



# Water Education through Stories Using Open and Big Data

2015 Sustaining Colorado's Watersheds, October 8, 2015



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# Education

1. The process of receiving **systematic instruction**, especially at a school or university
2. A **body of knowledge** acquired while being educated
3. An **enlightening** experience
4. **Information** about or training in a particular field or subject

[http://www.oxforddictionaries.com/us/definition/american\\_english/education](http://www.oxforddictionaries.com/us/definition/american_english/education)

# Data and Information

“You can have data without information, but you cannot have information without data.”

- Daniel Keys Moran, programmer and writer

“If we have data, let’s look at data. If all we have are opinions, let’s go with mine.”

- Jim Barksdale, former Netscape CEO

“The goal is to turn data into information, and information into insight”

- Carly Fiorina, former HP CEO

<http://spotfire.tibco.com/blog/?p=19781>

# Open Data Definition

- **Accessible to all** - the data becomes accessible outside of the organization that generated or collected it
- **Machine-readable** - data must be usable, which means it must be made available in formats that are easily used by third-party applications
- **Free - zero or low costs** for data access and openness
- **Unrestricted rights to use** - data that is unencumbered by contractual or other restrictions leads to the maximum potential of innovation
  - “Generating Economic Value through Open Data” in “Beyond Transparency”

# Big Data Definition

- Data sets so large or complex that **traditional data processing applications are inadequate**.
- Accuracy in big data **may lead to more confident decision making**, resulting in greater operational efficiency, cost reduction, and **reduced risk**.
- Analysis may find **new correlations**.
- Definition of “big” is a **moving target**.

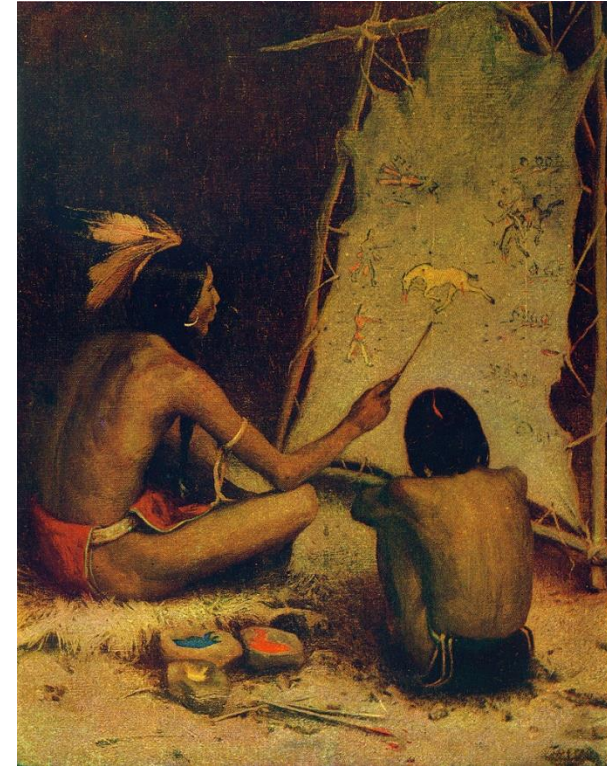
[https://en.wikipedia.org/wiki/Big\\_data](https://en.wikipedia.org/wiki/Big_data)

Photo credits: “The Matrix” movie, Imtech



# Storytelling

- Characters - roles, perspective
- Plot
- Narrative point of view
- Purpose: share values, pass knowledge, generate outcome



<https://en.wikipedia.org/wiki/Storytelling>

Free Public  
Lecture

the **ETHICS** of  
**STORYTELLING**  
**SCIENCE**  
IN  
**COMMUNICATION**

<http://www.compassonline.org/>

# Roles of Science in Policy and Politics

- **Pure Scientist** - share fundamental information (provide the data, let it speak)
- **Science Arbiter** - resource for decision-maker (answer questions)
- **(Stealth) Issue Advocate** - make a case for one alternative over another
- **Honest Broker of Policy Alternatives** - comprehensive guide, allow decision-maker to reduce list of choices based on preferences and values

- “The Honest Broker,” Roger Pielke, Jr.

# What are Educational Roles?

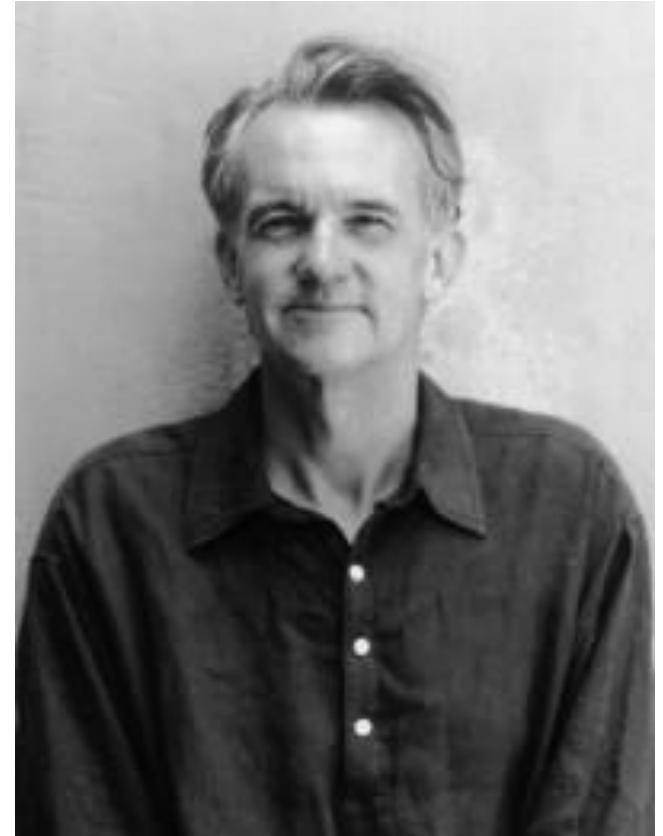
- Government
  - Educating the public - outreach
  - Educating public servants/politicians
- Universities
  - Education
  - Research - Pure Scientist
- Nonprofits - advocacy or neutral
- Private industry - trade groups, best practices
- Media - neutral? biased?
- Citizens



# Telling Your Story with Data

“There are two goals when presenting data: convey your story and establish credibility.”

-Edward Tufte



[https://en.wikipedia.org/wiki/Edward\\_Tufte](https://en.wikipedia.org/wiki/Edward_Tufte)

# Communication Through Allegory



“Temba, his arms wide” (sharing)

“Darmok and Jalad at Tanagra” (two warriors that had to cooperate to defeat a beast)

Photo credit: Picard and Dathon, [http://www.startrek.com/database\\_article/darmok](http://www.startrek.com/database_article/darmok)  
Star Trek the Next Generation, <https://en.wikipedia.org/wiki/Darmok>

# Shared Experience



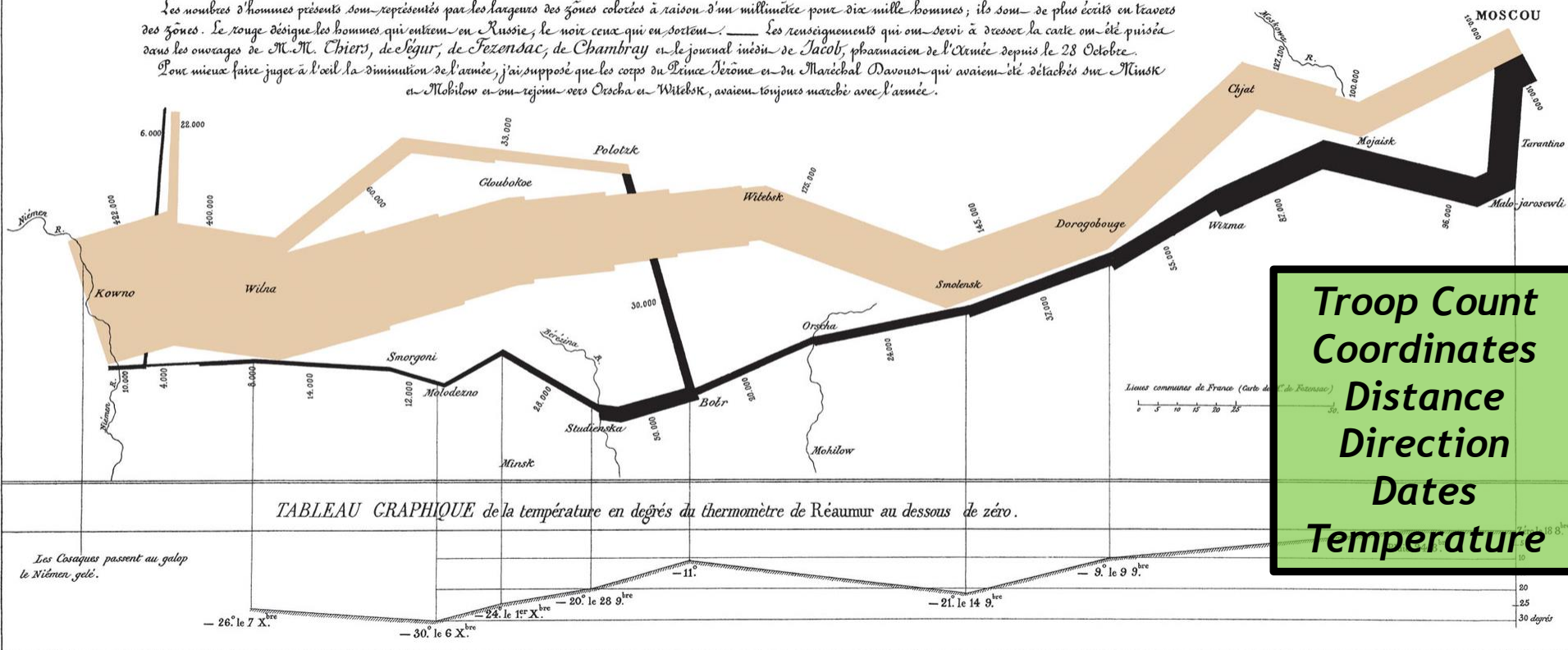
# A Classic Data Visualization

## Carte Figurative des pertes successives en hommes de l'Armée Française dans la campagne de Russie 1812-1813.

Dressée par M. Minard, Inspecteur Général des Ponts et Chaussées en retraite. Paris, le 20 Novembre 1869.

Les nombres d'hommes présents sont représentés par les largeurs des zones colorées à raison d'un millimètre pour dix mille hommes; ils sont de plus écrits en traits de zones. Le rouge désigne les hommes qui entrent en Russie, le noir ceux qui en sortent. — Les renseignements qui ont servi à dresser la carte ont été puisés dans les ouvrages de M. M. Chiers, de Légar, de Fezensac, de Chambray et le journal inédit de Jacob, pharmacien de l'Armée depuis le 28 Octobre.

