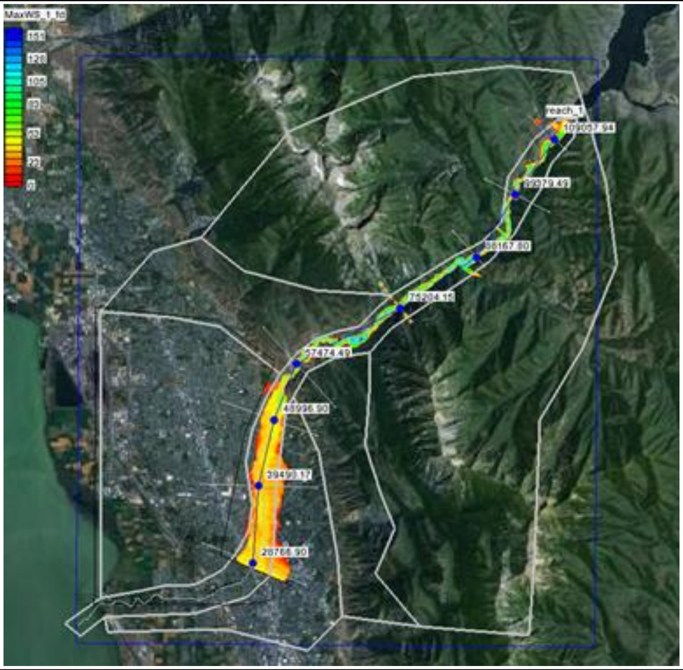
WMS 11.4 Tutorial

Simplified Dam Break

Learn how to run a dam break simulation and delineate its floodplain



Objectives

Setup a conceptual model of stream centerlines and cross sections for the simplified dam break (SMPDBK) model. Export the conceptual model to SMPDBK and run the analysis code. Read the results back into WMS and delineate the floodplain to determine the impact of the dam break.

Prerequisite Tutorials

- Basic Feature Objects
- DEM Basics
- Using TINs

Required Components

- WMS Core
- SMPDBK Model

Time

- 30–60 minutes

1 Introduction

Simplified Dam Break (SMPDBK) is a model that does just what its name says—it models dam failures using simplified methods. One alternative to using SMPDBK is to use sophisticated dam break models such as the National Weather Service's (NWS) DAMBRK model. These models require extensive data, time, and computing power. When these data or resources are not available, SMPDBK can be used to create a "quick and dirty" solution to the flood depths downstream of a dam failure. By combining the SMPDBK results with the floodplain delineation and display capabilities of WMS, it's possible to create a good picture of the aerial extents of a flood resulting from a dam break.

2 Preparing the Model

Start with preparing the model in WMS before executing it in SMPDBK.

2.1 Running TOPAZ

In this section, load the DEM and run TOPAZ to compute the flow directions and flow accumulations. The purpose of doing this is to obtain a stream arc that represents the centerline of the stream downstream from the dam. This stream arc will be used in a 1D-Hydraulic Centerline coverage to create the geometry for the SMPDBK model in WMS.

1. Open WMS. If WMS is already open, select *File* | **New** then click **No** if asked to save changes.
2. Select *File* | **Open** to access the *Open* dialog.
3. Locate the "smpdbk" folder in the files for this tutorial and select the file name "smpdbk.wms".
4. Click **Open** to import the project.

The starting project should appear similar to Figure 2-1.

