
Based On Dr. Walker's Formulas

Results rebuilt by
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# WATER QUALITY ANALYSIS OF ERTP ALTERNATIVES

# Bill Walker's ERTP Model

- Designed to:
  - assess TP concentrations and loads under various stage and flow scenarios
  - determine the influence of stage and flow scenarios on exceeding the Long-Term Limit
- Uses 2x2 model stage and flow results as model inputs
- Daily TP concentrations at S12s, S333, and S334 are determined from Walker's regression equations for each structure using the historic stage and stage rise relationships with TP
- Daily stage data from 3A-3, 3A-4, and 3A-28 were averaged to represent the stage
- Daily flow data from S12A, S12B, S12C, and S12D were summed to represent the S12s. Net flow to NESRS was determined as S333 minus S334 flows
- Daily loads were determined from daily flows combined with daily TP concentrations predicted from Walker's equations
- Annual loads and flows were determined and
- FWM TP concentrations were calculated for each year and compared to the Long-Term Limit TP

# Caveats for the Walker model

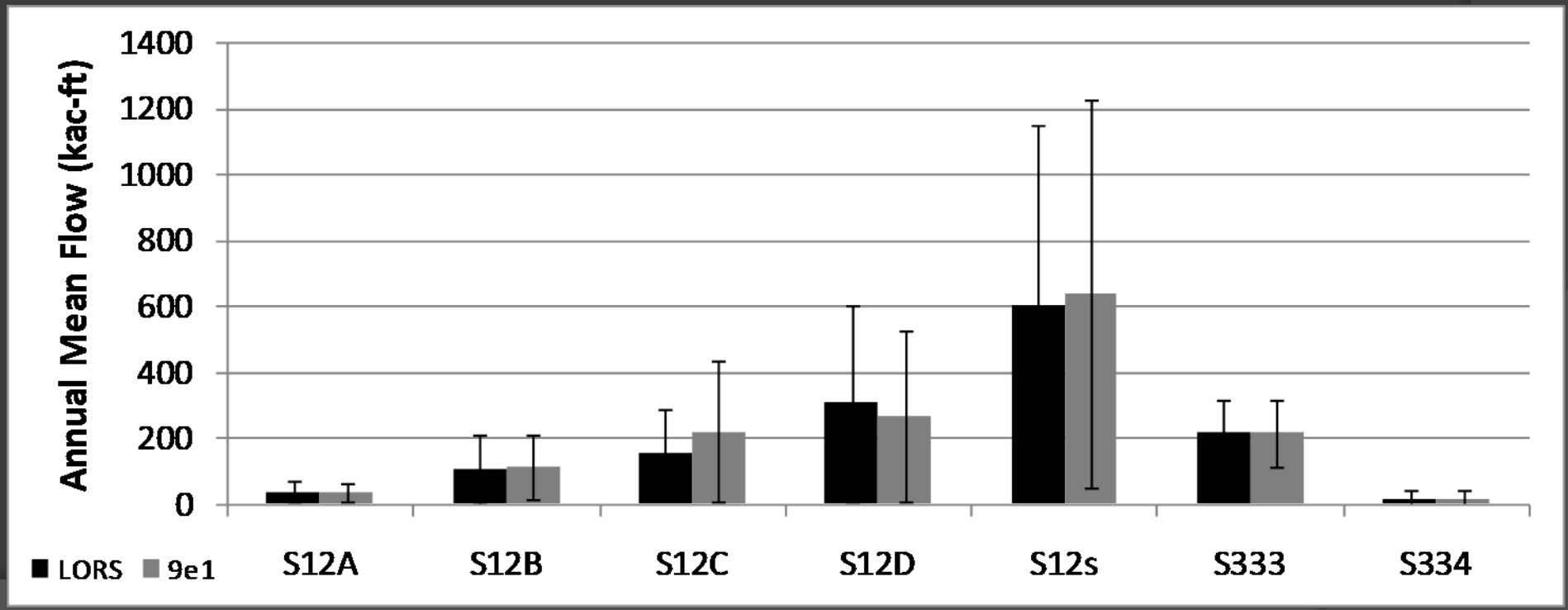
- Walker's model was created to evaluate water quality impacts from an early ERTP alternative
- His model was created for his use only, was not intended for distribution; therefore it has no documentation and should be considered draft
- Bill Walker has not been available to work with us or the Corps during our application of his model
- The Walker model utilizes output from the 2x2 model
  - all models have error
  - coupling models compounds that error
- Evaluating potential water quality impacts of ERTP alternatives is difficult because of system complexity, differences between actual and hypothetical operations in the 2x2 simulations, and lack of mechanistic models to simulate flow and phosphorus transport in the upstream marsh/canal system.
- The results of these preliminary analyses provide order-of-magnitude estimates that require simplifying assumptions.

