Recovering from the Flood: Building Better by Working with Nature

Boulder County Parks & Open Space

Sharla Lovern - Project Engineer
Prashant KC - Project Engineer
Obadiah Broughton - Planner
Ernst Strenge - Senior Planner

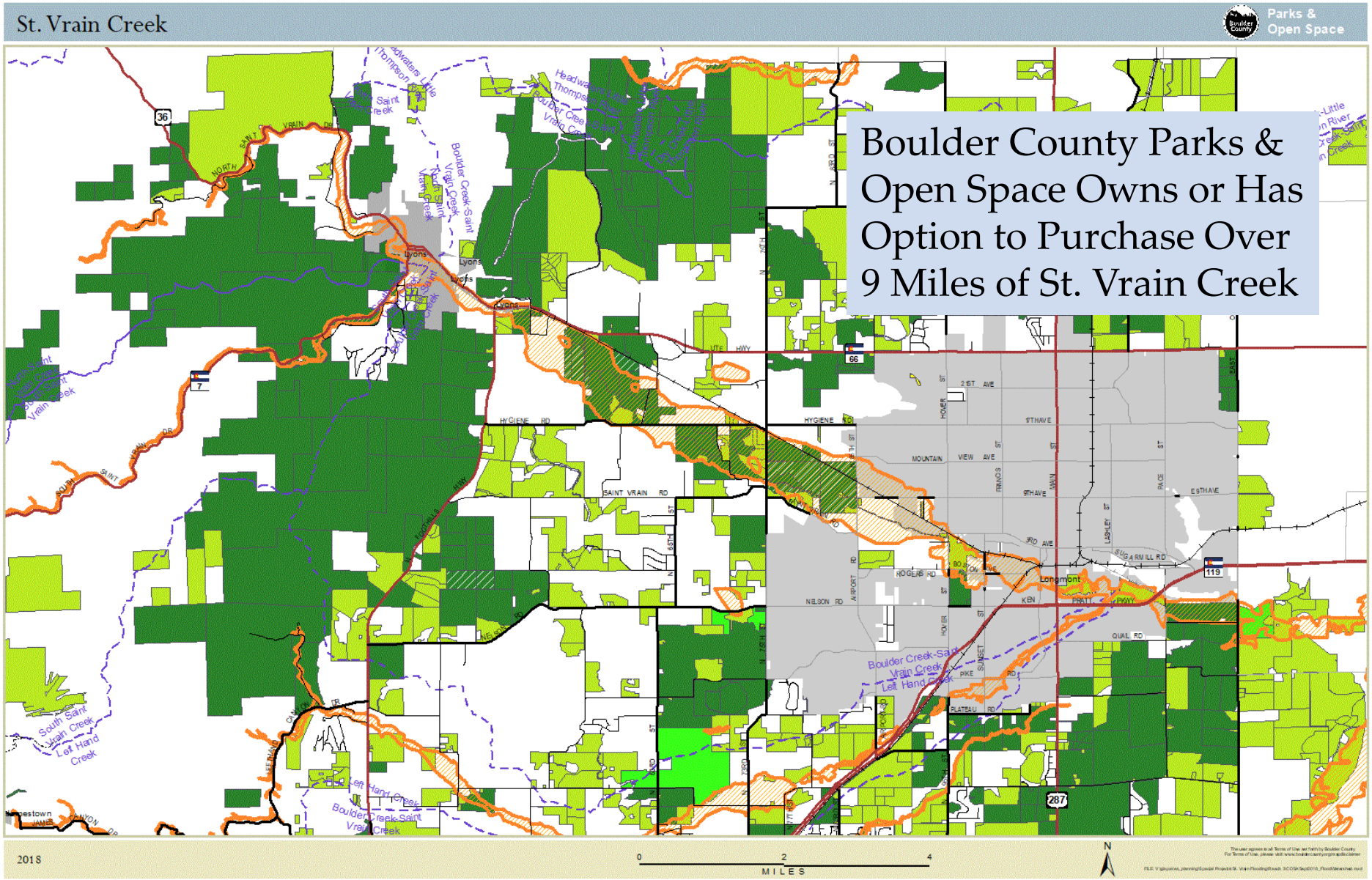
Recovering from the Flood

1. Overview of Flood and Post-Flood Planning
2. Flood Recovery Projects
   - South St. Vrain Creek
   - St. Vrain Creek
3. Challenges, Opportunities, and Lessons Learned
4. Q&A

Flood Statistics

- 1000-year rain event / 200+ year flood event
- 18+ inches of rain over 10 days
  - Average 20.5 inches per year
- St Vrain peaked at 28,500 CFS in Longmont
  - Equal to 12,791,688 GPM
  - 1 CFS equal in size to a basketball

2013 Flood Footprint



Timeline

Emergency Response

September 2013

Immediate Threat Assessment and Mitigation

September 2013 – Spring 2014

Long-Term Vision and Prioritization

Watershed Master Plans (2014)

Waterways & Stream Teams

Flood Recovery Projects

2014 – 2021?

Planning & Project Overview

- Damage Assessments
- Planning
  - Internal discussions and prioritization
  - St. Vrain Creek Watershed Master Plan
  - Public meetings and site visits
- Planning Considerations
  - Public safety
  - Public & private property and infrastructure
  - Habitat, species of concern, and environmental
  - Trails and public access
  - Cultural resources
  - Water infrastructure - reservoirs & ditches
  - Agriculture – fences, pastures, water delivery
  - POS management plans & long-term objectives

Planning & Project Overview

- Collaboration and Partnerships
  - Local, state, and federal agencies
  - St. Vrain Creek Coalition, ditch & water, stakeholders
  - Communities and neighbors
- Temporary vs Permanent Repairs
- Funding
- Permitting
- Construction
- Maintenance & Monitoring

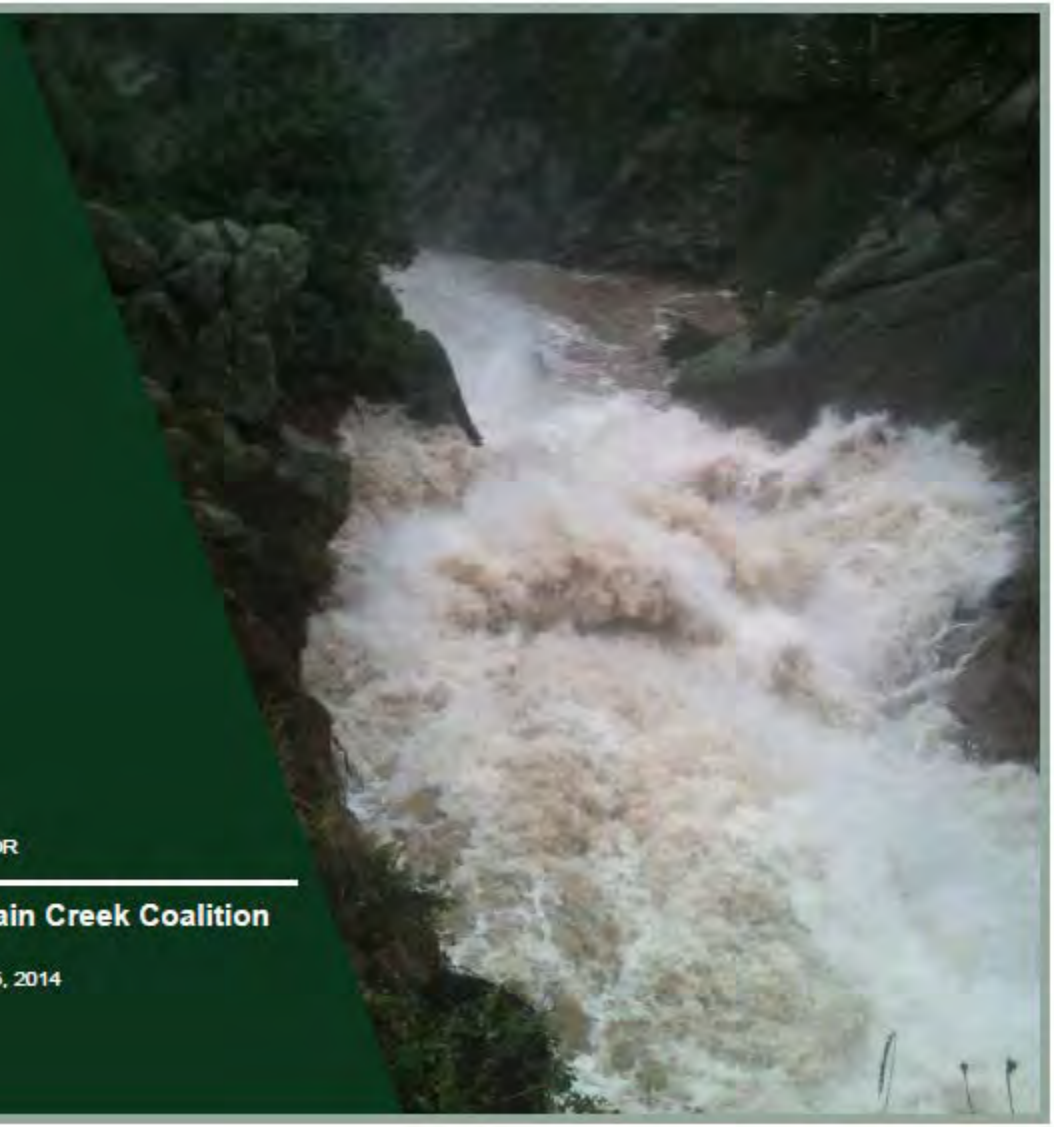
Assessments & Priorities

- What happened, where do we begin, how do we repair, and how do we pay for it?






St. Vrain Creek Watershed Master Plan



PREPARED BY

Baker

CDR ASSOCIATES

S2O Reinventing Whitewater

Walsh Environmental Scientists and Engineers, LLC

PREPARED FOR

The St. Vrain Creek Coalition

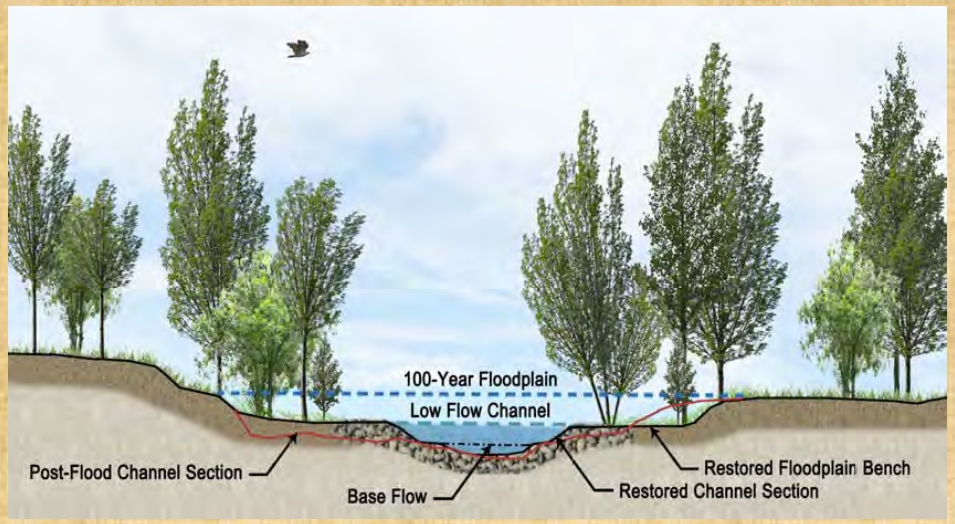
NOVEMBER 25, 2014

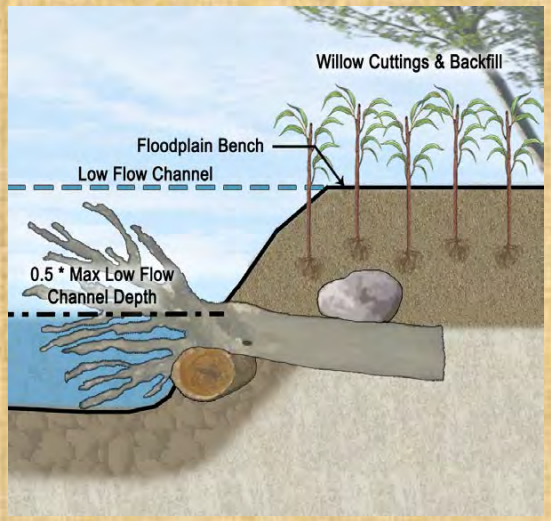
St. Vrain Creek Watershed Master Plan

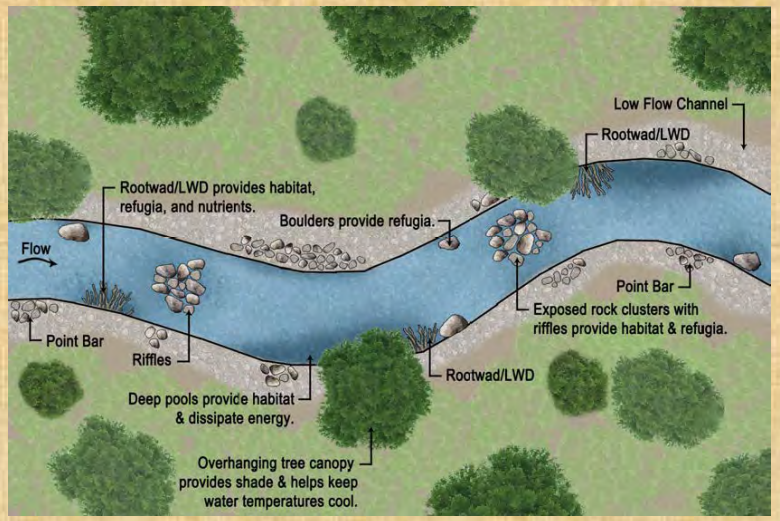
- Watershed-level Planning
- "Roadmap for long-term recovery"
  - Geomorphic and Ecological Assessments
  - Public Engagement
  - Conceptual-level Designs
  - Project Prioritization

