Sweetwater Branch/Paynes Prairie

Restoration Project
Part 1: Stream Assessment and Water Quality Modeling

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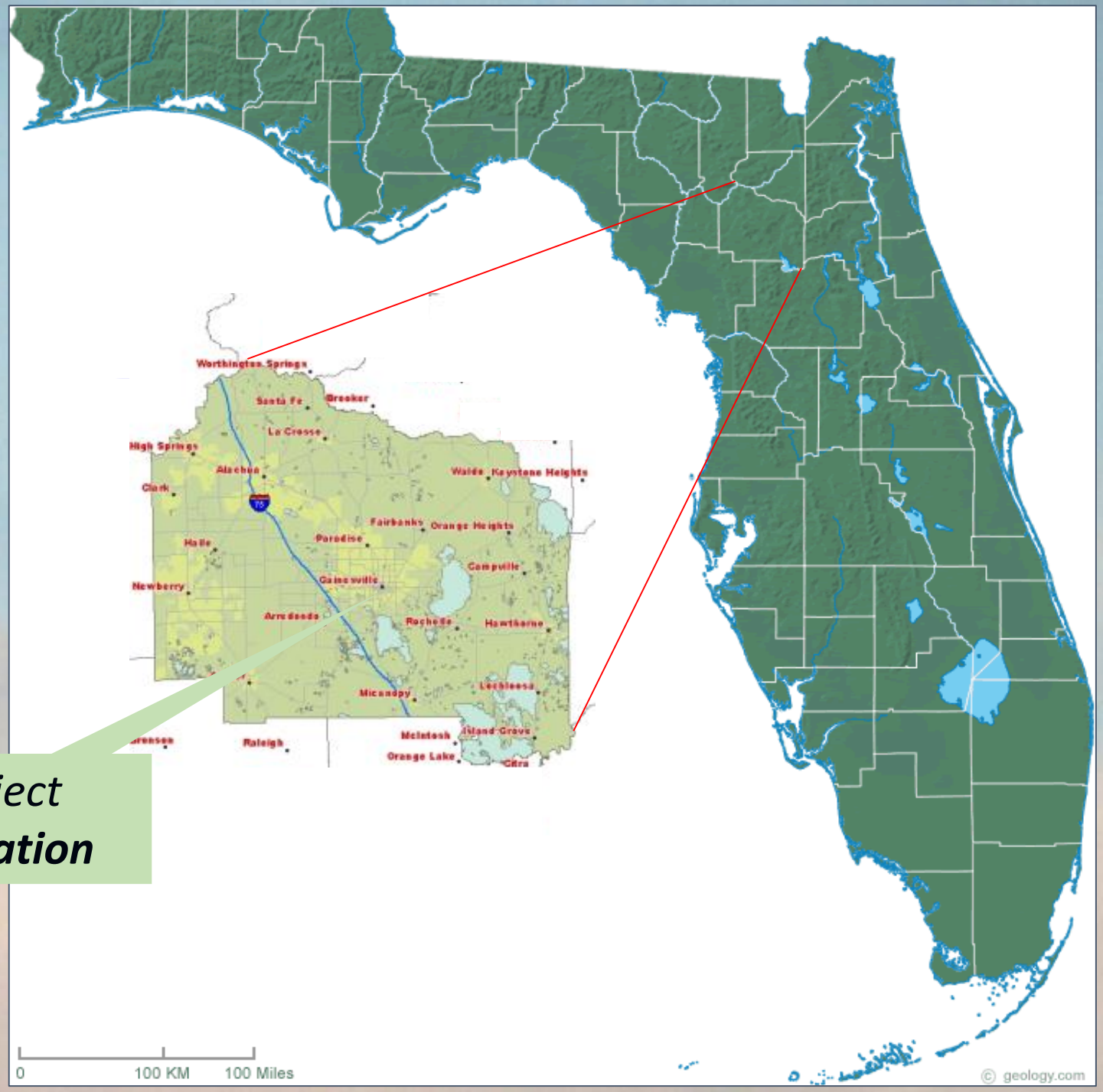
Presentation Overview

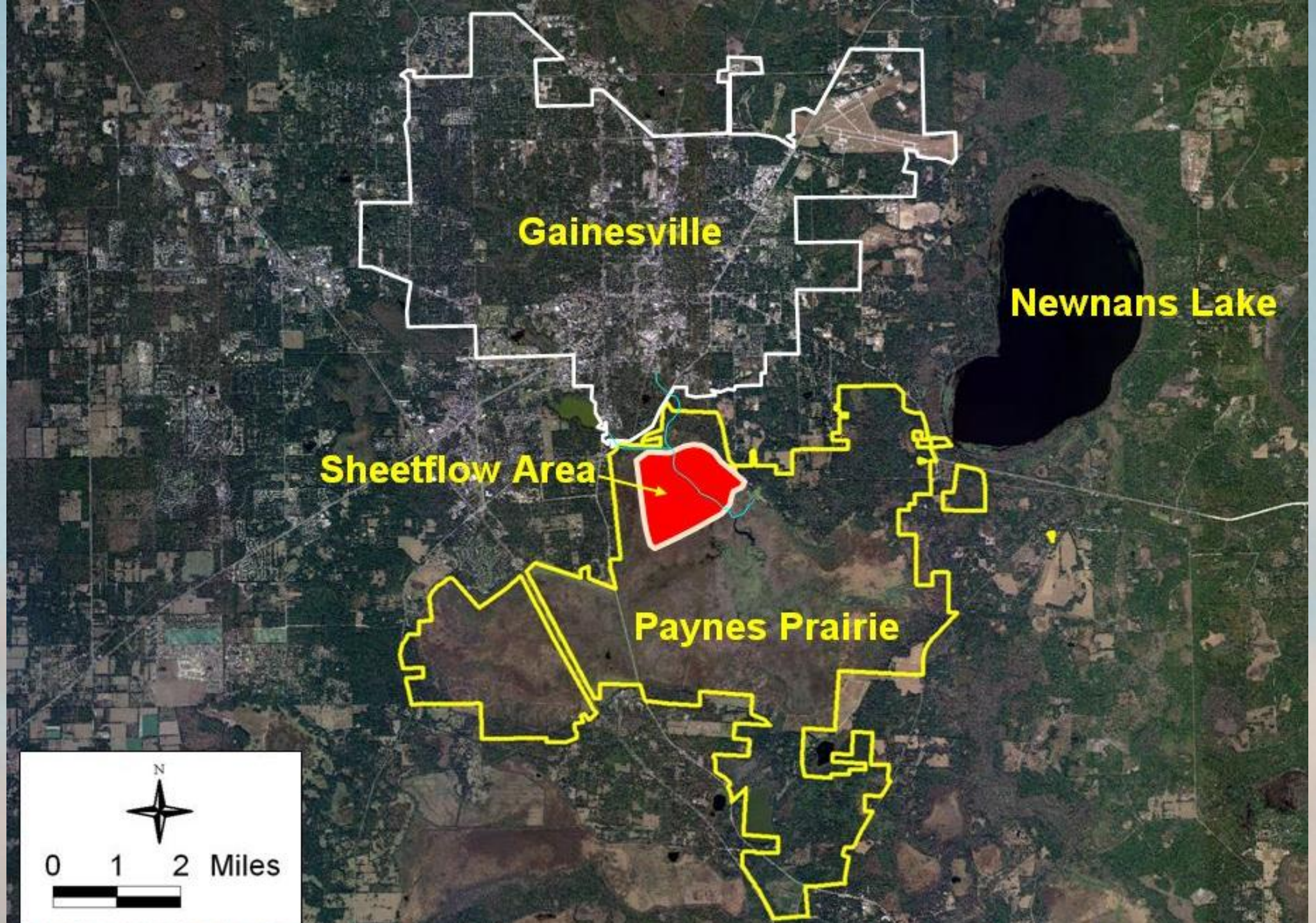
1	Background/ Empirical Data Assessment
2	Stressor ID and NNC compliance
3	QUAL2K Stream Model
4	Model Confirmation
5	Future Loading Scenarios

