USDA United States Department of Agriculture
Natural Resources Conservation Service

COLORADO
Colorado Water Conservation Board
Department of Natural Resources

COLORADO
Department of Local Affairs
Community Development Block Grant — Disaster Recovery

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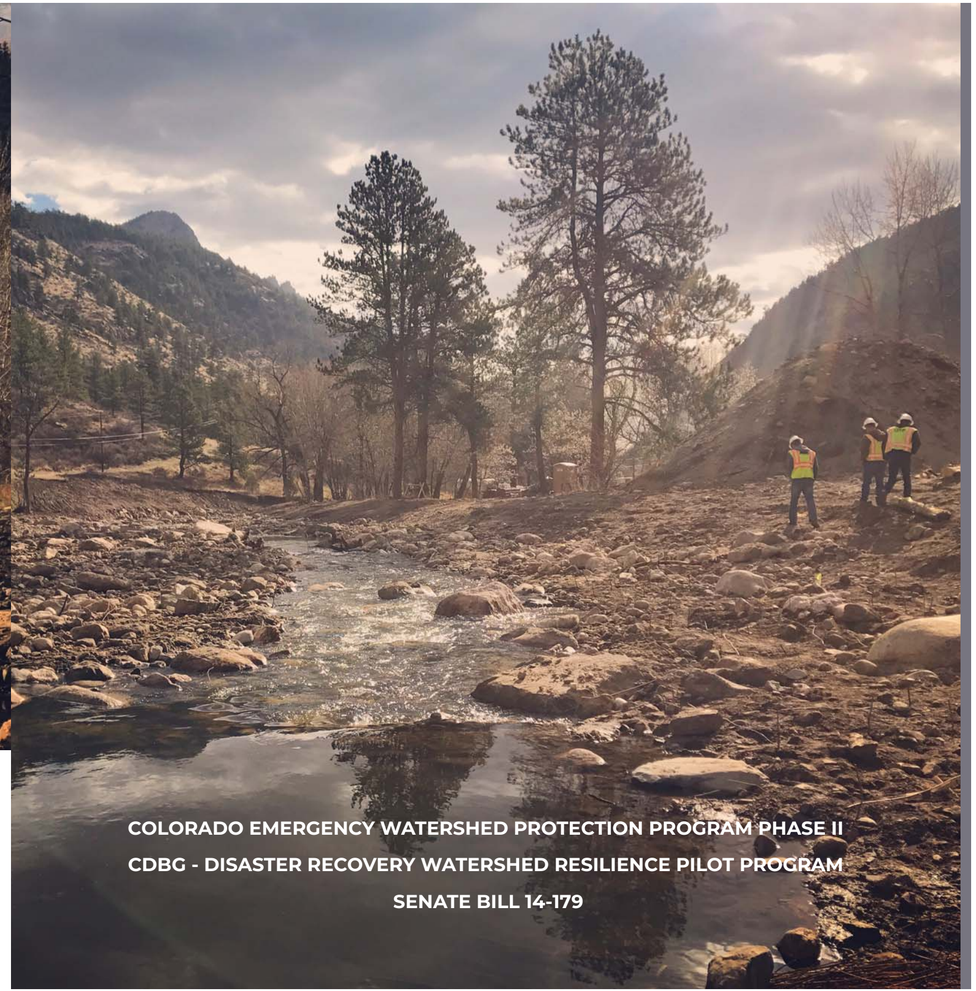

COLORADO

WATERSHED FLOOD RECOVERY

2013-2018

COLORADO EMERGENCY WATERSHED PROTECTION PROGRAM PHASE II

CDBG - DISASTER RECOVERY WATERSHED RESILIENCE PILOT PROGRAM

SENATE BILL 14-179

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COLORADO WATERSHED FLOOD RECOVERY

In early September 2013 several days of rain caused massive flooding across Colorado's Front Range communities. Streams reclaimed floodplains, destroyed roads, bridges, and buildings and ripped vegetation from riverbanks. In total, the flood caused approximately $4 billion in damage to infrastructure and public and private property. Emergency repairs opened highway corridors but often bulldozed rivers, leaving them in dysfunctional alignments and often with channels that were too small to safely convey normal river flows. Unable to self-repair, the damaged and unstable rivers needed a boost.

Communities came together with encouragement and support from Federal and State partners. Recognizing the impacts of historic encroachment on floodplains and seeing a need to build resiliency into the systems, the State took a new, more holistic approach to recovery. In the past, disaster recovery was often completed on an individual property within a single local jurisdiction. With this new approach, the State remained committed to protecting life and property, but implemented projects on a much larger scale. The State sponsored programs focused on five key principles:

1. Complete recovery work on a watershed scale with coordinated project design and sequencing
2. Support early planning to identify root issues, develop holistic solutions, and allow time to secure appropriate funding
3. Support watershed coalitions as a model for stakeholder engagement, improved project outcomes, and recovery that crosses jurisdictional boundaries to prioritize river system recovery
4. Execute projects with multiple objectives, including safety, ecological and environmental benefits, and community and economic development outcomes
5. Incorporate resiliency into every project to mitigate a similar scale of damage in future events

Thanks to early and bold visioning and partnership building by the Colorado Water Conservation Board (CWCB) and continued dedication to recovery principles by other State agencies like the Department of Local Affairs (DOLA), Division of Local Government, as well as numerous local and private partners, the recovery of Colorado's flood impacted watersheds have created a new model for disaster recovery.

