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Tapping into Leaks: Using Water Audit Data for Resilience Planning in the Delaware River Basin

Michael Thompson, P.E.

November 9, 2026

AWRA 2026 Annual Water Resources Conference

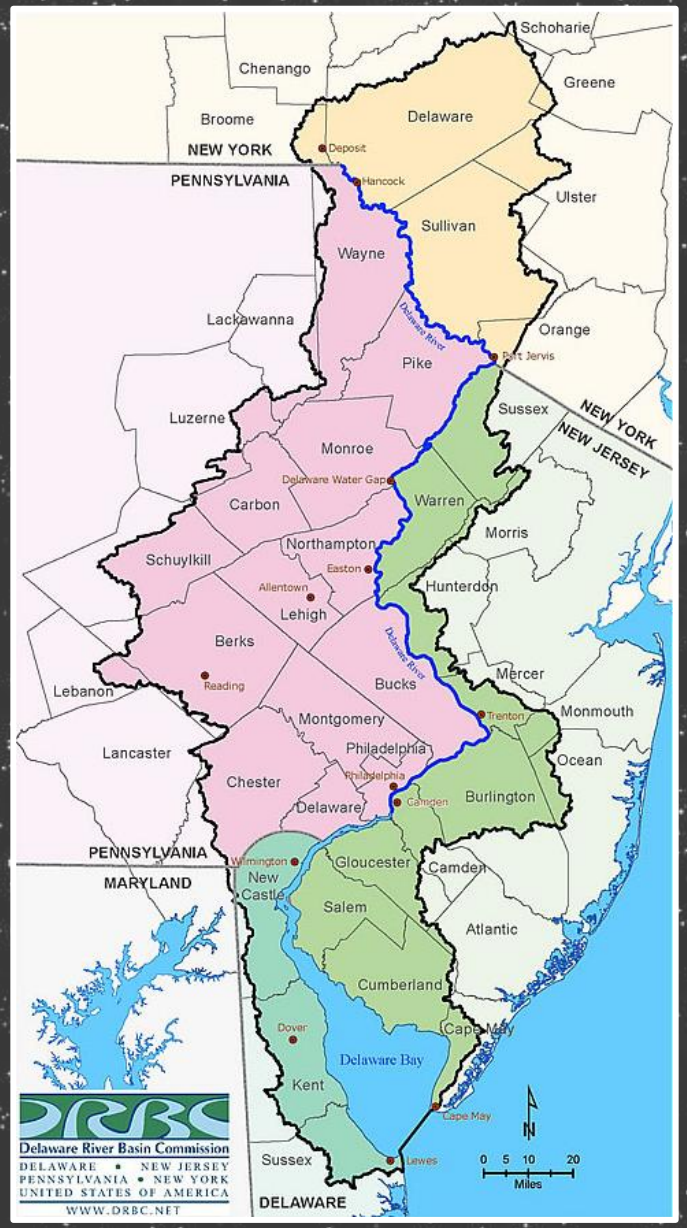
About the speaker



Michael Thompson is a Senior Water Resource Engineer at the Delaware River Basin Commission (DRBC). He joined the Commission in 2018 and has led numerous research projects and authored publications which provide key insight into the region's water resource management. His work is focused on sustainable water use planning for the Basin, which includes but is not limited to hydrology, groundwater and surface water availability modelling, withdrawal data analysis, as well as water audits and water loss conservation. He received a B.S. in Civil Engineering from Lafayette College, an M.S.C.E. from the University of Notre Dame, and is a licensed professional engineer in Pennsylvania.

Delaware River Basin

- 330 miles long
- interstate boundary
- un-dammed
- 13,539 square miles
- 8.6 million people live here (2020)
- ½ of New York City's water supply
- 6.2 billion gal/day withdrawn (2024)
- Cools 102 TWh of energy (2024)





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What is the Delaware River Basin Commission?



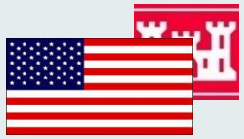
Established by interstate compact in 1961, a regional body with the force of law to oversee a unified approach to managing a river system without regard to political boundaries.


Delaware


New Jersey


New York


Pennsylvania

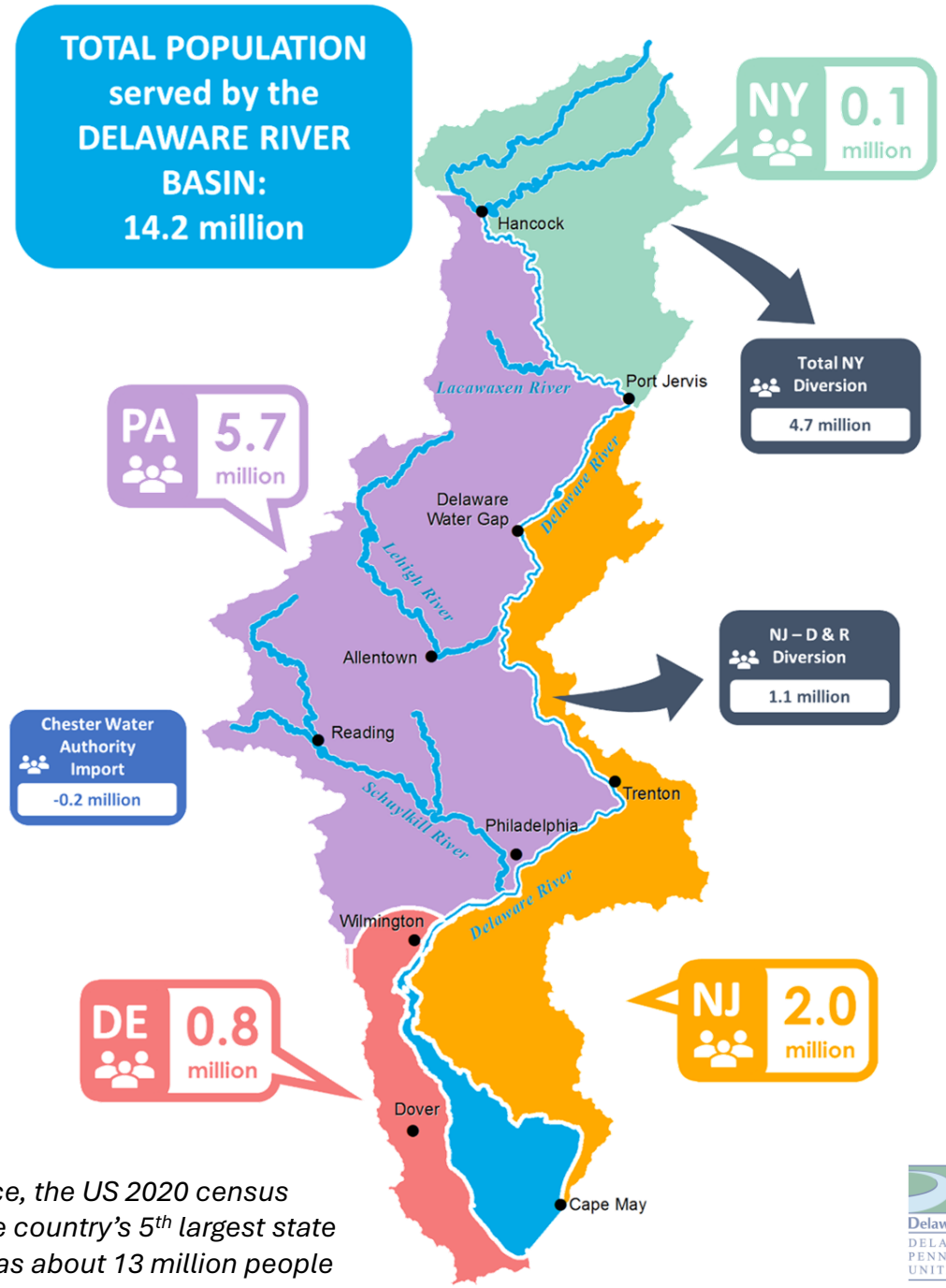

Federal Gov't (USACE)



"provide trusted, effective and coordinated management of our Basin's shared water resources."

