

# Introductions



Gretchen Wilson, Principal |  
Founder, Dig Studio  
ASLA, PLA, LEED AP



Jesse Giuliano, Project  
Manager, PE





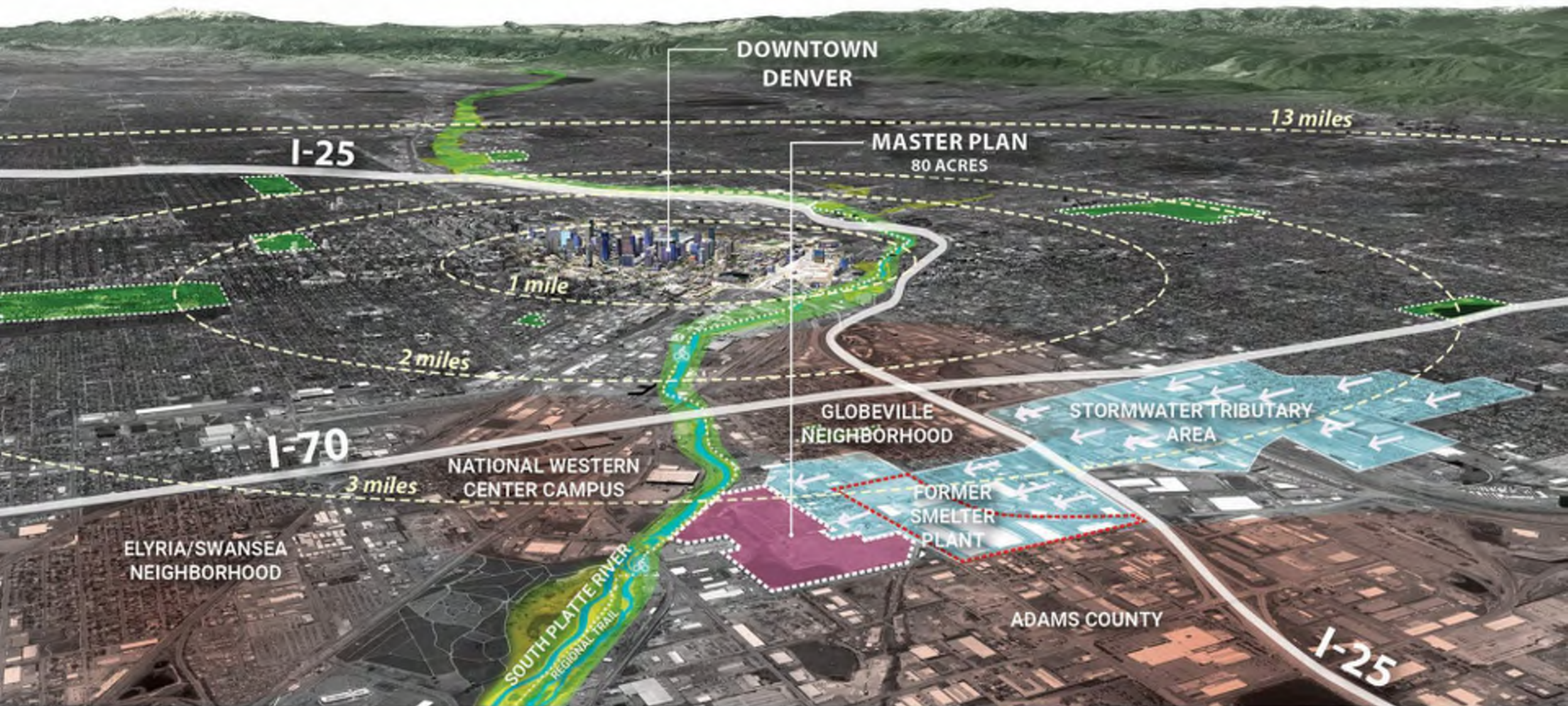
# *Stormwater Quality & Improved Quality of Life*

*A new 80 acre park in North Denver*



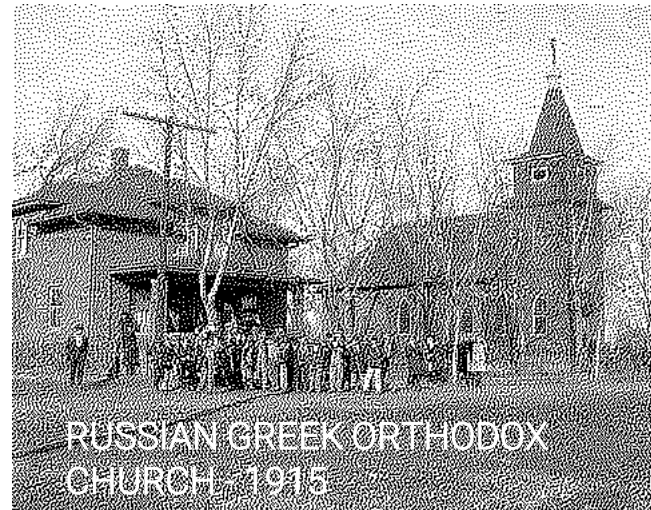
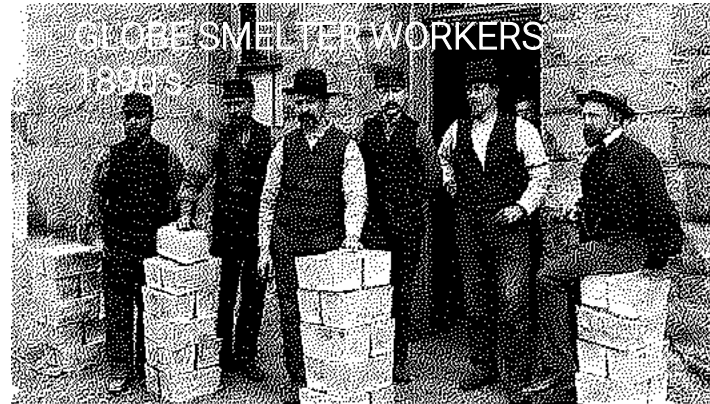


# Context



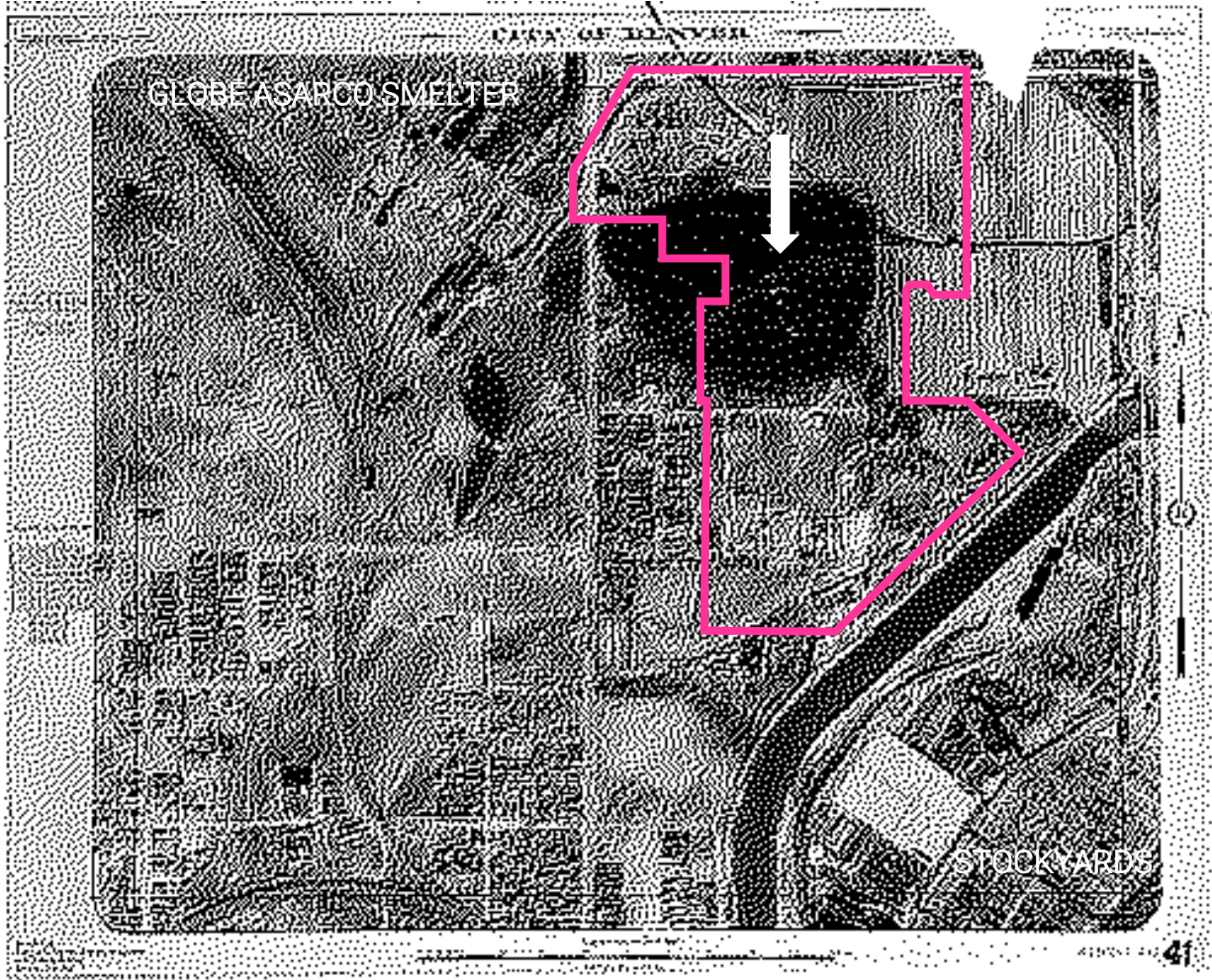


# Globeville History

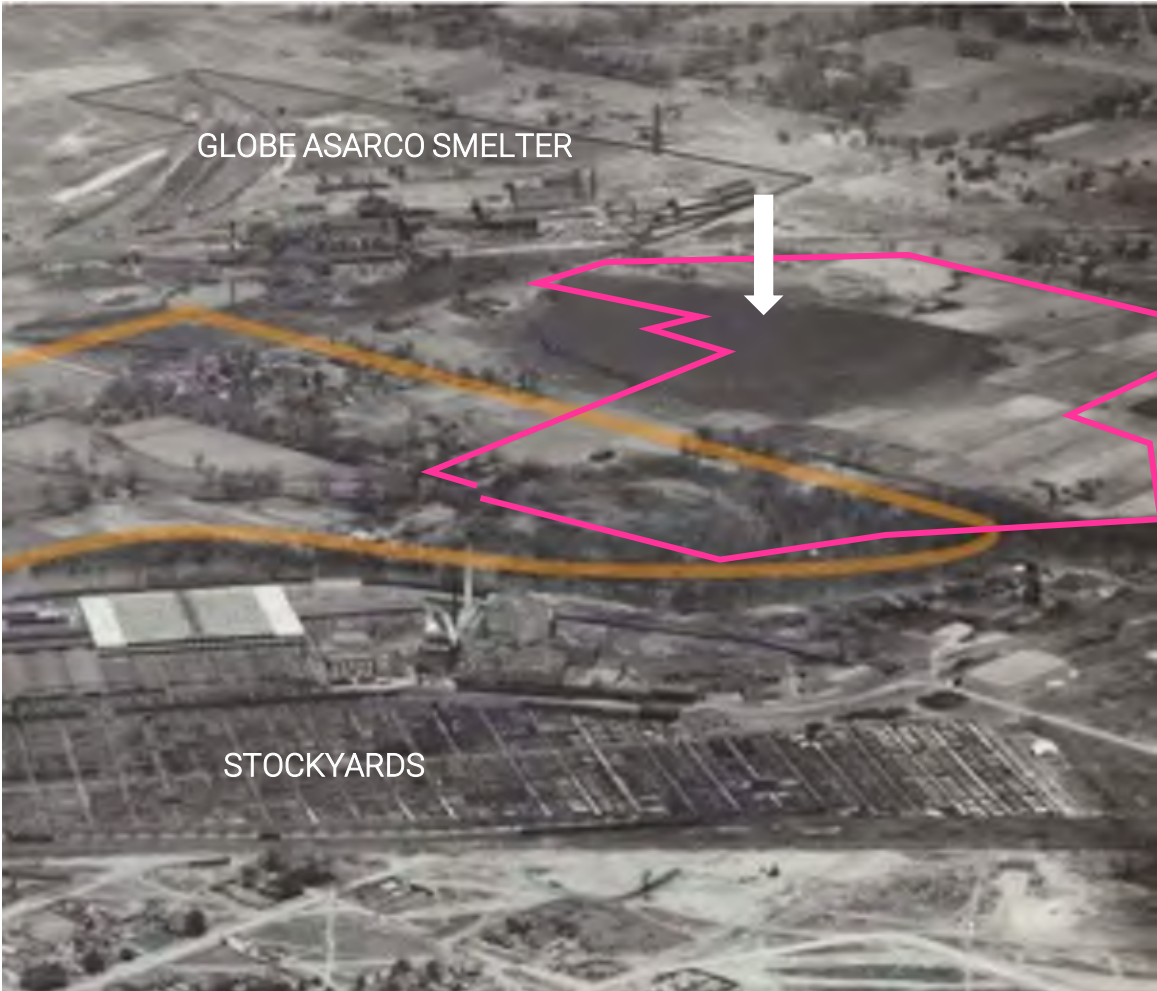




# Site History



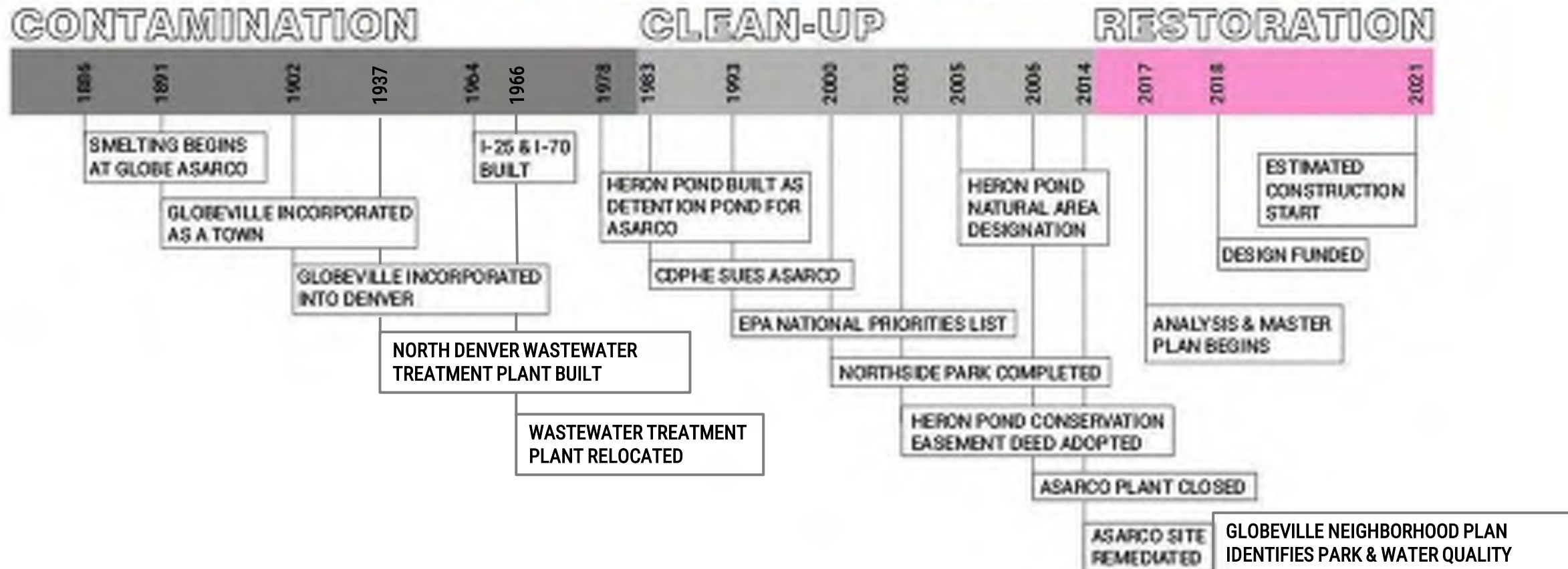
1933 Aerial



c. 1944 Aerial



# Site History





# Site History



1993



2003



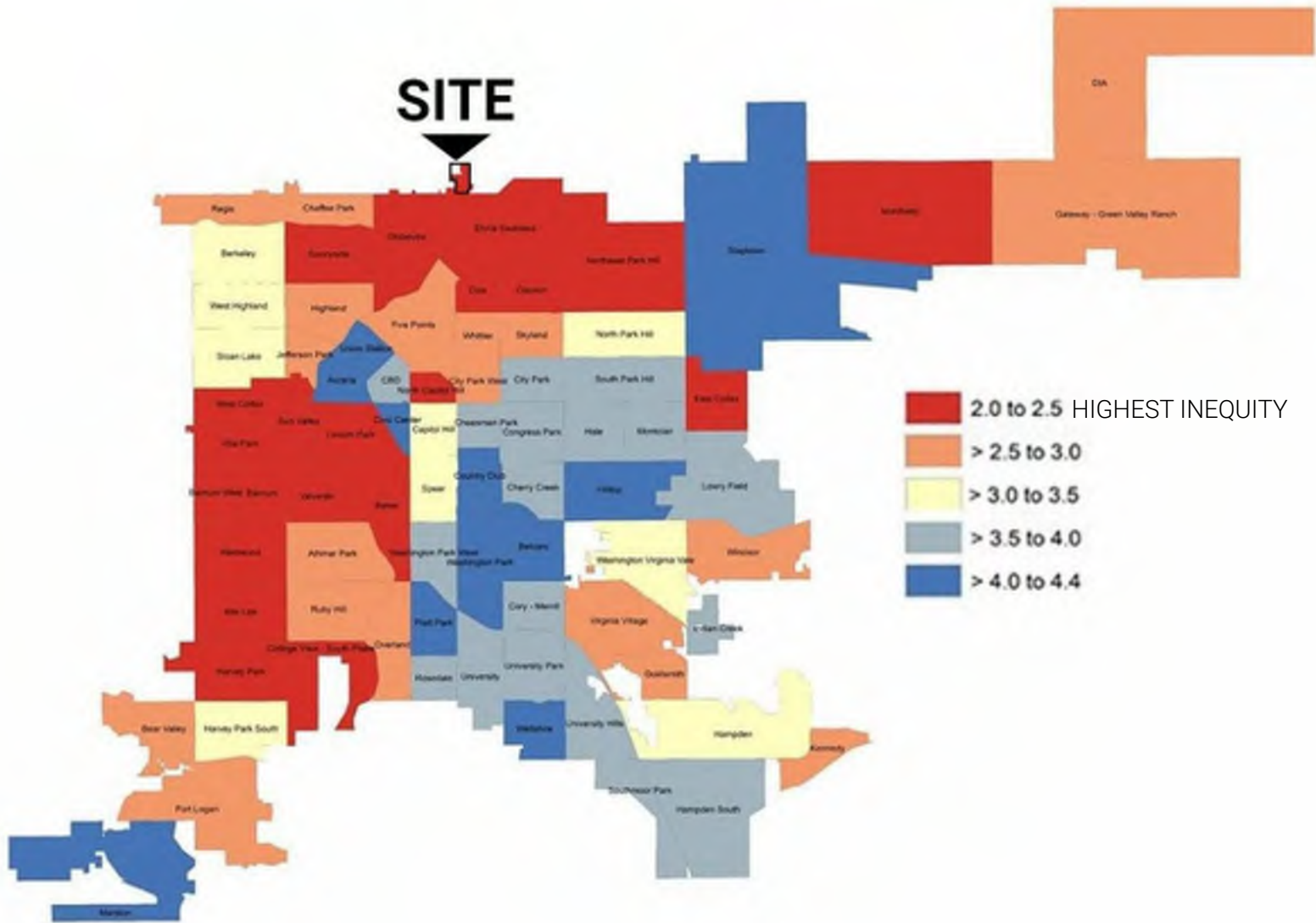
2007



2015

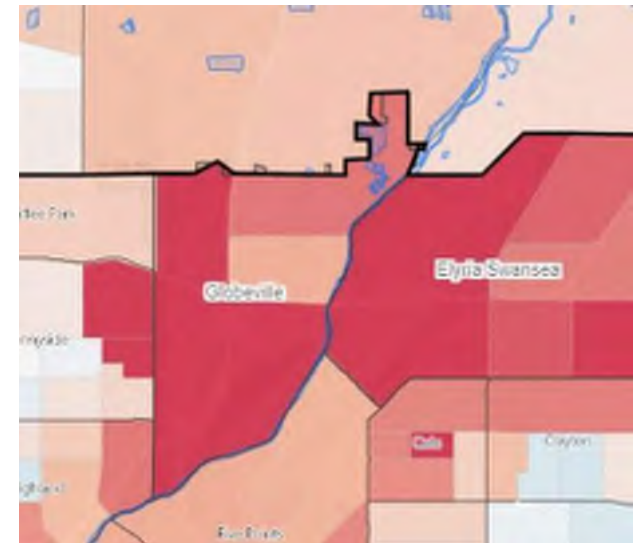


# Equity

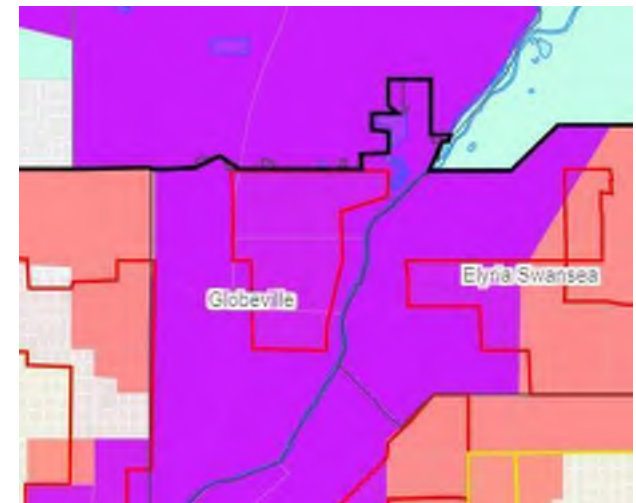


CITY &amp; COUNTY OF DENVER

CDPHE, Denver Neighborhood Equity Index



## HEAT ISLAND VULNERABILITY

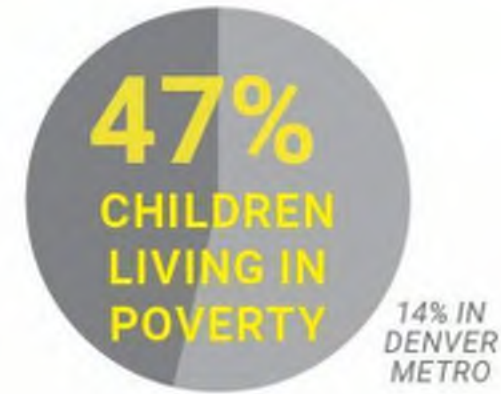
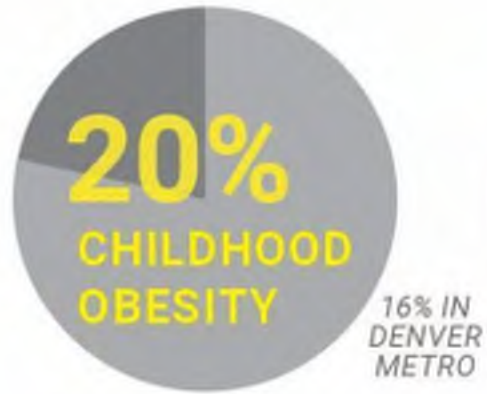


