GSTARS 2.1 GUI TUTORIAL

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June 7, 2001

This short tutorial shows some of the basic steps used to set up a GSTARS 2.1 run using its Graphical User Interface (GUI), run the GSTARS 2.1 model, and view the results of a run. To use this tutorial effectively, you should install GSTARS 2.1 in your computer and try to follow the steps as closely as possible. In the GSTARS 2.1 distribution there are files containing the example applications presented in appendix B of the GSTARS 2.1 manual, and you can use them as a starting point.

Starting the GSTARS 2.1 GUI


start.bat

After installing GSTARS 2.1 (see the GSTARS 2.1 Installation Guide supplied in the GSTARS 2.1 distribution), you cat start the GUI by double-clicking on the start.bat icon (see picture on the right) under the main GSTARS installation directory (the word directory is used here as a synonym of folder). Two windows are created: a standard MS-DOS window and a Java window (picture on the left; the color scheme of your computer may be different from the one used in this tutorial, therefore the colors in your computer may differ). The Java window is the main GUI window. You can safely ignore the MS-DOS window, because all the activity will take place in the GUI window. From now on we will not refer to the MS-DOS window again. When using the GUI we recommend that you maximize its window by clicking in the appropriate button located at its top right-hand corner in the title bar.

The GSTARS 2.1 manual can be viewed at any time by going to *Help>Help*, as shown in the figure above. For this command to work you have to have a PDF viewer installed in your machine, such as Adobe's AcrobatReader or similar. **Notation:** we use italic typeface to denote commands issued from pull down or pup-up menus, of buttons; the character '>' denotes a lower level menu.

A GUI session is started by clicking *File>New* (new session) or *File>Open* (to open a previously saved session). A working window is created with the appropriate information displayed, if opening an existing session, or which is simply blank if a new session has been started. In this tutorial we will assume that a new session is being started and walk through the steps to have a complete GSTARS 2.1 run and view its results.

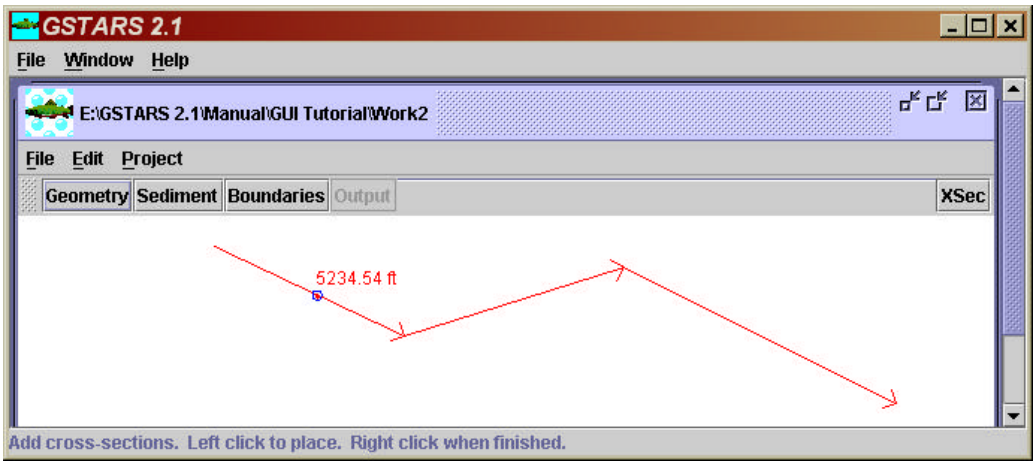
A GUI session starts by adding river segments using *Edit>River>Add River Segments* from the working window. A river segment represents a reach of the river being modeled. You can add as many river segments as you want, starting from upstream and ending in the downstream-most point in the reach being modeled. Segments are added using the left mouse button; segment entry is completed by right-clicking on the last point. At that time, a dialog box (titled *River Units*) pops-up asking for the coordinate of the downstream-most point and the overall length of the reach, in feet. In this tutorial the US system of units is used (pound/feet/second), but the Metric System can be chosen in the dialog box. However, you should choose the system of units you want at this time and stick with it for the remainder of the session. In the case shown in the picture to the right, the river reach to be modeled has 5000 ft in length. The coordinate of the downstream-most cross section is 1000 ft, meaning that the upstream-most cross section will be located at coordinate 6000 ft.

GSTARS 2.1 uses absolute distances, counting from the downstream-most cross section. All cross section data will use that referential system. River segments can be edited at a later time by using the options menu under *Edit>River*. River segments can be added, inserted, removed, or edited. An arrow head will show the upstream-to-downstream direction, but that direction can also be reversed using *Edit>River>Reverse River Segments* (try the command yourself to see how it works). Finally, the river parameters can be edited by using *Edit>River>Edit River Parameters*.

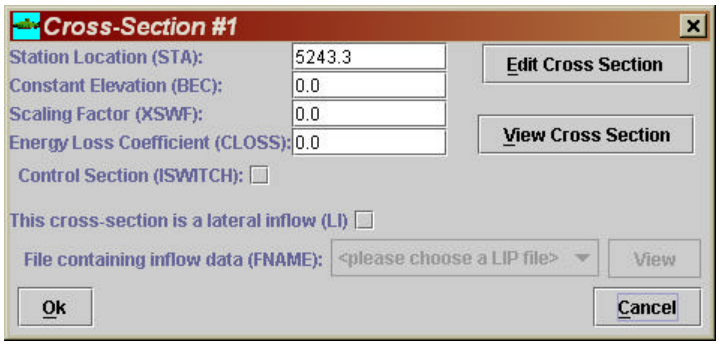
The GUI has the capability of adding river parameters over an image, which is a jpeg or gif file intended to contain a map or aerial photo of the study reach. However, by using this capability a considerable demand is placed on the graphics engine of the computer, which can slow down considerably the performance of the interactivity of the GUI (menus and commands become slower to respond). This depends on the computational power of the computer and on the size of the image. Use this feature carefully. A background image is added by using *Edit>Background>Add Background Image*. The image can be removed from the display using *Edit>Background>Remove Background Image*.

