

C H A P T E R 5

Developing the HEC-RAS Import File

The HEC-RAS Import File consists of geometric attribute data necessary to perform hydraulic computations in HEC-RAS. The import file is developed from an existing Digital Terrain Model (DTM) of the channel and surrounding land surface. Geometric data are extracted from the DTM by locating the points of intersection of the RAS Coverages with the DTM. Currently, a triangulated irregular network (TIN) is the only supported type of DTM.

RAS Coverages created by the user include coverages for the Main Channel Invert, Main Channel Banks (*optional*), Flow Paths (*optional*), and Cross Section Cut Lines. Data extracted from the DTM and RAS Coverages form an import file which contains: river, reach, and station identifiers; cross section cut lines; cross section surface lines; cross section main channel bank stations; and downstream reach lengths for the left overbank, main channel, and right overbank.

At this time, channel and overbank roughness coefficients, hydraulic structure data, and optional cross-section properties such as levees and ineffective flow areas are not written to the import file.

Chapter 5 discusses the steps in developing the HEC-RAS Import File.

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Digital Terrain Model

HEC-GeoRAS requires an existing DTM from which the geometric data will be extracted. Currently, a TIN representation must be used for the DTM. The DTM must be representative of both the land surface of the surrounding floodplain and channel bottom.

Developing a hydraulic model begins with an accurate geometric description of the surrounding landform, especially the channel geometry. Channel geometry will dominate flow in river systems; therefore, **only DTMs describing channel geometry with a high resolution should be considered to perform hydraulic analysis**. Further, RAS Coverages should be created with thoughtful evaluation of the hydraulics as governed by the terrain.

Creating a Contour Coverage

Before creating a Contour Coverage, select the DTM using the browsing button or right clicking over the *Digital Terrain Model* field and selecting from the popup list. Create a Contour Coverage from the DTM by selecting **Create Contour Coverage** from the **RASPrep** menu on the project manager. Enter the name of the *Contour Coverage* and *Contour Interval* in the form that appears (see Figure 5.1). The contouring interval should be selected based on the definition of the DTM. Contouring interval units are read from the DTM header and displayed below the *Contour Interval* field.

It should only take a few minutes to create the Contour Coverage depending on the *Contour Interval* and number of points in the DTM. The Contour Coverage is used to establish the geographic limits for creating new coverages and to visually aid the user in properly drawing the RAS Coverages. The Contour Coverage is not used for data extraction.

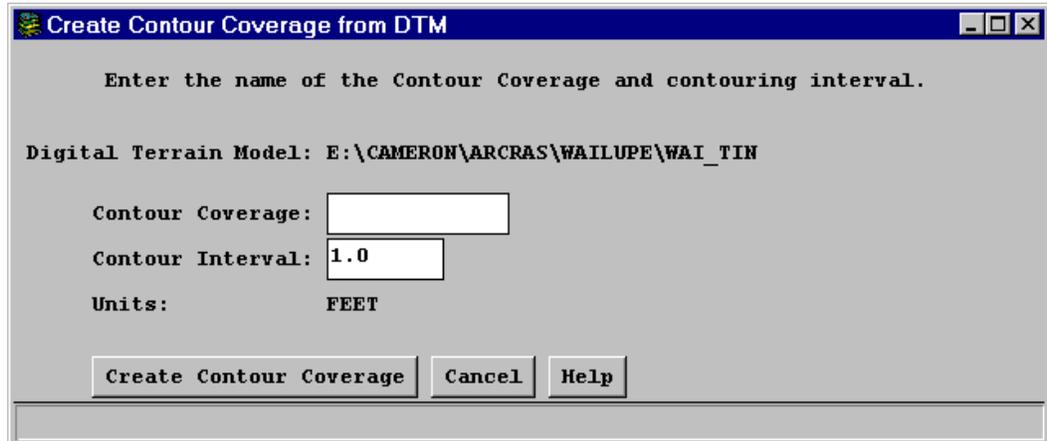


Figure 5.1 Create contour coverage window

Creating and Editing RAS Coverages

Throughout this manual, the coverages used for extracting geometric attribute data from the DTM are collectively referred to as RAS Coverages. The RAS Coverages are created by drawing arcs (lines) which represent the geometric data needed to create a HEC-RAS model. The four RAS coverages are the Main Channel Invert, Main Channel Banks (*optional*), Flow Paths (*optional*), and Cross Section Cut Lines.

Creating and editing the RAS Coverages is accomplished in ARCEDIT using the Edit RAS Coverages window. The editing environment is accessed from the project menu by selecting **Create/Edit RAS Coverages** from the **RASPrep** menu. An editing window will appear to the right of the Edit RAS Coverages window. The windows may be moved, and the editing window may be sized to the users preference.

To import existing coverages, select them from the project manager before accessing the coverage editing environment. The coverages will be imported into the editing environment as each coverage is selected for editing.