## FLOOD VULNERABILITY & REDLINING

## Groundwork, Climate Safe Neighborhoods



# Equity



**GLOBEVILLE NEIGHBORHOOD AVG. HOUSEHOLD INCOME: \$37,180**  
**DENVER METRO AREA AVG. HOUSEHOLD INCOME: \$76,413**



# Existing Conditions





# Stormwater Tributary Area





# Existing Drainage



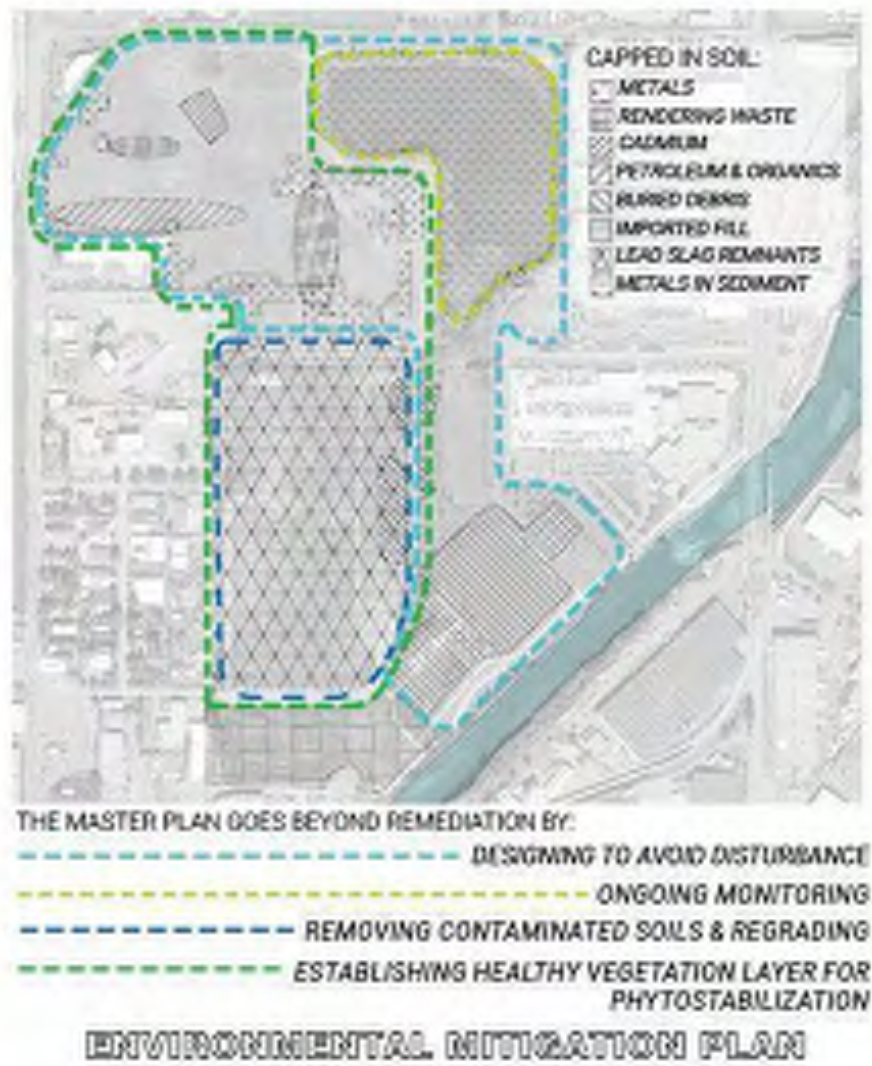
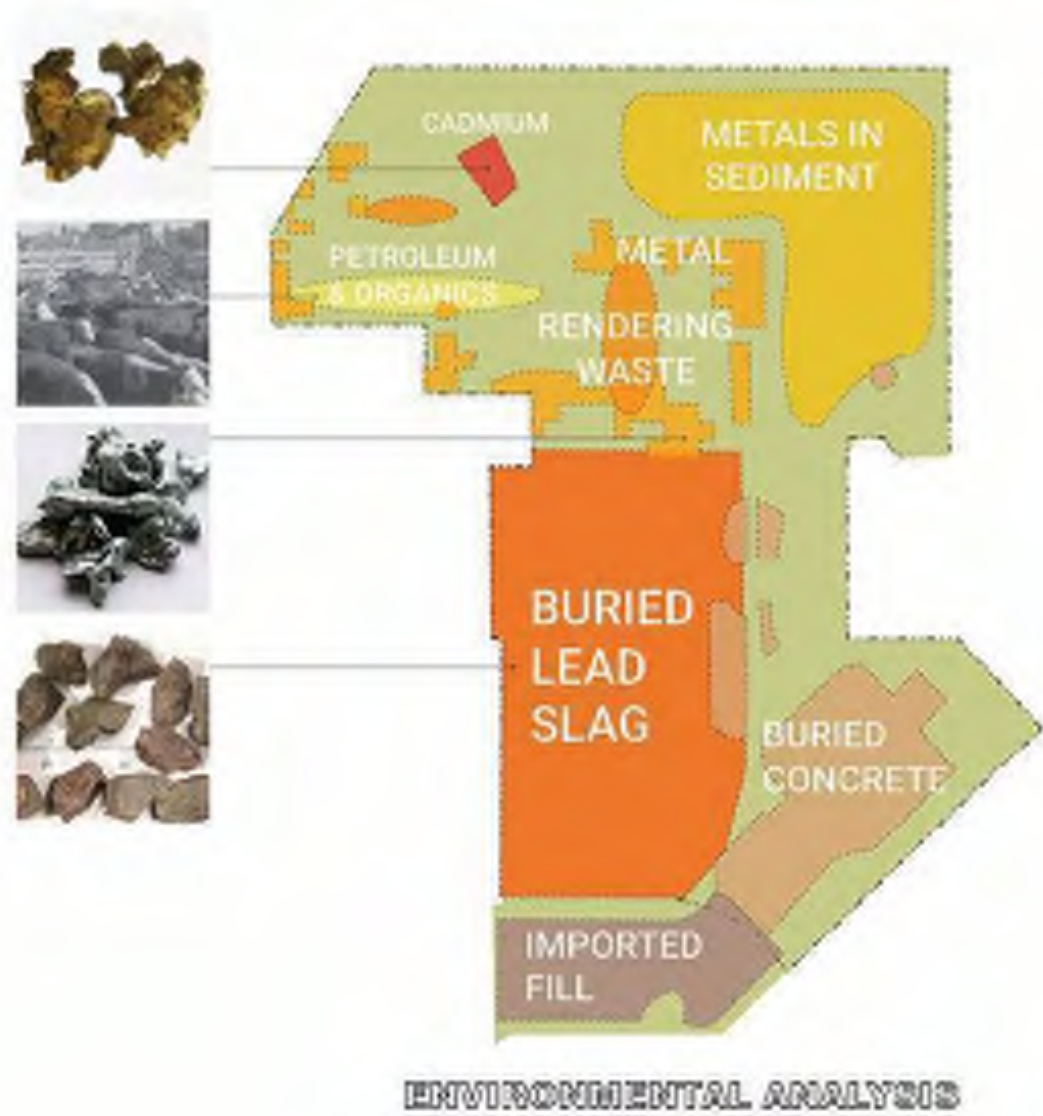


# Existing Drainage



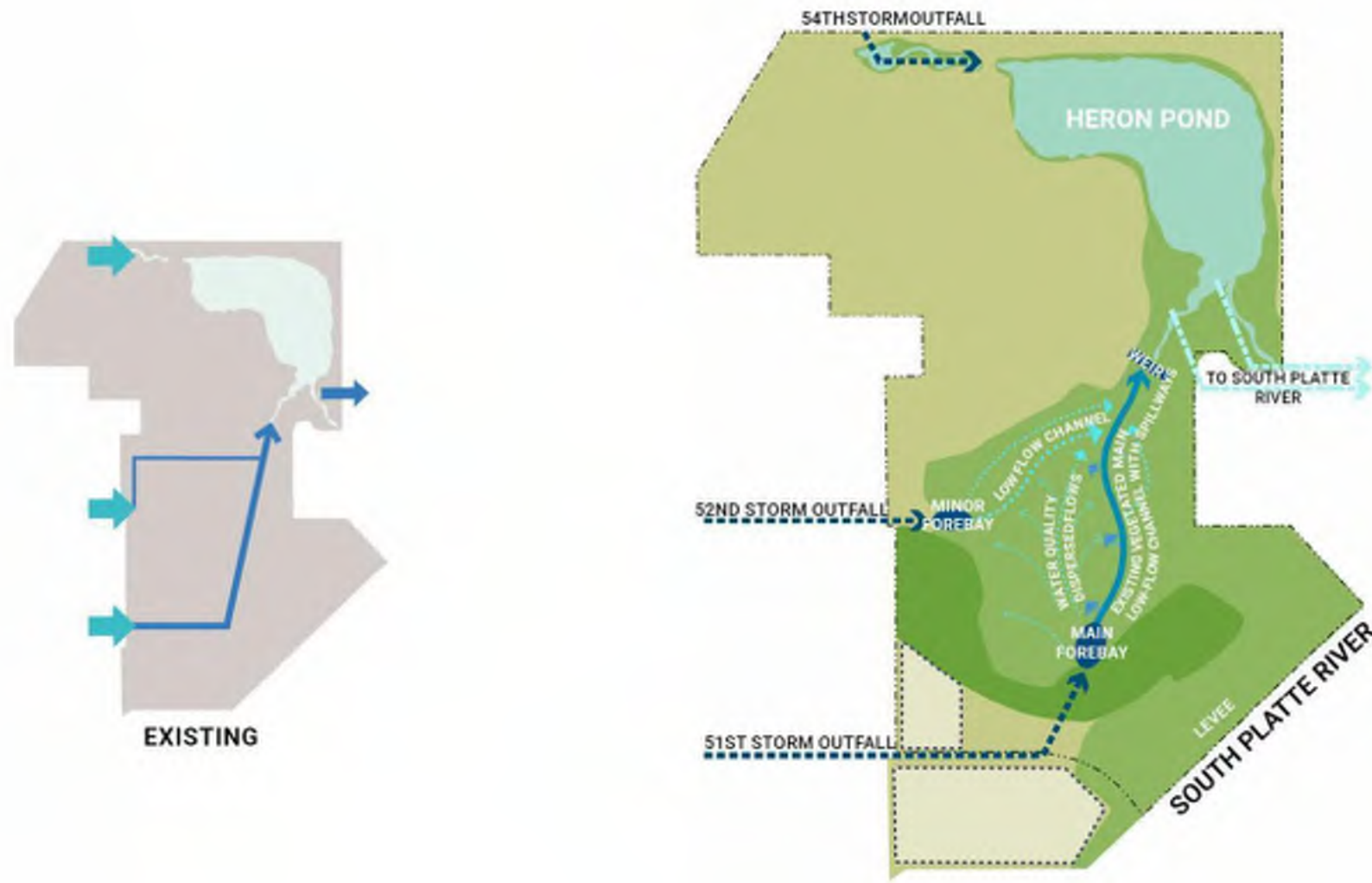


# Environmental Site Constraints





# Proposed Drainage & Water Quality Plan





# Proposed Water Quality Pond





# Park Design

## PLAN GOALS



### HEALTHY ECOSYSTEM

- RESTORE
- ENHANCE



### HEALTHY COMMUNITY

- MENTAL AND SPIRITUAL HEALTH
- PHYSICAL HEALTH

## PARK PROGRAM



### COMMUNITY PARK ZONE

- FUTURE COMMUNITY USE PARCEL
- TREE LINED ALAMEDA /ART/ HISTORY WALK
- MARKET PAVILION
- AMPHITHEATER
- EX. GRAFFITI WALLS
- PUMP TRACK
- PARKING
- COMMUNITY PLAY AREA
- FLEX FIELDS
- RESTROOMS



### ENHANCED NATURAL AREAS (PRAIRIE AND POND)



- BIRD BLINDS
- PRAIRIE OVERLOOK
- MEANDERING SOFT TRAILS
- POND OVERLOOK
- RESTORED NATIVE VEGETATION

### 11 ACRE STORMWATER QUALITY FACILITY



- SOFT TRAILS, BOARDWALKS
- OUTDOOR CLASSROOMS
- WATER QUALITY OVERLOOK
- PRAIRIE RIPARIAN VEGETATION
- BIRD & POLLINATOR HABITAT

### RIPARIAN CONNECTION



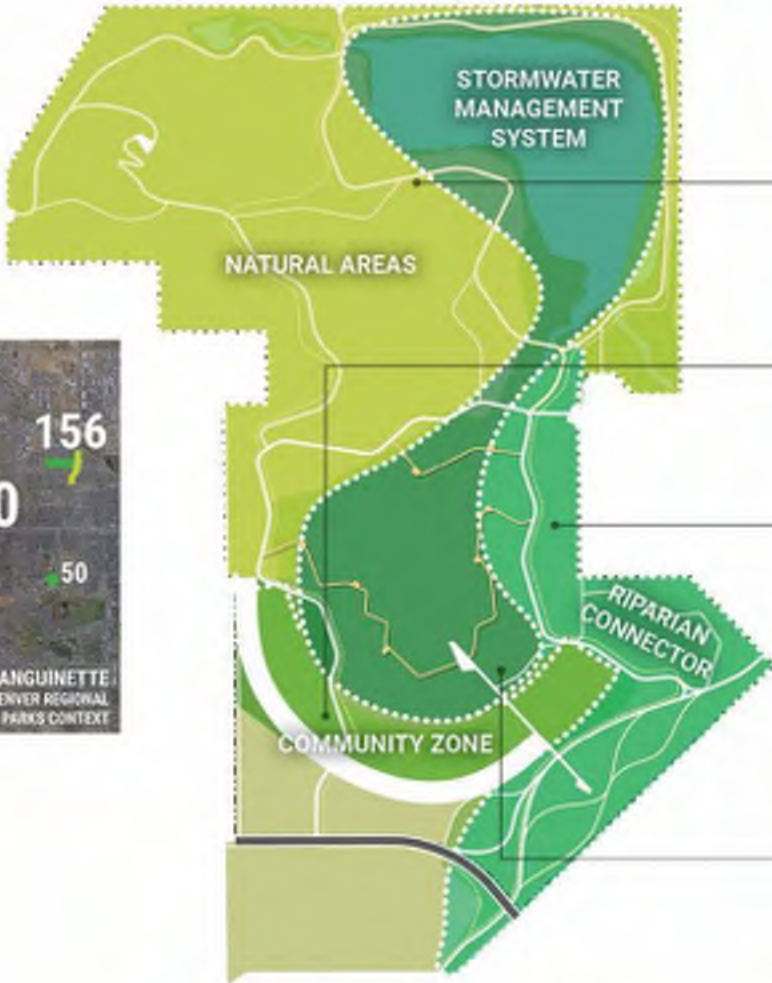
- NATIVE VEGETATION CONVERSION
- HABITAT CREATION
- CONNECTING RIVER TO HERON POND
- RIVER OVERLOOK
- RIVERFRONT TRAIL CONNECTIONS
- RIVER ENTRY ACCESS
- REALIGNED REGIONAL TRAIL ENTERING PARK
- LOWERED RIVERBANK FOR WETLAND HABITAT & FLOOD MITIGATION



# Park Design



URBAN NATURE



ECOLOGICAL & USE ZONES

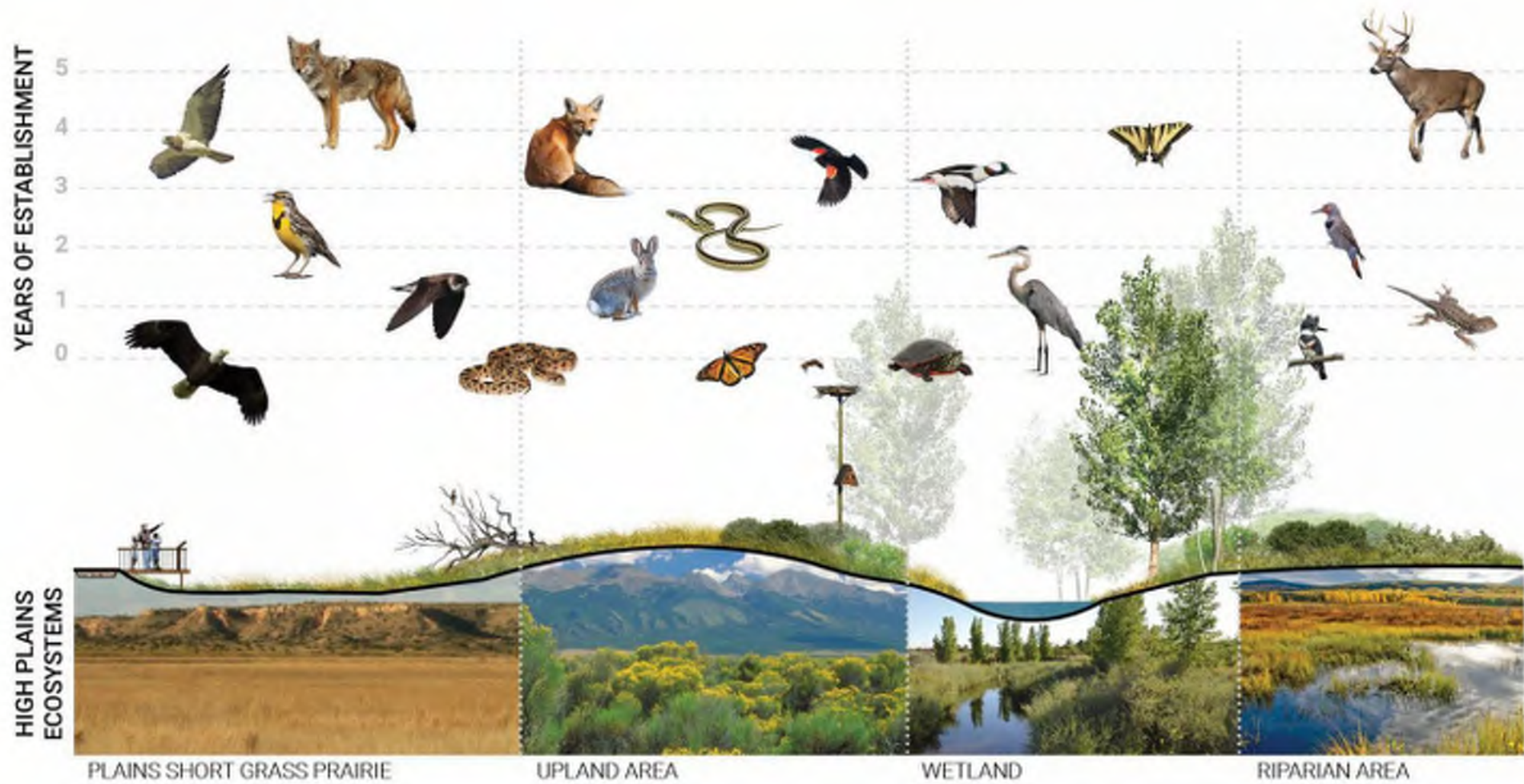


EXISTING ZONES TO ENHANCE



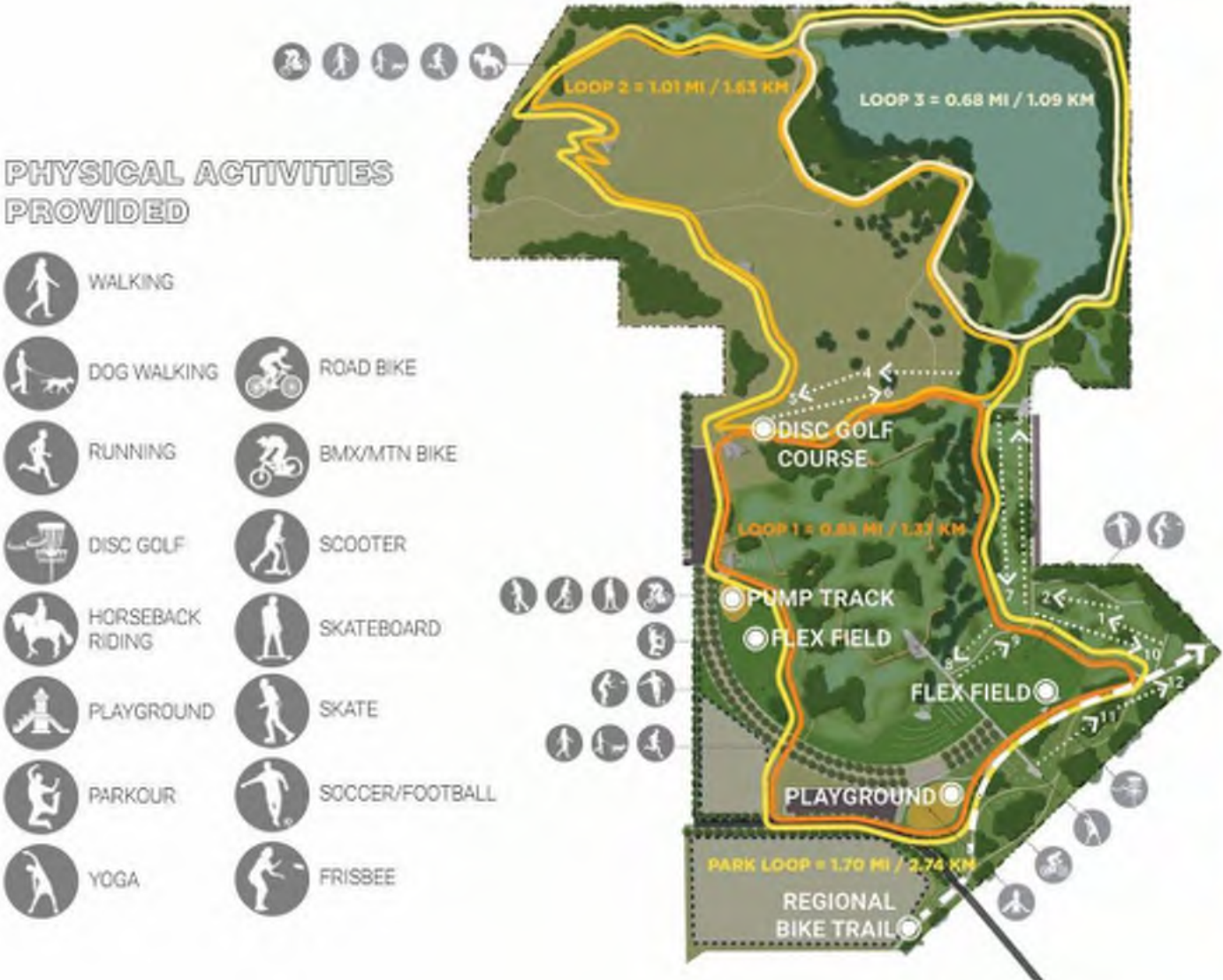
# Park Design

7,500 NATIVE SHRUBS PLANTED      30 ACRES OF NATIVE SEEDING      550 NATIVE TREES PLANTED





# Park Design





# Park Design





# Interactive Education Nodes





# Park Design



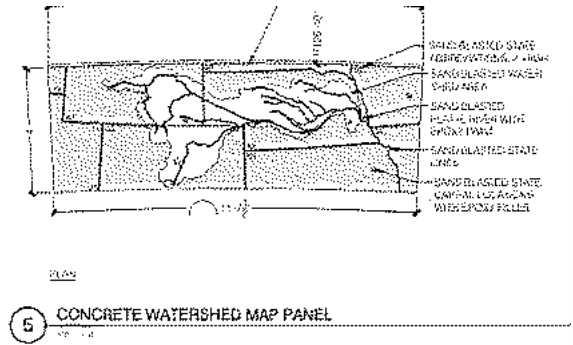


# Park Design





# Park Design





# Proposed 51<sup>st</sup> Forebay





# Proposed 51<sup>st</sup> Forebay



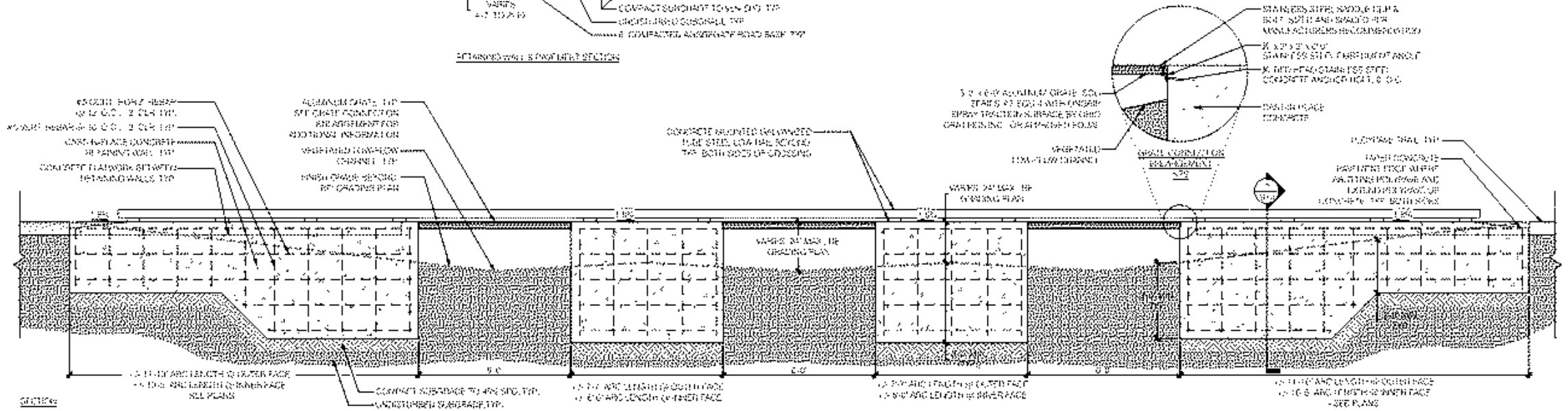
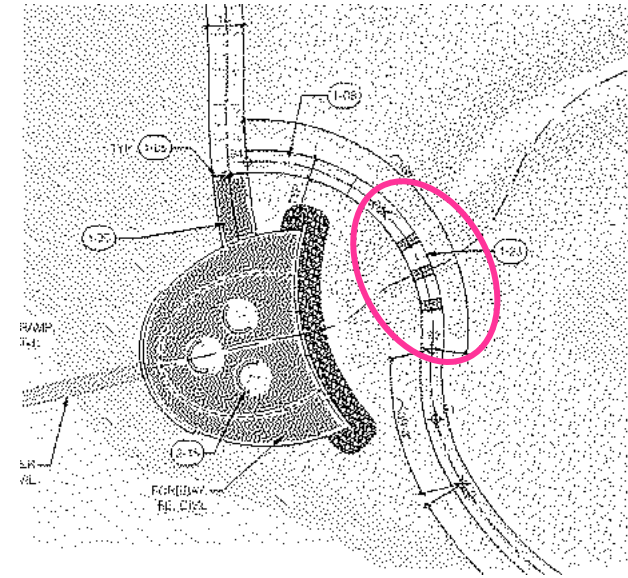
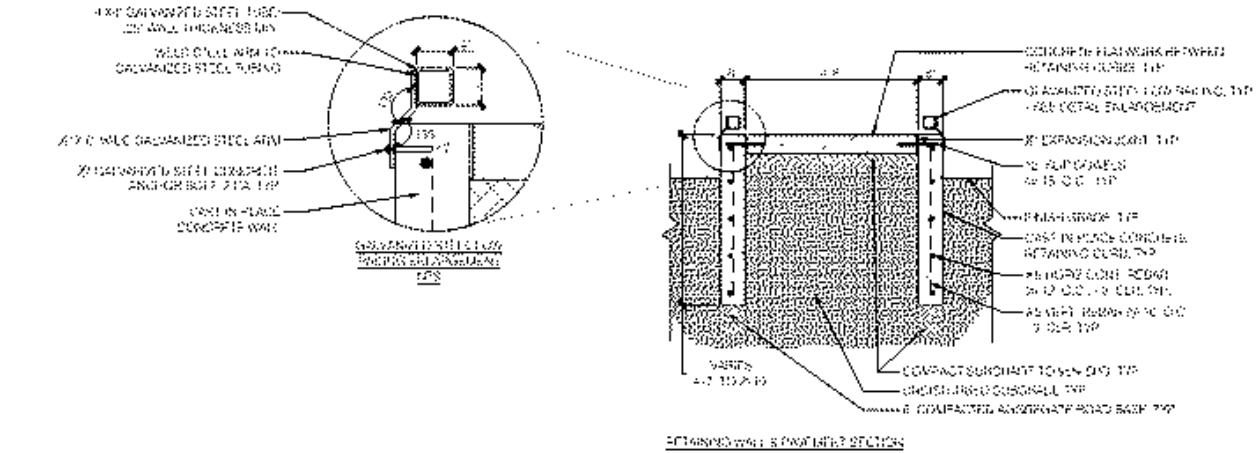