Cross Section Information

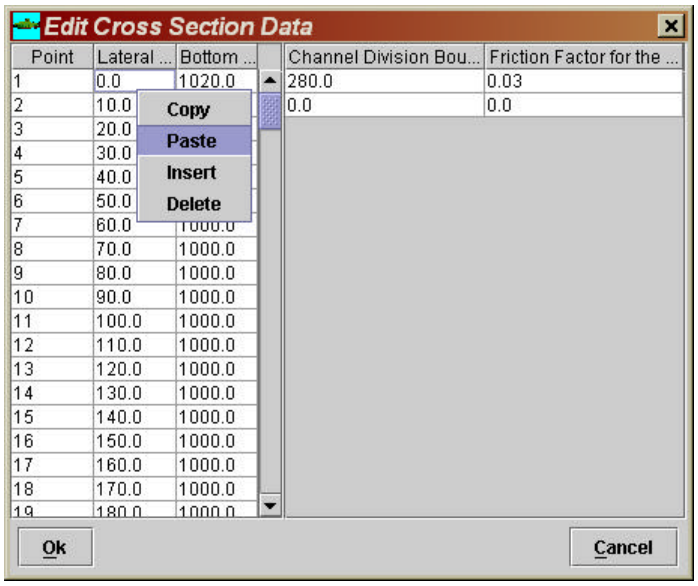
Cross section data is added one cross section at a time using *Edit>Cross-sections>Add Cross-sections*. By moving the mouse near the river segment, a numerical value is displayed showing the absolute location on the river segment (see figure below). You can place any number of cross sections on the segment by left-clicking at the desired locations. The operation is terminated by clicking the right mouse button anywhere on the working window. A mark is placed at each cross section location. In the figure below, a river reach is represented by three segments, and a cross section was placed at location 5234.54 ft.



After placing cross sections, the GUI automatically enters the edit cross section mode. In this mode, also started by choosing *Edit>Cross-sections>Edit Cross-sections*, allows to enter cross section data one at a time. To do this, point to the desired cross section and left-click on it. A dialog box pops-up where you can enter the desired values, as shown in the picture to the left. The meaning of all the parameters is explained under Record ST in the GSTARS 2.1 User's Manual. At this point do not click on the "This cross-section is a lateral inflow (LI)" check box. This should only be done later, after entering the lateral inflow parameters (explained later in this tutorial). Note that the title of the pop-up box shows the cross section number corresponding to the cross section in effect. Cross sections are numbered from upstream to downstream, with cross section #1 being the upstream-most.

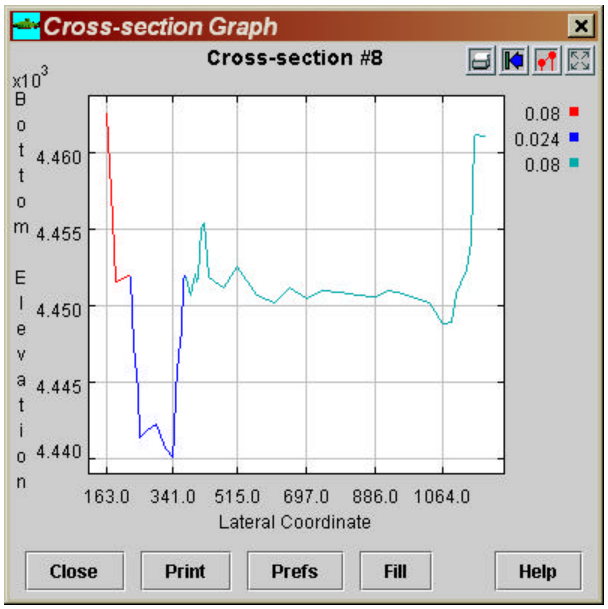


Cross section coordinates are entered by clicking on the *Edit Cross Section* button. A pop-up window allows the user to enter the lateral coordinates of the cross section. You can enter it by hand, or you can use the Copy and Paste menu. To use the Copy and Paste option (for example, when copying data from a spreadsheet) click on the desired cell with the left mouse button to select it and right-click to show a pop-up menu with several commands. Click on *Paste* (or press Ctrl-V on your keyboard) to place data from the clipboard into the GUI (see figure below). The paste command is set to overwrite, therefore the data will be pasted into the selected cell replacing the previously existing value. Similar considerations apply when entering the friction factor(s) for the cross section. If typing data manually into the spreadsheet, make sure that you press the <Return> (or <Enter>) key for each cell to enter the data. The mouse should not be used to jump from cell to cell before pressing <Return>. You can use the arrow keys to navigate across the spreadsheet.



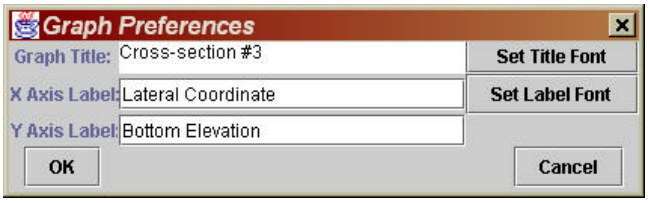
The lateral coordinate input data spreadsheet automatically numbers the points in the left column. Do not attempt to enter data there. The last row of the spreadsheet always has zeros in it (both for the lateral coordinates and for the friction factors). Do not worry about that: this is a device used by the GUI to know which is the last point entered and will not cause errors when running the GSTARS 2.1 numerical engine.

After all the data is entered correctly, click the *OK* button to return to the cross section menu. At this point you can plot the cross section geometry by clicking on the *View Cross Section* button, as shown in the figure below. The areas of the wetted perimeter with different roughness coefficients will be shown with different colors. After entering all the correct cross section data, click on the *OK* button and proceed to the next cross section, and so on until you are done. Right-click on the working window when you are finished so that you can proceed with your data entry.



In the *Cross-section Graph* window (figure above) there are a few buttons. The button *Fill* is used to resize the scale of the graph such that the plot fills the entire plotting window. The button *Prefs*

sets the graph preferences, i.e., it is used to set graph title, X-axis and y-axis labels, as well as the font type and size (see figure below). The graph can be saved in a file with the GIF format using the *Print* button. The *Help* button is inactive in the current release version of the GSTARS 2.1 GUI.



Additional buttons:

 Print button.

 Reset x- and y-ranges to original values.

 Similar to the *Prefs* button, but with more options.

 Same as the *Fill* button.

All the plotting windows have the same basic functionality, i.e., they have the same buttons and perform identically.

You can add and edit cross sections at a later time by using the *Edit>Cross-sections>Add Cross-sections* and the *Edit>Cross-sections>Edit Cross-sections* menus and proceeding as described above. To remove a cross section simply choose *Edit>Cross-sections>Remove Cross-sections*, point to the desired cross section and click on it with the left mouse button. Right-click on the working window when finished.

