NORTH CAROLINA Department of Transportation

Location & Surveys DTM Manual

JUNE, 2002



Table of Contents

Item	Page
Product Support & Revisions	2
GEOPAK Help	3
Overview & History	4
Flow Chart for DTM's	5
DTM Symbology	9
PHOTOGRAMMETRY DTM Symbology	_10
Exceptions & Special Cases	11
Procedures	12
Creating .dat files	
Using Survey Manager	13
Extracting by Levels	18
Building Triangles	21
Checking Triangles	21
Reports	22
Loading Triangles	24
Loading Contours	25
Checking DTM's	26
Building Lattice Files	29
Editing DTM's	29
Naming Conventions	32
Definitions	32
Example Sheet	33

PRODUCT SUPPORT

VERSION

PLATFORM	WINDOWS NT	4.0
CADD SOFTWARE	MICROSTATION	J
COORDINATE GEOMETRY	GEOPAK	2001
DATA COLLECTOR	HUSKY FS/2 DOS	3.3
DATA COLLECTOR SOFTWARE	TDS "SURVEY PRO"	4.3.11

REVISIONS

DATE

Pages 9 & 11	01/13/98
Pages 1-2,5-6, & 10	04/28/98
Revised for Geopak98	05/99
Page 18,II,1	01/20/2000
Page 19,1	01/20/2000
Page 22,2	01/20/2000
Page 2,12	03/30/2001
Revised for Geopak 2001	06/2002

This manual was put together to help the Location & Surveys Unit. It is not intended to replace GEOPAK HELP. Please browse this section. For Further information, please consult the "Location & Surveys HYRDO-GUIDELINE" Manual.

<u>F</u> ile	<u>E</u> dit	Element	<u>S</u> ettings	<u>T</u> ools	<u>U</u> tilities	Work	space	Applications	<u>₩</u> i	ndow <u>H</u> elp			
							GEOP	AK	•				
							GEOP	AK ROAD	•				
						-	GEOP	AK SURVEN		GEOPAK	<u>S</u> URVEY Tools	s	
										<u>P</u> roject Ma Acti <u>v</u> e Cha GEOPAK I	anager ain Control Element Attribu	ites ►	
										<u>U</u> ser Prefe <u>G</u> eometry Pla <u>n</u> s Prep DTM <u>I</u> ool <u>M</u> enu Bar	erences paration Is	;	
									1	<u>H</u> elp		•	Introduction
													Project Manager Coordinate Geometry Survey Manager Digital Terrain Modeling
			GEOPAK O	nline Help									English to Metric Conversion Geodetic Conversions Tables Labeling Legal Description
		E	ile <u>E</u> dit Boo	ok <u>m</u> ark <u>O</u>	ptions <u>H</u> elp			8 12 50 1					<u>M</u> enu Bar
			Cont Survey DI Triangulat Display an Height Qu Profiles Drainage	ex Eine Emf: IM Tool tion Stat d Draw lery Tools	s s tistics Feature	<u>P</u> rint 5	t <u>O</u> ptic	ons <u> Հ</u>				-	

LOCATION & SURVEYS DTM MANUAL

History: The Location & Surveys Unit has a distinct role in preconstruction That role is to be the **EYES & EARS** for the rest of the departments. All other Units have placed their full confidence in our ability to collect, edit & format our data for each Unit to use. The data could be for a small bridge job where an existing bridge would be replaced with a culvert, or a major widening / relocation job with 10 or 12 lanes of traffic. In recent years more & more demands have been placed on our Unit. We have more than doubled our work load while ever raising our standards for accuracy. In order for Location & Surveys to meet and exceed the demands that we now have, then we must **standardize** an ever increasing part of our work. That part is called **DTM's**, **Digital Terrain Modeling**.

In order for other Units to use our work we **must** accept the task of delivering a product, (a 3d design file) in a standard format! The guidelines listed below are to help us do so. We understand the theory, "If it is not easy to do in the field, it probably will not get done." However, we need to use a format that **<u>EVERYONE</u>** (from the mountains to the coast) can use. There will be times that it is **very** difficult to collect DTM data this way, and sometimes **impossible**. Nevertheless, the end result will be a **standard** finished product.

When we receive a request to collect both Planimetric & DTM data, these standards will be easier to use in the field than in the past. We would transmit two design files; One, a Planimetric 2d design file (pml), and the other, a 3d design file (dtl) with Breaklines and Random points on their proper levels. We understand that when only DTM's are requested it would be easier to collect everything as a regular Breakline or Regular point, however, we can not deviate from our DTM standards.

The standards listed below are to be followed! There will be no reason to send in a DTM file with EP's on level 51 & using white dashed lines to identify them. If you are in doubt on what attributes to give to a feature, answer "YES" or "NO" to the questions on the following pages.

- I: Is the item a Breakline?
 - No, goto "II" (page 8)

Yes, Would the Breakline be also for planimetrics?

- No, goto "A" (page 7)
- Yes, Is the Breakline a Major or a Minor Structure?
 - No, goto "1" (page 6)
 - Yes, Is the Breakline a Major Structure?
 - No, goto "a"
 - Yes, Is the Breakline a BRIDGE:
 - HW, WW, End Wall?
 - No, The Breakline is a bridge deck; collect the Breakline using the feature code: *3101*; BRIDGE, TUNNEL etc. and leave on level 5.
 - Yes, Collect data using the feature code 3119 & move the Breaklines to level 51 in the DTM design file

a) It is a Minor Structure; Is it a pipe?

- No, goto "b" (page 6)
- Yes, Collect the Pipe using the proper feature code: (32**, 42**, 52**) But do NOT show them in the DTM file.

b) Is it a Pipe WW, HW?

No,

Then it is a paved ditch; Use this feature in your DTM files *only* when it is nonstandard. Use feature code: 3123; PAVED DITCH and *move* to level 51.

