CHAPTER 7

TERRAIN PROCESSES

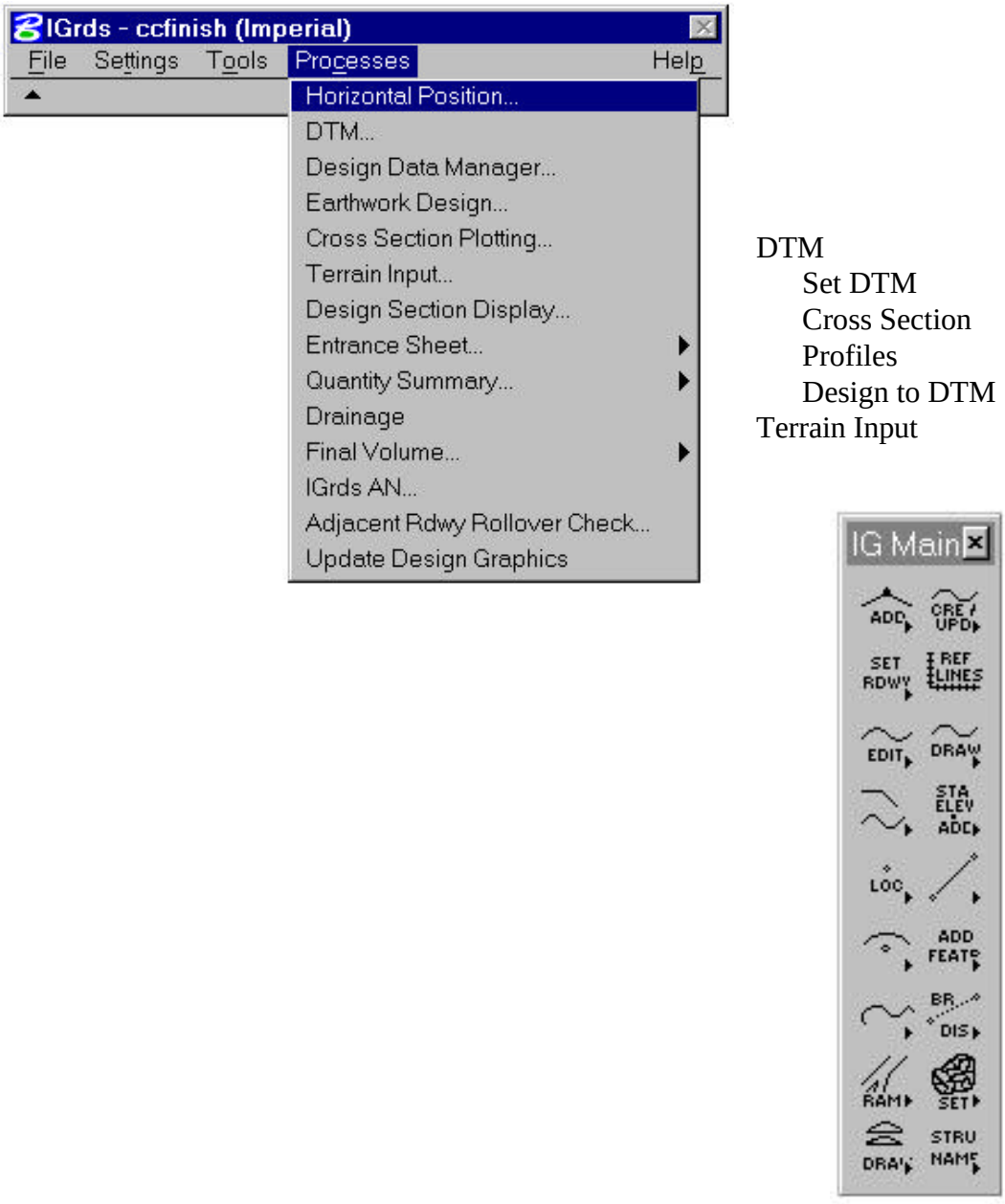

Figure 7-1
Terrain Processes

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TERRAIN PROCESSES

INTRODUCTION

This chapter discusses the methods for inputting Terrain data into the IGrds processes which when combined with design data results in design cross sections. The processes are discussed below and the entry methodology is discussed in detail within the chapter.

Terrain Input

This process provides for selecting Input files for terrain data in cross section form and executing processes for storing this data in Project working files.

DTM (Digital Terrain Model)

Four DTM process are provided

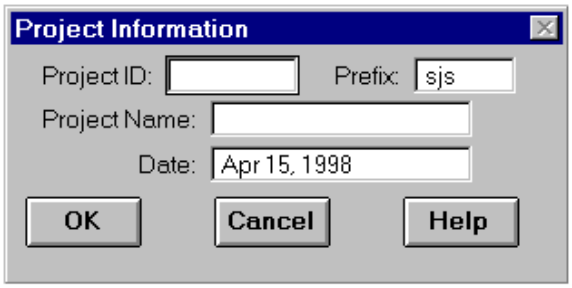
- Set DTM Surface
- Generation of original cross sections from DTM Surfaces.
- Generation of profile displays from DTM Surfaces.
- Preparation of data for new DTM surfaces based on design cross sections.

