



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]

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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 (ft²/s): 57.00
- Unit discharge at constricted opening, q_{2c} (ft²/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.

Select Project

List		Details	
Group	River Mechanics		
Project Group	ID	Reference	Title
Rational Method	00100	KVLEXAMPLE7	Rational Method Tutorial
River Mechanics	00057	ABUTMENT_NCHRP1	Abutment Scour using HEC-18 NCHRP Procedure
River Mechanics	00058	ABUTMENT_NCHRP2	Abutment Scour using HEC-18 NCHRP Procedure
River Mechanics	00157	BANKPROTECTION1	
River Mechanics	00158	BANKPROTECTIONFCD	River Mechanics Example - Bank Protection
River Mechanics	00109	BRIDGEPIERFCD	River Mechanics Example - Bridge Pier
River Mechanics	00159	BRIDGEPIERFCD1	River Mechanics Example - Bridge Pier
River Mechanics	00056	GUIDEBANK_NCHRP	Guide Bank Scour using HEC-18 NCHRP Procedure
River Mechanics	00055	GUIDEBANK_NCHRP2	Guide Bank Scour using HEC-18 NCHRP Procedure
River Mechanics	00162	LATEROSION1	Lateral Erosion Example
River Mechanics	00112	LATEROSIONEXAMPLE	Lateral Erosion Example
River Mechanics	00111	LAUNCHABLERIPRAP	River Mechanics Example - Launchable RipRap
River Mechanics	00117	MODELTHALWEG	Sedimentation Model Examples
River Mechanics	00054	PIER_INFLUENCE	Pier Influence Zone calculation using HEC-18 Procedure
River Mechanics	00053	PRESSURE_SCOUR	Pressure Flow Scour using HEC-18 Procedure
River Mechanics	00107	PROJECTXSECTIONS	River Mechanics Cross Sections

Date: 05/10/2018

- (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.

Select Project

List

Details

Project Reference

Project ID: 00166 Reference: V680_GUIDEBANK_NCHRP

Title: Guide Bank Scour using HEC-18 NCHRP Procedure

Location: Maricopa County, Arizona

Agency: Flood Control District of Maricopa County

☐ Hydrology and Hydraulics Only

☒ River Mechanics Only

Project Defaults

Soils: FCDMC

Land Use: FCDMC

This is a tutorial project about the guide bank scour using HEC-18 NCHRP procedure.


Date: 05/10/2018

Update Defaults Default Versions Info Print... Delete Add OK

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.

- (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.

Total Scour - MB: 01 - ID: GUIDE01

List **Total** Long Term General Local Bedform Low Flow Pier Influence

ID

Major Basin ID 01

ID GUIDE01

Scour Depth

Include Calc FS Value Custom Calc FS Method

Long Term ☐

General ☐

Local ☒ 0.00 0.00 ☐ ☐ Guide Banks (HEC 18 - 2012)

Bedform ☐

Low Flow ☐

Headcut ☐

Tailcut ☐

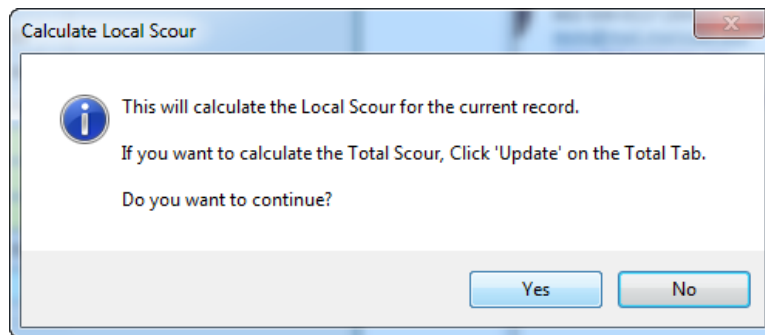
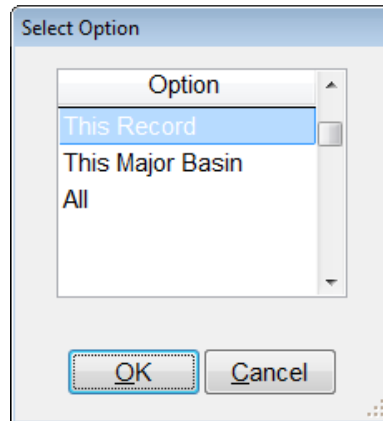
Total (ft)