**When it is a standard "V", paved ditch show the bottom as a Drainline, feature code: 4003; DRAINLINE The DRAINLINE feature will not show in the Planimetric file.

- Yes, Collect data using feature code: *3120*; PIPE HW, WW and *move* the Breaklines to level 51 in the DTM design file.
- 1. Is the Breakline an EP?
 - No, goto 2
 - Yes, Collect the Breakline using the proper feature code: (3001-3005) & do not change the level. Keep the EP's on level 3.

2. Is the Breakline at the waterline?

- No, It is a Breakline that would be included in a Planimetric file, but is *not* a Major structure, a Minor structure, an Edge of water or an EP. Collect the Breakline using the proper feature code: (*3604* for WDS_LINE, *3410* for FENCE_LINE, etc.), And *move* the Breaklines to level 51 in the DTM design file.
- Yes, Collect the edge of water (creek stream, river, shoreline, etc.) Using the feature code 3620;
 STREAM, BODY OF WATER.
 Do not change the level.
 Keep the Breaklines on level 10.

- A: The Breakline would *not* be used in a Planimetric file;
 - Is the Breakline below the waterline? (a creek or river channel) No, goto "c"

 - Yes, Collect the below water Breakline using the feature code 4007, UNDERWATER BREAKLINE.
 - Is the Breakline on the Top of Rail or @ the c) Crown of a Road?
 - No. goto "d"
 - Yes, Is the Breakline on Top of Rail?
 - Collect the Crown of a Road No, using the feature code: 3008; CROWNLINE
 - Collect the Top of Rail using Yes, the feature code: 4006; TOP OF RAIL
 - d) Is the Breakline located at a *ridge* or a *drain*? (ditch)
 - Then it is considered a "Regular Breakline". No. Collect the Breakline using the feature code: 4005; BREAKLINE goto "e" Yes,
 - Is the Breakline at a ridge? e)
 - Then it is considered a "Drainline". Collect No, the Breakline using the feature code: 4003; DRAINLINE
 - Then it is considered a "Ridgeline". Collect Yes, the Breakline using the feature code: 4002; RIDGELINE

- II: It is a Point; Would the Point be also for Planimetrics?
 - No, goto "A"
 - Yes, It is a Point feature that would be used in a Planimetric design file. Collect the Random DTM points using the proper feature code: (3501 for POWER_POLE, 3601 for TREE, etc.) And move the Point to level 47 in the DTM design file.
 - A: Is the Point below the waterline?
 - No, goto "a"
 - Yes, Then it is a below water random Point. Use the feature code: *4008*; U/W REGULAR POINT
 - a) Is the Point on top of a Hill, Knoll, or in a Depression?
 - No, Then it is a Regular Point. Use the feature code: *4001*; REGULAR POINT
 - Yes, It is a Spot elevation. Use the feature code: *4000*; SPOT ELEVATION

LOCATION & SURVEYS DTM SYMBOLOGY

				Ft 119)
			C	CHA. C	DR
<u>LEVEI</u>	<u>L ITEM DESCRIPTION</u>	<u>CO</u>	\underline{WT}	<u>LS</u>	<u>FEATURE CODE</u>
3	ROADS				
Ũ	*EOP	4	1	0	3001
	EOT	18	1	0	3002
	EOP Other	32	1	0	3003
	*Curbs	4	3	0	3004
	Soil or Gravel Rd.	4	2	2	3005
5	MAJOR STRUCTURES	5 (DO NO	OT EXTRA	ACT, TUI	RN THIS LEVEL OFF)
	Bridge Deck, Tunnels,				
	Box Culverts	6	3	0	3101
10	HYDROGRAPHY				
	*Stream, Body of Water	1	1	0	3620
	# Swamp	2	1	K	3622
20	Point Symbols for Break	klines			
	* Breakline	0	0	Α	4005
	* Ridgeline	2	0	Α	4002
	* Drainline	1	0	Α	4003
	* EOP	4	0	Α	3001-3005
	* Crownline	32	0	А	3008
44	RAILROAD				
	Top of Rail	7	1	3	4006
47	DTM POINTS				
	Regular point	3	0	А	4001
:	** Any other Regular point needed	?	?	?	
48	DTM POINTS				
	*Spot Elevation	0	1	В	4000
	*** See Page 11				
	**** See Page 11				

* See Page 11

LOCATION & SURVEYS DTM SYMBOLOGY

				Ft 119	
			C	CHA. O	R
<u>LEVEL</u>	ITEM DESCRIPTION	<u>CO</u>	<u>WT</u>	<u>LS</u>	FEATURE CODE
49	HYDROGRAPHY Underwater Breakline (Creek Channel)	9	1	6	4007
50	HYDROGRAPHY				
	Underwater Regular Point	9	1	А	4008
	(Random Points in Pond, Cr	eek, etc	:.)		
51	BREAKLINES				
	Breakline	0	1	3	4005
	Ridgeline	2	2	0	4002
	Drain Line	1	1	0	4003
	Tidal Ditch	1	1	3	4004
	(Bottom of Ditch)				
	<mark>*</mark> Crownline	32	1	1	3008
:	*** Bridge Wing Wall,				
	Head Wall, End Wall	6	3	0	3119
:	*** Pipe: Head & End Walls	6	3	0	3120
	*** Paved Ditch or Gutter	6	1	3	3123
**	*** Any other Regular Breakline	?	?	?	
,	*** See Page 11				
	**** See Page 11				

* See Page 11

PHOTOGRAMMETRY DTM SYMBOLOGY

<u>LEVEL</u>	ITEM DESCRIPTION	<u>CO</u>	<u>WT</u>	<u>LS</u>	
21	BREAKLINES (From Stereo)	5	1	2	
11	DTM POINTS (From Stereo) (These are zero, "0" length l	3 ines)	3	0	
13	DTM POINTS (From Stereo) (These are zero, "0" length l	0 ines)	5	1	

EXCEPTIONS & SPECIAL CASES

In the DTM design file, ONLY these levels are to be used: [3,5,10,20,44,47,48,49,50,51&63] Turn off level 5, this is bridge deck and should not be extracted Turn off level 20,63, these are default symbols and point numbers Any data on other levels is to be deleted.

