Updated Phase 6 Modeling Results for Climate Change Impacts and Climate Allocation Methods

WQGIT Recommendations to the Management Board
September 17, 2020

James Martin and Ed Dunne, WQGIT Co-Chairs

WQGIT; Gary Shenk, USGS; Lewis Linker, EPA; Richard Tian, UMCES; Gopal Bhatt, Penn State; Isabella Bertani, UMCES; Carl Cerco, Attain; and CBP Modeling Workgroup

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Overview

- **Policy Issue I:** Adoption of refined climate models and targets
- **Policy Issue II:** Year on which to base climate targets (e.g., 2025/2035/2045/2055)
- **Policy Issue III:** Timing options for achieving the climate targets (By 2025? Post-2025? Date certain post-2025?)
- **Policy Issue IV:** Options for allocating climate targets (pollutant loads) amongst the jurisdictions

- 10 Recommendations from the WQGIT
- 1 Recommendation pending

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Previous PSC 2025 Climate Change Decisions

1. Incorporate Climate Change in the Phase III WIPs

Include a narrative strategy in the Phase III WIPs that describe the jurisdictions current action plans and strategies to address climate change, as well as the jurisdiction-specific nutrient and sediment pollution loadings due to 2025 climate change conditions, while incorporating local priorities and actions to address climate change impacts.

2. Understand the Science

Address the uncertainty by documenting the current understanding of the science and identifying research gaps and needs:

a) Develop an estimate of pollutant load changes (N, P and Sediment) due to climate change conditions.
b) Develop a better understanding of the BMP responses, including new or other emerging BMPs, to climate change conditions.
c) In 2021, the Partnership will consider results of updated methods, techniques, and studies and revisit existing estimated loads due to climate change to determine if any updates to those load estimates are needed.
d) Jurisdictions will be expected to account for additional nutrient and sediment pollutant loads due to 2025 climate change conditions in a Phase III WIP addendum and/or 2-year milestones beginning in 2022.

3. Incorporate into Milestones

Starting with the 2022-2023 milestones, determine how climate change will impact the BMPs included in the WIPs and address these vulnerabilities in the two-year milestones.

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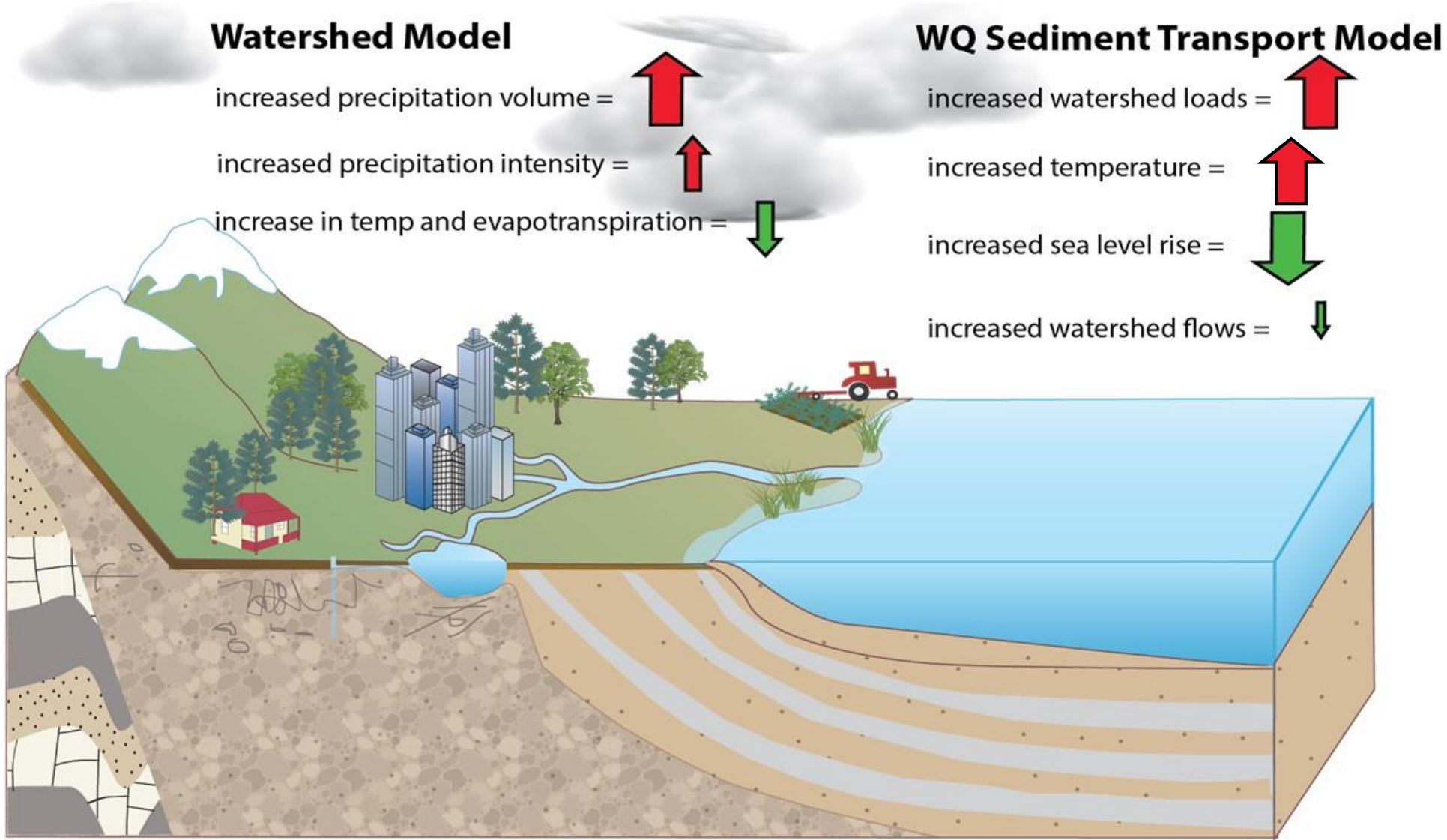
Components of Climate Change – Effect on Tidal Dissolved Oxygen



