



**GRAIP 1.0
GEOMORPHOLOGIC ROAD ANALYSIS
AND INVENTORY PACKAGE**

A Tool to Analyze the Environmental Impact of Roads on Forested Watersheds

**Tutorial &
Reference Manual**

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<http://www.engineering.usu.edu/dtarb/graip/>



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DISCLAIMERS

Although care has been taken in developing and testing GRAIP, errors and inadequacies may still occur, particularly in new applications. A user must therefore make the final evaluation as to the usefulness of GRAIP for their application. GRAIP is a tool to be used by investigators who have some knowledge and experience concerning analysis of the impact of roads on forested watersheds. It requires engineering judgment and common sense in developing input parameters and interpretation of the results.

The authors of GRAIP assume no liability or responsibility for the use of GRAIP, the interpretation of GRAIP results, or the consequences of management decisions that are based upon GRAIP. In no event shall the authors be liable for any damages whatsoever arising out of the use, or attempts to use GRAIP.

DISTRIBUTION

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<http://www.gnu.org/copyleft/gpl.html>

or from:

The Free Software Foundation, Inc., 59 Temple Place - Suite 330, Boston, MA 02111-1307, USA.

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SUPPORT

There is a contract currently in place for the Tarboton Group at Utah State University to provide some limited support to the Forest Service for GRAIP. Other than this, there is no formal ongoing support for this freely distributed open source software. However, we are interested in feedback. If you find errors, have suggestions, or are interested in any later versions contact:

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CONVENTIONS USED IN THIS MANUAL

A few conventions were established in developing this manual. Being aware of these conventions will make the manual easier to use.

- A.** Detailed step-by-step instructions for the user to execute are listed as numbered steps in grey boxes. These are used both for the steps in the installation of the software and steps in the tutorial.
- B.** Lists of items that are part of the general discussion and not specific steps to be executed are presented in lettered lists.
- C.** The symbol -> indicates the next level in a tree structure or in nested menus.

INTRODUCTION

The Geomorphologic Road Analysis and Inventory Package (GRAIP) is a process and set of tools for analyzing the impact of roads on forested watersheds. This manual describes how to install and use this set of tools to perform a typical GRAIP analysis. Several tools were developed as part of GRAIP and are included with the package, such as the GRAIP Preprocessor and the GRAIP ArcGIS Toolbar. In addition, GRAIP also requires the use of several other software packages which must be acquired separately. This includes ArcGIS 9.1/9.2, TauDEM, Hawth's Tools and SINMAP2.0.

GRAIP performs the following analyses to derive information on the environmental impact of roads on forested watersheds:

- A. Calculates and analyzes the production of road-based sediment and the input of that sediment into the stream network.
- B. Calculates the impact of road drainage on terrain stability and the potential for the formation of gullies due to erosion.
- C. Identifies fish passage passability at road-stream crossings and analyzes the resulting contiguity and fragmentation of the stream network fish habitat.

OVERVIEW

The construction and use of forest roads can have a significant negative impact on geomorphic processes and erosion patterns in forested basins. To analyze this impact, the Tarboton Group and the USDA Forest Service (USFS) developed the GRAIP (Geomorphologic Road Analysis and Inventory Package) process. Charles Luce and Thomas Black of the Forest Service developed much of the theory and the road inventory based approach which forms the foundation of GRAIP. Most of the work on the GRAIP tools was done by Ajay Prasad as his MS project under the supervision of David Tarboton. GRAIP is designed to help forest managers effectively manage road and road drainage systems and hence minimize the negative impacts of forest roads.

The GRAIP process begins by creating a detailed road inventory using GPS (Global Positioning System) based surveys. Then, a GRAIP analysis uses a number of GIS tools including the GRAIP tools along with a DEM (Digital Elevation Model) to derive environmental impact information from this inventory. Please note that the GRAIP system requires that the shapefiles developed as part of the road inventory and the DEM all must use the same coordinate system. GRAIP makes the assumption that they are the same, without actually checking to see that that is the case.

The GRAIP analysis begins by using the GRAIP Preprocessor, a standalone application, to review the road inventory data for inconsistencies, document the inconsistencies, adjust and filter the data, and then builds the GRAIP database and the consolidated drain point and road shapefiles. This process ensures a minimum data quality and allows the data to be represented in a structured format that is more suitable for analysis.

The remainder of the analysis is performed using a number of tools including the GRAIP Toolbar, an ArcGIS 9.1/9.2 toolbar, that performs the heart of the analysis. In addition, a GRAIP analysis uses ArcGIS 9.1/9.2, TauDEM, Hawth's Tools and SINMAP2.0.

The GRAIP Toolbar performs a number of analysis functions. The first group of functions calculates the sediment production for each road segment from slope, length, road surface condition and flow path vegetation. Road segment sediment production is then accumulated at each drain point. Digital elevation model (DEM) derived overland flow directions are then used to accumulate the sediment input to each stream segment. The second group of functions analyzes the impact of road drainage on terrain stability by calculating the specific discharge due to road drainage and using this, together with slope, as inputs to an infinite plane slope stability model. An erosion sensitivity index calculated using slope and contributing road length at each drain point is also calculated to predict gullying. The final function group analyzes the fragmentation of stream network fish habitat due to potential blockage of fish passage at stream crossings.

INSTALLATION

Prerequisites

A GRAIP analysis requires a number of software packages that are not included with GRAIP and they should be installed prior to installing GRAIP:

1. Install ArcGIS with an ArcInfo and Spatial Analysis license. For more information, see the installation information that came with ArcGIS or the website <http://esri.com/>.
2. Install TauDEM: The website <http://hydrology.neng.usu.edu/taudem/> explains how to install and use the TauDEM toolbar.
3. Install SINMAP2.0: The website <http://hydrology.neng.usu.edu/sinmap2> explains how to install and use the SINMAP toolbar.
4. Install Hawth's Tools: The website <http://www.spataleecology.com> describes how to install and use Hawth's analysis tools.

GRAIP Setup

Once these packages have been installed, GRAIP itself can be installed.

5. Install the GRAIP Toolbar and GRAIP Preprocessor: The website <http://www.engineering.usu.edu/dtarb/graip/> provides a link to the GRAIP GIS Tool setup file: "GRAIPSetup.exe". Download GRAIPSetup.exe and save it to your working folder. Double click to run the setup.

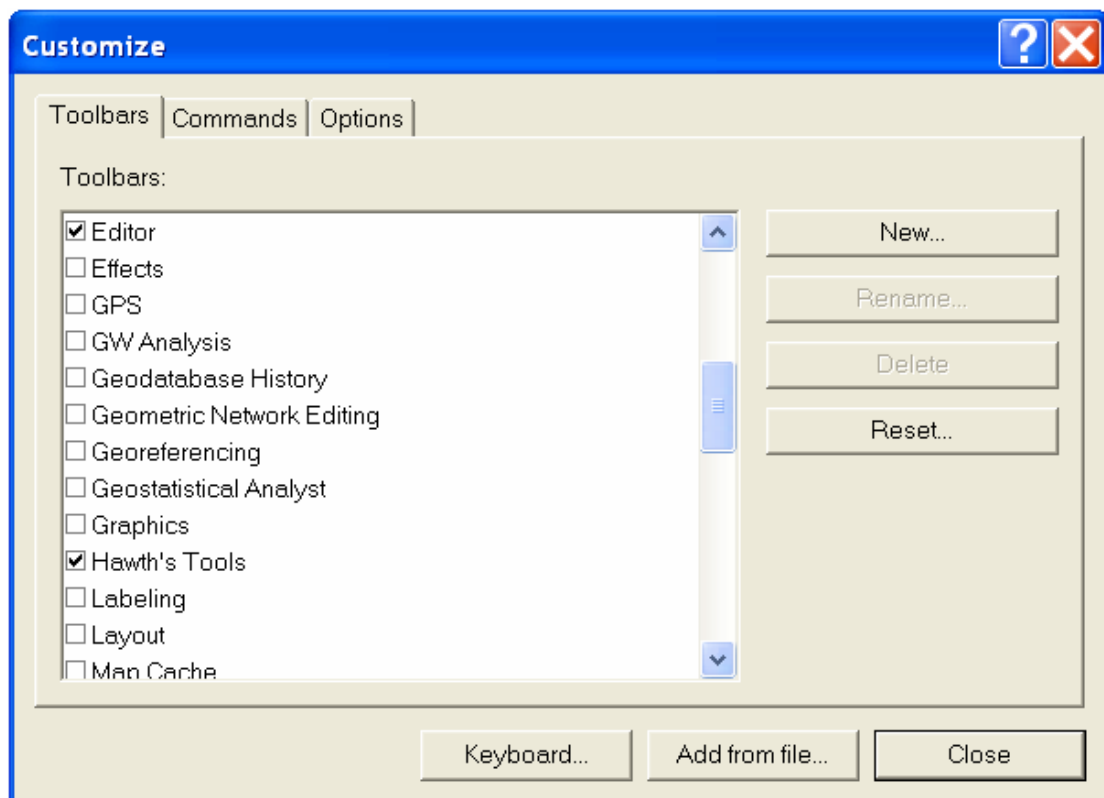
This will install GRAIP in the designated folder (by default C:\Program Files\GRAIP). The GRAIP installation includes:

- A. An executable, GRAIPPreprocessor.exe, and 3 binary libraries, consolidateShp.dll, agGRAIP.dll and graipCOMDLL.dll. These file make up both the Preprocessor and the ArcGIS toolbar.
- B. The GRAIP database template, GRAIP.mdb, located in the graip db folder. This file is required by the Preprocessor.

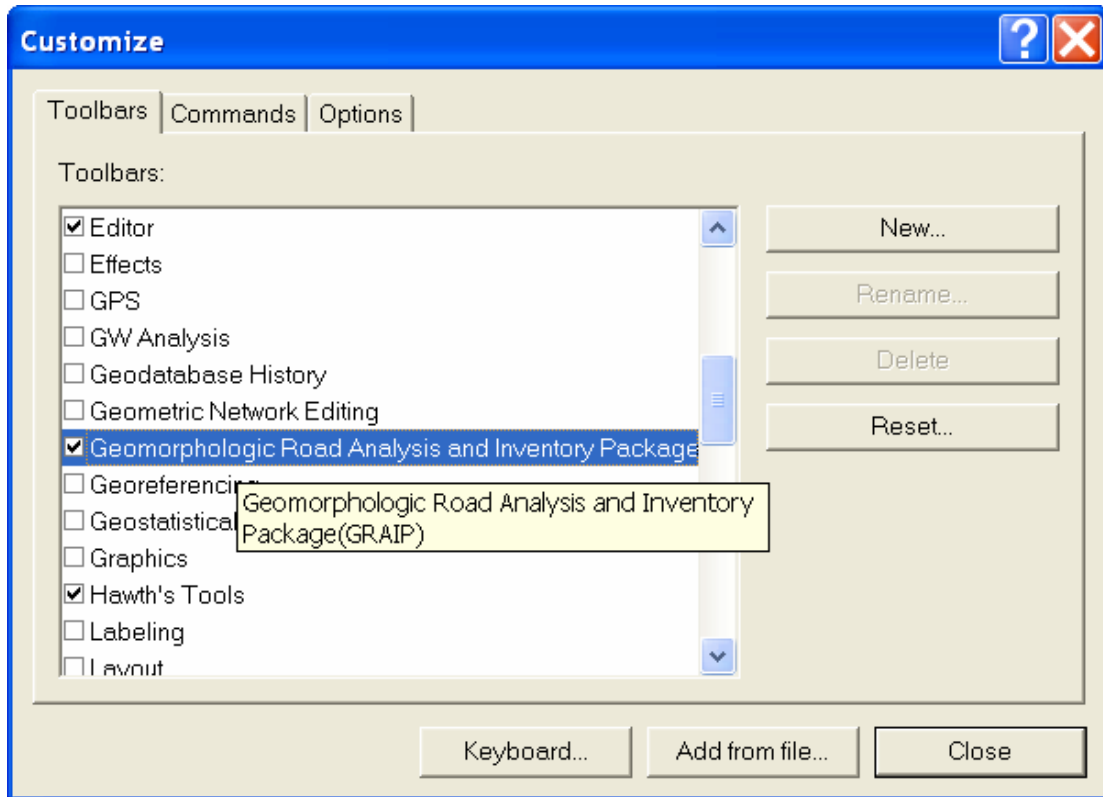
- C. A tutorial folder that contains this manual and a zipped file of data needed for the tutorial. This zip file contains a 'demo' folder which contains the "dem" (ESRI Raster Grid) file and a shapefiles folder containing eight types of drain points shapefiles (BBdip.shp, Diffuse.shp, Ditchrel.shp, Lead_off.shp, ned.shp, Str_Xing.shp, sump.shp, waterbar.shp) and one road lines shapefile (road.shp).
- D. A shortcut to the GRAIP Database Preprocessing tool that is installed in the Start-> Programs menu.

ArcGIS-GRAIP Toolbar Configuration

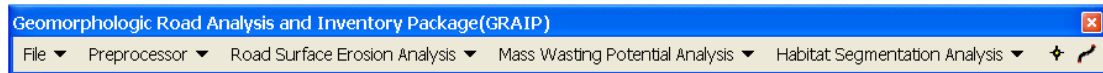
6. Start ArcMap by clicking the windows Start button and selecting All Programs -> ArcGIS -> ArcMap.
7. Select Tool -> Customize to open this dialog:



8. Click the Add from file... button to open the Open dialog.
9. Browse to the \Program Files\GRAIP folder.
10. Select the agGRAIP.dll file, click the OK button.
11. Click the Close button.
12. Check the "Geomorphologic Road Analysis and Inventory Package (GRAIP)" checkbox.



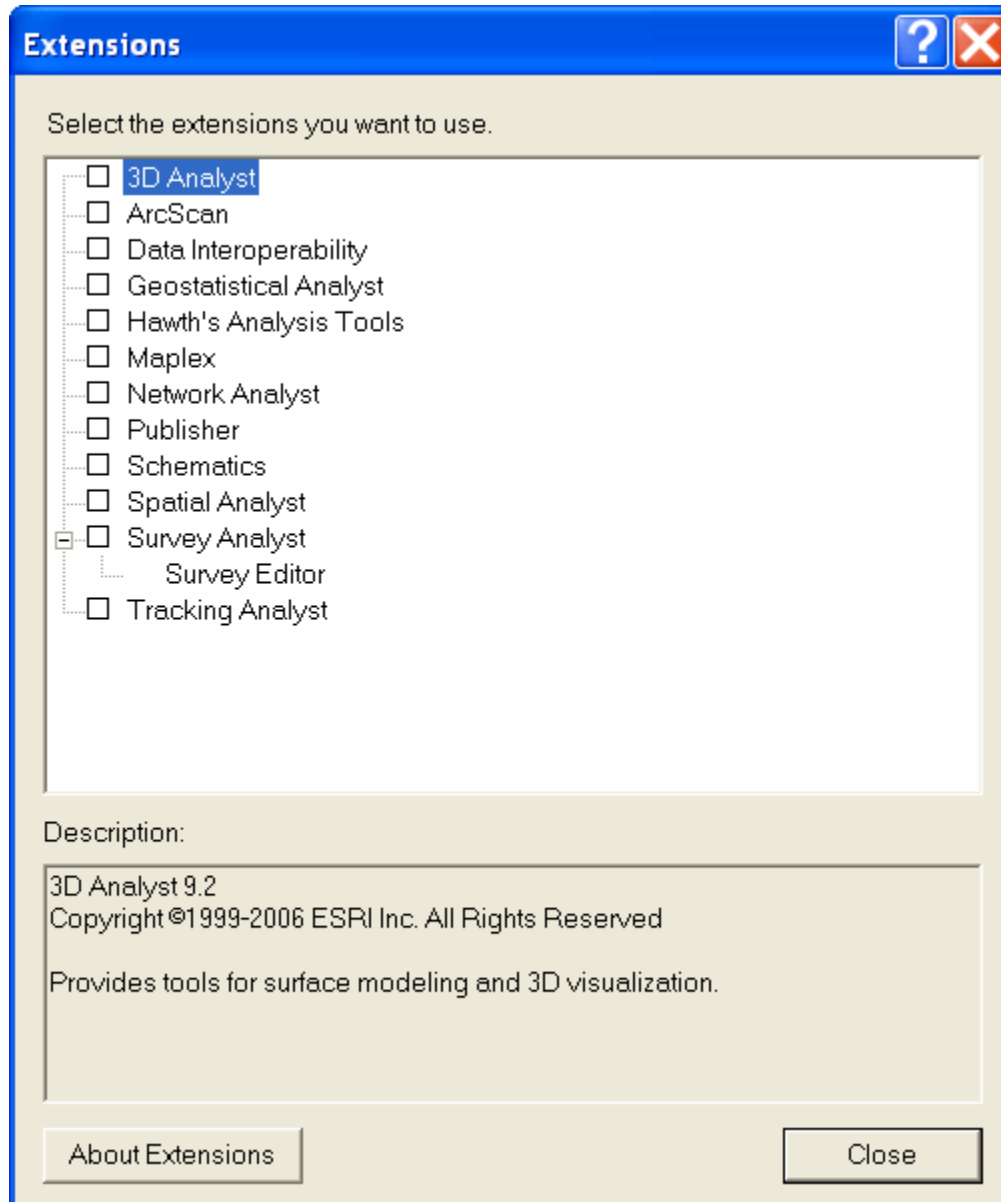
13. Click the “Close” button to make this toolbar visible.



ArcGIS-Spatial Analyst Configuration

GRAIP uses features from ArcGIS’ Spatial Analyst extension and so this extension must be unlocked. To do this:

14. Select Tool -> Extensions to open this dialog:



15. Click on Spatial Analyst and then click the Close button.

Installing the Tutorial Files

If you wish to work through the tutorial examples, you will also need to install the tutorial files.

16. Unzip the C:\Program Files\GRAIP\tutorial\demo.zip file to a convenient working folder. For the purpose of the tutorial examples, we have used C:\demo.

TUTORIAL

This tutorial describes the steps taken in a typical GRAIP analysis.