Pier Influence ☐

Help Info Print... Delete Add MB Update OK

2.3 Step 3 - Calculate the Guide Bank Scour

- On the **TOTAL SCOUR** form, select the **Local** tab.
- Enter "85" into the **Projected Length of Embankment, L (ft)** textbox.
- Enter "100" into the **Width of Floodplain, B_f (ft)** textbox.
- Enter "10" into the **Upstream Flow Depth, y_1 (ft)** textbox.
- Enter "57" into the **Upstream Unit Discharge, q_1 (sq ft/sec)** textbox.
- Enter "78.6" into the **Unit Discharge in the Constricted Opening, q_{2c} (sq ft/sec)** textbox.
- Enter "9.5" into the **Flow Depth Prior to Scour, Y_o (ft)** textbox.
- Click the **Save** button to save the entered data.
- 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**.
- 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.

Total Scour - MB: 01 - ID: GUIDE01

[List](#) | [Total](#) | [Long Term](#) | [General](#) | **[Local](#)** | [Bedform](#) | [Low Flow](#) | [Pier Influence](#)

Guide Bank Parameters (HEC 18 - 2012)

Projected Length of Abutment, L (ft)
 Width of Floodplain, Bf (ft)
 Guide Bank Scour Condition **A**

Condition A

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 for Live-Bed Conditions, aa	1.618
Maximum Flow Depth Resulting from Abutment Scour, Ymax (ft)	21.31
Flow Depth Prior to Scour, Yo (ft)	9.50
Abutment Scour Depth, Ys (ft)	11.81

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 (ft²/s): 5.70
- Unit discharge at constricted opening, q_{2f} (ft²/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.

Agreement



Drainage Design Management System

This program has been written to aid in the management of drainage design. It is provided as a public service to aid in implementation of the technical information data, and procedures, presented in the Drainage Design Manuals. The user of this information releases, indemnifies and holds free the Flood Control District of Maricopa County and KVL Consultants, Inc. from any and all liabilities, damages, lawsuits and causes of action that result as a consequence of their reliance on and use of the DDMSW computer program and the data supplied with it. The use of this program and the results developed are the responsibility of the user.

Many of the default values provided are generic and serve to guide users in their modeling. Users must exercise judgement to evaluate and modify default values based on the specific watershed. An approval for default table values for a specific watershed must be obtained from the appropriate agency

Continuing signifies your acceptance of this disclaimer.

KVL Consultants, Inc.

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

Select Project

List
Details
Default Table Versions

Group River Mechanics

Project Group ^	ID	Reference	Title
River Mechanics	00125	SEDMODELS	Import Sediment Transport Model Long Term Scour
River Mechanics	00136	T15_LAUNCHABLERR	Tutorial #15 - Launchable Riprap Analysis
River Mechanics	00141	V605_ABUTMENT_NCHRP1	Abutment Scour using HEC-18 NCHRP Procedure
River Mechanics	00142	V605_ABUTMENT_NCHRP2	Abutment Scour using HEC-18 NCHRP Procedure
River Mechanics	00143	V605_GUIDEBANK_NCHRP	Guide Bank Scour using HEC-18 NCHRP Procedure
Street Drainage	00105	KVLEXAMPLE12	Street Drainage Example
Street Drainage	00101	KVLEXAMPLE8	Street Drainage Examples

Modification Date
03/31/2022
Update Project Defaults
Info
Print...
Delete
Add
OK

- (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.

