MEMORANDUM

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SUBJECT: South Florida Water Management Model (SFWMM) V5.5x Trigger Module Modifications.

The purpose of this memorandum is to document the most recent changes made to the Lower East Coast Water Supply trigger package of SFWMM V5.5x. It describes the changes that were requested and how they were incorporated in the model through source code and input modifications. Although this document references Lower East Coast subRegional (LECsR) MODFLOW model sporadically, the changes discussed in this document are pertinent to SFWMM V5.5x only.

Introduction

In July 2005, South Florida Water Management District (SFWMD) undertook a review of the methodologies used to simulate Lower East Coast (LEC) water supply cutbacks in the regional (SFWMM) and sub-regional (LECsR) hydrologic models. The review was conducted by staff from both the Water Supply Department and the Hydrologic and Environmental Systems Modeling Department (HESM). Several changes to the trigger module were proposed during this review. The objectives of these changes were to ensure that the LECsR and SFWMM models had the capability of simulating water shortage declarations in the LEC region in a consistent manner. This

memo details the source code and input data modifications that were made to the SFWMM.

SFWMM Trigger Module (Version 5.4.4x and older)

The SFWMM trigger module was originally developed in 1993. It monitors the simulated water levels at several key gage locations and declares water restrictions at prescribed phases if the monitored heads falls below pre-determined threshold values for a predefined number of days for a certain month (these days do not need to be contiguous). It further enforces phase dependent cutbacks at appropriate locations based on the water usage types (public water supply, urban landscape, nursery, golf course and agricultural).

Once the need for cutbacks is established in the system then the cutbacks are enforced at appropriate locations--i.e. the pumpage demands for water usage types are reduced by the corresponding cutback value. The SFWMM compares the model simulated water levels at the monitoring stations with the user specified threshold levels. If the head falls below one of the four limits corresponding to the four levels of water shortage intensity then a counter is updated for each occurrence. A monitoring station is used to designate a trigger cell and a trigger or a group of triggers affect an area called a trigger zone. Trigger zones are selected based on the influence of pumpage wells in a particular region and their position in the service areas. In the event of a cutback declaration, the model counts violations in the previous month and enforces cutbacks in the next month as long as the numbers of violations exceed the prescribed number of days. For instance, the model counts the violations for January to accomplish the cutbacks in February. The cutbacks remain effective until the end of the dry season, during what is called the “dry season” criteria window (November through May) or a more severe cutback is triggered, whichever comes first. Also, the cutbacks can still happen all year long (i.e., during dry and wet seasons).

Trigger zones are rectangular in shape and many zones may comprise one service area but a trigger zone may not include parts of more than one service area. Service areas are planning areas while the zones are needed for simulation reasons. There is a

connection among the monitoring station, trigger cell, trigger zone and service areas. Modification to any one of these will affect others. Trigger module of SFWMM V5.4.4x has six zones: North Service Area A & B, North Service Area A, Lower East Coast Service 1-A, Lower East Coast Service 1-B, Lower East Coast Service Area 2, Lower East Coast service Area 3 [see Figure 1].

SFWMM Trigger package after modifications (Version 5.5x and newer)

The following changes were incorporated in to the SFWMM V5.5x trigger module:

1) Re-alignment of the SFWMM zones in accordance with LECsR zones. This resulted in an increase of SFWMM zones from 6 to 21.
2) Threshold water levels below which cutbacks are implemented changed for Lake Worth, Hollywood and Airport triggering locations (phases 1 and 2).
3) No triggering of cutbacks during the wet season (June-October) and at the end of the dry season (April and May). Dry season criteria restrictions are extended until the end of May.
4) Cutbacks triggered only during the months of November through March in the dry season.

Figures 1 and 2 show the trigger zones in V5.5x (red lines) and the corresponding zones in LECsR (black hatched lines). SFWMM zones were modified to be consistent with the LECsR zones as close as possible in terms of the boundaries, trigger location and number. The column and row locations at southwest and northeast corners of the trigger zones used in SFWMM and LECsR are shown in Table 1. Due to the difference in the model cell size of SFWMM (4 square miles) and LECsR (0.017 square miles) and cell–grid location, an approximation had to be made in terms of SFWMM zone boundaries. The location of the trigger cells was not changed and the triggers that have been used historically were used again. Care was also taken to include the same number of pumpage wells in each zone as used by LECsR. These changes were made in the input files of SFWMM (trginput.dat) by modifying the cell locations of southwest and northeast corners of the trigger zones. For comparison purposes, SFWMM V5.4.4x zones (before

trigger module modifications) and SFWMM V5.5x zones (after trigger module modifications) are shown in the Figure 3 with the approximate location of the triggers.