TERRAIN INPUT

This process stores terrain data (original cross sections, etc.) from an AN Input file. The AN input file must contain SYSTEM record with Job Type "WF" and Keep = "YES". All initialization fields on the SYSTEM record must be set to "NO" to prevent deletion of existing data. The input file must also include an RRDES record specifying the baseline the terrain is stored on.

Name	Displays the selected file name.
Files	Select the desired file from the list (change directory if necessary).
Directories	Select the proper directory for the desired input file.
Project Information	Click to view the Project Information dialog box (see page 7-5).
OK	Click to execute the Process.
Cancel	Click to close the dialog box without executing the process.
Help	Click to display Help information relating to this command.

PROJECT INFORMATION



This dialog displays Project Information to be placed on Terrain Input plots and listings.

Project ID	Project Identification (up to 3 characters).
Prefix	Earthwork output file prefix.
Project Name	Project Name.
Date	The system date (&date) will be displayed. Enter a different date if desired.
OK	Click to use displayed data.
Cancel	Click to cancel dialog.
Help	Click to display help for this dialog.

DTM PROCESSES

IGrds DTM Processes

A Digital Terrain Model (DTM) is a digital representation of a surface. The DTM processing capability within IGrds only requires that a 3D design file with the DTM triangles be displayed. This allows any DTM vendor that can display the DTM triangles in a 3D design file to be compatible with IGrds.

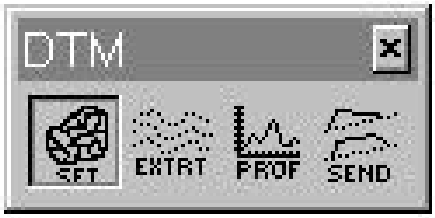
The IGrds DTM Interface consists of four sub-processes which allow IGrds to access the DTM for cross sections and profiles, and send roadway design data to the DTM in two formats, CAiCE and InRoads, to be merged with existing terrain models. Cross sections are extracted directly from the DTM and stored in the station file (.xsX). Profiles are displayed in the appropriate roadway reference line.

The subprocesses are:

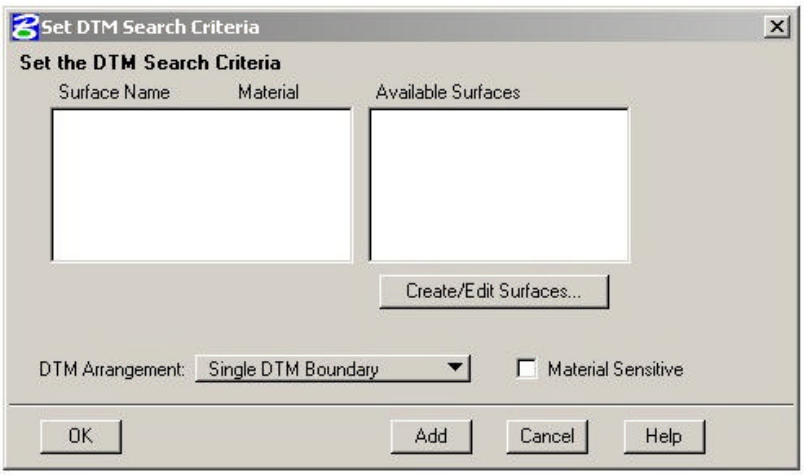
- Set DTM Project relationship
- Cross Sections from DTM
- Profiles from DTM
- Roadway Design Data to DTM

As described above, the DTM surfaces are established by external DTM processes. Instructions for those processes are provided separately by the DTM providers.

SET THE DTM SEARCH CRITERIA



Selection of the Set icon on the DTM tool box opens the Set DTM Search Criteria and Surface dialog shown here. This command is used to associate the proper DTM Criteria with the current IGrds working files in order to obtain information about the various terrain surfaces involved in the design. Upon opening IGrds working files, the last DTM search criteria and surface(s) are automatically opened.



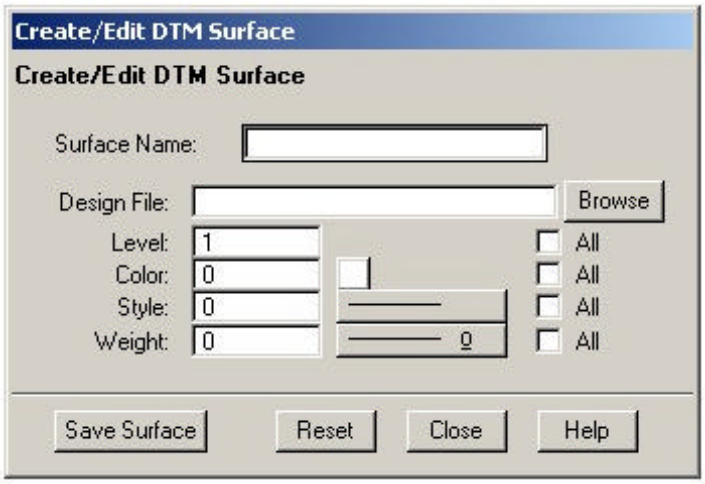
Multiple surfaces can be defined in situations where large DTMs have been broken up into several surfaces. The Create/Edit Surfaces dialog described below provides for the definition of these surfaces.