- # You can not have a "SPOT" and a "BREAKLINE" on the same level. You will need to move SWAMP (feature code 3622) from level 10 to level 50 for Underwater Spot.
- These are Default point symbols that are placed at the ends of lines.
 <u>Do not use levels 20 when you extract Points or Breaklines</u>.
- ** Any other point such as a: tree, power pole, manhole, etc. that you need in your DTM file, you are to move to level 47. You do not need to change the symbol as it was located in the field.
 - *Example:* If you have a tree that you need to put in your DTM file to strengthen that area, simply move that symbol from level 11 to level 47. Again except for the levels listed above there is to be **no** other data in the DTM design file!

Any data on levels: 1,2,4,7-9,12,14-19,22-43,45,46,52-62 is to be deleted. This will remove any doubt from anyone processing this file.

- *** Use the "topo" feature code and move Head, Wing, & End Walls to level 51. This will allow a "true" representation of the area while keeping bridge decks turned off.
- **** Any other Breakline such as: a woods line, fence line, dam, etc. that you need in your DTM file, you are to move to level 51. Do not change the line symbology as it was located in the field.
 - *Example:* If you have a fence line, (that <u>IS</u> a Breakline), that you need to put in your DTM file to strengthen that area, simply move that line from level 8 to level 51. Again except for the levels listed above there is to be **no** other data in the DTM design file!
- * There is either an Elevation placed on level 60 Or a Comment placed on level 61 in the .dtl file. DELETE THESE BEFORE THE FILE IS TRANSMITTED!

If DTM (.dtl) design files are sent in with **any** deviation from the above symbology they **<u>WILL</u>** be sent back to the field office!

DTM PROCEDURES

Now that you have a good *field* DTM file you need to process and check it using GEOPAK. Here is a check list to help you.

A DTM, (dtl) file can contain multiple levels with crossing Breaklines, (e.g. EP's on lvl. 3 that go under a bridge deck on lvl. 5, etc.). You will need to check the "non-ground" DTM's independently.

There are two ways you can process DTM's to create a .dat file.

#1 (See Page 13) You can use GEOPAK SURVEY MANAGER & create a .dat file at the same time you create the planimetric design file. Survey Manager will use the DTM attributes set in the NCDOT?.SMD file. The feature can have a:



*See the feature code sheet for the list of codes that are used.

#2 (See Page 18) You can create a design file with the correct symbology by moving elements to the correct DTM level and extracting by levels under DTM>> EXTRACT

You can use *either* way, but we are responsible for two items:

- **One:** A 3d design, (dtl) file that has the correct attributes. (Elements with correct X, Y, Z position on the proper level & the correct symbology)
- Two: A .tin (tnl) file that has the triangle information of the earth's **surface** that is requested. The .tin file will include Bridge Head Walls and Wing Walls, but not the bridge deck itself. See the DTM Symbology sheets for other features that are **or** are not to be included.

Along with checking the accuracy of **our** field data, the Location & Surveys Unit is also responsible for checking PEF design files. For this reason this manual will cover **both** ways. When we check PEF design files we will need to use "**EXTRACT by LEVELS**".

(USING GEOPAK 98 & TDS software on Husky FS/2)

Example:

"b5000.cgr" is a field file that has EP's on lvl. 3, bridge decks on lvl. 5, & Breaklines on lvl. 51. (Not to mention points.) You can **"double code"** features in the field.

- Example: There is a fence line that runs along the ridge of a hill. Key-in the feature code "**bl*3410** ***bl*4002**" this will start two line features; a Fence line on level 8 and a Ridge-line on level 51. You will need to delete planimetric features in the DTM (dtl) file & DTM features in the planimetric (pml) file. The .dat file will **not** have the bridge decks. You will need to "snap" to the corners of the bridge deck to check their elevation. **Pipes** will no longer be shown in the DTM file.
- I: Open the design file: "b5000_ls_dtl_020411.dgn" using *file Manager*.
- II: Create a ".dat" file. This is for GEOPAK DTM's **not** our old conversion .*dat* file.
- 1. On the command bar choose: Applications>>GEOPAK SURVEY>>PROJECT MANAGER>>



2. To create a new Project, under Project Manager menu bar, choose New:

😤 Project Manager		×			
Projects Directory Ac	dmin				
D:\PDSG\					
Filter: .prj	Type Project				
Projects:	Directories:		Create New Project		
	[]		Project Name	: test1	
	[charlie]		Working Director	, dt/pdeg/tests	
	[geopak]		Working Directory		, iselect.
	[pictures]		Job Number	: 001 Select	Preferences
	[presintations]	-	Project Description:		
Job Number:					
Description:					
			<u> </u>		Cancel
<u>o</u> k	Cancel				

*** Note: The "Preferences" should already be set to: (for English)

GEOPAK User Pi	references		
Distance Decimal	99.1234	Direction	Bearing
Angle Sec. Decimal	9^9'9	Coordinate	NE
Station Decimal	9+99(9).12	 Unit 	English 📑
Station Format	12+34		
Working Directory			Select
<u> </u>	references		
COGO Pr	eferences]		
Superelevatio	n Preferences	Classic	-
<u> </u>		Cancel	
□ <u>S</u> how	this dialog at GEOF	PAK startup.	