Other Useful Commands

There are a few useful commands that will not be explained in detail. It is convenient to present them here, before continuing with the description of how to input other data. The commands *File>Save* and *File>Save As* in the working window allow to save the session in a file. The file should have the extension .gpj, which can be included in the file name by the user (if not explicitely given, the GUI will automatically add the .gpj extension to the file name). The session can be imported at a later time by starting the GUI and choosing *File>Open* from the main menu. Only files with extension .gpj can be imported by this command. The main menu is the menu that appears at the main window when the GUI is started. The commands that were described in the preceding section were invoked from the working window menu, not from the main menu. The command *File>Import Input File* allows the GUI to read-in a file that was prepared for the GSTARS 2.1 program using a plain ASCII text editor, as explained in the GSTARS 2.1 User's Manual. GSTARS 2.1 data files should have an extension .dat or .data. All the information will be processed by the GUI and immediately be available for display. Similarly, the menu option *File>Load Output File* is used to import the results of a previous GSTARS 2.1 run (files .out, .dbg, .sed, .xpl, and .wpl) and make them available for display.

In the working window, the command *Edit>Annotate View>Add Text* allows to add strings of text to the working window. Text boxes are created every time that the left mouse button is clicked on the working surface until another menu item is selected. The text boxes are empty and have a default size, but they are resizable. The text and its attributes (font style, size, etc.) can be set by right-clicking or double-clicking on the box. A pop-up window allows the user to enter the desired

text. Any number of text strings are allowed. Each text string can be edited or removed by right-clicking on it and choosing the appropriate command from the pop-up menu. The *Edit>Annotate View>Add Graphic* allows to add small jpeg or gif graphics to the working window.

Choosing *Edit>Preferences* from the working window menu provides a way to change the colors of the working window. The default is red foreground (*River Color*) on a white background (*Background Color*). The pop-up window that is used to change colors can also be used to specify the location of the GSTARS 2.1 numerical engine (gstars2.1.exe), but we recommend that this feature should not be used, as you incur the risk of breaking the link between the GUI and the GSTARS 2.1 program.

There are four buttons on the working window: *Geometry*, *Sediment*, *Boundaries*, and *Output*.

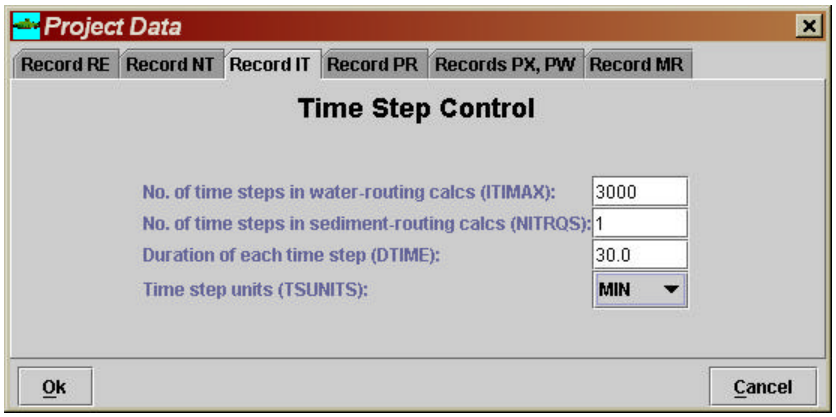
- ***Geometry.*** This causes a window to appear that displays each cross section geometry. The window is titled *X-Section Geometry*. The cross section is selected by simply pointing at it in the working window, i.e., hovering over it with the mouse cursor without clicking on it. This shows the run initial conditions, i.e., before the GSTARS 2.1 numerical engine is used.
- ***Sediment.*** This button displays a window, titled *X-Section Particle Size Distribution*, with bed composition information, and should be used only if the sediment transport computations are requested. It will be shown in a later section how to deal with sediment transport data. This window works just like the *X-Section Geometry* window, i.e., it plots the initial bed particle size distribution of the selected cross section.
- ***Boundaries.*** This button creates a window titled *Thalweg* that shows a plot of the lowest coordinate point in each cross section, i.e., the thalweg.
- ***Output.*** This button is similar to the *Geometry* button, but it works for the output data created by a GSTARS 2.1 run. It starts a window called *X-Section N*, where *N* is the number of the cross section being displayed. The window displays the output of the GSTARS 2.1 run and it is possible to navigate through all the output for each cross section (i.e., through the time step data) by using the buttons => and <=. Cross section selection is also accomplished by pointing to the desired section in the working window.

All the windows mentioned in the paragraph above are fully resizable and can be placed anywhere within the GSTARS 2.1 GUI main window. Because windows sometimes get cluttered, it becomes necessary to clean-up the work space. That can be done automatically by using the menu *Window>Organize* in the main GUI window.

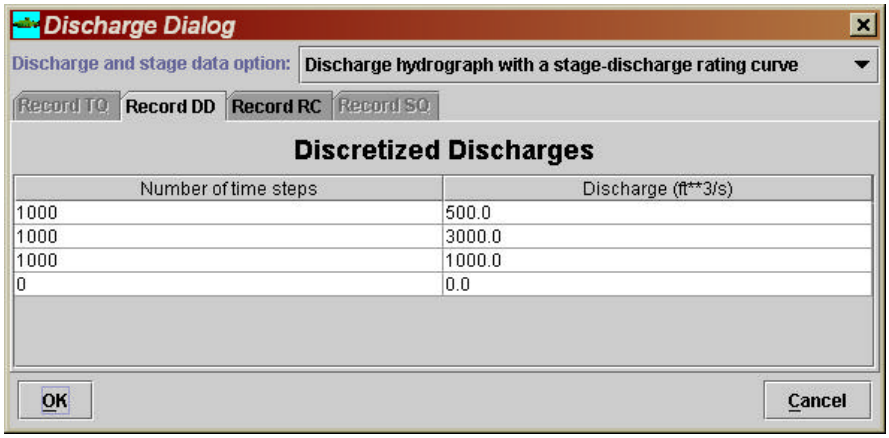
Hydraulic Data

The next step after entering cross section data is to enter hydraulic data. First, the project title can be entered using *Project>Title* in the working window. This data corresponds to the Records TT described in the GSTARS 2.1 User's Manual.

Using *Project>Project Data* starts a pop-up window that is used for several types of input (see figure below). In this window the data for Records RE (roughness equation and friction loss calculation), NT (number of stream tubes), IT (iteration control), PR, PX, PW (print-out control), and MR (stream power minimization computations are entered. The input is rather easy and intuitive, therefore we will not give more details here. Note, however, that stream power minimization computations, i.e., channel width changes, can be selected only when the sediment computations are activated (see next section).