Available Surfaces	This scrollable field displays the list of available surfaces defined through the Create/Edit Surfaces Dialog. (See Add below for selecting from this list.)
Surface Name	This scrollable field displays the list of surfaces named active for this design session. By default, the DTM arrangement is set to "Single DTM Boundary" and only one surface can be selected. If "Multiple DTM Boundaries" is set, up to 20 surfaces can be selected and will be considered as a single contiguous surface. This option is used when a large DTM is broken up into smaller surfaces. If "Multiple Subsurfaces" is set, up to 20 surfaces can be selected and IGrds will include them in each cross section extracted from the DTM as they are encountered. (See Add and Delete below to add or remove names from this list.)
Material	If the surface name is associated with a material type, the type will be shown here. (See Material Sensitive option following.)

Create/Edit Surfaces	Select this button to open a modal dialog in which a new surface may be created or an existing surface may be modified. (See Create/Edit Surfaces Dialog below)
DTM Arrangement:	Select one of the following three options. • Single DTM boundary. A single DTM surface is being used (default condition). • Multiple DTM Boundaries Multiple DTM surfaces are being used which model a single large surface model. • Multiple Subsurfaces Multiple DTM surfaces are selected which model subsurface strata.
Material Sensitive	Option Button • Depress this button if it is desired to associate a material type with a surface selected from the list of Available Surfaces. Selecting this option causes the Subsurface Materials scrolling dialog menu to be displayed each time a surface is selected. The procedure continues by making a selection on the Subsurface Materials menu. See the discussion of that submenu below. See Note 1. • Release this button to ignore the procedure of associating materials with surfaces. (Default condition.)
Surface Database Description	If a surface chosen from the list of Available Surfaces has a database description, that description will be displayed in a read-only field appearing under the Surface Name/ Material list box. It remains there until another surface is chosen.

OK	Select OK to attach the named DTM Search Criteria to the current design session. The current DTM Search Criteria and surface is also saved to the project ini file (.ini extension). Each time the project is opened, the last DTM settings are automatically opened for use.
Delete	(This button appears only when one or more surfaces appear in the list of active surface names.) Highlight a name from the list of active surfaces and press Delete to remove it from the list.
Modify	(This button appears only when one or more surfaces appear in the list of active surface names.) Highlight a name from the list of active surfaces and press Modify to display the Subsurface Materials scrolling dialog menu of material types. Select a new material and press OK on that dialog to modify the material name in the active surface list.
Add	(This button appears only when one or more names appear in the list of Available Surfaces.) Highlight (by cursor selection) a name from the list of Available Surfaces that is to be used in the current design process and press Add to add it to the list of surfaces to be activated. If the Material Sensitive option is active, the Subsurface Materials dialog will be displayed. Continue with that menu as described below.
Cancel	Select Cancel to close off the Set DTM Project dialog without taking any action.
Help	Select Help to display information about this command.

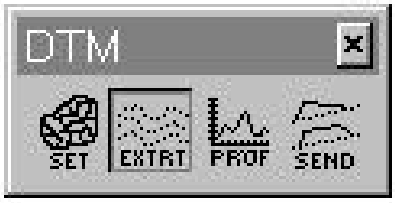
Create/Edit DTM Surface



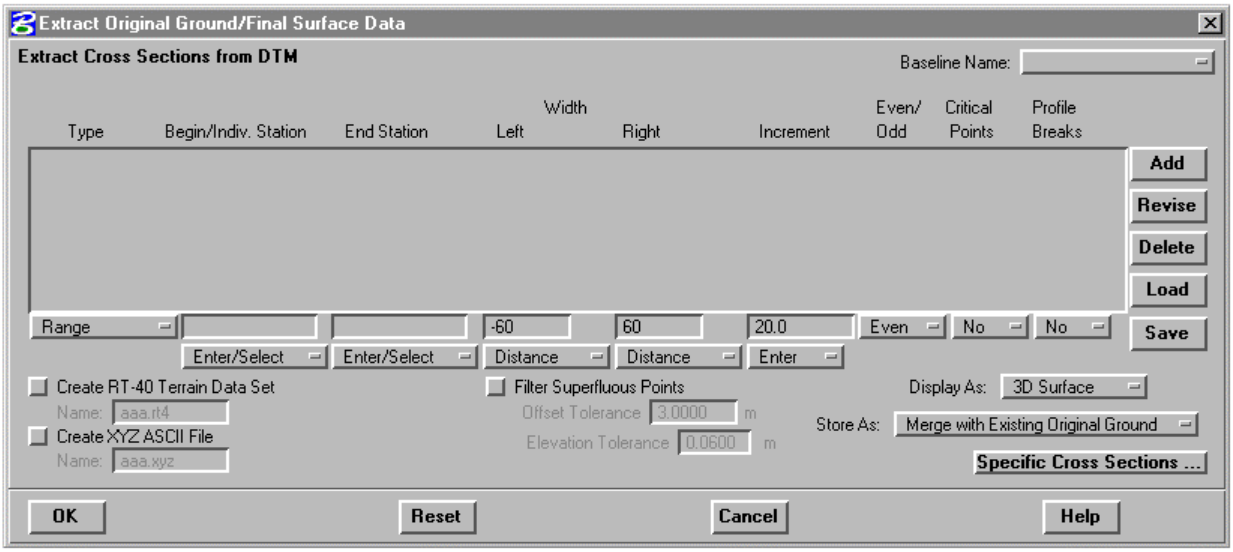
The Create/Edit DTM Surface dialog shown at the left is opened from the Set DTM Search Criteria dialog. This dialog is used to define the search criteria - Level, Color, Line Style, and Line Weight – which defines a surface. The surfaces defined through this dialog will be displayed in the Available Surfaces list box on the Set DTM Surface dialog.