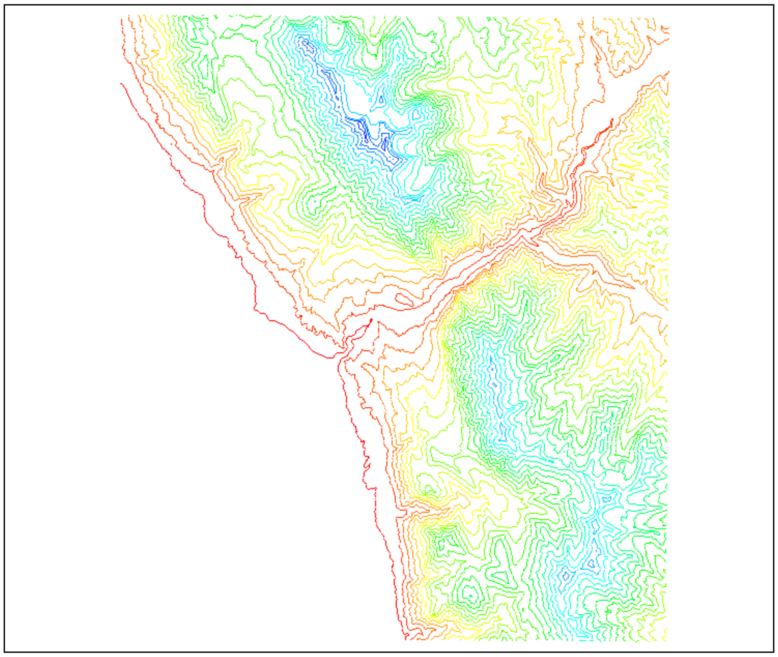


Figure 2-1 Starting project

5. Switch to the **Drainage** module.
6. Select *DEM* | **Compute Flow Direction/Accumulation** to open the *Flow Direction/Accumulation Run Options* dialog.
7. Accept the defualt setting and select **OK** to bring up the *Units* dialog.
8. Accept the settings and select **OK** to start the *Model Wrapper* and run TOPAZ.
9. Select **Close** once TOPAZ finishes running (this may take a few seconds to a minute) to exit the *Model Wrapper*.

A network of streams should appear on top of the DEM. TOPAZ computes flow directions for individual DEM cells and creates streams based on these directions. Change the flow accumulation threshold so that smaller or larger streams show up.

10. Right-click on "DEM (Converted)" on the Project Explorer and select **Display Options** to open the *Display Options* dialog.
11. On the *DEM* tab, change the *Min Accumulation for Display* to "5.0" sq miles and turn on the *Flow Accumulation* option.
12. Select **OK** to clsoe the *Display Options* dialog.

2.2 Creating Outlets and Streams

The next step in creating a SMPDBK model is to convert the computed TOPAZ flow data to a stream arc. This arc can then be used as the stream centerline in the SMPDBK model.

1. In the **Drainage** module, select the **Create Outlet Point** tool.
2. Create an outlet on the river in the lower left corner of the DEM, as seen in Figure 2-2. Be sure to click close enough to the river so the outlet snaps to the flow accumulation cell on the stream. The dam is located in the upper right corner of the DEM.

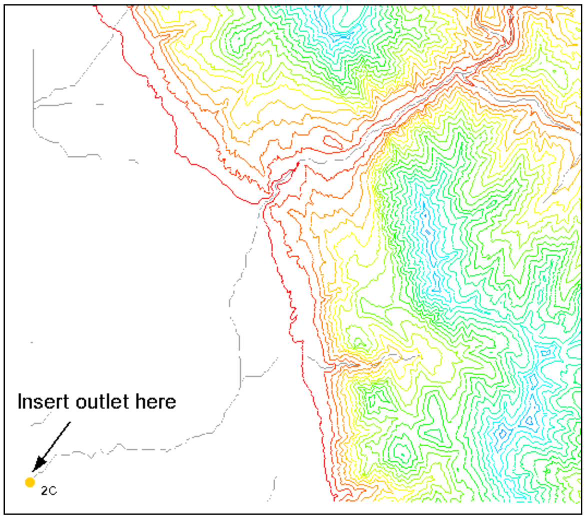


Figure 2-2: New outlet point.

3. Select *DEM* | **DEM** →**Stream Arcs** to open the *Stream Feature Arcs Options* dialog.
4. Accept the default settings and select **OK** to close the *Stream Features Arc Options* dialog.
5. Switch to the **Map** module.
6. Using the **Select Feature Arc** tool, select the three stream arcs that branch off of the main arc and *Delete* them.

The main stream arc is now isolated. The screen should look like Figure 2-3.

