



# Using Open Data and Software for Water Resources to Drive Transparency and Innovation

AWRA 2015 Annual Water Resources Conference, November 18, 2015



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# Introduction



openwater  
FOUNDATION

- 2013 - Open Water Foundation (nonprofit focusing on open data and open source software for water resources)
- 2014 - TriLynx Systems (for-profit focusing on real-time data management and flood warning systems)
- Both located in Innosphere start-up incubator



# 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”

# Transparency and Innovation

## Transparent

- free from pretense or deceit
- readily **understood**
- characterized by **visibility** or **accessibility** of information especially concerning **business practices**

## Innovation

- the introduction of something **new**
- a new idea, method, or device

## ...also...Evolution

- process of **continuous change** from a lower, simpler, or worse to a higher, more complex, or better state

<http://www.merriam-webster.com/dictionary/transparent>



# Why be Open with Data?

## The President says so

- “open government” executive orders (how’s that going AWRA?)

## Requirements to do so

- often, “open government” = budget transparency
- regulatory requirements (publish, but how accessible, usable?)
- open data policies

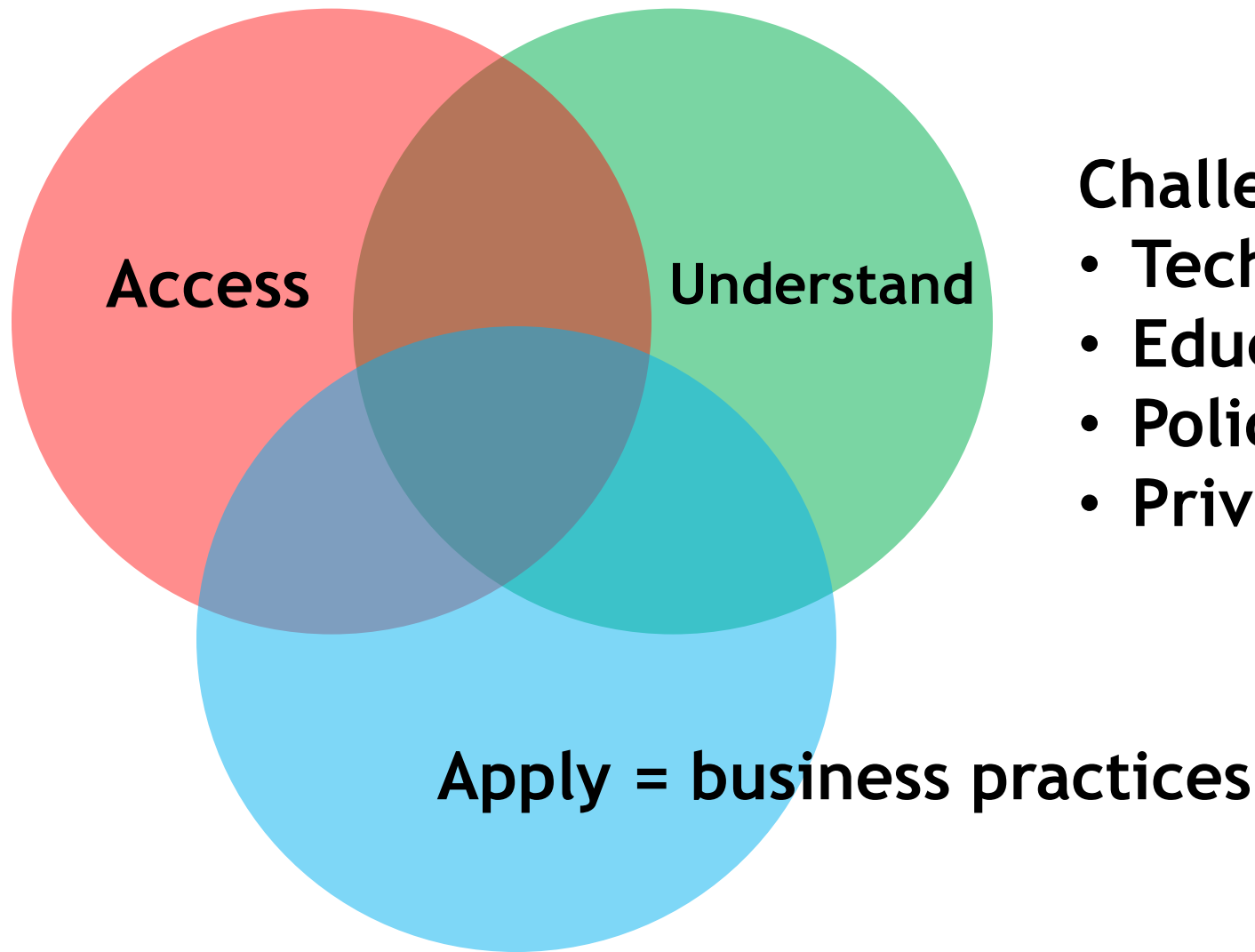
## Values

- culture of understanding, collaboration, and innovation
- encourage participatory government
- or, maybe because we don’t trust people



Photo: [http://www.huffingtonpost.com/jeana-lee-tahnk/neat-products-for-teachin\\_b\\_7138030.html](http://www.huffingtonpost.com/jeana-lee-tahnk/neat-products-for-teachin_b_7138030.html)

# Transparency Leads to Innovation



## Challenges:

- Technology
- Education
- Policy
- Privacy concerns

# Example: Water Use Efficiency

“Water saving options laid out - City hopes to reduce water usage per person by 9 percent by 2030, which may also affect water bills.”