(for Metric)

Distance Decimal	99.1234	Direction	Bearing
Angle Sec. Decimal	9^99	Coordinate	NE
Station Decimal	9+99(9).123	- Unit	Metric
Station Format	12+34	-	
Working Directory			Select
<u> </u>	references		
<u></u> 0G0 Pr	eferences		
Superelevatio	n Preferences	Classic	-
<u></u> K		Cancel	
200 - Contraction - Contractio			•

3. Create a new user and the Project menu will appear: Choose SURVEY, Select the File Name and <u>**OK**</u>.

Project Users: test1.prj	×	
<u>U</u> sers		
Project Users:	- User Info	New User
[toynia]	Full Name:	Name: john
	OP Code:	Full Name: john doe OP Code: jd
	<u> </u>	Description:
Description:	Cancel	<u>OK</u> Cancel
ROAD	11.prj X Select <u>Bun</u> SURVEY Descri Untitle	Run ame Time ntitled 04/27/1999 10:16:43 ption ed
		OK Cancel

The Survey Box will come up. Fill in the needed information, the NCDOT?.SMD file will be filled in for you, and Process Survey Data using Network Least Squares. After you "Process Survey" then "Import To Database". When this process is finished you will be able to do any of the "highlighted" functions.

SURVEY PROJECT	[r2606b_311] USER [test] RUN [Untitled]	×
🗋 🖻 🖬 🖶	🔩 🖆 💷 📷	
Data Source Mapping Option Control Code Adjustment Method	DGN File D:\CC\testnewenglish.dgn File SEED File C:\NCDOT_MSJ_WORKSPACE\NCDI File	
✓ Draw Mapping	Points Name / Number Elevation Descrp Label Comment	
	Point Label Re-Mapping : <u>Redraw according to SMD</u>	



4. When you are ready, choose "**Create DTM**". This will prompt you for a ".dat" file. Fill out the name & <u>**Process**</u>

GEOP	AK - DTI	M 200	0	×
<u>S</u> ettings	<u>E</u> xtract	<u>B</u> uild	<u>E</u> dit <u>D</u> rape <u>L</u> oad <u>R</u> eports <u>A</u> nalysis <u>U</u> tilities	
	Graphic XYZ DEM Set For	nat	GEOPAK - Extract Graphics File Name b5000.dat File type Binary File open Create File open Create Feature Breaks Mode Extraction Select Criteria Veights Select Veights Select Match Display Reset	
			Fence VI Apply	
			✓ Curve Stroke Tolerance 0.15000 ✓ Minimum Linear Distance 30.0000	

These are suggestions for English: "Curve Stroke Tolerance" & the "Min. Linear Distance" they can & will vary. Please note these on the transmittal.

After you have created the "**.dat**" file you will need to create Triangles, (see pg. 21) and check the data by displaying **Contours**. (see pg. 25) Check for Crossing **Breaklines**, (see pg. 23) and use **Drainage DTM Tools**, (see pg. 27)

SUGGESTED	"Arc Stroke Tolerance"	'& the "Min. Linear Distance"
Metric:	0.050	10.00 (Meters)
English:	0.15'	30.00' (Feet)

The length of the chord segments can be determined by setting the *Arc Stroke Tolerance.* This distance is used to interpolate new shots from the curved break lines. This value is used as a perpendicular minimum distance from chords generated along the arc. Chords are drawn along the arc and the perpendicular distance is measured from the middle of each chord to the arc. (see figure on following page) If this distance is larger that the Arc Stroke Tolerance, the process is repeated with a shorter chord length. This process is repeated until the end of the curve is reached. The flatter the curve, the fewer number of points will be calculated. The steeper the curve, the greater number of points that will be calculated.



Activate the Stroke Linear toggle if you wish to identify portions of linear elements. The *Minimum Linear Distance* is utilized to interpolate new shots from the linear elements. For instance, if survey data was taken approximately every 50 master units and this distance was set to 25 master units, then a new shot would be interpolated every 25 master units. In this example, twice as many shots would be used to create the DTM in the linear sections of the break lines. Still utilizing our original median nose, the following graphic depicts the generated triangles when the Stroke Linear toggle is activated and the Min. Linear Distance is set to 25. Interpolated vertices have been added whenever the distance between survey vertices is greater than 25 master units.

This is for **"EXTRACTING by LEVELS"** (USING GEOPAK 2001)

Example:

"b5000_ls_dtl_020411.dgn" is a 3d design file that has EP's on lvl. 3, bridge decks on lvl. 5, & Breaklines on lvl. 51. (Not to mention points.) Create a ".dat" file called: "b5000.dat" (for regular features). The .dat file will **not** have the bridge decks. You will need to "snap" to the corners of the bridge deck to check their elevation.

- I: **O**pen "b5000_ls_dtl_020411.dgn" using *File Manager*.
- **C**reate a ".dat" file. II:
 - This is for GEOPAK DTM's **not** our old conversion .dat file.
- 1. On the command bar choose:

Applications >>GEOPAK ROAD >>DTM Tools>> Then press DTM Menu button (top left)

<u>U</u> tilities	Wor <u>k</u> space	<u>Applications</u>	Window	Help		
		GEOPAK		GEC	PAK ROAD Tools	
		GEOPAK R GEOPAK SI	OAD) URVEY)	Eroj Actij GEC	ect Manager ve Chain Control JPAK Element Attrijbutes	•
				<u>U</u> se <u>G</u> eo <u>D</u> es <u>P</u> lar DTN	r Preferences ometry ign & Computation Manager 1s Preparation 4 Tools	•
				3D 1	Tools	
				Cros	ss Sections	
				Utili	ties	•
				Lau	nch Comp Book <u>F</u> orms	
				<u>H</u> elp <u>W</u> el	o b Help	+



You will need to set the Stroke Tolerances *before* you extract the DTM's.

