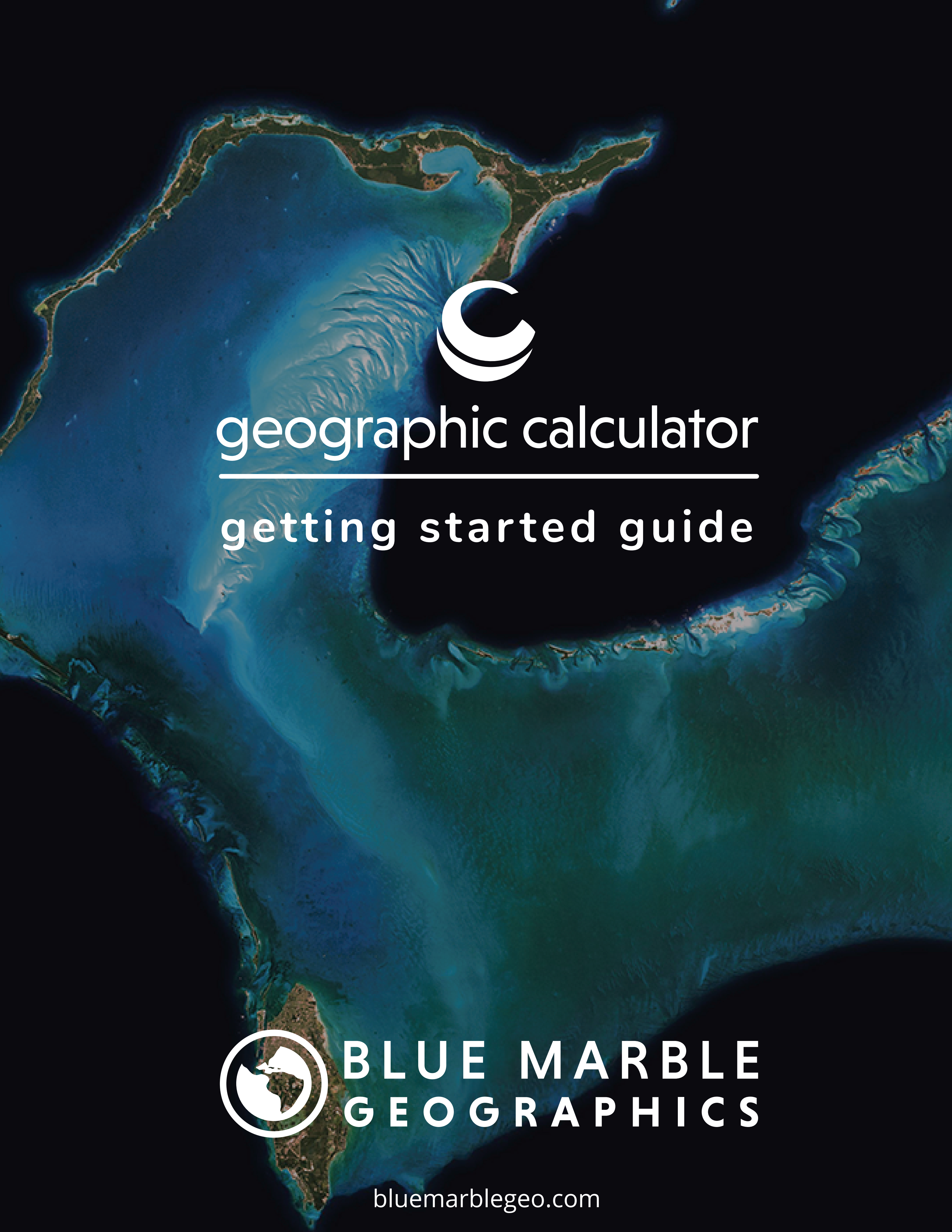


geographic calculator

getting started guide

BLUE MARBLE GEOGRAPHICS

bluemarblegeo.com

Table of Contents

Introduction

This guide provides a direct, project oriented approach to learning the capabilities of Geographic Calculator. It is intended to guide the user step-by-step through some of the basic operations of Geographic Calculator. It also provides "hands on" experience with real data. This lab manual is ideal for new users who would like to gain some experience with the application and for experienced users who would like to sharpen their skills.

Geographic Calculator Components:

- Administrative tools to allow streamlining and guidance for users, as well as restrictions on coordinate system editing and usage.
- Data Corral to help organize your project data within the desktop
- Workspaces and a Project manager to allow grouping of common tasks, set up of batch jobs, or to organize different projects within the Desktop
- A Vector and Raster Viewer to visualize data before and after conversion
- Importers to bring in geodetic parameters from other databases and file formats
- The ability to use any datum as an intermediary for datum transformations
- An XML based geodetic datasource that allows for creation of custom definitions and advanced geodetic object manipulation and querying
- A web registry connection to the GeoCalc Geodetic Registry and the OGP's online registry for EPSG datasource and advance parameter support
- An application Start Page that is an interactive page with information about appropriate job types, data support and updates

Vector Data Jobs

- Interactive Calculations- Single point conversions and Forward and Inverse Calculations
- Point Database Calculations- Point Conversions and Forward and Inverse Calculations, on tabular data formats
- Vector Data Conversions- Convert entire vector layers from popular GIS and CAD formats and Spatial Databases.
- Seismic Survey Conversions - Streamlined conversion of SEG, SPS, and UKO formatted files.

Raster Data Jobs

- Georeferencing- Assigning coordinates to a raster image
- Transformation- Reprojecting raster images and digital elevation models, both single and batch mode

Before Beginning

This Getting Started Guide assumes that the user has a basic familiarity with the Windows operating system. It is important to understand double-clicking, right-clicking, cut-paste, and navigating Windows operating systems.

It is important to ensure that you have the appropriate permissions on your computer to be able to define new coordinate systems. If you are on a restricted installation, please see your administrator to obtain the appropriate access.

System Requirements

Geographic Calculator minimum system configuration recommendations:

- Intel Pentium 4 class processor or newer
- Windows 10, Windows 8, or Windows 7
- 8GB RAM
- Disk space sufficient for file processing
- Windows Administrator permissions

Geographic Calculator General Tools

Geographic Calculator has some general tools that are available in the application. These tools are related to the overall user experience in the software. There are tools to help you set up workspaces that you can share with other users, tools for managing the data files you use in your Projects, and tools you can use to help streamline working with coordinate systems.

The goals of this section are to:

- Use the Start Page to see the available jobs and supported file formats.
- Familiarize yourself with the Project Manager.
- Set up a Workspace and save its settings for later use.
- Change some default settings in the Preferences.

With the Project Manager and Workspaces, you can set up and save Geographic Calculator settings for each of your projects. They allow you to standardize your layout settings and preferences as well as the jobs and tasks associated with your projects. You can even Export Workspaces with defined jobs to your fellow employees, assisting their workflow by setting up template jobs or datasource views to guide their work with coordinate systems.

The Geographic Calculator help file provides any additional information that you may require. This manual will take you through the process of setting up a project and saving your workspace settings, and offers several labs:

- Section 1: Start Page
- Section 2: Working with Projects
- Section 3: Working with Workspaces
- Section 4: Setting Preferences

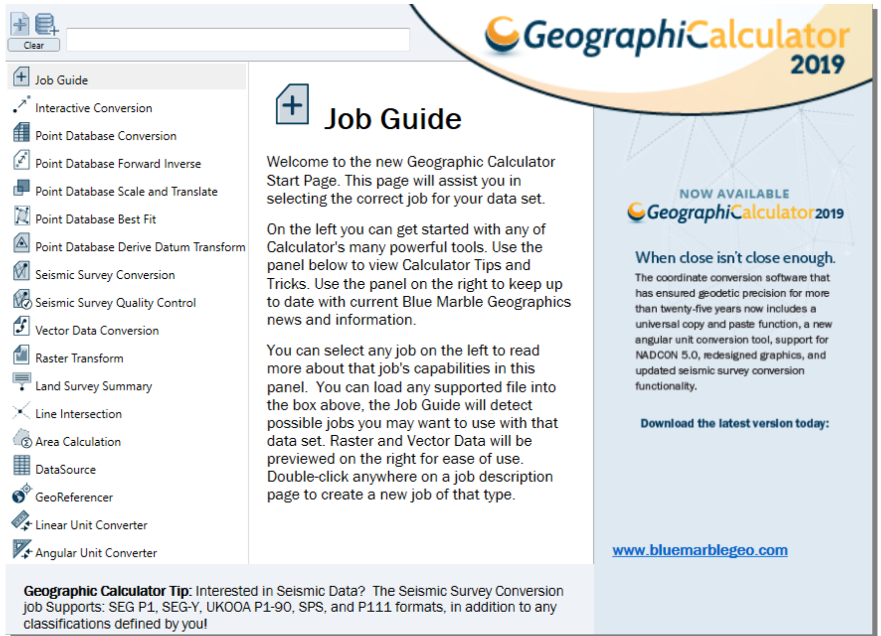
Start Page

Objective: Familiarize yourself with the tasks available in Geographic Calculator and the supported file formats.

The Start Page displays information about job types, as well as Geographic Calculator news. Select jobs from the start page list to read more about the capabilities. We will work with these different job types in later sections. A job represents a discrete task that involves processing a particular type of input data.

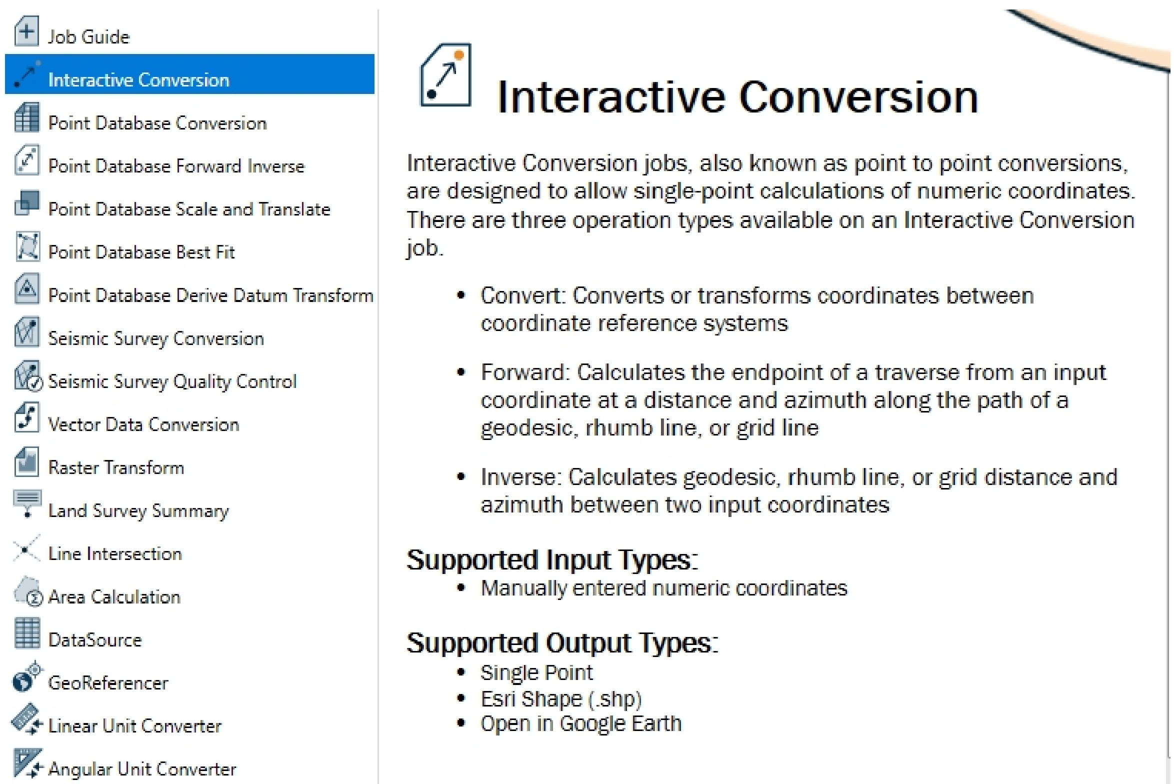
Data: Africa_Photo.tif

When you begin working with your own data, you can load data in the top of the start page using the *Open File*  buttons to see a list of the available relevant jobs.



Then double-click the job name to initiate a new job of that type, using the specified data, if any has been loaded.

1. Select the Interactive Conversion from the job guide list to see information about the Interactive Conversion Job.



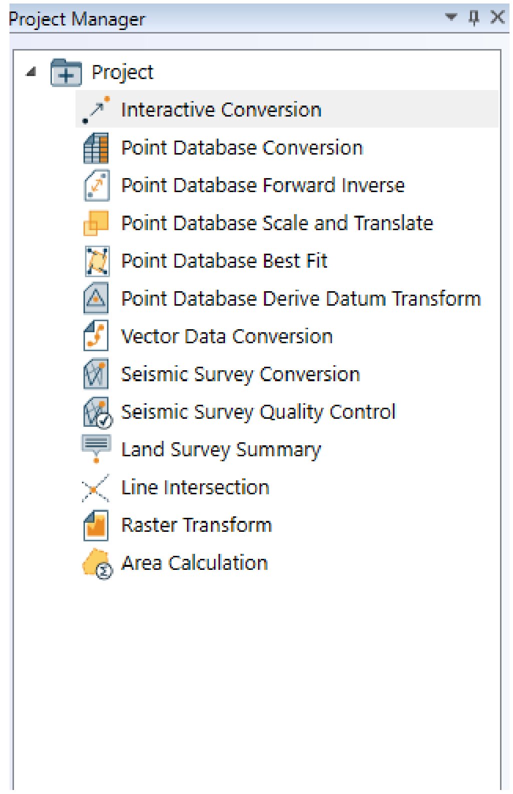
2. Choose the  button. Navigate to the Getting Started Guide data (C:\geographic-calculator-getting-started-guide\GSG) and load the Africa_Photo.tif

The list of jobs inside of the start page is limited to only those that work with the loaded data. The right pane of the start page displays a data viewer with the loaded data. The source coordinate system is also listed, because it is recognized from the file format. The tip section also mentions the Georeferencer tool, which can be found in the tools menu, since that may be applicable to this data format.

Working With Projects

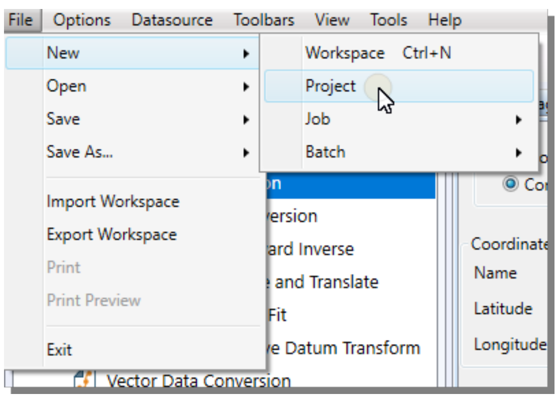
Objective: The steps below will familiarize you with Geographic Calculator's Project Manager and its use.

To create and work with a new project in Geographic Calculator:



1. Open Geographic Calculator and look for the **Project Manager** on the left side of the application workspace. Geographic Calculator will start with one Project containing one of each job type; Interactive Conversion, Seismic Survey Conversion, Point Database Conversion, Point Database Forward Inverse, Land Survey Summary, Area Calculation, Line Intersection, Vector Data Conversion, Raster Transform, Point Database Scale and Translate, Point Database BestFit, Point Database Derive Datum Shift.

2. From the menu bar, select **File > New > Project**. This will add a new 'Project1' node to your Project Manager window.



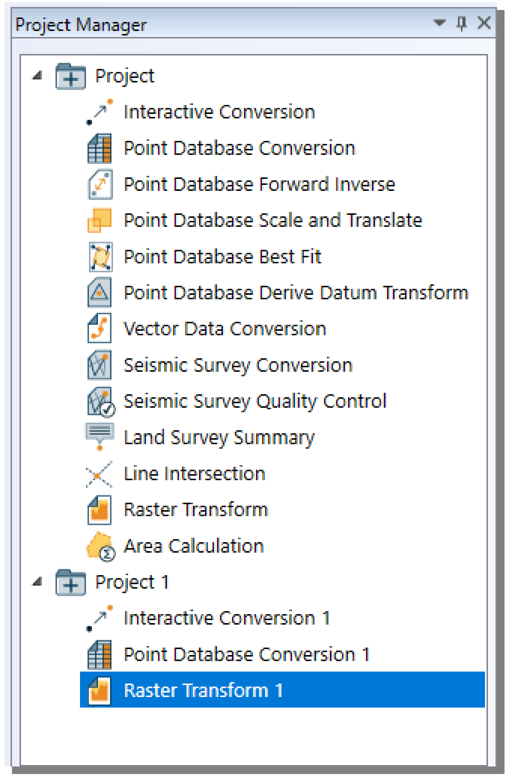
To change the name of the Project, right-click on the name 'Project1' and select 'Rename'.

3. Click on each of the job items listed in the project and note how the active tab associated with each item changes when you click it.

4. You can also click on the  Create a new project button in the Projects Toolbar.

5. Next, from the menu bar, select **File > New > Job > Interactive Conversion** and **File > New > Job > Point Database Conversion**. This will add two jobs under 'Project1': Interactive Conversion 1 and Point Database Conversion 1.

6. Right-click on 'Project1' in the Project Manager window and select **Create New Job > Raster Transform**. This will add another job under 'Project1': Raster Transform 1.



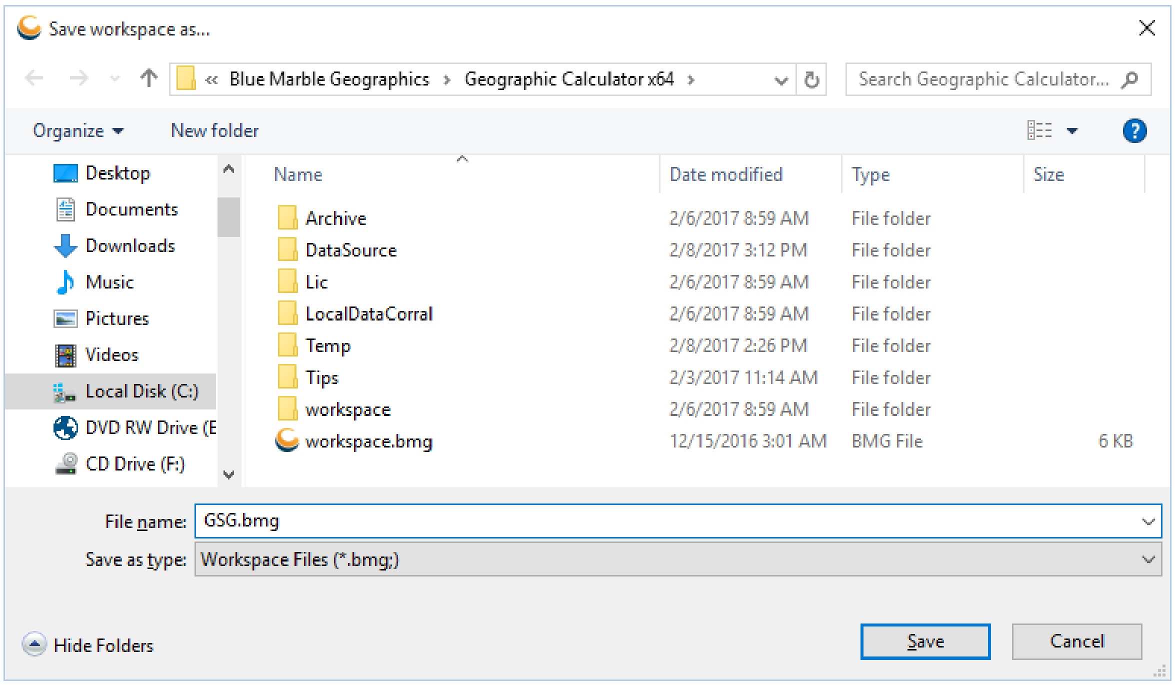
Continue to Working with Workspaces

Working With Workspaces

> **Objective:** In the steps below, you will save and then retrieve a workspace. This continues from the previous steps, outlined in '*Section 1: Working With Projects*'. **Geographic Calculator** should be open, and in your Project Manager there should be two projects, each with several job items in them.

Follow these steps to work with your workspace:

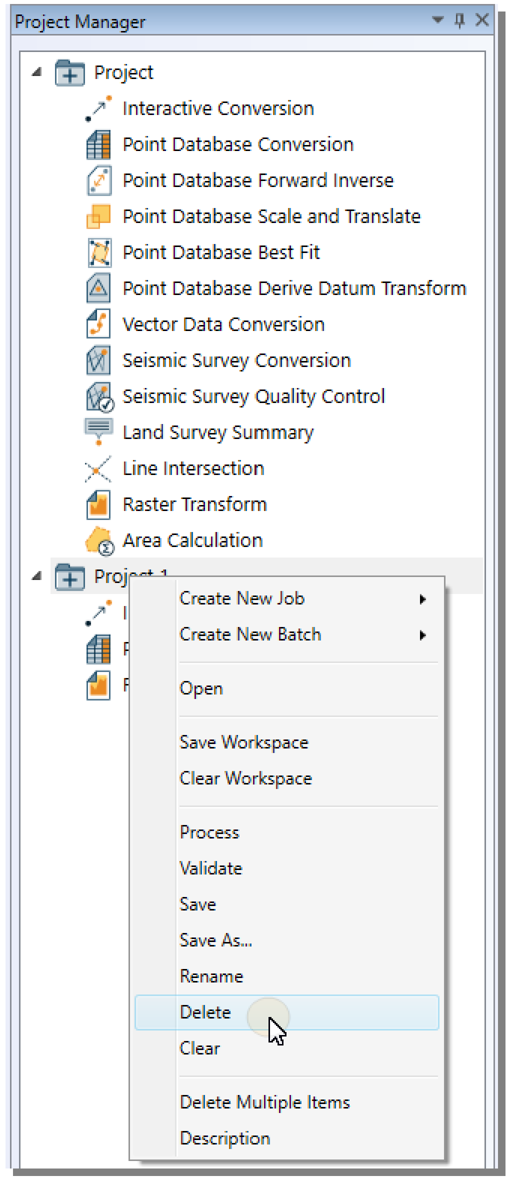
1. From the menu bar, select **File > Save As > Workspace**. This will open the *Save Workspace As* dialog box. Save this workspace as GSG.bmg.



The application will save the workspace to a file for future use, including all open projects, jobs and workspace settings.

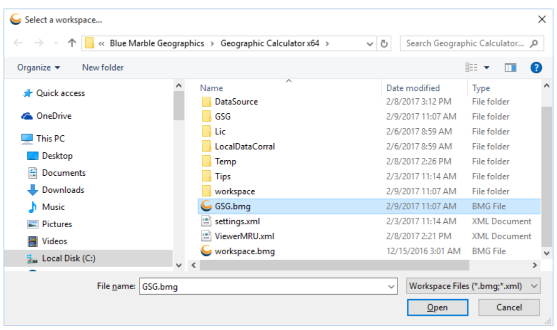
2. In the Project Manager, right-click on 'Project1' and select **Delete** from the context menu.

   The application will then delete 'Project1' and all of its jobs from the Project Manager.



3. Close **Geographic Calculator**. If you are prompted to save your workspace changes, click **No**.
4. Re-start Geographic Calculator. Note that the application starts with a default workspace.
5. From the menu bar, select **File > Open > Workspace**.

   If you are prompted to save the current workspace before opening another one, click **No**. You will then be presented with the *Select a workspace...* dialog box. Select the GSG.bmg file and click Open.



   The application will load the workspace settings from GSG.bmg into the Project Manager. Note how 'Project1' is available again, since we saved the workspace before we deleted 'Project1'.

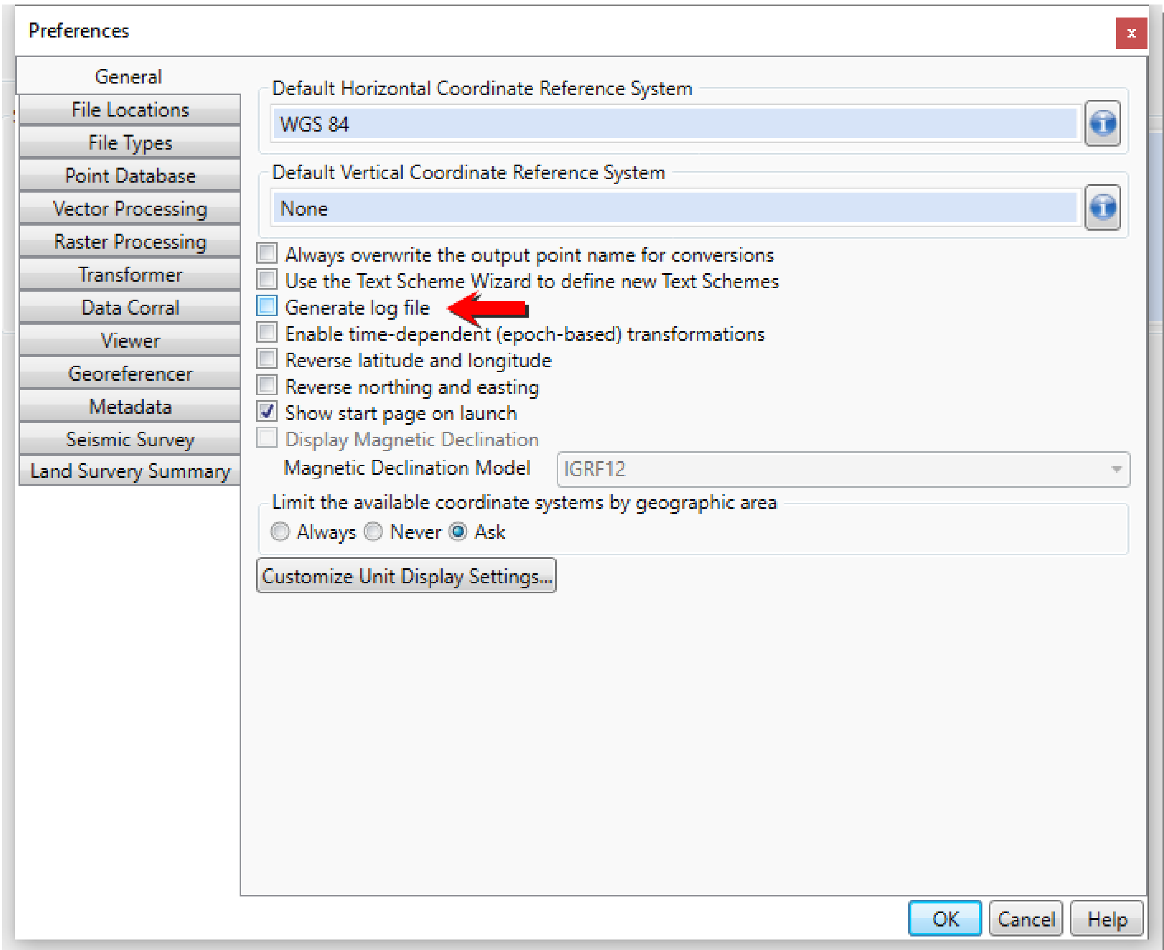
Continue to Setting Preferences

Setting Preferences

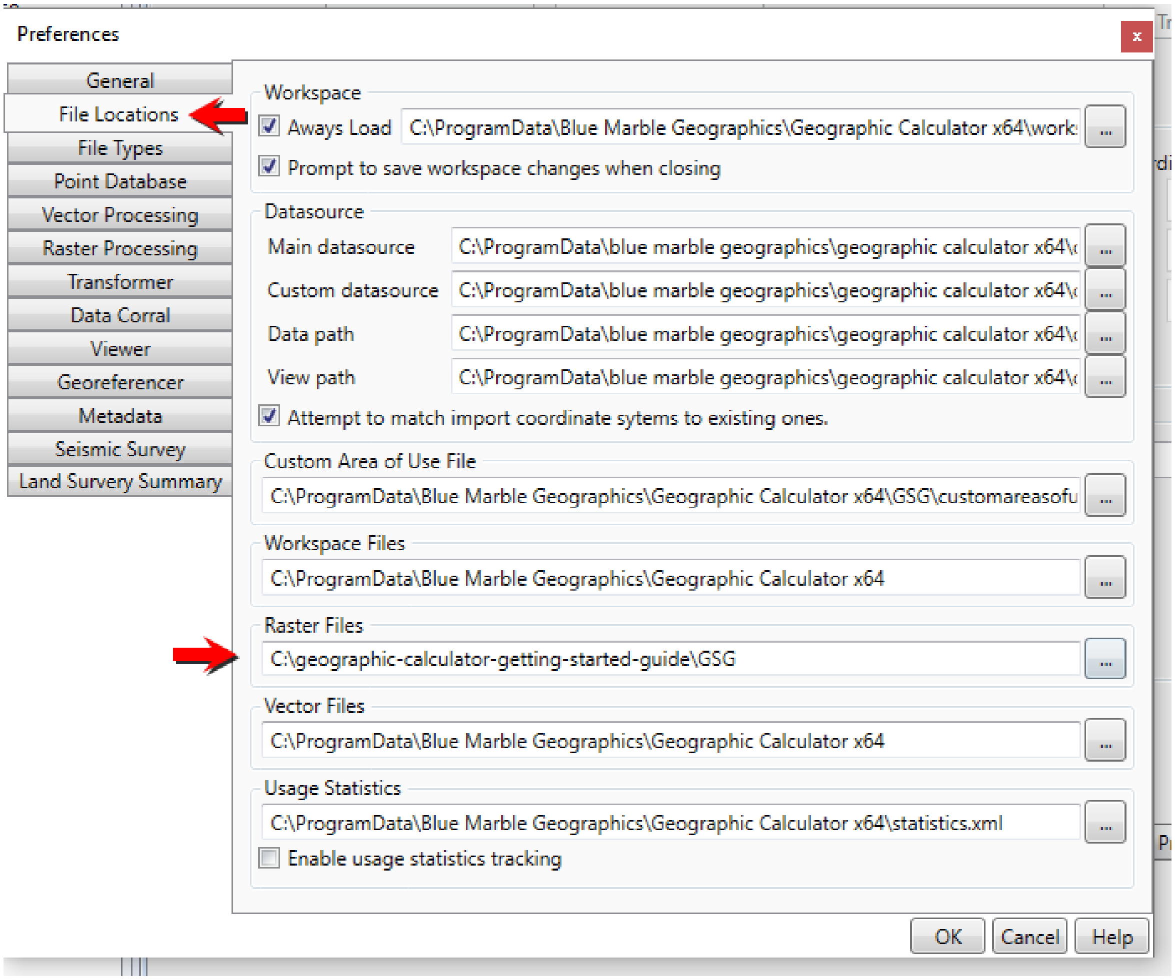
Objective: Now that you are familiar with how to set up and edit a Project or Workspace, the dialogue below will introduce you to setting up user Preferences for Projects and Workspaces in Geographic Calculator. Once set, Preference settings will propagate to all Projects and Workspaces set up on the user's workstation.

1. From the menu bar, select **Options > Preferences**.

   When the **Generate Log File** box is checked, the application will generate a log file that records the operations you perform in a session. The log file is stored in the default program data or application data directory.



2. The **File Locations** section contains the settings and locations for system files.

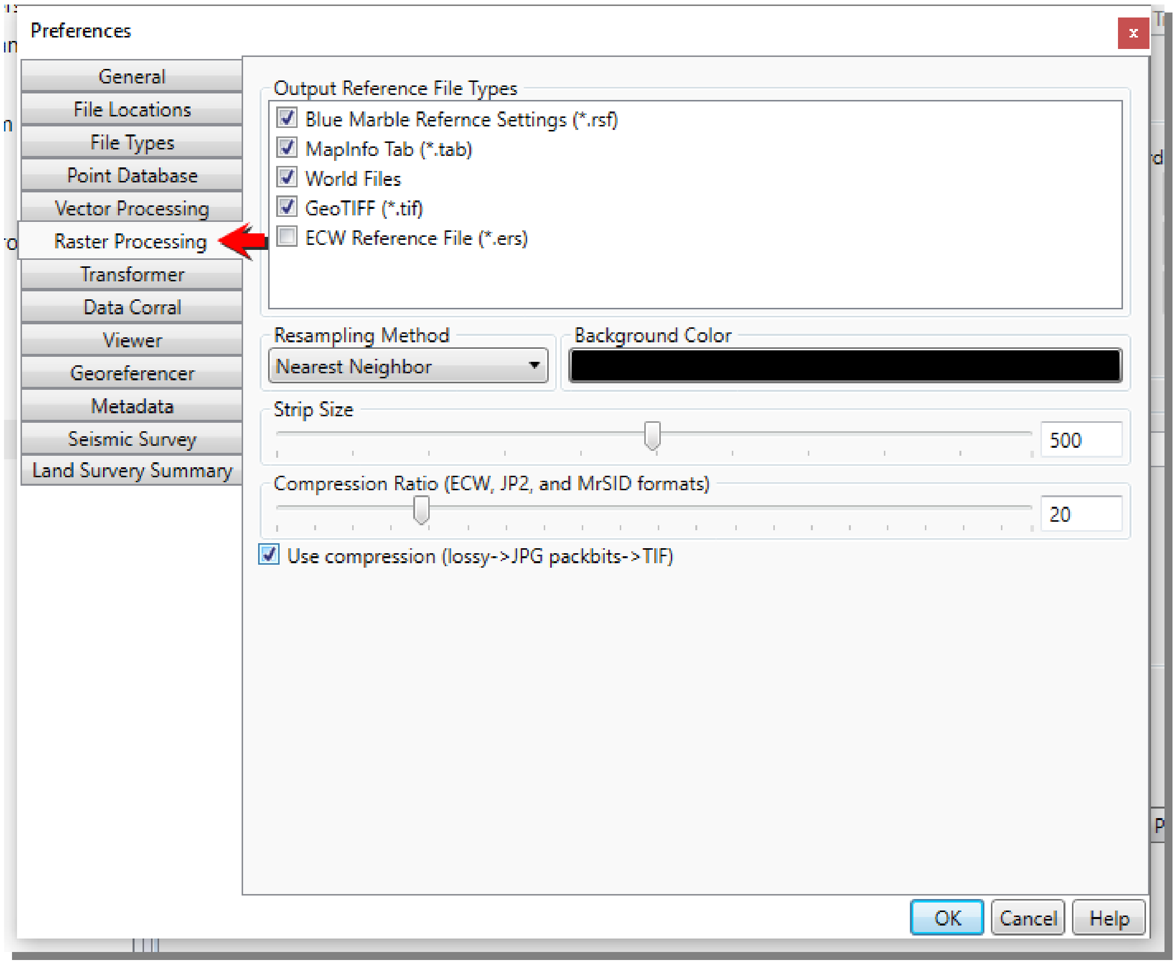


These are saved for the individual workstations and are not workspace-specific.

> Note that within the Preferences dialog, the **File Locations** section allows you to tell the system where to look for workspace, setting, project, and job files. When using Geographic Calculator in a network group, you might want to share system files and data folders from a network server.

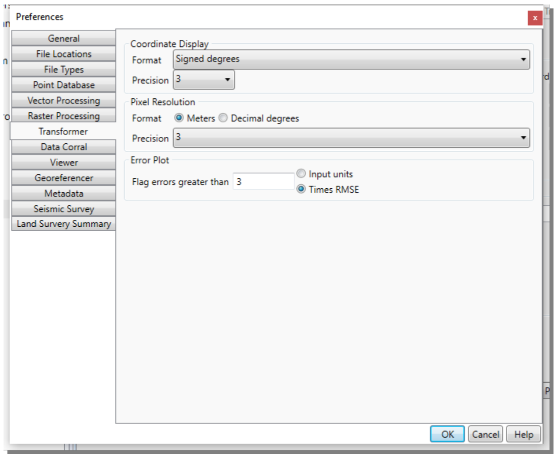
3. If you plan on completing the 'Working With Raster Data' Labs found in the latter part of the guide, you can change the Raster files field to the work folder that contains the sample data you downloaded with this Getting Started Guide. You can type the path in the text field or use the ellipsis button to browse to the folder.

4. Click on the *Raster Processing* section of the Preferences dialog. Here you will see the various settings the Desktop will default to when working with your raster images. Note the default Strip Size and Compression Ratio settings. By default, all of the Output Reference File Types check boxes are checked.



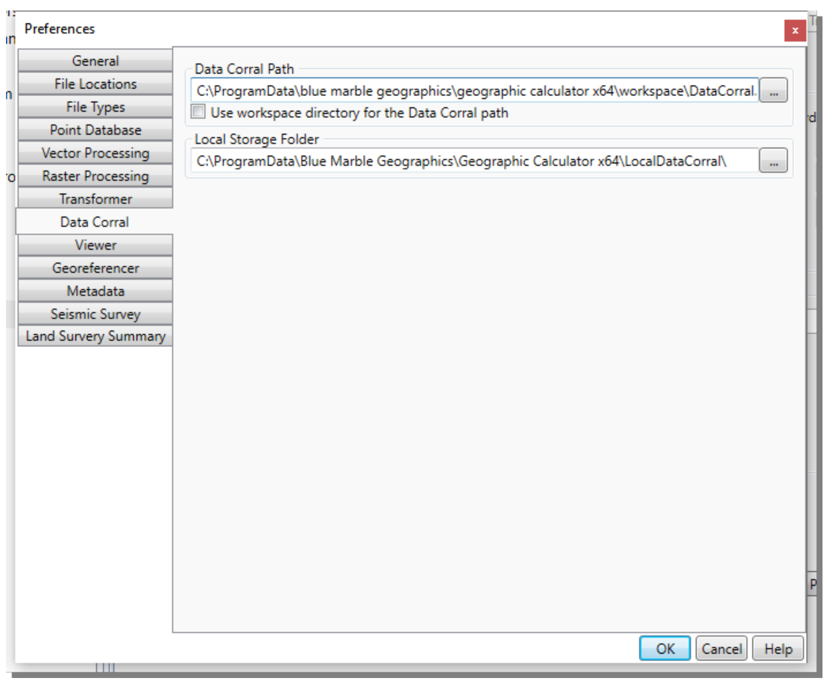
The application will generate all reference file types for any file output from the Geographic Calculator. These can be changed to match your usual reference file needs once you have completed this Getting Started Guide.

5. Click on the *Transformer* section of the *Preferences* dialog. This section contains additional **Geographic Transformer** settings. Here you can set the coordinate **Format** and precision to be used in raster transformations, and set a default unit of measurement to be used for expressing **Pixel Resolution**.



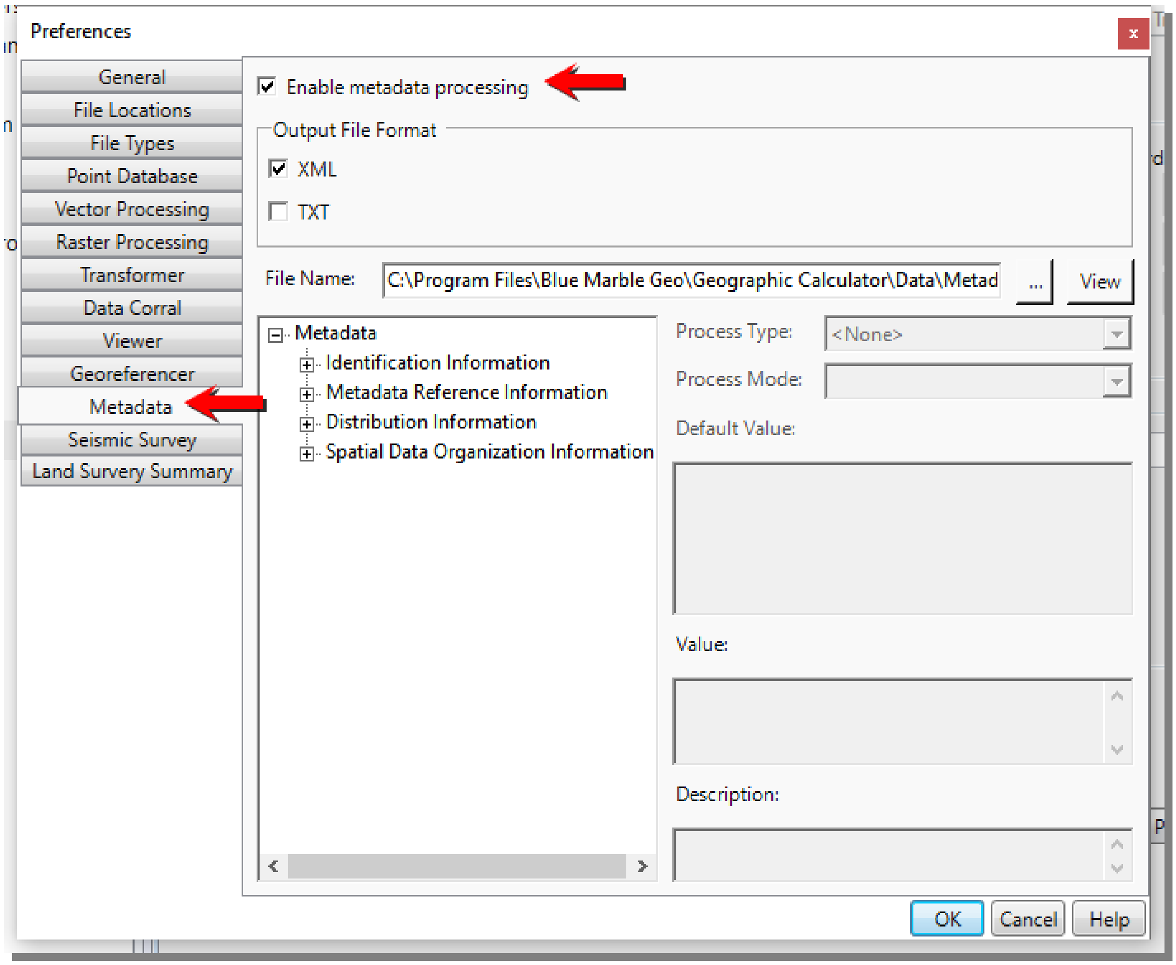
6. The *Data Corral* section of the **Preferences** dialogue allows you to save references to raster and vector images, point data files, spatial database data, and other files that are part of your workspace, with the option of copying files to a local directory. These local files will process faster and allow you the flexibility of taking your work with you on a laptop computer.

   You can change the *Local Storage Folder* to another folder or directory location in one of two ways: Click on the ellipsis button to open a *Browse For Folder* dialog, or type in the file path and name into the *Local Storage Folder* text box. The application will store all of your corralled files to this location. You must first create the folder before you can point to it. You can create a folder in the Windows File Explorer, or by using the *Make New Folder* button on the *Browse For Folder* dialog.



7. In the *Metadata* tab of the **Preferences** dialog, users can specify all the preset options which will apply to each file output they perform.

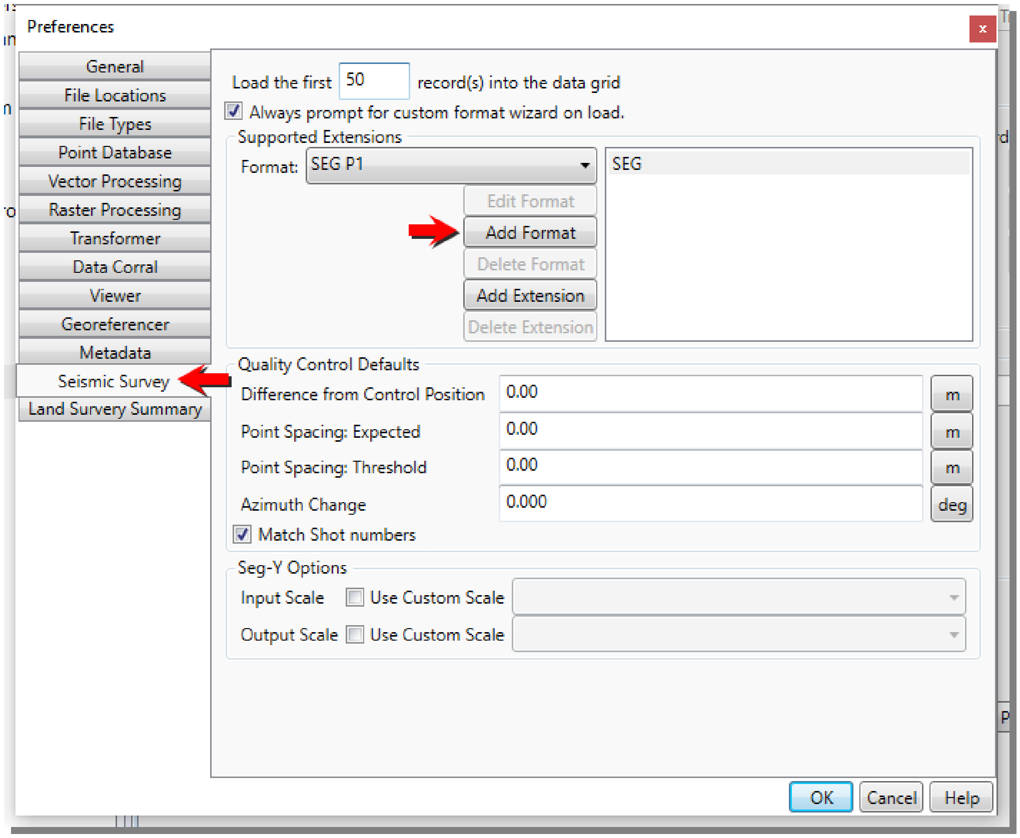
> In each of the main jobs of Geographic Calculator which export a file as output, you can write a metadata file along with the output data. It can be valuable to be able to set default values for certain metadata fields in order to save time on each output job.



You can first choose to turn metadata processing on or off entirely, and then activate whether you would like to write out metadata as XML, TXT, or both.

The default template shown in the **File Name** field is shipped with the application, but users can click the ellipsis to load a custom template to use when writing files if they desire.

8. On the *Seismic Survey* tab there are a number of options that allow you to alter settings related to how the Seismic Survey jobs are processed. Check **Always prompt for custom format wizard on load** to prompt users to define non-standard formatting schemes when loading seismic data.



The **Supported Extensions** settings are used to configure defaults for different formats and extensions, the **Add Format** button allows you to define a new format which will be saved for future use using the **Text File Scheme Wizard.**

Quality Control Defaults are used to specify the default threshold and point spacing values for the new **Seismic Quality Control** jobs.

> More information on Seismic Survey jobs can be found in the *Geographic Calculator User Guide*, accessed from the **Help Tab > Contents**. In the help guide, navigate to *Using Geographic Calculator > Workspaces > Jobs*. The full User Guide is accessible by hitting '**F1**' with the application open.

9. If you have made any changes to the Preferences, press **OK** to close the dialog.

Administrative Tools

In Geographic Calculator, there are a number of tools for an administrative level user to set restrictions on regular users' interaction with the application. These tools can be employed individually or together, allowing Administrators to have as much or as little control as they wish.

The Administrative Settings allow you to:

- Set a Password on a workspace to lock the Administrative Settings
- Set restrictions on adding, modifying, or deleting entries in the Geodetic Datasource
- Lock the location of the Geodetic Datasource files
- Hide specific objects in the Geodetic Datasource from users
- Change the name of objects as they appear to users
- Set custom Areas of Use to help users pick appropriate datum transformations
- Disable Area of Use filtering on Datum Transformation selection for power users
- Enable validation checks on the Datasource files and:
  - Prevent the application from loading an invalid Datasource
  - Alert users of possible invalid Datasource

Note: This section of the Getting Started Guide assumes a high level of knowledge of Geodetics and is geared towards Administrative level users. Users that have password protected locked workspaces from an Administrator will not be able to complete this lab.

In the following sections, step-by-step instructions will cover setting up various Administrative Settings, applying them, and then undo the settings. This lab covers things like setting a Password for the workspace and locking settings in place that can only be undone via re-entering the password.

- Hiding Datasource Objects from Users
- Changing an Object's Display Name
- Defining Custom Datum Transformation Areas of Use
- Restricting Access to the Geodetic Datasource
- Enable Validation on Datasource Files
- Setting the Admin Password
- Administrative Lockdown
- Exporting the Workspace to Users

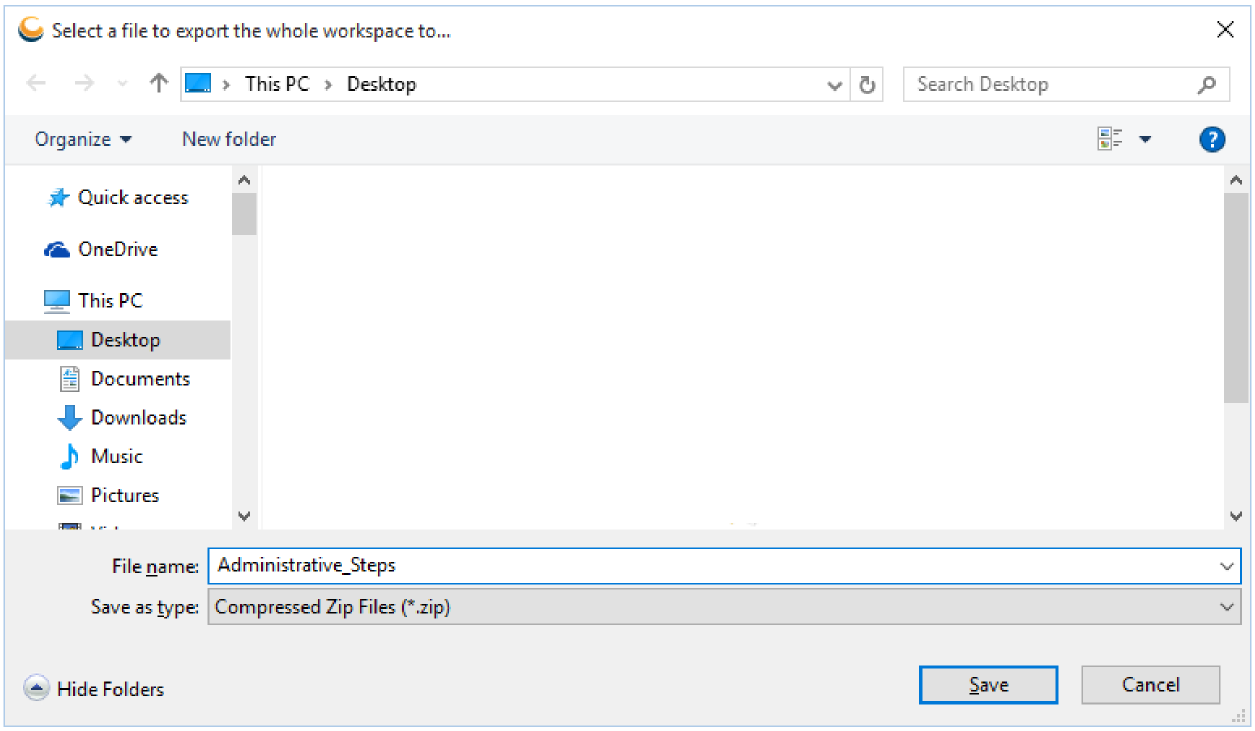
As with any Administrative changes, care should be exercised while completing any of the steps in the following instructions.

The following settings are workspace specific. To prevent any permanent changes, we will first export and import a workspace to perform these administrative settings in. Once these sections are completed, the workspace can be deleted and the default settings will be applied in a fresh instance of Geographic Calculator.

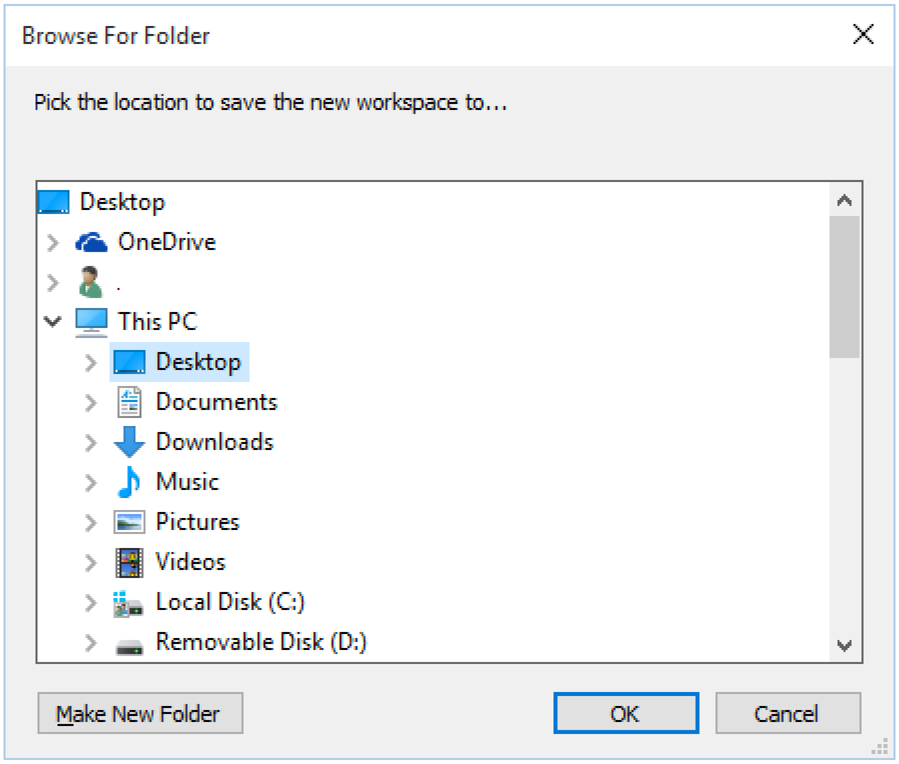
Exporting a Practice Workspace

In order to practice hiding datasource objects, changing an object's display name, and defining a custom area of use, we will export and open a practice workspace. This will prevent these administrative settings from being applied to the default workspace, and allow them to be quickly removed. **Objective:** Export a practice workspace. Then load that workspace before completing the following administrative exercises, in order to revert to the default administrative settings.

1. Open Geographic Calculator
2. Navigate to the File Menu > Export Workspace
3. Save this workspace as Administrative_Steps.zip in an easily accessible location (Desktop or C:\TEMP)



4. with Calculator open, Import the workspace saved in step 3.
5. A 'Browse for Folder' window will open, Select an easily accessed folder to save this imported workspace to.
    - Since this workspace is going to be deleted at the end of this section, it is recommended that this workspace is saved to the Desktop or Temp folder.



6. This will be the workspace that the administrative settings are saved in.

Hiding Datasource Objects from Users

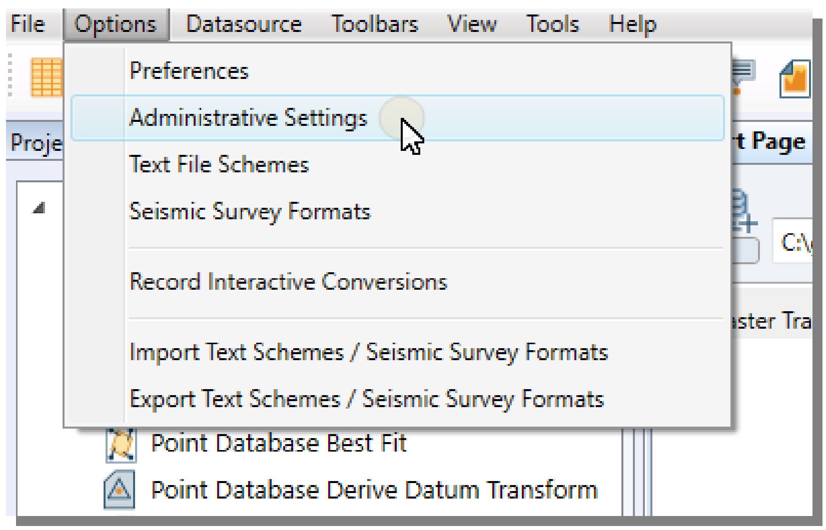
The steps below are designed to walk an Administrative user through hiding specific objects in the Datasource from view, so that they cannot be seen or selected while working in the application. Within Geographic Calculator **coordinate systems**, **coordinate transformations**, **Areas of Use** and more are defined as 'objects' in Geographic Calculator's datasource. Any **object** in the Datasource can be hidden from view.

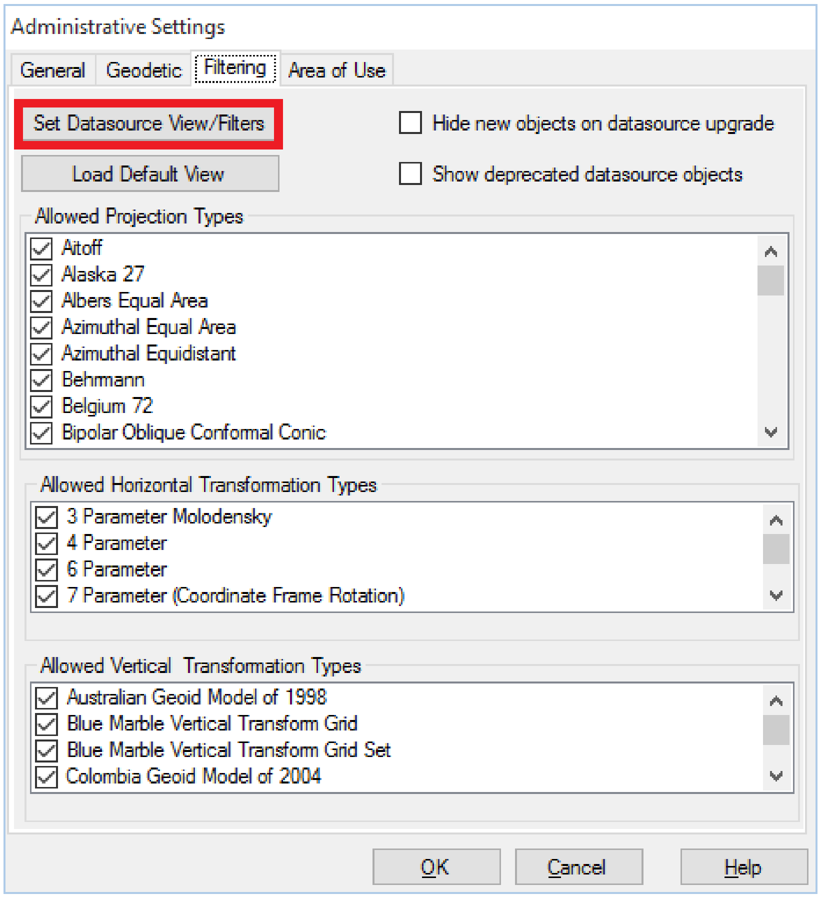
For example, if you have a particular user that only deals with data from onshore continental US, you might hide coordinate systems from all other continents.

Objective: In this section, as an example, we will hide a single geodetic coordinate system for demonstration purposes.

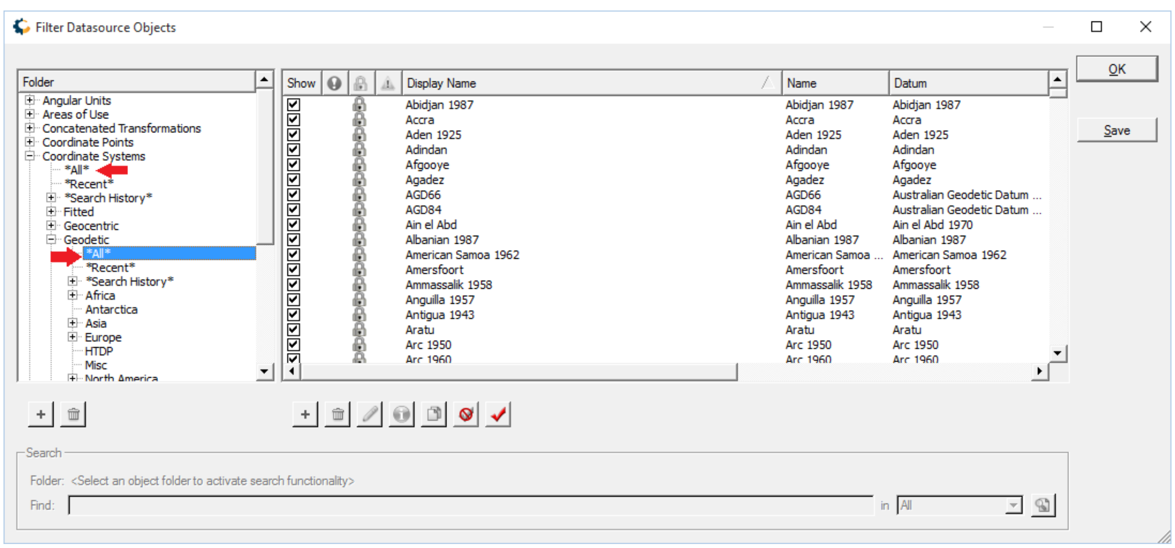
Before completing this exercise make sure to [export and open a sample workspace] so the changes are not permanent. The open workspace should be Administrative_Steps.

1. Go to **Options > Administrative Settings**.
2. Click the button on the **Filtering** tab labeled **Set Datasource View/Filters**. The Filter Datasource Objects dialog will open.

