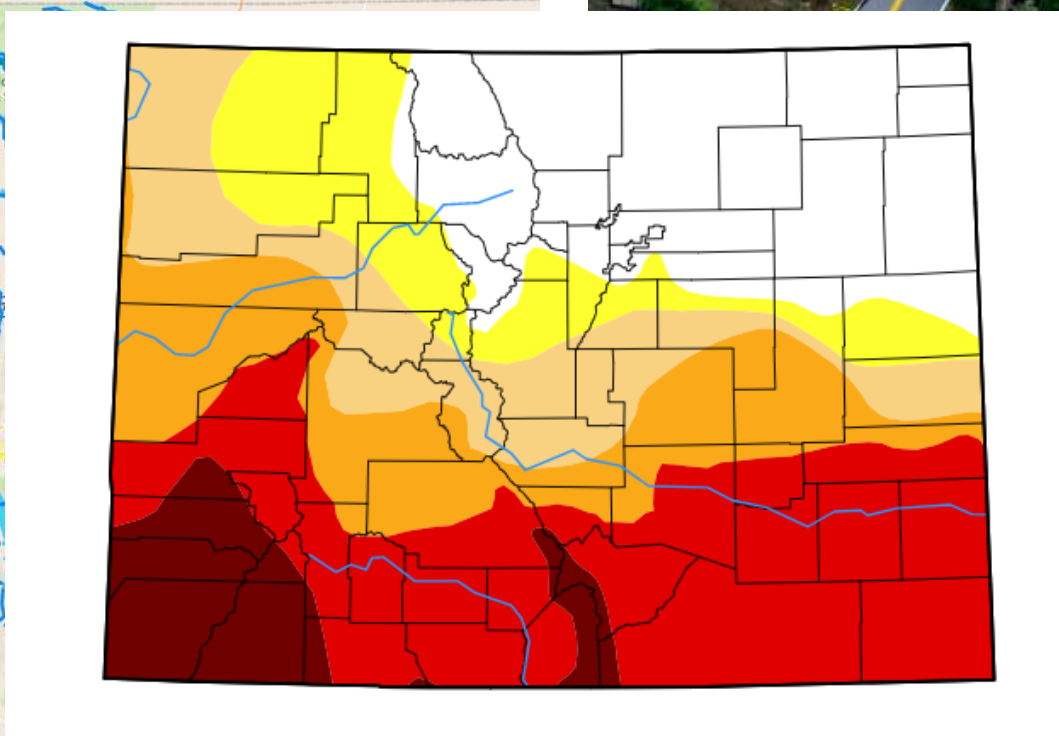
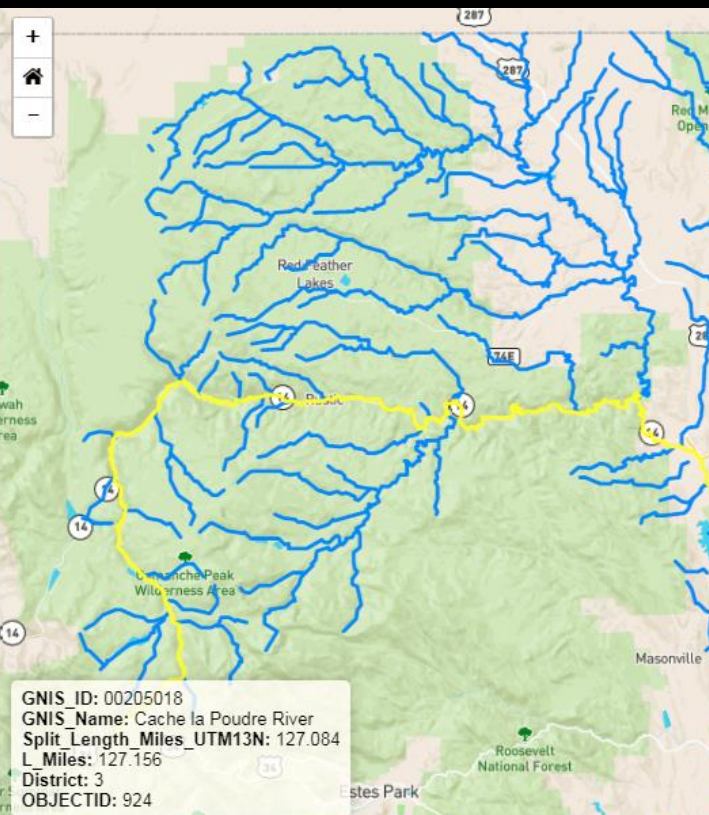


Water Literate Leaders of Northern Colorado

Data and Information for Water Development

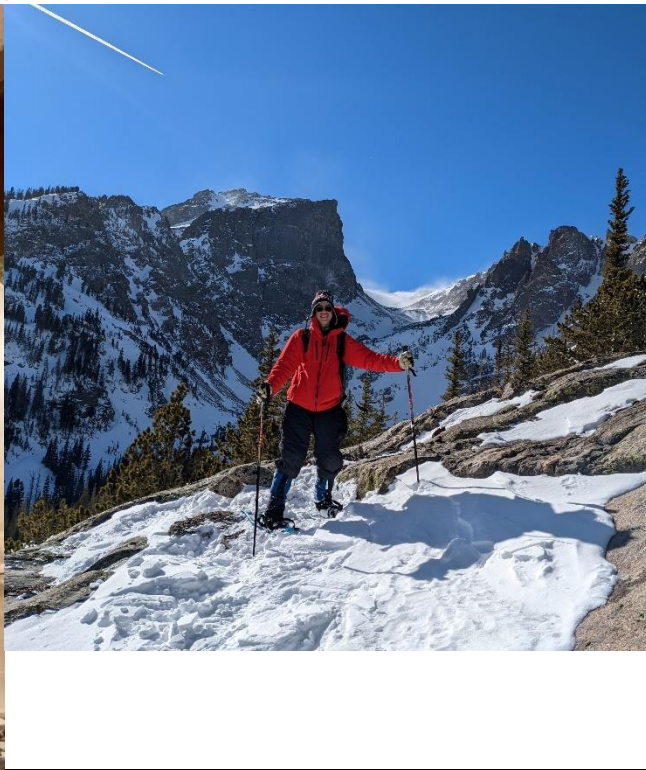
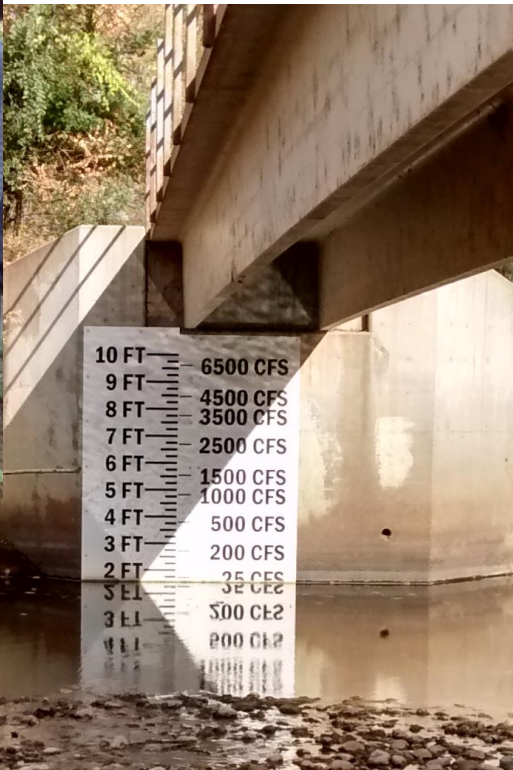
November 9, 2022



Steve Malers, Open Water Foundation
steve.malers@openwaterfoundation.org
openwaterfoundation.org

Steve Malers

- Grew up in La Junta
- Graduated from CSU (Civil Engineering)
- Founder, CEO, CTO, Open Water Foundation (2013)
- Co-founder, CTO, TriLynx Systems (2015)
- Water Education Colorado Water Leader (2014)
- Fort Collins Water Board (2011-2020)
- Poudre Runs Through It



Open Water Foundation

Nonprofit social enterprise focusing on developing open source software and open data solutions to help make better decisions about water resources. Water is a public resource, and water data and software tools should also be public.



open data | open software | open decisions

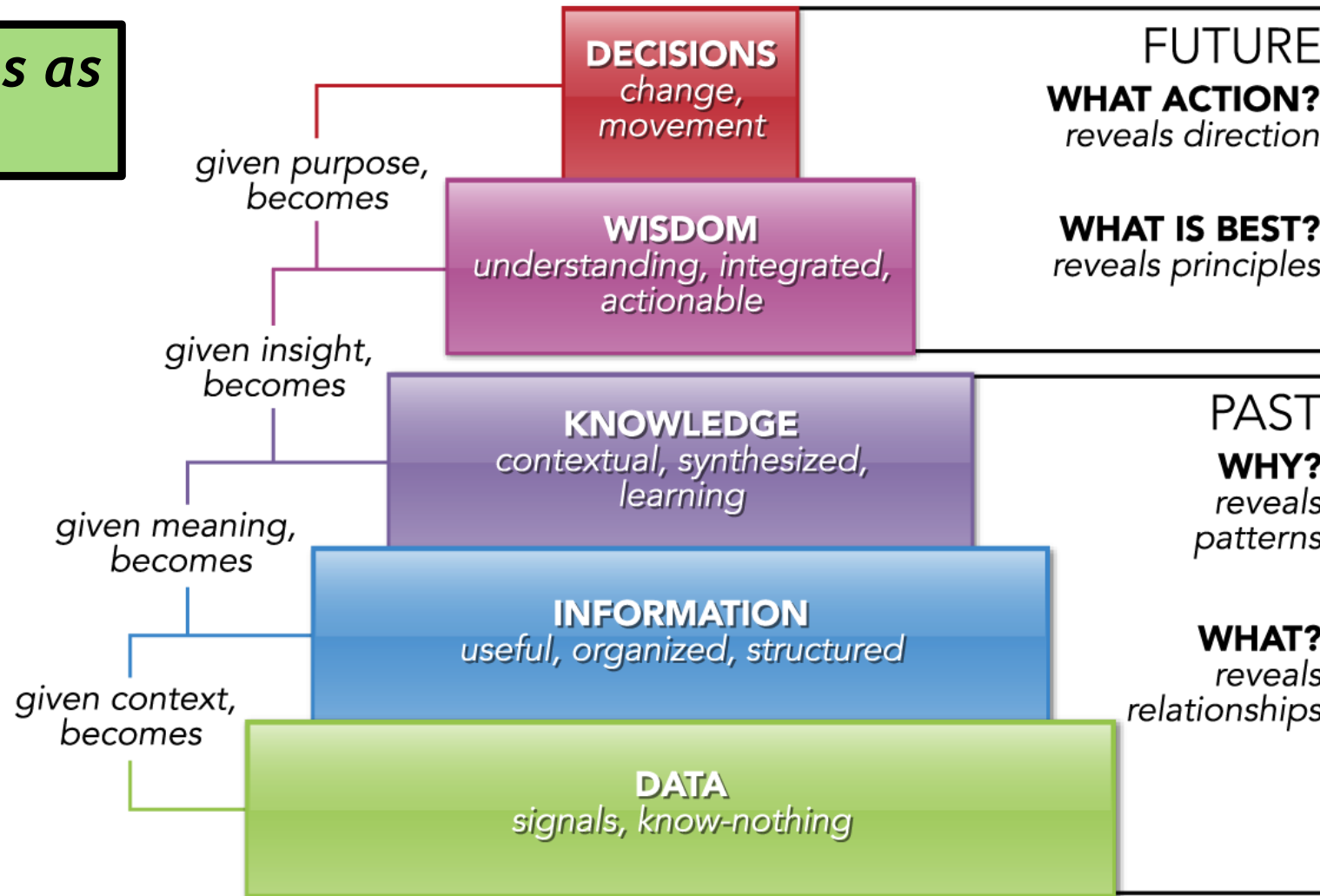
openwaterfoundation.org

Goals of Presentation

- Provide examples of data and their sources.
- Highlight the importance of context, including temporal and spatial context and “annotations”.
- Provide examples of information products.
- Emphasize the value of interoperability, automation, operational efficiency, and cost-effective solutions.
- Illustrate the benefits of community-based information and decisions.
- Illustrate that water touches everything.

Open Data is Infrastructure for Innovation

**Visualizations as
Insight**



Data and information are infrastructure, and are necessary like gray and natural infrastructure

Context - World Risks

“Climate and tech pose the biggest risks to our world in 2018”



“Identify the most severe risks on a global scale over the next 10 years”

■ Economic ■ Environmental ■ Geopolitical ■ Societal ■ Technological



2022 Report
Water Nexus?

Context - Drought

<https://poudre.openwaterfoundation.org>

US Drought Monitor

DM: 0

Click on a feature for more information

Current Drought

Poudre Stream Reaches

Poudre Stream Reaches



Poudre Stream Reaches

US Drought Monitor

US Drought Monitor



US Drought Monitor

- D0 (Abnormally Dry)
- D1 (Moderate Drought)
- D2 (Severe Drought)
- D3 (Extreme Drought)
- D4 (Exceptional Drought)
- No data

Continental Divide

Continental Divide



Continental divide based on Hydrologic Unit Code basins

CO DWR Water Districts

CO DWR Water District 3

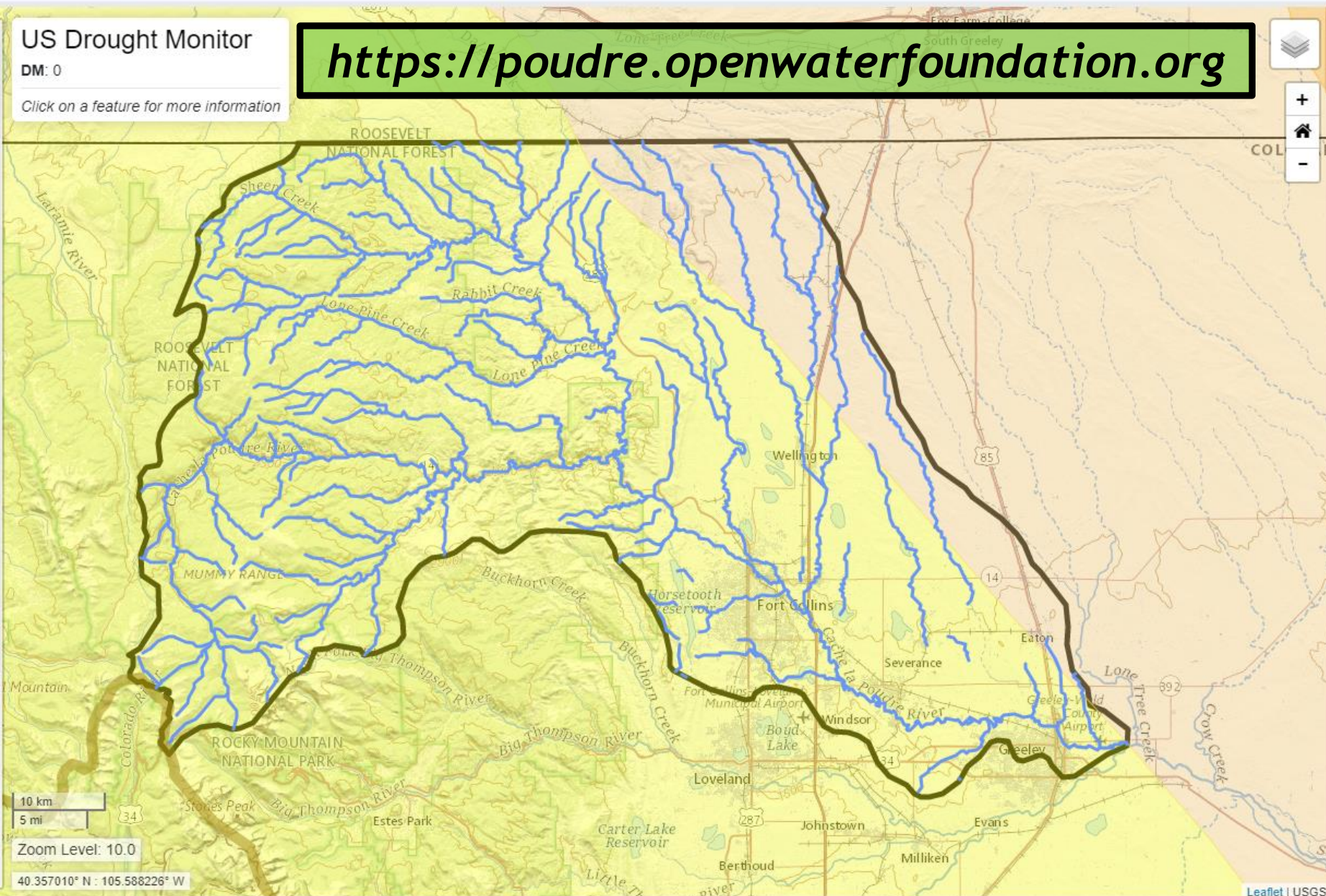


Water District 3 boundary from the Colorado Division of Water Resources

10 km
5 mi

Zoom Level: 10.0

40.357010° N : 105.588226° W



Context - Drought

Poudre Basin Information

Basin Entities Historical Data Current Conditions Seasonal Outlook Future Planning Resources