Pour mieux faire juger à l'œil la diminution de l'armée, j'ai supposé que les corps du Prince Sviatome et du Maréchal Davout qui avaient été détachés sur Minsk et Mohilow et qui rejoignent vers Orscha et Witebsk, avaient toujours marché avec l'armée.



Troop Count  
Coordinates  
Distance  
Direction  
Dates  
Temperature

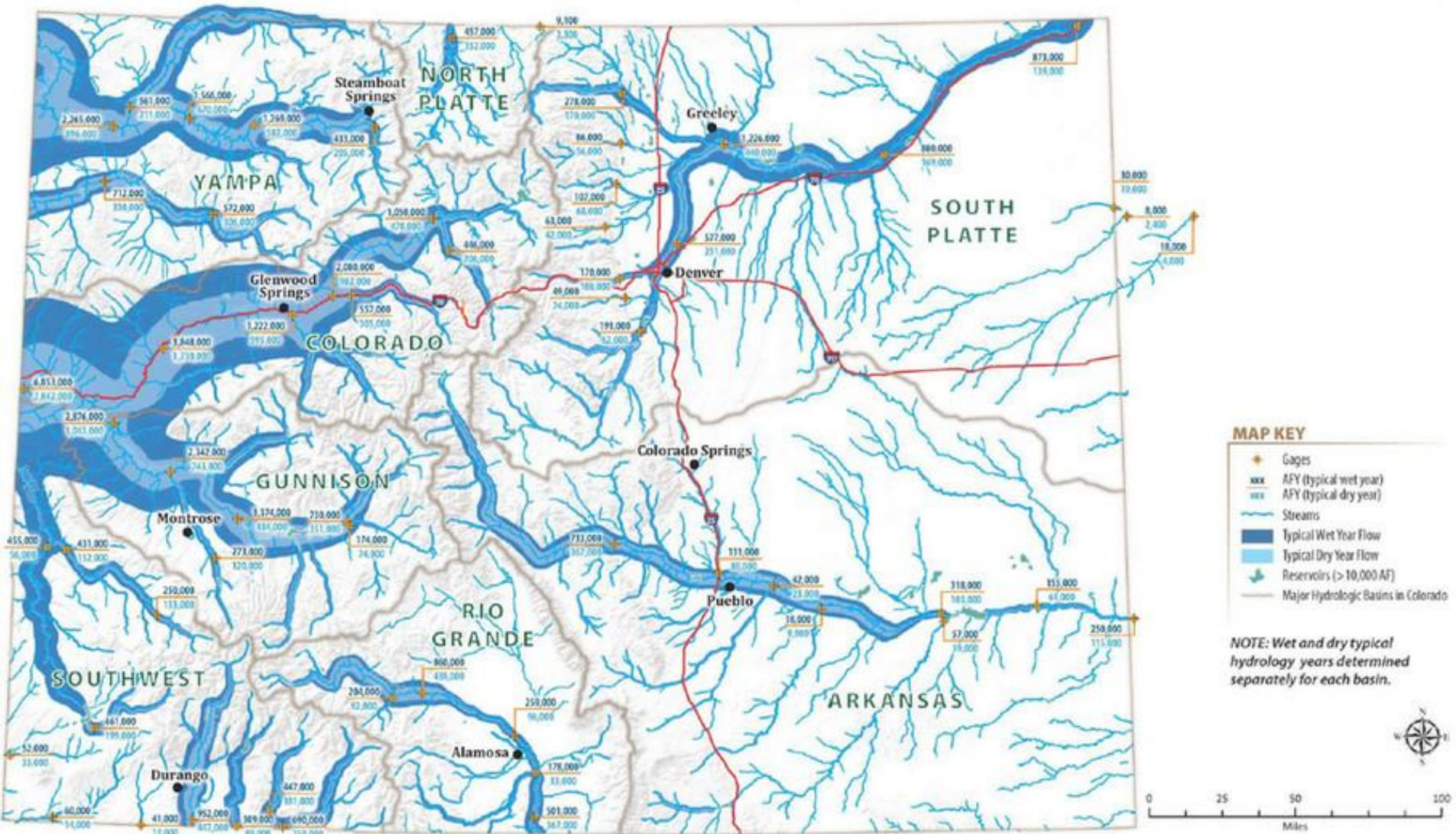
[https://en.wikipedia.org/wiki/Charles\\_Joseph\\_Minard](https://en.wikipedia.org/wiki/Charles_Joseph_Minard)

# The "Snake" Diagram

DRAFT

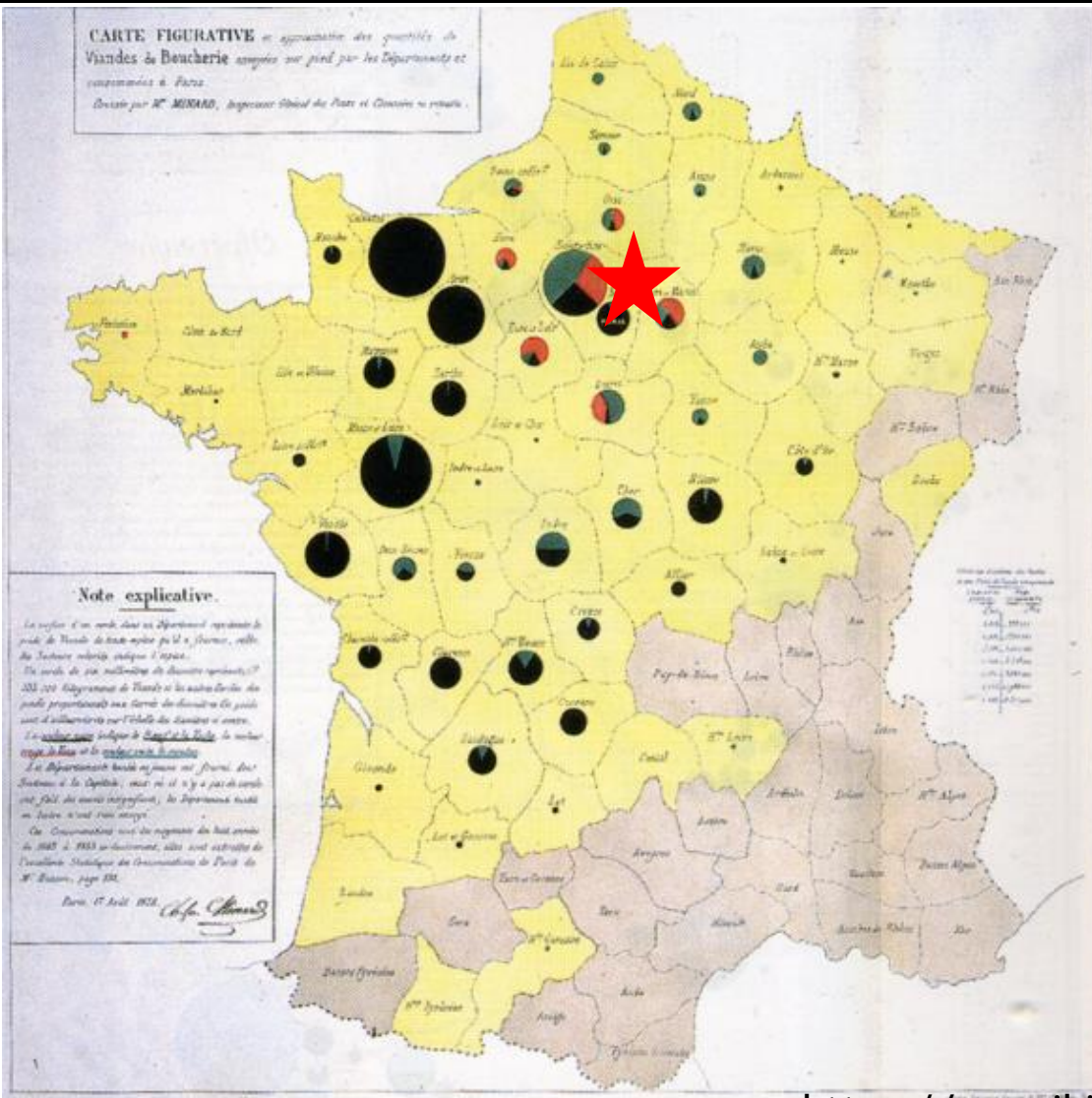
## STATEWIDE

### Summary of Observed Wet & Dry Surface Water Hydrology



# Early Virtual Water Example

Source of beef for Paris, France



[https://en.wikipedia.org/wiki/Charles\\_Joseph\\_Minard](https://en.wikipedia.org/wiki/Charles_Joseph_Minard)

# Virtual Water / Water Footprint

<http://virtualwater.eu/>

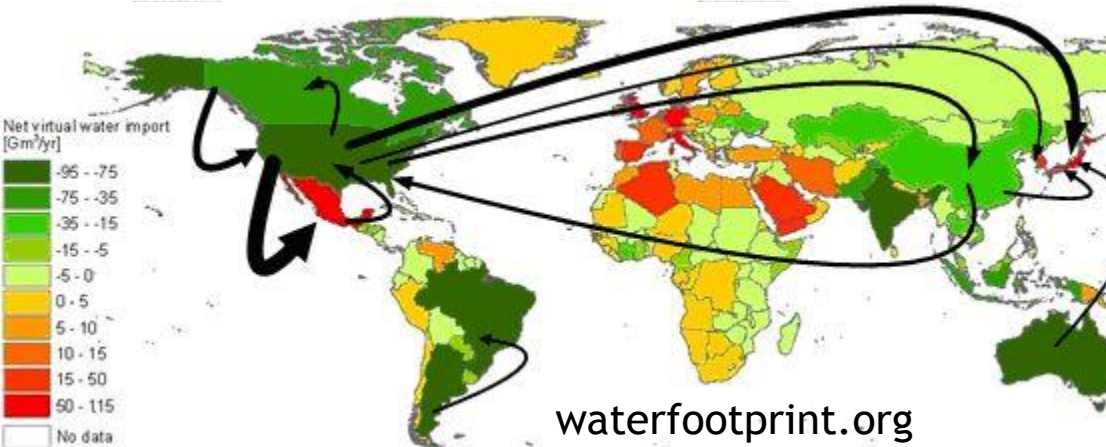


[http://pacinst.org/wp-content/uploads/2013/02/ca\\_ftprint\\_full\\_report3.pdf](http://pacinst.org/wp-content/uploads/2013/02/ca_ftprint_full_report3.pdf)