# Scenarios

- LORS – Base run
- 9e1 – Corps tentatively selected plan – intended to lower stages in WCA3

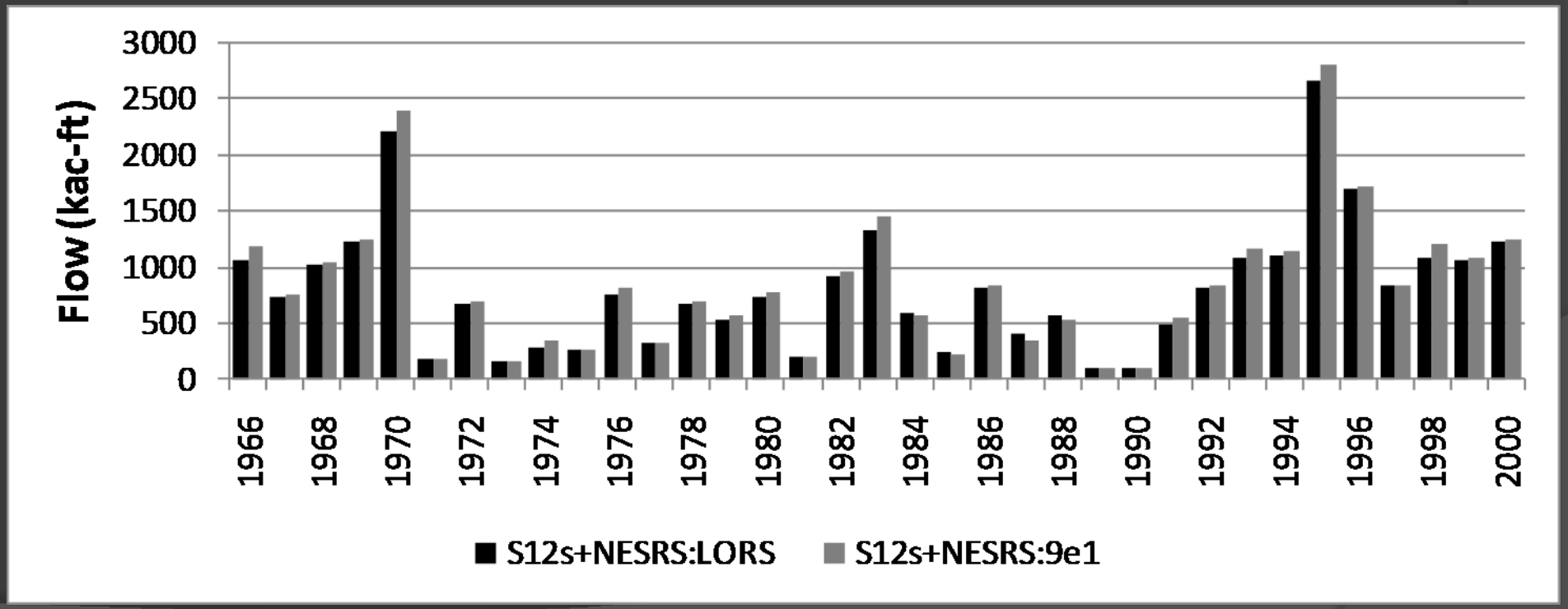
# Flow Distributions

- 9e1 distributes more water through the S12s, particularly farther west through the S12C and S12B structures, relative to LORS