Fort Collins Coloradoan, November 15, 2015

## WEATHER-NORMALIZED WATER DEMAND

\*Measured in gallons per person, per day



Source: Fort Collins Utilities

GANNETT GRAPHIC

## Questions:

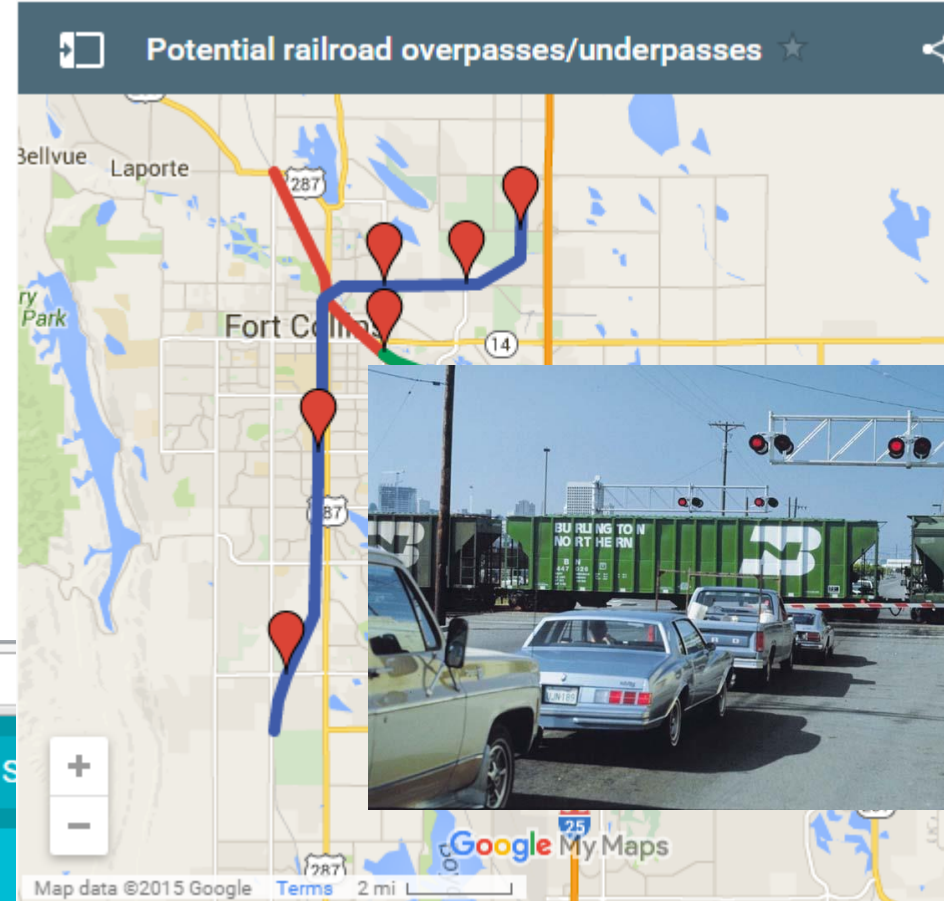
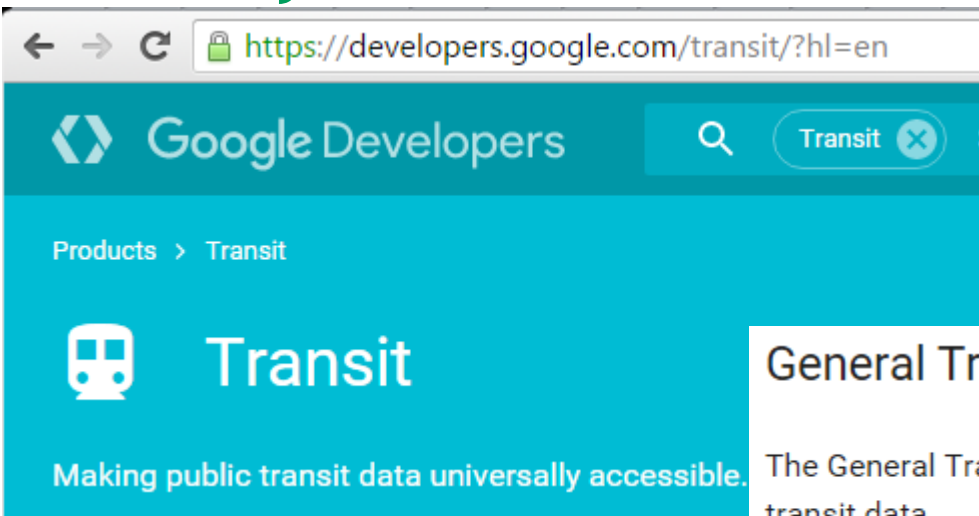
- What causes changes in use?
- How low can water use go?
- Indoor/outdoor use impacts?
- Change in total water bill or change in cost/gallon?
- What are we learning?

# Example: Train Crossing Delays

“Railroads don’t release schedules, leave public in dark.”

Questions:

- Can an “app” help?
- Is it a structural problem?
- Where should we spend money?



## General Transit Feed Specification (GTFS)

The General Transit Feed Specification (GTFS) can be used to share static public transit data.

[READ ABOUT GTFS](#)

Map: Fort Collins Coloradoan, November 15, 2015 Photo: [www.fhwa.dog.gov](http://www.fhwa.dog.gov)



# Open Innovation Example - GPS

## HOW GPS WORKS



### GPS

IS A CONSTELLATION OF 24 OR MORE SATELLITES FLYING 20,350 KM ABOVE THE SURFACE OF THE EARTH. EACH ONE CIRCLES THE PLANET TWICE A DAY IN ONE OF SIX ORBITS TO PROVIDE CONTINUOUS, WORLDWIDE COVERAGE.

