



# GIS3: ADVANCED GIS

## Learning Lab: Interoperability with GNSS, Google and AGOL

### The learning problem

In the GEO arena, we often need to share data among organizations that use different GIS applications (ArcGIS vs. QGIS vs. MapInfo) or, for example, that use a GIS application made by one company, a GPS application made by another company, and a geoprocessing model that was developed in-house. To share data across these different platforms, we rely on a philosophy called interoperability.

Interoperability is a mindset that seeks to allow different information technologies and software applications to exchange data easily; to prevent the loss or corruption of data during exchange; and to minimize the cost (e.g., time, labor) to handle the exchange. Technically speaking, interoperability is made possible by adopting standards (e.g. file standards include: CSV, JSON, shapefile, TIFF, and JPG; metadata standards include ISO and FGDC). Culturally speaking, interoperability is made possible by understanding our partners'/clients'/customers' needs and catering to them.

### The practical vehicle for learning

The Harrisburg Mural Festival (HMF) is a city beautification project. It started during the first two weeks of September 2017 and involved the painting of large murals in Harrisburg's Downtown and Midtown neighborhoods.

HMF organizers published two maps before the event. One map (printed hardcopy) showed the locations of 11 planned mural-painting sites as well as the locations of 8 extant murals that were painted before the festival. The second map (posted online) shows 14 planned sites but none of the murals that existed prior. Not only do the two maps differ in number and content, but not all the plotted locations agree. So, there seems to be some uncertainty and a need for a third and definitive map that correctly marks all the locations of all of the murals in Harrisburg. Our purpose is, therefore, to answer the question: *Where are all the murals located in Harrisburg and what are their attributes?*

### Our information technologies

We're going to use three different information technologies en route to answering our question, and we need these technologies to interoperate effectively.

#### 1. Esri Story Maps

ArcGIS Online is a cloud-based tool. It allows people and organizations to share geographic information, geoprocessing services, and media within the familiar browser environment. Specifically, you can use ArcGIS Online to build maps and interactive map applications. A "Map Tour" is a type of map application that's used for presenting geographic information with compelling photographic or media elements. In this lab, we're going to use Esri's "Map Tour" template to help us present a map and a compelling set of mural photographs.

#### 2. Google Sheets

Google Sheets is a spreadsheet tool that looks and functions much like any other spreadsheet tool, but - because it is a cloud-based app - it offers you some powerful sharing and interoperability options. If you know how to use Microsoft Excel®, then you'll feel comfortable using Google Sheets. In this lab, we're going to use Google Sheets to build a spreadsheet of point locations and their attributes because it is easy to use and it has some pretty cool data sharing features.



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### 3. Trimble Global Navigation Satellite Systems

In this lab, you are going to learn how to conduct a coordinate and attribute survey of Harrisburg murals using a differential grade Trimble device and GPS Pathfinder Office software.

A Global Navigation Satellite System (GNSS) is a class of geotechnology that is useful for measuring location, elevation and time; recording attributes; and assisting navigation and tracking. Many environmental projects involve both fieldwork with GNSS and office work with GIS, so it is useful to learn how to leverage both technologies.

Geospatial data are exchangeable between Trimble and Esri software because both technologies recognize the WGS84 geographic coordinate system as a standard way to spatially reference locations and both adopted the same data exchange formats (i.e., their proprietary files can be exported to ASCII text files, shapefiles, etc.). In other words, we can achieve interoperability with ArcGIS and Trimble because both systems use the same standards.

Most GNSS devices, including Trimble devices, come in one of three grades: recreational, differential, and survey:

1. Recreational devices (e.g., mobile phones and pocket receivers) are typically small hand-held computers that can be used for place finding, waypoint marking, and geotagging media; under only the very best conditions, they can make repeated horizontal coordinate measures with  $\pm 3$  meters of precision.
2. Differential grade devices have larger antennas, better hardware, and better software than recreational devices. When coupled with post-processing techniques, differential grade devices can make repeated horizontal coordinate measures with sub-meter precision.
3. Survey grade devices are the state-of-the-art and expensive. They can make repeated horizontal coordinate measures with  $\pm 1$  centimeter of precision *in real time*.

