Tool Handbook

MnModel Phase 4 User Guide: Appendix C

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Contents

Introduction

The purpose of this handbook is to document the tools used to develop data, variables, and models for MnModel Phase 4. It covers procedures for using tools that run in ArcGIS, but not procedures for statistical modeling in R, which is covered in a separate guidebook.

Organization

This handbook is organized by the following categories:

- Data Development
- Variable Derivation
- Preparation for Modeling
- Creating Prediction Rasters
- Utilities

To the extent possible, tools are discussed in the order in which they should be run. In some cases, this order is not critical, but in others it is necessary to have run one tool before proceeding with another. Always verify the necessary inputs are present before attempting to run a tool.

Standards

Paths and File Names

Standardized paths and file names were developed for MnModel Phase 4 (Figure 1). These are used in this handbook to specify which files to use in each tool. The highest level directory in this standard system is 'MNMODEL4'. That directory may sit at the root of any drive or within another directory. For some tools, one need to specify only the location of the MNMODEL4 directory and the name of the modeling region (i.e. BGWD). In some cases, additional information such as the gSSURGO year, model version number, etc. may be necessary. However, most paths and filenames should be standardized so that they are identical from region to region. This is enforced by the scripts and the required inputs to the tools.

Figure 1. MnModel Phase 4 Data Directory Structure
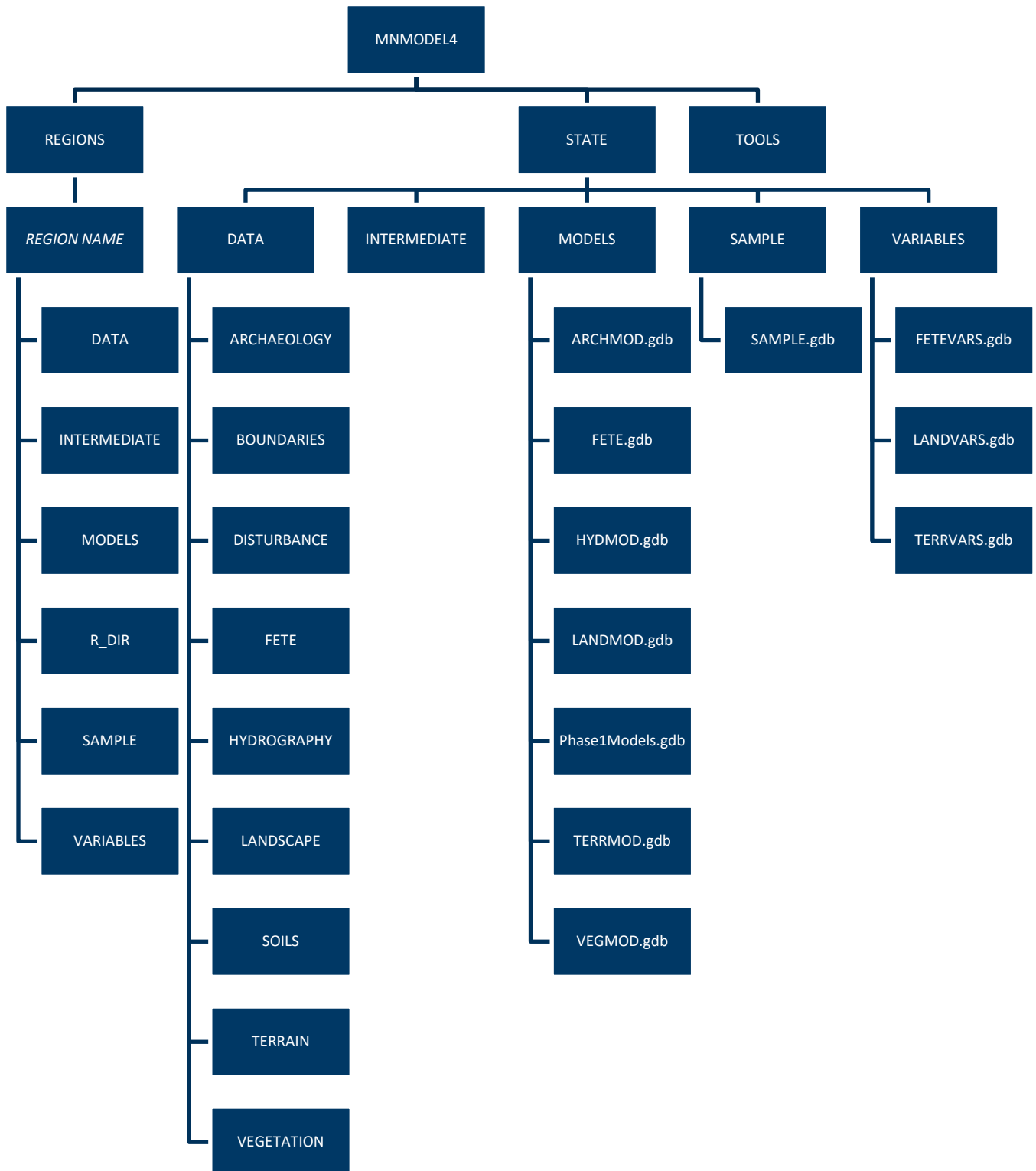
Environment Settings

When running most tools in ArcGIS, the MnModel Phase 4 standard default geoprocessing environments must be set (Figure 2).   Some tools handle this themselves.

Figure 2: 'Environment Settings' Dialog Box
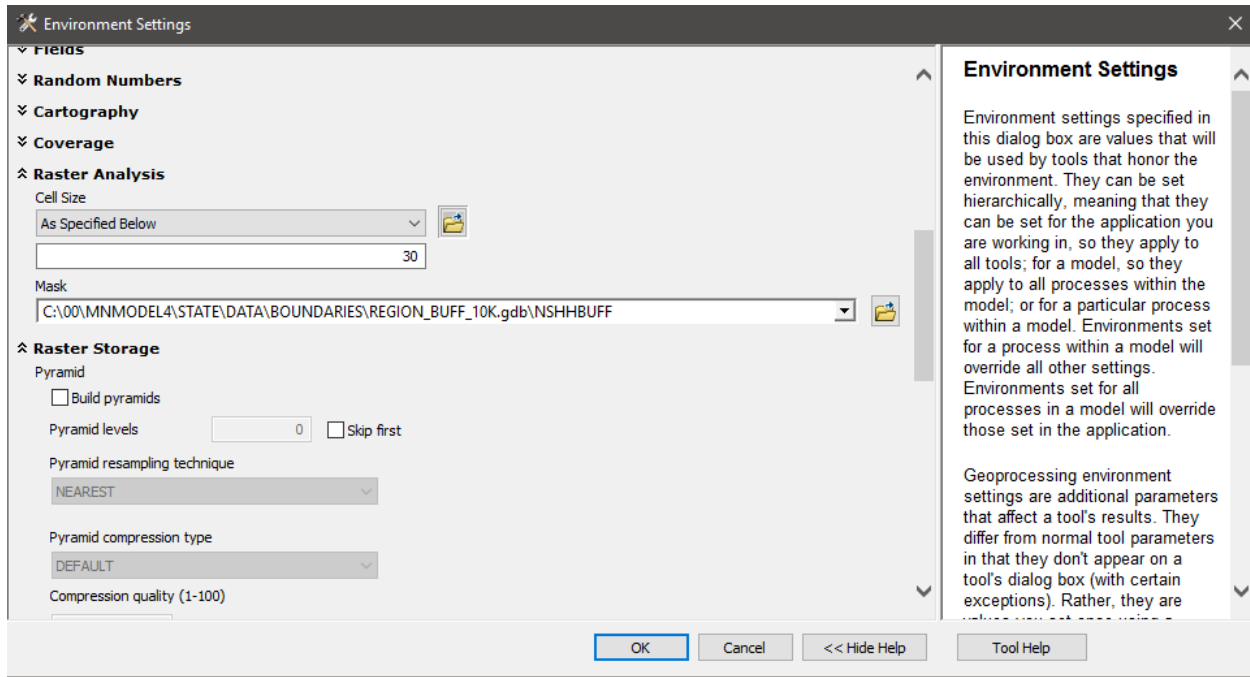
MnModel Phase 4 Standard Environment Settings

- **Output Coordinates:** NAD_1983_UTM_Zone_15N
- **Processing Extent:**
  - Extent:
    - Same as layer \MNMODEL4\STATE\DATA\TERRAIN\DTM.gdb\DTM10COND for statewide 10 m rasters.
    - Same as layer \MNMODEL4\STATE\DATA\TERRAIN\DTM.gdb\DTM30COND for statewide 30 m rasters.
    - Same as layer \MNMODEL4\STATE\DATA\BOUNDARIES\REGION_BUFF_10K.gdb*REG*BUFF for regional variables and models.
  - Snap Raster:
    - \MNMODEL4\STATE\DATA\TERRAIN\DTM.gdb\DTM10COND for 10 m rasters
    - \MNMODEL4\STATE\DATA\TERRAIN\DTM.gdb\DTM30COND for 30 m rasters.

- **Raster Analysis**
    - Cell Size:
        - 10 meters for terrain data, terrain variables, landscape variables, and soils variables.
        - 30 meters for the vegetation and hydrographic models, the cost-path variables, the vegetation variables, and the predictive models.
        - 90 meters for the FETE variables
    - Mask:
        - \MNMODEL4\STATE\DATA\TERRAIN\DTM.gdb\DTM10COND for 10 m rasters
        - \MNMODEL4\STATE\DATA\TERRAIN\DTM.gdb\DTM30COND for 30 m rasters.
        - For regions, be careful to use the buffered region boundary, \MNMODEL4\STATE\DATA\BOUNDARIES\REGION_BUFF_10K.gdb*REG*BUFF, not a statewide mask.
- **Raster Storage**
    - **DO NOT BUILD PYRAMIDS.** Prediction (and other classified) grids with pyramids do not display well.
    - **Raster Statistics:** Calculate.

Data Development Tools

Data development tools are used in the earliest stages of the modeling process, when archaeological and environmental data are converted and manipulated to make them suitable to serve as sources for variables.

Soils Data Conversion

gSSURGO data are released by NRCS each year. It may not be necessary to update the gSSURGO data for MnModel with each release. However, if new areas are mapped by gSSURGO, an update may be warranted.

Merge gSSURGO Geodatabases

Tool Name: Merge gSSURGO Geodatabases (Figure 3)

Tool Location: \\MNMODEL4\TOOLS\TOOLBOXES\MnModel\mnmodel.pyt\VARIABLES\Merge gSSURGO Geodatabases

Purpose of Tool: Merges gSSURGO soil polygons from adjacent states within a 10km buffer surrounding Minnesota with all gSSURGO soil polygons within Minnesota and puts the merged polygons and merged tables into one common geodatabase.

Figure 3: 'Merge gSSURGO Geodatabases' Tool
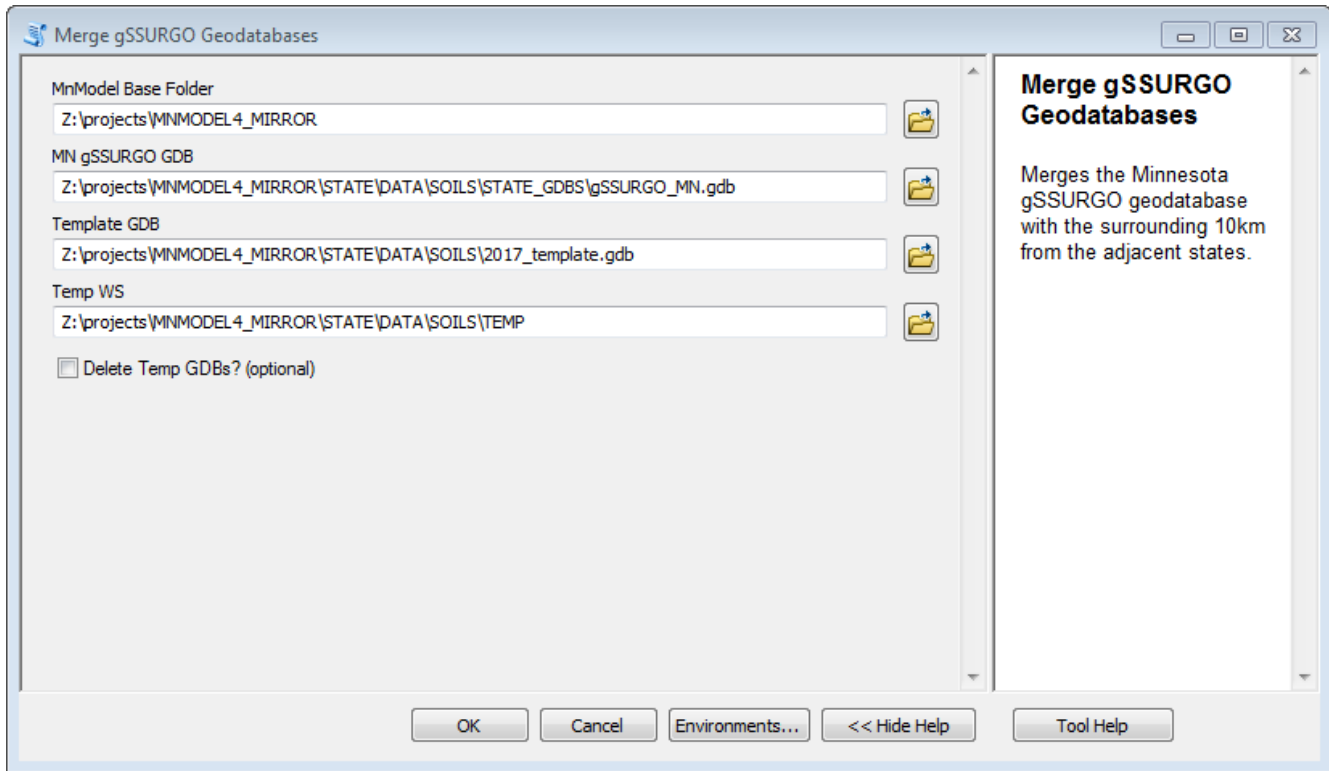
Requirements:

- gSSURGO soils data for Minnesota and surrounding states
- A Temporary Workspace Folder
- A template geodatabase to allow for the preservation of data relationships within the final output merged gSSURGO soils geodatabase
- To create a template geodatabase export the Minnesota gSSURGO soils data to an XML Workspace document as Figure 4 depicts.
  - Set the options for exporting an XML workspace document as they are set in Figure 5, specifying that the 'Schema Only' should be exported as *YEAR*_template.gdb. Export metadata as well.

Figure 4: Export gSSURGO to XML Workspace Procedure
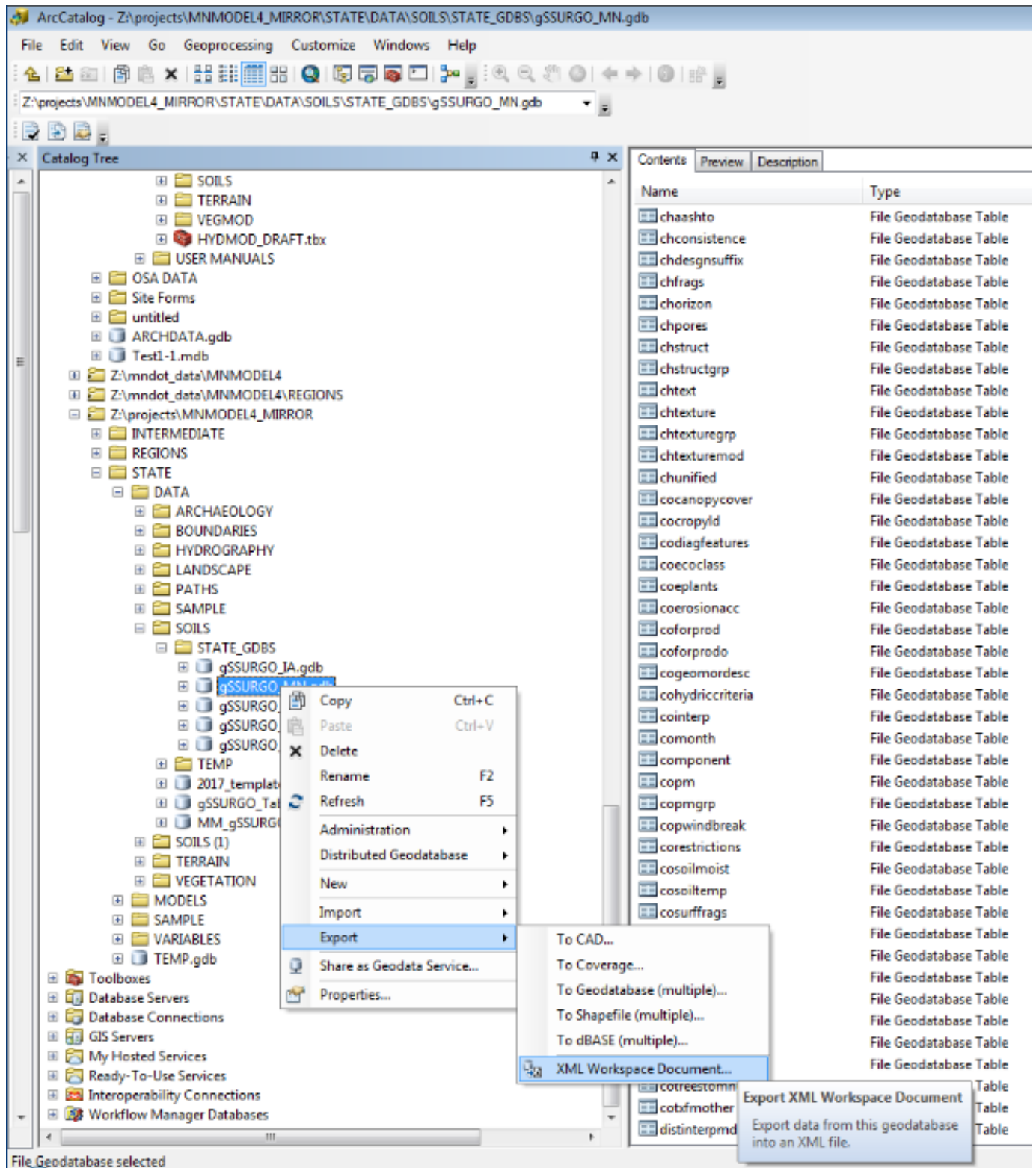
Figure 5: 'Export XML Workspace Document' Dialog Box
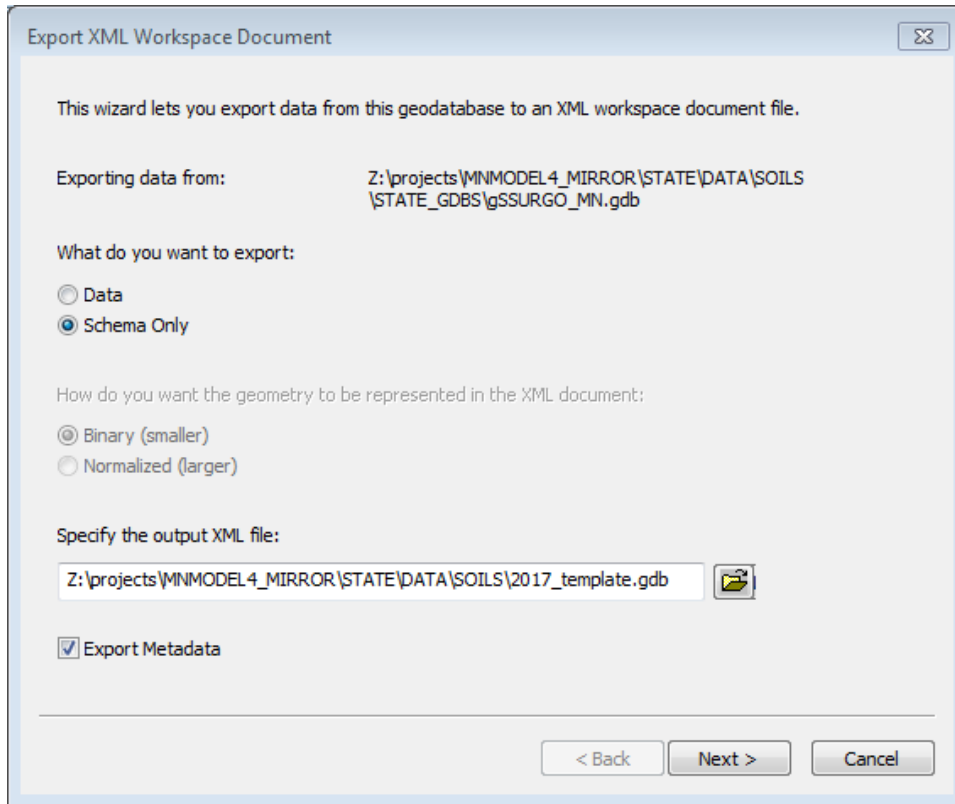
Inputs:

- **MnModel Base Folder:** The file path to the MNMODEL4 folder
- **MN gSSURGO GDB:** Minnesota gSSURGO (soils) geodatabase
- **Template GDB:** Previously generated template geodatabase
- **Temp WS:** Temporary workspace for intermediate data
- **Delete Temp GDBs?:** Specify if temporary geodatabases should be deleted after the tool is finished running

Outputs:

Merged soils geodatabase containing all Minnesota soil polygons and soil polygons from surrounding states within 10km of Minnesota as well as all associated tables.

- \\MNMODEL\STATE\DATA\SOILS\gSSURGO_merged.gdb

Summarize Tables

Tool Name: Summarize Tables (Figure 6)

Tool Location: \\MNMODEL\TOOLS\TOOLBOXES\MnModel\mnmodel.pyt\Utils

Purpose of Tool: The purpose of this tool is to summarize certain gSSURGO soil tables into one, easy to use table. Specifically, the tool was designed to summarize soil component data by mapunits. However, this tool can also be utilized to summarize any suitable table.

Figure 6: 'Summarize Tables' Tool
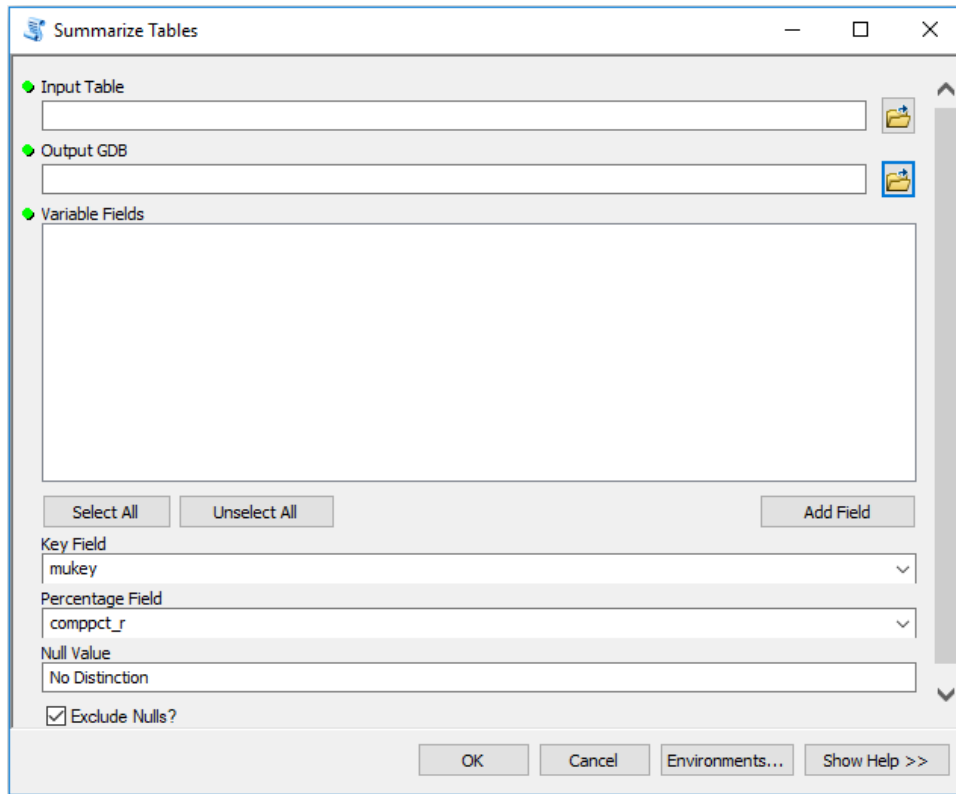
Inputs:

- **Input Table:** The table from which the fields will be summarized.
- **Output GDB:** The geodatabase where the output table will be saved.
- **Variable Fields:** The fields to be summarized.
- **Key Field:** The field by which the variable fields will be summarized.
- **Percentage Field:** The field representing the percentage of the key field a row covers.
- **Null Value:** A value to be considered null.
- **Exclude Nulls:** Whether the values marked as null will be excluded from the summary.
- **Deleted Existing Output:** Whether the tool should delete the output table if it already exists.
- **Create Relationship Class:** Whether the tool should create a relationship class between the input table and the output summary table.

