RECLAMATION

Managing Water in the West

DRAFT SRH-Capacity User Manual Version 1.37

U.S. Department of the Interior
Bureau of Reclamation
Technical Service Center
Denver, Colorado

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SRH-Capacity User Manual

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1. Introduction

1.1 Background

SRH-Capacity was developed by Jianchun Victor Huang and Blair P. Greimann at the Sedimentation and River Hydraulics Group, Technical Service Center, Bureau of Reclamation. The purpose of the model is to compute sediment transport capacity for a given set of hydraulics and flow value.

1.2 SRH-Capacity Capabilities

SRH-1D is a hydraulic and sediment transport numerical model developed to calculate the sediment transport capacity, incipient motion, and annual sediment loads. Some of the model's capabilities are:

- Sediment transport capacity in a river reach given reach hydraulics.
- Incipient motion hydraulics for each sediment size class.
- Optional annual sediment load.
- Multiple non-cohesive sediment transport equations that are applicable to a wide range of hydraulic and sediment conditions.

1.3 Disclaimer

The program SRH-Capacity and information in this manual are developed for use at the Bureau of Reclamation. Reclamation does not guarantee the performance of the program, nor help external users solve their problems. Reclamation assumes no responsibility for the correct use of SRH-Capacity and makes no warranties concerning the accuracy, completeness, reliability, usability, or suitability for any particular purpose of the software or the information contained in this manual. SRH-Capacity is a program that requires engineering expertise to be used correctly. Like other computer programs, SRH-Capacity is potentially fallible. All results obtained from the use of the program should be carefully examined by an experienced engineer to determine if they are reasonable and accurate. Reclamation will not be liable for any special, collateral, incidental, or consequential damages in connection with the use of the software.

2. Input Data Needed

The following input data are needed to run SRH-Capacity

1. Hydraulics for typical cross-section or river reach where sediment transport capacity is to be computed.
2. Particle size gradation data of sediment.
3. Optional hydrology data.