Coverage Editor

The Edit RAS Coverages window is organized by function. A menu bar at the top of the window provides access to the File and Help menus. The upper portion of the window allows the user to select the type of coverage to be edited and displays the entire pathname for the current edit coverage. The middle portion of the edit window provides the user with tools for editing the RAS Coverages. The bottom portion of the window allows the user to display background coverages when editing a coverage. Editing options are shown in Figure 5.2.

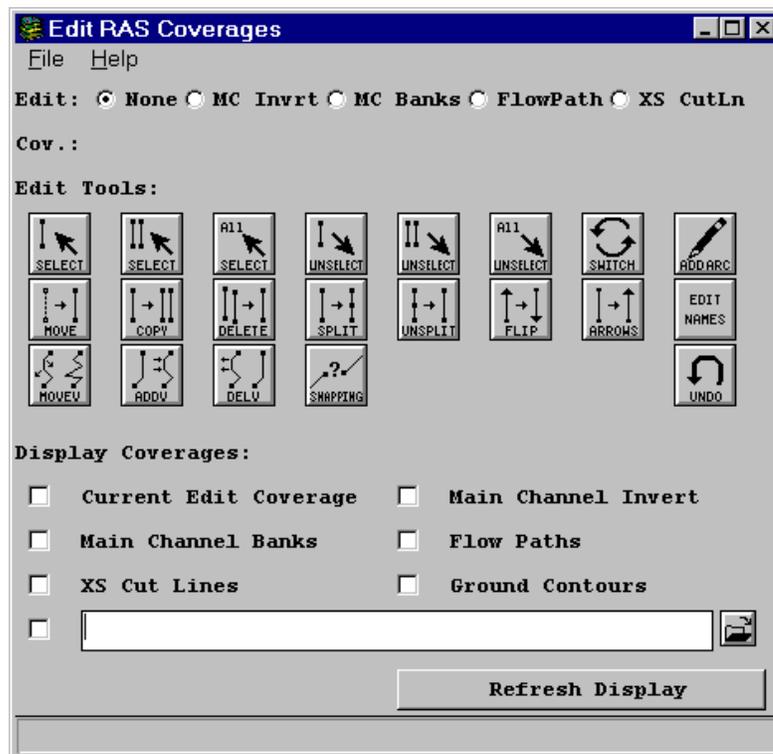


Figure 5.2 Edit RAS Coverages window

Managing Coverages

Coverages are managed in the edit environment under the File menu, the *Edit* type choices, and the *Cov.* display field.

New, Open, Save, and Save As options are available from the File menu option and cannot be used until a *Edit* type is chosen. The Command Line option and Exit are available under the File menu, as well.

New: Creates a new coverage of the *Edit* type selected. A message box will allow the user to input the new coverage name. If the name conflicts with an existing coverage, the user will be prompted to overwrite the existing coverage. The coverage will be created in the default directory if the entire pathname is not given.

Open: Opens an existing coverage. The coverage is opened as the current *Edit* type.

Save: Saves the current edit coverage. Operations are also performed on the edit coverage which create nodes at intersecting arcs. Dangling arcs are created when an intersection is created and an arc overshoots the intersecting node. Dangling arcs should be removed from the Main Channel Invert Coverage.

Save As: Saves the current edit coverage with the new name entered. If the name is in conflict with an existing coverage, the user will be prompted to overwrite the existing coverage. The coverage will be saved in the default directory if an entire pathname is not given.

Command Line: Allows the user to provide line commands at the ARCEDIT prompt. Type &RETURN to return to the user interface. *This option should only be used by experienced ARC/INFO users.*

Exit: Quits from the editing environment and returns the user to the project manager.

The Help menu allows the user to access online help using the Help and ArcDoc options.

Help: Results in the display of a popup window with an ascii help file specific to the editing window.

ArcDoc: Activates the ARC/INFO online help document.

Edit: Allows the user to select the RAS Coverage type to edit. If no coverage has been entered in the corresponding text field on the project manager, a new coverage of the *Edit* type will be created. If the coverage has been entered, it will be loaded as the current edit coverage and drawn in the editing window at the full extent of the coverage.

Cov.: Displays the pathname of the current edit coverage.

Edit Tools

The edit tools allow the user to create and edit the RAS Coverages using a mouse. The edit coverage is displayed in black, while the currently selected arcs are displayed in magenta. The following edit options are available:



SELECT One: Selects one arc to be edited. Use the left mouse button to select an arc. Select an arc before performing edits such as COPY, DELETE, MOVE, etc ...



SELECT Many: Selects many arcs to be edited. Use the left mouse button to select arc. When finished selecting arcs press, Ctrl + right mouse button to exit.



SELECT All: Selects all the arcs in the edit coverage.



UNSELECT One: Unselects one arc. Use the left mouse button to unselect an arc.



UNSELECT Many: Unselects many arcs. Use the left mouse button to unselect arcs. When finished unselecting arcs press, Ctrl + right mouse button to exit.



UNSELECT All: Unselects all the arcs in the edit coverage.



SWITCH: Switches the selection. Unselected arcs are selected as selected arcs are unselected.



ADD ARC: Adds an arc. The right mouse button begins and ends an arc by drawing a node. The left mouse button draws a vertex. An arc must be composed of at least two nodes: a FROM node and a TO node. Press Ctrl + right mouse button when finished. Arcs may contain no more than 500 points (498 vertices and 2 nodes).