SUGGESTED	"Arc Stroke Tolerance"	& the "Min. Linear Distance"
Metric:	0.050	10.00 (Meters)
English:	0.15'	30.00' (Feet)

2. On the GEOPAK DTM command bar choose:

Extract>>Graphics>> Settings Extract Build Edit Drape Load Reports Analysis Utilities Graphics XYZ DEM Set Format

This is for Random Points:

GEOPA	(- Extract Graphics	×				
File Name	b5000.dat	Files				
File type	Ascii 💌 Dec	cimal 4 💌				
File open	Create 💌		🔁 Le	wel Mas	k	×
Feature	Spots 💌		1	2 3 4	567	8
Mode	Extraction 💌		9	10 11 1	2 13 14 15	16
Select C	riteria		17	18 19 2	0 21 22 23	24
✓ Levels	Select D Stules	Select	25	26 27 2	8 29 30 31	32
			33	34 35 3	6 37 38 39	40
U Weigh	ts Select Types	Select	41	42 43 4	4 45 46 47	48
Colors			49	50 51 5	2 53 54 55	56
Ма	tch Display	Reset	57	58 59 6	0 61 62 63	
Extract				<u>DK</u>	Cancel	
Fence	▼	Apply				

- 3. Under the Extract Parameters pallet:
 - a) Fill in the *File Name* with the correct path & the desired file name. Example: b5000.dat (This will be a new file)
 - b) File Type: Ascii Open: Create
 - c) Decimal: 4
 - d) *Feature Type*: Spots
 - e) *Mode*: **Extraction**

Sele	ct Criteria		
	X	Levels	Select: All levels that have
			Random Points
f)	Extract		
	Fen	ice *	Apply

* Check the Fence area & the Fence Lock. (example: Overlap)

This is for Breaklines:

GEOPAH	(- Extract Graphics	×		
File Name	b5000.dat	Files		
File type	Ascii 💌 Decimal	4 🔽	Level Mask	×
File open	Append 🔻		1 2 3 4	5678
Feature	Breaks 💌 Stroki	ng	9 10 11 12 1	3 14 15 16
Mode	Extraction 💌		17 18 19 20	21 22 23 24
Select C	riteria		25 26 27 28 2	29 30 31 32
I avala	Coloot Colo		33 34 35 36 3	37 38 39 40
IV Levels			41 42 43 44	15 46 47 48
🗌 🗌 Weigh	ts Select 🗌 🗌 Types Sele	ct	49 50 51 52 5	53 54 55 56
Colors			57 58 59 60 6	61 62 63
Ма	tch Display Res	et	OK	Cancel
Extract Fence	▼ Ap	ply		

4. Make these changes Under the Extract Parameters pallet:

a)			
b)	File Type:		Open: Append
c)	Decimal:		
d)	Feature Ty	pe Br	eaks
e)	Mode:		
Selec	ct Criteria		
	X	Levels	Select: All levels that have
			"Ground" Breaklines
f)	Fen	ce *	Apply

* Check the Fence area & the Fence Lock. (example: Overlap) The GEOPAK .dat file is an Ascii file listing points, X,Y,Z.

1	(Spot Point)	1	485069.001	264906	.690	249.	168
1	(Spot Point)	1	485082.293	264845	.329	248.	737
2	(Begin Breakline)	2	485084.950	264825	.962	249.	781

3 (End Breakline)2 (Begin Breakline)3 (End Breakline)

3 485090.389 264802.754 250.371 2 485090.389 264802.754 250.371 3 485086.146 264772.499 249.179 etc.

III: Build Triangles using the ".*dat*" file.

B GEOPAK - DTM	1 2000	×	
Settings Extract	<u>Build Edit Drap</u> Triangles	pe <u>L</u> oad <u>R</u> eports <u>A</u> nalysis <u>U</u> tilities	
	Lattice Merge TINs	GEOPAK - Build Triangles	X
	<u>Clip TIN</u> <u>P</u> ad <u>D</u> elta Surface	Data File : b5000.dat TIN File : b5000_ls_tnl_020411.tin Dissolve Option : Side Side Length : 30.000000 Process	Files

- 1. Under the GEOPAK DTM command bar choose: **Build**>>**Triangles>>**
- 2. Under the BUILD TRIANGLES pallet:
 - a) Fill in the .*dat* filename b5000.dat
 - b) Fill in the *tin* filename Example: b5000_ls_tnl_020411.tin (this will create a *.tin* file)
 - c) **x** Minimize Inserted Break Points
 - d) Dissolve Option: Side
 - e) Side Length: **30** (Length of *interior* triangle legs; change as needed) Process
- **IV**: Check the Triangles using the ".tin" (tnl) file.

	1.	On the Utilit	GEC y >>)PA] Ch e	K DTI eck 1	M bai Fria i	r choos ngula	e: I tion >	·>
and a second sec	GEC	PAK - DT	M 200	D					
I	Setting	is <u>E</u> xtract	<u>B</u> uild	<u>E</u> dit	Drape	Load	<u>R</u> eports	<u>A</u> nalysis	Utilities

GEOPAK - DTM 2000	×
ettings <u>Extract</u> <u>Build</u> <u>Edit</u> <u>Drape</u> <u>Load</u> <u>R</u> eports <u>A</u> nalysis	<u>U</u> tilities
	Convert TIN
	ASCII to Binary
SGEUPAK - Check TIN	Binary to ASCII
Tin: b5000_ls_tnl_020411.tin Files	<u>L</u> heck Triangulation
	Metric<->English
Process	Export Lattice To Trimble DTX

a) Under the CHECK TRIANGLES pallet choose the correct .tin file

and **Process**

If correct, a message will appear: "Triangulation Valid"

