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Background

- In recent decades, the Town of Bluffton has undergone rapid land use changes due to growth and development in the May River Watershed.
- The development has greatly increased the impervious surfaces in the area, leading to larger volumes of stormwater runoff.
 - Increased runoff is also linked to a rise in pollutants, such as fecal coliform (FC), which ultimately drains to the May River.
 - More pollutants in the May River have led to disruptions to the river's key qualities, including shellfish harvesting and organism habitats.
- The "May River Watershed Action Plan" was developed to monitor and combat the rise of the pollutants.
- The model calibration efforts presented here will utilize components of the Action Plan to develop a water quality model to assess FC in the Headwaters of the May River.

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Project Overview

- In a previous update to the May River Watershed Action Plan:
 - Water quality models were created in XPSWMM for 2002 (baseline) and 2018 (current) conditions.
 - Updates to Town's water quality monitoring program were suggested to reduce model assumptions.
 - Concepts for areas and types of water quality BMPs were suggested to target reducing pollutants.



Project Overview

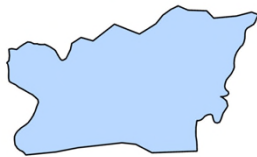
- In a previous update to the May River Watershed Action Plan:
 - Water quality models were created in XPSWMM for 2002 (baseline) and 2018 (current) conditions.
 - Updates to Town's water quality monitoring program were suggested to reduce model assumptions.
 - Concepts for areas and types of water quality BMPs were suggested to target reducing pollutants.
- The model update presented here will focus on:
 - Creation of an updated water quality model for present day (2024) conditions.
 - Utilizing more robust data set following changes made to water quality monitoring program.
 - Converting previously developed XPSWMM models for 2002 and 2018 conditions to PCSWMM to compare with the new current model (2024) for this update.
 - More user-friendly software compared to XPSWMM, but both rely on the same framework for modeling stormwater.
 - Incorporating the preliminary concept plan designs for "action projects" into PCSWMM to evaluate their impact on pollutant reduction.



Model Development

- Drainage Network
 - To simplify calculations, the models are broken out into various drainage areas, defined as the area where stormwater drains to a single outfall point.