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Over 14 million people rely on the Delaware River Basin for drinking water



For reference, the US 2020 census reported the country's 5th largest state population as about 13 million people (Pennsylvania).

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Most people in the Basin rely on public water supply

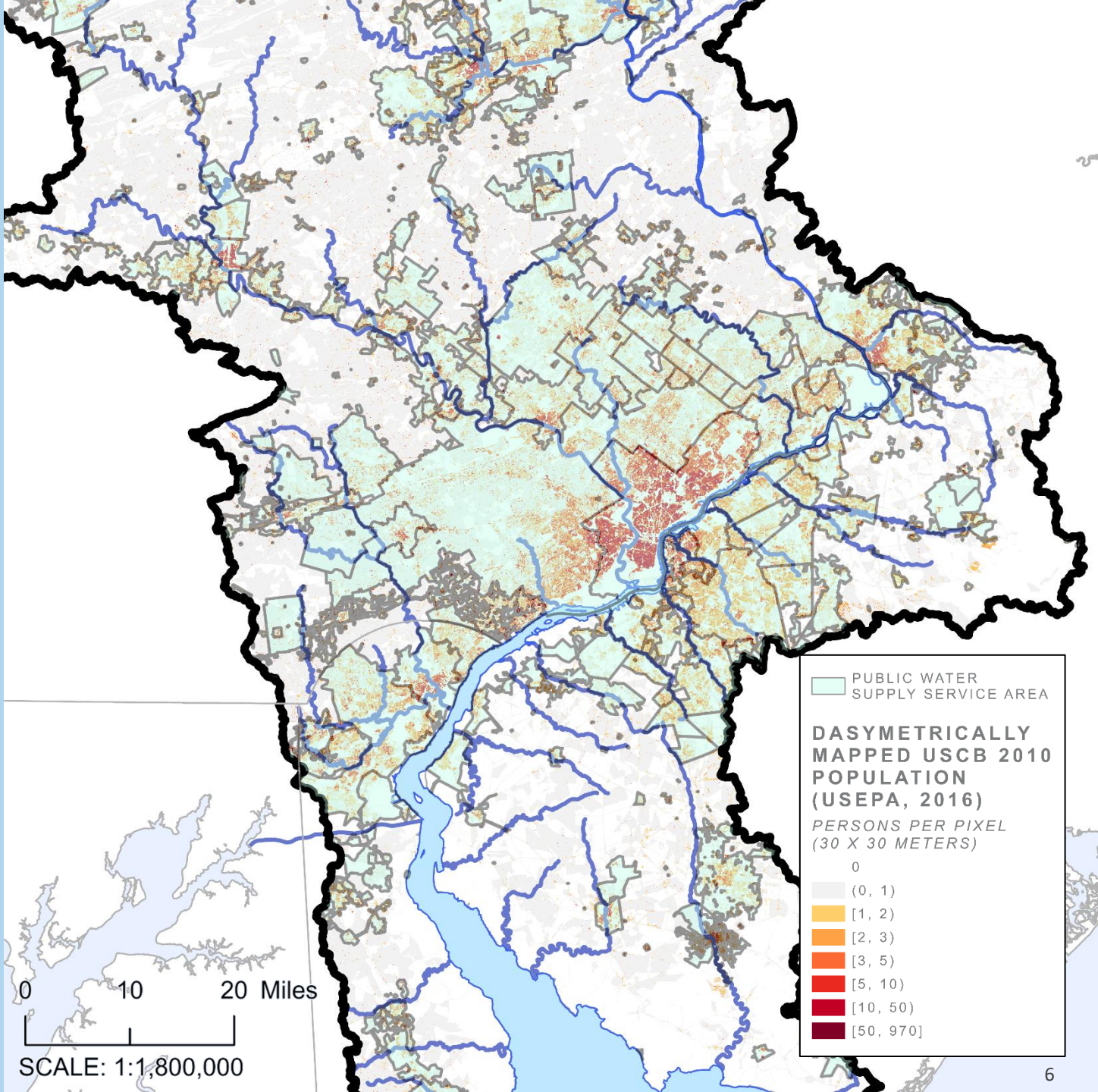


8.629 million people live in Delaware River Basin (2020 Census)



7.366 million people live inside public water supply service areas
~ 85% of the population

