P7 Watershed Model Planning

Gary Shenk – CBPO

Modeling Workgroup

1/4/2021

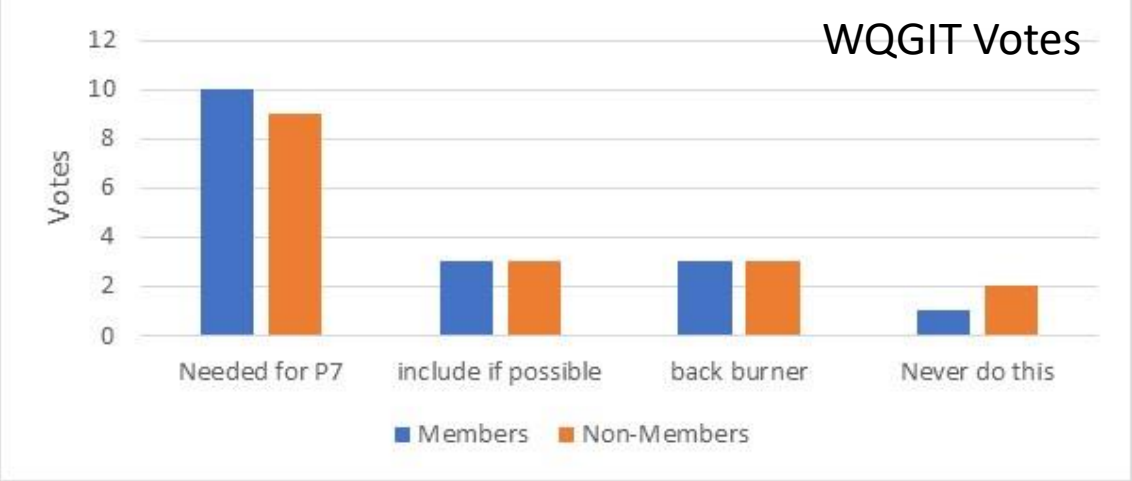
Input from various groups

- WQGIT
  - October 2021 meeting, voting and comments
  - Phase 6 review 2016
- Other GITs – November/December 2021
- STAC
  - P6 review (2017)
  - Modeling beyond 2025 workshop (2019)
- Other partners for hydrology – October 2019
- Modeling Workgroup - ongoing

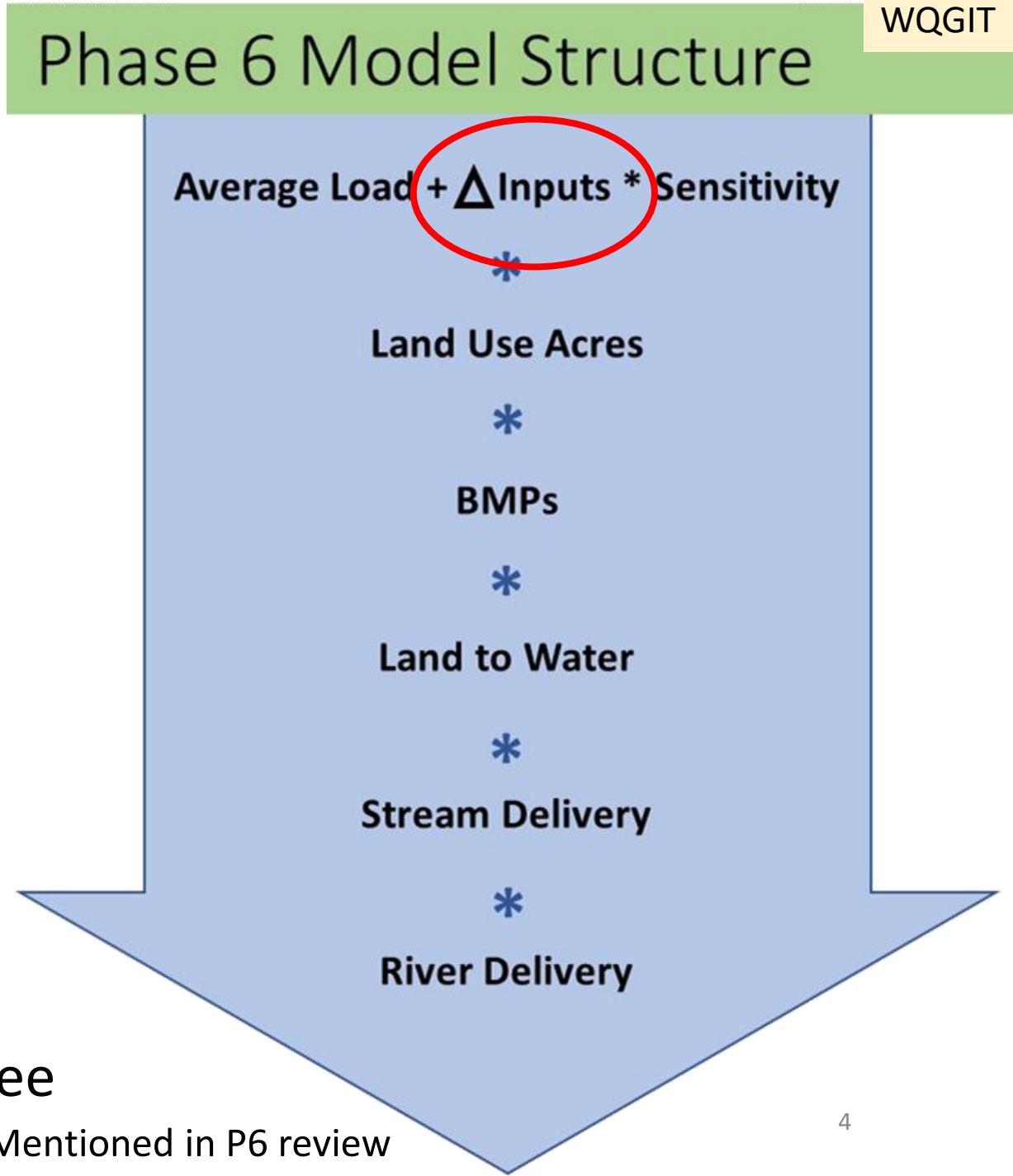
Potential Areas of Focus	Recommend-ations	Impacts Estuarine Model	Impacts CAST	Level of effort	Benefits
Finer-scale modeling	WQGIT, other GITs, STAC	✓	✓	High	Greater accuracy watershed modeling; Enables fine scale targeting of practices; Needed for some co-benefits
Spatially explicit CAST	Non-CB TMDL partners		✓	Medium	Enables CAST output on a fine scale
Physical process simulation	STAC, WQGIT other GITs, CBPO	✓	✓	Low-High	Greater watershed model accuracy overall
Nutrient Application calculation	CBPO		✓	Medium-High	Increases transparency of CAST scenarios; Reduces unintended consequences of model and data changes
Land use change 1985-2035	CBPO, WQGIT	✓	✓	High	Greater accuracy of land use changes through time. Allows direct use of fine-scale land use data in CAST
Improve climate change modeling	PSC, WQGIT	✓	✓	Low	Directly addresses PSC priorities; improves confidence in 2025 climate decision.
Uncertainty Quantification	WQGIT, STAC			Medium	Helps prioritize model updates; Incorporates trends in monitored data
Co-benefits and ecosystem services	WQGIT, other GITs, STAC		✓	Low-High	Helps partners develop comprehensive plans that benefit local citizens.
WQ standards Assessment	WQGIT, STAC			Low-Medium	Potential to assess all tidal oxygen standards and to delist segments

https://www.chesapeakebay.net/channel_files/41830/watershed_modeling_workplan_options_for_2025_v2021_08_26_clean.pdf