Infrastructure Protection

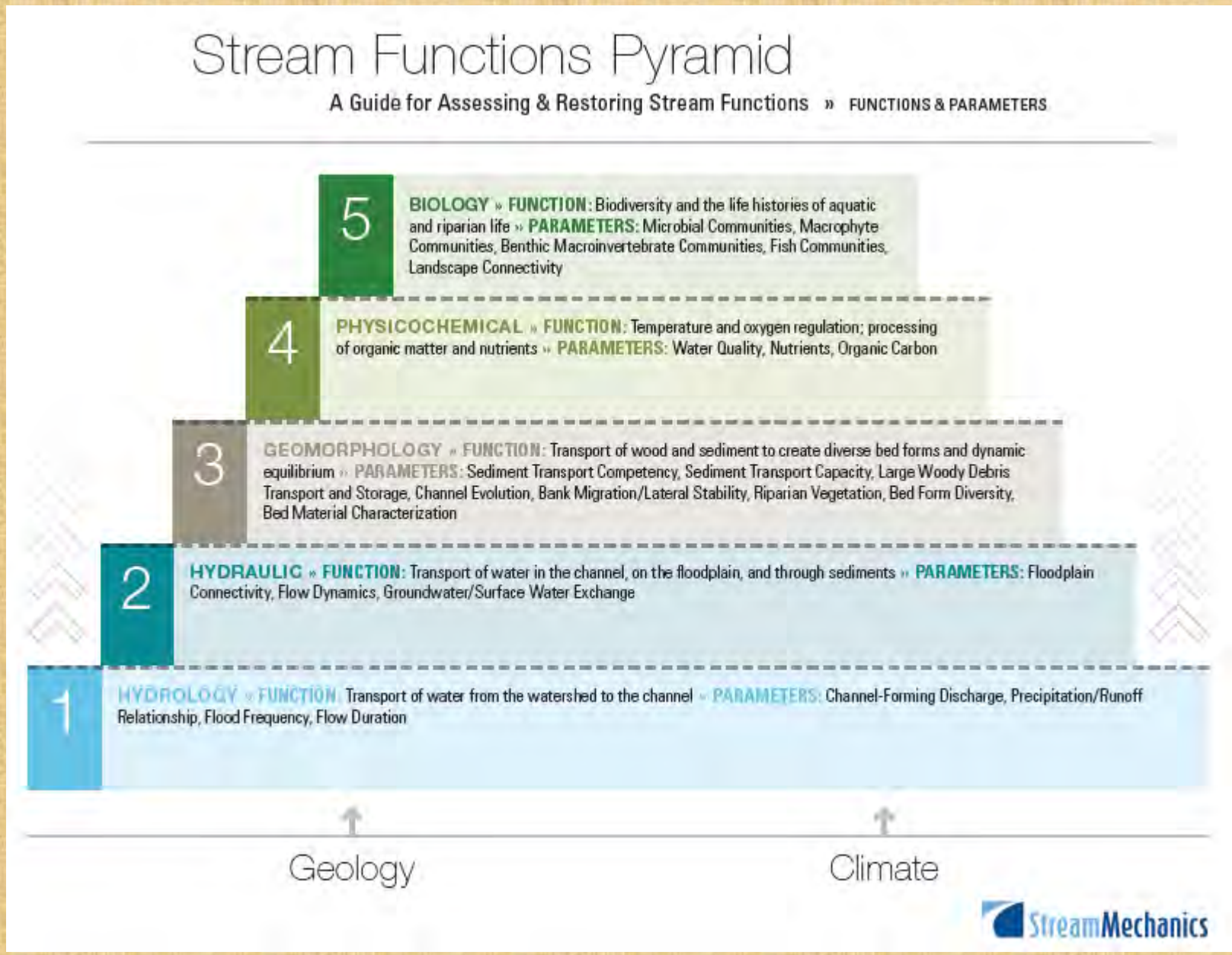
Natural Channel Design







- Images from *St. Vrain Creek Watershed Master Plan*. (Michael Baker Jr. et. al, 2014)



Harman, W., R. Starr, M. Carter, K. Tweedy, M. Clemmons, K. Suggs, C. Miller. 2012. *A Function-Based Framework for Stream Assessment and Restoration Projects.* US Environmental Protection Agency, Office of Wetlands, Oceans, and Watersheds, Washington, DC EPA 843-K-12-006.

CSU Water Center Collaborative Project

WOOD: Windows Of Opportunity for Debris Retention in Response to 2013 Front Range Flooding

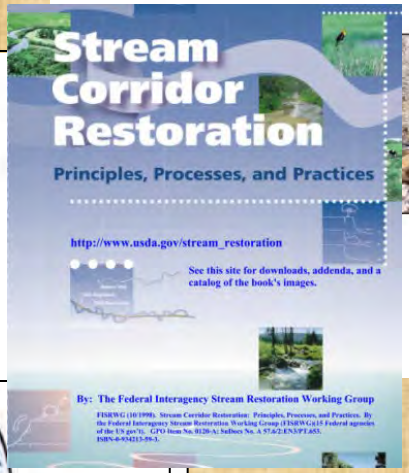
PIs: Ellen Wohl, Brian Bledsoe, Kevin Bestgen, Mike Gooseff, Kurt Fausch

Objective: To
wood entrain
for future ma

Recent Conte
during Sept.
management
Substantial a
along river co
Poudre River
are proceedi
Natural Area
wood, but la
departments

Part 654
National Engineering Handbook

Stream Restoration Design



River Corridor Protection and Management

FACT SHEET

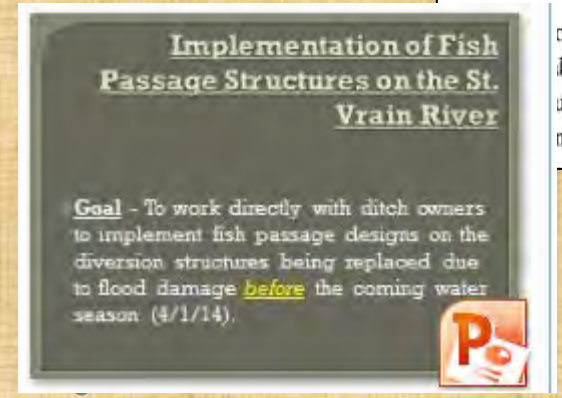
Colorado Water Conservation Board

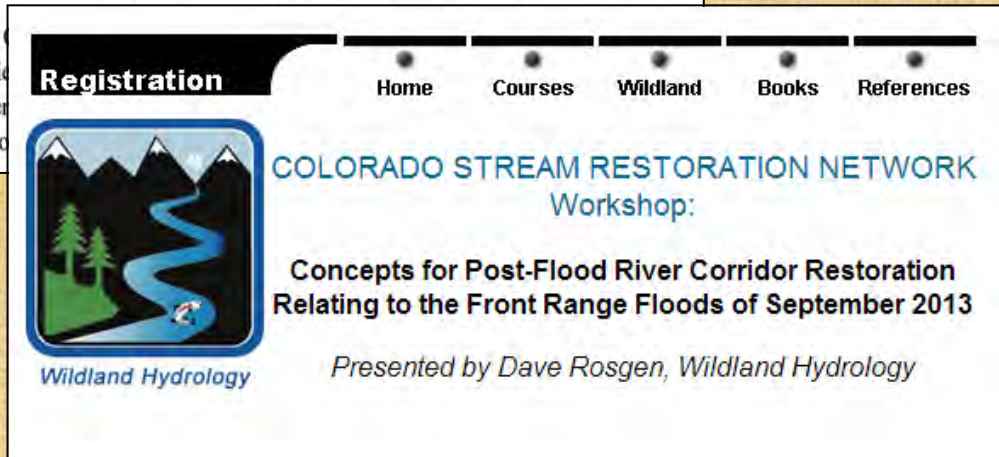
Overview

For most early se
and transport out
Colorado's water
warnings from pe
addition to thous
estimates that ap
located in Colora

REBUILDING FLOOD-DAMAGED DIVERSION STRUCTURES TO BENEFIT MULTIPLE USES

o Parks and Wildlife (CPW), the
keholders can assist municipaliti
ucting flood-damaged water diver
ns while providing for fish and bo





Large Wood

- Salvaged from creeks post-flood to reduce hazards
- Stabilizing and environmentally beneficial restoration tool

Species Conservation

Native Colorado Fish

- Plains Topminnow, Common Shiner (CPW Threatened), Iowa Darter (CPW SSC), Stonecat (CPW SSC)
- St. Vrain Creek is one of best Front Range habitats
- Collaborating to retain species
- Shallow backwaters, side-channels, fish passage and bioengineering structures

Iowa darter

Preble's Meadow Jumping Mouse

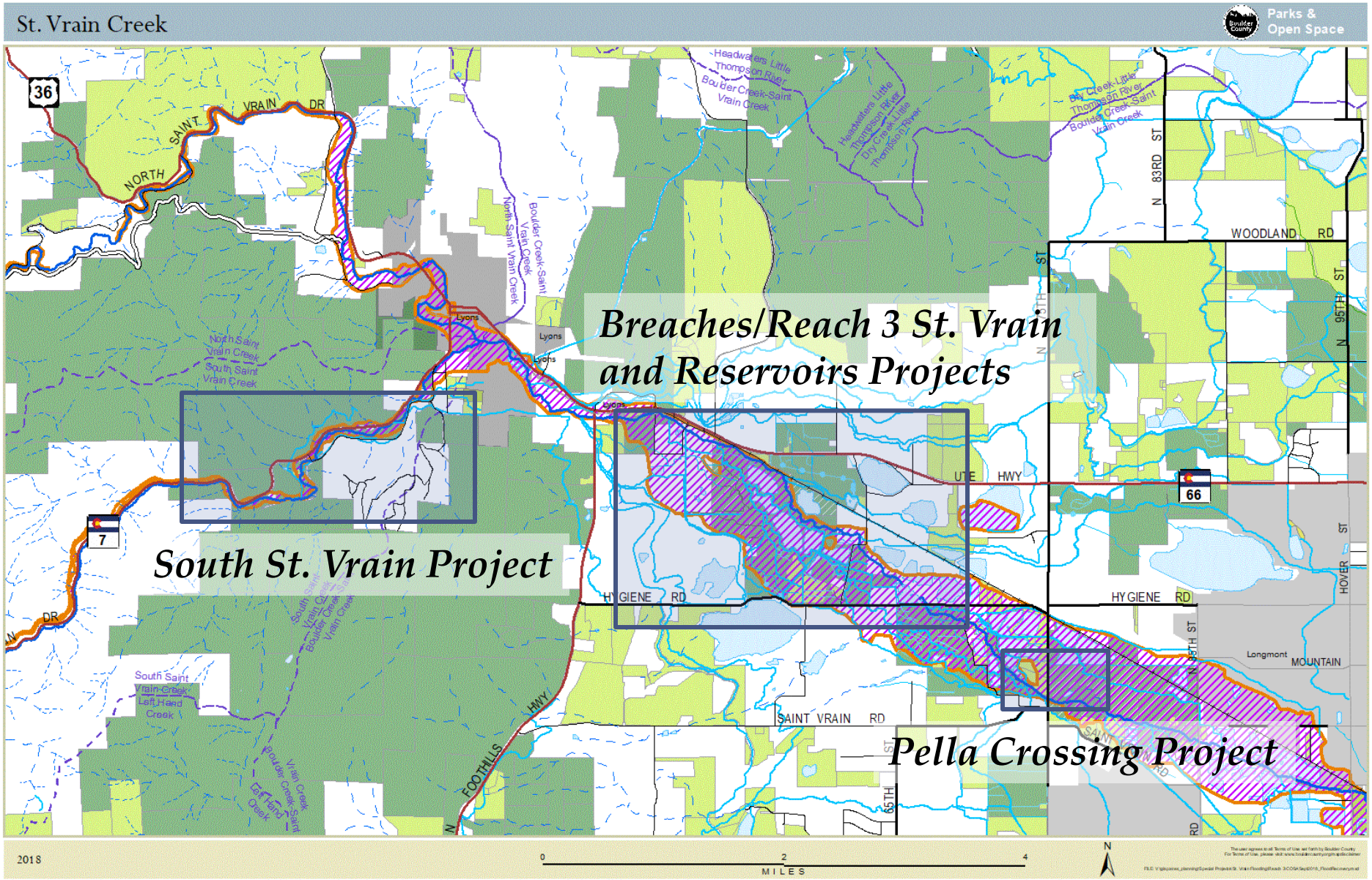
- St. Vrain occupied habitat
- USFWS conservation measures
- Creek access and equipment staging
- Restoration of habitat