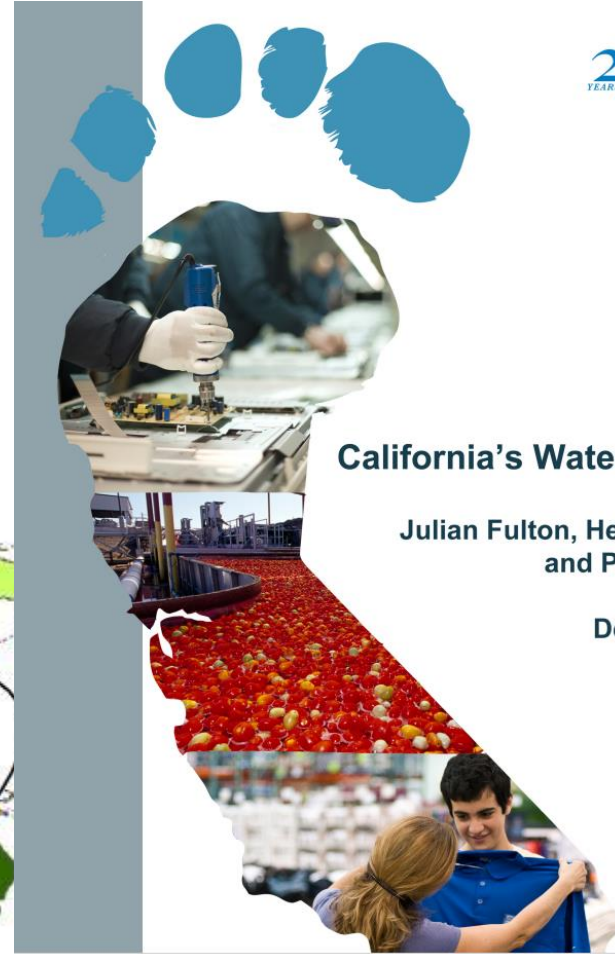


## Why beef is the new SUV

<http://www.cnn.com/2015/09/29/opinions/sutter-beef-suv-climate-two-degrees/>



[waterfootprint.org](http://waterfootprint.org)



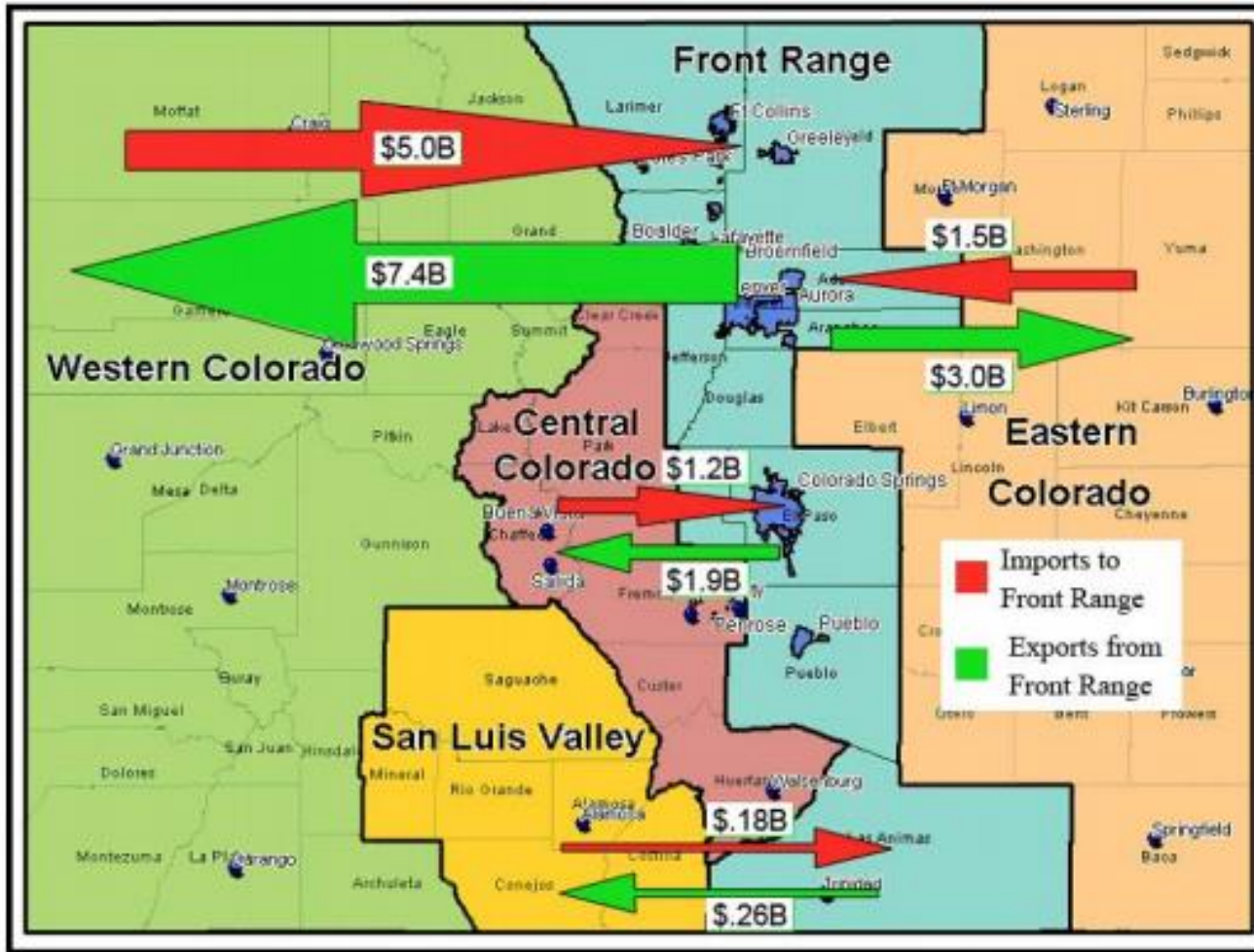
## California's Water Footprint

Julian Fulton, Heather Cooley, and Peter H. Gleick

December 2012

# Colorado Water Economy

## Front Range Trade Flows



*“Water and the Colorado Economy”,  
Front Range Water Council,  
2009*

Source: MIG, Summit/Adams

[http://www.denverwater.org/docs/assets/4bea7503-0237-e833-64a3f4c3447f588c/frwc\\_econ\\_report.pdf](http://www.denverwater.org/docs/assets/4bea7503-0237-e833-64a3f4c3447f588c/frwc_econ_report.pdf)

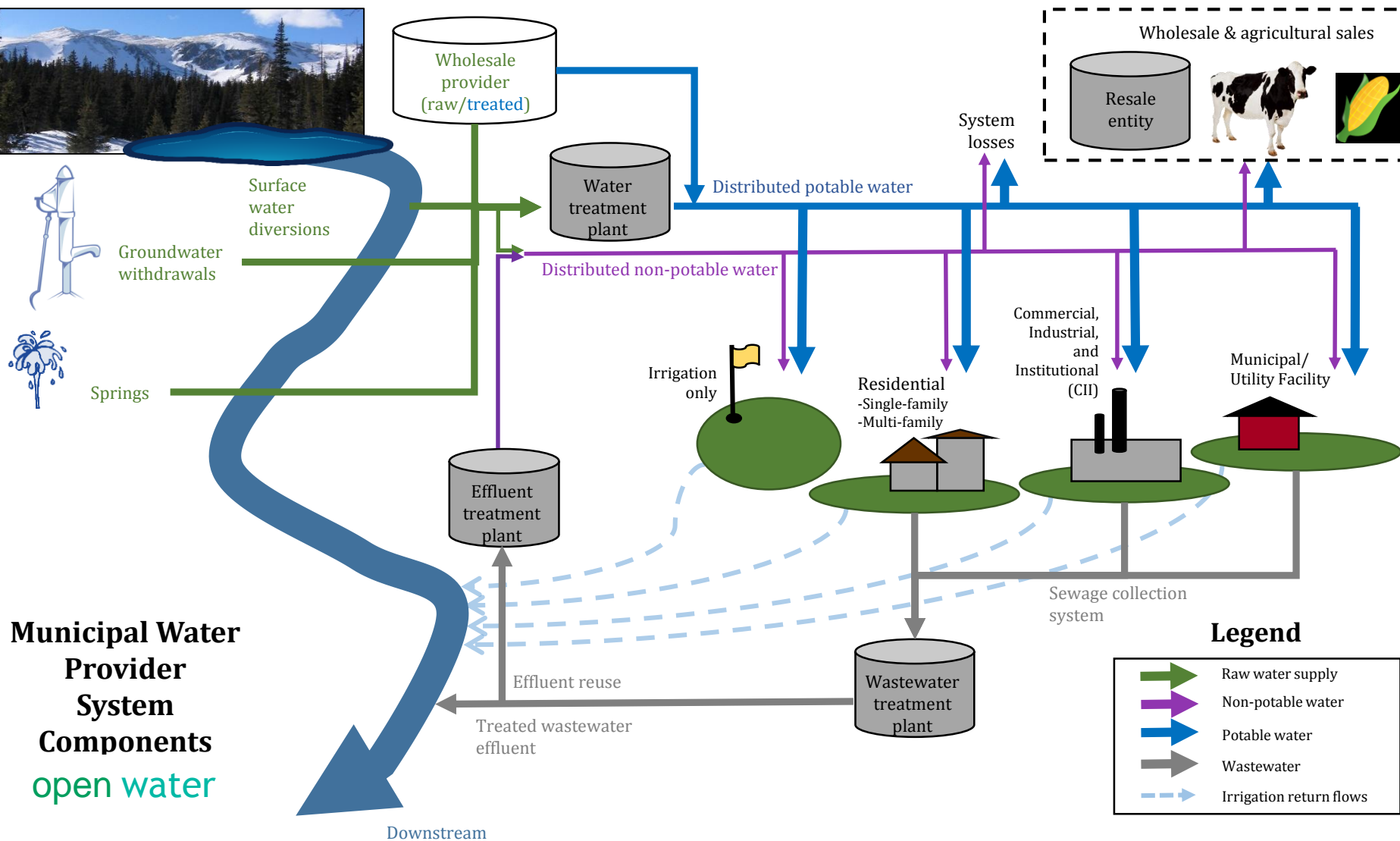


# Clarity / Context / What is “Water Use”?

- “Depletions from river/aquifer”?
- Metered deliveries?
- Consumptive use?