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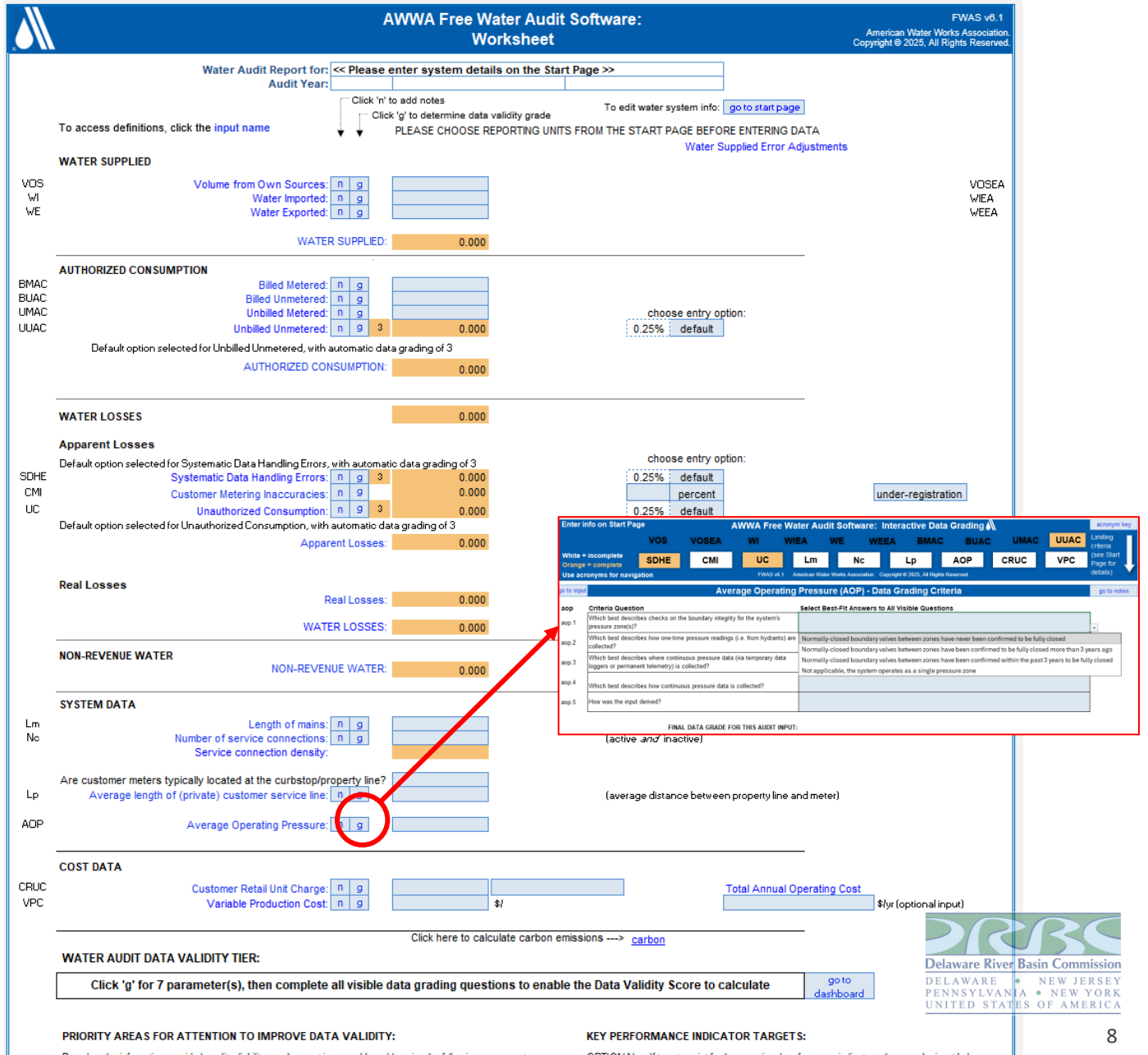
What is a "Water Audit" & Why should I care



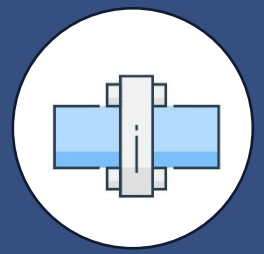
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What is a “water audit”

1. Input data to determine how much water is “lost”
2. Answer questions about the data inputs to get a sense of accuracy



The DRBC "Water Audit Program" applies to around 300 water systems



29,000 miles of water main (enough to circle the Earth)



2.5 million service connections (active and inactive)

2000
International Water Association publishes research standardizing methods to quantify water loss

2006
DRBC staff participate on the American Water Works Association (AWWA) Water Loss Control Committee (WLCC) and help publish the first AWWA Free Water Audit Software (FWAS)

2007-2009
DRBC undergoes rulemaking process
Adopted Res 2009-1 to amend the Water Code
Applies to systems which:
"distribute water supplies in excess of an average of 100,000 gallons per day (gpd) during any 30-day period"

2013
The first mandatory water audits are due for CY2012

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Drought of Record (1961-1967)

Delaware River near Trenton, New Jersey



DRBC Water Code (18 CFR Part 410 §2.400.1)
"The Drought of Record (DOR), which occurred in the period 1961-1967, shall be the basis for determination and planning of dependable Basin water supply."

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I need water now.



SUNDAY CALL-CHRONICLE

SUNDAY, JULY 29, 1962

1,800 Guards Will Re-enter Labor Market

WATER SUPPLY HAS DRIED UP

'Delaware Dry Gap' Faces Crisis

Macing Charge Made by Nine Bucks Workers



SATURDAY, AUGUST 21, 1965

Bristol Daily Courier

The Levittown Times

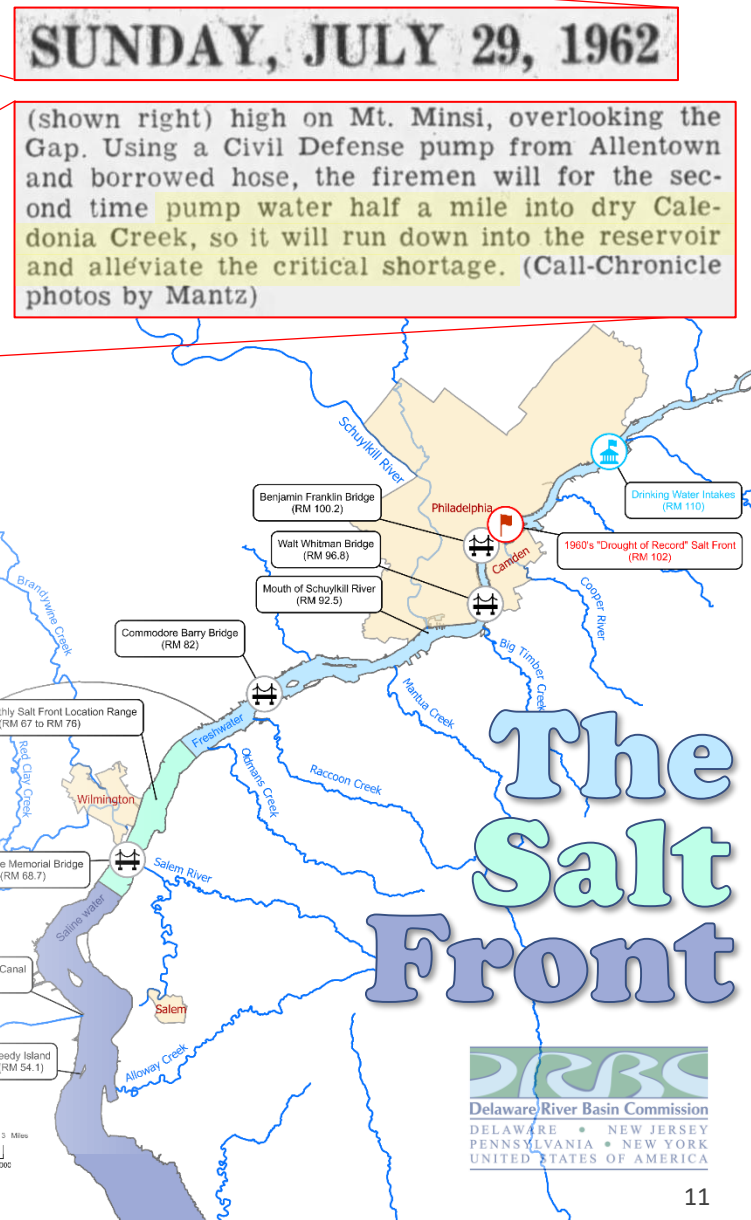
Owned and Published by the Bristol Printing Company
Route 13, Levittown, Pa., Telephone WI 3-1000
(Incorporated May 27, 1914)

Plan Now For Dry Days

With each successive day of drought, the water shortage that is menacing North New Jersey and New York City comes that much closer to Lower Bucks County. It is high time that our municipalities and our residents showed some awareness of this situation.

