

NATURAL RIVERS, URBAN STREAMS, AND WORKING WATERWAYS – USING CONTEXT TO INFORM RESTORATION

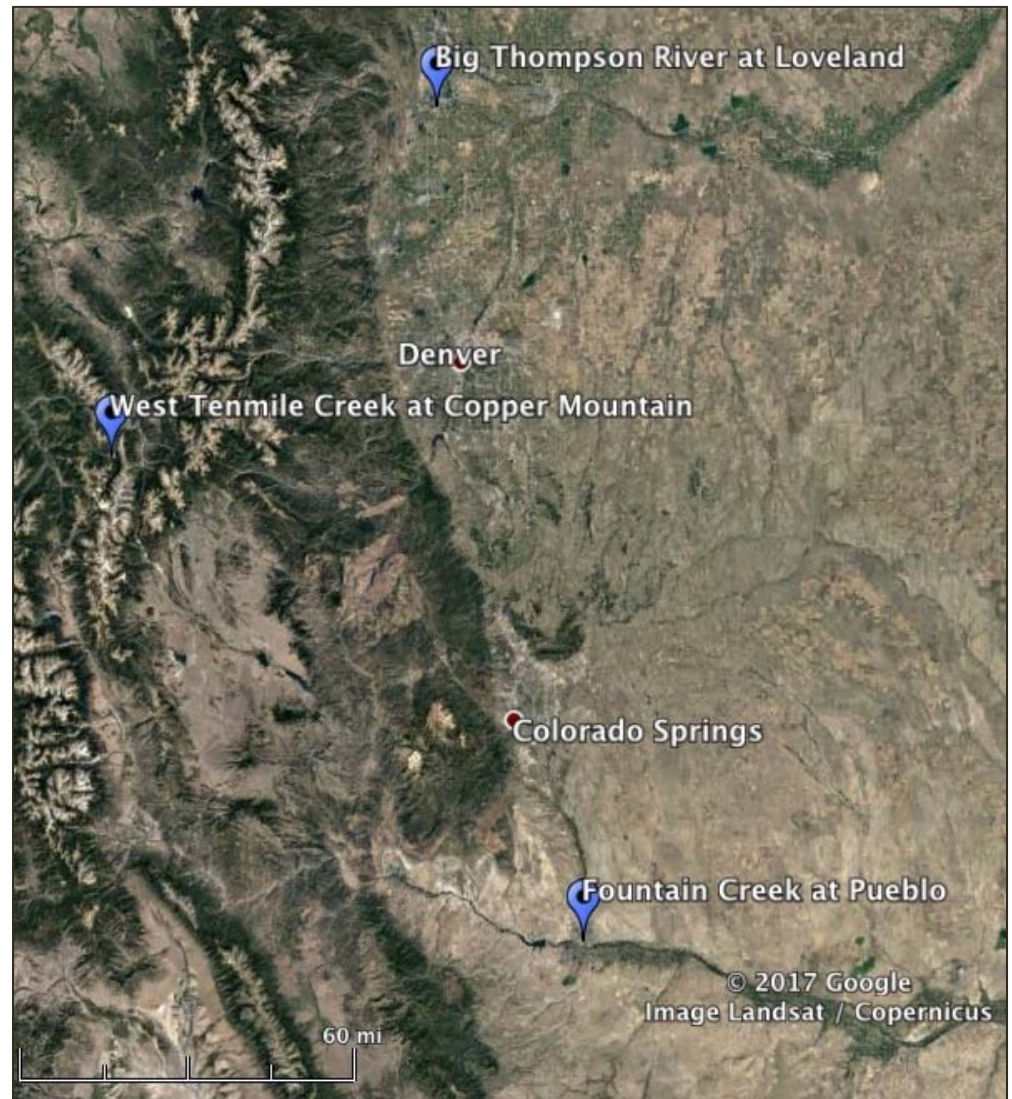
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Denver, Colorado

November 16, 2017

International Erosion Control Association
Mountain States Chapter Annual Conference

Presentation Overview

- Introduction and objectives
- Case studies
 - ▣ West Tenmile Creek
 - ▣ Big Thompson River
 - ▣ Fountain Creek
- Lessons from Case Studies



Themes of Presentation

- Diversity of stream types in Colorado
- Variations in uses and water quality standards
- Importance of hydrology in understanding stream dynamics
- Relationship between geology and hydromodification

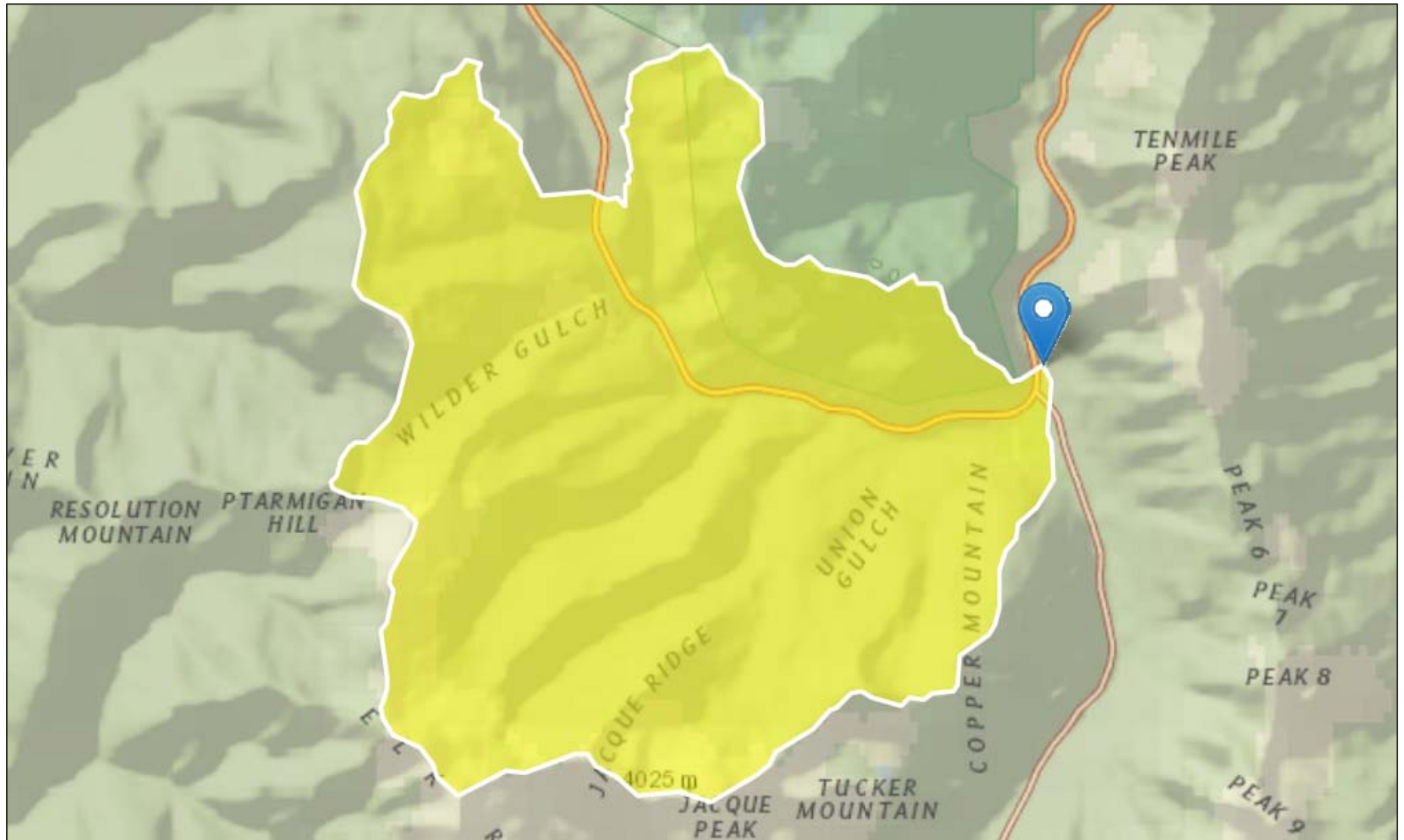




West Tenmile Creek

- Pristine Watershed
- Protection of Water Quality During Extensive Construction Activities
- Biological Monitoring

