Geomorphic/Sediment FRAMEWORK
Developed by the
Texas Water Development Board

I. Establish Existing and Historical Conditions at Gage Sites

Deliverable: The deliverable from this effort will be the development of a data package for each of the BBEST selected gages. This data package will include:

1. Channel bed material samples collected by TWDB in the vicinity of each BBEST selected gage,
2. Flow duration, flood flow and low flow frequency curves,
3. Historical rating curves developed from USGS streamflow measurements,
4. Limited USGS cross sections taken during the streamflow measurements, and
5. Additional cross-sections by TWDB depending on time and budget constraints, and
6. Plots of annual peak flow and if available annual peak stage for certain periods of record at each gage.

Objective: The objective of this work will be to establish the existing geomorphic and hydrologic conditions, and to identify if the existing hydrology represents a substantial departure from historical conditions at each of the BBEST selected gage locations.

<u>Narrative and Numerical Components</u>

The narrative and numerical components for each gage will provide the reader with the following:

1. The geographic description of the gage including a small map, amount of upstream drainage area, geologic features and land use upstream.
2. A plot and table of the bed material gradation curve as shown in Figure 1.
3. Plots of the flow frequency and flow duration curves. Flow frequency Low Flow Figure 2 and Flood flows Figure 3 and the flow duration curve will include data for the period of record used to develop the HEFR table, and proceeding data and/or data that occurred after the HEFR development period. Current channel bathymetry is best described by the recent hydrologic regime. If the BBEST chooses a historical period of record, efforts will be made to find data that describes the channel bathymetry during the selected time period.
4. The discharge measurements made by the USGS will be used to plot rating curves for each gaging station. The rating curves will be analyzed to determine whether channel aggradation or channel degradation is occurring. Figure 2 shows a typical rating curve where channel aggradation is occurring and Figure 3 depicts channel degradation.

5. Cross-section plots developed from USGS discharge measurements will be used to evaluate channel adjustments and these cross-sections will also be used to supplement the rating curve analysis. Channels that are significantly aggrading should show smaller flow area while channels that are degrading should show increased flow areas and lower channel thalwegs.
6. The annual peak stage and discharge plots are useful in identifying flow regime changes. Reservoirs and other infrastructure can sometimes lead to significant changes in annual peak flows and stages. This data can be useful in explaining geomorphic changes and in determining changes in frequency and duration of overbank flooding.