Nutrient Application

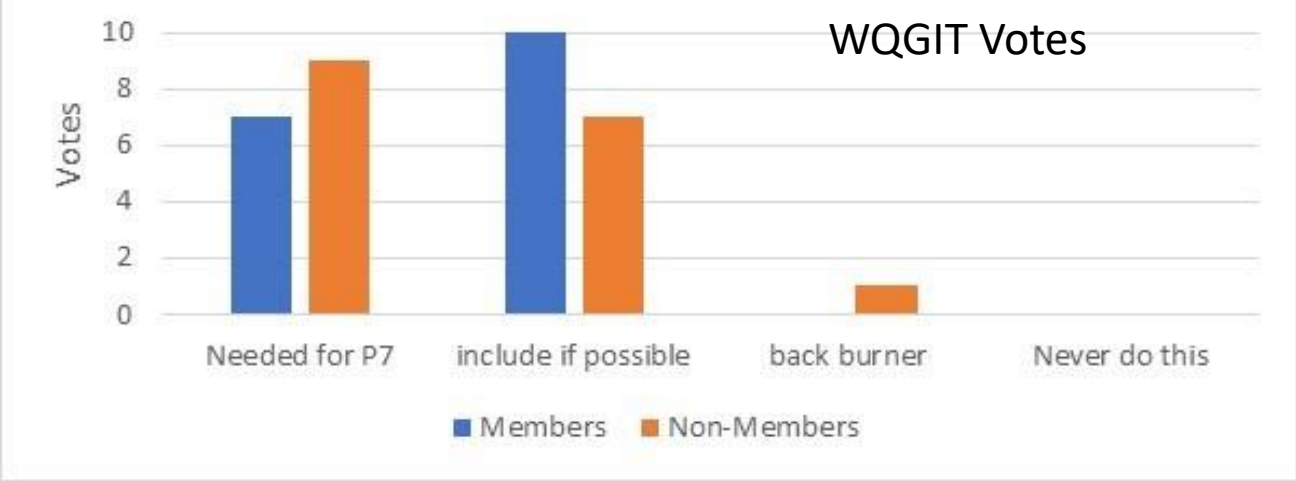


- Animal Counts / Manure *
- Fertilizer *
- Fixation
- Soil P*
- Urban fertilizer
- Need Agricultural Modeling Subcommittee

