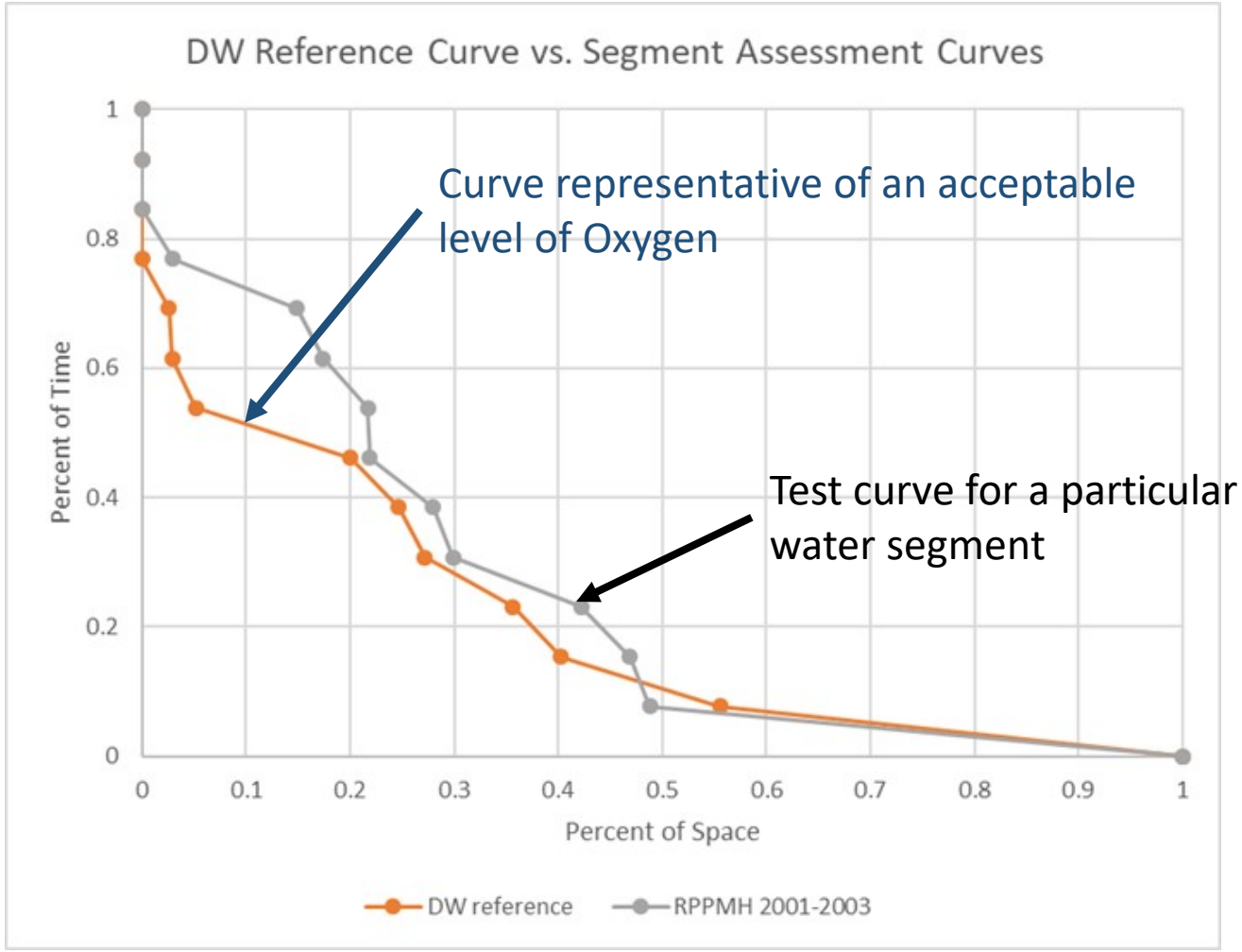
Climate allocation methods

MWG 4/7/2020

Gary Shenk, Lewis Linker, Richard Tian, Gopal Bhatt, Isabella Bertani, Danny Kaufman, Cuiyin Wu

An Assessment of Dissolved Oxygen Criteria

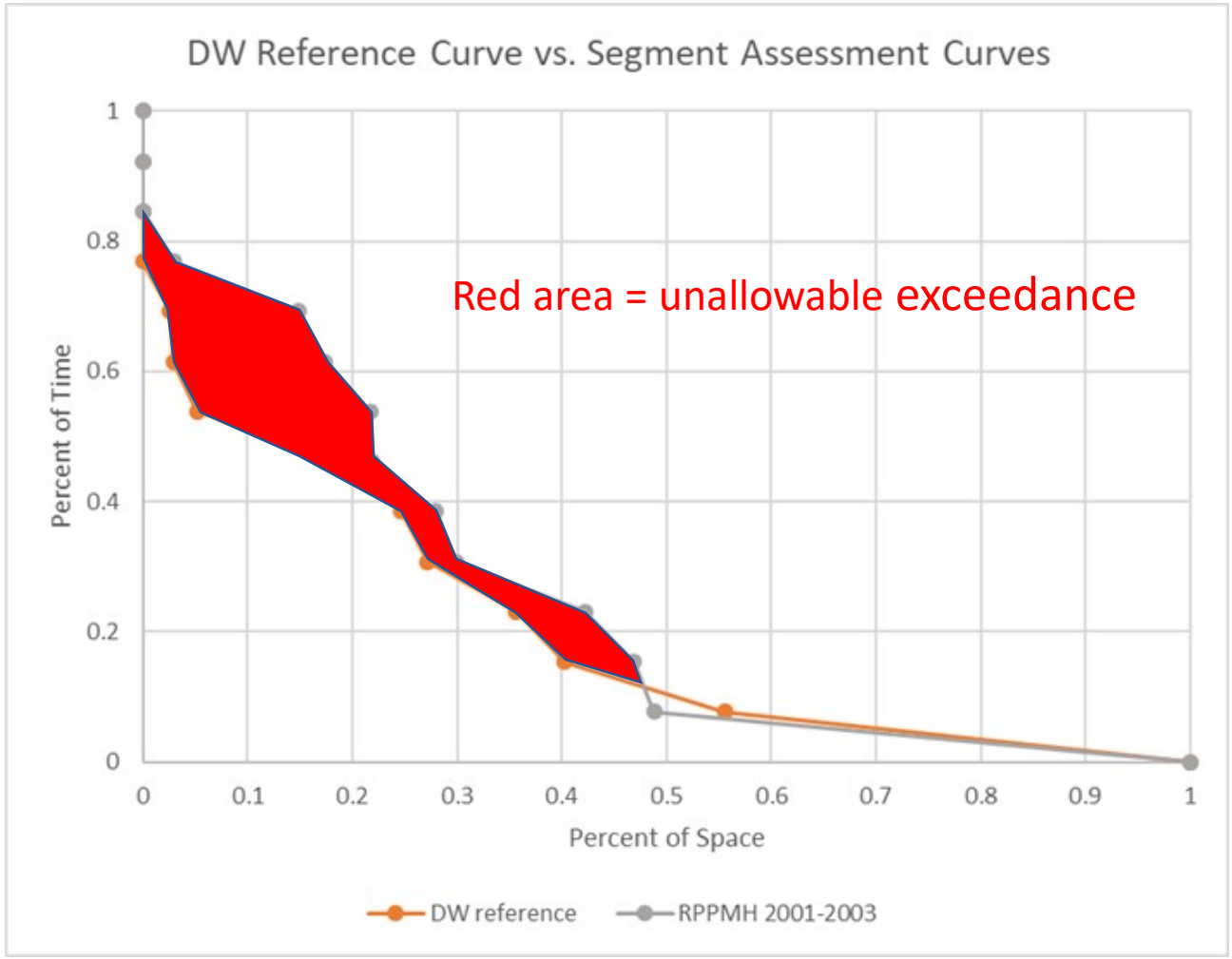


Temporal Extent of Low Oxygen =>

Spatial Extent of Low Oxygen =>

Building Block #1

An Assessment of Dissolved Oxygen Criteria



Temporal Extent of Low Oxygen =>

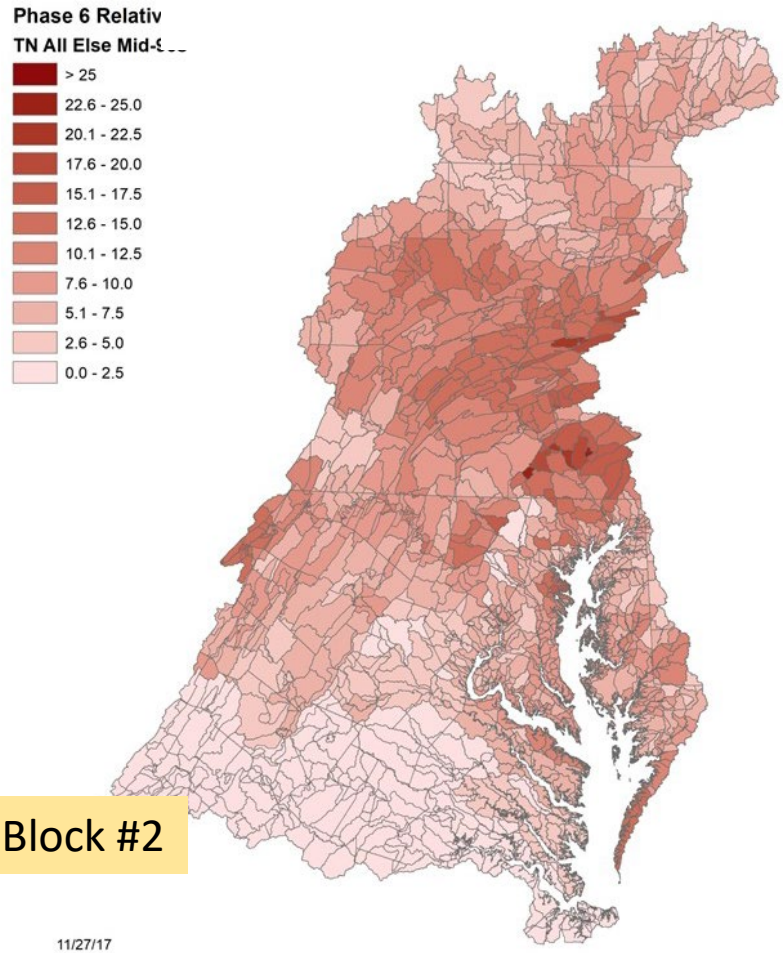
Spatial Extent of Low Oxygen =>

Building Block #1

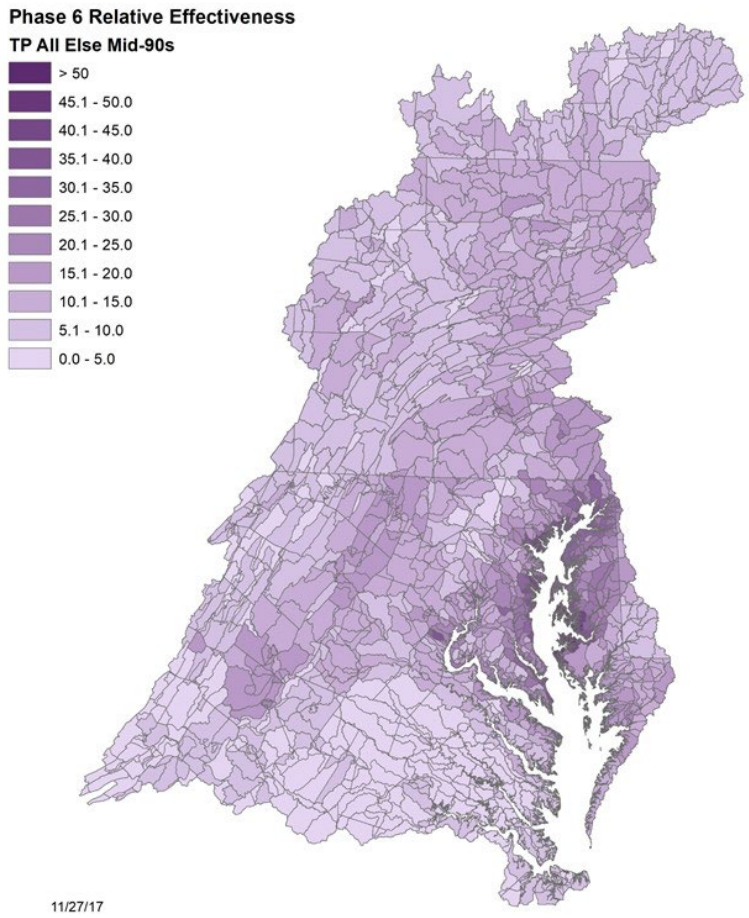
Dissolved Oxygen effect per pound of nutrient released in the watershed