2. On the GEOPAK DTM bar choose: **Reports**>>**Triangle Statistics**>>

				0					
GEOP	AK - DTI	M 2000)						×
<u>S</u> ettings	Extract	<u>B</u> uild	<u>E</u> dit	<u>D</u> rape	Load	<u>R</u> eports	<u>A</u> nalysis	<u>U</u> tilities	
						Duplicate	Points		
						<u>C</u> rossing	Features		
						Lattice S	b tatistics		
						Farrice a	dustics		
		E	GE	OPAK -	TIN St	atistics		×	
			Tin	L5000	la hal f	120411 Fin	Files		
				100000	15_011_0	- 1	1103		
			Dec	cimal Poi	nts :j	3 🔻			
				Statistic				-	
			Numb	or Of L	ince ·	oints :			
			Numt	per Of 1	riangl	es :			
			Numt	er Of E	Ireaks	:			
			Numb	per Of C	Contou	rs :			
			Numb	ber Of V	oids :				
			Numb	oer Of L	sianas Ioles ·	12			
			ra canne		TOIGS .) 14		D	
		3	v '	Minimu	n	Maximun	9	nange	
			Ŷ						
			z						
		100							
					P	rocess			

- a) Under the TRIANGLE STATISTICS pallet choose the correct .tin

 (.tnl) file and Process
 It will show the Minimum, Maximum & a Range of X, Y, Z.

 Pay close attention to the "Z" Range!
- 3. On the GEOPAK DTM bar choose: **Report>>Duplicate Points>>**



	🔀 GEOPAK - Report Crossing Features 🛛 🔀
GEOPAK - Report Duplicate Points	Data File : b5000.dat Files Report File : b5000.rpt Files Color Cossing Features Color : 3 Weight : 7 Style : 0 Process

Choose the correct *.dat* file & the *.rpt* file that the report will be in and **Process**

*** NOTE: GEOPAK WILL SHOW THE SAME REPORT FILE NAME WHEN YOU PROCESS THE SECOND REPORT*** THIS WILL OVERWRITE THE PREVIOUS FILE!!!

4. On the GEOPAK DTM bar choose: **Report>>Crossing Features>>**

Choose the correct *.dat* file & the new *.rpt* file that the report will be in. Also choose the symbology that you want to see for the crossing Breaklines and **Process.** Should you have crossing breaklines, all sho

GEOPAK does not apply the side length that you "key-in" to the interior triangles. GEOPAK connects all interior data points regardless of triangle length keyed in. When you triangulate areas that do not connect, GEOPAK will connect them *for* you in the ".tin" file. This *will* cause problems when you display the contours and see contour lines where you did not collect data in the field!!! For now you will need to delete the "bogus" contour lines before you check the others.

Under Edit, you can use Edit Lines and delete the interior side of an exterior triangle and then save the ".tin" (tnl) file.

GEOPAK - DTM 2000)		×
Settings Extract Build	D Edit Drape Load E Triangles Duplicate Points Crossing Features Filter Vertices Join Linear Features Z Range Clip	eports <u>Analysis</u> <u>Utilities</u> Tin Edit Tools Preferences Add Vertex Delete Vertex XY Move Vertex XY Move Vertex Z Polygon Move Z Delete Line Swap Line Insert Break Line Insert Break Line Insert Drape Line Delete Triangle	× ×
		Tin Update Undo To Last Save Save	

Warning: You will find an "Triangles" command under Edit on the DTM menu bar. This will not allow you to delete "exterior triangles" GEOPAK created. The errors you will get when you try" to "Delete Triangle" will be: "POINT IN VOID", "TRIANGLE CAN NOT BE DELETED", or "POINT EXTERNAL TO TIN HULL". There is also a "Clip" command under Build on the DTM menu. You can clip, (interior or exterior) boundaries to create "mini". tin files, but you can not merge ".tin" files that do not connect! So both of these options will NOT work for what Location & Surveys needs to do.

5. **Load** >> **DTM Features** >>

In the **Load DTM Features** pallet; Select the proper ".tin" file and choose "*Triangles*" in the feature window. Next turn on the display switch for the Triangles using the "light bulb" toggles to the right of the features window and set the symbology you want on bottom of the window and **Load**. You do not need to write them to your design file. (.*dtl*)

Sollingo Eutroph D	ild Edit Drapa I.a	Depa	uto Anol	LARS FIGHT			
Settings Extract Br	wa <u>Fak D</u> iahe To	an <u>P</u> ehr	ins Anal	iysis <u>O</u> ullu	es		1.1
	<u>D</u>	I M Feat	ure				
	GEOPAK Load	DTM Fea	itures				>
	Eile						
	Level File TIM	- 10-23	LE000 L.	N.L. 000411	No.		
	Load File TIN	 III 0: V 	DOUDO_IS_	(ni_020411.	an	Files	Load
	Display Prefer	ences				<u></u>	
	Display Prefer	ences	🔽 Displa	ay Only 🔽	Graphic 6	àroup	
	Display Prefer	ences	🔽 Displa	ay Only 🔽	Graphic C	àroup	
	Display Preference Load For Fene	ences	Displa	ay Only 🔽 Weight	Graphic 0 Style	àroup Display	
	Display Prefer Load For Fence Feature Triangles	ences	Color 2	ay Only 🔽 Weight 0	Graphic 0 Style 0	àroup Display ON	
	Display Preference Load For Fenere Feature Triangles Tin Hull	ences ce Level	Color 2 1	ay Only 🔽 Weight 0 0	Graphic C Style 0 0	àroup Display ON OFF	- - -
	Display Prefer Load For Force Feature Triangles Tin Hull Contours	Level	Color 2 1	ay Only 🔽 Weight 0 0	Graphic C Style 0 0	Display ON OFF OFF	- - - -
	Display Prefer Load For Fence Feature Triangles Tin Hull Contours Major Lines	Level	Color 2 1 3	ay Only 🔽 Weight 0 0	Graphic C Style O - 0	àroup Display ON OFF OFF OFF	
	Display Prefer Load For Fend Feature Triangles Tin Hull Contours Major Lines Major Label	Level	Color 2 1 3 4	ay Only 🔽 Weight 0 0 0 0	Graphic C Style 0 0 0	àroup Display ON OFF OFF OFF OFF	
	Display Prefer Load For Fend Feature Triangles Tin Hull Contours Major Lines Minor Lines	ences <u>Level</u> 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Color 2 1 3 4 5	ay Only ☑ Weight 0 - 0 0 0 0	Graphic C Style 0 0 0 0 0	Display ON OFF OFF OFF OFF OFF OFF	

