Low-Head Dam Search: Training

Background:

The purpose of this document is to facilitate the search of low-head dams across the United States. This training document details how to use ArcGIS Pro and Google Earth Pro to prepare and execute the search. The data points that are found are stored in a .kmz file that can easily be shared.

Figures 1, 2 and 3 contain some examples of low-head dams. If you come across some structure during your search that you think may be a low-head dam, be sure to mark it. We'd rather have some points that are not correct than miss a low-head dam.

Figure 1: Example of a Low-Head Dam

Figure 2: Example of a Low-Head Dam

Figure 3: Example of a Low-Head Dam

To reiterate, there may be times when you are unsure if the point is an actual location. We would rather have more points than less, so, when in doubt, mark it and move on.

Prerequisites:

This document requires some experience with ArcGIS Pro or a similar software. Most of the steps done in ArcGIS Pro could be done using a similar software, but this document focusses only on ArcGIS Pro. You will also need Google Earth Pro which is available for free download at:
https://www.google.com/earth/versions/#earth-pro.

Steps:

1. Find and Obtain Data
2. Create and Manipulate Files in ArcGIS Pro
3. Import Files into Google Earth Pro and Search
4. Report and Share Results

Step 1: Find and Obtain Data

To limit the areas in google earth that need to be searched, it is essential to obtain a shapefile that contains the water systems of the desired state. Some states have excellent GIS services and the data is readily available. However, many states require using the United States Geological Survey (USGS) database. The remainder of the document will assume the use of files from the USGS database, but state-maintained data could also be used using the steps outlined in this document. Go to https://www.sciencebase.gov/catalog/folder/5136012ce4b03b8ec4025bf7 and find the shapefile for your desired state. Download the FileGDB from the related external resources as shown at the bottom of Figure 4. This zip file will many files that are unnecessary; delete everything except any file with some variation of flow line in the title.

Figure 4: Example of a FileGDB from USGS Database from www.sciencebase.gov/catalog/item/5a96cdafe4b06990606c4d23 (Screenshot by author)

You will also need to acquire a shapefile containing the county borders within the selected state. If your state has a GIS database, find a county shapefile there. Otherwise, use a shapefile containing all the

counties in the US from https://catalog.data.gov/dataset/tiger-line-shapefile-2017-nation-u-s-current-county-and-equivalent-national-shapefile.

Step 2: Create and Manipulate Files in ArcGIS Pro

Optimize Shapefile

Use ArcGIS Pro to streamline the files that you downloaded. If there are multiple files containing flow lines, use the Merge tool to combine the flowline files. This will allow for easier manipulation of the data. The method explained below uses model builder (See Appendix) to deselect flow lines that are unnecessary and merge the files in one sweep. This could be done by using each tool separately to the same effect.

Use the merge tool as shown in Figure 5 to combine any number of flow line files into one file. Then use the select tool and Table 1 to select only the flow lines that are of interest using the FCode. Excluding pipelines, coastlines, underground conduits, and ephemeral streams will make your search much easier.
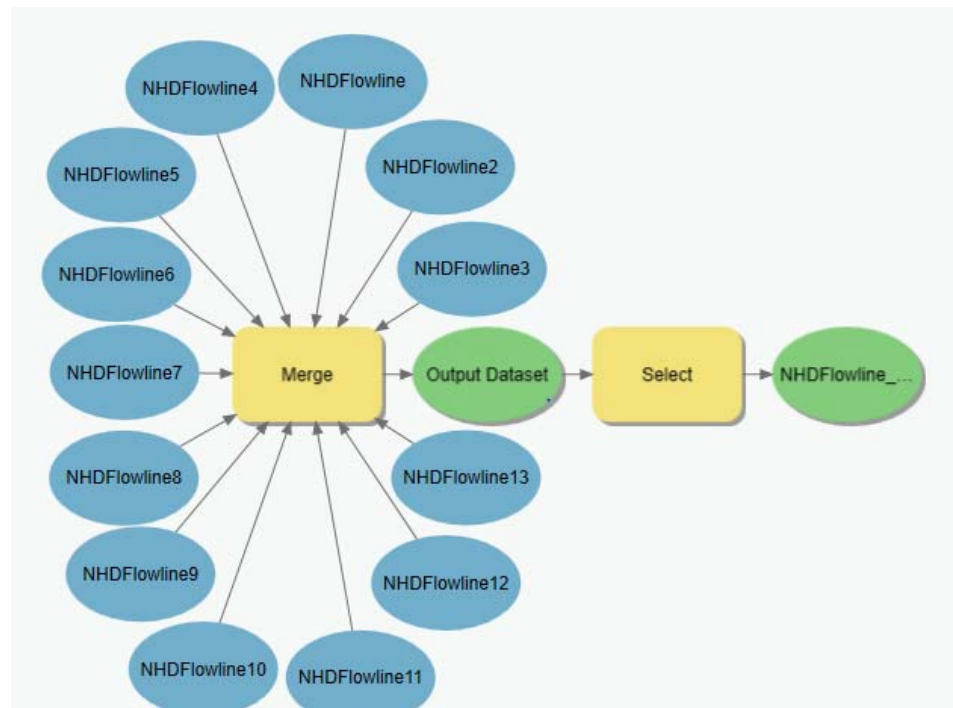