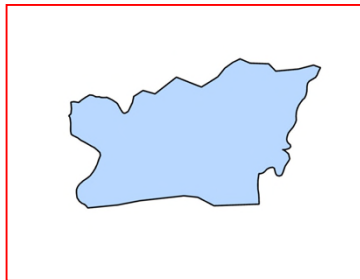
Subcatchment RD-17



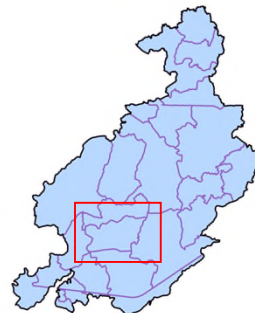
Model Development

- Drainage Network

Subcatchment RD-17

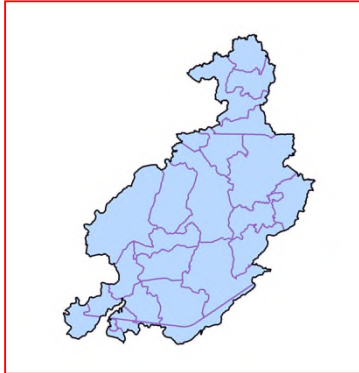


**Rose Dhu Creek
Subwatershed**

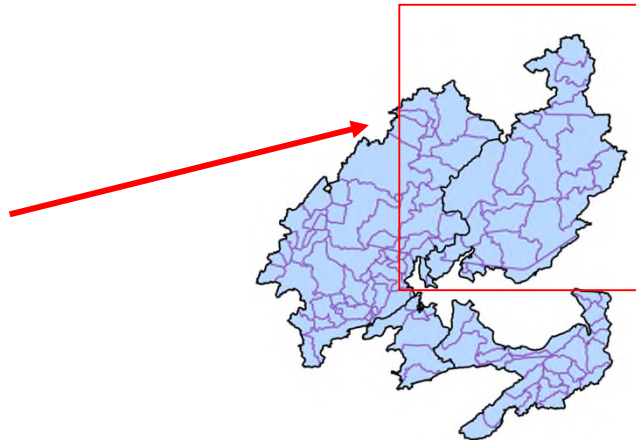


Model Development

- Drainage Network



Rose Dhu Creek **Subwatershed**



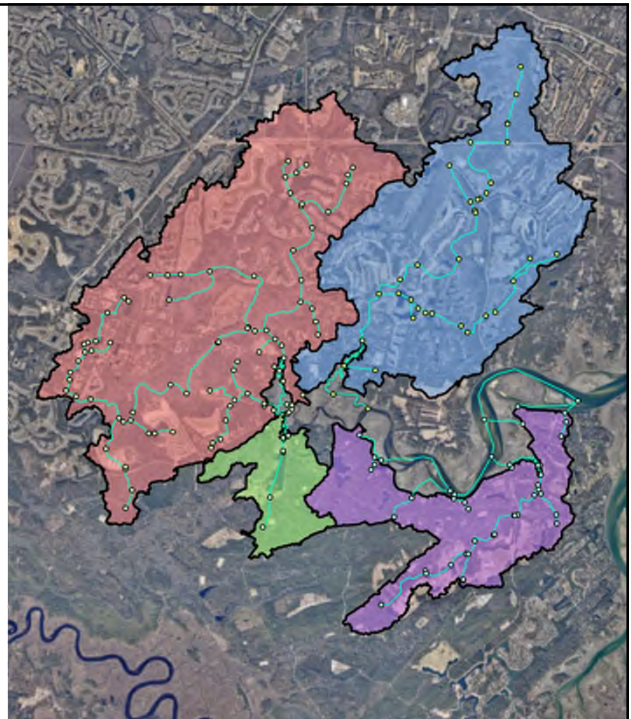
Headwaters of the May River **Watershed**



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Model Development

- Channels
 - Main drainage pathways in subwatersheds were used.
 - Measured from LiDAR.
 - Upstream and downstream channel invert also taken from LiDAR and adjusted accordingly.
 - Flow lengths estimated to be the length of the channels going through each subcatchment.
 - Used to calculate subcatchment widths.



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Model Development

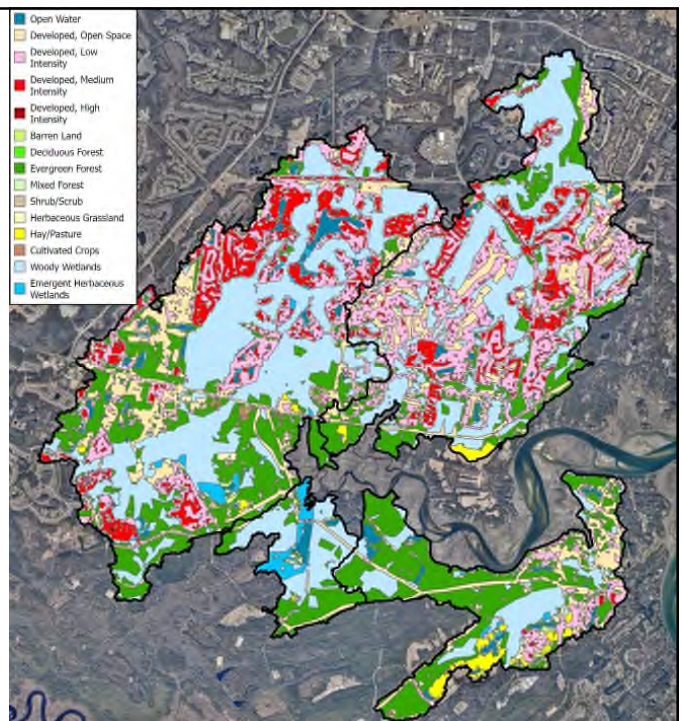
- Impervious Cover
 - Impervious GIS data provided by Town.
 - Added pond footprints to impervious dataset.



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Model Development

- Land Use
 - National Land Cover Database (NLCD).
 - Town provided land cover types by parcel, NLCD has fixed resolution.



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Model Development

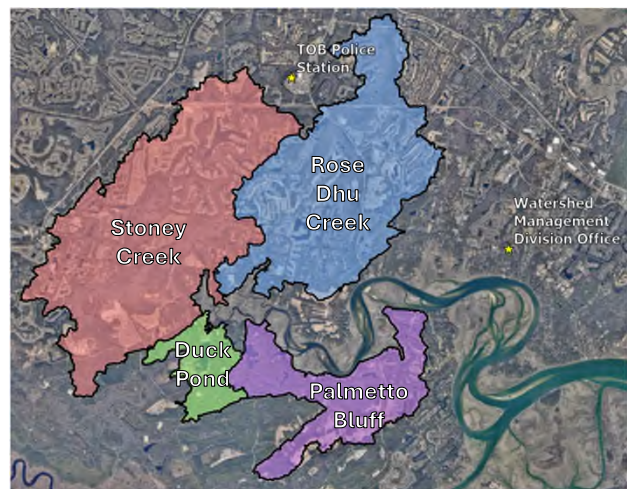
- Wastewater Type (by parcel)
 - Parcels that utilize septic systems
 - Parcels that have connections to sewer
- Distinction made as septic tanks can lead to higher amounts of pollutants in stormwater runoff, especially during heavy rains or system failures.



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Model Development

- Meteorological Data
 - Rainfall
 - TOBPD Station
 - Collects rainfall/other weather data every 15 minutes.
 - WMDO
 - Collects data every 30 minutes
 - More complete dataset for model period, used in PC24 models.
- Evapotranspiration/Evaporation
 - Calculated with Hamon method using weather station data.
 - (vapor pressure/monthly avg temp)



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Model Development

- Infiltration
 - Minimum infiltration rates set based on Hydrologic Soil Group (HSG) Type.
 - Maximum infiltration rates set based on developed/undeveloped land use types.

Minimum Infiltration Rates.