Surface Name	This text field allows the user to enter a surface name to be created.
Design File	This text field is accompanied by a Browse button, and allows the user to specify the design file this surface will be defined from.
Level **Color** **Style** **Weight**	These options allow the user to define the specific attributes of the surface in the given design file. A toggle button (All) is available for each of the attributes in which case the search criteria would allow all Levels, for example.

CROSS SECTIONS FROM DTM



This sub-process is used to generate cross sections along a specified base line roadway and store them as original ground cross sections for the active baseline. Selection of the extract icon on the DTM tool box opens the Cross Sections from DTM dialog box shown below.



If not already done for some other DTM process, the SET DTM command must be executed to set the DTM surface before using this command.

Baseline Name	The active baseline name is displayed. Click on this pull down selection bar and select a different baseline roadway if required.
List Box Record Edit Fields	
Type	Select Option • Individual Selecting this option means that only one cross section will be generated at the specified station. • Range Selecting this option means that a set of cross sections will be generated over a specified station range.

Begin/Indiv. Station	Select Option • Enter/Select Enter the value of the station where a cross section is desired or the starting station for a range of cross sections. Alternately, use the cursor to graphically select the station. • Begin Displays the beginning station of the alignment.
End Station	Select Option (grayed out for Individual type) • End Displays the ending station of the alignment. • Enter/Select Enter the value of the ending station in a range of cross sections. Alternately, use the cursor to graphically select the station.
Width Left	Select Option • Distance Enter the distance left of the baseline that defines the extent of the cross section on that side. • Geom Elm Select a line, arc, or chain on the left side that defines the limit of the cross section on that side.
Width Right	Select Option • Distance Enter the distance right of the baseline that defines the extent of the cross section on that side. • Geom Elm Select a line, arc, or chain on the right side that defines the limit of the cross section on that side.

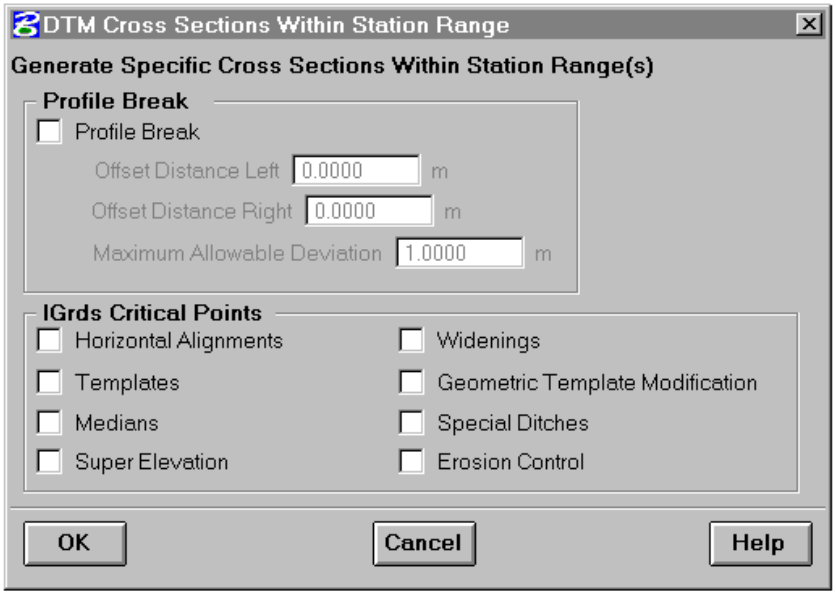
Increment	Select Option (grayed out for Individual type) • Enter Enter the station increment value to be used when generating cross sections over a range of stations. • None Select None when it is desired to generate cross sections at Critical Points only over the specified station range.
Even/Odd	Select Option (grayed out for Individual type) • Even Select Even when it is desired to cut cross sections only at even station increments following the beginning station which may be any value. • Odd Select Odd when it is desired to cut cross sections only at odd station increments following the beginning station which may be any value.
Critical Points	Select Option (grayed out for Individual type) • No Select No (default) when generation of cross sections at Critical Points is not desired. • Yes Select Yes when it is desired to generate cross sections at Critical Points over the station range. (Use with the Specific Cross Sections... option button.)