RIGHT: Construction on the Little Thompson River at Green Bridge in Larimer County. Project implemented by the Little Thompson Watershed Coalition. COVER: Construction photo of the North Fork of the Big Thompson implemented by Larimer County in partnership with the Big Thompson Watershed Coalition.

Colorado Hazard Identification and Mitigation Programs

Colorado Hazard Mapping Program (CHAMP)

The Colorado Hazard Mapping Program (CHAMP) is preparing updated flood hazard information for the streams most affected by the September 2013 flooding. These areas include the Big Thompson & St. Vrain watersheds as well as the South Platte River. Community leaders will use the updated hazard information to assess areas subject to flood inundation and identify mitigation opportunities in their community. The updated information is intended to be used to update Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRM), which are used to determine flood insurance requirements and rates in communities that participate in the National Flood Insurance Program (NFIP).

Fluvial Hazard Zone (FHZ) Mapping Pilot Program

Erosion, sedimentation, and channel avulsion are significant hazards associated with flooding that are not incorporated into traditional floodplain maps, however, these processes ravaged the river systems of the Front Range in 2013 resulting in property damage, infrastructure failure, and death. The CWCB has developed a program focused on the identification and mapping of these hazards as well as tools to help communities and landowners better understand ALL the hazards associated with flood events. The CWCB's pilot program defines the Fluvial Hazard Zone as the area streams have occupied in recent history, could occupy, or could physically influence as they store and transport sediment and debris during flood events.

Debris Flow Mapping Program

Debris flows and mud flows are usually caused by heavy rainfall in steep terrain or on wildfire burn scars. Debris flows are common in Colorado and these hazards have a history of causing significant damage to homes and infrastructure as well as taking lives. The Debris Flow Mapping Program aims to map those areas susceptible to debris flows as well as to identify the area that may be inundated with debris where the material is deposited. In the aftermath of the 2013 flood, Boulder, Larimer, Jefferson, Douglas and El Paso counties were prioritized for mapping with a goal to finish maps in the remainder of the state in another 5 years.

Preparing for the Next Flood

Flooding represents the most common natural disaster in the United States, resulting in significant property and infrastructure damage. Floods have resulted in 11 federal disaster declarations for Colorado with one or more major floods occurring every decade in the State. Average annual flood losses in Colorado are estimated to be $83,000,000 in property damage based on data from 1911 to 2013 (inflation-adjusted 2013 dollars). Knowing that the next big flood could be right around the corner, CWCB and state partners are embarking on several state-wide programs to identify, educate, address, and mitigate damage from future flood events. The CWCB knows that the success of flood mitigation will be measured by a community's ability to solve problems at the watershed scale and in a way that reduces future flood loss while maintaining stream function. At a state-wide level, this means developing better technical programs that recognize that streams and rivers are naturally dynamic systems that transport water, sediment and debris, but, equally important, developing outreach and education materials to better inform communities of their risk and disaster recovery resources.

PHOTO: Aftermath of 1976 Big Thompson flood at Drake, Colorado.

"THIS WAS A NEW WAY OF DOING BUSINESS. WE TOOK A DIFFERENT, MORE HOLISTIC APPROACH AND WE'RE EXCITED TO SEE THE RESULTS ON THE GROUND."

-KEVIN HOUCK, CWCB

Flood Recovery Goals

The primary goals of the Colorado Watershed Flood Recovery were to:

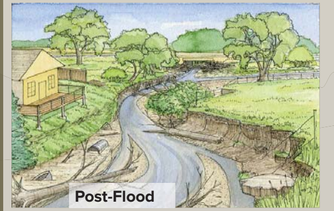
- Reduce hazards and protect life, safety and property
- Use federal and state funding effectively
- Enhance the health and resilience of stream corridors and their broader watersheds
- Build the capacity of watershed coalitions
- Advance a watershed-based approach to flood recovery hazard, hazard identification, and risk communication

These flood recovery program principals were based on the philosophies of the CWCB Colorado Watershed Restoration Program (CWRP). CWRP is a decade old program that focuses on projects and plans that protect life and property while restoring the ecological processes that connect land and water. This vision for flood recovery is also restated in the Colorado Water Plan.

PHOTO: Project construction site-walk at North 63rd Street improvements on Lefthand Creek with staff from the NRCS, CWCB, Left Hand Watershed Oversight Group, and the State EWP Technical Assistance Team.