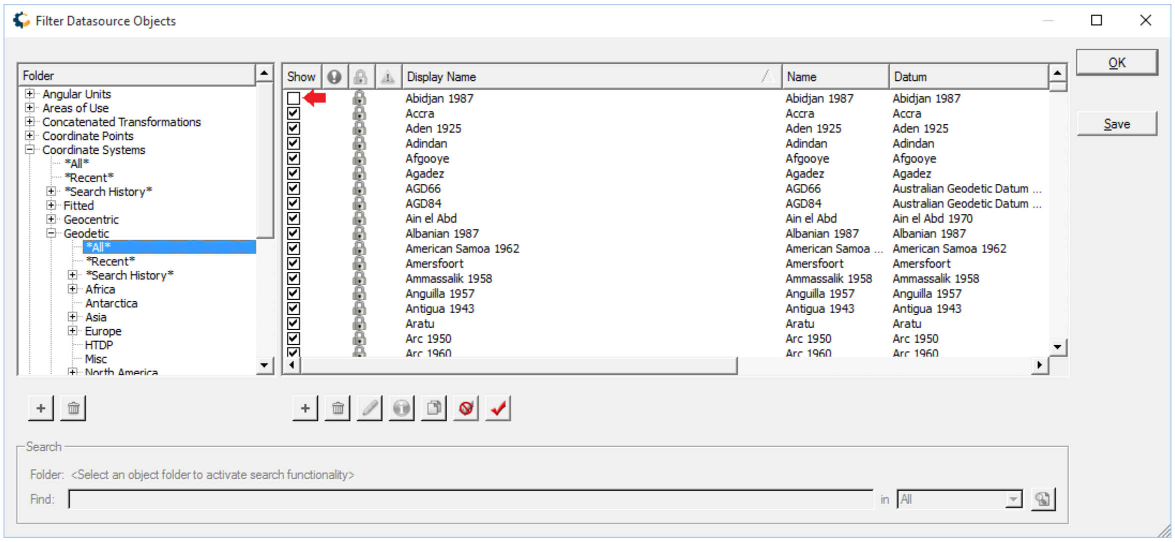




3. In the tree view on the left, expand the **Coordinate Systems** folder, and the **Geodetic** folder below it. There is a category of coordinate systems named *All*, select it. The systems in that folder will display in the pane on the right.



4. In the pane on the right where all the systems are listed, the very first column is labeled **Show** and has a checkbox for each entry below. For each entry you will hide, you can uncheck the box in the **Show** column.
   You can either uncheck each entry manually, or to uncheck them all, click the **Hide All Objects**  button beneath the details pane. In this case we will hide only the first entry, 'Abidjan 1987'. To do this, uncheck the box next to it.



5. Click the **Save** button. A verification window will pop up asking if you would like to save the changes, click **Yes**.

6. Click **Ok** to close the Filter Data Source Objects dialog, and **OK** again to close the Administrative Settings dialog.

Continue to [Changing an Object's Display Name]

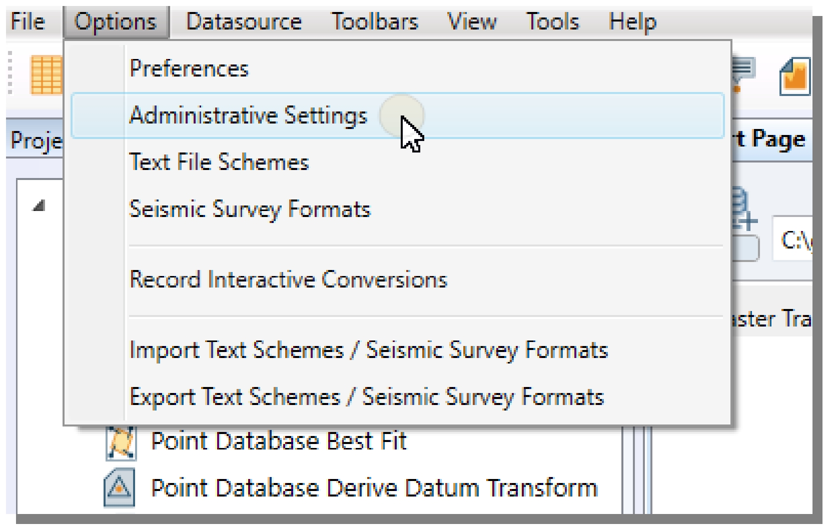
Changing an Object's Display Name

The names used in the Geodetic Datasource largely come from the EPSG database (www.epsg.org). Some users prefer to rename some of these objects to use more common names or to add on designations for preferred systems.

Objective: In this section, you will alter the display name of a coordinate system object as a user would see it, then find the object with its new name.

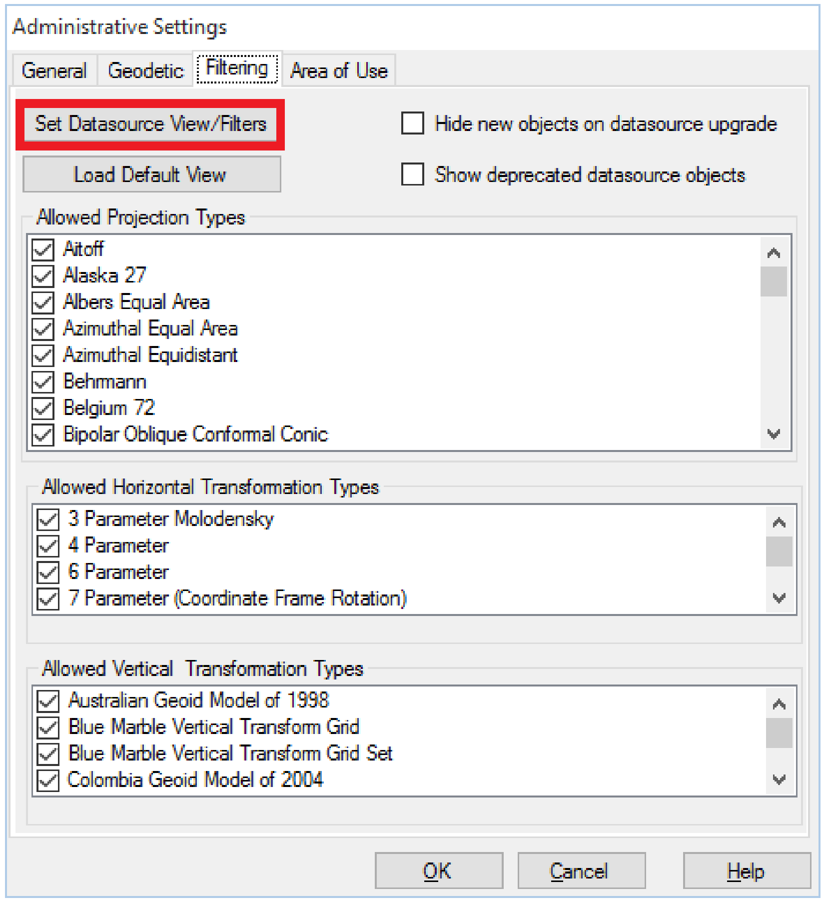
Before completing this exercise make sure to export and open a sample workspace so the changes are not permanent. The open workspace should be Administrative_Steps.

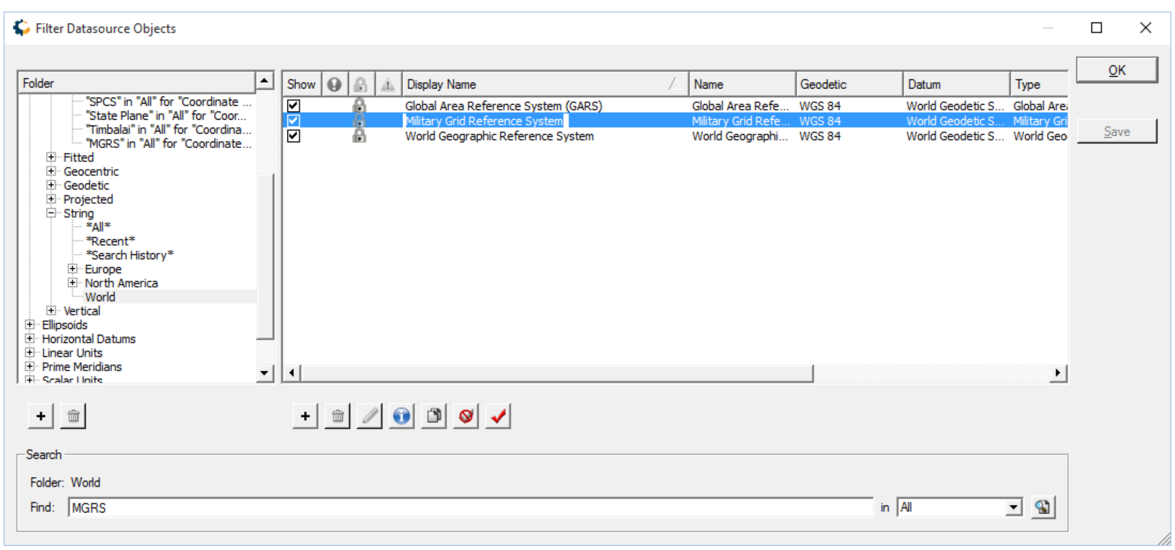
1. Go to **Options > Administrative Settings**.



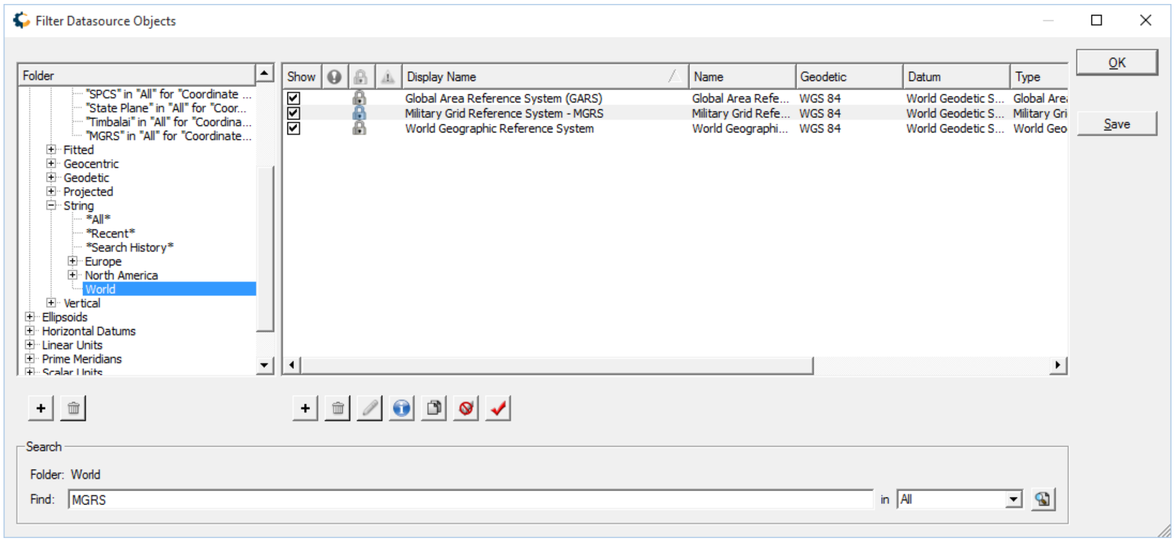
2. Click the button on the **Filtering** tab labeled **Set Datasource Filters/Views**. The Filter Datasource Objects dialog will open.

3. You will not actually be altering the name of the object in the master data source, **geodata.xml** since those definitions are protected, but rather changing the display name for the object which is stored in a separate View file **view.xvw** that is stored as part of your workspace. This will allow your name changes to be carried forward when Blue Marble publishes updates to the master datasource. In the Filter Datasource Objects dialog, expand the folder **Coordinate Systems** > **String**. Select the folder **World**.





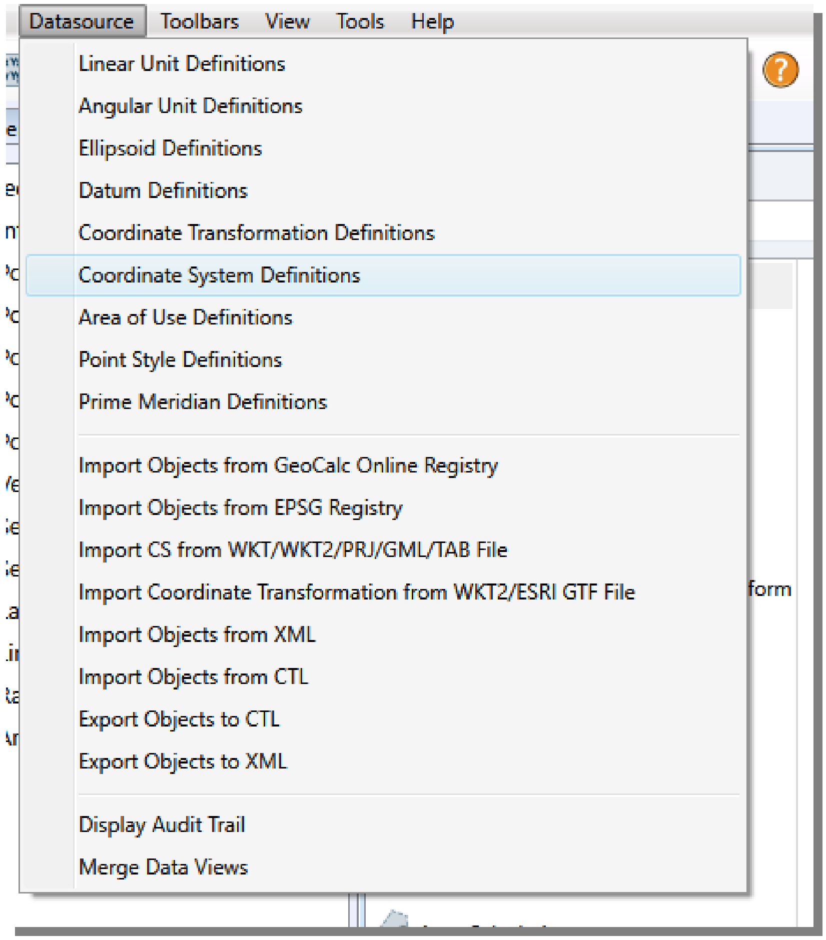
4. In the column labeled 'Display Name' of the details pane, click on **Military Grid Reference System** and after a brief pause, click it again to select it for renaming. You should see the text highlight for editing with a blinking cursor. Rename the object to 'Military Grid Reference System-MGRS' and press enter or tab to finalize the change.



5. Click the **Save** button. A verification window will pop up asking if you would like to save the changes, click **Yes**.

6. Click **OK** to close the Filter Data Source Objects dialog, and **OK** again to close the Administrative Settings dialog.

7. To see the filter in effect, go to **Datasource > Coordinate System Definitions**.
8. Browse to **Coordinate Systems > String** and select the **World** category. You should now see the Display Name field reflecting the altered name.



Continue to Defining Custom Datum Transformation Area of Use

Defining a Custom Datum Transformation Area of Use

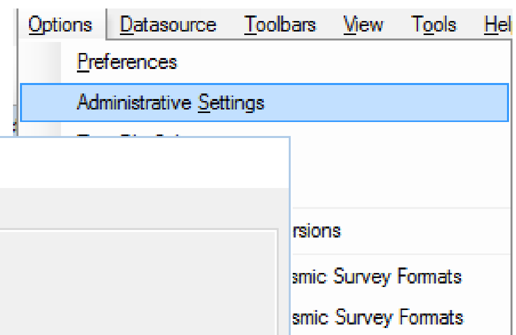
Geographic Calculator has tools to help guide users to the proper datum transformation for the area they are working in. All datum transformations have a geographic envelope or Area of Use defined for them. You can tailor the Area of Use envelopes to the requirements of your enterprise by setting custom Areas of Use. This is achieved in Administrative Settings on a preview map, by drawing or importing polygons in the map, in which you will associate a preferred datum transformation.

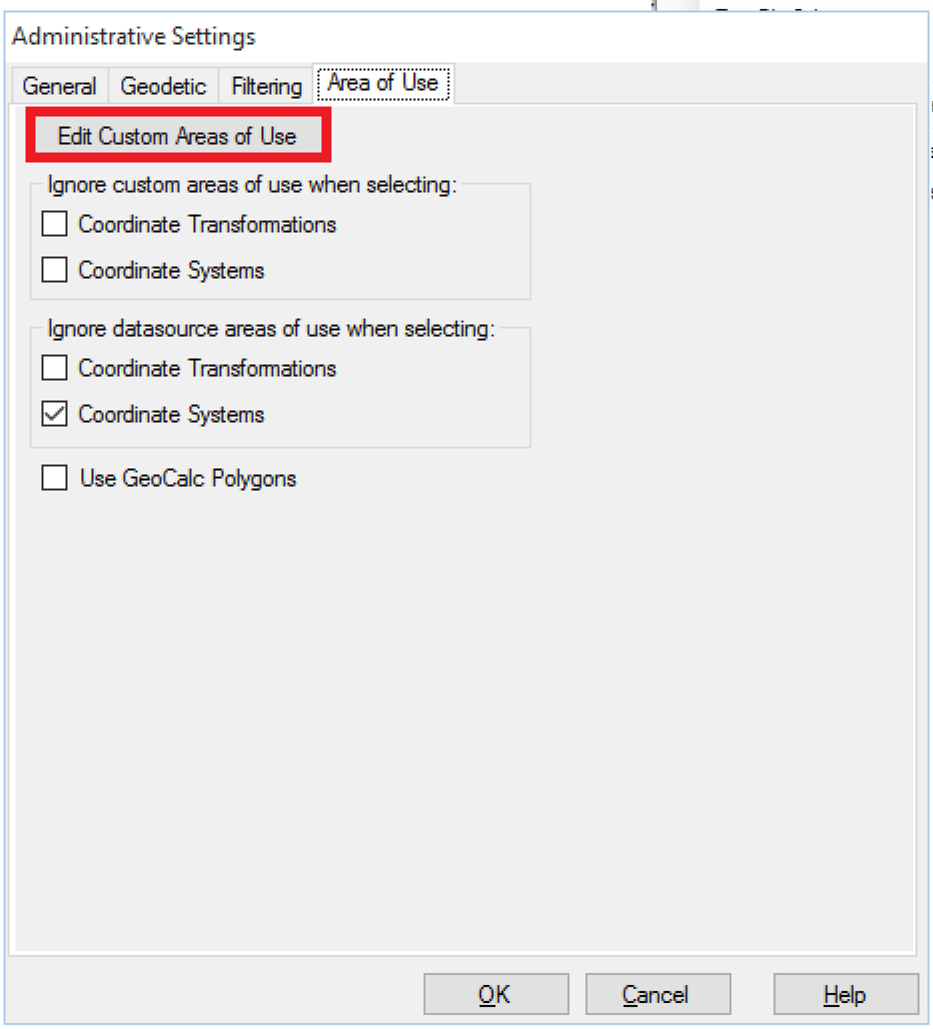
Objective: Define a Custom Area of Use for Japan and filter the transformations available to only allow one datum transformation.

Before completing this exercise make sure to export and open a sample workspace so the changes are not permanent. The open workspace should be Administrative_Steps.

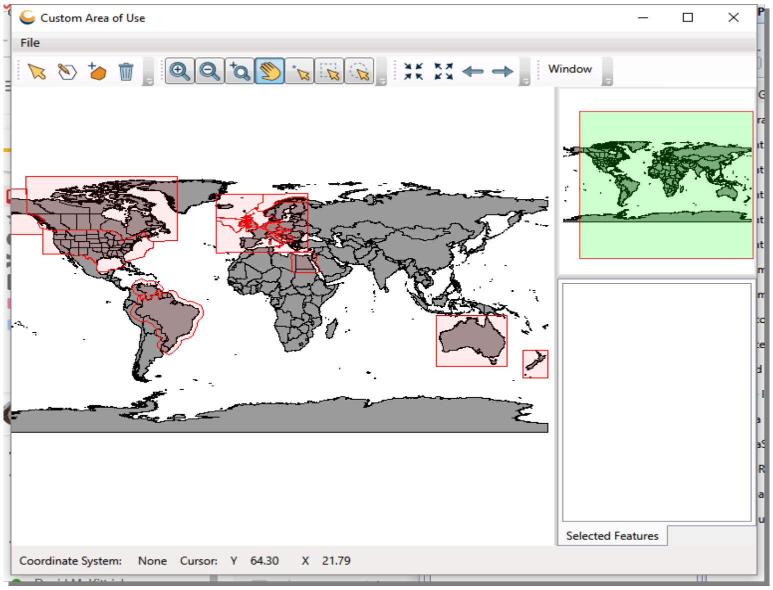
To set a custom Area of Use for a datum transformation:

1. Go to **Options > Administrative Settings**.

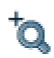


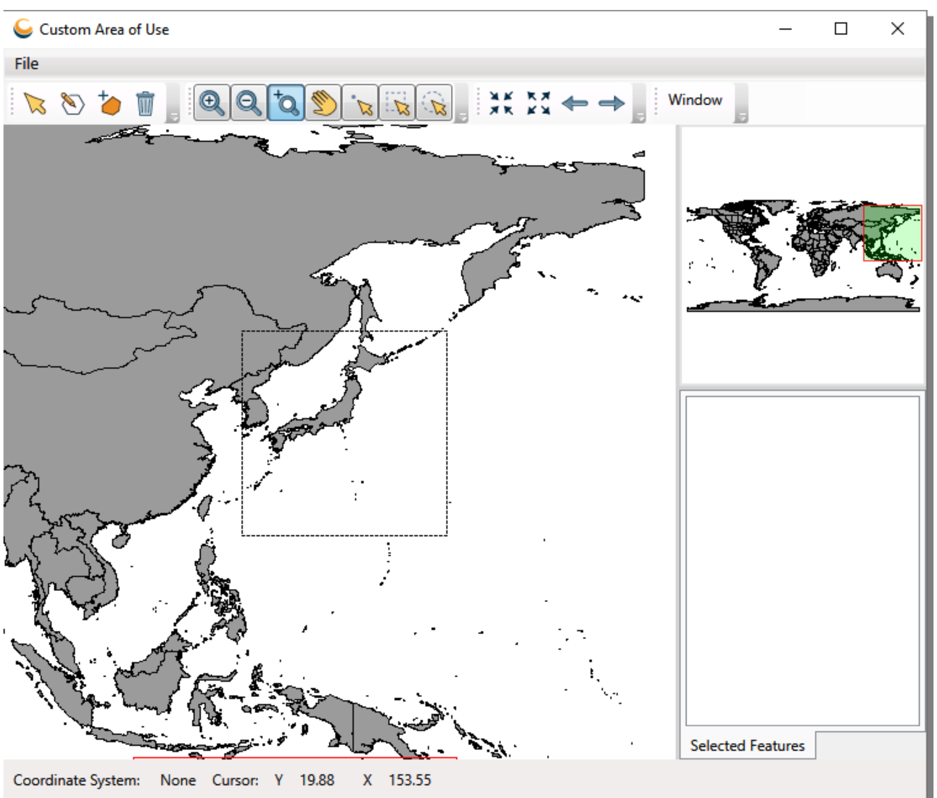


2. On the **Area of Use** tab, click **Edit Custom Areas of Use**. This will launch the custom Areas of Use viewer.

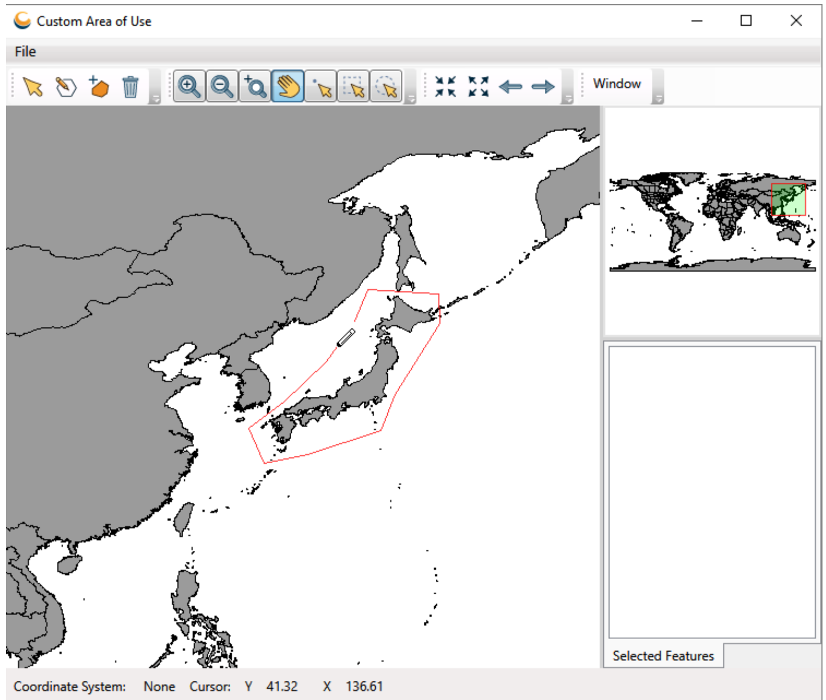


3. If prompted to open a map layer, select the **World_Countries.tab** file located in the Geographic Calculator installation folder. For most users the map will open automatically.

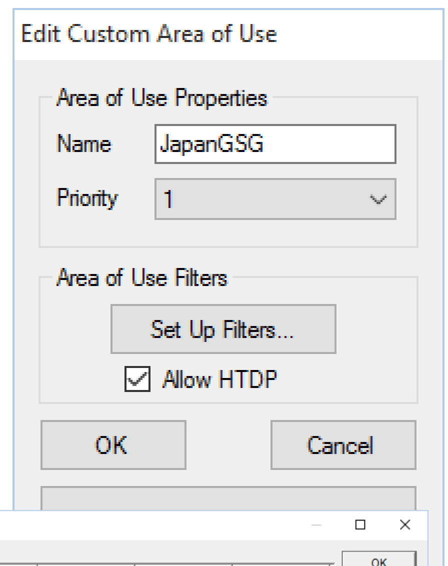
4. Select the **Zoom to Rectangle** tool  and zoom in to the islands of Japan in Eastern Asia.



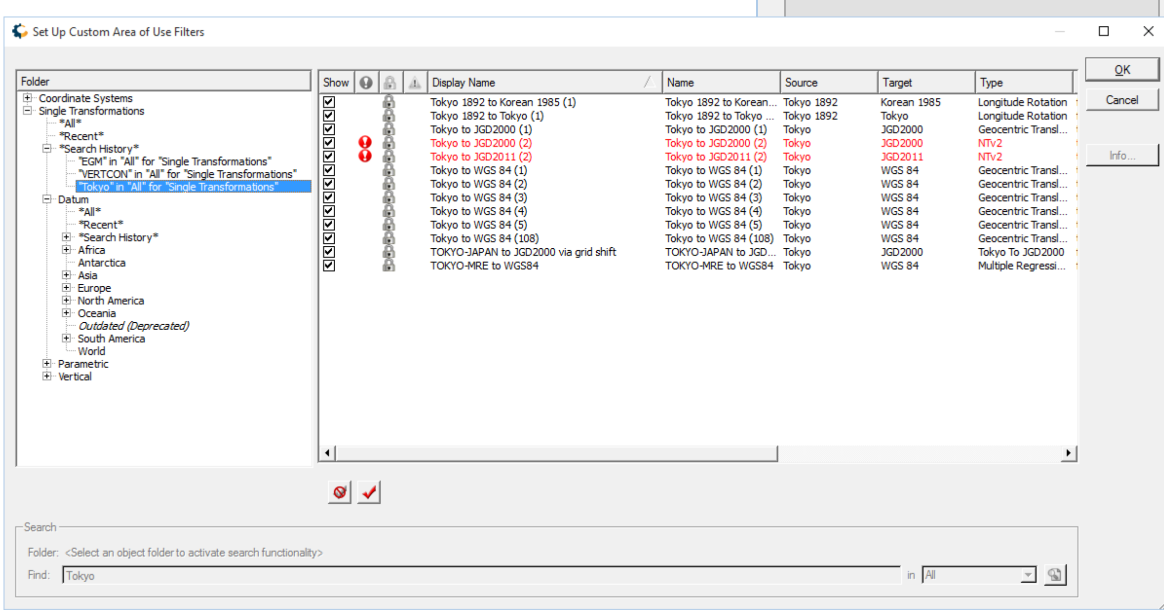
5. Select the **Create New Area of Use** tool and click on the map to begin drawing your Area of Use. Draw a polygon around Japan. Double-click to close the polygon when finished.



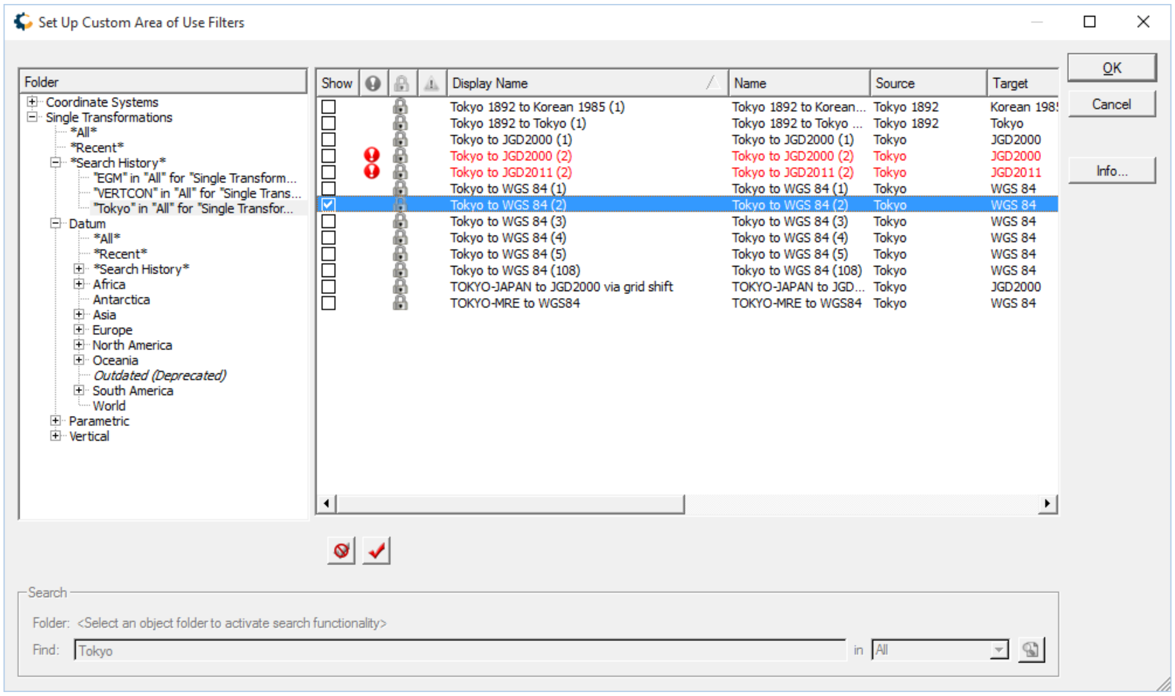
6. The edit custom Area of Use dialog will open automatically. Here you can define the name of the custom Area of Use, the priority for the Area of the Use and access the filter parameters. Name the Area of Use **'JapanGSG'** and set the priority to 1.



7. Click **Set Up Filters...** and the **Set Up Custom Area of Use Filters** dialog will open. In the folders list on the left, select the top level, **Single Transformations** . In the **Search** field at the bottom enter 'Tokyo' and click **Enter**. The search results will display in the details pane on the right.



8. Disable the **Show** setting check-box for all datum transformations except the one named 'Tokyo to WGS84 (2)'



9. Click **OK** to close the **Set Up Custom Areas of Use Filters** dialog. Go to **File> Save** in the **Edit Custom Area of Use** dialog.

10. Another way to set a custom Area of Use is to go to **File** > **Import Polygon Data** or **Import Custom Area of Use** to import a pre-made polygon to the Areas of Use editor.

    You can also use the **Load Area Polygon**  from GeoCalc tool to use a predefined polygon as a custom Area of Use. When the polygon is closed by double-clicking, the **Edit Custom Area of Use** dialog will open. This will allow the user to assign this Area of Use a Name and a Priority, if desired.

11. The area of use filter will hide the other datum transformations available for conversion within the area contained by your polygon. The area of use settings are stored in the workspace file which can be exported for use by another user. As well, these areas of use can be locked in place and password protected in the workspace. For information on password protection and lockdown, see:

    - Setting the Admin Password
    - Administrative Lockdown

Testing the Area of Use Filter

12. To test the restriction on Tokyo transformations in the Custom Area of Use, we will perform an interactive conversion. In the Project Manager select the Interactive Conversion Job. For more details on the interactive conversion job see Lab 1: Interactive Conversions

13. In the Coordinate Point Definition set the Latitude and Longitude to the following point:

Latitude 36.03 deg

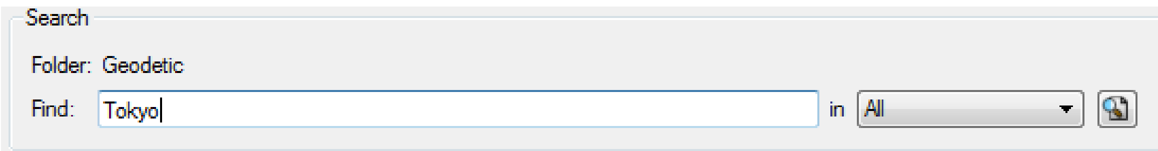
Longitude 138.5 deg

14. Confirm the source coordinate system is set to **WGS 84**.

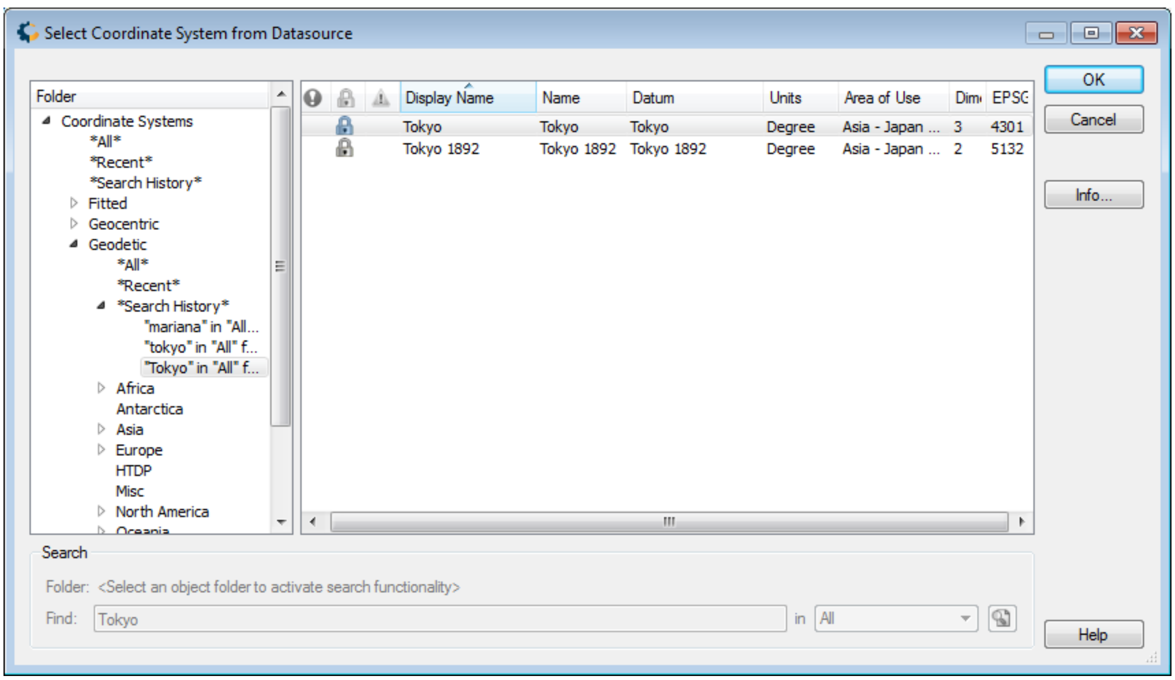
    If the source system is not WGS 84, double click the blue system box. Navigate to **Geodetic> World** and select **WGS 84**. For more detailed instructions see Lab 1: Section 1 Input Parameters

15. Double click the blue system box in Target Coordinate system. If you are prompted to limit the coordinate systems by geographic area select **No**.

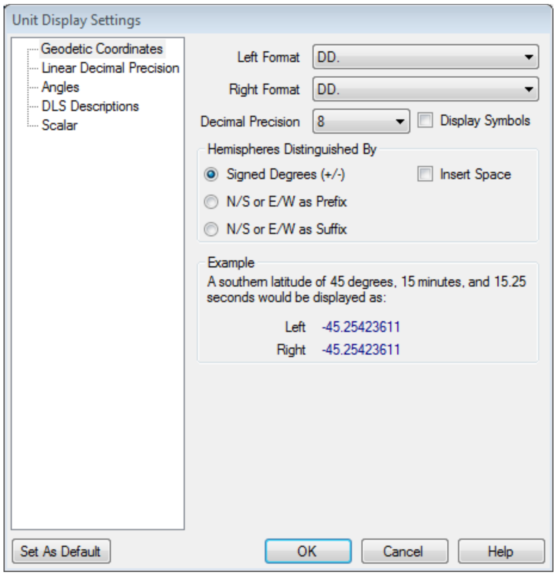
    Select the **Geodetic** folder. In the Search bar at the bottom, enter **Tokyo** and press the search button to the right.



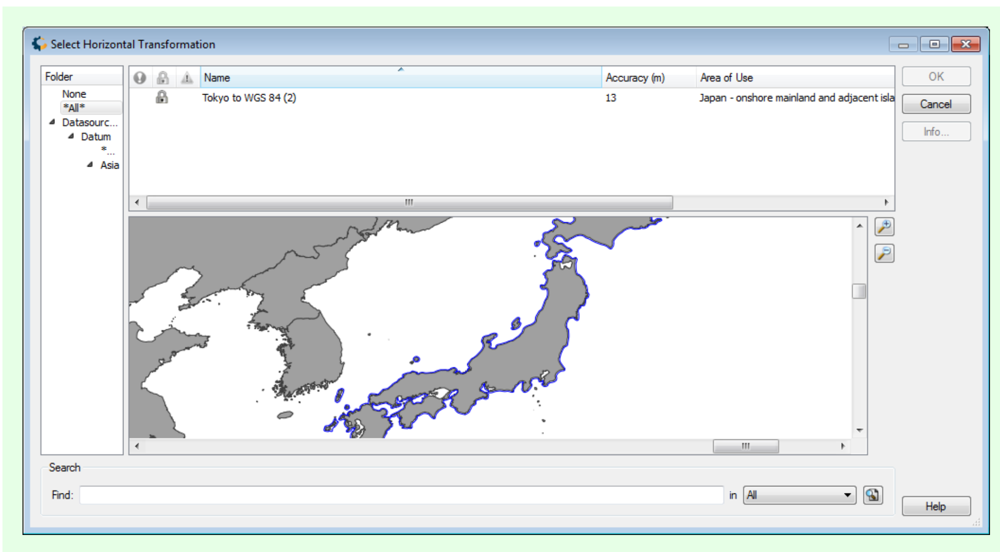
From the search results select the Tokyo Datum



16. Press the **Format** button. Enter the following settings for format:



17. Double click the blue Coordinate Transformation box. The only available transformation will be **Tokyo to WGS 84 (2)**.



Press **Calculate** to process the transformation.

These settings previously applied are now saved in the specific workspace. Once this workspace is deleted any datasource objects that were hidden, changes in names, or area of use transformations will be cleared from Geographic Calculator.

Undo the Area of Use Filtering

The following section is optional to undo the area of use filtering, since the **Administrative_ Steps** practice workspace will be deleted.

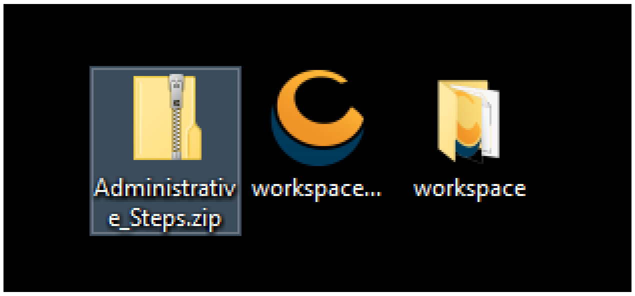
18. To undo these settings, go to **Options > Administrative Settings**.
19. On the **Filtering** tab, click **Edit Custom Areas of Use**. This will launch the custom Areas of Use viewer.
20. On the Custom Areas of Use map, select the **Delete** tool. Click on the polygon you drew around Japan. It will highlight the selected polygon and prompt you to confirm deletion of the polygon. Click **Yes** when prompted to delete your custom polygon. Again, when you close the Custom Areas of Use map you will be prompted to save the changes, click **Yes** when prompted.

Continue to Deleting the Practice Workspace

Deleting the Practice Workspace

Objective: Delete the practice workspace used in the above exercises, and revert to the default workspace to undo the administrative changes.

1. Close Geographic Calculator
2. Navigate to the location where Administrative_steps.zip was saved
3. Delete the folders workspace and Administrative_steps.zip
4. Delete the file workspace.bmg



5. The administrative settings that were set in previous steps will now be deleted

Continue to Restricting Access to the Geodetic Datasource

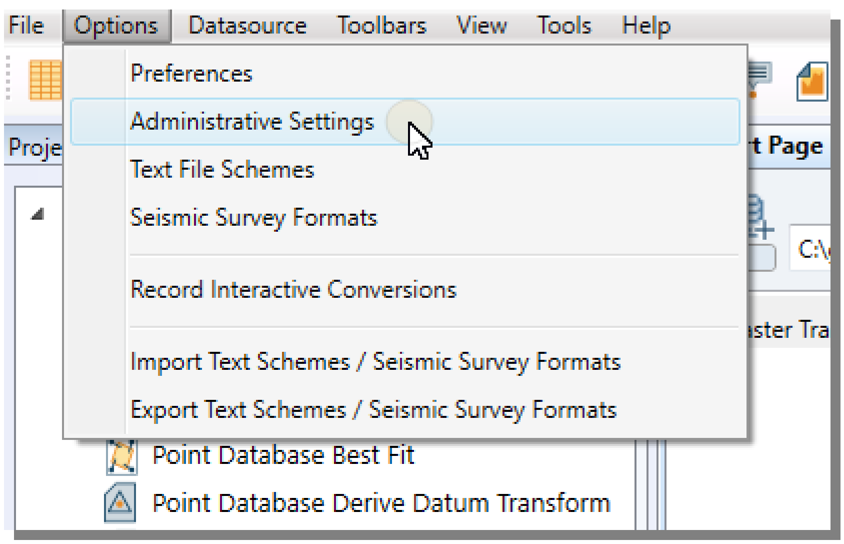
Restricting Access to the Geodetic Datasource

The Geodetic Datasource in the Geographic Calculator is the most comprehensive commercially available coordinate system library. However, some enterprises may wish to reduce the access to the Datasource by their users to prevent users from adding inappropriate systems to the Datasource, or modifying the contents of any custom parameters.

Objective: Lock the datasource so that users can not add custom objects, or make changes to the existing definitions.

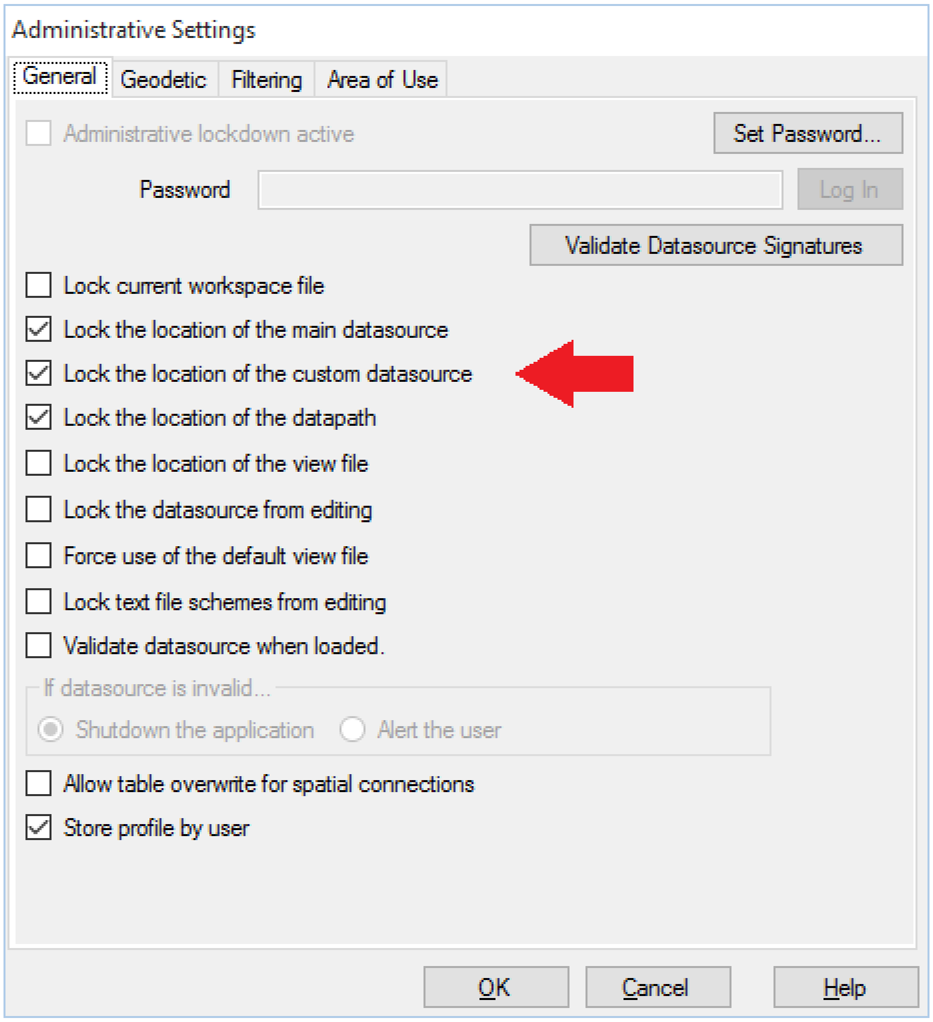
These next steps apply settings that are not workspace specific. Any changes will be applied to all instances of Geographic Calculator. It is recommended that you complete all steps so that changes are undone.

1. Open a fresh instance of Geographic Calculator.
2. Go to **Options > Administrative Settings**.



3. By default it should open on the **General** tab.

4. To restrict the user from editing or relocating Geographic Calculator's Datasource, you can enable the check boxes **Lock the location of the main datasource**, **Lock the location of the custom datasource**, and **Lock the datasource from editing.**



5. Click **OK** to close the dialog. It will return you to the main screen of Geographic Calculator. You will see that the options under the Datasource menu, other than Display Audit Trail, are grayed out. This will prevent any user from editing any parameters in the datasource. This can be locked in place in the workspace by setting a password on the workspace. For steps to password protecting these settings see: Setting the Admin Password

6. To unlock the Datasource, go to **Options > Administrative Settings**.

7. Click onto the *Administrative* tab.

8. Disable the check boxes **Lock the location of the main datasource**, **Lock the location of the custom datasource**, and **Lock the datasource from editing**

9. Click **OK** to close the dialog. It will return you to the main screen of Geographic Calculator. You will see that the Datasource toolbar and the Datasource menu are again enabled.

Continue to Enable Validation on Datasource Files

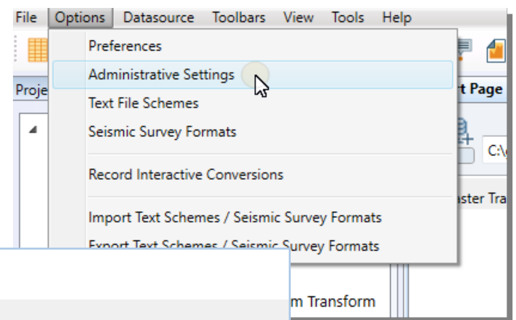
Enable Validation on Datasource Files

The Geodetic Datasource in Geographic Calculator is XML-based and therefore can be easily read and manually edited given the right software. However, due to the complexities of the database, this is generally not recommended. Errors can be introduced that can affect the quality of the output of the Desktop.

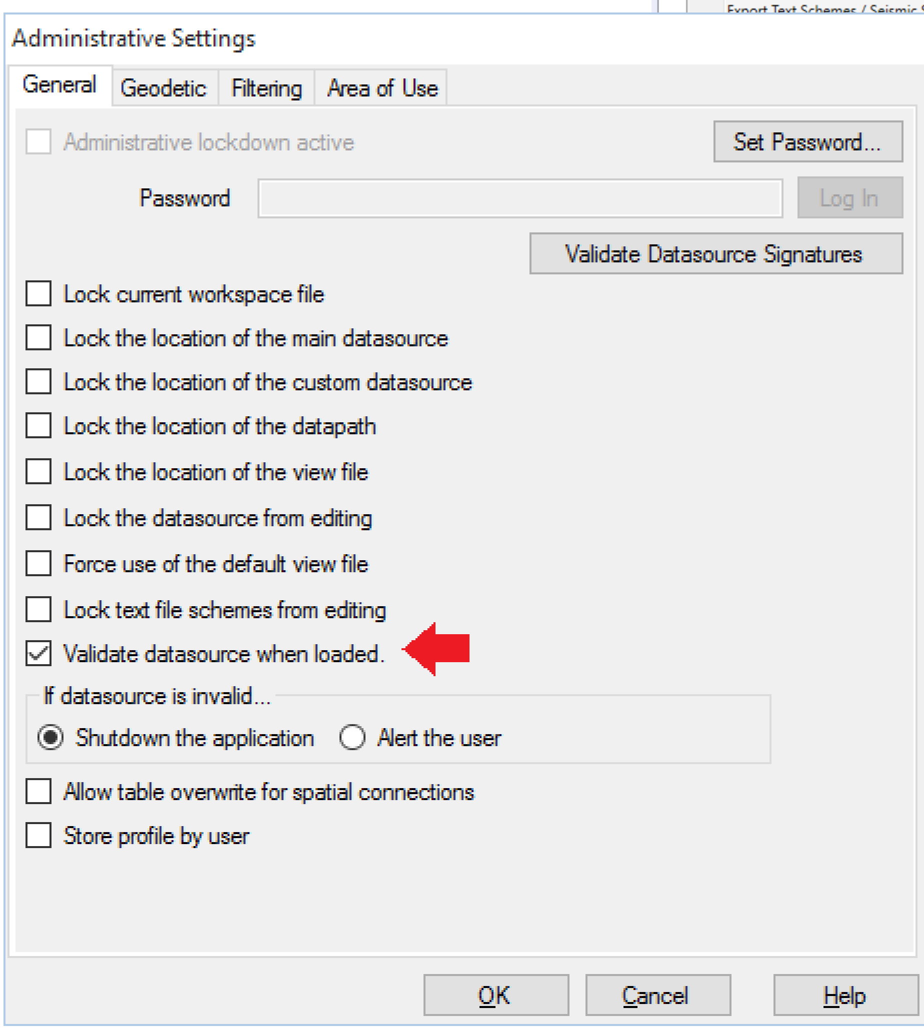
Objective: In this section, we will enable validation on digital signatures in the datasource to verify that the Geodetic Datasource has not been edited except via the proper dialogs.

This validation setting is most commonly used in conjunction with Restricting Access to the Geodetic Datasource

To enable signature validation:



1. Go to **Options > Administrative Settings**.
2. Click onto the **Administrative** tab.
3. Here, you can enable the check-box labeled **Validate datasource when loaded.**



4. You have a choice when enabling this setting to either **Shutdown the application** or simply **Alert the user.**
5. Click **OK** to close the Administrative Settings.
6. Close out of Geographic Calculator and restart it. The application should start up normally.
7. To verify the new settings were applied, go to **Options > Administrative Settings**.
8. Click the **Validate Datasource Signatures** button. You should get a pop-up stating that the signatures are valid.
9. These settings can be locked in place via Administrative Lockdown
10. To reverse the settings, disable the check-box for **Validate datasource when loaded.**
11. Click **OK** to close the Administrative Settings.

Continue to Section 6: Setting the Admin Password

Setting the Admin Password

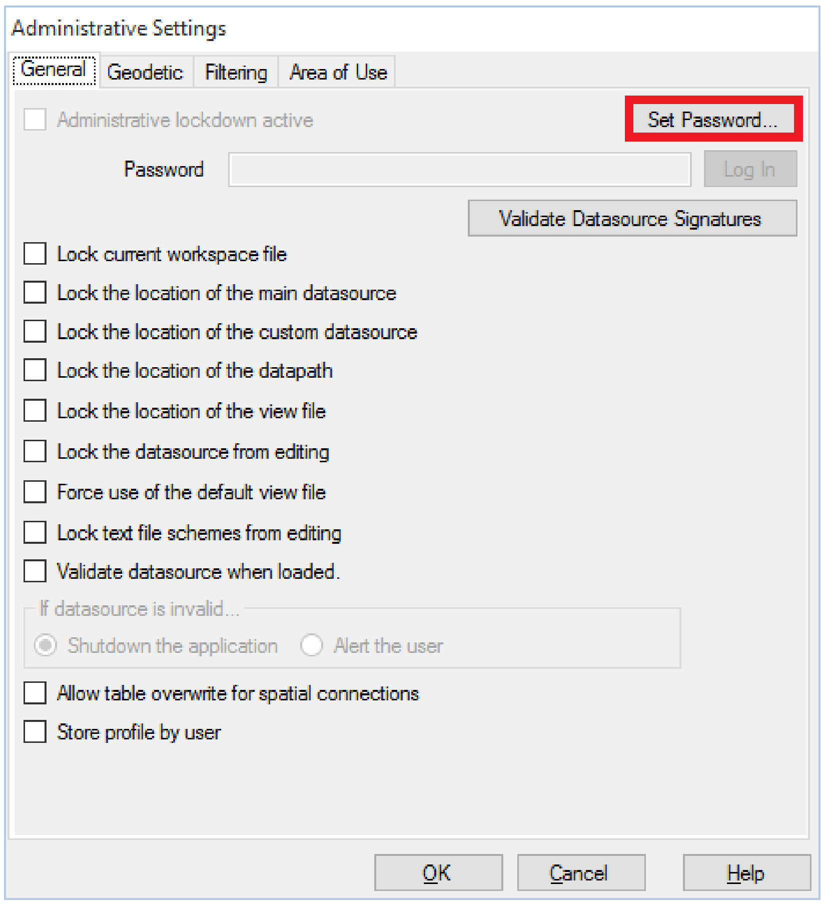
The Admin password is the key to all of the datasource protection features in Geographic Calculator. Without setting the Admin Password, any of the Administrative settings can be reversed by an end-user.

Objective: In the steps below, we will set an Admin password for the workspace and then disable it. It is extremely important to use a password you can remember, because there is no way to disable the password without first reentering it.

These next steps apply settings that are not workspace specific. Any changes will be applied to all instances of Geographic Calculator. It is recommended that you complete all steps so that changes are undone.

To enter a password for the workspace:

1. Go to **Options > Administrative Settings**.
2. Click the **Set Password** button. In the Set Password dialog, enter your password, and then reenter it to verify.
3. Click **OK**, to set the password. You should get a popup that says 'Administrator Password Set.'
4. Your password is now in place and you can then enable Administrative Lockdown or continue on here to clear the password.
5. To clear the password, you must login with your password on the General tab of the Administrative Settings.



6. Once logged in, click **Set Password**, clear both fields and click **OK**.
7. Then click **OK** to close out of the Administrative Settings.

Continue to Administrative Lockdown

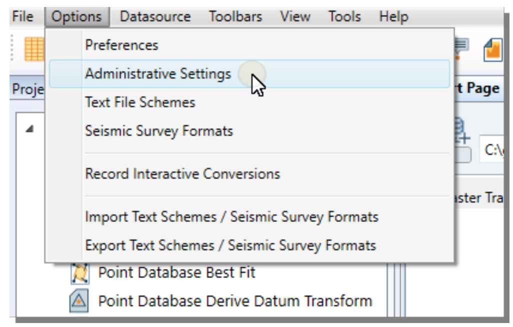
Administrative Lockdown

The password protected Administrative Lockdown setting, is the key to completely securing the workspace settings defined in the Administrative Settings dialogs. Once enabled, the end-user will have no access to change any of the Administrative Settings, without logging in using the Admin Password.

Objective: Activate the Administrative Lockdown

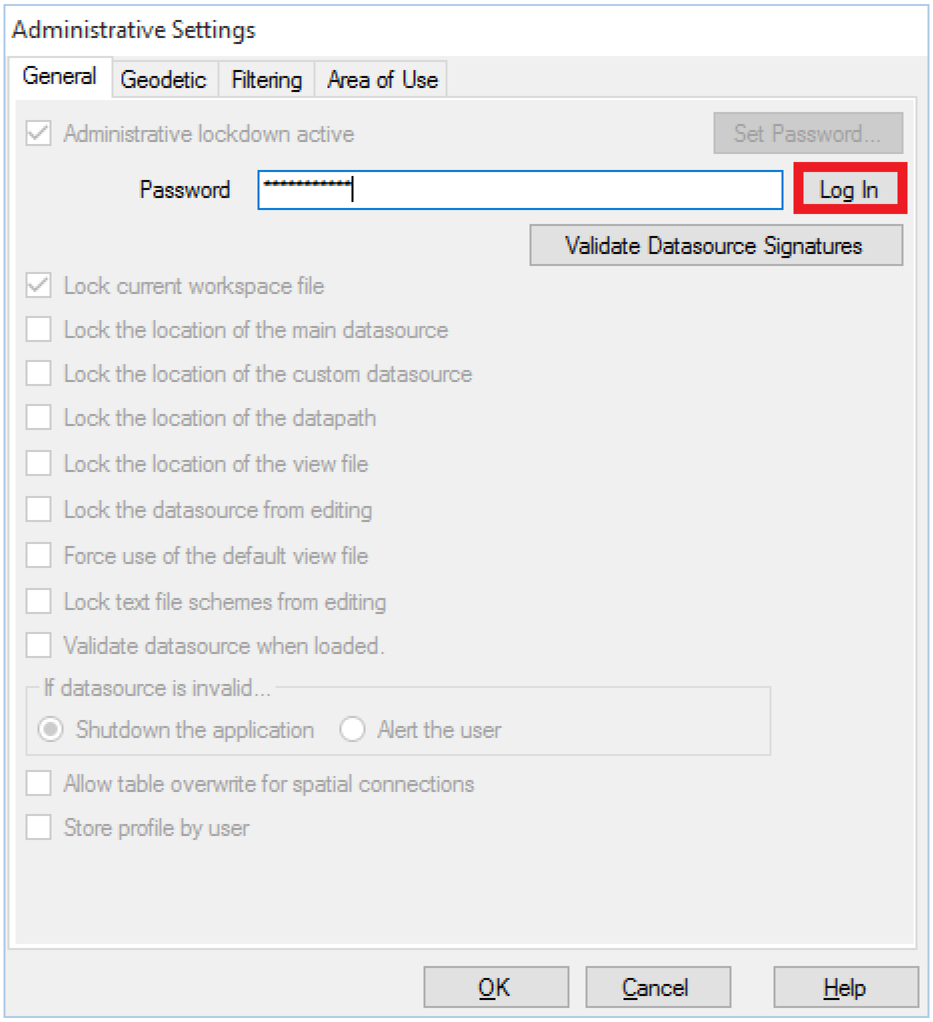
To activate the Administrative Lockdown, you would want to first set any other Administrative Settings desired (Custom envelopes, Restricted datasource access, Views, etc.).

These next steps apply settings that are not workspace specific. Any changes will be applied to all instances of Geographic Calculator. It is recommended that you complete all steps so that changes are undone.



1. Go to **Options > Administrative Settings**.
2. Click onto the **Administrative** tab.
3. Log in with the Admin Password and check the boxes for the items that you want to lock. If you want to ensure that users cannot make any changes to the workspace, check the '**Lock the current workspace file**' box and enable the checkbox for **Administrative lockdown active...**
4. Click **OK** to close out of the Administrative Settings.
5. Close out of Geographic Calculator and restart it.
6. Go to **Options > Administrative Settings**.
7. You should see both tabs of the Administrative Settings dialog grayed out and disabled, with the exception of the **Password** field to Log in.
8. The workspace can then be exported for use by an end-user (see: Exporting the Workspace to Users), or you can continue to disable the lockdown.

9. To disable the Administrative Lockdown, enter your Admin password and click Log In. This will unlock the settings.



10. Once logged in, disable the checkbox for **Administrative lockdown active...**
11. Then click **OK**, to close the Administrative Settings.

Continue to [Exporting the Workspace to Users]

Exporting the Workspace to Users

Once you have set up all the **Administrative Settings** you wish to enable, you can export the locked workspace for use by an end-user. The export process produces a single zip file that can be imported on another workstation.

Alternately, the datasource, data files and workspace can be accessed on all user machines from a network location. There are additional options for administering a restricted version of Geographic Calculator that involve a combination of local and network accessed files, but the examples covered here represent the extreme versions of Enterprise deployment.

Objective: The following steps will export a restricted workspace and import it locally to an end user machine. The second section will copy the datasource and data files to a network location, then create a workspace that references the files from the network. Then the workspace will be saved directly to the network.

Local Deployment of a Locked Workspace

To export the workspace:

1. Set all the various Administrative Settings you wish to employ. If you want to ensure that users cannot make any changes to the workspace that you will export to them, check the 'Lock the current workspace file' box. Set up any predefined jobs you wish to share with users.
2. Go to **File > Export Workspace**
3. You will be prompted to save a compressed ZIP file. Name your zip file something you can recognize and save it to a location you can access.
4. That's it!

Then, to import the workspace on another machine:

1. Copy your exported ZIP file to the end-user machine.
2. Start up Geographic Calculator
3. Go to **File > Import Workspace**.
4. To permanently lock the end-user workspace, you can go to **Options > Preferences** and set the workspace to always load the workspace you just imported.
5. Then, return to the Administrative Settings and enable the Administrative Lockdown.
6. When the Desktop is started, it will load the workspace in lockdown mode, unless unlocked via the Admin Password.