PREPROCESSOR

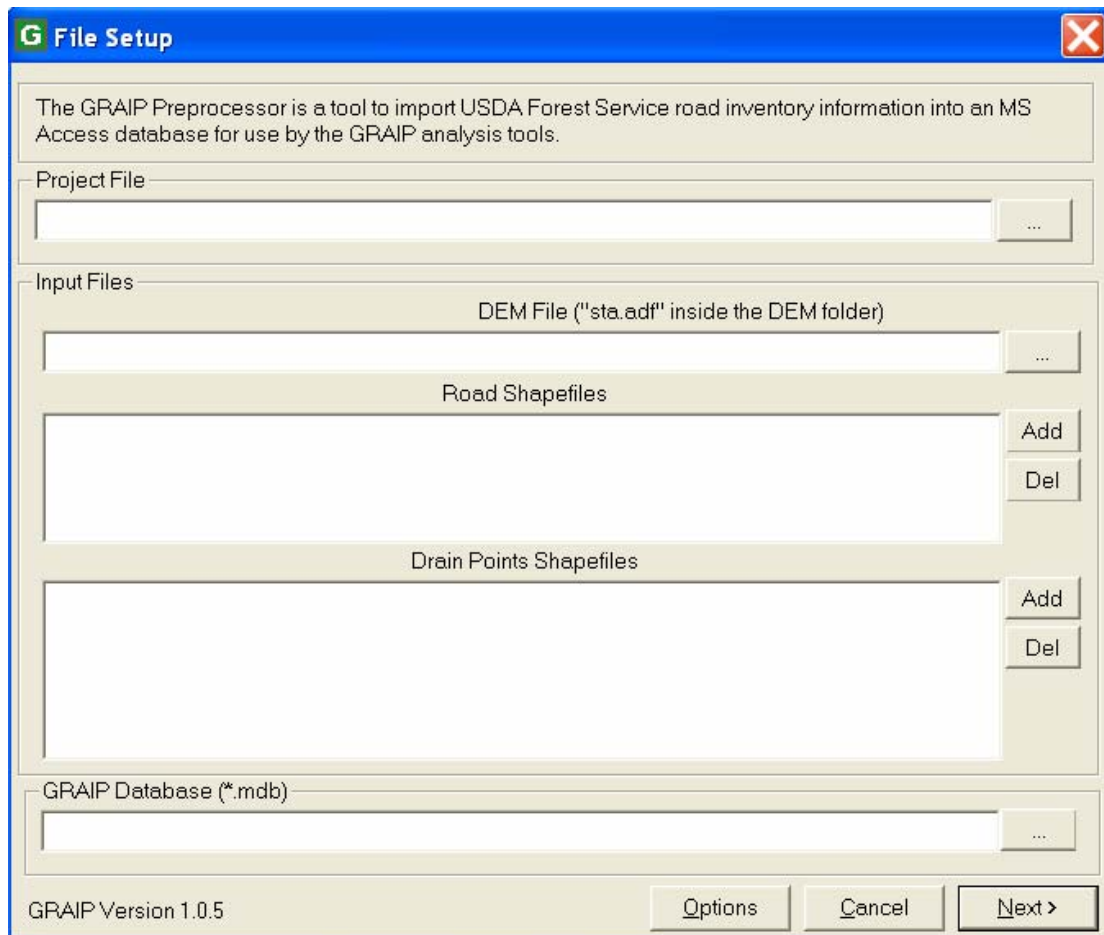
Introduction

The GRAIP Preprocessor is an application that validates and imports USFS road inventory shapefile attributes into a relational database structure created in the MS Access file format. The purpose of this database (the GRAIP Database) is to enforce referential integrity and ensure consistency between related attributes. The Preprocessor helps to correct and/or screen out invalid or corrupt data so the user has a better dataset with which to perform the forest road impact analysis. It also consolidates multiple drain point and road line shapefiles, creating a single shapefile for each.

Starting the Preprocessor

1. Start the GRAIP Preprocessor by clicking the windows Start button and selecting All Programs -> GRAIP -> GRAIP Preprocessor.

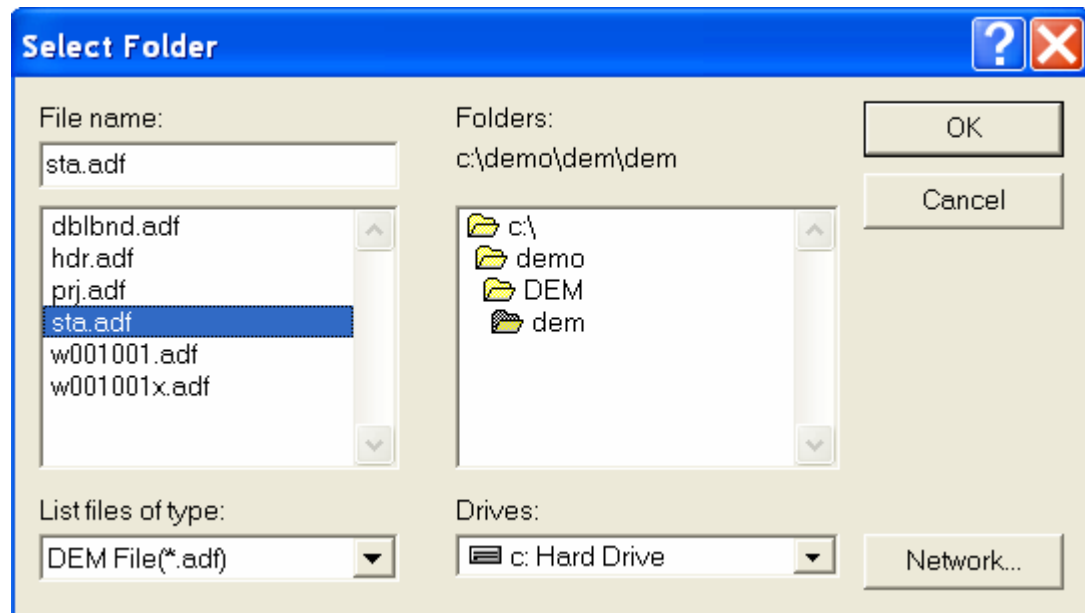
This screen will appear:



2. Click on the More Button (...) next to the Project File field. Browse to your tutorial working folder where you unzipped the demo data, use the file name "test.graip" and click Save.

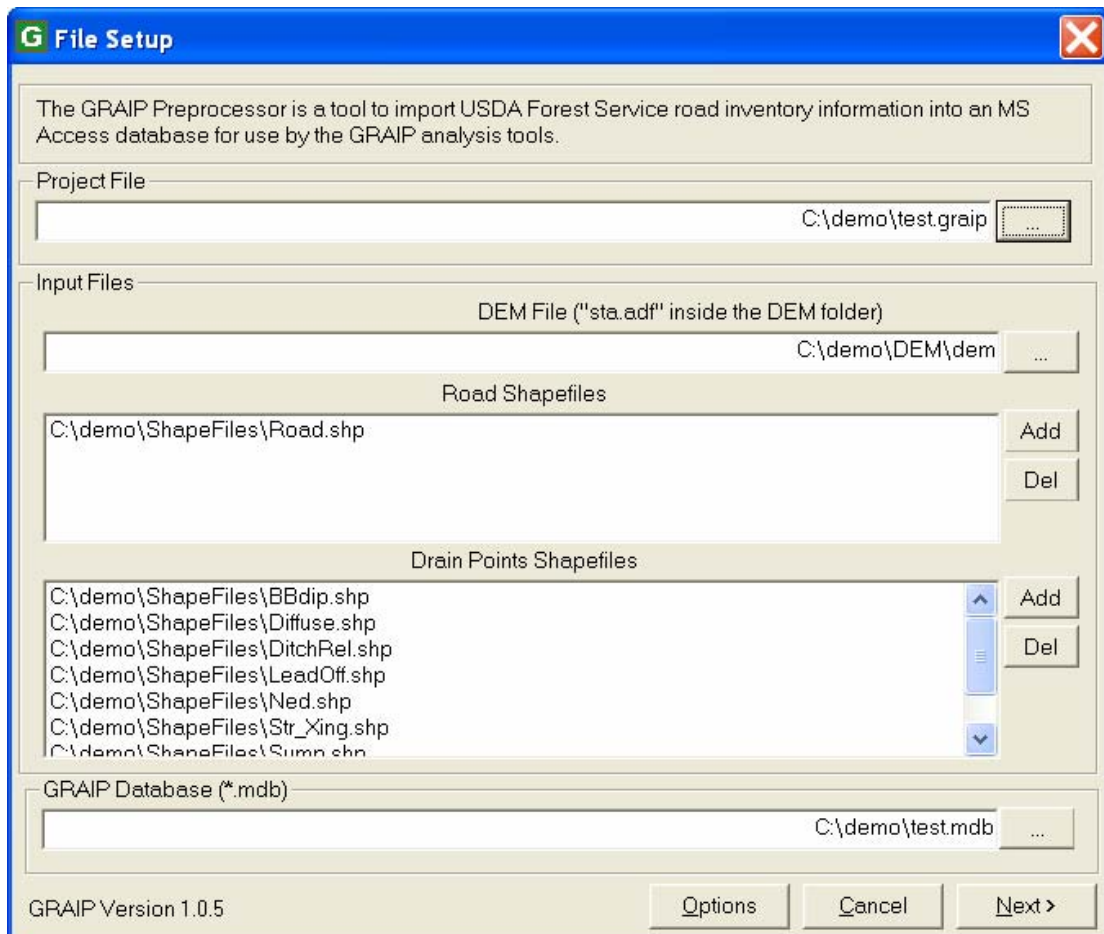
An initial path and file name for the GRAIP Database file will be generated based on the path and file name selected.

- Click on the More button (...) next to the DEM File field. Browse to the \DEM\dem folder in your tutorial working folder, select the sta.adf file and click "OK". See the location of the DEM\dem\sta.adf file used in this example:

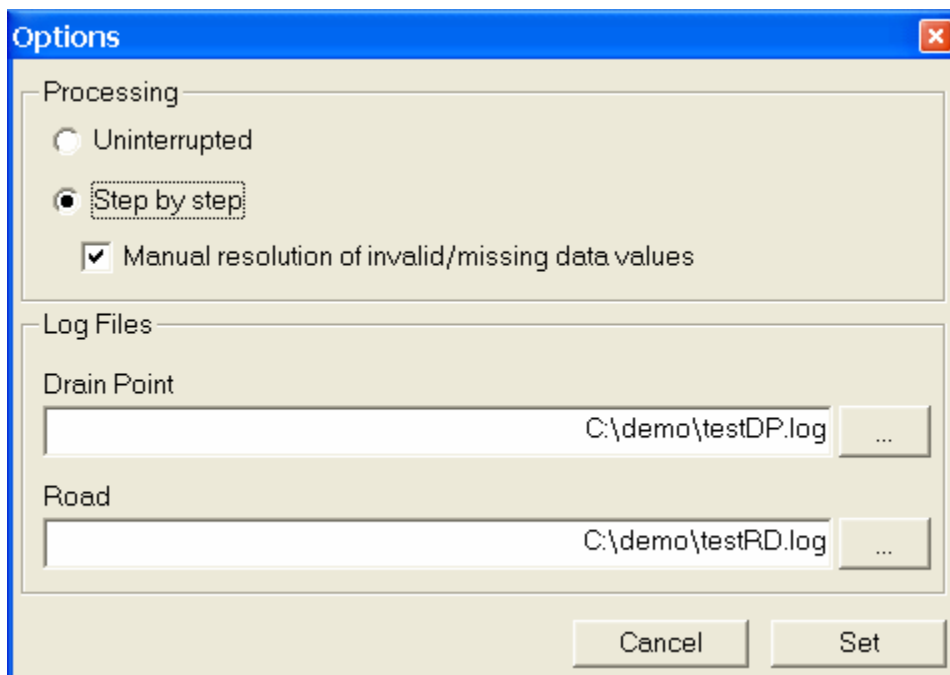


- Click on the Add button adjacent to Road Shapefiles field. Browse to the \ShapeFiles\ folder in your tutorial working folder, select the Road.shp file, and click "OK".
- Click on the Add button adjacent to Drain Points Shapefiles field. Select the following files from the Shapefiles directory by holding down the Ctrl key and clicking on each filename in this list: BBdip.shp, Diffuse.shp, DitchRel.shp, LeadOff.shp, Ned.shp, Str_Xing.shp, Sump.shp, WaterBar.shp. Release the Ctrl key and click OK.

Your screen should now look like this:



6. Click the “Options” button to open the dialog shown below:



The Options dialog allows you to choose the type of processing the Preprocessor will perform. Uninterrupted processing does not display any dialogs. It just uses all of the defaults and continues until all of the shapefiles are processed. Step by Step processing stops at each of the shapefile import screens allowing the user to adjust the options before importing each shapefile. Also if you choose Step by step processing, you have another choice to make, Manual resolution of invalid/missing values. If you select this option, anytime there is a value in an attribute field that is not in the dictionary for that field, a screen pops up to decide how to handle the situation. If you do not select this option, the preprocessor will use the default values and continue with the processing. In all cases, all data issues are logged for later review. This dialog also allows you to change the log file names and paths.

7. For the purpose of this tutorial, do not change any of the options. Just click "Cancel".
8. Click Next.

The first Import Drain Point Shapefile screen for matching fields from the first drain point shapefile to the appropriate target field in the GRAIP database table appears.

Before proceeding lets see what has been done. If you look in the working folder where the demo data was unzipped, you should see that a new GRAIP project file (test.graip) has been created which holds the lists of files that are part of the project. A new MS Access database file (test.mdb and test.ldb) has also been created. All the shapefile attributes will be validated and stored in this database file. Two logfiles (testDP.log and testRD.log) have been created as well.

Import Drain Point Attributes

Lets now return to the first Import Drain Point Shapefile screen shown:

G Import Drain Point Shapefile: 1 of 8

Match a source field from the input file to the appropriate target field in the database table

File being imported
C:\demo\ShapeFiles\BBdip.shp

Set Field Names

Drain Point Type
Broad base dip

For each target field, select the source field that should be loaded into it.

Target Field	Matching Source Field
CDate	CDATE
CTime	CTIME
VehicleID	VEHICLE
StreamConnectID	STREAM_CON
SlopeShapeID	SLOPE_SHAP
DischargeToID	DISCHRG_TO
ObstructionID	OBSTRUCT

< Back Next >

The File being imported field displays the path of the next drain point shapefile to be imported. This comes from the list of shapefiles identified earlier. The Drain Point Type default value is automatically selected by the program based on the name, but can be changed by the user.

The Set Field Names table is used to designate the fields from the drain point shapefile that will be imported into the GRAIP database. The Target Field column lists the fields in the GRAIP database and the Matching Source Field column indicates how each field in the GRAIP database is to be filled, either with a default value or from a field in the drain point shapefile. The tool will attempt to match the fields by default, but if no default is found, "<No Match Use Default>" is used. If any of the default values need to be changed, click on that row in the Matching Source Field column and a list of choices will appear on a drop down menu:

G Import Drain Point Shapefile: 1 of 8

Match a source field from the input file to the appropriate target field in the database table

File being imported
C:\demo\ShapeFiles\BBdip.shp

Set Field Names

Drain Point Type
Broad base dip

For each target field, select the source field that should be loaded into it.

Target Field	Matching Source Field
CDate	CDATE
CTime	CTIME
VehicleID	VEHICLE
StreamConnectID	STREAM_CON
SlopeShapeID	STREAM_CON
DischargeToID	OBSTRUCT
ObstructionID	FILL_EROS
	TYPE
	CONDIT
	MATERIAL
	COMMENT
	CDATE

< Back Next >

9. In this example, the defaults are acceptable, so click Next.

A progress bar will appear at the bottom of the screen while the shapefile is imported.

10. Once again, the defaults are acceptable, so click Next for the 2nd Import Drain Point Import Shapefile screen and then again click Next for the the 3rd Import Drain Point Shapefile screen.

As the DitchRel shapefile is being imported after you have clicked Next on its Drain Point Import Screen, an attribute value of "Previous" is found in the FlowDiversionID field, which is not defined in the FlowDiversionDefinitions table. The Define Value dialog appears to help you resolve this issue:

Define Value

Value '<25 degrees' in field 'ChannelAngleID' is not in the definitions table.

Use default value

Reassign this value to an existing value in definitions table

Definitions

Add new entry to definitions table

Table Name

ID

Definition

Description

You now need to decide how you want the Preprocessor to handle all occurrences of this undefined value in this field. Your choices are to use the default defined value for this field (shown next to the Use default value label), reassign all occurrences of this value to one of the existing defined values, or create a new definition for this value.

11. For this tutorial, click Use default value.

The choices made on resolving mismatched during data import are recorded in the DPErrorLog table and testDP.log file.

12. Click Ok.

Once all of the invalid values in that drain point table are processed, the next drain points validate and import screen is displayed.

13. Continue these steps clicking "Next" and resolving invalid/missing values until all the drain point shapefiles are imported to the database.

Once all the drain points shapefiles are validated and imported, the Road Lines import screen is displayed.

Import Road Lines Attributes

The Road Lines Import screen looks like this:

G Import Road Line Shapefile: 1 of 1

Match a source field from the input file to the appropriate target field in the database table

File being imported

Set Field Names

Road Network	Base Erosion Rate (kg/m/yr)	Description
Default	79	Default Base rate from Luce and Black, 199

For each target field, select the source field that should be loaded into it.

Target Field	Matching Source Field
SurfaceTypeID	SURF_TYPE
SurfaceConditionID	SURF_COND
RoadTypeID	ROAD_TYPE
RoadEdge1ID	RD_EDGE_1
RoadEdge2ID	RD_EDGE_2
EdgeVegetation1ID	EDGE_VEG_1
EdgeVegetation2ID	EDGE_VEG_2

< Back Next >

The File being imported field displays the path of the road line shapefile to be imported. This comes from file selected in the initial Preprocessing screen. The Road Network field shows the road network type. The Base Erosion Rate field shows the rate associated with this road network type. The Description field gives an explanation for the base rate used. The + button is used to add an additional road network type along with its associated base rate and description. The - button is used to remove a road network type and its associated base erosion rate. The Default road network type cannot be removed.

The Set Field Names table is used to designate the fields from the drain point shapefile that will be imported into the GRAIP database. The Target Field column lists the fields in the GRAIP database and the Matching Source Field column indicates how each field in the GRAIP database is to be filled, either with a default value or from a field in the drain point shapefile. The tool will attempt to match the fields by default, but if no default is found, "<No Match Use Default>" is used. If any of the default values need to be changed, click on that row in the Matching Source Field column and a list of choices will appear on a drop down menu:

G Import Road Line Shapefile: 1 of 1

Match a source field from the input file to the appropriate target field in the database table

File being imported: C:\demo\ShapeFiles\Road.shp

Set Field Names

Road Network: Default | Base Erosion Rate (kg/m/yr): 79 | Description: Default Base rate from Luce and Black, 199

For each target field, select the source field that should be loaded into it.