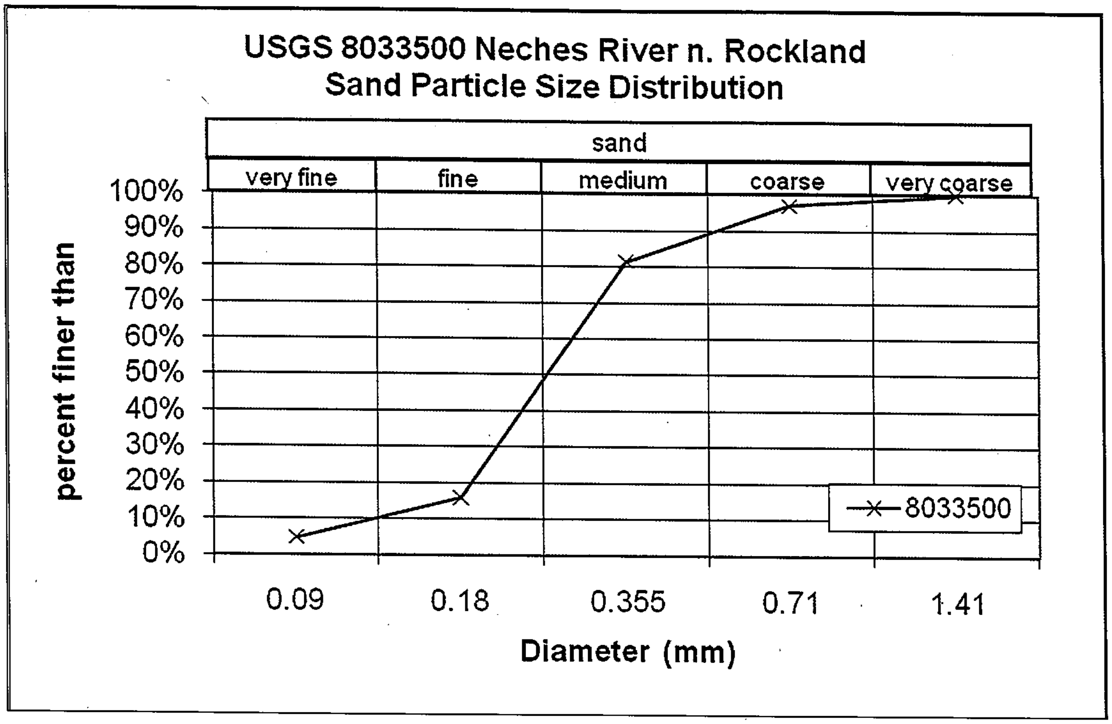

Figure 1 – Bed Material Gradation Curve

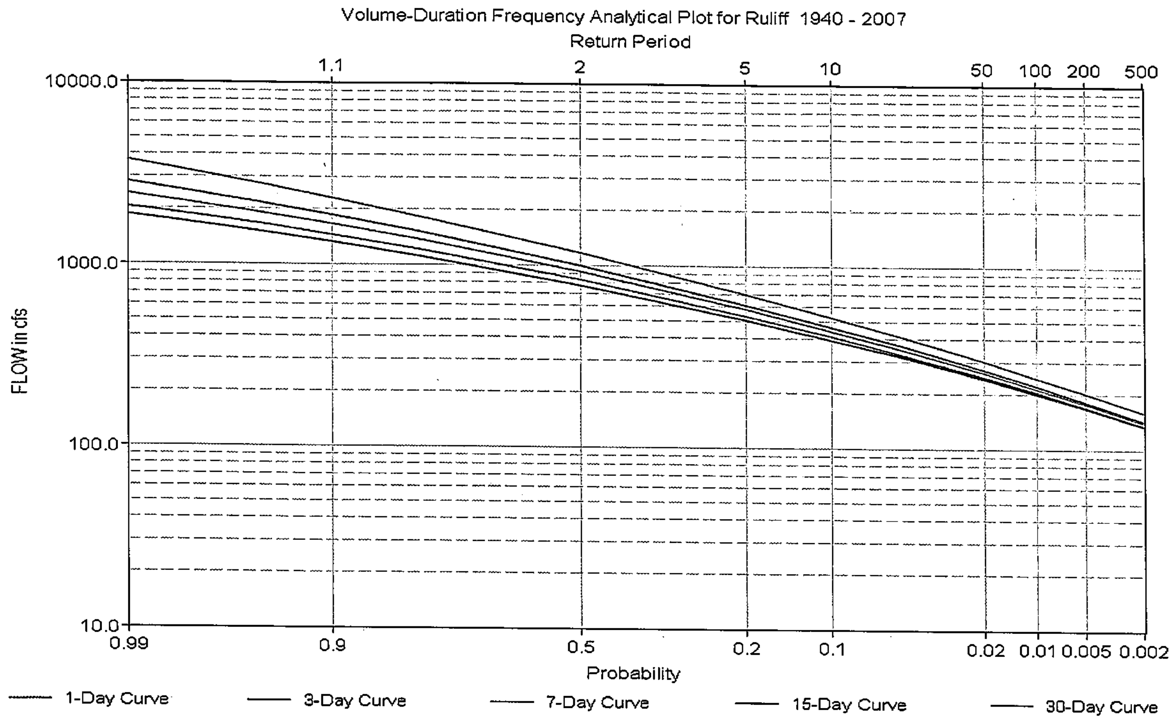

Figure 2 Low flow frequency curve

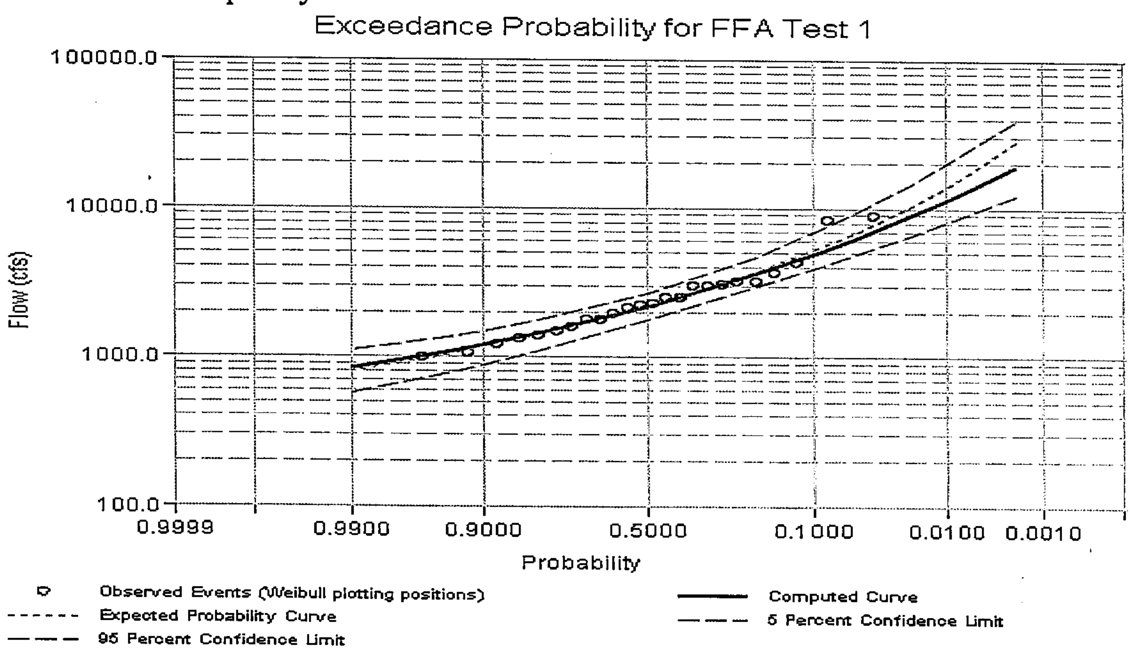

Figure 3 Flood flow frequency curve

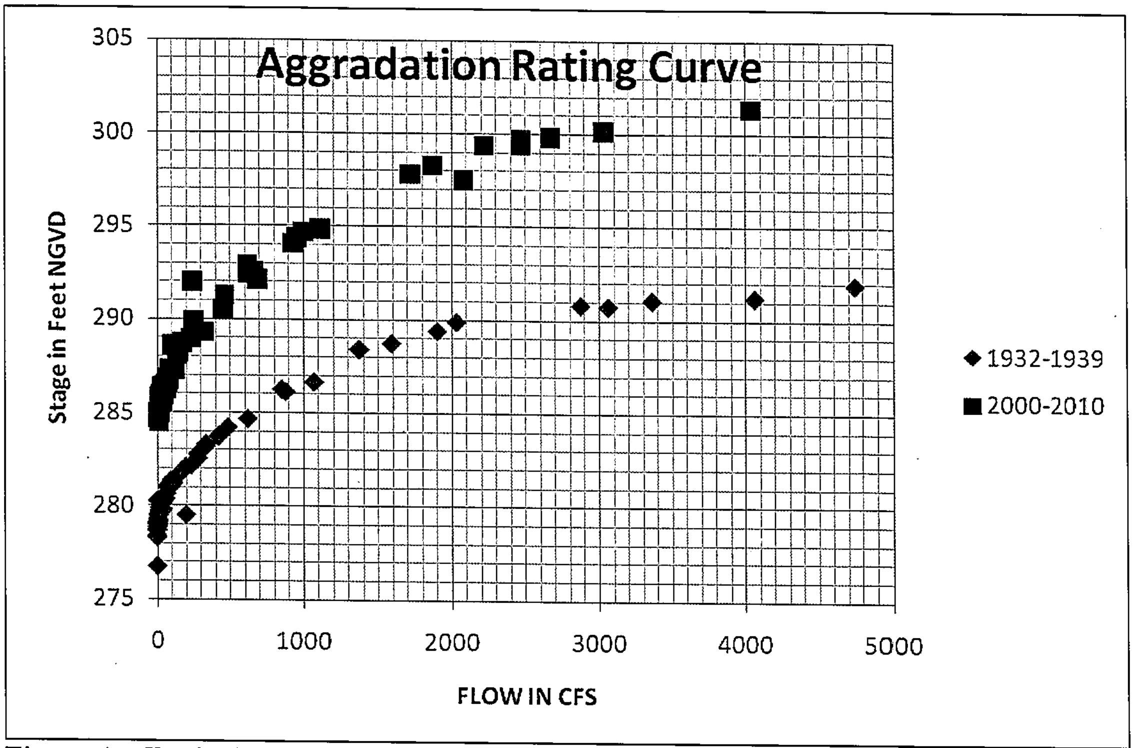

Figure 4 – Typical Channel Rating Curves for Aggrading Condition

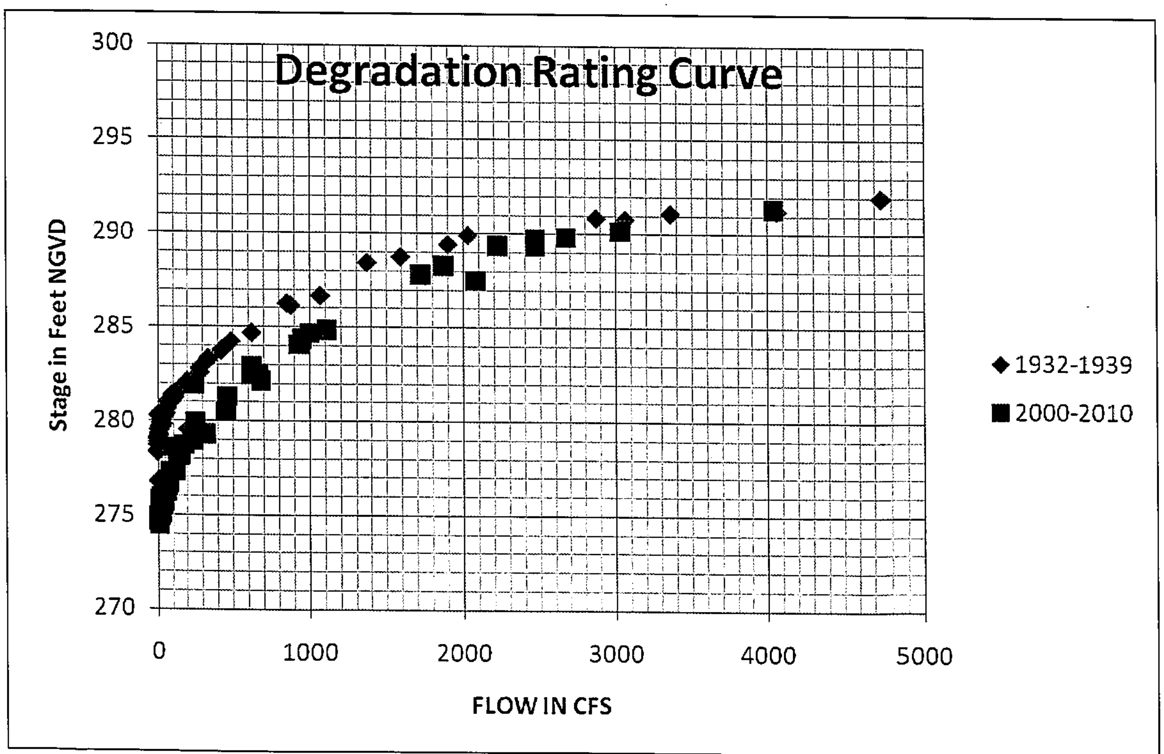

Figure 5 – Typical Channel Rating Curves for Degrading Condition

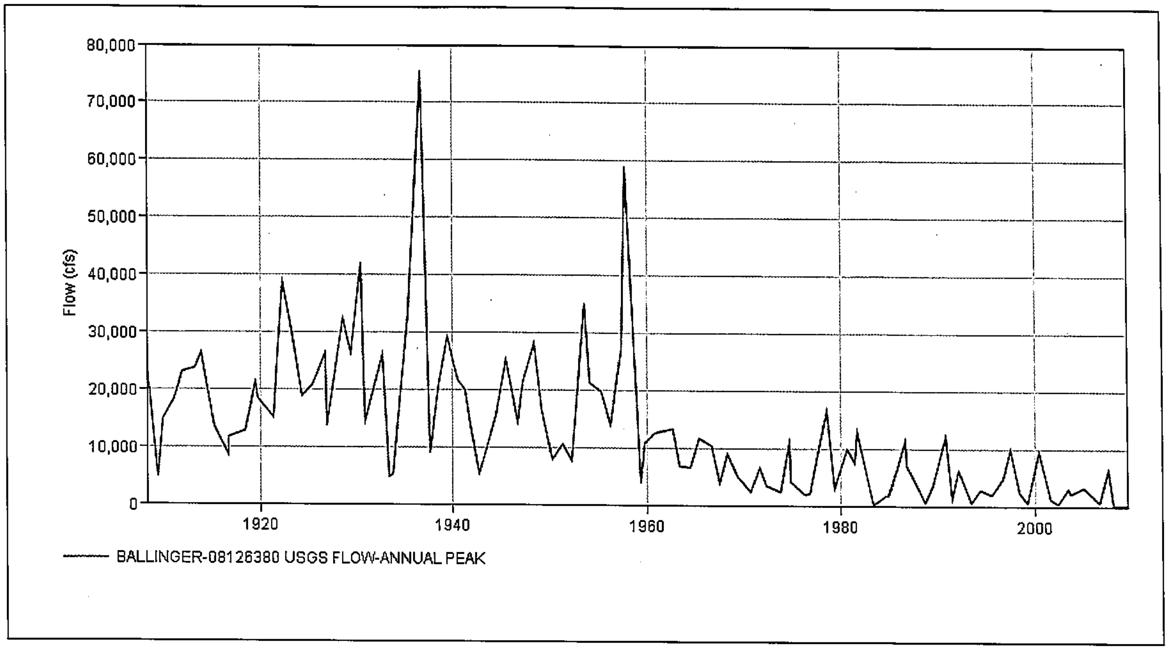

Figure 6 Annual Peak Flow Colorado River at Ballinger

II Establish Future Hydrologic Conditions at Gage Sites

Deliverable: The purpose of this work will be to develop the hydrology that will exist after the implementation of the HEFR regime. The period of record used in developing the HEFR regime will be adjusted to reflect the daily flows that would have existed if the HEFR flow regime had been in place. The new hydrology will be used to compute flow duration, flood flow and low flow frequency curves.