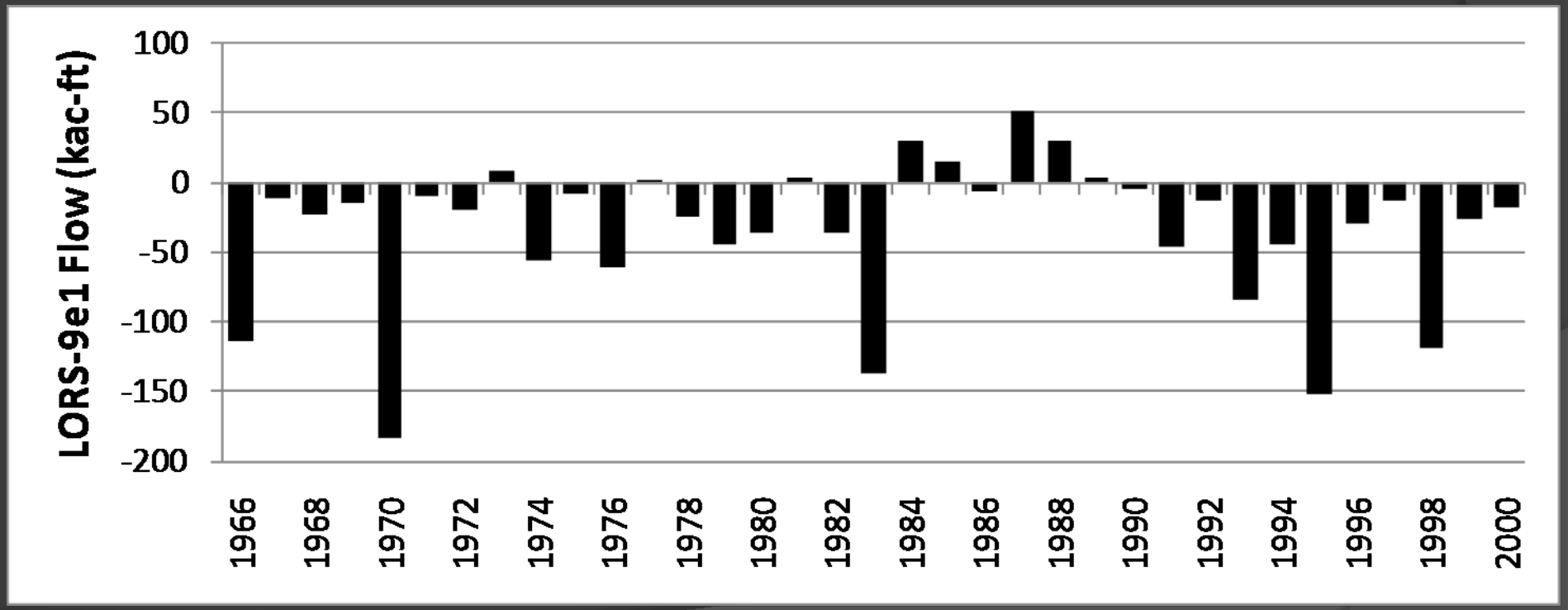
# Annual Flows

- 9e1 annual flows (mean = 839 kac-ft) are higher than LORS annual flows (mean = 805 kac-ft)