At present, both Bristol Borough and the Lower Bucks County Joint Municipality among others, rely upon the Delaware River for much of their water. The salt line is creeping up the river from Delaware Bay and the drought is creeping down from reservoirs diverting what little water is left to other users. The underground water level is dropping each day and soon our reserve supplies, our wells, will be in trouble.

The hour to practice conservation and to clean up pollution is not when the water famine is upon us; it is now. We need objective, intelligent direction on this point and we need complete, individual compliance.



Data management and review



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What does the dataset look like?

Statistics for the DRBC's Water Audit Program (2012-2021)

Year	First Year	Last Year	Expected	Missing	v4.1	v4.2	v5.0	v6.0	v6.1	Received	Compliance	Filtered Dataset
2012	305		305	63	3	239				242	79%	197
2013		2	305	44	2	257	2			261	86%	200
2014		2	303	43	1	96	163			260	86%	167
2015			301	35		7	259			266	88%	175
2016			301	11		1	289			290	96%	183
2017	1		302	8			294			294	97%	188
2018	1	5	303	7			296			296	98%	192
2019	5	3	303	18		1	284			285	94%	201
2020	1	2	301	13			150	138		288	96%	207
2021		3	299	6			6	287		293	98%	187
2022		3	296	11			4	280		285	96%	194
2023			293	14				278	1	279	95%	192
2024	1	1	294	11				281	2	283	96%	193
2025			293	19				132	145	274	94%	204

Filtering Criteria

1. Cannot be backfilled report data
2. Losses >= 0
3. CMI < 25% of Total Water Loss
4. ILI 1 < ILI <20
5. BMAC > 1,000 gal/conn/month

Data backfill example…

YEAR	VOS
2012	121.000
2013	
2014	
2015	
2016	93.230
2017	75.545
2018	82.466
2019	
2020	80.712
2021	94.000

→

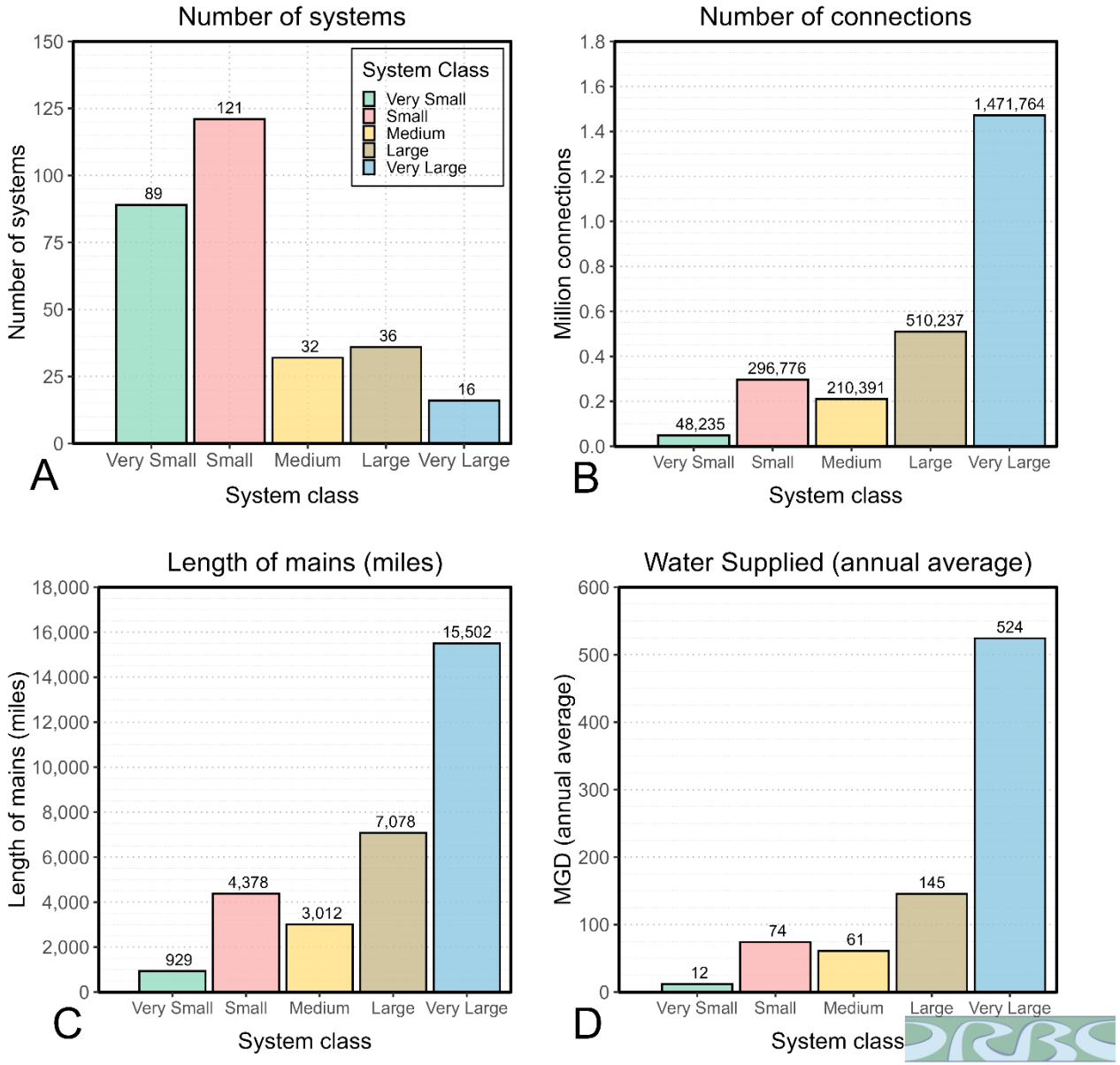
YEAR	VOS
2012	121.000
2013	93.230
2014	93.230
2015	93.230
2016	93.230
2017	75.545
2018	82.466
2019	80.712
2020	80.712
2021	94.000

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What does the dataset look like?

System size class	Abbv.	Active/Inactive Connections
Very Small	VS	< 1,000
Small	S	[1,000, 5,000)
Medium	M	[5,000, 10,000)
Large	L	[10,000, 20,000)
Very Large	VL	≥ 20,000