Figure 5: Model to Combine and Select Flow Lines

Table 1: FCode values

Feature Type	FCode	Description
ARTIFICIAL PATH	55800	feature type only: no attributes
CANAL/DITCH	33600	feature type only: no attributes
CANAL/DITCH	33601	Canal/Ditch Type|aqueduct
CANAL/DITCH	33603	Canal/Ditch Type|stormwater
COASTLINE	56600	feature type only: no attributes
CONNECTOR	33400	feature type only: no attributes
PIPELINE	42800	feature type only: no attributes
PIPELINE	42801	Product|water; Pipeline Type|aqueduct; Relationship to Surface|at or near
PIPELINE	42802	Product|water; Pipeline Type|aqueduct; Relationship to Surface|elevated
PIPELINE	42803	Product|water; Pipeline Type|aqueduct; Relationship to Surface|underground
PIPELINE	42804	Product|water; Pipeline Type|aqueduct; Relationship to Surface|underwater
PIPELINE	42805	Product|water; Pipeline Type|general case; Relationship to Surface|at or near
PIPELINE	42806	Product|water; Pipeline Type|general case; Relationship to Surface|elevated
PIPELINE	42807	Product|water; Pipeline Type|general case; Relationship to Surface|underground
PIPELINE	42808	Product|water; Pipeline Type|general case; Relationship to Surface|underwater
PIPELINE	42809	Product|water; Pipeline Type|penstock; Relationship to Surface|at or near
PIPELINE	42810	Product|water; Pipeline Type|penstock; Relationship to Surface|elevated
PIPELINE	42811	Product|water; Pipeline Type|penstock; Relationship to Surface|underground
PIPELINE	42812	Product|water; Pipeline Type|penstock; Relationship to Surface|underwater
PIPELINE	42813	Product|water; Pipeline Type|siphon; Relationship to Surface|unspecified
PIPELINE	42814	Product|water; Pipeline Type|general case
PIPELINE	42815	Product|water; Pipeline Type|penstock
PIPELINE	42816	Product|water; Pipeline Type|aqueduct
STREAM/RIVER	46000	feature type only: no attributes
STREAM/RIVER	46003	Hydrographic Category|intermittent
STREAM/RIVER	46006	Hydrographic Category|perennial
STREAM/RIVER	46007	Hydrographic Category|ephemeral
UNDERGROUND CONDUIT	42000	feature type only: no attributes
UNDERGROUND CONDUIT	42001	Positional Accuracy|definite
UNDERGROUND CONDUIT	42002	Positional Accuracy|indefinite
UNDERGROUND CONDUIT	42003	Positional Accuracy|appoximate

Create Grid

The search is much easier if the state is cut into more manageable sections. To do this, create a new feature class (see Appendix) as shown in Figure 6. Be sure to use the appropriate projection for the state being searched.

