DRAINAGE DESIGN MANAGEMENT SYSTEM FOR WINDOWS

VERSION 5.6.0

Tutorial # 21
Pressure Flow Scour Analysis
HEC-18 Procedure

KVL Consultants, Inc.

PRESSURE FLOW SCOUR ANALYSIS (HEC-18 PROCEDURE)

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1.0 PROBLEM STATEMENT

A pressure flow scour depth under the bridge inundation conditions is computed using equation developed by FHWA (2012). Based on the transport of bed material, there are two conditions for pressure flow scour: live-bed condition and clear-water condition. A typical bridge inundation flow is shown below.

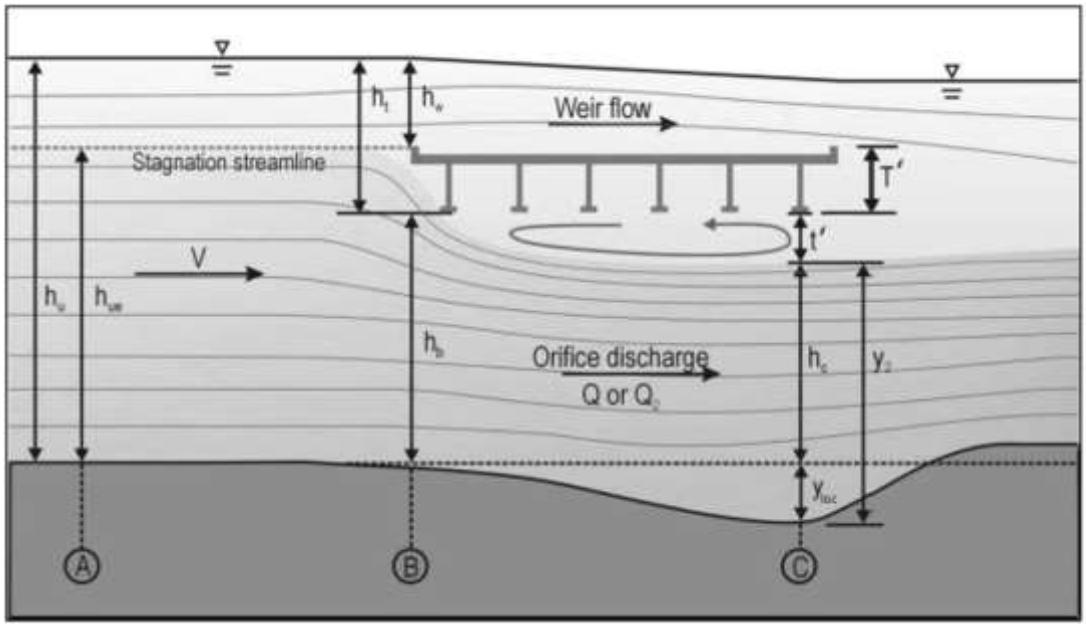


Figure 1: Vertical contraction under the bridge (FHWA, 2012)

2.0 PRESSURE FLOW SCOUR FOR LIVE-BED CONDITION

To estimate the pressure flow scour using HEC-18 procedure use the following given conditions:

- The Cross Section "*BRIDGE_SEC*"
  - Parameters for Hydraulics and Geometry:
    - **Design Flow Rate (cfs):** *600*
    - **Dominant Flow Rates (cfs):** *800*
    - **Channel Slope** for **Design Flow (ft/ft):** *0.005*
    - **Channel Slope** for **Dominant Flow (ft/ft):** *0.005*
    - **Channel Manning's n** for **Design Flow:** *0.035*
    - **LOB Manning's n** for **Design Flow:** *0.035*
    - **ROB Manning's n** for **Design Flow:** *0.035*
    - **Channel Manning's n** for **Dominant Flow:** *0.035*
    - **LOB Manning's n** for **Dominant Flow:** *0.035*
    - **ROB Manning's n** for **Dominant Flow:** *0.035*

- **The geometric data (station and elevation) of the cross section:**

Station (X)	Elevation (Y)	Notes
0	*30*	
5	*23*	*Left Bank Station*
10	*12*	
15	*11*	
18	*14*	
22	*22*	*Right Bank Station*
25	*30*	

❖ The Cross Section "*UPSTREAM_SEC*"

➢ Parameters for Hydraulics and Geometry:

- **Design Flow Rate (cfs):** *900*
- **Channel Slope** for **Design Flow (ft/ft):** *0.012*
- **Channel Manning's n** for **Design Flow**: *0.040*
- **LOB Manning's n** for **Design Flow:** *0.040*
- **ROB Manning's n** for **Design Flow:** *0.040*
- **The geometric data (station and elevation) of the cross section:**

Station (X)	Elevation (Y)	Notes
0	*25*	
6	*18*	*Left Bank Station*
8	*16*	
14	*13*	
22	*14*	
28	*18*	*Right Bank Station*
35	*19*	
41	*25*	

❖ Parameters for ***live-bed condition and non-overtopping case calculation***:

- **Particle size D_{50} (ft)**: *20.00*
- **Bottom width of upstream channel, W_1 (ft)**: *210.00*
- **Bottom width of contraction less piers, W_2 (ft)**: *40.00*
- **Vertical size of the bridge opening, h_b (ft)**: *3.00*
- **Height of the obstruction, T (ft):** *0.50*