MOVE: Moves the selected arc(s). Use the left mouse button to drag and drop the selection.



COPY: Copies the selected arc(s). The selection is copied parallel at the position indicated by the cross-hairs by pressing the left mouse button.



DELETE: Deletes the selected arc(s).



SPLIT: Splits the selected arc into two arcs by placing a node at the selected location.



UNSPLIT: Combines two arcs into one by removing a shared node. If this option does not combine the arcs, zoom in and check that the nodes lie on top of each other (share the same point). If the nodes do not share the same point, use the **MOVEVertex** option to snap the nodes to the same point.



FLIP: Reverse the direction of the selected arc(s) by reversing the FROM and TO nodes. Use the **ARROWS** option to determine arc orientation.



ARROWS : Indicates the direction the arc was constructed by placing an arrow in the direction of the TO node.



EDIT NAMES: Edits the river and reach name of the selected arc. River reaches will be labeled and cross-hairs will appear to allow the user to select the reach to edit. The window shown in Figure 5.3 appears, after selecting a river reach. River and reach names must be 16 characters long or less. Reach names on the same river must be unique. The **?** button provides a list of previously used river names which may be selected. **OK** accepts the entered names, dismisses the window, and saves the edit coverage. **Cancel** dismisses the window without changing the names.

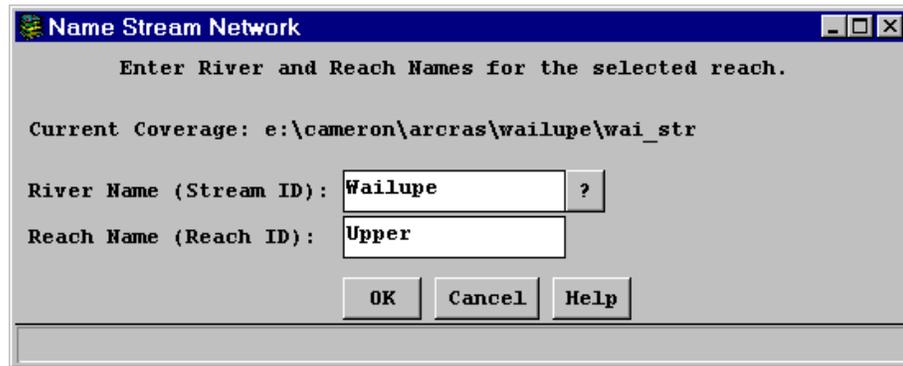


Figure 5.3 Stream network editing window



MOVEVertex: Moves a vertex on the selected arc. Select a vertex by placing the cross-hairs over a vertex and pressing the left mouse button. Move the cross-hairs to the new location and press the left mouse button a second time. The cross-hairs will remain on the editing window allowing the user to continue to move vertices. If trouble is encountered, zoom in on the vertex so that the exact location of the vertex may more easily be selected. Press the right mouse button when finished moving vertices.



ADDVertex: Adds a vertex to the selected arc. Place the cross-hairs over the location to add a vertex and press the left mouse button. Cross-hairs will remain allowing the user to continue to add vertices. Press the right mouse button when finished adding vertices.



DELETEVertex: Deletes a vertex from the selected arc. Place the cross-hairs over the vertex and press the left mouse button. This option will also delete a node making the vertex on the end the new node. However, if an node is on top of a vertex the user must delete both the node and vertex. Cross-hairs will remain, allowing the user to continue to delete vertices. Press the right mouse button when finished deleting vertices.



SNAPPING: Sets the node snap environment. This option will invoke the node snap environment window shown in Figure 5.4. The snapping tolerance determines the distance between nodes before they will snap when drawing *new* arcs (or moving nodes and arcs) and is shown in the units taken from the DTM header. The * button allows the user to set the snapping tolerance visually in the editing window. Node snapping may be turned on or off. The default is ON with the snapping tolerance set to 1/1,000 of the width or height, whichever is greatest, of the current edit

coverage. Press **OK** to dismiss the window with the current node snap environment.



Figure 5.4 Node Snap Environment window

The node snap tolerance will determine the minimum allowable distance between two nodes. When a coverage is saved, any vertices or nodes that are separated by less than the snap tolerance will snap together, altering the construction of the corresponding arc.



UNDO: Undoes the last edit. Undo keeps track of the edits since the coverage was last saved. Undo will not work with the EDIT NAMES option.

Display Coverages

To aid the user in creating and editing the Edit Coverage, coverages may be displayed in the background of the editing window by selecting the corresponding checkbox. The empty input field allows the user to select a background coverage other than the Contour Coverage and RAS Coverages. At this time, the background coverage must be a line coverage. Each coverage is displayed in a unique color as summarized below.

Coverage	Color
Current Edit Coverage	Black
Main Channel Invert	Blue
Bank Stations	Red
XS Cut Lines	Green
Overbank Flow Paths	Blue
Ground Contours	Grey

Coverage	Color
Background Coverage	Orange

Refresh Display: Redraws the editing window, displaying the coverages corresponding to the depressed checkboxes. Maintains the current extent and position of the of the editing window.