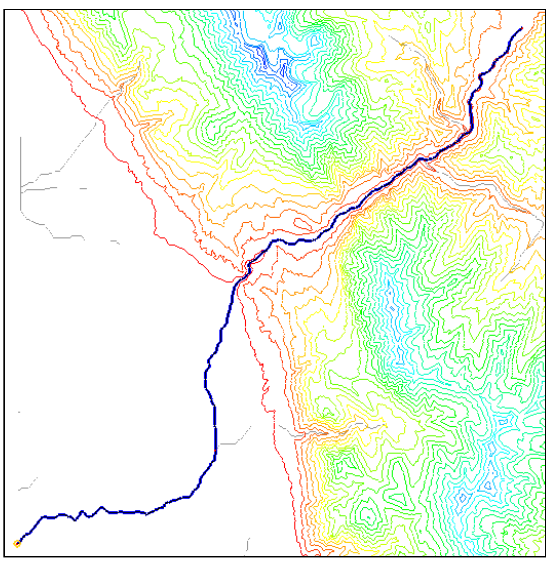


Figure 2-3: Main stream arc.

2.3 Creating 1D Hydraulic Coverages

The next step is to create arcs representing the stream centerline (in a 1D-Hydraulic Centerline coverage) and to create cross section arcs along this centerline (in a 1D-Hydraulic Cross Section coverage).

1. Using the **Select Feature Point/Node** tool, drag a box around the entire stream arc. Five nodes should be selected.
2. Select *Feature Objects* **| Vertex ↔ Node**.

This will convert all the selected nodes to vertices, turning the stream centerline into a single arc.

3. In the Project Explorer, right-click on the " Drainage" coverage and select *Type* **| 1D-Hyd Centerline**.
4. Using the **Select Feature Arc** tool, select the stream centerline arc
5. Select *Feature Objects* **| Reverse Directions**.

The **Reverse Directions** command changes the direction of the flow of the stream. If wanting to view this change, go to the map display options and turn on the *Stream Arrows* option. A small blue arrow will appear indicating the direction of the flow at the center of the stream. The direction should indicate that the stream is flowing down and to the left (southwest).

6. Switch to the **Terrain Data** module.
7. In the Project Explorer, right-click on " DEM (Converted)" and select *Convert* | *DEM → TIN* **| Filtered** to open the *DEM Conversion Options* dialog.
8. Make sure that *Triangulate new TIN* and *Delete DEM* options are turned on
9. Select **OK** to close the *DEM Conversion Options* dialog.
10. In the Project Explorer, right-click on " New tin" and select **Display Options** to open the *Display Options* dialog.
11. In the *TIN Data* options, make certain *Triangles* is turned off.
12. Select **OK** to close the *Display Options* dialog.
13. In the Project Explorer, right-click on the " Coverages" folder and select **New Coverage** to open the *Properties* dialog.
14. Select "1D-Hyd Cross Section" from the *Coverage type* drop-down box
15. Select **OK** to close the *Properties* dialog.
16. Using the **Create Feature Arc** tool, create eight cross sections as shown in Figure 2-4.

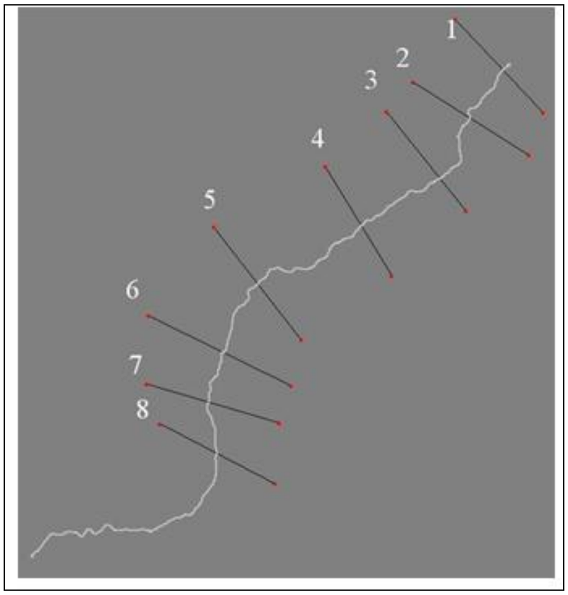


Figure 2-4: Cross Sections on Stream Arc.