Network Access to a Locked Workspace

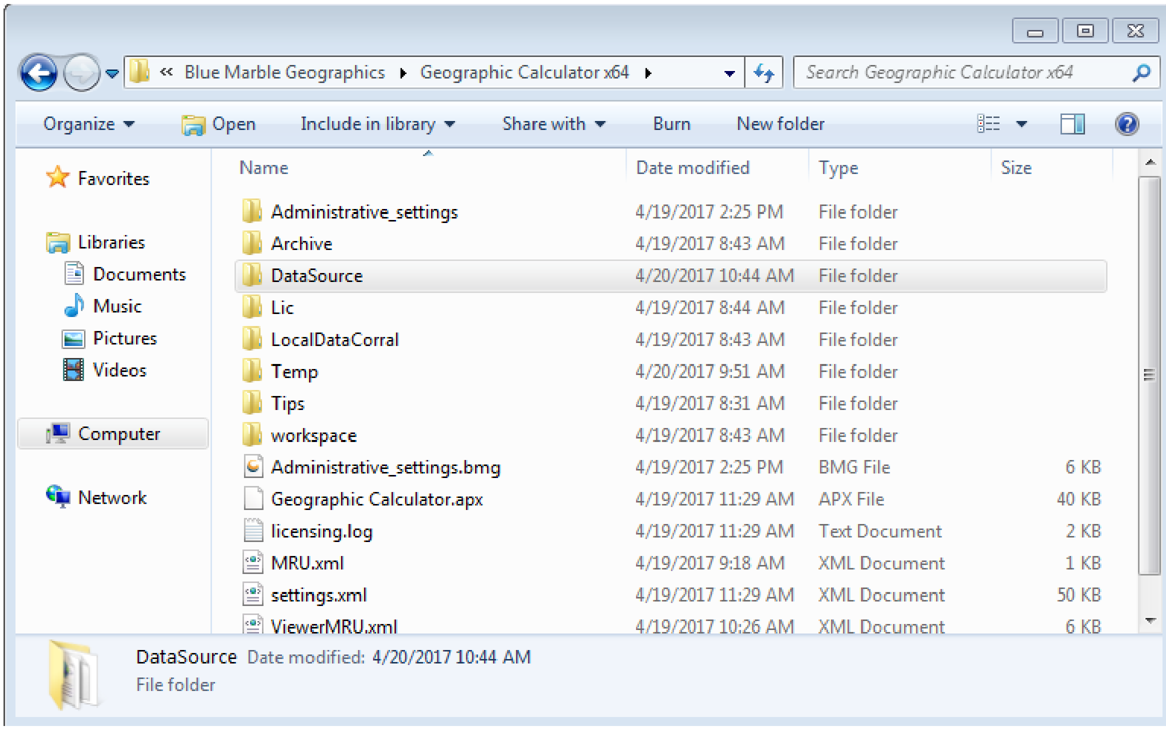
The following steps are meant as guidelines for setting up a network accessible workspace.

To create workspace that reference a network datasource:

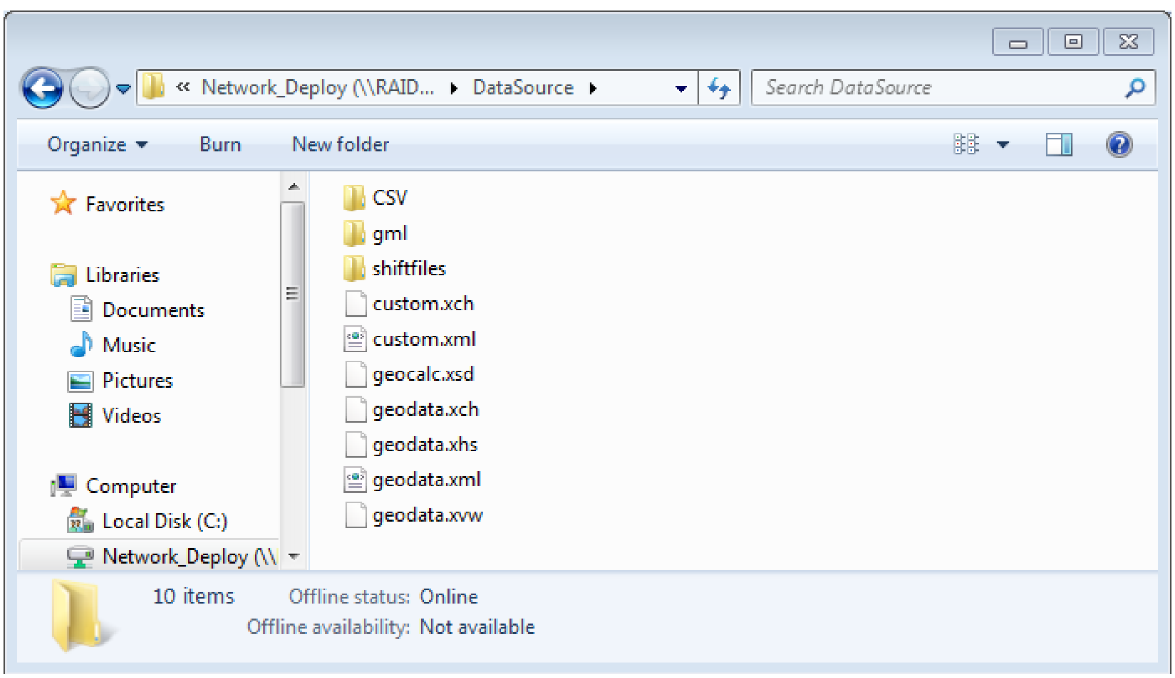
1. The first step in a network accessed workspace and datasource is to copy the datasource files to the network location. Navigate to:

   C:\ProgramData\Blue Marble Geographics\Geographic Calculator x64\

   or C:\ProgramData\Blue Marble Geographics\Geographic Calculator\

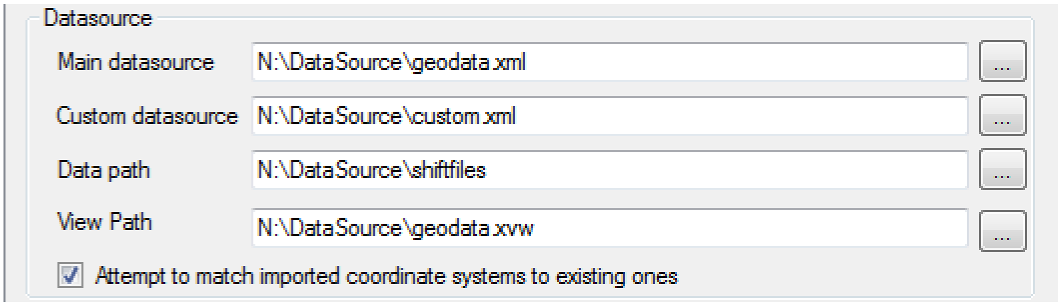


Copy the entire **DataSource** folder to a network location. The Datasource folder on the network will look like this:



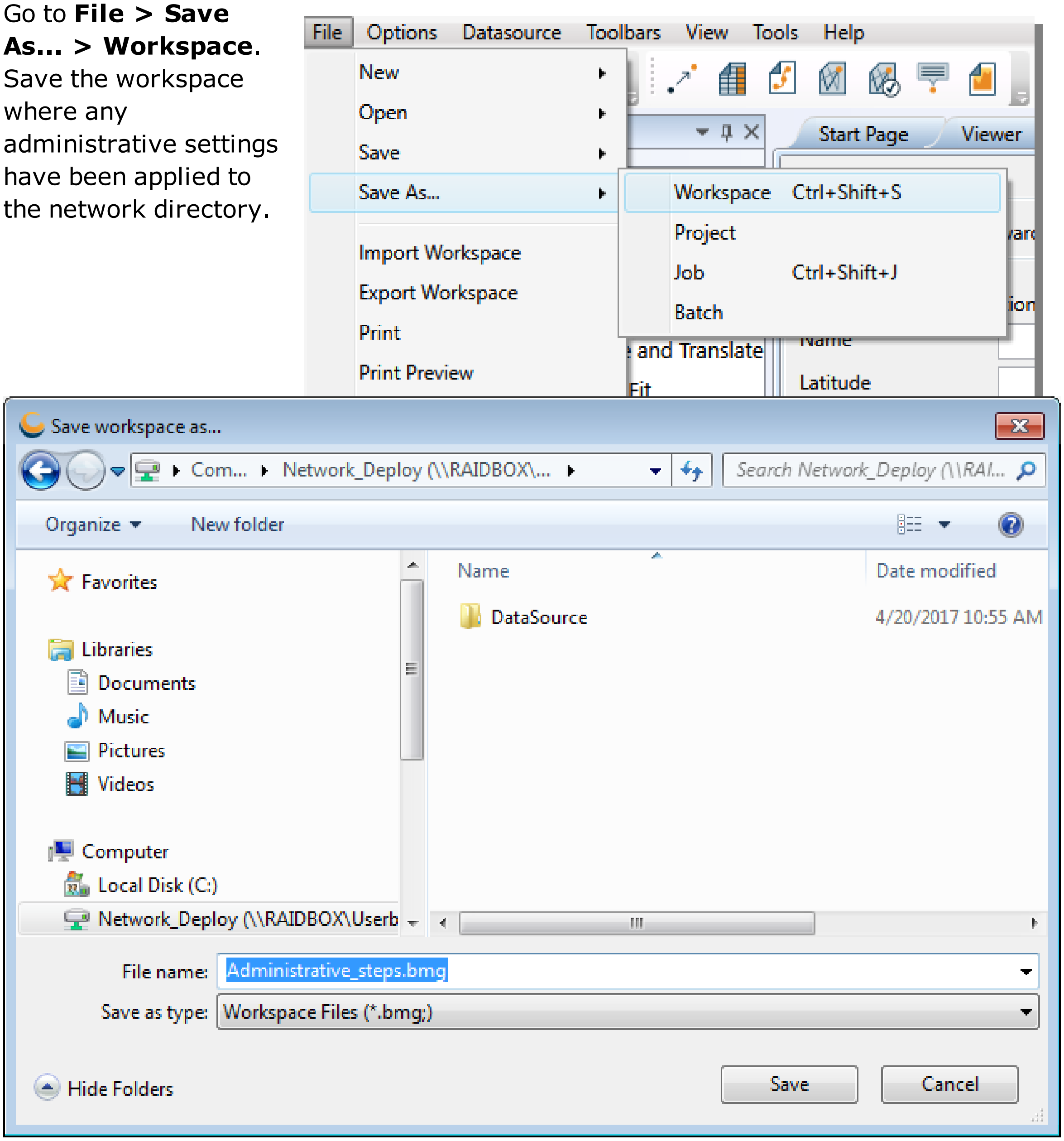
> **Note:** The *custom.xml* file will only be created if custom object definitions have been added to the datasource.

2. In the Geographic Calculator workspace go to **Options> Preferences**. In the file location tab set the Datasource section to reference the DataSource files on the network:



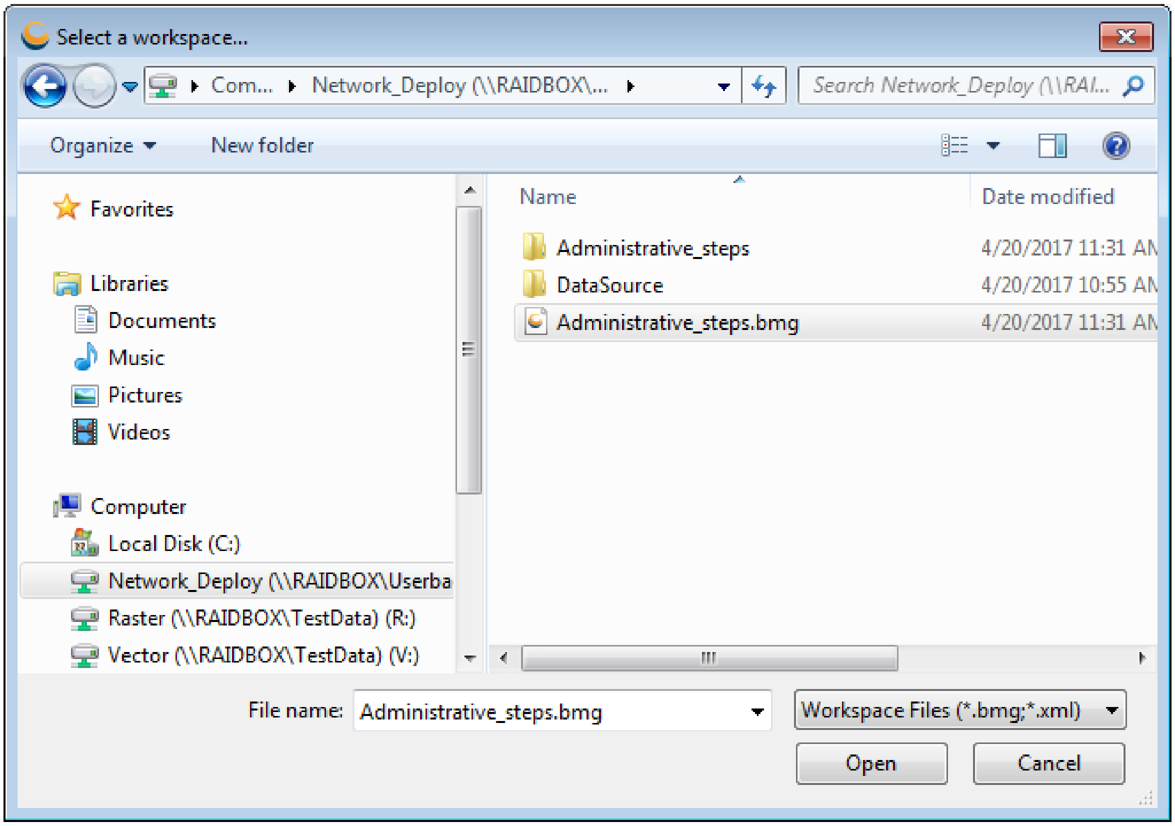
Click **OK** to save the updated datasource paths to the workspace.

3. Go to **File > Save As… > Workspace**. Save the workspace where any administrative settings have been applied to the network directory.



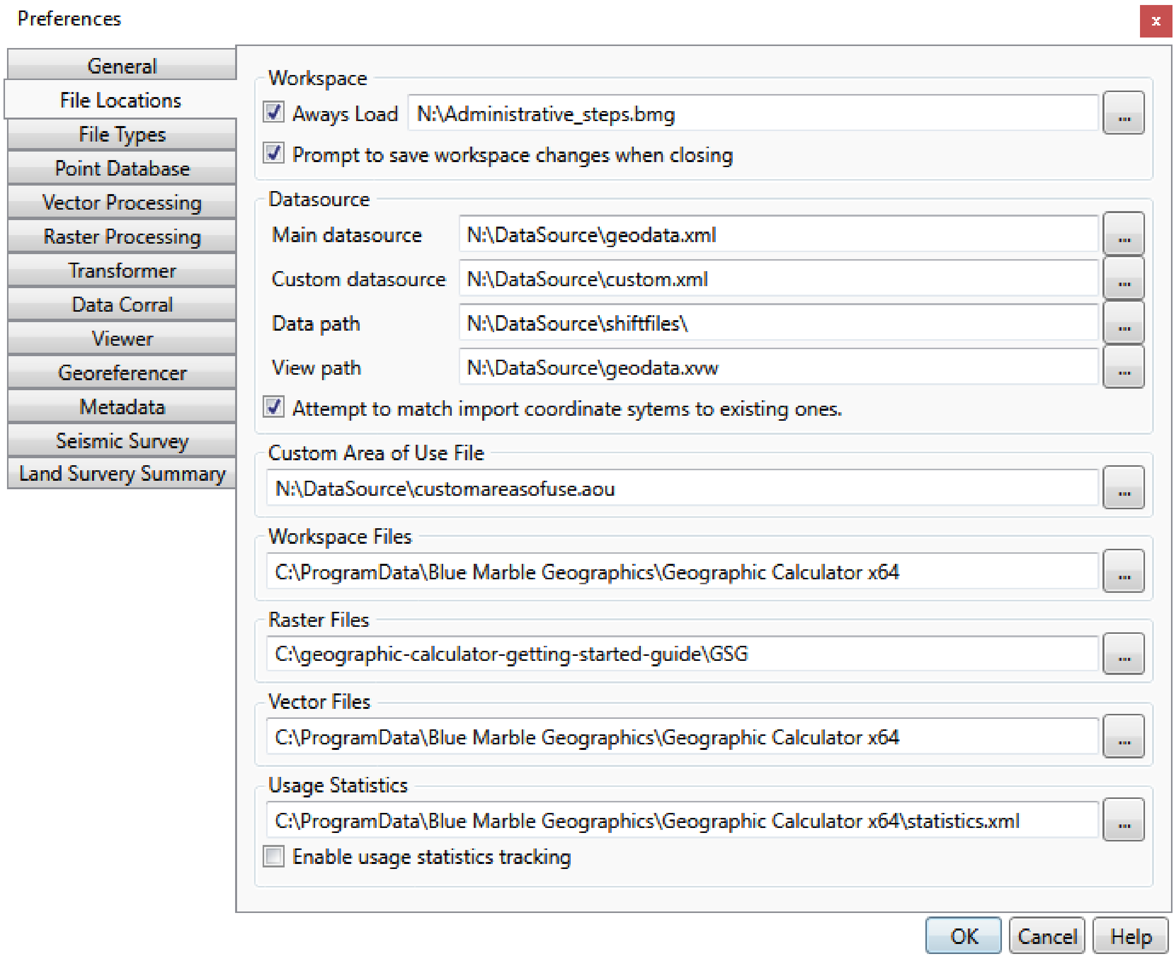
Now that the files are available on the network, the last step is to access the workspace from the user machine, and set it as the default workspace to always load.

1. On an end user machine, go to **File> Open > Workspace**. Select the saved workspace on the network.



Check to make sure the administrative settings and datasource customizations have been applied.

2. Go to **Options > Preferences**. In the **File Locations** section under *Workspace* select **Always Load** and set the path to the workspace on the network.



As a final test close the application and note that the network workspace is loaded when the application launches.

Practice Exercises

The lab section of this guide provides a direct, project oriented approach to learning the capabilities of the Geographic Calculator. It is intended to provide 'hands on' experience with the application. Each section of the manual takes the user step-by-step through a particular process with actual data. The lab manual is ideal for new users who would like some practice using the Geographic Calculator with real data or for experienced users who simply need a refresher.

Some of the coordinate data needed for the exercises is provided within the text of the Getting Started Guide. The rest of the data is provided with the Getting Started Guide. The coordinate data and map file data used in the labs are intended to represent a diverse range of applications. The exercises are examples of some of the most common uses of the Geographic Calculator.

The exercises will assume that the Getting Started Guide data folder has been unzipped and placed at ***C:\geographic-calculator-getting-started-guide\GSG***, however you can choose to place the data in another location.

The labs presented in this part of the manual range from basic procedures, such as interactive conversion, to the more advanced procedures, like fitted coordinate systems. The labs are illustrated with diagrams and screen captures from Geographic Calculator tools. The first five labs work with points or vector data formats, and the last four labs work with images and elevation data.

Lab 1: Interactive Conversions

The **Interactive Conversions Job** in Geographic Calculator is designed to complete coordinate conversions in an easy and convenient manner. Geographic Calculator allows the user to convert coordinates from a comprehensive set of coordinate systems. The Interactive Conversions screen is divided into two identical sections. When performing a coordinate conversion, it is necessary to choose one side of the screen as the **Source**, or **Input** section. The remaining side becomes the **Destination**, or **Output** section. *It does not matter which side is used for the Input or Output*.

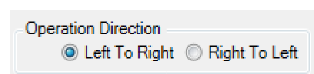
There are five sections to this lab:

Section 1: Interactive Conversions

The Interactive Conversions Job in Geographic Calculator is designed to complete coordinate conversions in an easy and convenient manner. Geographic Calculator allows the user to convert coordinates from a comprehensive set of coordinate systems. The Interactive Conversions screen is divided into two identical sections.

When performing a coordinate conversion, it is necessary to select the operation direction from left to right or right to left. These radio buttons are present at the top of the Interactive Conversion Job.

This may be toggled from left to right and vice versa by selecting one of the following radio buttons.



Objective: To convert a point in the Geodetic Latitude/Longitude NAD27 coordinate system to US State Plane 1983 grid values, save it to a file, and print the conversion information.

Your project calls for coordinates to be stated in the US State Plane 1983 grid. The Geodetic Lat/Long coordinates in NAD27 that you have are:

Latitude: 44 13 36.96 N

Longitude: 69 46 08.11 W

Set-up Conversions for Output to File

It is often desirable to record an interactive conversion for later reference or presentation. This function must be set up prior to the interactive conversion.

To set up Geographic Calculator for recording the conversion:

1. Open Geographic Calculator
2. Go to **Options > Record Interactive Conversions...**
3. Select a folder to save to and name your output log file '**Interactive Log.txt'**.
4. Click **Save**.

Geographic Calculator will now record the following Interactive Conversion to the file that was just selected.

Follow these steps to complete an Interactive Conversion of this point:

Input Parameters

1. In the Project Manager, click on the **Interactive Conversion** job. This will bring the Interactive interface onto the screen.
2. Go to the **Coordinate Point Definition** area located on the left. This is going to be the Input side.
3. Place the cursor in the **Name** box and title the source point "A"

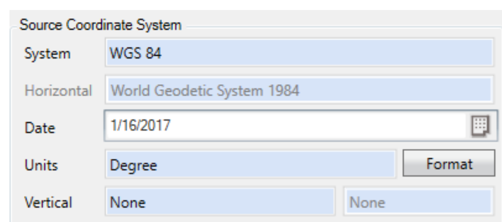
4. Enter the Lat/Long coordinates below into the North/South and East/West boxes below the name box. Enter the Latitude value (N) in the **Latitude** (North/South) field and enter the Longitude value (W) in the **Longitude** (East/West) field.

Name: A

Latitude: 44 13 36.96 N

Longitude: 69 46 08.11 W

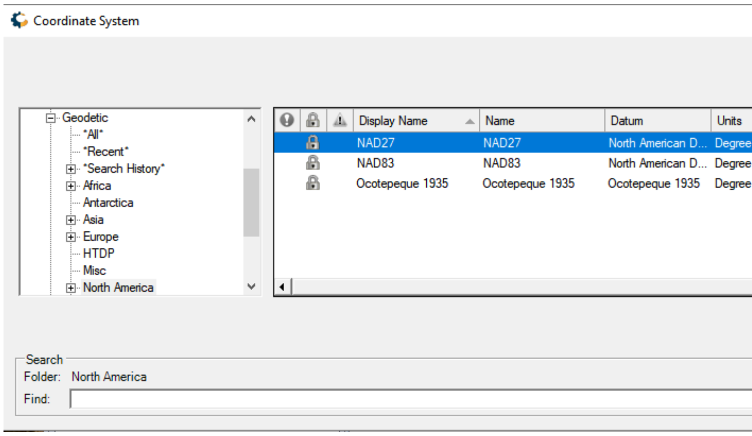
5. To select your input Coordinate System, double-click on the blue box labeled **System** in the Source Coordinate System area. By default, Geographic Calculator starts with the geodetic coordinate system of WGS84 selected.



   By default, a window will ask if you would like to limit the available systems by Geographic Area. For the purposes of this lesson, click '**No**'. The **Select Coordinate System** from Datasource dialog will then launch.

6. In the **Select Coordinate System from Datasource** dialog, coordinate systems are organized in the folder list on the left by type (Geodetic Lat/Long, Projected, Geocentric, Fitted, and String), continent, then by country. If a coordinate system covers an entire continent, it will be found by clicking on the continent folder itself. In the tree view on the left, browse under **Geodetic > North America**, in the coordinate system list on the right, select **NAD27** Coordinate System.

> **Note:** Date values are only relevant for time-dependent transformations.

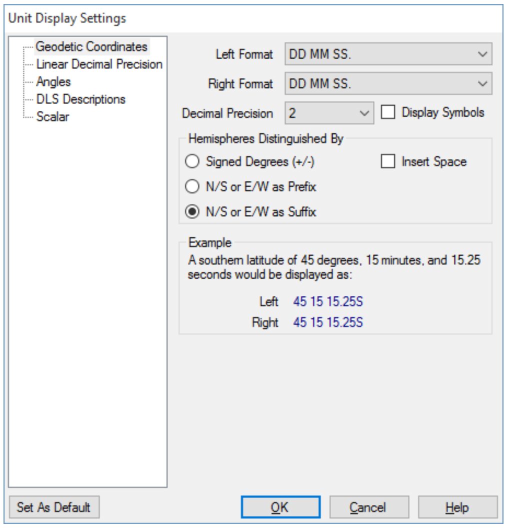


7. Select the format for your input point by going to the Source Coordinate System area and clicking on the **Format** control button.

8. A dialog box will appear. Select the following parameters, shown to the right.

9. Leave the **Vertical** field set to **None**. There are no elevation parameters for this conversion.

   Leave the **Date** set to the default values.



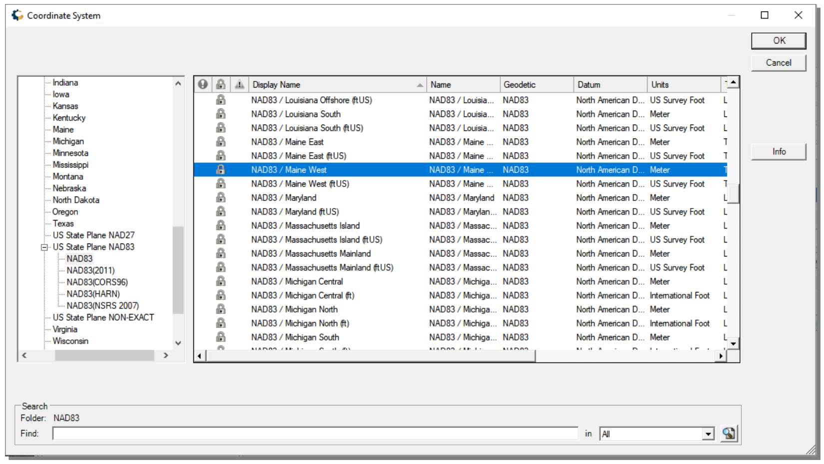
Output Parameters

The next few steps will be performed in the **Output** side of the screen.

Remember: The user can decide which side is used as the **Input** side and which side is the **Output** side by clicking the arrow button at the bottom of the conversion job.

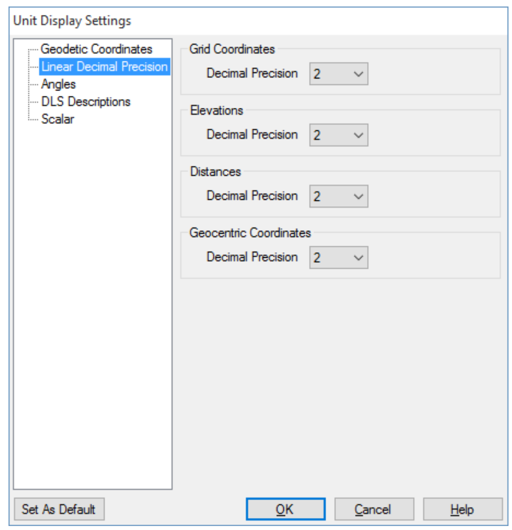
1. Go to the side of the interface you have selected for output.
2. Type 'B' in the **Name** box.
3. To select the output coordinate system, double-click on the blue box labeled **System** in the **Target Coordinate System** area. By default, the Calculator starts with the geodetic coordinate system of WGS84 selected. This will launch the Select Coordinate System dialog.

4. To select the NAD 83 US State Plane, Maine West Zone, in the tree view on the left, browse under **Projected > North America > United States > US State Plane NAD83** ; in the coordinate system list on the right, select **NAD83 / Maine West**. Click **OK**.



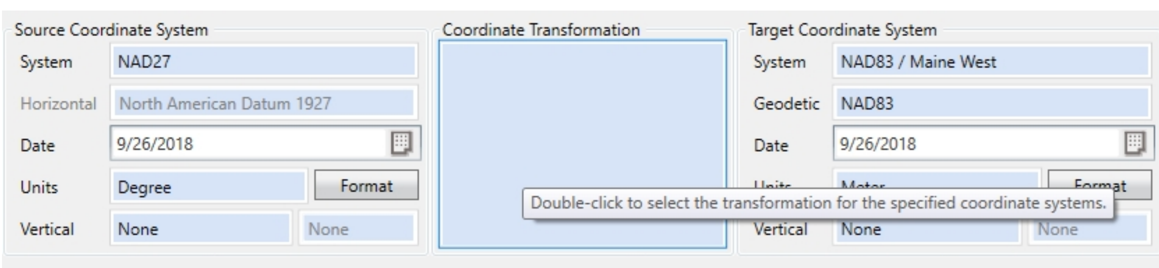
5. Select the format for your output point by going to the **Target Coordinate System** area and clicking on the **Format** control button.

   A **Unit Display Settings** dialog box will appear. Since the Output System is a projected system, select **Linear Decimal Precision** and then set the following parameters, shown to the right.



Conversion

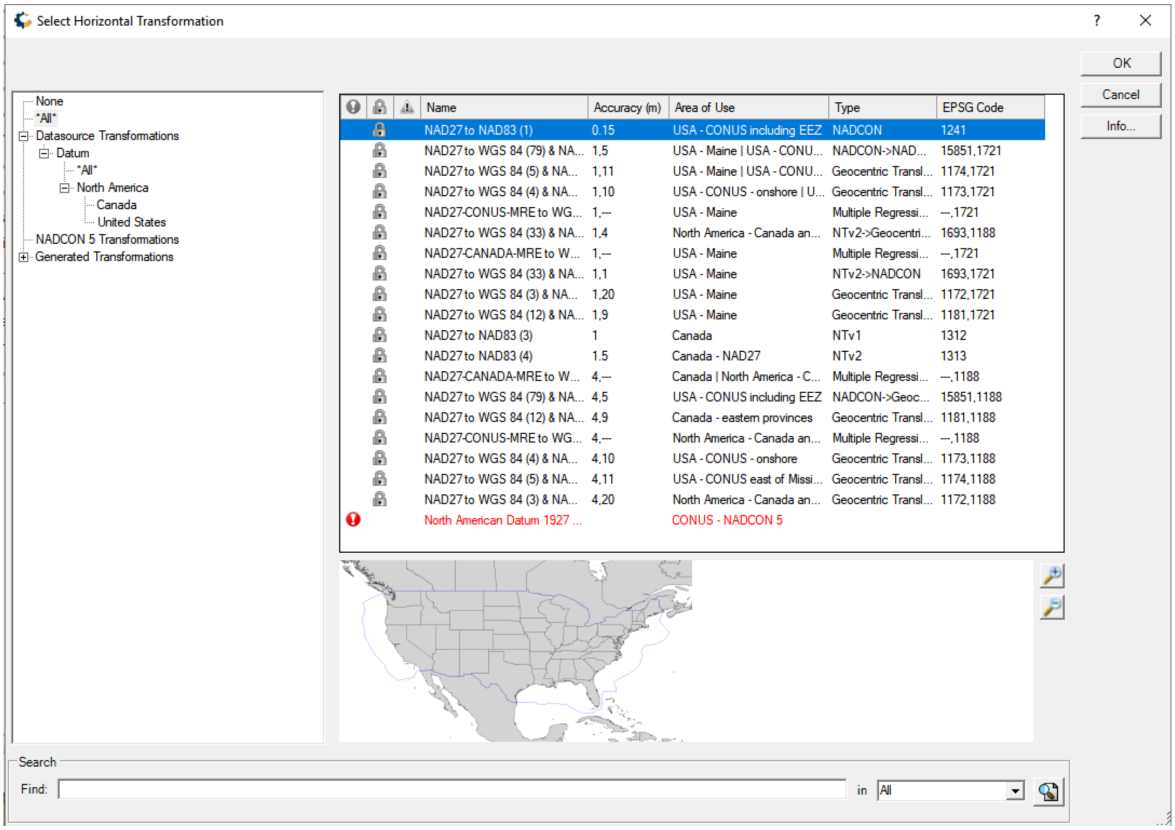
6. Before completing the conversion, you may double-click the **Coordinate Transformation** field to select a Datum Transformation that can be used to convert the coordinates from the NAD27 datum to the NAD83 datum.



> **Note:** If you don't select a Datum Transformation at this time, you will be prompted to do so during the Calculate step below.

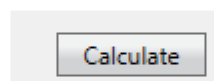
The **Select Horizontal Transformation** dialog will assist you in selecting an appropriate datum transformation for your coordinates by only displaying those shifts that have a suitable defined area of use containing the input coordinates. The Transformations are listed in a tree view like other objects in the Geodetic Datasource.

Use the **Accuracy(m)** and **Area of Use** columns to determine the best transformation. When a transformation is selected, the area of use is also displayed in the map view at the bottom of the dialog.



For this example result shown below, select **NAD27 to NAD83 (1)**, which is the NADCON transformation for the Continental US. You may also try other transformations. Press the **Info...** button to see more details about a highlighted transformation.

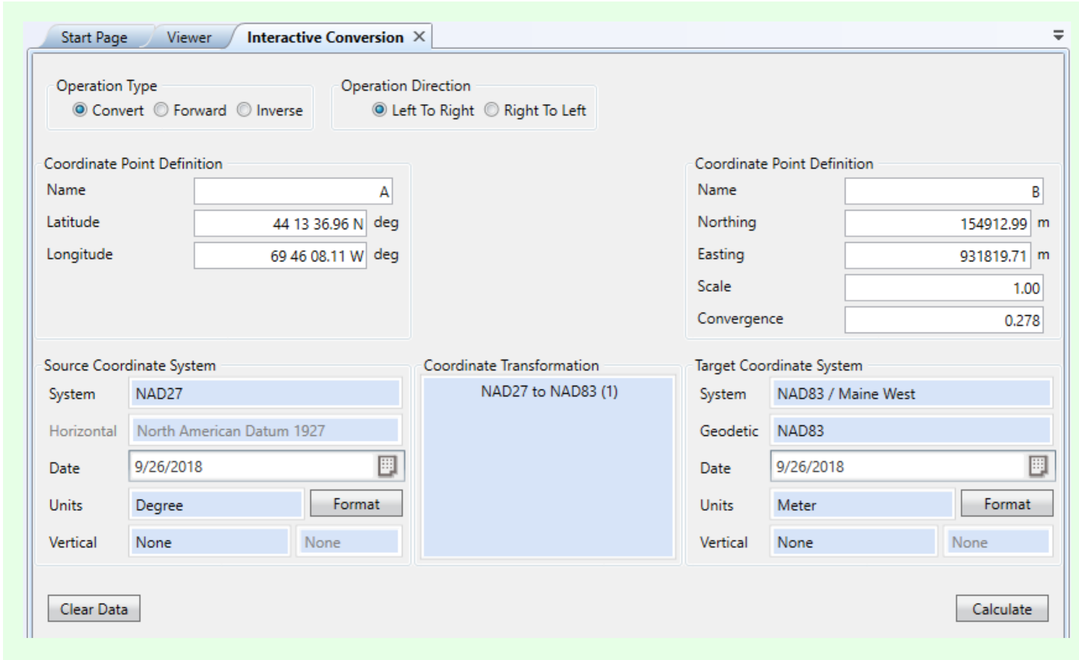
7. Click on the **Calculate** button to complete the conversion.



The results will appear in the destination area in the corresponding boxes:

> **Northing:** 154912.99 m
>
> **Easting:** 931819.71 m
>
> These are the US State Plane Values for the Geodetic Lat/Long coordinates.

Example: Completed Conversion

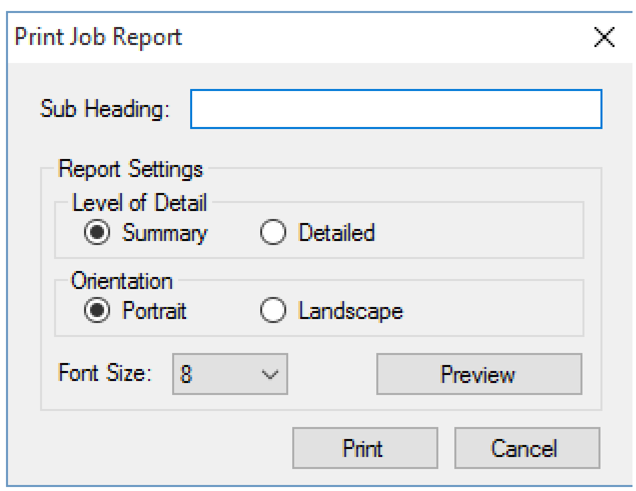


Note: You can save the conversion settings (Input and Output Coordinate System Settings) by going to **File > Save As... > Job** and naming an output file. This saves all of the settings in the Interactive Job. This file can be recalled and the parameters are automatically entered into the active dialog.

The coordinate conversion is complete. The conversion data (Original point coordinates, output coordinates, conversion parameters, etc.) can be viewed in a text editor by opening the text file specified before the conversion (**InteractiveLog.txt**) .

Alternatively, the conversion data can be viewed and printed by going to **File > Print** (or clicking the print button). The display can be changed to suit your needs.

Once you have chosen your layout and detail settings you can view a preview of the printed report by clicking the **Preview** button.



Interactive Conversion Report Geographic Calculator 64 bit 2019

Datasource: C:\ProgramData\blue marble geographics\geographic calculator x64\datasource\geodata.xml

	A	B
Latitude	44 13 36.96 N	
Longitude	69 46 08.11 W	
Northing		154912.99
Easting		931819.71
Base latitude	44 13 36.96 N	44 13 37.21 N
Base longitude	69 46 08.11 S	69 46 06.27 S
Convergence	0.000	0.278
Convergence Format	D.	D.
Scale Factor	0.00	1.00
Orthometric Height Scale	1.00	0.00
Coordinate System	NAD27	NAD83 / Maine West
HorizontalDatum/GeodeticCoordSys	North American Datum 1927	NAD83
Date	9/26/2018	9/26/2018
Units	deg	m
Format	DD MM SS.	X.
Vertical Coordinate System	None	None
Vertical Units	None	None
Coordinate Transformation	NAD27 to NAD83 (1)	

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Continue to Forward Conversions

Section 2: Forward Conversions

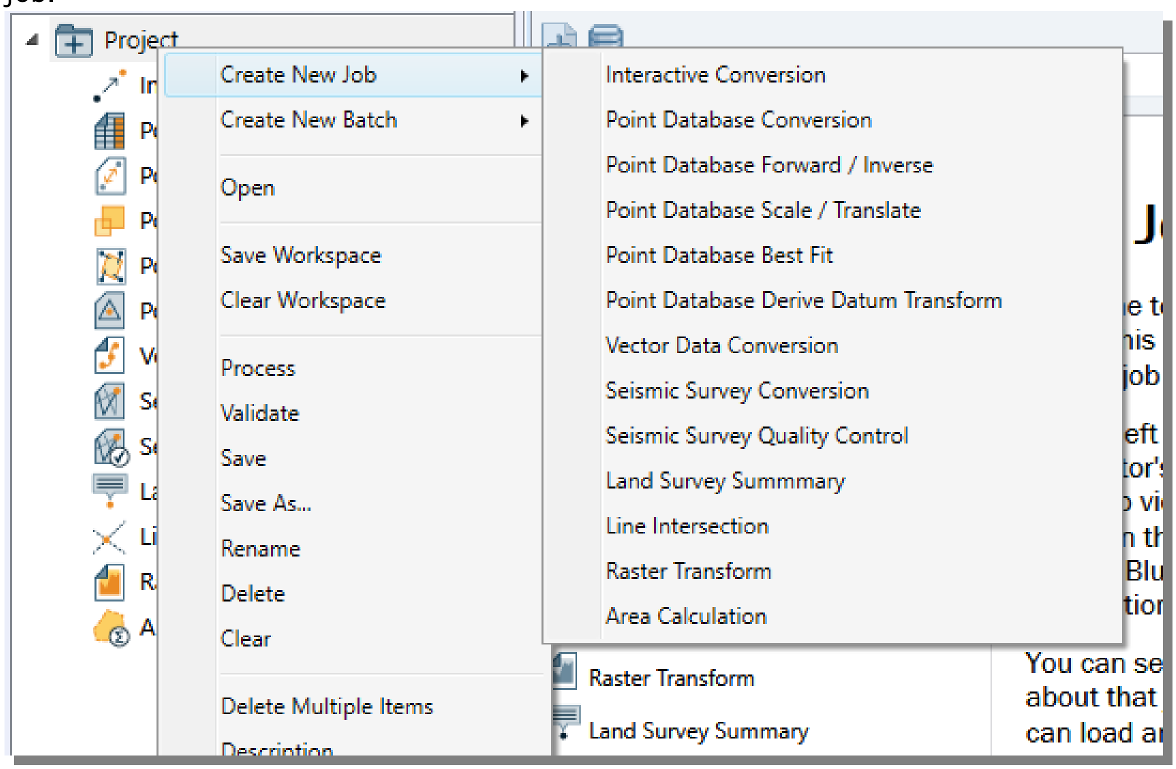
Geographic Calculator can perform **Forward** geodetic conversions. This function allows the user to calculate a coordinate by its distance and heading (Azimuth) from a source coordinate using either Geodesic, CCG, or Rhumb Line methods.

For example, the user has a coordinate (x, y) that is specified in Geodetic Lat/Long in WGS84 and would like to calculate the coordinate that is 7 degrees (azimuth), 100 meters away.

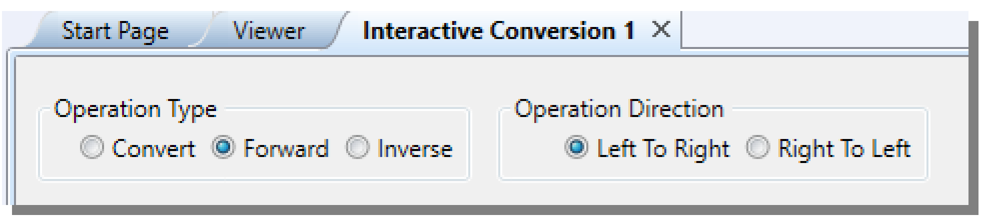
Objective: To calculate a new coordinate that is a specified direction and distance away from a source coordinate.

Follow these steps to complete a forward coordinate conversion:

1. Open Geographic Calculator and right click on the Project in the project manager. Select **Create New Job > Interactive Conversion** to open a new Interactive Conversion job.



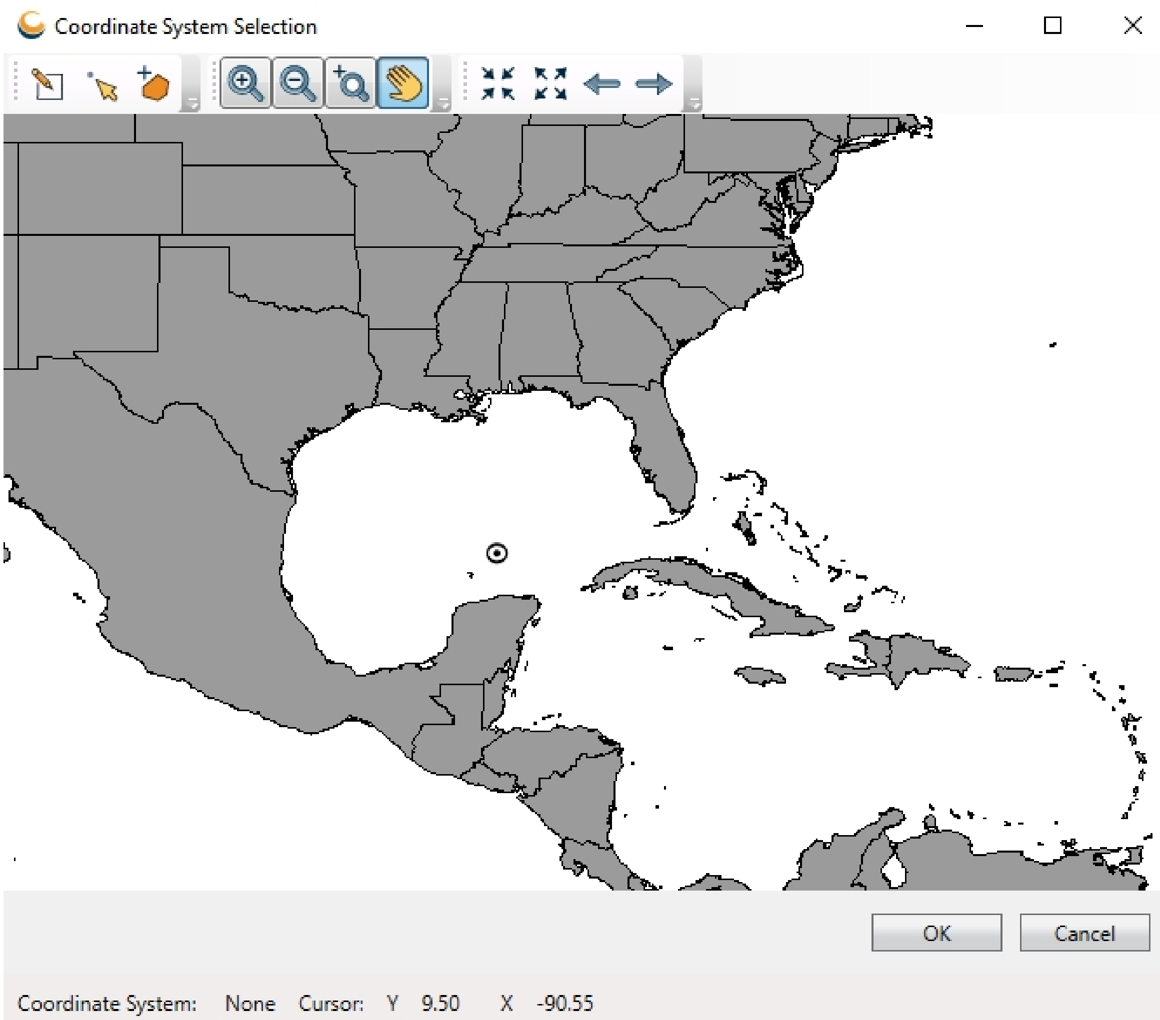
2. Use the radio buttons at the bottom to select **Forward** as the Operation type. The interface will change to show the Forward parameters:



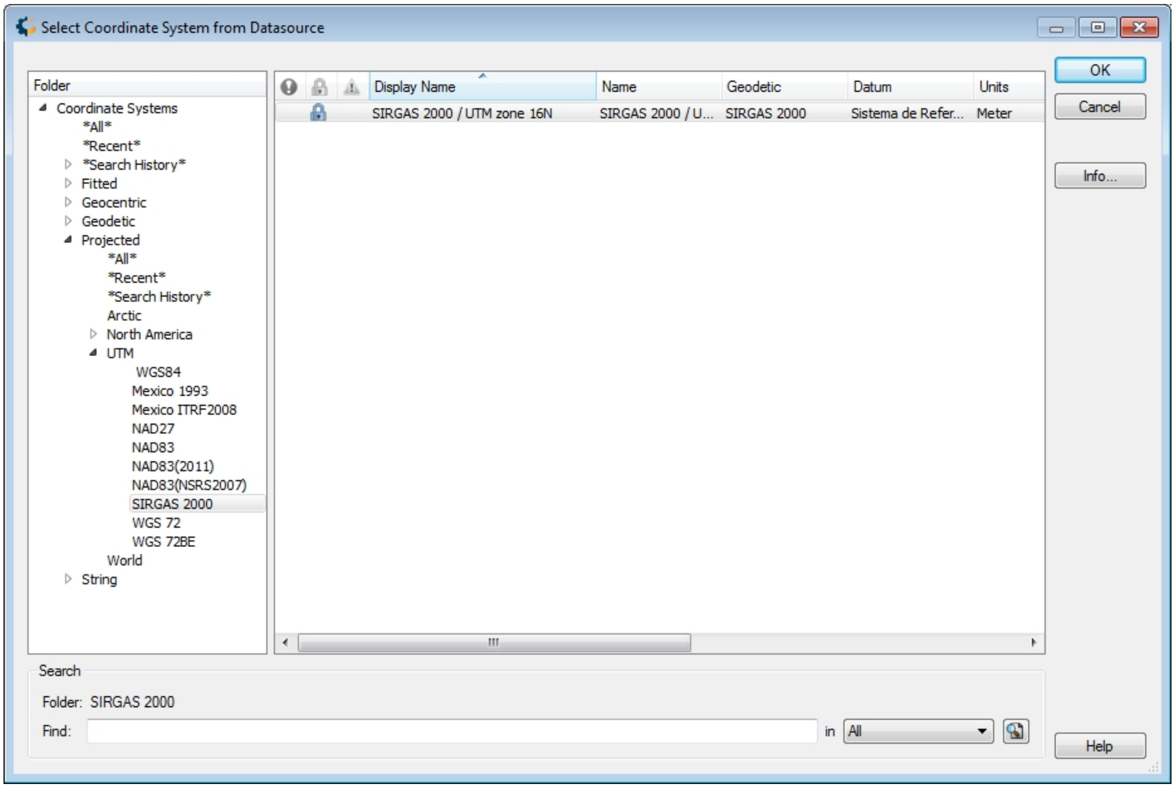
3. Set the operation direction to determine which half of the interface will be used as the input side. For this exercise, the operation will go Left to Right.

4. To select your input Coordinate System, double-click on the blue box labeled System in the **Source Point Coordinate System** area. By default, the Calculator starts with the geodetic coordinate system of WGS84 selected. By default, a window will ask if you would like to limit the available systems by Geographic Area. Select **Yes** to limit the list of coordinate systems by location. This will launch the Coordinate System Selection dialog.

5. Select the  Select Coordinate System by Point button, and place a point in the southern Gulf of Mexico.



6. In the Select Coordinate System dialog, coordinate systems are organized in the folder list on the left by type (Geodetic Lat/Long, Projected, Geocentric, String and Fitted), continent, then by country.   In the tree view on the left, browse under **Projected > UTM >SIRGAS 2000**; in the coordinate system list on the right, select **SIRGAS 2000/ UTM zone 16N**.



7. Enter this Projected Northing Easting coordinate:

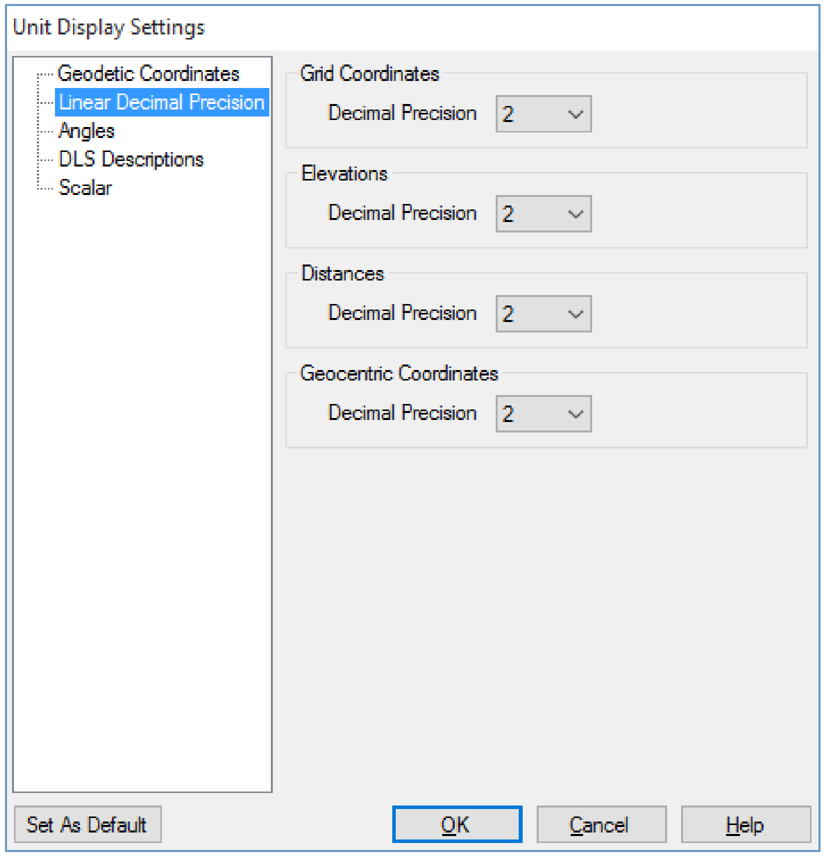
> **Name:** Point A
>
> **Northing:** 2960746.55 m
>
> **Easting:** 16088.31 m

8. Select the **Format** button in the **Source Coordinate System** area to set the format settings for your input point

9. A dialog box will appear. Select the following parameters:

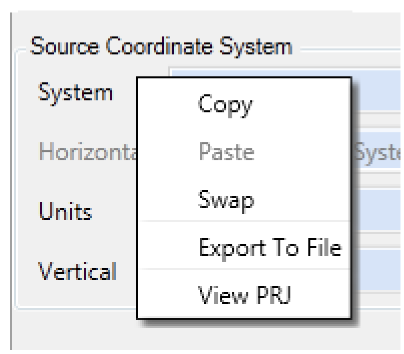
10. Leave the **Vertical Reference** field, set to **None**. There are no elevation parameters for this calculation.

> **Note:** When performing Forward conversions, the Source and Target Coordinate Systems must be based on the same datum. In this example, the coordinate system will not be converted.



11. Select the same coordinate system for the Target Coordinate System.

> **Tip:** Right-click on the Coordinate System box to enable Copy and Paste options



12. Choose the **Geodesic** method in the drop down between the Coordinate Point Definition fields.

13. Enter the following values and units:

> **Distance: 1000 meters**
>
> **Azimuth: 7 degrees**

Make sure you specify the units using the appropriate units button.

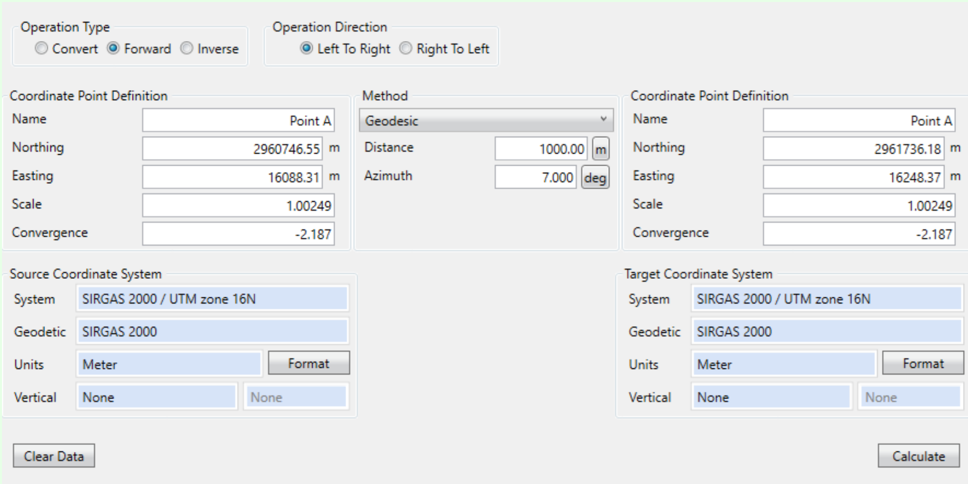
14. Click **Calculate**.

    The coordinate 1000 meters, azimuth 7 degrees from the source coordinate is:

    Northing 2961736.18 m

    Easting 16248.37 m

    This information will be displayed in the output half of the Interactive Conversions screen.



Continue to Section 3: Inverse Conversions

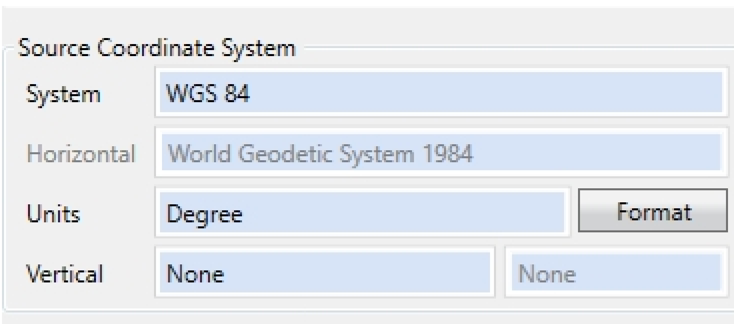
Section 3: Inverse Conversions

Geographic Calculator can perform inverse calculations to determine the Distance and Azimuth between two known points on the same datum.

Objective: To calculate the Distance and Azimuth between two known locations.

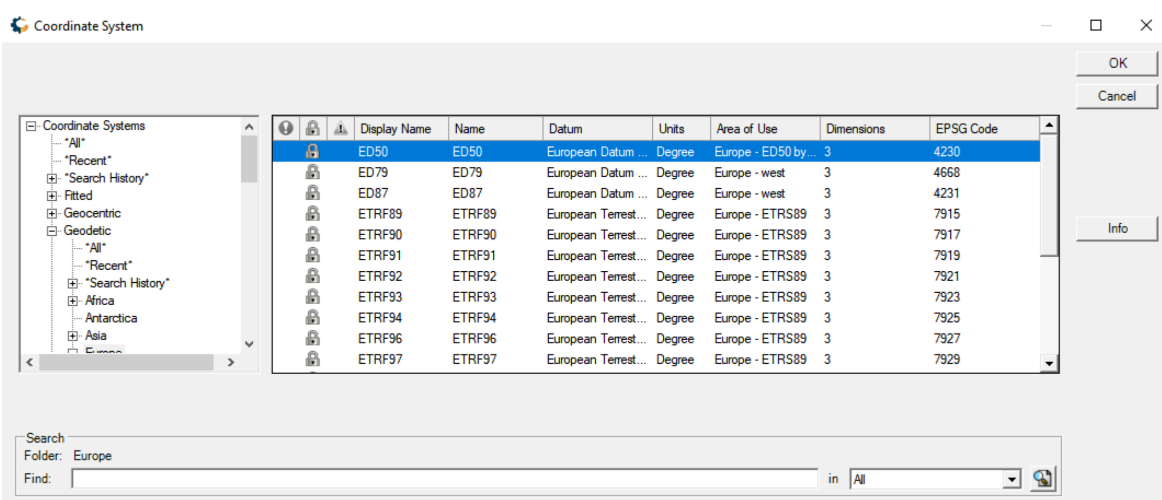
Follow these steps to perform an inverse calculation:

1. Open Geographic Calculator and create a new **Interactive Conversion** job.
2. In the Operation area at the top of the job settings, select the radio button for **Inverse**. The interface will change to reflect settings needed for Inverse calculations.
3. By default, the software starts with the geodetic coordinate system of WGS84 selected. To select your Input Coordinate System, double-click on the blue box labeled **System** in the Source Coordinate System area at the bottom of the job page.



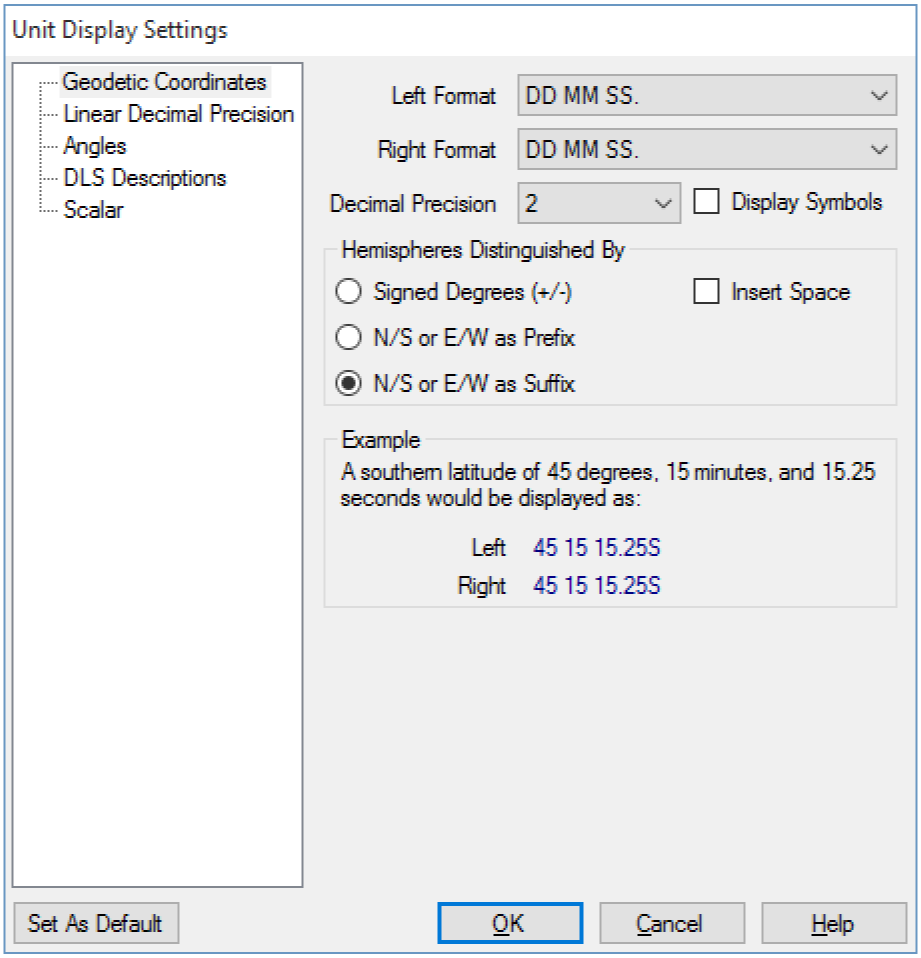
   Press **No** to limiting the coordinate system by map. This will launch the Select Coordinate System dialog.