2.1 Step-by-Step Procedures

Step 1: Establish a New River Mechanics Project and Defaults Set-up

Step 2: Prepare cross section hydraulics data

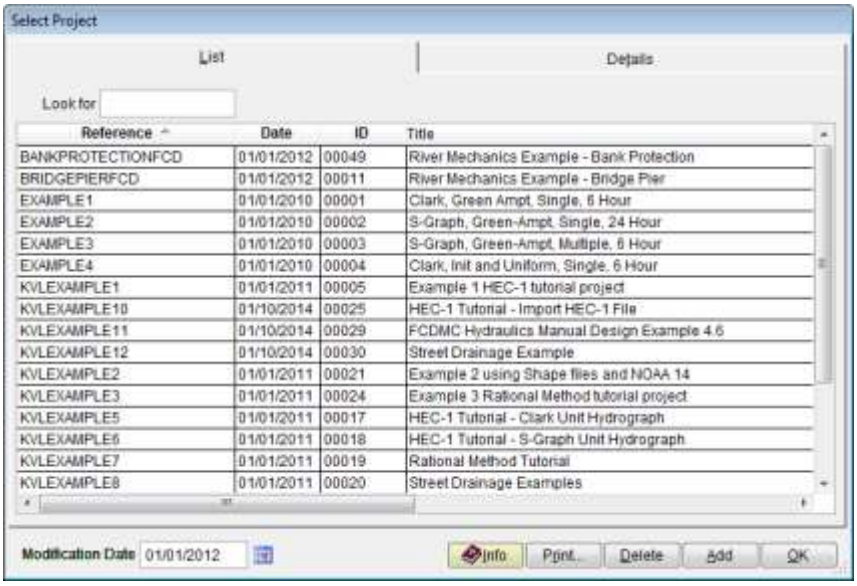
Step 3: Calculate Pressure Flow Scour

Step 4: Report and Document the results

2.1.1 Step 1 - Establish a New Project and Defaults Set-up

(a) Click the **DDMSW** icon on the Desktop or Program menu to launch the **DDMSW.** Click the **OK** button to accept the software disclaimer as shown in the following figure.

After the **DDMSW** is launched, the **SELECT PROJECT** window is automatically opened as shown in the following figure.



(b) Click the **Add** button on the **SELECT PROJECT** window to start a new project (Or **File ➔ New Project ➔ Add**).

(c) Select **River Mechanics** checkbox and click the **OK** button on the **NEW PROJECT OPTIONS** form.

(d) Type "*PRESSURE_SCOUR*" into the **Reference** textbox. This is the name of this newly created project. Users can choose any name for the Reference textbox as long as it does not exist in the current **DDMSW** project database.

(e) Type into the **Title** textbox a brief descriptive title for this project. ***(Optional)***

(f) Type into the **Location** textbox the location of this project. ***(Optional)***

(g) Type into the **Agency** textbox the agency or company name**.** ***(Optional)***

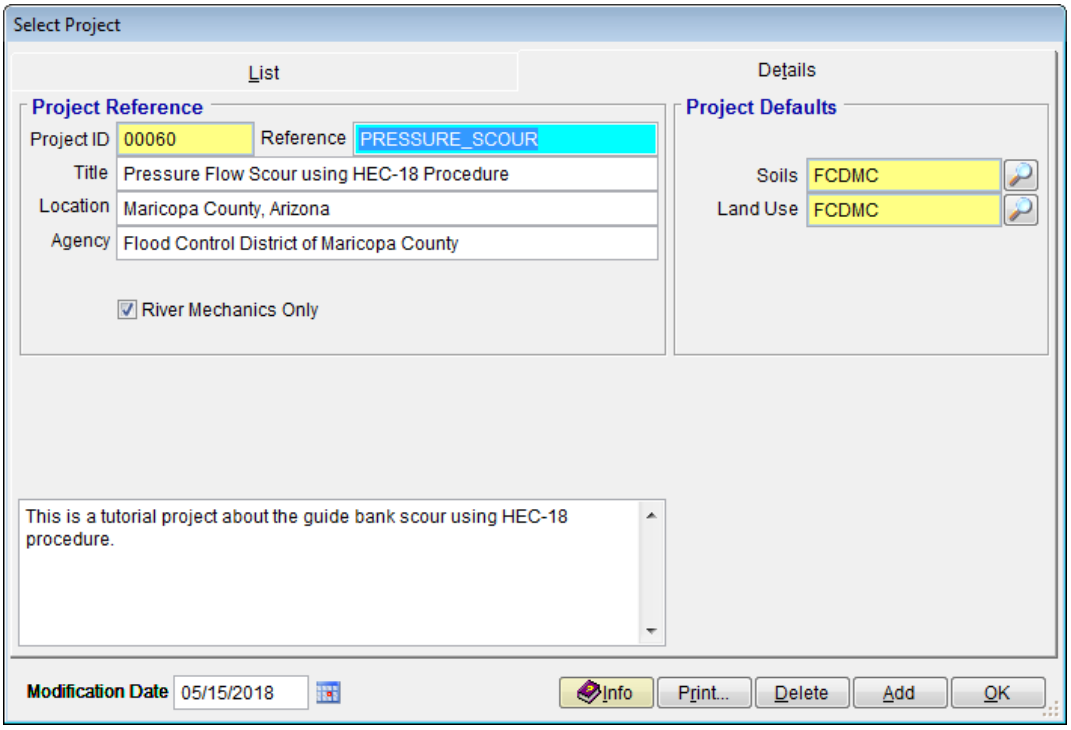
(h) Check **River Mechanics Only** checkbox for this project.

(i) Type a detailed description of this project into the comment area under the **Project Reference** frame. ***(Optional)***

(j) Set the Modification Date using today's date by clicking on the Calendar icon.

(k) Click the **Save** button to save the entered data.