Outputs:

The summary output table will be created in the output geodatabase.

Create MM_gSSURGO Tables

Script Name: gSSURGO_Variable_Extract.pyt\Create MM_gSSURGO Tables (Figure 7)

Tool Location: \\MNMODEL4\TOOLS\TOOLBOXES\SOILS

Purpose of Tool: This tool extracts data from the gSSURGO geodatabase and summarizes it by map unit for display and analysis.

Figure 7: 'Create MM_gSSURGO Tables' Tool
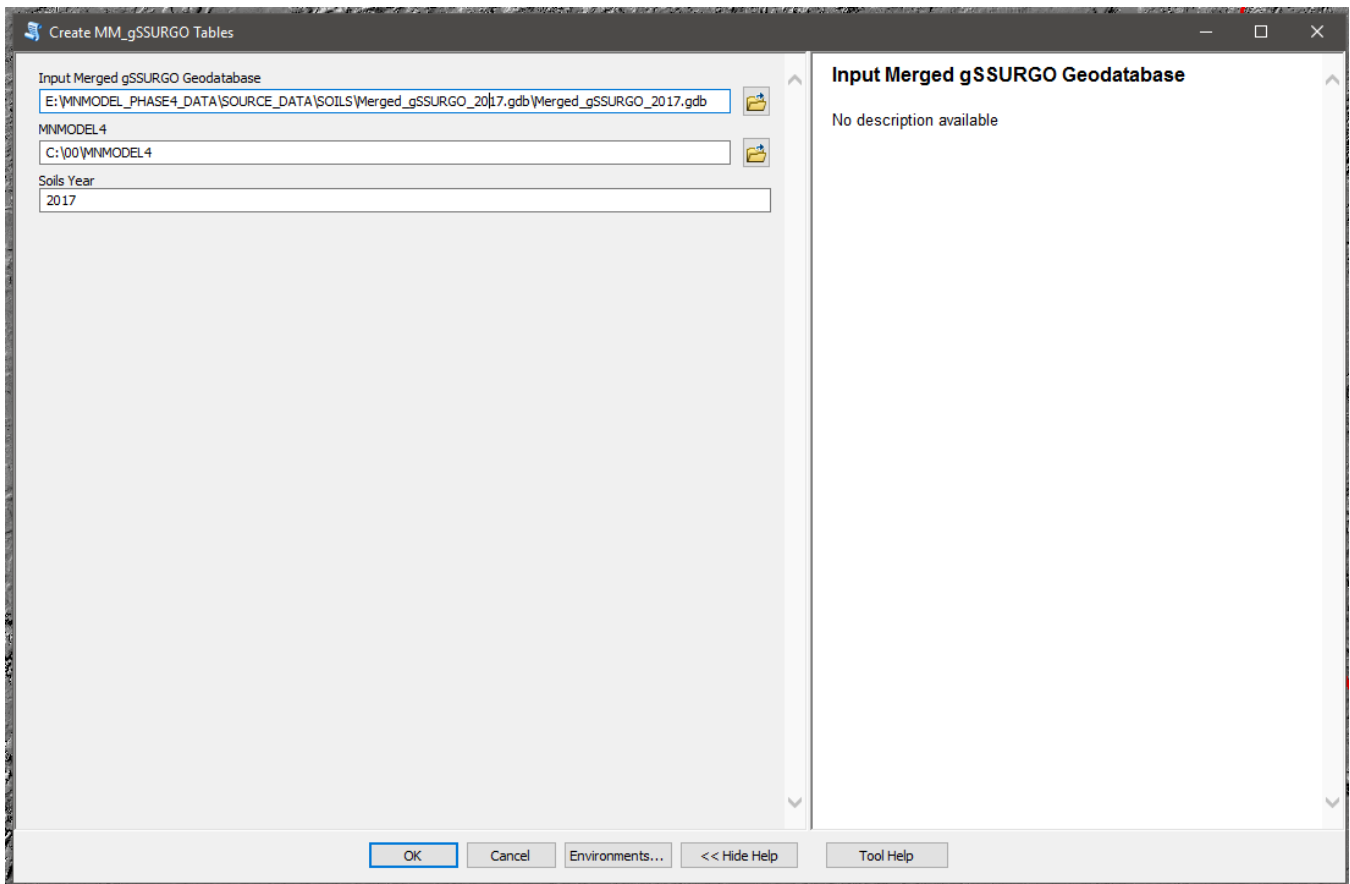
Requirements:

- **gSSURGO_merged.gdb:** \\MNMODEL4\STATE\DATA\SOILS\gSSURGO_merged.gdb
  - Created by running Merge gSSURGO Geodatabases tool.
  - Tables used by this tool (all tables will be present in the gSSURGO_merged geodatabase):
    - mupolygon
    - mapunit
    - component
    - muaggatt
    - valu1

- chorizon
- cogeomordesc
- copm
- copmgrp

- **MaxComp_DI_PI_regime:** \\MNMODEL4\STATE\DATA\SOILS\di_pi_2017.gdb\MaxComp_DI_PI_regime.
  - Created by running the **Summarize Tables** tool on tables provided by Michigan State.

Inputs:

- **Merged gSSURGO Geodatabase**: \\MNMODEL4\STATE\DATA\SOILS\gSSURGO_merged.gdb
- **MNMODEL4**: Path to the MNMODEL 4 folder
- **Soils Year**: Year (####) associated with gSSURGO data

Outputs:

- (MM_Mapunit, MM_Component, MM_Comp_Horizon, MM_Mapunit_Hdyro, MM_Mapunit_SoilTax, MM_Mapunit_Surface, MM_Mapunit_Veg, MM_Mapunit_Geomorph, MM_Mapunit_Parent_Material, MM_Mapunit_MGSField, MM_Mapunit_Interpreted[empty]) tables
  - Found in \\MNMODEL4\STATE\DATA\SOILS\MM_gSSURGO_*year*.gdb.

Notes:

The MM_Interpreted table is left empty for manual interpretation since values in gSSURGO tables change from year to year. It may be possible to expedite this interpretation by joining to previous versions of this table using the mapunit key as a join item, calculating matching records, and interpreting only new mapunits. Be careful of this, though, as NRCS has been known to change mapunit keys from one gSSURGO release to the next.

Hydrographic Data Editing

Modern hydrographic data from several sources were combined and edited to obtain polygons for the hydrographic model. The overlay resulted in sliver polygons that needed to be merged with the appropriate adjacent larger polygon. Tools were developed to assign the values of large classified polygons to adjacent smaller, unclassified polygons.

Add QAQC Fields to MODWATGLO_MU

Tool Name: Add QAQC Fields (Figure 8)

Tool Location: \\MNMODEL4\TOOLS\TOOLBOXES\MnModel\mnmodel.pyt\HYDPREP

Purpose of Tool: This tool copies all fields in \\MNMODEL4\REGIONS\REG\DATA\HYDROGRAPHY\HYD_PREP_REG.gdb\MODWATGLO_MU besides OBJECTID, SHAPE, SHAPE_Length, and SHAPE_Area and appends _MSU to the copied field names. 'MSU' is added to the beginning of field aliases to make differentiating copies from originals easier. While editing this feature class,

users make edits to the MSU fields in order to retain the original values. Users can then use the **Apply Changes** tool to copy the MSU field values to the original fields.

Figure 8: 'Add QAQC Fields' Tool
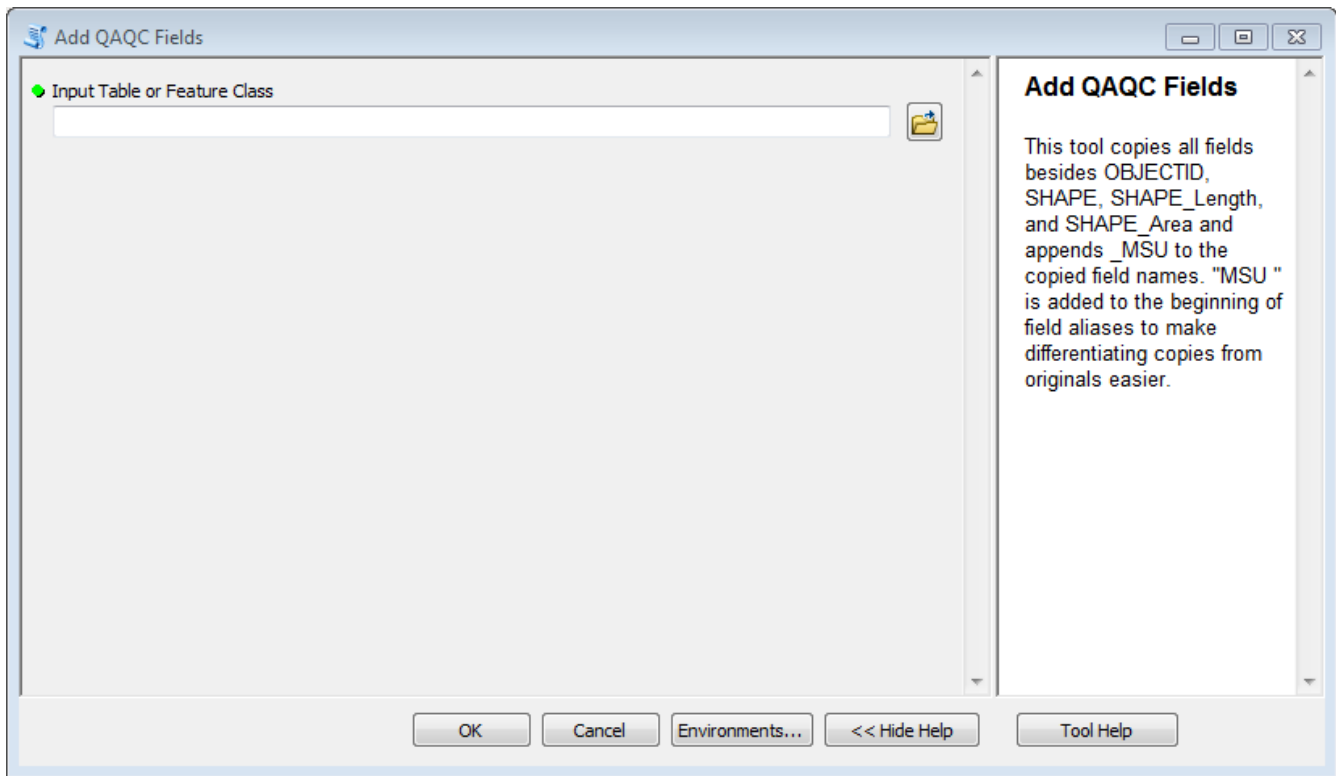
Requirements:

- **MODWATGLO_MU:**
  \\MNMODEL4\REGIONS\REG\DATA\HYDROGRAPHY\HYD_PREP_REG.gdb\MODWATGLO_MU
  - o Containing these fields:
    - ▪ SOURCE
    - ▪ HYD_SYS
    - ▪ CLASS
    - ▪ TYPE

Inputs:

MODWATGLO_MU:
\\MNMODEL4\REGIONS\REG\DATA\HYDROGRAPHY\HYD_PREP_REG.gdb\MODWATGLO_MU

Outputs:

\\MNMODEL4\REGIONS\REG\DATA\HYDROGRAPHY\HYD_DATA_REG.gdb\MODWATGLO_MU with MSU QAQC fields added.

Apply Changes

Tool Name: Apply Changes (Figure 9)

Tool Location: \\MNMODEL4\TOOLS\TOOLBOXES\MnModel\mnmodel.pyt\HYDPREP

Purpose of Tool: This tool: Field calculates the HYD_SYS, SOURCE, CLASS, TYPE, and CLASS_CONF fields to the values of MSU_HYD_SYS, MSU_SOURCE, MSU_CLASS, MSU_TYPE, and MSU_CLASS_CONF, respectively. The tool respects any user selections.

Figure 9: 'Apply Changes' Tool
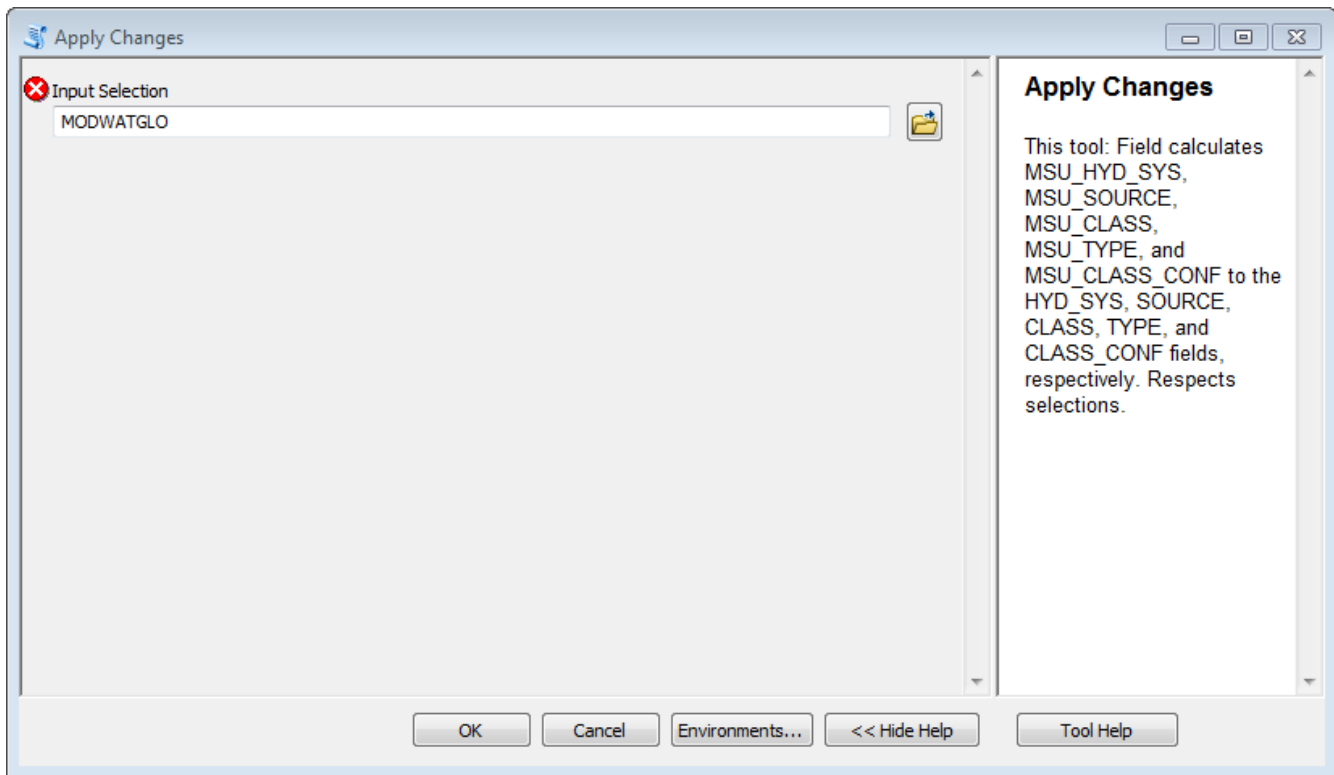
Requirements:

- \\MNMODEL4\REGIONS*REG*\DATA\HYDROGRAPHY\HYD_PREP_*REG*.gdb\MODWATGLO_MU feature layer
- HYD_SYS, SOURCE, CLASS, TYPE, CLASS_CONF, MSU_HYD_SYS, MSU_SOURCE, MSU_CLASS, MSU_TYPE, and MSU_CLASS_CONF fields.

Inputs:

\\MNMODEL4\REGIONS*REG*\DATA\HYDROGRAPHY\HYD_PREP_*REG*.gdb\MODWATGLO_MU layer with hydrographic polygons whose attributes the user would like changed selected

Outputs:

Original MODWATGLO_MU fields are updated. No new output feature class created.

Create Neighbors Table

Tool Name: Create Neighbors Table (Figure 10)

Tool Location: \\MNMODEL4\TOOLS\TOOLBOXES\MnModel\mnmodel.pyt\HYDPREP

Purpose of Tool: This tool creates a polygon neighbors table that many of the tools in this toolbox require. The neighbors table consists of records of any feature that shares a boundary with another feature. The feature's OBJECTID and the neighboring feature's OBJECTID are recorded.

Figure 10: 'Create Neighbors Table' Tool
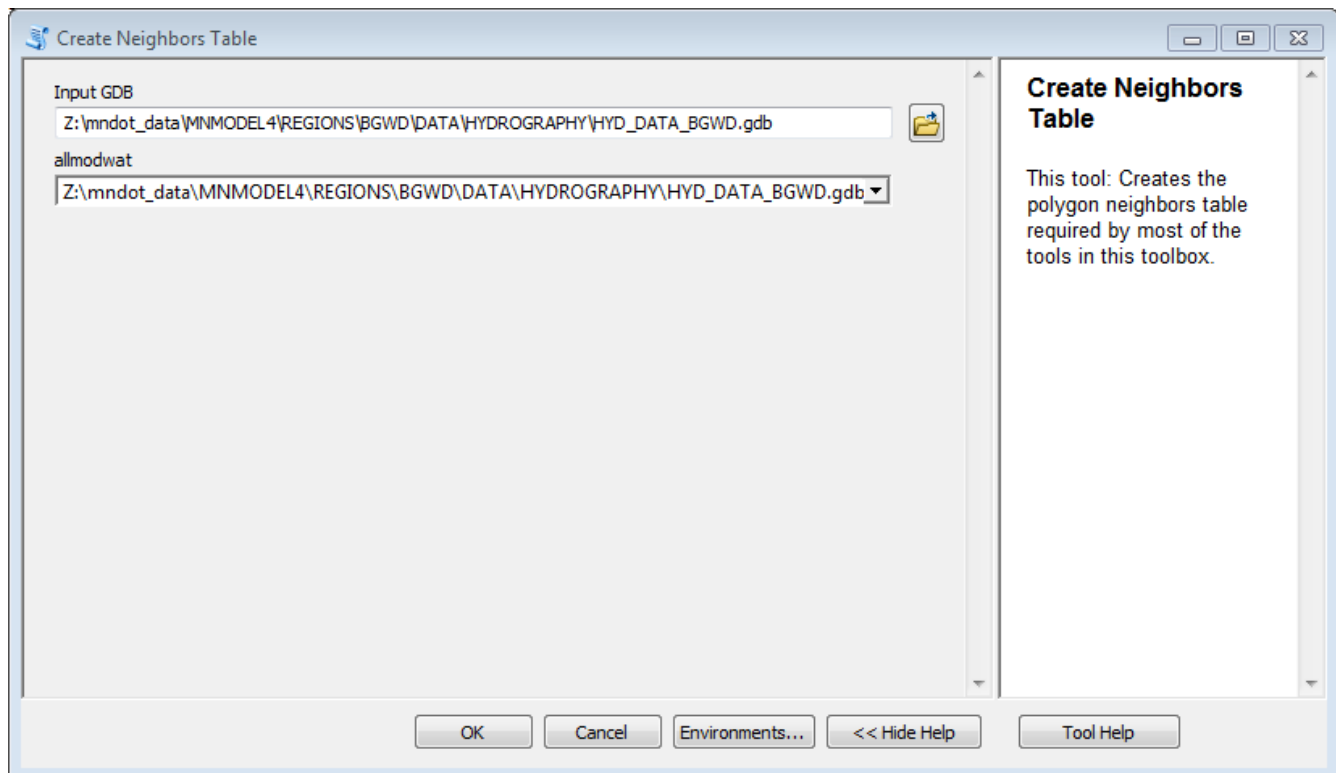
Requirements:

MODWATGLO_MU:
\\MNMODEL4\REGIONS*REG*\DATA\HYDROGRAPHY\HYD_PREP_*REG*.gdb\MODWATGLO_MU

Inputs:

- **HYD_PREP_*REG*.gdb:** \\MNMODEL4\REGIONS*REG*\DATA\HYDROGRAPHY\HYD_PREP_*REG*.gdb
- **MODWATGLO_MU:**
  \\MNMODEL4\REGIONS*REG*\DATA\HYDROGRAPHY\HYD_PREP_*REG*.gdb\MODWATGLO_MU

Outputs:

\\MNMODEL4\REGIONS\REG\DATA\HYDROGRAPHY\HYD_PREP_*REG*.gdb\MODWATGLO_MU_neighbors

Fix Neighbors

Tool Name: Fix Neighbors (Figure 11)

Tool Location: \\MNMODEL4\TOOLS\TOOLBOXES\MnModel\mnmodel.pyt\HYDPREP

Purpose of Tool: This tool finds all neighbors of each selected source feature and then selects those neighbors flagged by users as needing to be checked (SOURCE is 'CHKALLWAT', 'CHKDNR', 'CHKGSS', 'CHKNHD', 'CHKNPC', 'CHKNPCNWI', 'CHKWATDNR', 'CHKWATGSS', 'CHKWATNPC', 'CHKWATNWI', 'NOTWATDNR', 'NOTWATGSS', 'NOTWATNHD', 'NOTWATNPC', or 'NOTWATNWI'). If the selected source feature is the neighbor with the longest shared edge, then the selected neighbor's attribute values (SOURCE, HYD_SYS, CLASS, and TYPE) are calculated to those of the selected source feature. The selected feature must have been coded 'trustworthy' (SOURCE is 'GSS', 'NWI', 'NPC', 'NHD', or 'GLO').

Figure 11: 'Fix Neighbors' Tool
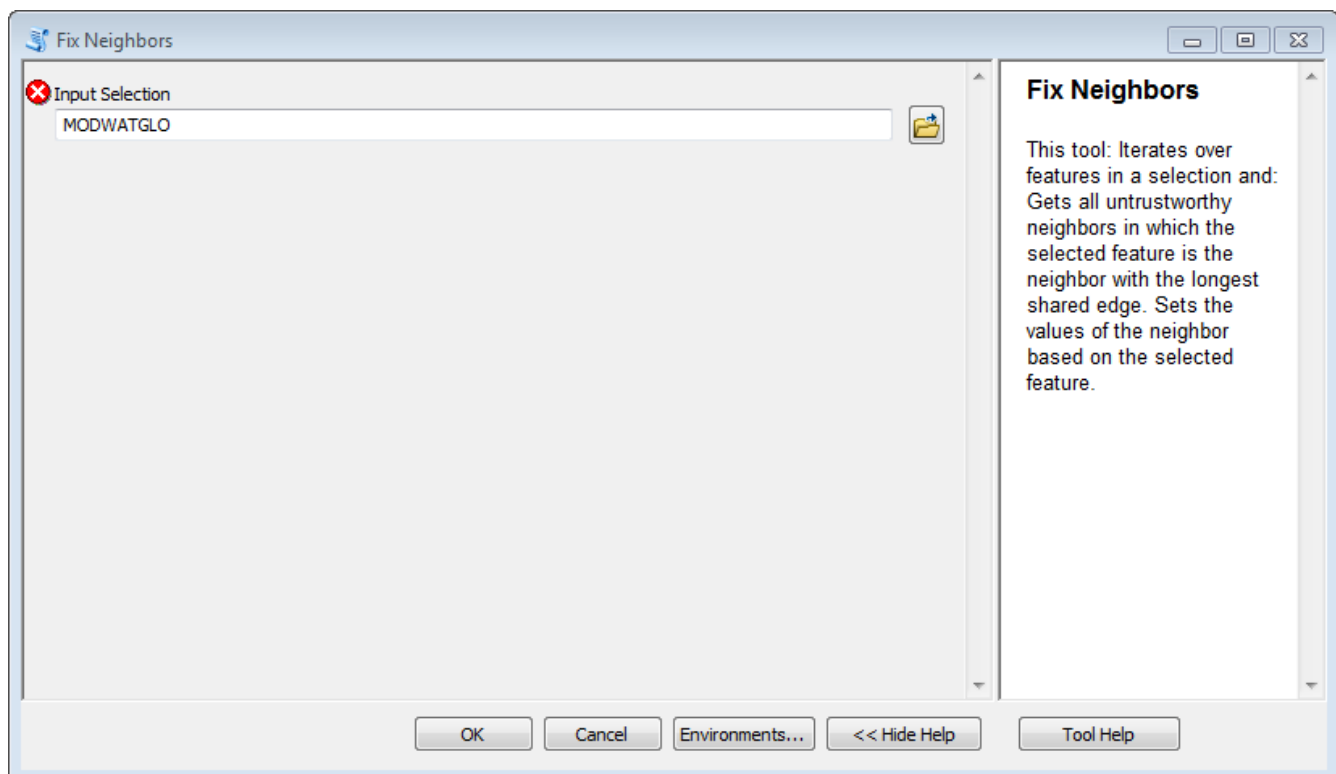
Requirements:

- **MODWATGLO_MU:**
  \\MNMODEL4\REGIONS*REG*\DATA\HYDROGRAPHY\HYD_PREP_*REG*.gdb\MODWATGLO_MU
  - Containing these fields:

- SOURCE
- HYD_SYS
- CLASS
- TYPE

- A polygon neighbors table from the **Create Neighbors Table** tool.