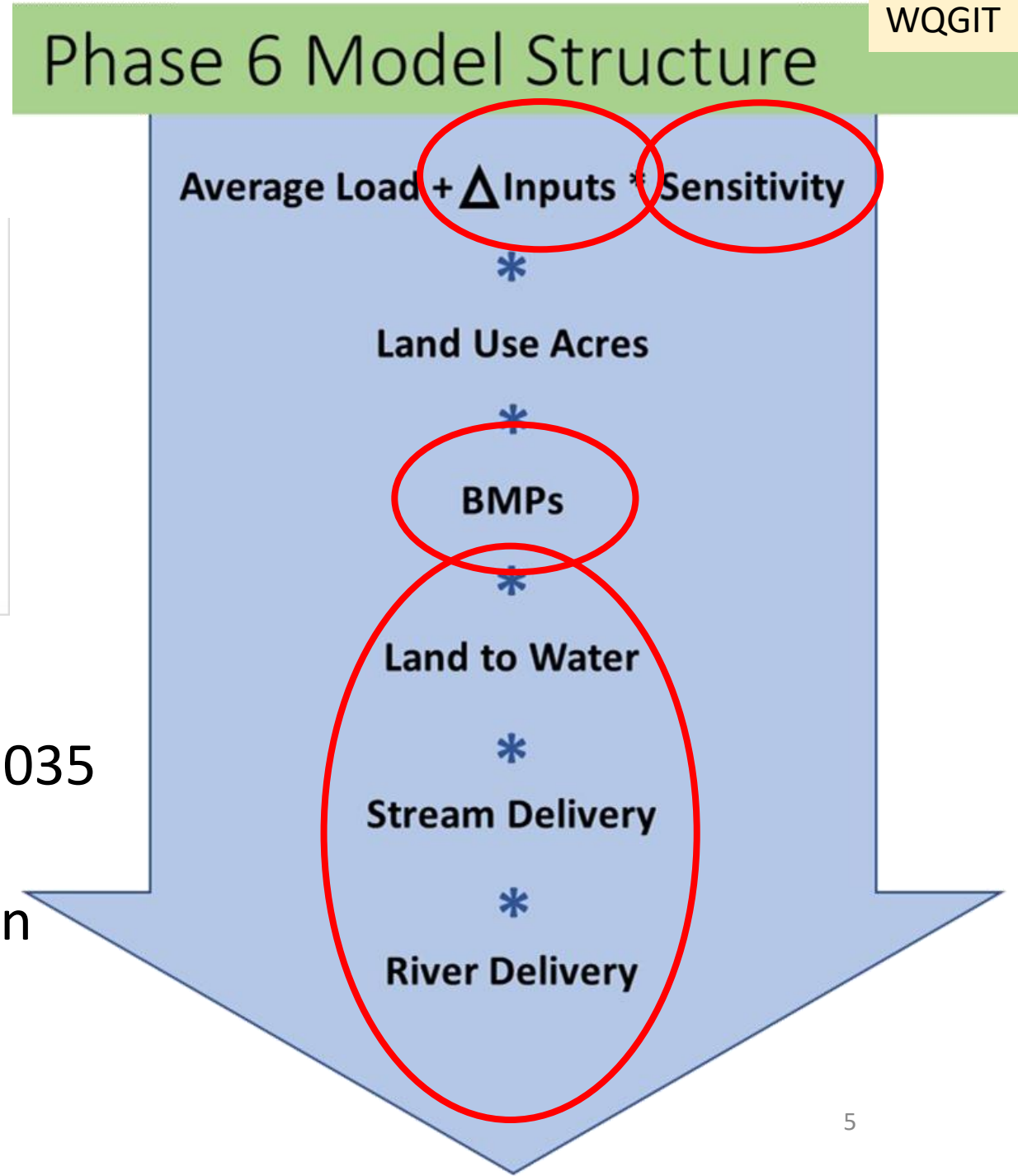


*Mentioned in P6 review

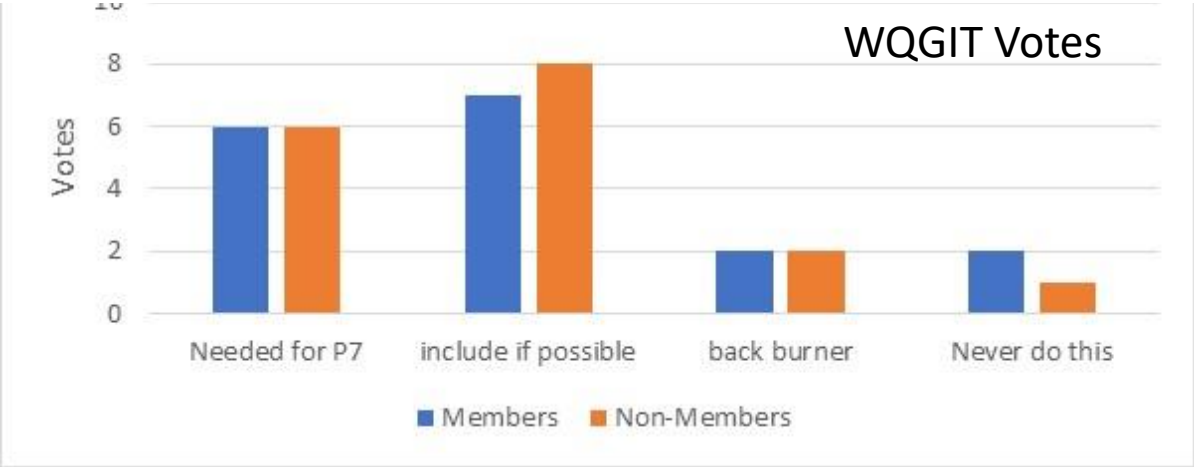
Improve Climate Modeling



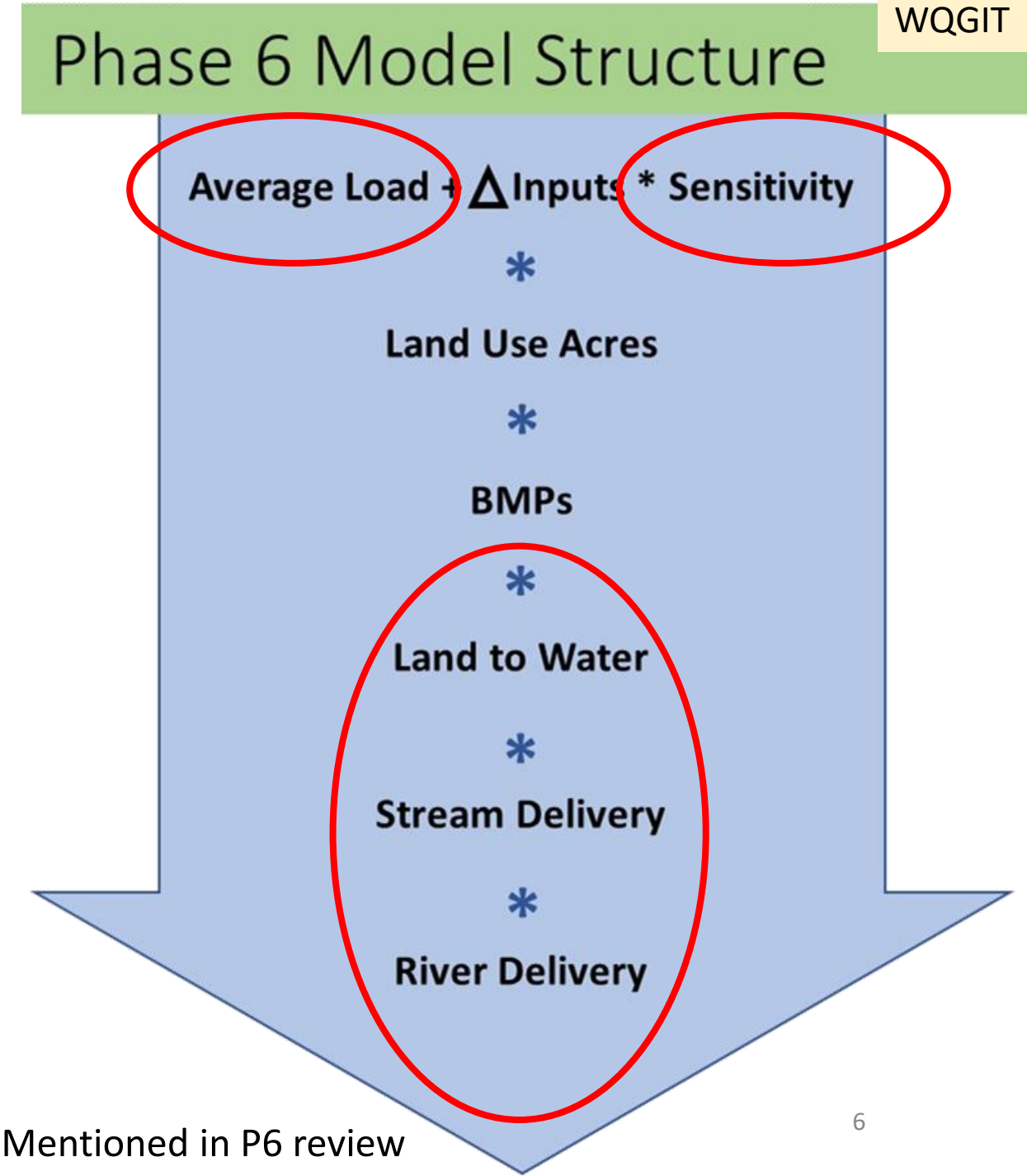
- Very few comments
- Recognition that we needed to make a 2035 assessment
- Climate effects are a scenario that we run after development



Physical Process Simulation



- Average loads by land use *
  - Will require significant workgroup effort
- Sensitivities *
- Urban P *
- Groundwater
- Delivery *
- Speciation



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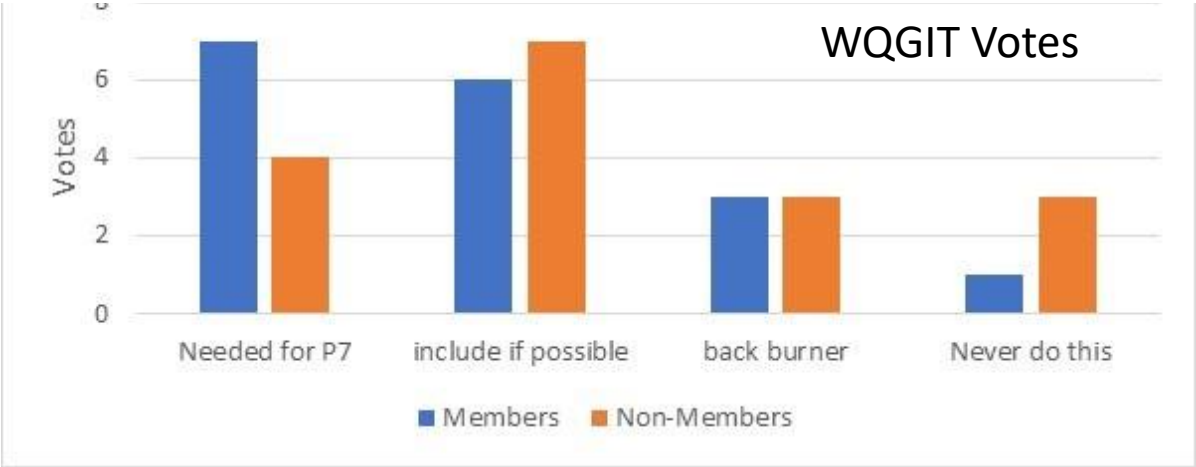
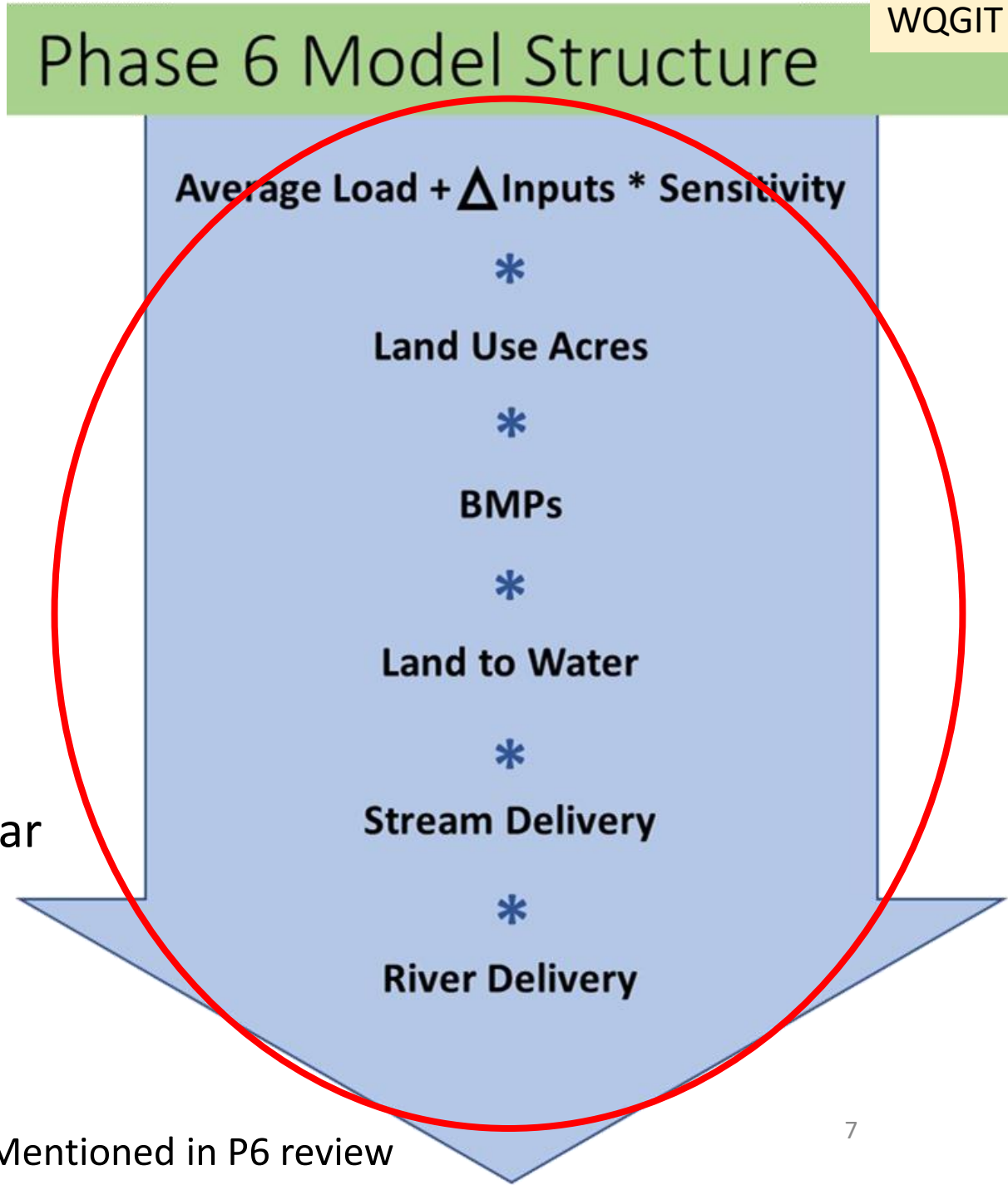
Uncertainty Quantification



