



Smart Management for
Small Water Systems

Technologies to Save Energy, Resources and Time in Water System Operations

April 25, 2018

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This program is made possible under a cooperative agreement with the U.S. EPA.



Webinar Overview

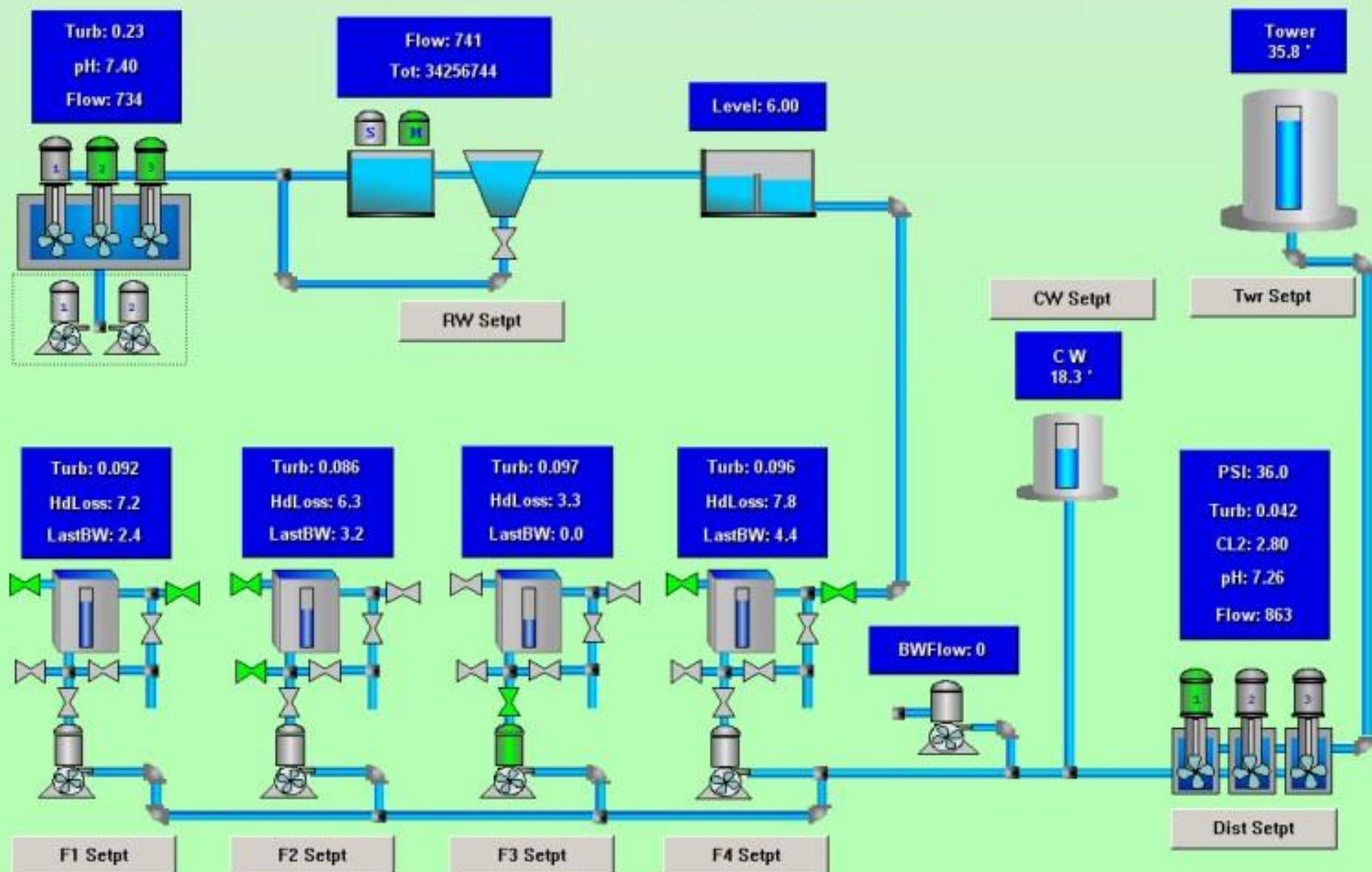
- SCADA – Supervisory Control & Data Acquisition
- Variable Frequency Drives
- Remote Monitoring
- Niche & Emerging Technologies



SCADA Overview

- Supervisory Control & Data Acquisition
- Largely for process controls
 - Graphical user interface
- Can be local plant, remote or both
- Widely used in water & wastewater utilities

Water Department Overview



CITY OF SOUTH HOUSTON VIRGINIA WATER PLANT

[LOGOUT](#)
[DISMISS](#)

PUMP INFORMATION

OPERATION MODE: PLANT IN PRIMARY

ETM PUMP RESET



TO GROUND STORAGE TANK

ENABLE

AUTO

HAND

ENABLE

DISABLE

HRS 0

MIN 32

ENABLE

DISABLE

HRS 0

MIN 50

ENABLE

DISABLE

HRS 0

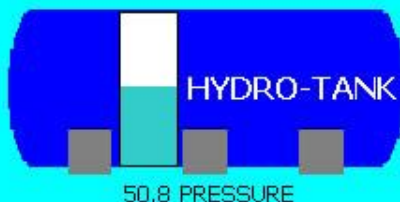
MIN 47

ENABLE

DISABLE

HRS 16

MIN 24



PUMP OFF

BOOSTER PUMP#1

PUMP OFF

BOOSTER PUMP#2

PUMP OFF

BOOSTER PUMP#3

PUMP RUN

BOOSTER PUMP#4

ENABLE

AUTO

HAND

ENABLE

DISABLE

HRS 0

MIN 0

ENABLE

DISABLE

HRS 10

MIN 34

BOOSTER PUMP

ONPRESS OFFPRESS

LEAD 50.0 52.0

LAG#1 46.0 52.0

LAG#2 44.0 52.0

LAG#3 42.0 52.0

HIGH PSI ALARM 56.0

LOW PSI ALARM 40.0

FLOWMETER

621.4 g/m
TOT 842041000

VALVE OPEN

SW VALVE

FROM CITY OF HOUSTON

ONLEVEL OFFLEVEL

WELL PUMP	15.0	18.0
GST FILL VALVE	17.0	19.0

LO-LEVEL CUTOFF 8.0
 HIGH LEVEL ALARM 22
 LOW LEVEL ALARM 10

COMM GOOD

17.2 GST LEVEL

TO GROUND STORAGE TANK

DAILY REPORT

[CITY MAP](#)
[ALARM](#)



SCADA Equipment

- Electronic Sensors
- Programmable Logic Controls
- Computers, software, custom programming
- Communications

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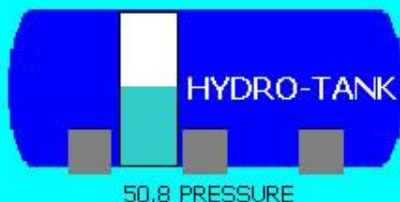
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BOOSTER PUMP#1

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CITY MAP
 ALARM

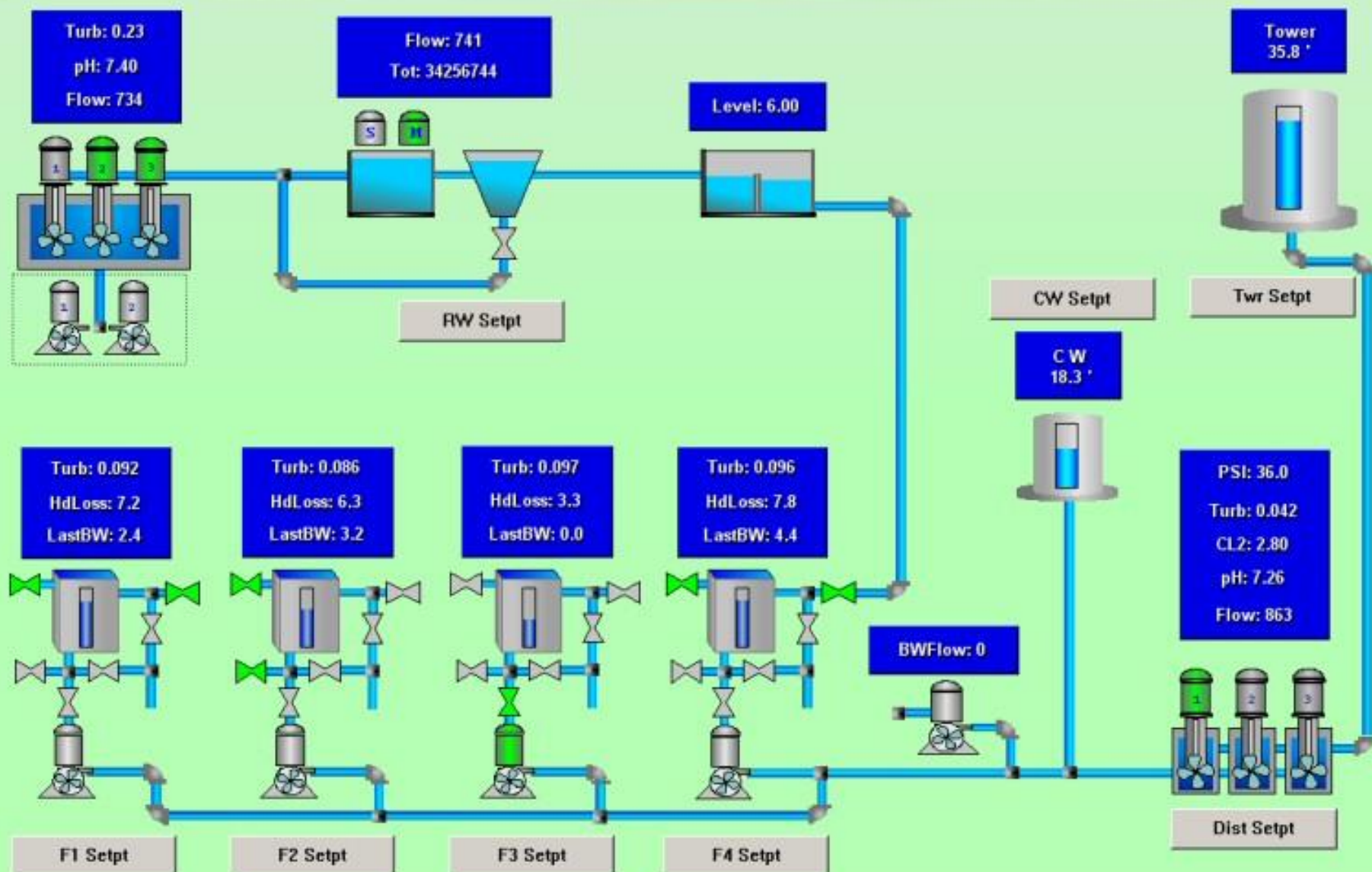
17.2 GST LEVEL



SCADA for Optimization

- Electrical Savings
 - Equipment power status
 - Monitor Usage/Hours/Amps
 - Control variable speed pumps
- Labor savings
 - Remote turn on/off
 - Automatic logging of data
 - Alarms/dialers
- Water Conservation
 - Real-time flow
 - Real-time pressure
- Chemical Savings
 - Allows monitoring/pacing
- Reliability & Safety
 - Trend monitoring
 - Instant responses
 - Faster diagnostics
 - Alarms
 - Confined spaces

Water Department Overview





Variable Frequency Drives

Learn how they work & where they are appropriate



What is a VFD?