Profile Breaks	Select Option (grayed out for Individual type) (Note: This option can be used only after cross sections have been cut at some specified interval over a range, since the intervals between existing cross sections are used in the sever break analysis. See Figure 7-1 for a description of the process. • No Select No (default) when generation of cross sections at Profile Breaks is not desired. • Yes Select Yes when it is desired to generate cross sections at Profile Break points over the station range. (Use with the Specific Cross Sections... option button.)
Add	Select Add to add a cross section data record from the edit fields to the list box.
Revise	Select Revise when the data in the edit fields is to replace the highlighted data.
Delete	Select Delete when it is desired to delete a highlighted record from the list.
Load	Select the Load button when it is desired to load a previously Saved file of Cross Sections from DTM menu specifications. Selecting Load causes the Load DTM Cross Section File dialog to be displayed. This dialog is a typical File and Directory list box from which a previously saved file can be retrieved. Data from such a file, having the *.cut filter, will be loaded into the Cross Sections from DTM dialog.
Save	Select the Save button when it is desired to save the data in the Cross Sections from DTM dialog for future use. All data is saved, including Specific Cross Section data. Selecting Save causes the Save DTM Cross Section File dialog to be displayed. This typical file and directory list box menu permits the saving of the data in the default working file name and path or some other user specified name and location. The file is normally saved with the *.cut filter.

Create RT-40 Terrain Data Set	Click the option box on if it is desired to generate an RT-40 Terrain Data set. The default is off for no data set.
Name	Grayed out unless an RT-40 data set is to be generated. The default file name appears. When active, the default name may be changed.
Create XYZ ASCII File	Click the option box on if it is desired to generate an ASCII file of cross section data in XYZ form. The default is off for no XYZ data.
Name	Grayed out unless an XYZ data set is to be generated. The default file name appears. When active, the default name may be changed.
Filter Superfluous Points	Click the option box on if it is desired to filter out points falling along the cross section that are within close proximity to adjacent points and would not change the shape of the section if they were eliminated.
Offset Tolerance	Enter the horizontal distance from an adjacent point that a point must fall within to be considered for elimination.
Elevation Tolerance	Enter the vertical distance from an adjacent point that a point must fall within to be considered for elimination.
Display As:	Select the desired scan line display. The default for a 3D design file is 3D Surface. For 2D design files, this option is hidden.
Store As:	Select the desired storage mechanism for the cross sections. The default is Merge with Existing Original Ground.
Specific Cross Sections...	Select this option button when it is desired to generate specific cross sections within station ranges. This causes an additional dialog, DTM Cross Sections Within Station Range, to be displayed. (See the description of this submenu following this one.)

OK	Select OK to execute the cross section generation process with the data as defined in the dialog.
Reset	Select Reset to return the dialog values to their original settings prior to any editing.
Cancel	Select Cancel to close the dialog without taking any action.
Help	Select Help to display information about this command.

DTM CROSS SECTIONS WITHIN STATION RANGE



Within a given station range and increment, it is possible to generate additional cross sections at both profile break points and critical IGrds design points. This is done through the use of the DTM Cross Sections Within Station Range dialog box shown at left. As mentioned previously, this dialog is displayed when the Specific Cross Sections button is selected on the DTM cross sections dialog box.

Profile Break	Click the option box on if it is desired to activate the following three grayed out profile break parameters used to establish limits for generating cross sections at excessive profile break points that may exist between incremented DTM cross section stations. Default values are shown, but can be changed after activation. See Figure 7-1 for a description of the severe break analysis.
Offset Dist. Lt.	Specify the distance left of the centerline to be analyzed for severe profile breaks. IGrds will generate a profile from DTM at this offset for sever break analysis. This distance cannot exceed the minimum cross section width on this side of the roadway. The system calculates and displays the minimum cross section width when this option is selected.
Offset Dist. Rt.	Specify the distance right of the centerline to be analyzed for severe profile breaks. IGrds will generate a profile from DTM at this offset for sever break analysis. This distance cannot exceed the minimum cross section width on this side of the roadway. The system calculates and displays the minimum cross section width when this option is selected.