Native Plants and Revegetation

Funding

- FEMA Public Assistance
- Department of Local Affairs
  - Community Development Block Grant – Disaster Relief
- Natural Resource Conservation Service
- State of Colorado
- Boulder County

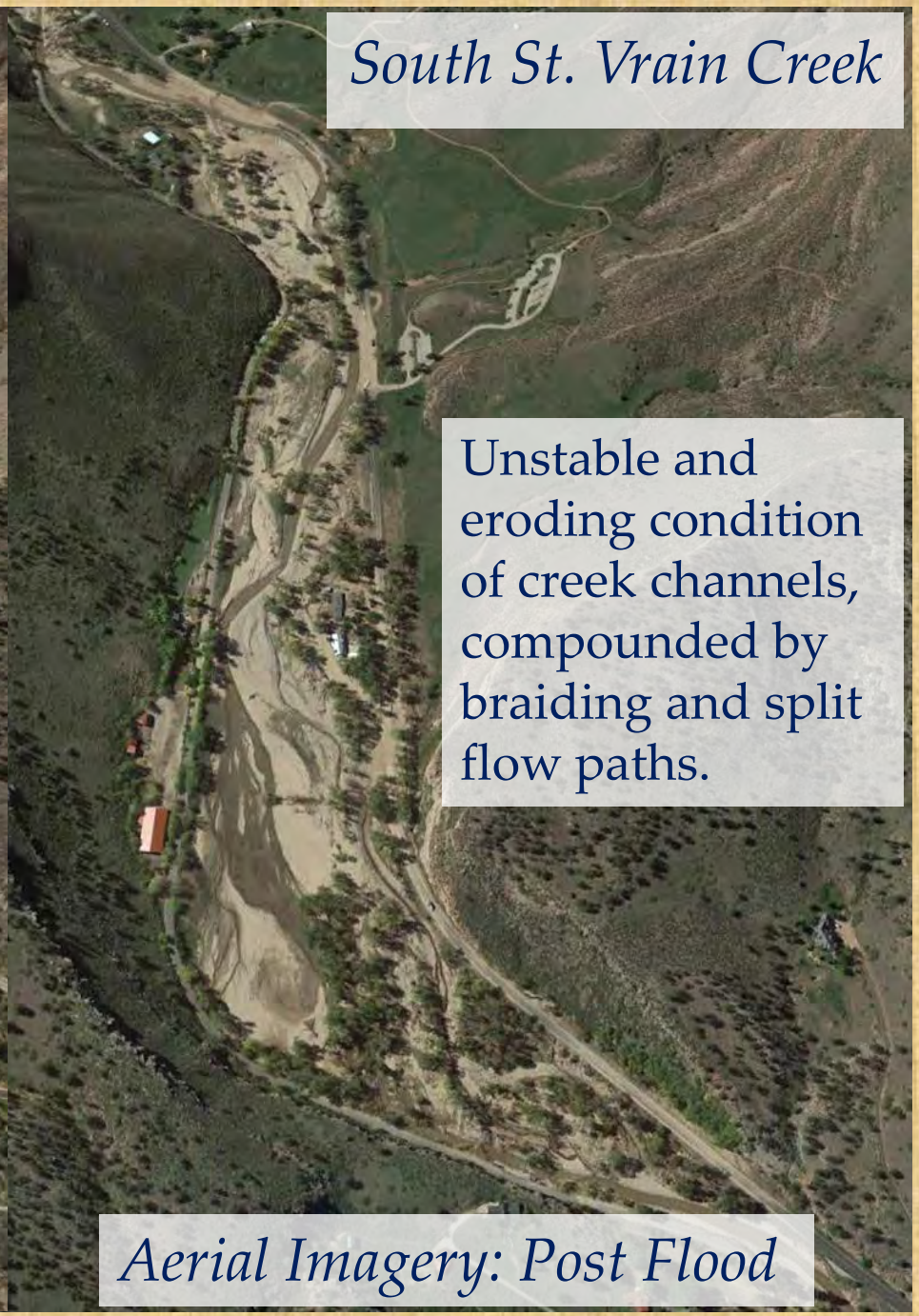
Projects


St. Vrain Creek
Parks & Open Space
Breaches/Reach 3 St. Vrain and Reservoirs Projects
South St. Vrain Project
Pella Crossing Project
Lyons
HYGIENE RD
SAINT VRAIN RD
WOODLAND RD
UTE HWY
FOOTHILLS HWY
Longmont
MOUNTAIN
2018
MILES

Recovering from the Flood

South St. Vrain Creek

Aerial Imagery: Pre Flood



South St. Vrain Creek

Unstable and eroding condition of creek channels, compounded by braiding and split flow paths.

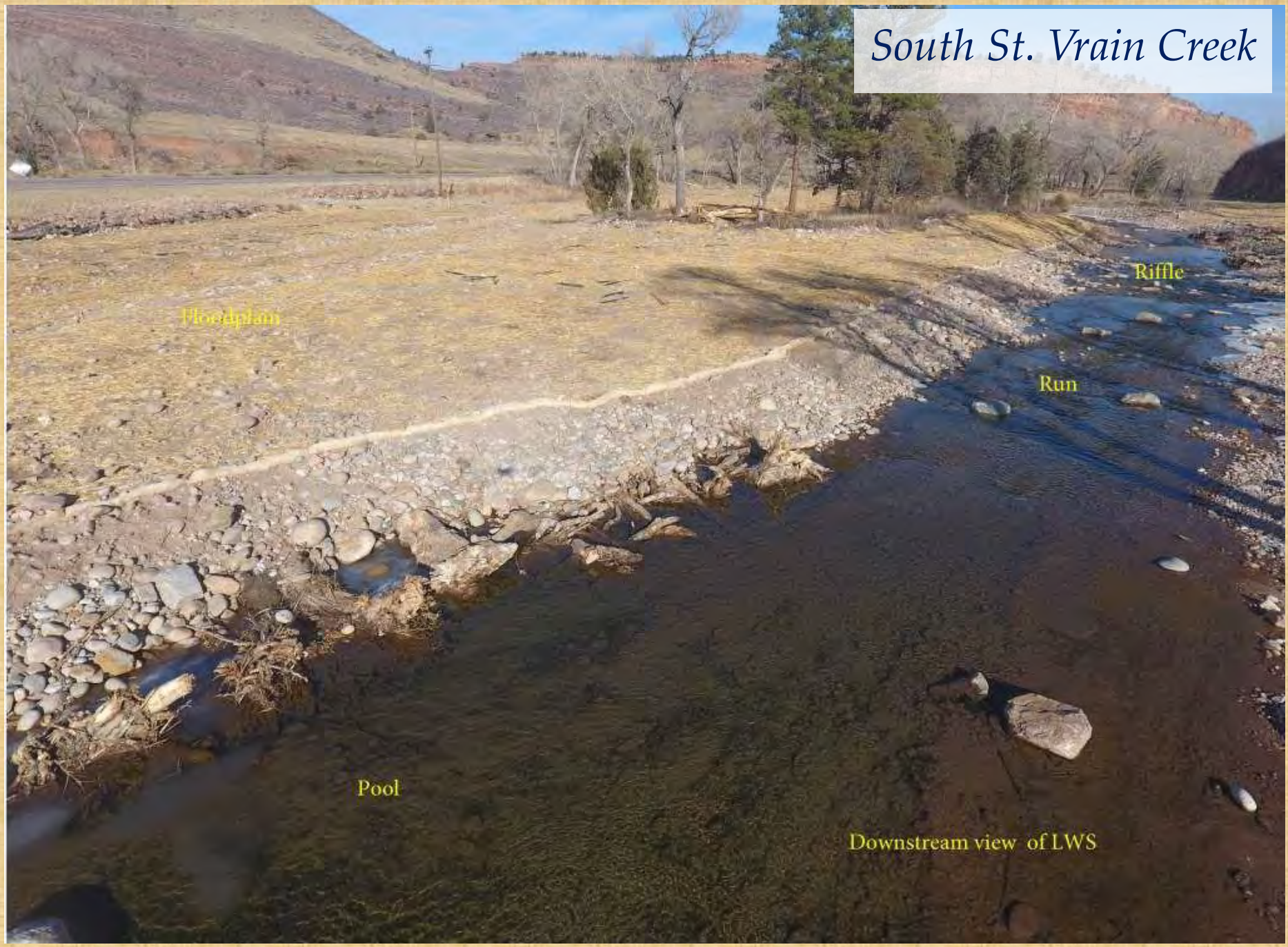
Aerial Imagery: Post Flood


Aerial Imagery:
Post Flood
Post Construction
South St. Vrain Creek


LATERAL CONNECTIVITY
South St. Vrain Creek
Over flow channel A
FloodPlain
Over flow channel B
Main Channel
Extensive grading across alluvial fan for lateral connectivity and flood retainage.


South St. Vrain Creek
CHANNEL DIVERSITY
Riffle
Bed roughness
Low flow channel
Large Woody Structure
Cross section Transitions
Pool
Bank Contour
Riffle

South St. Vrain Creek


South St. Vrain Creek
Riffle
Floodplain
Run
Pool
Downstream view of LWS


South St. Vrain Creek
POOL
Large Woody Structure designed for bank protection and habitat values
Each LWS comprises 8-9 specified logs designed individually and configured to act as a cohesive unit at different flow conditions

South St. Vrain Creek

Looking Upstream: Re-aligned meandering channel planform to dissipate flow energy.

Overflow channel crest set at different elevation relative to main channel and activates at different flood events.

Extended riffle crest flooplain sill to limit flow profile migration.

Extended riffle face to generate flow energy to scour pool improving flow conveyance and sediment transport.

OFC sill stabilizes it's alignment.