Flood Recovery Community Resource and Guidance Documents

The 2013 Colorado flood mobilized some of the country's best minds and challenged them to solve complex problems related to disaster recovery and community resilience. In the ensuing years, a number of excellent resources were developed to assist with the recovery effort as well as to act as reference documents for long-term guidance. Target audiences for these documents included technical practitioners in both the public and private sectors, civil servants responsible for funding and policy development, watershed coalitions, stewardship groups, and non-profit organizations, and landowners responsible for management decisions on private land. These resources are now widely available in digital format and should serve the people of Colorado and other states whom find themselves preparing for or recovering from a flood as well as those making river-related management decisions in the interim.



Post-Flood

Large flood event caused widespread inundation of the floodplain. The stream exceeded its banks and extended to the surrounding floodplain causing damage to private property as well as roads, bridges and multi-use paths.

The stream avulsed to create new flow paths. Sediment and debris disrupted or destroyed instream form (riffle features). Sediment deposits altered channel hydraulics (cross-section and gradient). Lateral instability during the flood caused excessive bank erosion.

Large amounts of sediment delivered from the upper watershed caused a sediment imbalance. Sediment transport is not in equilibrium due to large disruptive event. Trash and debris mobilized within the stream channel.

The stream has felled trees adjacent to its banks. More woody debris exists in the channel after the flood. Vegetation within the riparian zone is disrupted, initiating large event-based changes in riparian habitat. Water quality condition is worse than pre-flood due to elevated turbidity, suspended sediment, and poor vegetation conditions. Macroinvertebrate community is likely damaged from high flows and sedimentation.

Photo Credit: Glenn Patterson

Restoration

The flood highlighted the loss of connection between the stream and the floodplain. Roads restored or replaced. Dredging completed around bridges to restore flow capacity. Bridges replaced as needed.

Restoration projects focused on bank restoration (lateral stability) and adjusting the stream grade (vertical stability) via drop structures (riffle sequences). Channel cross-section restored / improved to restore the stream's hydraulic capacity. Secondary channels allow for the transport of high flow.

Upper watershed no longer delivering large sediment loads. Sediment from bank erosion is returning to normal due to restoration project. Stream is working to return to equilibrium conditions for sediment transport.

New vegetation planted as part of bank stabilization, which has helped to improve water quality. Instream stream features restored. Trees and large wood removed from the stream which in some cases degraded instream conditions. Restored habitat includes planting native plant species and removing invasive or non-native habitat.

Links to Guidance

Stream Stewardship and Recovery Handbook

Resilient Crossings Handbook

Adaptive Management Guide

Plant Restoration Matrix

Living Streambanks: A Manual of Bioengineering Treatments for Colorado Streams

Flood Recovery Project Monitoring Methods

Technical Guidance: Revegetation Plans for Stream Restoration Projects

Emergency Watershed Protection (EWP) Program 2013 Colorado Flood Recovery Phase 2 Project Engineering Guidance

Project Operation, Inspection, & Maintenance Plan Template

These documents can also be found at:

www.coloradoewp.com

LEFT: Excerpt from the Adaptive Management Guide developed by Left Hand Watershed Oversight Group. Funding supported by the DOLA CDBG-DR Resiliency Planning Program, June 2018.

Program Partners

To fully implement flood recovery in Colorado, numerous partners were needed to provide guidance, sponsor, and to manage projects. In total, 9 watershed coalitions, 9 local government agencies, four non-profit organizations, one special district, and one state agency directly managed and contributed financially to the watershed flood recovery projects in partnership with CWCB and DOLA. Through these partnerships, the State was able to:

- Directly engage citizens through watershed coalitions to communicate flood risk as well as to have open discussions about project goals, objectives, and limitations.
- Achieve community buy-in on flood recovery projects and allow for projects that span multiple properties to occur.
- Create improved opportunities for tourism and recreation through the implementation of projects.
- Enhance the environment along each stream corridor, resulting in improved stream function, ecology, and wildlife habitat.
- Create opportunities for community and economic development to help communities and the environment recover and bounce forward.

RIGHT: Revegetation and planting during construction at Streamcrest on Left Hand Creek.

THE RELATIONSHIPS ESTABLISHED DURING THIS FLOOD RECOVERY PROGRAM WILL BE INVALUABLE FOR FUTURE DISASTERS.

Recovery Timeline

2013 Floods

From September 9-14, record setting rains caused severe flooding in 10 watersheds along Colorado's Front Range. The flooding resulted in 10 deaths and 4 billion dollars in damage to homes, businesses, and infrastructure.

SEPTEMBER 2013

Emergency Response and Repairs

Immediately following the flood, federal, state, and local agencies implemented emergency repairs to repair and protect property and infrastructure. These repairs reopened roads, repaired water intake structures, mitigated immediate risk, and were temporary in nature.

SEPTEMBER/OCTOBER 2013

Project Identification and Scoping

Following completion of the master plans, the highest priority projects were scoped and funding was sought for implementation. Projects were granted or allocated funding depending on their specific goals and compatibility with funding requirements.

Master Planning Begins

Starting in 2014, master planning began under the CWCB's Watershed Master Plan Grant Program. Master plans brought communities together to discuss project prioritization and implementation. Master plans also provided an opportunity for all stakeholders to form a common vision for their community's recovery.