4. In the Select Coordinate System dialog, coordinate systems are organized in the folder list on the left by type (Geodetic Lat/Long, Projected, Geocentric, String and Fitted), continent, then by country. In the tree view on the left, browse under **Geodetic >Europe**, in the coordinate system list on the right, select **ED50**.



5. Select the format for your input point by going to the **Source Coordinate System** area and clicking on the **Format** control button.

6. A dialog box will appear. Select the following parameters:

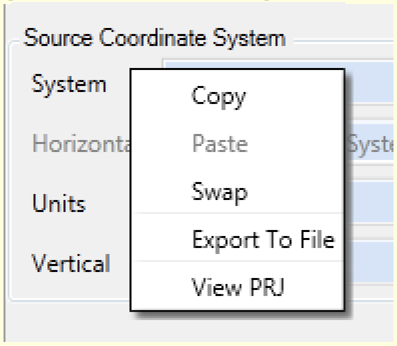


Leave the **Vertical Reference** field, set to **None**. There are no elevation parameters for this calculation.

Note: When performing Forward conversions, **the Input and Output Coordinate Systems must be based on the same reference ellipsoid**. In this example, the coordinate system will not be converted.

7. Select the same coordinate system for the coordinate system in the **Target Coordinate System** area.

Right-click on the Source Coordinate system text label and choose copy, then right-click on the Target Coordinate System text and choose paste.



8. Choose the **Geodesic** method in the drop down between the Coordinate Point Definition fields.

9. Enter the two points into the coordinate fields to calculate distance and azimuth between:

Point 1: (on the Left):

Name: Point 1

Latitude: 50 45 36.96N

Longitude: 04 46 08.11E

Point 2 (on the Right):

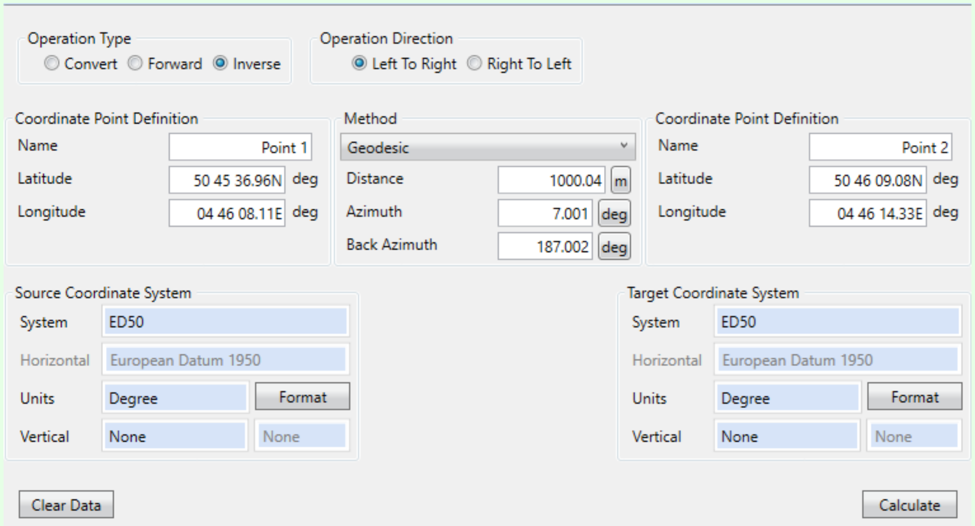
Name: Point 2

Latitude: 50 46 09.08N

Longitude: 04 46 14.33E

10. Once the coordinates have been entered, click the **Calculate** button. The distance and azimuth will display in the appropriate fields.

The points should be approximately 1000 meters apart at a heading of 7 degrees.



Continue to Section 4: HTDP Conversions

Section 4: HTDP Conversions

Geographic Calculator includes support for Horizontal Time Dependent Positioning (HTDP). This functionality allows the user to enter an epoch (date) for both input and output coordinate systems in Interactive Conversion, Point Database Conversion, and Vector Data Conversion jobs. The software will then calculate a transformation between the two systems that takes into account the plate movement between the epochs.

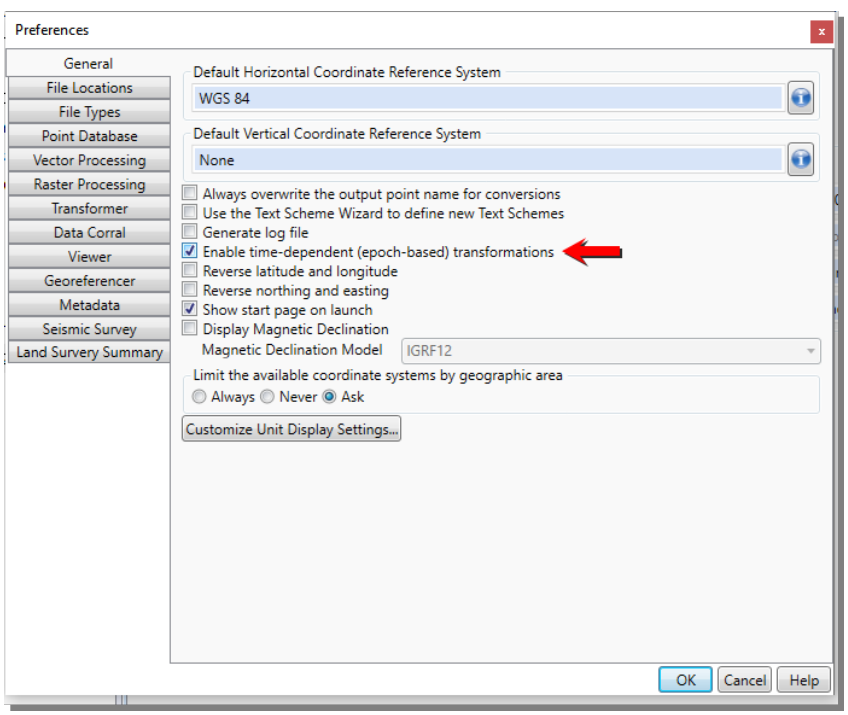
HTDP conversions can be computed with or without an epoch change and with or without a datum change. The first example in this lab shows a datum change without epoch change, to simulate a conversion from GPS collected data to the most current realization of NAD83. The second example shows an epoch change, to simulate an update of historic data.

Note: HTDP conversions are only available for certain datums and geographic areas. The crustal motion velocities and displacements were calculated by the National Geodetic Survey for plates in the United States and its territories.

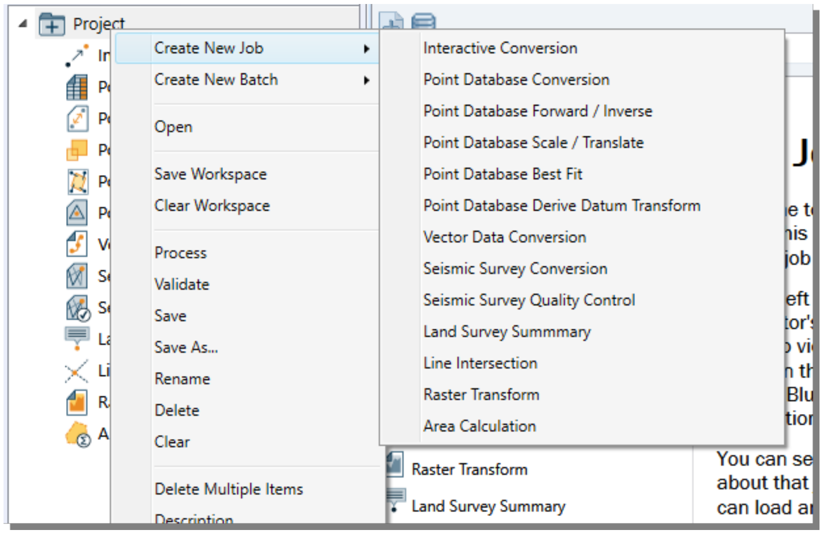
Objectives:
Example 1 - To convert a point from WGS84 geodetic coordinates to NAD83 state plane coordinates, correcting for the divergence between those two systems as of today's date.
Example 2 - To convert a point that was collected in 1990 to its current location as of today's date.

Example 1

1. To enable the HTDP functionality, go to **Options > Preferences**. On the *General* tab of the **Preferences** dialog, check the option to **'Enable time-dependent (epoch-based) transformations'**. Click **OK** to save the Preference and close the dialog.

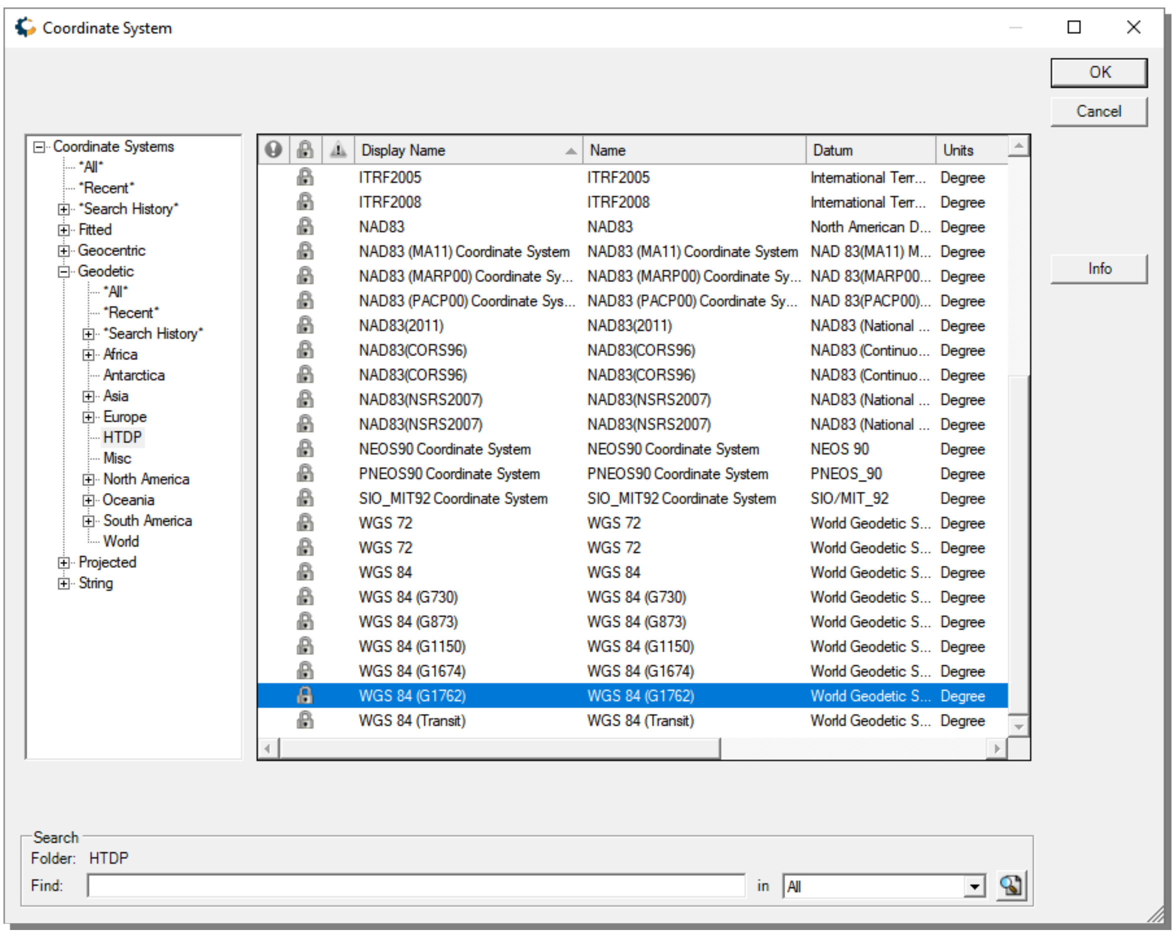


2. Right click on the Project in the project manager. Select **Create New Job > Interactive Conversion** to open a new Interactive Conversion job.

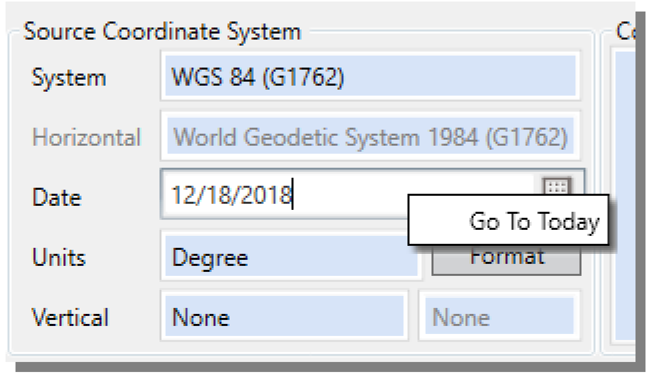


3. Double click the **System** box in the Source Coordinate System area to select your input coordinate system. All of the geodetic systems that are HTDP compatible are together in the **HTDP** folder.

Select the **WGS84 (G1762)** Coordinate system, which represents the most recent realization of the WGS84 datum.



4. In the left side coordinate system area, right click in the Date box and select **Go to Today.** The box will be checked and populated with today's date.



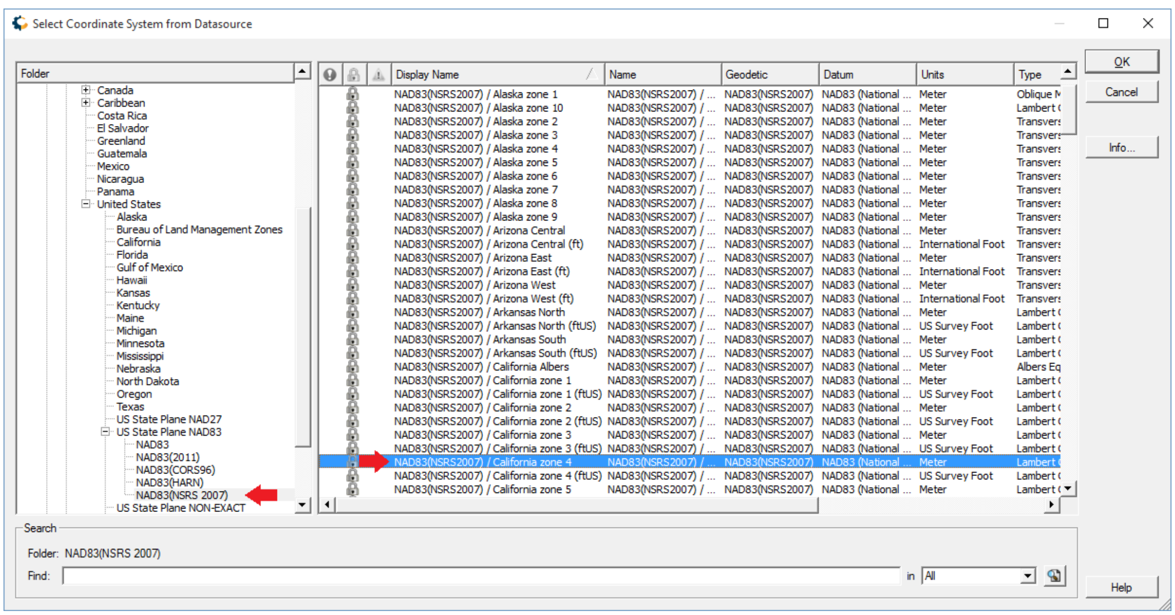
5. Click the **Format** button to set your geodetic coordinate format. Set the left side format to **DD.** with **decimal precision of 8** and **signed degrees (+/-)**. Click OK to close the Format window.

6. In the left side coordinate point definition area, enter the point

   latitude 36

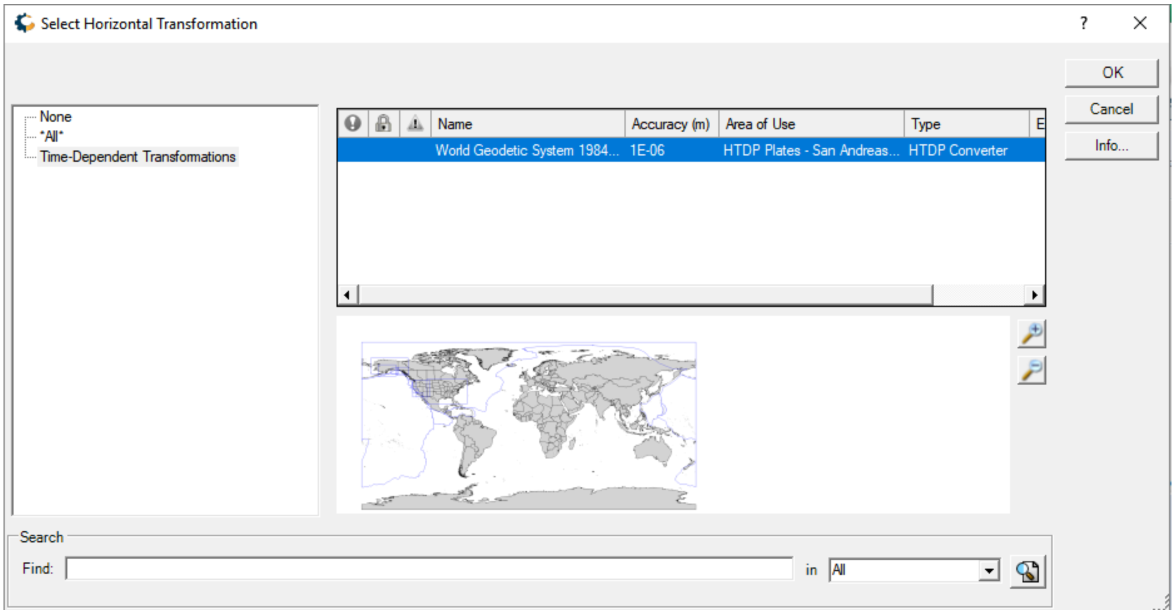
   longitude -120

7. Double click in the **System** box in the Target Coordinate System area to select your output coordinate system. Navigate to the **Projected** folder, *North America> United States> US State Plane NAD83> NAD83(NSRS2007)*. Select the **NAD83 (NSRS2007)/California zone 4** system (not USft, meters).

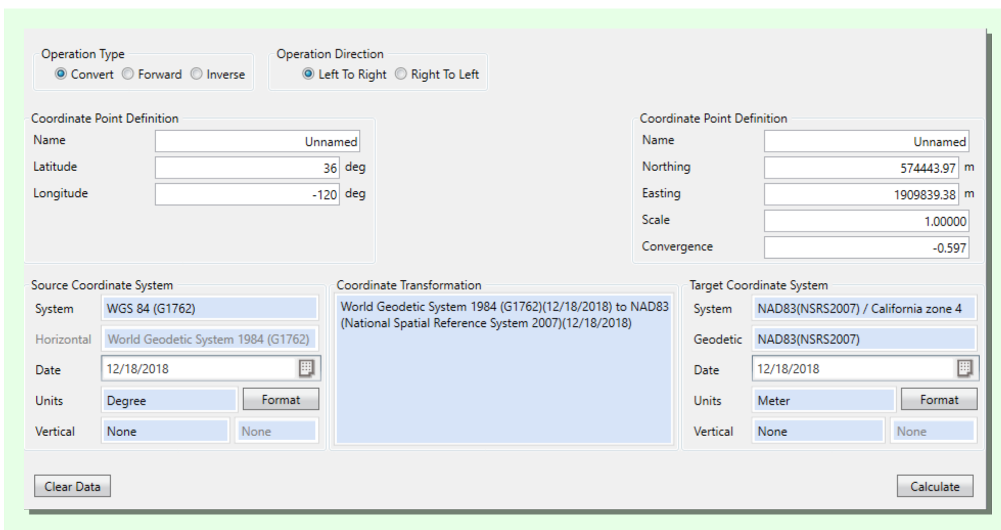


8. Set the Target Coordinate System date to today's date.

9. Double click in the **Coordinate Transformation** box. Select Time Dependent Transformations. This will automatically select an HTDP transformation between the two epochs and datums.

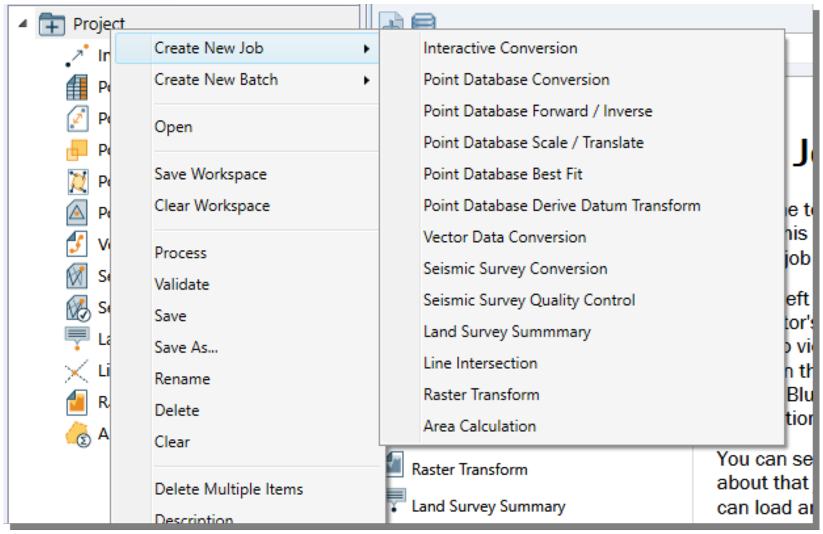


10. Click the **Calculate** button to complete the conversion.



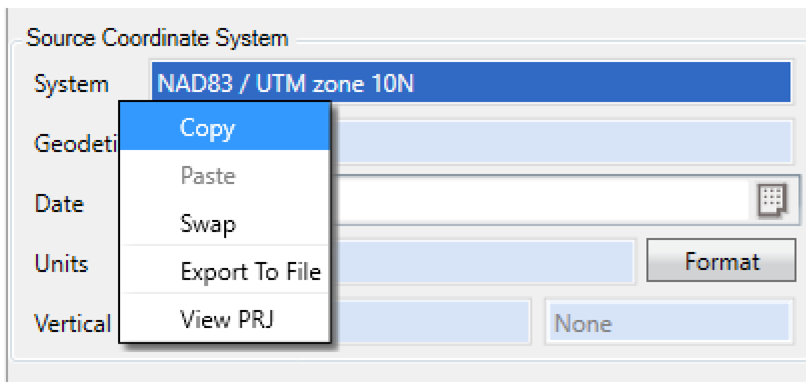
Example 2

1. Right click on the Project in the project manager. Select **Create New Job > Interactive Conversion** to open a new Interactive Conversion job.



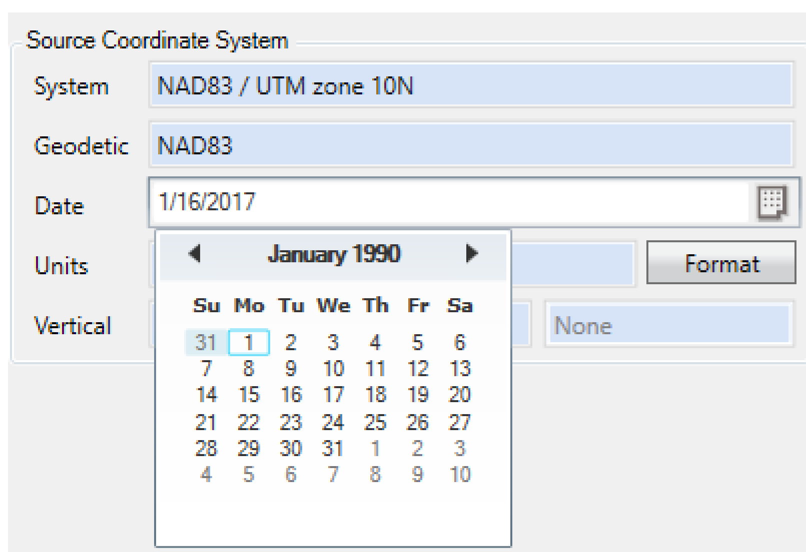
2. In the Source Coordinate System area, double-click in the **System** box to select your input coordinate system. Navigate to the *Projected > UTM > NAD83* folder and select **NAD83/UTM zone 10N**.

3. This example will use the same coordinate system for the output point. Right click in the Source Point Coordinate System area and select **Copy**.



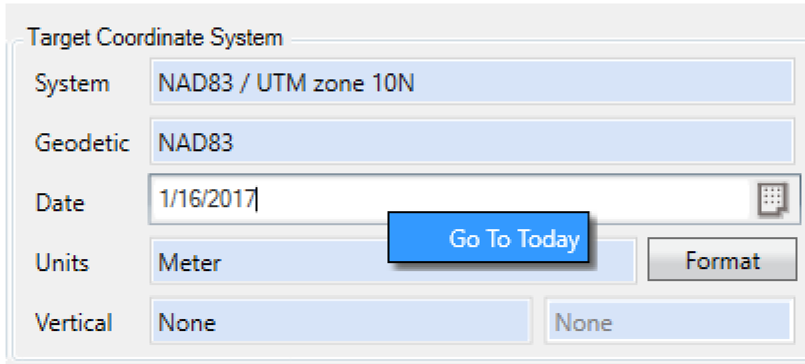
4. Right- click in the Target Coordinate System area and select **paste**. Now, both coordinate systems should be set to NAD83 / UTM zone 10N.

5. Returning to the Source Coordinate System area, click the dropdown arrow to activate the calendar.



6. In the calendar, click on the month and year at the top. Then click the year at the top. Use the arrows to select 1990. Use the left and right arrows to set the Month to January, and select the 1st on the calendar. Click away from the calendar to finalize your date as 1/1/1990.

7. In the right side coordinate system area, right click in the **Date** box and select **Go to Today**. Todays date will be displayed.



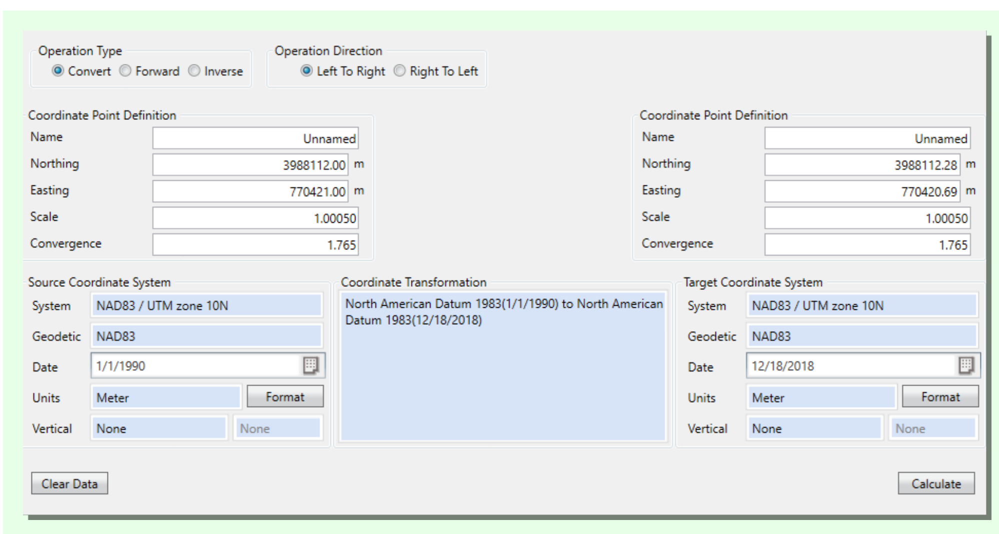
8. On the left coordinate point definition, enter the point

Northing 3988112

Easting 770421

9. Double click in the Coordinate Transformation area and select Time-Dependent Transformations from the left pane. An HTDP transformation will automatically be selected.

10. Click the **Calculate** button to complete the conversion. Your results may be slightly different from those shown below, because your output date (today's date) will be different. As you can see, over that period of time, the point has moved less than a meter to the north and less than a meter to the west.



Continue to Section 5: Vertical Conversions

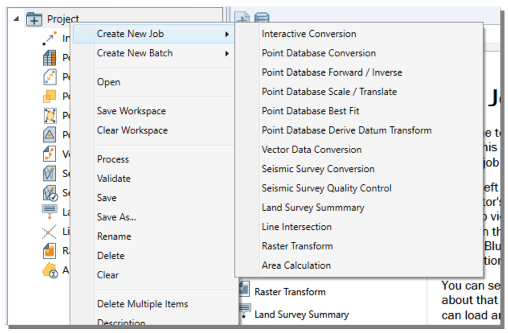
Section 5: Vertical Conversions

In addition to converting between horizontal datums, Geographic Calculator can convert data from one vertical datum to another. These conversions can be downloaded either in the application or from the Blue Marble Website.

Vertical conversions are available in all Interactive Conversion, Point Database Conversion, and Vector Data Conversion jobs.

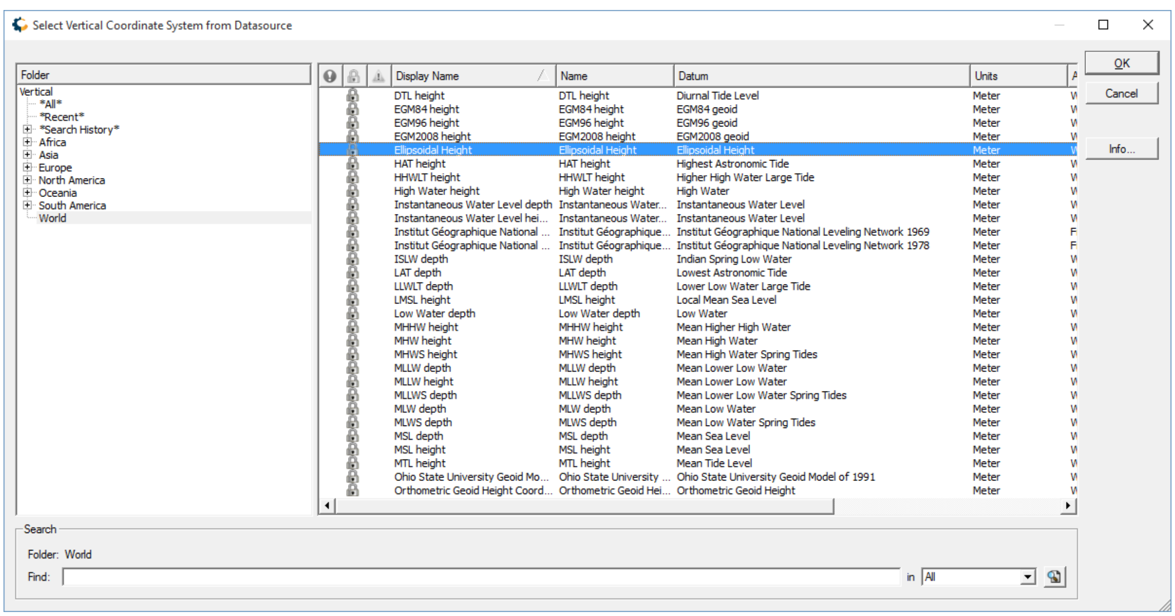
Objective: To convert a point from ellipsoidal height (vertical distance from the ellipsoid) to geoid height (vertical distance from a geoid, which is an approximation of mean sea level).

1. Right click on the Project in the project manager. Select **Create New Job >> Interactive** Conversion to open a new **Interactive Conversion** job.



2. The new job will open with WGS84 as the default coordinate system on both sides. Double-click in the **Vertical** box for the Source Coordinate System to select a vertical reference.

3. In the **Vertical Reference Selection** dialog, any systems for which you have not yet downloaded the additional grid files will be listed in red. Select **Ellipsoidal Height** from the World folder and click **OK** to finalize your selection.



4. When you have selected a vertical reference, a textbox for height will appear in the Coordinate Point Definition area.

   Enter the point:

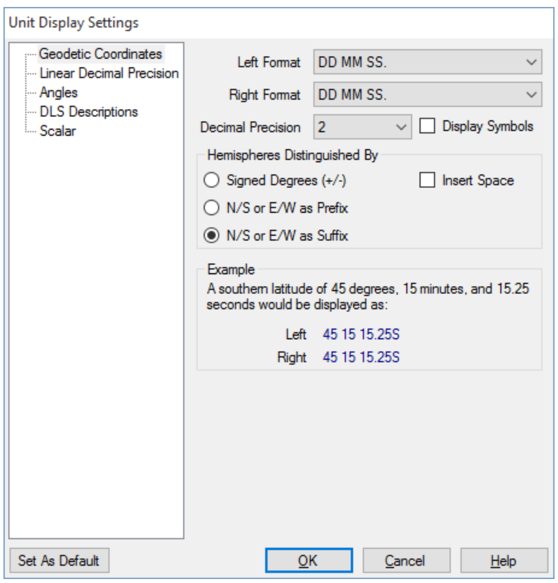
   Latitude 45

   Longitude -70

   Height 10

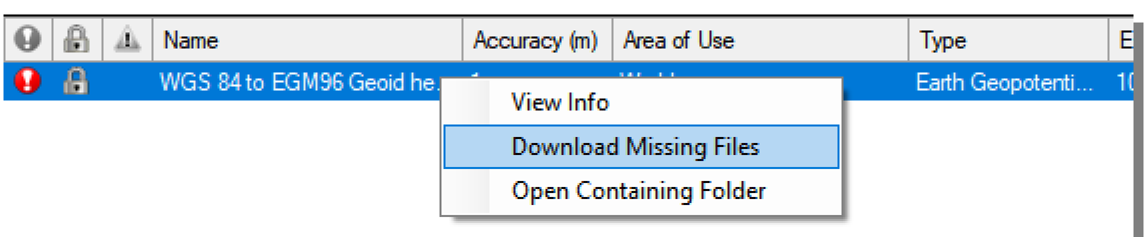
5. In the right side **Coordinate System** area, double click the Vertical box to select a vertical reference. Select Earth Geopotential Model of 1996 (**EGM96 height**) from the *World* folder.

6. Click on the **Format** button and set your coordinate format as shown below:



7. Double-click the Coordinate Transformation box. Since the input and output horizontal datums are identical in this conversion, a horizontal datum transformation is not needed. From the Select Vertical Transformation dialog, choose **WGS 84 to EGM96 Geoid Height (1)**.

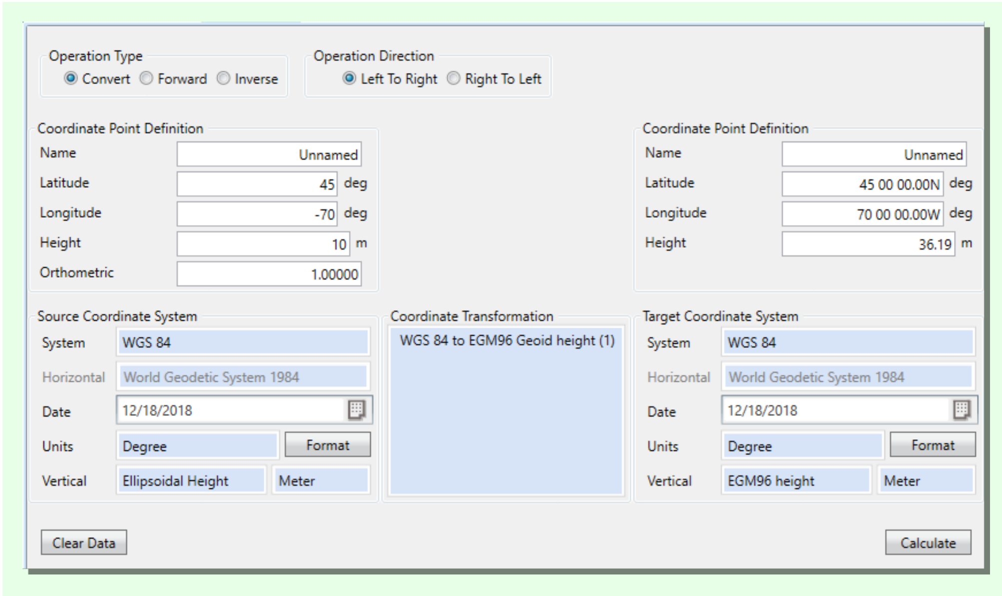
   If the object is displayed in red, right-click on it and select **Download Missing Files**.



Note: If the machine is offline, the files may also be downloaded from the Blue Marble Website in the **Data and Shift files** section below the software download.

Click **OK** once the file has finished downloading.

8. Click the **Calculate** button to complete the conversion.



Lab 2: Point Database Conversions

Point Database files can be processed in Geographic Calculator. All of the basic functionality available for single point conversions in the Interactive Point Conversions tab can be applied to point files. These basic functions include:

- Coordinate Conversions
- Inverse Calculations
- Forward Calculations
- Best-Fit Calculations
- Scale and Translate Calculations

In this lab we will explore the tasks that can be completed in a Point Database Job in Geographic Calculator. There are four sections in this lab:

- Section 1: Point Database Conversions
- Section 2: Saving Point Database Conversion Results
- Section 3: Creating a Text File Scheme
- Section 4: Batch Point Database Conversions

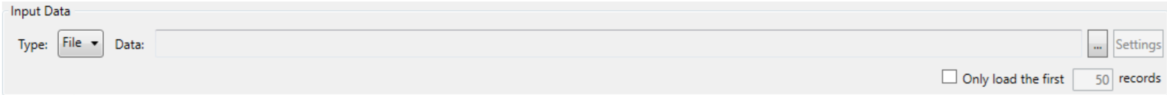
Section 1: Point Database Conversions

The Point Database Conversion functions of Geographic Calculator are designed to handle coordinate conversions on columns of data in a table. This exercise will familiarize the user with the basic workings of the Point Database Conversion area. **Objective:** Use the interactive spreadsheet (Point Database Conversions) to convert a list of coordinates from Geodetic Lat/Long to Universal Transverse Mercator. For this exercise, you have been given an Excel spreadsheet containing coordinates. The coordinates are in Geodetic Lat/Long, WGS84. They must be converted to Universal Transverse Mercator grid values. **Data:** WGS84boatlnch.xls

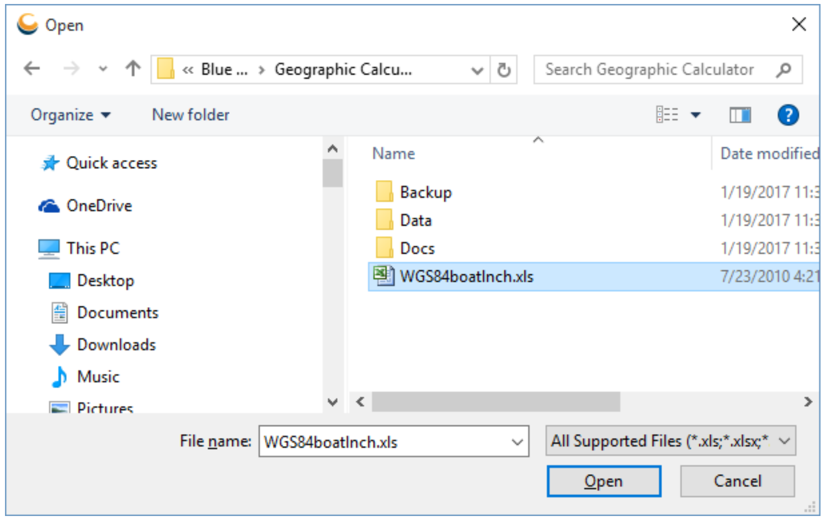
Follow these steps to complete a conversion of these coordinates in a Point Database Conversions job:

1. Open Geographic Calculator.
2. Click on the **Point Database Conversion** job to open the interface.

3. Load a point database file by clicking the **"..."** button in the Input Data area at the top of the job.



On the dialog that opens, select File from the dropdown list, and click the Browse button to locate the file you will open. The file to open is in the folder for the Getting Started Guide (C:\geographic-calculator-getting-started-guide\GSG) named: **WGS84boatInch.xls**

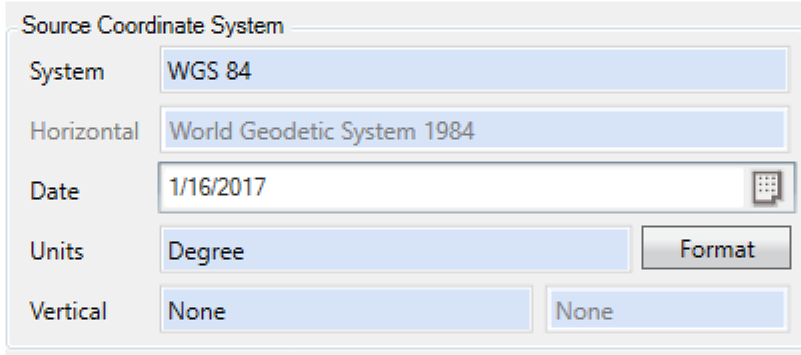


4. When you open the file, you will be asked if the file contains a header, select **Yes**. This will use the first row of the spreadsheet to name the columns in the table.

5. Once loaded, the table should look like this:

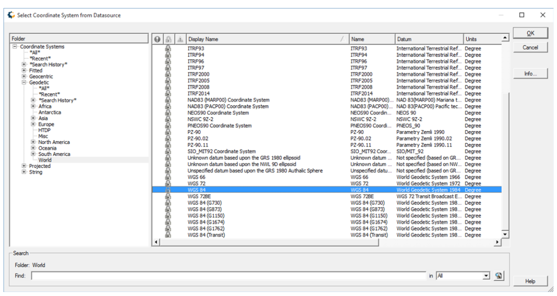
	Latitude	Longitude	TOWN
▶	45.2169009301056	-69.5318978049842	ABBOT
2	45.2172973992144	-69.5479979289822	ABBOT
3	43.5698977496495	-70.9724981649683	ACTON
4	43.5531994094356	-70.953398419754	ACTON
5	43.5499988567816	-70.892098310264	ACTON
6	44.5077990179894	-67.7224988731985	ADDISON
7	44.6152011196927	-67.7506991617595	ADDISON
8	44.2721991166282	-70.7116988113415	ALBANY TWP
9	47.0704981660228	-69.0769003541489	ALLAGASH

7.



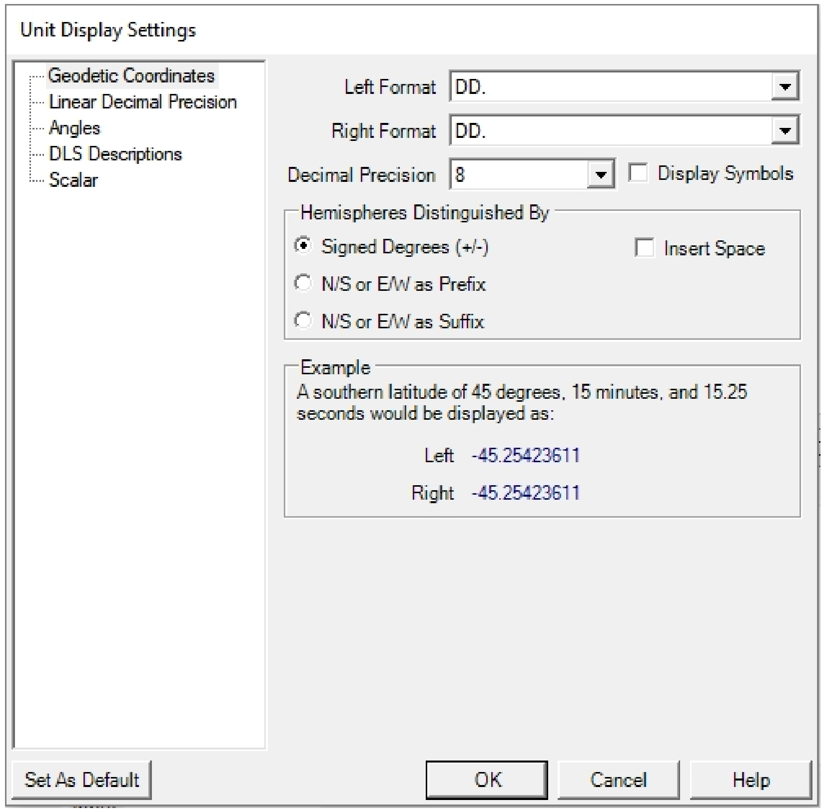
To select your input coordinate system, double-click on the blue box labeled **System** in the **Source Coordinate System** area at the bottom of the job page. By default, the Calculator starts with the geodetic coordinate system of WGS84 selected. This will launch the Select Coordinate System dialog.

8. In the Select Coordinate System from Datasource dialog, coordinate systems are organized in the folder list on the left by type (Geodetic Lat/Long, Projected, Geocentric, String, and Fitted), continent, and then by country. In the tree view on the left, browse under **Geodetic>World** in the coordinate system list on the right, and select **WGS84 Coordinate System**.



9. Select the format for your input point by going to the **Coordinate System** area and clicking on the **Format** control button.

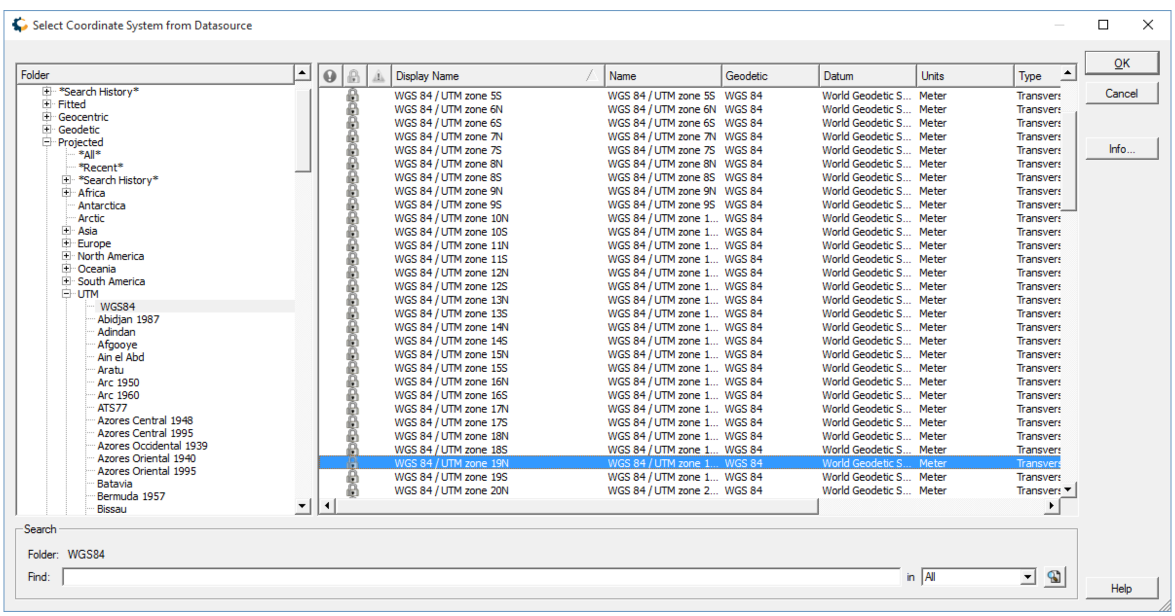
10. A dialog box will appear. Select the following parameters, shown to the right.



11. Leave the **Vertical Reference** field, set to **(none)**. There are no elevation parameters for this conversion.

12. To select the output coordinate system, double-click on the blue box labeled **System** in the Target Coordinate System area . This will launch the *Select Coordinate System* dialog. By default, Geographic Calculator starts with the geodetic coordinate system of WGS84 selected.

13. To select the Universal Transverse Mercator Zone 19 North, browse under **Projected > UTM > WGS84** in the tree view on the left, in the coordinate system list on the right, select **Zone 19N**. Then click **OK**.

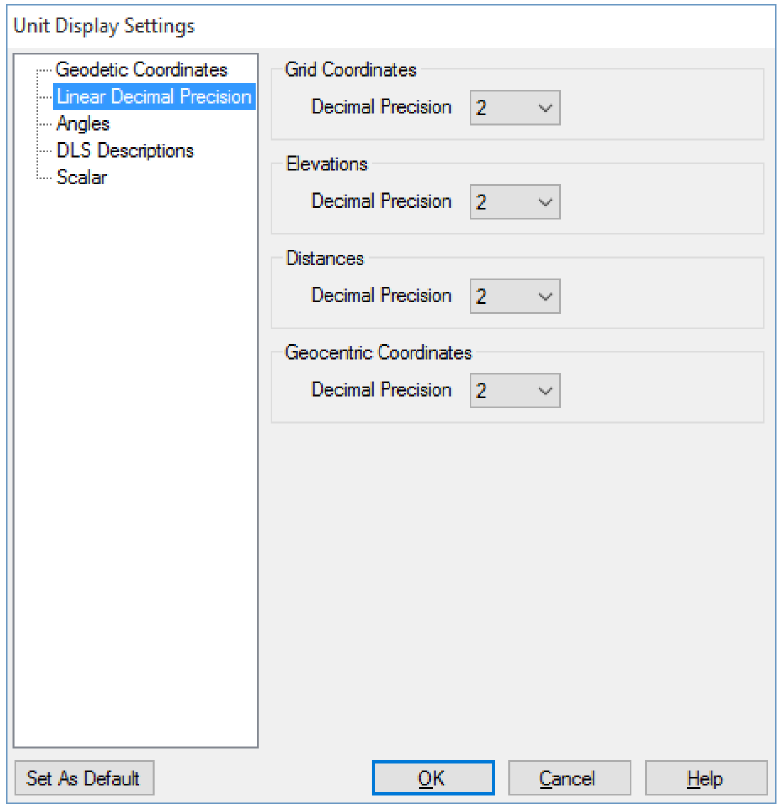


14. Leave the **Date** set to the default values.

Note: Date values are only relevant for time-dependent transformations.

15. Select the format for your output point by going to the **Coordinate System** area and clicking on the **Format** control button.

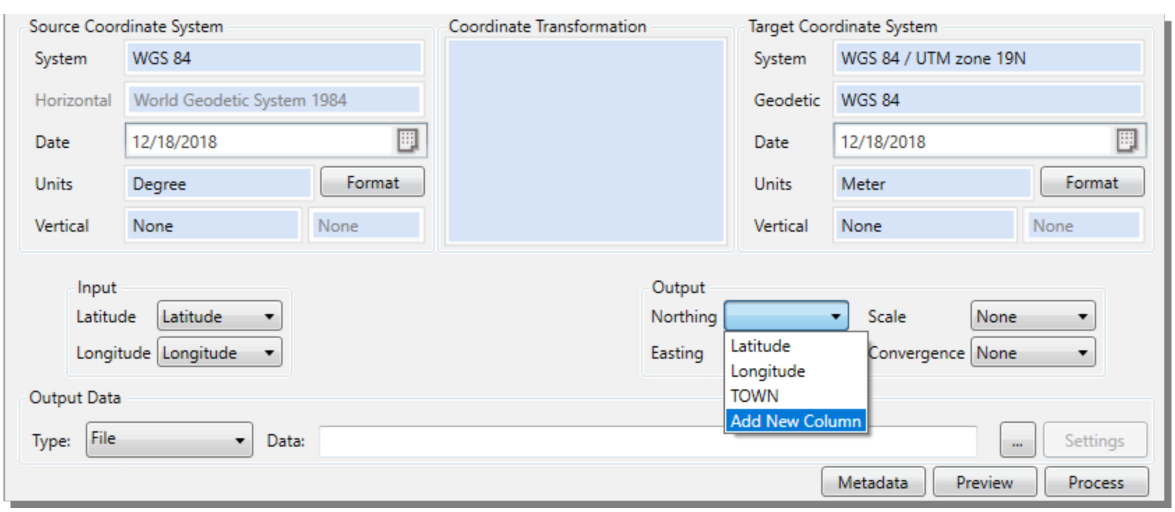
16. A dialog box will appear. Select the following parameters:



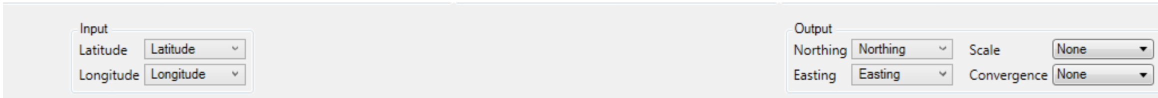
17. In this example, both the input and output coordinate systems use WGS84 as the datum, so a Datum Transformation is not necessary.

18. Now that the source and destination coordinate systems have been defined you can set up your **Column Settings** from the bottom of the Point Database Conversion job. Column settings are labeled under Input and Output.

19. On the **Input** side set the drop down menus to match the column headers for the Latitude and Longitude columns.

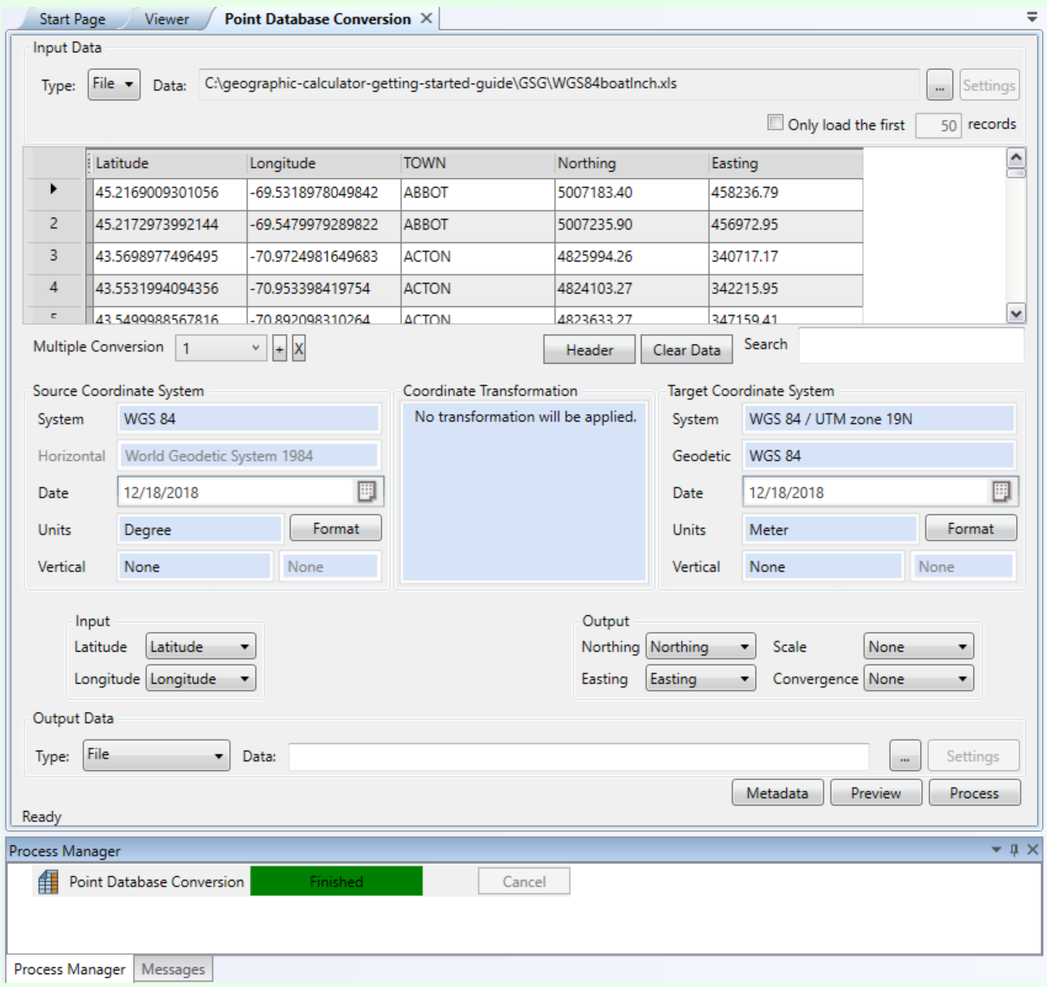


20. On the **Output** side of the settings, select 'Add New Column' from the dropdown to create a new column for the **Northing**, and a new column for the **Easting**. In the table displaying the data, right-click on the new column (name of C4 or C5) and select 'Rename'. Then rename the columns to either Northing or Easting.
The column settings dialog should then look like this:



20. Click the **Preview** button. The UTM coordinates will appear in the columns that you created via the Column Settings dialog.

Below are the sample results that should be displayed:



Continue to [Section 2: Saving Point Database Conversion Results]

Section 2: Saving Point Database Conversion Results

This exercise is a continuation from Section 1: Point Database Conversions, and assumes that you have already completed the conversion from that lab.

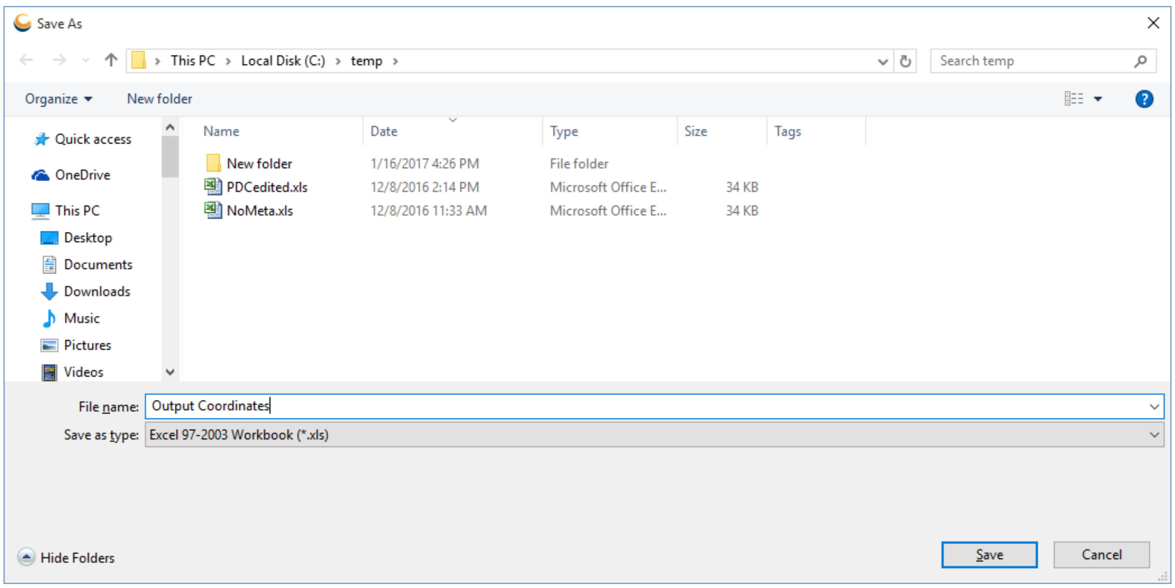
Objective: Save Point Database Conversion results both as a point database file and as a vector file. View the vector file in Geographic Calculator's viewer with another vector file overlay.

Data: *continued from Section 1,* MeTwp24.shp

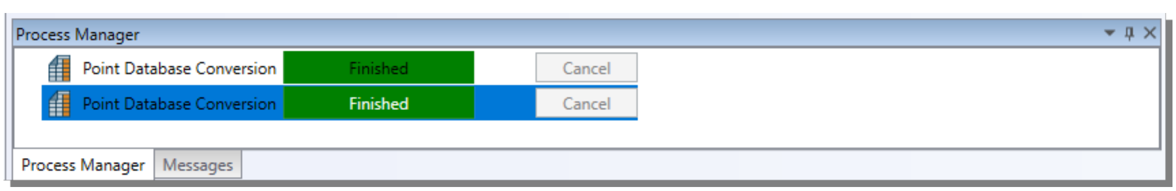
1. After calculating the conversion from Section 1 of this lab, click the ellipses button next to the Output Data line.

2. A *Save As* window will open.

   Select a folder in which to save your output data. Enter a descriptive file name, such as Output_coordinates. From the Save as Type list, select Excel (*.xls).



3. Click the **Save** button to close the *Save As* window. Click **Process** to save your data. You will be asked if you want to save your header information. Choose **Yes**. When the file is saved, the status bar in the Process Manager will turn green and say Finished. Ifyou cannot see the Process manager, go to the View menu > Process Manager.



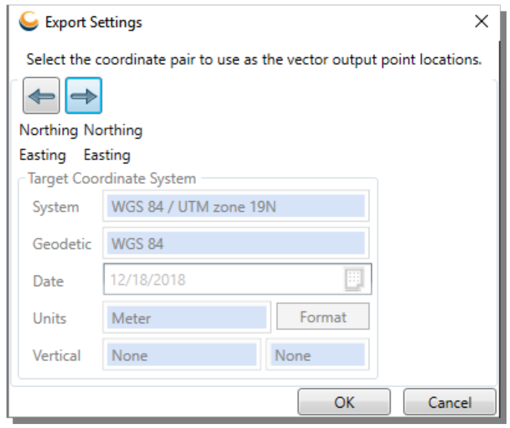
4. Click **OK** to close the window. You have saved an excel file with all of the columns that appear in the Point Database Conversion grid. If you would like, you can view that file.

5. We will now save the output data again, this time as an ESRI shape file. Click the ellipses in the Output Data area of the Point Database Conversion Job.