HSG	Infiltration rate (in/hr)
A	0.37
B	0.22
C	0.10
D	0.03

Maximum Infiltration Rates

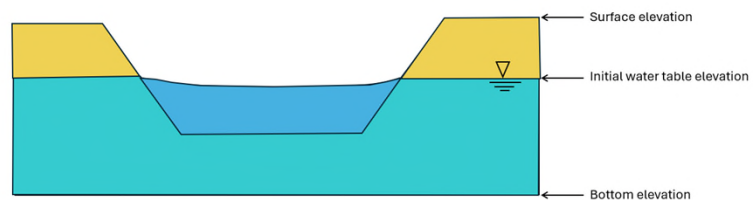
Pervious Area Land Cover Type	Infiltration Rate (in/hr)
Managed/Developed Pervious	5
Forest/Heavy Vegetation	10



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Model Development

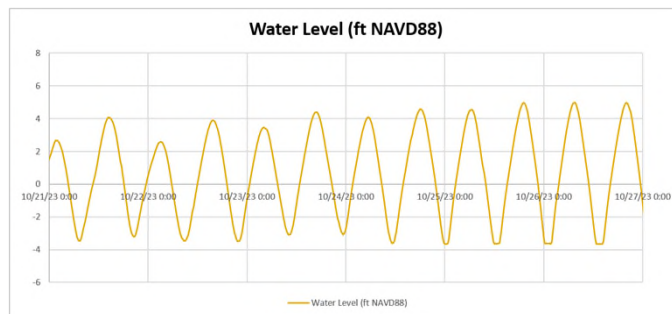
- Groundwater
 - Initial parameters set based on previous XPSWMM model inputs assuming no major changes since development and literature values.
 - Models must run for some time before baseflow from groundwater becomes established.



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Model Development

- Downstream Boundary
 - Tidal Data from Calhoun St Dock Gauge
 - Used fit equations from previous tidal study to translate the WSEs at Calhoun St to WSEs closer to subwatershed outlets.



Model Development

- Water Quality EMC Values

PCSWMM Land Use Type	NLCD Land Covers Included	Initial FC EMC value (#/100mL)
Developed, Open Space	Developed, Open Space	2500
Developed, Low/Medium Intensity (Sewer)	Developed, Low Intensity (Sewer), Developed, Medium Intensity (Sewer)	5150
Developed, Low/Medium Intensity (Septic)	Developed, Low Intensity (Septic), Developed, Medium Intensity (Septic)	6180
Developed, High Intensity (Sewer)	Developed, High Intensity	4000
Natural/Open Water	Barren Land, Deciduous Forest, Evergreen Forest, Mixed Forest, Shrubland, Hay/Pasture, Cultivated Crops, Woody Wetlands, Emergent Herbaceous Wetlands, Open Water	400

Flow Calibration

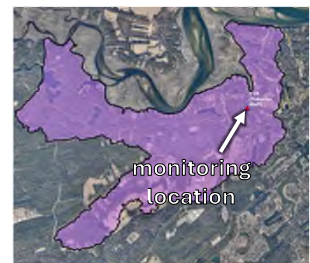
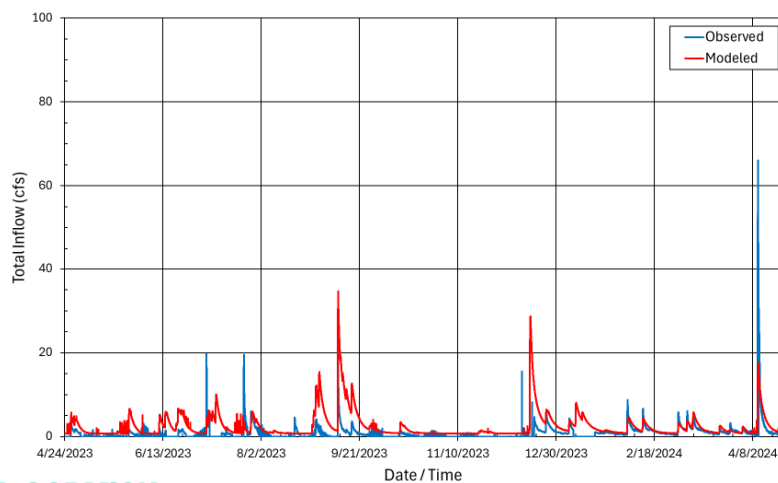
- Flow calibration performed using flow monitoring data recorded in Rose Dhu Creek, Stoney Creek, and Palmetto Bluff subwatersheds.
 - Monitoring locations were compared to the closest model node location.
- Duck Pond used a water surface elevation study of the pond surface to calibrate how water is retained in and exits the pond.
- PCSWMM's Sensitivity-based Radio Tuning Calibration (SRTC) tool used to overlay field measurements with model results and adjust parameters to better calibrate the models.