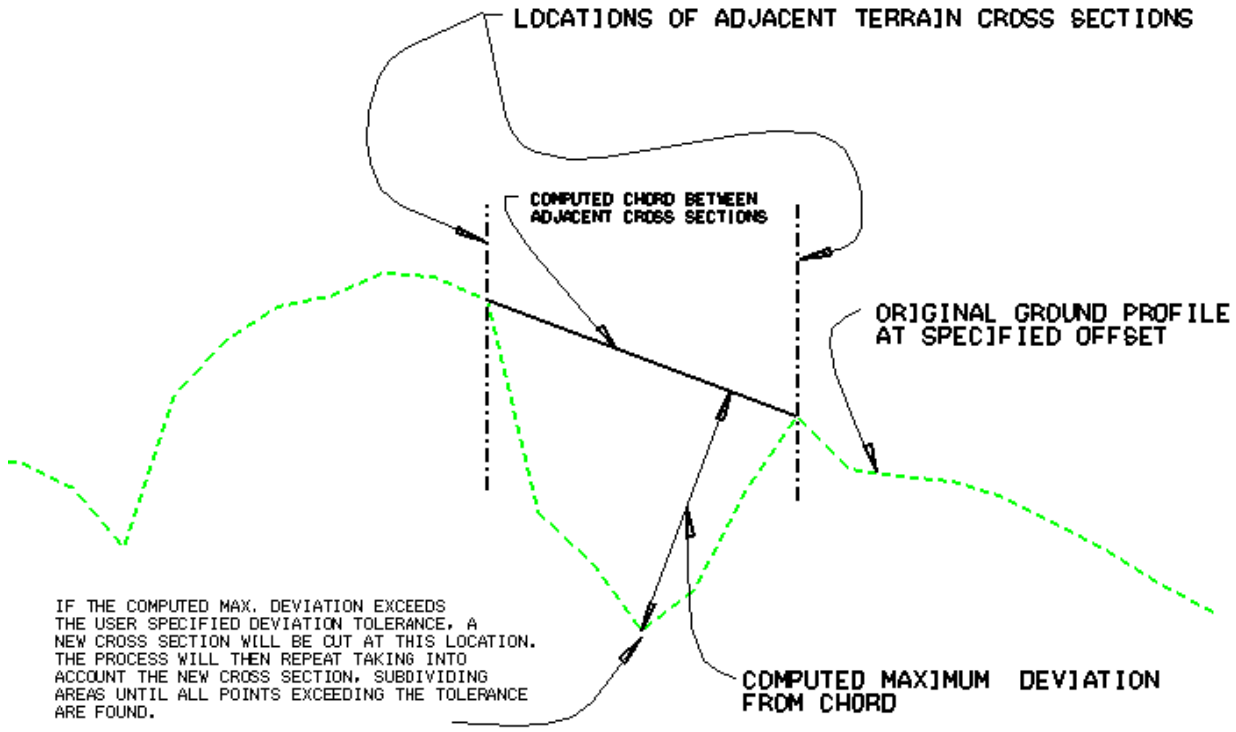
Max. Allow. Deviation	Enter the maximum allowable deviation in elevation between the profile generated between any pair of DTM cross sections, and the profile generated between the same two sections. (See Figure 7-1.)

IGrds Critical Points

The Critical Points process can generate cross sections on a roadway baseline at any of the optional design point locations listed below. When generating these cross sections, all design roadways associated with the baseline are interrogated as well.

Horizontal Alignments	Click the option box on if it is desired to generate cross sections at all of the key points on the alignment. These key points include the alignment start and end points, station equations, PCs, PTs, TSs, SCs, etc.
Templates	Click the option box on if it is desired to generate cross sections at all roadway template stations.
Medians	Click the option box on if it is desired to generate cross sections at all median beginning and ending stations.
Superelevation	Click the option box on if it is desired to generate cross sections at all begin transition, begin full superelevation, end full superelevation, and end transition stations.
Widenings	Click the option box on if it is desired to generate cross sections at all begin transition, begin full widening, end full widening, and end transition stations.
Geometric Template Modification	Click the option box on if it is desired to generate cross sections at all begin and end geometric template modification stations.
Special Ditches	Click the option box on if it is desired to generate cross sections at the begin and end stations of all special ditches.

Erosion Control	Click the option box on if it is desired to generate cross sections at the begin and end stations of all erosion control ditches.
OK	Select OK to return to the main cross section menu with the data defined in this submenu.
Cancel	Select Cancel to close the menu without taking any action.
Help	Select Help to display information about this command.



General Steps in Severe Break Analysis.

1. Scan all intervals starting at the beginning of alignment.

2. At each interval:

   a. Create chord between adjacent terrain sections.

   b. Analyze all profile break points along chord as shown to find the point of maximum deviation from the chord.

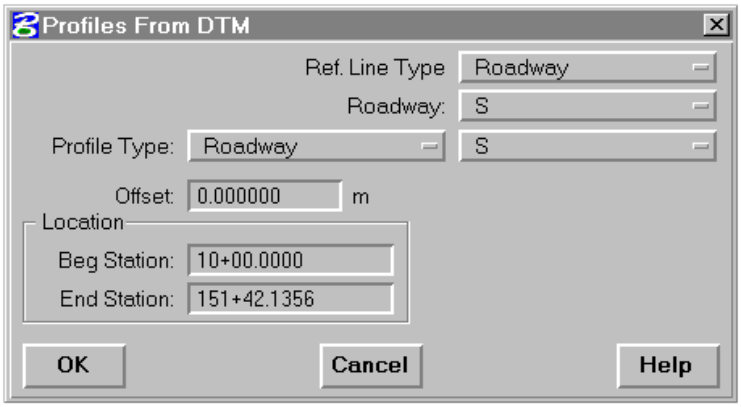
   c. If the point of maximum deviation exceeds the specified maximum allowable value, cut a cross section at this location.

3. Continue analyzing all intervals, including new intervals created when additional cross sections are cut.

Figure 7-1

PROFILES FROM DTM

This subprocess extracts profile data along an alignment or offset alignment or geometry element and will plot it on a vertical alignment reference scale if one exists prior to execution. If none exists, it may be established afterwards, but the profile will have to be plotted using the original ground profile drawing command.



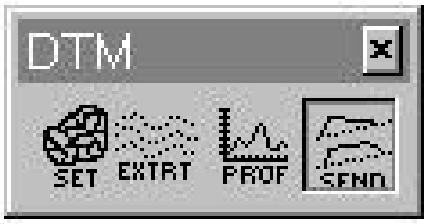
If not already done for some other DTM process, the SET DTM command must be executed to set the DTM surface before using this command.