Current Drought ⓘ

Poudre Stream Reaches

Poudre Stream Reaches

Poudre Stream Reaches

US Drought Monitor

US Drought Monitor

US Drought Monitor

- D0 (Abnormally Dry)
- D1 (Moderate Drought)
- D2 (Severe Drought)
- D3 (Extreme Drought)
- D4 (Exceptional Drought)
- No data

Continental Divide

Continental Divide

Continental divide based on Hydrologic Unit Code basins

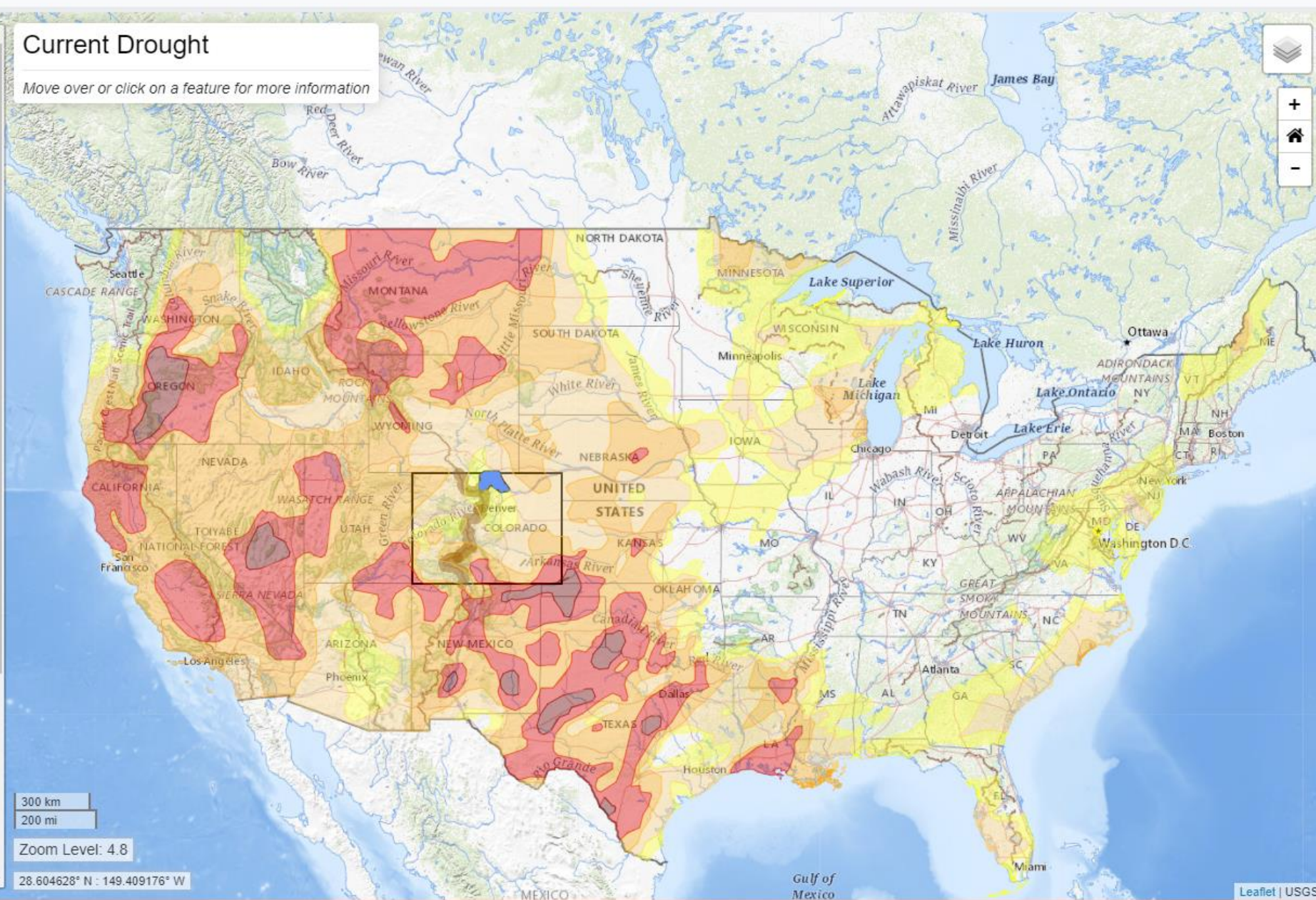
CO DWR Water Districts

CO DWR Water District 3

Water District 3 boundary from the Colorado Division of Water Resources

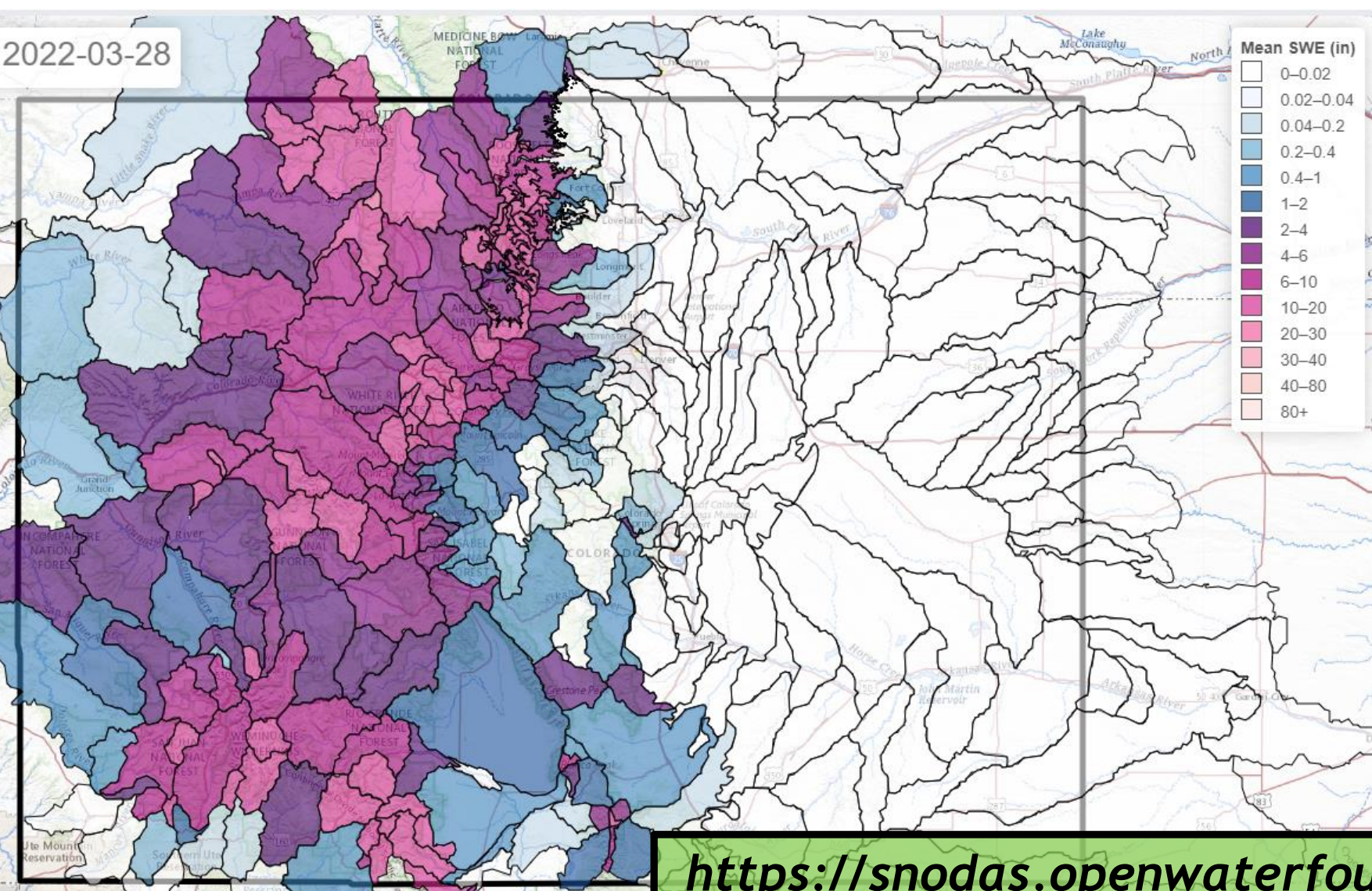
Current Drought

Move over or click on a feature for more information



Context - Water Supply

Map Data Date: 2022-03-28



Select Date
Selected SNODAS Date
2022-03-28

Select Basin
Selected Basin
Name: N/A
ID: N/A

SNODAS Data Graphs

- Snow Cover
- SWE
- SWE Volume
- SWE Upstream Total Volume
- SWE 1 Week Change
- SWE Volume Gain, Cumulative
- SWE Upstream Total Volume Gain, Cumulative

SNODAS Animation

<https://snodas.openwaterfoundation.org>

Daily Basin Statistics
Hours over a basin

30 mi
28.0675078 N - 100.8232758 W

Context - Time, History, and Trends

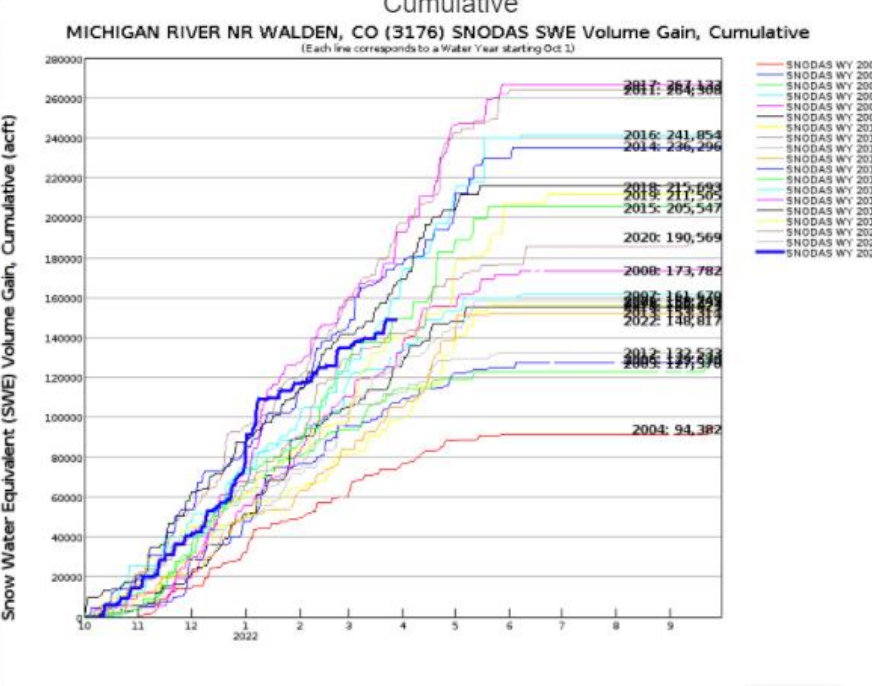
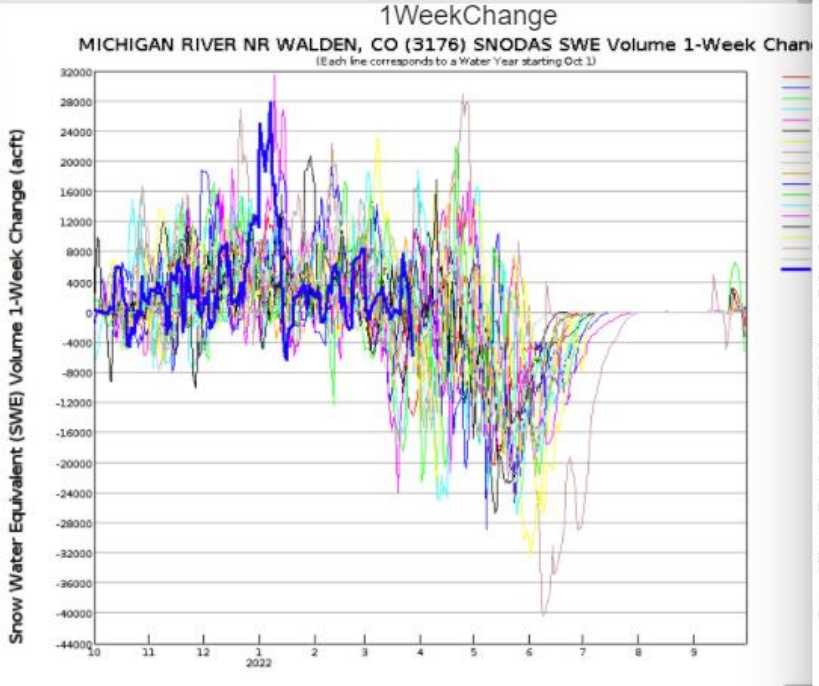
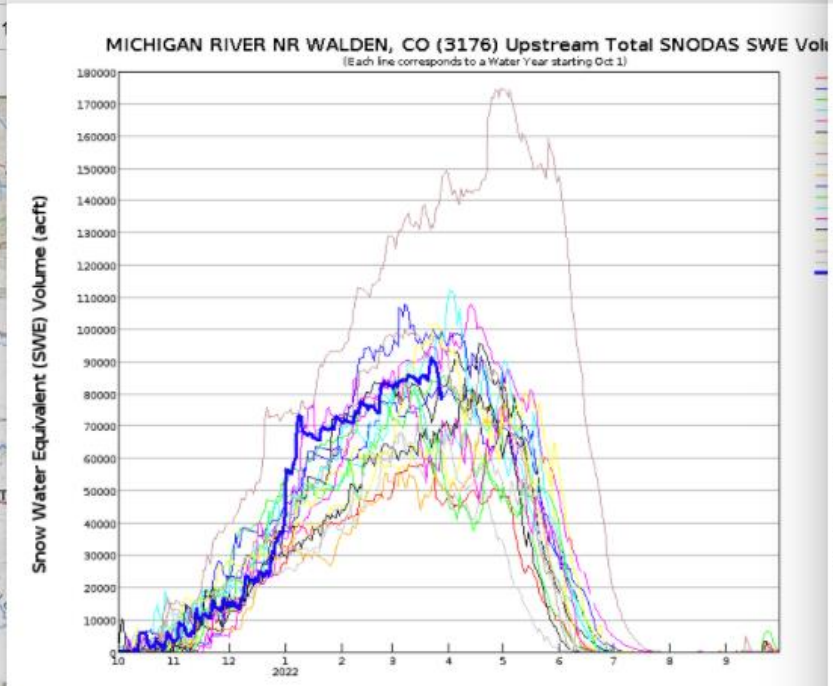
Map Data Date: 2022-03-28

