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Watershed Management Optimization Support Tool (WMOST): Benefits Module

Loucks and van Beek 2005

Naomi Detenbeck

U.S. EPA Office of Research and Development

Atlantic Coastal and Environmental Sciences Division

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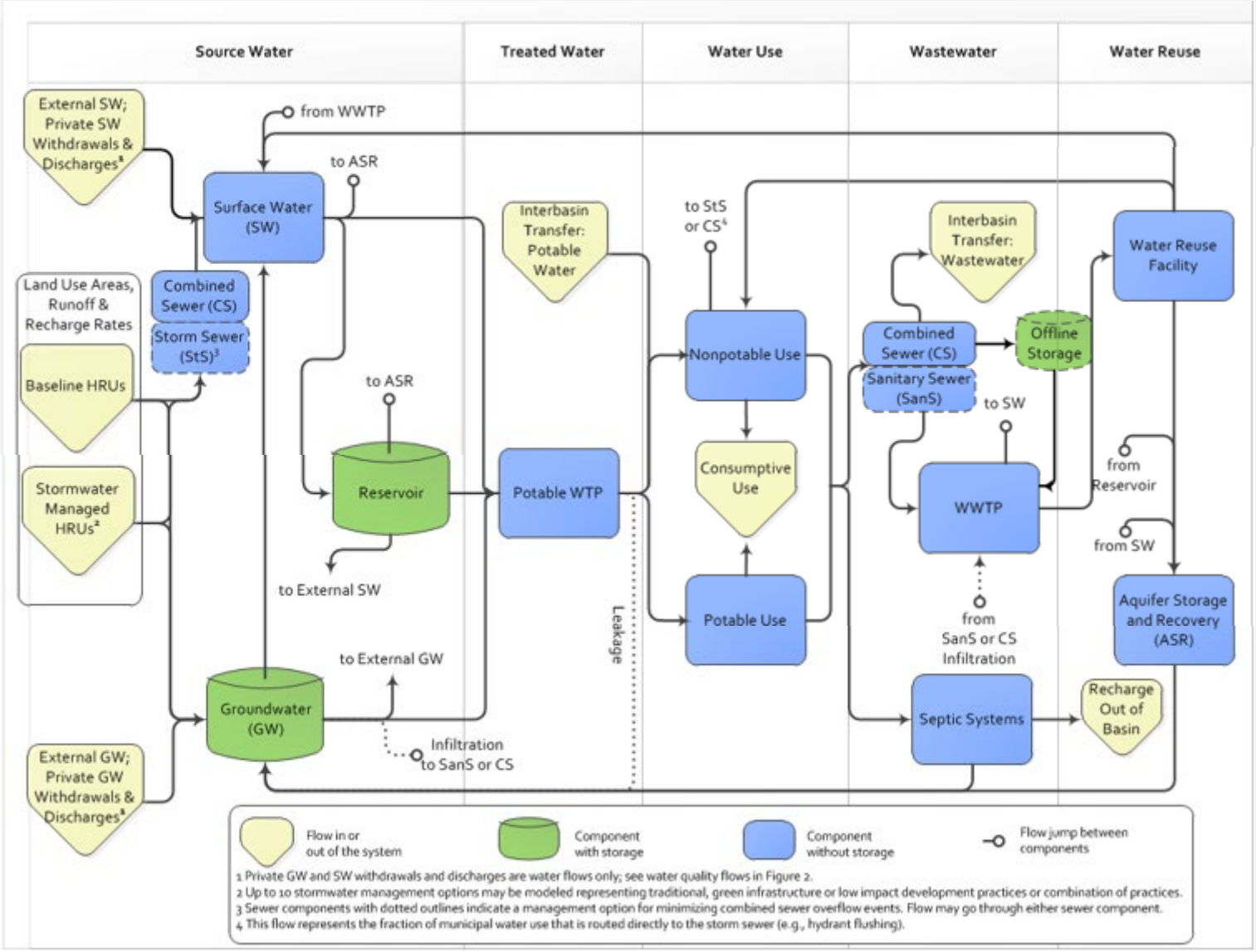
Watershed Management Optimization Support Tool