FWAS data for CY2024



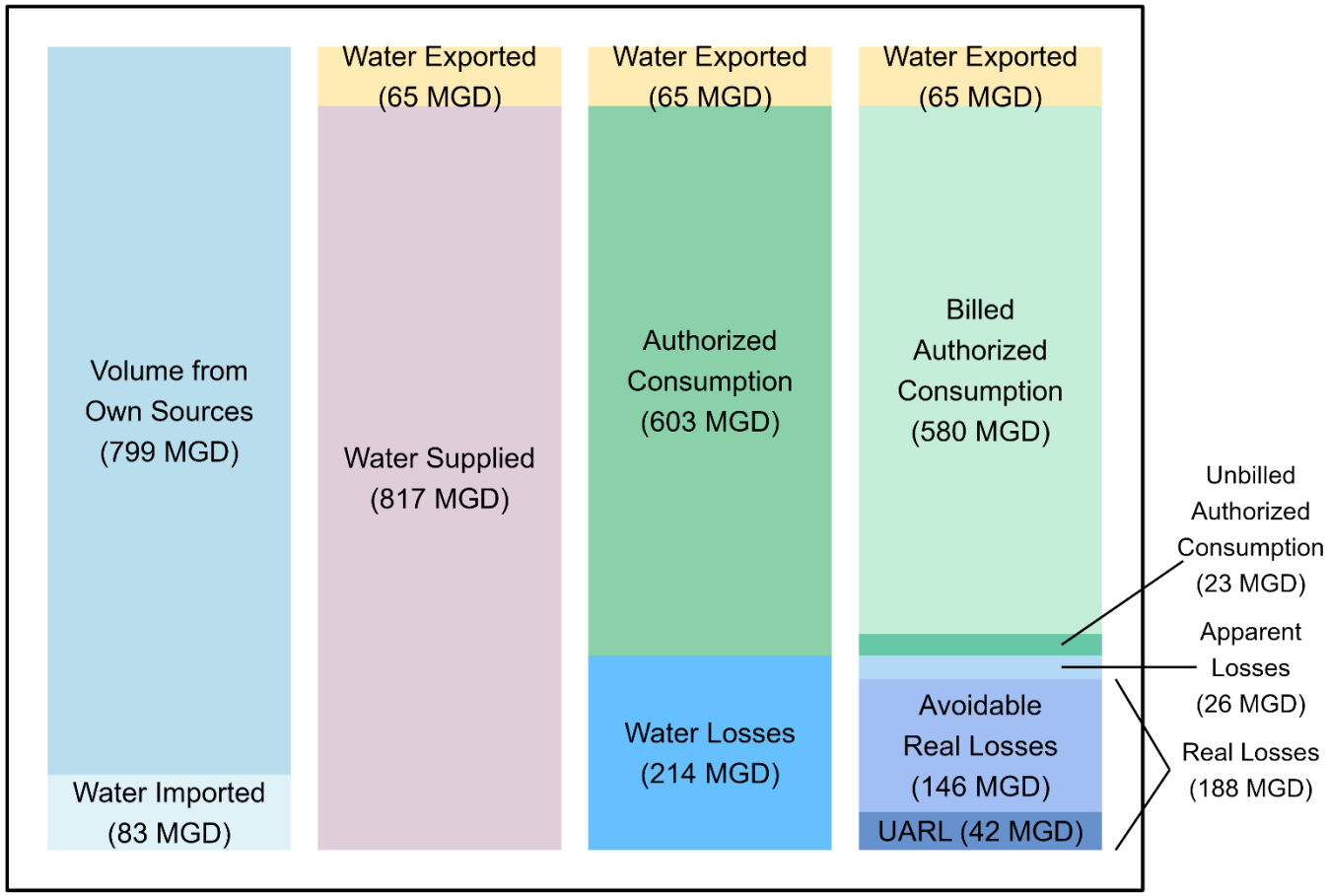
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Basin wide, 2024

- Aggregate data for 294 reports
- Net “Import-Export” = 18 MGD
- Water supplied = 817 MGD

UARL (42 MGD)

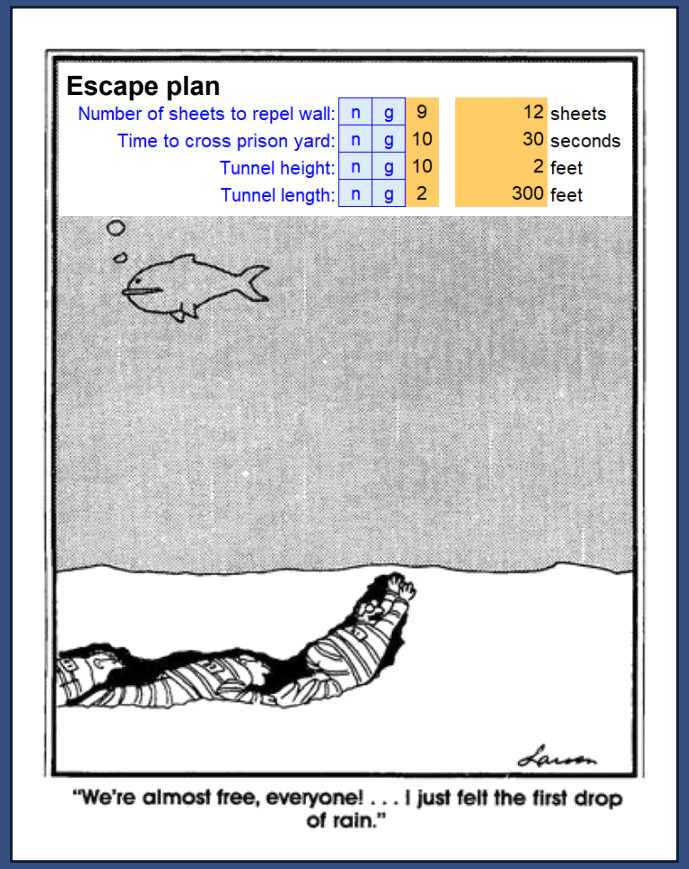
- Not all real losses can be resolved
- Addition of UARL to the water balance adds some context to Real Loss volume
- The word “avoidable” used here as the antonym to “unavoidable”, but perhaps there is better terminology …