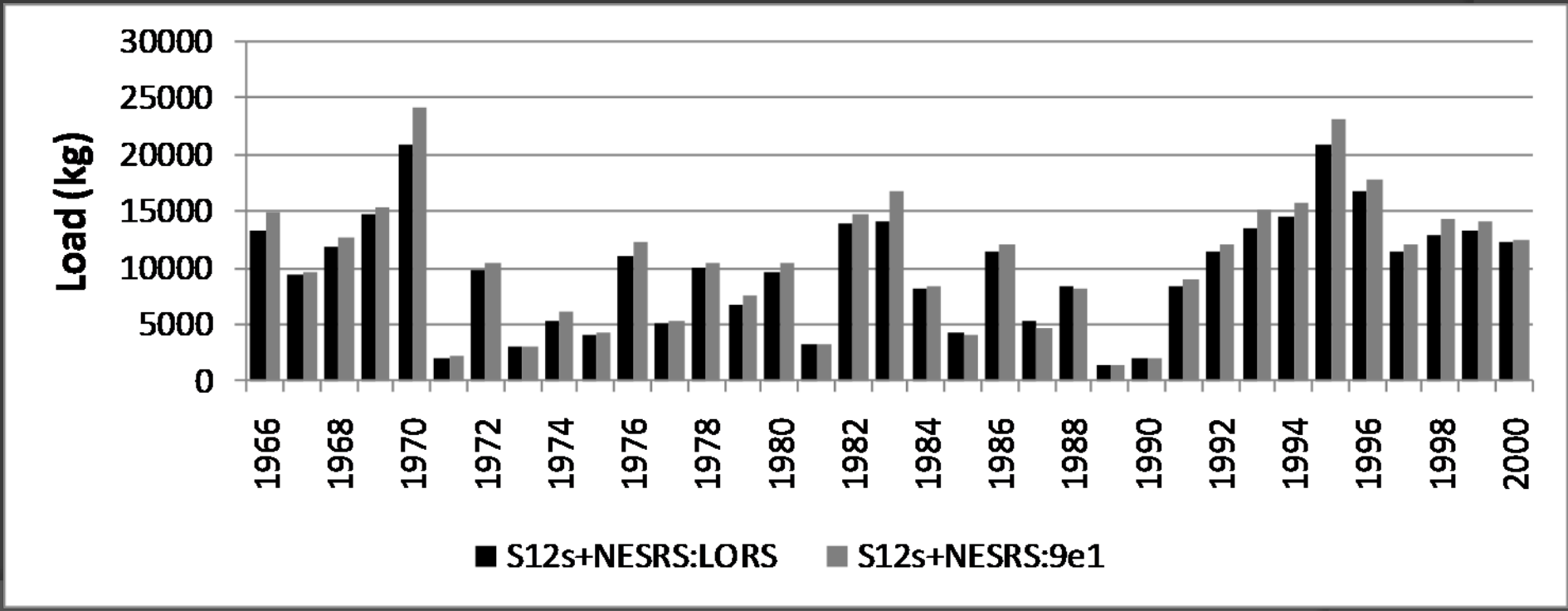
# Annual Flows

- The 9e1 annual flows were greater than LORS 77% of the POR by as much as 184 kac-ft