Once created, add the file to the current project from the geodatabase by clicking and dragging it onto the map. Then navigate to the Edit ribbon and select Create as seen in Figure 7.
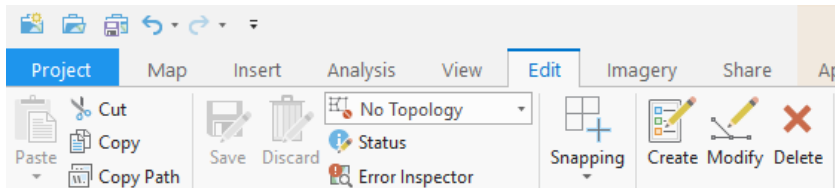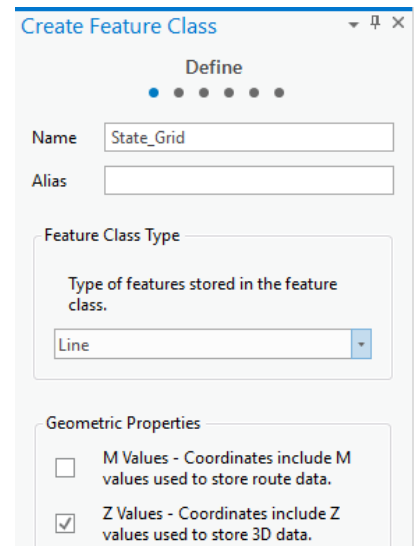

Figure 7: Edit Ribbon

Figure 6: New Line Feature Class

Ensure that the State_Grid is selected and proceed to create lines cutting the state into a grid. Don't worry too much about being exact. The purpose of this grid is to break the counties into smaller sections to make it easier to split the work or have a goal to finish that will not take very long to accomplish. Figure 8 is an example of a grid made for the state of Utah.

Intersect

Use the intersect tool to intersect the files containing flow and grid lines with each county in the state. This can be done individually or in a model. Be sure to name each file appropriately to ensure good organization of the information.

Export Files

The files that you have created will be saved automatically in the geodatabase created by ArcGIS Pro. They can also be exported into individual shapefiles that will be used in later steps. To do this, right click the feature in the contents pane, click data and then export feature
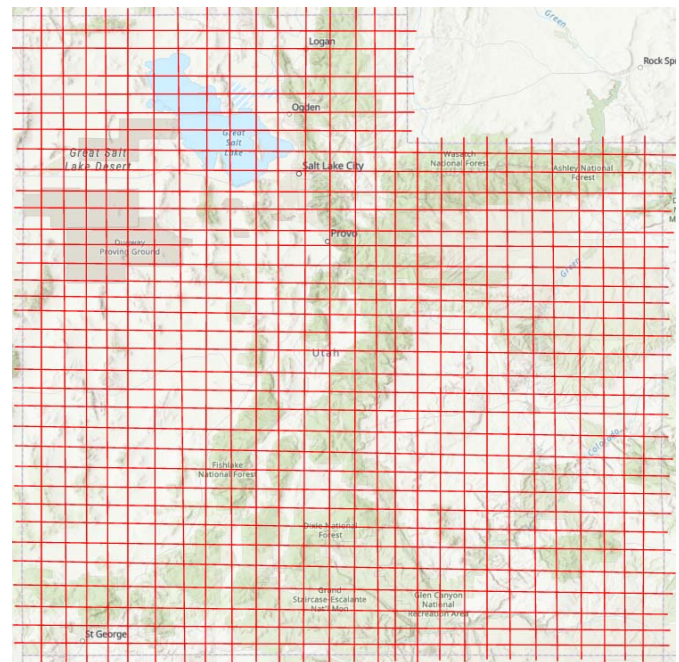

Step 3: Import Files into Google Earth Pro and Search

Settings

It is important that the settings in Google Earth Pro are the same for everyone assisting in the search. Under the Layers pane (Figure 9), turn off everything except 1st and 2nd Level Administration Borders and Terrain. It is also easier to use the data points if

Figure 8: Utah grid Shapefile

the coordinates are recorded in decimal degrees. To make this switch go to options under the tools ribbon as shown in Figures 10 and 11 and select decimal degrees.
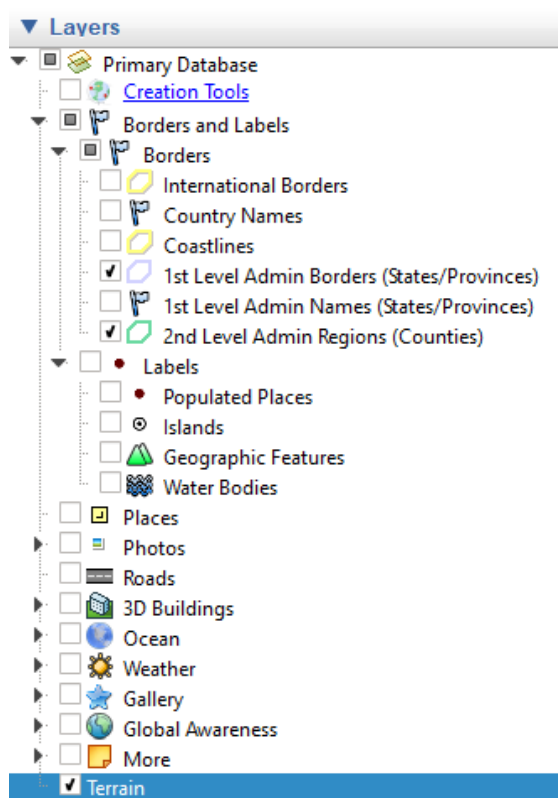

