Improving Agreement between CAST and the Watershed Model Loads

CASTTOOL.ORG
MASTONLINE.ORG
VASTTOOL.ORG
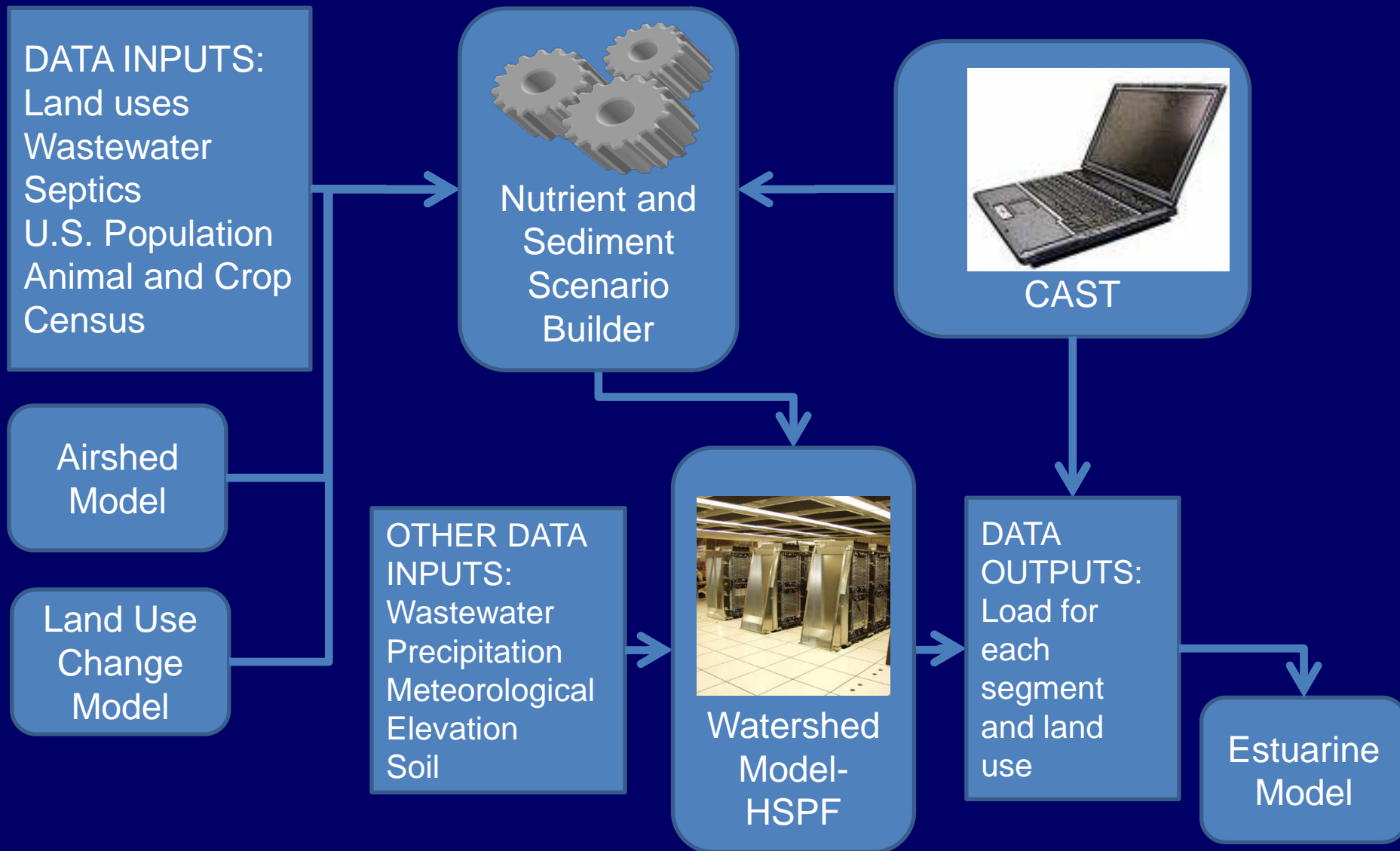
Olivia H. Devereux and Jessica R. Rigelman