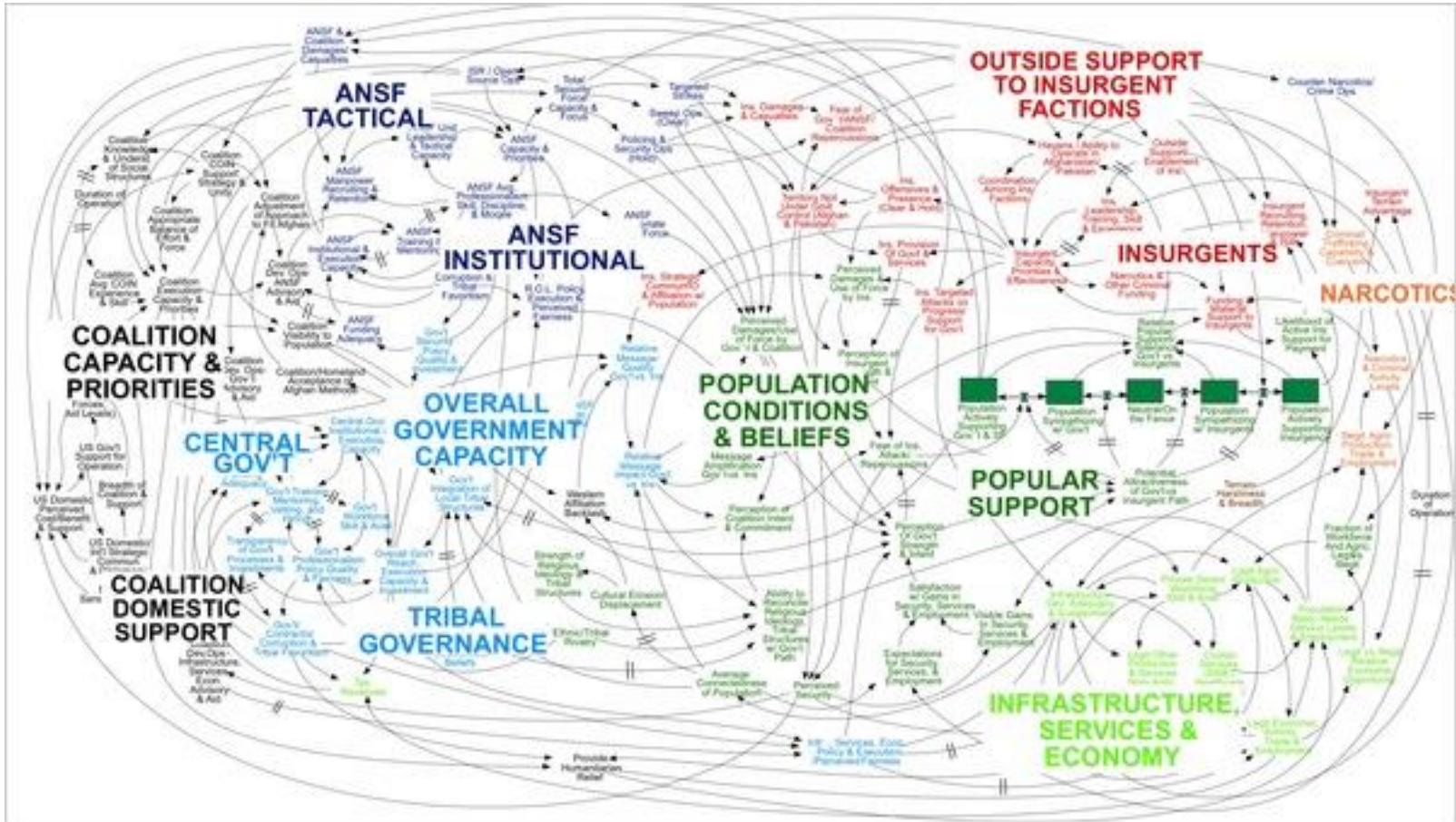
*From which perspective(s) is the story told?  
What points are being made?*

# Urban Water Provider System



# We Have Met the Enemy and He is PowerPoint

PowerPoint diagram to display the complexity of the American strategy in Afghanistan



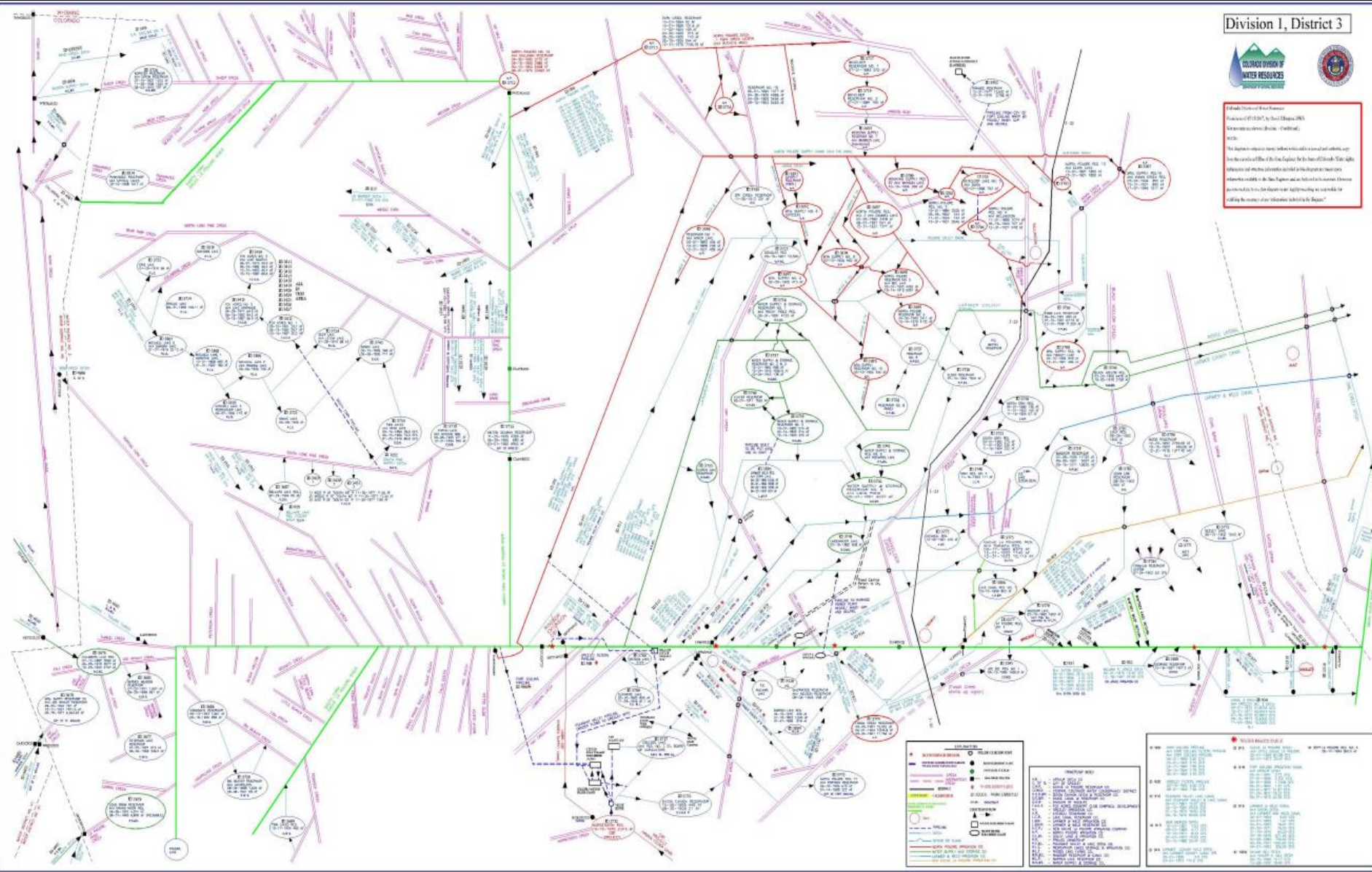
<http://www.nytimes.com/2010/04/27/world/27powerpoint.html>

# Poudre Basin Straight Line Diagram

Division 1, District 3



**Final** Straight Line Diagram  
 Approved by the Board of Directors on 11/15/2011  
 City of Fort Collins, Colorado  
 The Board of Directors hereby certifies that this diagram is a true and correct copy of the records of the City of Fort Collins. It is the policy of the City of Fort Collins to maintain accurate records of the water resources of the City. It is the policy of the City of Fort Collins to maintain accurate records of the water resources of the City. It is the policy of the City of Fort Collins to maintain accurate records of the water resources of the City.



**LEGEND**

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**MANHOLE NO.**

101	102	103	104	105	106	107	108	109	110
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171	172	173	174	175	176	177	178	179	180
181	182	183	184	185	186	187	188	189	190
191	192	193	194	195	196	197	198	199	200

**WATER MAINS TABLE**

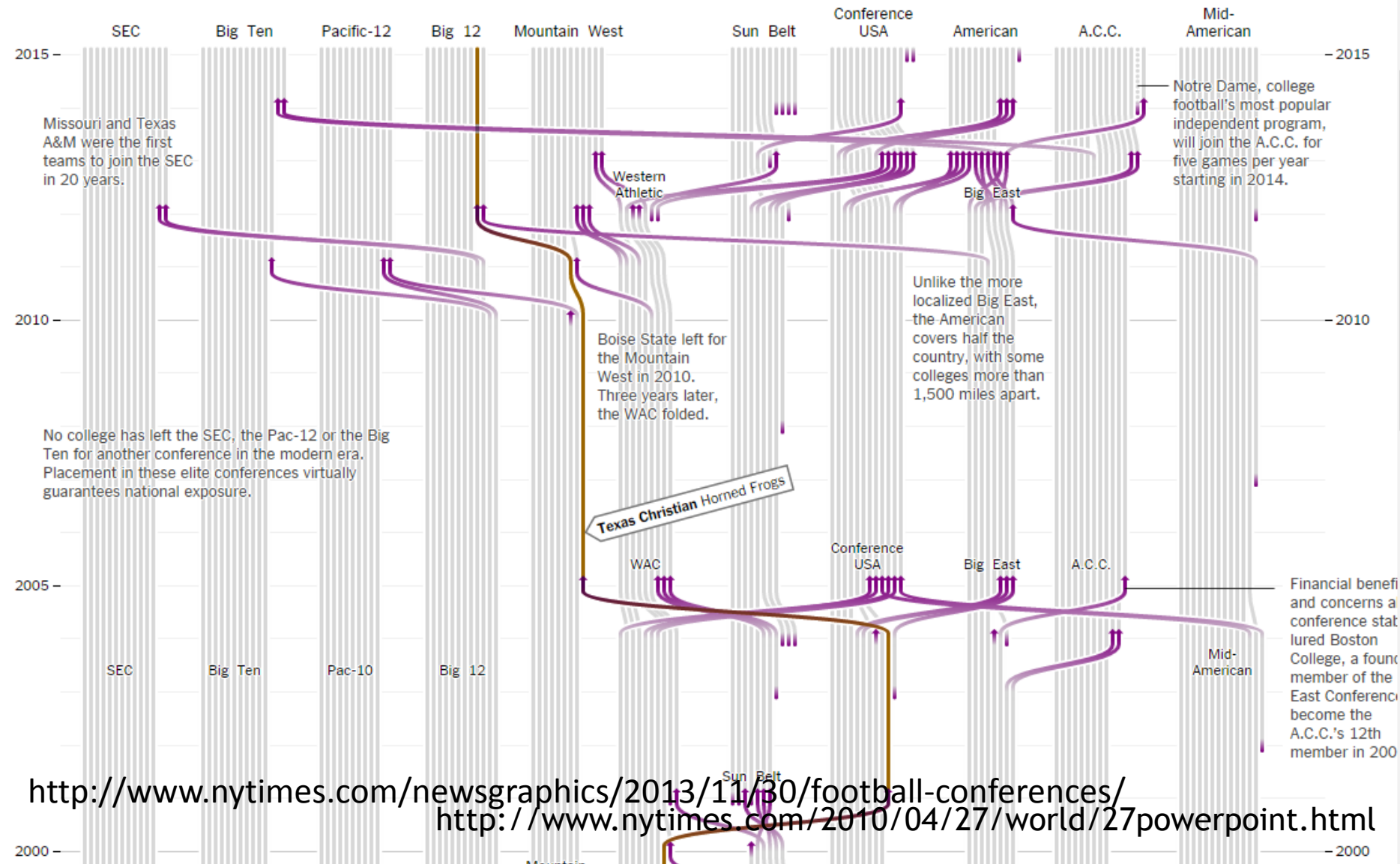
LINE NO.	START	END	DIAMETER	DEPTH	DATE	BY
1	101	102	12"	4'	10/10/11	JM
2	102	103	12"	4'	10/10/11	JM
3	103	104	12"	4'	10/10/11	JM
4	104	105	12"	4'	10/10/11	JM
5	105	106	12"	4'	10/10/11	JM
6	106	107	12"	4'	10/10/11	JM
7	107	108	12"	4'	10/10/11	JM
8	108	109	12"	4'	10/10/11	JM
9	109	110	12"	4'	10/10/11	JM
10	110	111	12"	4'	10/10/11	JM
11	111	112	12"	4'	10/10/11	JM
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82	182	183	12"	4'	10/10/11	JM
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# Changes Over Time and Space