Editing Window

There are several options available from the Pan/Zoom menu on the editing window, shown in Figure 5.5 will be displayed. The pan and zoom options may be used in the middle of a editing operation such as ADD ARC. After execution of a menu option the editing window will be redrawn. The Pan/Zoom menu options are described below:

Pan/Zoom	
<u>C</u> reate	Ctrl+w
<u>P</u> an	Ctrl+a
Z <u>o</u> om <u>I</u> n	Ctrl+v
Z <u>o</u> om <u>O</u> ut	Ctrl+x
Z <u>o</u> om <u>I</u> n Center	Ctrl+i
Z <u>o</u> om <u>O</u> ut Center	Ctrl+o
<u>E</u> xtent	Ctrl+e
<u>G</u> et Extent	Ctrl+g
<u>F</u> ullview	Ctrl+f
<u>S</u> cale 1:1	Ctrl+t
<u>R</u> edisplay	Ctrl+r

Figure 5.5 Pan/Zoom menu options

Create: Creates another window using the extent provided by the user. Use the left mouse button to select opposite corners of the extent to be created.

Pan: Pans the view in the direction of the mouse. Use the left mouse button to pan.

Zoom In: Zooms in at the location of the mouse. Use the left mouse button to zoom.

Zoom out: Zooms out at the location of the mouse. Use the left mouse button to zoom.

Zoom In Center: Zooms in to the center of the window by a factor of 2.

Zoom Out Center: Zooms out of the center of the window by a factor of 2.

Extent: Allows the user to specify the window extent (area to zoom into). Use the cross-hairs and left mouse button to select opposite corners of the extent to be viewed.

Get Extent: Prints the window extent to the ARCEDIT prompt.

Fullview: Displays the entire extent defined by the Contour Coverage.

Scale 1:1: Displays the window contents at a 1 to 1 scale.

Redisplay: Redraws the editing display window.

The geospatial position of the cursor is also shown at the bottom of the editing window in Windows NT and at the top on UNIX systems. The change in distance in the vertical direction and horizontal direction is shown along with the total distance the cursor has moved from a specified origin. To select a specified origin, select the location with the mouse and press the left or right mouse button. The cursor position statistics displayed on the ARCPLOT window are turned on and off using the ARCWINDOWSTATS environment variable.

Main Channel Invert Coverage

The river and reach network is represented by the Main Channel Invert Coverage. The network is created on a reach by reach basis, starting from the upstream end and working downstream following the channel thalweg. Construct arcs with the TO node downstream of the FROM node (in the direction of flow) as done in HEC-RAS. Each reach is identified by a *River Name* and a *Reach Name*. A river is made up of one or more reaches with the same River Name. All reaches within a river must have unique Reach Names. Refer to the HEC-RAS User's Manual, Chapter 6 for more details.

Creating the Network

Begin by selecting the **MC Invert** choice from the Edit RAS Coverages window. In the response window, enter the name of the coverage to create and press **OK**. The name of the coverage may be no longer than 13 characters. The blank coverage will be set as the coverage to edit.

Each reach is represented by an arc. To draw a reach, press the **ADD ARC** button from the edit palette. Place the mouse cursor at the upstream end of the reach and press the right mouse button to “drop” a node. Draw the reach downstream stream using the left mouse button to create vertices along the channel. At the end of the reach, press the right mouse button to create the end node. After the end node is placed, a window will appear to enter the *River Name* and *Reach Name*. The river and reach names may be 16 characters or less. The **?** button may be used to select a *River Name* used previously in the Main Channel Invert Coverage. The **?** button will only list the river names since the last save.

To begin a connected reach, press the right mouse button to create a new node and begin to draw the reach downstream. A junction is formed when two or more nodes are placed one on top of another. A least one of the nodes must be the FROM node on the downstream reach. Each reach may be constructed with no more than 500 points.

It is recommended that the node snap tolerance be set by the user before creating the stream network. Greater snap tolerances ensure that reaches are connected at junctions; however, snap tolerance that are too large will create problems with nodes snapping to the wrong junction nodes. Each time that a coverage is Saved, nodes and vertices that are separated by less than the node snap tolerance will be combined, thereby moving the delineation of the main channel. If this problem occurs, reduce the node snap tolerance.

Editing the river and reach network is accomplished using the editing tools described earlier. The EDIT NAMES option should be used to check that the *River Names* and *Reach Names* are correctly named and that all reach names within a river are unique.

Be sure to select **MC Invert** from the *Edit* choice on the Edit RAS Coverages window to indicate that the edit coverage is the Main Channel

Invert Coverage. If another *Edit* choice is selected, the *River Name* and *Reach Name* cannot be edited.

The Main Channel Invert Coverage is shown in Figure 5.6. Ground Contours displayed in the background, clearly delineate the main channel. (Note that the “V” of the contours points in the upstream direction.) Reaches are separated by nodes, displayed in ARCEDIT as black squares.