3176-UpstreamTotal-SNODAS-SWE-Volume

3176-SNODAS-SWE-Volume-1WeekChange

3176-SNODAS-SWE-Volume-Gain-Cumulative

Mean SWE (in) Select Date

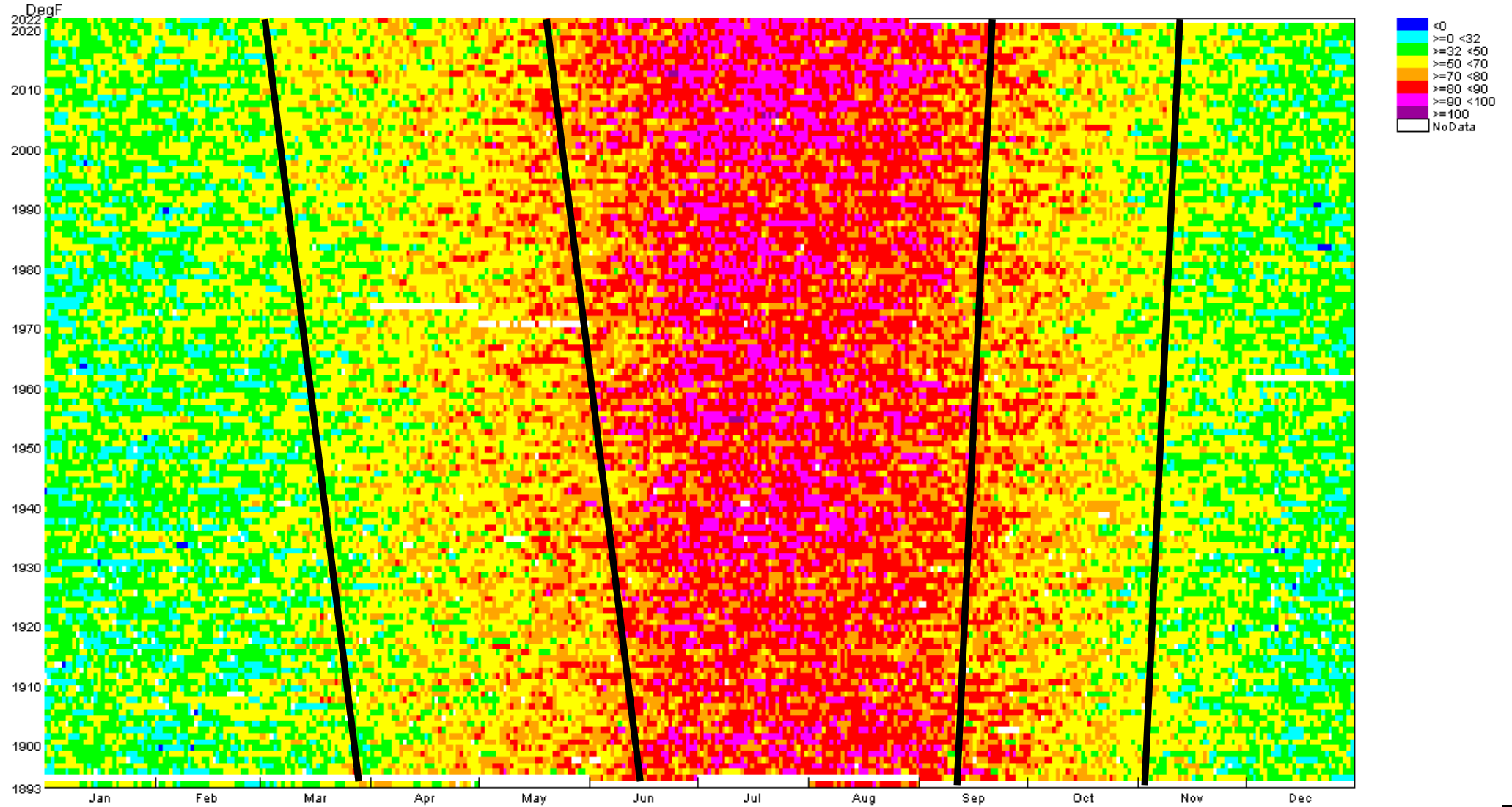


Map showing basin boundaries and geographical features. Includes labels for 'Daily Basin Statistics', 'Ute Mountain Reservation', 'Farmingington', 'Juan R.', 'Agua Fria Nation Reservation', '50 km', and '30 mi'.

Time Series - Daily Maximum Temperature

Fort Collins (053005) Maximum Daily Air Temperature

High temperatures are hot colors

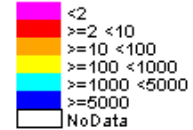
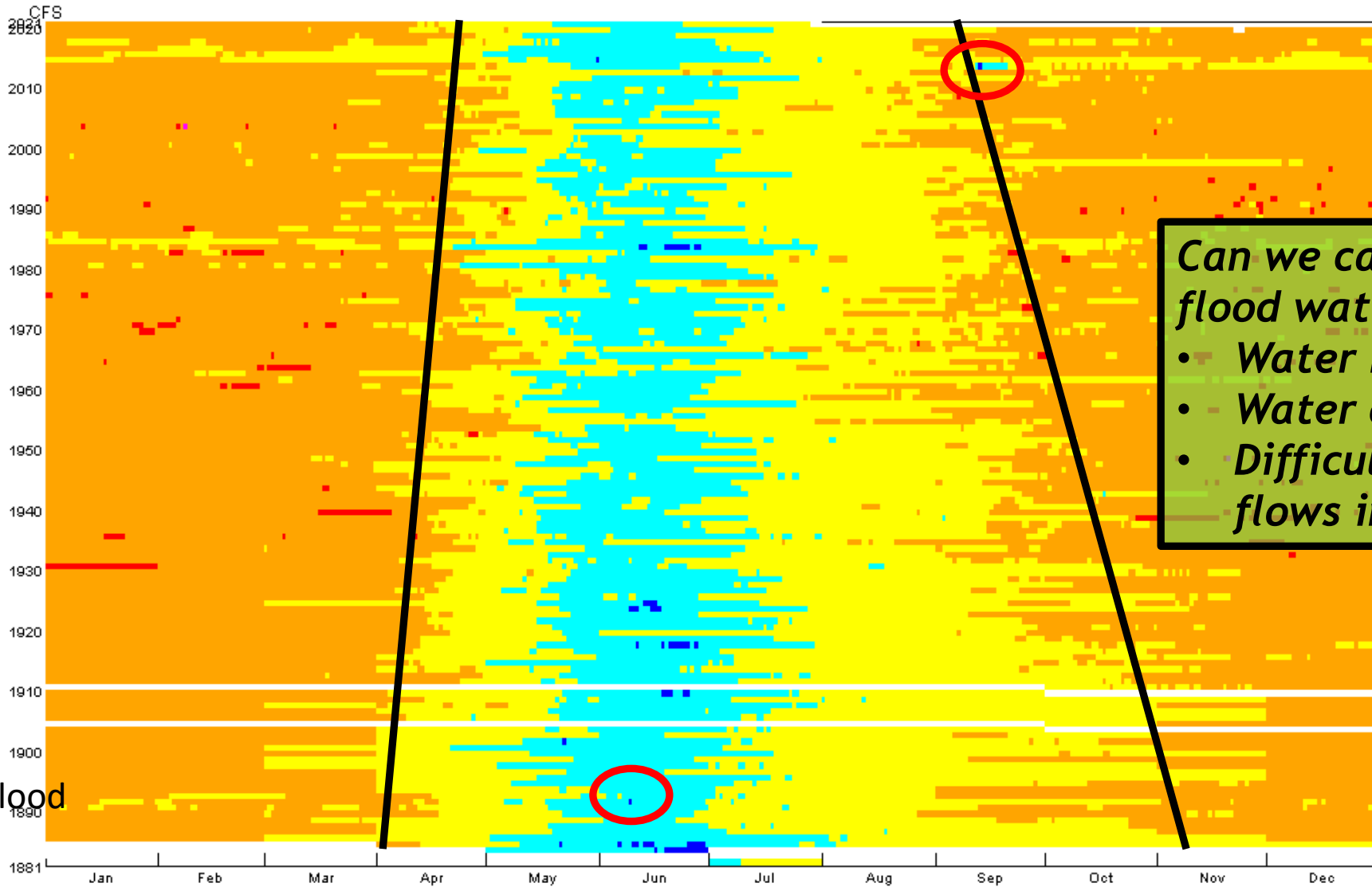


FORT COLLINS, COOP:053005.ACIS.maxt.Day (1893-01-01 to 2021-08-28)

Time Series - Daily Average Streamflow

Poudre River at Mouth of Canyon (06752000) Daily Average Streamflow
Low flow are hot colors

Sep 2013 flood
(2+ years of
base flows)
~8140 CFS



C-BT 1947
First deliveries

June 8, 1891
Chambers lake flood
~21,000 CFS

Can we capture and use flood waters?

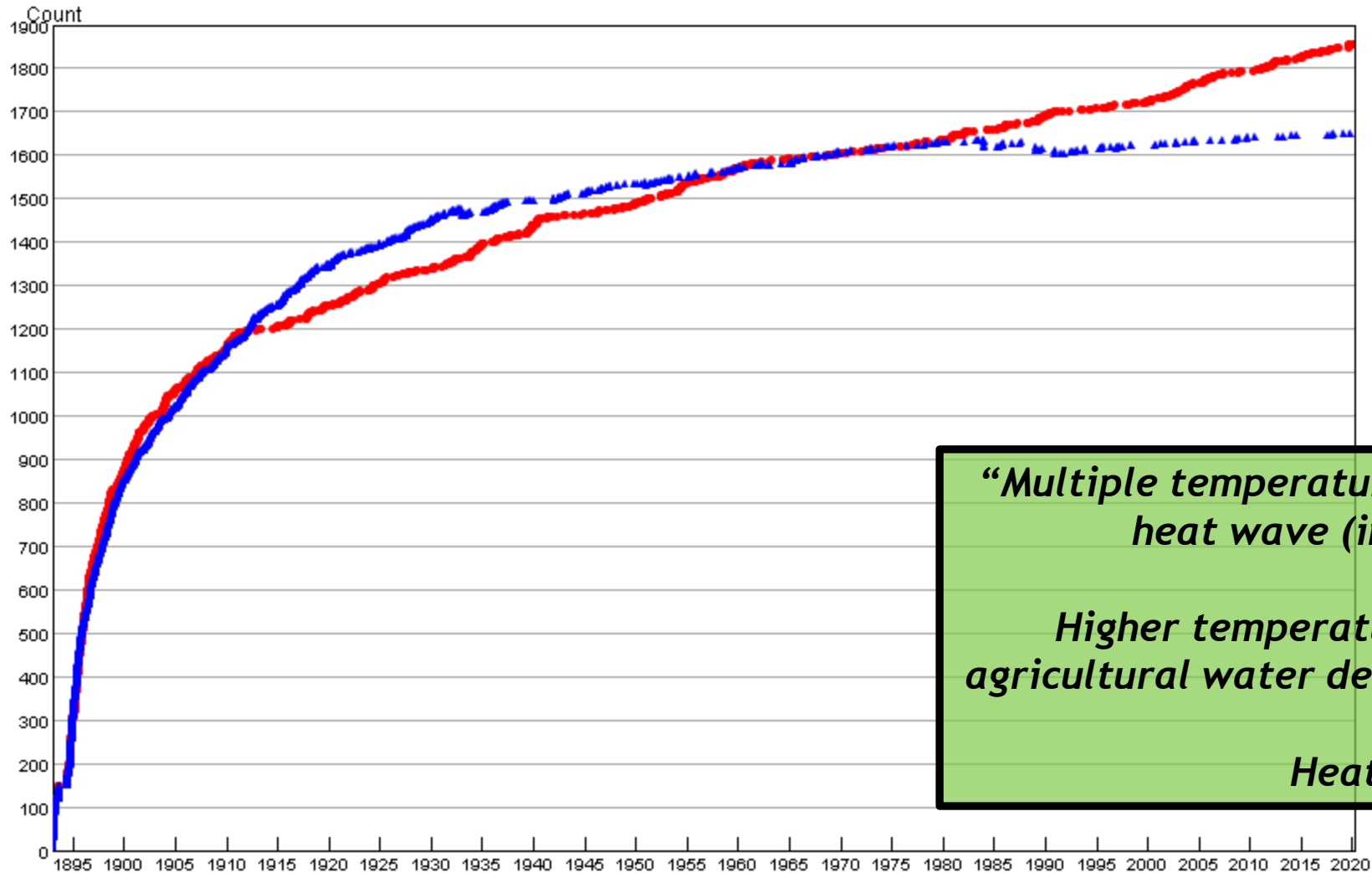
- *Water rights issues*
- *Water quality issues*
- *Difficult to capture high flows in infrastructure*

CACHE LA POUDRE AT CANYON MOUTH NEAR FORT COLLINS, 06752000.DWR.Streamflow.Day (1881-07-01 to 2020-07-31)

Temperature - Number of New Daily High Records

Fort Collins, CO (053005)

Cumulative Count of New Daily Maximum Temperature Records (New Max of Daily Max, New Min of Daily Max)



“Multiple temperature records fall in Colorado amid heat wave (insert latest date here)”

Higher temperatures = higher landscape and agricultural water demand and longer growing season