Calibration runs of SFWMM V5.4.4x to define Trigger levels.

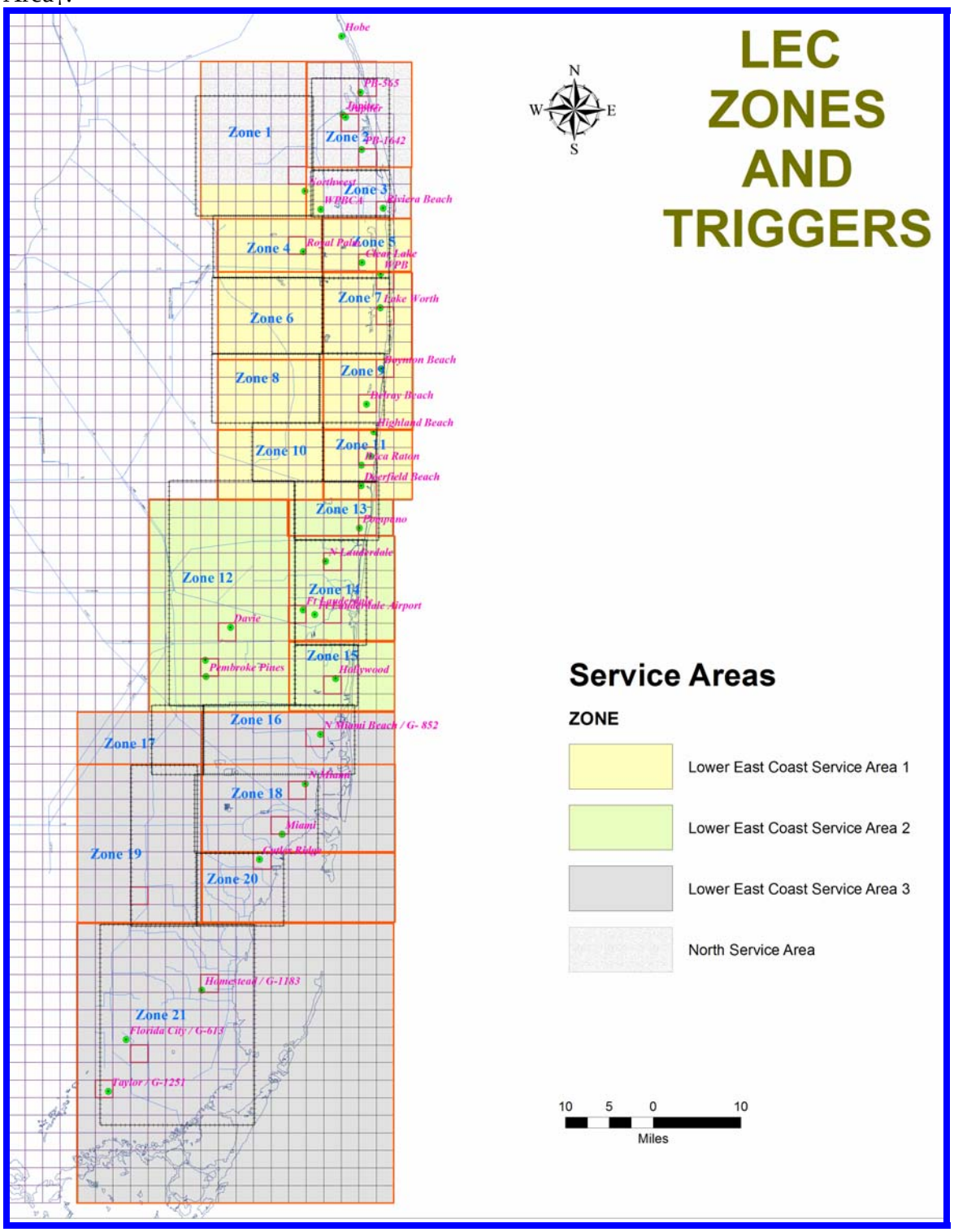
The SFWMM calibration/verification run (1981-2000) was used as a base run to verify the adequacy of the newly modified triggering module. Since the historical pumpage data used in the calibration run has cutbacks already inherently enforced, changes in the input files were done to ensure that any additional cutbacks were not imposed. In SFWMM, cutbacks for public water supply and industrial supply are a fraction of total required cutbacks for other suppliers (urban landscape, nursery, golf course and agricultural). Cutbacks for other usage types are expressed as maximum net irrigation application rate (inches/month). Changes to the trigger module input file (trginput.dat) were done to set the cutbacks for public and other usage types to zero. The purpose of this exercise was to assure that the SFWMM, with the modified triggering module, would reproduce historically observed cutback declarations.