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Flow Calibration

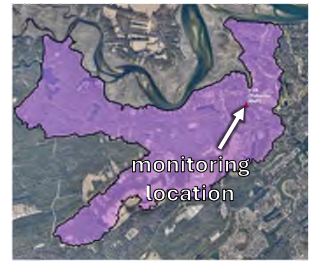
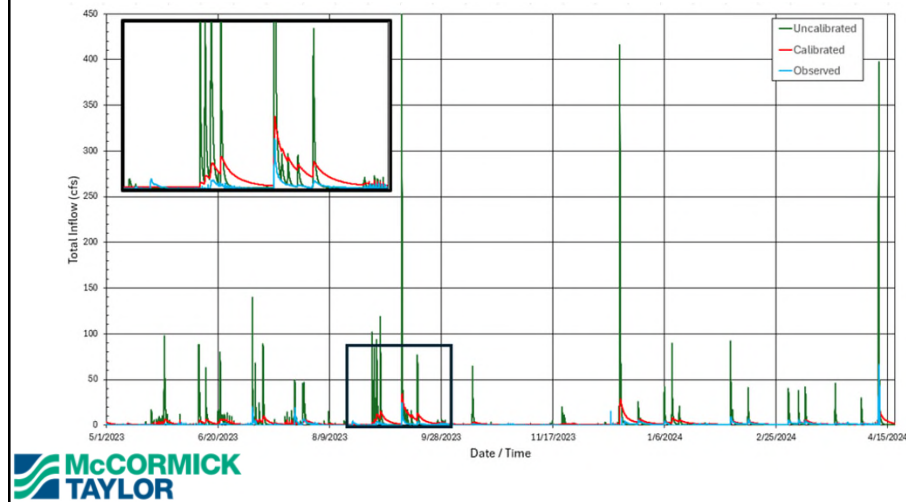
- Palmetto Bluff location I2-A



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Flow Calibration

- Palmetto Bluff location I2-A



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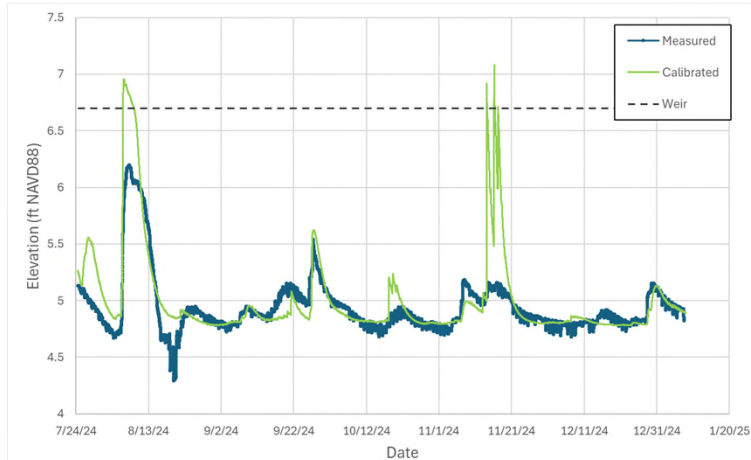
Flow Calibration

- Parameters changed:
 - Calibration parameters to fit groundwater equations
 - Percent of runoff routed to subcatchment outlet
 - Subcatchment width

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Flow Calibration

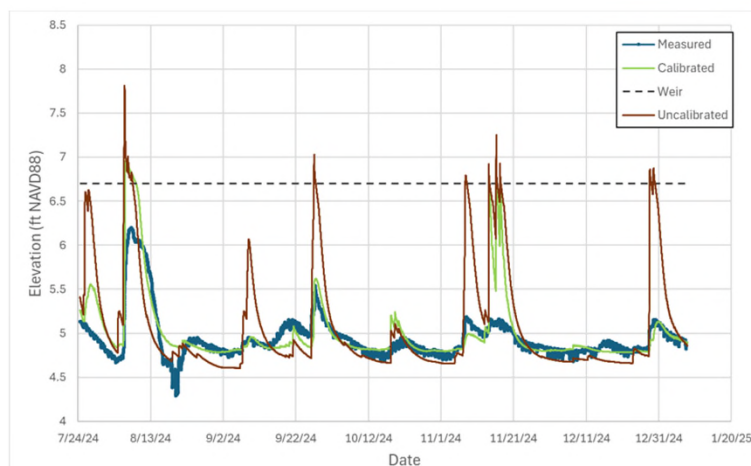
- Duck Pond



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Flow Calibration

- Duck Pond



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Flow Calibration

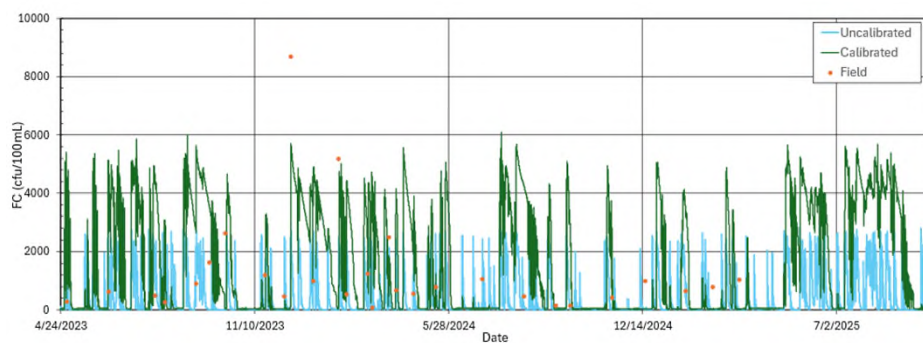
- Parameters changed:
 - Calibration parameters to fit groundwater equations
 - Percent of runoff routed to subcatchment outlet
 - Subcatchment width
 - Adjusted orifice at pond outfall to better capture water surface elevations