# Integrated Education & Recreation



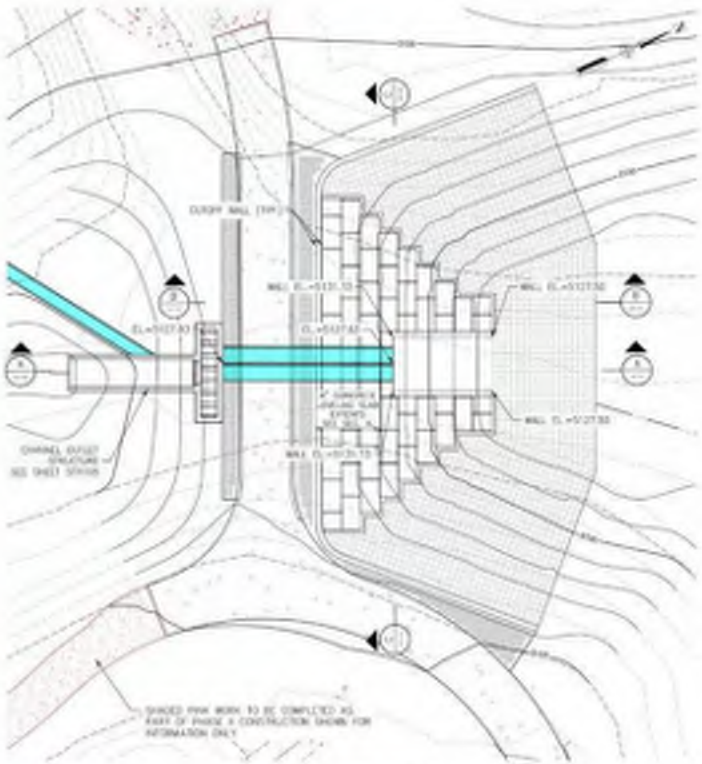


# Low Water Crossing

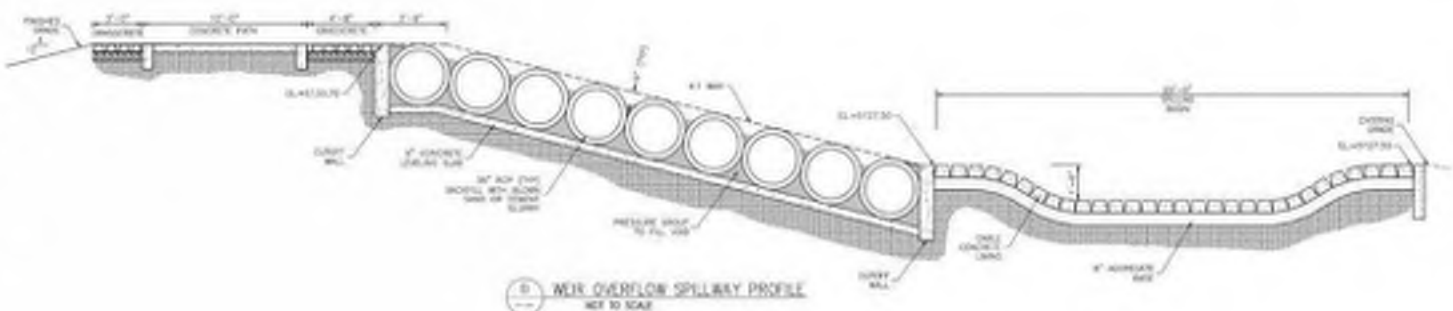




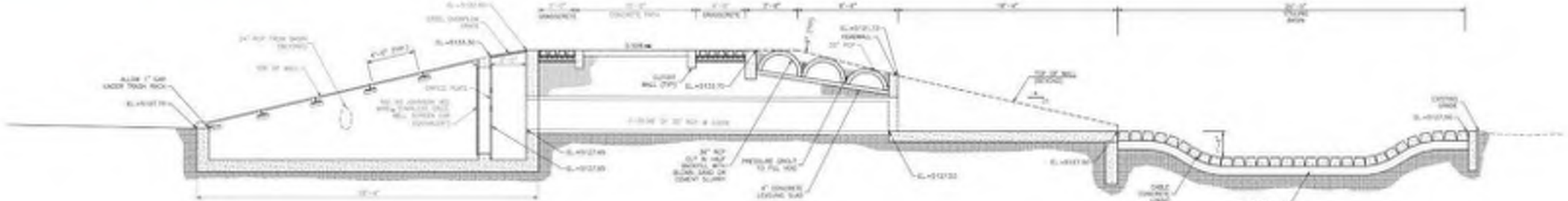
# Weir



WEIR OVERFLOW STRUCTURE PLAN



WEIR OVERFLOW SPILLWAY PROFILE  
NOT TO SCALE



WEIR OVERFLOW PROFILE  
NOT TO SCALE



# Conclusion





Thank you!



Questions?



# Urban Debris Management Pilot Program

City and County of Denver-  
DOTI-Wastewater Management Division

Presenters: **Selena Klosowski, P.E.,CFM** and **Rick Abeyta, P.E., CFM**

Feedback? Questions? Want to Collaborate? Email: [Selena.Klosowski@denvergov.org](mailto:Selena.Klosowski@denvergov.org) or call 303.446.3520



# Pilot Program Overview

**UDMPP** aims to assess, implement and monitor alternative debris management devices that reduce trash load on our waterways and rivers.

One of the deliverables is to provide a guidance document for designer engineers for their debris management solutions, so that they are sustainable to maintain.



# Guidance Document Outline

- List of Equipment in WMD and preferences
- Design suggestions (ex. Off-line, installed at a drop, trash rack configuration/type, help us standardize, consider dry-weather flows)
- List of criteria for decentralized devices
- Possibly a conclusion on our preference on decentralized or centralized devices



# Debris Management Devices

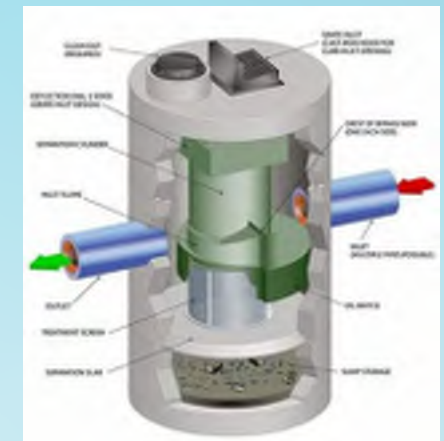
## 1. Centralized: Trash Vaults, Outfall Nets, etc..

### CCD Trash Vaults

- a) City Park Golf Course (Built by IPM in 2018)
- b) Sanderson Gulch (Built by IPM in 2019)
- c) Denargo & Arkins (Built by WMD in 2019)



## 2. Decentralized: Inlet Bags, Hydrodynamic Separators, etc..





## 2019 WMD Urban Debris Management Pilot Program (UDMPP)



## 2020 WMD Urban Debris Management Pilot Program (UDMPP)

### Monitoring Phase



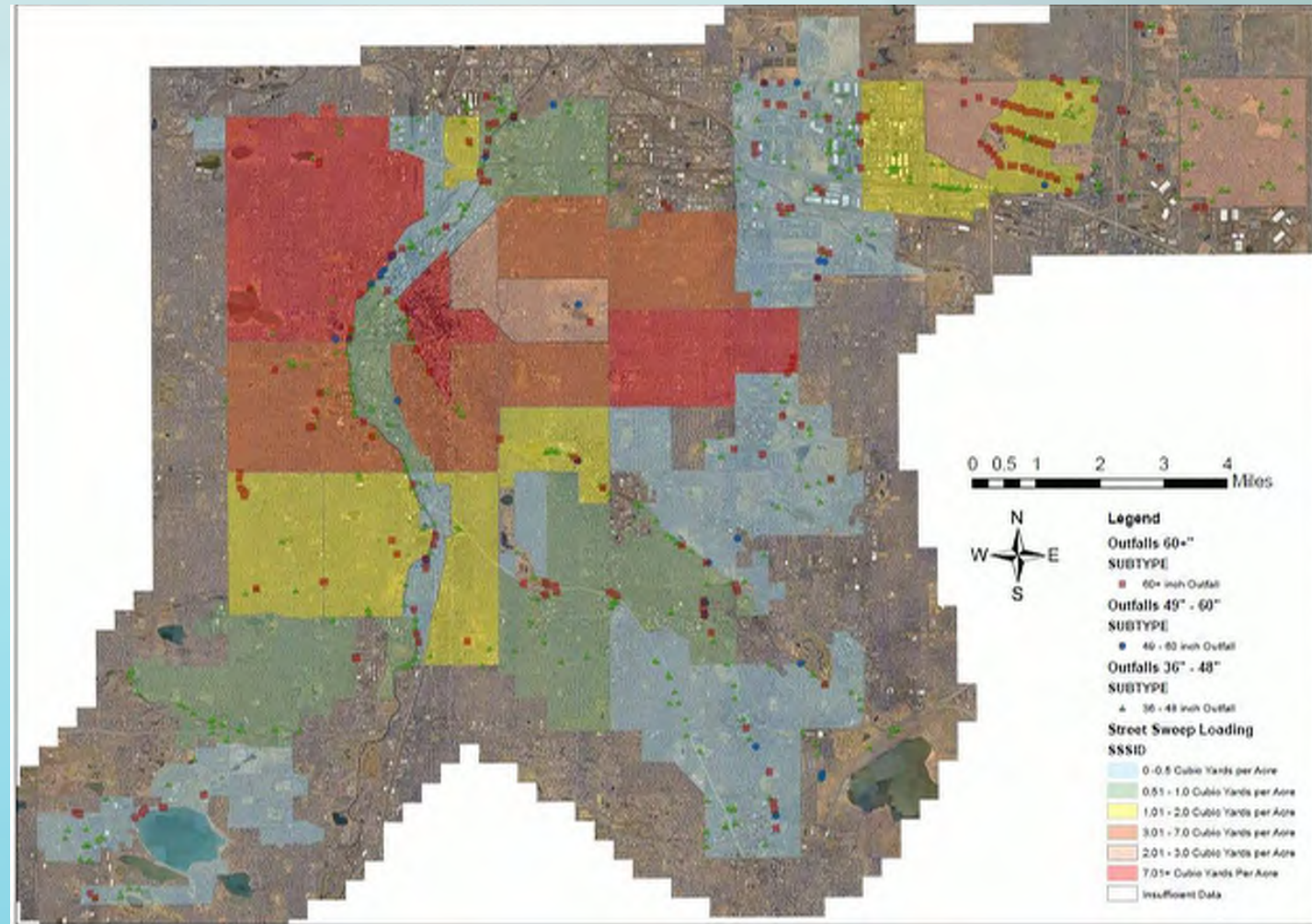


# Trash Vault Planning- Select a Location

Acknowledgments: Kevin Monaweck, E.I.  
and Raul Rodriguez, P.E.

Debris (trash) loading into CCD's storm sewer system was estimated.

- Street sweeping collection volume data (right)
- Large pipe size with a large basin
- Large grade or elevation change. Minimal impact on HGL
- No dry weather flow
- Pipe material and condition
- Ease of construction access and minimal traffic disruption
- Field observations- trashy?



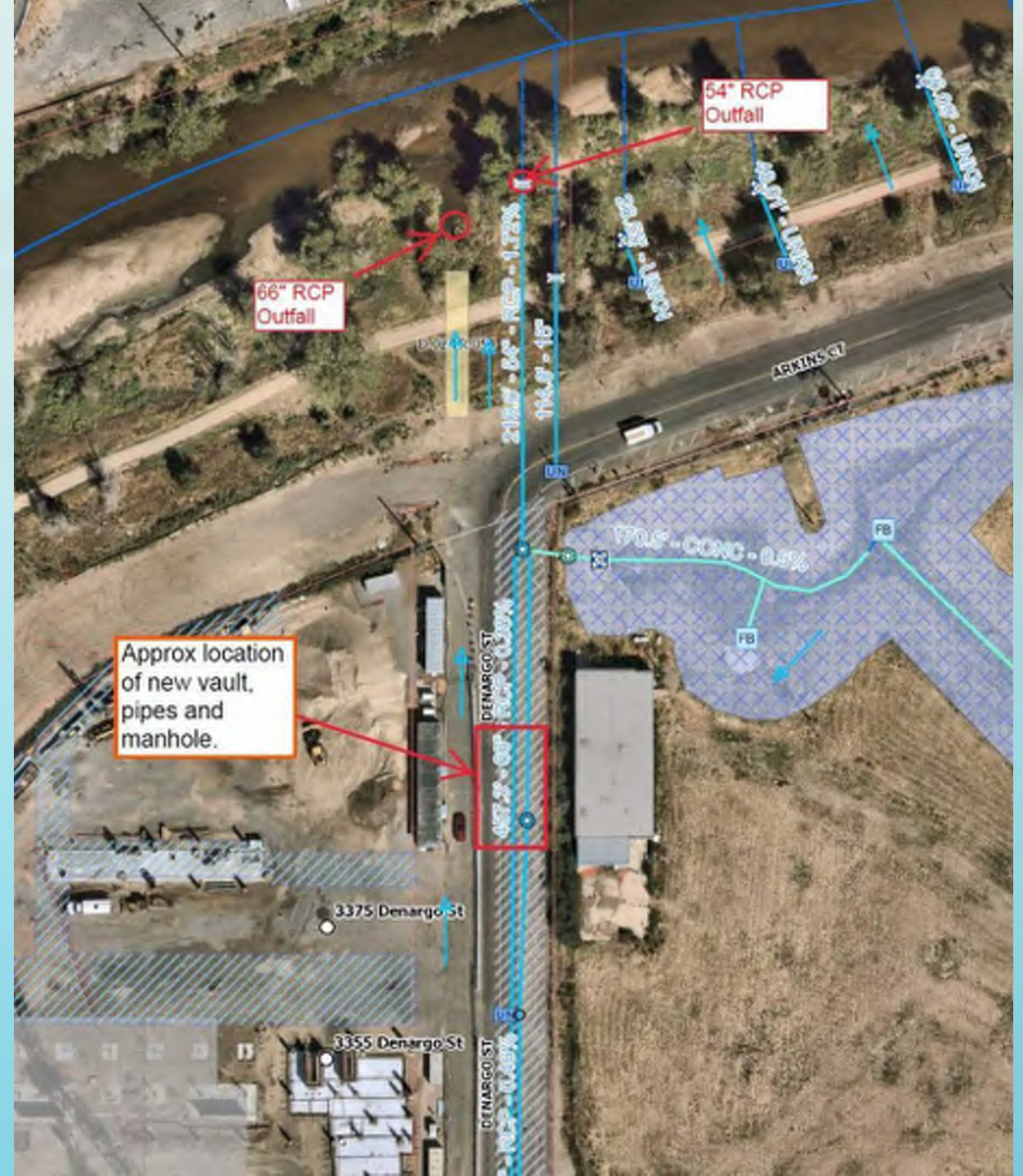






# Denargo & Arkins Trash Vault- Goals Met ✓

- ✓ Red Area on Heat Map
- ✓ Large pipe size with a large basin
- ✓ Drop Manhole = minimal impact on HGL
- ✓ No dry weather flow
- ✓ Large concrete pipe in good condition
- ✓ Ease of construction access and minimal traffic disruption
- ✓ Field observations- “trashy”

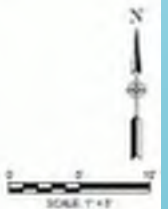
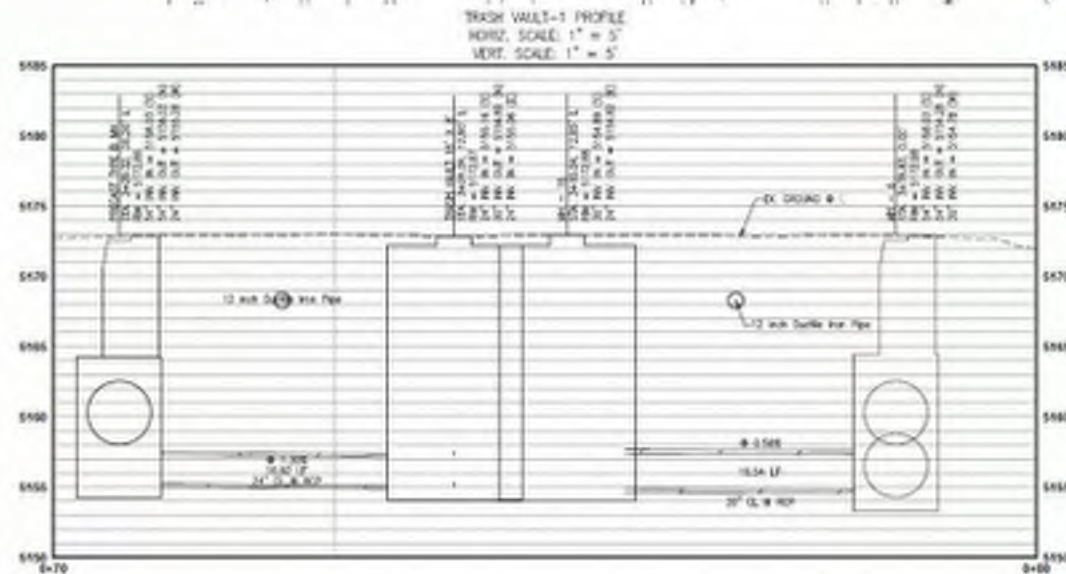
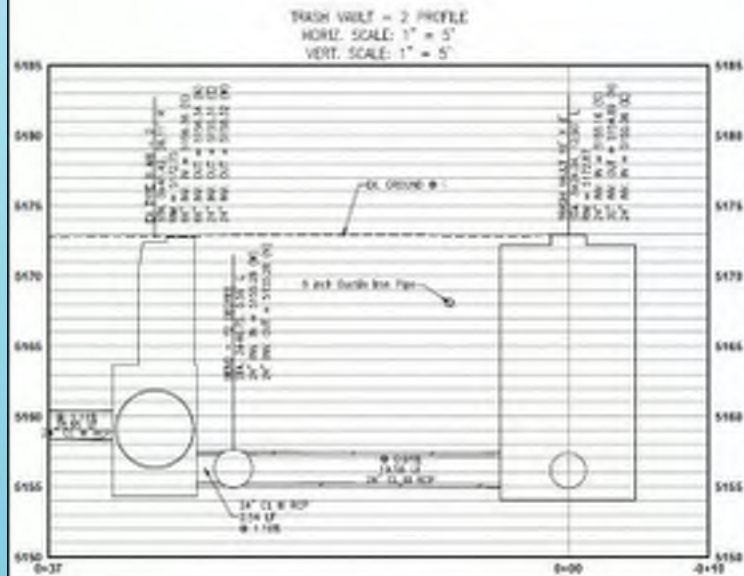
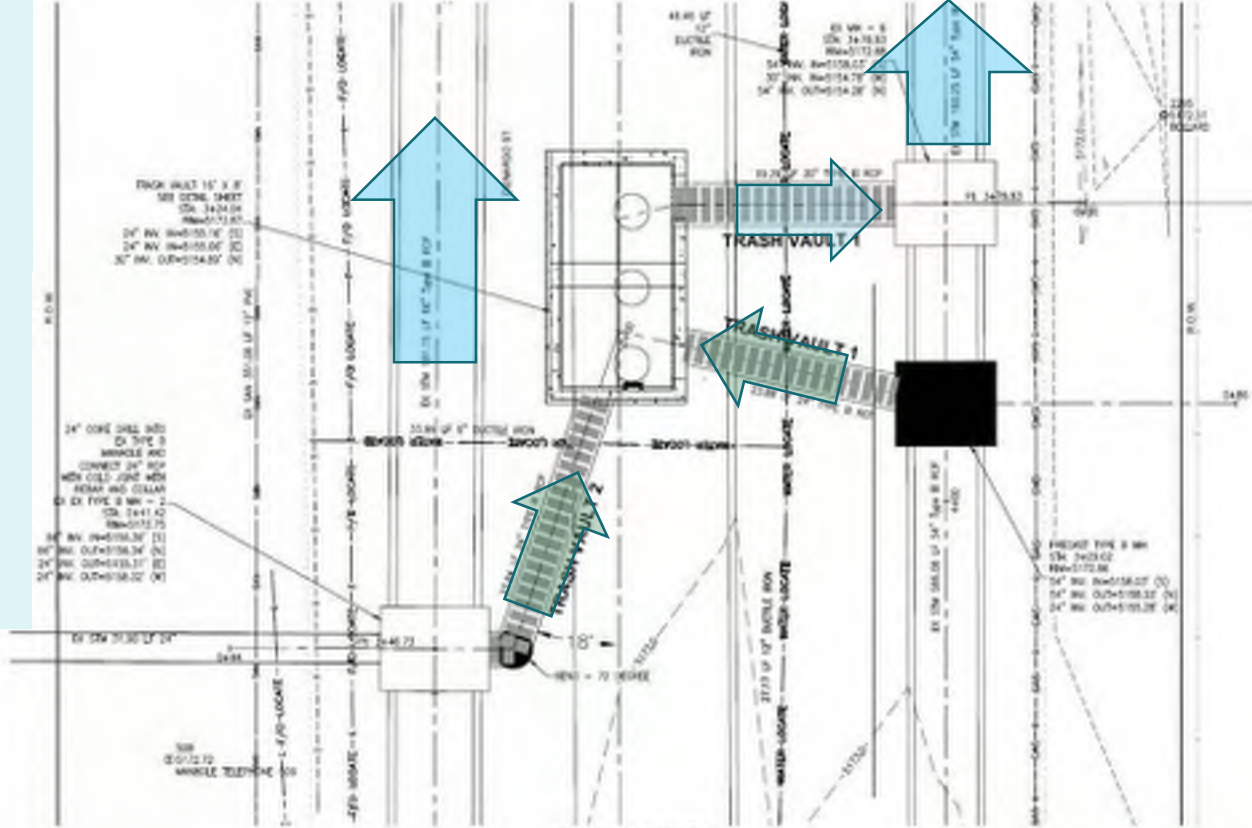




# Denargo & Arkins Trash Vault: In-house Design

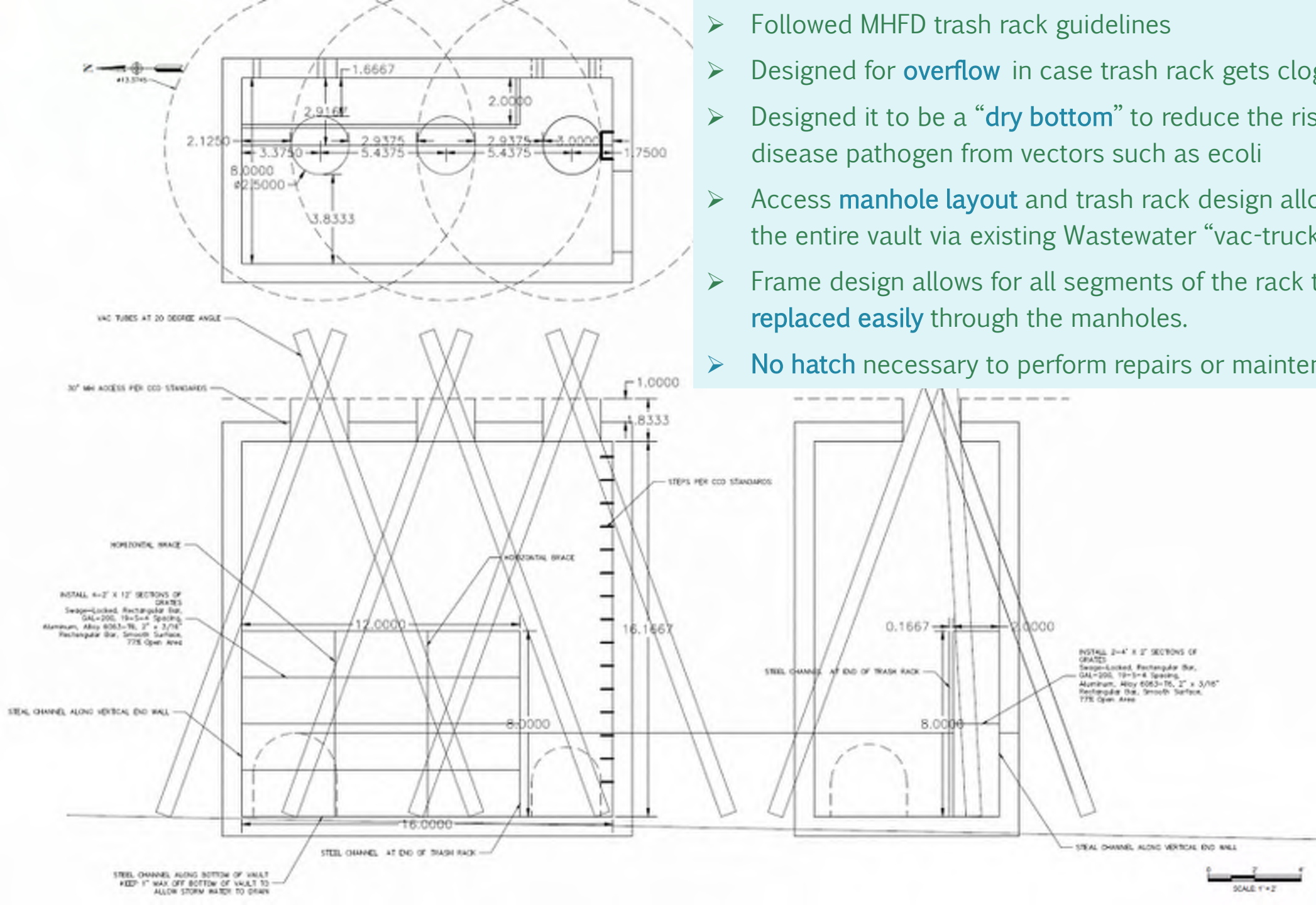
Lead Designer, Senior Engineer: Mark Gehrke, P.E.

