# Mississippi Mound Trail, Phase 1:
# Cartography Instructions

The following provides a thorough description of how the various maps and data files included for every site were generated.

## XYZ point cloud, MGC-MDEM Hinds LiDAR (bare earth):

The dataset was accessed and downloaded from the Mississippi Geospatial Clearinghouse by the process detailed in document, “A Description of Steps Taken to Generate Contour Maps From Bare Earth LiDAR and DEMs” (by R. P. Stephen Davis, Jr.; updated 1 May 2013), available at: http://rla.unc.edu/mmt-1/general/MMT_LiDAR_3.pdf

The dataset is located online at URL:
http://www.gis.ms.gov/portal/lidarDetail.aspx?dom=0&x=1280&y=895&browser=Netscape&caption=MDEM%20Hinds%20LIDAR%20Elevation

The necessary download manager page can be reached from the website’s homepage (located at: http://www.gis.ms.gov/portal/home.aspx?dom=&x=1280&y=895&browser=Netscape) by following the subsequent series of links: Download → Elevation → LIDAR Download (Under MDEM Hinds LIDAR Elevation).

The associated metadata is located online at:
http://www.gis.ms.gov/portal/xmlViewer.aspx?fileName=MetadataHindsCoMS.xml
This file can be reached from the homepage by the subsequent series of links: Download → Elevation → Metadata (Under MDEM Hinds LIDAR Elevation).

The dataset is projected in Mississippi State Plane West with NAD83 horizontal datum and default grid units in feet. Grid coordinates were then converted to the metric based Universal Transverse Mercator (UTM) coordinate system (Zone 15 North), and all X, Y, Z data points reflect this. A preliminary 1000 meter by 1000 meter tile of the site and its surrounding area was used.

## XYZ point cloud, MGC-MDEM Delta LiDAR (bare earth):

The dataset was accessed and downloaded from the Mississippi Geospatial Clearinghouse by the process detailed in document, “A Description of Steps Taken to Generate Contour Maps From Bare Earth LiDAR and DEMs” (by R. P. Stephen Davis, Jr.; updated 1 May 2013), available at: http://rla.unc.edu/mmt-1/general/Feltus_Test_Results.pdf

The dataset is located online at URL:

http://www.gis.ms.gov/portal/lidarDetail.aspx?dom=0&x=1280&y=895&browser=Netscape&caption=MDEM%20Delta%20LIDAR%20Elevation

The necessary download manager page can be reached from the website's homepage (located at: http://www.gis.ms.gov/portal/home.aspx?dom=&x=1280&y=895&browser=Netscape) by following the subsequent series of links: Download → Elevation → LIDAR Download (Under MDEM Delta LIDAR Elevation).

The associated metadata is located online at:
http://www.gis.ms.gov/portal/xmlViewer.aspx?fileName=LIDAR%20Elevation.xml
This file can be reached from the homepage by the subsequent series of links: Download → Elevation → Metadata (Under MDEM Delta LIDAR Elevation).

The dataset is projected in Mississippi State Plane West with NAD83 horizontal datum and default grid units in feet. Grid coordinates were then converted to the metric based Universal Transverse Mercator (UTM) coordinate system (Zone 15 North), and all X, Y, Z data points reflect this. A preliminary 1000 meter by 1000 meter tile of the site and its surrounding area was used.

## XYZ point cloud, Atlas LiDAR (bare earth):

The dataset was accessed and downloaded from Atlas: The Louisiana Statewide GIS, through the LiDAR Data Downloader, by the process detailed in document, "A Description of Steps Taken to Generate Contour Maps From Bare Earth LiDAR and DEMs" (by R. P. Stephen Davis, Jr.; updated 1 May 2013), available at: http://rla.unc.edu/mmt-1/general/MMT_LiDAR_3.pdf

The dataset is located online at URL:
http://atlas.lsu.edu/lidar/

The necessary download manager page can be reached from the website's homepage (located at: http://atlas.lsu.edu) by following the subsequent series of links: Download Data→ LIDAR Data.

The associated metadata is located online at:
http://atlas.lsu.edu/lidar/
This file can be reached from the homepage by the subsequent series of links: Download Data→ LIDAR Data.