Based on the review of the SFWMM run that included all of the above mentioned changes (zone boundaries redefined, number of zones increased and zero cutbacks) the LECsR modeling team suggested an additional set of changes. Over the 1981 to 2000 simulation period, the SFWMM triggered at least once every year except in 1986 and 1998. The triggering frequency at Hollywood (F-291), Homestead (G-1183), Fla City (G-613), Airport (G-561), Tequesta (PB-565), Jupiter and Lake Worth (PB-88) was higher than the previous version. In order to reduce the triggering frequency at the above mentioned locations, trigger levels at Lake Worth, Airport and Hollywood were changed to the levels recommended by LECsR modeling team. By changing the trigger threshold levels for Hollywood, Lake Worth and Jupiter it was possible to make the two model versions consistent. The new and old calibration trigger levels are shown in Table 2. The frequency and severity of water restriction triggers for SFWMM V5.4.4x (before trigger module modifications) and V5.5x (after the trigger module modifications) are shown in Figures 4 and 5. Based on Figures 4 & 5, the frequency and severity of water restriction at Hollywood was reduced.

In addition, the following set of changes was implemented through source code modifications: no cutbacks during the wet season (June-October) and at the end of the dry season (April and May) and cutbacks only from November to March in the dry season. Changes in the source code were verified by a thorough QA/QC of the model output by the LECsR and SFWMM modeling team. A broad summary of all the modifications in the trigger module of SFWMM V5.5x (after modifications) and SFWMM V5.4.4x (before modifications) is shown in Table 3.