West Tenmile Creek Watershed



Key Watershed Characteristics

- Area = 27.4 square miles
- Mean annual precipitation = 29 inches
- Mean watershed elevation = 11,100 feet
- 100-year 24-hour precipitation = 3.3 inches
- 2-year 24-hour precipitation = 1.4 inches
- Percentage of clay soils ~ 17%
- Time of concentration ~ 1 hour
- Very little development in watershed



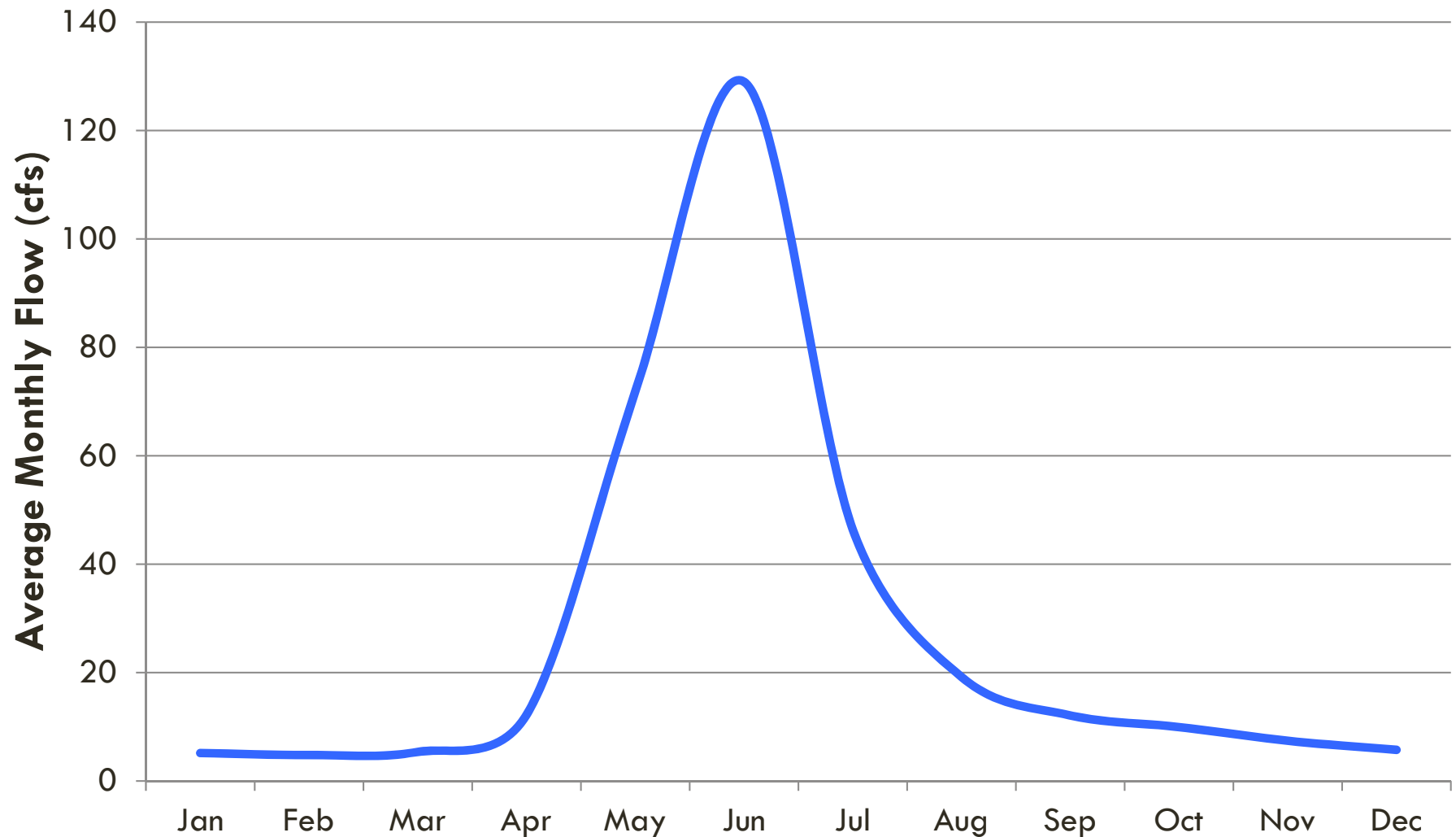
Copper Mountain

© 2017 Google

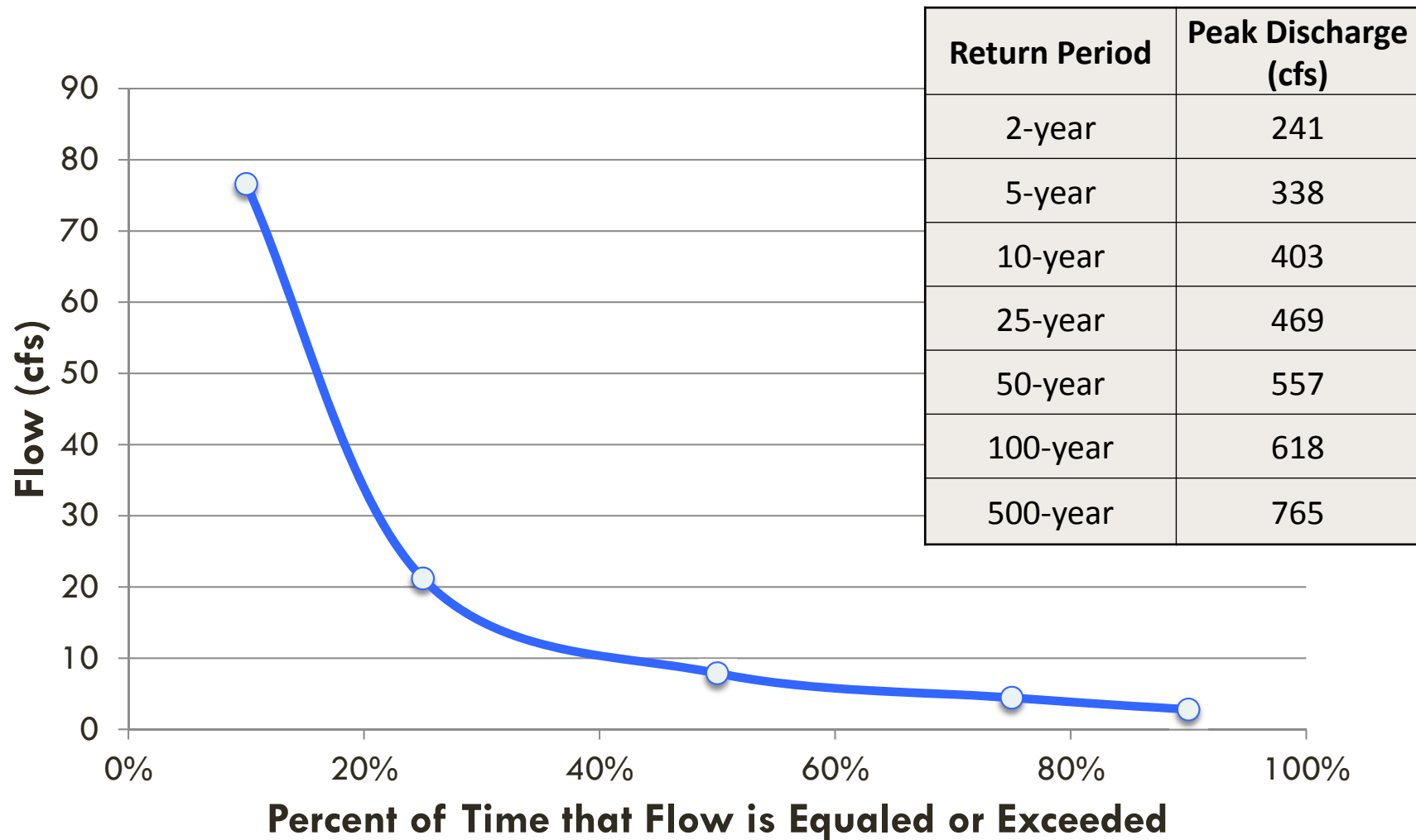
Google earth

1700 ft

West Tenmile Creek Average Monthly Flows



West Tenmile Creek Flow Duration & Peak Flood Discharges

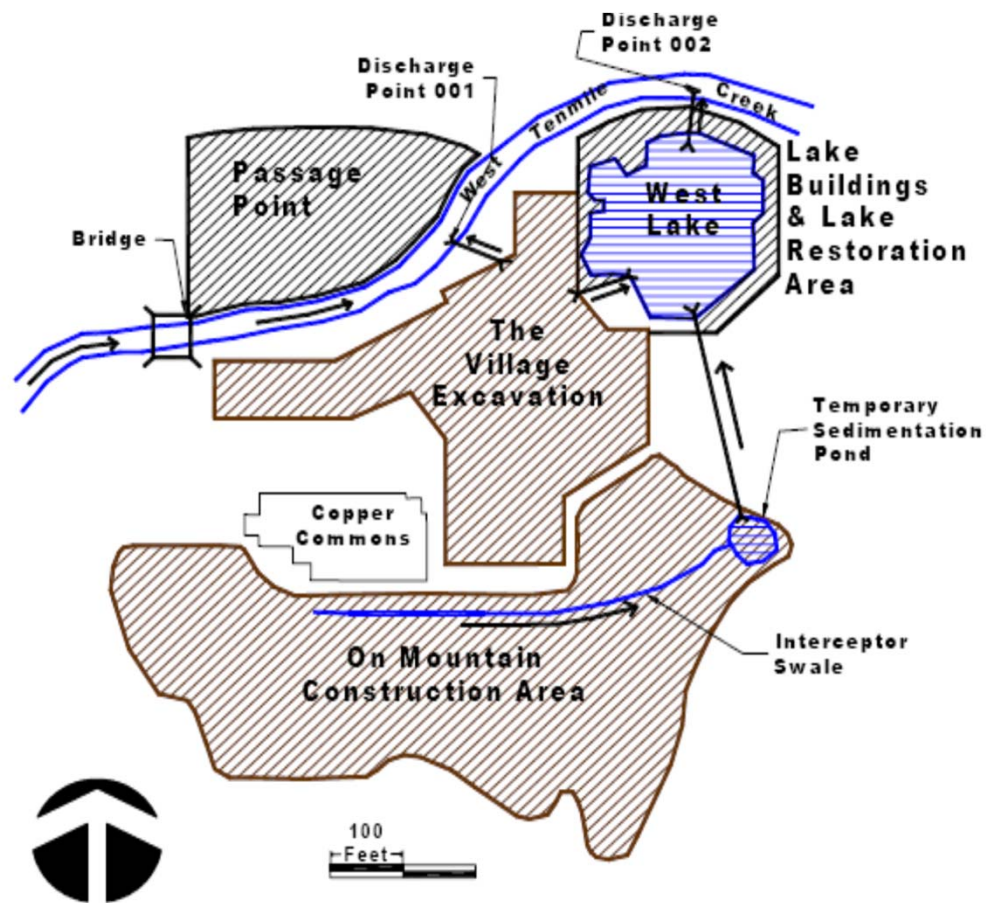


Typical Streambed Conditions



- Well armored channel with cobble to boulder sized bed material
- Very resistant to erosion from typical flows
- Good substrate for macroinvertebrates

1999 - 2000 Base Area Core Development



Water Quality Standards for West Tenmile Creek

14. Mainstem of Tenmile Creek, including all tributaries and wetlands from a point immediately above the confluence with West Tenmile Creek to Dillon Reservoir, except for the specific listing in Segment 16.

COUCBL14	Classifications	Physical and Biological		Metals (ug/L)	
Designation	Agriculture	DM	MWAT	acute	chronic
Reviewable	Aq Life Cold 1	Temperature °C	CS-I	Aluminum	—
	Recreation E	acute	chronic	Arsenic	340
	Water Supply	D.O. (mg/L)	—	Arsenic(T)	0.02
Qualifiers:		D.O. (spawning)	—	Beryllium	—
Other:		pH	6.5 - 9.0	Cadmium	TVS(tr)
Temporary Modification(s):		chlorophyll a (mg/m ²)	—	Chromium III	TVS
Arsenic(chronic) = hybrid		E. Coli (per 100 mL)	—	Chromium III(T)	50
Expiration Date of 12/31/2021				Chromium VI	TVS