Objective: To follow the procedures described in the SAC guidance document entitled "Fluvial Sediment Transport as an Overlay to Instream Flow Recommendations For Environmental Flow Allocation Process," it is required that the period of record flows for the HEFR analysis be adjusted to reflect hydrologic conditions that would exist after the implementation of the HEFR flow regime. A number of procedures to develop the future condition flows have been proposed; however, to date a consensus has not emerged from these discussions. Therefore, the geomorphic framework document will be modified to include the BBEST guidance when such guidance becomes available. Determining how to adjust the existing hydrology to reflect an implemented HEFR flow regime is an area that needs additional discussions and how it impacts the Biological overlay, Nutrient and Water Quality overlay, and the Freshwater Inflows for the Estuaries overlay. For these reasons it definitely requires more input than could be provided in this document.

<u>Numerical Components</u>

The numerical component of this work will be to compute daily flows for the HEFR development period of record. The adjusted daily flows will then be used to develop flow duration curves and low and flood flow frequency curves.

III Development of the Geomorphic/Fluvial Sediment Transport for Overlay

Deliverable: The deliverable from this work effort will be a geomorphic/fluvial sediment transport package for each of the BBEST selected gages. This package will include tables and plots that show how the HEFR table implementation changes the flow duration and flow frequency curves, and most importantly will show that flow changes will change the computed effective discharge at each of the gage locations.

Objective: The objective of this will be to tie the historical, existing and future hydrologic and geomorphic conditions together. The use of the effective discharge computations as set out in the SAC guidance "Fluvial Sediment Transport as an Overlay to Instream Flow Recommendations for the Environmental Flows Allocation Process" allows the comparison of the effective discharge for the flow regime that was used in development of the HEFR table and the flow regime that is expected to exist after the flow HEFR flow regime is implemented. One very important concept to keep in mind is that if the existing channel does not display near dynamic equilibrium, such as would be the case for an actively incising channel-bed, then a computation of effective discharge does not describe the condition acceptable for conservation or restoration efforts.