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Water Quality Calibration

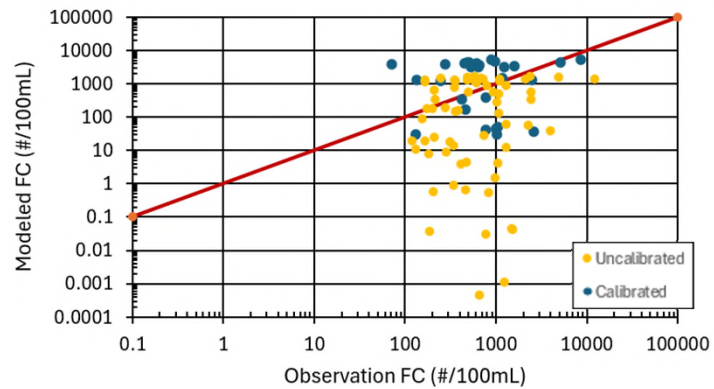
- Stoney Creek location SC-4



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Water Quality Calibration

- Stoney Creek location SC-4



Water Quality Calibration

- Parameters changed:
 - Some impact from the flow calibration variables that were changed
 - Modified EMC values

PCSWMM Land Use Type	Initial FC EMC Value (#/100ml)	Calibrated FC EMC Value (#/100ml)
Developed, Open Space	2,500	6,500
Developed, Low/Medium Intensity (Sewer)	5,150	12,400
Developed, Low/Medium Intensity (Septic)	6,180	15,000
Developed, High Intensity (Sewer)	4,000	10,000
Natural/Open Water	400	1,200

2002 and 2018 Model Conversion

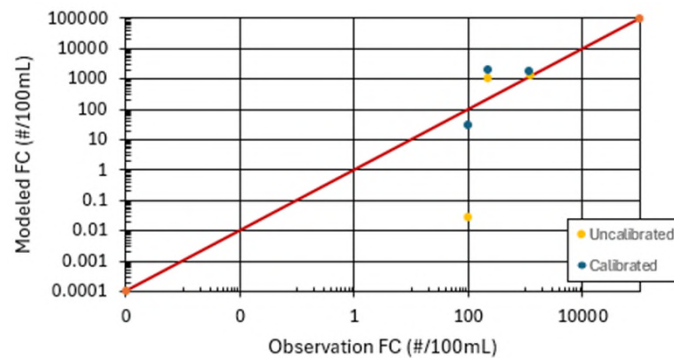
- Used XPSWMM Viewer v2024.1 to convert 2002 and 2018 XPSWMM model inputs to PCSWMM inputs.
- Direct conversion resulted in high routing errors.
 - Solution: modify channel cross sections and elevations to allow for overbank flows during larger storm events.
- All other inputs such as land uses, impervious, etc. preserved from earlier models.
- Once converted, 2002 and 2018 PCSWMM models went through their own calibration like the 2024 PCSWMM model.



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2002 and 2018 Model Conversion

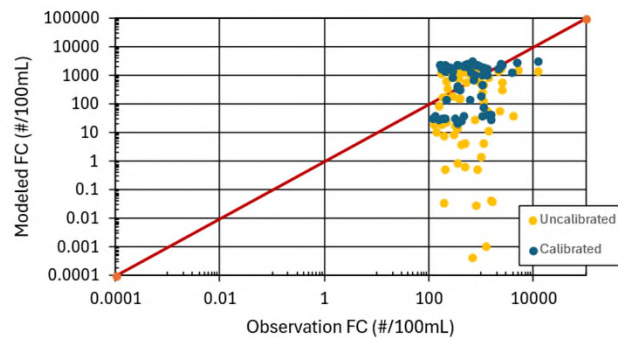
- 2002 Stoney Creek SC-149



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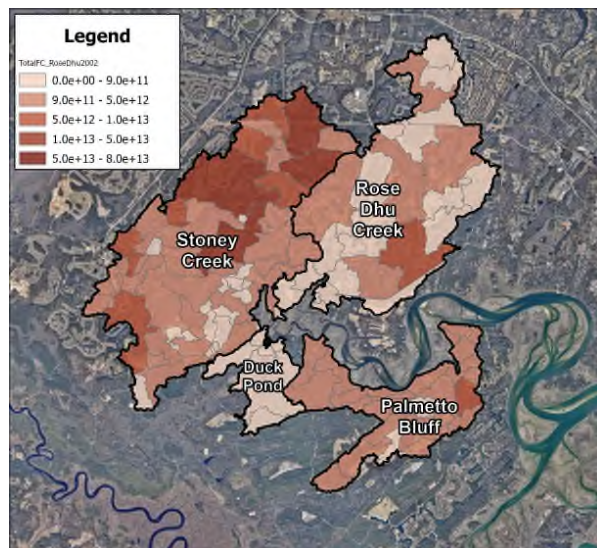
2002 and 2018 Model Conversion

