SOFTWARE VALIDATION TEST PLAN AND REPORT
ArcView GIS®, Version 3.3
and
Spatial Analyst Extension®, Version 2.0a

Prepared for

U.S. Nuclear Regulatory Commission
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1 SCOPE

ArcView GIS® 3.3, developed by Environmental Systems Research Institute®, Inc. (ESRI®), is a geographic information systems (GIS) software product that allows the user to author, visualize, analyze, query, map, and organize geographic information. The extensions/utilities that will be validated in this test plan and report are Import71, Projection Utility, Spatial Analyst®, Geoprocessing, Import Data Source, Export Data Source, Add XY, Data Query, Grid to XYZ Text file, and Field Calculation. These products cover limited functionality as listed below.

Geographic Analysis
Data Conversion
Data Editing and Compilation
Data Management
Visualization
Geoprocessing

The software validation test plan and report of ArcView GIS® 3.3 should confirm that the software can correctly perform the above-listed functions with original data, maintaining geospatial relationships and coordinates. This list of extensions is a subset of the entire list of extensions available. It was chosen as a representative sample of commonly used functions necessary for processing data from start to a finished product.

2 REFERENCES

Environmental Systems Research Institute, Inc. "Using ArcView GIS." Redlands, California: Environmental Systems Research Institute, Inc. 2002.

———. "ESRI GIS Mapping Software ArcView 3.x." Redlands, California: Environmental Systems Research Institute, Inc. <http://www.esri.com/software/arcview/arcview3x.html> (February 2, 2006a).

———. "ArcView 3.x Brochure." Redlands, California: Environmental Systems Research Institute, Inc. <http://www.esri.com/library/brochures/pdfs/arcgisbro.pdf> (February 2, 2006b).

Texas Natural Resources Information System (TNRIS). "Helotes Data. USGS Digital Elevation Model Data. Scale: 1:24,000. <http://www.tnris.org/index.htm> (February 2, 2006).

———. "Helotes Data. TXDOT 015 Urban Files, Bexar County. 2002. <http://www.tnris.org/index.htm> (February 2, 2006).

———. "Helotes Data. TXDOT 010 Urban Files, Bandera Country. 2002. <http://www.tnris.org/index.htm> (February 2, 2006).

3 ENVIRONMENT

3.1 Software

ArcView GIS 3.3 is a commercially developed software application by ESRI for advanced GIS mapping and analysis. ArcView GIS "can use data from virtually any source and across most

popular computing platforms." (ESRI, 2006b) The following ArcView extensions are required to perform validation testing activities:

ArcView 3.3 has the following software extension/utility applications:

- Geoprocessing
- Add XY
- Import Data Source
- Export Data Source
- Grid to XYZ Text file
- Projection Utility
- Spatial Analyst
- Import71 Utility
- Data Query

Operating System: Microsoft® Windows® 2000

3.2 Hardware

- CPU speed of 1.0 GHz or higher
- Pentium or higher processor
- 24 MB or higher memory/RAM
- 200 MB minimum swapspace
- 171 MB free disk space

4 PREREQUISITES

Running ArcView GIS 3.3 requires installation of the commercially available software, per the developers' User's Manual.

5 ASSUMPTIONS AND CONSTRAINTS

The user of ArcView GIS 3.3 is assumed to be familiar with GIS and geospatial data sets.

Data supplied for this software validation plan and test are available for download from Texas National Resources Information System website. Metadata for each set of data are contained in the individual data file folders on the attached CD of downloaded data. All data compressed in ZIP files have been uncompressed for use in this software validation test.

6 TEST CASES

The test cases described in this section involve extensions that provide the user specialized GIS functionality. The number of extensions and/or scripts available is not limited to those used here, because some are provided with the software or can be created as needed by users or ESRI, and are available to the public on the ESRI website (http://arcscripts.esri.com/). Some extensions ESRI sells are separate products that expand the capabilities of GIS processing and analysis. ArcView Spatial Analyst, is one of these specialized software packages used in this limited validation. Each test covers one or more extensions or utilities. All extensions and

utilities used in the test are provided with the ArcView GIS 3.3 software package, except ArcView Spatial Analyst. All tests combine to make a GIS project. The tests involve locating, managing, creating, editing, geoprocessing, displaying, querying, and viewing raster and/or vector data.

6.1 Test Case 1 – Workspace, Manage Data, Create and Edit Vector Data

ArcView GIS is employed to organize, find, and use GIS data. ArcView contains a comprehensive collection of geoprocessing functions including tools for data conversion, data management, coverage processing, vector analysis, statistical analysis, and geocoding.

6.1.1 Objectives

- Demonstrate that ArcView GIS can be used to set the working directory for the project, search for and discover GIS data on the local network, create and edit GIS data on the local network, and manage the data.
- Demonstrate that ArcView GIS functions correctly convert, process, and prepare data for use with other ArcGIS products.

6.1.2 Test Input

(1) HELOTES - DEM, 2998270g.dem
(2) BEXAR - TxDOT Urban Data, urban015_dd.e00
(3) BANDERA - TxDOT Urban Data, urban010_dd.e00

6.1.3 Test Procedure

(1) Open ArcView GIS 3.3.and open a new **View**.

(2) Under **File**, select **Set Working Directory** (Figure 1a).

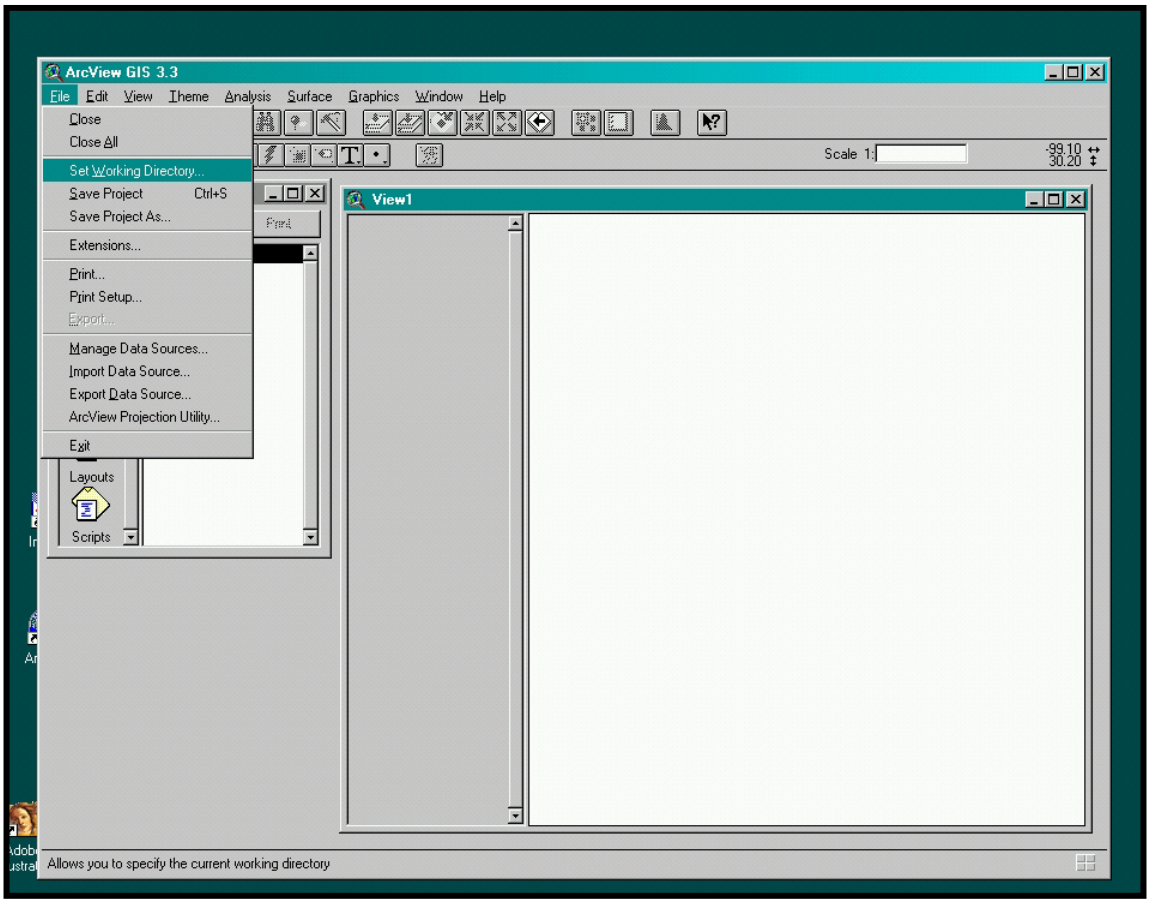

Figure 1a. Set Working Directory

A window opens showing the location where newly created data and temporary files will be saved. The default location is the ***Temp*** file where ArcView GIS is installed (Figure 1b).

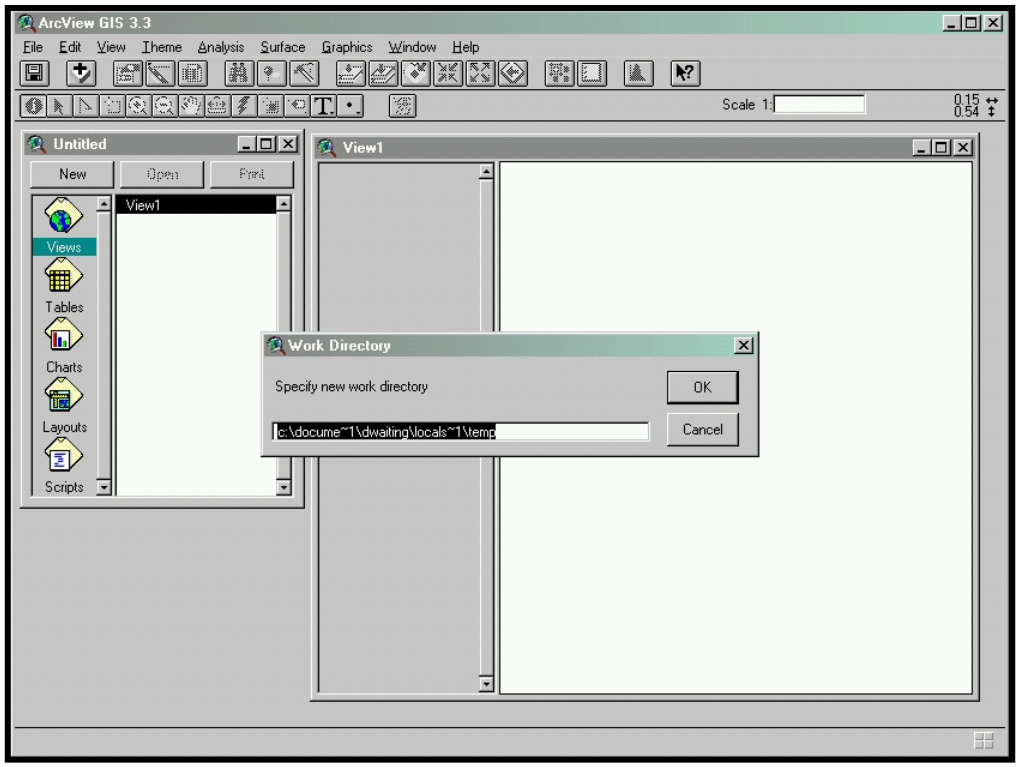

Figure 1b. Default Directory

Change the location to the **data_gis_validation** directory.

(3) Using the **Add Data** button, search for the location of the data listed in Test Input, Section 6.1.2.

ArcView GIS does not recognize the file formats having the extensions *.dem* and *.e00*. These files will have to be converted to formats that ArcView GIS recognizes. The conversion will be done using the Import Utility, **Import71** or **Import Data Source**, in the following steps.

- Use the standalone **Import71 Utility** to convert the ArcINFO interchange files to ArcINFO coverages compatible with ArcView GIS. The utility is part of the ArcView Program group that is shipped with ArcView GIS 3.3.

  Open the **Import71 Utility** in the ArcView program group by clicking on the Microsoft Windows Start icon on the standard toolbar. Select **Programs > ESRI > ArcView GIS > Import71** (Figure 2a).

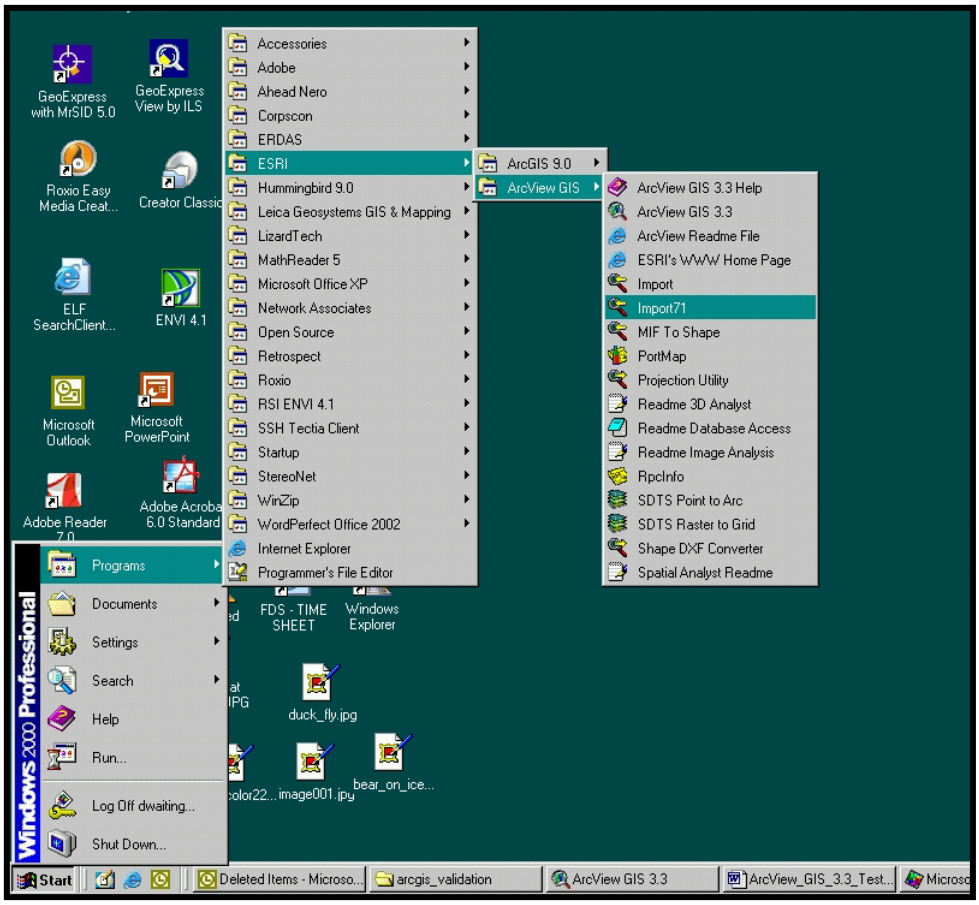

Figure 2a. Path of Import71 Utility

- Use the **Import71 Utility** dialog window to browse to the location of the **TxDOT** files, and select the **ArcINFO Interchange** file (.e00) for the **Bexar/Helotes TXDOT Urban Data** (urban015_dd.e00) as the **Export Filename**.
- Click **OPEN**, then use the **Output Data Source Browse** to indicate the directory location. When you click on the **Browse** button, the path defaults to the directory of the import file. The imported file will be saved in the **tx_dot_a** folder (Figure 2b).

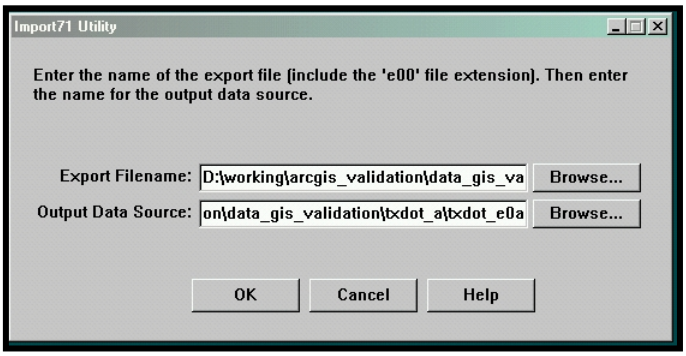

Figure 2b. Import71 Utility Dialog Window

- In the **Import Utility Window**, name the *urban015_dd.e00* file *txdot_e0a* (Figure 2b). When the process is complete, you will receive a message showing the path and whether the conversion is complete. Click **OK**.
- Repeat this import procedure for the *Bandera urban010_dd.e00* file. Save the file as *txdot_e0b* in the **txdot_b** folder.

In ArcView, use **Import Data Source** to import the Digital Elevation Model (DEM) into ArcView GIS. **File > Import Data Source > USGS DEM**.

- Open the **File Menu**, select **Import Data Source**, and then select **USGS DEM** (Figure 3a).

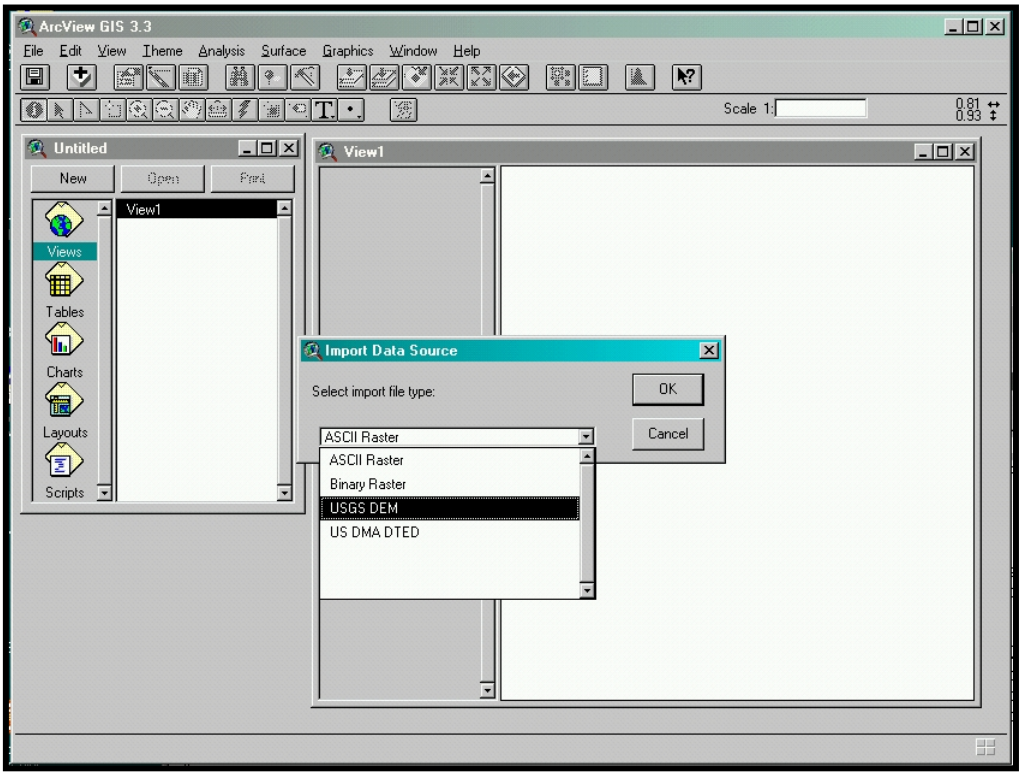

Figure 3a. Import Data Source Dialog Window

In the **Import USGS DEM** files window, select the file *2998270g.dem* in the **helotes_DEM** directory in the *data_gis_validation* directory as the **USGS DEM** input file.

- ArcView should have defaulted to the **data_gis_validation** directory as set in Test Procedure 2 above. In the **Output Grid Window**, name the output grid file *helotes_dem* and save it in the **helotes_DEM** folder in the *data_gis_validation* directory (Figure 3b).