Outline

- Goals for CAST

- Load estimation methodology

- Initial validation results

- Remaining work

GOALS FOR CAST

Chesapeake Bay Program Models

DATA INPUTS:
Land uses
Wastewater
Septics
U.S. Population
Animal and Crop
Census

Nutrient and Sediment Scenario Builder

CAST

Airshed Model

Land Use Change Model

OTHER DATA INPUTS:
Wastewater
Precipitation
Meteorological
Elevation
Soil

Watershed Model-HSPF

DATA OUTPUTS:
Load for each segment and land use

Estuarine Model

About CAST | Contact Us

Chesapeake Assessment Scenario Tool

Scenarios | Scenario Details | **BMPs** | Calculate Summary

Edit Profile | Log Out

2025 Phase 2 WIP - York County
Urban BMPs

Pre-BMP Landuse Acres ▲	Non-Federal	Federal
CSS construction	0.0	0.0
CSS extractive	0.0	0.0
CSS impervious developed	0.0	0.0
CSS pervious developed	0.0	0.0
nonregulated extractive	0.0	0.0
nonregulated impervious developed	10,329.6	1.1
nonregulated pervious developed	40,372.1	2.7
regulated construction	1,637.0	0.1
regulated extractive	3,367.9	0.4
regulated impervious developed	25,454.4	637.7
regulated pervious developed	78,007.7	845.7

Pre Bmp Landuse Raw Data ⬇

Select the BMP you would like to add:

Bioretention/raingardens - A/B soils, underdrain ▼

Select the land use or land use group you would like to apply the BMP to:

Regulated urban ▼

Land Group Components 📊

Select the geographic scale you would like to use to determine the area for the BMP:

County ▼

Specify which geographic area you would like the BMP applied to:

York, PA ▼

Enter an amount and select a unit for the BMP:

15 ⦿ acres treated ○ percent

Notes:

New regulation planned, currently in public response period

[Add] [Reset]

Download BMP Data ⬇

[Delete Selected Items] [Multi Edit Mode]

| BMP	Landuse Group	Geography	Unit	Amount	Notes		
Abandoned Mine Reclamation	Extractive-all	York, PA	acres	517.67		Edit	Delete
Dirt & Gravel Road Erosion & Sediment Control - Driving Surface Aggregate + Raising the Roadbed	nonregulated impervious developed	York, PA	feet	42756.01		Edit	Delete
Dirt & Gravel Road Erosion & Sediment Control - Outlets only	nonregulated impervious developed	York, PA	feet	42756.01		Edit	Delete
Dirt & Gravel Road Erosion & Sediment Control - with Outlets	nonregulated impervious developed	York, PA	feet	42756.01		Edit	Delete
Dry Detention Ponds and Hydrodynamic Structures	nonregulated impervious developed	York, PA	acres treated	256.67		Edit	Delete
	nonregulated pervious		acres				

Usage of CAST, MAST, and VAST

Users for CAST, MAST, and VAST

- 404, 26% (MAST)
- 716, 45% (CAST)
- 453, 29% (VAST)
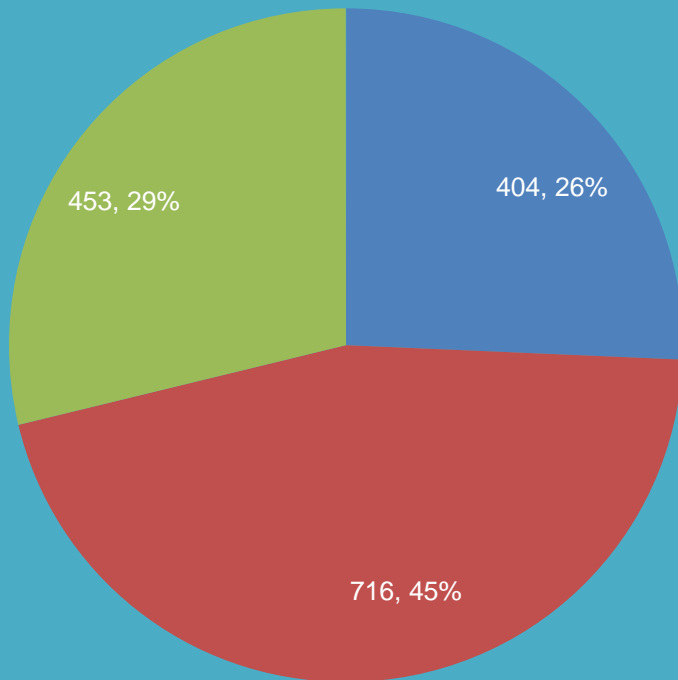
■ MAST ■ CAST ■ VAST