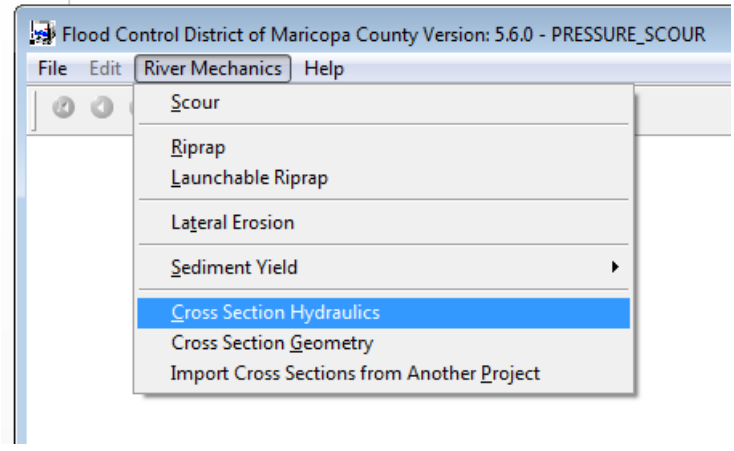
(l) Click the **OK** button on the **SELECT PROJECT** window, and click the **OK** button on the pop-up message box. The following figure shows what the window looks like.



Note: the **Project ID** *"00060"* in the above figure is the unique database record identifier for the project, which is automatically generated by the program when a new project is created. When users create a new project, the **Project ID** of the new project will not be the same as the **Project ID** shown in the above figure.

2.1.2 Step 2 - Prepare cross section hydraulics Data

From the menu bar of main application window, click **River Mechanics** ➔ **Cross Section Hydraulics**, to open **RIVER MECHANICS – CROSS SECTION HYDRAULICS** form.



2.1.2.1 Entering Data for "*BRIDGE_SEC*" cross section

(a) Type "*BRIDGE_SEC*" into the blue textbox inside **Section ID** frame.

(b) Check both **Design** and **Dominant** check boxes.

(c) Enter *0"* into the **Flow Rate (cfs)** textbox under **Design** check box column.

(d) Enter *"* *"* into the **Flow Rate (cfs)** textbox under **Dominant** check box column.

(e) Enter "*0.005"* into the **Slope (ft/ft)** textbox under **Design** check box column.

(f) Enter "*0.005"* into the **Slope (ft/ft)** textbox under **Dominant** check box column.

(g) Enter *"0.035"* into **Manning's n Channel** textbox under **Design** check box column.

(h) Enter *"0.035"* into **Manning's n LOB** textbox under **Design** check box column.

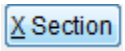
(i) Enter *"0.035"* into **Manning's n ROB** textbox under **Design** check box column.

(j) Enter *"0.035"* into **Manning's n Channel** textbox under **Dominant** check box column.

(k) Enter *"0.035"* into **Manning's n LOB** textbox under **Dominant** check box column.

(l) Enter *"0.035"* into **Manning's n ROB** textbox under **Dominant** check box column.

(m) Click the **Save** button to save the entered data.

(n) Click on *"X Section"* button 

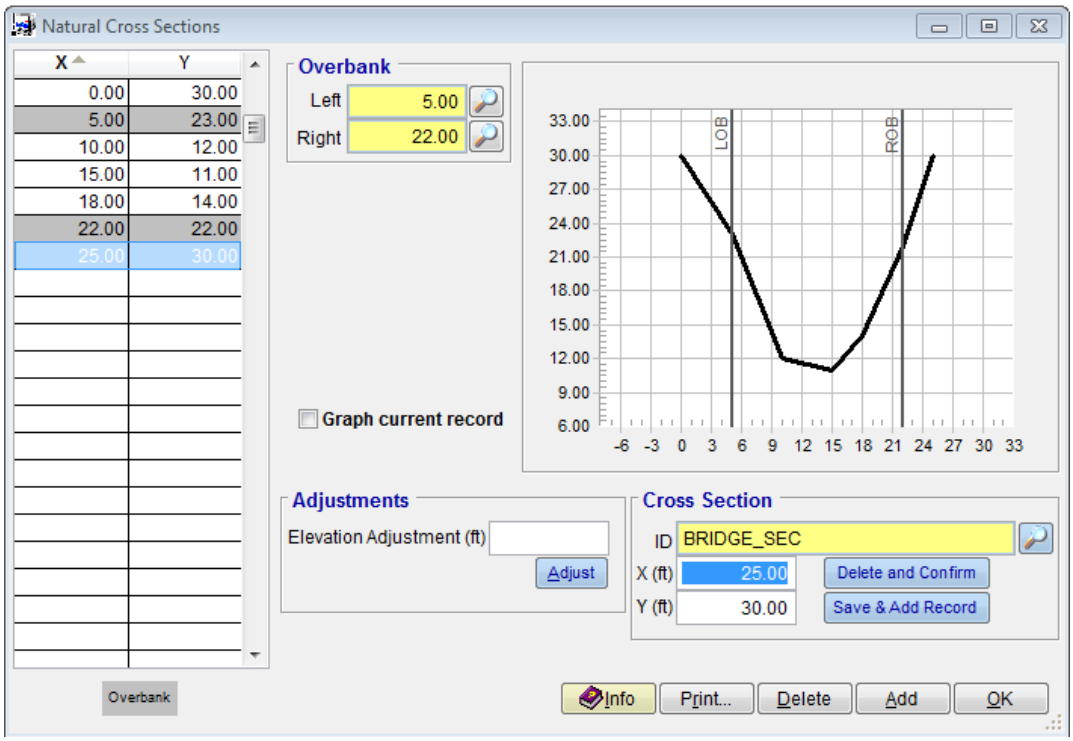
at the bottom to enter x and y ordinates for channel cross section.