- Adjusts frequency of input electricity to vary motor speed.
- Very high power savings if the speed of the motor can be dropped without sacrificing performance.
- Requires inverter rated motors



VFD Math – Pumps/Affinity Law

Flow is proportional to speed

$$\frac{Q_1}{Q_2} = \left(\frac{N_1}{N_2} \right)$$

Pressure proportional to square of shaft speed

$$\frac{H_1}{H_2} = \left(\frac{N_1}{N_2} \right)^2$$

Power proportional to cube of shaft speed

$$\frac{P_1}{P_2} = \left(\frac{N_1}{N_2} \right)^3$$



VFD Energy Savings

► Power Input

$$\text{HP} \approx \text{rpm}^3$$

Example: speed
reduction to 50%

$$\begin{aligned}\text{HP}_{0.5} &= \text{HP}_1 \times (0.5)^3 \\ &= \text{HP}_1 \times 0.126\end{aligned}$$

*VT/VH = Variable Torque/Variable Horsepower

VT/VH Power vs Speed	
Speed	Power
100%	100%
90%	73%
80%	51%
70%	34%
60%	22%
50%	13%
40%	6%
30%	3%
20%	1%
10%	0.1%



What kind of energy savings?

- VFD manufacturer reps can calculate based upon specific loads and operating conditions.
- 10% to 30% is not uncommon
- Biggest savings are where there's a lot of waste
 - i.e. throttling valves



What a VFD can do.

- Soft start, soft stop
 - Prevent pressure spikes
 - Lower machinery stress
 - Lower main breaks
- Match supply/demand almost perfectly
 - Keep reservoirs full
 - Allow to run during tower outage
- Ability to have feedback loops for controls
 - Tower Elevation
 - System Pressure
- Most have motor protections similar to soft starts



Cautions against VFDs

- VFDs can be programmed to match demand almost instantaneously.
 - What does this do to water storage and age?
 - Make sure to swing tower elevation in programming.
- VFDs can take pumps away from their most efficient set point.



More VFD Considerations

- VFDs cost money to install & maintain
 - Don't forget sensors for feedback loops/automatic controls
- VFDs take up space
 - Smaller than the past
- VFDs require proper ventilation



VFD Summary

- VFDs can save a lot of energy in the right application
- VFDs only work when:
 - Proper sensors are in place
 - Proper programming has been completed
 - Systems are maintained
- VFDs are sometimes utilized as a band-aid
 - Ensure equipment is right before VFD install



Remote Monitoring

What exists and how it can benefit your utility.

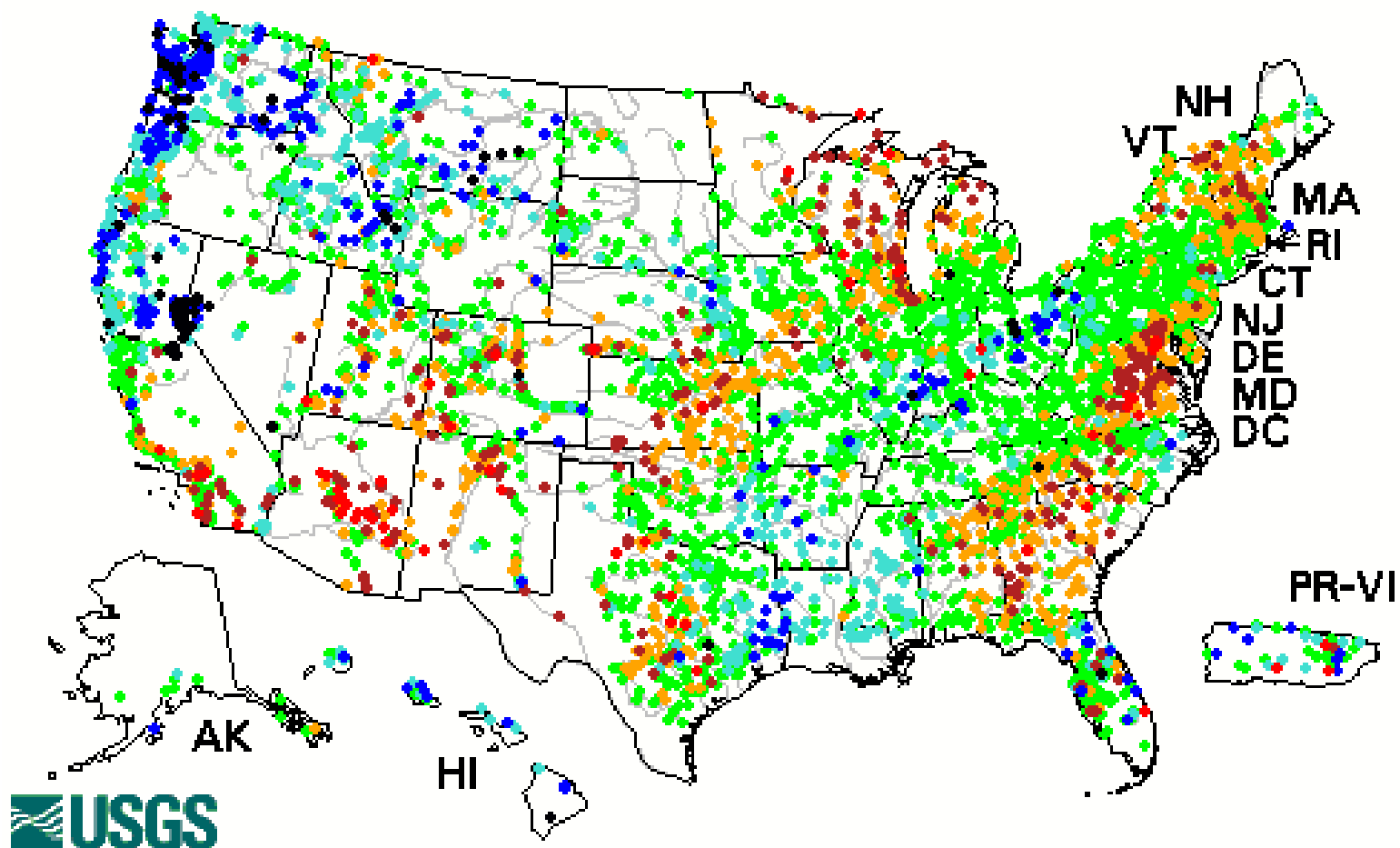


Existing Remote Monitors

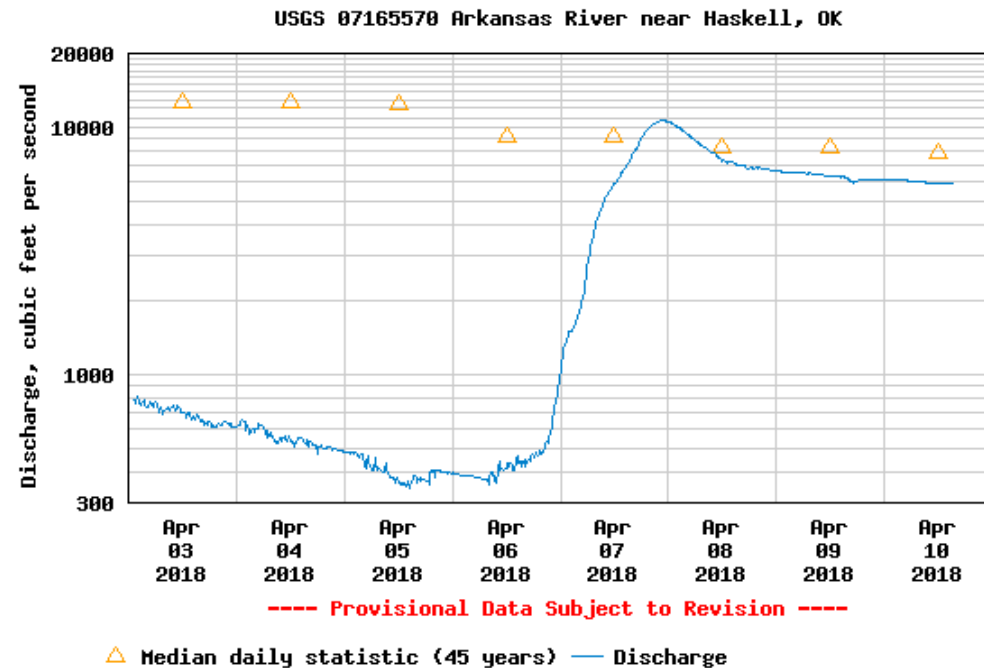
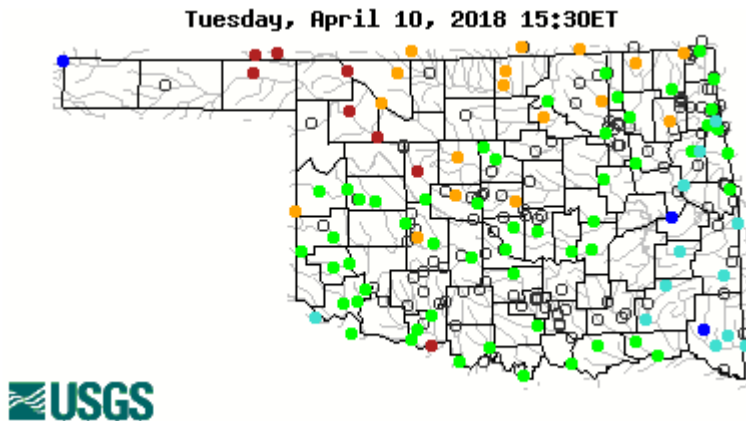
- Numerous in-place remote monitors may be beneficial to your utility
 - Surface Water
 - Groundwater Levels
 - Weather
 - Evapotranspiration