If you want to write the triangles into the design file turn "**Set Graphic Group**" on & "**Display Only**" off. Checking "Set Graphic Group" allows you to delete all triangles at one time.

Note: You must have "Graphic Group" lock on in MicroStation.

6. Load >> DTM Feature >>

In the **Load DTM Features** pallet; Select the proper ".tin" file. Before you can display the contours you must **Read**. This will show the *Range* of elevation. Highlight "*Contours*" in the feature window and turn on the display of each type of contour wanted with the light bulb icon to the right of the window. Set the Major & Minor contour interval. This will vary on the terrain. Depending on the contour interval, you can get overlapping contours using the *Smooth Contours* option. This is graphically, *not* internally. It is recommended that you use "*Display Only*" first to adjust the contour interval, text height, and symbology. Once you are satisfied with your settings, Toggle off "*Display Only*": Choose the symbology you want and **Load**

8 GEOPAK - DTM 2000			>	<			
<u>Settings Extract Build Edit Drape</u>	Load <u>R</u> eports <u>A</u> nalysis	Utilities					
	<u>D</u> TM Feature			-			
	GEOPAK Load E)TM Fe	atures				×
	Eile						
	Load File TIN	▼ [d	\b5000_ls_tr	I_020411	.tin	Files	Load
	Display Preferen	nces				<u> </u>	
	Load Extent	•	🔽 Display	Only 🔽	Graphic G	roup	
	F .		C 1		C1 1	D: 1	
	Feature	Level	Lolor	Weight	Style	Display	
	Contours	12	25)	-	12	ON	수업
	Major Lines	1	3	0	0	ON	et
	Major Label	1	4	0	0	ON	
	Minor Lines	1	5	0	0	ON	$-\mathbf{v}$
	Minor Label	1	6	0	0	OFF	9
	Spots	1	7	0	0	OFF	-
	E.	N	finor Interval	5.000	Major Ir	nterval 2	0.000
	🗌 🔲 Smooth Contou	rs	Registration	0.000	Minimur	n Area 🛛 🛛	.000
	Range 🔻 Minir	mum Z	0.000	Maximu	m Z 0.000		Read

CHECKING DTM's



Check the contour lines and look for anything **different**. Such as erratic lines in a plowed field or road, or a "thumb print", (shown above) where contour lines are irregular. "Spikes", (shown below) may occur when contour lines connect to one shot with different elevations. These are usually caused from a **bad rod height**.



Breaklines, such as the crown line and edge of pavement lines, should be viewed through the profile tool to check that the breakline information was collected correctly.

SECOPAK - DTM 2000	×
<u>Settings</u> <u>Extract</u> <u>Build</u> <u>Edit</u> <u>Drape</u> <u>Load</u> <u>Reports</u>	<u>Analysis</u> <u>U</u> tilities
GEOPAK Site Profile	Height Profile
Selection Profile Preferences	Volumes <u>E</u> levation Differences
Select Element Place Element Place Profile Curve Stroking 0.000	<u>S</u> lope Area <u>T</u> hemes
Extracted Profile View	Drainage Tools
]

The profile tool can also be used to cut random cross sections to check the DTM's collected around roads and creek.

Selection Prol	ile Prefer	ences			
Select Element	ile View	ementi Place Pro	ofile Curve	e Stroking 0.1	000
12.373		_			
		\sim			_
	M			\checkmark	
10.741	V		26		86,702
A1750213					

Other Options for checking DTM's

Analysis >> **Drainage Tools** >>

There are several tool boxes that can help you in the checking process. "Delineate Sump Lines" and "Delineate Ridge Lines" will help along with the "Delineate High Points" & "Delineate Low Points". The "Trace" options will help you to check the flow of streams and creeks. Remember to delete **all** of these checks before the file is transmitted.

8 GEOPAK - DTM 2000		×
<u>Settings Extract Build Edit Drape Load Reports</u>	<u>Analysis</u> <u>U</u> tilities	27,52
CEOPAK Drainage Patterns	Height Profile Volumes Elevation Differences Slope Area Themes Drainage Tools Visibility	

Analysis >> Height>>

In the **Height** tool pallet; Select the proper ".tin" (.tnl) file and data point within the tin Hull. This option will show the X, Y, Z, Slope & Aspect at the data point location.

GEOPAK - DTM 2000	×
<u>Settings</u> <u>Extract</u> <u>Build</u> <u>Edit</u> <u>Drape</u> <u>Load</u> <u>Reports</u>	Analysis Utilities
	<u>H</u> eight
🔀 GEOPAK Height 🛛 🔀	<u>P</u> rofile
	<u>V</u> olumes
TIN File d:\b5000_ls_tnl_020411. Files	Elevation Differences
Options	<u>S</u> lope Area
Show Contour	Themes
🗖 Show Triangle 🔄	<u>D</u> rainage Tools
Show Flow Arrow	⊻isibility
Cursor Point Values	
X:	
Y: 7.	
Slope :	
DP Draw Dynamic	

Build >> Lattice >>

You can build a lattice ".lat" file that will place points within the hull of the triangles. You can then **"Load" 'DTM Features**" the .lat file & then rotate the views to show the ground surface.

