DRAINAGE DESIGN MANAGEMENT SYSTEM FOR WINDOWS

VERSION 6.8.0

TUTORIAL # 20

GUIDE BANK SCOUR ANALYSIS

KVL Consultants, Inc.

GUIDE BANK SCOUR ANALYSIS
[HEC-18 PROCEDURE]

TABLE OF CONTENTS

No. Section Page

TUTORIAL # 20 1

GUIDE BANK SCOUR ANALYSIS 1

[HEC-18 Procedure] 1

1.0 Introduction 1

2.0 Guide Bank Scour For Live-Bed Condition 1

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

2.2 Step 2 - Set up Guide Bank Scour Basic Data 4

2.3 Step 3 - Calculate the Guide Bank Scour 7

2.4 Step 4 - Report and Document the Results 9

3.0 Guide Bank Scour For Clear-Water Condition 10

3.1 Step 1 - Establish a New Project and Defaults Set-up 10

3.2 Step 2 - Set up Guide Bank Scour Basic Data 13

3.3 Step 3 - Calculate the Guide Bank Scour – Grain Size Equation 16

3.4 Step 4 - Calculate the Guide Bank Scour – Shear Stress Equation 18

3.5 Step 5 - Report and Document the Results 21

GUIDE BANK SCOUR ANALYSIS
[HEC-18 PROCEDURE]
DATE UPDATED: MAY 7, 2024
TUTORIAL TIME: 40 MINUTES

1.0 INTRODUCTION

Based on the ratio between the embankment projected length (L) and floodplain width (B_f), guide bank scour can be computed based on two conditions: **Live-Bed Condition** and **Clear-Water Condition**. If the ratio (L/B_f) is greater than or equal to 0.75, the live-bed condition equations will be used. Conversely, if the ratio (L/B_f) is less than 0.75, the clear-water condition equations will be used. The guide bank scour procedure is similar to the abutment scour procedure under *'Spill-Through'*.

2.0 GUIDE BANK SCOUR FOR LIVE-BED CONDITION

If the L/B_f ratio is greater than or equal 0.75, the live-bed guide bank scour equations should be used to compute the local scour. The **Live-Bed Condition** is also referred as **Condition A** in the HEC-18 Manual of the Federal Highway Administration (2012).

The following sets of data are used for evaluating the guide bank scour under the live-bed condition.

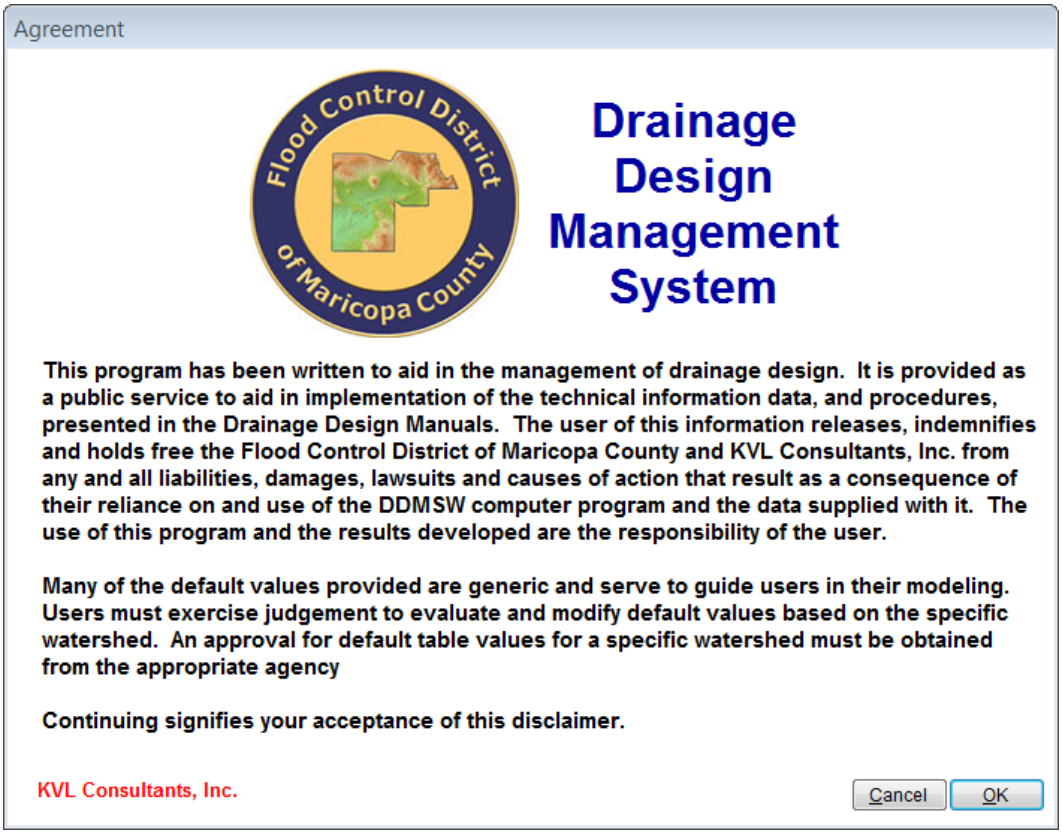
- Embankment and Floodplain Data:
  - Projected length of embankment, L (ft): *85.00*
  - Width of floodplain, B_f (ft): *100.00*
- Hydraulic Data:
  - Upstream flow depth, y_1 (ft): *10.00*
  - Unit discharge at upstream floodplain, q_1 (ft^2/s): *57.00*
  - Unit discharge at constricted opening, q_{2c} (ft^2/s): *78.60*
  - Flow depth prior to scour, Y_o (ft): *9.50*

The analysis procedure for evaluating guide bank scour for live-bed condition is summarized as follows:

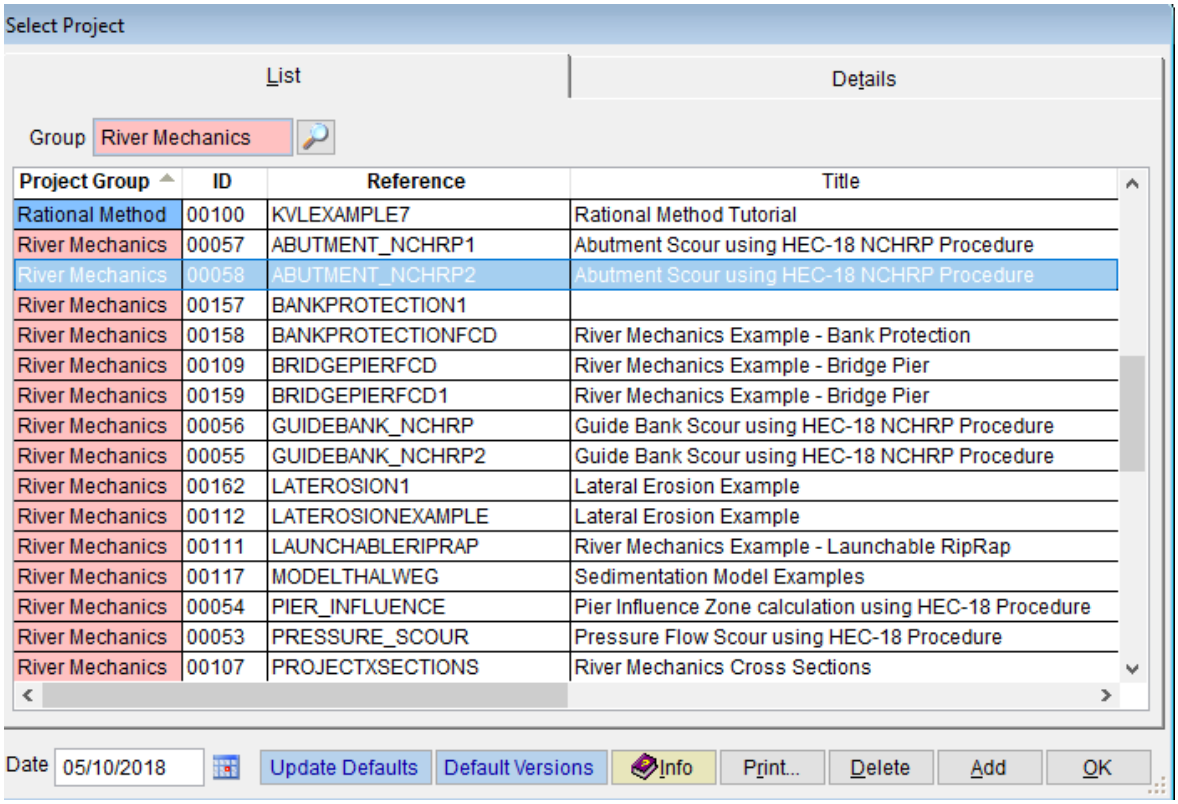
- Step 1: Establish a New River Mechanics Project and Defaults Set-up
- Step 2: Set up Guide Bank Scour Basic Data
- Step 3: Calculate Guide Bank Scour
- Step 4: Report and Document the results

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

(a) Start **DDMSW**. Click the ***OK*** button to accept the software disclaimer as shown below.