More Impact, Do More

Nitrogen

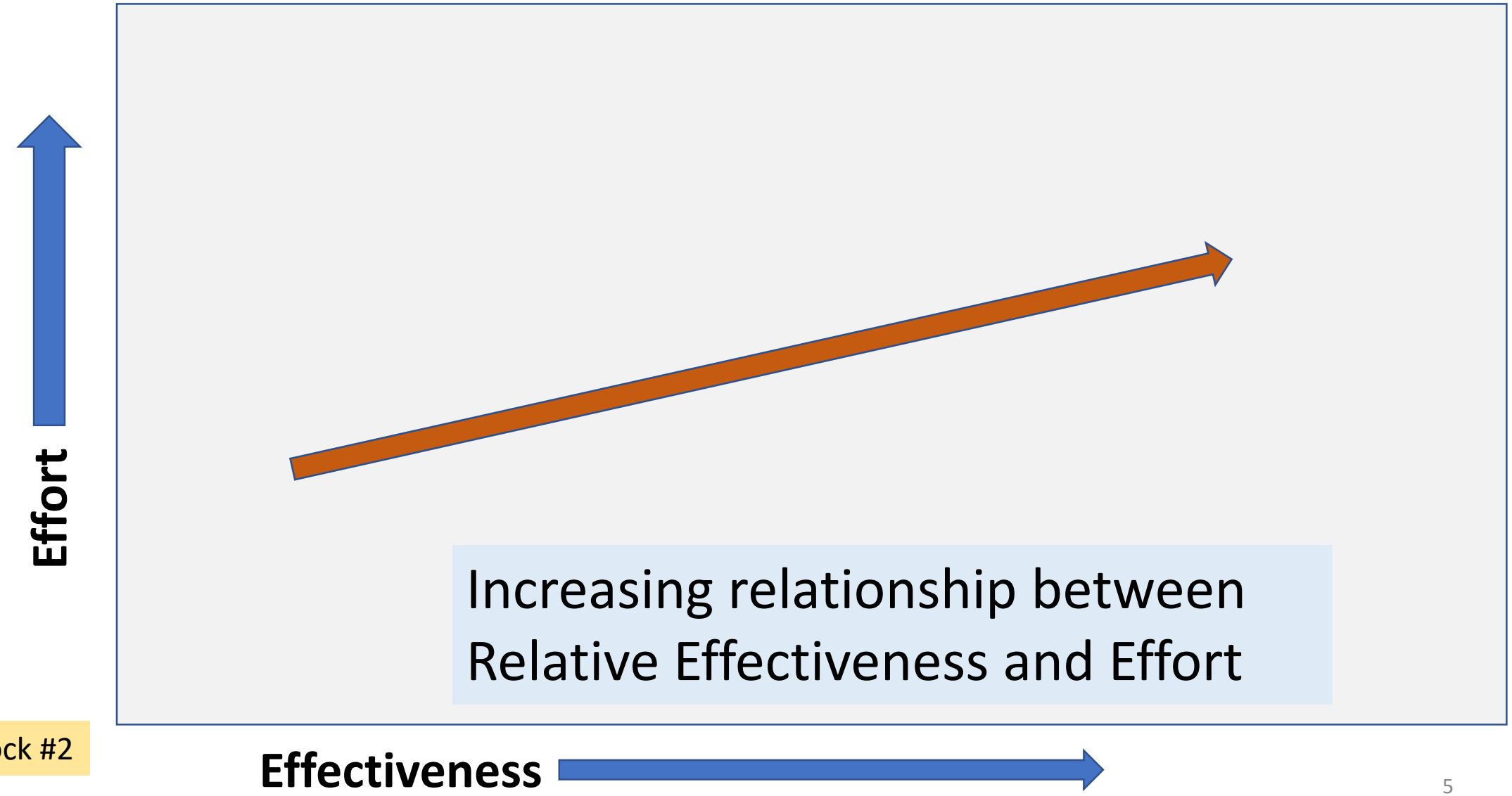


Phase 6 Phosphorus



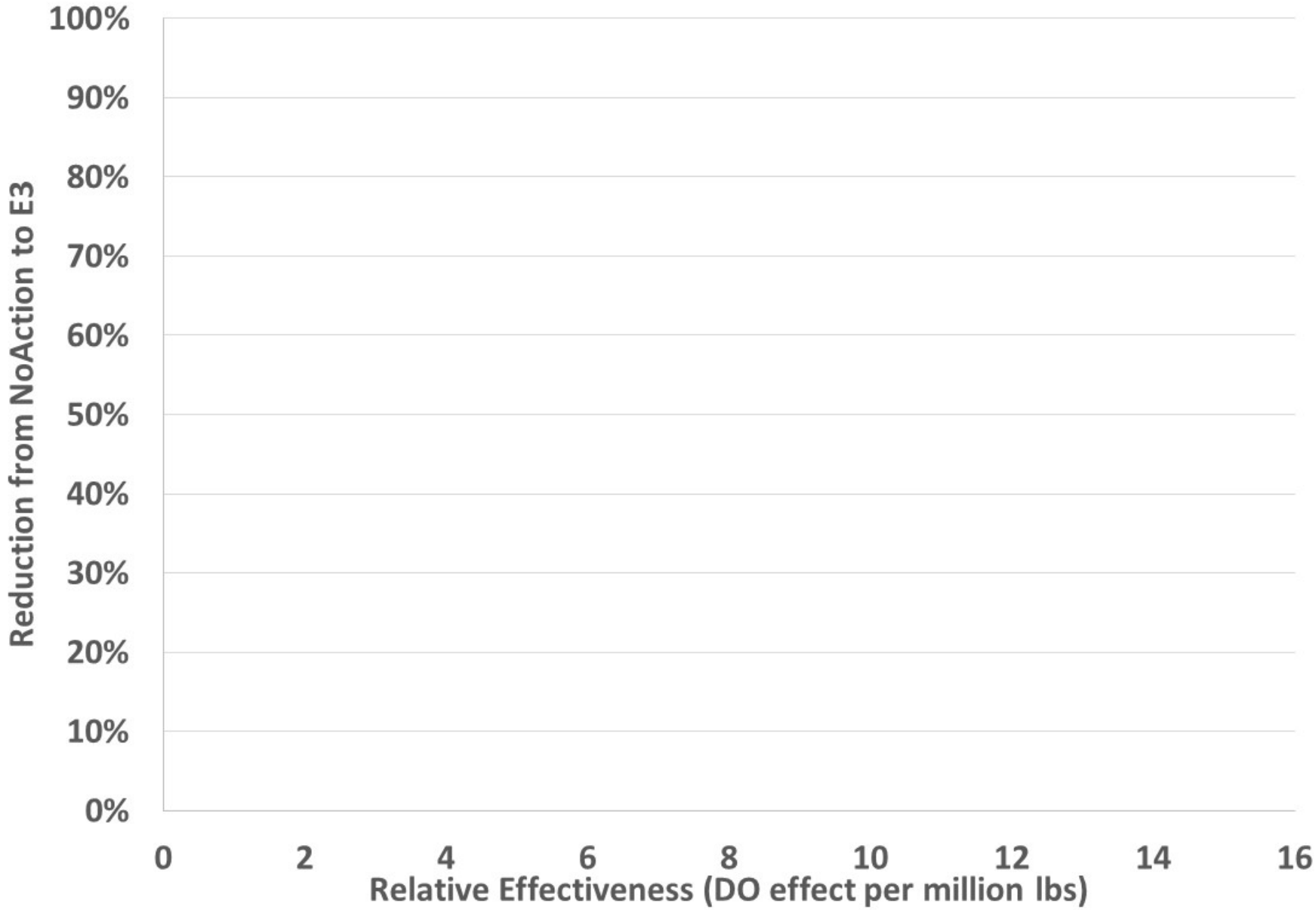
Building Block #2

Guidelines for 2010 Allocation and 2017 Planning Targets

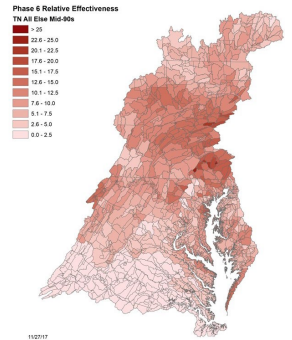


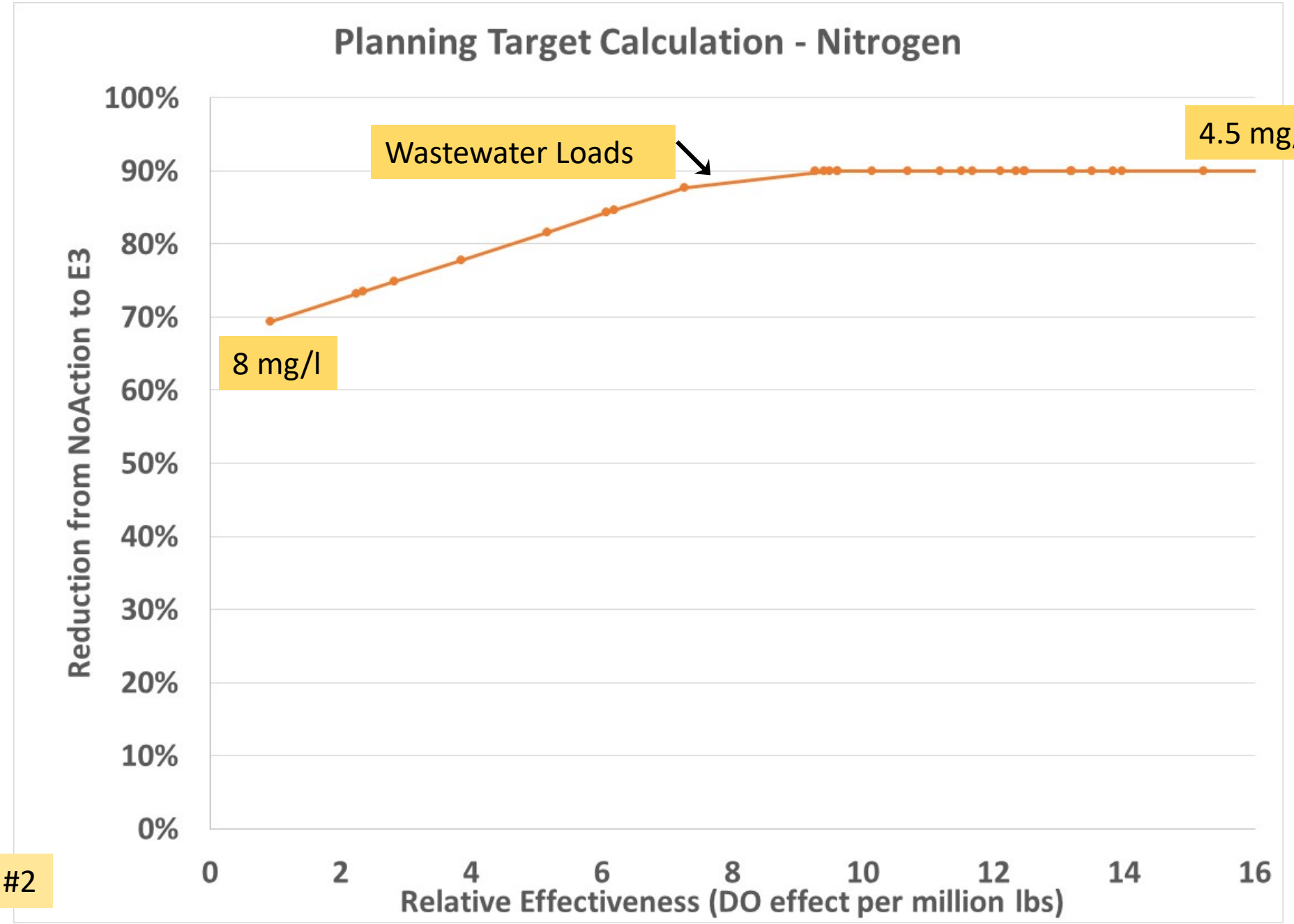
Building Block #2

Planning Target Calculation - Nitrogen

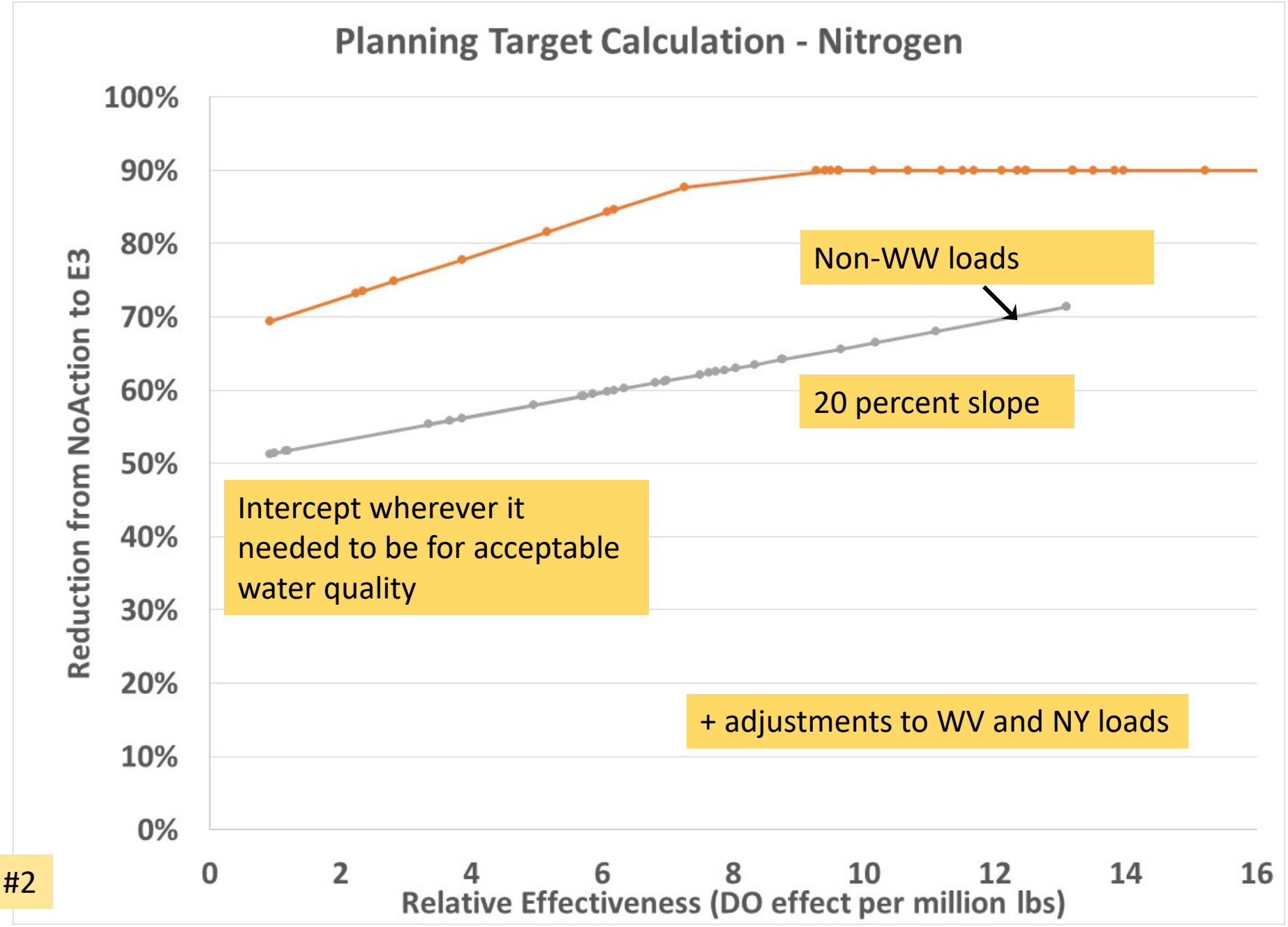


Building Block #2



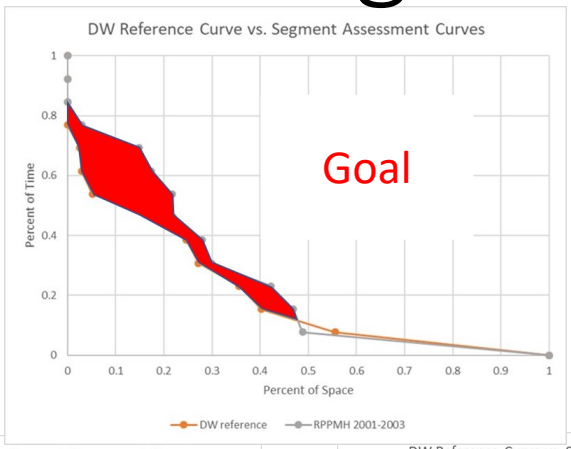


Building Block #2

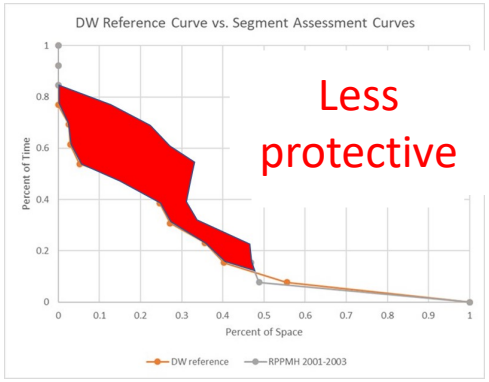


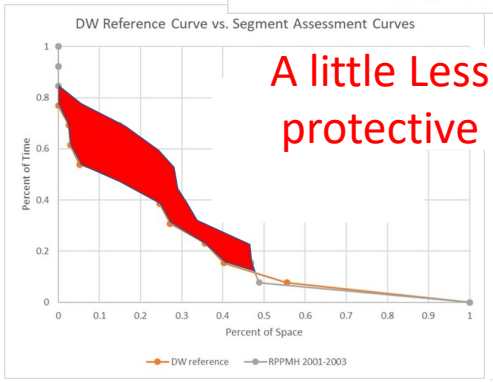
Building Block #2

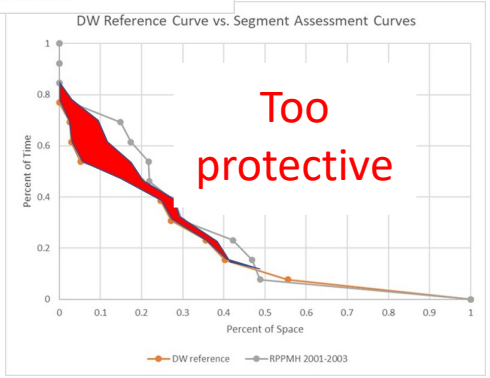
Putting the two building blocks together

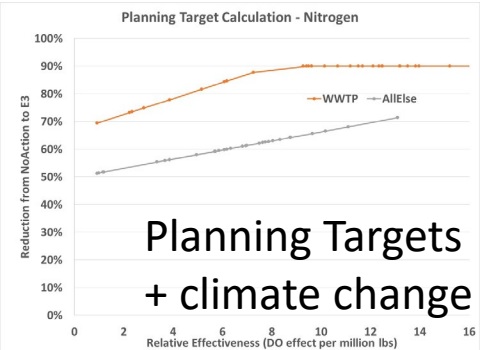


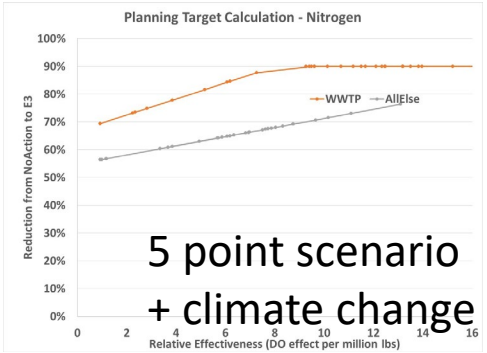
- Find point where climate change effects are counteracted