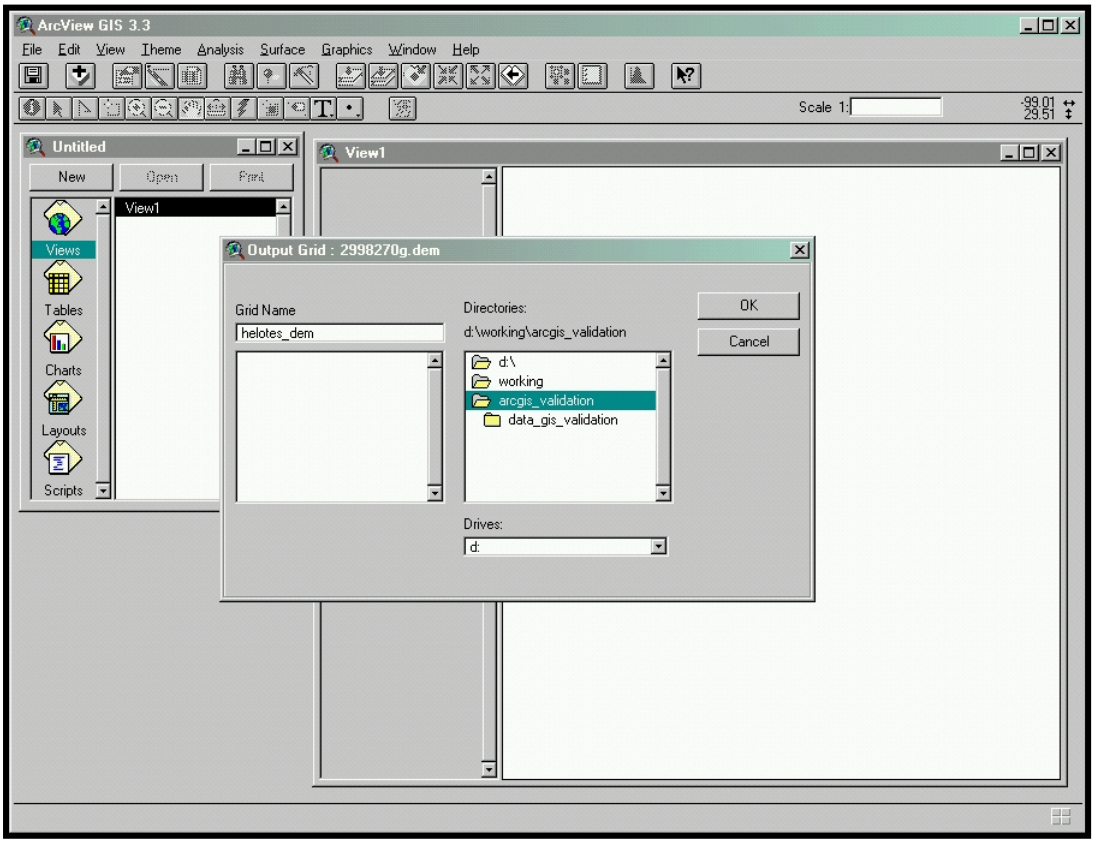

Figure 3b. Defaults to Work Directory

- When the **Import Data Source Dialog** window displays "Add grid as theme to View?" click on **Yes**.

(4) When ArcView opens a grid file in the **View Window**, it defaults to nine classification bins based on the value of each grid cell, plus a "no data" class. The classification bins are represented by a graduated color ramp where the darkest color is assigned to the highest number (Figure 4a).

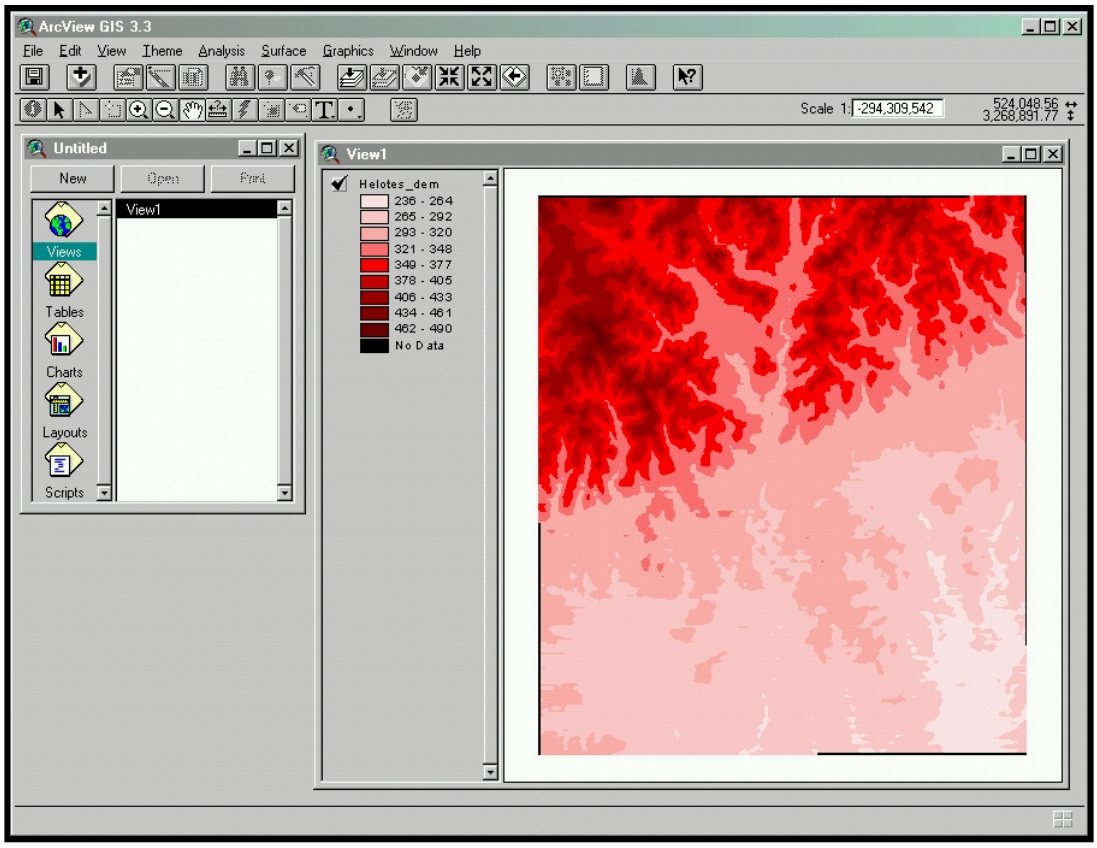

Figure 4a. Grid Default Settings

(5) Using the **Legend Editor**, the number of classification bins can either be increased to show more detail or decreased to show less detail. The color ramp can be replaced to a grey scale where the highest elevation will be represented by the lightest color.

- Reclassify the grid and revise the color ramp.
  - Double-click on the theme name (*Helotes_dem*) in the **View's Table of Contents** (**TOC**) to open the **Legend Editor**.
  - Click on the **Classify Button** and change the number of classes to 12; click **OK**. The **Legend Editor** now represents the values separated into 12 classification bins. Update the **View** by clicking on **Apply** in the **Legend Editor** (Figure 4b).

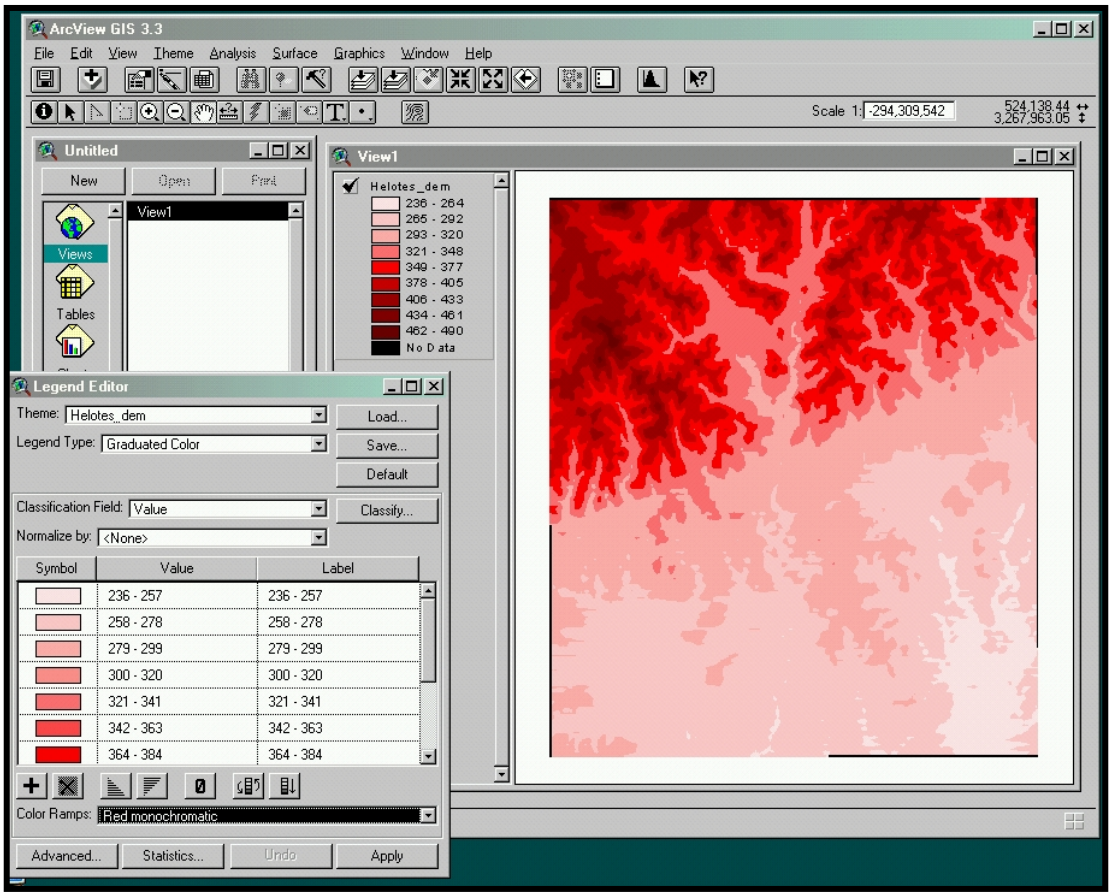

Figure 4b. Edit Grid Classification Bins

- In the **Legend Editor**, click on the **Color Ramps** drop-down menu and select grey monochromatic, then click on the ramp button above the **Color Ramps** menu (arrow in Figure 4c) that has two arrows indicating top to bottom and bottom to top to switch the colors of the ramp (Figure 4c).

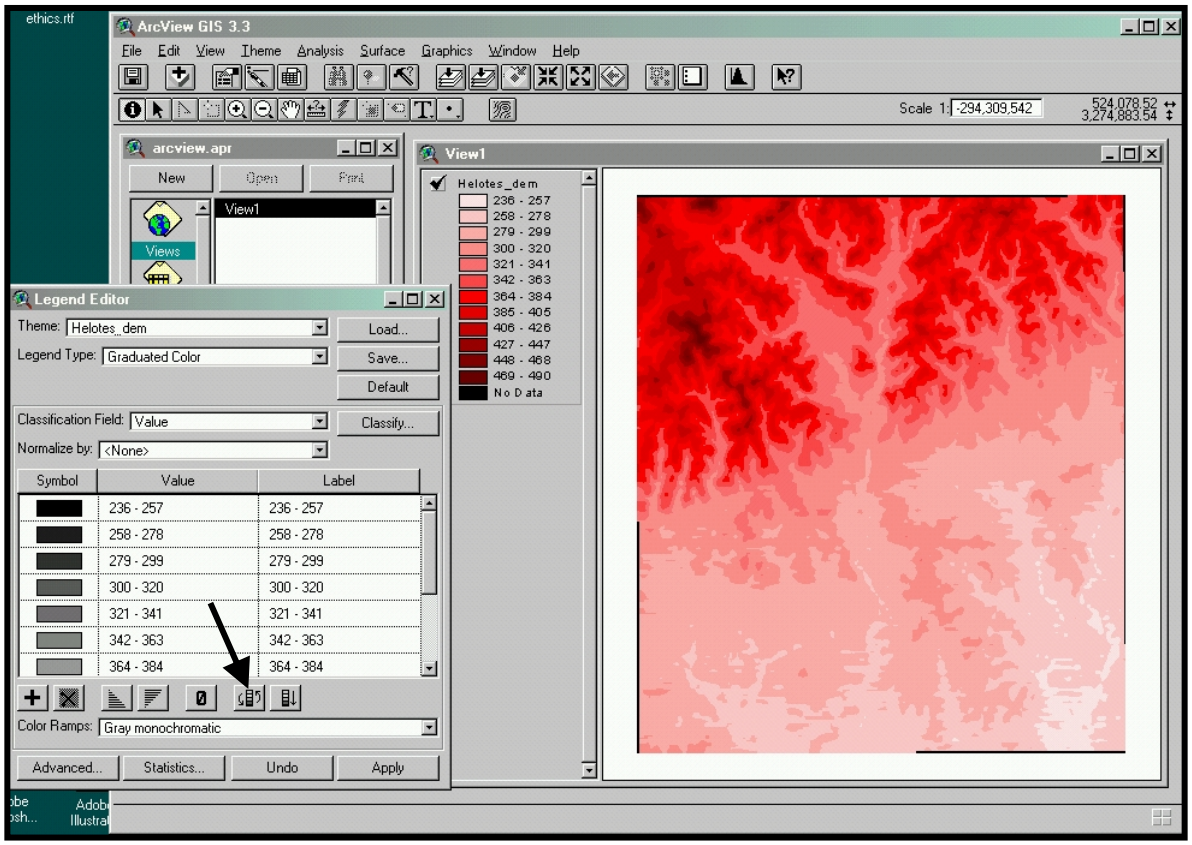

Figure 4c. Alter Color Ramp

- Click **Apply** to accept the changes, and notice the DEM grid where dark areas are low elevations and light areas are higher elevations. Close the **Legend Editor**.

- Verify the *helotes_dem* file location by clicking **Add Theme** button with the **Data Source Types** set as **Grid Data Source** and locate the *helotes_dem* file. The source of the data can also be checked in **Theme > Properties**.
  - Click on the *Helotes_dem* theme in the **TOC** to make it active, if it is not already.
  - Click on the **Theme Properties** button. The path of the **Source** should be the path to the location of the grid file. Notice the other information about the grid that is available in this window (Figure 5).

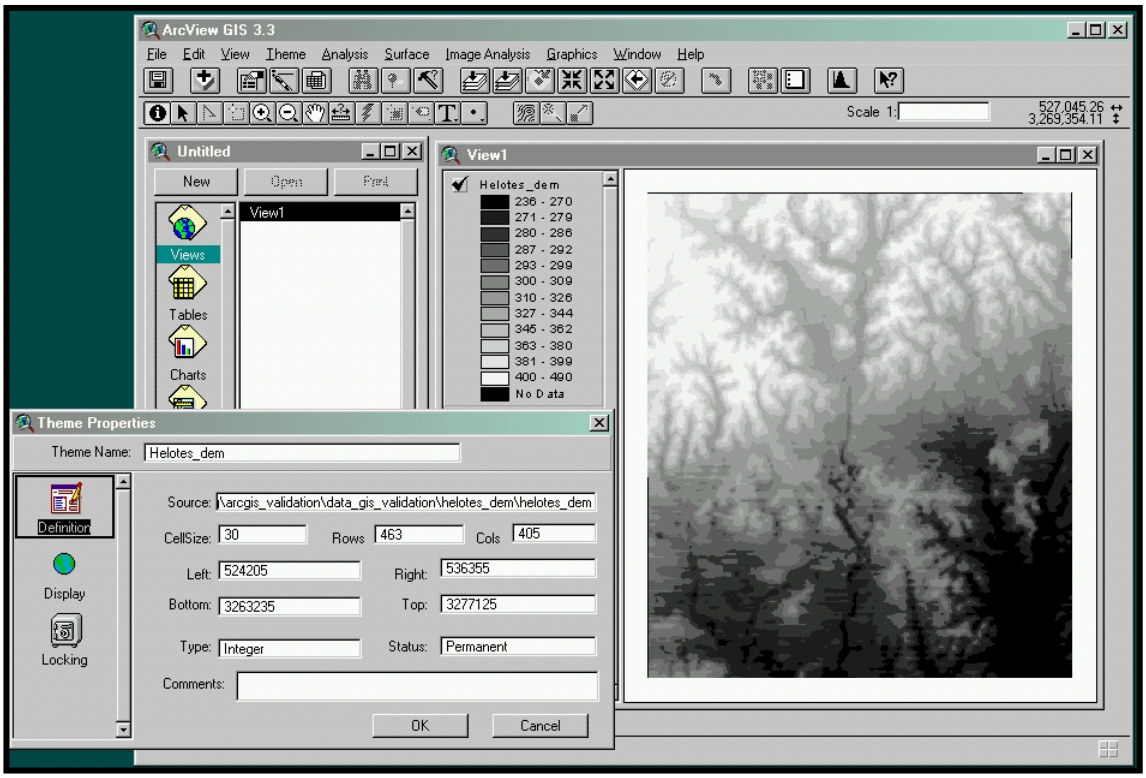

Figure 5. Theme Properties > Source

- Close the **Theme Properties** and uncheck the *Helotes_dem* box in the **View TOC**.

(6) Create a new shapefile (*highways.shp*) from the **ArcINFO coverage** *txdot_e0a*, use the **Build Query Tool** to create another new shapefile from *highways.shp* containing only the **General Feature of Highway** (*bexar_hwy.shp*), edit the *bexar_hwy* shapefile to remove highway segments, and add **XY Data** to the **Highway Attribute Table**.

- Create a **Shapefile** from an **ArcINFO** coverage.
  - From the **txdot_a Directory**, select the **ArcINFO** coverage*, txdot_e0a* and open in the **View**.
  - With the *txdot_e0a* coverage active in the **View TOC**, select **Theme > Convert to Shapefile**.
  - The **Convert Txdot_e0a Window** opens to the **Work Directory** (data_gis_validation) with a default shapefile, *theme1.shp* (Figure 6).
  - Name the shapefile *highway.shp* and click **OK**.

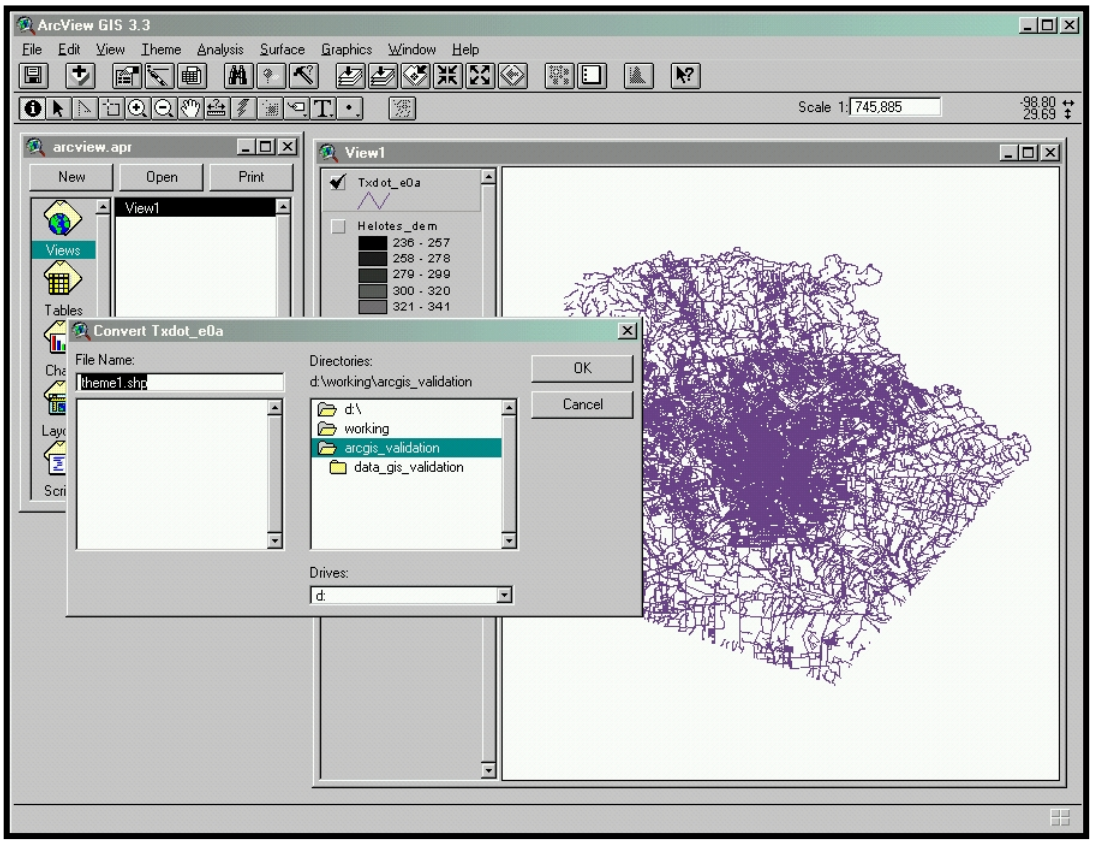

Figure 6. Convert to Shapefile Default Path

- When the conversion is complete, the **Convert to Shapefile Message Window** will ask whether you want to add the new theme to a **View**. Select **Yes**.
- *Highway.shp* has been added at the top of the **View TOC**. Check the box to make it visible. It should completely overlap the **ArcINFO** coverage.
- Having the *highway.shp* theme active, select **Theme > Properties** to check that the saved location of the new theme is the same as the selected location.
- Deselect the **ArcINFO** *txdot_e0a* coverage to make it invisible.
- Insure the *highway.shp* theme is active, and click on the **Open Theme > Table** button. The **Attribute Table** for *highway.shp* will open.