Scenarios per Tool
Total number of scenarios - 3,428

- 50% (MAST)
- 22% (CAST)
- 28% (VAST)
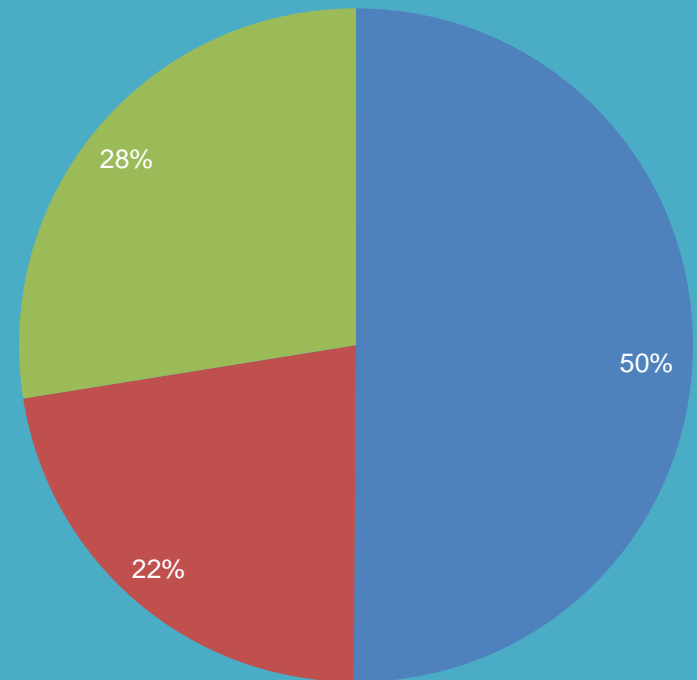
■ MAST ■ CAST ■ VAST

LOAD ESTIMATION METHODOLOGY

Source Data

- Initial load from Watershed Model

- User Inputs
  - BMP
  - Geographic area
  - Land use

- Output
  - BMP summary
  - Estimated loads
  - Scenario Builder input files-validated and ready to run

Load Calculation

- Calculate an initial load for every land use in every modeling segment
  - Use an artificial land use
    - Land Segments = 377
    - River Segments= 1,084
    - Land uses = 31
    - Simulation Years = 20

  - Run the scenario with no BMPs

  - Run the scenario through Watershed Model

Load Calculation-cont.

- Apply load reduction same as the Chesapeake Bay Program models (same groups and sequence)

- Adjust the land use from user-entered BMPs

- Calculate the per acre load

- Output: User sees total load per segment
  – Multiply by acres
  – Shows edge of stream loads and load delivered to the Bay

Methodology for BMP Calculations

- CAST calculates all BMPs identically to the Chesapeake Bay Program's models except for Animal BMPs, BMPs in lbs, and any BMPs reduced by hydrological effects.

  - Animal BMPs affect the amount of manure

  - CAST calculates manure lbs based on user-selected BMP implementation level, same as Scenario Builder

- Distribution of manure lbs based on regressions

- Three classifications of manure
  - direct deposit manure (pasture land uses only)
  - storage loss manure (AFO/CFO)
  - stored manure (crop and pasture land)

