C H A P T E R   14

Using GIS Data With HEC-RAS

HEC-RAS has the ability to import three-dimensional (3D) river schematic and cross section data created in a GIS or CADD system. While the HEC-RAS software only utilizes two-dimensional data during the computations, the three-dimensional information is used in the program for display purposes. After the user has completed a hydraulic analysis, the computed water surface profiles can be exported back to the GIS or CADD system for development and display of a flood inundation map.

The importing and exporting of GIS or CADD data is accomplished through the use of formatted ASCII text files. The text files provide a generic way of exchanging data between GIS/CADD systems and HEC-RAS, without adopting any single GIS/CADD system. **Appendix B of this manual provides a detailed description and examples of the file formats used for importing and exporting GIS or CADD data**.

The HEC has developed an ArcView GIS extension called GeoRAS, that was specifically designed to process geospatial data for use with HEC-RAS. The GeoRAS software allows a user to write geometric data to a file in the required format for HEC-RAS. Additionally, the users can read the HEC-RAS results into GeoRAS and perform the flood inundation mapping. This software is not part of the HEC-RAS program. The software and a user's manual are provided as a separate program to be used with ArcView. Also, the Intergraph Corporation has adding the capability to exchange data with HEC-RAS in their Software package called Storm and Sewer Works (Intergraph, 1999)

This chapter discusses how to import GIS or CADD data into HEC-RAS; what additional information will need to be added to complete the data; and how to export the results back to the GIS or CADD system.

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General Modeling Guidelines

The current version of HEC-RAS has the ability to import the following geometric data from a GIS/CADD system:

River System Schematic. The structure of the stream network as represented by a series of interconnected reaches. Each reach is represented as a multi-point line, which is assumed to follow the invert of the main channel. The River and Reach labels, as well as the Junction labels, are also imported from the GIS/CADD.

Cross Section Data. The following cross section data can be imported from a GIS/CADD:

1.   River, Reach, and River Station identifiers.

2.   Cross Section Cut Lines (X and Y coordinates of the plan-view line that represents the cross section). This is a multi-point line that can have two or more points.

3.   The cross section surface line. This line is sent to HEC-RAS as a series of X, Y, Z coordinates for each point in the cross section. HEC-RAS transforms these coordinates into station and elevation points (X and Y) for computational purposes. The first station of the cross section is always set to zero. The true (real world) coordinates of the cross section are recomputed from the cross section cut line for the purposes of displaying the data (3D plot).

4.   Cross section main channel bank stations.

5.   Downstream reach lengths for the left overbank, main channel, and right overbank.

6.   Manning's n values.

7.   Levee locations and elevations.

8.   Ineffective flow areas.

9.   Top of road station and elevation for bridges and culverts.

10.   Storage area boundaries and elevation versus volume relationship.

At this time, contraction and expansion coefficients, optional cross section properties (blocked obstructions, etc.), and hydraulic structure data (bridges, culverts, etc..) are not imported from a GIS/CADD system. Many of these variables will be added in future versions of the software.

The general procedure for utilizing GIS/CADD data with HEC-RAS is the following:

1.   The first step is to start a New Project. This is accomplished from the **File** menu of the main HEC-RAS window.

2.   The next step is to go to the Geometric Data editor and import the GIS/CADD data into HEC-RAS. GIS/CADD data are imported by selecting **Import Geomtric Data,** and then **GIS Format** from the **File** menu on the Geometric Data window. This is assuming that you have already used a GIS system to write the required geometry data into a text file, using the required HEC-RAS format. The format of this file is described in Appendix B of this manual.

3.   After the GIS data are imported, the user will need to add any additional geometric data that is needed to represent the physical system.

4.   The next step is to perform the water surface profile calculations for the desired flow rates.

5.   Once the water surface profiles are calculated, the user can then output the results to a text file using the **Export GIS Data** option from the **File** menu of the main HEC-RAS window.

6.   The last step is to import the HEC-RAS results file into the GIS/CADD system and develop the floodplain maps for each of the profiles.