- Inverse quantification *
  - Uncertainty of predicted change in load
  - Compare to observed trends
  - Isabella has been presenting for the past year
- Forward Propagation *
  - Estimate uncertainty of all inputs
  - Identify most important inputs
  - Takes a lot of work from the partnership



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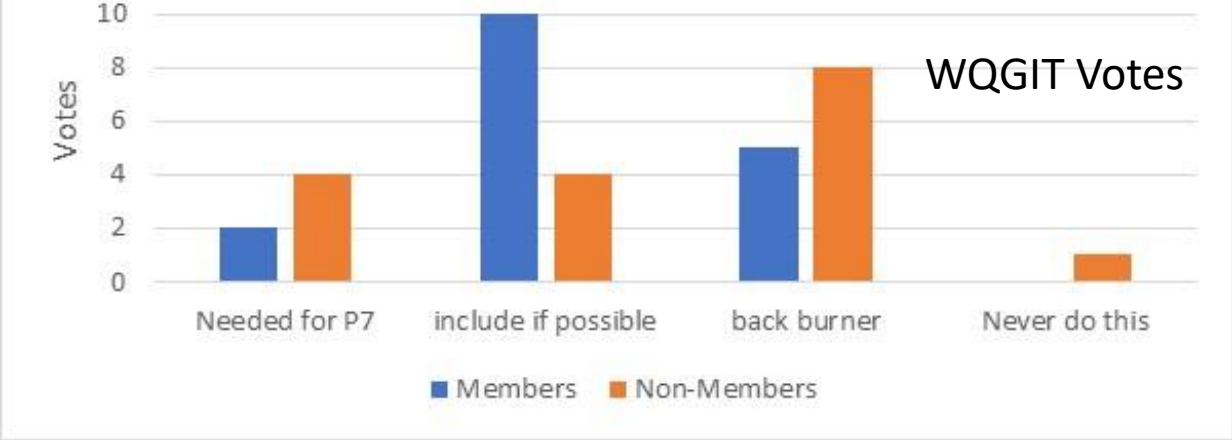
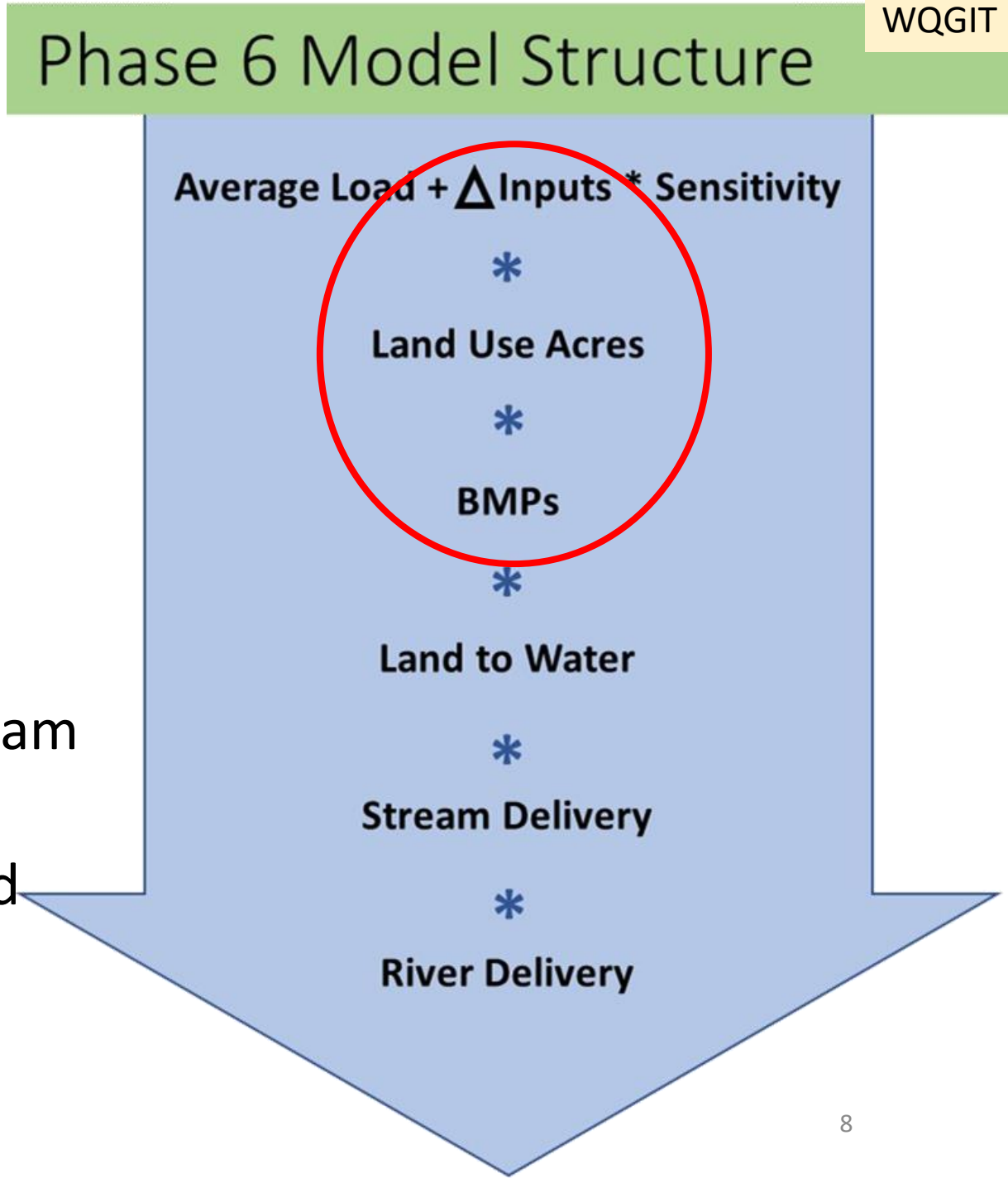
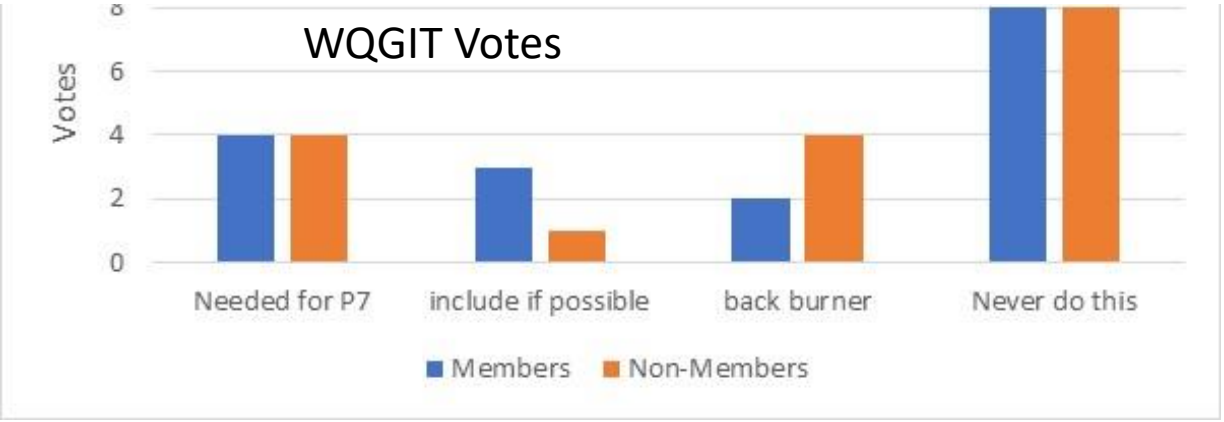
Co-Benefits