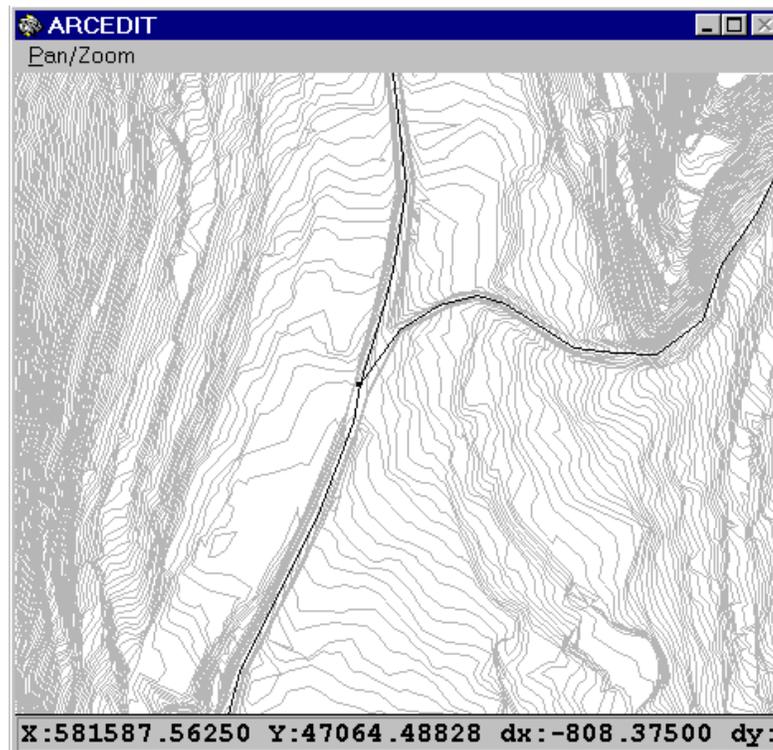


Figure 5.6 Main Channel Invert Coverage

Adding Reaches to an Existing Network

Adding a new reach to an existing river and reach network requires that a reach be split. To split a reach, select the reach and choose the **SPLIT** arc option from the *Edit Tool* palette. Cross-hairs will appear for the user to select the location to break the reach. Press the left mouse button when the location is selected. The user will then be prompted to edit the reach names of the two reaches and the selection cross-hairs will appear over the editing window. Select the first reach and edit or accept the *Reach Name* and press **OK**. Use the cross-hairs to select the second reach and edit or

accept the *Reach Name*. Pressing **Cancel** will keep the current names, as will pressing **OK** without making any edits.

Adding Tributaries to an Existing Network

After a reach is split, add a new reach using the **ADD ARC** option. Enter the *River Name* and *Reach Name* at the window prompt. To check that the node of the new reach lies on top the node of the downstream reach, zoom into the junction. If the nodes are not aligned, the nodes can be snapped together by moving the new reach or moving the end node of the new reach. The latter is suggested. Select the new reach and choose the **MOVEV** (move vertex) button from the editing palette. Select the **TO** node with the cross-hairs and press the left mouse button. Select the **FROM** node of the downstream reach and press the left mouse button. Note that if the snapping tolerance had been greater than the separation of the nodes, the nodes would have snapped on top of each other as the new reach was created.

Merge Reaches in an Existing Network

To merge two reaches into a single reach, they must share a node. In other words, the downstream node of the upstream river (**TO** node) must coincide with the upstream node (**FROM** node) of the downstream river. To verify that two nodes are coincident, zoom into the nodes' location and move one of the nodes on top of the other while the **SNAPPING** option is **ON**.

Select the two reaches to be joined and choose the **UNSPLIT** option from the *Edit Tools* palette. One reach will be drawn to the screen (only two nodes, instead of three) and the Name Stream Network window will appear. Enter the name of the newly formed reach and select **OK**. Pressing **Cancel** will keep the names displayed.

Main Channel Banks Coverage

The Main Channel Banks Coverage is a line coverage which indicates the separation between the main channel and the overbanks and is used to determine the main channel bank stations on the cross sections. *The Main*

Channel Banks Coverage is optional. To indicate bank positioning, use the **ADD ARC** option from the *Edit Tool* palette and draw the position of the bank stations for *both sides of each river*.

The bank lines may be broken and may cross where tributaries join a river reach. If two parallel bank lines are indicated (i.e., two broken bank lines overlap), the bank stationing farthest from the river will be used. Orientation of the bank station lines is not important. The Main Channel Banks Coverage is shown in Figure 5.7, along with the main channel.