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



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

(c) Check the ***River Mechanics*** checkbox, then click the ***OK*** button to exit the **NEW PROJECT OPTIONS** dialog box.

(d) On the **SELECT PROJECT** form, enter '*V680_GUIDEBANK_NCHRP*' into the ***Reference*** textbox. This is the name of the new project. Users can choose any name for the ***Reference*** textbox as long as it does not already exist in the current **DDMSW** project database.

(e) Type into the ***Title*** textbox a brief descriptive title for this project *(Optional) (e.g., 'Guide Bank Scour using HEC-18 NCHRP Procedure').*

(f) Type into the ***Location*** textbox the location of this project *(Optional) (e.g., 'Maricopa County, Arizona')*

(g) Type into the ***Agency*** textbox the agency or company name *(Optional) (e.g., 'Flood Control District of Maricopa County').*

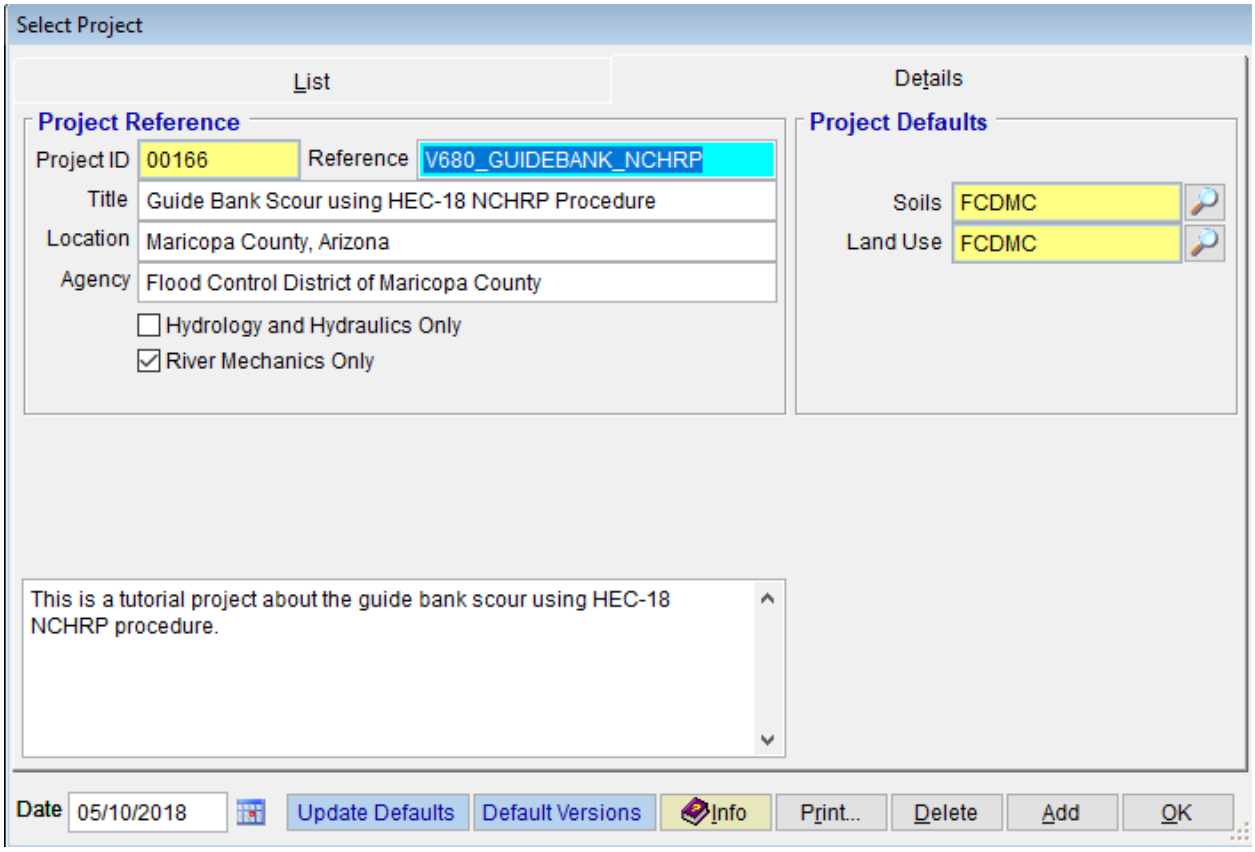
(h) Check the ***River Mechanics Only*** checkbox.

(i) Type a detailed description of this project into the comment area under the ***Project Reference*** frame *(Optional) (e.g., 'This is a tutorial project for evaluating Guide Bank Scour using HEC-18 NCHRP Procedure').*

(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.

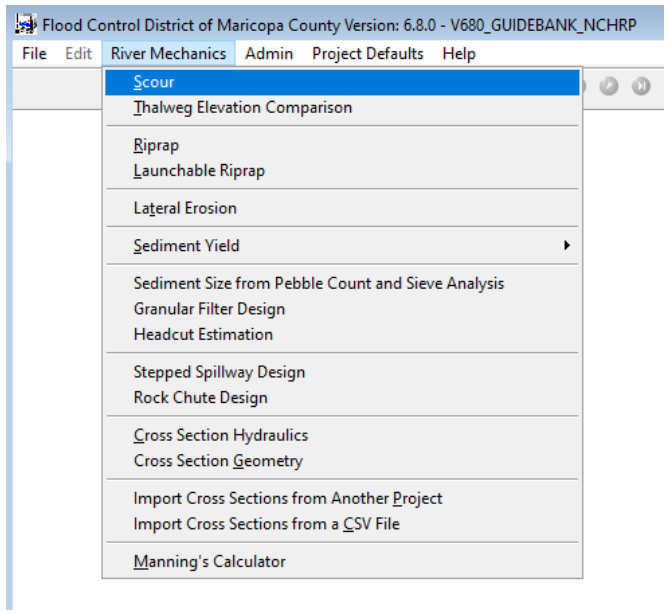
(l) Click the ***OK*** button on the **SELECT PROJECT** form to exit.



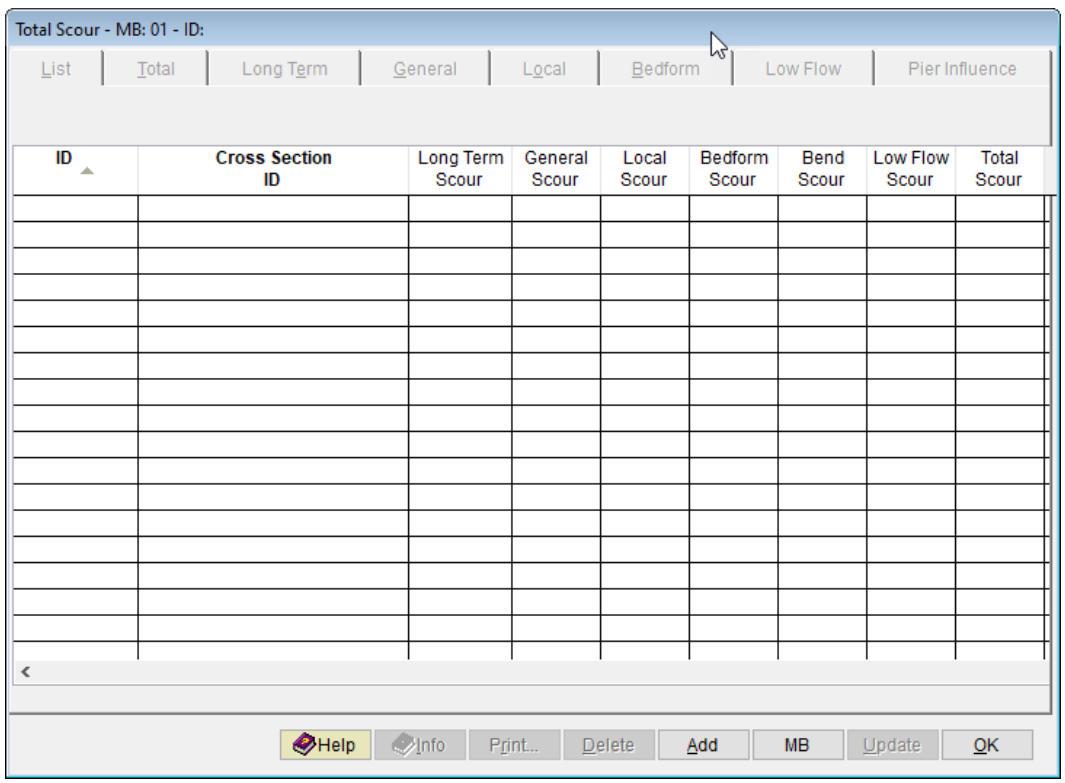
Note: The ***Project ID*** *"00166"* in the above figure is the unique database record identifier for the project, which is automatically generated by the program. Each time a new project is created, a ***Project ID*** is assigned by the program. The ***Project ID*** assigned to your project will not necessary be the same as the ***Project ID*** shown in the above figure.