Inputs:

MODWATGLO_MU:
\\MNMODEL4\REGIONS\REG\DATA\HYDROGRAPHY\HYD_PREP_REG.gdb\MODWATGLO_MU

Outputs:

The neighbors are updated with values the selected trusted polygon.

Notes:

- This tool is used during an interactive edit session.
- The trusted polygon is selected by the user.

Get Editing Progress

Tool Name: Get Editing Progress (Figure 12)

Tool Location: \\MNMODEL4\TOOLS\TOOLBOXES\MnModel\mnmodel.pyt\HYDPREP

Purpose of Tool: This tool issues queries to get the count of the remaining 'untrustworthy' polygons (where SOURCE is 'CHKALLWAT', 'CHKDNR', 'CHKGSS', 'CHKNHD', 'CHKNPC', 'CHKNPCNWI', 'CHKWATDNR', 'CHKWATGSS', 'CHKWATNPC', 'CHKWATNWI', 'NOTWATDNR', 'NOTWATGSS', 'NOTWATNHD', 'NOTWATNPC', or 'NOTWATNWI') in each of three size groups: large (larger than 485640m^2); medium (smaller than 485640m^2 and larger than 161880m^2); small (between 161880m^2 and 12140.6m^2) and; tiny (smaller than 12140.6m^2).

Figure 12: 'Get Editing Progress' Tool
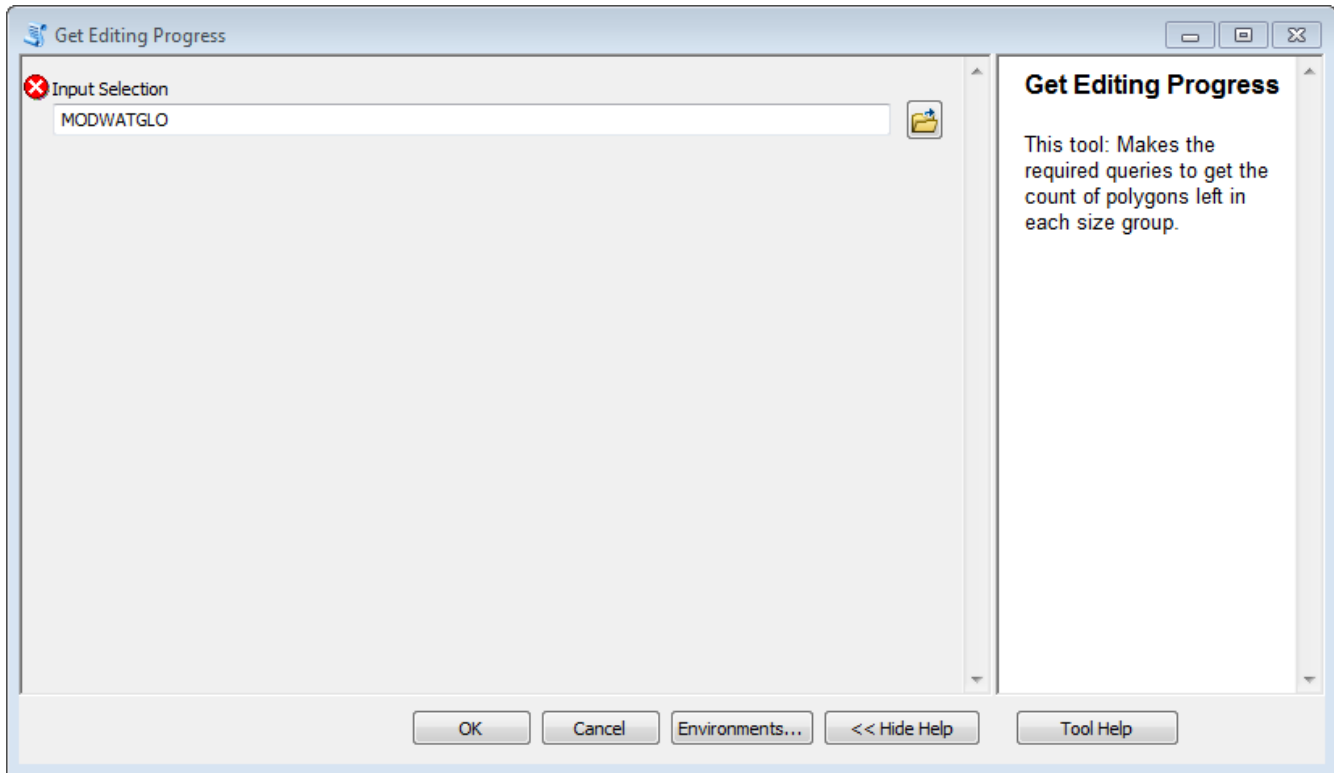
Requirements:

- **MODWATGLO_MU must exist:**
  \\MNMODEL4\REGIONS\REG\DATA\HYDROGRAPHY\HYD_PREP_REG.gdb\MODWATGLO_MU
- **MODWATGLO_MU fields must exist:**
  - SOURCE, with the following acceptable values:
    - GSS, NWI, NPC, NHD, GLO, CHKALLWAT, CHKDNR, CHKGSS, CHKNHD, CHKNPC, CHKNPCNWI, CHKWATDNR, CHKWATGSS, CHKWATNPC, CHKWATNWI, NOTWATDNR, NOTWATGSS, NOTWATNHD, NOTWATNPC, NOTWATNWI
  - CLASS_CONF (integer)

Inputs:

\\MNMODEL4\REGIONS*REG*\DATA\HYDROGRAPHY\HYD_PREP_*REG*.gdb\MODWATGLO_MU

Outputs:

An editing progress table in the feature class's geodatabase:

- \\MNMODEL4\REGIONS*REG*\DATA\HYDROGRAPHY\HYD_PREP_*REG*.gdb\editing_progress

Select Neighbors

Tool Name: Select Neighbors (Figure 13)

Tool Location: \\MNMODEL4\TOOLS\TOOLBOXES\MnModel\mnmodel.pyt\HYDPREP

Purpose of Tool: This tool updates a user selection with all neighbors of the selected polygon.

Figure 13: 'Select Neighbors' Tool
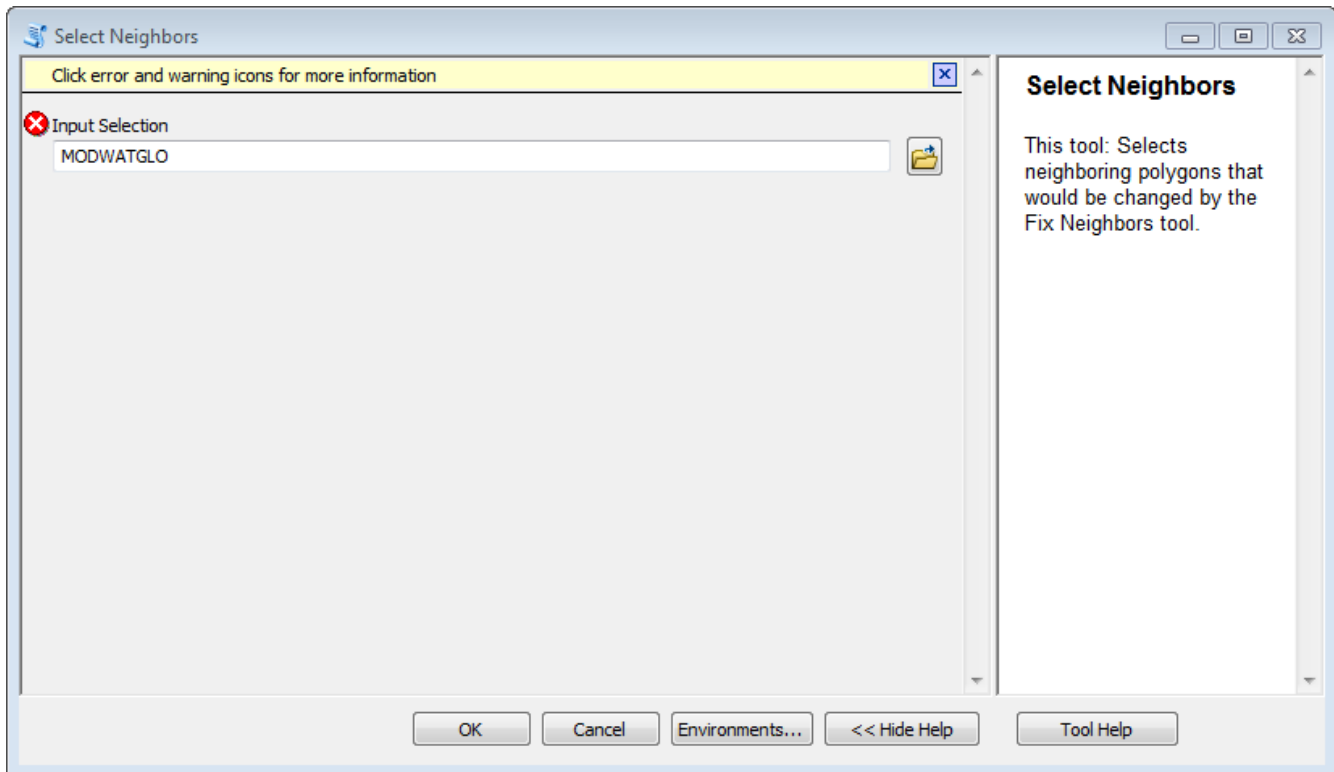
Requirements:

The user must be working in ArcGIS and have made a selection in a polygon layer.

Inputs:

\\MNMODEL4\REGIONS*REG*\DATA\HYDROGRAPHY\HYD_PREP_*REG*.gdb\MODWATGLO_MU

Outputs:

Neighbors of initially selected features are selected as a result of this tool.

Notes:

The user must run the tool again in order to make subsequent selections.

Set Values

Tool Name: Set Values (Figure 14)

Tool Location: \\MNMODEL4\TOOLS\TOOLBOXES\MnModel\mnmodel.pyt\HYDPREP

Purpose of Tool: This tool sets the values of selected features with attribute values selected by the user. This tool is useful when the user sees one or more features that should all be reclassified to the same SOURCE, HYD_SYS, CLASS, and TYPE values.

Figure 14: 'Set Values' Tool
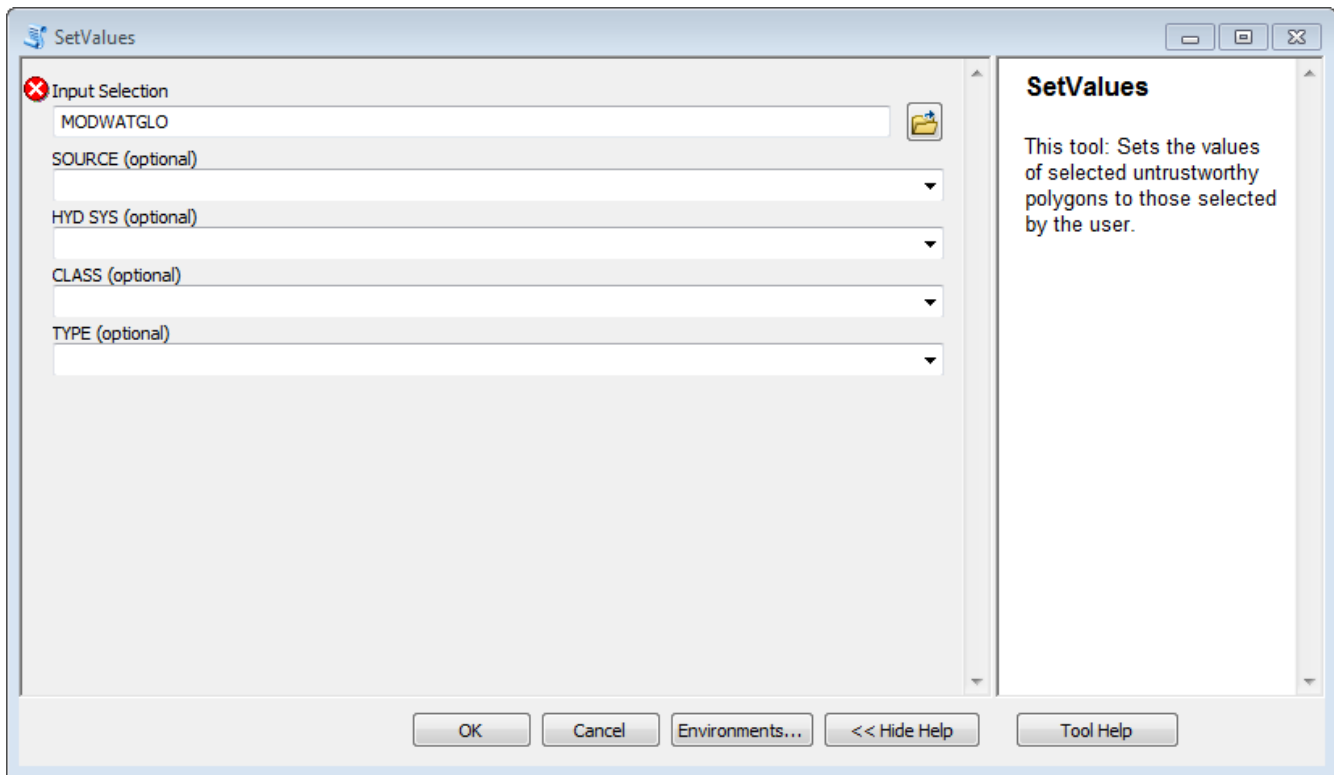
Requirements:

- The user should be working in an ArcMap editing session.
- The active feature class attribute table must have the fields SOURCE, HYD_SYS, CLASS, and TYPE. It does not matter what values are in those fields. You will get the option to set them to trusted values.

Inputs:

- A hydrographic feature layer with selected polygons that have values the user would like to calculate to the user-specified values.
- [Optional] SOURCE: User-specified data source to assign to the selected hydrographic feature (e.g. NWI, GLO, NHD)

- [Optional] HYD SYS: User-specified hydrological system to assign to the selected features (e.g. Lacustrine, Riverine, Artificial)
- [Optional] CLASS: User-specified hydrological class to assign to the selected features (e.g. Artificial Lake)
- [Optional] TYPE: User-specified hydrological type to assign to the selected features (e.g. Floodplain Forest, Wet Meadow)

Outputs:

The selected polygons are updated with user-defined values.

Notes: Because this is a hierarchical classification system, the HYD_SYS value is dependent on the CLASS value, which is dependent on the TYPE value. If you select a TYPE value, the CLASS AND HYD_SYS fields will automatically be filled with the correct values. The Source field indicates the source of the data. Valid values and their positions in the hierarchy are:

- **Source**:
  - GSS = gSSURGO
  - NWI = National Wetlands Inventory
  - NPC = MnDNR Natural Plant Communities
  - NHD = National Hydrography Dataset
  - GLO = General Land Office (Public Land Survey) plat maps
- **HYD_SYS**:
  - RIVERINE
    - **CLASS**:
      - AQUATIC RIVER COMMUNITY
        - **TYPE**:
          - RESERVOIR
          - UNCONSOLIDATED SHORE
          - ROCKY SHORE
          - RIVER BED
          - DITCH
          - WILLOW SANDBAR SHRUBLAND
  - LACUSTRINE
    - **CLASS**:
      - AQUATIC LAKE COMMUNITY
        - **TYPE**:
          - LAKE BED
          - ROCKY SHORE
          - RESERVOIR
          - UNCONSOLIDATED SHORE

- o PALUSTRINE
  - **CLASS**:
    - BOG
      - o **TYPE**:
        - BOG
        - BLACK SPRUCE BOG
        - OPEN SPHAGNUM BOG
    - CONIFER SWAMP FOREST
      - o **TYPE**:
        - CONIFER SWAMP
        - BLACK SPRUCE SWAMP
        - EVERGREEN CONIFER SWAMP
        - TAMARACK SWAMP
        - WHITE CEDAR SWAMP
    - EMERGENT MARSH
      - o **TYPE**:
        - MARSH
        - CATTAIL MARSH
        - ESTUARY MARSH
        - MIXED EMERGENT MARSH
        - PHALARIS MARSH
    - FLOODPLAIN FOREST
      - o **TYPE**:
        - FLOODPLAIN FOREST
        - TERRACE FOREST
    - HARDWOOD SWAMP FOREST
      - o **TYPE**:
        - HARDWOOD SWAMP
        - BLACK ASH SWAMP
        - WET ASPEN FOREST
    - INTERMITTENT WATER
      - o **TYPE**:
        - INTERMITTENT WATER
        - DISTURBED LAND
        - RESERVOIR
    - SHRUB SWAMP
      - o **TYPE**:
        - SHRUB SWAMP

- ■ ALDER SWAMP
- ■ WILLOW SWAMP
- • SWAMP FOREST
  - o **TYPE**:
    - ■ SWAMP FOREST
    - ■ DECIDUOUS (HARDWOOD OR CONIFER) SWAMP
- • WET MEADOW/FEN
  - o **TYPE**:
    - ■ WET MEADOW/FEN
    - ■ CALCAREOUS SEEPAGE FEN
    - ■ FEN
    - ■ POOR FEN
    - ■ RICH FEN
    - ■ RICH/POOR FEN
    - ■ SALINE WET PRAIRIE COMPLEX
    - ■ SEEPAGE MEADOW
    - ■ SEEPAGE WETLAND COMPLEX
    - ■ SHRUB FEN
    - ■ WET BRUSH-PRAIRIE
    - ■ WET MEADOW
    - ■ WET PRAIRIE
    - ■ WET SALINE PRAIRIE
- o ARTIFICIAL
  - ■ **CLASS**:
    - • ARTIFICIAL LAKE
      - o **TYPE**:
        - ■ MINE
    - • ARTIFICAL POND
      - o **TYPE**:
        - ■ CONSTRUCTED POND
        - ■ MINE
    - • BUILT WETLAND
      - o **TYPE**:
        - ■ BUILT MARSH
    - • INTERMITTENT WATER
      - o **TYPE**:
        - ■ DITCH
        - ■ MINE

Set Values from Selected

Tool Name: Set Values from Selected (Figure 15)

Tool Location: \\MNMODEL4\TOOLS\TOOLBOXES\MnModel\mnmodel.pyt\HYDPREP

Purpose of Tool: This tool sets the values of selected polygons coded by the user as 'untrustworthy' (where SOURCE is 'CHKALLWAT', 'CHKDNR', 'CHKGSS', 'CHKNHD', 'CHKNPC', 'CHKNPCNWI', 'CHKWATDNR', 'CHKWATGSS', 'CHKWATNPC', 'CHKWATNWI', 'NOTWATDNR', 'NOTWATGSS', 'NOTWATNHD', 'NOTWATNPC', or 'NOTWATNWI') to those from a single selected 'trustworthy' (SOURCE is 'GSS', 'NWI', 'NPC', 'NHD', or 'GLO') polygon's values. It does not matter in which order polygons are selected. Only one trustworthy polygon can be selected but as many untrustworthy polygons as the user chooses can be selected.

Figure 15: 'Set Values From Selected' Tool
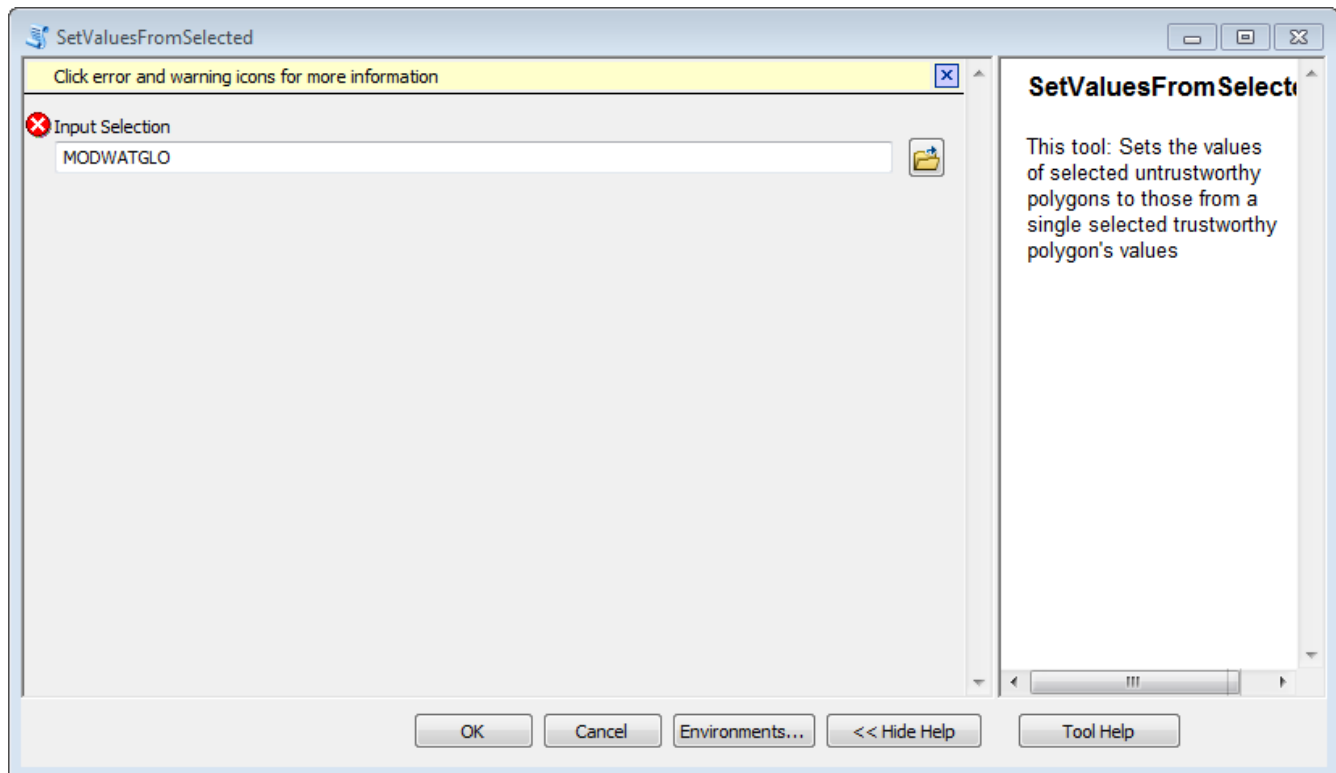
Requirements:

- The user must be using ArcMap and should be working in an editing session.
- Hydrographic feature layer with the following fields:
  - SOURCE (Text)
  - HYD_SYS (Text)
  - CLASS (Text)
  - TYPE (Text)
  - CLASS_CONF (Integer)

Inputs:

A hydrographic feature layer with one or more 'untrustworthy' polygons selected and a single 'trustworthy' polygon selected. All 'untrustworthy' polygons and the single 'trustworthy' polygon are in a single selection set. The order does not matter. The values of the 'untrustworthy' polygons will be set to the trustworthy polygon's values.

Outputs:

A hydrographic feature class with corrected values for selected polygons.

Notes:

Hold the Shift key while using the selection cursor in ArcMap to select multiple features as part of one selection.

Hydrographic Modeling Tool

A single tool creates the MnModel Phase 4 Hydrographic Model. It also creates feature classes of historic and prehistoric floodplains.

Create Hydrographic Model

Tool Name: Create Hydrographic Model (Figure 16)

Tool Location: \\MNMODEL4\TOOLS\TOOLBOXES\MnModel\mnmodel.pyt\HYDMOD

Purpose of Tool: This tool generates regional historic and prehistoric hydrographic models to be used as input to MnModel.