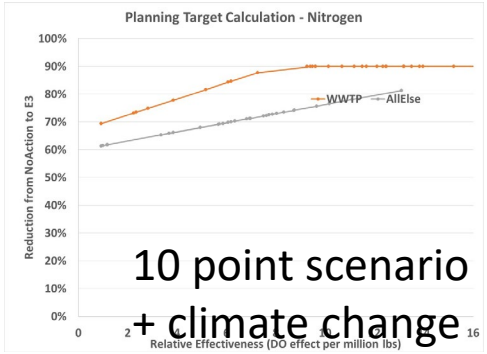


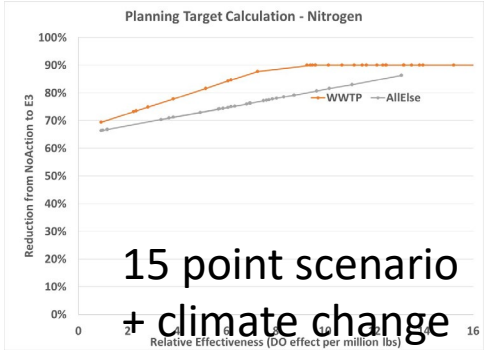


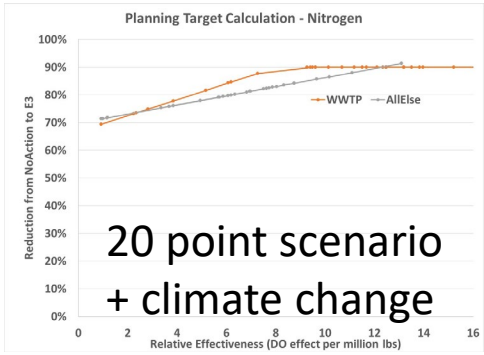




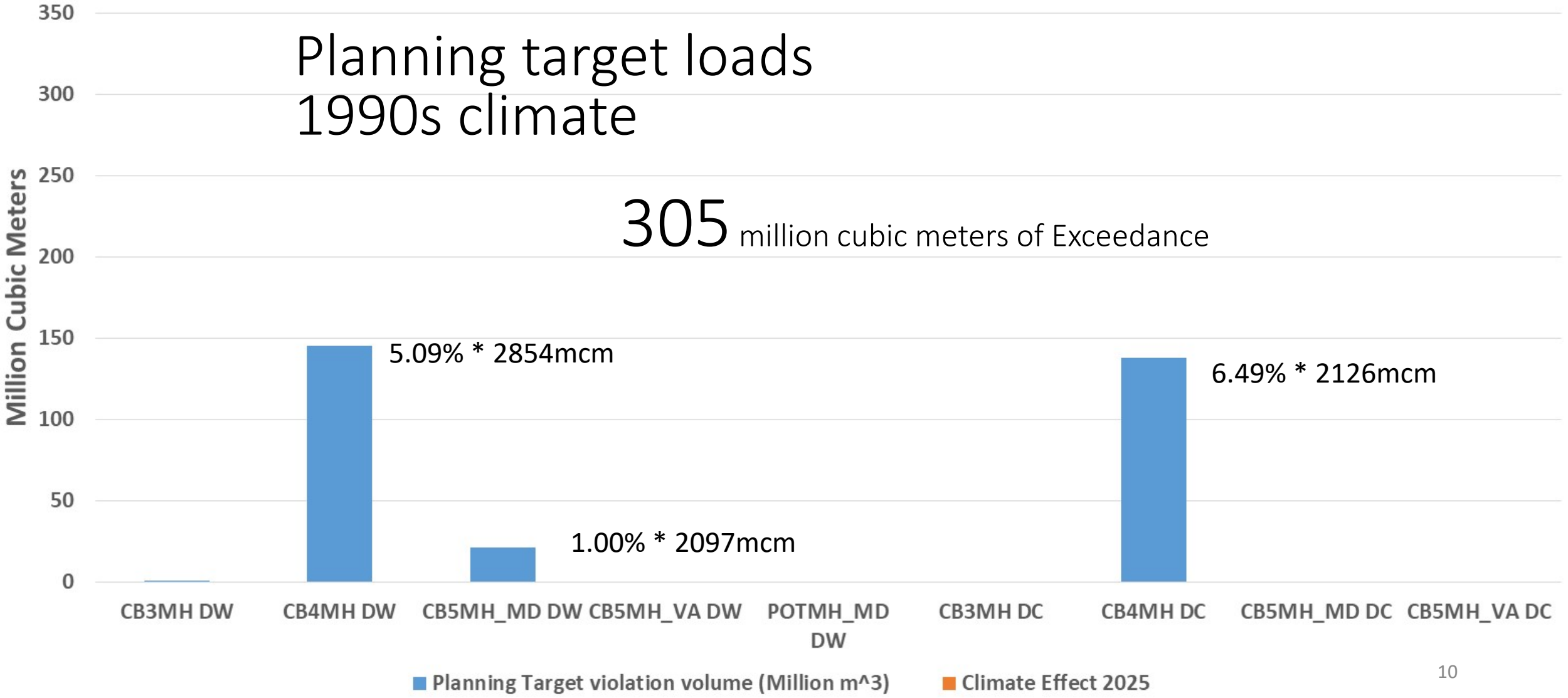








Climate Change Effect on Main Bay DWDC



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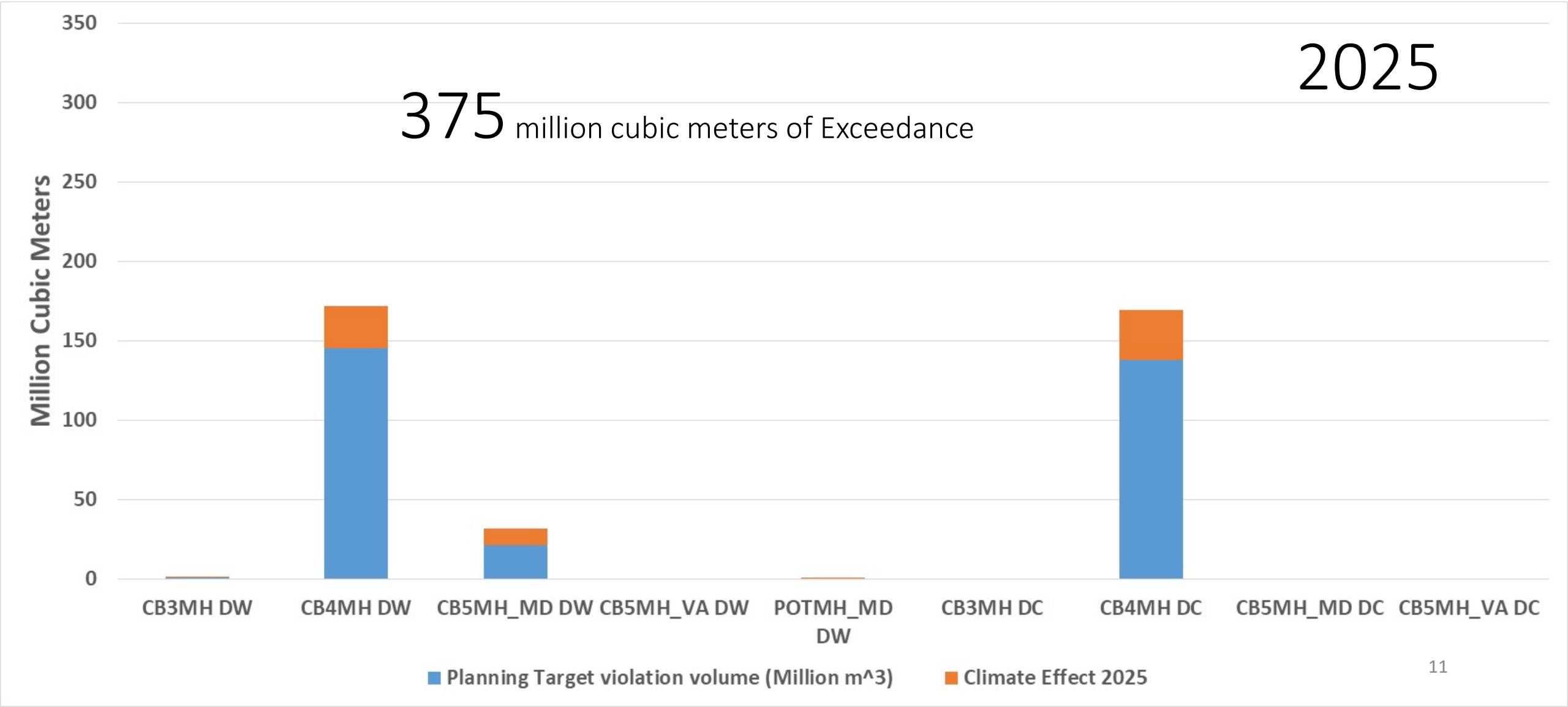

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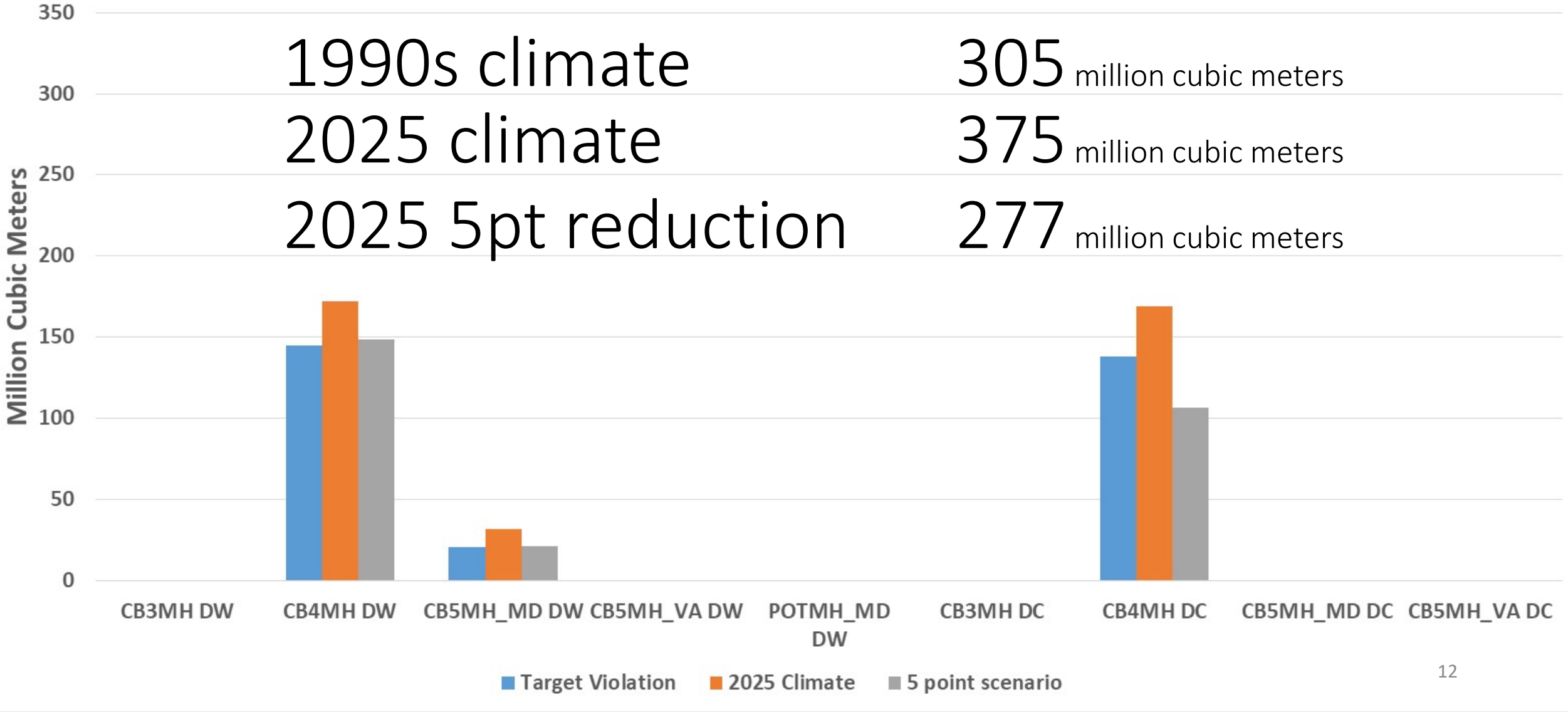
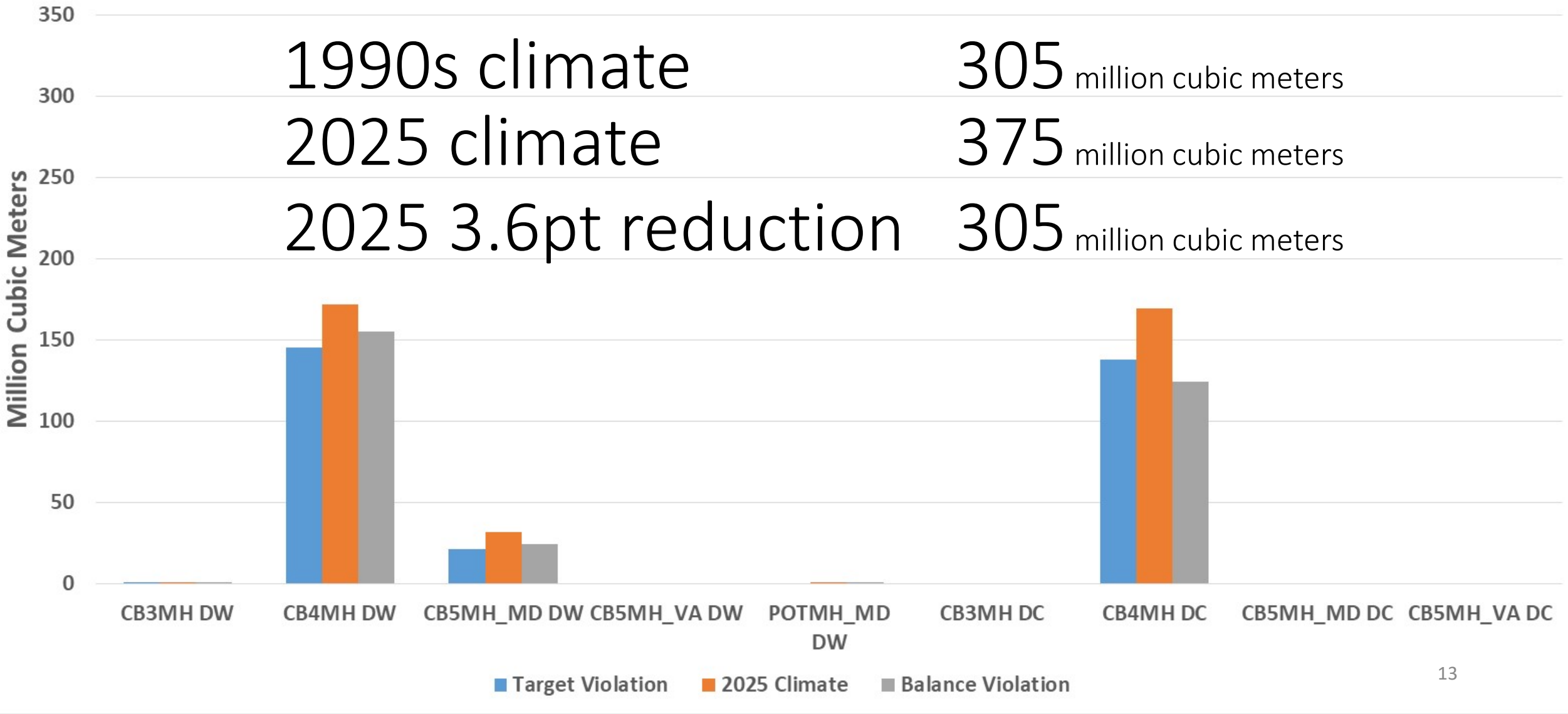


Climate Change Effect on Main Bay DWDC

1990s climate 305 million cubic meters

2025 climate 375 million cubic meters

2025 3.6pt reduction 305 million cubic meters

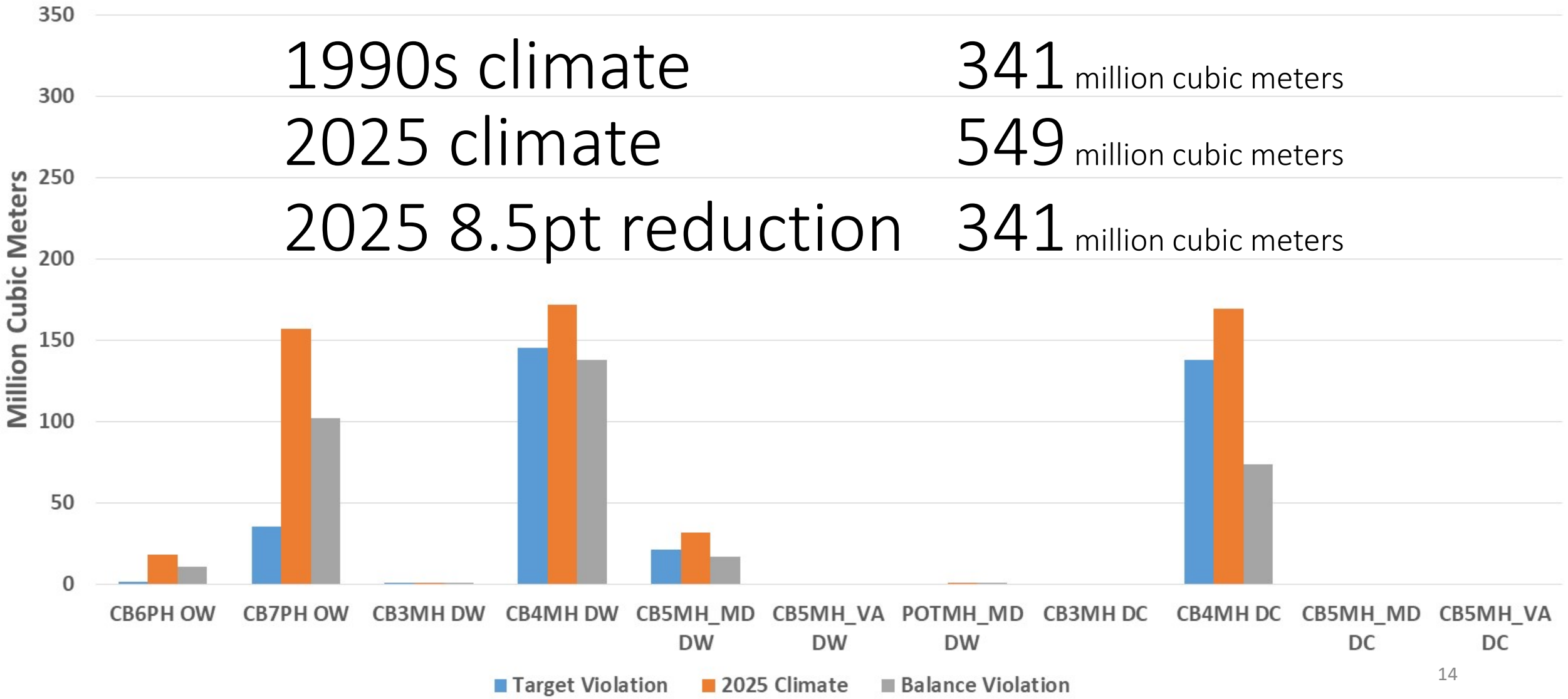


Climate Change Effect on Main Bay OWDWDC

1990s climate 341 million cubic meters

2025 climate 549 million cubic meters

2025 8.5pt reduction 341 million cubic meters



Numbers have changed since February

- WQGIT wanted to maintain variances - needed to transpose climate model violation rates to 2017 model violations rates
  - No effect on reduction amounts except where variances were threatened
  - Red percent and volumes changed
- February numbers had incorrect lower volumes for CB6 and CB7 Open Water.
  - Higher volumes increasing the volume-balanced reduction needs when including CB6 and CB7
- Additional WQGIT options

Climate allocation options

- Open Water
  - ~~Ignore Open Water~~
  - Lump OW in with other segments
  - Separate allocations and then reconcile
- WWTP responsibility
  - Only non-WWTP sources
  - Include WWTP
- Variances
  - ~~Assume variances can change~~
  - ~~Keep variances the same~~
  - Meet variances and load balance
- Relative impact Conowingo
  - ~~1995 level as used in TMDL/2017~~
  - Current status
- Relative impact segments
  - ~~Always use TMDL/2017 segments~~
  - Use the group of segments being protected
- Watershed loads first
  - Take out jurisdiction loads first
  - Do not consider jurisdiction loads

Climate allocation options

These don't matter!