2.2 Step 2 - Set up Guide Bank Scour Basic Data

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

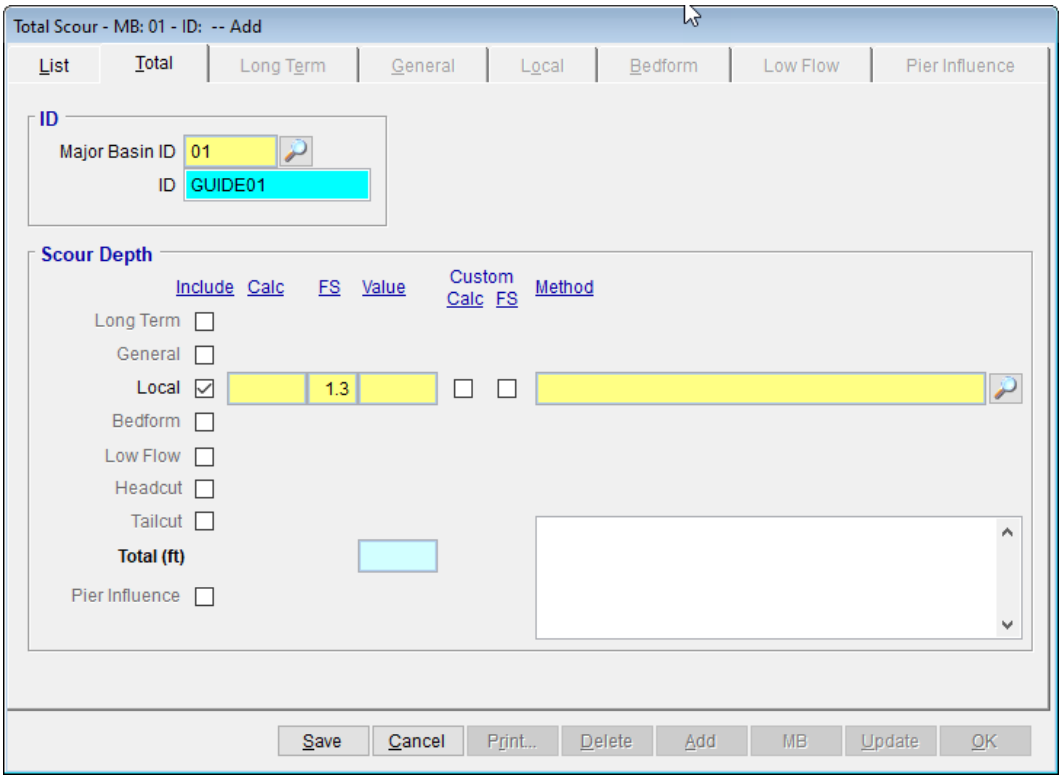


(b) On the **TOTAL SCOUR** form, click the ***Add*** button at the bottom of the form to activate the necessary data entry fields.

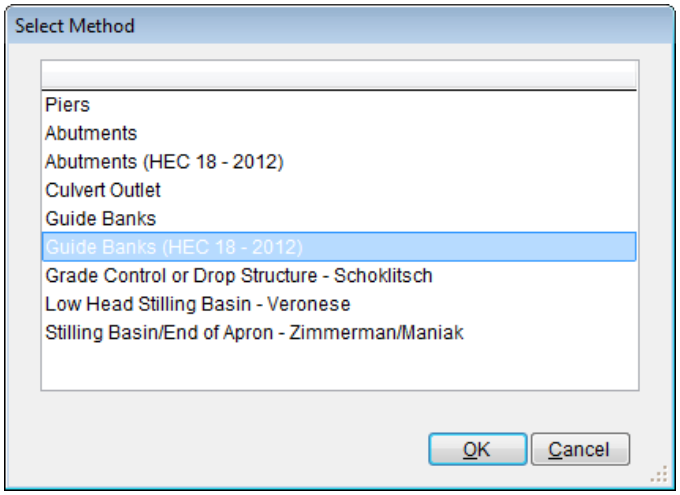


(c) Type "*GUIDE01*" into the ***ID*** textbox (this ***ID*** is for Guide Bank No.1).

(d) Check the ***Local*** checkbox only.

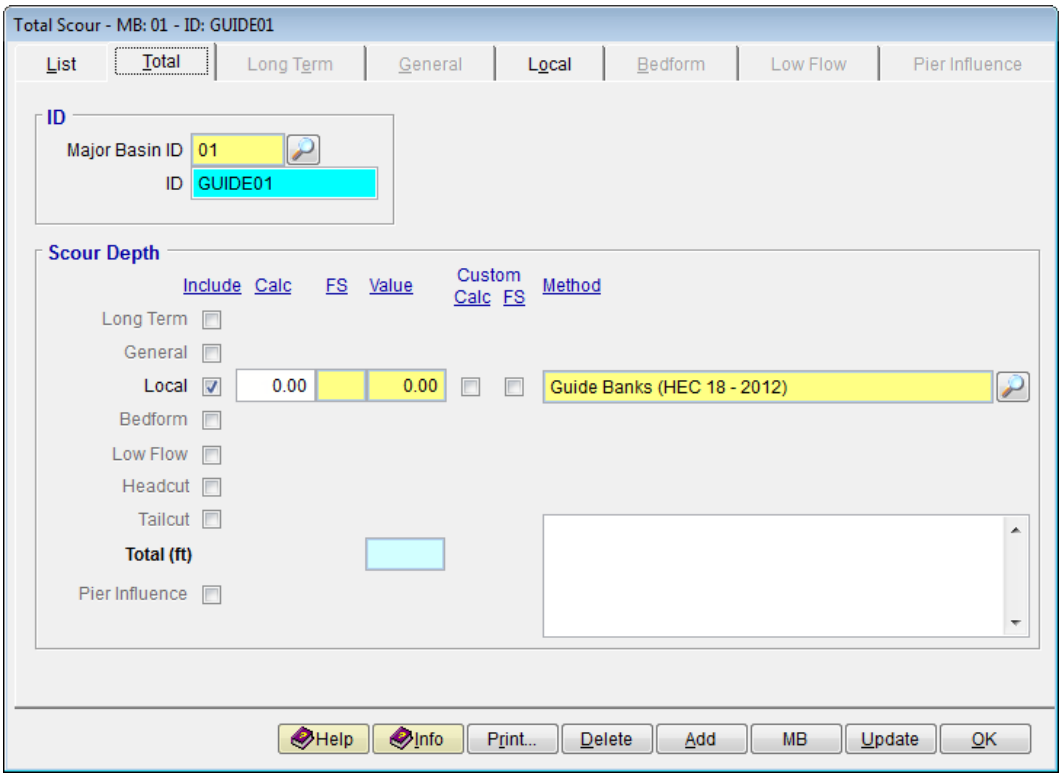


(e) Click the browse button in the ***Method*** column across the ***Local*** checkbox to access and select specific local scour method for the project.



(f) Select "*Guide Banks (HEC 18 – 2012)*" from the **SELECT METHOD** dialog box, then click ***OK*** to exit.

(g) Click the ***Save*** button to save the entered data. The **TOTAL SCOUR** form should look like the figure provided below.



2.3 Step 3 - Calculate the Guide Bank Scour

(a) On the **TOTAL SCOUR** form, select the ***Local*** tab.

(b) Enter "*85*" into the ***Projected Length of Embankment, L (ft)*** textbox.

(c) Enter "*100*" into the ***Width of Floodplain, B_f (ft)*** textbox.

(d) Enter "*10*" into the ***Upstream Flow Depth, y_1 (ft)*** textbox.

(e) Enter "*57*" into the ***Upstream Unit Discharge, q_1 (sq ft/sec)*** textbox.

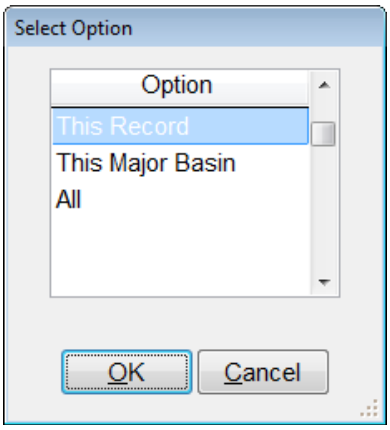
(f) Enter *"78.6"* into the ***Unit Discharge in the Constricted Opening, q_{2c} (sq ft/sec)*** textbox.

