CHAPTER 3: WATERSHED HYDROLOGY
APPENDIX 3.D: EVALUATION OF MODEL UNCERTAINTY

The hydrologic modeling for the WSIS utilized the SJRWMD's Common Logic and PEST for the development of its parameter set. This does not account for the uncertainty of the input-output representation of the model.

In hydrology the uncertainties affecting rainfall-runoff models remains a major scientific and operational challenge. Hydrologic modeling is affected by four main sources of uncertainty:

(1) input uncertainty, e.g., sampling and measurement errors in catchment rainfall estimates;
(2) output uncertainty, e.g., rating curve errors affecting runoff estimates;
(3) structural uncertainty arising from lumped and simplified representation of hydrological processes in hydrologic models; and
(4) parametric uncertainty, reflecting the inability to specify exact values of model parameters due to finite length and uncertainties in the calibration data, imperfect process understanding, model approximations, etc.

The modeler has little control or complete understanding of the actual magnitude of the input-output uncertainty. The data sources report the general errors; missing data is filled in to provide complete data sets. PEST can help reduce some of the uncertainty in the parameter set used in the model. An evaluation of closeness of fit of the model results to the observed data can help determine the performance of a model. The Nash-Sutcliffe was used in the watershed hydrology modeling for the WSIS analysis. The closer the Nash-Sutcliffe statistic is to 1, the more confidence there is in the model. Confidence can be considered the opposite of uncertainty.

The SJRWMD's Bureau of Environmental Sciences (ES) developed a uncertainty ranking score for their WSIS work groups. This uncertainty score method was associated with the Nash-Sutcliffe performance rating (Table 3 - 80) to bring the same system to the results of the watershed hydrologic modeling.

Table 3.D.1. Nash-Sutcliffe values and the SJRWMD's Environmental Science's uncertainty rating

Performance Rating	Nash-Sutcliffe (Monthly)	ES Uncertainty Rating
Very good	0.75 < NSE < 1.00	Very Low
Good	0.65 < NSE < 0.75	Low
Satisfactory	0.50 < NSE < 0.65	Moderate
Unsatisfactory	< 0.50	High / Very High

ES work groups settled on a segmentation of the SJR watershed based on similar environments and hydrology. This segmentation of the river is described in detail in the Environmental Science's chapters that are part of the WSIS.

Except for river segment four, there were multiple calibrated models in each river segment. The evaluation of uncertainty in each river segment was developed by calculating an area weighted Nash-Sutcliffe for the calibrated models that contributed to a river segment. The Nash-Sutcliffe value was multiplied by the area up stream of the calibration gage. These values were summed within the river segment and divided by the total calibrated area of the river region.

Table 3.D.2. HSPF estimated uncertainty using ES methodology. Based on Nash-Sutcliff values for calibrated areas.

ES River Segments	Approximate Location in the SJR Watershed	Level of Uncertainty
1	SJR mouth	Low
2	SJR north mainstem	Moderate
3	SJR north mainstem	Very Low
4	SJR south mainstem	UnKnown (no calibrated watershed in the river segment)
5	Lake George	Low
6	Lake Jesup, Lake Monroe, Lake Harney	Low
7	Lake Poinsett	Very Low
8	Lake Winder	Low
9	Lake Washington and upstream	Moderate

The HSPF model uncertainty can be evaluated directly by the environmental work groups only in river regions 7, 8 and 9, where the HSPF model output is directly used in the environmental analysis. In river regions 1 through 6, the HSPF uncertainty will be factored into the overall uncertainty of the EFDC hydrodynamic model. The environmental work groups in these river regions should evaluate their work based on the EFDC uncertainty described in Chapter 6.