3. Running SRH-Capacity

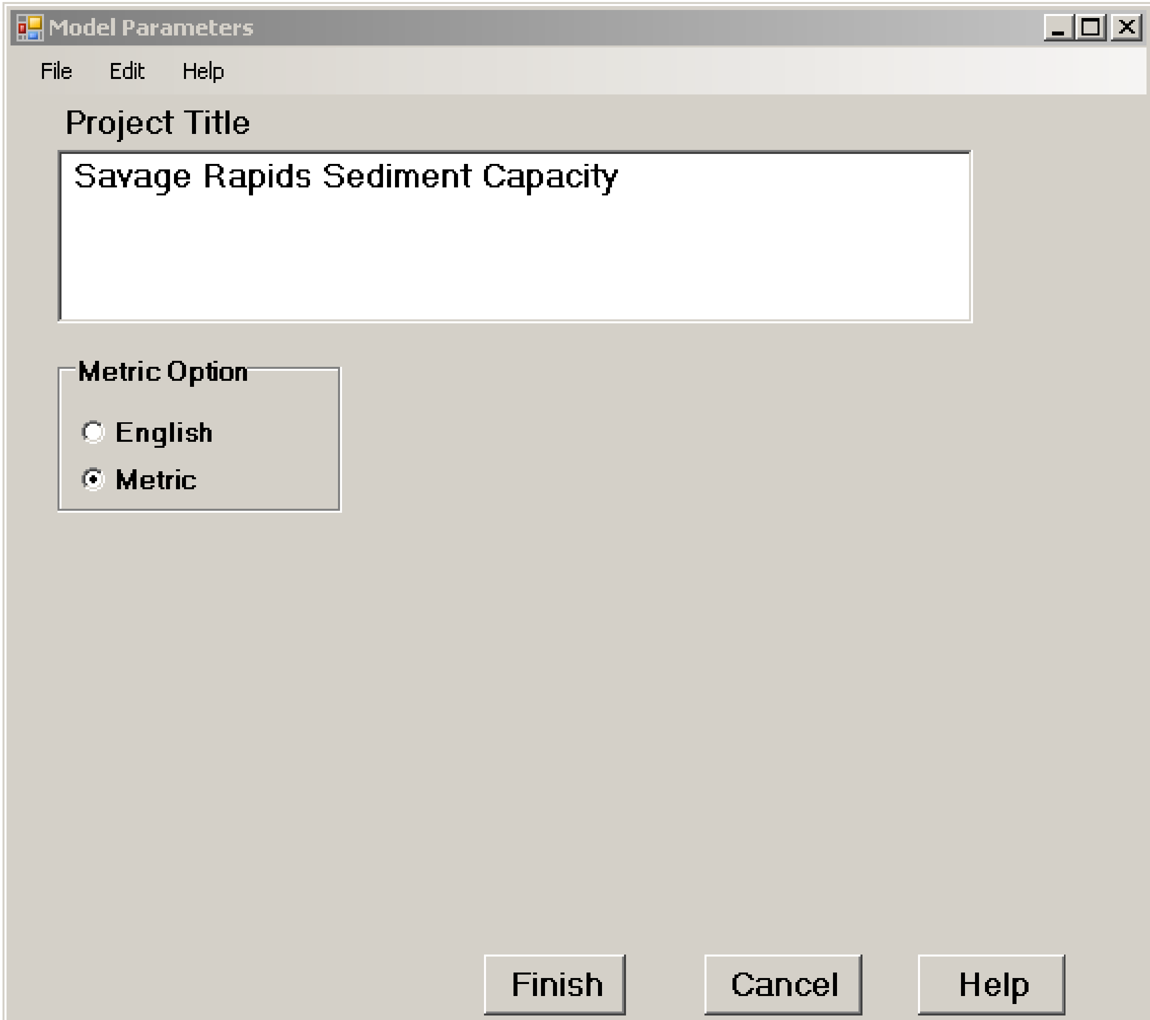
In order to run SRH-Capacity, the user must install the program, enter the necessary input data, and then run the program. The necessary input data consists of the model parameters, sediment data, flow data (hydraulics), and hydrology data, all of which can be found under the edit drop-down menu.

Step 1: Installation

Install the program using the executable file. Administrative rights are needed to install the program but are not required to run the program. The program is designed to run on windows. Once installed, the program should be available through the start, programs menu under the SRH folder.

Step 2: Enter Model Parameters

Under this module, the user enters a project title and selects either English or Metric for input data and output units. When done entering data, hit the “finish” button and move on to the next step.