- **Off-line:** “Low flows” from two existing large storm pipes (54” and 66”) into one vault, without affecting the capacity of the existing storm system.





- Followed MHFD trash rack guidelines
- Designed for **overflow** in case trash rack gets clogged
- Designed it to be a “**dry bottom**” to reduce the risk of transmission of disease pathogen from vectors such as ecoli
- Access **manhole layout** and trash rack design allows for maintenance of the entire vault via existing Wastewater “vac-trucks”.
- Frame design allows for all segments of the rack to be **removed and replaced easily** through the manholes.
- **No hatch** necessary to perform repairs or maintenance.





# Construction

## Construction Planning Challenges

- 20' deep excavation in unstable material in the middle of the roadway.
- Contaminated soils as the area was once a landfill.
- RTD bus route
- Denargo Market Business District
- Connecting large diameter pipes to existing manholes at deep depths.
- Setting heavy precast concrete segments.





# Traffic Re-route





# Construction Challenges Solutions

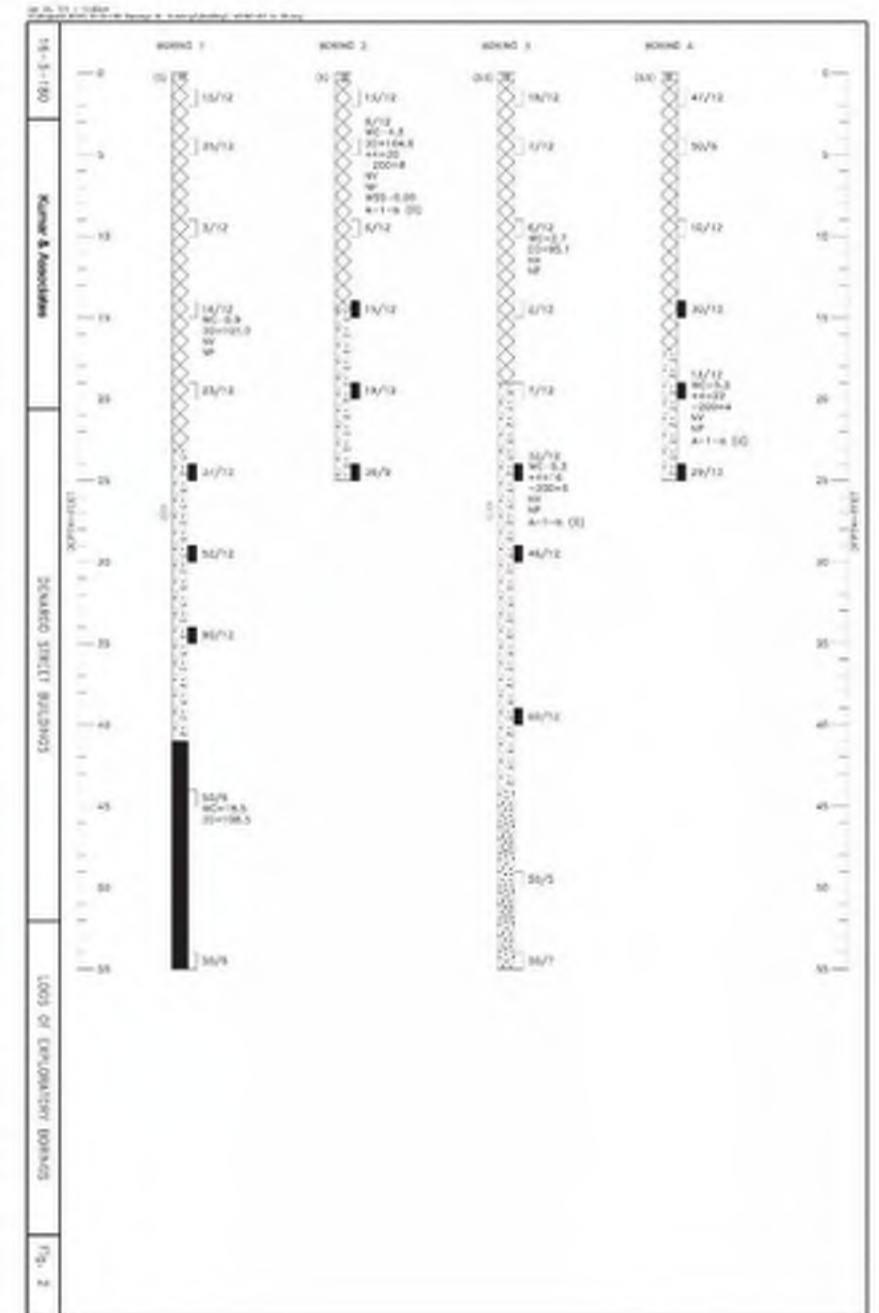
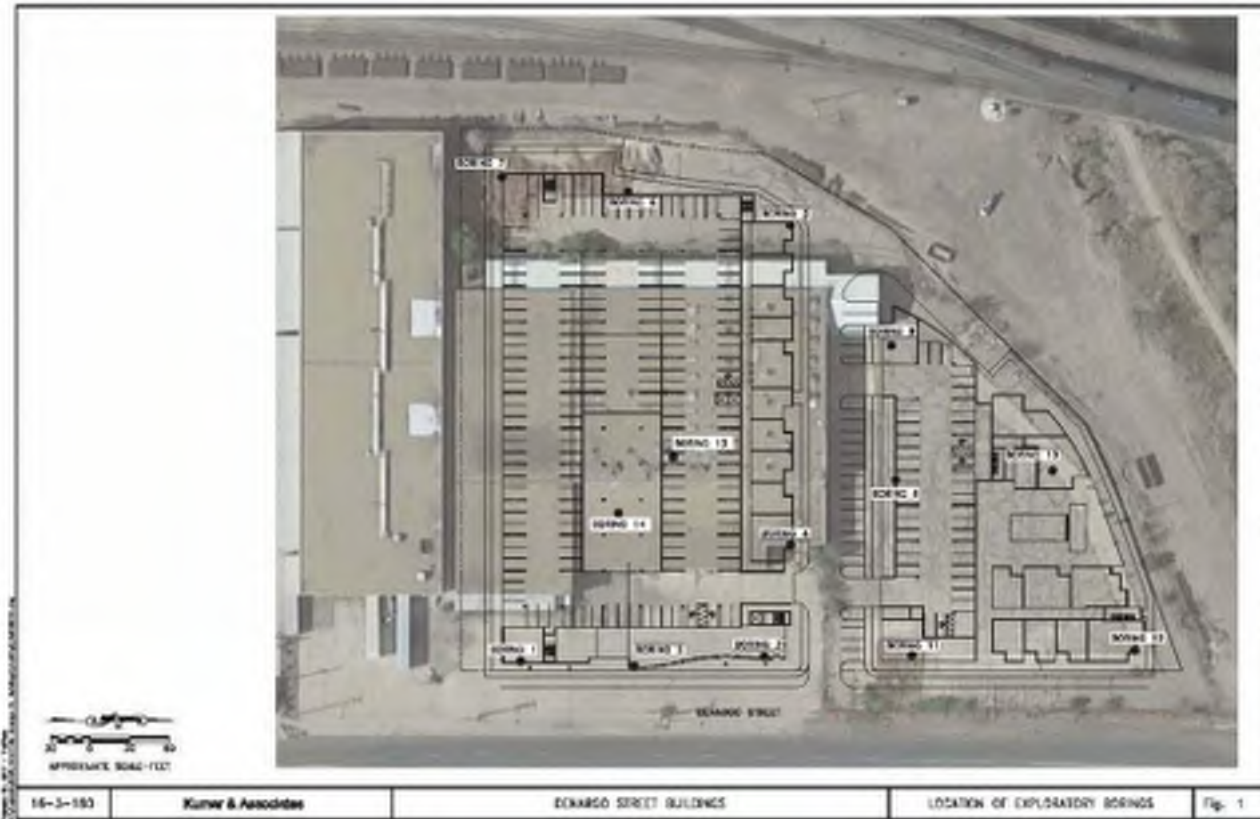
- Shoring and the use of GME Slide Rail Shoring Systems
- Working with DDPHE and Waste Management to manifest and dispose of contaminated material.
- Coordination with RTD and Denargo Market Business District.





# Shoring Selection

Boring logs along Denargo Street show from 1 to 15 feet  
Variable soils and debris. (contaminated fill).  
From 15 to 40 feet poorly graded sand (unstable).







## Mass Excavation and Haul

A total of 866 cubic yards of excavation were manifested and hauled to Denver Arapahoe Disposal Site.







# Slide Rail Installation





## Excavation to Depth



## Bedding for the Vault





# Setting Precast Vault Segments





110 Ton Crane setting 27,500  
LBS Vault section.





# Lateral Pipe Connections

Concrete collars connecting new RCP to existing and new manholes.



30" diameter core hole through existing manhole 2' thick.





# Backfill, Compaction and Pavement

Clean select fill material supplied by Central 70 Project. 650 cubic yards delivered at no cost to the project.

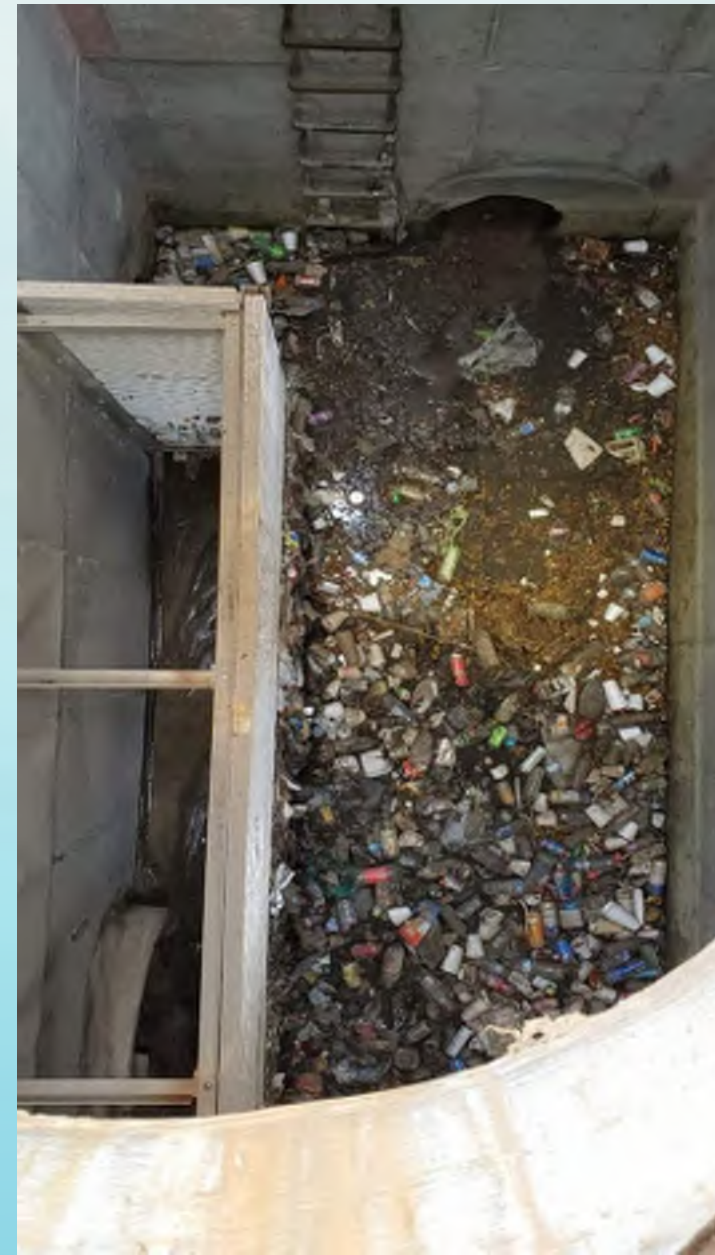


Asphalt pavement supplied and placed by Denver DOTI Street Maintenance.



# Grating and Trash Collection

DOTI Wastewater master trades installing custom grating to collect the trash.



Trash collection 7/15/2020



# Total Trash Vault Cost and Duration

- Labor Cost \$101,832.53
- Equipment Cost \$70,257.64
- Materials Cost \$56,597.09
- Subcontractors \$5,231.65
- Total Cost \$233,918.91

Begin Construction October 15, 2019.  
Completed Construction January 21, 2020.

## Completed Lucity Work Order

Work Order Number	Address	Completed Date	Labor Hours	Labor Cost	Equip. Cost	Material Cost	Misc. Cost	Contractor Cost	Task Units	Average Cost	Total Cost	Notes
19-00415	3125 DUNBAR ST	10/15/2019	481.52	\$14,115.11	\$4,204.42	\$9.40	\$0.00	\$4.39	1.00	\$14,554.33	\$14,554.33	SPRINKLER SYSTEM
19-01543	2225 DUNBAR ST	10/22/2019	718.30	\$24,546.88	\$1,303.10	\$0.00	\$0.00	\$1.00	1.00	\$25,849.98	\$25,849.98	SPECIAL PROJECTS
19-01135	3125 DUNBAR ST	10/21/2019	864.54	\$10,927.80	\$8,192.32	\$0.00	\$0.00	\$0.00	1.00	\$19,120.12	\$19,120.12	SPECIAL PROJECTS
20-02123	3125 DUNBAR ST	10/12/2019	883.20	\$19,543.82	\$16,139.22	\$17,309.33	\$0.00	\$5,231.65	1.00	\$51,023.42	\$51,023.42	SPECIAL PROJECTS
20-02106	2225 DUNBAR ST	10/22/2019	152.20	\$6,161.70	\$1,623.12	\$0.00	\$0.00	\$0.00	1.00	\$7,784.82	\$7,784.82	Install New MH - STM
20-02116	3125 DUNBAR ST	10/21/2019	162.83	\$5,112.16	\$1,283.46	\$0.00	\$0.00	\$0.00	1.00	\$6,395.62	\$6,395.62	Install New MH - STM
Grand Crew Total:			7,092.59	\$101,832.53	\$17,750.12	\$16,597.09	\$0.00	\$5,231.65			\$233,918.91	
Work Orders:			7,092.59	\$101,832.53	\$17,750.12	\$16,597.09	\$0.00	\$5,231.65			\$233,918.91	

\* Attached file indicates permission to use the shared field is waived off

Page: 1



# UDMPP Support & Feedback

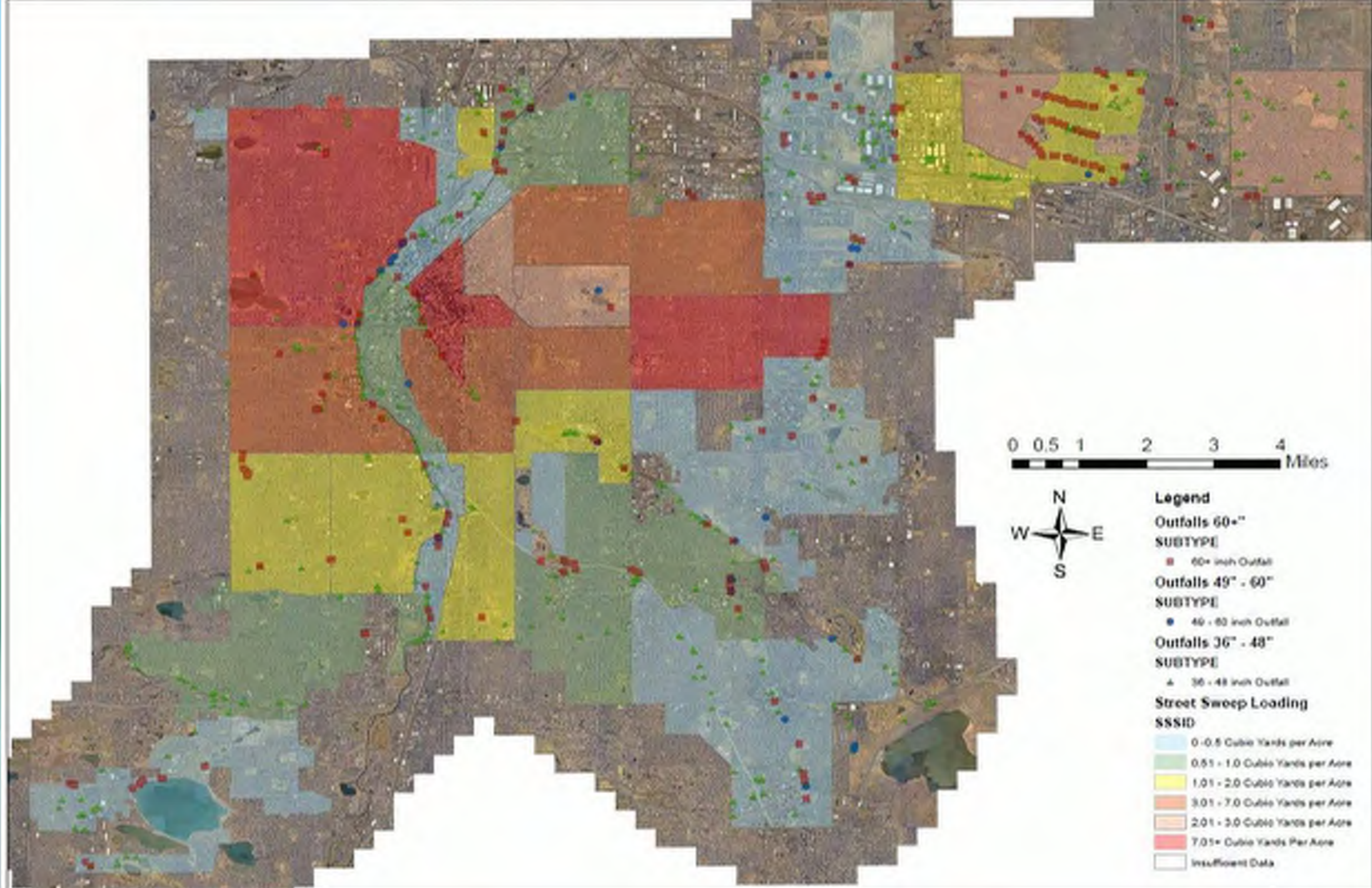
Questions? Feedback? Want to collaborate or share data?

Contact me at:

[Selena.Klosowski@denvergov.org](mailto:Selena.Klosowski@denvergov.org)

303-446-3520







An aerial photograph of a city, likely Portland, Oregon, showing a dense urban grid, a river (the Willamette River) winding through the center, and various green spaces including parks and sports fields. A semi-transparent green banner is overlaid across the middle of the image.

# PLANNING FOR GREEN INFRASTRUCTURE SUCCESS

CASFM 2020



# Overview

- ❑ Drivers
- ❑ Challenges
- ❑ Elements
- ❑ Summary of SRA
- ❑ Programmatic strategies
- ❑ Regulatory strategies
- ❑ Public vs. Private
- ❑ Public engagement



# DRIVERS

- MS4 Compliance
  - TMDL Waste Load Allocations
  - Non-degradation planning
- Channel erosion
- Land and infrastructure damage/risk
- Recreational, aesthetic, ecological and economic values





# GREEN INFRASTRUCTURE $\longleftrightarrow$ MS4 PERMIT



## Public Education and Outreach

- Program establishment
- Target webpage
- Education materials
- Specific materials for priority areas



## Public Involvement/Participation

- Program
- Target webpage
- Priority area planning
- Implementation

## Illicit Discharge Detection and Elimination

- Program
- Target webpage with reporting mechanism
- Rainleader disconnection

## Construction Site Stormwater Management

- Program
- Target webpage
- Development ordinance updated



## Post-Construction Stormwater Management

- Program
- Target webpage
- New development and redevelopment ordinance updated prioritizing Green Infrastructure

## Pollution Prevention/Good Housekeeping

- Program
- Target webpage
- Pollution prevention plan



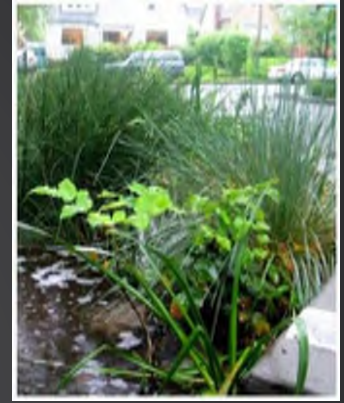
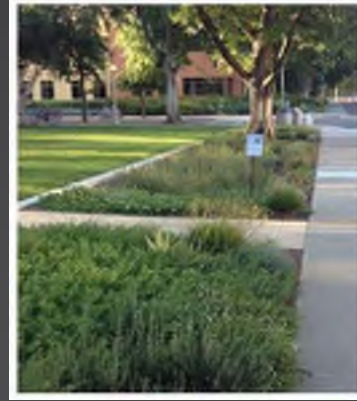
Main MCM's Addressed





# CHALLENGES

- Built-out urban landscape
- Cost and Funding
- Perceptions
- Program adaptability
- ROW issues
- Climate adaptability





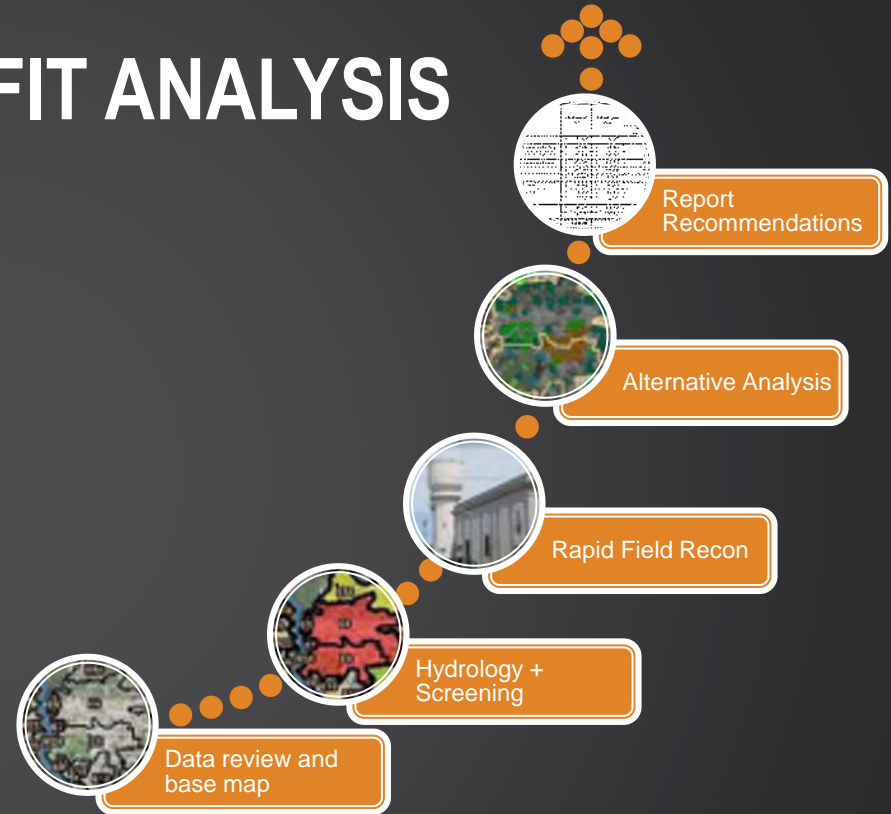
# ELEMENTS

- Implementation plan
  - Targeted and prioritized retrofit plan (“PTM” with measurable results)
  - Public and private strategies
- Stormwater WQ Program
  - Ordinances updated
  - Education-outreach and Public Participation program (E/O & PP)
  - Funding mechanism