Animal BMPs

BMPs that increase stored manure, which is then applied to crops and pasture

BMPs that decrease total manure

- Alum
- Lagoon Covers
- AWMS
- Mortality Composting
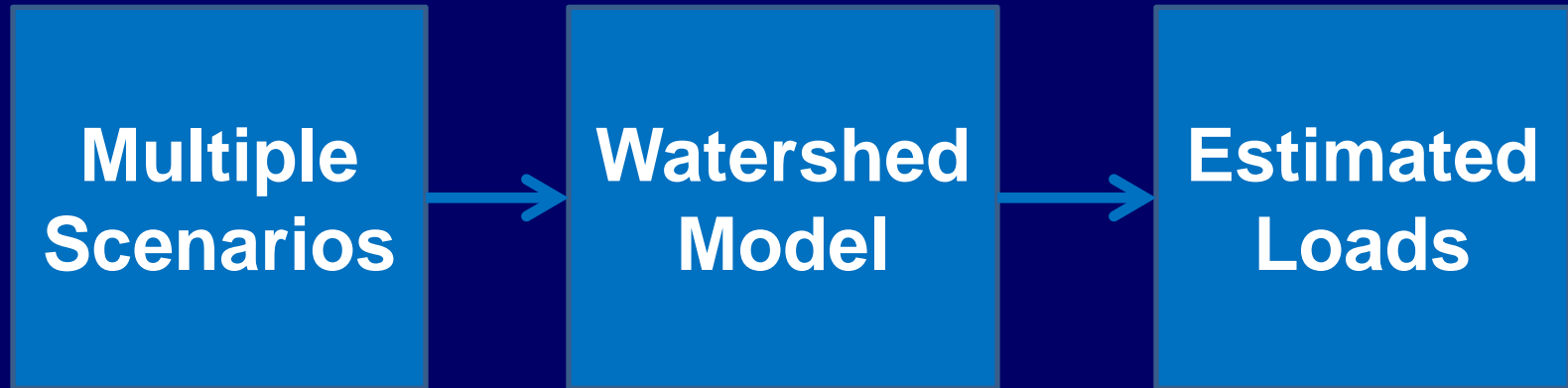
- Dairy Precision Feeding
- Poultry Phytase
- Swine Phytase

Factors Impacting Manure

- CAST calculates the amount of manure

- Regressions created using scenarios that included terms for:

    - BMP types and % implementation
    - Ratio of manure to land available
    - Nutrient management
    - Interaction effects

- The regression equations translate the manure into a loading rate by county, land use, and nitrogen or phosphorus.

135 Scenarios for Regressions

Multiple Scenarios → **Watershed Model** → **Estimated Loads**

- Three levels of increasing and decreasing BMPs (0, 50, 100%)

- Five levels of nutrient management (0, 50, 75, 90, 100%)

- Nine levels of land use change to determine the ratio of manure to manure receiving land uses (0, 5, 10,15, 20, 25, 30, 35, 40%) simulated with tree planting on agricultural land

1,000s of Different Regression Equations
## -Vary by County, Pollutant, and Land Use

- Terms:
  - Intercept
  - Stored
  - MLUF
  - NMFraction
  - Stored*MLUF
  - Stored*NMFraction
  - MLUF*NMFraction
  - NMFraction*NMFraction
  - MLUF*MLUF
  - Direct
  - Direct*MLUF
  - Direct*NMFraction
  - NMFrac*NMFrac*NMFrac
  - MLUF*MLUF*NMFraction
  - MLUF*NMFrac*NMFrac
  - MLUF*MLUF*NMFrac*NMFrac

- Generalized equation: WSM Load (Lb/A) ~ Intercept + (Direct deposit (lbs) * regression coefficient for direct) + …..
- Definitions:
  - Stored - Amount of stored manure
  - MLUF - amount of manure / acres of manure receiving land uses
  - NMFraction - fraction of nutrient management on manure receiving land uses
  - Direct - Amount of direct deposit manure