JANUARY 2014

2015

Design and Permitting

Project-specific design and permitting began in early 2016.

2016

Major Construction Begins

In early 2017, construction began on a majority of the EWP and CDBG-DR flood recovery projects. At the peak of flood recovery implementation, 43 different projects were in construction simultaneously.

JANUARY 2017

Major Construction Completed

Construction was completed on many of the projects by late 2017. Construction of all Colorado Phase II EWP projects was completed by May of 2018. A handful of remaining CDBG-DR Resilience projects will be completed by June, 2019.

MAY 2018

Watershed Coalition Building

The purpose of a watershed coalition is to foster awareness and stewardship of the issues affecting a watershed's health and fosters planning and implementation of projects to address these issues. Coalitions coordinate a common vision and promote community actions that integrate local priorities and concerns. Following the 2013 Colorado flood, it quickly became evident that watershed coalitions would be a critical component in disaster recovery. The CWCB and DOLA encouraged and supported the formation and expansion of ten watershed coalitions through the first year of recovery; these initial coalitions were run entirely by volunteers and stakeholders. Beginning in the summer of 2015, and supported by CDBG-DR Watershed Capacity funding and CWCB Colorado Watershed Restoration Program funds, coalitions were able to hire full- and part-time staff into Watershed Coordinator and Assistant Coordinator positions. Funding of coalition staff through CWCB and DOLA was continued through the summer of 2018 with a smaller round made available through the summer of 2019. Many coalitions will persist beyond the five-year mark as independent entities with a renewed focus on wildfire and flood preparedness.

The role and value of the watershed coalitions to catalyze recovery cannot be overemphasized. Projects demonstrating the holistic vision of the CWCB flood recovery programs came to fruition as a direct result of the hard work and dedication of watershed coalition boards, volunteers, stakeholders, and staff.

RIGHT: Volunteer revegetation work on Fish Creek improvements project in Estes Park. Project implemented by the Estes Valley Watershed Coalition.

THE IMPLEMENTATION OF THESE PROGRAMS HAS CHANGED THE WAY FLOOD RECOVERY WILL BE COMPLETED IN THE FUTURE.

A Model for Other Communities

The flood recovery implementation efforts by the State of Colorado are a model for future disaster recovery programs. Key accomplishments of the programs include:

- Improvements were evaluated beyond political boundaries and implemented in locations local governments are often unable to address, such as on private property, which allowed much larger and more holistic projects to be implemented.
- Every project design focused on geomorphology and ecology, not just hydraulics, lending to complete assessments of the river's problems and possible solutions.
- Capacity was established for future disaster recovery and near future river projects by developing expertise in local government, non-profit watershed coalitions, and within the design community.
- Creative thinking maximized available funding to meet all project needs. Individual federal programs tend to leave funding gaps when trying to develop holistic solutions; coordination between funding programs at the state, local, and federal level were able to address needs and keep projects on schedule.
- Resources were developed for program management, communications and outreach, design, and construction that will become reference and guidance documents to expedite and streamline response in the event of a future flood.
- The programs were developed in a way that allows for long-term effectiveness monitoring of projects.

LEFT: Post construction photo of Wall Street project on Fourmile Creek implemented by the Fourmile Watershed Coalition.

Enhancing the Environment

Enhancement of ecological function was a foundational goal of each project and was incorporated into the concepts and design at the onset of project scoping. Depending on the location, enhancement of ecologic function could mean the creation of in-stream habitat for native fish; the creation of in-stream, wetland, and floodplain habitat for macroinvertebrates, amphibians, and zooplankton; diversification of the plant communities; installation of pollinator-friendly flowers; and/or floodplain and riparian habitat for sensitive species such as Preble's Jumping Mouse. Guiding principles established for the implementation of Colorado Flood Recovery projects included:

- Incorporation of bioengineering techniques which rely on the integration and strength of vegetation.
- Channel sections that considered the hydrology and hydraulics for low flows, annual flows, and flood events and how fish species would be able to use the creek at all these water levels.
- Aquatic, riparian, and terrestrial habitat enhancement using plants and other native materials.
- Revegetation with native plant species in abundance and diversity, including those lost years ago to grazing.
- Removal of invasive species, such as crack willow (salix fragilis), that created debris blockages during the flood.

RIGHT: Container stock awaiting planting at a flood recovery project site. Plants were grown specifically for flood recovery implementation in partnership with the Colorado State Forest Service. On a majority of projects, river and stream bank treatments were constructed using live vegetation as a structural component. Collectively, these types of treatments are referred to as "bioengineering".

Colorado Storage for Riparian Seeds

The CWCB is working with Colorado State University and Colorado State Forest Service to purchase a cold storage facility for riparian seeds. The facility will enable the State of Colorado to collect, store, maintain, and, in the event of an emergency, provide a location-specific seed mix for soil stabilization. Additionally, the seed storage unit will promote re-introduction of regionally adapted plants in areas will they have evolved to thrive.