6. In the *Save As...* window, select an output location. Enter the file name Shape_Output. Set the *Save as type* to ESRI shape (*.shp)

7. Click the **Save** button to close the *Save As...* window. Your file name and type will be displayed in the Output Data line. Click **Process.**

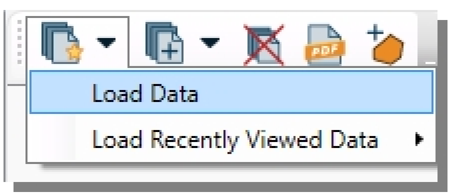
8. An **Export Settings** dialog will open. These settings will be preset, by default, to the same settings you used for your output columns and output coordinate system. You can leave the settings as they are and click the **OK** button.



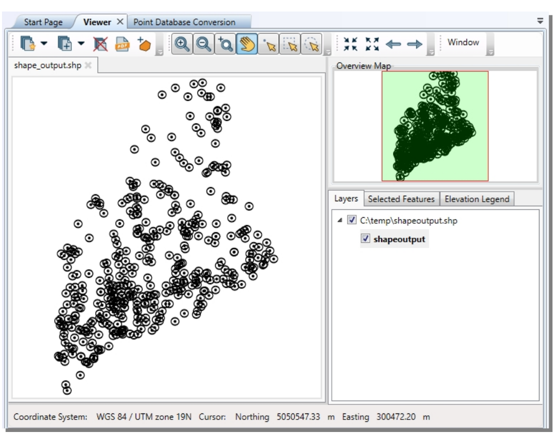
9. Your output data will be saved to a .shp file. Click the **OK** button to close the popup window.

10. Open the Geographic Calculator viewer by clicking on the **Display Viewer** button.

11. In the viewer window, click the **Import Data into a New Map** button and select **Load Data...**

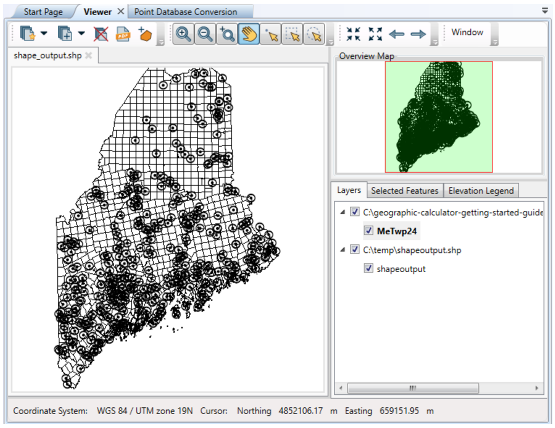


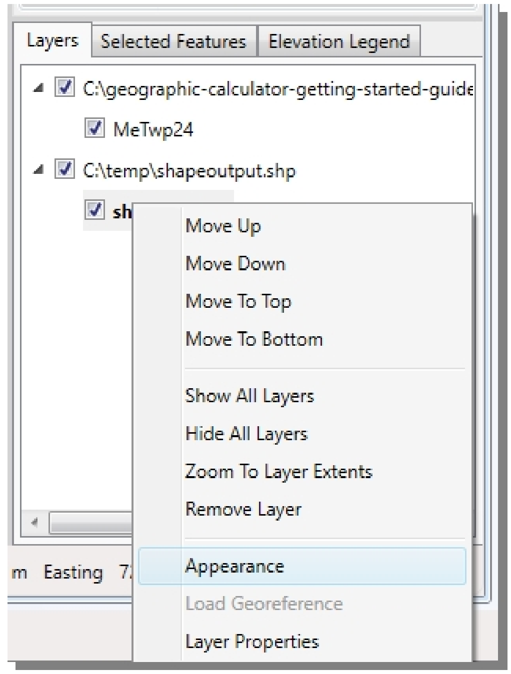
12. Click the **"..."** and navigate to the file Shape_Output.shp that you just saved. The file will be displayed in the viewer.



13. To overlay these boat launch locations with a map of Maine townships, you can open **MeTwp24.shp** in the current map. Select the Import Data into the Current Map button , and the *Load Data* option.

14. From the Getting Started Guide folder, select **MeTwp24.shp**. The Map of Maine's townships will be overlaid on top of the boat launch file.

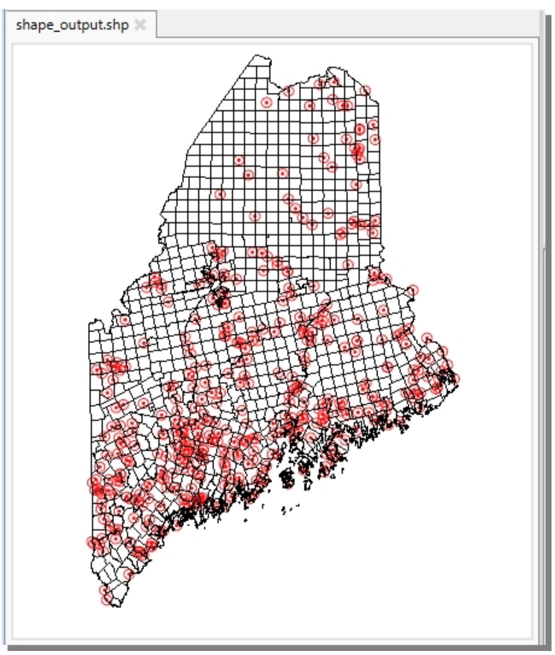


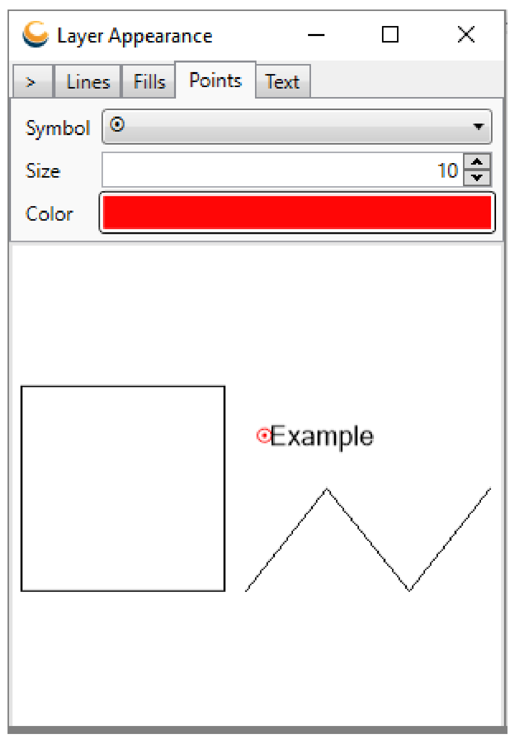


15. To display the two layers more clearly, you can change the appearance of one of the vector layers. In the bottom right of the viewer, select the Layers window to see the list of vector layers. Right click on the Shape_Output layer and select **Appearance...**

16. In the **Layer Appearance** dialog, open the **Points** tab. Reduce the symbol size to 10 and change the color to red.

17. The viewer window will now display Maine's boat launches with your selected point size and color.





Continue to [Section 3: Creating a Text File Scheme]()

Section 3: Creating a Text File Scheme

Geographic Calculator allows the user to customize the layout of the interactive spreadsheets. The Text File Scheme Dialog Box is where new data formats are created. In the Text File Scheme dialog box, the user may define a unique text file scheme or amend existing text file schemes.

Any custom text file has two main criteria by which it is defined:

1. Delimited or fixed length fields and their corresponding characteristics.
2. Header records and their implementation.

Several default text file scheme definitions are installed with the Geographic Calculator. In this exercise we will create a new scheme to bring in a 3 column, space-delimited file with no header rows. The file is named **Bluemarble.pts**.

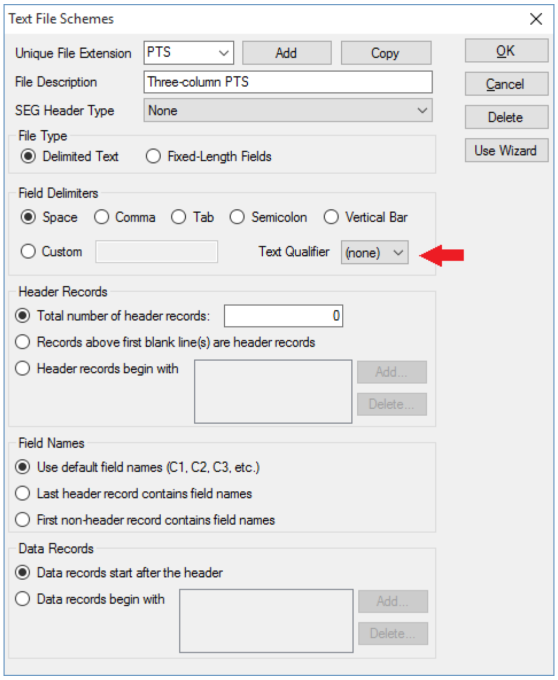
Objective: To create a custom 3 column text file scheme for space-delimited ASCII text data.

Data: Bluemarble.pts

1. Go to **Options > Text File Schemes**
2. In the Unique File Extension box, enter the three letter extension for the file we will be loading, **PTS**. Click on the **Add** button.
3. Enter a description for the text file scheme. For this exercise, enter **'Three-column PTS'** in the description field.
4. In the File Type area, select the **Delimited text** radio button.
5. Next select the appropriate Field Delimiter* and Text Qualifier. For this exercise select the **Space** radio-button for the Field Delimiter and **(none)** as the Text Qualifier.

   > *The **Delimiter** determines how the text is separated in the list. For example, the **PTS** list for the exercise is space-delimited with the text qualifier set to "none". Every entry on a particular line that is separated by a space is assigned its own column and text entries do not need a special character to be recognized.

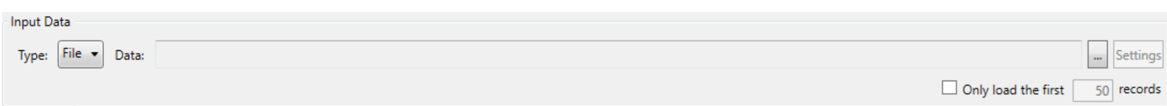
6. The header records, field names, and data records should be left as the default settings. Your text scheme should look like this:



7. Click on **OK** to save the new scheme. The PTS scheme is added to the text file scheme list. The PTS text file scheme is now able to support the sample point list used for this exercise. The sample database file to be converted is named **Bluemarble.pts** and can now be loaded into Geographic Calculator.

8. Open a new Point Database Conversion job by clicking on **File > New > Job > Point Database Conversion**. The new job will be opened and added to your Project Manager.

9. Load a point database file by clicking the **"..."** button in the Input Data area at the top of the job.

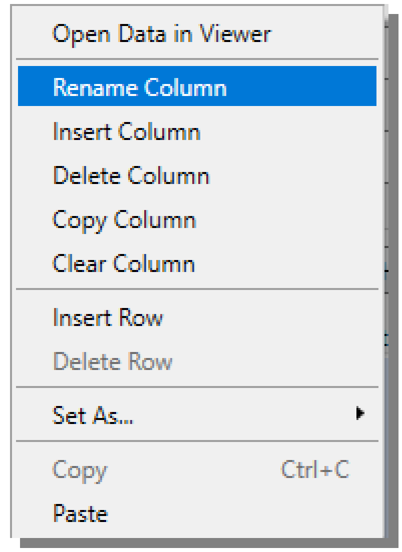


Locate the file you will open. Select **Bluemarble.pts** (located in C:\geographic-calculator-getting-started-guide\GSG\) and open.

10. The list is opened into the grid. There are three columns of data that represent:

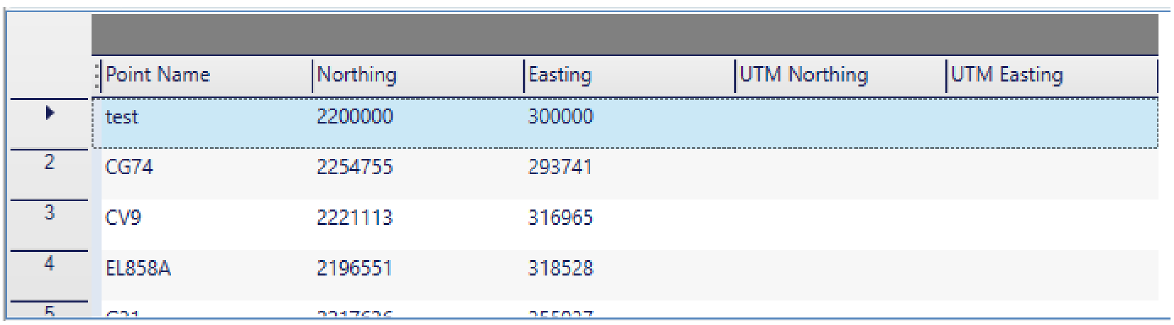
    Point name, Northing, and Easting

11. Rename the columns for clarity.
    a. Place the mouse pointer over the header of column C1.
    b. Right-Click and select **Rename Column**, enter "Point Name" in the popup window and click **OK**.
    c. Repeat this to rename columns C2 and C3 as **Northing** and **Easting**, respectively.

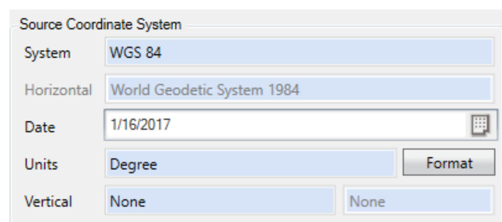


12. Create two new columns by right clicking to the right of the third column and select **Insert Column**. Name the new columns **UTM Northing** and **UTM Easting**. Rename columns C1, C2 and C3 by right clicking on them and selecting **Rename Column**.

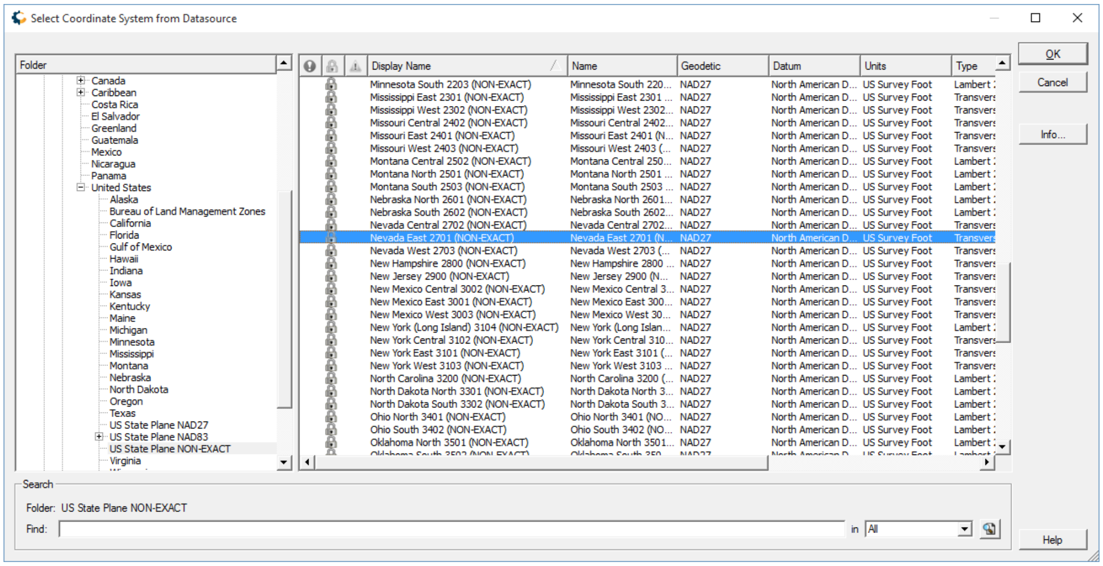
    The grid should look like this when you are done:



13. To select your input coordinate system, double-click on the blue box labeled **System** in the Source Coordinate System area. By default, the Geographic Calculator starts with the geodetic coordinate system of WGS84 selected. This will launch the Select Coordinate System dialog.



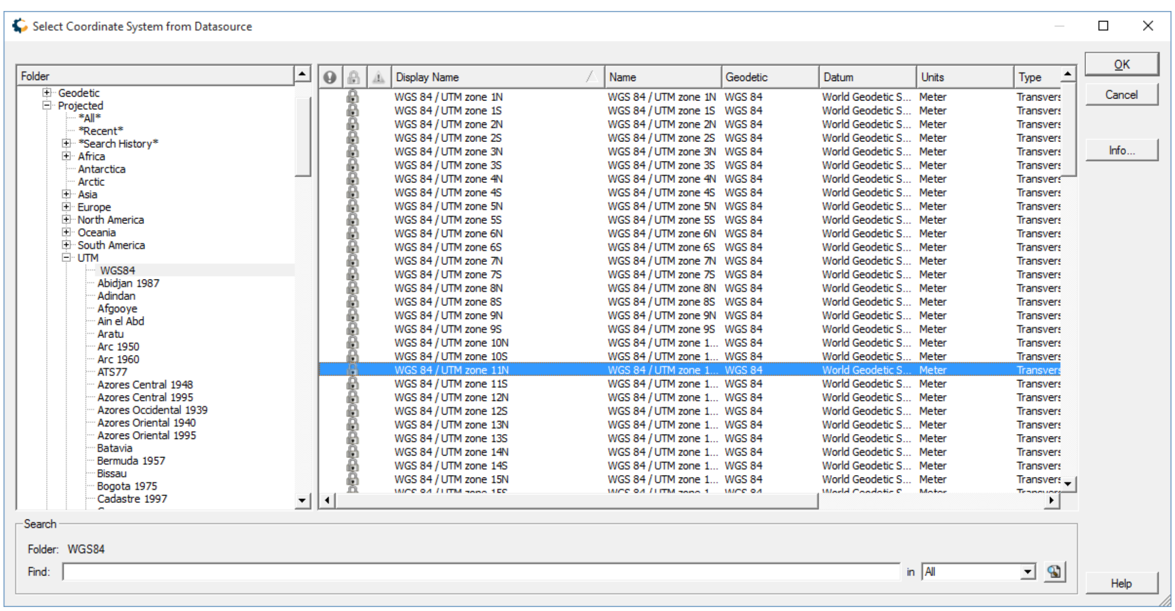
14. In the *Select Coordinate System from Datasource* dialog, coordinate systems are organized in the folder list on the left by type (Geodetic Lat/Long, Projected, Geocentric, String, and Fitted), continent, then by country. In the tree view on the left, browse under **Projected > North America > United States > US State Plane NON-EXACT**, in the coordinate system list on the right, select **Nevada East 2701 (NON-EXACT)**.



Click **OK** to accept the coordinate system.

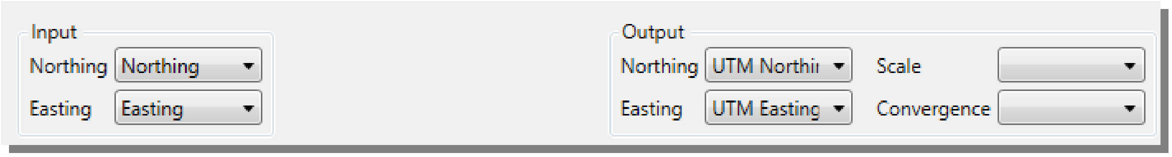
15. To select the output coordinate system, double-click on the blue box labeled System in the Target Coordinate System area. By default, Geographic Calculator starts with the geodetic coordinate system of WGS84 selected. This will launch the *Select Coordinate System* dialog.

16. To select the Universal Transverse Mercator Zone 11 North, in the tree view on the left, browse under **Projected > UTM > WGS84**, in the coordinate system list on the right, select **Zone 11N**. Then click **OK**.



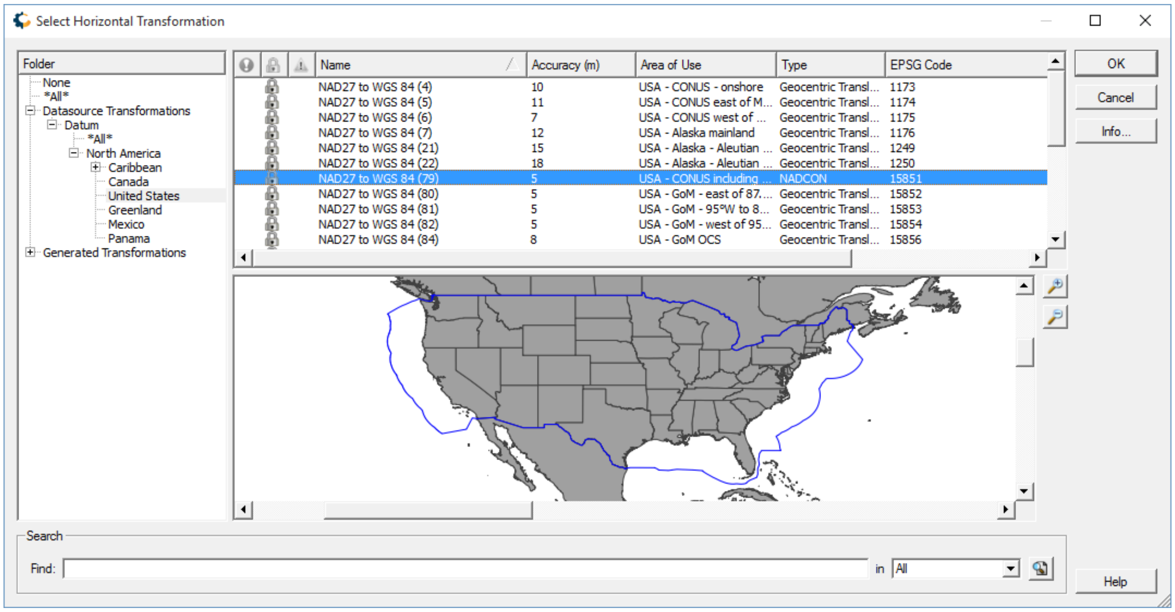
23. Select the columns for your conversion by going to the Input and Output dropdown menus near the bottom of the Point Database Conversion Job.

24. Select the following parameters:

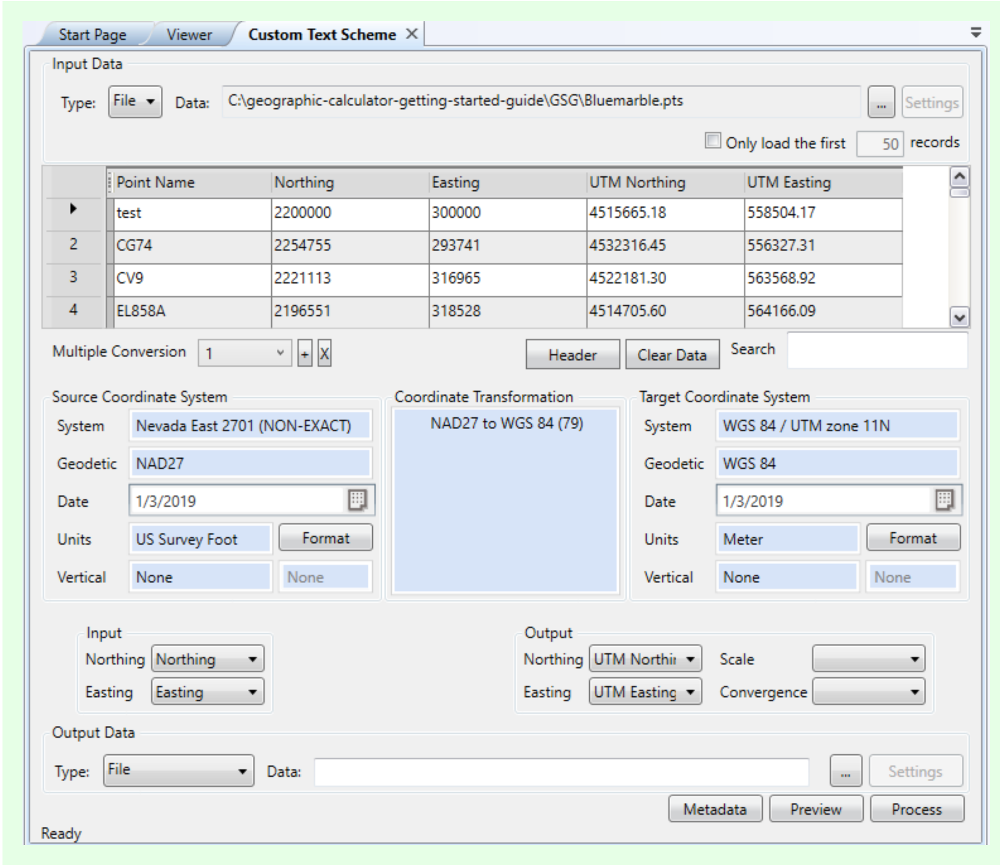


(Input) Northing:	Northing
(Input) Easting:	Easting
(Output) Northing:	UTM Northing
(Output) Easting:	UTM Easting

25. Click on the **Preview** button. Since the coordinate systems selected use different datums, you will be prompted to select an appropriate datum transformation. Use the dialog to select the **NADCON** transformation for the Continental USA and click **OK**.



26. The UTM coordinates will appear in the columns **UTM Northing** and **UTM Easting**.



The resulting output may then be saved by setting a path in Output Data and selecting **Process**, or **File > Save As**

Continue to [Section 4: Batch Point Database Conversions]()

Section 4: Batch Point Database Conversions

Geographic Calculator is capable of converting coordinates in multiple point database lists in one operation.

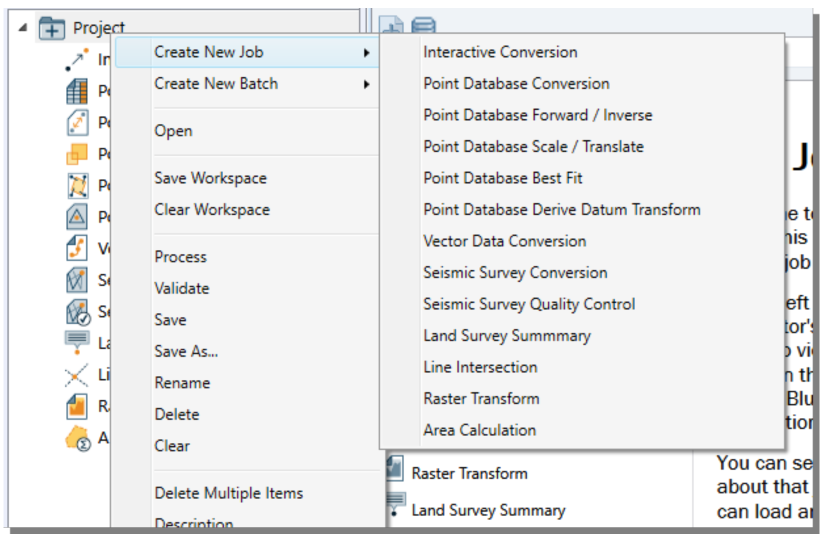
Objective: Create a Batch of Point Database Conversion jobs to convert three similar XLS files.

For this exercise, you have been given several similar Excel spreadsheets containing coordinates. The coordinates are in Geodetic Lat/Long, WGS84. They must be converted to Universal Transverse Mercator grid values.

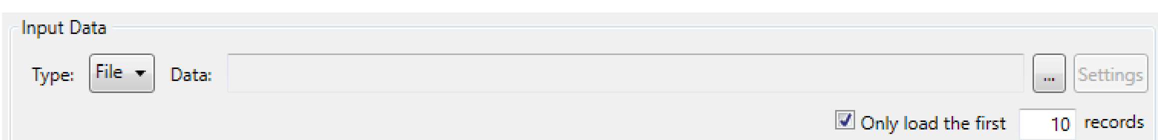
Data: Batch1.xls, Batch2.xls, Batch3.xls

Follow these steps to complete a batch conversion of these coordinates in a Point Database Conversions job:

1. Open Geographic Calculator.
2. Right-click the Project in the Project Manager and select **Create New Job > Point Database Conversion**



3. Click on the new **Point Database Conversion** job to open the interface.
4. Before loading a file, check the box next to "Only load the first ___ records" and type 10 in the blank. Load a point database file by clicking the **...** button in the Input Data area at the top of the job.

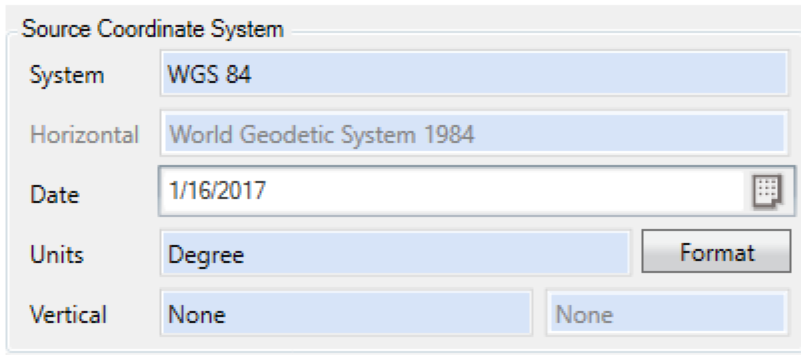


The file to open is in the folder for the Getting Started Guide (C:\Program Files\Blue Marble Geo\Geographic Calculator\Getting Started Guide) named **Batch1.xls**.

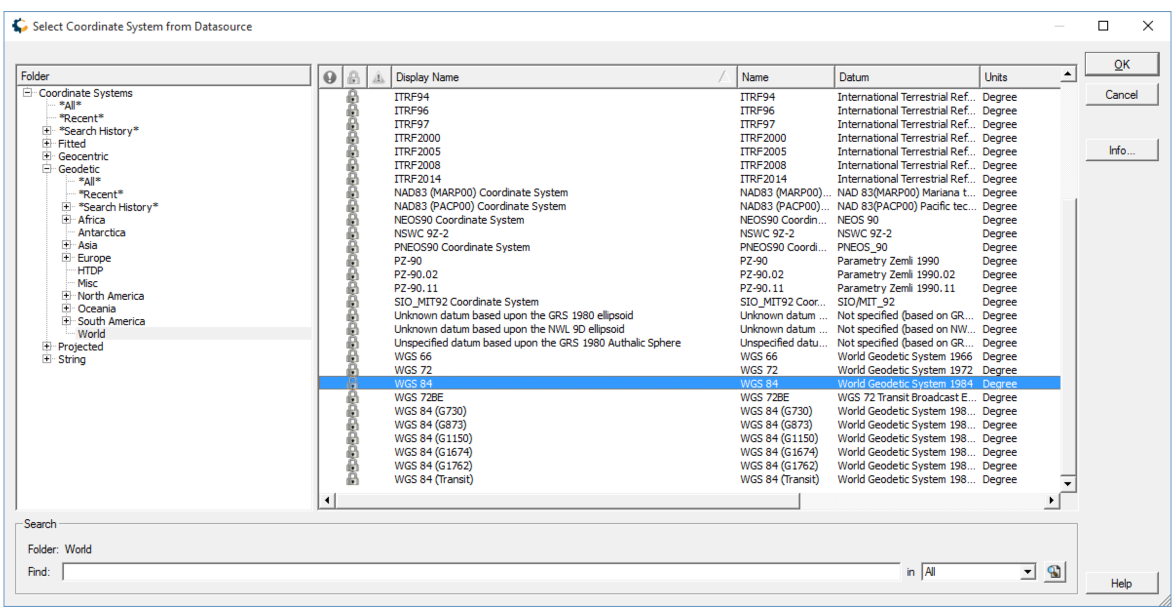
5. When prompted, select **Yes** the file being loaded has a header. Once loaded, the table should look like this:

	LONGITUDE	LATITUDE	TEST	RESULT	DATUM
▸	69 46 19.90 W	44 16 18.72 N	test1	4785	WGS84
2	69 46 43.49 W	44 18 59.83 N	test2	7543	WGS84
3	69 46 08.11 W	44 13 36.96 N	test3	4978	WGS84
4	69 46 19.90 W	44 18 59.83 N	test4	5961	WGS84

6. To select your input coordinate system, double-click on the blue box labeled System in the Source Coordinate System area at the bottom of a job page. By default, the Calculator starts with the geodetic coordinate system of WGS84 selected. This will launch the *Select Coordinate System* dialog.



7. In the *Select Coordinate System* dialog, coordinate systems are organized in the folder list on the left by type (Geodetic Lat/Long, Projected, Geocentric, and Fitted), continent, and then by country. If a coordinate system covers an entire continent, it will be found by clicking on the continent folder itself. In the tree view on the left, browse under **Geodetic > World**, in the coordinate system list on the right, select **WGS84 Coordinate System** and click **OK** to close the dialog.



8. Select the format for your input point by going to the **Source Coordinate System** area and clicking on the **Format** control button.

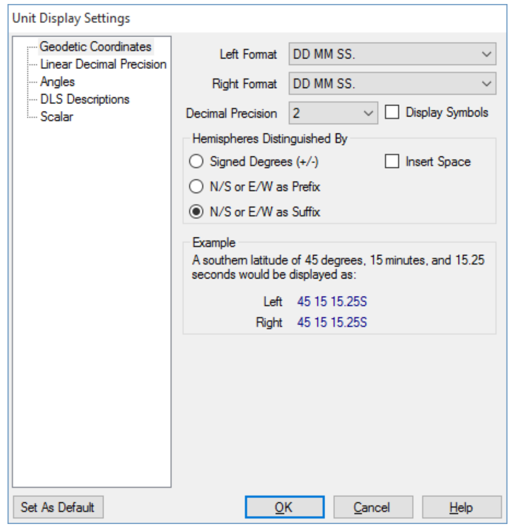
9. A dialog box will appear.

10. Select Left Format:

    DD MM SS.

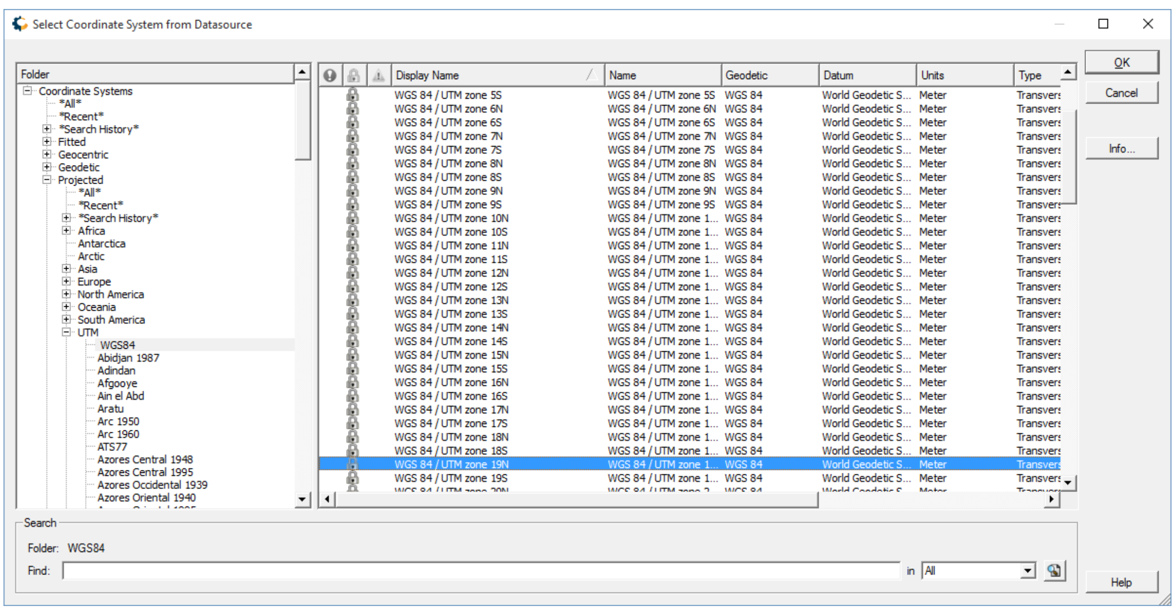
11. Leave the **Vertical Reference** field, set to **(none)**. There are no elevation parameters for this conversion.

    Leave the **Date** set to the default values.



> **Note:** Date values are only relevant for time-dependent transformations.

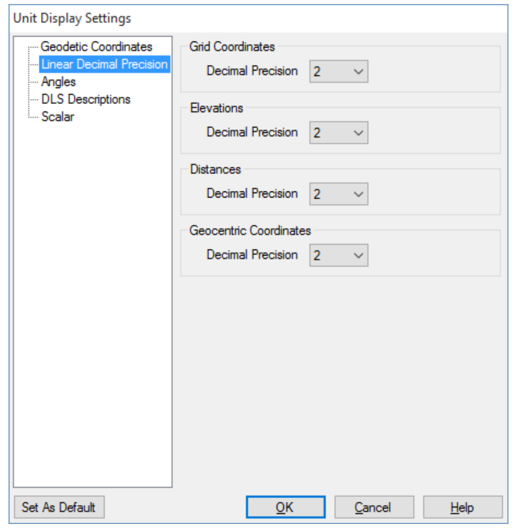
12. To select your Target Coordinate System, double-click on the blue box labeled System in the Target Coordinate System area. To select the Universal Transverse Mercator Zone 19 North, in the tree view on the left, browse under **Projected > UTM > WGS84**, in the coordinate system list on the right, select **Zone 19N**. Then click **OK**.



13. Select the format for your output point by going to the **Coordinate System** area and clicking on the **Format** control button.

    A dialog box will appear.

    Set Decimal Precision: **2**

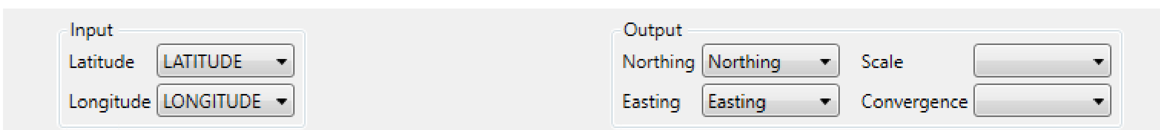


14. In this example, both the input and output coordinate systems use WGS84 as the datum, so a Datum Transformation is not necessary. Now that the source and destination coordinate systems have been defined, you can set up your **Column Settings**.

15. On the **Input** side below the Source Coordinate System Area, set the drop-down menus to match the column headers for the latitude and longitude columns.

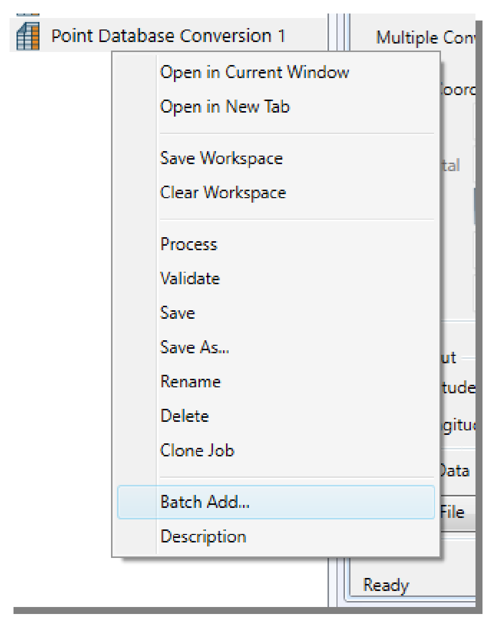
16. On the **Output** side of the settings, select 'Add New Column' from the dropdown menu to create a new column for the **Northing**, and a new column for the **Easting**.

    The column settings dialog should then look like this:

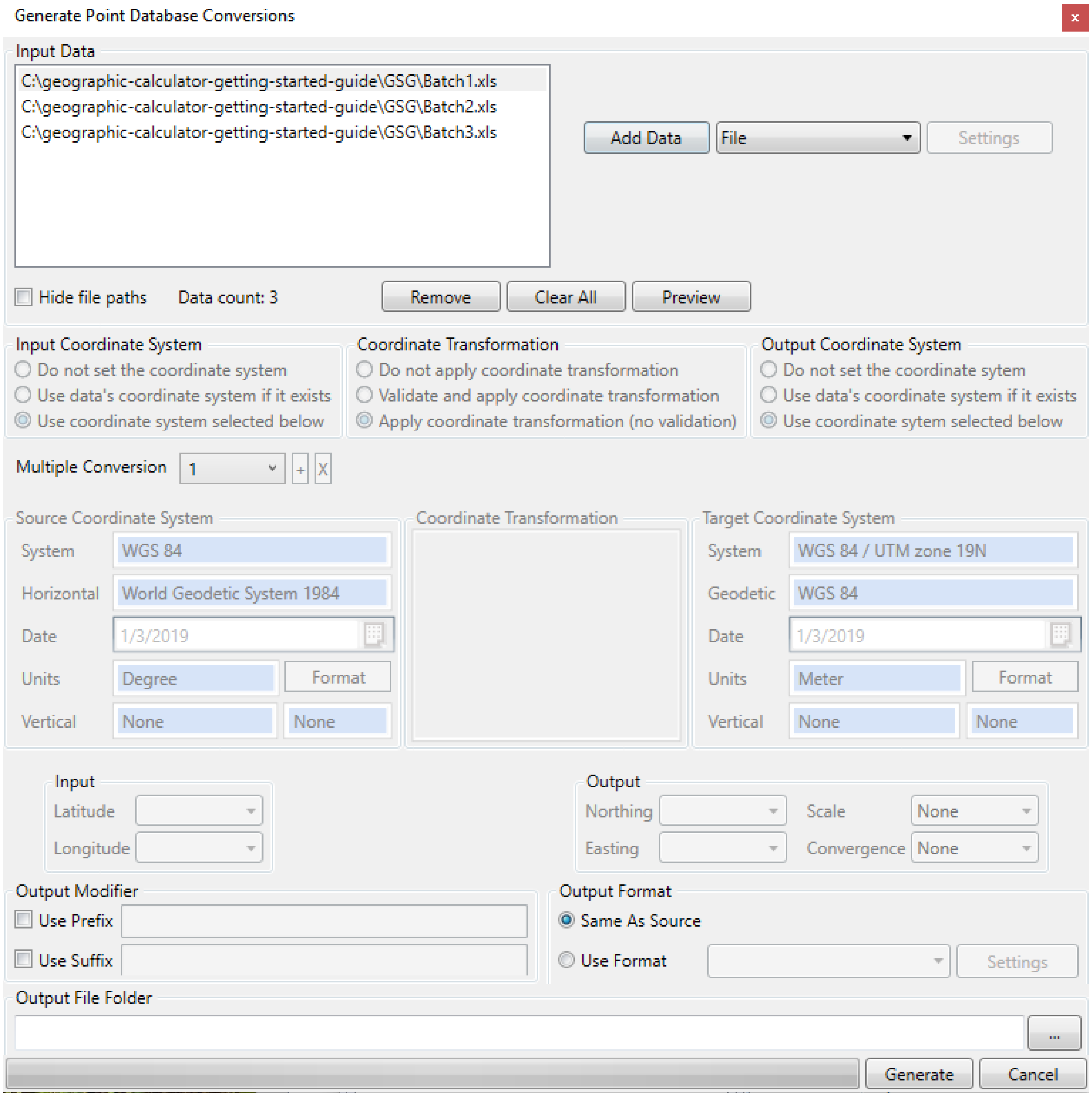


17. Click the **Preview** button to preview a conversion of the ten records that you loaded. The preview allows you to quickly check your settings before creating a batch of jobs. You should see the *Northing* and *Easting* columns populate with converted coordinates.

18. To create a batch of Point Database Conversions based on the settings that you made for this single job, right click on the Point Database Conversion job in the Project Manager and select **Batch Add...**

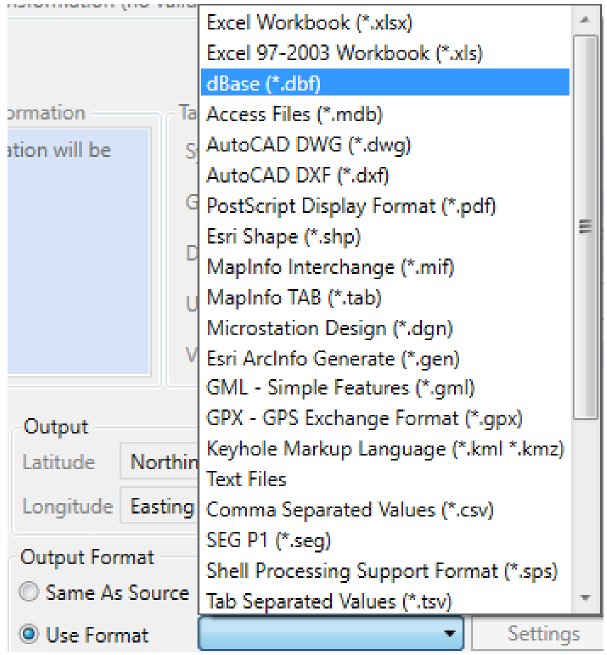


19. The Batch Add dialog will open. Click the **"Add Data"** button in the upper right corner and select the three files that you want to convert together: **Batch1.xls**, **Batch2.xls**, and **Batch3.xls.** These files will appear in the Input Data area.



20. Because you started with a fully configured **Point Database Conversion** job, the **Column Settings**, **Coordinate System** and **Datum Transformation** areas are already set, and cannot be altered in this dialog. If you created a new batch without a template job, you would be able to set these items in the Batch dialog.

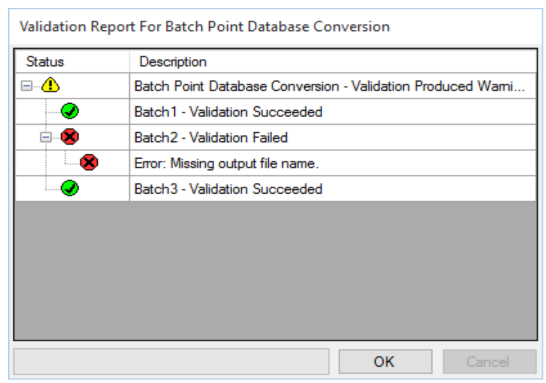
21. In the Output Format area, select the **Use Format** radio button. From the dropdown list, select dBase (*.dbf)



22. Click the **"..."** button to the right of the Output File Folder box. Select a folder to save your output files.

23. Click the **Generate** button at the bottom right of the dialog to create the batch of Point Database Conversion jobs. A Batch Point Database Conversion will be added to the Project Manager, with a job for each of the input files that you selected in the Batch Add dialog.

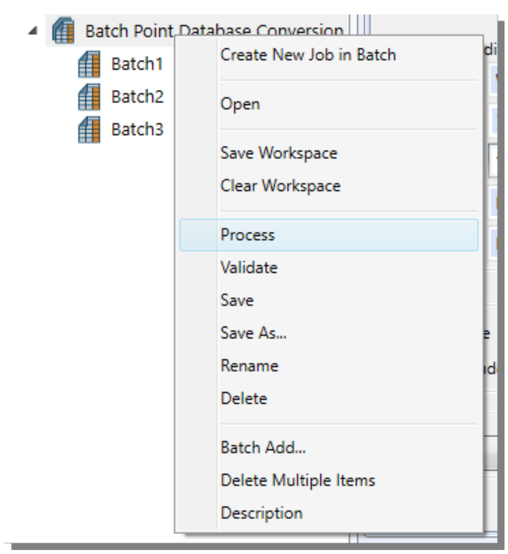
24. To ensure that all of the jobs are complete, you can validate the batch before processing. Right click on the Batch in the Project Manager and select Validate. A window will open indicating that validation has succeeded for all jobs.



> **Note:** If validation fails, a window will appear which shows the different batch jobs. The job with the error will have a red x, and a plus sign next to it. Expand the error and the error will be listed.

25. To run the batch, right click on the Batch in the Project Manager and select **Process.**

26. Each Job will convert in succession. The complete output files will be saved in the directory you chose to save them to.



Lab 3: Vector Data Conversions

Geographic Calculator can convert vector data from one coordinate system to another and also convert vector data from one file format or spatial database to another using the Vector Data Conversions job. In this Lab, we will explore coordinate conversion and file type translation on vector data.

The Vector Data Conversions job type supports a number of types of vector files, below is a list of some of the more common file formats.

Section 1: Vector Data Conversions

Objective: To convert the coordinate system of a vector map file from Latitude/Longitude to Mercator world projection and change a vector file from one format to another.

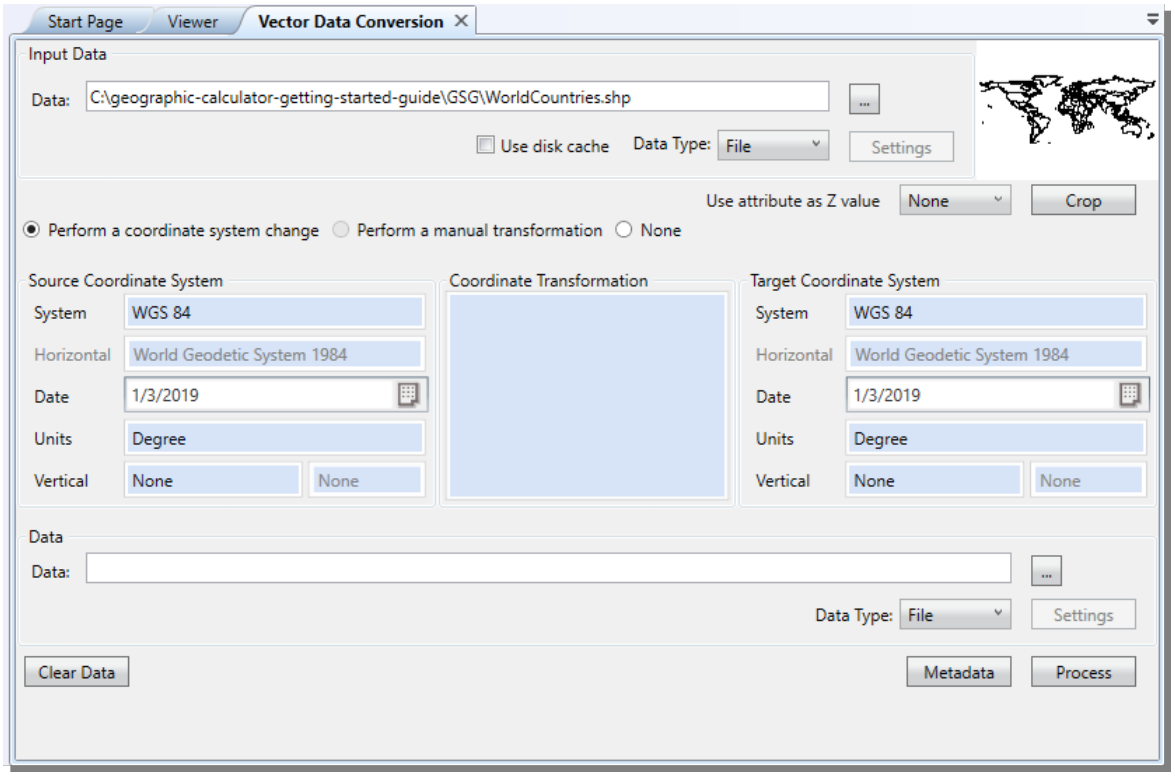
Data: ESRI Shape File- WorldCountries.shp

To successfully complete any Vector Data Conversion, *the coordinate system of the original map file must be known*. A coordinate conversion that does not have accurate input coordinate system information will not yield accurate results.

Follow these steps to convert the coordinate system of a vector data file:

1. Open Geographic Calculator and click the **Vector Data Conversion** job.
2. Open the Vector Data for your conversion by clicking the "**...**" button next to the Input Data field.

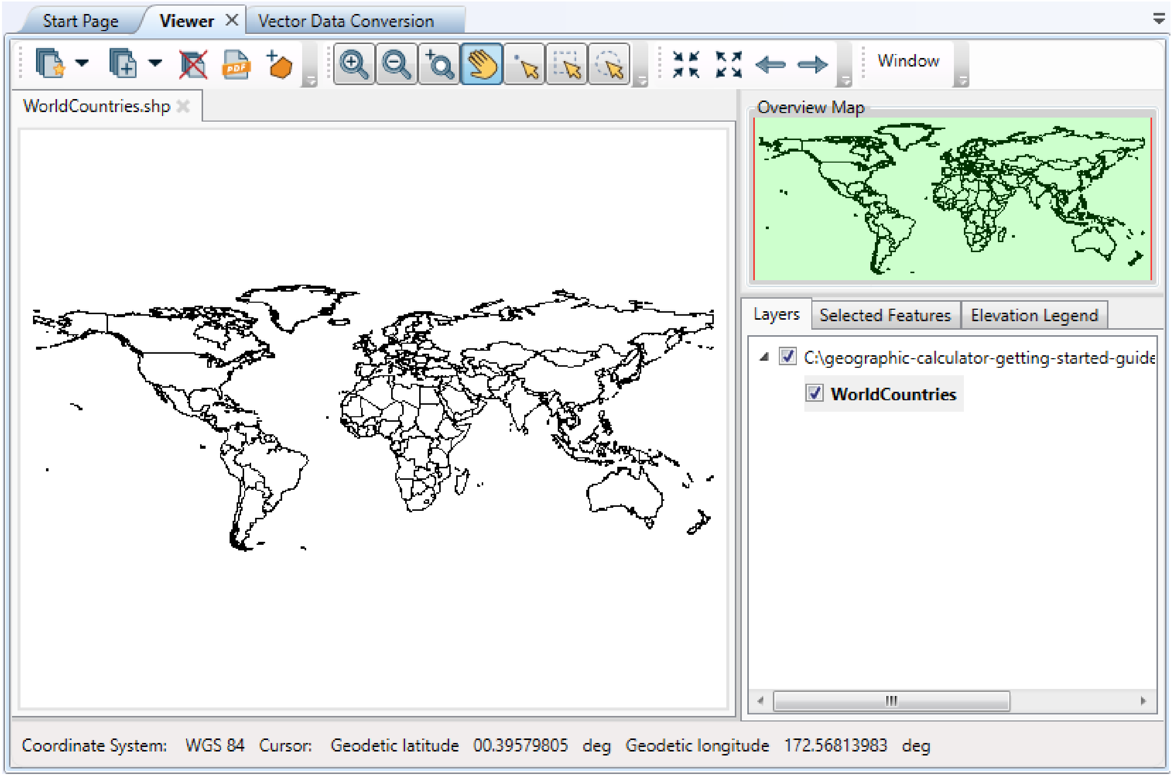
3. In the open file dialog that appears, browse to the directory where the Getting Started Guide installed its data and select **WorldCountries.shp**



Geographic Calculator will detect the coordinate system for the shape file because it has an attached PRJ file. **Not all files will have a projection defined with them**. Be sure that the setting to perform a coordinate system change is enabled.

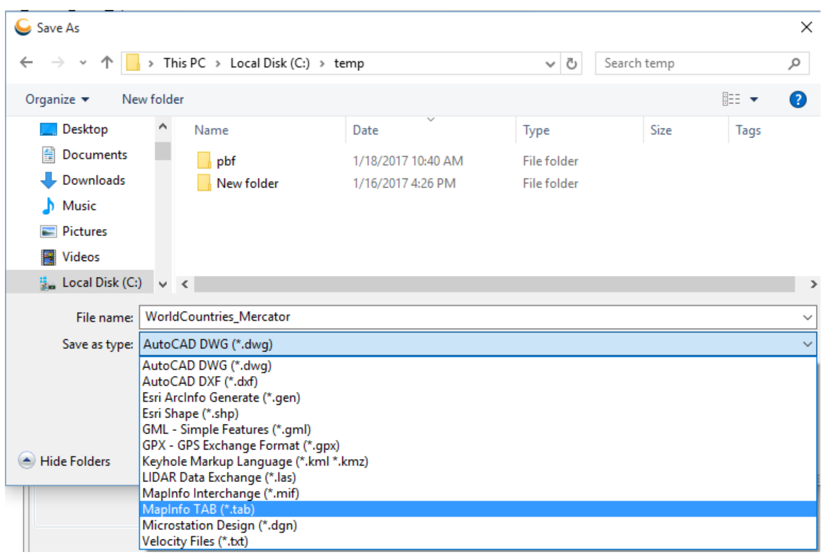
Note: Cropping areas and layers will be handled in sections 2 and 3.

4. To view the Input Data in Geographic Calculator's viewer, right click on the Input Data field and select **Open Data in Viewer**. The input file will look like this:



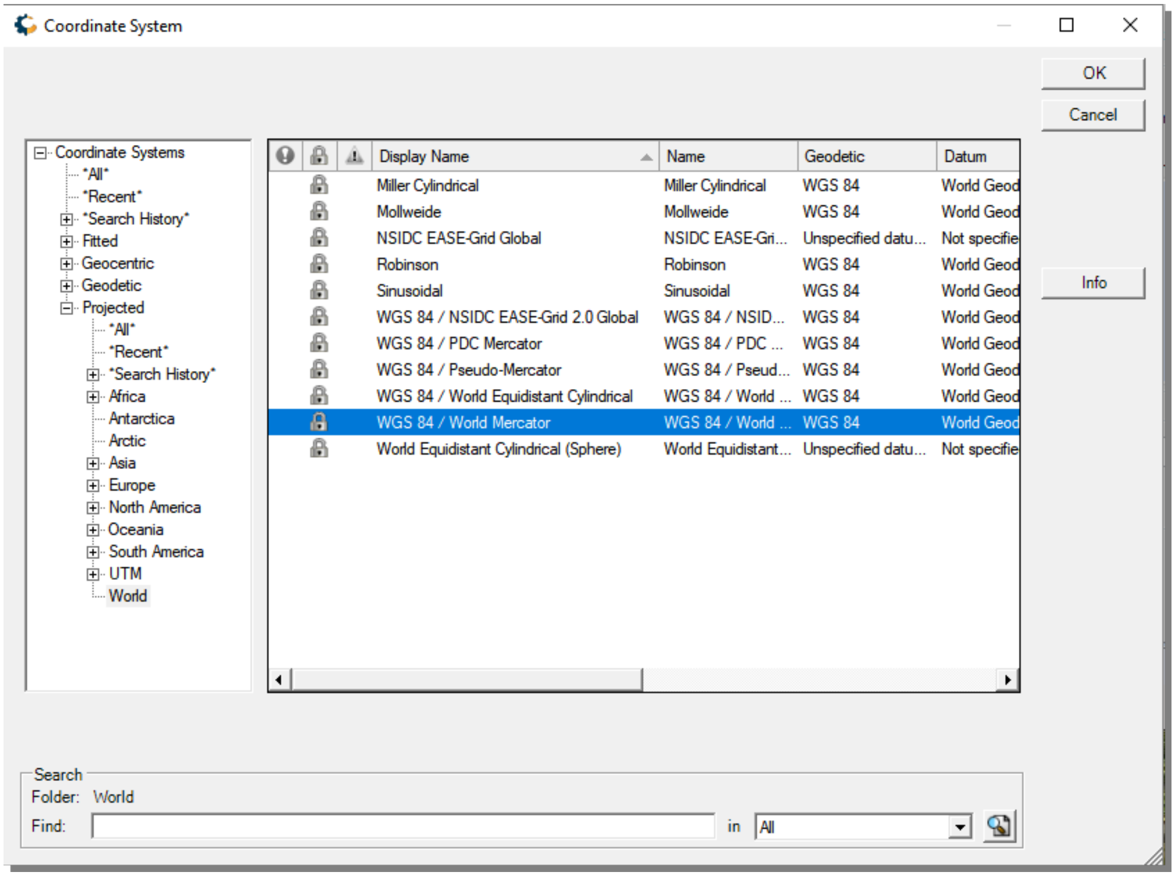
5. Click the Vector Data Conversion tab to return to the settings for this job.

6. Name the output file and choose an output format by clicking the "**...**" button next to the **Output Data** field. Browse to a location where you can save your output file on your local machine, and name the file "**WorldCountries_ Mercator**". We can select any appropriate output format for our output file. For this exercise, we will select **MapInfo TAB**.



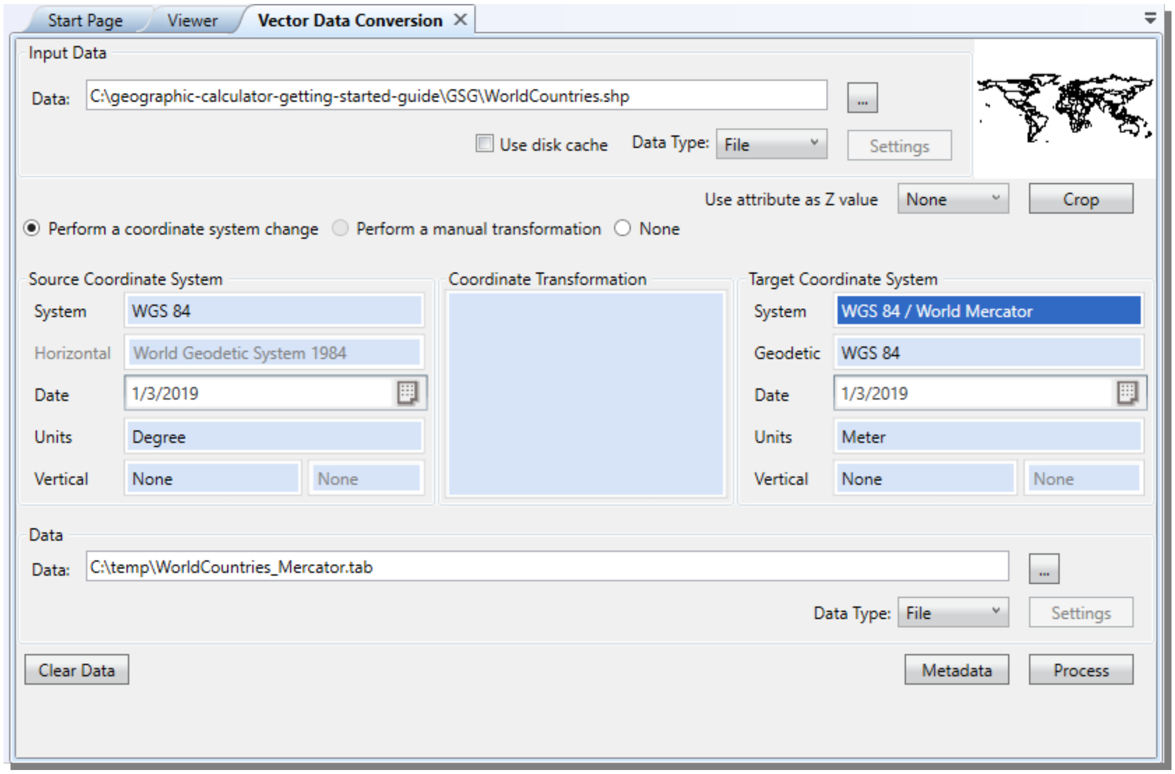
7. To select the output coordinate system, double-click on the blue box labeled **System** in the **Target Coordinate System** group. By default, the Vector Data Conversion job starts with WGS 84 in the System field. This will launch the *Select Coordinate System* dialog.