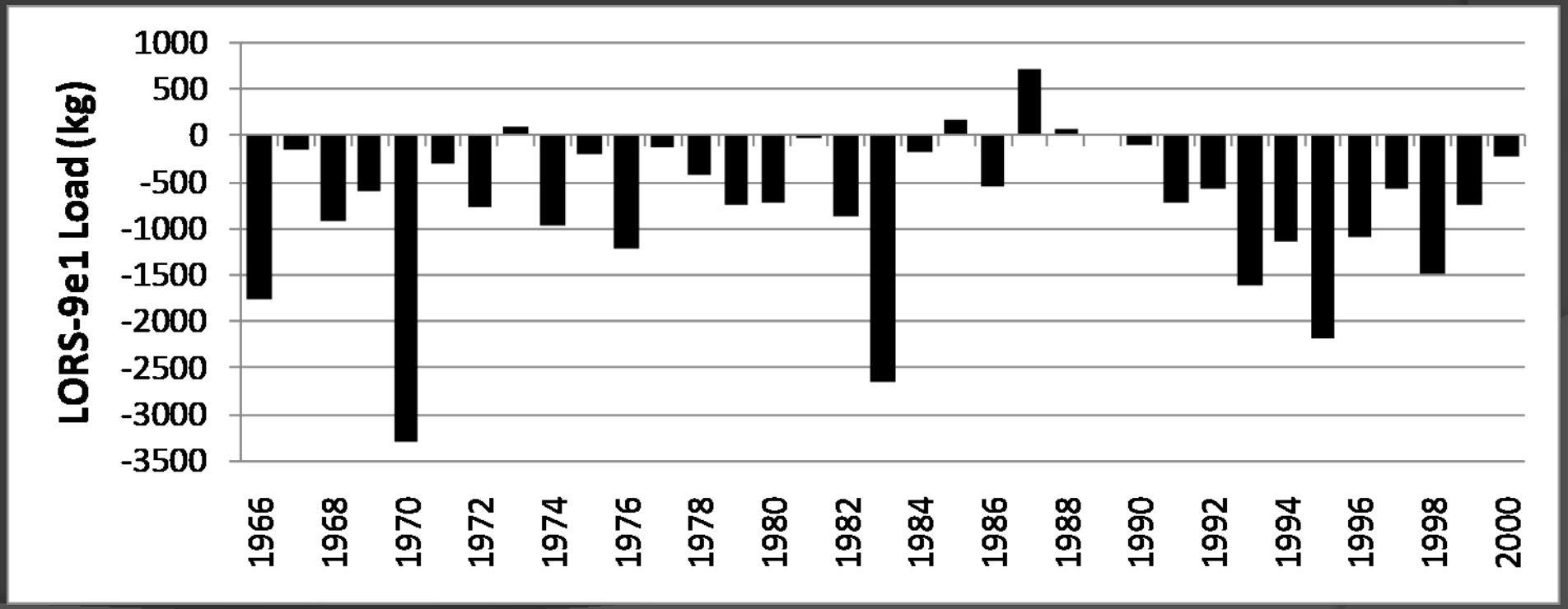
# Annual Loads

- Annual 9e1 TP loads (mean = 10,579 kg $yr^{-1}$) are higher than LORS (mean = 9,840 kg $yr^{-1}$)