Target Field	Matching Source Field
SurfaceTypeID	SURF_TYPE
SurfaceConditionID	SURF_COND
RoadTypeID	
RoadEdge1ID	<No Match Use Default>
RoadEdge2ID	SURF_TYPE
EdgeVegetation1ID	SURF_COND
EdgeVegetation2ID	ROAD_TYPE
	RD_EDGE_1
	RD_EDGE_2
	EDGE_VEG_1
	EDGE_VEG_2

< Back Next >

14. In this example, the defaults are acceptable, so click Next.

As the Road.shp shapefile is being imported, an attribute value of >50' is found in the FillChannelID field, which is not defined in the FillChannelDefinitions table. The Define Value dialog appears to help you resolve this issue:

Define Value

Value '>50' in field 'FillChannelID' is not in the definitions table.

Use default value

Reassign this value to an existing value in definitions table

Definitions

Add new entry to definitions table

Table Name

ID

Definition

Description

15. Click Use default value and click “OK”.
16. Continue resolving invalid/missing values until the road line shapefile is imported to the database.

The consolidate shapefiles progress bar will appear while the shapefiles are being consolidated.

Preprocessor Output Files

Here is a list of the output files created by the GRAIP Database Preprocessor tool:

Name ▲	Size	Type
DrainPoints.dbf	10 KB	DBF File
DrainPoints.shp	26 KB	SHP File
DrainPoints.shx	8 KB	SHX File
RoadLines.dbf	11 KB	DBF File
RoadLines.shp	381 KB	SHP File
RoadLines.shx	9 KB	SHX File
test.graip	1 KB	GRAIP File
test.mdb	10,936 KB	Microsoft Office Access Application
testDP.log	5 KB	Text Document
testRD.log	2 KB	Text Document

The output files include 2 log files that identify the issues found with the data during operation of the preprocessor. A copy of this information can also be found in 2 of the tables in the Access database file.

DATA PREPARATION

This data preparation step should be done before using the GRAIP GIS Tool:

17. Start ArcMap by clicking the windows “Start” button and selecting All Programs -> ArcGIS -> ArcMap.
18. Click the Add Data tool from ArcMap’s Standard toolbar, browse to the DEM folder in the demo folder, select the dem grid and click Add.
19. Perform the Basic Grid Analysis -> Select Base DEM grid ... and Basic Grid Analysis -> Do All functions of the TauDEM toolbar. See <http://hydrology.neng.usu.edu/taudem/> for more information.

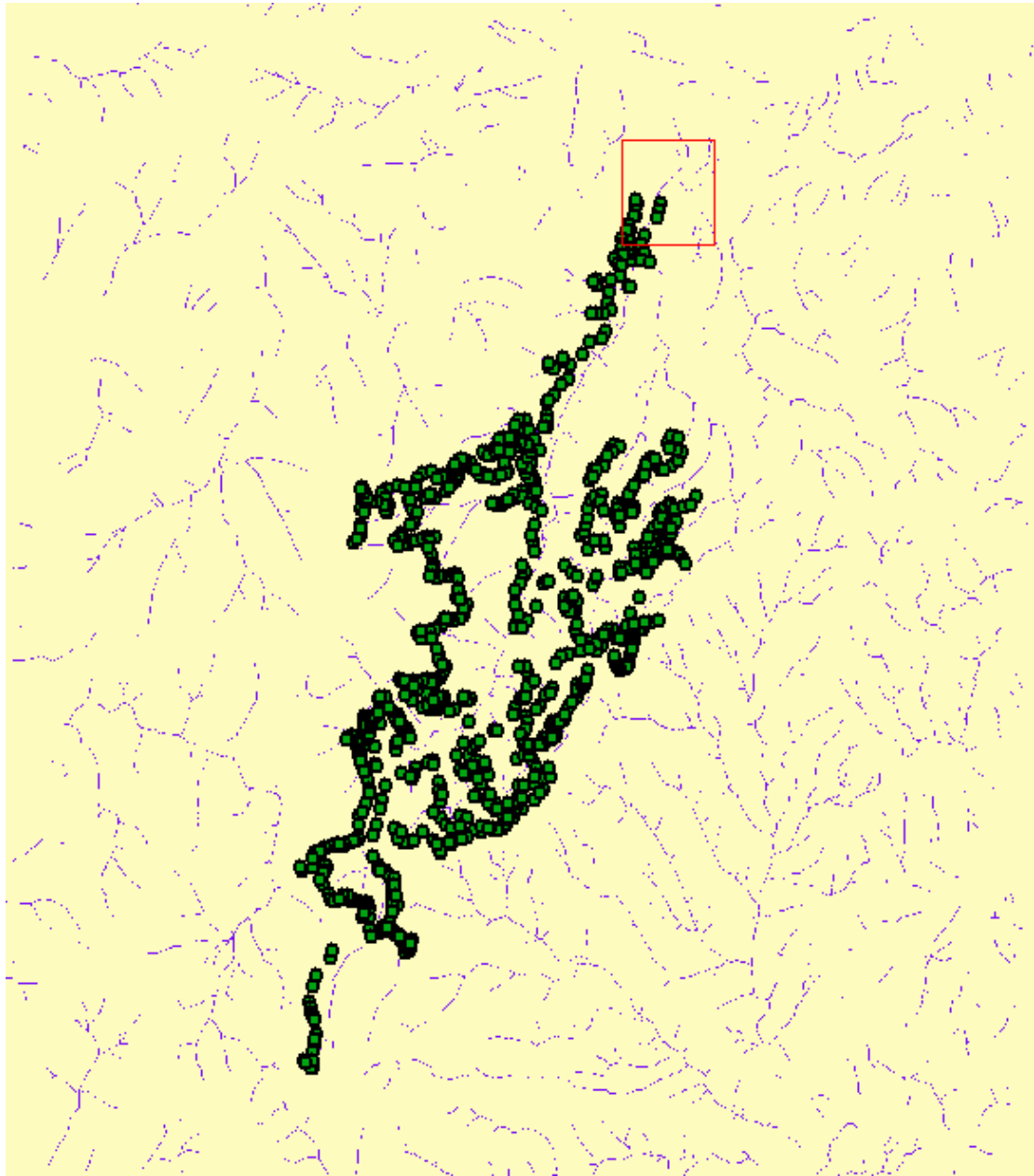
Now you need to identify the outlet of the watershed you will be working with. To do this, use ArcCatalog to create a new empty point type shapefile named "Outlet".

20. Start ArcCatalog by selecting Tools -> ArcCatalog.
21. Right click on the Shapefile folder in the demo folder where you are working and select 'New/Shapefile...'. Set the name 'Outlet' and set the feature class to point. Click OK to create the shapefile.

Then add the outlet point to the new shapefile.

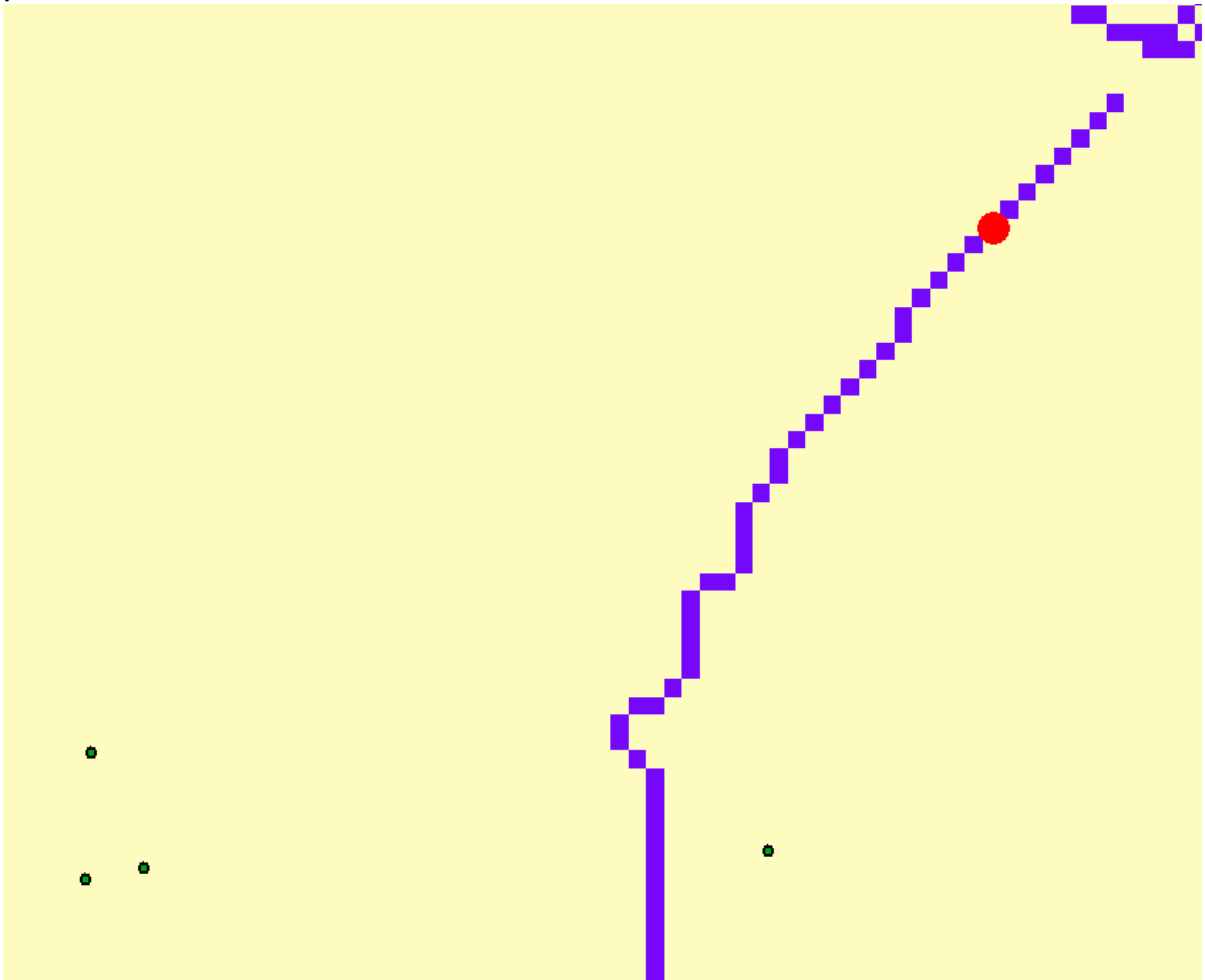
22. Switch back to ArcMap. Click the Add Data tool from ArcMap’s Standard toolbar, browse to the Shapefiles folder in the demo folder and select Outlet.shp. If the Editor toolbar is not visible, Select View -> Toolbars -> Editor to display it. Select Editor -> Start Editing from the Editing toolbar. Select the \demo\Shapfiles folder and click OK. Select Outlet.shp, and click Start Editing.
23. Use the layer demsrc.src to ensure that you are locating a point on a stream path. Click the Add Data tool from ArcMap’s Standard toolbar, to add the DrainPoints shapefile.

The demsrc.src layer with the DrainPoints file looks like this (except it won’t have the red box):



24. Use the Magnifying Glass tool to zoom in on the downstream area of the watershed (which was highlighted by the red box in the previous image).
25. Use the Sketch tool to carefully locate a point at the outlet of the watershed (downstream of all of the drain points).

Your point should look something like this:



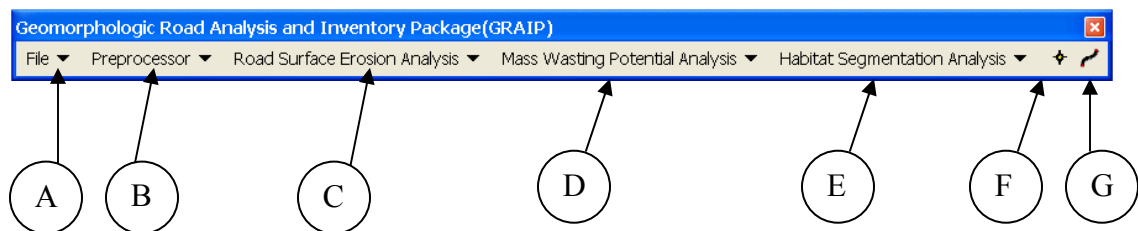
26. Select Editor -> Stop Editing , and then Save.

If you had difficulties creating the outlet file and adding your outlet point, instead you can use the Outlet1.shp file that is in the demo folder. Outlet.shp (or Outlet1.shp if you are using the pre-built file) is now a one point shapefile.

27. Run the Network Delineation functions of the TauDEM toolbar using Outlet.shp as the outlets file to delineate a stream network based on the DEM. See <http://hydrology.neng.usu.edu/taudem/> for more information.

GRAIP TOOLBAR MENU & TOOLS

The GRAIP toolbar has the following menus:



- A. **File Menu**—to set and adjust project settings and files.
- B. **Preprocessor Menu**—to perform several preliminary steps necessary to a GRAIP analysis
- C. **Road Surface Erosion Analysis Menu**—to quantify sediment production from forest roads and its delivery to streams.
- D. **Mass Wasting Potential Analysis Menu**—to quantify the impact of forest roads on terrain stability and gully potential.
- E. **Habitat Segmentation Analysis Menu**—to analyze and demarcate fish habitat segmentation due to failed or blocked culverts.

In addition to the menus, there are two tools on the GRAIP toolbar:

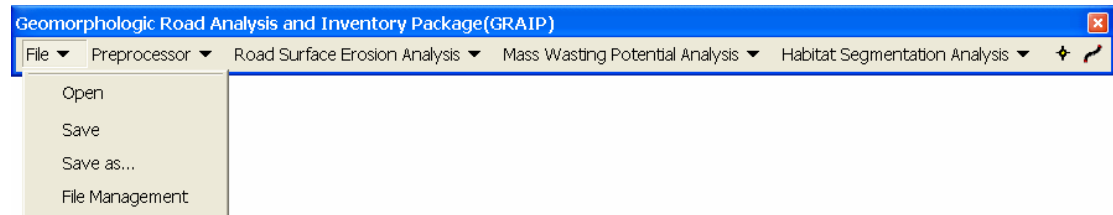
- F. **Drain Rex**—to trace the road segments draining to a particular drain point. (Rex being the faithful dog to sniff out where road segments drain.)
- G. **Road Rex**—to find drain points to which a particular road segment is draining.

FILE MENU

Open Function

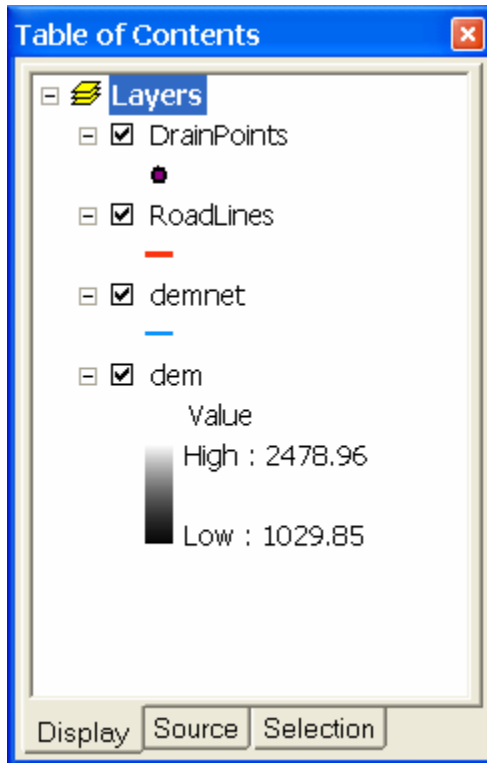
The Open function opens the project file that contains information about files and paths for the GRAIP analysis that was created by the GRAIP Preprocessor.

28. Select “File” -> “Open” from the GRAIP Toolbar.



29. In the Open dialog, browse to your working folder and select the test.graip project file that was created by the GRAIP Preprocessor. Click Open.

Once this has been opened, the DEM, DrainPoints.shp, RoadLines.shp and demnet.shp files will be loaded and displayed in ArcMap. ArcMap’s Table of Contents should look like this:



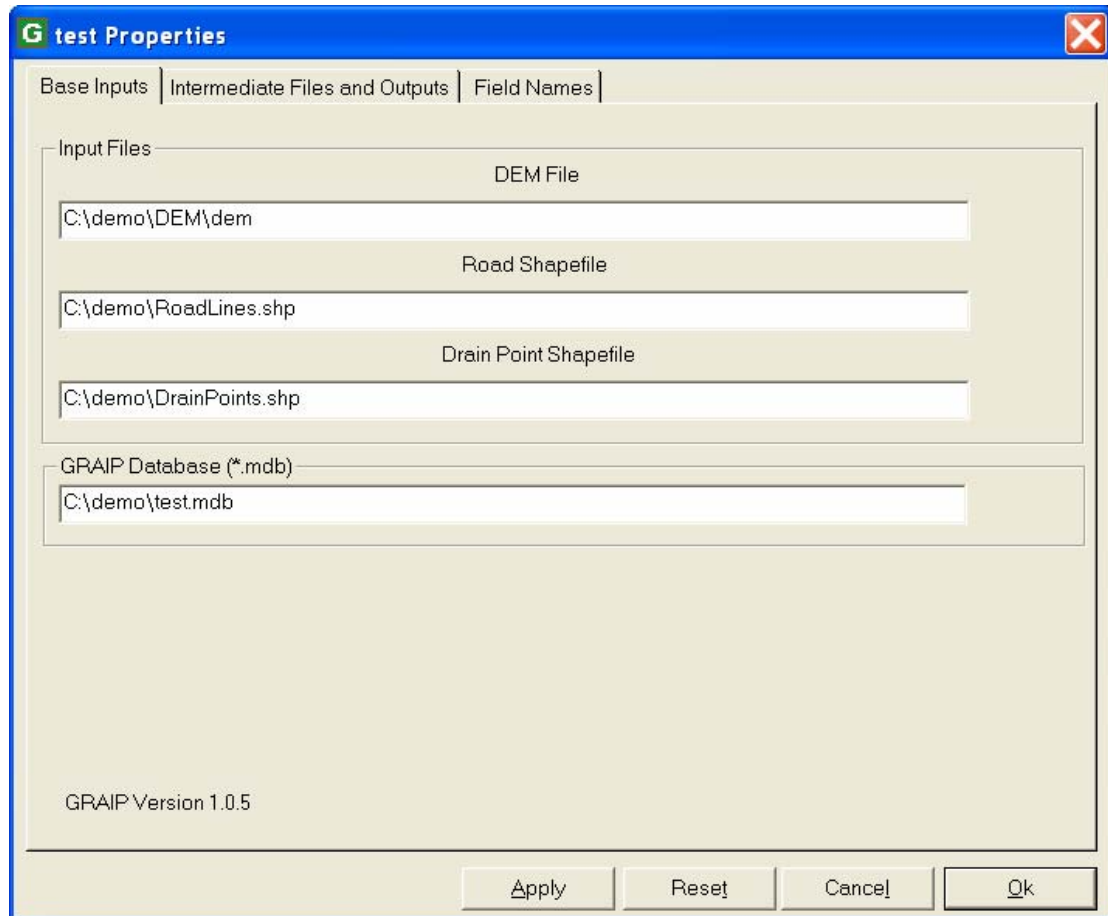
When the project file is used to load the files, the RoadLines and DrainPoints shapefiles are also joined to their corresponding tables in the GRAIP Database (*.mdb) so that the attributes are available for analysis. This allows to open the RoadLines shapefile attribute table and see the data stored in the RoadLines database table:

RoadLines.FID	RoadLines.Shape	RoadLines.GRAIPRID	RoadLines.RoadEdge2ID *	RoadLines.EdgeVegetation1ID *	RoadLines.EdgeVegetation2ID *
0	Polyline	0	1	3	3
1	Polyline	1	3	5	5
2	Polyline	2	1	3	2
3	Polyline	3	1	3	3
4	Polyline	4	1	1	4
5	Polyline	5	1	1	4
6	Polyline	6	1	1	4

File Management Function

To view the default file names and paths that will be used for this analysis or if there is a need to change any of the files or file paths for any of the input, intermediate or output files, use the File Management function.