- User-friendly decision support tool that identifies most cost-effective integrated water management actions for meeting specific goals for water quantity and quality
- Developed explicitly to inform management decisions at small watershed scale (≤ HUC12 – HUC10)
- Uniqueness – scale, IWRM scope/coordinated approach, cost, broad audience, level of technical expertise required
- Value added to existing tools and models
  - Uses output from existing TMDL models (e.g., HSPF, SWAT, SWMM)
  - Integrated with SUSTAIN/SWMM to simulate BMP processes
  - Uses output from FEMA's HAZUS tool to incorporate flooding costs/risks
- Promotes efficiency in finding best solutions through optimization rather than doing repeated model simulations

WMOST mass balances of water & pollutants



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Benefits monetized in WMOSTv3 prior to benefits module

- WMOST provides optimal (least-cost) integrated management solution to meet water quantity and quality targets
  - Wastewater, stormwater, drinking water, land conservation
  - Capital and O&M infrastructure costs included
- Reduced costs associated with meeting loading targets through integrated management practices can be derived through scenario comparisons, e.g.,
  - Reductions in flood-related risk and costs (flood module)
  - Reductions in potential CSO storage/treatment (e.g., underground storage) associated with repair of I/I problems, green infrastructure BMPs
  - Reductions in interbasin transfer costs for drinking water imports if infiltration by GI stormwater BMPs increases groundwater availability

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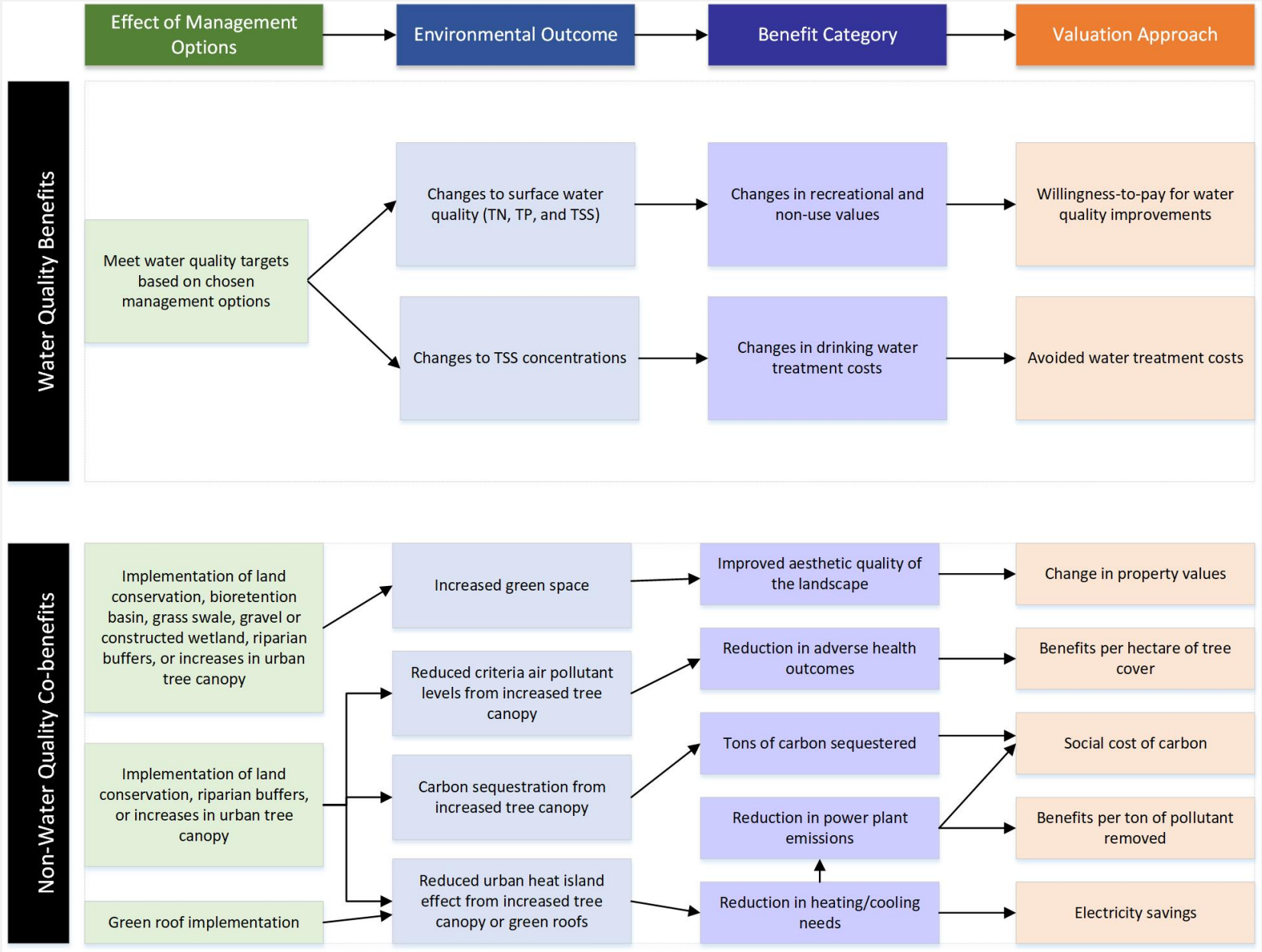
Additional benefits and cobenefits monetized in new Benefits Module