Figure 9: Google Earth Layers

Figure 10:Google Earth Pro Tools Ribbon

Figure 11: Google Earth Options

Import Files

Now that the settings are correct, the files that were created need to be imported into Google Earth Pro. Under file in the main toolbar click import (Figure 12).

Navigate to the folder where the shapefiles created in previous steps are located. Then switch the file type to all files and select all files associated with your shapefiles as seen in Figure 13.
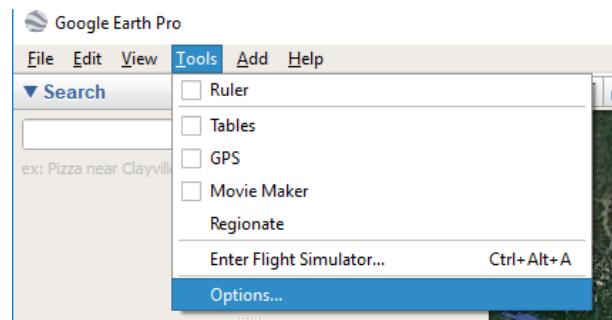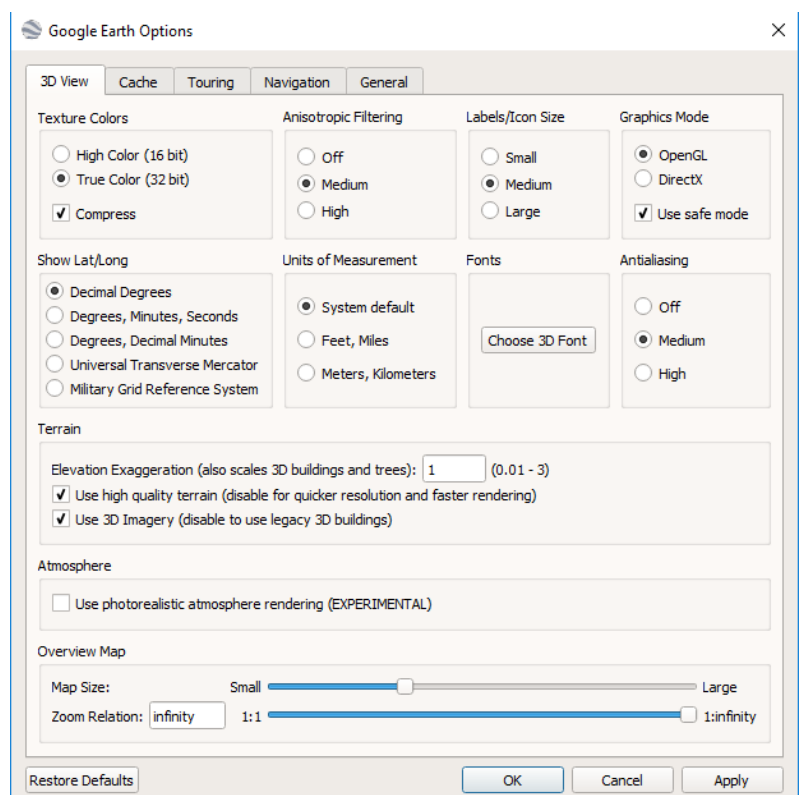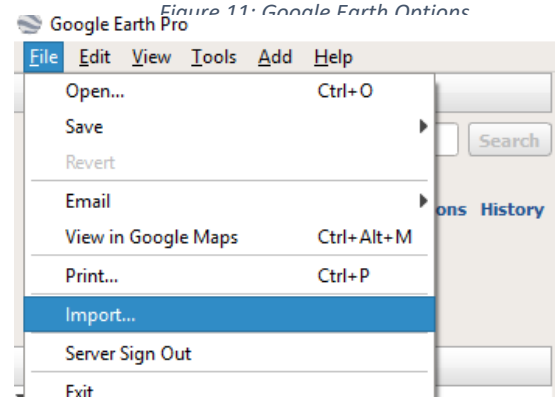