USGS Real Time Streamflows

Tuesday, April 10, 2018 15:30ET



USGS State Level Views



Available Parameters

- ☐ All 3 Available Parameters for this site
- ☒ 00045 Precipitation
- ☒ 00060 Discharge
- ☒ 00065 Gage height

Available Period

2017-12-11 2018-04-02
1987-10-07 2018-04-10
2007-10-01 2018-04-10

Output format

- ☒ Graph
- ☐ Graph w/ stats
- ☐ Graph w/o stats
- ☐ Graph w/ (up to 3) parms
- ☐ Table
- ☐ Tab-separated

Days (7)

-- or --

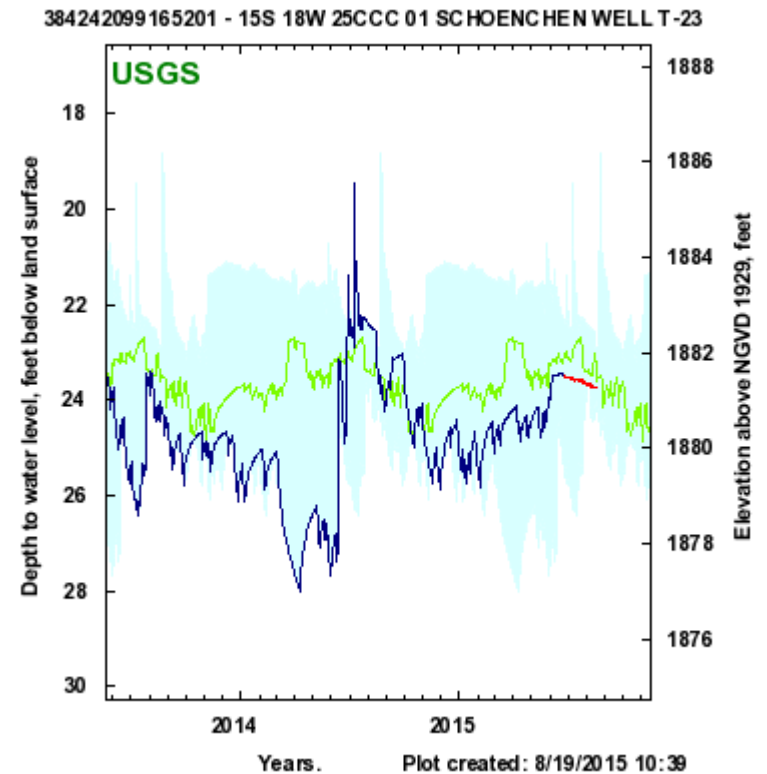
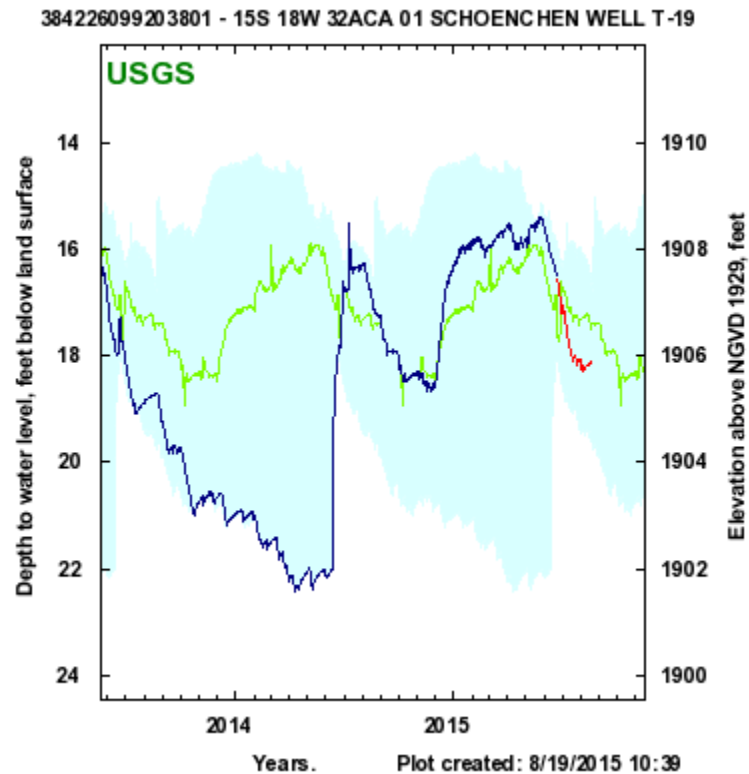
Begin date

End date

GO

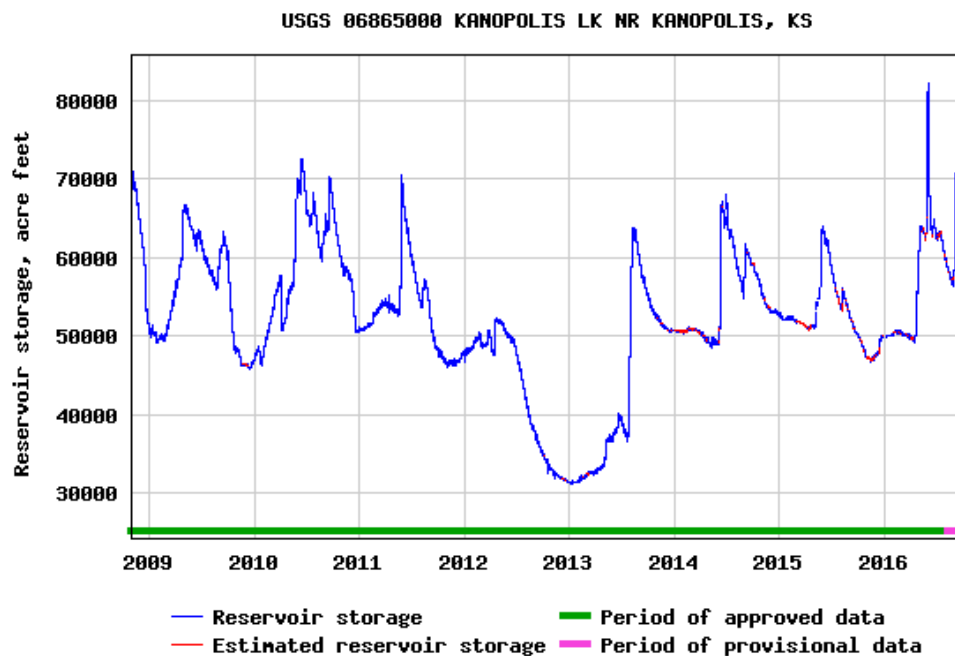
[Summary of all available data for this site](#)
[Instantaneous-data availability statement](#)

USGS Groundwater Levels



Reservoir Levels

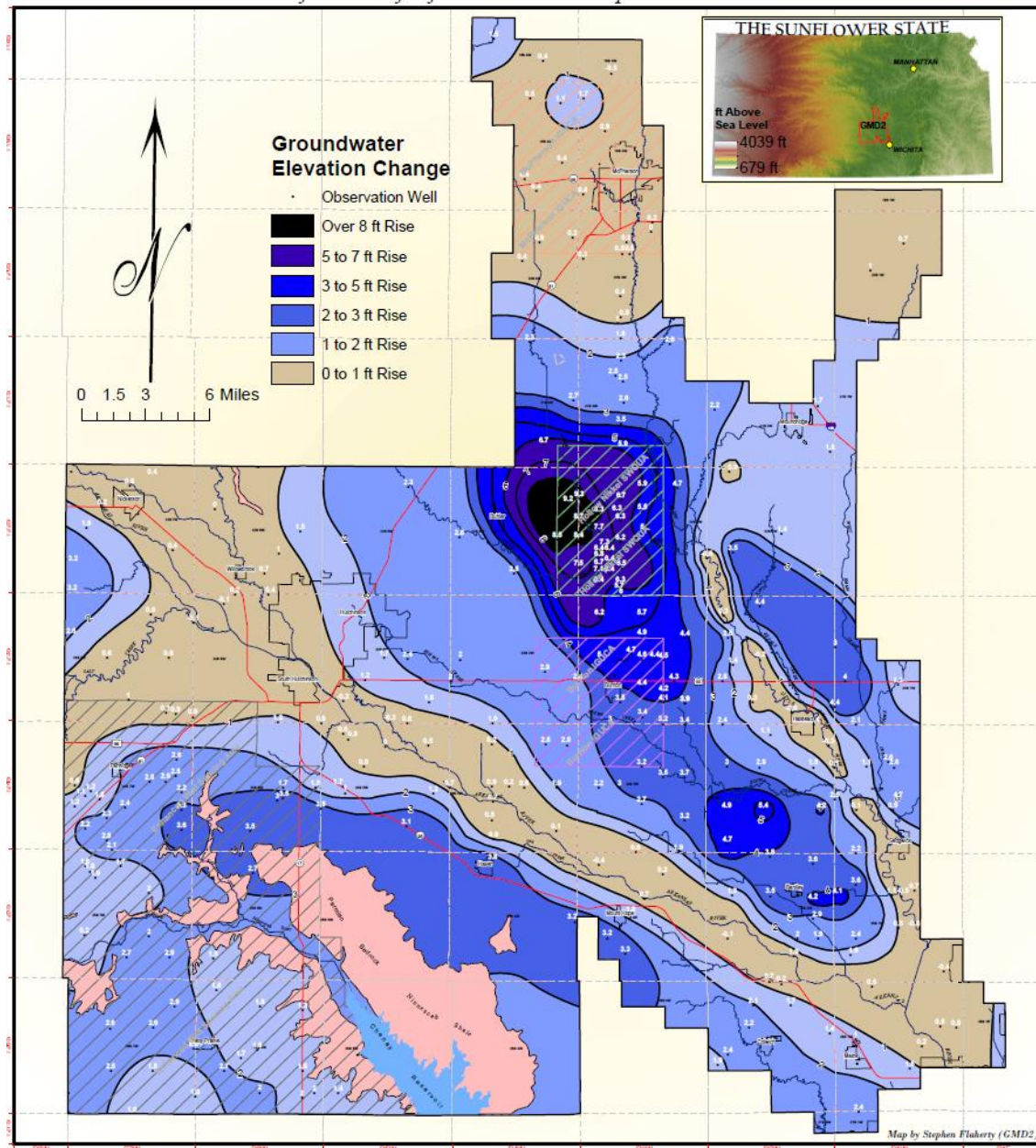
- Data may be hosted on various federal sites
 - i.e. Bureau of Land Management, Army Corps of Engineers, USGS, etc.
- Data may be on state-level or project-level sites
 - i.e., state park, water office, irrigation district, etc.