- Benefits (related to water quality endpoints)
  - Changes in recreational and non-use values
  - Reduced drinking water treatment costs (TSS)
- Co-benefits (related to non water-quality endpoints)
  - Property values (green space)
  - Social cost of carbon
  - Heating/cooling costs
  - Human health
    - Reduced exposure to atmospheric emissions

Summary of Benefits and Cobenefits



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WQ Benefits
Recreational and non-use values

- Water Quality Index approach – used in multiple EPA rule-makings
  - total nonmarket benefits of water quality changes based on the changes in ecosystem services provided by surface water that are valued by humans, including water-based recreation, aquatic biodiversity, wildlife support, aesthetic, and non-use
  - meta-regression model of surface water valuation studies (U.S. EPA, 2015)
  - WQI aggregates multiple parameters into a single index value (0-100 scale)
    - TN, TP, TSS changes due to management derived from WMOST runs
    - Other WQ parameters (DO, BOD, fecal coliform) baseline derived from nationwide database or local user input

WQ Benefits
Drinking water treatment costs

- ΔTSS => Δ turbidity (US EPA 2009)
- Aluminum sulfate is the primary coagulant used to treat turbidity
- $Al = 33\log(T) - 28$ (US EPA 2009)
  - Al = aluminum dose (mg/L)
  - T = turbidity (NTU)

$$TC_{Al} = \sum_{t=1}^{ndays}(Q_{SwWtp,t} + Q_{ResWtp,t}) \times \left(\frac{Al \times (3.79 \times 10^6)}{9.07 \times 10^8}\right) \times C_{Al}$$

- TC_{Al} = total alum cost
- $Q_{SwWtp,t}$ = daily flow from surface water system to water treatment plant (MG/day)
- $Q_{ResWtp,t}$ = daily flow from reservoir to treatment plant (MG/day)

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Non-WQ Cobenefits Property values

- Δ housing prices resulting from increased green space (both natural and constructed green infrastructure) per HUC12 or HUC10 using coefficients from meta-regression of results in existing hedonic literature (Mazzotta et al. 2014)
- % change in annual rental value of property depends on
  - % percentage change in green space
  - distance of green space from residences
  - characteristics of the changed green space
  - population density
- Supported by nationwide database of residential buildings within 250 and 500 meters of riparian zone at HUC12 scale

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Non-WQ Cobenefits Related to canopy cover

Environmental Outcome	Benefit	Source(s)	Region Type
Increased acres of canopy cover	Increased carbon sequestration	Social Cost of Carbon: Global: IWGSCC (2016) Domestic: U.S. EPA (2019a)	National
	Avoided human health damages resulting from tree removal of air pollutants (NO_2, SO_2, O_3, $PM_{2.5}$)	Nowak et al. (2014)	National (regressions); county-level (population density)
Increased acres of urban/community trees	Electricity savings	Nowak et al. (2017); personal communication with authors	State-level
	Avoided human health damages from avoided NO_x, SO_2, and $PM_{2.5}$ emissions from power plants	Quantification: Nowak et al. (2012); Nowak et al. (2017) Monetization: U.S. EPA (2018)	Quantification: State-level Monetization: National
	Avoided CO_2 emissions from power plants	Quantification: Nowak et al. (2012); Nowak et al. (2017) Monetization: IWGSCC (2016), U.S. EPA (2019a)	Quantification: State-level Monetization: National