## Major college football programs since 1965

Texas Christian Horned Frogs x v

Schools switching conferences are highlighted



<http://www.nytimes.com/newsgraphics/2013/11/30/football-conferences/>  
<http://www.nytimes.com/2010/04/27/world/27powerpoint.html>

# Make the Complicated...Simple

“Making the simple complicated is commonplace.

Making the complicated simple, awesomely simple, that’s creativity”

-Charles Mingus



[https://en.wikiquote.org/wiki/Charles\\_Mingus](https://en.wikiquote.org/wiki/Charles_Mingus)

# Poudre River

Metadata | Thumbnails | Annotations

Page 1 of 1 PDF

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Last Modified  
9/16/2009 1:35:03 PM  
Creation Date  
2/8/2007 10:43:27 AM

Fields

Template: Straight Line Diagrams  
Division  
1  
Water District  
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Stream Name  
CACHE LA POUDBRE RIVER  
COMPLEX

Page 10

CACHE LAPOUDRE RIVER COMPLEX

Name	No.	R / L	Location
55.11 Charles Hansen Canal		R	SB 8-70-14CBC ✓
Praefke Spring	Dch 44NS		SB 8-71-24D
H. P. Foster Ditch	Dch 195		SB 8-70-15D
54.85 Lewstone Creek (34)		R	SB 8-70-14CBD
54.83 Pleasant Valley & Lake Canal	Dch 4	R	SB 8-70-14cAC
48.33 (Claymore Lake Reservoir)	Res 8		SB 8-69-32CCA)
Crystal Springs Seepage Ditch	Dch 173		SB 9-68-19C
Kremers Ditch No. 1 & Storage Ponds	Dch 41NS		SB 9-69-31A
Maxfield & Alford Ditch No. 2	Dch 194W	R	SB 8-70-12BDD ✓
Maxfield & Alford Ditch No. 1	Dch 194W	R	SB 8-70-11DAD ✓
Unnamed Irrigation & Collect	Dch 194W	R	SB 8-70-11DAD ✓
54.27 Spring Creek			SB 8-70-13CAC
53.74 Larimer County Canal			SB 8-70-13CAC
(Curtis Lake Reservoir)	None		SB 8-69-16BAA)

**Stream mile = simple**

**Getting this in a machine readable format? = not simple**

Document management portal powered by Laserfiche  
WebLink 3.0.1 © 1998-2009 Laserfiche

<http://dwrweblink.state.co.us/dwrweblink/0/doc/689151/Page1.aspx?searchid=50445a93-c225-4344-b262-d6bea7a0d915>

# National Hydrography Dataset (USGS)

Standard Advanced Annotation Active Tool: Map Navigation

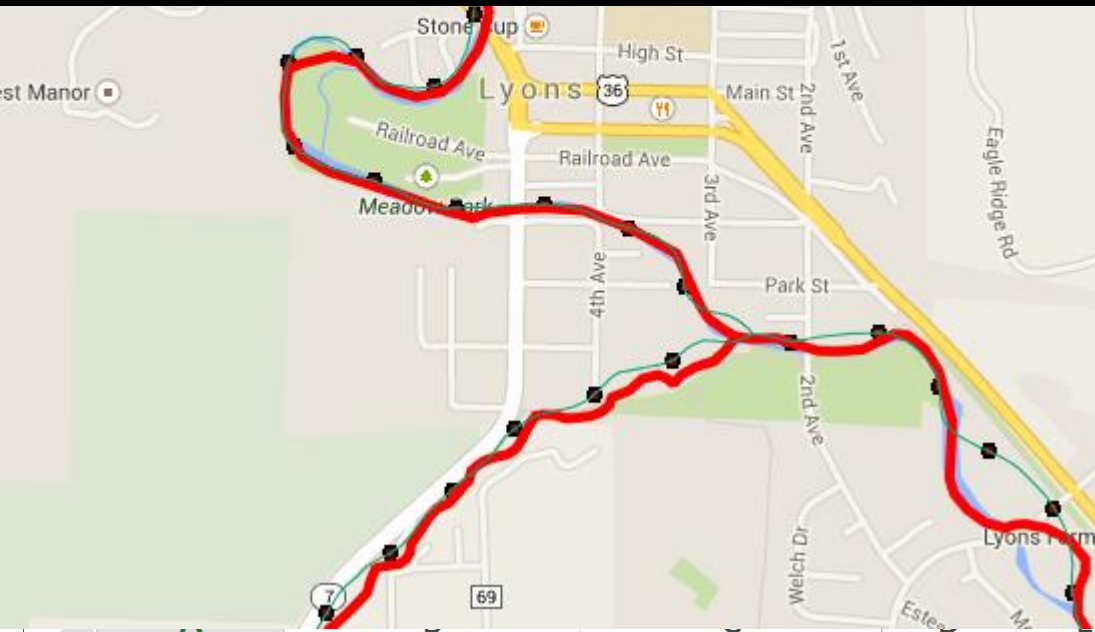
**NHD = complicated**

**Division of Water Resource's  
Source Water Route  
Framework (SWRF) = simpler**

<http://viewer.nationalmap.gov/viewer/nhd.html?p=nhd>



# Stream Mile Representation Framework



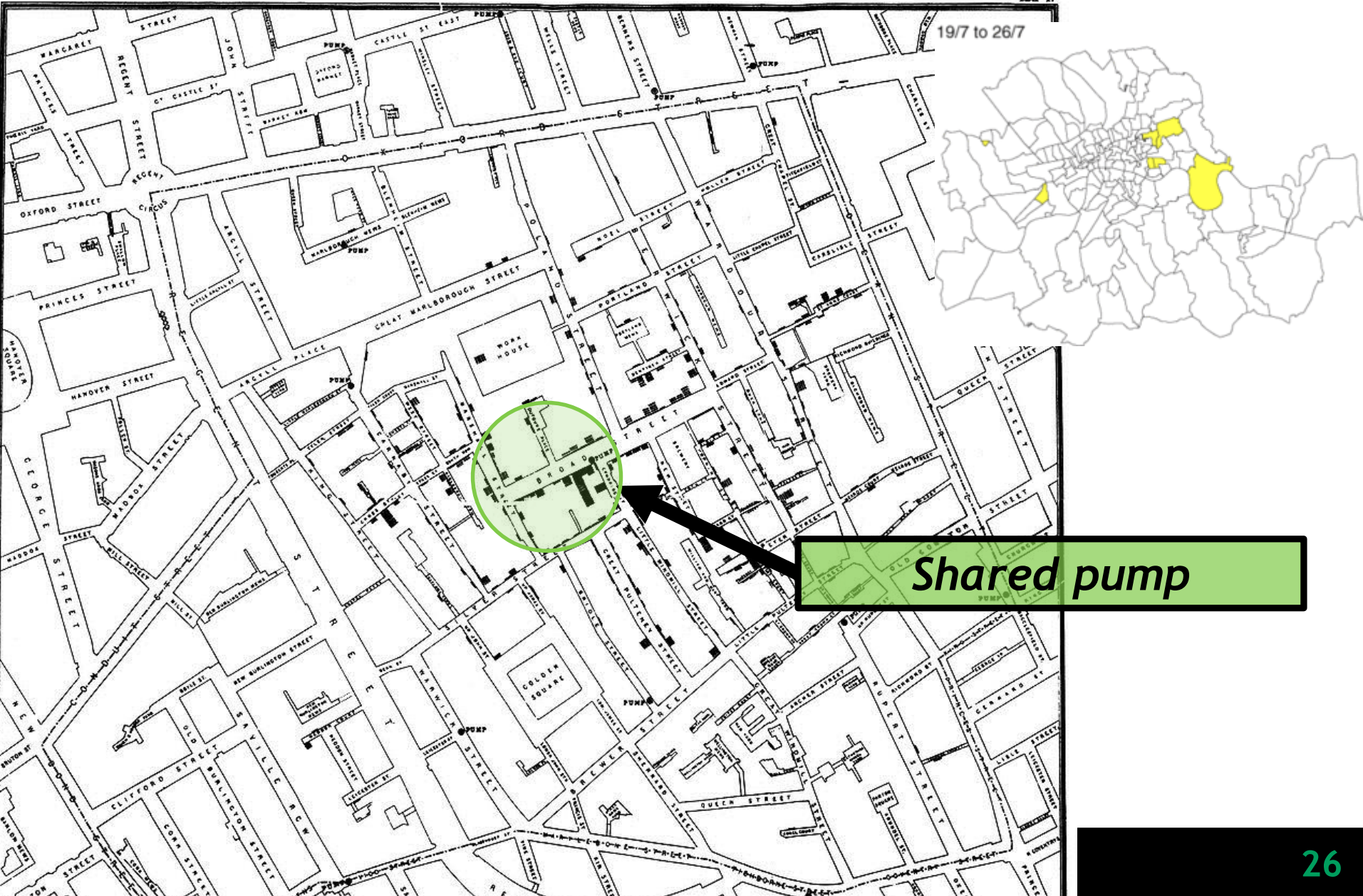
*E&R Attributes  
Instream Flow Reaches  
Projects & Methods  
Stream Gages  
Diversion Headgates  
Organization Extent  
Master Plans  
and more...*