1 GPS satellites broadcast radio signals providing their locations, status, and precise time  $\{t_1\}$  from on-board atomic clocks.

2 The GPS radio signals travel through space at the speed of light  $\{c\}$ , more than 299,792 km/second.

3 A GPS device receives the radio signals, noting their exact time of arrival  $\{t_2\}$ , and uses these to calculate its distance from each satellite in view.

*GPS provides location and time*

and the time the signal is received  $\{t_2\}$ .

4 Once a GPS device knows its distance from at least four satellites, it can use geometry to determine its location on Earth in three dimensions.

The GPS Master Control Station tracks the satellites via a global monitoring network and manages their health on a daily basis.

Ground antennas around the world send data updates and operational commands to the satellites.

The Air Force launches new satellites to replace aging ones when needed. The new satellites offer upgraded accuracy and reliability.

How does GPS help farmers? Learn more about the Global Positioning System and its many applications at

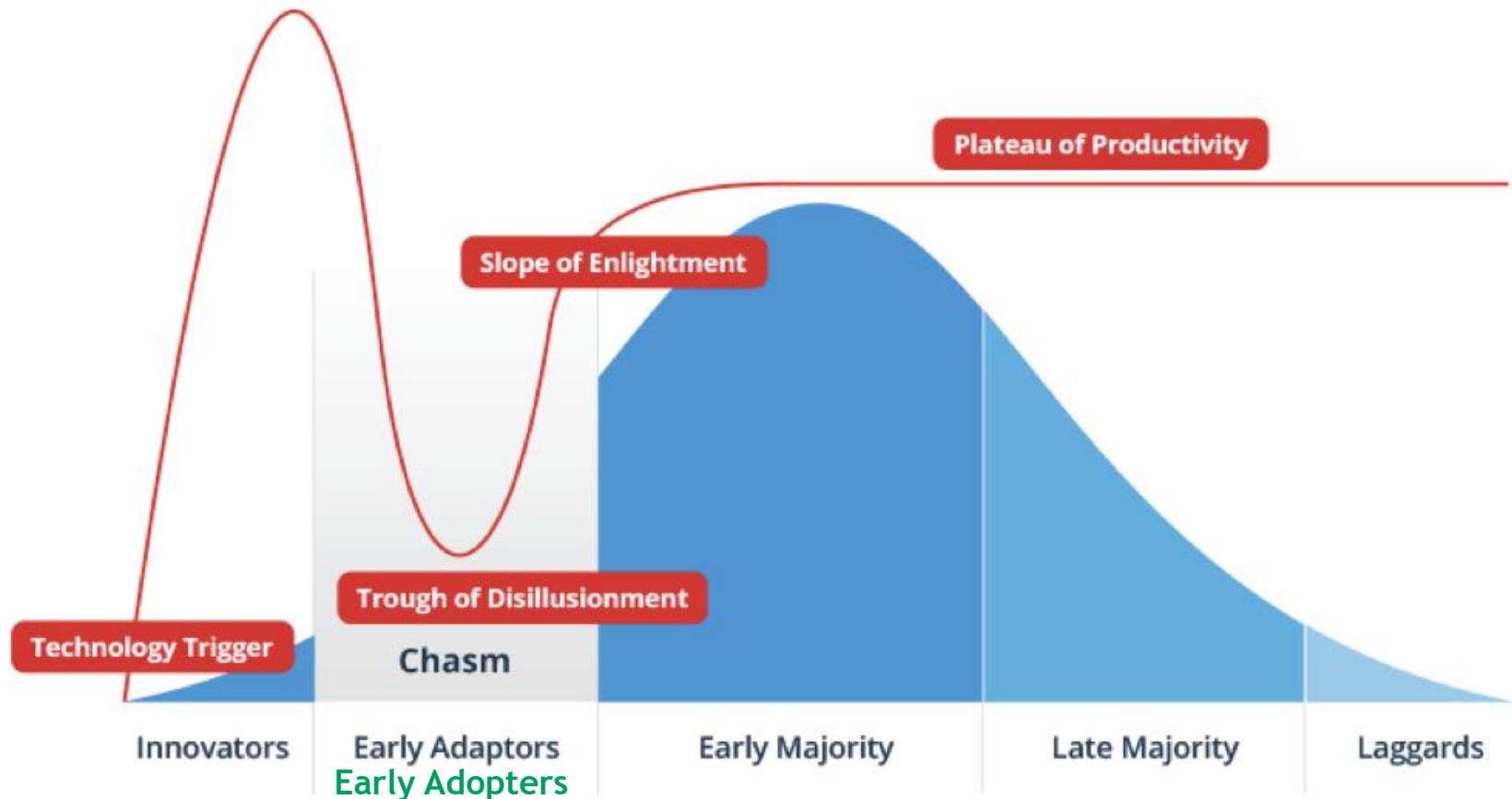
[WWW.GPS.GOV](http://WWW.GPS.GOV)

<https://www.defenseindustrydaily.com>



# Diffusion of Innovation

## Crossing the Chasm (Geoffrey Moore)



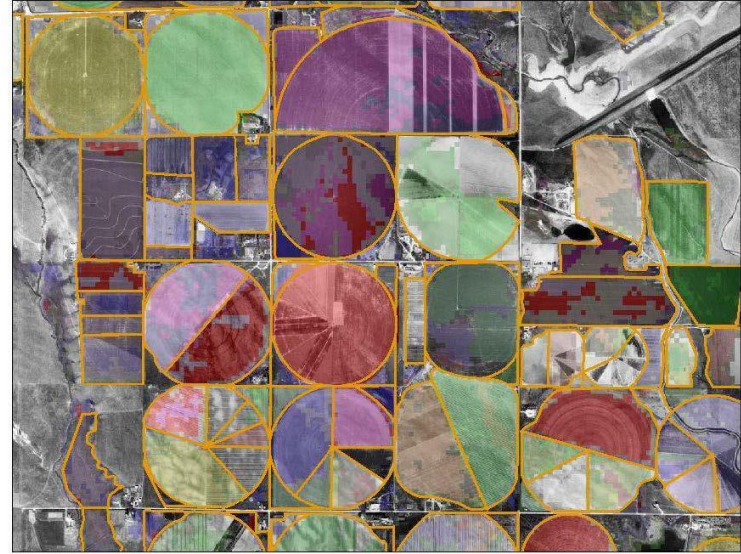
<http://www.datameer.com/blog/big-data-analytics-perspectives/big-data-crossing-the-chasm-in-2013.html>