Molybdenum(chronic) = current conditions		Inorganic (mg/L)		Copper	TVS
Expiration Date of 12/31/2018		acute	chronic	Iron	—
*chlorophyll a (mg/m ²)(chronic) = applies only above the facilities listed at 33.5(4).		Ammonia	TVS	Iron(T)	1000
*Phosphorus(chronic) = applies only above the facilities listed at 33.5(4).		Boron	—	Lead	TVS
		Chloride	—	Manganese	TVS
		Chlorine	0.019	Mercury	0.01(t)
		Cyanide	0.005	Molybdenum(T)	210
		Nitrate	10	Nickel	TVS
		Nitrite	—	Selenium	TVS
		Phosphorus	—	Silver	TVS(tr)
		Sulfate	—	Uranium	—
		Sulfide	—	Zinc	TVS



Habitat Assessment Scores for West Tenmile Creek

Metric	WTC-1 5/2000	WTC-1 9/2005	WTC-2 5/2000	WTC-2 9/2005	WTC-3 5/2000	WTC-3 9/2005	WTC-4 5/2000	WTC-4 9/2005
Epifaunal substrate/available cover	20	10	20	20	20	20	20	20
Embeddedness	19	19	19	19	18	19	13	19
Velocity/depth regime	13	14	13	13	13	13	17	17
Sediment deposition	20	19	19	19	19	19	13	17
Channel flow status	19	18	20	19	18	17	20	12
Channel alteration	20	20	20	20	15	13	18	18
Frequency of riffles	20	20	20	20	20	20	20	20
Bank stability	20	20	18	18	18	19	18	19
Vegetative protection	20	20	19	19	10	12	14	15
Riparian vegetative zone	17	17	12	13	8	8	10	10
TOTAL SCORE	188	187	180	180	159	160	163	167

West Tenmile Creek Benthic Sampling Scores

Metric	WTC-1 5/2000	WTC-1 9/2005	WTC-2 5/2000	WTC-2 9/2005	WTC-3 5/2000	WTC-3 9/2005	WTC-4 5/2000	WTC-4 9/2005
Taxa richness	22	15	18	11	15	12	11	19
EPT Index	16	9	12	4	10	5	8	12
Percent contribution of dominant taxon	19	29	35	33	64	33	45	36
Scraper-filtering collector ratio	0.4	0.6	0.6	0.4	0.25	1.1	0	0.9
EPT-Chironomidae ratio	3.9	31.0	25.5	9.0	30.7	0.9	*	3.4
Modified HBI	3.4	4.0	2.9	4.0	3.1	4.7	2.4	3.7