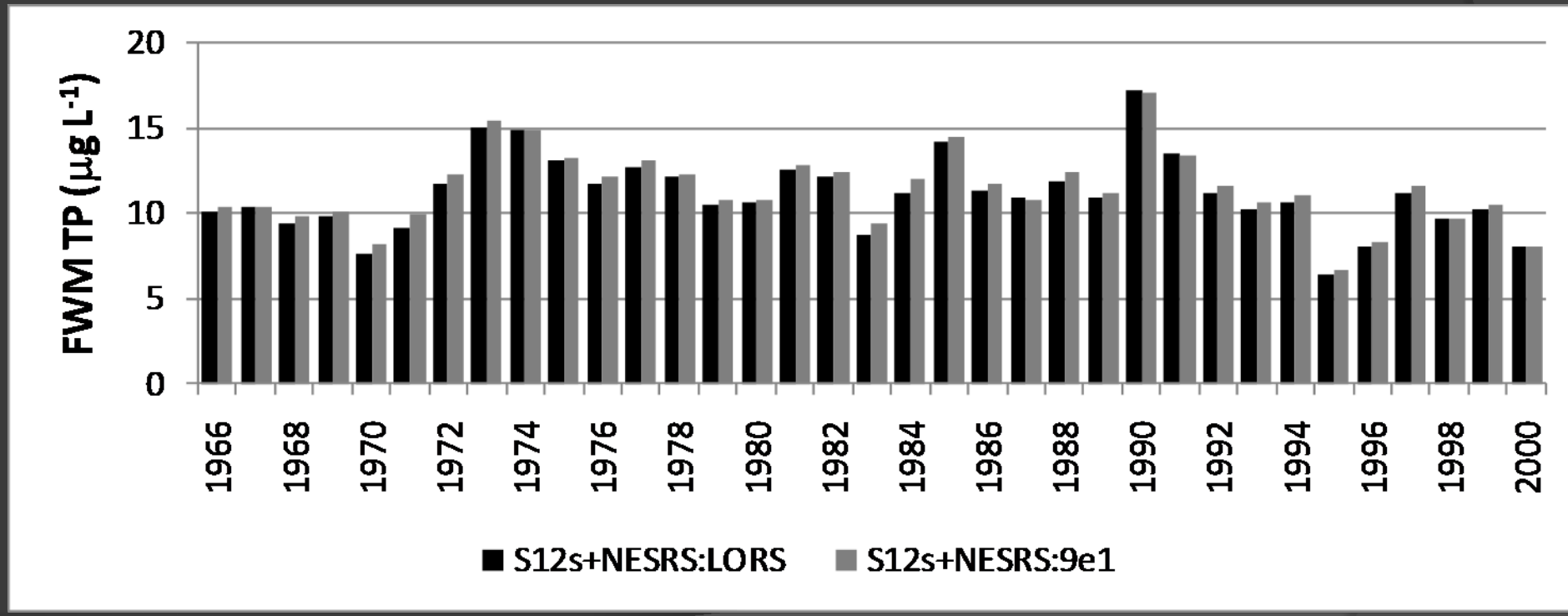
# Annual Loads

- Annual 9e1 TP loads were greater than LORS 86% of the POR by as much as 3,289 kg



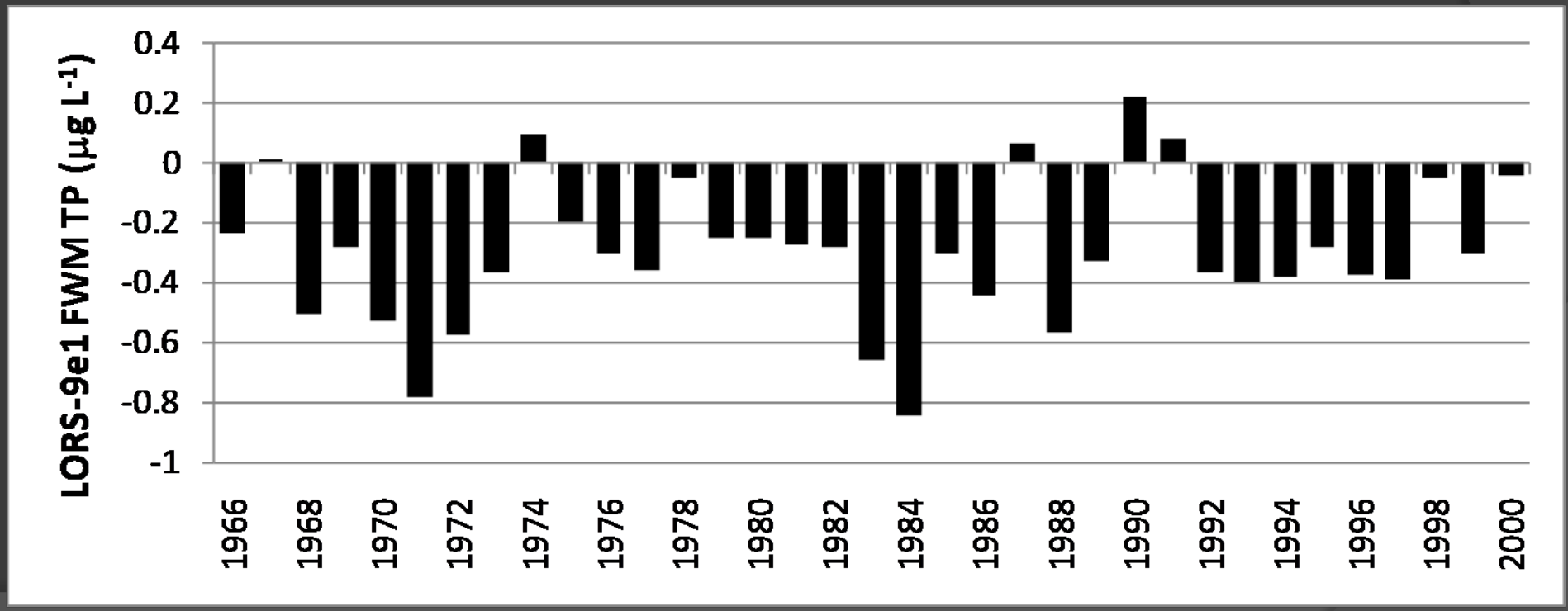
# Annual FWM TP

- Annual 9e1 FWM TP concentration (mean = 11.41 μg $L^{-1}$) is higher than LORS (mean = 11.11 μg $L^{-1}$)