The dataset is projected in Universal Transverse Mercator (UTM) coordinate system (Zone 15 North) with NAD83 horizontal datum and default grid units in meters. All X, Y, Z data points reflect this. A preliminary 1000 meter by 1000 meter tile of the site and its surrounding area was used.

## XYZ point cloud, NED (bare earth):

The dataset was accessed and downloaded from the United States Geological Survey, through The National Map Viewer & Download Platform (formerly known as The National Elevation Dataset (NED)), by the process detailed in document, "A Description of Steps Taken to Generate Contour Maps From Bare Earth LiDAR and DEMs" (by R. P. Stephen Davis, Jr.; updated 1 May 2013), available at: http://rla.unc.edu/mmt-1/general/MMT_LiDAR_3.pdf

The dataset is located online at URL:
http://viewer.nationalmap.gov/viewer/

The necessary download manager page can be reached from the website's homepage (located at: http://nationalmap.gov/index.html) by following the subsequent series of links: The National Map Viewer & Download Platform→ Click here to go to *The National Map* Viewer and Download Platform!

The associated metadata is located online at:
http://viewer.nationalmap.gov/viewer/
This file can be reached from the homepage by the subsequent series of links: The National Map Viewer & Download Platform→ Click here to go to *The National Map* Viewer and Download Platform!

The dataset is projected in geographic coordinate system with NAD83 horizontal datum and default grid units in decimal degrees. Grid coordinates were then converted to the metric based Universal Transverse Mercator (UTM) coordinate system (Zone 15 North), and all X, Y, Z data points reflect this. A preliminary 1000 meter by 1000 meter tile of the site and its surrounding area was used.

## XYZ point cloud, total station:

This dataset was created in the following manner:

1. Geospatial control was established at each site with a Topcon GR-3 Triple Constellation Receiver. This instrument system has two identical units, which, using GPS, Glonass, and Galileo satellite positioning technologies, accurately recover the coordinates of the points over which they are set up. The two units are referred to as the BASE and the ROVER and establish points GPS 1 and GPS 2, respectively. The instrument units are left to run and gather positioning data for approximately an hour.

2. The two data files created by the GR-3 units are stored on MiniSD cards and need to undergo post-processing through the Online Positioning User Service (OPUS), located at: http://www.ngs.noaa.gov/OPUS/. Detailed steps on instrument set-up, data recovery, and post-processing procedures for the GR-3 are located in the following documents:
   - Instructions for Establishing Reference Points Using the Topcon GR-3 and FC-200 (by R. P. Stephen Davis, Jr.; updated 1 Jan 2013)
     - http://rla.unc.edu/mmt-1/general/Topcon_GR-3_Instructions.pdf
   - Excel Spreadsheet and Instructions for Computing the Vertical Height to the Topcon GR-3 Antenna Reference Point (ARP) (by R. P. Stephen Davis, Jr.; updated 26 Jan 2013)
     - http://rla.unc.edu/mmt/general/ARP_Vertical_Height_Calculator_for_GR-3.xlsx
     - http://rla.unc.edu/mmt-1/general/ARP_Vertical_Height_Calculator_for_GR-3.xlsx

   Both documents can be accessed through the Mississippi Mound Trail Archive (Southern Region) website in the Phase I Mapping section under the General Information category.

3. OPUS returns a data readout for each submitted file, which, along with a lot of other information, contains the coordinates of the point in various grid units. The UTM system was used for the entirety of this project. However, the UTM northing and easting for each point was uniformly adjusted within each given site. A whole number would be subtracted from the easting so as to get a result in which the new easting was a six or seven digit and decimal sequence. The same was also done with the northing. This created a more manageable and localized site grid, which could easily be converted back into full length UTM coordinates.