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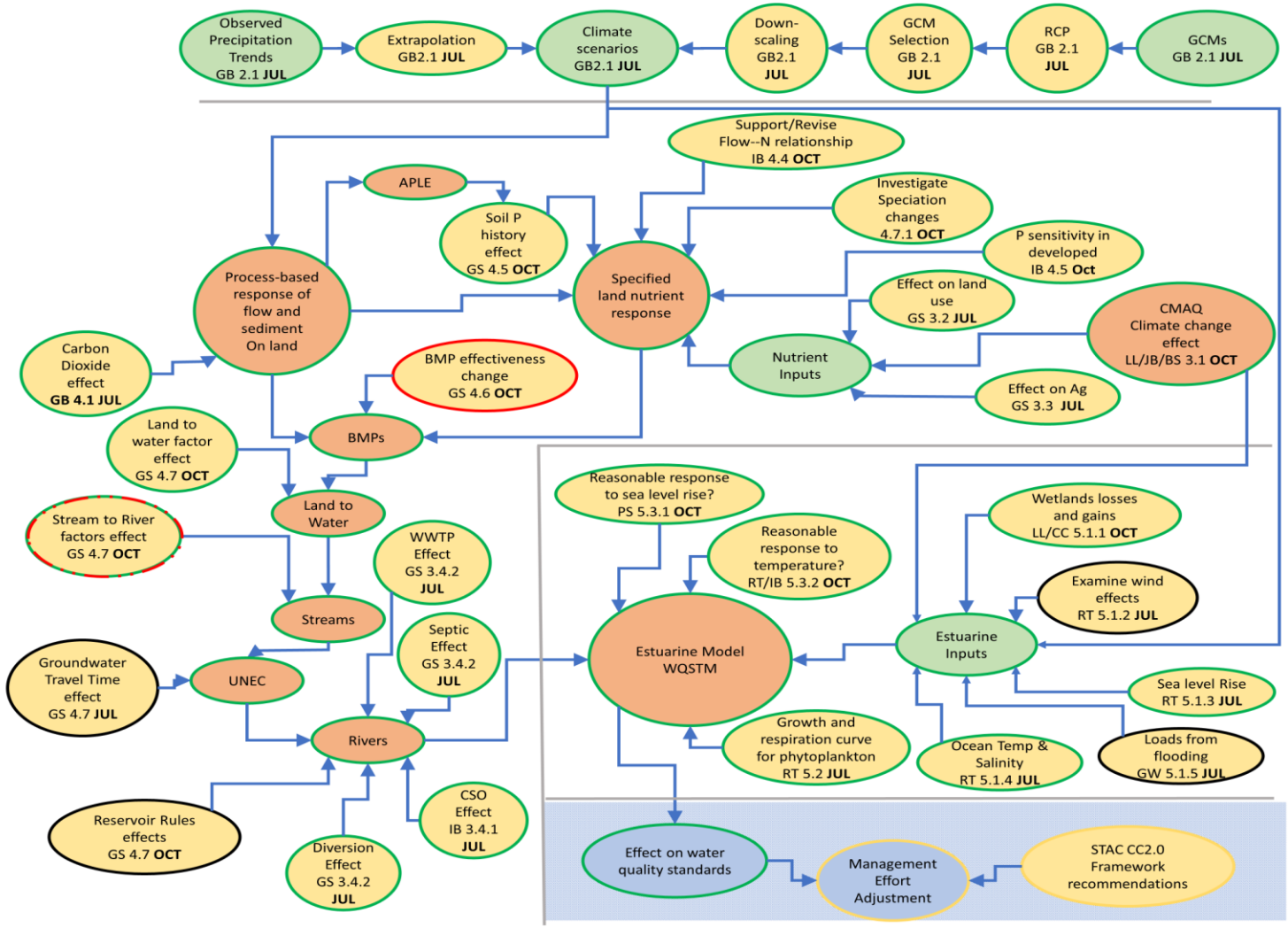
Elements of Chesapeake Water Quality Climate Risk Assessment

Model
Data Set
Endpoint
Project/Decision

Complete
In Process
Not included But important
Not included minor

Initials indicate the responsible person
Numbers indicate the section of the documentation

Climate Change Processes and Dependencies



Climate

Watershed

Estuary

Management

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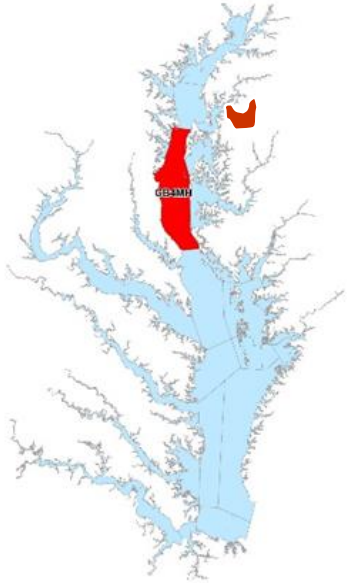
WQGIT Recommendations to the Management Board

1. Accept updated models for use in re-evaluating climate change for 2025 and 2035.

△Achievement of Deep Channel DO Water Quality Standard

Achievement of **Deep Channel DO** water quality standard (1mg/l instantaneous minimum) expressed as ***an incremental increase*** over the PSC agreed to 2025 planning targets

CB Segment	State	2025 Climate 2025 Land Use 204TN 14.0TP 1993-1995 DO Deep Channel	2035 Climate 2025 Land Use 208TN 14.6TP 1993-1995 DO Deep Channel	2045 Climate 2025 Land Use 212TN 15.4TP 1993-1995 DO Deep Channel	2055 Climate 2025 Land Use 220TN 16.7TP 1993-1995 DO Deep Channel
CB3MH	MD	0.00%	0.00%	0.00%	0.00%
CB4MH	MD	1.47%	3.15%	4.62%	7.31%
CB5MH	MD	0.00%	0.00%	0.00%	0.00%
CB5MH	VA	0.00%	0.00%	0.00%	0.00%
POTMH	MD	0.00%	0.00%	0.00%	0.00%
RPPMH	VA	0.00%	0.00%	0.00%	0.00%
ELIPH	VA	0.00%	0.00%	0.00%	0.00%
CHSMH	MD	0.01%	0.92%	1.08%	2.34%



△Achievement of Deep Water DO Water Quality Standard

Achievement of **Deep Water DO** water quality standard (3 mg/l 30-day mean) expressed as ***an incremental increase*** over the PSC agreed to 2025 planning targets.