1	GNIS_ID	GNIS_Name	GNIS_ID_FMEAS	FMEAS	TMEAS	FocusArea	BaldEagle	BrassyMinnow
614	00205012	Saint Vrain Creek	00205012_000.5	0.5	0.6	Saint Vrain Creek		Yes
615	00205012	Saint Vrain Creek	00205012_000.6	0.6	0.7	Saint Vrain Creek		Yes
616	00205012	Saint Vrain Creek	00205012_000.7	0.7	0.8	Saint Vrain Creek		Yes
617	00205012	Saint Vrain Creek	00205012_000.8	0.8	0.9	Saint Vrain Creek		Yes
618	00205012	Saint Vrain Creek	00205012_000.9	0.9	1.0	Saint Vrain Creek		Yes
619	00205012	Saint Vrain Creek	00205012_001.0	1.0	1.1	Saint Vrain Creek	Yes	Yes
620	00205012	Saint Vrain Creek	00205012_001.1	1.1	1.2	Saint Vrain Creek	Yes	Yes
621	00205012	Saint Vrain Creek	00205012_001.2	1.2	1.3	Saint Vrain Creek	Yes	Yes
622	00205012	Saint Vrain Creek	00205012_001.3	1.3	1.4	Saint Vrain Creek	Yes	Yes

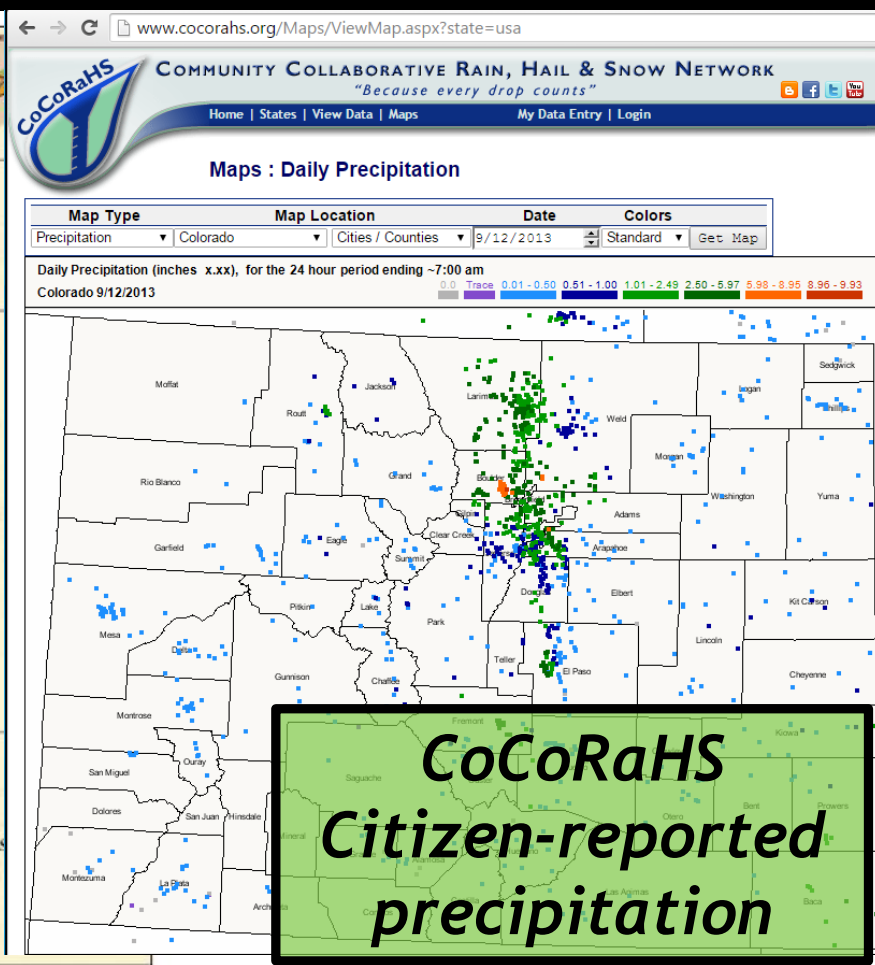
*Stream mile + Excel  
= simpler yet*

# London Cholera Epidemic of 1854

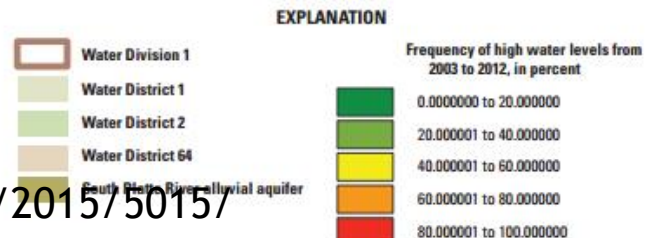
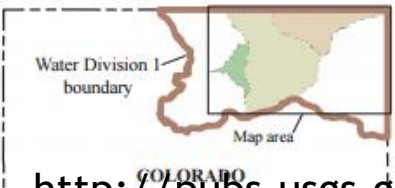
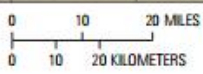
[https://en.wikipedia.org/wiki/John\\_Snow\\_\(physician\)](https://en.wikipedia.org/wiki/John_Snow_(physician))



# Citizen Science



Base from U.S. Geological Survey digital data, 2009, 1:100,000  
Lambert Conformal Conic projection (Colorado State Plane Central)  
Standard parallels 38°27'N and 37°45'N, central meridian 105°00'W



<http://www.cocorahs.org>

<http://pubs.usgs.gov/sir/2015/5015/>

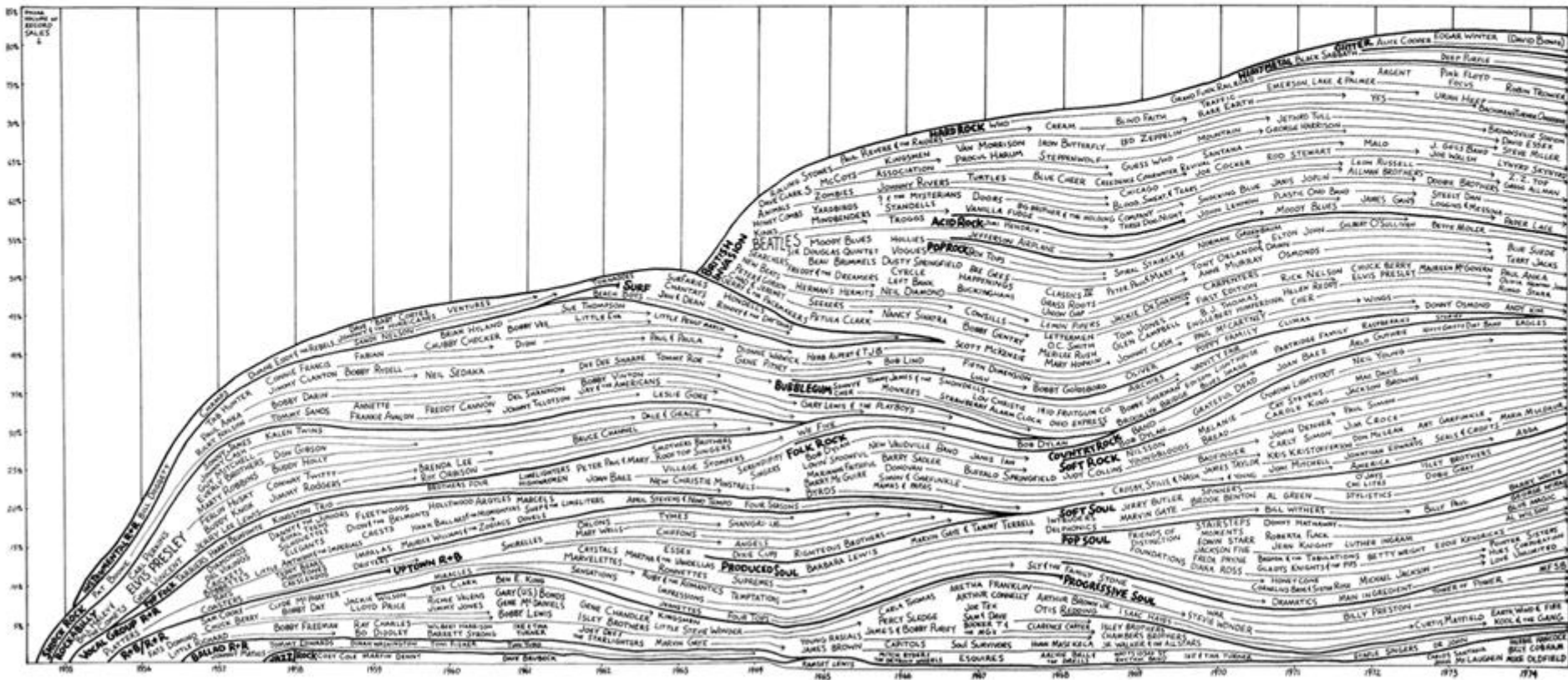
# Time Again: History of Rock and Roll

HERE is a musical streams-of-story, an appealing history of "marketing trends and stylistic patterns in the development of pop/rock music." Topping the chart is a time-series that tracks sales of popular and rock music as a share of total record sales, although the names are not scaled in proportion to their contributions to the grand total. Bold letters indicate some 24 stylistic categories, fountains flowing into musical streams (e.g., **Surf Rock**, lower left). Several fashions, including **Bubblegum** and **Surf**, did not last, to the relief of a grateful world. In these overlapping parallel time-series, a few names of the 470 artists

Steve Chapple and Rebeca Garofalo, *Rock 'N' Roll is Here to Stay: The History and Politics of the Music Industry* (Chicago, 1977), inside front and inside back covers. Concept and design by Rebeca Garofalo; graphics by Damon Roney; copyright 1975 by Robert L. Garofalo.

are repeated, as they resurface in fresh currents. The multiple, parallel flows locate music-makers in two dimensions—linking musical parents and offspring from 1955 to 1974, and listing contemporaries for each year.<sup>10</sup> With an intense richness of detail (measuring in at 20% of the typographic density of a telephone book), this nostalgic and engaging chart fascinates many viewers—at least those of a certain age. Also the illustration presents a somewhat divergent perspective on popular music: songs are not merely singles—unique, one-time, *de novo* happenings—rather, music and music-makers share a pattern, a context, a history.