Flood Recovery Master Planning

The watershed master plan grant program was created to guide watershed coalitions and communities towards prioritization and implementation of stream restoration projects that reduced flood and geomorphic hazards and improved ecological conditions within the flood-impacted rivers.

The master plans defined each watershed's vision for recovery and enhanced the community's understanding of the river corridor and associated risks. Conceptual designs and cost estimates were developed and prioritized for projects aiming to reduce damage from future flood events; provide long-term support of recreational, educational, and economic opportunities in the river corridor; and promote functional fish, wildlife, and native riparian plant communities. Through education and outreach, the master planning process fostered consensus-driven and technically sound solutions that formed the foundation for project implementation.

Funding for this program was made available through a special release of the CWCB Colorado Watershed Restoration Program. Nearly $2 million was made available for master planning, and it was matched equally by the local watershed coalitions.

ABOVE: Master plan alternatives development on Fish Creek in Estes Park.

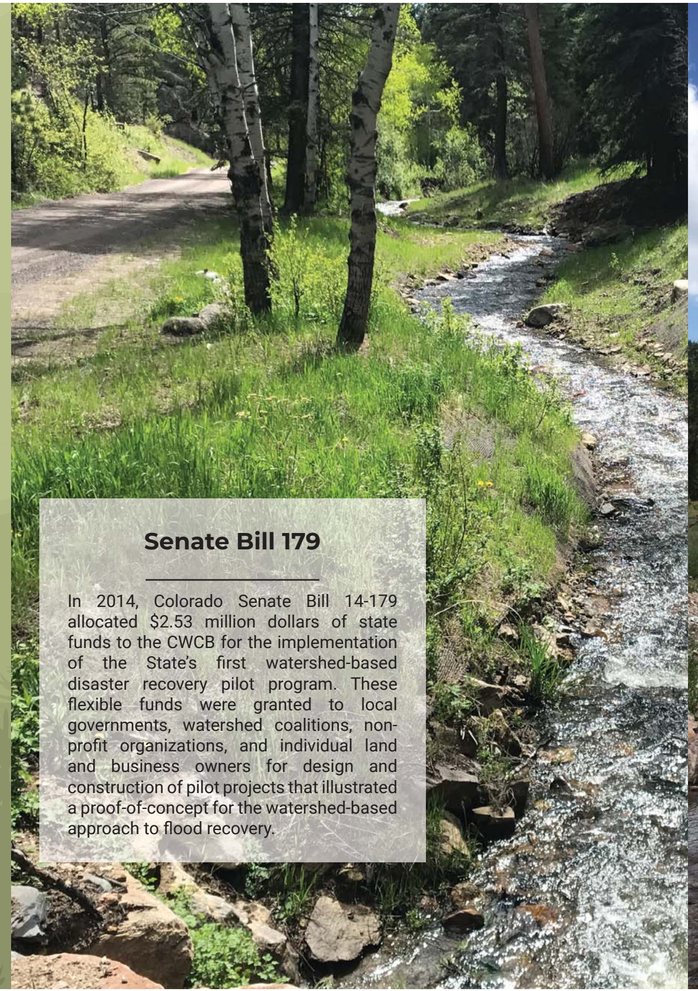
Colorado Emergency Watershed Protection (EWP) Program

The Colorado Emergency Watershed Protection (EWP) Program, as run by the CWCB, is a large-scale recovery program intended to protect life and property and rebuild functional river systems. Funding was allocated to the Natural Resources Conservation Service (NRCS), a part of the United Stated Department of Agriculture (USDA), and the program was managed and administered by the CWCB. Federal funding provided reimbursement for 75% of all construction related costs. The CWCB also served as a state-wide sponsor for every implemented project, providing 12.5% of the program's construction costs. Organizations such as watershed coalitions, local governments, and conservancy districts were then contracted to be local sponsors with a responsibility to provide the final 12.5% of the project's construction costs and to carry out the work. CWCB's management of the $70 million program began in the summer of 2015 and ended in the summer of 2018.

The program implemented recovery measures in nine watersheds impacted by the 2013 Colorado flood. In just three years, the Colorado EWP Program identified, scoped, designed, permitted and implemented 67 flood recovery projects to reduce erosion, stabilize streambanks, remove sediment and debris, provide soil stabilization and rehabilitate damaged wildlife and aquatic habitat.