CITY OF GAINESVILLE
every path starts with passion
FLORIDA

SWEETWATER WETLANDS PARK



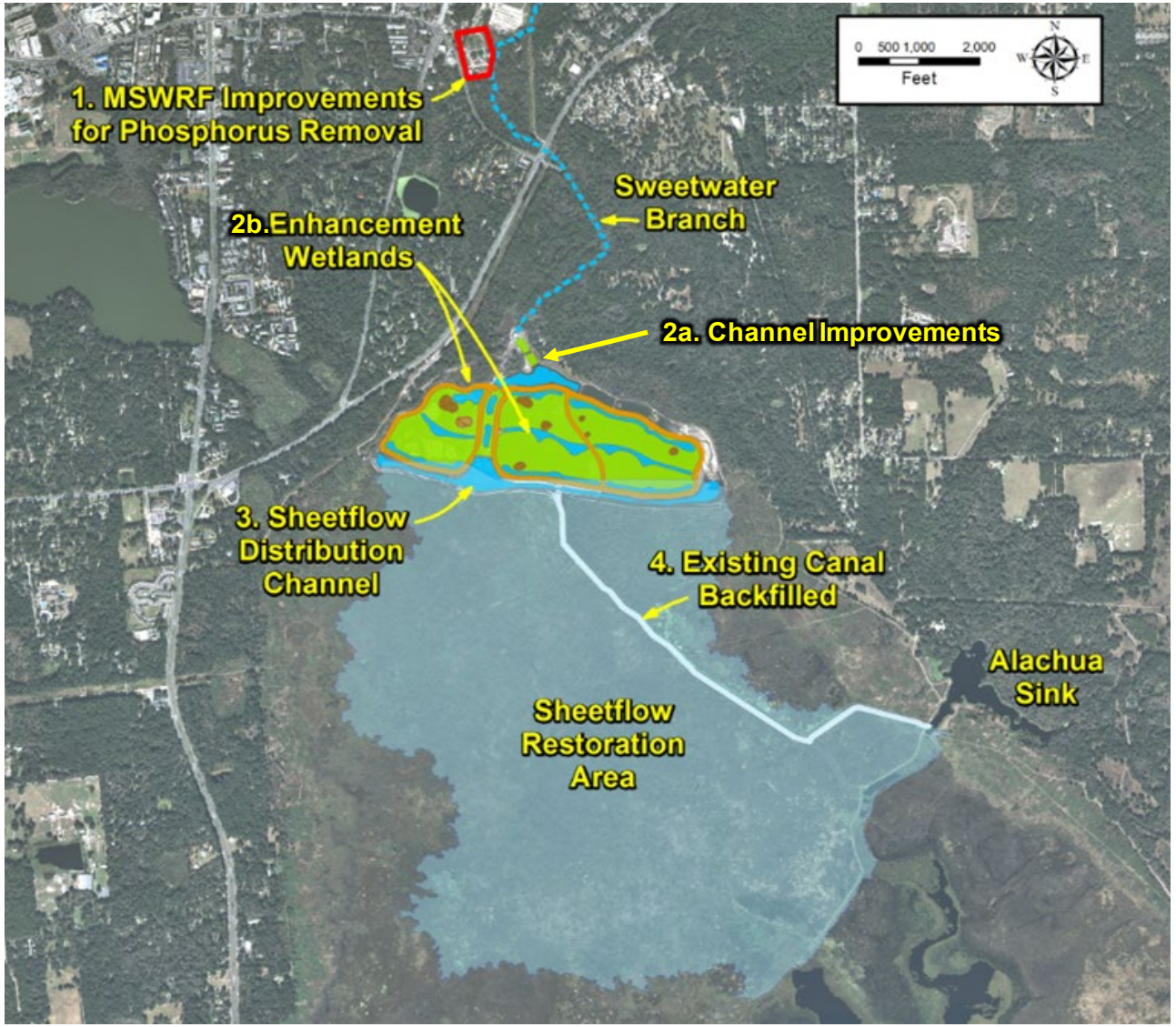
Project
Location


Gainesville
Newnans Lake
Sheetflow Area
Paynes Prairie
N
0 1 2 Miles

Background

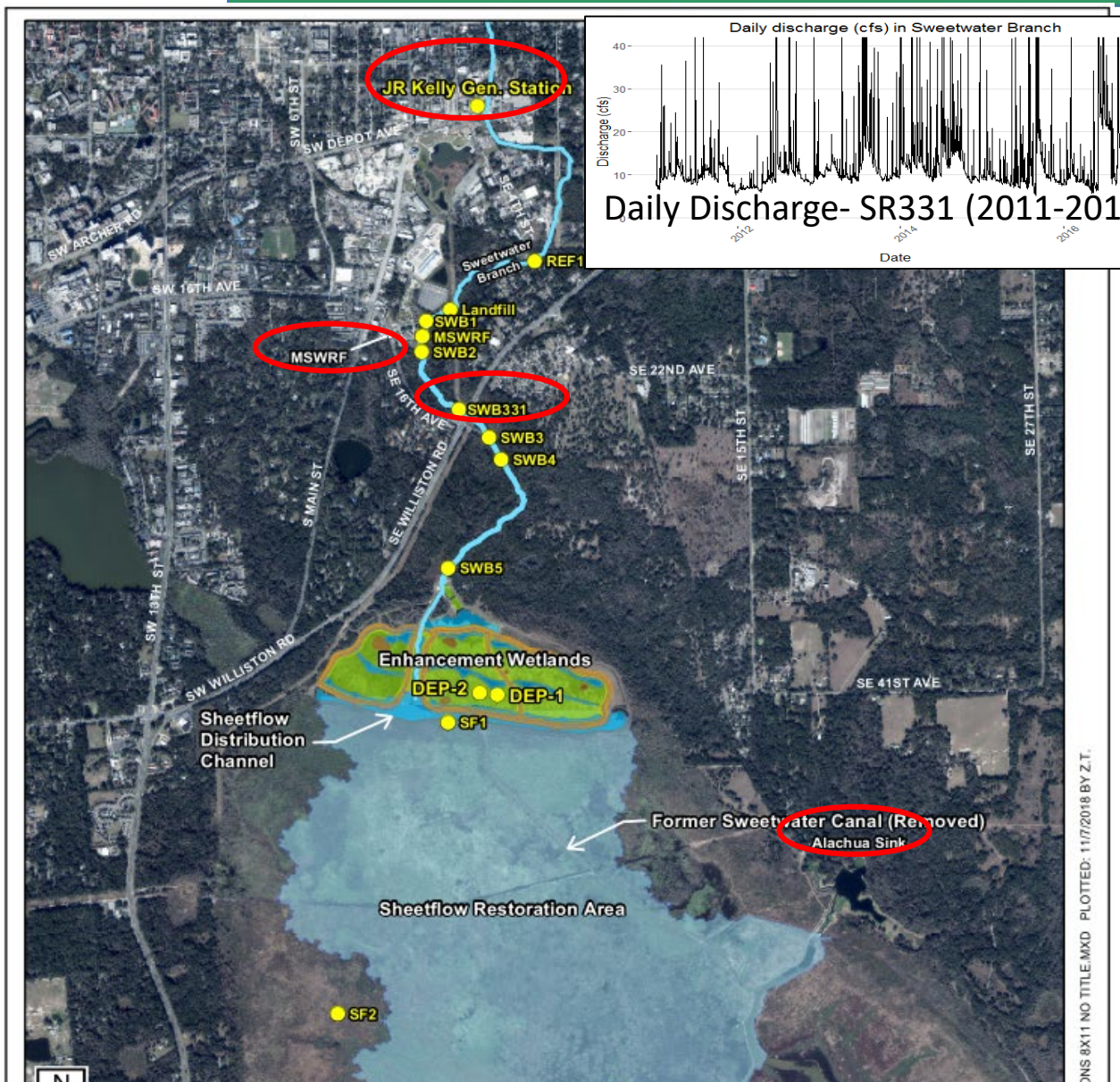
- Restore Paynes Prairie and Alachua Sink
- Nutrient (and trash) removal and sheetflow restoration
- Assess Sweetwater Branch for nutrient impairment
- Set site-specific NNC for Sweetwater to ensure it is protected in the future
- Demonstrate reasonable assurance via field testing of current conditions and modeling for future conditions
  - Stressor identification in Sweetwater

Project Concept



- Upgrade Main Street WRF TP Removal to TP < 0.3 mg/l
- Enhancement Wetland
  - Reduce TN from all sources in SWB to TN < 3.0 mg/l
- Fill in Sweetwater Canal
  - Additional Nutrient Removal on Paynes Prairie
    - TP < 0.09 mg/l
    - TN < 1.42 mg/l
- Overall Cost $27.5M

Sweetwater Branch Characteristics



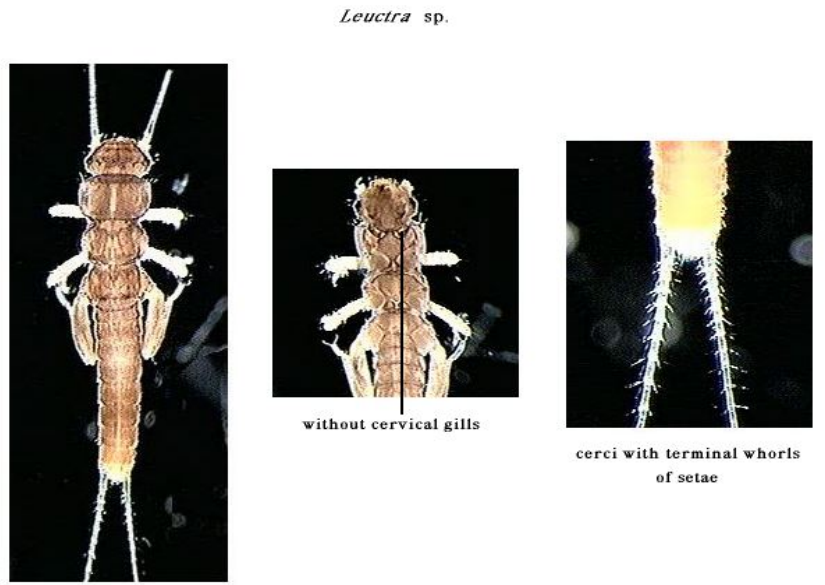
Daily Discharge- SR331 (2011-2016

- **Alachua Sink impaired for TN**
- Watershed (3 mi^2); Length (3.7 mi)
- **KGS**: Kelly Generating Station (0.24 MGD)
- **MSWRF**: Main Street Water Reclamation Facility (6.7 MGD=10.3 cfs)
- Mean flow (cfs) at SR331 (13.3) (2011-2016)
- **Artificially channelized**
- **Impervious Surfaces** (= 38%)
- **Landscape Development Intensity Index** = 6.4 (10 is worst)
- **Hydrologic Modification** Score = 10 (worst)
- **Sedimentation** = 540,437 cubic feet delivered at flow of 20 cfs