CB Segment	State	2025 Climate 2025 Land Use 204TN, 14.0TP 1993-1995 DO Deep Water	2035 Climate 2025 Land Use 208TN, 14.6TP 1993-1995 DO Deep Water	2045 Climate 2025 Land Use 212TN, 15.4TP 1993-1995 DO Deep Water	2055 Climate 2025 Land Use 220TN, 16.7TP 1993-1995 DO Deep Water
CB3MH	MD	0.01%	0.15%	0.16%	0.21%
CB4MH	MD	0.94%	1.61%	2.00%	2.66%
CB5MH	MD	0.52%	1.01%	1.32%	1.66%
CB5MH	VA	0.00%	0.00%	0.00%	0.00%
CB6PH	VA	0.00%	0.00%	0.00%	0.00%
CB7PH	VA	0.00%	0.00%	0.00%	0.00%
PATMH	MD	0.01%	0.02%	0.42%	2.66%
MAGMH	MD	1.66%	1.66%	1.91%	1.91%
SOUMH	MD	0.00%	0.00%	0.00%	0.00%
SEVMH	MD	0.00%	0.00%	0.00%	0.00%
PAXMH	MD	0.00%	0.00%	0.00%	0.00%
POTMH	MD	0.03%	0.15%	0.56%	0.81%
RPPMH	VA	0.00%	0.24%	1.48%	1.85%
YRKPH	VA	0.00%	0.00%	0.00%	0.00%
ELIPH	VA	0.00%	0.00%	0.00%	0.00%
SBEMH	VA	0.00%	0.00%	0.44%	3.12%
CHSMH	MD	0.00%	0.00%	0.00%	0.00%

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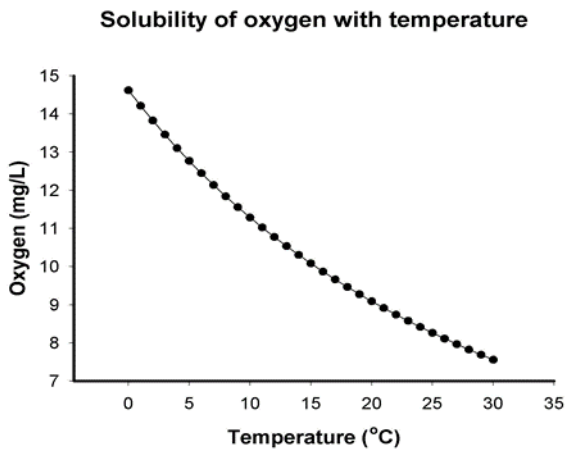
Tidal Fresh Open Water DO Water Quality Standard Violation Rates

Nonattainment of **Tidal Fresh Open Water DO** water quality standard (5.5mg/l 30-day mean)

Estimating substantial increases in Open Water DO non-attainment under increased (1°C) 2025 temperature in shallow waters.



		1995 Climate	2025 Climate	2035 Climate	2045 Climate	2055 Climate
PAXTF	MD	2.81%	11.93%	11.95%	12.37%	13.35%
WBRTF	MD	0.00%	32.27%	32.27%	39.65%	54.64%
PISTF	MD	4.63%	4.65%	4.65%	4.65%	4.65%
MATTF	MD	0.00%	0.00%	0.00%	0.00%	0.00%
RPPTF	VA	0.00%	0.00%	0.00%	0.00%	1.65%
MPNTF	VA	1.31%	27.03%	36.88%	41.21%	35.67%
PMKTF	VA	6.90%	71.26%	81.54%	74.44%	69.83%
JMSTFL	VA	0.00%	0.00%	0.38%	0.96%	1.02%
JMSTFU	VA	0.00%	0.00%	0.00%	0.00%	0.00%
APPTF	VA	4.59%	0.00%	0.00%	0.00%	4.59%
NORTF	MD	0.00%	0.00%	0.00%	0.00%	0.00%
CHSTF	MD	0.00%	0.00%	0.00%	0.00%	0.00%
CHOTF	MD	0.00%	0.00%	0.00%	0.00%	0.00%
NANTF_MD	MD	0.00%	0.73%	4.70%	0.73%	0.00%
POCTF	MD	0.00%	69.83%	77.48%	77.48%	77.48%

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Open Water is Important!

- The Open Water 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) with DO water quality standards in place to protect living resources.
- It is the portion of the Bay that we interact with the most.
- Shallow Open Water (less than 2 meters deep) may have increased impacts from future estimated temperature increases.

- Open Water DO nonattainment in shallow water requires additional investigation. Ultimately, an improved Bay Model simulation of shallow water is needed to better understand the climate effects on Open Water DO water quality standards in Chesapeake's shallow waters.

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Main Bay and Tributary Open Water Violation Rates

Non-attainment of **Open Water DO** water quality standard (5 - 5.5 mg/l 30-day mean)

- 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%

Why are CB6 and CB7 acting so differently?