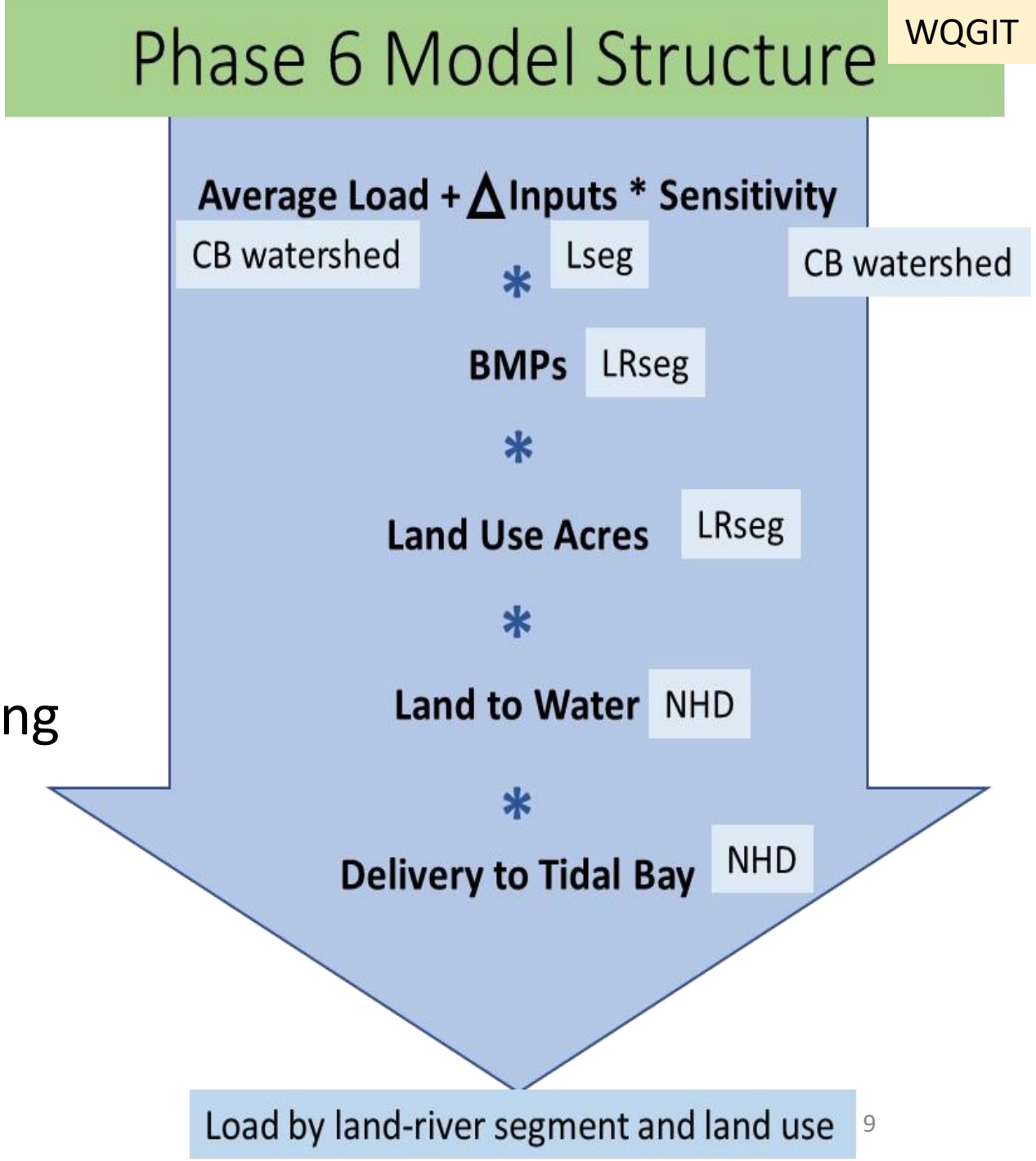
- Non-WQ effects from TMDL actions
- Work falls mostly outside of Modeling team and WQGIT
- Requires coordination with modeling and CAST teams