Local Groundwater Monitoring

- Local & State Districts may monitor groundwater volumes & quality
- Can this be a proxy for your utility?
- Source, Kansas GMD2





Utility Specific Monitoring

- Generally will use SCADA to implement
- Monitors may/may not feed into control system



SCADA Monitoring Capacities

- Electrical
 - Voltage
 - Amperage
- Water flow rates/volumes
- Pressure
- Tank elevations
- Valves on/off



Water Level Monitoring

- Elevated Tanks
- Wells
- Underground Tanks
- Treatment Processes
- Supply Reservoirs
- Local Streams



Water Quality Monitoring

Supplies

- Turbidity
- Temperature
- pH
- Conductivity

Treatment/distribution

- Turbidity
- Chlorine
- pH
- Temperature
- Pressure (proxy for biological contamination)



Security

- New internet connected cameras/sensors greatly expand ability of utilities to remotely monitor security of remote facilities
- Requires:
 - Power supply
 - Internet connection
 - Monitors for employees



Niche & Emerging Technologies



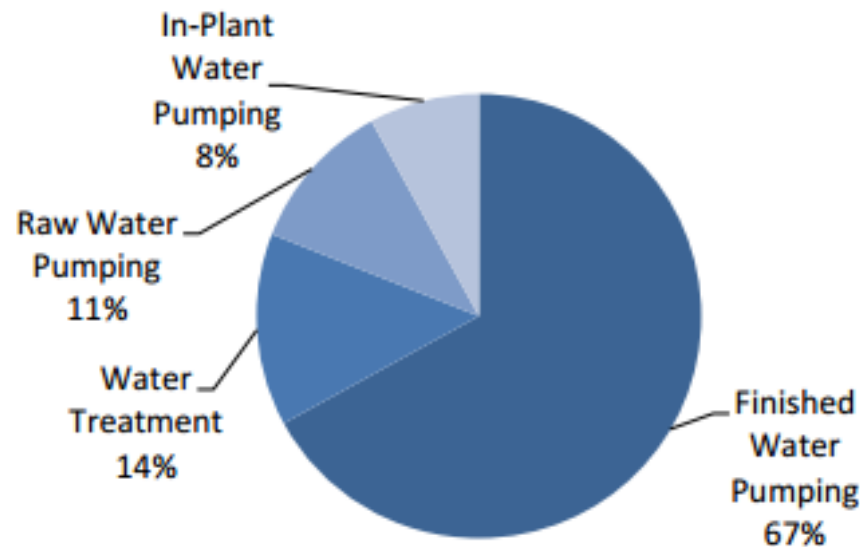
Niche & Emerging Technologies

Storage Tanks as Batteries

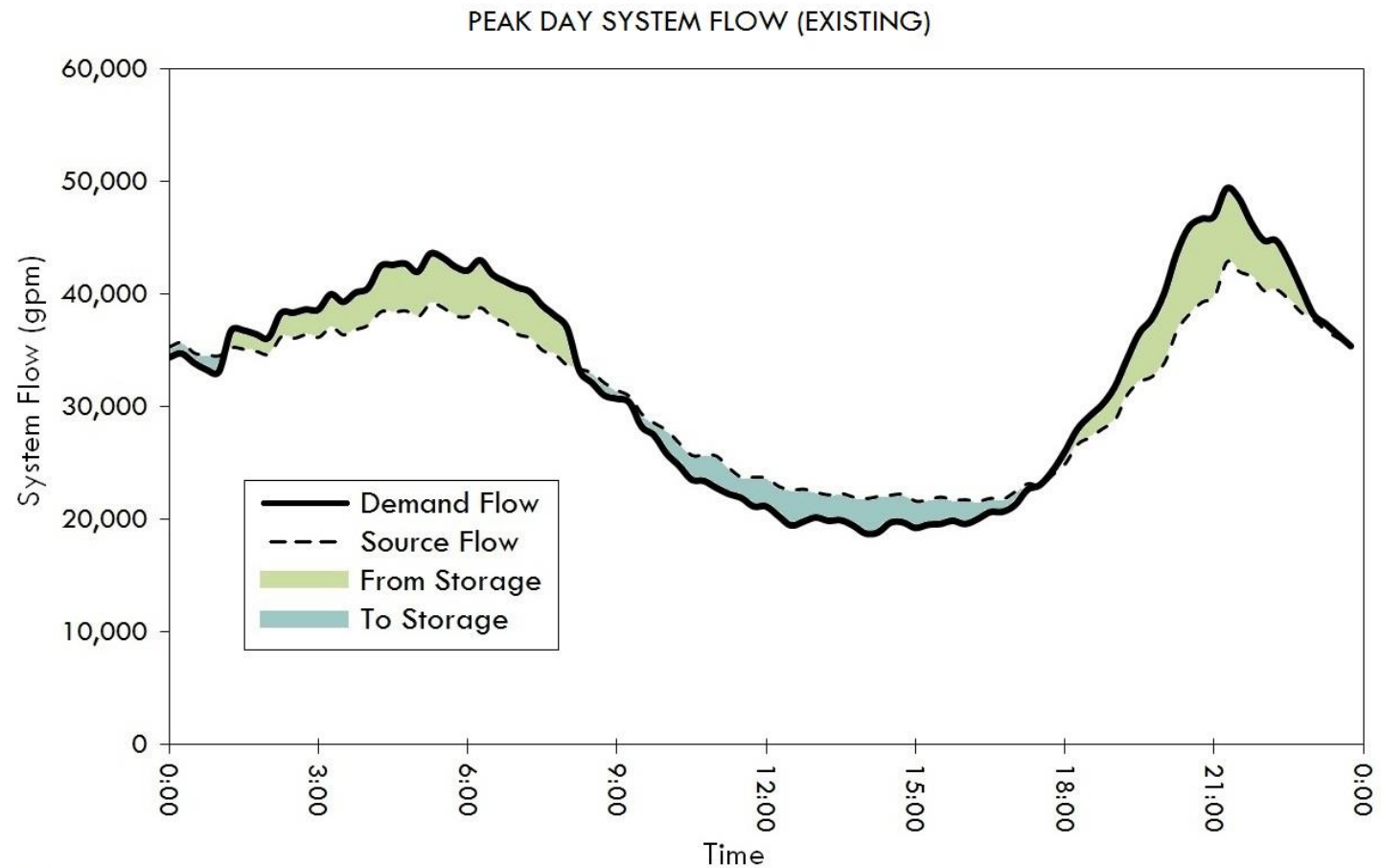
How often do your pumps turn on?

- Pumping uses a lot of energy
- Energy costs are typically a significant part of a utility's budget
- Frequent start/stop adds wear and tear to the pump – and pipes
- How do you meet peak demand?

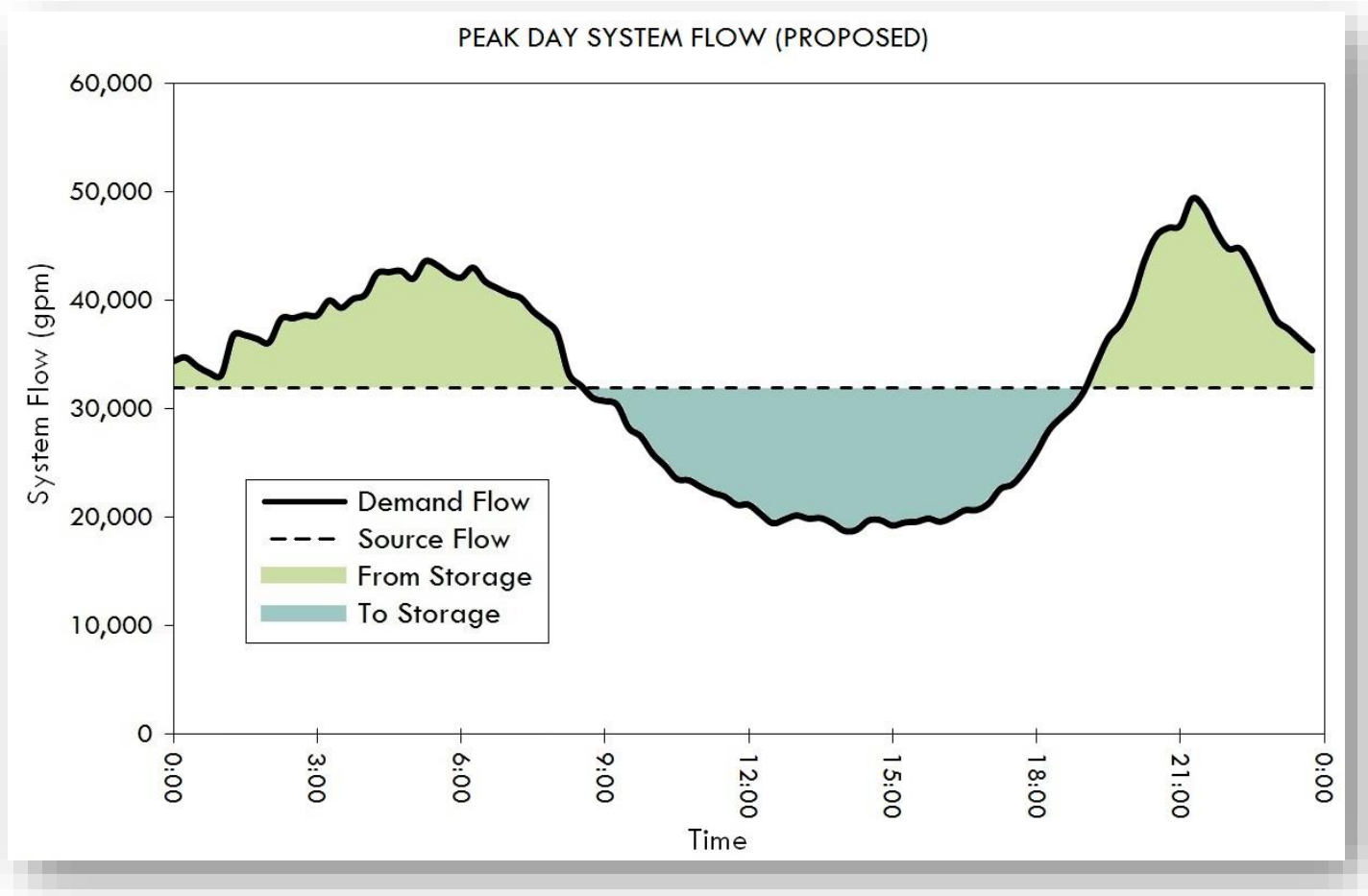
Typical Energy End-Uses in Public Surface Water Systems