4. On site once again, the two established GPS datums were corrected relative to one another through the process of point reconciliation. A surveying instrument is set up over GPS 1 and the coordinates of both points are entered into the total station as originally provided by OPUS. It is arbitrarily assumed that the X and Y coordinates of GPS 1 are correct and that the Z value of GPS 2 is correct. GPS 2 is then shot from GPS 1 by the total station and the resultant X and Y coordinates are assumed to be correct and override the X and Y provided for GPS 2 by OPUS. The difference should only be slight, and a drastic variance suggests problems stemming from the

quality of the Topcon GR-3 coordinate recovery process or the faulty manipulation of data in the post-processing steps. As for the Z value of GPS 2, the original OPUS number is kept, but the difference is calculated and applied to the Z of GPS 1 in one of two ways:

- If the total station calculates the Z of GPS 2 as lower than that which was given by OPUS, then the instrument is computing that the GPS 1 point on which it is set up is lower than what it actually is in reality. To correct for this, the difference between the GPS 2 Z from OPUS and the new GPS 2 Z is calculated and added to the Z of GPS 1. This effectively raises the GPS 1 datum's elevation to a point where the total station readings of GPS 2's Z match the Z provided by OPUS.
- If the total station calculates the Z of GPS 2 as higher than that which was given by OPUS, then the instrument is computing that the GPS 1 point on which it is set up is higher than what it actually is in reality. To correct for this, the difference between the GPS 2 Z from OPUS and the new GPS 2 Z is calculated and subtracted from the Z of GPS 1. This effectively lowers the GPS 1 datum's elevation to a point where the total station readings of GPS 2's Z match the Z provided by OPUS.

The newly reconciled points are re-entered into the total station instrument, altering, as calculated above, the Z coordinate for GPS 1 and the X and Y coordinates for GPS 2. Back-sighting to GPS 2 from GPS 1, the total station is used to verify that the instrument results for GPS 2 match with the newly calculated and re-entered GPS 2, to within ±5 mm on the X, Y, and/or Z coordinates.

5. At this stage the site has an established grid and any mapping or surveying work done off of the two GPS datums is appropriately oriented and scaled within a three dimensional plane that adheres to the UTM coordinate system.

6. Using these geospatially controlled datums and total station surveying instruments, topographic data from the site was collected during February of 2013 by a crew from the Research Laboratories of Archaeology at the University of North Carolina at Chapel Hill. One part of the overall crew consisted of Dr. Vincas P. Steponaitis, Dr. R. P. Stephen Davis Jr., and Dr. Brett H. Riggs who carried out the Topcon GR-3 work and upon point reconciliation proceeded to plant permanent copper pipe fixed points as well as more temporary datums. The actual topographic mapping was undertaken by the remainder of the crew, which was comprised of Erin Stevens Nelson, Megan C. Kassabaum, Claire Novotny, Harvey Bagwell, and Andrius Valiunas. Three different total stations were used over the span of this project. All were from Leica-Geosystems and the models were the TCR307, TC407, and TS02plus.

## XYZ point cloud, combined total station &…
**MGC-MDEM Hinds LiDAR (bare earth),**
**MGC-MDEM Delta LiDAR (bare earth),**
**Atlas LiDAR (bare earth),** or
**NED (bare earth):**

This data file is the result of combining the sets of data described in the previous sections; the X, Y, Z data points derived from the online LiDAR and digitized contour repositories, and those gathered in the field through total station survey work. The two datasets were essentially spliced together using a procedure thoroughly described in "An Illustration of the Steps Used to Create Detailed Mound Site Maps by Combining LiDAR and Total Station Topographic Coverage" (by R. P. Stephen Davis, Jr.; updated 28 Dec 2012), available online at: [http://rla.unc.edu/mmt-1/general/Feltus_Test_Results.pdf](http://rla.unc.edu/mmt-1/general/Feltus_Test_Results.pdf)

## Surfer grid file, (1000 x 1000 m, 2 m grid):

The preferred computer software program for generating maps during this project was Surfer (9th edition) from Golden Software. So as to manipulate and eventually present the X, Y, and Z point cloud generated in the previous section, the software requires the data to be converted into a singular and proprietary format known as a grid file (.grd). Once Surfer 9 is open, this step is simply done by, at the top of the page, going to Grid → Data and then selecting the .xlsx (Excel) or .txt (Notepad) file containing the desired coordinate data. Gridding and mapping point clouds is made easiest when the first three columns within the document are associated with the X, Y, and Z coordinates, respectively. When chosen, an options dialogue is presented. In creating all the grid files for the various MMT sites, the Kriging gridding method was used with 2 meter spacing, specified under Grid Line Geometry. The Advanced Options tab allows the inclusion of breaklines into the .grd file, a mapping feature discussed further on. After checking to see that the coordinate variables are appropriately matched under the Data Columns heading, the grid file is generated by clicking OK. It is also in this options dialogue that the site area to be gridded and presented later on can be constrained so as to specify a particular tile size or omit periphery point data. Once the .grd file has been created it can no longer be edited, and any and all desired new changes must be incorporated by re-creating the file.