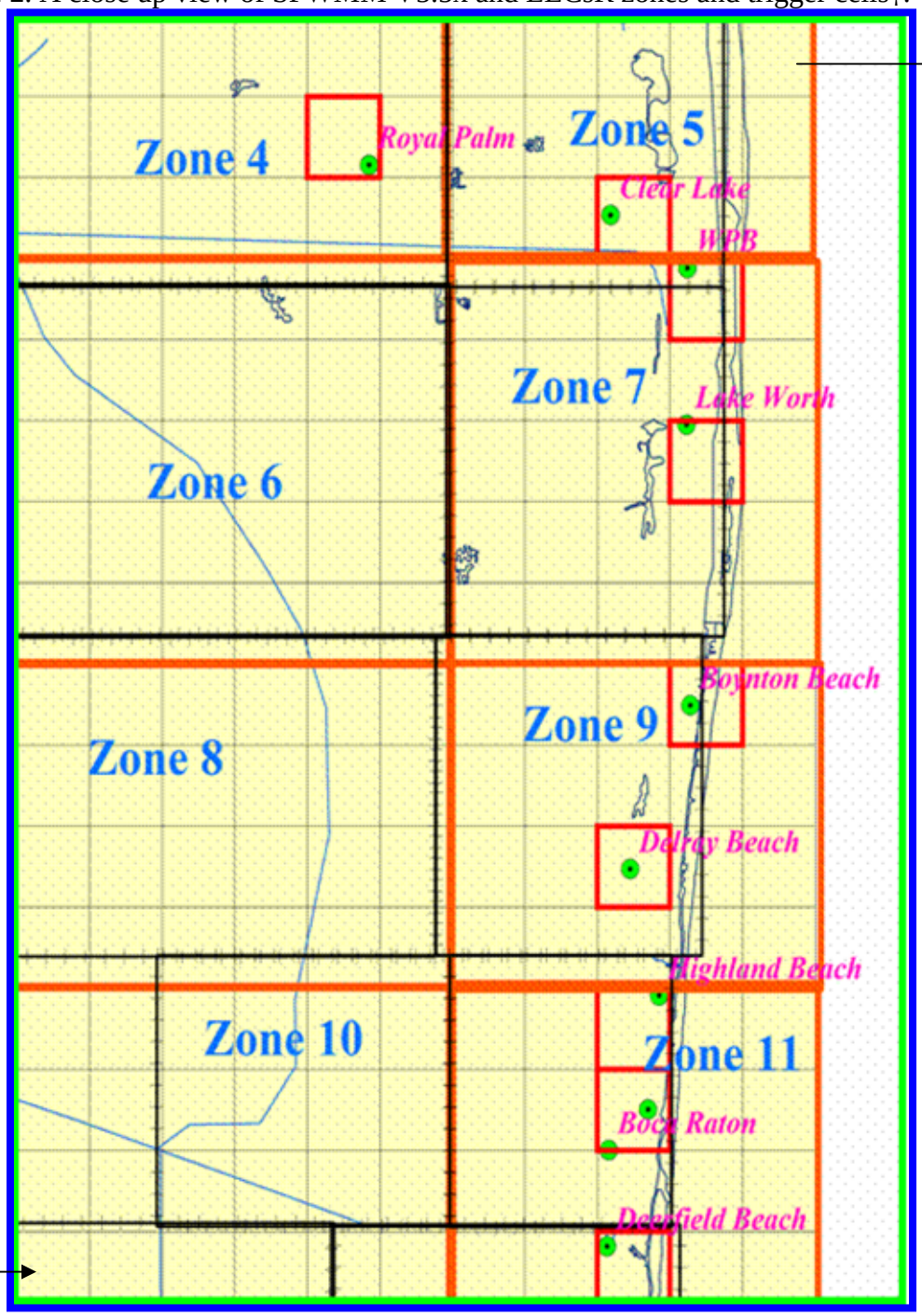
In addition to the changes made in the source code and input files, the economic post processing utilities and performance measure scripts had to be modified to account for the new changes.