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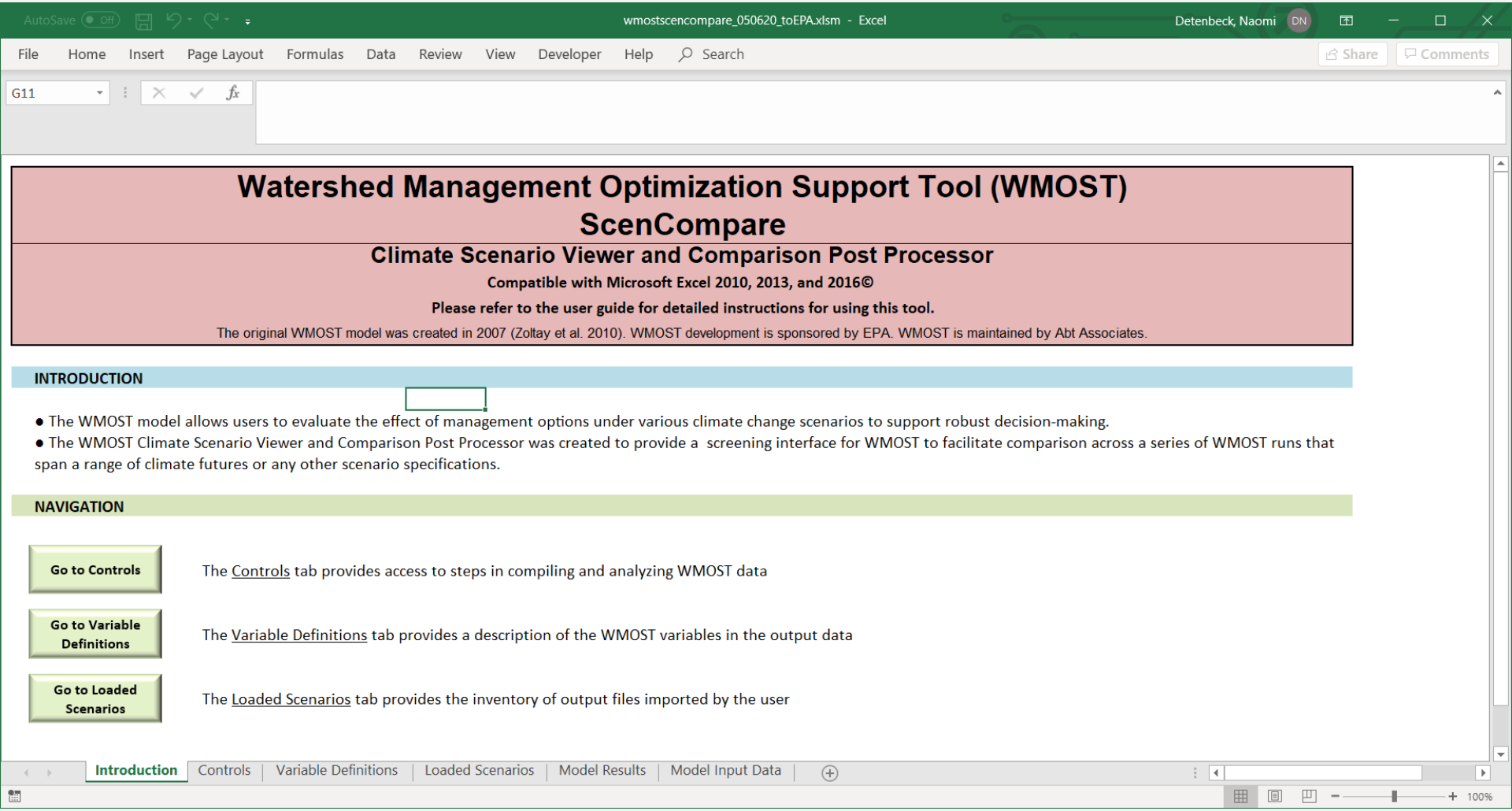
Non-WQ Cobenefits Related to green roofs

Benefit	Source(s)	Region Type
Electricity savings	State-level: U.S. EIA (2018)	State-level (you can provide local values)
Avoided human health damages from avoided NO_x, SO_2, and $PM_{2.5}$ emissions from power plants	Quantification: U.S. EPA (2019b) Monetization: U.S. EPA (2018)	Quantification: Regional (AVERT regions) Monetization: National
Avoided CO_2 emissions from power plants	Quantification: U.S. EPA (2019b) Monetization: IWGSCC (2016), U.S. EPA (2019a)	Quantification: Regional (AVERT regions) Monetization: National

Benefits Module Interface



- Embedded in WMOST Scenario Comparison Tool
- Allows import of multiple WMOST run result files (TN,TP,TSS)
- Incorporates required look-up tables

Benefits Module Interface

Return to Loaded Scenarios

Benefit Calculations

ScenCompare will calculate benefits related to outcomes targeted by a management practice (direct benefits) and benefits that arise from other outcomes of implementing the management practice selected to meet the target (co-benefits).