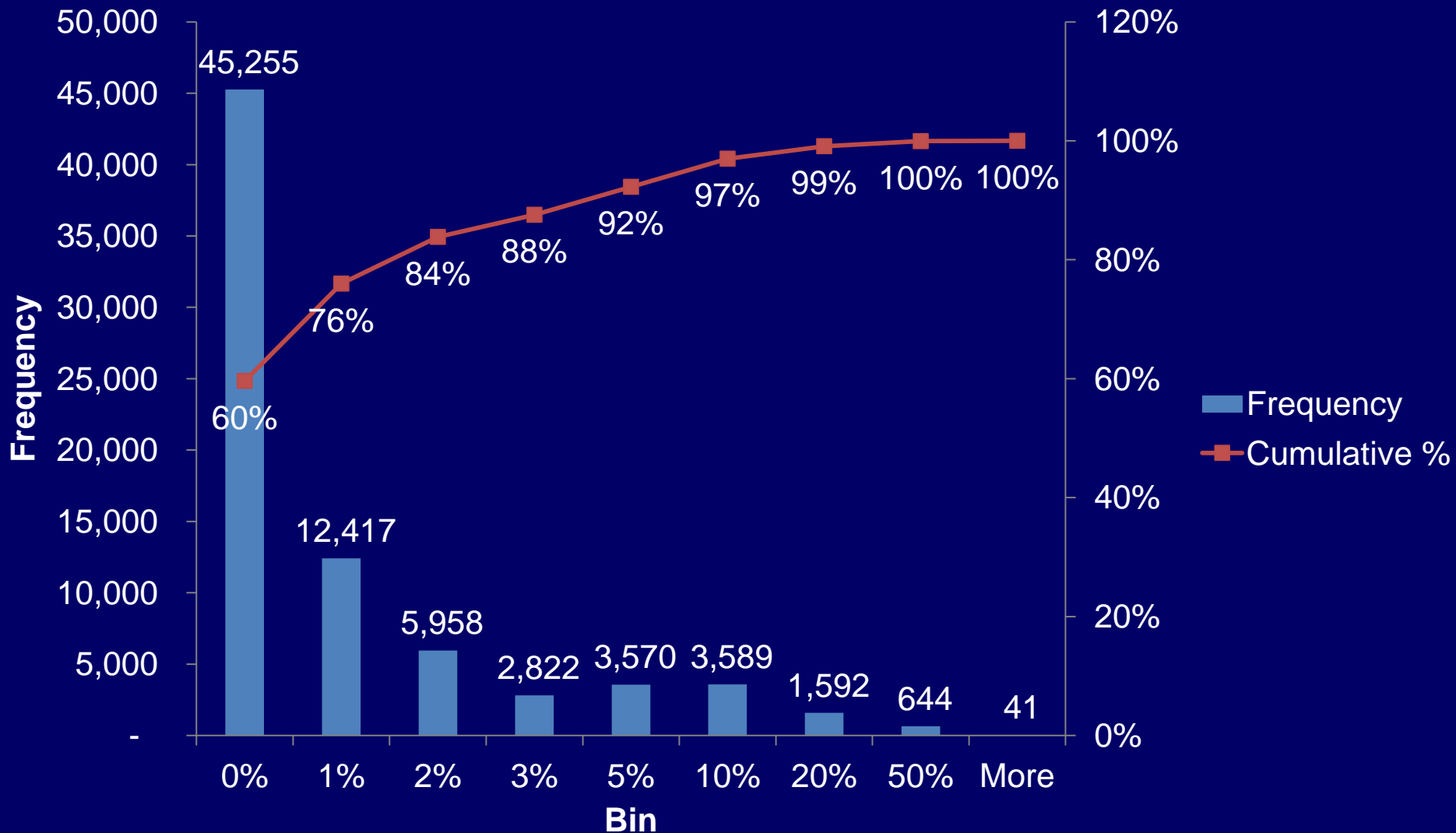# INITIAL VALIDATION RESULTS

TN Percent Difference
2025 WIP No Pound BMPs
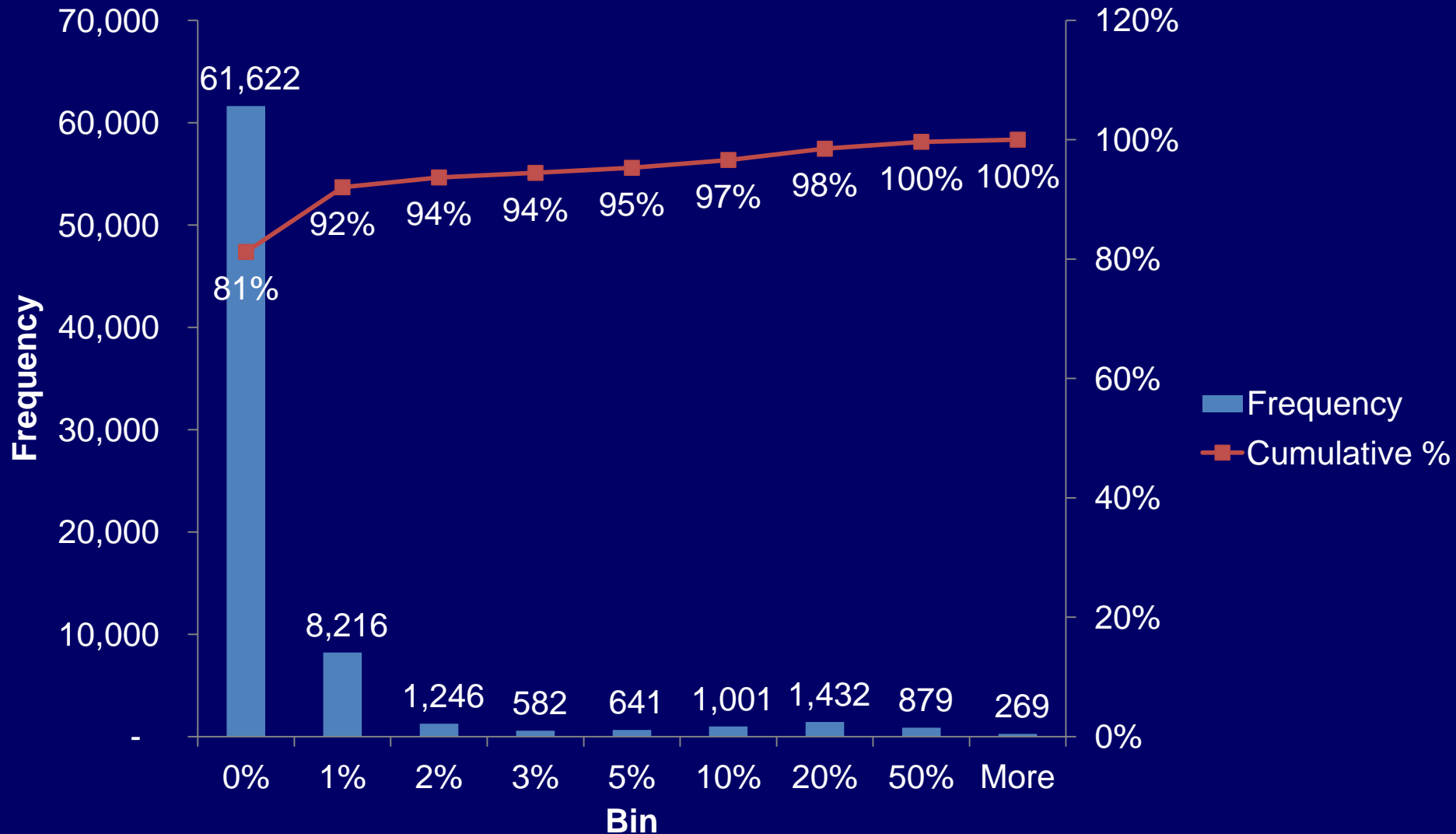