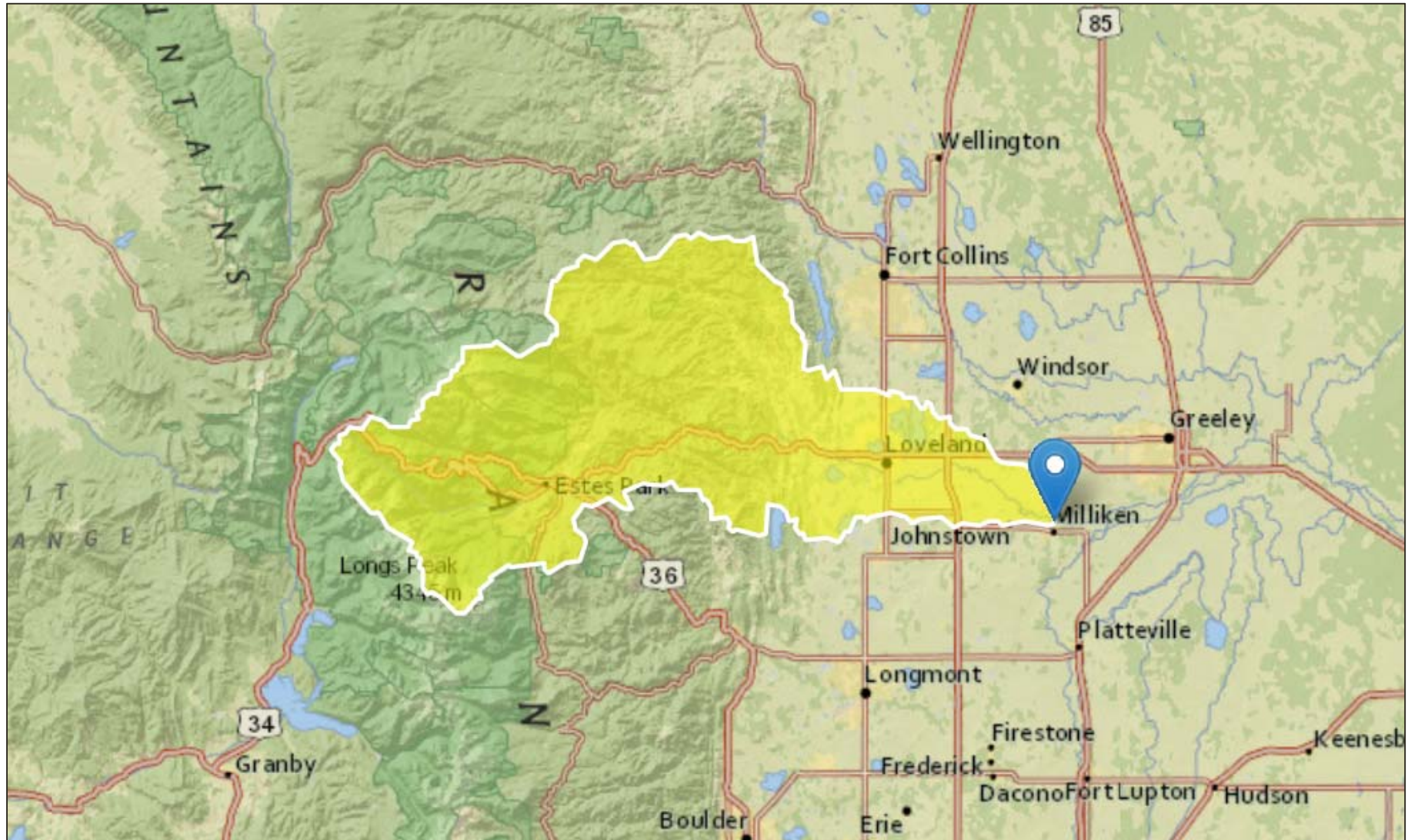
Bottom Line – No Adverse Effects Detected on Habitat and Benthic Community from Base Area Constructing Work



Big Thompson River

- Working River
- Flood Resilience
- Multifunctional Natural Areas

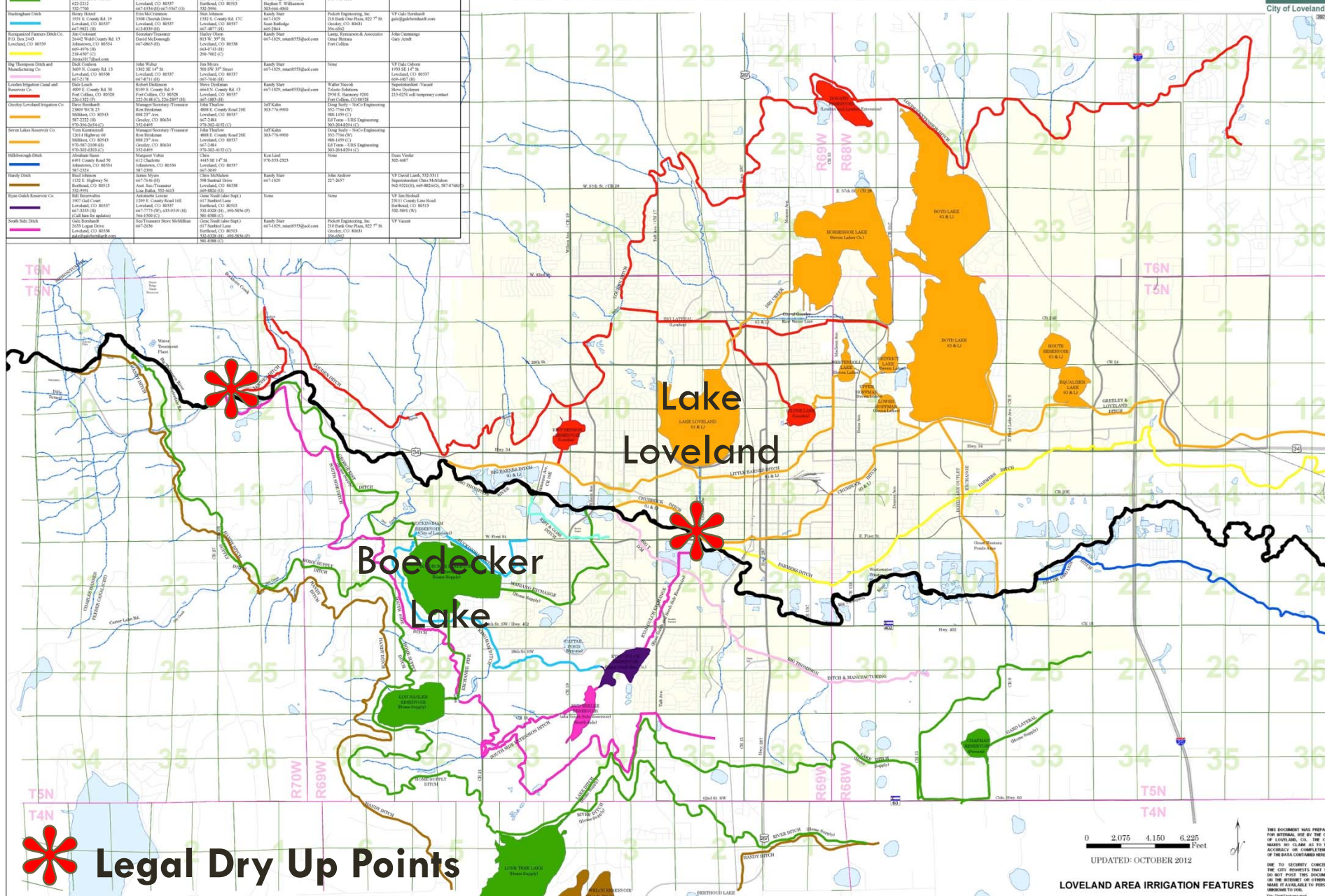
Big Thompson River Watershed



Key Watershed Characteristics

- Area = 612 square miles
- Mean annual precipitation = 22 inches
- Mean watershed elevation = 7,700 feet
- 100-year 24-hour precipitation = 5.01 inches
- 2-year 24-hour precipitation = 1.81 inches
- Percentage of clay soils ~ 16%
- Time of concentration ~ 15.25 hours
- Overall watershed ~ 7% impervious with several concentrated urban areas