Biological Tools for Streams

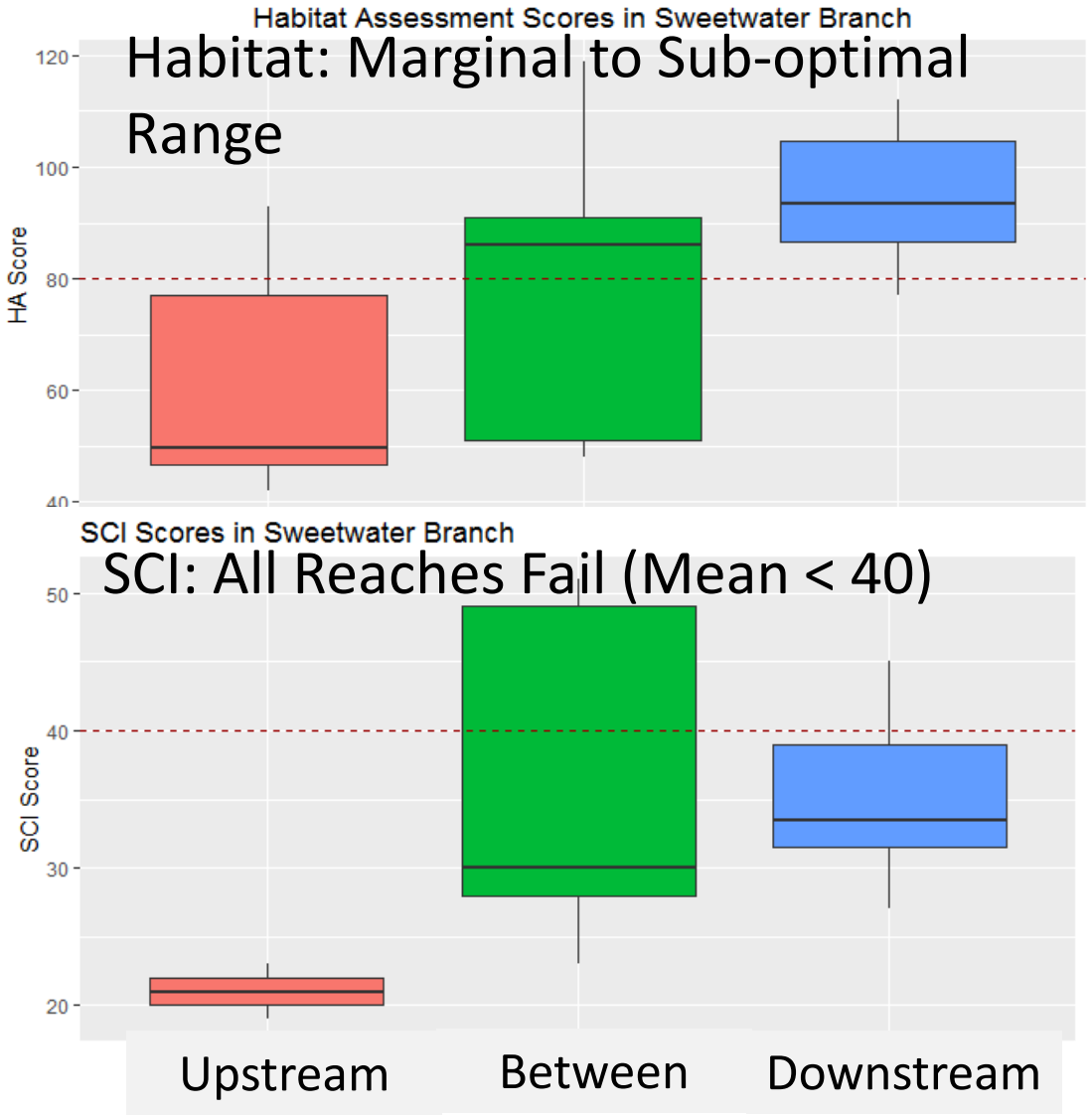
"Balanced" flora and fauna are based on minimally disturbed reference streams:

- Attached algae: Rapid Periphyton Survey (RPS)
- Vascular Plants: Linear Vegetation Survey (LVS)
- Phytoplankton: Chlorophyll a
- Benthic Invertebrates: Stream Condition Index (SCI)
- Habitat Assessment as explanatory information



Habitat and SCI

(POR= 1985-2015)



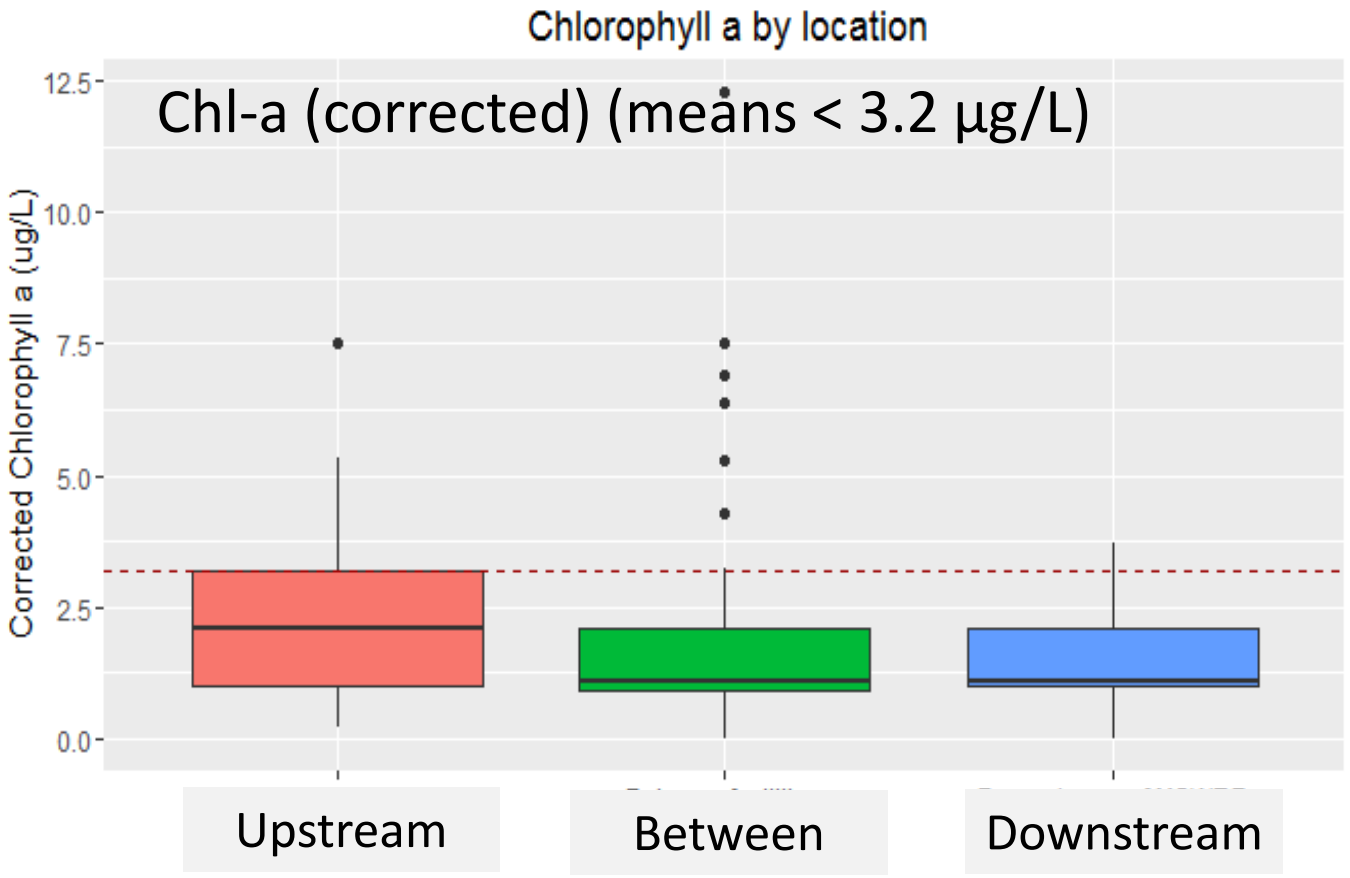
Upstream KGS

Between KGS-MSWRF

Downstream MSWRF

RPS, LVS, and Chlorophyll (POR= 1985-2015)

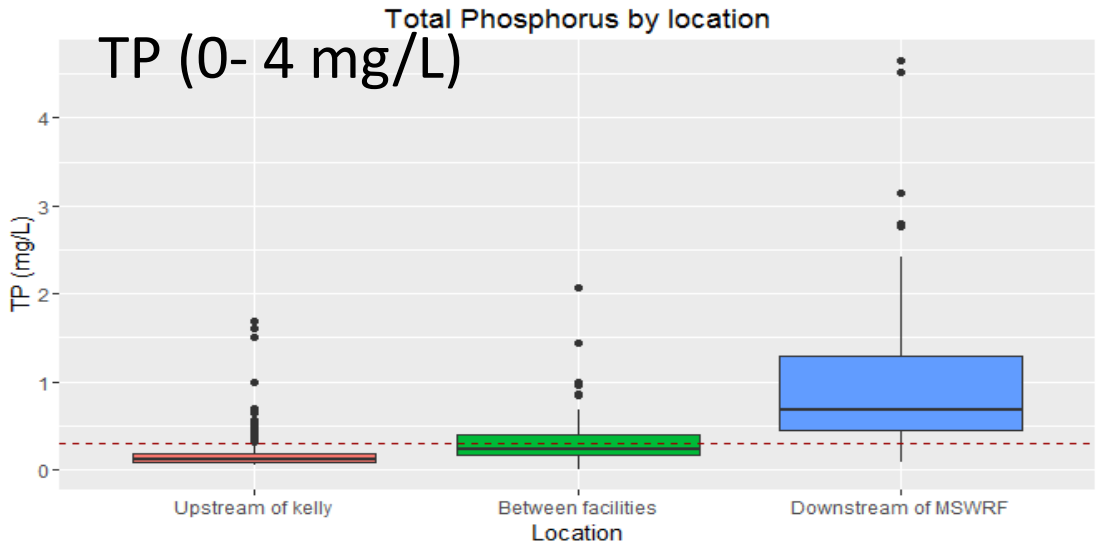
- Rapid Periphyton Survey (RPS) achieved criteria at all three reaches
- Linear Vegetation Survey (LVS) achieved criteria below both outfalls but not at upstream reach
- Chlorophyll achieved criteria

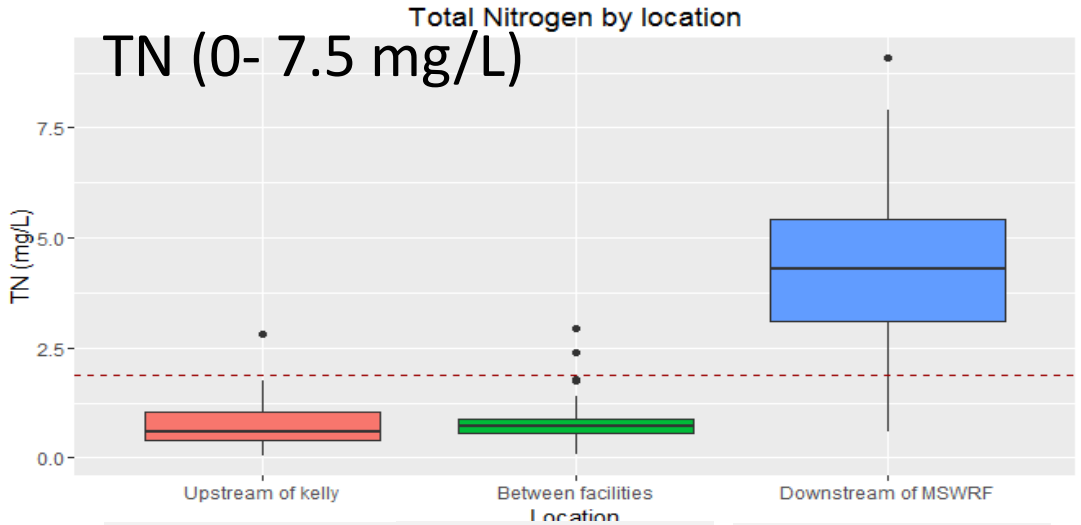


Empirical Assessment Conclusions

(POR= 1985-2015)

- Sweetwater Branch flora are healthy
- Standard water quality criteria (e.g., toxicity, organic contaminants, metals, Total Ammonia Nitrogen, conductivity, DO) all achieved
- Exceeds regional nutrient thresholds (TP = 0.3 mg/L, TN = 1.87 mg/L) and fails SCI (< 40)
- Without conducting a Stressor Identification Analysis, Sweetwater Branch fails NNC
- Are nutrients causing SCI failures?