8. To select the Mercator world projection, in the tree view on the left, go to **Projected > World** and select **WGS 84 / World Mercator** in the coordinate system list in the right-hand pane. Click OK to close the dialog.



9. Since the coordinate systems for input and output both use the WGS84 datum, a coordinate transformation is not necessary.

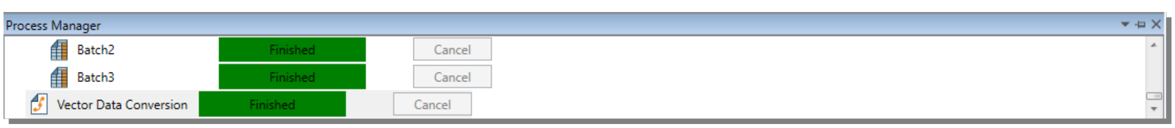
10. Your settings should now look like this:



> **Note:** The **Date** field does not need to match the above example, as long as the input and output are set to the same date. This field is used for advanced transformations including time dependent transformations, 14-parameter Helmert transformations, and magnetic declination output. The Date field can also be disabled in **Preferences** by turning off time-dependent transformations.

11. Click the **Process** button at the bottom of the **Vector Data Conversion** job.

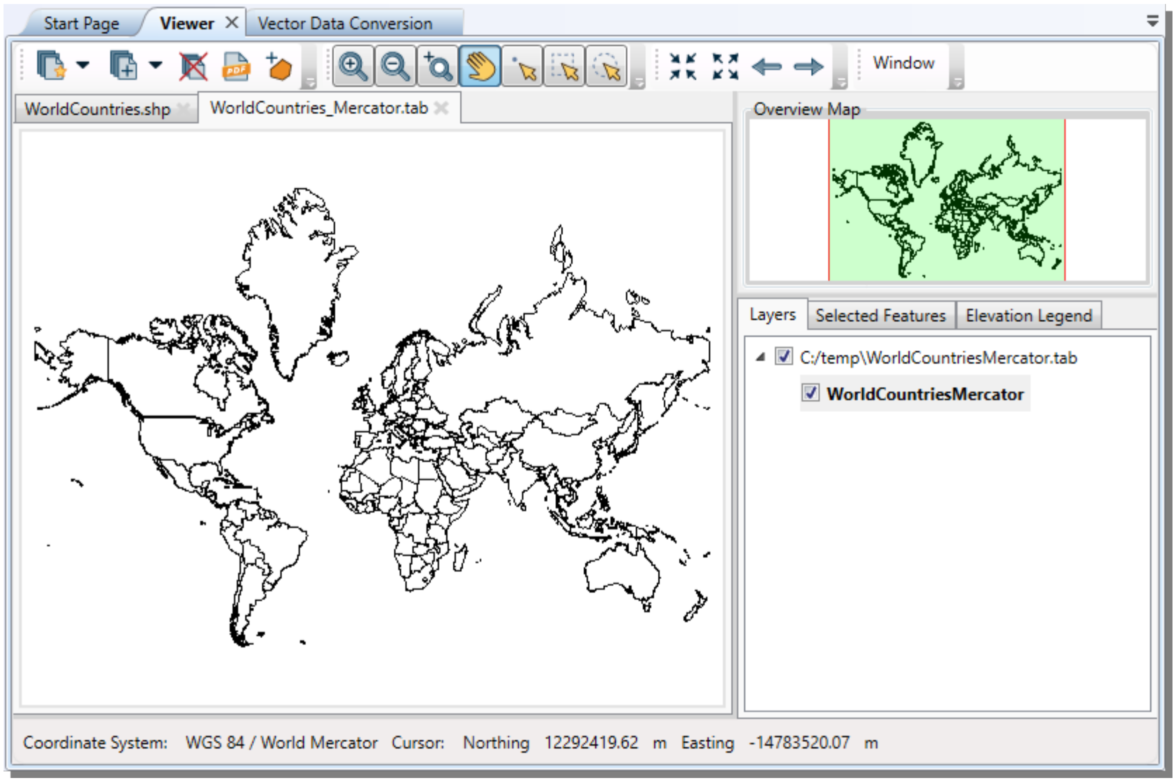
12. The **Process Manager** window at the bottom of the job will indicate the progress of the conversion.



13. Once complete the **Progress Monitor** will indicate "Finished".

14. Select "**Yes**" when asked to view the image.

    Select **New map** for the map window, and press **OK** to open the projected output in a new viewer tab.



15. This section is now complete, you are ready to move on to Vector Data Conversions, Layer Splitting.

Continue to **Section 2: Vector Data Conversions, Layer Splitting**

Section 2: Vector Data Conversions, Layer Splitting

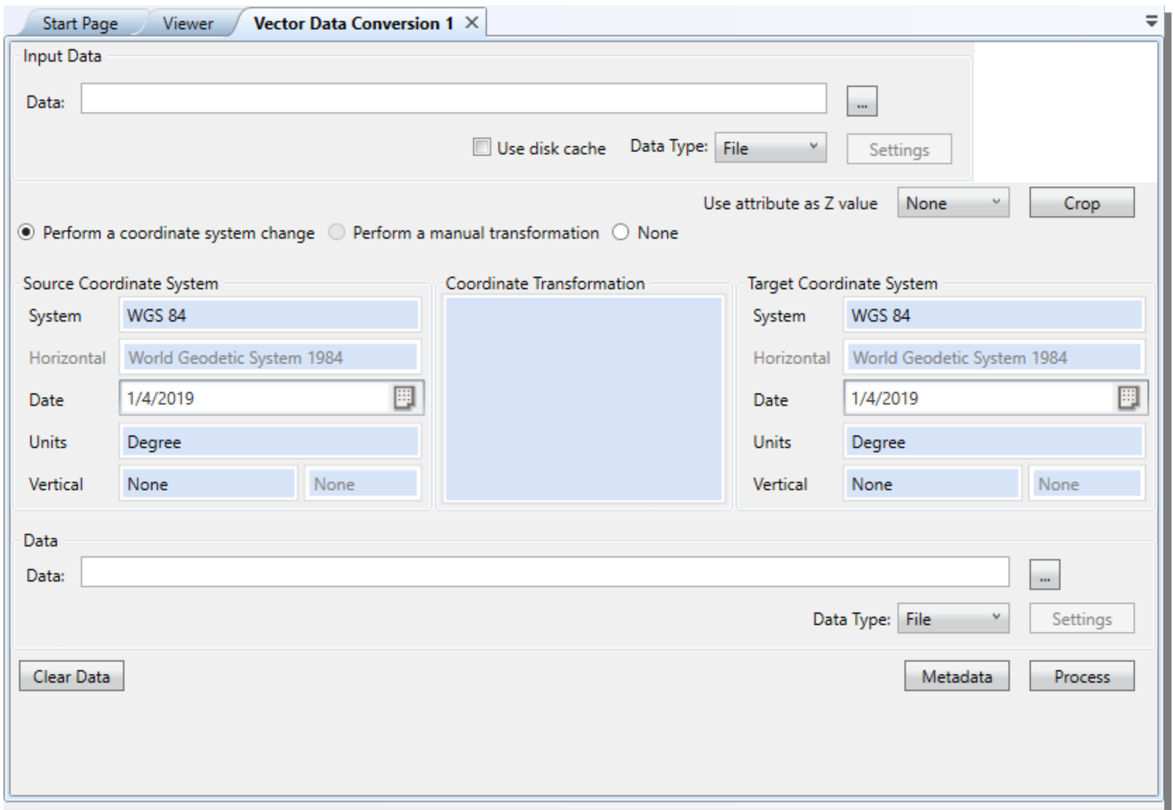
Objective: To select one layer from a vector file with multiple layers and write out only that section.

Data: SplitAndCrop.dgn

To successfully complete any Vector Data Conversion, the coordinate system of the original map file must be known. A coordinate conversion that does not have accurate input coordinate system information will not yield accurate results.

Follow these steps to split the layers of a vector data file:

1. Open the Geographic Calculator and click the **Vector Data Conversion** job.



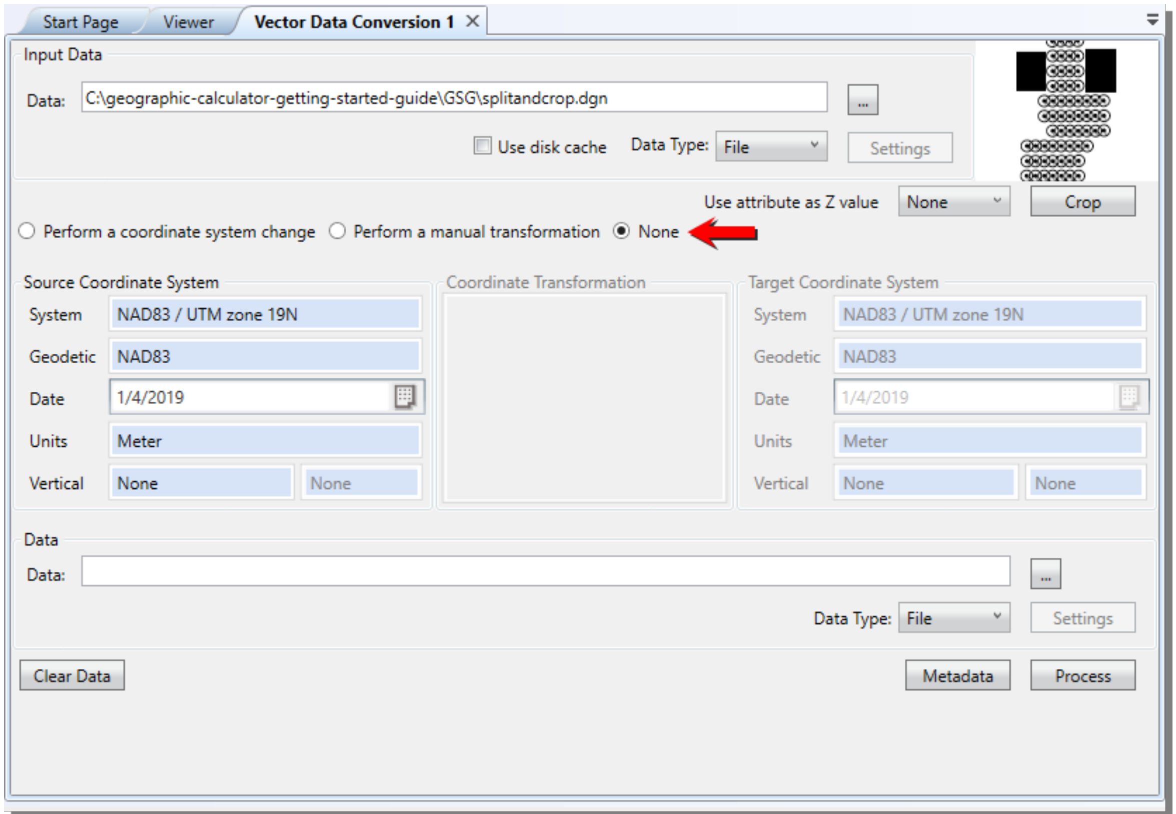
2. Open the Vector Data for your conversion by clicking the "**...**" button next to the **Input Data** field.

3. In the open file dialog that appears, browse to the directory where the Getting Started Guide data is and select **SplitAndCrop.dgn.**

   Geographic Calculator will read NAD83 / UTM Zone 19N as the Source Coordinate System from the prj file associated with splitandcrop.dgn.

   Note: Not all vector files contain embedded projection information or use a prj file. Be sure you are using the correct input coordinate system.

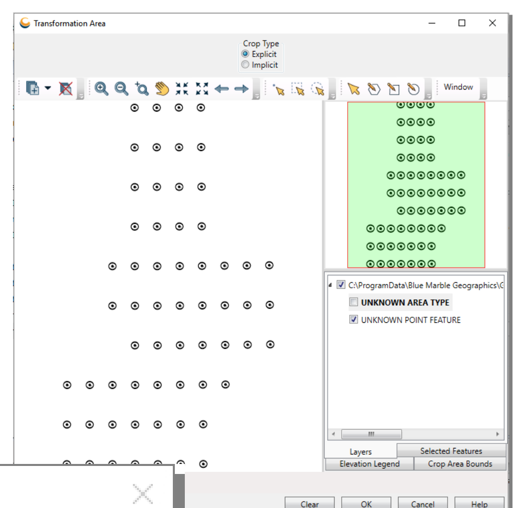
Select the radio buton next to **None** to not perform a coordinate change on the file.

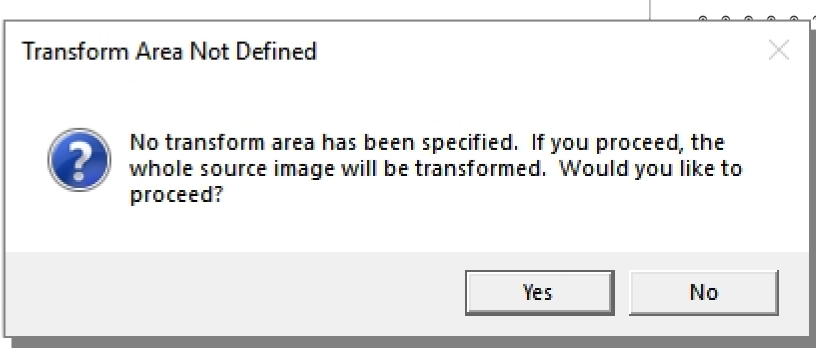


4. Click on the **'Crop'** button to open the window for cropping and splitting layers:

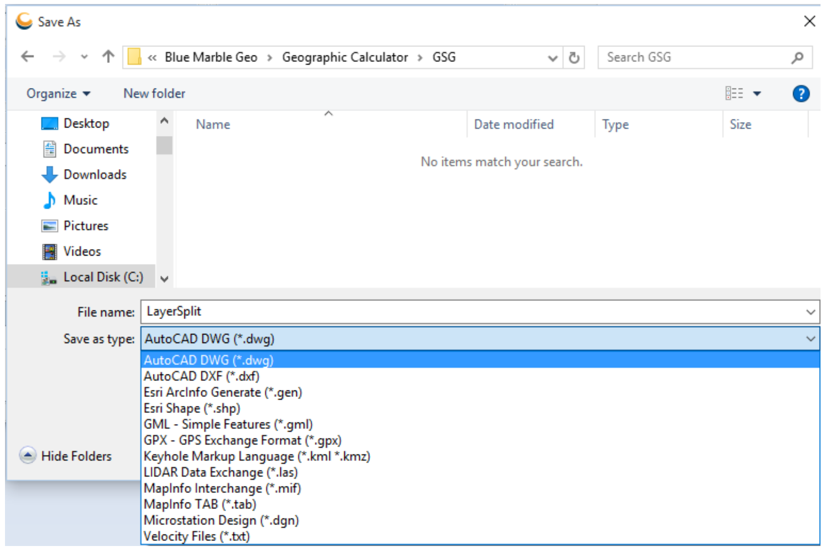
5. On the right side in the '**Vector Layers**' section two layers are defined, with checkboxes next to them to turn these layers on or off. **Uncheck** the layer named 'UKNOWN AREA TYPE' so that only the points are displayed.

6. Click **OK** to close this window and return to the main **Vector Data Conversion** screen. Since a crop area has not been defined the system will alert you that it will automatically set the crop area to the full extent of the data set. Click yes to proceed.



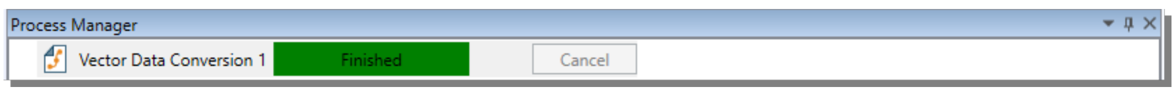


7. Name the output file and choose an output format by clicking the **"..."** button next to the **Output Data** field. Browse to a location where you can save your output file on your local machine, and name the file "**Layer Split**". We can select any appropriate output format for our output file. For this exercise, we will select **AutoCAD DWG**.

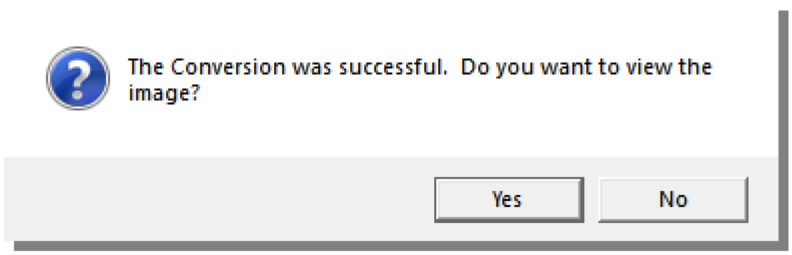


8. Click the **Process** button at the bottom of the Vector Data Conversion job.

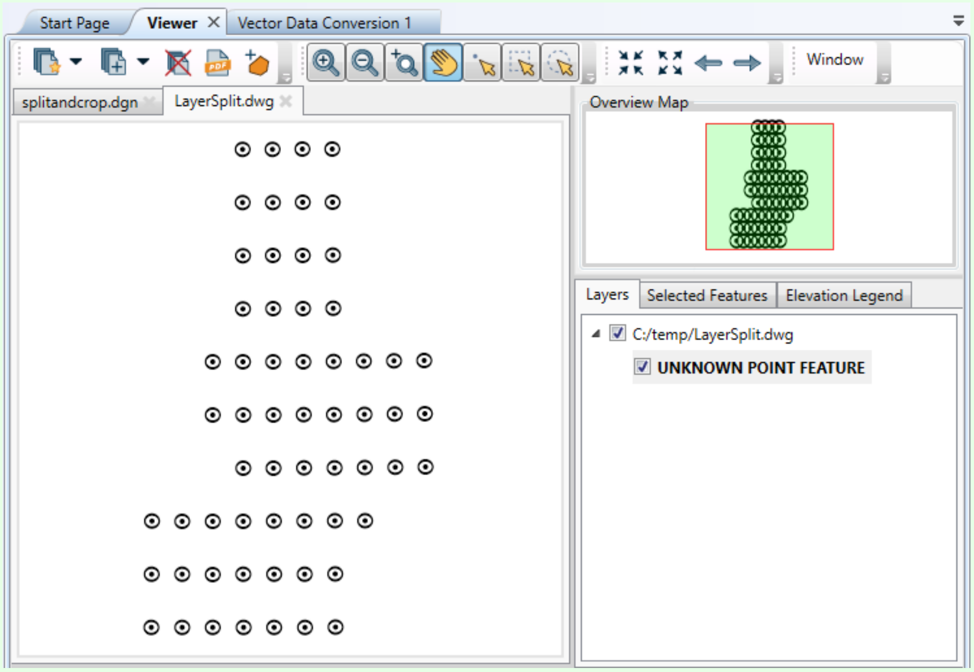
9. The Process Manager window at the bottom of the job will indicate the progress of the conversion.



10. Once complete the Progress Monitor will indicate "Finished".



You can then open the output file in a GIS application or within Geographic Calculator's own viewer. In the resulting pop-up window, select **Yes** to view image in a new viewer window.



The exported DWG will contain just the point features, and no area features.

This section is now complete, you are ready to move on to **Vector Data Conversions**, Cropping.

Continue to Section 3: Vector Data Conversions, Cropping

Section 3: Vector Data Conversions, Layer Cropping

Objective: To crop a small portion from a vector file and write out only that section.

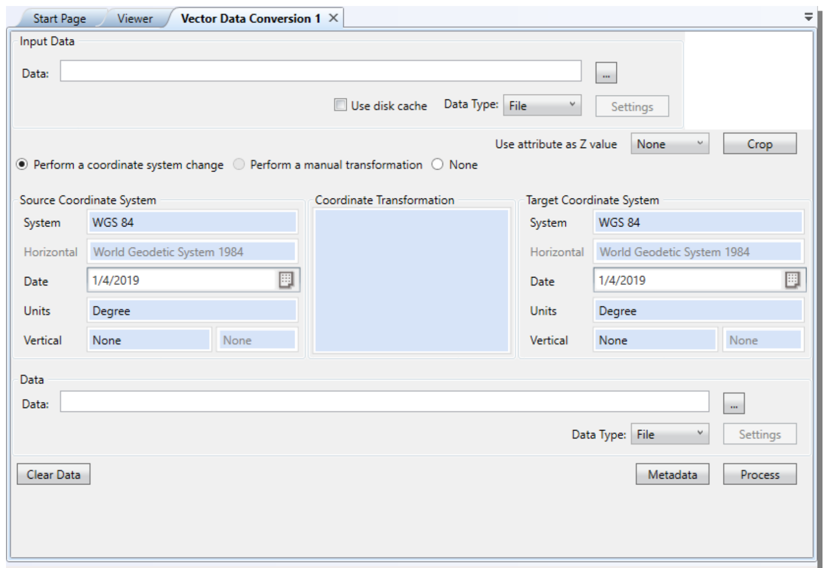
Data: SplitAndCrop.dgn

To successfully complete any Vector Data Conversion, *the coordinate system of the original map file must be known*. A coordinate conversion that does not have accurate input coordinate system information will not yield accurate results.

Follow these steps to crop the layers of a vector data file:

If you completed the last exercise, you can right click on the previous vector job in the Project Manager and choose **Clone Job**. Then skip to step 5.

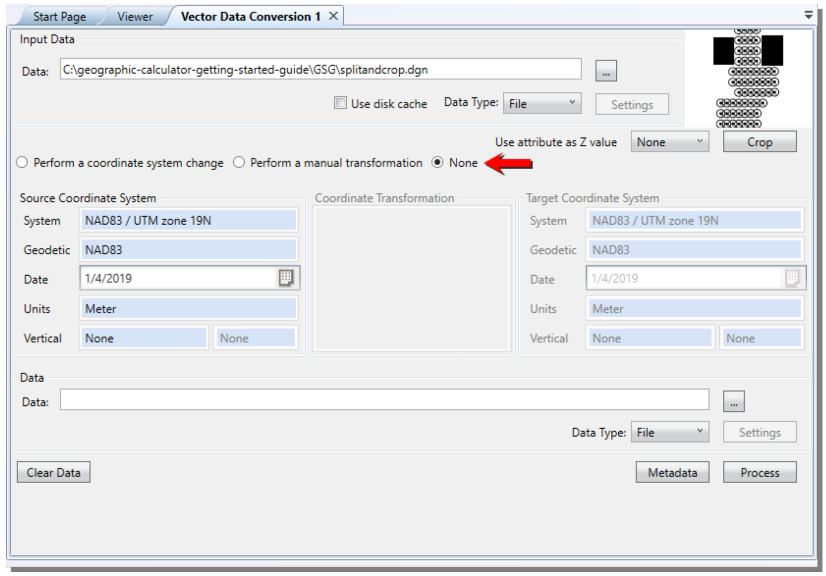
1. Open the Geographic Calculator and click the **Vector Data Conversion** job.
2. Open the Vector Data for your conversion by clicking the **"..."** button next to the **Input Data** field.
3. In the open file dialog that appears, browse to the directory where the Getting Started Guide installed its data and select **SplitAndCrop.dgn**



4. Geographic Calculator will read NAD83 / UTM Zone 19N as the Source Coordinate System from the prj file associated with splitandcrop.dgn.

   Not all files will use a prj file, so be sure you are using the correct input coordinate system.

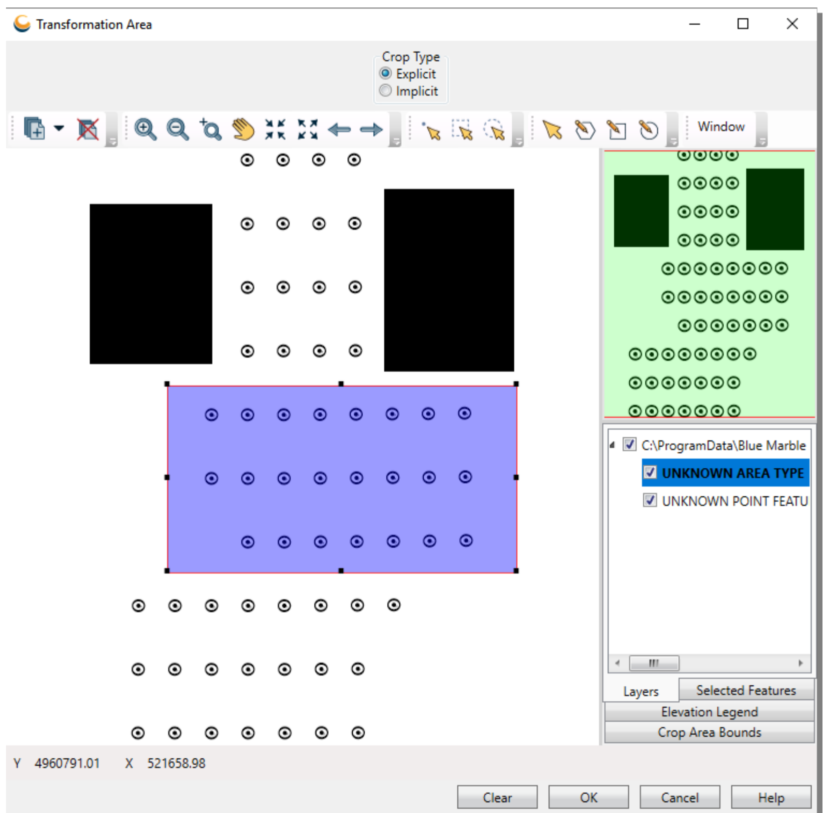
   Be sure that the radio button next to **None** is selected to choose not to perform a coordinate change.



5. Click on the **Crop** button to open the window for cropping and splitting layers.
6. Along the top of this window is a menu bar with several buttons.

   Select the  **Define Rectangular Crop Area** button and select a section of the data.
7. Along the top of the window is a section labeled **Crop Type**.

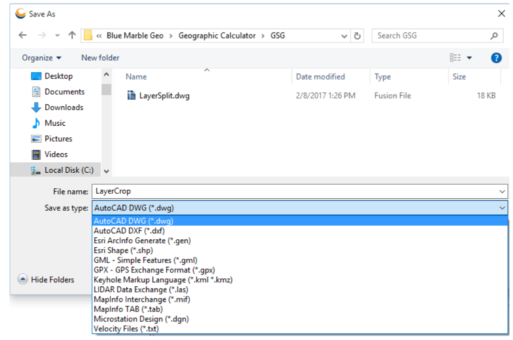
   Explicit *(Crop by containment*) the purple area will be clipped so the segments that lay outside the crop area will be discarded.



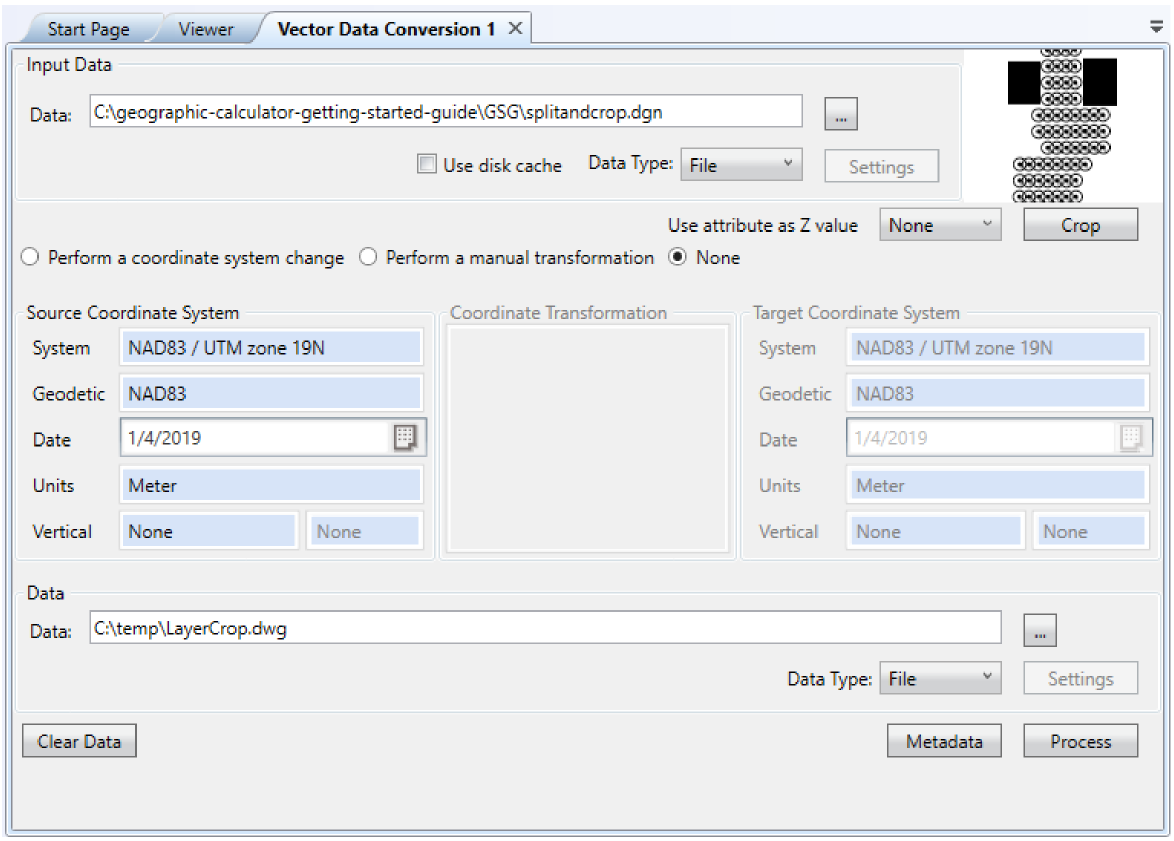
   Implicit *(Crop by intersection)* all features that intersect with any point of the crop area will be selected, meaning that the full extents of features within the purple area will be included in the crop.

   For this example we can leave this as **Explicit**.

8. Name the output file and choose an output format by clicking the "**...**" button next to the **Output Data** field. Browse to a location where you can save your output file on your local machine, and name the file "**Layer Crop**". We can select any appropriate output format for our output file. For this exercise, we will select **AutoCAD DWG**.

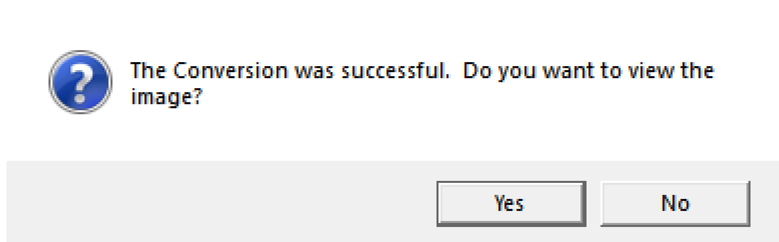


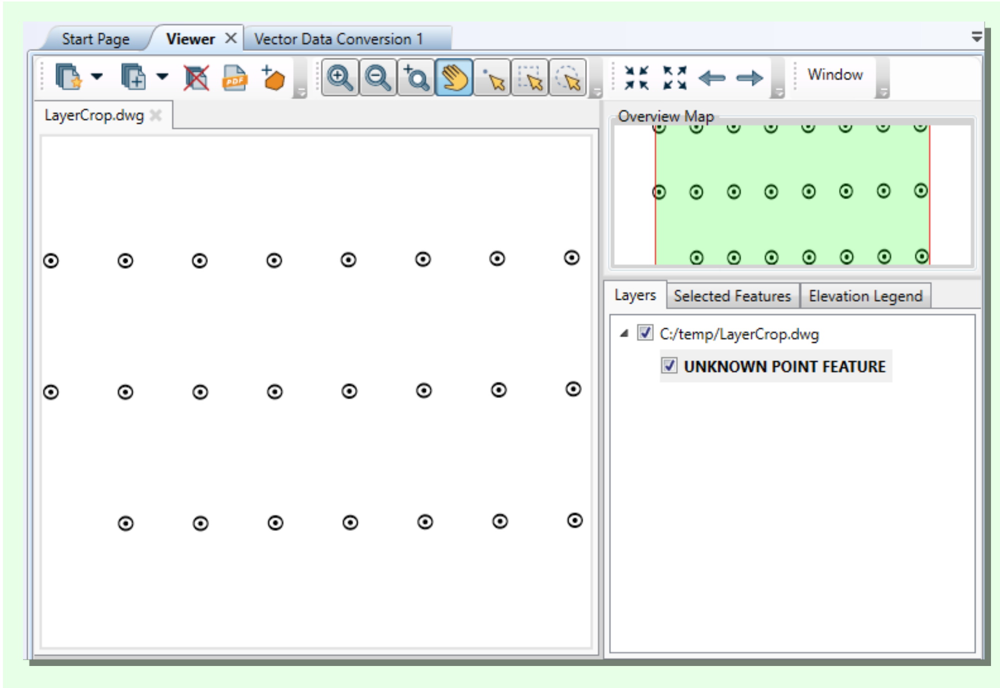
9. Your settings should now look like this:



10. Click the **Process** button at the bottom of the Vector Data Conversion job.

11. You can then open the output file in a GIS application or within Geographic Calculator's own viewer. In the resulting pop-up window, select **Yes** to view image in the viewer.





This section is now complete, you are ready to move on to **Batch Vector Data Conversions**. Continue to Section 4: Batch Vector Data Conversions

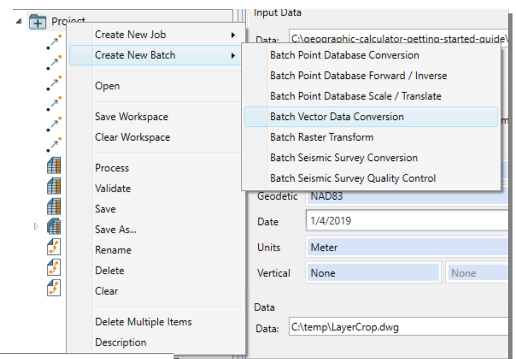
Section 4: Batch Vector Data Conversions

The Vector Data Conversion job can be used to set up batches of data conversions. The job allows for data with different coordinate systems, spatial database types and/or file formats to all be run simultaneously and convert them all to the same coordinate system, or even to different coordinate systems and output formats. The batch tools for Vector Data Conversion are very flexible for input and output. In this lab, we will set up a batch of files and convert them to a similar output file type and a similar coordinate system.

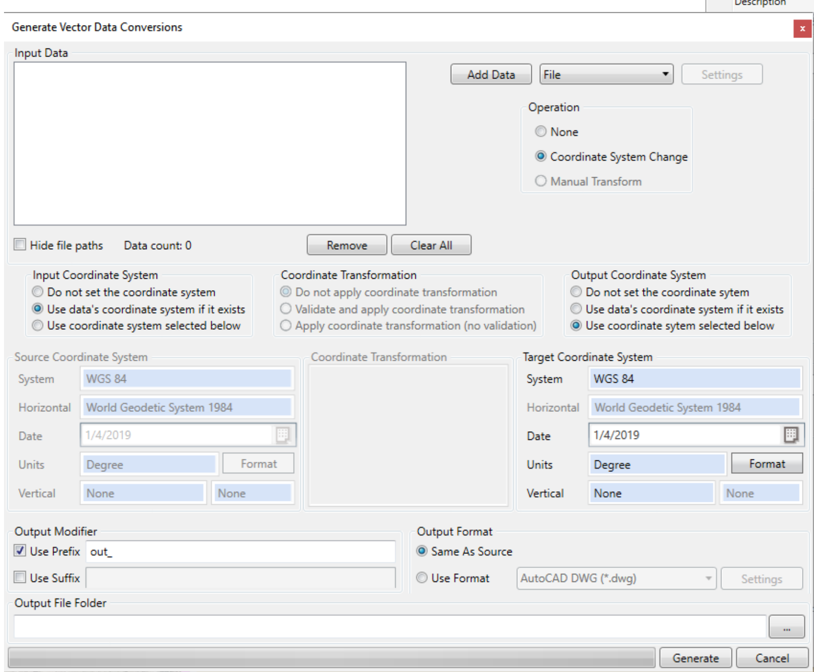
Objective: To set up a batch of Vector Data Conversions to run simultaneously.

Data: MeTwp24.shp, boatlaunch.shp

1. Open Geographic Calculator. Create a Vector Data Conversion Batch by right-clicking on the project folder and selecting **Create New Batch>Batch Vector Data Conversion**.



2. The Batch Vector Data Conversion will be added to the Project Manager. Right-click on the Batch Vector Data Conversion job and select **Batch Add**. This will launch the **Generate Vector Data Conversions** dialog.



This dialog has options for fully defining the batch you want to run. We will load our files, have Geographic Calculator detect the appropriate coordinate system for our input, and set the output coordinate systems. We will also use some tools to automatically name our output files.

3. Add the input files by clicking the **Add Data** button. Browse to the directory where the Getting Started Guide Data is installed (typically: C:\geographic-calculator-getting-started-guide\GSG), select the files named **boatlaunch.shp** and **MeTwp24.shp** and click **Open.**

   > Hold down the CTRL key to select multiple files to open

   This will add the files to the Input Files list.

4. The files we are loading have PRJ files associated with them, so for the Input Coordinate System we will set the option to **Use data's coordinate system if it exists.** When each file is loaded, the Desktop will then check for a coordinate system definition. If it detects one, that coordinate system will be used.

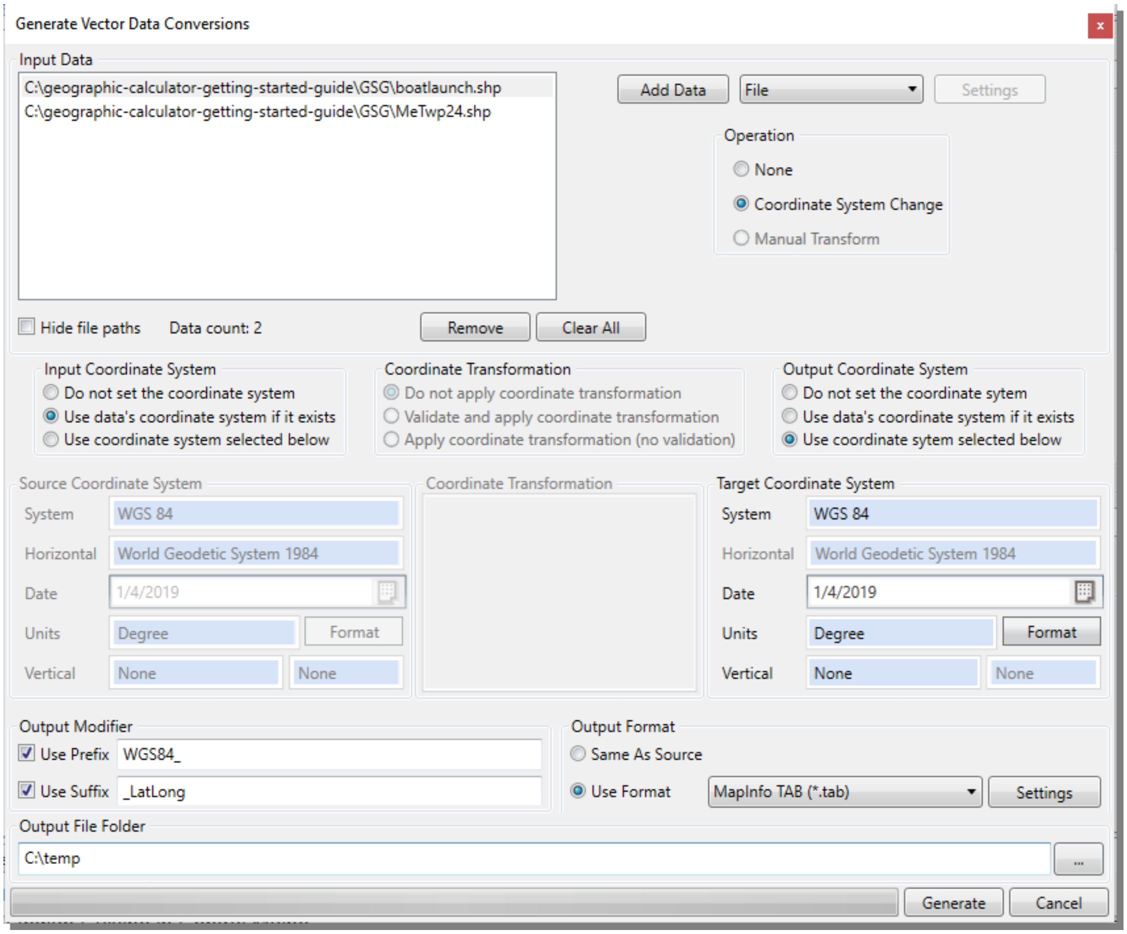
5. For the **Output Coordinate System** we will convert these files to Geodetic WGS84. In the **Output Coordinate System** area, select the radio button to **Use coordinate system selected below**.

   To set the coordinate system for all of the output files, double-click the blue box labeled **System.** In the Select Coordinate System dialog, coordinate systems are organized in the folder list on the left by type (Geodetic Lat/Long, Projected, Geocentric, String, and Fitted), continent, and then by country. If a coordinate system covers an entire continent, it will be found by clicking on the continent folder itself. In the tree view on the left, browse under **Geodetic>World**, in the coordinate system list on the right, select **WGS84 Coordinate System** and click **OK**.

6. To set up the output naming of our files, we will use the **Output Modifier** to add a prefix and suffix to the original file names. It is common to add a prefix and/or suffix containing information about the new coordinate system for a file. Enable the checkbox next to **Use Prefix**, and enter **WGS84_** in the field. Also enable the check box next to **Use Suffix** and enter **_LatLong** in the field.

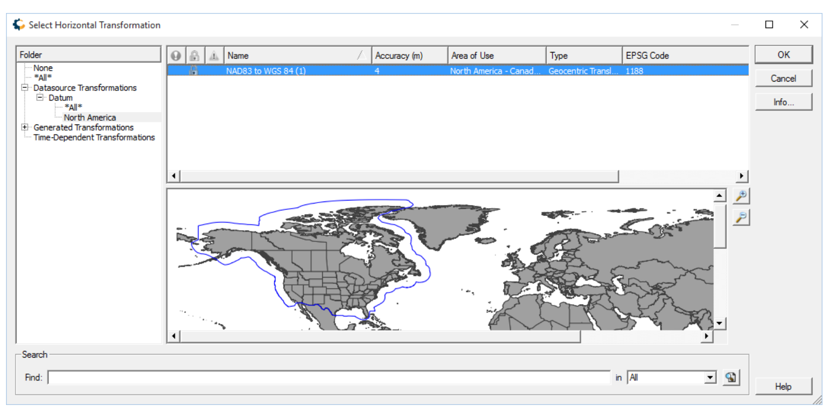
7. We will write our files out to the **MapInfo TAB** format. In the **Output Format** area, select the **Use Format** radio button, and select **MapInfo TAB** from the dropdown list.

8. The final setting is the location of the output files. Use the ellipsis **"..."** button in the Output File Folder area to select a folder on your local machine to write your output files into. Your settings should now look like this:



9. Click **Generate**. A job will be created in the batch for each of the input files that you selected.

10. In this Batch Generation dialog, we did not set a Coordinate Transformation. To complete the necessary datum transformation, select each of the conversion jobs from the Project Manager and double-click the blue **Coordinate Transformation** box in the center of the settings. The datum transformation selector will present you with a list of applicable datum transformations. For this exercise, select the North America datum transformation found in the **Geocentric Transformation** category and click **OK**.

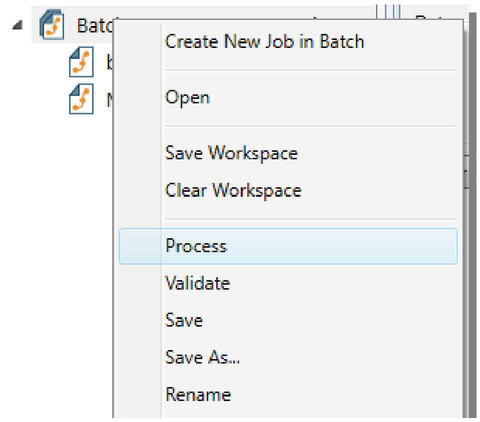


11. All of the needed settings for the batch should now be in place.

12. Right click on the Batch and select **Process** to start the batch.

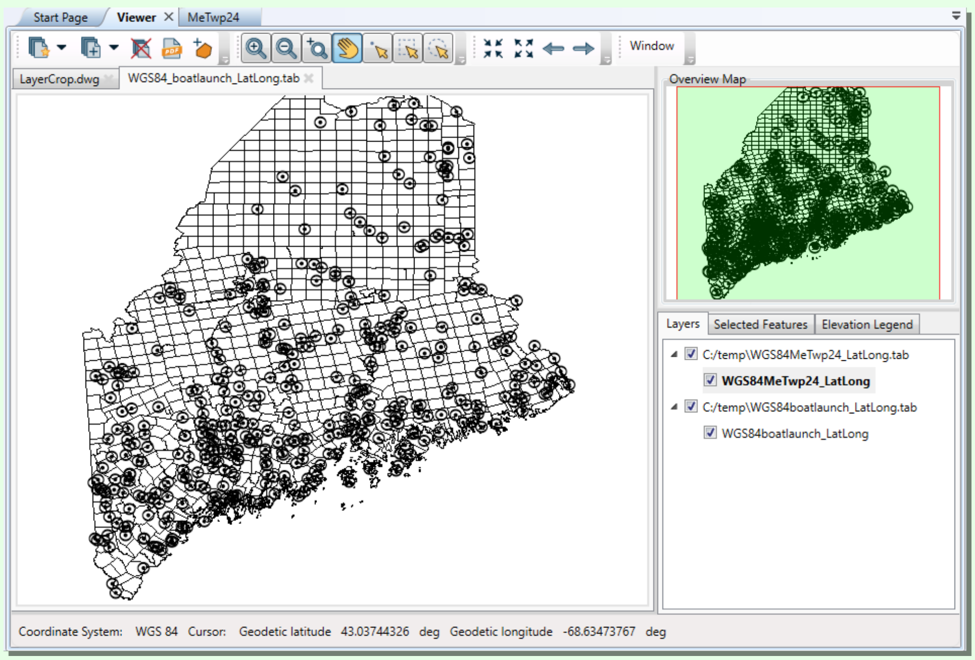
13. The Process Manager window will display the progress of the batch validation and processing. Once complete, all the jobs will indicate a finished status.

14. To inspect the output files in the viewer, go to either of the individual jobs in the batch, right-click on the output file field, and select **Open Data in Viewer**.



    Once the viewer opens, you can use the  **Import Data Into Current Map** button to open the second output file into the same view.

Once converted, your data will look like the main screen below:



Lab 4: Best Fit Coordinate Systems

Geographic Calculator can define a custom local coordinate system by computing a polynomial transformation between point values in an 'unknown' coordinate system and their respective values in a known coordinate system. The local system could be a mining grid coordinate system, a surface engineering coordinate system, or any other local set of coordinates with no known relationship to a projection or geodetic model.

Section 1: Best Fit Coordinate Systems

Lab 4: Custom Coordinate System Definition By Best Fit

Objective: To create a Best Fit coordinate system for a Mine Grid system using surveyed control points in UTM zone 15.

A Best Fit coordinate system takes input control points in a local grid system with corresponding coordinates in a known base coordinate system, and create a new custom fitted system. The custom system is linked by a calculated equation in the selected Math Transform type.

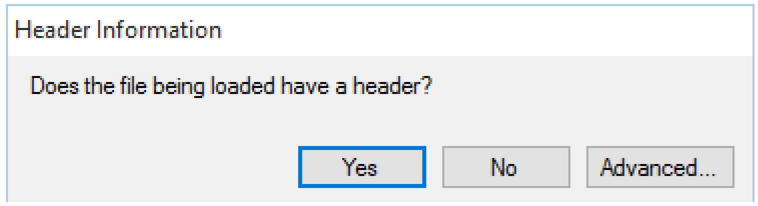
Data: Best-Fit_Input.xls

Follow these steps to register a local coordinate system:

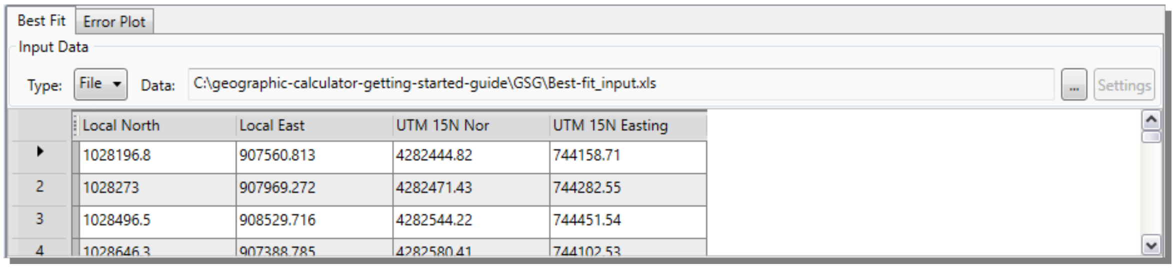
1. Open Geographic Calculator.
2. Select **File > New > Job > Point Database Best Fit** to open a new Point Database Best Fit job.
3. Load a point database file by clicking the **"..."** button in the input data area.

The file to open is in the folder for the Getting Started Guide (C:\geographic-calculator-getting-started-guide\GSG\) named **Best-Fit_Input.xls**.

4. When you open the file, you will be asked if the file contains a Header. Select **Yes**. This will use the first row of the spreadsheet to name the columns in the table.

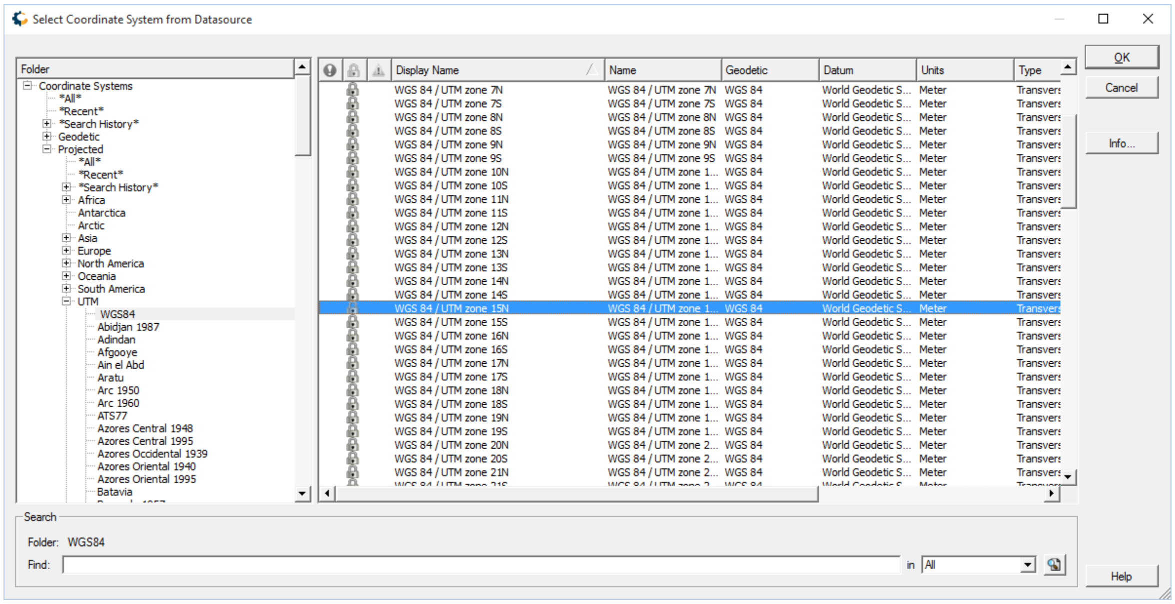


   Once loaded, the table should look like this:

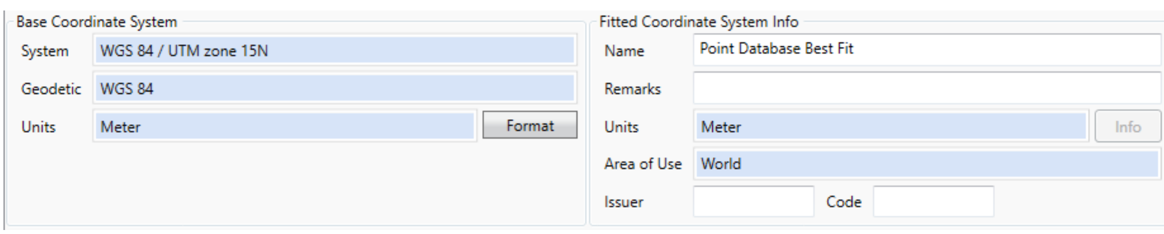


5. At the bottom of the job there will be a section for your **Base Coordinate System**, and your **Fitted Coordinate System**.

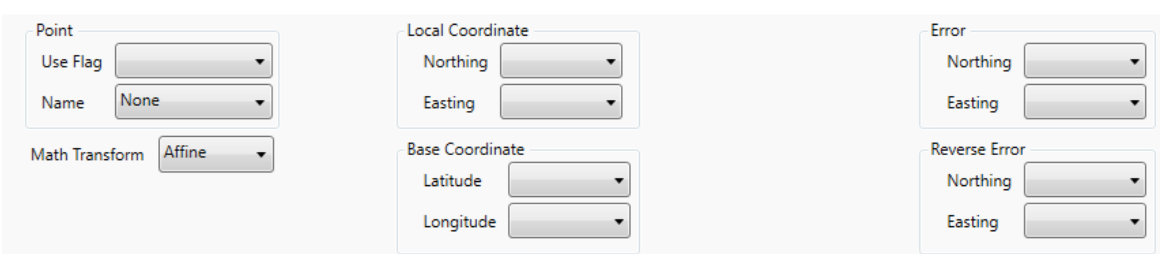
6. Your Base Coordinate System is in **UTM Zone 15 North, WGS84, Meters.** To select the coordinate system, double-click on the blue box labeled **System** in the Base Coordinate System area at the bottom left of the Point Database Best Fit job. By default, the Calculator starts with the geodetic coordinate system of WGS84 selected. This will launch the Select Coordinate System dialog.



To select the Universal Transverse Mercator Zone 15 North, in the tree view on the left, browse under **Projected > UTM > WGS84**, in the coordinate system list on the right, select **Zone 15N**. Then click **OK**.



7. Below the Base Coordinate System and Fitted Coordinate System areas there are **column settings**. These dropdown options specify which columns of data in the point database will be used to compute the transformation.



8. The local coordinates from the system being registered are in the Local North and Local East columns. Under '**Local Coordinate**', select the dropdown menus and set these settings:

    Northing: **Local North**

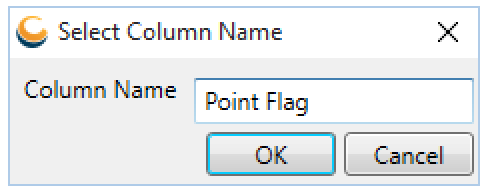
    Easting: **Local East**

9. The Base Coordinates are the control coordinates that the Fit will be based on. Under **'Base Coordinate'**, select the dropdown menus and set these settings:

    Northing: **UTM 15 North**

    Easting: **UTM 15 East**

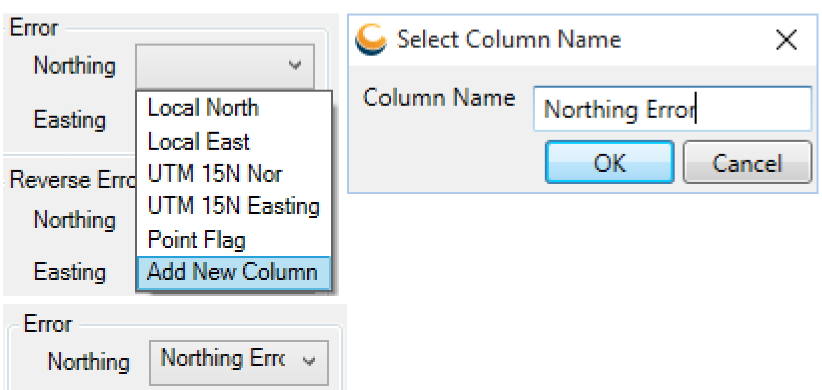
10. The **Point Use Flag** is a column that will act as a switch to either include or exclude particular control pairs from the Best Fit model. Select **Add New Column** to add this column. You will see a column **'C5'** be added to the table. Right-click on the column and select **"Rename"** and name it "Point Flag". When you do so, a column will be added containing a '1' on every row. A '1' in this attribute indicates that this control pair will be included in the Best Fit model. We will come back to this later.



11. Set the Point Name to **None** because we do not have a column containing unique names for the control points.

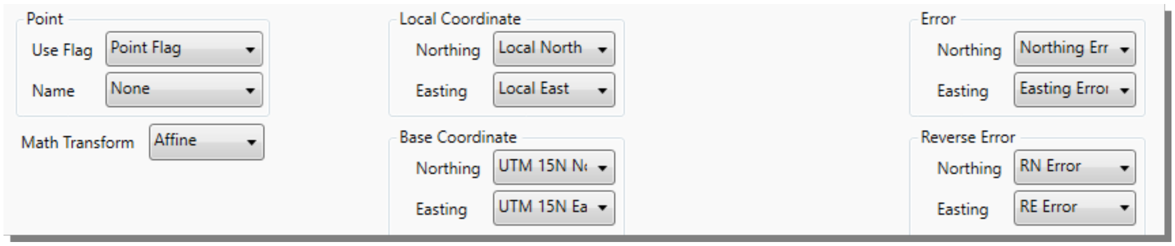
12. Select the Math Transform **Affine**.

13. The remaining parameters should be assigned to empty columns that you add to the point database best fit table. They can automatically be added by selecting **Add New Column** in the dropdown menu next to each output parameter. It is a good idea to simply name each new column with the names shown for each drop down. Example is shown below:

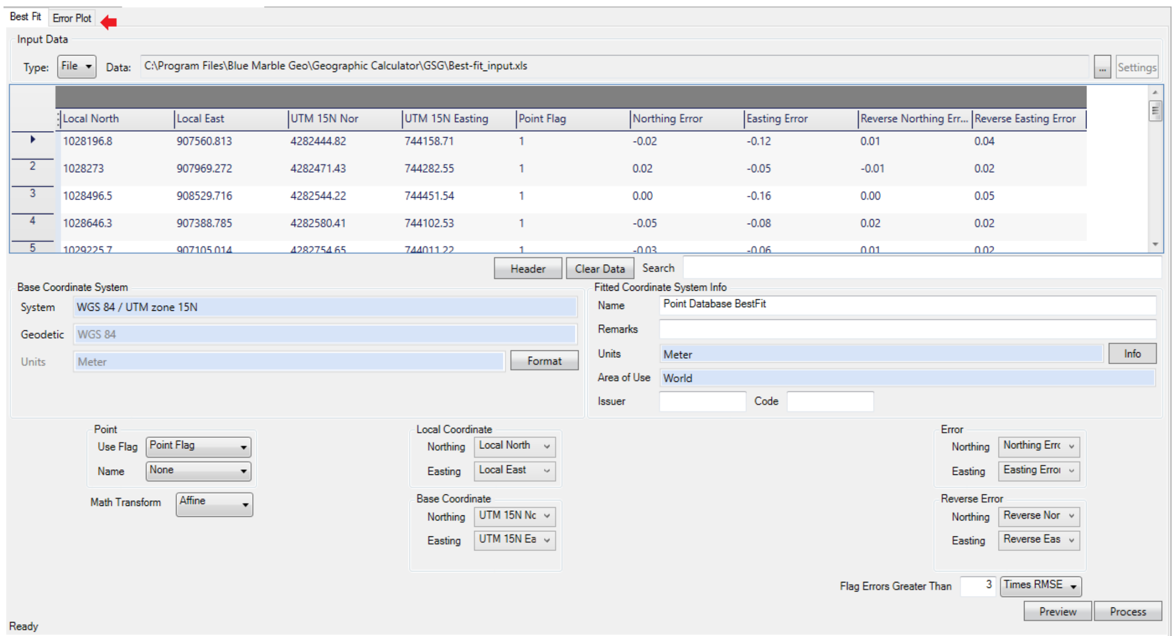


14. In the **Flag Errors Greater Than** area, leave the default of **3 Times RMSE** (Root Mean Square Error). This will flag control points in the error plot that are significantly different from what the Math Transform calculates.