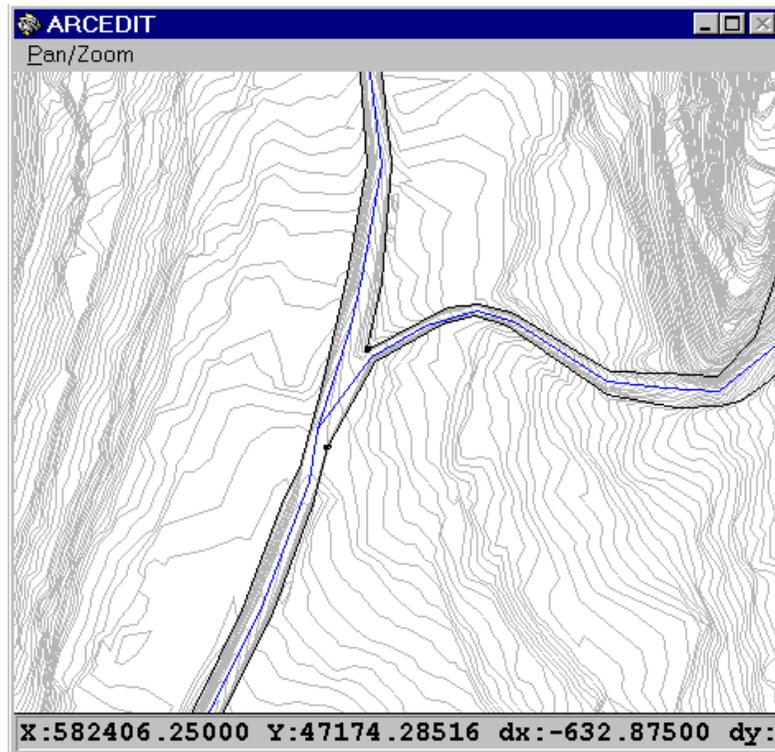


Figure 5.7 Main Channel Banks Coverage

Flow Paths Coverage

The Flow Paths Coverage is used to determine the downstream reach lengths between cross sections in the left overbank, main channel, and right overbank. *The Flow Paths Coverage is optional.*

The coverage is created by using the **ADD ARC** option to draw the hydraulic flow paths in the left overbank, main channel, and right overbank. If the Main Channel Invert Coverage already exists, the main channel flow path will be copied into the Overbank Flow Path Coverage and, therefore, will not need to be created. The three flow paths lines should not cross, cross each cross section cut line exactly once, and be drawn in the direction of flow (i.e., the TO node downstream of the FROM node). The Overbank Flow Path Coverage is shown in Figure 5.8.

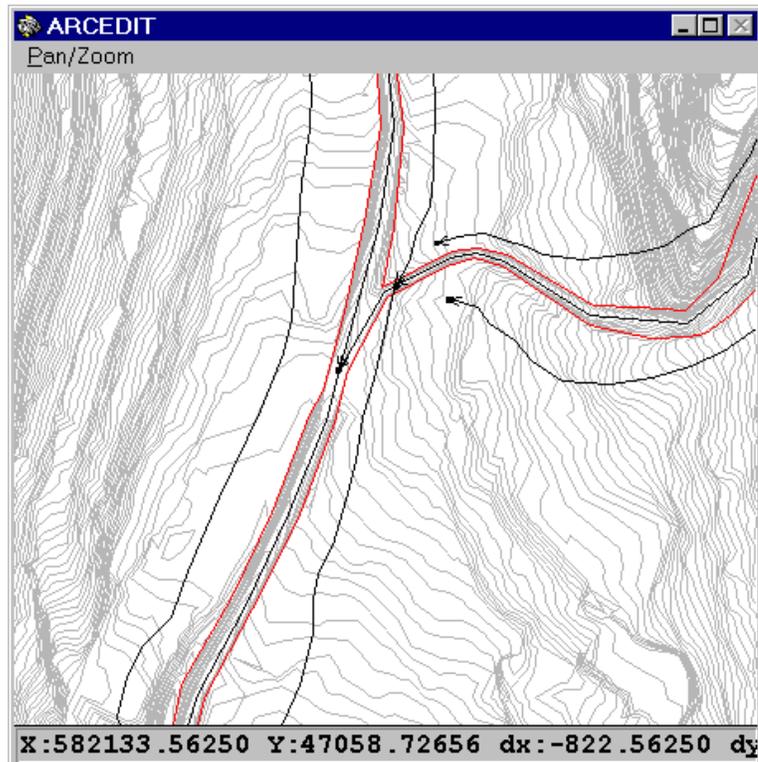


Figure 5.8 Over Bank Flow Path Coverage

Cross Section Cut Lines Coverage

The location, position, and expanse of channel cross sections is represented by the Cross Section Cut Lines Coverage. The cross section cut lines are used to extract the station and elevation data from the digital terrain model.

To draw a cross section cut line choose the **ADD ARC** option from the

editing palette. Press the right mouse button to place the FROM node and draw the cut line to the TO node. Press the right mouse button to end the cut line. Cross section cut lines are constructed with the FROM node at the edge of the left overbank to the TO node at the edge of the right overbank. Vertices may be placed between the FROM and TO node using the left mouse button so that the cut line may be dog-legged perpendicular to the direction of flow. A cut line should cross a reach line exactly once, and should not cross another cut line.

The orientation of cut lines may be checked using the **ARROWS** option on the *Edit Tools* palette. When pressed, the **ARROWS** option places an arrow at the TO node pointing in the direction the arc was created. The Cross Section Cut Line Coverage is shown in Figure 5.9 with the **ARROWS** option turned on. If the cut line was constructed in the incorrect direction, use the **FLIP** option to reverse the FROM and TO node. The **FLIP** option may be used on one or many arcs.