(7) Use a query expression (**[Feature_general] = "Highway"**) to select features by attribute: **Query Builder > Select from Set > New Set > Save as Shapefile.**

- Click on *highway.shp* in the **TOC** to ensure that it is active.
- Click on the **Query Builder** button. The query can be built by clicking on fields, by clicking on operators and values, or by typing it in. From the **Fields** list, double-click on [**Feature_general**]. Click on the equals operator (=) and then type in "**Highway**" with the quotation marks.

- Click on **New Set**. The records meeting the expression criteria will be highlighted in the **Attribute Table** and will be selected in the **View**.
- The number of records selected is displayed in the table's tool bar (arrow, Figure 7a).

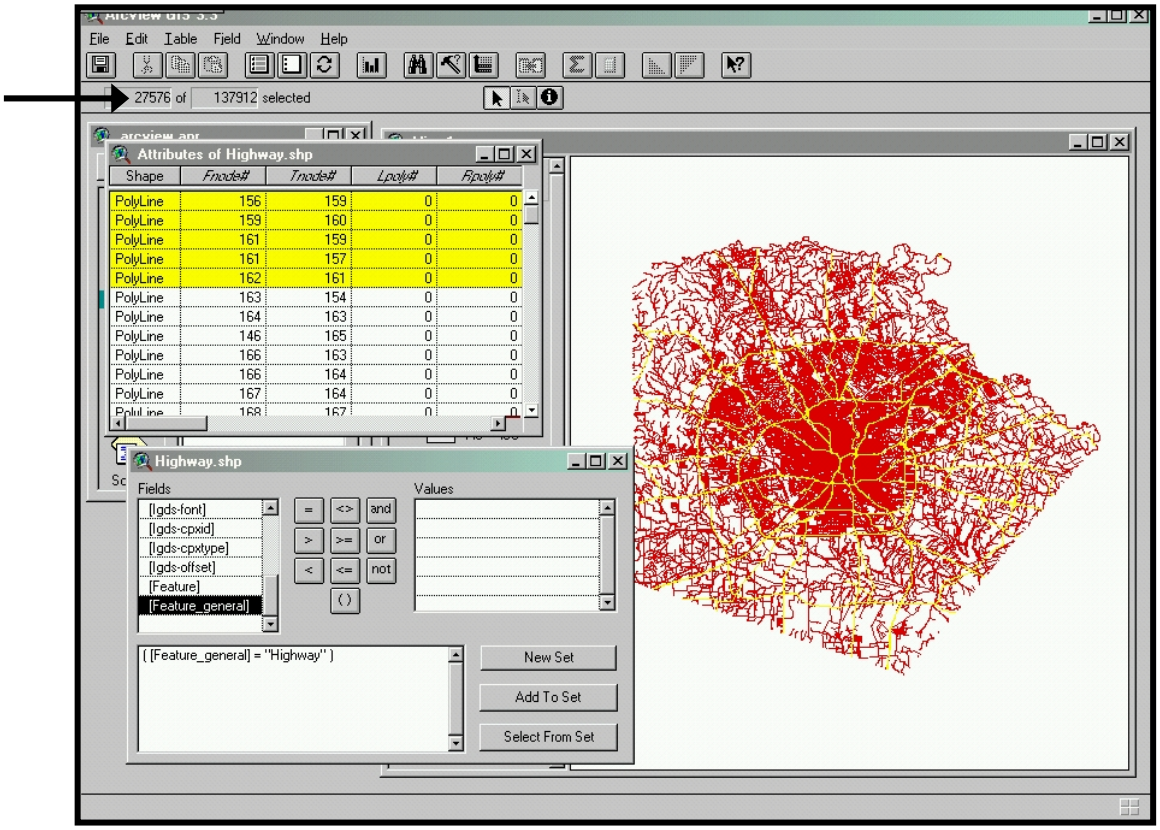

Figure 7a. Query Builder Dialog Box

- Confirm that only **Highway** in **Feature_general** is chosen. Make the **Attributes of Highway.shp Attribute Table** active. Click on the **Promote** icon (arrow directed upward, next to **Query** button). Use the **Attribute Table** scroll bars to view the **Feature_general** field (Figure 7b).

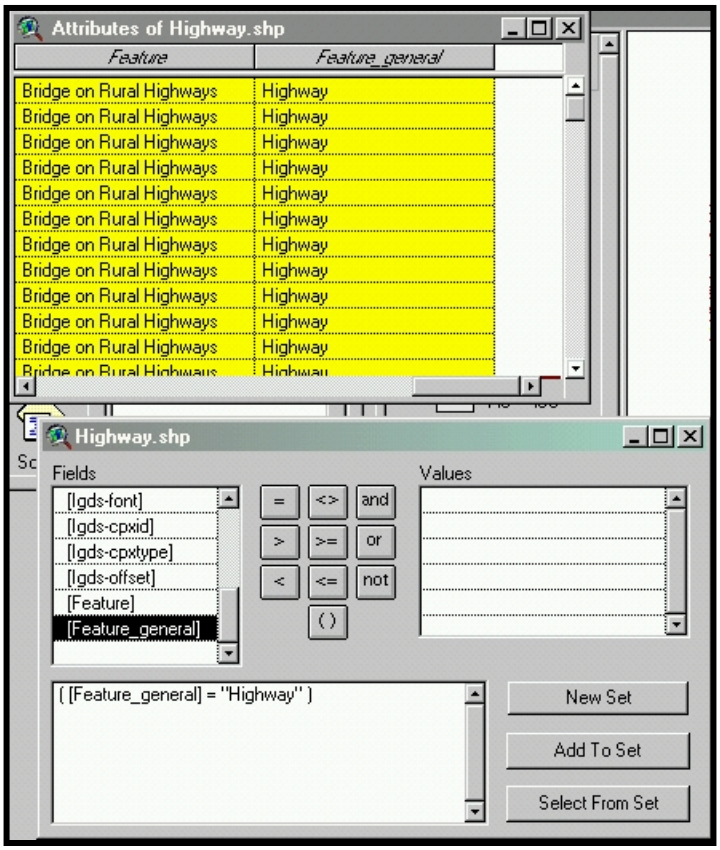

Figure 7b. Verify Selected Feature Information

- Close the **Query Builder Tool** and make the **View** active. In the **Theme** menu, select **Convert to Shapefile**. Save the file as *bexar_hwys.shp* in the *data_gis_validation* directory, click **OK**, and add to the **View**.
- Open the **Attributes of bexar_hwy.shp** table and scroll through to see that the **Feature_general** field is only **Highway**. Click on the *bexar_hwy.shp* name in the **TOC**; use the **Identify** tool to select a section of highway in the view, and review the information in the **Results** window (Figure 7c).

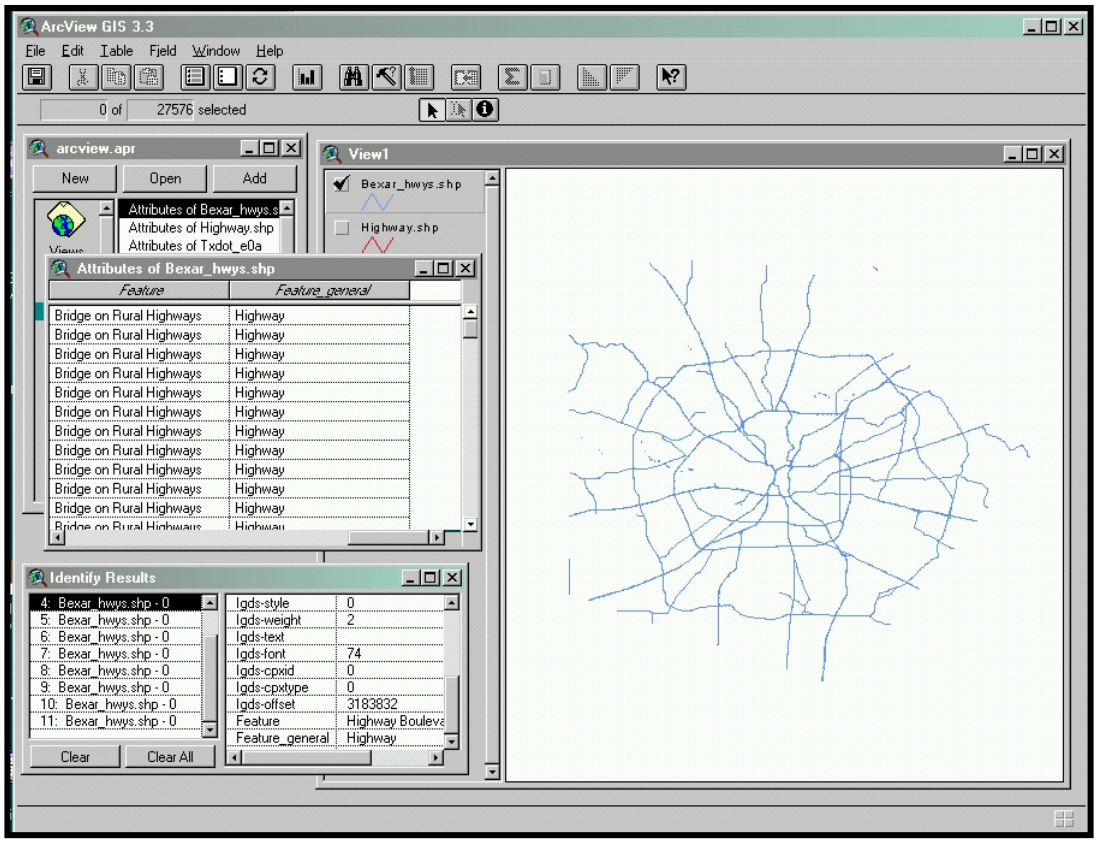

Figure 7c. Identify Tool to Verify Feature Information

(8) Edit **Theme** to remove disconnected features. **Theme > Start Editing > Select Feature > Stop Editing > Save Edits.** Use **Add XY** extension to add x and y coordinates to a theme's **Attribute Table**.

- *Bexar_hwy.shp* theme should be active. Keep the theme **Attribute Table** open.
- Click on **Theme > Start Editing**.
- Use the **Selection Tool** (square box icon), and draw a rectangle around a feature or a group of features that do not appear connected to the highways. The selected features will be highlighted in the **Attribute Table** and will be encased by eight solid black boxes in the **View** (Figure 8a,b). These boxes can also be used to change size and length of a feature being edited.

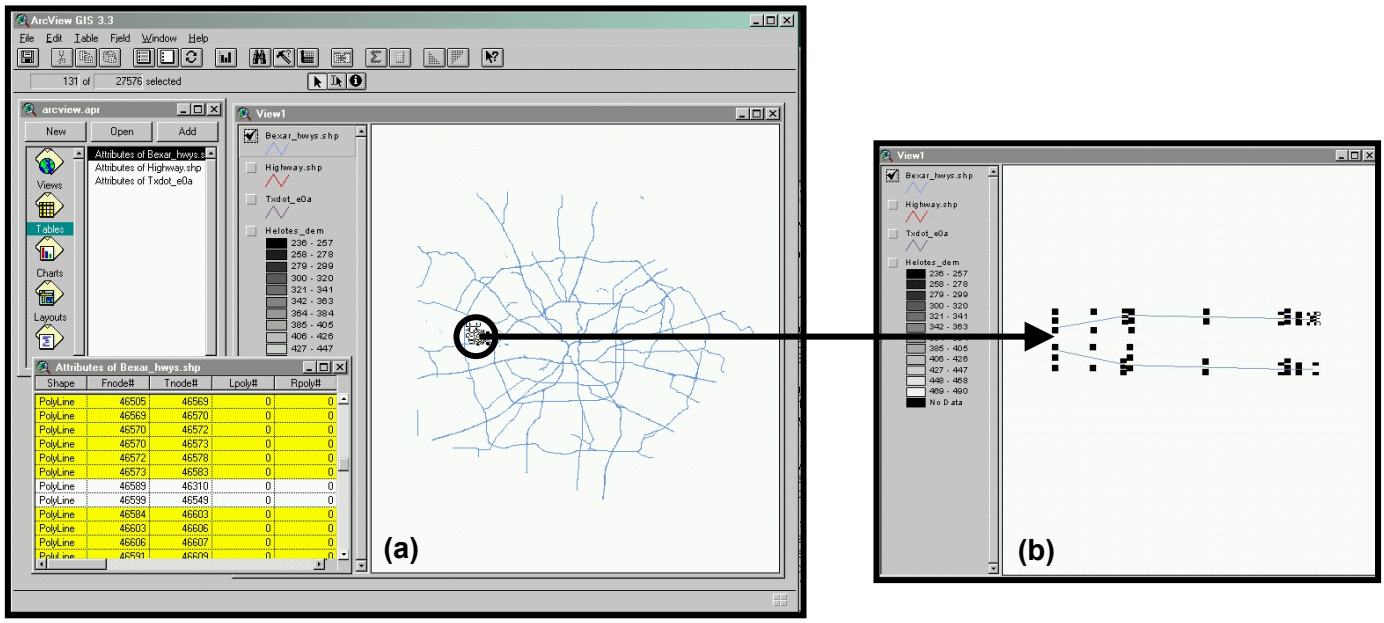

Figure 8a,b. (a) Edit Theme by Selecting Features in View. (b) Edit Handles of Selected Features in Figure 8a.

- If part of the highway you wanted to keep is deleted, click **Edit > Undo Feature Edit** and the last edit will be added back in the **View** and **Table**.
- When edits are complete, click on **Theme > Stop Editing > Save Edits**. If the original file needed to be saved intact as it was before editing, use the **Save Edits As** option. The original file is not needed here, so save edits to the current theme.
- The **Add XY** extension calculates the x and y coordinates for a point or polygon in the same coordinate system as the **Shapefile** or **ArcINFO** coverage without being in the **Edit Mode**. When used on a line, the point is located at the center of the line between two end nodes. Other user-created extensions are available for download at the ESRI website that will add coordinates for line end points (**FNODE and TNODE**) as well as the vertices of polylines and polygons. Click on *bexar_hwy.shp* to make it active, if not already. Click **Theme > Add XY**. ArcView GIS adds two fields or columns to the end of the **Attribute Table**: one named x-coord and one named y-coord (Figure 8c).

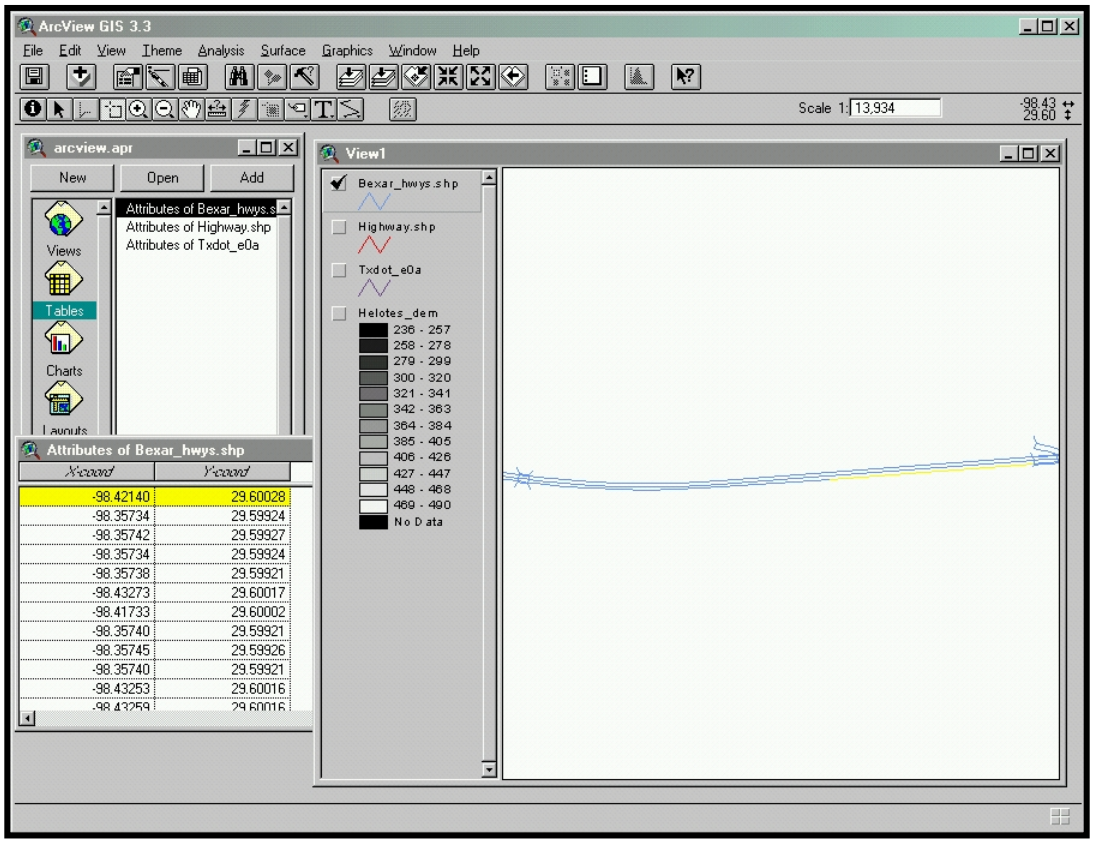

Figure 8c. Add X and Y Coordinates to Attribute Table

(9) Use the **Geoprocessing Wizard** to merge two themes together, creating a new **Theme**: **View > Geoprocessing Wizard > Merge Themes Together**. Add both ***highway.shp*** and ***bandera_rds.shp*** to the **View**, if not listed in the **TOC**.

Click on the *Highway.shp* theme in the **TOC** to make it active, if not already active. In the **View Menu,** select **Geoprocessing Wizard**. The eligible processes for the selected theme will only be available. Choose **Merge Themes Together**. Click **Next**.

- The **GeoProcessing Window** opens with a list of eligible themes and their feature type. Select *Highway.shp* as the first **Input Theme** (Figure 9a).
- Hold down the **Shift** key and select *bandera_rds.shp* as the second input **Theme** in the same selection box (Figure 9a).
- In the **Use Fields From** dropdown menu, select *highway.shp* – Polyline (Figure 9a).

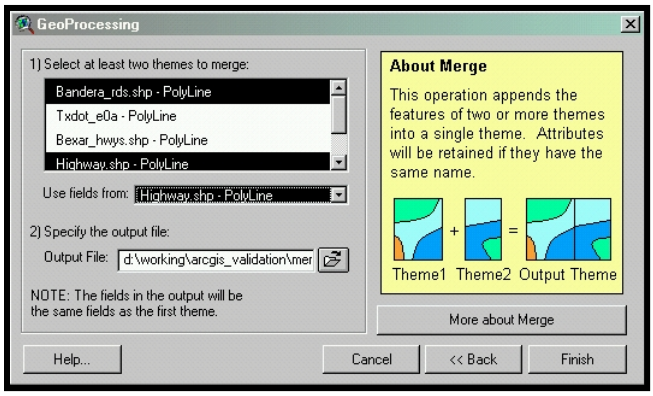

Figure 9a. Merge Two Themes With Geoprocessing Wizard

- Name the output file *all_roads.shp* and save it in the *data_gis_validation* directory. The path to the directory should already be set.
- Click **Finish**.
- When ArcView completes the merge, the new theme (*all_roads.shp*) is added to the TOC. Activate the *all_roads.shp* theme. The single theme overlays the *highway.shp* and the *bandera_rds.shp* themes (Figure 9b).