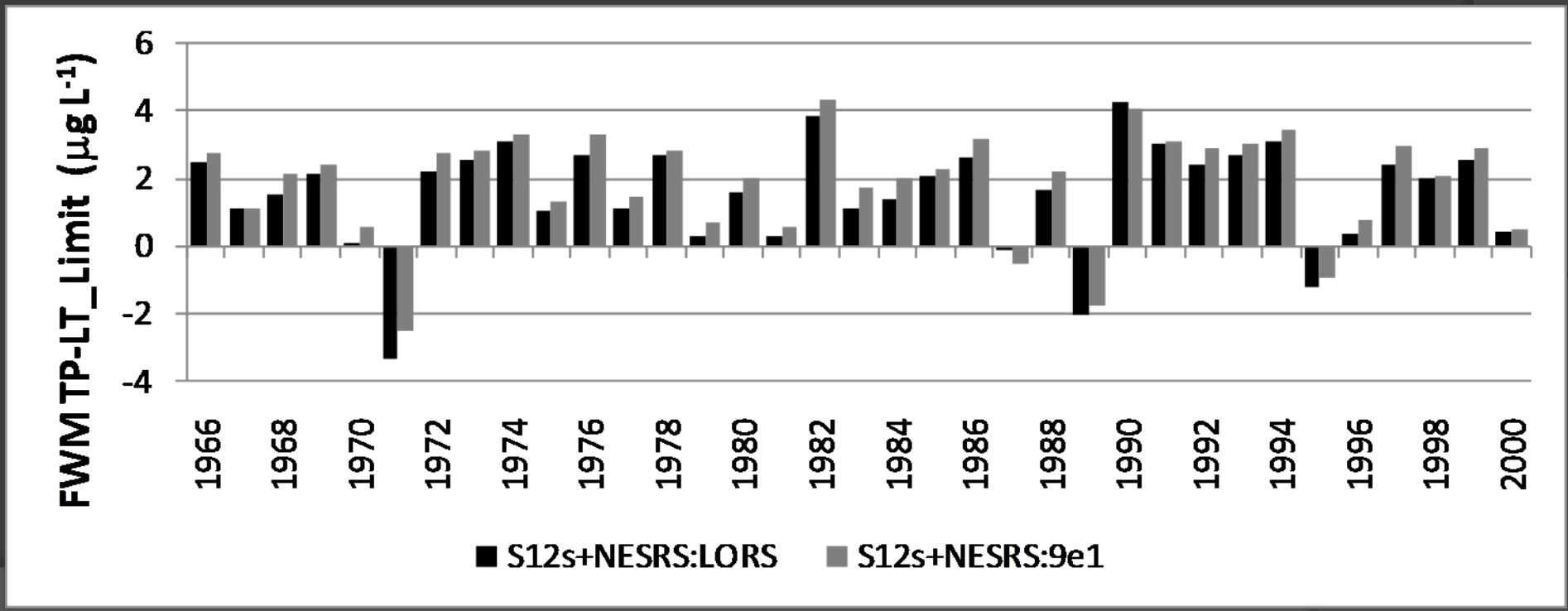
# Annual FWM TP

- The annual 9e1 FWM TP concentrations were greater than LORS 86% of the POR by as much as 0.84 μg $L^{-1}$