Select Project

List	Details
<p>Project Reference</p> <p>Project ID: 00167 Reference: V680_GUIDEBANK_NCHR2</p> <p>Title: Guide Bank Scour using HEC-18 NCHRP Procedure</p> <p>Location: Maricopa County, Arizona</p> <p>Agency: Flood Control District of Maricopa County</p> <p> <input type="checkbox"/> Hydrology and Hydraulics Only <input checked="" type="checkbox"/> River Mechanics Only </p>	<p>Project Defaults</p> <p>Soils: FCDMC</p> <p>Land Use: FCDMC</p>


This is a tutorial project about the guide bank scour using HEC-18 NCHRP procedure.

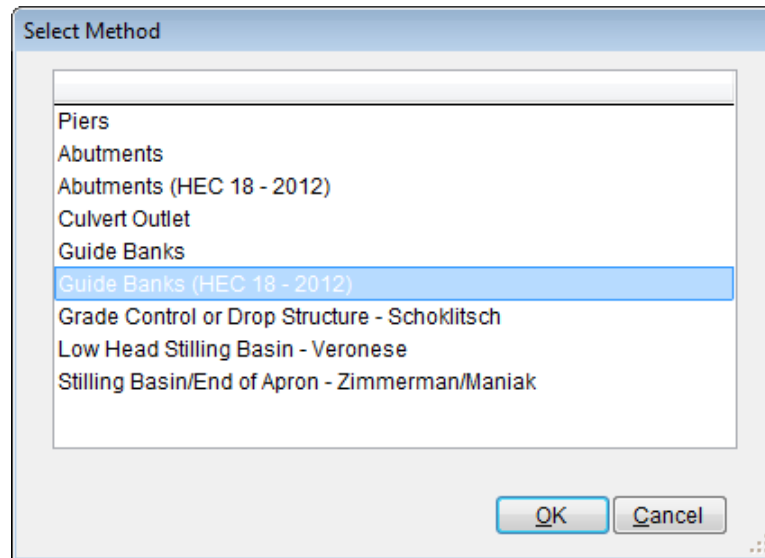
Date: 05/10/2018 Update Defaults Default Versions Info Print... Delete Add OK

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.

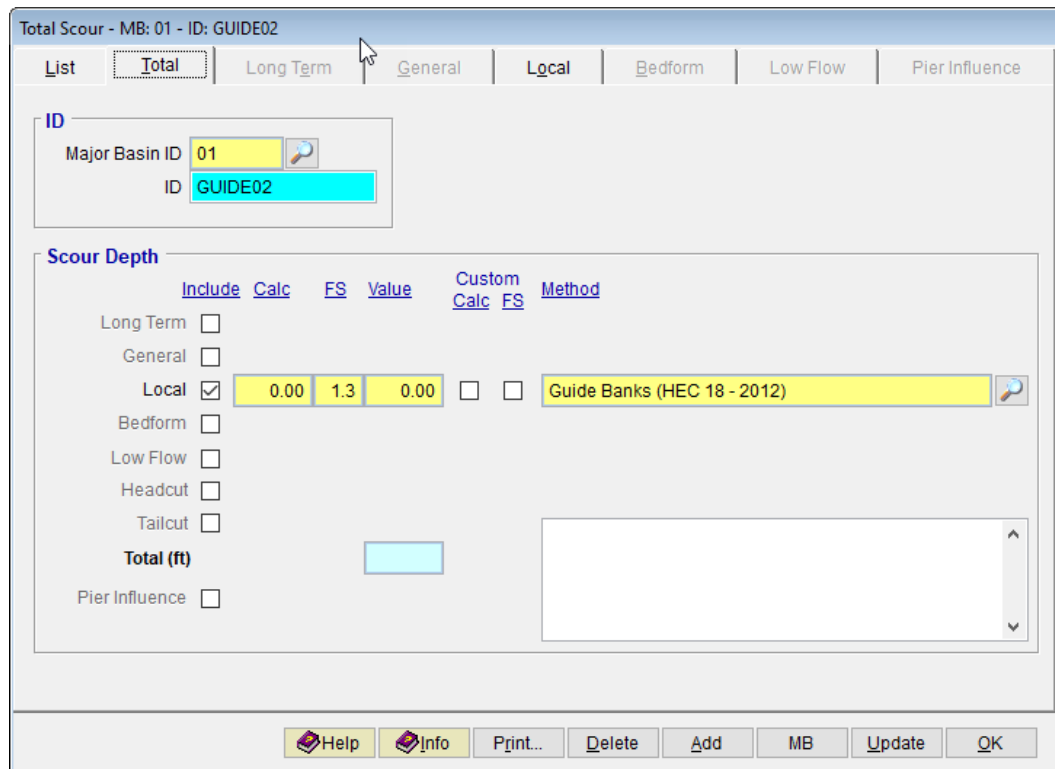
3.2 Step 2 - Set up Guide Bank Scour Basic Data