Loading Problem

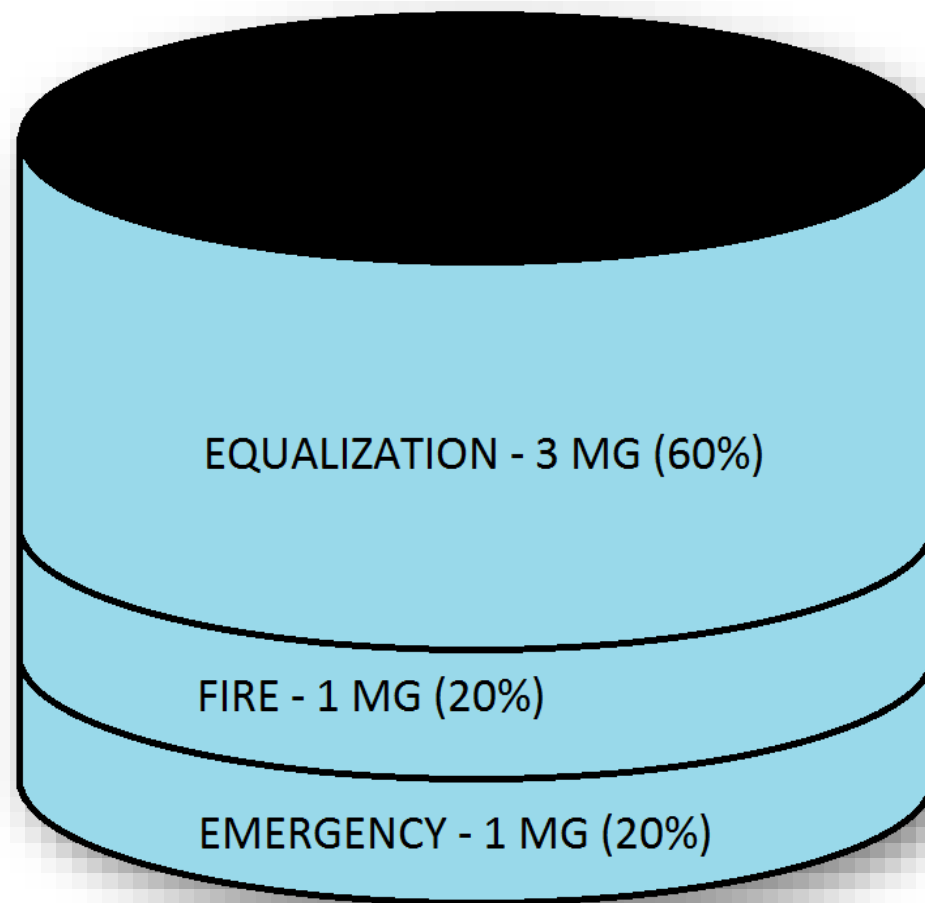


Loading Solution



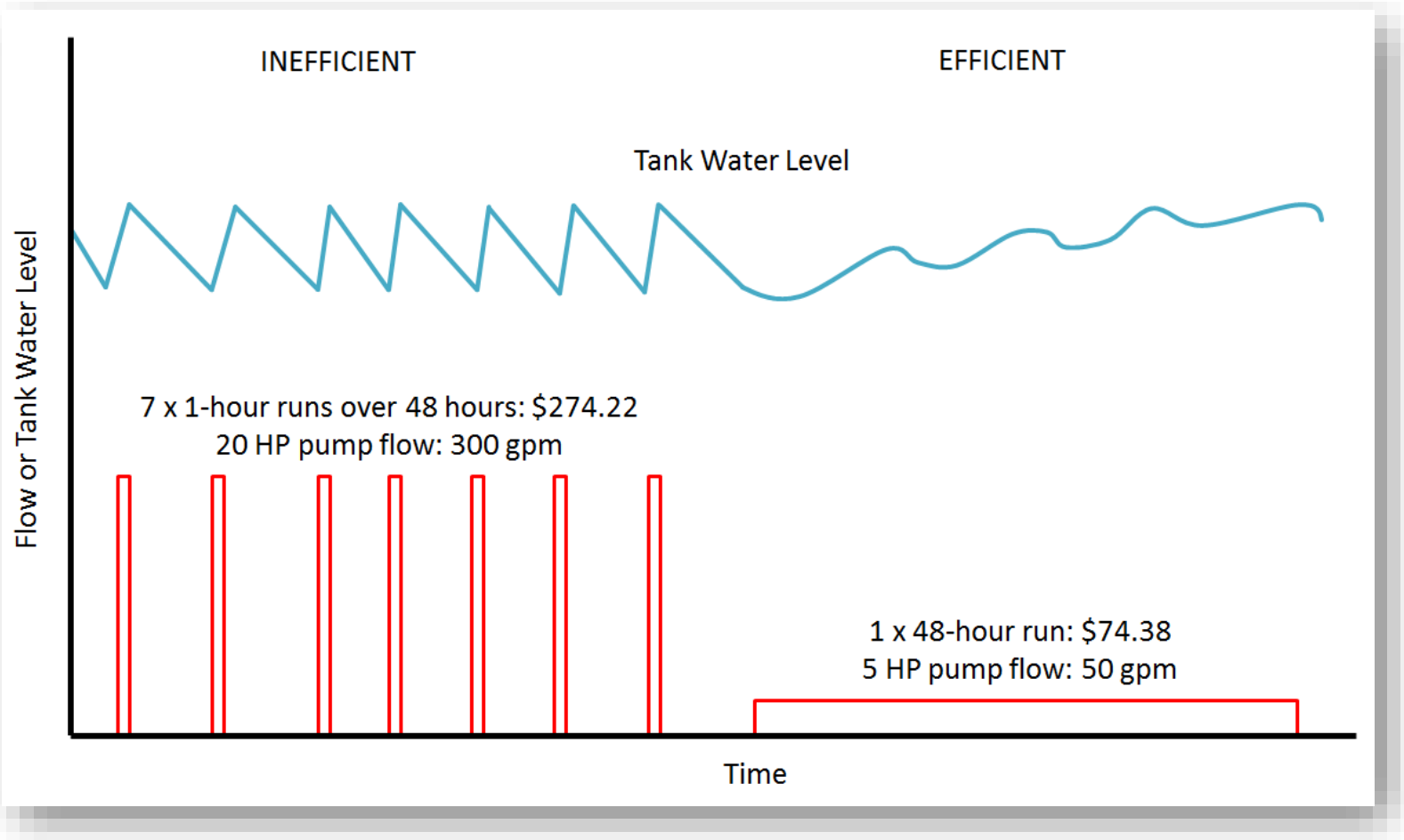


Loading Solution





Loading Example





Loading Diagnosis

How to detect:

- Intermittent pump operation
- Oversized facilities
- Little storage fluctuation
- Hydraulic modeling

How to resolve:

- Use storage
- Keep source and pump flow as constant as possible
- Modify pump station



Niche & Emerging Technologies

Leaks and Leak Detection Technologies



Lost Water = Lost \$ | How much are you losing?

- Water Produced – Water Sold = **THIS IS NOT CORRECT**
- Water Produced – Water Sold = Non-Revenue Water
- Non Revenue Water Includes anything we don't sell
 - Water we give away
 - Theft
 - Errors (meters and/or data)
 - Real Losses
- Real Water Loss = Leaking Water (mains, service lines and tanks)



Determine the causes of Non-Revenue Water First

- AWWA's Water Audit Software
 - Industry Standard (M36)
 - Free
 - Excel based
 - <http://awwa.org/waterlosscontrol>



American Water Works
Association



If Real Losses (Leaks) are a problem

Issue you are addressing	Tools to use	Cost Range
Real Losses	Collecting & Analyzing Break Data	Low
Real Losses	Improve speed/quality of repairs	Low
Real Losses	Locate & eliminate pressure transients (surges, water hammer)	Low-Mid
Real Losses	Night Flow Analysis	Mid
Real Losses	Reduce peak and overall pressure	Mid-High
Real Losses: Leakage on Mains	Main Replacement	High
Real Losses: Leakage on Services	Service Replacement	Mid - High
Real Losses: Unreported Leaks	Acoustic leak survey	Mid
Real Losses: Overflows and Leakage on Storage Tanks	Tank Management, Data Collection, & Inspection	Low



Leak Detection Technologies

- Active Listening
 - Sonic ground listening devices
 - Correlators
 - Probes
 - Walking main lines and listening at valves
- Passive Listening
 - Permanent and semi-permanent listening devices
 - Transmits data to central location
 - Analyzes night flows
- Other detection technologies
 - Tracer Gas Leak Detection
 - Sahara, Smartball, internal devices



Niche & Emerging Technologies

Drone Use



Drone Use



- Wide range of possibilities: inspection, maintenance, testing
- Same locations and angles every visit for fair before and after comparisons
- Safer and faster than in-person
- More frequent visual inspection can be completed for less money
- Can be equipped with sensors (ultrasound, thermal imaging)
- Eliminates concerns of getting to remote areas in times of snow or wet weather

Source: ReliabilityWeb.com



Niche & Emerging Technologies

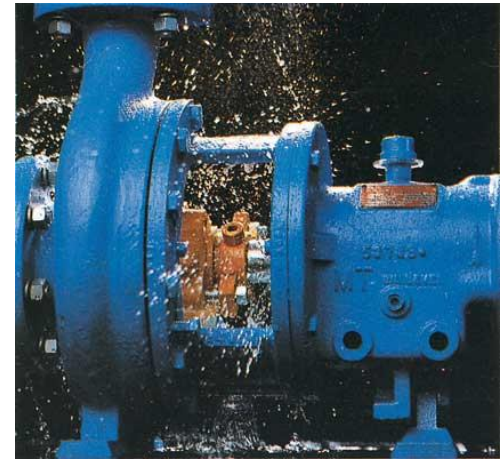
Energy Based Condition Monitoring



Condition Monitoring

- Condition monitoring can decrease your motor operations and maintenance (O&M) expenses by up to 25 percent
- The use of energy monitoring is increasing
- Energy based condition monitoring
 - affordable method for providing continuous, remote monitoring
 - can detect motor damaging electrical stressors, so you have a chance to intervene and correct the issue before it harms your asset.