15. The Settings should now look like this:

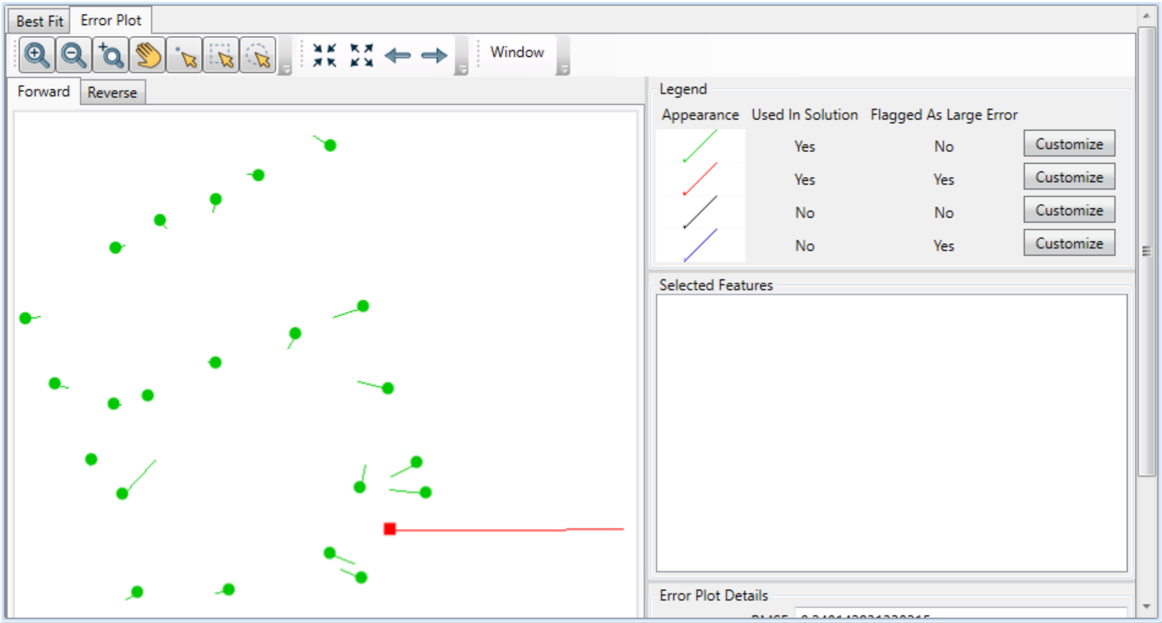


16. Click on the **Preview** button to compute the transformation. If the processing was successful, you will see error values in the columns you added for North Error, East Error, North Reverse Error, and East Reverse Error. Also, the error plot tool button and menu item will be enabled. The table should look like this:

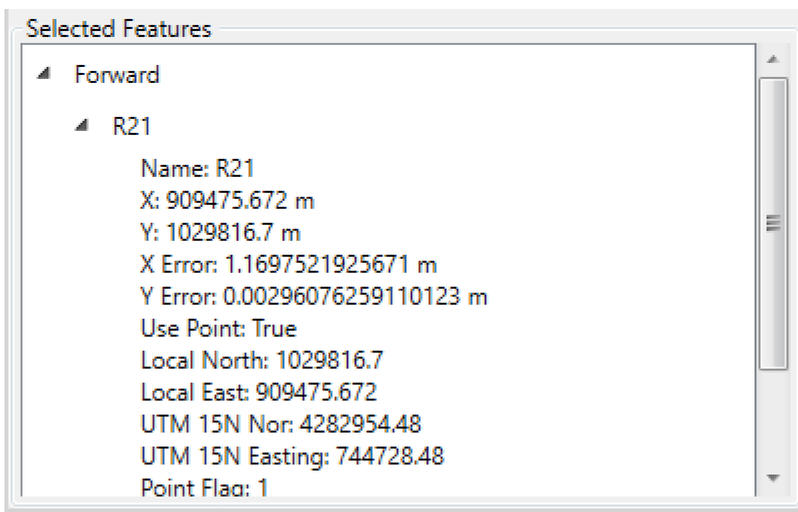


17. Once a Best Fit has been calculated, you can view a plot displaying the relative errors. To View the Error Plot click the **Error Plot** tab.

18. In the plot, the locations of all of the points in the point database are shown, with a line drawn from each to signify the direction and relative magnitude of the point's residual error (the difference between its file-specified location and its computed location from the transformation). The tabs at the top of the Error Plot allow you to alternate between the display of the residual errors from the forward transformation and those of the reverse transformation.



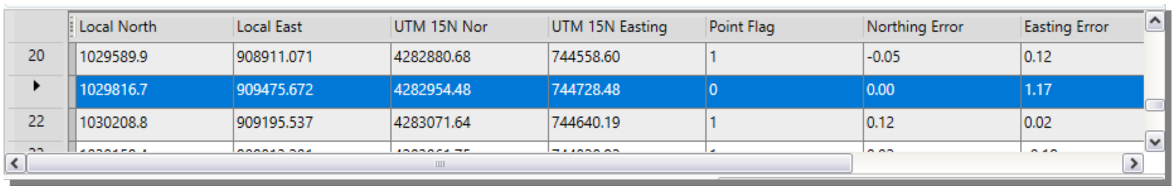
19. Points which were used to compute the coordinate system transformation are shown with a circle and are normally drawn in green. Those points which were excluded are drawn in black. A point whose residual error has a magnitude exceeding the criteria specified by the Best-Fit conversion settings (in this case three times the root mean square of the residual errors) are drawn in red. The RMSE in the Error Plot Details Window indicates the overall error in the units specified for the coordinate systems, in this case Meters. In viewing the Error Plot, it is obvious that one of the control points is questionable in this case. Choose the Select with Point tool and click on the red point with the large line coming off of it to see the point's details in the Selected Features window.



We can see that there is an X error of over 1 meter for point R21 (the point in Row 21).

20. To remove that control point from the model, navigate back to the Best fit Tab.

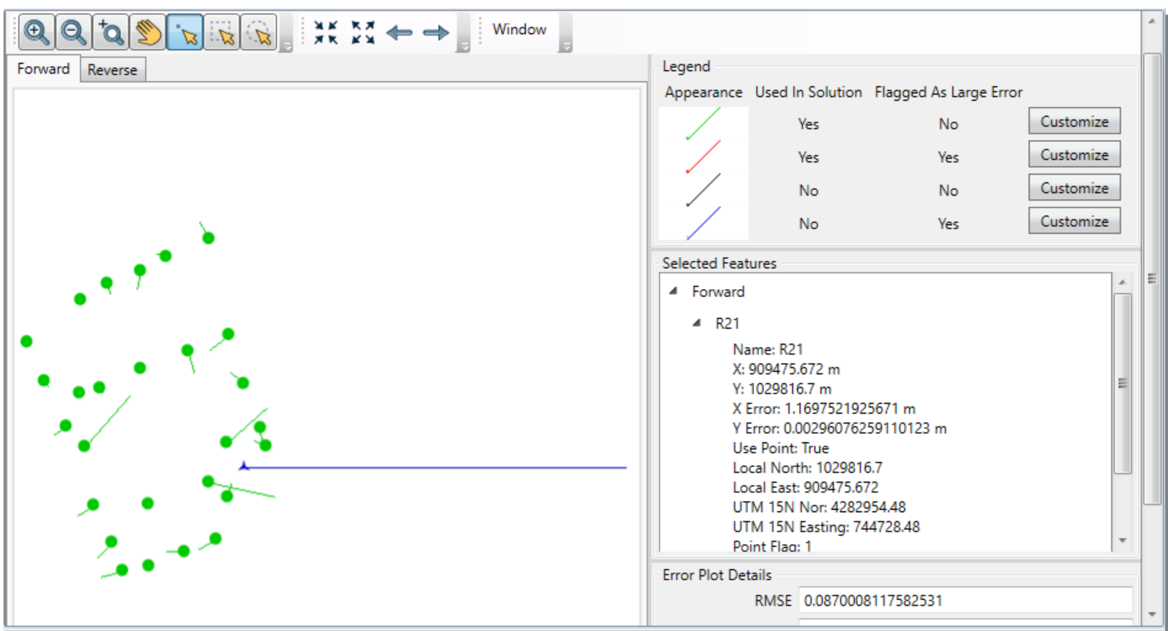
21. In the Table, scroll down to row 21 and change the value of the Point Flag column from "1" to "0". When the fit is computed, the 0 will remove that control point from the model. Then click **Process** to recalculate the Best Fit model. You will see the error values all change to reflect the new model.



	Local North	Local East	UTM 15N Nor	UTM 15N Easting	Point Flag	Northing Error	Easting Error
20	1029589.9	908911.071	4282880.68	744558.60	1	-0.05	0.12
▸	1029816.7	909475.672	4282954.48	744728.48	0	0.00	1.17
22	1030208.8	909195.537	4283071.64	744640.19	1	0.12	0.02

22. Click the **Error Plot** button to see the new Error Plot for the model. The effect of excluding the points should be readily apparent in the new plot. The removed point will be displayed in black. The RMSE for the whole model will also have decreased significantly, indicating a better fit of the points. The clustered points now fit much better to the computed transformation (which is also reflected in a lower root-mean-square residual error), while the excluded points have greater errors.

> **NOTE:** While excluding points is useful to remove suspect points from the transformation, care must be taken not to exclude so many points that the transformation becomes less accurate or reliable throughout the area of interest.

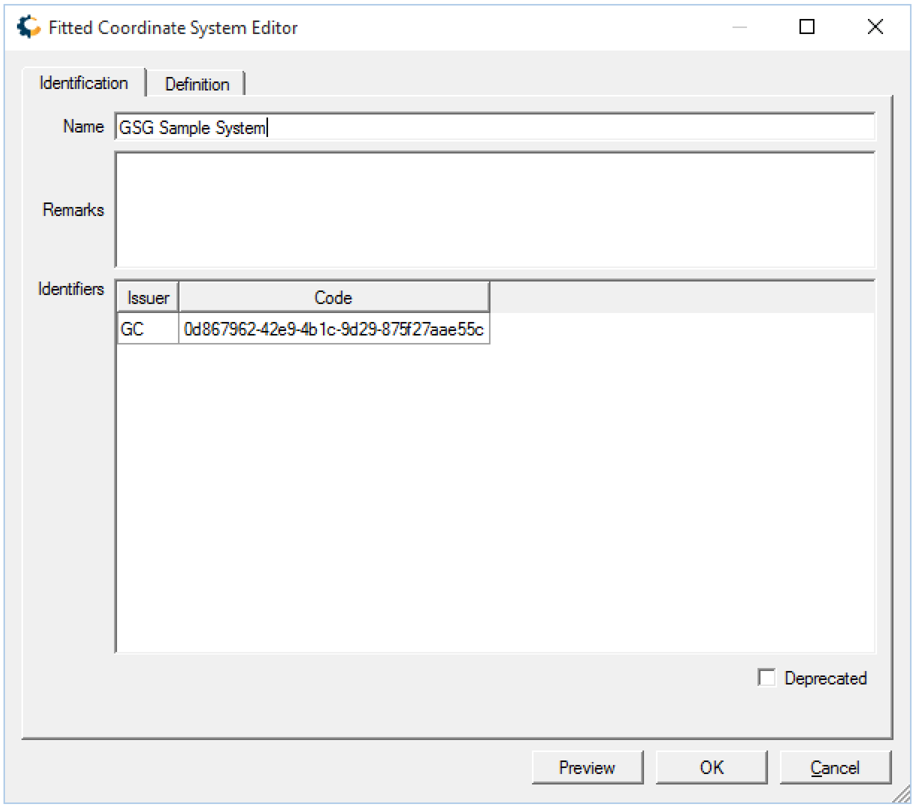


23. The fit parameters are automatically entered into the Geodetic Data Source's **Custom.xml** file. However, to make the fitted system a permanent addition to your Geographic Calculator, you will need to save the change. To save the change, go to

Datasource > Coordinate System Definitions or click the Coordinate System Definitions menu button

24. To view and name your fitted system, select **Fitted** in the tree-view on the left. You will see your new system in blue on the right. The blue text of the name and the absence of the lock icon indicates that this entry is in the **Custom.xml** file and is editable by the user.

25. To assign a name to the fitted system you will create, double click the entry 'Point Database BestFit'. In the dialog that pops up, go to the **Identification** tab and change the Name to 'GSG Sample System'. Click **OK** to close the dialog.



26. To save the new system, click the **Save** button on the right.

Your fitted system is then available for use like any other coordinate system. Since the system created in this exercise is imaginary, you can remove the system by right clicking it and selecting **Delete Object**. If you delete the system, you will want to save again.

Lab 5: Seismic Survey Conversions

Seismic Survey Conversion (SSC) is the job designed for streamlined conversions of SEG, SPS, and UKO format specifications and the variations of these specifications. Use this tool when performing conversions from/to the above formats. The SSC job is especially useful when an input file contains both shotpoint and receiver records which need to be converted.

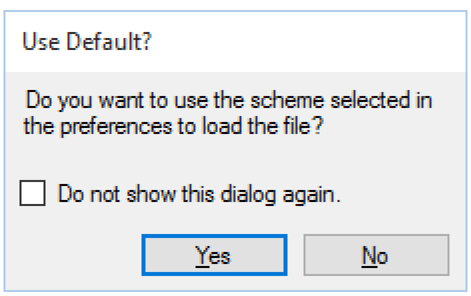
- Section 1: Loading Seismic Survey Data
- Section 2: Loading Data Files with Format Variations
- Section 3: Batch Seismic Survey Conversions

Section 1: Loading Seismic Survey Data

Objective: Using the Seismic Survey Conversion job, set up and process a conversion on an example SEG file which contains minor variations from the default SEG P1 specification.

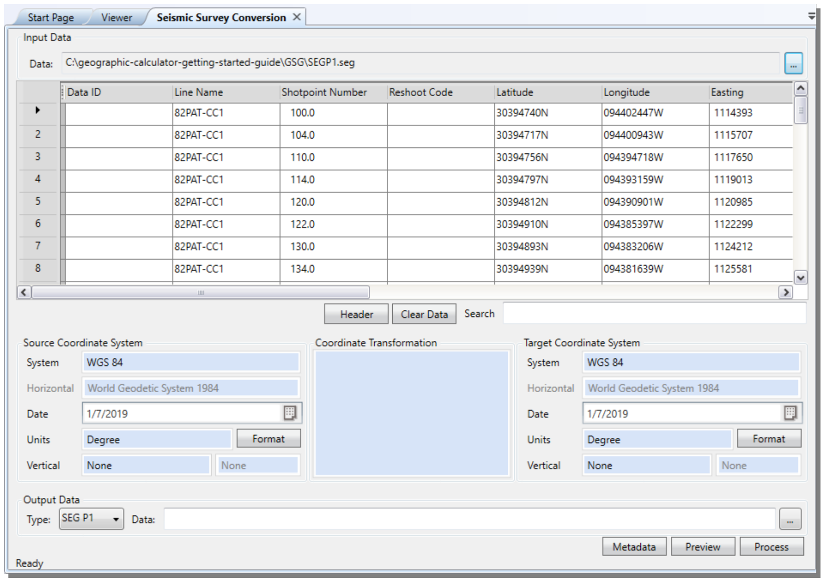
Data: SEGP1.seg

1. Open Geographic Calculator.
2. Click on the **Seismic Survey Conversion** job in the Project Manager.
3. In the upper right of the Seismic Survey Conversion job interface, click the ellipsis (**...**) button to select an input file.
4. In the resulting dialog, select the file in the folder for the Getting Started Guide (C:\geographic-calculator-getting-started-guide\GSG) named: **SEGP1.SEG**
5. When you click **Open**, you will be prompted by the following dialog:



For now, we will click **Yes** to use the default SEG scheme to load this data.

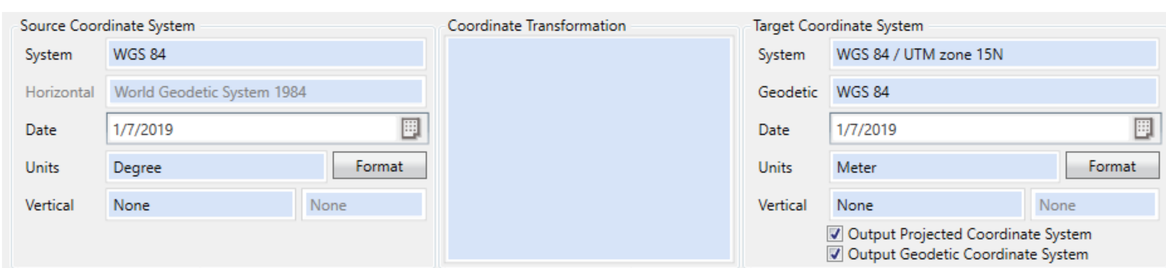
6. With the data loaded, we will see that the interface is similar to that seen in the Point Database Job. One major difference is that we do not need to specify the columns in the Seismic Survey Conversion. This is because the specifications of these formats dictate which columns contain which type of data (projected or Lat/Long), so the user is not required to define this.



7. The next step is to define the coordinate systems. For specific instructions on selecting coordinate systems and datum transformations, please see the previous Labs. The input coordinate system is **WGS84**, which should already be your default. The other large difference between the SSC interface and the PDC interface is the **Target Coordinate System**. Set the output projection to **WGS84 / UTM Zone 15N**.

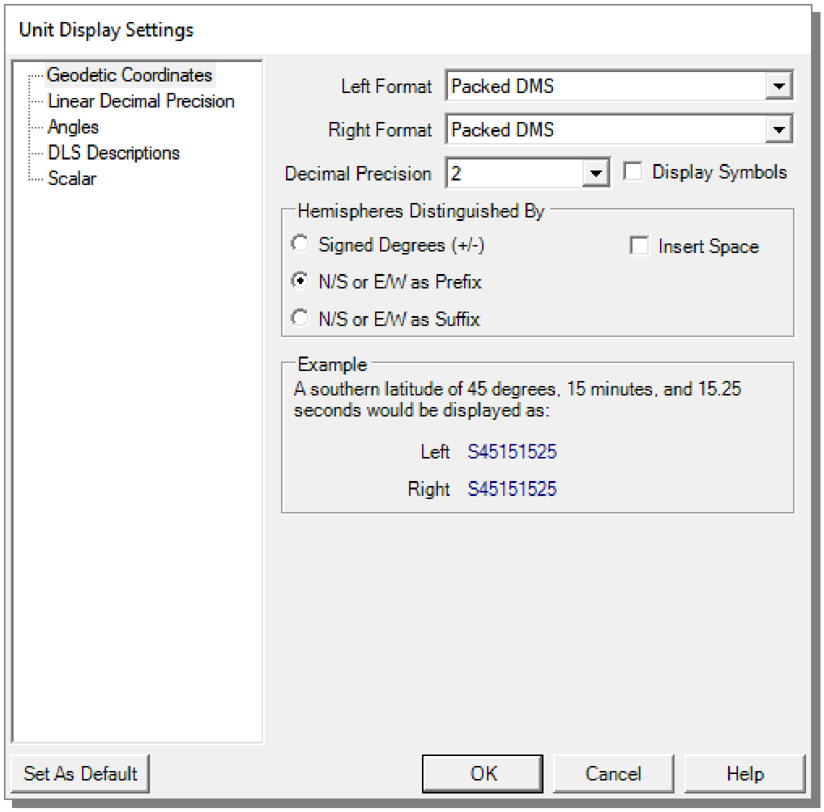
8. Once a projected system is set for output, notice that there is a checkbox to decide **Output Projected Coordinate System** and **Output Geodetic Coordinate System**. This allows the user to specify whether they would like to output data to the projected columns, geodetic columns, or both.

   In this case, activate both the Projected and Geodetic categories.

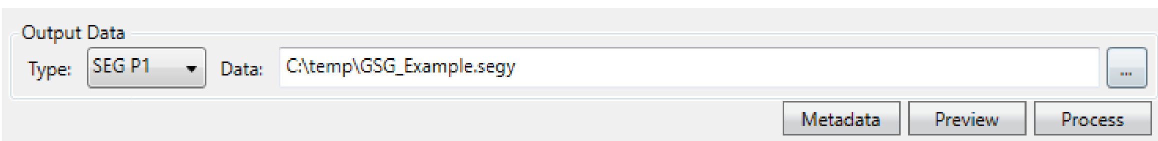


9. Next we will specify the geodetic coordinates format.Click the **Format** button and navigate to **Geodetic Coordinates**

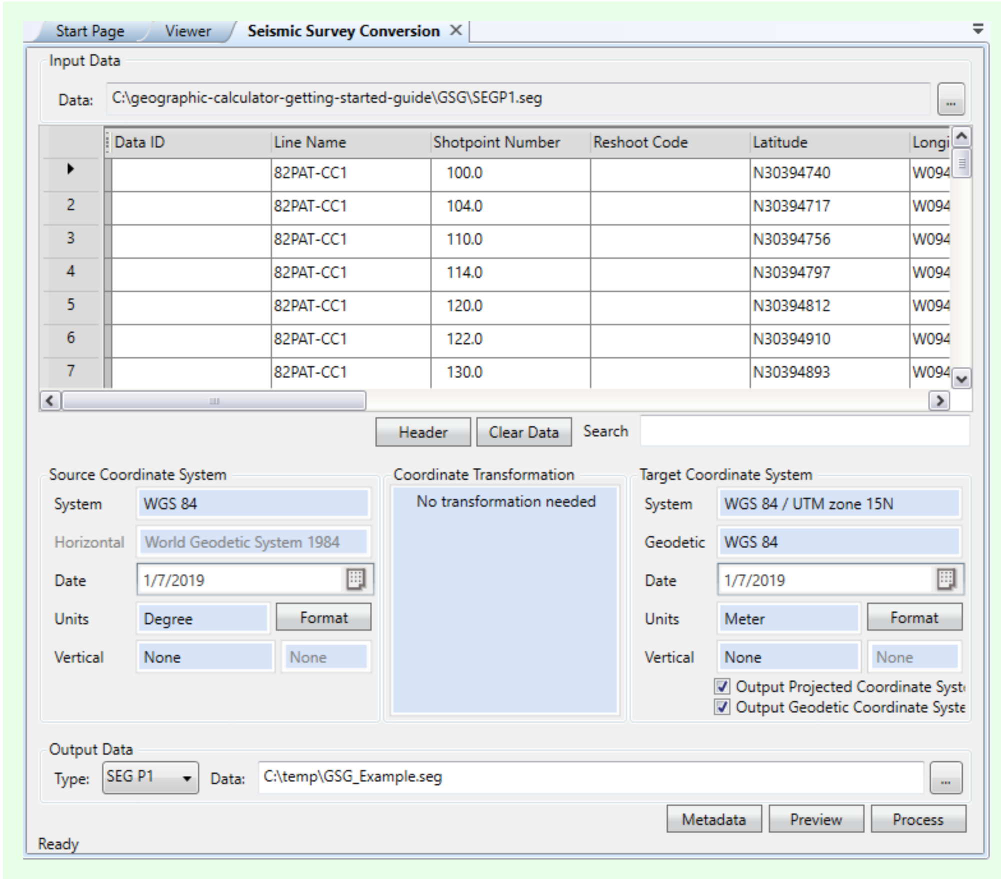
   Set the **Left and Right side format** to **Packed DMS**, **Decimal Precision** to **2**, and Hemispheres Distinguished by N/S or E/W as Prefix.



10. Click **OK** in the format dialog, then click the ellipsis in the Output Data section to specify where to output your data. Enter a path to output your data.



11. Enter any path to output your data. In the below example, you will see a fully defined SSC job writing out to **C:\temp\GSG_Example.seg**.



12. You can now click the **Metadata** button to specify metadata for this conversion, **Preview** to perform the conversion in the view but not write any output data, or **Process** to perform the conversion and write out your resulting file(s).

Next we will look into loading data which has a header specification variation, as well as other possibilities available to users in defining custom Seismic Survey Conversion Formats. Please continue to Section 2: Loading Data Files with Format Variations.

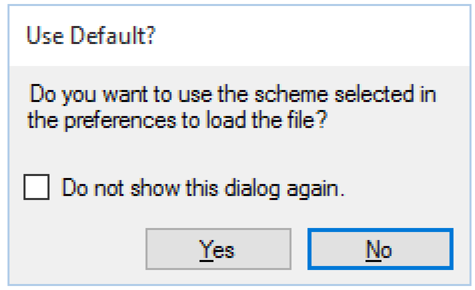
Section 2: Loading Data Files with Format Variations

Objective: Load a data file which has an alternative header definition to the base specification, as well as overview other variation options available to users in the Seismic Survey Format specification.

Data: Altered_UKO.uko

1. Click the Seismic Survey Conversion button  to create a new SSC job.
2. In the new SSC job, click the ellipsis button in the load data dialog to load an input file.
3. As in lab 1, specify the file in the folder for the Getting Started Guide (C:\geographic-calculator-getting-started-guide\GSG) named **Altered_ UKO.uko.**

   Select **NO** in the resulting 'Use Default' window.

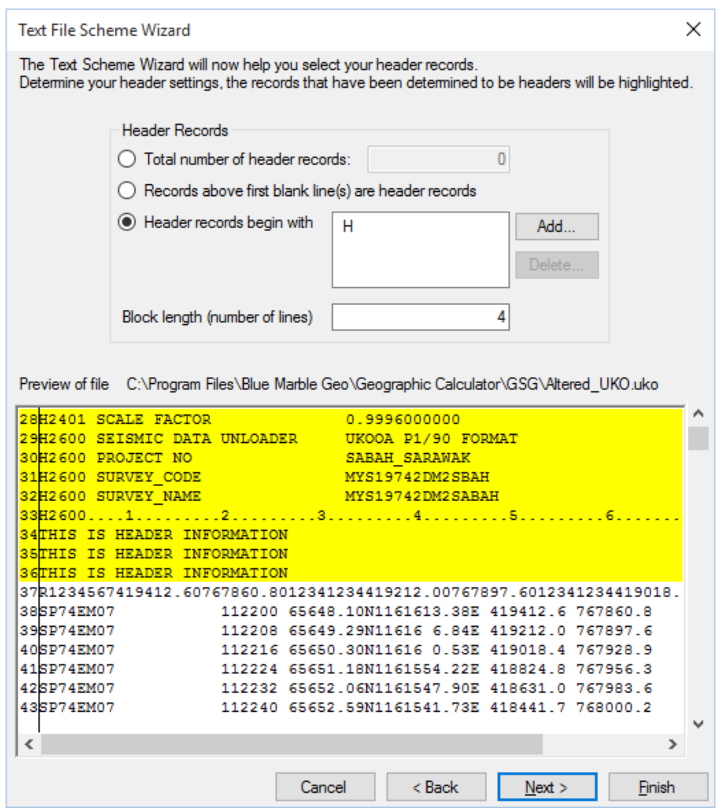


4. The resulting dialog is the Text File Scheme Wizard. This is where we can specify how the application will load your file – specifically, how it will identify header records and data records. In the first dialog, you will see the Type preset to UKOAA P1-90 due to the loaded file extension, and the file path and file preview will be set according to the loaded file.

   Click **Next**.

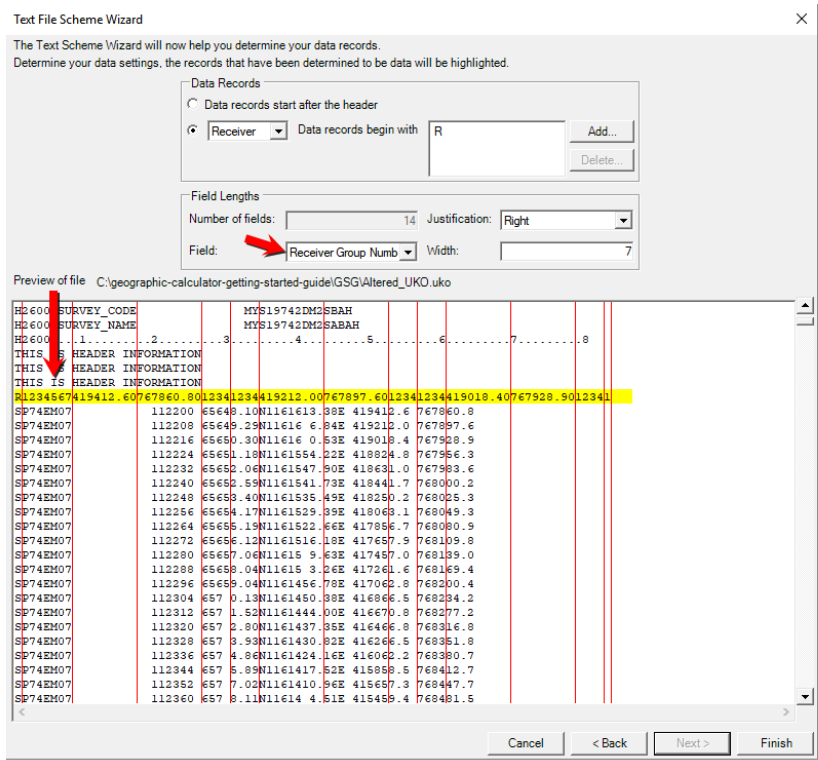
5. The yellow highlighting will indicate the header section of the file. All records with the leading "H" character have been identified as header rows.

   Set the **Block length** to **4** to also include lines 34, 35 and 36 as part of the header.



6. Click **Next**. The next dialog allows you to specify the format of data records and how they are identified. Notice that unlike the previous file used, this file has both a *Receiver* and a *Shotpoint* record. These can each be computed simultaneously; however they will usually have different formats and must be defined separately. We will configure the Receiver format first. If it is not selected, click on the radio button next to the Receiver/Shotpoint dropdown.

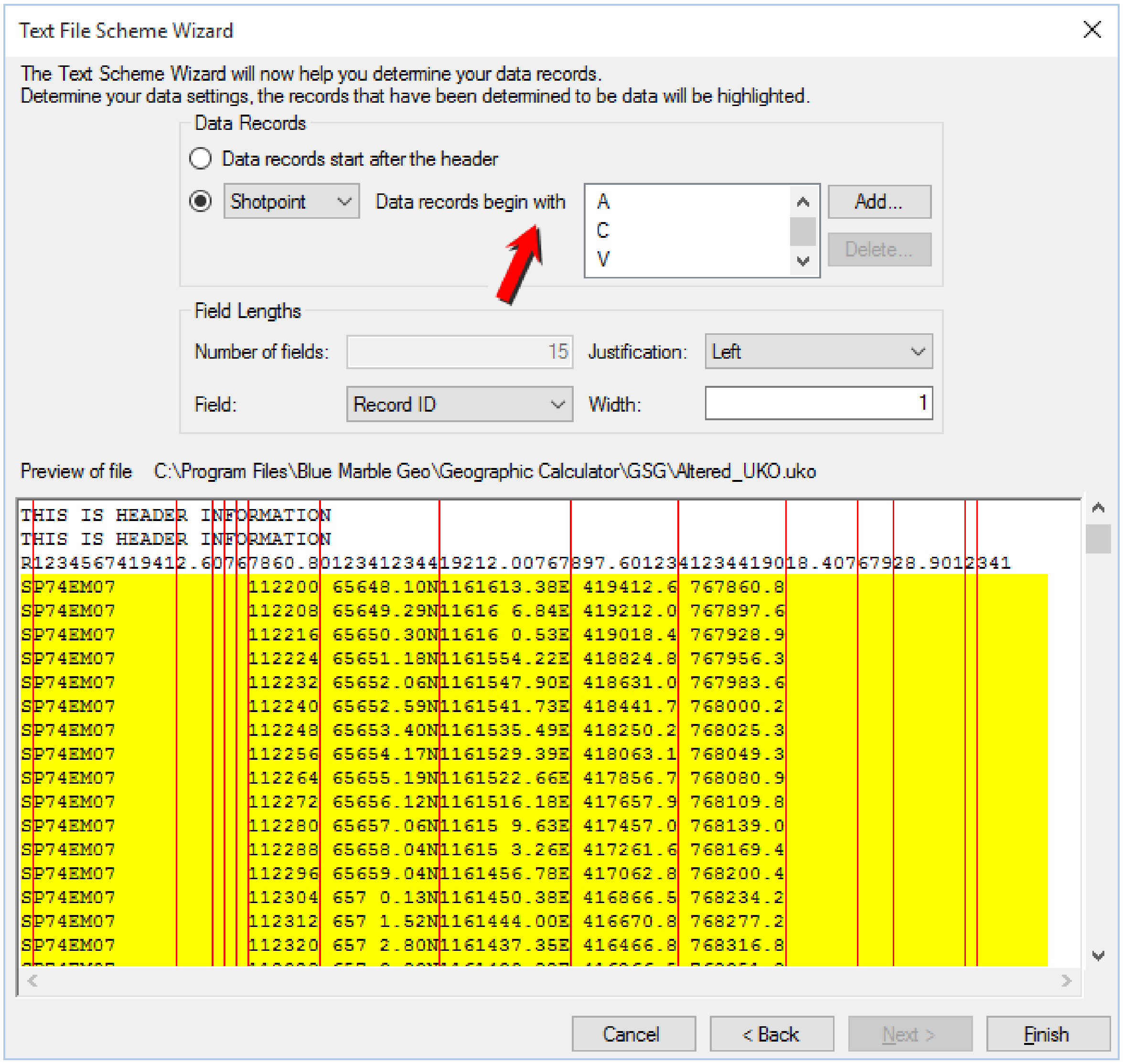
7. Under the Field Lengths area, note the **Width** box after **Field**. Here is where you can define the field length for this file. Select the field name in the dropdown and edit the width for the selected field in the text field to the right. Below are the Field names and Widths for this file, which you can change in the dropdown shown by the first red arrow.



- Record ID - 1
- Receiver Group Number - 7
- Easting - 9
- Northing - 9
- Cable Depth - 4
- Receiver Group Number - 4
- Easting - 9
- Northing - 9
- Cable Depth - 4
- Receiver Group Number - 4
- Easting - 9
- Northing - 9
- Cable Depth - 4
- Streamer ID - 1

Note: You can also perform this step by using the preview panel as a graphical interface. To move a column separator, simply click and drag the red lines. To create new separators, double click in the preview panel (For UKO files such as this, you cannot create new separators due to the number of fields being fixed by the format specification).

8. Once the Receiver records are defined correctly, we can move on to the Shotpoint records. Change the dropdown from Receiver to Shotpoint. Notice that by default, Shotpoints can be identified by many leading characters. Since the additional header rows added start with "T", we will need to remove this from the **Data Records Begin With** list. Find **T** and click **Delete**.



9. The default settings for Shotpoint records should be set up correctly for this file.

> **Note:** In order to convert a Seismic Survey file, only the data records are required. As you can see in this file, some attributes are not populated in the data records, but the conversion will process regardless.

10. Click **Finish** to load the file into the Seismic Survey Conversion job.

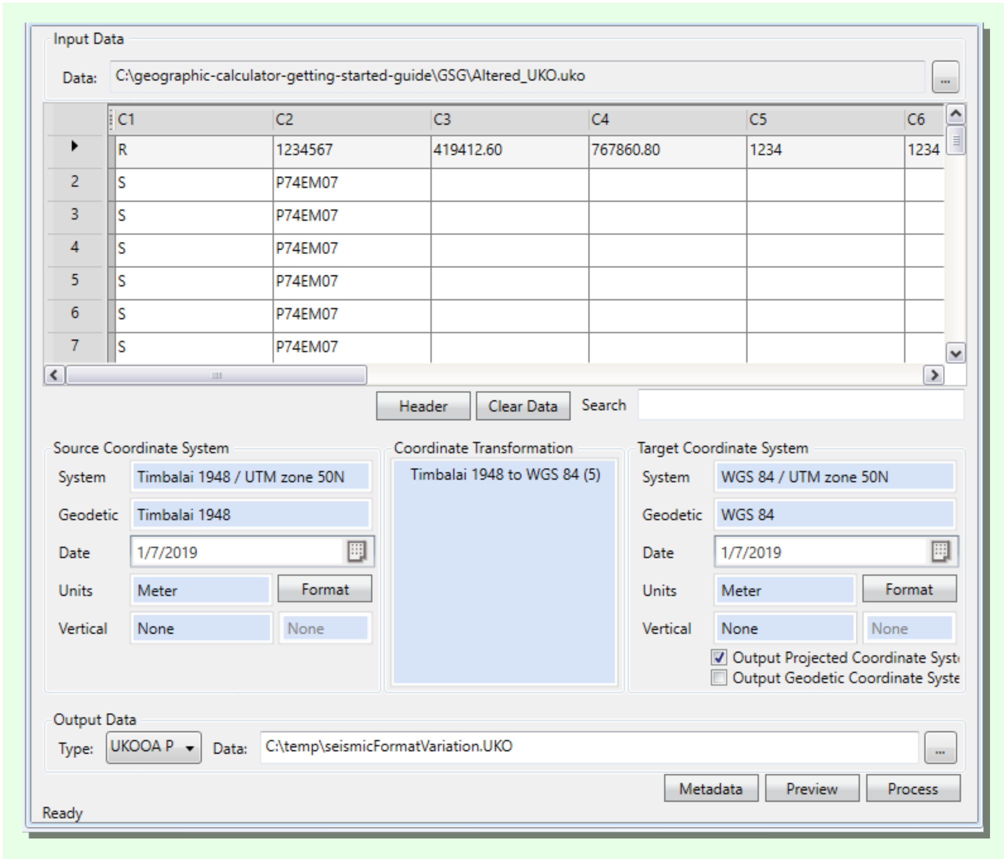
11. Next we will specify the coordinate systems for input and output.

    Set the **Source Coordinate System** to **Timbalai 1948 / UTM Zone 50N** (*Projected > UTM >Timbalai 1948*).

    Set the **Target Coordinate System (Projected)** to **WGS84 / UTM Zone 50N** (*Projected > UTM> WGS84*). Double click the **Datum Transformation** box to select the **Timbalai 1948 to WGS84 Brunei (5)** transformation.

12. In this example, we will **disable** the **Output Geodetic Coordinate System** checkbox so that only the projected data columns are altered on output.

13. Lastly, enter any path for your output data. Below you will see a fully defined Seismic Survey Conversion. You can now click **Preview** to view the conversion before saving the output file, **Process** to run the conversion and save the output file, or **Metadata** to edit metadata before processing.



14. After processing this file, open the results in Notepad. You will notice that the projected data in the Receiver and Shotpoint rows were converted, however the Lat/Long columns in the Shotpoint rows were not converted because the Output Geodetic Coordinate System was unchecked.

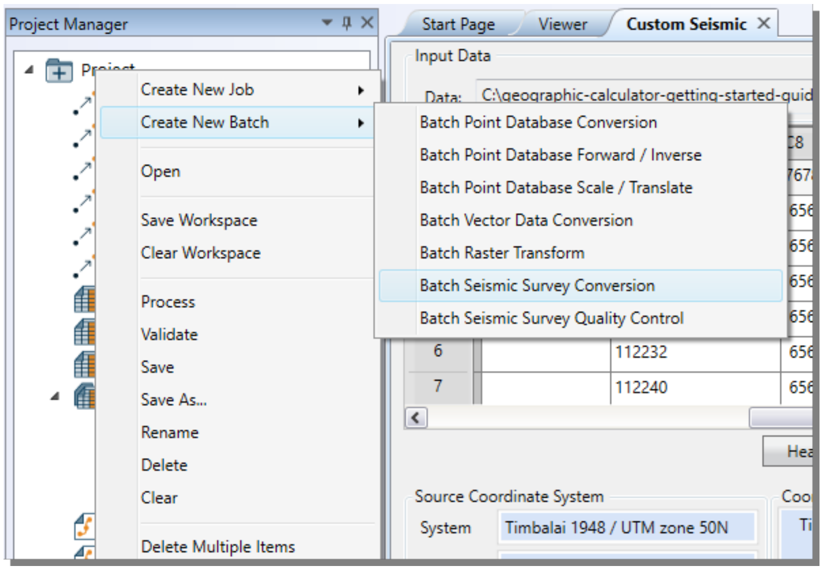
Please continue to Section 3: Batch Seismic Survey Conversions.

Section 3: Batch Seismic Survey Conversions

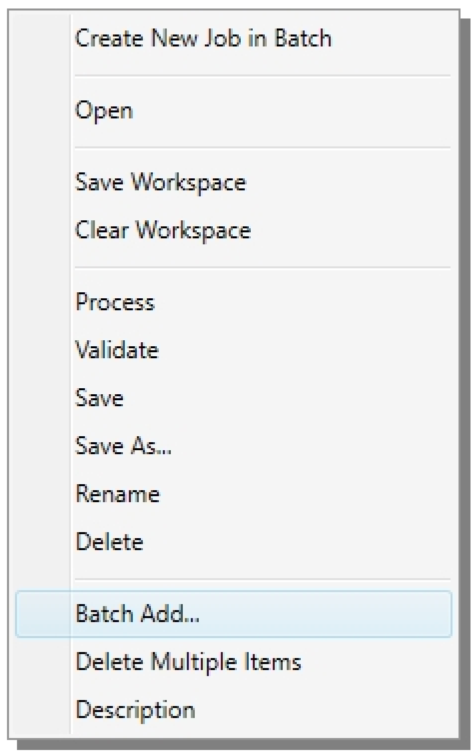
Objective: Create a Batch Seismic Survey Conversion in order to process multiple Seismic Survey data files of similar nature all at once.

Data: XO5C507.SPS , XO5C507 (2).SPS, XO5C507 (3).SPS , XO5C507 (4).SPS, XO5C507 (5).SPS

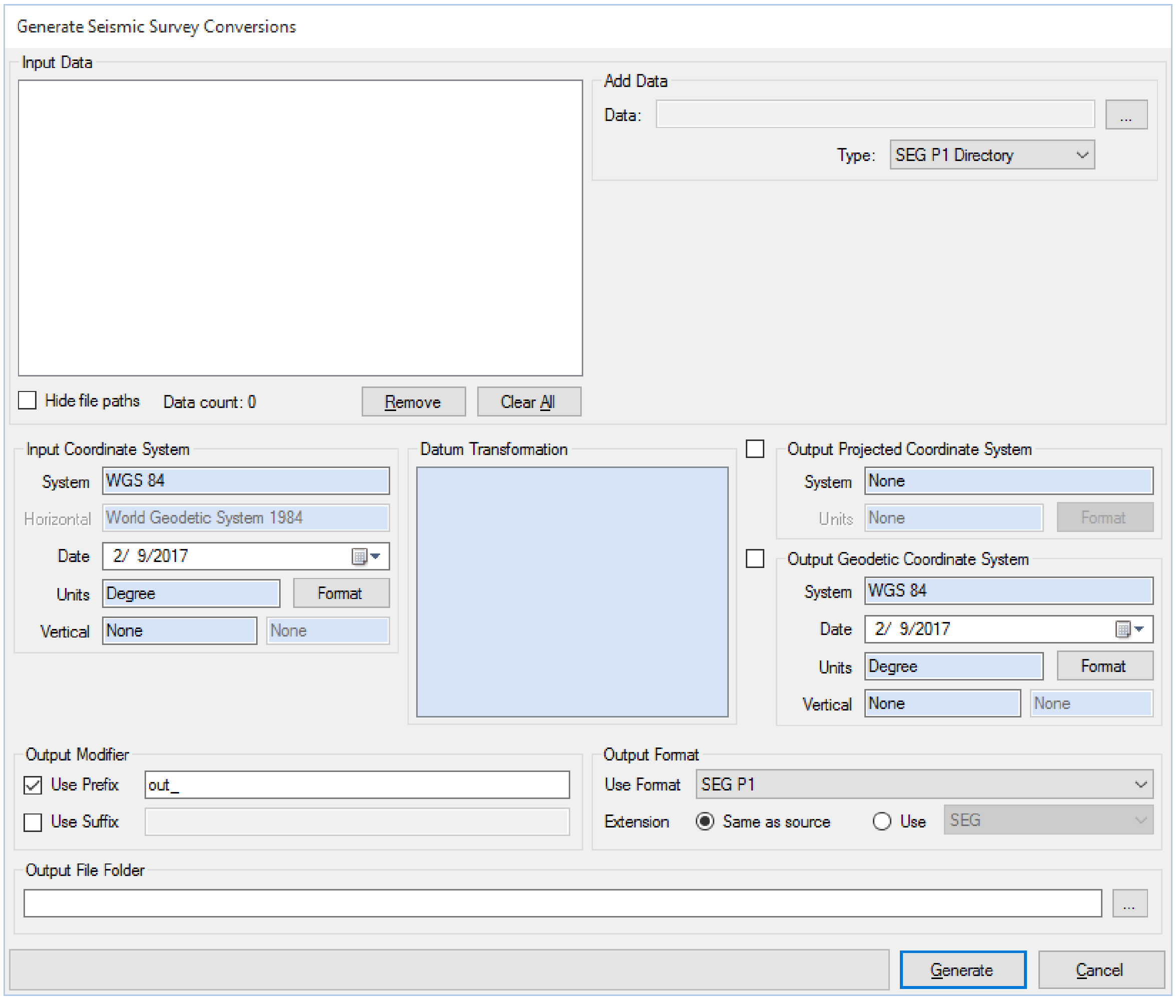
1. Within Geographic Calculator, right click on the Project in the Project Manager and select **Create New Batch->Batch Seismic Survey Conversion.**



2. This will create a new node in the Project Manager called "Batch Seismic Survey Conversion". Right click on this node to view the context menu.
3. Note that the first option is to Create New Job in this Batch. This will allow you to create new Seismic Survey Conversion jobs one at a time, define each, and then run all at once through the batch. While this can be beneficial in certain cases, we will select "**Batch Add...**" to create multiple Seismic Survey Conversions at once.



4. When you click "**Batch Add...**" you will see the Batch Seismic Survey Conversion dialog, as shown below.



5. The first step to creating the batch is to load the data files which need to be converted. Click on the **Add Data** button to load data. Set the file filter to SPS. In the example files associated with the Getting Started Guide, you will find **5 files** named **X05C507.SPS, X05C507 (2) .SPS, etc**. Select all 5 of these files and click **Open**.

   Use the CTRL or SHIFT key to select multiple files to load at once.

   When prompted select **yes** to using the scheme specified in preferences to load the SPS Files.

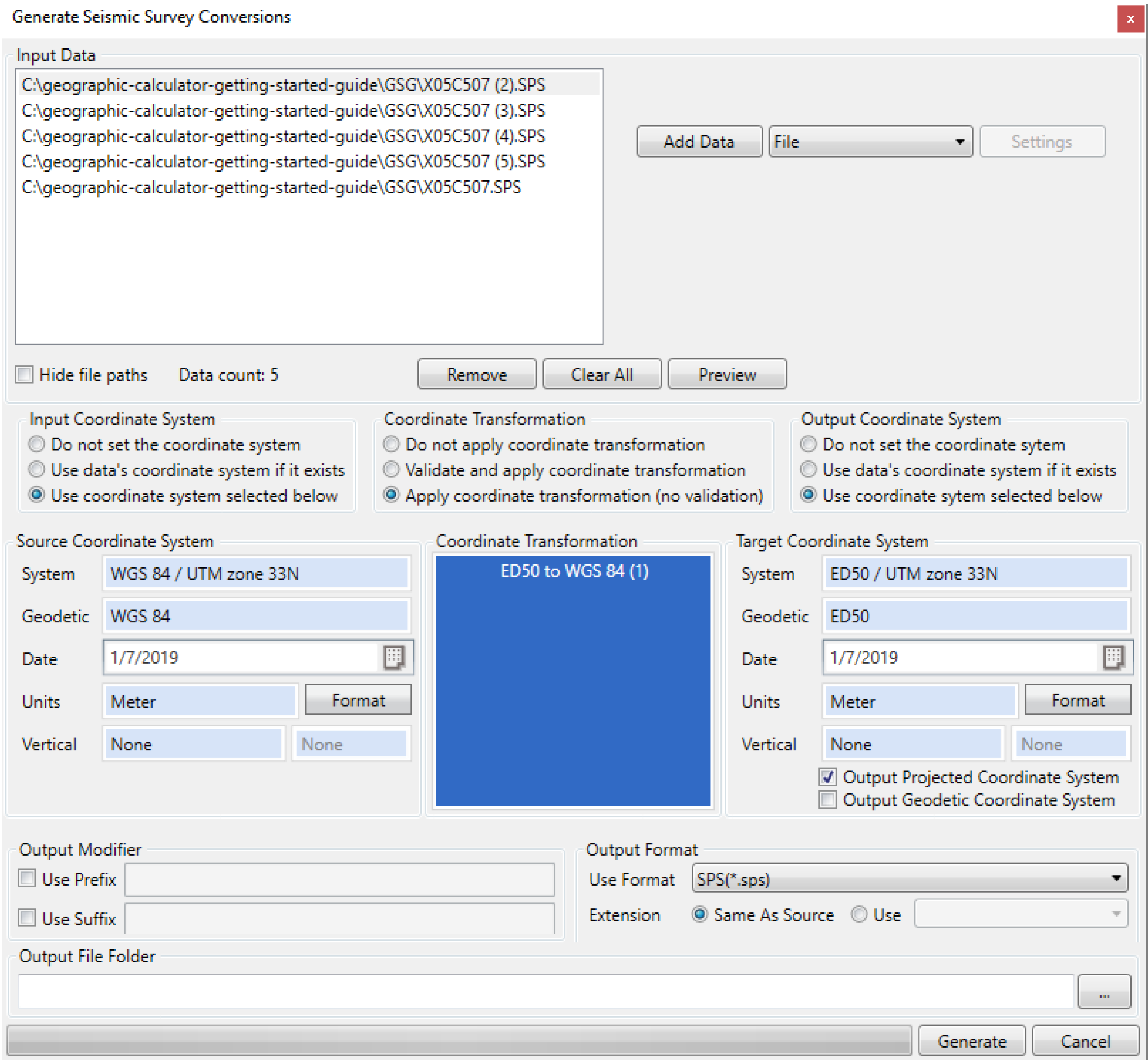
6. After these files have been successfully loaded we will then need to set the appropriate *Input* and *Output Coordinate System* settings. Set the Input and Output Systems to **Use Coordinate System Selected Below**.

   In the **Source Coordinate System**, double click the System box to select **WGS84 UTM Zone 33N**.

   In the **Target Coordinate System** box, double click the System Box to select **ED50 UTM Zone 33N**.

Set the *Coordinate Transformation* to **Apply coordinate transformation (no validation)**. Double click in the **Datum Transformation** box to select **"ED50 to WGS84 (1)"**.

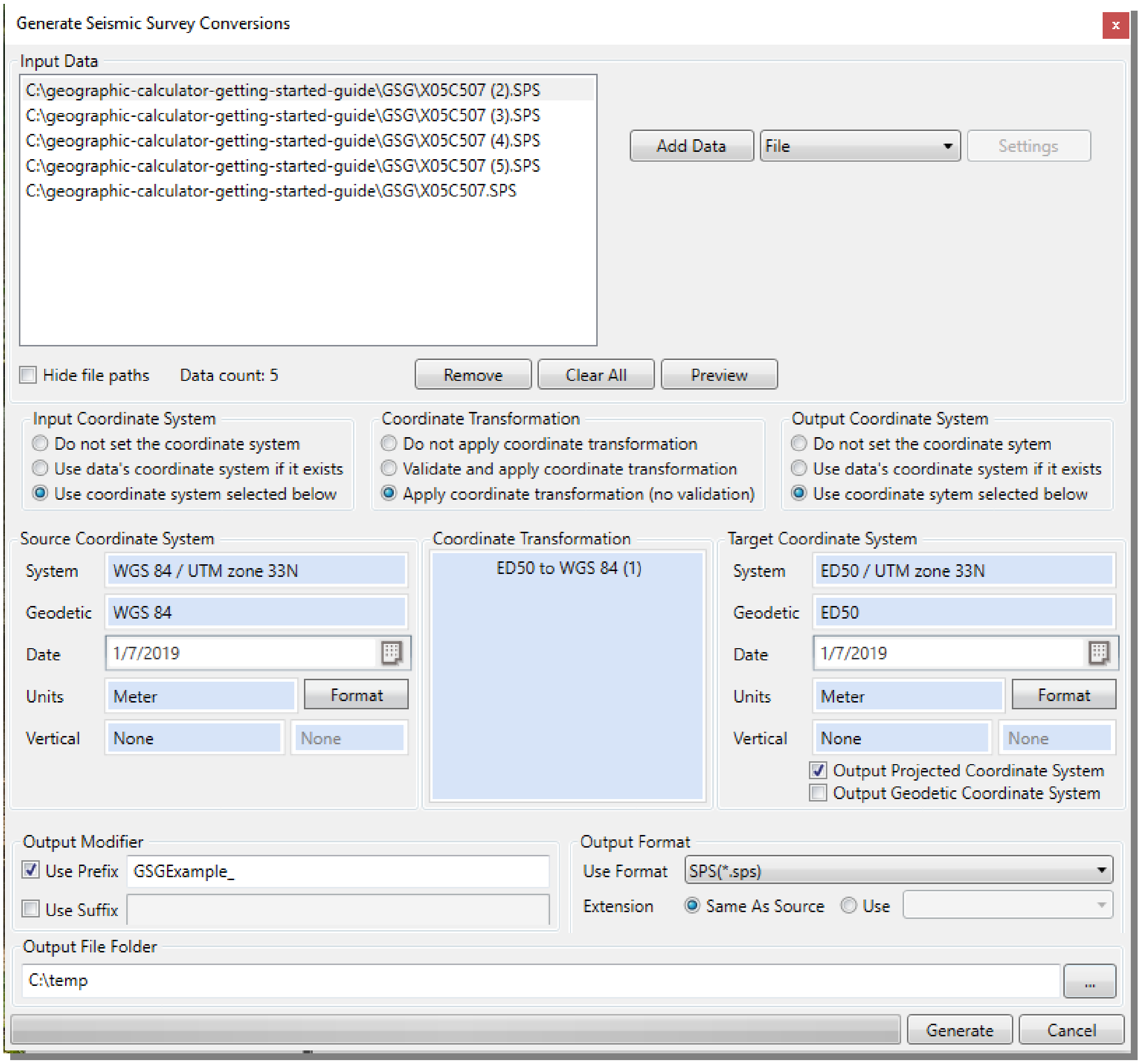
Activate the checkbox next to the Output Projected Coordinate System section to indicate that we will **output only Projected data**.



7. Finally, we will select the output preferences. On the left, select the Output Modifier **Use Prefix**. The output file name(s) will be based off the input file associated with the process, however we can alter the modifiers to make the output files more easily recognizable. Change the **Use Prefix** to "**GSGExample_**".

8. We will leave the output format as default, however for future reference this is where we would specify whether we want to write out to the same format with the same extension, or a custom defined format, a process performed in the Preferences.

9. In the Output File Folder section, click the ellipsis to select a folder to output the final results. Below is an example of the Generate Seismic Survey Conversions dialog just before generation.



10. Click **Generate**. This will process for a moment, and you should then be returned to the main Geographic Calculator interface, and there will be 5 new jobs nested beneath the previously created Batch Seismic Survey Conversions node. Note that **these jobs have not yet been processed**. The Generate Seismic Survey Conversions dialog is designed only to create the jobs. At this point you can continue to click on each job to edit individual settings, or continue to process the batch as a whole.

11. To process all 5 files at once, right click on the Batch Seismic Survey Conversions dialog and select "**Process**".

12. After processing, all output files will be in the directory you specified.

Lab 6: Georeferencing

Objective: The goals of this lab are to

- Georeference an image using the Georeferencer.
- Save a Reference Settings File. The source image data is a USGS Topographic Quad Map.

When raster data is first created either as a picture of the earth from an airplane or satellite, or even when a paper map is scanned into a computer, it has no relation to any real world coordinate system. The process of georeferencing establishes the relationship between image pixel locations and real world ground coordinates. Georeferencing is accomplished by selecting points on the image with known ground coordinates (benchmarks, grid ticks, etc.) and linking them to specific pixel locations. After the image is georeferenced, each pixel will have a real world coordinate assigned to it.

The online help file provides any additional information that you may require. This lab manual will take you through the process of referencing and manipulating image data.

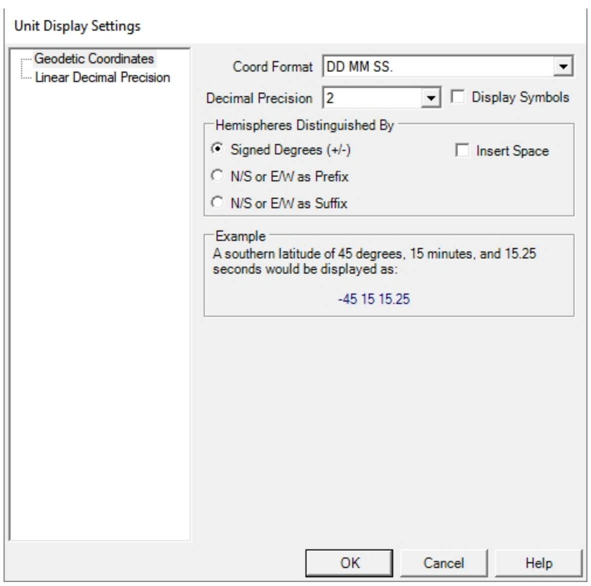
Data: Africa_Photo.tif, World_Countries.shp

Section 1: Point Selection

In this exercise, you will take an image of Africa and georeference it using the Source and Reference image viewers in the Georeferencer.

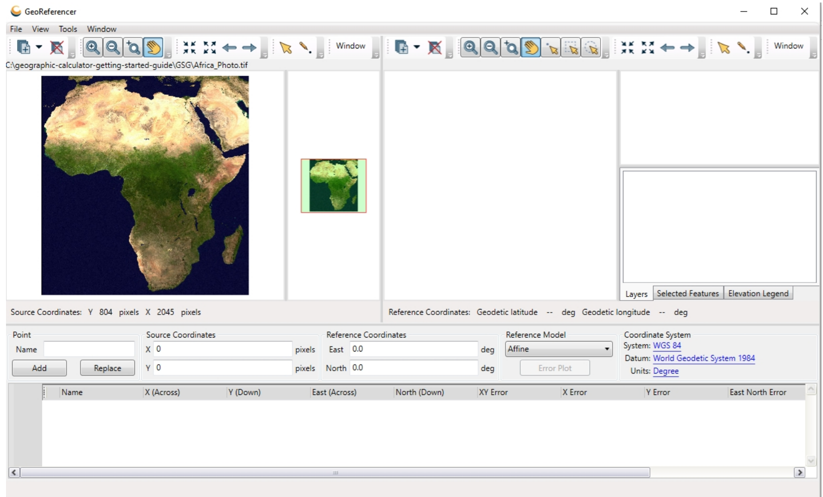
Follow these steps to add reference points to an image:

1. Select **Options>Preferences** in the **Georeferencer** menu. This will bring up a **Preferences** dialog. Set the Coord Format to **DD MM SS**. and the **Decimal Precision** to **2**. Click **OK** to close the dialog.



2. Click the **Open Georeferencer** button. This will open the **Georeferencer**.

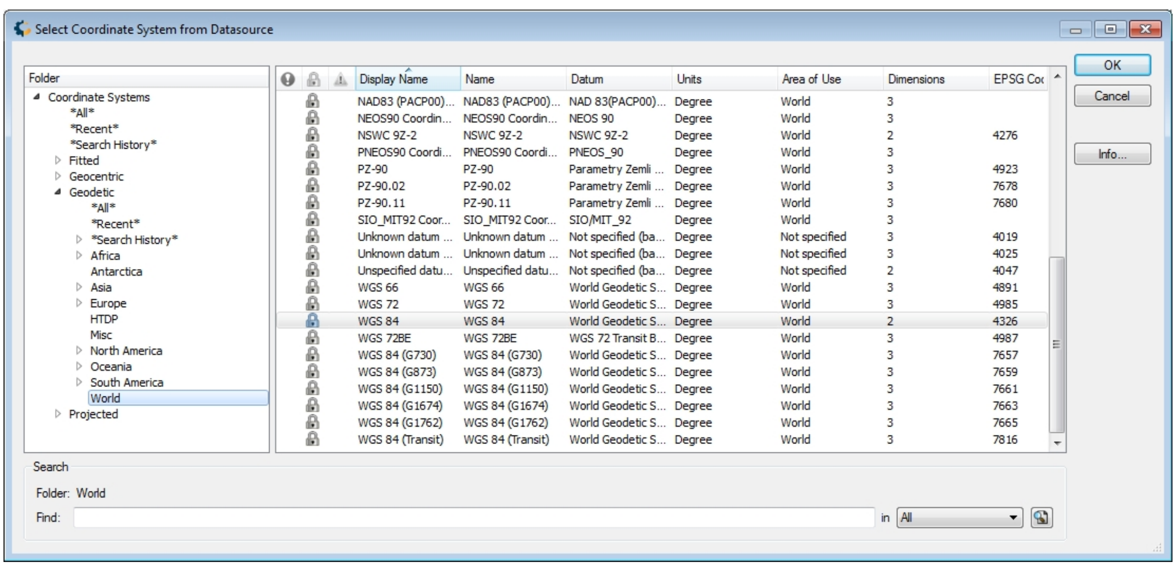
   The **Georeferencer** has two viewer windows, the *Source Data Viewer* and the *Reference Viewer,* next to each other for setting up and viewing the reference points.

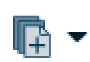


3. In the **Coordinate System** area of the Georeferencer, the Coordinate System should be set to WGS84. If not, click the blue Coordinate System link to open the *Select Coordinate System from Datasource* dialog box.