Figure 16: 'Create Hydrographic Model' Tool
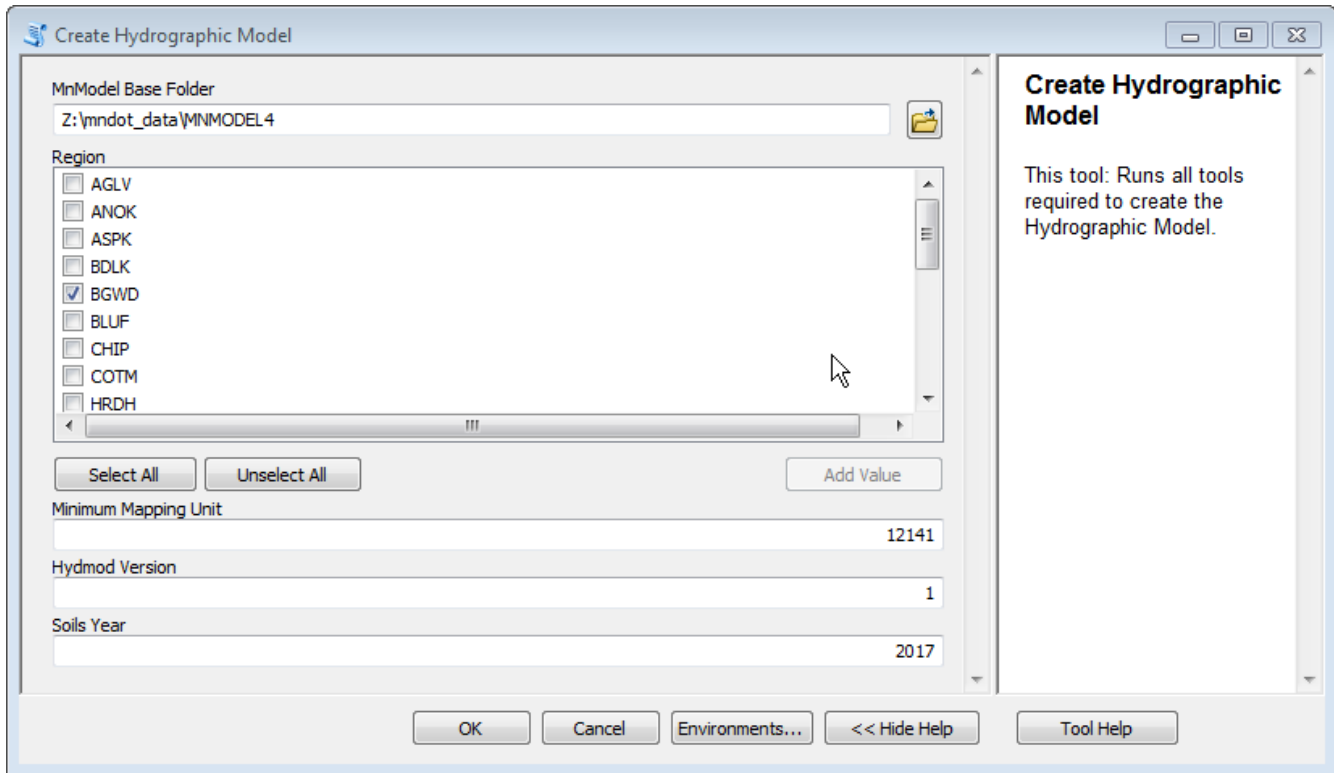
Requirements:

The hydrographic data feature classes must match the specifications described below and, if edited by regions, merged back into the state feature classes. The ALR_MODWATGLO_MU, GLO_WATER, and STREAMS feature classes must each have a 'USE' field coded as either 1 or 0. Only features coded 'USE = 1' will be used for the hydrographic model.

- \\MNMODEL4\STATE\DATA\HYDROGRAPHY\HYDMOD.gdb\ALR_MODWATGLO_MU. For MnModel Phase 4, ALR_MODWATGLO_MU included only water features coded as Artificial, Lacustrine, or Riverine. Palustrine features were excluded as those were derived from the Vegetation model. It is not necessary to exclude palustrine features as the hydrographic model tool excludes those automatically. This version of the edited modern water polygons has only two attributes:
  - USE (Integer)
    - 1: Use in model
    - 0: Do not use in model
  - MODHYD (String)
    - Artificial
    - Lake
    - River
    - Wetland

- ▪ Beach
- \\MNMODEL4\STATE\DATA\HYDROGRAPHY\HYD_DATA.gdb\GLO_WATER. This is the feature class of lake and river polygons digitized from the General Land Office plat maps. It must include the following fields:
  - o SYSTEM
  - o CLASS
  - o TYPE
  - o USE (Integer)
    - ▪ 1: Use in model
    - ▪ 0: Do not use in model
- \\MNMODEL4\STATE\DATA\HYDROGRAPHY\HYD_DATA.gdb\STREAMS. This is the statewide line feature class of streams. It includes streams from several sources and must include the following fields:
  - o USE (Integer)
    - ▪ 1: Use in model
    - ▪ 0: Do not use in model
  - o ALTERED
  - o HYD_REG
  - o STRM_LONG
- State MnModel Soils data. The MM_mupolygon feature class and MM_Mapunit_Interpreted table are used to identify soil polygons that were saturated at some time in the past, on the basis of Great Groups.
  - o \\MNMODEL4\STATE\DATA\SOIL\MM_gSSURGO_*YEAR*.gdb\MM_mupolygon
  - o \\MNMODEL4\STATE\DATA\SOIL\MM_gSSURGO_*YEAR*.gdb\MM_Mapunit_Interpreted, which must have the following fields:
    - ▪ mukey: the mapunit key field that will allow the table to be joined to the MM_mupolygon feature class.
    - ▪ HYDMODGRP. This field was coded as '1' for soil polygons to include in the prehistoric hydrographic model and '0' for soil polygons not to include in the hydrographic model, based on those soils' Great Group categories.
- \\MNMODEL4\STATE\DATA\LANDSCAPE\LANDSCAPE.gdb\LANDCHRON. This version of the MnModel Phase 4 Landscape Model (LANDMOD) must have the following fields indicating chronology of the landforms:
  - o GLACIAL: Type of glacial feature represented by the polygon. Valid values are:
    - ▪ FLOODPLAIN
    - ▪ LAKE BASIN
    - ▪ LAKE BED
    - ▪ LAKE SHORE
    - ▪ N (feature not present at this time period)

- RIVER BED
- SUBRIVER (river flowing within an ice sheet)
- X (Not a hydrographic feature at this time period)
  - o PREHISTORIC: Type of prehistoric, but post-glacial, feature represented by the polygon. Valid values are:
    - BOG
    - FEN
    - FLOODPLAIN
    - LAKE BASIN
    - LAKE BED
    - LAKE SHORE
    - N (feature not present at this time period)
    - RIVER BED
    - VALLEY
    - WETLAND
    - X (Not a hydrographic feature at this time period)
  - o HISTORIC: Type of historic feature represented by the polygon. Valid values are:
    - BOG
    - FEN
    - FLOODPLAIN
    - LAKE BASIN
    - LAKE SHORE
    - N (feature not present at this time period)
    - RIVER BED
    - VALLEY
    - WETLAND
    - X (Not a hydrographic feature at this time period)
  - o MODERN
    - BOG
    - FEN
    - FLOODPLAIN
    - LAKE BASIN
    - LAKE SHORE
    - RESERVOIR
    - RIVER BED
    - VALLEY
    - WETLAND
    - X (Not a hydrographic feature at this time period)

- Region Vegetation Rasters

    o \\MNMODEL4\REGIONS*REG*\DATA\VEGETATION\VEGMOD_*REG*.gdb\VEGMOD1. This is the original version of the vegetation model for the region. This tool will insert the historic lakes and rivers from the historic hydrographic model into this raster to create the final version of the vegetation model.

    o \\MNMODEL4\REGIONS*REG*\DATA\VEGETATION\VEGMOD_*REG*.gdb\WETMOD1. These are the wetland classes extracted from the regional vegetation model. They will be used to represent wetlands in the historic hydrographic model.

Inputs:

- **MNMODEL4 Base Folder:** location of MNMODEL4 directory.
- **Region:** Modeling region. Select one or more.
- **Minimum Mapping Unit:** The smallest hydrographic feature size to be included in the final output data. All polygons smaller than this size are excluded. The default value is 12141.
- **Hydmod Version**: The version number to be appended to the ends of output geodatabases and feature classes. This is useful if multiple hydrographic models need to be created.
- **Soils Year**: Year of gSSURGO data to use (should correspond to input MM_gSSURGO_*YEAR*.gdb).

Outputs:

- \\MNMODEL4\REGIONS*REG*\MODELS\HYD_DATA_*REG*.gdb:
    o INT_STREAMS: Intermittent streams feature class
    o MAJOR_RIVERS: Major Rivers feature class.
    o ORD_STREAM: Stream Order raster.
    o PER_STREAMS: Perennial Streams feature class.
- \\MNMODEL4\REGIONS*REG*\MODELS\HYDMOD_*REG*.gdb raster datasets
    o HISTHYD: Historic hydrographic features.
    o HISTFLOODPLAINS: Historic floodplains
    o PREHYD: Prehistoric hydrographic features.
    o PREFLOODPLAINS: Prehistoric floodplains.
- \\MNMODEL4\REGIONS\REG\MODELS\VEGMOD_REG.gdb raster dataset:
    o VEGMOD – This final version of the historic vegetation model is updated to include lakes and rivers from HYDMOD.

Variable Derivation Tools

Environmental variables are aspects of the environmental data (terrain, landscape, soils, hydrography, and vegetation) thought to be related to the location of archaeological sites.   They serve as the independent variables in all statistical modeling procedures.

Terrain Variables

Create Terrain Variables

Script Name: Create Terrain Variables (Figure 17)

Tool Location: \\MNMODEL4\TOOLS\TOOLBOXES\MnModel\mnmodel.pyt\VARIABLES\Create Terrain Variables

Purpose of Tool: These tools use the statewide conditioned Digital Terrain Model (DTM) to generate multiple terrain variables for use within MnModel. Tool output is created for user-specified 10-kilometer buffered modeling regions. All outputs are clipped to each region's extent.

Figure 17: 'Create Terrain Variables' Tool
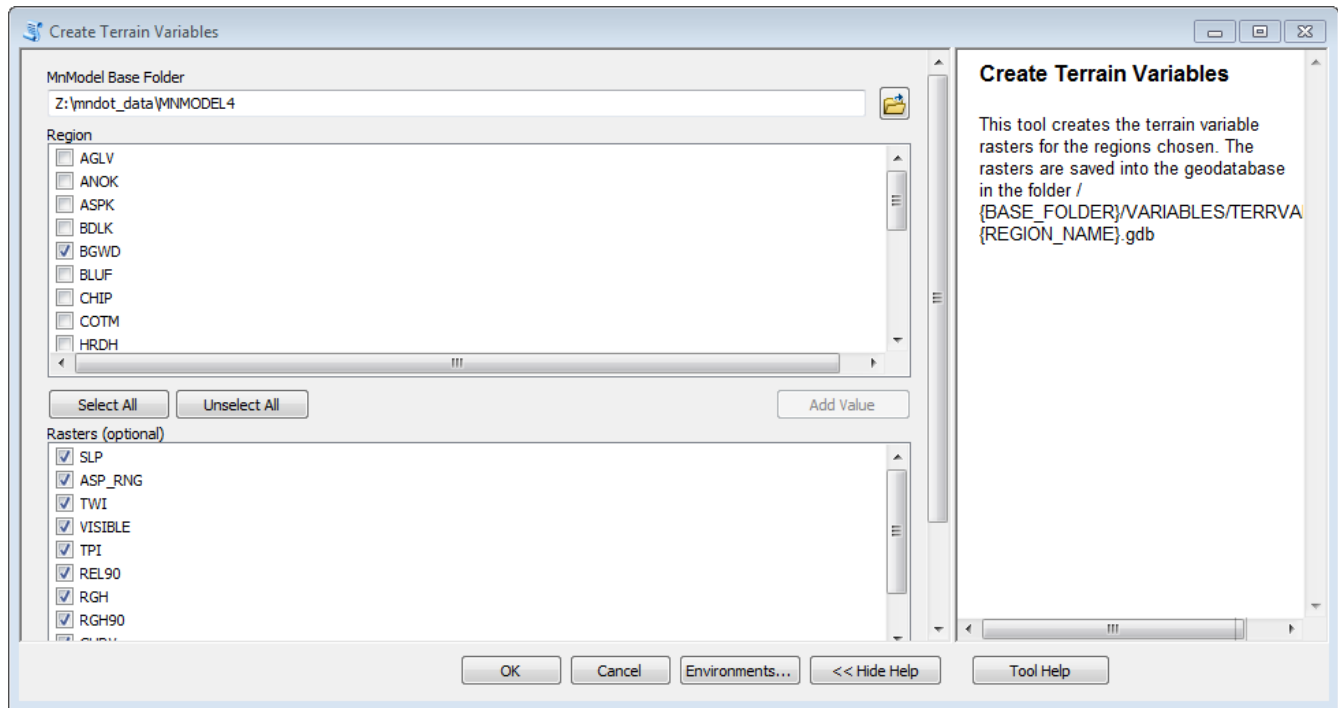
Requirements:

- **Statewide Conditioned DTM Raster:** //MNMODEL4/STATE/DATA/TERRAIN/DTM.gdb/DTM10COND
- **Statewide Conditioned and Pits Removed DTM Raster:**
  //MNMODEL4/STATE/DATA/TERRAIN/DTM.gdb/DTM10CONDPR

Inputs:

- **MNMODEL4 Base Folder:** location of MNMODEL4 directory
- **Region:** The region or regions that should have terrain variables produced.
- **Rasters:** The specific rasters to be created.

- **Recreate:** Indicates whether the tool should delete and recreate any previously existing output variables.

Outputs:

The following variable grids are created in \\MNMODEL4\REGIONS*REG*\VARIABLES\TERRVARS_*REG*.gdb.

- **ELEV:** Elevation
- **SLOPE:** Slope
- **SLP:** Prevailing slope within 80 meters.
- **ASPECT:** Aspect
- **ASP_RNG:** Aspect reclassified by cardinal direction
- **TWI:** Topographic Wetness Index
- **VISIBLE:** Visibility
- **TPI90:** Topographic Position Index, 90 meter radius
- **TPI250:** Topographic Position Index, 250 meter radius
- **TPI500:** Topographic Position Index, 500 meter radius
- **TPI1000:** Topographic Position Index, 1000 meter radius
- **TPI1MI:** Topographic Position Index, 1 mile radius
- **TPI5MI:** Topographic Position Index, 5 mile radius
- **REL:** Relative elevation within 5,000 meters
- **REL90:** Relative elevation within 90 meters
- **CURV:** Surface Curvature
- **SHELTER:** Shelter Index

Soil Variables

Soil variables used in MnModel Phase 4 are rasters exported from the MM_gSSURGO mapunit feature class linked to the soil attribute tables created using the soils data conversion tools.

Create Soil Variables

Tool Name: Create Soil Variables (Figure 18)

Tool Location: \\MNMODEL4\TOOLS\TOOLBOXES\MnModel\mnmodel.pyt\VARIABLES

Purpose of Tool: To create raster layers from selected soil variables. These layers are used as input to the statistical model.

Figure 18: 'Create Soil Variables' Tool
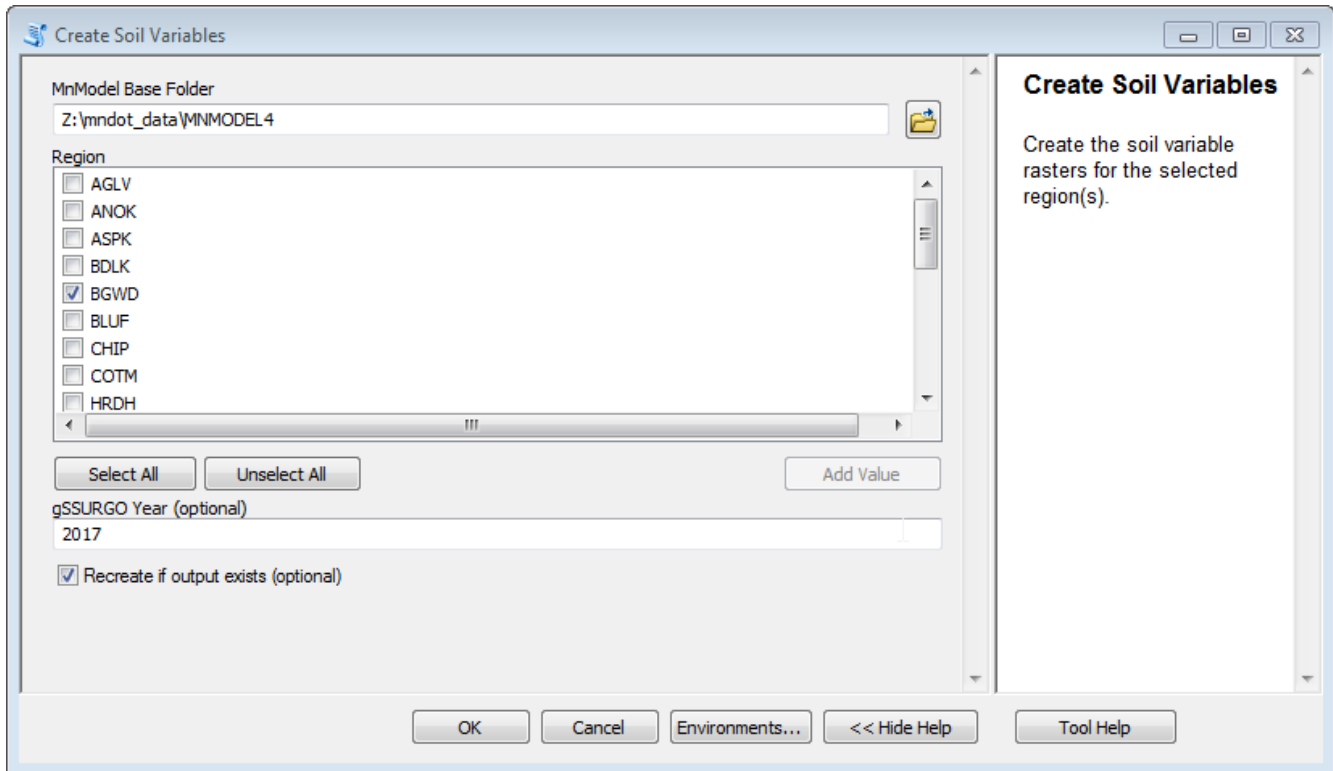
Requirements:

- Requires the feature class 'MM_mupolygon' to be in //MNMODEL4/STATE/DATA/SOILS/MM_gSSURGO_*year*.gdb.
- Requires the feature class '*REG*BUFF' to be in //MNMODEL4/STATE/DATA/BOUNDARIES/REGION_BUFF_10k.gdb.
- Requires the table 'SOILVAR_Table_*year*' to be in //MNMODEL4/STATE/DATA/SOILS/MM_gSSURGO_*year*.gdb.
- Requires that the //MNMODEL4/REGIONS/*REG*/DATA/SOILS/ folder exists.

Inputs:

- **MNMODEL4:** Path to the MNMODEL4 folder
- **REGION:** Modeling region(s) for which the tool will generate variables
- **gSSURGO Year:** Year (####) of the gSSURGO data to be used
- **Recreate if output exists (optional):** Indicates whether the tool should delete and recreate any previously existing variable rasters.

Outputs:

MNMODEL4\VARIABLES\SOILVARS_*REG*.gdb, containing the following rasters:

- **AWS150:** Available water storage 0 to 150 cm – weighted average
- **CACO3:** Calcium carbonate
- **CEC7:** Cation exchange capacity at pH 7.0
- **CLAY:** Total clay
- **DI:** Drainage index
- **DRAIN:** Drainage class – interpreted
- **FFD_R:** Frost free days – representative value
- **FLDFRQD:** Flooding frequency dominant condition
- **GRTGRP:** Great Group – code for the taxonomic GREAT GROUP category [related to soils]
- **GYPSUM:** Gypsum
- **HYDGRPDCD:** Hydrologic group – dominant
- **HZDEP:** Depth of surface horizon
- **OM:** Organic matter
- **PI:** Productivity index
- **REG_RICH:** Regime – Richness component
- **REG_WET:** Regime – Wetness component
- **SAND:** Total sand
- **SILT:** Total silt
- **WETSOIL:** Wet soils

Landscape (Geomorphic) Variables

Landscape variables consist of categorical variables extracted from the landscape model (LANDMODVARS) and variables expressing distance to specific types of landforms or landscapes thought to be important for prehistoric people.
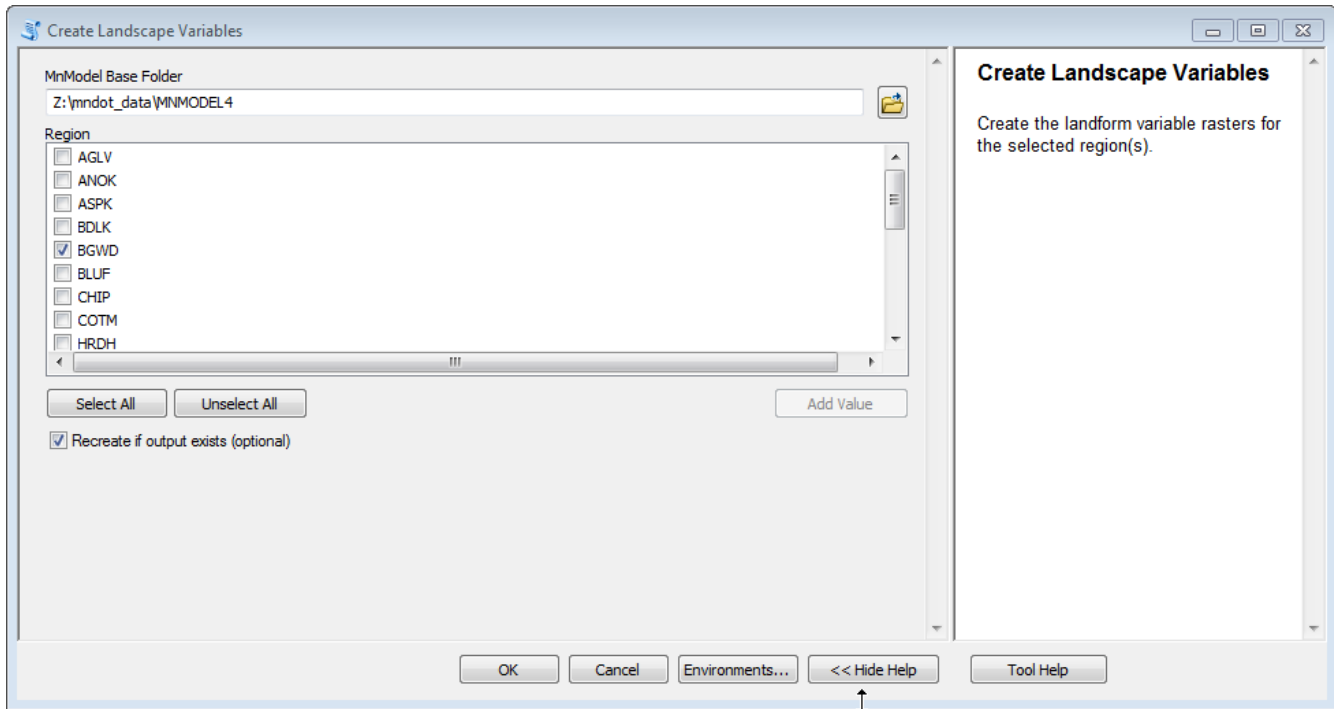
Create Landscape Variables

Tool Name: Create Landscape Variables (Figure 19)

Tool Location: \\MNMODEL4\TOOLS\TOOLBOXES\MnModel\mnmodel.pyt\VARIABLES

Purpose of Tool: To create statewide raster layers for each categorical variable in the Landscape Model and to create variables from MnDNR watershed and National Wetland Inventory island polygons.

Figure 19: 'Create Landscape Variables' Tool

Requirements:

- **State LANDFORM:** \\MNMODEL4\STATE\VARIABLES\LANDVARS.gdb\LFORM. This is a statewide 10 meter raster created from the numeric LFORM field of the MnModel Phase 4 Landscape Model (\\MNMODEL4\STATE\MODELS\LANDMOD.gdb\LANDMOD). You must have already exported this raster.

- **State LANDSCAPE:** \\MNMODEL4\STATE\VARIABLES\LANDVARS.gdb\LSCAPE. This is a statewide 10 meter raster created from the numeric LSCAPE field of the MnModel Phase 4 Landscape Model (\\MNMODEL4\STATE\MODELS\LANDMOD.gdb\LANDMOD). You must have already exported this raster.

- **State ISLANDS:** \\MNMODEL4\STATE\DATA\LANDSCAPE\LAND_SRC.gdb\ISLANDS. These are island polygons exported from National Wetlands Inventory.

- **State MAJRIDGE:** \\MNMODEL4\STATE\DATA\LANDSCAPE\LAND_SRC.gdb\MAJRIDGE. These are major watershed polygons (assumed to be local 'ridges') exported from MnDNR data.

- **State MINRIDGE:** \\MNMODEL4\STATE\DATA\LANDSCAPE\LAND_SRC.gdb\MINRIDGE. These are minor watershed polygons (assumed to be local 'ridges') exported from MnDNR data.

- **State DTM:** \\MNMODEL4\REG\VARIABLES\TERRVARS_REG.gdb\ELEV. This is created by running the Create Terrain Variables tool.

- **Vegetation Model:** \\MNMODEL4\REG\MODELS\VEGMOD_REG.gdb\VEGMOD. This is created after running the complete vegetation modelling process as well as running the Create Hydrographic Model tool.