### Objectives

In this lab, we are going to:

1. use GNSS technology to measure mural locations and record mural attributes;
2. build and share a cloud-based spreadsheet of mural locations and their attributes;
3. build a web map application that operates within a browser;  
and
4. use some very specialized GIS knowledge and training to develop these materials so that people without GIS skills can access and interact with the data you collected.

To accomplish our objectives, we need to develop a workflow that assures the data we collect and share are accurate, consistent, and complete. **Bolstad (2016: p617-624)**

Before collecting any data, we need to plan:

1. Perform *GNSS mission planning* to identify the blocks of time when GNSS satellite-receiver geometries are optimal.
2. Set-up our digital cameras to capture images with a 4:3 aspect ratio (4 pixels wide for every 3 pixels high).
3. Identify the vector feature class (point, line, or polygon) that is most appropriate for representing “a mural”. In this case, we’re going to use points.



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4. Identify the necessary attributes for every mural. In this case, we're going to record:
  - a. Mural title
  - b. Mural description
  - c. Artist's name
  - d. Artist's Instagram handle
  - e. Artist's website URL
  - f. Artist description

While in the field:

5. Conduct coordinate and attribute surveys with good equipment and during the good blocks of time (see *mission planning*).

Back in the lab:

6. Post-process the GPS data to *differentially correct* the raw positions that support each feature;
7. Export the corrected mural features to a file in CSV format;
8. Prepare and upload the CSV file to Google Drive;
9. Convert the CSV file to a Google Sheet;
10. Publish the Google Sheet as a CSV file (wait, what huh?????)
11. Use ArcGIS Online to build a web map using the published CSV file
12. Use ArcGIS Online to develop a web map app of Harrisburg Murals

### Methods for using Trimble GPS devices – Part 1: Mission planning & preparation

Step 1. Perform GNSS mission planning. **Bolstad (2016: p203-213)**

Anyone who has used a car navigation system or a mobile device knows that your 'blue dot' can be plotted incorrectly. Usually, that's because the device was set to measure positions quickly under any satellite constellation rather than wait until a suitable constellation is available for measuring positions reliably. GNSS mission planning is the process of predicting when the satellite constellation above your work site will be suitable for collecting reliable GNSS data.

Use John Deere's NAVCON's *Satellite Predictor* application (link below) to plan your mission and to identify blocks of time when GPS satellites-receiver geometries will be optimal.

<http://satpredictor2.deere.com/lookup>

1. Page 1
  - a. Choose **Your location**: Either type in "Harrisburg, PA" or use the map to choose a spot in Harrisburg, PA. **[Continue]**
2. Page 2
  - a. Choose the right **Time Zone**. If you're planning field work in Pennsylvania between March and November, then you want Eastern Daylight Saving Time (EDT). If you're planning fieldwork in Pennsylvania between November and March, then you want Eastern Standard Time (EST).
  - b. Our Trimble devices communicate with the US fleet of [X] **GPS** satellites only; they do not communicate with the Russian fleet of [ ] GLONASS satellites.
  - c. Because we'll be working among tall buildings, we cannot assume we'll have an unobstructed view of the sky along our entire horizon. Specify a 15° **Elevation Mask** above our work site horizon. **[Continue]**
3. Page 3
  - a. Choose the **Date** we will be in the field.

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- b. Review the expected satellite **Visibility** at our designated place and time. Take notes about when 6 or fewer satellites are expected to be visible, for using GPS during those blocks of time could yield less-than-optimal data. [\[Print report\]](#)
- c. Review the expected **DOPs**. A DOP value works like a golf score – lower numbers are better (see **Figure 5-12 in Bolstad, 2016: p213**). Values equal to or less than 3 are considered good; between 3 and 6, moderate; and greater than 6, poor.  
H = Horizontal measures (long,lat). V = Vertical measures (elevation). P = Position (horizontal and vertical combined). [\[Print report\]](#)

**Question 1:** Report each 'bad' block of time (from start time to end time) when the HDOPs are expected to be equal to 3.0 or greater. This is important because we want to avoid doing any GPS work during those bad blocks of time. Attach copies of your NAVCON reports to your lab report.

Steps 2 and 3. Thinking about what needs to be mapped and what needs to be observed.

Begin a session of **GPS Pathfinder Office** and setup a **New...** project named *Harrisburg* in your GIS3 folder.<sup>1</sup> Direct the **Project Folder:** to either your **T:** drive; the **C:\Geotemp** folder; or a workspace on your external memory device.