[http://en.wikipedia.org/wiki/Crossing\\_the\\_Chasm](http://en.wikipedia.org/wiki/Crossing_the_Chasm)



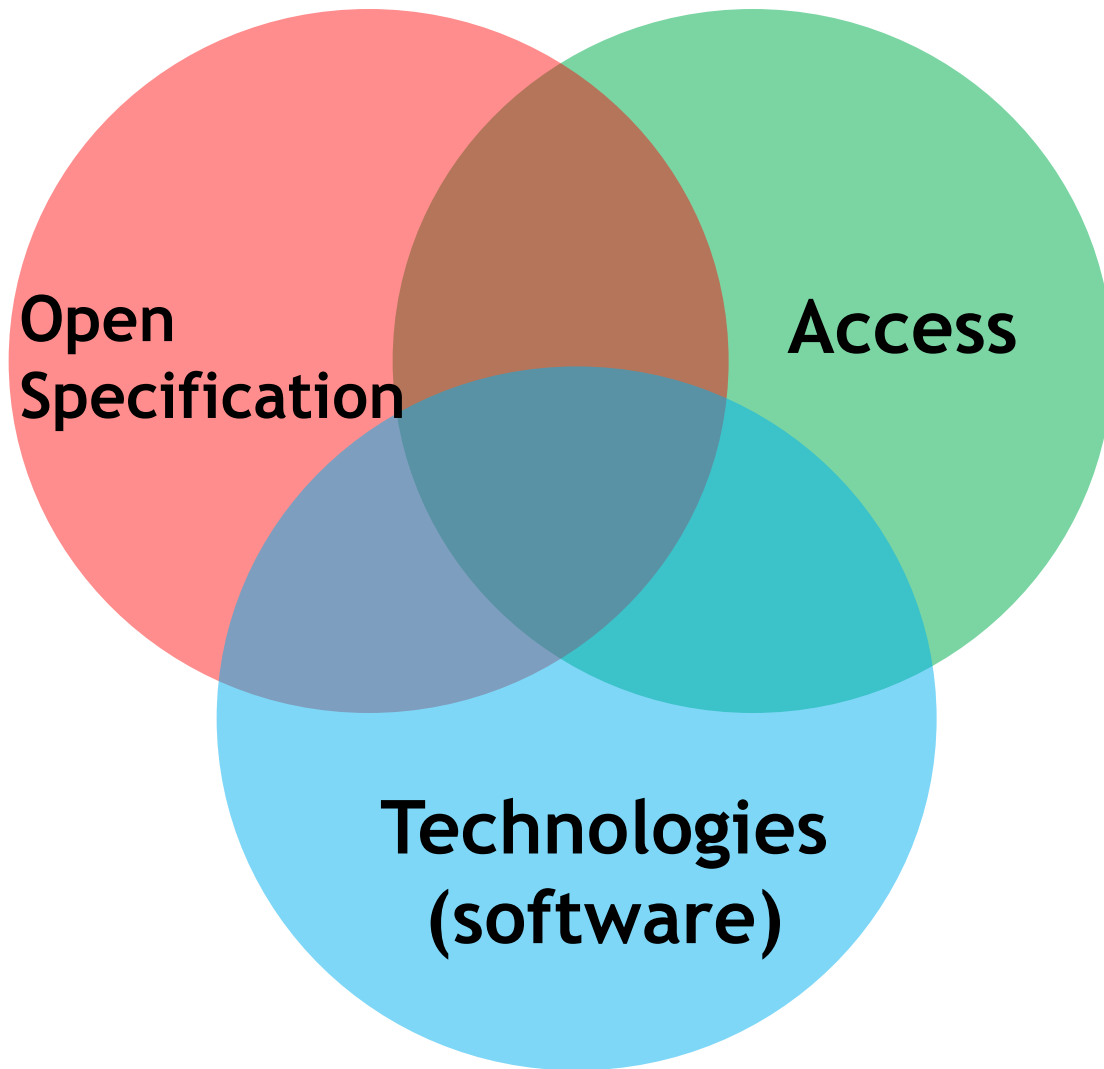
# Federal Datasets have Driven Innovation

- GPS
- Landsat
- Census
- Federal agency datasets, for example:
  - United States Geological Survey
  - Natural Resources Conservation Service
  - Bureau of Reclamation
  - National Weather Service



*What about state  
and local data?*

# Moving from Theory to Application



## Challenges:

- Who creates specification?
- Where are data hosted?
- Who develops software technologies?
- Who maintains software?