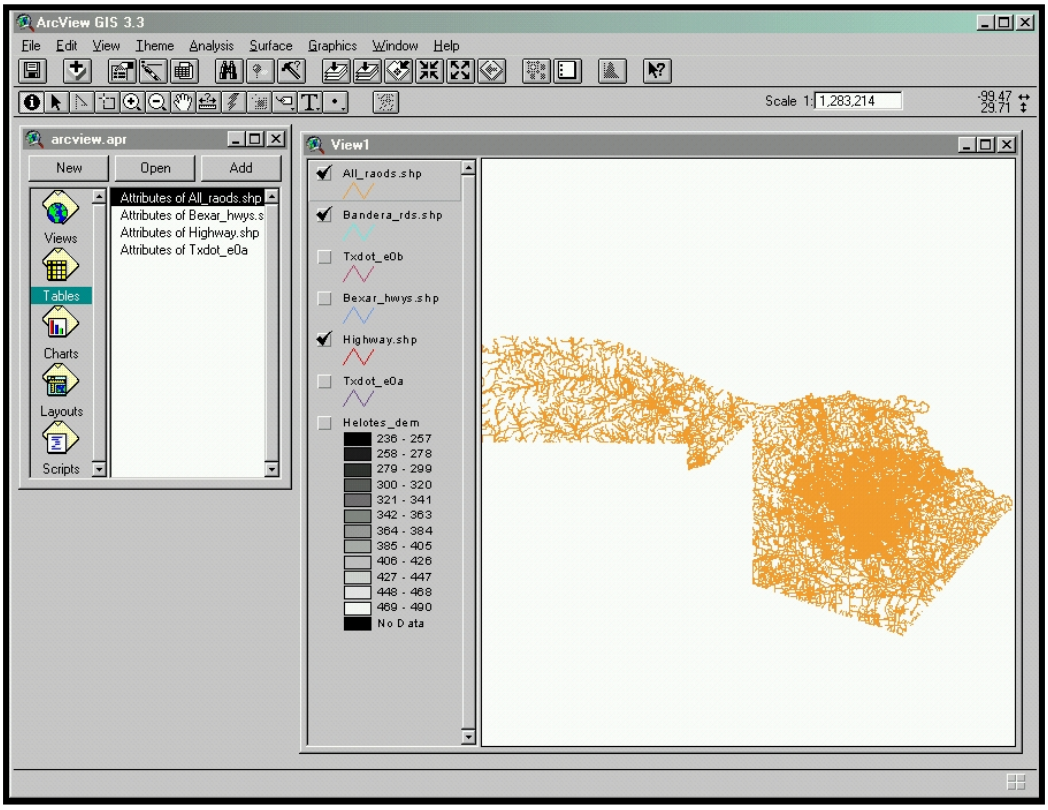

Figure 9b. Verify Merged Theme

- Check the location of *all_roads.shp* in the **Theme Properties Source** (**Theme > Properties**).

(10) Reproject themes using **File Menu > ArcView Projection Utility**.

- In the **View TOC**, check the *highway.shp* theme and the *helotes_dem* grid. As mentioned previously, Helotes is in Bexar County and should be aligned in the **View Frame**. They are not both in the same **View** frame, because they are in different coordinate systems with different horizontal units of measurement. Because *highway.shp* is the same as *txdot_e0a*, but in a different format, the coordinate system will be identical for both. The **Projection** or **Spatial Information** of the themes and/or grid should be available in the **Metadata** file or, in this case, a **README** text file included with the data files.
  - Use the **Microsoft Windows Explorer**, or similar utility, to locate the *readme_dd.txt* file that was extracted from the *015urban_dd.zip* file. **Open** the file in **Notepad** or similar utility. Section II of the *readme_dd.txt* file gives the information that the file is in geographic, horizontal units of decimal degrees, and in North American Datum of 1983 (NAD83) (Figure 10a).

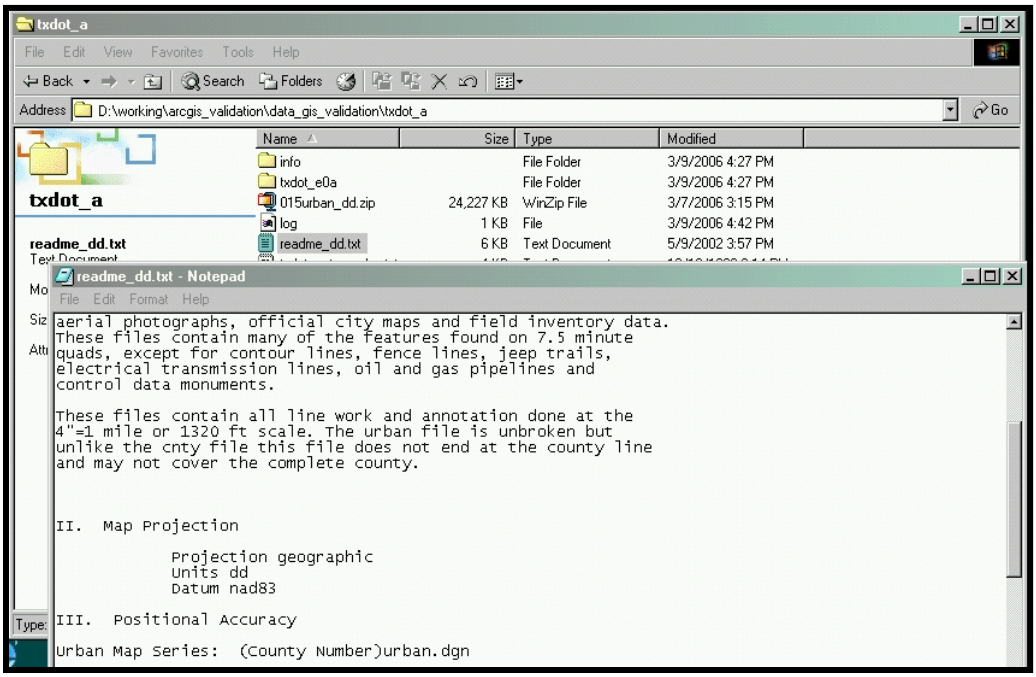

Figure 10a. Section II of *Readme_dd.txt*

  - The *helotes_dem* is in Universal Transverse Mercator (UTM) Projection, Zone 14, Horizontal and Z units, meters; Horizontal Datum of NAD27, the o*rdr9dem.txt* (Figure 10b) file, indicates the horizontal and vertical datums are invalid, but TNRIS verified the datum information to be the same for all the 7.5′ DEMs.

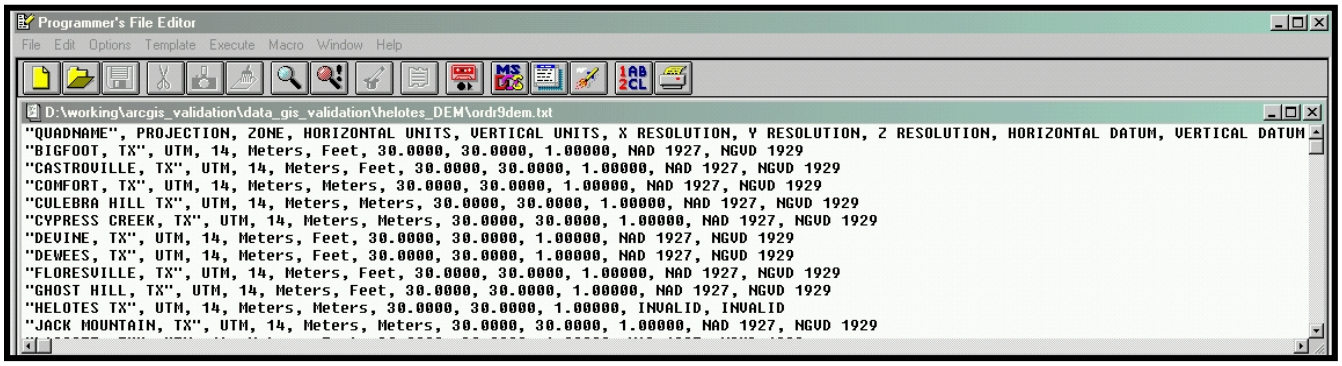

Figure 10b. *Ordr9dem.txt* File Contained in *2998270g.zip* (Helotes DEM)

- **UTM** is more commonly used for local mapping, so the *highway.shp* file will be reprojected to align with the *helotes_dem*.
- **File > ArcView Projection Utility**. Select the **ArcView Projection Utility** located in the **File** menu. In the Step 1 window, browse to the location of *highway.shp*, select the file, and click **Open**. The *highway.shp* file is now shown in the Step 1 window. Click *highway.shp* to highlight; click **Next** button.
- Step 2 of the **ArcView Projection Utility** asks that the shapefile's current coordinate system be input. The coordinate system that is listed is geographic, decimal degrees, NAD27 datum (Figure 10c), which is the default when ArcView GIS is unable to read a projection for a file.

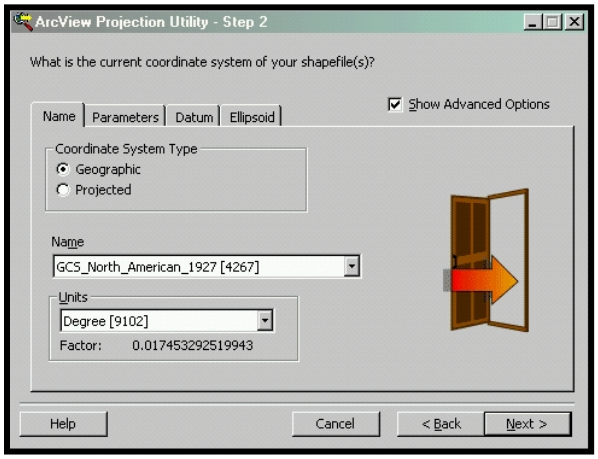

Figure 10c. Default Coordinate System of Projection Utility

- Located at the top of Step 2 is the box **Show Advanced Options**. Check the box. Three tabs become available to customize the projection, if necessary.
- To set the current coordinate system for *highway.shp*, click on the dropdown list for **Name**. Select the GCS_North_American_1983 [4269]; the units should remain at **Degree**. Click **Next**.

- Select the **Datum Tab** from the **Advanced Options**. A transformation will be required for ArcView GIS to calculate NAD83 to NAD27. Under **Geographic Transformation**, select **NAD_1983_to_NAD_1927_NADON** (Figure 10d) (the "to" in the transformation description can also be a "from" as the transformation works in either direction).

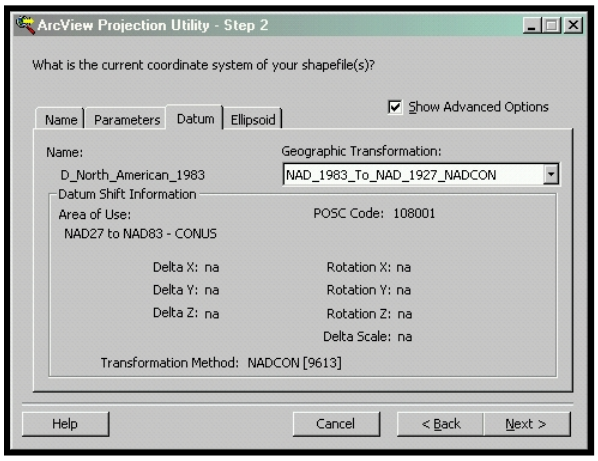

Figure 10d. Advanced Options of Projection Wizard

- Another **ArcView Projection Utility** window will open to inform the user that a coordinate system has been specified for the shapefile and asks whether you would like to save the coordinate system information. When **Yes** is selected, ArcView will create a projection file (.prj) in the same name as the shapefile. Select **Yes**.
- The **ArcView Projection Utility** automatically changes to Step 3. Select the new coordinate system for the shapefile. Change the **Coordinate Type** to **Projected**. The default projected coordinate system is **World_Mercator** [54004], with the units, meters. Open the dropdown list of projection names. Scroll until you find **NAD_1927_UTM_Zone_14N [26714]** and select (Figure 10e). Click **Next**.

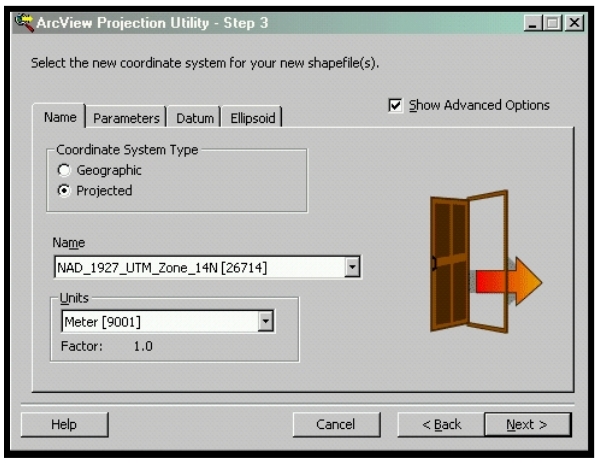

Figure 10e. Step 3—Input of New Coordinate System

- The Step 4 window asks the location and name for the new shapefile. Open **Browse**. The directory should be the *data_gis_validation* directory; rename *newshapefile.shp* to *hwy_u14n27.shp*. Select **Save**. After checking on the path and revised name in Step 4, select **Next**.
- The **ArcView Projection Utility Summary Window** lists all the information from the **Input Shapefile** and the **Output Shapefile**. If the information is correct, select **Finish**. If at any time file coordinate system or names need editing, use the **Back** button on any of the **Projection Utility** windows.
- The **ArcView Projection Utility Progress Window** will open so you can observe the transformation progress. When the transformation is completed, the **ArcView Projection Utility Complete Window** opens. Click **OK**.
- A **Projection Utility Window** will open asking whether the new shapefile should be added to the **View**. Click **Yes**. The **Add Projected Data Window** will open in the directory of the newly projected shapefile (Figure 10f); select the *hwy_u14n27.shp* file and click **OK**.

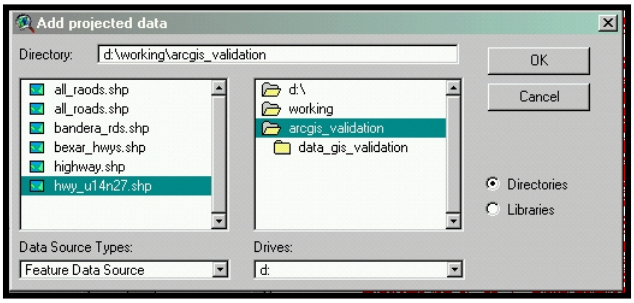

Figure 10f. Add Projected Data Window

- Another **Projection Window** will open asking whether you want the newly projected shapefile opened in one of the current **Views** or you want to open a **New View** and add the new file. Select **View1** and click **OK**.
- Click the **Check Box** for *hwy_u14n27.shp*, then click on the *helotes_dem* in the **View's TOC**. Select the **Zoom to Active Themes** button. The reprojected highway theme now aligns with the *helotes_dem* (Figure 10g).

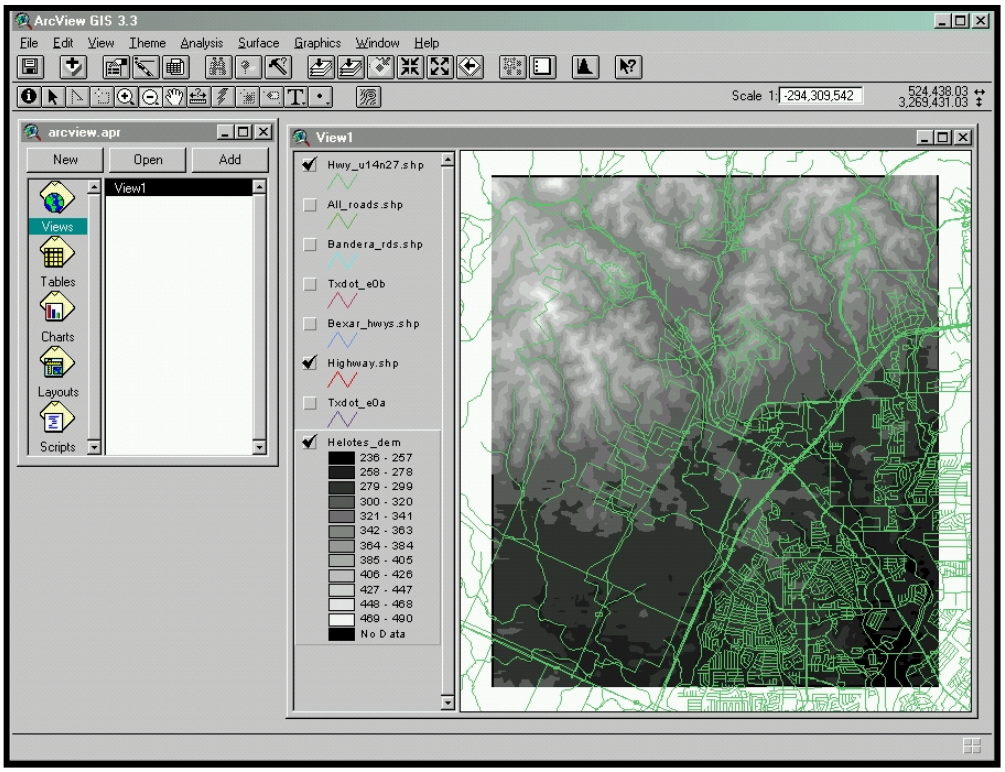

Figure 10g. Verify Projected Data Alignment

- Use the **Zoom In** tool to check the alignment (Figure 10h) and the **Zoom Out** tool to perceive the size of the Helotes Quadrangle in relation to Bexar County (Figure 10i).

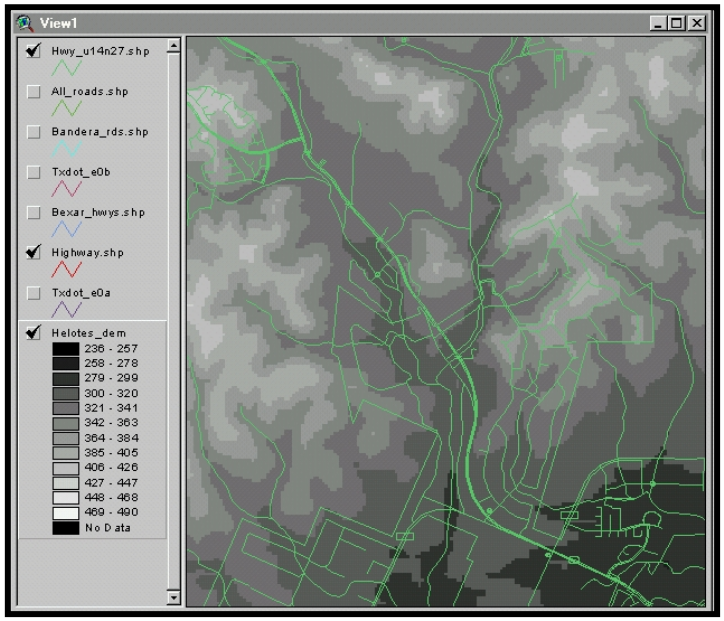

Figure 10h. Zoom In—Scrutinize Alignment

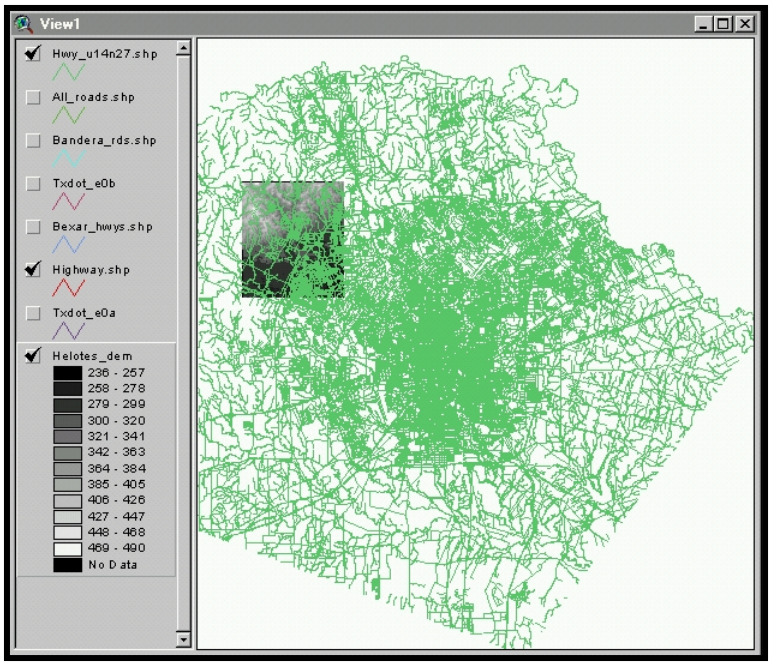

Figure 10i. Zoom Out—Perceive Relationship of Helotes Quadrangle and Bexar County

- While holding down the **Shift Key**, click on the names *all_roads.shp, bandera_rds.shp, txdot_e0b, bexar_hwys.shp, highway.shp*, and *txdot_e0a*. Select **Edit > Delete Themes**. A window will open asking, "Are you sure you want to delete theme *all_roads.shp*?" Click **Yes** to **All**.

(11) Create a new vector polygon theme, calculate the area of the new theme, use the new theme polygon to extract features from a line vector theme, and save the extracted line data to another new theme.

- With the **Project View** active, click on the **View Menu > New Theme**. In the **New Theme** window, select **Polygon** as the **Feature Type** and click **OK**. The **New Theme** window now prompts for the name of the new theme and location for saving the new theme. Rename *theme1.shp* to *helotes_poly.shp* and save in the *data_gis_validation* directory.
- A new theme will open in the **TOC** with the symbology of a filled polygon and in **Edit Mode** (check box is dashed). The **Rectangle Tool** is automatically moved to the top of the **Drawing Tools** (arrow, Figure 11a).