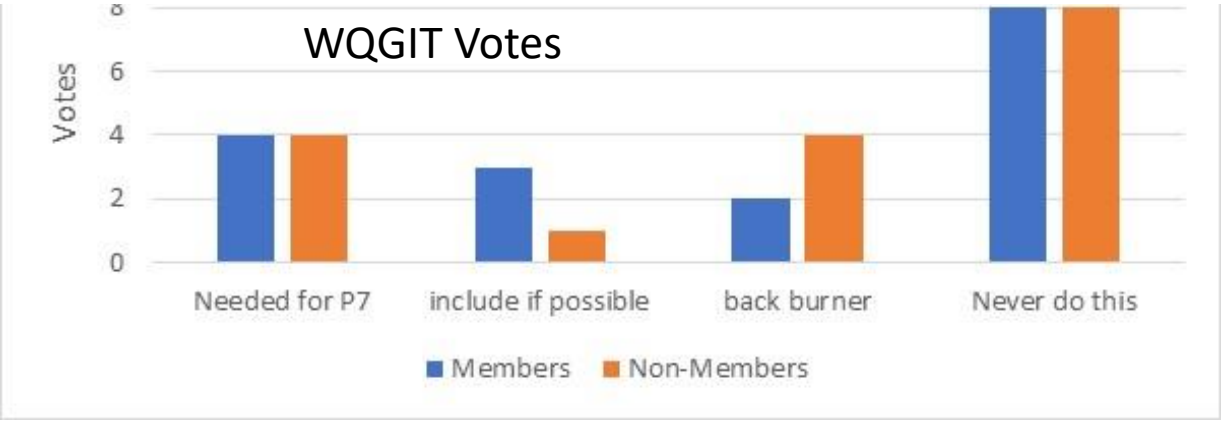
Fine-Scale



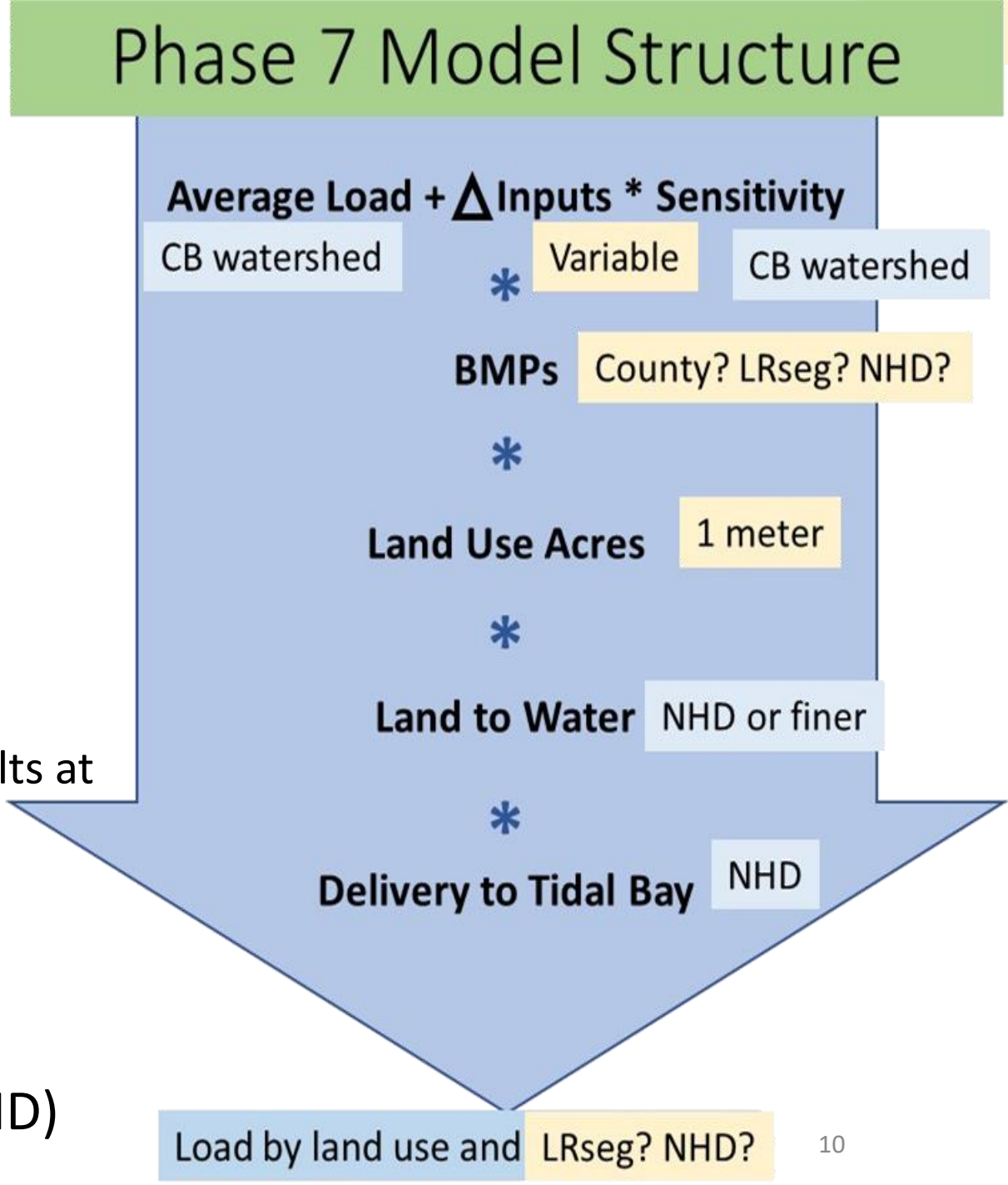
- Few comments
- Half of comments favored use for targeting
- Half opposed
  - Resources better used elsewhere
  - Greater uncertainty at finer scales



Fine-Scale –> Multi-Scale



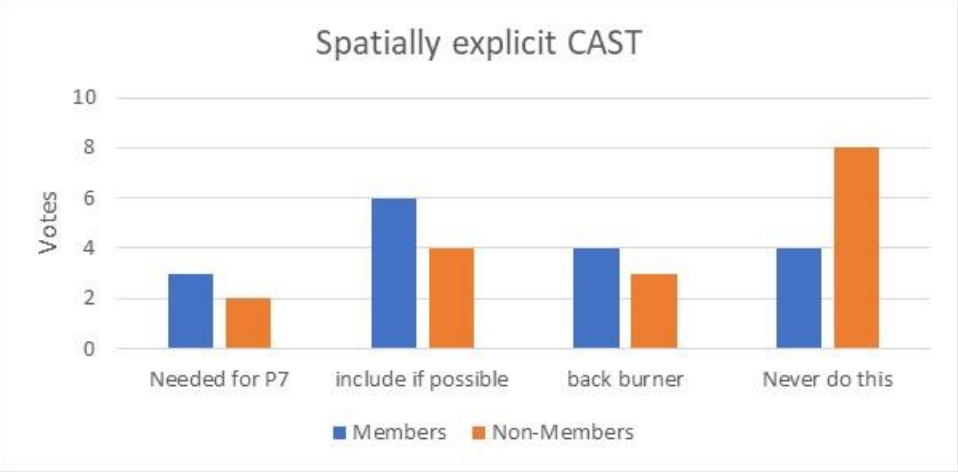
- For the TMDL, what scale for reporting and receiving credit for BMPs based on location?
  - Do you support the opportunity for receiving results at a finer scale that approximate the official results?
- What scale will you use for optimization?
  - How long will you wait for an optimization run?
- What scale of output do we need for the estuarine model? (CBPO recommendation NHD)



Other priorities

- Need to get all standards assessed

- Mixed reaction to fine-scale output



- Support for
  - BMP reporting transparency
  - High-resolution land use
  - Land use change modeling
  - New estuarine model

- Many unsolicited comments on
  - CAST usability improvements
  - WQGIT processes
  - Program evaluation
  - BMPs
  - Future planning target calculation methods

Other GITs


Goal Implementation Teams
Sustainable Fisheries
Habitat
Water Quality
Maintain Healthy Watersheds
Fostering Chesapeake Stewardship
Enhance Partnering, Leadership and Management

CAST use case

State agencies
Environment
Agriculture

Phase 6 Watershed Model/CAST

Nitrogen, Phosphorus, Sediment

Compare to State goal

Proposed WIP

Other GITs, Goals, and Outcomes

Organization that can make ***Water Quality*** change

Strategy 1 – Piggyback
Consideration of your outcome in water quality organizations' decisions

Example: Healthy Watersheds
Make water quality implementors aware of their plans on your outcome