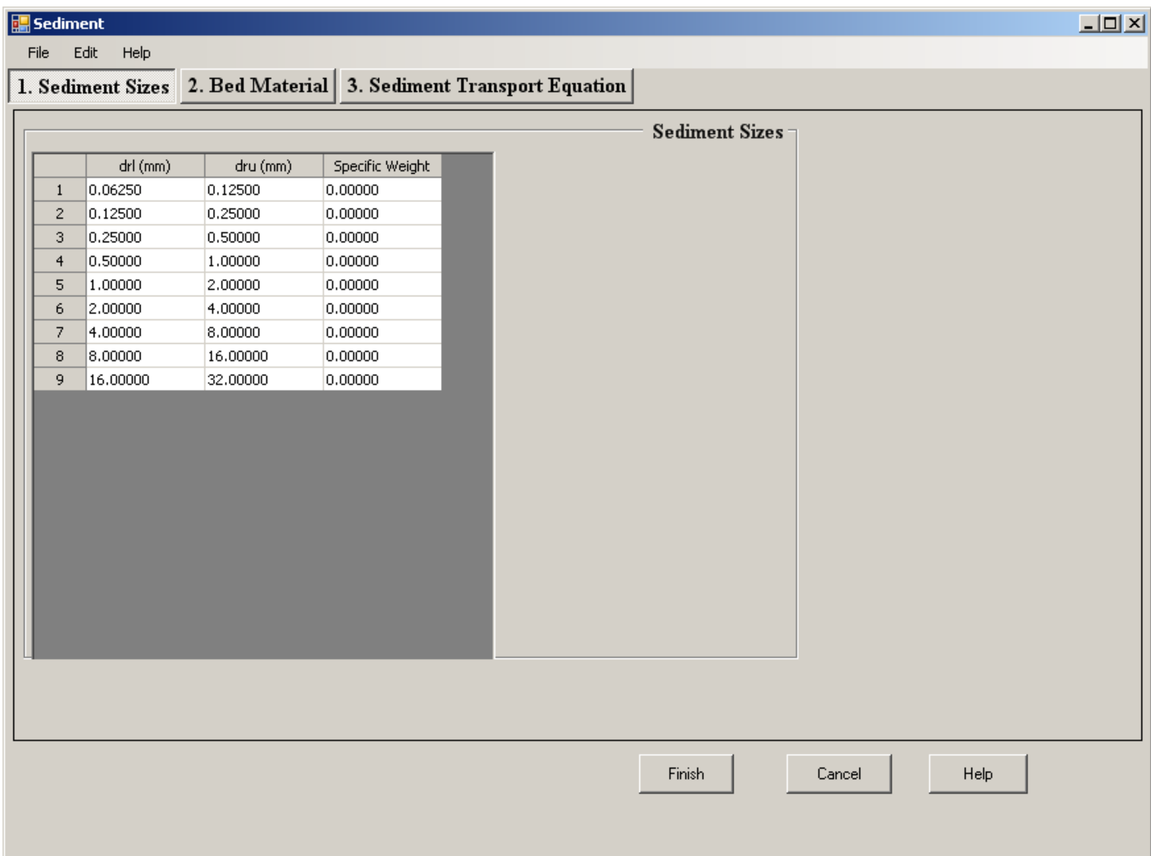


Step 3: Enter Sediment Data

Step 3a: Enter sediment sizes

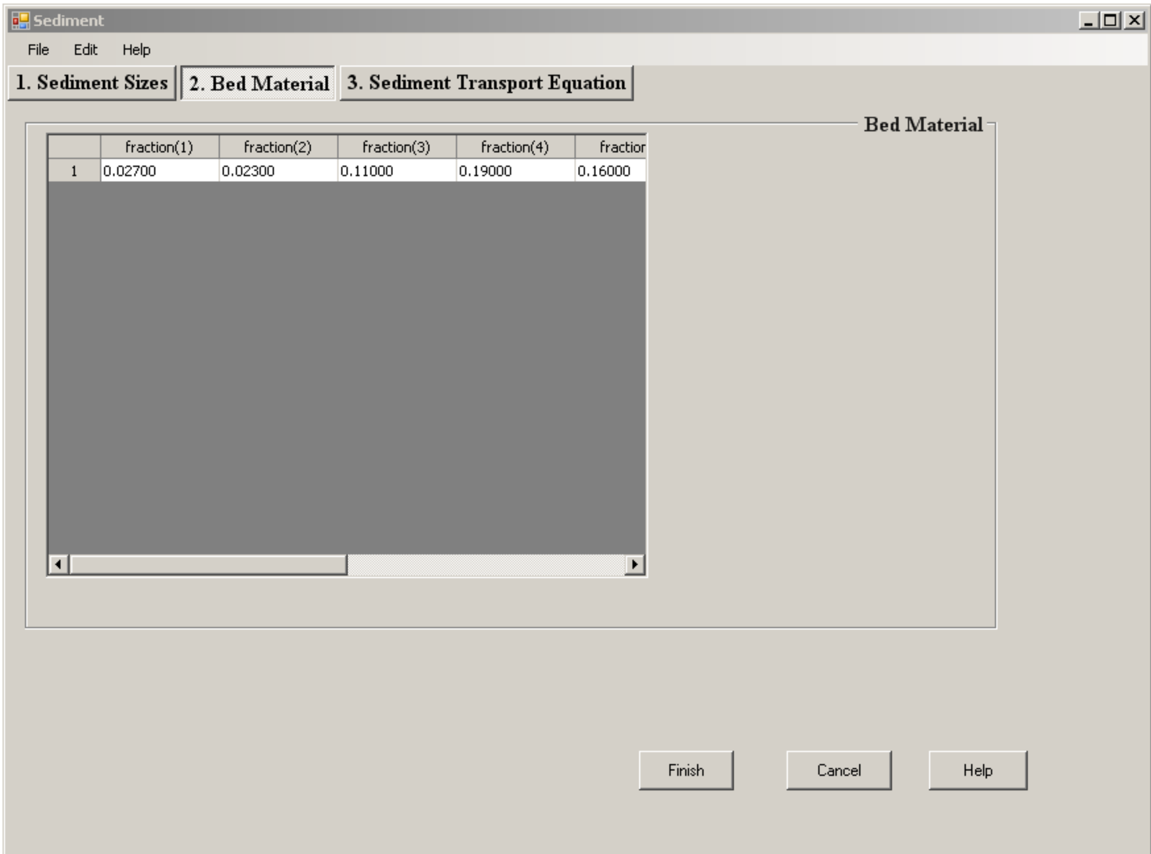
Under this step, the user enters bins of sediment size classes that capture the range of size classes to be computed. Typical size class ranges are shown in Table 1. Note that sediment transport capacity computations are usually limited to sediment particles that are mobilized as bed material load, ranging from sand to cobble-sized sediment. Size classes are always entered in millimeters (mm) regardless of units selected under the model parameters step. Sediments in silt and clay range are considered as cohesive sediments in SRH-Capacity, and their transport rates are site-specific and can not to be simulated by SRH-Capacity. A specific weight can also be entered, but if not known the user may just enter 0 to have the default values utilized. When done entering data, hit the “finish” button and move on to the next step.

Description	Lower bin (mm)	Upper bin (mm)
Silt and clay	0.0005	0.0625
Very fine sand	0.062	0.125
Fine sand	0.125	0.25
Medium sand	0.25	0.5
Coarse sand	0.5	1
Very coarse sand	1	2
Very fine gravel	2	4
Fine gravel	4	8
Medium gravel	8	16
Coarse gravel	16	32
Very coarse gravel	32	64
Small cobble	64	128
Large cobble	128	256
Boulders	256	4096