Source: ReliabilityWeb.com

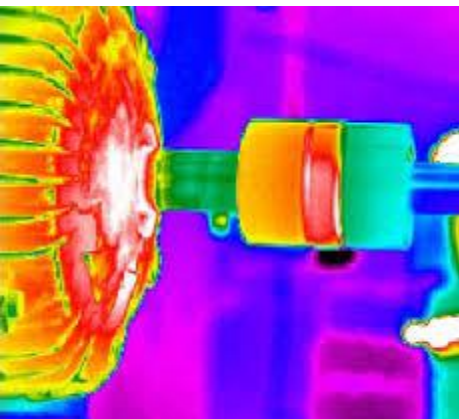




Condition Monitoring

- Thermography

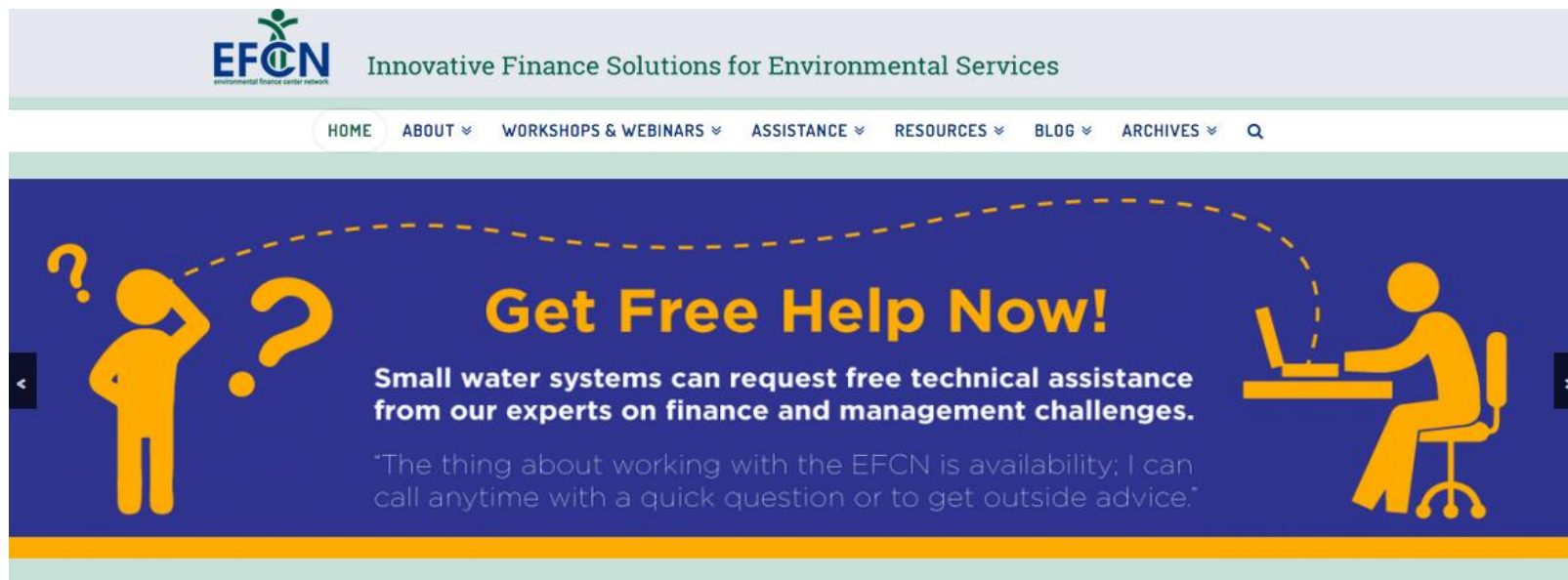
- Thermal cameras produce thermal (heat) pictures of equipment which can indicate if the equipment may soon fail
- For preventive maintenance, thermal images taken over time are compared and changes can indicate problems to investigate before they cause failure.
- Technology is becoming more affordable – cell phone cameras are available





Visit the EFCN Website – *www.efcnetwork.org*

for more information on upcoming events, funding, and resources.



The screenshot shows the EFCN website header with the logo and tagline "Innovative Finance Solutions for Environmental Services". Below the header is a navigation menu with links: HOME, ABOUT, WORKSHOPS & WEBINARS, ASSISTANCE, RESOURCES, BLOG, ARCHIVES, and a search icon. The main banner has a dark blue background with yellow text and graphics. It features a person icon with question marks on the left and a person at a laptop on the right, connected by a dashed line. The central text reads: "Get Free Help Now! Small water systems can request free technical assistance from our experts on finance and management challenges." Below this is a quote: "The thing about working with the EFCN is availability; I can call anytime with a quick question or to get outside advice."

EFCN Innovative Finance Solutions for Environmental Services

HOME ABOUT WORKSHOPS & WEBINARS ASSISTANCE RESOURCES BLOG ARCHIVES Q

Get Free Help Now!

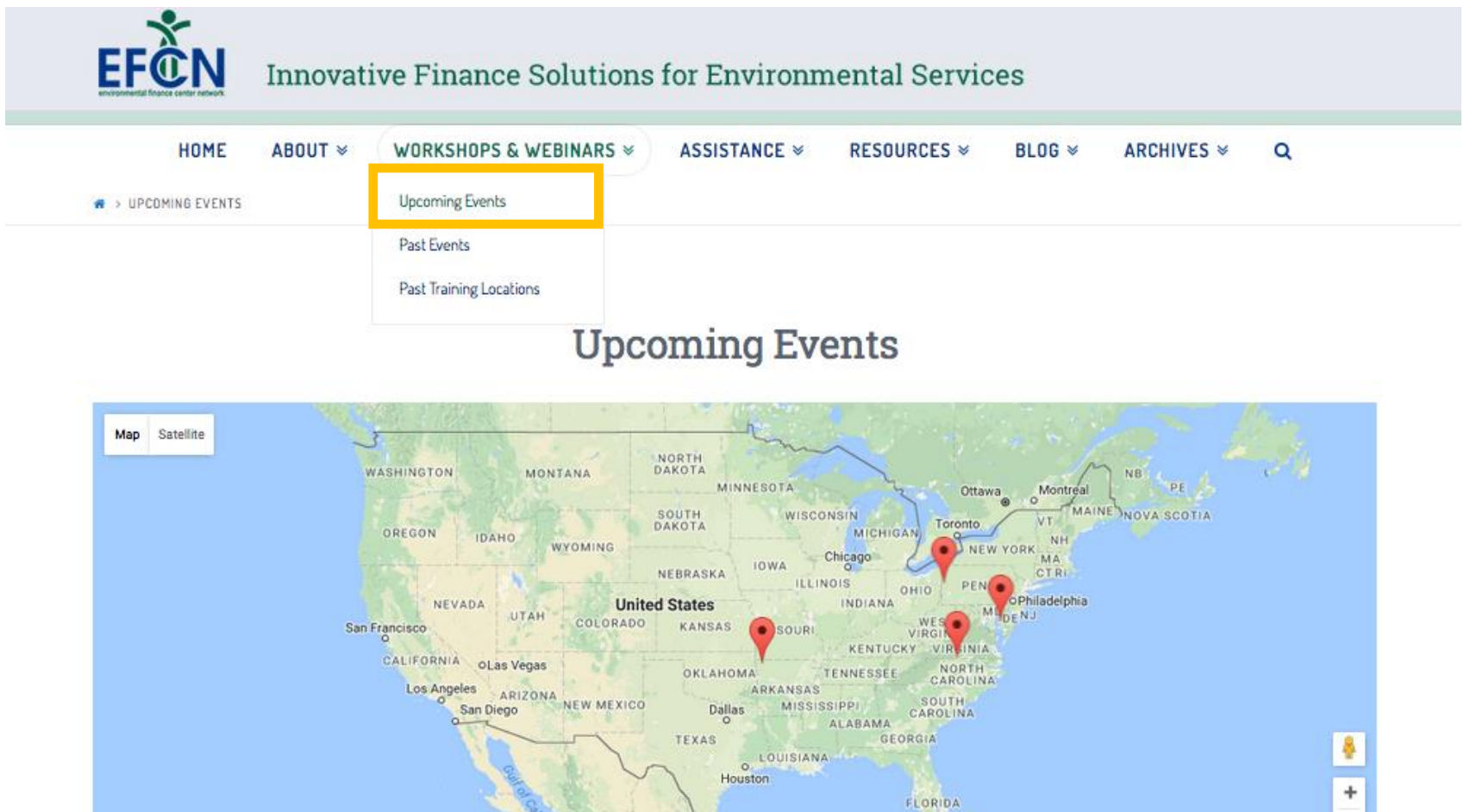
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Upcoming Events Calendar

Select “Upcoming Events” under the Workshops & Webinars Tab.




The screenshot displays the EFCN (Environmental Finance Center Network) website. The header features the EFCN logo and the tagline "Innovative Finance Solutions for Environmental Services". The navigation menu includes links for HOME, ABOUT, WORKSHOPS & WEBINARS, ASSISTANCE, RESOURCES, BLOG, and ARCHIVES. The "WORKSHOPS & WEBINARS" menu is expanded, highlighting "Upcoming Events". Below the navigation bar, a breadcrumb trail shows "UPCOMING EVENTS". A section titled "Upcoming Events" is visible, followed by a map of the United States. The map shows several red location pins indicating event sites in various states, including California, Texas, Illinois, Ohio, Pennsylvania, and New York. A legend in the top left corner of the map allows switching between "Map" and "Satellite" views.