(o) Enter first X and Y values (X: 0 and Y: 25) from the following table in **X (ft)** and **Y (ft)** text box of *"Natural Cross Sections – Edit" window*. After entering the data click on *"Save & Add Record"* button. Now enter all values of X and Y from following table.

Station (X)	Elevation (Y)	Notes
0	*30*	
5	*23*	*Left Bank Station*
10	*12*	
15	*11*	
18	*14*	
22	*22*	*Right Bank Station*
25	*30*	

(p) After entering all X and Y values set left and right over bank by selecting the row with X value of "5" on X and Y table on the left and then clicking a "Selection" button next to left text box in "Natural Cross Sections" window to set left over bank and by selecting the row with X value of "22" and then clicking a "Selection" button next to right text box in "Natural Cross Sections" window to set right over bank

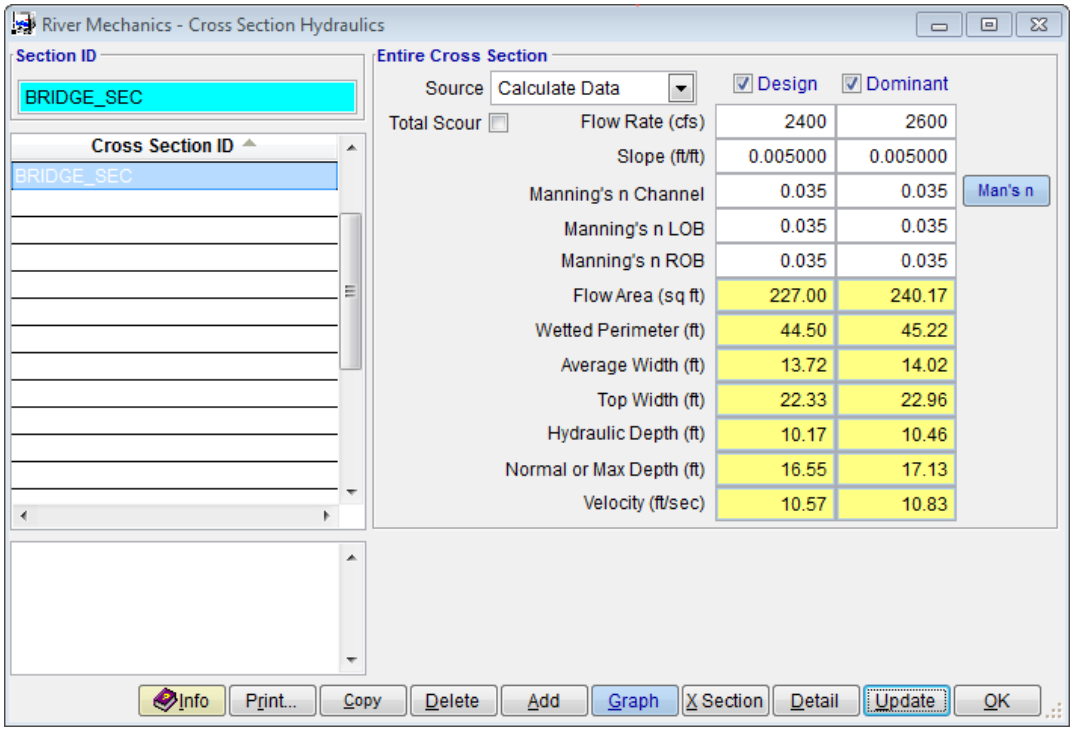
(q) Once all X and Y values are entered along with LOB and ROB station, the *"Natural Cross Sections"* window should look like following:



(r) Click on *"OK"* button to close the *"Natural Cross Sections"* window.

(s) Click on *"Update"* button to update the hydraulics for the *"BRIDGE_SEC"*.

(t) After the update is complete, the *"River Mechanics – Cross Section Hydraulics"* window should look like the following:



2.1.2.2 Entering Data for "*UPSTREAM_SEC*" cross section

(a) Now click on *"Add"* button in *"River Mechanics – Cross Section Hydraulics"* window to add data for *"UPSTREAM_SEC"*.

(b) Type "*UPSTREAM _SEC*" into the blue textbox inside **Section ID** frame.

(c) Check both **Design** check box only.

(d) Enter "  " into the **Flow Rate (cfs)** textbox under **Design** check box column.

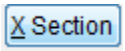
(e) Enter "*0.012"* into the **Slope (ft/ft)** textbox under **Design** check box column.

(f) Enter *"0.040"* into **Manning's n Channel** textbox under **Design** check box column.

(g) Enter *"0.040"* into **Manning's n LOB** textbox under **Design** check box column.

(h) Enter *"0.040"* into **Manning's n ROB** textbox under **Design** check box column.

(i) Click the **Save** button to save the entered data.