# Open Source Software

- Leverage open data standards
- Application programming interfaces (APIs)
  - provide access to open data, facilitate automation
- Facilitate innovation through rapid prototyping

## Challenge: Sustainability...

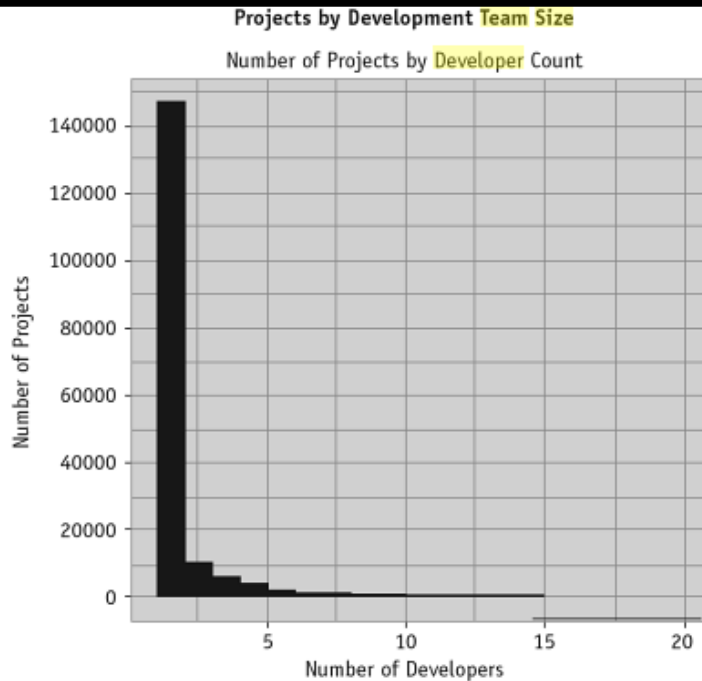
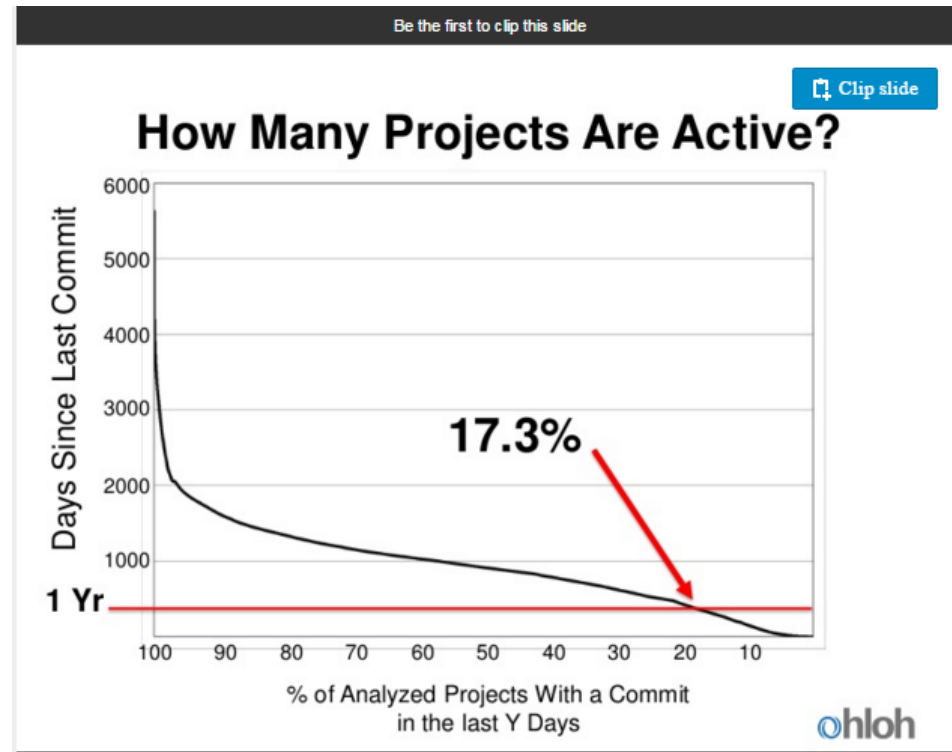


FIGURE 7.3 Distribution of 2009 SourceForge Projects by Development Team Size.



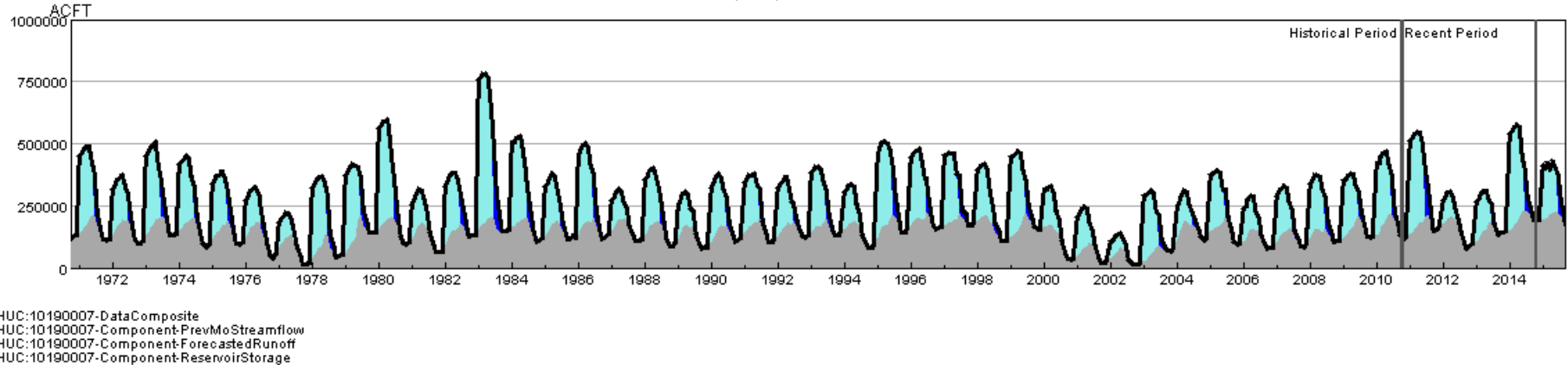
<http://www.slideshare.net/blackducksoftware/open-source-by-the-numbers>