Warning!!! Depending upon the size of the area this can take up a lot of memory, 10meg. easily. When you display the .lat file it will take a long time, up to 10 minutes...Keyin the ".lat" file and Process

😤 GEOPAK - DT	M 2000	×
Settings Extract	<u>Build</u> <u>E</u> dit <u>D</u> r	ape <u>L</u> oad <u>R</u> eports <u>A</u> nalysis <u>U</u> tilities
	<u>T</u> riangles	
	<u>L</u> attice	GEOPAK - Build Lattice
	<u>M</u> erge TINs <u>C</u> lip TIN	TIN File : site.tnl
	Pad	LAT File : site.lat Files
	Delta Surface	Interpolation : Planar Lattice Option : Set
		Lattice Intervals X Interval : 0.000000 Y Interval : 0.000000 X Register : 0.0000000 Y Register : 0.000000
		Process

If you have "curb & gutter" areas to check *Keyin* a small "X, Y" interval Example: (0.1)Metric, (0.3') English in the X & Y. This will show the "curb & gutter" in the model.

EDITING DTMs

There are several procedures to follow for processing survey data to obtain a final DTM, however we will discuss only two. One way is to let the (*.smd*) file sort through the collected data and determine what is and what is not to be considered in the DTM. This method is the easiest but limits the flexibility of choosing which topo features need to be included in the DTM (e.g. Bridge Decks and Top of Rails). This procedure is described on pages 12 -17. The other way is to obtain a 3D design file (*.dtm or dtl*) and create the needed (*.dat*) file by **extracting by levels.** This method is a little more rigorous but is necessary to achieve maximum efficiency in the "field to finish" procedure. This procedure is described on pages 18 - 21.

The 3D design file (.*dtm* or *dtl*) is the control file for creating the (.*dat*, .*tin*, .*lat*, .etc. ...). Therefore it seems necessary to edit DTMs by editing this Microstation design file. Using this as the control file also makes it easier to merge additional data, to edit Breaklines, to modify points, and to massage the whole DTM by graphically manipulating elements using Microstation commands (*move, copy, tentative, modify, extend, AZ=, LV=,* .etc. ...). It is possible to edit the (.*tin* or *tnl*) files or the (.*dat*) file, but this is a one time deal. If there is additional data needed or other major problems found in the DTM all edits must be redone after reprocessing. If at all possible, edit the .RW5 file and reprocess the file again. This will allow you to reproduce the DTM design file if needed.

Editing the 3D design file using Microstation commands is an acquired skill. Try experimenting with a 3D design file using the different commands above. Try moving some point symbols, modifying some Breaklines, changing active elevation (AZ=), changing levels (LV=), and extending lines. Pay close attention to what the *data* and *tentative* buttons do to the location of modified elements in conjunction with the active elevation. Use the following command to check your results

(X, Y, Z or E, N, Elev.) : set tpmode locate

When you are satisfied that your DTM file is "valid", **check it again!** Before you transmit the 3d design file you will want to "clean it up".

- 1. Compress the design file. (Microstation compress)
- 2. "Fit all" in top view & save settings.

View each level and delete what is not from the field. The DTM file should contain Breaklines, Ridgelines, Drainlines, Regular points, etc., No Contour lines, Water Drainage lines, or Triangles! Since this standard is Unit wide, you do not need to attach a note in the file as you have had to do in the past. Other departments will know that any EP's collected will be on level 3 & level 3 ONLY!!!

Location & Surveys will be transmitting ".tin"(tnl) files. The tnl and dtl will be forwarded to Photogrammetry or the Roadway Design Unit. This "**tnl**" file should represent the surface of the earth. The "**tnl**" that is sent in should not represent structures such as bridge decks. The file should include under water elements.

You will need to fill out the transmittal stating (1) Stroke Tolerance, (2) *Minimum Linear Distance* and (3) which *Dissolve Option* you used along with the (4) *Side Length*. This can vary from job to job.

GEOP	AK - DTI	M 200	D						×
<u>S</u> ettings	Extract	<u>B</u> uild	<u>E</u> dit	<u>D</u> rape	Load	<u>R</u> eports	<u>A</u> nalysis	<u>U</u> tilities	
<u>S</u> troking]								
	8	DTM S	itroki	ng Opti	ons	5	×		
		Curve	Strok	e Toler	ance	0.15000			
		Minim	um Lir	iear Dist	ance]	30.0000			

⇒ The **Naming Conventions** for Location & Surveys are as follows:

For a DTM file;	Example: b50	00_ls_dtl_020411.dgn
For a tin file;	Example:	b5000_ls_tnl_020411.tin

DEFINITIONS

REGULAR POINT A collection of random points with no implied relationship between each other.

SPOT ELEVATIONS Basically the same as regular points, the only difference since the points are usually taken at Local High & Low points. (Top of hills, Bottom of depressions, etc.)

BREAK LINES A collection of points having an implied Linear relationship. If connected, they would create a line that follows a sudden change in a surface slope. Triangle lines will not cross the Breakline. (Top of ridge, Bottom of ditch, etc.)

DTM file (**dtl**)A 3d design file that contains (x, y, z) intelligence. It
can include: Regular Points, Spot Elevations, and
Breaklines. A DTM file is a graphical
representation of "Real Ground" terrain.

.tin file (**tnl**) A binary file that contains triangle intelligence. The (x, y, z) position of the end of the triangle points along with the slope and aspect of each triangle.

- *.lat file* Lattice models are grid meshes that are draped over triangulated data.
- *.dat file* The .dat file is a file that contains the number of vertices at the point, and the X, Y, Z of the vertices in the dtl file. The data in the .dat file is either binary or ASCII format.