2.4 Reading in Area Properties

An area property coverage is used to assign Manning's roughness values to the cross sections in SMPDBK. Area property coverages contain polygons with materials (representing land cover types) assigned to each polygon. In this section load an existing area property coverage. Also create an area property coverage from a background image or map.

1. Select *File* **| Open** to bring up the *Open* dialog.
2. Select the file "areaprop.map" and click **Open** to import the area properties coverage.
3. Switch to the **Map** module.
4. Using the **Select Feature Polygon**, double-click on the polygons open the *Land Poly Atts* dialog.
5. When done viewing the assinged material, click **Cancel** to close the *Land Poly Atts* dialog.

2.5 Extracting Cross Sections

Once having completed the centerline, cross section, and materials; the cross sections elevations can be extracted from the TIN. After the extracting the cross sections, the coverage data can be converted to a hydraulic model.

1. Select the " 1D-Hyd Cross Section" coverage to make it the active coverage.
2. Select *River Tools* **| Extract Cross Section** to open the *Extract Cross Sections* dialog.
3. Turn on *Using arcs* and select "1D-Hyd Centerline" from the drop-down list/
4. Select "Area Property" from the *Material Zones* drop-down list.
5. Select **OK** to close the *Extract Cross Sections* dialog.

6. Using the **Select Feature Arc** tool, double-click on a cross section to open the *River Cross Section Attributes* dialog.
7. Click on **Assign Cross Section** to open the *Assign Cross Section* dialog and view the cross section profile.
8. When done, select **Cancel** to exit the *Assign Cross Section* dialog.
9. Select **Cancel** to exit the *River Cross Section Attributes* dialog.
10. Select the " 1D-Hyd Centerline" coverage to make it the active coverage.
11. Select *River Tools* | **Map** → **1D Schematic**.

3 Using SMPDBK

Setting up the hydraulic model geometry is 90% of the work associated with creating a SMPDBK model. The other 10% involves entering information about the dam and the Manning's roughness values for each of the different area properties. Find this information on the Internet or in the National Inventory of Dams (NID) database. This section will guide through the process of finishing the SMPDBK model setup.

3.1 Edit Parameters

1. Select the **River** module.
2. From the *Model* drop-down box, select "SMPDBK".
3. Select *SMPDBK* | **Edit Parameters** to open the *Properties* dialog.
4. Enter the following values:

Dam name	MYDAM
River name	MYRIVER
Dam type	Earth dam
Elevation of water when dam breaches	5417.0
Elevation of breach bottom	5257.27
Volume of reservoir	193614.0
Surface area of the reservoir at dam crest	2965.0
Width of rectangular breach	250.0
Time for breach to develop	120.0
Non-breach flow	10000.0
Dead storage equivalent Manning's N	0.5
Number of cross sections	8
Distance to primary point of interest	14.0

5. Select **OK** to close the *Properties* dialog.
6. Select *SMPDBK* | **Material Properties** to open the *Hecras Material Properties* dialog.
7. Enter the following values:

River	0.05
Shrub/Brush	0.06
Residential	0.08
Forest	0.08

8. Select **OK** to close the *Hecras Material Properties* dialog.
9. Select *SMPDBK* | **Model Control** to open the *HEC-RAS Model Control* dialog.

10. Choose “Materials” from the *Roughness* drop-down box.
11. Select **OK** to close the *HEC-RAS Model Control* dialog.
12. Select *SMPDBK* | **Export SMPDBK File** to open a **Save File** dialog.
13. Enter “smpdbk.dat” as the *File name* and click **Save**.
14. Select **OK** to continue saving the data if any errors are encountered

3.2 Using the DOS Emulator

When running on a 64-bit Windows operating system, SMPDBK will not be able to run from WMS. Instead, run SMPDBK from a DOS command prompt by installing a DOS emulation program, such as DOSBOX (http://www.dosbox.com/) or a similar free product.