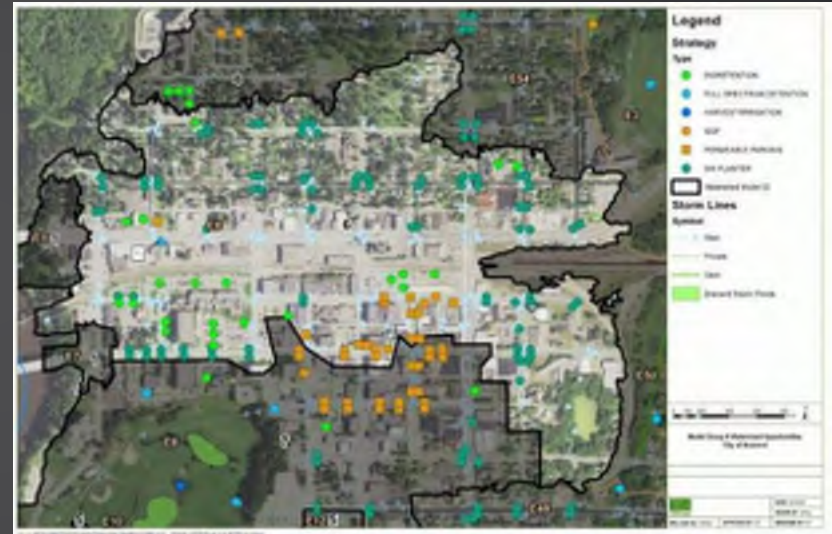
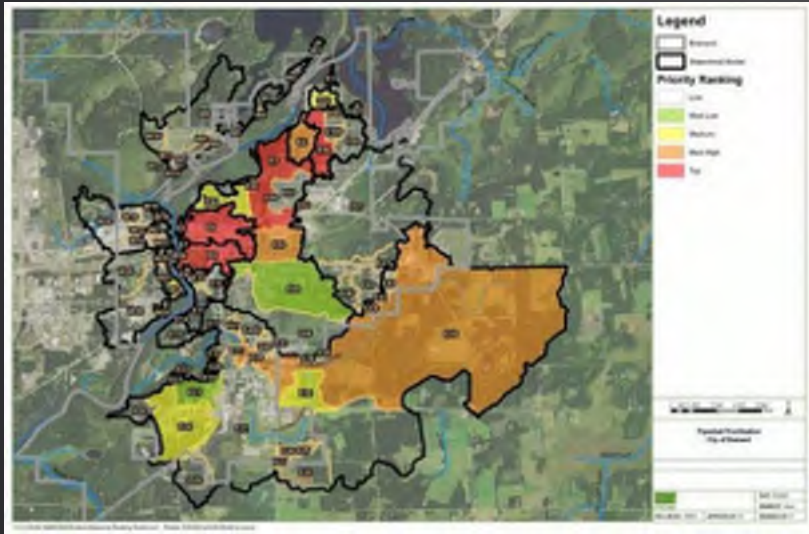


# SUBWATERSHED RETROFIT ANALYSIS





# SUBWATERSHED RETROFIT ANALYSIS



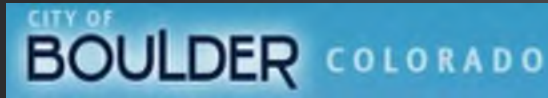
# SUBWATERSHED RETROFIT ANALYSIS

Subwatershed	Alternative	Construction Cost	Present Day Value	Pollutant Removal Relative to Outfall to River		\$ /lb-TSS	\$ /lb-TP
				TSS-Lbs Removed	TP-Lbs Removed		
E49/50	Site #1 Stormwater Wetland + IESF	\$ 250,000	\$ 281,380	54,832	152	\$ 0.17	\$ 62
E8	Bioretention and/or Stormwater Planters (13% TSS)	\$ 47,250	\$ 53,760	4,037	4	\$ 0.44	\$ 448
E6	Bioretention and/or Stormwater Planters (20% TSS)	\$ 160,650	\$ 182,785	10,877	8	\$ 0.56	\$ 762
E8	Site #2 Full Spectrum Detention (maximized to site)	\$ 317,128	\$ 353,745	14,894	30.1	\$ 0.79	\$ 392
E6	Full Spectrum Detention	\$ 292,768	\$ 329,385	10,449	15	\$ 1.05	\$ 732
E54	Site #2 P3001 IESF	\$ 119,060	\$ 87,019	2,484	13	\$ 1.17	\$ 223
E53	Bioretention and/or Stormwater Planters	\$ 70,950	\$ 85,273	1,674	4	\$ 1.70	\$ 711
E3	Bioretention and/or Stormwater Planters	\$ 70,950	\$ 85,273	1,674	4	\$ 1.70	\$ 711
E8	Permeable Parking (11% TSS)	\$ 85,758	\$ 336,151	3,258	7	\$ 3.44	\$ 1,601
E6	Permeable Parking (4a% TSS)	\$ 85,758	\$ 336,151	2,000	5	\$ 5.60	\$ 2,241
W15/18	Pond P4002 IESF	\$ 184,710	\$ 149,130	282	13.8	\$ 17.63	\$ 360
	<b>Totals</b>	<b>\$ 1,684,982</b>		<b>106,461</b>	<b>256</b>		



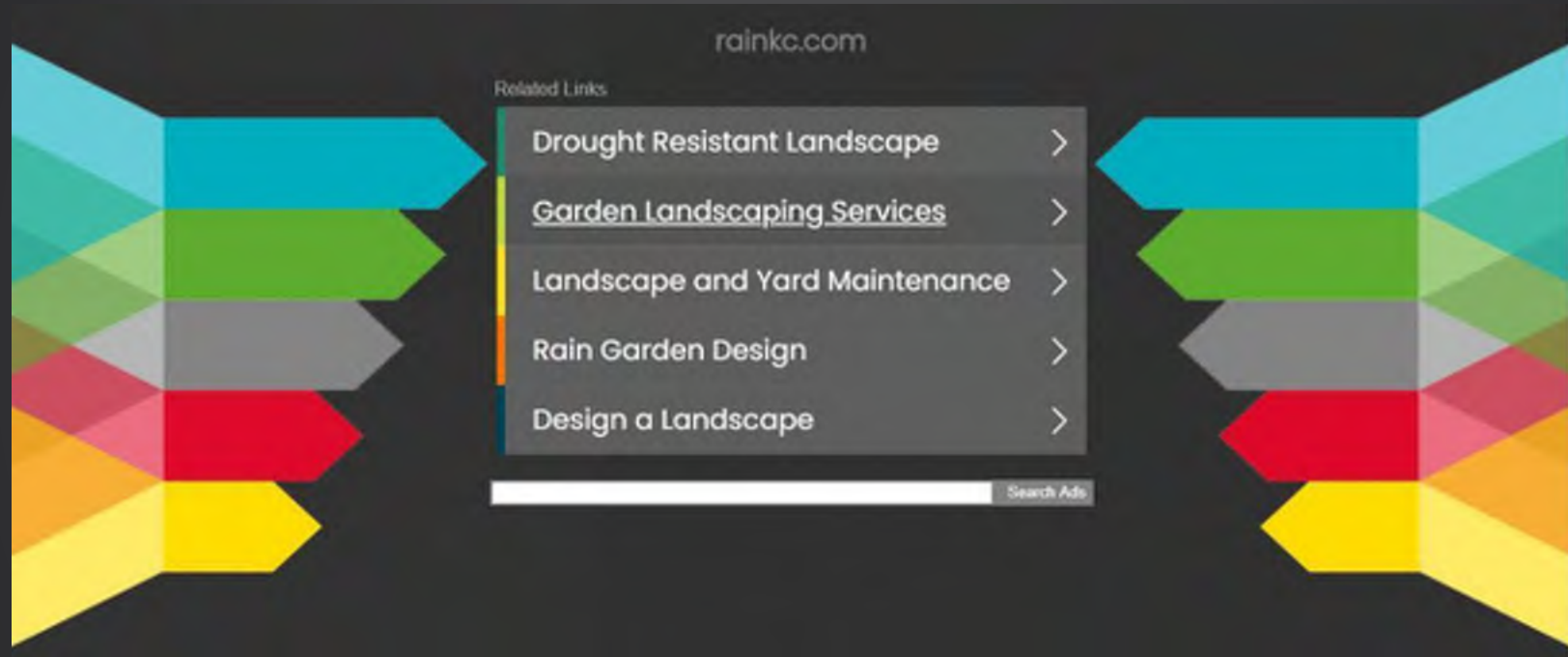
# PUBLIC AND PRIVATE IMPEMENTATION

## PUBLIC ENGAGEMENT AND BUY-IN



# PUBLIC AND PRIVATE IMPEMENTATION

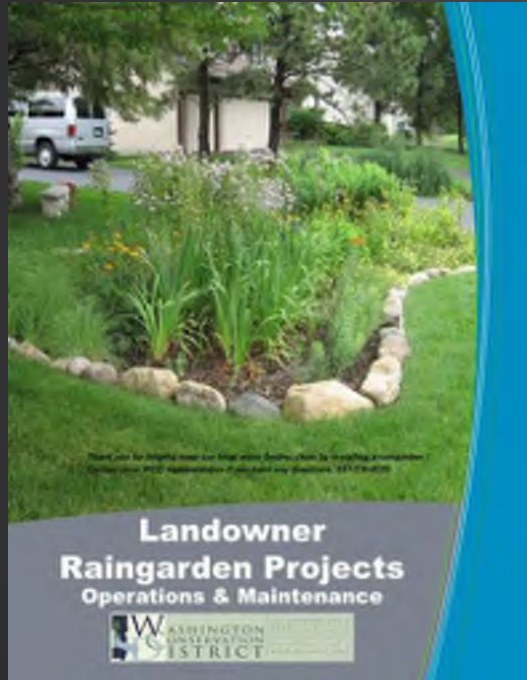
## PUBLIC ENGAGEMENT AND BUY-IN





# PUBLIC AND PRIVATE IMPEMENTATION

## PUBLIC ENGAGEMENT AND BUY-IN



We have discussed the guidelines for operations and maintenance contained herein.

Landowner: \_\_\_\_\_ Date: \_\_\_\_\_

We agree to the terms of the operations and maintenance contract contained herein.

Landowner: \_\_\_\_\_ Date: \_\_\_\_\_

We agree to the terms of the operations and maintenance contract contained herein.

Browns Creek Watershed District Representative \_\_\_\_\_ Date: \_\_\_\_\_



# PUBLIC AND PRIVATE IMPEMENTATION



## 803.05: STORMWATER BEST MANAGEMENT PRACTICE (BMP) MAINTENANCE

- Maintenance req's
  - Private stormwater BMP's maintenance (5-yr)
  - Maintenance plan
  - Inspection
  - Public stormwater maintenance
- Inventory of stormwater BMP's
- Failure to maintain private BMP's



### Stormwater Best Management Practice (BMP) Maintenance Checklist

Property Name	
Site Address	
City, State, Zip	
Contact Person	
Phone	
Email	
Date	

All sites with stormwater BMP's are required to provide the following. Templates are available for use on the City Website [www.ci.roseville.ca.us/gov/civdiv.htm](http://www.ci.roseville.ca.us/gov/civdiv.htm)

- ☐ 1. Contact the City with a schedule of maintenance activities.
- ☐ 2. Inspect and fill out and inspection checklist for each BMP.
  - a. If your site has multiple BMP's, an overview map should be included noting the location and inspection number.
  - b. Ponds, wetlands, and sumped catch basins/manholes should use the Pond Inspection Checklist and others practices can use the Maintenance Checklist. If your BMP is a manufactured proprietary structure (StormTech, StormTrap, ConTech, etc.), refer to their maintenance recommendations.
- ☐ 3. Maintain the BMP to ensure proper functionality.
  - a. Information on maintaining the BMP can be found on the Minnesota Stormwater Manual's webpage [https://stormwater.pca.state.mn.us/index.php?title=Main\\_Page](https://stormwater.pca.state.mn.us/index.php?title=Main_Page), or per your manufacturer's recommendations.
  - b. Maintaining storm ponds should follow the MPCA's "Managing Stormwater Sediment Best Management Practice Guidance" May 2017.
- ☐ 4. Document the BMP post-maintenance to show the work completed, and include 1-2 photos of each BMP.
- ☐ 5. Fill out and return the Operation and Maintenance Agreement (example available on City website)
- ☐ 6. Create and submit a Maintenance Plan that provides a narrative, schedule, task, and responsible person for maintenance (example available on City website).
- ☐ 7. Submit the this final checklist with inspection documentation
- ☐ 8. Email items 1-7 to [rain Johnson@ci.roseville.ca.us](mailto:rain Johnson@ci.roseville.ca.us) for review.



# PUBLIC ENGAGEMENT AND BUY-IN

## COMMON ROADBLOCKS

- “Green Infrastructure is too wild, wooly and weedy looking”



## SOLUTIONS

- Well-designed landscaping approach

# PUBLIC ENGAGEMENT AND BUY-IN

## COMMON ROADBLOCKS

- “Green Infrastructure is too wild, wooly and weedy looking”
- “The public doesn’t know how to maintain them”



## SOLUTIONS

- Well-designed landscaping approach
- Provide workshops and simple maintenance plans



# PUBLIC ENGAGEMENT AND BUY-IN

## COMMON ROADBLOCKS

- “Green Infrastructure is too wild, wooly and weedy looking”
- “The public doesn’t know how to maintain them”
- “Public works staff doesn’t know how to maintain them”



## SOLUTIONS

- Well-designed landscaping approach
- Provide workshops and simple maintenance plans
- Train staff and provide maintenance plans by type

# PUBLIC ENGAGEMENT AND BUY-IN

## COMMON ROADBLOCKS

- “Green Infrastructure is too wild, wooly and weedy looking”
- “The public doesn’t know how to maintain them”
- “Public works staff doesn’t know how to maintain them”
- “Green infrastructure requires too much maintenance”



## SOLUTIONS

- Well-designed landscaping approach
- Provide workshops and simple maintenance plans
- Train staff and provide maintenance plans by type
- Maintenance-driven design + sediment forebay



# PUBLIC ENGAGEMENT AND BUY-IN

## COMMON ROADBLOCKS

- “Green Infrastructure is too wild, wooly and weedy looking”
- “The public doesn’t know how to maintain them”
- “Public works staff doesn’t know how to maintain them”
- “Green infrastructure requires too much maintenance”
- “Green infrastructure doesn’t work in semi-arid to arid landscapes”



## SOLUTIONS

- Well-designed landscaping approach
- Provide workshops and simple maintenance plans
- Train staff and provide maintenance plans by type
- Maintenance-driven design + sediment forebay
- Present case studies from semi-arid and arid muni’s

# PUBLIC ENGAGEMENT AND BUY-IN

## COMMON ROADBLOCKS

- “Green Infrastructure is too wild, wooly and weedy looking”
- “The public doesn’t know how to maintain them”
- “Public works staff doesn’t know how to maintain them”
- “Green infrastructure requires too much maintenance”
- “Green infrastructure doesn’t work in semi-arid to arid landscapes”
- “It’s too expensive”



## SOLUTIONS

- Well-designed landscaping approach
- Provide workshops and simple maintenance plans
- Train staff and provide maintenance plans by type
- Maintenance-driven design + sediment forebay
- Present case studies from semi-arid and arid muni’s
- Cheapest \$/LB-pollutant



# Take Home Messages

- Prioritizes specific, targeted and measurable strategies
- Assures fiscal responsibility
- Assures sustainable solutions
- Tie-in to MS4 Program and Comp Plans

# Contact Information



**Shawn Tracy, WR PM**  
[stracy@hrgreen.com](mailto:stracy@hrgreen.com)

**Chris McFarland, PE CFM**  
[cmcfarland@hrgreen.com](mailto:cmcfarland@hrgreen.com)

[HRGREEN.COM](http://HRGREEN.COM)



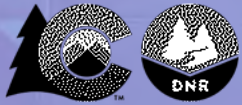
# Colorado Fluvial Hazard Mapping Program

CASFM - 2020

- Michael Blazewicz, Round River Design
- Katie Jagt, Watershed Science and Design
- Joel Sholtes, University of Colorado, WASH Engineering
- Chris Sturm, Colorado Water Conservation Board



# Colorado Fluvial Hazard Mapping Program



**COLORADO**

Colorado Water  
Conservation Board

Department of Natural Resources



**WATERSHED**

SCIENCE + DESIGN



**wash**  
WATER SCIENCE AND ENGINEERING



**COLORADO**  
FLUVIAL HAZARD ZONE



[www.ColoradoFHZ.com](http://www.ColoradoFHZ.com)



# Bottom Line

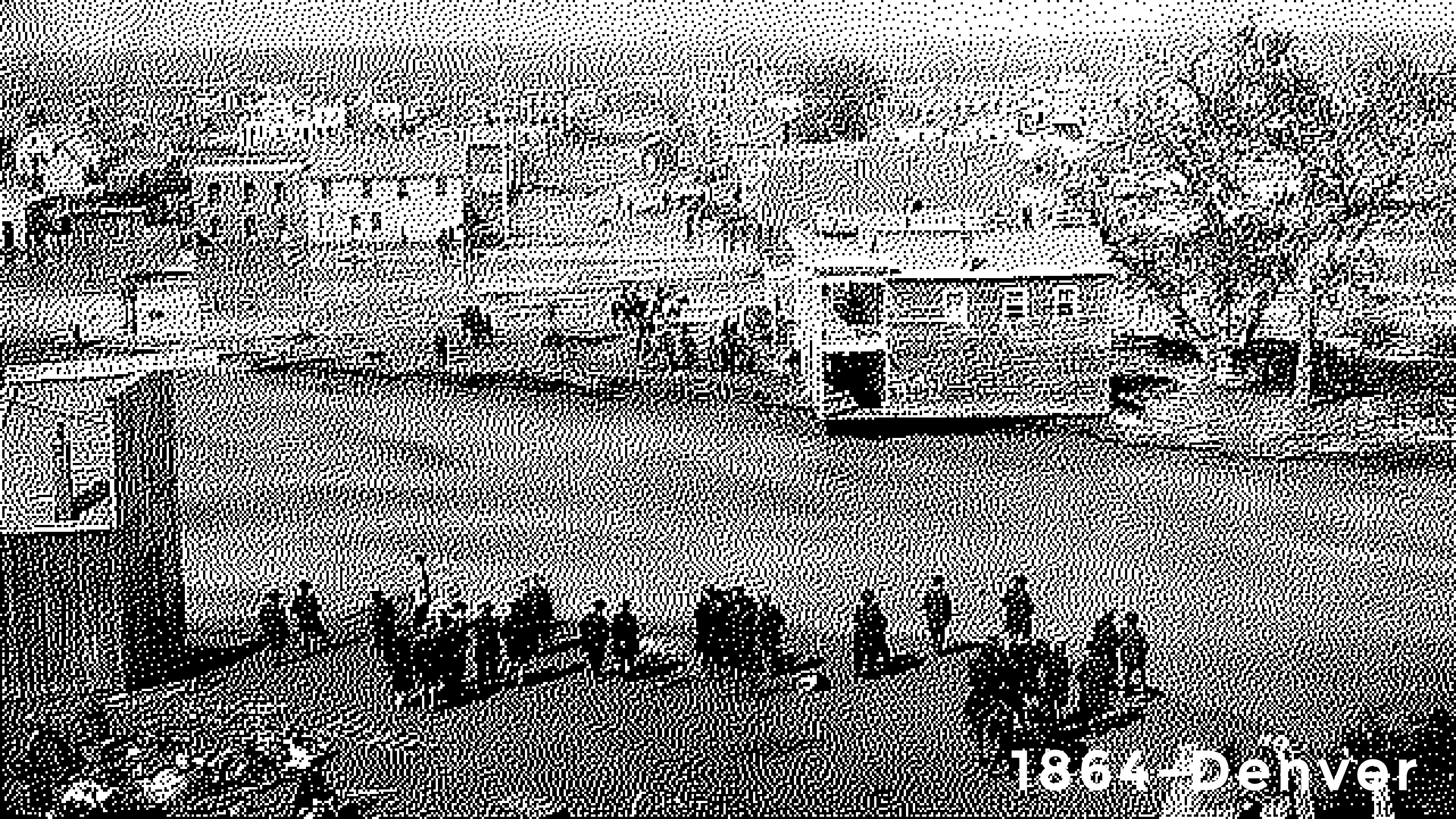
1. Streams are dynamic, they require space
2. Streams are corridors, not lines
3. Here's a way to define the space they occupy and influence
4. For better or for worse



2013-Lyons







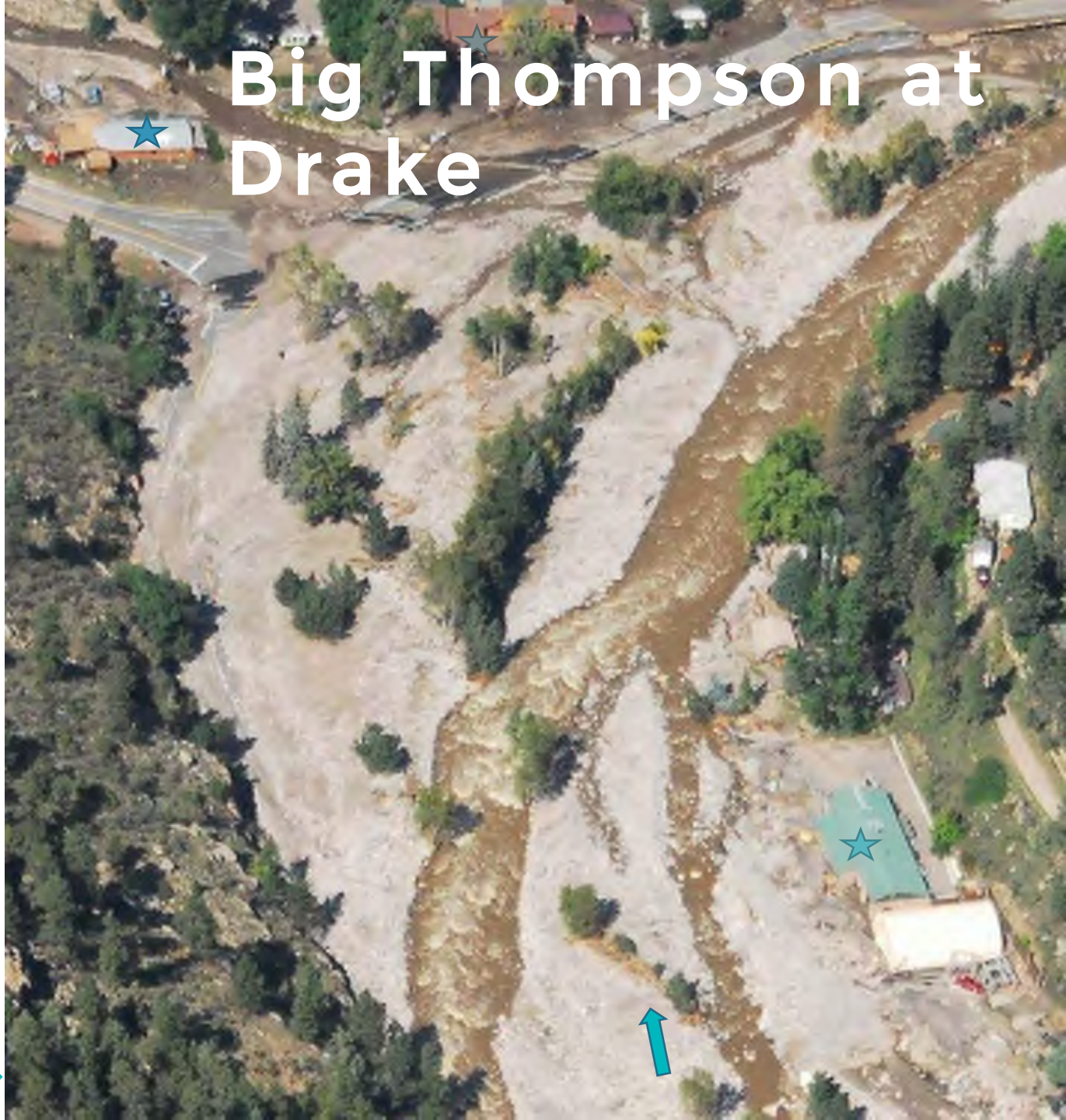
1864-Denver





1976 ↑

2013 ↓



Big Thompson at  
Drake



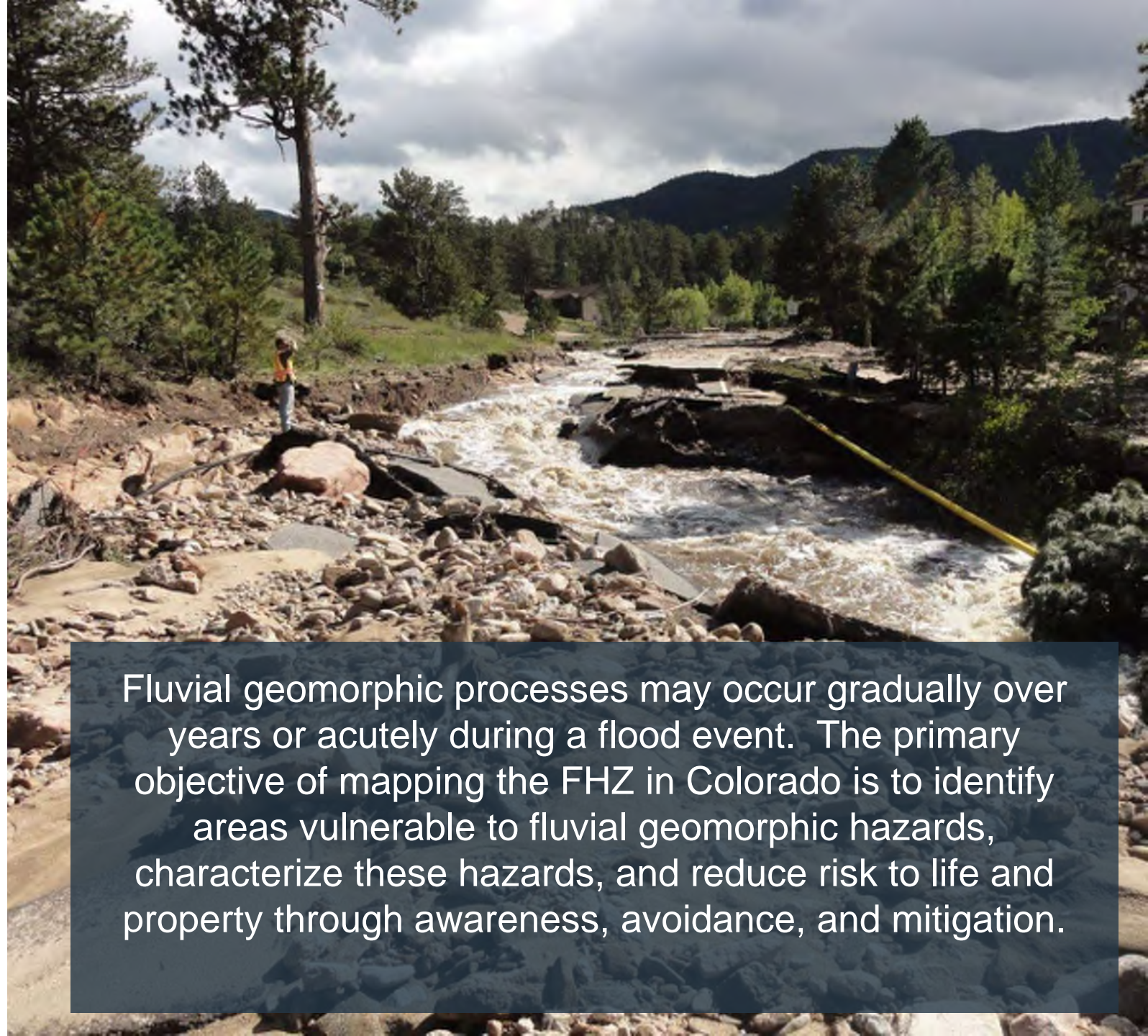


Rio Grande



# Fluvial Hazard Zone

The Fluvial Hazard Zone (FHZ) is the area a stream has occupied in recent history, may occupy, or may physically influence as it stores and transports water, sediment, and debris.