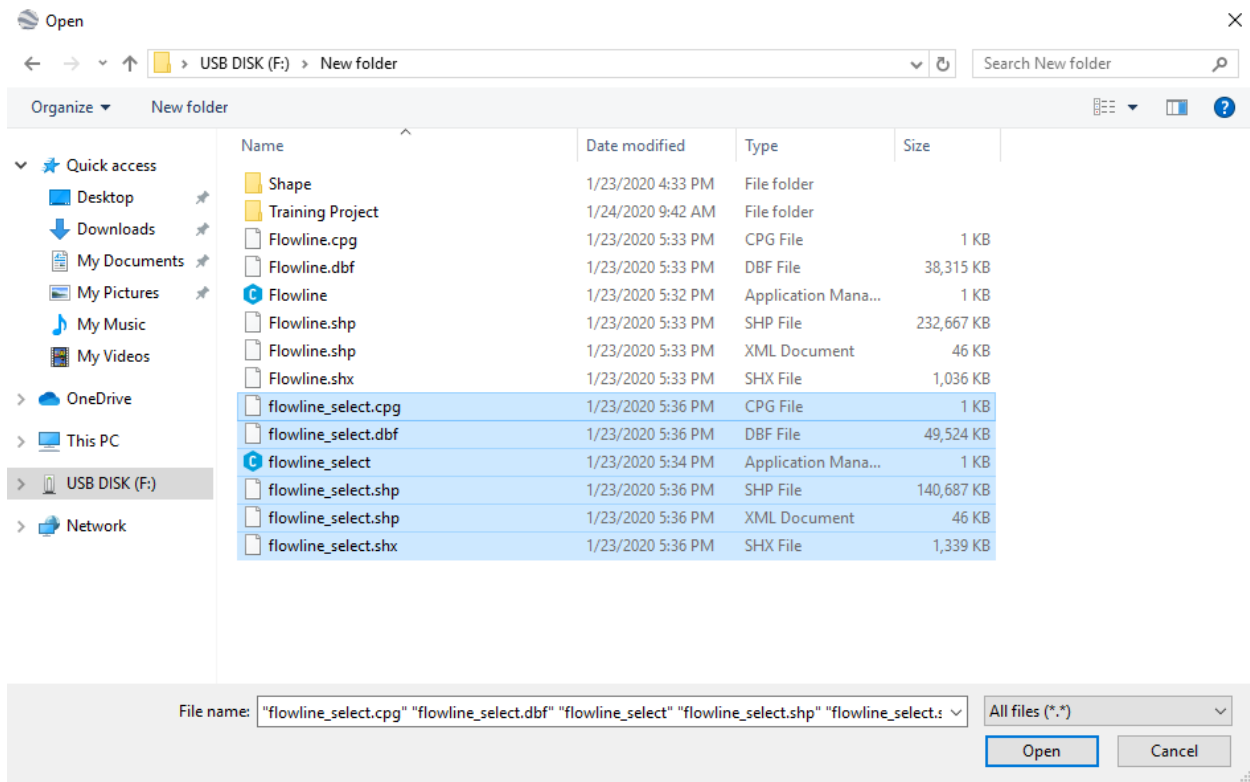*Figure 12: Import Files into Google Earth Pro*

Figure 13: Import All Files Created in Step 2

If prompted, select "Import All" and select no to the second prompt. The file will not automatically appear. You will have to turn the layer on in the Places pane of Google Earth Pro.

Create a Places Folder

The next step will help keep all the files and points that are found together. Right click My Place in the Places pane select Add and then Folder (Figure 15).