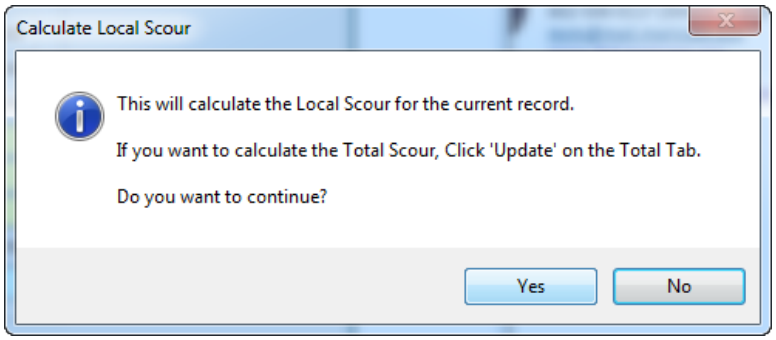
(g) Enter "*9.5*" into the ***Flow Depth Prior to Scour, Y_o (ft)*** textbox.

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

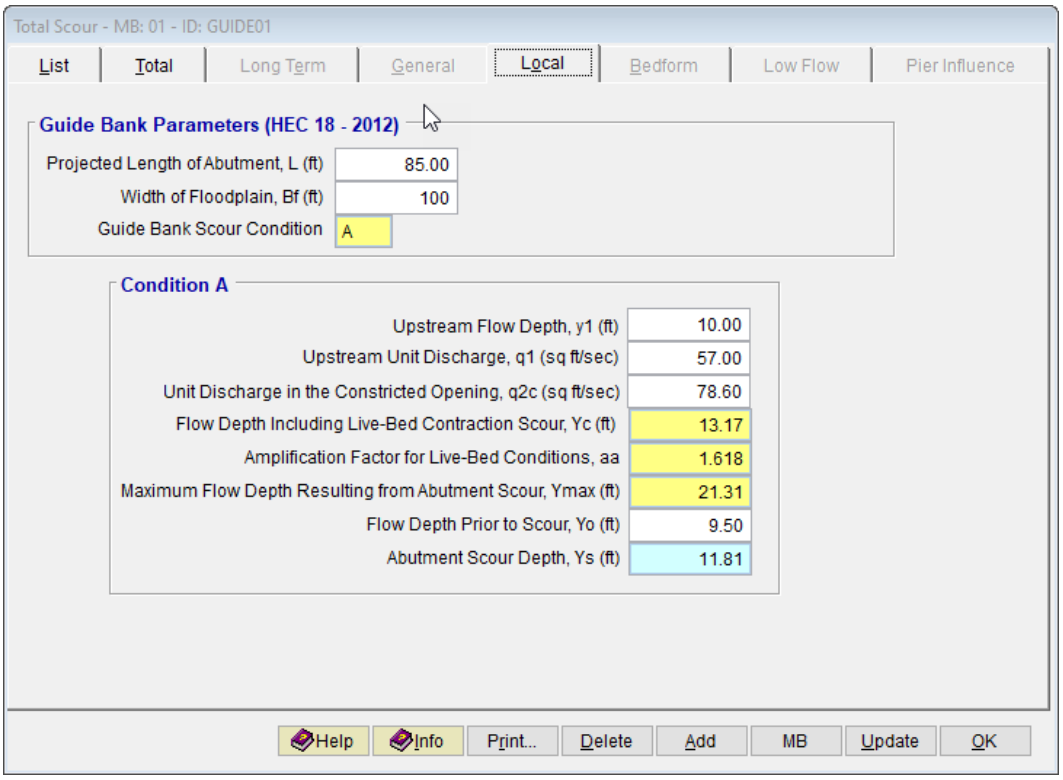
(i) Click the ***Update*** button to update past analysis results if they exist or to initiate the evaluation of the Guide Bank Scour for the **Live-Bed Condition.**

(j) Select "*This Record*" from the **SELECTION OPTION** dialog box, then click ***OK*** to exit. On the **CALCULATE LOCAL SCOUR** dialog box, click ***Yes*** to continue.





After the update the ***Local*** tab form should look like the figure provided below.



2.4 Step 4 - Report and Document the Results

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

(a) To view the results on the screen, click the ***Print …*** button on the ***Local*** Tab of **TOTAL SCOUR – MB: 01 – ID: GUIDE01** form. A report will be generated as shown in the following figure.

Flood Control District of Maricopa County
Drainage Design Management System
LOCAL SCOUR - GUIDE BANKS HEC-18, CONDITION A
Page 1 **Project Reference: V680_GUIDEBANK_NCHRP** 5/14/2024

ID: GUIDE01

Projected Length of Abutment, L (ft)	85.00
Width of Floodplain, Bf (ft)	100
Abutment Scour Condition	A
Select Equation Based On:	
Upstream Flow Depth, y1 (ft)	10.00
Upstream Unit Discharge, q1 (sq ft/sec)	57.00
Unit Discharge in the Constricted Opening, q2c (sq ft/sec)	78.60
Flow Depth Including Live-Bed Contraction Scour, Yc (ft)	13.17
Amplification Factor forLive-Bed Conditions, aa	1.62
Maximum Flow Depth Resulting from Abutment Scour, Ymax (ft)	21.31
Flow Depth Prior to Scour, Yo (ft)	9.50
Scour depth, ys (ft)	**11.81**

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

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

This concludes the first tutorial for **Guide Bank Scour under Live-bed Condition** (or **Condition A**).

3.0 GUIDE BANK SCOUR FOR CLEAR-WATER CONDITION

If the L/B_f ratio is less than 0.75, the clear-water guide bank scour equations should be used. The clear-water condition is also referred as **Condition B** in the HEC-18 Manual of the Federal Highway Administration (2012).

To data sets provided below are for evaluating guide bank scour using the HEC-18 (NCHRP) procedure.

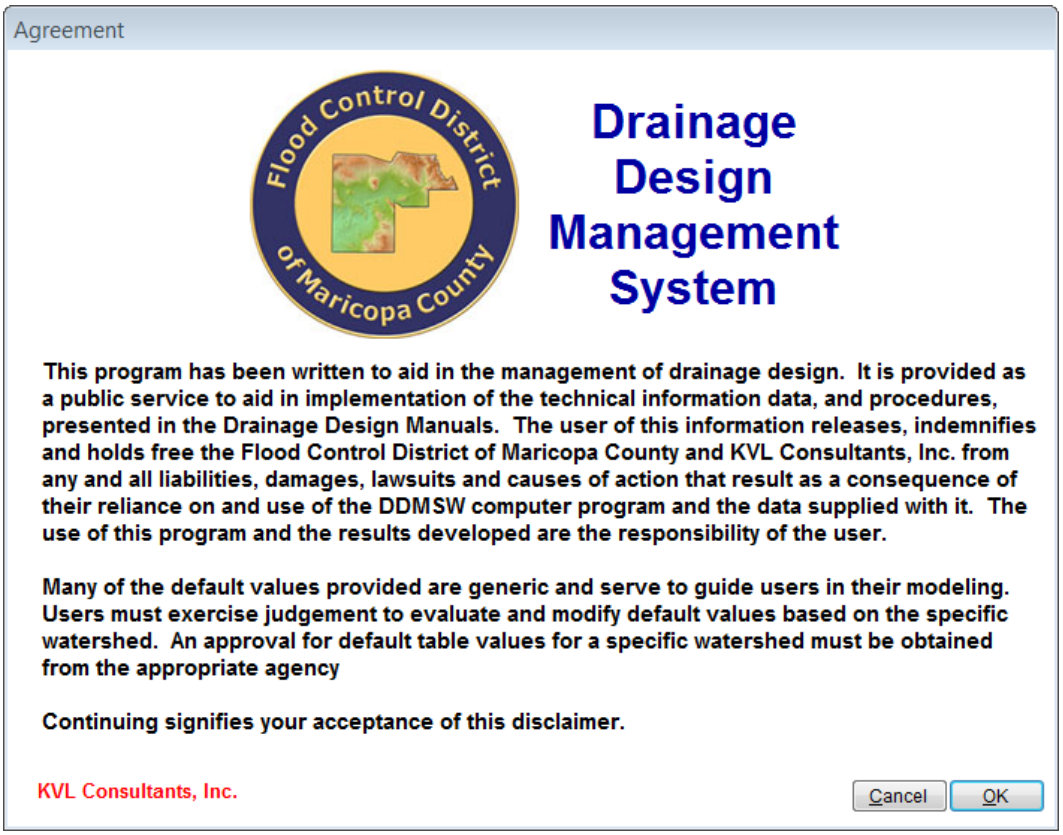
- Embankment and Floodplain Data:
  - Projected length of embankment, L (ft): *65.00*
  - Width of floodplain, B_f (ft): *100.00*
- Hydraulic and Sediment Data:
  - Unit discharge at upstream floodplain, q_f (ft^2/s): *5.70*
  - Unit discharge at constricted opening, q_{2f} (ft^2/s): *10.10*
  - Particle size with 50 percent finer, D_{50} (ft): *0.0010*
  - Manning's n of floodplain under the bridge: *0.025*
  - Critical shear stress for floodplain material: *0.04*
  - Flow depth prior to scour, Y_o (ft): *3.50*