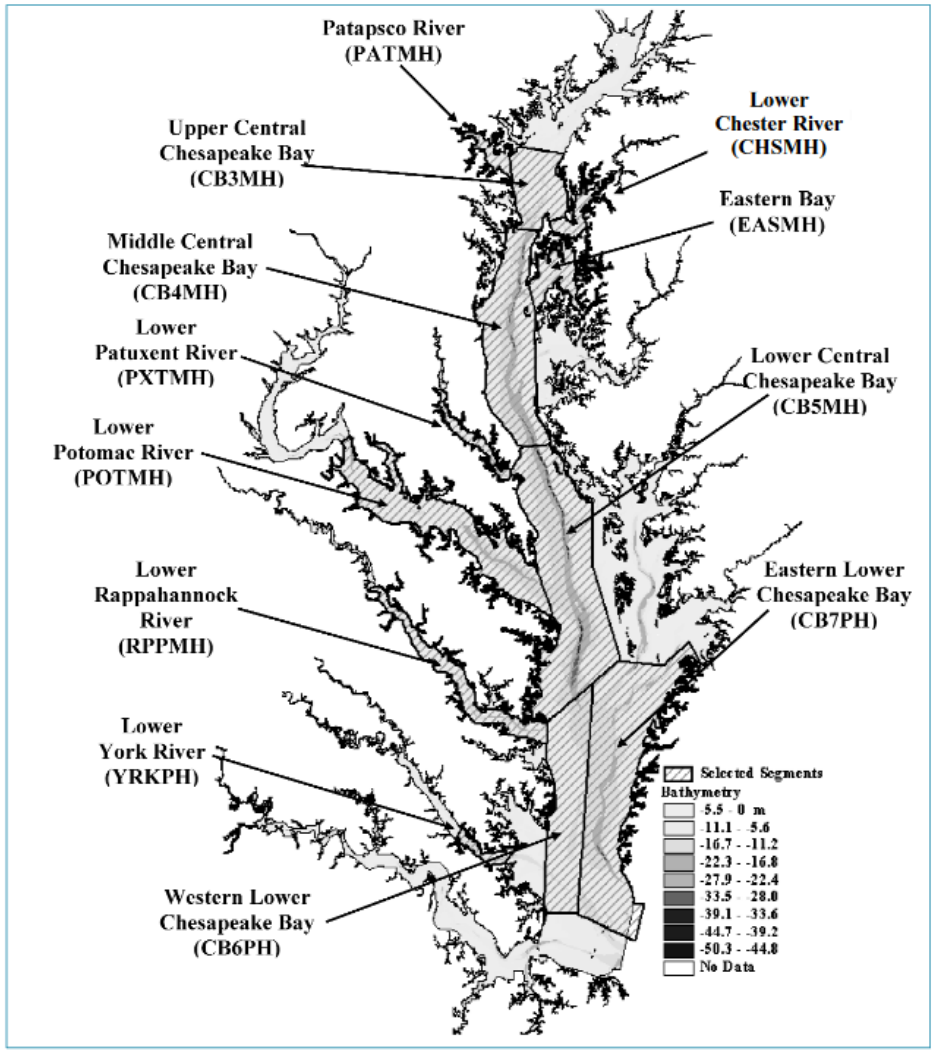


Figure IV-19. Chesapeake Bay Program segments identified as having chronic low dissolved oxygen

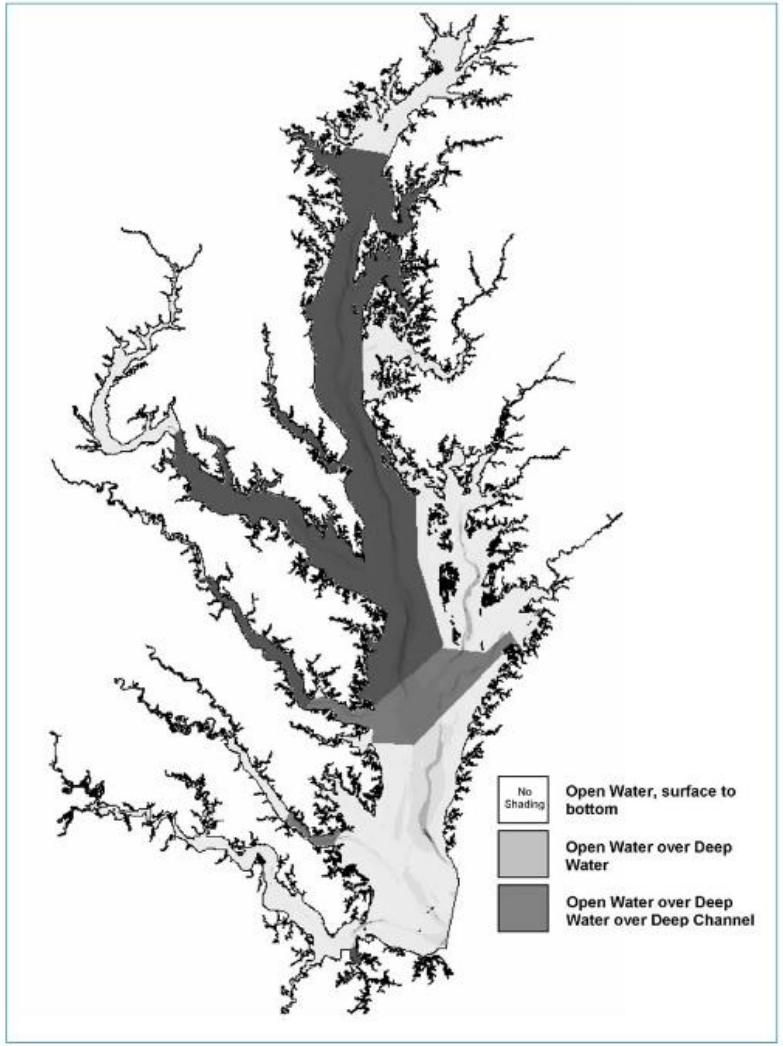


Figure IV-23. Map showing the dissolved oxygen designated uses of the Chesapeake Bay and its tidal tributaries.