Update List of Model Runs

1. Study Characteristics

1A. Specify the year of the analysis.

2016

Specify the dollar year in which you'd like to evaluate benefits.

$2019

Calculate Social Cost of Carbon

If calculating management option co-benefits (see Section 3), choose if you would like to calculate co-benefits using the global *or* domestic social cost of carbon.

Global social cost of carbon	$ 45.56	$/metric ton; *delete either the global or domestic cost as appropriate*
Domestic social cost of carbon		$/metric ton; *delete either the global or domestic cost as appropriate*

1B. The Benefits Module uses several databases to calculate management option direct benefits and co-benefits. The databases are based on USGS' fourth level of hydrologic unit classification (HUC12).

The Module also requires land use-specific information about the land uses found within your watershed.

Select a model below that represents your watershed using the drop-down list.

Model run representing your watershed.	Scenario_TSS

Press the button below to populate the table with the HRU names from your watershed.

Setup HRU Table

Select each data header for more information.

HRU Name	Agricultural land	Residential land	Green space percentage
Turfgrass A/B Montgomery County	0	1	10
Turfgrass C/D Montgomery County	0	1	10
Turfgrass A/B City of Rockville	0	1	5
Turfgrass C/D City of Rockville	0	1	5
Turfgrass A/B MD State Highway	0	1	5
Turfgrass C/D MD State Highway	0	1	5
Turfgrass A/B Other Regulated	0	1	10
Turfgrass C/D Other Regulated	0	1	10
Natural-nonforested	0	0	0
Natural	0	0	0
Water	0	0	0

After setting up the HRU table, enter the number of HUC12s that make up your study area (up to 20).

1

Setup HUC12 Table

HUC12 ID	Proportion of HUC12 (percentage)
020700081003	100

2. Calculation of Direct Benefits

Once input values have been entered below, use this button to calculate the value of direct benefits.

Calculate Direct Benefits

If any of the direct benefit calculations are inappropriate for your study area, leave the model run choices blank under step 2A.

2A. Choose the appropriate baseline and managed model runs below.

Fill out the **blue** input cells to compute the direct benefit value of...

Baseline Model Run
Baseline_TSS_WTP
Managed Model Run
Scenario_TSS_WTP

Change in water treatment costs

Estimated ratio of turbidity to TSS	1.5	1.5 by default
	$ 300.00	$/ton
Cost of alum	2016	Dollar year

Water treatment cost changes

$ 199.22

Baseline Model Run - TN
Baseline_TN
Baseline Model Run - TP
Baseline_TP
Baseline Model Run - TSS
Baseline_TSS
Model Run Estimating TN Changes

Total nonmarket benefits of water quality changes

Indicate below if your case study falls into any of the three defined US regions.

If your case study does not fall into any of the three, leave all values as zero.

Northeast	0	1 if located in the Northeast (ME, NH, VT, MA, RI, CT, and NY); 0 otherwise
Central	0	1 if located in the Central US (OH, MI, IN, IL, WI, MN, IA, MO, ND, SD, NE, KS, MT, WY, UT, and CO); 0 otherwise
South	0	1 if located in the South (NC, SC, GA, FL, KY, TN, MS, AL, AR, LA, OK, TX, and

Annual willingness-to-pay for water quality changes

$ 1,924,228.74

Key references

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- United States Environmental Protection Agency (U.S. EPA). (2019b). AVERT Avoided Emission Factors 2007-2018. Retrieved from: https://www.epa.gov/sites/production/files/2019-05/documents/avert_emission_factors_05-30-19_508.pdf

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More info

- Naomi Detenbeck (detenbeck.naomi@epa.gov)
- WMOST (www.epa.gov/ceam/wmost)
- Benefits module (in review)
  - Will be added to WMOST web site
  - Tool
  - Tool with example data set
  - User guide
  - Theoretical documentation (includes stand-alone spreadsheet illustrating underlying calculations)