**4.B. CONCLUSIONS AND RECOMMENDATIONS FOR HSPF**

**1. Model Objectives, Conceptualization, and Design**

The NFSEG HSPF model’s objectives are clearly described, and the model is very well conceptualized and designed. All major hydrologic inputs and processes are accounted for at a reasonable level, and the closed basin representation and spring simulation features are innovative. The model is appropriately delineated, i.e., segmented into watersheds and individual land cover-based hydrologic units. The calibration procedures and PEST objective function conceptualization appear to be valid. The correct output quantities are used to provide the recharge and maximum saturated ET to the MODFLOW model.

**2. Assumptions and Limitations of Input Data**

The input data for the NFSEG HSPF model include rainfall, PET, water use/irrigation, land elevation and slope, land use/cover, contributing watershed areas, waterbody characterization, and observed streamflow for calibration, i.e., comparison with simulated flow. The model does a good job of recognizing and mitigating the assumptions and limitations of the most important inputs, including rainfall and PET, observed flows, and watershed delineation-related data. The preparation and limitations of somewhat less critical data, such as water use and irrigation, are addressed in less detail.

**3. Model Calibration and Sensitivity**

Based on the statistical and graphical results presented, the model is generally well-calibrated to observed flow data at most stream gauges where the measured flow is reliable and watersheds that don’t have major man-made or tidal influences. Some stream gauges where the data are uncertain (i.e., poor quality as judged by USGS) have unsatisfactory calibration statistics. These are generally locations that are influenced by tidal flows, man-made structures and flow modifications, and unusually flat or areas of strong groundwater interaction with surface flows. These poorly-calibrated gauges should be discussed briefly in the calibration summaries for each HUC8 watershed.

Sensitivity is not addressed in the documentation for the NFSEG HSPF model. If reasonable care and appropriate assumptions are used in constructing the model and input data, then HSPF models are generally most sensitive to the major driving force inputs (rainfall and PET), and the major parameters for affecting ET and infiltration, such as the upper and lower soil storage parameters, infiltration rate, and ET from interception storage and the plant root zone. A possible future enhancement would include sensitivity analysis of these parameters in selected watersheds.

**4. Model Documentation (explanation of model, data sources, and assumptions)**

The HSPF documentation is very good at explaining the model, data sources, most assumptions, and the calibration results. In the calibration approach section, watersheds with tidal and man-made influences on measured flows should be discussed, and the possible effects on computed recharge should be evaluated. Since PEST is used for the automated calibration, the effects of specific objective function components on calibration should be discussed in the section on PEST. In the calibration section, the final parameter values of selected HSPF parameters should be compiled and summarized, and HSPF water balance summaries should be compiled and summarized to verify their reasonableness and verify that the total actual ET calibration to expected/literature values is adequate.

**5. Suitability of MODFLOW and Related HSPF Models for Intended Applications**

The use of HSPF to develop recharge (and maximum saturated ET) for input to MODFLOW-based groundwater flow models is suitable.

**Note: items 6, 7, and 8 are combined into one response:**

**6. Appropriateness, Defensibility, and Validity of Model/Relationships;**

**7. Validity and Appropriateness of All Assumptions Used in Development of Model/Relationships; and**

**8. Deficiencies, Errors, or Sources of Uncertainty in Model/Relationship Development, Calibration, and Application**

The NFSEG HSPF model is conceptualized, constructed, and calibrated appropriately over the majority of the model domain, and it is defensible for its intended purpose over the entire domain. The primary sources of possible errors derive from developing the model input rainfall and the implicit assumption that the measured streamflow is representative of the constructed watershed. Some of the watersheds are affected by processes that are not included in these models due to the limitations imposed by the large area and large number of models. These include man-made modifications, tidal effects, and large groundwater influence on surface water flows. The modelers made a decision to not include man-made changes in the models, and HSPF is generally not capable of representing significant groundwater or tidal effects without additional conceptualization and use of special features. Therefore, it is fair to say that the underlying HSPF process relationships are somewhat limited for accurately calibrating watersheds with these conditions unless they are explicitly included by the modeler. This is illustrated in many of the poorly calibrated gauges in the model. However, some of the poorly calibrated watersheds are likely resulting in reasonable and appropriate recharge, since many of the objective function criteria are being satisfied. In those watersheds where the percent bias is extremely high (and therefore the recharge is more likely to be invalid), it is recommended (in future calibrations of the model) that the model be modified to represent the man-made influences, or alternatively those watersheds should be assigned parameter values from a nearby watershed that is well calibrated. This recommendation of using calibrated parameters from another watershed should also be applied to gauges that have strong tidal influences.