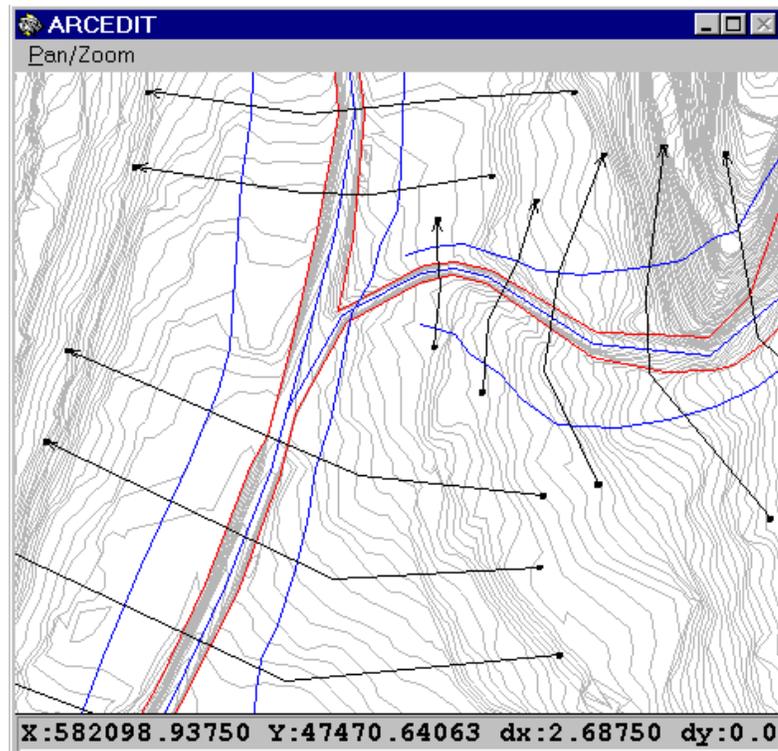


Figure 5.9 Cross Section Cut Line Coverage

Creating the HEC-RAS Import File

To create the HEC-RAS Import File, select **Create RAS Import File** from the **RASPrep** menu on the project manager. This will invoke a window with input fields for the four RAS Coverages as shown in Figure 5.10. The user must have specified the Digital Terrain Model, a Main Channel Invert Coverage, and a Cross Section Cut Line Coverage from the project manager before attempting to create the import file. The input fields for the Main Channel Bank Stations Coverage and Overbank Flow Paths Coverage may be left blank.

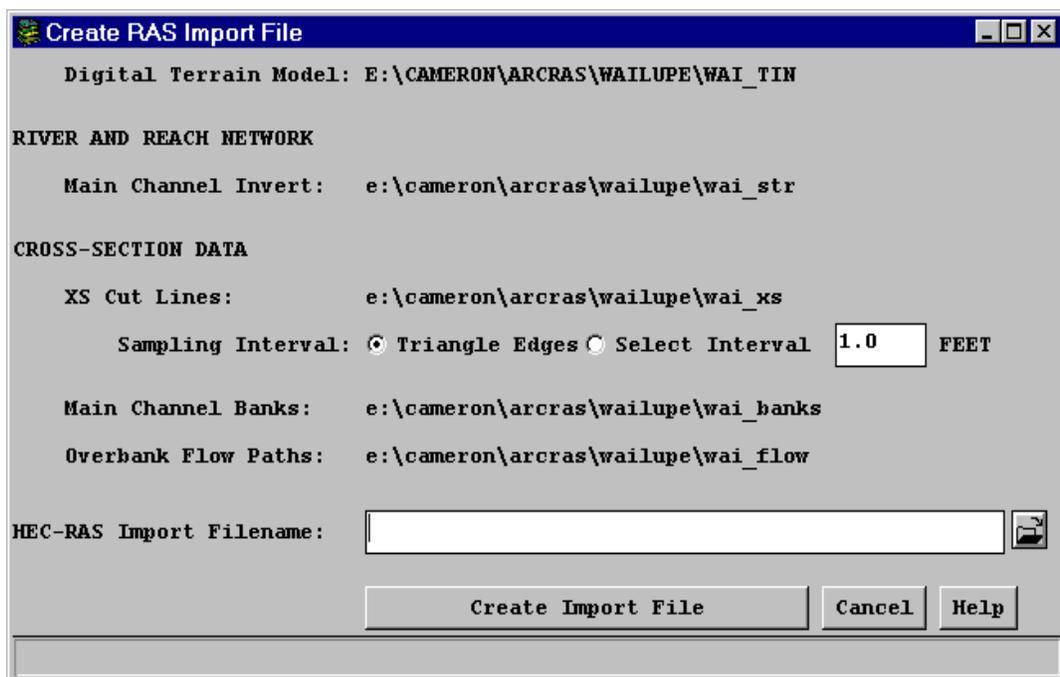


Figure 5.10 Create RAS Import File window

Select the sampling interval method. The sampling method indicates where the station and elevation data for cross sections will occur. The default method (*Triangle Edges*) samples the land-surface elevation at the edge of each triangle in the TIN. Choosing *Select Interval* allows the user to specify a uniform distance between cross-section stations. The units used for the sampling are read from the DTM.