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- WWTP responsibility
  - Only non-WWTP sources
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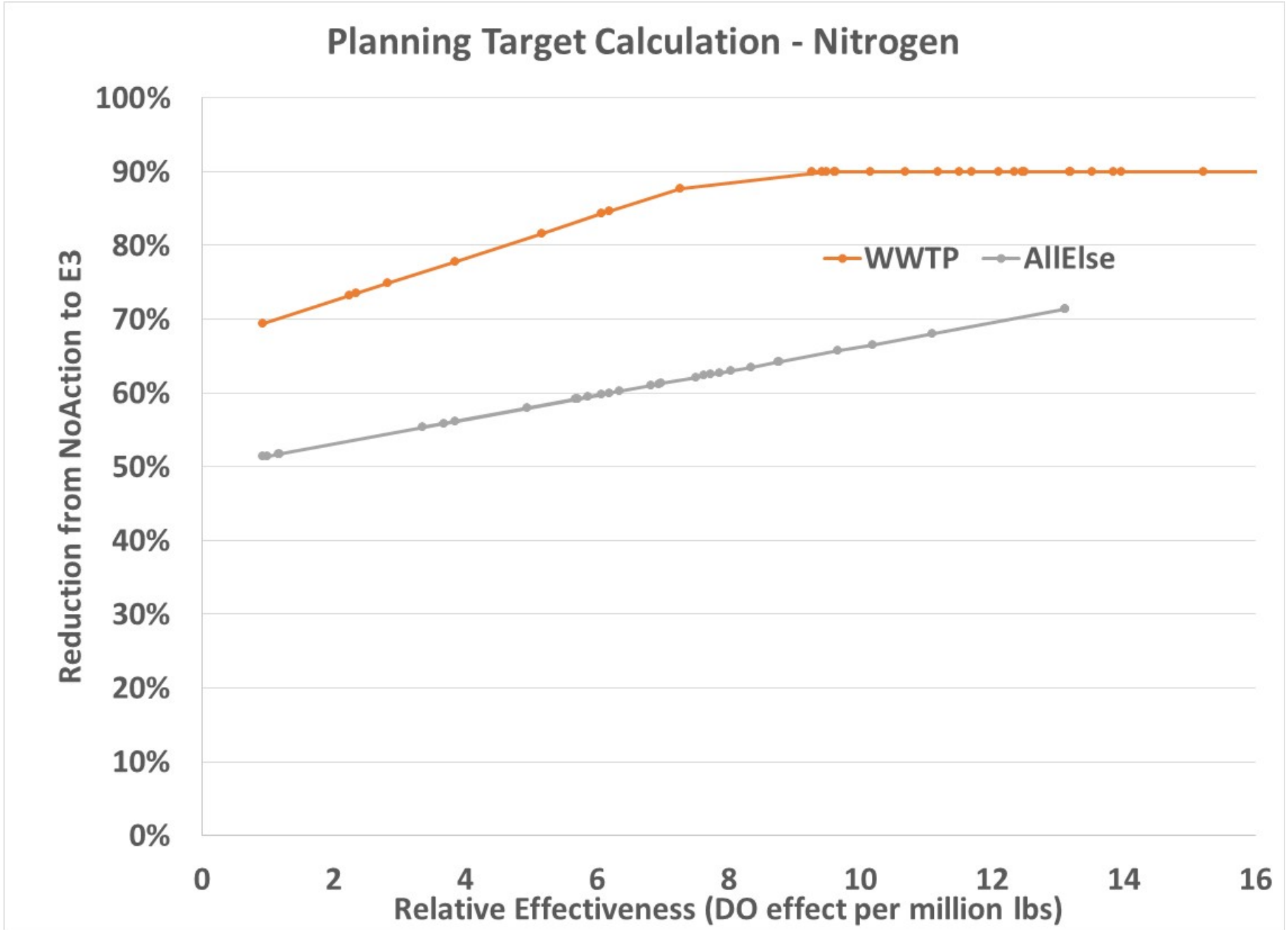
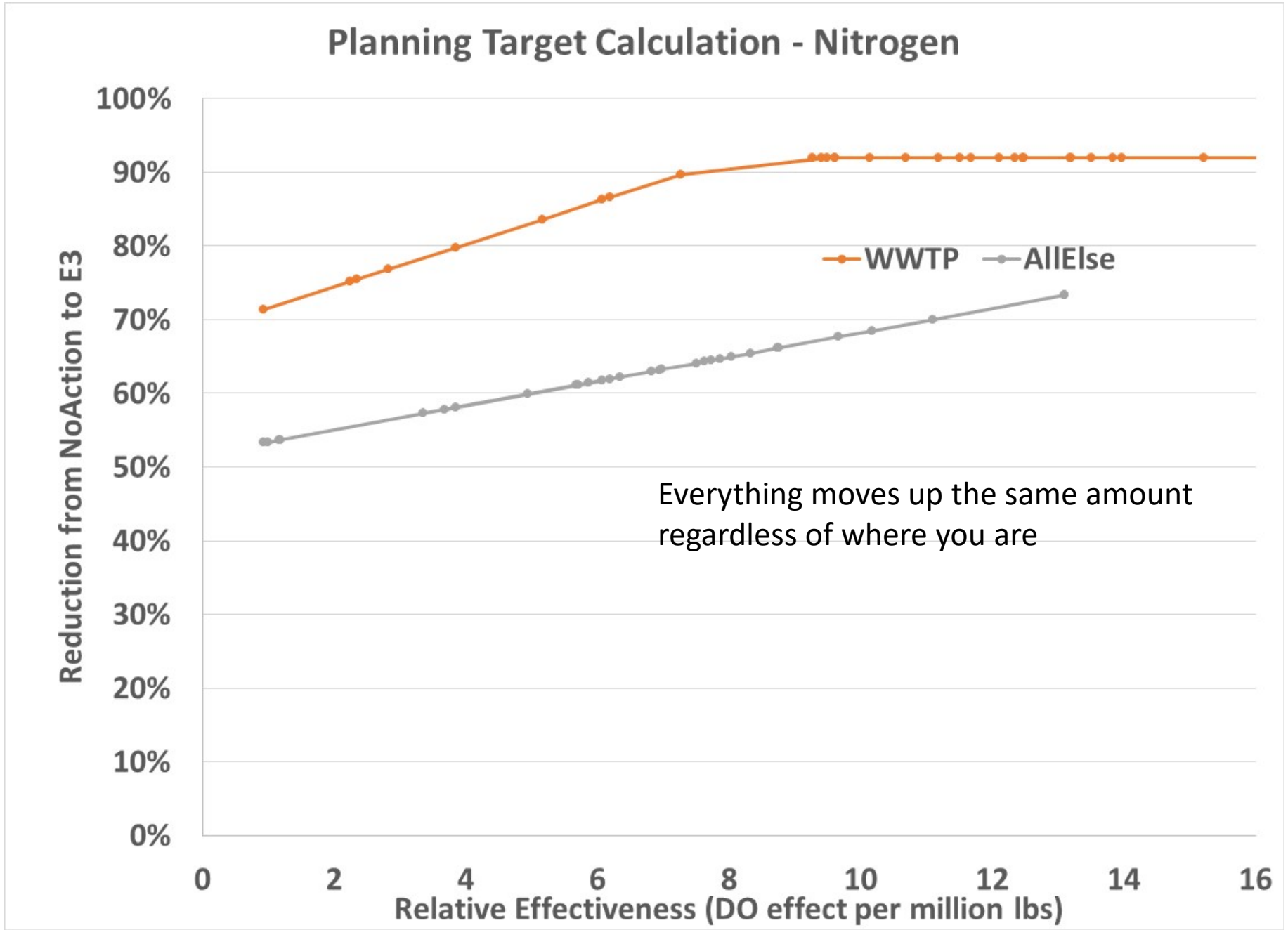

Planning Target Calculation - Nitrogen
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Reduction from NoAction to E3
WWTP
AllElse
0
2
4
6
8
10
12
14
16
Relative Effectiveness (DO effect per million lbs)


Planning Target Calculation - Nitrogen
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Reduction from NoAction to E3
WWTP
AllElse
Everything moves up the same amount regardless of where you are
0
2
4
6
8
10
12
14
16
Relative Effectiveness (DO effect per million lbs)

Climate allocation options

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  - ~~Ignore Open Water~~
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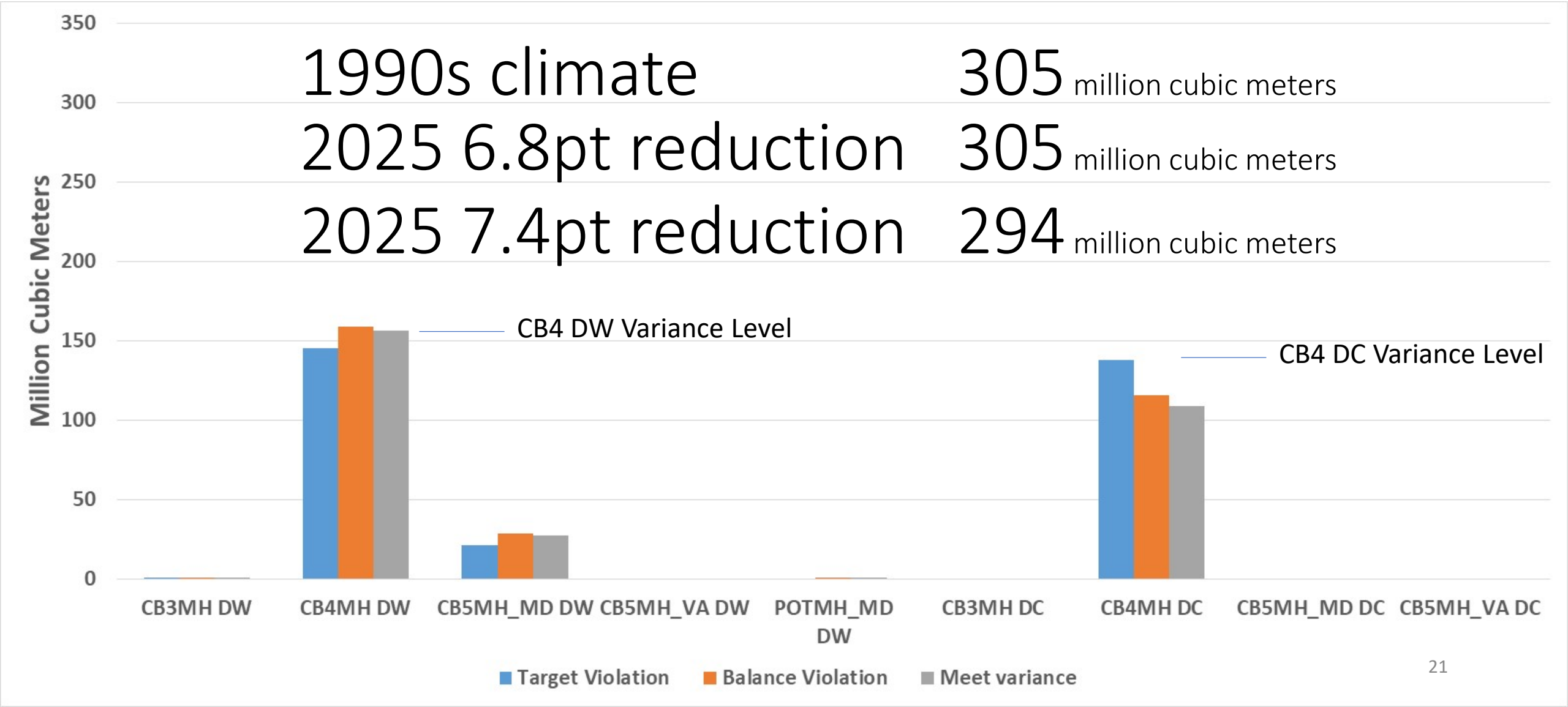
2035 DWDC lower load to meet CB4 DW



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Watershed Loads First

- Ran WQSTM run to show reduced non-attainment for jurisdiction reductions equal to the climate load increase
- Allocated remaining effect

	Climate Increase		Allocated Additional Reduction		Total Reduction
DC	0.00		0.00		0.00
DE	0.00		0.01		0.01
MD	0.11		0.09		0.20
NY	0.04	+	0.01	=	0.06
PA	0.09		0.12		0.21
VA	0.34		0.16		0.49
WV	0.01		0.01		0.02
Total	0.60		0.40		1.00

Climate allocation options

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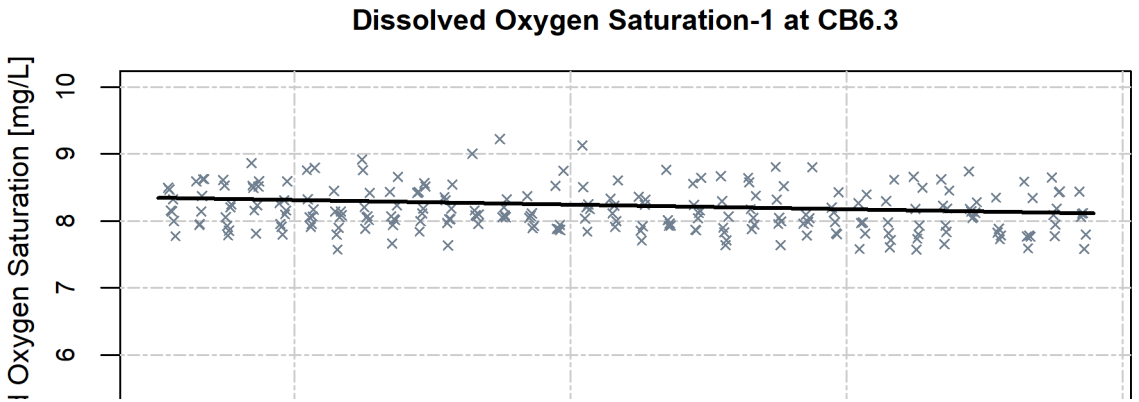
Open water is important!

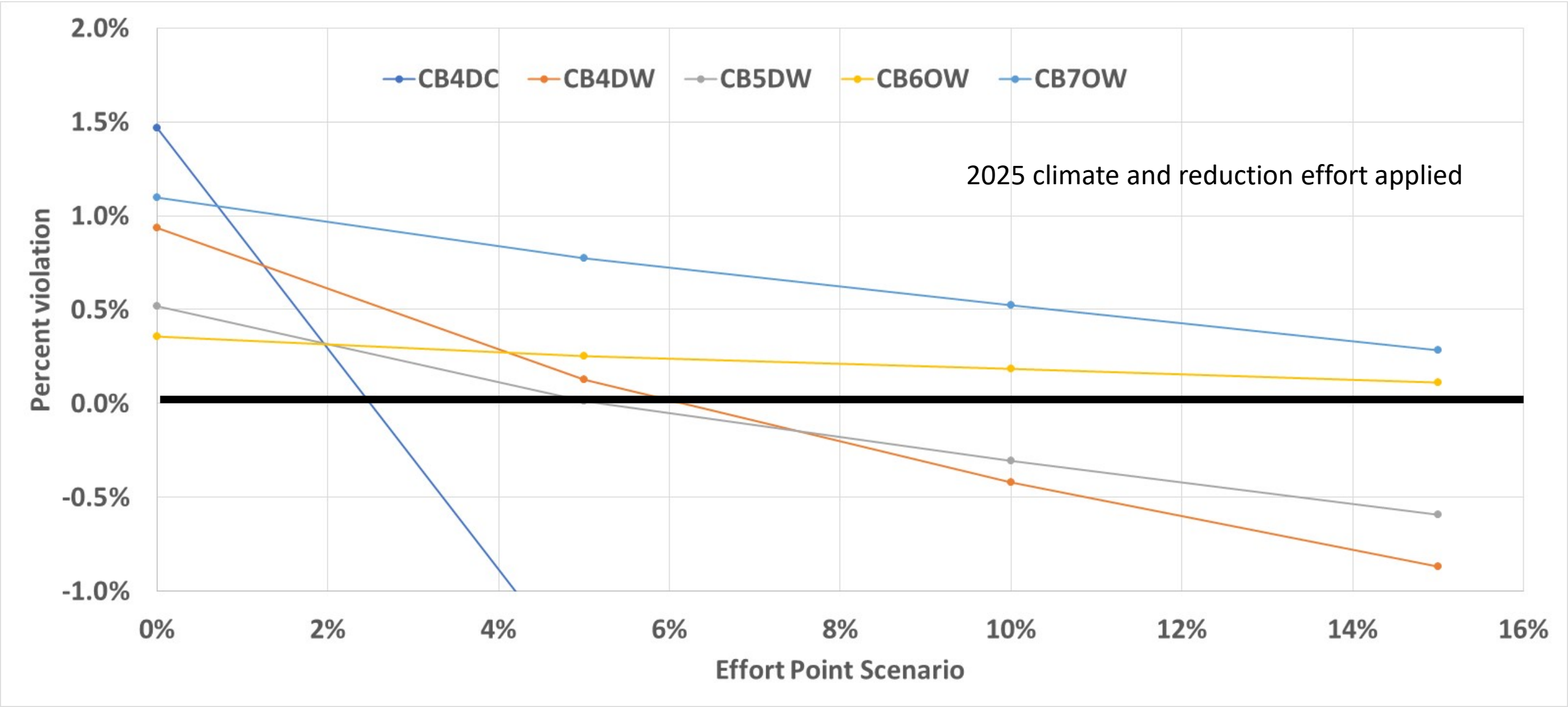
- The OW criteria are based on living resource needs for striped bass and other important species
- There is a huge amount of open water (2/3 of the Bay)
- It’s the part of the bay that humans interact with

Open water is likely affected by climate change

- Climate change is decreasing the saturation concentration of oxygen
- Open water is more often saturated or super saturated so it will be decreased by a lowering of the saturation level
- Deep water and Deep Channel rarely approach saturation, so lowering of the saturation concentration may have less of an effect



CB6 and CB7 are less sensitive to reductions



Open Water violation rates in large CBSEGs

- Most areas do not reach violation, even by 2055
- CB6 and CB7 are much more effected

Cbseg	Planning Target	2025	2035	2045	2055
CB1TF	0.00%	0.00%	0.00%	0.00%	0.00%
CB2OH	0.00%	0.00%	0.00%	0.00%	0.00%
CB3MH	0.00%	0.00%	0.00%	0.00%	0.00%
CB4MH	0.00%	0.00%	0.00%	0.00%	0.00%
CB5MH_MD	0.00%	0.00%	0.00%	0.00%	0.00%
CB5MH_VA	0.00%	0.00%	0.00%	0.00%	0.00%
CB6PH	0.03%	0.39%	0.71%	0.99%	1.29%
CB7PH	0.32%	1.41%	2.11%	3.02%	4.19%
CB8PH	0.00%	0.00%	0.00%	0.00%	0.00%

Cbseg	Planning Target	2025	2035	2045	2055
PAXMH	0.00%	0.00%	0.00%	0.00%	0.03%
POTMH_MD	0.00%	0.00%	0.00%	0.00%	0.00%
RPPMH	0.00%	0.00%	0.00%	0.00%	0.00%
YRKPH	0.00%	0.00%	0.00%	0.00%	0.00%
MOBPH	0.00%	0.00%	0.01%	0.11%	0.16%
JMSPH	0.00%	0.00%	0.00%	0.00%	0.00%
CHSMH	0.00%	0.00%	0.00%	0.00%	0.00%
EASMH	0.00%	0.00%	0.00%	0.00%	0.00%
CHOMH2	0.00%	0.00%	0.00%	0.00%	0.00%
TANMH_MD	0.00%	0.00%	0.00%	0.00%	0.00%
TANMH_VA	0.00%	0.00%	0.00%	0.00%	0.03%

https://www.chesapeakebay.net/content/publications/cbp_13218.pdf

Why are CB6 and CB7 acting so differently?