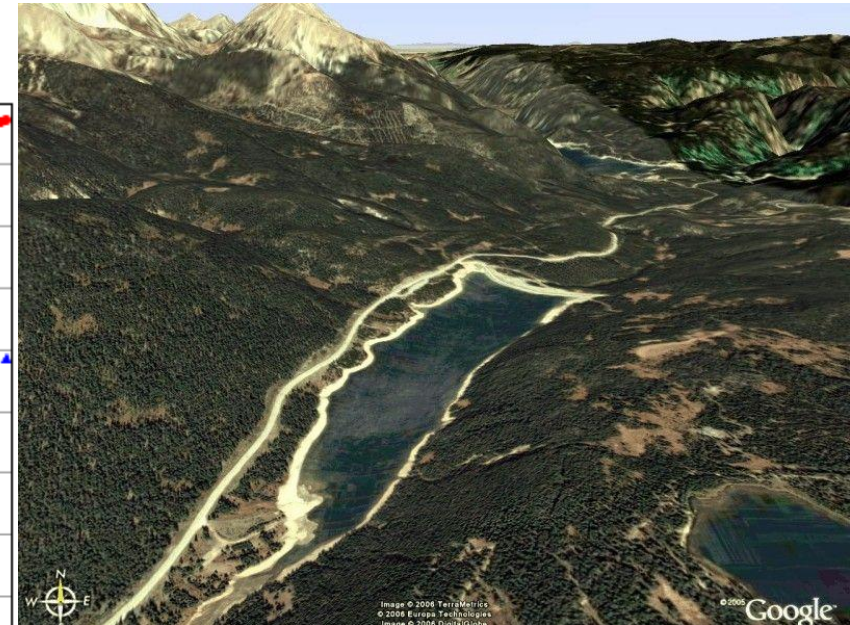
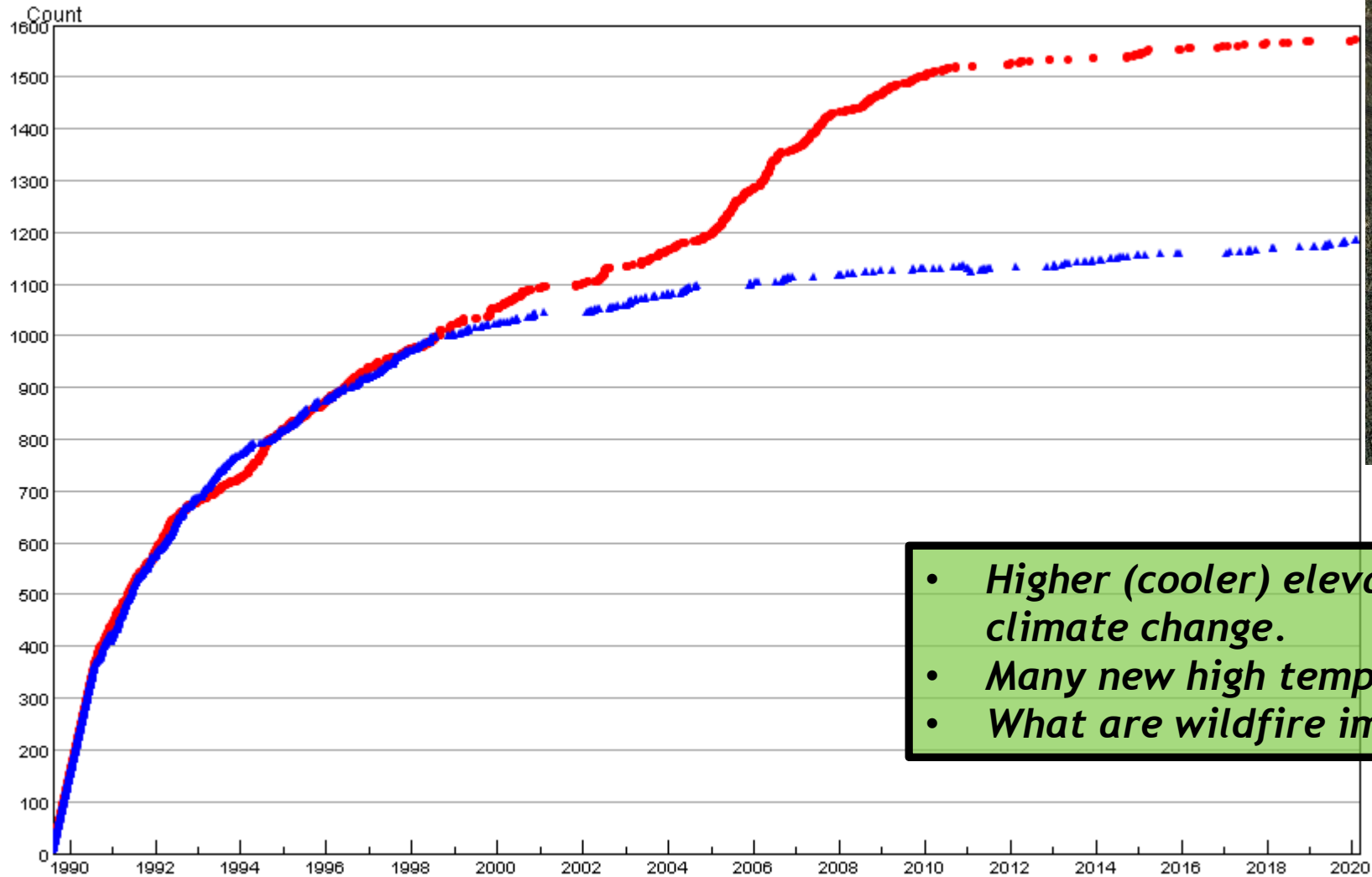
Heat island effects?

● 053005-NewMaxCount-Day - FORT COLLINS, NA11-year run stat, replaceValue(0.000,100000.000,1.000), cumulative, 053005..NewMaxCount.Day (1893-01-01 to 2020-03-01)
▲ 053005-NewMinCount-Day - FORT COLLINS, NA11-year run stat, replaceValue(0.000,100000.000,1.000), cumulative, 053005..NewMinCount.Day (1893-01-01 to 2020-03-01)

Temperature - Number of New Daily High Records

Joe Wright Reservoir, CO (USS0005J37S)

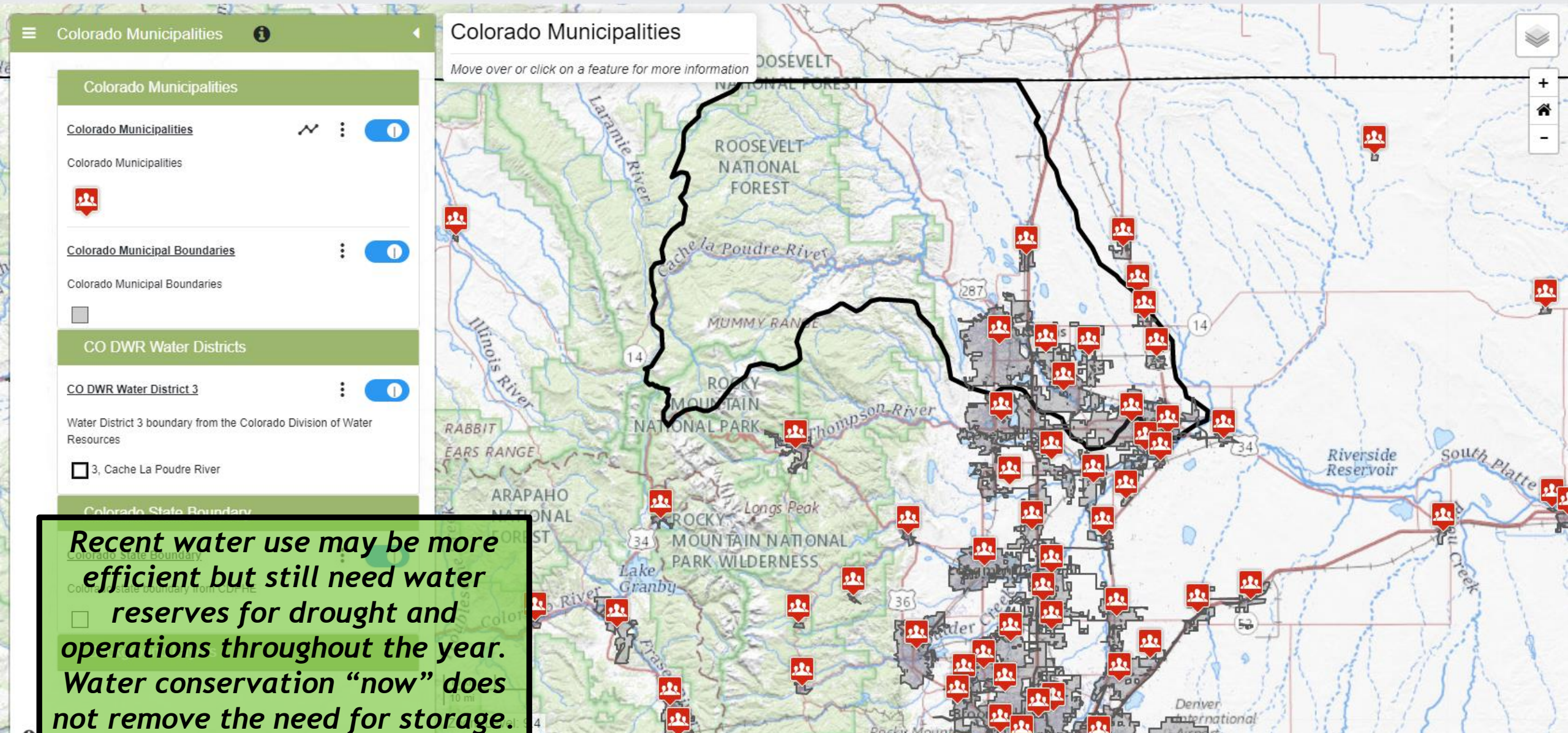
Cumulative Count of New Daily Maximum Temperature Records (New Max of Daily Max, New Min of Daily Max)



- Higher (cooler) elevations are impacted more by climate change.
- Many new high temperatures are in colder months.
- What are wildfire impacts on snowmelt (less canopy)?

USS0005J37S-NewMaxCount-Day - JOE WRIGHT, NAll-year run stat, replaceValue(0.000,100000.000,1.000), cumulative, USS0005J37S..NewMaxCount.Day (1989-08-09 to 2020-02-28)
USS0005J37S-NewMinCount-Day - JOE WRIGHT, NAll-year run stat, replaceValue(0.000,100000.000,1.000), cumulative, USS0005J37S..NewMinCount.Day (1989-08-09 to 2020-02-28)

Growth = Increased Water Demand?

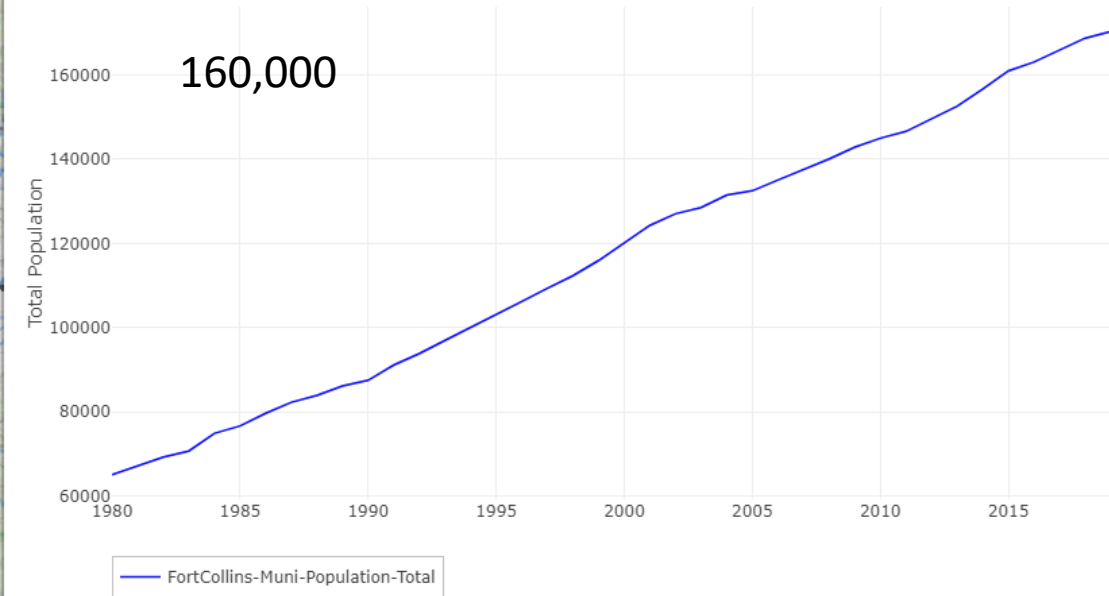


Recent water use may be more efficient but still need water reserves for drought and operations throughout the year. Water conservation “now” does not remove the need for storage.

Growth = Increased Water Demand?