Figure1**.** Location of Trigger Cells and Zones in the South Florida Water Management Model (V5.5x) Used to Trigger Water Restrictions in the Lower East Coast Developed Area‡.



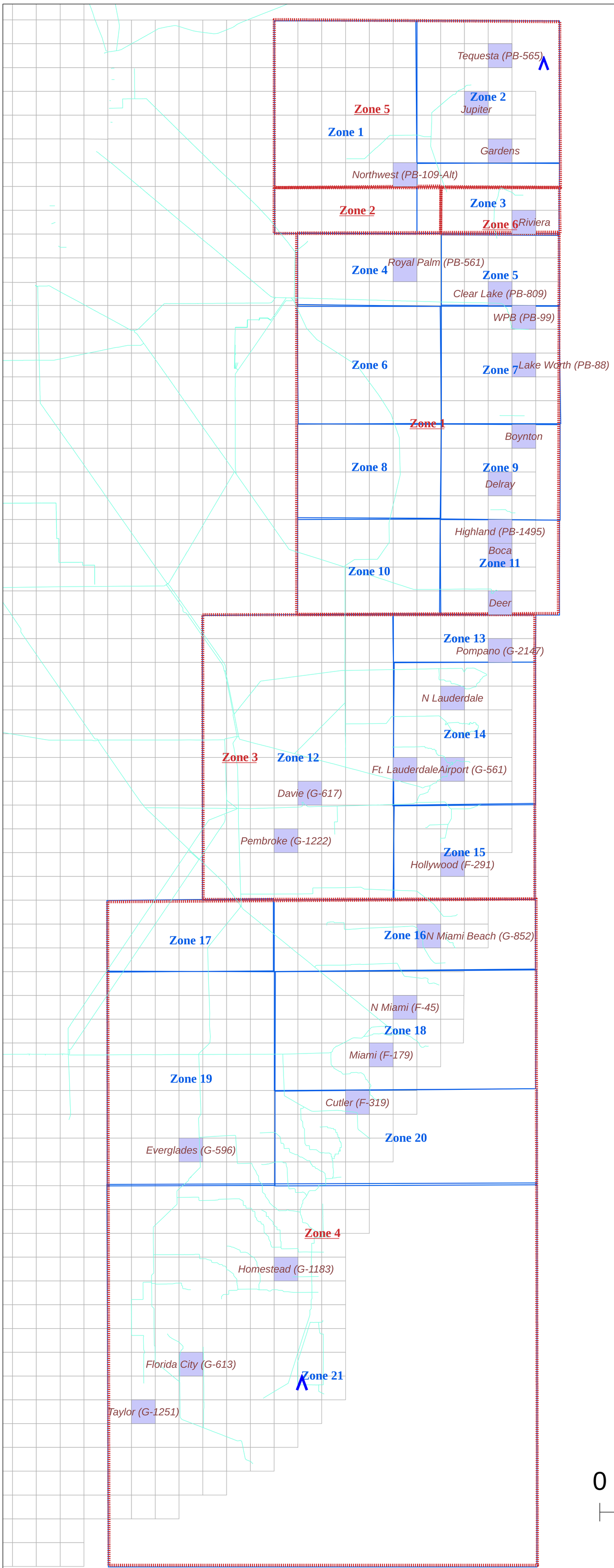
‡Red lines = SFWMM zone boundaries
Black hatched lines = LECsR zone boundaries