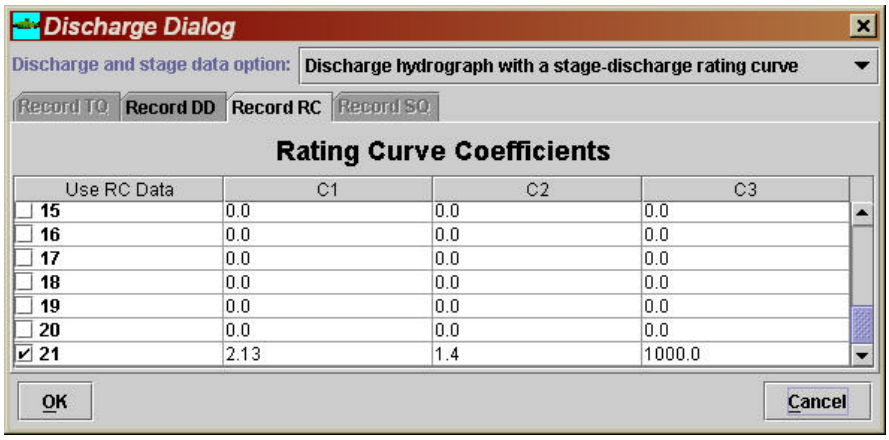


Discharge data is entered by selecting *Project>Discharge Data* in the working window. A pop-up window titled *Discharge Dialog* allows the user to select one of the three types of stage-discharge input information described in section 5.2 of the GSTARS 2.1 User's Manual. A pull-down selector is presented to the right of "Discharge and stage data option", as shown in the figure below. In the figure, the option chosen is "Discharge hydrograph with a stage-discharge rating curve", in which DD Records are used to enter a discretized hydrograph, and NC and RC Records are used to define appropriate rating curves. Therefore, only the tabs titled *Record DD* and *Record RC* are available for selection (the tabs titled *Record TQ* and *Record SQ* are grayed out, and clicking on them will have no effect). Alternatively, you could select "Table of discharges with a rating curve at the control section", for which the tabs *Record TQ* and *Record RC* would be available; or you could select "Stage-discharge table at control section", for which the tab *Record SQ* will be available.

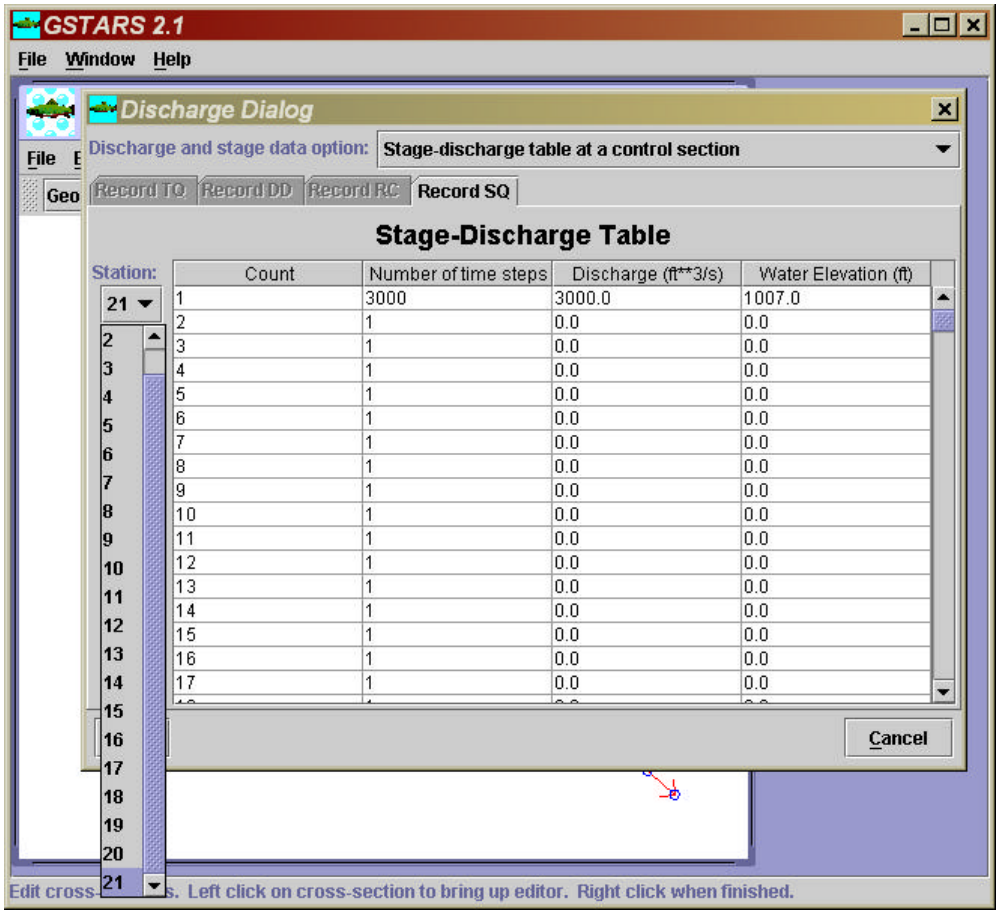


Data is entered using selectors and spreadsheet type input. For example, in *Record DD* the data is entered row by row until the total number of time steps is equal to the value entered in *Project>Project Data* in the *Record IT* tab. The spreadsheets work in the same way as described in the cross-sectional coordinate data input: you can type in data or use the Copy and Paste menu of the GUI. If data is typed, the <Return> key must be pressed for each cell entry. The last row of the spreadsheet is automatically added and always contains zeros. Press the *OK* button after entering all the data, or *Cancel* to discard the changes.

In the *Record RC* input window there is a similar spreadsheet to be filled, but a checkbox selector is shown in the first column. The desired rows are selected with a check mark by clicking in the respective box. Each row has the number of the respective cross section. This is shown in the figure below for a case with 21 cross sections. The control rating curve is defined at the last cross section (cross section #21).



Another type of selector is shown in the figure below. In tab *Record SQ*, the cross section is selected by a pull down selector menu rather than by a checkbox mark.