Next, use Trimble's **Utility > Data Dictionary Editor** tool to help you prepare mural attribute collection. When the tool opens, create a data dictionary called **HBGMF-<your initials>.ddf** and save it in your folder. Set up your data dictionary as follows:

1. Name: **HBGMuralFest-<your initials>**
2. Comment: **Fall 2017**
3. Version: **TerraSync v5.00 and later**
4. Create a **New point Feature...** called *Mural* with the following settings and symbol:
  - a. Default setting
    - i. Select a 1-second position logging interval;
    - ii. Use a minimum of 120 raw positions to support each mural;
  - b. Symbol
    - i. Choose 20-pt and artsy-looking symbol of any color.
    - ii. [\[ OK \]](#)
  - c. Next, create **New Attributes...**
    - i. Text attribute
      1. Name: Mtitle
      2. Comment/Alias: Mural title?
      3. Length: 64
      4. On Creation: Required
      5. On Update: Normal
    - ii. Text attribute
      1. Name: Mdescr
      2. Comment/Alias: Describe the mural.

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<sup>1</sup> You will need to change the project path because you do not have write permissions to the IT Administrator account that installed the software.



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3. Length: 64
4. On Creation: Required
5. On Update: Normal
- iii. Numeric attribute
  1. Name: MYear
  2. Comment/Alias: In which year was it painted?
  3. Decimal places: 0
  4. Minimum: 1990
  5. Maximum: 2020
  6. Default: 2017
  7. On Creation: Normal
  8. On Update: Normal
- iv. Text attribute
  1. Name: Aname
  2. Comment/Alias: Artist's name?
  3. Length: 64
  4. On Creation: Required
  5. On Update: Normal
- v. Menu attribute
  1. Name: Photo
  2. Alias: Did you take a picture?
  3. Menu Attribute Values:
    - a. [New...]
      - i. Attribute value: Yes
      - ii. Default: checked
      - iii. Code Value 1: 1
      - iv. [Add]
      - v. Attribute value: No
      - vi. Default: unchecked
      - vii. Code Value 1: 0
      - viii. [Add]
  4. Display in Field As: Radio Buttons
  5. On creation: Required
  6. On update: Normal
- vi. Numeric attribute
  1. Name: Photos
  2. Comment/Alias: How many?
  3. Decimal places: 0
  4. Minimum: 1
  5. Maximum: 20
  6. Default: 1
  7. On Creation: Normal
  8. On Update: Normal
  9. Condition: [Change]
    - a. Enable condition: checked
    - b. If this condition is true, "Photo is No", then:
      - i. On creation: Not Visible
      - ii. On Update: Not Visible

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## vii. Text field

1. Name: Comments
2. Comment/Alias: Open ended comment.
3. Length: 48
4. On Creation: Normal

Save your data dictionary file and compare your setup against Figure 1. If everything looks good, then close the editor.