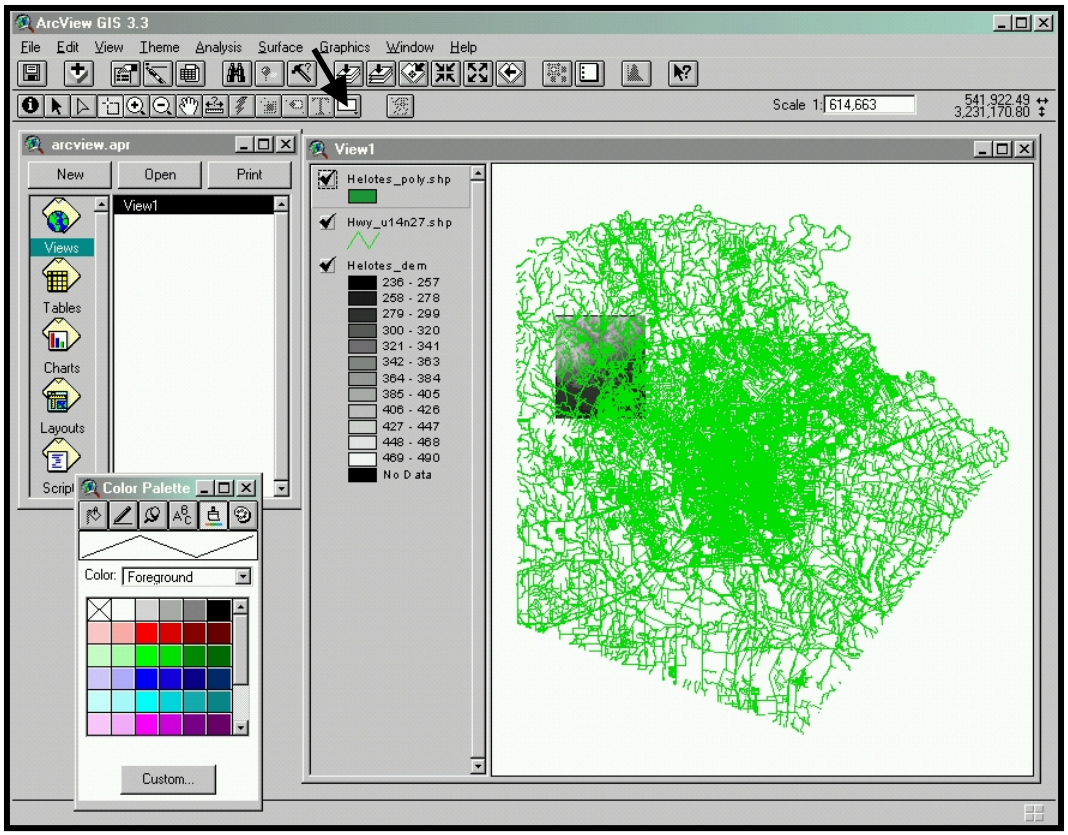

Figure 11a. Drawing Tool Used to Create New Theme

- Double-click on *helotes_poly.shp* name to open the **Legend Editor**. Double-click on the symbol. The **Color Palette** will open or if open, will come to the front. Select the **Fill Palette** button (the pouring bucket). Select the first sample (white square with black outline), which represents a polygon with no fill color or pattern. Click the **Outline** window and **Select 2** for the thickness of the polygon outline. Select the paintbrush button to open the **Color Palette**. **Open** the color dropdown menu and select **Outline**; click on the color **Red**. The **Legend Editor** should be a rectangle with a red outline (Figure 11b).

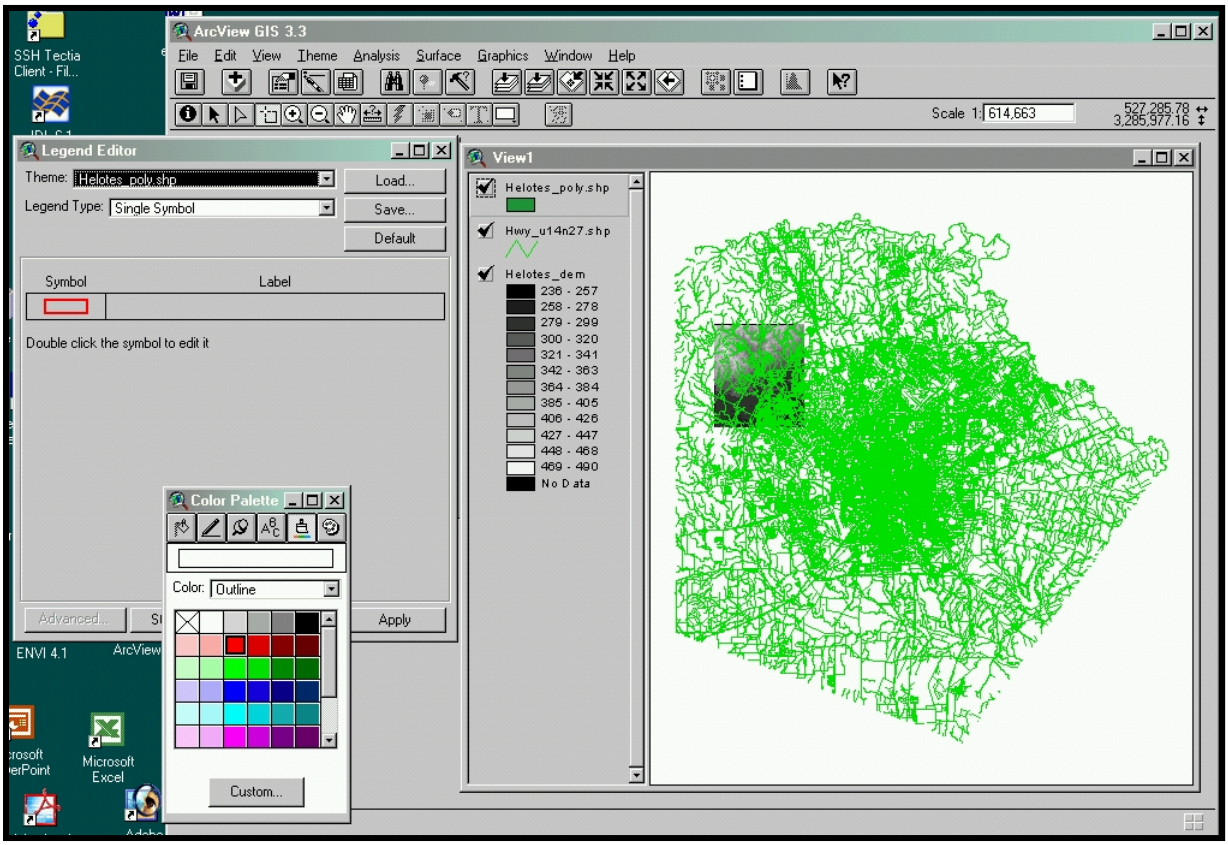

Figure 11b. Edit Theme Symbology

- Click **Apply** and the theme name will reflect the new symbol. Close the **Legend Editor**.
- **Zoom In** to the extent of *helotes_dem*. Click the **Rectangle Tool**, click on one corner of the *helotes_dem* in the **View**, and drag the rectangle to the opposite corner. Release the mouse button. Any edits can be made by using the pointer on a black square to adjust the outline. When the polygon outline is complete, click **Theme > Stop Editing > Save the Edits**.
- Open the *helotes_poly.shp* **Attribute Table**. The table only has one record and two fields/columns. Make sure the **Project View** is active as well as *helotes_poly.shp*. Click **Theme > Add XY**. The **Attribute Table** now has the x and y coordinates for a point in the center of the polygon.
- Make the *helotes-poly.shp* **Attribute Table** active. Click **Table > Start Editing**. The **Field Names** are no longer italicized. Select from the **Table Edit menu, Add Field**. The **Field Definition** window will open. In the **Name Box**, put in **Area**. Type will remain at number and width will remain at 16. Change the Decimal Places to 4 (Figure 11c).

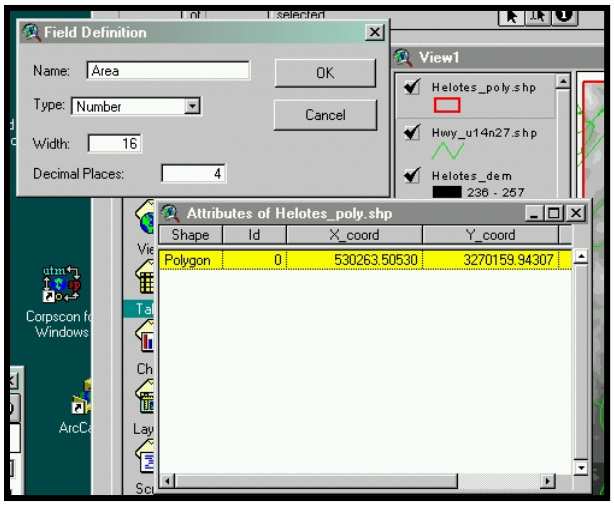

Figure 11c. Adding Data to Attribute Table

- Click **OK**.
- The **Area Field** heading is added and selected. Select the **Edit Tool** from the **Table Tool Bar** ("I" with the upward arrow). Click in the empty bordered space to make it active with a flashing cursor.
- Click on the **Calculator Button** (next to the sum symbol). The **Field Calculator** window opens, and the space selected in the previous step now has a 0.0000 entered. Above the dialog box, "**[Area] =**" is the beginning of the calculation dialog (the area field is active). Double-click on **[Shape]** and this is added to the dialog. Click behind the bracket and add "**. (period)ReturnArea,**" shown in Figure 11d.

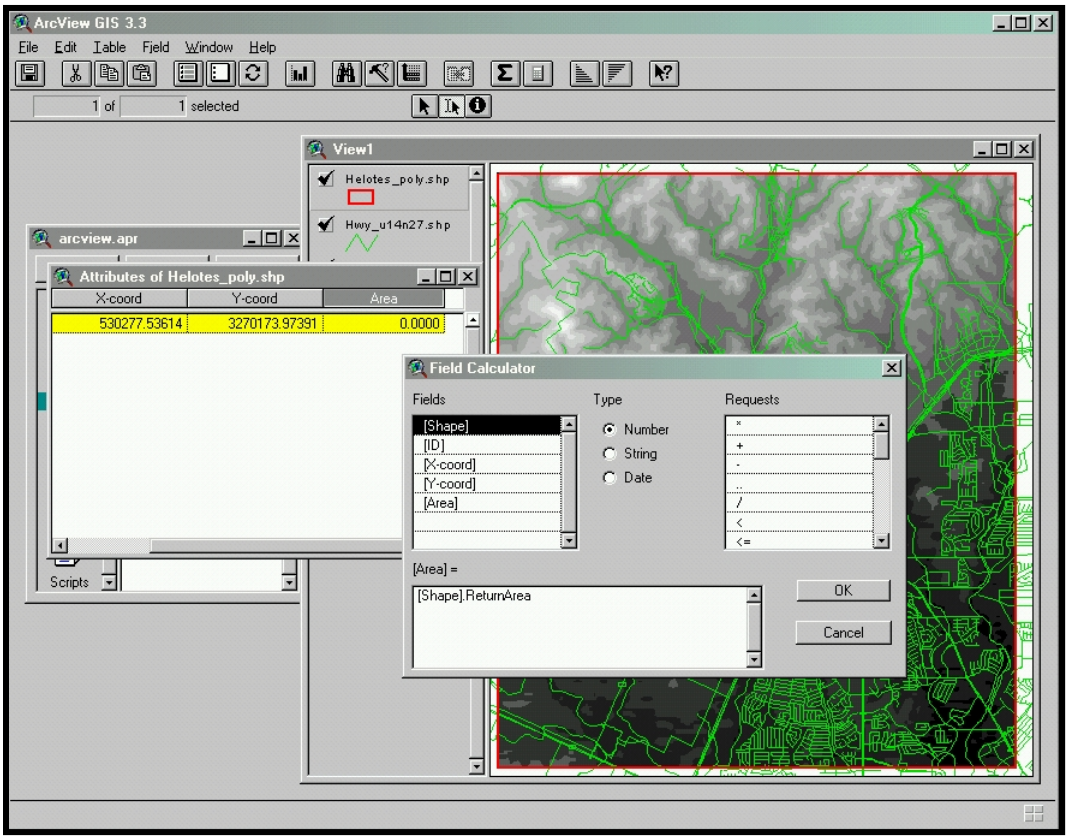

Figure 11d. Field Calculator Used to Add Data to Attribute Table

- Type should be number; click **OK**. The area in map units of meters is added to the **Attribute Table**. Select **Table > Stop Editing > Save Edits**. The heading names are now italicized. Click on the **Select None** button and close the *helotes_poly.shp* **Attribute Table**.
- Use the polygon *helotes_poly.shp* to extract the highway **Feature_General** features of *hwy_u14n27.shp* that are within the boundaries of *helotes_dem*.
  - Click on *hwy_u14n27.shp* name to make the theme active. Click the **Table Button** to open the **Attribute Table** for *hwy_u24n27.shp*. Click the **Query Builder** button. Enter the **([Feature_ge] = "Highway")** in the **Query Builder Dialog** window as used earlier. Click **New Set**. The records that satisfy the query are now selected in the **Attribute Table** and in the **Project View** (Figure 11e).

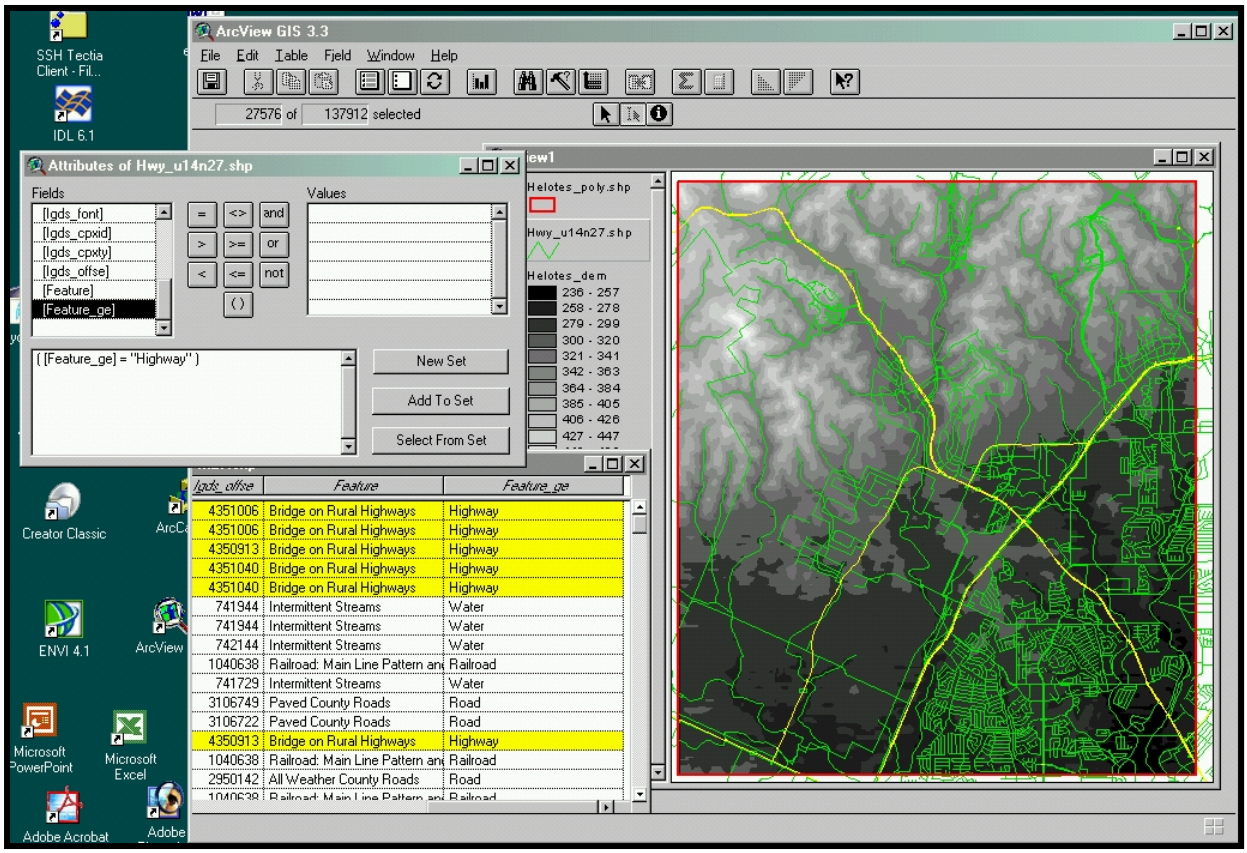

Figure 11e. Query Builder Used to Select Theme Features

- Close **Query Builder Dialog** window.
- Select *helotes_poly.shp* in the TOC to make it active.
- Select **View > Geoprocessing Wizard > Clip One Theme Based on Another**.
  - Open the **Geoprocessing Wizard** in the **View** menu, and select **Clip One Theme Based on Another** operation. Click **Next**.
  - Select *hwy_u14n27.shp* as the **Input Theme to Clip**. The check indicates that only selected features will be clipped from the **Input Theme**, and the total number of features in the **Input Theme** are listed below. Keep the box checked. Select *helotes_poly.shp* as the **Polygon Overlay Theme**. Specify the **Output Directory Location** in the data_gis_validation directory and name the theme *helotes_hwy.shp*. Click **Finish**. Helotes_hwy.shp will be added to the **Project View**. Change the color of the *helotes_hwy* line symbol for better contrast with yellow and green symbol colors. *Helotes_hwy.shp* overlays the selected highways from *hwy_u14n27.shp*. Click the **Select None** button; close *hwy_u14n27.shp* **Attribute Table**. Uncheck *helotes_poly.shp* and *hwy_u14n27.shp*. *Helotes_hwy.shp* is the only highway theme visible. Zoom out to verify that *helotes_hwy.shp* was clipped from *hwy_u14n27.shp* (Figure 11f).

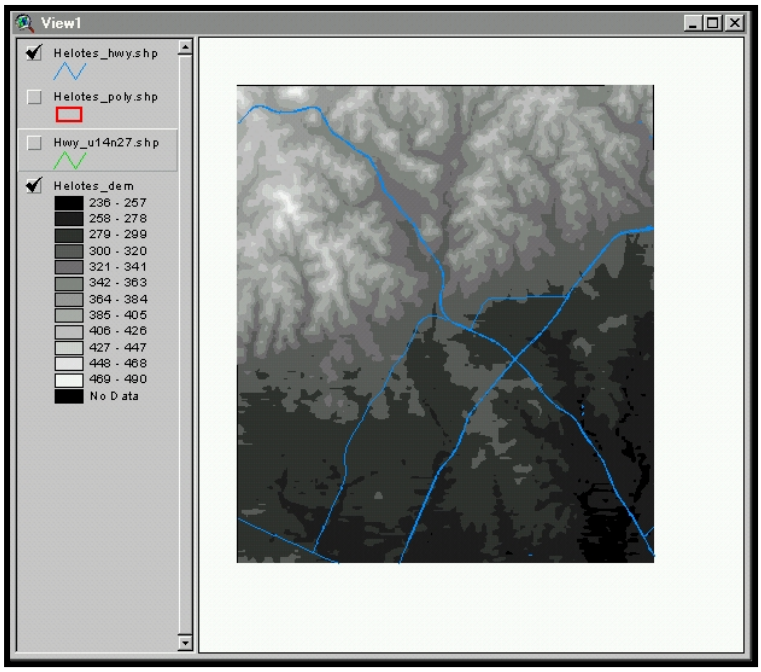

Figure 11f. Verify Extent of Clipped Theme

- Select *Helotes_poly.shp* and *hwy_u14n27.shp* while holding down the **Shift Key** to make active. Click **Edit > Delete Themes** and **Yes to All** in the next window. Click the **Return to Previous Extent** button to return to previous scale of the DEM. Uncheck *helotes_hwy.shp*.

6.1.4 Expected Test Results

- The **Set Working Directory** will set the default directory for saving data.
- The **Import71** standalone utility will change the *ArcINFO Interchange* format to *ArcINFO coverage*. The **Import Data Source** will convert a *USGS DEM* to an *ArcINFO grid*.
- The grid data will be reclassified, and editing the color ramp will increase the visibility of the cell elevation data.
- ArcView GIS will readily convert *ArcINFO coverages* to shapefiles creating the **Attribute Table** containing all the information from the original file format.
- The **Query Builder** will extract the desired data from a shapefile and create a new shapefile with the queried data.
- In ArcView GIS, shapefiles can be edited in a **Project View** or by editing the **Attribute Table**. The **Add XY** tool will add coordinates to the **Attribute Table**.
- The **Geoprocessing Wizard** will create a new theme by merging two separate themes and will create one **Attribute Table**.
- The ArcView **Projection Utility** will create a projection file for a theme, and then change the projection and datum, making a new shapefile to align with a base image.

- A new polygon shapefile will be created using the **New Theme** tool. The **Field Calculator** will be used to calculate the area of the new polygon and will be used to clip a shapefile to the extent of the base image.