Inputs:

- **Base Folder:** Location of MNMODEL4 directory
- **Regions**: Region or regions for which you want to generate landscape variables.
- **Recreate:** Whether previously created output files should be deleted and recreated.

Outputs:

- \\MNMODEL4\VARIABLES\LANDVARS_*REG*.gdb, containing the following rasters:
  - **LFORM:** Landforms (numeric codes)
  - **LSCAPE**: Landscapes (numeric codes)
  - **CP_MAJRIDGE:** Least-cost path distance to the nearest Major watershed divide
  - **CP_MINRIDGE:** Least-cost path distance to the nearest Minor watershed divide
  - **ISLAND:** Islands (coded '1' for 'On an island' and '0' for 'Not on an island')
- MNMODEL4\DATA\LANDSCAPE\LANDSCAPE_REG.gdb, containing the following feature classes:
  - **MAJRIDGE:** Polygon feature class containing the statewide major ridges clipped by the region buffer. Used to calculate the CP_MAJRIDGE.
  - **MINRIDGE:** Polygon feature class containing the statewide minor ridges clipped by the region buffer. Used to calculate the CP_MINRIDGE.

Hydrographic Variables

Except for Order of Nearest Stream (ORD_STRM), Path Distance to Nearest Intermittent Stream (CP_INT) and Path Distance to Nearest Perennial Stream (CP_PEREN) all hydrographic variables are last-cost path distances to various types of surface hydrographic features, either historic or prehistoric, from the MnModel Phase 4 Hydrographic Model.
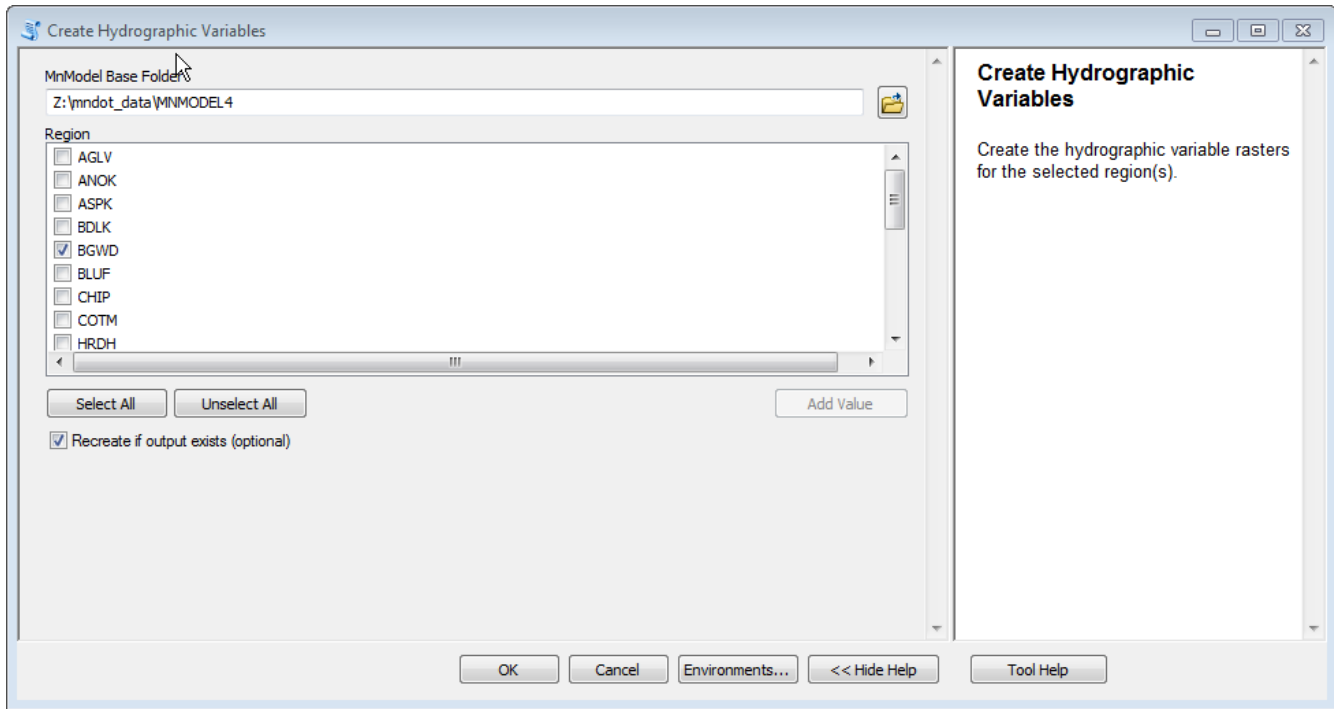
Create Hydrographic Variables

Tool Name: Create Hydrographic Variables (Figure 20)

Tool Location: \\MNMODEL4\TOOLS\TOOLBOXES\MnModel\mnmodel.pyt\VARIABLES

Purpose of Tool: To derive statewide raster layers for each hydrographic variable needed for MnModel Phase 4.

Figure 20: 'Create Hydrographic Variables' Tool

Requirements:

The 'Create Hydrographic Model' tool must have already been run and the following data must be in place.

- \\MNMODEL4\REGIONS*REG*\MODELS\HYDMOD_*REG*.gdb, with the raster datasets:
  - HISTHYD
  - HISTFLOODPLAINS
  - PREHYD
  - PREFLOODPLAINS
- \\MNMODEL4\REGIONS*REG*\MODELS\VEGMOD_*REG*.GDB\VEGMOD\VEGMOD (raster feature class). The vegetation model is used to determine resistance values for the least-cost path calculations.
- \\MNMODEL4\REGIONS*REG*\DATA\HYDROGRAPHY\HYD_DATA_*REG*.gdb with the feature classes (created by running the 'Create Hydrographic Model' tool):
  - INT_STREAMS: Intermittent streams
  - PER_STREAMS: Perennial streams
- \\MNMODEL4\STATE\DATA\HYDROGRAPHY\HYD_DATA.gdb\ORD_STREAM
- \\MNMODEL4\REGIONS*REG*\VARIABLES\TERRVARS_*REG*.GDB\ELEV. This is created by running the 'Create Terrain Variables' tool.

Inputs:

- **Base Folder:** Location of MNMODEL4 directory

- **Regions**: Region(s) for which you want to generate hydrographic variables.
- **Recreate:** Whether previously existing output files should be deleted and recreated.

Outputs:

\\MNMODEL4\REGION*REG*\VARIABLES\HYDVARS_*REG*.gdb, containing the following rasters:

- CP_BOG: Least-cost path distance to nearest historic bog
- CP_FLOOD: Least-cost path distance to nearest historic floodplain
- CP_INT: Least-cost path distance to nearest historic intermittent stream
- CP_LAKE: Least-cost path distance to nearest historic lake
- CP_LLK: Least-cost path distance to nearest historic large lake
- CP_MARSH: Least-cost path distance to nearest historic marsh
- CP_MEADOW: Least-cost path distance to nearest historic meadow
- CP_PEREN: Least-cost path distance to nearest historic perennial river or stream
- CP_PFLOOD: Least-cost path distance to nearest prehistoric floodplain
- CP_PLAKE: Least-cost path distance to nearest prehistoric lake
- CP_PLLK: Least-cost path distance to nearest prehistoric large lake
- CP_PWET: Least-cost path distance to nearest prehistoric wetland
- CP_RIVER: Least-cost path distance to nearest historic river
- CP_SWAMP: Least-cost path distance to nearest historic swamp
- CP_WAT: Least-cost path distance to nearest historic surface water of all types
- CP_WET: Least-cost-path distance to nearest historic 'wet' land
- CP_WETLAND: Least-cost-path distance to nearest historic wetland
- ORD_STRM: Strahler 'stream order' of nearest stream (>=5)

Vegetation Variables

There are three types of vegetation variables: the dominant type of vegetation at the location of a site, the diversity of vegetation types within one, five, and ten-kilometer distances from a site, and the cost-path distance to wild rice resources. In addition, there is a resistance variable associated with vegetation type that is used in all least-cost path calculations.
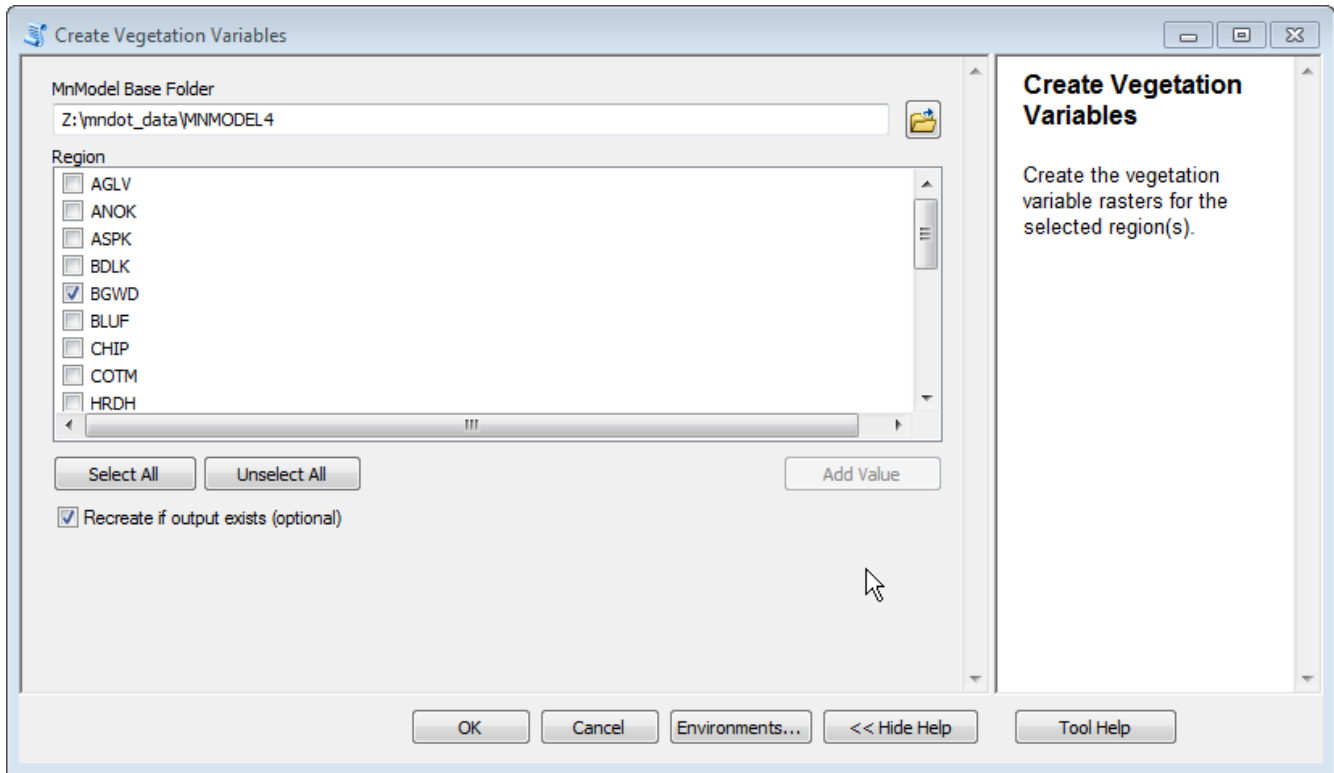
Create Vegetation Variables

Tool Name: Create Vegetation Variables (Figure 21)

Tool Location: \\MNMODEL4\TOOLS\TOOLBOXES\MnModel\mnmodel.pyt\VARIABLES\Create Vegetation Variables

Purpose of Tool: Create vegetation variable rasters from the vegetation model raster.

Figure 21: 'Create Vegetation Variables' Tool

Requirements:

The following data must be in place:

- \\MNMODEL4\REGIONS*REG*\MODELS\VEGMOD_*REG*.gdb\VEGMOD
- \\MNMODEL4\REGIONS*REG*\DATA\VEGETATION\VEG_SRC_*REG*.gdb\RICE

Inputs:

- **MnModel Base Folder:** MNMODEL4 folder location
- **Region:** Region(s) for which you want to create vegetation variables

Outputs:

\\MNMODEL4\REGION*REG*\VARIABLES\VEGVARS_*REG*.gdb, containing the following rasters:

- CP_RICE: Cost-path distance to wild rice
- RESIST: Resistance - input to cost-path variables
- VEGDIV1K: Number of vegetation types within 1 km
- VEGDIV5K: Number of vegetation types within 5 km
- VEGDIV10K: Number of vegetation types within 10 km
- VEGMOD: Potential historic vegetation type

FETE Variables

The FETE (From Everywhere To Everywhere) model for Minnesota was run for MnModel Phase 4 by Devon White, Sandia National Laboratories. Paths suggested by this model were grouped into major, intermediate, and minor path categories based on their weights. Variables include cost-path distances to each of these categories of paths plus the 'order' or weight of the nearest path.

Create FETE Variables

Tool Name: Create FETE Variables (Figure 22)

Tool Location: \\MNMODEL4\TOOLS\TOOLBOXES\MnModel\mnmodel.pyt\VARIABLES

Purpose of Tool: Creates the FETE variable rasters for the selected regions

Figure 22: 'Create FETE Variables' Tool
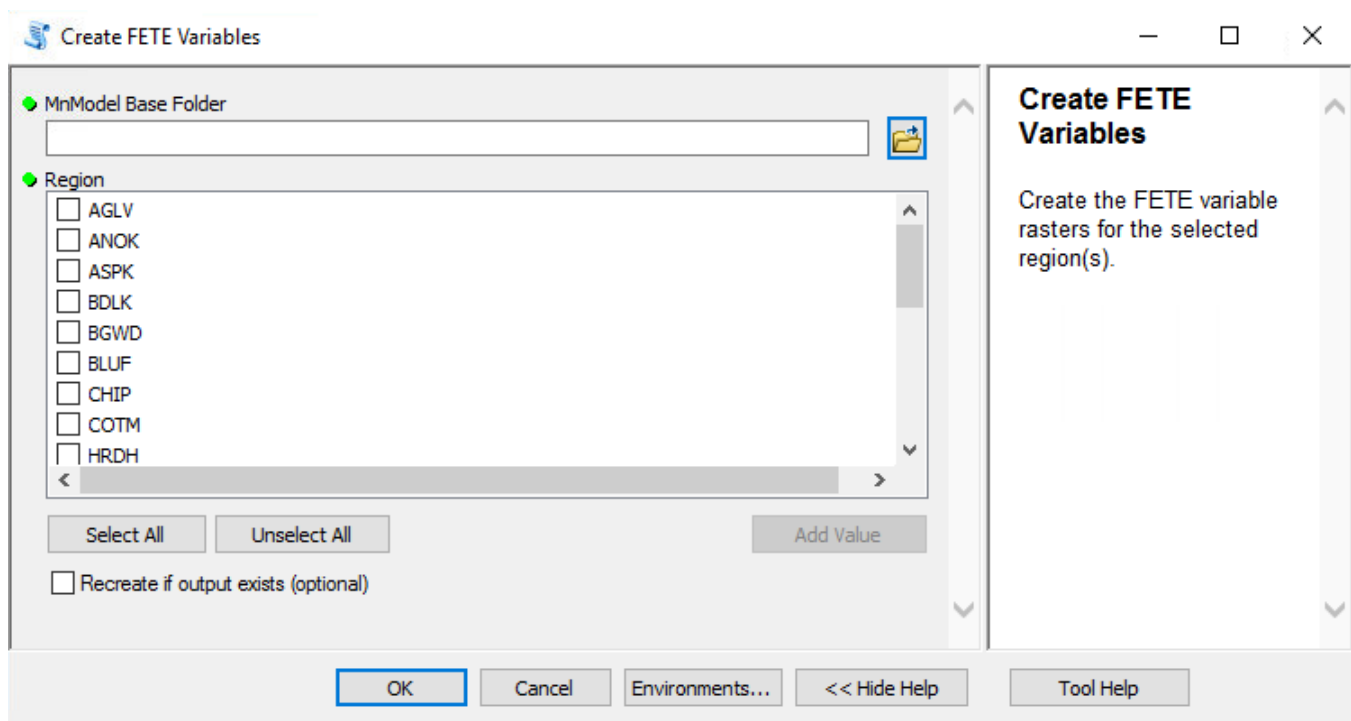
Requirements:

- \\MNMODEL4\STATE\MODELS\FETE.gdb\FETE_GRID
- \\MNMODEL4\REGIONS*REG*\VARIABLES\TERRVARS_*REG*.GDB\ELEV. This is created by running the Create Terrain Variables tool.
- \\MNMODEL4\REGIONS*REG*\MODELS\VEGMOD_*REG*.GDB\VEGMOD. This is created after running the complete vegetation modelling process as well as running the Create Hydrographic Model tool.

Inputs:

- **MnModel Base Folder**: Location of MNMODEL4 folder
- **Region(s):** Region(s) for which you want to deriver variables
- **Recreate if output exists**: Whether any previously existing output should be deleted and recreated.

Outputs:

\\MNMODEL4\REGIONS\REG\VARIABLES\FETEVARS_*REG*.gdb, containing the following rasters:

- FETE: clipped version of the statewide FETE_GRID raster
- PATH_ORD: The FETE path order of each cell.
- CP_MAJPATH: The path distance to the nearest major path.
- CP_MEDPATH: The path distance to the nearest medium path.
- CP_MINPATH: The path distance to the nearest minor path

Create Variable Geodatabases (optional)

Create ALLARCHLIST and SOILARCHLIST

ALLARCHLIST.gdb is a geodatabase containing the environmental variables for the archaeological predictive models covering an entire region. These are all variables except most soil variables. All regions are missing soils data, at least in part. The missing data may be only within water bodies and disturbed locations or it may be more extensive areas. Consequently, ALLARCHLIST contains only one soil variable, WETSOIL, which has been deliberately created to cover most areas missing other soils data. SOILARCHLIST.gdb is a geodatabase containing all of the environmental variables for archaeological predictive models, including soils data, but with gaps for that part of the region missing soils data. Both ALLARCHLIST.gdb and SOILARCHLIST.gdb contain all of the terrain, hydrographic, FETE, and vegetation variables used for the predictive models.

Tool Name: Create ALLARCHLIST.gdb and SOILARCHLIST.gdb (Figure 23)

Tool Location: \\MNMODEL4\TOOLS\TOOLBOXES\MnModel\mnmodel.pyt\VARIABLES

Purpose of Tool: To copy ALLARCHLIST variable rasters to ALLARCHLIST.gdb and SOILARCHLIST variable rasters to SOILARCHLIST.gdb. It is not necessary to create these geodatabases if you plan to use the **Sample Region** tool (below).

Figure 23: 'Create ALLARCHLIST.gdb and SOILARCHLIST.gdb' Tool
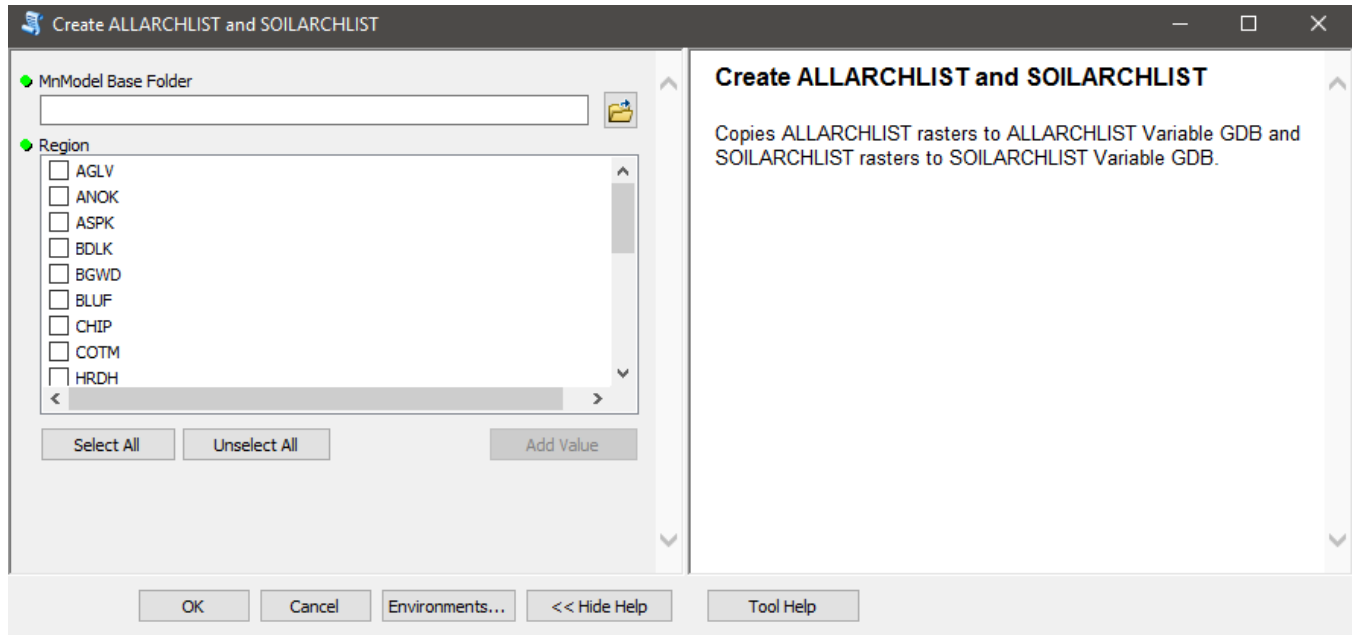
Requirements:

The previous variable derivation tools must be run before this tool can be run. The following geodatabases must be in the \\MNMODEL4\REGIONS*REG*\VARIABLES directory:

- FETEVARS_*REG*.gdb
- HYDVARS_*REG*.gdb
- LANDVARS_*REG*.gdb
- SOILVARS_*REG*.gdb
- TERRVARS_*REG*.gdb
- VEGVARS_*REG*.gdb

Inputs:

- **MnModel Base Folder**: Location of MNMODEL4 directory
- **Region**: Regions for which the geodatabases are to be created.

Outputs:

- \\MNMODEL4\REGIONS*REG*\VARIABLES\ALLARCHLIST_*REG*.gdb
- \\MNMODEL4\REGIONS*REG*\VARIABLES\SOILARCHLIST_*REG*.gdb

Preparation for Modeling

This set of tools is used to create input files for the archaeological predictive models.

Modeling Mask

The modeling mask is necessary to prevent the model from trying to calculate values in cells with no data. These cells are exclusively derived from the gSSURGO data, which has NULL values within current (not necessarily historic) water bodies and disturbed areas. These are also areas where archaeologists are not likely to survey. Consequently, the modeling mask can be used at the end of the modeling process to imprint water bodies and disturbed areas on the model and code them as such, if desired. The same mask is used for creating the Historic Vegetation Model.

Create MODMASK

Tool Name: Create MODMASK (Figure 24)

Tool Location: \\MNMODEL4\TOOLS\TOOLBOXES\MnModel\PREDICTIVE_MODEL\MODMASK.tbx\Modeling Tools\Create MODMASK

Purpose of Tool: To create a statewide modeling mask (MODMASK) for MnModel Phase 4.