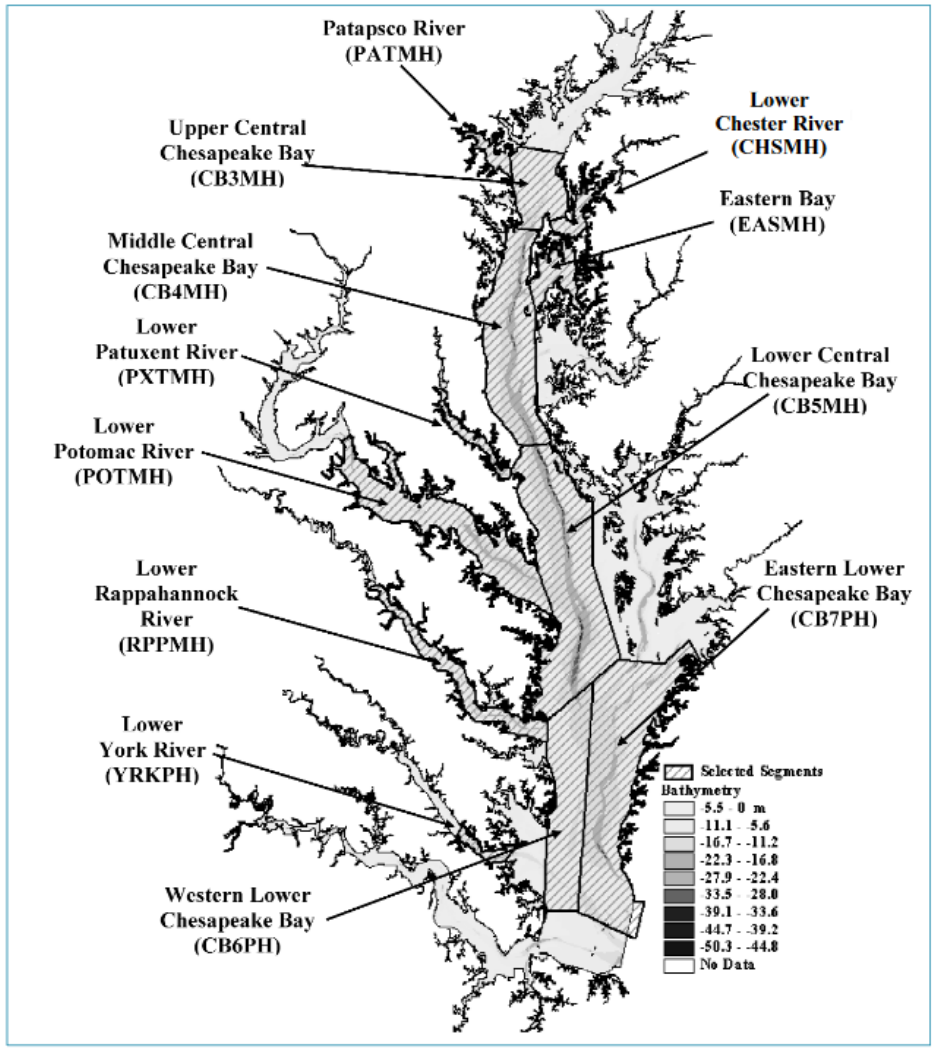


Figure IV-19. Chesapeake Bay Program segments identified as having chronic low dissolved oxygen

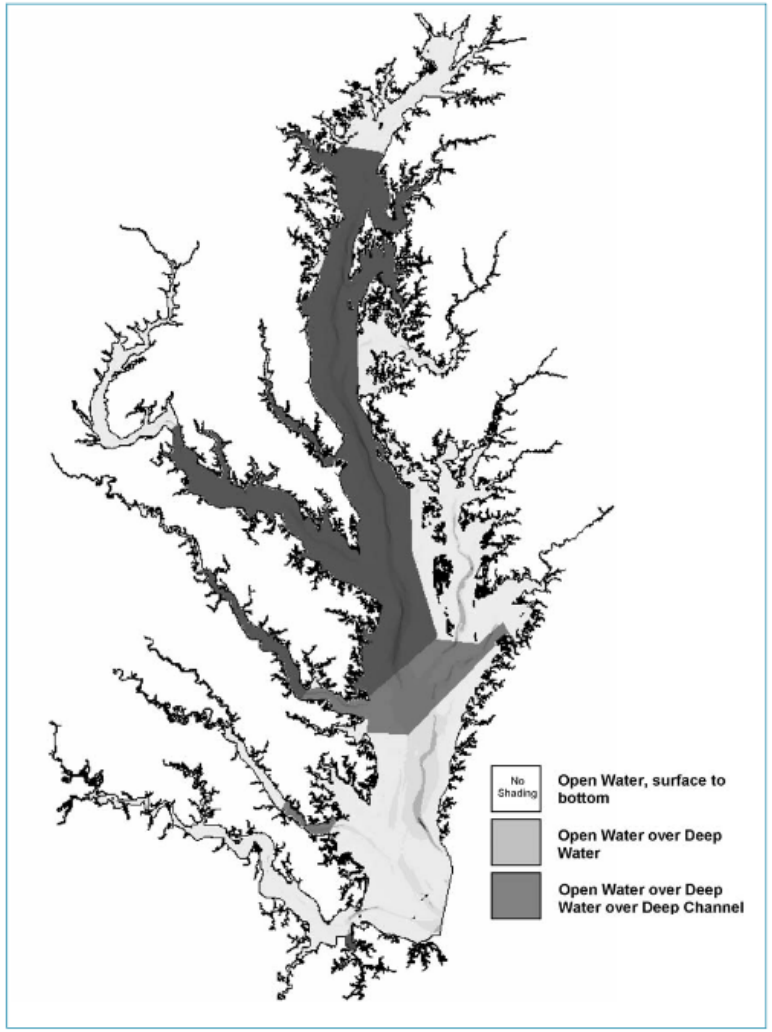
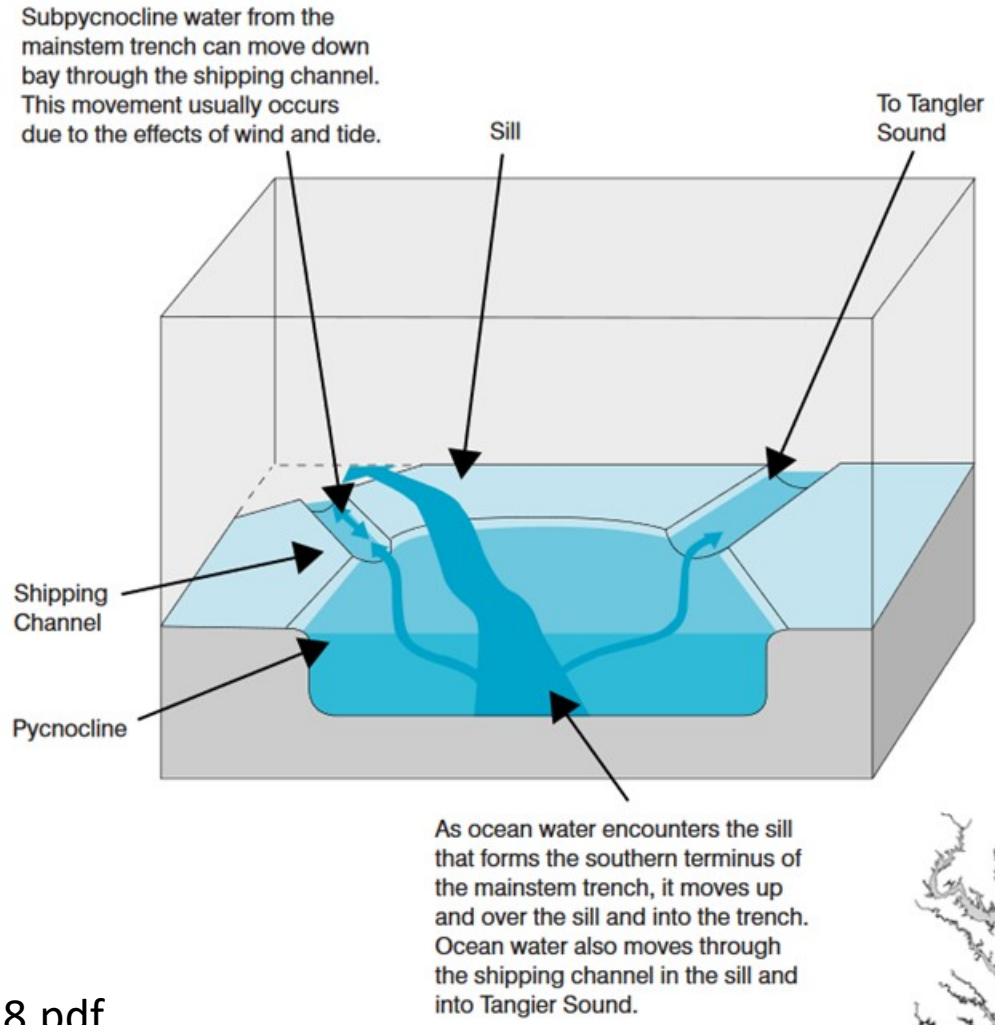


Figure IV-23. Map showing the dissolved oxygen designated uses of the Chesapeake Bay and its tidal tributaries.

- 2003 Technical Support Document

Why DW in the northern parts only?

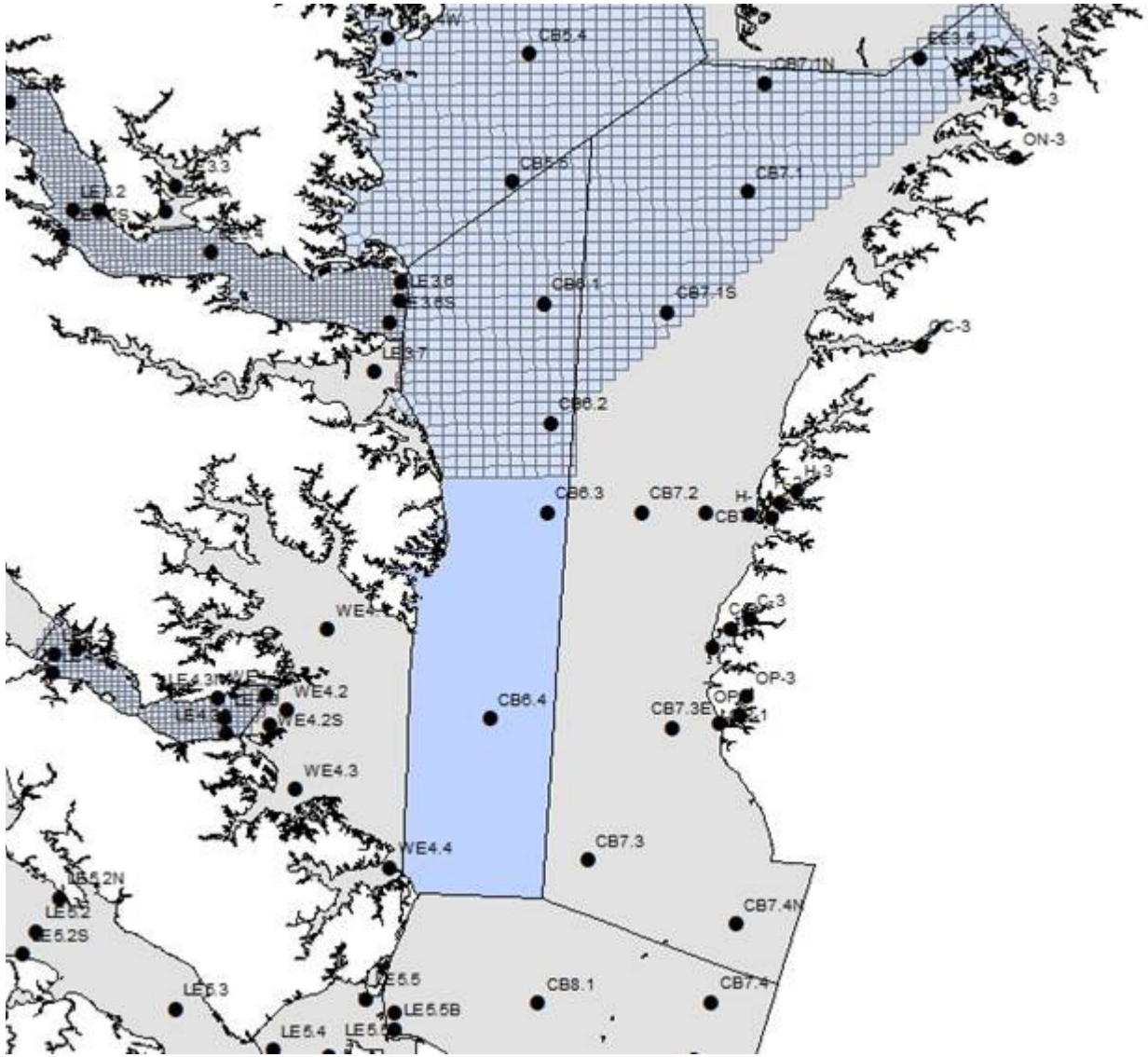
- “The deep-water designated use, therefore, extends below the sill in these two segments.”
- “The delineation of the boundary was determined by examining maps of contemporary dissolved oxygen concentration distributions and the anecdotal historical dissolved oxygen concentration data record.”



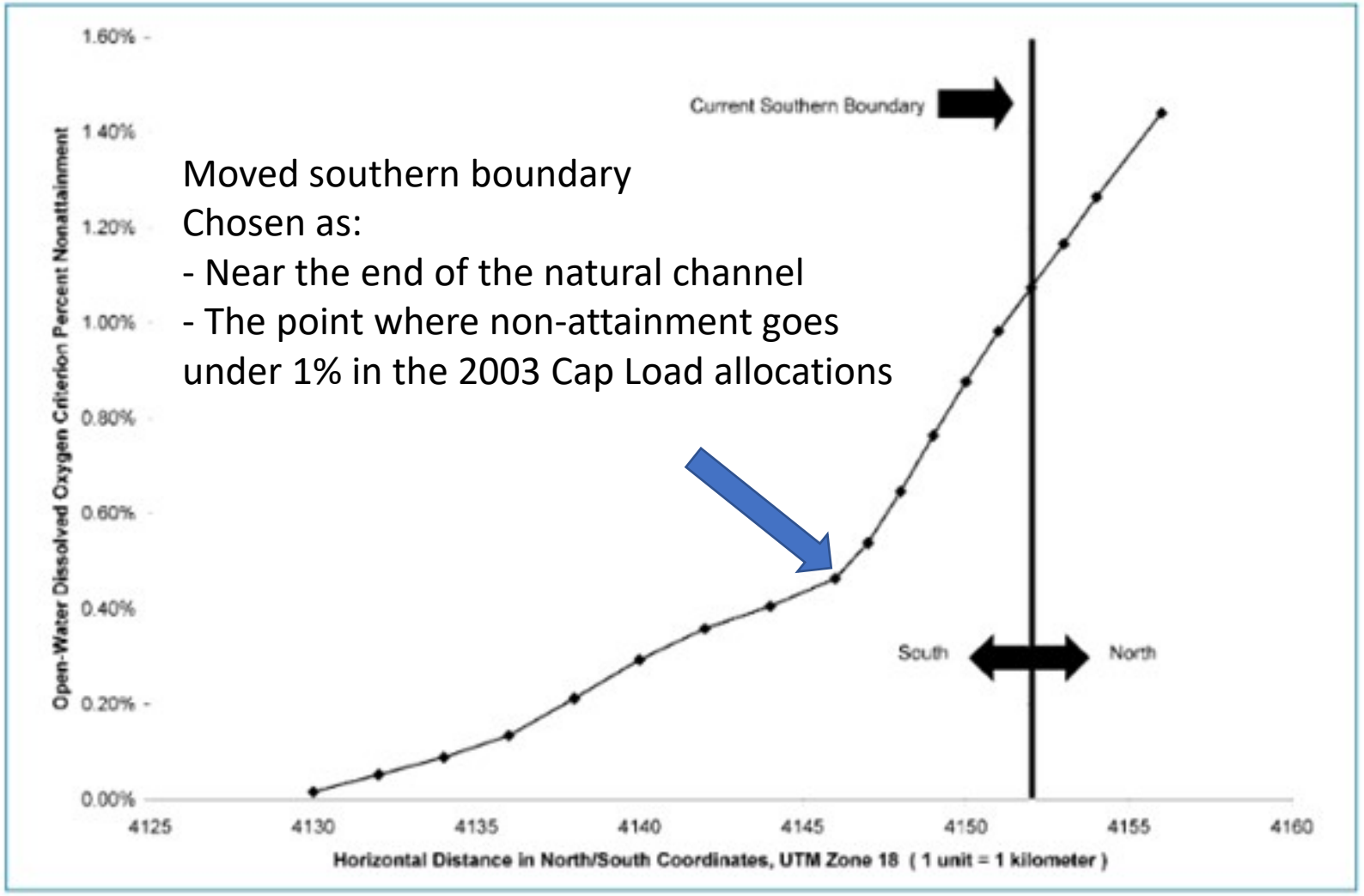
https://www.chesapeakebay.net/content/publications/cbp_13218.pdf

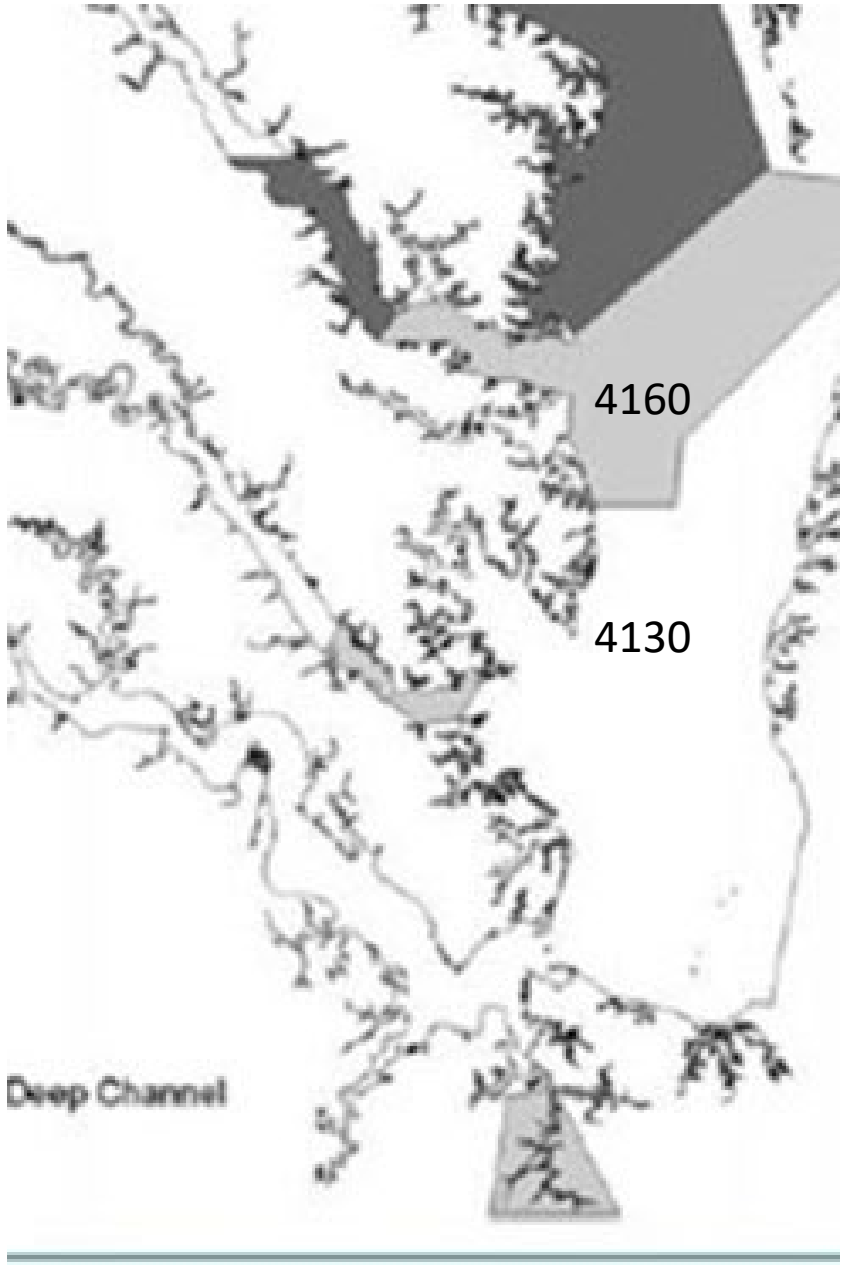
Current Map

- CB6 boundary was moved south



2004 Addendum to TSD





https://www.chesapeakebay.net/content/publications/cbp_13270.pdf

Are there violations above the pycnocline in CB6 and CB7?