Fluvial geomorphic processes may occur gradually over years or acutely during a flood event. The primary objective of mapping the FHZ in Colorado is to identify areas vulnerable to fluvial geomorphic hazards, characterize these hazards, and reduce risk to life and property through awareness, avoidance, and mitigation.



# FHZ

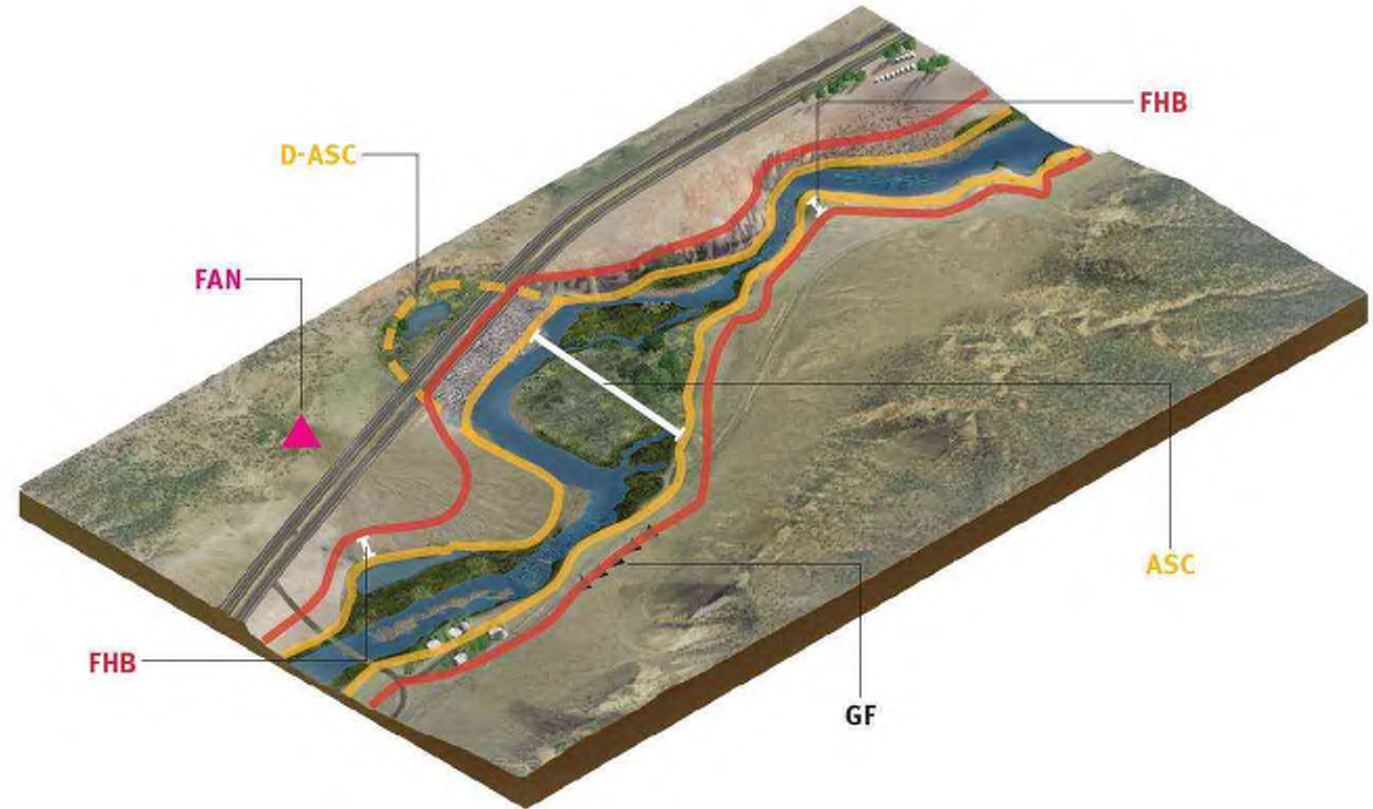
## Colorado FLUVIAL HAZARD ZONE Delineation Protocol

AUGUST 2020



COLORADO  
Colorado Water  
Conservation Board  
Department of Natural Resources

[www.ColoradoFHZ.com](http://www.ColoradoFHZ.com)



- Active Stream Corridor (ASC)
- Fluvial Hazard Buffer (FHB)
- Avulsion Hazard Zone (AHZ)–Not Shown
- Fan (F)
- Geotechnical Flag (GF)
- Disconnected Active Stream Corridor (D-ASC)

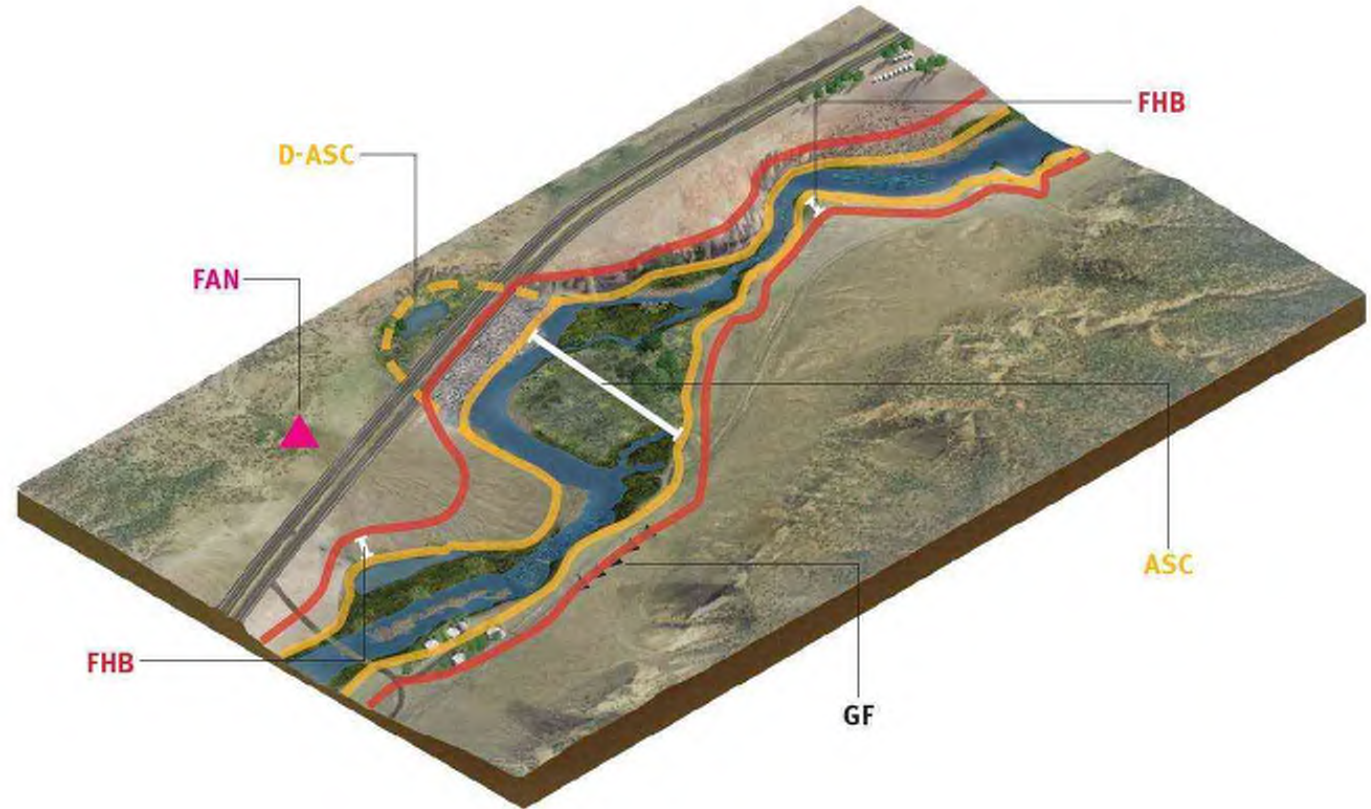




# FHZ

## Colorado FLUVIAL HAZARD ZONE Delineation Protocol

AUGUST 2020



- **Active Stream Corridor (ASC)**
- **Fluvial Hazard Buffer (FHB)**
- Avulsion Hazard Zone (AHZ)–Not Shown
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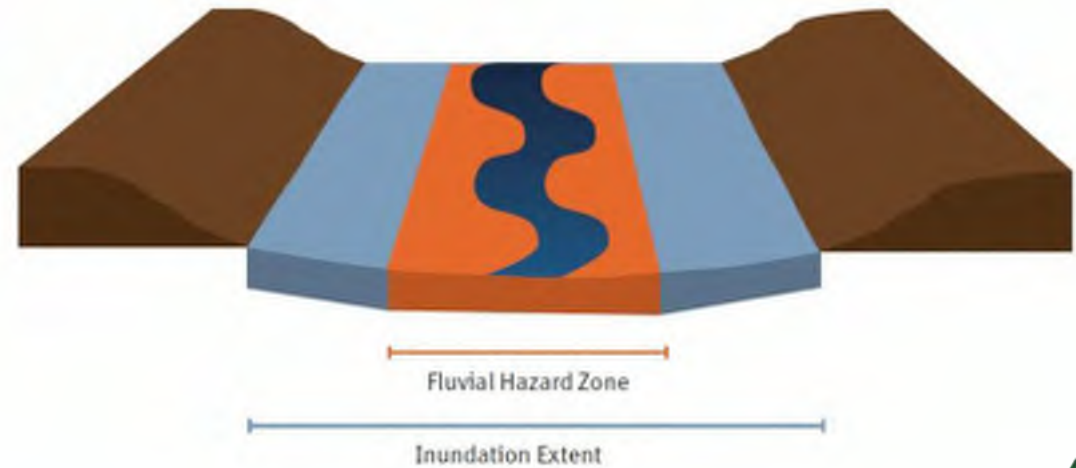
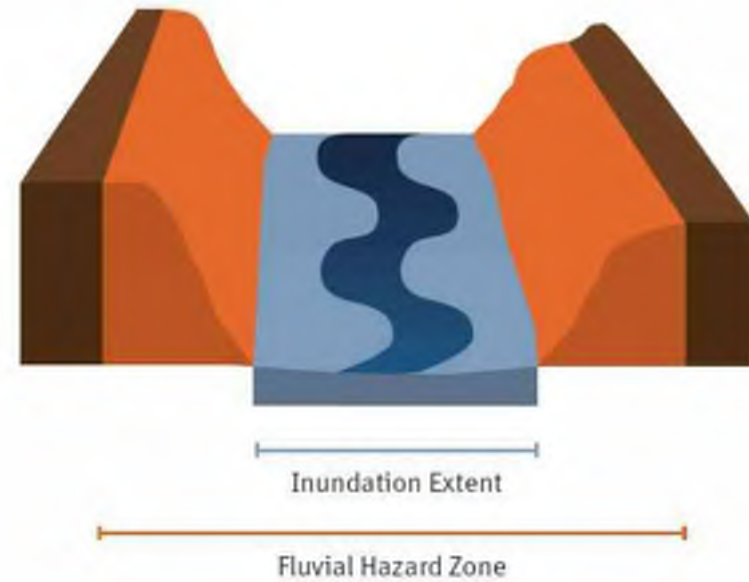


# Fluvial Hazard Zones vs Floodplain Inundation Models and Maps

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# Fluvial Hazard Zone vs Inundation Zone