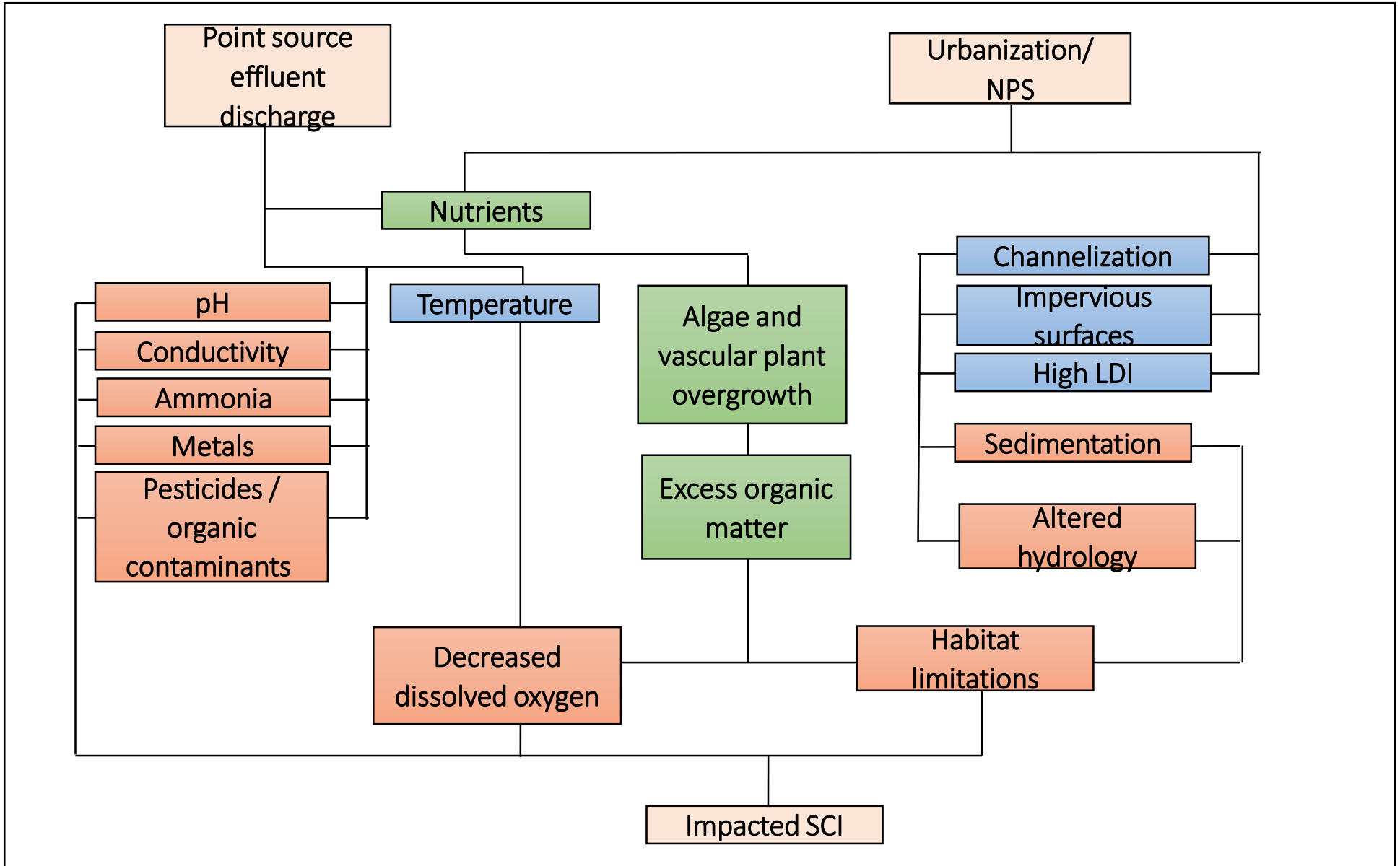
Upstream Between Downstream

What is a Stressor ID Study?

- A systematic method to gather appropriate data and analyze the most probable causes for biological failures

- Evaluate stressors following EPA CADDIS approach:
  1. Develop conceptual model
  2. Evaluate data from the case, data from elsewhere
  3. Draw conclusions using a weight of evidence approach

Conceptual Model for Stressor ID



Human Activity

Modifying Stressor

Proximate Stressor

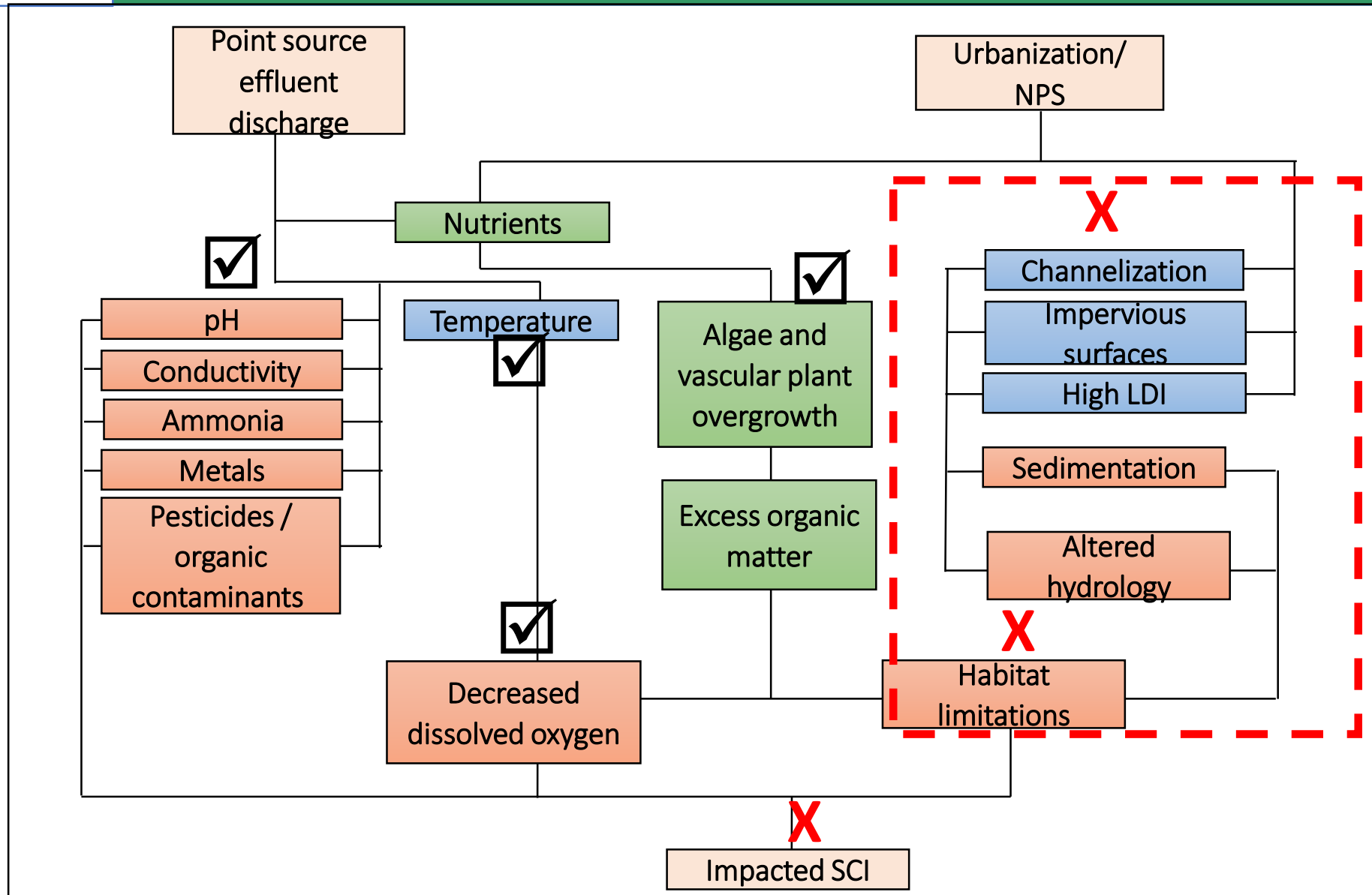
Nutrient stressor pathway

Sweetwater Branch Stressor ID

- Measures Determined to be OK ☑
- Rapid Periphyton Survey RPS (% Rank 4-6) OK
- Linear Vegetation Survey LVS (Avg C of C and FLEPPC %) OK
- Chl-a (µg/L as Annual Geometric Mean and no increasing Chl-a trend)
- Organic contaminants (undetected)
- Metals, Dissolved Oxygen, Total Ammonia Nitrogen OK
- **TN and TP (Exceeds Regional Threshold but flora is OK so nutrients are not causing imbalances)**

- Measures Causing Biological Failures **X**
- Habitat Assessment (Marginal)
- Impervious Surfaces = 38%
- Hydrologic Modification Score=10 (10 is worst)
- Landscape Development Intensity, LDI=6 (10 is worst)
- Sediment Smothering (High)
- **Habitat, hydrology, and sedimentation causing biological failures in Sweetwater**

Sweetwater Branch Stressor ID



Summary

Plants OK so exceeding nutrient thresholds not causing imbalances.