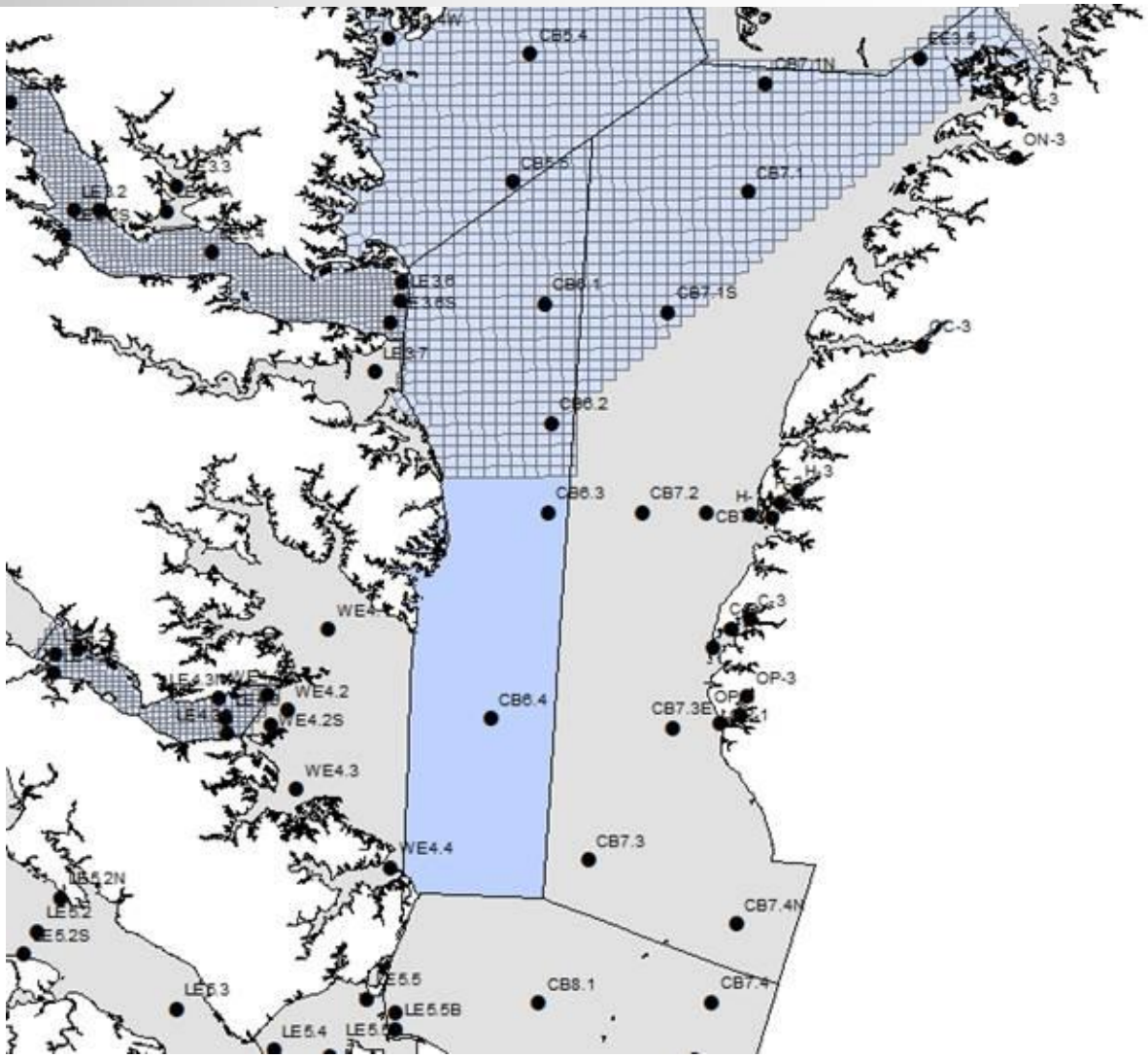
- 2003 Technical Support Document

"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

Deep Water Boundary

- CB6 boundary adjusted in 2004 as:
  - Near the end of the natural channel
  - The point where non-attainment goes under 1% in the 2003 Cap Load allocations
- Modeling Team took a closer look at the Open Water DO nonattainment forecasted in CB6 and CB7
  - Nonattainment was happening below the pycnocline.
  - But DO concentrations below the pycnocline would not violate the Deep Water DO standard (> 3 mg/l).
- The Modeling Workgroup recommended to the WQGIT that it avoid driving allocations with CB6 and CB7 Open Water DO because:
  - Attainment is relatively insensitive to load reductions.
  - No other mainstem segment had Open Water DO violations estimated through 2055.
  - A more appropriate delineation of the designated uses of Open Water DO and Deep Water DO is needed.



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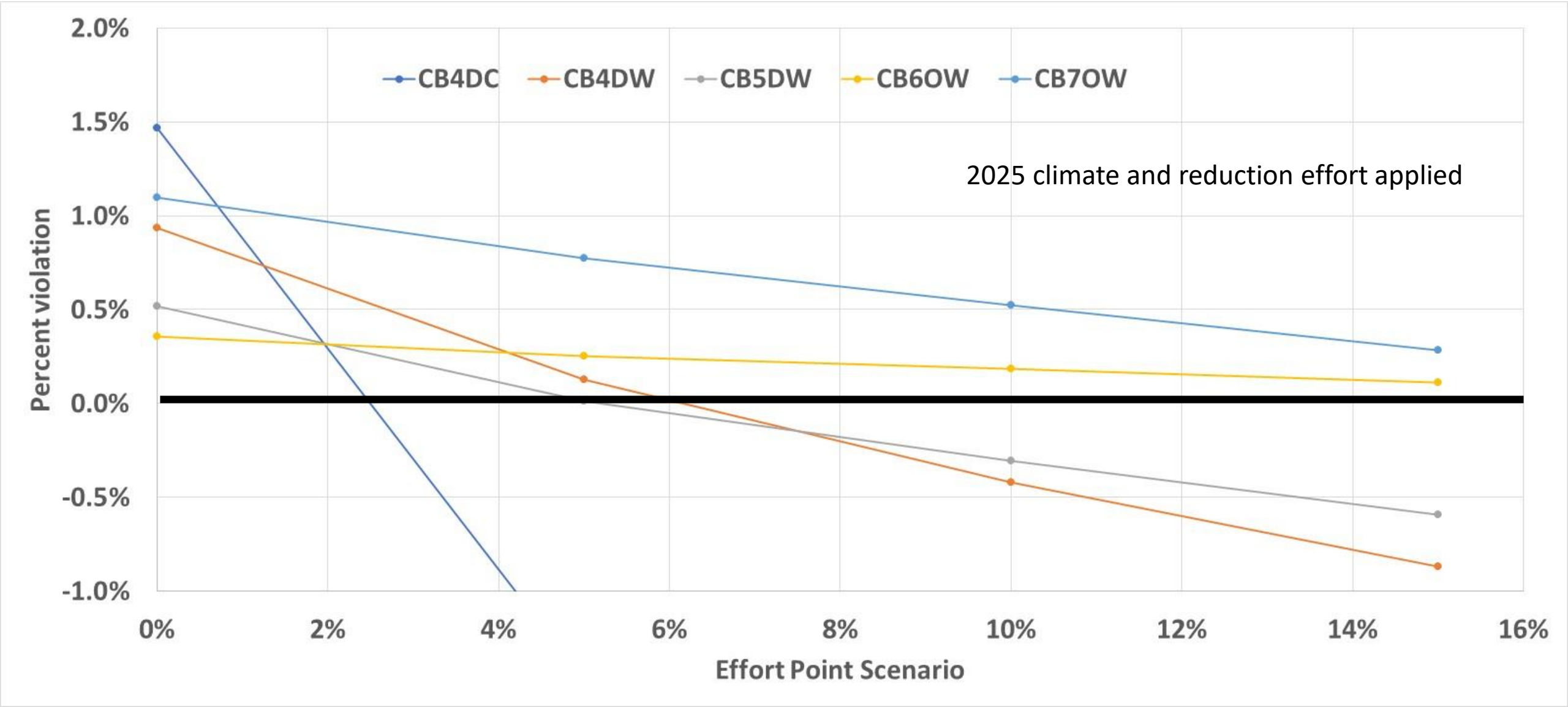
CB6 and CB7 are Less Sensitive to Reductions