The analysis procedure for evaluating Guide Bank Scour for clear-water condition is summarized as follows:

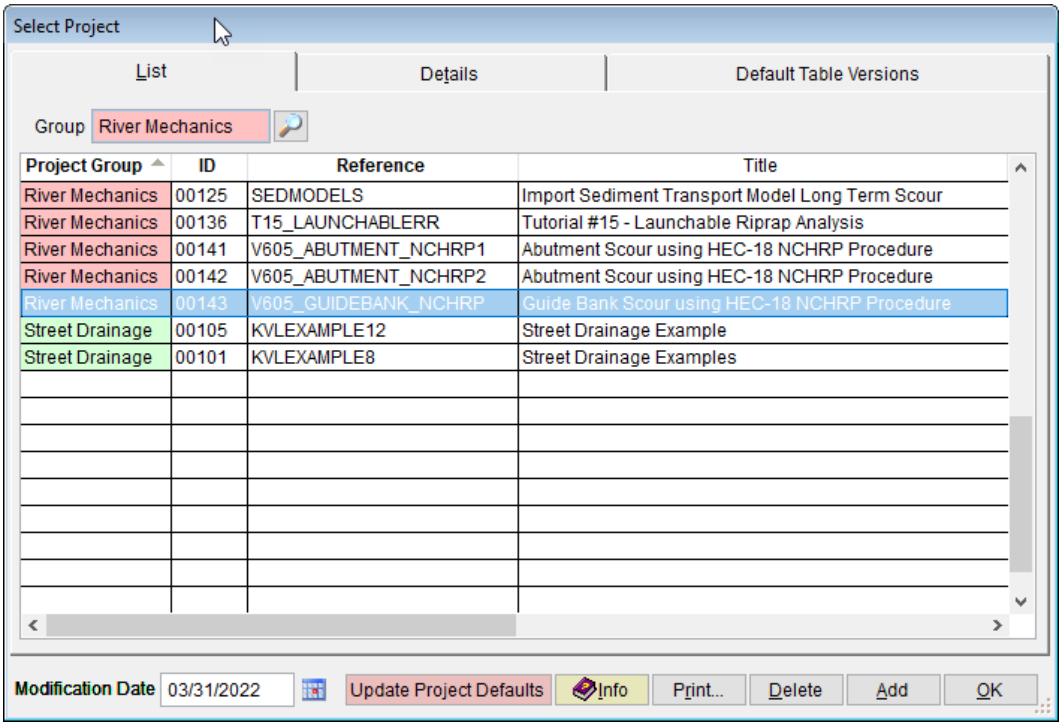
- Step 1: Establish a New River Mechanics Project and Defaults Set-up
- Step 2: Set up Guide Bank Scour Basic Data
- Step 3: Calculate Guide Bank Scour – Grain Size Equation
- Step 4: Calculate Guide Bank Scour – Shear Stress Equation
- Step 5: Report and Document the results

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

(a) Start **DDMSW**. Click the ***OK*** button to accept the software disclaimer as shown below.



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



(b) Click the ***Add*** button on the **SELECT PROJECT** form to start a new project. Alternatively, one can add/create a new project by executing ***File ➔ New Project ➔ Add***.

(c) Select the ***River Mechanics*** checkbox, then click the ***OK*** button to close the **NEW PROJECT OPTIONS** dialog box.

(d) On the **SELECT PROJECT** form, enter "V680_*GUIDEBANK_NCHR2*" into the ***Reference*** textbox. This is the name of the new project. Users can choose any name for the ***Reference*** textbox as long as it does not exist already in the current **DDMSW** project database.

(e) Type into the ***Title*** textbox a brief descriptive title for this project. *(Optional) (e.g., 'Guide Bank Scour using HEC-18 NCHRP Procedure')*

(f) Type into the ***Location*** textbox the location of this project**.** *(Optional) (e.g., 'Maricopa County, Arizona').*

(g) Type into the ***Agency*** textbox the agency or company name**.** *(Optional) (e.g., 'Flood Control District of Maricopa County')*

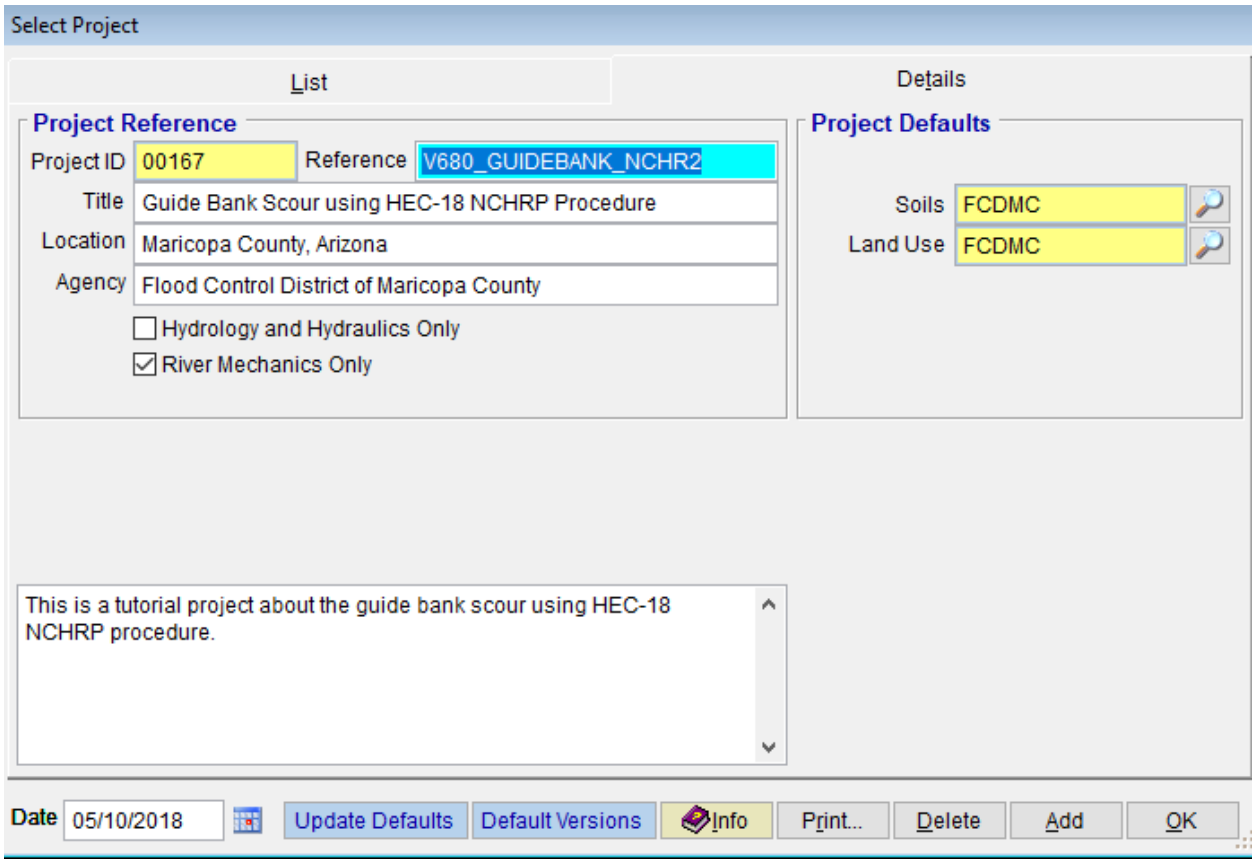
(h) Check the ***River Mechanics Only*** checkbox for this project.

(i) Type a detailed description of this project into the comment area under the ***Project Reference*** frame. *(Optional) (e.g., 'This is a tutorial project for evaluating Guide Bank Scour (Clear-Water Condition) using HEC-18 NCHRP Procedure')*

(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. The figure provided below shows what the form should look like.

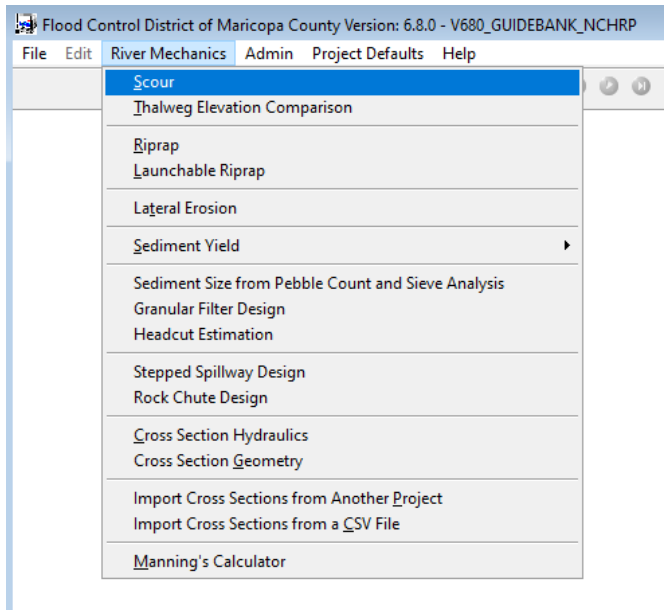
(l) Click the **OK** button on the **SELECT PROJECT** window, and click the **OK** button on the pop-up message box. The following figure shows what the window looks like.