- There are no violations in the surface mixed layer at 2035 at WIP implementation.
- The violation is in the deeper ocean-influence water.

Scenario	Planning Target	2025	2035	2045	2055	2035 - DW everywhere
CB1TF	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CB2OH	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CB3MH	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CB4MH	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
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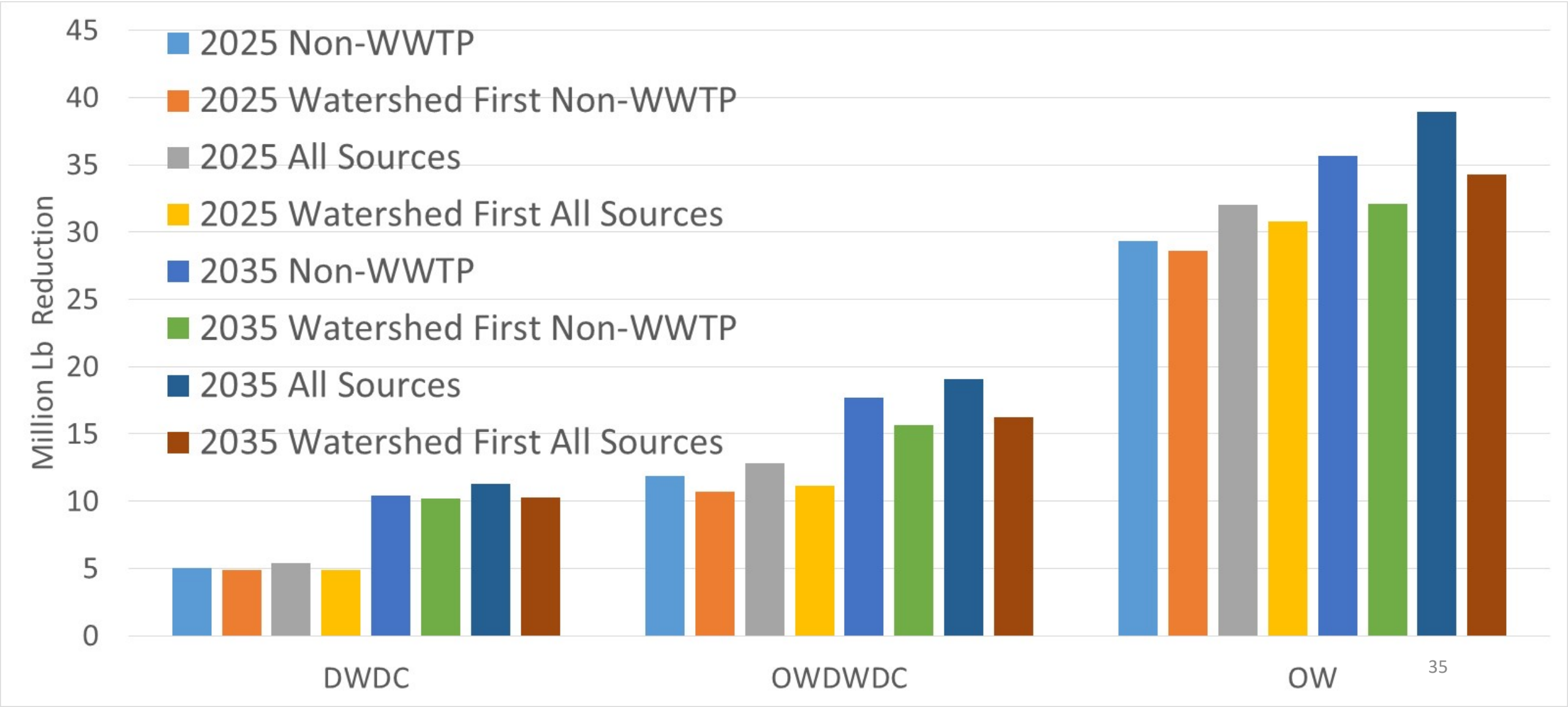
CB6PH	0.03%	0.39%	0.71%	0.99%	1.29%	0.00%
CB7PH	0.32%	1.41%	2.11%	3.02%	4.19%	0.00%
CB8PH	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Open Water Thoughts

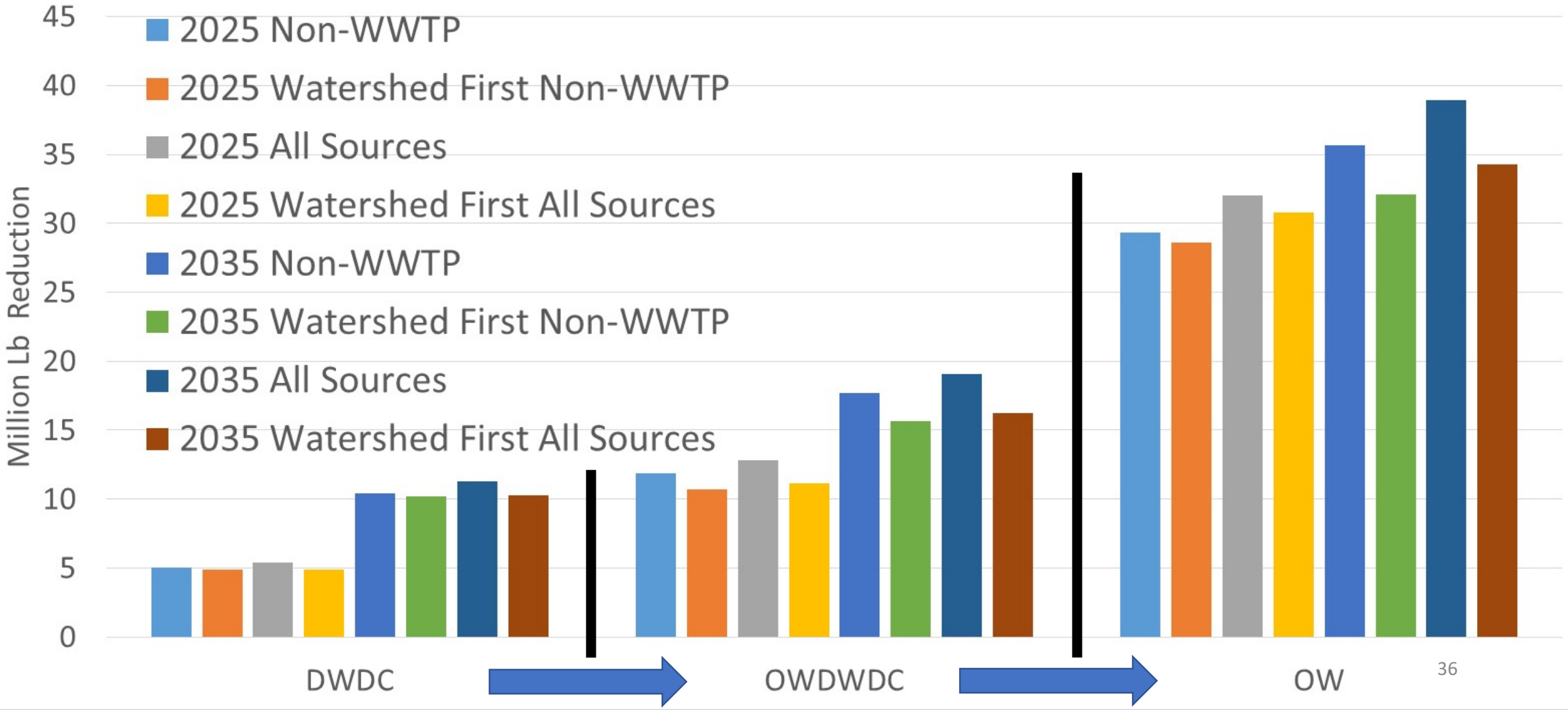
- Open water is an important use for living resources
- Open water may be more affected by temperature due to concentrations closer to saturation
- The partnership may not want to drive allocations with CB6 and CB7 open water
  - Relatively insensitive to load reductions
  - No other Mainstem Open Water violations through 2055
    - Other large rivers mostly have no violations through 2055
  - Strong dependence on the appropriate delineation between ‘Open Water over Deep Water’ and ‘Open Water to the bottom’

Nitrogen Total Reductions



Nitrogen Total Reductions

- **Open Water is a big lift**
- 2035 increases effort substantially
- Including WWTP increases necessary reductions
- Watershed loads first are a little lower for N



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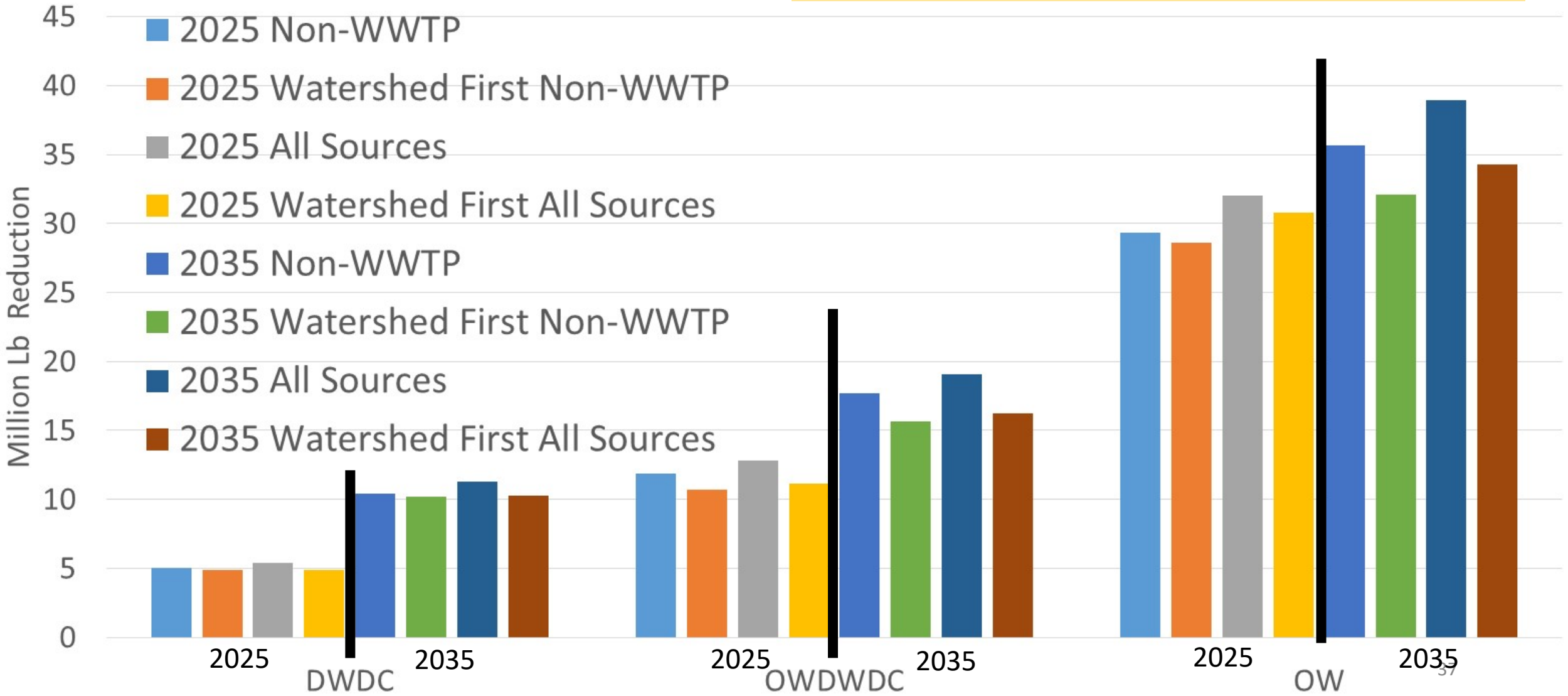

Nitrogen Total Reduction

- Open Water is a big lift
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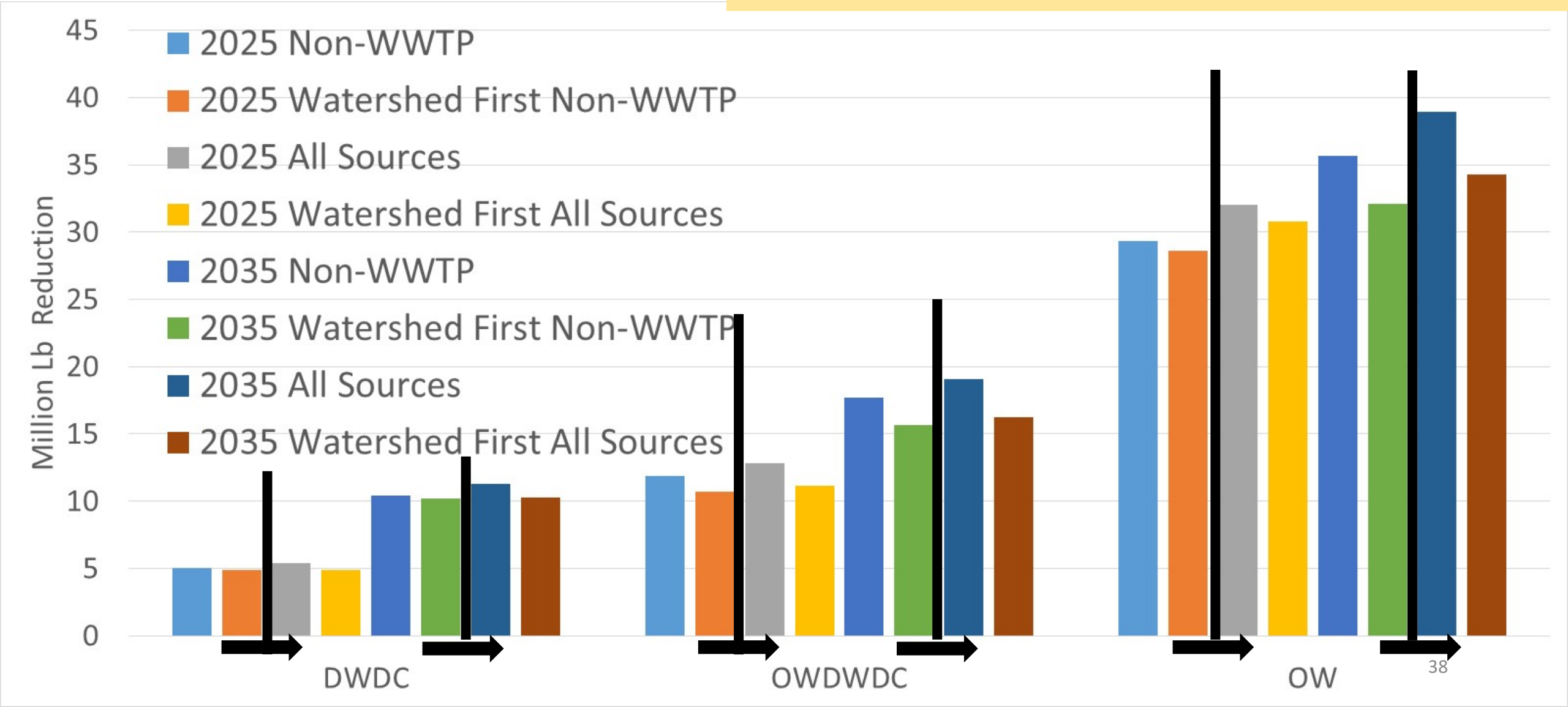