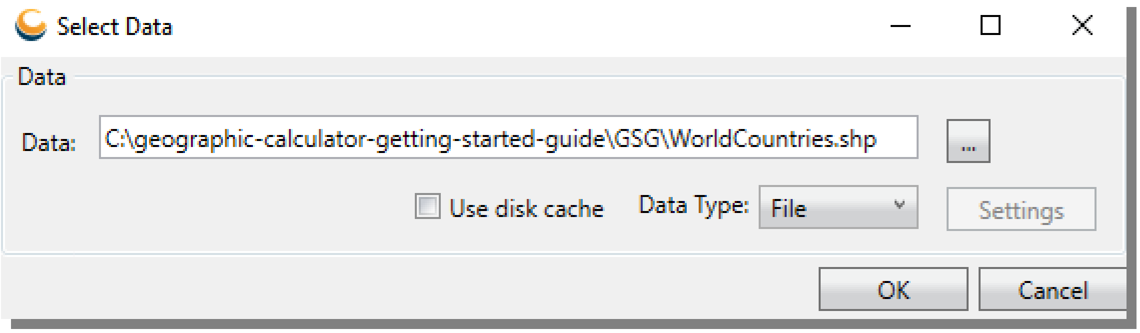
   If prompted for a Coordinate System Selection Method, press **No** to view the full Coordinate System list.

   If not already highlighted, select **WGS84** from the Geodetic list of Coordinate Systems and click **OK** to close the *Select Coordinate System from Datasource* dialog box. Click **OK** to close the *Coordinate System* dialog box.



4. In the *Source Viewer* on the left click the **Import Data into Reference**  button, and choose **Load Data**. Select the file Africa_Photo.tif (C:\geographic-calculator-getting-started-guide\GSG).

5. In the *Reference Viewer*, click the **Import Data into Reference** button, and choose **Load Data**. This will pop up a dialog:

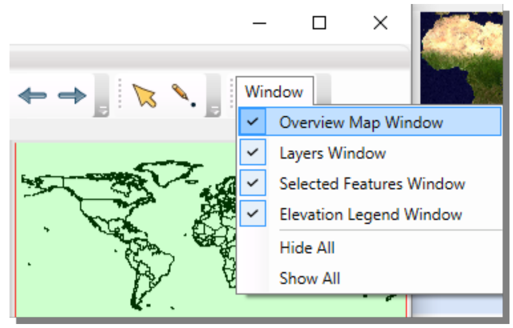


Click **'...'** and select the *World_Countries.shp* file that was downloaded with this Getting Started Guide (C:\geographic-calculator-getting-started-guide\GSG). Click **OK**; the map will be displayed in the main view panel of the *Reference Viewer.*

6. The portion of the image displayed in the main panel of each viewer, and the actions which can be performed within it, are controlled by using the set of tool buttons at the top of the viewer. Some of the buttons perform immediate actions on the main view panel, while others are a set of option buttons which assign mouse actions to various tasks.

    - Clicking the **Go To Previous View** button undoes the most recent change to the panel's display area.
    - Clicking the **Go To Next View** button redoes the most recent change to the panel's display area. Using these buttons, the user can navigate through the 30 most recent display actions.
    - Clicking the **Zoom To Map Extents** button displays the entire image within the main view panel.
    - With the **Recenter** tool option selected, clicking the left mouse button moves the display such that the point clicked is shown in the center of the panel.
    - With the **Zoom To Rectangle** tool option selected, the user can zoom to a rectangular area that is clicked-and-dragged with the mouse.
    - With the **Zoom In** tool option selected, clicking the left mouse button both recenters the display to the clicked location and zooms the display in by the factor currently specified in the Viewer tab of *Preferences*.
    - With the **Zoom Out** tool option selected, clicking the left mouse button both recenters the display to the clicked location and zooms the display out by the factor currently specified in the Viewer tab of *Preferences*.
    - With the **Make A New Point** tool option selected, clicking the left mouse button automatically places the image pixel coordinates within the reference point information Source X (Across) and Source Y (Down) input boxes.
    - The **Remove All Layers From All Maps** tool will clear all map layers from the Image Viewer allowing the user to start with an empty map.

You can also activate additional information windows. The Source Data viewer can include an additional *Overview Map* window, and the Reference viewer can include any or all of the following: *Overview Map*, *Raster Layers*, *Vector Layers*, *Selected Features*, and *Elevation Legend*. Clicking on the Window menu allows you to hide or show these different windows.



7. Using the aforementioned tools, in the *Source Data Viewer*, zoom the display in to the area near the Strait of Gibraltar in the upper area of the image, such that you can easily identify the point of land that forms the straight. Once you've zoomed in, open the *Overview Map* from the *Source Data Viewer* Windows in the Windows menu to view the Overview map. You will see the extents of the map displayed with a green and red box in the upper left area to represent what the main view window is displaying.

   If you prefer to have the Overview map hidden, uncheck Overview window from the Window menu on the toolbar.

8. In the *Reference Viewer*, zoom the display in to the area near the Strait of Gibraltar above Africa, similar to what is showing in the *Source Data Viewer*.

9. In the *Source Data Viewer*, click on the **Make A New Point** tool, then click on the point of the Strait of Gibraltar. Two numbers will appear in the X and Y fields of the *Source (pixels)* box on the Reference Point List.

   Note: These numbers should be approximately **X =347, Y =70** depending on exactly which pixel you choose. You may want to zoom in very close to get more accurate selections.

10. In the *Reference Viewer*, click on the **Make A New Point** tool, then click on the same point of the Strait of Gibraltar. Two numbers will appear in the East and North fields of the *Reference (ground units)* box on the Reference Point List.

    Note: These numbers should be approximately East =-05 25 17.86, North =35 53 03.68 depending on exactly where you click.

11. Give the reference point a unique name (in the *Name* field of the Point box), such as "Gibraltar".

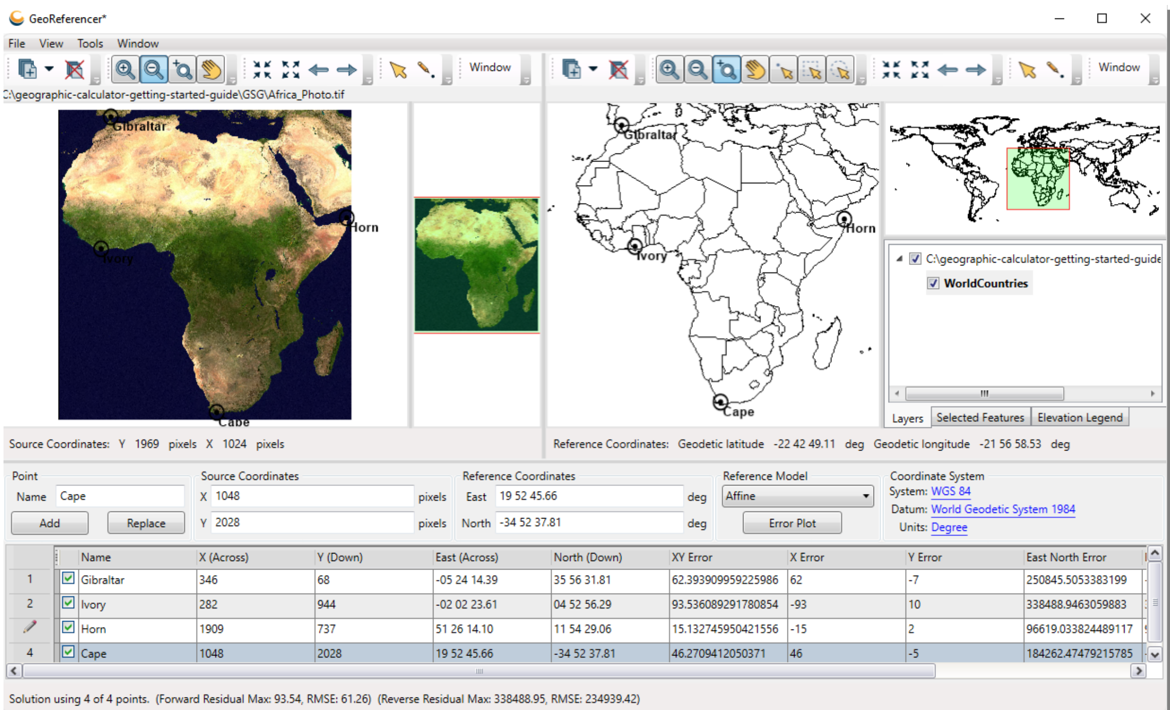
    Note: All points in a given list require different names. If you do not to enter a unique point name, the Geographic Calculator will request one.

12. Click on the Add button below the point name to add the point to the *Reference Point List* below. A symbol 

will appear on the image in both viewer windows.

13. Repeat steps 6 through 11 for three more points, the Cape of Good Hope (southern tip of Africa), the Horn (the point on the east coast of Africa) and a point along the Ivory Coast (the western coast of Africa) would be good selections.

    Entries in the *Reference Point List* may be recalled to the Reference Point Information area by double-clicking the entry in the *Reference Point List*. This also changes the color of the point marker in the source viewer's main view panel to green rather than red. Entries may also be deleted, either individually or all (In the *Reference Point List* right click and select appropriate option).

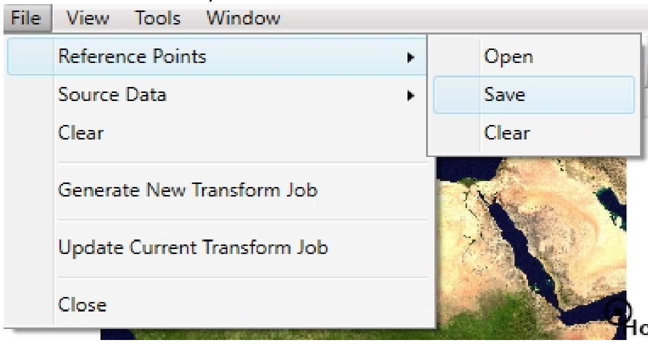


14. Your Georeference is now complete and you are ready to continue on to [Section 2: Saving the Reference Point File](#)

Section 2: Saving the Reference Point File

Once you have selected all four corner points, they must be saved as a group (i.e. a *Reference Settings File*).

1. From menu bar, select **File>Reference Points>Save**.



Africa

2. Give the Reference Point file a name.

> **Note:** A name should be selected that will easily be associated with the image. Title this file "Africa_Photo.rsf". This is a Reference Settings File. It is an Input file that contains reference point information. When this RSF is processed, a text file is generated. This text file can be viewed in a text editor or printed.

3. Click **Save**.
4. Close the *Georeferencer* window.

You are now ready to continue on to [Lab 2: Transformation](#)

Lab 7: Transforming Images

The transformation process repositions source image pixels based on the relationship defined by a referencing file and a transformation model and creates a new image map from a geographically referenced source image. A transformation can be viewed as the joining of the Source Image and the Reference Settings File. The process is documented in the generated *.log file.

Objective: The goal of this lab is to transform an image with its referencing file into an image map. The data used are an image of Africa and an RSF file created by the referencing process in Lab 6.

In Lab 6, reference points were selected and saved in an RSF file. Now click on the **Raster Transform** tab to open the transform dialog. The *Source Data* and *Reference* files and the input coordinate system will be pre-selected in the **Image File**,**Reference File**, and the **Coordinate System** areas.

Data: Africa_Photo.tif, Africa_Photo.rsf (*created in Lab 1: Georeferencing*)

Note: Image Files and Reference Files may also be opened by clicking the ellipsis "**...**" button and selecting the desired file.

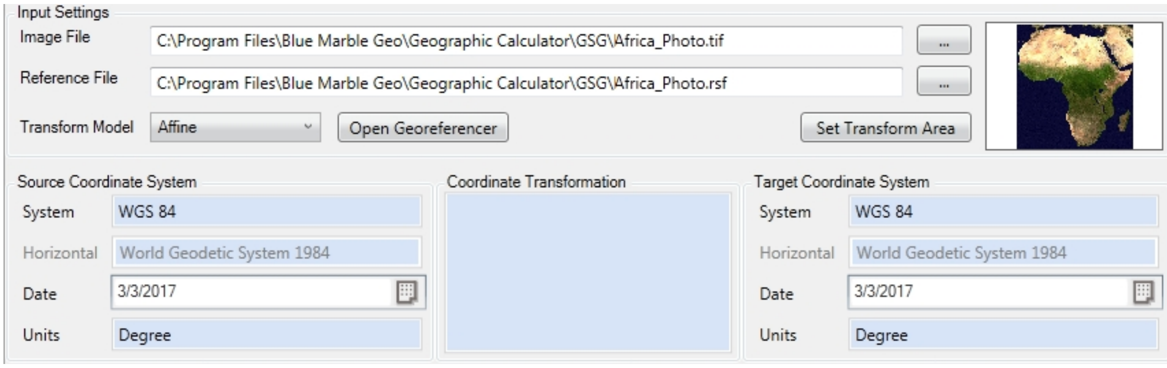
Section 1: Transforming the Image

This lab requires the completion of Lab 6, which created a reference file (*.rsf) for the *Africa_Photo.tif* image.

Follow these steps to set the input parameters for Transformation:

1. Create a new Raster Transform job.
2. For the *Image File* box, or the one listed is incorrect, click the browse (...) button to the right of that box. Look for the *Africa_Photo.tif* file that was used in Lab 6, which came with your **Getting Started Guide.**

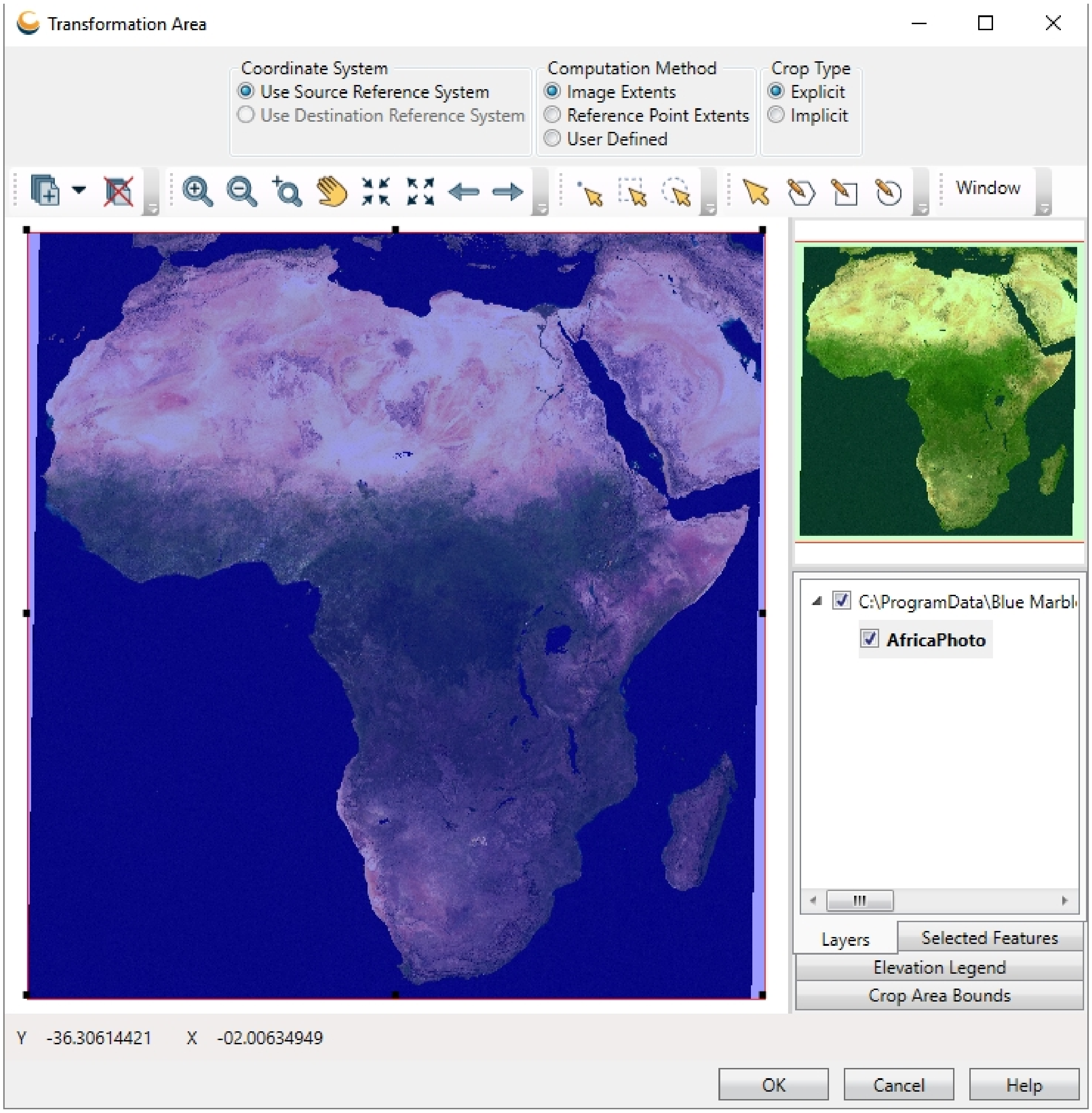
3. If there is no file listed in the *Reference File* box or the one listed is incorrect, click the browse (...) button to the right of that box. Look for the *Africa_Photo.rsf* file that was created in Lab 6.



4. If your *Reference Coordinate System* is not showing as **WGS84**, double-click in the *System* text box in that area to open the *Select Coordinate System from Datasource* box.

   Select **WGS84** from the Geodetic list of Coordinate Systems and click **OK** to close the *Select Coordinate System from Datasource* dialog box. Click **OK** to close the Coordinate System dialog box.

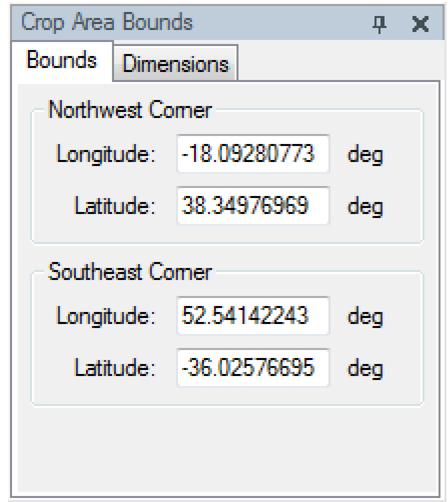
5. Click the **Set Transform Area** button. This will display the Transformation Area form:



6. In the *Computation Method* area of the *Transformation Area* window, make sure the *Image Extents* radio button is selected.

   The viewer window will show a red highlighted box to represent the transformation area to be used.

   You could adjust the transform area by manipulating the red box right in the view window, or by typing in corner coordinates in the *Crop Area Bounds* boxes in the tab at the lower right of the window. Selecting *Image Extents* will fill the *Crop Area Bounds* boxes automatically.

   These coordinates define the Minimum Bounding Rectangle (MBR) of the source image. This is the area that will be written out to the new image map as a result of the Transformation process. This is the MBR that corresponds to the reference points in the RSF.

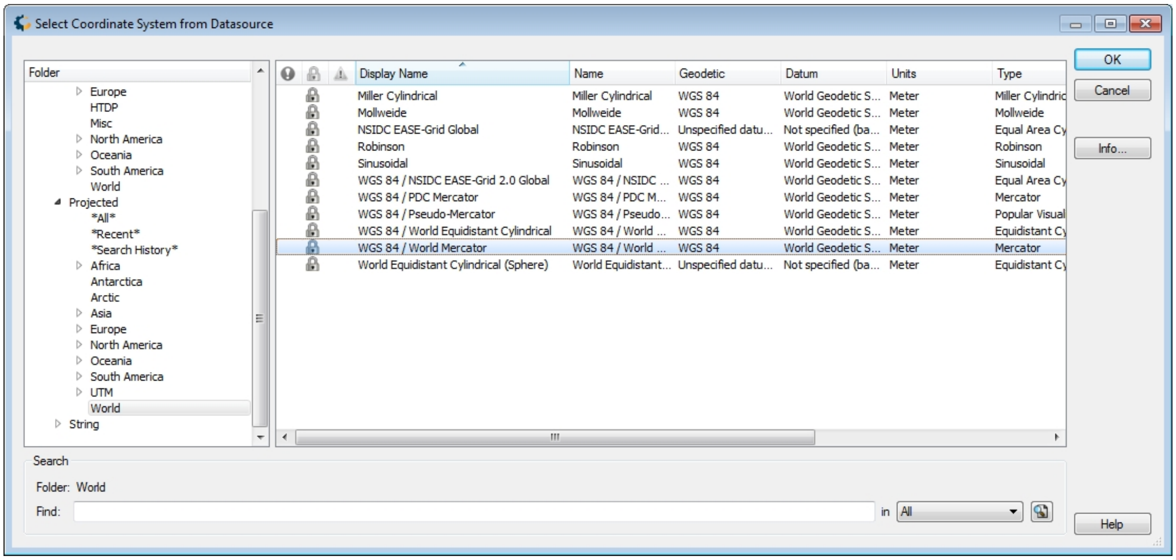
7. Click **OK** to save the settings and return to the transform job of the main window.

Continue to Section 2: Output Parameters

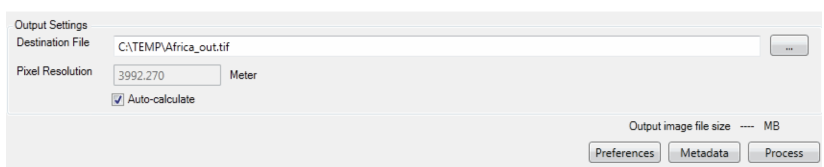
Section 2: Output Parameters

Follow these steps to set the Output Parameters:

1. Go to the *Destination Coordinate System* section of the transform job.
2. Double-click the **System** text box to open the *Select Coordinate System from Datasource* box.

   Select the **WGS84 / World Mercator** system from the world projections and click **OK**.
3. In the output settings area, click the browse **'...'** button next to the *Destination File* box to browse for a location to place your output image. This will allow you to name the image map and select the type of image file.
4. Enter the name and type of file as *Africa_out.tif*.
5. Click **Save**. Saving this information will enter *Africa_out.tif* and its path into the box.
6. Select the **Auto-calculate** check-box below the *Pixel Resolution* box.

   The pixel resolution is displayed as the resolution ***per pixel* in the defined output coordinate system**. Normally, the output resolution is equal to the resolution of the source image. If you would like to use a different output resolution, you may enter it into the *Pixel Resolution* field.

   When the image is transformed, by default, three types of reference files will be created, Reference Settings File (.RSF), MapInfo Table File (.TAB), and an ESRI World File (.TFW). This can be changed in the preferences by clicking the **Preferences** button and checking the required file types listed in the *Output Reference File Types* area.

Continue to [Section 3: Performing the Transformation]

Section 3: Performing the Transformation

Follow these steps to complete the transformation:

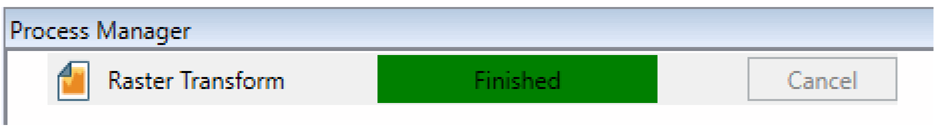
The image is now ready to be transformed.

1. You can save your transform job settings by using the menu bar to select **File>Save>Job**

   This will save your transform job settings so you can pull them up at a later date to run the transformation.

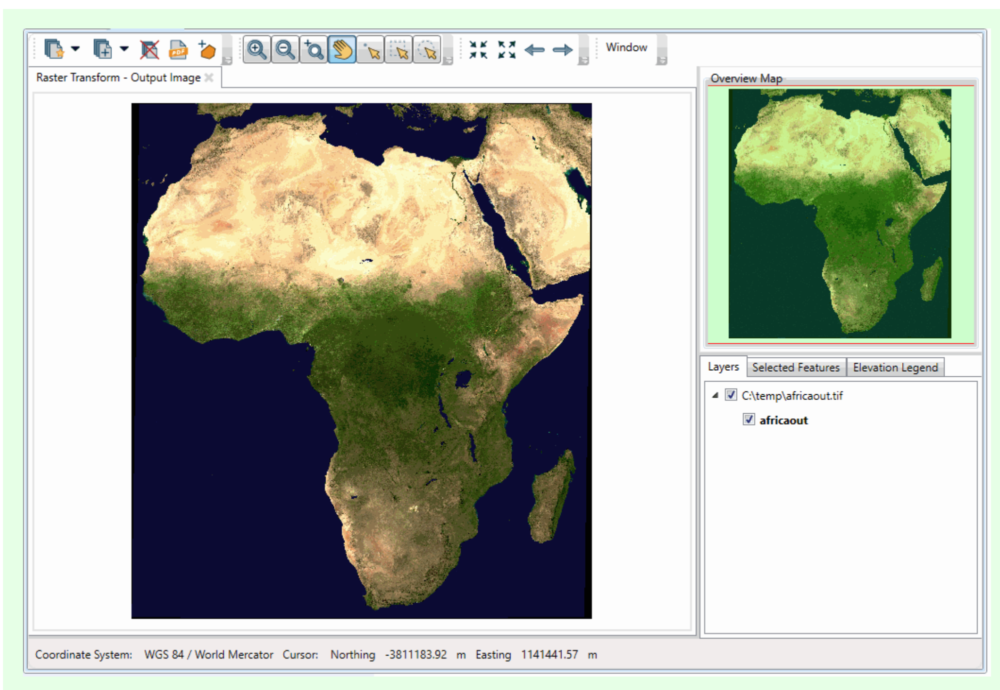
2. Click the **Process** button.

   While the transform job is running, the Process Manager at the bottom of the application will give you a continuous update of the status of the transformation. The bar also has a **Cancel** button that gives you the ability to cancel the transformation while it is running.



3. When the transformation is complete, you will receive a message that says, "The transform was successful. Do you want to view the image?" Click **Yes** to view the image.

   The image will be displayed in the *Viewer* tab.



> **Note:** The Coordinate System bar below the image shows the transformed coordinate system and the cursor location.

You are now ready to move on to Lab 3: Batch Transformation

Lab 8: Batch Raster Transformations

Objective: The goal of this lab is to set up several transform jobs and run them as a batch.

Geographic Calculator allows users to set up and save transform jobs to process at a later time or date. With the Batch Transform functionality, the user can add transform jobs to a batch to process all at once. This allows users to run multiple jobs during off hours, when they are at lunch or in a meeting or whenever it is most convenient for productive workflow.

Section 1: Prepare Batch Transform Files

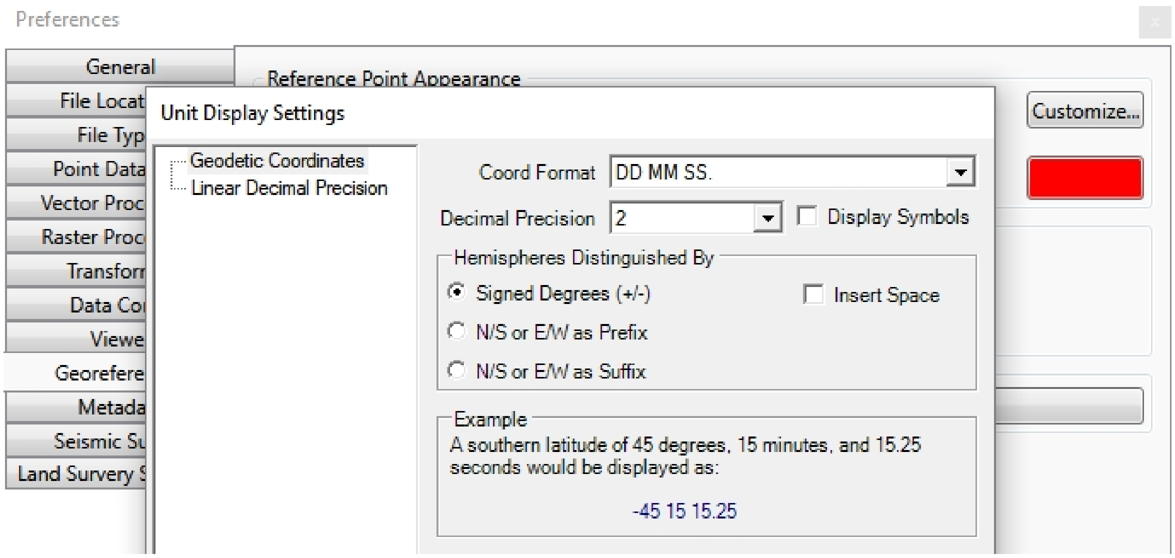
Objective: In order to complete the batch transform, four images must be referenced and transformed.

Data: Lab_Image1.tif, Lab_Image2.tif, Lab_Image3.tif, Lab_Image4.tif

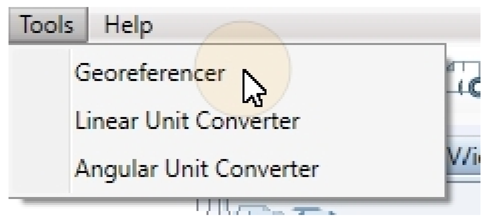
Note: This section of the Batch Transformation lab involves georeferencing source files. If you want to skip ahead to batch creation, you can use the reference files that were included with the Getting Started Guide.
To skip the georeferencing, copy the files from the *...\GSG\ReferenceFiles* (the reference file subfolder) to ...*GSG* (the folder that contains the source files.)
Then, skip ahead to Section 2: Create a Template Batch Job.

Follow these steps to prepare the files for your Batch Transformation:

1. Select **Options > Preferences** from the menu to bring up the Preferences dialog. Navigate to the *Georeferencer* tab and select the **Customize Coordinate Display Settings...** button. Make sure that the Geodetic **Coordinate Format** is set to "**DD MM SS.**" and that decimal precision is **2**. Also make sure that the **Linear Decimal Precision Format** has a decimal precision of **2**.

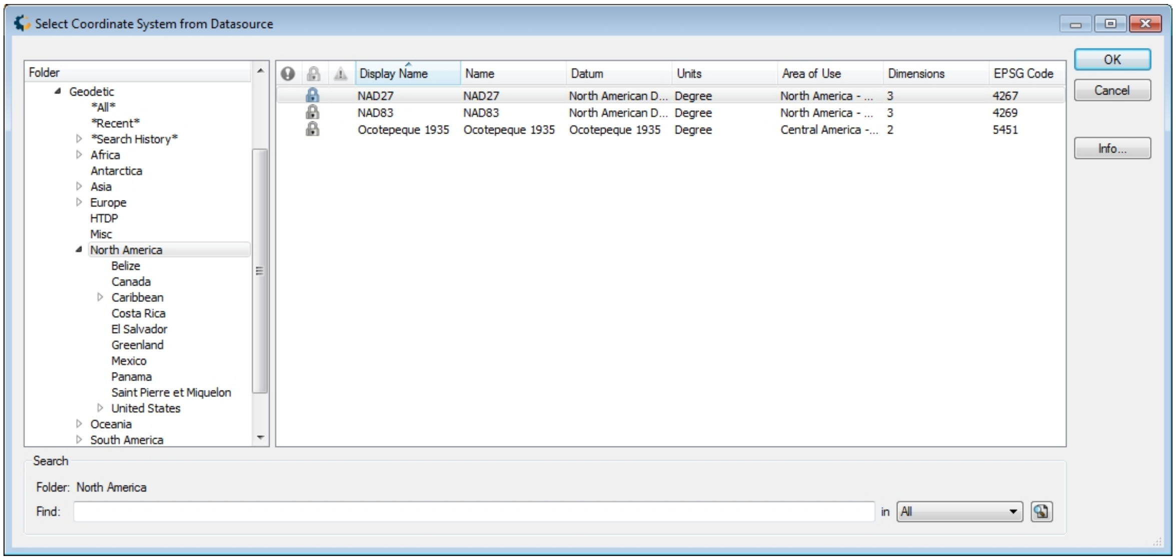


2. Select **Georeferencer** from the Tools menu to open the Georeferencer.

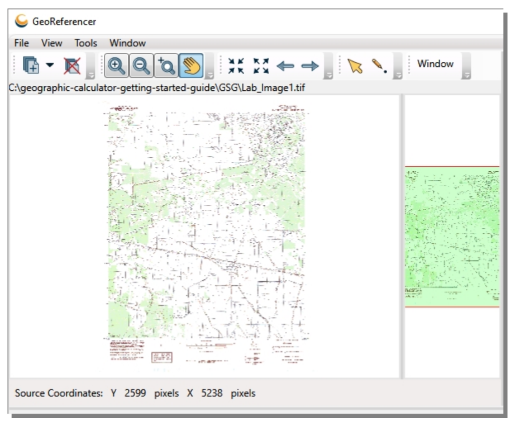


3. In the *Coordinate System* area of the Georeferencer window, click the blue text of the Coordinate System. Double-click in the *System* text box to open the *Coordinate System* dialog box.

   If not already highlighted, select **NAD27** from the Geodetic list of Coordinate Systems and click **OK** to close the *Select Coordinate System from Datasource* dialog box. Click **OK** to close the *Coordinate System* dialog box.



4. In the *Source Image Viewer*, click the **Import Data** button, and choose Load Data. Select the *Lab_Image1.tif* file that was downloaded with this **Getting Started Guide.**



5. Zoom the display in to the northwest corner of the map.

6. Using the **Make A New Point** tool, click the corner of the map image.

   These numbers should be approximately **X = 290, Y = 289**

7. In the *Reference Point List* entry area, enter the reference coordinate from the map. These numbers should be **East =-94 45 0, North =30 7 30**

8. Give the reference point a unique name, such as "**Point 1**".

9. Click on the **Add** button below the point name to add the point to the *Reference Point List* below.

10. Zoom into the other corners of the map image to create three more points. You can use the following points to check your work:

Point 2	
X value:	4645
Y value:	293
East value:	-94 37 30
North value:	30 7 30
Point 3	
X value:	4647
Y value:	5287
East value:	-94 37 30
North value:	30 0 0
Point 4	
X value:	285
Y value:	5287
East value:	-94 45 0
North value:	30 0 0

11. Once all four points have been added, select **File > Reference Points > Save** from the menu bar and save the reference file for this image.

12. Close the *Georeferencer* window. Repeat steps 1 through 11 for the other 3 image files, *Lab_Image2.tif, Lab_Image3.tif,* and *Lab_Image4.tif*. View the readme file for each image if you wish to confirm the reference points to use.

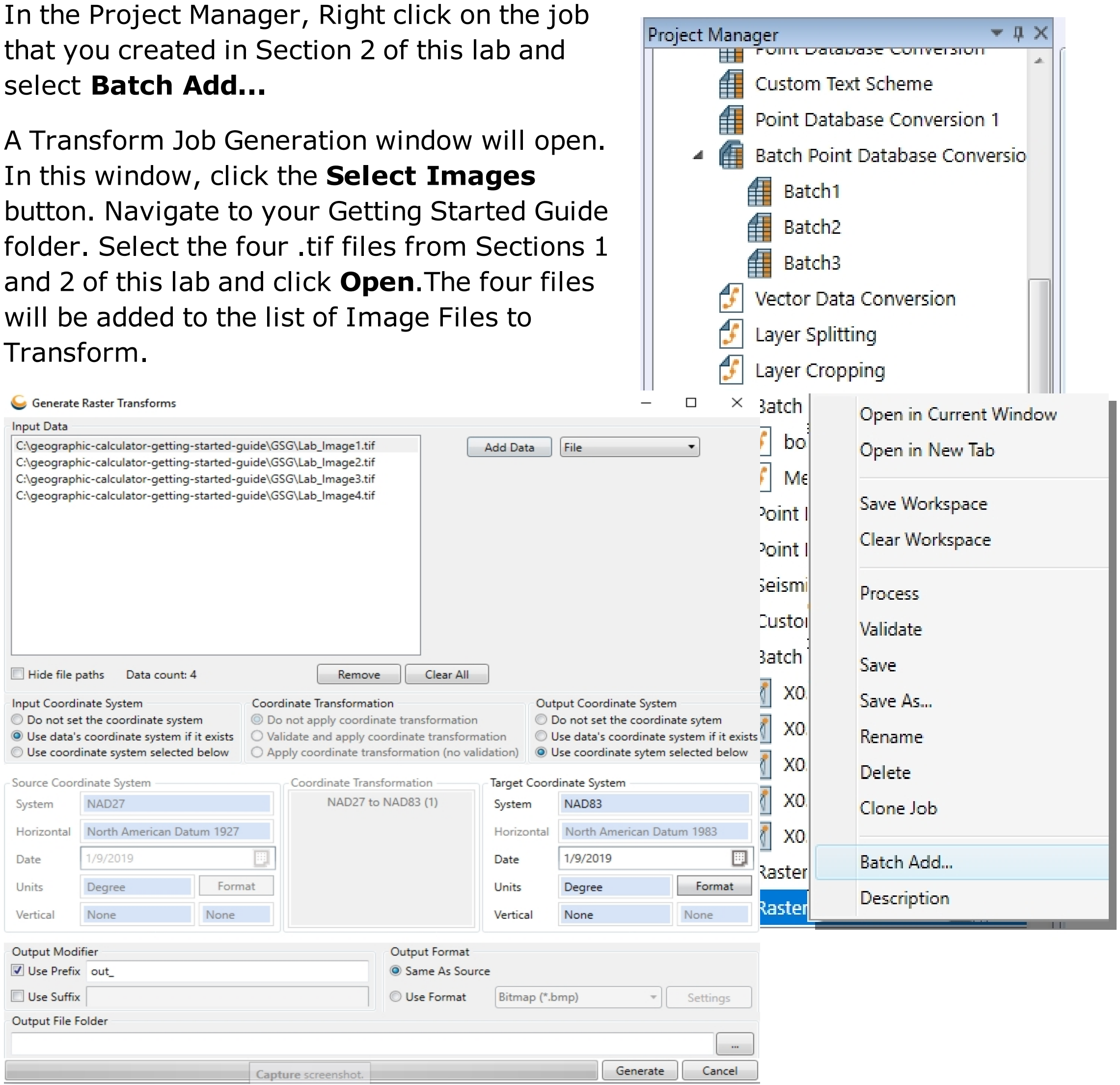
Section 2: Create a Template Batch Job

1. Click the Create a new transform button to open a new Raster Transform job.
2. Click the browse (**...**) button to the right of the Image File box to select an input image file. Select *Lab_Image1.tif* from the Getting Started Guide folder.
3. Click the browse (**...**) button to the right of the Reference File box to select the reference file that you created in Section 1 of this lab. Select *Lab_Image1.rsf* from the Getting Started Guide folder.
4. In the transform job, set the *Destination Coordinate System* to Geodetic **NAD83**.
5. Double-click the *Datum Transformation* text box. Select **NAD27 to NAD83 (1)** from the Datasource Transformations> Datum> North America > United States folder for the datum transformation to use in the *Select Datum Transformation from Datasource* box.
6. Click on the **Set Transform Area** button to open the Transformation Area dialog. Set the **Computation Method** to **Reference Point Extents**, then click **OK** to close the dialog.
7. Set the *Pixel Resolution* to **Auto-calculate**.

Continue to Section 3: Process a Batch Transform

Section 3: Process a Batch Transform

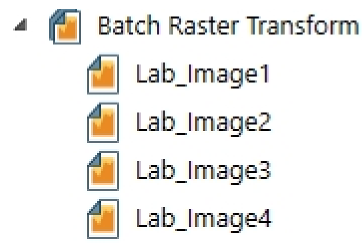
1. In the Project Manager, Right click on the job that you created in Section 2 of this lab and select **Batch Add...**
2. A Transform Job Generation window will open. In this window, click the **Select Images** button. Navigate to your Getting Started Guide folder. Select the four .tif files from Sections 1 and 2 of this lab and click **Open**.The four files will be added to the list of Image Files to Transform.



The Source and Target systems will be copied from the template job created in Section 2, but note the other options available for specifying input and output coordinate system and transformation.

3. Click the browse (**...**) button to the right of Destination Folder to select a folder where your transformed images will be written.
4. You can leave the *Output Modifier*, and *Output Format* settings at their defaults. The output files will be written as .tif files with the prefix out_ and the name of the input file.

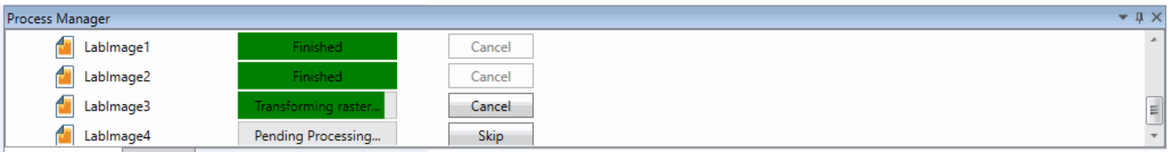
5. Click the **Generate** button. A Batch Raster Transform will be created and added to the project manager. Individual jobs for each of the input files will be added to the batch.



6. If you have any last minute adjustments you need to make to the settings of any of the transform jobs, click its name in the Project Manager and it will display in the main job window.

7. Right click on the Batch Raster Transform in the Project Manager and select **Process**.

   The *Process Manager* will show the progress of each transform job in the batch. Any errors encountered will also be noted.



Lab 9: DEM Transformation

Geographic Calculator now includes support for three dimensional Digital Elevation Models (DEM files). The following file formats are supported:

Supported input formats:

- Arc/Info Ascii Grid (*.asc)
- Arc/Info Binary Grid (*.adf)
- DTED Military Elevation (*.dt0, *.dt1, *.dt2, *.dt3, *.dt4)
- USGS SDTS DEM (*.ddf)
- USGS Ascii DEM (*.dem)
- BIL Raster Dataset (*.bil) (This file type could contain either two-dimensional or three-dimensional data.)
- BSQ (*.bsq) (This file type could contain either two-dimensional or three-dimensional data.)
- Shuttle Radio Topography Mission (*.hgt)

Supported DEM output formats:

- Arc/Info Ascii Grid (*.asc)
- USGS Ascii DEM (*.dem)

DEM files can also be written out as two-dimensional raster images in any of the supported raster output file types. Converting a three dimensional image to a two dimensional raster will create a file with two-dimensional coordinate referencing and colors based on the DEM shader options.

This Lab includes three sections:

- Section 1: Configuring the Shader
- Section 2: Converting DEM to DEM

Section 1: Configuring the Shader

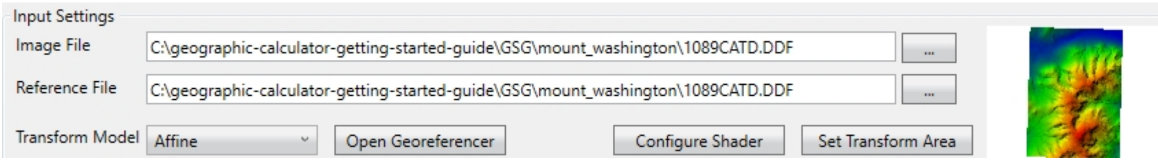
In the Geographic Calculator viewer, DEM files are colorized to indicate elevations. The viewer also uses hillshading to indicate slopes. Users can configure these options to customize the appearance of the file. The shader controls both the current appearance of the file in the viewer and the appearance of the raster image that is created from a DEM conversion.

Objective: To configure the DEM shader to the user's preferences before converting a DEM file to a raster image.

Data: mount_washington/1089CATD.DDF

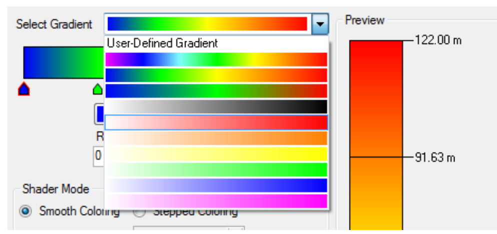
1. Create a new Raster Transform job by right clicking on the Project in the Project Manager and selecting **Create New Job> Raster Transform.**

2. In the Raster Transform job, click the Browse **(...)** button to the right of the Image File field to select an input image. Select **1089CATD.DDF** from the Mount Washington folder within the Getting Started Guide data. This file name will appear in both the Image File and Reference File fields, and a thumbnail view of the image will be displayed.



3. Click on the **Configure Shader** button. This button only appears when a DEM file has been loaded as the input image file.

4. The Configure Elevation Shader dialog will open, showing the default settings for the DEM shader. In the *Select Gradient* drop-down box at the top of the dialog, you can choose from one of the predefined gradients. Open this box and select the third gradient, blue - green - red. You will see that the preview changes to match your selection.



5. You can also customize the gradient by adding, removing, or selecting and changing the color steps. These steps are shown as arrows below the gradient. Select the red arrow at the right of the gradient, and the color bar below will show the red color of that step. Click on the color bar to change that color, and choose yellow from the color selection window. The gradient and the preview will now both show a blue - green - yellow gradient.

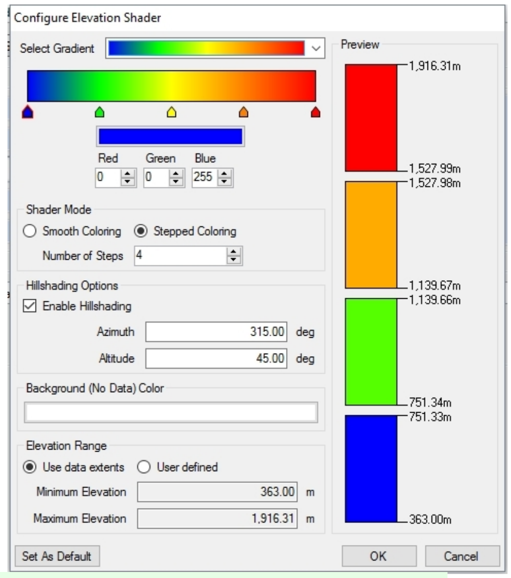
6. In the Shader Mode area, select **Stepped Coloring** and set the number of steps to 4. The Preview will now show the new gradient, and the maximum and minimum elevation for each of the color steps. Stepped coloring allows the user to view discrete elevation ranges as different bands of color.

7. Hillshading gives the illusion of slope to a DEM image by applying a virtual light source.

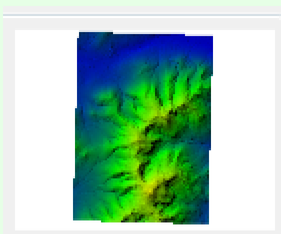
   Azimuth represents the angle of this light source, measured as degrees from north (i.e., 315 is Northwest).

   Altitude represents the height of this light source, measured as degrees up from the horizon.

   For this exercise, you can leave the hillshading options at their defaults.



8. Choose a desirable color ramp and smooth or stepped coloring. Then click **OK** to close the Elevation Shader window.



You will see that the thumbnail image reflects your changes.

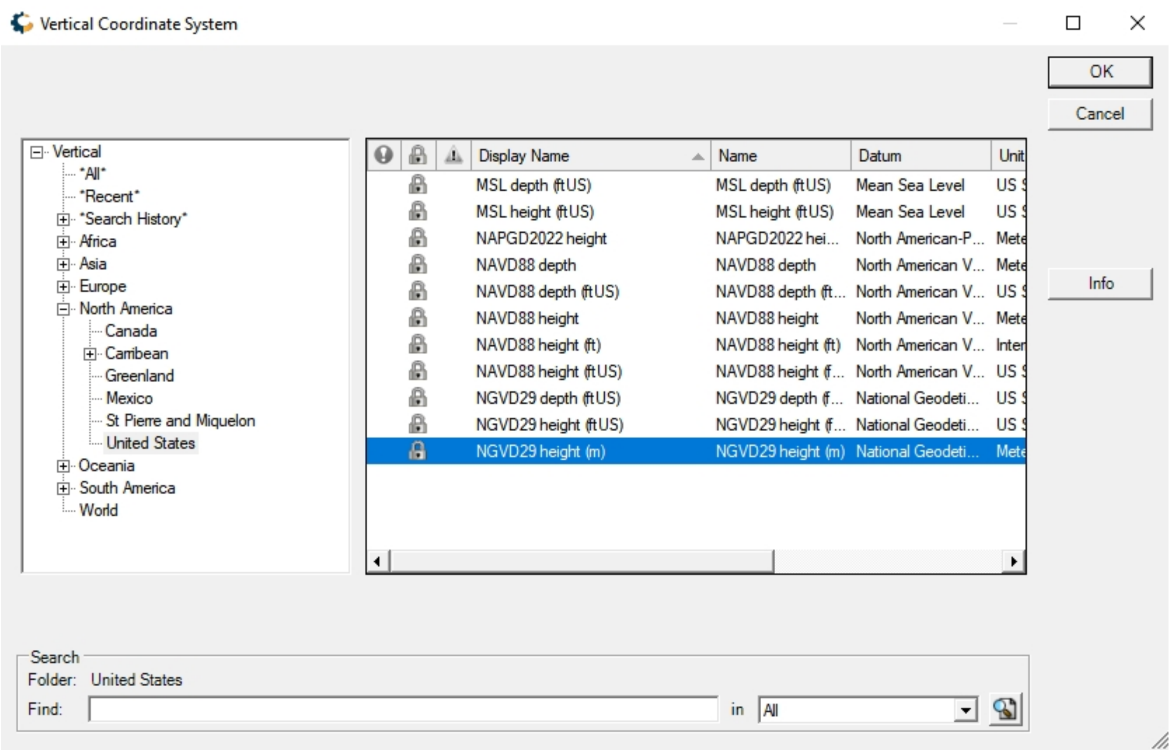
You are now ready to move on to "Section 2: Converting DEM to DEM" on the next page

Section 2: Converting DEM to DEM

Objective: To convert a DEM file from the .ddf format to the .asc format, while transforming both the horizontal and vertical data.

This exercise is a continuation of "Section 1: Configuring the Shader" on page 155. You should already have the Mount Washington input file *1089CATD.DDF* loaded.

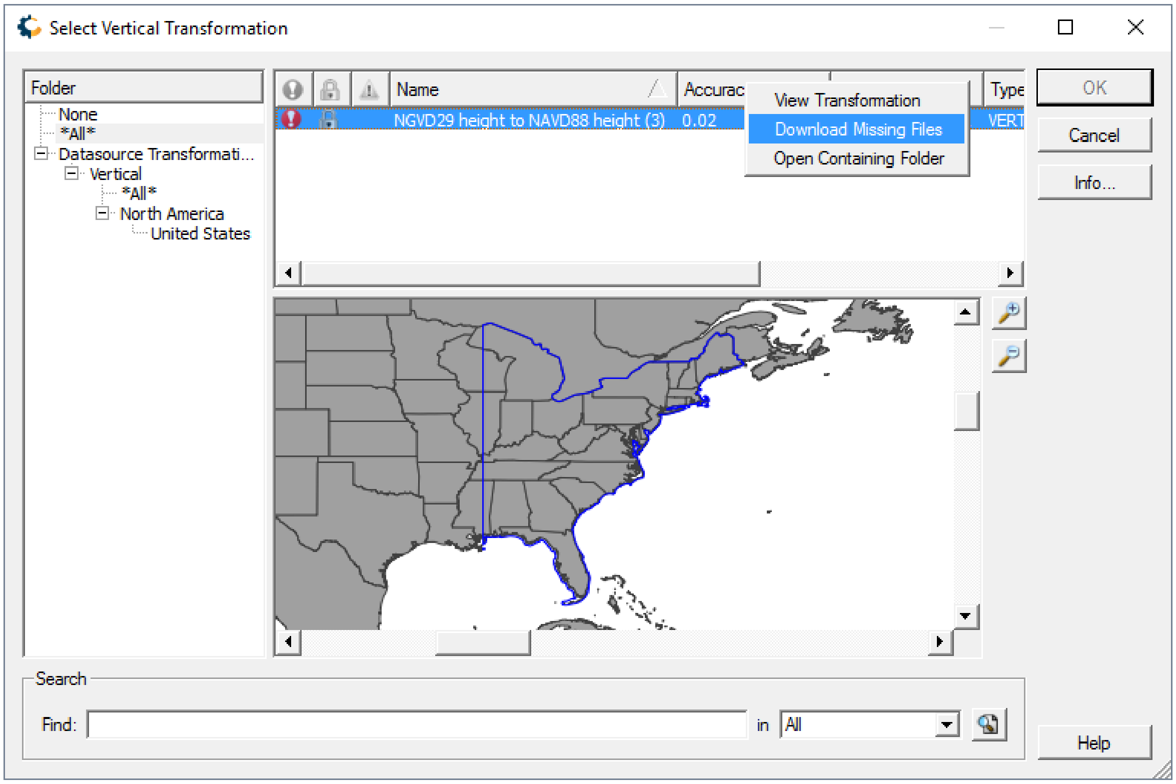
1. The Reference Coordinate System will have loaded with the reference file. It should be set to **NAD 27 / UTM zone 19N**.
2. Set the Destination Coordinate System. Double click in the System box of the Destination Coordinate System area to launch the *Select Coordinate System* dialog. Select **UTM zone 19N** from the **Projected > UTM > NAD83 folder**.
3. We will set a vertical transformation as well. In the Reference Coordinate System area, double click in the **Vertical** box to select the input Vertical Reference system. From the United States folder, select **NGVD29 height (m).**



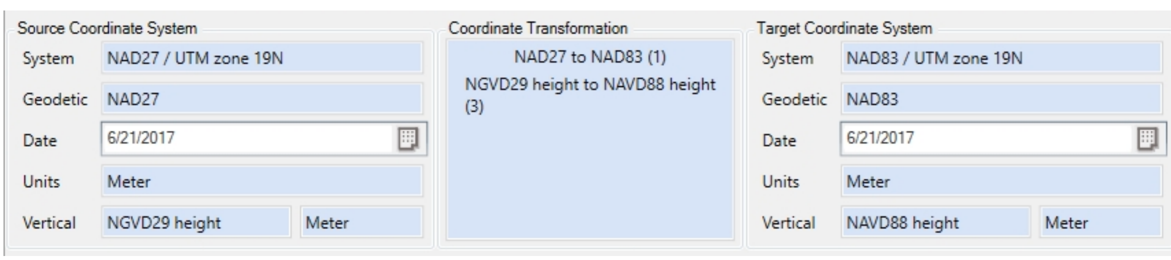
Confirm the unit box to the right of the vertical coordinate system is to set the units to **Meters**.

4. In the Destination Coordinate System area, double click in the **Vertical** box to select the destination Vertical Reference system. From the United States folder, select **NAVD88 height**. The vertical unit for the target will be **Meters**.
5. Double click in the Datum Transformation box to select a datum transformation. Select the **NAD27 to NAD83 (1) Continental USA** transformation in the *Select Horizontal Transformation* dialog.

Select **NGVD29 height to NAVD88 height (3)** in the *Select Vertical Transformation* dialog. If the transformation appears red, with a red exclamation point, right click on the transformation and select **Download Missing Files**.



6. Your Coordinate System settings should now look like this:



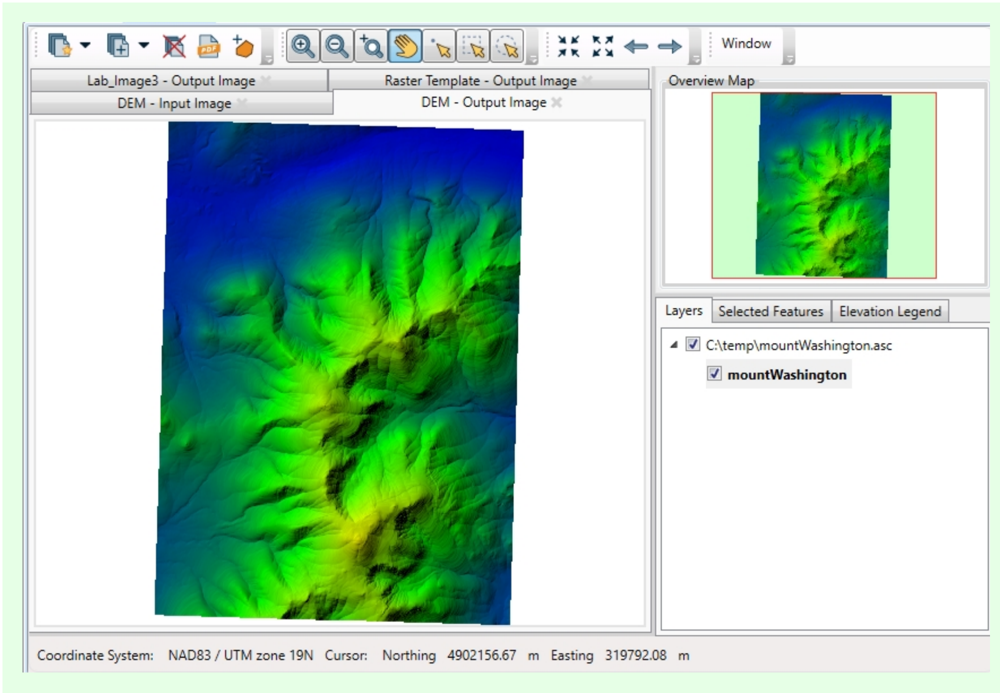
Note: The date field will display when time dependent transformations are enabled in the preferences. It will not be used in the transformation as long as the input and output date are the same.

7. Click the Browse (**...**) button to the right of Destination File to create a new output file. Select an output file location and name. Set the Save as Type to Arc/Info Ascii Grid (.asc) and click **Save** to finalize your output settings.

8. Click the **Process** button to perform the transformation. When the process is compete, you will see a prompt asking whether you want to view the image. Choose **Yes**. The output file will be displayed in the viewer.

9. Open the *Elevation Legend* window in the bottom right of the Viewer. You will see that the .asc file has been rendered with the custom shading that was set in Section 1 of this lab.

10. Click the Customize button to change the shader. Select one of the predefined gradients from the dropdown list and switch the Shader Mode to smooth coloring. Click the **OK** button to view the image with the new shader options.



Notes

This section includes additional information about working with raster data.

Transformation Models

There are six types of raster referencing solutions available in Geographic Calculator:

Affine

The Affine solution incorporates a single scale change, a rotation, and two translations to transform unknown coordinates from one arbitrary system to coordinates in another system given the values of known reference points. A minimum of 3 reference points must be defined and unmasked in order to use the Affine solution. This solution type should generally be applied when referencing large scale maps (1:50,000 or less) published in a nearly rectilinear map projection.

1st Order Polynomial

A minimum of 4 controls points must be defined and unmasked (See Using the Reference Point List) in order to use the 1st Order Polynomial solution. This solution type is a compromise between the Affine and 2nd Order Polynomial solution types.

2nd Order Polynomial

A minimum of 6 controls points must be defined and unmasked (See Using the Reference Point List) in order to use the 2nd Order Polynomial solution. This solution type should generally be applied when referencing small-scale maps (1:250,000 or more) published in a non-rectilinear map projection such as the Lambert Conformal Conic. You should also generally select this solution type when referencing aerial photographs or satellite images containing relatively significant distortion due to terrain relief.

3rd Order Polynomial

A minimum of 10 controls points must be defined and unmasked in order to use the 3rd Order Polynomial solution.

4th Order Polynomial

A minimum of 15 controls points must be defined and unmasked in order to use the 4th Order Polynomial solution.

5th Order Polynomial

A minimum of 21 controls points must be defined and unmasked in order to use the 5th Order Polynomial solution.

Assessing Residual Error

Some of the basic types of reference model supported by Geographic Calculator are:

Affine: This solution incorporates a single scale change, a rotation, and two translations. This is done to transform unknown coordinates from one system to another given the values of known reference points. The **minimum** number of control points required for the Affine model is **three**. This solution is ideal for large-scale maps (approximately 1:50,000 or less).

1st Order Polynomial: A **minimum** of **four** control points is needed to complete this solution type. It is the middle ground between Affine and 2nd Order Polynomial.

2nd Order Polynomial: This solution type requires a **minimum** of **six** control points. Smaller scale maps, such as 1:250,000 or more are ideal for this solution type. It is also excellent for non-linear map projections, aerial photographs, and satellite images.

When the solution type and proper amount of control points have been selected, the Geographic Transformer will calculate residual errors for each reference point. Large residual errors result from inaccuracies in the source coordinates, reference coordinates, or both.

Residual Errors

Residual error is the computed difference between an observed source coordinate and calculated source coordinate. The idea is to minimize residual error. Minimal error results in more accurate transformations. Selecting the appropriate transformation method will help to minimize error.

A reference point that is causing error in the transform may be unselected by right clicking on the point in the *Reference Point List* and selecting **Exclude point**. A common method of introducing error is by imprecise point selection. Zooming in close to the pixel of interest may reduce error introduced from point selection error. Using a small number of very accurately selected reference points yields better results than many less accurately selected points.

The Geographic Transformer graphs residual errors. Below the *Reference Point List*, click the **Error Plot** button to see the residual error graph. The Graph Error function calculates the accuracy of the georeferencing based on selected control points and their respective location within the image. Individual point error is shown in tabular form inside of the *Reference Point List*.

Image Extents

The Geographic Transformer uses the center of the pixel for conversion calculations. However, when image extents are calculated, the Transformer uses the corner of the pixel. The direction that is defaulted to is dependent on whether it is the (0,0) corner, or the (x,y) corner. The (0,0) corner shifts from the center to the NW corner of the pixel. The (x,y) corner would shift from the center to the SE corner of the pixel.

This process shifts the reference point, but also moves the pixel. The pixel then overlaps the outside of the image map. It therefore appears to be a half pixel larger in both the NW and SE directions. If a perfect square is desired, this effect must be compensated for.

Image Extents vs. Reference Points Extents

The difference between using **Image Extents** and using **Reference Point Extents** is an important concept for a user to understand. This functionality allows the user to clip images (e.g. borders, collars, etc.) or retain the full source image during the transformation process. This process is performed relative to real-world coordinate values and their relationship to your input source image.

Reference Point Extents are the **outermost** NW and SE corner points defined in the Reference Point Pick. The transformation will clip the image at these points.

Image Extents are the outermost NW and SE pixels in the entire source image. If the source image contains a colored border, such as the white border of the USGS Quad, it will be included in the image map resulting from the Transformation process.