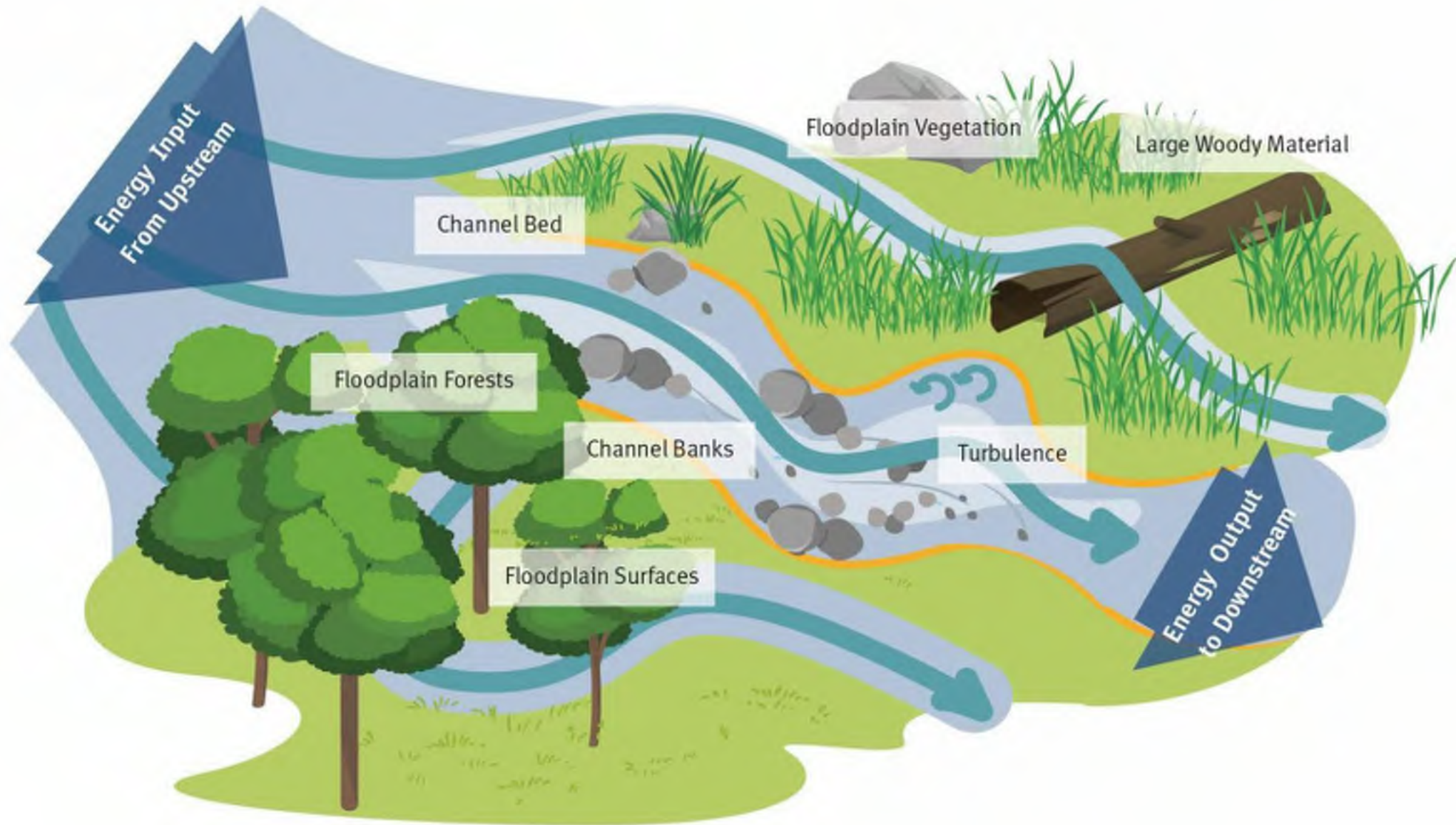




# Mapping the FHZ

Understanding Process

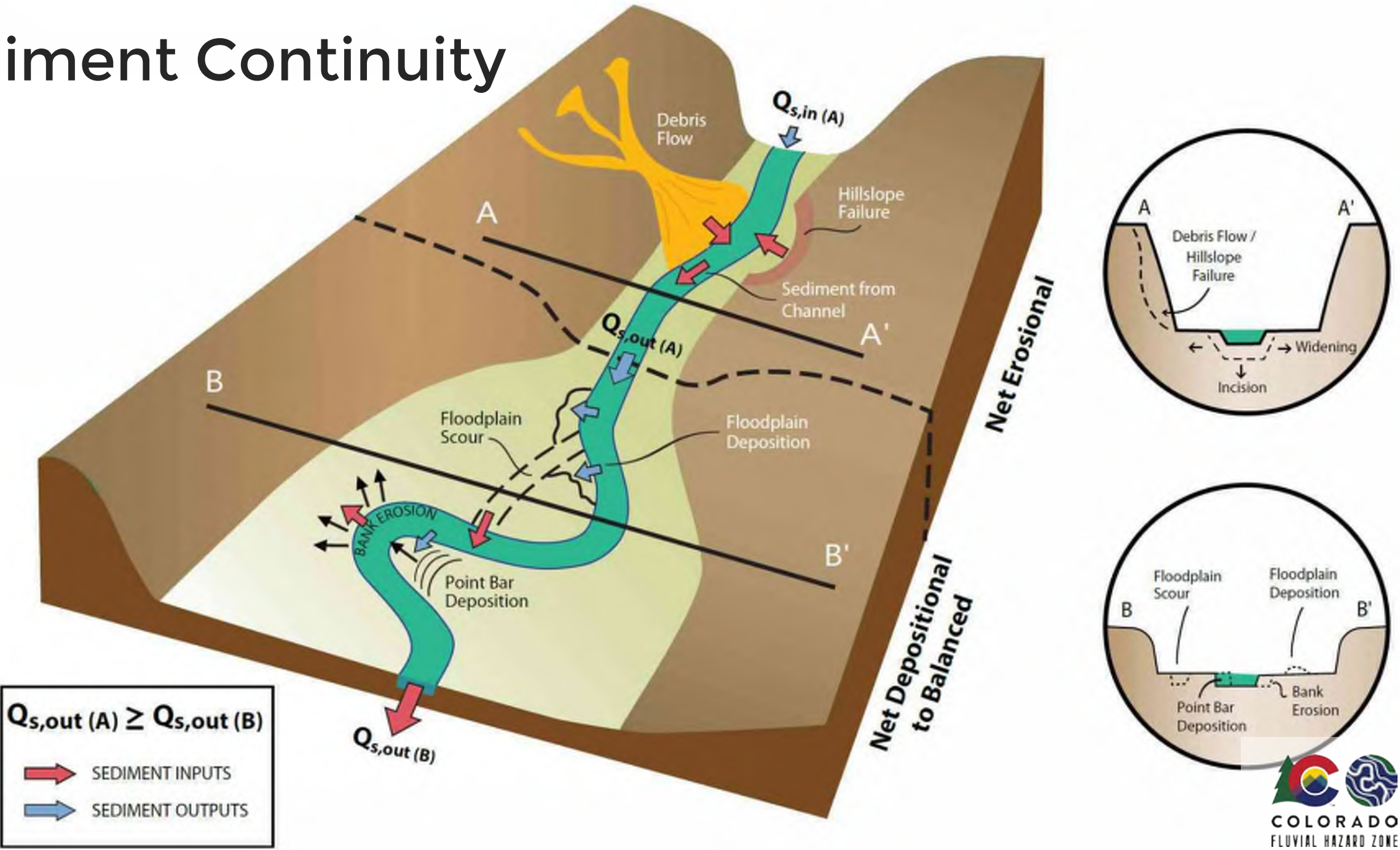




# Energy Flow and Dissipation



# Sediment Continuity

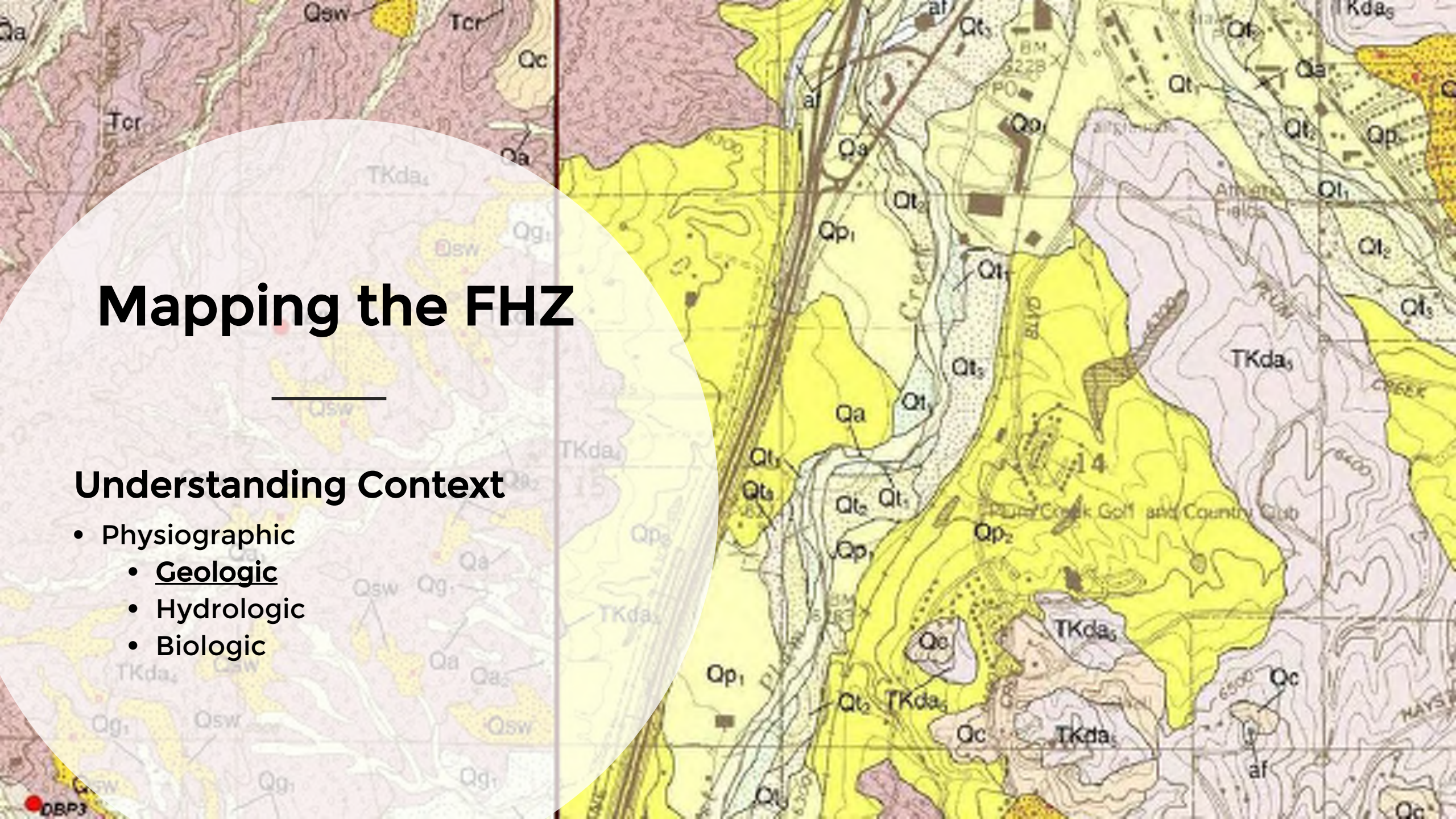




# Mapping the FHZ

## Understanding Context

- Physiographic
  - Geologic
  - Hydrologic
  - Biologic

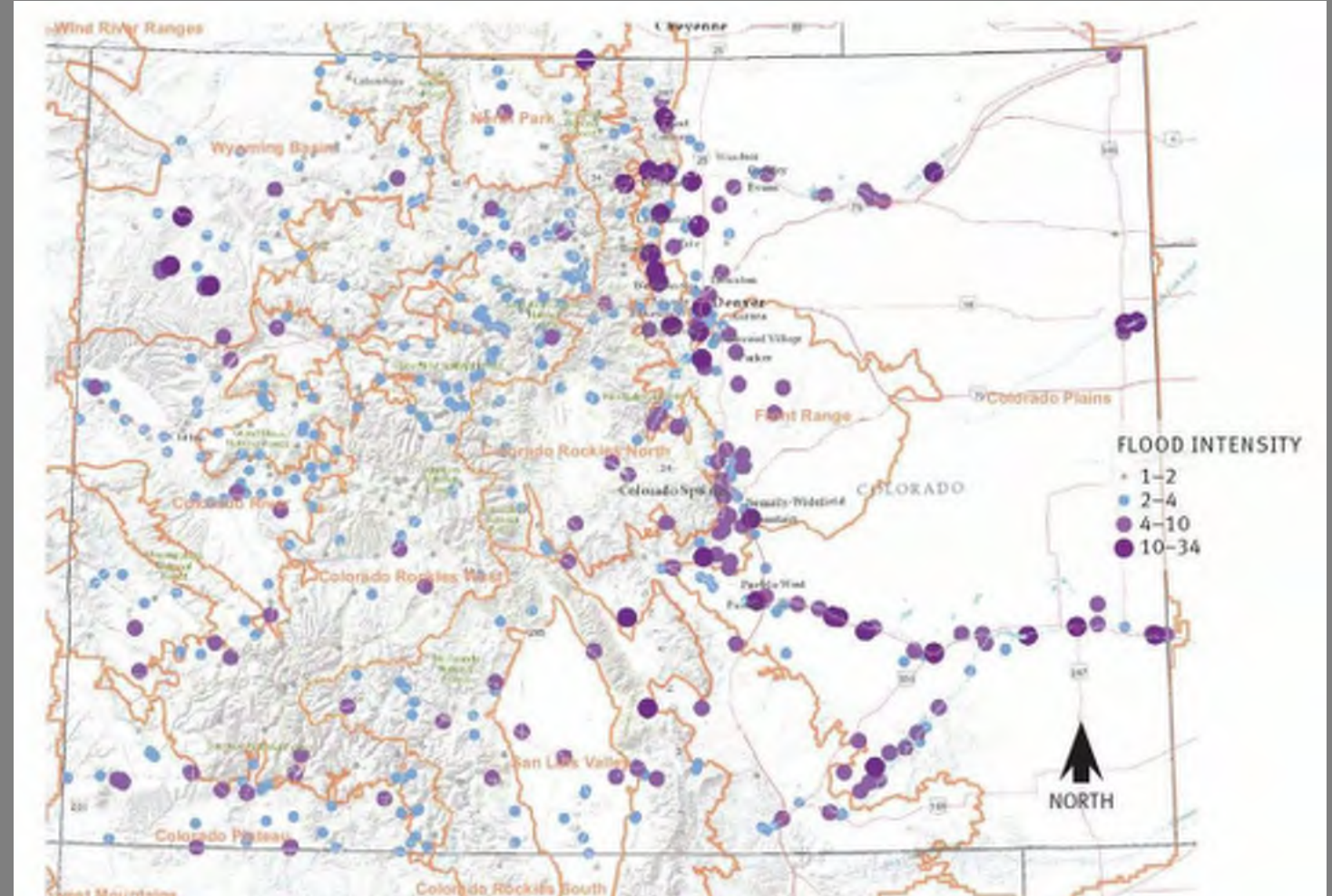




# Mapping the FHZ

## Understanding Context

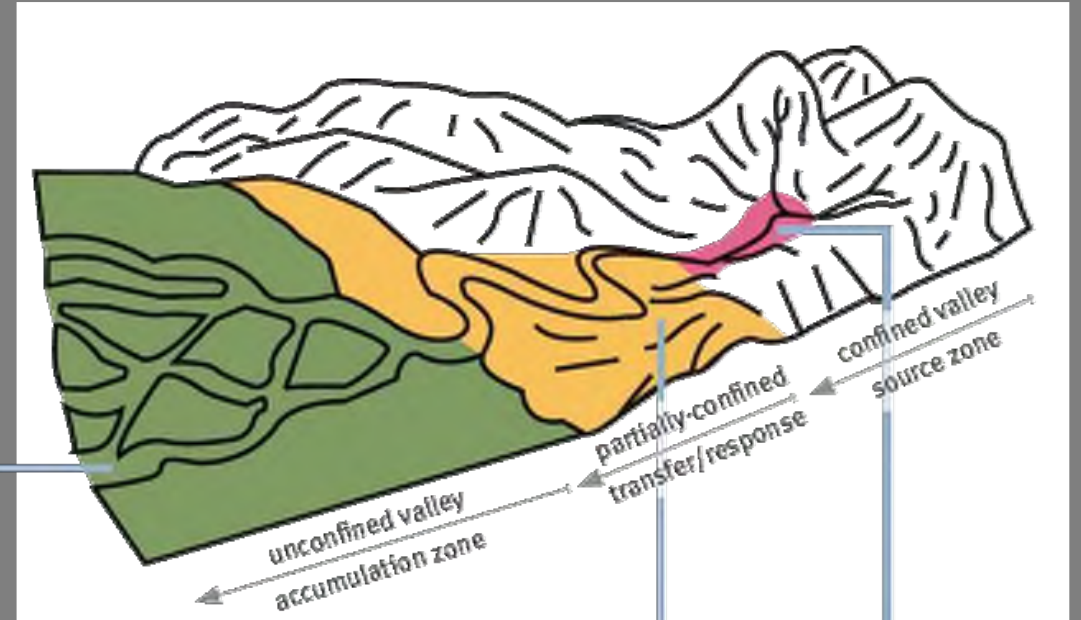
- Physiographic
  - Geologic
  - Hydrologic
  - Biologic



# Mapping the FHZ

## Understanding Context

- Geomorphic
  - Valley to reach scales







Active Stream Corridor

Mapped Stream River Corridor  
2012 Aerial Photo  
South St. Vrain Creek



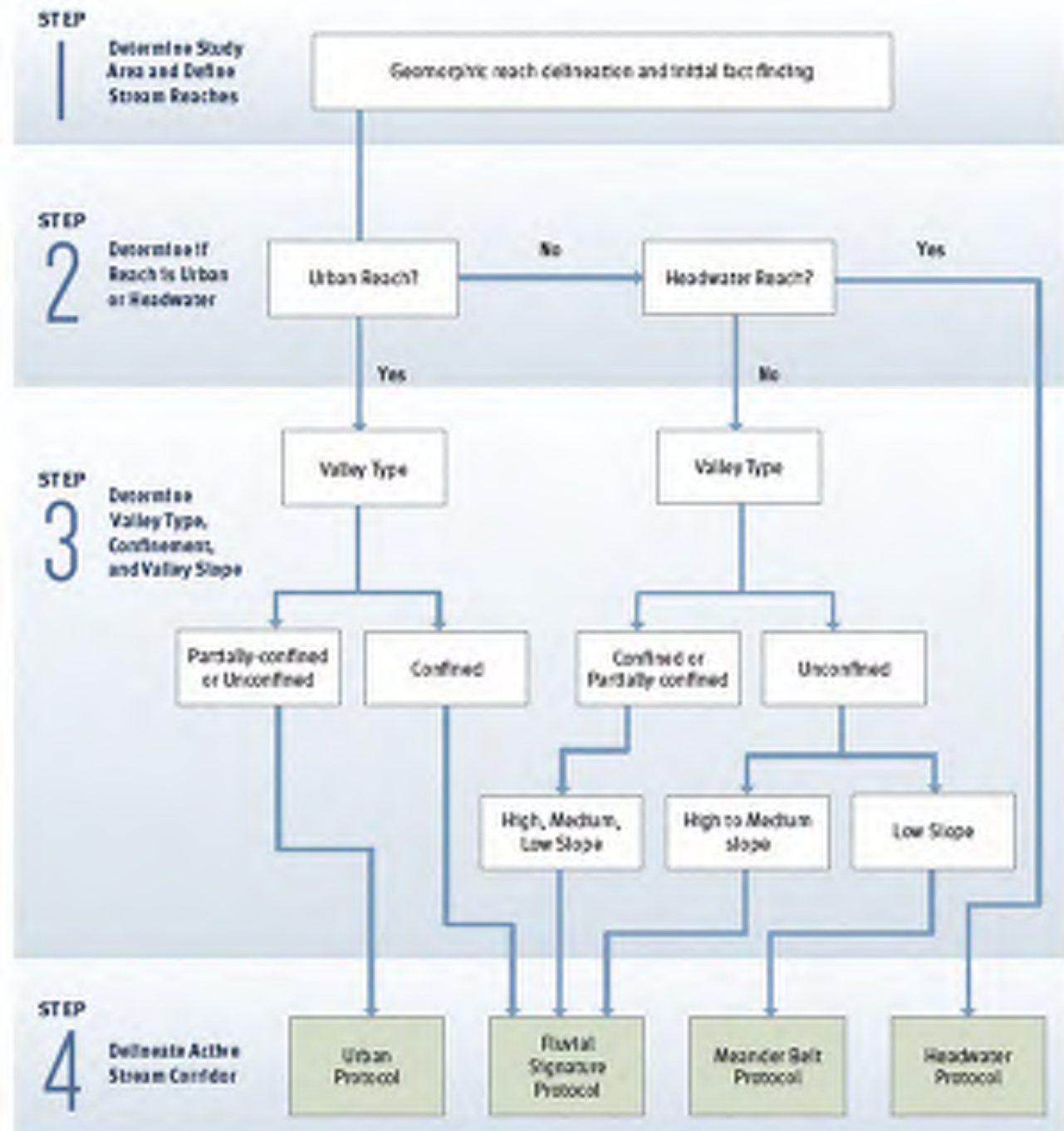


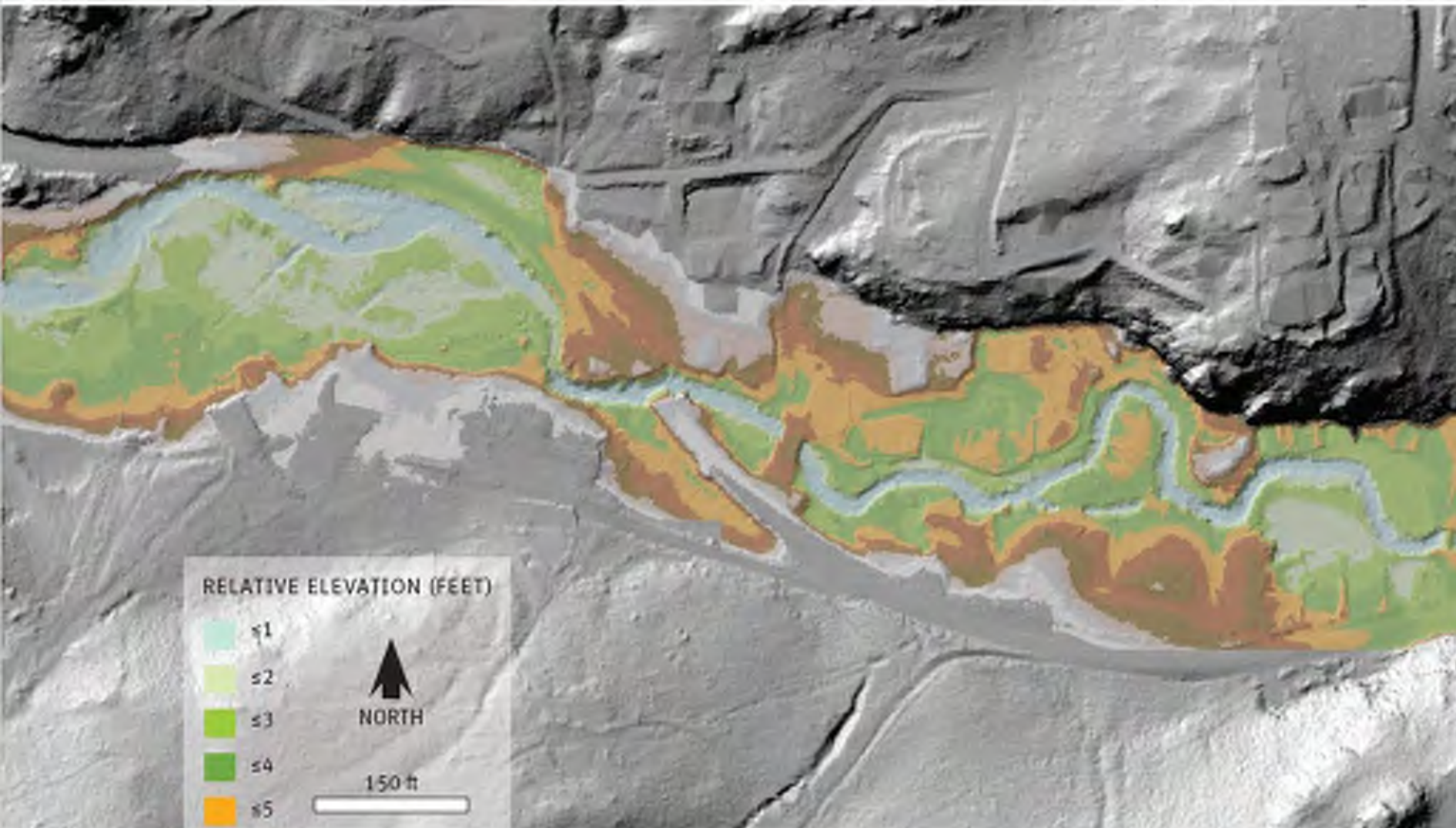
**Active Stream Corridor**

Mapped Active Stream Corridor  
2013 Aerial Photo  
South St. Vrain Creek



# Mapping the Active Stream Corridor





## Active Stream Corridor— Fluvial Signature



# Active Stream Corridor—Fluvial Signature





# Active Stream Corridor

Fluvial Signature



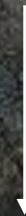
Geomorphic  
Floodplain &  
Bounding Features

Meander  
Beltwidth



Migration  
Corridor

Urban



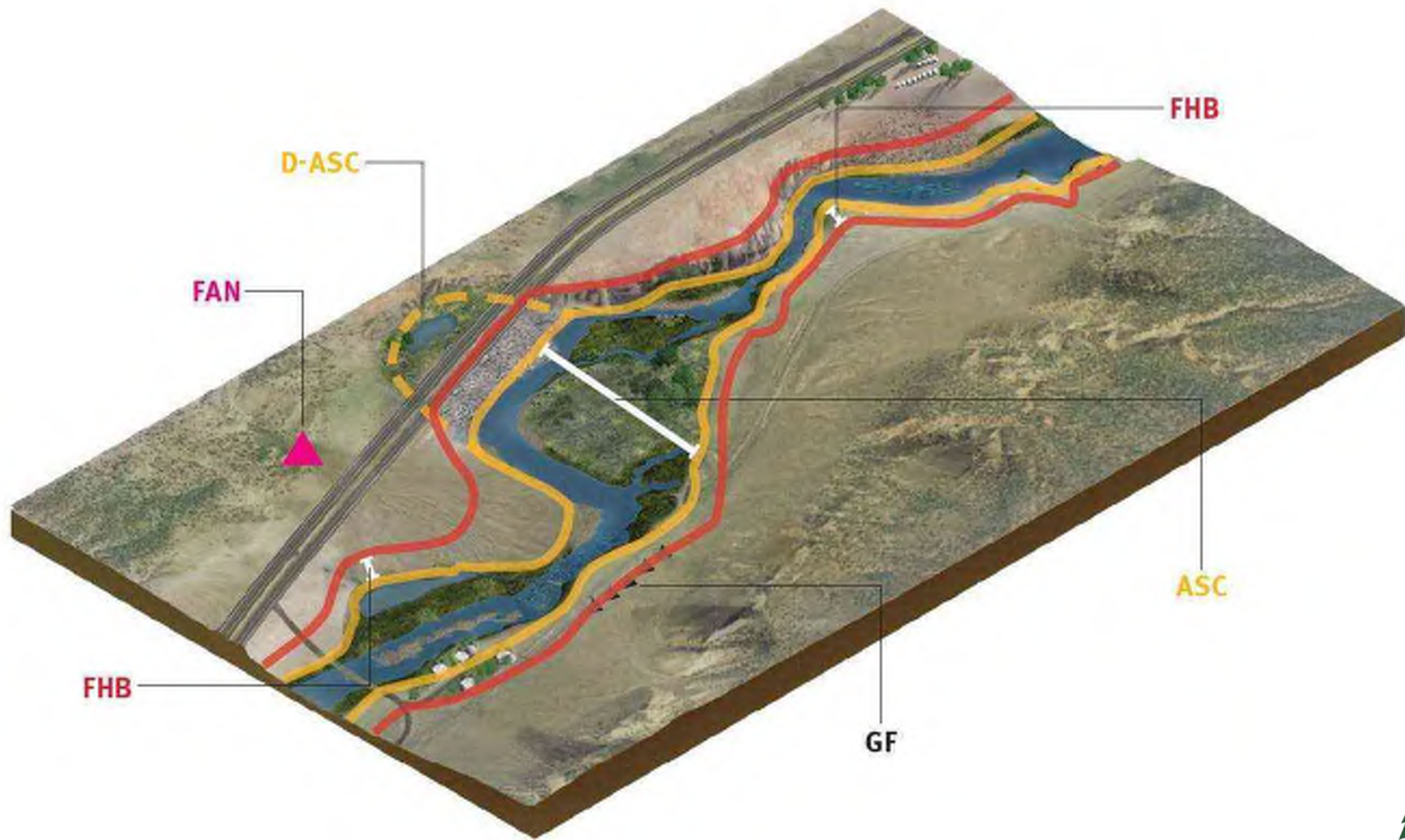
Longitudinal  
and Absolute  
Stream Power

Headwaters

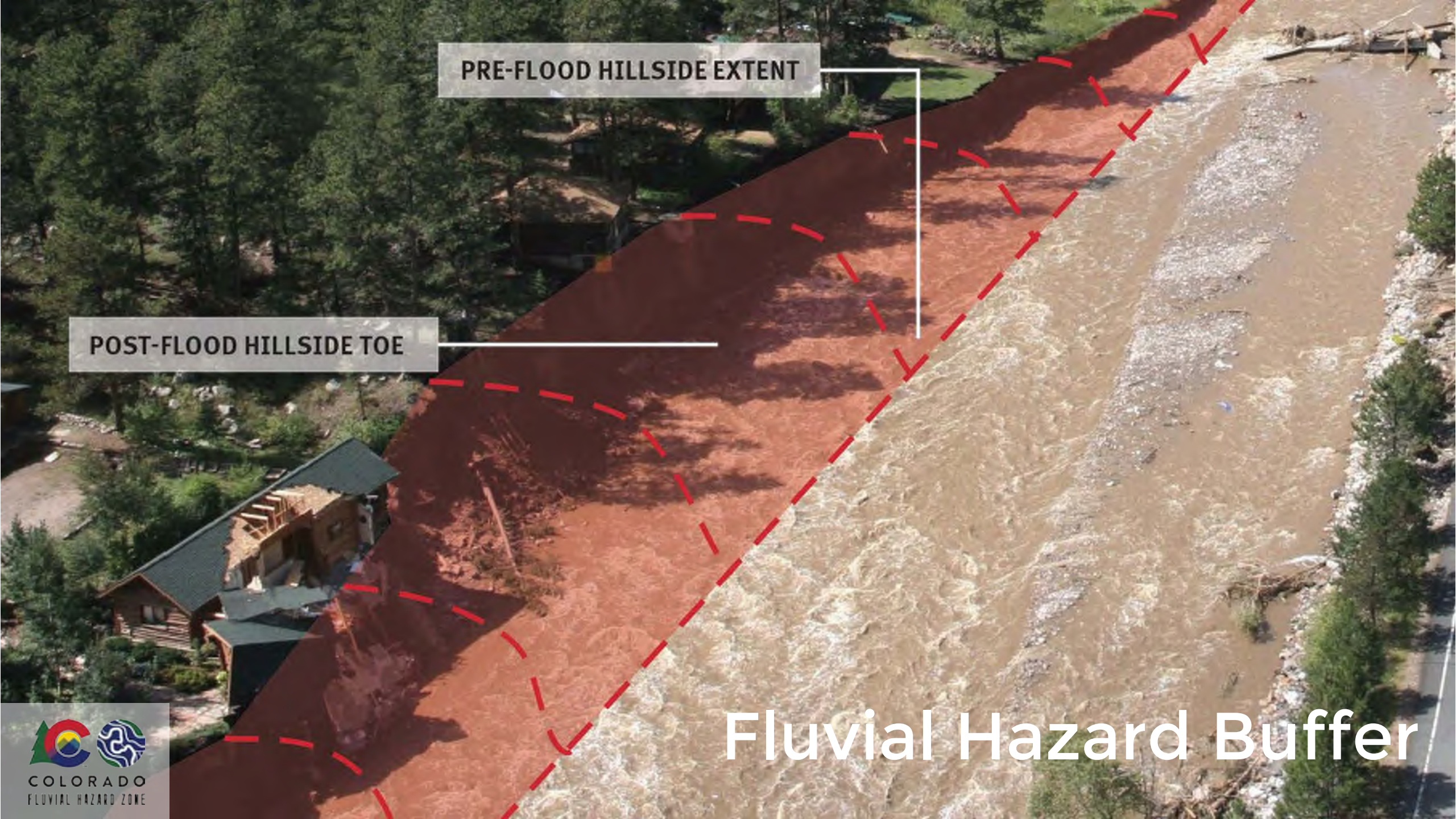


Setback









PRE-FLOOD HILLSIDE EXTENT

An aerial photograph of a river with a large area of reddish-brown sediment deposited along its left bank. A semi-transparent red buffer zone is overlaid on the image, bounded by dashed red lines. A white line points from the 'PRE-FLOOD HILLSIDE EXTENT' label to the upper boundary of the buffer. Another white line points from the 'POST-FLOOD HILLSIDE TOE' label to the lower boundary of the buffer. A house is visible on the left side of the image, partially obscured by the buffer zone.

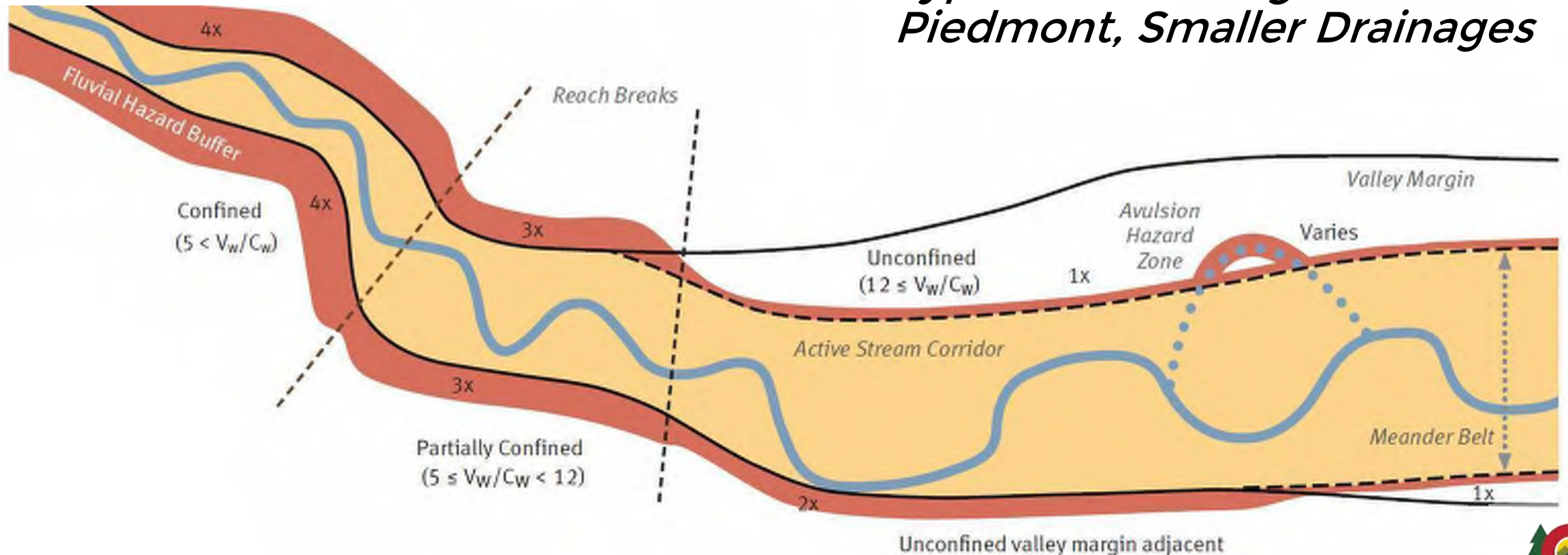
POST-FLOOD HILLSIDE TOE

Fluvial Hazard Buffer



# Fluvial Hazard Buffer

*Type I: Front Range and  
Piedmont, Smaller Drainages*





An aerial photograph of a river. On the left, a white boat is on a sandy bank. A bridge with a dark structure spans the river. The water is dark and calm. The surrounding area is green with trees and vegetation.

# Applications: Hazard Reduction

- Accommodate erosion and deposition in river corridors;
- Provide more accurate assessments of flood hazards.
- Defensible delineations for site development and use in land planning.
- Reduce reliance on channelization, levees, and bank armoring.







