RES 17-06

M E M O R A N D U M

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SUBJECT: SFWMM Enhancements V3.7 to V4.4

The South Florida Water Management Model (SFWMM) has been the primary modeling tool for the following projects:

- Development of the Draft Lower East Coast Regional Water Supply Plan (SFWMD, 1993) (V2.10)
- Central and Southern Florida Flood Control Project Comprehensive Review Study Final Integrated Feasibility Report and Programmatic Environmental Impact Statement (Restudy) (USACE and SFWMD, 1999) (V3.5)
- Lower East Coast Regional Water Supply Plan (SFWMD, 2000) (V3.7)
- Water Preserve Area (WPA) Feasibility Study (V3.5)
- Interim Structural and Operational Plan (ISOP) (V3.8)
- Modified Water Deliveries (New Combined Structural and Operational Plan – CSOP) (V3.7, V4.4)
- Operational Planning (V3.8-V4.4)

The evolution of the SFWMM code since V3.7 has been mainly driven by: 1) ongoing needs of operational planning project and drought management, and 2) needs of ISOP and CSOP. Version 4.4 will also be the starting point for updating the SFWMM period of simulation through year 2000.

The purpose of this document is to describe code enhancements to the SFWMM since version 3.7. As part of the WPA modeling, it was necessary to enhance V3.5, the version previously used for the Restudy. Therefore, differences in capabilities between V3.5 used for the WPA feasibility study and V3.7 are also presented to document these retroactive changes to V3.5. Note that V4.4 also includes all enhancements that have been added previously to the model.

Differences in Capabilities of V3.5-WPA and V3.7

V3.5-WPA	V3.7
1. Adequate to simulate small and large reservoirs as long as outflow from reservoir is not directed to same cell as reservoir. V4.4 is more flexible and complete.*	1. Not adequate to simulate small reservoirs. V3.5–WPA code would need to be added to simulate latest WPA configuration.
2. Not able to simulate ASR recovery across basins or LEC service areas. To obtain this ability, V3.7 code must be added.	2. Able to simulate ASR recovery across basins (e.g. C51ASR can be used to meet WPB canal basin demands in EAA).
3. Not able to simulate S12 structures separately	3. Able to simulate S12 structures separately.
4. LOK schedule can be WSE-like, which considers some climate forecasting, but does not allow full implementation of WSE decision tree.	4. Full WSE schedule can be simulated for LOK
5. Lake Istokpoga demands/runoff considered same as historical included in the Lake Okeechobee MDS.	5. Lake Istokpoga demands/runoff can be considered separately.

* In small reservoirs, the actual surface area is much smaller than one grid cell area. V4.4 is the only version that can simulate small reservoirs as separate, independent entities within grid network. Previous versions estimate water depths within reservoirs based on cell ponding depths.

New Features Added in V4.4 since V3.7

1. Algorithms fully developed in V4.4 to simulate small and large reservoirs:
   - Small reservoirs (actual area much less than grid cell area)
     - Reservoirs are simulated as separate, independent entities within grid network.
     - Reservoir topography and land use type can be specified to be different from rest of grid cell(s) in which reservoir is located.
     - Cells containing small reservoirs do not have to be grouped in a separate hydrologic basin.
     - Reservoir stage is determined independently from rest of grid cell(s) in which reservoir is located. A maximum of 3 small reservoirs can be simulated within a grid cell.
     - Overland flow is simulated through reservoir cells in a manner similar to that in remaining grid cells.
     - Inflow intended for reservoir enters reservoir directly and is not spread over entire grid cell.
     - One-dimensional surface and groundwater flow within long narrow reservoirs is simulated.
   - Large reservoirs (actual area covers a majority of one-cell or covers one or more modeling cells)
     - Reservoir stage is estimated based on grid cell stage. Actual area of reservoir in relation to grid size is considered for this operation.
     - When cell ponding depth is equal to zero, reservoir stage is equal to cell stage.
     - Cells containing large reservoir must be grouped in a separate hydrologic basin.
     - Any surface water flow from external cells to reservoir cells is simulated with passive broad-crested weirs
     - Flow intended for reservoir is spread over entire grid cell.

   Versions 3.8.1 through 4.3 were developed to simulate all reservoirs as "large" reservoirs referenced above. Unlike V4.4, these versions cannot simulate small reservoirs as separate, independent entities within grid network. Although V4.4 has additional capability, it can still simulate all reservoirs as "large" reservoirs if so chosen by the user.

2. Flexibility has been added to run the model in position analysis mode or continuous simulation (long-term planning) mode.