Habitat, hydrology, and sedimentation causing the problem

Conclusions

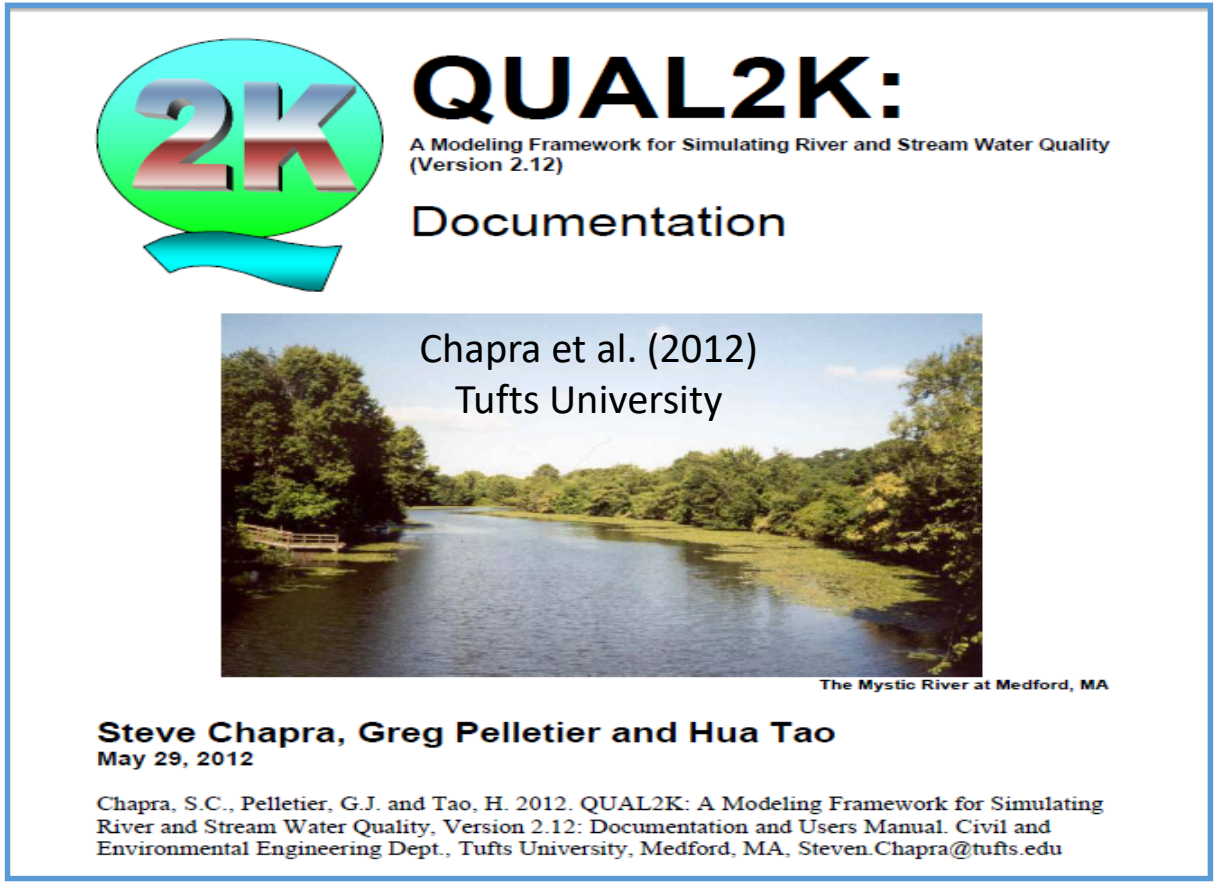
- Rule 62-302.531(2)(a)1.d., F.A.C allows a site-specific nutrient interpretation if a stressor identification study demonstrates that the adverse biological effects are not due to nutrients
- CADDIS systematically demonstrated that nutrients are not causing the low SCI scores in Sweetwater Branch
- Stressors responsible for low SCI scores are **hydrologic modification, sediment movement, and habitat alterations**

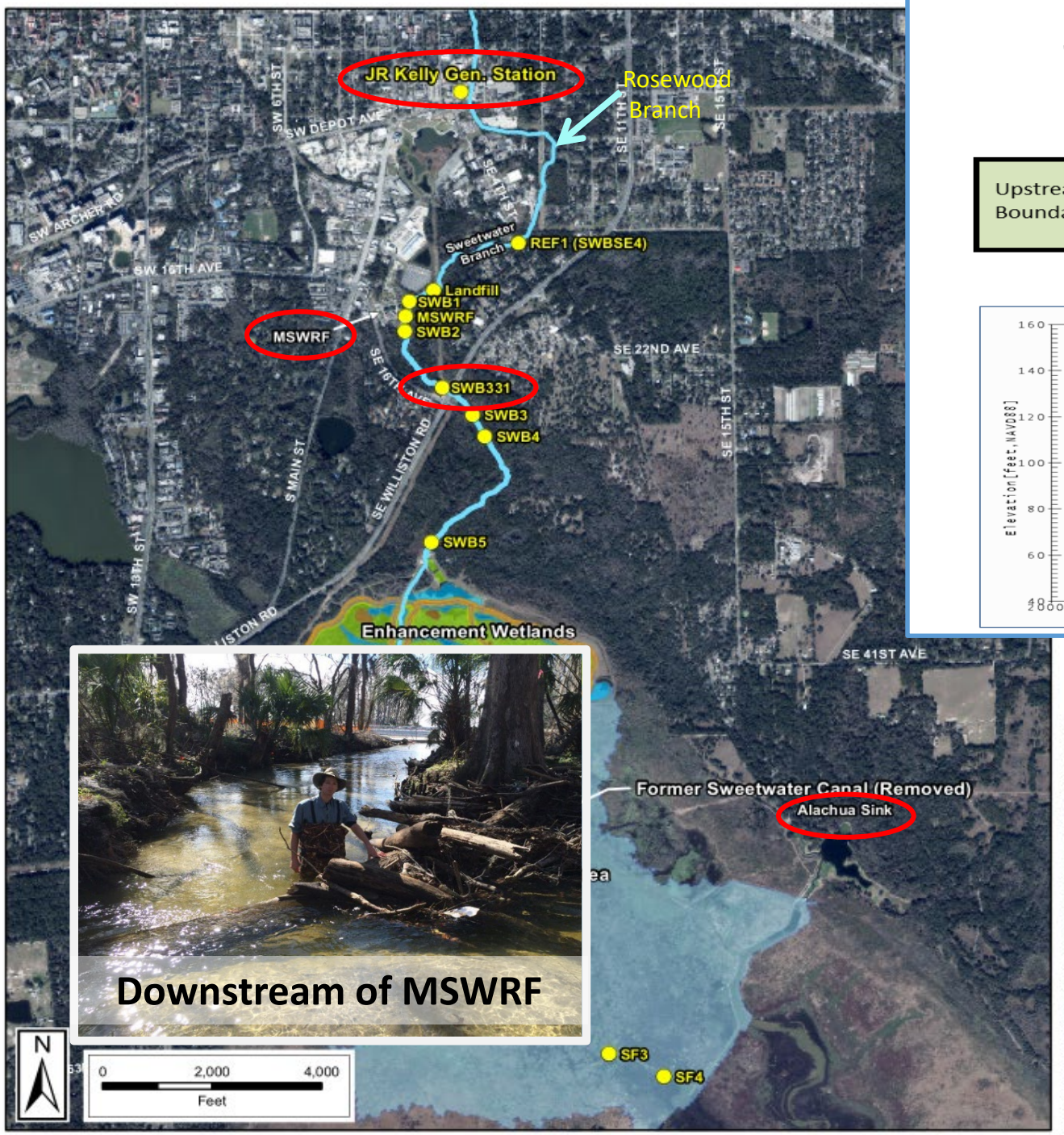
Presentation Overview

1. ☑ Problem Description/ Empirical Data Assessment
2. ☑ Stressor ID and NNC compliance
3. QUAL2K Stream Model
4. Model Confirmation
5. Future Loading Scenarios

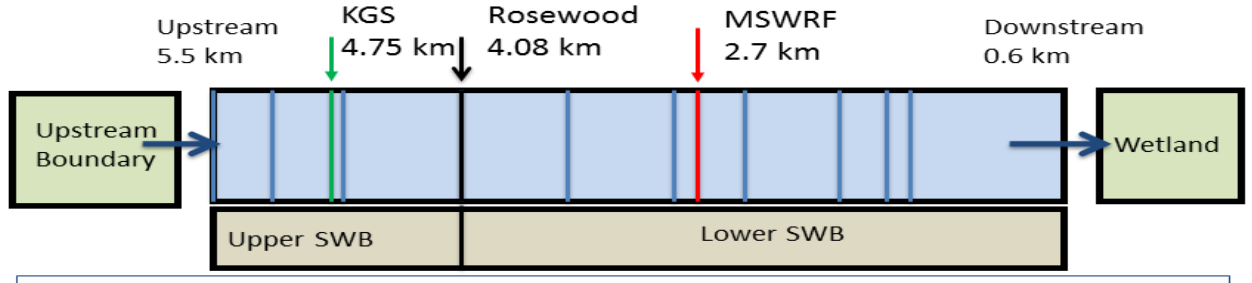
QUAL2K Stream Model

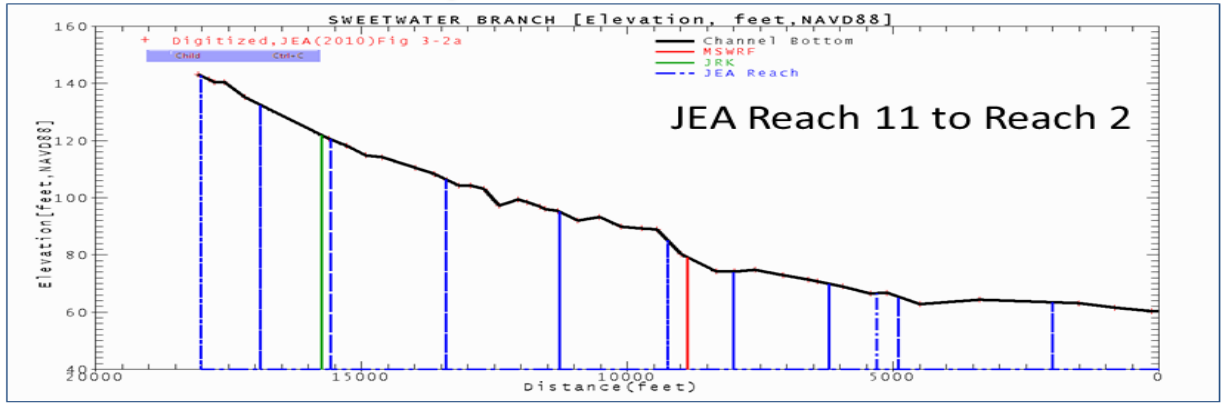
- EPA Public Domain Water Quality (WQ) model
- 1D (longitudinal), steady-state
- Flow, Conductivity, Wtemp, Nutrients (N,P), DO, CBOD, Inorganic Sediment, Detritus, pH-alkalinity, Phytoplankton, Periphyton, internal Sediment Flux (DO, N,P)
- Technical basis for Level II WQ Based Effluent Limits (WQBELs) for NPDES permits & stream Numeric Nutrient Criteria (NNC)