LOVELAND AREA IRRIGATION FEATURES



Typical Streambed Conditions



- Cobble bed in upper reaches through Loveland
- Transitions to gravel and silt bed in lower reaches through City
- Significant scour in 2013 flood but little day-to-day erosion of bed or banks



1976 & 2013 Floods



Peak Discharges from Flood Insurance Study

<u>Flooding Source and Location</u>	<u>Drainage Area (Square Miles)</u>	<u>Peak Discharges (cfs)</u>		
		<u>10-Percent Annual Chance</u>	<u>2-Percent Annual Chance</u>	<u>1-Percent Annual Chance</u>
Big Thompson River				
At Larimer-Weld County Line	595	3,600	7,600	10,000
At Interstate 25	515	4,300	8,800	11,500
At County Road 9E	515	4,700	12,300	19,000
At Railroad Avenue	515	4,700	12,300	19,000
At Mouth of Canyon (Drake Gage)	535	4,700	12,300	19,000
At Drake Below North Fork	274	3,700	7,850	10,400
At Drake Above North Fork	191	2,750	5,700	7,500
At Lake Estes Below Dry Gulch	156	2,250	3,800	4,700
At Lake Estes	137.5	1,510	1,190	2,180
At St. Vrain Avenue	136.9	1,510	1,190	2,180
At Confluence with Fall River	87.1	980	1,340	1,460
At Craggs Drive in Estes Park	87	980	1,340	1,460

Note: Peak discharges for Big Thompson River are currently being updated as a part of the Colorado Hazard Mapping Program (CHAMP).

Updated peak discharges in Loveland area are similar to existing published values.

Gravel Pits



Gravel Pits



Urban Area Considerations



Water Quality



Coming Soon...