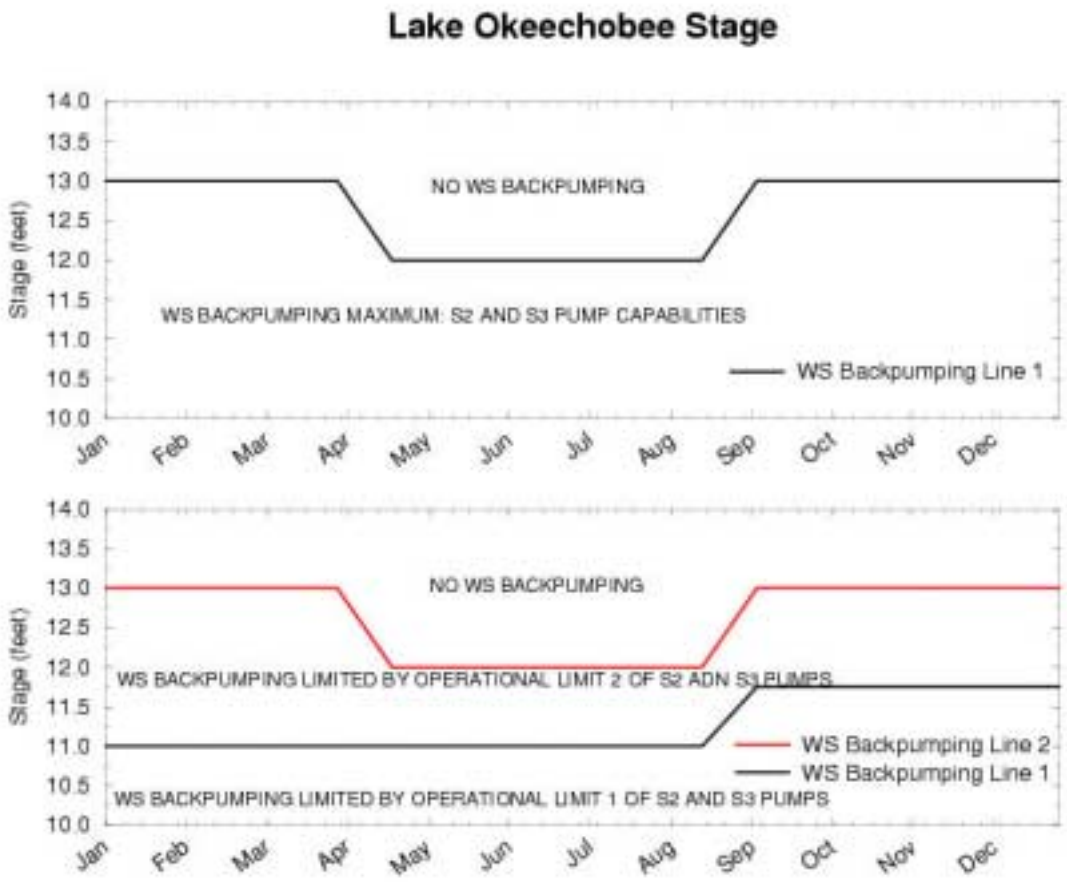
3. Model can simulate drawdown of appropriate canals during the times that major storms are anticipated during the entire simulation period. The beginning dates (month, day year), duration (in days), canal names, structure names and operational levels during the drawdown are input by the user.

4. Model can simulate forward pumping through S354, S351, and S352 from LOK when LOK stage is sufficiently low. The forward pumps are in lieu of, not in addition to, gravity flow through the structures. The stage at which forward pumping begins and stage at which forward pumping is discontinued and gravity flow resumes are input for each of the structures.

   Forward pump and gravity flow through S354, S351 and S352 are further limited by the following conditions:

- Gravity flow to meet EAA demands can occur when LOK is above 8.0 feet NGVD.
- Gravity flow from LOK for environmental water supply to Everglades or water supply to LEC service areas occurs when LOK is greater than 8.0 feet and when flow through conveyance capacity in major EAA canals is available.
- When LOK stage is 7.0 feet or below, forward pumping from LOK can no longer occur.
- When LOK ≤7.0 NGVD (with forward pumping) or ≤8.0 ft. NGVD (without forward pumping) none of EAA demands or LEC service area demands are met by LOK.
- Conveyance restrictions for gravity are more limiting flow in V4.4 than in previous versions, at low LOK stages (<8.5 ft.) and more closely represent field conditions.

5. Flexibility to simulate water supply backpumping of EAA runoff to Lake Okeechobee has been enhanced as depicted below. The increase in flexibility is illustrated by comparing the figures below. The backpumping lines in the figures are for illustration only and do not reflect actual operations or data input into the SFWMM.



In addition, the user can change the fraction of runoff backpumped from each EAA basin, when stage in the appropriate WCA is below floor elevation. Before fraction was assumed to be 1.0 when backpumping occurred.

6. Additional flexibility has been added to the simulation of the Lake Okeechobee Operational Schedule so that deviations within a calendar year can be investigated. The beginning and ending dates (month and day) for the deviation in LOK operations are input by user.

7. The SFWMM is able to simulate regulatory releases from LOK through WCAs to tidewater even if WCAs are below schedule.

8. Floor elevations in WCAs are calendar-based (similar to flood control schedules) instead of representing constant elevations throughout the year..

9. When the appropriate WCA(s) is at or below its floor elevation, water supply trigger levels in canals in corresponding service area(s) can be modified during simulation. The minimum levels for each canal are input for wet and dry seasons. The user also has the capability to specify a time window within the calendar year when this option is effective.

10. Deliveries from LOK to meet EAA demands can be performed on specified days of the week. The specified days of the week are input for:

    a. Times when LEC demands are low or non-existent.
    b. Times when LEC demands are higher and thus compete with EAA for water supply.

11. Water supply from WCAs to LECSAs can be delivered on specified days of the week. Days of the week can be specified for each WCA.

12. Simulation of outlet structures from WCAs has been modified so that each structure can have its own regulation schedule.

13. Flexibility has been added to vary capacities of appropriate outlet structures as a function of months of the year.

14. Added input for tailwater constraints, which are calendar-based, for outlet structures in Water Conservation Areas.

15. The SFWMM source code is under continuous restructuring. The main program, as well as indata.F and lakewca.F subroutines have been divided into a series of smaller subroutines. V4.4 has approximately 35 more subroutines, including new algorithms.

It is important to note that the model is designed so that the user, via the input data, has the flexibility to simulate proposed deviations in operational rules which require use of the additional features, or simulate standard operational rules already developed in the model. Thus, the latest version of the model (V4.4), even with its increased capabilities, can duplicate the assumptions made in simulations performed by previous versions of the model. Any changes in the results from previous versions, assuming the assumptions are the same, reflect any improvements or refinements made to the algorithms already existing in previous versions and NOT the result of adding new features or algorithms to the model.