- 2018 Stoney Creek SC-4



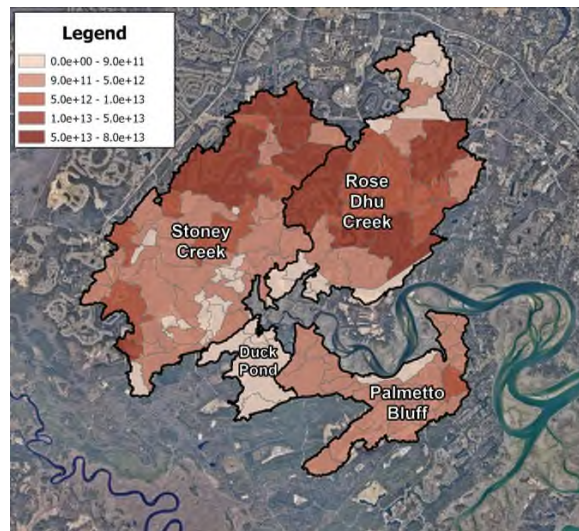
Model Results

- 2002 Total FC loading (#/yr)



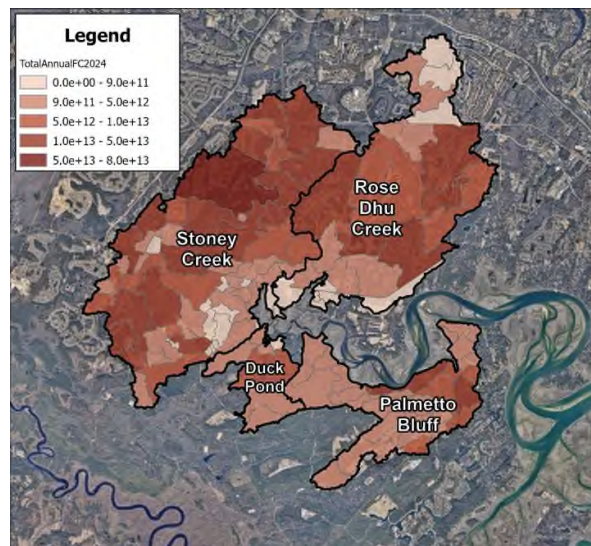
Model Results

- 2018 Total FC loading (#/yr)



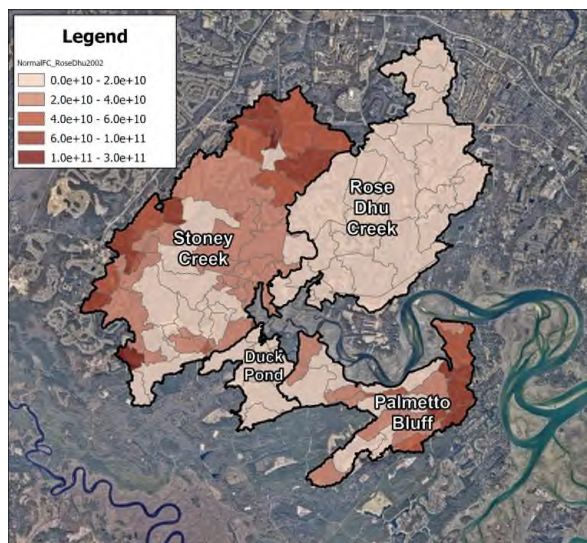
Model Results

- 2024 Total FC loading (#/yr)



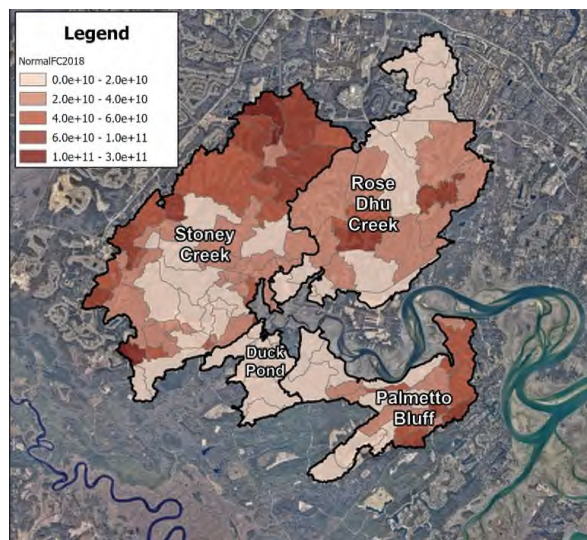
Model Results

- 2002 Normalized FC loading (#/yr/acre)