Step 3b: Enter percent retained for each sediment size class

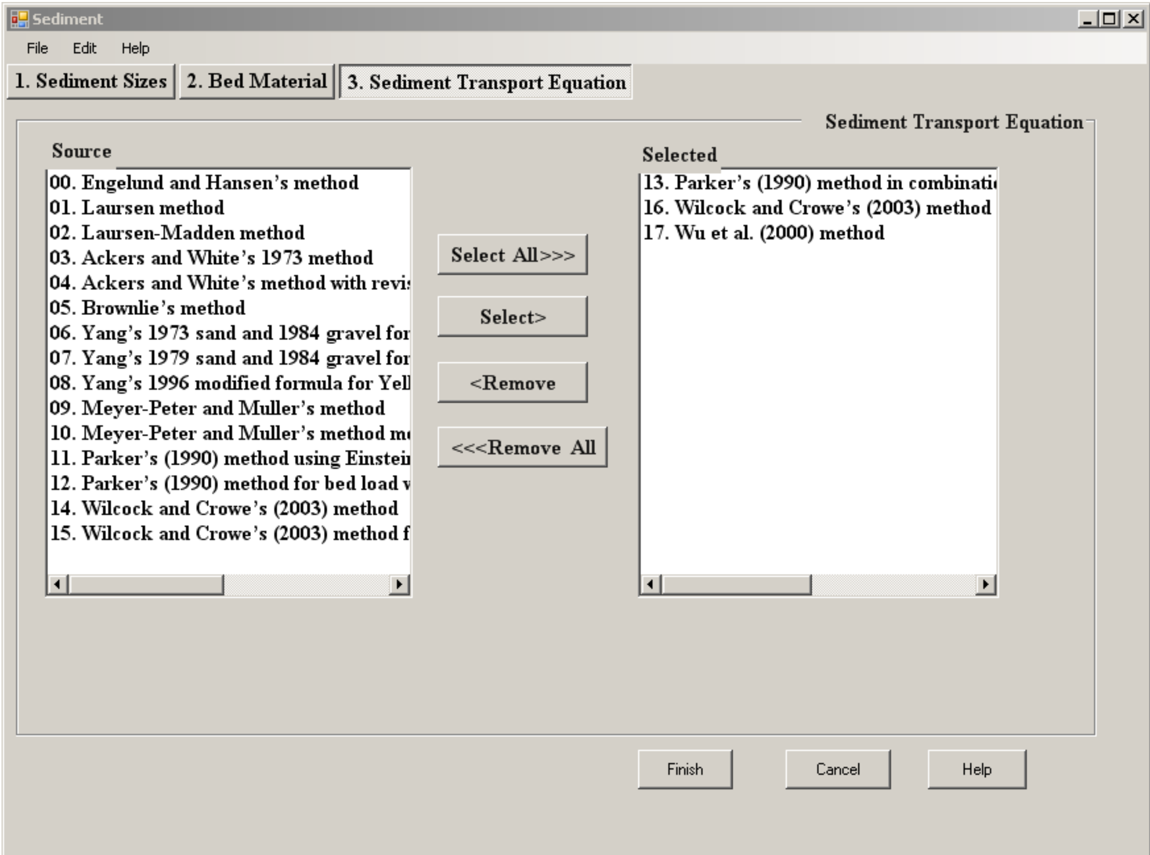
In this step the user enters the individual (not cumulative) percent of sediment retained between each size fraction range entered in step 3a. Each row entered in the program in step 3a (sediment sizes) is referenced in this step by RiverReach (e.g. row 1 is referenced as RiverReach 1; row 2 is referenced as RiverReach 2, and so on). Users can right click the table to show the menu and change the row number of the table. The sediment size percent of sediment class i defined in Step 3a is input in column i (fraction(i)). The sediment percent in a reach should sum up to 1 or 100. When done entering data, hit the "finish" button and move on to the next step.



Step 3c: Select Sediment Transport Formula(s)

The literature contains many sediment transport functions. Usually, each transport equation was developed for a certain range of sediment size and flow conditions. Most sediment transport equations predict transport capacity for each grain size separately. Computed results based on different transport equations can differ significantly from each other and from actual measurements. No universal equation exists which can be applied with accuracy to all sediment and flow conditions. Many predictive sediment transport equations have been programmed to facilitate their use.

The choice of a predictive sediment transport equation depends primarily on the sediment particle grain size and on the experience of the user. Different equations can give a large range of results and when applied improperly can lead the user to incorrect conclusions. In this program, more than one equation can be selected concurrently in order to compare results before making final interpretations on sediment transport capacity. When Parker's method (1990) or Wilcock and Crowe's (2003) methods is selected, sensitivity analysis can be performed by changing the reference Shield's number and hiding factor.



Some predictive sediment transport equations that are often used for sand-sized sediment are listed below:

- Engelund and Hansen (1972),
- Ackers and White (1973),
- Yang (1973),
- Yang (1979),

Some predictive sediment transport equations that are often used for gravel-sized sediment are listed below:
- Wilcock and Crowe (2003),
- Parker (1990),
- Meyer-Peter and Müller (1948)
- Yang (1984)

Some predictive sediment transport equations that are often used for rivers with both sand and gravel-sized sediment are listed below:
- Parker (1990) and Engelund and Hansen combined.