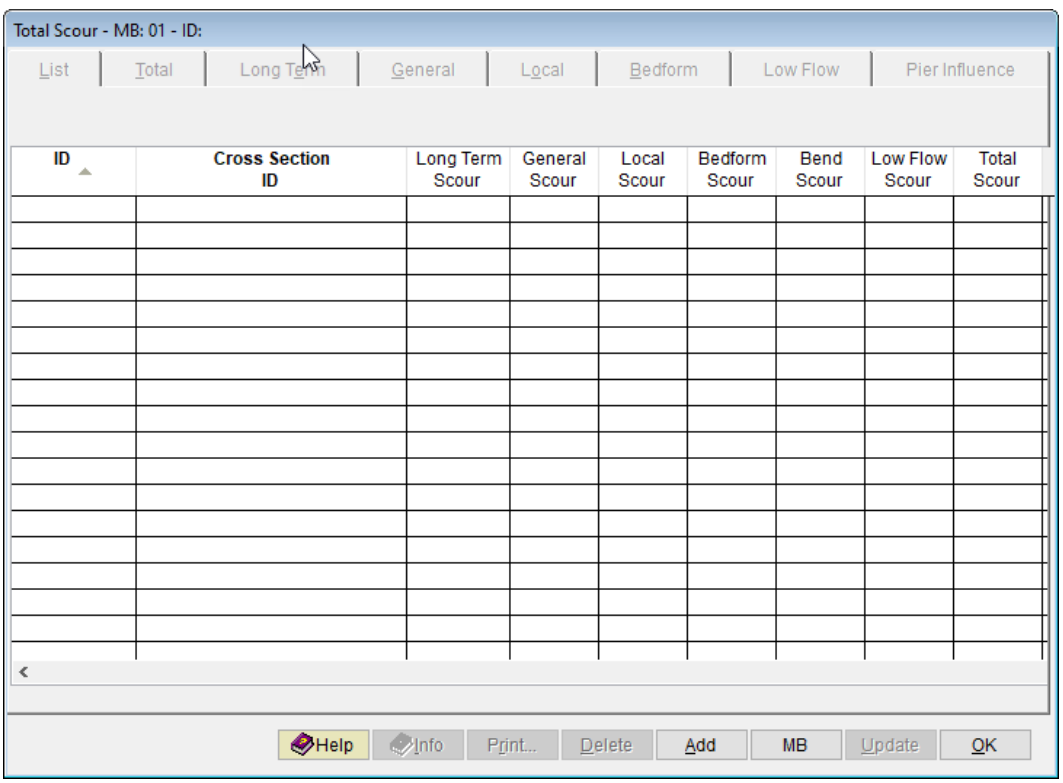
Note: The ***Project ID*** *"00167"* in the above figure is the unique database record identifier for the project, which is automatically generated by the program when a new project is created. Each time a new project is created, a ***Project ID*** is assigned by the program. The ***Project ID*** assigned to your project will not necessary be the same as the ***Project ID*** shown in the above figure.

3.2 Step 2 - Set up Guide Bank Scour Basic Data

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



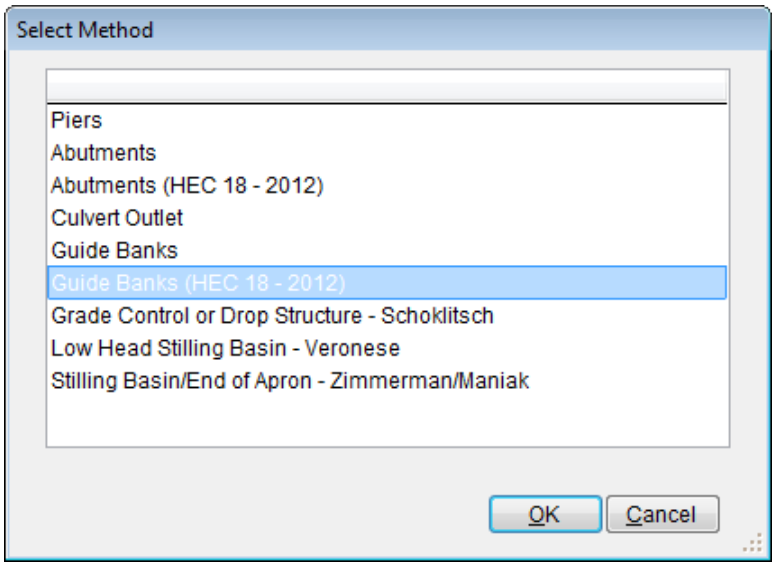
(b) On the **TOTAL SCOUR** form, click the ***Add*** button to activate the necessary data entry fields for the new project.



(c) Enter "*GUIDE02*" into the ***ID*** textbox (this ***ID*** identifies that it is for Guide Bank No.2).

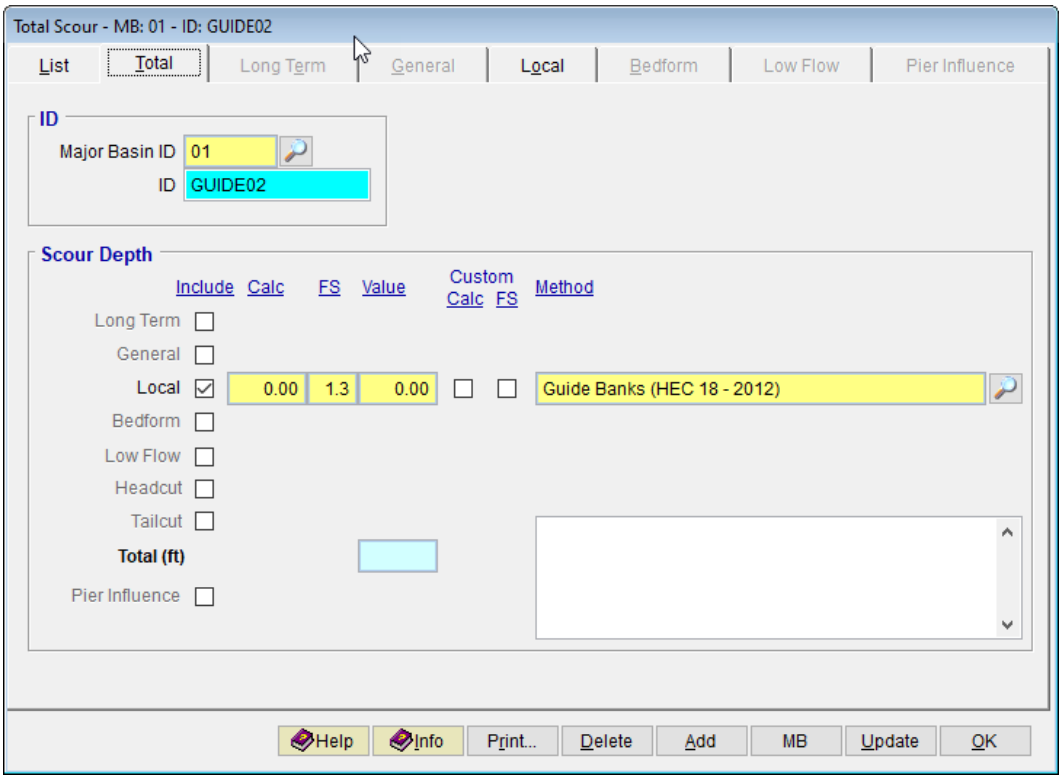
(d) Check the ***Local*** checkbox only.

(e) Click the browse button under the ***Method*** column across the ***Local*** checkbox to open the local scour method select menu.



(f) Select '*Guide Banks (HEC 18 – 2012)*' from the **SELECT METHOD** dialog box, then click ***OK*** to close.

(g) Back to the **TOTAL SCOUR – MB: 01 – ID: GUIDEO2** form, click the ***Save*** button to save the entered data.



3.3 Step 3 - Calculate the Guide Bank Scour – Grain Size Equation

(a) Click the ***Local*** tab open the form for entering relevant data for evaluating Guide Bank Scour depth.