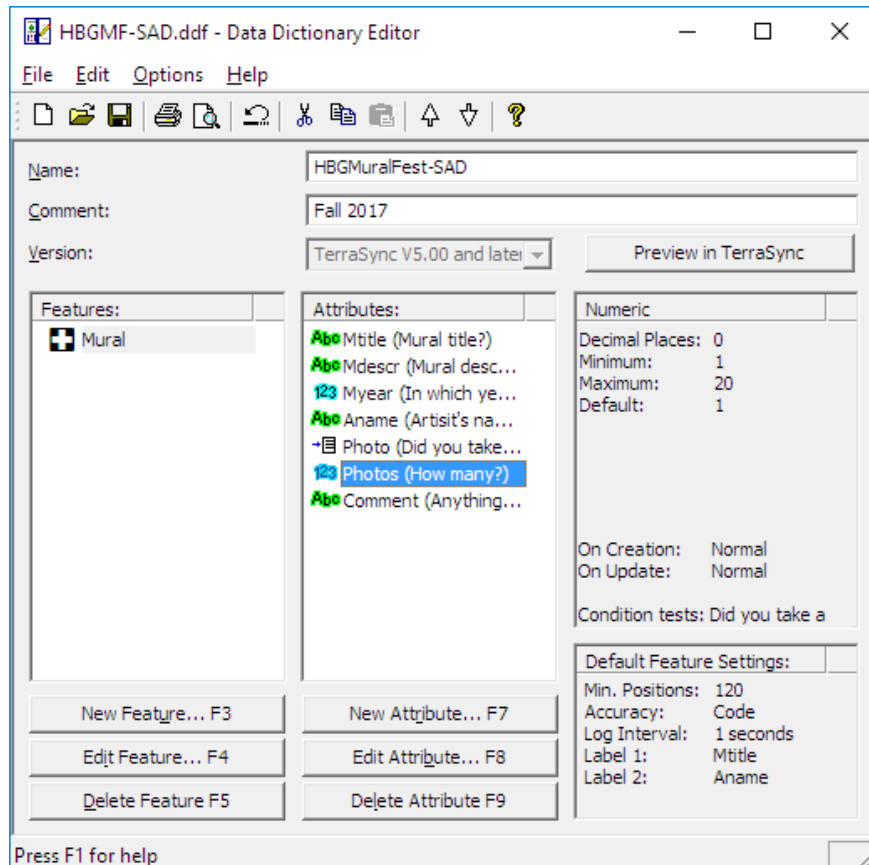


Figure 1. Snapshot of a complete data dictionary.

Next, obtain a Trimble device and insert it into the grey cradle (GeoExplorer 3000 series) or connect it via USB (Juno series). Turn on the device (green button). On your workstation, Microsoft's Mobile Device software should recognize the newly-connected Trimble device and open a port for communication. When prompted, choose "Connect without setting up your device" (we're not trying to sync music libraries or anything like that, just connect).

Next, open Trimble GPS Pathfinder Office's **Data Transfer** utility and connect with the *GIS Datalogger* on *Windows Mobile* device (if it hasn't already done so).

Next, add your data dictionary file to your send list, then transfer everything on the send list to the Trimble device. **Close** and **Exit** the utility.

*Read everything before doing anything! Visualize your final product.*



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### Methods for using Trimble GPS devices – Part 2: Collecting data

Before beginning any fieldwork, make sure you are prepared with suitable clothing, water, and sun protection (e.g., a hat, sunscreen). Expect to be outside for a few hours, so plan accordingly.

Go to Harrisburg, collect mural data, and take pictures. **Bolstad (2016: 227-239; p96-97)**

When you are in the field and ready to start your survey, start **GPS / TerraSync** (Professional). TerraSync is data collection software that works with a GPS receiver, reads satellite signals, and calculates positions. It can take several minutes to ‘lock’ onto all the GPS signals that are above your local horizon, so be patient.

On start, TerraSync will display its **Status** window. Think of yourself as standing at the center and the circle. The circumference of the circle represents the 360° local horizon around you. The box symbols represent the GPS satellites that are in the volume of space above your horizontal.

Next, choose the **Data** option from the pull-down menu, which will let you select and use your data dictionary: **HBGMuralFest-XYZ** as a template.

Data file names are auto-generated: the prefix is usually the letter “R” (R for rover); the next two characters indicate the month (“09” for September); the next two indicate the day of the month; the next two indicate the hour of the day (on a 24-hour clock); and the suffix is usually a letter that auto-increments (from A to Z) during the hour. Be sure to choose your data dictionary before you **Create** your data file.

Next, enter the height of the GPS antenna above ground (1.5 m is about right for the average person).

Next, if you followed all the directions above, then you should now see 4 buttons: [Mural] and the three default feature classes: [Point\_generic], [Line\_Generic], and [Area\_generic].

When you’re finished with all your field work, then **Close** the data file, **Exit** TerraSync, and power down the device by holding the green power button.

If the TerraSync software on your Trimble device is still open, then **Menu > Exit** before inserting it back into its cradle.

Insert the device into its cradle or attach it via USB cable. Microsoft’s Mobile Device software should re-open a port for communication. When prompted, “Connect without setting up your device.”

Start a new session of GPS Pathfinder Office. Re-open your *Harrisburg* project.

Next, open the Data Transfer Utility. Add your data file to your **receive** list, then transfer all the items on the receive list to your Harrisburg folder. Close Data Transfer.

**Question 2:** How did Mission Planning and building a data dictionary change the typical way you do fieldwork?



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### Methods for using Trimble GPS devices – Part 3: Post-processing and export

All that mission planning you did was to ensure that you collected data when optimal conditions were predicted. Working according to plan does not guarantee, however, that field conditions were actually optimal, that you collected good data, or that you collected all the data you needed.