Figure 2. A close up view of SFWMM V5.5x and LECsR zones and trigger cells‡.



‡Red lines = SFWMM zone boundaries
Black hatched lines = LECsR zone boundaries

Figure 3. LEC TRIGGERS AND ZONES [V5.5 and V5.4]



V5.4.4X_Zones

V5.5X_Zones

0 10 20 40 Miles

Figure 4. Frequency and Severity of water restriction triggers for SFWMM V5.4.4x (before SFWMM trigger module modifications).

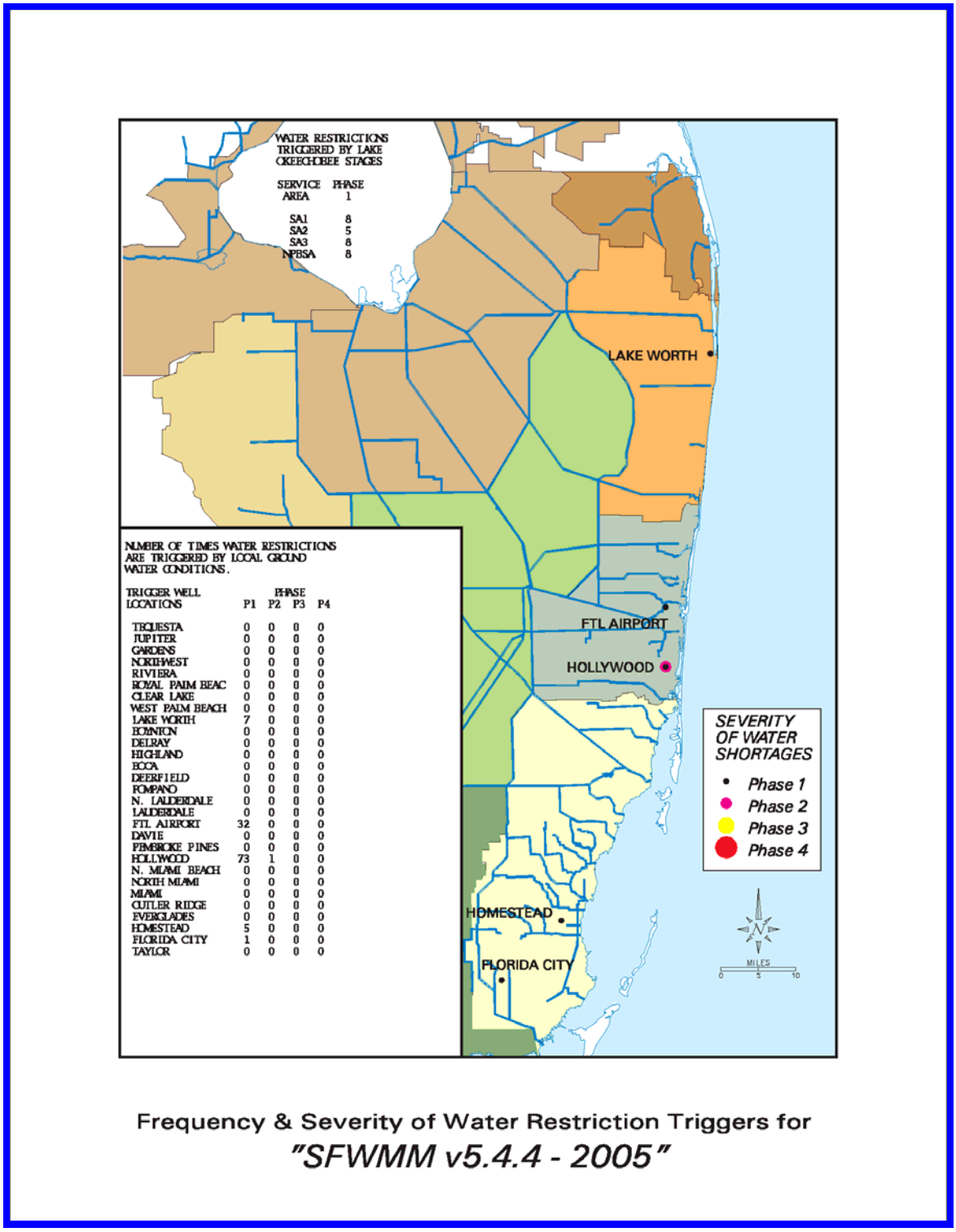


Figure 5. Frequency and Severity of water restriction triggers for SFWMM V5.5x. (after SFWMM trigger module modifications).