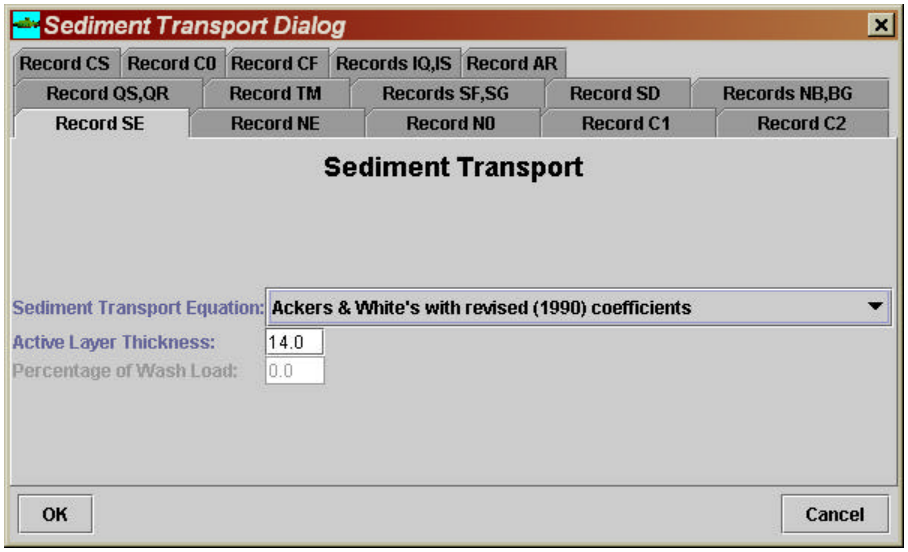
Sediment Data

Sediment data entry is accomplished using the pop-up window resulting from choosing *Project>Sediment Data* in the working window menu. The window is titled *Sediment Transport Dia-*

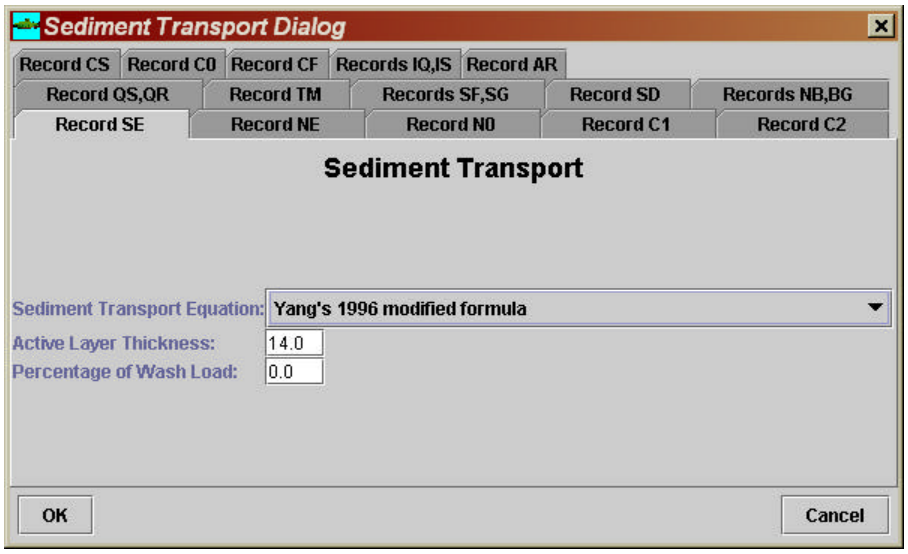
log. Data for each Record is entered by first left-clicking on the tab selector corresponding to the desired Record. A detailed description of each Record is given in the GSTARS 2.1 User's Manual, but the GUI is very straightforward and works in the same way as the *Discharge Dialog* window, with check boxes, buttons, selectors, and spreadsheet screens.

Sediment computations are activated by selecting a sediment transport capacity equation in *Record SE*. This is accomplished using the pull down menu "Sediment Transport Equation". Unless sediment computations are activated in this manner, the GSTARS 2.1 model will not run the sediment transport module.

The selector tabs are ordered in the way you should proceed entering the data (see picture below). Start by using the front (lower) row and proceeding from left to right: start with *Record SE*, then *Record NE*, and so forth. After completing *Record C2* proceed to the middle row and go from left to right again: start with *Records QS,QR*, then *Record TM*, etc. Finally, go to the back (upper) row and again go from left to right, starting with *Record CS*, then *Record C0*, etc. It is not necessary to follow this order exactly, but it may help because it follows a reasonable logic (and it also follows the GSTARS 2.1 User's Manual). Note that most of the records have default values, so if you do not want to change those you can skip them altogether. Hint: by hovering over each tab, a small pop-up text string containing a short description of the Record will appear.

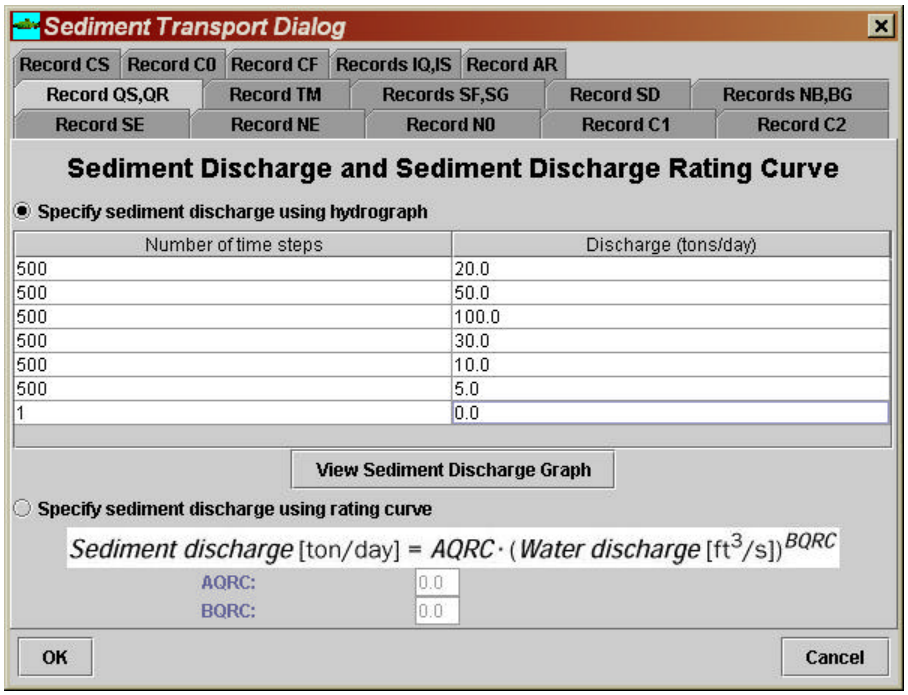


Sometimes you will see dimmer text, such as the "Percentage of Wash Load" box in the previous figure. This means that you cannot use that option under the current conditions. In the example above, the Ackers and White sediment transport equation is selected, but the percentage of wash load is used only if Yang's (1996) equation is used. This is a device to help prevent the input of wrong or unnecessary data. By choosing the appropriate option, that feature will automatically be made available for use:

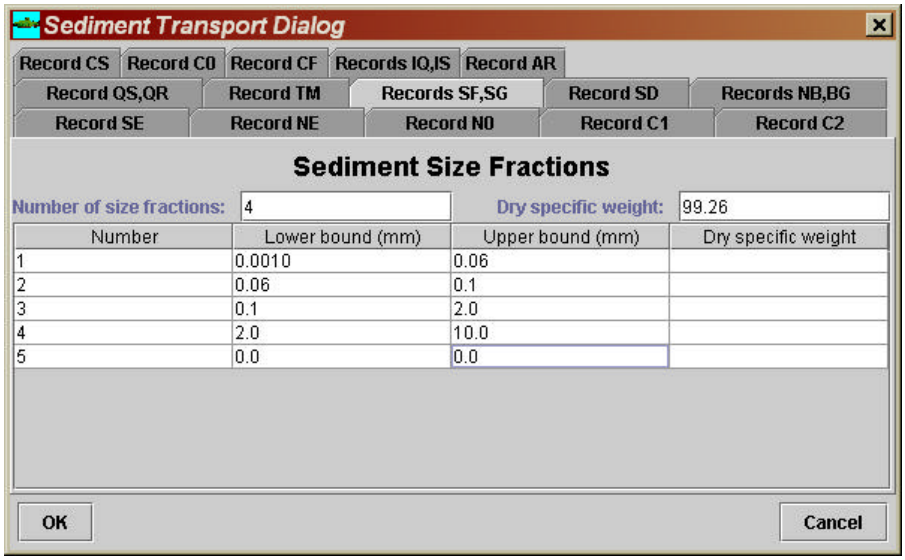


Note that there are several mutually exclusive data records, as explained in the GSTARS 2.1 User's Manual. For example, the non-equilibrium sediment transport records NE and N0 fall in this category. In the GUI, the desired record is selected by using a checkbox ("Include this record in input" in the tabs titled *Record NE* and *Record N0*) and selecting the checkbox in one record will automatically de-select it in the complementary record.

Some dialog screens implement two GSTARS 2.1 records. Such is the case of *Record QS,QR*, as shown in the next figure. Data entry is done by selecting the desired form using the radio button. In the example below the sediment discharge hydrograph is selected (radio button to the left of "Specify sediment discharge using hydrograph"). Note that the *View Sediment Discharge Graph* button will only display the data entered in this mode: it will not show the sediment discharge curve if the rating curve option is selected.

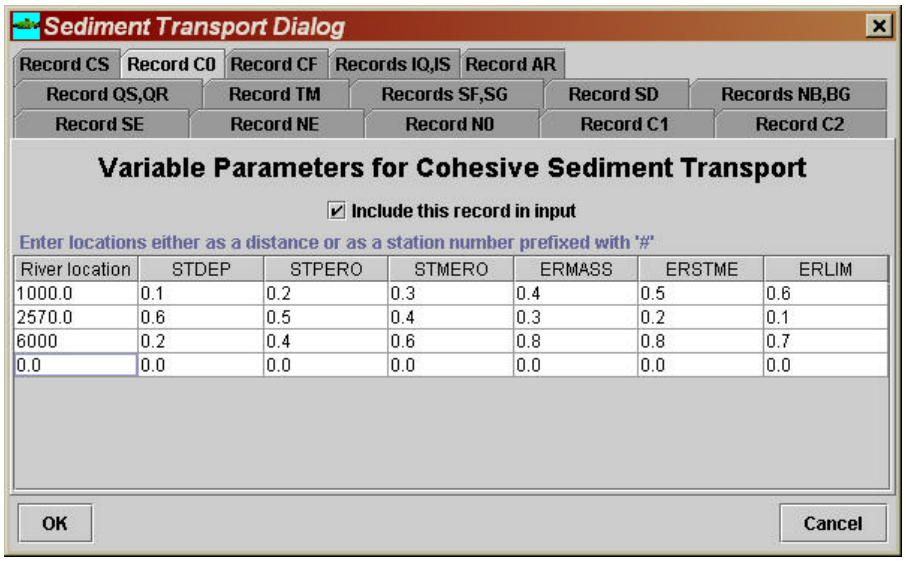


The definition of the sediment size fractions is accomplished in *Record SF,SG*. This data must be defined before records SD, NB, BG, IQ, and IS can be used. Be careful when changing the number of particle size fractions or their range during an editing session. The corresponding data in records SD, NB, BG, IQ, and IS may have to be updated accordingly. The dry specific weight of each individual size class does not need to be specified, i.e., the rightmost column in the spreadsheet may be left blank (see next figure). I that case, the default value for the dry specific weight (99.26 lb/ft^3) is assumed. See Appendix A of the GSTARS 2.1 User's Manual for more information about the use of records SF and SG.



Data in *Record CS* and *Record C0* are mutually exclusive (other mutually exclusive records are NE and N0, and SD and NB/BG). The appropriate record is selected using the check box "Include this record in input", as shown in the figure below. Note, however, that records CS and C0 are used only if at least one sediment size class falls in the silt and/or clay range, as explained in the GSTARS 2.1 User's Manual.

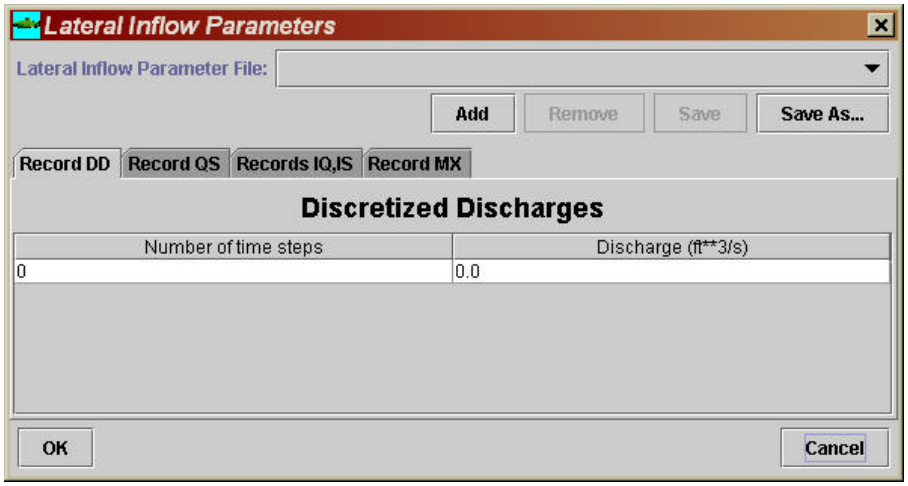
In *Record C0*, River Location (first column in the spreadsheet) can be entered in two ways. One way is by specifying a coordinate (usually the river mile where the measurements were taken). Another way is to specify the number of the cross section with a leading '#'. However, the data must be specified in the upstream direction, i.e., in increasing river coordinate — which is the same as decreasing cross section number. This type of input is similar to the corresponding data in *Record N0* and in *Record NB,BG*.