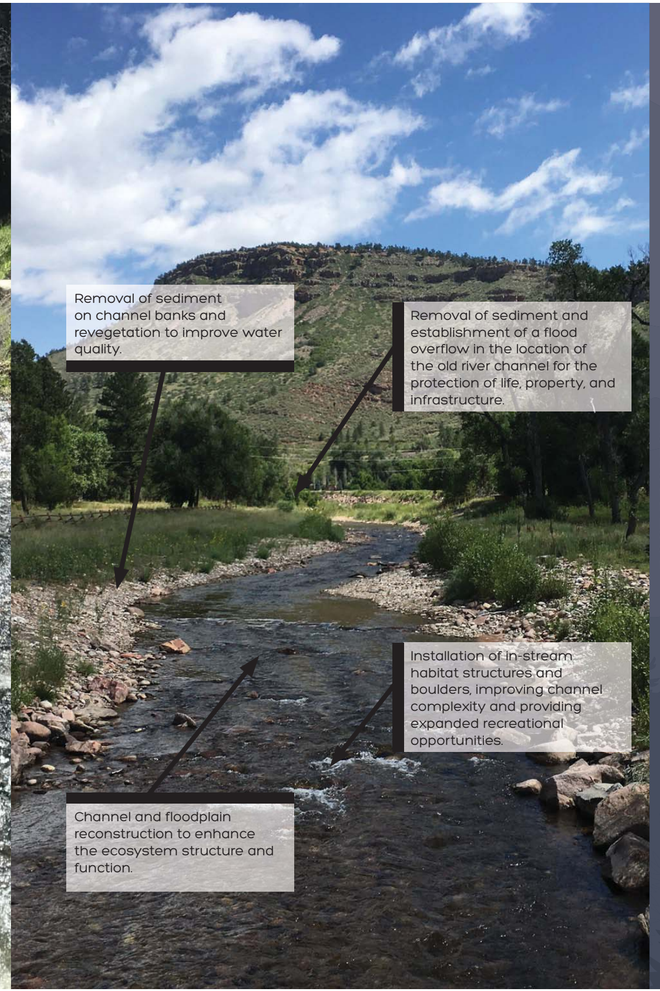
COLORADO EWP

RIGHT: Fox Creek at Glen Haven. Project implemented by Larimer County in partnership with the Big Thompson Watershed Coalition.



Senate Bill 179

In 2014, Colorado Senate Bill 14-179 allocated $2.53 million dollars of state funds to the CWCB for the implementation of the State's first watershed-based disaster recovery pilot program. These flexible funds were granted to local governments, watershed coalitions, non-profit organizations, and individual land and business owners for design and construction of pilot projects that illustrated a proof-of-concept for the watershed-based approach to flood recovery.



POST PROJECT

Multi-Objective Goals and Outcomes

The overall goal of the Colorado flood recovery programs was to implement watershed recovery projects that reduced risk to life and property, enhanced riparian ecosystems, provided community and economic development outcomes, and generated long-term stream system resilience through a collaborative process that incorporated the needs of diverse stakeholders.

The Colorado Watershed Flood Recovery programs achieved multi-benefit outcomes including:

- Protection of:
  - Life, property, and infrastructure
  - Home access
  - Affordable housing
  - Public facilities
  - Vulnerable human populations
- Mitigation of flood risk
- Engagement of local community
- Enhancement of ecosystem structure and function
- Bolstering economic development and economic diversity
- Expanding recreational opportunities
- Improvements to water quality
- Protecting water supply
- Improvements to natural area access to benefit physical/psychological health
- Creation of more resilient land-use patterns

LEFT: River improvements on North St Vrain Creek at Apple Valley implemented by the St. Vrain Creek Coalition.

A Watershed Approach to Flood Recovery and River Management

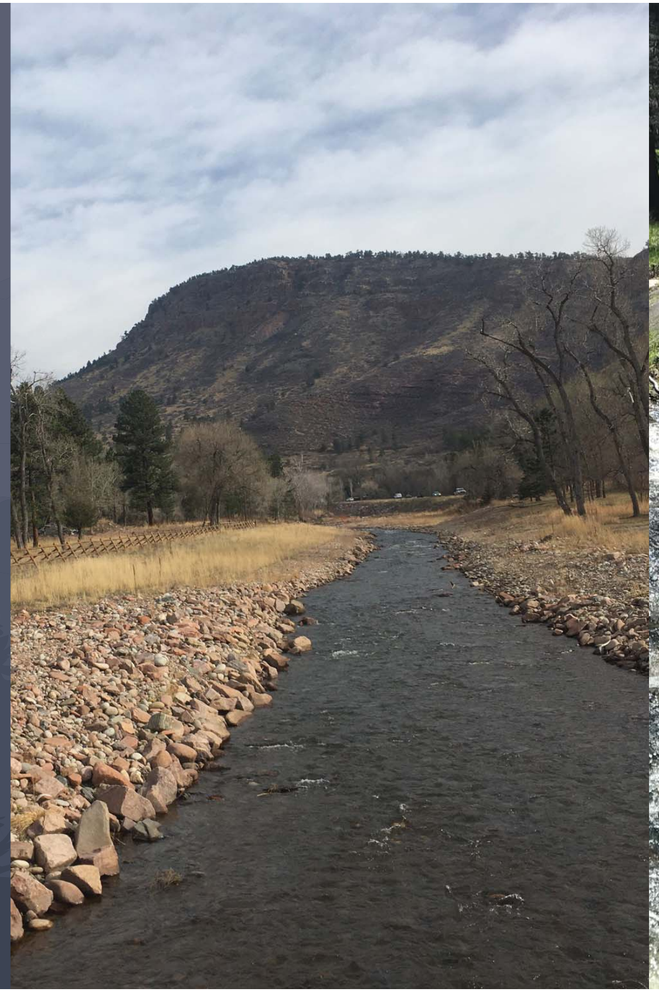
Doing good work in river corridors requires the fundamental understanding that all actions are connected. In our recent past, flood mitigation projects have been "band-aid" solutions that address the symptoms of a problem, but do not work toward solving the problems itself. These programs are different.