Engineered Large woody structure installation at prioritized locations to intervene flood flow and flood debris

South St. Vrain Creek

South St. Vrain Creek: Main Channel Re-alignment

Segment of main channel re-alignment:
before, during, and after construction

South St. Vrain Creek: Floodplain Large Wood Structures

Active construction of the Type 5 Large Woody Structures

South St. Vrain Creek: Overflow Channel Stabilization

- Looking upstream during flood (top left)
- During construction (top right)
- After construction (bottom left)

South St. Vrain Creek: Instream Large Wood Structures

Type 2 Large Woody Structures:
during construction and completed

South St. Vrain Creek: Riffle Crest

Placement of rock mix

Floodplain sill key-in

South St. Vrain Creek: Revegetation

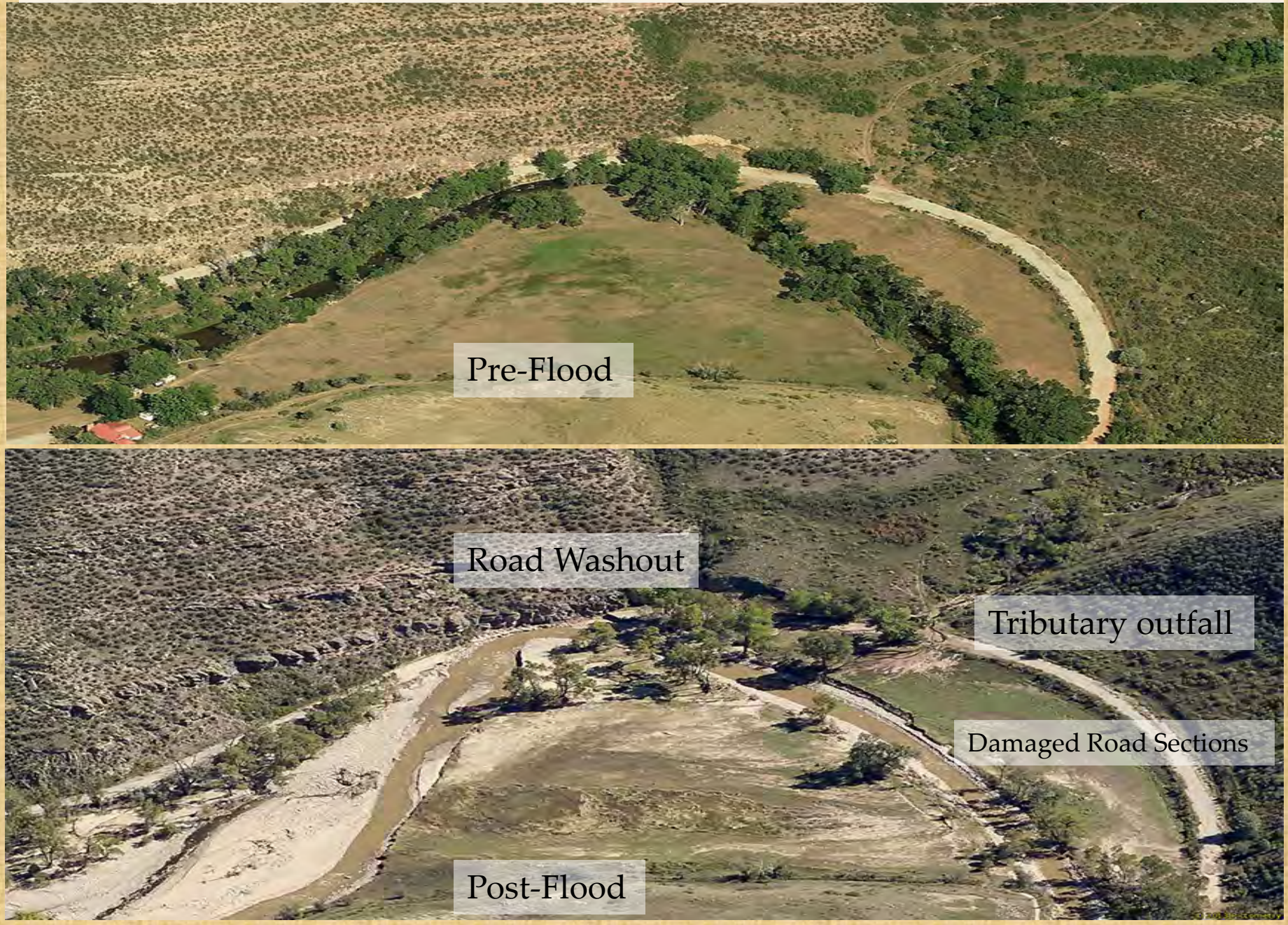
Perennial tubelings installation in overflow channel

South St. Vrain Creek: Revegetation

Progression of vegetation establishment

South St. Vrain Creek: Revegetation

Hall Ranch II Road Repair and Hazard Mitigation Project



Hall Ranch II Road Repair and Hazard Mitigation Project

Damage:

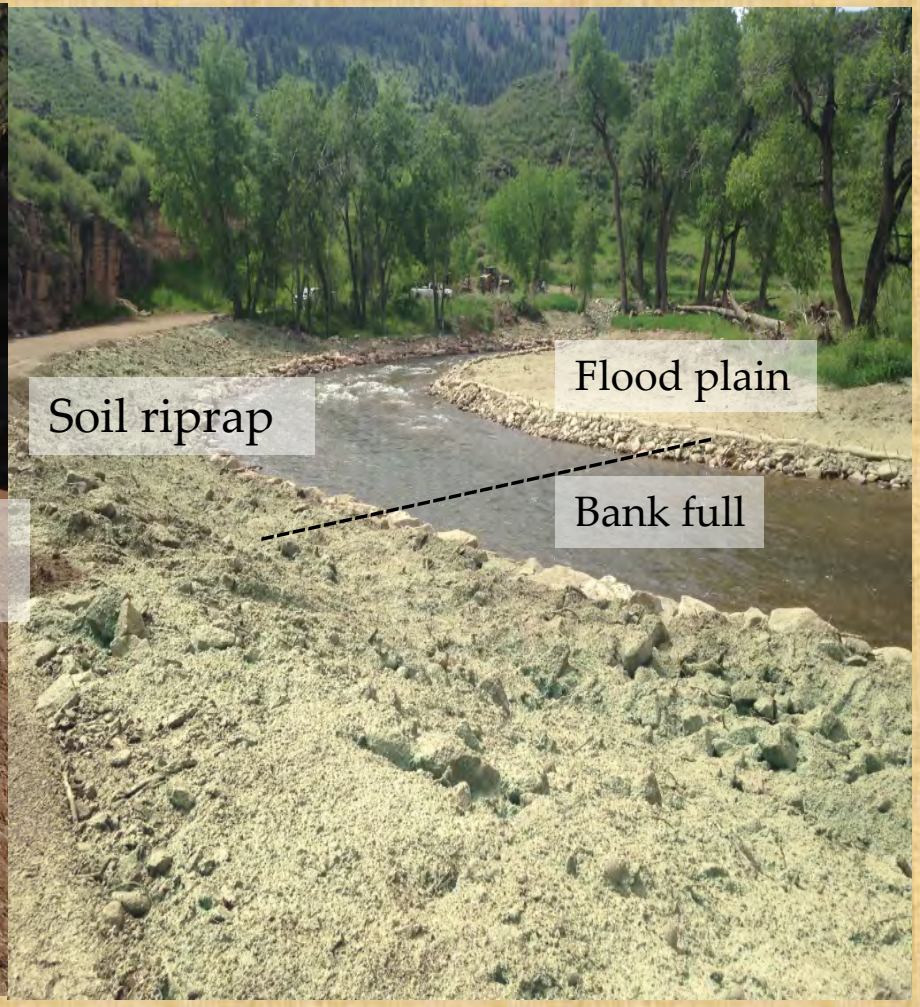
- volume of water
- velocity of water
- amount of sediment and debris

Hall Ranch II Road Repair and Hazard Mitigation Project

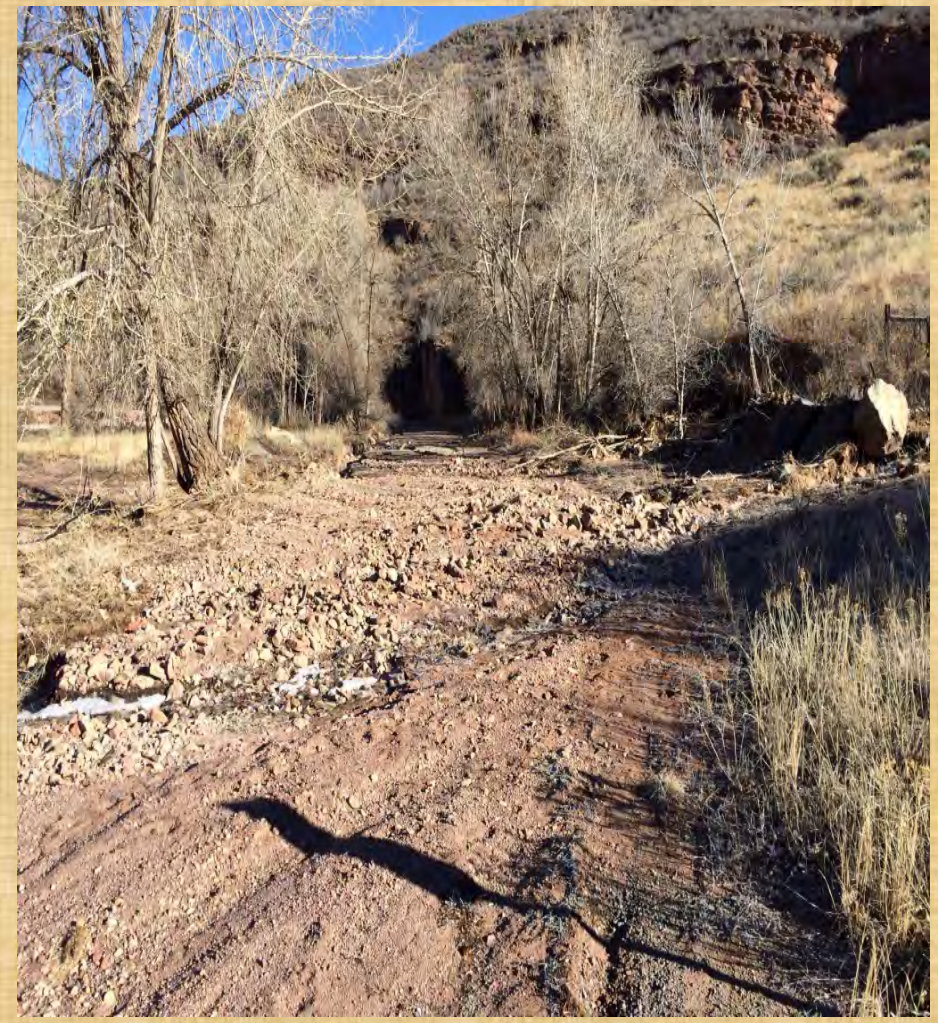
Looking Downstream

Looking Upstream

Hall Ranch II Road Repair and Hazard Mitigation Project



Tributary



- Eroded gullies through the road surface and sub-base

Active Construction

Placement of RCP elliptical culverts and concrete low water crossing with ditch downstream directing tributary flow to stabilized outfall to South St. Vrain Creek.

Access Road

Pre-flood

Post-flood

Access Road: Active Construction

High concentrated flows damaged culverts, caused debris flows across the road and clogged roadside ditches.

Surface and compact road with Aggregate Base Course

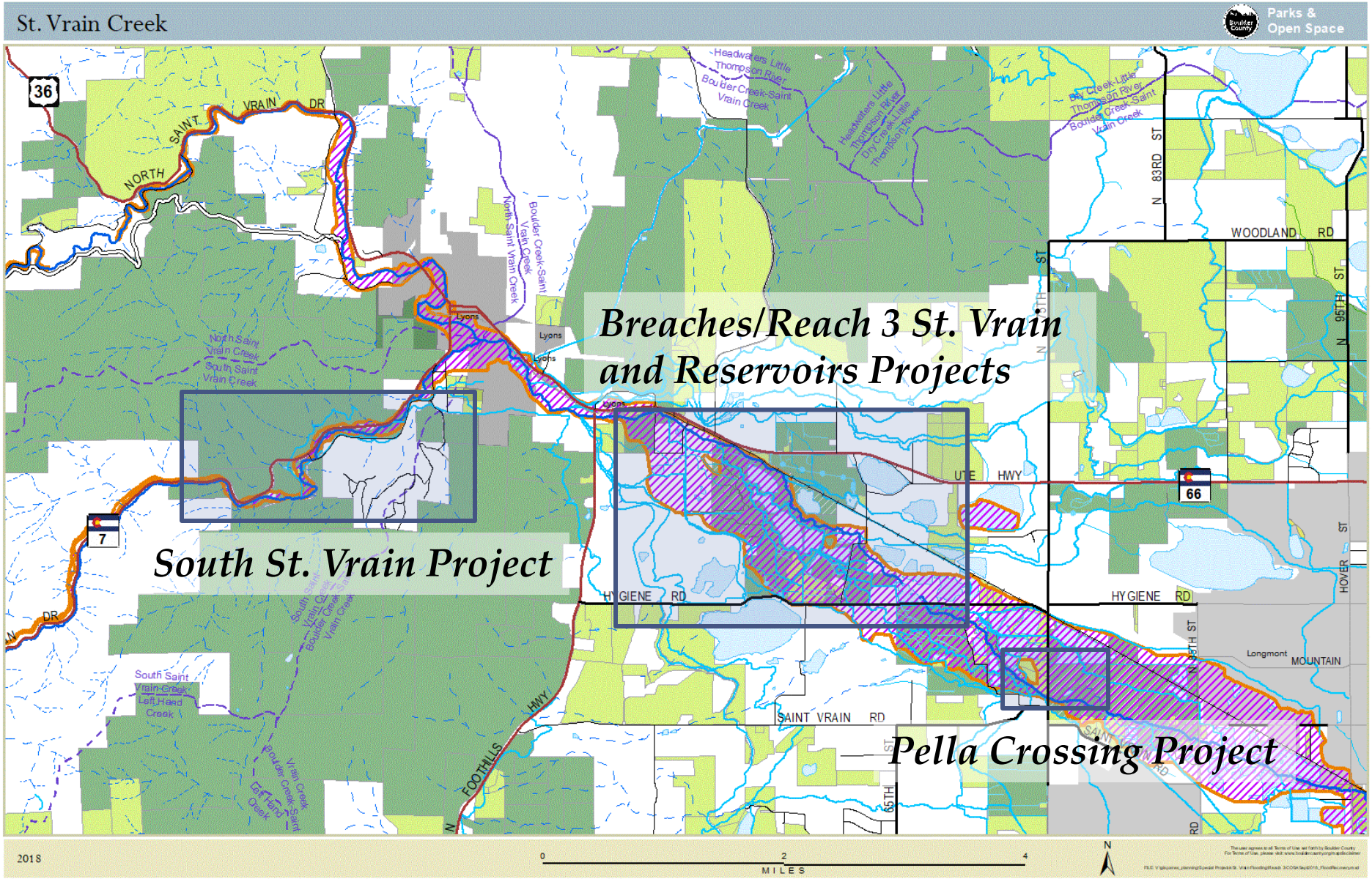
Challenges

Lessons Learned

Factors contributing to the project success

Maintenance and Monitoring:

Post-Flood Projects

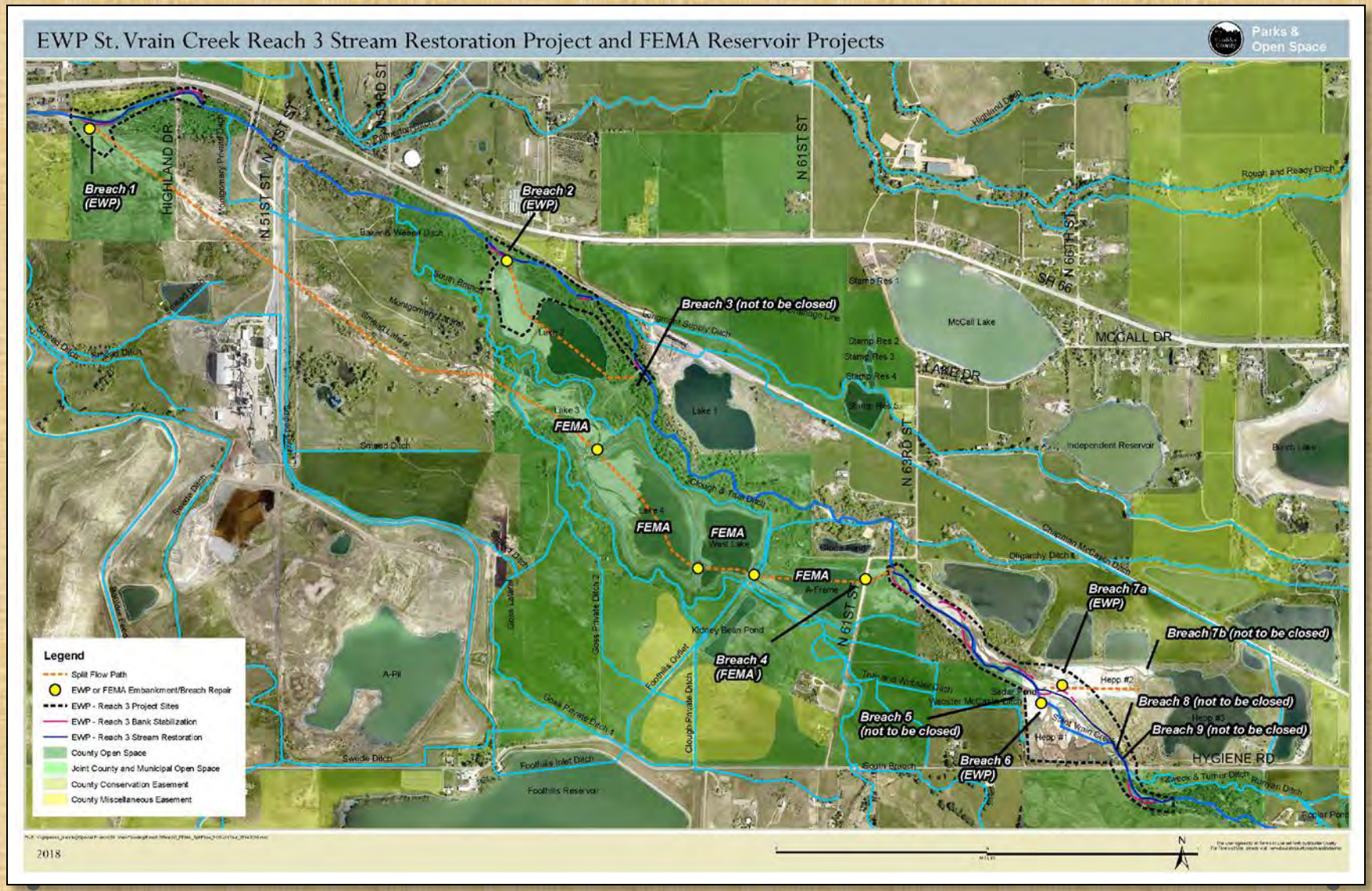


St. Vrain Creek Reach 3/Breaches: Objectives

- Protect and restore the natural creek and riparian habitat impacted by the Flood
- Flood Risk Mitigation: Protect local & downstream infrastructure from future flood

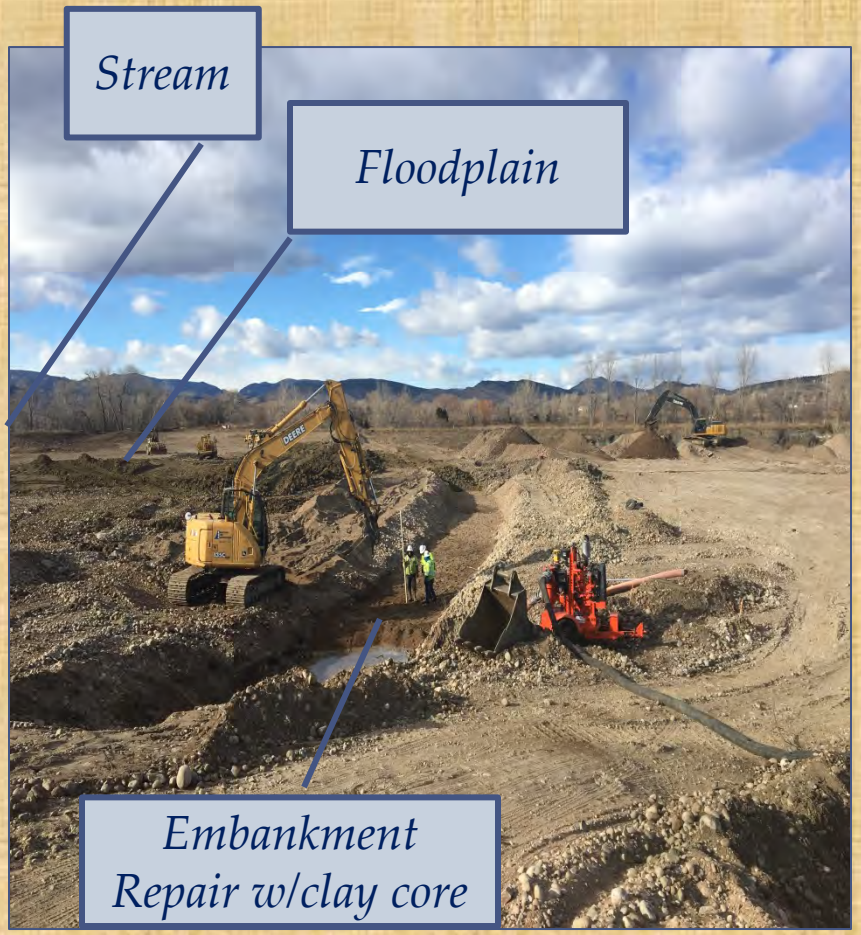
- Increase Floodplain Connectivity
- Incorporate Natural Channel Design Stream Restoration