Name the folder according to your desires. Suggestions include the state or county name that is currently being searched. Once that is created drag the files that were imported in the previous step into that folder. As shown in Figure 14, you can also add a folder within the main folder to record all locations that you come across.
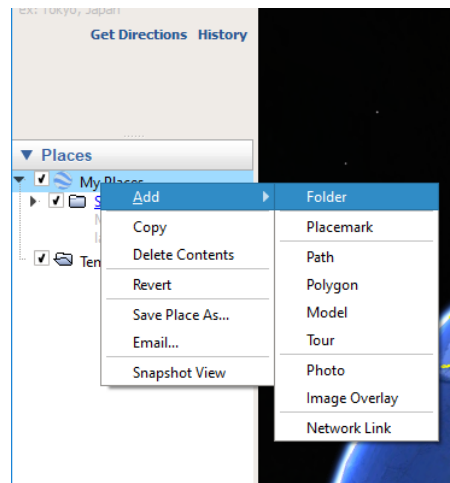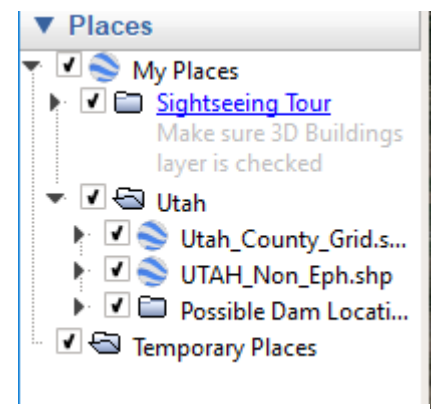

Figure 15: Add Folder to My Places

Figure 14: Move all Files to one Folder

Searching

You may change the properties of the grid file or the stream file to whatever helps you. Figure 16 is an example in Utah County, Utah.
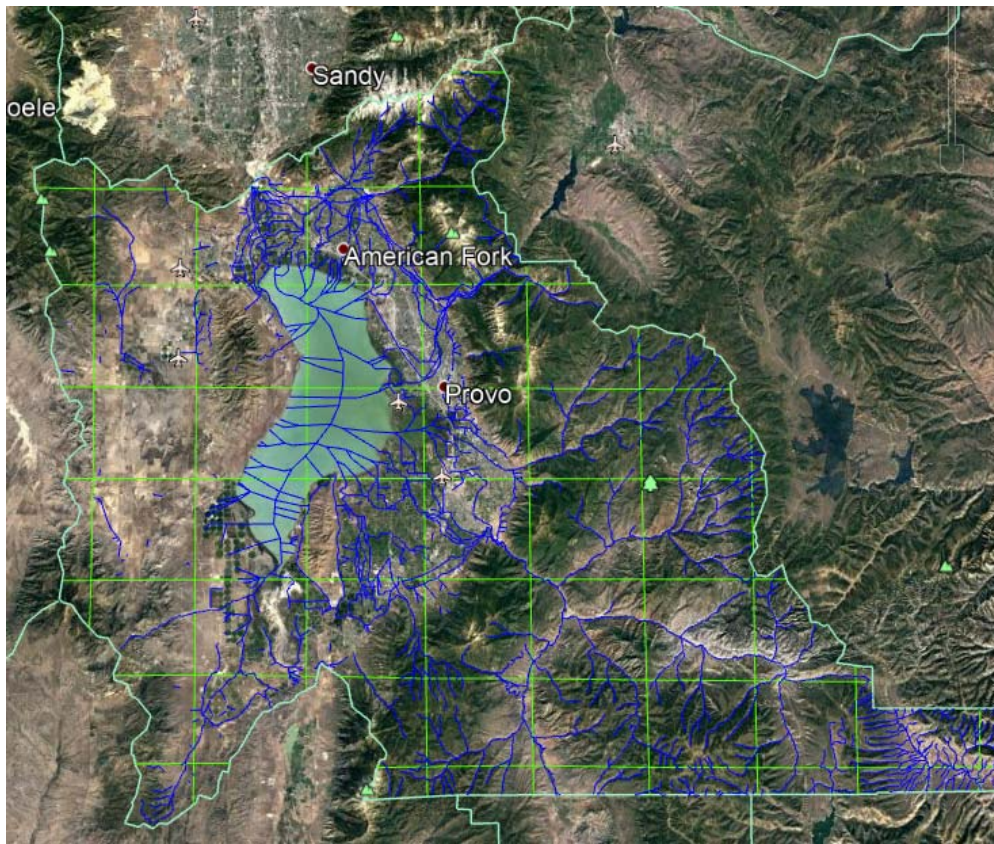