TP Percent Difference
2025 WIP No Pound BMPs
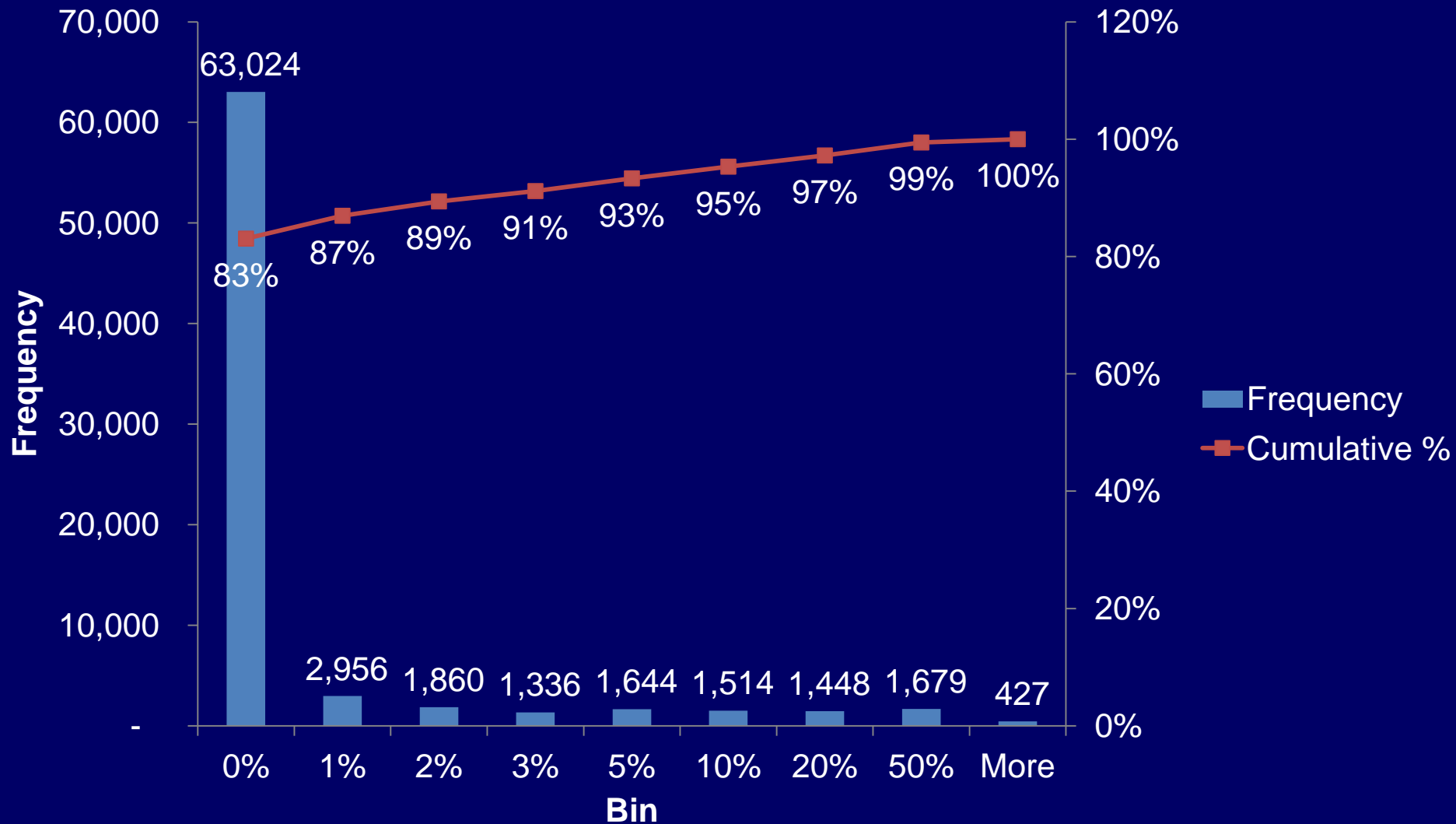
TSS Percent Difference
2025 WIP No Pound BMPs