6.1.5 Test Results

The default directory was reset using the Set Working Directory tool. The E00 and the DEM file format were converted to ESRI ArcINFO format using the **Import71** utility and the Import Data Source, respectfully. The data classification of the ArcINFO grid was changed to show more elevation ranges in the grid, and the color legend was changed to reflect high areas as white and low areas as black.

The ArcINFO coverage was converted to a shapefile and retained all information in the new Attribute Table. A new subset shapefile was created using the Query Builder, and the information for the selected features was retained in the new Attribute Table. The shapefile was edited in the Project View using the Edit Theme tool, and editing was also accomplished by editing the Attribute Table. Coordinate data was added to the Attribute Table using the **Add XY** tool. Two shapefile themes were merged to a single shapefile theme with an Attribute Table containing data from both files using the Geoprocessing Wizard.

A projection file (.prj) was created for a shapefile theme and then reprojected to a new coordinate system using the Projection Utility.

A new polygon theme was created to the extent of the ArcINFO grid. The Field Calculator added the area of the polygon to the Attribute Table. The polygon was used to create a new subset of the ArcINFO coverage theme using the Geoprocessing Wizard.

Results verified by: _____ Date: _____

6.2 Text Case 2 – Spatial Analyst Extension 2.0a

The Spatial Analyst Extension is a separate program to expand the capabilities of ArcView GIS allowing the user to better understand spatial data relationships and allowing new types of analysis using raster data. Spatial Analyst analyzes data by zones, distance, and demographics and can be used for defining land use, analyzing hazards and hydrologic basins, and visualizing areas from a specified location. Spatial Analyst has tools for creating contours as well as histograms and can interpolate grids from point or line data.

6.2.1 Objectives

ArcView GIS will be used to create a **Shapefile** from an **Event Theme** using x and y coordinates.

Spatial Analyst Extension 2.0a with **ArcView GIS 3.3** can be used to perform the following functions.

- Use an elevation grid to create an **Aspect** grid of the degree of steepness from each cell to its neighbor.
- Use an elevation grid to create a **Slope** grid representing the maximum rate of change for each cell to its neighbor.
- Use an elevation grid to create a **Hillshade** that can be used as a hypothetical illumination of a surface for analyses or display.
- Use elevation grid cell values to create **Elevation** contours at a selected interval from a selected base number.
- Create a **Grid** from raster data using the **Query Dialog Builder**.
- Create a **Grid** using a point feature theme and export the grid to a **XYZ text** file.

6.2.2 Test Input

(1) *helotes_dem* from Section 6.1

(2) *sample_water_wells.dbf* [This *dbf file* was extracted from the list of wells with stratigraphic contacts Alvin Schultz, consultant to San Antonio Water Systems supplied for another project and was saved as a *DBF 4* (*dBASE IV*) file using Microsoft Excel®. This file is not available online.]

6.2.3 Test Procedure

(1) Open ArcView GIS 3.3 if it is not already open, and open the project file if it was saved in Test 1. Add *helotes_dem*, if it is not in the **Project View**. Double-click on *helotes_dem* to open the **Legend Editor**. Change the number of classes to 12, and select **Elevation #1** from the **Color Ramp** dropdown menu. Click **Apply**. The classification bins are now represented by unique colors from cyan as the lowest elevation to white as the highest elevation to mimic surface topology (Figure 12).

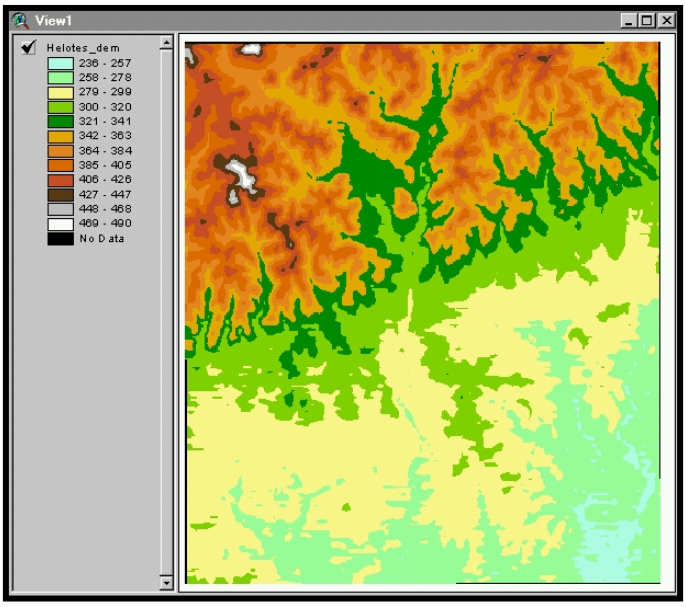

Figure 12. Apply Elevation Color Ramp to Elevation DEM

- Click **File > Extensions > Spatial Analyst** and check the box, if unchecked.
- Use **Spatial Analyst** to obtain the **Aspect** of a DEM.
  - With *helotes_dem* still active, click **Surface > Derive Aspect**. ArcView GIS automatically adds the new grid to the **Project View**. The legend represents the degree of the steepest downhill slope direction from each cell to its neighbor. The slope direction is classified by quarter directional degree intervals (N, NE, E, etc.) (Figure 13a).

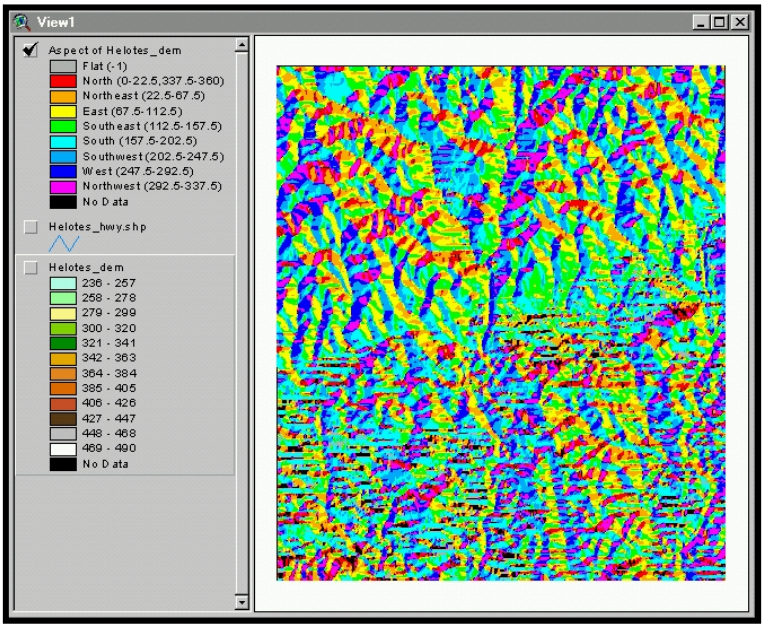

Figure 13a. Aspect of Helotes DEM

- *Aspect_of_Helotes_dem* was saved to the *data_gis_validation* directory and is temporary; it is totally dependent on the *helotes_dem*. When the *helotes_dem* is deleted, the *Aspect grid* will be deleted. Look in the *data_gis_validation* directory or look at **Theme > Properties** to see the **Source** (Figure 13b).

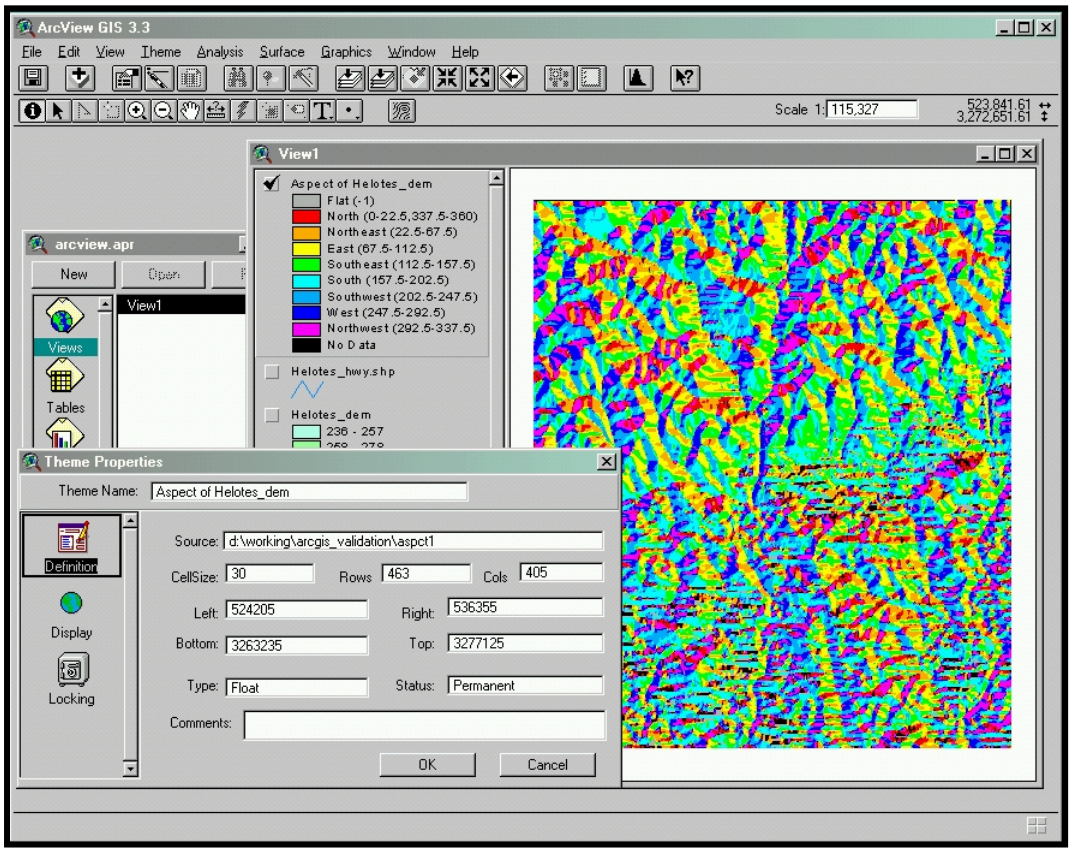

Figure 13b. Theme Source in Theme Properties

- This grid was saved as ***Aspect1***. If this grid needs to be permanent, it will need to be saved as a grid at **Theme > Convert to Grid** (Figure 13c).

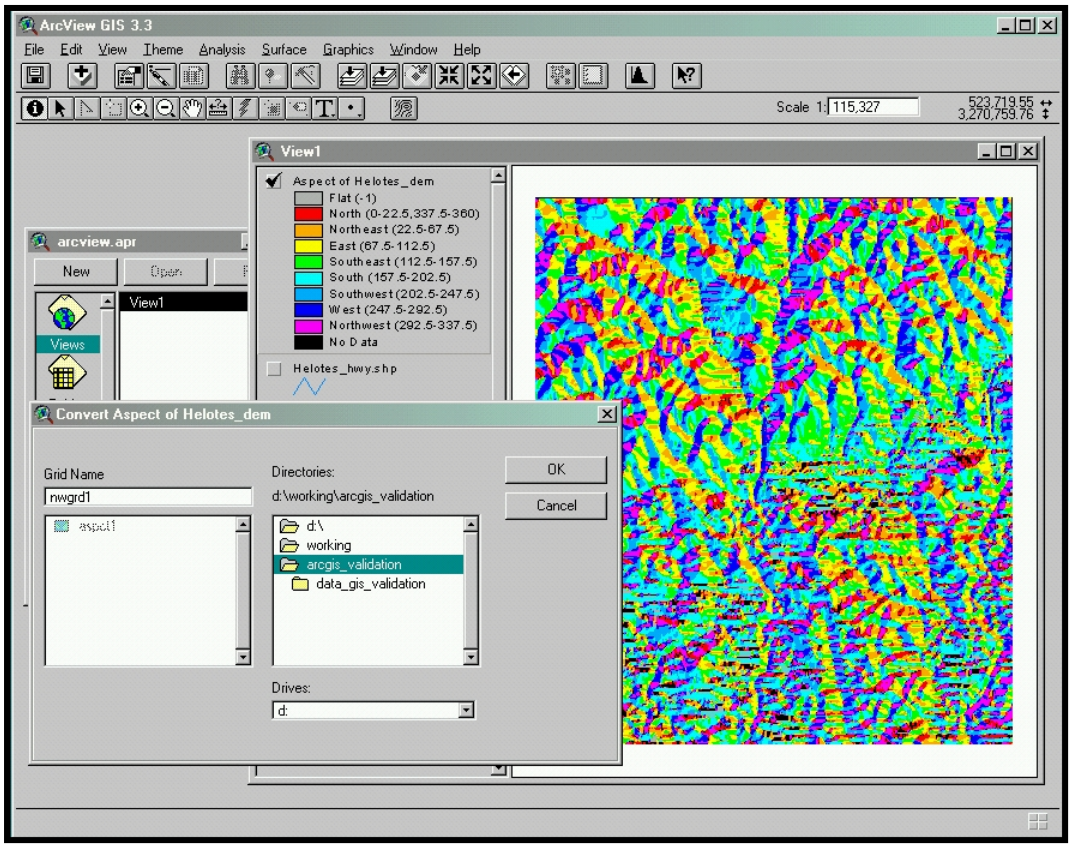

Figure 13c. Convert to Grid

- Grid data can be queried using the **Map Query Dialog**, as well as making calculations using the **Map Calculator**.
  - Click *aspect_of_Helotes_dem* to make it active. Click **Analysis > Map Query** to open **Map Query Dialog Builder**. Enter "([*aspect_of_Helotes_dem*])>=107.126AsGrid" in the dialog box by using the available choices in the menu boxes. "**AsGrid**" is added automatically. The resulting grid is temporary and dependent on *aspect_of_Helotes_dem*. If *aspect_of_Helotes_dem* is deleted from the **Project**, **Query1** grid will be deleted from the *data_gis_validation* directory. **Query1 grid**, value >=107.126, has three classification bins: **True**, **False**, and **No Data**. To better display the information, change the **True** color to blue using the **Legend Editor**. The red, orange, and yellow areas are showing through from the *aspect_of_Helotes_dem* that is equal to the **False** statement of the **Query**. Check the values in *aspect_of_Helotes_dem* to confirm the query results. The **East** direction represented by yellow shows values larger than or equal to 107.126; values less than 107.126 are in the **True** category of the **Query** (Figure 13d).

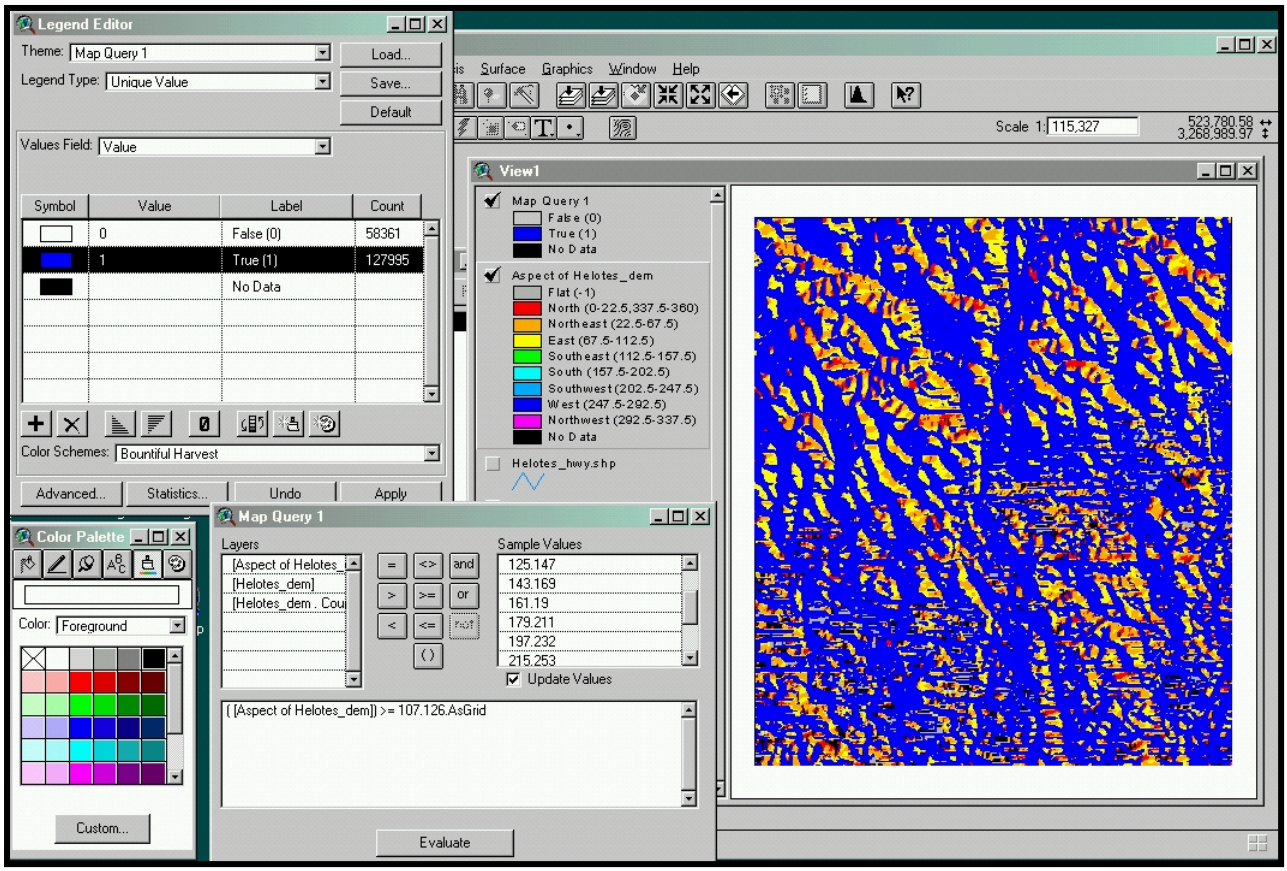

Figure 13d. Query Aspect Grid

- **Uncheck** the **TOC boxes** for *Map Query1* and *aspect_of_Helotes_dem* to make them invisible.

- Calculate the maximum rate of change from each cell to its neighbor by using the **Slope** function.
  - Click on *helotes_dem* to make it active.
  - Select **Surface > Derive Slope**. ArcView GIS automatically creates a new grid saved in the *data_gis_validation* directory; the classification bins represent degree of slope. Use the **Legend Editor** to change the color ramp if it is difficult to distinguish the classifications (Figure 14).

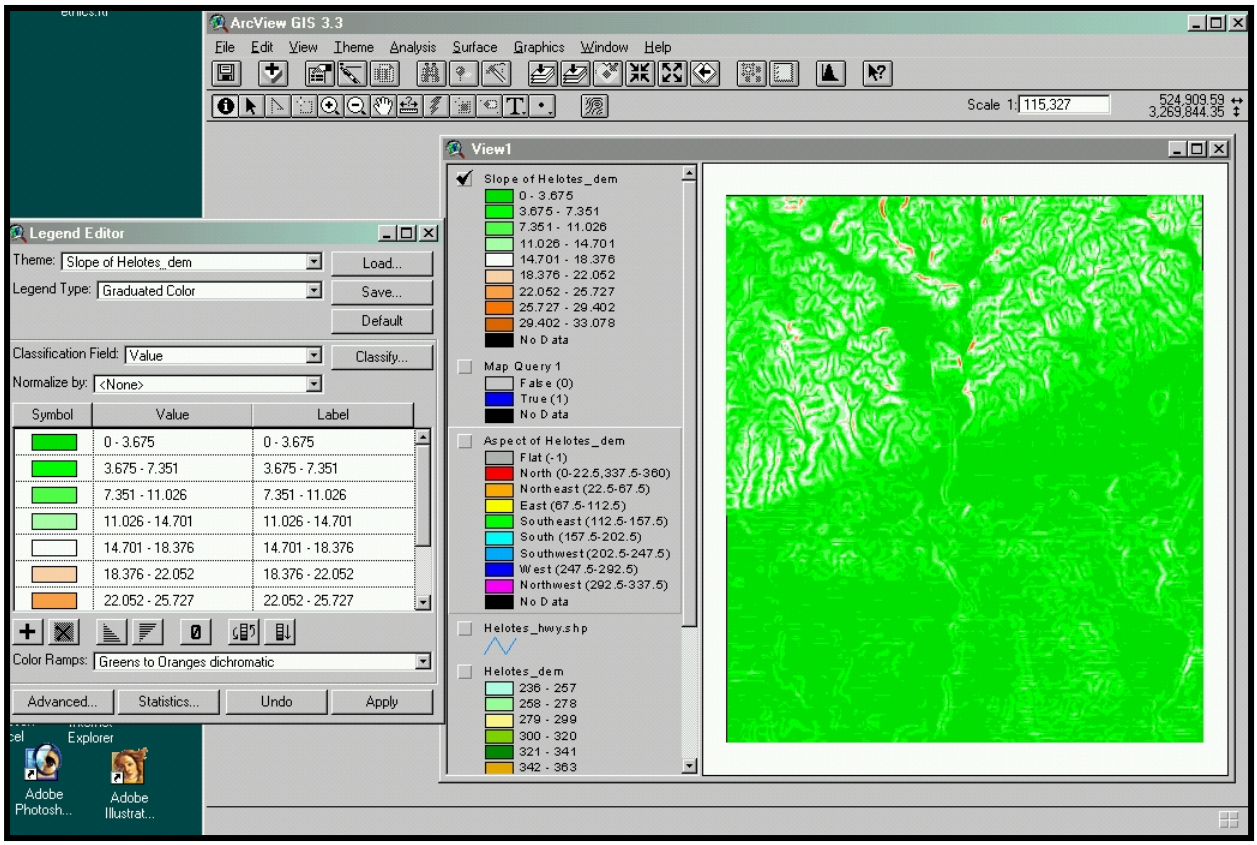

Figure 14. Slope of Helotes DEM

(2) Create a **Hillshade** or **Shaded Relief** to give depth to *helotes_dem*. The **Hillshade** represents the hypothetical illumination of a surface that can be used for analysis or as a background display.