Your raw position data are likely infected with some errors, which means your average feature locations can be off from true. For example, tall nearby buildings or trees can interfere with incoming satellite signals or, worse, cause them to bounce around before arriving at your device. **See Figure 5-31 in Bolstad (2016, p231)**. Or, you might have committed some mistakes while learning how to use the Trimble device. Or, you might have started taking short cuts and making blunders the longer you worked. These are just some of the reasons why you never want to give raw data to a client.

Before post-processing, make a copy of your data file (e.g., **copyR0\*.ssf**). Working with a copy of your data will let you practice and play without fear of losing your data. You'll always have the original \*.SSF file as a back-up.

Start a session of **GPS Pathfinder Office** and re-open your *Harrisburg* project. Make sure you can see the *Map*, *Time Line*, *Feature Properties*, and *Position Properties* windows.

Next, set the **Options > Coordinate System...** to *US State Plane 1983, Pennsylvania South 3702 (NAD83)*. Set your vertical datum to be *Mean Sea Level* (via the latest GEOIDxx model). All coordinate values should be displayed in *meters*.<sup>2</sup>

Next, **File > Open...** your data file (**copyR0\*.ssf**). If you setup your data dictionary correctly, then you should see *where* your features were measured (*Map* window) and *when* they were measured (*Time Line* window). You can use your cursor to select a feature in either window and the corresponding symbol will become selected in the other window. Notice how the *Feature* and *Position* attributes change with your selection.

**Question 3:** How many mural features are in your mural feature class?

#### Exploring your raw data

Use your cursor to select a mural. The *Feature Properties* window lets you review the attribute data for the mural. Meanwhile, the *Position Properties* window reports the average but *uncorrected* Easting, Northing, and Altitude values derived from your sample of 120 positions.

Change the **View > Layers > Features... > Not in Feature > Symbol...** properties so they have a dark color and a thick width.

Next, use the *Feature Properties* window to **Delete** your selected feature. Relax, deleting a feature doesn't actually delete a feature (unless you hit "save"). Deleting a feature allows you to see the sample of raw single-fix position coordinates that support your average feature coordinates. Change map scale and pan to focus on your supporting sample.

**Question 4:** How many raw single-fix positions (repeated measures) were used to support the average coordinates for your feature?

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<sup>2</sup> Remember, all GNSS receivers spatially reference positions to the WGS84 ellipsoid model only. These settings do not change the actual geographic coordinates {  $\lambda$ ,  $\Phi$ ,  $h$  } that you measured; rather, they simply tell the software which spatial reference system/projection method you want to use on-screen for display purposes only.



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Next, use your cursor to select raw positions, one-by-one, and examine their coordinates and DOP values. Use the Position Properties window to see how your measuring method changed over time as GPS satellites entered or left the constellation above your local horizon.

**Question 5:** Describe any changes that occurred to your satellites-receiver geometry as you collected these raw data.

**Question 6:** Do you notice any sequence of raw single-fix positions that seems to fall along an apparent straight line? If so, do the elevations or coordinates drift as you poke along the line?

**Question 7:** Change map scale and look at the entire pool of supporting positions.

- a) Does your pool of supporting positions have a central cluster? If so, how wide is it? (Use the Measure tool. You might have to change your display units to show meters; not kilometers.)
- b) How far apart are the most distant pair of raw positions?
- c) Interpret your answers above to characterize how consistently your measuring equipment/method produced the same result during repeated measures? In other words, use the two distances you just measured to describe the precision of your equipment/method.

Return to your Feature Properties window and **[Un-delete]** your selected feature.

### **Applying differential corrections to your raw data. Bolstad (2016: p215-221)**

As described in your textbook, differential correction techniques require at least two proximate GNSS receivers to read satellite data simultaneously. One receiver is installed at a fixed and known point; this receiver is called the “base” (e.g., a National Geodetic Survey CORS site). The other receiver is mobile and used for fieldwork; this receiver is the “rover.” Because the “base” is at a known spot and it measures that known spot over-and-over again, any difference between the actual coordinates (thanks NGS) and the measured coordinates (obtained via GPS) can be blamed on the GPS system.

$$Difference_{base @ time_x} = Actual_{base} - Measured_{base @ time_x} \quad \text{Eq. 1}$$

If we assume that your rover unit used the same satellites to measure positions as the nearest base station was using to measure itself, then any observed “differences” at the base can, in turn, be used to “correct” the data in the rover; hence, *differential corrections*.

$$Correct_{rover @ time_x} = Raw_{rover @ time_x} - Difference_{base @ time_x} \quad \text{Eq. 2}$$

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Trimble GPS correction software performs differential correction swiftly. Speed is great for the professional, but that same speed makes it difficult for students to watch what is happening and learn. So, follow these directions and you'll be able to watch the process and get a better sense of how differences measured at the nearest CORS are used to correct your rover data.