30. Select File -> File Management to open the File Management dialog as shown:



Here you can review the default file names and make any necessary adjustments. For this tutorial, we will not make any changes.

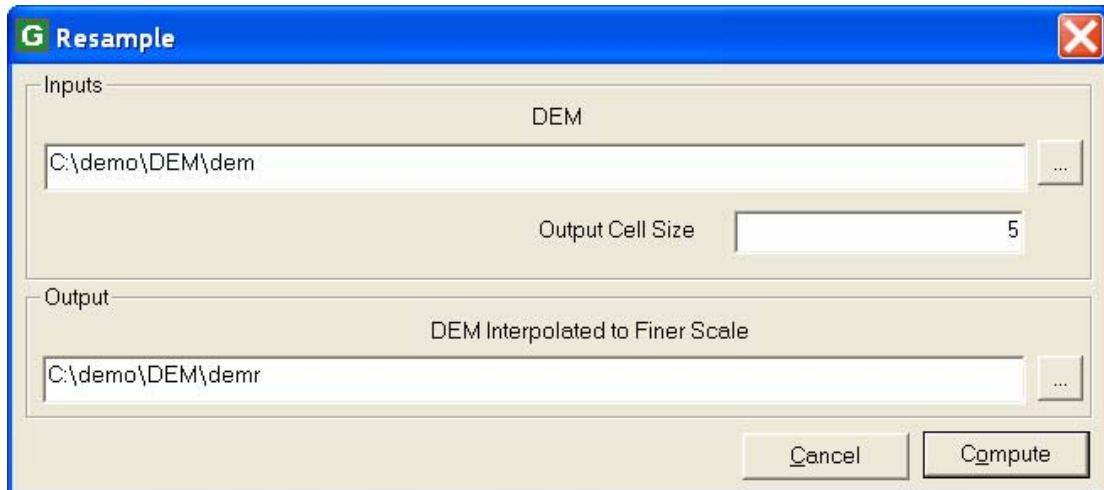
31. Click Cancel.

PREPROCESSOR MENU

Resample DEM Function

This function resamples a DEM to a finer scale using the cubic convolution method from the ArcGIS Toolbox.

32. Select Preprocessor -> Resample DEM on the GRAIP Toolbar to get the “Resample” dialog as shown here:

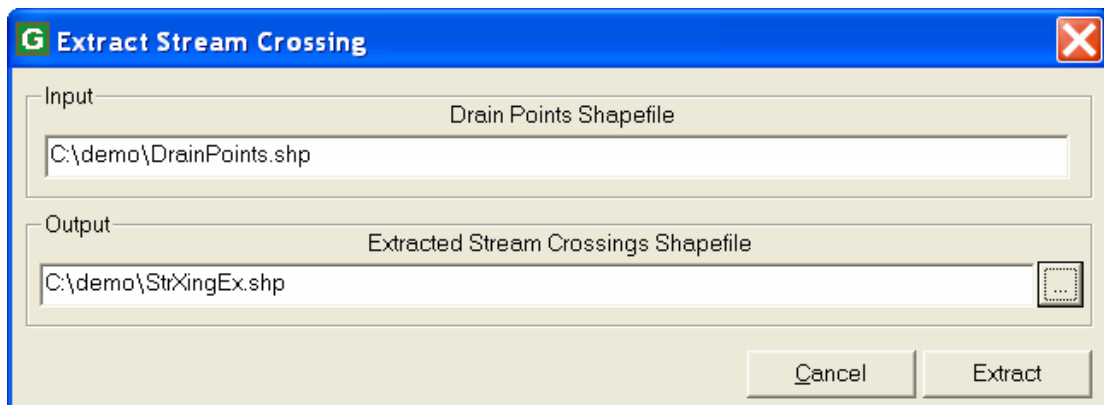


33. Click Compute.

Extract Stream Crossings Function

This function extracts the stream crossing drain points from the consolidated DrainPoints shapefile created by the GRAIP Preprocessor.

34. Select Preprocessor -> Extract Stream Crossings from the GRAIP toolbar to get the screen shown:

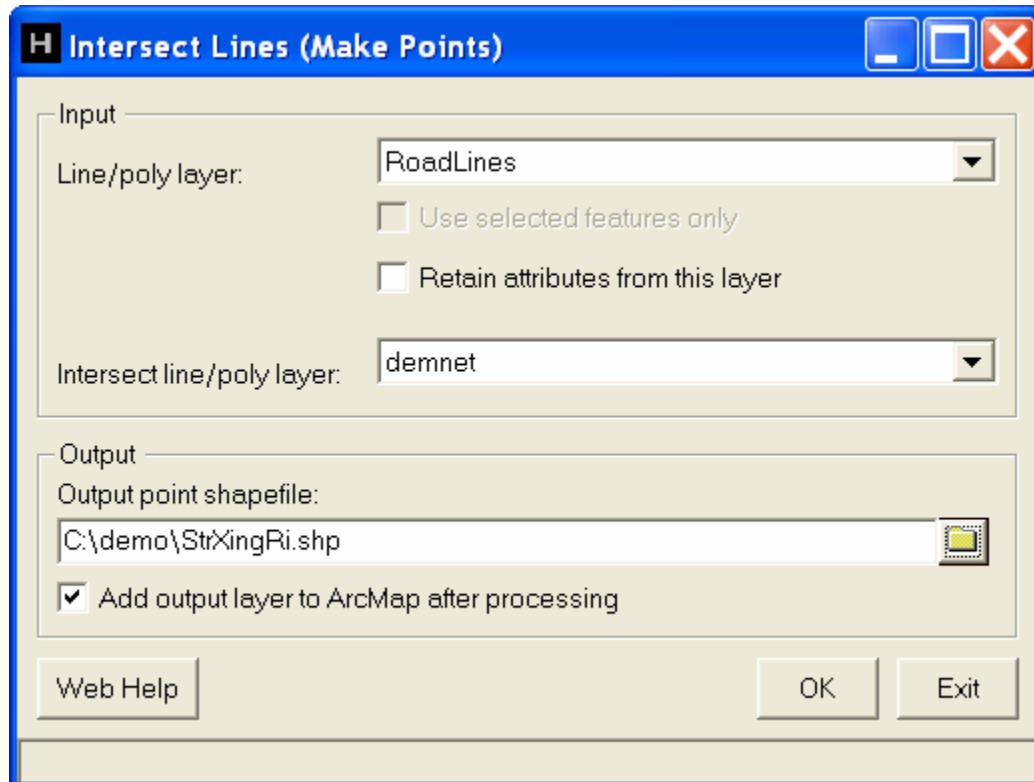


35. Click "Extract".

Hawth's Tool-Intersect Lines (Make Points) Function

This function creates a shapefile containing points that are the intersections of the roads from the RoadLines shapefile with the stream network generated by TauDEM.

36. Select Hawth's Tools -> Vector Editing Tools -> Intersect Lines (Make Points) from the Hawth's Tools toolbar to get the "Intersect Lines (Make Points)" dialog.
37. Select RoadLines as the Line/poly layer, demnet as the Intersect line/poly layer and for the Output point shapefile, browse to the folder you are using for this tutorial and name the file StrXingRi.shp so the screen looks like this:

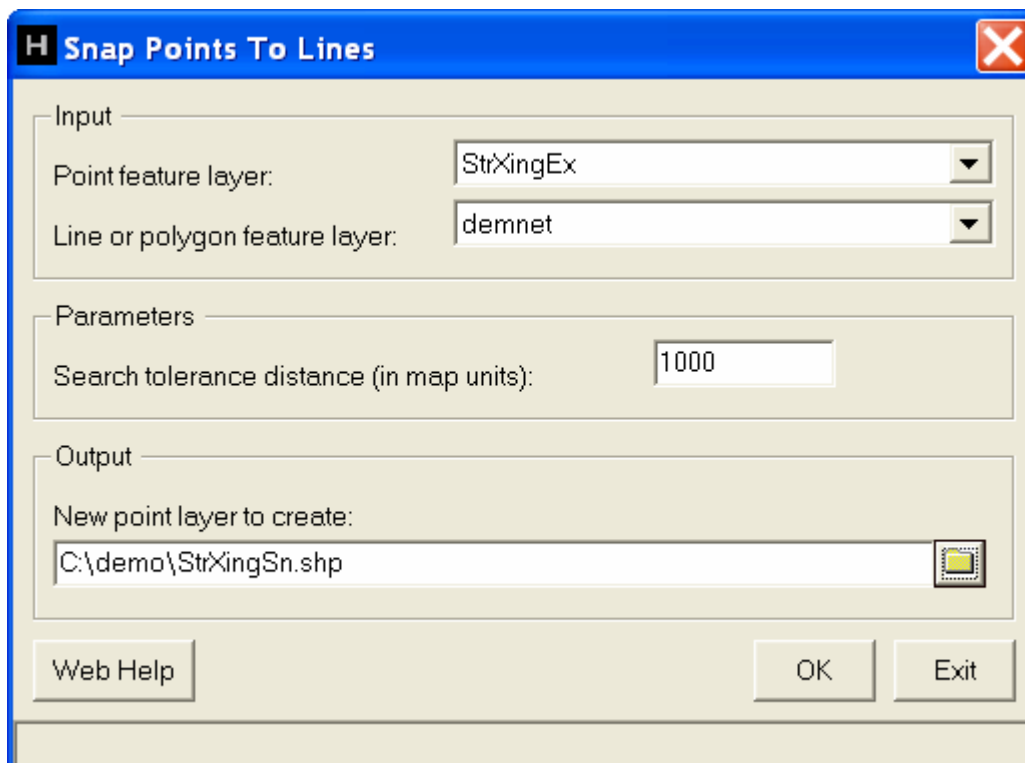


38. Click the OK button. Click OK on the confirmation screen.

Hawth's Tools-Snap Points to Lines Tool Function

This function will create a new point shapefile that contains the drainpoints after they have been adjusted so that they actually lie on the preliminary stream network that was created by TauDEM.

39. Select Hawth's Tools -> Vector Editing Tools -> Snap Points to Lines Tool from the Hawth's Tools toolbar to get the "Snap Points To Lines" dialog.
40. Select StrXingEx as the Point feature layer and demnet as the Line or polygon feature layer. For the New point layer to create, browse to the folder you are using for the tutorial and name the file "StrXingSn.shp".



41. Click the OK button. Click OK again on the confirmation screen.

Filter Stream Crossings Function

This function automatically associates the appropriate points on the stream network from the snapped stream crossings file (StrXingSn.shp), and the points that are road-stream intersections (StrXingRi.shp), with nearby surveyed stream crossings (StrXingEx.shp), screened according to nearness and a geomorphologically derived channel width criterion. Three shapefiles are created by this function, one containing all of the merged stream crossings (MergedSX.shp), one containing only the matched stream crossings (MatchSX.shp) and the last containing only the unmatched stream crossings (UMatchSX.shp).

The goal of this function is to position each surveyed stream crossing from StrXingEx.shp on the stream network. This is attempted by examining both the nearest position on the stream to which the stream crossing can be snapped (StrXingSn.shp) and the nearest road stream intersection (StrXingRi.shp). Points that passed one or both of these criteria are in MatchSX.shp. The user should in most cases be able to accept these without further analysis. The surveyed stream crossings for which there was no match found are placed in UMatchSX.shp.

Please Note: This function requires the ArcInfo license.

42. Select Preprocessor -> Filter Stream Crossings from the GRAIP toolbar from the GRAIP toolbar as shown:

Filter Stream Crossings

Inputs

Extracted Stream Crossing Shapefile
C:\demo\StrXingEx.shp

Hawth Snapped Stream Crossing Shapefile
C:\demo\StrXingSn.shp

Hawth Road Stream Intersection Shapefile
C:\demo\StrXingRi.shp

Contributing Area Grid
C:\demo\DEM\demad8

Geomorphological Channel Width Parameters

GeoCW = $a A^b$ a = 7
GeoCW in ft
A in mi^2 b = 0.404

Filter Criteria

$|(\text{Chan_Width} - \text{GeoCW})| / (\text{Chan_Width} + \text{GeoCW}) / 2 \leq 0.5$

Nearest Stream Crossing Distance (m) ≤ 100

Outputs

Merged Stream Crossings Shapefile
C:\demo\MergedSX.shp

Matched Stream Crossings Shapefile
C:\demo\MatchSX.shp

Unmatched Stream Crossings Shapefile
C:\demo\UMatchSX.shp

Cancel Compute

43. Click Compute.

At this point, the user might want to use ArcGIS or other GIS tools to review the unmatched stream points, examining why they are not placed on a stream, making appropriate edits to place them on a stream, and/or identifying situations requiring further examination in the field. For the purposes of this tutorial, we will accept the matched and unmatched stream crossing shapefiles as they were created.

ArcGIS Combine Outlets Task

Now you need to use the ArcGIS tools to create a revised outlets file that contains a combination of all of the matched on-stream points along with the original outlet points from the original outlets file (outlet.shp). As part of this you need to make sure that the Id field is unique. Since the Ids of the matched stream points are already unique, you just need to make sure that the Id of the original outlet is not a duplicate

of any of the matched stream point Ids. Also, be sure not to change any of the matched stream point Ids since they are used in the fish habitat analysis.

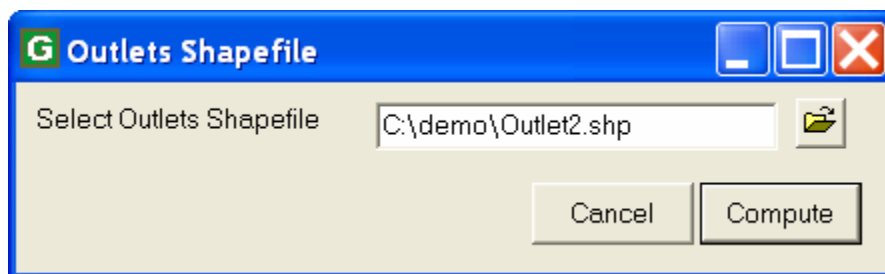
44. Select Editor -> Start Editing from ArcMap's Editor toolbar to show the Start Editing dialog. Click on the C:\demo folder (or the folder that contains the outlet.shp file) and click OK. You will receive a warning about the editing being in a different coordinate system. Click Start Editing. In the Editor toolbar, set the target layer to "Outlet." Right click on the MatchSX layer and select "Open Attribute Table" to show the Attributes of MatchSX dialog. Click the Options button and select "Select All". Select Edit -> Copy. Click on the Close Box. Right click on the Outlet layer and select "Open Attribute Table" to show the Attributes of Outlet dialog. Select Edit -> Paste. Click on the Close Box. Select Editor -> Stop Editing. Click Yes when asked if you want to save your edits.

If you have any difficulty with this step, you can use the Outlet2.shp file that is in the demo folder.

Create TauDEM Stream Network Function

This function runs the TauDEM Stream Network utility to create a new stream network shapefile using the revised outlets shapefile which contains both the original outlet point as well as the corrected stream crossing points. This revised stream network shapefile is similar to the previous version except that the stream segments are split at stream crossings.

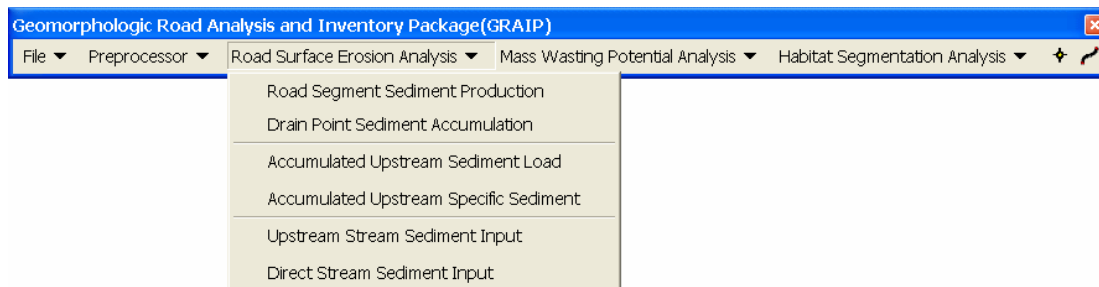
45. Select Preprocessor->Create TauDEM Stream Network from the GRAIP toolbar to get the Outlets Shapefile screen shown:



46. Click Compute. When asked if it is OK to overwrite files, click Yes.

ROAD SURFACE EROSION ANALYSES MENU

The functions on the GRAIP toolbar menu Road Surface Erosion should be run in sequence from top to bottom.



Road Segment Sediment Production Function

The Road Segment Sediment Production function calculates sediment production values for each stream segment according to:

$$E_i = \frac{aLSrv}{2}$$

where E is the erosion from each forest road segment in kg/yr, i indicates the side of the road, a is the annual base erosion rate (with 79 kg/yr being the default, although a different value could be defined for each road segment shapefile when it is imported with the preprocessor), L is the road segment length, S is the slope, r is the road surface multiplier which varies depending on the type of road surface, and v is the flow path vegetation multiplier which varies depending on the density of the flow path vegetation. Please realize that LS is also equal to the difference in maximum and minimum elevations in the road segment.