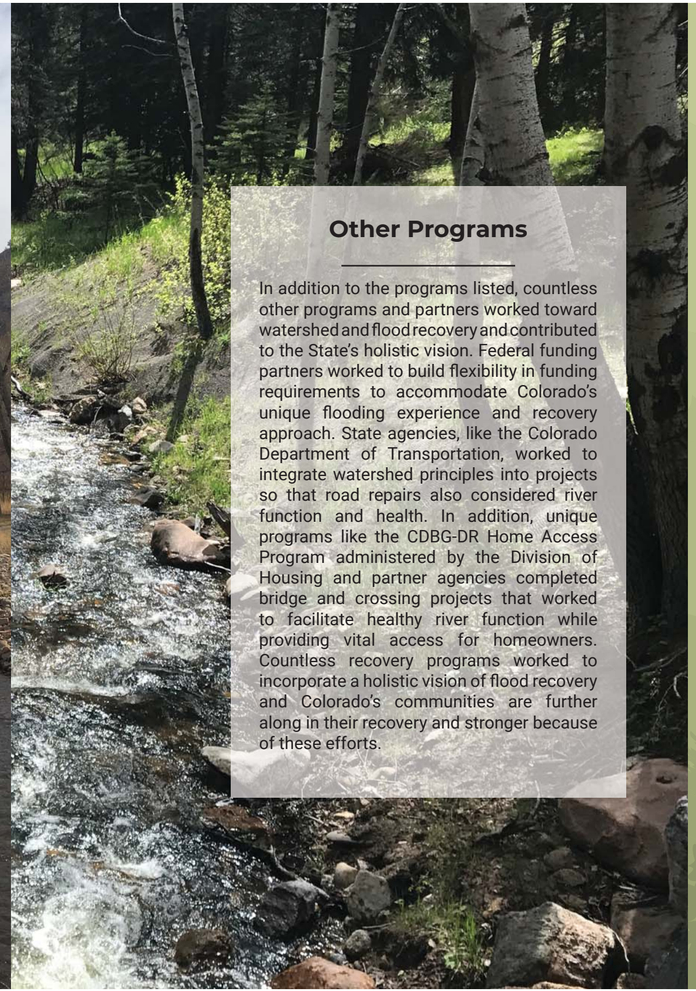
Project concepts were created carefully, such that physical and ecologic concerns were addressed at their foundation. Care was taken to ensure that proposed solutions did not transfer problems to adjacent properties or to downstream communities. For example, raising an embankment and installing a rock facade on one side of the river does not solve the problem of erosion—it merely transfers the erosion to the other side of the river or to a softer bank downstream.

Most unique to the Colorado Flood Recovery programs was the guiding principle of using natural geomorphic processes and river function as the basis for providing flood mitigation. This design approach incorporated planned depositional zones, natural woody materials, extensive vegetation and biostabilization, as well as provided space for the river to move where there is room. These programs are intended to replace traditional flood management strategies that failed on a grand scale in 2013. Rather than rebuilding with the same failed strategies Colorado took this very costly and tragic event to recover utilizing the latest science and a grander vision for how rivers function in our landscape acknowledging that we can better learn to live with and interact with these critical, dynamic systems.

RIGHT: North St. Vrain Creek at Apple Valley following emergency repairs and prior to Phase II EWP/CDBG-DR project.