Remaining Work on Agreement with WSM

- Address the BMP reduction for hydrology (generally 1-2%, could be as much as 9% on a per acre basis)

- Add in pound BMP correction

- Program into CAST
  - Include a message for lrseg and land uses where agreement is not within 5% of WSM

Initial Design of Cost Functionality

- Incorporate annualized unit cost of practices ($/acre/year) into CAST
  - Default costs for each BMP will be the EPA estimates for WIP BMPs
  - Users will be able to specify their own cost
  - Types of cost for each BMP include the following where applicable
    - Capital
    - Operations
    - Maintenance
    - Opportunity
  - Annualization is likely to be zero
  - Users will be able to save multiple versions of costs
  - Available on the Summary Results, Compare Scenarios, and in the BMP file that the user may download

Trainings

CAST and VAST training focused on urban applications
Date: Tuesday, September 10, 2013
Time: 1:00 to 3:00 pm.
URL: https://epa.connectsolutions.com/cast_mast_vast_training/
Telephone conference line: (866) 299-3188, Participant Code- 2679856222

MAST training focused on urban applications
Date: Wednesday, September 11, 2013
Time: 1:00 to 3:00 pm.
URL: https://epa.connectsolutions.com/cast_mast_vast_training/
Telephone conference line: (866) 299-3188, Participant Code-2675715

CAST, MAST, and VAST training focused on agricultural applications
Date: Thursday, September 12, 2013
Time: 1:00 to 3:00 pm.
URL: https://epa.connectsolutions.com/cast_mast_vast_training/
Telephone conference line: (866) 299-3188, Participant Code- 2679856222

Please note that the URL is the same for all of the trainings, but the conference line changes.

Conclusion

- CAST is a reasonable approximation of the Watershed Model's N, P, and sediment loads
  - Available to the public for free
  - Online, no need to download special software

- Local jurisdictions learned that
  - pollutant loads are more sensitive to some BMPs than others
  - runoff and the resulting pollutant loads depend on the location of BMPs

- Users are learning to be selective about which BMPs they implement and where they are located to more effectively reduce loads.

- Using multiple models strengthens all models. Comparisons between MAST/CAST/VAST and Scenario Builder/Watershed Model led to changes to Scenario Builder and/or the Watershed Model

The Watershed Model determines if jurisdictions are meeting loads; CAST is a reasonable approximation for planning and engagement of local jurisdictions.

QUESTIONS?

We encourage you to test the tools at:
www.casttool.org
www.vasttool.org
www.mastonline.org