The three parameters, a , r and v are stored in the following field/tables in the project database which for the tutorial is located at C:\demo\test.mdb:

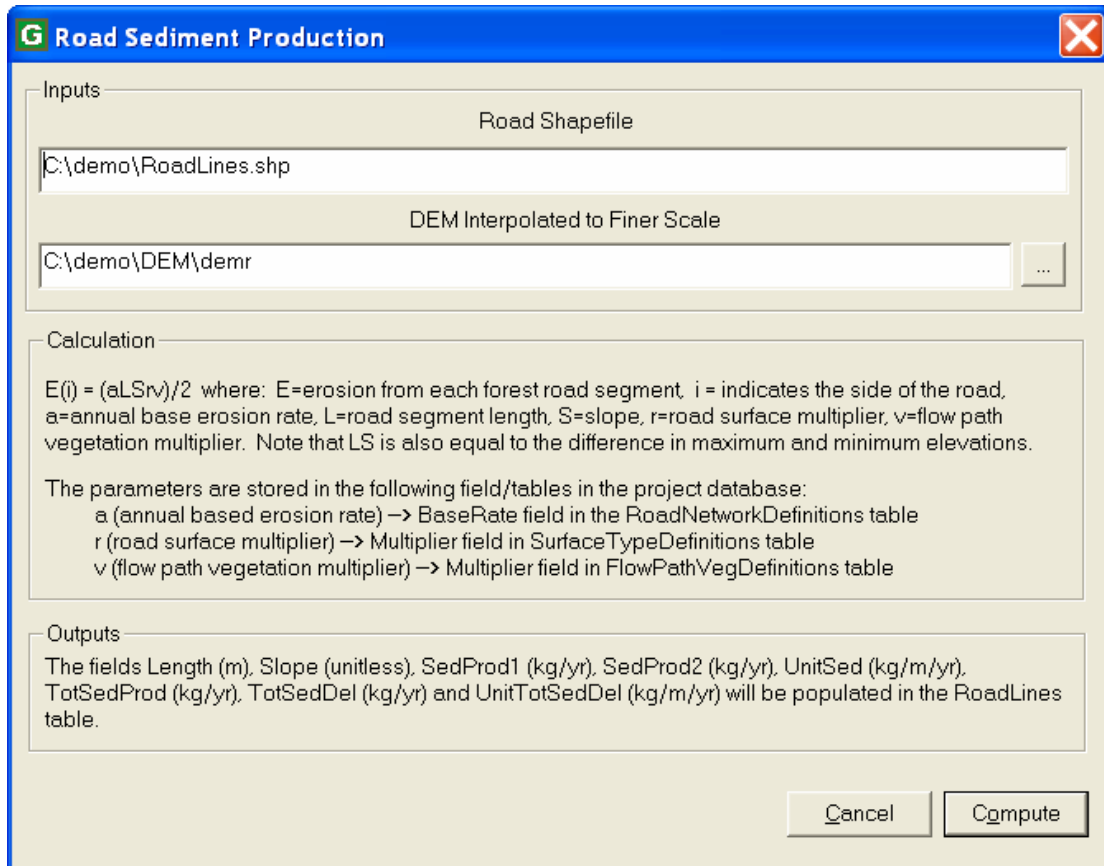
- A. a (annual based erosion rate) --> BaseRate field in the RoadNetworkDefinitions table
- B. r (road surface multiplier) --> Multiplier field in the SurfaceTypeDefinitions table
- C. v (flow path vegetation multiplier) --> Multiplier field in the FlowPathVegDefinitions table

These parameters can be edited prior to executing this step by double clicking on the test.mdb file in the file explorer. Then double click on the table for the desired parameter and edit the field listed for that parameter. Changes are automatically saved when you exit each record.

The Road Sediment Production function populates the following fields in the RoadLines table in the GRAIP database, test.mdb:

- A. **Length**-Road length (meters)
- B. **SedProd1**-Sediment production for one side of the road (kg/yr)
- C. **SedProd2**-Sediment production for the other side of the road (kg/yr)
- D. **UnitSed**-Unit sediment production from the road segment (kg/m/yr)
- E. **TotSedProd**-SedProd1+SedProd2 (kg/yr)
- F. **TotSedDel**-Sediment delivered to streams (calculated using stream connection information for each road) (kg/yr)
- G. **UnitTotSedDel**-TotSedDel/Length (kg/m/yr)

47. Select Road Surface Erosion Analysis -> Road Segment Sediment Production function to show this screen:



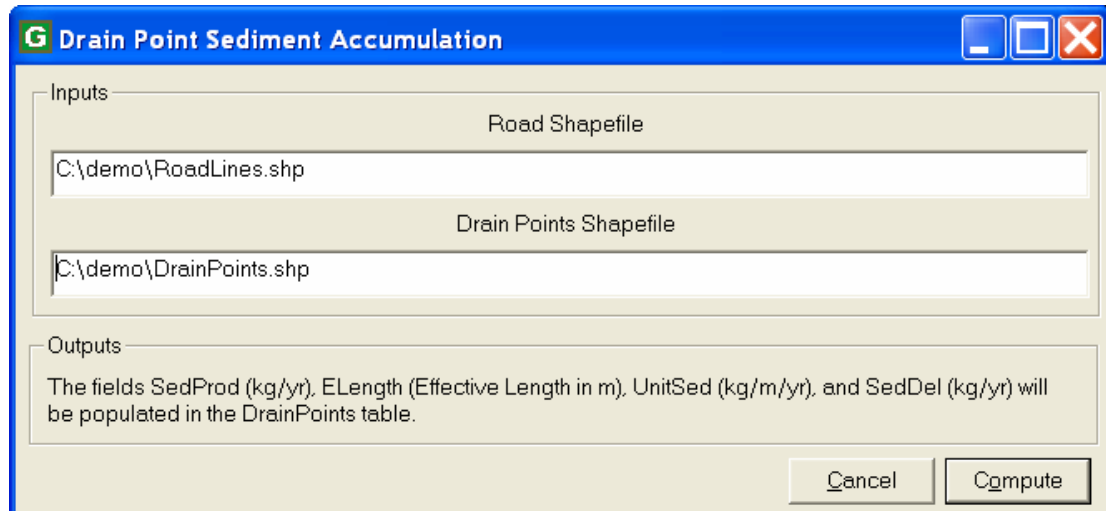
48. Click Compute.

Drain Point Sediment Accumulation Function

This function calculates sediment accumulation values for each drain point. As part of this, the following drain point fields are populated:

- A. SedProd-Total accumulated sediment load at each drain point due to road surface erosion (kg/yr)
- B. ELength-Effective length of road draining to each drain point (meters)
- C. UnitSed-SedProd/ELength (kg/m/yr)
- D. SedDel-Sediment delivery depending on stream connection (kg/yr)

49. Select Road Surface Erosion Analysis ->Drain Point Sediment Accumulation function to open this screen:



50. Click Compute.

Accumulated Upstream Sediment Load Function

This function creates the following output grids:

- A.** Weight grid with Drain Point accumulated sediment load (with a *swt name format).
- B.** Weighted Sediment Accumulation grid (with a *sac name format).

The user can select between D8 and Dinf Contributing area functions.

51. Select Road Surface Erosion Analysis-> Accumulated Upstream Sediment Load function in the GRAIP toolbar to show this screen:

G Accumulated Upstream Sediment Load

Inputs

Drain Points Shapefile
C:\demo\DrainPoints.shp

D8 (default)/Dinf Flow Direction Grid
C:\demo\DEM\demp

Use D8 Contributing Area Function Use Dinf Contributing Area Function

Stream Connected Total Sediment Production

Outputs

Sediment Production Weight Grid
C:\demo\DEM\demswt

Accumulated Upstream Sediment Load Grid
C:\demo\DEM\demsac

Add Layers to the Map

Cancel Compute

52. Click Compute.

Accumulated Upstream Specific Sediment Function

This function creates the upstream specific sediment accumulation grid (with a *spe name format).

53. Select Road Surface Erosion Analysis -> Accumulated Upstream Specific Sediment function to show the following screen.

G Specific Sediment Accumulation

Inputs

Accumulated Upstream Sediment Load Grid
C:\demo\DEM\demsac

Upstream Contributing Area Grid
C:\demo\DEM\demad8

Output

Specific Sediment Accumulation Grid
C:\demo\DEM\demspe

Add Layer to the Map

Cancel Compute

54. Click Compute.

Upstream Stream Sediment Input Function

This function calculates sediment accumulation for the downstream end of each stream segment. The following fields are appended to the stream network shapefile (that has a *.net.shp name format):

- A. **SedAccum**-Accumulated Sediment Inputs for each stream segment (kg/yr).
- B. **SpecSed**-Accumulated Specific Sediment Load per unit area for each stream segment (Mg/km²/yr).

55. Select Road Surface Erosion Analysis-> Upstream Stream Sediment Input function to show this screen.

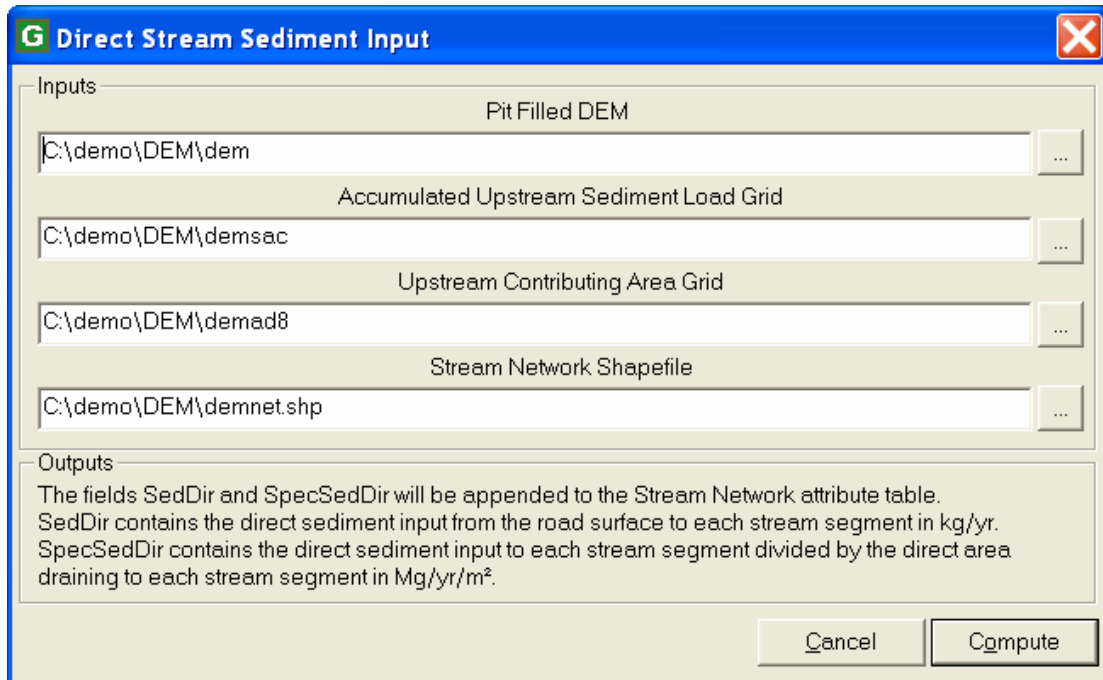
56. Click Compute.

Direct Stream Sediment Input Function

This function calculates the sediment load for the area draining directly to stream segment. These fields are appended to the stream network shapefile (that has a *.net.shp name format).

- A. **SedDir**-Direct Sediment Inputs for each stream segment (kg/yr).
- B. **SpecSedDir**-Direct Specific Sediment Load per unit area for each stream segment (Mg/km²/yr).

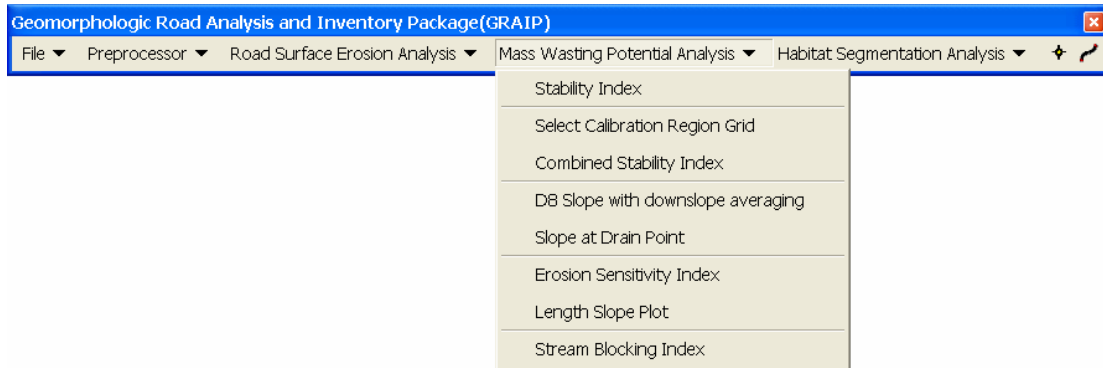
57. Select Road Surface Erosion Analysis->Direct Stream Sediment Input function from the GRAIP toolbar to show this screen:



58. Click Compute.

MASS WASTING POTENTIAL ANALYSIS MENU

The functions on the Mass Wasting Potential Analysis Menu (Figure 20) should be run in a sequence from top to bottom.



SINMAP 2.0 Stability Index & Calibration Region Grid Functions

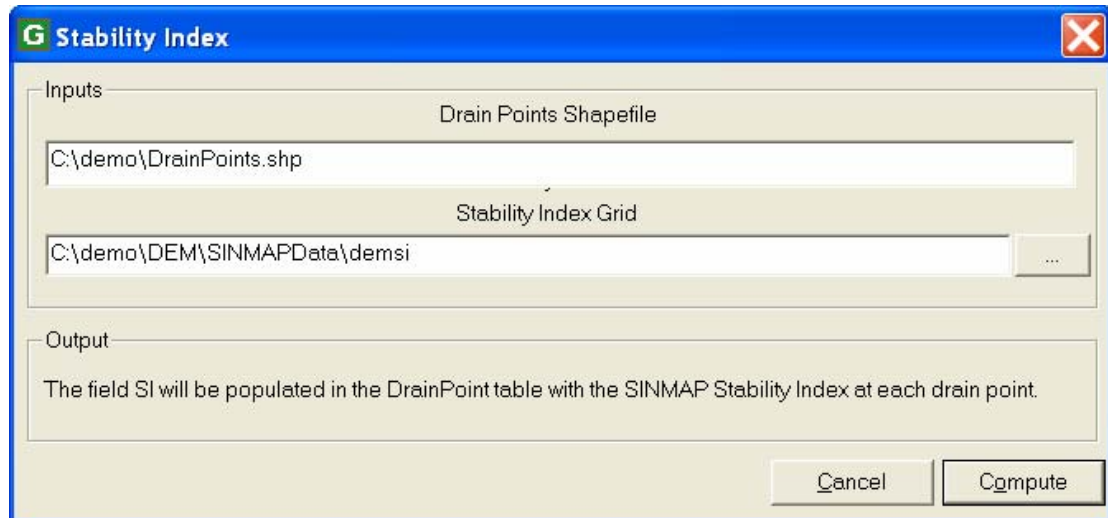
SINMAP2.0 is used to create a Stability Index (SI) grid and a calibration region grid from the DEM. Calibration regions are areas within which single lower bound and upper bound calibration parameters values can represent T/R, dimensionless cohesion, friction angle (ϕ) and soil density (ρ).

59. Run SINMAP 2.0 to create a Stability Index (SI) grid (C:\demo\DEM\SINMAPData\demsi) and a calibration region grid (C:\demo\DEM\SINMAPData\demcal) from the DEM. For more information on using SINMAP 2.0, see <http://hydrology.neng.usu.edu/sinmap2/>.

Stability Index Function

This function looks up the Stability Index grid values at each drain point and stores them in the SI field in the DrainPoints table.

60. Select Mass Wasting Potential Analysis -> Stability Index from the GRAIP toolbar to show this screen:

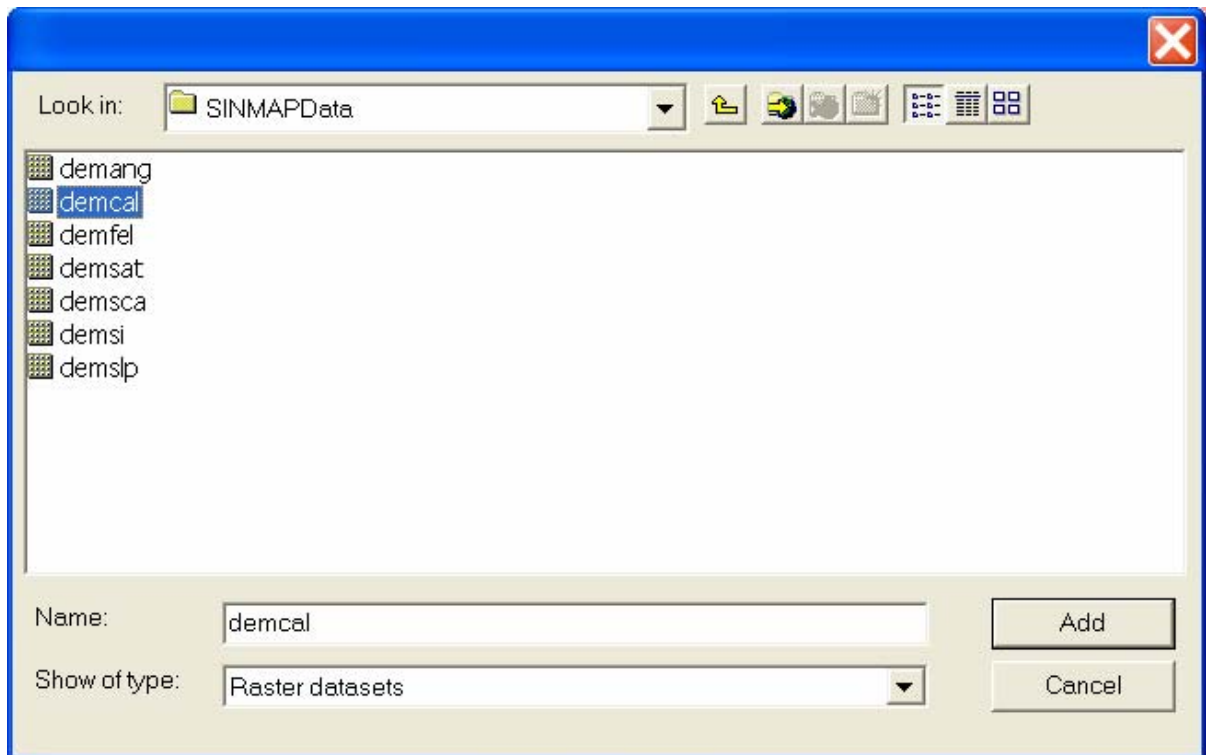


61. Click compute.

Combined Stability Index Function

This function creates a Combined Stability Index Grid (with a *.sic file format) and stores the value from that grid at each drain point in the SIR Field of the drain point table in the GRAIP database.