Enter the filename for the import file. The extension *.geo* will be added to the filename. The user is not allowed to change the extension. Press

Create Import File when finished. **Cancel** dismisses the window and returns the user to the project manager.

Once the **Create Import File** button is pressed, the attributes of the RAS Coverages will be checked for missing data. Progress updates will be displayed in the Create RAS Import File status window shown in Figure 5.11.

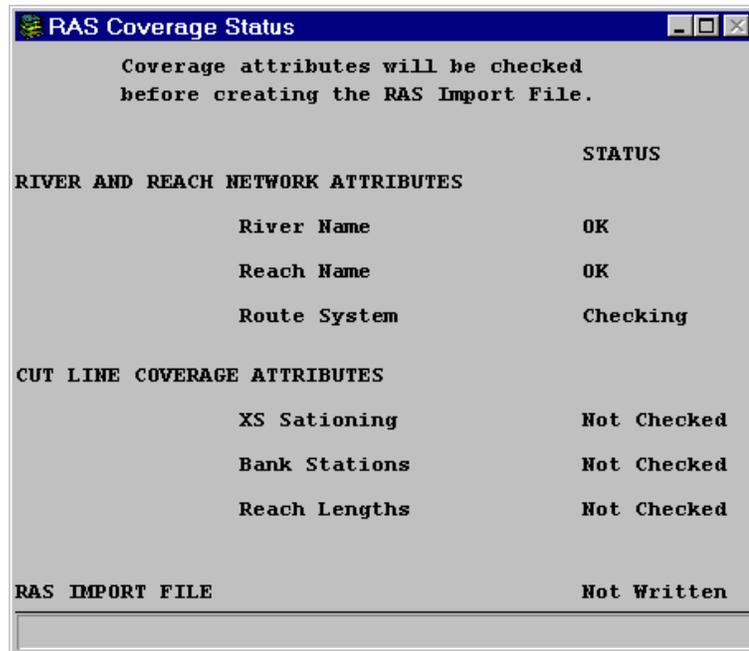


Figure 5.11 RAS Coverage Status window

Coverage Checking

Before the RAS Import File is created, the RAS Coverages will be checked. As the coverages are checked, geometric attribute data will be added or updated to the Cross Section Cut Line Coverage. The window shown in Figure 5.11 will update to indicate the progress of the coverage checking procedures. The status messages that are updated to the window and their meaning are listed below. If any of the coverages were not correctly created by the user, the checking procedure will be stopped and the user informed of the missing coverage data.

Message	Meaning
Not Checked	The corresponding attribute has not been checked.
Checking	The corresponding attribute is being checked.
OK	The coverage attribute was checked and the appropriate coverage data is present.
Updating	The attribute data is being updated.
Unmodified	The coverage attributes present were not updated since last attempt to create a RAS Import File.
No Stations	The Main Channel Banks Coverage is not present.
No Reaches	The Overbank Flow Paths Coverage is not present.
Not Written	The RAS Import File has not been written.
Writing	The RAS Import File is being written.

River and Reach Network Attributes

The river and reach network attributes are checked first. The checking procedure looks to see that the Main Channel Invert Coverage has a *River* and *Reach Name* for each reach in the coverage. Specifically, the checking procedure looks to see that the arc attribute table (AAT) for the Main Channel Invert Coverage contains the stream and reach items and that the items are not blank. STR_NAME and RCH_NAME are the default name created when the Main Channel Invert Coverage is create in the edit environment. *Reach uniqueness is not checked*; therefore, it is recommended that the user check the reach names prior to attempting to create the RAS Import File. If the *River* and *Reach Names* are not present, the checking procedure will be aborted and the user will be informed to edit the invert coverage river and reach names.

Cross section stationing is determined by dynamic segmentation of the Main Channel Invert Coverage. If this Route System is not present, windows will direct the user to create one based on the lengths of the river

arcs. Two ARC/INFO tables are created named as the Main Channel Invert Coverage name followed by .SECHECSTR and .RATHECSTR. If the Route System is already present, the user will be given the choice to update the tables.

Cut Line Coverage Attributes

After the river and reach network attributes are checked, items are added to the Cross Section Cut Line Coverage without user input. The user will only be prompted to update the tables, if the geometric attribute data are already present.

Cross section stationing data are added to the STATION item. If the STATION item does not exist, it will be added.

Bank station data are contained by the items BANK1 and BANK2 (left and right, respectively). Bank Stations will not be added if the Main Channel Banks Coverage has not been specified. BANK1 and BANK2 are optional items.

Reach length data are contained by RL1, RL2, RL3 (left bank, main channel, and right overbank, respectively). Reach lengths will not be added if the Flow Paths Coverage has not been specified. RL1, RL2, and RL3 are optional items.