POST EMERGENCY WORK





Other Programs

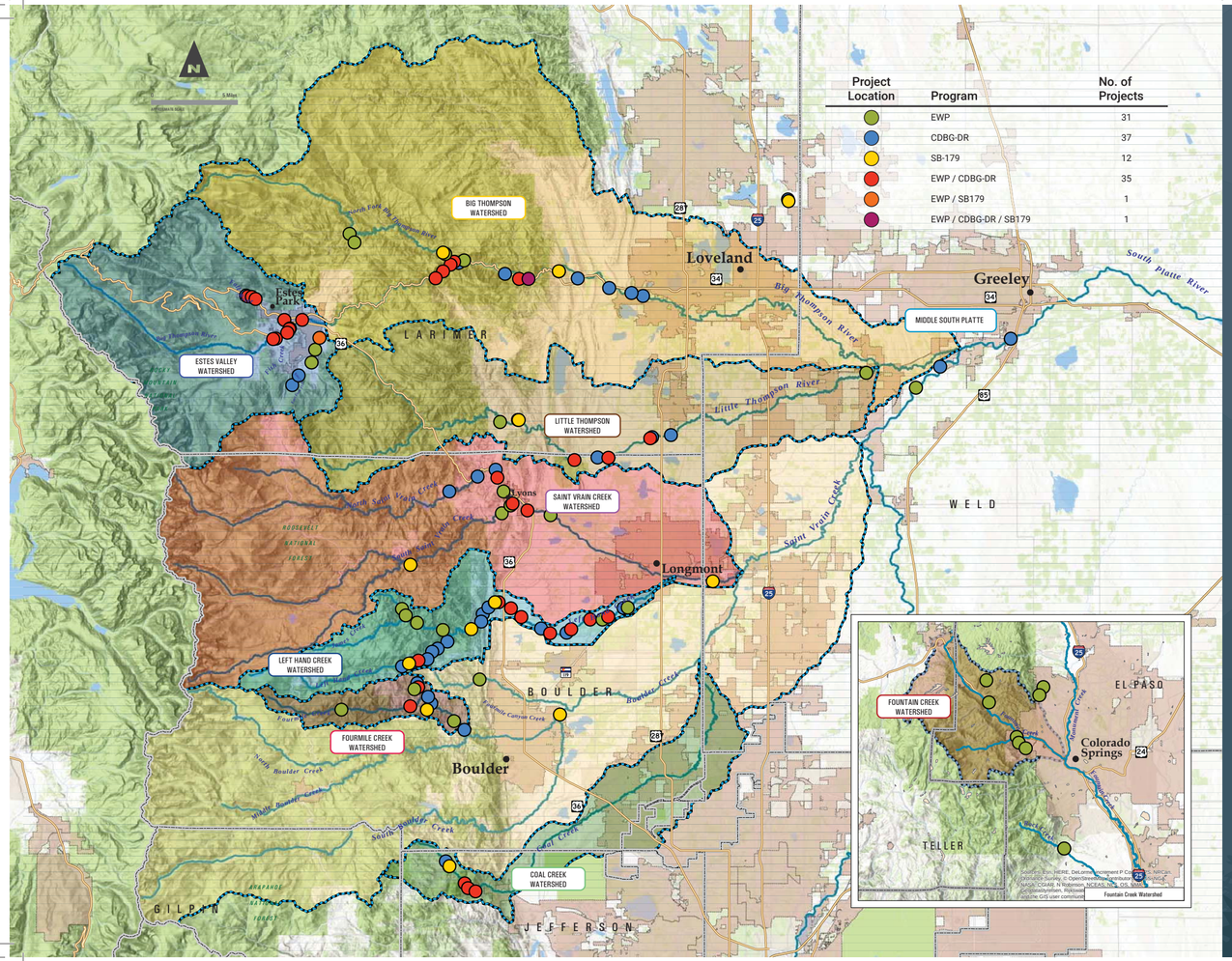
In addition to the programs listed, countless other programs and partners worked toward watershed and flood recovery and contributed to the State's holistic vision. Federal funding partners worked to build flexibility in funding requirements to accommodate Colorado's unique flooding experience and recovery approach. State agencies, like the Colorado Department of Transportation, worked to integrate watershed principles into projects so that road repairs also considered river function and health. In addition, unique programs like the CDBG-DR Home Access Program administered by the Division of Housing and partner agencies completed bridge and crossing projects that worked to facilitate healthy river function while providing vital access for homeowners. Countless recovery programs worked to incorporate a holistic vision of flood recovery and Colorado's communities are further along in their recovery and stronger because of these efforts.

Watershed Resilience Pilot Program

The Watershed Resilience Pilot Program is a holistic program designed to align watershed restoration and risk mitigation with community and economic development goals using a collaborative, multi-jurisdictional, coalition-of-partners approach. Funding for the program comes from the Department of Housing and Urban Development (HUD) via the Community Development Block Grant - Disaster Recovery (CDBG-DR) Program.

These watershed program funds supported capacity building through watershed coalition staffing; multi-objective planning, modeling, and conceptual design activities; and project implementation. The goal of all project work is to protect life and property while building resilience and achieving community and economic development outcomes in watersheds that sustained damage from the 2012 and 2013 federally-declared fire and flood disasters. This work was completed in coordination with the CDBG-DR Resilience Planning Program, which funded design work as well as community and landowner tools such as the Resilient Crossings Handbook and Stream Stewardship Handbook.

DOLA administered these funds in partnership with CWCB. Approximately $36 million was made available for watershed recovery work, including nearly $4 million targeted for agricultural ditch repair projects. All funded projects were prioritized through watershed coalitions. Approximately 80% of funds were allocated to the hardest-hit counties of Boulder, Larimer, and Weld.



By the Numbers

- ***117*** total flood recovery projects completed
- Total construction costs of over ***$70 million***
- Over ***$270 million*** in avoided short-term damage to infrastructure and private structures
- ***65 miles*** of river and floodplain improvements implemented
- ***12*** watershed master plans finalized
- ***34*** resiliency planning studies completed
- ***23*** comprehensive recovery planning studies completed
- Over ***700*** private property owners engaged
- DOLA awarded ***$4.2 million*** across 10 coalitions for capacity building staffing grants. CWCB supplemented this with an additional $400,000. Most coalitions received support for two full-time staff for over 3 years.

RIGHT: Construction of the North 41st Street project on Left Hand Creek, implemented by the Left Hand Watershed Oversight Group.