initiating work on the ground, we changed our expectations as the process of landowner engagement happened naturally on its own timeline. With stalled momentum and waning participation over the winter, we realized we needed to shift our focus. We asked our constituents what was happening and heard from them that they did not want to be a part of another group that holds meetings but does nothing. The needs on the ground were simple; community members were ready to contribute and work together but preferred to do so informally, neighbor to neighbor, without the "red tape." Action on the ground generates informal leadership and participation, with landowners and other partners coming on board with their time and support as our work unfolded on the ground in the drainage. From this process, landowner workgroups emerged naturally, and participation became more meaningful, less forced. The coalition was taking the form of an informal network and thriving on its own.

We learned through trial and error that this is the accepted, most effective way of gaining traction and trust in small, rural communities such as those around the Hayden Pass Fire burn scar. The terms "coalition" or "collaboration" tend to generate negative feelings, alienate neighbors from organizations and agencies, and dissipate momentum in these types of communities.

As more fires continue to burn in populated areas throughout the basin, working effectively with communities -even if it does not match the prescribed model - is paramount. Trying to force a particular model on a community that is not a good fit will only waste resources and time while alienating the community. When life, safety, and long-term recovery are at stake, getting the job done is vital. The Hayden Pass Fire area community network was established through Phase 1 and 2 of this work, giving them the tools to continue on the path of long-term recovery through new partnerships and projects.

Long-Term Recovery Tools

As communities and the land continue to heal five years after the fire, we are building on this regeneration. The Hazard Report calls into focus remaining concerns and threats to long-term recovery, giving shape to potential projects that will help solve them. Through the Drainage Recovery Plan, we plan for projects that will support the long-term recovery of the forests, wildlife, watersheds, and communities affected by the fire. Through the Case Study, we share this community's story of fire and recovery to empower others to prepare to respond to the difficult, overwhelming challenges of fire and flood.

ACTUAL EXPENSE BUDGET

Task	Description	Cost	Match	Project Total
1	HFFR Coordinator	$ 31,432.00	$177,623.43	$ 209,055.43
2	Mapping Assets & Conditions	$ 21,751.00		$ 21,751.00
3	Risk Characterization	$ 10,651.00		$ 10,651.00
4	Recovery Plan	$ 17,666.00		$ 17,666.00
5	Monitoring	$ 50,924.00		$ 50,924.00
6	Grant Administration	$ 11,400.00		$ 11,400.00
Total		**$ 143,824.00**	**$ 177,623.43**	**$ 321,447.43**

DELIVERABLES

Floodplain Hazard Identification and Assessment Report (Hazard Report)
https://www.arkcollaborative.org/uploads/1/2/6/9/126983442/hazard_report.pdf

Hayden Pass Fire & Flood Recovery Case Study
https://www.arkcollaborative.org/uploads/1/2/6/9/126983442/arwc_haydenpassdocument_final_web.pdf

Big Cottonwood Creek Drainage Recovery Plan (5+ Years) Opportunities and Recommendations
https://www.arkcollaborative.org/uploads/1/2/6/9/126983442/big_cottonwood_recovery_plan.pdf

ADDITIONAL DELIVERABLES:

Hayden Pass Fire information and resource page hosted on arkcollaborative.org
https://www.arkcollaborative.org/hayden-pass-fire.html

Recovery StoryMap
https://storymaps.arcgis.com/stories/a6c6e1de05b04d0d8361b0d57b7c9ffd

Hydrology and Hydraulics Report
https://www.arkcollaborative.org/uploads/1/2/6/9/126983442/rs_hh_report.pdf