Time Series - Graph

Fort Collins Municipality Total Population

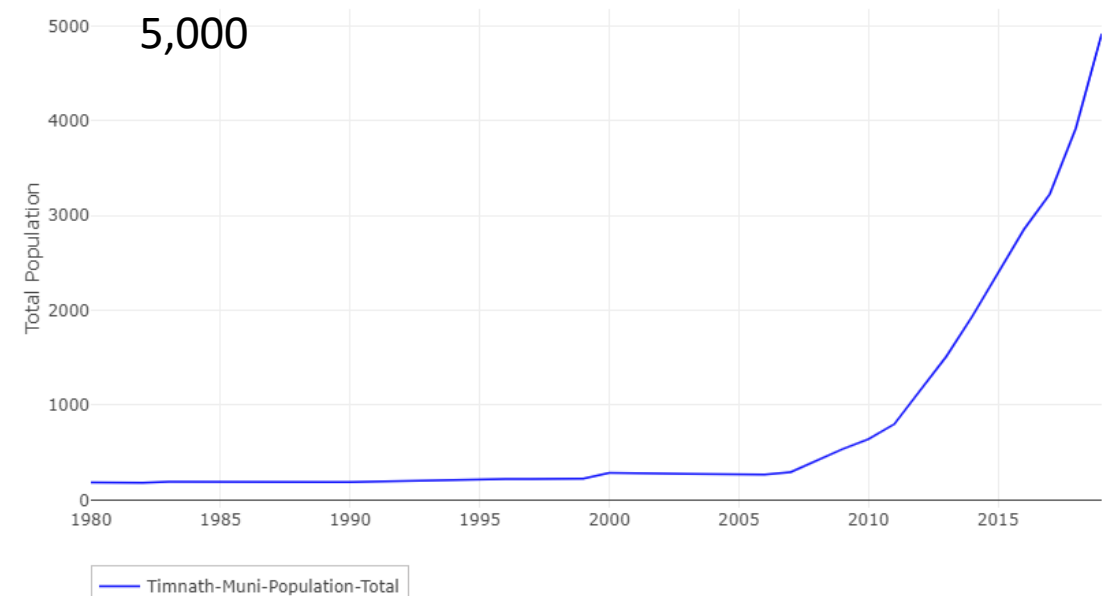


Data Table

Close

Time Series - Graph

Timnath Municipality Total Population

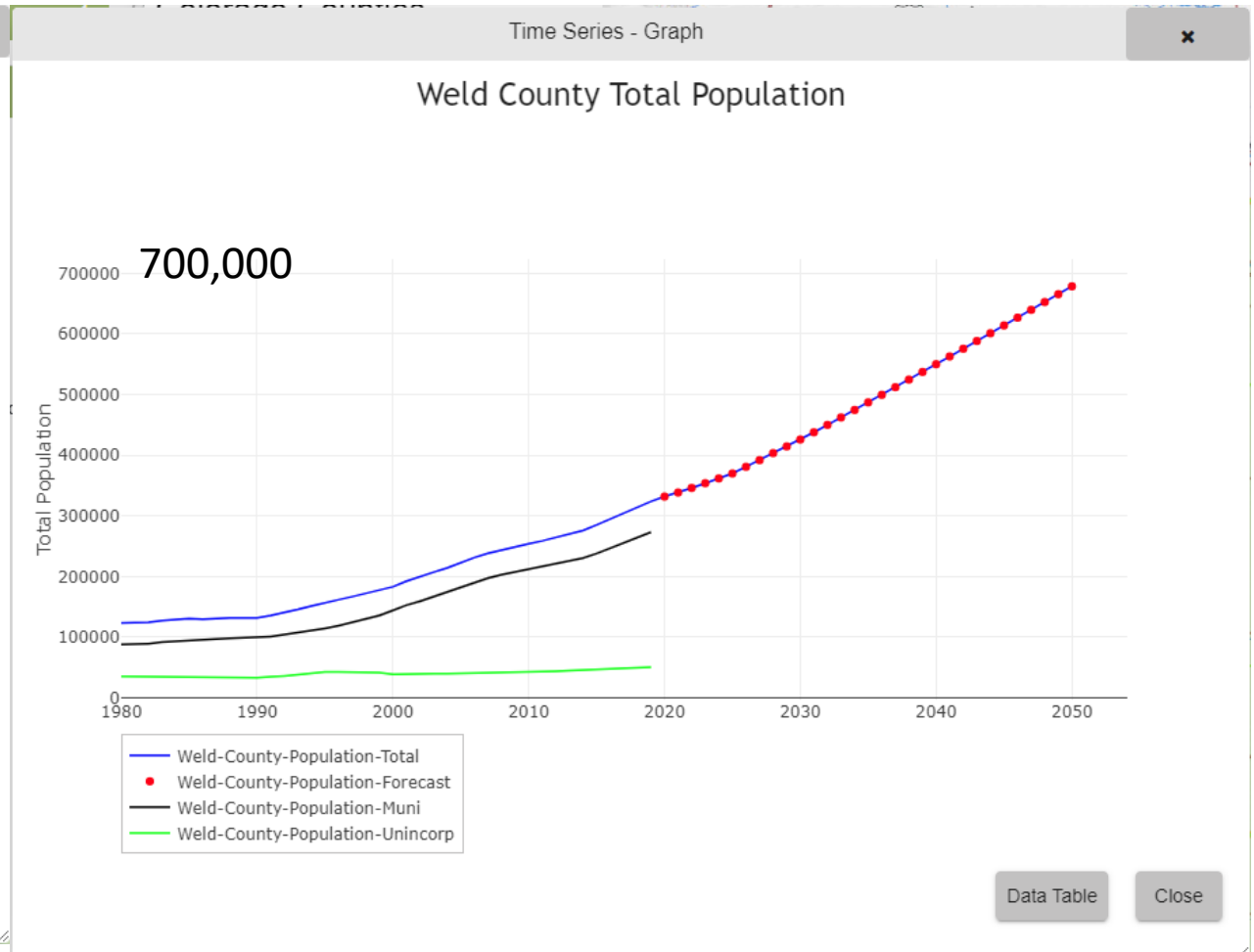
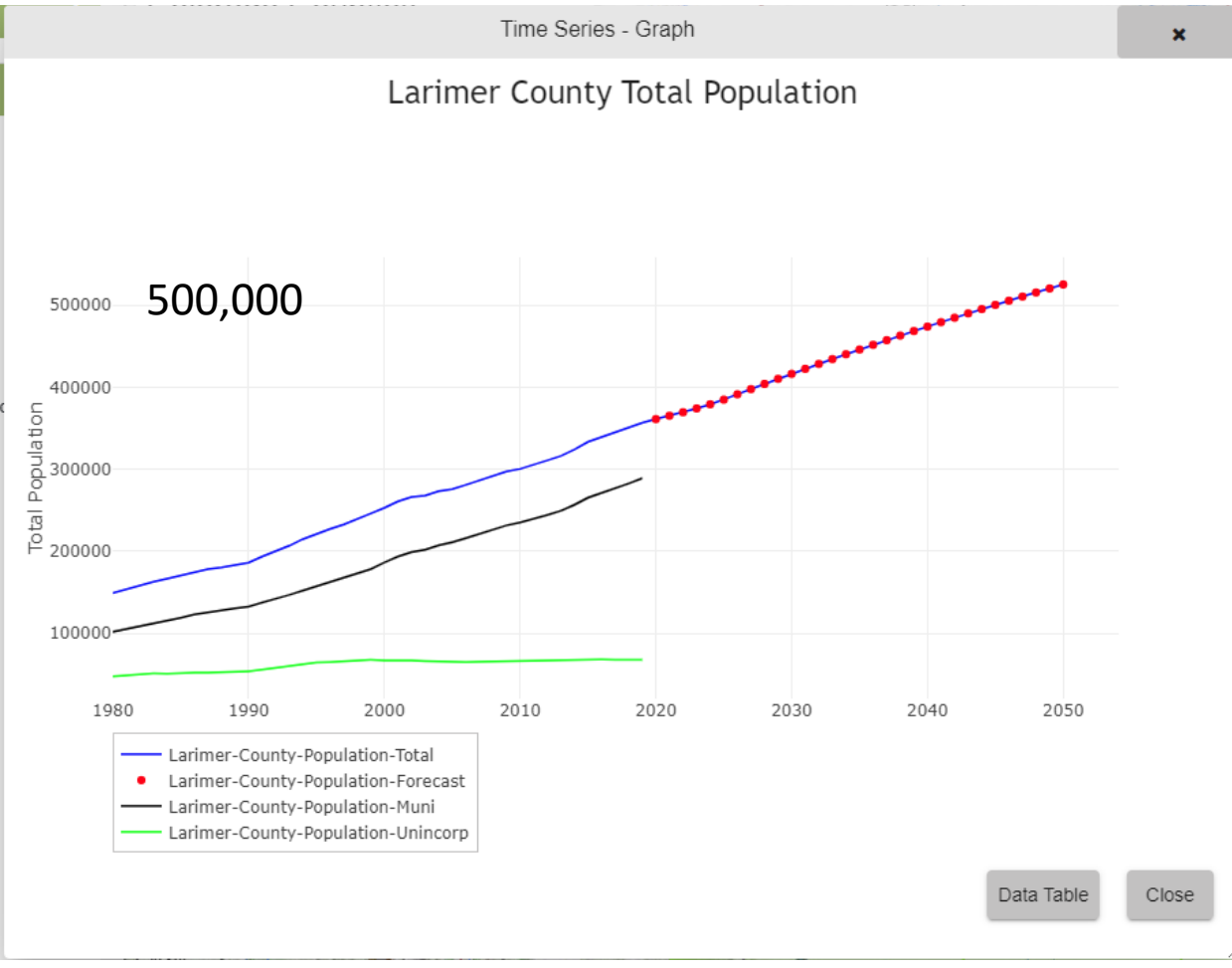


Data Table

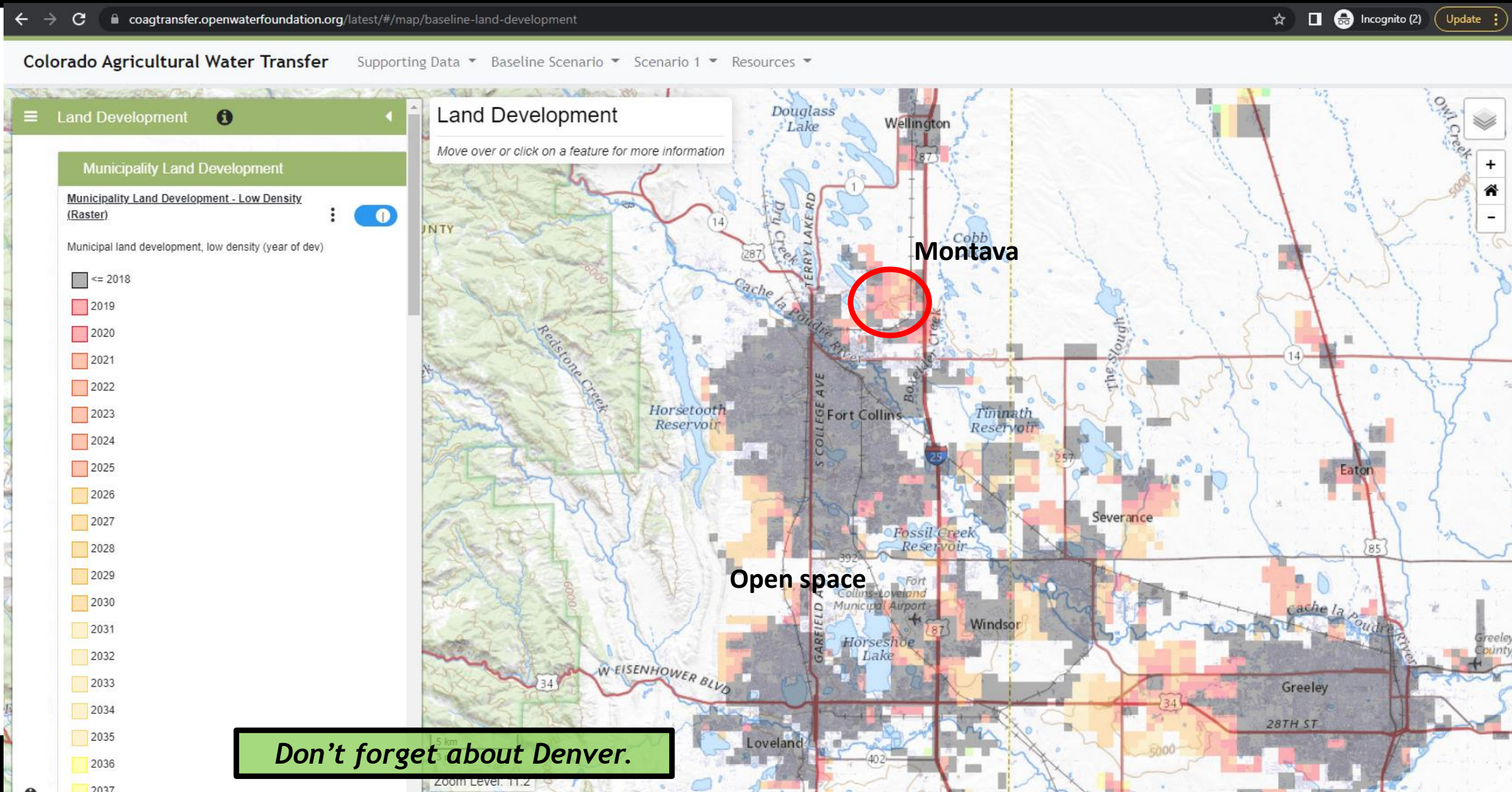
Close

Also must consider unincorporated areas.

Growth = Increased Water Demand?



Where will Growth Occur?



Water Providers are Competing for Water

Colorado Water Providers ⓘ

Colorado Water Providers

Colorado Water Providers ⓘ

Colorado Water Providers ⓘ

Water Provider Boundaries (Districts & Utilities) ⓘ

Water Provider Boundaries, merged from multiple sources

Water Provider Boundaries (Districts) ⓘ

CO DWR Water Districts

CO DWR Water District 3 ⓘ

Water District 3 boundary from the Colorado Division of Water Resources

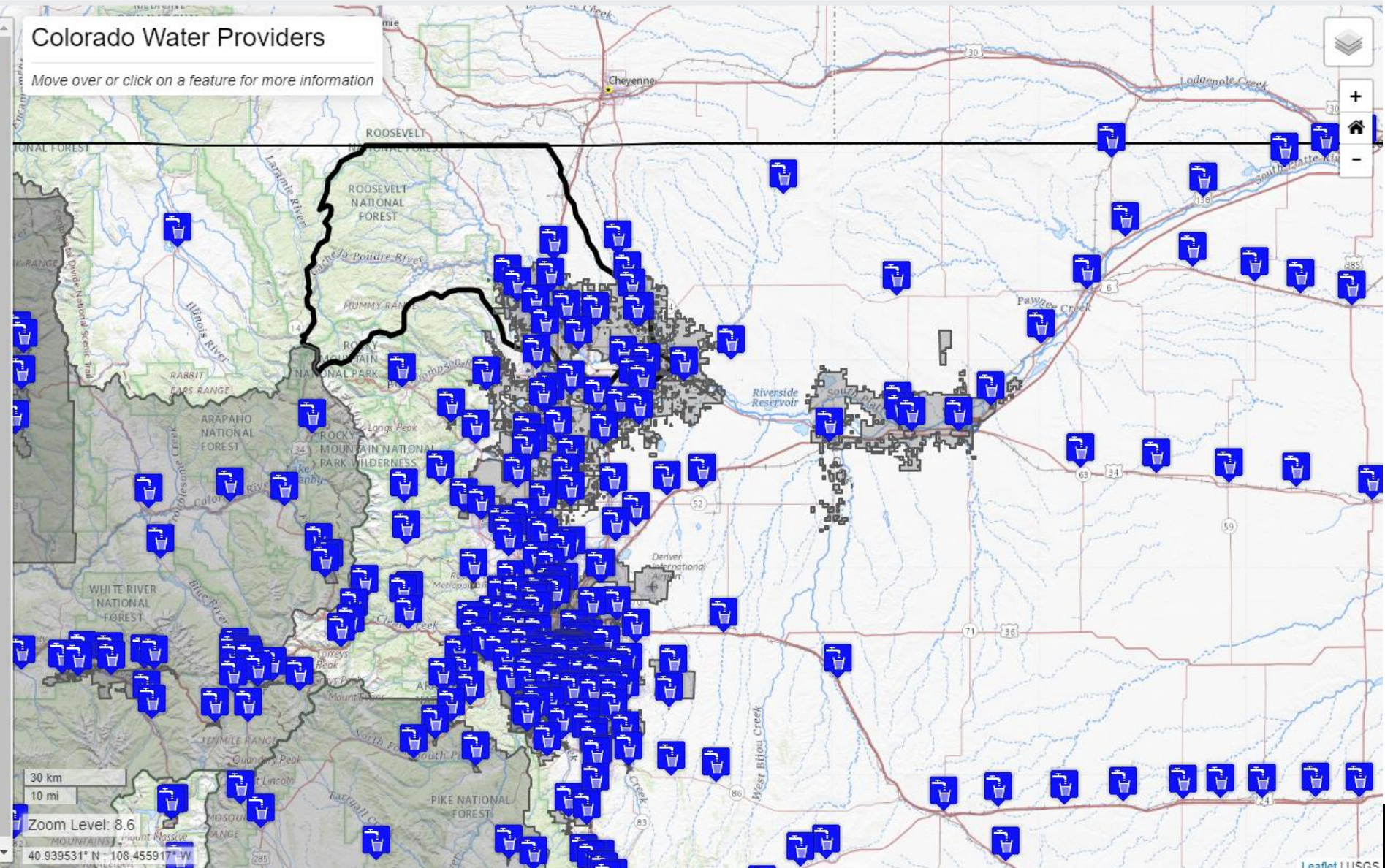
3, Cache La Poudre River

Colorado State Boundary

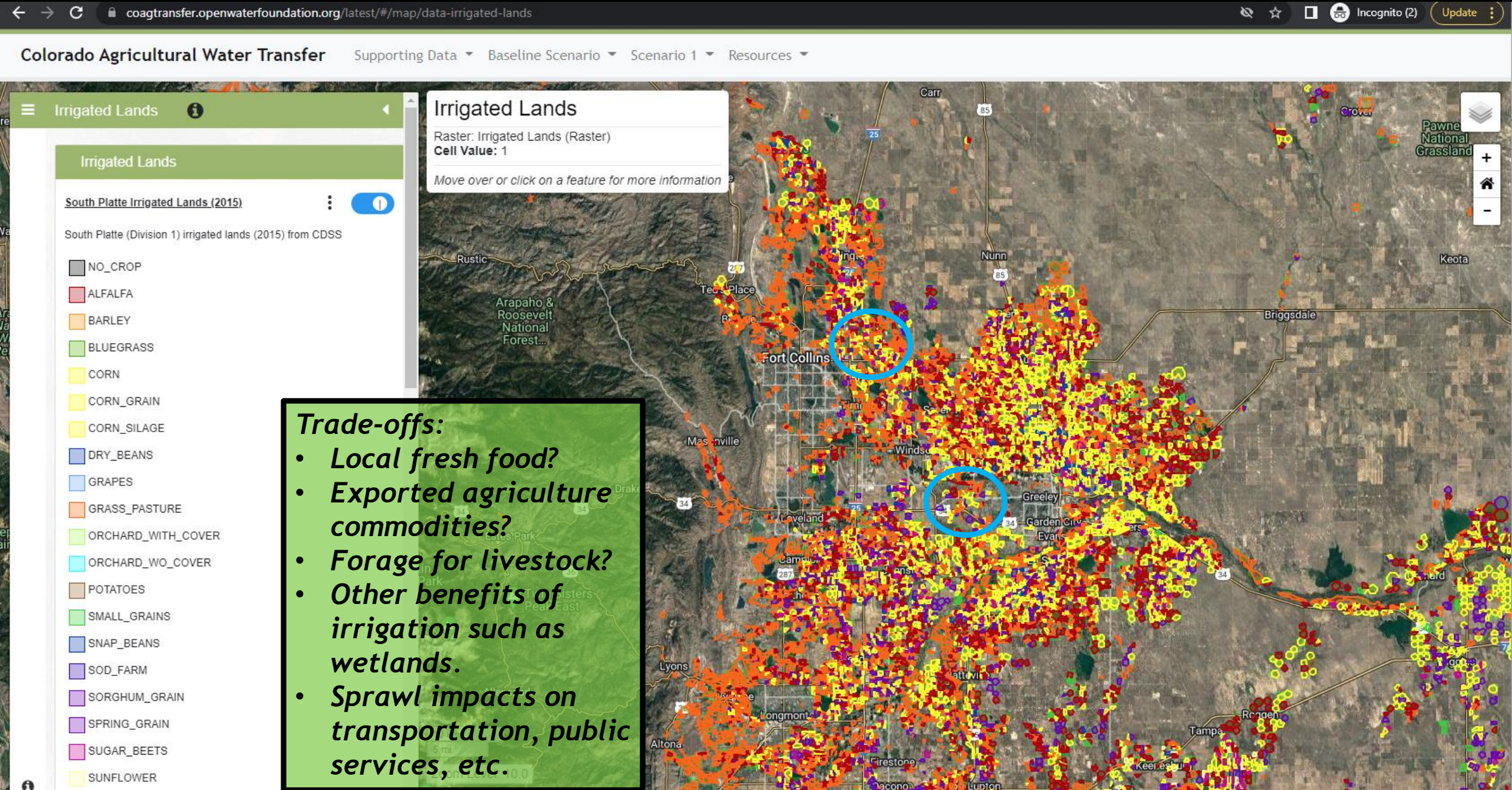
Colorado State Boundary ⓘ

Colorado state boundary from CDPHE

Background Layers



Where will Water Supplies Come From? Mostly Agriculture?