<u>Numerical Components</u>
Effective discharge is the flow that cumulatively transports the majority of sediment, i.e. bed-material load, at a channel cross section over time (Figure 5). It is usually a flow of moderate magnitude and frequency. Although high-magnitude floods can transport substantial quantities of sediment, their relatively infrequent occurrence often is outpaced by the sediment transport of more frequent moderate flows (from SAC Guidance Document).

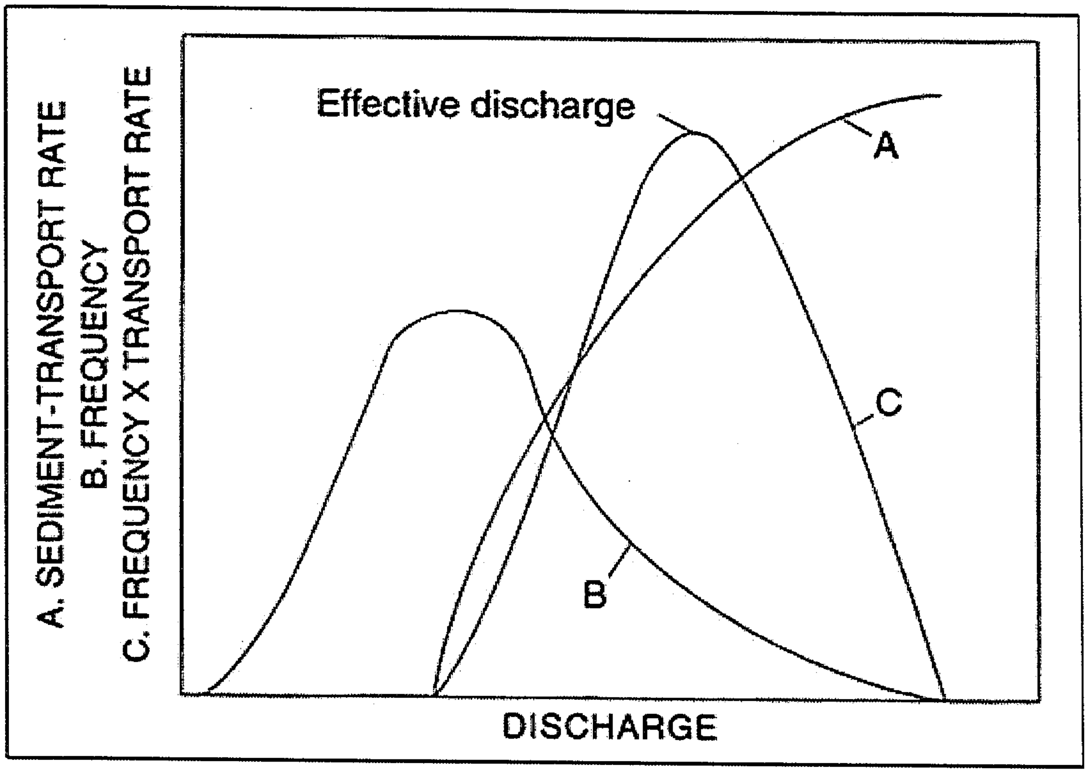

Figure 5. Effective discharge, in its graphical form, is the largest product of the sediment transport rate and the frequency of transport (from Wolman and Miller, 1960; scanned from Andrews and Nankervis, 1998). (From SAC Guidance Document)

Flow duration, low flow and flood frequency will be computed using the computer program HEC-SSP. HEC-SPP is the U.S. Army Corps of Engineers Statistical Software Package developed by the Hydrologic Engineering Center. This software allows you to perform statistical analyses of hydrologic data. The current version of HEC-SSP can perform flood flow frequency analysis based on Bulletin 17B, "Guidelines for Determining Flood Flow Frequency" (1982), a generalized frequency analysis on not only flow data but other hydrologic data as well, and a volume-duration frequency analysis on high and low flows.