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

- (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: GUIDE02** form, click the **Save** button to save the entered data.

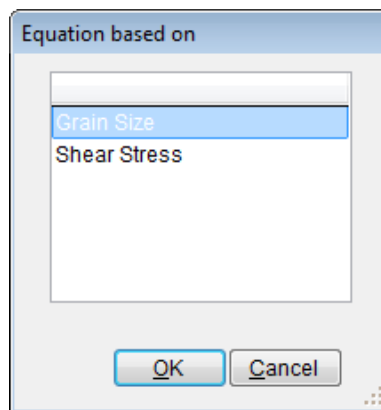
A screenshot of the "Total Scour - MB: 01 - ID: GUIDE02" form. The "Local" tab is selected. Under "ID", "Major Basin ID" is 01 and "ID" is GUIDE02. The "Scour Depth" section has a table with columns: Include, Calc, FS, Value, Custom Calc, FS, and Method. The "Local" row is checked, with values 0.00, 1.3, and 0.00, and the method "Guide Banks (HEC 18 - 2012)" is selected. The "Total (ft)" field is empty. At the bottom are buttons for Help, Info, Print..., Delete, Add, MB, Update, and OK.

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.

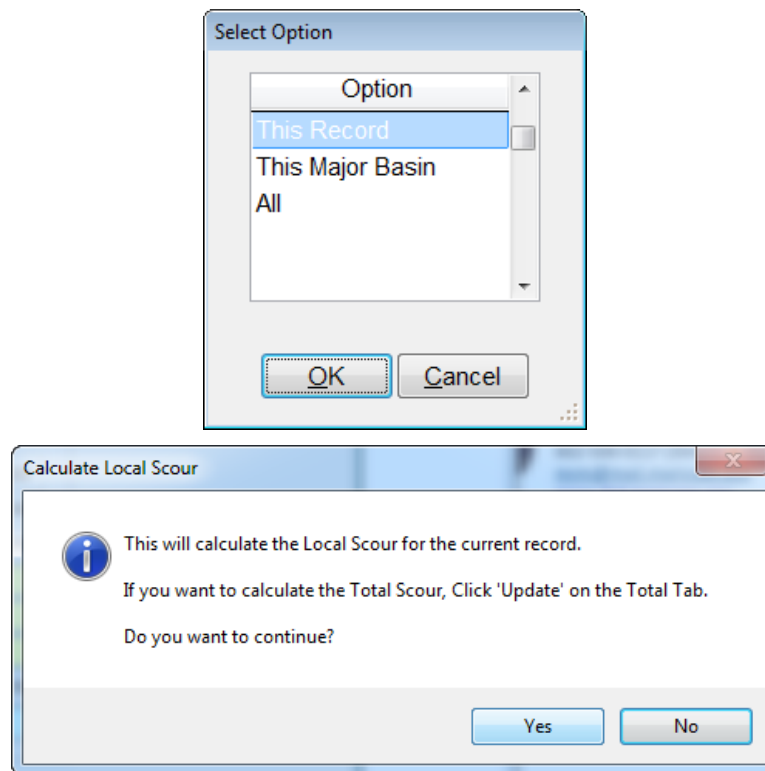
The updated form has changed the value of **Guide Bank Scour Condition** to “B”, and has made the **Select Equation Based On** textbox visible.

- (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.