62. Select Mass Wasting Potential Analysis -> Select Calibration Region Grid and browse to the calibration region grid (C:\demo\DEM\SINMAPData\demcal) to get the screen shown:



63. Click the “Add” button.

The grid is added to ArcMap.

64. Select Mass Wasting Potential Analysis -> Combined Stability Index from the GRAIP toolbar to show this screen:

Combined Stability Index

Inputs

Drain Point Shapefile
C:\demo\DrainPoints.shp

Road Shapefile
C:\demo\RoadLines.shp

Specify Road Width (m)
5

Calibration Parameters Text File
C:\demo\DEM\demcalp.csv

View/Edit Calibration Parameter File

Minimum Terrain Recharge (m/hr)
0.0009

Maximum Terrain Recharge (m/hr)
0.00135

Minimum Additional Road Surface Runoff (m/hr)
0.001

Maximum Additional Road Surface Runoff (m/hr)
0.002

Dinf Slope
C:\demo\DEM\demslp

Dinf Specific Catchment Area
C:\demo\DEM\demsca

Calibration Grid
C:\demo\DEM\SINMAPData\demcal

Outputs

Combined Stability Index Grid
C:\demo\DEM\demsic

The field SIR is appended to the attribute table of the Drain Point shapefile with the Road Stability Index at each drain point estimated from SINMAP output at each drain point location.

Add SI combined grid to the Map

Cancel Compute

The View/Edit Calibration Parameter File button on the Combined Stability Index dialog can be used to open the Parameter Values of the Calibration Grid dialog shown:

Parameter Values of the Calibration Grid

Value	Region	Tmin	Tmax	Cmin	Cmax	PHlmin	PHlmax	RhoS
1	Region 1	2.708	2.708	0	0.25	30	45	2000

Cancel Save

These parameters are user adjustable. But for the purposes of this tutorial, we will not open the dialog.

65. Click Compute.

The output and intermediate files created are:

- A. Minimum and maximum depth of terrain runoff generated (with *rmin and *rmax file formats).
- B. Specific discharge due to road drainage for Minimum runoff and Maximum runoff (with *rdmin and *rdmax file formats).
- C. Combined Stability Index Grid (with a *sic file format).

The intermediate outputs (A) and (B) are not added to ArcMap. The output file (C) is added if the “Add SI combined grid to the Map” checkbox is checked which is the default.

In this function, stability index (SI) due to terrain contributing area can be calculated by setting the road surface runoff to be 0, and SI due to road runoff only can be computed setting terrain recharge to be 0. The SI values from the grid are used to identify SI values to store in the SIR Field in for each drain point in the GRAIP database.

D8 Slope Grid with Downslope Averaging Function

This function uses the D8 flow directions approach to trace downslope and find the average slope for each grid cell over the specified averaging distance. The output from this function is the slope grid with downslope averaging (Suffix .slpd).

- 66. Select Mass Wasting Potential Analysis -> D8 Slope Grid with downslope averaging from the GRIAP toolbar to show this screen:**

D8 Slope with Downslope Averaging

Inputs

Pit Filled DEM
C:\demo\DEM\dem

D8 Flow Direction Grid
C:\demo\DEM\demp

Downgradient Trace Distance (m) 150

Output

D8 Slope with Downslope Averaging Grid
C:\demo\DEM\demslpd

Add Layer to the Map

Cancel Compute

67. Click Compute.***Slope at Drain Point Function***

This function calculates the slope at each drain point and stores it in the Slope field in the DrainPoints table of the GRAIP database.

68. Select Mass Wasting Potential Analysis -> Slope at Drain Point from the GRAIP toolbar to open this screen:

Slope at Drain Point

Inputs

Drain Points Shapefile

C:\demo\DrainPoints.shp

D8 Slope with Downslope Averaging Grid

C:\DEMO\DEM\demslpd

Output

The field Slope will be populated in the DrainPoints table. The Slope at each drain point is assigned from the D8 Slope with Downslope Averaging Grid.

Cancel Compute

69. Click Compute.

Erosion Sensitivity Index Function

This function populates the ESI field in the DrainPoint table. ESI is calculated as LS^α where S is the slope and L is the Effective Length of the road draining to each drain point.

70. Select Mass Wasting Potential Analysis -> Erosion Sensitivity Index from the GRAIP toolbar to show this screen:

Erosion Sensitivity Index

Inputs

Drain Points Shapefile

C:\demo\DrainPoints.shp

Exponent Alpha 2

Output

The field ESI is populated in the DrainPoints table. ESI is evaluated as LS^α .

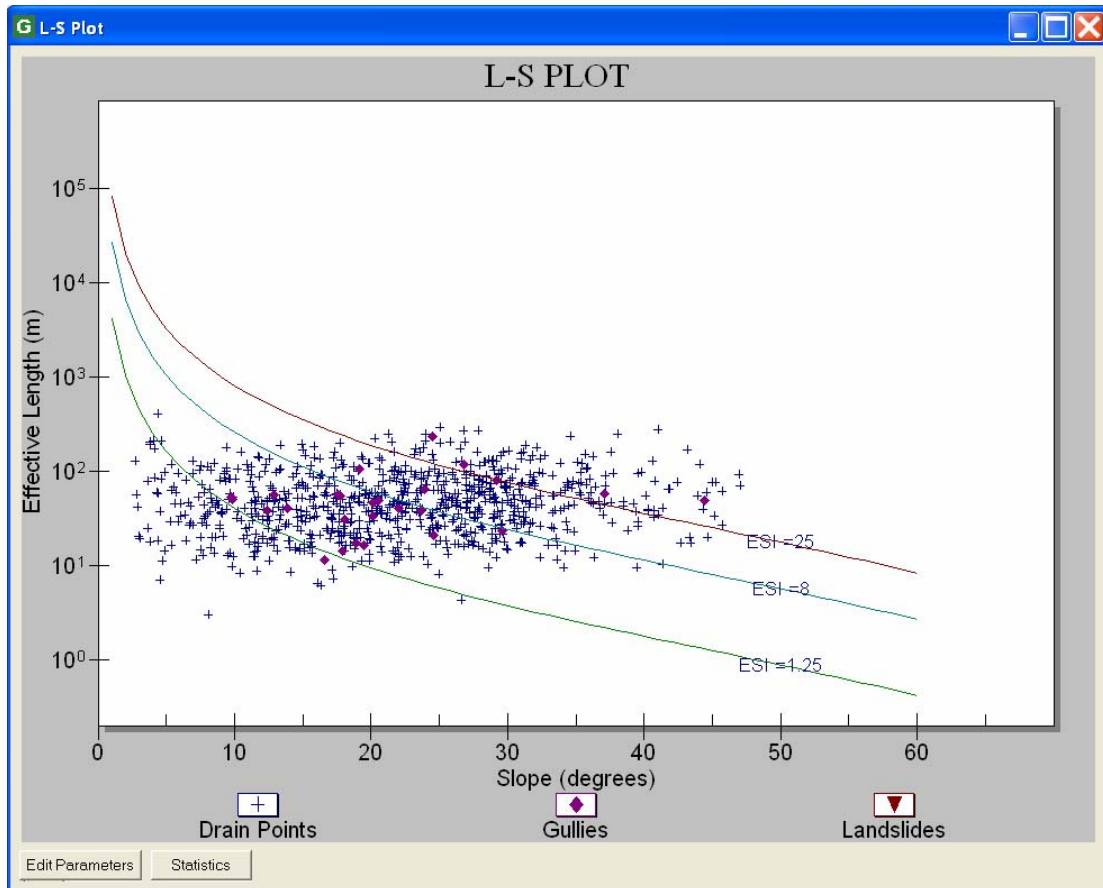
Cancel Compute

71. Click Compute.

Length Slope Plot Function

This function shows the Length-Slope plot with Length on the Y-axis and Slope on the X-axis.

72. Select Mass Wasting Potential Analysis -> Length Slope Plot from the GRAIP toolbar to show this screen:



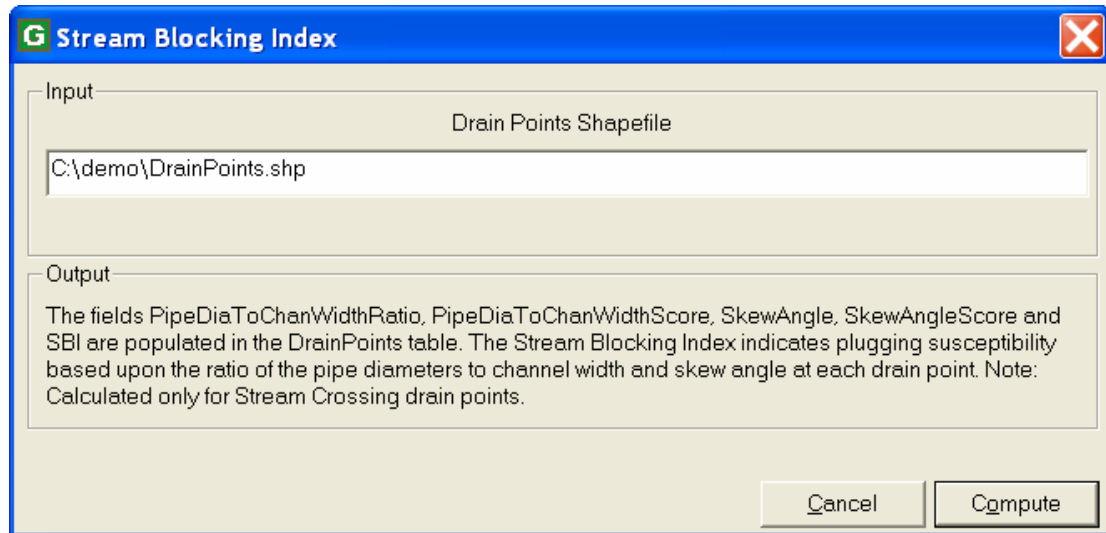
73. Click the Close icon in the upper right corner of the dialog.

Stream Blocking Index Function

This function populates these fields in the DrainPoints table in the GRAIP database:

- A.** SBI: Stream Blocking Index indicating plugging susceptibility based on the ratio of pipe diameters to channel width ratio class and skew angle score.
- B.** PipeDiaToChannelWidthScore: Ratio of pipe diameter divided by channel width ratio class.
- C.** SkewAngleScore: Skew angle score.

74. Select Mass Wasting Potential -> Stream Blocking Index from the GRAIP toolbar to show this screen:



75. Click Compute.

HABITAT SEGMENTATION ANALYSIS MENU

Fish Passage Barrier Function

This function identifies the fish passage barriers and assigns an identifier representing the status of the stream crossing: 0-Blocked Passage, 1- Possible Passage and 2- Clear Passage. This identifier is used to populate the Barrier field in the DrainPoints table in the GRAIP database. Possible Passage identifies the stream crossings that may be passable to some species, but not to others.

76. Select Habitat Segmentation Analysis -> Fish Passage Barrier from the GRAIP Toolbar to show this screen:

Fish Passage Barrier

Inputs

Crossing Slope Sp (%)

Outlet Drop ODp (ft)

Pipe/Channel Width ratio w*p

Outlet Drop to Pool Depth ratio

Drain Points Shapefile

Output

The field Barrier is populated in the DrainPoints table using criteria to flag stream crossings that are barriers.

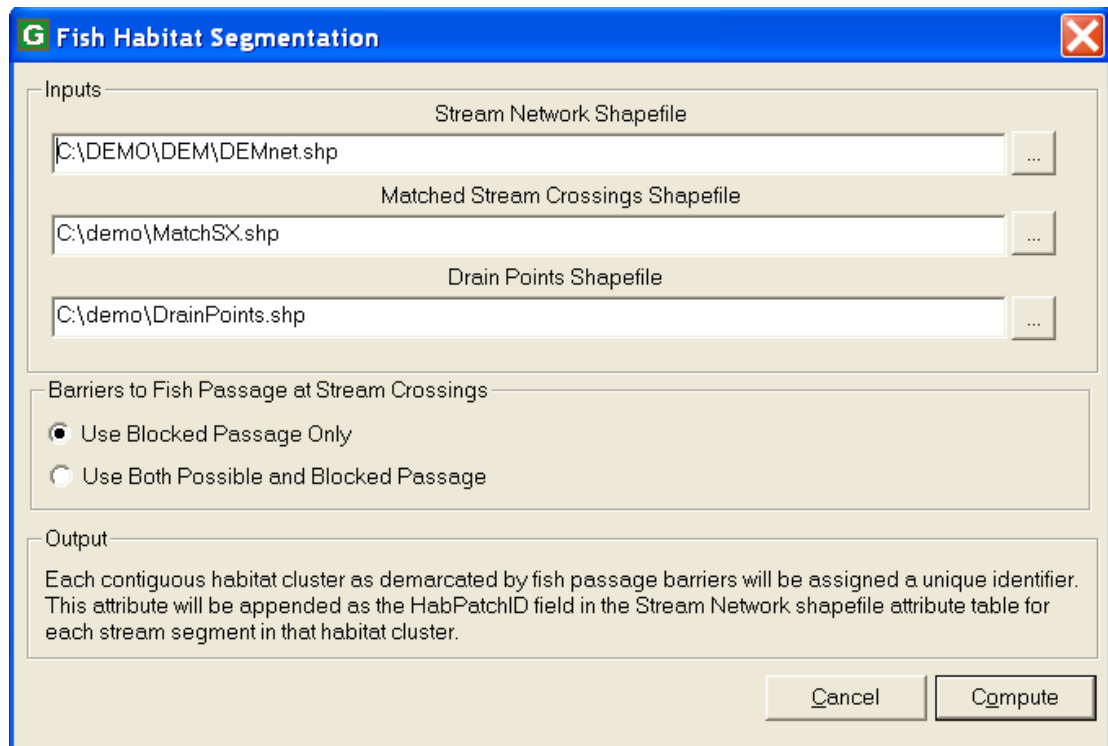
0: Blocked Passage - Impassable for all species.
 1: Possible Passage - Passable for some species.
 2: Clear Passage - Passable for all species.

77. Click Compute.

Fish Habitat Segmentation Function

This function assigns an identifier to each stream segment indicating the habitat cluster to which it belongs. The habitat cluster identifier is appended to the TauDEM stream network shapefile attribute table.

78. Select Habitat Segmentation Analysis -> Fish Habitat Segmentation function from the GRAIP toolbar to show this screen:



The dialog box titled "Fish Habitat Segmentation" has a blue header bar with a green "G" icon and a red "X" close button. It contains three input fields for shapefiles, a section for barriers to fish passage, and an output description. The input fields are: "Stream Network Shapefile" with path "C:\DEMO\DEM\DEMnet.shp", "Matched Stream Crossings Shapefile" with path "C:\demo\MatchSX.shp", and "Drain Points Shapefile" with path "C:\demo\DrainPoints.shp". The barrier section has two radio buttons: "Use Blocked Passage Only" (selected) and "Use Both Possible and Blocked Passage". The output section contains a text block explaining that each contiguous habitat cluster will be assigned a unique identifier, which will be added as the "HabPatchID" field in the Stream Network shapefile attribute table. At the bottom right are "Cancel" and "Compute" buttons.

G Fish Habitat Segmentation

Inputs

Stream Network Shapefile
C:\DEMO\DEM\DEMnet.shp

Matched Stream Crossings Shapefile
C:\demo\MatchSX.shp

Drain Points Shapefile
C:\demo\DrainPoints.shp

Barriers to Fish Passage at Stream Crossings

Use Blocked Passage Only
 Use Both Possible and Blocked Passage

Output

Each contiguous habitat cluster as demarcated by fish passage barriers will be assigned a unique identifier. This attribute will be appended as the HabPatchID field in the Stream Network shapefile attribute table for each stream segment in that habitat cluster.