Downstream of MSWRF



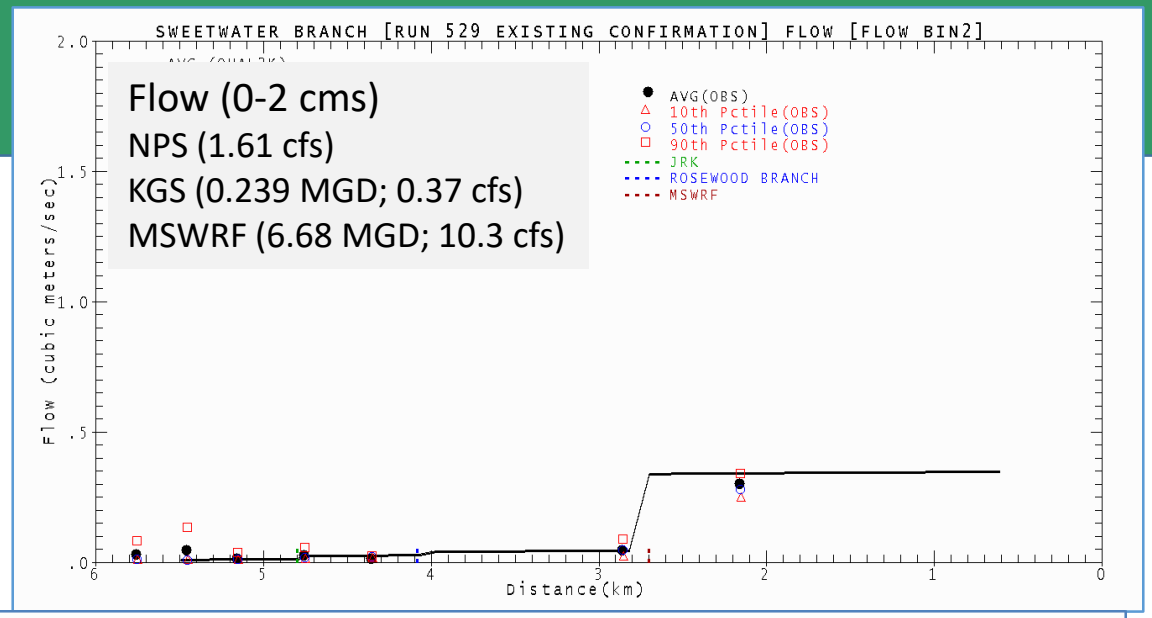


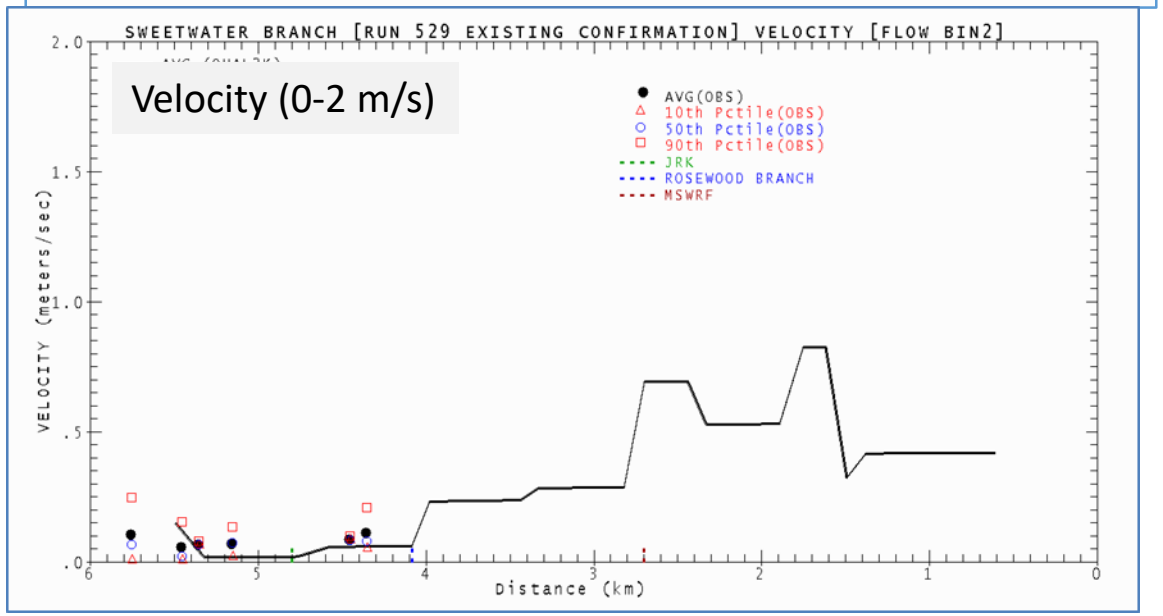
- **<u>Sweetwater Branch (SWB) Data Sources</u>**
- Stream geometry/channel slope (JEA, 2010)
- Stream flow (SJRWMD SR331 Gage)
- Upstream, Rosewood, NPS Flow (proportional to SJRWMD ΔDA & SR331 flow/DA)
- NPDES Flow & WQ (GRU- KGS & MSWRF)
- WQ (FDEP, Alachua Co., Frydenborg, GRU)
- Meteorology (FSU Florida Climate Center)

Model Confirmation

- Observed Flow & Water Quality data from 2013-2016
- Low (Bin1), Middle (Bin2) & High (Bin3) Flow Conditions

- <u>Results for Middle Flow (Bin2)</u>
- Hydraulics (Flow & Velocity
- Nutrients (TN & TP)
- Flora (Phytoplankton & Periphyton)

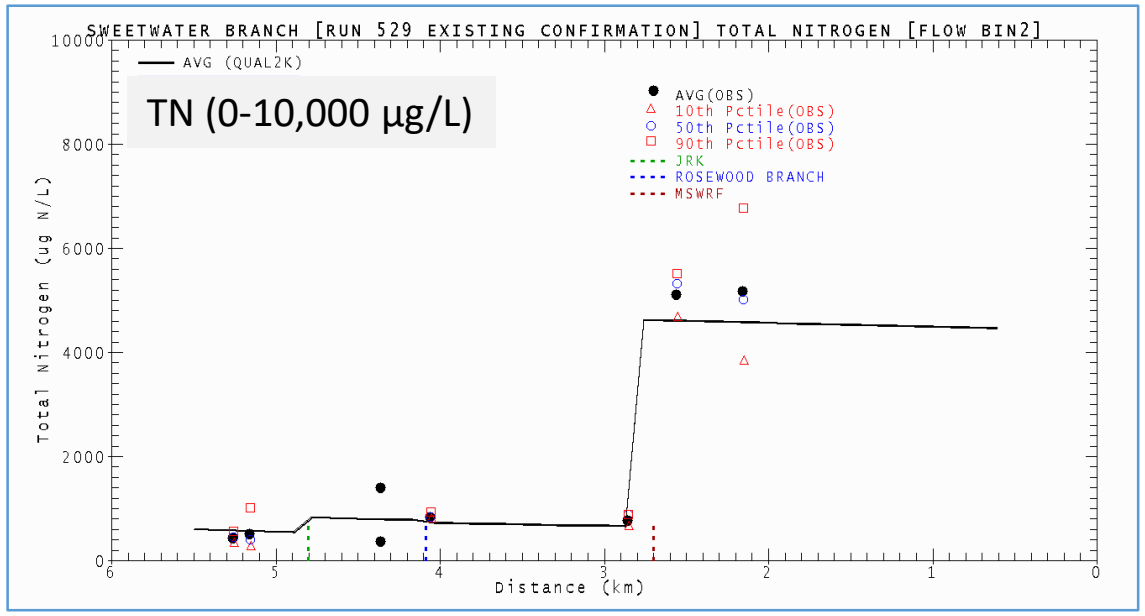




Nutrients (TN & TP) (Bin2 Flow)