Reference Line Type	Select the Reference Line Type. • Roadway • Geometry Element This option button selection determines whether the reference line defines a vertical plane for a roadway or a geometry element.
Roadway	If the reference line type selected is "Roadway", then the desired roadway. The currently active roadway is shown. Note that the horizontal alignment for the roadway must exist.
Geometry	If the reference line type selected is "Geometry Element", then select the desired linear geometry element. The currently active geometry element is shown. Note that the geometry element must have previously been defined as having a profile associated with it.

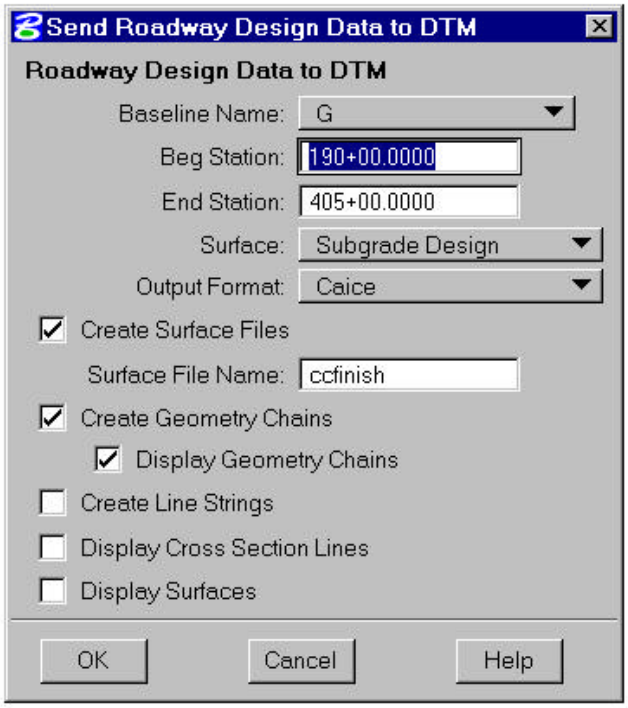
Profile Type	Select the type of profile to be displayed in the reference line. • Roadway • Geometry Element If **Roadway** is selected, an the option list will display a list of all available alignments. Select the desired roadway. A profile from DTM will be generated for the alignment and projected into the reference line. If **Geometry Element** is selected, an edit field will appear to specify which geometry element to use. Enter or select the desired geometry element. A profile from DTM will be generated for the geometry element and projected into the reference line.
Roadway	The active roadway is displayed. Click on field to change roadway.
Offset	Enter ± offset from the roadway centerline to the desired profile.
Begin Station	The beginning station of the roadway will be displayed. Enter station to modify.
End Station	The end station of the roadway will be displayed. Enter station to modify.
OK	Click to execute the subprocess selected.
Cancel	Click to cancel the dialog.
Help	Click to display information about this command.

Note: The reference line for the roadway must be established prior to executing the profile option..

ROADWAY DESIGN DATA TO DTM



This sub-process collects all roadway design data between specified stations and loads it into three files as three dimensional strings ready for input to DTM's provided by CAiCE and InRoads. The roadway design data is represented as feature lines and random points. The strings may also be displayed in the plan view as IGrds geometry chains on the current active level for geometry. To view the geometry chains by their respective feature codes, use the Display By Feature code command on the Geometry Features palette. See the section that follows for information on how to associate design codes with feature codes. As mentioned above, the process can create surface files in either the CAiCE or the InRoads DTM raw input.



Baseline Name	Select desired baseline.
Begin Station	The beginning station of base line will be displayed. Enter or select station to modify.
End Station	The ending station of base line will be displayed. Enter or select station to modify.
Surface	Click and hold on the surface type pulldown list and choose one of the four available options: Subgrade, Finish, Subcut, or Removal.
Output Format	Click and hold on the Output Format option button to select the desired output format. CAiCE or InRoads. The process will then create the surface files in the selected format.

Create Surface Files	Select this option when it is desired to create DTM surface files ready for input to one of the DTM processes (default). Release the option to forego file creation.
Surface File Name	Enter desired DTM surface file name. The default is the current working file name.
Create Geometry Chains	Select this option when it is desired to create geometry chains for the linear design features (catch lines, ditch lines, pavement edges, etc.) created by this command (default). Release the option to forego chain creation.
Display Geometry Chains	Select this option when it is desired to display the linear design feature chains generated by the Create Geometry Chains option (default). Release the option if display of the chains is unnecessary.
Create Line Strings	Select this option to generate and display 3D line strings representing the longitudinal features.
Display Cross Section Lines	Select this option to display the cross section lines along with the 3D line strings.
Display Surfaces	Select this option to display renderable 3D Polygonal MicroStation surfaces representing the design. The surfaces will be displayed according to user defined feature codes in feat.met or feat.imp. Feature codes are established according to the four character IGrds design codes via the des_code.tab file in the custom directory. See the discussion of associating design codes with user defined feature codes that follows.
OK	Click to execute the subprocess.
Cancel	Click to cancel the dialog.
Help	Click to display information about this command.

Notes: This subprocess:

- Sends design data for all design roadways (up to 6) in a single pass.