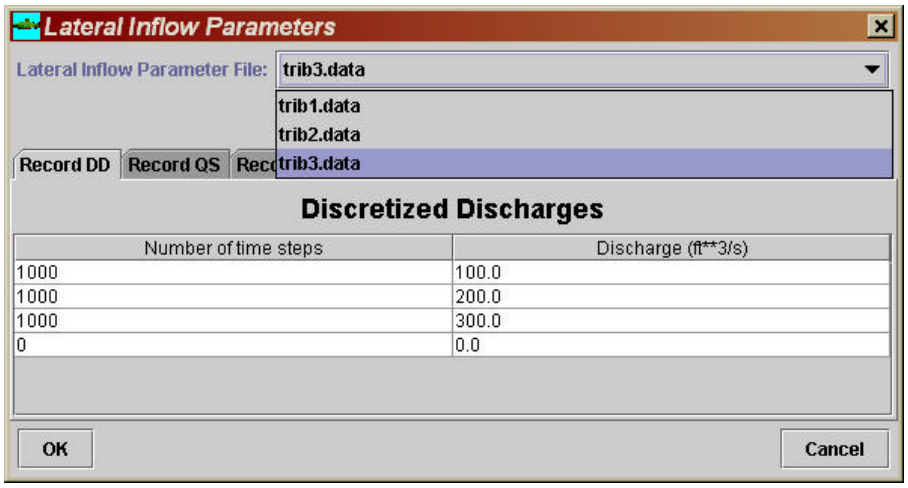
If sediment transport computations are requested from GSTARS 2.1, then the computation of channel width variations can be activated. This is done by choosing *Project>Project Data* in the working window menu and clicking on the *Record MR* selector tab. Click on the check box to the right of "Include MR Record" to activate the computations and enter the desired data in the spreadsheet screen. For more details see the full description of Record MR in the GSTARS 2.1 User's Manual.

Lateral Input Parameters

The data necessary for tributary inflow computations is entered in the window titled *Lateral Inflow Parameters*. This window pops-up when menu *Project>Lateral Inflow Parameters* is selected in the working window. There are two options to fill in the data: by reading a file that already contains the information, or by entering the data from scratch (i.e., by hand). In the first case simply press the *Add* button (see figure below) and load the appropriate file. After editing the data and before moving into the next tributary file, do not forget to save it by pressing the *Save* button. Note that the *Save* button will be grayed-out until changes have been done to the data.

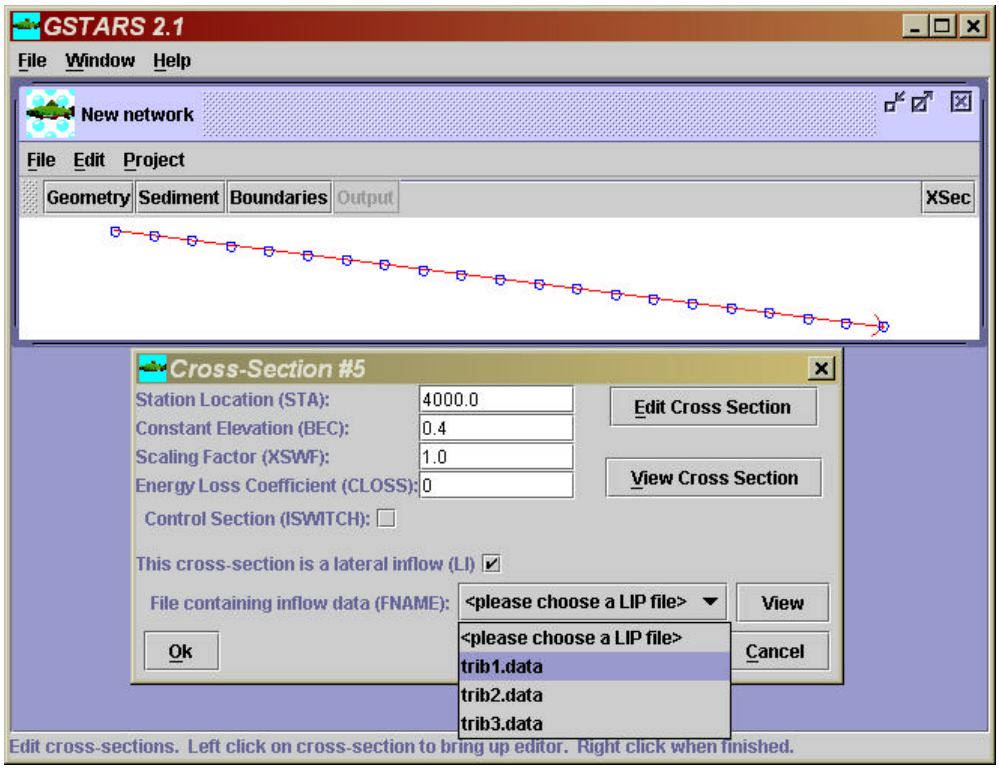


If data is entered from scratch, it must be saved by pressing the *Save As…* button. A name must be assigned to the file, which will appear in the pull down menu "Lateral Inflow Parameters File". The figure below shows an example with three lateral inflow files named trib1.dat, trib2.dat, and trib3.dat. The data of each file can be edited by selecting the desired file from this menu. The files can be removed from the pull down menu by clicking on the *Remove* button. The *Remove* button will not delete the file from the drive where it is stored.