Cancel Compute

79. Click Compute.

REFERENCE MANUAL

USFS ROAD INVENTORY TABLES DATA DICTIONARY

Roads Shapefile Attribute Table

Field Name	Description
SURF_TYPE	Road surface type
SURF_COND	Road surface condition
ROAD_TYPE	System road or high clearance
RD_EDGE_1	Cut slope height or road edge feature
RD_EDGE_2	Cut slope height 2 or road edge feature
EDGE_VEG_1	Roadside vegetation density 1
EDGE_VEG_2	Roadside vegetation density 2
EDG_CND_1	Edge condition 1
EDG_CND_2	Edge condition 2
FLOW_PATH1	Location of flowing water 1
FLOW_PATH2	Location of flowing water 2
FLWPTH_VG1	Vegetation on flow path 1
FLWPTH_VG2	Vegetation on flow path 2
FLWPTHCOND1	Condition of flow path 1
FLWPTHCOND2	Condition of flow path 2
FILL_CHAN	Fill slope toe to channel edge distance in feet
SURF_COV	Road surface cover
CDATE	Survey collection date
CTIME1	Survey collection time 1
CTIME2	Survey collection time 2
VEHICLE	Survey vehicle used
COMMENT	Additional information about the road segment

Broad Based Dip Drain Point Shapefile Attribute Table

Field Name	Description
SLOPE_SHAP	Shape of the slope
DISCHRG_TO	Destination of discharge (i.e., gully, forest floor)
STREAM_CON	Stream connection
OBSTRUCT	Debris in flow path of drain
FILL_EROS	Fill erosion present or not
TYPE	Broad based dip type
CONDIT	Condition of the drain point
MATERIAL	Material found in the drain point
COMMENT	Comment
CDATE	Survey collection date
CTIME	Survey collection time
VEHICLE	Survey vehicle used

Diffuse Drain Point Shapefile Attribute Table

Field Name	Description
SLOPE_SHAP	Slope shape
DISCHRG_TO	Destination of discharge (i.e., gully, forest floor)
STREAM_CON	Stream connection present or not
OBSTRUCT	Debris in flow path of drain
FILL_EROS	Fill erosion present or not
COMMENT	Comment
CDATE	Survey collection date
CTIME	Survey collection time
VEHICLE	Survey vehicle used

Ditch Relief Drain Point Shapefile Attribute Table

Field Name	Description
SIZE	Pipe diameter in inches
TYPE	Culvert material
SLOPE_SHAP	Slope shape
DISCHRG_TO	Destination of discharge (i.e., gully, forest floor)
STREAM_CON	Is there a stream connection?
FILL_EROS	Fill slope eroded below pipe?
FLOW_DIVER	Presence of flow diversion?
OBSTRUCT	Debris in flow path of drain?
FLOW_DIFFU	Flow diffuser type
COMMENT	Comment
CDATE	Survey collection date
CTIME	Survey collection time
PIPE_LEN	Pipe length in feet
CONDIT	Sediment occlusion
VEHICLE	Survey vehicle used

Lead-off Drain Point Shapefile Attribute Table

Field Name	Description
SLOPE_SHAP	Slope shape
DISCHRG_TO	Discharge to (i.e. gully, forest floor)
STREAM_CON	Stream connection present or not?
CONDIT	Condition
OBSTRUCT	Debris in flow path of drain
COMMENT	Comment
CDATE	Survey collection date
CTIME	Survey collection time
VEHICLE	Survey vehicle used

Non-Engineered Drain Point Shapefile Attribute Table

Field Name	Description
SLOPE_SHAP	Slope shape
DISCHRG_TO	Destination of discharge (i.e., gully, forest floor)
STREAM_CON	Stream connection present or not?
OBSTRUCT	Debris in flow path of drain?
FILL_EROS	Fill erosion present or not?
CONDIT	Condition
COMMENT	Comment
CDATE	Survey collection date
CTIME	Survey collection time
VEHICLE	Survey vehicle used

Stream Crossing Drain Point Shapefile Attribute Table

Field Name	Description
TYPE	Culvert Material
R_PIPE_DIA	Round pipe diameter in inches
OVAL_PIPE	Oval pipe size
PIPE_LEN	Pipe length in feet
CHAN_WDTH	Channel width in feet
PIPE_NUM	Number of pipes used
FILL_DEPTH	Fill depth in feet
CONDIT	Condition
CHAN_ANGL	Angle between pipe and channel
BLOCK_TYP	Evidence of blockage
OUTLET_DRP	Outlet drop measured below pipe in feet and tenths
PL_DEPTH	Depth below outfall in feet and tenths
PIPE_GRADE	Grade measured in percent
SUBSTRATE	Crossing substrate
DEBRIS_FLW	Debris flow
FILL_EROS	Fill erosion
DIVERSION	Presence and direction of channel diversion
COMMENT	Comment
CDATE	Survey collection date
CTIME	Survey collection time
VEHICLE	Survey vehicle used

Sump Drain Point Shapefile Attribute Table

Field Name	Description
CONDIT	Condition
COMMENT	Comment
CDATE	Survey collection date
CTIME	Survey collection time
VEHICLE	Survey vehicle used

Water Bar Drain Point Shapefile Attribute Table

Field Name	Description
SLOPE_SHAP	Slope shape
DISCHRG_TO	Destination of discharge (i.e.; gully, forest floor)
STREAM_CON	Stream connection present or not?
OBSTRUCT	Debris in flow path of drain?
FILL_EROS	Fill erosion present or not?
TYPE	Drain point material
CONDIT	Condition
COMMENT	Comment
CDATE	Survey collection date
CTIME	Survey collection time
VEHICLE	Survey vehicle used

GRAIP DATABASE TABLES

MASTER TABLES

DrainPoints Table

Field Name	Description	Menu Function
GRAIPDID	Unique drain point identifier. Primary key.	Preprocessor
DrainTypeID	Type of drain point	Preprocessor
CDate	Survey collection date	Preprocessor
CTime	Survey collection time. 10 character text field.	Preprocessor
VehicleID	Survey vehicle identifier	Preprocessor
DrainID	Numeric drain point identifier built from the CDATE, CTIME and VEHICLEID fields. Should be unique for each drain point.	Preprocessor
StreamConnectID	Stream connection present or not. Field not in SteamCrossing or Sump shapefiles. Data is populated by assuming 2 (Yes) for all StreamCrossing drain points and 1 (No) for all Sump drain points.	Preprocessor
Comments	Description or comments about the drain point feature	Preprocessor
SedProd	Accumulated road sediment load to each drain point (kg/yr)	Drain Point Sediment Accumulation
ELength	Effective length of the road draining to each drain point (m)	Drain Point Sediment Accumulation
UnitSed	Drain point unit sediment load (kg/m/yr)	Drain Point Sediment Accumulation
SedDel	Sediment load delivered to streams (kg/yr)	Drain Point Sediment Accumulation
SI	SINMAP stability index values at each drain point	Stability Index
SIR	SINMAP stability index values at each drain point accounting for road runoff	Stability Index
Slope	Slope at each drain point	Slope at Drain Point
ESI	Erosion sensitivity index (m) values at each drain point	Erosion Sensitivity Index
PipeDiaToChanWidthRatio	Ratio of culvert pipe diameter to channel width	Stream Blocking Index

PipeDiaToChanWidthScore	Hazard score calculated from ratio of culvert pipe diameter to channel width	Stream Blocking Index
SkewAngle	Channel skew angle	Stream Blocking Index
SkewAngleScore	Hazard score calculated from channel skew angle	Stream Blocking Index
SBI	Stream blocking index indicating culvert plugging susceptibility	Stream Blocking Index
Barrier	Flag representing whether the drain point is a fish passage barrier or not. 0=totally blocked, 1=partially blocked, 2=totally open	Fish Passage Barrier

RoadLines Table

Field Name	Description	Menu Function
GRAIPRID	Unique road line segment identifier	Preprocessor
CDate	Survey collection date	Preprocessor
CTime1	Survey collection time 1. This is a 4 digit numeric field.	Preprocessor
CTime2	Survey collection time 2. This is a 4 digit numeric field.	Preprocessor
VehicleID	Survey vehicle identifier	Preprocessor
OrigSourceCode	Original road line feature ID	Preprocessor
RoadNetworkID	Identifier for a road network. Base erosion rate depends on road network ID	Preprocessor
RoadTypeID	Identifier for type of the road (i.e.: system road, trail)	Preprocessor
OrigDrainID1	Original drain point identifier for side one of the road	
OrigDrainID2	Original drain point identifier for side two of the road	
GRAIPDID1	Identifier of drain point that drains side one of the road	Preprocessor
GRAIPDID2	Identifier of drain point that drains side two of the road	Preprocessor
SurfaceTypeID	Identifier representing road surface type.	Preprocessor
SurfaceConditionID	Identifier representing road surface condition	Preprocessor
SurfaceCoverID	Identifier representing the road surface cover	Preprocessor
RoadEdge1ID	Identifier for road side one edge information	Preprocessor
RoadEdge2ID	Identifier for road side two edge information	Preprocessor
EdgeVegetation1ID	Identifier for road side one edge vegetation	Preprocessor

EdgeVegetation2ID	Identifier for road side two edge vegetation	Preprocessor
EdgeConditionID1	Identifier for road side one edge condition	Preprocessor
EdgeConditionID2	Identifier for road side two edge condition	Preprocessor
FlowPath1ID	Identifier for road side one flow path information	Preprocessor
FlowPath2ID	Identifier for road side two flow path information	Preprocessor
FlowPathVeg1 ID	Identifier for road side one flow path vegetation	Preprocessor
FlowPathVeg2 ID	Identifier for road side two flow path vegetation	Preprocessor
FlowPathCond1 ID	Identifier for road side one flow path condition	Preprocessor
FlowPathCond2 ID	Identifier for road side two flow path condition	Preprocessor
FillChannelID	Identifier giving road fill channel information	Preprocessor
HUCName	HUC Name	Preprocessor
Miles	Length of road segment (miles)	Preprocessor
Comments	Additional Comments about the road segment	Preprocessor
StreamConnect1ID	Identifier for road side one stream connectivity status	Preprocessor
StreamConnect2ID	Identifier for road side two stream connectivity status	Preprocessor
Length	Length of the road segment (m)	Road Segment Sediment Production
Slope	Slope of the road segment (unitless)	Road Segment Sediment Production
SedProd1	Sediment production from side one of the road (kg/yr)	Road Segment Sediment Production
SedProd2	Sediment production from side two of the road (kg/yr)	Road Segment Sediment Production
UnitSed	Unit sediment production from both sides of the road segment (kg/m/yr)	Road Segment Sediment Production
TotSedProd	Total sediment production from both sides of the road (kg/yr)	Road Segment Sediment Production
TotSedDel	Total sediment delivered to streams (kg/yr)	Road Segment Sediment Production

UnitTotSedDel	Total unit sediment delivered to streams (kg/m/yr)	Road Segment Sediment Production
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BroadBaseDipAtt Table

Field Name	Description
GRAIPDID	Drain Point identifier. Foreign key to GRAIPDID in DrainPoints Table
BroadBaseDipTypeID	Identifier representing Broad Base Dip type
SlopeShapeID	Identifier for drain point discharge slope shape
DischargeToID	Identifier for drain point discharge feature (e.g. gully, forest floor)
ObstructionID	Identifier for the presence of an obstruction
FillErosionID	Identifier for presence of fill erosion
BroadBaseDipConditionID	Identifier for broad base dip drain point condition
MaterialID	Identifier for material found in the drain point

DiffuseDrainAtt Table

Field Name	Description
GRAIPDID	Drain Point identifier. Foreign key to GRAIPDID in DrainPoints Table
SlopeShapeID	Identifier for drain point discharge slope shape
DischargeToID	Identifier for drain point discharge feature (e.g. gully, forest floor)
ObstructionID	Identifier for the presence of an obstruction
FillErosionID	Identifier for presence of fill erosion

DitchReliefAtt Table

Field Name	Description
GRAIPDID	Drain Point identifier. Foreign key to GRAIPDID in DrainPoints Table
SizeID	Identifier for the size of the drain point
PipeLength	Length of the culvert pipe used
DitchReliefTypeID	Identifier for ditch relief type
DitchReliefConditionID	Identifier for ditch relief condition
SlopeShapeID	Identifier for drain point discharge slope shape
DischargeToID	Identifier for drain point discharge feature (e.g. gully, forest floor)
FillErosionID	Identifier for presence of fill erosion
ObstructionID	Identifier for the presence of an obstruction
FlowDiversionID	Identifier for the presence of flow diversion
FlowDiffuserID	Identifier for flow diffuser type

LeadOffAtt Table

Field Name	Description
GRAIPDID	Drain Point identifier. Foreign key to GRAIPDID in DrainPoints Table
SlopeShapeID	Identifier for drain point discharge slope shape
DischargeToID	Identifier for drain point discharge feature (e.g. gully, forest floor)
LeadOffConditionID	Identifier for condition of lead off drain point
ObstructionID	Identifier for the presence of an obstruction

NonEngAtt Table

Field Name	Description
GRAIPDID	Drain Point identifier. Foreign key to GRAIPDID in DrainPoints Table
NonEngConditionID	Identifier for condition of Non-Engineered drain point
SlopeShapeID	Identifier for drain point discharge slope shape
DischargeToID	Identifier for drain point discharge feature (e.g. gully, forest floor)
ObstructionID	Identifier for the presence of an obstruction
FillErosionID	Identifier for presence of fill erosion

StrXingAtt Table

Field Name	Description
GRAIPDID	Drain Point identifier. Foreign key to GRAIPDID in DrainPoints Table
StrXingTypeID	Identifier for stream crossing type
PipeDimID	Identifier for culvert pipe dimension
PipeLength	Culvert pipe length (feet)
ChannelWidth	Channel width (feet)
PipeNumberID	Identifier for number of pipes used
FillDepth	Fill depth (feet)
StrXingConditionID	Identifier for condition of stream crossing drain point
FillErosionID	Identifier for presence of fill erosion
ChannelAngleID	Identifier for angle between stream and stream crossing
BlockTypeID	Identifier for the presence and type of stream crossing blockage
OutletDrop	Outlet channel drop (feet)
PoolDepth	Channel pool depth (feet)
PipeGradient	Stream crossing pipe gradient in percentage
SubstrateID	Identifier for substrate material
DebrisFlowID	Identifier for the presence of a debris flow
DiversionID	Identifier for the presence and direction of channel diversion

SumpAtt Table

Field Name	Description
GRAIPDID	Drain Point identifier. Foreign key to GRAIPDID in DrainPoints Table
SumpConditionID	Identifier for condition of sump drain point

WaterBarAtt Table

Field Name	Description
GRAIPDID	Drain Point identifier. Foreign key to GRAIPDID in DrainPoints Table
WaterBarTypeID	Identifier for water bar type
SlopeShapeID	Identifier for drain point discharge slope shape
DischargeToID	Identifier for drain point discharge feature (e.g. gully, forest floor)
ObstructionID	Identifier for presence of obstruction
FillErosionID	Identifier for presence of fill erosion
WaterBarConditionID	Identifier for condition of water bar crossing drain point

PREFERRED VALUE TABLES

BlockTypeDefinitions

BlockTypeID	BlockType	Description
1	No	Stream crossing not blocked (Default)
2	Sediment Plume	Stream crossing blocked by sediment plume
3	Scoured road	Stream crossing blocked due to scoured road
4	Washed out road	Stream crossing blocked due to washed out road
5	Organic debris pile	Stream crossing blocked by organic debris pile

BroadBaseDipCondDefinitions

BroadBaseDipConditionID	Condition	Description
1	No Problem	Default
2	Puddles on road	
3	Wetland in ditch	
4	Saturated fill	

BroadBaseDipTypeDefinitions

BroadBaseDipTypeID	BroadBaseDipTypeName	Description
1	Grade Reversal	Default
2	Flat Ditch	
3	Constructed	

ChannelAngleDefinitions

ChannelAngleID	ChannelAngle	Description
1	< 25 degrees	The flow changes direction by less than 25 degrees when entering stream crossing (Default)
2	25-45 degrees	The flow changes direction by between 25 and 45 degrees when entering stream crossing
3	45-75 degrees	The flow changes direction by between 45 and 75 degrees when entering stream crossing
4	> 75 degrees	The flow changes direction by more than 75 degrees when entering stream crossing

DebrisFlowDefinitions

DebrisFlowID	DebrisFlow	Description
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1	No	Default
2	Yes	

DischargeToDefinitions

DischargeToID	DischargeTo	Description
1	Forest Floor	Default
2	Gully	
3	Ditch	
4	Landslide	
5	Wetland	
6	Stream	

DitchReliefCondDefinitions

DitchReliefConditionID	Condition	Description
1	0	Ditch relief drain in good condition (Default)
2	1-20%	Ditch relief drain 1-20% blocked
3	20-80%	Ditch relief drain 20-80% blocked
4	80-100%	Ditch relief drain 80-100% blocked
5	Partially Crushed	Ditch relief drain partially crushed
6	Totally Crushed	Ditch relief drain totally crushed
7	Rusted Significantly	Ditch relief drain significantly rusted
8	Flows around pipe	Ditch relief drain flows around the pipe

DitchReliefTypeDefinitions

DitchReliefTypeID	DitchReliefTypeName	Description
1	CMP (Steel)	Default
2	CON (Concrete)	
3	ALM (Aluminum)	
4	ABS (Plastic)	
5	WDN (LOG)	

DiversionDefinitions

DiversionID	Diversion	Description
1	None	Default
2	1 Direction	
3	2 Direction	

DrainTypeDefinitions

DrainTypeID	DrainTypeName	TableName	Description
1	Broad base dip	BroadBaseDipAtt	Attribute table name for Broad Base Dip type drain point
2	Diffuse drain	DiffuseDrainAtt	Attribute table name for Diffused type drain point
3	Ditch relief	DitchReliefAtt	Attribute table name for Ditch Relief type drain point
4	Lead off	LeadOffAtt	Attribute table name for Lead Off type drain point
5	Non-engineered	NonEngAtt	Attribute table name for Non-Engineered type drain point
6	Stream Crossing	StrXingAtt	Attribute table name for Stream Crossings type drain point
7	Sump	SumpAtt	Attribute table name for Sump type drain point
8	Water bar	WaterBarAtt	Attribute table name for Waterbar type drain point

FillErosionDefinitions

FillErosionID	FillErosion	Description
1	No	Default
2	Yes	

FlowDiffuserDefinitions

FlowDiffuserID	FlowDiffuser	Description
1	None	Default
2	Half pipe fabric	
3	Fabric hose	
4	Rip rap	

FlowDiversionDefinitions

FlowDiversionID	FlowDiversion	Description
0	Unknown	Default
1	No	
2	Yes	

LeadOffCondDefinitions

LeadOffConditionID	Condition	Description
1	No problem	Default
2	Gullied	
3	Not functional	
4	Excess deposition	

MaterialDefinitions

MaterialID	MaterialName	Description
1	Crushed	
2	Native soil	Default
3	Vegetated	
4	Paved	
5	Cinder	

NonEngCondDefinitions

NonEngConditionID	Condition	Description
1	Blocked ditch	Default
2	Diverted wheel track	
3	Broken berm	
4	Gully crosses road	
5	Outsloped	

ObstructionDefinitions

ObstructionID	Obstruction	Description
1	None	Drain point not obstructed
2	Moderate	Drain point has moderate obstruction (Default)
3	Abundant	Drain point has considerable obstruction

PipeDimDefinitions

PipeDimID	Dimension	Description
0	N/A	Default
1	12	Round 12 inch pipe
2	15	Round 15 inch pipe
3	18	Round 18 inch pipe
4	24	Round 24 inch pipe
5	36	Round 36 inch pipe
6	48	Round 48 inch pipe
7	60	Round 60 inch pipe
8	>60	Pipe greater than 60 inches diameter
9	13X17	Oval pipe 13 inches x 17 inches
10	15X21	Oval pipe 15 inches x 21 inches

11	20X28	Oval pipe 20 inches x 28 inches
12	24X35	Oval pipe 24 inches x 35 inches
13	29X42	Oval pipe 29 inches x 42 inches
14	33X49	Oval pipe 33 inches x 49 inches
15	38X57	Oval pipe 38 inches x 57 inches

PipeNumberDefinitions

PipeNumberID	PipeNumber	Description
0	N/A	Default
1	1	
2	2	
3	3	
4	>3	

SizeDefinitions

SizeID	DSize	Description
1	<12"	Pipe size less than 12 inches
2	12"	12 inch pipe
3	15"	15 inch pipe
4	18"	18 inch pipe (Default)
5	24"	24 inch pipe
6	>24"	Pipe size greater than 24 inches

SlopeShapeDefinitions

SlopeShapeID	SlopeShape	Description
1	Concave	
2	Planar	
3	Convex	

StreamConnectDefinitions

StreamConnectID	StreamConnection	Description
0	Unknown	
1	No	Drain point discharge does not enter stream directly. (Default)
2	Yes	Drain point discharge enters stream directly

StrXingCondDefinitions

StrXingConditionID	Condition	Description
1	Open and Sound	Default
2	Partially blocked	

3	Totally blocked	
4	Partially crushed	
5	Totally crushed	
6	Rusted significantly	
7	Flows around pipe	
8	Scoured under bridge	