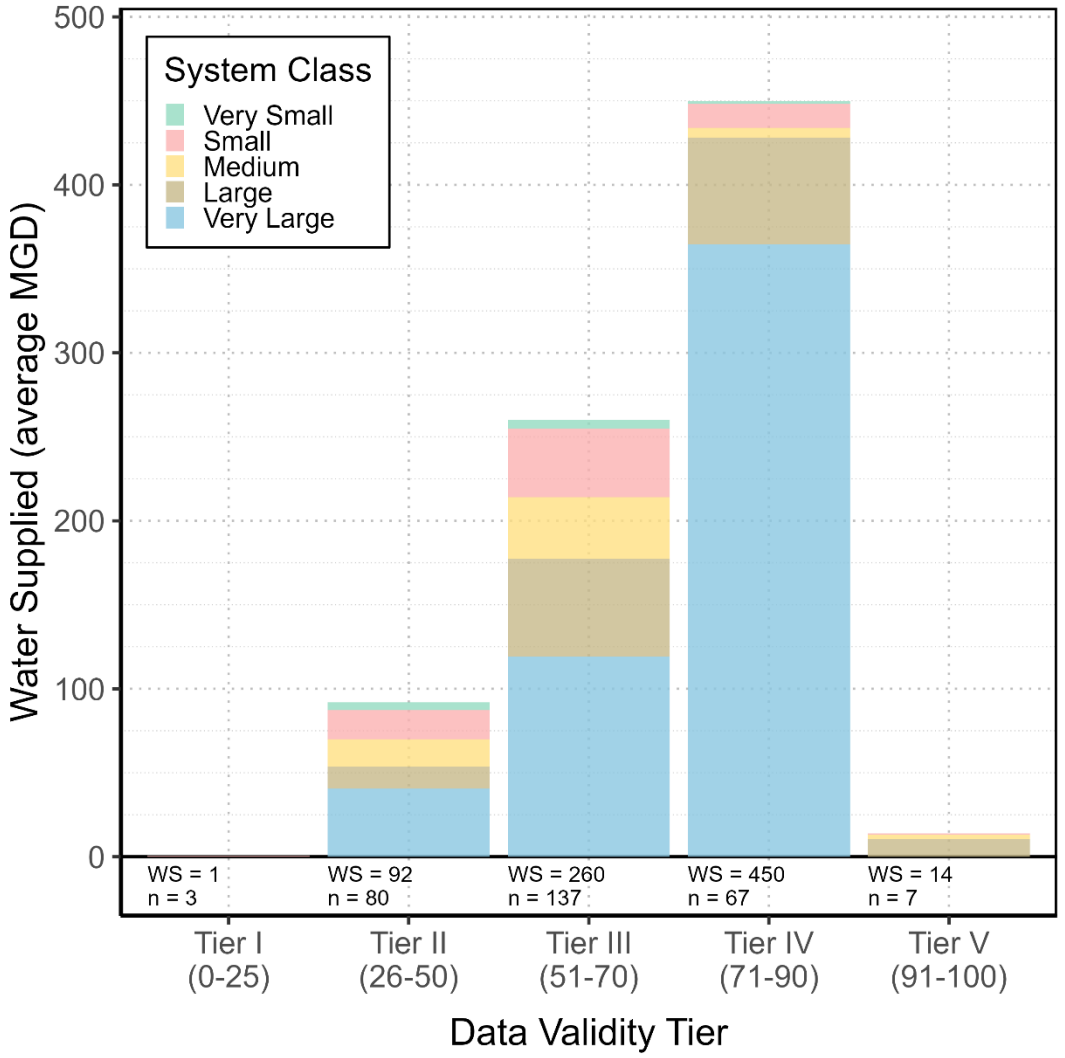


CY2024 aggregate water balance from 294 reports submitted by systems within the Delaware River Basin. Note that the UARL=42 MGD summation is based on standard UARL calculations performed for all systems regardless of operating pressure or number of connections (if ILI<1, UARL was replaced with the observed real loss value).

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“Are you sure?”





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Real Losses & Reduction Potential



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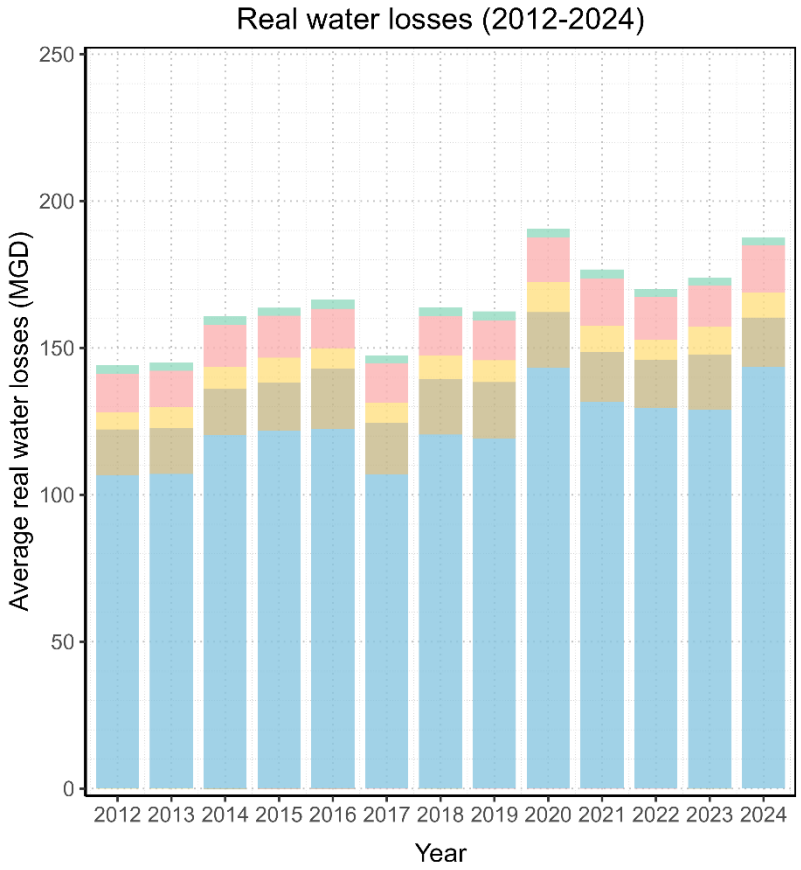
Real losses

Quoting the 2023 report…

> "The volume of real losses has remained relatively constant, with increases in the last two years (2020, 2021)."

Looking at data through 2024…

> "???"



Class	Max N_c	Count*
Very Small	1,000	89
Small	5,000	123
Medium	10,000	30
Large	20,000	36
Very Large	> 20,000	16

* The count is the number of systems in each class, based on CY2024 reports

Primarily GW

~1/3 rely on SW

14/16 rely on SW

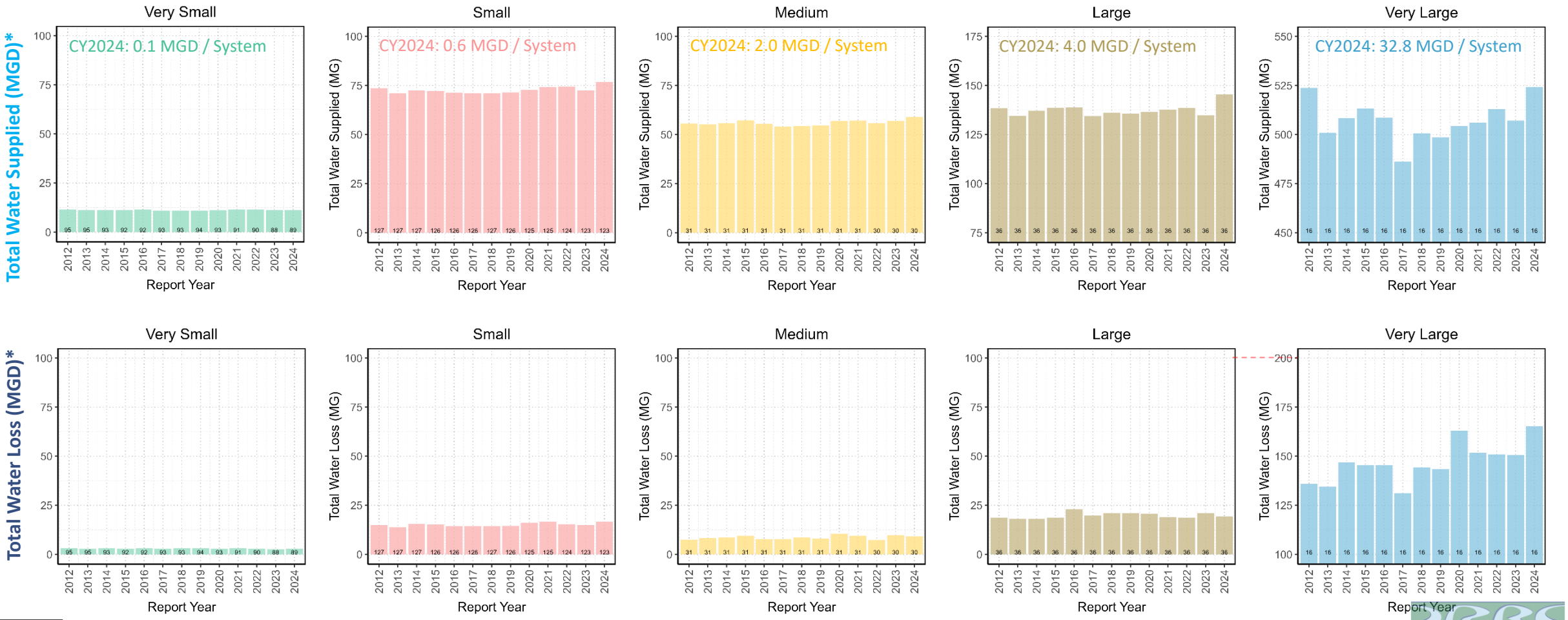
Recall planning objectives related to a repeated DOR:

(1) will the water be there for taking on the day its needed

(2) could mitigating losses today help prevent future shortfalls (if any)

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Where to start



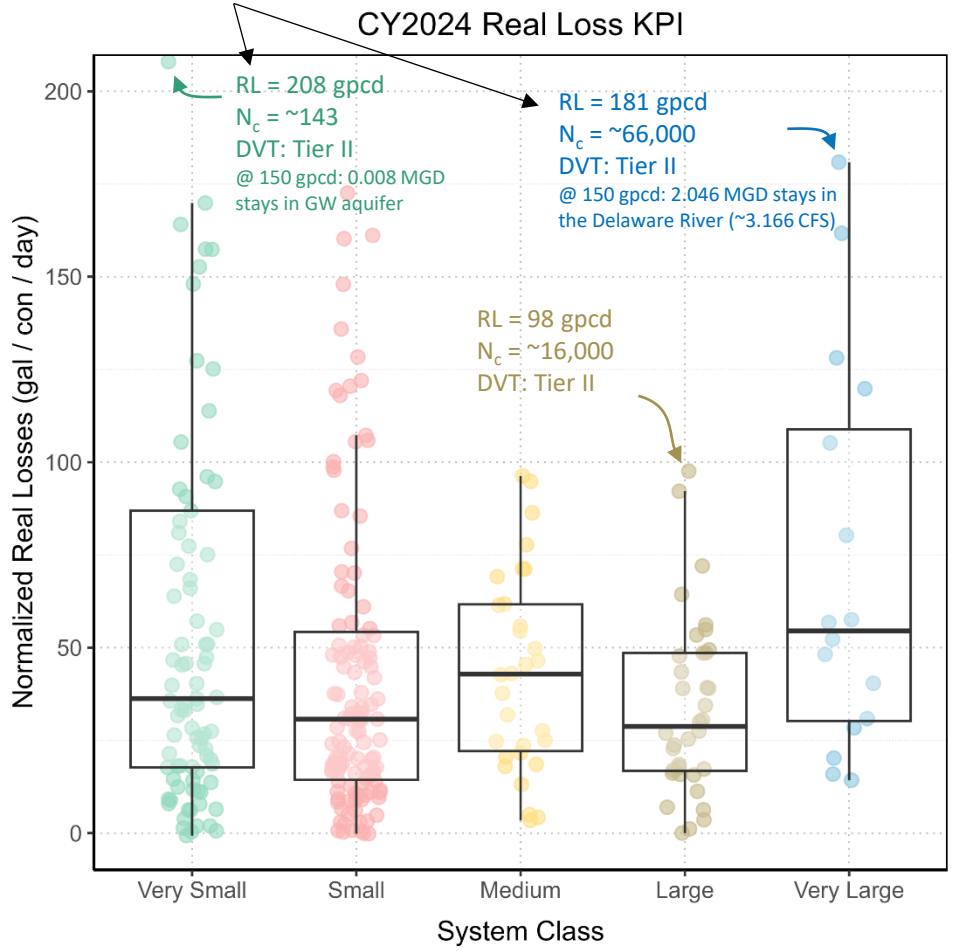
Class	Max N_c
Very Small	1,000
Small	5,000
Medium	10,000
Large	20,000
Very Large	>20,000

** Scales are different, but Δy is the same (100 MG)*

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Key Performance Indicators

Yes, there are different levels of effort for each system to reach 150 gpcd. This is a hypothetical scenario for illustrative purposes.



Keep in mind:

1. Are we sure? (DVT Tier II)
2. Leak rates ≠ Operational efficiency

[1] Not considering connection density, which may suggest using an alternate KPI of (gal / mi main / day) would be more suitable.

[2] WARD 2018 (FWAS V6 speedometer) 90th percentile is about 115 gpcd

[3] Similar leakage rates ≠ Similar performance (see slide #25)

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Real Loss Reduction Potential

- Cross-plot: Real Loss vs. UARL (unit rates)
- All above ILI=_ reduce to ILI=_ → water savings
- Economic Level of Leakage (ELL) would greatly improve overall estimates – all systems decreasing to ILI=1 is not realistic
- Similar leakage rates do not necessarily mean similar performance