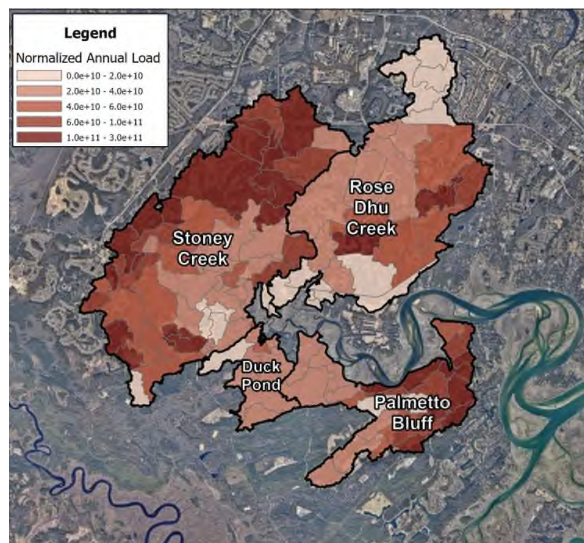
Model Results

- 2018 Normalized FC loading (#/yr/acre)



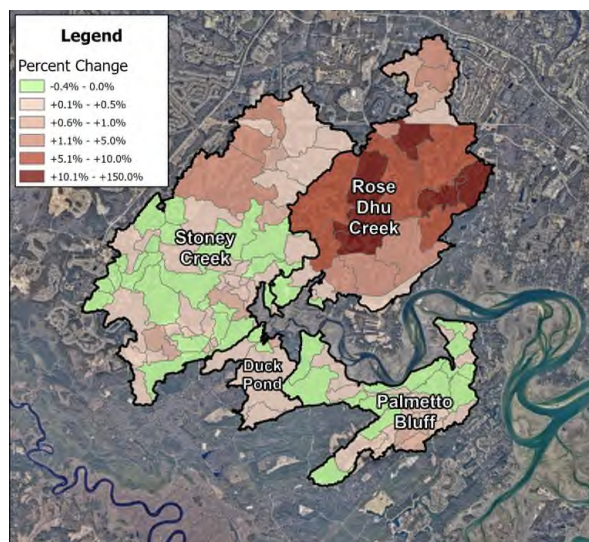
Model Results

- 2024 Normalized FC loading (#/yr/acre)



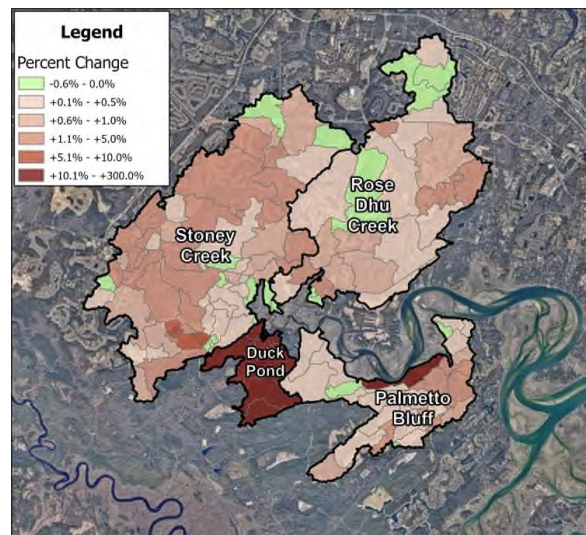
Model Results

- Change in Normalized FC loading (#/yr/acre) 2002 to 2018



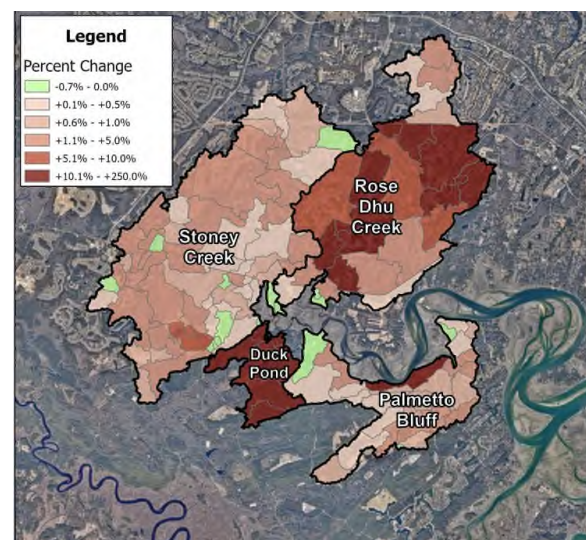
Model Results

- Change in Normalized FC loading (#/yr/acre) 2018 to 2024



Model Results

- Change in Normalized FC loading (#/yr/acre) 2002 to 2024



Action Plan Projects

- Preliminary concept plan designs were developed for 9 sites throughout the Headwaters.
- Each site contains several proposed water quality BMPs, including:
 - Bioretention cells
 - Infiltration trenches
 - Permeable pavement
 - Infiltration chambers
 - Conservation areas (not modeled)