- Remove the check mark from *Slope_of_Helotes_dem*. Click the *helotes_dem* in the **TOC** to make it active.
- In the **Surface** menu, click **Compute Hillshade**. **Surface > Compute Hillshade**. The **Compute Hillshade** window opens so the azimuth of the light source direction and the degree of altitude above the light source horizon can be selected. The light source is usually thought of as the sun. Keep the default parameters and click **OK**. The *hillshade_of_Helotes_dem* grid opens with a grayscale color ramp. This grid is also a temporary file dependent on *helotes_dem* grid.
- Make the *hillshade* visible by checking its box. The grid becomes a representation of the surface having the sun coming from the northwest. This is apparent from high areas being illuminated on the northwest-facing surface (#1 arrow, Figure 15a) with the shadow on the southeast side. Illuminated areas of the lows are the northwest-facing surface of the southeast wall (#2 arrow, Figure 15a).

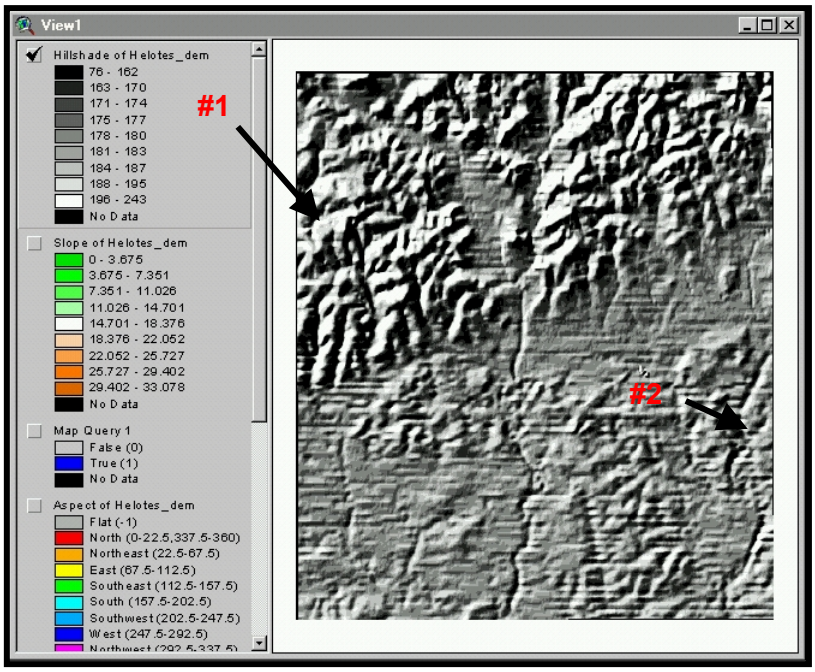

Figure 15a. Hillshade

- Click *helotes_dem* name in the **TOC** and drag it up the **TOC** until it is below *slope_of_Helotes_dem*. With *helotes_dem* active, again select **Surface > Compute Hillshade**. In the **Compute Hillshade** window, change azimuth to 20 and click **OK**. The second *hillshade* is added having the same name as the first *hillshade*; however, ArcView GIS has actually saved the grid as *hlshd2*. This can be confirmed by checking **Source** in **Theme > Properties** (Figure 15b).

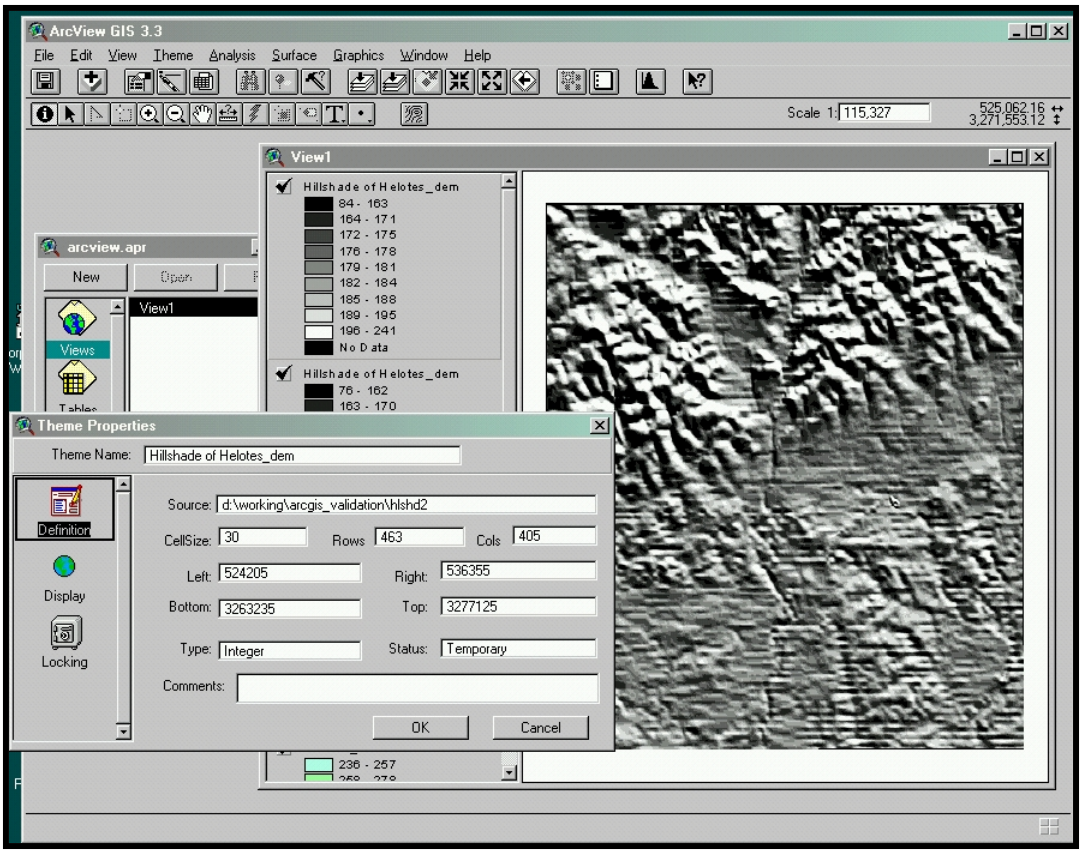

Figure 15b. Naming Convention of Duplicates by Grid Source

- Compare the hillshades by turning the new hillshade on top on and off a few times. Make the new *hillshade_of_Helotes_dem* active, then select **Edit > Delete Themes**. Click **Yes to All** to remove the grid from the project.
- The *hillshade* grid can be used as brightness when combined with another grid used for color. Both grids need to be of the same area and in the same projection.
  - Uncheck the *hillshade_of_Helotes_dem* box so it will not conceal the results of applying it to the *helotes_dem* grid. Double-click the *helotes_dem* grid to open the **Legend Editor**. Click on the **Advanced** button. From the **Advanced Options** window, select *hillshade_of_Helotes_dem* as the **Brightness Theme**. The defaults for the **Minimum** and **Maximum Cell Brightness** are 20 and 80. Do not change the numbers and click **OK**. Click **Apply** in the **Legend Editor** (Figure 15c).

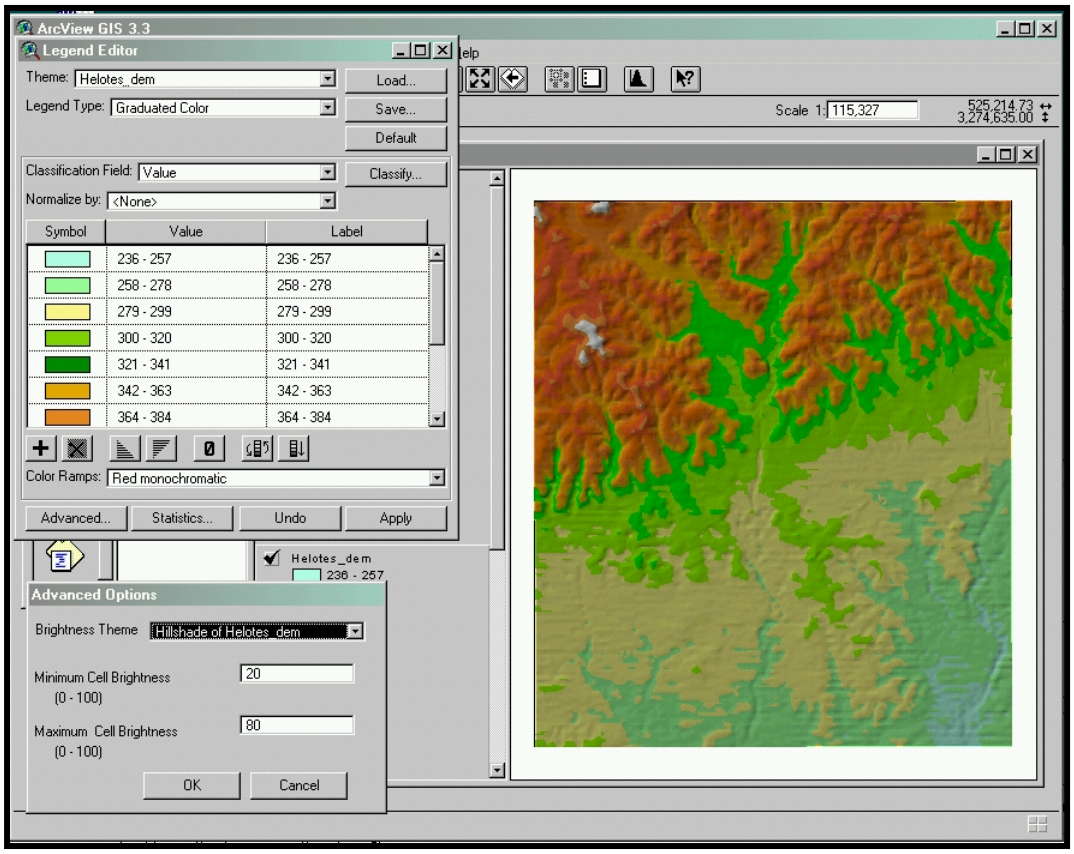

Figure 15c. Hillshade Used as Brightness Theme

- Increasing the number for the **Minimum Cell Brightness** increases the brightness (no cell can have a brightness less than 20) without adding to the relief. Decreasing the **Maximum Cell Brightness** number decreases the brightness. The brightness settings help to enhance the surface relief and should be adjusted for the desired effects. Reclick on **Advanced** in the **Legend Editor**, and change the **Minimum** and **Maximum Cell Brightness** to 50. Click **OK** and then click **Apply** in the **Legend Editor** (Figure 15d).

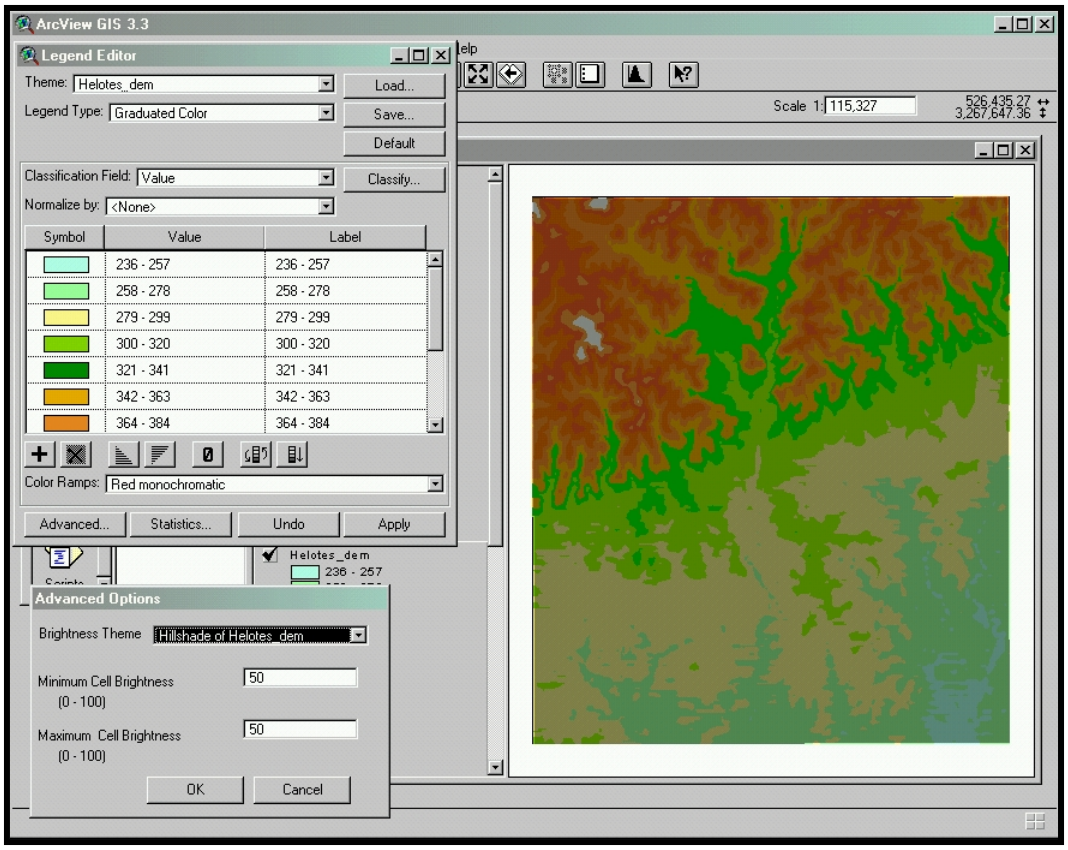

Figure 15d. Cell Brightness Settings

- Repeat the procedure changing the **Minimum** to 20 and the **Maximum** to 100 (Figure 15e).

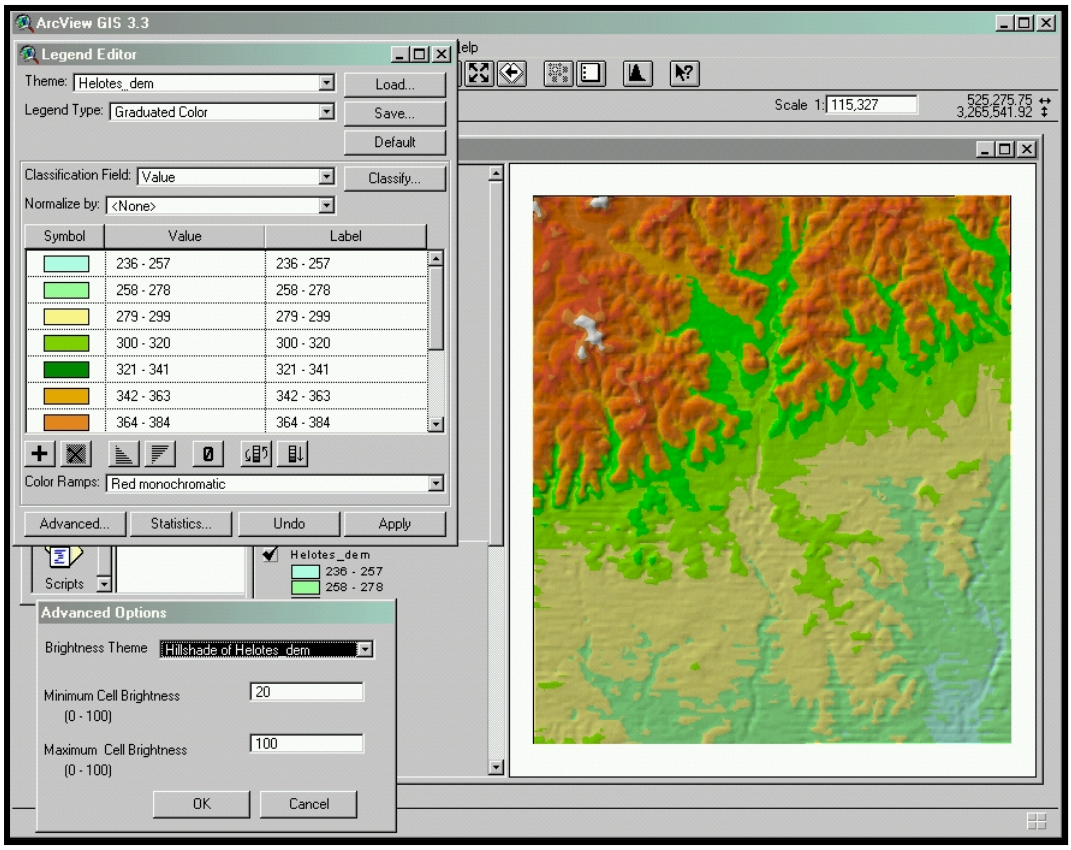

Figure 15e. Increasing Maximum Brightness Value Increases Relief

- Using a hillshade as a brightness theme is useful for analysis of surface features and can make some information easier to visualize. Repeat the previous procedure, and apply *hillshade_of_Helotes_dem* as the brightness theme for *slope_of_Helotes_dem* using the default **Cell Brightness** settings (Figure 15f).

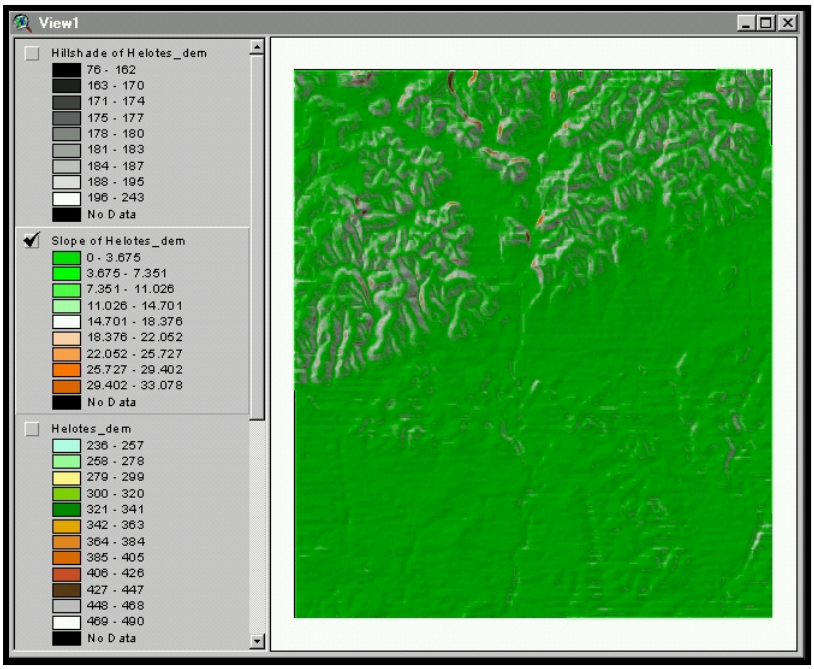

Figure 15f. Brightness Theme Applied to Slope Grid

- The areas with the highest degree of slope are much easier to identify. While holding down the **Shift Key**, select *slope_of_Helotes_dem*, *Query1*, and *aspect_of_Helotes_dem*. Delete from the **Project View** (**Theme > Delete Themes > Yes to All**).

(3) **Spatial Analyst** can also create contour lines where the lines represent all contiguous values of the same height, magnitude, or whatever the grid values represent. The function interpolates a line with the same magnitude, which rarely passes through the center of the cell. The function also smoothes the lines, resulting in a realistic representation of the contour. The output of the **Contour** function is a line theme.

- Click on the *Helotes_dem* to make it active. Click on **Surface** and on **Create Contours**.
- In the **Contour Parameter** window, change the **Contour Interval** parameter to 50, leave the base contour at 0, and click **OK**.
- ArcView GIS calculates the contours in 50-meter intervals and adds the new **Shapefile** theme. The contour units will be the same as the z-value (in this case) units as the source grid.
- Click on *contours of Helotes_dem* to make it active. Use the **Identify Tool**, and select one of the contours to confirm the elevation is a multiple of 50 (Figure 16).