Figure 24: 'Create MODMASK' Tool
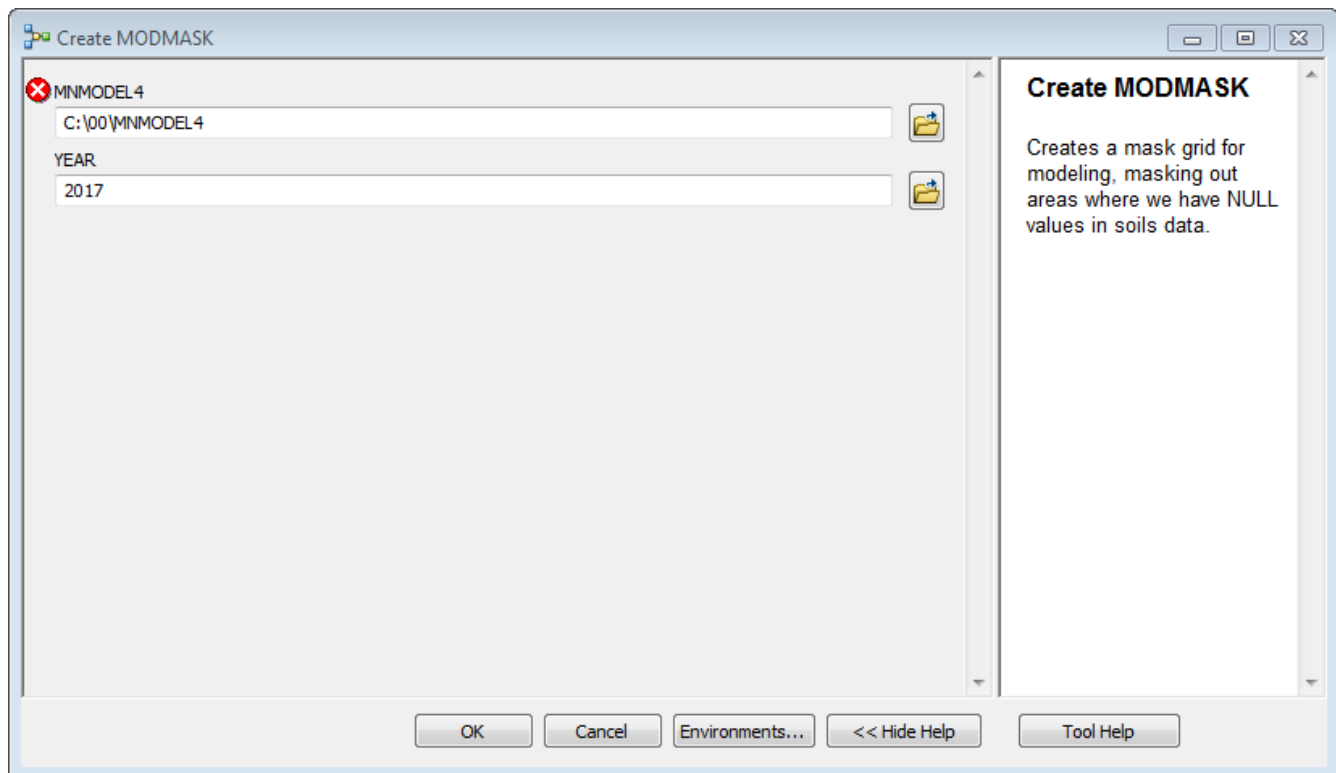
Requirements:

The Create MM_gSSURGO Tables tool must be run before this tool can be used. The required outputs of that tool are:

- \\MNMODEL4\STATE\DATA\SOILS\MM_gSSURGO_*YEAR*.gdb\MM_mupolygon
- \\MNMODEL4\STATE\DATA\SOILS\MM_gSSURGO_*YEAR*.gdb\MM_Mapunit_interpreted. This table must have been populated by the user by interpretation of information contained in multiple fields. For example, the DISTURB field contains information about soil disturbance gleaned from the mapunit name (MM_Mapunit table, **muname** field) and the **otherph, localphase,** and **compname** fields (MM_Component table).

Inputs:

- **MNMODEL4**: Location of MNMODEL4 directory
- **YEAR**: year of gSSURGO data to be used

Outputs:

- \\MNMODEL4\STATE\DATA\BOUNDARIES\BOUNDARIES.gdb\MODMASKPL (polygon feature class)
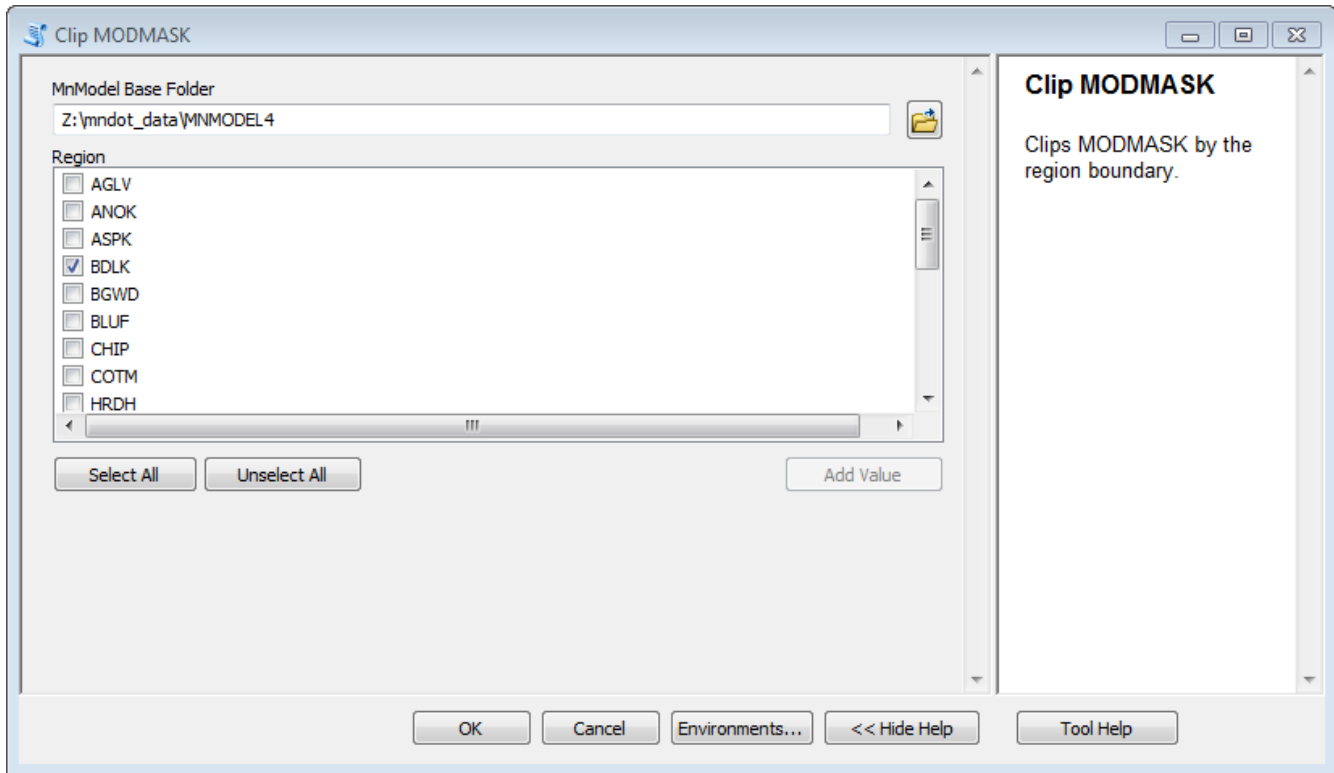- \\MNMODEL4\STATE\DATA\BOUNDARIES\BOUNDARIES.gdb\MODMASK (raster)

Clip MODMASK

Tool Name: Clip MODMASK (Figure 25)

Tool Location: \\MNMODEL4\TOOLS\TOOLBOXES\MnModel\mnmodel.pyt\SAMPLING\Clip MODMASK

Purpose of Tool: This tool clips a statewide MODMASK raster dataset to buffered regional boundaries generating region specific MODMASKs.

Figure 25: 'Clip MODMASK' Tool

Requirements:

- **Snap Raster:** \\MNMODEL4\STATE\DATA\TERRAIN\DTM.gdb\DTM10COND
- \\MNMODEL4\STATE\DATA\BOUNDARIES\REGION_BUFF_10K.gdb*REG*BUFF feature class for each region that you want to clip.
- \\MNMODEL4\STATE\DATA\BOUNDARIES\BOUNDARIES.gdb\MODMASK raster.
- \\MNMODEL4\STATE\DATA\BOUNDARIES\BOUNDARIES.gdb\MODMASKPL feature class.

Inputs:

- **MnModel Base Folder**: MNMODEL4 folder location
- **Region**: Region(s) for which you want to clip MODMASK.

Outputs:

- \\MNMODEL4\REGIONS*REG*\DATA\BOUNDARIES\BOUNDARIES_*REG*.gdb\MODMASK
- \\MNMODEL4\REGIONS*REG*\DATA\BOUNDARIES\BOUNDARIES_*REG*.gdb\MODMASKPL

Prepare Archaeological Site Polygons

These data preparation tools are for cleaning up the archaeological site polygons by either deleting duplicate site polygons or merging multiple adjacent polygons that should represent a single site.
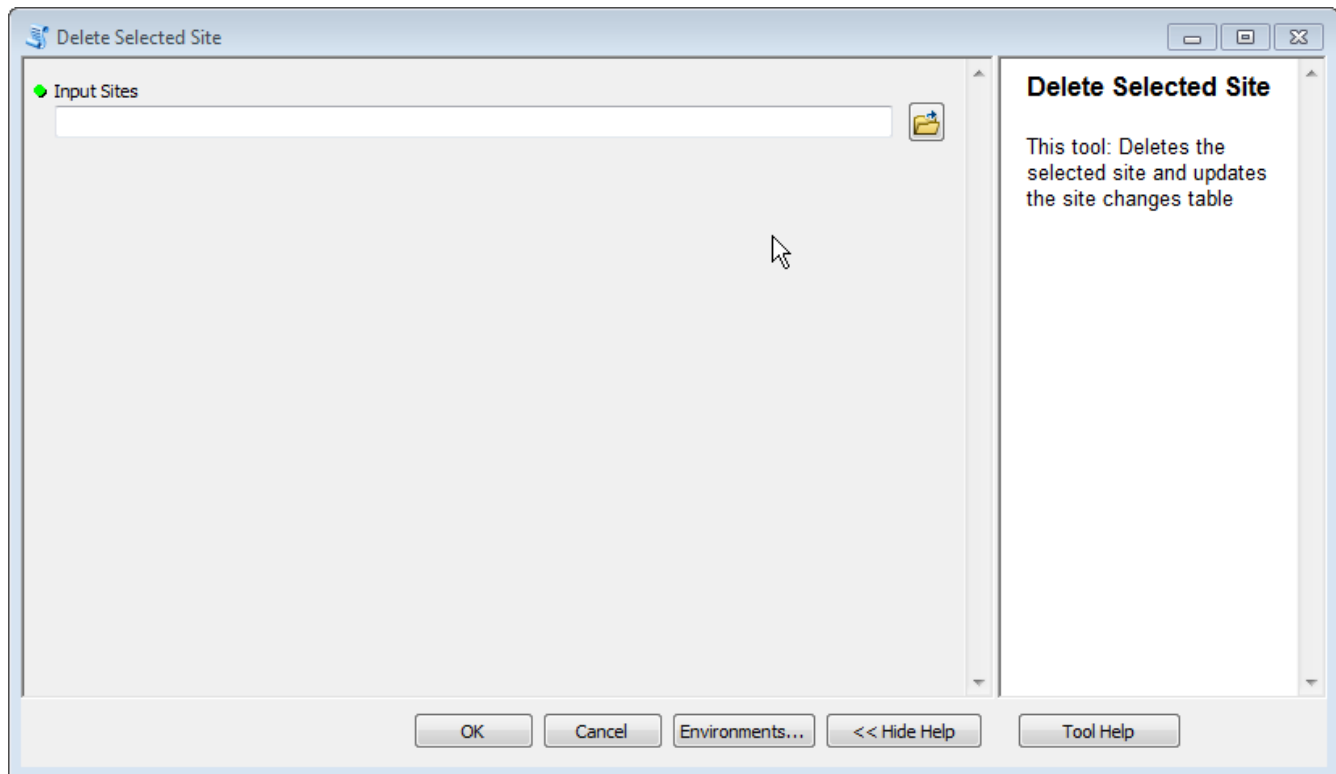
Delete Selected Site

Tool Name: Delete Selected Site (Figure 26)

Tool Location: \\MNMODEL4\TOOLS\TOOLBOXES\MnModel\mnmodel.pyt\ARCHPREP

Purpose of Tool: To delete selected duplicate archaeological site polygons and update the site changes table accordingly.

Figure 26: 'Delete Selected Site' Tool

Requirements:

- **ARCHSITES:** \\MNMODEL4\STATE\DATA\ARCHAEOLOGY\ARCHDATA.gdb\ARCHSITES
- User must be working in an ArcMap edit session.
- Site(s) to be deleted must be selected.
- Deleted sites are recorded in \\MNMODEL4\STATE\DATA\ARCHAEOLOGY\ARCHDATA.gdb\changes.
  - ○ Fields must exist on changes table:
    - ▪ SITENUM (text)

- ORIGINAL_OID (text)
- ACTION (text)
- REASON (text)

Inputs:

- **Input Sites:** ARCHSITES layer (click and drag from ArcMap table of contents).

Outputs:

Selected site(s) are deleted from the input feature layer.

Merge Selected Sites Tool
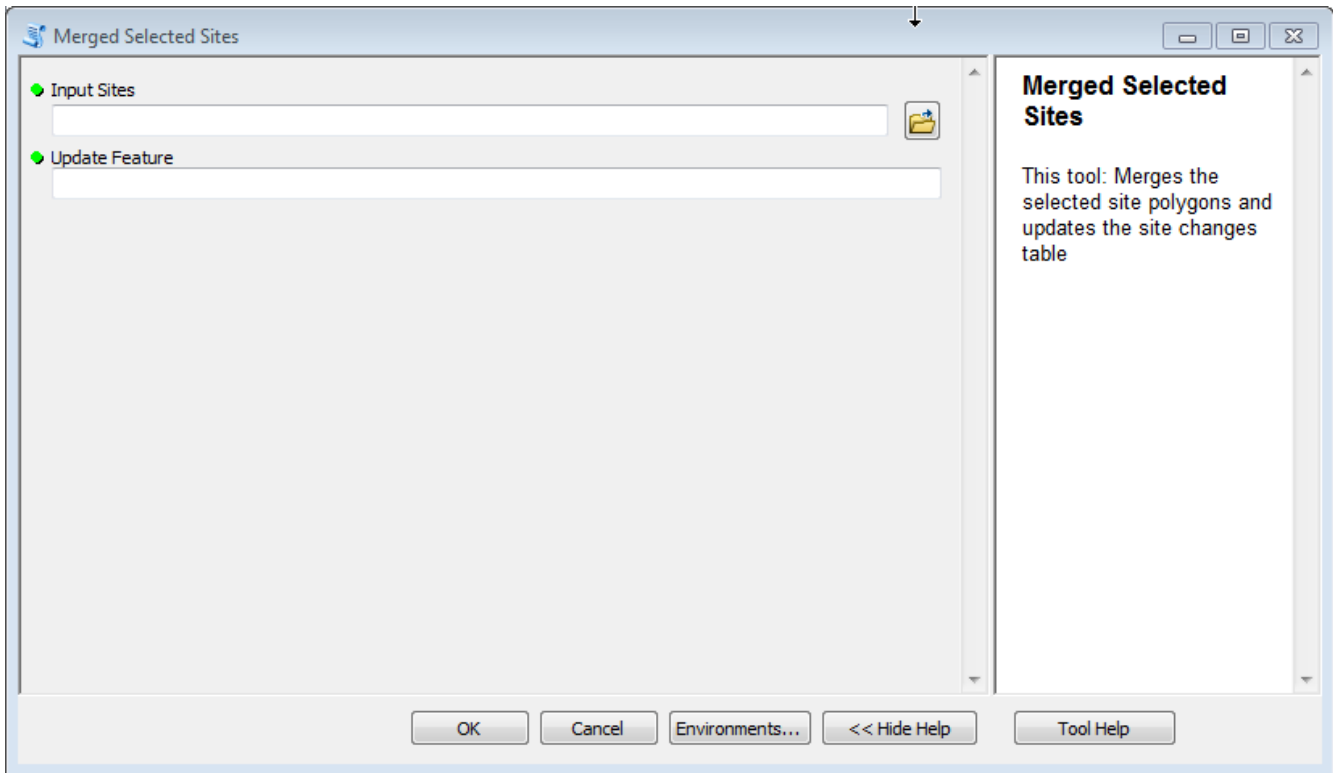
Tool Name: Merge Selected Sites (Figure 27)

Tool Location: \\MNMODEL4\TOOLS\TOOLBOXES\MnModel\mnmodel.pyt\ARCHPREP

Purpose of Tool: To merge selected duplicate archaeological site polygons into a single polygon.

Figure 27: 'Merge Selected Sites' Tool

Requirements:

- \\MNMODEL4\STATE\DATA\ARCHAEOLOGY\ARCHDATA.gdb\ARCHSITES
- User must be working in an ArcMap session.

- Site(s) to be merged must be selected.
- Merged sites are recorded in \\MNMODEL4\STATE\DATA\ARCHAEOLOGY\ARCHDATA.gdb\changes
  - Fields must exist on changes table:
    - SITENUM (text)
    - ORIGINAL_OID (text)
    - ACTION (text)
    - REASON (text)

Inputs:

- **Input Sites**: Selected unique archeological site polygons to combine into one site polygon.
- **Update Feature**: The selected site into which to merge the other sites. The merged feature will retain the update feature's data. Upon entering the Input Sites parameter, only the selected features' OBJECTIDs will be selected in the Update Feature dropdown menu.

Outputs:

- Selected polygons are merged into the 'Update Feature'. The input layer will be modified.

Create Prediction Points

Prediction points are needed to export the final model values from R into ArcGIS. Prediction points consist of a 30-m grid of points for the entire state or region, so the files are quite large.
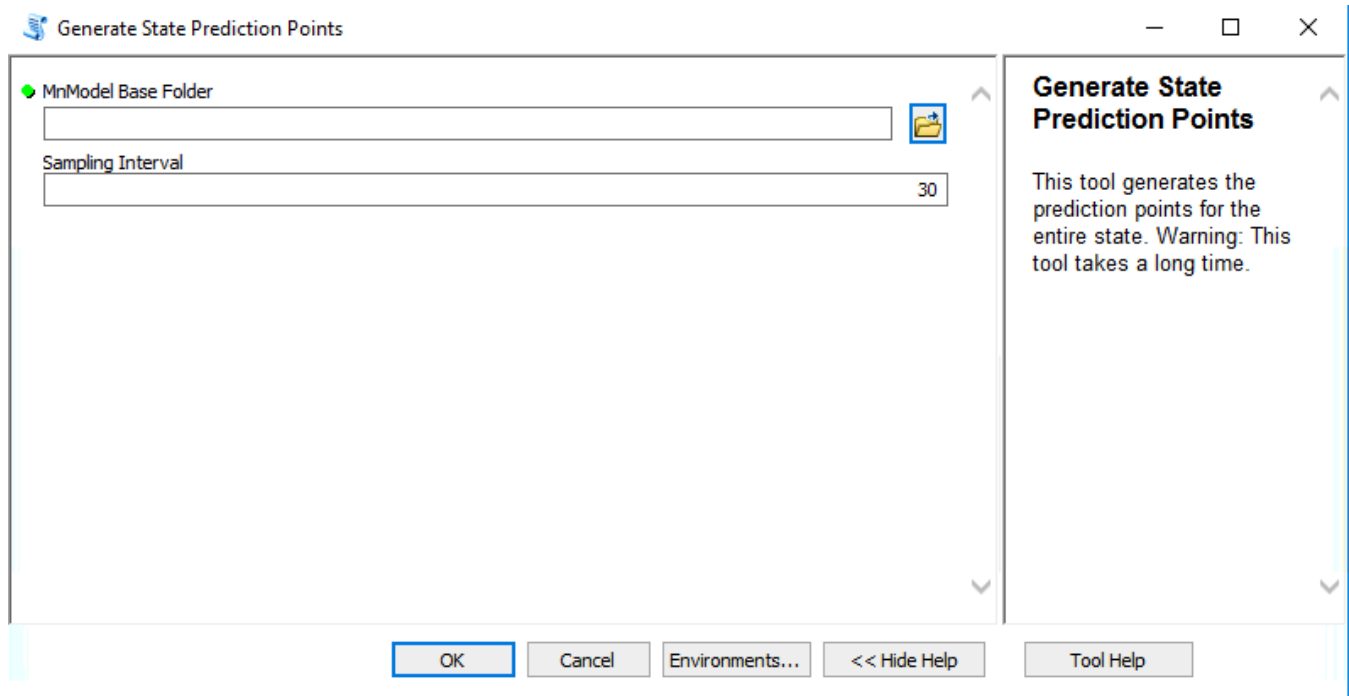
Generate State Prediction Points Tool

Tool Name: Generate State Prediction Points (Figure 28)

Tool Location: \\MNMODEL4\TOOLS\TOOLBOXES\MnModel\mnmodel.pyt\SAMPLING\Generate State Prediction Points

Purpose of Tool: Creates a 30-m resolution point grid with x, y coordinates for the entire state to be used for importing statistical model results from R to ArcGIS.

Figure 28: 'Generate State Prediction Points' Tool

Requirements:

- **Snap Raster:** \\MNMODEL4\STATE\DATA\TERRAIN\DTM.gdb\DTM30COND
- **State Buffer:** \\MNMODEL4\STATE\DATA\BOUNDARIES\BOUNDARIES.gdb\buff10k

Inputs:

- **MnModel Base Folder**: MNMODEL4 directory location
- **Sample Interval**: The desired sampling interval in meters. The standard value is 30 but this can be changed.

Outputs:

\\MNMODEL4\STATE\SAMPLE\SAMPLE\SAMPLE.gdb\PREDICT_PT

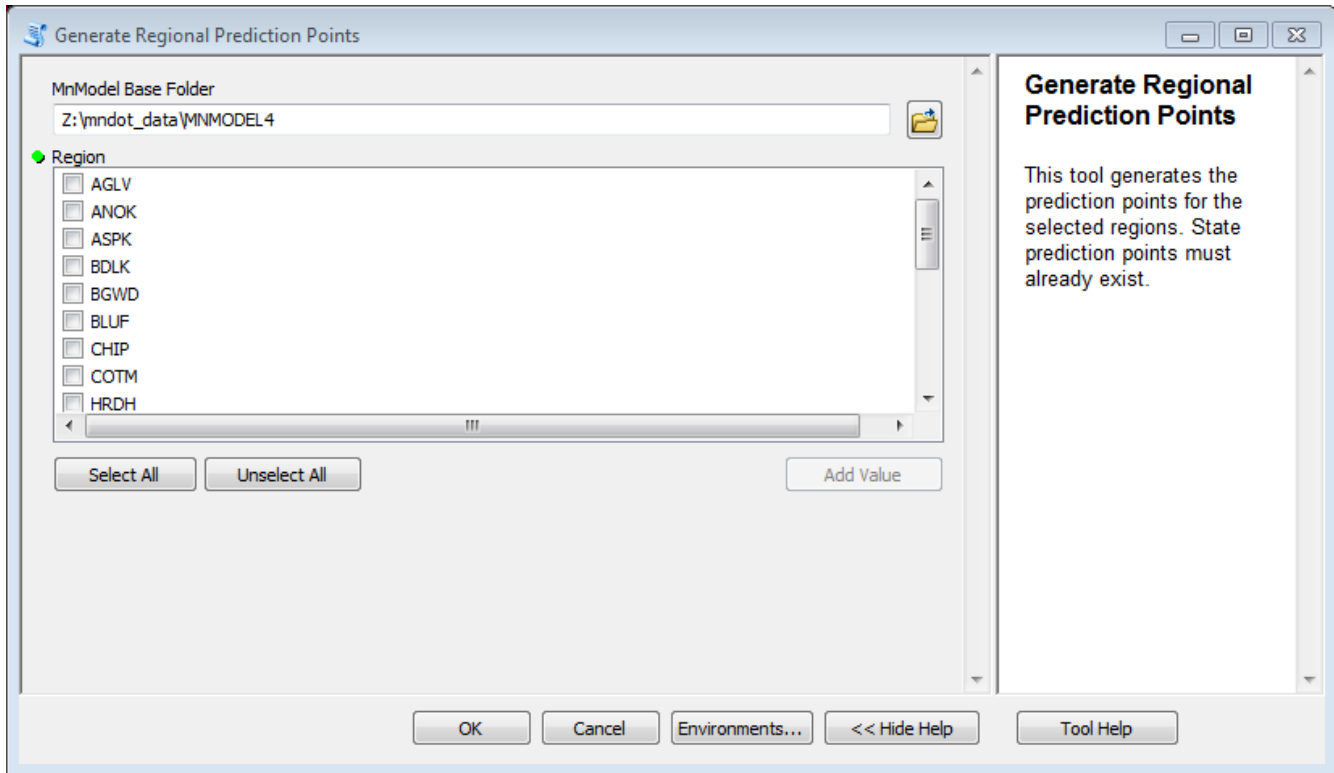## Generate Regional Prediction Points

Tool Name: Generate Regional Prediction Points (Figure 29)

Tool Location: \\MNMODEL4\TOOLS\TOOLBOXES\MnModel\mnmodel.pyt\SAMPLING\

Purpose of Tool: This tool clips the state prediction points for the selected regions. State prediction points must already exist. The output feature class is used to create the sample files ALLPREDARCH and SOILPREDARCH.

Figure 29: 'Generate Regional Prediction Points' Tool

Requirements:

- \\MNMODEL4\STATE\SAMPLE\SAMPLE.gdb\PREDICT_PT
    - Output of Generate State Prediction Points tool
- **Snap Raster:** \\MNMODEL4\STATE\DATA\TERRAIN\DTM.gdb\DTM10COND
- **Mask:** \\MNMODEL4\REG\DATA\BOUNDARIES\BOUNDARIES.gdb\MODMASKPL
- **Region Buffer:** \\MNMODEL4\STATE\DATA\BOUNDARIES\REGION_BND.gdb*REG*

Inputs:

- **MnModel Base Folder**: Location of the MNMODEL4 directory.
- **Region**: Region(s) for which the prediction points will be clipped.