# Example: Surface Water Supply Index

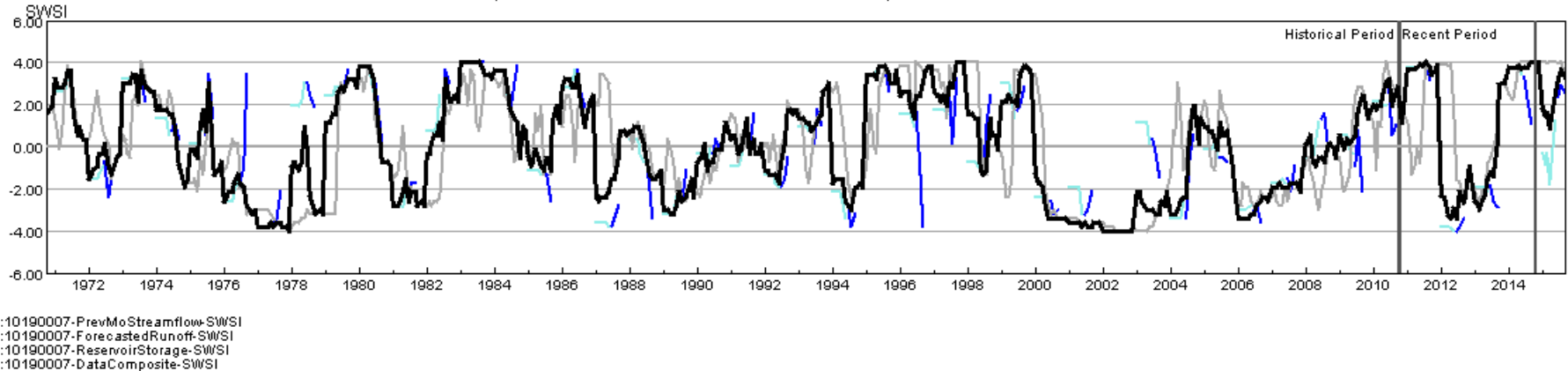
HUC 10190007 (Cache La Poudre) Surface Water Supply

Monthly component volumes



HUC 10190007 (Cache La Poudre) SWSI

Historical period SWSI values establish the SWSI distribution to lookup recent and current SWSI values.

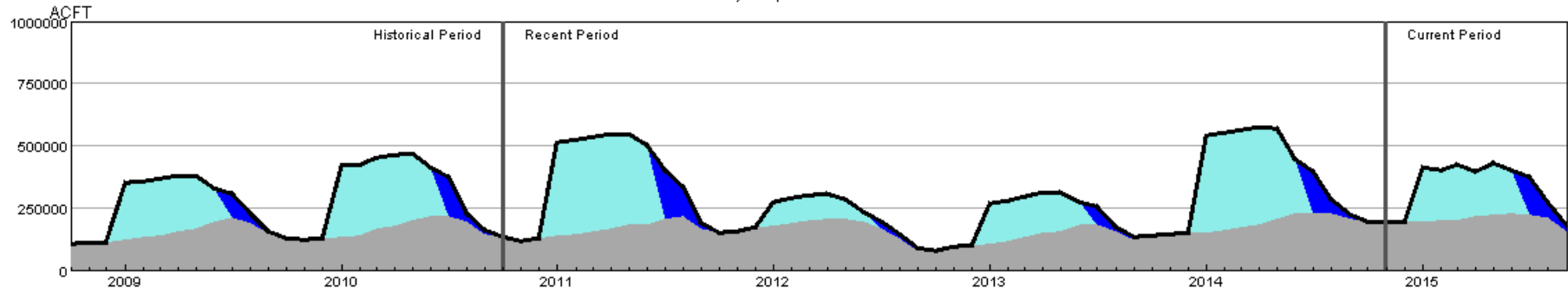


**TSTool software - moving to open source licensing**  
**Web services: USGS NWIS, NRCS AWDB, Colorado DWR**

# Example: Surface Water Supply Index

## HUC 10190007 (Cache La Poudre) Surface Water Supply

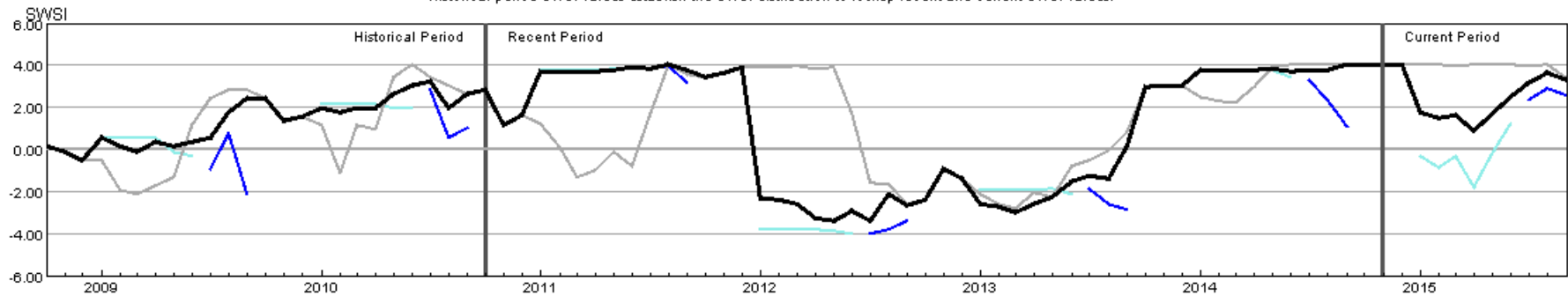
Monthly component volumes



— HUC:10190007-DataComposite  
— HUC:10190007-Component-PrevMoStreamflow  
— HUC:10190007-Component-ForecastedRunoff  
— HUC:10190007-Component-ReservoirStorage

## HUC 10190007 (Cache La Poudre) SWSI

Historical period SWSI values establish the SWSI distribution to lookup recent and current SWSI values.