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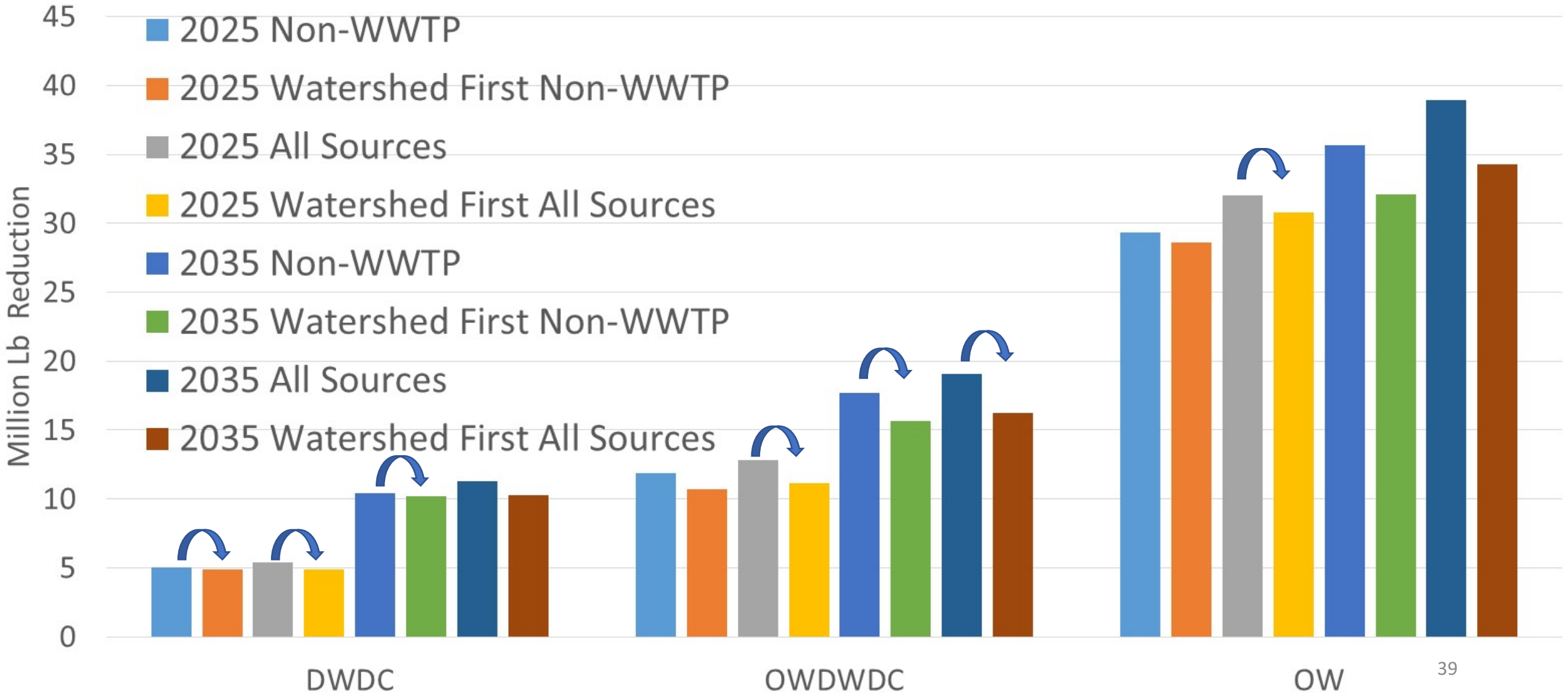

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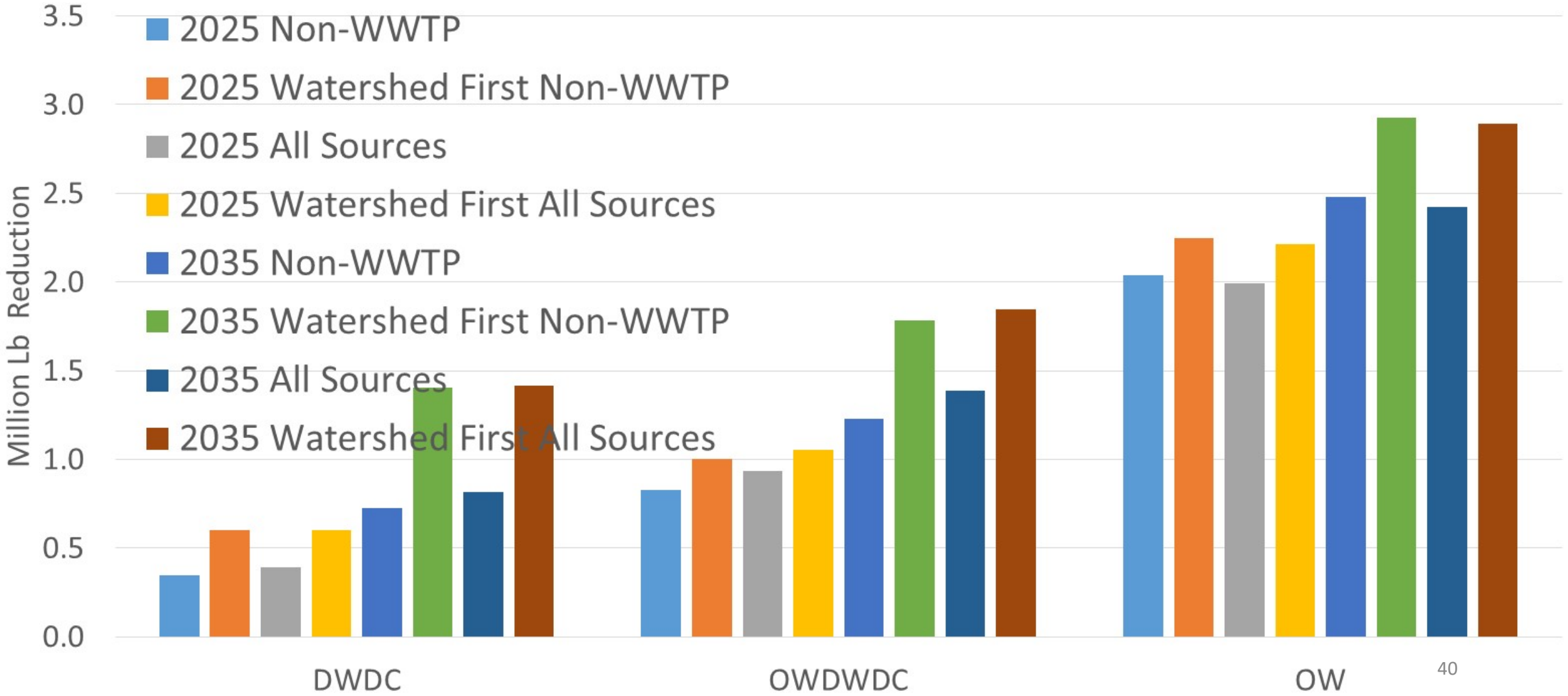

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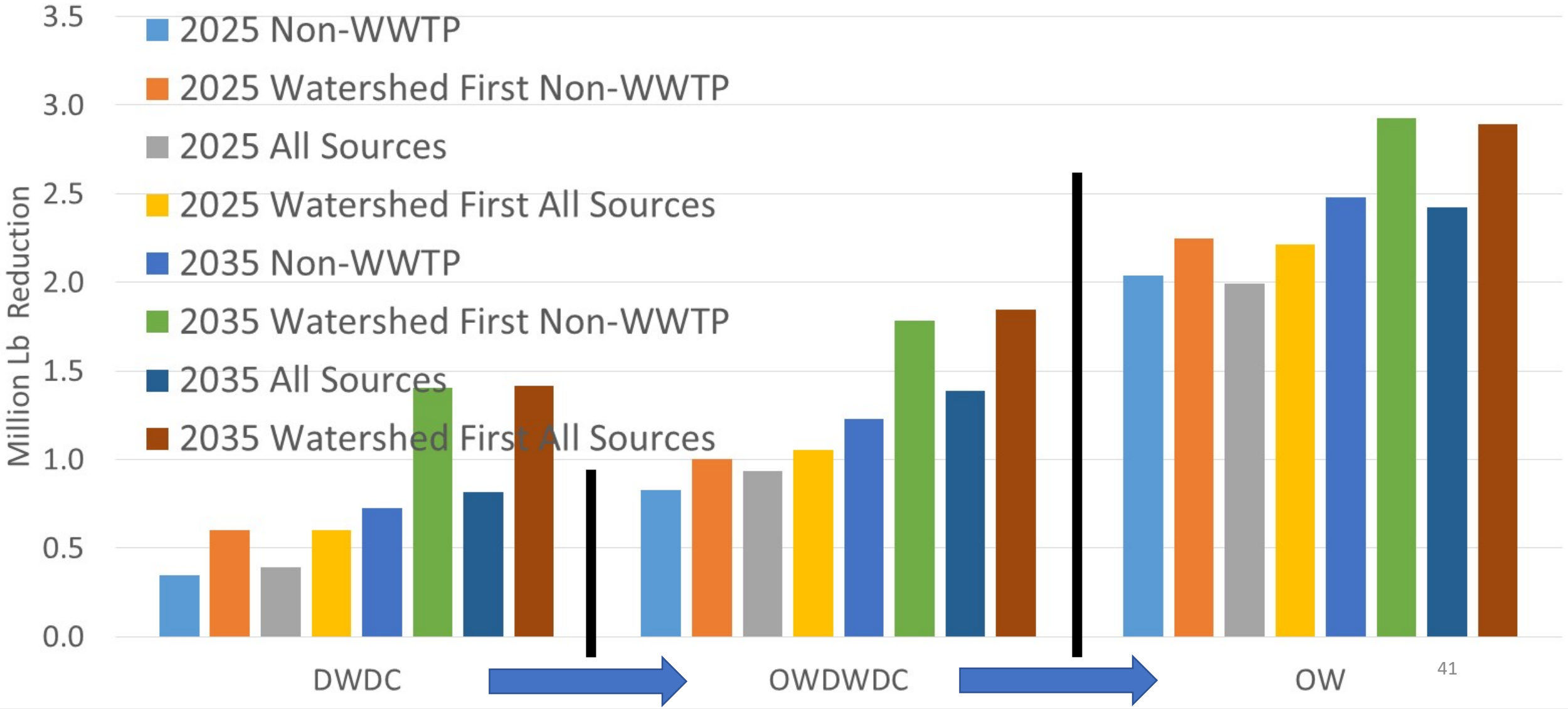

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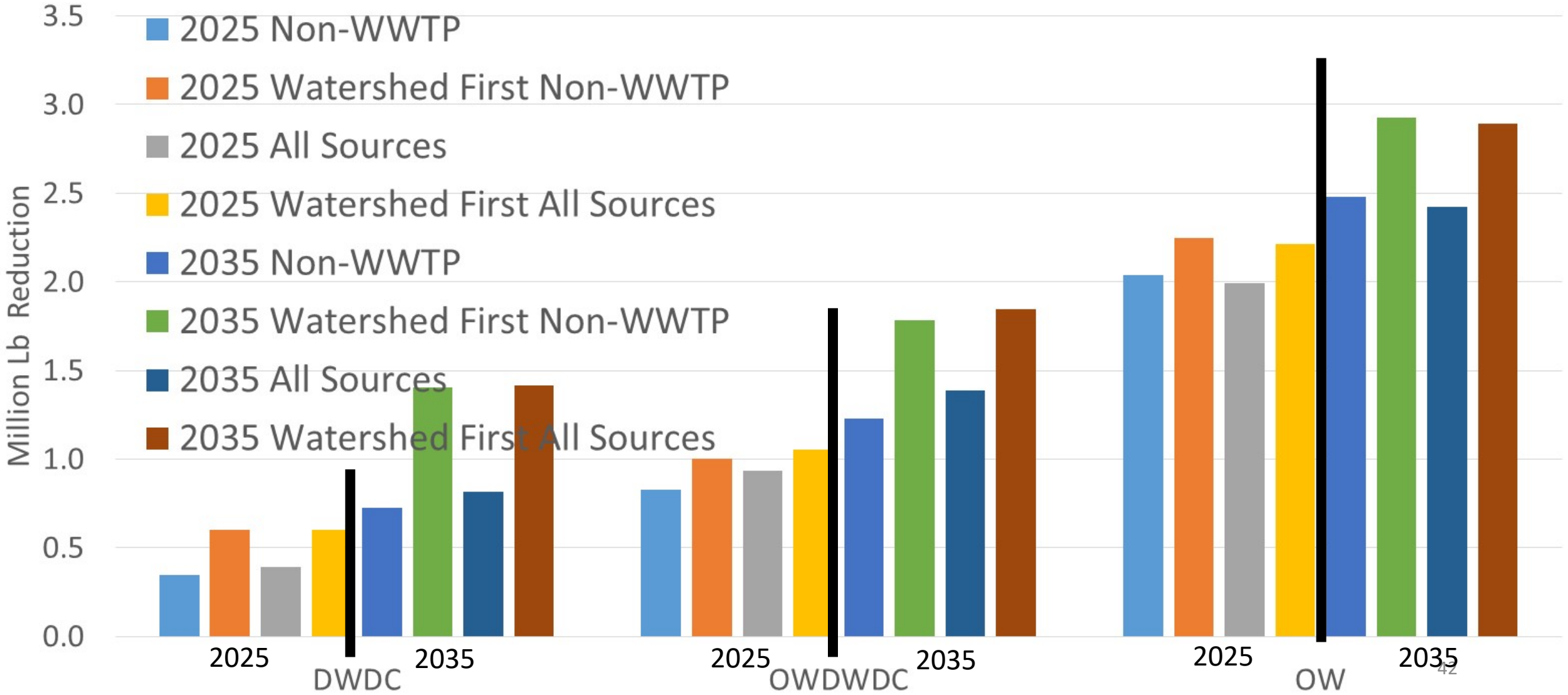

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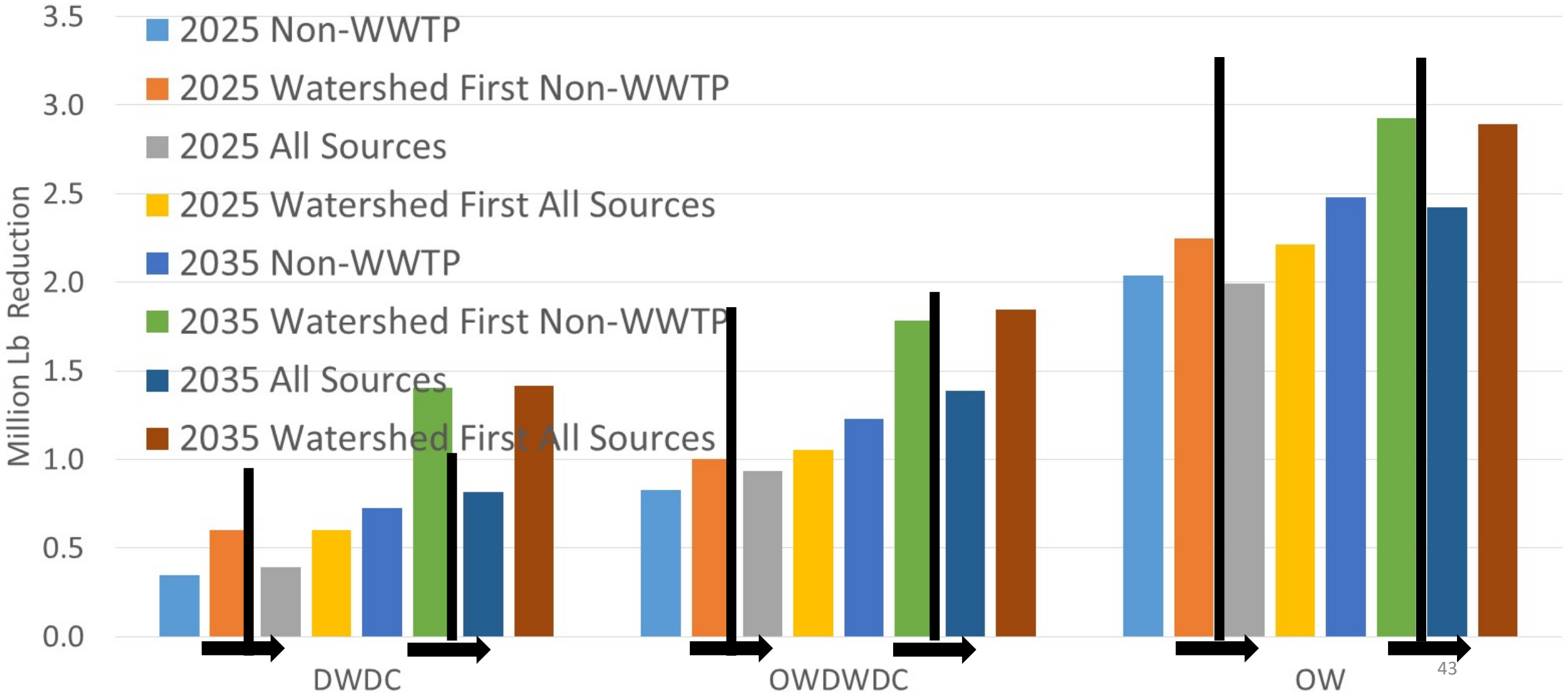