Outputs:

- \\MNMODEL4\REGIONS*REG*\SAMPLE\SAMPLE_*REG*.gdb\PREDICT_PT

Split Survey Polygons
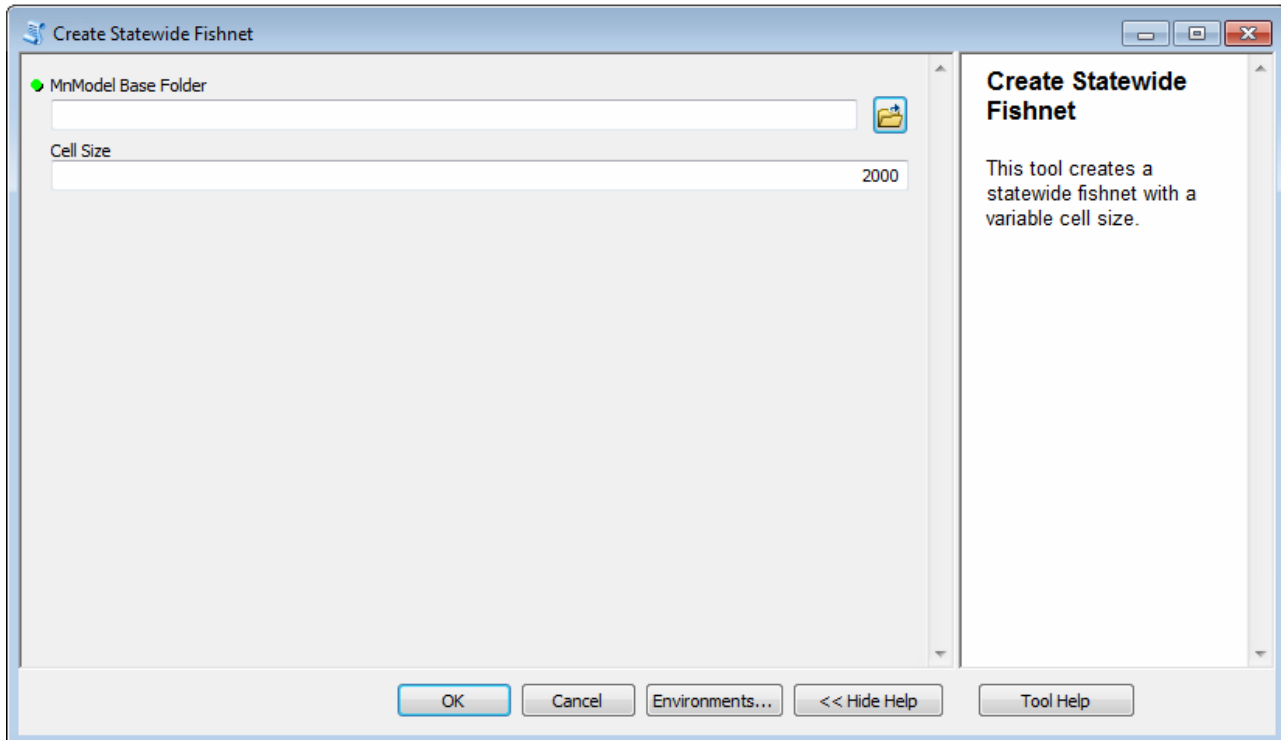
Create Statewide Fishnet

The fishnet grid is used to subdivide large survey polygons into smaller sizes for sampling.

Tool Name: Create Statewide Fishnet (Figure 30)

Tool Location: \\MNMODEL4\TOOLS\TOOLBOXES\MnModel\mnmodel.pyt\SAMPLING

Purpose of Tool: This tool creates a statewide fishnet with a user-specified cell size. The default cell size is 2,000m^2.

Figure 30: 'Create Statewide Fishnet' Tool

Requirements:

\\MNMODEL4\STATE\DATA\BOUNDARIES\BOUNDARIES.gdb\buff10k

Inputs:

- **MnModel Base Folder**: Location of MNMODEL4 folder.
- **Cell size**: User choice, but defaults to 2,000m^2.

Outputs:

\\MNMODEL4\STATE\SAMPLE\SAMPLE.gdb\FISHNET2k

Notes:

The name of the output file does not change based on the input cell size. If you use a different cell size and wish the filename to reflect that, you must rename the file.

Split Large Survey Polygons

Tool Name: Split Large Survey Polygons (Figure 31)

Tool Location: \\MNMODEL4\TOOLS\TOOLBOXES\MnModel\mnmodel.pyt\SAMPLING

Purpose of Tool: This tool ensures that the highest confidence surveys will supersede lower confidence surveys when survey polygons overlap each other. It then splits survey polygons larger than 4,000,000m^2 using the fishnet grid. If the default fishnet cell size is used, the survey polygons are segmented to a sampling interval of 2,000m. By splitting large survey polygons, the tool helps reduct environmental variation within sampled areas. This tool creates the feature class used for sampling in the archaeological survey predictive model.

Figure 31: 'Split Large Survey Polygons' Tool
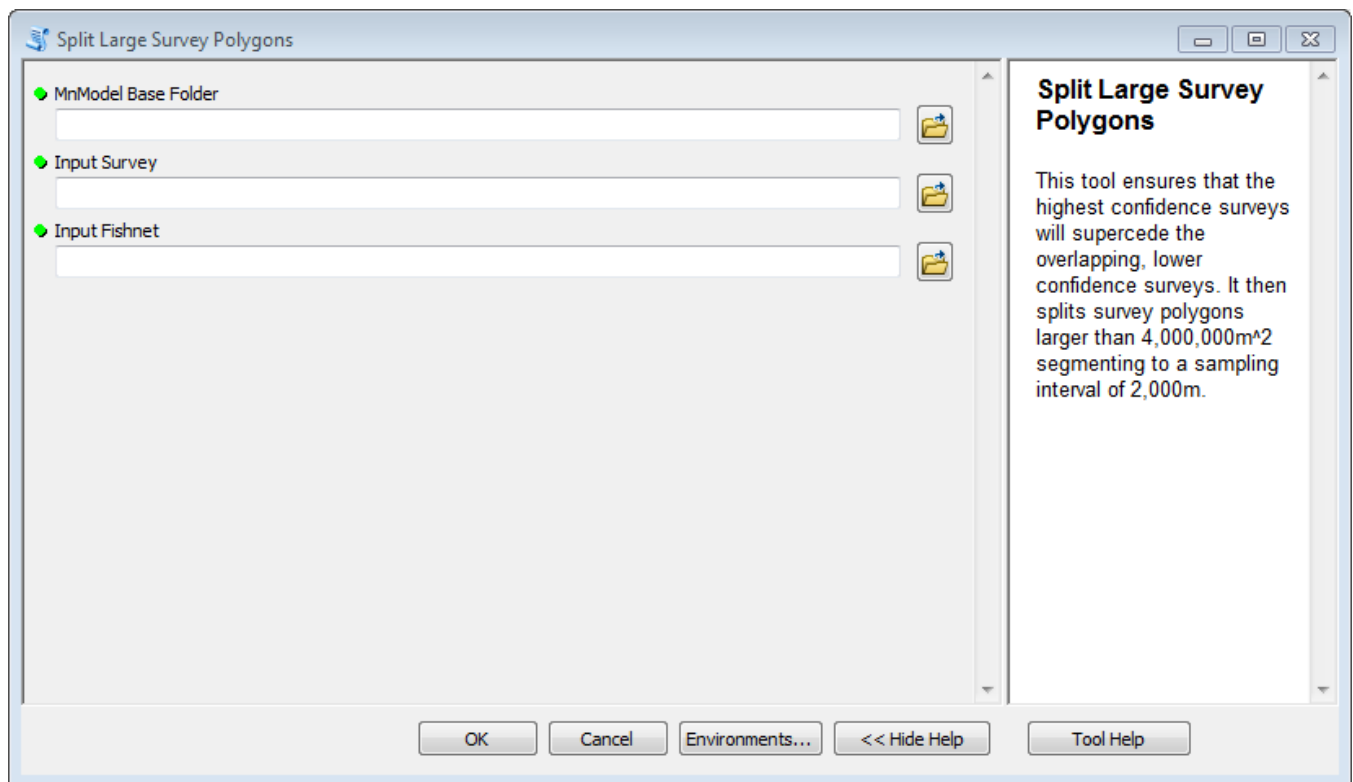
Requirements:

Inputs:

- **MnModel Base Folder**: Location of MNMODEL4 folder.
- **Input Survey**: Archaeological survey polygons (\\MNMODEL4\STATE\DATA\ARCHDATA.gdb\ARCHSURV)
- **Input Fishnet**: Output of the Create Statewide Fishnet tool
  (\\MNMODEL4\STATE\SAMPLE\SAMPLE.gdb\FISHNET2k)

Outputs:

\\MNMODEL4\STATE\SAMPLE\SAMPLE.gdb\SURVSAMP

Sampling Tools

Sampling tools are used to sample the variable rasters and create input tables for the R statistical modeling procedures.

Sample Region

Tool Name: Sample Region (Figure 32)

Tool Location: \\MNMODEL4\TOOLS\TOOLBOXES\MnModel\mnmodel.pyt\SAMPLING

Purpose of Tool: To sample the variable rasters at the locations of a region's archeological sites, surveys, and prediction points.

Figure 32: 'Sample Region' Tool
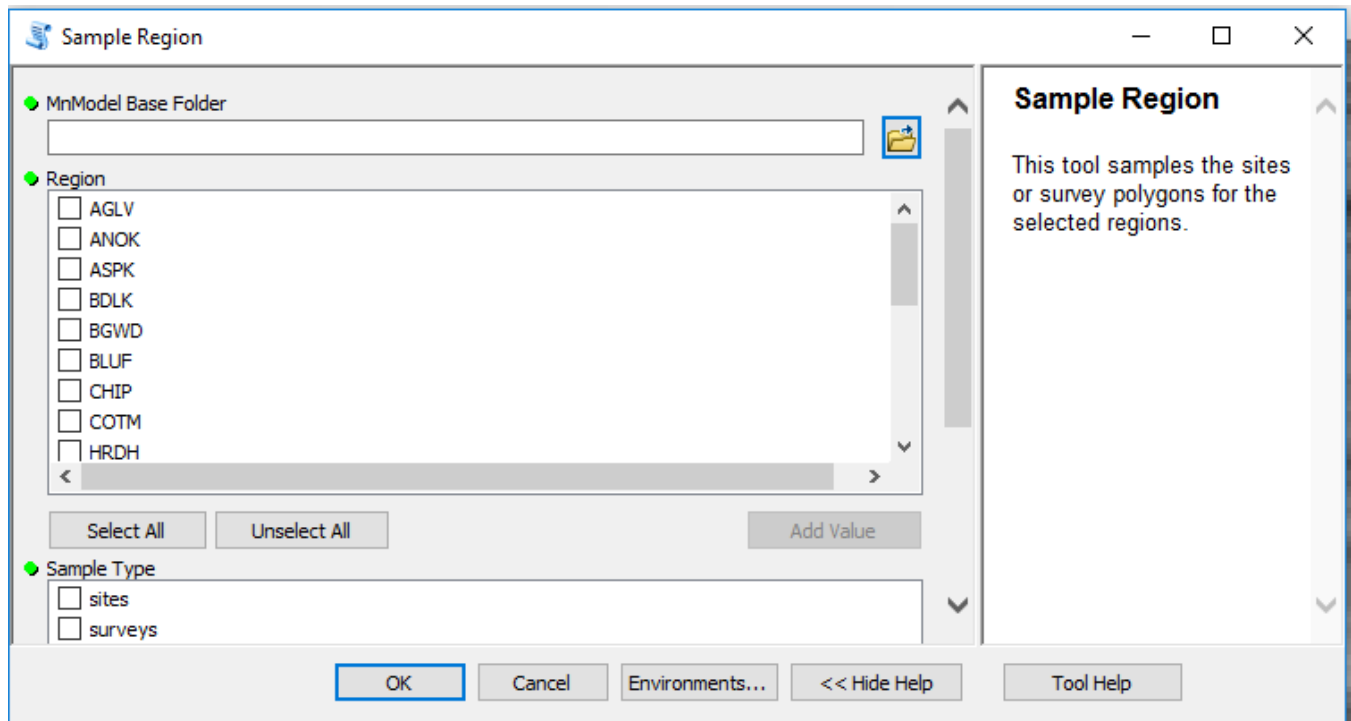
Requirements:

- \\MNMODEL4\STATE\DATA\SAMPLE\SAMPLE.GDB
  - o PREDICT_PT
    - ▪ Required only if the **Generate Region Prediction Points** tool has not been run.
  - o SITESAMP

- o SURVSAMP
- \\MNMODEL4\REG\SAMPLE\SAMPLE.gdb\PREDICT_PT
    - o Will be clipped from state prediction points if it does not already exist.
- Variables rasters in:
    - o \\MNMODEL4\REGIONS*REG*\VARIABLES\ALLARCHLIST_*REG*.gdb
    - o \\MNMODEL4\REGIONS*REG*\VARIABLES\SOILARCHLIST_*REG*.gdb

Inputs:

- **MnModel Base Folder**: Location of MNMODEL4 folder
- **Region**: The region(s) to be sampled.
- **Sample Type**: The type(s) of sample data.

Outputs:

Point feature classes and corresponding .csv files containing values derived from the variable rasters.

- \MNMODEL4\REGIONS*REG*\SAMPLE
    - o SAMPLE_*REG*.gdb
        - ▪ ALLSITE
        - ▪ SOILSITE
        - ▪ ALLSURV
        - ▪ SOILSURV
        - ▪ ALLPREDARCH
        - ▪ SOILPREDARCH
    - o ALLSITE.csv
    - o SOILSITE.csv
    - o ALLSURV.csv
    - o SOILSURV.csv
    - o ALLPREDARCH.csv
    - o SOILPREDARCH.csv

Notes:

- The tools to create variable rasters for the region to be sampled should be run before running this tool. The tool will not fail if there are missing rasters. Those rasters will just not be sampled.
- The tool uses ArcGIS's **Spatial Analyst\Zonal\Zonal Statistics as Table** to summarize values of the input rasters within zones defined by the site or survey polygons. It uses 'MAJORITY' or 'MEAN' as the statistics type, depending on the variable. Majority values are used for discrete variables such as vegetation type or landform. Means are used for continuous variables, such as least-cost path distances

or surface roughness. The majority or mean value of the variable within the site or survey polygon is attached to a point representing the polygon's centroid.

- The tool samples cell values of each variable raster at the location of each prediction point.
- The .csv files produced by this tool are used as input to the statistical analysis in R.
- Note that this creates sample files only for the archaeological predictive models, not the Historic Vegetation Model.

Creating Prediction Rasters

R creates statistical models that are output in .csv format. These tools are used to create GIS rasters from these .csv files and subsequently develop several classified versions of each model.

Rasterization

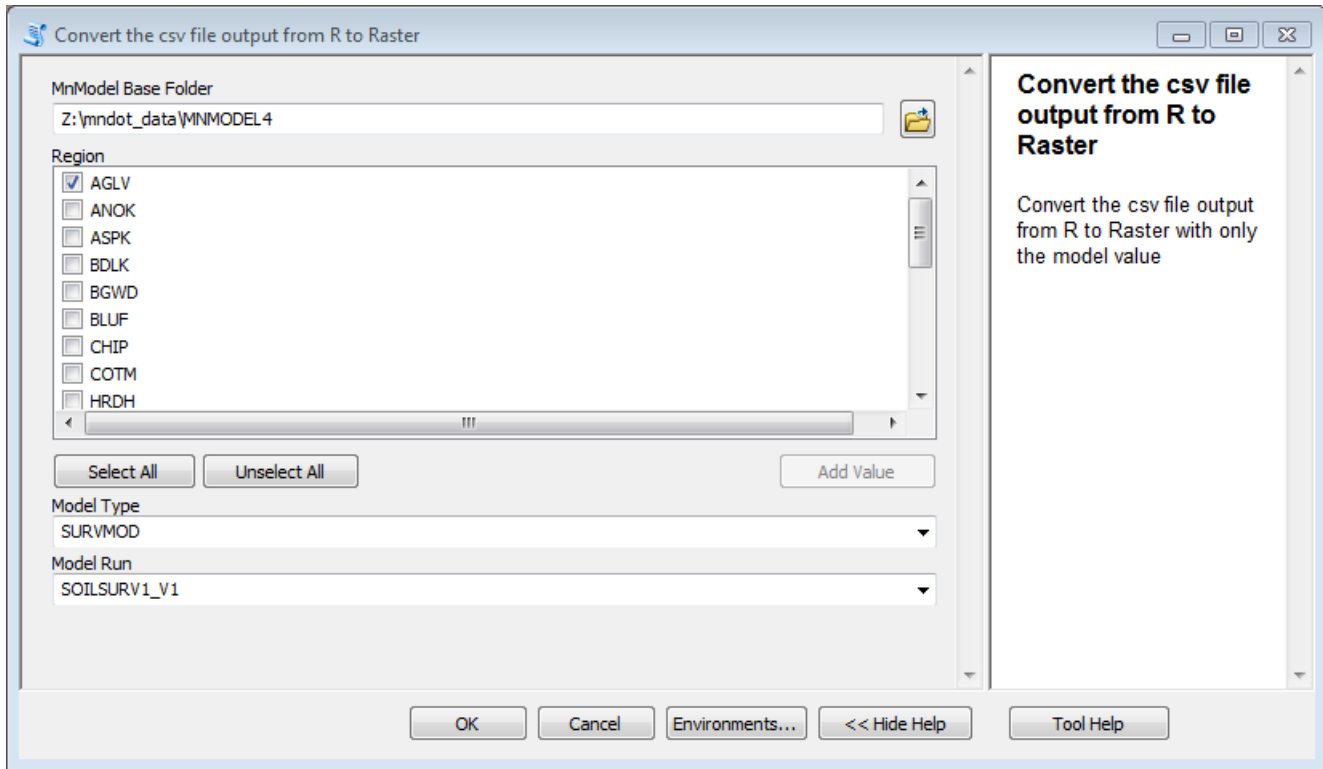### Convert the .csv file output from R to Raster

Tool Name: Convert the csv file output from R to Raster (Figure 33)

Tool Location: \\MNMODEL4\TOOLS\TOOLBOXES\MnModel\mnmodel.pyt\MODEL

Purpose of Tool: This tool creates an ArcGIS floating point grid from the .csv format prediction table generated by RStudio.

Figure 33: 'Convert the csv file output from R to Raster' Tool

Requirements:

- **Prediction Table:** A model output table, in .csv format, generated by the enhanced R modeling script. The file name will vary depending on which model version is run. For example:
  - \\MNMODEL4\REGIONS*REG*\R_DIR/*SITEMOD**ALLSITE1_V1**ALLSITE*Predictions.csv

Inputs:

- **MnModel Base Folder**: Location of MNMODEL4 folder.
- **Region**: The region you are modeling. Only one region/file may be processed at a time.
- **Model Type**: The type of model, either SITE (site model) or SURV (survey model). This will determine which subdirectory of the user's R directory contains the model files. For example:
  - \\MNMODEL4\REGIONS*REG*\R_DIR*SITE*MOD\
- **Model Run**: The name the user assigned to the specific model run. This should be the same as the name of the subdirectory in which the .csv file will be found. For example:
  - \\MNMODEL4\REGIONS*REG*\R_DIR*SITE*MOD*ALLSITE1_V3*

Outputs:

Floating point version of the model raster. The file location will be
\\MNMODEL4\REGIONS*REG*\INTERMEDIATE*MODEL_RUN*.gdb. For example:

- \\MNMODEL4\REGIONS\ASPK\INTERMEDIATE\ALLSITE1_V1.gdb\ALLSITE1_V1

Notes:

- The required prediction table from the enhanced R script must be named {ALL/SOIL}{SITE/SURV}Predictions.csv (for example ALLSURVPredictions.csv). The R script outputs the predictions in this format. If, for some reason, the predictions are not named using this convention, rename the file to follow the convention and the script will run.
- This tool loads the .csv output file generated in R, converts the .csv file to a table, then converts the table to an XY event layer. From the event layer it creates a floating point raster with a 30 m cell size.

Classification

Floating point grids are lovely to look at but difficult to interpret. Users need to have models classified into high and low probability areas. Classification requires a decision rule about where to make the distinction between high and low probability. The choice of this rule is subjective. For MnModel Phase 4 we experimented with several different decision rules for model classification. These tools assist with implementing them.
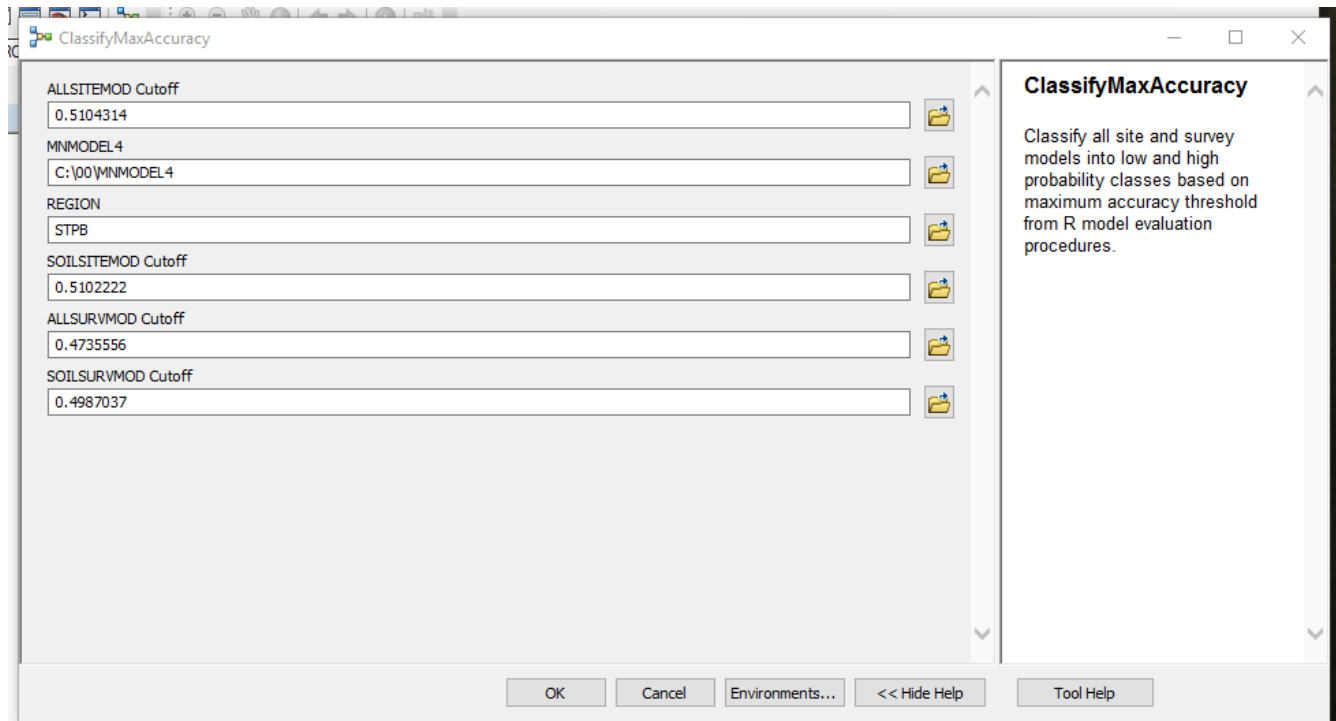
Classify Maximum Accuracy Models

Tool Name: ClassifyMaxAccuracy (Figure 34)

Tool Location: \MNMODEL4\TOOLS\TOOLBOXES\CLASSIFY_MODEL.tbx

Purpose of Tool: Classify models into high and low probability areas using the 'maximum accuracy' cutoff suggested by R.

Figure 34: 'ClassifyMaxAccuracy' Tool

Requirements:

- The \\MNMODEL4\REGION*REG*\INTERMEDIATE\ARCHMOD_*REG*.gdb geodatabase must already exist.
- The floating point model rasters you want to classify must be copied from their individual geodatabases (see documentation for 'Convert the csv file output from R to Raster' tool above) into the \\MNMODEL4\REGION*REG*\INTERMEDIATE\ARCHMOD_*REG*.gdb geodatabase. Rename the input floating point model rasters to following:
    - ALLSITE
    - SOILSITE
    - ALLSURV
    - SOILSURV

Inputs:

- **ALLSITEMOD Cutoff**: Maximum accuracy cutoff value for the ALLSITE model. This is found in the R documentation of the ALLSITE model run that created the model version you are using. For example, \\MNMODEL4\REGIONS*REG*\R_DIR*SITE*MOD\ALLSITE*1_V3*\ALLSITE*1_V3*.html.
- **MNMODEL4**: Location of MNMODEL4 directory
- **REGION**: Region abbreviation for defining paths to data.