# Applications: Resilient Infrastructure

- Identify at-risk infrastructure and critical facilities within FHZ
- Avoid FHZ when repairing and replacing
- Site new infrastructure in less hazardous areas within river corridor
- Reduce maintenance and repair costs



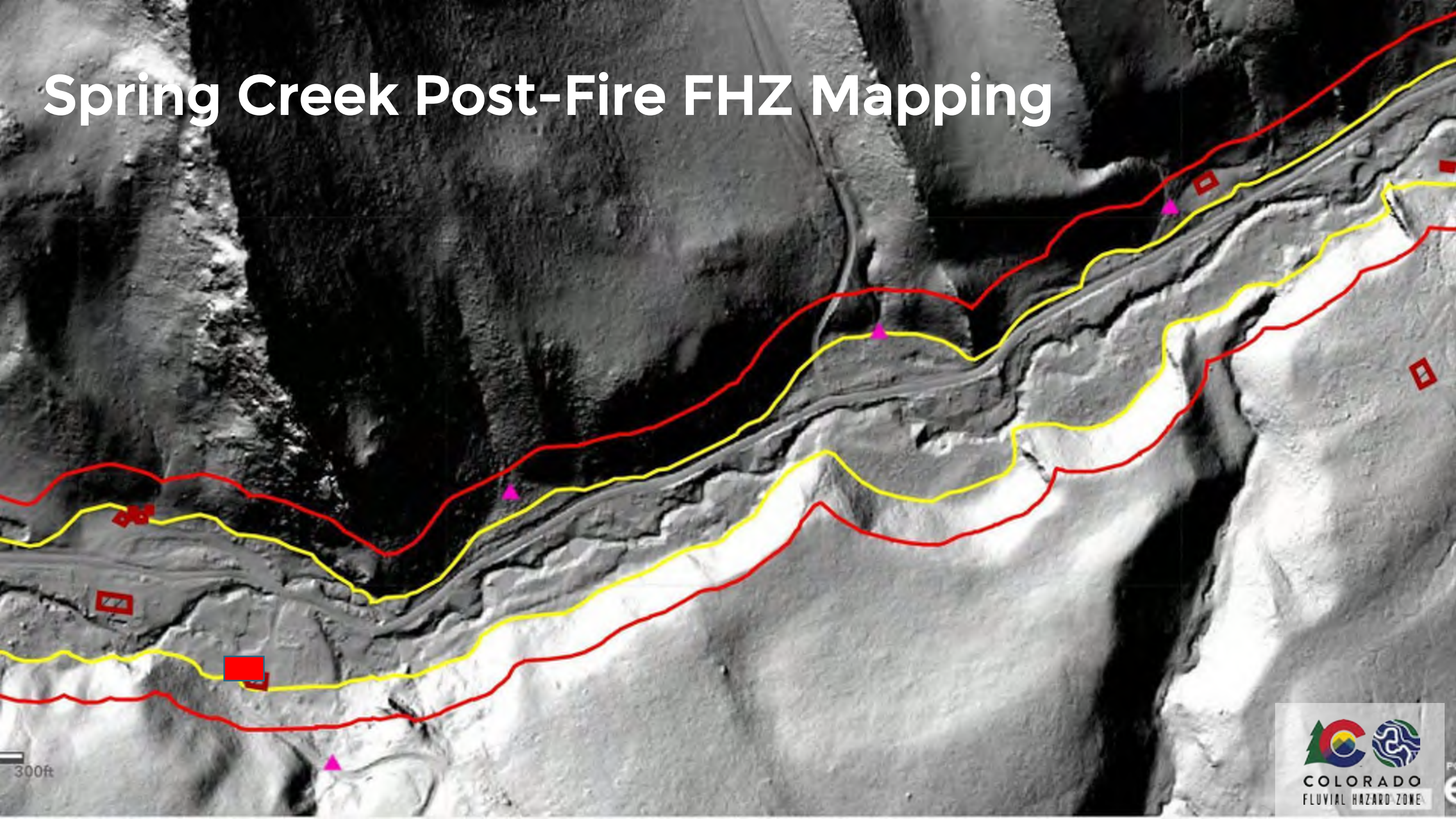
# Applications: Wildfire

---

- Provide space for erosion and sediment deposition after a wildfire.
- Provide natural fire breaks possibly aiding a community's firefighting response.



# Spring Creek Post-Fire FHZ Mapping



300ft



# Regulatory Support





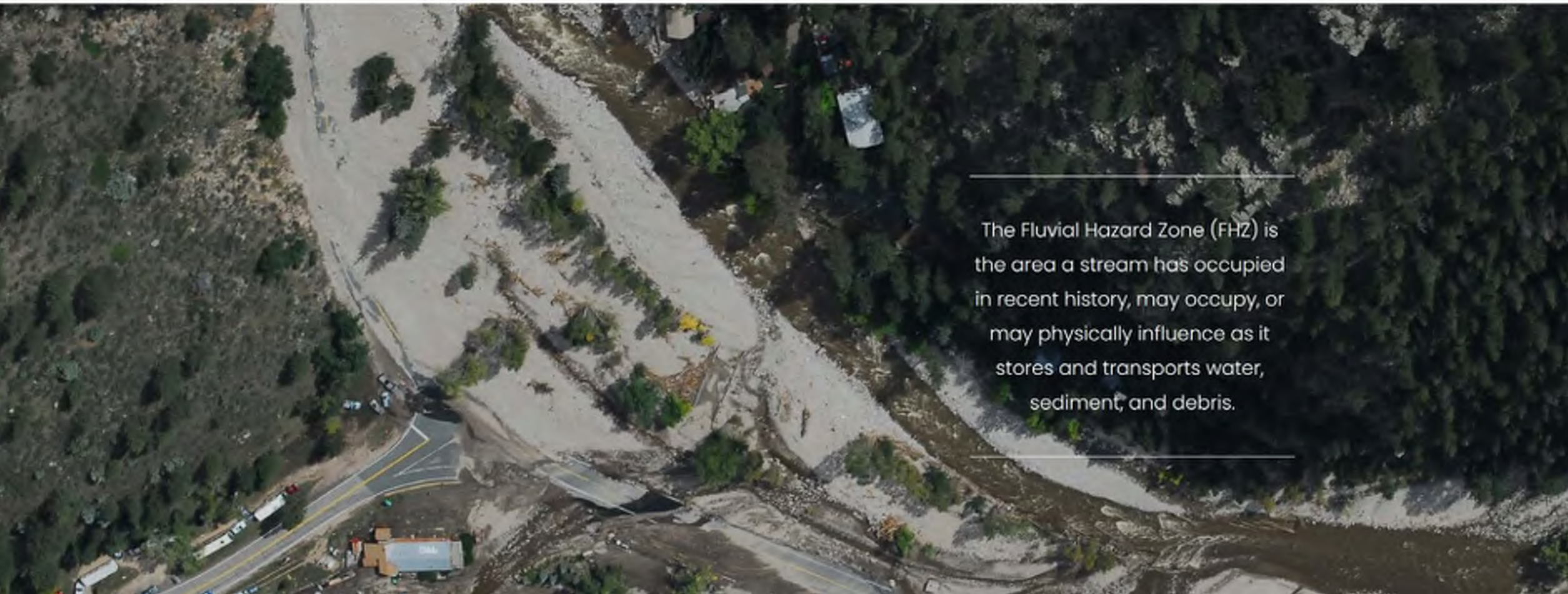
# Communication

- Fluvial Hazards exist (mapped or not)
- Mapping FHZs do not create new hazards
- Providing additional hazard information for informed decision making,



# Resources:

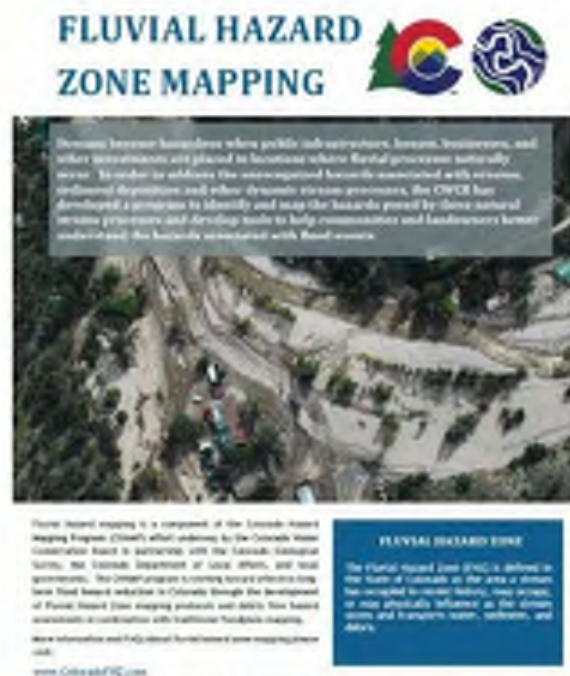
## [www.ColoradoFHZ.com](http://www.ColoradoFHZ.com)

An aerial photograph showing a wide, light-colored river channel, likely a floodplain or a dry riverbed, winding through a landscape of green trees and shrubs. A road with yellow lane markings crosses the channel. Several vehicles, including a white truck and a blue car, are visible on the road. The surrounding area is a mix of dense vegetation and open, sandy or silty ground.

The Fluvial Hazard Zone (FHZ) is the area a stream has occupied in recent history, may occupy, or may physically influence as it stores and transports water, sediment, and debris.



# FHZ Documents and Tools



## FHZ Fact Sheet

The FHZ Fact Sheet is an introduction to the concepts of fluvial hazards, the CWCB program developed to identify them, and provides an explanation as to how FHZ maps differ from FEMA floodplain maps.

## Quickstart Guide

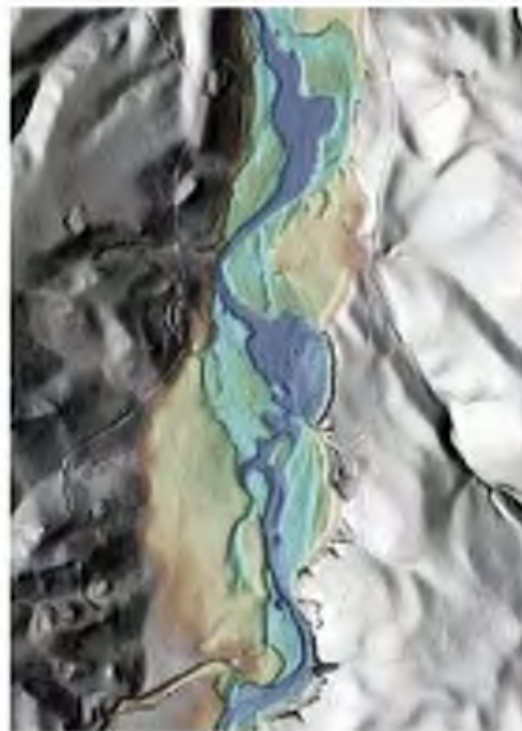
This document provides communities, agencies, and organizations with guidance on how FHZ mapping can be incorporated into planning, disaster response, administration, and regulation (if applicable).

## FHZ Zoning Overlay Model Ordinance

Coming Soon!



## 2020 FHZ Mapping Protocol



## REM Generation Tool (ArcMap Plug-In)

This tool will assist users in creating a Relative Elevation Model (REM) which can be useful in mapping Fluvial Hazard Zones. The User Guide is Appendix C of the protocol.



## Draft FHZ Mapping Protocol Comments

This PDF provides documentation of and a response to the comments received by CWCB between January and March 2020 on the Public Review Draft of the Fluvial Hazard Zone Mapping Protocol.





COLORADO  
FLUVIAL HAZARD ZONE

Thank you.

- Michael Blazewicz, [michael@roundriverdesign.com](mailto:michael@roundriverdesign.com)
- Katie Jagt, [katiejagt@watershedscienceanddesign.com](mailto:katiejagt@watershedscienceanddesign.com)
- Joel Sholtes, [jsholtes@coloradomesa.edu](mailto:jsholtes@coloradomesa.edu)
- Chris Sturm, [chris.sturm@state.co.us](mailto:chris.sturm@state.co.us)



[www.ColoradoFHZ.com](http://www.ColoradoFHZ.com)



# Colorado Post Wildfire Flooding Guide

2020 CASFM Conference  
September 29 - October 2, 2020

Danae Olsen, Project Management Specialist

Elise Jarrett, Water Resources Planner



US Army Corps  
of Engineers®



## Colorado Post-Wildfire Guide

A Resource for Colorado Communities



Developed by the Colorado Silver Jackets Team







# PRESENTERS



Elise Jarrett, Water Resources Planner  
Elise.M.Jarrett@usace.army.mil



Danae Olsen, Project Management Specialist  
Danae.M.Olsen@usace.army.mil





# PRESENTATION OUTLINE



- What is Silver Jackets?
- What are post-wildfire hazards? Higher risk of flooding?
- CO Flood After Fire Guide overview
- Interagency collaboration
- Project content
- Q&A





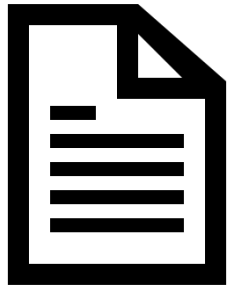
# SILVER JACKETS – WHAT IS IT?



*“Many partners, one team”*

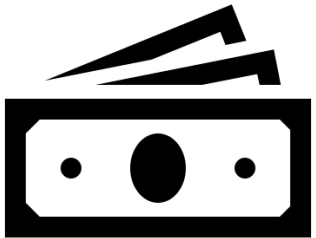


- State-led interagency teams
- Bring together Federal, State and locals



Interagency Projects

- 12-18 months
- Typically <\$150K of USACE Support



Each dollar invested by USACE leverages another dollar in project-focused partner contributions





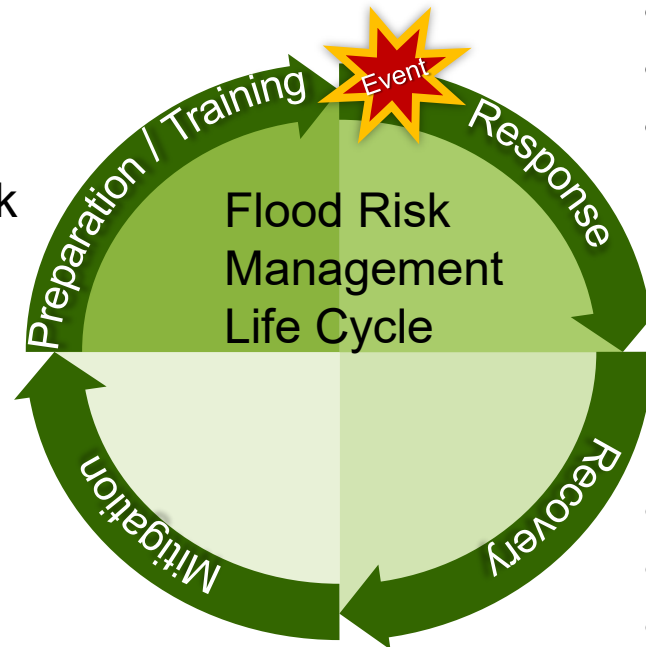
# SILVER JACKETS – WHAT IS IT?

## Preparation/Training

- Floodplain Mapping
- EAPs/ Table Top Exercises
- Training Workshops
- Community Rating System
- Levee Safety Risk and Flood Risk Communication Programs

## Mitigation

- Evacuation Plans
- SHMP Updates
- SHMP Actions:  
Ex. Buy-Outs
- Risk Map Support



## Response

- Technical Assistance Post-Disaster
- Inter-State Basin Coordination
- Produce/Update EAPs
- Flood Warning System Planning

## Recovery

- Post-Disaster Resources Guides**
- Outreach & Education
- Flood Risk Mgmt training & Education
- ID and Implement Nonstructural measures

## DIVERSITY OF STATE TEAM ACTIVITIES







# POST-WILDFIRE HAZARDS



- Post-wildfire hazards can persist for weeks, months, or even years following a wildfire:

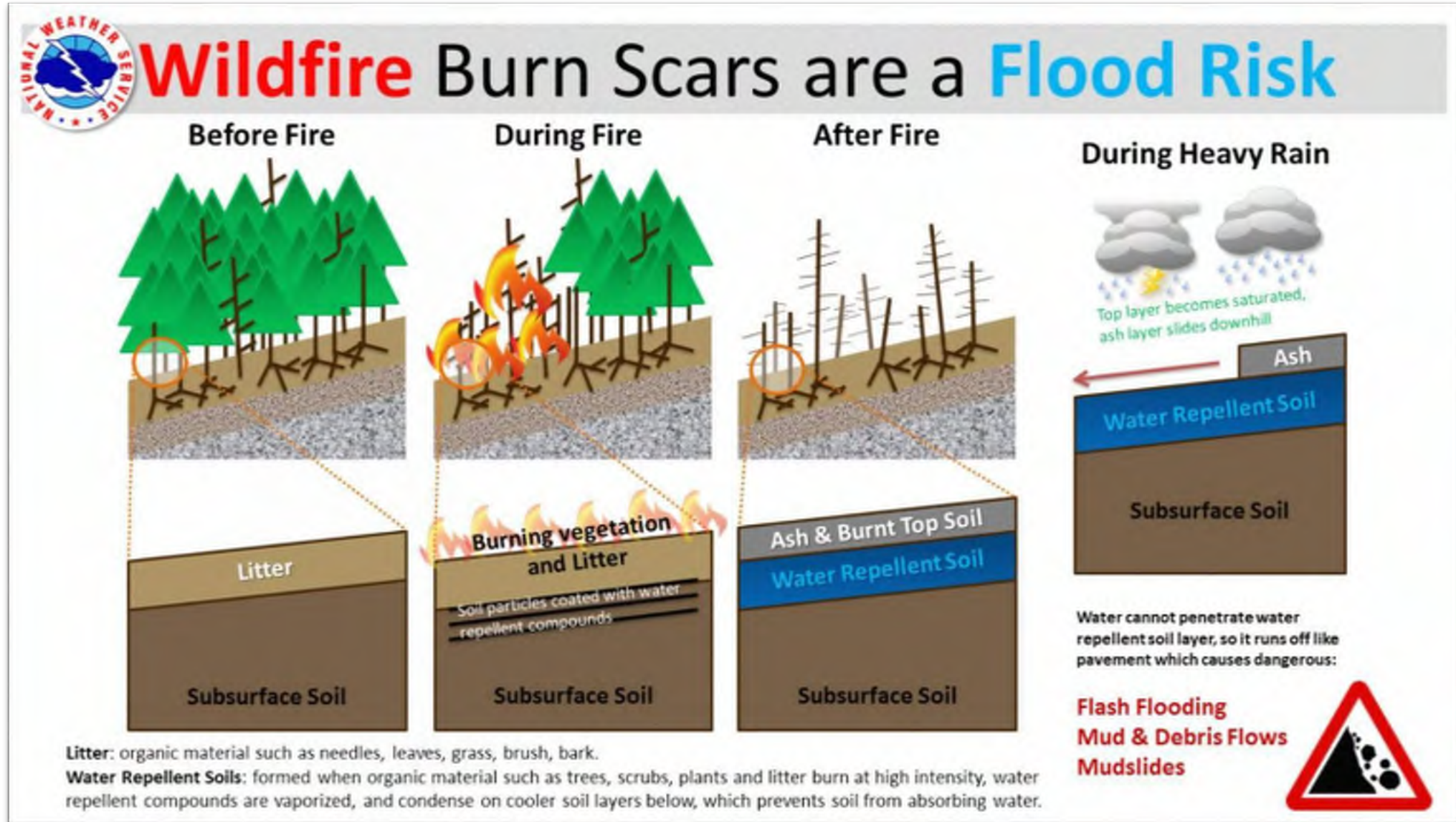
- Flash flooding and debris flows
- Rocks falls
- Structural damage
- Road instability
- Damaged trees



Source :CAL FIRE

- Why is there a higher risk of flooding after a fire?
  - Extreme heat destroys protective groundcover and changes soil properties, creating a water repellent layer that prevents water infiltration- can cause excessive runoff

# POST-WILDFIRE HAZARDS





# FLASH FLOODING AND DEBRIS FLOWS

- Takes much less rainfall to result in flash flooding than before a wildfire
- Modest rainfall can cause flash flooding that impacts communities miles downstream of a burned area → can turn into debris flows
- Thunderstorms that develop quickly over a burned area can produce flash flooding flows nearly as fast as the National Weather Service radar can detect them- very short warning window!
- General rule of thumb:  $\frac{1}{2}$  inch of rainfall in less than an hour is sufficient to cause flash flooding in a burn area



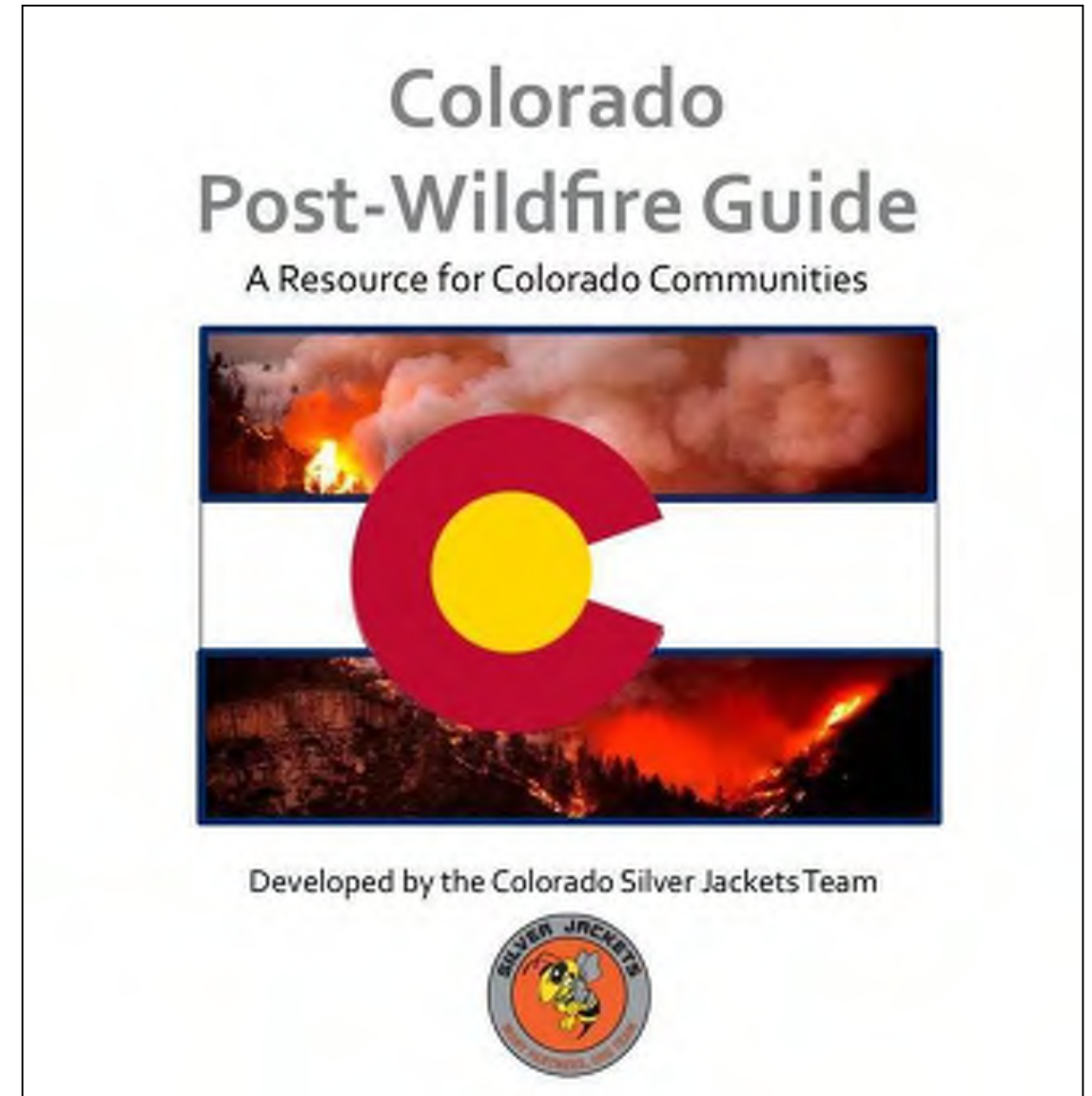


# COLORADO POST-WILDFIRE FLOOD GUIDE

9



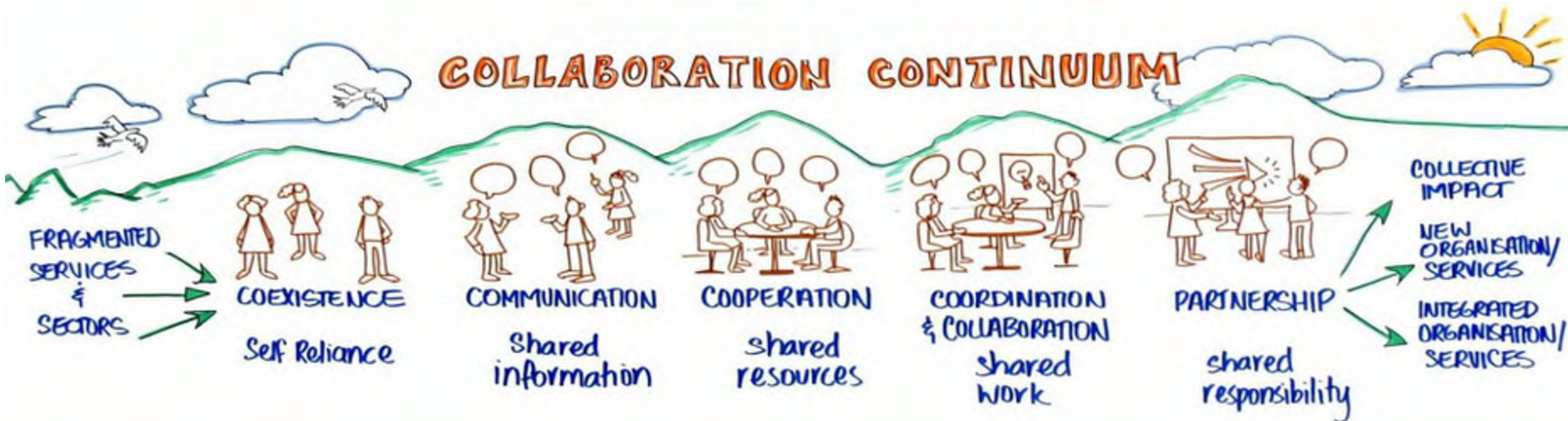
- **PURPOSE:** create a consolidated resource to help communities and individuals start on the road to recovery and plan for post-wildfire hazards
- Many resources available making it overwhelming and confusing on where to start
- Collaboration with Colorado agencies and subject-matter experts was a critical and foundational piece to guide development





# PROJECT INTERAGENCY COLLABORATION

- Approx. 10 contributing agencies from local, state, and federal levels
  - Collaboration
  - Data/resource sharing
  - Consolidated products





# GUIDE CONTENT



- Provides practical guidance and resources on the following:
  - How to determine your fire and flood risk
  - How to stay safe before, during, and after a fire
  - How to plan ahead for the recovery process (flood insurance, resources for weather and emergency alerts, etc.)
  - How to mobilize your community (establish a post-wildfire coordination team)
  - Recovery support programs







For more information on Silver Jackets or the CO Guide please contact:

Elise Jarrett: [Elise.M.Jarrett@usace.army.mil](mailto:Elise.M.Jarrett@usace.army.mil), 916-557-6622

Danae Olsen: [Danae.M.Olsen@usace.army.mil](mailto:Danae.M.Olsen@usace.army.mil), 916-557-5391