Once the user has a project that is utilizing GIS data, then additional data can be imported directly into an existing HEC-RAS geometry file without starting a new project. This allows the user to go back to the GIS and extract additional cross sections on an as-needed basis. The HEC-RAS program will automatically place the new cross sections into the appropriate River and Reach, based on the identifiers defined for each cross section in the GIS import file.

After the user has performed the hydraulic analyses, the computed water surface profiles information can be written to a text file, which can then be imported into the GIS for development and display of floodplain maps. HEC-RAS exports the cross section Cut Line coordinates (X and Y), as well as the water surface elevation for each profile. This is done for every cross section in the model. Additionally, the program exports a series of bounding polygons (one per river reach) for each computed profile.   For information on the HEC-RAS GIS export file format, review the detailed write up found in Appendix B of this manual.

Importing GIS or CADD Data Into HEC-RAS

Within HEC-RAS, GIS data are imported from the Geometric Data Window. To import geometric data from a GIS/CADD system into HEC-RAS, the following steps should be followed:

1. The first step is to extract the necessary geometric information from a GIS/CADD system and write it to a text file in the required HEC-RAS format. As mentioned previously, HEC has developed an ArcView GIS extension called GeoRAS to help you do this. Likewise, the Intergraph Corporation has added this capability to their program called Stream and Storm Works. You have the option of obtaining the GeoRAS software from HEC (for use in ArcView); using the software developed by Intergraph; or developing your own routines to extract this data from the GIS/CADD system of your choice. The file formats for the required text file are outlined in Appendix B of this manual.

2. The next step is to start a new project in HEC-RAS. This is accomplished by selecting the **New Project** option from the **File** menu of the main HEC-RAS window. This option will allow the user to enter a project title and filename.

3. After a new project is started, the user should open the Geometric Data Editor. Once the editor is opened, the user can import GIS/CADD data into HEC-RAS by selecting the **Import Geometry Data - GIS Format** option from the **File** menu of the Geometric Data window. When this option is selected, a window will appear (Figure 14.1) in which the user can select the file that contains the geometry data from the GIS.
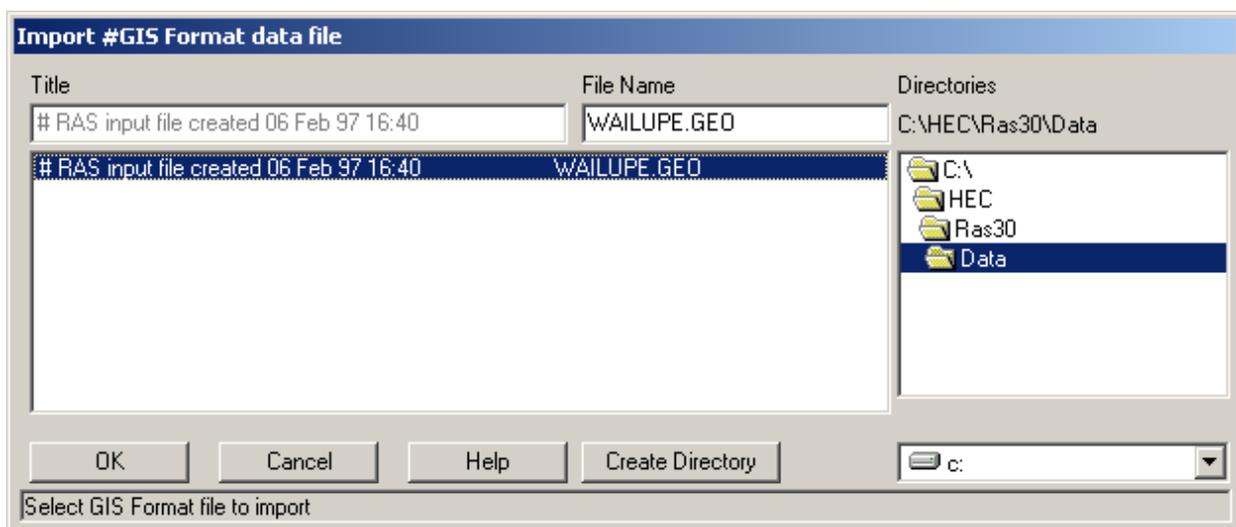