Phase 6 Watershed Model/CAST

Nitrogen, Phosphorus, Sediment

Loss of Healthy Watersheds

Land Conservation in Healthy Watersheds

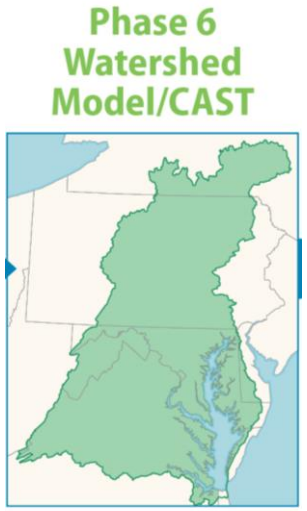
Compare to goals

Proposed Water Quality Strategy

Other GITs, Goals, and Outcomes

Organization that can make change for **your outcome**

Strategy 2 – Mirror
Direct use of CAST by implementors of your goal



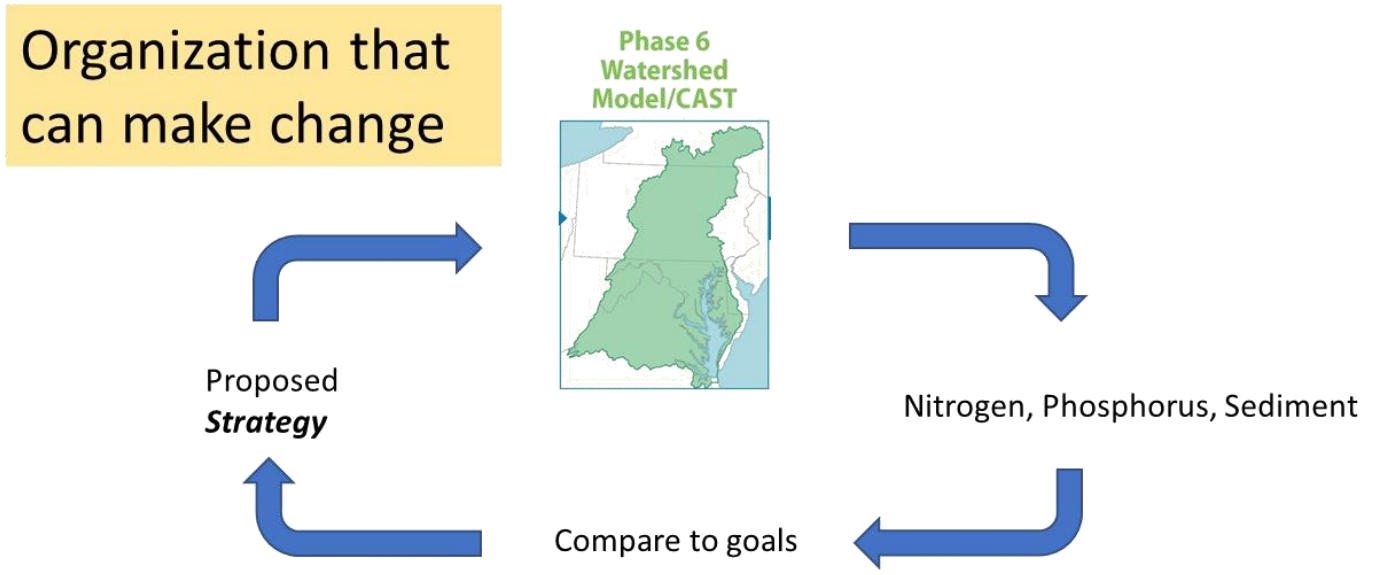
Example: Habitat GIT
A local government could look at the effects of imperviousness or tree canopy
EPA could look at sulfate deposition

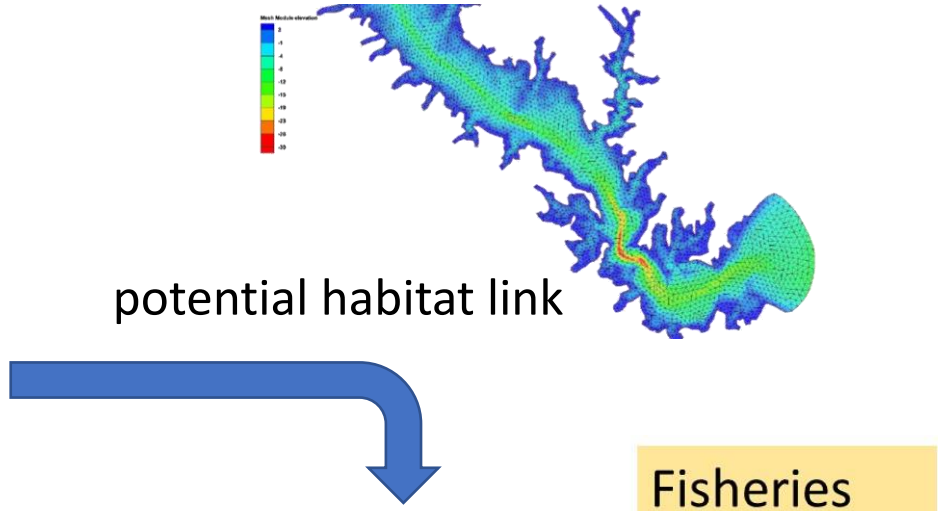
Proposed
Strategy for **your outcome**
Impervious, tree canopy, sulfate deposition

BIBI – stream health
Nitrogen, Phosphorus, Sediment

Compare to goals

Other GITs, Goals, and Outcomes





Strategy 3: Downstream
Completely separate model

Fisheries GIT
Long history of model use
CAST not suited for fisheries questions
…but could land management strategies decrease natural mortality in fish models?

STAC review of P6 – recommendations for P7

- Evolve P6
  - Develop a true ensemble model (leave inputs as distributions)
  - More formalized optimization techniques
- Further refine the BMP expert panel approach
- Develop higher spatial resolution models to inform management
- Develop improved modeling strategies for key processes that are not adequately quantifiable based on available scientific knowledge (particularly sediment)

Paraphrased

STAC Modeling Beyond 2025 Workshop - N

- Better quantify nitrogen sources, sinks, and BMPs by exploiting available high-resolution data and by process modeling.
- Develop a true ensemble model (leave inputs as distributions)
- More formal modular and hierarchical modeling system.
- Develop an ensemble of dynamic watershed models.

STAC Modeling Beyond 2025 Workshop - P

- Speciation
- Pay attention to river processes
- Identify critical source areas to target limited restoration resources more efficiently.
- Better account for land use change effects on P exports to capture legacy effects.
- Use more local phosphorus monitoring data for calibration.

Paraphrased

STAC Modeling Beyond 2025 Workshop - Sed

- Establish a sediment modeling work group
- Implement short-term improvements.
  - evaluate upland sediment sources
  - improvement of estimates of sediment delivery
  - lowland sediment production and storage
- Long-term improvements
  - New research
  - New conceptual models
  - New numerical models

Paraphrased

2019 Regional Hydrologic Model Meeting

- Aligning with living resource modelers and water supply partners
- Outputs
  - Flow, Temperature, Oxygen, Sediment
  - Hourly simulation
  - NHD100k scale
- Benefits to CBP
  - Reservoir operations
  - Withdrawal data
  - Dynamic simulation

Phase III WIP Schedule (I think)

Year	2022	2022	2022	2022	2023	2023	2023	2023	2024	2024	2024	2024	2025	2025	2025	2025	2026	2026	2026	2026	2027	2027	2027	2027	2028	2028	2028	2028
Quarter	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Phase III WIP evaluation	Implement														Final Progress			Evaluation?											
Current Plans													New 2035 Climate Targets															

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Phase III WIP evaluation	Implement														Final Progress			Evaluation?										
Under Discussion																					New 2035 Climate Targets, combine with new model and Conowingo							

Model Development Schedules

Phase 4
Combined phase 2 and phase 3 functionality
Longer simulation
Recalibration

1995 Development
1996 Development
1997 P4.1 application
1998 Development
1999 Development
2000 P4.3 application

Phase 5
Restructuring, Resegmentation, Automated calibration

2000 Ideation
2001 Development
2002-2004 WQS
2005 Development
2006 Development
2007 Development
2008 Development
2009 Development
2010 Review/application

Phase 6
Radical restructuring

2011 Ideation
2012 Priorities
2013 Development
2014 Development
2015 Development
2016 Development
2017 Review
2018 Apply

Phase 7
Expansion and overhaul

2019 Climate
2020 Climate
2021 Ideation
2022 Development
2023 Development
2024 Review
2025 Apply

Model Development Schedules

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Phase III WIP evaluation	Implement														Final Progress		Evaluation?											
Under Discussion																					New 2035 Climate Targets, combine with new model and Conowingo							
Model development	Work plan	Build Models			Work plan	Build Models			Work plan	Build Models			Work plan	Build Models			Review Models				Apply Models to climate, conowingo, outside-in						Track	
Planning target calculation methods	Discuss				Discuss				Discuss				Discuss				Discuss				Test	PT decision, with climate, conowingo, shallow water						