Ditch Companies use ~80% of the Water

Poudre Ditch Service Areas

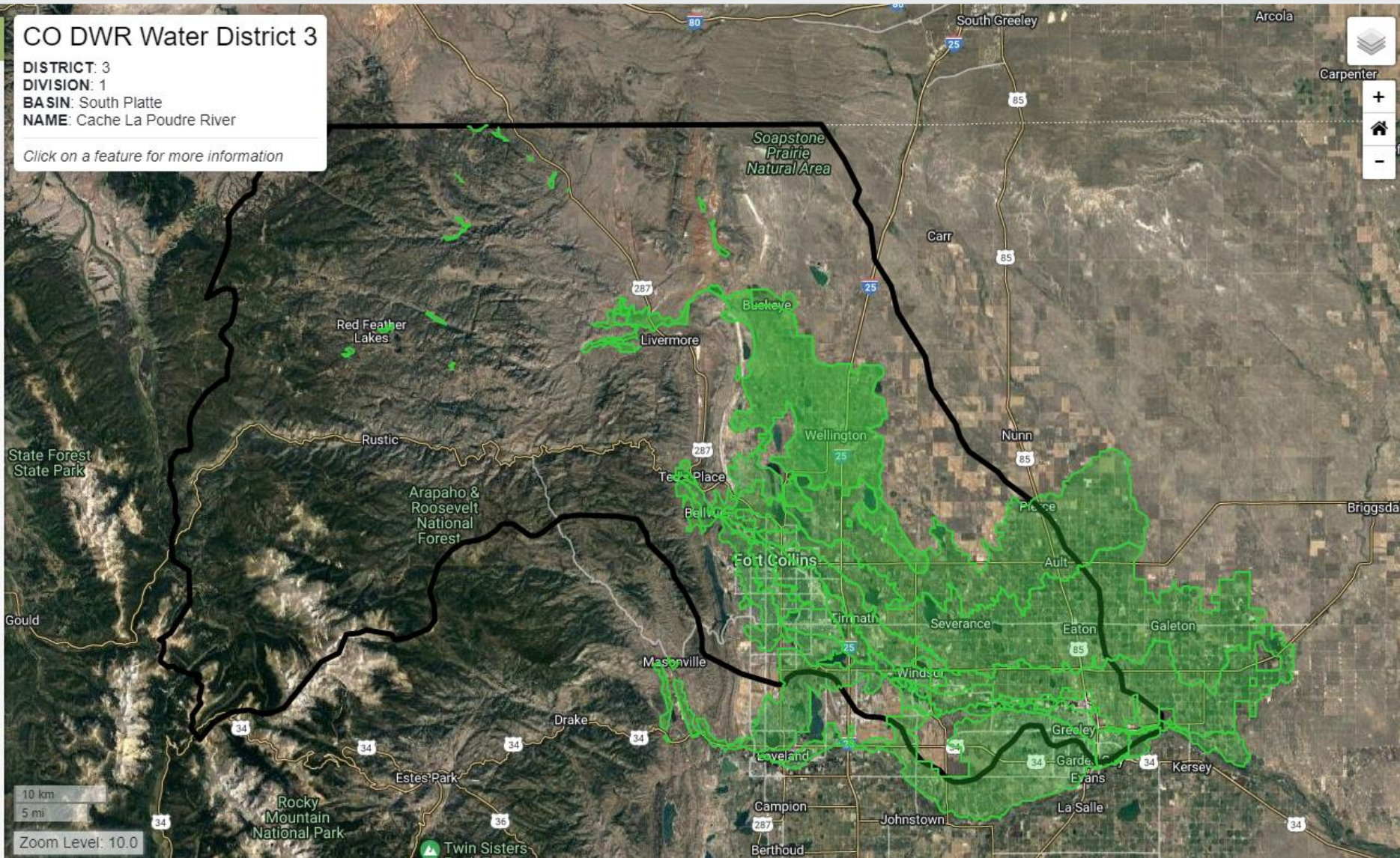
Poudre Ditch Service Areas

- District 3 Ditch Service Areas (2005)** 1
Ditch service areas (2005) from CDSS
- District 3 Ditch Service Areas (2001)** 0
- District 3 Ditch Service Areas (1987)** 0
- District 3 Ditch Service Areas (1976)** 0
- District 3 Ditch Service Areas (1956)** 0

CO DWR Water Districts

- CO DWR Water District 3** 1
Water District 3 boundary from the Colorado Division of Water Resources
- 3, Cache La Poudre River

Background Layers



Major Water Projects

Major Projects

Major Water Projects

Major water projects

Poudre Stream Reaches

Poudre stream reaches, from the Colorado Division of Water Resources

CO DWR Water Districts

CO DWR Water District 3

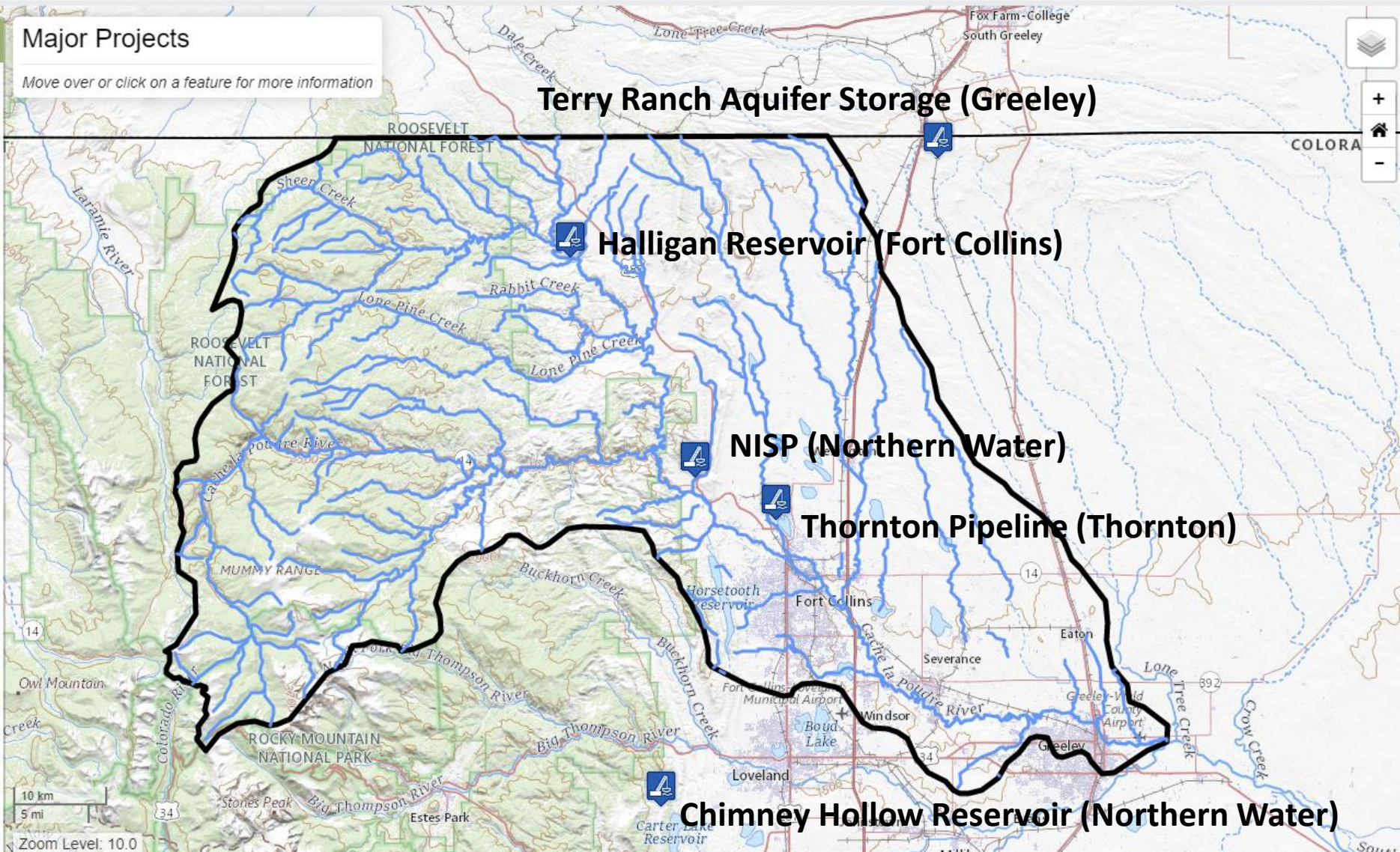
Water District 3 boundary, from the Colorado Division of Water Resources

3, Cache La Poudre River

Colorado State Boundary

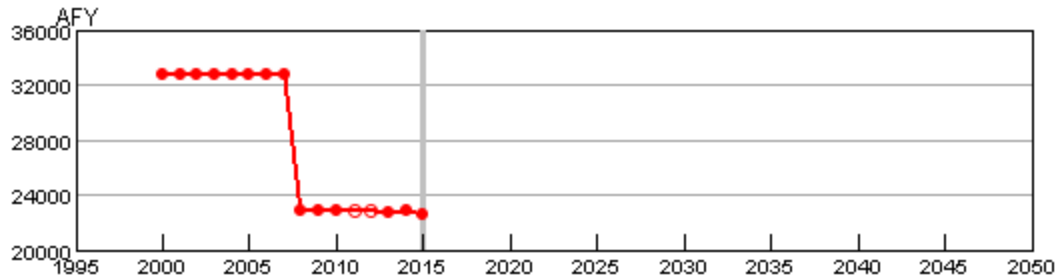
Colorado state boundary from CDPHE

Background Layers



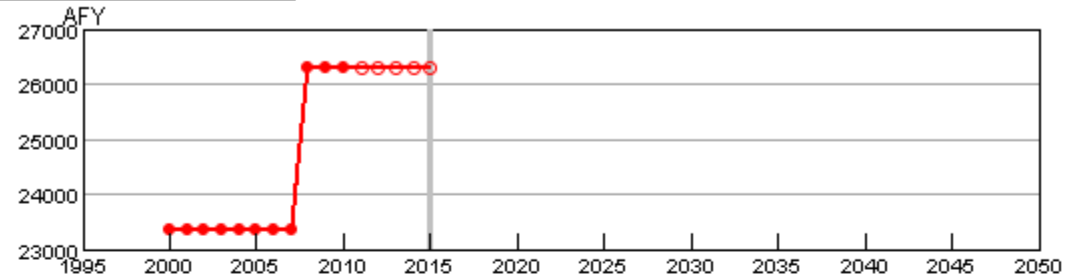
Water Conservation - Water Use Efficiency

FtCollins GPCD
Historical Water Use



Old data and may not be accurate.

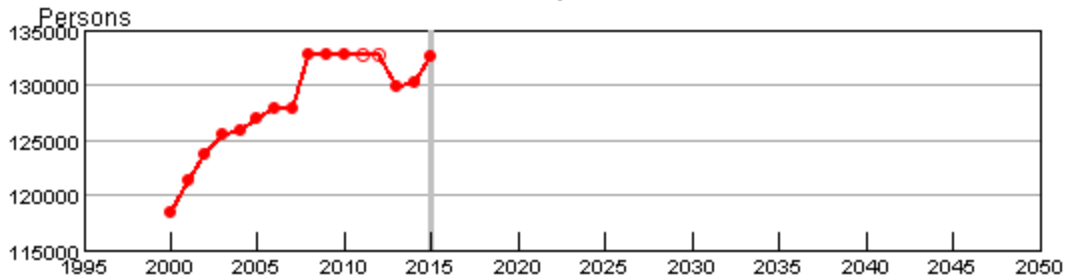
Greeley GPCD
Historical Water Use



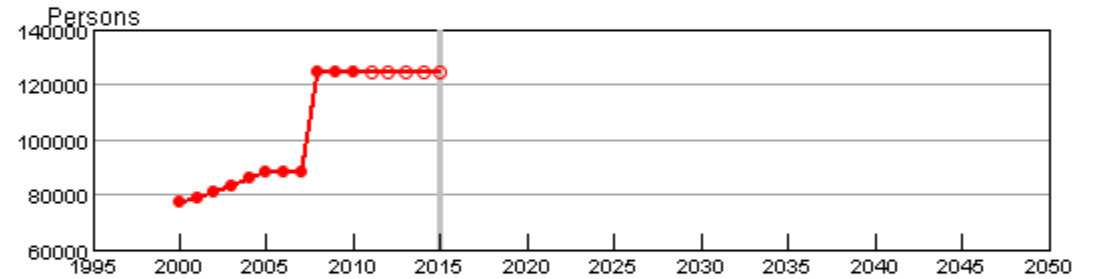
Provider:FtCollins-wateruse (sum from SWSI 2010 and WEDP data)

Provider:Greeley-wateruse (sum from SWSI 2010 and WEDP data)

Historical Population



Historical Population

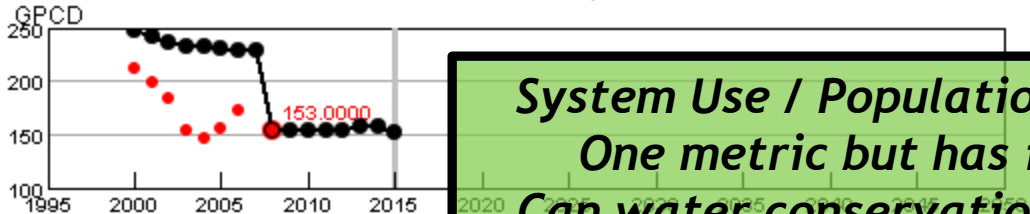


Provider:FtCollins-population (sum from SWSI 2010 and WEDP data)

Provider:Greeley-population (sum from SWSI 2010 and WEDP data)