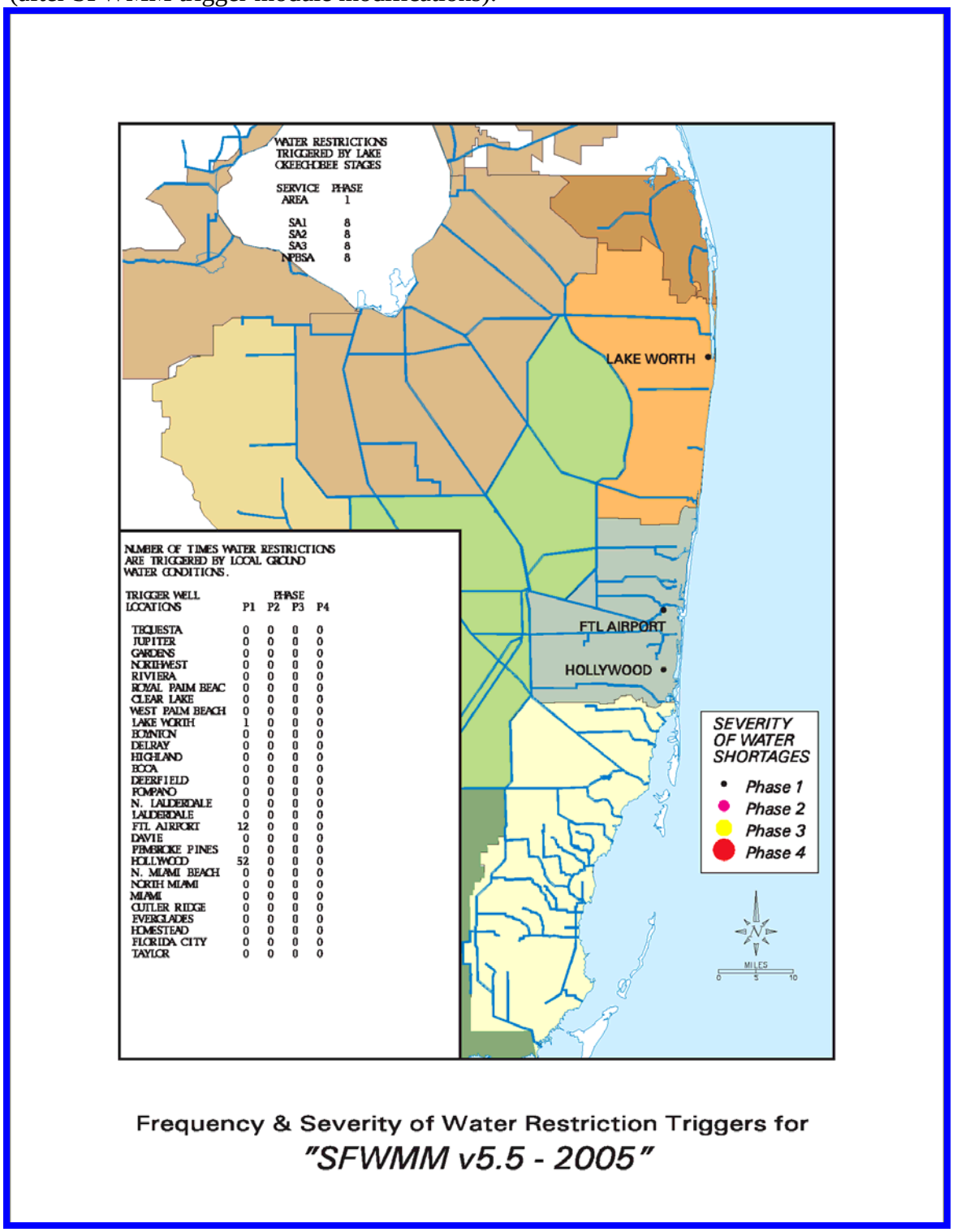


Table 1. Row, Column locations at the southwest and northeast corners of the trigger zones used in SFWMM and LECsR.

	SFWMM (V5.4.4)	SFWMM(V5.5)	LECsR
	(Col,Row)	(Col,Row)	(Col,Row)‡
Zone1	31,41	30,57	29,63
	41,56	35,65	36,57
Zone2	30,57	36,60	36,64
	36,58	41,65	40,59
Zone3	27,29	36,57	26,59
	40,40	41,59	40,57
Zone4	23,1	31,54	30,57
	40,58	36,56	36,53
Zone5	30,59	37,54	36,57
	41,65	41,56	40,53
Zone6	37,57	31,49	30,53
	41,58	36,53	36,49
Zone7		37,49	36,53
		41,53	40,49
Zone8		31,45	30,49
		36,48	36,45
Zone9		37,45	36,49
		41,48	40,45
Zone10		31,41	32,45
		36,44	36,42
Zone11		37,41	36,45
		41,44	39,42
Zone12		27,29	28,42
		34,40	35,29
Zone13		35,39	35,42
		40,40	40,38
Zone14		35,33	35,38
		40,38	39,32
Zone15		35,29	35,32
		40,32	38,29
Zone16		30,26	30,29
		40,28	38,35
Zone17		23,26	27,29
		29,28	30,25
Zone18		30,21	29,25
		40,25	36,21
Zone19		23,17	26,25
		29,25	29,16
Zone20		30,17	29,20
		40,20	34,16
Zone21		23,1	24,16
		40,16	5,32

‡Row and column location are in SFWMM terminology.

Table 2. Changes made to the threshold water levels (ft. NGVD) below which cutbacks are triggered‡.

Feet (NGVD)	Lake Worth	Hollywood	Airport
Phase 1	2.75(3.00)	0.75(1.00)	0.80(1.00)
Phase 2	2.25(2.00)	0.25(0.50)	0.30(0.50)

‡ values in ( ) indicate SFWMM V5.4.4x (and older) water trigger levels.

Table 3. Summary of modifications made to the trigger module of SFWMM V5.4.4x (before trigger module modifications) and SFWMM V5.5x (after trigger module modifications).

Features	SFWMM V5.4.4x	SFWMM V5.5x
Zones	6	21
Service Areas	4	4
Triggering Window	January-December	November-April
Trigger threshold water levels (ft NGVD)	Lake Worth (3.00 & 2.00)‡ Airport (1.00 & 0.50)‡ Hollywood (1.00 & 0.50)‡	Lake Worth(2.75 & 2.25)‡ Airport (0.80 & 0.30)‡ Hollywood (0.75 & 0.25)‡
New Triggers	NA	WPBCA (not functional)

‡Phase 1 and 2 water levels