Musing on P_{AO} and ILI

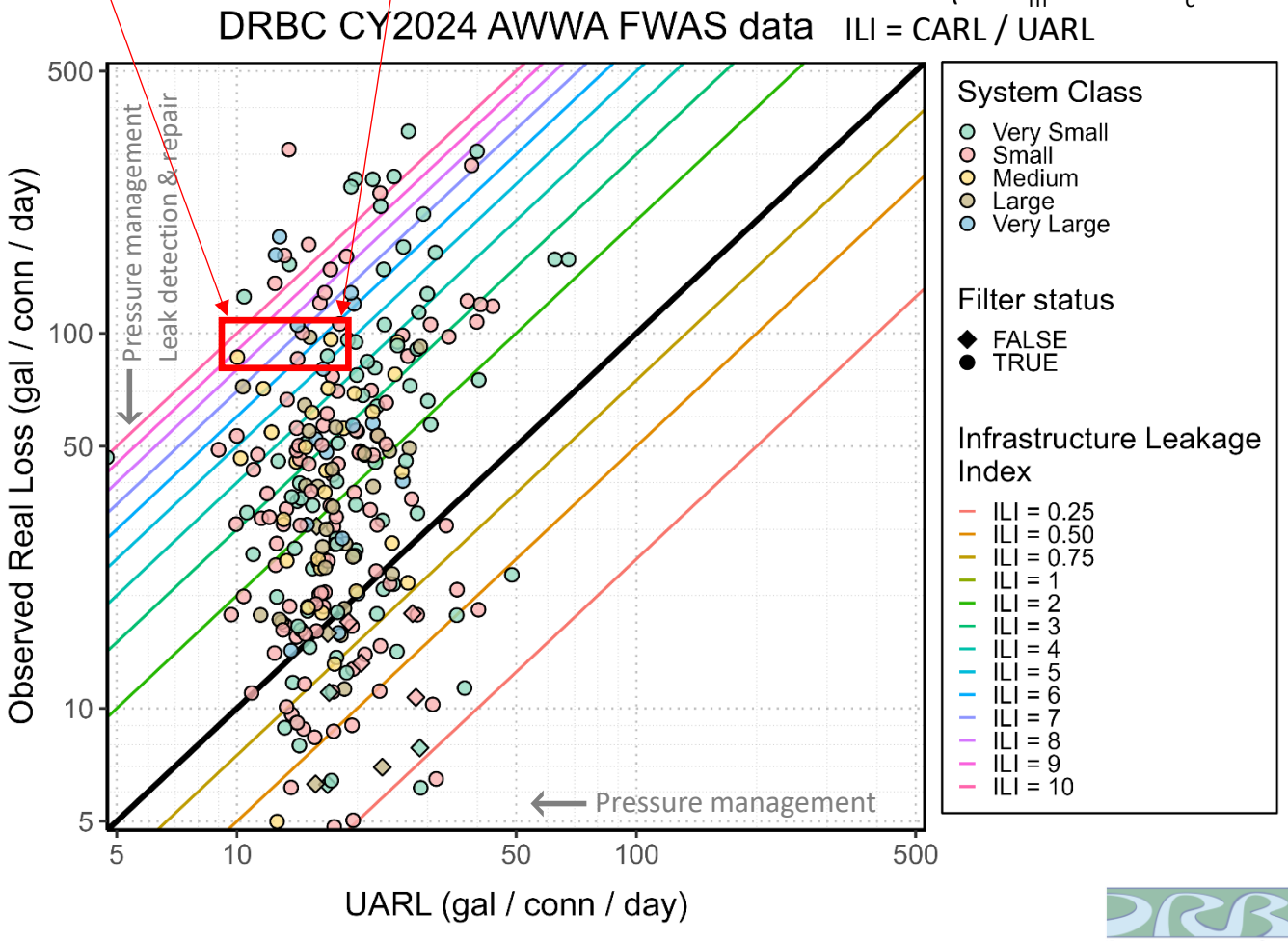
Pressure and leakage are directly related (i.e., orifice equation) – decreases in P_{AO} should be reflected in leakage, adjusting ILI accordingly

Similar leakage rates ≠ similar performance

Medium system #1
Real losses ~86 gcd
ILI~8.6
N_c = 6,616
L_m = 21 mi
L_p = 0 ft.
P_{AO} = 60 psi

Medium system #2
Real losses ~96 gcd
ILI~5.6
N_c = 5,683
L_m = 129 mi
L_p = 60 ft.
P_{AO} = 48 psi

Recall:
UARL =$(18*L_m + 0.80*N_c + 25*L_p) * P$
ILI = CARL / UARL

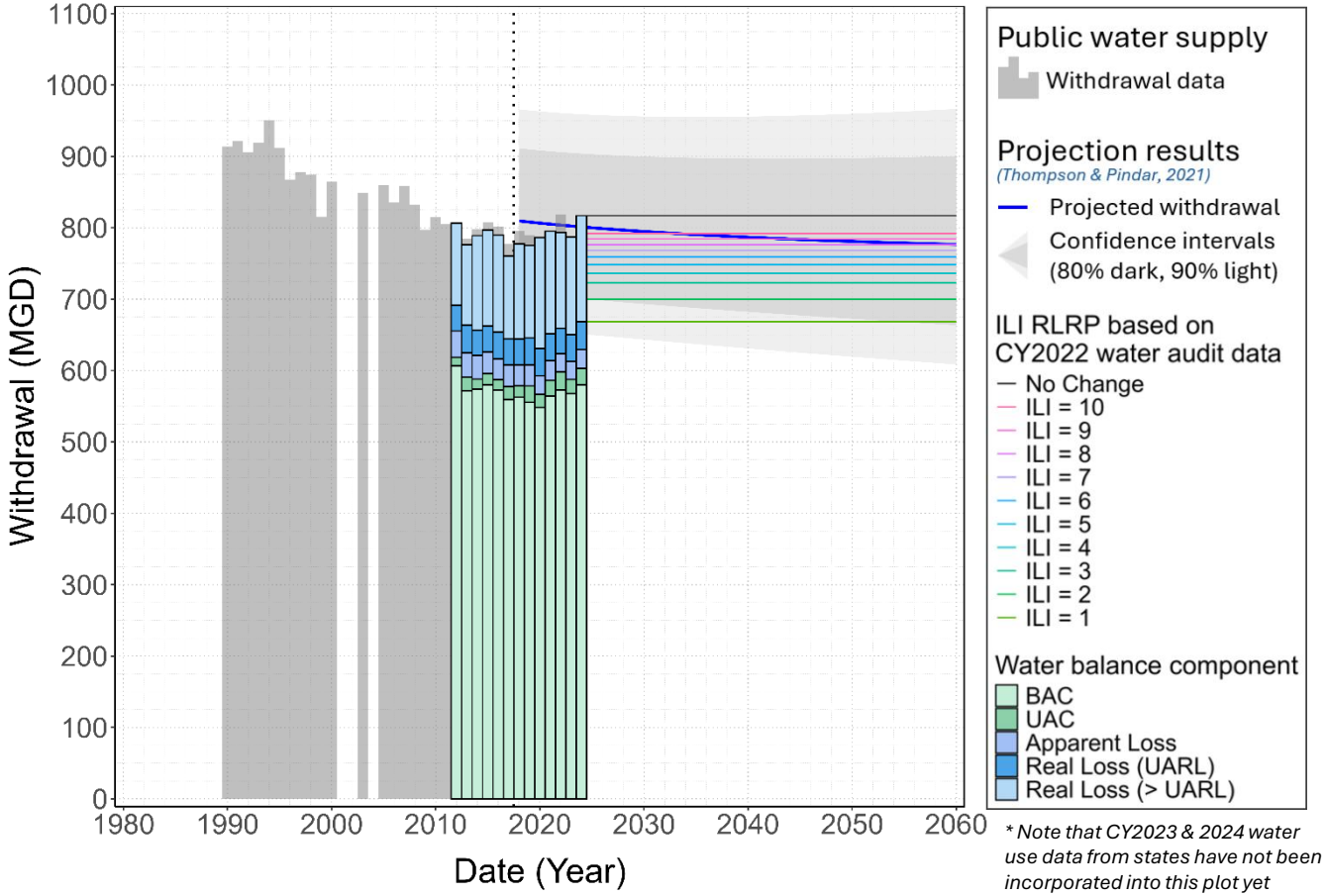


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RLRP: So what?

> “The decrease in projected withdrawals (based on current operational trends) is equivalent in magnitude to systems above ILI=7 reducing to ILI≈7”

- There is room for improvement e.g. ELL are not included in assessment. ILI=1 not a realistic scenario and ELL analyses may help improve understanding.
- Is it possible the projection may reach an inflection point? Continued population growth outweighs reductions?



** Note that CY2023 & 2024 water use data from states have not been incorporated into this plot yet (grey bars)*

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We never know the Worth of Water, till the Well is dry.



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DRBC website

DRBC audit program

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