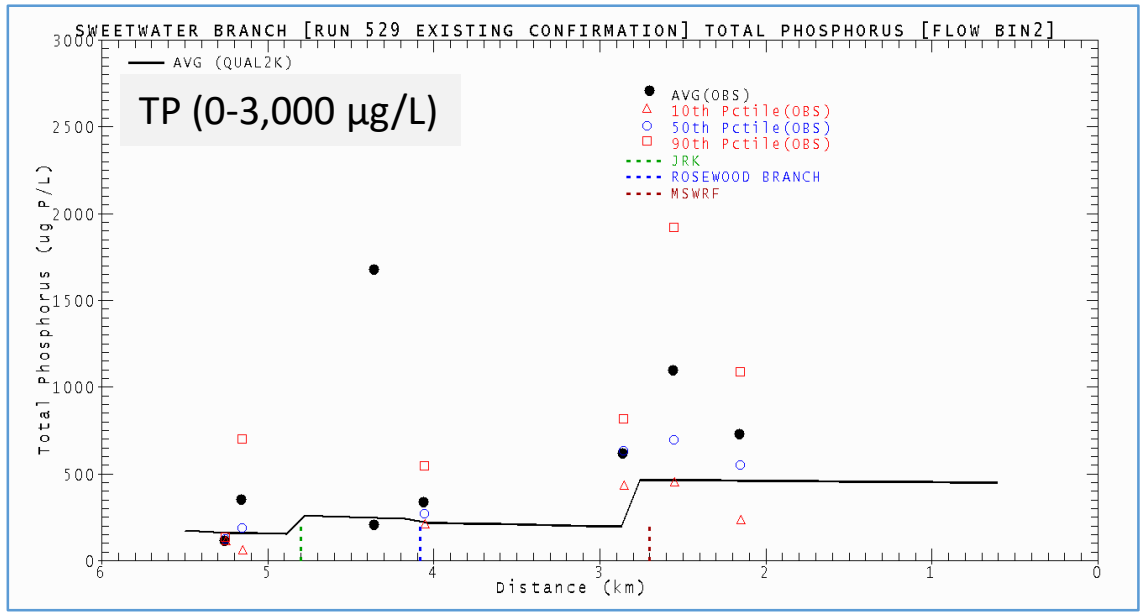
Nitrogen: Half-Saturation Constants

Phytoplankton: Kn = 15 µg N/L
Periphyton: Kn = 300 µg N/L



Phosphorus: Half-Saturation Constants

Phytoplankton: Kp = 2 µg P/L
Periphyton: Kp = 100 µg P/L

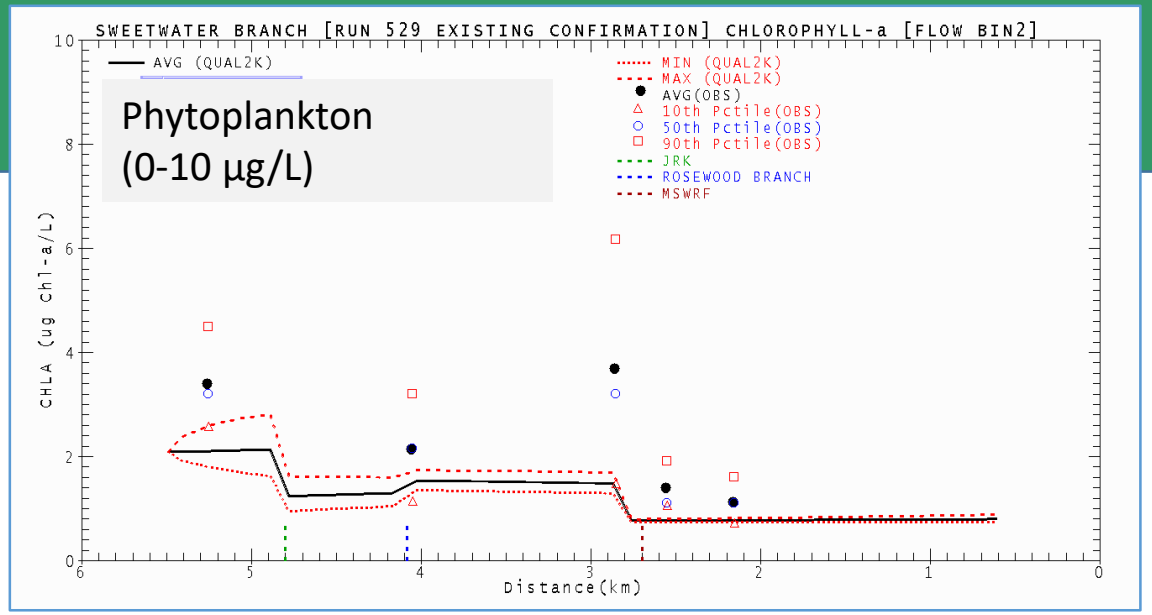


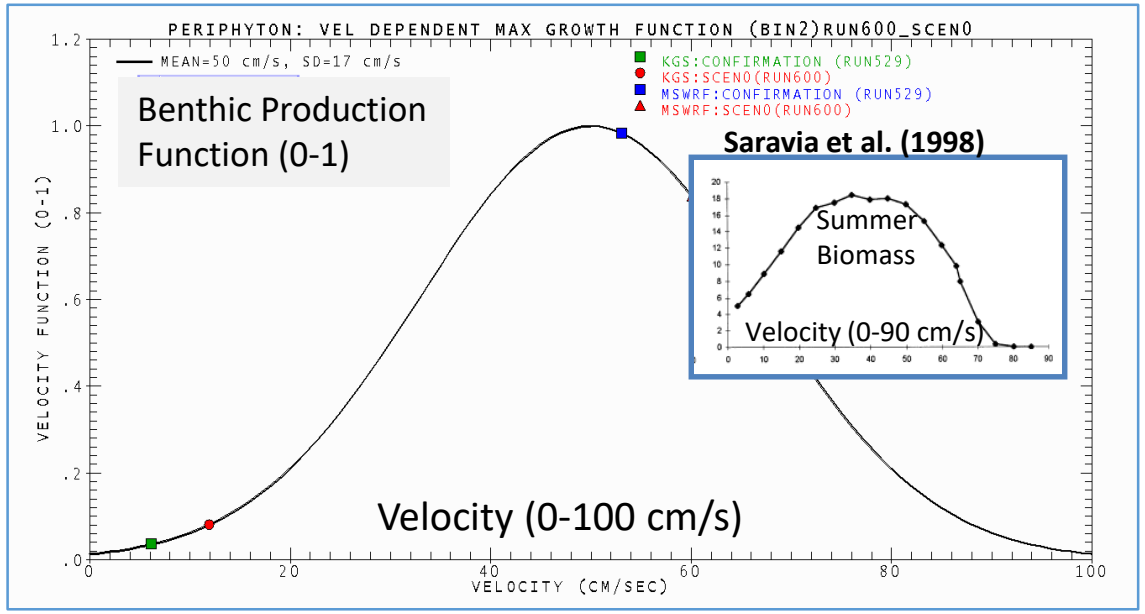
Phytoplankton & Periphyton (Bin2 Flow)

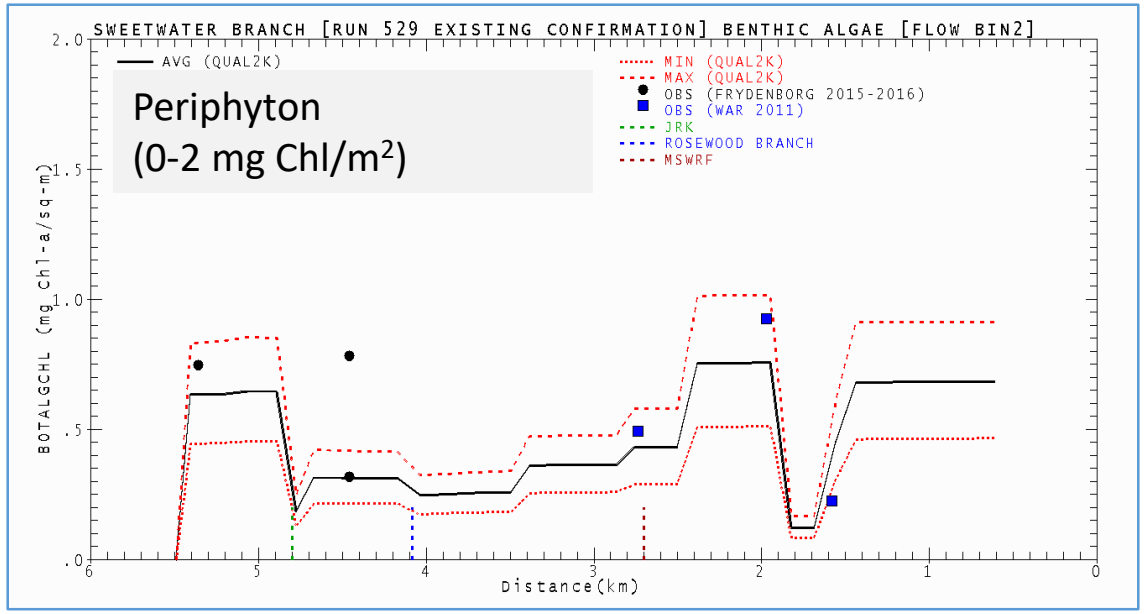
<u>Oligotrophic/Mesotrophic Mesotrophic/Eutrophic</u>

10 µg/L & 20 mg/m^2 30 µg/L & 70 mg/m^2

Dodds, Jones, Welch (1998), Water Research 32(5)
Stream Classification Suspended and Benthic Chl-a