Figure 16: Utah County, Utah

The search process utilizes two tools in Google Earth Pro; the pin tool and the path tool (Figures 17-18). The path tool will help keep track of which streamlines have already been searched. The pin tool will contain the coordinates and view of every location that you find.
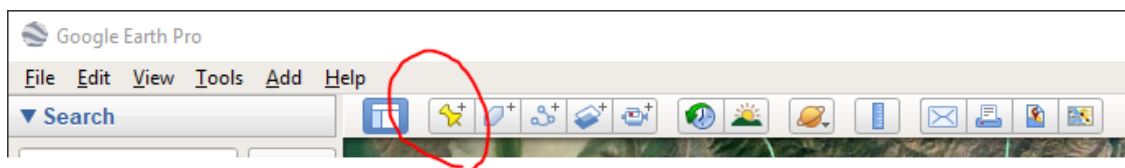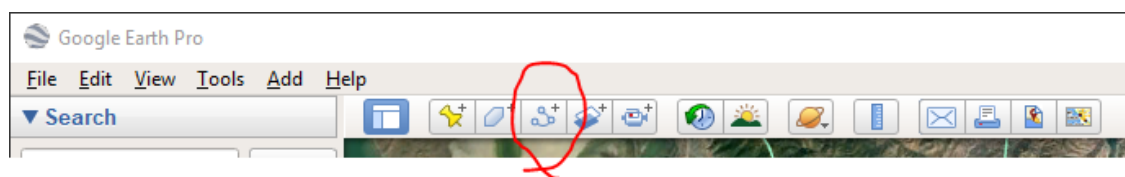

Figure 17: The Pin Tool

Figure 18: The Path Tool

When the path tool is being operated the mouse is ineffective to scroll through the map. Therefore, the arrow keys or the "W" "A" "S" and "D" can be used to move through the map. Be sure to zoom to an appropriate level that you can clearly see the river or stream you are searching (Figure 19).

Figure 19: Example of Path and Point Tools at an Appropriate Zoom

There are instances in which the current imaging used for Google Earth are not effective because of shadow or foliage restricting the view of the waterway. If this occurs, you can use the historical imagery tool to cycle through older images to try and get a clearer or better image of the area (Figure 20).
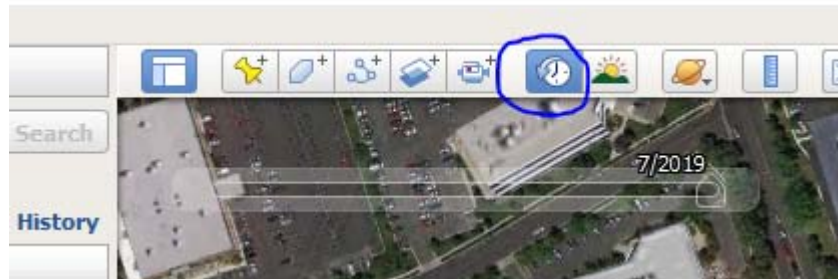
Figure 20: Historical Imagery Tool

Saving the File

Once you are done searching, either temporarily or permanently, save the folder by right clicking it and selecting Save Place As. Saving it as a kmz file will allow you to share your progress with other people. If you do not delete the folder from the My Places section of the Places Pane in Google Earth Pro it will remain on your computer even after you have exited the program. However, remember to save the file regularly to ensure that you do not lose any progress.

Step 4: Report and Share Results

Once the search has been completed, the final kmz file can be used to check each location to verify that it is a low head dam. Double clicking the pin in the Places pane of Google Earth will automatically take you to that location as well as the zoom that was used when the pin was created. This will allow for you or others to easily check the potential locations. Also, the file may be shared with any people that require or request the information.

Appendix 1: Additional Instruction

This section is to explain some steps in more detail for those unfamiliar with the process.

Model Builder

Model builder can be used to perform multiple tools at once. To access it go to the project toolbox in the Catalog Pane and right click. Select new and then Model as shown in Figure 21.

Once in Model builder you can drag in files from either the Contents or Catalog pane. You may then search for tools to use by using the Tool drop down menu in the Ribbon, or by beginning to type the name of the tool. Double click on the tool you desire, and it will appear in the Model. Each tool has different settings that must be satisfied to run. Some require only inputs, such as the merge tool. Others require clauses such as the select tool. If you have questions regarding how to use a specific tool, use the help button (a question mark located in the upper right-hand corner of the dialogue box for each tool.