StrXingTypeDefinitions

StrXingTypeID	StrXingTypeName	Description
1	Steel culvert round	Default
2	Steel culvert oval	
3	Steel arch bottomless	
4	Plastic culvert	
5	Baffled culvert	
6	Concrete culvert	
7	Log culvert	
8	Concrete ford	
9	Natural ford	
10	Aluminum culvert	
11	Bridge	

SubstrateDefinitions

SubstrateID	Substrate	Description
1	Culvert Material	Default
2	Sand	
3	Gravel	
4	Boulders	
5	Bedrock	
6	Baffled	
7	Concrete	

SumpCondDefinitions

SumpConditionID	Condition	Description
1	No problem	Default
2	Fill saturation	
3	Puddles on road	

WaterBarCondDefinitions

WaterBarConditionID	Condition	Description
1	No problem	Default
2	Damaged	
3	Too small	
4	Drains inboard ditch	

5	Wheel track damage	
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WaterBarTypeDefinitions

WaterBarTypeID	WaterBarTypeName	Description
1	Road material	Default
2	Fabricated material	

EdgeConditionDefinitions

EdgeConditionID	EdgeCondition	Description
1	No problem	Default
2	Badly rilled	
3	Badly ravelling	
4	Badly slumping	
5	Bedrock	

EdgeVegetationDefinitions

EdgeVegetationID	EdgeVegetation	Description
1	Default	Road side vegetation density is unknown or not specified (Default)
2	>75%	Road side vegetation density is greater than 75%
3	>50%	Road side vegetation density is greater than 50%
4	>25%	Road side vegetation density is greater than 25%
5	>10%	Road side vegetation density is greater than 10%
6	0%	Road side vegetation density is less than 10%

FillChannelDefinitions

FillChannelID	FillChannel	Description
1	0	Fill slope ends right at channel
2	1-20	Distance from fill slope toe to channel is between 1 and 20 feet
3	21-50	Distance from fill slope toe to channel is between 21 and 50 feet
4	Above 50	Distance from fill slope toe to channel is greater than 50 feet (Default)

FlowPathCondDefinitions

FlowPathCondID	FlowPathCond	Description
1	No problem	Default
2	Gullied	
3	Buried	
4	Rutted	
5	Blocked	
6	Stream course	
7	Woody veg (%)	

FlowPathDefinitions

FlowPathID	FlowPath	Description
1	Ditch	Default
2	Wheel tracks	
3	Base of cut	
4	Berm	
5	Diffuse	

FlowPathVegDefinitions

FlowPathVegID	FlowPathVeg	Description	Multiplier
1	110%	Unknown or unspecified road side flow path vegetation density (Default)	1
2	>75%	Road side flow path vegetated more than 75%	0.14
3	>50%	Road side flow path vegetated 50% to 75%	0.14
4	>25%	Road side flow path vegetated 25% to 50%	0.14
5	>10%	Road side flow path vegetated 10% to 25%	1
6	>0%	Road side flow path vegetated 0 to 10%	1
7	0%	No road side flow path vegetation	1

RoadEdgeDefinitions

RoadEdgeID	RoadEdge	Description
1	Fill	Road side feature is fill
2	0' no ditch	Road side level with terrain, no ditch
3	0-6'	Road side cut between 0 and 6 ft high (Default)
4	6-18'	Road side cut 6 to 18 ft high
5	>18', 0%	Road side cut higher than 18 ft

RoadNetworkDefinitions

RoadNetworkID	RoadNetwork	Description	BaseRate
1	Default	Default Base rate from Luce and Black, 1999	79
2	Custom	Custom base rate for a specific study area	79

RoadTypeDefinitions

RoadTypeID	RoadType	Description
1	System road	Default
2	High clearance road	

SurfaceConditionDefinitions

SurfaceConditionID	SurfaceCondition	Description
1	Good	
2	Rilled/eroded	
3	Washboard	
4	Rutted	
5	Rocky	

SurfaceCoverDefinitions

SurfaceCoverID	SurfaceCover	Description
1	>75%	Road surface is vegetated more than 75% (Default)
2	>50%	Road surface is vegetated between 50 and 75%
3	>25%	Road surface is vegetated between 25 and 50%
4	>10%	Road surface is vegetated between 10 and 25%
5	0%	Road surface is vegetated between 0 and 10%

SurfaceTypeDefinitions

SurfaceTypeID	SurfaceType	Description	Multiplier
1	Default	Default	1
2	Crushed rock		1
3	Native		5
4	Paved		0.2
5	Herbaceous Veg		1
6	Brush		1
7	Trees > 4 in Dia		1
8	Cinder		1

VehicleDefinitions

VehicleID	Vehicle	Description
1	Survey Truck	

UTILITY TABLES

FieldMatches

ID	AttTableID	DBField	DBField
1	0	SurfaceTypeID	SURF_TYPE
2	0	SurfaceConditionID	SURF_COND
3	0	RoadTypeID	ROAD_TYPE
4	0	RoadEdge1ID	RD_EDGE_1
5	0	RoadEdge2ID	RD_EDGE_2
6	0	EdgeVegetation1ID	EDGE_VEG_1
7	0	EdgeVegetation2ID	EDGE_VEG_2
8	0	EdgeCondition1ID	EDG_CND_1
9	0	EdgeCondition2ID	EDG_CND_2
10	0	FlowPath1ID	FLOW_PATH1
11	0	FlowPath2ID	FLOW_PATH2
12	0	FlowPathVeg1ID	FLWPTH_VG1
13	0	FlowPathVeg2ID	FLWPTH_VG2
14	0	FlowPathCond1ID	FLWPTHCOND1
15	0	FlowPathCond2ID	FLWPTHCOND2
16	0	FillChannelID	FILL_CHAN
17	0	SurfaceCoverID	SURF_COV
18	0	CDate	CDATE
19	0	CTime1	CTIME1
20	0	CTime2	CTIME2
21	0	VehicleID	VEHICLE
22	1	Comments	COMMENT
23	1	CDate	CDATE
24	1	CTime	CTIME
25	1	VehicleID	VEHICLE
26	1	StreamConnectID	STREAM_CON
27	1	BroadBaseDipTypeID	TYPE
28	1	SlopeShapeID	SLOPE_SHAP
29	1	DischargeToID	DISCHRG_TO
30	1	ObstructionID	OBSTRUCT
31	1	FillErosionID	FILL_EROS
32	1	BroadBaseDipConditionID	CONDIT
33	1	MaterialID	MATERIAL
34	1	Comments	COMMENT
35	2	CDate	CDATE
36	2	CTime	CTIME
37	2	VehicleID	VEHICLE
38	2	StreamConnectID	STREAM_CON
39	2	SlopeShapeID	SLOPE_SHAP

40	2	DischargeToID	DISCHRG TO
41	2	ObstructionID	OBSTRUCT
42	2	FillErosionID	FILL EROS
43	2	Comments	COMMENT
44	3	CDate	CDATE
45	3	CTime	CTIME
46	3	VehicleID	VEHICLE
47	3	StreamConnectID	STREAM CON
48	3	SizeID	SIZE
49	3	PipeLength	PIPE LEN
50	3	DitchReliefTypeID	TYPE
51	3	DitchReliefConditionID	CONDIT
52	3	SlopeShapeID	SLOPE SHAP
53	3	DischargeToID	DISCHRG TO
54	3	FillErosionID	FILL EROS
55	3	ObstructionID	OBSTRUCT
56	3	FlowDiversionID	FLOW DIVER
57	3	FlowDiffuserID	FLOW DIFFU
58	3	Comments	COMMENT
59	4	CDate	Date
60	4	CTime	Time
61	4	VehicleID	Vehicle
62	4	StreamConnectID	STREAM CON
63	4	SlopeShapeID	SLOPE SHAP
64	4	DischargeToID	DISCHRG TO
65	4	LeadOffConditionID	CONDIT
66	4	ObstructionID	OBSTRUCT
67	4	Comments	COMMENT
68	5	CDate	CDATE
69	5	CTime	CTIME
70	5	VehicleID	VEHICLE
71	5	StreamConnectID	STREAM CON
72	5	SlopeShapeID	SLOPE SHAP
73	5	DischargeToID	DISCHRG TO
74	5	ObstructionID	OBSTRUCT
75	5	FillErosionID	FILL EROS
76	5	NonEngConditionID	CONDIT
77	5	Comments	COMMENT
78	6	CDate	CDATE
79	6	CTime	CTIME
80	6	VehicleID	VEHICLE
81	6	StrXingTypeID	TYPE
82	6	PipeDimID	R PIPE DIA
83	6	PipeDimID(Oval)	OVAL PIPE
84	6	PipeLength	PIPE LEN
85	6	ChannelWidth	CHAN WPTH
86	6	PipeNumberID	PIPE NUM
87	6	FillDepth	FILL DEPTH
88	6	StrXingConditionID	CONDIT
89	6	ChannelAngleID	CHAN ANGL

90	6	BlockTypeID	BLOCK_TYP
91	6	OutletDrop	OUTLET_DRP
92	6	PoolDepth	PL_DEPTH
93	6	PipeGradient	PIPE_GRADE
94	6	SubstrateID	SUBSTRATE
95	6	DebrisFlowID	DEBRIS_FLW
96	6	FillErosionID	FILL_EROSN
97	6	DiversionID	DIVERSION
98	6	Comments	COMMENT
99	7	CDate	CDATE
100	7	CTime	CTIME
101	7	VehicleID	VEHICLE
102	7	SumpConditionID	CONDIT
103	7	Comments	COMMENT
104	8	Cdate	Date
105	8	Ctime	Time
106	8	VehicleID	Vehicle
107	8	StreamConnectID	STREAM_CON
108	8	WaterBarTypeID	TYPE
109	8	SlopeShapeID	SLOPE_SHAP
110	8	DischargeToID	DISCHRG_TO
111	8	ObstructionID	OBSTRUCT
112	8	FillErosionID	FILL_EROS
113	8	WaterBarConditionID	CONDIT
114	8	Comments	COMMENT

DPErrLog Table Structure

Field Name	Description
Index	Unique identifier (Auto number in MS Access)
GRAIPDID	Identifier from DrainPoints table
DrainType	Type of the drain point (Eg: Broad Base Dip)
ErrorMessage	Validation error message
ActionTaken	Action taken to correct error

RDErrLog Table Structure

Field Name	Description
Index	Unique identifier (Auto number in MS Access)
GRAIPRID	Identifier from RoadLines table
RoadType	Type of road line (Eg: System road)
ErrorMessage	Validation error message
ActionTaken	Action taken to correct error

MetaData

ID	IDFieldName	DefinitionTable
1	DrainTypeID	DrainTypeDefinitions

2	VehicleID	VehicleDefinitions
3	StreamConnectID	StreamConnectDefinitions
4	BroadBaseDipTypeID	BroadBaseDipTypeDefinitions
5	SlopeShapeID	SlopeShapeDefinitions
6	DischargeToID	DischargeToDefinitions
7	ObstructionID	ObstructionDefinitions
8	FillErosionID	FillErosionDefinitions
9	BroadBaseDipConditionID	BroadBaseDipCondDefinitions
10	MaterialID	MaterialDefinitions
11	DitchReliefTypeID	DitchReliefTypeDefinitions
12	DitchReliefConditionID	DitchReliefCondDefinitions
13	FlowDiversionID	FlowDiversionDefinitions
14	FlowDiffuserID	FlowDiffuseDefinitions
15	LeadOffConditionID	LeadOffCondDefinitions
16	NonEngConditionID	NonEngCondDefinitions
17	StrXingTypeID	StrXingTypeDefinitions
18	PipeDimID	PipeDimDefinitions
19	PipeNumberID	PipeNumberDefinitions
20	StrXingConditionID	StrXingCondDefinitions
21	ChannelAngleID	ChannelAngleDefinitions
22	BlockTypeID	BlockTypeDefinitions
23	SubstrateID	SubstrateDefinitions
24	DebrisFlowID	DebrisFlowDefinitions
25	DiversionID	DiversionDefinitions
26	SumpConditionID	SumpCondDefinitions
27	WaterBarTypeID	WaterBarTypeDefinitions
28	WaterBarConditionID	WaterBarCondDefinitions
29	RoadNetworkID	RoadNetworkDefinitions
30	RoadTypeID	RoadTypeDefinitions
31	SurfaceTypeID	SurfaceTypeDefinitions
32	SurfaceConditionID	SurfaceConditionDefinitions
33	SurfaceCoverID	SurfaceCoverDefinitions
34	RoadEdge1ID	RoadEdgeDefinitions
35	RoadEdge2ID	RoadEdgeDefinitions
36	EdgeVegetation1ID	EdgeVegetationDefinitions
37	EdgeVegetation2ID	EdgeVegetationDefinitions
38	EdgeCondition1ID	EdgeConditionDefinitions
39	EdgeCondition2ID	EdgeConditionDefinitions
40	FlowPathVeg1ID	FlowPathVegDefinitions
41	FlowPathVeg2ID	FlowPathVegDefinitions
42	FlowPath1ID	FlowPathDefinitions
43	FlowPath2ID	FlowPathDefinitions
44	FlowPathCond1ID	FlowPathCondDefinitions
45	FlowPathCond2ID	FlowPathCondDefinitions
46	FillChannelID	FillChannelDefinitions

TAUDEM STREAM NETWORK SHAPEFILE ATTRIBUTE TABLE

The TauDEM stream network delineation function creates a stream network shapefile with the following attributes:

Field	Description
LINKNO	Link Number. A unique number associated with each link (segment of channel between junctions)
DSLINKNO	Link Number of the downstream link. -1 indicates that this does not exist.
USLINKNO1	Link Number of first upstream link
USLINKNO2	Link Number of second upstream link.
DSNODEID	Node identifier for node at downstream end of stream reach. This identifier corresponds to the "id" attribute from the Outlets shapefile used to designate nodes.
Order	Strahler Stream Order
Length	Length of the link
Magnitude	Shreve Magnitude of the link. This is the total number of sources upstream
DS_Cont_Ar	Drainage area at the downstream end of the link. Generally this is one grid cell upstream of the downstream end because the drainage area at the downstream end grid cell includes the area of the stream being joined.
Drop	Drop in elevation from the start to the end of the link
Slope	Average slope of the link (computed as drop/length)
Straight L	Straight line distance from the start to the end of the link
US_Cont_Ar	Drainage area at the upstream end of the link
WSNO	Watershed number. Cross reference to the *w.shp and *w grid files giving the identification number of the watershed draining directly to the link.
DOUT_END	Distance to the outlet from the downstream end of the link
DOUT_START	Distance to the outlet from the upstream end of the link
DOUT_MID	Distance to the outlet from the midpoint of the link

The following attributes that record sediment input to the stream network and habitat patch clusters are added to the stream network shapefile by the GRAIP toolbar:

Field	Description	Menu Function
SedAccum	Accumulated upstream sediment load from road surface at the downstream end of each stream segment (kg/yr)	Upstream Stream Sediment Input
SedDir	Direct sediment input from road surface to each stream segment (kg/yr)	Direct Stream Sediment Input

SpecSed	Specific sediment accumulation to each stream segment defined as accumulated upstream sediment production divided by upstream contributing area at the downstream end of each stream segment (Mg/yr/m ²)	Upstream Stream Sediment Input
SpecSedDir	Direct specific sediment input to each stream segment divided by the direct area draining to each stream segment (Mg/yr/m ²)	Direct Stream Sediment Input
HabPatchID	A unique identifier for each contiguous habitat cluster as demarcated by fish passage barrier	Habitat Segmentation

GRAIP SOURCECODE FOLDER ORGANIZATION

TOOLBARCOMDLL

Source code for C++ .dll that is used by the GRAIP Toolbar.

VS 6 workspace: COMDLL\rsamCOMDLL.dsw

Release config compiles to: COMDLL\ReleaseMinDependency\graipCOMDLL.dll

Debug config compiles to: C:\Program Files\GRAIP\graipCOMDLL.dll

Depends on:

- A. RasterIO.dll (for execution)
- B. RasterIO.lib (for compiling)
- C. ShapeCode that is included in this folder

CONSOLIDATESHP

Source code for C++ .dll that is used by the GRAIP Preprocessor.

VS 6 workspace: consolidateShp.dsw

Release config compiles to: ReleaseMinSize\consolidateShp.dll

Debug config compiles to: C:\Program Files\GRAIP\consolidateShp.dll

Depends on:

- A. ShapeLib that is included in this folder

DATABASEPREPROCESSOR

Source code for VB executable that is the GRAIP Preprocessor.

VB 6 project: GRAIPPreprocessor.vbp

Compiles to: C:\Program Files\GRAIP\DBPreprocessor.exe

Depends on:

- A. consolidateShp.dll
- B. MS Access database file GRAIP DB\GRAIP.mdb to run

ARCTOOLBAR

Source code for VB .dll for ArcMap Plug-in.

VB6 project: agRSAM.vbp

Compiles to: C:\Program Files\GRAIP\agGRAIP.dll

Depends on:

- A. tkTauDEM.dll

- B.** ToolBarComDLL.dll
- C.** sinmapCOMDLL.dll in C:\Program Files\TauDEM
- D.** C:\Program Files\GRAIP
- E.** C:\Program Files\SINMAP
- F.** Pro Essentials

INSTALLATION

Installshield project for GRAIP. This gets files from ReleaseFiles that has the same structure as Program Files\GRAIP. Pro essentials is not distributed with GRAIP because it is part of SINMAP and GRAIP depends on SINMAP.

RELEASEFILES

Contains release files that Installshield uses.

RELEASESETUP

Contains output from installshield for distribution.

DOCUMENTATION

Contains the wordprocessing and image files for the documentation.

GRAIP 1.0 RELEASE NOTES

Issue	Resolution
If you get the following error message: Run-time error '-2147467259 (80004005)': [Microsoft][ODBC Driver Manager] Data source name not found and no default driver specified	You need to create an ODBC Data Source called "dBASE Files" that uses the ODBC driver "Microsoft dBase Driver (* .dbf)".

Versions

Number	Release Date	Notes
1.0.0	5/24/07	
1.0.1	6/4/07	
1.0.2	7/6/07	
1.0.3	7/10/07	
1.0.4	8/14/07	Link between Roadlines and Drainpoints created from CDate, CTime and Vehicle fields
1.0.5	9/14/07	<ul style="list-style-type: none"> - If near match is found for Add Value, reassign is now initially selected. - Added alpha and beta parameters to the Filter Stream Crossing Function. - Added Slope to the Roadlines table. - Added alpha parameter to the LS Plot Function. - Clarified the meaning of Possible Passage.