BIG THOMPSON RIVER CORRIDOR MASTER PLAN



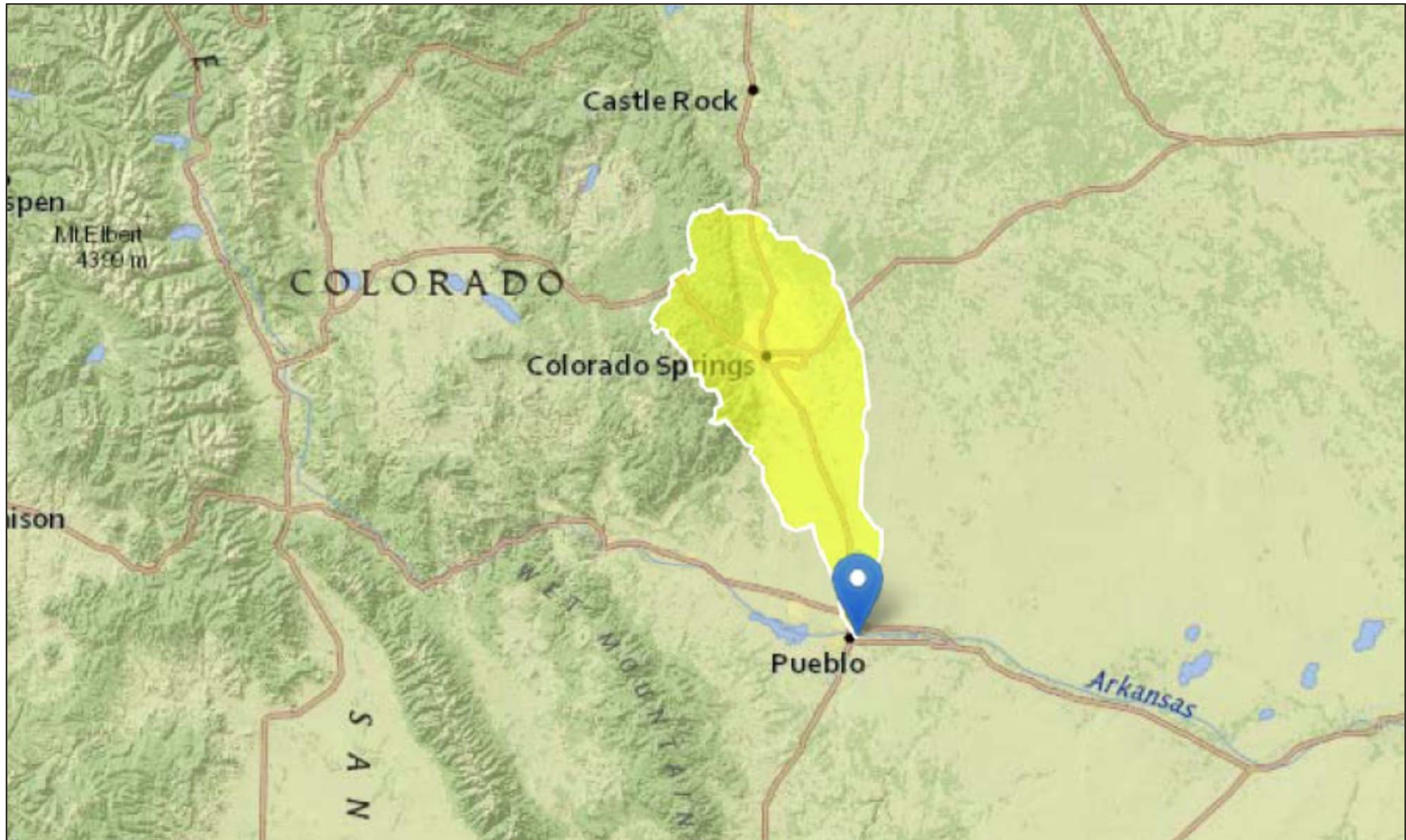
Draft October 2017



Fountain Creek

- Hydromodification
- Significant Urbanization
- Sediment

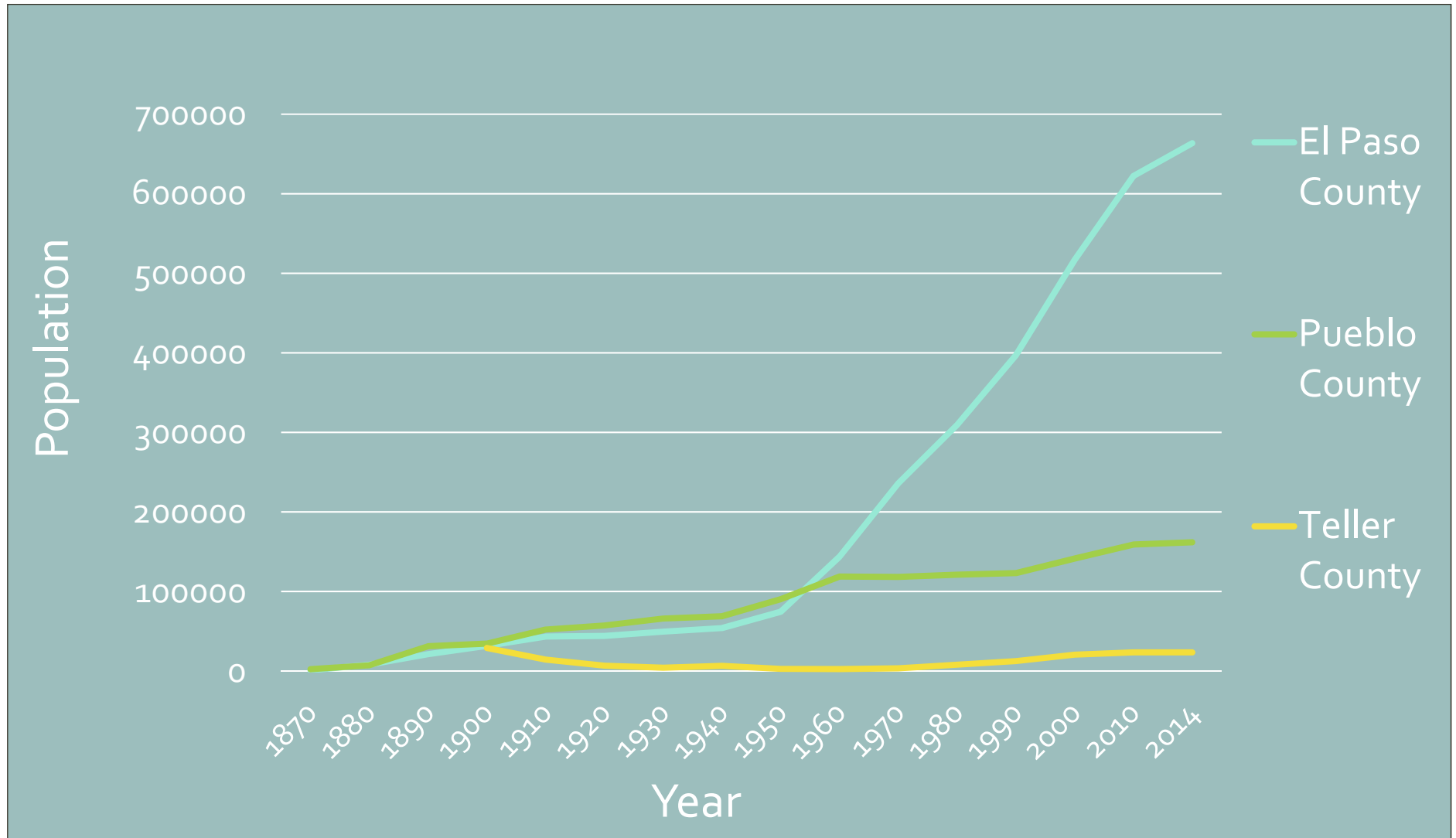
Fountain Creek Watershed

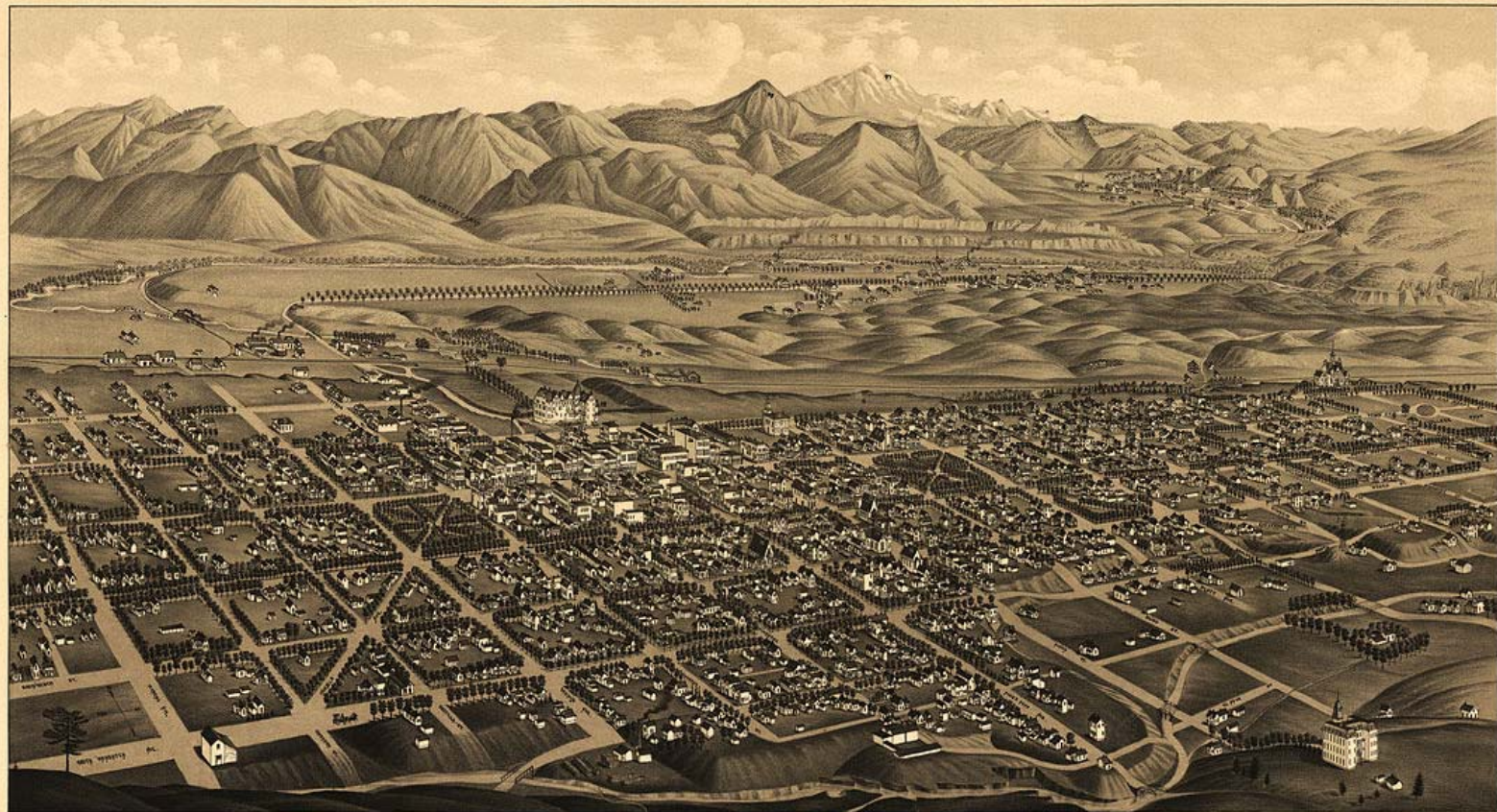


Key Watershed Characteristics

- Area = 927 square miles
- Mean annual precipitation = 19 inches
- Mean watershed elevation = 6,760 feet
- 100-year 24-hour precipitation = 5.2 inches (C Springs)
- 2-year 24-hour precipitation = 1.9 inches
- Percentage of clay soils ~ 22%

Population of El Paso, Pueblo, and Teller Counties, 1870–2010, with projected year 2014 population (U.S. Decennial Census)





Published by J. J. Stoner, Manitou, Wyo.

1. Colorado College.
2. Blind and Deaf-Mute Institute.
3. High School and School Buildings.
4. Court House.
5. County Jail.
6. Opera House.
7. Gas Works.
8. D. & R. G. R. W. Depot.
9. Alamo Square or South Park.
10. Acacia Place, or North Park.
11. Fire Engine House.

12. Churches.
13. Congregational Church.
14. Methodist Episcopal Church.
15. Presbyterian Church.
16. Baptist Church.
17. M. E. South Church.
18. Christian Church.
19. E. Catholic Church.
20. Cumberland Presbyterian Church.
21. African Church.
22. Methodist Church, Colorado City.

PANORAMIC
BIRD'S EYE VIEW OF
COLORADO SPRINGS,
COLORADO CITY-MANITOU, COLO.
1882.
Copyright 1882 by J. J. Stoner, Manitou, Wyo.
43. Depot D. & R. G. R. W.
44. School House.
45. Congregational Church.
46. Garden of the Gods.
47. Pike's Peak, 14,299 feet high.
48. Cameron's Cove.

23. Plaster Mill, Colorado City.
24. Brewery, Colorado City.
25. Colorado City School House.
26. Hotel.
27. Palmer House.
28. Spaulding House, T. A. Hirschbaugh, Prop'r.
29. National Hotel.
30. Colorado Springs Hotel.
31. Crawford House.
32. Empire House, T. Jones, Prop'r.
33. Maxwell House, T. Maxwell, Prop'r.