*Breaklines:* XYZ coordinate point sequences from the overall data point cloud used to define and pronounce linear segments of abrupt elevation change (e.g. ridgelines, inflections, road banks, cliffs, and natural or artificial edges).

- To create a breakline, first establish a linear, uninterrupted, and non-intersected sequence of XYZ coordinates from the pre-existing point cloud. This is easiest to accomplish in a spreadsheet editor like Excel.
- Take the sequence and copy it into a Notepad document. Format it so that the coordinates for any one point are in the XYZ order with a comma and space separating the three values. Furthermore, make sure that the number of vertices (data points) for every sequence is listed prior to said sequence. The format should look as follows:

4
666132.290959, 3501379.797735, 109.444801
666130.606104, 3501385.699491, 108.961772
666127.18204, 3501393.394765, 108.663507
666123.928945, 3501401.108744, 108.458016
3
666120.19114, 3501409.26654, 107.95748
666117.879378, 3501418.369379, 107.579301
666115.948832, 3501425.299877, 107.14718

- Open Surfer 9 and select File → New → Worksheet [Ctrl]+[W]
- In the new worksheet go to File → Import File… then find and Open the Notepad document just created.
- In the Data Import Options dialogue that appears, make sure that the Field Format is Delimited and that both Comma and Space are checked under Delimiters, then hit OK.
- Go to File → Save As… and choose BLN Golden Software Blanking (*.bln) and Save.
- The breakline file is now created and can be added through the Breaklines tab in the ‘Advanced Options’ section when creating the .grd file described above.

It is also necessary to convert the breaklines .bln file into a .dxf file format. This will need to be used as a map layer later on in the ArcMap 10 software which does not recognize the .bln format.

- To do so effectively, select Map at the top of the Surfer interface then New → Contour Map… and choose the desired .grd file to create a preliminary map canvas.
- In the ‘Object Manager’ expand the Map header for the contour map.
- Right click on the layer title (default is Contours) and go to Add → Base Layer…
- Find and Open the .bln file associated with the breaklines.
- Once the Base Layer is added, right click it in the ‘Object Manager’ and select Break Apart Layer.
- Next, either make invisible or remove everything from the ‘Object Manager’ except the breaklines layer.
- Go to File → Export… and Save the layer as a DXF AutoCAD DXF Drawing (*.dxf) file.

## ArcGIS/ArcMap document, all layers, (1000 x 1000 m):

This data file is the singular compilation of all the relevant pre-existing and created mapping layers used in making the various maps for each given site. Layers produced in software ArcMap 10 from ArcGIS, Surfer 9, and/or DesignCAD 3D Max 21 are all juxtaposed on a single ArcMap document canvas.The ensuing section details the order of operations by which each particular layer was generated and how the overall map file was assembled.

NOTE: There are a number of map files that are included for every site on the Mississippi Mounds Trail website (http://rla.unc.edu/mmt-1/index.html) but not directly discussed in this document. These maps are alternate outputs created through different combinations of preferences and varying the expression of certain editable map characteristics within either the ArcMap or Surfer software. The majority of the files were the result of basic changes to map type, view angles, visible site area, general formatting, and what individual layers were concurrently presented. By default, the descriptions for the all-inclusive "all layers" map files cover the specific processes by which the simpler maps were made.

### Layer 1 – Cultural & Natural Features

***Using Surfer 9:***

7. The Surfer software is used to create a simple contour map from the .grd file output generated by the procedure outlined in the previous section. Starting at the top of the software interface, clicking Map → New → Contour Map… → then selecting the desired grid file will produce a basic contour map.

8. The program will select a contour interval based on its own internal criteria and calculations. The desired interval is .5 m and, if it does not match, the default interval can be altered; under Object Manager on the left-hand side of the screen, right-click on Contours and select Properties. At the top of the Properties dialogue box select Levels, then press Levels again and here the interval can be changed. Hit OK twice to lock in any changes.