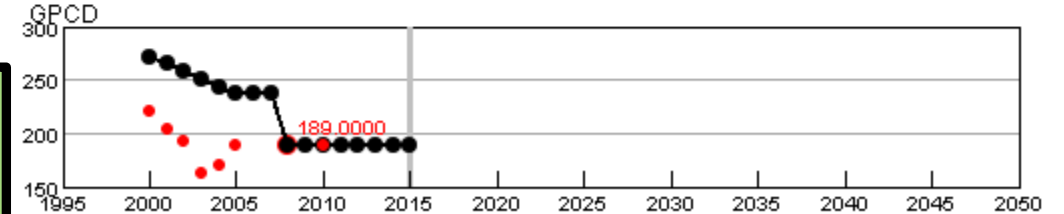
Baseline GPCD

Provider Water Use / Provider Population



Baseline GPCD

Provider Water Use / Provider Population



*System Use / Population = GPCD
One metric but has issues.
Can water conservation savings
equate to supply for growth?*

Provider:FtCollins-gpcd-baseline-best-SWSI2010
Provider:FtCollins-gpcd-baseline - calculated from water use / population
Provider:FtCollins-gpcd-baseline-SWSI2010

Provider:Greeley-gpcd-baseline-best-SWSI2010
Provider:Greeley-gpcd-baseline - calculated from water use / population
Provider:Greeley-gpcd-baseline-SWSI2010

The Big Municipalities are the Most Efficient

Gapminder

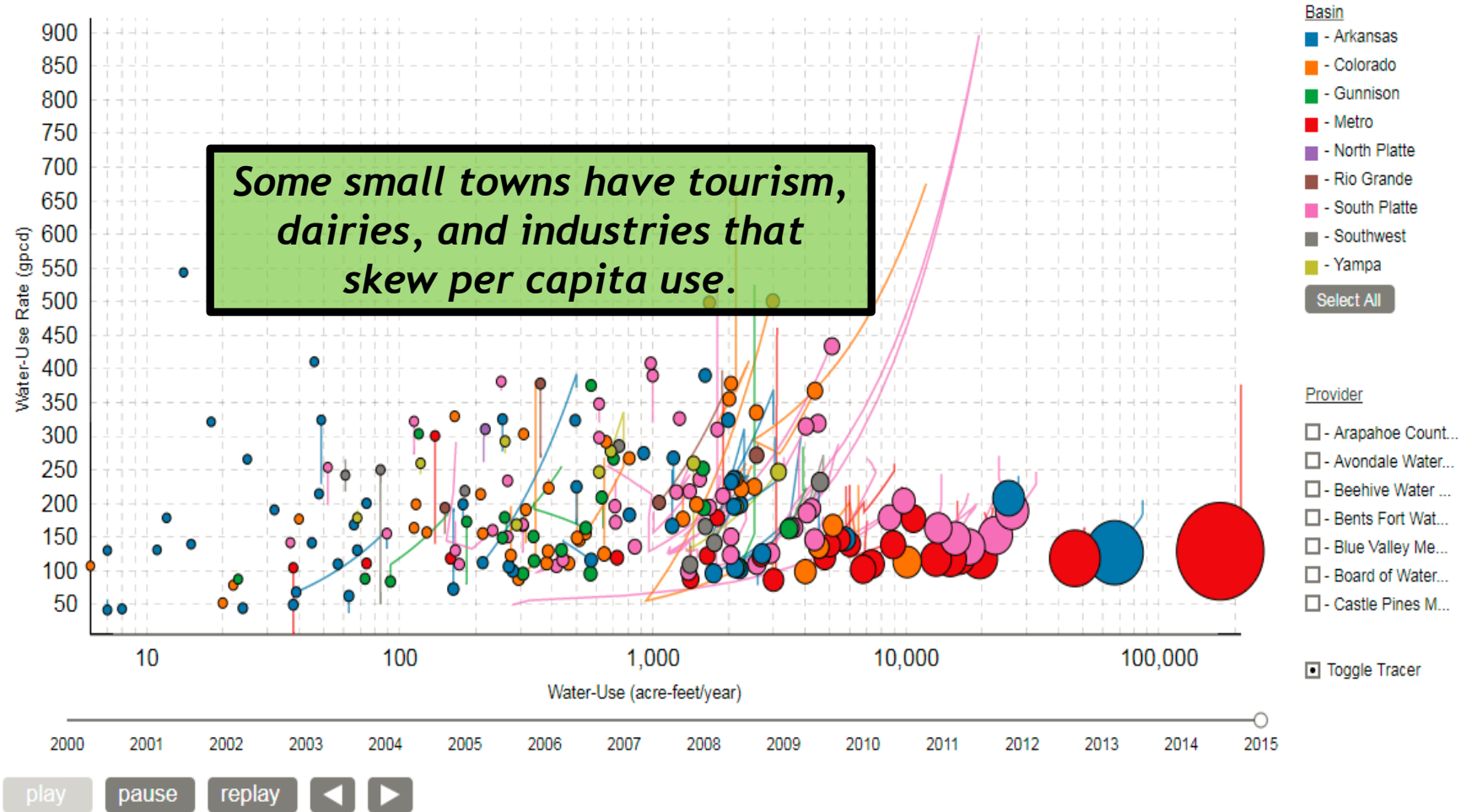
Data

Documentation

Sources

Water Providers in Colorado

Population(size), Basin(color), Water-Use(x), and Water-Use Rate(y).



Other Drivers - Wildfires and Floods

Flood Conditions

Flood Warning Precipitation Stations

3-Hour Precipitation

1-Day Precipitation

7-Day Precipitation

7-day precipitation from Larimer County FWS (using general precipitation levels for markers)

- < .1 inch of precipitation in the last 7 days
- .1 - < .25
- .25 - < .5
- .5 - < 1
- >= 1
- No data

Data last refreshed at 10:01 PM.

Flood Warning Water Level Stations

Flood Warning System Water Level Stations

Flood Warning System water level stations from Larimer County FWS

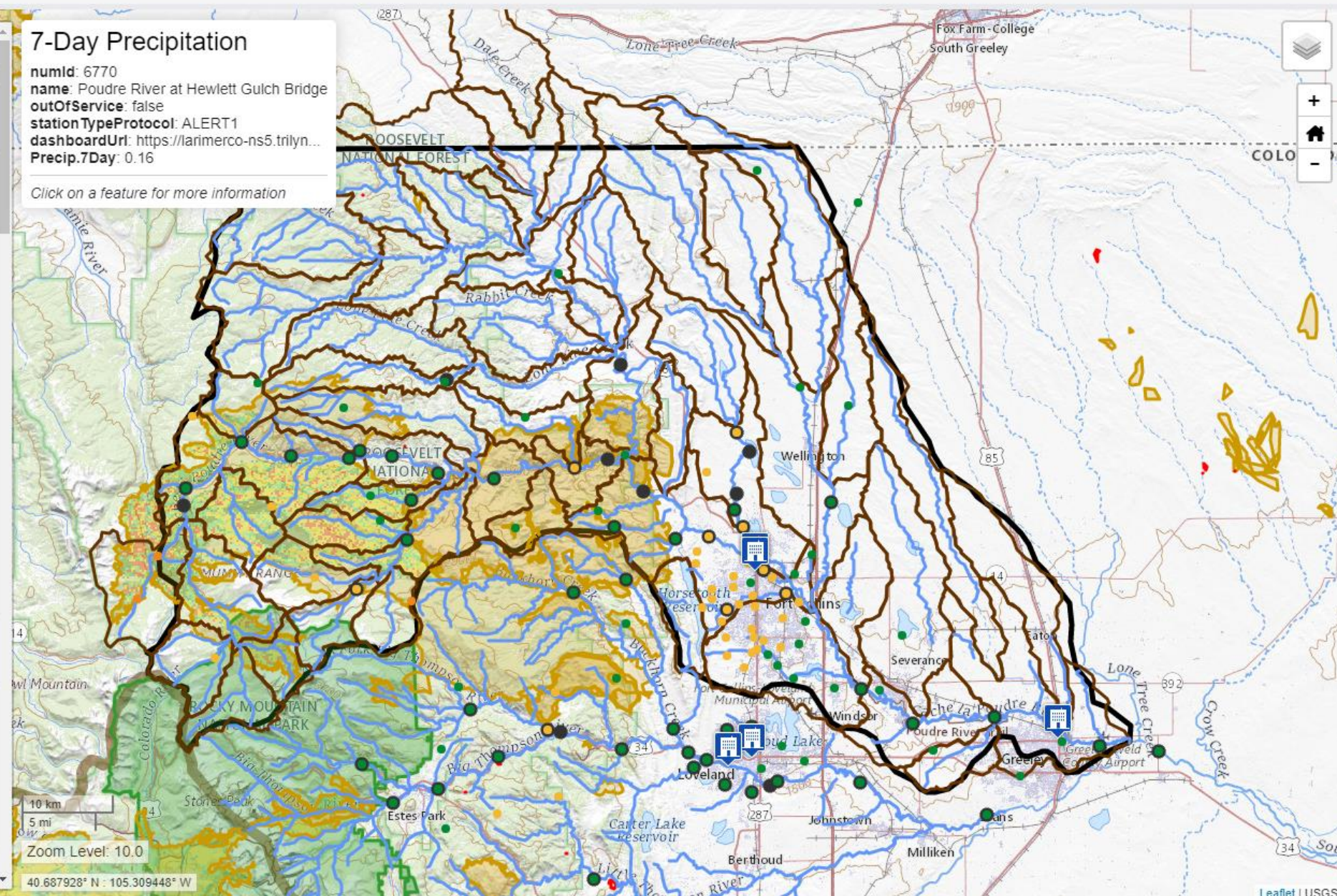
Data last refreshed at 10:01 PM.

Flood Organizations

7-Day Precipitation

numId: 6770
name: Poudre River at Hewlett Gulch Bridge
outOfService: false
stationTypeProtocol: ALERT1
dashboardUrl: https://larimerco-ns5.trily...
Precip.7Day: 0.16

Click on a feature for more information



10 km / 5 mi

Zoom Level: 10.0

40.687928° N : 105.309448° W

Data and Information Sources

- State (CWCB, DWR, DOLA)
- Federal (USGS, NRCS, RCC, NOAA, Reclamation, Drought Monitor, etc.)
- Colorado Climate Center
- Specific entities such as Northern Water
- Poudre Basin Information (Open Water Foundation)
- Businesses - water rights, economic analysis (may need to pay for products and services)

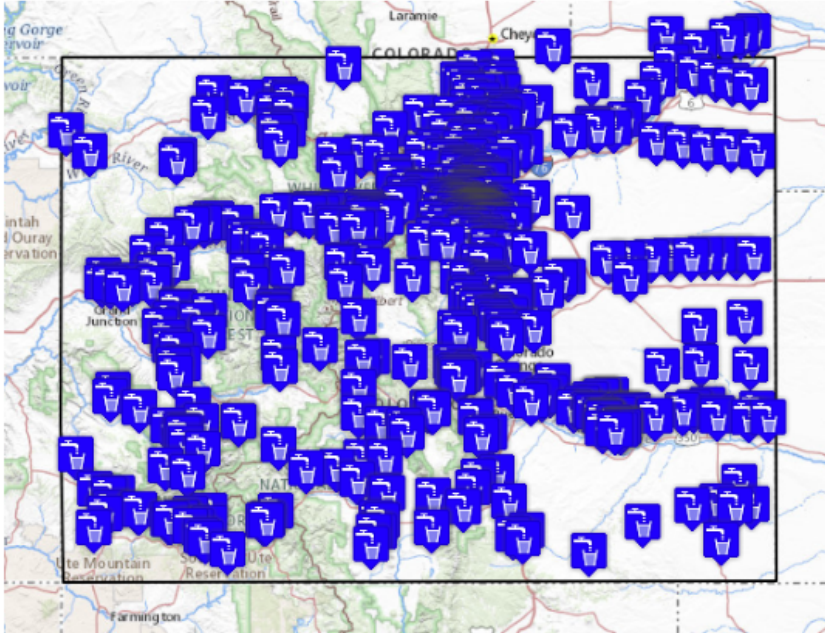
Open Data - Cloud-hosted Datasets

data.openwaterfoundation.org/state/co/owf/municipal-water-providers/



Data Visualizations Stories More ▾

Dataset: Colorado Municipal Water Providers



Property	Description
title	Colorado Municipal Water Providers
identifier	owf-data-co-municipal-water-providers
description	Colorado Municipal Water Providers.
issued	2022-08-16
modified	
version	
keyword	point,municipal water providers

Dataset Publisher

Property	Description
name	Open Water Foundation
mbox	info@openwaterfoundation.org

Dataset Details

Overview

This dataset contains Excel, csv, and GeoJSON point features files for Colorado municipal water providers. This is a statewide layer.

Open Data - Colorado's Decision Support Systems

← → ↻ dwr.state.co.us/Tools Update

COLORADO'S
Decision Support Systems
CWCB / DWR

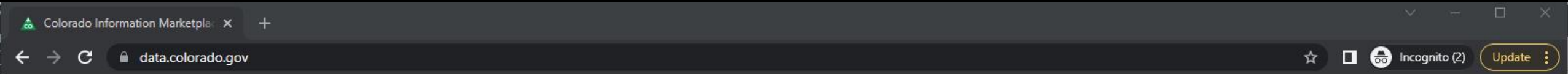
<https://dwr.state.co.us/Tools>

Welcome Guest, [Click here to Login](#)

☰ **CDSS Data & Tools** Help

- Administrative Calls & Analysis**
Active, Historical & Analysis Tools
- Climate Stations**
Temperature, Precipitation, Snow, Etc
- Dam Safety**
Dams, Livestock Water, Erosion Control
- Groundwater**
Water Levels & Geophysical Logs
- Stations**
Current Conditions & Historical Data
- Structures**
Diversion Records & Other Details
- Water Rights**
Decree Details, Court Docs, Net Amounts
- Well Permits**
Application History & Well Details
- Map Viewer**
DWR Online GIS Products
- Aquifer Determination**
Denver Basin & Dakota/Cheyenne
- Information Marketplace**
DWR Data on "CIM" Platform
- Location Tools**
Coordinates & Distance Calculators
- Data Submittal**
User Reporting
- My Stations**
Station Lists and Alerts
- REST Web Services**
GET CDSS Data Programmatically

Open Data - Colorado Information Marketplace



COLORADO
Information Marketplace

https://data.colorado.gov

[Home](#) [Data Catalog](#) [Help](#) [Video Tutorials](#) [Feedback](#)

[Sign In](#)



Welcome!
Colorado's open data at your fingertips.
Coronavirus Disease 2019 (COVID-19) in
Colorado: State & National Resources



COVID-19



Business



Education



Health



Interoperability, Automation and Operational Efficiency

File Edit View Commands Commands(Table) Commands(Plugin) Run Results Tools Help

Input/Query Options

Datstore:

Datstore:

Data type:

Time step:

Where: =

Where:

Where:

Where:

Where:

Time Series List (40 time series, 1 selected)