Figure 14.1 Window for Selecting GIS Data File To Import

4.   Once the user selects the file containing the GIS data, and then presses the **OK** button, a window will appear that will show you what is available within the import file, and it will allow you to select what you want to import (Figure 14.2)
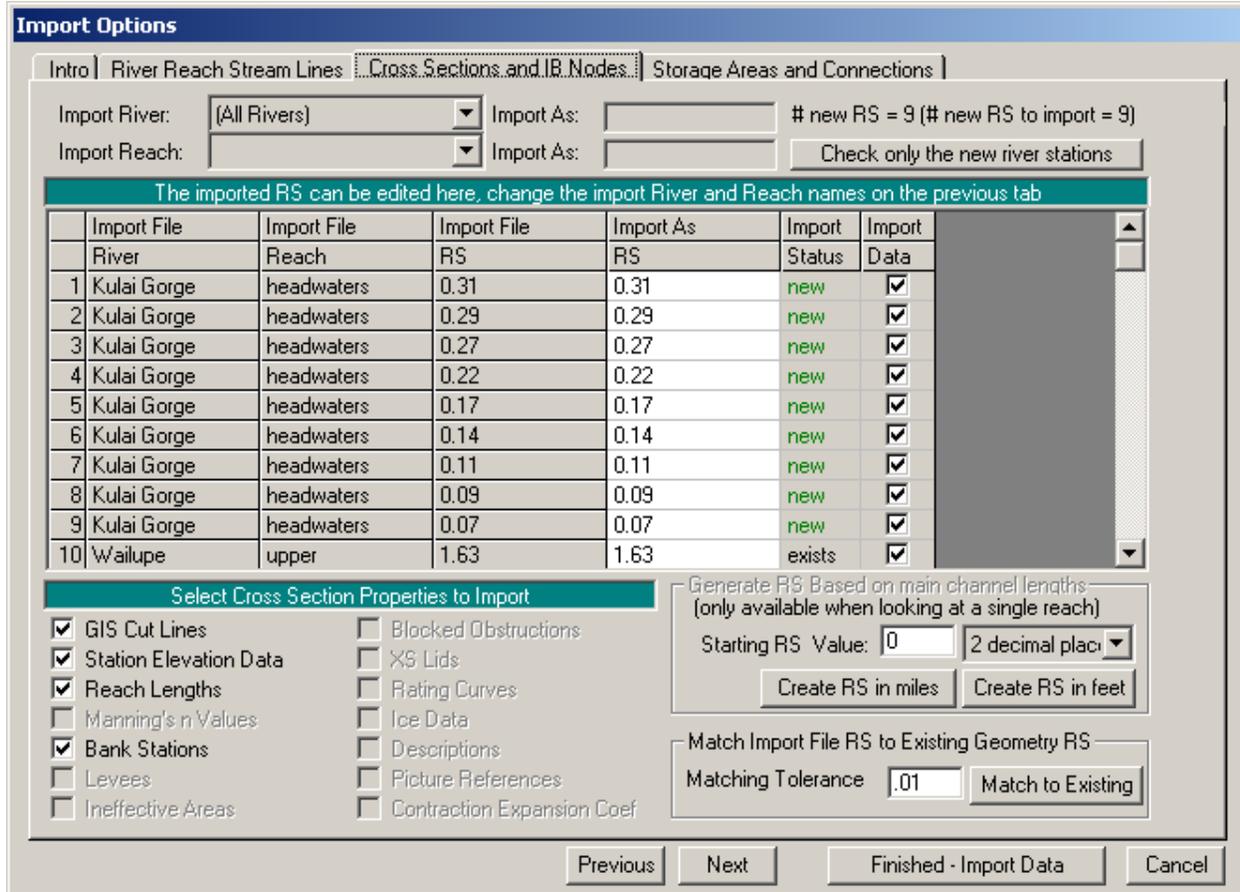
Figure 14.2 GIS Data Import Options Window

As shown in Figure 14.2, the user has several options when importing GIS data. There are four tabs at the top of the window. The first tab is just an introductory tab that explains how to proceed. The second tab **River Reach Steam Lines**, allows the user to select which reaches found in the import file will be imported. The next tab, **Cross Sections and IB Nodes**, allows the user to select which cross sections and internal boundaries (bridges and culverts) will be imported, as well as what specific cross section properties to import. The final tab, **Storage Areas and Connections** allows the user to select which storage areas and connections between storage areas to import.