34. Post Office.
35. Daily Gazette.
36. Daily Republican.
37. L. O. of G. F. Hall.
38. Masonic Hall, Opera House Building.
39. Manitou, Site of the Panoram Sols and Iron Springs.
40. Manitou House.
41. Barker House, C. W. Barker, Prop'r.
42. Cliff House.

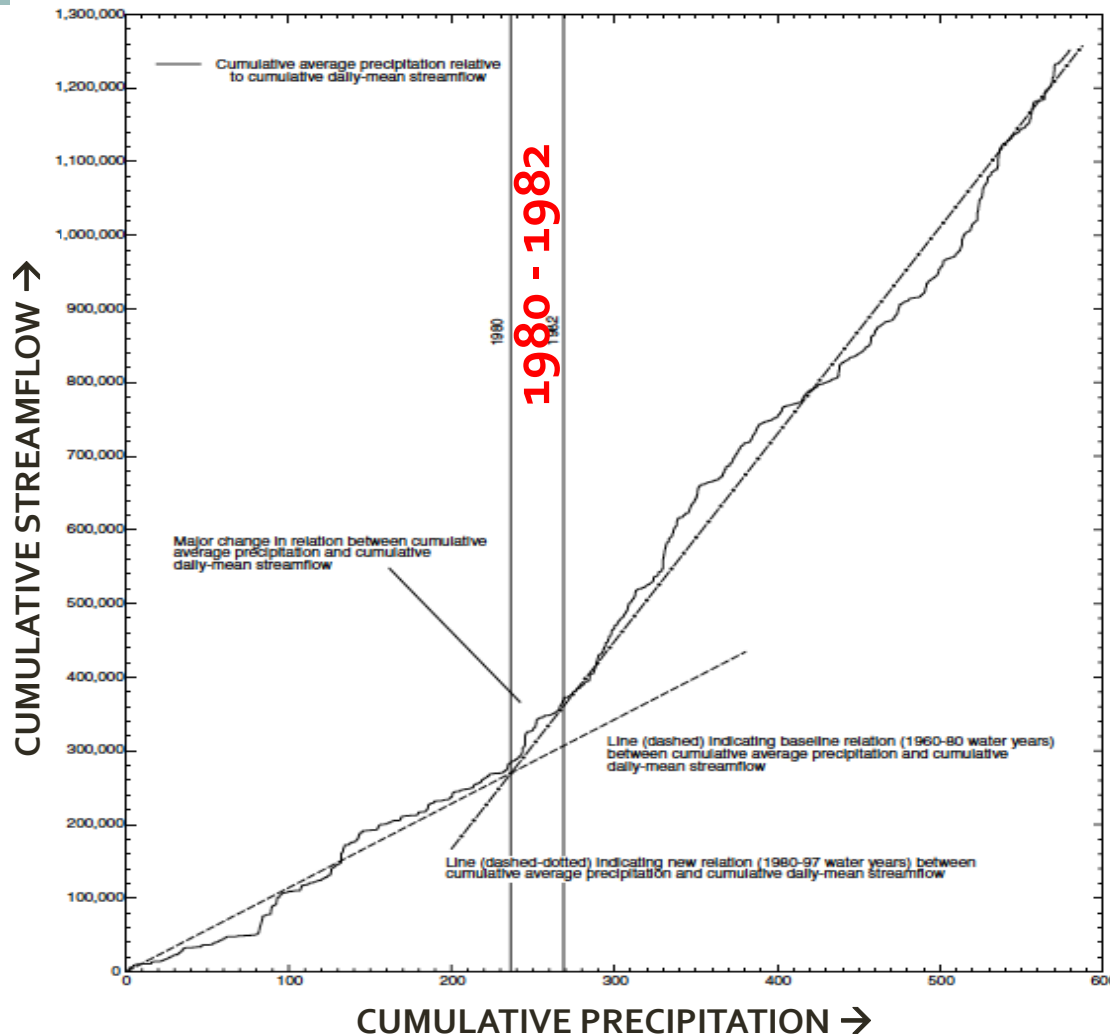
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94314
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1882
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Stoner, J. J., Panoramic bird's eye view of Colorado Springs, Colorado City and Manitou, Colo. 1882.

Shift in Rainfall-Runoff Response c. 1980 (USGS 2000)

34



Plausible reasons for changes:

- Importation of transbasin water from outside the watershed;
- Sparse spatial distribution of precipitation stations
- Changes in land use within the watershed could have altered the hydrologic response of the watershed to precipitation events; or
- Changes are due to combination of these variables (Stogner 2000).

Impervious Area (square miles)

Location	1992	1997	2000
Fountain Cr. near Manitou	17	23	24
Monument Cr. Drainage US Cottonwood Cr.	27	45	45
Fountain Cr. at Security	111	153	165

USGS, Edelman, et al., 2002

Growth in the watershed continues

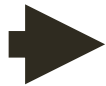
Trans-Mountain Diversions

Project	From	To	Users	Acre Feet / year
Homestake	Eagle River	Rampart Reservoir	Colorado Springs	64,700
Blue River	Blue River	North Catamount Reservoir	Colorado Springs	7,800
Fry-Ark	Roaring Fork	WTPs via pipelines from reservoir system	Colorado Springs, Fountain, Security	11,700
Sources: Colorado Water Conservation Board (CWCB) Watershed Flow Evaluation Tool (WFET) Pilot Study Report & SDS FEIS				84,200

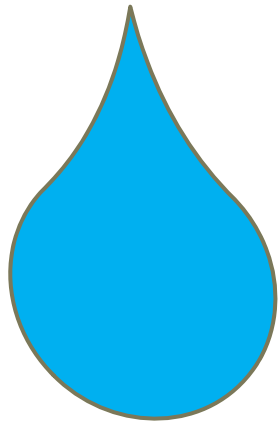
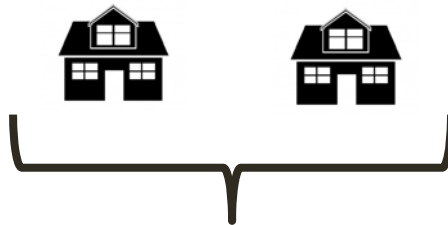
- + Monument Municipal Groundwater Wells
- + Southern Delivery System
- + Increased runoff from development supported by imported water