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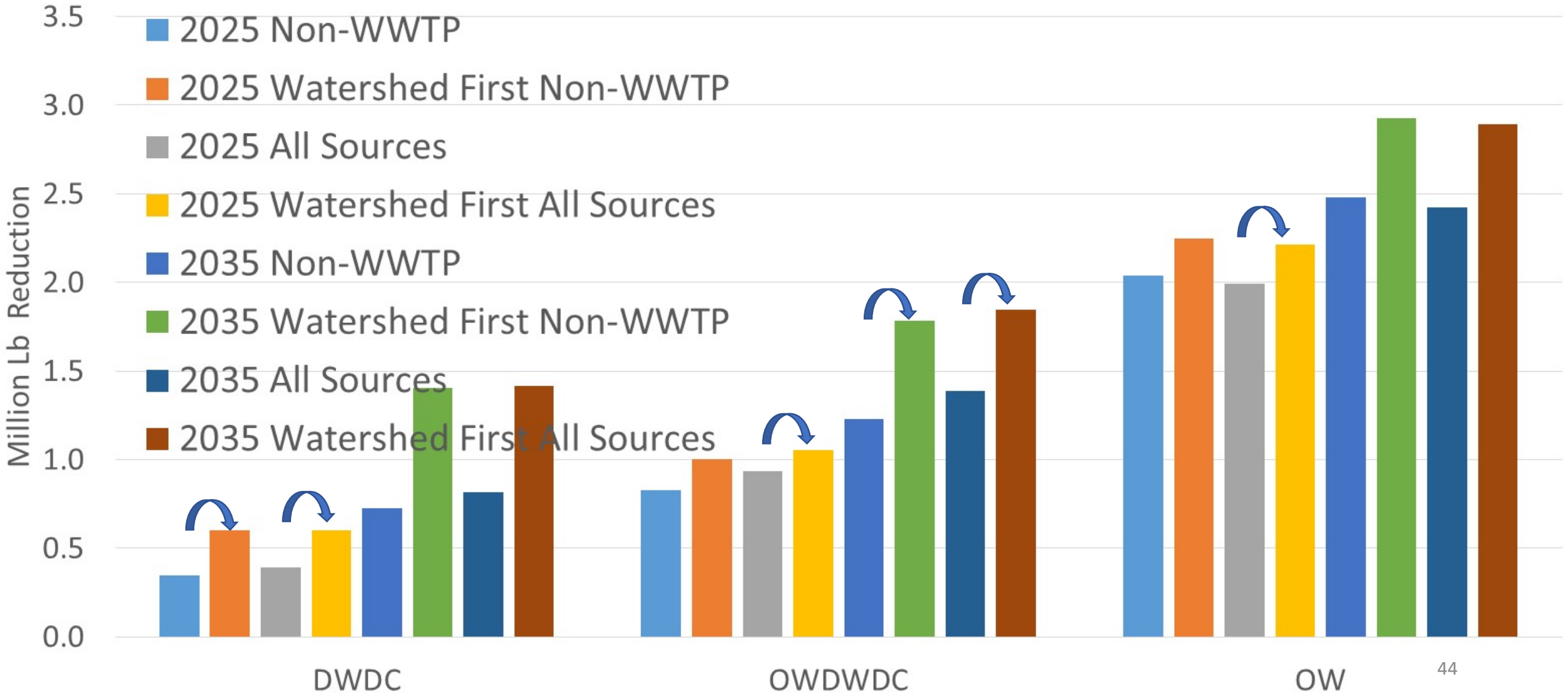
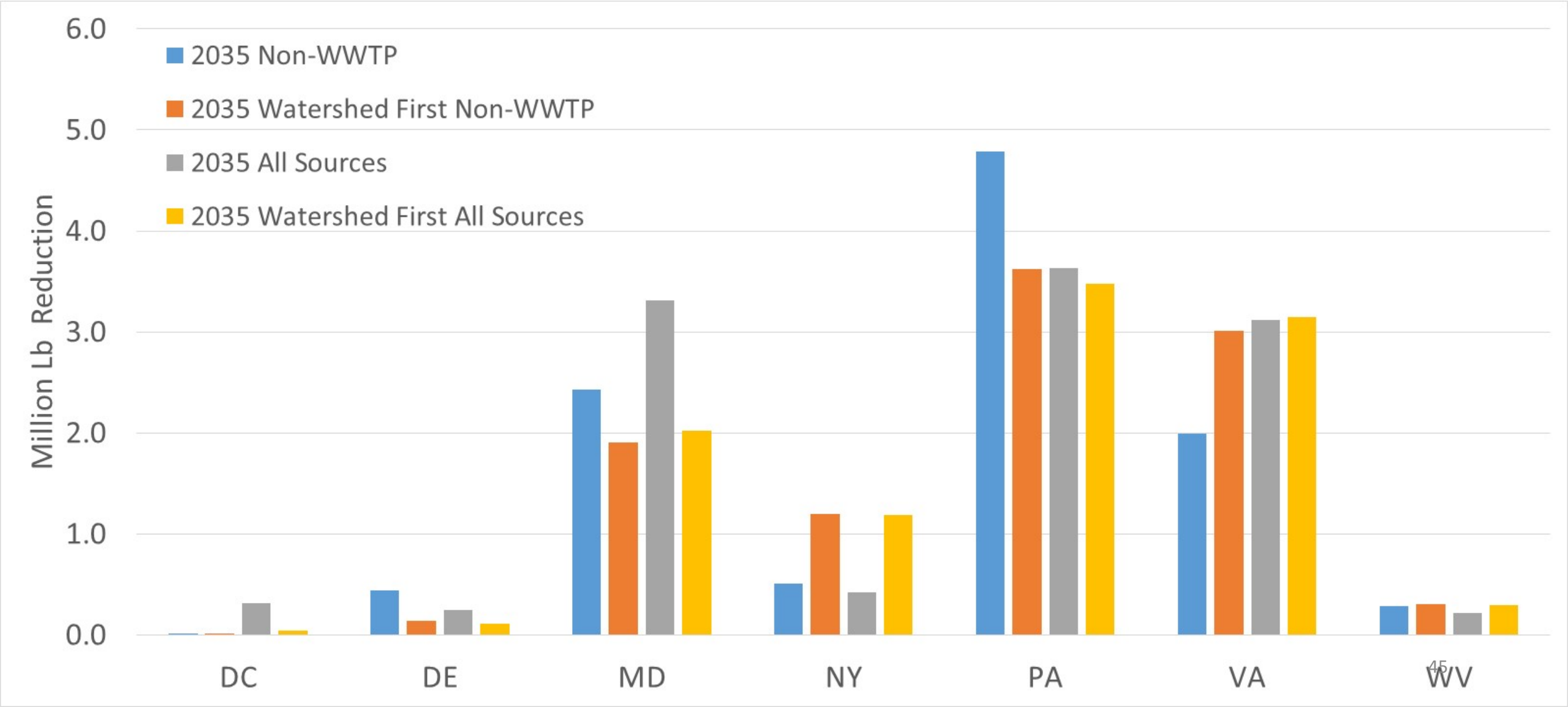


Nitrogen DWDC Reductions

- Watershed loads first vs allocation
  - Most jurisdictions have big changes
- Including WWTP increases DC, MD, VA effort
- 2035 increases effort substantially for everyone



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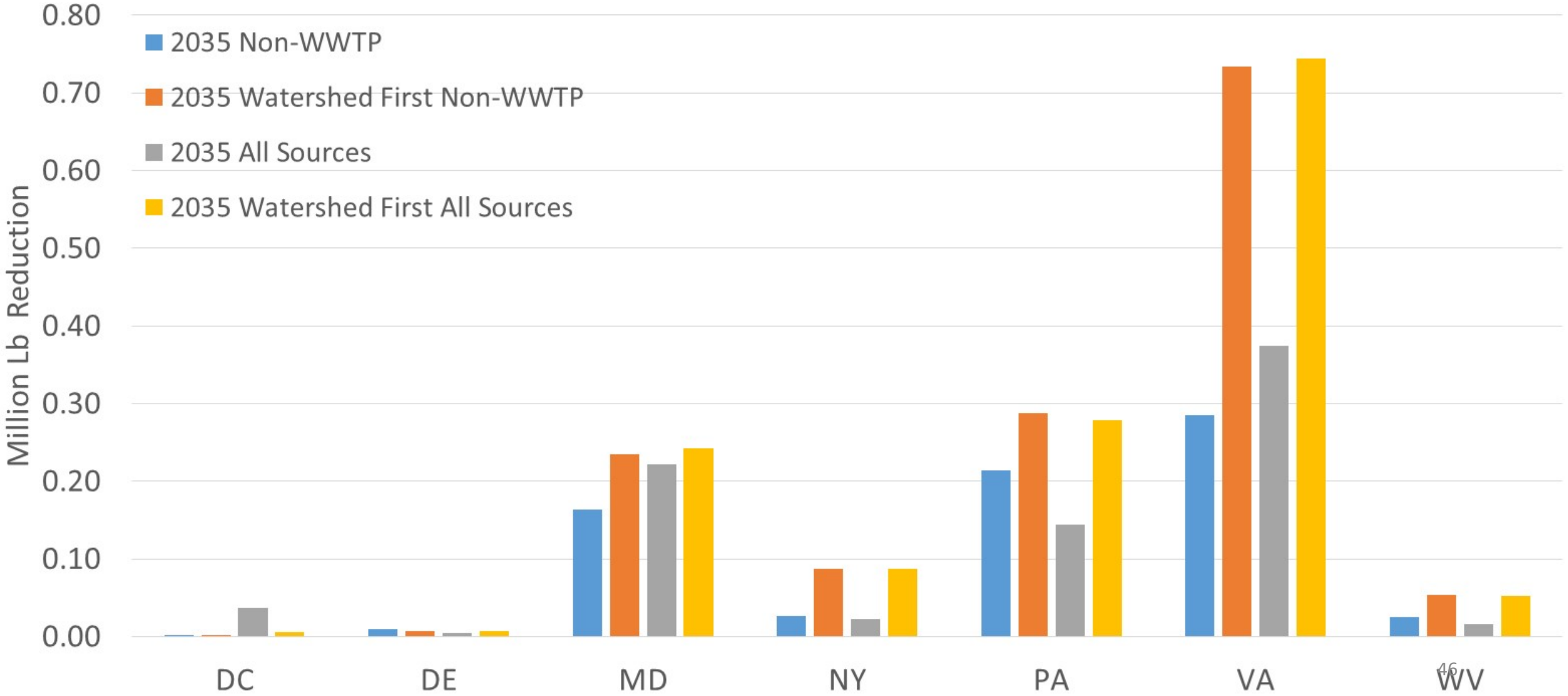

Summary – allocation options ready

- Include CB6 and CB7 Open Water?
- Include responsibility for WWTP loads?
- Reduce watershed loads first and allocate the rest?
- 2025 or 2035?

Include WWTP	Non-WWTP	Non-WWTP	Non-WWTP	Non-WWTP	All Sources	All Sources	All Sources	All Sources	Non-WWTP	Non-WWTP	Non-WWTP	Non-WWTP	All Sources	All Sources	All Sources	All Sources
DU	DWDC	DWDC	DWDC	DWDC	DWDC	DWDC	DWDC	DWDC	DWDC	DWDC	DWDC	DWDC	DWDC	DWDC	DWDC	DWDC
Scenario	C25	C35	25 L1st	35 L1st	C25	C35	25 L1st	35 L1st	C25	C35	25 L1st	35 L1st	C25	C35	25 L1st	35 L1st
State	TN	TN	TN	TN	TN	TN	TN	TN	TP	TP	TP	TP	TP	TP	TP	TP
DC	0.00	0.01	0.00	0.00	0.15	0.32	0.00	0.04	0.00	0.00	0.00	0.00	0.02	0.04	0.00	0.00
DE	0.21	0.44	0.00	0.06	0.12	0.24	0.00	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
MD	1.16	2.43	0.00	0.31	1.59	3.31	0.00	0.42	0.08	0.16	0.00	0.02	0.11	0.22	0.00	0.03
NY	0.24	0.50	0.00	0.06	0.20	0.42	0.00	0.05	0.01	0.03	0.00	0.00	0.01	0.02	0.00	0.00
PA	2.30	4.79	0.00	0.60	1.74	3.63	0.00	0.46	0.10	0.21	0.00	0.03	0.07	0.14	0.00	0.02
VA	0.96	1.99	0.00	0.25	1.50	3.12	0.00	0.39	0.14	0.29	0.00	0.04	0.18	0.37	0.00	0.05
WV	0.14	0.29	0.00	0.04	0.10	0.21	0.00	0.03	0.01	0.03	0.00	0.00	0.01	0.02	0.00	0.00
Total	5.01	10.45	0.00	1.32	5.40	11.25	0.00	1.42	0.35	0.73	0.00	0.09	0.39	0.82	0.00	0.10

Include WWTP	Non-WWTP	Non-WWTP	Non-WWTP	Non-WWTP	All Sources	All Sources	All Sources	All Sources	Non-WWTP	Non-WWTP	Non-WWTP	Non-WWTP	All Sources	All Sources	All Sources	All Sources
DU	OW	OW	OW	OW	OW	OW	OW	OW	OW	OW	OW	OW	OW	OW	OW	OW
Scenario	C25	C35	25 L1st	35 L1st	C25	C35	25 L1st	35 L1st	C25	C35	25 L1st	35 L1st	C25	C35	25 L1st	35 L1st
State	TN	TN	TN	TN	TN	TN	TN	TN	TP	TP	TP	TP	TP	TP	TP	TP
DC	0.02	0.02	0.02	0.02	0.90	1.09	0.73	0.71	0.00	0.01	0.00	0.00	0.09	0.11	0.07	0.07
DE	1.24	1.51	1.00	0.98	0.69	0.84	0.56	0.55	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.01
MD	6.81	8.28	5.51	5.40	9.43	11.46	7.63	7.48	0.46	0.56	0.37	0.36	0.54	0.66	0.44	0.43
NY	1.41	1.72	1.14	1.12	1.19	1.45	0.97	0.95	0.07	0.09	0.06	0.06	0.05	0.07	0.04	0.04
PA	13.44	16.34	10.87	10.66	10.32	12.54	8.35	8.18	0.60	0.73	0.49	0.48	0.35	0.42	0.28	0.28
VA	5.60	6.81	4.53	4.44	8.88	10.79	7.18	7.04	0.80	0.97	0.65	0.63	0.91	1.11	0.74	0.72
WV	0.81	0.98	0.65	0.64	0.61	0.74	0.49	0.48	0.07	0.09	0.06	0.06	0.04	0.05	0.03	0.03
Total	29.34	35.65	23.72	23.26	32.03	38.92	25.90	25.39	2.04	2.48	1.65	1.62	1.99	2.42	1.61	1.58

Include WWTP	Non-WWTP	Non-WWTP	Non-WWTP	Non-WWTP	All Sources	All Sources	All Sources	All Sources	Non-WWTP	Non-WWTP	Non-WWTP	Non-WWTP	All Sources	All Sources	All Sources	All Sources
DU	OWDWDC	OWDWDC	OWDWDC	OWDWDC	OWDWDC	OWDWDC	OWDWDC	OWDWDC	OWDWDC	OWDWDC	OWDWDC	OWDWDC	OWDWDC	OWDWDC	OWDWDC	OWDWDC
Scenario	C25	C35	25 L1st	35 L1st	C25	C35	25 L1st	35 L1st	C25	C35	25 L1st	35 L1st	C25	C35	25 L1st	35 L1st
State	TN	TN	TN	TN	TN	TN	TN	TN	TP	TP	TP	TP	TP	TP	TP	TP
DC	0.01	0.01	0.00	0.00	0.36	0.54	0.18	0.21	0.00	0.00	0.00	0.00	0.04	0.06	0.02	0.02
DE	0.50	0.75	0.24	0.29	0.28	0.41	0.13	0.16	0.01	0.02	0.01	0.01	0.00	0.01	0.00	0.00
MD	2.76	4.10	1.34	1.58	3.78	5.61	1.84	2.16	0.19	0.28	0.09	0.11	0.25	0.38	0.12	0.15
NY	0.57	0.85	0.28	0.33	0.48	0.71	0.23	0.27	0.03	0.04	0.01	0.02	0.03	0.04	0.01	0.01
PA	5.45	8.10	2.65	3.12	4.14	6.14	2.01	2.37	0.24	0.36	0.12	0.14	0.16	0.24	0.08	0.09
VA	2.27	3.37	1.10	1.30	3.56	5.29	1.73	2.04	0.32	0.48	0.16	0.19	0.43	0.63	0.21	0.24
WV	0.33	0.49	0.16	0.19	0.24	0.36	0.12	0.14	0.03	0.04	0.01	0.02	0.02	0.03	0.01	0.01
Total	11.90	17.67	5.79	6.81	12.84	19.06	6.24	7.34	0.83	1.23	0.40	0.47	0.93	1.39	0.45	0.53

Variance and load balance

			Red Percent						Red volume					Points to restore		
CB Seg	DU	Tot volume	Max	Planning Target	PT + Climate 2025	PT + CC25 + 5point	PT + CC25 + 10point	PT + CC25 + 15point	Planning Target	PT + Climate 2025	PT + CC25 + 5point	PT + CC25 + 10point	PT + CC25 + 15point	Variance	Planning Target	Volume
CB3MH	DW	864	1.49%	0.05%	0.06%	0.06%	0.05%	0.05%	0.43	0.52	0.52	0.43	0.43	0	0.1	
CB4MH	DW	2854	5.49%	5.09%	6.03%	5.21%	4.67%	4.22%	145.26	171.97	148.82	133.19	120.47	0.03301	0.061381	
CB5MH_MI	DW	2097	1.49%	1.00%	1.52%	1.01%	0.69%	0.40%	20.90	31.80	21.16	14.51	8.44	0.002612	0.051982	
CB5MH_VA	DW	1605	1.49%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00	0.00	0.00	0.00	0.00	0	0	
POTMH_M	DW	1839	1.49%	0.00%	0.03%	0.00%	0.00%	0.00%	0.00	0.53	0.09	0.05	-0.06	0	0	
CB3MH	DC	390	1.49%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00	0.00	0.00	0.00	0.00	0	0	
CB4MH	DC	2126	6.49%	6.49%	7.96%	5.01%	2.81%	1.15%	137.96	169.12	106.57	59.74	24.49	0.024911	0.024911	
CB5MH_MI	DC	2875	1.49%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00	0.00	0.00	0.00	0.00	0	0	
CB5MH_VA	DC	1848	1.49%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00	0.00	0.00	0.00	0.00	0	0	
								Vol=>	304.55	373.93	277.17	207.92	153.77			0.035852
				Point=>	0	0.05	0.1	0.15		0	0.05	0.1	0.15			
													Final =>		0.1	0.035852

		Planning Target	PT + Climate 2025	PT + CC25 + 5point	PT + CC25 + 10point	PT + CC25 + 15point
CB4MH	DW	5.74%	6.67%	5.86%	5.31%	4.87%
CB4MH	DC	6.59%	8.06%	5.12%	2.91%	1.26%

Original values from runs

Variance and load balance

			Red Percent						Red volume					Points to restore		
CB Seg	DU	Tot volume	Max	Planning Target	PT + Climate 2035	PT + CC35 + 5point	PT + CC35 + 10point	PT + CC35 + 15point	Planning Target	PT + Climate 2035	PT + CC35 + 5point	PT + CC35 + 10point	PT + CC35 + 15point	Variance	Planning Target	Volume
CB3MH	DW	864	1.49%	0.05%	0.20%	0.06%	0.06%	0.05%	0.43	1.71	0.52	0.52	0.43	0	0.15	
CB4MH	DW	2854	5.49%	5.09%	6.70%	5.82%	5.16%	4.61%	145.26	191.24	165.99	147.17	131.69	0.07472	0.106175	
CB5MH_MI	DW	2097	1.49%	1.00%	2.01%	1.56%	1.03%	0.69%	20.90	42.07	32.69	21.51	14.52	0.056438	0.104352	
CB5MH_VA	DW	1605	1.49%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00	0.00	0.00	0.00	0.00	0	0	
POTMH_M	DW	1839	1.49%	0.00%	0.15%	0.05%	0.00%	0.00%	0.00	2.73	0.89	0.09	-0.03	0	0	
CB3MH	DC	390	1.49%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00	0.00	0.00	0.00	0.00	0	0	
CB4MH	DC	2126	6.49%	6.49%	9.64%	6.36%	3.87%	1.65%	137.96	205.01	135.18	82.32	35.08	0.048015	0.048015	
CB5MH_MI	DC	2875	1.49%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00	0.00	0.00	0.00	0.00	0	0	
CB5MH_VA	DC	1848	1.49%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00	0.00	0.00	0.00	0.00	0	0	
								Vol=>	304.55	442.78	335.27	251.61	181.68			0.068363
				Point=>	0	0.05	0.1	0.15		0	0.05	0.1	0.15			
													Final =>		0.15	0.07472