After making the selections of what to import, The user presses the **Finished – Import** Data button. The data will be imported and a schematic of the river system will show up in the Geometric Data window (Figure 14.3). Once the importing of the data is completed, the user should save the geometric data by selecting **Save Geometry Data As** from the **File** menu of the Geometric Data window.
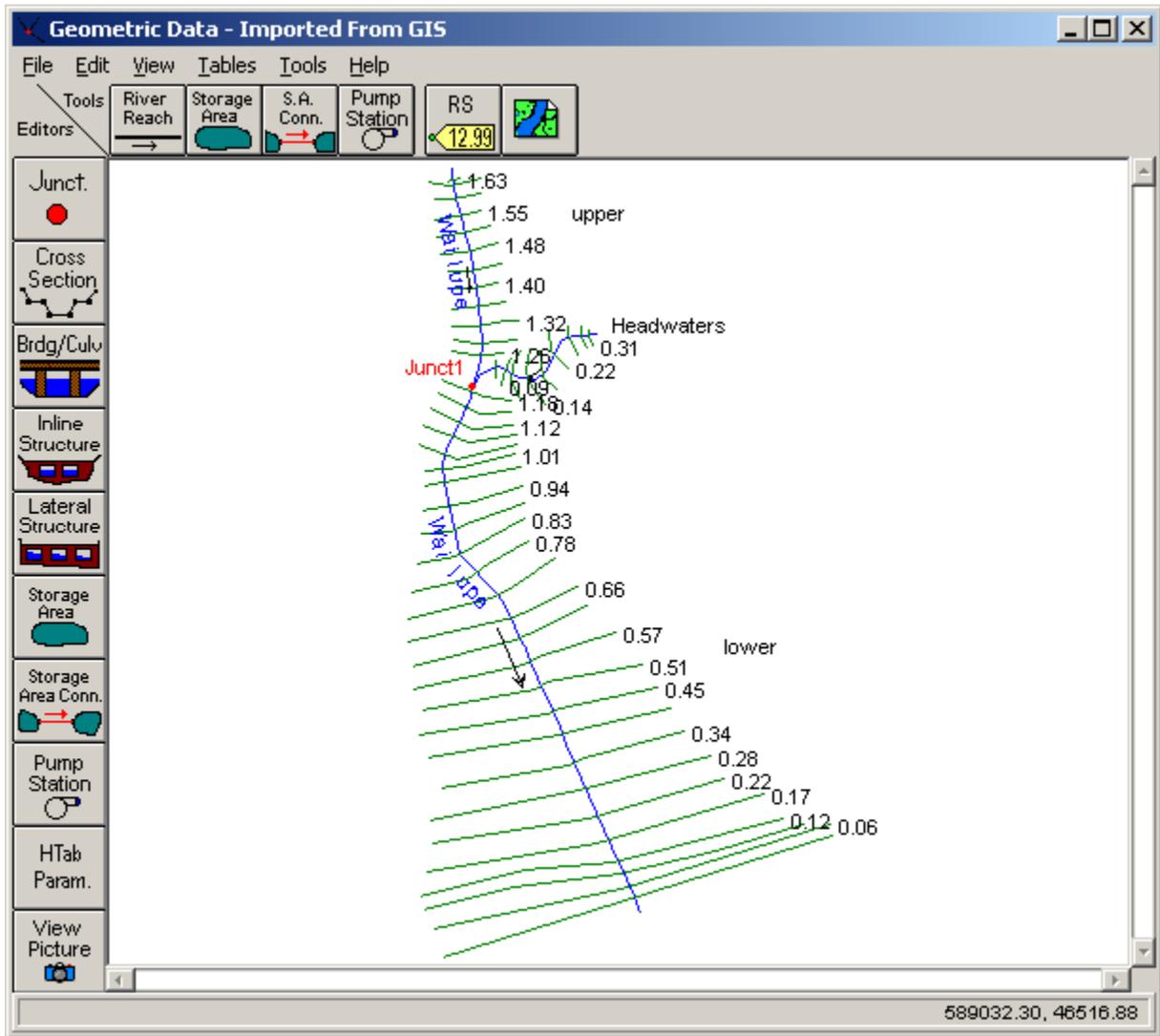
Figure 14.3 River System Schematic of Imported GIS Data