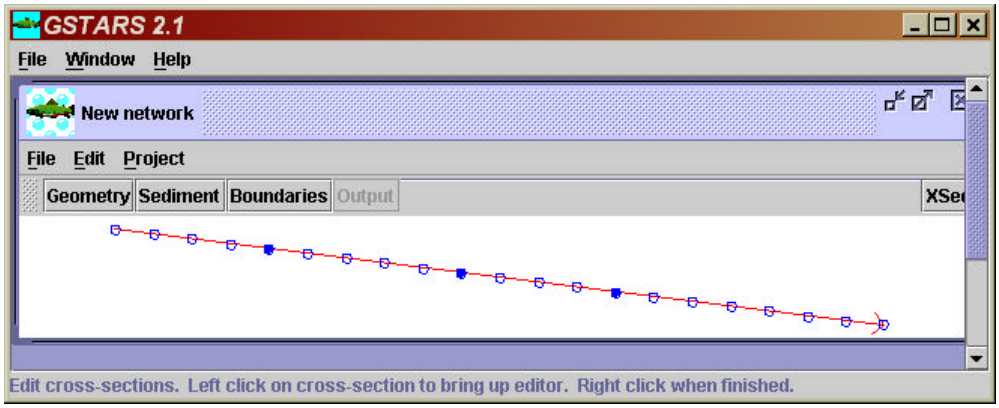


Fill in all the appropriate Record information and save the data in a file name by clicking on the *Save* button. After that is done, the file name will appear in the pull down menu to the right of "Lateral Inflow Parameter File". Click on the *OK* button to return to the working window. You can return to the *Lateral Inflow Parameters* window at any time (click on menu *Project>Lateral Inflow Parameters*) to add new lateral inflow parameter files or to edit existing files. To change the contents of any tributary simply select the file name from the pull down menu and perform the changes as usual.

To add tributary inflow data, go to the main working window and select the section that will have a lateral inflow by clicking on it (you may have to select *Edit>Cross-sections>Edit Cross-sections* from the working window menu; a little hand should appear over the cross section being pointed at). Left-click on the cross section and a window will pop-up titled *Cross-Section #N*, where *N* is the number of the cross section selected. Click on the check box to the right of "This cross-section is a lateral inflow (LI)" as shown in the figure below. Then select the file containing the parameters of the lateral inflow from the pull down menu "File containing inflow data (FNAME):". Press the OK button to enter your choice. Proceed in the same way until all the lateral inflow parameter files are associated with the corresponding cross sections.

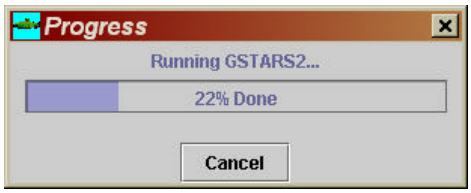


The working window will display the cross sections containing lateral inflows by a filled circle, as opposed to open circles for all the others:

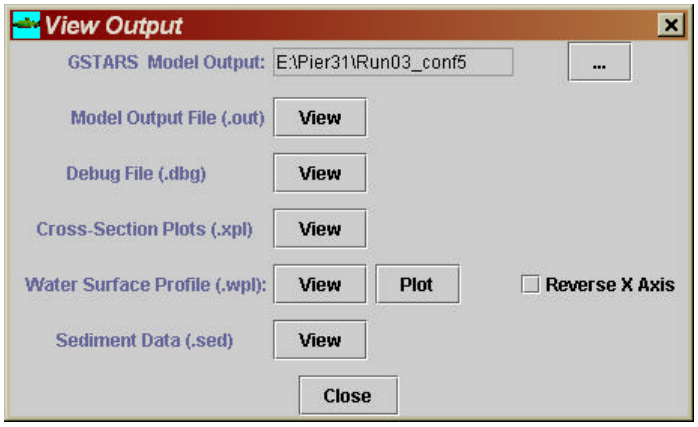


Running The GSTARS 2.1 Model

After all the data is entered, it is possible to save it in a file that can be interpreted by the GSTARS 2.1 numeric engine. This is accomplished from menu *Project>Generate Input* in the working window. This will save the data but will not run the GSTARS 2.1 model. The model is run from menu *Project>Execute*. The GUI will ask for a file name when you click on *Project>Execute*. All the data contained in the GUI will be saved into the specified file and GSTARS 2.1 will run using its data. Note that when executing GSTARS 2.1 from *Project>Execute* you will always have to save the data in a file (you can create a new file or write over an existing one), even if you just saved that information using *Project>Generate Input*.



During the GSTARS 2.1 run a progress bar will be displayed, as shown in the picture to the left. After the run is completed, the GUI will automatically load the resulting output files and prepare the data for viewing. The *View Output* window will automatically pop-up and the data can be accessed by clicking on the desired buttons (see figure below). The *View* buttons will display data in text (ASCII) format, and the *Plot* button will plot bed and water surface profile data in graphic format. Cross-sectional data can be viewed by pressing the *Output* button in the working window.



Pending Issues

This tutorial was developed for version 1.0 of the GSTARS 2.1 Graphical User Interface. Due to the complexity of developing such a program and releasing it for the first time, it is likely that some imperfections remain in spite of all the efforts. It is hoped that they will not diminish the usefulness of the program. However, some known issues are presented here.

As described earlier in this tutorial, both the English and the Metric systems of units can be used by selection the desired choice from the pull down menu in the *River Units* dialog window (*Edit>River>Edit River Parameters* menu), as shown in the figure to the right. Units are not shown in most dialog boxes (consult the GSTARS 2.1 User's Manual if in doubt). In the few instances that they are shown, you should see the appropriate units for the selected system. The exception is in the *Record QS,QR* tab in the *Sediment Transport Dialog* window, where the units of the coefficients used in the rating curve are only shown in the English system.

When starting data entry in one system of units and then changing to the other, there is no unit conversion performed in the data already entered. Example: suppose data is entered in the English system. A water discharge of, say, 1000 ft^3/s is specified. Upon changing to the Metric system, the GUI will now have a discharge of 1000 m^3/s.

Sometimes the GUI appears to behave improperly. The most frequent reason for this to happen is the existence of wrong (illegal) data values. Be careful when importing GSTARS data files that contain errors.

When the GSTARS 2.1 numerical engine aborts with an error, the GUI sometimes does not automatically load the generated output files (i.e., the .out, .dbg, and other output files), therefore making it impossible to see what error occurred. If this happens simply load the output files from

the menu *File>Load Output File* in the working window. The files can then be viewed in the usual manner.

Use the GUI in a logical manner. Enter data in sequence. Start by entering cross section data, even if only partially (cross sections can be added, removed, and edited at a later time). Do not enter discharge data before entering cross section and project data. Do not enter sediment data before defining the discharge data. Because data is interdependent, cross-check your numbers frequently. Don't forget that changing the number of cross sections impacts many other parameters, such as location of the outlet boundary condition (where water surface elevation is defined) and of possible tributaries. Likewise, changing the number of time steps impacts many other parameters. Although the GUI performs some basic checking, it is impossible to predict the user's intentions and, therefore, any automatic corrections to the data are potentially flawed.

Finally, check the GSTARS 2.1 Web site (go to http:/www.usbr.gov/srhg/ and follow the respective links) for new versions of the code.