After installing a DOS emulator, do the following to run SMPDBK:

1. Launch DOSBOX.

After starting the program, it’s necessary to mount the drive(s) where SMPDBK is installed.

2. Mount a drive by typing the location of the drive with the SMPDBK files. For example type “mount C C:\” if all the files are located on the C drive.
3. After mounting the drive, type "C:" to go to the C drive.
4. Change to the directory containing the "smpdbk.dat" file. For example, if the smpdbk.dat file is located in "C:\Users\aquaveo\Documents\smpdbk", type “cd C:\Users\aquaveo\docume~1\smpdbk”.

Note that the DOS truncates files and folders containing more than 8 characters to be 8 characters. Determine the truncated name by typing “dir” at the command prompt or just begin typing the name and hit the *TAB* key to have the DOS emulator finish the name.

Once in the directory containing the smpdbk.dat file, run smpdbk from a command prompt. WMS installs smpdbk.exe in the same directory as WMS, so if WMS is installed in "c:\program files\WMS 11.0 64-bit\" do the following:

5. Enter “c:\progra~1\WMS11~1\smpdbk.exe” (note the truncated name) at the command prompt to start SMPDBK.

Once SMPDBK is started, it asks several questions.

6. Make sure the *CAPS LOCK* key is turned on. ENTER the following answers for the SMPDBK questions:
    a. Is this a National Service Office (e.g., RH, RFC, WSFO)? Enter “NO”.
    b. Do you with to run an existing file? Enter “YES”.
    c. What is the name of the datra set you with to run? Enter “SMPDBK.DAT”.
    d. Do you want your output to come to the terminals? Enter “NO”.
    e. Enter the filename for he output information: Enter “SMPDBK.OUT”.

After completely the last question, SMPDBK will run. A file called SMPDBK.OUT will be created in the project directory.

7. In WMS, read this file using the *SMPDBK* | **Read Solution** command to bring up an *Open File* dialog.
8. Select the “SMPDBK.OUT” file and click **Open** to import the solution.

After doing this, continue on to the Post-Processing section.

4 Post-Processing

Once having finished running SMPDBK, WMS reads the solution as a 2D scattered dataset. This solution contains water surface elevation points where each cross section intersects the stream centerline. When delineating the floodplain, it's necessary to have additional solution points to create a well-defined map. This section will guide through the processes of interpolating solution points along the centerline and the cross sections. After interpolating to create additional solution points, delineate the floodplain from these points.

4.1 Interpolation

1. Select the " 1D-Hyd Centerline" coverage to make it the active coverage
2. Select *River Tools* | **Interpolate Water Surface Elevations** to open the *Interpolate Stages* dialog.
3. For the *Create a data point* option, select "At a specified spacing".
4. Change Data point spacing to "1000".
5. Select **OK** to close the *Interpolate Stages* dialog.
6. Click on the " 1D-Hyd Cross Section" coverage to make it the active coverage
7. Select *River Tools* | **Interpolate Water Surface Elevations** to open the *Interpolate Stages* dialog.
8. Accept the entered values and select **OK** to close the *Interpolate Stages* dialog.

4.2 Open Background Image

Load in a background image (Aerial photo or a topo map) for the project site.

1. Select *File* | **Open** to bring up the *Open* dialog.
2. Select the file "aerial.jpg" and click **Open** to in import the image.

4.3 Floodplain Delineation

This section will show how to delineate a flood using the WMS floodplain delineation tools. It will also show how to adjust the display options to better display the results of the SMPDBK simulation.

1. Switch to the **Terrain Data** module.
2. Select *Flood* | **Delineate** to open the *Floodplain Delination* dialog.
3. Set the *Max search radius* to "5000".
4. Select **OK** to close the *Floodplain Delineatin* dialog.
5. In the Project Explorer, select " MaxWS_fd' under the " Terrain Data" folder.
6. Right-click on " MaxWS_fd" and select **Contour Options** to open the *MaxWS_fd Contour Options* dialog.
7. Set the *Contour Method* to "Color Fill" and set the *Transparency* to "40%".