Completing The Data and Performing The Computations

Completing The Geometric Data

Once the user has imported the geometric data from a GIS/CADD system, the next step is to add any additional data required to perform the analyses. Depending on what data was extracted from the GIS (i.e. if n-values were not extracted from the GIS), the user may be required to enter Manning's n values for all of the cross sections. Manning's n values can be entered directly from the cross section data editor (on a cross section by cross section basis) or through the **Manning's n-values** table (this is the preferred way because the n values can be entered more efficiently). The Manning's n value table is available from the **Tables** menu on the Geometric Data window.

In addition to the Manning's n values, the user may need to enter the following data to complete the geometry file: additional user entered cross-section data; interpolated cross sections; optional cross section properties (ineffective flow areas, levees, blocked obstructions, etc.); and hydraulic structures (bridges, culverts, weirs and spillways).

Entering Additional Cross Section Data

If additional cross sections are entered by the user from the cross section editor (or through the HEC-2 import feature), the user will need to enter the coordinates of the cross section strike line in order to maintain a geospatially correct schematic and XYZ plot. The cross section strike line coordinates can be entered by selecting **XS Schematic Lines** from the **Edit** menu on the Geometric Data window. When this option is selected a window will appear as show in Figure 14.4.
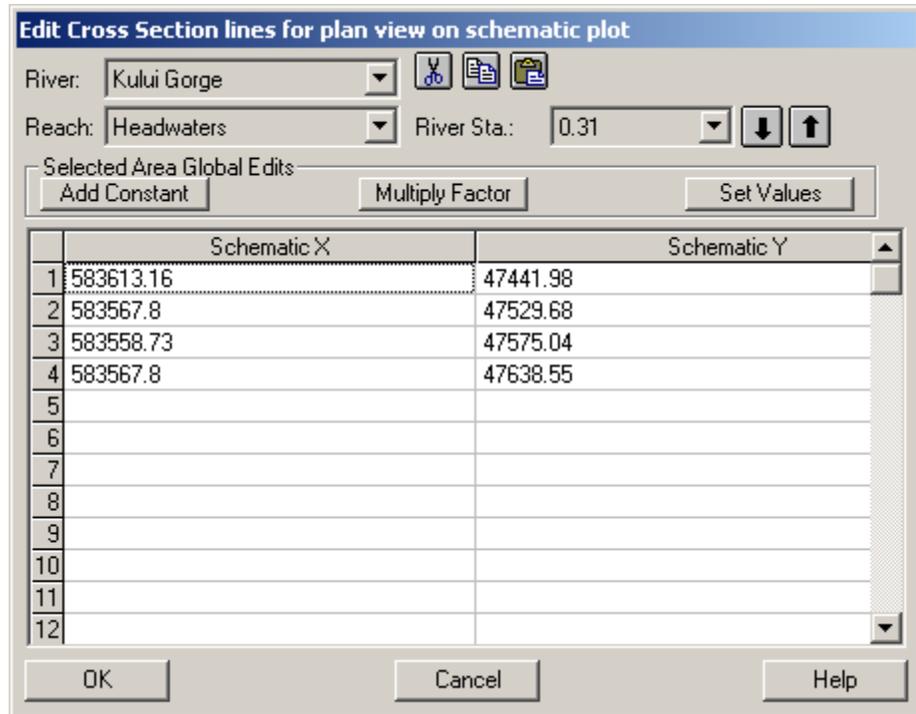
Figure 14.4 Cross Section Schematic Line X and Y Coordinates

The coordinates that are entered for the cross section schematic lines must be consistent with the previously entered GIS data (i.e., if the GIS data is in state plane coordinates, then the user entered data must also be in state plane coordinates). Once all of the cross section schematic lines have consistent coordinates, the schematic and XYZ plot will provide a geospatially correct display of the cross sections.