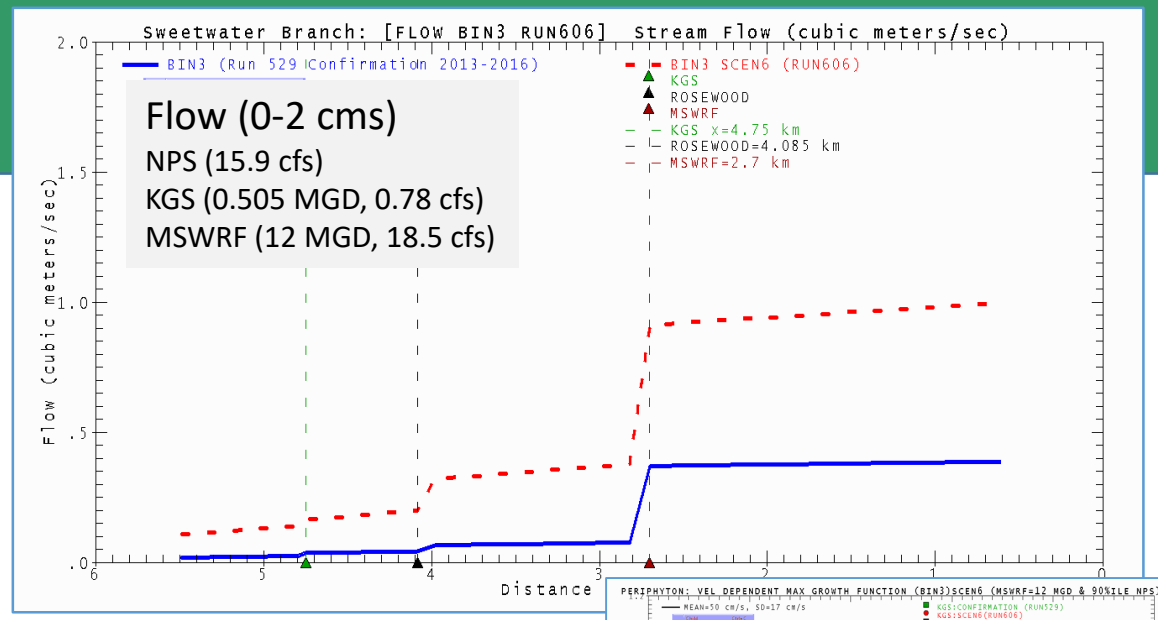


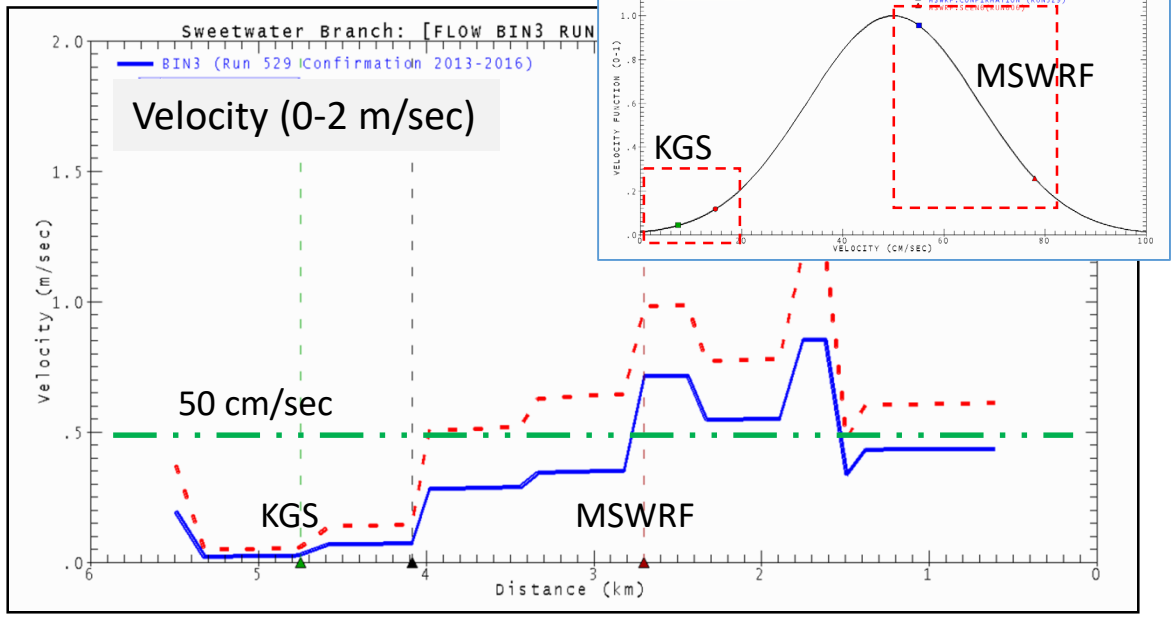




Future Loading Scenarios (Bin3)

- Baseline (———) Future (- - - - -)
- MSWRF load based on Full Buildout (12 MGD, TN=8 mg/L, TP=0.3 mg/L)
- KGS load based on Maximum Daily Load (MDL) 95% Confidence Interval statistics from effluent records (0.505 MGD, TN=2 mg/L, TP=0.548 mg/L)
- Baseline NPS loads based on 50th percentile statistics from Bin3 observations (3.0 cfs NPS, TN=0.78 mg/L, TP=0.11 mg/L)
- Future "Worst-case" NPS stormflow loads based on 90th percentile statistics from Bin3 observations (15.9 cfs NPS, TN=1.0 mg/L, TP=0.215 mg/L)





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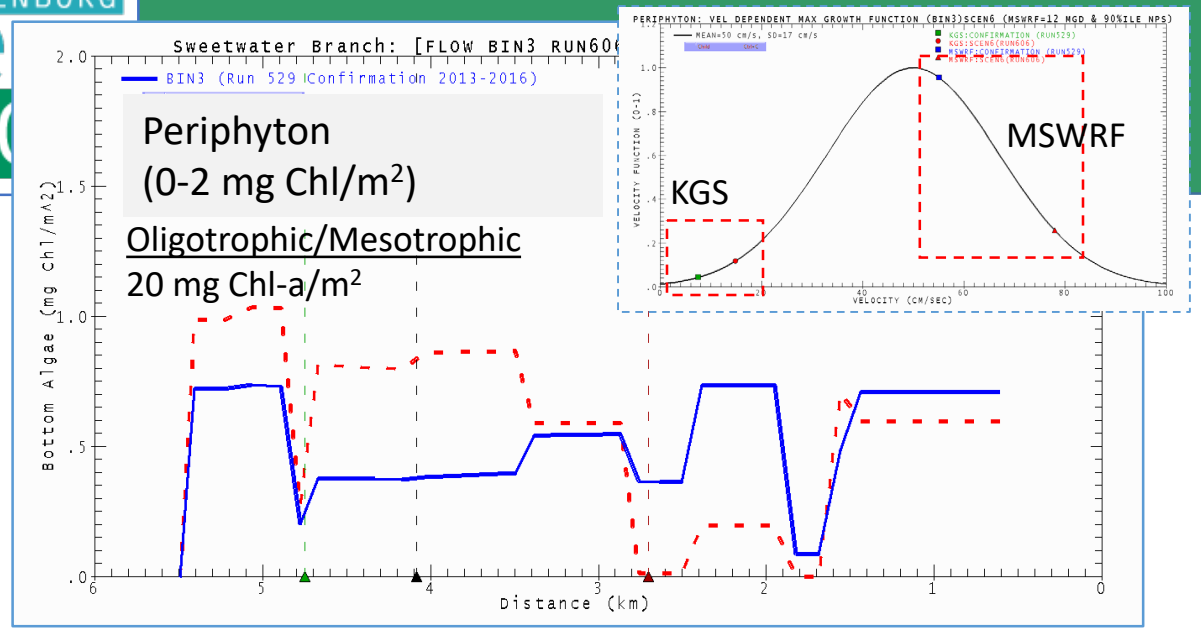

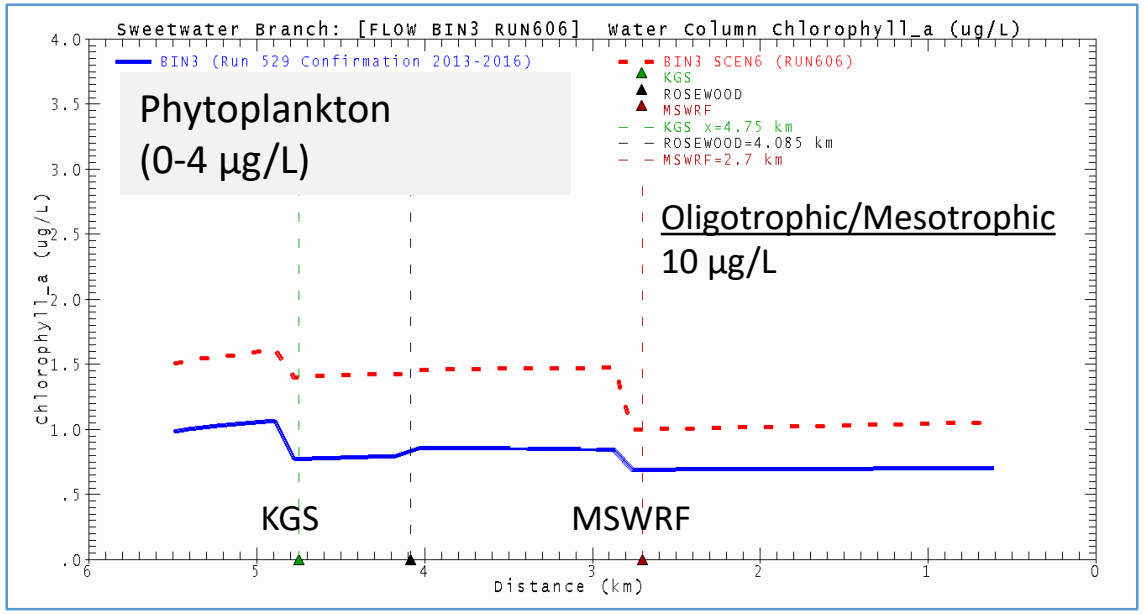

- Baseline (———) Future (- - - - -)
- MSWRF 12 MGD Buildout & *Baseline NPS flow* has minor impact on phytoplankton and periphyton in SWB
- MSWRF Buildout & *Future "Worst-Case" NPS flow* increased phytoplankton in SWB from 7X increase in upstream headwater load of phytoplankton
- Periphyton increased in Upper SWB & decreased in Lower SWB from impact of velocity dependent benthic production
- Phytoplankton and periphyton biomass in SWB are low compared to other stream ecosystems (Dodds et al., 1998)

QUAL2K Model Outcomes

- Model confirmed with good agreement to observations from 2013-2016 for low (Bin1), middle (Bin2) and high (Bin3) NPS flow conditions
- Confirmed model for NPS flow-baseline (Bin3) used for evaluation of future load scenario based on MSWRF Buildout (12 MGD) and "Worst-Case" NPS Stormflow conditions
- Short residence time and dense canopy shade cover prevents accumulation of phytoplankton and benthic biomass in SWB
- Nutrients (N, P) are not limiting phytoplankton or periphyton production in SWB
- Level II WQBELs for TN and TP established for MSWRF, KGS, and "Worst-Case" urban NPS runoff are protective of Water Quality and flora in Sweetwater Branch
- Site-specific interpretation of Numeric Nutrient Criteria (NNC) is established for Sweetwater Branch

Questions & Discussion

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