= In Person Event



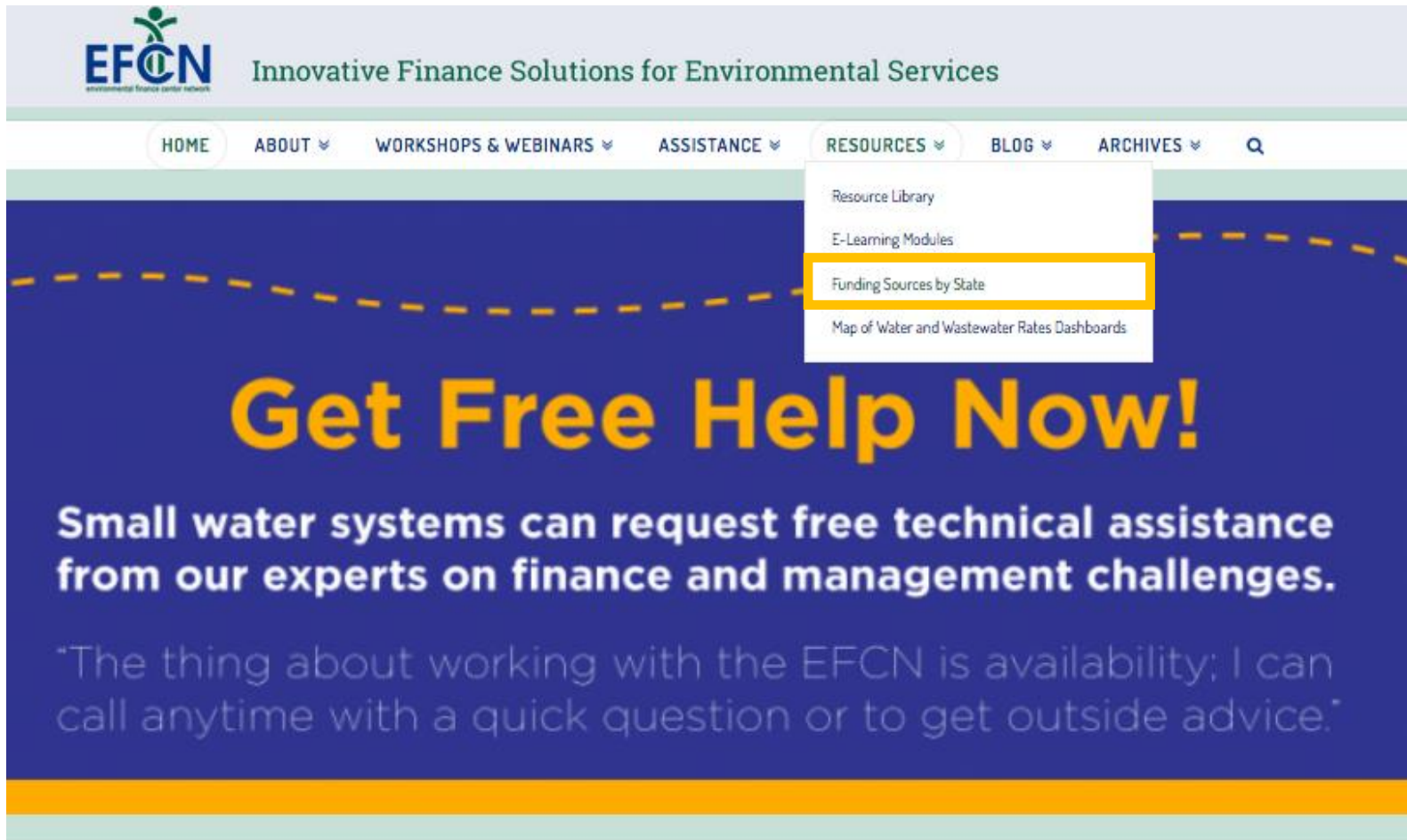
= Webinar

Type	Date/Time	Event
	03/09/2017 2:00 pm - 3:00 pm	WEBINAR Preparing Winning Financing Applications for Water Infrastructure Projects
	03/22/2017 2:00 pm - 3:00 pm	WEBINAR Water Audits and Water Loss Control: Entering Your Data into the Spreadsheet
	03/30/2017 9:00 am - 4:30 pm	Maryland Rates and Finance Workshop for Small Water Systems <i>Easton Utilities, Easton MD</i>
	04/04/2017 1:00 pm - 2:00 pm	WEBINAR: Workforce Development: An Overview of Key Components
	05/11/2017 9:00 am - 4:30 pm	Virginia Rates and Finance Workshop for Small Systems <i>The Institute for Advanced Learning and Research, Danville Virginia</i>
	05/25/2017 9:00 am - 4:30 pm	Arkansas Rates and Finance Workshop for Small Water Systems <i>Beaver Water District, Lowell AR</i>
	09/13/2017 9:00 am - 4:30 pm	Pennsylvania Rates and Finance Workshop for Small Water Systems <i>Pennsylvania American Water Co, New Castle PA</i>



Funding Tables By State

Select “Funding Sources by State” under the Resources Tab.



The screenshot shows the EFCN website header with the logo and tagline "Innovative Finance Solutions for Environmental Services". The navigation menu includes links for HOME, ABOUT, WORKSHOPS & WEBINARS, ASSISTANCE, RESOURCES, BLOG, and ARCHIVES. The RESOURCES dropdown menu is open, displaying four options: Resource Library, E-Learning Modules, Funding Sources by State (highlighted with a yellow border), and Map of Water and Wastewater Rates Dashboards. Below the navigation bar is a large blue banner with the text "Get Free Help Now!" in orange, followed by a white text box stating: "Small water systems can request free technical assistance from our experts on finance and management challenges." and a quote: "The thing about working with the EFCN is availability; I can call anytime with a quick question or to get outside advice."

EFCN Innovative Finance Solutions for Environmental Services
environmental finance center network

HOME ABOUT WORKSHOPS & WEBINARS ASSISTANCE **RESOURCES** BLOG ARCHIVES

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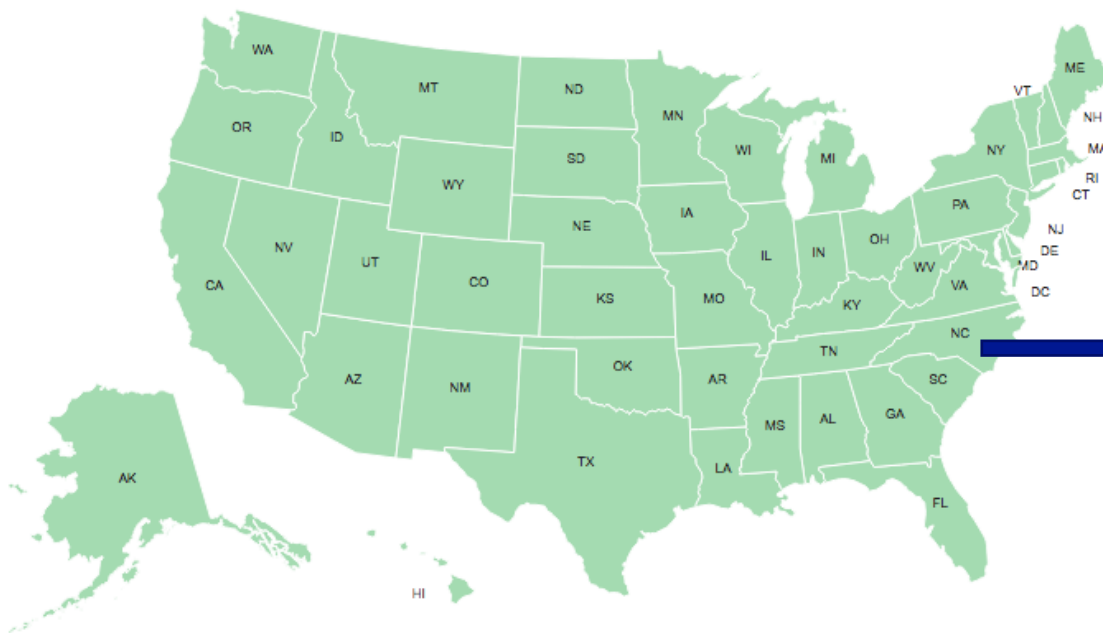
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Funding Sources by State

Note: Some states may have additional resources listed below the map.

Click on the map below to view funding sources for each state:



Click on an individual state to view funding table.

Oregon Water and Wastewater Funding Sources (Compiled by the OWR, March 2018)					
Organization	Program (Funding Source)	Purpose or Use of Funds	Application Dates	Website	Contact
Oregon Health Division	Safe Drinking Water Monitoring and Assessment	Financially and administratively assist local water utilities and non-profit organizations with monitoring and assessment activities, including water quality monitoring, drinking water safety, and public information.	Applications for fiscal year 2019 are currently being accepted. For more information, visit the OWR website.	https://www.ohd.org/programs/monitoring-and-assessment/	Debra Thompson debra.thompson@ohd.org
	Wastewater Discharge Monitoring and Assessment	Financially and administratively assist local wastewater utilities and non-profit organizations with monitoring and assessment activities, including wastewater quality monitoring, discharge permits, and public information.	Applications for fiscal year 2019 are currently being accepted. For more information, visit the OWR website.	https://www.ohd.org/programs/wastewater-discharge-monitoring-and-assessment/	Debra Thompson debra.thompson@ohd.org
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Request Technical Assistance

Select “Request Assistance” under the Assistance Tab off the EFCN homepage to access and submit the TA request form electronically.




REQUEST ASSISTANCE

A screenshot of the "Technical Assistance Request Form" page. The page has a header with a banner image showing hands working on a document, a calculator, and a water treatment facility. The main content area is titled "Technical Assistance Request Form" and includes a paragraph stating: "The EFCN offers free help on financial and managerial topics to systems serving 10,000 or fewer people. Examples of assistance we can provide include:". Below this is a list of services: "Creating an Asset management plan", "Near-term financial planning and rate setting", "Analyzing your revenues and expenses", "Offering ideas on how to effectively budget", "Long-term capital planning", "Assessing options for lowering energy use and/or water loss", "Identifying sources of outside funding", "Collaborating with other water systems", and "Resiliency Planning". At the bottom, a paragraph states: "If you are interested in requesting assistance from our experts, please fill out the form below. You will be asked a few questions to help us understand your water system and what kind of assistance you need."

Rates Dashboards

Select “Map of Water and Wastewater Rates Dashboards” under the Resources Tab, and click on any state in blue to view its dashboard.