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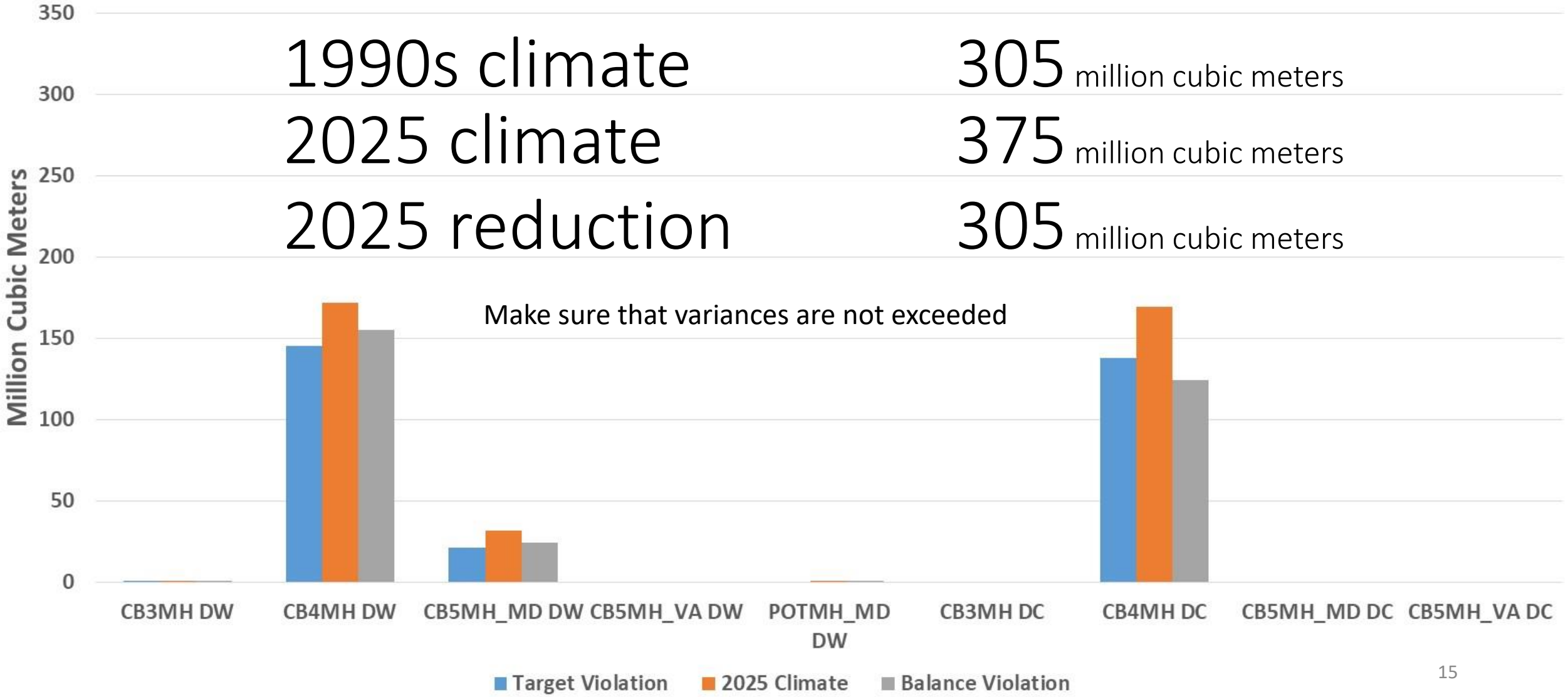
Climate Change Effect on Main Bay DWDC

1990s climate 305 million cubic meters

2025 climate 375 million cubic meters

2025 reduction 305 million cubic meters

Make sure that variances are not exceeded



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WQGIT Recommendations to the Management Board

2. Exclude model estimated nonattainment in shallow (or non-main stem segment) Open Water DO from the climate change allocation.
3. Exclude model estimated nonattainment in Open Water DO in CB6 and CB7 from the climate change allocation.
4. Criteria Assessment Protocol (CAP) Workgroup will evaluate climate change risks to current water quality standard criteria and designated uses, including the open water designated use for CB6MH and CB7MH.
5. The 2025 climate change estimate will ensure main Bay Deep Water and Deep Channel DO additional nonattainment under climate change returns to 2017 Planning Target levels and within existing variances.

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WQGIT Recommendations to the Management Board

6. Incorporate the additional nitrogen (N) and phosphorus (P) loads due to 2025 climate change conditions into Programmatic Milestones no later than the 2022-2023 milestones, with all actions to achieve those reductions in place by 2025.
7. Include a narrative in the Milestones that describe the current estimated jurisdiction-specific nutrient loads due to 2035 climate change conditions.
8. Continue efforts to improve understanding of the science and refine estimates of pollutant load changes due to 2035 climate change conditions.
   a) Develop a better understanding of the BMP responses, including new or other emerging BMPs, to climate change conditions.
   b) Compare the current 2025 climate change assumptions with measured climate conditions through 2024.
      i. To include: rainfall volume, intensity and distribution; air temperature, hydrology, water temperature, sea level rise, and changes in bay stratification and circulation.
   c) Consider the efficacy of using projections from measured trends versus downscaled global climate model data for revised 2035 estimates.
9. In 2025, the Partnership will consider results of updated methods, techniques, and studies and revisit existing estimated loads due to climate change to determine if any updates to those 2035 load estimates are needed.