(j) Click on *"X Section"* button 

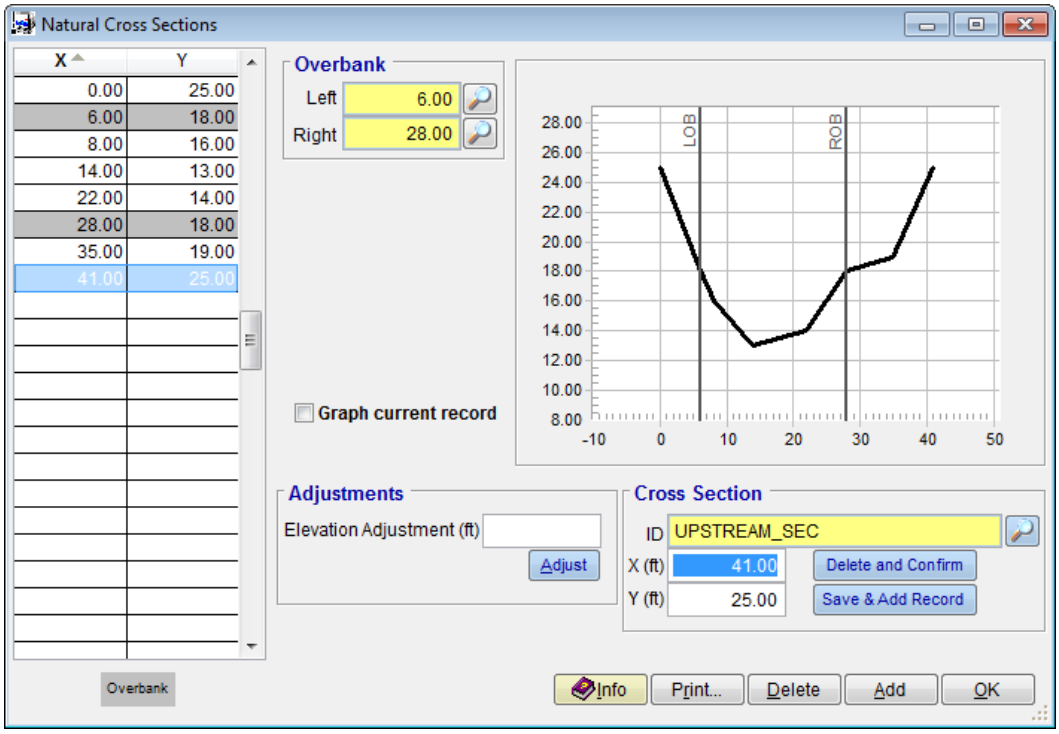
at the bottom to enter x and y ordinates for channel cross section.

(k) Enter first X and Y values (X: 0 and Y: 25) from the following table in **X (ft)** and **Y (ft)** text box of *"Natural Cross Sections – Edit" window*. After entering the data click on *"Save & Add Record"* button. Now enter all values of X and Y from following table.

Station (X)	Elevation (Y)	Notes
0	*25*	
6	*18*	*Left Bank Station*
8	*16*	
14	*13*	
22	*14*	
28	*18*	*Right Bank Station*
35	*19*	
41	*25*	

(l) After entering all X and Y values set left and right over bank by selecting the row with X value of "6" on X and Y table on the left and then clicking a "Selection"  button next to left text box in "Natural Cross Sections" window to set left over bank and by selecting the row with X value of "28" and then clicking a "Selection"  button next to right text box in "Natural Cross Sections" window to set right over bank

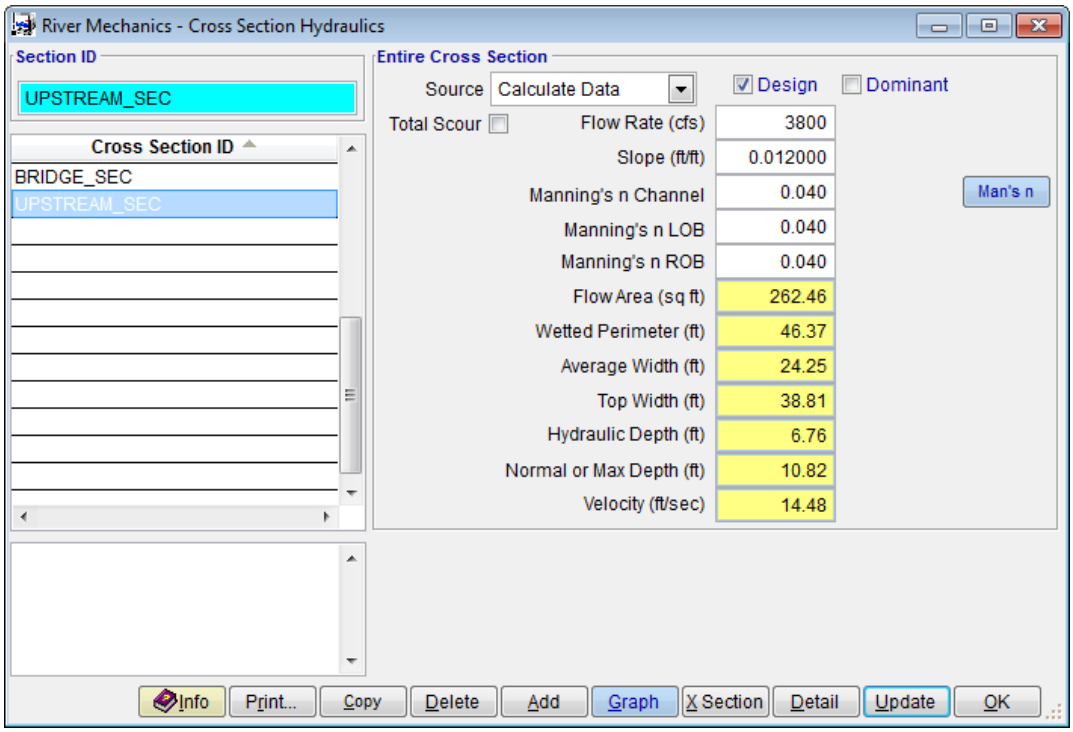
(m) Once all X and Y values are entered along with LOB and ROB station, the *"Natural Cross Sections"* window should look like following:



(n) Click on *"OK"* button to close the *"Natural Cross Sections"* window.