<sup>10</sup> Among the missing are The Weavers, Pete Seeger, Bonnie Raitt, and Lou Reed and The Velvet Underground.



[http://www.edwardtufte.com/board/q-and-a-fetch-msg?msg\\_id=0002N4](http://www.edwardtufte.com/board/q-and-a-fetch-msg?msg_id=0002N4)



# The Complexity of Colorado Water

## Appendix B: Quick Guide to Diversion Record Codes

SOURCE Code	
1	Natural Stream Flow
2	Reservoir Storage
3	Ground Water
4	Transbasin Water
5	Non-Stream Flow
8	Re-usable Water
X	Unspecified

TYPE Code	
	Blank is acceptable
Types of diversions	
1	Exchange
2	Trade
4	Alternate Point of Diversion
A	Authorized/Augmented
U	Unauthorized Diversion
D	Out-of-priority Depletion
J	In-priority Depletion
Types of releases	
7	Released to Stream
8	Released Off-stream
L	Release of Dominion and Control
E	Release of Excess Diversion

USE Code	
0	Storage
1	Irrigation
2	Municipal
3	Commercial
4	Industrial
5	Recreation
6	Fishery
7	Fire
8	Domestic
9	Stock
A	Augmentation
B	Sub-basin export
C	Change of Use Return Flows
E	Evaporation
F	Federal reserved
G	Geothermal
H	Household use only
K	Snow making
M	Minimum stream flow/lake level
P	Power generation
Q	Quantification of amount
R	Recharge
S	Export from State
T	Transbasin export
W	Wildlife

Not Used/Not Released Code (NUC/NRC)	
	Blank is acceptable
A	Structure not usable
B	No water available
C	Water available, but not taken
D	Water taken in another structure
E	Water taken, but no data available
F	No information available

Structure Type Allowed to have a Diversion Record		
1	Ditch	N
2	Well	N
WG	Well Group	N
4	Spring	N
5	Seep	N
6	Mine	N
7	Pipeline	N
8	Pump	N
9	Power Plant	N
0	Other	N
M	Measuring Point	N
MF	Minimum Flow	N
R	Reach (Non-Aggregating)	N
WF	Well Field	A
3	Reservoir	A

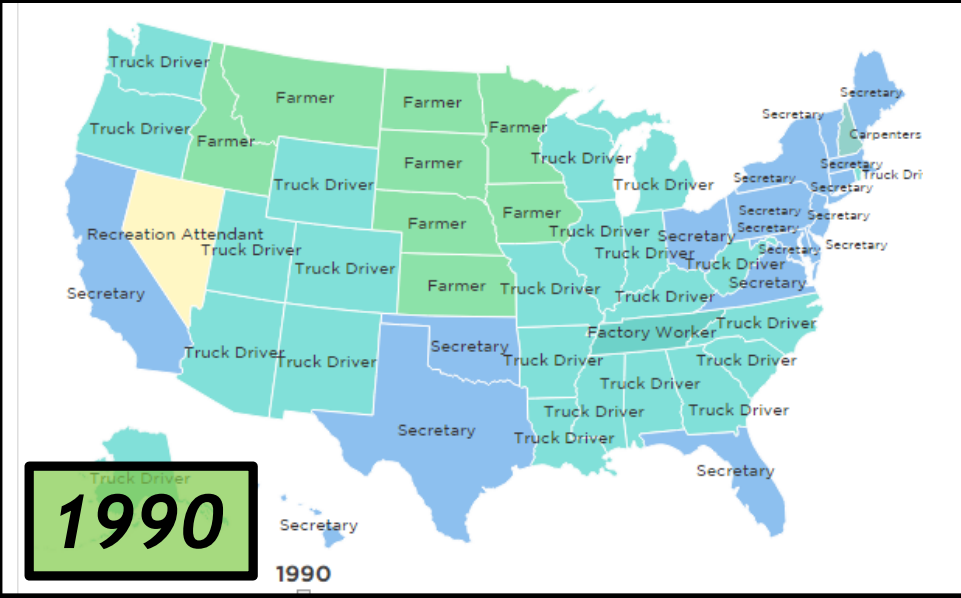
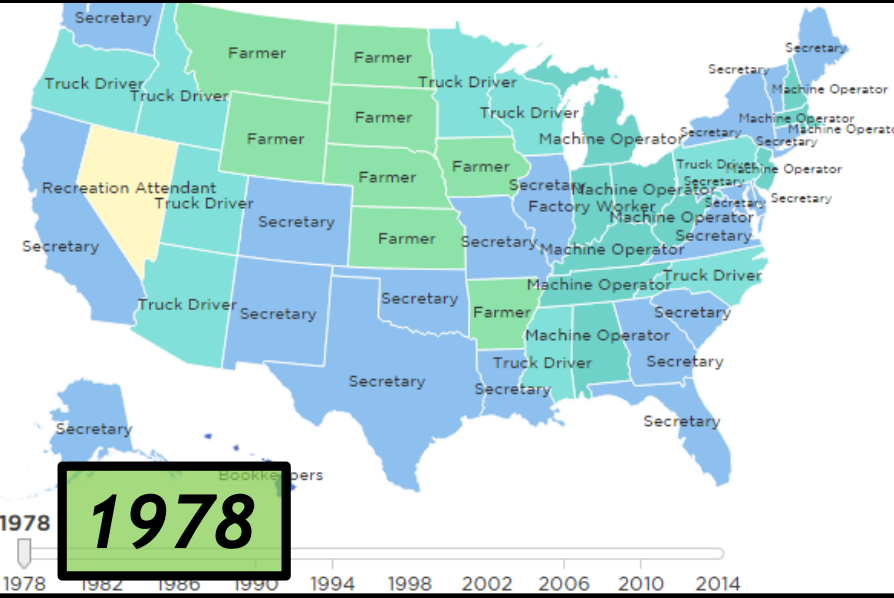
# The Complexity of Colorado Water

## 7.1 Water Class Definition

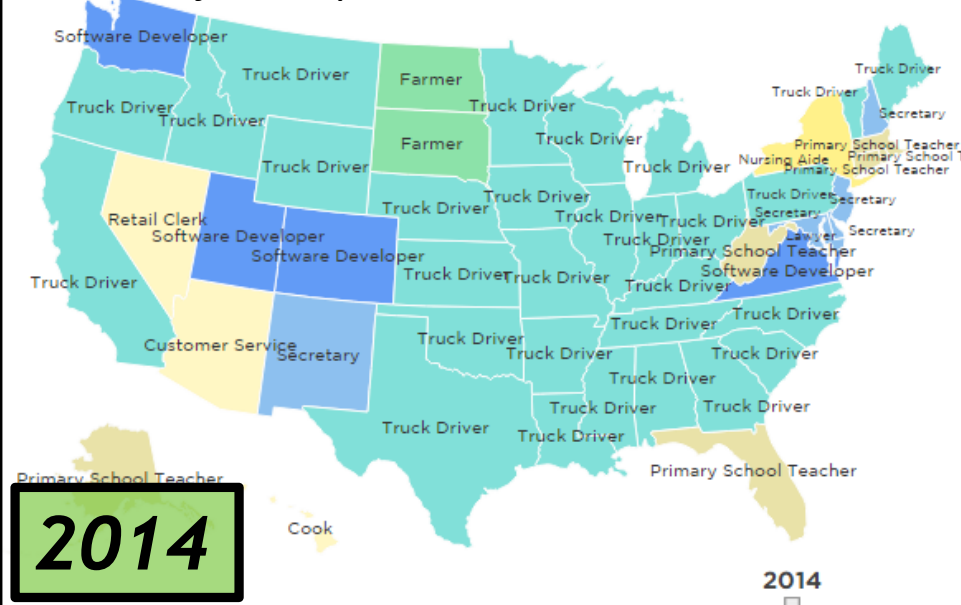
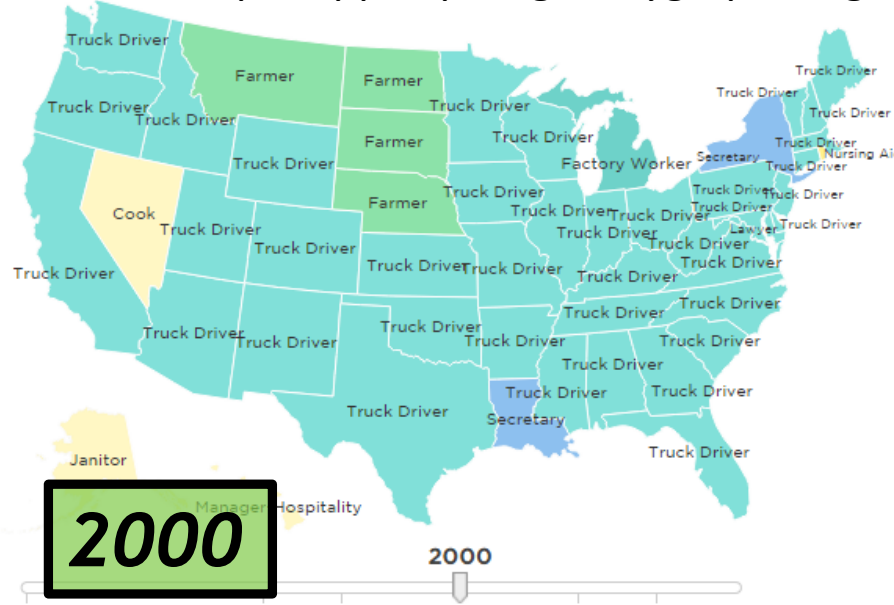
Diversion records are a language. The basic sentence in the language is the Water Class, which consists of a series of codes that provide the location of the diversion, the SOURCE of water, the USE of the water and the administrative operation that was required to perform the operation. The Water Class, combined with a daily, monthly or annual volume, constitutes a "Diversion Record". The codes that make up a Water Class, are:

- WDID - structure ID at which the diversion was made
- ACT - each WDID **may** have multiple accounts as indicated by a three digit extension appended to the right of a decimal point after the WDID
- SOURCE - source of the water being diverted
- FROM - structure ID of "enabling structure" associated with more complex diversions; may also have an ACT extension
- USE - how the diverted water was used
- TYPE - provides additional detail regarding the administrative operation associated with the diversion
- GROUP - the WDID of a group or authorizing agent associated with the diversion
- TO - the WDID of a structure to which a release is being delivered; may also have an ACT extension