- **SOILSITEMOD Cutoff**: Maximum accuracy cutoff value for SOILSITE model. This is found in the R documentation of the SOILSITE model run that created the model version you are using. For example, \\MNMODEL4\REGIONS*REG*\R_DIR*SITE*MOD\SOILSITE*1_V1*\SOILSITE*1_V1*.html.
- **ALLSURVMOD Cutoff**: Maximum accuracy cutoff value for ALLSURV model. This is found in the R documentation of the ALLSURV model run that created the model version you are using. For example, \\MNMODEL4\REGIONS*REG*\R_DIR*SURV*MOD\ALLSURV*2_V1*\ALLSURV*2_V1*.html.
- **SOILSURVMOD Cutoff**: Maximum accuracy cutoff value for SOILSURV model. This is found in the R documentation of the ALLSURV model run that created the model version you are using. For example, \\MNMODEL4\REGIONS*REG*\R_DIR*SURV*MOD\SOILSURV*1_V1*\SOILSURV*1_V1*.html.

Outputs:

The following maximum accuracy models, in the \\MNMODEL4\REGION*REG*\INTERMEDIATE\ARCHMOD_*REG*.gdb geodatabase:

- ALLSITEMAX
- SOILSITEMAX
- ALLSURVMAX
- SOILSURVMAX

Notes:

Maximum accuracy cutoffs are calculated in R ONLY for models developed from a subset of the total site or survey population. That is because another population subset must be used to test the model for the cutoff to be determined. Moreover, accuracy is a function of both true positives and true negatives. Thus the maximum accuracy cutoff is the threshold value that 'optimizes' the prediction of a 25% subset of the population. In our experience with these models, the prediction of true negatives outweighs the effects of the effect of true positives in determining accuracy. Thus the percentage of sites or surveys predicted at the maximum accuracy cutoff may not be 'optimum' for cultural resource purposes.

Make Composite Maximum Accuracy Model

Tool Name: CompositeMaxAccuracy (Figure 35)

Tool Location: \MNMODEL4\TOOLS\TOOLBOXES\CLASSIFY_MODEL.tbx

Purpose of Tool: Create composite site and survey models where values of models constructed using soils data take precedence over values of models lacking soils data. The models lacking soils data (the ALLSITEMAX and ALLSURVMAX models) will replace the NULL values of the SOILSITEMAX or SOILSURVMAX models where soils data are missing.

Figure 35: 'CompositeMaxAccuracy' Tool
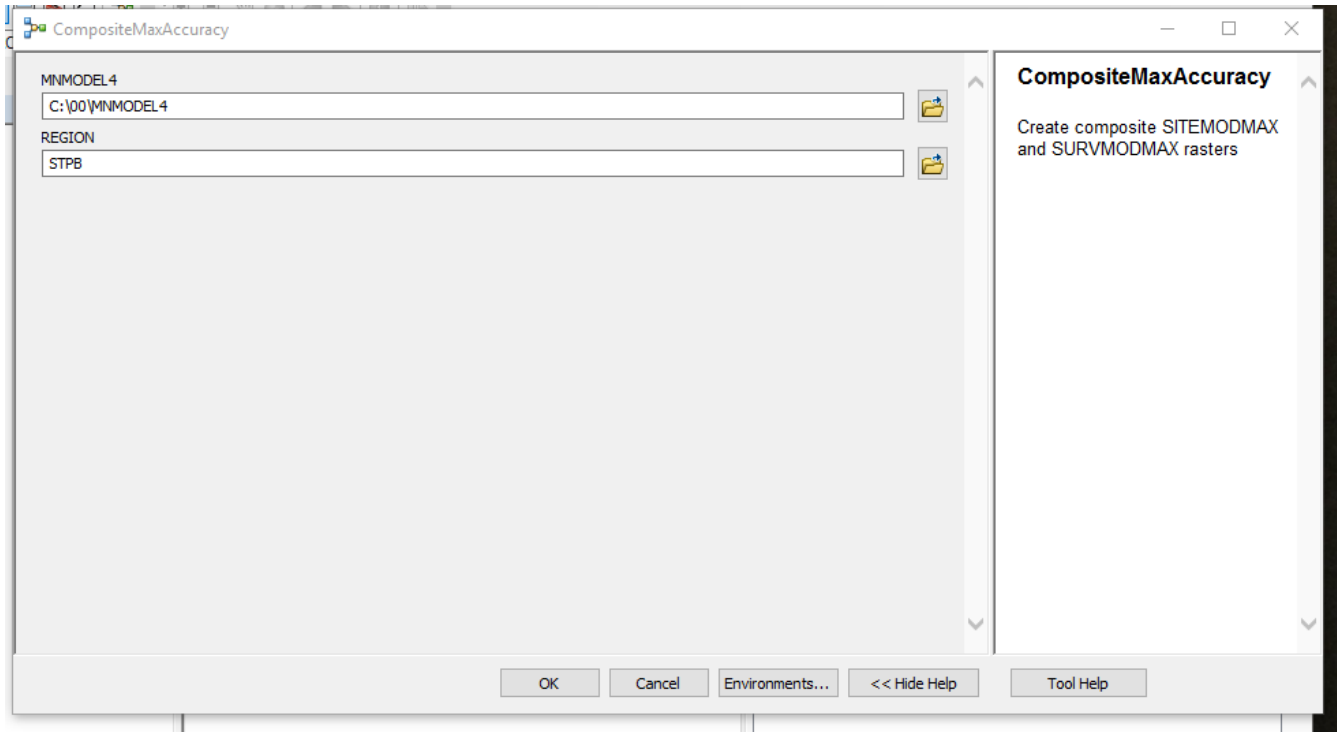
Requirements

- The \MNMODEL4\REGION*REG*\INTERMEDIATE\ARCHMOD_*REG*.gdb geodatabase must already exist.
- Classified rasters with the following names must be in the \\MNMODEL4\REGION*REG*\INTERMEDIATE\ARCHMOD_*REG*.gdb geodatabase:
  - ALLSITEMAX
  - SOILSITEMAX
  - ALLSURVMAX
  - SOILSURVMAX

Inputs:

- **MNMODEL4**: Location of MNMODEL4 directory
- **REGION**: Region abbreviation

Outputs:

Two composite models in the \\MNMODEL4\REGION*REG*\INTERMEDIATE\ARCHMOD_*REG*.gdb geodatabase:

- SITEMODMAX: Composite maximum accuracy site model
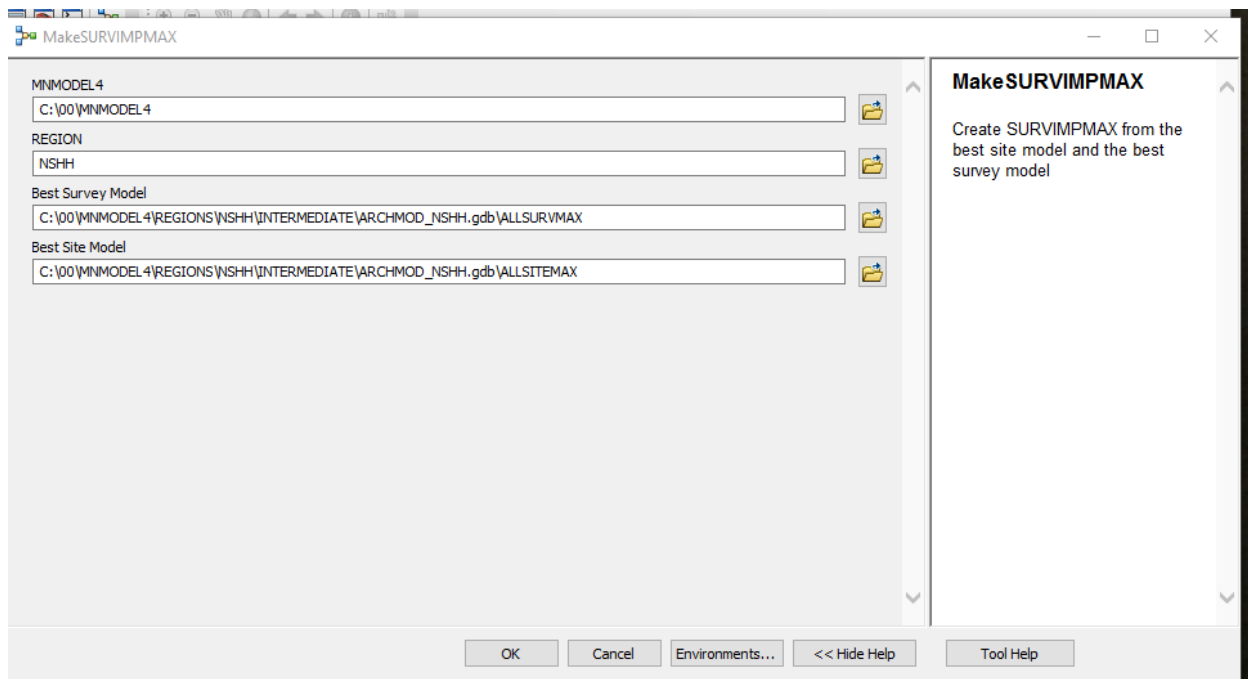- SURVMODMAX: Composite maximum accuracy survey model

---

Create SURVIMPMAX

Tool Name: MakeSURVIMPMAX (Figure 36)

Tool Location: \MNMODEL4\TOOLS\TOOLBOXES\CLASSIFY_MODEL.tbx

Purpose of Tool: To create a survey implementation model from the best maximum accuracy site model and the best maximum accuracy survey model.

Figure 36: 'MakeSURVIMPMAX' Tool

Requirements:

- The \MNMODEL4\REGION*REG*\INTERMEDIATE\ARCHMOD_*REG*.gdb geodatabase must already exist.
- Classified rasters with the following names must be in the \\MNMODEL4\REGION*REG*\INTERMEDIATE\ARCHMOD_*REG*.gdb geodatabase:
  - ALLSITEMAX
  - SITEMODMAX
  - ALLSURVMAX
  - SURVMODMAX
- The user must have already evaluated the models. That is, the user must have determined which of each pair of models performs best. Refer to the MnModel Phase 4 *Archaeological Predictive Modeling Guide* (Chapter 3, Section 3) for model evaluation procedures.

Inputs:

- **MNMODEL4**: Location of MNMODEL4 directory
- **REGION**: Region abbreviation
- **Best Survey Model**: The best survey model, either ALLSURVMAX or SURVMODMAX, as determined by evaluation procedures. The full path to the model is included.
- **Best Site Model**: The best site model, either ALLSITEMAX or SITEMODMAX, as determined by evaluation procedures.

Outputs:

\\MNMODEL4\REGIONS*REG*\INTERMEDIATE\ARCHMOD_*REG*.gdb\SURVIMPMAX

Create Target Sensitivity Site Models

Target sensitivity site models classify models based on a target percentage of archaeological sites the user wants to fall into the high probability area. For cultural resources management, this ensures that an agency's goals are met and that the user has a fair idea of what percentage of unknown sites may be predicted by the model.

Tool Name: TargetSensitivityModels (Figure 37)

Tool Location: \\MNMODEL4\TOOLS\TOOLBOXES\CLASSIFY_MODEL.tbx

Purpose of Tool: To create models ensuring that 85%, 90%, and 95% of known sites are in the high probability areas.

Figure 37: 'TargetSensitivityModels' Tool
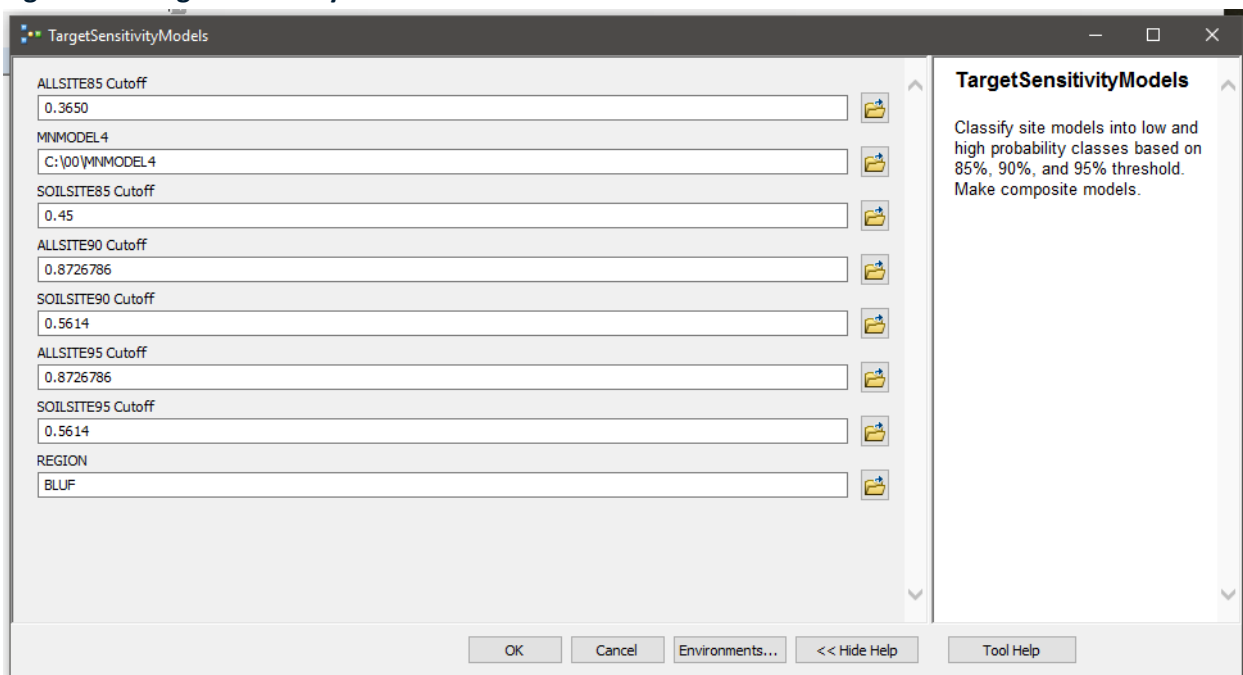
Requirements:

- The \MNMODEL4\REGION*REG*\INTERMEDIATE\ARCHMOD_*REG*.gdb geodatabase must already exist.
- Floating point rasters with the following names must be in the
  \\MNMODEL4\REGION*REG*\INTERMEDIATE\ARCHMOD_*REG*.gdb geodatabase:
- ALLSITE
- SOILSITE
- The user must have already determined the threshold values for each percentage cutoff for each model models. Refer to the MnModel Phase 4 *Archaeological Predictive Modeling Guide* (Chapter 3, Section 2) for the procedures for determining these thresholds.

Inputs:

- **ALLSITE85 Cutoff**: User-determined cutoff value to capture 85% of sites in high probability areas of ALLSITE model.
- **MNMODEL4**: Location of MNMODEL4 directory.
- **SOILSITE85 Cutoff**: User-determined cutoff value to capture 85% of sites in high probability areas of SOILSITE model.
- **ALLSITE90 Cutoff**: User-determined cutoff value to capture 90% of sites in ALLSITE model.
- **SOILSITE90 Cutoff**: User-determined cutoff value to capture 90% of sites in SOILSITE model.
- **ALLSITE95 Cutoff**: User-determined cutoff value to capture 95% of sites in ALLSITE model.
- **SOILSITE95 Cutoff**: User-determined cutoff value to capture 95% of sites in SOILSITE model.
- **REGION**: Region abbreviation

Outputs:

The following classified models in the \MNMODEL4\REGIONS*REG*\INTERMEDIATE\ARCHMOD_*REG*.gdb:

- ALLSITE85
- SOILSITE85
- SITEMOD85
- ALLSITE90
- SOILSITE90
- SITEMOD90
- ALLSITE95
- SOILSITE95
- SITEMOD95

Make Target Sensitivity Survey Implementation Models

There are three tools, but they all work the same. Only the first is illustrated here.

Tool Name: MakeSurvImp85 (Figure 38), MakeSurvImp90, MakeSurvImp95

Tool Location: \MNMODEL4\TOOLS\TOOLBOXES\CLASSIFY_MODEL.tbx

Purpose of Tool: To combine the best target sensitivity site model for the target percentage with the best maximum accuracy survey model to create a target sensitivity survey implementation model.

Figure 38: 'MakeSURVIMP85' Tool
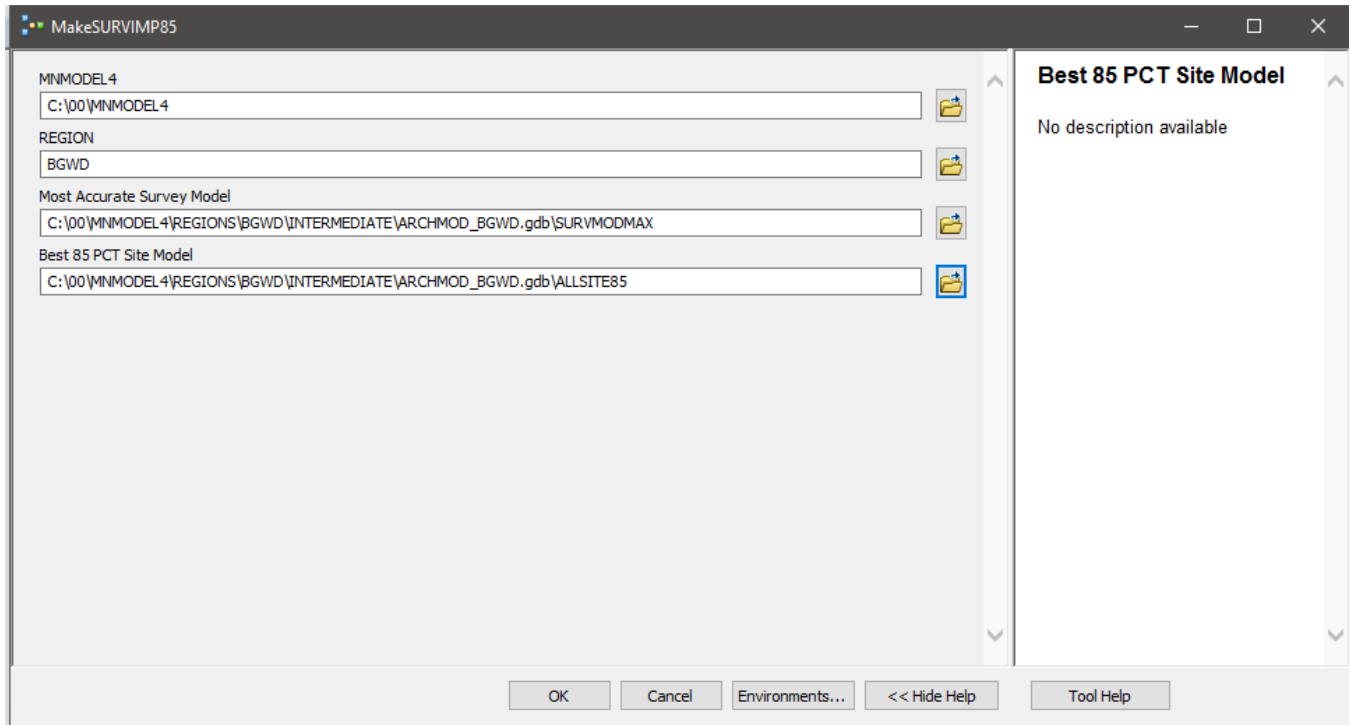
Requirements:

- The \MNMODEL4\REGION*REG*\INTERMEDIATE\ARCHMOD_*REG*.gdb geodatabase must already exist.
- Classified rasters with the following names must be in the \\MNMODEL4\REGION*REG*\INTERMEDIATE\ARCHMOD_*REG*.gdb geodatabase:
  - ALLSITE85
  - SITEMOD85
  - ALLSITE90
  - SITEMOD90
  - ALLSITE95
  - SITEMOD95
- The user must have already evaluated the models. That is, the user must have determined which of each pair of models performs best. Refer to the MnModel Phase 4 *Archaeological Predictive Modeling Guide* (Chapter 3, Section 3) for model evaluation procedures.

Inputs:

- **MNMODEL4**: Location of MNMODEL4 directory
- **REGION**: Region abbreviation
- **Most Accurate Survey Model**: Path and file name for the best maximum accuracy survey model (either ALLSURVMAX or SURVMODMAX).
- **Best *XX*% PCT Site Model**: Path and file name for the best site model for the target percentage prediction. Choices are between the ALLSITE*XX* models and the composite SITEMOD*XX* models for each target sensitivity percentage:
    - ALLSITE85 or SITEMOD85
    - ALLSITE90 or SITEMOD90
    - ALLSITE95 or SITEMOD95

Outputs:

\\MNMODEL4\REGION*REG*\INTERMEDIATE\ARCHMOD_*REG*.gdb\SURVIMP%

Utility Tools

Utility tools are those tools that maybe be used to perform various time-saving functions, that are required by other tools, or that don't fit into any other category.
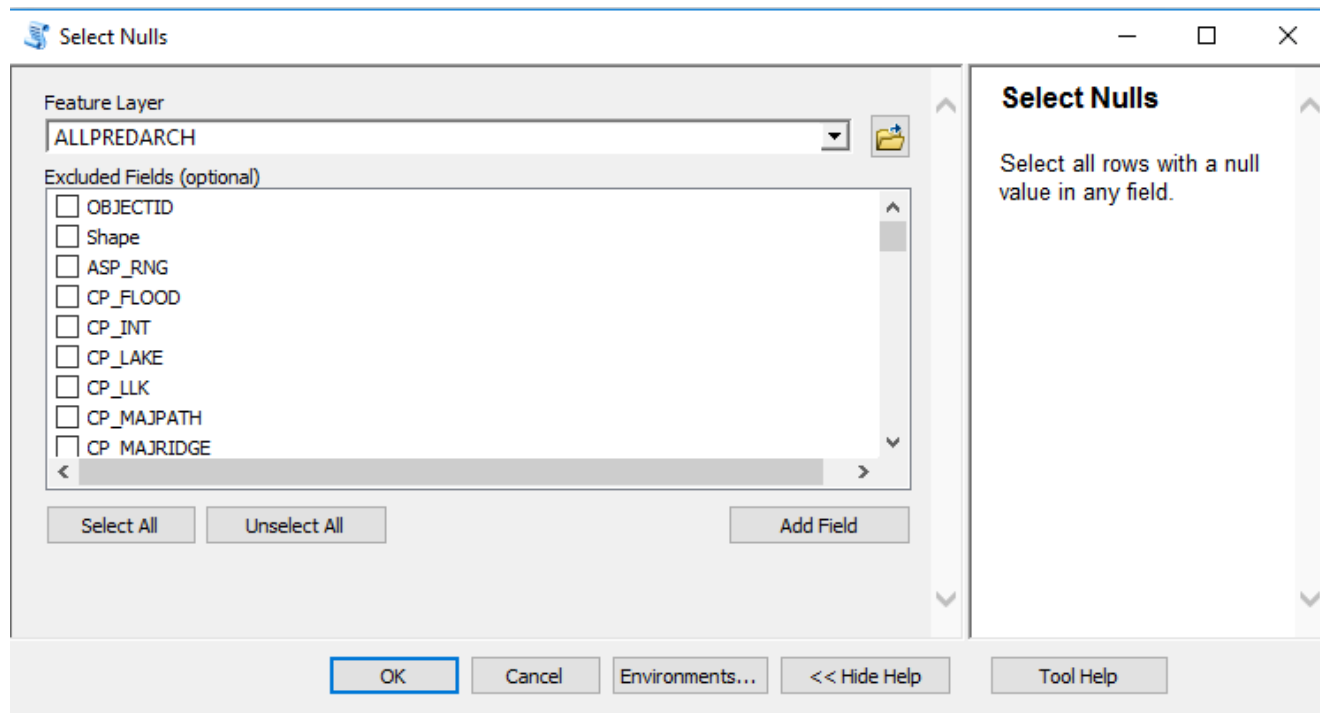
Select Nulls

Tool Name: Select Nulls (Figure 39)

Tool Location: \\MNMODEL4\TOOLS\TOOLBOXES\MnModel\mnmodel.pyt\UTILS

Purpose of Tool: In an ArcMap session, create a new selection of a feature layer where the chosen fields contain null values.

Figure 39: 'Select Nulls' Tool

Requirements:

The user must be working in an ArcMap session.

Inputs:

- **Feature Layer**: The feature class from which records will be selected.
- **Excluded Fields**: Fields that should be excluded from the NULL selection.

Outputs:

Rows with null values in any of the unselected fields are selected.

Notes:

This tool has been used to perform quality control on sampled point files to make sure they do not contain NULL values prior to modeling in R.