9. The next step is to convert the created map into a file format useable by the ArcMap 10 program from the ArcGIS software suite. The contour map will provide contextual assistance in the addition of cultural feature layers to the map. To do so, select File at the top-right of the Surfer interface and choose Export. Under 'Save as type:' designate SHP ESRI Shapefile (*.shp). Use the default settings when the options box appears and hit OK to generate the .shp file.

***Using ArcMap 10:***

10. Upon launching ArcMap 10, press the Add Data button below the Selection tab of the interface. Use the Connect to Folder tab at the top-right of the dialogue box to

navigate to where the .shp file was exported to from step 9. Once selected, click Add to bring the contour map into view.

NOTE: For the map to be oriented correctly and have appropriate grid units, it is necessary that the .shp file has a projection (.prj) file associated with it. This file is the same for all of the MMT sites falling within UTM Zone 15 North (the entire southern region of the MMT is included). The projection file needs to be in the same folder directory and have the same name as the main .shp file and its other constituents.

**Layer 2 – Shapefile, 50 cm Contours**

As a result of completing steps one through four above, en route to creating the *Cultural & Natural Features* layer, the second layer, *Shapefile, 50 cm Contours, 2013 (1000 x 1000 m),* is also produced.

11. To the right of and attached to the Add Data button is a drop down list arrow. Selecting Add Basemap allows various map layers to be brought into the active working window as both over and underlays. To achieve the sought after mapping results of this project multiple Basemaps were used including both ArcGIS stock layers as well as additional layers downloaded from ArcGIS Online.
    Stock layers: Imagery, OpenStreets Map, Street, Topographic, USA Topo Maps.
    Downloaded layers: North America Rivers, USA Railroads.

**Layer 3 – Imagery Basemap**

The imagery basemap available from the stock repository was left as a layer of the final map since the aerial satellite view aids in contextualizing the actual site and the other map layers.

12. The Basemaps were all used, in whatever combinations necessitated, as tracing backdrops for digitizing both cultural and natural features. Features deemed essential to the site maps included major/developed roads, undeveloped/unimproved roads, railroads, bodies of water, watercourses, and buildings. For any given site map all major roads, railroads, watercourses, and lakes were digitized and included. However, for undeveloped roads, ponds, and buildings, only the features that were relevant and proximal to the site proper (the mounds) were included. The actual digitization of these features was simply accomplished with the Line drawing tool that can be accessed at the top of the software interface through Customize → Toolbars → Draw. To digitize buildings, bodies of water, and complex intersections, the outermost perimeter was traced. To digitize roads and watercourses, only the centerline of the feature was traced, and the width (to be incorporated later) was marked by two parallel dashes placed at the straightest and easiest to view segment of the feature in question.

13. Once traced, the features were saved as a singular group and exported to be further worked on in another software program, DesignCAD 3D Max 21. To do so, right click on Layers in the Table of Contents and select 'Convert Graphics to Features...'

In the options dialogue make sure that 'this layer's source data:' is selected and that the appropriate .shp file is highlighted in the drop-down list. Hit OK and then Yes when prompted on if the exported data should be added to the map as a layer. Thereafter, right click on this newly created layer in the Table of Contents and select Data → Export to CAD. In the options box make sure that DXF_R14 is chosen in the Output Type drop-down list. Hit OK to finish the exporting process.

***Using DesignCAD 3D Max 21:***

14. Import the aforementioned file into the DesignCAD 3D Max 21 software by selecting File → Import, in the top left of the interface. Under 'Files of Type' highlight DXF and proceed to 'Open' the desired file.

15. Select all the line entities on screen, [Ctrl] + [A], and open the Info Box in the upper-right hand side of the program. Herein, de-select the 'Color by Layer' and 'Line Style by Layer' options.

