PIMA COUNTY REGIONAL FLOOD CONTROL DISTRICT'S
TECHNICAL POLICY

POLICY NO: Technical Policy, TECH-033 **EFFECTIVE DATE:** August 1, 2013

POLICY NAME: Criteria for Two-Dimensional Modeling

PURPOSE: To standardize Two-Dimensional Modeling for hydrologic and /or hydraulic studies in Pima County, Arizona.

BACKGROUND: Two-Dimensional (2-D) flood routing modeling is typically used in those areas where flows are distributary and/or non-uniform and where the terrain is too complex to be modeled accurately by one-dimensional models designed for riverine floodplains. The changes in flow patterns associated with such runoff make it necessary to utilize 2-D models that react both to the terrain and hydraulic fluctuations through the duration of the flood hydrograph. A 2-D model can include rainfall and/or runoff modeling. This policy outlines the Pima County Regional Flood Control District's (District) standards for 2-D model submittals for watersheds less than 10 square miles.

POLICY:

Two-Dimensional (2-D) modeling reports submitted to the District for review shall adhere to the following procedures:

A. The report shall state the name and the version of the 2-D model used. Be aware some models and versions may not be acceptable for remapping a floodplain through the Federal Emergency Management Agency (FEMA). The 2-D model submitted to the District must be in a version the District is able to review.

B. Unless otherwise approved by the District the 2-D model and subsequent map products shall contain digitally projected data with the following projection control:

Projection = State Plane, Arizona Central Zone
Horizontal Datum = NAD83-92(HARN)
Units = International Feet
Vertical Datum NAVD-88

C. The digital elevation data shall be incorporated into the 2-D model using the following criteria:

1. The selected grid size must be able to capture the detail required for the project, and digital elevation data must be adequate to support the selected grid resolution. The engineer shall provide justification for the size of the grid elements. It is recommended the engineer discuss the grid element size with the District before conducting the study.

2. Two dimensional models allow for flow to spread out across the Digital Elevation Model (DEM). Therefore it is often necessary to extend the limits of the DEM upstream and downstream from the project site to allow for the natural expansion and contraction of the flow through the duration of the hydrograph.

3. An electronic copy of the DEM in ASCII format is to be supplied to the District if the data does not come from an accessible public source. If from a public source, the source shall be identified in the report.

D. Hydrology can be modeled with some 2-D modeling software although the software may limit the type of hydrologic methods used. When using 2-D software to perform hydrologic modeling, the following criteria shall be followed:

1. Watershed delineation may be difficult due to the distributary nature of the watershed. In addition to the DEM, the use of aerial photography, including historical aerial photography is recommended to discern watershed boundaries.

2. Modeling criteria shall follow District *Technical Policies TECH-010, TECH-015 and TECH-018.*

3. The rainfall values are not to be aerially-reduced unless approved otherwise by the District.

4. In order to reduce the size of or otherwise limit the upstream modeling extent of the 2-D model, hydrologic modeling of portions of the watershed upstream of the project may be accomplished by methods presented in *Technical Policy TECH-018*, and the resulting flood hydrograph may be input into the 2-D model as inflow hydrographs. Rainfall shall be added to the model downstream of inflow hydrographs, unless the engineer justifies that adding rainfall will not have any significant impact to the total inundation maps or the total flow volume. The rainfall distribution shall be the same as the design storm used to produce the inflow hydrograph. The following criteria shall be applied to create rainfall distribution for cases where PC-Hydro is used to create the inflow hydrographs:

a. When the watershed is less than one square mile, or results in a PC-Hydro time of concentration of less than one hour, the NOAA Atlas 14 Point Precipitation Values from the Upper 90% confidence limit values for the 5, 10, 15, 30 and 60 minute storms are to be used to create a rainfall distribution. These rainfall Intensity-Duration-Frequency (IDF) values are to be used with the peak intensity rainfall value centered in the Isohyetal graph for a total duration of one hour.

b. When the watershed modeled by PC-Hydro has a time of concentration of between one hour and two hours, the NOAA Atlas 14 Point Precipitation Values from the Upper 90% confidence limit values for the 5, 10, 15, 30, 60 and 120 minute storms are to be used to create a rainfall distribution. These rainfall

Intensity-Duration-Frequency (IDF) values are to be used with the peak intensity rainfall value centered in the Isohyetal graph for a total duration of two hours.

c. If other hydrological criteria are to be used other than that described above, the hydrological methodology is to be discussed with and approved by the District prior to report submittal.

5. Hydraulic modeling of 2-D models are to follow the following guidelines:

   a. Multiple runs may be necessary in dynamic distributary areas. Dynamic distributary areas are regions in which there is a greater chance of flow redistribution overtime. Dynamic distribution areas are subject to channel avulsion and sedimentation. Such areas may also be susceptible to debris changing the discharge distribution. Multiple floodplain models may be necessary to account for flow re-distribution. Multiple runs may include but are not necessarily limited to creating channel blockage (or levee) situations to force more flow into other paths, or increasing the discharge values along each flow path. The multiple runs are to be combined to create a map from the maximum depths, water surface elevations and flows. Careful examination of the site conditions, soils, historical aerial photography and hydraulic conditions are warranted prior to developing the flow variables. Consultation with District staff is recommended prior to mapping flows in active distributary areas.

   b. Hydraulic structures such as culverts, detention basins, levees, constructed channels or natural channels be modeled following the guidelines within the user's manual for the software program. The engineer is to provide a narrative description of the hydraulic structures modeled.

6. The output of a 2-D model is to include the following:

   a. The output data is to include:

      i. Maximum Flow Depth
      ii. Maximum Water Surface Elevation
      iii. Maximum Velocity
      iv. Peak Discharge

   b. Unique output data may be required depending on type of project. Such output data may include but is not necessarily limited to:

      i. Flow vectors
      ii. Momentum computations such as velocity times depth of flow or the square of the velocity times depth of flow
      iii. Duration of inundation

c. If floodplain cross sections are generated, the cross sections are to include peak discharge values which will be the summation of discharge values from grid cells across the cross section. When practicable, the placement of the cross section is to be perpendicular to the flow path as determined at the moment of maximum inundation.

7. Shape file data is required by the District with 2-D models. Data is to include:

   a. Separate grid shape files for:
      i. Grid identification
      ii. Ground elevation
      iii. Maximum flow depth from data output
      iv. Maximum water surface elevation from data output
      v. Maximum velocity from data output

   b. Unique shape file data may be required depending on type of project. Such output data may include but is not necessarily limited to:
      i. Flow vectors
      ii. Momentum data such as velocity times depth of flow or the square of the velocity times depth of flow
      iii. Duration of inundation

   c. When practicable, water surface contours generated from maximum water surface elevation data.

   d. The engineer is also to include point or line shape files for the hydraulic structures.

8. In addition to traditional hydrologic and hydraulic map products, reports submitted with 2-D models shall include paper and/or PDF map(s) with the grid elements shown with grid identification numbers. When hydrologic and hydraulic work maps are provided they shall be prepared in conformance with *District Standard DS-305.*

9. The report is to include the digital 2-D model input and output data on disk or portable hard drive.

APPROVED BY:

Suzanne Shields — 7/31/2013

Suzanne Shields, P.E.
Director and Chief Engineer

Date