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Climate Allocation Options

- Watershed loads first?
  - Take out jurisdiction's watershed load increases due to climate change first, then allocate any remaining reductions using the planning targets method
  - Allocate all climate change reductions using planning targets method

- Adjustments to planning target allocation method?
  - Only move the non-WWTP sources line (no change)
  - Move the WWTP and non-WWTP sources lines by the same amount
  - Set the WWTP source line at 8mg/l and 4mg/l then move the non-WWTP sources line to achieve the remaining reductions
  - Several other adjustments to the WWTP line were considered and ruled out by the WQGIT

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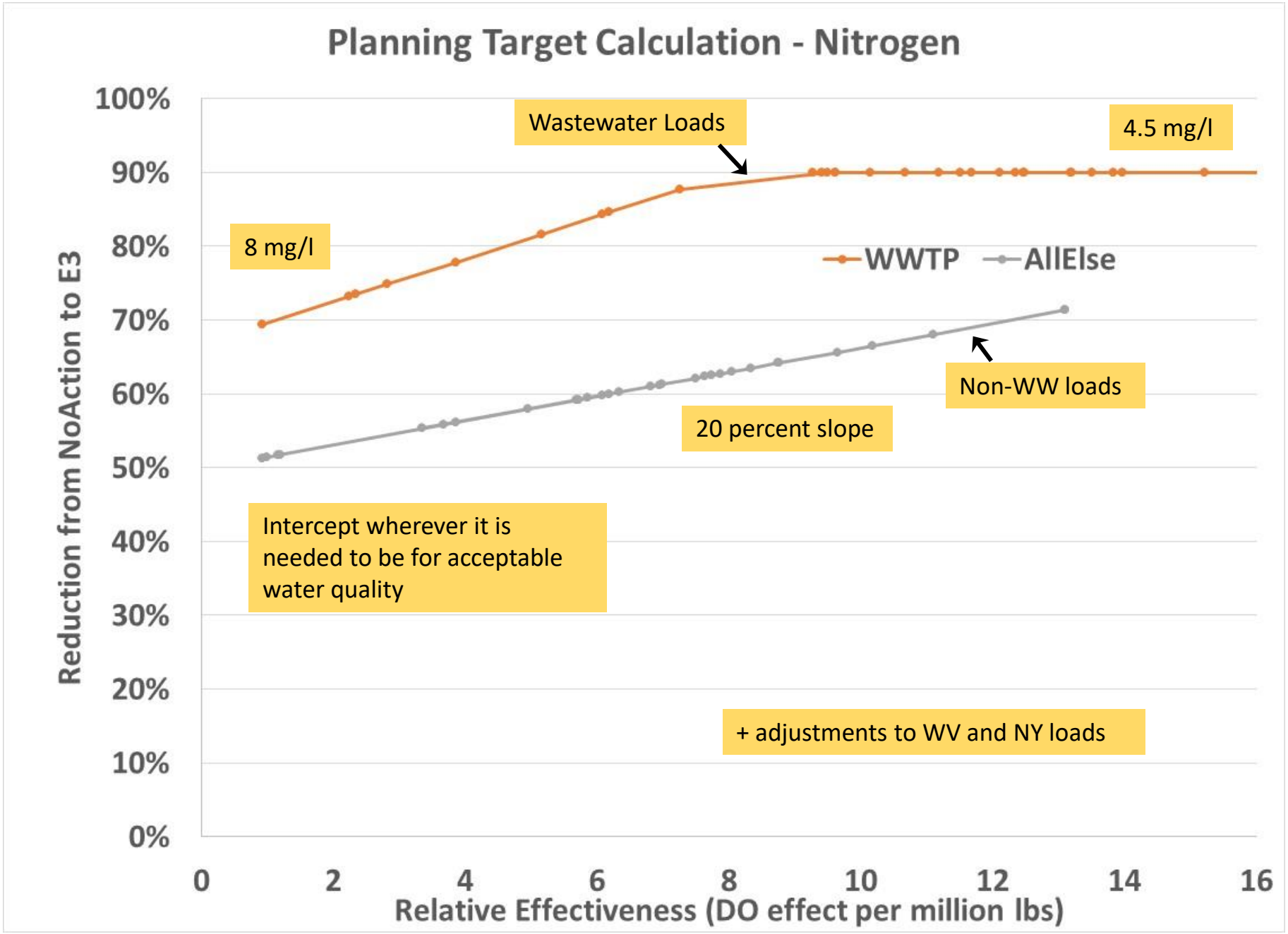

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2025 Climate Allocation Options

Effects from climate changes between 1995 and 2025

WWTP Scenario	NPS only	NPS only	NPS+PS	NPS+PS	8 and 4	8 and 4
Year	2025	2025	2025	2025	2025	2025
Watershed First	No	L1st	No	L1st	No	L1st
State	TN	TN	TN	TN	TN	TN
DC	0.003	0.006	0.152	0.006	0.257	0.259
DE	0.212	0.036	0.116	0.036	0.054	-0.122
MD	1.164	1.061	1.590	1.061	1.922	1.819
NY	0.242	0.699	0.201	0.699	0.179	0.636
PA	2.298	1.683	1.740	1.683	1.407	0.793
VA	0.957	1.476	1.497	1.476	1.190	1.709
WV	0.138	-0.054	0.103	-0.054	0.082	-0.111
Total	5.015	4.908	5.400	4.908	5.091	4.984

WWTP Scenario	NPS only	NPS only	NPS+PS	NPS+PS	8 and 4	8 and 4
Year	2025	2025	2025	2025	2025	2025
Watershed First	No	L1st	No	L1st	No	L1st
State	TP	TP	TP	TP	TP	TP
DC	0.001	0.001	0.018	0.001	0.021	0.021
DE	0.005	0.003	0.002	0.003	0.002	0.000
MD	0.079	0.111	0.107	0.111	0.116	0.149
NY	0.013	0.044	0.011	0.044	0.011	0.043
PA	0.103	0.095	0.069	0.095	0.070	0.062
VA	0.137	0.337	0.179	0.337	0.121	0.321
WV	0.012	0.009	0.008	0.009	0.007	0.003
Total	0.348	0.599	0.393	0.599	0.348	0.599