8. Turn on *Specify a range*
9. Deselect *Fill below* and *Fill above*
10. Click **Legend** to open the *Contour Legend Options* dialog.
11. Turn on the *Display Legend* option.
12. Click **OK** to exit the *Contour Legend Options* dialog.
13. Click **OK** to close the *MaxWS_fd Contour Options* dialog.

The flood depths from the SMPDBK simulation can now be viewed as a spatial map. Notice that some areas appear flooded that they know are not actually flooded if the dam breaches. These areas can be corrected by drawing polygons around the areas known to be not flooded and then re-delineating the floodplain. The following steps explain how to do this.

14. Right-click on the " Coverages" folder and select **New Coverage** to open the *Properties* dialog.
15. Select "Flood Barrier" from the *Coverage Type* drop-down box.
16. Select **OK** to close the *Properties* dialog.
17. Using the **Create Feature Arcs** tool, draw an arc representing a polygon around the extra data that needs to be deleted. This includes areas clearly outside of the floodplain and areas where data does not exist to give accurate results, such as outside the extents of the hydraulic model (see Figure 4-1). WMS will ignore the areas inside this polygon when delineating the floodplain. Be sure the arc forms a closed loop.

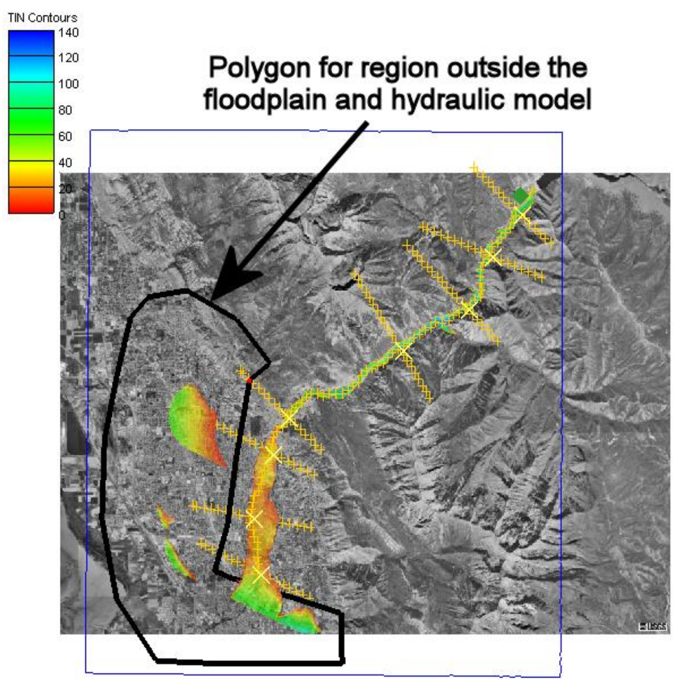


Figure 4-1: Creating a polygon for regions outside the model extents

18. Switch to the **Map** module.
19. Select *Feature Objects* | **Build Polygon.**

20. Select **OK** to use all arcs.
21. Switch to the **Terrain Data** module.
22. Select *Flood* **| Delineate** to open the *Floodplain Delineation* dialog.
23. Select the *User defined flood barrier coverage* option
24. Change the *Solution Name* to “MaxWS_1”
25. Select **OK** to close the *Flooplain Delineation* dialog.
26. To view the new data, select “ MaxWS_1_fd” under the “ MaxWS_1 (FLOOD)” solution folder.

Switch between “ MaxWS_fd” and “ MaxWS_1_fd” in the Project Explorer to view the effects of the flood barrier coverage on the floodplain delineation

5 Conclusion

In this exercise, the following was covered:

- Setup a conceptual model of stream centerlines and cross sections for the simplified dam break (SMPDBK) model
- Export the conceptual model to SMPDBK and run the analysis code

Read the results back into WMS and delineate the floodplain to determine the impact of the dam break.