Total Scour - MB: 01 - ID: GUIDE02

List Total Long Term General **Local** Bedform Low Flow Pier Influence

Guide Bank Parameters (HEC 18 - 2012)

Projected Length of Abutment, L (ft) 65.00 Select Equation Based On: Grain Size

Width of Floodplain, Bf (ft) 100

Guide Bank Scour Condition B


Condition B - Grain Size

Upstream Floodplain Unit Discharge, q_f (sq ft/sec)	5.70
Unit Discharge in the Constricted Opening, q_{2f} (sq ft/sec)	10.10
Ku	11.170
Particle Size with 50 Percent Finer, D50 (ft)	0.0010
Flow Depth Including Clear-water Contraction Scour, Y_c (ft)	6.60
Amplification Factor for Clear-water Conditions, ab	2.111
Maximum Flow Depth Resulting from Abutment Scour, Y_{max} (ft)	13.94
Flow Depth Prior to Scour, Y_o (ft)	3.50
Abutment Scour Depth, Y_s (ft)	10.44

Help Info Print... Delete Add MB Update OK

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.

- On the same **Local** tab form, keep the same data that were employed for the ‘*Grain Size*’ option.
- Click browse  button beside the **Select Equation Based On** textbox and select “*Shear Stress*”. Click **OK** to exit the **EQUATION BASED ON** dialog box.

Equation based on

Grain Size

Shear Stress

OK Cancel

- 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)**.

The screenshot shows the 'Total Scour' software interface with the 'Local' tab selected. The 'Guide Bank Parameters (HEC 18 - 2012)' section includes input fields for 'Projected Length of Abutment, L (ft)' (65.00), 'Width of Floodplain, Bf (ft)' (100), and 'Guide Bank Scour Condition' (B). The 'Select Equation Based On:' dropdown is set to 'Shear Stress'. Below this, the 'Condition B - Shear Stress' section displays a table of calculated values and input fields.

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	
Critical Shear Stress for the Floodplain Material, t_c (lb/sq ft)	
Unit Weight of Water (lb/cu ft)	62.40
Ku	1.486
Flow Depth Including Clear-water Contraction Scour, Yc (ft)	6.60
Amplification Factor for Clear-water Conditions, ab	2.111
Maximum Flow Depth Resulting from Abutment Scour, $Ymax$ (ft)	13.94
Flow Depth Prior to Scour, Yo (ft)	3.50
Abutment Scour Depth, Ys (ft)	10.44

At the bottom of the form are buttons for 'Save', 'Cancel', 'Print...', 'Delete', 'Add', 'MB', 'Update', and 'OK'.


- (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.

Total Scour - MB: 01 - ID: GUIDE02

[List](#) | [Total](#) | [Long Term](#) | [General](#) | [Local](#) | [Bedform](#) | [Low Flow](#) | [Pier Influence](#)

Guide Bank Parameters (HEC 18 - 2012)



Projected Length of Abutment, L (ft)
 Select Equation Based On: **Shear Stress** 

Width of Floodplain, Bf (ft)

Guide Bank Scour Condition **B**

Condition B - Shear Stress

Upstream Floodplain Unit Discharge, q_f (sq ft/sec)	5.70
Unit Discharge in the Constricted Opening, q_2f (sq ft/sec)	10.10
Manning n of the Floodplain Material Under the Bridge, n	0.025
Critical Shear Stress for the Floodplain Material, τ_c (lb/sq ft)	0.04
Unit Weight of Water (lb/cu ft)	62.40
Ku	1.486
Flow Depth Including Clear-water Contraction Scour, Y_c (ft)	5.11
Amplification Factor for Clear-water Conditions, ab	2.111
Maximum Flow Depth Resulting from Abutment Scour, Y_{max} (ft)	10.79
Flow Depth Prior to Scour, Y_o (ft)	3.50
Abutment Scour Depth, Y_s (ft)	7.29

 Help |
  Info |
 Print... |
 Delete |
 Add |
 MB |
 Update |
 OK

- (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.

Select Option

Option

- This Record**
- This Major Basin
- All