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Action Plan Projects

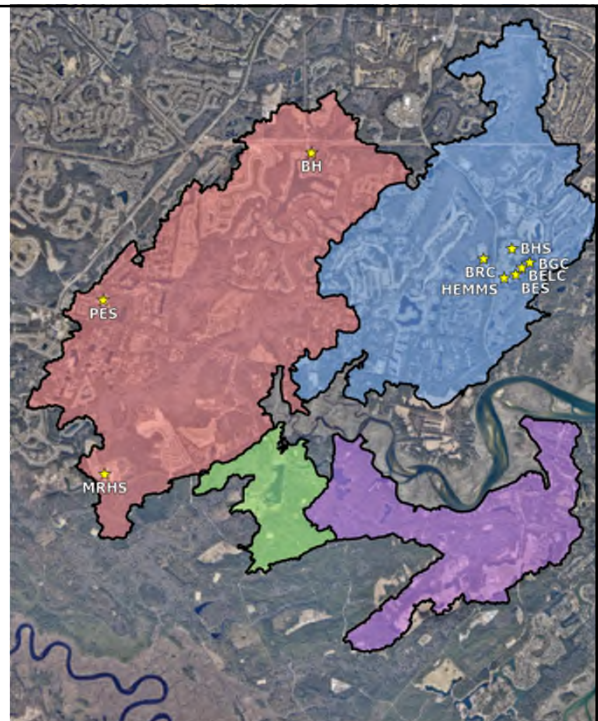
Site Name	Abbreviation	Subwatershed Location
Bluffton Early Learning Center	BELC	Rose Dhu Creek
Bluffton High School	BHS	Rose Dhu Creek
Bluffton Elementary School	BES	Rose Dhu Creek
H. E. McCracken Middle School	HEMMS	Rose Dhu Creek
May River High School	MRHS	Stoney Creek
Pritchardville Elementary School	PES	Stoney Creek
Boys & Girls Club	BGC	Rose Dhu Creek
Buckwalter Recreation Complex	BRC	Rose Dhu Creek
Benton House	BH	Stoney Creek



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Action Plan Projects

- How action plans were recorded in the models:
 - LID editor in PCSWMM
 - Modeled “full” design scenario versus “reduced” design scenario



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Action Plan Projects

Site Abbreviation	Full Projects FC Removal (billions/yr)	Reduced Projects FC Removal (billions/yr)	Difference
BELC	286	136	-52%
BHS	1,828	1,828*	0%
BES	402	383	-5%
HEMMS	813	690	-15%
MRHS	3,054	701	-77%
PES	623	318	-49%
BGC	241	224	-7%
BRC	374	374*	0%
BH	253	0**	-100%
Total	7,088	4,654	-34%

* All BMPs are ranked high/medium, no additional reduction in FC.

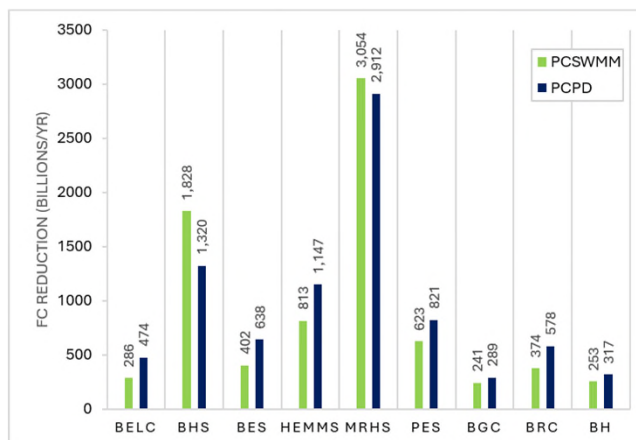
** All BMPs that are not conservation areas are ranked low.



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Action Plan Projects

- Compared modeled FC reductions in PCSWMM to the original preliminary concept plan designs.



Action Plan Projects

Modeled Annual FC Reductions at Subwatershed Outfall.

Site Abbreviation	Full Projects FC Removal (billions/yr)	Reduced Projects FC Removal (billions/yr)	Difference
BELC	154	71	-54%
BHS	1,105	1,105	0%
BES	226	217	-4%
HEMMS	548	440	-20%
MRHS	2,378	453	-81%
PES	423	214	-49%
BGC	70	37	-48%
BRC	238	238	0%
BH	205	0	-100%
Total	5,346	2,774	-48%

Conclusions

- Monitoring program updates following the development of the 2002 and 2018 XPSWMM models allowed for the creation and calibration of a new “current” water quality model to that is more accurate as it relies less on assumptions.
- While water quality models are known to have high uncertainty, the models here are suitable for the incorporation of the “Action Plan” projects and determining how effective they will be at reducing pollutants.
 - Beneficial in modeling long-term pollutant trends.
 - Measuring impact in FC fate and transport with land use changes and reductions that result from implementing “action plan” projects.
- The water quality models created in PCSWMM are intended to be able to adapt and change as the Town’s Watershed Action Plan continues to evolve.
 - Models can continue to be recalibrated as more data becomes available in the future.
 - Additionally, models can be modified in the future to consider other pollutants or changes to BMPs as the progression of the action plan projects develop over time.



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Questions?



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