16. To complete drawing a road:
    - Use the measuring tool, accessed through Dimensions → Units or keyboard key [U], to check the perpendicular distance between the two parallel dashes placed earlier on either side of a given road to denote width.
    - With measurement in hand select the centerline and at the top of the screen follow Edit → Convert to Double Line. Enter the measured Line Width, choose Align Center and Cap None, and hit Convert Selected Lines.
    - Right-click on the transformed double line and select Explode.
    - Repeat the three bulleted steps above for all roads present on map.
    - Use the following tools to complete editing the roads and cleaning up intersections:
        - Section Cutoff: Edit → Section Edit → Section Cutoff
            - Essentially a precision eraser used to partition singular line entities and/or remove the segments all together.
        - Gravity Snap: Point → Gravity (Keyboard shortcut key [ . ])
            - Automatically pulls the cursor to the nearest point handle, which allows to draw seamless lines and shapes, even if done sporadically.
        - Line Draw: Draw → Lines…→ Line
    - Use Combine Lines tool, Edit → Selection Edit → Combine Lines (Shortcut key: [B]), to group all the constituent parts of any given road or road network, so as to be able to edit them as a singular entity.

17. To complete drawing solid perimeter objects (i.e. buildings, bodies of water):
    - Use Section Cutoff, Gravity Snap, and Line Draw tools to fill in any perimeter gaps.
    - Use Combine Lines tool to create continuous polygons.

18. Once again select all line entities except those comprising buildings and select Edit → Selection Edit → Convert → Line to Curve. This transforms all line entities into curves, thereby smoothing out any angular junctions and making the final product look better. Note; not all line segments will always transform in a desired way, and line to curve transformations often need to be done on a case by case basis, depending on the preferred result.

19. Group the features into categories by color-coding each different type. Color can be manipulated through the right hand Info Box panel. Principal color categories are as follows, with additional categories added as needed: main/developed roads, unimproved/undeveloped roads/paths, bodies of water, buildings, railroads, and each separate watercourse. It is also in the Info Box panel that the line style of railroad features can be altered to reflect a more useful representation showing rail ties and tracks.

20. Save the work as a .dxf file to preserve georeferencing.

***Using Surfer 9:***

21. Once a satisfactory contour map (to function as a contextual basemap canvas) has been produced within the Surfer program, the cultural and natural features layer can be completed.

22. In the 'Object Manager' on the left hand side of the program interface, right select the contour basemap and Add → Base Layer. Select the appropriate .dxf file from step 20 above and proceed to select OK and NO in the ensuing dialogue boxes to successfully add a draped and georeferenced features layer to the working map.

23. Under Object Manager, right click on the newly added Base and select Break Apart Layer to make it an editable entity within the Surfer workspace.

24. Proceed to edit the constituents of the features layer by right click entering into the Properties of particular polyline segments and polygons in the expanded Base tab under 'Object Manager'. Line characteristics for different feature types are as follows:

    <u>Polylines:</u>
    - <u>Main/developed road:</u> Style - Solid; Width - .02 cm; Color – Blue.
    - <u>Unimproved/undeveloped road/path:</u> Style - .03 in. Dashed; Width - .02 cm; Color – Blue.
    - <u>Railroad tracks:</u> Style – Solid; Width - .01 cm; Color – Black.
    - <u>Watercourses:</u> Style – Solid; Width - adjust to fit channel cut and match aerial imagery/contours; Color - Sky Blue.

    <u>Polygons:</u>

- Bodies of water: Fill Pattern – Solid; Color - Sky Blue; Opacity - 70% for contour maps, 100% otherwise.
- Buildings: Fill Pattern - Forward Slash; Color - Ruby Red; Width - .01 cm; Opacity - Foreground 100%, Background 0%.

25. Once finished editing characteristics, export the Cultural & Natural Features layer as a .dxf file again. To do so, de-select everything in the Object Manager except the Map/Base corresponding to the Features layer. Highlight this and select File → Export, and choose 'DXF AutoCAD DXF Drawing (*.dxf)' under 'Save as type:' Press Save to successfully export the file.

***Using ArcMap 10:***

26. Now, it is time to begin constructing the final *ArcGIS/ArcMap document, all layers, (1000 x 1000 m)* file, which consists of multiple default and created layers. First, Add Data as previously done in step 10 to bring up the .shp file of the site's 50 cm interval contour map. Then underlay the 'Imagery' Basemap as done in step 11.