— HUC:10190007-PrevMoStreamflow-SWSI  
— HUC:10190007-ForecastedRunoff-SWSI  
— HUC:10190007-ReservoirStorage-SWSI  
— HUC:10190007-DataComposite-SWSI

# Example: Surface Water Supply Index

|    | A         | B        | C            | D        | E               | F                     | G        | H                                 |
|----|-----------|----------|--------------|----------|-----------------|-----------------------|----------|-----------------------------------|
|    | Basinwide |          |              |          |                 |                       |          |                                   |
| 1  | Include   | Analysis | SWSI Basin   | HUC      | HUC Name        | Data Type             | ID       | Station Name                      |
| 57 | YES       | YES      | South Platte | 10190007 | Cache La Poudre | ForecastedNaturalFlow | 06752000 | CACHE LA POUDRE R AT CANYON MOUTH |
| 58 | YES       | YES      | South Platte | 10190007 | Cache La Poudre | ReservoirStorage      | 06016030 | BLACK HOLLOW RESERVOIR            |
| 59 | YES       | YES      | South Platte | 10190007 | Cache La Poudre | ReservoirStorage      | 06016050 | CACHE LA POUDRE                   |
| 60 | YES       | YES      | South Platte | 10190007 | Cache La Poudre | ReservoirStorage      | 06016070 | CHAMBERS LAKE                     |
| 61 | YES       | YES      | South Platte | 10190007 | Cache La Poudre | ReservoirStorage      | 0601     |                                   |
| 62 | YES       | YES      | South Platte | 10190007 | Cache La Poudre | ReservoirStorage      | 0601     |                                   |
| 63 | YES       | YES      | South Platte | 10190007 | Cache La Poudre | ReservoirStorage      | 0601     |                                   |
| 64 | YES       | YES      | South Platte | 10190007 | Cache La Poudre | ReservoirStorage      | 0601     |                                   |
| 65 | YES       | YES      | South Platte | 10190007 | Cache La Poudre | ReservoirStorage      | 0601     |                                   |
| 66 | YES       | YES      | South Platte | 10190007 | Cache La Poudre | NaturalFlow           | 0675     |                                   |

*Simple Excel input,  
use open source  
Apache POI library*

|    | A | B           | C       | D        | E     | F                                         |
|----|---|-------------|---------|----------|-------|-------------------------------------------|
| 19 |   | NaturalFlow | 1997-07 | 08250000 | 0     | MO-Fix negative value but preserve volume |
| 20 |   | NaturalFlow | 1997-08 | 08250000 | 1822  | MO-Fix negative value but preserve volume |
| 21 |   | NaturalFlow | 2000-07 | 08250000 | 0     | MO-Fix negative value but preserve volume |
| 22 |   | NaturalFlow | 2000-08 | 08250000 | 1300  | MO-Fix negative value but preserve volume |
| 23 |   | NaturalFlow | 2009-08 | 08250000 | 0     | MO-Fix negative value but preserve volume |
| 24 |   | NaturalFlow | 2009-09 | 08250000 | 2808  | MO-Fix                                    |
| 25 |   | NaturalFlow | 2002-06 | 09251000 | 66279 | MO-Fix                                    |
| 26 |   | NaturalFlow | 2002-07 | 09251000 | 0     | MO-Fix                                    |
| 27 |   | NaturalFlow | 1978-07 | 09370500 | 936   | MO-Fix                                    |
| 28 |   | NaturalFlow | 1978-08 | 09370500 | 0     | MO-Fix                                    |
| 29 |   | NaturalFlow | 1994-06 | 09370500 | 5588  | MO-Fix                                    |
| 30 |   | NaturalFlow | 1994-07 | 09370500 | 0     | MO-Fix                                    |

*Monthly data  
corrections are flagged  
in results (part of  
business process)*