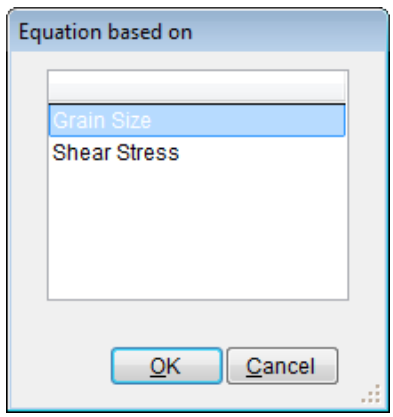
(b) Enter "*65*" into the ***Projected Length of Embankment, L (ft)*** textbox.

(c) Enter "*100*" into the ***Width of Floodplain, B_f (ft)*** textbox.

(d) Click the ***Save*** button to update the data entry fields on the form.

The updated form has changed the value of ***Guide Bank Scour Condition*** to *"B"* , and has made the ***Select Equation Based On*** textbox visible.

(e) Click the browse button on the right side of the ***Select Equation Based On*** textbox to select *"Grain Size"*. or *"Shear Stress"*. Click ***OK*** to exit the **EQUATION BASED ON** dialog box.



(f) Back on the ***Local*** tab form, click the ***Save*** button to save the entered data.

(g) Enter "*5.7*" into the ***Upstream Floodplain Unit Discharge, q_f (sq ft/sec)*** textbox.

(h) Enter "*10.1*" into the ***Unit Discharge in the Constricted Opening, q_{2c} (sq ft/sec)*** textbox.

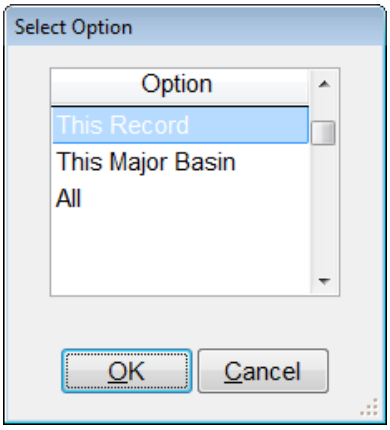
(i) Enter "*0.0010*" into the ***Particle Size with 50 Percent Finer, D_{50} (ft)*** textbox.

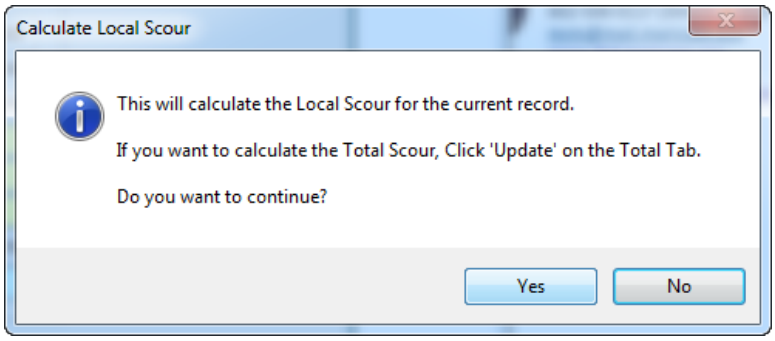
(j) Enter "*3.5*" into the ***Flow Depth Prior to Scour, Y_o (ft)*** textbox.

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

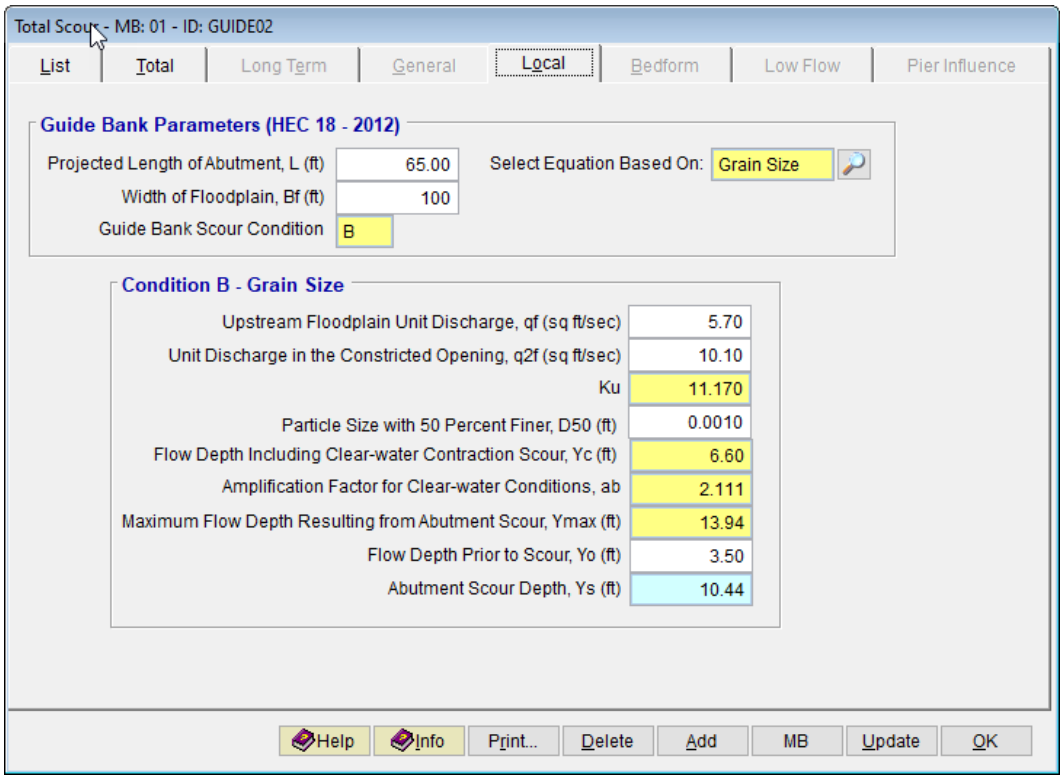
(l) Click the ***Update*** button to update the analysis.

(m) Select "*This Record*" from the **SELECTION OPTION** dialog box, then click ***Yes*** to continue.





After the update, the form should now look like the figure provided below.

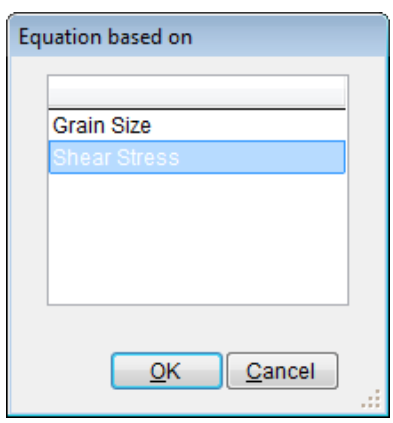


3.4 Step 4 - Calculate the Guide Bank Scour – Shear Stress Equation

An alternative option to evaluate the Guide Bank Scour is to use equations for the *"Shear Stress"* option.

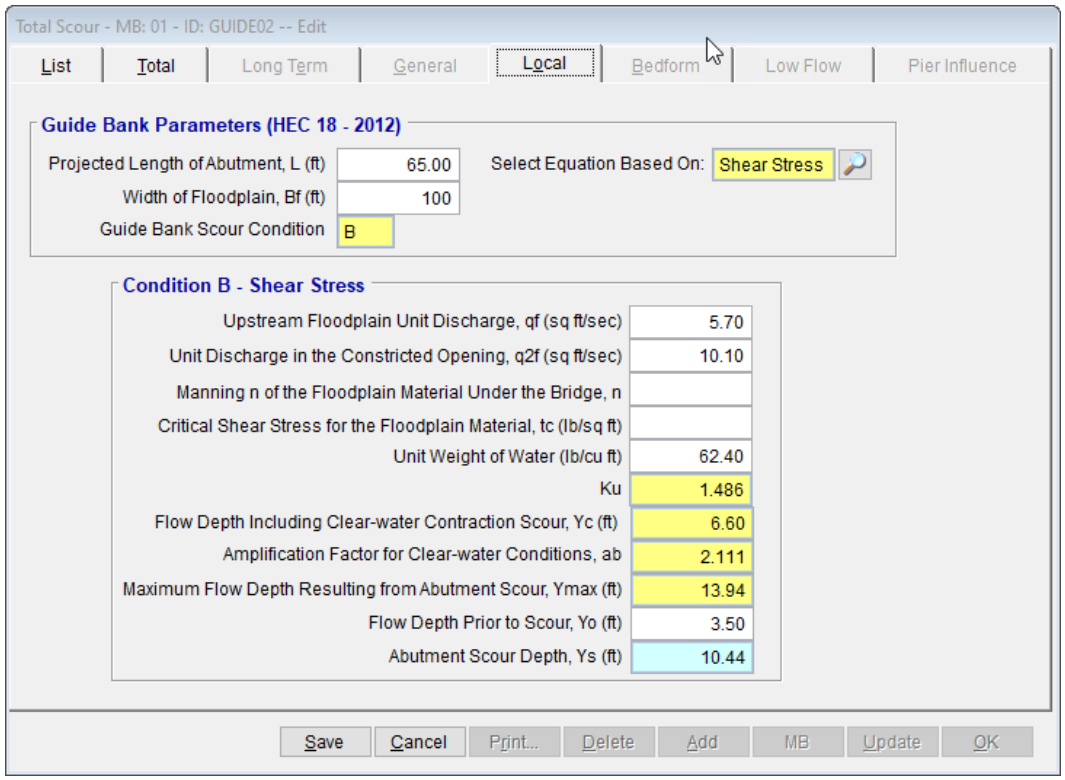
(a) On the same ***Local*** tab form, keep the same data that were employed for the *'Grain Size'* option.