27. Select File → Add Data… → Add Data to bring in the Cultural & Natural Features (.dxf) layer completed in step 25. The export/import procedures underwent by the layer, between the various editing software, tend to strip the .dxf file of certain polyline/polygon characteristics. These can be restored or altered by entering the polyline and polygon components of the Feature layer group in the 'Table of Contents'. The feature elements will be grouped by shared color from the last export iteration out of Surfer, and any edits to a color group equally affect all elements within said group. The partitioning of features into categories carried out in step 19 along with keeping consistent colors in the remaining steps allows for easy manipulation of feature characteristics in ArcMap once this stage is reached. Changes can be made to any feature group by entering the Natural & Cultural Features layer in the 'Table of Contents', opening either the Polyline or Polygon drop down menus, and double left clicking on the desired element in the color coded drop down menu, consequently opening the Layer Properties options dialogue.
    - The exact formatting specifications that were uniformly applied across all the sites can most easily be viewed by downloading (http://rla.unc.edu/mmt-1/index.html) one of the '*ArcGIS/ArcMap document, all layers'* files for any site and following the above mentioned procedure.

28. At this stage, repeat steps four and five to insert Layers 2 and 3, the *Shapefile, 50 cm Contours* and *Imagery Basemap*, respectively.

## Layer 4 – Relief Map, Vertical View

***Using Surfer 9:***

29. This layer is generated entirely in Surfer 9 and originates from the previously discussed .grd file. To create this layer, a vertically viewed, shaded, topographic relief

map, first select Map at the top of the program interface then New → 3D Surface… and choose the proper .grd file.

30. A rudimentary three dimensional site map is generated and needs the following changes so as to become the necessary layer. On the left hand side of the screen, under 'Object Manager', right click on the Map header that corresponds with the 3D Surface and enter the Properties. Here, under the View tab, make sure that Rotation is 0 degrees, Tilt is 90 degrees and Projection is Orthographic. Under the Scale tab make sure that the values for X and Y are identical and that Z is exactly half of either X or Y to ensure a 2x vertical exaggeration. Also, confirm that the checkbox for Proportional XY Scaling is marked. Once finished hit Apply and then OK to lock in the changes.

31. In 'Object Manager' expand the drop down list associated with the 3D Surface Map header and right click on 3D Surface to enter the Properties. Under the General tab is where the colors and gradients of the map can be altered. In addition, if the map is to be presented at an angle (not in this layer's case) check the box for Show Base, which fills in the blank void that exists between the actual map surface and the axes upon which it rests. The angles and intensity of the light cast upon the map can be altered as needed under the Lighting tab.

32. Under the same Map header in 'Object Manager' uncheck the boxes next to the axes to make them invisible.

33. With the 3D Surface Map header highlighted, select File → Export... and for 'Save as Type:' denote 'TIF Tagged Image File (*.tif, *.tiff)'. Press Save and pan over to Spatial References in the options box that appears. Make sure that "Save spatial reference information in:" is selected and that "Internal file format (if possible)" and ESRI World File are marked, otherwise the layer will not be properly georeferenced once brought into ArcMap in the forthcoming steps. It is also important to keep together all the resulting files that Surfer creates in the export process.

***Using ArcMap 10:***

34. Once out of Surfer the map layer is no longer interactive and can only be presented as a static image on the ArcMap document canvas. To do so, simply click File → Add Data → Add Data… and then select the appropriate .tif file. Click Add and if a dialogue box appears hit OK.

**Layer 5 – Reference Points**

35. The following layer shows all the established reference points (datums) that were created and used at any given site. To achieve this in an effective manner it is important to first create an Excel spreadsheet (recommended) or Notepad document that contains four columns labeled X, Y, Z, and Point ID with the appropriate data listed underneath. The layer is a georeferenced point plot of the coordinate data.

36. At the top right of the software interface, follow File → Add Data → Add XY Data…Hit the folder button to the right of "Choose a table from the map or browse for another table:" to find and then Add the spreadsheet columns created in the previous step. In the options box, make sure the desired sheet is selected and that the X, Y and Z fields correspond correctly, then choose OK.

37. Once the points have been added their attributes as they appear on the map canvas, such as size, color, and labels can be easily edited through the left hand side 'Table of Contents'. Right click on the Reference Points layer and enter the Layer Properties window. Use the options under the Symbology and Labels tabs to manipulate the presentation of the layer's points as necessary.