- Transfers design data as three dimensional feature (break) lines to the fullest extent possible (i.e., roadway ridge lines, ditch lines, catch lines, Bridge End Treatment (BET) etc.).

The files produced are:

- CAiCE
    - Feature line file (.srv) - Contains Roadway Design elements represented as feature lines. These include roadway ridge lines, ditch lines, catch lines, and other points of the same description on adjacent cross sections.
    - Clipped Polygon file (.CLP) - Contains the definition of a closed polygon which is used by the DTM to remove all terrain points within the design limits.
    - Random point file (.XYZ) - Contains Roadway Design points that do not lie on a feature line.
- InRoads
    - Feature line file (.dis) - Contains Roadway Design elements represented as feature lines. These include roadway ridge lines, ditch lines, catch lines, and other points of the same description on adjacent cross sections.
    - Clipped Polygon file (.clp) - Contains the definition of a closed polygon which is used by the DTM to remove all terrain points within the design limits.
    - Random point file (.xyz) - Contains Roadway Design points that do not lie on a feature line.

Associating IGrds Design Codes With User Defined Feature Codes

IGrds allows user designated feature codes to be attached to the geometry chains generated by the "Design to DTM" command. These feature codes can also be used to control display appearance of polygonal surface elements. These feature codes are entered into the geometry feature code file (feat.imp or feat.met). When feature codes are attached to the chains representing the proposed design, the other geometry feature commands can be used to display, quantify, and generate lists by feature code. These commands can be found on the Geometry Features Palette on the Geometry pulldown menu.

Feature codes are attached to the geometry chains and surfaces by associating them with the design codes which are automatically generated by the IGrds design process. For example, a design code of CLP can be associated with a user defined feature code of CLPT. This is done by editing a new equivalence table names **des_code.tab**. This file along with the system supplied feature files can be found in the IGrds custom directory. An example of **des_code.tab** is shown below:

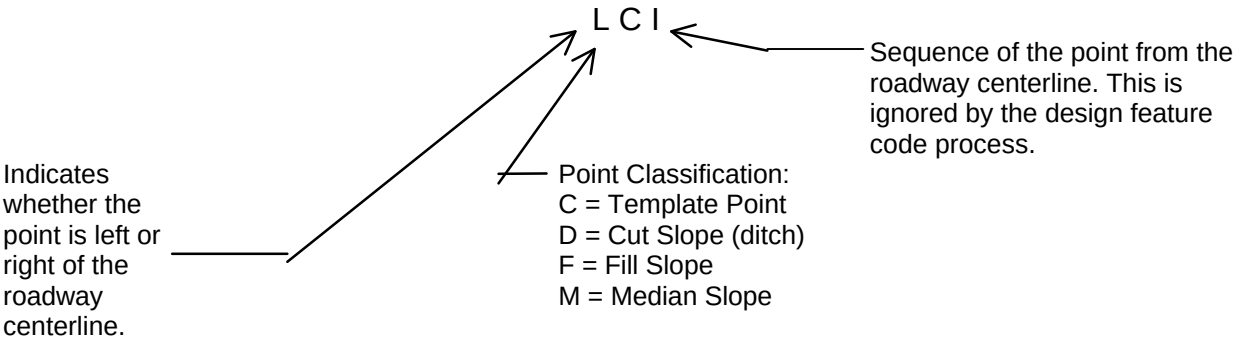
```
! Note that the roadways and point number are left off.
!
!des code    feature code     comments
CLP           CLPT             !Roadway Centerline
LC            LTMP             !Left Crown Line
RC            RTMP             !Right Crown Line
LD            DTCH             !Ditch Line
RD            DTCH             !Ditch Line
LF            FSLP             !Fill Line
RF            FSLP             !Fill Line
RM            MEDN             !Median Line
LM            MEDN             !Median Line
MP            MEDN             !Median Line
etc.
.
```

The file is an ASCII free format file which uses an "!" to allow comments to be added. The *first* entry contains the IGrds generated design point code. (A discussion of design point codes follows). The *second* entry contains the user defined feature code. There is one line per design code - feature code equivalence, with at least one space separating them. For the association to work, the feature codes *must* exist in the feature file being used. A partial feature file (**feat.met**) containing a feature code referenced in des_code.tab (in italics) is shown below.

```
101    1   1   1   0   0   VPI    1.0000          TREES    THIS IS FEATURE NO. 1
102    2   3   3   3   2         16.0000          RODS     THIS IS FEATURE NO. 2
103    3   3   3   3   3           .0000229568    ACRES    THIS IS FEATURE NO. 3
CLPT   2   2   2   2   2          1.000                    ROADWAY CENTERLINE
```

Discussion of IGrds Generated Design Point Codes:

Proposed design cross sections created by IGrds contain codes automatically generated for each point which indicate which portion of the design they represent. The scheme used is illustrated below:



There are several special type points which require exceptions to the coding scheme. They are as follows:

- The centerline point for each roadway is always labeled as "CLP" indicating "centerline point".
- The median point between two roadways is labeled as "MP".
- Any terrain points that fall within the design cross section are labeled as "TERR" indicating terrain point.
- Any point that occurs as a result of an overlapping slope pattern resolution is labeled with the letters "DP" for ditch point.

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