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Watershed Loads First with 2025 NY Special Case

State	TN Dec 2017 PSC	TN L1st Climate increase	TN Adjusted L1st Proposed	TP Dec 2017 PSC	TP L1st Climate increase	TP Adjusted L1st Proposed
DC	0.006	0.006	0.007	0.001	0.001	0.001
DE	0.397	0.036	0.039	0.006	0.003	0.003
MD	2.194	1.061	1.142	0.117	0.111	0.111
NY	0.400	**0.699**	0.399	0.015	0.044	0.044
PA	4.135	1.683	1.811	0.143	0.095	0.095
VA	1.722	1.476	1.589	0.187	0.337	0.337
WV	0.236	**-0.054**	0.000	0.017	0.009	0.009
Total	9.089	4.908	4.986	0.485	0.599	0.599

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WQGIT Recommendations to the Management Board

10. For 2025 climate change estimate, allocate using the jurisdiction's watershed loads first option with a 2025 special case for NY.
    a) The NY special case is a policy adjustment to the science-based watershed loads and applies only to the 2025 nitrogen climate allocation.
    b) Reduce NY nitrogen allocation to 0.399 (returning to a value similar to the initial estimate in 2017)
    c) Increase WV nitrogen allocation from -0.054 to 0.000
    d) Increase remaining jurisdictions to 108% of their science-based nitrogen allocation

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2035 Climate Allocation Options

Effects from climate changes between 1995 and 2035

WWTP Scenario	NPS only	NPS only	NPS+PS	NPS+PS	8 and 4	8 and 4
Year	2035	2035	2035	2035	2035	2035
Watershed First	No	L1st	No	L1st	No	L1st
State	TN	TN	TN	TN	TN	TN
DC	0.007	0.007	0.316	0.046	0.260	0.260
DE	0.442	0.138	0.242	0.112	0.284	-0.020
MD	2.426	1.905	3.315	2.017	3.184	2.663
NY	0.504	1.202	0.420	1.191	0.441	1.139
PA	4.789	3.618	3.627	3.472	3.899	2.728
VA	1.995	3.009	3.121	3.151	2.228	3.242
WV	0.288	0.308	0.214	0.299	0.231	0.252
Total	10.451	10.187	11.255	10.288	10.528	10.263

WWTP Scenario	NPS only	NPS only	NPS+PS	NPS+PS	8 and 4	8 and 4
Year	2035	2035	2035	2035	2035	2035
Watershed First	No	L1st	No	L1st	No	L1st
State	TP	TP	TP	TP	TP	TP
DC	0.002	0.001	0.037	0.006	0.022	0.021
DE	0.010	0.007	0.004	0.007	0.007	0.004
MD	0.164	0.235	0.222	0.242	0.201	0.272
NY	0.026	0.087	0.023	0.087	0.025	0.086
PA	0.214	0.287	0.143	0.278	0.181	0.255
VA	0.285	0.733	0.374	0.745	0.269	0.718
WV	0.025	0.053	0.016	0.052	0.020	0.048
Total	0.726	1.404	0.818	1.416	0.726	1.404

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Pending Recommendation to the Management Board

11. For 2035 climate change estimate, the WQGIT has not yet reached a consensus on the allocation approach.
    a) NPS Only (3 ,4, 7, 1, 1)and NPS+PS (4, 3, 7, 1, 1) were similarly preferred in polling of members. 8 and 4 (2, 2, 8, 1, 3) was least favored of the options.
    b) All allocation options (and any possible special cases) should be re-considered in 2025 when the revised 2035 estimates are established. Do not want to set a precedent with this decision.
    c) Revisiting WQGIT Recommendation #7 may be necessary to reach consensus.

(Endorse, Agree w/ Reservations, Stand Aside, Hold, Stop)

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WQGIT Recommendations to the Management Board

1. Accept updated models for use in re-evaluating climate change for 2025 and 2035.
2. Exclude model estimated non-attainment in shallow open water from the climate change allocation.
3. Exclude model estimated non-attainment in open water in CB6 and CB7 from the climate change allocation.
4. Criteria Assessment Protocol (CAP) Workgroup will evaluate climate change risks to current water quality standard criteria and designated uses, including the open water designated use for CB6MH and CB7MH.
5. 2025 climate change estimate will consider main Bay DW/DC and ensure additional non-attainment returns to 2017 Planning Target levels and within existing variances.
6. Incorporate the additional nitrogen (N) and phosphorus (P) loads due to 2025 climate change conditions into Programmatic Milestones no later than the 2022-2023 milestones, with all actions to achieve those reductions in place by 2025.
7. Include a narrative in the Milestones that describe the current estimated jurisdiction-specific nutrient loads due to 2035 climate change conditions.
8. Continue efforts to improve understanding of the science and refine estimates of pollutant load changes due to 2035 climate change conditions.
   a) Develop a better understanding of the BMP responses, including new or other emerging BMPs, to climate change conditions.
   b) Compare the current 2025 climate change assumptions with measured climate conditions through 2024.
      i. To include: rainfall volume, intensity and distribution; air temperature, hydrology, water temperature, sea level rise, and changes in bay stratification and circulation.
   c) Consider the efficacy of using projections from measured trends versus downscaled global climate model data for revised 2035 estimates.
9. In 2025, the Partnership will consider results of updated methods, techniques, and studies and revisit existing estimated loads due to climate change to determine if any updates to those 2035 load estimates are needed.
10. For 2025 climate change estimate, allocate using the jurisdiction's watershed loads first option with a 2025 special case for NY.
    a) The NY special case is a policy adjustment to the science-based watershed loads and applies only to the 2025 nitrogen climate allocation.
    b) Reduce NY nitrogen allocation to 0.399 (returning to a value similar to the initial estimate in 2017)
    c) Increase WV nitrogen allocation from -0.054 to 0.000
    d) Increase remaining jurisdictions to 108% of their science-based watershed nitrogen allocation