(b) Click browse button beside the ***Select Equation Based On*** textbox and select *"Shear Stress"*. Click ***OK*** to exit the **EQUATION BASED ON** dialog box.



(c) Click the ***Save*** button to save the changes made on the data.

Note that the selection of *"Shear Stress"* for the ***Guide Bank Scour Condition B analysis*** has transformed the ***Local*** tab form as shown. Now the form has added three more input data fields. They are ***Manning's n of the Floodplain Material Under the Bridge***, ***Critical Shear Stress for the Floodplain Material, t_c (lb/sq ft)***, and ***Unit Weight of Water (lb/cu ft).***

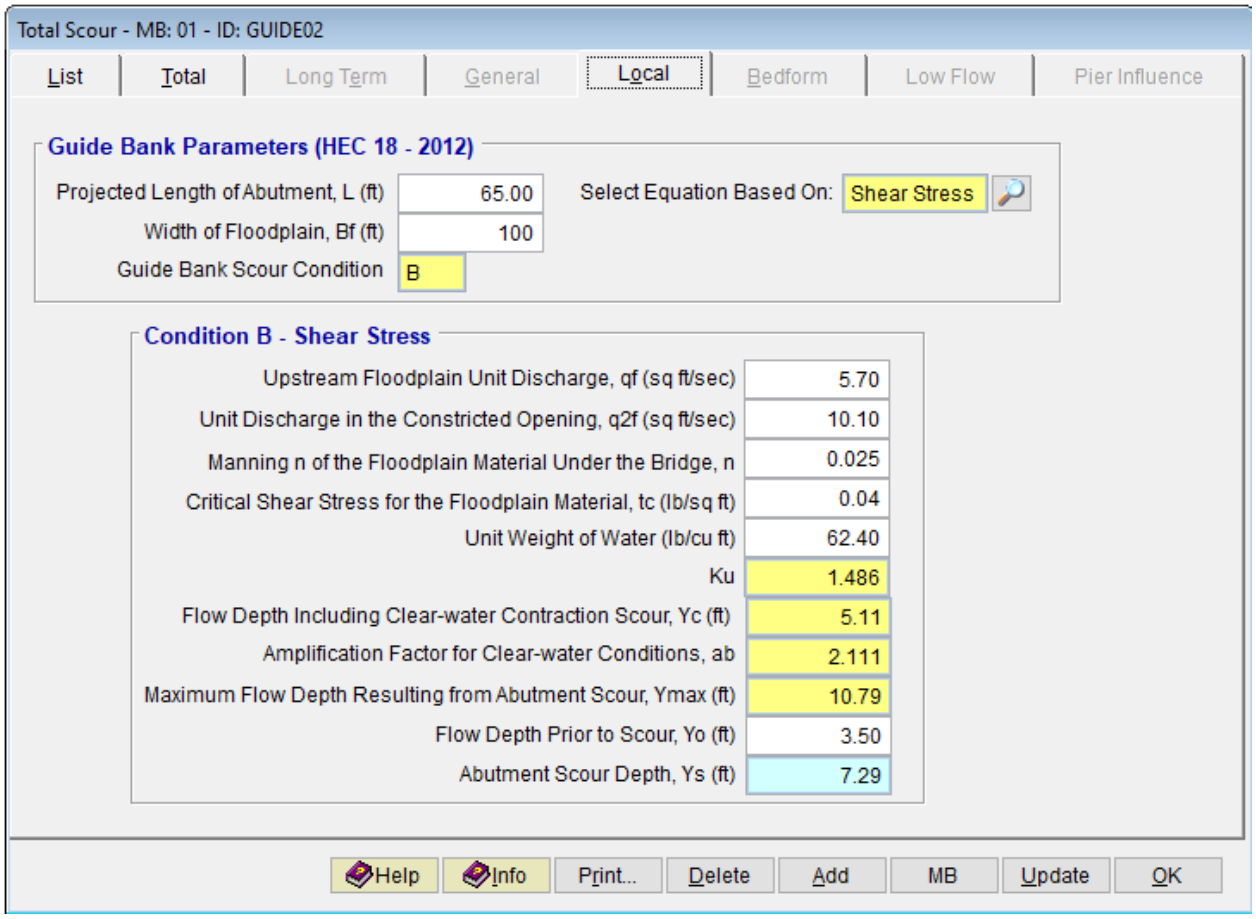


(d) Enter *"0.025"* into the ***Manning n of the Floodplain Material Under the Bridge, n*** textbox.

(e) Enter *"0.04"* into the ***Critical Shear Stress for the Floodplain Material, t_c (lb/sq ft)*** textbox.

(f) Enter *"62.4"* into the ***Unit Weight of Water (lb/cu ft)*** textbox.

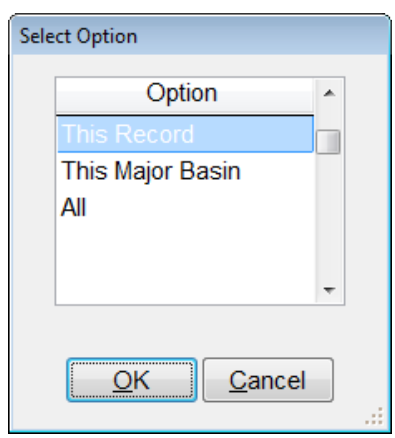
Keep the other input data on the form to be the same as were used in the *"Grain Size"* option. The completed form should now look like the figure below.

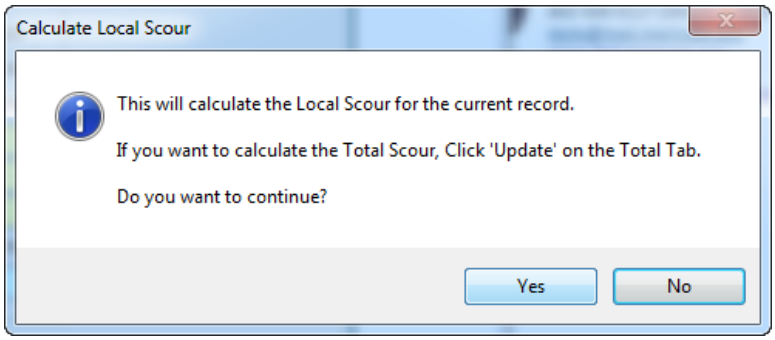


(g) Click the ***Save*** button to accept all the changes made on the form.

(h) Click the ***Update*** button to update the Guide Bank scour analysis results.

(i) Select "*This Record*" from the **SELECTION OPTION** dialog box, then click ***Yes*** to continue.





After the update, the evaluated Guide Bank Scour depth for the "Shear Stress" option (*i.e., 7.29*) appears to be less than the one evaluated for the "Grain Size" option (*i.e., 10.44*).

3.5 Step 5 - Report and Document the Results

This section includes procedures how to view, print, and export results from performing Guide Bank Scour analysis.

(a) To view the analysis results on the screen, click the ***Print …*** button on the ***Local*** tab of the **TOTAL SCOUR – MB: 01 – ID: GUID02** form. As a result, a report will be generated as shown below.

Flood Control District of Maricopa County
Drainage Design Management System
LOCAL SCOUR - GUIDE BANKS HEC-18, CONDITION B - SHEAR STRESS
Page 1 **Project Reference: V680_GUIDEBANK_NCHR2** 5/14/2024

ID: GUIDE02

Projected Length of Abutment, L (ft)	65.00
Width of Floodplain, Bf (ft)	100
Abutment Scour Condition	B
Select Equation Based On:	Shear Stress
Upstream Floodplain Unit Discharge, qf (sq ft/sec)	5.70
Unit Discharge in the Constricted Opening, q2f (sq ft/sec)	10.10
Manning n of the Floodplain Material Under the Bridge, n	0.025
Critical Shear Stress for the Floodplain Material, tc (lb/sq ft)	0.04
Unit Weight of Water (lb/cu ft)	62.40
Ku	1.486
Flow Depth Including Clear-water Contraction Scour, Yo (ft)	5.11
Amplification Factor for Clear-water Conditions, ab	2.11
Maximum Flow Depth Resulting from Abutment Scour, Ymax (ft)	10.79
Flow Depth Prior to Scour, Yo (ft)	3.50
Scour depth, ys (ft)	**7.29**

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

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

This concludes this second tutorial for **Guide Bank Scour under Clear-Water Condition (Condition B).**