1. Open the **Utilities > Differential Correction...** utility. You might be prompted to save your data file if you made any changes: the choice is yours to make.
  - a. Select the SSF file(s) you wish to correct.
    - i. [Next]
  - b. Processing type
    - i. *Automatic Code and Carrier Processing* (Recommended)
    - ii. Use a single base provider
    - iii. [Next]
  - c. [Change...] the Correct Settings
    - i. Output positions:
      1. Corrected only
    - ii. Use new GPS Filtering settings:
      1. Elevation mask = 15°
      2. Minimum Signal-to-Noise ratio = 33
      3. Maximum PDOP = 6
      4. DO re-correct real-time code positions
      5. [OK]
    - iii. [Next]
  - d. Base Data
    - i. Use *Base Provider Search* and **Select...** the CORS, YORK (YORK), PENNSYLVANIA site, which is the closest base station. Choosing this option instructs the software to access the CORS server via the Internet and request base station data.
    - ii. DO use the position from the downloaded base files.
    - iii. DO Confirm base data and base position before processing.
    - iv. [NEXT]
  - e. Output folder
    - i. Use the same folder as the input file
    - ii. Create a unique filename ...
    - iii. [START]

**Question 8:** How many base files, if any, did the software download for you?

**Question 9:** How much coverage (amount of temporal overlap, expressed as a percent) exists between your rover data and the base data?

iv. [CONFIRM]

**Question 10:** Knowing that satellites-receiver geometry can change over time, it is likely that you measured some raw positions more precisely than others. How many (#) and what share (%) of your corrected positions fell into each “range” of uncertainty?

**See Bolstad (2016) Figures 5-11, 5-12, and 5-31**

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v. [CLOSE]

2. **File > Close** your uncorrected data file (\*.SSF).
3. **File > Open** your corrected data file (\*.COR).

**Question 11:** Did you lose any features during differential correction? (#,%)?

## Exporting your corrected data

Follow these directions to export your corrected mural features from Trimble \*.COR format to delimited text \*.CSV format.

1. Open the **Utilities > Export...** tool.
  - a. Select your corrected (\*.COR) data file as input for export.
  - b. Choose your output folder (where the outputted CSV file will be saved).
  - c. Choose the *Sample Configurable ASCII Setup* option.
  - d. [Properties...]
    - i. Data
      1. "Export all Features"
      2. Uncheck "Include Not in Feature Positions"
    - ii. Output
      1. "For each input file create output file(s) of the same name."
      2. System File Format: Windows.
    - iii. Attributes (for the output attribute table)
      1. Export menu attributes as *Attribute Value*
      2. All features (check all of the following)
        - a. PDOP
        - b. HDOP
        - c. Correction status
        - d. Receiver type
        - e. Date recorded
        - f. Time recorded
        - g. Data File Name
        - h. Total positions
        - i. Filtered positions
        - j. Data Dictionary Name
      3. Point features (check at least the following)
        - a. Vertical Precision
        - b. Horizontal precision
    - iv. Units
      1. *Use Current Display Units*
      2. Latitude/Longitude Options: *DDD.dddddd*
      3. Time format: *24 Hour clock*
    - v. Position Filter
      1. **Position Filter Criteria**
        - a. **Minimum Geometry = 3D (5 or more)**
        - b. **Maximum PDOP = Any**
        - c. **Maximum HDOP = 6**