ID	CO Abbrev.	Name/Description	Data Source	Data Source N...	Data Type	Time Step	Units
4	0300926	BOXDITCO BOXELDER DITCH	NWSDR	Cooperative SDR...	DISCHRG	15Min	cfs
5	0301200	CLAFTRCO CACHE LA POUFRE AT CANYON MOUTH NEAR FORT COLLINS	DWR	Co. Division of W...	DISCHRG	15Min	cfs
6	0301201	CLAGRECO CACHE LA POUFRE NEAR GREELEY	DWR	Co. Division of W...	DISCHRG	15Min	cfs
7	0301673	CLABOXCO CACHE LA POUFRE RIV AB BOXELDER CRK NR TIMNATH, CO	USGS	U. S. Geological S...	DISCHRG	15Min	cfs
8	0302900	CLAFORCO CACHE LA POUFRE RIVER AT FORT COLLINS, CO	USGS	U. S. Geological S...	DISCHRG	15Min	cfs
9	0301674	CLAWASCO CACHE LA POUFRE RIVER AT GREELEY WASTEWATER PLANT	DWR	Co. Division of W...	DISCHRG	15Min	cfs
10	0302929	CLARVCO CACHE LA POUFRE RIVER BELOW NEW CACHE	DWR	Co. Division of W...	DISCHRG	15Min	cfs
11	0300934	CANAL3CO CANAL # 3 NEAR GREELEY	DWR	Co. Division of W...	DISCHRG	15Min	cfs
12	0302901	CENJNZCO CCWCD JONES DITCH AUG RETURN	DWR	Co. Division of W...	DISCHRG	15Min	cfs
13	0303774	FOSOUTCO FOSSIL CREEK OUTLET	NCSDR	Cooperative Prog...	DISCHRG	15Min	cfs

Commands (6 commands, 0 selected, 0 with failures, 0 with warnings)

```

1 # CLAFTRCO (0301200) - CACHE LA POUFRE AT CANYON MOUTH NEAR FORT COLLINS
2 abbrev:CLAFTRCO.DWR.DISCHRG.15Min-HydroBaseWeb
3 # CLAFORCO (0302900) - CACHE LA POUFRE RIVER AT FORT COLLINS, CO
4 abbrev:CLAFORCO.USGS.DISCHRG.15Min-HydroBaseWeb
5 # CLAWASCO (0301674) - CACHE LA POUFRE RIVER AT GREELEY WASTEWATER PLANT
6 abbrev:CLAWASCO.DWR.DISCHRG.15Min-HydroBaseWeb
7
8
9
10
11
12
13
14
    
```

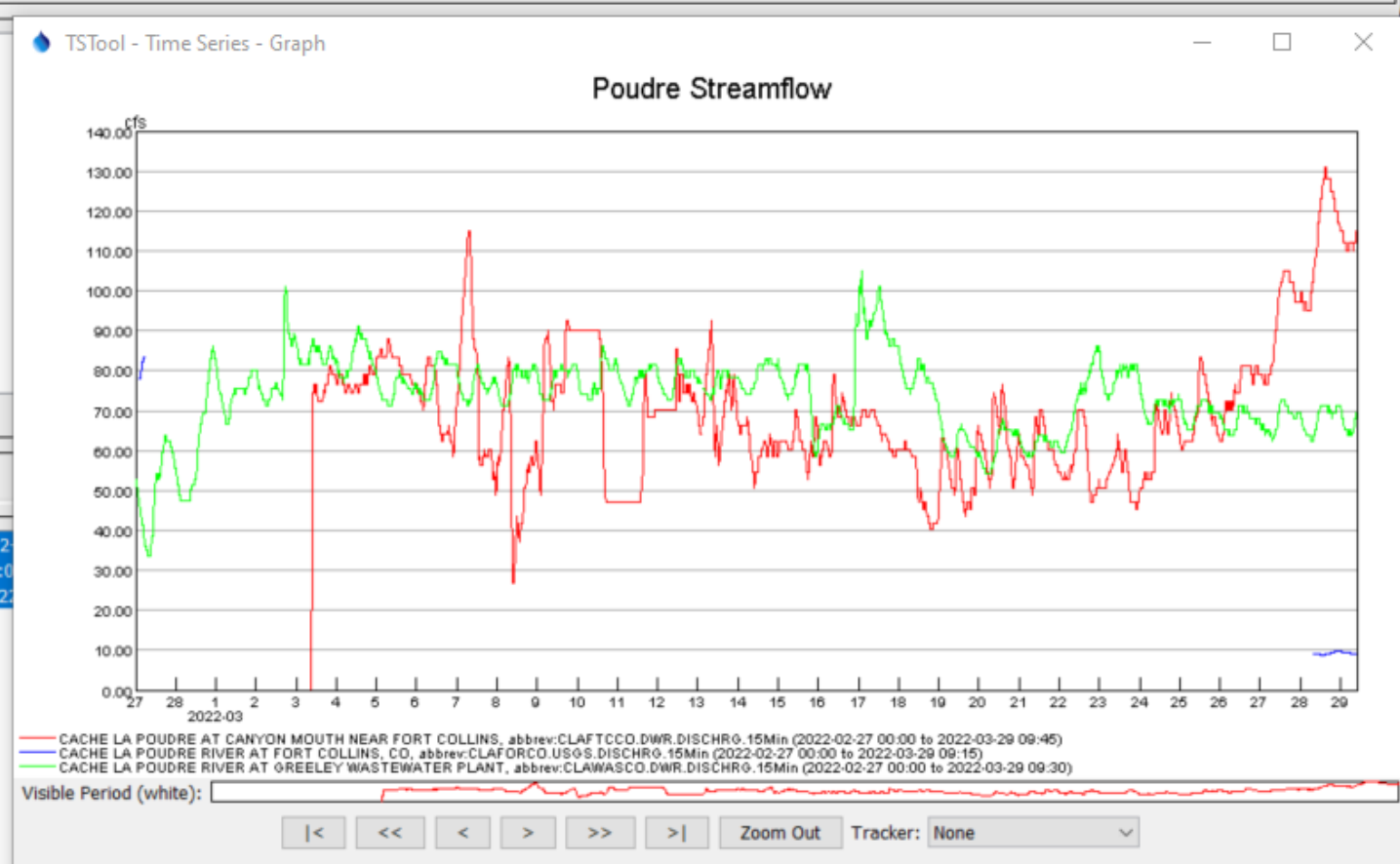
Results

Ensembles Networks Output Files Problems Properties Tables Time Series Views

3 time series, 3 selected

```

1) CACHE LA POUFRE AT CANYON MOUTH NEAR FORT COLLINS - abbrev:CLAFTRCO.DWR.DISCHRG.15Min (2022-02-27 00:00 to 2022-03-29 09:45)
2) CACHE LA POUFRE RIVER AT FORT COLLINS, CO - abbrev:CLAFORCO.USGS.DISCHRG.15Min (2022-02-27 00:00 to 2022-03-29 09:15)
3) CACHE LA POUFRE RIVER AT GREELEY WASTEWATER PLANT - abbrev:CLAWASCO.DWR.DISCHRG.15Min (2022-02-27 00:00 to 2022-03-29 09:30)
    
```



Tools are available to help organizations access and use data.

Indicators for Situational Awareness

Poudre Basin Water Indicators Summary Dashboard (PROTOTYPE)

Water Affordability



Water Supply



Water Security



Environmental Health



Local Agriculture



Recreation



Long View



<p>Water cost per Acre Foot</p> <p>✓ 42.0 ▲ 2.00</p>	<p>New House Water Cost</p> <p>✓ 42.0 ▲ 2.00</p>	<p>Water Utility Cost</p> <p>✓ 42.0 ▲ 2.00</p>	
<p>Surface Water Supply Index</p> <p>✓ 0.00 ▲</p>	<p>Reservoir Storage (% of median)</p> <p>✓ 74.72 ▼ -1.95</p>	<p>Streamflow (% of median)</p> <p>✓ 92.22 ▲ 6.59</p>	<p>US Drought Monitor</p> <p>✓ 0.50 ▼ -0.06</p>
<p>Local Water Ownership</p> <p>✓ 42.0 ▲ 2.00</p>	<p>Reservoir Capacity</p> <p>✓ 42.0 ▲ 2.00</p>	<p>Net Basin Export</p> <p>✓ 42.0 ▲ 2.00</p>	<p>Supply Redundancy</p> <p>✓ 42.0 ▲ 2.00</p>
<p>Water Quality</p> <p>✓ 42.0 ▲ 2.00</p>	<p>Environmental Flows</p> <p>✓ 42.0 ▲ 2.00</p>	<p>Forest Health</p> <p>✓ 42.0 ▲ 2.00</p>	<p>Legal Protections</p> <p>✓ 42.0 ▲ 2.00</p>
<p>Irrigated Lands</p> <p>✓ 42.0 ▲ 2.00</p>	<p>Agricultural Economy</p> <p>✓ 42.0 ▲ 2.00</p>	<p>Conserved Lands</p> <p>✓ 42.0 ▲ 2.00</p>	<p>Water Rentals & Agreements</p> <p>✓ 42.0 ▲ 2.00</p>
<p>Boating Conditions</p> <p>✓ 42.0 ▲ 2.00</p>	<p>Fishing Conditions</p> <p>✓ 42.0 ▲ 2.00</p>	<p>Water Parks</p> <p>✓ 42.0 ▲ 2.00</p>	
<p>Climate Change</p> <p>✓ 42.0 ▲ 2.00</p>	<p>Population Growth</p> <p>✓ 42.0 ▲ 2.00</p>	<p>Planning</p> <p>✓ 42.0 ▲ 2.00</p>	<p>Education</p> <p>✓ 42.0 ▲ 2.00</p>

Dashboards for Context

Poudre Basin Water Supply Dashboard (PROTOTYPE)

Surface Water Supply Index



▲ 0.00

Area-weighted US Drought Monitor



▼ -0.06

0.50

Reservoir Storage (% of median)



▼ -1.95

74.72

Streamflow (% of median)

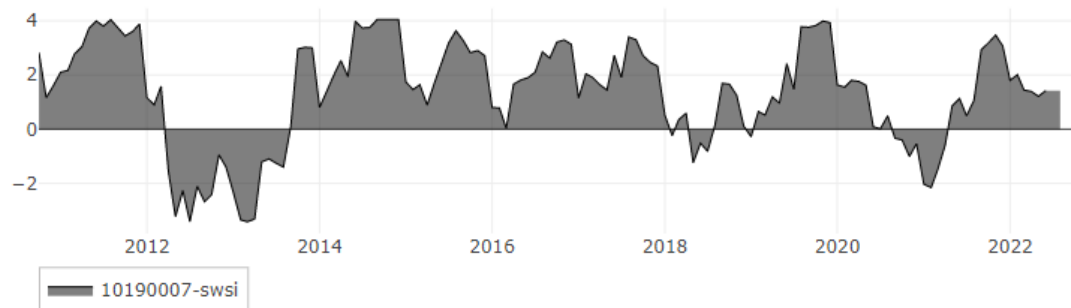


▲ 6.59

92.22

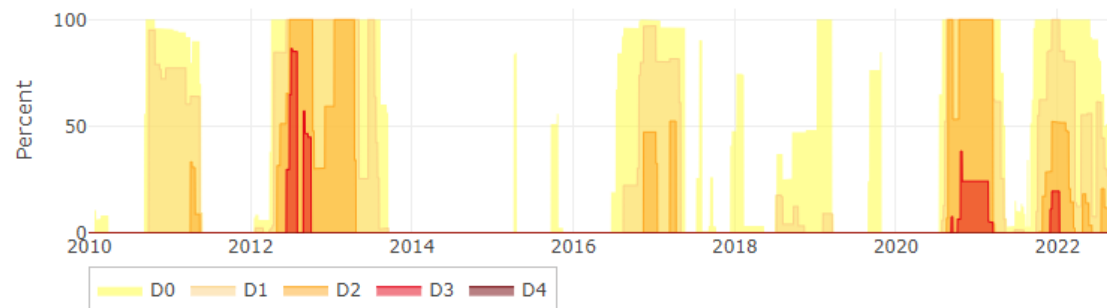
10190007 (Cache la Poudre) Surface Water Supply Index

Reservoir storage + snowpack + streamflow forecast, 4 = abundant supply, -4 = extreme drought



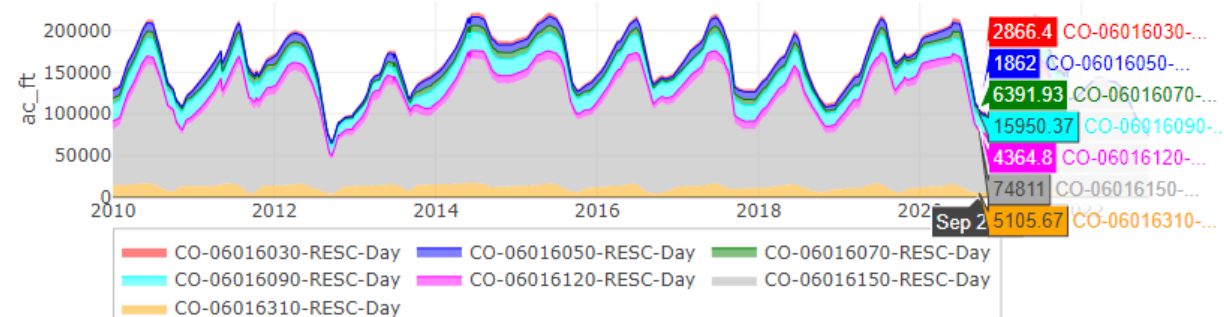
Drought Monitor for HUC Basin 10190007 (Cache la Poudre)

Percent of basin area at different drought levels, D0 = Abnormally Dry, D4 = Exceptional Drought



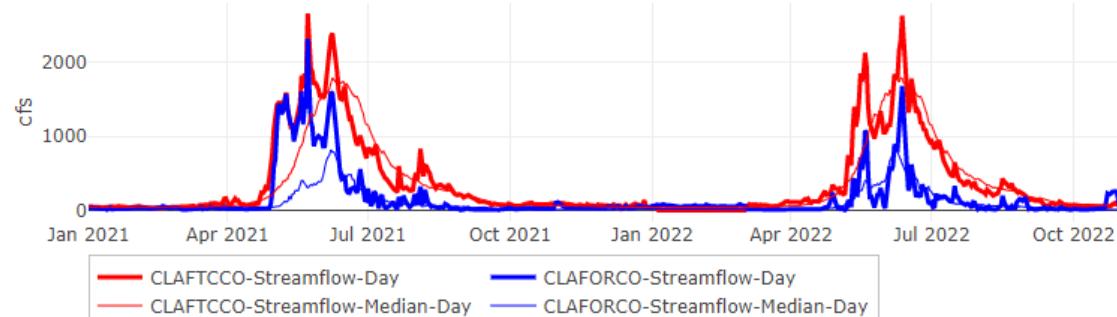
10190007 (Cache la Poudre) Reservoir Storage

Storage total for important water supply reservoirs



Poudre River Streamflow

Daily average flows and median of historical flows, CLAFTCCO = Mouth of Canyon, CLAFORCO = at Fort Collins



Publishing Data

- Cloud storage linked to a website (Amazon Web Services, Google Cloud Platform, Microsoft Azure, etc.)
- Esri ArcGIS Online
- Open Data Portal (Socrata, CKAN)
- GitHub and other version-controlled repositories
- Other web technologies

Thoughts on Water Supply

- Dedication policy (cash or water rights) is a driver.
- Cities with senior portfolios need cash for infrastructure.
- Cities with junior portfolios need water rights and must make growth pay.
- Keeping water in the Poudre and Big Thompson basins will allow for many options - exporting water outside of the basin reduces options.
- Regional planning can help address land and water issues.
- Climate change is and will be a major disruptor.
- Water is so complicated that organizations and people struggle to understand.

Open Water Foundation Ask

- Publish your data.
- Support regional coordination efforts.
- Funding - need matching funds for many opportunities.
- It is difficult to seek funding from many entities and easier to work with key partners as innovators.
- Water Literate Leaders and other education programs help develop knowledgeable decision makers and data- and science-driven policies.
- Keep innovating and collaborating.

Open Water Foundation Contact

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open data | open software | open decisions
openwaterfoundation.org