- Wilcock and Crowe (2003) and Hansen combined
- Wu (2004)

When done entering data, hit the "finish" button and move on to the next step.

Step 4: Flow (Hydraulics)

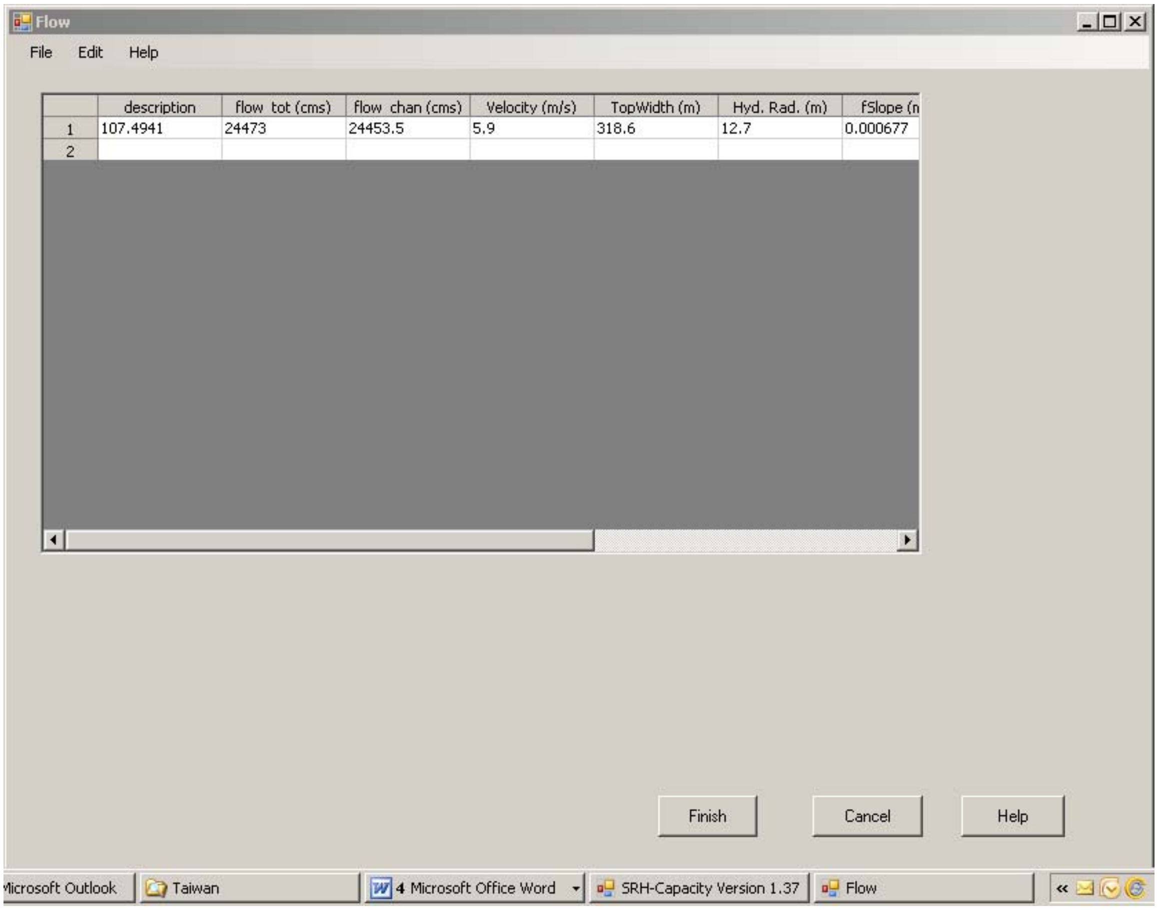
Under the flow category, the user enters information on the stream hydraulics. Stream hydraulics should be computed at a typical (representative) cross-section or alternatively, a reach-average of several cross-sections for which sediment transport capacity is of interest. Generally hydraulics are entered for the active, unvegetated portion of channel where the majority of sediment is being transported. Most 1D hydraulics programs, such as the Army Corps of Engineers HEC-RAS, allow the user to produce hydraulic output specifically for the channel area. If field data indicate that the floodplain transports large amount of sediment, the hydraulics for the whole channel should be used instead.