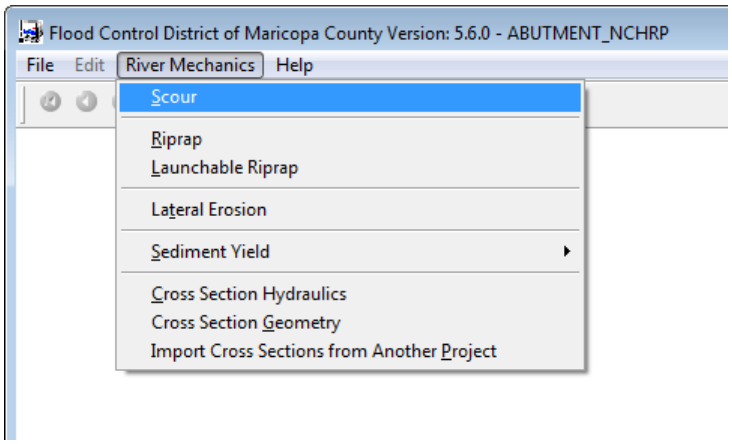
(o) Click on *"Update"* button to update the hydraulics for the *"BRIDGE_SEC"*.

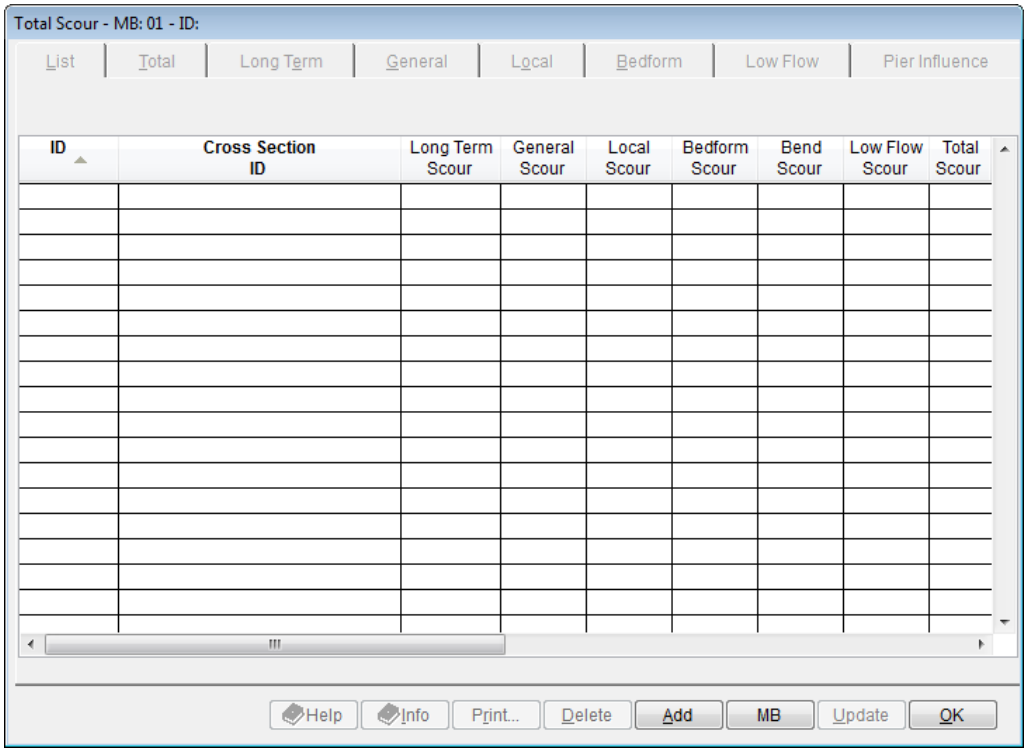
(p) After the update is complete, the *"River Mechanics – Cross Section Hydraulics"* window should look like the following:



2.1.3 Step 3 - Calculate the Pressure Flow Scour

(a) From the menu bar of main application window, click **River Mechanics** ➔ **Scour**, to open the **TOTAL SCOUR** form.



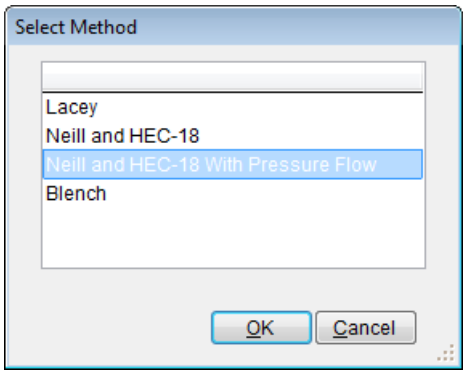


(b) Click the **Add** button to activate the necessary data entry fields.

(c) Type "*PRESS01*" into the **ID** textbox.