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2. Include positions that are:
  - a. Check every option except Uncorrected positions
- vi. Coordinate system
  1. Use Export Coordinate System [Change]
    - a. System: Lat/Long
    - b. Datum: WGS 1984
    - c. Altitude units: Meters
    - d. Altitude reference: MSL
- vii. Configurable ASCII
  1. File Options: One Set of Files per Feature Type
  2. Template List
    - a. [Delete] any templates that are there (e.g., pos, att, etc.)
    - b. Make a [New...] template called CSV
      - i. Output file extension: csv
      - ii. Apply to: Points
      - iii. Field format: Delimited
      - iv. Delimiters
        1. Field: Comma (,)
        2. Text: Double Quotes (")
        3. Decimal: Dot (.)
      - v. Template Worksheet (see Figure 2 below)
      - vi. {Feature ID} {Longitude} {Latitude} {MSL} ~ {Attributes} [New Line]
3. [OK]
- e. [OK]

ASCII Export Template Editor: CSV

Output File Extension:

Apply to: ☒ Points ☐ Lines ☐ Areas

☐ Use Template as Heading

Field Format: ☒ Delimited ☐ Fixed Column

Delimiters: Field:  Other:  Text:  Decimal:

Macro Palette:

{Latitude}	{Northing}	{Feature ID}	{Header Start}	{GPS Time}
{Longitude}	{Easting}	{Feature Name}	{Footer Start}	{Text: }
{HAE}	{MSL}	{Attributes}	{Hdr/Ftr End}	New Line

Template Worksheet:

{Feature ID} {Longitude} {Latitude} {MSL} {Attributes}

OK Cancel Clear Template Help

Figure 2: ASCII Export Template Editor: You new CSV template

*Read everything before doing anything! Visualize your final product.*





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**Question 12:** How many features were discarded because all their supporting positions did not pass through the export filter (see 1.d.v.1 above)?

Close your file and exit *GPS Pathfinder Office*.

### **Upload your mural photographs to your SHIP website.**

We need to put copies of your good mural photographs in a place that's accessible via the Internet. Your SHIP website will work great for this. So, in your GIS folder, make two subfolders: 1) MuralPhotos and 2) MuralThumbs. Place copies of your originals in your MuralPhotos folder.

To work best with ArcGIS Online, all the images in your MuralPhotos folder must be resized (or cropped) down to 1000 px wide, 750 px high. Feel free to use Adobe Photoshop, IrfanView, or any other photo editing software that gives you fine control over your edits.

Next, copy and paste all the images into your MuralThumbs folder. The images in your MuralThumbs folder should then be resized (or cropped) further - down to 200 px wide, 150 px high.

### **Upload your CSV file to Google Drive and share it with your professor**

Lastly, upload your CSV file to Google Drive and share it with me ([sadrzy@gmail.com](mailto:sadrzy@gmail.com)). I don't need full editing privileges, but I do need to be able to view it and to make comments. We're going to finish this lab together during class by building map applications with ArcGIS Online.

**Question 13:** This isn't really a question; rather, a task. Create a folder and name it using your lastname. Next, make sure the folder contains copies of only the following:

1. Your data dictionary (\*.ddf) file;
2. Your raw positions data file (\*.ssf);
3. Your differentially-corrected positions data file (\*.cor);

Use 7-Zip or another zipping utility to ZIP the folder. Send me your ZIP file as an email attachment. If you don't use this link in the PDF [sadrzy@ship.edu](mailto:sadrzy@ship.edu), then be sure to type "GIS3 GNSS" as your subject line.

### **Deliverables**

Complete a well-written report of the lab exercise. Include your name, date, and page numbers. Your report should include five sections and headings: Purpose, Objectives, Methods and Data, Results and Answers, and Summary. Provide concise purpose and objectives using your own words, and describe the important methods and input data you used to address the tasks listed above. In the Results and Answers section, address any issues or questions prompted during the lab. Include tables and figures in the same order you refer to them. In the Summary section, describe how you accomplished the purpose of the lab (i.e., how well did you answer the research question); then identify anything that you learned, or anything that remains problematic. Your List of References should list any and every published work that you used to support your work.

All lab reports should be typed and printed on 8.5" by 11" stock. Before drafting your report, set your left and top margins to 1.2" and set the others to 0.7". Enter your name, the lab title, and the date in your document header. Use single line spacing in your header.

For the body, set the normal font face to be Bookman Antiqua, Bookman Old Style, or Georgia; never use Times New Roman or any kind of *decorative font*. Use 1.5 line spacing. Set the normal font size to be 11 points. Include page numbers on every page. Major section headings should be in **bold face**. All tables and figures must be inserted into the body of your report and conform to the formatting and margin requirements.

*Read everything before doing anything! Visualize your final product.*