The following parameters are required as input:

- description – text description of cross-section or reach without space
- flow tot (cfs or cms) – total flow for entire cross-section.
- flow chan (cfs or cms) – flow conveyed in main channel for which hydraulics are entered.
- velocity (ft/s or m/s) – computed or estimated cross-sectional average main channel velocity.
- top width (ft or m) – computed or estimated wetted top width of main channel.
- hydraulic radius (ft or m) – computed value.
- fSlope – computed friction slope.
- Slope (ft/ft or m/m) – estimated bed slope in reach of interest.
- Temperature (C or F)– water temperature.
- indexRiverReach – corresponds to row number (river reach) in Step 3b.

When done entering data, hit the "finish" button and move on to the next step.

NOTE: when you copy data from an excel file, make sure that the last column for indexRiverReach is copied right in place.



Step 5: Hydrology

Under the Hydrology category, the user enters information on flow frequency. The hydrology data is option, and is only required to estimate the annual sediment load assuming the sediment transport is in equilibrium state, e.g., the sediment transport in the river reach is the same as the stream sediment transport capacity.

The following parameters are required as input:

- description – text description of flow rate (without space)
- discharge (cfs or cms) – total flow rate.
- probability – flow frequency which sums up to 1 for a reach defined by indexRiverReach.
- indexRiverReach – river reach index defined in Step 3b and used in Step 4.

When done entering data, hit the “finish” button and move on to the next step.

Step 6: Save Input File

The user can save the file during any step of the input for later use by selecting "export SRH-capacity input file" under the file drop-down menu.

Step 7: Run Model

To run the model, the user first selects "check all data" under the run menu. If all the input data has been entered correctly, the programs displays a text box as shown below.

Once the input data has passed, the user selects run. The program will then let the user know with a text box when the sediment transport capacity computations have been completed (there is a series of 3 text boxes to represent each set of computations).

Step 8: Model Output

The model output is provided within the program or can be saved to an output text file. To view the results within the program, click on the plot discharge vs capacity button. Under this module, the user can change sediment transport capacity equation if multiple equations were selected or change reaches if hydraulics for multiple locations (reaches) were entered.

To view the results in a text editor or other program, select "export sediment capacity results" under the file pull down menu. A sample ASCII output file is provided in

Attachment A. The program also has the capability to export in a Tecplot format, a model output post-processing and viewing software.

The Sediment Capacity output contains the following information:

- Unit choice.
- Sediment size fraction input data.
- Hydraulics (flow module) input data.
- #QsPotential(i)=sediment transport capacity for size i if all bed material are in size i.
- #QsCapTotal=Total sediment transport capacity.
- #QsCapacity(i)=sediment transport capacity for size i.
- Incipient motion computations for d50 and each size class to document the minimum flow at which that sediment size class can be mobilized; flow listed is limited to the flows entered. If Parker (1990) or Wilcock and Crowe (2003) sediment transport equations are used, incipient motion is computed based on the default or used input reference Shield's number. Sediment transport rates are exceedingly small if Shield's number is smaller than reference number. The incipient motion for each size class is calculated to find the incipient discharge assuming that the bed contained only uniform sediment of that size or the d50 is of that size. For all other methods, incipient motion is assumed if the volumetric sediment concentration per unit width for *i*th fraction is greater then $0.002 p_{bi} V_*^3 /[(s-1)g]$, where p_{bi} is the gradation of the *i*th fraction of bed material, V_* is shear velocity, *s* is sediment specific weight, and d_i is the sediment size.

The Annual Sediment Load output contains the following information:

- QsAnnual(i) = annual sediment transport capacity for size *i*.
- QsAnnualTotal = total annual sediment transport capacity.

Attachment A: Sample Output File