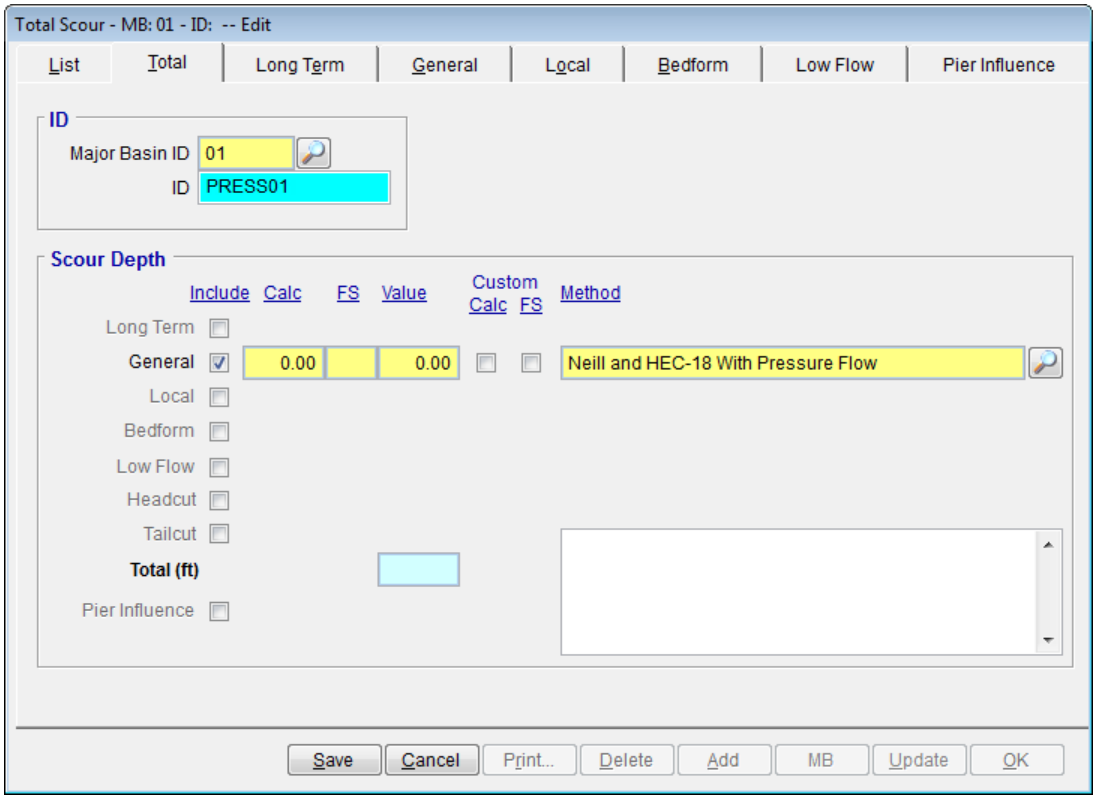
(d) Check the **General** Checkbox only.

(e) Click the browse button  in the **Method** column across **General** check box to launch local scour method select menu.



Select the "*Neill and HEC-18 With Pressure Flow*" from the **SELECT METHOD** window, and click **OK** to close the **SELECT METHOD** window

(f) Click the **Save** button to save the entered data. The **TOTAL SCOUR – MB: 01 – ID** window shows up like following figure.



(g) Click the **General** tab

(h) Select *"BRIDGE_SEC"* for *"Bridge Section ID"* inside *"Sections"* frame.

(i) Select *"UPSTREAM_SEC"* for *"Upstream Section ID"* inside *"Sections"* frame.

(j) Under *"Neill Parameters (use Bridge Section)"* frame, select *"Sand"* for **Exponent m** textbox and select *"Straight Reach"* for **Bend Factor Z** textbox.

(k) Enter *"20"* into the **D50 (mm)** textbox.

(l) Enter *"210"* into the **Bottom width of upstream channel, W1 (ft)** textbox.

(m) Enter *"40"* into the **Bottom width of contraction less piers, W2 (ft)** textbox.

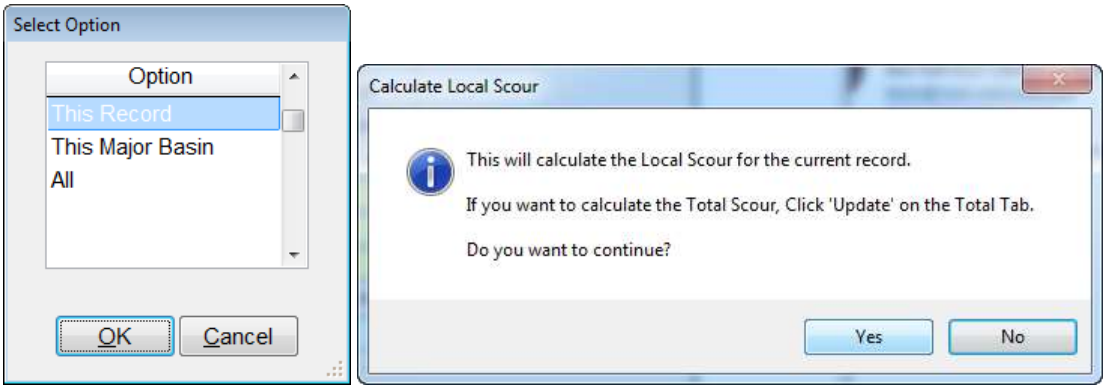
(n) Enter into the **Vertical size of the bridge opening, hb (ft)** textbox.

(o) Enter " " into the **Height of the obstruction, T (ft)** textbox.

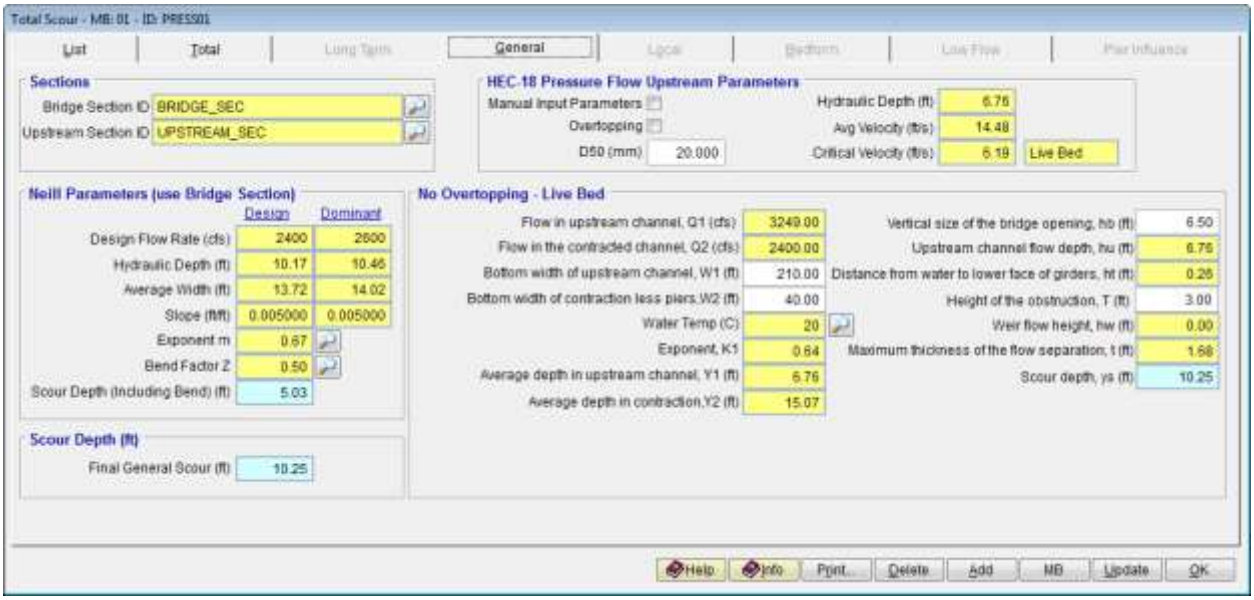
(p) Click the **Save** button to save the entered data.