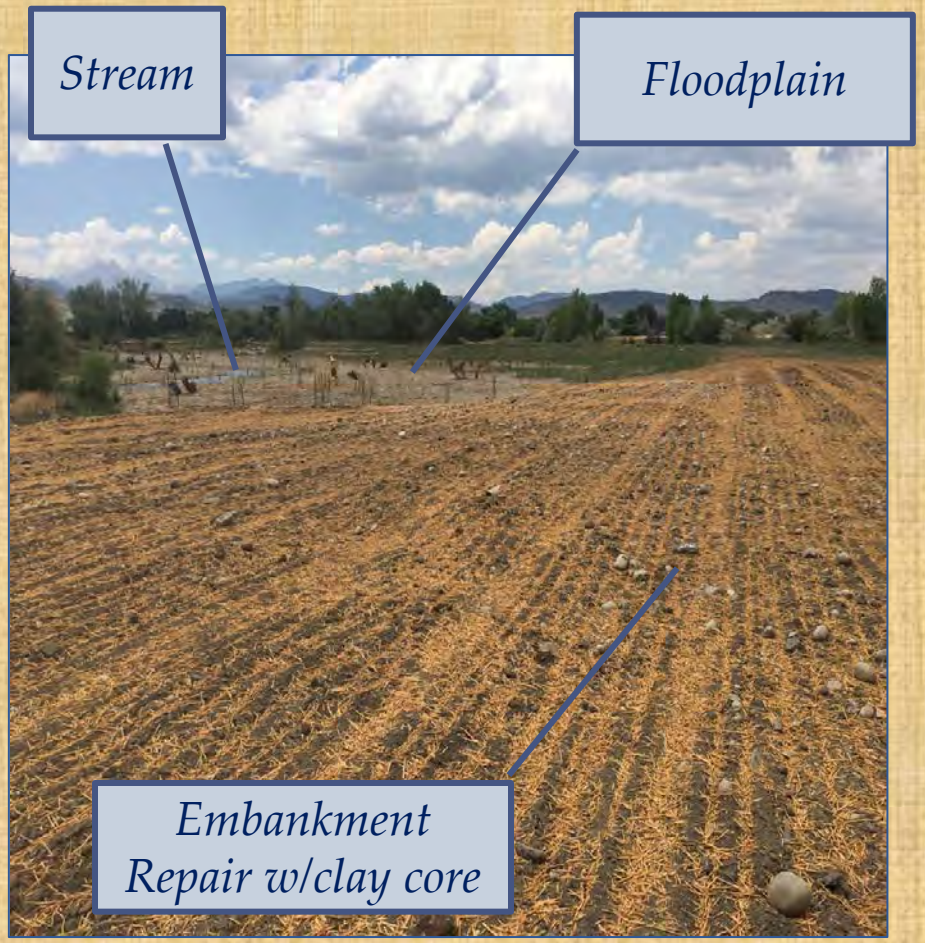
St. Vrain Creek Reach 3/Breaches



Reach 3/Breaches: Riffle/Pool/Glide

Reach 3/Breaches: Embankment "Breach" Repair





- Embankment repair trench with clay core. 10′ x 10′ x 10′ ~200′ long

- Embankment repair and floodplain bench

Reach 3/Breaches: Bank Stabilizations

Reach 3/Breaches: Willow Pole Installation

Design..Fund..Contract..Construct

1. **Mission of Resiliency** for people and ecology

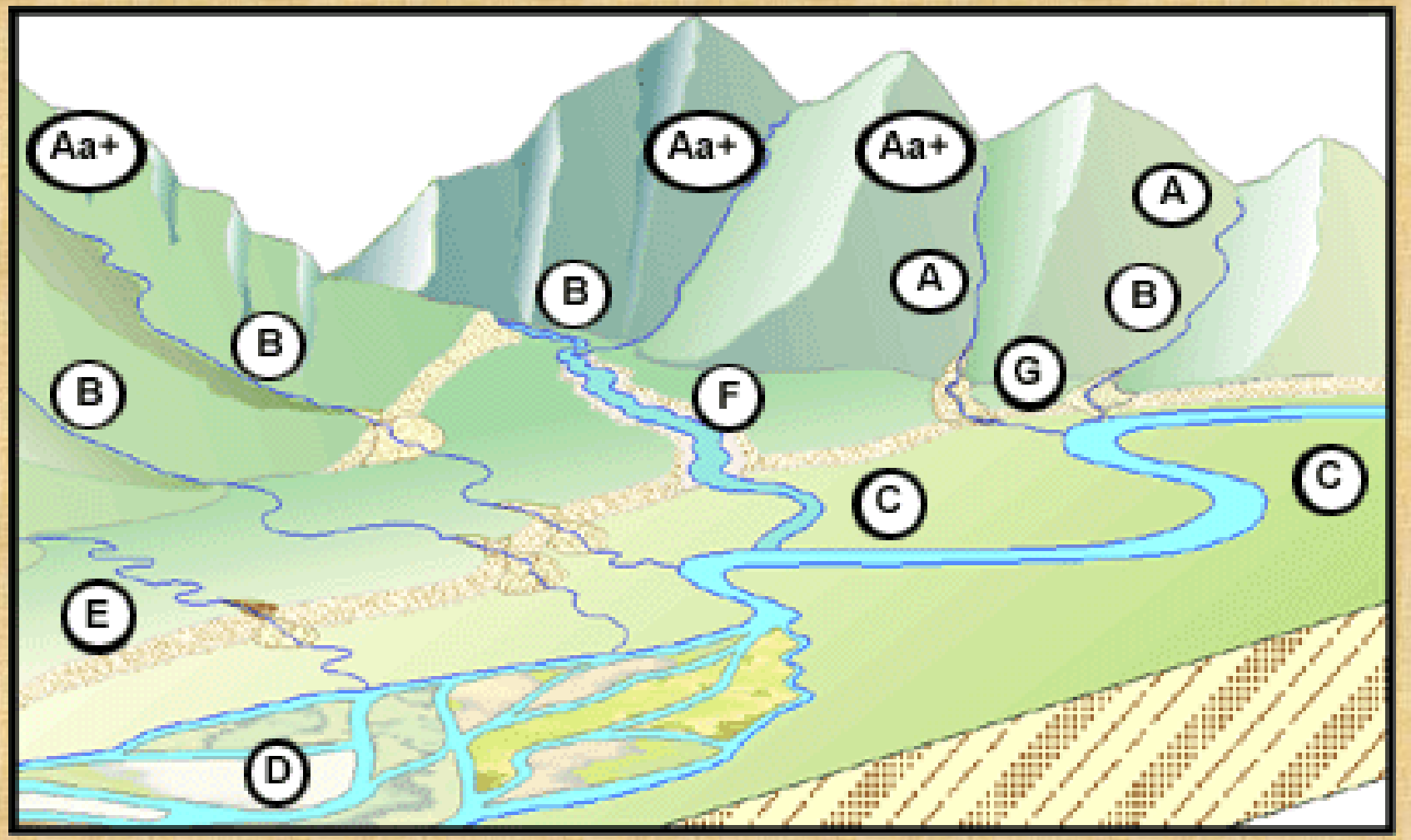
Create places that improve rather than degrade over time

2. Multi-disciplinary fully-functional team
3. Glass half-full
4. Public involvement from Day 0
5. Schedule and…..

   Schedule changes

https://www.bouldercounty.org/open-space/management/st-vrain-creek-restoration-reach-3/

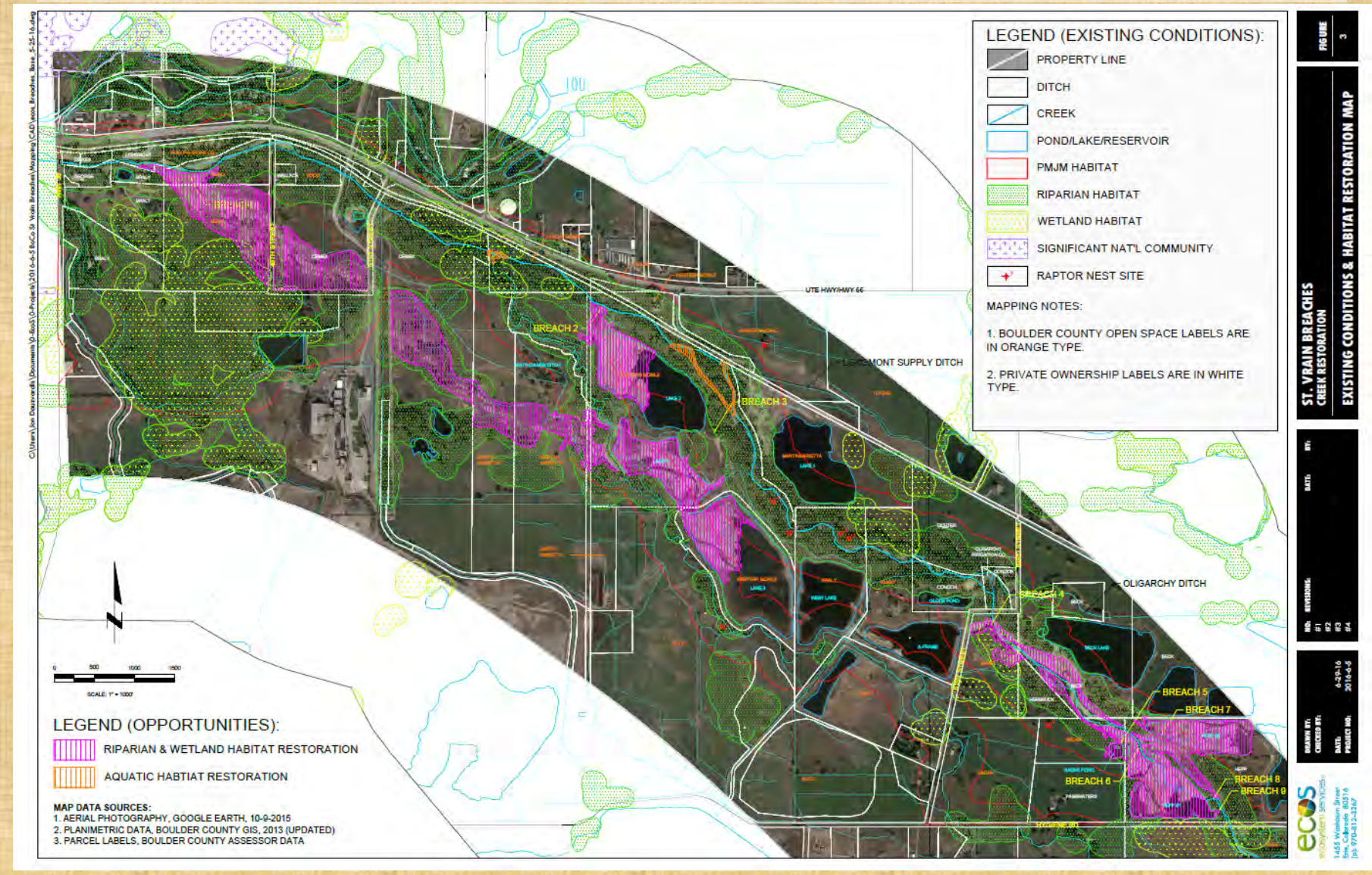
Post-Flood Projects: Goldilocks Principle



Fundamentals of Rosgen Stream Classification System | Watershed Academy Web | US EPA

cfpub.epa.gov

Design:
Involve All Up-Front



Fund:
Roll With It

Responsibility to the Public: Designed to Protect All Parties

Different Rules, Different Interpretation of the Rules

Contract:
Prescribe Carefully

- Ecologically sensitive species: Preble's Meadow Jumping Mouse, Migratory Birds, Raptors
- Responsible Compromise When Possible

Construct:
Specify Exactly What You Mean

Warranty:
Better Have It in Writing!

Evaluate, Learn!

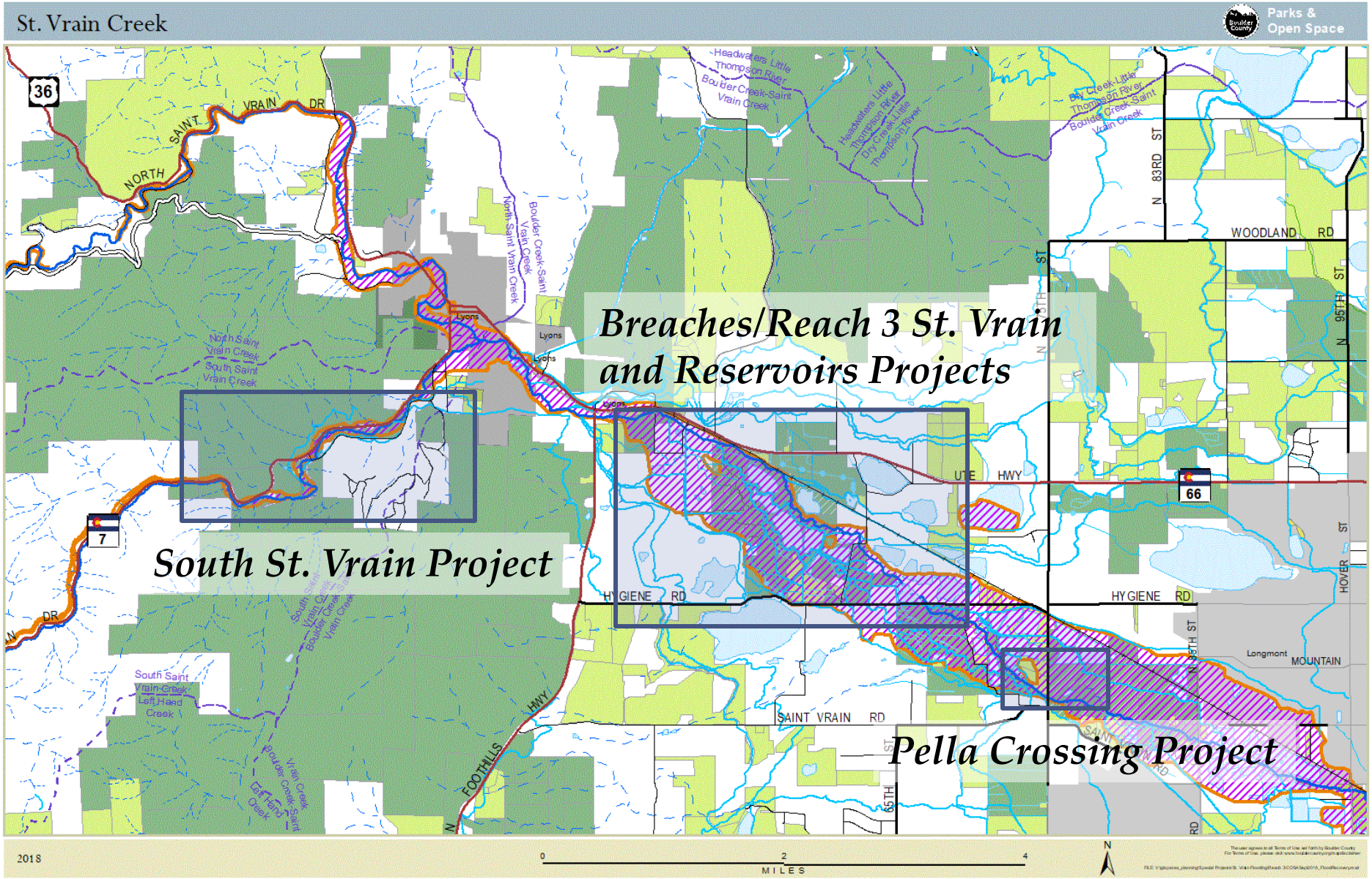
Reach 3 / Breaches Objectives

- Protect local and downstream infrastructure
- A messy creek is a healthy creek
  - Will nature heal on its own?
  - Floodplain connectivity, sediment transport, overbank events, lateral migration
  - Nature adapted to disturbances
- Utilize previous plans as a start
  - Get all stakeholders involved
  - Communicate effectively

St. Vrain Reach 3 (Breaches)

https://www.bouldercounty.org/open-space/management/st-vrain-creek-restoration-reach-3/

Post-Flood Projects



Upcoming Project :