Phase 7 Model Tentative Schedule

	2022	2022	2022	2022	2023	2023	2023	2023	2024	2024	2024	2024	2025	2025	2025	2025
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Planning (doc section)	Work plan	Build Models			Work plan	Build Models			Work plan	Build Models			Work plan	Build Models		
Delineation (12)	Determine official CBPO GIS layers															
Weather and atmospheric inputs (11)	Finalize system of annual updates															
CalCAST (10)	Combine average load calculator and CalCAST (p6 data)				Use CalCAST as primary calibration tool											
Dynamic Model (11)	Finalize Methods				Produce output for estuarine models, provide temporal output for lag calibration and overall validation											
Nutrient Inputs (3 and 2)	Structure AMS				Update nutrient inputs (section 3) and loads (section 2)											
Average Loads (2)				Average Loads												
Sensitivities (4)						Sensitivities										
land-to-water (7)					Land-to-water											
Stream to bay (9)					Stream to Bay											
Climate Change (14)													Climate Change			
Withdrawal data																
Reservoir Effects																
Uncertainty quantification																
New Septic?												new septic?				
Data sets available								Geomorphometry		Ag Census		land use				

Workplan Tracking

	2022 1	2022 2	2022 3	2022 4	2023 1	2023 2	2023 3	2023 4	2024 1	2024 2	2024 3	2024 4	2025 1	2025 2	2025 3	2025 4
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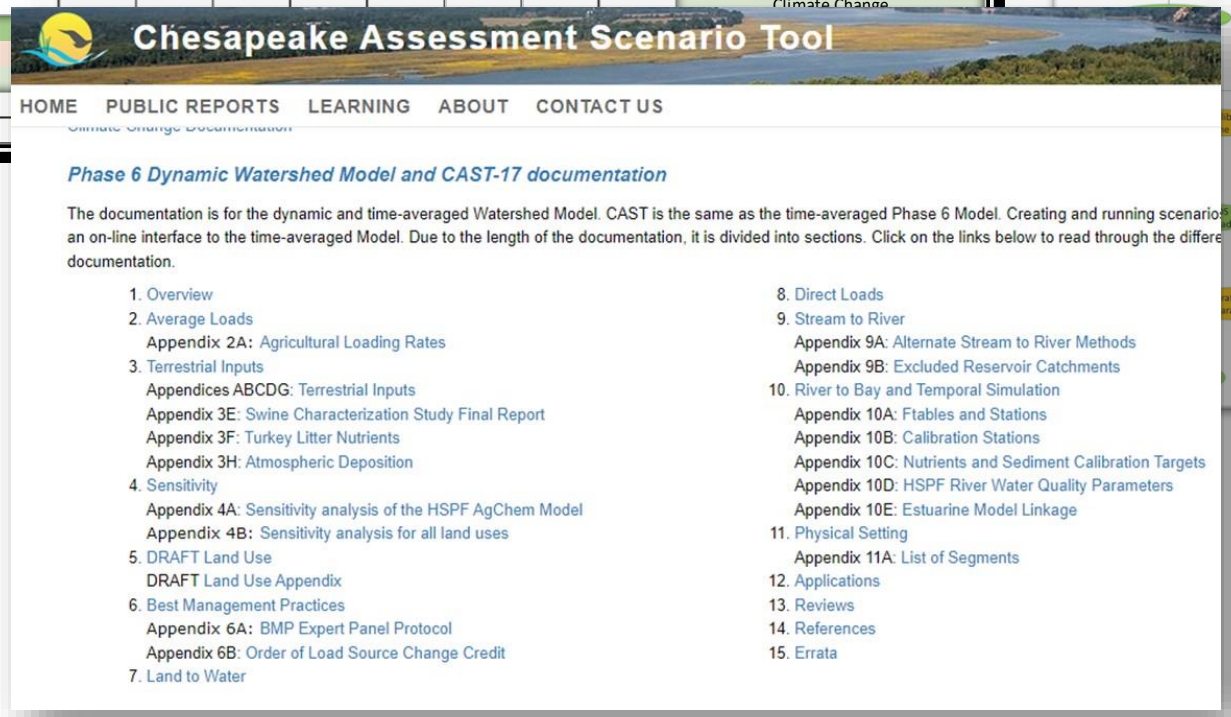

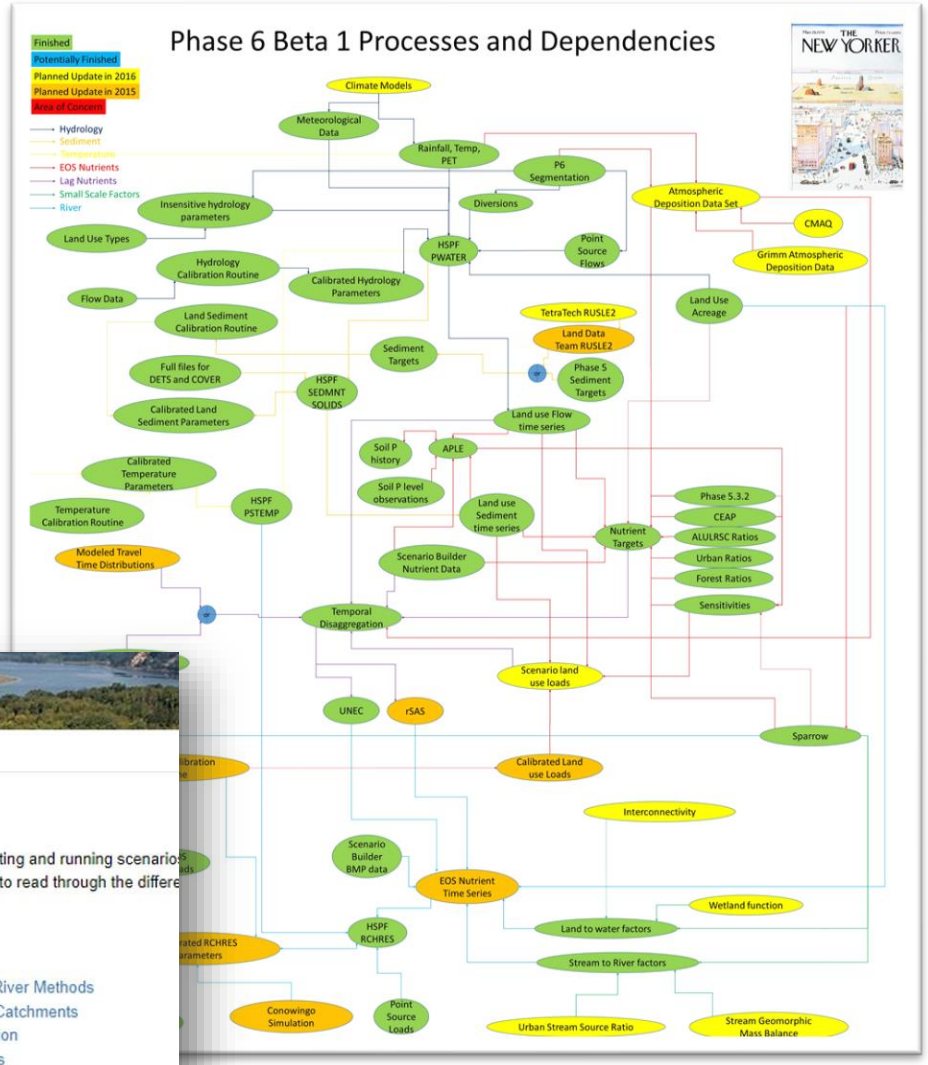

CalCAST

Load for a land use in a segment

$$L = \left(A + \left(\begin{array}{l} \text{Biosolid} * Sb \\ \text{Manure} * Sm \\ \text{Fertilizer} * Sfert \\ \text{Uptake} * Sup \end{array} \right)_{County,lu} + \left(\begin{array}{l} \text{Fixation} * Sx \\ \text{Cover} * Sc \\ \text{SoilP} * Sp \end{array} \right)_{County,\,lu} + \left(\begin{array}{l} \text{Atdep} * Sa \\ \text{Stormflow} * Sf \\ \text{Sediment} * Ss \\ \text{Climate} * Scl \end{array} \right)_{nhd,lu} \right) * \text{Acres}_{NHD,\,lu} * \text{BMP}_{NHD,\,lu} * \text{Delivery}_{NHD,\,lu?}$$

NHD-Scale

Where:

A = CropRate * ClassRatioToCrop * LUratioToClass