# The Most Common Jobs in Each State

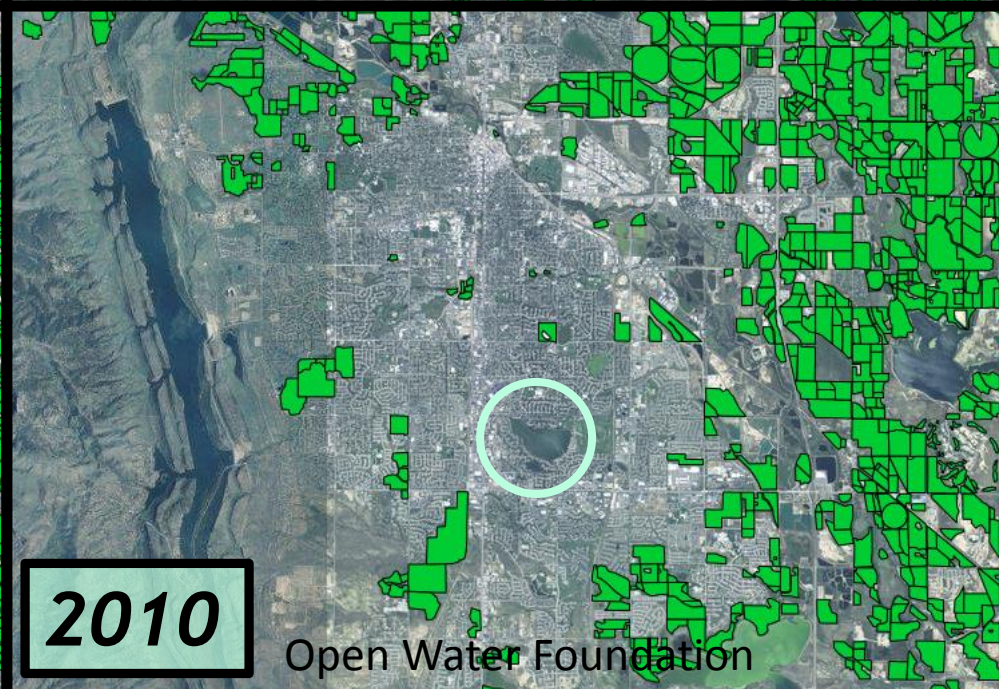
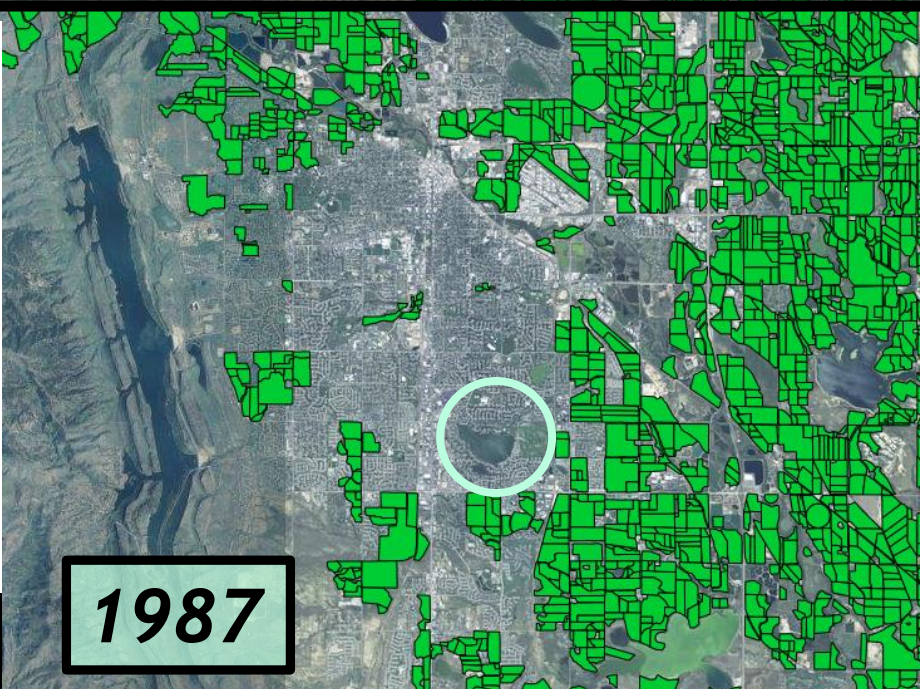
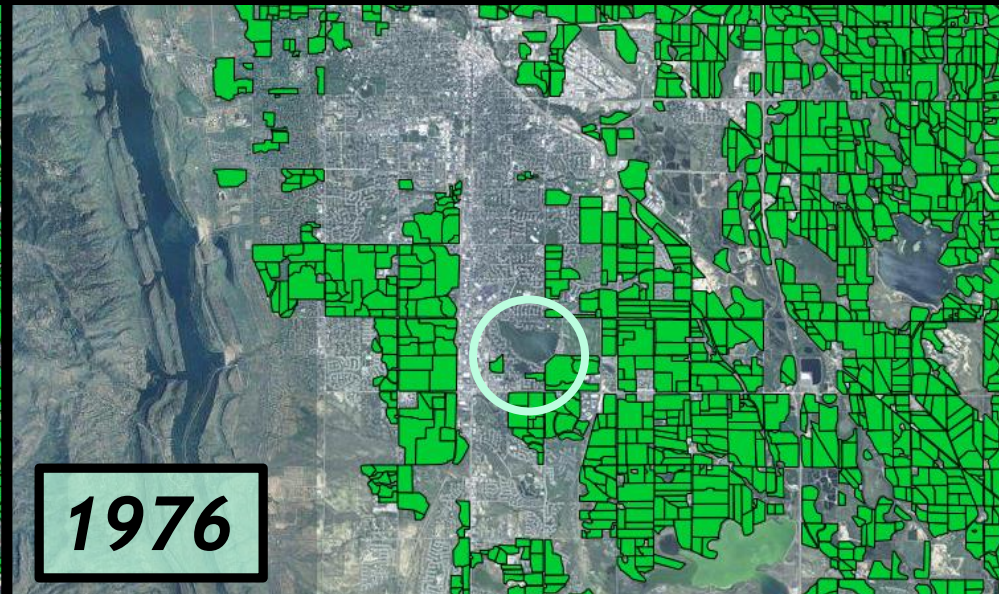
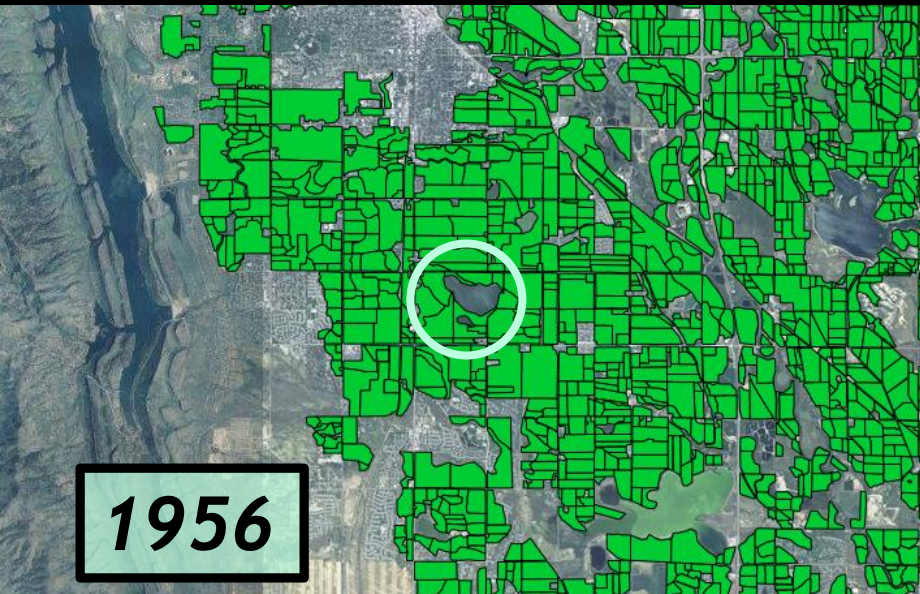


<http://apps.npr.org/dailygraphics/graphics/hist-job-map-90/child.html>





# Irrigated Agriculture Dry Up





Search

Clear All Options

### View Types

- Data Lens pages [What's this?](#)
- Datasets
- Charts
- Maps
- Calendars
- Filtered Views
- External Datasets
- Files and Documents
- Forms
- APIs

### Categories

- (All)
- Agriculture
- Business
- Demographics
- Economic Growth
- Education
- Water**

[View All](#)

### Topics

- 2013
- bic
- colorado
- gocode
- pueblo

## Results matching category of Water

Most Relevant

	Name	Popularity	Type
<input checked="" type="checkbox"/>	<b>DWR Water Right Net Amounts</b> Water water right, gocode A Water Right is a property right that is either conditional or	3,164 views	
<input checked="" type="checkbox"/>	<b>DWR Well Application Permit</b> Water well, application, permit, gocode All well applications and permits issued.	2,406 views	
<input checked="" type="checkbox"/>	<b>DWR Water Right Transactions</b> Water water right, gocode A Water Right is a property right that is either conditional or	1,575 views	
<input checked="" type="checkbox"/>	<b>DWR Administrative Structures</b> Water ditch, headgate, reservoir, well, gocode Contains physical, manmade structures used for diverting, storing, releasing, or measuring water; struct	1,520 views	
<input checked="" type="checkbox"/>	<b>DWR Current Surface Water Conditions Map (Statewide)</b> Water Current streamflow conditions	1,456 views	
<input checked="" type="checkbox"/>	<b>DWR Active Calls</b> Water river administration, river call, gocode Division of Water Resources (DWR) Active Calls. The Call is a term used by the state engineer to effectivel	1,358 views	
<input checked="" type="checkbox"/>	<b>DWR Current Surface Water Conditions</b> Water streamflows, current conditions, gocode Division of Water Resources (DWR) Current Surface Water Conditions. This is a list of all remote monitore	1,268 views	
<input checked="" type="checkbox"/>	<b>DWR Calls History</b> Water administrative call, gocode Division of Water Resources (DWR) Call History. The Call is a term used by the state engineer to effectivel	1,316 views	
<input checked="" type="checkbox"/>	<b>DWR Well Water Level</b> Water well, water level, level, gocode Water Level wells with the State of Colorado along with their last known water level.	1,295 views	
<input checked="" type="checkbox"/>	<b>DWR Active Calls Map (Statewide)</b> Water active call, river administration Division of Water Resources (DWR) Active Calls. The Call is a term used by the state engineer to effectivel	968 views	

# Observations

- There is **great potential** to use open/big data to tell stories about water resources.
- The challenge is to **make complex things simple**, or at least easier to understand.
- We must **leverage** each other's data and work collaboratively to be effective, efficient, and transparent.
- **Water education can benefit** from open/big data and technologies used to tell stories.
- **Organizational capacity is perhaps the biggest challenge to telling big stories.**

# Share It

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**open data | open software | open decisions**

[openwaterfoundation.org](http://openwaterfoundation.org)