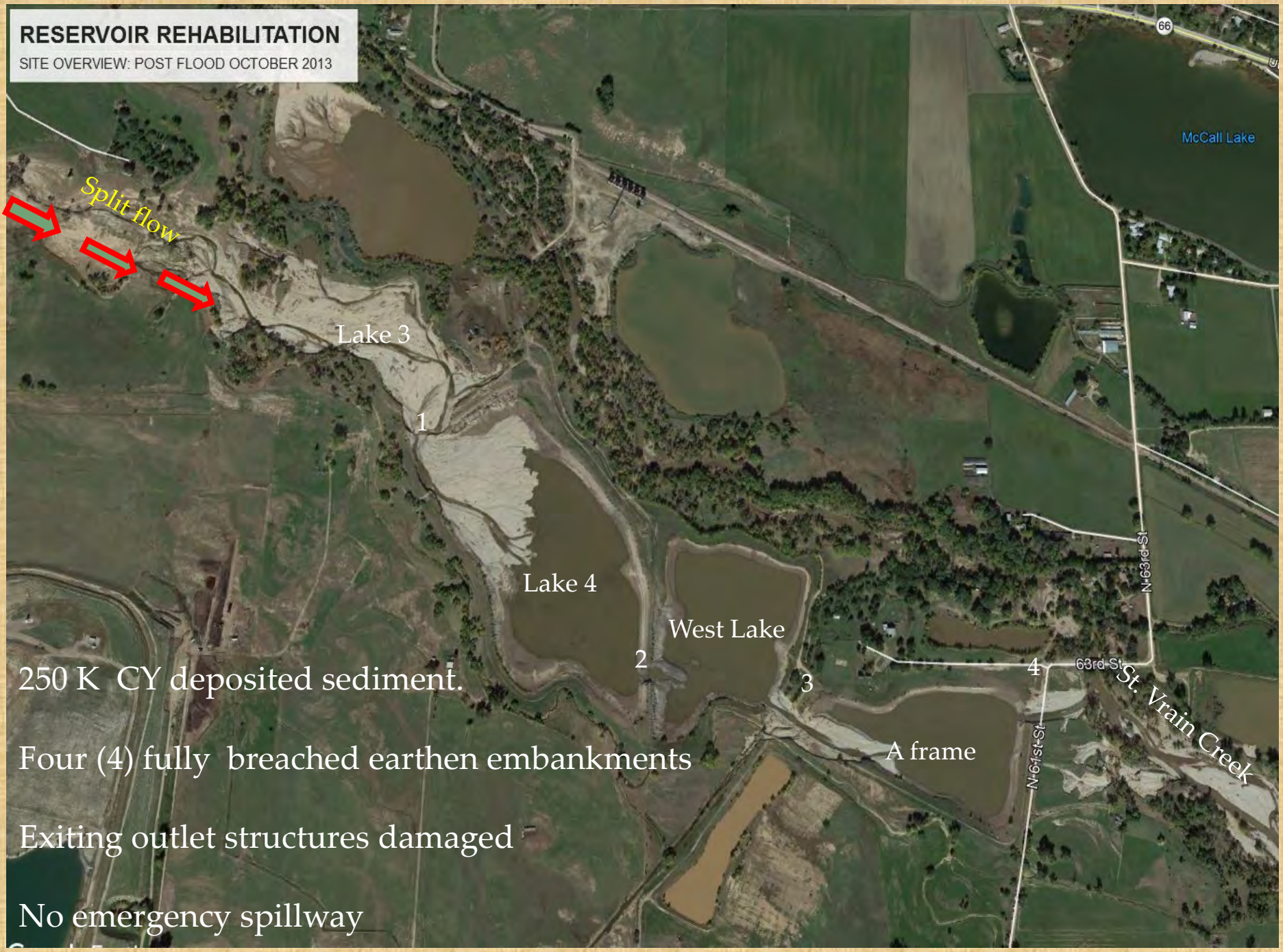
Lake 4, West Lake and A-Frame Dam Rehabilitation

Construction startup: Late Fall 2018

Funding:

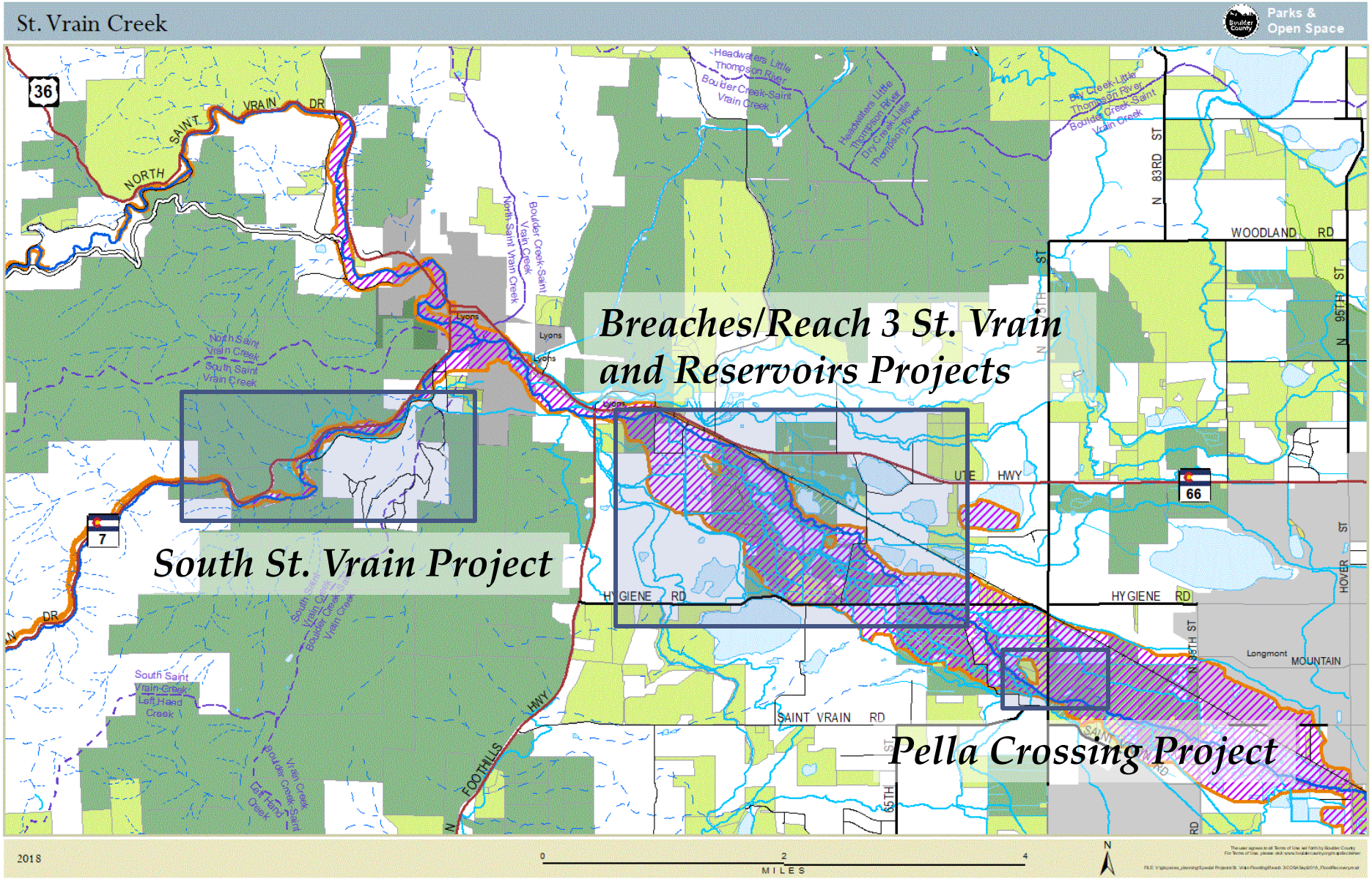
This project is supported by a loan from the Colorado Water Conservation Board's (CWCB) Colorado Watershed Program, a grant from the Federal Emergency Management Agency (FEMA), a Community Development Block Grant – Disaster Recovery (CDBG-DR) administered by a Boulder County Collaborative.


RESERVOIR REHABILITATION
SITE OVERVIEW: PREFLOOD OCTOBER 2012
66
McCall Lake
Lake 3
St. Vrain Creek
Lake 4
West Lake
N 63rd St
63rd St
A frame
N 61st St
St. Vrain Creek


RESERVOIR REHABILITATION
SITE OVERVIEW: POST FLOOD OCTOBER 2013
Split flow
Lake 3
1
Lake 4
West Lake
2
3
4
A frame
McCall Lake
66
63rd St
N 63rd St
N 61st St
St. Vrain Creek
250 K CY deposited sediment.
Four (4) fully breached earthen embankments
Exiting outlet structures damaged
No emergency spillway


RESERVOIR REHABILITATION
SITE OVERVIEW AUGUST 2018: SCOPE OF WORK
Lake 3
Major Scope:
• Construction services for the restoration of four (4) breached earthen embankments on the County's Western Mobile Open Space property. Lake 4 (including the embankment between Lake 3 and Lake 4), West Lake, A-Frame Lake
• Construction of the associated emergency spillways, outlet structures.
• Installation of two (2) inverted siphons to route historical ditches across one (1) of the pond embankments
• Lake 4 Outlet Pipeline Rehabilitation
Lake 4
West Lake
Lake 4 Pipe line
A frame
63rd St
N 63rd St
N 61st St