Innovative Finance Solutions for Environmental Services

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[🏠 > MAP OF WATER AND WASTEWATER RATES DASHBOARDS](#)

Resource Library

E-Learning Modules

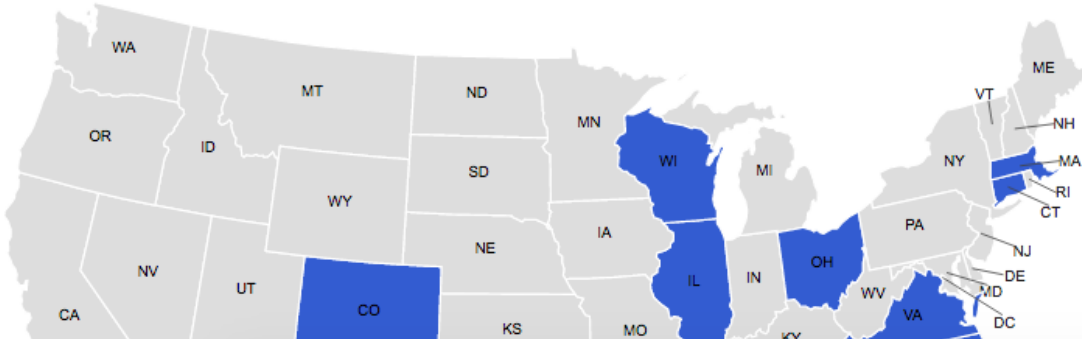
Funding Sources by State

Map of Water and Wastewater Rates Dashboards

Map of Water and Wastewater

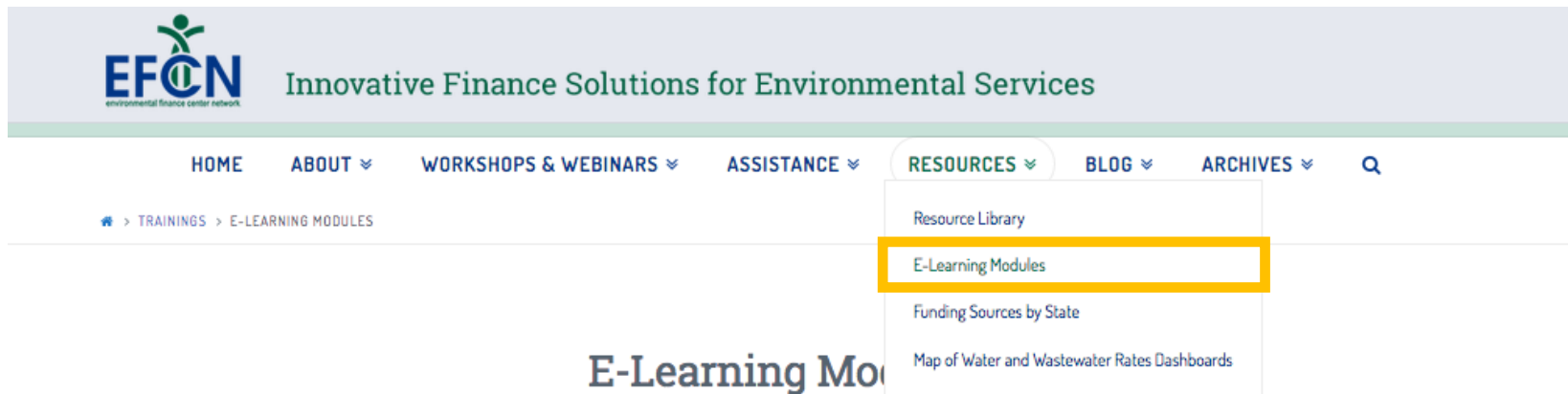
This map shows Water and Wastewater Rates Dashboards created by the EFCN:

Click a state in blue to view its dashboard



E-Learning Modules

Select “E-Learning Modules” under the Resources Tab off the EFCN homepage.



As part of its continued effort to provide resources and training to small water systems, the Environmental Finance Network is creating E-Learning modules on finance and management topics for system managers.

E-Learning modules provide training through pre-recorded content. You will be able to access the content, watch presentations, complete quizzes and exercises, and access tools and resources at your own pace.

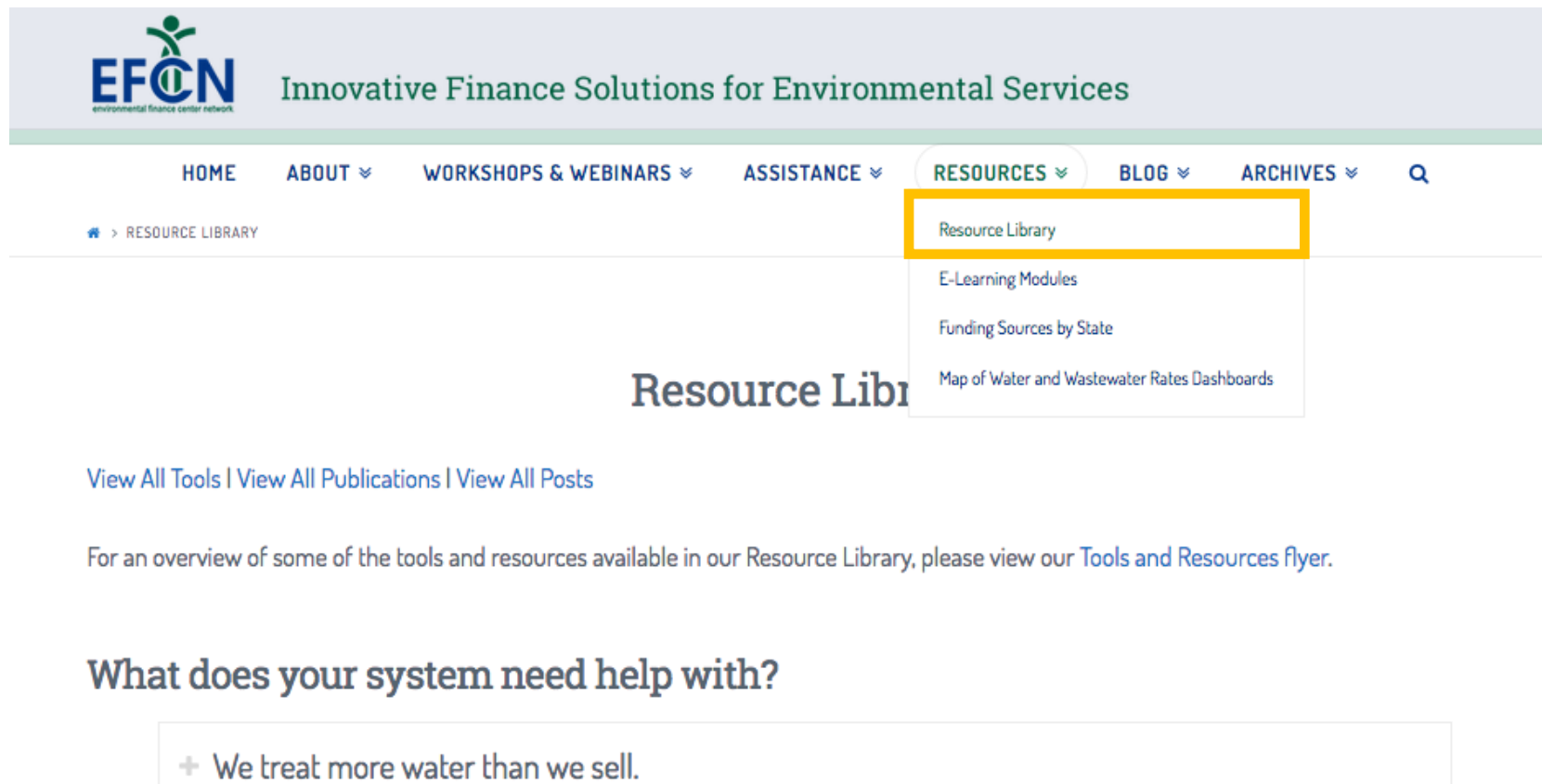
Financial Sustainability for Small Systems

[Click Here to Access the Course on AWWA's website](#)

This eLearning course is made possible through a USEPA grant for small systems training in conjunction with the EFCN's training partner, AWWA.

Resource Library

Select “Resource Library” under the Resources Tab off the EFCN homepage.



The screenshot shows the EFCN homepage with a blue header. The EFCN logo is on the left, followed by the tagline "Innovative Finance Solutions for Environmental Services". The navigation bar includes links for HOME, ABOUT, WORKSHOPS & WEBINARS, ASSISTANCE, RESOURCES, BLOG, and ARCHIVES, along with a search icon. The RESOURCES dropdown menu is open, highlighting "Resource Library". Below the navigation bar, a breadcrumb trail shows "RESOURCE LIBRARY". The main heading "Resource Library" is partially visible. Below it, there are links for "View All Tools", "View All Publications", and "View All Posts". A paragraph of text follows, and then a section titled "What does your system need help with?" with a list item starting with a plus sign.

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RESOURCE LIBRARY

Resource Library

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Resource Libr

[View All Tools](#) | [View All Publications](#) | [View All Posts](#)

For an overview of some of the tools and resources available in our Resource Library, please view our [Tools and Resources flyer](#).

What does your system need help with?

- + We treat more water than we sell.



Resource Library Continued...

Click on a what your system needs help with to reveal tools and publications related to that topic.

✖ We have insufficient revenue to cover our costs.

Tools

February 16, 2017

[Online Water Rate Checkup Tool](#)

February 17, 2016

[Water Utility Customer Assistance Program Cost Estimation Tool](#)

September 3, 2014

[Water & Wastewater Residential Rates Affordability Assessment Tool](#)

December 18, 2012

[Plan to Pay: Scenarios to Fund your C.I.P.](#)

November 15, 2012

[Dashboard for Using Capital Reserve Fund to Avoid Rate Shock](#)

November 7, 2016

[Modelo de Análisis para las Tarifas de Agua y Aguas Residuale](#)

January 26, 2016

[Financial Health Checkup for Water Utilities](#)

August 15, 2013

[Rates and Financial Benchmarking Dashboards](#)

November 20, 2012

[Water & Wastewater Rates Analysis Model](#)

November 4, 2012

[Loan Analysis Tool](#)

Publications

April 14, 2014

[Rural and Small Systems Guidebook to Sustainable Utility Management](#)

August 29, 2013

[Asset Management: A Handbook for Small Water Systems](#)

August 29, 2013

[Setting Small Drinking Water System Rates for a Sustainable Future](#)

August 27, 2013

[Designing Rate Structures that Support Your Objectives](#)

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**Thank you for participating today.
We hope to see you at a future workshop!**

www.efcnetwork.org

