Memorandum

TO: Senate Bill 3 Science Advisory Committee
FROM: Dan Opdyke, Texas Parks and Wildlife Department
DATE: May 7, 2010
RE: HEFR Enhancements

Based on input from the Science Advisory Committee (SAC) and other interested parties, several recent enhancements have been added to the Hydrology-based Environmental Flow Regime (HEFR) model. These enhancements are summarized below. In the near future, these enhancements will also be documented in a revision of the SAC document entitled "Use of Hydrologic Data in the Development of Instream Flow Recommendations for the Environmental Flows Allocation Process and the Hydrology-Based Environmental Flow Regime (HEFR) Methodology."

At this time, most of the enhancements described below have not been fully quality controlled, nor has a version of HEFR containing these enhancements been released for public use.

None of the original functionality of HEFR has been removed, rather these enhancements constitute additional options and outputs for the benefit of the user.

Recent Enhancements

Enhanced Statistics and Functionality for Intermittent and Ephemeral Streams

HEFR outputs now include a new worksheet entitled "ZeroFlows." This sheet provides (1) a listing of historical zero flow "events" (i.e., all periods of zero flows) including start date and duration, (2) historical frequency of zero flow days, calculated both annually and seasonally, (3) minimum, median, and maximum duration of historical zero flow events, calculated both annually and seasonally, and (4) historical average number of zero flow events per year and per season. These outputs are prepared for all HEFR runs, with no need for input from the analyst.

HEFR now has an input option to calculate all subsistence and base flow statistics solely on non-zero flow days. It is anticipated that this functionality will help to evaluate the hydrologic behavior of intermittent and ephemeral streams. Essentially, if the analyst selects this option, they will have at their disposal both the frequency of zero flow days as well as the usual HEFR statistics calculated solely on non-zero flow days. This combination should provide substantial flexibility for the analyst to craft reasonable flow recommendations. Note that this change affects the HEFR calculations only, not the hydrographic separation. Depending on your location and hydrographic separation, it is possible that only zero flow days are assigned to the subsistence flow category (i.e., IHA extreme low flow category). If this is the case and the user selects the "Subsistence Flows Threshold Percentile" option, then the subsistence flow recommendation cannot be based on non-zero flow days and will be listed as "N/A." This is because the calculation can only be applied to "extreme low flow" days and if there are no such

days that are non-zero, then the calculation cannot be performed. If the user selects the "Q95" option (see below) for subsistence flow days (and picks the "non-zero flow days" option) then Q95 will be based on the non-zero flow days and a non-zero value will presented.

Additional Calculation Options for Subsistence Flows

HEFR now has the option to calculate subsistence flow recommendations using Q95. Q95 is the 5^{th} percentile (95^{th} percent exceedence level) of the unseparated flow dataset. The calculations are performed both annually and seasonally. Q95 has been used (Acreman et al., 2006; Hardy et al., 2006) and/or discussed (BIO-WEST, 2008) in the literature and was considered by the Sabine-Neches BBEST.

Duration of Subsistence Flows

HEFR now presents summary statistics on events with flows less than or equal to the seasonal subsistence flow recommendations in sheet "SubsistenceDurations." These statistics are identical to the statistics presented for zero flow events (see above). These outputs are automatically generated and there is no user input required.

Regression Diagnostics

When the frequency method is used, HEFR now outputs (1) a figure showing regression residuals versus peak flows to examine potential biases and non-constant variance, and (2) a quantile-quantile plot of the residuals to allow for a comparison to normality. The intent of these figures is to assist the user in selecting reasonable regression forms (i.e., LN/LN or quadratic) and to highlight when/if the regression outputs provide a poor fit to the data and may need to be replaced with a custom analysis.

In common practice, the recommended high flow pulses are on the very low end of the volume versus peak flow and duration versus peak flow regressions. In such cases, while the regressions may fit the majority of the data satisfactorily, they may not fit the data in the area of interest, i.e., in the vicinity of the flow recommendations. It is strongly recommended that the user examine the regression model fits, particularly in the area of flow recommendations, and critically evaluate if such fits are satisfactory. Each regression chart will now have the x and y scales automatically set to the approximate vicinity of the associated flow recommendation to help the user inspect the regression fit.

As an aside, intermediate regression calculations have been deleted from HEFR in an attempt to reduce file sizes.

Bankfull Warning

In the HEFR input dialog box, the user can now input their best estimate of bankfull at their location. If the user does so and selects the frequency approach for episodic events, then HEFR will post a warning if the user selects an overbank event that is below bankfull or a high flow

pulse that is above bankfull. This warning will help eliminate such misidentification of flow recommendations.

The percentile approach for episodic events automatically specifies high flow pulses solely on events designated as high flow pulses in the hydrographic separation and likewise for overbank events, thus the percentile approach has not been susceptible to misidentification of flow recommendations.

Historical Frequencies of Episodic Events

When using the frequency approach for episodic events, HEFR has always generated a figure and table of the average historical frequency of events with different peak flow values. These average historical frequencies (e.g., "one per year") represent typical hydrologic characteristics at the location. However, some years will have no events of this magnitude and some years will have two or more. From a SB3 and permitting perspective, it can sometimes be useful to know a different set of historical frequencies, namely, the annual frequency of none of the "one per year" events, the annual frequency of exactly one of the "one per year" events, the annual frequency of exactly two of the "one per year" events, etc. HEFR now calculates such frequencies two different ways: (1) based on the number of events that equaled or exceeded all three characteristics of peak flow, duration, and volume, and (2) based on the number of events that equaled or exceeded just the peak flow.

It is important to recognize that these frequencies (which may be labeled "historical" frequencies or "attainment" frequencies) represent the annual and seasonal frequencies of the episodic events and do not necessarily equate to the frequency of achieving the stated average historical frequency. For example, if the user selects the "one per two seasons" event for the winter season, these new frequencies calculate the historical winter seasonal frequency at which events of that size (or larger) occurred, not the frequency of meeting a strict once every other winter season requirement.

Terminology Changes

The "Original, Percentile-based Approach" has been renamed the "Percentile Approach."

The "Alternate, Frequency-based Approach" has been renamed the "Frequency Approach."

The three levels of base flows have been named low, medium, and high (instead of dry, average, and wet). The terms dry, average, and wet will still apply to hydrologic conditions, where desired.

Planned Future Enhancements

Linkage to TCEQ-CRWR Workflow Package Trident

The Texas Commission on Environmental Quality (TCEQ) currently has a contract with the University of Texas Center for Research in Water Resources to develop hydrologic software tools that facilitate the electronic acquisition and analysis of data. A near term goal for HEFR (June 2010) is to add an option for HEFR to be run externally, likely via the workflow software Trident (a Microsoft package). This will facilitate model runs and also allow batch processing to efficiently analyze preliminary model runs at multiple gages. Batch processing is expected to be helpful to the Colorado-Lavaca BBEST.

The existing manual operation of HEFR will be maintained unchanged.

MBFIT

One minor bug fix has been added in the latest version of MBFIT (previously, if a gage went from zero flow on one day to a flow greater than the upper threshold for high flow pulses on the very next day, MBFIT returned an error; this did not occur in the Sabine, Neches, Trinity, or San Jacinto basins).

A new version of MBFIT that is more user friendly and less vulnerable to corruption would be beneficial to the SB 3 process. No functional changes are expected. A schedule for this task has not been identified.

References

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Hardy, T.B., C. Addley and E. Saraeva. 2006. Evaluation of Interim Instream Flow Needs in the lower Klamath River, Phase II, Final Report. Prepared for: U.S. Department of the Interior, Washington D.C. 229 pp.