Figure 21: Create a New Model

Create a new Feature Class

To create a new feature class, navigate to the project geodatabase under the databases section of the Catalog Pane. Right click, select new and then feature class (Figure 23).

You have to name the new feature class and select the type of feature you desire. For the purposes of this document, use only line feature classes. There are other settings that can be changed but are not necessary for the extent of this project. Once the Feature Class has been created it will appear under the drop down of the project geodatabase (Figure 22).
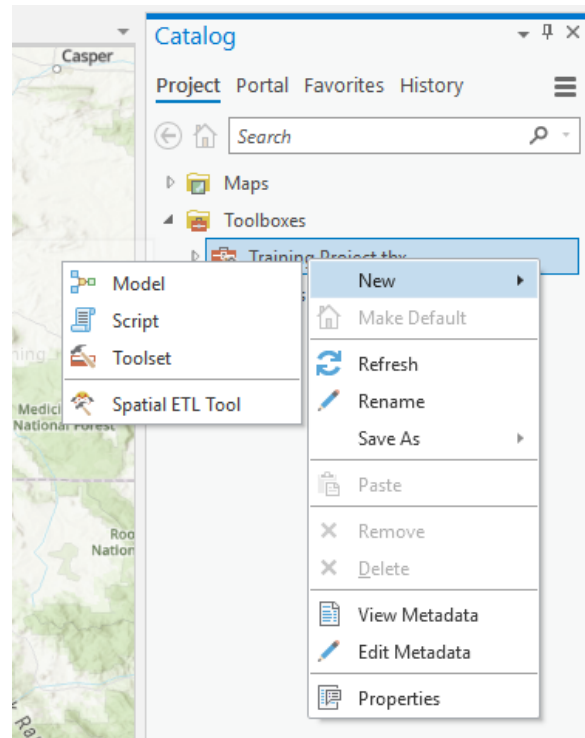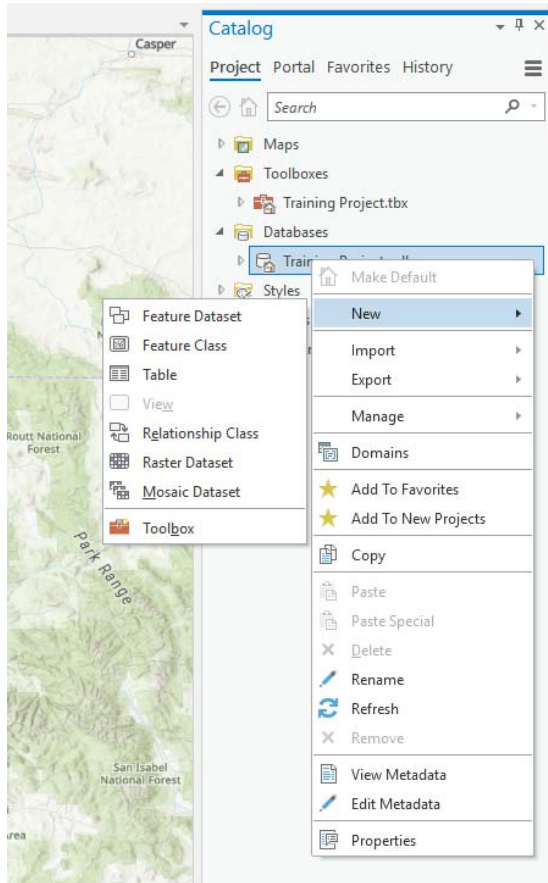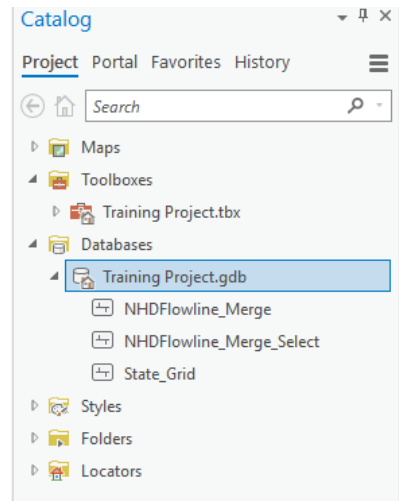
Figure 23: Creating a New Feature Class

Figure 22: Location of New Feature Class