**Layer 6 – Breaklines**

As previously described, this layer is originally created in the Surfer program. Breaklines are not tangible map components such as a road or reference point and, instead, these phenomena are algorithmically incorporated into the actual .grd file by which the contour and relief map layers are created. Although they are an internal aspect of the visible map document, this created layer serves to show the location and shape of added breaklines. For visualization purposes the layer shows the breaklines as black line segments connecting the individual points in a given breakline sequence.

38. At the top right of the software interface, select File → Add Data → Add Data… then find and Add the right breakline .dxf file. The breaklines layer was kept as is, with the default attributes designated by the program.

NOTE: It is vital that all the files created by the process just described are all kept and remain in the same folder directory. This includes the primary maps and their layers, as well as their secondary support files generated by the numerous import and export iterations. ArcMap 10 does not store all the incorporated data and layers internally and instead recalls them from their directory and redraws the map every time that it is opened. If a file or constituent is no longer in the same place as when the map was last drawn and saved, ArcMap will note an error and then not incorporate that aspect into the map.

## Surfer map file, all layers, (1000 x 1000 m) & (500 x 500 m):

This map file is very much like the *ArcGIS/ArcMap document, all layers, (1000 x 1000 m)* file detailed in the above section. Essentially, it is all the same layers as discussed in the previous section, except the Imagery Basemap (Layer 3), just assembled and presented in the Surfer 9 software as opposed to ArcMap 10. Since many of the layers originated in Surfer, this map file is actually much more interactive and conducive to alterations of both map and layer characteristics than the ArcMap equivalent. Through following the 38 steps described above, all of the necessary layers for this map file have actually already been created. They need only to be kept in the Surfer software rather than exported. The following breakdown shows what steps to follow to make this map file.

Layer 1 – Cultural & Natural Features

- Once the layer is created in steps 7 through 20, bring it into surfer by following steps 21 through 23 and finalize it by completing steps 23 and 24.

Layer 2 – Shapefile, 50 cm Contours

- Follow steps 7 and 8.
- Note that axes attributes can be changed by right clicking into the properties under the appropriate layers header in the 'Object Manager'.

Layer 4 – Relief Map, Vertical View

- Follow steps 29 through 32.

Layer 5 – Reference Points

- In the 'Object Manager' expand one the Map headers for either the contour or relief map.
- Right click on the layer title (e.g. Contours, 3D Surface) and go to Add → Post Layer…
- Find and Open the apt Excel or Notepad file, as discussed in step 35.
- Once the Post map is added, right click it in the 'Object Manager' and select Break Apart Layer.
- Right click on the layer title (Post) and enter the Properties window. The symbol attributes can be changed under the General tab and labels can be added to the points under the Labels tab.

Layer 6 – Breaklines

- In the 'Object Manager' expand one of the Map headers for either the contour or relief map.
- Right click on the layer title (e.g. Contours, 3D Surface) and go to Add → Base Layer…
- Find and Open the .dxf or .bln file associated with the breaklines.
- Once the Base Layer is added, right click it in the 'Object Manager' and select Break Apart Layer.
- The layer attributes can be altered much in the same way as for Layer 5 above; however, for the purposes of these map files Surfer's default characteristics were kept.

The map files of this type occur in two different tile sizes, (1000 x 1000 m) or (500 x 500 m), which are specified by limiting the extents of any given map/layer. In the 'Object Manger' right click into the Properties dialogue of any of the Map headers. Map tile sizes can then be adjusted under the Limits tab.

If needed, a scale bar can be added to the map document by right clicking on the title of one of the layers (e.g. Contours, 3D Surface) in the 'Object Manger' and selecting Scale Bar… Adjust the options in the pop-up window and hit OK to create a scale bar that can be placed anywhere. Text can be added to the map canvas by utilizing the Text tool located under Draw in the software's primary menu bar.

The exact formatting specifications that were uniformly applied across all the sites can most easily be viewed by downloading (http://rla.unc.edu/mmt-1/index.html) one of the '*Surfer map file, all layers, (1000 x 1000 m)* or *(500 x 500 m)* files for any site and following the above mentioned procedures for noting and editing map and layer features.