Summary - The Effect of Imported Water

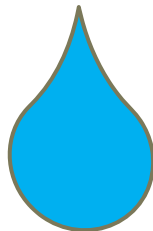
1 acre-foot
of imported
water/year



Supports 2 families of 4



Return Flows



0.6 ac-ft /yr

+

Added Runoff

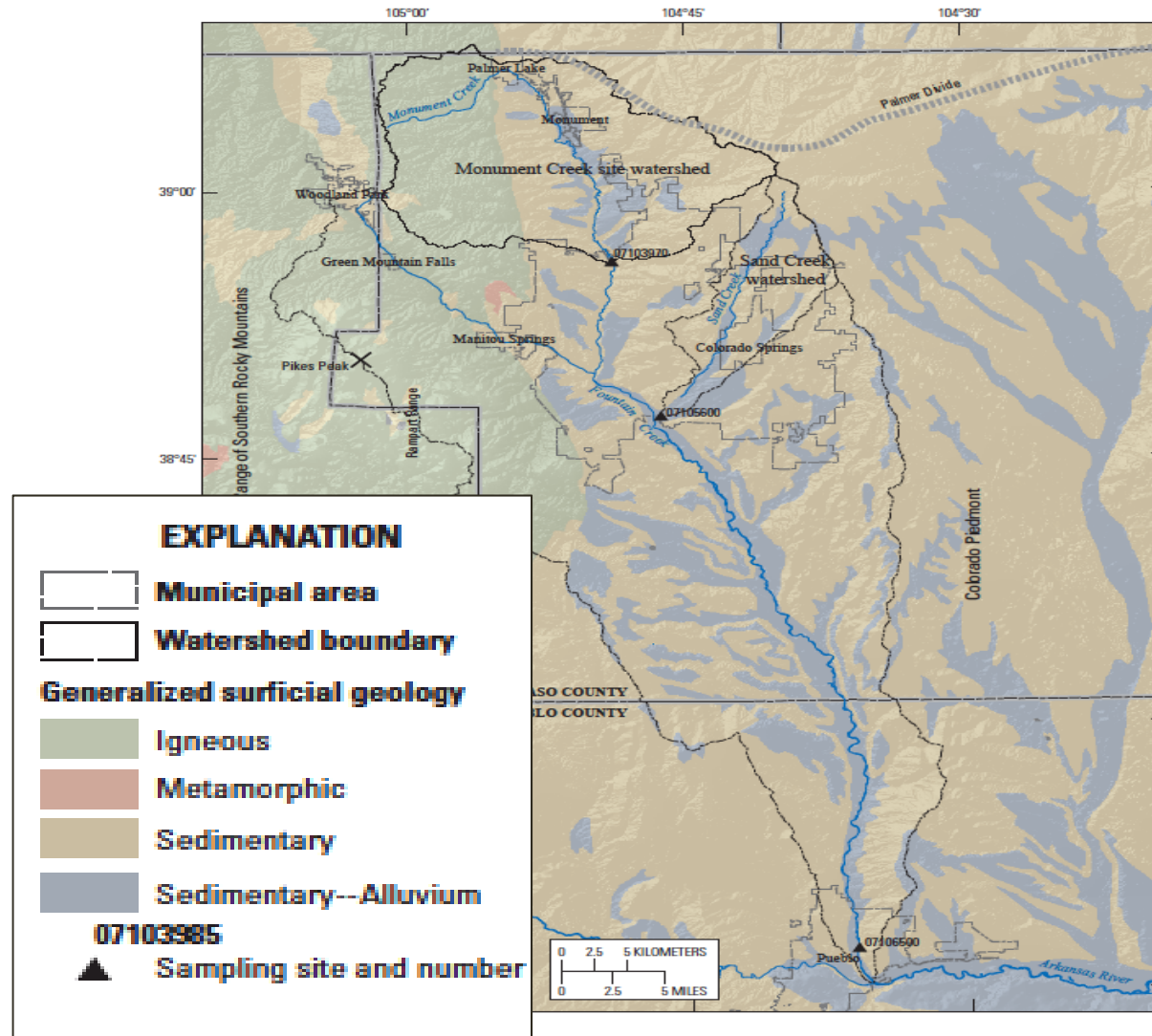
Impervious Area (0.25 ac)
(houses, roads, etc.)



0.25 ac-ft /yr

“New” water
in Fountain
Creek ~ 0.85
acre-
feet/year

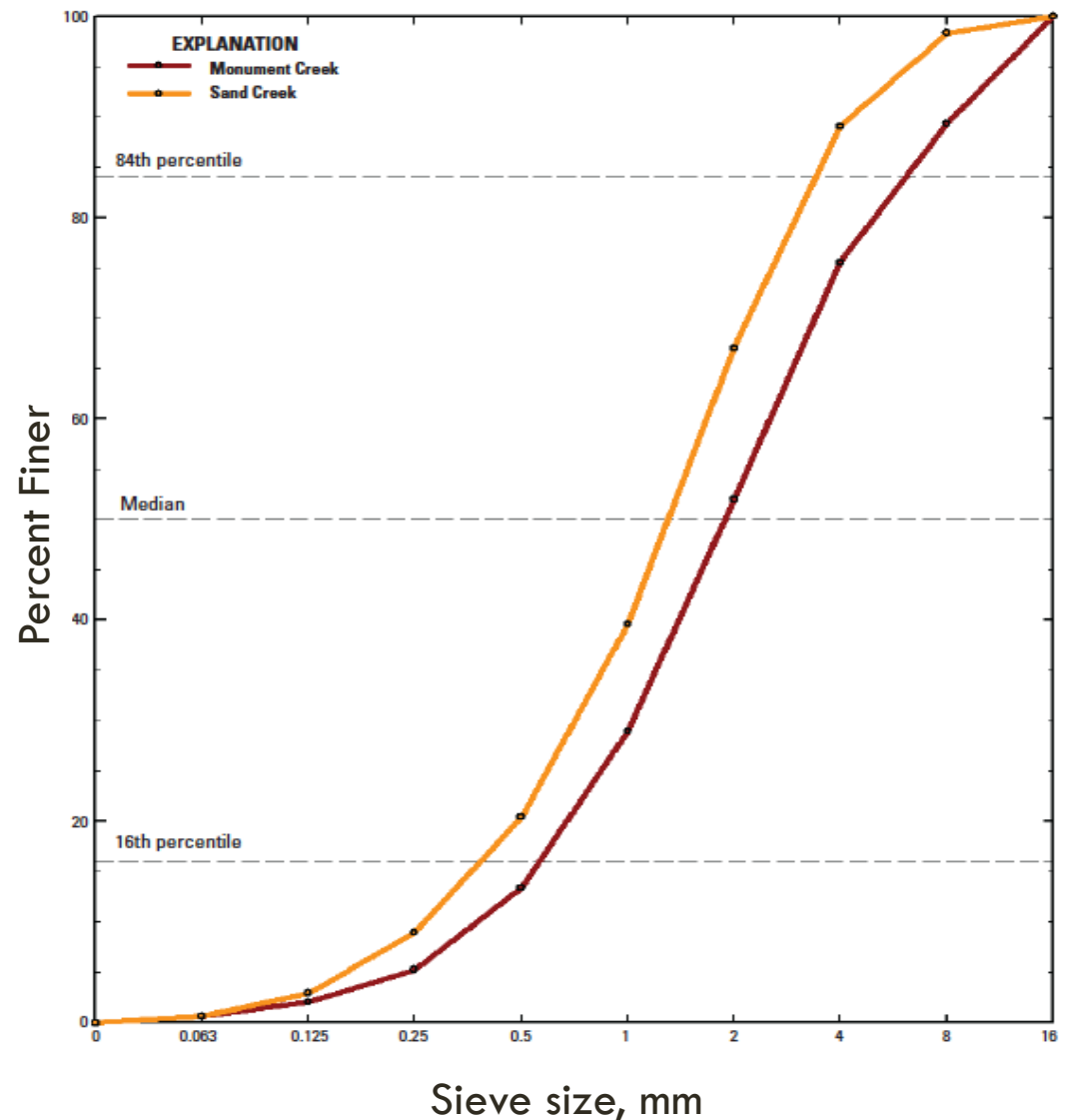
Surficial Geology of Watershed



Monument Creek & Sand Creek Bed Material (USGS, 2007)

Minimum streamflows in Fountain Creek and its tributaries have the capacity to transport sand-size particles.

Higher streamflows ranging from 0.28 cubic meters per second (m^3/s) [9.9 cfs] to 17 m^3/s [600 cfs] have capacity to transport gravel-size particles (Mau and others, 2007)



Piñon Bridge – looking upstream



Effects of Altered Hydrologic and Sediment Transport Regimes



Confluence — Arkansas River (on left) and Fountain Creek (on right)

COLORADO SPRINGS **Independent**

Springs, Pueblo agree to 20-year, \$460 million pact

By Pam Zubeck [@PZubeck](#)



Colorado Springs Utilities

Lessons Learned from Case Studies



- ❑ Understand your project in context of watershed and stream
- ❑ Hydrology is a fundamental driver
- ❑ Data collection can be critical
- ❑ Base planning and design decisions on site-specific conditions

Questions?

Thank you for attending our presentation!

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