# Annual Limit Excursions

- Annual 9e1 FWM TP (mean = 1.88 μg $L^{-1}$; median = 2.2 μg $L^{-1}$) magnitude of exceeding the Long-Term Limit was higher than LORS (mean = 1.54 μg $L^{-1}$; median = 2.0 μg $L^{-1}$)



# Discussion

- FWM TP concentration is higher in 9e1 than LORS by approximately 0.3 $\mu g\ L^{-1}$
- Increased flows and concentrations from 9e1 increase average TP loads to Shark River Slough by about 739 kg $yr^{-1}$ relative to LORS, and as much as 3,289 kg in individual years
- Exceedances of the Long-Term Limit occur in 31 of 35 years for each alternative
- However, these exceedance estimates are over-estimates
  - Actual exceedances from 1991-2000 occurred in 7 of 10 years
  - Modeled exceedances from 1991-2000 occurred in 9 of 10 years
- We know from Taylor Slough that increased loads can cause cattail expansion
- Shark River Slough exceeded the Long-Term Limit in 2008, may do so again in 2010, and TP concentrations in inflows already are higher than desired
- Sediment TP surveys show evidence of TP enrichment downstream from the S-12s

# Corps alternative methods for ERTP WQ analysis

- In addition to the Walker model, the Corps used four alternative analyses for assessing exceedances
  - Stage Neutral Analysis
  - Partial Stage Neutral Analysis
  - Structure FWM Analysis
  - Seasonal Structure FWM Analysis
- Stage Neutral and Partial Stage Neutral analyses are based on the hypothesis that the stage/TP relationships do not persist over time
- Structure and Seasonal Structure FWM approaches examine how discharging water through the various structures (S12s, S333, and S334) impacts TP loads and FWMs

# Corps alternative methods for ERTP WQ analysis

- Stage Neutral Analysis
  - Relies on LORS stages applied to all scenarios
  - Could be a potential screening tool to estimate how flow impacts TP loads and FWMs
  - The 2x2 model stage output for alternative scenarios are not used in this assessment
  - Relative to the Walker approach, the Stage Neutral approach creates a new relationship between stage and TP for the alternatives
    - Higher stage
    - Lower daily TP concentrations and loads

# Corps alternative methods for ERTP WQ analysis

- Partial Stage Neutral Analysis
  - Relies on LORS stages when stages are higher than 9.5 ft (55 to 60% of the time)
  - 40 to 45% of the 2x2 stage data are used in the scenario runs when stages are below 9.5 ft
  - A large fraction of 2x2 model stage output for alternative scenarios is not used in this assessment
  - Relative to the Walker approach, the Partial Stage Neutral approach results in a new relationship between stage and TP for the alternatives
    - Higher stages
    - Lower daily TP concentrations and loads

# Corps alternative methods for ERTP WQ analysis

- Structure and Seasonal Structure FWM Analysis
  - Assesses TP loads and FWM for each structure based on total flow and loads calculated for 10 years (2000-2009 – ISOP/IOP)
  - Could be a potential screening tool to assess how changing FWM TP concentration changes loads within a scenario
  - Could be a potential screening tool to assess the changes to loads as a result of changing flow distributions among structures
  - These approaches are based on one FWM TP value for each structure aggregated from a decade (ISOP/IOP) of TP data
  - Applying structure FWM concentrations does not account for TP concentrations changes that may result from lowering stages
  - These analyses employed different FWM TP assumptions for the structures than Walker used, resulting in lower TP load and FWM impacts

# Conclusions

- 9e1 results in higher TP concentration and load to Shark River Slough than LORS
- The Corps' approaches provide some understanding of how sensitive the increases in loads and FWM TP are to ERTP alternatives
- The Corps' approaches do not apply (or only apply at low stages) the 2x2 model's stage output; thus, the well-established stage/TP relationship (lower stages, higher TP) is not fully considered in their analyses
- Because of these differences, we prefer the Walker model that specifically incorporates stage and stage changes that would occur under 9e1 and LORS
- If more time were available, refinements of these analyses could be applied to develop an ERTP alternative that has neutral, or even positive, water quality aspects