[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 ▾

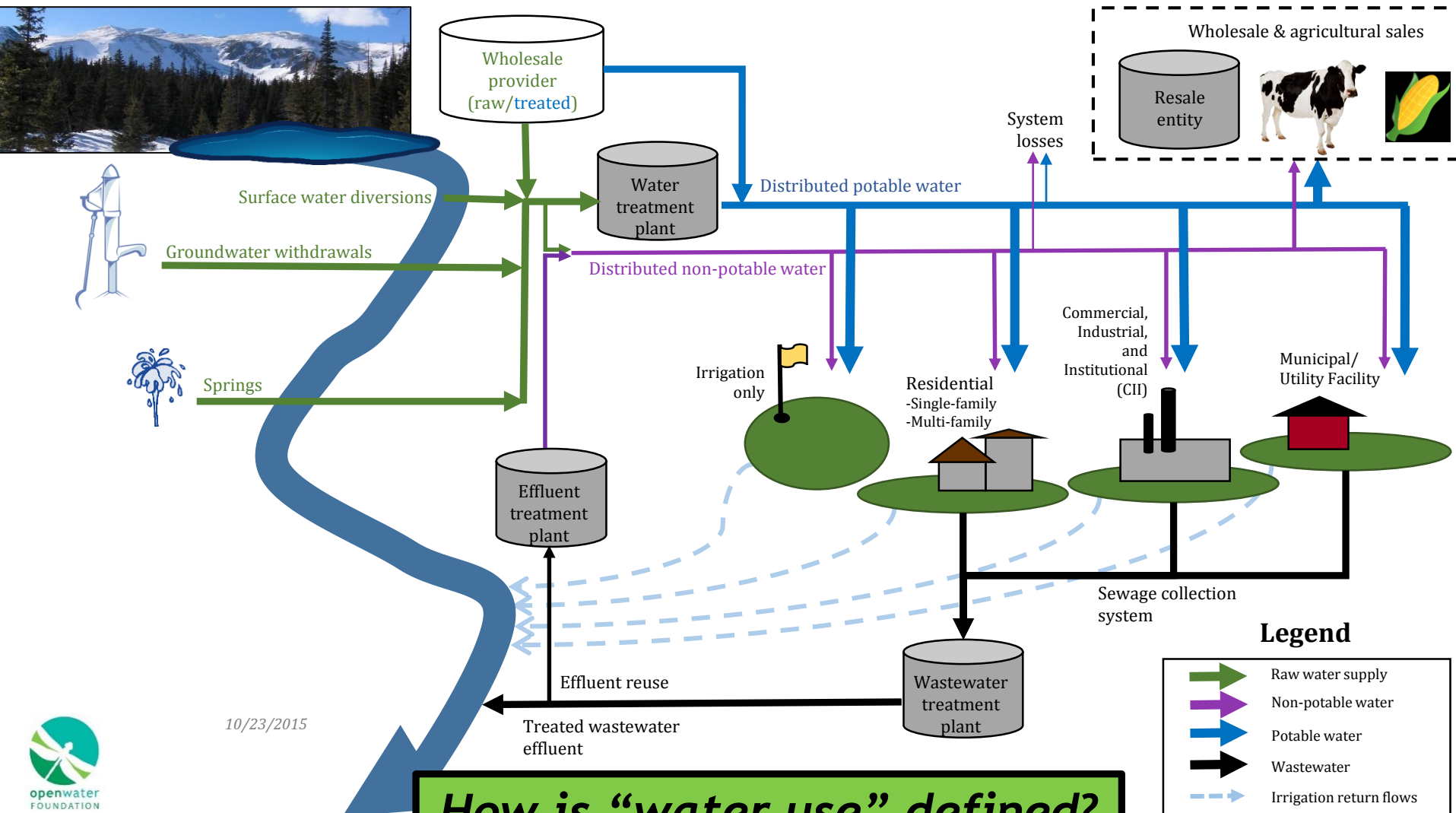
|       | Name                                                                                                                                                                                                            | Popularity  | Type |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|------|
| ▼ 1.  | <a href="#">DWR Water Right Net Amounts</a> Water water right, gocode<br>A Water Right is a property right that is either conditional or                                                                        | 3,164 views |      |
| ▼ 2.  | <a href="#">DWR Well Application Permit</a> Water well, application, permit, gocode<br>All well applications and permits issued.                                                                                | 2,406 views |      |
| ▼ 3.  | <a href="#">DWR Water Right Transactions</a> Water water right, gocode<br>A Water Right is a property right that is either conditional or                                                                       | 1,575 views |      |
| ▼ 4.  | <a href="#">DWR Administrative Structures</a> Water ditch, headgate, reservoir, well, gocode<br>Contains physical, manmade structures used for diverting, storing, releasing, or measuring water; struct        | 1,520 views |      |
| ▼ 5.  | <a href="#">DWR Current Surface Water Conditions Map (Statewide)</a> Water<br>Current streamflow conditions                                                                                                     | 1,456 views |      |
| ▼ 6.  | <a href="#">DWR Active Calls</a> Water river administration, river call, gocode<br>Division of Water Resources (DWR) Active Calls. The Call is a term used by the state engineer to effectivel                  | 1,358 views |      |
| ▼ 7.  | <a href="#">DWR Current Surface Water Conditions</a> Water streamflows, current conditions, gocode<br>Division of Water Resources (DWR) Current Surface Water Conditions. This is a list of all remote monitore | 1,268 views |      |
| ▼ 8.  | <a href="#">DWR Calls History</a> Water administrative call, gocode<br>Division of Water Resources (DWR) Call History. The Call is a term used by the state engineer to effectivel                              | 1,316 views |      |
| ▼ 9.  | <a href="#">DWR Well Water Level</a> Water well, water level, level, gocode<br>Water Level wells with the State of Colorado along with their last known water level.                                            | 1,295 views |      |
| ▼ 10. | <a href="#">DWR Active Calls Map (Statewide)</a> Water active call, river administration<br>Division of Water Resources (DWR) Active Calls. The Call is a term used by the state engineer to effectivel         | 968 views   |      |

1 2 3 4 5 6 7 8 9 ...

Showing 10 of 150



# Urban Water Provider System Components



***How is “water use” defined?  
What are efficiency metrics?***

# The Virtuous Cycle

## Open data and software

- Open data policies
- Public access to machine-readable datasets with metadata and documentation
- Open APIs
- Open source software (in particular when applied to open data and societal challenges)

## Innovation (and Evolution)

- Automation/efficiency
- Integration of data sets and software
- Education

## Social Impact and Economic Development

- Address important problems
- More data, more transparency, more innovation

# Transparency = Innovation

## Government

- open data and software provide transparency (policy-driven)
- public data access also overcomes government silos = high performing government
- data-driven decisions
- avoid vendor lock-in

## Public

- more educated - understands context, drill-down to data
- less frustrated, more engaged - sees government at work

## Industry / Nonprofits / Universities

- integrate data in new ways
- standards-based interfaces, faster start-up, hand-off
- greater opportunities for collaboration
- open innovation

# Thank you



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

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