Performing The Computations and Viewing Results

Once the user has completed the geometric data file, flow data can be entered and the computations can be performed. When utilizing GIS data, there are no special requirements for entering flow data or performing the computations. Once the hydraulic computations are completed, the user can begin to review the output. When GIS data are utilized, the HEC-RAS XYZ perspective plot has the ability to plot a true three dimensional perspective of the river system and the water surface profiles. An example XYZ plot with GIS data is shown in Figure 14.5.
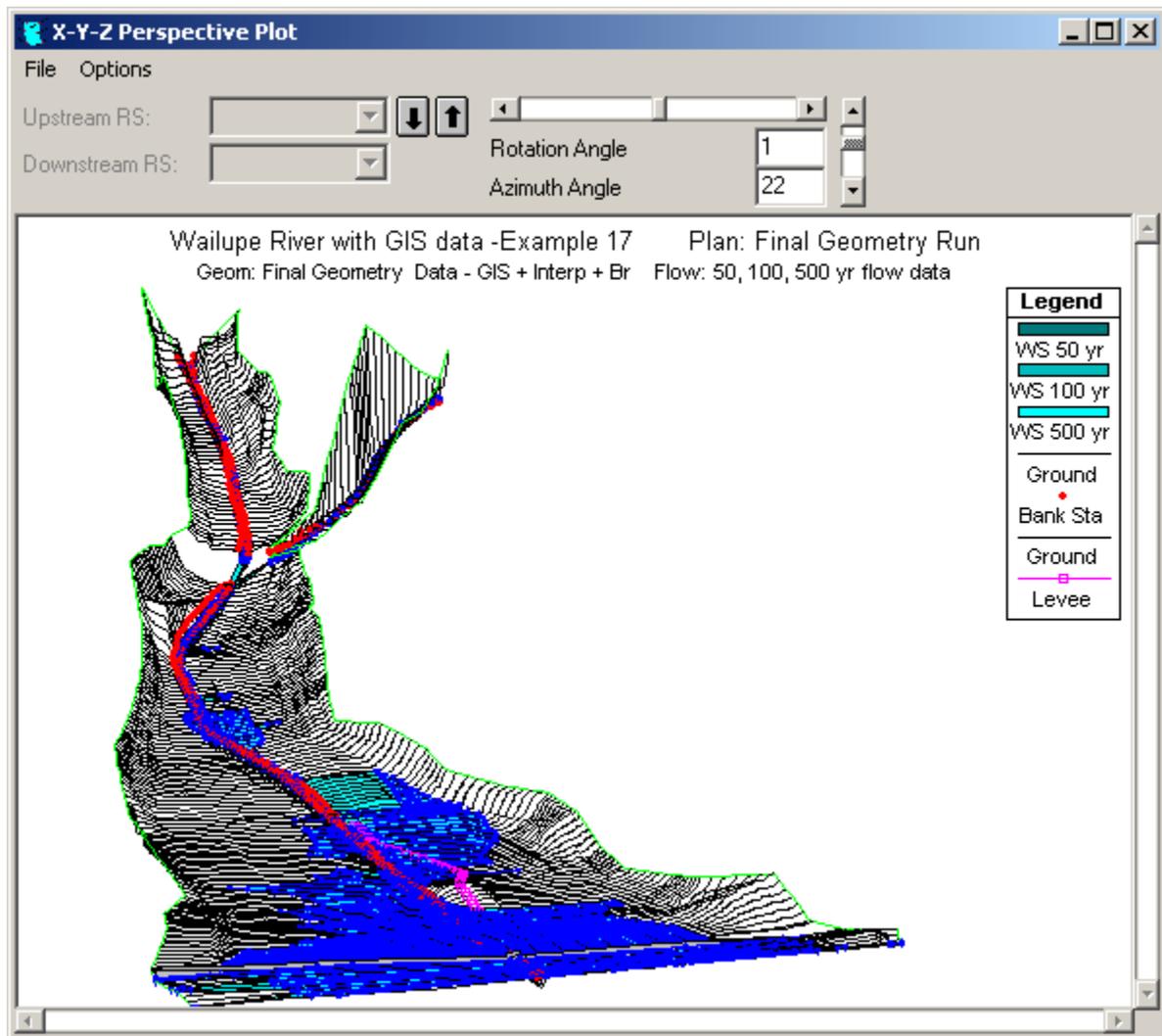