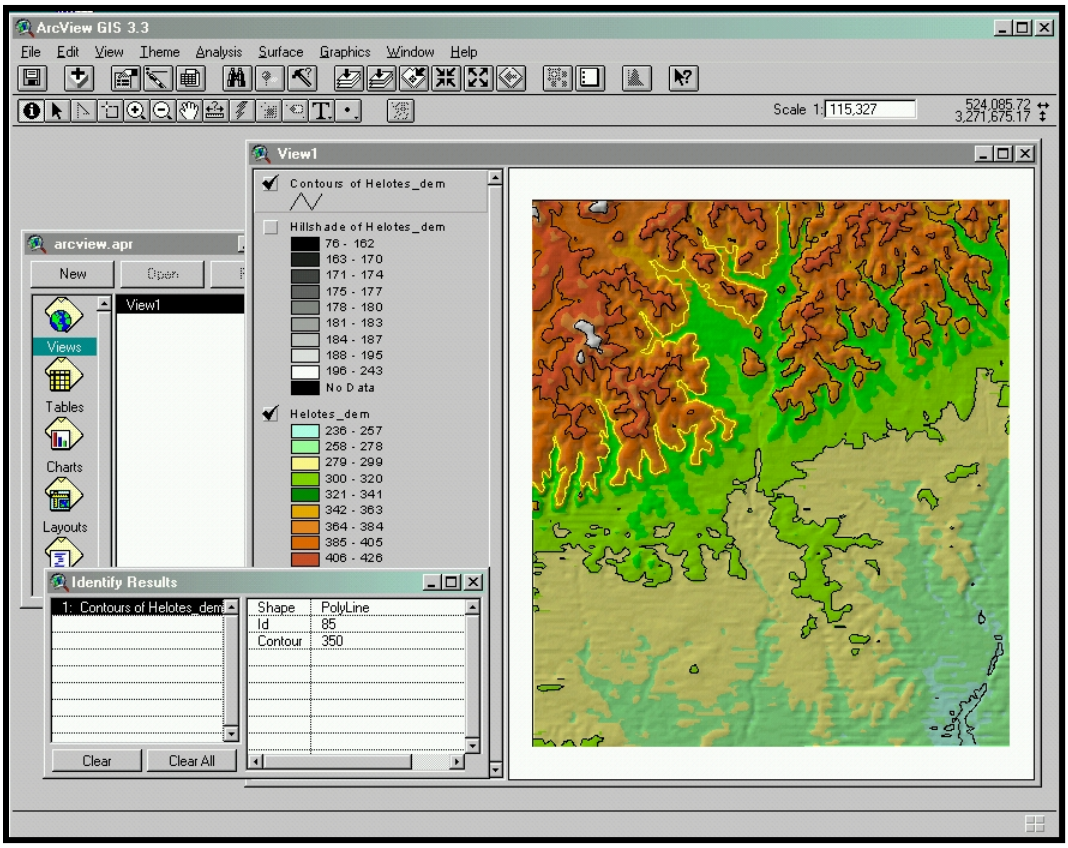

Figure 16. Interpolation of Elevation Contours

(4) A **Vector** theme can be created using a table in **dBASE** (.dbf), **INFO**, or **Delimited Text** (.txt) format containing x and y coordinates. The new theme will continue its relationship to the table so that any changes made to the table are reflected in the theme. This relationship may not be practicable when the table is the result of a query in a separate database and the connection to that database is not available. Use **Theme > Convert to Shapefile** to create an independent theme to add to the project, and then the **Event Theme** created theme can be deleted from the **Project**.

- Add the provided well location table to the project and create an **Event Theme**. With the **View** active, choose **Properties** from the **View Menu**. Enter **Meters as Map Units**, if not set. Click **OK** to close the **View Properties** window. Make the **Project** window active. Select **Tables**. A list of the **Attribute Tables** worked with earlier is listed along with three option buttons at the top of the window. Select **Add**. The table is located in *data_gis_validation\helotes_wells*. The table is in dbf format and will not be visible if the **List Files of Type** shows a different format. Select *helotes_well_loc.dbf* table and click **OK**. The dBASE table opens and the name is added to the list of tables in the **Project** window.

  - Add the well location points to the **View**. In the **View Menu**, select **Add Event Theme**. The **Event Theme** dialog box opens. Select *helotes_well_loc.dbf* from the **Table** dropdown list (Figure 17a).

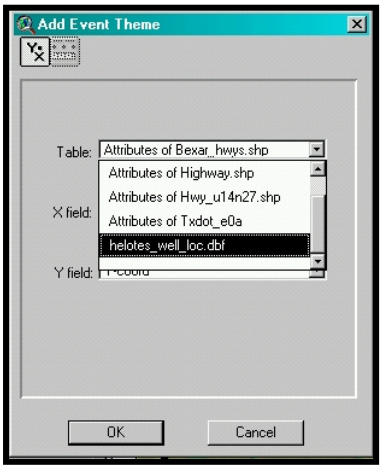

Figure 17a. Add Event Theme Source Table

- In the **X** field, select **East27** from the list and in the **Y** field, select **North27** (Figure 17b).

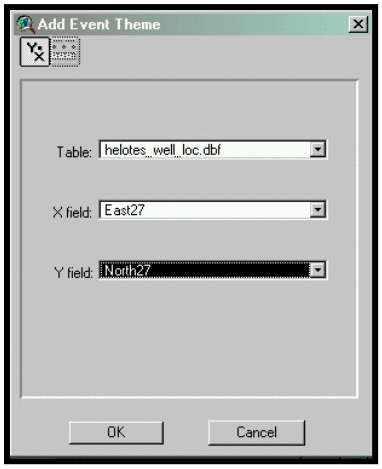

Figure 17b. Add Event Theme X and Y Coordinates Source Field

- Click **OK**. ArcView GIS created a point theme of the well locations. Close the *helotes_well_loc.dbf* table. Make the *helotes_well_loc.dbf* theme active. Use the selection tool to select a well. Reopen the dbf table by clicking on the **Open Theme Table** button. The selected well location in the **View** is highlighted in the table. Place the pointer tool over the well's location point in the **View**. The **X** and **Y** coordinates of the point are displayed in the upper right-hand corner of the ArcView GIS window. The coordinates should be nearly the same as the record selected in the table (Figure 17c).

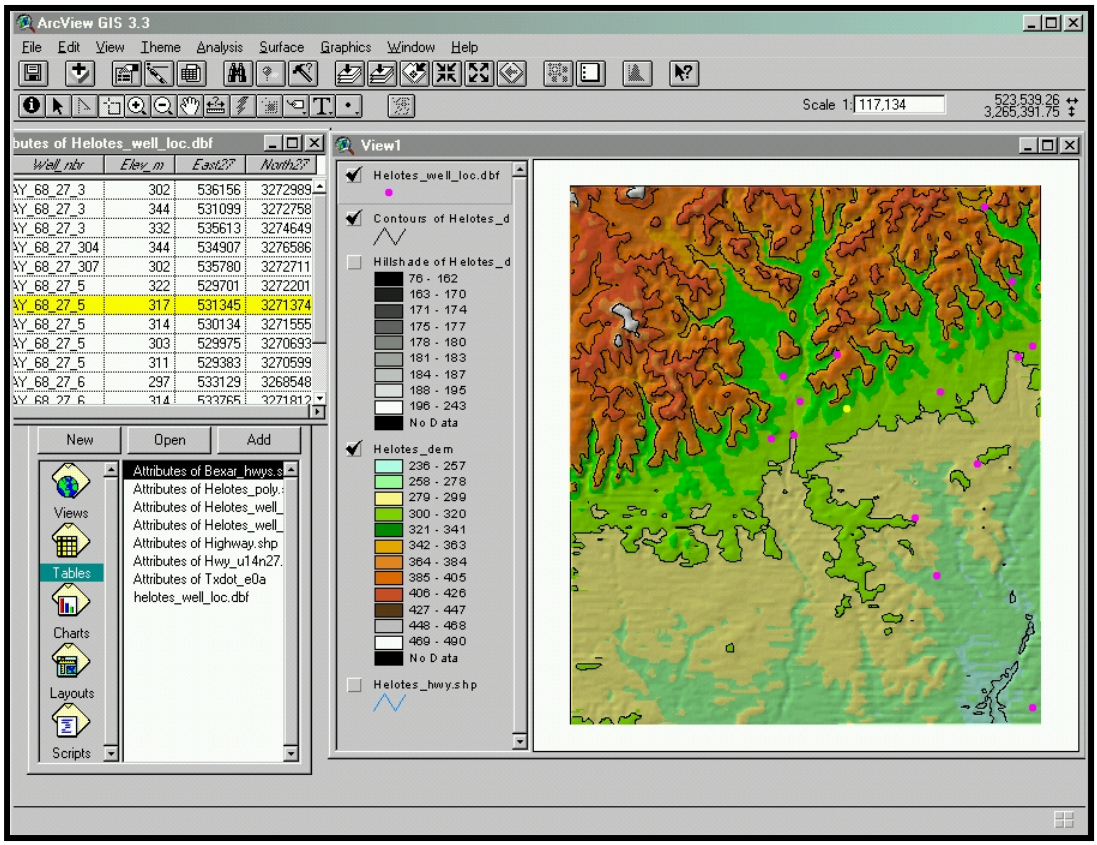

Figure 17c. Verify Feature Location Using the Attribute Table

- The scale of the **View** makes direct location very difficult. Right click with the pointer in the **View**, and select **Shape** properties from the menu. The selected location point is covered by a black marker point, and the **Shape Properties** box opens showing the type of feature and the location. The edit options are not available, because the theme is not in **Edit** mode (Figure 17d).

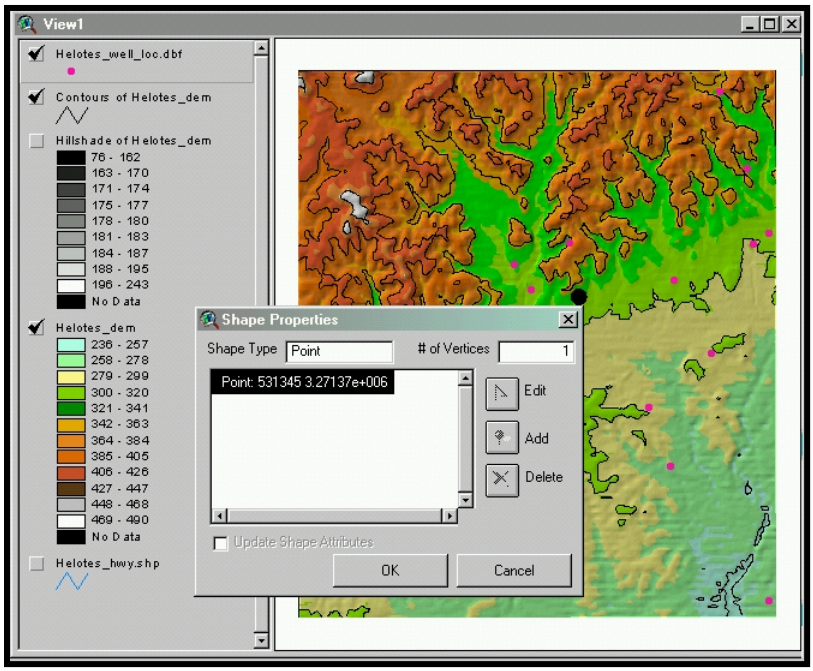

Figure 17d. Shape Properties Box

- Select **OK** or **Cancel**, and the **Shape Properties** box and the marker point are deleted.
- Make the *helotes_well_loc.dbf* theme active, if it is not already. Click on the **Select None** button. If the **Shapefile** is made with a selection made, only the selected features will be in the new shapefile. Select **Theme > Convert to Shapefile**. ArcView GIS should have opened in the *data_gis_validation* directory. Rename the file *wells_loc.shp*. Select **Yes** in the **Convert to Shapefile** window to add the theme to the **Project View**.
  - Change the point color in the **Color Palette** to increase visibility, if needed. Delete the *helotes_well_loc.dbf* theme in the **TOC**. Select **Yes to All** after **Delete Themes** in the **Edit**. Close *helotes_well_loc.dbf* table. Make the **Project** window active and select the table name. Select **Delete** '*helotes_well_loc.dbf*' from the **Project** and **Yes to All** in the next window.

(5) Create a grid from a point file, and then export the grid to an **XYZ text** file.

- Select *well_loc.shp* in the **TOC** to make it active, if it is not already. Open the **Surface Menu**; select **Interpolate Grid**. In the **Output Grid Specification** window, change the **Output Grid Extent** to **Same As** *well_loc.shp* and **Output Grid Cell Size** to **Same As** *helotes_dem*. The cell size should now read 30 m, 431 rows, and 226 columns (Figure 18a).

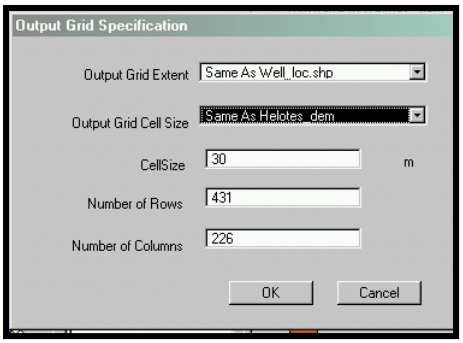

Figure 18a. Output Grid Specification Dialog Box

- Click **OK**. Leave the default selections in the **Interpolate Surface** window (make sure the **Z-value Field** is listed as *elev_m*) and click **OK**.
- ArcView GIS adds the grid to the **Project View**. Again, this is a temporary file, dependent on the *well_loc.shp* theme. Click on *well_loc.shp* in the **TOC**, and drag it above the '**Surface from *well_loc.shp***' grid legend (Figure 18b).

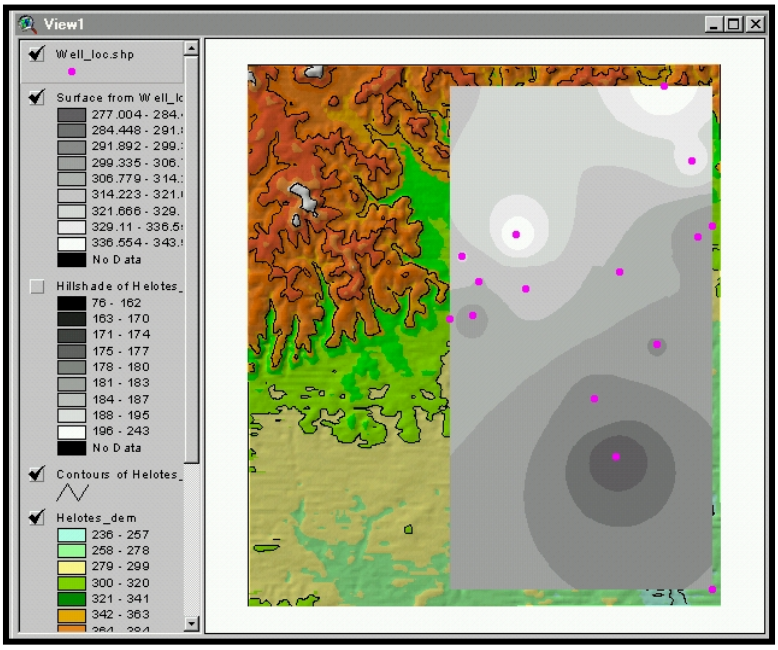

Figure 18b. Convert Point Feature Theme to a Grid

- With **Surface from *well_loc.shp*** active, select **Theme > Convert to Grid**. Save the grid in the *data_gis_validation* direction as *well_surface*.
- Export data from the grid to the **XYZ text** file. Select **File > Export Data Source > ASCII Raster** in the **Export File Type** window. In the **Export Grids Window**, select *well_surface* grid. In the **Export File: well_surface** window, rename the grid *well_grid_xyz.asc*. Select **OK**. Verify the text file contains **XYZ** data from the *well_surface* grid by opening the asc file in **Microsoft Notepad** (Figure 18c).

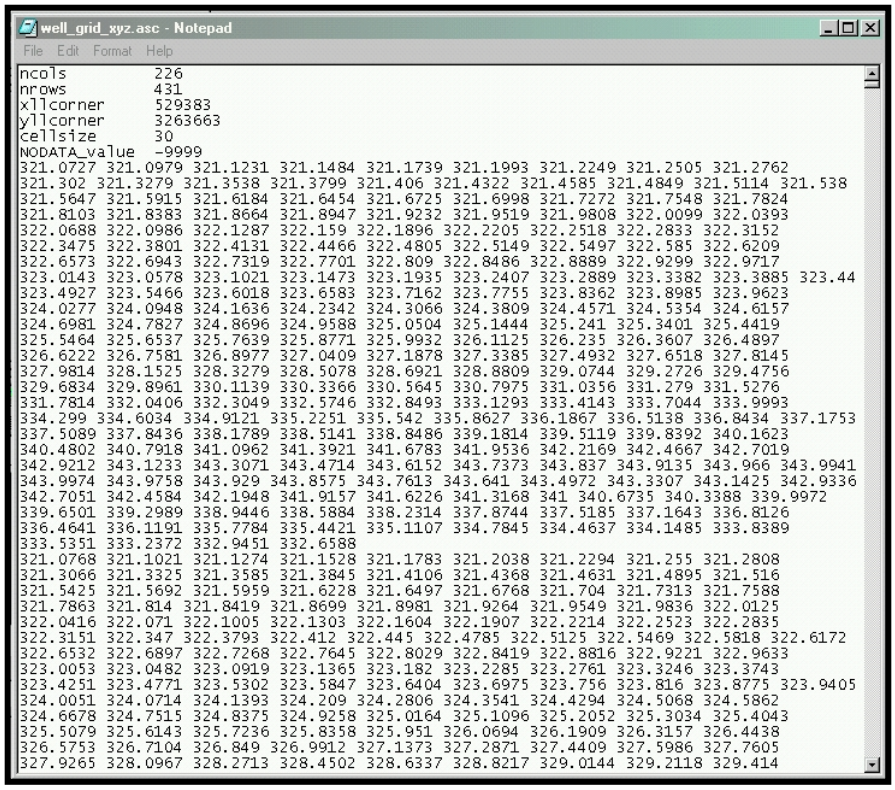

Figure 18c. Export Data Source to Convert Grid to Text File

- The .asc format uses the cell size and the xy coordinates of the lower left corner to determine the spatial location. The numbers listed are the elevations of the center point of the cell in meters. This information corresponds to the information in the grid classifications. This can be verified using the **Identify** tool on the *well_surface* grid.

6.2.4 Expected Test Results

ArcView GIS and the ArcView GIS Spatial Analyst Extension 2.0a will be used to create the following features:

- An **Aspect** grid representing the steepest downslope direction from each cell to its neighbors will be created.
- The **Query Builder** will be used to group a specified range of values, which should result in a new grid containing those values.
- A **Slope** grid identifying the maximum rate of change from each cell to its neighbors will be created.
- A **Hillshade** of the elevation grid will be made depicting the hypothetical illumination of the surface.
- The **Hillshade** of an elevation grid will be used as a brightness theme to another grid having color resulting in giving the color grid depth or surface relief.

- The amount of surface relief will be controlled by adjusting the cell value of the minimum and maximum cell brightness.
- An **Elevation Contour Shapefile** of contiguous values will be made at the specified contour interval.
- A **Table** containing **X and Y** coordinates will be displayed in ArcView GIS as a dependent **Event Theme**. The **Event Theme** will be converted to an independent **Shapefile**.
- Location points will be verified by using the pointer, using the identify tool on the point, and opening the **Shape Properties Box**.
- The point file will be used to make a **Grid** of elevations at a specified cell size and boundary limit.
- The elevation grid of the point file will be converted to an **ASCII** text file having X, Y, and Z data.

6.2.5 Test Results

Spatial Analyst Extension 2.0a tools created an **Aspect** grid representing the steepest downslope direction from each cell to its neighbor and a **Slope** grid identifying the maximum rate of change from each cell to its neighbor from an ArcINFO elevation grid. **Hillshade** created a shaded relief of the elevations depicting the hypothetical illumination of the surface. The brightness theme was used to give depth or surface relief controlled by adjusting the cell value of the minimum and maximum cell brightness. A **Contour** shapefile was created of contiguous elevation values at the specified interval. An elevation grid was created from a point file containing elevations as a feature using the **Interpolate Grid** tool.

ArcView created a point **Event Theme** from a spreadsheet containing x and y coordinates and then converted the event theme to a shapefile. Grid data was exported to a text file format (ASCII) using the **Export Data Source** tool.

Results verified by: _____ Date: _____