Post-Flood Projects

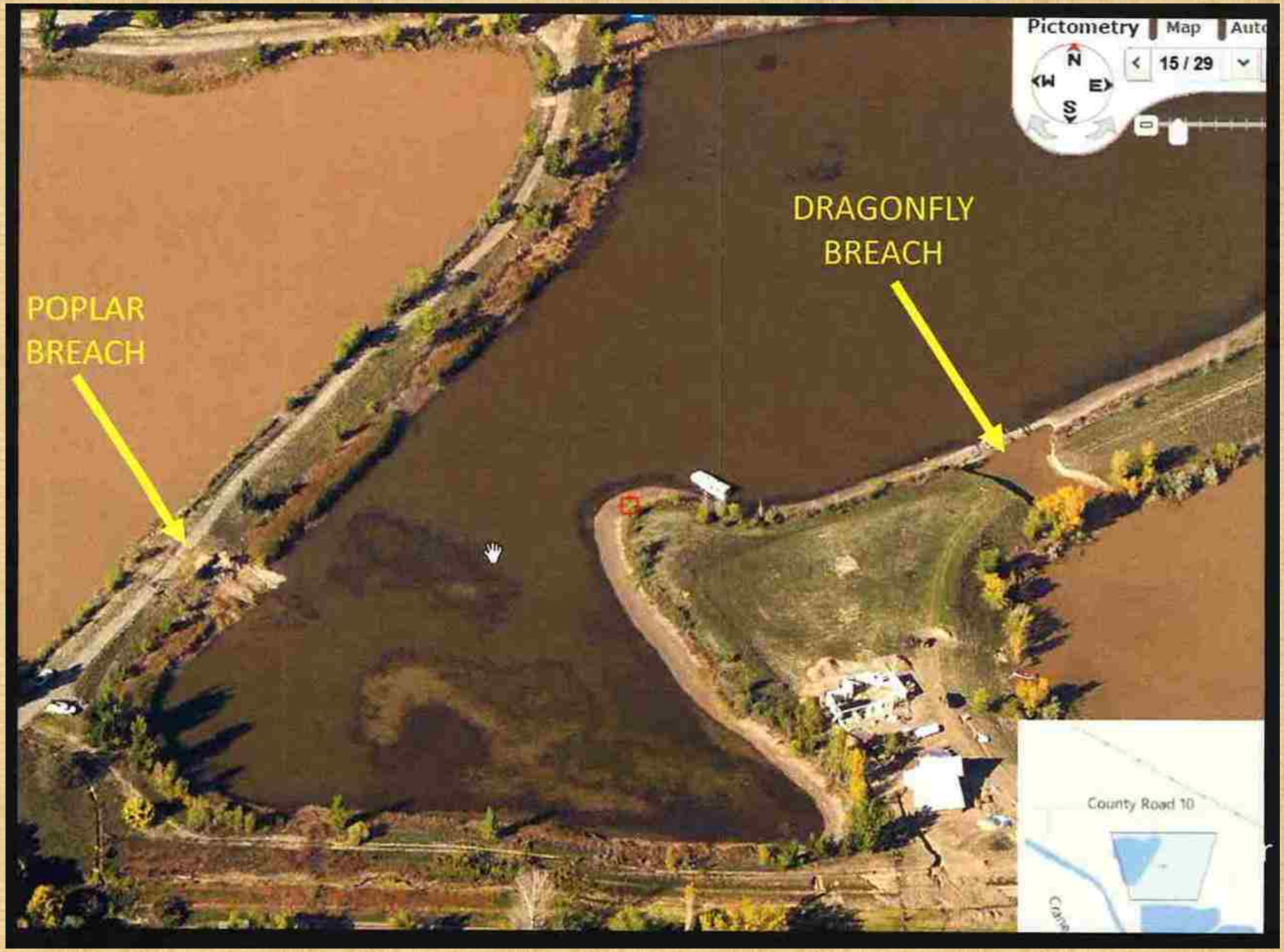


Restore and Improve Water Resource Functions

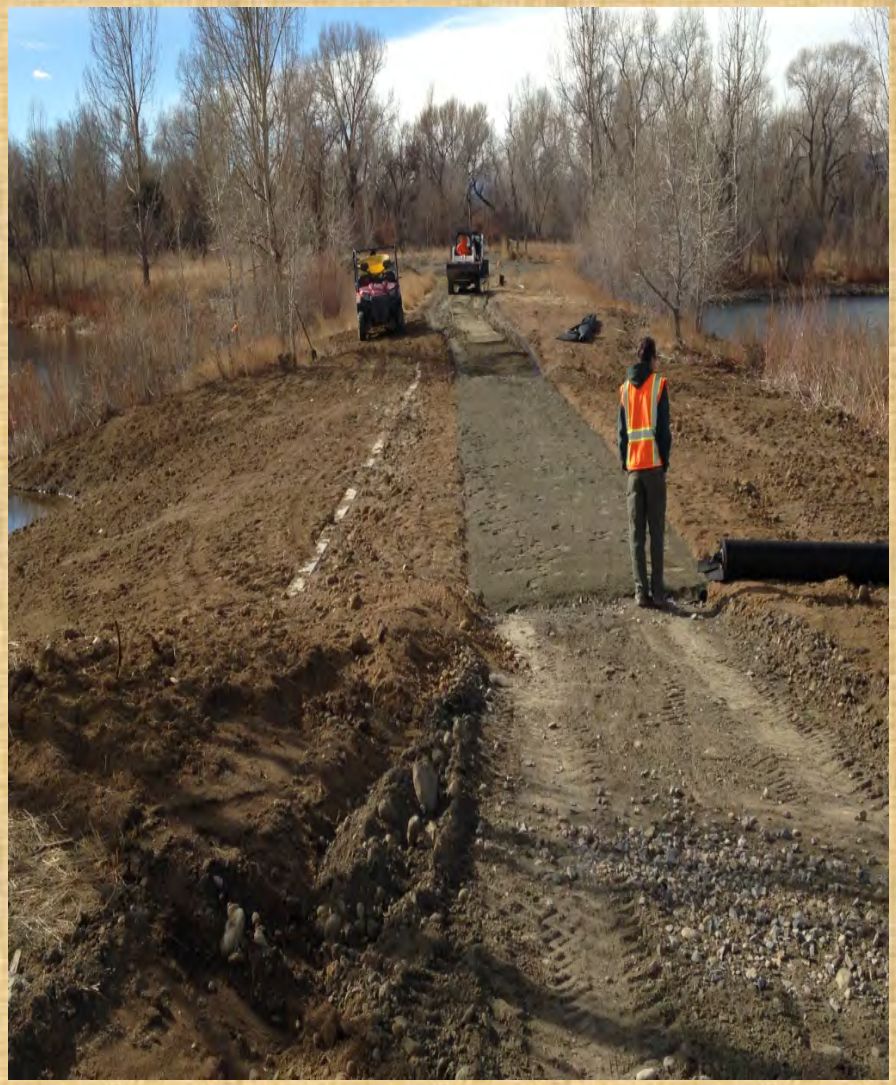
OBJECTIVES

- Restore visitor use facilities
- Restore and improve water functions
- Improve resiliency in future flood
- Diversify habitat functions opportunistically

MARLATT SIDE (WEST SIDE)

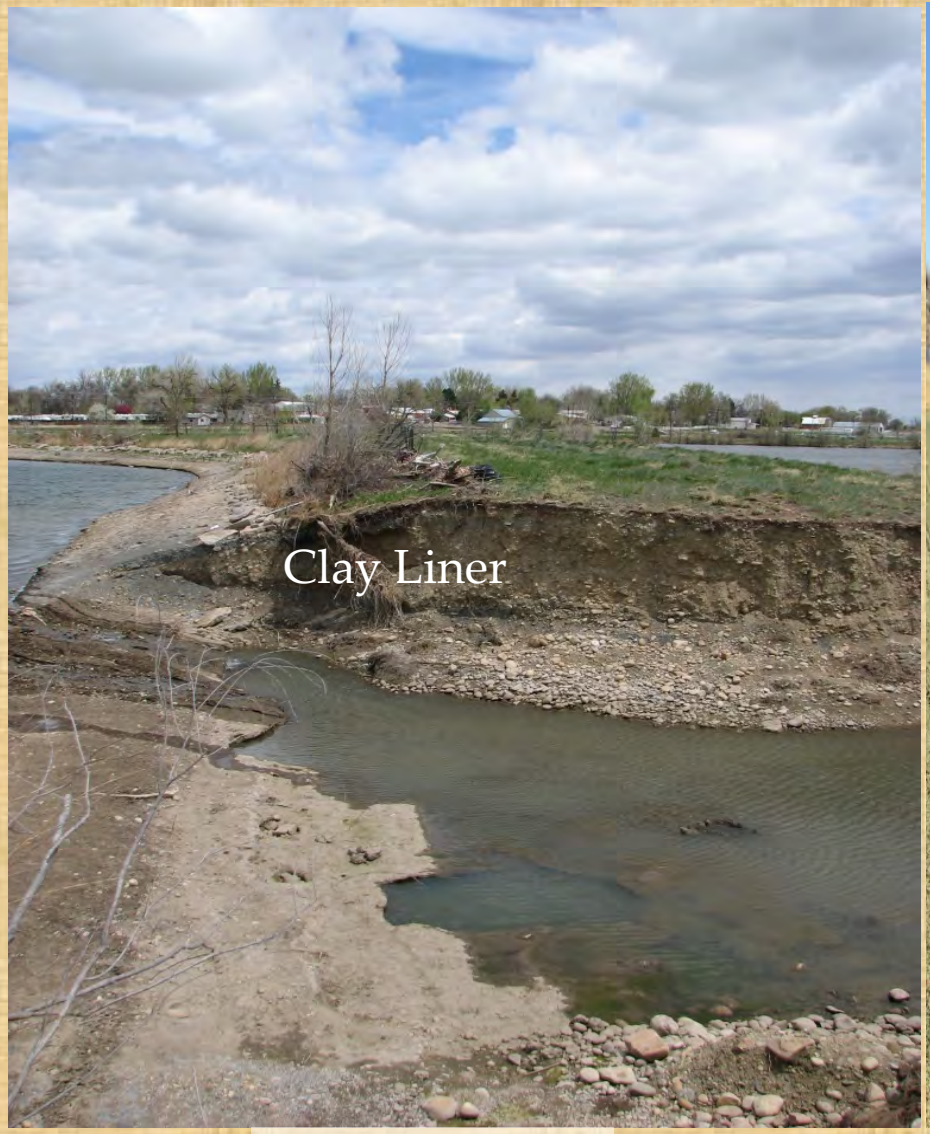

POPLAR
BREACH
DRAGONFLY
BREACH
Pictometry
Map
15 / 29
N
W
E
S
County Road 10

Partial Breach



Restored Embankment

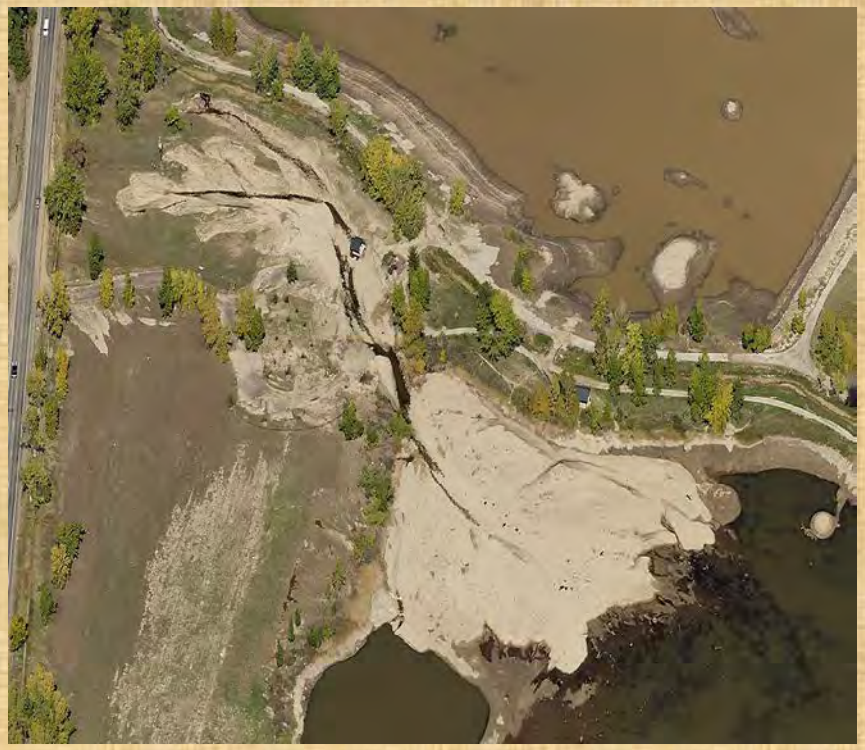
POPLAR



Full Breach

Spillway

DRAGONFLY




Erosion Control Groin Construction


Sediment deposition


Final grading for Wetland creation

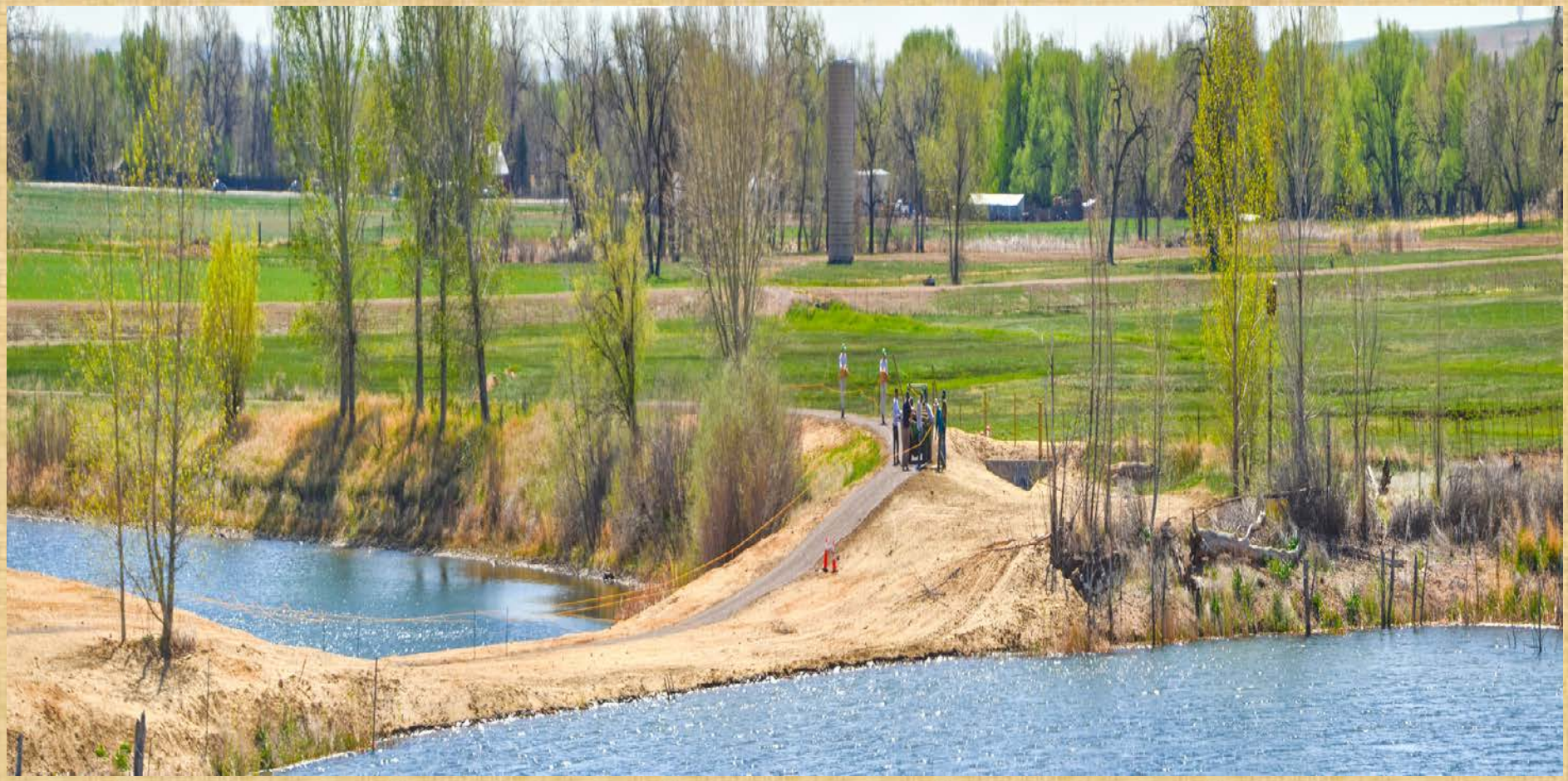
Heavy damage to trail head and parking lot

Amenities restored

Full Breach

Reconstructed embankment

WEBSTER



Structural Spillway

Re-alignment of Zweck and Turner ditch across Webster embankment through inverted siphon

Trail loop restored

HDPE Crossover pipe (top left)

Inverted siphon installation (top right)

Concrete encasement (bottom left)

Partial Breach

Structural spillway with inline water control structure

SUNSET

QUESTIONS?

Boulder County, Search "Flood"

https://www.bouldercounty.org/disasters/flood/2013-flood/

https://www.bouldercounty.org/disasters/flood/creek-restoration/

https://www.bouldercounty.org/transportation/closures-and-construction/ongoing-flood-recovery-projects/