(q) Click the **Update** button to update the data.

(r) Select "*This Record*" from the **SELECTION OPTION** window, and click **Yes** from the confirmation message to proceed.



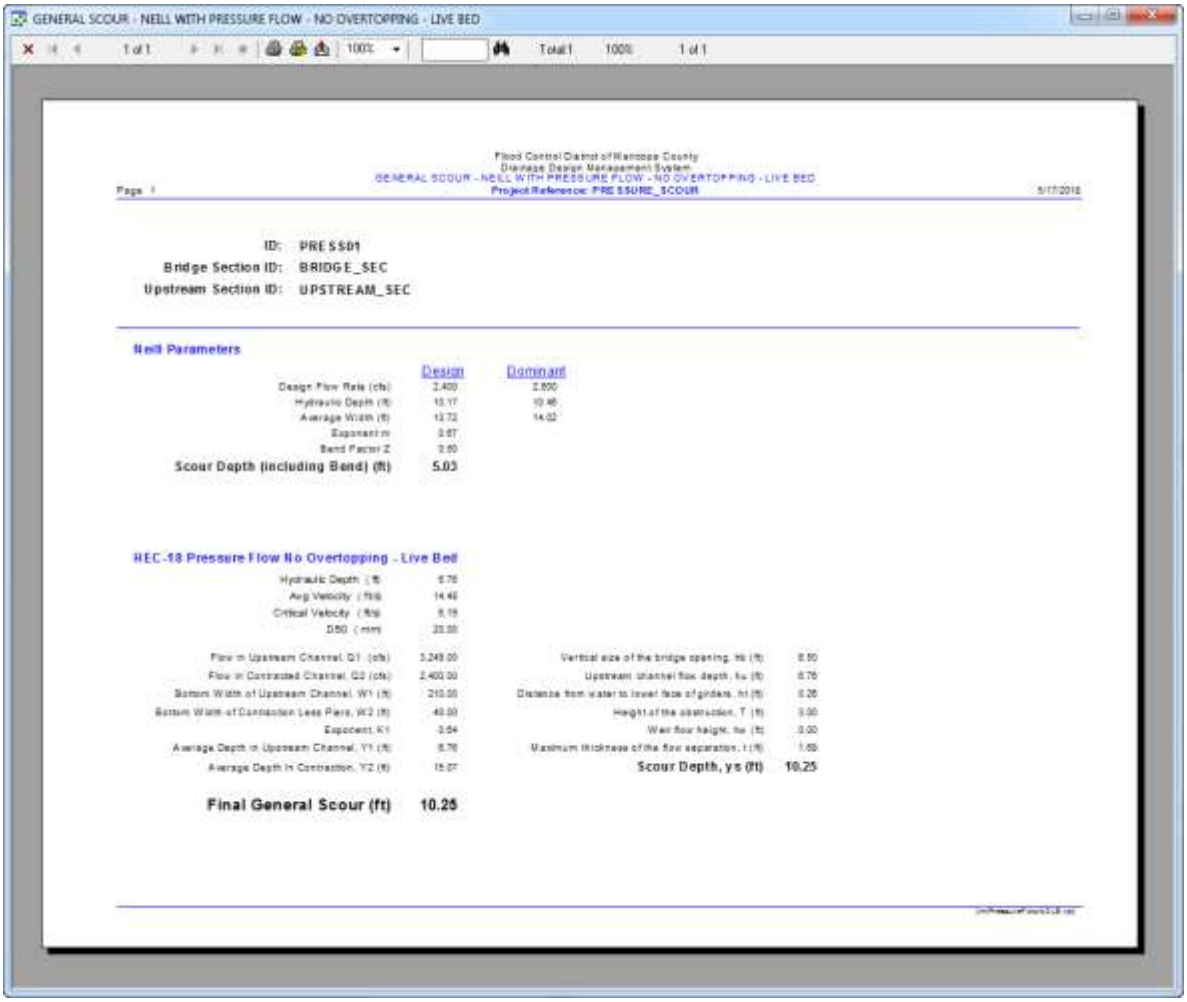
(s) After the update the window looks like what is shown in the following figure



2.1.4 Step 4 - Report and Document the Results

In this section, the instruction will be given on how to view, print, and export the calculation results of the guide bank scour.

(a) To view the results on the screen, click the **Print …** button on the Local Tab of **TOTAL SCOUR – MB: 01 – ID: PRESS01** window, a report will be generated as is shown in the following figure.



(b) To print out the results on a printer, click the printer symbol ( ).

(c) To export the results in PDF format or other formats, click the export symbol ( )

This concludes tutorial for Pressure Flow Scour.