Figure 14.5 XYZ Perspective Plot With GIS Data

Exporting Computed Results To The GIS or CADD

Once the user has completed all of the hydraulic calculations, the computed water surface profiles can be exported to the GIS/CADD in order to develop floodplain maps. The HEC-RAS results are exported to an ASCII text file, which can then be imported by the GIS/CADD system. The format of the HEC-RAS results file is documented in Appendix B of this manual.

Exporting the HEC-RAS computed water surface profiles to a GIS/CADD system is accomplished by selecting **Export GIS Data** from the **File** menu on the main HEC-RAS window. Once this option is selected, a window will appear as shown in Figure 14.6.
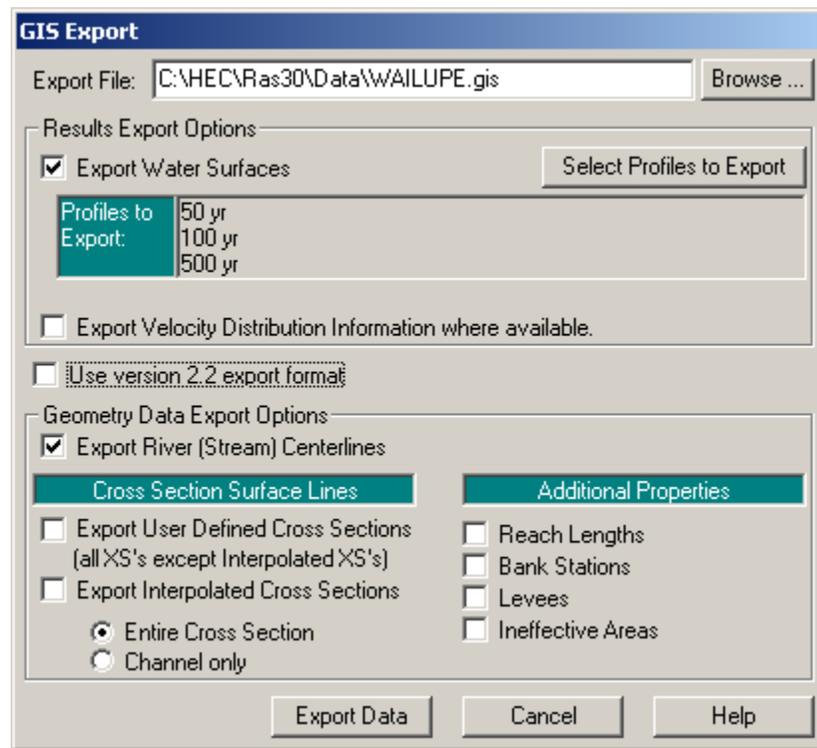
**Figure 14.6   Window to Enter a Filename For Exporting
                        Results to GIS**

As shown in Figure 14.6, the user first enters a filename for the HEC-RAS Export file. Next, the user can select what they would like to export. Normally the user would select "Export Water Surfaces," and then select which profiles to export by using the **Select Profiles to Export** button. Once these options are selected, the information can be exported by pressing the **Export Data** button.

Additional options are available to export geometry data from HEC-RAS to the GIS/CADD system. This option can be very useful for supplementing terrain data with additional surveyed cross sections. It is a common occurrence for terrain models to have good information in the overbank areas,

but not as good, if at all, in the main channel. HEC-RAS allows the user to export the entire cross section, or just the main channel portion only. Also, the user can send all cross sections, including interpolated sections, or they can turn off the interpolated cross sections. Additionally, there are options to send reach lengths, bank stations, levees, and ineffective flow areas to the GIS system.

In order to use the feature of sending terrain data from HEC-RAS to the GIS, the user must enter geospatial coordinates for all of the cross sections, and the stream centerline before exporting the data. These coordinates are required in order to correctly locate the data spatially within the terrain model.